PMIx10^{18}

Process Management Interface for Exascale (PMIx) Standard

Version 3.2 (Draft)

Created on August 25, 2020

This document describes the Process Management Interface for Exascale (PMIx) Standard, version 3.2 (Draft).

Comments: Please provide comments on the PMIx Standard by filing issues on the document repository https://github.com/pmix/pmix-standard/issues or by sending them to the PMIx Community mailing list at https://groups.google.com/forum/#!forum/pmix. Comments should include the version of the PMIx standard you are commenting about, and the page, section, and line numbers that you are referencing. Please note that messages sent to the mailing list from an unsubscribed e-mail address will be ignored.

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Contents

CHAPTER 1

Introduction

1   The Process Management Interface (PMI) has been used for quite some time as a means of
2   exchanging wireup information needed for inter-process communication. Two versions (PMI-1 and
3   PMI-2) have been released as part of the MPICH effort, with PMI-2 demonstrating better scaling
4   properties than its PMI-1 predecessor. However, two significant challenges face the High
5   Performance Computing (HPC) community as it continues to move towards machines capable of
6   exaflop and higher performance levels:

7   • the physical scale of the machines, and the corresponding number of total processes they support,
8   is expected to reach levels approaching 1 million processes executing across 100 thousand nodes.
9   Prior methods for initiating applications relied on exchanging communication endpoint
10   information between the processes, either directly or in some form of hierarchical collective
11   operation. Regardless of the specific mechanism employed, the exchange across such large
12   applications would consume considerable time, with estimates running in excess of 5-10
13   minutes; and

14 • whether it be hybrid applications that combine OpenMP threading operations with MPI, or
15   application-steered workflow computations, the HPC community is experiencing an
16   unprecedented wave of new approaches for computing at exascale levels. One common thread
17   across the proposed methods is an increasing need for orchestration between the application and
18   the system management software stack (SMS) comprising the scheduler (a.k.a. the workload
19   manager (WLM)), the resource manager (RM), global file system, fabric, and other subsystems.
20   The lack of available support for application-to-SMS integration has forced researchers to
21   develop "virtual" environments that hide the SMS behind a customized abstraction layer, but this
22   results in considerable duplication of effort and a lack of portability.

23 Process Management Interface - Exascale (PMIx) represents an attempt to resolve these questions
24 by providing an extended version of the PMI definitions specifically designed to support clusters up
25 to exascale and larger sizes. The overall objective of the project is not to branch the existing
26 definitions – in fact, PMIx fully supports both of the existing PMI-1 and PMI-2 Application
27 Programming Interfaces (APIs) – but rather to:

28 a) add flexibility to the existing APIs by adding an array of key-value "attribute" pairs to each API
29   signature that allows implementers to customize the behavior of the API as future needs emerge
30   without having to alter or create new variants of it;
31 b) add new APIs that provide extended capabilities such as asynchronous event notification plus
32   dynamic resource allocation and management;

c) establish a collaboration between SMS subsystem providers including resource manager, fabric, file system, and programming library developers to define integration points between the various subsystems as well as agreed upon definitions for associated APIs, attribute names, and data types;

d) form a standards-like body for the definitions; and

e) provide a reference implementation of the PMIx standard.

Complete information about the PMIx standard and affiliated projects can be found at the PMIx web site: https://pmix.org

1.1 Charter

The charter of the PMIx community is to:

- Define a set of agnostic APIs (not affiliated with any specific programming model or code base) to support interactions between application processes and the SMS.

- Develop an open source (non-copy-left licensed) standalone "reference" library implementation to facilitate adoption of the PMIx standard.

- Retain transparent backward compatibility with the existing PMI-1 and PMI-2 definitions, any future PMI releases, and across all PMIx versions.

- Support the "Instant On" initiative for rapid startup of applications at exascale and beyond.

- Work with the HPC community to define and implement new APIs that support evolving programming model requirements for application interactions with the SMS.

Participation in the PMIx community is open to anyone, and not restricted to only code contributors to the reference implementation.

1.2 PMIx Standard Overview

The PMIx Standard defines and describes the interface developed by the PMIx Reference Implementation (PRI). Much of this document is specific to the PMIx Reference Implementation (PRI)'s design and implementation. Specifically the standard describes the functionality provided by the PRI, and what the PRI requires of the clients and resource managers (RMs) that use it's interface.

1.2.1 Who should use the standard?

The PMIx Standard informs PMIx clients and RMs of the syntax and semantics of the PMIx APIs.

PMIx clients (e.g., tools, Message Passing Environment (MPE) libraries) can use this standard to understand the set of attributes provided by various APIs of the PRI and their intended behavior.

1 Additional information about the rationale for the selection of specific interfaces and attributes is
2 also provided.

3 PMIx-enabled RMs can use this standard to understand the expected behavior required of them
4 when they support various interfaces/attributes. In addition, optional features and suggestions on
5 behavior are also included in the discussion to help guide RM design and implementation.

1.2.2 What is defined in the standard?

7 The PMIx Standard defines and describes the interface developed by the PMIx Reference
8 Implementation (PRI). It defines the set of attributes that the PRI supports; the set of attributes that
9 are required of a RM to support, for a given interface; and the set of optional attributes that an RM
10 may choose to support, for a given interface.

1.2.3 What is *not* defined in the standard?

12 No standards body can require an implementer to support something in their standard, and PMIx is
13 no different in that regard. While an implementer of the PMIx library itself must at least include the
14 standard PMIx headers and instantiate each function, they are free to return "not supported" for any
15 function they choose not to implement.

16 This also applies to the host environments. Resource managers and other system management stack
17 components retain the right to decide on support of a particular function. The PMIx community
18 continues to look at ways to assist SMS implementers in their decisions by highlighting functions
19 that are critical to basic application execution (e.g., **PMIx_Get**), while leaving flexibility for
20 tailoring a vendor's software for their target market segment.

21 One area where this can become more complicated is regarding the attributes that provide
22 information to the client process and/or control the behavior of a PMIx standard API. For example,
23 the **PMIX_TIMEOUT** attribute can be used to specify the time (in seconds) before the requested
24 operation should time out. The intent of this attribute is to allow the client to avoid "hanging" in a
25 request that takes longer than the client wishes to wait, or may never return (e.g., a **PMIx_Fence**
26 that a blocked participant never enters).

27 If an application (for example) truly relies on the **PMIX_TIMEOUT** attribute in a call to
28 **PMIx_Fence**, it should set the required flag in the **pmix_info_t** for that attribute. This informs
29 the library and its SMS host that it must return an immediate error if this attribute is not supported.
30 By not setting the flag, the library and SMS host are allowed to treat the attribute as optional,
31 ignoring it if support is not available.

32 It is therefore critical that users and application implementers:

33   a) consider whether or not a given attribute is required, marking it accordingly; and
34   b) check the return status on all PMIx function calls to ensure support was present and that the
35   request was accepted. Note that for non-blocking APIs, a return of **PMIX_SUCCESS** only
36   indicates that the request had no obvious errors and is being processed – the eventual callback
37   will return the status of the requested operation itself.

While a PMIx library implementer, or an SMS component server, may choose to support a particular PMIx API, they are not required to support every attribute that might apply to it. This would pose a significant barrier to entry for an implementer as there can be a broad range of applicable attributes to a given API, at least some of which may rarely be used. The PMIx community is attempting to help differentiate the attributes by indicating those that are generally used (and therefore, of higher importance to support) vs those that a "complete implementation" would support.

Note that an environment that does not include support for a particular attribute/API pair is not "incomplete" or of lower quality than one that does include that support. Vendors must decide where to invest their time based on the needs of their target markets, and it is perfectly reasonable for them to perform cost/benefit decisions when considering what functions and attributes to support.

The flip side of that statement is also true: Users who find that their current vendor does not support a function or attribute they require may raise that concern with their vendor and request that the implementation be expanded. Alternatively, users may wish to utilize the PMIx-based Reference RunTime Environment (PRRTE) as a "shim" between their application and the host environment as it might provide the desired support until the vendor can respond. Finally, in the extreme, one can exploit the portability of PMIx-based applications to change vendors.

1.2.4 General Guidance for PMIx Users and Implementors

The PMIx Standard defines the behavior of the PMIx Reference Implementation (PRI). A complete system harnessing the PMIx interface requires an agreement between the PMIx client, be it a tool or library, and the PMIx-enabled RM. The PRI acts as an intermediary between these two entities by providing a standard API for the exchange of requests and responses. The degree to which the PMIx client and the PMIx-enabled RM may interact needs to be defined by those developer communities. The PMIx standard can be used to define the specifics of this interaction.

PMIx clients (e.g., tools, MPE libraries) may find that they depend only on a small subset of interfaces and attributes to work correctly. PMIx clients are strongly advised to define a document itemizing the PMIx interfaces and associated attributes that are required for correct operation, and are optional but recommended for full functionality. The PMIx standard cannot define this list for all given PMIx clients, but such a list is valuable to RMs desiring to support these clients.

PMIx-enabled RMs may choose to implement a subset of the PMIx standard and/or define attributes beyond those defined herein. PMIx-enabled RMs are strongly advised to define a document itemizing the PMIx interfaces and associated attributes they support, with any annotations about behavior limitations. The PMIx standard cannot define this list for all given PMIx-enabled RMs, but such a list is valuable to PMIx clients desiring to support a broad range of PMIx-enabled RMs.

1.3 PMIx Architecture Overview

This section presents a brief overview of the PMIx Architecture [1]. Note that this is a conceptual model solely used to help guide the standards process — it does not represent a design requirement

on any PMIx implementation. Instead, the model is used by the PMIx community as a sounding
board for evaluating proposed interfaces and avoid unintentionally imposing constraints on
implementers. Built into the model are two guiding principles also reflected in the standard. First,
PMIx operates in the mode of a *messenger*, and not a *doer* — i.e., the role of PMIx is to provide
communication between the various participants, relaying requests and returning responses. The
intent of the standard is not to suggest that PMIx itself actually perform any of the defined
operations — this is left to the various SMS elements and/or the application. Any exceptions to that
intent are left to the discretion of the particular implementation.
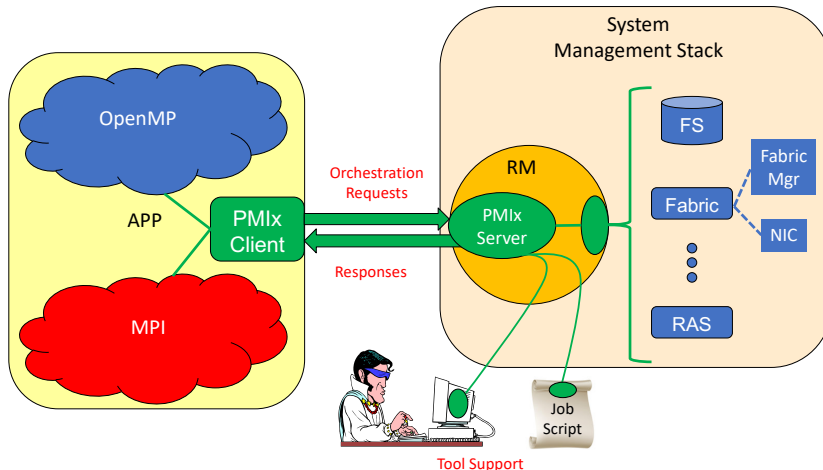
Figure 1.1.: PMIx-SMS Interactions

Thus, as the diagram in Fig. 1.1 shows, the application is built against a PMIx client library that
contains the client-side APIs, attribute definitions, and communication support for interacting with
the local PMIx server. Intra-process cross-library interactions are supported at the client level to
avoid unnecessary burdens on the server. Orchestration requests are sent to the local PMIx server,
which subsequently passes them to the host SMS (here represented by an RM daemon) using the
PMIx server callback functions the host SMS registered during PMIx_server_init. The host SMS
can indicate its lack of support for any operation by simply providing a *NULL* for the associated
callback function, or can create a function entry that returns *not supported* when called.

The conceptual model places the burden of fulfilling the request on the host SMS. This includes
performing any inter-node communications, or interacting with other SMS elements. Thus, a client
request for a network traffic report does not go directly from the client to the Fabric Manager (FM),
but instead is relayed to the PMIx server, and then passed to the host SMS for execution. This
architecture reflects the second principle underlying the standard — namely, that connectivity is to
be minimized by channeling all application interactions with the SMS through the local PMIx
server.

Recognizing the burden this places on SMS vendors, the PMIx community has included interfaces

by which the host can request support from local SMS elements. Once the SMS has transferred the request to an appropriate location, a PMIx server interface can be used to pass the request between SMS subsystems. For example, a request for network traffic statistics can utilize the PMIx networking abstractions to retrieve the information from the FM. This reduces the portability and interoperability issues between the individual subsystems by transferring the burden of defining the interoperable interfaces from the SMS subsystems to the PMIx community, which continues to work with those providers to develop the necessary support.

Tools, whether standalone or embedded in job scripts, are an exception to the communication rule and can connect to any PMIx server providing they are given adequate rendezvous information. The PMIx conceptual model views the collection of PMIx servers as a cloud-like conglomerate — i.e., orchestration and information requests can be given to any server regardless of location. However, tools frequently execute on locations that may not house an operating PMIx server — e.g., a users notebook computer. Thus, tools need the ability to remotely connect to the PMIx server "cloud".

The scope of the PMIx standard therefore spans the range of these interactions, between client-and-SMS and between SMS subsystems. Note again that this does not impose a requirement on any given PMIx implementation to cover the entire range — implementers are free to return *not supported* from any PMIx function.

1.3.1 The PMIx Reference Implementation (PRI)

The PMIx community has committed to providing a complete, reference implementation of each version of the standard. Note that the definition of the PMIx Standard is not contingent upon use of the PMIx Reference Implementation (PRI) — any implementation that supports the defined APIs is a PMIx Standard compliant implementation. The PRI is provided solely for the following purposes:

- Validation of the standard.
  No proposed change and/or extension to the PMIx standard is accepted without an accompanying prototype implementation in the PRI. This ensures that the proposal has undergone at least some minimal level of scrutiny and testing before being considered.

- Ease of adoption.
  The PRI is designed to be particularly easy for resource managers (and the SMS in general) to adopt, thus facilitating a rapid uptake into that community for application portability. Both client and server PMIx libraries are included, along with examples of client usage and server-side integration. A list of supported environments and versions is maintained on the PMIx web site https://pmix.org/support/faq/what-apis-are-supported-on-my-rm/

The PRI does provide some internal implementations that lie outside the scope of the PMIx standard. This includes several convenience macros as well as support for consolidating collectives for optimization purposes (e.g., the PMIx server aggregates all local **PMIx_Fence** calls before passing them to the SMS for global execution). In a few additional cases, the PMIx community (in partnership with the SMS subsystem providers) have determined that a base level of support for a given operation can best be portably provided by including it in the PRI.

Instructions for downloading, and installing the PRI are available on the community's web site https://pmix.org/code/getting-the-reference-implementation/.The PRI targets support for the Linux operating system. A reasonable effort is made to support all major, modern Linux distributions; however, validation is limited to the most recent 2-3 releases of RedHat Enterprise Linux (RHEL), Fedora, CentOS, and SUSE Linux Enterprise Server (SLES). In addition, development support is maintained for Mac OSX. Production support for vendor-specific operating systems is included as provided by the vendor.

1.3.2 The PMIx Reference RunTime Environment (PRRTE)

The PMIx community has also released PRRTE — i.e., a runtime environment containing the reference implementation and capable of operating within a host SMS. PRRTE provides an easy way of exploring PMIx capabilities and testing PMIx-based applications outside of a PMIx-enabled environment by providing a "shim" between the application and the host environment that includes full support for the PRI. The intent of PRRTE is not to replace any existing production environment, but rather to enable developers to work on systems that do not yet feature a PMIx-enabled host SMS or one that lacks a PMIx feature of interest. Instructions for downloading, installing, and using PRRTE are available on the community's web site https://pmix.org/code/getting-the-pmix-reference-server/

1.4 Organization of this document

The remainder of this document is structured as follows:

- Introduction and Overview in Chapter 1 on page 1
- Terms and Conventions in Chapter 2 on page 13
- Data Structures and Types in Chapter 3 on page 18
- PMIx Initialization and Finalization in Chapter 4 on page 99
- Key/Value Management in Chapter 5 on page 112
- Process Management in Chapter 6 on page 141
- Job Management in Chapter 7 on page 166
- Event Notification in Chapter 8 on page 196
- Data Packing and Unpacking in Chapter 9 on page 205
- PMIx Server Specific Interfaces in Chapter 11 on page 220

1.5 Version 1.0: June 12, 2015

The PMIx version 1.0 *ad hoc* standard was defined in the PMIx Reference Implementation (PRI) header files as part of the PRI v1.0.0 release prior to the creation of the formal PMIx 2.0 standard. Below are a summary listing of the interfaces defined in the 1.0 headers.

- Client APIs
  - PMIx_Init, **PMIx_Initialized**, **PMIx_Abort**, **PMIx_Finalize**
  - **PMIx_Put**, **PMIx_Commit**,
  - **PMIx_Fence**, **PMIx_Fence_nb**
  - **PMIx_Get**, **PMIx_Get_nb**
  - **PMIx_Publish**, **PMIx_Publish_nb**
  - **PMIx_Lookup**, **PMIx_Lookup**
  - **PMIx_Unpublish**, **PMIx_Unpublish_nb**
  - **PMIx_Spawn**, **PMIx_Spawn_nb**
  - **PMIx_Connect**, **PMIx_Connect_nb**
  - **PMIx_Disconnect**, **PMIx_Disconnect_nb**
  - **PMIx_Resolve_nodes**, **PMIx_Resolve_peers**
- Server APIs
  - **PMIx_server_init**, **PMIx_server_finalize**
  - **PMIx_generate_regex**, **PMIx_generate_ppn**
  - **PMIx_server_register_nspace**, **PMIx_server_deregister_nspace**
  - **PMIx_server_register_client**, **PMIx_server_deregister_client**
  - **PMIx_server_setup_fork**, **PMIx_server_dmodex_request**
- Common APIs
  - **PMIx_Get_version**, **PMIx_Store_internal**, **PMIx_Error_string**
  - PMIx_Register_errhandler, PMIx_Deregister_errhandler, PMIx_Notify_error

The **PMIx_Init** API was subsequently modified in the PRI release v1.1.0.

1.6 Version 2.0: Sept. 2018

The following APIs were introduced in v2.0 of the PMIx Standard:

- Client APIs

  - **PMIx_Query_info_nb**, **PMIx_Log_nb**

  - **PMIx_Allocation_request_nb**, **PMIx_Job_control_nb**,
    PMIx_Process_monitor_nb, **PMIx_Heartbeat**

- Server APIs

  - **PMIx_server_setup_application**, **PMIx_server_setup_local_support**

- Tool APIs

  - **PMIx_tool_init**, **PMIx_tool_finalize**

- Common APIs

  - **PMIx_Register_event_handler**, **PMIx_Deregister_event_handler**

  - **PMIx_Notify_event**

  - **PMIx_Proc_state_string**, **PMIx_Scope_string**

  - **PMIx_Persistence_string**, **PMIx_Data_range_string**

  - **PMIx_Info_directives_string**, **PMIx_Data_type_string**

  - **PMIx_Alloc_directive_string**

  - **PMIx_Data_pack**, **PMIx_Data_unpack**, **PMIx_Data_copy**

  - **PMIx_Data_print**, **PMIx_Data_copy_payload**

The **PMIx_Init** API was modified in v2.0 of the standard from its *ad hoc* v1.0 signature to
include passing of a **pmix_info_t** array for flexibility and "future-proofing" of the API. In
addition, the PMIx_Notify_error, PMIx_Register_errhandler, and PMIx_Deregister_errhandler
APIs were replaced.

1.7 Version 2.1: Dec. 2018

The v2.1 update includes clarifications and corrections from the v2.0 document, plus addition of
examples:

- Clarify description of **PMIx_Connect** and **PMIx_Disconnect** APIs.

- Explain that values for the **PMIX_COLLECTIVE_ALGO** are environment-dependent

- Identify the namespace/rank values required for retrieving attribute-associated information using
  the **PMIx_Get** API

- Provide definitions for **session**, **job**, **application**, and other terms used throughout the
  document

1 • Clarify definitions of **PMIX_UNIV_SIZE** versus **PMIX_JOB_SIZE**

2 • Clarify server module function return values

3 • Provide examples of the use of **PMIx_Get** for retrieval of information

4 • Clarify the use of **PMIx_Get** versus **PMIx_Query_info_nb**

5 • Clarify return values for non-blocking APIs and emphasize that callback functions must not be
6   invoked prior to return from the API

7 • Provide detailed example for construction of the **PMIx_server_register_nspace** input
8   information array

9 • Define information levels (e.g., **session** vs **job**) and associated attributes for both storing and
10   retrieving values

11 • Clarify roles of PMIx server library and host environment for collective operations

12 • Clarify definition of **PMIX_UNIV_SIZE**

13 1.8 Version 2.2: Jan 2019

14   The v2.2 update includes the following clarifications and corrections from the v2.1 document:

15 • Direct modex upcall function (**pmix_server_dmodex_req_fn_t**) cannot complete
16   atomically as the API cannot return the requested information except via the provided callback
17   function

18 • Add missing **pmix_data_array_t** definition and support macros

19 • Add a rule divider between implementer and host environment required attributes for clarity

20 • Add **PMIX_QUERY_QUALIFIERS_CREATE** macro to simplify creation of **pmix_query_t**
21   qualifiers

22 • Add **PMIX_APP_INFO_CREATE** macro to simplify creation of **pmix_app_t** directives

23 • Add flag and **PMIX_INFO_IS_END** macro for marking and detecting the end of a
24   **pmix_info_t** array

25 • Clarify the allowed hierarchical nesting of the **PMIX_SESSION_INFO_ARRAY**,
26   **PMIX_JOB_INFO_ARRAY**, and associated attributes

27 1.9 Version 3.0: Dec. 2018

28   The following APIs were introduced in v3.0 of the PMIx Standard:

29 • Client APIs

30   – **PMIx_Log**, **PMIx_Job_control**

- – **PMIx_Allocation_request**, **PMIx_Process_monitor**
  - – **PMIx_Get_credential**, **PMIx_Validate_credential**
- Server APIs
  - – **PMIx_server_IOF_deliver**
  - – **PMIx_server_collect_inventory**, **PMIx_server_deliver_inventory**
- Tool APIs
  - – **PMIx_IOF_pull**, **PMIx_IOF_push**, **PMIx_IOF_deregister**
  - – **PMIx_tool_connect_to_server**
- Common APIs
  - – **PMIx_IOF_channel_string**

The document added a chapter on security credentials, a new section for Input/Output (IO) forwarding to the Process Management chapter, and a few blocking forms of previously-existing non-blocking APIs. Attributes supporting the new APIs were introduced, as well as additional attributes for a few existing functions.

1.10 Version 3.1: Jan. 2019

The v3.1 update includes clarifications and corrections from the v3.0 document:

- Direct modex upcall function (**pmix_server_dmodex_req_fn_t**) cannot complete atomically as the API cannot return the requested information except via the provided callback function
- Fix typo in name of **PMIX_FWD_STDDIAG** attribute
- Correctly identify the information retrieval and storage attributes as "new" to v3 of the standard
- Add missing **pmix_data_array_t** definition and support macros
- Add a rule divider between implementer and host environment required attributes for clarity
- Add **PMIX_QUERY_QUALIFIERS_CREATE** macro to simplify creation of **pmix_query_t** qualifiers
- Add **PMIX_APP_INFO_CREATE** macro to simplify creation of **pmix_app_t** directives
- Add new attributes to specify the level of information being requested where ambiguity may exist (see 3.4.11)
- Add new attributes to assemble information by its level for storage where ambiguity may exist (see 3.4.12)

1　• Add flag and **PMIX_INFO_IS_END** macro for marking and detecting the end of a
2　　**pmix_info_t** array

3　• Clarify that **PMIX_NUM_SLOTS** is duplicative of (a) **PMIX_UNIV_SIZE** when used at the
4　　**session** level and (b) **PMIX_MAX_PROCS** when used at the **job** and **application** levels,
5　　but leave it in for backward compatibility.

6　• Clarify difference between **PMIX_JOB_SIZE** and **PMIX_MAX_PROCS**

7　• Clarify that **PMIx_server_setup_application** must be called per-**job** instead of
8　　per-**application** as the name implies. Unfortunately, this is a historical artifact. Note that
9　　both **PMIX_NODE_MAP** and **PMIX_PROC_MAP** must be included as input in the *info* array
10　　provided to that function. Further descriptive explanation of the "instant on" procedure will be
11　　provided in the next version of the PMIx Standard.

12　• Clarify how the PMIx server expects data passed to the host by
13　　**pmix_server_fencenb_fn_t** should be aggregated across nodes, and provide a code
14　　snippet example

1.11　Version 3.2: Sept. 2020

16　The v3.2 update includes clarifications and corrections from the v3.1 document:

17　• Correct an error in the **PMIx_Allocation_request** function signature, and clarify the
18　　allocation ID attributes

19　• Rename the **PMIX_ALLOC_ID** attribute to **PMIX_ALLOC_REQ_ID** to clarify that this is a
20　　string the user provides as a means to identify their request to query status

21　• Add a new **PMIX_ALLOC_ID** attribute that contains the identifier (provided by the host
22　　environment) for the resulting allocation which can later be used to reference the allocated
23　　resources in, for example, a call to **PMIx_Spawn**

24　• Update the **PMIx_generate_regex** and **PMIx_generate_ppn** descriptions to clarify
25　　that the output from these generator functions may not be a NULL-terminated string, but instead
26　　could be a byte array of arbitrary binary content.

27　• Add a new **PMIX_REGEX** constant that represents a regular expression data type.

PMIx Terms and Conventions

1   The PMIx Standard has adopted the widespread use of key-value *attributes* to add flexibility to the
2   functionality expressed in the existing APIs. Accordingly, the community has chosen to require that
3   the definition of each standard API include the passing of an array of attributes. These provide a
4   means of customizing the behavior of the API as future needs emerge without having to alter or
5   create new variants of it. In addition, attributes provide a mechanism by which researchers can
6   easily explore new approaches to a given operation without having to modify the API itself.

7   The PMIx community has further adopted a policy that modification of existing released APIs will
8   only be permitted under extreme circumstances. In its effort to avoid introduction of any such
9   backward incompatibility, the community has avoided the definitions of large numbers of APIs that
10   each focus on a narrow scope of functionality, and instead relied on the definition of fewer generic
11   APIs that include arrays of directives for "tuning" the function's behavior. Thus, modifications to
12   the PMIx standard increasingly consist of the definition of new attributes along with a description
13   of the APIs to which they relate and the expected behavior when used with those APIs.

14   One area where this can become more complicated relates to the attributes that provide directives to
15   the client process and/or control the behavior of a PMIx standard API. For example, the
16   `PMIX_TIMEOUT` attribute can be used to specify the time (in seconds) before the requested
17   operation should time out. The intent of this attribute is to allow the client to avoid hanging in a
18   request that takes longer than the client wishes to wait, or may never return (e.g., a `PMIx_Fence`
19   that a blocked participant never enters).

20   If an application truly relies on the `PMIX_TIMEOUT` attribute in a call to `PMIx_Fence`, it should
21   set the *required* flag in the `pmix_info_t` for that attribute. This informs the library and its SMS
22   host that it must return an immediate error if this attribute is not supported. By not setting the flag,
23   the library and SMS host are allowed to treat the attribute as optional, silently ignoring it if support
24   is not available.

———————————————— Advice to users ————————————————

25   It is critical that users and application developers consider whether or not a given attribute is
26   required (marking it accordingly) and always check the return status on all PMIx function calls to
27   ensure support was present and that the request was accepted. Note that for non-blocking APIs, a
28   return of `PMIX_SUCCESS` only indicates that the request had no obvious errors and is being
29   processed. The eventual callback will return the status of the requested operation itself.

While a PMIx library implementer, or an SMS component server, may choose to support a particular PMIx API, they are not required to support every attribute that might apply to it. This would pose a significant barrier to entry for an implementer as there can be a broad range of applicable attributes to a given API, at least some of which may rarely be used in a specific market area. The PMIx community is attempting to help differentiate the attributes by indicating in the standard those that are generally used (and therefore, of higher importance to support) versus those that a "complete implementation" would support.

In addition, the document refers to the following entities and process stages when describing use-cases or operations involving PMIx:

- *session* refers to an allocated set of resources assigned to a particular user by the system WLM. Historically, HPC sessions have consisted of a static allocation of resources - i.e., a block of resources are assigned to a user in response to a specific request and managed as a unified collection. However, this is changing in response to the growing use of dynamic programming models that require on-the-fly allocation and release of system resources. Accordingly, the term *session* in this document refers to the current block of assigned resources and is a potentially dynamic entity.

- *slot* refers to an allocated entry for a process. WLMs frequently allocate entire nodes to a *session*, but can also be configured to define the maximum number of processes that can simultaneously be executed on each node. This often corresponds to the number of hardware Processing Units (PUs) (typically cores, but can also be defined as hardware threads) on the node. However, the correlation between hardware PUs and slot allocations strictly depends upon system configuration.

- *job* refers to a set of one or more *applications* executed as a single invocation by the user within a session. For example, "*mpiexec -n 1 app1 : -n 2 app2*" is considered a single Multiple Program Multiple Data (MPMD) job containing two applications.

- *namespace* refers to a character string value assigned by the RM to a *job*. All *applications* executed as part of that *job* share the same *namespace*. The *namespace* assigned to each *job* must be unique within the scope of the governing RM.

- *application* refers to a single executable (binary, script, etc.) member of a *job*. Applications consist of one or more *processes*, either operating independently or in parallel at any given time during their execution.

- *rank* refers to the numerical location (starting from zero) of a process within the defined scope. Thus, global rank is the rank of a process within its *job*, while *application rank* is the rank of that process within its *application*.

- *workflow* refers to an orchestrated execution plan frequently spanning multiple *jobs* carried out under the control of a *workflow manager* process. An example workflow might first execute a computational job to generate the flow of liquid through a complex cavity, followed by a visualization job that takes the output of the first job as its input to produce an image output.

- *resource manager* is used in a generic sense to represent the system that will host the PMIx server library. This could be a vendor's RM, a programming library's RunTime Environment (RTE), or some other agent.

- *host environment* is used interchangeably with *resource manager* to refer to the process hosting the PMIx server library.

This document borrows freely from other standards (most notably from the Message Passing Interface (MPI) and OpenMP standards) in its use of notation and conventions in an attempt to reduce confusion. The following sections provide an overview of the conventions used throughout the PMIx Standard document.

2.1 Notational Conventions

Some sections of this document describe programming language specific examples or APIs. Text that applies only to programs for which the base language is C is shown as follows:

──────────────── C ────────────────

C specific text...

```
int foo = 42;
```

──────────────── C ────────────────

Some text is for information only, and is not part of the normative specification. These take several forms, described in their examples below:

Note: General text...

----------------- Rationale -----------------

Throughout this document, the rationale for the design choices made in the interface specification is set off in this section. Some readers may wish to skip these sections, while readers interested in interface design may want to read them carefully.

──────────────── Advice to users ────────────────

Throughout this document, material aimed at users and that illustrates usage is set off in this section. Some readers may wish to skip these sections, while readers interested in programming with the PMIx API may want to read them carefully.

1 Throughout this document, material that is primarily commentary to PMIx library implementers is
2 set off in this section. Some readers may wish to skip these sections, while readers interested in
3 PMIx implementations may want to read them carefully.

4 Throughout this document, material that is primarily commentary aimed at host environments (e.g.,
5 RMs and RTEs) providing support for the PMIx server library is set off in this section. Some
6 readers may wish to skip these sections, while readers interested in integrating PMIx servers into
7 their environment may want to read them carefully.

8 2.2 Semantics

9 The following terms will be taken to mean:

10 • *shall*, *must* and *will* indicate that the specified behavior is *required* of all conforming
11   implementations

12 • *should* and *may* indicate behaviors that a complete implementation would include, but are not
13   required of all conforming implementations

14 2.3 Naming Conventions

15 The PMIx standard has adopted the following conventions:

16 • PMIx constants and attributes are prefixed with **PMIX**.

17 • Structures and type definitions are prefixed with **pmix**.

18 • Underscores are used to separate words in a function or variable name.

19 • Lowercase letters are used in PMIx client APIs except for the PMIx prefix (noted below) and the
20   first letter of the word following it. For example, **PMIx_Get_version**.

21 • PMIx server and tool APIs are all lower case letters following the prefix - e.g.,
22   **PMIx_server_register_nspace**.

23 • The **PMIx_** prefix is used to denote functions.

24 • The **pmix_** prefix is used to denote function pointer and type definitions.

25 Users should not use the **PMIX**, **PMIx**, or **pmix** prefixes in their applications or libraries so as to
26 avoid symbol conflicts with current and later versions of the PMIx standard and implementations
27 such as the PRI.

2.4 Procedure Conventions

While the current PMIx Reference Implementation (PRI) is solely based on the C programming language, it is not the intent of the PMIx Standard to preclude the use of other languages. Accordingly, the procedure specifications in the PMIx Standard are written in a language-independent syntax with the arguments marked as IN, OUT, or INOUT. The meanings of these are:

- IN: The call may use the input value but does not update the argument from the perspective of the caller at any time during the calls execution,

- OUT: The call may update the argument but does not use its input value

- INOUT: The call may both use and update the argument.

2.5 Standard vs Reference Implementation

The *PMIx Standard* is implementation independent. The *PMIx Reference Implementation* (PRI) is one implementation of the Standard and the PMIx community strives to ensure that it fully implements the Standard. Given its role as the community's testbed and its widespread use, this document cites the attributes supported by the PRI for each API where relevant by marking them in red. This is not meant to imply nor confer any special role to the PRI with respect to the Standard itself, but instead to provide a convenience to users of the Standard and PRI.

Similarly, the *PMIx Reference RunTime Environment* (PRRTE) is provided by the community to enable users operating in non-PMIx environments to develop and execute PMIx-enabled applications and tools. Attributes supported by the PRRTE are marked in green.

CHAPTER 3

Data Structures and Types

1   This chapter defines PMIx standard data structures (along with macros for convenient use), types,
2   and constants. These apply to all consumers of the PMIx interface. Where necessary for
3   clarification, the description of, for example, an attribute may be copied from this chapter into a
4   section where it is used.

5   A PMIx implementation may define additional attributes beyond those specified in this document.

—————————————— Advice to PMIx library implementers ——————————————

6   Structures, types, and macros in the PMIx Standard are defined in terms of the C-programming
7   language. Implementers wishing to support other languages should provide the equivalent
8   definitions in a language-appropriate manner.

9   If a PMIx implementation chooses to define additional attributes they should avoid using the **PMIX**
10 prefix in their name or starting the attribute string with a *pmix* prefix. This helps the end user
11 distinguish between what is defined by the PMIx standard and what is specific to that PMIx
12 implementation, and avoids potential conflicts with attributes defined by the standard.

—————————————————— Advice to users ——————————————————

13 Use of increment/decrement operations on indices inside PMIx macros is discouraged due to
14 unpredictable behavior. For example, the following sequence:

```
15  PMIX_INFO_LOAD(&array[n++], "mykey", &mystring, PMIX_STRING);
16  PMIX_INFO_LOAD(&array[n++], "mykey2", &myint, PMIX_INT);
```

17 will load the given key-values into incorrect locations if the macro is implemented as:

```
18  define PMIX_INFO_LOAD(m, k, v, t)                            \
19    do {                                                      \
20      if (NULL != (k)) {                                      \
21        pmix_strncpy((m)->key, (k), PMIX_MAX_KEYLEN);        \
22      }                                                       \
23      (m)->flags = 0;                                         \
24      pmix_value_load(&((m)->value), (v), (t));              \
25    } while (0)
```

26 since the index is cited more than once in the macro. The PMIx standard only governs the existence
27 and syntax of macros - it does not specify their implementation. Given the freedom of
28 implementation, a safer call sequence might be as follows:

18

```
1       PMIX_INFO_LOAD(&array[n], "mykey", &mystring, PMIX_STRING);
2       ++n;
3       PMIX_INFO_LOAD(&array[n], "mykey2", &myint, PMIX_INT);
4       ++n;
```

3.1 Constants

6   PMIx defines a few values that are used throughout the standard to set the size of fixed arrays or as
7   a means of identifying values with special meaning. The community makes every attempt to
8   minimize the number of such definitions. The constants defined in this section may be used before
9   calling any PMIx library initialization routine. Additional constants associated with specific data
10   structures or types are defined in the section describing that data structure or type.

11   **PMIX_MAX_NSLEN**   Maximum namespace string length as an integer.

——————————————— Advice to PMIx library implementers ———————————————

12   **PMIX_MAX_NSLEN** should have a minimum value of 63 characters. Namespace arrays in PMIx
13   defined structures must reserve a space of size **PMIX_MAX_NSLEN**+1 to allow room for the **NULL**
14   terminator

15   **PMIX_MAX_KEYLEN**   Maximum key string length as an integer.

——————————————— Advice to PMIx library implementers ———————————————

16   **PMIX_MAX_KEYLEN** should have a minimum value of 63 characters. Key arrays in PMIx defined
17   structures must reserve a space of size **PMIX_MAX_KEYLEN**+1 to allow room for the **NULL**
18   terminator

3.1.1 PMIx Error Constants

The **`pmix_status_t`** structure is an **`int`** type for return status.

The tables shown in this section define the possible values for **`pmix_status_t`**. PMIx errors are required to always be negative, with 0 reserved for **`PMIX_SUCCESS`**. Values in the list that were deprecated in later standards are denoted as such. Values added to the list in this version of the standard are shown in **magenta**.

---------------------------- Advice to PMIx library implementers ----------------------------

A PMIx implementation must define all of the constants defined in this section, even if they will never return the specific value to the caller.

---------------------------- Advice to users ----------------------------

Other than **`PMIX_SUCCESS`** (which is required to be zero), the actual value of any PMIx error constant is left to the PMIx library implementer. Thus, users are advised to always refer to constant by name, and not a specific implementation's value, for portability between implementations and compatibility across library versions.

3.1.1.1 General Error Constants

These are general constants originally defined in versions 1 and 2 of the PMIx Standard.

`PMIX_SUCCESS`   Success
`PMIX_ERROR`   General Error
`PMIX_ERR_SILENT`   Silent error
`PMIX_ERR_DEBUGGER_RELEASE`   Error in debugger release
`PMIX_ERR_PROC_RESTART`   Fault tolerance: Error in process restart
`PMIX_ERR_PROC_CHECKPOINT`   Fault tolerance: Error in process checkpoint
`PMIX_ERR_PROC_MIGRATE`   Fault tolerance: Error in process migration
`PMIX_ERR_PROC_ABORTED`   Process was aborted
`PMIX_ERR_PROC_REQUESTED_ABORT`   Process is already requested to abort
`PMIX_ERR_PROC_ABORTING`   Process is being aborted
`PMIX_ERR_SERVER_FAILED_REQUEST`   Failed to connect to the server
`PMIX_EXISTS`   Requested operation would overwrite an existing value
`PMIX_ERR_INVALID_CRED`   Invalid security credentials
`PMIX_ERR_HANDSHAKE_FAILED`   Connection handshake failed
`PMIX_ERR_READY_FOR_HANDSHAKE`   Ready for handshake
`PMIX_ERR_WOULD_BLOCK`   Operation would block
`PMIX_ERR_UNKNOWN_DATA_TYPE`   Unknown data type
`PMIX_ERR_PROC_ENTRY_NOT_FOUND`   Process not found
`PMIX_ERR_TYPE_MISMATCH`   Invalid type
`PMIX_ERR_UNPACK_INADEQUATE_SPACE`   Inadequate space to unpack data

1	**PMIX_ERR_UNPACK_FAILURE**	Unpack failed
2	**PMIX_ERR_PACK_FAILURE**	Pack failed
3	**PMIX_ERR_PACK_MISMATCH**	Pack mismatch
4	**PMIX_ERR_NO_PERMISSIONS**	No permissions
5	**PMIX_ERR_TIMEOUT**	Timeout expired
6	**PMIX_ERR_UNREACH**	Unreachable
7	**PMIX_ERR_IN_ERRNO**	Error defined in **errno**
8	**PMIX_ERR_BAD_PARAM**	Bad parameter
9	**PMIX_ERR_RESOURCE_BUSY**	Resource busy
10	**PMIX_ERR_OUT_OF_RESOURCE**	Resource exhausted
11	**PMIX_ERR_DATA_VALUE_NOT_FOUND**	Data value not found
12	**PMIX_ERR_INIT**	Error during initialization
13	**PMIX_ERR_NOMEM**	Out of memory
14	**PMIX_ERR_INVALID_ARG**	Invalid argument
15	**PMIX_ERR_INVALID_KEY**	Invalid key
16	**PMIX_ERR_INVALID_KEY_LENGTH**	Invalid key length
17	**PMIX_ERR_INVALID_VAL**	Invalid value
18	**PMIX_ERR_INVALID_VAL_LENGTH**	Invalid value length
19	**PMIX_ERR_INVALID_LENGTH**	Invalid argument length
20	**PMIX_ERR_INVALID_NUM_ARGS**	Invalid number of arguments
21	**PMIX_ERR_INVALID_ARGS**	Invalid arguments
22	**PMIX_ERR_INVALID_NUM_PARSED**	Invalid number parsed
23	**PMIX_ERR_INVALID_KEYVALP**	Invalid key/value pair
24	**PMIX_ERR_INVALID_SIZE**	Invalid size
25	**PMIX_ERR_INVALID_NAMESPACE**	Invalid namespace
26	**PMIX_ERR_SERVER_NOT_AVAIL**	Server is not available
27	**PMIX_ERR_NOT_FOUND**	Not found
28	**PMIX_ERR_NOT_SUPPORTED**	Not supported
29	**PMIX_ERR_NOT_IMPLEMENTED**	Not implemented
30	**PMIX_ERR_COMM_FAILURE**	Communication failure
31	**PMIX_ERR_UNPACK_READ_PAST_END_OF_BUFFER**	Unpacking past the end of the buffer
32		provided
33	**PMIX_ERR_LOST_CONNECTION_TO_SERVER**	Lost connection to server
34	**PMIX_ERR_LOST_PEER_CONNECTION**	Lost connection to peer
35	**PMIX_ERR_LOST_CONNECTION_TO_CLIENT**	Lost connection to client
36	**PMIX_QUERY_PARTIAL_SUCCESS**	Query partial success (used by query system)
37	**PMIX_NOTIFY_ALLOC_COMPLETE**	Notify that allocation is complete
38	**PMIX_JCTRL_CHECKPOINT**	Job control: Monitored by PMIx client to trigger checkpoint
39		operation
40	**PMIX_JCTRL_CHECKPOINT_COMPLETE**	Job control: Sent by PMIx client and monitored
41		by PMIx server to notify that requested checkpoint operation has completed.
42	**PMIX_JCTRL_PREEMPT_ALERT**	Job control: Monitored by PMIx client to detect an RM
43		intending to preempt the job.

| 1 | **PMIX_MONITOR_HEARTBEAT_ALERT** | Job monitoring: Heartbeat alert |

1   **PMIX_MONITOR_HEARTBEAT_ALERT**   Job monitoring: Heartbeat alert
2   **PMIX_MONITOR_FILE_ALERT**   Job monitoring: File alert
3   **PMIX_PROC_TERMINATED**   Process terminated - can be either normal or abnormal
4   termination
5   **PMIX_ERR_INVALID_TERMINATION**   Process terminated without calling
6   **PMIx_Finalize**, or was a member of an assemblage formed via **PMIx_Connect** and
7   terminated or called **PMIx_Finalize** without first calling **PMIx_Disconnect** (or its
8   non-blocking form) from that assemblage.

3.1.1.2 Operational Error Constants

10   **PMIX_ERR_EVENT_REGISTRATION**   Error in event registration
11   **PMIX_ERR_JOB_TERMINATED**   Error job terminated
12   **PMIX_ERR_UPDATE_ENDPOINTS**   Error updating endpoints
13   **PMIX_MODEL_DECLARED**   Model declared
14   **PMIX_GDS_ACTION_COMPLETE**   The global data storage (GDS) action has completed
15   **PMIX_ERR_INVALID_OPERATION**   The requested operation is supported by the
16   implementation and host environment, but fails to meet a requirement (e.g., requesting to
17   *disconnect* from processes without first *connecting* to them).
18   **PMIX_PROC_HAS_CONNECTED**   A tool or client has connected to the PMIx server
19   **PMIX_CONNECT_REQUESTED**   Connection has been requested by a PMIx-based tool
20   **PMIX_MODEL_RESOURCES**   Resource usage by a programming model has changed
21   **PMIX_OPENMP_PARALLEL_ENTERED**   An OpenMP parallel code region has been entered
22   **PMIX_OPENMP_PARALLEL_EXITED**   An OpenMP parallel code region has completed
23   **PMIX_LAUNCH_DIRECTIVE**   Launcher directives have been received from a PMIx-enabled
24   tool
25   **PMIX_LAUNCHER_READY**   Application launcher (e.g., mpiexec) is ready to receive directives
26   from a PMIx-enabled tool
27   **PMIX_OPERATION_IN_PROGRESS**   A requested operation is already in proigress
28   **PMIX_OPERATION_SUCCEEDED**   The requested operation was performed atomically - no
29   callback function will be executed

3.1.1.3 System error constants

31   **PMIX_ERR_NODE_DOWN**   Node down
32   **PMIX_ERR_NODE_OFFLINE**   Node is marked as offline
33   **PMIX_ERR_SYS_OTHER**   Mark the beginning of a dedicated range of constants for system
34   event reporting.

3.1.1.4 Event handler error constants

36   **PMIX_EVENT_NO_ACTION_TAKEN**   Event handler: No action taken
37   **PMIX_EVENT_PARTIAL_ACTION_TAKEN**   Event handler: Partial action taken
38   **PMIX_EVENT_ACTION_DEFERRED**   Event handler: Action deferred
39   **PMIX_EVENT_ACTION_COMPLETE**   Event handler: Action complete

3.1.1.5 User-Defined Error Constants

PMIx establishes an error code boundary for constants defined in the PMIx standard. Negative values larger than this (and any positive values greater than zero) are guaranteed not to conflict with PMIx values.
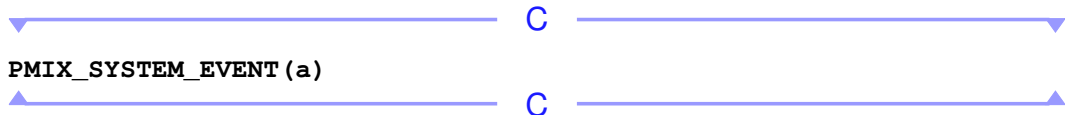
PMIX_EXTERNAL_ERR_BASE   A starting point for user-level defined error constants. Negative values lower than this are guaranteed not to conflict with PMIx values. Definitions should always be based on the **PMIX_EXTERNAL_ERR_BASE** constant and not a specific value as the value of the constant may change.

3.1.2 Macros for use with PMIx constants

3.1.2.1 Detect system event constant

Test a given error constant to see if it falls within the dedicated range of constants for system event reporting.

PMIx v2.2

```
PMIX_SYSTEM_EVENT(a)
```

IN   a
  Error constant to be checked (**pmix_status_t**)

Returns **true** if the provided values falls within the dedicated range of constants for system event reporting
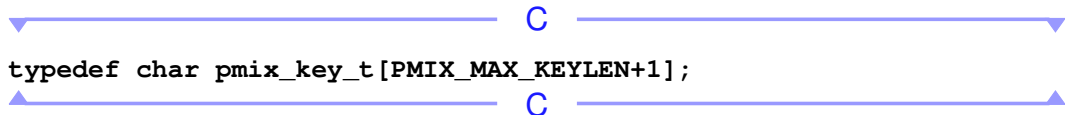
3.2 Data Types

This section defines various data types used by the PMIx APIs. The version of the standard in which a particular data type was introduced is shown in the margin.

3.2.1 Key Structure

The **pmix_key_t** structure is a statically defined character array of length **PMIX_MAX_KEYLEN**+1, thus supporting keys of maximum length **PMIX_MAX_KEYLEN** while preserving space for a mandatory **NULL** terminator.

PMIx v2.0

```
typedef char pmix_key_t[PMIX_MAX_KEYLEN+1];
```

Characters in the key must be standard alphanumeric values supported by common utilities such as *strcmp*.

---------- Advice to users ----------

References to keys in PMIx v1 rwere defined simply as an array of characters of size
PMIX_MAX_KEYLEN+1. The **pmix_key_t** type definition was introduced in version 2 of the
standard. The two definitions are code-compatible and thus do not represent a break in backward
compatibility.

Passing a **pmix_key_t** value to the standard *sizeof* utility can result in compiler warnings of
incorrect returned value. Users are advised to avoid using *sizeof(pmix_key_t)* and instead rely on
the **PMIX_MAX_KEYLEN** constant.

3.2.1.1 Key support macro

Compare the key in a **pmix_info_t** to a given value

PMIx v3.0 ──────────────── C ────────────────

```
PMIX_CHECK_KEY(a, b)
```
──────────────── C ────────────────

IN   a
    Pointer to the structure whose key is to be checked (pointer to **pmix_info_t**)
IN   b
    String value to be compared against (**char***)

Returns **true** if the key matches the given value

3.2.2 Namespace Structure

The **pmix_nspace_t** structure is a statically defined character array of length
PMIX_MAX_NSLEN+1, thus supporting namespaces of maximum length **PMIX_MAX_NSLEN**
while preserving space for a mandatory **NULL** terminator.

PMIx v2.0 ──────────────── C ────────────────

```
typedef char pmix_nspace_t[PMIX_MAX_NSLEN+1];
```
──────────────── C ────────────────

Characters in the namespace must be standard alphanumeric values supported by common utilities
such as *strcmp*.

1   References to namespace values in PMIx v1 rwere defined simply as an array of characters of size
2   **PMIX_MAX_NSLEN+1**. The **pmix_nspace_t** type definition was introduced in version 2 of the
3   standard. The two definitions are code-compatible and thus do not represent a break in backward
4   compatibility.

5   Passing a **pmix_nspace_t** value to the standard *sizeof* utility can result in compiler warnings of
6   incorrect returned value. Users are advised to avoid using *sizeof(pmix_nspace_t)* and instead rely
7   on the **PMIX_MAX_NSLEN** constant.

3.2.2.1 Namespace support macro

9   Compare the string in a **pmix_nspace_t** to a given value

PMIx v3.0 ———————————————————— C ————————————————————

10   **PMIX_CHECK_NSPACE(a, b)**

———————————————————— C ————————————————————

11 **IN   a**
12   Pointer to the structure whose value is to be checked (pointer to **pmix_nspace_t**)
13 **IN   b**
14   String value to be compared against (**char***)

15 Returns **true** if the namespace matches the given value

3.2.3 Rank Structure

17 The **pmix_rank_t** structure is a **uint32_t** type for rank values.

PMIx v1.0 ———————————————————— C ————————————————————

18   **typedef uint32_t pmix_rank_t;**

———————————————————— C ————————————————————

19 The following constants can be used to set a variable of the type **pmix_rank_t**. All definitions
20 were introduced in version 1 of the standard unless otherwise marked. Valid rank values start at
21 zero.

22 **PMIX_RANK_UNDEF**   A value to request job-level data where the information itself is not
23   associated with any specific rank, or when passing a **pmix_proc_t** identifier to an
24   operation that only references the namespace field of that structure.
25 **PMIX_RANK_WILDCARD**   A value to indicate that the user wants the data for the given key
26   from every rank that posted that key.
27 **PMIX_RANK_LOCAL_NODE**   Special rank value used to define groups of ranks. This constant
28   defines the group of all ranks on a local node.

1   **PMIX_RANK_LOCAL_PEERS**   Special rank value used to define groups of rankss. This
2   constant defines the group of all ranks on a local node within the same namespace as the
3   current process.
4   **PMIX_RANK_INVALID**   An invalid rank value.
5   **PMIX_RANK_VALID**   Define an upper boundary for valid rank values.

6 3.2.4 Process Structure

7   The **pmix_proc_t** structure is used to identify a single process in the PMIx universe. It contains
8   a reference to the namespace and the **pmix_rank_t** within that namespace.

PMIx v1.0 ▼ ──────────────── C ──────────────── ▼

```
9    typedef struct pmix_proc {
10       pmix_nspace_t nspace;
11       pmix_rank_t rank;
12   } pmix_proc_t;
```

▲ ──────────────── C ──────────────── ▲

13 3.2.5 Process structure support macros

14   The following macros are provided to support the **pmix_proc_t** structure.

15 3.2.5.1 Initialize the pmix_proc_t structure

16   **PMIX_PROC_CONSTRUCT**

17   Initialize the **pmix_proc_t** fields

PMIx v1.0 ▼ ──────────────── C ──────────────── ▼

18   **PMIX_PROC_CONSTRUCT(m)**

▲ ──────────────── C ──────────────── ▲

19   **IN   m**
20   Pointer to the structure to be initialized (pointer to **pmix_proc_t**)

21 3.2.5.2 Destruct the pmix_proc_t structure

22   There is nothing to release here as the fields in **pmix_proc_t** are all declared *static*. However,
23   the macro is provided for symmetry in the code and for future-proofing should some allocated field
24   be included some day.

3.2.5.3 Create a `pmix_proc_t` array

Allocate and initialize an array of `pmix_proc_t` structures

PMIx v1.0 ───────────────────────── C ─────────────────────────

```
PMIX_PROC_CREATE(m, n)
```

───────────────────────── C ─────────────────────────

INOUT m
    Address where the pointer to the array of `pmix_proc_t` structures shall be stored (handle)
IN n
    Number of structures to be allocated (`size_t`)

3.2.5.4 Free a `pmix_proc_t` array

Release an array of `pmix_proc_t` structures

PMIx v1.0 ───────────────────────── C ─────────────────────────

```
PMIX_PROC_FREE(m, n)
```

───────────────────────── C ─────────────────────────

IN m
    Pointer to the array of `pmix_proc_t` structures (handle)
IN n
    Number of structures in the array (`size_t`)

3.2.5.5 Load a `pmix_proc_t` structure

Load values into a `pmix_proc_t`

PMIx v2.0 ───────────────────────── C ─────────────────────────

```
PMIX_PROC_LOAD(m, n, r)
```

───────────────────────── C ─────────────────────────

IN m
    Pointer to the structure to be loaded (pointer to `pmix_proc_t`)
IN n
    Namespace to be loaded (`pmix_nspace_t`)
IN r
    Rank to be assigned (`pmix_rank_t`)

3.2.5.6 Compare identifiers

Compare two **pmix_proc_t** identifiers

PMIx v3.0

C

```
PMIX_CHECK_PROCID(a, b)
```

C

IN **a**
Pointer to a structure whose ID is to be compared (pointer to **pmix_proc_t**)
IN **b**
Pointer to a structure whose ID is to be compared (pointer to **pmix_proc_t**)

Returns **true** if the two structures contain matching namespaces and:

- the ranks are the same value

- one of the ranks is **PMIX_RANK_WILDCARD**

3.2.6 Process State Structure

PMIx v2.0 The **pmix_proc_state_t** structure is a **uint8_t** type for process state values. The following
constants can be used to set a variable of the type **pmix_proc_state_t**. All values were
originally defined in version 2 of the standard unless otherwise marked.

Advice to users

The fine-grained nature of the following constants may exceed the ability of an RM to provide
updated process state values during the process lifetime. This is particularly true of states in the
launch process, and for short-lived processes.

PMIX_PROC_STATE_UNDEF   Undefined process state
PMIX_PROC_STATE_PREPPED   Process is ready to be launched
PMIX_PROC_STATE_LAUNCH_UNDERWAY   Process launch is underway
PMIX_PROC_STATE_RESTART   Process is ready for restart
PMIX_PROC_STATE_TERMINATE   Process is marked for termination
PMIX_PROC_STATE_RUNNING   Process has been locally **fork**'ed by the RM
PMIX_PROC_STATE_CONNECTED   Process has connected to PMIx server
PMIX_PROC_STATE_UNTERMINATED   Define a "boundary" between the terminated states
    and **PMIX_PROC_STATE_CONNECTED** so users can easily and quickly determine if a
    process is still running or not. Any value less than this constant means that the process has not
    terminated.
PMIX_PROC_STATE_TERMINATED   Process has terminated and is no longer running
PMIX_PROC_STATE_ERROR   Define a boundary so users can easily and quickly determine if
    a process abnormally terminated. Any value above this constant means that the process has
    terminated abnormally.

1 **PMIX_PROC_STATE_KILLED_BY_CMD**   Process was killed by a command
2 **PMIX_PROC_STATE_ABORTED**   Process was aborted by a call to **PMIx_Abort**
3 **PMIX_PROC_STATE_FAILED_TO_START**   Process failed to start
4 **PMIX_PROC_STATE_ABORTED_BY_SIG**   Process aborted by a signal
5 **PMIX_PROC_STATE_TERM_WO_SYNC**   Process exited without calling **PMIx_Finalize**
6 **PMIX_PROC_STATE_COMM_FAILED**   Process communication has failed
7 **PMIX_PROC_STATE_CALLED_ABORT**   Process called **PMIx_Abort**
8 **PMIX_PROC_STATE_MIGRATING**   Process failed and is waiting for resources before
9   restarting
10 **PMIX_PROC_STATE_CANNOT_RESTART**   Process failed and cannot be restarted
11 **PMIX_PROC_STATE_TERM_NON_ZERO**   Process exited with a non-zero status
12 **PMIX_PROC_STATE_FAILED_TO_LAUNCH**   Unable to launch process

3.2.7 Process Information Structure

14 The **pmix_proc_info_t** structure defines a set of information about a specific process
15 including it's name, location, and state.

PMIx v2.0 ▽———————————————— C ————————————————▽

```
16      typedef struct pmix_proc_info {
17          /** Process structure */
18          pmix_proc_t proc;
19          /** Hostname where process resides */
20          char *hostname;
21          /** Name of the executable */
22          char *executable_name;
23          /** Process ID on the host */
24          pid_t pid;
25          /** Exit code of the process. Default: 0 */
26          int exit_code;
27          /** Current state of the process */
28          pmix_proc_state_t state;
29      } pmix_proc_info_t;
```

△———————————————— C ————————————————△

3.2.8 Process Information Structure support macros

31 The following macros are provided to support the **pmix_proc_info_t** structure.

3.2.8.1 Initialize the `pmix_proc_info_t` structure

Initialize the `pmix_proc_info_t` fields

▼ ——————————————— C ———————————————— ▼

PMIX_PROC_INFO_CONSTRUCT(m)

▲ ——————————————— C ———————————————— ▲

IN   m
    Pointer to the structure to be initialized (pointer to `pmix_proc_info_t`)

3.2.8.2 Destruct the `pmix_proc_info_t` structure

Destruct the `pmix_proc_info_t` fields

▼ ——————————————— C ———————————————— ▼

PMIX_PROC_INFO_DESTRUCT(m)

▲ ——————————————— C ———————————————— ▲

IN   m
    Pointer to the structure to be destructed (pointer to `pmix_proc_info_t`)

3.2.8.3 Create a `pmix_proc_info_t` array

Allocate and initialize a `pmix_proc_info_t` array

▼ ——————————————— C ———————————————— ▼

PMIX_PROC_INFO_CREATE(m, n)

▲ ——————————————— C ———————————————— ▲

INOUT m
    Address where the pointer to the array of `pmix_proc_info_t` structures shall be stored
    (handle)
IN   n
    Number of structures to be allocated (`size_t`)

3.2.8.4 Free a `pmix_proc_info_t` array

Release an array of `pmix_proc_info_t` structures

▼ ——————————————— C ———————————————— ▼

PMIX_PROC_INFO_FREE(m, n)

▲ ——————————————— C ———————————————— ▲

IN   m
    Pointer to the array of `pmix_proc_info_t` structures (handle)
IN   n
    Number of structures in the array (`size_t`)

3.2.9   Scope of Put Data

The **pmix_scope_t** structure is a **uint8_t** type that defines the scope for data passed to
PMIx_Put. The following constants can be used to set a variable of the type **pmix_scope_t**.
All definitions were introduced in version 1 of the standard unless otherwise marked.

Specific implementations may support different scope values, but all implementations must support
at least **PMIX_GLOBAL**. If a scope value is not supported, then the **PMIx_Put** call must return
PMIX_ERR_NOT_SUPPORTED.

PMIX_SCOPE_UNDEF   Undefined scope
PMIX_LOCAL   The data is intended only for other application processes on the same node.
    Data marked in this way will not be included in data packages sent to remote requestors —
    i.e., it is only available to processes on the local node.
PMIX_REMOTE   The data is intended solely for applications processes on remote nodes. Data
    marked in this way will not be shared with other processes on the same node — i.e., it is only
    available to processes on remote nodes.
PMIX_GLOBAL   The data is to be shared with all other requesting processes, regardless of
    location.
PMIX_INTERNAL   The data is intended solely for this process and is not shared with other
    processes.

3.2.10   Range of Published Data

The **pmix_data_range_t** structure is a **uint8_t** type that defines a range for data *published*
via functions other than **PMIx_Put** - e.g., the **PMIx_Publish** API. The following constants can
be used to set a variable of the type **pmix_data_range_t**. Several values were initially defined
in version 1 of the standard but subsequently renamed and other values added in version 2. Thus, all
values shown below are as they were defined in version 2 except where noted.

PMIX_RANGE_UNDEF   Undefined range
PMIX_RANGE_RM   Data is intended for the host resource manager.
PMIX_RANGE_LOCAL   Data is only available to processes on the local node.
PMIX_RANGE_NAMESPACE   Data is only available to processes in the same namespace.
PMIX_RANGE_SESSION   Data is only available to all processes in the session.
PMIX_RANGE_GLOBAL   Data is available to all processes.
PMIX_RANGE_CUSTOM   Range is specified in the **pmix_info_t** associated with this call.
PMIX_RANGE_PROC_LOCAL   Data is only available to this process.
PMIX_RANGE_INVALID   Invalid value

— Advice to users —

The names of the **pmix_data_range_t** values changed between version 1 and version 2 of the
standard, thereby breaking backward compatibility

3.2.11 Data Persistence Structure

PMIx v1.0 The **pmix_persistence_t** structure is a **uint8_t** type that defines the policy for data published by clients via the **PMIx_Publish** API. The following constants can be used to set a variable of the type **pmix_persistence_t**. All definitions were introduced in version 1 of the standard unless otherwise marked.

PMIX_PERSIST_INDEF   Retain data until specifically deleted.
PMIX_PERSIST_FIRST_READ   Retain data until the first access, then the data is deleted.
PMIX_PERSIST_PROC   Retain data until the publishing process terminates.
PMIX_PERSIST_APP   Retain data until the application terminates.
PMIX_PERSIST_SESSION   Retain data until the session/allocation terminates.
PMIX_PERSIST_INVALID   Invalid value

3.2.12 Data Array Structure

PMIx v2.0 ───────────────────── C ─────────────────────

```
typedef struct pmix_data_array
    pmix_data_type_t type;
    size_t size;
    void *array;
 pmix_data_array_t;
```

───────────────────── C ─────────────────────

The **pmix_data_array_t** structure is used to pass arrays of related values. Any PMIx data type (including complex structures) can be included in the array.

3.2.13 Data array structure support macros

The following macros are provided to support the **pmix_data_array_t** structure.

3.2.13.1 Initialize the **pmix_data_array_t** structure

Initialize the **pmix_data_array_t** fields, allocating memory for the array itself.

PMIx v2.2 ───────────────────── C ─────────────────────

```
PMIX_DATA_ARRAY_CONSTRUCT(m, n, t)
```

───────────────────── C ─────────────────────

IN   m
     Pointer to the structure to be initialized (pointer to **pmix_data_array_t**)
IN   n
     Number of elements in the array (**size_t**)
IN   t
     PMIx data type for the array elements (**pmix_data_type_t**)

3.2.13.2 Destruct the `pmix_data_array_t` structure

Destruct the `pmix_data_array_t` fields, releasing the array's memory.

▽ ───────────── C ───────────── ▽

```
PMIX_DATA_ARRAY_DESTRUCT(m)
```

▲ ───────────── C ───────────── ▲

IN m
    Pointer to the structure to be destructed (pointer to `pmix_data_array_t`)

3.2.13.3 Create and initialize a `pmix_data_array_t` object

Allocate and initialize a `pmix_data_array_t` structure and initialize it, allocating memory for the array itself as well.

▽ ───────────── C ───────────── ▽

```
PMIX_DATA_ARRAY_CREATE(m, n, t)
```

▲ ───────────── C ───────────── ▲

INOUT m
    Address where the pointer to the `pmix_data_array_t` structure shall be stored (handle)
IN n
    Number of elements in the array (`size_t`)
IN t
    PMIx data type for the array elements (`pmix_data_type_t`)

3.2.13.4 Free a `pmix_data_array_t` object

Release a `pmix_data_array_t` structure, including releasing the array's memory.

▽ ───────────── C ───────────── ▽

```
PMIX_DATA_ARRAY_FREE(m)
```

▲ ───────────── C ───────────── ▲

IN m
    Pointer to the `pmix_data_array_t` structure (handle)

3.2.14 Value Structure

The **pmix_value_t** structure is used to represent the value passed to **PMIx_Put** and retrieved by **PMIx_Get**, as well as many of the other PMIx functions.

A collection of values may be specified under a single key by passing a **pmix_value_t** containing an array of type **pmix_data_array_t**, with each array element containing its own object. All members shown below were introduced in version 1 of the standard unless otherwise marked.

PMIx v1.0 ▼ ——————————————————————————— C ——————————————————————————— ▼

```
typedef struct pmix_value {
    pmix_data_type_t type;
    union {
        bool flag;
        uint8_t byte;
        char *string;
        size_t size;
        pid_t pid;
        int integer;
        int8_t int8;
        int16_t int16;
        int32_t int32;
        int64_t int64;
        unsigned int uint;
        uint8_t uint8;
        uint16_t uint16;
        uint32_t uint32;
        uint64_t uint64;
        float fval;
        double dval;
        struct timeval tv;
        time_t time;                        // version 2.0
        pmix_status_t status;               // version 2.0
        pmix_rank_t rank;                   // version 2.0
        pmix_proc_t *proc;                  // version 2.0
        pmix_byte_object_t bo;
        pmix_persistence_t persist;         // version 2.0
        pmix_scope_t scope;                 // version 2.0
        pmix_data_range_t range;            // version 2.0
        pmix_proc_state_t state;            // version 2.0
        pmix_proc_info_t *pinfo;            // version 2.0
        pmix_data_array_t *darray;          // version 2.0
        void *ptr;                          // version 2.0
        pmix_alloc_directive_t adir;        // version 2.0
```

```
1              } data;
2         } pmix_value_t;
```

——————————————————— C ———————————————————

3.2.15 Value structure support macros

The following macros are provided to support the **pmix_value_t** structure.

3.2.15.1 Initialize the **pmix_value_t** structure

Initialize the **pmix_value_t** fields

PMIx v1.0 ▽ ——————————————— C ———————————————— ▽

```
PMIX_VALUE_CONSTRUCT(m)
```

——————————————————— C ———————————————————

IN   m
    Pointer to the structure to be initialized (pointer to **pmix_value_t**)

3.2.15.2 Destruct the **pmix_value_t** structure

Destruct the **pmix_value_t** fields

PMIx v1.0 ▽ ——————————————— C ———————————————— ▽

```
PMIX_VALUE_DESTRUCT(m)
```

——————————————————— C ———————————————————

IN   m
    Pointer to the structure to be destructed (pointer to **pmix_value_t**)

3.2.15.3 Create a **pmix_value_t** array

Allocate and initialize an array of **pmix_value_t** structures

PMIx v1.0 ▽ ——————————————— C ———————————————— ▽

```
PMIX_VALUE_CREATE(m, n)
```

——————————————————— C ———————————————————

INOUT m
    Address where the pointer to the array of **pmix_value_t** structures shall be stored (handle)
IN   n
    Number of structures to be allocated (**size_t**)

CHAPTER 3. DATA STRUCTURES AND TYPES   **35**

3.2.15.4 Free a `pmix_value_t` array

Release an array of `pmix_value_t` structures

PMIx v1.0

```
PMIX_VALUE_FREE(m, n)
```

IN   **m**
    Pointer to the array of `pmix_value_t` structures (handle)
IN   **n**
    Number of structures in the array (`size_t`)

3.2.15.5 Load a value structure

Summary

Load data into a `pmix_value_t` structure.

PMIx v2.0

```
PMIX_VALUE_LOAD(v, d, t);
```

IN   **v**
    The `pmix_value_t` into which the data is to be loaded (pointer to `pmix_value_t`)
IN   **d**
    Pointer to the data value to be loaded (handle)
IN   **t**
    Type of the provided data value (`pmix_data_type_t`)

Description

This macro simplifies the loading of data into a `pmix_value_t` by correctly assigning values to the structure's fields.

———————————————————— Advice to users ————————————————————

The data will be copied into the `pmix_value_t` - thus, any data stored in the source value can be modified or free'd without affecting the copied data once the macro has completed.

1 **3.2.15.6   Unload a `pmix_value_t` structure**

2   **Summary**
3   Unload data from a `pmix_value_t` structure.

PMIx v2.2 ──────────────────── C ────────────────────

4   `PMIX_VALUE_UNLOAD(r, v, d, t);`
──────────────────── C ────────────────────

5   **OUT r**
6   Status code indicating result of the operation `pmix_status_t`
7   **IN   v**
8   The `pmix_value_t` from which the data is to be unloaded (pointer to `pmix_value_t`)
9   **INOUT d**
10   Pointer to the location where the data value is to be returned (handle)
11   **INOUT t**
12   Pointer to return the data type of the unloaded value (handle)

13   **Description**
14   This macro simplifies the unloading of data from a `pmix_value_t`.

───────────────────── Advice to users ─────────────────────

15   Memory will be allocated and the data will be in the `pmix_value_t` returned - the source
16   `pmix_value_t` will not be altered.

17 **3.2.15.7   Transfer data between `pmix_value_t` structures**

18   **Summary**
19   Transfer the data value between two `pmix_value_t` structures.

PMIx v2.0 ──────────────────── C ────────────────────

20   `PMIX_VALUE_XFER(r, d, s);`
──────────────────── C ────────────────────

21   **OUT r**
22   Status code indicating success or failure of the transfer (`pmix_status_t`)
23   **IN d**
24   Pointer to the `pmix_value_t` destination (handle)
25   **IN s**
26   Pointer to the `pmix_value_t` source (handle)

Description

This macro simplifies the transfer of data between two `pmix_value_t` structures, ensuring that all fields are properly copied.

———————————————————— Advice to users ————————————————————

The data will be copied into the destination `pmix_value_t` - thus, any data stored in the source value can be modified or free'd without affecting the copied data once the macro has completed.

3.2.15.8 Retrieve a numerical value from a `pmix_value_t`

Retrieve a numerical value from a `pmix_value_t` structure

PMIx v3.0

———————————————————————— C ————————————————————————

```
PMIX_VALUE_GET_NUMBER(s, m, n, t)
```

———————————————————————— C ————————————————————————

OUT **s**
    Status code for the request (`pmix_status_t`)
IN **m**
    Pointer to the`pmix_value_t` structure (handle)
OUT **n**
    Variable to be set to the value (match expected type)
IN **t**
    Type of number expected in *m* (`pmix_data_type_t`)

Sets the provided variable equal to the numerical value contained in the given `pmix_value_t`, returning success if the data type of the value matches the expected type and `PMIX_ERR_BAD_PARAM` if it doesn't

3.2.16 Info Structure

The `pmix_info_t` structure defines a key/value pair with associated directive. All fields were defined in version 1.0 unless otherwise marked.

PMIx v1.0

———————————————————————— C ————————————————————————

```
typedef struct pmix_info_t {
    pmix_key_t key;
    pmix_info_directives_t flags;    // version 2.0
    pmix_value_t value;
} pmix_info_t;
```

———————————————————————— C ————————————————————————

3.2.17 Info structure support macros

The following macros are provided to support the `pmix_info_t` structure.

3.2.17.1 Initialize the `pmix_info_t` structure

Initialize the `pmix_info_t` fields

PMIx v1.0 ───────────────────── C ─────────────────────

```
PMIX_INFO_CONSTRUCT(m)
```

───────────────────── C ─────────────────────

IN m
    Pointer to the structure to be initialized (pointer to `pmix_info_t`)

3.2.17.2 Destruct the `pmix_info_t` structure

Destruct the `pmix_info_t` fields

PMIx v1.0 ───────────────────── C ─────────────────────

```
PMIX_INFO_DESTRUCT(m)
```

───────────────────── C ─────────────────────

IN m
    Pointer to the structure to be destructed (pointer to `pmix_info_t`)

3.2.17.3 Create a `pmix_info_t` array

Allocate and initialize an array of `pmix_info_t` structures

PMIx v1.0 ───────────────────── C ─────────────────────

```
PMIX_INFO_CREATE(m, n)
```

───────────────────── C ─────────────────────

INOUT m
    Address where the pointer to the array of `pmix_info_t` structures shall be stored (handle)
IN n
    Number of structures to be allocated (`size_t`)

3.2.17.4 Free a `pmix_info_t` array

Release an array of `pmix_info_t` structures

PMIx v1.0 ───────────────────── C ─────────────────────

```
PMIX_INFO_FREE(m, n)
```

───────────────────── C ─────────────────────

IN m
    Pointer to the array of `pmix_info_t` structures (handle)
IN n
    Number of structures in the array (`size_t`)

3.2.17.5 Load key and value data into a `pmix_info_t`

——————————————— C ———————————————

```
PMIX_INFO_LOAD(v, k, d, t);
```

——————————————— C ———————————————

IN   `v`

    Pointer to the `pmix_info_t` into which the key and data are to be loaded (pointer to `pmix_info_t`)

IN   `k`

    String key to be loaded - must be less than or equal to `PMIX_MAX_KEYLEN` in length (handle)

IN   `d`

    Pointer to the data value to be loaded (handle)

IN   `t`

    Type of the provided data value (`pmix_data_type_t`)

This macro simplifies the loading of key and data into a `pmix_info_t` by correctly assigning values to the structure's fields.

———————————— Advice to users ————————————

Both key and data will be copied into the `pmix_info_t` - thus, the key and any data stored in the source value can be modified or free'd without affecting the copied data once the macro has completed.

3.2.17.6 Copy data between `pmix_info_t` structures

Copy all data (including key, value, and directives) between two `pmix_info_t` structures.

——————————————— C ———————————————

```
PMIX_INFO_XFER(d, s);
```

——————————————— C ———————————————

IN   `d`

    Pointer to the destination `pmix_info_t` (pointer to `pmix_info_t`)

IN   `s`

    Pointer to the source `pmix_info_t` (pointer to `pmix_info_t`)

This macro simplifies the transfer of data between two `pmix_info_t` structures.

———————————— Advice to users ————————————

All data (including key, value, and directives) will be copied into the destination `pmix_info_t` - thus, the source `pmix_info_t` may be free'd without affecting the copied data once the macro has completed.

3.2.17.7 Test a boolean `pmix_info_t`

A special macro for checking if a boolean `pmix_info_t` is **true**

—————————— C ——————————

```
PMIX_INFO_TRUE(m)
```
—————————— C ——————————

IN   m
> Pointer to a `pmix_info_t` structure (handle)

A `pmix_info_t` structure is considered to be of type **PMIX_BOOL** and value **true** if:

- the structure reports a type of **PMIX_UNDEF**, or

- the structure reports a type of **PMIX_BOOL** and the data flag is **true**
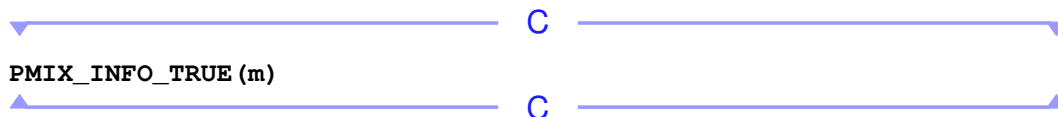
3.2.18 Info Type Directives

The `pmix_info_directives_t` structure is a **uint32_t** type that defines the behavior of command directives via `pmix_info_t` arrays. By default, the values in the `pmix_info_t` array passed to a PMIx are *optional*.

———————————————— Advice to users ————————————————

A PMIx implementation or PMIx-enabled RM may ignore any `pmix_info_t` value passed to a PMIx API if it is not explicitly marked as **PMIX_INFO_REQD**. This is because the values specified default to optional, meaning they can be ignored. This may lead to unexpected behavior if the user is relying on the behavior specified by the `pmix_info_t` value. If the user relies on the behavior defined by the `pmix_info_t` then they must set the **PMIX_INFO_REQD** flag using the **PMIX_INFO_REQUIRED** macro.

———————————————— Advice to PMIx library implementers ————————————————

The top 16-bits of the `pmix_info_directives_t` are reserved for internal use by PMIx library implementers - the PMIx standard will *not* specify their intent, leaving them for customized use by implementers. Implementers are advised to use the provided **PMIX_INFO_IS_REQUIRED** macro for testing this flag, and must return **PMIX_ERR_NOT_SUPPORTED** as soon as possible to the caller if the required behavior is not supported.

1 The following constants were introduced in version 2.0 (unless otherwise marked) and can be used
2 to set a variable of the type **`pmix_info_directives_t`**.

3 **`PMIX_INFO_REQD`**   The behavior defined in the **`pmix_info_t`** array is required, and not
4   optional. This is a bit-mask value.
5 **`PMIX_INFO_ARRAY_END`**   Mark that this **`pmix_info_t`** struct is at the end of an array
6   created by the **`PMIX_INFO_CREATE`** macro. This is a bit-mask value.

────────────────── Advice to PMIx server hosts ──────────────────

7 Host environments are advised to use the provided **`PMIX_INFO_IS_REQUIRED`** macro for
8 testing this flag and must return **`PMIX_ERR_NOT_SUPPORTED`** as soon as possible to the caller if
9 the required behavior is not supported.

▲ ── ▲

10 3.2.19 Info Directive support macros

11 The following macros are provided to support the setting and testing of **`pmix_info_t`** directives.

12 3.2.19.1 Mark an info structure as required

13 **Summary**
14 Set the **`PMIX_INFO_REQD`** flag in a **`pmix_info_t`** structure.

PMIx v2.0 ▼ ──────────────────────── C ──────────────────────── ▼

15 **`PMIX_INFO_REQUIRED(info);`**

▲ ──────────────────────── C ──────────────────────── ▲

16 **IN   info**
17   Pointer to the **`pmix_info_t`** (pointer to **`pmix_info_t`**)

18 This macro simplifies the setting of the **`PMIX_INFO_REQD`** flag in **`pmix_info_t`** structures.

19 3.2.19.2 Mark an info structure as optional

20 **Summary**
21 Unsets the **`PMIX_INFO_REQD`** flag in a **`pmix_info_t`** structure.

PMIx v3.0 ▼ ──────────────────────── C ──────────────────────── ▼

22 **`PMIX_INFO_OPTIONAL(info);`**

▲ ──────────────────────── C ──────────────────────── ▲

23 **IN   info**
24   Pointer to the **`pmix_info_t`** (pointer to **`pmix_info_t`**)

25 This macro simplifies marking a **`pmix_info_t`** structure as *optional*.

3.2.19.3 Test an info structure for *required* directive

Summary

Test the **PMIX_INFO_REQD** flag in a **pmix_info_t** structure, returning **true** if the flag is set.

PMIx v2.0 ▼ ———————————————————— C ————————————————————— ▼

```
PMIX_INFO_IS_REQUIRED(info);
```

▲ ———————————————————— C ————————————————————— ▲

IN   info
    Pointer to the **pmix_info_t** (pointer to **pmix_info_t**)

This macro simplifies the testing of the required flag in **pmix_info_t** structures.

3.2.19.4 Test an info structure for *optional* directive

Summary

Test a **pmix_info_t** structure, returning **true** if the structure is *optional*.

PMIx v2.0 ▼ ———————————————————— C ————————————————————— ▼

```
PMIX_INFO_IS_OPTIONAL(info);
```

▲ ———————————————————— C ————————————————————— ▲

IN   info
    Pointer to the **pmix_info_t** (pointer to **pmix_info_t**)

Test the **PMIX_INFO_REQD** flag in a **pmix_info_t** structure, returning **true** if the flag is *not* set.

3.2.19.5 Test an info structure for *end of array* directive

Summary

Test a **pmix_info_t** structure, returning **true** if the structure is at the end of an array created by the **PMIX_INFO_CREATE** macro.

PMIx v2.2 ▼ ———————————————————— C ————————————————————— ▼

```
PMIX_INFO_IS_END(info);
```

▲ ———————————————————— C ————————————————————— ▲

IN   info
    Pointer to the **pmix_info_t** (pointer to **pmix_info_t**)

This macro simplifies the testing of the end-of-array flag in **pmix_info_t** structures.

3.2.20 Job Allocation Directives

The **`pmix_alloc_directive_t`** structure is a **`uint8_t`** type that defines the behavior of allocation requests. The following constants can be used to set a variable of the type **`pmix_alloc_directive_t`**. All definitions were introduced in version 2 of the standard unless otherwise marked.

> **`PMIX_ALLOC_NEW`**   A new allocation is being requested. The resulting allocation will be disjoint (i.e., not connected in a job sense) from the requesting allocation.
> **`PMIX_ALLOC_EXTEND`**   Extend the existing allocation, either in time or as additional resources.
> **`PMIX_ALLOC_RELEASE`**   Release part of the existing allocation. Attributes in the accompanying **`pmix_info_t`** array may be used to specify permanent release of the identified resources, or "lending" of those resources for some period of time.
> **`PMIX_ALLOC_REAQUIRE`**   Reacquire resources that were previously "lent" back to the scheduler.
> **`PMIX_ALLOC_EXTERNAL`**   A value boundary above which implementers are free to define their own directive values.

3.2.21 IO Forwarding Channels

The **`pmix_iof_channel_t`** structure is a **`uint16_t`** type that defines a set of bit-mask flags for specifying IO forwarding channels. These can be bitwise OR'd together to reference multiple channels.

> **`PMIX_FWD_NO_CHANNELS`**   Forward no channels
> **`PMIX_FWD_STDIN_CHANNEL`**   Forward stdin
> **`PMIX_FWD_STDOUT_CHANNEL`**   Forward stdout
> **`PMIX_FWD_STDERR_CHANNEL`**   Forward stderr
> **`PMIX_FWD_STDDIAG_CHANNEL`**   Forward stddiag, if available
> **`PMIX_FWD_ALL_CHANNELS`**   Forward all available channels

3.2.22 Environmental Variable Structure

Define a structure for specifying environment variable modifications. Standard environment variables (e.g., **`PATH`**, **`LD_LIBRARY_PATH`**, and **`LD_PRELOAD`**) take multiple arguments separated by delimiters. Unfortunately, the delimiters depend upon the variable itself - some use semi-colons, some colons, etc. Thus, the operation requires not only the name of the variable to be modified and the value to be inserted, but also the separator to be used when composing the aggregate value.

```
1    typedef struct
2        char *envar;
3        char *value;
4        char separator;
5     pmix_envar_t;
```

3.2.23 Environmental variable support macros

The following macros are provided to support the **pmix_envar_t** structure.

3.2.23.1 Initialize the **pmix_envar_t** structure

Initialize the **pmix_envar_t** fields

PMIx v3.0

```
10   PMIX_ENVAR_CONSTRUCT(m)
```

IN   m
    Pointer to the structure to be initialized (pointer to **pmix_envar_t**)

3.2.23.2 Destruct the **pmix_envar_t** structure

Clear the **pmix_envar_t** fields

PMIx v3.0

```
15   PMIX_ENVAR_DESTRUCT(m)
```

IN   m
    Pointer to the structure to be destructed (pointer to **pmix_envar_t**)

3.2.23.3 Create a **pmix_envar_t** array

Allocate and initialize an array of **pmix_envar_t** structures

PMIx v3.0

```
20   PMIX_ENVAR_CREATE(m, n)
```

INOUT m
    Address where the pointer to the array of **pmix_envar_t** structures shall be stored (handle)
IN   n
    Number of structures to be allocated (**size_t**)

3.2.23.4 Free a `pmix_envar_t` array

Release an array of `pmix_envar_t` structures

PMIx v3.0 ────────────────── C ──────────────────

```
PMIX_ENVAR_FREE(m, n)
```

────────────────── C ──────────────────

IN **m**
Pointer to the array of `pmix_envar_t` structures (handle)
IN **n**
Number of structures in the array (`size_t`)

3.2.23.5 Load a `pmix_envar_t` structure

Load values into a `pmix_envar_t`

PMIx v2.0 ────────────────── C ──────────────────

```
PMIX_ENVAR_LOAD(m, e, v, s)
```

────────────────── C ──────────────────

IN **m**
Pointer to the structure to be loaded (pointer to `pmix_envar_t`)
IN **e**
Environmental variable name (`char*`)
IN **v**
Value of variable (`char*`)
IN **v**
Separator character (`char`)

3.2.24 Lookup Returned Data Structure

The `pmix_pdata_t` structure is used by `PMIx_Lookup` to describe the data being accessed.

PMIx v1.0 ────────────────── C ──────────────────

```
typedef struct pmix_pdata {
    pmix_proc_t proc;
    pmix_key_t key;
    pmix_value_t value;
} pmix_pdata_t;
```

────────────────── C ──────────────────

3.2.25 Lookup data structure support macros

The following macros are provided to support the `pmix_pdata_t` structure.

3.2.25.1 Initialize the `pmix_pdata_t` structure

Initialize the `pmix_pdata_t` fields

PMIx v1.0 ▼ ——————————————————— C ———————————————————— ▼

```
PMIX_PDATA_CONSTRUCT(m)
```

▲ ——————————————————— C ———————————————————— ▲

IN m
    Pointer to the structure to be initialized (pointer to `pmix_pdata_t`)

3.2.25.2 Destruct the `pmix_pdata_t` structure

Destruct the `pmix_pdata_t` fields

PMIx v1.0 ▼ ——————————————————— C ———————————————————— ▼

```
PMIX_PDATA_DESTRUCT(m)
```

▲ ——————————————————— C ———————————————————— ▲

IN m
    Pointer to the structure to be destructed (pointer to `pmix_pdata_t`)

3.2.25.3 Create a `pmix_pdata_t` array

Allocate and initialize an array of `pmix_pdata_t` structures

PMIx v1.0 ▼ ——————————————————— C ———————————————————— ▼

```
PMIX_PDATA_CREATE(m, n)
```

▲ ——————————————————— C ———————————————————— ▲

INOUT m
    Address where the pointer to the array of `pmix_pdata_t` structures shall be stored (handle)
IN n
    Number of structures to be allocated (`size_t`)

3.2.25.4 Free a `pmix_pdata_t` array

Release an array of `pmix_pdata_t` structures

PMIx v1.0 ▼ ——————————————————— C ———————————————————— ▼

```
PMIX_PDATA_FREE(m, n)
```

▲ ——————————————————— C ———————————————————— ▲

IN m
    Pointer to the array of `pmix_pdata_t` structures (handle)
IN n
    Number of structures in the array (`size_t`)

3.2.25.5 Load a lookup data structure

Summary

Load key, process identifier, and data value into a `pmix_pdata_t` structure.

PMIx v1.0 ──────────────────────── C ────────────────────────

```
PMIX_PDATA_LOAD(m, p, k, d, t);
```
──────────────────────── C ────────────────────────

IN **m**
   Pointer to the `pmix_pdata_t` structure into which the key and data are to be loaded
   (pointer to `pmix_pdata_t`)

IN **p**
   Pointer to the `pmix_proc_t` structure containing the identifier of the process being
   referenced (pointer to `pmix_proc_t`)

IN **k**
   String key to be loaded - must be less than or equal to `PMIX_MAX_KEYLEN` in length
   (handle)

IN **d**
   Pointer to the data value to be loaded (handle)

IN **t**
   Type of the provided data value (`pmix_data_type_t`)

This macro simplifies the loading of key, process identifier, and data into a `pmix_proc_t` by
correctly assigning values to the structure's fields.

──────────────────────── Advice to users ────────────────────────

Key, process identifier, and data will all be copied into the `pmix_pdata_t` - thus, the source
information can be modified or free'd without affecting the copied data once the macro has
completed.

3.2.25.6 Transfer a lookup data structure

2   **Summary**
3   Transfer key, process identifier, and data value between two **pmix_pdata_t** structures.

PMIx v2.0 ──────────────── C ────────────────

4
```
PMIX_PDATA_XFER(d, s);
```
──────────────── C ────────────────

5   **IN   d**
6   Pointer to the destination **pmix_pdata_t** (pointer to **pmix_pdata_t**)
7   **IN   s**
8   Pointer to the source **pmix_pdata_t** (pointer to **pmix_pdata_t**)

9   This macro simplifies the transfer of key and data between two **pmix_pdata_t** structures.

───────────────── Advice to users ─────────────────

10   Key, process identifier, and data will all be copied into the destination **pmix_pdata_t** - thus, the
11   source **pmix_pdata_t** may free'd without affecting the copied data once the macro has
12   completed.

3.2.26   Application Structure

14   The **pmix_app_t** structure describes the application context for the **PMIx_Spawn** and
15   **PMIx_Spawn_nb** operations.

PMIx v1.0 ──────────────── C ────────────────

16
```
typedef struct pmix_app {
    /** Executable */
    char *cmd;
    /** Argument set, NULL terminated */
    char **argv;
    /** Environment set, NULL terminated */
    char **env;
    /** Current working directory */
    char *cwd;
    /** Maximum processes with this profile */
    int maxprocs;
    /** Array of info keys describing this application*/
    pmix_info_t *info;
    /** Number of info keys in 'info' array */
    size_t ninfo;
} pmix_app_t;
```
──────────────── C ────────────────

3.2.27 App structure support macros

The following macros are provided to support the **pmix_app_t** structure.

3.2.27.1 Initialize the **pmix_app_t** structure

Initialize the **pmix_app_t** fields

PMIx v1.0 ──────────────── C ────────────────

```
PMIX_APP_CONSTRUCT(m)
```

──────────────── C ────────────────

IN **m**
  Pointer to the structure to be initialized (pointer to **pmix_app_t**)

3.2.27.2 Destruct the **pmix_app_t** structure

Destruct the **pmix_app_t** fields

PMIx v1.0 ──────────────── C ────────────────

```
PMIX_APP_DESTRUCT(m)
```

──────────────── C ────────────────

IN **m**
  Pointer to the structure to be destructed (pointer to **pmix_app_t**)

3.2.27.3 Create a **pmix_app_t** array

Allocate and initialize an array of **pmix_app_t** structures

PMIx v1.0 ──────────────── C ────────────────

```
PMIX_APP_CREATE(m, n)
```

──────────────── C ────────────────

INOUT m
  Address where the pointer to the array of **pmix_app_t** structures shall be stored (handle)
IN **n**
  Number of structures to be allocated (**size_t**)

3.2.27.4 Free a**pmix_app_t** array

Release an array of **pmix_app_t** structures

PMIx v1.0 ──────────────── C ────────────────

```
PMIX_APP_FREE(m, n)
```

──────────────── C ────────────────

IN **m**
  Pointer to the array of **pmix_app_t** structures (handle)
IN **n**
  Number of structures in the array (**size_t**)

3.2.27.5 Create the `pmix_info_t` array of application directives

Create an array of `pmix_info_t` structures for passing application-level directives, updating the *ninfo* field of the `pmix_app_t` structure.

PMIx v2.2 ───────────────── C ─────────────────

```
PMIX_APP_INFO_CREATE(m, n)
```

───────────────── C ─────────────────

IN   m
    Pointer to the `pmix_app_t` structure (handle)
IN   n
    Number of directives to be allocated (`size_t`)

3.2.28   Query Structure

The `pmix_query_t` structure is used by `PMIx_Query_info_nb` to describe a single query operation.

PMIx v2.0 ───────────────── C ─────────────────

```
typedef struct pmix_query {
    char **keys;
    pmix_info_t *qualifiers;
    size_t nqual;
} pmix_query_t;
```

───────────────── C ─────────────────

3.2.29   Query structure support macros

The following macros are provided to support the `pmix_query_t` structure.

3.2.29.1   Initialize the `pmix_query_t` structure

Initialize the `pmix_query_t` fields

PMIx v2.0 ───────────────── C ─────────────────

```
PMIX_QUERY_CONSTRUCT(m)
```

───────────────── C ─────────────────

IN   m
    Pointer to the structure to be initialized (pointer to `pmix_query_t`)

3.2.29.2 Destruct the `pmix_query_t` structure

Destruct the `pmix_query_t` fields

▼ ──────────────────── C ──────────────────── ▼

PMIX_QUERY_DESTRUCT(m)

▲ ──────────────────── C ──────────────────── ▲

IN   m
    Pointer to the structure to be destructed (pointer to `pmix_query_t`)

3.2.29.3 Create a `pmix_query_t` array

Allocate and initialize an array of `pmix_query_t` structures

▼ ──────────────────── C ──────────────────── ▼

PMIX_QUERY_CREATE(m, n)

▲ ──────────────────── C ──────────────────── ▲

INOUT m
    Address where the pointer to the array of `pmix_query_t` structures shall be stored (handle)
IN   n
    Number of structures to be allocated (`size_t`)

3.2.29.4 Free a `pmix_query_t` array

Release an array of `pmix_query_t` structures

▼ ──────────────────── C ──────────────────── ▼

PMIX_QUERY_FREE(m, n)

▲ ──────────────────── C ──────────────────── ▲

IN   m
    Pointer to the array of `pmix_query_t` structures (handle)
IN   n
    Number of structures in the array (`size_t`)

3.2.29.5 Create the `pmix_info_t` array of query qualifiers

Create an array of `pmix_info_t` structures for passing query qualifiers, updating the *nqual* field
of the `pmix_query_t` structure.

▼ ──────────────────── C ──────────────────── ▼

PMIX_QUERY_QUALIFIERS_CREATE(m, n)

▲ ──────────────────── C ──────────────────── ▲

IN   m
    Pointer to the `pmix_query_t` structure (handle)
IN   n
    Number of qualifiers to be allocated (`size_t`)

3.3 Packing/Unpacking Types & Structures

This section defines types and structures used to pack and unpack data passed through the PMIx API.

3.3.1 Byte Object Type

The **pmix_byte_object_t** structure describes a raw byte sequence.

PMIx v1.0 ────────────────────── C ──────────────────────

```
typedef struct pmix_byte_object {
    char *bytes;
    size_t size;
} pmix_byte_object_t;
```
────────────────────── C ──────────────────────

3.3.2 Byte object support macros

The following macros support the **pmix_byte_object_t** structure.

3.3.2.1 Initialize the **pmix_byte_object_t** structure

Initialize the **pmix_byte_object_t** fields

PMIx v2.0 ────────────────────── C ──────────────────────

```
PMIX_BYTE_OBJECT_CONSTRUCT(m)
```
────────────────────── C ──────────────────────

IN m
　　　Pointer to the structure to be initialized (pointer to **pmix_byte_object_t**)

3.3.2.2 Destruct the **pmix_byte_object_t** structure

Clear the **pmix_byte_object_t** fields

PMIx v2.0 ────────────────────── C ──────────────────────

```
PMIX_BYTE_OBJECT_DESTRUCT(m)
```
────────────────────── C ──────────────────────

IN m
　　　Pointer to the structure to be destructed (pointer to **pmix_byte_object_t**)

3.3.2.3 Create a `pmix_byte_object_t` structure

Allocate and intitialize an array of `pmix_byte_object_t` structures

PMIx v2.0 ───────────────────── C ─────────────────────

```
PMIX_BYTE_OBJECT_CREATE(m, n)
```
───────────────────── C ─────────────────────

INOUT m
　　Address where the pointer to the array of `pmix_byte_object_t` structures shall be stored
　　(handle)
IN   n
　　Number of structures to be allocated (`size_t`)

3.3.2.4 Free a `pmix_byte_object_t` array

Release an array of `pmix_byte_object_t` structures

PMIx v2.0 ───────────────────── C ─────────────────────

```
PMIX_BYTE_OBJECT_FREE(m, n)
```
───────────────────── C ─────────────────────

IN   m
　　Pointer to the array of `pmix_byte_object_t` structures (handle)
IN   n
　　Number of structures in the array (`size_t`)

3.3.2.5 Load a `pmix_byte_object_t` structure

Load values into a `pmix_byte_object_t`

PMIx v2.0 ───────────────────── C ─────────────────────

```
PMIX_BYTE_OBJECT_LOAD(b, d, s)
```
───────────────────── C ─────────────────────

IN b
　　Pointer to the structure to be loaded (pointer to `pmix_byte_object_t`)
IN d
　　Pointer to the data to be loaded (`char*`)
IN s
　　Number of bytes in the data array (`size_t`)

3.3.3 Data Array Structure

The **pmix_data_array_t** structure defines an array data structure.

```
typedef struct pmix_data_array {
    pmix_data_type_t type;
    size_t size;
    void *array;
} pmix_data_array_t;
```

3.3.4 Data array support macros

The following macros support the **pmix_data_array_t** structure.

3.3.4.1 Initialize a **pmix_data_array_t** structure

Initialize the **pmix_data_array_t** fields, allocating memory for the array of the indicated type.

```
PMIX_DATA_ARRAY_CONSTRUCT(m, n, t)
```

IN m
Pointer to the structure to be initialized (pointer to **pmix_data_array_t**)
IN n
Number of elements in the array (**size_t**)
IN t
PMIx data type of the array elements (**pmix_data_type_t**)

3.3.4.2 Destruct a **pmix_data_array_t** structure

Destruct the **pmix_data_array_t**, releasing the memory in the array.

```
PMIX_DATA_ARRAY_CONSTRUCT(m)
```

IN m
Pointer to the structure to be destructed (pointer to **pmix_data_array_t**)

3.3.4.3 Create a `pmix_data_array_t` structure

Allocate memory for the `pmix_data_array_t` object itself, and then allocate memory for the array of the indicated type.

PMIx v2.2 ───────────────── C ─────────────────

PMIX_DATA_ARRAY_CREATE(m, n, t)

───────────────── C ─────────────────

INOUT m
    Variable to be set to the address of the structure (pointer to `pmix_data_array_t`)
IN n
    Number of elements in the array (`size_t`)
IN t
    PMIx data type of the array elements (`pmix_data_type_t`)

3.3.4.4 Free a `pmix_data_array_t` structure

Release the memory in the array, and then release the `pmix_data_array_t` object itself.

PMIx v2.2 ───────────────── C ─────────────────

PMIX_DATA_ARRAY_FREE(m)

───────────────── C ─────────────────

IN m
    Pointer to the structure to be released (pointer to `pmix_data_array_t`)

3.3.5 Generalized Data Types Used for Packing/Unpacking

The `pmix_data_type_t` structure is a `uint16_t` type for identifying the data type for packing/unpacking purposes. New data type values introduced in this version of the Standard are shown in **magenta**.

─────────────── Advice to PMIx library implementers ───────────────

The following constants can be used to set a variable of the type `pmix_data_type_t`. Data types in the PMIx Standard are defined in terms of the C-programming language. Implementers wishing to support other languages should provide the equivalent definitions in a language-appropriate manner. Additionally, a PMIx implementation may choose to add additional types.

1   **PMIX_UNDEF**   Undefined
2   **PMIX_BOOL**   Boolean (converted to/from native **true**/**false**) (**bool**)
3   **PMIX_BYTE**   A byte of data (**uint8_t**)
4   **PMIX_STRING**   **NULL** terminated string (**char***)
5   **PMIX_SIZE**   Size **size_t**
6   **PMIX_PID**   Operating process identifier (PID) (**pid_t**)
7   **PMIX_INT**   Integer (**int**)
8   **PMIX_INT8**   8-byte integer (**int8_t**)
9   **PMIX_INT16**   16-byte integer (**int16_t**)
10   **PMIX_INT32**   32-byte integer (**int32_t**)
11   **PMIX_INT64**   64-byte integer (**int64_t**)
12   **PMIX_UINT**   Unsigned integer (**unsigned int**)
13   **PMIX_UINT8**   Unsigned 8-byte integer (**uint8_t**)
14   **PMIX_UINT16**   Unsigned 16-byte integer (**uint16_t**)
15   **PMIX_UINT32**   Unsigned 32-byte integer (**uint32_t**)
16   **PMIX_UINT64**   Unsigned 64-byte integer (**uint64_t**)
17   **PMIX_FLOAT**   Float (**float**)
18   **PMIX_DOUBLE**   Double (**double**)
19   **PMIX_TIMEVAL**   Time value (**struct timeval**)
20   **PMIX_TIME**   Time (**time_t**)
21   **PMIX_STATUS**   Status code **pmix_status_t**
22   **PMIX_VALUE**   Value (**pmix_value_t**)
23   **PMIX_PROC**   Process (**pmix_proc_t**)
24   **PMIX_APP**   Application context
25   **PMIX_INFO**   Info object
26   **PMIX_PDATA**   Pointer to data
27   **PMIX_BUFFER**   Buffer
28   **PMIX_BYTE_OBJECT**   Byte object (**pmix_byte_object_t**)
29   **PMIX_KVAL**   Key/value pair
30   **PMIX_MODEX (Deprecated in PMIx 2.0)**   Modex
31   **PMIX_PERSIST**   Persistance (**pmix_persistence_t**)
32   **PMIX_POINTER**   Pointer to an object (**void***)
33   **PMIX_SCOPE**   Scope (**pmix_scope_t**)
34   **PMIX_DATA_RANGE**   Range for data (**pmix_data_range_t**)
35   **PMIX_COMMAND**   PMIx command code (used internally)
36   **PMIX_INFO_DIRECTIVES**   Directives flag for **pmix_info_t**
37   (**pmix_info_directives_t**)
38   **PMIX_DATA_TYPE**   Data type code (**pmix_data_type_t**)
39   **PMIX_PROC_STATE**   Process state (**pmix_proc_state_t**)
40   **PMIX_PROC_INFO**   Process information (**pmix_proc_info_t**)
41   **PMIX_DATA_ARRAY**   Data array (**pmix_data_array_t**)

1   **PMIX_PROC_RANK**   Process rank (**pmix_rank_t**)
2   **PMIX_QUERY**   Query structure (**pmix_query_t**)
3   **PMIX_COMPRESSED_STRING**   String compressed with zlib (**char***)
4   **PMIX_ALLOC_DIRECTIVE**   Allocation directive (**pmix_alloc_directive_t**)
5   **PMIX_IOF_CHANNEL**   Input/output forwarding channel (**pmix_iof_channel_t**)
6   **PMIX_ENVAR**   Environmental variable structure (**pmix_envar_t**)
7   **PMIX_REGEX**   Regular expressions - can be a valid NULL-terminated string or an arbitrary
8   array of bytes

9 3.4 Reserved attributes

10   The PMIx standard defines a relatively small set of APIs and the caller may customize the behavior
11   of the API by passing one or more attributes to that API. Additionally, attributes may be keys
12   passed to **PMIx_Get** calls to access the specified values from the system.

13   Each attribute is represented by a *key* string, and a type for the associated *value*. This section
14   defines a set of **reserved** keys which are prefixed with **pmix.** to designate them as PMIx standard
15   reserved keys. All definitions were introduced in version 1 of the standard unless otherwise marked.

16   Applications or associated libraries (e.g., MPI) may choose to define additional attributes. The
17   attributes defined in this section are of the system and job as opposed to the attributes that the
18   application (or associated libraries) might choose to expose. Due to this extensibility the
19   **PMIx_Get** API will return **PMIX_ERR_NOT_FOUND** if the provided *key* cannot be found.

20   Attributes added in this version of the standard are shown in *magenta* to distinguish them from
21   those defined in prior versions, which are shown in **black**. Deprecated attributes are shown in *green*
22   and will be removed in future versions of the standard.

23   **PMIX_ATTR_UNDEF NULL** (**NULL**)
24   Constant representing an undefined attribute.

25 3.4.1 Initialization attributes

26   These attributes are defined to assist the caller with initialization by passing them into the
27   appropriate initialization API - thus, they are not typically accessed via the **PMIx_Get** API.

28   **PMIX_EVENT_BASE "pmix.evbase"** (**struct event_base ***)
29   Pointer to libevent[1] **event_base** to use in place of the internal progress thread.
30   **PMIX_SERVER_TOOL_SUPPORT "pmix.srvr.tool"** (**bool**)
31   The host RM wants to declare itself as willing to accept tool connection requests.
32   **PMIX_SERVER_REMOTE_CONNECTIONS "pmix.srvr.remote"** (**bool**)
33   Allow connections from remote tools. Forces the PMIx server to not exclusively use
34   loopback device.
35   **PMIX_SERVER_SYSTEM_SUPPORT "pmix.srvr.sys"** (**bool**)

---

[1]http://libevent.org/

The host RM wants to declare itself as being the local system server for PMIx connection requests.

PMIX_SERVER_TMPDIR "pmix.srvr.tmpdir" (**char***)
  Top-level temporary directory for all client processes connected to this server, and where the PMIx server will place its tool rendezvous point and contact information.

PMIX_SYSTEM_TMPDIR "pmix.sys.tmpdir" (**char***)
  Temporary directory for this system, and where a PMIx server that declares itself to be a system-level server will place a tool rendezvous point and contact information.

PMIX_SERVER_ENABLE_MONITORING "pmix.srv.monitor" (**bool**)
  Enable PMIx internal monitoring by the PMIx server.

PMIX_SERVER_NSPACE "pmix.srv.nspace" (**char***)
  Name of the namespace to use for this PMIx server.

PMIX_SERVER_RANK "pmix.srv.rank" (**pmix_rank_t**)
  Rank of this PMIx server

PMIX_SERVER_GATEWAY "pmix.srv.gway" (**bool**)
  Server is acting as a gateway for PMIx requests that cannot be serviced on backend nodes (e.g., logging to email)

3.4.2 Tool-related attributes

These attributes are defined to assist PMIx-enabled tools to connect with the PMIx server by passing them into the **PMIx_tool_init** API - thus, they are not typically accessed via the **PMIx_Get** API.

PMIX_TOOL_NSPACE "pmix.tool.nspace" (**char***)
  Name of the namespace to use for this tool.

PMIX_TOOL_RANK "pmix.tool.rank" (**uint32_t**)
  Rank of this tool.

PMIX_SERVER_PIDINFO "pmix.srvr.pidinfo" (**pid_t**)
  PID of the target PMIx server for a tool.

PMIX_CONNECT_TO_SYSTEM "pmix.cnct.sys" (**bool**)
  The requestor requires that a connection be made only to a local, system-level PMIx server.

PMIX_CONNECT_SYSTEM_FIRST "pmix.cnct.sys.first" (**bool**)
  Preferentially, look for a system-level PMIx server first.

PMIX_SERVER_URI "pmix.srvr.uri" (**char***)
  uniform resource identifier (URI) of the PMIx server to be contacted.

PMIX_SERVER_HOSTNAME "pmix.srvr.host" (**char***)
  Host where target PMIx server is located.

PMIX_CONNECT_MAX_RETRIES "pmix.tool.mretries" (**uint32_t**)
  Maximum number of times to try to connect to PMIx server.

PMIX_CONNECT_RETRY_DELAY "pmix.tool.retry" (**uint32_t**)
  Time in seconds between connection attempts to a PMIx server.

PMIX_TOOL_DO_NOT_CONNECT "pmix.tool.nocon" (**bool**)
  The tool wants to use internal PMIx support, but does not want to connect to a PMIx server.

```
1       PMIX_RECONNECT_SERVER "pmix.tool.recon" (bool)
2           Tool is requesting to change server connections
3       PMIX_LAUNCHER "pmix.tool.launcher" (bool)
4           Tool is a launcher and needs rendezvous files created
```

5 3.4.3 Identification attributes

6 These attributes are defined to identify a process and it's associated PMIx-enabled library. They are
7 not typically accessed via the **PMIx_Get** API, and thus are not associated with a particular rank.

```
8       PMIX_USERID "pmix.euid" (uint32_t)
9           Effective user id.
10      PMIX_GRPID "pmix.egid" (uint32_t)
11          Effective group id.
12      PMIX_DSTPATH "pmix.dstpath" (char*)
13          Path to shared memory data storage (dstore) files.
14      PMIX_VERSION_INFO "pmix.version" (char*)
15          PMIx version of contractor.
16      PMIX_REQUESTOR_IS_TOOL "pmix.req.tool" (bool)
17          The requesting process is a PMIx tool.
18      PMIX_REQUESTOR_IS_CLIENT "pmix.req.client" (bool)
19          The requesting process is a PMIx client.
```

20 3.4.4 Programming model attributes

21 These attributes are associated with programming models.

```
22      PMIX_PROGRAMMING_MODEL "pmix.pgm.model" (char*)
23          Programming model being initialized (e.g., "MPI" or "OpenMP")
24      PMIX_MODEL_LIBRARY_NAME "pmix.mdl.name" (char*)
25          Programming model implementation ID (e.g., "OpenMPI" or "MPICH")
26      PMIX_MODEL_LIBRARY_VERSION "pmix.mld.vrs" (char*)
27          Programming model version string (e.g., "2.1.1")
28      PMIX_THREADING_MODEL "pmix.threads" (char*)
29          Threading model used (e.g., "pthreads")
30      PMIX_MODEL_NUM_THREADS "pmix.mdl.nthrds" (uint64_t)
31          Number of active threads being used by the model
32      PMIX_MODEL_NUM_CPUS "pmix.mdl.ncpu" (uint64_t)
33          Number of cpus being used by the model
34      PMIX_MODEL_CPU_TYPE "pmix.mdl.cputype" (char*)
35          Granularity - "hwthread", "core", etc.
36      PMIX_MODEL_PHASE_NAME "pmix.mdl.phase" (char*)
37          User-assigned name for a phase in the application execution (e.g., "cfd reduction")
38      PMIX_MODEL_PHASE_TYPE "pmix.mdl.ptype" (char*)
39          Type of phase being executed (e.g., "matrix multiply")
```

1   **PMIX_MODEL_AFFINITY_POLICY "pmix.mdl.tap"** (**char***)
2   Thread affinity policy - e.g.: "master" (thread co-located with master thread), "close" (thread
3   located on cpu close to master thread), "spread" (threads load-balanced across available cpus)

4   3.4.5   UNIX socket rendezvous socket attributes

5   These attributes are used to describe a UNIX socket for rendezvous with the local RM by passing
6   them into the relevant initialization API - thus, they are not typically accessed via the **PMIx_Get**
7   API.

8   **PMIX_USOCK_DISABLE "pmix.usock.disable"** (**bool**)
9   Disable legacy UNIX socket (usock) support
10   **PMIX_SOCKET_MODE "pmix.sockmode"** (**uint32_t**)
11   POSIX *mode_t* (9 bits valid)
12   **PMIX_SINGLE_LISTENER "pmix.sing.listnr"** (**bool**)
13   Use only one rendezvous socket, letting priorities and/or environment parameters select the
14   active transport.

15   3.4.6   TCP connection attributes

16   These attributes are used to describe a TCP socket for rendezvous with the local RM by passing
17   them into the relevant initialization API - thus, they are not typically accessed via the **PMIx_Get**
18   API.

19   **PMIX_TCP_REPORT_URI "pmix.tcp.repuri"** (**char***)
20   If provided, directs that the TCP URI be reported and indicates the desired method of
21   reporting: **'-'** for stdout, **'+'** for stderr, or filename.
22   **PMIX_TCP_URI "pmix.tcp.uri"** (**char***)
23   The URI of the PMIx server to connect to, or a file name containing it in the form of
24   **file:<name of file containing it>**.
25   **PMIX_TCP_IF_INCLUDE "pmix.tcp.ifinclude"** (**char***)
26   Comma-delimited list of devices and/or Classless Inter-Domain Routing (CIDR) notation to
27   include when establishing the TCP connection.
28   **PMIX_TCP_IF_EXCLUDE "pmix.tcp.ifexclude"** (**char***)
29   Comma-delimited list of devices and/or CIDR notation to exclude when establishing the
30   TCP connection.
31   **PMIX_TCP_IPV4_PORT "pmix.tcp.ipv4"** (**int**)
32   The IPv4 port to be used.
33   **PMIX_TCP_IPV6_PORT "pmix.tcp.ipv6"** (**int**)
34   The IPv6 port to be used.
35   **PMIX_TCP_DISABLE_IPV4 "pmix.tcp.disipv4"** (**bool**)
36   Set to **true** to disable IPv4 family of addresses.
37   **PMIX_TCP_DISABLE_IPV6 "pmix.tcp.disipv6"** (**bool**)
38   Set to **true** to disable IPv6 family of addresses.

3.4.7 Global Data Storage (GDS) attributes

These attributes are used to define the behavior of the GDS used to manage key/value pairs by passing them into the relevant initialization API - thus, they are not typically accessed via the **PMIx_Get** API.

PMIX_GDS_MODULE "pmix.gds.mod" (**char***)
    Comma-delimited string of desired modules.

3.4.8 General process-level attributes

These attributes are used to define process attributes and are referenced by their process rank.

PMIX_CPUSET "pmix.cpuset" (**char***)
    hwloc[2] bitmap to be applied to the process upon launch.
PMIX_CREDENTIAL "pmix.cred" (**char***)
    Security credential assigned to the process.
PMIX_SPAWNED "pmix.spawned" (**bool**)
    true if this process resulted from a call to **PMIx_Spawn**.
PMIX_ARCH "pmix.arch" (**uint32_t**)
    Architecture flag.

3.4.9 Scratch directory attributes

These attributes are used to define an application scratch directory and are referenced using the **PMIX_RANK_WILDCARD** rank.

PMIX_TMPDIR "pmix.tmpdir" (**char***)
    Full path to the top-level temporary directory assigned to the session.
PMIX_NSDIR "pmix.nsdir" (**char***)
    Full path to the temporary directory assigned to the namespace, under **PMIX_TMPDIR**.
PMIX_PROCDIR "pmix.pdir" (**char***)
    Full path to the subdirectory under **PMIX_NSDIR** assigned to the process.
PMIX_TDIR_RMCLEAN "pmix.tdir.rmclean" (**bool**)
    Resource Manager will clean session directories

3.4.10 Relative Rank Descriptive Attributes

These attributes are used to describe information about relative ranks as assigned by the RM, and thus are referenced using the process rank except where noted.

PMIX_CLUSTER_ID "pmix.clid" (**char***)
    A string name for the cluster this proc is executing on
PMIX_PROCID "pmix.procid" (**pmix_proc_t**)
    Process identifier

---

[2]https://www.open-mpi.org/projects/hwloc/

PMIX_NSPACE "pmix.nspace" (**char***)
    Namespace of the job.
PMIX_JOBID "pmix.jobid" (**char***)
    Job identifier assigned by the scheduler.
PMIX_APPNUM "pmix.appnum" (**uint32_t**)
    Application number within the job.
PMIX_RANK "pmix.rank" (**pmix_rank_t**)
    Process rank within the job.
PMIX_GLOBAL_RANK "pmix.grank" (**pmix_rank_t**)
    Process rank spanning across all jobs in this session.
PMIX_APP_RANK "pmix.apprank" (**pmix_rank_t**)
    Process rank within this application.
PMIX_NPROC_OFFSET "pmix.offset" (**pmix_rank_t**)
    Starting global rank of this job - referenced using **PMIX_RANK_WILDCARD**.
PMIX_LOCAL_RANK "pmix.lrank" (**uint16_t**)
    Local rank on this node within this job.
PMIX_NODE_RANK "pmix.nrank" (**uint16_t**)
    Process rank on this node spanning all jobs.
PMIX_LOCALLDR "pmix.lldr" (**pmix_rank_t**)
    Lowest rank on this node within this job - referenced using **PMIX_RANK_WILDCARD**.
PMIX_APPLDR "pmix.aldr" (**pmix_rank_t**)
    Lowest rank in this application within this job - referenced using **PMIX_RANK_WILDCARD**.
PMIX_PROC_PID "pmix.ppid" (**pid_t**)
    PID of specified process.
PMIX_SESSION_ID "pmix.session.id" (**uint32_t**)
    Session identifier - referenced using **PMIX_RANK_WILDCARD**.
PMIX_NODE_LIST "pmix.nlist" (**char***)
    Comma-delimited list of nodes running processes for the specified namespace - referenced
    using **PMIX_RANK_WILDCARD**.
PMIX_ALLOCATED_NODELIST "pmix.alist" (**char***)
    Comma-delimited list of all nodes in this allocation regardless of whether or not they
    currently host processes - referenced using **PMIX_RANK_WILDCARD**.
PMIX_HOSTNAME "pmix.hname" (**char***)
    Name of the host where the specified process is running.
PMIX_NODEID "pmix.nodeid" (**uint32_t**)
    Node identifier where the specified process is located, expressed as the node's index
    (beginning at zero) in the array resulting from expansion of the **PMIX_NODE_MAP** regular
    expression for the **job**
PMIX_LOCAL_PEERS "pmix.lpeers" (**char***)
    Comma-delimited list of ranks on this node within the specified namespace - referenced
    using **PMIX_RANK_WILDCARD**.
PMIX_LOCAL_PROCS "pmix.lprocs" (**pmix_proc_t array**)

1	Array of **pmix_proc_t** of all processes on the specified node - referenced using
2	**PMIX_RANK_WILDCARD**.
3	**PMIX_LOCAL_CPUSETS "pmix.lcpus"** (**char***)
4	Colon-delimited cpusets of local peers within the specified namespace - referenced using
5	**PMIX_RANK_WILDCARD**.
6	**PMIX_PROC_URI "pmix.puri"** (**char***)
7	URI containing contact information for a given process.
8	**PMIX_LOCALITY "pmix.loc"** (**uint16_t**)
9	Relative locality of the specified process to the requestor.
10	**PMIX_PARENT_ID "pmix.parent"** (**pmix_proc_t**)
11	Process identifier of the parent process of the calling process.
12	**PMIX_EXIT_CODE "pmix.exit.code"** (**int**)
13	Exit code returned when process terminated

3.4.11 Information retrieval attributes

The following attributes are used to specify the level of information (e.g., **session**, **job**, or **application**) being requested where ambiguity may exist - see 5.1.5 for examples of their use.

PMIX_SESSION_INFO "pmix.ssn.info" (**bool**)
    Return information about the specified session. If information about a session other than the one containing the requesting process is desired, then the attribute array must contain a **PMIX_SESSION_ID** attribute identifying the desired target.

PMIX_JOB_INFO "pmix.job.info" (**bool**)
    Return information about the specified job or namespace. If information about a job or namespace other than the one containing the requesting process is desired, then the attribute array must contain a **PMIX_JOBID** or **PMIX_NSPACE** attribute identifying the desired target. Similarly, if information is requested about a job or namespace in a session other than the one containing the requesting process, then an attribute identifying the target session must be provided.

PMIX_APP_INFO "pmix.app.info" (**bool**)
    Return information about the specified application. If information about an application other than the one containing the requesting process is desired, then the attribute array must contain a **PMIX_APPNUM** attribute identifying the desired target. Similarly, if information is requested about an application in a job or session other than the one containing the requesting process, then attributes identifying the target job and/or session must be provided.

PMIX_NODE_INFO "pmix.node.info" (**bool**)
    Return information about the specified node. If information about a node other than the one containing the requesting process is desired, then the attribute array must contain either the **PMIX_NODEID** or **PMIX_HOSTNAME** attribute identifying the desired target.

3.4.12 Information storage attributes

The following attributes are used to assemble information by its level (e.g., **session**, **job**, or **application**) for storage where ambiguity may exist - see 11.1.3.1 for examples of their use.

PMIX_SESSION_INFO_ARRAY **"pmix.ssn.arr"** (**pmix_data_array_t**)
    Provide an array of **pmix_info_t** containing session-level information. The **PMIX_SESSION_ID** attribute is required to be included in the array.

PMIX_JOB_INFO_ARRAY **"pmix.job.arr"** (**pmix_data_array_t**)
    Provide an array of **pmix_info_t** containing job-level information. The **PMIX_SESSION_ID** attribute of the **session** containing the **job** is required to be included in the array whenever the PMIx server library may host multiple sessions (e.g., when executing with a host RM daemon). As information is registered one job (aka namespace) at a time via the **PMIx_server_register_nspace** API, there is no requirement that the array contain either the **PMIX_NSPACE** or **PMIX_JOBID** attributes when used in that context (though either or both of them may be included). At least one of the job identifiers must be provided in all other contexts where the job being referenced is ambiguous.

PMIX_APP_INFO_ARRAY **"pmix.app.arr"** (**pmix_data_array_t**)
    Provide an array of **pmix_info_t** containing app-level information. The **PMIX_NSPACE** or **PMIX_JOBID** attributes of the **job** containing the application, plus its **PMIX_APPNUM** attribute, are must to be included in the array when the array is *not* included as part of a call to **PMIx_server_register_nspace** - i.e., when the job containing the application is ambiguous. The job identification is otherwise optional.

PMIX_NODE_INFO_ARRAY **"pmix.node.arr"** (**pmix_data_array_t**)
    Provide an array of **pmix_info_t** containing node-level information. At a minimum, either the **PMIX_NODEID** or **PMIX_HOSTNAME** attribute is required to be included in the array, though both may be included.

Note that these assemblages can be used hierarchically:

- a **PMIX_JOB_INFO_ARRAY** might contain multiple **PMIX_APP_INFO_ARRAY** elements, each describing values for a specific application within the job

- a **PMIX_JOB_INFO_ARRAY** could contain a **PMIX_NODE_INFO_ARRAY** for each node hosting processes from that job, each array describing job-level values for that node

- a **PMIX_SESSION_INFO_ARRAY** might contain multiple **PMIX_JOB_INFO_ARRAY** elements, each describing a job executing within the session. Each job array could, in turn, contain both application and node arrays, thus providing a complete picture of the active operations within the allocation

━━━━━━━━━━ Advice to PMIx library implementers ━━━━━━━━━━

PMIx implementations must be capable of properly parsing and storing any hierarchical depth of information arrays. The resulting stored values are must to be accessible via both **PMIx_Get** and **PMIx_Query_info_nb** APIs, assuming appropriate directives are provided by the caller.

3.4.13   Size information attributes

These attributes are used to describe the size of various dimensions of the PMIx universe - all are referenced using **PMIX_RANK_WILDCARD**.

PMIX_UNIV_SIZE "pmix.univ.size" (uint32_t)
> Number of allocated slots in a session - each slot may or may not be occupied by an executing process. Note that this attribute is the equivalent to the combination of **PMIX_SESSION_INFO_ARRAY** with the **PMIX_MAX_PROCS** entry in the array - it is included in the Standard for historical reasons.

PMIX_JOB_SIZE "pmix.job.size" (uint32_t)
> Total number of processes in this job across all contained applications. Note that this value can be different from **PMIX_MAX_PROCS**. For example, users may choose to subdivide an allocation (running several jobs in parallel within it), and dynamic programming models may support adding and removing processes from a running **job** on-they-fly. In the latter case, PMIx events must be used to notify processes within the job that the job size has changed.

PMIX_JOB_NUM_APPS "pmix.job.napps" (uint32_t)
> Number of applications in this job.

PMIX_APP_SIZE "pmix.app.size" (uint32_t)
> Number of processes in this application.

PMIX_LOCAL_SIZE "pmix.local.size" (uint32_t)
> Number of processes in this job or application on this node.

PMIX_NODE_SIZE "pmix.node.size" (uint32_t)
> Number of processes across all jobs on this node.

PMIX_MAX_PROCS "pmix.max.size" (uint32_t)
> Maximum number of processes that can be executed in this context (session, namespace, application, or node). Typically, this is a constraint imposed by a scheduler or by user settings in a hostfile or other resource description.

PMIX_NUM_SLOTS "pmix.num.slots" (uint32_t)
> Number of slots allocated in this context (session, namespace, application, or node). Note that this attribute is the equivalent to **PMIX_MAX_PROCS** used in the corresponding context - it is included in the Standard for historical reasons.

PMIX_NUM_NODES "pmix.num.nodes" (uint32_t)
> Number of nodes in this session, or that are currently executing processes from the associated namespace or application.

3.4.14   Memory information attributes

These attributes are used to describe memory available and used in the system - all are referenced using **PMIX_RANK_WILDCARD**.

PMIX_AVAIL_PHYS_MEMORY "pmix.pmem" (**uint64_t**)
   Total available physical memory on this node.
PMIX_DAEMON_MEMORY "pmix.dmn.mem" (**float**)
   Megabytes of memory currently used by the RM daemon.
PMIX_CLIENT_AVG_MEMORY "pmix.cl.mem.avg" (**float**)
   Average Megabytes of memory used by client processes.

3.4.15   Topology information attributes

These attributes are used to describe topology information in the PMIx universe - all are referenced using **PMIX_RANK_WILDCARD** except where noted.

PMIX_NET_TOPO "pmix.ntopo" (**char***)
   eXtensible Markup Language (XML) representation of the network topology.
PMIX_LOCAL_TOPO "pmix.ltopo" (**char***)
   XML representation of local node topology.
PMIX_TOPOLOGY "pmix.topo" (**hwloc_topology_t**)
   Pointer to the PMIx client's internal hwloc topology object.
PMIX_TOPOLOGY_XML "pmix.topo.xml" (**char***)
   XML-based description of topology
PMIX_TOPOLOGY_FILE "pmix.topo.file" (**char***)
   Full path to file containing XML topology description
PMIX_TOPOLOGY_SIGNATURE "pmix.toposig" (**char***)
   Topology signature string.
PMIX_LOCALITY_STRING "pmix.locstr" (**char***)
   String describing a process's bound location - referenced using the process's rank. The string
   is of the form:
   NM%s:SK%s:L3%s:L2%s:L1%s:CR%s:HT%s
   Where the **%s** is replaced with an integer index or inclusive range for hwloc. **NM** identifies
   the numa node(s). **SK** identifies the socket(s). **L3** identifies the L3 cache(s). **L2** identifies the
   L2 cache(s). **L1** identifies the L1 cache(s). **CR** identifies the cores(s). **HT** identifies the
   hardware thread(s). If your architecture does not have the specified hardware designation
   then it can be omitted from the signature.
   For example: **NM0:SK0:L30-4:L20-4:L10-4:CR0-4:HT0-39**.
   This means numa node **0**, socket **0**, L3 caches **0,1,2,3,4**, L2 caches **0-4**, L1 caches
   0-4, cores **0,1,2,3,4**, and hardware threads **0-39**.
PMIX_HWLOC_SHMEM_ADDR "pmix.hwlocaddr" (**size_t**)
   Address of the HWLOC shared memory segment.
PMIX_HWLOC_SHMEM_SIZE "pmix.hwlocsize" (**size_t**)
   Size of the HWLOC shared memory segment.

```
1       PMIX_HWLOC_SHMEM_FILE "pmix.hwlocfile" (char*)
2           Path to the HWLOC shared memory file.
3       PMIX_HWLOC_XML_V1 "pmix.hwlocxml1" (char*)
4           XML representation of local topology using HWLOC's v1.x format.
5       PMIX_HWLOC_XML_V2 "pmix.hwlocxml2" (char*)
6           XML representation of local topology using HWLOC's v2.x format.
7       PMIX_HWLOC_SHARE_TOPO "pmix.hwlocsh" (bool)
8           Share the HWLOC topology via shared memory
9       PMIX_HWLOC_HOLE_KIND "pmix.hwlocholek" (char*)
10          Kind of VM "hole" HWLOC should use for shared memory
```

3.4.16 Request-related attributes

These attributes are used to influence the behavior of various PMIx operations - they do not represent values accessed using the **PMIx_Get** API.

```
14      PMIX_COLLECT_DATA "pmix.collect" (bool)
15          Collect data and return it at the end of the operation.
16      PMIX_TIMEOUT "pmix.timeout" (int)
17          Time in seconds before the specified operation should time out (0 indicating infinite) in
18          error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
19          the target process from ever exposing its data.
20      PMIX_IMMEDIATE "pmix.immediate" (bool)
21          Specified operation should immediately return an error from the PMIx server if the requested
22          data cannot be found - do not request it from the host RM.
23      PMIX_WAIT "pmix.wait" (int)
24          Caller requests that the PMIx server wait until at least the specified number of values are
25          found (0 indicates all and is the default).
26      PMIX_COLLECTIVE_ALGO "pmix.calgo" (char*)
27          Comma-delimited list of algorithms to use for the collective operation. PMIx does not
28          impose any requirements on a host environment's collective algorithms. Thus, the
29          acceptable values for this attribute will be environment-dependent - users are encouraged to
30          check their host environment for supported values.
31      PMIX_COLLECTIVE_ALGO_REQD "pmix.calreqd" (bool)
32          If true, indicates that the requested choice of algorithm is mandatory.
33      PMIX_NOTIFY_COMPLETION "pmix.notecomp" (bool)
34          Notify the parent process upon termination of child job.
35      PMIX_RANGE "pmix.range" (pmix_data_range_t)
36          Value for calls to publish/lookup/unpublish or for monitoring event notifications.
37      PMIX_PERSISTENCE "pmix.persist" (pmix_persistence_t)
38          Value for calls to PMIx_Publish.
39      PMIX_DATA_SCOPE "pmix.scope" (pmix_scope_t)
40          Scope of the data to be found in a PMIx_Get call.
41      PMIX_OPTIONAL "pmix.optional" (bool)
```

Look only in the client's local data store for the requested value - do not request data from the PMIx server if not found.

PMIX_EMBED_BARRIER "pmix.embed.barrier" (bool)

Execute a blocking fence operation before executing the specified operation. For example, **PMIx_Finalize** does not include an internal barrier operation by default. This attribute would direct **PMIx_Finalize** to execute a barrier as part of the finalize operation.

PMIX_JOB_TERM_STATUS "pmix.job.term.status" (pmix_status_t)

Status to be returned upon job termination.

PMIX_PROC_STATE_STATUS "pmix.proc.state" (pmix_proc_state_t)

Process state

3.4.17 Server-to-PMIx library attributes

Attributes used by the host environment to pass data to its PMIx server library. The data will then be parsed and provided to the local PMIx clients. These attributes are all referenced using **PMIX_RANK_WILDCARD** except where noted.

PMIX_REGISTER_NODATA "pmix.reg.nodata" (bool)

Registration is for this namespace only, do not copy job data - this attribute is not accessed using the **PMIx_Get**

PMIX_PROC_DATA "pmix.pdata" (pmix_data_array_t)

Array of process data. Starts with rank, then contains more data.

PMIX_NODE_MAP "pmix.nmap" (char*)

Regular expression of nodes - see 11.1.3.1 for an explanation of its generation.

PMIX_PROC_MAP "pmix.pmap" (char*)

Regular expression describing processes on each node - see 11.1.3.1 for an explanation of its generation.

PMIX_ANL_MAP "pmix.anlmap" (char*)

Process mapping in Argonne National Laboratory's PMI-1/PMI-2 notation.

PMIX_APP_MAP_TYPE "pmix.apmap.type" (char*)

Type of mapping used to layout the application (e.g., **cyclic**).

PMIX_APP_MAP_REGEX "pmix.apmap.regex" (char*)

Regular expression describing the result of the process mapping.

3.4.18 Server-to-Client attributes

Attributes used internally to communicate data from the PMIx server to the PMIx client - they do not represent values accessed using the **PMIx_Get** API.

PMIX_PROC_BLOB "pmix.pblob" (pmix_byte_object_t)

Packed blob of process data.

PMIX_MAP_BLOB "pmix.mblob" (pmix_byte_object_t)

Packed blob of process location.

3.4.19 Event handler registration and notification attributes

Attributes to support event registration and notification - they are values passed to the event registration and notification APIs and therefore are not accessed using the **PMIx_Get** API.

PMIX_EVENT_HDLR_NAME "pmix.evname" (**char***)
　　String name identifying this handler.
PMIX_EVENT_HDLR_FIRST "pmix.evfirst" (**bool**)
　　Invoke this event handler before any other handlers.
PMIX_EVENT_HDLR_LAST "pmix.evlast" (**bool**)
　　Invoke this event handler after all other handlers have been called.
PMIX_EVENT_HDLR_FIRST_IN_CATEGORY "pmix.evfirstcat" (**bool**)
　　Invoke this event handler before any other handlers in this category.
PMIX_EVENT_HDLR_LAST_IN_CATEGORY "pmix.evlastcat" (**bool**)
　　Invoke this event handler after all other handlers in this category have been called.
PMIX_EVENT_HDLR_BEFORE "pmix.evbefore" (**char***)
　　Put this event handler immediately before the one specified in the **(char*)** value.
PMIX_EVENT_HDLR_AFTER "pmix.evafter" (**char***)
　　Put this event handler immediately after the one specified in the **(char*)** value.
PMIX_EVENT_HDLR_PREPEND "pmix.evprepend" (**bool**)
　　Prepend this handler to the precedence list within its category.
PMIX_EVENT_HDLR_APPEND "pmix.evappend" (**bool**)
　　Append this handler to the precedence list within its category.
PMIX_EVENT_CUSTOM_RANGE "pmix.evrange" (**pmix_data_array_t***)
　　Array of **pmix_proc_t** defining range of event notification.
PMIX_EVENT_AFFECTED_PROC "pmix.evproc" (**pmix_proc_t**)
　　The single process that was affected.
PMIX_EVENT_AFFECTED_PROCS "pmix.evaffected" (**pmix_data_array_t***)
　　Array of **pmix_proc_t** defining affected processes.
PMIX_EVENT_NON_DEFAULT "pmix.evnondef" (**bool**)
　　Event is not to be delivered to default event handlers.
PMIX_EVENT_RETURN_OBJECT "pmix.evobject" (**void ***)
　　Object to be returned whenever the registered callback function **cbfunc** is invoked. The object will only be returned to the process that registered it.
PMIX_EVENT_DO_NOT_CACHE "pmix.evnocache" (**bool**)
　　Instruct the PMIx server not to cache the event.
PMIX_EVENT_SILENT_TERMINATION "pmix.evsilentterm" (**bool**)
　　Do not generate an event when this job normally terminates.
PMIX_EVENT_PROXY "pmix.evproxy" (**pmix_proc_t***)
　　PMIx server that sourced the event
PMIX_EVENT_TEXT_MESSAGE "pmix.evtext" (**char***)
　　Text message suitable for output by recipient - e.g., describing the cause of the event

3.4.20 Fault tolerance attributes

Attributes to support fault tolerance behaviors - they are values passed to the event notification API and therefore are not accessed using the **PMIx_Get** API.

PMIX_EVENT_TERMINATE_SESSION "pmix.evterm.sess" (**bool**)
 The RM intends to terminate this session.
PMIX_EVENT_TERMINATE_JOB "pmix.evterm.job" (**bool**)
 The RM intends to terminate this job.
PMIX_EVENT_TERMINATE_NODE "pmix.evterm.node" (**bool**)
 The RM intends to terminate all processes on this node.
PMIX_EVENT_TERMINATE_PROC "pmix.evterm.proc" (**bool**)
 The RM intends to terminate just this process.
PMIX_EVENT_ACTION_TIMEOUT "pmix.evtimeout" (**int**)
 The time in seconds before the RM will execute error response.
PMIX_EVENT_NO_TERMINATION "pmix.evnoterm" (**bool**)
 Indicates that the handler has satisfactorily handled the event and believes termination of the application is not required.
PMIX_EVENT_WANT_TERMINATION "pmix.evterm" (**bool**)
 Indicates that the handler has determined that the application should be terminated

3.4.21 Spawn attributes

Attributes used to describe **PMIx_Spawn** behavior - they are values passed to the **PMIx_Spawn** API and therefore are not accessed using the **PMIx_Get** API when used in that context. However, some of the attributes defined in this section can be provided by the host environment for other purposes - e.g., the environment might provide the **PMIX_MAPPER** attribute in the job-related information so that an application can use **PMIx_Get** to discover the layout algorithm used for determining process locations. Multi-use attributes and their respective access reference rank are denoted below.

PMIX_PERSONALITY "pmix.pers" (**char***)
 Name of personality to use.
PMIX_HOST "pmix.host" (**char***)
 Comma-delimited list of hosts to use for spawned processes.
PMIX_HOSTFILE "pmix.hostfile" (**char***)
 Hostfile to use for spawned processes.
PMIX_ADD_HOST "pmix.addhost" (**char***)
 Comma-delimited list of hosts to add to the allocation.
PMIX_ADD_HOSTFILE "pmix.addhostfile" (**char***)
 Hostfile listing hosts to add to existing allocation.
PMIX_PREFIX "pmix.prefix" (**char***)
 Prefix to use for starting spawned processes.
PMIX_WDIR "pmix.wdir" (**char***)
 Working directory for spawned processes.

1   **PMIX_MAPPER "pmix.mapper"** (**char***)
2   Mapping mechanism to use for placing spawned processes - when accessed using
3   **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping
4   mechanism used for the provided namespace.
5   **PMIX_DISPLAY_MAP "pmix.dispmap"** (**bool**)
6   Display process mapping upon spawn.
7   **PMIX_PPR "pmix.ppr"** (**char***)
8   Number of processes to spawn on each identified resource.
9   **PMIX_MAPBY "pmix.mapby"** (**char***)
10   Process mapping policy - when accessed using **PMIx_Get**, use the
11   **PMIX_RANK_WILDCARD** value for the rank to discover the mapping policy used for the
12   provided namespace
13 **PMIX_RANKBY "pmix.rankby"** (**char***)
14   Process ranking policy - when accessed using **PMIx_Get**, use the
15   **PMIX_RANK_WILDCARD** value for the rank to discover the ranking algorithm used for the
16   provided namespace
17 **PMIX_BINDTO "pmix.bindto"** (**char***)
18   Process binding policy - when accessed using **PMIx_Get**, use the
19   **PMIX_RANK_WILDCARD** value for the rank to discover the binding policy used for the
20   provided namespace
21 **PMIX_PRELOAD_BIN "pmix.preloadbin"** (**bool**)
22   Preload binaries onto nodes.
23 **PMIX_PRELOAD_FILES "pmix.preloadfiles"** (**char***)
24   Comma-delimited list of files to pre-position on nodes.
25 **PMIX_NON_PMI "pmix.nonpmi"** (**bool**)
26   Spawned processes will not call **PMIx_Init**.
27 **PMIX_STDIN_TGT "pmix.stdin"** (**uint32_t**)
28   Spawned process rank that is to receive **stdin**.
29 **PMIX_FWD_STDIN "pmix.fwd.stdin"** (**bool**)
30   Forward this process's **stdin** to the designated process.
31 **PMIX_FWD_STDOUT "pmix.fwd.stdout"** (**bool**)
32   Forward **stdout** from spawned processes to this process.
33 **PMIX_FWD_STDERR "pmix.fwd.stderr"** (**bool**)
34   Forward **stderr** from spawned processes to this process.
35 **PMIX_FWD_STDDIAG "pmix.fwd.stddiag"** (**bool**)
36   If a diagnostic channel exists, forward any output on it from the spawned processes to this
37   process (typically used by a tool)
38 **PMIX_DEBUGGER_DAEMONS "pmix.debugger"** (**bool**)
39   Spawned application consists of debugger daemons.
40 **PMIX_COSPAWN_APP "pmix.cospawn"** (**bool**)
41   Designated application is to be spawned as a disconnected job. Meaning that it is not part of
42   the "comm_world" of the parent process.
43 **PMIX_SET_SESSION_CWD "pmix.ssncwd"** (**bool**)

Set the application's current working directory to the session working directory assigned by the RM - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the session working directory assigned to the provided namespace

PMIX_TAG_OUTPUT "pmix.tagout" (**bool**)
    Tag application output with the identity of the source process.

PMIX_TIMESTAMP_OUTPUT "pmix.tsout" (**bool**)
    Timestamp output from applications.

PMIX_MERGE_STDERR_STDOUT "pmix.mergeerrout" (**bool**)
    Merge **stdout** and **stderr** streams from application processes.

PMIX_OUTPUT_TO_FILE "pmix.outfile" (**char***)
    Output application output to the specified file.

PMIX_INDEX_ARGV "pmix.indxargv" (**bool**)
    Mark the **argv** with the rank of the process.

PMIX_CPUS_PER_PROC "pmix.cpuperproc" (**uint32_t**)
    Number of cpus to assign to each rank - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the cpus/process assigned to the provided namespace

PMIX_NO_PROCS_ON_HEAD "pmix.nolocal" (**bool**)
    Do not place processes on the head node.

PMIX_NO_OVERSUBSCRIBE "pmix.noover" (**bool**)
    Do not oversubscribe the cpus.

PMIX_REPORT_BINDINGS "pmix.repbind" (**bool**)
    Report bindings of the individual processes.

PMIX_CPU_LIST "pmix.cpulist" (**char***)
    List of cpus to use for this job - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the cpu list used for the provided namespace

PMIX_JOB_RECOVERABLE "pmix.recover" (**bool**)
    Application supports recoverable operations.

PMIX_JOB_CONTINUOUS "pmix.continuous" (**bool**)
    Application is continuous, all failed processes should be immediately restarted.

PMIX_MAX_RESTARTS "pmix.maxrestarts" (**uint32_t**)
    Maximum number of times to restart a job - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the max restarts for the provided namespace

PMIX_SPAWN_TOOL "pmix.spwn.tool" (**bool**)
    Indicate that the job being spawned is a tool

3.4.22 Query attributes

Attributes used to describe **PMIx_Query_info_nb** behavior - these are values passed to the **PMIx_Query_info_nb** API and therefore are not passed to the **PMIx_Get** API.

PMIX_QUERY_REFRESH_CACHE "pmix.qry.rfsh" (**bool**)

1	Retrieve updated information from server.
2	**PMIX_QUERY_NAMESPACES "pmix.qry.ns"** (**char***)
3	Request a comma-delimited list of active namespaces.
4	**PMIX_QUERY_JOB_STATUS "pmix.qry.jst"** (**pmix_status_t**)
5	Status of a specified, currently executing job.
6	**PMIX_QUERY_QUEUE_LIST "pmix.qry.qlst"** (**char***)
7	Request a comma-delimited list of scheduler queues.
8	**PMIX_QUERY_QUEUE_STATUS "pmix.qry.qst"** (**TBD**)
9	Status of a specified scheduler queue.
10	**PMIX_QUERY_PROC_TABLE "pmix.qry.ptable"** (**char***)
11	Input namespace of the job whose information is being requested returns
12	(**pmix_data_array_t**) an array of **pmix_proc_info_t**.
13	**PMIX_QUERY_LOCAL_PROC_TABLE "pmix.qry.lptable"** (**char***)
14	Input namespace of the job whose information is being requested returns
15	(**pmix_data_array_t**) an array of **pmix_proc_info_t** for processes in job on same
16	node.
17	**PMIX_QUERY_AUTHORIZATIONS "pmix.qry.auths"** (**bool**)
18	Return operations the PMIx tool is authorized to perform.
19	**PMIX_QUERY_SPAWN_SUPPORT "pmix.qry.spawn"** (**bool**)
20	Return a comma-delimited list of supported spawn attributes.
21	**PMIX_QUERY_DEBUG_SUPPORT "pmix.qry.debug"** (**bool**)
22	Return a comma-delimited list of supported debug attributes.
23	**PMIX_QUERY_MEMORY_USAGE "pmix.qry.mem"** (**bool**)
24	Return information on memory usage for the processes indicated in the qualifiers.
25	**PMIX_QUERY_LOCAL_ONLY "pmix.qry.local"** (**bool**)
26	Constrain the query to local information only.
27	**PMIX_QUERY_REPORT_AVG "pmix.qry.avg"** (**bool**)
28	Report only average values for sampled information.
29	**PMIX_QUERY_REPORT_MINMAX "pmix.qry.minmax"** (**bool**)
30	Report minimum and maximum values.
31	**PMIX_QUERY_ALLOC_STATUS "pmix.query.alloc"** (**char***)
32	String identifier of the allocation whose status is being requested.
33	**PMIX_TIME_REMAINING "pmix.time.remaining"** (**char***)
34	Query number of seconds (**uint32_t**) remaining in allocation for the specified namespace.

3.4.23 Log attributes

36   Attributes used to describe **PMIx_Log_nb** behavior - these are values passed to the
37   **PMIx_Log_nb** API and therefore are not accessed using the **PMIx_Get** API.

38   **PMIX_LOG_SOURCE "pmix.log.source"** (**pmix_proc_t***)
39   ID of source of the log request
40   **PMIX_LOG_STDERR "pmix.log.stderr"** (**char***)
41   Log string to **stderr**.

```
1    PMIX_LOG_STDOUT "pmix.log.stdout" (char*)
2        Log string to stdout.
3    PMIX_LOG_SYSLOG "pmix.log.syslog" (char*)
4        Log data to syslog. Defaults to ERROR priority. Will log to global syslog if available,
5        otherwise to local syslog
6    PMIX_LOG_LOCAL_SYSLOG "pmix.log.lsys" (char*)
7        Log data to local syslog. Defaults to ERROR priority.
8    PMIX_LOG_GLOBAL_SYSLOG "pmix.log.gsys" (char*)
9        Forward data to system "gateway" and log msg to that syslog Defaults to ERROR priority.
10   PMIX_LOG_SYSLOG_PRI "pmix.log.syspri" (int)
11       Syslog priority level
12   PMIX_LOG_TIMESTAMP "pmix.log.tstmp" (time_t)
13       Timestamp for log report
14   PMIX_LOG_GENERATE_TIMESTAMP "pmix.log.gtstmp" (bool)
15       Generate timestamp for log
16   PMIX_LOG_TAG_OUTPUT "pmix.log.tag" (bool)
17       Label the output stream with the channel name (e.g., "stdout")
18   PMIX_LOG_TIMESTAMP_OUTPUT "pmix.log.tsout" (bool)
19       Print timestamp in output string
20   PMIX_LOG_XML_OUTPUT "pmix.log.xml" (bool)
21       Print the output stream in XML format
22   PMIX_LOG_ONCE "pmix.log.once" (bool)
23       Only log this once with whichever channel can first support it, taking the channels in priority
24       order
25   PMIX_LOG_MSG "pmix.log.msg" (pmix_byte_object_t)
26       Message blob to be sent somewhere.
27   PMIX_LOG_EMAIL "pmix.log.email" (pmix_data_array_t)
28       Log via email based on pmix_info_t containing directives.
29   PMIX_LOG_EMAIL_ADDR "pmix.log.emaddr" (char*)
30       Comma-delimited list of email addresses that are to receive the message.
31   PMIX_LOG_EMAIL_SENDER_ADDR "pmix.log.emfaddr" (char*)
32       Return email address of sender
33   PMIX_LOG_EMAIL_SUBJECT "pmix.log.emsub" (char*)
34       Subject line for email.
35   PMIX_LOG_EMAIL_MSG "pmix.log.emmsg" (char*)
36       Message to be included in email.
37   PMIX_LOG_EMAIL_SERVER "pmix.log.esrvr" (char*)
38       Hostname (or IP address) of estmp server
39   PMIX_LOG_EMAIL_SRVR_PORT "pmix.log.esrvrprt" (int32_t)
40       Port the email server is listening to
41   PMIX_LOG_GLOBAL_DATASTORE "pmix.log.gstore" (bool)
42       Store the log data in a global data store (e.g., database)
43   PMIX_LOG_JOB_RECORD "pmix.log.jrec" (bool)
```

1   Log the provided information to the host environment's job record

3.4.24   Debugger attributes

Attributes used to assist debuggers - these are values that can be passed to the **PMIx_Spawn** or
PMIx_Init APIs. Some may be accessed using the **PMIx_Get** API with the
PMIX_RANK_WILDCARD rank.

PMIX_DEBUG_STOP_ON_EXEC "pmix.dbg.exec" (**bool**)
       Passed to **PMIx_Spawn** to indicate that the specified application is being spawned under
       debugger, and that the launcher is to pause the resulting application processes on first
       instruction for debugger attach.
PMIX_DEBUG_STOP_IN_INIT "pmix.dbg.init" (**bool**)
       Passed to **PMIx_Spawn** to indicate that the specified application is being spawned under
       debugger, and that the PMIx client library is to pause the resulting application processes
       during **PMIx_Init** until debugger attach and release.
PMIX_DEBUG_WAIT_FOR_NOTIFY "pmix.dbg.notify" (**bool**)
       Passed to **PMIx_Spawn** to indicate that the specified application is being spawned under
       debugger, and that the resulting application processes are to pause at some
       application-determined location until debugger attach and release.
PMIX_DEBUG_JOB "pmix.dbg.job" (**char***)
       Namespace of the job to be debugged - provided to the debugger upon launch.
PMIX_DEBUG_WAITING_FOR_NOTIFY "pmix.dbg.waiting" (**bool**)
       Job to be debugged is waiting for a release - this is not a value accessed using the
       PMIx_Get API.
PMIX_DEBUG_JOB_DIRECTIVES "pmix.dbg.jdirs" (**pmix_data_array_t***)
       Array of job-level directives
PMIX_DEBUG_APP_DIRECTIVES "pmix.dbg.adirs" (**pmix_data_array_t***)
       Array of app-level directives

3.4.25   Resource manager attributes

Attributes used to describe the RM - these are values assigned by the host environment and accessed
using the **PMIx_Get** API. The value of the provided namespace is unimportant but should be
given as the namespace of the requesting process and a rank of **PMIX_RANK_WILDCARD** used to
indicate that the information will be found with the job-level information.

PMIX_RM_NAME "pmix.rm.name" (**char***)
       String name of the RM.
PMIX_RM_VERSION "pmix.rm.version" (**char***)
       RM version string.

3.4.26 Environment variable attributes

Attributes used to adjust environment variables - these are values passed to the **PMIx_Spawn** API and are not accessed using the **PMIx_Get** API.

PMIX_SET_ENVAR "pmix.envar.set" (pmix_envar_t*)
    Set the envar to the given value, overwriting any pre-existing one
PMIX_UNSET_ENVAR "pmix.envar.unset" (char*)
    Unset the environment variable specified in the string.
PMIX_ADD_ENVAR "pmix.envar.add" (pmix_envar_t*)
    Add the environment variable, but do not overwrite any pre-existing one
PMIX_PREPEND_ENVAR "pmix.envar.prepnd" (pmix_envar_t*)
    Prepend the given value to the specified environmental value using the given separator
    character, creating the variable if it doesn't already exist
PMIX_APPEND_ENVAR "pmix.envar.appnd" (pmix_envar_t*)
    Append the given value to the specified environmental value using the given separator
    character, creating the variable if it doesn't already exist

3.4.27 Job Allocation attributes

Attributes used to describe the job allocation - these are values passed to and/or returned by the **PMIx_Allocation_request_nb** and **PMIx_Allocation_request** APIs and are not accessed using the **PMIx_Get** API

PMIX_ALLOC_REQ_ID "pmix.alloc.reqid" (char*)
    User-provided string identifier for this allocation request which can later be used to query
    status of the request.
PMIX_ALLOC_ID "pmix.alloc.id" (char*)
    A string identifier (provided by the host environment) for the resulting allocation which can
    later be used to reference the allocated resources in, for example, a call to **PMIx_Spawn**.
PMIX_ALLOC_NUM_NODES "pmix.alloc.nnodes" (uint64_t)
    The number of nodes.
PMIX_ALLOC_NODE_LIST "pmix.alloc.nlist" (char*)
    Regular expression of the specific nodes.
PMIX_ALLOC_NUM_CPUS "pmix.alloc.ncpus" (uint64_t)
    Number of cpus.
PMIX_ALLOC_NUM_CPU_LIST "pmix.alloc.ncpulist" (char*)
    Regular expression of the number of cpus for each node.
PMIX_ALLOC_CPU_LIST "pmix.alloc.cpulist" (char*)
    Regular expression of the specific cpus indicating the cpus involved.
PMIX_ALLOC_MEM_SIZE "pmix.alloc.msize" (float)
    Number of Megabytes.
PMIX_ALLOC_NETWORK "pmix.alloc.net" (array)

1   Array of **`pmix_info_t`** describing requested network resources. This must include at
2   least: **`PMIX_ALLOC_NETWORK_ID`**, **`PMIX_ALLOC_NETWORK_TYPE`**, and
3   **`PMIX_ALLOC_NETWORK_ENDPTS`**, plus whatever other descriptors are desired.
4   **`PMIX_ALLOC_NETWORK_ID "pmix.alloc.netid"`** (**`char*`**)
5   The key to be used when accessing this requested network allocation. The allocation will be
6   returned/stored as a **`pmix_data_array_t`** of **`pmix_info_t`** indexed by this key and
7   containing at least one entry with the same key and the allocated resource description. The
8   type of the included value depends upon the network support. For example, a TCP allocation
9   might consist of a comma-delimited string of socket ranges such as
10   *"32000-32100,33005,38123-38146"*. Additional entries will consist of any provided
11   resource request directives, along with their assigned values. Examples include:
12   **`PMIX_ALLOC_NETWORK_TYPE`** - the type of resources provided;
13   **`PMIX_ALLOC_NETWORK_PLANE`** - if applicable, what plane the resources were assigned
14   from; **`PMIX_ALLOC_NETWORK_QOS`** - the assigned QoS; **`PMIX_ALLOC_BANDWIDTH`** -
15   the allocated bandwidth; **`PMIX_ALLOC_NETWORK_SEC_KEY`** - a security key for the
16   requested network allocation. NOTE: the assigned values may differ from those requested,
17   especially if **`PMIX_INFO_REQD`** was not set in the request.
18   **`PMIX_ALLOC_BANDWIDTH "pmix.alloc.bw"`** (**`float`**)
19   Mbits/sec.
20   **`PMIX_ALLOC_NETWORK_QOS "pmix.alloc.netqos"`** (**`char*`**)
21   Quality of service level.
22   **`PMIX_ALLOC_TIME "pmix.alloc.time"`** (**`uint32_t`**)
23   Time in seconds.
24   **`PMIX_ALLOC_NETWORK_TYPE "pmix.alloc.nettype"`** (**`char*`**)
25   Type of desired transport (e.g., *"tcp"*, *"udp"*)
26   **`PMIX_ALLOC_NETWORK_PLANE "pmix.alloc.netplane"`** (**`char*`**)
27   ID string for the NIC (aka *plane*) to be used for this allocation (e.g., CIDR for Ethernet)
28   **`PMIX_ALLOC_NETWORK_ENDPTS "pmix.alloc.endpts"`** (**`size_t`**)
29   Number of endpoints to allocate per process
30   **`PMIX_ALLOC_NETWORK_ENDPTS_NODE "pmix.alloc.endpts.nd"`** (**`size_t`**)
31   Number of endpoints to allocate per node
32   **`PMIX_ALLOC_NETWORK_SEC_KEY "pmix.alloc.nsec"`** (**`pmix_byte_object_t`**)
33   Network security key

3.4.28 Job control attributes

35   Attributes used to request control operations on an executing application - these are values passed
36   to the **`PMIx_Job_control_nb`** API and are not accessed using the **`PMIx_Get`** API.

37   **`PMIX_JOB_CTRL_ID "pmix.jctrl.id"`** (**`char*`**)
38   Provide a string identifier for this request.
39   **`PMIX_JOB_CTRL_PAUSE "pmix.jctrl.pause"`** (**`bool`**)
40   Pause the specified processes.
41   **`PMIX_JOB_CTRL_RESUME "pmix.jctrl.resume"`** (**`bool`**)

Resume ("un-pause") the specified processes.

PMIX_JOB_CTRL_CANCEL "pmix.jctrl.cancel" (**char***)

Cancel the specified request (**NULL** implies cancel all requests from this requestor).

PMIX_JOB_CTRL_KILL "pmix.jctrl.kill" (**bool**)

Forcibly terminate the specified processes and cleanup.

PMIX_JOB_CTRL_RESTART "pmix.jctrl.restart" (**char***)

Restart the specified processes using the given checkpoint ID.

PMIX_JOB_CTRL_CHECKPOINT "pmix.jctrl.ckpt" (**char***)

Checkpoint the specified processes and assign the given ID to it.

PMIX_JOB_CTRL_CHECKPOINT_EVENT "pmix.jctrl.ckptev" (**bool**)

Use event notification to trigger a process checkpoint.

PMIX_JOB_CTRL_CHECKPOINT_SIGNAL "pmix.jctrl.ckptsig" (**int**)

Use the given signal to trigger a process checkpoint.

PMIX_JOB_CTRL_CHECKPOINT_TIMEOUT "pmix.jctrl.ckptsig" (**int**)

Time in seconds to wait for a checkpoint to complete.

PMIX_JOB_CTRL_CHECKPOINT_METHOD
"pmix.jctrl.ckmethod" (**pmix_data_array_t**)

Array of **pmix_info_t** declaring each method and value supported by this application.

PMIX_JOB_CTRL_SIGNAL "pmix.jctrl.sig" (**int**)

Send given signal to specified processes.

PMIX_JOB_CTRL_PROVISION "pmix.jctrl.pvn" (**char***)

Regular expression identifying nodes that are to be provisioned.

PMIX_JOB_CTRL_PROVISION_IMAGE "pmix.jctrl.pvnimg" (**char***)

Name of the image that is to be provisioned.

PMIX_JOB_CTRL_PREEMPTIBLE "pmix.jctrl.preempt" (**bool**)

Indicate that the job can be pre-empted.

PMIX_JOB_CTRL_TERMINATE "pmix.jctrl.term" (**bool**)

Politely terminate the specified processes.

PMIX_REGISTER_CLEANUP "pmix.reg.cleanup" (**char***)

Comma-delimited list of files to be removed upon process termination

PMIX_REGISTER_CLEANUP_DIR "pmix.reg.cleanupdir" (**char***)

Comma-delimited list of directories to be removed upon process termination

PMIX_CLEANUP_RECURSIVE "pmix.clnup.recurse" (**bool**)

Recursively cleanup all subdirectories under the specified one(s)

PMIX_CLEANUP_EMPTY "pmix.clnup.empty" (**bool**)

Only remove empty subdirectories

PMIX_CLEANUP_IGNORE "pmix.clnup.ignore" (**char***)

Comma-delimited list of filenames that are not to be removed

PMIX_CLEANUP_LEAVE_TOPDIR "pmix.clnup.lvtop" (**bool**)

When recursively cleaning subdirectories, do not remove the top-level directory (the one given in the cleanup request)

3.4.29 Monitoring attributes

Attributes used to control monitoring of an executing application- these are values passed to the
PMIx_Process_monitor_nb API and are not accessed using the **PMIx_Get** API.

PMIX_MONITOR_ID "pmix.monitor.id" (**char***)
        Provide a string identifier for this request.
PMIX_MONITOR_CANCEL "pmix.monitor.cancel" (**char***)
        Identifier to be canceled (**NULL** means cancel all monitoring for this process).
PMIX_MONITOR_APP_CONTROL "pmix.monitor.appctrl" (**bool**)
        The application desires to control the response to a monitoring event.
PMIX_MONITOR_HEARTBEAT "pmix.monitor.mbeat" (**void**)
        Register to have the PMIx server monitor the requestor for heartbeats.
PMIX_SEND_HEARTBEAT "pmix.monitor.beat" (**void**)
        Send heartbeat to local PMIx server.
PMIX_MONITOR_HEARTBEAT_TIME "pmix.monitor.btime" (**uint32_t**)
        Time in seconds before declaring heartbeat missed.
PMIX_MONITOR_HEARTBEAT_DROPS "pmix.monitor.bdrop" (**uint32_t**)
        Number of heartbeats that can be missed before generating the event.
PMIX_MONITOR_FILE "pmix.monitor.fmon" (**char***)
        Register to monitor file for signs of life.
PMIX_MONITOR_FILE_SIZE "pmix.monitor.fsize" (**bool**)
        Monitor size of given file is growing to determine if the application is running.
PMIX_MONITOR_FILE_ACCESS "pmix.monitor.faccess" (**char***)
        Monitor time since last access of given file to determine if the application is running.
PMIX_MONITOR_FILE_MODIFY "pmix.monitor.fmod" (**char***)
        Monitor time since last modified of given file to determine if the application is running.
PMIX_MONITOR_FILE_CHECK_TIME "pmix.monitor.ftime" (**uint32_t**)
        Time in seconds between checking the file.
PMIX_MONITOR_FILE_DROPS "pmix.monitor.fdrop" (**uint32_t**)
        Number of file checks that can be missed before generating the event.

3.4.30 Security attributes

PMIx v3.0   Attributes for managing security credentials

PMIX_CRED_TYPE "pmix.sec.ctype" (**char***)
        When passed in **PMIx_Get_credential**, a prioritized, comma-delimited list of desired
        credential types for use in environments where multiple authentication mechanisms may be
        available. When returned in a callback function, a string identifier of the credential type.
PMIX_CRYPTO_KEY "pmix.sec.key" (**pmix_byte_object_t**)
        Blob containing crypto key

3.4.31 IO Forwarding attributes

Attributes used to control IO forwarding behavior

PMIX_IOF_CACHE_SIZE "pmix.iof.csize" (uint32_t)
    The requested size of the server cache in bytes for each specified channel. By default, the
    server is allowed (but not required) to drop all bytes received beyond the max size.

PMIX_IOF_DROP_OLDEST "pmix.iof.old" (bool)
    In an overflow situation, drop the oldest bytes to make room in the cache.

PMIX_IOF_DROP_NEWEST "pmix.iof.new" (bool)
    In an overflow situation, drop any new bytes received until room becomes available in the
    cache (default).

PMIX_IOF_BUFFERING_SIZE "pmix.iof.bsize" (uint32_t)
    Controls grouping of IO on the specified channel(s) to avoid being called every time a bit of
    IO arrives. The library will execute the callback whenever the specified number of bytes
    becomes available. Any remaining buffered data will be "flushed" upon call to deregister the
    respective channel.

PMIX_IOF_BUFFERING_TIME "pmix.iof.btime" (uint32_t)
    Max time in seconds to buffer IO before delivering it. Used in conjunction with buffering
    size, this prevents IO from being held indefinitely while waiting for another payload to arrive.

PMIX_IOF_COMPLETE "pmix.iof.cmp" (bool)
    Indicates whether or not the specified IO channel has been closed by the source.

PMIX_IOF_TAG_OUTPUT "pmix.iof.tag" (bool)
    Tag output with the channel it comes from.

PMIX_IOF_TIMESTAMP_OUTPUT "pmix.iof.ts" (bool)
    Timestamp output

PMIX_IOF_XML_OUTPUT "pmix.iof.xml" (bool)
    Format output in XML

3.4.32 Application setup attributes

Attributes for controlling contents of application setup data

PMIX_SETUP_APP_ENVARS "pmix.setup.env" (bool)
    Harvest and include relevant environmental variables

PMIX_SETUP_APP_NONENVARS ""pmix.setup.nenv" (bool)
    Include all relevant data other than environmental variables

PMIX_SETUP_APP_ALL "pmix.setup.all" (bool)
    Include all relevant data

3.5 Callback Functions

PMIx provides blocking and nonblocking versions of most APIs. In the nonblocking versions, a
callback is activated upon completion of the the operation. This section describes many of those
callbacks.

3.5.1 Release Callback Function

Summary

The **pmix_release_cbfunc_t** is used by the **pmix_modex_cbfunc_t** and
pmix_info_cbfunc_t operations to indicate that the callback data may be reclaimed/freed by
the caller.

Format

PMIx v1.0

---------------------------- C ----------------------------

```
typedef void (*pmix_release_cbfunc_t)
    (void *cbdata)
```

---------------------------- C ----------------------------

INOUT cbdata
    Callback data passed to original API call (memory reference)

Description

Since the data is "owned" by the host server, provide a callback function to notify the host server
that we are done with the data so it can be released.

3.5.2 Modex Callback Function

Summary

The **pmix_modex_cbfunc_t** is used by the **pmix_server_fencenb_fn_t** and
pmix_server_dmodex_req_fn_t PMIx server operations to return modex business card
exchange (BCX) data.

PMIx v1.0

---------------------------- C ----------------------------

```
typedef void (*pmix_modex_cbfunc_t)
    (pmix_status_t status,
     const char *data, size_t ndata,
     void *cbdata,
     pmix_release_cbfunc_t release_fn,
     void *release_cbdata)
```

---------------------------- C ----------------------------

IN   status
    Status associated with the operation (handle)
IN   data
    Data to be passed (pointer)
IN   ndata
    size of the data (**size_t**)
IN   cbdata
    Callback data passed to original API call (memory reference)

1	**IN** `release_fn`
2	Callback for releasing *data* (function pointer)
3	**IN** `release_cbdata`
4	Pointer to be passed to *release_fn* (memory reference)

Description

A callback function that is solely used by PMIx servers, and not clients, to return modex BCX data in response to "fence" and "get" operations. The returned blob contains the data collected from each server participating in the operation.
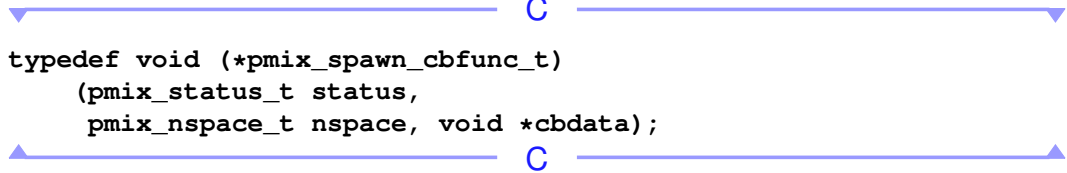
3.5.3 Spawn Callback Function

Summary

The **pmix_spawn_cbfunc_t** is used on the PMIx client side by **PMIx_Spawn_nb** and on the PMIx server side by **pmix_server_spawn_fn_t**.

PMIx v1.0 ▼ ──────────── C ──────────── ▼

```
typedef void (*pmix_spawn_cbfunc_t)
    (pmix_status_t status,
     pmix_nspace_t nspace, void *cbdata);
```

▲ ──────────── C ──────────── ▲

16	**IN** `status`
17	Status associated with the operation (handle)
18	**IN** `nspace`
19	Namespace string (**pmix_nspace_t**)
20	**IN** `cbdata`
21	Callback data passed to original API call (memory reference)

Description

The callback will be executed upon launch of the specified applications in **PMIx_Spawn_nb**, or upon failure to launch any of them.

The *status* of the callback will indicate whether or not the spawn succeeded. The *nspace* of the spawned processes will be returned, along with any provided callback data. Note that the returned *nspace* value will not be protected by the PRI upon return from the callback function, so the receiver must copy it if it needs to be retained.

3.5.4 Op Callback Function

Summary

The **`pmix_op_cbfunc_t`** is used by operations that simply return a status.

PMIx v1.0 ────────────────── C ──────────────────

```
typedef void (*pmix_op_cbfunc_t)
    (pmix_status_t status, void *cbdata);
```
────────────────── C ──────────────────

IN   status
    Status associated with the operation (handle)
IN   cbdata
    Callback data passed to original API call (memory reference)

Description
Used by a wide range of PMIx API's including **`PMIx_Fence_nb`**,
`pmix_server_client_connected_fn_t`, **`PMIx_server_register_nspace`**. This
callback function is used to return a status to an often nonblocking operation.

3.5.5 Lookup Callback Function

Summary

The **`pmix_lookup_cbfunc_t`** is used by **`PMIx_Lookup_nb`** to return data.

PMIx v1.0 ────────────────── C ──────────────────

```
typedef void (*pmix_lookup_cbfunc_t)
    (pmix_status_t status,
     pmix_pdata_t data[], size_t ndata,
     void *cbdata);
```
────────────────── C ──────────────────

IN   status
    Status associated with the operation (handle)
IN   data
    Array of data returned (**`pmix_pdata_t`**)
IN   ndata
    Number of elements in the *data* array (**`size_t`**)
IN   cbdata
    Callback data passed to original API call (memory reference)

Description

A callback function for calls to **PMIx_Lookup_nb** The function will be called upon completion of the command with the *status* indicating the success or failure of the request. Any retrieved data will be returned in an array of **pmix_pdata_t** structs. The namespace and rank of the process that provided each data element is also returned.

Note that these structures will be released upon return from the callback function, so the receiver must copy/protect the data prior to returning if it needs to be retained.

3.5.6 Value Callback Function

Summary

The **pmix_value_cbfunc_t** is used by **PMIx_Get_nb** to return data.

PMIx v1.0 ▼ ———————————————— C ———————————————— ▼

```
typedef void (*pmix_value_cbfunc_t)
    (pmix_status_t status,
     pmix_value_t *kv, void *cbdata);
```

▲ ———————————————— C ———————————————— ▲

IN   status
  Status associated with the operation (handle)
IN   kv
  Key/value pair representing the data (**pmix_value_t**)
IN   cbdata
  Callback data passed to original API call (memory reference)

Description

A callback function for calls to **PMIx_Get_nb**. The *status* indicates if the requested data was found or not. A pointer to the **pmix_value_t** structure containing the found data is returned. The pointer will be **NULL** if the requested data was not found.

3.5.7 Info Callback Function

Summary

The **pmix_info_cbfunc_t** is a general information callback used by various APIs.

PMIx v2.0 ▼ ———————————————— C ———————————————— ▼

```
typedef void (*pmix_info_cbfunc_t)
    (pmix_status_t status,
     pmix_info_t info[], size_t ninfo,
     void *cbdata,
     pmix_release_cbfunc_t release_fn,
     void *release_cbdata);
```

1	**IN** **status**
2	Status associated with the operation (**pmix_status_t**)
3	**IN** **info**
4	Array of **pmix_info_t** returned by the operation (pointer)
5	**IN** **ninfo**
6	Number of elements in the *info* array (**size_t**)
7	**IN** **cbdata**
8	Callback data passed to original API call (memory reference)
9	**IN** **release_fn**
10	Function to be called when done with the *info* data (function pointer)
11	**IN** **release_cbdata**
12	Callback data to be passed to *release_fn* (memory reference)

Description

14 The *status* indicates if requested data was found or not. An array of **pmix_info_t** will contain
15 the key/value pairs.

16 3.5.8 Event Handler Registration Callback Function

17 The **pmix_evhdlr_reg_cbfunc_t** callback function.

—————————————————— Advice to users ——————————————————

18 The PMIx *ad hoc* v1.0 Standard defined an error handler registration callback function with a
19 compatible signature, but with a different type definition function name
20 (pmix_errhandler_reg_cbfunc_t). It was removed from the v2.0 Standard and is not included in this
21 document to avoid confusion.

PMIx v2.0

```
typedef void (*pmix_evhdlr_reg_cbfunc_t)
    (pmix_status_t status,
     size_t evhdlr_ref,
     void *cbdata)
```

26	**IN** **status**
27	Status indicates if the request was successful or not (**pmix_status_t**)
28	**IN** **evhdlr_ref**
29	Reference assigned to the event handler by PMIx — this reference * must be used to
30	deregister the err handler (**size_t**)
31	**IN** **cbdata**
32	Callback data passed to original API call (memory reference)

Description
2 Define a callback function for calls to **PMIx_Register_event_handler**

3.5.9   Notification Handler Completion Callback Function

Summary

The **pmix_event_notification_cbfunc_fn_t** is called by event handlers to indicate
completion of their operations.

PMIx v2.0 ▼ ——————————— C ——————————— ▼

```
typedef void (*pmix_event_notification_cbfunc_fn_t)
    (pmix_status_t status,
     pmix_info_t *results, size_t nresults,
     pmix_op_cbfunc_t cbfunc, void *thiscbdata,
     void *notification_cbdata);
```

▲ ——————————— C ——————————— ▲

IN   status
    Status returned by the event handler's operation (**pmix_status_t**)
IN   results
    Results from this event handler's operation on the event (**pmix_info_t**)
IN   nresults
    Number of elements in the results array (**size_t**)
IN   cbfunc
    pmix_op_cbfunc_t function to be executed when PMIx completes processing the
    callback (function reference)
IN   thiscbdata
    Callback data that was passed in to the handler (memory reference)
IN   cbdata
    Callback data to be returned when PMIx executes cbfunc (memory reference)

Description

Define a callback by which an event handler can notify the PMIx library that it has completed its
response to the notification. The handler is *required* to execute this callback so the library can
determine if additional handlers need to be called. The handler shall return
PMIX_EVENT_ACTION_COMPLETE if no further action is required. The return status of each
event handler and any returned **pmix_info_t** structures will be added to the *results* array of
pmix_info_t passed to any subsequent event handlers to help guide their operation.

If non-NULL, the provided callback function will be called to allow the event handler to release the
provided info array and execute any other required cleanup operations.

1 **3.5.10 Notification Function**

2 **Summary**
3 The **`pmix_notification_fn_t`** is called by PMIx to deliver notification of an event.

───────────────────────── Advice to users ─────────────────────────

4 The PMIx *ad hoc* v1.0 Standard defined an error notification function with an identical name, but
5 different signature than the v2.0 Standard described below. The *ad hoc* v1.0 version was removed
6 from the v2.0 Standard is not included in this document to avoid confusion.

PMIx v2.0 ───────────────────────── C ─────────────────────────

```
7   typedef void (*pmix_notification_fn_t)
8       (size_t evhdlr_registration_id,
9        pmix_status_t status,
10       const pmix_proc_t *source,
11       pmix_info_t info[], size_t ninfo,
12       pmix_info_t results[], size_t nresults,
13       pmix_event_notification_cbfunc_fn_t cbfunc,
14       void *cbdata);
```

───────────────────────── C ─────────────────────────

15 **IN   evhdlr_registration_id**
16   Registration number of the handler being called (**`size_t`**)
17 **IN   status**
18   Status associated with the operation (**`pmix_status_t`**)
19 **IN   source**
20   Identifier of the process that generated the event (**`pmix_proc_t`**). If the source is the SMS,
21   then the nspace will be empty and the rank will be PMIX_RANK_UNDEF
22 **IN   info**
23   Information describing the event (**`pmix_info_t`**). This argument will be NULL if no
24   additional information was provided by the event generator.
25 **IN   ninfo**
26   Number of elements in the info array (**`size_t`**)
27 **IN   results**
28   Aggregated results from prior event handlers servicing this event (**`pmix_info_t`**). This
29   argument will be **`NULL`** if this is the first handler servicing the event, or if no prior handlers
30   provided results.
31 **IN   nresults**
32   Number of elements in the results array (**`size_t`**)
33 **IN   cbfunc**
34   **`pmix_event_notification_cbfunc_fn_t`** callback function to be executed upon
35   completion of the handler's operation and prior to handler return (function reference).

IN   cbdata
    Callback data to be passed to cbfunc (memory reference)

Description

Note that different RMs may provide differing levels of support for event notification to application processes. Thus, the *info* array may be **NULL** or may contain detailed information of the event. It is the responsibility of the application to parse any provided info array for defined key-values if it so desires.

──────────────────────────── Advice to users ────────────────────────────

Possible uses of the *info* array include:

- for the host RM to alert the process as to planned actions, such as aborting the session, in response to the reported event

- provide a timeout for alternative action to occur, such as for the application to request an alternate response to the event

For example, the RM might alert the application to the failure of a node that resulted in termination of several processes, and indicate that the overall session will be aborted unless the application requests an alternative behavior in the next 5 seconds. The application then has time to respond with a checkpoint request, or a request to recover from the failure by obtaining replacement nodes and restarting from some earlier checkpoint.

Support for these options is left to the discretion of the host RM. Info keys are included in the common definitions above but may be augmented by environment vendors.

──────────────────────── Advice to PMIx server hosts ────────────────────────

On the server side, the notification function is used to inform the PMIx server library's host of a detected event in the PMIx server library. Events generated by PMIx clients are communicated to the PMIx server library, but will be relayed to the host via the **pmix_server_notify_event_fn_t** function pointer, if provided.

3.5.11 Server Setup Application Callback Function

The **PMIx_server_setup_application** callback function.

Summary

Provide a function by which the resource manager can receive application-specific environmental variables and other setup data prior to launch of an application.

Format

─────────────────────── C ───────────────────────

```
typedef void (*pmix_setup_application_cbfunc_t)(
                        pmix_status_t status,
                        pmix_info_t info[], size_t ninfo,
                        void *provided_cbdata,
                        pmix_op_cbfunc_t cbfunc, void *cbdata)
```

─────────────────────── C ───────────────────────

IN   status
    returned status of the request (**pmix_status_t**)
IN   info
    Array of info structures (array of handles)
IN   ninfo
    Number of elements in the *info* array (integer)
IN   provided_cbdata
    Data originally passed to call to **PMIx_server_setup_application** (memory
    reference)
IN   cbfunc
    pmix_op_cbfunc_t function to be called when processing completed (function reference)
IN   cbdata
    Data to be passed to the *cbfunc* callback function (memory reference)

Description

Define a function to be called by the PMIx server library for return of application-specific setup
data in response to a request from the host RM. The returned *info* array is owned by the PMIx
server library and will be free'd when the provided *cbfunc* is called.

3.5.12   Server Direct Modex Response Callback Function

The **PMIx_server_dmodex_request** callback function.

Summary

Provide a function by which the local PMIx server library can return connection and other data
posted by local application processes to the host resource manager.

Format

─────────────────────── C ───────────────────────

```
typedef void (*pmix_dmodex_response_fn_t)(pmix_status_t status,
                        char *data, size_t sz,
                        void *cbdata);
```

1   **IN**   `status`
2   Returned status of the request (**`pmix_status_t`**)
3   **IN**   `data`
4   Pointer to a data "blob" containing the requested information (handle)
5   **IN**   `sz`
6   Number of bytes in the *data* blob (integer)
7   **IN**   `cbdata`
8   Data passed into the initial call to **`PMIx_server_dmodex_request`** (memory reference)

9   **Description**
10 Define a function to be called by the PMIx server library for return of information posted by a local
11 application process (via **`PMIx_Put`** with subsequent **`PMIx_Commit`**) in response to a request
12 from the host RM. The returned *data* blob is owned by the PMIx server library and will be free'd
13 upon return from the function.

3.5.13   PMIx Client Connection Callback Function

15   **Summary**
16 Callback function for incoming connection request from a local client

17   **Format**

PMIx v1.0

```
C
```

```
18  typedef void (*pmix_connection_cbfunc_t)(
19                                  int incoming_sd, void *cbdata)
```

```
C
```

20   **IN**   `incoming_sd`
21   (integer)
22   **IN**   `cbdata`
23   (memory reference)

24   **Description**
25 Callback function for incoming connection requests from local clients - only used by host
26 environments that wish to directly handle socket connection requests.

3.5.14   PMIx Tool Connection Callback Function

28   **Summary**
29 Callback function for incoming tool connections.

Format

```
typedef void (*pmix_tool_connection_cbfunc_t)(
                                 pmix_status_t status,
                                 pmix_proc_t *proc, void *cbdata)
```

IN   status
    pmix_status_t value (handle)
IN   proc
    pmix_proc_t structure containing the identifier assigned to the tool (handle)
IN   cbdata
    Data to be passed (memory reference)

Description
Callback function for incoming tool connections. The host environment shall provide a
namespace/rank identifier for the connecting tool.

———————— Advice to PMIx server hosts ————————

It is assumed that **rank=0** will be the normal assignment, but allow for the future possibility of a
parallel set of tools connecting, and thus each process requiring a unique rank.

3.5.15 Credential callback function

Summary
Callback function to return a requested security credential

```
2    typedef void (*pmix_credential_cbfunc_t)(
3                                    pmix_status_t status,
4                                    pmix_byte_object_t *credential,
5                                    pmix_info_t info[], size_t ninfo,
6                                    void *cbdata)
```

7   **IN   status**
8   **pmix_status_t** value (handle)
9   **IN   credential**
10   **pmix_byte_object_t** structure containing the security credential (handle)
11   **IN   info**
12   Array of provided by the system to pass any additional information about the credential - e.g.,
13   the identity of the issuing agent. (handle)
14   **IN   ninfo**
15   Number of elements in *info* (**size_t**)
16   **IN   cbdata**
17   Object passed in original request (memory reference)

18   **Description**
19   Define a callback function to return a requested security credential. Information provided by the
20   issuing agent can subsequently be used by the application for a variety of purposes. Examples
21   include:

22   • checking identified authorizations to determine what requests/operations are feasible as a means
23   to steering workflows

24   • compare the credential type to that of the local SMS for compatibility

—————————————————————————— Advice to users ——————————————————————————

25   The credential is opaque and therefore understandable only by a service compatible with the issuer.
26   The *info* array is owned by the PMIx library and is not to be released or altered by the receiving
27   party.

28 3.5.16   Credential validation callback function

29   **Summary**
30   Callback function for security credential validation

Format

```C
typedef void (*pmix_validation_cbfunc_t)(
                                    pmix_status_t status,
                                    pmix_info_t info[], size_t ninfo,
                                    void *cbdata);
```

IN   **status**
    pmix_status_t value (handle)
IN   **info**
    Array of **pmix_info_t** provided by the system to pass any additional information about the
    authentication - e.g., the effective userid and group id of the certificate holder, and any related
    authorizations (handle)
IN   **ninfo**
    Number of elements in *info* (**size_t**)
IN   **cbdata**
    Object passed in original request (memory reference)

Description

Define a validation callback function to indicate if a provided credential is valid, and any
corresponding information regarding authorizations and other security matters.

— Advice to users —

The precise contents of the array will depend on the host environment and its associated security
system. At the minimum, it is expected (but not required) that the array will contain entries for the
PMIX_USERID and **PMIX_GRPID** of the client described in the credential. The *info* array is
owned by the PMIx library and is not to be released or altered by the receiving party.

3.5.17 IOF delivery function

Summary

Callback function for delivering forwarded IO to a process

Format

```
typedef void (*pmix_iof_cbfunc_t)(
                                  size_t iofhdlr, pmix_iof_channel_t channel,
                                  pmix_proc_t *source, char *payload,
                                  pmix_info_t info[], size_t ninfo);
```

IN   iofhdlr
Registration number of the handler being invoked (**size_t**)
IN   channel
bitmask identifying the channel the data arrived on (**pmix_iof_channel_t**)
IN   source
Pointer to a **pmix_proc_t** identifying the namespace/rank of the process that generated the
data (**char***)
IN   payload
Pointer to character array containing the data.
IN   info
Array of **pmix_info_t** provided by the source containing metadata about the payload. This
could include **PMIX_IOF_COMPLETE** (handle)
IN   ninfo
Number of elements in *info* (**size_t**)

Description
Define a callback function for delivering forwarded IO to a process. This function will be called
whenever data becomes available, or a specified buffering size and/or time has been met.

─────────────────── Advice to users ───────────────────

Multiple strings may be included in a given *payload*, and the *payload* may *not* be **NULL** terminated.
The user is responsible for releasing the *payload* memory. The *info* array is owned by the PMIx
library and is not to be released or altered by the receiving party.

3.5.18   IOF and Event registration function

Summary
Callback function for calls to register handlers, e.g., event notification and IOF requests.

Format

PMIx v3.0

```
C
```

2   **typedef void (*pmix_hdlr_reg_cbfunc_t)(pmix_status_t status,**
3   **size_t refid,**
4   **void *cbdata);**

```
C
```

5   **IN   status**
6   **PMIX_SUCCESS** or an appropriate error constant (**pmix_status_t**)
7   **IN   refid**
8   reference identifier assigned to the handler by PMIx, used to deregister the handler (**size_t**)
9   **IN   cbdata**
10   object provided to the registration call (pointer)

11   **Description**
12   Callback function for calls to register handlers, e.g., event notification and IOF requests.

3.6 Constant String Functions

14   Provide a string representation for several types of values. Note that the provided string is statically
15   defined and must NOT be **free**'d.

16   **Summary**
17   String representation of a **pmix_status_t**.

PMIx v1.0

```
C
```

18   **const char***
19   **PMIx_Error_string(pmix_status_t status);**

```
C
```

20   **Summary**
21   String representation of a **pmix_proc_state_t**.

PMIx v2.0

```
C
```

22   **const char***
23   **PMIx_Proc_state_string(pmix_proc_state_t state);**

```
C
```

1 **Summary**
2 String representation of a **pmix_scope_t**.

PMIx v2.0 ▼ ───────────────── C ───────────────── ▼

```
3 const char*
4 PMIx_Scope_string(pmix_scope_t scope);
```
▲ ───────────────── C ───────────────── ▲

5 **Summary**
6 String representation of a **pmix_persistence_t**.

PMIx v2.0 ▼ ───────────────── C ───────────────── ▼

```
7 const char*
8 PMIx_Persistence_string(pmix_persistence_t persist);
```
▲ ───────────────── C ───────────────── ▲

9 **Summary**
10 String representation of a **pmix_data_range_t**.

PMIx v2.0 ▼ ───────────────── C ───────────────── ▼

```
11 const char*
12 PMIx_Data_range_string(pmix_data_range_t range);
```
▲ ───────────────── C ───────────────── ▲

13 **Summary**
14 String representation of a **pmix_info_directives_t**.

PMIx v2.0 ▼ ───────────────── C ───────────────── ▼

```
15 const char*
16 PMIx_Info_directives_string(pmix_info_directives_t directives);
```
▲ ───────────────── C ───────────────── ▲

17 **Summary**
18 String representation of a **pmix_data_type_t**.

PMIx v2.0 ▼ ───────────────── C ───────────────── ▼

```
19 const char*
20 PMIx_Data_type_string(pmix_data_type_t type);
```
▲ ───────────────── C ───────────────── ▲

1   **Summary**
2   String representation of a **pmix_alloc_directive_t**.

PMIx v2.0 ▼ ─────────────────────────── C ───────────────────────────── ▼

3   `const char*`
4   `PMIx_Alloc_directive_string(pmix_alloc_directive_t directive);`
     ▲ ─────────────────────────── C ───────────────────────────── ▲

5   **Summary**
6   String representation of a **pmix_iof_channel_t**.

PMIx v3.0 ▼ ─────────────────────────── C ───────────────────────────── ▼

7   `const char*`
8   `PMIx_IOF_channel_string(pmix_iof_channel_t channel);`
     ▲ ─────────────────────────── C ───────────────────────────── ▲

Initialization and Finalization

1   The PMIx library is required to be initialized and finalized around the usage of most of the APIs.
2   The APIs that may be used outside of the initialized and finalized region are noted. All other APIs
3   must be used inside this region.

4   There are three sets of initialization and finalization functions depending upon the role of the
5   process in the PMIx universe. Each of these functional sets are described in this chapter. Note that
6   a process can only call *one* of the init/finalize functional pairs - e.g., a process that calls the client
7   initialization function cannot also call the tool or server initialization functions, and must call the
8   corresponding client finalize.

—————————————————— Advice to users ——————————————————

9   Processes that initialize as a server or tool automatically are given access to all client APIs. Server
10   initialization includes setting up the infrastructure to support local clients - thus, it necessarily
11   includes overhead and an increased memory footprint. Tool initialization automatically searches for
12   a server to which it can connect — if declared as a *launcher*, the PMIx library sets up the required
13   "hooks" for other tools (e.g., debuggers) to attach to it.

4.1 Query

15   The API defined in this section can be used by any PMIx process, regardless of their role in the
16   PMIx universe.

4.1.1 `PMIx_Initialized`

18   **Format**
     PMIx v1.0
———————————————————————— C ————————————————————————

19   `int PMIx_Initialized(void)`
———————————————————————— C ————————————————————————

20   A value of **1** (true) will be returned if the PMIx library has been initialized, and **0** (false) otherwise.

- Rationale -

21   The return value is an integer for historical reasons as that was the signature of prior PMI libraries.

Description

Check to see if the PMIx library has been initialized using any of the init functions: **PMIx_Init**, **PMIx_server_init**, or **PMIx_tool_init**.

4.1.2 `PMIx_Get_version`

Summary

Get the PMIx version information.

Format

PMIx v1.0

```
const char* PMIx_Get_version(void)
```

Description

Get the PMIx version string. Note that the provided string is statically defined and must *not* be free'd.

4.2 Client Initialization and Finalization

Initialization and finalization routines for PMIx clients.

──────────── Advice to users ────────────

The PMIx *ad hoc* v1.0 Standard defined the **PMIx_Init** function, but modified the function signature in the v1.2 version. The *ad hoc* v1.0 version is not included in this document to avoid confusion.

4.2.1 `PMIx_Init`

Summary

Initialize the PMIx client library

Format

PMIx v1.2

────────────────────────── C ──────────────────────────

```
pmix_status_t
PMIx_Init(pmix_proc_t *proc,
          pmix_info_t info[], size_t ninfo)
```

────────────────────────── C ──────────────────────────

INOUT `proc`
    proc structure (handle)
IN   `info`
    Array of `pmix_info_t` structures (array of handles)
IN   `ninfo`
    Number of element in the *info* array (`size_t`)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for implementers of PMIx libraries:

PMIX_USOCK_DISABLE "pmix.usock.disable" (**bool**)
    Disable legacy UNIX socket (usock) support If the library supports Unix socket
    connections, this attribute may be supported for disabling it.

PMIX_SOCKET_MODE "pmix.sockmode" (**uint32_t**)
    POSIX *mode_t* (9 bits valid) If the library supports socket connections, this attribute may
    be supported for setting the socket mode.

PMIX_SINGLE_LISTENER "pmix.sing.listnr" (**bool**)
    Use only one rendezvous socket, letting priorities and/or environment parameters select the
    active transport. If the library supports multiple methods for clients to connect to servers,
    this attribute may be supported for disabling all but one of them.

PMIX_TCP_REPORT_URI "pmix.tcp.repuri" (**char***)
    If provided, directs that the TCP URI be reported and indicates the desired method of
    reporting: `'-'` for stdout, `'+'` for stderr, or filename. If the library supports TCP socket
    connections, this attribute may be supported for reporting the URI.

PMIX_TCP_IF_INCLUDE "pmix.tcp.ifinclude" (**char***)
    Comma-delimited list of devices and/or CIDR notation to include when establishing the
    TCP connection. If the library supports TCP socket connections, this attribute may be
    supported for specifying the interfaces to be used.

PMIX_TCP_IF_EXCLUDE "pmix.tcp.ifexclude" (**char***)
    Comma-delimited list of devices and/or CIDR notation to exclude when establishing the
    TCP connection. If the library supports TCP socket connections, this attribute may be
    supported for specifying the interfaces that are *not* to be used.

1 **PMIX_TCP_IPV4_PORT** **"pmix.tcp.ipv4"** (**int**)
2   The IPv4 port to be used.   If the library supports IPV4 connections, this attribute may be
3   supported for specifying the port to be used.

4 **PMIX_TCP_IPV6_PORT** **"pmix.tcp.ipv6"** (**int**)
5   The IPv6 port to be used.   If the library supports IPV6 connections, this attribute may be
6   supported for specifying the port to be used.

7 **PMIX_TCP_DISABLE_IPV4** **"pmix.tcp.disipv4"** (**bool**)
8   Set to **true** to disable IPv4 family of addresses.   If the library supports IPV4 connections,
9   this attribute may be supported for disabling it.

10 **PMIX_TCP_DISABLE_IPV6** **"pmix.tcp.disipv6"** (**bool**)
11   Set to **true** to disable IPv6 family of addresses.   If the library supports IPV6 connections,
12   this attribute may be supported for disabling it.

13 **PMIX_EVENT_BASE** **"pmix.evbase"** (**struct event_base ***)
14   Pointer to libevent[1] **event_base** to use in place of the internal progress thread.

15 **PMIX_GDS_MODULE** **"pmix.gds.mod"** (**char***)
16   Comma-delimited string of desired modules.   This attribute is specific to the PRI and
17   controls only the selection of GDS module for internal use by the process. Module selection
18   for interacting with the server is performed dynamically during the connection process.

19 **Description**
20 Initialize the PMIx client, returning the process identifier assigned to this client's application in the
21 provided **pmix_proc_t** struct. Passing a value of **NULL** for this parameter is allowed if the user
22 wishes solely to initialize the PMIx system and does not require return of the identifier at that time.

23 When called, the PMIx client shall check for the required connection information of the local PMIx
24 server and establish the connection. If the information is not found, or the server connection fails,
25 then an appropriate error constant shall be returned.

26 If successful, the function shall return **PMIX_SUCCESS** and fill the *proc* structure (if provided)
27 with the server-assigned namespace and rank of the process within the application. In addition, all
28 startup information provided by the resource manager shall be made available to the client process
29 via subsequent calls to **PMIx_Get**.

30 The PMIx client library shall be reference counted, and so multiple calls to **PMIx_Init** are
31 allowed by the standard. Thus, one way for an application process to obtain its namespace and rank
32 is to simply call **PMIx_Init** with a non-NULL *proc* parameter. Note that each call to
33 **PMIx_Init** must be balanced with a call to **PMIx_Finalize** to maintain the reference count.

34 Each call to **PMIx_Init** may contain an array of **pmix_info_t** structures passing directives to
35 the PMIx client library as per the above attributes.

---

[1]http://libevent.org/

1 Multiple calls to **PMIx_Init** shall not include conflicting directives. The **PMIx_Init** function
2 will return an error when directives that conflict with prior directives are encountered.

4.2.2   **PMIx_Finalize**

4 **Summary**
5 Finalize the PMIx client library.

6 **Format**

PMIx v1.0 ▼——————————————— C ———————————————▼

```
pmix_status_t
PMIx_Finalize(const pmix_info_t info[], size_t ninfo)
```

▲——————————————— C ———————————————▲

9 **IN**   **info**
10   Array of **pmix_info_t** structures (array of handles)
11 **IN**   **ninfo**
12   Number of element in the *info* array (**size_t**)

13 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼—————————————— Optional Attributes ——————————————▼

14 The following attributes are optional for implementers of PMIx libraries:

15 **PMIX_EMBED_BARRIER "pmix.embed.barrier"** (**bool**)
16   Execute a blocking fence operation before executing the specified operation. For example,
17   **PMIx_Finalize** does not include an internal barrier operation by default. This attribute
18   would direct **PMIx_Finalize** to execute a barrier as part of the finalize operation.

▲——▲

19 **Description**
20 Decrement the PMIx client library reference count. When the reference count reaches zero, the
21 library will finalize the PMIx client, closing the connection with the local PMIx server and
22 releasing all internally allocated memory.

4.3   **Tool Initialization and Finalization**

24 Initialization and finalization routines for PMIx tools.

4.3.1   **PMIx_tool_init**

26 **Summary**
27 Initialize the PMIx library for operating as a tool.

```
2    pmix_status_t
3    PMIx_tool_init(pmix_proc_t *proc,
4                      pmix_info_t info[], size_t ninfo)
```
———————————————————————— C ————————————————————————

5 **INOUT** `proc`
6   **pmix_proc_t** structure (handle)
7 **IN** `info`
8   Array of **pmix_info_t** structures (array of handles)
9 **IN** `ninfo`
10   Number of element in the *info* array (**size_t**)

11 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼----------------- Required Attributes -----------------▼

12 The following attributes are required to be supported by all PMIx libraries:

13 **PMIX_TOOL_NSPACE** `"pmix.tool.nspace"` (**char***)
14   Name of the namespace to use for this tool.

15 **PMIX_TOOL_RANK** `"pmix.tool.rank"` (**uint32_t**)
16   Rank of this tool.

17 **PMIX_TOOL_DO_NOT_CONNECT** `"pmix.tool.nocon"` (**bool**)
18   The tool wants to use internal PMIx support, but does not want to connect to a PMIx server.

19 **PMIX_SERVER_URI** `"pmix.srvr.uri"` (**char***)
20   URI of the PMIx server to be contacted.
▲--▲

▼----------------- Optional Attributes -----------------▼

21 The following attributes are optional for implementers of PMIx libraries:

22 **PMIX_CONNECT_TO_SYSTEM** `"pmix.cnct.sys"` (**bool**)
23   The requestor requires that a connection be made only to a local, system-level PMIx server.

24 **PMIX_CONNECT_SYSTEM_FIRST** `"pmix.cnct.sys.first"` (**bool**)
25   Preferentially, look for a system-level PMIx server first.

26 **PMIX_SERVER_PIDINFO** `"pmix.srvr.pidinfo"` (**pid_t**)
27   PID of the target PMIx server for a tool.

28 **PMIX_TCP_URI** `"pmix.tcp.uri"` (**char***)
29   The URI of the PMIx server to connect to, or a file name containing it in the form of
30   `file:<name of file containing it>`.

31 **PMIX_CONNECT_RETRY_DELAY** `"pmix.tool.retry"` (**uint32_t**)

Time in seconds between connection attempts to a PMIx server.

PMIX_CONNECT_MAX_RETRIES **"pmix.tool.mretries"** (**uint32_t**)
 Maximum number of times to try to connect to PMIx server.

PMIX_SOCKET_MODE **"pmix.sockmode"** (**uint32_t**)
 POSIX *mode_t* (9 bits valid)   If the library supports socket connections, this attribute may
 be supported for setting the socket mode.

PMIX_TCP_REPORT_URI **"pmix.tcp.repuri"** (**char***)
 If provided, directs that the TCP URI be reported and indicates the desired method of
 reporting: **'-'** for stdout, **'+'** for stderr, or filename.   If the library supports TCP socket
 connections, this attribute may be supported for reporting the URI.

PMIX_TCP_IF_INCLUDE **"pmix.tcp.ifinclude"** (**char***)
 Comma-delimited list of devices and/or CIDR notation to include when establishing the
 TCP connection.   If the library supports TCP socket connections, this attribute may be
 supported for specifying the interfaces to be used.

PMIX_TCP_IF_EXCLUDE **"pmix.tcp.ifexclude"** (**char***)
 Comma-delimited list of devices and/or CIDR notation to exclude when establishing the
 TCP connection.   If the library supports TCP socket connections, this attribute may be
 supported for specifying the interfaces that are *not* to be used.

PMIX_TCP_IPV4_PORT **"pmix.tcp.ipv4"** (**int**)
 The IPv4 port to be used.   If the library supports IPV4 connections, this attribute may be
 supported for specifying the port to be used.

PMIX_TCP_IPV6_PORT **"pmix.tcp.ipv6"** (**int**)
 The IPv6 port to be used.   If the library supports IPV6 connections, this attribute may be
 supported for specifying the port to be used.

PMIX_TCP_DISABLE_IPV4 **"pmix.tcp.disipv4"** (**bool**)
 Set to **true** to disable IPv4 family of addresses.   If the library supports IPV4 connections,
 this attribute may be supported for disabling it.

PMIX_TCP_DISABLE_IPV6 **"pmix.tcp.disipv6"** (**bool**)
 Set to **true** to disable IPv6 family of addresses.   If the library supports IPV6 connections,
 this attribute may be supported for disabling it.

PMIX_EVENT_BASE **"pmix.evbase"** (**struct event_base ***)
 Pointer to libevent[2] **event_base** to use in place of the internal progress thread.

PMIX_GDS_MODULE **"pmix.gds.mod"** (**char***)
 Comma-delimited string of desired modules.   This attribute is specific to the PRI and
 controls only the selection of GDS module for internal use by the process. Module selection
 for interacting with the server is performed dynamically during the connection process.

---

[2]http://libevent.org/

Description

Initialize the PMIx tool, returning the process identifier assigned to this tool in the provided `pmix_proc_t` struct. The *info* array is used to pass user requests pertaining to the init and subsequent operations. Passing a **NULL** value for the array pointer is supported if no directives are desired.

If called with the **PMIX_TOOL_DO_NOT_CONNECT** attribute, the PMIx tool library will fully initialize but not attempt to connect to a PMIx server. The tool can connect to a server at a later point in time, if desired. In all other cases, the PMIx tool library will attempt to connect to according to the following precedence chain:

- if **PMIX_SERVER_URI** or **PMIX_TCP_URI** is given, then connection will be attempted to the server at the specified URI. Note that it is an error for both of these attributes to be specified. **PMIX_SERVER_URI** is the preferred method as it is more generalized — **PMIX_TCP_URI** is provided for those cases where the user specifically wants to use a TCP transport for the connection and wants to error out if it isn't available or cannot succeed. The PMIx library will return an error if connection fails — it will not proceed to check for other connection options as the user specified a particular one to use

- if **PMIX_SERVER_PIDINFO** was provided, then the tool will search under the directory provided by the PMIX_SERVER_TMPDIR environmental variable for a rendezvous file created by the process corresponding to that PID. The PMIx library will return an error if the rendezvous file cannot be found, or the connection is refused by the server

- if **PMIX_CONNECT_TO_SYSTEM** is given, then the tool will search for a system-level rendezvous file created by a PMIx server in the directory specified by the PMIX_SYSTEM_TMPDIR environmental variable. If found, then the tool will attempt to connect to it. An error is returned if the rendezvous file cannot be found or the connection is refused.

- if **PMIX_CONNECT_SYSTEM_FIRST** is given, then the tool will search for a system-level rendezvous file created by a PMIx server in the directory specified by the PMIX_SYSTEM_TMPDIR environmental variable. If found, then the tool will attempt to connect to it. In this case, no error will be returned if the rendezvous file is not found or connection is refused — the PMIx library will silently continue to the next option

- by default, the tool will search the directory tree under the directory provided by the PMIX_SERVER_TMPDIR environmental variable for rendezvous files of PMIx servers, attempting to connect to each it finds until one accepts the connection. If no rendezvous files are found, or all contacted servers refuse connection, then the PMIx library will return an error.

If successful, the function will return **PMIX_SUCCESS** and will fill the provided structure (if provided) with the server-assigned namespace and rank of the tool. Note that each connection attempt in the above precedence chain will retry (with delay between each retry) a number of times according to the values of the corresponding attributes. Default is no retries.

1	Note that the PMIx tool library is referenced counted, and so multiple calls to **PMIx_tool_init**
2	are allowed. Thus, one way to obtain the namespace and rank of the process is to simply call
3	**PMIx_tool_init** with a non-NULL parameter.

4.3.2 `PMIx_tool_finalize`

Summary

Finalize the PMIx library for a tool connection.

Format

PMIx v2.0 ─────────────────── C ───────────────────

```
pmix_status_t
PMIx_tool_finalize(void)
```
─────────────────── C ───────────────────

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Finalize the PMIx tool library, closing the connection to the server. An error code will be returned
if, for some reason, the connection cannot be cleanly terminated — in this case, the connection is
dropped.

4.3.3 `PMIx_tool_connect_to_server`

Summary

Switch connection from the current PMIx server to another one, or initialize a connection to a
specified server.

Format

PMIx v3.0 ─────────────────── C ───────────────────

```
pmix_status_t
PMIx_tool_connect_to_server(pmix_proc_t *proc,
                            pmix_info_t info[], size_t ninfo)
```
─────────────────── C ───────────────────

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

1   The following attributes are required to be supported by all PMIx libraries:

2   **PMIX_CONNECT_TO_SYSTEM** **"pmix.cnct.sys"** (**bool**)
3   The requestor requires that a connection be made only to a local, system-level PMIx server.

4   **PMIX_CONNECT_SYSTEM_FIRST** **"pmix.cnct.sys.first"** (**bool**)
5   Preferentially, look for a system-level PMIx server first.

6   **PMIX_SERVER_URI** **"pmix.srvr.uri"** (**char***)
7   URI of the PMIx server to be contacted.

8   **PMIX_SERVER_NSPACE** **"pmix.srv.nspace"** (**char***)
9   Name of the namespace to use for this PMIx server.

10   **PMIX_SERVER_PIDINFO** **"pmix.srvr.pidinfo"** (**pid_t**)
11   PID of the target PMIx server for a tool.

12   **Description**
13   Switch connection from the current PMIx server to another one, or initialize a connection to a
14   specified server. Closes the connection, if existing, to a server and establishes a connection to the
15   specified server. This function can be called at any time by a PMIx tool to shift connections
16   between servers. The process identifier assigned to this tool is returned in the provided
17   **pmix_proc_t** struct. Passing a value of **NULL** for this parameter is allowed if the user wishes
18   solely to connect to the PMIx server and does not require return of the identifier at that time.

19   PMIx tools and clients are prohibited from being connected to more than one server at a time to
20   avoid confusion in subsystems such as event notification.

21   When a tool connects to a server that is under a different namespace manager (e.g., host RM) as the
22   prior server, the identifier of the tool must remain unique in the namespaces. This may require the
23   identifier of the tool to be changed on-the-fly, that is, the *proc* parameter would be filled (if
24   non-NULL) with a different nspace/rank from the current tool identifier.

25   Passing a **NULL** value for the *info* pointer is not allowed and will result in returning an error.

26   Some PMIx implementations (for example, the current PRI) may not support connecting to a server
27   that is not under the same namespace manager (e.g., host RM) as the tool.

4.4 Server Initialization and Finalization

Initialization and finalization routines for PMIx servers.

4.4.1 `PMIx_server_init`

Summary

Initialize the PMIx server.

Format

PMIx v1.0

```
pmix_status_t
PMIx_server_init(pmix_server_module_t *module,
                 pmix_info_t info[], size_t ninfo)
```

INOUT `module`
  `pmix_server_module_t` structure (handle)
IN `info`
  Array of **`pmix_info_t`** structures (array of handles)
IN `ninfo`
  Number of elements in the *info* array (`size_t`)

Returns **`PMIX_SUCCESS`** or a negative value corresponding to a PMIx error constant.

▼----------------- Required Attributes -----------------▼

The following attributes are required to be supported by all PMIx libraries:

`PMIX_SERVER_NSPACE` `"pmix.srv.nspace"` (`char*`)
  Name of the namespace to use for this PMIx server.

`PMIX_SERVER_RANK` `"pmix.srv.rank"` (`pmix_rank_t`)
  Rank of this PMIx server

`PMIX_SERVER_TMPDIR` `"pmix.srvr.tmpdir"` (`char*`)
  Top-level temporary directory for all client processes connected to this server, and where the
  PMIx server will place its tool rendezvous point and contact information.

`PMIX_SYSTEM_TMPDIR` `"pmix.sys.tmpdir"` (`char*`)
  Temporary directory for this system, and where a PMIx server that declares itself to be a
  system-level server will place a tool rendezvous point and contact information.

`PMIX_SERVER_TOOL_SUPPORT` `"pmix.srvr.tool"` (`bool`)
  The host RM wants to declare itself as willing to accept tool connection requests.

`PMIX_SERVER_SYSTEM_SUPPORT` `"pmix.srvr.sys"` (`bool`)
  The host RM wants to declare itself as being the local system server for PMIx connection
  requests.

1   The following attributes are optional for implementers of PMIx libraries:

2   **PMIX_USOCK_DISABLE** **"pmix.usock.disable"** (**bool**)
3   Disable legacy UNIX socket (usock) support   If the library supports Unix socket
4   connections, this attribute may be supported for disabling it.

5   **PMIX_SOCKET_MODE** **"pmix.sockmode"** (**uint32_t**)
6   POSIX *mode_t* (9 bits valid)   If the library supports socket connections, this attribute may
7   be supported for setting the socket mode.

8   **PMIX_TCP_REPORT_URI** **"pmix.tcp.repuri"** (**char***)
9   If provided, directs that the TCP URI be reported and indicates the desired method of
10   reporting: **'-'** for stdout, **'+'** for stderr, or filename.   If the library supports TCP socket
11   connections, this attribute may be supported for reporting the URI.

12   **PMIX_TCP_IF_INCLUDE** **"pmix.tcp.ifinclude"** (**char***)
13   Comma-delimited list of devices and/or CIDR notation to include when establishing the
14   TCP connection.   If the library supports TCP socket connections, this attribute may be
15   supported for specifying the interfaces to be used.

16   **PMIX_TCP_IF_EXCLUDE** **"pmix.tcp.ifexclude"** (**char***)
17   Comma-delimited list of devices and/or CIDR notation to exclude when establishing the
18   TCP connection.   If the library supports TCP socket connections, this attribute may be
19   supported for specifying the interfaces that are *not* to be used.

20   **PMIX_TCP_IPV4_PORT** **"pmix.tcp.ipv4"** (**int**)
21   The IPv4 port to be used.   If the library supports IPV4 connections, this attribute may be
22   supported for specifying the port to be used.

23   **PMIX_TCP_IPV6_PORT** **"pmix.tcp.ipv6"** (**int**)
24   The IPv6 port to be used.   If the library supports IPV6 connections, this attribute may be
25   supported for specifying the port to be used.

26   **PMIX_TCP_DISABLE_IPV4** **"pmix.tcp.disipv4"** (**bool**)
27   Set to **true** to disable IPv4 family of addresses.   If the library supports IPV4 connections,
28   this attribute may be supported for disabling it.

29   **PMIX_TCP_DISABLE_IPV6** **"pmix.tcp.disipv6"** (**bool**)
30   Set to **true** to disable IPv6 family of addresses.   If the library supports IPV6 connections,
31   this attribute may be supported for disabling it.

32   **PMIX_SERVER_REMOTE_CONNECTIONS** **"pmix.srvr.remote"** (**bool**)
33   Allow connections from remote tools. Forces the PMIx server to not exclusively use
34   loopback device.   If the library supports connections from remote tools, this attribute may
35   be supported for enabling or disabling it.

PMIX_EVENT_BASE **"pmix.evbase"** (**struct event_base ***)
    Pointer to libevent[3] **event_base** to use in place of the internal progress thread.

PMIX_GDS_MODULE **"pmix.gds.mod"** (**char***)
    Comma-delimited string of desired modules.   This attribute is specific to the PRI and
    controls only the selection of GDS module for internal use by the process. Module selection
    for interacting with the server is performed dynamically during the connection process.

▲--▲

Description

Initialize the PMIx server support library, and provide a pointer to a **pmix_server_module_t**
structure containing the caller's callback functions. The array of **pmix_info_t** structs is used to
pass additional info that may be required by the server when initializing. For example, it may
include the **PMIX_SERVER_TOOL_SUPPORT** key, thereby indicating that the daemon is willing
to accept connection requests from tools.

──────────── Advice to PMIx server hosts ────────────

Providing a value of **NULL** for the *module* argument is permitted, as is passing an empty *module*
structure. Doing so indicates that the host environment will not provide support for multi-node
operations such as **PMIx_Fence**, but does intend to support local clients access to information.

4.4.2 `PMIx_server_finalize`

Summary

Finalize the PMIx server library.

Format

PMIx v1.0   ▼──────────── C ────────────▼

```
pmix_status_t
PMIx_server_finalize(void)
```
    ▲──────────── C ────────────▲

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Finalize the PMIx server support library, terminating all connections to attached tools and any local
clients. All memory usage is released.

---

[3] http://libevent.org/

Key/Value Management

---

1   Management of key-value pairs in PMIx is a distributed responsibility. While the stated objective of
2   the PMIx community is to eliminate collective operations, it is recognized that the traditional
3   method of publishing/exchanging data must be supported until that objective can be met. This
4   method relies on processes to discover and publish their local information which is collected by the
5   local PMIx server library. Global exchange of the published information is then executed via a
6   collective operation performed by the host SMS servers.

7   Keys are required to be unique within a specific level of information as defined in 3.4.11. For
8   example, a value for **PMIX_NUM_NODES** can be specified for each of the **session**, **job**, and
9   **application** levels. However, subsequently specifying another value for that attribute in the
10 **session** level will overwrite the prior value.

11   5.1   Setting and Accessing Key/Value Pairs

12   5.1.1   **PMIx_Put**

13 **Summary**
14 Push a key/value pair into the client's namespace.

15 **Format**

PMIx v1.0 ▼ ─────────────── C ─────────────── ▼

```
16  pmix_status_t
17  PMIx_Put(pmix_scope_t scope,
18           const pmix_key_t key,
19           pmix_value_t *val)
```

▲ ─────────────── C ─────────────── ▲

20 IN   scope
21   Distribution scope of the provided value (handle)
22 IN   key
23   key (**pmix_key_t**)
24 IN   value
25   Reference to a **pmix_value_t** structure (handle)

26 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Push a value into the client's namespace. The client's PMIx library will cache the information locally until **PMIx_Commit** is called.

The provided *scope* is passed to the local PMIx server, which will distribute the data to other processes according to the provided scope. The **pmix_scope_t** values are defined in Section 3.2.9 on page 31. Specific implementations may support different scope values, but all implementations must support at least **PMIX_GLOBAL**.

The **pmix_value_t** structure supports both string and binary values. PMIx implementations will support heterogeneous environments by properly converting binary values between host architectures, and will copy the provided *value* into internal memory.

──────────────── Advice to PMIx library implementers ────────────────

The PMIx server library will properly pack/unpack data to accommodate heterogeneous environments. The host SMS is not involved in this action. The *value* argument must be copied - the caller is free to release it following return from the function.

──────────────── Advice to users ────────────────

The value is copied by the PMIx client library. Thus, the application is free to release and/or modify the value once the call to **PMIx_Put** has completed.

Note that keys starting with a string of "**pmix**" are exclusively reserved for the PMIx standard and must not be used in calls to **PMIx_Put**. Thus, applications should never use a defined "PMIX_" attribute as the key in a call to **PMIx_Put**.

5.1.2 **PMIx_Get**

Summary

Retrieve a key/value pair from the client's namespace.

```
2   pmix_status_t
3   PMIx_Get(const pmix_proc_t *proc, const pmix_key_t key,
4            const pmix_info_t info[], size_t ninfo,
5            pmix_value_t **val)
```

6   **IN   proc**
7   process reference (handle)
8   **IN   key**
9   key to retrieve (**pmix_key_t**)
10 **IN   info**
11   Array of info structures (array of handles)
12 **IN   ninfo**
13   Number of element in the *info* array (integer)
14 **OUT val**
15   value (handle)

16 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------ Required Attributes ------------------▼

17 The following attributes are required to be supported by all PMIx libraries:

18 **PMIX_OPTIONAL "pmix.optional"** (**bool**)
19   Look only in the client's local data store for the requested value - do not request data from
20   the PMIx server if not found.

21 **PMIX_IMMEDIATE "pmix.immediate"** (**bool**)
22   Specified operation should immediately return an error from the PMIx server if the requested
23   data cannot be found - do not request it from the host RM.

24 **PMIX_DATA_SCOPE "pmix.scope"** (**pmix_scope_t**)
25   Scope of the data to be found in a **PMIx_Get** call.

26 **PMIX_SESSION_INFO "pmix.ssn.info"** (**bool**)
27   Return information about the specified session. If information about a session other than the
28   one containing the requesting process is desired, then the attribute array must contain a
29   **PMIX_SESSION_ID** attribute identifying the desired target.

30 **PMIX_JOB_INFO "pmix.job.info"** (**bool**)

Return information about the specified job or namespace. If information about a job or namespace other than the one containing the requesting process is desired, then the attribute array must contain a **PMIX_JOBID** or **PMIX_NSPACE** attribute identifying the desired target. Similarly, if information is requested about a job or namespace in a session other than the one containing the requesting process, then an attribute identifying the target session must be provided.

PMIX_APP_INFO **"pmix.app.info"** (**bool**)
Return information about the specified application. If information about an application other than the one containing the requesting process is desired, then the attribute array must contain a **PMIX_APPNUM** attribute identifying the desired target. Similarly, if information is requested about an application in a job or session other than the one containing the requesting process, then attributes identifying the target job and/or session must be provided.

PMIX_NODE_INFO **"pmix.node.info"** (**bool**)
Return information about the specified node. If information about a node other than the one containing the requesting process is desired, then the attribute array must contain either the **PMIX_NODEID** or **PMIX_HOSTNAME** attribute identifying the desired target.

▲--▲

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for host environments:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
Time in seconds before the specified operation should time out (*0* indicating infinite) in error. The timeout parameter can help avoid "hangs" due to programming errors that prevent the target process from ever exposing its data.

▲--▲

────────────── Advice to PMIx library implementers ──────────────

We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host environment due to race condition considerations between delivery of the data by the host environment versus internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT** directly in the PMIx server library must take care to resolve the race condition and should avoid passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not created.

▲──▲

Description

Retrieve information for the specified *key* as published by the process identified in the given
pmix_proc_t, returning a pointer to the value in the given address.

This is a blocking operation - the caller will block until either the specified data becomes available
from the specified rank in the *proc* structure or the operation times out should the **PMIX_TIMEOUT**
attribute have been given. The caller is responsible for freeing all memory associated with the
returned *value* when no longer required.

The *info* array is used to pass user requests regarding the get operation.

───────────────────────── Advice to users ─────────────────────────

Information provided by the PMIx server at time of process start is accessed by providing the
namespace of the job with the rank set to **PMIX_RANK_WILDCARD**. The list of data referenced in
this way is maintained on the PMIx web site at https://pmix.org/support/faq/wildcard-rank-access/
but includes items such as the number of processes in the namespace (**PMIX_JOB_SIZE**), total
available slots in the allocation (**PMIX_UNIV_SIZE**), and the number of nodes in the allocation
(**PMIX_NUM_NODES**).

Data posted by a process via **PMIx_Put** needs to be retrieved by specifying the rank of the posting
process. All other information is retrievable using a rank of **PMIX_RANK_WILDCARD** when the
information being retrieved refers to something non-rank specific (e.g., number of processes on a
node, number of processes in a job), and using the rank of the relevant process when requesting
information that is rank-specific (e.g., the URI of the process, or the node upon which it is
executing). Each subsection of Section 3.4 indicates the appropriate rank value for referencing the
defined attribute.

5.1.3 PMIx_Get_nb

Summary

Nonblocking **PMIx_Get** operation.

Format

———————————————————————— C ————————————————————————

```
pmix_status_t
PMIx_Get_nb(const pmix_proc_t *proc, const char key[],
            const pmix_info_t info[], size_t ninfo,
            pmix_value_cbfunc_t cbfunc, void *cbdata)
```

———————————————————————— C ————————————————————————

IN   proc
   process reference (handle)
IN   key
   key to retrieve (string)
IN   info
   Array of info structures (array of handles)
IN   ninfo
   Number of elements in the *info* array (integer)
IN   cbfunc
   Callback function (function reference)
IN   cbdata
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

If executed, the status returned in the provided callback function will be one of the following constants:

- **PMIX_SUCCESS** The requested data has been returned

- **PMIX_ERR_NOT_FOUND** The requested data was not available

- a non-zero PMIx error constant indicating a reason for the request's failure

▼----------------- Required Attributes -----------------▼

The following attributes are required to be supported by all PMIx libraries:

PMIX_OPTIONAL "pmix.optional" (**bool**)
   Look only in the client's local data store for the requested value - do not request data from the PMIx server if not found.

PMIX_IMMEDIATE "pmix.immediate" (bool)
   Specified operation should immediately return an error from the PMIx server if the requested
   data cannot be found - do not request it from the host RM.

PMIX_DATA_SCOPE "pmix.scope" (pmix_scope_t)
   Scope of the data to be found in a **PMIx_Get** call.

PMIX_SESSION_INFO "pmix.ssn.info" (bool)
   Return information about the specified session. If information about a session other than the
   one containing the requesting process is desired, then the attribute array must contain a
   PMIX_SESSION_ID attribute identifying the desired target.

PMIX_JOB_INFO "pmix.job.info" (bool)
   Return information about the specified job or namespace. If information about a job or
   namespace other than the one containing the requesting process is desired, then the attribute
   array must contain a **PMIX_JOBID** or **PMIX_NSPACE** attribute identifying the desired
   target. Similarly, if information is requested about a job or namespace in a session other than
   the one containing the requesting process, then an attribute identifying the target session
   must be provided.

PMIX_APP_INFO "pmix.app.info" (bool)
   Return information about the specified application. If information about an application other
   than the one containing the requesting process is desired, then the attribute array must
   contain a **PMIX_APPNUM** attribute identifying the desired target. Similarly, if information is
   requested about an application in a job or session other than the one containing the requesting
   process, then attributes identifying the target job and/or session must be provided.

PMIX_NODE_INFO "pmix.node.info" (bool)
   Return information about the specified node. If information about a node other than the one
   containing the requesting process is desired, then the attribute array must contain either the
   PMIX_NODEID or **PMIX_HOSTNAME** attribute identifying the desired target.

▲--▲

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT "pmix.timeout" (int)
   Time in seconds before the specified operation should time out (*0* indicating infinite) in
   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
   the target process from ever exposing its data.

▲--▲

Advice to PMIx library implementers

We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
environment due to race condition considerations between delivery of the data by the host
environment versus internal timeout in the PMIx server library. Implementers that choose to
support **PMIX_TIMEOUT** directly in the PMIx server library must take care to resolve the race
condition and should avoid passing **PMIX_TIMEOUT** to the host environment so that multiple
competing timeouts are not created.

Description

The callback function will be executed once the specified data becomes available from the
identified process and retrieved by the local server. The *info* array is used as described by the
PMIx_Get routine.

Advice to users

Information provided by the PMIx server at time of process start is accessed by providing the
namespace of the job with the rank set to **PMIX_RANK_WILDCARD**. Attributes referenced in this
way are identified in 3.4 but includes items such as the number of processes in the namespace
(**PMIX_JOB_SIZE**), total available slots in the allocation (**PMIX_UNIV_SIZE**), and the number
of nodes in the allocation (**PMIX_NUM_NODES**).

In general, data posted by a process via **PMIx_Put** and data that refers directly to a process-related
value needs to be retrieved by specifying the rank of the posting process. All other information is
retrievable using a rank of **PMIX_RANK_WILDCARD**, as illustrated in 5.1.5. See 3.4.11 for an
explanation regarding use of the *level* attributes.

5.1.4 `PMIx_Store_internal`

Summary

Store some data locally for retrieval by other areas of the proc.

Format

```
C
2    pmix_status_t
3    PMIx_Store_internal(const pmix_proc_t *proc,
4                        const pmix_key_t key,
5                        pmix_value_t *val);
C
```

6   **IN   proc**
7   process reference (handle)
8   **IN   key**
9   key to retrieve (string)
10   **IN   val**
11   Value to store (handle)

12   Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

14   Store some data locally for retrieval by other areas of the proc. This is data that has only internal
15   scope - it will never be "pushed" externally.

5.1.5 Accessing information: examples

17   This section provides examples illustrating methods for accessing information at various levels.
18   The intent of the examples is not to provide comprehensive coding guidance, but rather to illustrate
19   how **PMIx_Get** can be used to obtain information on a **session**, **job**, **application**, process,
20   and node.

5.1.5.1 Session-level information

22   The **PMIx_Get** API does not include an argument for specifying the **session** associated with
23   the information being requested. Information regarding the session containing the requestor can be
24   obtained by the following methods:

25   • for session-level attributes (e.g., **PMIX_UNIV_SIZE**), specifying the requestor's namespace and
26   a rank of **PMIX_RANK_WILDCARD**; or

27   • for non-specific attributes (e.g., **PMIX_NUM_NODES**), including the **PMIX_SESSION_INFO**
28   attribute to indicate that the session-level information for that attribute is being requested

29   Example requests are shown below:

```
1    pmix_info_t info;
2    pmix_value_t *value;
3    pmix_status_t rc;
4    pmix_proc_t myproc, wildcard;
5
6    /* initialize the client library */
7    PMIx_Init(&myproc, NULL, 0);
8
9    /* get the #slots in our session */
10   PMIX_PROC_LOAD(&wildcard, myproc.nspace, PMIX_RANK_WILDCARD);
11   rc = PMIx_Get(&wildcard, PMIX_UNIV_SIZE, NULL, 0, &value);
12
13   /* get the #nodes in our session */
14   PMIX_INFO_LOAD(&info, PMIX_SESSION_INFO, NULL, PMIX_BOOL);
15   rc = PMIx_Get(&wildcard, PMIX_NUM_NODES, &info, 1, &value);
```

16 Information regarding a different session can be requested by either specifying the namespace and a
17 rank of **PMIX_RANK_WILDCARD** for a process in the target session, or adding the
18 **PMIX_SESSION_ID** attribute identifying the target session. In the latter case, the *proc* argument
19 to **PMIx_Get** will be ignored:

```
20   pmix_info_t info[2];
21   pmix_value_t *value;
22   pmix_status_t rc;
23   pmix_proc_t myproc;
24   uint32_t sid;
25
26   /* initialize the client library */
27   PMIx_Init(&myproc, NULL, 0);
28
29   /* get the #nodes in a different session */
30   sid = 12345;
31   PMIX_INFO_LOAD(&info[0], PMIX_SESSION_INFO, NULL, PMIX_BOOL);
32   PMIX_INFO_LOAD(&info[1], PMIX_SESSION_ID, &sid, PMIX_UINT32);
33   rc = PMIx_Get(&myproc, PMIX_NUM_NODES, info, 2, &value);
```

5.1.5.2 Job-level information

Information regarding a job can be obtained by the following methods:

- for job-level attributes (e.g., **PMIX_JOB_SIZE** or **PMIX_JOB_NUM_APPS**), specifying the namespace of the job and a rank of **PMIX_RANK_WILDCARD** for the *proc* argument to **PMIx_Get**; or

- for non-specific attributes (e.g., **PMIX_NUM_NODES**), including the **PMIX_JOB_INFO** attribute to indicate that the job-level information for that attribute is being requested

Example requests are shown below:

———————————————————— C ————————————————————

```
pmix_info_t info;
pmix_value_t *value;
pmix_status_t rc;
pmix_proc_t myproc, wildcard;

/* initialize the client library */
PMIx_Init(&myproc, NULL, 0);

/* get the #apps in our job */
PMIX_PROC_LOAD(&wildcard, myproc.nspace, PMIX_RANK_WILDCARD);
rc = PMIx_Get(&wildcard, PMIX_JOB_NUM_APPS, NULL, 0, &value);

/* get the #nodes in our job */
PMIX_INFO_LOAD(&info, PMIX_JOB_INFO, NULL, PMIX_BOOL);
rc = PMIx_Get(&wildcard, PMIX_NUM_NODES, &info, 1, &value);
```

———————————————————— C ————————————————————

5.1.5.3 Application-level information

Information regarding an application can be obtained by the following methods:

- for application-level attributes (e.g., **PMIX_APP_SIZE**), specifying the namespace and rank of a process within that application;

- for application-level attributes (e.g., **PMIX_APP_SIZE**), including the **PMIX_APPNUM** attribute specifying the application whose information is being requested. In this case, the namespace field of the *proc* argument is used to reference the **job** containing the application - the **rank** field is ignored;

- or application-level attributes (e.g., **PMIX_APP_SIZE**), including the **PMIX_APPNUM** and **PMIX_NSPACE** or **PMIX_JOBID** attributes specifying the job/application whose information is being requested. In this case, the *proc* argument is ignored;

- for non-specific attributes (e.g., **PMIX_NUM_NODES**), including the **PMIX_APP_INFO** attribute to indicate that the application-level information for that attribute is being requested

Example requests are shown below:

————————————————————— C —————————————————————

```
pmix_info_t info;
pmix_value_t *value;
pmix_status_t rc;
pmix_proc_t myproc, otherproc;
uint32_t appsize, appnum;

/* initialize the client library */
PMIx_Init(&myproc, NULL, 0);

/* get the #processes in our application */
rc = PMIx_Get(&myproc, PMIX_APP_SIZE, NULL, 0, &value);
appsize = value->data.uint32;

/* get the #nodes in an application containing "otherproc".
 * Note that the rank of a process in the other application
 * must be obtained first - a simple method is shown here */

/* assume for this example that we are in the first application
 * and we want the #nodes in the second application - use the
 * rank of the first process in that application, remembering
 * that ranks start at zero */
PMIX_PROC_LOAD(&otherproc, myproc.nspace, appsize);

PMIX_INFO_LOAD(&info, PMIX_APP_INFO, NULL, PMIX_BOOL);
rc = PMIx_Get(&otherproc, PMIX_NUM_NODES, &info, 1, &value);

/* alternatively, we can directly ask for the #nodes in
 * the second application in our job, again remembering that
 * application numbers start with zero */
appnum = 1;
PMIX_INFO_LOAD(&appinfo[0], PMIX_APP_INFO, NULL, PMIX_BOOL);
PMIX_INFO_LOAD(&appinfo[1], PMIX_APPNUM, &appnum, PMIX_UINT32);
rc = PMIx_Get(&myproc, PMIX_NUM_NODES, appinfo, 2, &value);
```

————————————————————— C —————————————————————

5.1.5.4 Process-level information

Process-level information is accessed by providing the namespace and rank of the target process. In the absence of any directive as to the level of information being requested, the PMIx library will always return the process-level value.

5.1.5.5 Node-level information

Information regarding a node within the system can be obtained by the following methods:

- for node-level attributes (e.g., **PMIX_NODE_SIZE**), specifying the namespace and rank of a process executing on the target node;

- for node-level attributes (e.g., **PMIX_NODE_SIZE**), including the **PMIX_NODEID** or **PMIX_HOSTNAME** attribute specifying the node whose information is being requested. In this case, the *proc* argument's values are ignored; or

- for non-specific attributes (e.g., **PMIX_MAX_PROCS**), including the **PMIX_NODE_INFO** attribute to indicate that the node-level information for that attribute is being requested

Example requests are shown below:

———————————————————— C ————————————————————

```
pmix_info_t info[2];
pmix_value_t *value;
pmix_status_t rc;
pmix_proc_t myproc, otherproc;
uint32_t nodeid;

/* initialize the client library */
PMIx_Init(&myproc, NULL, 0);

/* get the #procs on our node */
rc = PMIx_Get(&myproc, PMIX_NODE_SIZE, NULL, 0, &value);

/* get the #slots on another node */
PMIX_INFO_LOAD(&info[0], PMIX_NODE_INFO, NULL, PMIX_BOOL);
PMIX_INFO_LOAD(&info[1], PMIX_HOSTNAME, "remotehost", PMIX_STRING);
rc = PMIx_Get(&myproc, PMIX_MAX_PROCS, info, 2, &value);
```

———————————————————— C ————————————————————

———————————————————— Advice to users ————————————————————

An explanation of the use of **PMIx_Get** versus **PMIx_Query_info_nb** is provided in 7.1.3.1.

5.2 Exchanging Key/Value Pairs

The APIs defined in this section push key/value pairs from the client to the local PMIx server, and circulate the data between PMIx servers for subsequent retrieval by the local clients.

5.2.1 `PMIx_Commit`

Summary

Push all previously **`PMIx_Put`** values to the local PMIx server.

Format

PMIx v1.0

──────────────── C ────────────────

```
pmix_status_t PMIx_Commit(void)
```

──────────────── C ────────────────

Returns **`PMIX_SUCCESS`** or a negative value corresponding to a PMIx error constant.

Description

This is an asynchronous operation. The PRI will immediately return to the caller while the data is transmitted to the local server in the background.

──────────────── Advice to users ────────────────

The local PMIx server will cache the information locally - i.e., the committed data will not be circulated during **`PMIx_Commit`**. Availability of the data upon completion of **`PMIx_Commit`** is therefore implementation-dependent.

5.2.2 `PMIx_Fence`

Summary

Execute a blocking barrier across the processes identified in the specified array, collecting information posted via **`PMIx_Put`** as directed.

Format

```
pmix_status_t
PMIx_Fence(const pmix_proc_t procs[], size_t nprocs,
           const pmix_info_t info[], size_t ninfo)
```

IN **procs**
Array of **pmix_proc_t** structures (array of handles)
IN **nprocs**
Number of element in the *procs* array (integer)
IN **info**
Array of info structures (array of handles)
IN **ninfo**
Number of element in the *info* array (integer)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------ Required Attributes ------------------▼

The following attributes are required to be supported by all PMIx libraries:

PMIX_COLLECT_DATA **"pmix.collect"** (**bool**)
Collect data and return it at the end of the operation.
▲--▲

▼------------------ Optional Attributes ------------------▼

The following attributes are optional for host environments:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
Time in seconds before the specified operation should time out (*0* indicating infinite) in
error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
the target process from ever exposing its data.

PMIX_COLLECTIVE_ALGO **"pmix.calgo"** (**char***)
Comma-delimited list of algorithms to use for the collective operation. PMIx does not
impose any requirements on a host environment's collective algorithms. Thus, the
acceptable values for this attribute will be environment-dependent - users are encouraged to
check their host environment for supported values.

PMIX_COLLECTIVE_ALGO_REQD **"pmix.calreqd"** (**bool**)
If **true**, indicates that the requested choice of algorithm is mandatory.
▲--▲

--------------- Advice to PMIx library implementers ---------------

1   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
2   environment due to race condition considerations between completion of the operation versus
3   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
4   directly in the PMIx server library must take care to resolve the race condition and should avoid
5   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
6   created.

7   **Description**
8   Passing a **NULL** pointer as the *procs* parameter indicates that the fence is to span all processes in
9   the client's namespace. Each provided **pmix_proc_t** struct can pass **PMIX_RANK_WILDCARD**
10   to indicate that all processes in the given namespace are participating.

11   The *info* array is used to pass user requests regarding the fence operation.

12   Note that for scalability reasons, the default behavior for **PMIx_Fence** is to not collect the data.

--------------- Advice to PMIx library implementers ---------------

13   **PMIx_Fence** and its non-blocking form are both *collective* operations. Accordingly, the PMIx
14   server library is required to aggregate participation by local clients, passing the request to the host
15   environment once all local participants have executed the API.

--------------- Advice to PMIx server hosts ---------------

16   The host will receive a single call for each collective operation. It is the responsibility of the host to
17   identify the nodes containing participating processes, execute the collective across all participating
18   nodes, and notify the local PMIx server library upon completion of the global collective.

19   5.2.3   `PMIx_Fence_nb`

20   **Summary**
21   Execute a nonblocking **PMIx_Fence** across the processes identified in the specified array of
22   processes, collecting information posted via **PMIx_Put** as directed.

▼─────────────── C ───────────────▼

```
pmix_status_t
PMIx_Fence_nb(const pmix_proc_t procs[], size_t nprocs,
              const pmix_info_t info[], size_t ninfo,
              pmix_op_cbfunc_t cbfunc, void *cbdata)
```

▲─────────────── C ───────────────▲

IN   procs
    Array of **pmix_proc_t** structures (array of handles)
IN   nprocs
    Number of element in the *procs* array (integer)
IN   info
    Array of info structures (array of handles)
IN   ninfo
    Number of element in the *info* array (integer)
IN   cbfunc
    Callback function (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called. This can occur if the collective involved only processes on the local node.

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

▼----------------- Required Attributes -----------------▼

The following attributes are required to be supported by all PMIx libraries:

PMIX_COLLECT_DATA **"pmix.collect"** (**bool**)
    Collect data and return it at the end of the operation.

▲--▲

1 The following attributes are optional for host environments that support this operation:

2 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
3   Time in seconds before the specified operation should time out (*0* indicating infinite) in
4   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
5   the target process from ever exposing its data.

6 **PMIX_COLLECTIVE_ALGO** **"pmix.calgo"** (**char***)
7   Comma-delimited list of algorithms to use for the collective operation. PMIx does not
8   impose any requirements on a host environment's collective algorithms. Thus, the
9   acceptable values for this attribute will be environment-dependent - users are encouraged to
10   check their host environment for supported values.

11 **PMIX_COLLECTIVE_ALGO_REQD** **"pmix.calreqd"** (**bool**)
12   If **true**, indicates that the requested choice of algorithm is mandatory.

------------------ Advice to PMIx library implementers ------------------

13 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
14 environment due to race condition considerations between completion of the operation versus
15 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
16 directly in the PMIx server library must take care to resolve the race condition and should avoid
17 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
18 created.

19 **Description**
20 Nonblocking **PMIx_Fence** routine. Note that the function will return an error if a **NULL** callback
21 function is given.

22 Note that for scalability reasons, the default behavior for **PMIx_Fence_nb** is to not collect the
23 data.

24 See the **PMIx_Fence** description for further details.

5.3   Publish and Lookup Data

The APIs defined in this section publish data from one client that can be later exchanged and looked up by another client.

Advice to PMIx library implementers
---

4   PMIx libraries that support any of the functions in this section are required to support *all* of them.

Advice to PMIx server hosts
---

5   Host environments that support any of the functions in this section are required to support *all* of
6   them.

5.3.1   `PMIx_Publish`

8   **Summary**
9   Publish data for later access via **PMIx_Lookup**.

10   **Format**

PMIx v1.0 ─────────────── C ───────────────

```
pmix_status_t
PMIx_Publish(const pmix_info_t info[], size_t ninfo)
```

─────────────── C ───────────────

13   **IN   info**
14   Array of info structures (array of handles)
15   **IN   ninfo**
16   Number of element in the *info* array (integer)

17   Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

-------------------- Required Attributes --------------------

18   PMIx libraries are not required to directly support any attributes for this function. However, any
19   provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
20   *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that
21   published the info.

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
    Time in seconds before the specified operation should time out (*0* indicating infinite) in
    error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
    the target process from ever exposing its data.

PMIX_RANGE **"pmix.range"** (**pmix_data_range_t**)
    Value for calls to publish/lookup/unpublish or for monitoring event notifications.

PMIX_PERSISTENCE **"pmix.persist"** (**pmix_persistence_t**)
    Value for calls to **PMIx_Publish**.

We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
environment due to race condition considerations between completion of the operation versus
internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
directly in the PMIx server library must take care to resolve the race condition and should avoid
passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
created.

Description
Publish the data in the *info* array for subsequent lookup. By default, the data will be published into
the **PMIX_RANGE_SESSION** range and with **PMIX_PERSIST_APP** persistence. Changes to
those values, and any additional directives, can be included in the **pmix_info_t** array. Attempts
to access the data by processes outside of the provided data range will be rejected. The persistence
parameter instructs the server as to how long the data is to be retained.

The blocking form will block until the server confirms that the data has been sent to the PMIx
server and that it has obtained confirmation from its host SMS daemon that the data is ready to be
looked up. Data is copied into the backing key-value data store, and therefore the *info* array can be
released upon return from the blocking function call.

Duplicate keys within the specified data range may lead to unexpected behavior depending on host
RM implementation of the backing key-value store.

1 Implementations should, to the best of their ability, detect duplicate keys and protect the user from
2 unexpected behavior - preferably returning an error. This version of the standard does not define a
3 specific error code to be returned, so the implementation must make it clear to the user what to
4 expect in this scenario. One suggestion is to define an RM specific error code beyond the
5 **PMIX_EXTERNAL_ERR_BASE** boundary. Future versions of the standard will clarify that a
6 specific PMIx error be returned when conflicting values are published for a given key, and will
7 provide attributes to allow modified behaviors such as overwrite.

5.3.2 `PMIx_Publish_nb`

Summary
Nonblocking **PMIx_Publish** routine.

Format

PMIx v1.0

—————————————————————————— C ——————————————————————————

```
pmix_status_t
PMIx_Publish_nb(const pmix_info_t info[], size_t ninfo,
                pmix_op_cbfunc_t cbfunc, void *cbdata)
```

—————————————————————————— C ——————————————————————————

IN   info
   Array of info structures (array of handles)
IN   ninfo
   Number of element in the *info* array (integer)
IN   cbfunc
   Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
  will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
  function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
  returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately
  processed and failed - the *cbfunc* will *not* be called

1   PMIx libraries are not required to directly support any attributes for this function. However, any
2   provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
3   *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that
4   published the info.

---------------- ▼ Optional Attributes ---------------- ▼

5   The following attributes are optional for host environments that support this operation:

6   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
7   Time in seconds before the specified operation should time out (*0* indicating infinite) in
8   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
9   the target process from ever exposing its data.

10   **PMIX_RANGE** **"pmix.range"** (**pmix_data_range_t**)
11   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

12   **PMIX_PERSISTENCE** **"pmix.persist"** (**pmix_persistence_t**)
13   Value for calls to **PMIx_Publish**.

———————————————— Advice to PMIx library implementers ————————————————

14   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
15   environment due to race condition considerations between completion of the operation versus
16   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
17   directly in the PMIx server library must take care to resolve the race condition and should avoid
18   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
19   created.

20   **Description**
21   Nonblocking **PMIx_Publish** routine. The non-blocking form will return immediately, executing
22   the callback when the PMIx server receives confirmation from its host SMS daemon.

23   Note that the function will return an error if a **NULL** callback function is given, and that the *info*
24   array must be maintained until the callback is provided.

25   ## 5.3.3 **PMIx_Lookup**

26   **Summary**
27   Lookup information published by this or another process with **PMIx_Publish** or
28   **PMIx_Publish_nb**.

1   **Format**

── C ──

2   `pmix_status_t`
3   `PMIx_Lookup(pmix_pdata_t data[], size_t ndata,`
4   `          const pmix_info_t info[], size_t ninfo)`

── C ──

5   **INOUT** `data`
6   Array of publishable data structures (array of handles)
7   **IN** `ndata`
8   Number of elements in the *data* array (integer)
9   **IN** `info`
10   Array of info structures (array of handles)
11 **IN** `ninfo`
12   Number of elements in the *info* array (integer)

13 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼────────────── Required Attributes ──────────────▼

14 PMIx libraries are not required to directly support any attributes for this function. However, any
15 provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
16 *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that is
17 requesting the info.

▲──▲

▼────────────── Optional Attributes ──────────────▼

18 The following attributes are optional for host environments that support this operation:

19 **PMIX_TIMEOUT "pmix.timeout" (int)**
20   Time in seconds before the specified operation should time out (*0* indicating infinite) in
21   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
22   the target process from ever exposing its data.

23 **PMIX_RANGE "pmix.range" (pmix_data_range_t)**
24   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

25 **PMIX_WAIT "pmix.wait" (int)**
26   Caller requests that the PMIx server wait until at least the specified number of values are
27   found (*0* indicates all and is the default).

▲──▲

1   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
2   environment due to race condition considerations between completion of the operation versus
3   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
4   directly in the PMIx server library must take care to resolve the race condition and should avoid
5   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
6   created.

7   **Description**
8   Lookup information published by this or another process. By default, the search will be conducted
9   across the **PMIX_RANGE_SESSION** range. Changes to the range, and any additional directives,
10   can be provided in the **pmix_info_t** array.

11   Note that the search is also constrained to only data published by the current user (i.e., the search
12   will not return data published by an application being executed by another user). There currently is
13   no option to override this behavior - such an option may become available later via an appropriate
14   **pmix_info_t** directive.

15   The *data* parameter consists of an array of **pmix_pdata_t** struct with the keys specifying the
16   requested information. Data will be returned for each key in the associated *value* struct. Any key
17   that cannot be found will return with a data type of **PMIX_UNDEF**. The function will return
18   **PMIX_SUCCESS** if any values can be found, so the caller must check each data element to ensure
19   it was returned.

20   The proc field in each **pmix_pdata_t** struct will contain the namespace/rank of the process that
21   published the data.

22   Although this is a blocking function, it will not wait by default for the requested data to be
23   published. Instead, it will block for the time required by the server to lookup its current data and
24   return any found items. Thus, the caller is responsible for ensuring that data is published prior to
25   executing a lookup, using **PMIX_WAIT** to instruct the server to wait for the data to be published, or
26   for retrying until the requested data is found.

27 ## 5.3.4 **PMIx_Lookup_nb**

28   **Summary**
29   Nonblocking version of **PMIx_Lookup**.

```
2    pmix_status_t
3    PMIx_Lookup_nb(char **keys,
4                       const pmix_info_t info[], size_t ninfo,
5                       pmix_lookup_cbfunc_t cbfunc, void *cbdata)
```

6   **IN keys**
7   Array to be provided to the callback (array of strings)
8   **IN info**
9   Array of info structures (array of handles)
10   **IN ninfo**
11   Number of element in the *info* array (integer)
12   **IN cbfunc**
13   Callback function (handle)
14   **IN cbdata**
15   Callback data to be provided to the callback function (pointer)

16   Returns one of the following:

17   • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
18   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
19   function prior to returning from the API.

20   • a PMIx error constant indicating an error in the input - the *cbfunc* will *not* be called

▼------------------ Required Attributes ------------------▼

21   PMIx libraries are not required to directly support any attributes for this function. However, any
22   provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
23   *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that is
24   requesting the info.

▲--▲

▼------------------ Optional Attributes ------------------▼

25   The following attributes are optional for host environments that support this operation:

26   **PMIX_TIMEOUT "pmix.timeout" (int)**
27   Time in seconds before the specified operation should time out (*0* indicating infinite) in
28   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
29   the target process from ever exposing its data.

30   **PMIX_RANGE "pmix.range" (pmix_data_range_t)**
31   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

32   **PMIX_WAIT "pmix.wait" (int)**

| 1 | Caller requests that the PMIx server wait until at least the specified number of values are |
| 2 | found (*0* indicates all and is the default). |

—————— Advice to PMIx library implementers ——————

3	We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
4	environment due to race condition considerations between completion of the operation versus
5	internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
6	directly in the PMIx server library must take care to resolve the race condition and should avoid
7	passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
8	created.

9 **Description**

10	Non-blocking form of the **PMIx_Lookup** function. Data for the provided NULL-terminated *keys*
11	array will be returned in the provided callback function. As with **PMIx_Lookup**, the default
12	behavior is to not wait for data to be published. The *info* array can be used to modify the behavior
13	as previously described by **PMIx_Lookup**. Both the *info* and *keys* arrays must be maintained until
14	the callback is provided.

15 5.3.5 `PMIx_Unpublish`

16 **Summary**

17 Unpublish data posted by this process using the given keys.

18 **Format**

PMIx v1.0 ▽ —————————————— C ——————————————— ▽

```
19   pmix_status_t
20   PMIx_Unpublish(char **keys,
21                  const pmix_info_t info[], size_t ninfo)
```

▲ —————————————— C ——————————————— ▲

22	**IN** `info`
23	Array of info structures (array of handles)
24	**IN** `ninfo`
25	Number of element in the *info* array (integer)

26 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------ Required Attributes ------------------▼

27	PMIx libraries are not required to directly support any attributes for this function. However, any
28	provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
29	*required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that is
30	requesting the operation.

Optional Attributes

1   The following attributes are optional for host environments that support this operation:

2   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
3   Time in seconds before the specified operation should time out (*0* indicating infinite) in
4   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
5   the target process from ever exposing its data.

6   **PMIX_RANGE** **"pmix.range"** (**pmix_data_range_t**)
7   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

                          Advice to PMIx library implementers

8   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
9   environment due to race condition considerations between completion of the operation versus
10   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
11   directly in the PMIx server library must take care to resolve the race condition and should avoid
12   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
13   created.

14   **Description**
15   Unpublish data posted by this process using the given *keys*. The function will block until the data
16   has been removed by the server (i.e., it is safe to publish that key again). A value of **NULL** for the
17   *keys* parameter instructs the server to remove all data published by this process.

18   By default, the range is assumed to be **PMIX_RANGE_SESSION**. Changes to the range, and any
19   additional directives, can be provided in the *info* array.

20   ## 5.3.6   **PMIx_Unpublish_nb**

21   **Summary**
22   Nonblocking version of **PMIx_Unpublish**.

```
2        pmix_status_t
3        PMIx_Unpublish_nb(char **keys,
4                          const pmix_info_t info[], size_t ninfo,
5                          pmix_op_cbfunc_t cbfunc, void *cbdata)
```

6   **IN   keys**
7   (array of strings)
8   **IN   info**
9   Array of info structures (array of handles)
10   **IN   ninfo**
11   Number of element in the *info* array (integer)
12   **IN   cbfunc**
13   Callback function **pmix_op_cbfunc_t** (function reference)
14   **IN   cbdata**
15   Data to be passed to the callback function (memory reference)

16   Returns one of the following:

17   • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
18   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
19   function prior to returning from the API.

20   • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
21   returned *success* - the *cbfunc* will *not* be called

22   • a PMIx error constant indicating either an error in the input or that the request was immediately
23   processed and failed - the *cbfunc* will *not* be called

▼------------------ Required Attributes ------------------▼

24   PMIx libraries are not required to directly support any attributes for this function. However, any
25   provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
26   *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process that is
27   requesting the operation.

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
Time in seconds before the specified operation should time out (*0* indicating infinite) in error. The timeout parameter can help avoid "hangs" due to programming errors that prevent the target process from ever exposing its data.

PMIX_RANGE **"pmix.range"** (**pmix_data_range_t**)
Value for calls to publish/lookup/unpublish or for monitoring event notifications.

▲--▲

◆----------------- Advice to PMIx library implementers -----------------▼

We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host environment due to race condition considerations between completion of the operation versus internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT** directly in the PMIx server library must take care to resolve the race condition and should avoid passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not created.

▲--▲

Description
Non-blocking form of the **PMIx_Unpublish** function. The callback function will be executed once the server confirms removal of the specified data. The *info* array must be maintained until the callback is provided.

Process Management

1 This chapter defines functionality used by clients to create and destroy/abort processes in the PMIx
2 universe.

6.1 Abort

4 PMIx provides a dedicated API by which an application can request that specified processes be
5 aborted by the system.

6.1.1 `PMIx_Abort`

7 **Summary**
8 Abort the specified processes

9 **Format**

PMIx v1.0 ──────────────────────── C ────────────────────────

```
10      pmix_status_t
11      PMIx_Abort(int status, const char msg[],
12                 pmix_proc_t procs[], size_t nprocs)
```

──────────────────────── C ────────────────────────

13 **IN   status**
14   Error code to return to invoking environment (integer)
15 **IN   msg**
16   String message to be returned to user (string)
17 **IN   procs**
18   Array of **pmix_proc_t** structures (array of handles)
19 **IN   nprocs**
20   Number of elements in the *procs* array (integer)

21 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Request that the host resource manager print the provided message and abort the provided array of *procs*. A Unix or POSIX environment should handle the provided status as a return error code from the main program that launched the application. A **NULL** for the *procs* array indicates that all processes in the caller's namespace are to be aborted, including itself. Passing a **NULL** *msg* parameter is allowed.

———————————————————— Advice to users ————————————————————

The response to this request is somewhat dependent on the specific resource manager and its configuration (e.g., some resource managers will not abort the application if the provided status is zero unless specifically configured to do so, and some cannot abort subsets of processes in an application), and thus lies outside the control of PMIx itself. However, the PMIx client library shall inform the RM of the request that the specified *procs* be aborted, regardless of the value of the provided status.

Note that race conditions caused by multiple processes calling **PMIx_Abort** are left to the server implementation to resolve with regard to which status is returned and what messages (if any) are printed.

6.2 Process Creation

The **PMIx_Spawn** commands spawn new processes and/or applications in the PMIx universe. This may include requests to extend the existing resource allocation or obtain a new one, depending upon provided and supported attributes.

6.2.1 **PMIx_Spawn**

Summary

Spawn a new job.

Format

─────────────────────── C ───────────────────────

```
pmix_status_t
PMIx_Spawn(const pmix_info_t job_info[], size_t ninfo,
           const pmix_app_t apps[], size_t napps,
           char nspace[])
```

─────────────────────── C ───────────────────────

IN   job_info
   Array of info structures (array of handles)
IN   ninfo
   Number of elements in the *job_info* array (integer)
IN   apps
   Array of **pmix_app_t** structures (array of handles)
IN   napps
   Number of elements in the *apps* array (integer)
OUT   nspace
   Namespace of the new job (string)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------   Required Attributes   ------------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is required to add the following attributes to those provided before passing the request to the host:

PMIX_SPAWNED "pmix.spawned" (**bool**)
   true if this process resulted from a call to **PMIx_Spawn**.

PMIX_PARENT_ID "pmix.parent" (**pmix_proc_t**)
   Process identifier of the parent process of the calling process.

PMIX_REQUESTOR_IS_CLIENT "pmix.req.client" (**bool**)
   The requesting process is a PMIx client.

PMIX_REQUESTOR_IS_TOOL "pmix.req.tool" (**bool**)
   The requesting process is a PMIx tool.

───

Host environments that implement support for **PMIx_Spawn** are required to pass the **PMIX_SPAWNED** and **PMIX_PARENT_ID** attributes to all PMIx servers launching new child processes so those values can be returned to clients upon connection to the PMIx server. In addition, they are required to support the following attributes when present in either the *job_info* or the *info* array of an element of the *apps* array:

PMIX_WDIR "pmix.wdir" (**char***)

1   Working directory for spawned processes.

2 **PMIX_SET_SESSION_CWD** **"pmix.ssncwd"** (**bool**)
3   Set the application's current working directory to the session working directory assigned by
4   the RM - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the
5   rank to discover the session working directory assigned to the provided namespace

6 **PMIX_PREFIX** **"pmix.prefix"** (**char***)
7   Prefix to use for starting spawned processes.

8 **PMIX_HOST** **"pmix.host"** (**char***)
9   Comma-delimited list of hosts to use for spawned processes.

10 **PMIX_HOSTFILE** **"pmix.hostfile"** (**char***)
11   Hostfile to use for spawned processes.
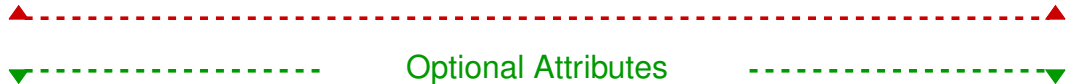
▲--▲

▼----------------- Optional Attributes -----------------▼

12 The following attributes are optional for host environments that support this operation:

13 **PMIX_ADD_HOSTFILE** **"pmix.addhostfile"** (**char***)
14   Hostfile listing hosts to add to existing allocation.

15 **PMIX_ADD_HOST** **"pmix.addhost"** (**char***)
16   Comma-delimited list of hosts to add to the allocation.

17 **PMIX_PRELOAD_BIN** **"pmix.preloadbin"** (**bool**)
18   Preload binaries onto nodes.

19 **PMIX_PRELOAD_FILES** **"pmix.preloadfiles"** (**char***)
20   Comma-delimited list of files to pre-position on nodes.

21 **PMIX_PERSONALITY** **"pmix.pers"** (**char***)
22   Name of personality to use.

23 **PMIX_MAPPER** **"pmix.mapper"** (**char***)
24   Mapping mechanism to use for placing spawned processes - when accessed using
25   **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping
26   mechanism used for the provided namespace.

27 **PMIX_DISPLAY_MAP** **"pmix.dispmap"** (**bool**)
28   Display process mapping upon spawn.

29 **PMIX_PPR** **"pmix.ppr"** (**char***)
30   Number of processes to spawn on each identified resource.

31 **PMIX_MAPBY** **"pmix.mapby"** (**char***)

1   Process mapping policy - when accessed using **PMIx_Get**, use the
2   **PMIX_RANK_WILDCARD** value for the rank to discover the mapping policy used for the
3   provided namespace

4 **PMIX_RANKBY "pmix.rankby"** (**char***)
5   Process ranking policy - when accessed using **PMIx_Get**, use the
6   **PMIX_RANK_WILDCARD** value for the rank to discover the ranking algorithm used for the
7   provided namespace

8 **PMIX_BINDTO "pmix.bindto"** (**char***)
9   Process binding policy - when accessed using **PMIx_Get**, use the
10   **PMIX_RANK_WILDCARD** value for the rank to discover the binding policy used for the
11   provided namespace

12 **PMIX_NON_PMI "pmix.nonpmi"** (**bool**)
13   Spawned processes will not call **PMIx_Init**.

14 **PMIX_STDIN_TGT "pmix.stdin"** (**uint32_t**)
15   Spawned process rank that is to receive **stdin**.

16 **PMIX_FWD_STDIN "pmix.fwd.stdin"** (**bool**)
17   Forward this process's **stdin** to the designated process.

18 **PMIX_FWD_STDOUT "pmix.fwd.stdout"** (**bool**)
19   Forward **stdout** from spawned processes to this process.

20 **PMIX_FWD_STDERR "pmix.fwd.stderr"** (**bool**)
21   Forward **stderr** from spawned processes to this process.

22 **PMIX_DEBUGGER_DAEMONS "pmix.debugger"** (**bool**)
23   Spawned application consists of debugger daemons.

24 **PMIX_TAG_OUTPUT "pmix.tagout"** (**bool**)
25   Tag application output with the identity of the source process.

26 **PMIX_TIMESTAMP_OUTPUT "pmix.tsout"** (**bool**)
27   Timestamp output from applications.

28 **PMIX_MERGE_STDERR_STDOUT "pmix.mergeerrout"** (**bool**)
29   Merge **stdout** and **stderr** streams from application processes.

30 **PMIX_OUTPUT_TO_FILE "pmix.outfile"** (**char***)
31   Output application output to the specified file.

32 **PMIX_INDEX_ARGV "pmix.indxargv"** (**bool**)
33   Mark the **argv** with the rank of the process.

34 **PMIX_CPUS_PER_PROC "pmix.cpuperproc"** (**uint32_t**)

1   Number of cpus to assign to each rank - when accessed using **PMIx_Get**, use the
2   **PMIX_RANK_WILDCARD** value for the rank to discover the cpus/process assigned to the
3   provided namespace

4 **PMIX_NO_PROCS_ON_HEAD** **"pmix.nolocal"** (**bool**)
5   Do not place processes on the head node.

6 **PMIX_NO_OVERSUBSCRIBE** **"pmix.noover"** (**bool**)
7   Do not oversubscribe the cpus.

8 **PMIX_REPORT_BINDINGS** **"pmix.repbind"** (**bool**)
9   Report bindings of the individual processes.

10 **PMIX_CPU_LIST** **"pmix.cpulist"** (**char***)
11   List of cpus to use for this job - when accessed using **PMIx_Get**, use the
12   **PMIX_RANK_WILDCARD** value for the rank to discover the cpu list used for the provided
13   namespace

14 **PMIX_JOB_RECOVERABLE** **"pmix.recover"** (**bool**)
15   Application supports recoverable operations.

16 **PMIX_JOB_CONTINUOUS** **"pmix.continuous"** (**bool**)
17   Application is continuous, all failed processes should be immediately restarted.

18 **PMIX_MAX_RESTARTS** **"pmix.maxrestarts"** (**uint32_t**)
19   Maximum number of times to restart a job - when accessed using **PMIx_Get**, use the
20   **PMIX_RANK_WILDCARD** value for the rank to discover the max restarts for the provided
21   namespace

Description

23 Spawn a new job. The assigned namespace of the spawned applications is returned in the *nspace*
24 parameter. A **NULL** value in that location indicates that the caller doesn't wish to have the
25 namespace returned. The *nspace* array must be at least of size one more than **PMIX_MAX_NSLEN**.

26 By default, the spawned processes will be PMIx "connected" to the parent process upon successful
27 launch (see **PMIx_Connect** description for details). Note that this only means that (a) the parent
28 process will be given a copy of the new job's information so it can query job-level info without
29 incurring any communication penalties, (b) newly spawned child processes will receive a copy of
30 the parent processes job-level info, and (c) both the parent process and members of the child job
31 will receive notification of errors from processes in their combined assemblage.

──────────────────── Advice to users ────────────────────

32 Behavior of individual resource managers may differ, but it is expected that failure of any
33 application process to start will result in termination/cleanup of all processes in the newly spawned
34 job and return of an error code to the caller.

6.2.2 `PMIx_Spawn_nb`

Summary

Nonblocking version of the **PMIx_Spawn** routine.

Format

PMIx v1.0

─────────────────────────── C ───────────────────────────

```
pmix_status_t
PMIx_Spawn_nb(const pmix_info_t job_info[], size_t ninfo,
              const pmix_app_t apps[], size_t napps,
              pmix_spawn_cbfunc_t cbfunc, void *cbdata)
```

─────────────────────────── C ───────────────────────────

IN   job_info
    Array of info structures (array of handles)
IN   ninfo
    Number of elements in the *job_info* array (integer)
IN   apps
    Array of **pmix_app_t** structures (array of handles)
IN   cbfunc
    Callback function **pmix_spawn_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- a PMIx error constant indicating an error in the request - the *cbfunc* will *not* be called

▼------------------ Required Attributes ------------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is required to add the following attributes to those provided before passing the request to the host:

PMIX_SPAWNED "pmix.spawned" (**bool**)
    true if this process resulted from a call to **PMIx_Spawn**.

PMIX_PARENT_ID "pmix.parent" (**pmix_proc_t**)
    Process identifier of the parent process of the calling process.

PMIX_REQUESTOR_IS_CLIENT "pmix.req.client" (**bool**)
    The requesting process is a PMIx client.

PMIX_REQUESTOR_IS_TOOL "pmix.req.tool" (**bool**)

1	The requesting process is a PMIx tool.

2	——

3	Host environments that implement support for **PMIx_Spawn** are required to pass the
4	**PMIX_SPAWNED** and **PMIX_PARENT_ID** attributes to all PMIx servers launching new child
5	processes so those values can be returned to clients upon connection to the PMIx server. In
6	addition, they are required to support the following attributes when present in either the *job_info* or
7	the *info* array of an element of the *apps* array:

8	**PMIX_WDIR "pmix.wdir" (char*)**
9	 Working directory for spawned processes.

10	**PMIX_SET_SESSION_CWD "pmix.ssncwd" (bool)**
11	 Set the application's current working directory to the session working directory assigned by
12	 the RM - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the
13	 rank to discover the session working directory assigned to the provided namespace

14	**PMIX_PREFIX "pmix.prefix" (char*)**
15	 Prefix to use for starting spawned processes.

16	**PMIX_HOST "pmix.host" (char*)**
17	 Comma-delimited list of hosts to use for spawned processes.

18	**PMIX_HOSTFILE "pmix.hostfile" (char*)**
19	 Hostfile to use for spawned processes.

▲--▲

▼----------------   Optional Attributes   ----------------▼
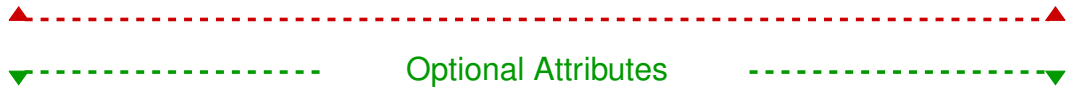
20	The following attributes are optional for host environments that support this operation:

21	**PMIX_ADD_HOSTFILE "pmix.addhostfile" (char*)**
22	 Hostfile listing hosts to add to existing allocation.

23	**PMIX_ADD_HOST "pmix.addhost" (char*)**
24	 Comma-delimited list of hosts to add to the allocation.

25	**PMIX_PRELOAD_BIN "pmix.preloadbin" (bool)**
26	 Preload binaries onto nodes.

27	**PMIX_PRELOAD_FILES "pmix.preloadfiles" (char*)**
28	 Comma-delimited list of files to pre-position on nodes.

29	**PMIX_PERSONALITY "pmix.pers" (char*)**
30	 Name of personality to use.

31	**PMIX_MAPPER "pmix.mapper" (char*)**

Mapping mechanism to use for placing spawned processes - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping mechanism used for the provided namespace.

PMIX_DISPLAY_MAP "pmix.dispmap" (bool)
Display process mapping upon spawn.

PMIX_PPR "pmix.ppr" (char*)
Number of processes to spawn on each identified resource.

PMIX_MAPBY "pmix.mapby" (char*)
Process mapping policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping policy used for the provided namespace

PMIX_RANKBY "pmix.rankby" (char*)
Process ranking policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the ranking algorithm used for the provided namespace

PMIX_BINDTO "pmix.bindto" (char*)
Process binding policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the binding policy used for the provided namespace

PMIX_NON_PMI "pmix.nonpmi" (bool)
Spawned processes will not call **PMIx_Init**.

PMIX_STDIN_TGT "pmix.stdin" (uint32_t)
Spawned process rank that is to receive **stdin**.

PMIX_FWD_STDIN "pmix.fwd.stdin" (bool)
Forward this process's **stdin** to the designated process.

PMIX_FWD_STDOUT "pmix.fwd.stdout" (bool)
Forward **stdout** from spawned processes to this process.

PMIX_FWD_STDERR "pmix.fwd.stderr" (bool)
Forward **stderr** from spawned processes to this process.

PMIX_DEBUGGER_DAEMONS "pmix.debugger" (bool)
Spawned application consists of debugger daemons.

PMIX_TAG_OUTPUT "pmix.tagout" (bool)
Tag application output with the identity of the source process.

PMIX_TIMESTAMP_OUTPUT "pmix.tsout" (bool)
Timestamp output from applications.

PMIX_MERGE_STDERR_STDOUT "pmix.mergeerrout" (bool)

1   Merge **stdout** and **stderr** streams from application processes.

2   **PMIX_OUTPUT_TO_FILE "pmix.outfile"** (**char***)
3   Output application output to the specified file.

4   **PMIX_INDEX_ARGV "pmix.indxargv"** (**bool**)
5   Mark the **argv** with the rank of the process.

6   **PMIX_CPUS_PER_PROC "pmix.cpuperproc"** (**uint32_t**)
7   Number of cpus to assign to each rank - when accessed using **PMIx_Get**, use the
8   **PMIX_RANK_WILDCARD** value for the rank to discover the cpus/process assigned to the
9   provided namespace

10 **PMIX_NO_PROCS_ON_HEAD "pmix.nolocal"** (**bool**)
11   Do not place processes on the head node.

12 **PMIX_NO_OVERSUBSCRIBE "pmix.noover"** (**bool**)
13   Do not oversubscribe the cpus.

14 **PMIX_REPORT_BINDINGS "pmix.repbind"** (**bool**)
15   Report bindings of the individual processes.

16 **PMIX_CPU_LIST "pmix.cpulist"** (**char***)
17   List of cpus to use for this job - when accessed using **PMIx_Get**, use the
18   **PMIX_RANK_WILDCARD** value for the rank to discover the cpu list used for the provided
19   namespace

20 **PMIX_JOB_RECOVERABLE "pmix.recover"** (**bool**)
21   Application supports recoverable operations.

22 **PMIX_JOB_CONTINUOUS "pmix.continuous"** (**bool**)
23   Application is continuous, all failed processes should be immediately restarted.

24 **PMIX_MAX_RESTARTS "pmix.maxrestarts"** (**uint32_t**)
25   Maximum number of times to restart a job - when accessed using **PMIx_Get**, use the
26   **PMIX_RANK_WILDCARD** value for the rank to discover the max restarts for the provided
27   namespace

28 **Description**
29 Nonblocking version of the **PMIx_Spawn** routine. The provided callback function will be
30 executed upon successful start of *all* specified application processes.

—————————————————— Advice to users ——————————————————

31 Behavior of individual resource managers may differ, but it is expected that failure of any
32 application process to start will result in termination/cleanup of all processes in the newly spawned
33 job and return of an error code to the caller.

6.3 Connecting and Disconnecting Processes

This section defines functions to connect and disconnect processes in two or more separate PMIx namespaces. The PMIx definition of *connected* solely implies the following:

- job-level information for each namespace involved in the operation is to be made available to all processes in the connected assemblage

- any data posted by a process in the connected assemblage (via calls to **PMIx_Put** committed via **PMIx_Commit**) prior to execution of the **PMIx_Connect** operation is to be made accessible to all processes in the assemblage - any data posted after execution of the *connect* operation must be exchanged via a separate **PMIx_Fence** operation spanning the connected processes

- the host environment should treat the failure of any process in the assemblage as a reportable event, taking action on the assemblage as if it were a single application. For example, if the environment defaults (in the absence of any application directives) to terminating an application upon failure of any process in that application, then the environment should terminate all processes in the connected assemblage upon failure of any member.

---------------- Advice to PMIx server hosts ----------------

The host environment may choose to assign a new namespace to the connected assemblage and/or assign new ranks for its members for its own internal tracking purposes. However, it is not required to communicate such assignments to the participants (e.g., in response to an appropriate call to **PMIx_Query_info_nb**). The host environment is required to generate a **PMIX_ERR_INVALID_TERMINATION** event should any process in the assemblage terminate or call **PMIx_Finalize** without first *disconnecting* from the assemblage.

---------------- Advice to users ----------------

Attempting to *connect* processes solely within the same namespace is essentially a *no-op* operation. While not explicitly prohibited, users are advised that a PMIx implementation or host environment may return an error in such cases.

Neither the PMIx implementation nor host environment are required to provide any tracking support for the assemblage. Thus, the application is responsible for maintaining the membership list of the assemblage.

6.3.1 **PMIx_Connect**

Summary

Connect namespaces.

1 **Format**

```C
pmix_status_t
PMIx_Connect(const pmix_proc_t procs[], size_t nprocs,
             const pmix_info_t info[], size_t ninfo)
```

5 **IN** **procs**
6   Array of proc structures (array of handles)
7 **IN** **nprocs**
8   Number of elements in the *procs* array (integer)
9 **IN** **info**
10   Array of info structures (array of handles)
11 **IN** **ninfo**
12   Number of elements in the *info* array (integer)

13 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------- Required Attributes -------------------▼

14 PMIx libraries are not required to directly support any attributes for this function. However, any
15 provided attributes must be passed to the host SMS daemon for processing.

▲--▲

▼------------------- Optional Attributes -------------------▼

16 The following attributes are optional for host environments that support this operation:

17 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
18   Time in seconds before the specified operation should time out (*0* indicating infinite) in
19   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
20   the target process from ever exposing its data.

21 **PMIX_COLLECTIVE_ALGO** **"pmix.calgo"** (**char***)
22   Comma-delimited list of algorithms to use for the collective operation. PMIx does not
23   impose any requirements on a host environment's collective algorithms. Thus, the
24   acceptable values for this attribute will be environment-dependent - users are encouraged to
25   check their host environment for supported values.

26 **PMIX_COLLECTIVE_ALGO_REQD** **"pmix.calreqd"** (**bool**)
27   If **true**, indicates that the requested choice of algorithm is mandatory.

▲--▲

1 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
2 environment due to race condition considerations between completion of the operation versus
3 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
4 directly in the PMIx server library must take care to resolve the race condition and should avoid
5 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
6 created.

Description

8 Record the processes specified by the *procs* array as *connected* as per the PMIx definition. The
9 function will return once all processes identified in *procs* have called either **PMIx_Connect** or its
10 non-blocking version, *and* the host environment has completed any supporting operations required
11 to meet the terms of the PMIx definition of *connected* processes.

12 All processes engaged in a given **PMIx_Connect** operation must provide the identical *procs* array
13 as ordering of entries in the array and the method by which those processes are identified (e.g., use
14 of **PMIX_RANK_WILDCARD** versus listing the individual processes) *may* impact the host
15 environment's algorithm for uniquely identifying an operation.

16 **PMIx_Connect** and its non-blocking form are both *collective* operations. Accordingly, the PMIx
17 server library is required to aggregate participation by local clients, passing the request to the host
18 environment once all local participants have executed the API.

19 The host will receive a single call for each collective operation. It is the responsibility of the host to
20 identify the nodes containing participating processes, execute the collective across all participating
21 nodes, and notify the local PMIx server library upon completion of the global collective.

22 Processes that combine via **PMIx_Connect** must call **PMIx_Disconnect** prior to finalizing
23 and/or terminating - any process in the assemblage failing to meet this requirement will cause a
24 **PMIX_ERR_INVALID_TERMINATION** event to be generated.

25 A process can only engage in one connect operation involving the identical *procs* array at a time.
26 However, a process can be simultaneously engaged in multiple connect operations, each involving a
27 different *procs* array.

28 As in the case of the **PMIx_Fence** operation, the *info* array can be used to pass user-level
29 directives regarding the algorithm to be used for any collective operation involved in the operation,
30 timeout constraints, and other options available from the host RM.

6.3.2 `PMIx_Connect_nb`

Summary

3 Nonblocking **`PMIx_Connect_nb`** routine.

4 **Format**

PMIx v1.0 ———————————————— C ————————————————

```
5    pmix_status_t
6    PMIx_Connect_nb(const pmix_proc_t procs[], size_t nprocs,
7                        const pmix_info_t info[], size_t ninfo,
8                        pmix_op_cbfunc_t cbfunc, void *cbdata)
```

———————————————— C ————————————————

9 **IN   procs**
10   Array of proc structures (array of handles)
11 **IN   nprocs**
12   Number of elements in the *procs* array (integer)
13 **IN   info**
14   Array of info structures (array of handles)
15 **IN   ninfo**
16   Number of element in the *info* array (integer)
17 **IN   cbfunc**
18   Callback function **`pmix_op_cbfunc_t`** (function reference)
19 **IN   cbdata**
20   Data to be passed to the callback function (memory reference)

21 Returns one of the following:

22 • **`PMIX_SUCCESS`**, indicating that the request is being processed by the host environment - result
23   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
24   function prior to returning from the API.

25 • **`PMIX_OPERATION_SUCCEEDED`**, indicating that the request was immediately processed and
26   returned *success* - the *cbfunc* will *not* be called

27 • a PMIx error constant indicating either an error in the input or that the request was immediately
28   processed and failed - the *cbfunc* will *not* be called

▼------------------ Required Attributes ------------------▼

29 PMIx libraries are not required to directly support any attributes for this function. However, any
30 provided attributes must be passed to the host SMS daemon for processing.

1   The following attributes are optional for host environments that support this operation:

2   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
3   Time in seconds before the specified operation should time out (*0* indicating infinite) in
4   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
5   the target process from ever exposing its data.

6   **PMIX_COLLECTIVE_ALGO** **"pmix.calgo"** (**char***)
7   Comma-delimited list of algorithms to use for the collective operation. PMIx does not
8   impose any requirements on a host environment's collective algorithms. Thus, the
9   acceptable values for this attribute will be environment-dependent - users are encouraged to
10   check their host environment for supported values.

11   **PMIX_COLLECTIVE_ALGO_REQD** **"pmix.calreqd"** (**bool**)
12   If **true**, indicates that the requested choice of algorithm is mandatory.

13   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
14   environment due to race condition considerations between completion of the operation versus
15   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
16   directly in the PMIx server library must take care to resolve the race condition and should avoid
17   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
18   created.

19   ### Description
20   Nonblocking version of **PMIx_Connect**. The callback function is called once all processes
21   identified in *procs* have called either **PMIx_Connect** or its non-blocking version, *and* the host
22   environment has completed any supporting operations required to meet the terms of the PMIx
23   definition of *connected* processes. See the advice provided in the description for **PMIx_Connect**
24   for more information.

25   ## 6.3.3 **PMIx_Disconnect**

26   ### Summary
27   Disconnect a previously connected set of processes.

Format

```c
pmix_status_t
PMIx_Disconnect(const pmix_proc_t procs[], size_t nprocs,
                const pmix_info_t info[], size_t ninfo);
```

IN `procs`
  Array of proc structures (array of handles)
IN `nprocs`
  Number of elements in the *procs* array (integer)
IN `info`
  Array of info structures (array of handles)
IN `ninfo`
  Number of element in the *info* array (integer)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

▼------------------- Required Attributes -------------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any provided attributes must be passed to the host SMS daemon for processing.

▲--▲

▼------------------- Optional Attributes -------------------▼

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT `"pmix.timeout"` (**int**)
  Time in seconds before the specified operation should time out (*0* indicating infinite) in error. The timeout parameter can help avoid "hangs" due to programming errors that prevent the target process from ever exposing its data.

▲--▲

———————— Advice to PMIx library implementers ————————

We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host environment due to race condition considerations between completion of the operation versus internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT** directly in the PMIx server library must take care to resolve the race condition and should avoid passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not created.

Description

Disconnect a previously connected set of processes. A `PMIX_ERR_INVALID_OPERATION` error will be returned if the specified set of *procs* was not previously *connected* via a call to `PMIx_Connect` or its non-blocking form. The function will return once all processes identified in *procs* have called either `PMIx_Disconnect` or its non-blocking version, *and* the host environment has completed any required supporting operations.

─────────────────────────── Advice to users ───────────────────────────

All processes engaged in a given `PMIx_Disconnect` operation must provide the identical *procs* array as ordering of entries in the array and the method by which those processes are identified (e.g., use of `PMIX_RANK_WILDCARD` versus listing the individual processes) *may* impact the host environment's algorithm for uniquely identifying an operation.

──────────────────── Advice to PMIx library implementers ────────────────────

`PMIx_Disconnect` and its non-blocking form are both *collective* operations. Accordingly, the PMIx server library is required to aggregate participation by local clients, passing the request to the host environment once all local participants have executed the API.

──────────────────── Advice to PMIx server hosts ────────────────────

The host will receive a single call for each collective operation. The host will receive a single call for each collective operation. It is the responsibility of the host to identify the nodes containing participating processes, execute the collective across all participating nodes, and notify the local PMIx server library upon completion of the global collective.

A process can only engage in one disconnect operation involving the identical *procs* array at a time. However, a process can be simultaneously engaged in multiple disconnect operations, each involving a different *procs* array.

As in the case of the `PMIx_Fence` operation, the *info* array can be used to pass user-level directives regarding the algorithm to be used for any collective operation involved in the operation, timeout constraints, and other options available from the host RM.

6.3.4 `PMIx_Disconnect_nb`

Summary

Nonblocking `PMIx_Disconnect` routine.

```
pmix_status_t
PMIx_Disconnect_nb(const pmix_proc_t procs[], size_t nprocs,
                   const pmix_info_t info[], size_t ninfo,
                   pmix_op_cbfunc_t cbfunc, void *cbdata);
```

——————————————————————————————— C ———————————————————————————————

IN   procs
    Array of proc structures (array of handles)
IN   nprocs
    Number of elements in the *procs* array (integer)
IN   info
    Array of info structures (array of handles)
IN   ninfo
    Number of element in the *info* array (integer)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
  will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
  function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
  returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately
  processed and failed - the *cbfunc* will *not* be called

▼----------------- Required Attributes -----------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any
provided attributes must be passed to the host SMS daemon for processing.

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT   "pmix.timeout" (**int**)
    Time in seconds before the specified operation should time out (*0* indicating infinite) in
    error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
    the target process from ever exposing its data.

1   We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
2   environment due to race condition considerations between completion of the operation versus
3   internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
4   directly in the PMIx server library must take care to resolve the race condition and should avoid
5   passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
6   created.

7   **Description**
8   Nonblocking **PMIx_Disconnect** routine. The callback function is called once all processes
9   identified in *procs* have called either **PMIx_Disconnect_nb** or its blocking version, *and* the
10   host environment has completed any required supporting operations. See the advice provided in the
11   description for **PMIx_Disconnect** for more information.

12 6.4   IO Forwarding

13   This section defines functions by which tools (e.g., debuggers) can request forwarding of
14   input/output to/from other processes. The term "tool" widely refers to non-computational programs
15   executed by the user or system administrator to monitor or control a principal computational
16   program. Tools almost always interact with either the host environment, user applications, or both
17   to perform administrative and support functions. For example, a debugger tool might be used to
18   remotely control the processes of a parallel application, monitoring their behavior on a step-by-step
19   basis.

20   Underlying the operation of many tools is a common need to forward stdin from the tool to targeted
21   processes, and to return stdout/stderr from those processes for display on the user's console.
22   Historically, each tool developer was responsible for creating their own IO forwarding subsystem.
23   However, with the introduction of PMIx as a standard mechanism for interacting between
24   applications and the host environment, it has become possible to relieve tool developers of this
25   burden.

26   The responsibility of the host environment in forwarding of IO falls into the following areas:

27   • Capturing output from specified child processes

28   • Forwarding that output to the host of the PMIx server library that requested it

29   • Delivering that payload to the PMIx server library via the **PMIx_server_IOF_deliver** API
30   for final dispatch

31   It is the responsibility of the PMIx library to buffer, format, and deliver the payload to the
32   requesting client.

1   The forwarding of IO via PMIx requires that both the host environment and the tool support PMIx,
2   but does not impose any similar requirements on the application itself.

3 6.4.1 `PMIx_IOF_pull`

4   **Summary**
5   Register to receive output forwarded from a set of remote processes.

6   **Format**

PMIx v3.0

C

```
pmix_status_t
PMIx_IOF_pull(const pmix_proc_t procs[], size_t nprocs,
              const pmix_info_t directives[], size_t ndirs,
              pmix_iof_channel_t channel, pmix_iof_cbfunc_t cbfunc,
              pmix_hdlr_reg_cbfunc_t regcbfunc, void *regcbdata)
```

C

12   **IN procs**
13   Array of proc structures identifying desired source processes (array of handles)
14   **IN nprocs**
15   Number of elements in the *procs* array (integer)
16   **IN directives**
17   Array of **pmix_info_t** structures (array of handles)
18   **IN ndirs**
19   Number of elements in the *directives* array (integer)
20   **IN channel**
21   Bitmask of IO channels included in the request (**pmix_iof_channel_t**)
22   **IN cbfunc**
23   Callback function for delivering relevant output (**pmix_iof_cbfunc_t** function reference)
24   **IN regcbfunc**
25   Function to be called when registration is completed (**pmix_hdlr_reg_cbfunc_t**
26   function reference)
27   **IN regcbdata**
28   Data to be passed to the *regcbfunc* callback function (memory reference)

29   Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant. In the event
30   the function returns an error, the *regcbfunc* will *not* be called.

1   The following attributes are required for PMIx libraries that support IO forwarding:

2   **PMIX_IOF_CACHE_SIZE** **"pmix.iof.csize"** (**uint32_t**)
3   The requested size of the server cache in bytes for each specified channel. By default, the
4   server is allowed (but not required) to drop all bytes received beyond the max size.

5   **PMIX_IOF_DROP_OLDEST** **"pmix.iof.old"** (**bool**)
6   In an overflow situation, drop the oldest bytes to make room in the cache.

7   **PMIX_IOF_DROP_NEWEST** **"pmix.iof.new"** (**bool**)
8   In an overflow situation, drop any new bytes received until room becomes available in the
9   cache (default).

▲--▲

10   The following attributes are optional for PMIx libraries that support IO forwarding:

11   **PMIX_IOF_BUFFERING_SIZE** **"pmix.iof.bsize"** (**uint32_t**)
12   Controls grouping of IO on the specified channel(s) to avoid being called every time a bit of
13   IO arrives. The library will execute the callback whenever the specified number of bytes
14   becomes available. Any remaining buffered data will be "flushed" upon call to deregister the
15   respective channel.

16   **PMIX_IOF_BUFFERING_TIME** **"pmix.iof.btime"** (**uint32_t**)
17   Max time in seconds to buffer IO before delivering it. Used in conjunction with buffering
18   size, this prevents IO from being held indefinitely while waiting for another payload to
19   arrive.

20   **PMIX_IOF_TAG_OUTPUT** **"pmix.iof.tag"** (**bool**)
21   Tag output with the channel it comes from.

22   **PMIX_IOF_TIMESTAMP_OUTPUT** **"pmix.iof.ts"** (**bool**)
23   Timestamp output

24   **PMIX_IOF_XML_OUTPUT** **"pmix.iof.xml"** (**bool**)
25   Format output in XML

▲--▲

Description

Register to receive output forwarded from a set of remote processes.

────────────────────────── Advice to users ──────────────────────────

Providing a **NULL** function pointer for the *cbfunc* parameter will cause output for the indicated channels to be written to their corresponding stdout/stderr file descriptors. Use of **PMIX_RANK_WILDCARD** to specify all processes in a given namespace is supported but should be used carefully due to bandwidth considerations.

▲──▲

6.4.2 `PMIx_IOF_deregister`

Summary

Deregister from output forwarded from a set of remote processes.

Format

PMIx v3.0

──────────────────────────── C ────────────────────────────

```
pmix_status_t
PMIx_IOF_deregister(size_t iofhdlr,
                        const pmix_info_t directives[], size_t ndirs,
                        pmix_op_cbfunc_t cbfunc, void *cbdata)
```

──────────────────────────── C ────────────────────────────

IN   iofhdlr
    Registration number returned from the **pmix_hdlr_reg_cbfunc_t** callback from the
    call to **PMIx_IOF_pull**(**size_t**)
IN   directives
    Array of **pmix_info_t** structures (array of handles)
IN   ndirs
    Number of elements in the *directives* array (integer)
IN   cbfunc
    Callback function to be called when deregistration has been completed. (function reference)
IN   cbdata
    Data to be passed to the *cbfunc* callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

Description

Deregister from output forwarded from a set of remote processes.

———————————— Advice to PMIx library implementers ————————————

Any currently buffered IO should be flushed upon receipt of a deregistration request. All received
IO after receipt of the request shall be discarded.

6.4.3 `PMIx_IOF_push`

Summary

Push data collected locally (typically from stdin or a file) to stdin of the target recipients.

Format

PMIx v3.0

———————————————— C ————————————————

```
pmix_status_t
PMIx_IOF_push(const pmix_proc_t targets[], size_t ntargets,
                pmix_byte_object_t *bo,
                const pmix_info_t directives[], size_t ndirs,
                pmix_op_cbfunc_t cbfunc, void *cbdata)
```

———————————————— C ————————————————

IN   targets
  Array of proc structures identifying desired target processes (array of handles)
IN   ntargets
  Number of elements in the *targets* array (integer)
IN   bo
  Pointer to **pmix_byte_object_t** containing the payload to be delivered (handle)
IN   directives
  Array of **pmix_info_t** structures (array of handles)
IN   ndirs
  Number of elements in the *directives* array (integer)
IN   directives
  Array of **pmix_info_t** structures (array of handles)
IN   cbfunc
  Callback function to be called when operation has been completed. (**pmix_op_cbfunc_t**
  function reference)
IN   cbdata
  Data to be passed to the *cbfunc* callback function (memory reference)

Returns one of the following:

1 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
2   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
3   function prior to returning from the API.

4 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
5   returned *success* - the *cbfunc* will *not* be called

6 • a PMIx error constant indicating either an error in the input or that the request was immediately
7   processed and failed - the *cbfunc* will *not* be called

▼------------------ Required Attributes ------------------▼

8 The following attributes are required for PMIx libraries that support IO forwarding:

9 **PMIX_IOF_CACHE_SIZE** **"pmix.iof.csize"** (**uint32_t**)
10   The requested size of the server cache in bytes for each specified channel. By default, the
11   server is allowed (but not required) to drop all bytes received beyond the max size.

12 **PMIX_IOF_DROP_OLDEST** **"pmix.iof.old"** (**bool**)
13   In an overflow situation, drop the oldest bytes to make room in the cache.

14 **PMIX_IOF_DROP_NEWEST** **"pmix.iof.new"** (**bool**)
15   In an overflow situation, drop any new bytes received until room becomes available in the
16   cache (default).

▲--▲

▼------------------ Optional Attributes ------------------▼

17 The following attributes are optional for PMIx libraries that support IO forwarding:

18 **PMIX_IOF_BUFFERING_SIZE** **"pmix.iof.bsize"** (**uint32_t**)
19   Controls grouping of IO on the specified channel(s) to avoid being called every time a bit of
20   IO arrives. The library will execute the callback whenever the specified number of bytes
21   becomes available. Any remaining buffered data will be "flushed" upon call to deregister the
22   respective channel.

23 **PMIX_IOF_BUFFERING_TIME** **"pmix.iof.btime"** (**uint32_t**)
24   Max time in seconds to buffer IO before delivering it. Used in conjunction with buffering
25   size, this prevents IO from being held indefinitely while waiting for another payload to
26   arrive.

▲--▲

Description

Push data collected locally (typically from stdin or a file) to stdin of the target recipients.

─────────────────────── Advice to users ───────────────────────

Execution of the *cbfunc* callback function serves as notice that the PMIx library no longer requires the caller to maintain the *bo* data object - it does *not* indicate delivery of the payload to the targets. Use of **PMIX_RANK_WILDCARD** to specify all processes in a given namespace is supported but should be used carefully due to bandwidth considerations.

Job Management and Reporting

1   The job management APIs provide an application with the ability to orchestrate its operation in
2   partnership with the SMS. Members of this category include the
3   **PMIx_Allocation_request_nb**, **PMIx_Job_control_nb**, and
4   **PMIx_Process_monitor_nb** APIs.

7.1   Query

6   As the level of interaction between applications and the host SMS grows, so too does the need for
7   the application to query the SMS regarding its capabilities and state information. PMIx provides a
8   generalized query interface for this purpose, along with a set of standardized attribute keys to
9   support a range of requests. This includes requests to determine the status of scheduling queues and
10   active allocations, the scope of API and attribute support offered by the SMS, namespaces of active
11   jobs, location and information about a job's processes, and information regarding available
12   resources.

13   An example use-case for the **PMIx_Query_info_nb** API is to ensure clean job completion.
14   Time-shared systems frequently impose maximum run times when assigning jobs to resource
15   allocations. To shut down gracefully, e.g., to write a checkpoint before termination, it is necessary
16   for an application to periodically query the resource manager for the time remaining in its
17   allocation. This is especially true on systems for which allocation times may be shortened or
18   lengthened from the original time limit. Many resource managers provide APIs to dynamically
19   obtain this information, but each API is specific to the resource manager.

20   PMIx supports this use-case by defining an attribute key (**PMIX_TIME_REMAINING**) that can be
21   used with the **PMIx_Query_info_nb** interface to obtain the number of seconds remaining in
22   the current job allocation. Note that one could alternatively use the
23   **PMIx_Register_event_handler** API to register for an event indicating incipient job
24   termination, and then use the **PMIx_Job_control_nb** API to request that the host SMS
25   generate an event a specified amount of time prior to reaching the maximum run time. PMIx
26   provides such alternate methods as a means of maximizing the probability of a host system
27   supporting at least one method by which the application can obtain the desired service.

28   The following APIs support query of various session and environment values.

7.1.1   PMIx_Resolve_peers

Summary

31   Obtain the array of processes within the specified namespace that are executing on a given node.

Format

C

```
pmix_status_t
PMIx_Resolve_peers(const char *nodename,
                   const pmix_nspace_t nspace,
                   pmix_proc_t **procs, size_t *nprocs)
```

C

IN   **nodename**
    Name of the node to query (string)
IN   **nspace**
    namespace (string)
OUT   **procs**
    Array of process structures (array of handles)
OUT   **nprocs**
    Number of elements in the *procs* array (integer)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Given a *nodename*, return the array of processes within the specified *nspace* that are executing on that node. If the *nspace* is **NULL**, then all processes on the node will be returned. If the specified node does not currently host any processes, then the returned array will be **NULL**, and *nprocs* will be **0**. The caller is responsible for releasing the *procs* array when done with it. The **PMIX_PROC_FREE** macro is provided for this purpose.

7.1.2   `PMIx_Resolve_nodes`

Summary

Return a list of nodes hosting processes within the given namespace.

Format

C

```
pmix_status_t
PMIx_Resolve_nodes(const char *nspace, char **nodelist)
```

C

IN   **nspace**
    Namespace (string)
OUT   **nodelist**
    Comma-delimited list of nodenames (string)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Given a *nspace*, return the list of nodes hosting processes within that namespace. The returned string will contain a comma-delimited list of nodenames. The caller is responsible for releasing the string when done with it.

7.1.3 `PMIx_Query_info_nb`

Summary

Query information about the system in general.

Format

PMIx v2.0

――――――――――――― C ―――――――――――――

```
pmix_status_t
PMIx_Query_info_nb(pmix_query_t queries[], size_t nqueries,
                   pmix_info_cbfunc_t cbfunc, void *cbdata)
```

――――――――――――― C ―――――――――――――

IN   queries
   Array of query structures (array of handles)
IN   nqueries
   Number of elements in the *queries* array (integer)
IN   cbfunc
   Callback function **pmix_info_cbfunc_t** (function reference)
IN   cbdata
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS** indicating that the request has been accepted for processing and the provided callback function will be executed upon completion of the operation. Note that the library must not invoke the callback function prior to returning from the API.

- a non-zero PMIx error constant indicating a reason for the request to have been rejected. In this case, the provided callback function will not be executed

If executed, the status returned in the provided callback function will be one of the following constants:

- **PMIX_SUCCESS** All data has been returned

- **PMIX_ERR_NOT_FOUND** None of the requested data was available

- **PMIX_ERR_NOT_SUPPORTED** The host RM does not support this function

- a non-zero PMIx error constant indicating a reason for the request's failure

1   PMIx libraries that support this API are required to support the following attributes:

2   **PMIX_QUERY_REFRESH_CACHE "pmix.qry.rfsh"** (**bool**)
3   Retrieve updated information from server.

4   **PMIX_SESSION_INFO "pmix.ssn.info"** (**bool**)
5   Return information about the specified session. If information about a session other than the
6   one containing the requesting process is desired, then the attribute array must contain a
7   **PMIX_SESSION_ID** attribute identifying the desired target.

8   **PMIX_JOB_INFO "pmix.job.info"** (**bool**)
9   Return information about the specified job or namespace. If information about a job or
10   namespace other than the one containing the requesting process is desired, then the attribute
11   array must contain a **PMIX_JOBID** or **PMIX_NSPACE** attribute identifying the desired
12   target. Similarly, if information is requested about a job or namespace in a session other than
13   the one containing the requesting process, then an attribute identifying the target session
14   must be provided.

15   **PMIX_APP_INFO "pmix.app.info"** (**bool**)
16   Return information about the specified application. If information about an application other
17   than the one containing the requesting process is desired, then the attribute array must
18   contain a **PMIX_APPNUM** attribute identifying the desired target. Similarly, if information is
19   requested about an application in a job or session other than the one containing the requesting
20   process, then attributes identifying the target job and/or session must be provided.

21   **PMIX_NODE_INFO "pmix.node.info"** (**bool**)
22   Return information about the specified node. If information about a node other than the one
23   containing the requesting process is desired, then the attribute array must contain either the
24   **PMIX_NODEID** or **PMIX_HOSTNAME** attribute identifying the desired target.

25   **PMIX_PROCID "pmix.procid"** (**pmix_proc_t**)
26   Process identifier   Specifies the process ID whose information is being requested - e.g., a
27   query asking for the **PMIX_LOCAL_RANK** of a specified process. Only required when the
28   request is for information on a specific process.

29   **PMIX_NSPACE "pmix.nspace"** (**char***)
30   Namespace of the job.   Specifies the namespace of the process whose information is being
31   requested - e.g., a query asking for the **PMIX_LOCAL_RANK** of a specified process. Must be
32   accompanied by the **PMIX_RANK** attribute. Only required when the request is for
33   information on a specific process.

34   **PMIX_RANK "pmix.rank"** (**pmix_rank_t**)
35   Process rank within the job.   Specifies the rank of the process whose information is being
36   requested - e.g., a query asking for the **PMIX_LOCAL_RANK** of a specified process. Must be
37   accompanied by the **PMIX_NSPACE** attribute. Only required when the request is for
38   information on a specific process.

1 Note that inclusion of the **PMIX_PROCID** directive and either the **PMIX_NSPACE** or the
2 **PMIX_RANK** attribute will return a **PMIX_ERR_BAD_PARAM** result, and that the inclusion of a
3 process identifier must apply to all keys in that **pmix_query_t**. Queries for information on
4 multiple specific processes therefore requires submitting multiple **pmix_query_t** structures,
5 each referencing one process.

6 PMIx libraries are not required to directly support any other attributes for this function. However,
7 any provided attributes must be passed to the host SMS daemon for processing, and the PMIx
8 library is *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client
9 process making the request.

10 ───

11 Host environments that support this operation are required to support the following attributes as
12 qualifiers to the request:

13 **PMIX_PROCID** **"pmix.procid"** (**pmix_proc_t**)
14   Process identifier Specifies the process ID whose information is being requested - e.g., a
15   query asking for the **PMIX_LOCAL_RANK** of a specified process. Only required when the
16   request is for information on a specific process.

17 **PMIX_NSPACE** **"pmix.nspace"** (**char***)
18   Namespace of the job. Specifies the namespace of the process whose information is being
19   requested - e.g., a query asking for the **PMIX_LOCAL_RANK** of a specified process. Must be
20   accompanied by the **PMIX_RANK** attribute. Only required when the request is for
21   information on a specific process.

22 **PMIX_RANK** **"pmix.rank"** (**pmix_rank_t**)
23   Process rank within the job. Specifies the rank of the process whose information is being
24   requested - e.g., a query asking for the **PMIX_LOCAL_RANK** of a specified process. Must be
25   accompanied by the **PMIX_NSPACE** attribute. Only required when the request is for
26   information on a specific process.

27 Note that inclusion of the **PMIX_PROCID** directive and either the **PMIX_NSPACE** or the
28 **PMIX_RANK** attribute will return a **PMIX_ERR_BAD_PARAM** result, and that the inclusion of a
29 process identifier must apply to all keys in that **pmix_query_t**. Queries for information on
30 multiple specific processes therefore requires submitting multiple **pmix_query_t** structures,
31 each referencing one process.

▼----------------- Optional Attributes -----------------▼

32 The following attributes are optional for host environments that support this operation:

33 **PMIX_QUERY_NAMESPACES** **"pmix.qry.ns"** (**char***)
34   Request a comma-delimited list of active namespaces.

35 **PMIX_QUERY_JOB_STATUS** **"pmix.qry.jst"** (**pmix_status_t**)
36   Status of a specified, currently executing job.

PMIX_QUERY_QUEUE_LIST `"pmix.qry.qlst"` (**char***)
　　　Request a comma-delimited list of scheduler queues.

PMIX_QUERY_QUEUE_STATUS `"pmix.qry.qst"` (**TBD**)
　　　Status of a specified scheduler queue.

PMIX_QUERY_PROC_TABLE `"pmix.qry.ptable"` (**char***)
　　　Input namespace of the job whose information is being requested returns
　　　(**pmix_data_array_t**) an array of **pmix_proc_info_t**.

PMIX_QUERY_LOCAL_PROC_TABLE `"pmix.qry.lptable"` (**char***)
　　　Input namespace of the job whose information is being requested returns
　　　(**pmix_data_array_t**) an array of **pmix_proc_info_t** for processes in job on same
　　　node.

PMIX_QUERY_SPAWN_SUPPORT `"pmix.qry.spawn"` (**bool**)
　　　Return a comma-delimited list of supported spawn attributes.

PMIX_QUERY_DEBUG_SUPPORT `"pmix.qry.debug"` (**bool**)
　　　Return a comma-delimited list of supported debug attributes.

PMIX_QUERY_MEMORY_USAGE `"pmix.qry.mem"` (**bool**)
　　　Return information on memory usage for the processes indicated in the qualifiers.

PMIX_QUERY_REPORT_AVG `"pmix.qry.avg"` (**bool**)
　　　Report only average values for sampled information.

PMIX_QUERY_REPORT_MINMAX `"pmix.qry.minmax"` (**bool**)
　　　Report minimum and maximum values.

PMIX_QUERY_ALLOC_STATUS `"pmix.query.alloc"` (**char***)
　　　String identifier of the allocation whose status is being requested.

PMIX_TIME_REMAINING `"pmix.time.remaining"` (**char***)
　　　Query number of seconds (**uint32_t**) remaining in allocation for the specified namespace.

PMIX_SERVER_URI `"pmix.srvr.uri"` (**char***)
　　　URI of the PMIx server to be contacted.　Requests the URI of the specified PMIx server's
　　　PMIx connection. Defaults to requesting the information for the local PMIx server.

PMIX_PROC_URI `"pmix.puri"` (**char***)
　　　URI containing contact information for a given process.　Requests the URI of the specified
　　　PMIx server's out-of-band connection. Defaults to requesting the information for the local
　　　PMIx server.
▲--▲

Description

Query information about the system in general. This can include a list of active namespaces, network topology, etc. Also can be used to query node-specific info such as the list of peers executing on a given node. We assume that the host RM will exercise appropriate access control on the information.

NOTE: There is no blocking form of this API as the structures passed to query info differ from those for receiving the results.

The *status* argument to the callback function indicates if requested data was found or not. An array of **pmix_info_t** will contain each key that was provided and the corresponding value that was found. Requests for keys that are not found will return the key paired with a value of type **PMIX_UNDEF**.

───────────────── Advice to users ─────────────────

The desire to query a list of attributes supported by the implementation and/or the host environment has been expressed and noted. The PMIx community is exploring the possibility and it will likely become available in a future release

───────────── Advice to PMIx library implementers ─────────────

Information returned from **PMIx_Query_info_nb** shall be locally cached so that retrieval by subsequent calls to **PMIx_Get** or **PMIx_Query_info_nb** can succeed with minimal overhead. The local cache shall be checked prior to querying the PMIx server and/or the host environment. Queries that include the **PMIX_QUERY_REFRESH_CACHE** attribute shall bypass the local cache and retrieve a new value for the query, refreshing the values in the cache upon return.

7.1.3.1 Using `PMIx_Get` vs `PMIx_Query_info_nb`

Both `PMIx_Get` and `PMIx_Query_info_nb` can be used to retrieve information about the system. In general, the *get* operation should be used to retrieve:

- information provided by the host environment at time of job start. This includes information on the number of processes in the job, their location, and possibly their communication endpoints

- information posted by processes via the `PMIx_Put` function

This information is largely considered to be *static*, although this will not necessarily be true for environments supporting dynamic programming models or fault tolerance. Note that the `PMIx_Get` function only accesses information about execution environments - i.e., its scope is limited to values pertaining to a specific `session`, `job`, `application`, process, or node. It cannot be used to obtain information about areas such as the status of queues in the WLM.

In contrast, the *query* option should be used to access:

- system-level information (such as the available WLM queues) that would generally not be included in job-level information provided at job start

- dynamic information such as application and queue status, and resource utilization statistics. Note that the `PMIX_QUERY_REFRESH_CACHE` attribute must be provided on each query to ensure current data is returned

- information created post job start, such as process tables

- information requiring more complex search criteria than supported by the simpler `PMIx_Get` API

- queries focused on retrieving multi-attribute blocks of data with a single request, thus bypassing the single-key limitation of the `PMIx_Get` API

In theory, all information can be accessed via `PMIx_Query_info_nb` as the local cache is typically the same datastore searched by `PMIx_Get`. However, in practice, the overhead associated with the *query* operation may (depending upon implementation) be higher than the simpler *get* operation due to the need to construct and process the more complex `pmix_query_t` structure. Thus, requests for a single key value are likely to be accomplished faster with `PMIx_Get` versus the *query* operation.

7.2 Allocation Requests

This section defines functionality to request new allocations from the RM, and request modifications to existing allocations. These are primarily used in the following scenarios:

- *Evolving* applications that dynamically request and return resources as they execute

- *Malleable* environments where the scheduler redirects resources away from executing applications for higher priority jobs or load balancing

1   • *Resilient* applications that need to request replacement resources in the face of failures

2   • *Rigid* jobs where the user has requested a static allocation of resources for a fixed period of time,
3   but realizes that they underestimated their required time while executing

4   PMIx attempts to address this range of use-cases with a flexible API.

7.2.1 `PMIx_Allocation_request`

Summary
Request an allocation operation from the host resource manager.

Format

PMIx v3.0

```
pmix_status_t
PMIx_Allocation_request(pmix_alloc_directive_t directive,
                        pmix_info_t info[], size_t ninfo,
                        pmix_info_t *results[], size_t *nresults);
```

IN   directive
   Allocation directive (handle)
IN   info
   Array of **pmix_info_t** structures (array of handles)
IN   ninfo
   Number of elements in the *info* array (integer)
INOUT results
   Address where a pointer to an array of **pmix_info_t** containing the results of the request
   can be returned (memory reference)
INOUT nresults
   Address where the number of elements in *results* can be returned (handle)

Returns one of the following:

• **PMIX_SUCCESS**, indicating that the request was processed and returned *success*

• a PMIx error constant indicating either an error in the input or that the request was refused

▼------------------   Required Attributes   ------------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any
provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
required to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process making
the request.

Host environments that implement support for this operation are required to support the following attributes:

PMIX_ALLOC_REQ_ID **"pmix.alloc.reqid"** (**char***)
    User-provided string identifier for this allocation request which can later be used to query status of the request.

PMIX_ALLOC_NUM_NODES **"pmix.alloc.nnodes"** (**uint64_t**)
    The number of nodes.

PMIX_ALLOC_NUM_CPUS **"pmix.alloc.ncpus"** (**uint64_t**)
    Number of cpus.

PMIX_ALLOC_TIME **"pmix.alloc.time"** (**uint32_t**)
    Time in seconds.

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▼----------------- Optional Attributes ------------------▼

The following attributes are optional for host environments that support this operation:

PMIX_ALLOC_NODE_LIST **"pmix.alloc.nlist"** (**char***)
    Regular expression of the specific nodes.

PMIX_ALLOC_NUM_CPU_LIST **"pmix.alloc.ncpulist"** (**char***)
    Regular expression of the number of cpus for each node.

PMIX_ALLOC_CPU_LIST **"pmix.alloc.cpulist"** (**char***)
    Regular expression of the specific cpus indicating the cpus involved.

PMIX_ALLOC_MEM_SIZE **"pmix.alloc.msize"** (**float**)
    Number of Megabytes.

PMIX_ALLOC_NETWORK **"pmix.alloc.net"** (**array**)
    Array of **pmix_info_t** describing requested network resources. This must include at least: **PMIX_ALLOC_NETWORK_ID**, **PMIX_ALLOC_NETWORK_TYPE**, and **PMIX_ALLOC_NETWORK_ENDPTS**, plus whatever other descriptors are desired.

PMIX_ALLOC_NETWORK_ID **"pmix.alloc.netid"** (**char***)
    The key to be used when accessing this requested network allocation. The allocation will be returned/stored as a **pmix_data_array_t** of **pmix_info_t** indexed by this key and containing at least one entry with the same key and the allocated resource description. The type of the included value depends upon the network support. For example, a TCP allocation might consist of a comma-delimited string of socket ranges such as *"32000-32100,33005,38123-38146"*. Additional entries will consist of any provided resource request directives, along with their assigned values. Examples include: **PMIX_ALLOC_NETWORK_TYPE** - the type of resources provided; **PMIX_ALLOC_NETWORK_PLANE** - if applicable, what plane the resources were assigned from; **PMIX_ALLOC_NETWORK_QOS** - the assigned QoS; **PMIX_ALLOC_BANDWIDTH** -

the allocated bandwidth; **PMIX_ALLOC_NETWORK_SEC_KEY** - a security key for the
requested network allocation. NOTE: the assigned values may differ from those requested,
especially if **PMIX_INFO_REQD** was not set in the request.

PMIX_ALLOC_BANDWIDTH "pmix.alloc.bw" (float)
    Mbits/sec.

PMIX_ALLOC_NETWORK_QOS "pmix.alloc.netqos" (char*)
    Quality of service level.

PMIX_ALLOC_NETWORK_TYPE "pmix.alloc.nettype" (char*)
    Type of desired transport (e.g., *"tcp"*, *"udp"*)

PMIX_ALLOC_NETWORK_PLANE "pmix.alloc.netplane" (char*)
    ID string for the NIC (aka *plane*) to be used for this allocation (e.g., CIDR for Ethernet)

PMIX_ALLOC_NETWORK_ENDPTS "pmix.alloc.endpts" (size_t)
    Number of endpoints to allocate per process

PMIX_ALLOC_NETWORK_ENDPTS_NODE "pmix.alloc.endpts.nd" (size_t)
    Number of endpoints to allocate per node

PMIX_ALLOC_NETWORK_SEC_KEY "pmix.alloc.nsec" (pmix_byte_object_t)
    Network security key

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Description

Request an allocation operation from the host resource manager. Several broad categories are
envisioned, including the ability to:

- Request allocation of additional resources, including memory, bandwidth, and compute. This
  should be accomplished in a non-blocking manner so that the application can continue to
  progress while waiting for resources to become available. Note that the new allocation will be
  disjoint from (i.e., not affiliated with) the allocation of the requestor - thus the termination of one
  allocation will not impact the other.
- Extend the reservation on currently allocated resources, subject to scheduling availability and
  priorities. This includes extending the time limit on current resources, and/or requesting
  additional resources be allocated to the requesting job. Any additional allocated resources will be
  considered as part of the current allocation, and thus will be released at the same time.
- Return no-longer-required resources to the scheduler. This includes the "loan" of resources back
  to the scheduler with a promise to return them upon subsequent request.

If successful, the returned results for a request for additional resources must include the host
resource manager's identifier (**PMIX_ALLOC_ID**) that the requester can use to specify the
resources in, for example, a call to **PMIx_Spawn**.

7.2.2 `PMIx_Allocation_request_nb`

Summary

Request an allocation operation from the host resource manager.

Format

```
pmix_status_t
PMIx_Allocation_request_nb(pmix_alloc_directive_t directive,
                           pmix_info_t info[], size_t ninfo,
                           pmix_info_cbfunc_t cbfunc, void *cbdata);
```

IN   directive
Allocation directive (handle)
IN   info
Array of **pmix_info_t** structures (array of handles)
IN   ninfo
Number of elements in the *info* array (integer)
IN   cbfunc
Callback function **pmix_info_cbfunc_t** (function reference)
IN   cbdata
Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

▼----------------- Required Attributes -----------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process making the request.

Host environments that implement support for this operation are required to support the following attributes:

PMIX_ALLOC_REQ_ID `"pmix.alloc.reqid"` (**char***)

1   User-provided string identifier for this allocation request which can later be used to query
2   status of the request.

3   **PMIX_ALLOC_NUM_NODES "pmix.alloc.nnodes"** (**uint64_t**)
4   The number of nodes.

5   **PMIX_ALLOC_NUM_CPUS "pmix.alloc.ncpus"** (**uint64_t**)
6   Number of cpus.

7   **PMIX_ALLOC_TIME "pmix.alloc.time"** (**uint32_t**)
8   Time in seconds.

▲ -- ▲

▼ ----------------- Optional Attributes ----------------- ▼

9   The following attributes are optional for host environments that support this operation:

10   **PMIX_ALLOC_NODE_LIST "pmix.alloc.nlist"** (**char***)
11   Regular expression of the specific nodes.

12   **PMIX_ALLOC_NUM_CPU_LIST "pmix.alloc.ncpulist"** (**char***)
13   Regular expression of the number of cpus for each node.

14   **PMIX_ALLOC_CPU_LIST "pmix.alloc.cpulist"** (**char***)
15   Regular expression of the specific cpus indicating the cpus involved.

16   **PMIX_ALLOC_MEM_SIZE "pmix.alloc.msize"** (**float**)
17   Number of Megabytes.

18   **PMIX_ALLOC_NETWORK "pmix.alloc.net"** (**array**)
19   Array of **pmix_info_t** describing requested network resources. This must include at
20   least: **PMIX_ALLOC_NETWORK_ID**, **PMIX_ALLOC_NETWORK_TYPE**, and
21   **PMIX_ALLOC_NETWORK_ENDPTS**, plus whatever other descriptors are desired.

22   **PMIX_ALLOC_NETWORK_ID "pmix.alloc.netid"** (**char***)
23   The key to be used when accessing this requested network allocation. The allocation will be
24   returned/stored as a **pmix_data_array_t** of **pmix_info_t** indexed by this key and
25   containing at least one entry with the same key and the allocated resource description. The
26   type of the included value depends upon the network support. For example, a TCP allocation
27   might consist of a comma-delimited string of socket ranges such as
28   *"32000-32100,33005,38123-38146"*. Additional entries will consist of any provided
29   resource request directives, along with their assigned values. Examples include:
30   **PMIX_ALLOC_NETWORK_TYPE** - the type of resources provided;
31   **PMIX_ALLOC_NETWORK_PLANE** - if applicable, what plane the resources were assigned
32   from; **PMIX_ALLOC_NETWORK_QOS** - the assigned QoS; **PMIX_ALLOC_BANDWIDTH** -
33   the allocated bandwidth; **PMIX_ALLOC_NETWORK_SEC_KEY** - a security key for the
34   requested network allocation. NOTE: the assigned values may differ from those requested,
35   especially if **PMIX_INFO_REQD** was not set in the request.

36   **PMIX_ALLOC_BANDWIDTH "pmix.alloc.bw"** (**float**)

1   Mbits/sec.

2   **PMIX_ALLOC_NETWORK_QOS** **"pmix.alloc.netqos"** (**char***)
3   Quality of service level.

4   **PMIX_ALLOC_NETWORK_TYPE** **"pmix.alloc.nettype"** (**char***)
5   Type of desired transport (e.g., *"tcp"*, *"udp"*)

6   **PMIX_ALLOC_NETWORK_PLANE** **"pmix.alloc.netplane"** (**char***)
7   ID string for the NIC (aka *plane*) to be used for this allocation (e.g., CIDR for Ethernet)

8   **PMIX_ALLOC_NETWORK_ENDPTS** **"pmix.alloc.endpts"** (**size_t**)
9   Number of endpoints to allocate per process

10   **PMIX_ALLOC_NETWORK_ENDPTS_NODE** **"pmix.alloc.endpts.nd"** (**size_t**)
11   Number of endpoints to allocate per node

12   **PMIX_ALLOC_NETWORK_SEC_KEY** **"pmix.alloc.nsec"** (**pmix_byte_object_t**)
13   Network security key

     ▲ - ▲

14   **Description**
15   Non-blocking form of the **PMIx_Allocation_request** API.

16 **7.3   Job Control**

17   This section defines APIs that enable the application and host environment to coordinate the
18   response to failures and other events. This can include requesting termination of the entire job or a
19   subset of processes within a job, but can also be used in combination with other PMIx capabilities
20   (e.g., allocation support and event notification) for more nuanced responses. For example, an
21   application notified of an incipient over-temperature condition on a node could use the
22   **PMIx_Allocation_request_nb** interface to request replacement nodes while
23   simultaneously using the **PMIx_Job_control_nb** interface to direct that a checkpoint event be
24   delivered to all processes in the application. If replacement resources are not available, the
25   application might use the **PMIx_Job_control_nb** interface to request that the job continue at a
26   lower power setting, perhaps sufficient to avoid the over-temperature failure.

27   The job control APIs can also be used by an application to register itself as available for preemption
28   when operating in an environment such as a cloud or where incentives, financial or otherwise, are
29   provided to jobs willing to be preempted. Registration can include attributes indicating how many
30   resources are being offered for preemption (e.g., all or only some portion), whether the application
31   will require time to prepare for preemption, etc. Jobs that request a warning will receive an event
32   notifying them of an impending preemption (possibly including information as to the resources that
33   will be taken away, how much time the application will be given prior to being preempted, whether
34   the preemption will be a suspension or full termination, etc.) so they have an opportunity to save
35   their work. Once the application is ready, it calls the provided event completion callback function to

indicate that the SMS is free to suspend or terminate it, and can include directives regarding any
desired restart.

7.3.1 `PMIx_Job_control`

Summary

Request a job control action.

Format

PMIx v3.0 ───────────── C ─────────────

```
pmix_status_t
PMIx_Job_control(const pmix_proc_t targets[], size_t ntargets,
                 const pmix_info_t directives[], size_t ndirs)
```

───────────── C ─────────────

IN targets
    Array of proc structures (array of handles)
IN ntargets
    Number of element in the *targets* array (integer)
IN directives
    Array of info structures (array of handles)
IN ndirs
    Number of element in the *directives* array (integer)
IN cbfunc
    Callback function **`pmix_info_cbfunc_t`** (function reference)
IN cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request was processed by the host environment and
  returned *success*

- a PMIx error constant indicating either an error in the input or that the request was refused

▼------------------ Required Attributes ------------------▼

PMIx libraries are not required to directly support any attributes for this function. However, any
provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is
required to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process making
the request.

───

Host environments that implement support for this operation are required to support the following
attributes:

PMIX_JOB_CTRL_ID "pmix.jctrl.id" (**char***)

Provide a string identifier for this request.

PMIX_JOB_CTRL_PAUSE **"pmix.jctrl.pause"** (**bool**)
Pause the specified processes.

PMIX_JOB_CTRL_RESUME **"pmix.jctrl.resume"** (**bool**)
Resume ("un-pause") the specified processes.

PMIX_JOB_CTRL_KILL **"pmix.jctrl.kill"** (**bool**)
Forcibly terminate the specified processes and cleanup.

PMIX_JOB_CTRL_SIGNAL **"pmix.jctrl.sig"** (**int**)
Send given signal to specified processes.

PMIX_JOB_CTRL_TERMINATE **"pmix.jctrl.term"** (**bool**)
Politely terminate the specified processes.

PMIX_REGISTER_CLEANUP **"pmix.reg.cleanup"** (**char***)
Comma-delimited list of files to be removed upon process termination

PMIX_REGISTER_CLEANUP_DIR **"pmix.reg.cleanupdir"** (**char***)
Comma-delimited list of directories to be removed upon process termination

PMIX_CLEANUP_RECURSIVE **"pmix.clnup.recurse"** (**bool**)
Recursively cleanup all subdirectories under the specified one(s)

PMIX_CLEANUP_EMPTY **"pmix.clnup.empty"** (**bool**)
Only remove empty subdirectories

PMIX_CLEANUP_IGNORE **"pmix.clnup.ignore"** (**char***)
Comma-delimited list of filenames that are not to be removed

PMIX_CLEANUP_LEAVE_TOPDIR **"pmix.clnup.lvtop"** (**bool**)
When recursively cleaning subdirectories, do not remove the top-level directory (the one
given in the cleanup request)

▲--▲

▼---------------- Optional Attributes ----------------▼

The following attributes are optional for host environments that support this operation:

PMIX_JOB_CTRL_CANCEL **"pmix.jctrl.cancel"** (**char***)
Cancel the specified request (**NULL** implies cancel all requests from this requestor).

PMIX_JOB_CTRL_RESTART **"pmix.jctrl.restart"** (**char***)
Restart the specified processes using the given checkpoint ID.

PMIX_JOB_CTRL_CHECKPOINT **"pmix.jctrl.ckpt"** (**char***)
Checkpoint the specified processes and assign the given ID to it.

PMIX_JOB_CTRL_CHECKPOINT_EVENT **"pmix.jctrl.ckptev"** (**bool**)

1   Use event notification to trigger a process checkpoint.

2   **PMIX_JOB_CTRL_CHECKPOINT_SIGNAL** **"pmix.jctrl.ckptsig"** (**int**)
3   Use the given signal to trigger a process checkpoint.

4   **PMIX_JOB_CTRL_CHECKPOINT_TIMEOUT** **"pmix.jctrl.ckptsig"** (**int**)
5   Time in seconds to wait for a checkpoint to complete.

6   **PMIX_JOB_CTRL_CHECKPOINT_METHOD**
7   **"pmix.jctrl.ckmethod"** (**pmix_data_array_t**)
8   Array of **pmix_info_t** declaring each method and value supported by this application.

9   **PMIX_JOB_CTRL_PROVISION** **"pmix.jctrl.pvn"** (**char***)
10   Regular expression identifying nodes that are to be provisioned.

11   **PMIX_JOB_CTRL_PROVISION_IMAGE** **"pmix.jctrl.pvnimg"** (**char***)
12   Name of the image that is to be provisioned.

13   **PMIX_JOB_CTRL_PREEMPTIBLE** **"pmix.jctrl.preempt"** (**bool**)
14   Indicate that the job can be pre-empted.
         ▲- ▲

Description

16   Request a job control action. The *targets* array identifies the processes to which the requested job
17   control action is to be applied. A **NULL** value can be used to indicate all processes in the caller's
18   namespace. The use of **PMIX_RANK_WILDCARD** can also be used to indicate that all processes in
19   the given namespace are to be included.

20   The directives are provided as **pmix_info_t** structures in the *directives* array. The callback
21   function provides a *status* to indicate whether or not the request was granted, and to provide some
22   information as to the reason for any denial in the **pmix_info_cbfunc_t** array of
23   **pmix_info_t** structures.

7.3.2 **PMIx_Job_control_nb**

Summary
26   Request a job control action.

Format

```
pmix_status_t
PMIx_Job_control_nb(const pmix_proc_t targets[], size_t ntargets,
                    const pmix_info_t directives[], size_t ndirs,
                    pmix_info_cbfunc_t cbfunc, void *cbdata)
```

IN   targets
    Array of proc structures (array of handles)
IN   ntargets
    Number of element in the *targets* array (integer)
IN   directives
    Array of info structures (array of handles)
IN   ndirs
    Number of element in the *directives* array (integer)
IN   cbfunc
    Callback function **pmix_info_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

-------------------- Required Attributes --------------------

PMIx libraries are not required to directly support any attributes for this function. However, any provided attributes must be passed to the host SMS daemon for processing, and the PMIx library is *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the client process making the request.

Host environments that implement support for this operation are required to support the following attributes:

PMIX_JOB_CTRL_ID "pmix.jctrl.id" (**char***)
    Provide a string identifier for this request.

1   **PMIX_JOB_CTRL_PAUSE "pmix.jctrl.pause"** (**bool**)
2   Pause the specified processes.

3   **PMIX_JOB_CTRL_RESUME "pmix.jctrl.resume"** (**bool**)
4   Resume ("un-pause") the specified processes.

5   **PMIX_JOB_CTRL_KILL "pmix.jctrl.kill"** (**bool**)
6   Forcibly terminate the specified processes and cleanup.

7   **PMIX_JOB_CTRL_SIGNAL "pmix.jctrl.sig"** (**int**)
8   Send given signal to specified processes.

9   **PMIX_JOB_CTRL_TERMINATE "pmix.jctrl.term"** (**bool**)
10   Politely terminate the specified processes.

11   **PMIX_REGISTER_CLEANUP "pmix.reg.cleanup"** (**char***)
12   Comma-delimited list of files to be removed upon process termination

13   **PMIX_REGISTER_CLEANUP_DIR "pmix.reg.cleanupdir"** (**char***)
14   Comma-delimited list of directories to be removed upon process termination

15   **PMIX_CLEANUP_RECURSIVE "pmix.clnup.recurse"** (**bool**)
16   Recursively cleanup all subdirectories under the specified one(s)

17   **PMIX_CLEANUP_EMPTY "pmix.clnup.empty"** (**bool**)
18   Only remove empty subdirectories

19   **PMIX_CLEANUP_IGNORE "pmix.clnup.ignore"** (**char***)
20   Comma-delimited list of filenames that are not to be removed

21   **PMIX_CLEANUP_LEAVE_TOPDIR "pmix.clnup.lvtop"** (**bool**)
22   When recursively cleaning subdirectories, do not remove the top-level directory (the one
23   given in the cleanup request)

▲--▲

▼------------------ Optional Attributes ------------------▼

24   The following attributes are optional for host environments that support this operation:

25   **PMIX_JOB_CTRL_CANCEL "pmix.jctrl.cancel"** (**char***)
26   Cancel the specified request (**NULL** implies cancel all requests from this requestor).

27   **PMIX_JOB_CTRL_RESTART "pmix.jctrl.restart"** (**char***)
28   Restart the specified processes using the given checkpoint ID.

29   **PMIX_JOB_CTRL_CHECKPOINT "pmix.jctrl.ckpt"** (**char***)
30   Checkpoint the specified processes and assign the given ID to it.

31   **PMIX_JOB_CTRL_CHECKPOINT_EVENT "pmix.jctrl.ckptev"** (**bool**)
32   Use event notification to trigger a process checkpoint.

33   **PMIX_JOB_CTRL_CHECKPOINT_SIGNAL "pmix.jctrl.ckptsig"** (**int**)

1   Use the given signal to trigger a process checkpoint.

2   **PMIX_JOB_CTRL_CHECKPOINT_TIMEOUT** **"pmix.jctrl.ckptsig"** (**int**)
3   Time in seconds to wait for a checkpoint to complete.

4   **PMIX_JOB_CTRL_CHECKPOINT_METHOD**
5   **"pmix.jctrl.ckmethod"** (**pmix_data_array_t**)
6   Array of **pmix_info_t** declaring each method and value supported by this application.

7   **PMIX_JOB_CTRL_PROVISION** **"pmix.jctrl.pvn"** (**char***)
8   Regular expression identifying nodes that are to be provisioned.

9   **PMIX_JOB_CTRL_PROVISION_IMAGE** **"pmix.jctrl.pvnimg"** (**char***)
10   Name of the image that is to be provisioned.

11   **PMIX_JOB_CTRL_PREEMPTIBLE** **"pmix.jctrl.preempt"** (**bool**)
12   Indicate that the job can be pre-empted.
      ▲- -▲

13   **Description**
14   Non-blocking form of the **PMIx_Job_control** API. The *targets* array identifies the processes to
15   which the requested job control action is to be applied. A **NULL** value can be used to indicate all
16   processes in the caller's namespace. The use of **PMIX_RANK_WILDCARD** can also be used to
17   indicate that all processes in the given namespace are to be included.

18   The directives are provided as **pmix_info_t** structures in the *directives* array. The callback
19   function provides a *status* to indicate whether or not the request was granted, and to provide some
20   information as to the reason for any denial in the **pmix_info_cbfunc_t** array of
21   **pmix_info_t** structures.

22 **7.4 Process and Job Monitoring**

23   In addition to external faults, a common problem encountered in HPC applications is a failure to
24   make progress due to some internal conflict in the computation. These situations can result in a
25   significant waste of resources as the SMS is unaware of the problem, and thus cannot terminate the
26   job. Various watchdog methods have been developed for detecting this situation, including
27   requiring a periodic "heartbeat" from the application and monitoring a specified file for changes in
28   size and/or modification time.

29   At the request of SMS vendors and members, a monitoring support interface has been included in
30   the PMIx v2 standard. The defined API allows applications to request monitoring, directing what is
31   to be monitored, the frequency of the associated check, whether or not the application is to be
32   notified (via the event notification subsystem) of stall detection, and other characteristics of the
33   operation. In addition, heartbeat and file monitoring methods have been included in the PRI but are
34   active only when requested.

7.4.1 `PMIx_Process_monitor`

Summary

Request that application processes be monitored.

Format

C

```c
pmix_status_t
PMIx_Process_monitor(const pmix_info_t *monitor, pmix_status_t error,
                     const pmix_info_t directives[], size_t ndirs)
```

C

IN `monitor`
  info (handle)
IN `error`
  status (integer)
IN `directives`
  Array of info structures (array of handles)
IN `ndirs`
  Number of elements in the *directives* array (integer)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request was processed and returned *success*

- a PMIx error constant indicating either an error in the input or that the request was refused

---------------- Optional Attributes ----------------

The following attributes may be implemented by a PMIx library or by the host environment. If supported by the PMIx server library, then the library must not pass the supported attributes to the host environment. All attributes not directly supported by the server library must be passed to the host environment if it supports this operation, and the library is *required* to add the **PMIX_USERID** and the **PMIX_GRPID** attributes of the requesting process:

PMIX_MONITOR_ID `"pmix.monitor.id"` (**char***)
  Provide a string identifier for this request.

PMIX_MONITOR_CANCEL `"pmix.monitor.cancel"` (**char***)
  Identifier to be canceled (**NULL** means cancel all monitoring for this process).

PMIX_MONITOR_APP_CONTROL `"pmix.monitor.appctrl"` (**bool**)
  The application desires to control the response to a monitoring event.

PMIX_MONITOR_HEARTBEAT `"pmix.monitor.mbeat"` (**void**)
  Register to have the PMIx server monitor the requestor for heartbeats.

PMIX_MONITOR_HEARTBEAT_TIME `"pmix.monitor.btime"` (**uint32_t**)
  Time in seconds before declaring heartbeat missed.

1	**PMIX_MONITOR_HEARTBEAT_DROPS "pmix.monitor.bdrop"** (**uint32_t**)
2	Number of heartbeats that can be missed before generating the event.
3	**PMIX_MONITOR_FILE "pmix.monitor.fmon"** (**char***)
4	Register to monitor file for signs of life.
5	**PMIX_MONITOR_FILE_SIZE "pmix.monitor.fsize"** (**bool**)
6	Monitor size of given file is growing to determine if the application is running.
7	**PMIX_MONITOR_FILE_ACCESS "pmix.monitor.faccess"** (**char***)
8	Monitor time since last access of given file to determine if the application is running.
9	**PMIX_MONITOR_FILE_MODIFY "pmix.monitor.fmod"** (**char***)
10	Monitor time since last modified of given file to determine if the application is running.
11	**PMIX_MONITOR_FILE_CHECK_TIME "pmix.monitor.ftime"** (**uint32_t**)
12	Time in seconds between checking the file.
13	**PMIX_MONITOR_FILE_DROPS "pmix.monitor.fdrop"** (**uint32_t**)
14	Number of file checks that can be missed before generating the event.

▲--▲

15 **Description**

16 Request that application processes be monitored via several possible methods. For example, that
17 the server monitor this process for periodic heartbeats as an indication that the process has not
18 become "wedged". When a monitor detects the specified alarm condition, it will generate an event
19 notification using the provided error code and passing along any available relevant information. It
20 is up to the caller to register a corresponding event handler.

21 The *monitor* argument is an attribute indicating the type of monitor being requested. For example,
22 **PMIX_MONITOR_FILE** to indicate that the requestor is asking that a file be monitored.

23 The *error* argument is the status code to be used when generating an event notification alerting that
24 the monitor has been triggered. The range of the notification defaults to
25 **PMIX_RANGE_NAMESPACE**. This can be changed by providing a **PMIX_RANGE** directive.

26 The *directives* argument characterizes the monitoring request (e.g., monitor file size) and frequency
27 of checking to be done

28 ## 7.4.2 **PMIx_Process_monitor_nb**

29 **Summary**
30 Request that application processes be monitored.

PMIx v2.0 ▼ ─────────────── C ─────────────── ▼

```
2        pmix_status_t
3        PMIx_Process_monitor_nb(const pmix_info_t *monitor, pmix_status_t error,
4                                const pmix_info_t directives[], size_t ndirs,
5                                pmix_info_cbfunc_t cbfunc, void *cbdata)
```
▲ ─────────────── C ─────────────── ▲

6   **IN   monitor**
7   info (handle)
8   **IN   error**
9   status (integer)
10   **IN   directives**
11   Array of info structures (array of handles)
12   **IN   ndirs**
13   Number of elements in the *directives* array (integer)
14   **IN   cbfunc**
15   Callback function **pmix_info_cbfunc_t** (function reference)
16   **IN   cbdata**
17   Data to be passed to the callback function (memory reference)

18   Returns one of the following:

19   • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
20   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
21   function prior to returning from the API.

22   • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
23   returned *success* - the *cbfunc* will *not* be called

24   • a PMIx error constant indicating either an error in the input or that the request was immediately
25   processed and failed - the *cbfunc* will *not* be called

▼----------------   Optional Attributes   ----------------▼

26   The following attributes may be implemented by a PMIx library or by the host environment. If
27   supported by the PMIx server library, then the library must not pass the supported attributes to the
28   host environment. All attributes not directly supported by the server library must be passed to the
29   host environment if it supports this operation, and the library is *required* to add the
30   **PMIX_USERID** and the **PMIX_GRPID** attributes of the requesting process:

31   **PMIX_MONITOR_ID "pmix.monitor.id" (char*)**
32   Provide a string identifier for this request.

33   **PMIX_MONITOR_CANCEL "pmix.monitor.cancel" (char*)**
34   Identifier to be canceled (**NULL** means cancel all monitoring for this process).

35   **PMIX_MONITOR_APP_CONTROL "pmix.monitor.appctrl" (bool)**

1   The application desires to control the response to a monitoring event.

2   **PMIX_MONITOR_HEARTBEAT** **"pmix.monitor.mbeat"** (**void**)
3   Register to have the PMIx server monitor the requestor for heartbeats.

4   **PMIX_MONITOR_HEARTBEAT_TIME** **"pmix.monitor.btime"** (**uint32_t**)
5   Time in seconds before declaring heartbeat missed.

6   **PMIX_MONITOR_HEARTBEAT_DROPS** **"pmix.monitor.bdrop"** (**uint32_t**)
7   Number of heartbeats that can be missed before generating the event.

8   **PMIX_MONITOR_FILE** **"pmix.monitor.fmon"** (**char***)
9   Register to monitor file for signs of life.

10   **PMIX_MONITOR_FILE_SIZE** **"pmix.monitor.fsize"** (**bool**)
11   Monitor size of given file is growing to determine if the application is running.

12   **PMIX_MONITOR_FILE_ACCESS** **"pmix.monitor.faccess"** (**char***)
13   Monitor time since last access of given file to determine if the application is running.

14   **PMIX_MONITOR_FILE_MODIFY** **"pmix.monitor.fmod"** (**char***)
15   Monitor time since last modified of given file to determine if the application is running.

16   **PMIX_MONITOR_FILE_CHECK_TIME** **"pmix.monitor.ftime"** (**uint32_t**)
17   Time in seconds between checking the file.

18   **PMIX_MONITOR_FILE_DROPS** **"pmix.monitor.fdrop"** (**uint32_t**)
19   Number of file checks that can be missed before generating the event.

20 **Description**
21 Non-blocking form of the **PMIx_Process_monitor** API. The *cbfunc* function provides a
22 *status* to indicate whether or not the request was granted, and to provide some information as to the
23 reason for any denial in the **pmix_info_cbfunc_t** array of **pmix_info_t** structures.

24 ## 7.4.3   **PMIx_Heartbeat**

25 **Summary**
26 Send a heartbeat to the PMIx server library

27 **Format**
PMIx v2.0
C
28   **PMIx_Heartbeat(void)**
C

29 **Description**
30 A simplified macro wrapping **PMIx_Process_monitor_nb** that sends a heartbeat to the PMIx
31 server library.

7.5 Logging

The logging interface supports posting information by applications and SMS elements to persistent storage. This function is *not* intended for output of computational results, but rather for reporting status and saving state information such as inserting computation progress reports into the application's SMS job log or error reports to the local syslog.

7.5.1 `PMIx_Log`

Summary

Log data to a data service.

Format

PMIx v3.0

```
pmix_status_t
PMIx_Log(const pmix_info_t data[], size_t ndata,
         const pmix_info_t directives[], size_t ndirs)
```

IN `data`
   Array of info structures (array of handles)
IN `ndata`
   Number of elements in the *data* array (`size_t`)
IN `directives`
   Array of info structures (array of handles)
IN `ndirs`
   Number of elements in the *directives* array (`size_t`)

Return codes are one of the following:

PMIX_SUCCESS The logging request was successful.
PMIX_ERR_BAD_PARAM The logging request contains at least one incorrect entry.
PMIX_ERR_NOT_SUPPORTED The PMIx implementation or host environment does not support this function.

▼----------------- Required Attributes -----------------▼

If the PMIx library does not itself perform this operation, then it is required to pass any attributes provided by the client to the host environment for processing. In addition, it must include the following attributes in the passed *info* array:

PMIX_USERID `"pmix.euid"` (`uint32_t`)
   Effective user id.

PMIX_GRPID `"pmix.egid"` (`uint32_t`)
   Effective group id.

Host environments or PMIx libraries that implement support for this operation are required to support the following attributes:

PMIX_LOG_STDERR **"pmix.log.stderr"** (**char***)
Log string to **stderr**.

PMIX_LOG_STDOUT **"pmix.log.stdout"** (**char***)
Log string to **stdout**.

PMIX_LOG_SYSLOG **"pmix.log.syslog"** (**char***)
Log data to syslog. Defaults to **ERROR** priority. Will log to global syslog if available, otherwise to local syslog

PMIX_LOG_LOCAL_SYSLOG **"pmix.log.lsys"** (**char***)
Log data to local syslog. Defaults to **ERROR** priority.

PMIX_LOG_GLOBAL_SYSLOG **"pmix.log.gsys"** (**char***)
Forward data to system "gateway" and log msg to that syslog Defaults to **ERROR** priority.

PMIX_LOG_SYSLOG_PRI **"pmix.log.syspri"** (**int**)
Syslog priority level

PMIX_LOG_ONCE **"pmix.log.once"** (**bool**)
Only log this once with whichever channel can first support it, taking the channels in priority order

▲--▲

▼------------------ Optional Attributes ------------------▼

The following attributes are optional for host environments or PMIx libraries that support this operation:

PMIX_LOG_SOURCE **"pmix.log.source"** (**pmix_proc_t***)
ID of source of the log request

PMIX_LOG_TIMESTAMP **"pmix.log.tstmp"** (**time_t**)
Timestamp for log report

PMIX_LOG_GENERATE_TIMESTAMP **"pmix.log.gtstmp"** (**bool**)
Generate timestamp for log

PMIX_LOG_TAG_OUTPUT **"pmix.log.tag"** (**bool**)
Label the output stream with the channel name (e.g., "stdout")

PMIX_LOG_TIMESTAMP_OUTPUT **"pmix.log.tsout"** (**bool**)
Print timestamp in output string

PMIX_LOG_XML_OUTPUT **"pmix.log.xml"** (**bool**)
Print the output stream in XML format

1   **PMIX_LOG_EMAIL "pmix.log.email"** (**pmix_data_array_t**)
2   Log via email based on **pmix_info_t** containing directives.

3   **PMIX_LOG_EMAIL_ADDR "pmix.log.emaddr"** (**char***)
4   Comma-delimited list of email addresses that are to receive the message.

5   **PMIX_LOG_EMAIL_SUBJECT "pmix.log.emsub"** (**char***)
6   Subject line for email.

7   **PMIX_LOG_EMAIL_MSG "pmix.log.emmsg"** (**char***)
8   Message to be included in email.

9   **PMIX_LOG_JOB_RECORD "pmix.log.jrec"** (**bool**)
10   Log the provided information to the host environment's job record

11   **PMIX_LOG_GLOBAL_DATASTORE "pmix.log.gstore"** (**bool**)
12   Store the log data in a global data store (e.g., database)

Description

14   Log data subject to the services offered by the host environment. The data to be logged is provided
15   in the *data* array. The (optional) *directives* can be used to direct the choice of logging channel.

— Advice to users —

16   It is strongly recommended that the **PMIx_Log** API not be used by applications for streaming data
17   as it is not a "performant" transport and can perturb the application since it involves the local PMIx
18   server and host SMS daemon. Note that a return of **PMIX_SUCCESS** only denotes that the data
19   was successfully handed to the appropriate system call (for local channels) or the host environment
20   and does not indicate receipt at the final destination.

7.5.2 **PMIx_Log_nb**

Summary
23   Log data to a data service.

Format

```C
pmix_status_t
PMIx_Log_nb(const pmix_info_t data[], size_t ndata,
            const pmix_info_t directives[], size_t ndirs,
            pmix_op_cbfunc_t cbfunc, void *cbdata)
```

IN   data
    Array of info structures (array of handles)
IN   ndata
    Number of elements in the *data* array (**size_t**)
IN   directives
    Array of info structures (array of handles)
IN   ndirs
    Number of elements in the *directives* array (**size_t**)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Return codes are one of the following:

PMIX_SUCCESS The logging request is valid and is being processed. The resulting status from
    the operation will be provided in the callback function. Note that the library must not invoke
    the callback function prior to returning from the API.

PMIX_OPERATION_SUCCEEDED, indicating that the request was immediately processed and
    returned *success* - the *cbfunc* will *not* be called

PMIX_ERR_BAD_PARAM The logging request contains at least one incorrect entry that prevents
    it from being processed. The callback function will not be called.

PMIX_ERR_NOT_SUPPORTED The PMIx implementation does not support this function. The
    callback function will not be called.

------------------- Required Attributes -------------------

If the PMIx library does not itself perform this operation, then it is required to pass any attributes
provided by the client to the host environment for processing. In addition, it must include the
following attributes in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
    Effective user id.

PMIX_GRPID "pmix.egid" (**uint32_t**)
    Effective group id.

Host environments or PMIx libraries that implement support for this operation are required to support the following attributes:

PMIX_LOG_STDERR **"pmix.log.stderr"** (**char***)
    Log string to **stderr**.

PMIX_LOG_STDOUT **"pmix.log.stdout"** (**char***)
    Log string to **stdout**.

PMIX_LOG_SYSLOG **"pmix.log.syslog"** (**char***)
    Log data to syslog. Defaults to **ERROR** priority. Will log to global syslog if available, otherwise to local syslog

PMIX_LOG_LOCAL_SYSLOG **"pmix.log.lsys"** (**char***)
    Log data to local syslog. Defaults to **ERROR** priority.

PMIX_LOG_GLOBAL_SYSLOG **"pmix.log.gsys"** (**char***)
    Forward data to system "gateway" and log msg to that syslog Defaults to **ERROR** priority.

PMIX_LOG_SYSLOG_PRI **"pmix.log.syspri"** (**int**)
    Syslog priority level

PMIX_LOG_ONCE **"pmix.log.once"** (**bool**)
    Only log this once with whichever channel can first support it, taking the channels in priority order

▲ --- ▲

▼------------------ Optional Attributes ------------------▼

The following attributes are optional for host environments or PMIx libraries that support this operation:

PMIX_LOG_SOURCE **"pmix.log.source"** (**pmix_proc_t***)
    ID of source of the log request

PMIX_LOG_TIMESTAMP **"pmix.log.tstmp"** (**time_t**)
    Timestamp for log report

PMIX_LOG_GENERATE_TIMESTAMP **"pmix.log.gtstmp"** (**bool**)
    Generate timestamp for log

PMIX_LOG_TAG_OUTPUT **"pmix.log.tag"** (**bool**)
    Label the output stream with the channel name (e.g., "stdout")

PMIX_LOG_TIMESTAMP_OUTPUT **"pmix.log.tsout"** (**bool**)
    Print timestamp in output string

PMIX_LOG_XML_OUTPUT **"pmix.log.xml"** (**bool**)
    Print the output stream in XML format

PMIX_LOG_EMAIL `"pmix.log.email"` (`pmix_data_array_t`)
  Log via email based on **pmix_info_t** containing directives.

PMIX_LOG_EMAIL_ADDR `"pmix.log.emaddr"` (`char*`)
  Comma-delimited list of email addresses that are to receive the message.

PMIX_LOG_EMAIL_SUBJECT `"pmix.log.emsub"` (`char*`)
  Subject line for email.

PMIX_LOG_EMAIL_MSG `"pmix.log.emmsg"` (`char*`)
  Message to be included in email.

PMIX_LOG_JOB_RECORD `"pmix.log.jrec"` (`bool`)
  Log the provided information to the host environment's job record

PMIX_LOG_GLOBAL_DATASTORE `"pmix.log.gstore"` (`bool`)
  Store the log data in a global data store (e.g., database)

▲- ▲

Description

Log data subject to the services offered by the host environment. The data to be logged is provided
in the *data* array. The (optional) *directives* can be used to direct the choice of logging channel. The
callback function will be executed when the log operation has been completed. The *data* and
directives arrays must be maintained until the callback is provided.

─────────────── Advice to users ───────────────

It is strongly recommended that the **PMIx_Log_nb** API not be used by applications for streaming
data as it is not a "performant" transport and can perturb the application since it involves the local
PMIx server and host SMS daemon. Note that a return of **PMIX_SUCCESS** only denotes that the
data was successfully handed to the appropriate system call (for local channels) or the host
environment and does not indicate receipt at the final destination.

Event Notification

1 This chapter defines the PMIx event notification system. These interfaces are designed to support
2 the reporting of events to/from clients and servers, and between library layers within a single
3 process.

8.1 Notification and Management

5 PMIx event notification provides an asynchronous out-of-band mechanism for communicating
6 events between application processes and/or elements of the SMS. Its uses span a wide range that
7 includes fault notification, coordination between multiple programming libraries within a single
8 process, and workflow orchestration for non-synchronous programming models. Events can be
9 divided into two distinct classes:

10 • *Job-specific events* directly relate to a job executing within the session, such as a debugger
11   attachment, process failure within a related job, or events generated by an application process.
12   Events in this category are to be immediately delivered to the PMIx server library for relay to the
13   related local processes.

14 • *Environment events* indirectly relate to a job but do not specifically target the job itself. This
15   category includes SMS-generated events such as Error Check and Correction (ECC) errors,
16   temperature excursions, and other non-job conditions that might directly affect a session's
17   resources, but would never include an event generated by an application process. Note that
18   although these do potentially impact the session's jobs, they are not directly tied to those jobs.
19   Thus, events in this category are to be delivered to the PMIx server library only upon request.

20 Both SMS elements and applications can register for events of either type.

————————— Advice to PMIx library implementers —————————

21 Race conditions can cause the registration to come after events of possible interest (e.g., a memory
22 ECC event that occurs after start of execution but prior to registration, or an application process
23 generating an event prior to another process registering to receive it). SMS vendors are *requested* to
24 cache environment events for some time to mitigate this situation, but are not *required* to do so.
25 However, PMIx implementers are *required* to cache all events received by the PMIx server library
26 and to deliver them to registering clients in the same order in which they were received

The generator of an event can specify the *target range* for delivery of that event. Thus, the generator
can choose to limit notification to processes on the local node, processes within the same job as the
generator, processes within the same allocation, other threads within the same process, only the
SMS (i.e., not to any application processes), all application processes, or to a custom range based
on specific process identifiers. Only processes within the given range that register for the provided
event code will be notified. In addition, the generator can use attributes to direct that the event not
be delivered to any default event handlers, or to any multi-code handler (as defined below).

Event notifications provide the process identifier of the source of the event plus the event code and
any additional information provided by the generator. When an event notification is received by a
process, the registered handlers are scanned for their event code(s), with matching handlers
assembled into an *event chain* for servicing. Note that users can also specify a *source range* when
registering an event (using the same range designators described above) to further limit when they
are to be invoked. When assembled, PMIx event chains are ordered based on both the specificity of
the event handler and user directives at time of handler registration. By default, handlers are
grouped into three categories based on the number of event codes that can trigger the callback:

- *single-code* handlers are serviced first as they are the most specific. These are handlers that are
  registered against one specific event code.

- *multi-code* handlers are serviced once all single-code handlers have completed. The handler will
  be included in the chain upon receipt of an event matching any of the provided codes.

- *default* handlers are serviced once all multi-code handlers have completed. These handlers are
  always included in the chain unless the generator specifically excludes them.

Users can specify the callback order of a handler within its category at the time of registration.
Ordering can be specified either by providing the relevant returned event handler registration ID or
using event handler names, if the user specified an event handler name when registering the
corresponding event. Thus, users can specify that a given handler be executed before or after
another handler should both handlers appear in an event chain (the ordering is ignored if the other
handler isn't included). Note that ordering does not imply immediate relationships. For example,
multiple handlers registered to be serviced after event handler *A* will all be executed after *A*, but are
not guaranteed to be executed in any particular order amongst themselves.

In addition, one event handler can be declared as the *first* handler to be executed in the chain. This
handler will *always* be called prior to any other handler, regardless of category, provided the
incoming event matches both the specified range and event code. Only one handler can be so
designated — attempts to designate additional handlers as *first* will return an error. Deregistration
of the declared *first* handler will re-open the position for subsequent assignment.

1	Similarly, one event handler can be declared as the *last* handler to be executed in the chain. This
2	handler will *always* be called after all other handlers have executed, regardless of category,
3	provided the incoming event matches both the specified range and event code. Note that this
4	handler will not be called if the chain is terminated by an earlier handler. Only one handler can be
5	designated as *last* — attempts to designate additional handlers as *last* will return an error.
6	Deregistration of the declared *last* handler will re-open the position for subsequent assignment.

-------- **Advice to users** --------

7	Note that the *last* handler is called *after* all registered default handlers that match the specified
8	range of the incoming event unless a handler prior to it terminates the chain. Thus, if the application
9	intends to define a *last* handler, it should ensure that no default handler aborts the process before it.

10	Upon completing its work and prior to returning, each handler *must* call the event handler
11	completion function provided when it was invoked (including a status code plus any information to
12	be passed to later handlers) so that the chain can continue being progressed. PMIx automatically
13	aggregates the status and any results of each handler (as provided in the completion callback) with
14	status from all prior handlers so that each step in the chain has full knowledge of what preceded it.
15	An event handler can terminate all further progress along the chain by passing the
16	**PMIX_EVENT_ACTION_COMPLETE** status to the completion callback function.

8.1.1 PMIx_Register_event_handler

Summary

Register an event handler

Format

PMIx v2.0

----------------------- C -----------------------

```
void
PMIx_Register_event_handler(pmix_status_t codes[], size_t ncodes,
                                   pmix_info_t info[], size_t ninfo,
                                   pmix_notification_fn_t evhdlr,
                                   pmix_evhdlr_reg_cbfunc_t cbfunc,
                                   void *cbdata);
```

----------------------- C -----------------------

IN   codes
  Array of status codes (array of **pmix_status_t**)
IN   ncodes
  Number of elements in the *codes* array (**size_t**)
IN   info
  Array of info structures (array of handles)

1	**IN** `ninfo`
2	Number of elements in the *info* array (`size_t`)
3	**IN** `evhdlr`
4	Event handler to be called `pmix_notification_fn_t` (function reference)
5	**IN** `cbfunc`
6	Callback function `pmix_evhdlr_reg_cbfunc_t` (function reference)
7	**IN** `cbdata`
8	Data to be passed to the cbfunc callback function (memory reference)

9   Upon completion, the callback will receive a status based on the following table:

10   **PMIX_SUCCESS** The event handler was successfully registered - the event handler identifier is
11   returned in the callback.
12   **PMIX_ERR_BAD_PARAM** One or more of the directives provided in the *info* array was
13   unrecognized.
14   **PMIX_ERR_NOT_SUPPORTED** The PMIx implementation does not support event notification,
15   or the host SMS does not support notification of the specified event code.

16   The callback function must not be executed prior to returning from the API.

▼----------------- Required Attributes -----------------▼

17   The following attributes are required to be supported by all PMIx libraries:

18   **PMIX_EVENT_HDLR_NAME** `"pmix.evname"` (`char*`)
19   String name identifying this handler.

20   **PMIX_EVENT_HDLR_FIRST** `"pmix.evfirst"` (`bool`)
21   Invoke this event handler before any other handlers.

22   **PMIX_EVENT_HDLR_LAST** `"pmix.evlast"` (`bool`)
23   Invoke this event handler after all other handlers have been called.

24   **PMIX_EVENT_HDLR_FIRST_IN_CATEGORY** `"pmix.evfirstcat"` (`bool`)
25   Invoke this event handler before any other handlers in this category.

26   **PMIX_EVENT_HDLR_LAST_IN_CATEGORY** `"pmix.evlastcat"` (`bool`)
27   Invoke this event handler after all other handlers in this category have been called.

28   **PMIX_EVENT_HDLR_BEFORE** `"pmix.evbefore"` (`char*`)
29   Put this event handler immediately before the one specified in the `(char*)` value.

30   **PMIX_EVENT_HDLR_AFTER** `"pmix.evafter"` (`char*`)
31   Put this event handler immediately after the one specified in the `(char*)` value.

32   **PMIX_EVENT_HDLR_PREPEND** `"pmix.evprepend"` (`bool`)
33   Prepend this handler to the precedence list within its category.

34   **PMIX_EVENT_HDLR_APPEND** `"pmix.evappend"` (`bool`)
35   Append this handler to the precedence list within its category.

PMIX_EVENT_CUSTOM_RANGE "pmix.evrange" (pmix_data_array_t*)
    Array of pmix_proc_t defining range of event notification.

PMIX_RANGE "pmix.range" (pmix_data_range_t)
    Value for calls to publish/lookup/unpublish or for monitoring event notifications.

PMIX_EVENT_RETURN_OBJECT "pmix.evobject" (void *)
    Object to be returned whenever the registered callback function cbfunc is invoked. The
    object will only be returned to the process that registered it.

───

Host environments that implement support for PMIx event notification are required to support the
following attributes:

PMIX_EVENT_AFFECTED_PROC "pmix.evproc" (pmix_proc_t)
    The single process that was affected.

PMIX_EVENT_AFFECTED_PROCS "pmix.evaffected" (pmix_data_array_t*)
    Array of pmix_proc_t defining affected processes.
▲--▲

▼----------------- Optional Attributes -----------------▼

Host environments that support PMIx event notification *may* offer notifications for environmental
events impacting the job and for SMS events relating to the job. The following attributes are
optional for host environments that suppport this operation:

PMIX_EVENT_TERMINATE_SESSION "pmix.evterm.sess" (bool)
    The RM intends to terminate this session.

PMIX_EVENT_TERMINATE_JOB "pmix.evterm.job" (bool)
    The RM intends to terminate this job.

PMIX_EVENT_TERMINATE_NODE "pmix.evterm.node" (bool)
    The RM intends to terminate all processes on this node.

PMIX_EVENT_TERMINATE_PROC "pmix.evterm.proc" (bool)
    The RM intends to terminate just this process.

PMIX_EVENT_ACTION_TIMEOUT "pmix.evtimeout" (int)
    The time in seconds before the RM will execute error response.

PMIX_EVENT_SILENT_TERMINATION "pmix.evsilentterm" (bool)
    Do not generate an event when this job normally terminates.
▲--▲

Description

Register an event handler to report events. Note that the codes being registered do *not* need to be PMIx error constants — any integer value can be registered. This allows for registration of non-PMIx events such as those defined by a particular SMS vendor or by an application itself.

──────────────── Advice to users ────────────────

In order to avoid potential conflicts, users are advised to only define codes that lie outside the range of the PMIx standard's error codes. Thus, SMS vendors and application developers should constrain their definitions to positive values or negative values beyond the **PMIX_EXTERNAL_ERR_BASE** boundary.

──────────────── Advice to users ────────────────

As previously stated, upon completing its work, and prior to returning, each handler *must* call the event handler completion function provided when it was invoked (including a status code plus any information to be passed to later handlers) so that the chain can continue being progressed. An event handler can terminate all further progress along the chain by passing the **PMIX_EVENT_ACTION_COMPLETE** status to the completion callback function. Note that the parameters passed to the event handler (e.g., the *info* and *results* arrays) will cease to be valid once the completion function has been called - thus, any information in the incoming parameters that will be referenced following the call to the completion function must be copied.

8.1.2 `PMIx_Deregister_event_handler`

Summary

Deregister an event handler.

Format

PMIx v2.0 ▼ ──────────────── C ──────────────── ▼

```
void
PMIx_Deregister_event_handler(size_t evhdlr_ref,
                              pmix_op_cbfunc_t cbfunc,
                              void *cbdata);
```

▲ ──────────────── C ──────────────── ▲

IN   **evhdlr_ref**
    Event handler ID returned by registration (**size_t**)
IN   **cbfunc**
    Callback function to be executed upon completion of operation **pmix_op_cbfunc_t**
    (function reference)
IN   **cbdata**
    Data to be passed to the cbfunc callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will *not* be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will *not* be called

If the provided cbfunc is called to confirm removal of the designated handler, the returned status code will be one of the following:

PMIX_SUCCESS The event handler was successfully deregistered.
PMIX_ERR_BAD_PARAM The provided *evhdlr_ref* was unrecognized.
PMIX_ERR_NOT_SUPPORTED The PMIx implementation does not support event notification.

Description
Deregister an event handler.

8.1.3   **PMIx_Notify_event**

Summary
Report an event for notification via any registered event handler.

```
2    pmix_status_t
3    PMIx_Notify_event(pmix_status_t status,
4                          const pmix_proc_t *source,
5                          pmix_data_range_t range,
6                          pmix_info_t info[], size_t ninfo,
7                          pmix_op_cbfunc_t cbfunc, void *cbdata);
```

— C —

8   **IN   status**
9   Status code of the event (**pmix_status_t**)
10   **IN   source**
11   Pointer to a **pmix_proc_t** identifying the original reporter of the event (handle)
12   **IN   range**
13   Range across which this notification shall be delivered (**pmix_data_range_t**)
14   **IN   info**
15   Array of **pmix_info_t** structures containing any further info provided by the originator of
16   the event (array of handles)
17   **IN   ninfo**
18   Number of elements in the *info* array (**size_t**)
19   **IN   cbfunc**
20   Callback function to be executed upon completion of operation **pmix_op_cbfunc_t**
21   (function reference)
22   **IN   cbdata**
23   Data to be passed to the cbfunc callback function (memory reference)

24   Returns one of the following:

25   **PMIX_SUCCESS** The notification request is valid and is being processed. The callback function
26   will be called when the process-local operation is complete and will provide the resulting
27   status of that operation. Note that this does *not* reflect the success or failure of delivering the
28   event to any recipients. The callback function must not be executed prior to returning from the
29   API.
30   **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
31   returned *success* - the *cbfunc* will *not* be called
32   **PMIX_ERR_BAD_PARAM** The request contains at least one incorrect entry that prevents it from
33   being processed. The callback function will *not* be called.
34   **PMIX_ERR_NOT_SUPPORTED** The PMIx implementation does not support event notification,
35   or in the case of a PMIx server calling the API, the range extended beyond the local node and
36   the host SMS environment does not support event notification. The callback function will *not*
37   be called.

1   The following attributes are required to be supported by all PMIx libraries:

2   **PMIX_EVENT_NON_DEFAULT** **"pmix.evnondef"** (**bool**)
3   Event is not to be delivered to default event handlers.

4   **PMIX_EVENT_CUSTOM_RANGE** **"pmix.evrange"** (**pmix_data_array_t***)
5   Array of **pmix_proc_t** defining range of event notification.

6   _____

7   Host environments that implement support for PMIx event notification are required to provide the
8   following attributes for all events generated by the environment:

9   **PMIX_EVENT_AFFECTED_PROC** **"pmix.evproc"** (**pmix_proc_t**)
10   The single process that was affected.

11   **PMIX_EVENT_AFFECTED_PROCS** **"pmix.evaffected"** (**pmix_data_array_t***)
12   Array of **pmix_proc_t** defining affected processes.

----

13   **Description**
14   Report an event for notification via any registered event handler. This function can be called by any
15   PMIx process, including application processes, PMIx servers, and SMS elements. The PMIx server
16   calls this API to report events it detected itself so that the host SMS daemon distribute and handle
17   them, and to pass events given to it by its host down to any attached client processes for processing.
18   Examples might include notification of the failure of another process, detection of an impending
19   node failure due to rising temperatures, or an intent to preempt the application. Events may be
20   locally generated or come from anywhere in the system.

21   Host SMS daemons call the API to pass events down to its embedded PMIx server both for
22   transmittal to local client processes and for the server's own internal processing.

23   Client application processes can call this function to notify the SMS and/or other application
24   processes of an event it encountered. Note that processes are not constrained to report status values
25   defined in the official PMIx standard — any integer value can be used. Thus, applications are free
26   to define their own internal events and use the notification system for their own internal purposes.

-------------------- Advice to users --------------------

27   The callback function will be called upon completion of the **notify_event** function's actions.
28   At that time, any messages required for executing the operation (e.g., to send the notification to the
29   local PMIx server) will have been queued, but may not yet have been transmitted. The caller is
30   required to maintain the input data until the callback function has been executed — the sole purpose
31   of the callback function is to indicate when the input data is no longer required.

Data Packing and Unpacking

---

1   PMIx intentionally does not include support for internode communications in the standard, instead
2   relying on its host SMS environment to transfer any needed data and/or requests between nodes.
3   These operations frequently involve PMIx-defined public data structures that include binary data.
4   Many HPC clusters are homogeneous, and so transferring the structures can be done rather simply.
5   However, greater effort is required in heterogeneous environments to ensure binary data is correctly
6   transferred. PMIx buffer manipulation functions are provided for this purpose via standardized
7   interfaces to ease adoption.

8   9.1   Data Buffer Type

9   The **`pmix_data_buffer_t`** structure describes a data buffer used for packing and unpacking.

PMIx v2.0 ▼ ─────────────── C ───────────────── ▼

```
10    typedef struct pmix_data_buffer {
11        /** Start of my memory */
12        char *base_ptr;
13        /** Where the next data will be packed to
14            (within the allocated memory starting
15            at base_ptr) */
16        char *pack_ptr;
17        /** Where the next data will be unpacked
18            from (within the allocated memory
19            starting as base_ptr) */
20        char *unpack_ptr;
21        /** Number of bytes allocated (starting
22            at base_ptr) */
23        size_t bytes_allocated;
24        /** Number of bytes used by the buffer
25            (i.e., amount of data -- including
26            overhead -- packed in the buffer) */
27        size_t bytes_used;
28    } pmix_data_buffer_t;
```

▲ ─────────────── C ───────────────── ▲

9.2 Support Macros

PMIx provides a set of convenience macros for creating, initiating, and releasing data buffers.

9.2.1 `PMIX_DATA_BUFFER_CREATE`

Summary

Allocate memory for a **`pmix_data_buffer_t`** object and initialize it

Format

PMIx v2.0

```C
PMIX_DATA_BUFFER_CREATE(buffer);
```

OUT **`buffer`**
Variable to be assigned the pointer to the allocated **`pmix_data_buffer_t`** (handle)

Description

This macro uses *calloc* to allocate memory for the buffer and initialize all fields in it

9.2.2 `PMIX_DATA_BUFFER_RELEASE`

Summary

Free a **`pmix_data_buffer_t`** object and the data it contains

Format

PMIx v2.0

```C
PMIX_DATA_BUFFER_RELEASE(buffer);
```

IN **`buffer`**
Pointer to the **`pmix_data_buffer_t`** to be released (handle)

Description

Free's the data contained in the buffer, and then free's the buffer itself

9.2.3 `PMIX_DATA_BUFFER_CONSTRUCT`

Summary

Initialize a statically declared **`pmix_data_buffer_t`** object

Format

———————————————————————————————— C ————————————————————————————————————

2   `PMIX_DATA_BUFFER_CONSTRUCT(buffer);`

———————————————————————————————— C ————————————————————————————————————

3   **IN   buffer**
4   Pointer to the allocated **pmix_data_buffer_t** that is to be initialized (handle)

5   **Description**
6   Initialize a pre-allocated buffer object

9.2.4   `PMIX_DATA_BUFFER_DESTRUCT`

8   **Summary**
9   Release the data contained in a **pmix_data_buffer_t** object

10   **Format**

———————————————————————————————— C ————————————————————————————————————

11   `PMIX_DATA_BUFFER_DESTRUCT(buffer);`

———————————————————————————————— C ————————————————————————————————————

12   **IN   buffer**
13   Pointer to the **pmix_data_buffer_t** whose data is to be released (handle)

14   **Description**
15   Free's the data contained in a **pmix_data_buffer_t** object

9.2.5   `PMIX_DATA_BUFFER_LOAD`

17   **Summary**
18   Load a blob into a **pmix_data_buffer_t** object

19   **Format**

———————————————————————————————— C ————————————————————————————————————

20   `PMIX_DATA_BUFFER_LOAD(buffer, data, size);`

———————————————————————————————— C ————————————————————————————————————

21   **IN   buffer**
22   Pointer to a pre-allocated **pmix_data_buffer_t** (handle)
23   **IN   data**
24   Pointer to a blob (**char***)
25   **IN   size**
26   Number of bytes in the blob **size_t**
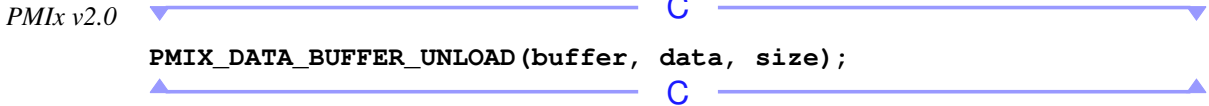
Description

Load the given data into the provided **pmix_data_buffer_t** object, usually done in preparation for unpacking the provided data. Note that the data is *not* copied into the buffer - thus, the blob must not be released until after operations on the buffer have completed.

9.2.6 `PMIX_DATA_BUFFER_UNLOAD`

Summary

Unload the data from a **pmix_data_buffer_t** object

Format

PMIx v2.0

```
PMIX_DATA_BUFFER_UNLOAD(buffer, data, size);
```

IN buffer
    Pointer to the **pmix_data_buffer_t** whose data is to be extracted (handle)
OUT data
    Variable to be assigned the pointer to the extracted blob (**void***)
OUT size
    Variable to be assigned the number of bytes in the blob **size_t**

Description

Extract the data in a buffer, assigning the pointer to the data (and the number of bytes in the blob) to the provided variables, usually done to transmit the blob to a remote process for unpacking. The buffer's internal pointer will be set to NULL to protect the data upon buffer destruct or release - thus, the user is responsible for releasing the blob when done with it.

9.3 General Routines

The following routines are provided to support internode transfers in heterogeneous environments.

9.3.1 `PMIx_Data_pack`

Summary

Pack one or more values of a specified type into a buffer, usually for transmission to another process

```
2          pmix_status_t
3          PMIx_Data_pack(const pmix_proc_t *target,
4                         pmix_data_buffer_t *buffer,
5                         void *src, int32_t num_vals,
6                         pmix_data_type_t type);
```

7   **IN   target**
8   Pointer to a **pmix_proc_t** containing the nspace/rank of the process that will be unpacking
9   the final buffer. A NULL value may be used to indicate that the target is based on the same
10   PMIx version as the caller. Note that only the target's nspace is relevant. (handle)
11   **IN   buffer**
12   Pointer to a **pmix_data_buffer_t** where the packed data is to be stored (handle)
13   **IN   src**
14   Pointer to a location where the data resides. Strings are to be passed as (char **) — i.e., the
15   caller must pass the address of the pointer to the string as the (void*). This allows the caller to
16   pass multiple strings in a single call. (memory reference)
17   **IN   num_vals**
18   Number of elements pointed to by the *src* pointer. A string value is counted as a single value
19   regardless of length. The values must be contiguous in memory. Arrays of pointers (e.g.,
20   string arrays) should be contiguous, although the data pointed to need not be contiguous
21   across array entries.(**int32_t**)
22   **IN   type**
23   The type of the data to be packed (**pmix_data_type_t**)

24   Returns one of the following:

25   **PMIX_SUCCESS** The data has been packed as requested
26   **PMIX_ERR_NOT_SUPPORTED** The PMIx implementation does not support this function.
27   **PMIX_ERR_BAD_PARAM** The provided buffer or src is **NULL**
28   **PMIX_ERR_UNKNOWN_DATA_TYPE** The specified data type is not known to this
29   implementation
30   **PMIX_ERR_OUT_OF_RESOURCE** Not enough memory to support the operation
31   **PMIX_ERROR** General error

32   **Description**
33   The pack function packs one or more values of a specified type into the specified buffer. The buffer
34   must have already been initialized via the **PMIX_DATA_BUFFER_CREATE** or
35   **PMIX_DATA_BUFFER_CONSTRUCT** macros — otherwise, **PMIx_Data_pack** will return an
36   error. Providing an unsupported type flag will likewise be reported as an error.

37   Note that any data to be packed that is not hard type cast (i.e., not type cast to a specific size) may
38   lose precision when unpacked by a non-homogeneous recipient. The **PMIx_Data_pack** function

1   will do its best to deal with heterogeneity issues between the packer and unpacker in such cases.
2   Sending a number larger than can be handled by the recipient will return an error code (generated
3   upon unpacking) — the error cannot be detected during packing.

4   The namespace of the intended recipient of the packed buffer (i.e., the process that will be
5   unpacking it) is used solely to resolve any data type differences between PMIx versions. The
6   recipient must, therefore, be known to the user prior to calling the pack function so that the PMIx
7   library is aware of the version the recipient is using. Note that all processes in a given namespace
8   are *required* to use the same PMIx version — thus, the caller must only know at least one process
9   from the target's namespace.

10   9.3.2   `PMIx_Data_unpack`

11   **Summary**
12   Unpack values from a **`pmix_data_buffer_t`**

13   **Format**

PMIx v2.0
─────────────────────────────── C ───────────────────────────────

```
14    pmix_status_t
15    PMIx_Data_unpack(const pmix_proc_t *source,
16                     pmix_data_buffer_t *buffer, void *dest,
17                     int32_t *max_num_values,
18                     pmix_data_type_t type);
19
```
─────────────────────────────── C ───────────────────────────────

20   **IN   source**
21   Pointer to a **`pmix_proc_t`** structure containing the nspace/rank of the process that packed
22   the provided buffer. A NULL value may be used to indicate that the source is based on the
23   same PMIx version as the caller. Note that only the source's nspace is relevant. (handle)
24   **IN   buffer**
25   A pointer to the buffer from which the value will be extracted. (handle)
26   **INOUT dest**
27   A pointer to the memory location into which the data is to be stored. Note that these values
28   will be stored contiguously in memory. For strings, this pointer must be to (char**) to provide
29   a means of supporting multiple string operations. The unpack function will allocate memory
30   for each string in the array - the caller must only provide adequate memory for the array of
31   pointers. (**`void*`**)
32   **INOUT max_num_values**
33   The number of values to be unpacked — upon completion, the parameter will be set to the
34   actual number of values unpacked. In most cases, this should match the maximum number
35   provided in the parameters — but in no case will it exceed the value of this parameter. Note
36   that unpacking fewer values than are actually available will leave the buffer in an unpackable
37   state — the function will return an error code to warn of this condition.(**`int32_t`**)

IN `type`
    The type of the data to be unpacked — must be one of the PMIx defined data types
    (`pmix_data_type_t`)

Returns one of the following:

PMIX_SUCCESS The data has been unpacked as requested
PMIX_ERR_NOT_SUPPORTED The PMIx implementation does not support this function.
PMIX_ERR_BAD_PARAM The provided buffer or dest is **NULL**
PMIX_ERR_UNKNOWN_DATA_TYPE The specified data type is not known to this
    implementation
PMIX_ERR_OUT_OF_RESOURCE Not enough memory to support the operation
PMIX_ERROR General error

Description
The unpack function unpacks the next value (or values) of a specified type from the given buffer.
The buffer must have already been initialized via an **PMIX_DATA_BUFFER_CREATE** or
PMIX_DATA_BUFFER_CONSTRUCT call (and assumedly filled with some data) — otherwise, the
unpack_value function will return an error. Providing an unsupported type flag will likewise be
reported as an error, as will specifying a data type that *does not* match the type of the next item in
the buffer. An attempt to read beyond the end of the stored data held in the buffer will also return an
error.

NOTE: it is possible for the buffer to be corrupted and that PMIx will *think* there is a proper
variable type at the beginning of an unpack region — but that the value is bogus (e.g., just a byte
field in a string array that so happens to have a value that matches the specified data type flag).
Therefore, the data type error check is *not* completely safe.

Unpacking values is a "nondestructive" process — i.e., the values are not removed from the buffer.
It is therefore possible for the caller to re-unpack a value from the same buffer by resetting the
unpack_ptr.

Warning: The caller is responsible for providing adequate memory storage for the requested data.
The user must provide a parameter indicating the maximum number of values that can be unpacked
into the allocated memory. If more values exist in the buffer than can fit into the memory storage,
then the function will unpack what it can fit into that location and return an error code indicating
that the buffer was only partially unpacked.

Note that any data that was not hard type cast (i.e., not type cast to a specific size) when packed may
lose precision when unpacked by a non-homogeneous recipient. PMIx will do its best to deal with
heterogeneity issues between the packer and unpacker in such cases. Sending a number larger than
can be handled by the recipient will return an error code generated upon unpacking — these errors
cannot be detected during packing.

The namespace of the process that packed the buffer is used solely to resolve any data type
differences between PMIx versions. The packer must, therefore, be known to the user prior to
calling the pack function so that the PMIx library is aware of the version the packer is using. Note

1   that all processes in a given namespace are *required* to use the same PMIx version — thus, the
2   caller must only know at least one process from the packer's namespace.

9.3.3   `PMIx_Data_copy`

Summary

Copy a data value from one location to another.

Format

———————————————————————————————————— C ————————————————————————————————————

```
pmix_status_t
PMIx_Data_copy(void **dest, void *src,
               pmix_data_type_t type);
```

———————————————————————————————————— C ————————————————————————————————————

IN   dest
       The address of a pointer into which the address of the resulting data is to be stored. (**void****)
IN   src
       A pointer to the memory location from which the data is to be copied (handle)
IN   type
       The type of the data to be copied — must be one of the PMIx defined data types.
       (**pmix_data_type_t**)

Returns one of the following:

PMIX_SUCCESS The data has been copied as requested
PMIX_ERR_NOT_SUPPORTED The PMIx implementation does not support this function.
PMIX_ERR_BAD_PARAM The provided src or dest is **NULL**
PMIX_ERR_UNKNOWN_DATA_TYPE The specified data type is not known to this
       implementation
PMIX_ERR_OUT_OF_RESOURCE Not enough memory to support the operation
PMIX_ERROR General error

Description

Since registered data types can be complex structures, the system needs some way to know how to
copy the data from one location to another (e.g., for storage in the registry). This function, which
can call other copy functions to build up complex data types, defines the method for making a copy
of the specified data type.

9.3.4   `PMIx_Data_print`

Summary

Pretty-print a data value.

```
2    pmix_status_t
3    PMIx_Data_print(char **output, char *prefix,
4                       void *src, pmix_data_type_t type);
```

5   **IN**   **output**
6   The address of a pointer into which the address of the resulting output is to be stored.
7   (**char****)
8   **IN**   **prefix**
9   String to be prepended to the resulting output (**char***)
10   **IN**   **src**
11   A pointer to the memory location of the data value to be printed (handle)
12   **IN**   **type**
13   The type of the data value to be printed — must be one of the PMIx defined data types.
14   (**pmix_data_type_t**)

15 Returns one of the following:

16   **PMIX_SUCCESS** The data has been printed as requested
17   **PMIX_ERR_BAD_PARAM** The provided data type is not recognized.
18   **PMIX_ERR_NOT_SUPPORTED** The PMIx implementation does not support this function.

19 **Description**
20 Since registered data types can be complex structures, the system needs some way to know how to
21 print them (i.e., convert them to a string representation). Primarily for debug purposes.

22 **9.3.5 PMIx_Data_copy_payload**

23 **Summary**
24 Copy a payload from one buffer to another

25 **Format**
PMIx v2.0

C

```
pmix_status_t
PMIx_Data_copy_payload(pmix_data_buffer_t *dest,
                       pmix_data_buffer_t *src);
```

C

IN   dest
    Pointer to the destination **pmix_data_buffer_t** (handle)

IN   src
    Pointer to the source **pmix_data_buffer_t** (handle)

Returns one of the following:

PMIX_SUCCESS The data has been copied as requested

PMIX_ERR_BAD_PARAM The src and dest **pmix_data_buffer_t** types do not match

PMIX_ERR_NOT_SUPPORTED The PMIx implementation does not support this function.

Description

This function will append a copy of the payload in one buffer into another buffer. Note that this is *not* a destructive procedure — the source buffer's payload will remain intact, as will any pre-existing payload in the destination's buffer. Only the unpacked portion of the source payload will be copied.

CHAPTER 10
Security

---

1   PMIx utilizes a multi-layered approach toward security that differs for client versus tool processes.
2   *Client* processes (i.e., processes started by the host environment) must be preregistered with the
3   PMIx server library via the `PMIx_server_register_client` API before they are spawned.
4   This API requires that you pass the expected uid/gid of the client process.

5   When the client attempts to connect to the PMIx server, the server uses available standard
6   Operating System (OS) methods to determine the effective uid/gid of the process requesting the
7   connection. PMIx implementations shall not rely on any values reported by the client process itself
8   as that would be unsafe. The effective uid/gid reported by the OS is compared to the values
9   provided by the host during registration - if they don't match, the PMIx server is required to drop
10   the connection request. This ensures that the PMIx server does not allow connection from a client
11   that doesn't at least meet some minimal security requirement.

12   Once the requesting client passes the initial test, the PMIx server can, at the choice of the
13   implementor, perform additional security checks. This may involve a variety of methods such as
14   exchange of a system-provided key or credential. At the conclusion of that process, the PMIx server
15   reports the client connection request to the host via the
16   `pmix_server_client_connected_fn_t` interface. The host may then perform any
17   additional checks and operations before responding with either `PMIX_SUCCESS` to indicate that
18   the connection is approved, or a PMIx error constant indicating that the connection request is
19   refused. In this latter case, the PMIx server is required to drop the connection.

20   Tools started by the host environment are classed as a subgroup of client processes and follow the
21   client process procedure. However, tools that are not started by the host environment must be
22   handled differently as registration information is not available prior to the connection request. In
23   these cases, the PMIx server library is required to use available standard OS methods to get the
24   effective uid/gid and report them upwards as part of invoking the
25   `pmix_server_tool_connection_fn_t` interface, deferring initial security screening to the
26   host. It is recognized that this may represent a security risk - for this reason, PMIx server libraries
27   must not enable tool connections by default. Instead, the host has to explicitly enable them via the
28   `PMIX_SERVER_TOOL_SUPPORT` attribute, thus recognizing the associated risk. Once the host
29   has completed its authentication procedure, it again informs the PMIx server of the result.

30   Applications and tools often interact with the host environment in ways that require security beyond
31   just verifying the user's identity - e.g., access to that user's relevant authorizations. This is
32   particularly important when tools connect directly to a system-level PMIx server that may be
33   operating at a privileged level. A variety of system management software packages provide
34   authorization services, but the lack of standardized interfaces makes portability problematic.

¹ This section defines two PMIx client-side APIs for this purpose. These are most likely to be used
² by user-space applications/tools, but are not restricted to that realm.

10.1 Obtaining Credentials

⁴ The API for obtaining a credential is a non-blocking operation since the host environment may have
⁵ to contact a remote credential service. The definition takes into account the potential that the
⁶ returned credential could be sent via some mechanism to another application that resides in an
⁷ environment using a different security mechanism. Thus, provision is made for the system to return
⁸ additional information (e.g., the identity of the issuing agent) outside of the credential itself and
⁹ visible to the application.

10.1.1 **PMIx_Get_credential**

Summary

Request a credential from the PMIx server library or the host environment

Format

PMIx v3.0

――――――――――――― C ―――――――――――――

```
pmix_status_t
PMIx_Get_credential(const pmix_info_t info[], size_t ninfo,
                    pmix_credential_cbfunc_t cbfunc, void *cbdata)
```

――――――――――――― C ―――――――――――――

IN   **info**
    Array of **pmix_info_t** structures (array of handles)
IN   **ninfo**
    Number of elements in the *info* array (**size_t**)
IN   **cbfunc**
    Callback function to return credential (**pmix_credential_cbfunc_t** function
    reference)
IN   **cbdata**
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request has been communicated to the local PMIx server -
  result will be returned in the provided *cbfunc*

- a PMIx error constant indicating either an error in the input or that the request is unsupported -
  the *cbfunc* will *not* be called

1   PMIx libraries that choose not to support this operation *must* return
2   **PMIX_ERR_NOT_SUPPORTED** when the function is called.

3   There are no required attributes for this API. Note that implementations may choose to internally
4   execute integration for some security environments (e.g., directly contacting a *munge* server).

5   Implementations that support the operation but cannot directly process the client's request must
6   pass any attributes that are provided by the client to the host environment for processing. In
7   addition, the following attributes are required to be included in the *info* array passed from the PMIx
8   library to the host environment:

9   **PMIX_USERID "pmix.euid"** (**uint32_t**)
10   Effective user id.

11 **PMIX_GRPID "pmix.egid"** (**uint32_t**)
12   Effective group id.

------------------ Optional Attributes ------------------

13 The following attributes are optional for host environments that support this operation:

14 **PMIX_TIMEOUT "pmix.timeout"** (**int**)
15   Time in seconds before the specified operation should time out (*0* indicating infinite) in
16   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
17   the target process from ever exposing its data.

——————— Advice to PMIx library implementers ———————

18 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
19 environment due to race condition considerations between completion of the operation versus
20 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
21 directly in the PMIx server library must take care to resolve the race condition and should avoid
22 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
23 created.

24 **Description**
25 Request a credential from the PMIx server library or the host environment

10.2 Validating Credentials

2   The API for validating a credential is a non-blocking operation since the host environment may
3   have to contact a remote credential service. Provision is made for the system to return additional
4   information regarding possible authorization limitations beyond simple authentication.

5   ## 10.2.1 `PMIx_Validate_credential`

6   **Summary**
7   Request validation of a credential by the PMIx server library or the host environment

8   **Format**

PMIx v3.0   C

```
9    pmix_status_t
10   PMIx_Validate_credential(const pmix_byte_object_t *cred,
11                             const pmix_info_t info[], size_t ninfo,
12                             pmix_validation_cbfunc_t cbfunc,
13                             void *cbdata)
```

                                                        C

14 **IN   cred**
15   Pointer to **pmix_byte_object_t** containing the credential (handle)
16 **IN   info**
17   Array of **pmix_info_t** structures (array of handles)
18 **IN   ninfo**
19   Number of elements in the *info* array (**size_t**)
20 **IN   cbfunc**
21   Callback function to return result (**pmix_validation_cbfunc_t** function reference)
22 **IN   cbdata**
23   Data to be passed to the callback function (memory reference)

24 Returns one of the following:

25 • **PMIX_SUCCESS**, indicating that the request has been communicated to the local PMIx server -
26   result will be returned in the provided *cbfunc*

27 • a PMIx error constant indicating either an error in the input or that the request is unsupported -
28   the *cbfunc* will *not* be called

1   PMIx libraries that choose not to support this operation *must* return
2   **PMIX_ERR_NOT_SUPPORTED** when the function is called.

3   There are no required attributes for this API. Note that implementations may choose to internally
4   execute integration for some security environments (e.g., directly contacting a *munge* server).

5   Implementations that support the operation but cannot directly process the client's request must
6   pass any attributes that are provided by the client to the host environment for processing. In
7   addition, the following attributes are required to be included in the *info* array passed from the PMIx
8   library to the host environment:

9   **PMIX_USERID** **"pmix.euid"** (**uint32_t**)
10   Effective user id.

11 **PMIX_GRPID** **"pmix.egid"** (**uint32_t**)
12   Effective group id.

13 The following attributes are optional for host environments that support this operation:

14 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
15   Time in seconds before the specified operation should time out (*0* indicating infinite) in
16   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
17   the target process from ever exposing its data.

18 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
19 environment due to race condition considerations between completion of the operation versus
20 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
21 directly in the PMIx server library must take care to resolve the race condition and should avoid
22 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
23 created.

24 **Description**
25 Request validation of a credential by the PMIx server library or the host environment.

Server-Specific Interfaces

1 The RM daemon that hosts the PMIx server library interacts with that library in two distinct
2 manners. First, PMIx provides a set of APIs by which the host can request specific services from its
3 library. This includes generating regular expressions, registering information to be passed to client
4 processes, and requesting information on behalf of a remote process. Note that the host always has
5 access to all PMIx client APIs - the functions listed below are in addition to those available to a
6 PMIx client.

7 Second, the host can provide a set of callback functions by which the PMIx server library can pass
8 requests upward for servicing by the host. These include notifications of client connection and
9 finalize, as well as requests by clients for information and/or services that the PMIx server library
10 does not itself provide.

11.1 Server Support Functions

12 The following APIs allow the RM daemon that hosts the PMIx server library to request specific
13 services from the PMIx library.

11.1.1 `PMIx_generate_regex`

15 **Summary**
16 Generate a compressed representation of the input string.

17 **Format**

PMIx v1.0

──────────────────────────── C ────────────────────────────

```
pmix_status_t
PMIx_generate_regex(const char *input, char **output)
```

──────────────────────────── C ────────────────────────────

20 **IN   input**
21   String to process (string)
22 **OUT   output**
23   Compressed representation of *input* (array of bytes)

24 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

Given a comma-separated list of *input* values, generate a reduced size representation of the input
that can be passed down to the PMIx server library's **PMIx_server_register_nspace** API
for parsing. The order of the individual values in the *input* string is preserved across the operation.
The caller is responsible for releasing the returned data.

The precise compressed representations will be implementation specific. However, all PMIx
implementations are required to include a **NULL**-terminated string in the output representation that
can be printed for diagnostic purposes.

———————————— Advice to PMIx server hosts ————————————

The returned representation may be an arbitrary array of bytes as opposed to a valid
NULL-terminated string. However, the method used to generate the representation shall be
identified with a colon-delimited string at the beginning of the output. For example, an output
starting with **"pmix:\0"** might indicate that the representation is a PMIx-defined regular
expression represented as a **NULL**-terminated string following the **"pmix:\0"** prefix. In contrast,
an output starting with **"blob:\0"** might indicate a compressed binary array follows the prefix.

Communicating the resulting output should be done by first packing the returned expression using
the **PMIx_Data_pack**, declaring the input to be of type **PMIX_REGEX**, and then obtaining the
resulting blob to be communicated using the **PMIX_DATA_BUFFER_UNLOAD** macro. The
reciprocal method can be used on the remote end prior to passing the regex into
PMIx_server_register_nspace. The pack/unpack routines will ensure proper handling of
the data based on the regex prefix.

11.1.2 `PMIx_generate_ppn`

Summary

Generate a compressed representation of the input identifying the processes on each node.

Format

PMIx v1.0 ▽ ——————————————— C ——————————————— ▽

```
pmix_status_t PMIx_generate_ppn(const char *input, char **ppn)
```

▲ ——————————————— C ——————————————— ▲

IN   input
    String to process (string)
OUT ppn
    Compressed representation of *input* (array of bytes)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

Description

The input shall consist of a semicolon-separated list of ranges representing the ranks of processes on each node of the job - e.g., "1-4;2-5;8,10,11,12;6,7,9". Each field of the input must correspond to the node name provided at that position in the input to **PMIx_generate_regex**. Thus, in the example, ranks 1-4 would be located on the first node of the comma-separated list of names provided to **PMIx_generate_regex**, and ranks 2-5 would be on the second name in the list.

―――――――――― Advice to PMIx server hosts ――――――――――

The returned representation may be an arbitrary array of bytes as opposed to a valid NULL-terminated string. However, the method used to generate the representation shall be identified with a colon-delimited string at the beginning of the output. For example, an output starting with **"pmix:"** indicates that the representation is a PMIx-defined regular expression represented as a NULL-terminated string. In contrast, an output starting with **"blob:\0size=1234:"** is a compressed binary array.

Communicating the resulting output should be done by first packing the returned expression using the **PMIx_Data_pack**, declaring the input to be of type **PMIX_REGEX**, and then obtaining the blob to be communicated using the **PMIX_DATA_BUFFER_UNLOAD** macro. The pack/unpack routines will ensure proper handling of the data based on the regex prefix.

11.1.3 `PMIx_server_register_nspace`

Summary

Setup the data about a particular namespace.

Format

PMIx v1.0

```c
pmix_status_t
PMIx_server_register_nspace(const pmix_nspace_t nspace,
                            int nlocalprocs,
                            pmix_info_t info[], size_t ninfo,
                            pmix_op_cbfunc_t cbfunc, void *cbdata)
```

IN nspace
   namespace (string)
IN nlocalprocs
   number of local processes (integer)
IN info
   Array of info structures (array of handles)
IN ninfo
   Number of elements in the *info* array (integer)

1 **IN   cbfunc**
2   Callback function **pmix_op_cbfunc_t** (function reference)
3 **IN   cbdata**
4   Data to be passed to the callback function (memory reference)

5 Returns one of the following:

6 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
7   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
8   function prior to returning from the API.

9 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
10   returned *success* - the *cbfunc* will not be called

11 • a PMIx error constant indicating either an error in the input or that the request was immediately
12   processed and failed - the *cbfunc* will not be called

▼----------------- Required Attributes -----------------▼

13 The following attributes are required to be supported by all PMIx libraries:

14 **PMIX_REGISTER_NODATA "pmix.reg.nodata"** (**bool**)
15   Registration is for this namespace only, do not copy job data - this attribute is not accessed
16   using the **PMIx_Get**

17 ──

18 Host environments are required to provide the following attributes:

19 • for the session containing the given namespace:

20 – **PMIX_UNIV_SIZE "pmix.univ.size"** (**uint32_t**)
21   Number of allocated slots in a session - each slot may or may not be occupied by an
22   executing process. Note that this attribute is the equivalent to the combination of
23   **PMIX_SESSION_INFO_ARRAY** with the **PMIX_MAX_PROCS** entry in the array - it
24   is included in the Standard for historical reasons.

25 • for the given namespace:

26 – **PMIX_JOBID "pmix.jobid"** (**char***)
27   Job identifier assigned by the scheduler.

28 – **PMIX_JOB_SIZE "pmix.job.size"** (**uint32_t**)
29   Total number of processes in this job across all contained applications. Note that this
30   value can be different from **PMIX_MAX_PROCS**. For example, users may choose to
31   subdivide an allocation (running several jobs in parallel within it), and dynamic
32   programming models may support adding and removing processes from a running **job**
33   on-they-fly. In the latter case, PMIx events must be used to notify processes within the
34   job that the job size has changed.

35 – **PMIX_MAX_PROCS "pmix.max.size"** (**uint32_t**)

1   Maximum number of processes that can be executed in this context (session,
2   namespace, application, or node). Typically, this is a constraint imposed by a scheduler
3   or by user settings in a hostfile or other resource description.

4   – **PMIX_NODE_MAP** **"pmix.nmap"** (**char***)
5   Regular expression of nodes - see 11.1.3.1 for an explanation of its generation.

6   – **PMIX_PROC_MAP** **"pmix.pmap"** (**char***)
7   Regular expression describing processes on each node - see 11.1.3.1 for an explanation
8   of its generation.

9 • for its own node:

10   – **PMIX_LOCAL_SIZE** **"pmix.local.size"** (**uint32_t**)
11   Number of processes in this job or application on this node.

12   – **PMIX_LOCAL_PEERS** **"pmix.lpeers"** (**char***)
13   Comma-delimited list of ranks on this node within the specified namespace - referenced
14   using **PMIX_RANK_WILDCARD**.

15   – **PMIX_LOCAL_CPUSETS** **"pmix.lcpus"** (**char***)
16   Colon-delimited cpusets of local peers within the specified namespace - referenced
17   using **PMIX_RANK_WILDCARD**.

18 • for each process in the given namespace:

19   – **PMIX_RANK** **"pmix.rank"** (**pmix_rank_t**)
20   Process rank within the job.

21   – **PMIX_LOCAL_RANK** **"pmix.lrank"** (**uint16_t**)
22   Local rank on this node within this job.

23   – **PMIX_NODE_RANK** **"pmix.nrank"** (**uint16_t**)
24   Process rank on this node spanning all jobs.

25   – **PMIX_NODEID** **"pmix.nodeid"** (**uint32_t**)
26   Node identifier where the specified process is located, expressed as the node's index
27   (beginning at zero) in the array resulting from expansion of the **PMIX_NODE_MAP**
28   regular expression for the **job**

29 If more than one application is included in the namespace, then the host environment is also
30 required to provide the following attributes:

31 • for each application:

32   – **PMIX_APPNUM** **"pmix.appnum"** (**uint32_t**)
33   Application number within the job.

34   – **PMIX_APPLDR** **"pmix.aldr"** (**pmix_rank_t**)
35   Lowest rank in this application within this job - referenced using
36   **PMIX_RANK_WILDCARD**.

1   – **PMIX_APP_SIZE** **"pmix.app.size"** (**uint32_t**)
2   Number of processes in this application.

3 • for each process:

4   – **PMIX_APP_RANK** **"pmix.apprank"** (**pmix_rank_t**)
5   Process rank within this application.

6   – **PMIX_APPNUM** **"pmix.appnum"** (**uint32_t**)
7   Application number within the job.

▲--▲

▼----------------- Optional Attributes -----------------▼
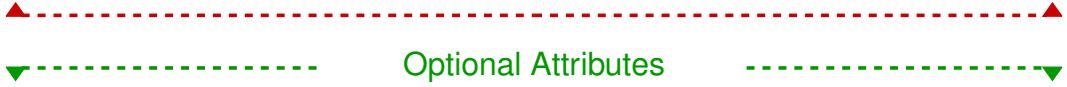
8 The following attributes may be provided by host environments:

9 • for the session containing the given namespace:

10   – **PMIX_SESSION_ID** **"pmix.session.id"** (**uint32_t**)
11   Session identifier - referenced using **PMIX_RANK_WILDCARD**.

12 • for the given namespace:

13   – **PMIX_SERVER_NSPACE** **"pmix.srv.nspace"** (**char***)
14   Name of the namespace to use for this PMIx server.

15   – **PMIX_SERVER_RANK** **"pmix.srv.rank"** (**pmix_rank_t**)
16   Rank of this PMIx server

17   – **PMIX_NPROC_OFFSET** **"pmix.offset"** (**pmix_rank_t**)
18   Starting global rank of this job - referenced using **PMIX_RANK_WILDCARD**.

19   – **PMIX_ALLOCATED_NODELIST** **"pmix.alist"** (**char***)
20   Comma-delimited list of all nodes in this allocation regardless of whether or not they
21   currently host processes - referenced using **PMIX_RANK_WILDCARD**.

22   – **PMIX_JOB_NUM_APPS** **"pmix.job.napps"** (**uint32_t**)
23   Number of applications in this job.

24   – **PMIX_MAPBY** **"pmix.mapby"** (**char***)
25   Process mapping policy - when accessed using **PMIx_Get**, use the
26   **PMIX_RANK_WILDCARD** value for the rank to discover the mapping policy used for
27   the provided namespace

28   – **PMIX_RANKBY** **"pmix.rankby"** (**char***)
29   Process ranking policy - when accessed using **PMIx_Get**, use the
30   **PMIX_RANK_WILDCARD** value for the rank to discover the ranking algorithm used for
31   the provided namespace

32   – **PMIX_BINDTO** **"pmix.bindto"** (**char***)

Process binding policy - when accessed using **PMIx_Get**, use the
PMIX_RANK_WILDCARD value for the rank to discover the binding policy used for the
provided namespace

- for its own node:

  - **PMIX_AVAIL_PHYS_MEMORY "pmix.pmem"** (**uint64_t**)
    Total available physical memory on this node.

  - **PMIX_HWLOC_XML_V1 "pmix.hwlocxml1"** (**char***)
    XML representation of local topology using HWLOC's v1.x format.

  - **PMIX_HWLOC_XML_V2 "pmix.hwlocxml2"** (**char***)
    XML representation of local topology using HWLOC's v2.x format.

  - **PMIX_LOCALLDR "pmix.lldr"** (**pmix_rank_t**)
    Lowest rank on this node within this job - referenced using **PMIX_RANK_WILDCARD**.

  - **PMIX_NODE_SIZE "pmix.node.size"** (**uint32_t**)
    Number of processes across all jobs on this node.

  - **PMIX_LOCAL_PROCS "pmix.lprocs"** (**pmix_proc_t array**)
    Array of **pmix_proc_t** of all processes on the specified node - referenced using
    PMIX_RANK_WILDCARD.

- for each process in the given namespace:

  - **PMIX_PROCID "pmix.procid"** (**pmix_proc_t**)
    Process identifier

  - **PMIX_GLOBAL_RANK "pmix.grank"** (**pmix_rank_t**)
    Process rank spanning across all jobs in this session.

  - **PMIX_HOSTNAME "pmix.hname"** (**char***)
    Name of the host where the specified process is running.

Attributes not directly provided by the host environment may be derived by the PMIx server library
from other required information and included in the data made available to the server library's
clients.

Description

Pass job-related information to the PMIx server library for distribution to local client processes.

―――――――――――――――― Advice to PMIx server hosts ――――――――――――――

Host environments are required to execute this operation prior to starting any local application process within the given namespace.

The PMIx server must register all namespaces that will participate in collective operations with local processes. This means that the server must register a namespace even if it will not host any local processes from within that namespace if any local process of another namespace might at some point perform an operation involving one or more processes from the new namespace. This is necessary so that the collective operation can identify the participants and know when it is locally complete.

The caller must also provide the number of local processes that will be launched within this namespace. This is required for the PMIx server library to correctly handle collectives as a collective operation call can occur before all the local processes have been started.

――――――――――――――――――――――― Advice to users ――――――――――――――――――――

The number of local processes for any given namespace is generally fixed at the time of application launch. Calls to **PMIx_Spawn** result in processes launched in their own namespace, not that of their parent. However, it is possible for processes to *migrate* to another node via a call to **PMIx_Job_control_nb**, thus resulting in a change to the number of local processes on both the initial node and the node to which the process moved. It is therefore critical that applications not migrate processes without first ensuring that PMIx-based collective operations are not in progress, and that no such operations be initiated until process migration has completed.

11.1.3.1 Assembling the registration information

The following description is not intended to represent the actual layout of information in a given PMIx library. Instead, it is describes how information provided in the *info* parameter of the **PMIx_server_register_nspace** shall be organized for proper processing by a PMIx server library. The ordering of the various information elements is arbitrary - they are presented in a top-down hierarchical form solely for clarity in reading.

────────────── Advice to PMIx server hosts ──────────────

Creating the *info* array of data requires knowing in advance the number of elements required for the array. This can be difficult to compute and somewhat fragile in practice. One method for resolving the problem is to create a linked list of objects, each containing a single **pmix_info_t** structure. Allocation and manipulation of the list can then be accomplished using existing standard methods. Upon completion, the final *info* array can be allocated based on the number of elements on the list, and then the values in the list object **pmix_info_t** structures transferred to the corresponding array element utilizing the **PMIX_INFO_XFER** macro.

──

A common building block used in several areas is the construction of a regular expression identifying the nodes involved in that area - e.g., the nodes in a **session** or **job**. PMIx provides several tools to facilitate this operation, beginning by constructing an argv-like array of node names. This array is then passed to the **PMIx_generate_regex** function to create a regular expression parseable by the PMIx server library, as shown below:

──────────────────────────── C ────────────────────────────

```
char **nodes = NULL;
char *nodelist;
char *regex;
size_t n;
pmix_status_t rc;
pmix_info_t info;

/* loop over an array of nodes, adding each
 * name to the array */
for (n=0; n < num_nodes; n++)
    /* filter the nodes to ignore those not included
     * in the target range (session, job, etc.). In
     * this example, all nodes are accepted */
    PMIX_ARGV_APPEND(&nodes, node[n]->name);


/* join into a comma-delimited string */
nodelist = PMIX_ARGV_JOIN(nodes, ',');
```

```
1           /* release the array */
2           PMIX_ARGV_FREE(nodes);
3
4           /* generate regex */
5           rc = PMIx_generate_regex(nodelist, &regex);
6
7           /* release list */
8           free(nodelist);
9
10          /* pass the regex as the value to the PMIX_NODE_MAP key */
11          PMIX_INFO_LOAD(&info, PMIX_NODE_MAP, regex, PMIX_STRING);
12          /* release the regex */
13          free(regex);
14
```
———————————————————————— C ————————————————————————

Changing the filter criteria allows the construction of node maps for any level of information.

A similar method is used to construct the map of processes on each node from the namespace being
registered. This may be done for each information level of interest (e.g., to identify the process map
for the entire **job** or for each **application** in the job) by changing the search criteria. An
example is shown below for the case of creating the process map for a **job**:

———————————————————————— C ————————————————————————
```
20          char **ndppn;
21          char rank[30];
22          char **ppnarray = NULL;
23          char *ppn;
24          char *localranks;
25          char *regex;
26          size_t n, m;
27          pmix_status_t rc;
28          pmix_info_t info;
29
30          /* loop over an array of nodes */
31          for (n=0; n < num_nodes; n++)
32              /* for each node, construct an array of ranks on that node */
33              ndppn = NULL;
34              for (m=0; m < node[n]->num_procs; m++)
35                  /* ignore processes that are not part of the target job */
36                  if (!PMIX_CHECK_NSPACE(targetjob,node[n]->proc[m].nspace))
37                      continue;
38
39                  snprintf(rank, 30, "%d", node[n]->proc[m].rank);
40                  PMIX_ARGV_APPEND(&ndppn, rank);
```

```
1
2          /* convert the array into a comma-delimited string of ranks */
3          localranks = PMIX_ARGV_JOIN(ndppn, ',');
4          /* release the local array */
5          PMIX_ARGV_FREE(ndppn);
6          /* add this node's contribution to the overall array */
7          PMIX_ARGV_APPEND(&ppnarray, localranks);
8          /* release the local list */
9          free(localranks);
10
11
12      /* join into a semicolon-delimited string */
13      ppn = PMIX_ARGV_JOIN(ppnarray, ';');
14
15      /* release the array */
16      PMIX_ARGV_FREE(ppnarray);
17
18      /* generate ppn regex */
19      rc = PMIx_generate_ppn(ppn, &regex);
20
21      /* release list */
22      free(ppn);
23
24      /* pass the regex as the value to the PMIX_PROC_MAP key */
25      PMIX_INFO_LOAD(&info, PMIX_PROC_MAP, regex, PMIX_STRING);
26      /* release the regex */
27      free(regex);
28
```

──────────────────── C ────────────────────

Note that the **PMIX_NODE_MAP** and **PMIX_PROC_MAP** attributes are linked in that the order of
entries in the process map must match the ordering of nodes in the node map - i.e., there is no
provision in the PMIx process map regular expression generator/parser pair supporting an
out-of-order node or a node that has no corresponding process map entry (e.g., a node with no
processes on it). Armed with these tools, the registration *info* array can be constructed as follows:

- Session-level information includes all session-specific values. In many cases, only two values
  (**PMIX_SESSION_ID** and **PMIX_UNIV_SIZE**) are included in the registration array. Since
  both of these values are session-specific, they can be specified independently - i.e., in their own
  pmix_info_t elements of the *info* array. Alternatively, they can be provided as a
  pmix_data_array_t array of **pmix_info_t** using the **PMIX_SESSION_INFO_ARRAY**
  attribute and identifed by including the **PMIX_SESSION_ID** attribute in the array - this is must
  in cases where non-specific attributes (e.g., **PMIX_NUM_NODES** or **PMIX_NODE_MAP**) are

passed to describe aspects of the session. Note that the node map can include nodes not used by the job being registered as no corresponding process map is specified.

The *info* array at this point might look like (where the labels identify the corresponding attribute - e.g., "Session ID" corresponds to the **PMIX_SESSION_ID** attribute):
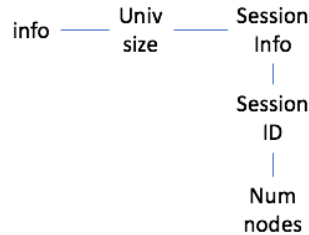
Figure 11.1.: Session-level information elements

- Job-level information includes all job-specific values such as **PMIX_JOB_SIZE**, **PMIX_JOB_NUM_APPS**, and **PMIX_JOBID**. Since each invocation of **PMIx_server_register_nspace** describes a single **job**, job-specific values can be specified independently - i.e., in their own **pmix_info_t** elements of the *info* array. Alternatively, they can be provided as a **pmix_data_array_t** array of **pmix_info_t** identified by the **PMIX_JOB_INFO_ARRAY** attribute - this is must in cases where non-specific attributes (e.g., **PMIX_NODE_MAP**) are passed to describe aspects of the job. Note that since the invocation only involves a single namespace, there is no need to include the **PMIX_NSPACE** attribute in the array.

Upon conclusion of this step, the *info* array might look like:

Note that in this example, **PMIX_NUM_NODES** is not required as that information is contained in the **PMIX_NODE_MAP** attribute. Similarly, **PMIX_JOB_SIZE** is not technically required as that information is contained in the **PMIX_PROC_MAP** when combined with the corresponding node map - however, there is no issue with including the job size as a separate entry.

The example also illustrates the hierarchical use of the **PMIX_NODE_INFO_ARRAY** attribute. In this case, we have chosen to pass several job-related values for each node - since those values are non-unique across the job, they must be passed in a node-info container. Note that the choice of what information to pass into the PMIx server library versus what information to derive from other values at time of request is left to the host environment. PMIx implementors in turn may, if they choose, pre-parse registration data to create expanded views (thus enabling faster response to requests at the expense of memory footprint) or to compress views into tighter representations (thus trading minimized footprint for longer response times).

- Application-level information includes all application-specific values such as **PMIX_APP_SIZE** and **PMIX_APPLDR**. If the **job** contains only a single **application**, then the application-specific values can be specified independently - i.e., in their own **pmix_info_t**
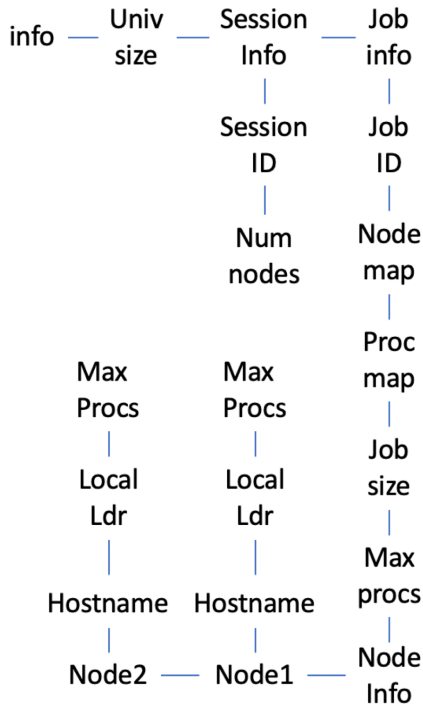
Figure 11.2.: Job-level information elements

elements of the *info* array - or as a **pmix_data_array_t** array of **pmix_info_t** using the
PMIX_APP_INFO_ARRAY attribute and identifed by including the **PMIX_APPNUM** attribute in
the array. Use of the array format is must in cases where non-specific attributes (e.g.,
PMIX_NODE_MAP) are passed to describe aspects of the application.

However, in the case of a job consisting of multiple applications, all application-specific values
for each application must be provided using the **PMIX_APP_INFO_ARRAY** format, each
identified by its **PMIX_APPNUM** value.

Upon conclusion of this step, the *info* array might look like that shown in 11.3, assuming there
are two applications in the job being registered:

- Process-level information includes an entry for each process in the job being registered, each
  entry marked with the **PMIX_PROC_DATA** attribute. The **rank** of the process must be the first
  entry in the array - this provides efficiency when storing the data. Upon conclusion of this step,
  the *info* array might look like the diagram in 11.4:

- For purposes of this example, node-level information only includes values describing the local
  node - i.e., it does not include information about other nodes in the job or session. In many cases,
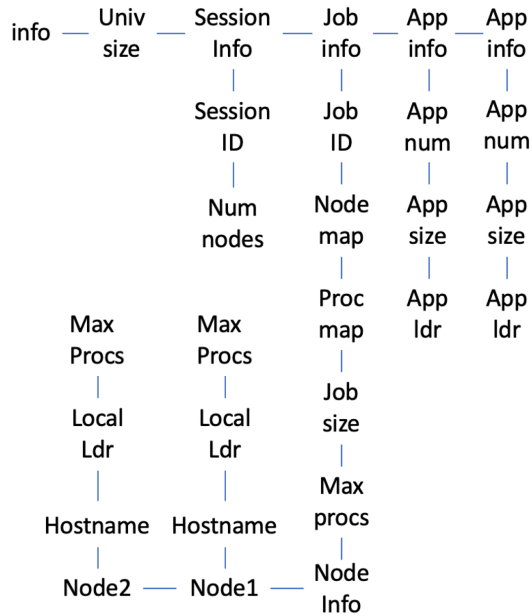
Figure 11.3.: Application-level information elements
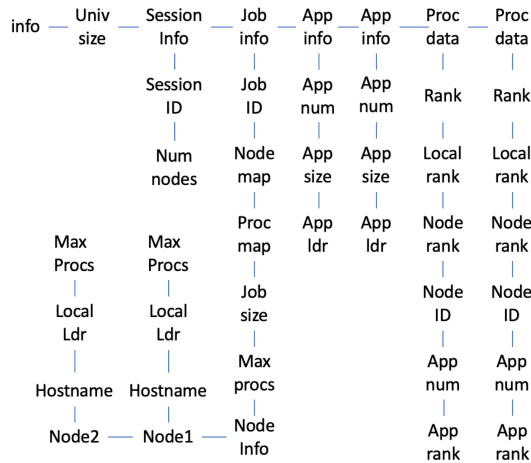
Figure 11.4.: Process-level information elements

the values included in this level are unique to it and can be specified independently - i.e., in their own **`pmix_info_t`** elements of the *info* array. Alternatively, they can be provided as a **`pmix_data_array_t`** array of **`pmix_info_t`** using the **`PMIX_NODE_INFO_ARRAY`**

attribute - this is must in cases where non-specific attributes are passed to describe aspects of the node, or where values for multiple nodes are being provided.

The node-level information requires two elements that must be constructed in a manner similar to that used for the node map. The **PMIX_LOCAL_PEERS** value is computed based on the processes on the local node, filtered to select those from the job being registered, as shown below using the tools provided by PMIx:

─────────────────────────────── C ───────────────────────────────

```
char **ndppn = NULL;
char rank[30];
char *localranks;
size_t m;
pmix_info_t info;

for (m=0; m < mynode->num_procs; m++)
    /* ignore processes that are not part of the target job */
    if (!PMIX_CHECK_NSPACE(targetjob,mynode->proc[m].nspace))
        continue;

    snprintf(rank, 30, "%d", mynode->proc[m].rank);
    PMIX_ARGV_APPEND(&ndppn, rank);

/* convert the array into a comma-delimited string of ranks */
localranks = PMIX_ARGV_JOIN(ndppn, ',');
/* release the local array */
PMIX_ARGV_FREE(ndppn);

/* pass the string as the value to the PMIX_LOCAL_PEERS key */
PMIX_INFO_LOAD(&info, PMIX_LOCAL_PEERS, localranks, PMIX_STRING);
/* release the list */
free(localranks);
```

─────────────────────────────── C ───────────────────────────────

The **PMIX_LOCAL_CPUSETS** value is constructed in a similar manner. In the provided example, it is assumed that the Hardware Locality (HWLOC) cpuset representation (a comma-delimited string of processor IDs) of the processors assigned to each process has previously been generated and stored on the process description. Thus, the value can be constructed as shown below:

```C
────────────────────────────── C ──────────────────────────────
1       char **ndcpus = NULL;
2       char *localcpus;
3       size_t m;
4       pmix_info_t info;
5
6       for (m=0; m < mynode->num_procs; m++)
7           /* ignore processes that are not part of the target job */
8           if (!PMIX_CHECK_NSPACE(targetjob,mynode->proc[m].nspace))
9               continue;
10
11          PMIX_ARGV_APPEND(&ndcpus, mynode->proc[m].cpuset);
12
13      /* convert the array into a colon-delimited string */
14      localcpus = PMIX_ARGV_JOIN(ndcpus, ':');
15      /* release the local array */
16      PMIX_ARGV_FREE(ndcpus);
17
18      /* pass the string as the value to the PMIX_LOCAL_CPUSETS key */
19      PMIX_INFO_LOAD(&info, PMIX_LOCAL_CPUSETS, localcpus, PMIX_STRING);
20      /* release the list */
21      free(localcpus);
22
────────────────────────────── C ──────────────────────────────
```

23   Note that for efficiency, these two values can be computed at the same time.

24   The final *info* array might therefore look like the diagram in 11.5:

11.1.4 `PMIx_server_deregister_nspace`

Summary

Deregister a namespace.

Format

PMIx v1.0

info — Univ size — Session Info — Job info — App info — App info — Proc data — Proc data

Session ID | Job ID | App num | App num | Rank | Rank | Local size

Num nodes | Node map | App size | App size | Local rank | Local rank | Local Peers

Proc map | App ldr | App ldr | Node rank | Node rank | Local cpusets

Max Procs | Max Procs | Job size | Node rank | Node rank

Local Ldr | Local Ldr | Max procs | Node ID | Node ID

Hostname | Hostname | Node Info | App num | App num

Node2 — Node1 — App rank | App rank

Figure 11.5.: Final information array

C

```
void PMIx_server_deregister_nspace(const pmix_nspace_t nspace,
                        pmix_op_cbfunc_t cbfunc, void *cbdata)
```

C

IN nspace
   Namespace (string)
IN cbfunc
   Callback function **pmix_op_cbfunc_t** (function reference)
IN cbdata
   Data to be passed to the callback function (memory reference)

Description
Deregister the specified *nspace* and purge all objects relating to it, including any client information from that namespace. This is intended to support persistent PMIx servers by providing an opportunity for the host RM to tell the PMIx server library to release all memory for a completed job. Note that the library must not invoke the callback function prior to returning from the API.

11.1.5 `PMIx_server_register_client`

Summary

Register a client process with the PMIx server library.

Format

PMIx v1.0

─────────────────────────────── C ───────────────────────────────

```
pmix_status_t
PMIx_server_register_client(const pmix_proc_t *proc,
                            uid_t uid, gid_t gid,
                            void *server_object,
                            pmix_op_cbfunc_t cbfunc, void *cbdata)
```

─────────────────────────────── C ───────────────────────────────

IN   **proc**
    pmix_proc_t structure (handle)
IN   **uid**
    user id (integer)
IN   **gid**
    group id (integer)
IN   **server_object**
    (memory reference)
IN   **cbfunc**
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   **cbdata**
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description

Register a client process with the PMIx server library.

The host server can also, if it desires, provide an object it wishes to be returned when a server function is called that relates to a specific process. For example, the host server may have an object that tracks the specific client. Passing the object to the library allows the library to provide that object to the host server during subsequent calls related to that client, such as a

CHAPTER 11. SERVER-SPECIFIC INTERFACES   **237**

1   **pmix_server_client_connected_fn_t** function. This allows the host server to access
2   the object without performing a lookup based on the client's namespace and rank.

--------------------------- Advice to PMIx server hosts ---------------------------

3   Host environments are required to execute this operation prior to starting the client process. The
4   expected user ID and group ID of the child process allows the server library to properly authenticate
5   clients as they connect by requiring the two values to match. Accordingly, the detected user and
6   group ID's of the connecting process are not included in the
7   **pmix_server_client_connected_fn_t** server module function.

--------------------------- Advice to PMIx library implementers ---------------------------

8   For security purposes, the PMIx server library should check the user and group ID's of a
9   connecting process against those provided for the declared client process identifier via the
10   **PMIx_server_register_client** prior to completing the connection.

11.1.6   **PMIx_server_deregister_client**

Summary

Deregister a client and purge all data relating to it.

Format

PMIx v1.0

--------------------------- C ---------------------------

```
void
PMIx_server_deregister_client(const pmix_proc_t *proc,
                              pmix_op_cbfunc_t cbfunc, void *cbdata)
```

--------------------------- C ---------------------------

IN   **proc**
   pmix_proc_t structure (handle)
IN   **cbfunc**
   Callback function **pmix_op_cbfunc_t** (function reference)
IN   **cbdata**
   Data to be passed to the callback function (memory reference)

Description

The **PMIx_server_deregister_nspace** API will delete all client information for that
namespace. The PMIx server library will automatically perform that operation upon disconnect of
all local clients. This API is therefore intended primarily for use in exception cases, but can be
called in non-exception cases if desired. Note that the library must not invoke the callback function
prior to returning from the API.

11.1.7 `PMIx_server_setup_fork`

2 **Summary**
3 Setup the environment of a child process to be forked by the host.

4 **Format**

PMIx v1.0

—————————————————————————— C ——————————————————————————

```
5 pmix_status_t
6 PMIx_server_setup_fork(const pmix_proc_t *proc,
7                                char ***env)
```

—————————————————————————— C ——————————————————————————

8 **IN   proc**
9   **pmix_proc_t** structure (handle)
10 **IN   env**
11   Environment array (array of strings)

12 Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant.

13 **Description**
14 Setup the environment of a child process to be forked by the host so it can correctly interact with
15 the PMIx server.

————————————————— Advice to PMIx server hosts —————————————————

16 Host environments are required to execute this operation prior to starting the client process.

17 The PMIx client needs some setup information so it can properly connect back to the server. This
18 function will set appropriate environmental variables for this purpose, and will also provide any
19 environmental variables that were specified in the launch command (e.g., via **PMIx_Spawn**) plus
20 other values (e.g., variables required to properly initialize the client's fabric library).

21 ## 11.1.8 `PMIx_server_dmodex_request`

22 **Summary**
23 Define a function by which the host server can request modex data from the local PMIx server.

Format

```
C
pmix_status_t PMIx_server_dmodex_request(const pmix_proc_t *proc,
                          pmix_dmodex_response_fn_t cbfunc,
                          void *cbdata)
C
```

IN   proc
    pmix_proc_t structure (handle)
IN   cbfunc
    Callback function **pmix_dmodex_response_fn_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- a PMIx error constant indicating an error in the input - the *cbfunc* will not be called

Description

Define a function by which the host server can request modex data from the local PMIx server. Traditional wireup procedures revolve around the per-process posting of data (e.g., location and endpoint information) via the **PMIx_Put** and **PMIx_Commit** functions followed by a **PMIx_Fence** barrier that globally exchanges the posted information. However, the barrier operation represents a signficant time impact at large scale.

PMIx supports an alternative wireup method known as *Direct Modex* that replaces the barrier-based exchange of all process-posted information with on-demand fetch of a peer's data. In place of the barrier operation, data posted by each process is cached on the local PMIx server. When a process requests the information posted by a particular peer, it first checks the local cache to see if the data is already available. If not, then the request is passed to the local PMIx server, which subsequently requests that its RM host request the data from the RM daemon on the node where the specified peer process is located. Upon receiving the request, the RM daemon passes the request into its PMIx server library using the **PMIx_server_dmodex_request** function, receiving the response in the provided *cbfunc* once the indicated process has posted its information. The RM daemon then returns the data to the requesting daemon, who subsequently passes the data to its PMIx server library for transfer to the requesting client.

--- Advice to users ---

While direct modex allows for faster launch times by eliminating the barrier operation, per-peer retrieval of posted information is less efficient. Optimizations can be implemented - e.g., by returning posted information from all processes on a node upon first request - but in general direct modex remains best suited for sparsely connected applications.

1 ## 11.1.9 `PMIx_server_setup_application`

2 **Summary**

3 Provide a function by which the resource manager can request application-specific setup data prior
4 to launch of a **job**.

5 **Format**

PMIx v2.0 ─────────────────────── C ───────────────────────

```
6 pmix_status_t
7 PMIx_server_setup_application(const pmix_nspace_t nspace,
8                               pmix_info_t info[], size_t ninfo,
9                               pmix_setup_application_cbfunc_t cbfunc,
10                              void *cbdata)
```

─────────────────────── C ───────────────────────

11 **IN   nspace**
12   namespace (string)
13 **IN   info**
14   Array of info structures (array of handles)
15 **IN   ninfo**
16   Number of elements in the *info* array (integer)
17 **IN   cbfunc**
18   Callback function **pmix_setup_application_cbfunc_t** (function reference)
19 **IN   cbdata**
20   Data to be passed to the *cbfunc* callback function (memory reference)

21 Returns one of the following:

22 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
23   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
24   function prior to returning from the API.

25 • a PMIx error constant indicating either an error in the input - the *cbfunc* will not be called

▼----------------- Required Attributes -----------------▼

26 PMIx libraries that support this operation are required to support the following:

27 **PMIX_SETUP_APP_ENVARS "pmix.setup.env"** (**bool**)
28   Harvest and include relevant environmental variables

29 **PMIX_SETUP_APP_NONENVARS ""pmix.setup.nenv"** (**bool**)
30   Include all relevant data other than environmental variables

31 **PMIX_SETUP_APP_ALL "pmix.setup.all"** (**bool**)

1   Include all relevant data

2   **PMIX_ALLOC_NETWORK** **"pmix.alloc.net"** (**array**)
3   Array of **pmix_info_t** describing requested network resources. This must include at
4   least: **PMIX_ALLOC_NETWORK_ID**, **PMIX_ALLOC_NETWORK_TYPE**, and
5   **PMIX_ALLOC_NETWORK_ENDPTS**, plus whatever other descriptors are desired.

6   **PMIX_ALLOC_NETWORK_ID** **"pmix.alloc.netid"** (**char***)
7   The key to be used when accessing this requested network allocation. The allocation will be
8   returned/stored as a **pmix_data_array_t** of **pmix_info_t** indexed by this key and
9   containing at least one entry with the same key and the allocated resource description. The
10   type of the included value depends upon the network support. For example, a TCP allocation
11   might consist of a comma-delimited string of socket ranges such as
12   *"32000-32100,33005,38123-38146"*. Additional entries will consist of any provided
13   resource request directives, along with their assigned values. Examples include:
14   **PMIX_ALLOC_NETWORK_TYPE** - the type of resources provided;
15   **PMIX_ALLOC_NETWORK_PLANE** - if applicable, what plane the resources were assigned
16   from; **PMIX_ALLOC_NETWORK_QOS** - the assigned QoS; **PMIX_ALLOC_BANDWIDTH** -
17   the allocated bandwidth; **PMIX_ALLOC_NETWORK_SEC_KEY** - a security key for the
18   requested network allocation. NOTE: the assigned values may differ from those requested,
19   especially if **PMIX_INFO_REQD** was not set in the request.

20   **PMIX_ALLOC_NETWORK_SEC_KEY** **"pmix.alloc.nsec"** (**pmix_byte_object_t**)
21   Network security key

22   **PMIX_ALLOC_NETWORK_TYPE** **"pmix.alloc.nettype"** (**char***)
23   Type of desired transport (e.g., *"tcp"*, *"udp"*)

24   **PMIX_ALLOC_NETWORK_PLANE** **"pmix.alloc.netplane"** (**char***)
25   ID string for the NIC (aka *plane*) to be used for this allocation (e.g., CIDR for Ethernet)

26   **PMIX_ALLOC_NETWORK_ENDPTS** **"pmix.alloc.endpts"** (**size_t**)
27   Number of endpoints to allocate per process

28   **PMIX_ALLOC_NETWORK_ENDPTS_NODE** **"pmix.alloc.endpts.nd"** (**size_t**)
29   Number of endpoints to allocate per node

▲--▲
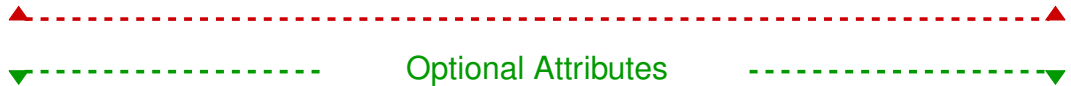
▼----------------- Optional Attributes -----------------▼

30   PMIx libraries that support this operation may support the following:

31   **PMIX_ALLOC_BANDWIDTH** **"pmix.alloc.bw"** (**float**)
32   Mbits/sec.

33   **PMIX_ALLOC_NETWORK_QOS** **"pmix.alloc.netqos"** (**char***)
34   Quality of service level.

35   **PMIX_ALLOC_TIME** **"pmix.alloc.time"** (**uint32_t**)

1   Time in seconds.

----

2   **Description**
3   Provide a function by which the RM can request application-specific setup data (e.g., environmental
4   variables, fabric configuration and security credentials) from supporting PMIx server library
5   subsystems prior to initiating launch of a job.

──────────────── Advice to PMIx server hosts ────────────────

6   Host environments are required to execute this operation prior to launching a job. In addition to
7   supported directives, the *info* array must include a description of the **job** using the
8   **PMIX_NODE_MAP** and **PMIX_PROC_MAP** attributes.

9   This is defined as a non-blocking operation in case contributing subsystems need to perform some
10   potentially time consuming action (e.g., query a remote service) before responding. The returned
11   data must be distributed by the RM and subsequently delivered to the local PMIx server on each
12   node where application processes will execute, prior to initiating execution of those processes.

──────────────── Advice to PMIx library implementers ────────────────

13   Support for harvesting of environmental variables and providing of local configuration information
14   by the PMIx implementation is optional.

11.1.10 `PMIx_server_setup_local_support`

16   **Summary**
17   Provide a function by which the local PMIx server can perform any application-specific operations
18   prior to spawning local clients of a given application.

Format

```
pmix_status_t
PMIx_server_setup_local_support(const pmix_nspace_t nspace,
                                pmix_info_t info[], size_t ninfo,
                                pmix_op_cbfunc_t cbfunc,
                                void *cbdata);
```
— C —

IN   nspace
    Namespace (string)
IN   info
    Array of info structures (array of handles)
IN   ninfo
    Number of elements in the *info* array (**size_t**)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description

Provide a function by which the local PMIx server can perform any application-specific operations prior to spawning local clients of a given application. For example, a network library might need to setup the local driver for "instant on" addressing. The data provided in the *info* array is the data returned to the host RM by the callback function executed as a result of a call to **PMIx_server_setup_application**.

— Advice to PMIx server hosts —

Host environments are required to execute this operation prior to starting any local application processes from the specified namespace.

11.1.11 `PMIx_server_IOF_deliver`

Summary

Provide a function by which the host environment can pass forwarded IO to the PMIx server library for distribution to its clients.

Format

PMIx v3.0

———————————————————— C ————————————————————

```
pmix_status_t
PMIx_server_IOF_deliver(const pmix_proc_t *source,
                        pmix_iof_channel_t channel,
                        const pmix_byte_object_t *bo,
                        const pmix_info_t info[], size_t ninfo,
                        pmix_op_cbfunc_t cbfunc, void *cbdata);
```

———————————————————— C ————————————————————

IN   source
> Pointer to **pmix_proc_t** identifying source of the IO (handle)

IN   channel
> IO channel of the data (**pmix_iof_channel_t**)

IN   bo
> Pointer to **pmix_byte_object_t** containing the payload to be delivered (handle)

IN   info
> Array of **pmix_info_t** metadata describing the data (array of handles)

IN   ninfo
> Number of elements in the *info* array (**size_t**)

IN   cbfunc
> Callback function **pmix_op_cbfunc_t** (function reference)

IN   cbdata
> Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description

Provide a function by which the host environment can pass forwarded IO to the PMIx server library

for distribution to its clients. The PMIx server library is responsible for determining which of its

clients have actually registered for the provided data and delivering it. The *cbfunc* callback function

will be called once the PMIx server library no longer requires access to the provided data.

11.1.12 `PMIx_server_collect_inventory`

Summary

Collect inventory of resources on a node

Format

PMIx v3.0

———————————————————————————— C ————————————————————————————

```
pmix_status_t
PMIx_server_collect_inventory(const pmix_info_t directives[],
                              size_t ndirs,
                              pmix_info_cbfunc_t cbfunc,
                              void *cbdata);
```

———————————————————————————— C ————————————————————————————

IN   directives

Array of **pmix_info_t** directing the request (array of handles)

IN   ndirs

Number of elements in the *directives* array (**size_t**)

IN   cbfunc

Callback function to return collected data (**pmix_info_cbfunc_t** function reference)

IN   cbdata

Data to be passed to the callback function (memory reference)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant. In the event

the function returns an error, the *cbfunc* will not be called.

Description

Provide a function by which the host environment can request its PMIx server library collect an

inventory of local resources. Supported resources depends upon the PMIx implementation, but may

include the local node topology and network interfaces.

———————————————————— Advice to PMIx server hosts ————————————————————

This is a non-blocking API as it may involve somewhat lengthy operations to obtain the requested

information. Inventory collection is expected to be a rare event – at system startup and upon

command from a system administrator. Inventory updates are expected to initiate a smaller

operation involving only the changed information. For example, replacement of a node would

generate an event to notify the scheduler with an inventory update without invoking a global

inventory operation.

1 11.1.13 `PMIx_server_deliver_inventory`

2 **Summary**
3 Pass collected inventory to the PMIx server library for storage

4 **Format**

PMIx v3.0 ──────────────── C ────────────────

```
5    pmix_status_t
6    PMIx_server_deliver_inventory(const pmix_info_t info[],
7                                  size_t ninfo,
8                                  const pmix_info_t directives[],
9                                  size_t ndirs,
10                                 pmix_op_cbfunc_t cbfunc,
11                                 void *cbdata);
```

──────────────── C ────────────────

12 **IN   info**
13   Array of **pmix_info_t** containing the inventory (array of handles)
14 **IN   ninfo**
15   Number of elements in the *info* array (**size_t**)
16 **IN   directives**
17   Array of **pmix_info_t** directing the request (array of handles)
18 **IN   ndirs**
19   Number of elements in the *directives* array (**size_t**)
20 **IN   cbfunc**
21   Callback function **pmix_op_cbfunc_t** (function reference)
22 **IN   cbdata**
23   Data to be passed to the callback function (memory reference)

24   Returns one of the following:

25 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
26   will be returned in the provided *cbfunc*. Note that the library must not invoke the callback
27   function prior to returning from the API.

28 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
29   returned *success* - the *cbfunc* will not be called

30 • a PMIx error constant indicating either an error in the input or that the request was immediately
31   processed and failed - the *cbfunc* will not be called

Description

Provide a function by which the host environment can pass inventory information obtained from a node to the PMIx server library for storage. Inventory data is subsequently used by the PMIx server library for allocations in response to **PMIx_server_setup_application**, and may be available to the library's host via the **PMIx_Get** API (depending upon PMIx implementation). The *cbfunc* callback function will be called once the PMIx server library no longer requires access to the provided data.

11.2 Server Function Pointers

PMIx utilizes a "function-shipping" approach to support for implementing the server-side of the protocol. This method allows RMs to implement the server without being burdened with PMIx internal details. When a request is received from the client, the corresponding server function will be called with the information.

Any functions not supported by the RM can be indicated by a **NULL** for the function pointer. Client calls to such functions will return a **PMIX_ERR_NOT_SUPPORTED** status.

The host RM will provide the function pointers in a **pmix_server_module_t** structure passed to **PMIx_server_init**. That module structure and associated function references are defined in this section.

———————— Advice to PMIx server hosts ————————

For performance purposes, the host server is required to return as quickly as possible from all functions. Execution of the function is thus to be done asynchronously so as to allow the PMIx server support library to handle multiple client requests as quickly and scalably as possible.

All data passed to the host server functions is "owned" by the PMIX server support library and must not be free'd. Data returned by the host server via callback function is owned by the host server, which is free to release it upon return from the callback

11.2.1 `pmix_server_module_t` Module

Summary

List of function pointers that a PMIx server passes to **PMIx_server_init** during startup.

Format

——————————————————— C ———————————————————

```
2    typedef struct pmix_server_module_3_0_0_t
3        /* v1x interfaces */
4        pmix_server_client_connected_fn_t     client_connected;
5        pmix_server_client_finalized_fn_t     client_finalized;
6        pmix_server_abort_fn_t                abort;
7        pmix_server_fencenb_fn_t              fence_nb;
8        pmix_server_dmodex_req_fn_t           direct_modex;
9        pmix_server_publish_fn_t              publish;
10       pmix_server_lookup_fn_t               lookup;
11       pmix_server_unpublish_fn_t            unpublish;
12       pmix_server_spawn_fn_t                spawn;
13       pmix_server_connect_fn_t              connect;
14       pmix_server_disconnect_fn_t           disconnect;
15       pmix_server_register_events_fn_t      register_events;
16       pmix_server_deregister_events_fn_t    deregister_events;
17       pmix_server_listener_fn_t             listener;
18       /* v2x interfaces */
19       pmix_server_notify_event_fn_t         notify_event;
20       pmix_server_query_fn_t                query;
21       pmix_server_tool_connection_fn_t      tool_connected;
22       pmix_server_log_fn_t                  log;
23       pmix_server_alloc_fn_t                allocate;
24       pmix_server_job_control_fn_t          job_control;
25       pmix_server_monitor_fn_t              monitor;
26       /* v3x interfaces */
27       pmix_server_get_cred_fn_t             get_credential;
28       pmix_server_validate_cred_fn_t        validate_credential;
29       pmix_server_iof_fn_t                  iof_pull;
30       pmix_server_stdin_fn_t                push_stdin;
31    pmix_server_module_t;
```

——————————————————— C ———————————————————

11.2.2 `pmix_server_client_connected_fn_t`

Summary

Notify the host server that a client connected to this server.

Format

```
typedef pmix_status_t (*pmix_server_client_connected_fn_t)(
                                    const pmix_proc_t *proc,
                                    void* server_object,
                                    pmix_op_cbfunc_t cbfunc,
                                    void *cbdata)
```

IN   proc
   pmix_proc_t structure (handle)
IN   server_object
   object reference (memory reference)
IN   cbfunc
   Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description

Notify the host environment that a client has called **PMIx_Init**. Note that the client will be in a blocked state until the host server executes the callback function, thus allowing the PMIx server support library to release the client. The server_object parameter will be the value of the server_object parameter passed to **PMIx_server_register_client** by the host server when registering the connecting client. If provided, an implementation of **pmix_server_client_connected_fn_t** is only required to call the callback function designated. A host server can choose to not be notified when clients connect by setting **pmix_server_client_connected_fn_t** to **NULL**.

It is possible that only a subset of the clients in a namespace call **PMIx_Init**. The server's **pmix_server_client_connected_fn_t** implementation should not depend on being called once per rank in a namespace or delay calling the callback function until all ranks have connected. However, if a rank makes any PMIx calls, it must first call **PMIx_Init** and therefore the server's **pmix_server_client_connected_fn_t** will be called before any other server functions specific to the rank.

This operation is an opportunity for a host environment to update the status of the ranks it manages. It is also a convenient and well defined time to perform initialization necessary to support further calls into the server related to that rank.

11.2.3 `pmix_server_client_finalized_fn_t`

Summary

Notify the host environment that a client called **PMIx_Finalize**.

Format

PMIx v1.0

```
typedef pmix_status_t (*pmix_server_client_finalized_fn_t)(
                                    const pmix_proc_t *proc,
                                    void* server_object,
                                    pmix_op_cbfunc_t cbfunc,
                                    void *cbdata)
```

IN   proc
    pmix_proc_t structure (handle)
IN   server_object
    object reference (memory reference)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description

Notify the host environment that a client called **PMIx_Finalize**. Note that the client will be in a blocked state until the host server executes the callback function, thus allowing the PMIx server support library to release the client. The server_object parameter will be the value of the server_object parameter passed to **PMIx_server_register_client** by the host server when registering the connecting client. If provided, an implementation of **pmix_server_client_finalized_fn_t** is only required to call the callback function designated. A host server can choose to not be notified when clients finalize by setting **pmix_server_client_finalized_fn_t** to **NULL**.

Note that the host server is only being informed that the client has called **PMIx_Finalize**. The client might not have exited. If a client exits without calling **PMIx_Finalize**, the server support library will not call the **pmix_server_client_finalized_fn_t** implementation.

───────────────────── Advice to PMIx server hosts ─────────────────────

This operation is an opportunity for a host server to update the status of the tasks it manages. It is also a convenient and well defined time to release resources used to support that client.

11.2.4 `pmix_server_abort_fn_t`

Summary

Notify the host environment that a local client called **PMIx_Abort**.

Format

PMIx v1.0 ▼───────────────── C ─────────────────▼

```
typedef pmix_status_t (*pmix_server_abort_fn_t)(
                                const pmix_proc_t *proc,
                                void *server_object,
                                int status,
                                const char msg[],
                                pmix_proc_t procs[],
                                size_t nprocs,
                                pmix_op_cbfunc_t cbfunc,
                                void *cbdata)
```

1　　**IN　proc**
2　　　　**pmix_proc_t** structure identifying the process requesting the abort (handle)
3　　**IN　server_object**
4　　　　object reference (memory reference)
5　　**IN　status**
6　　　　exit status (integer)
7　　**IN　msg**
8　　　　exit status message (string)
9　　**IN　procs**
10　　　　Array of **pmix_proc_t** structures identifying the processes to be terminated (array of
11　　　　handles)
12　　**IN　nprocs**
13　　　　Number of elements in the *procs* array (integer)
14　　**IN　cbfunc**
15　　　　Callback function **pmix_op_cbfunc_t** (function reference)
16　　**IN　cbdata**
17　　　　Data to be passed to the callback function (memory reference)

18　Returns one of the following:

19　• **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
20　　will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
21　　prior to returning from the API.

22　• **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
23　　returned *success* - the *cbfunc* will not be called

24　• a PMIx error constant indicating either an error in the input or that the request was immediately
25　　processed and failed - the *cbfunc* will not be called

26　**Description**
27　A local client called **PMIx_Abort**. Note that the client will be in a blocked state until the host
28　server executes the callback function, thus allowing the PMIx server library to release the client.
29　The array of *procs* indicates which processes are to be terminated. A **NULL** indicates that all
30　processes in the client's namespace are to be terminated.

31　## 11.2.5　**pmix_server_fencenb_fn_t**

32　**Summary**
33　At least one client called either **PMIx_Fence** or **PMIx_Fence_nb**.

```
2          typedef pmix_status_t (*pmix_server_fencenb_fn_t)(
3                                             const pmix_proc_t procs[],
4                                             size_t nprocs,
5                                             const pmix_info_t info[],
6                                             size_t ninfo,
7                                             char *data, size_t ndata,
8                                             pmix_modex_cbfunc_t cbfunc,
9                                             void *cbdata)
```

10   **IN   procs**
11   Array of **pmix_proc_t** structures identifying operation participants(array of handles)
12   **IN   nprocs**
13   Number of elements in the *procs* array (integer)
14   **IN   info**
15   Array of info structures (array of handles)
16   **IN   ninfo**
17   Number of elements in the *info* array (integer)
18   **IN   data**
19   (string)
20   **IN   ndata**
21   (integer)
22   **IN   cbfunc**
23   Callback function **pmix_modex_cbfunc_t** (function reference)
24   **IN   cbdata**
25   Data to be passed to the callback function (memory reference)

26   Returns one of the following:

27   • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
28   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
29   prior to returning from the API.

30   • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
31   returned *success* - the *cbfunc* will not be called

32   • a PMIx error constant indicating either an error in the input or that the request was immediately
33   processed and failed - the *cbfunc* will not be called

1   PMIx libraries are required to pass any provided attributes to the host environment for processing.

2   _____

3   The following attributes are required to be supported by all host environments:

4   **PMIX_COLLECT_DATA** **"pmix.collect"** (**bool**)
5   Collect data and return it at the end of the operation.

▲──▲

6   The following attributes are optional for host environments:

7   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
8   Time in seconds before the specified operation should time out (*0* indicating infinite) in
9   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
10   the target process from ever exposing its data.

11   **PMIX_COLLECTIVE_ALGO** **"pmix.calgo"** (**char***)
12   Comma-delimited list of algorithms to use for the collective operation. PMIx does not
13   impose any requirements on a host environment's collective algorithms. Thus, the
14   acceptable values for this attribute will be environment-dependent - users are encouraged to
15   check their host environment for supported values.

16   **PMIX_COLLECTIVE_ALGO_REQD** **"pmix.calreqd"** (**bool**)
17   If **true**, indicates that the requested choice of algorithm is mandatory.

▲──▲

──────────────── Advice to PMIx server hosts ────────────────

18   Host environment are required to return **PMIX_ERR_NOT_SUPPORTED** if passed an attributed
19   marked as **PMIX_INFO_REQD** that they do not support, even if support for that attribute is
20   optional.

▲──▲

Description

All local clients in the provided array of *procs* called either **PMIx_Fence** or **PMIx_Fence_nb**. In either case, the host server will be called via a non-blocking function to execute the specified operation once all participating local processes have contributed. All processes in the specified *procs* array are required to participate in the **PMIx_Fence**/**PMIx_Fence_nb** operation. The callback is to be executed once every daemon hosting at least one participant has called the host server's **pmix_server_fencenb_fn_t** function.

——————————— Advice to PMIx library implementers ———————————

The PMIx server library is required to aggregate participation by local clients, passing the request to the host environment once all local participants have executed the API.

——————————— Advice to PMIx server hosts ———————————

The host will receive a single call for each collective operation. It is the responsibility of the host to identify the nodes containing participating processes, execute the collective across all participating nodes, and notify the local PMIx server library upon completion of the global collective. Data received from each node must be simply concatenated to form an aggregated unit, as shown in the following example:

——————————————————— C ———————————————————

```c
uint8_t *blob1, *blob2, *total;
size_t sz_blob1, sz_blob2, sz_total;

sz_total = sz_blob1 + sz_blob2;
total = (uint8_t*)malloc(sz_total);
memcpy(total, blob1, sz_blob1);
memcpy(&total[sz_blob1], blob2, sz_blob2);
```

——————————————————— C ———————————————————

Note that the ordering of the data blobs does not matter.

The provided data is to be collectively shared with all PMIx servers involved in the fence operation, and returned in the modex *cbfunc*. A **NULL** data value indicates that the local processes had no data to contribute.

The array of *info* structs is used to pass user-requested options to the server. This can include directives as to the algorithm to be used to execute the fence operation. The directives are optional unless the **PMIX_INFO_REQD** flag has been set - in such cases, the host RM is required to return an error if the directive cannot be met.

11.2.6 `pmix_server_dmodex_req_fn_t`

Summary

Used by the PMIx server to request its local host contact the PMIx server on the remote node that
hosts the specified proc to obtain and return a direct modex blob for that proc.

Format

PMIx v1.0

```
typedef pmix_status_t (*pmix_server_dmodex_req_fn_t)(
                                 const pmix_proc_t *proc,
                                 const pmix_info_t info[],
                                 size_t ninfo,
                                 pmix_modex_cbfunc_t cbfunc,
                                 void *cbdata)
```

IN   proc
    pmix_proc_t structure identifying the process whose data is being requested (handle)
IN   info
    Array of info structures (array of handles)
IN   ninfo
    Number of elements in the *info* array (integer)
IN   cbfunc
    Callback function **pmix_modex_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
  will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
  prior to returning from the API.

- a PMIx error constant indicating either an error in the input or that the request was immediately
  processed and failed - the *cbfunc* will not be called

▼------------------ Required Attributes ------------------▼

PMIx libraries are required to pass any provided attributes to the host environment for processing.

1   The following attributes are optional for host environments that support this operation:

2   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
3   Time in seconds before the specified operation should time out (*0* indicating infinite) in
4   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
5   the target process from ever exposing its data.

▲--▲

6   **Description**
7   Used by the PMIx server to request its local host contact the PMIx server on the remote node that
8   hosts the specified proc to obtain and return any information that process posted via calls to
9   **PMIx_Put** and **PMIx_Commit**.

10   The array of *info* structs is used to pass user-requested options to the server. This can include a
11   timeout to preclude an indefinite wait for data that may never become available. The directives are
12   optional unless the *mandatory* flag has been set - in such cases, the host RM is required to return an
13   error if the directive cannot be met.

14   # 11.2.7   `pmix_server_publish_fn_t`

15   **Summary**
16   Publish data per the PMIx API specification.

17   **Format**
PMIx v1.0   ▼―――――――――――――― C ――――――――――――――▼

18   ```
     typedef pmix_status_t (*pmix_server_publish_fn_t)(
19   const pmix_proc_t *proc,
20   const pmix_info_t info[],
21   size_t ninfo,
22   pmix_op_cbfunc_t cbfunc,
23   void *cbdata)
     ```
     ▲―――――――――――――― C ――――――――――――――▲

24   **IN    proc**
25       **pmix_proc_t** structure of the process publishing the data (handle)
26   **IN    info**
27       Array of info structures (array of handles)
28   **IN    ninfo**
29       Number of elements in the *info* array (integer)
30   **IN    cbfunc**
31       Callback function **pmix_op_cbfunc_t** (function reference)

**IN**   **cbdata**
      Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼------------------ Required Attributes ------------------▼

PMIx libraries are required to pass any provided attributes to the host environment for processing. In addition, the following attributes are required to be included in the passed *info* array:

**PMIX_USERID "pmix.euid"** (**uint32_t**)
    Effective user id.

**PMIX_GRPID "pmix.egid"** (**uint32_t**)
    Effective group id.

Host environments that implement this entry point are required to support the following attributes:

**PMIX_RANGE "pmix.range"** (**pmix_data_range_t**)
    Value for calls to publish/lookup/unpublish or for monitoring event notifications.

**PMIX_PERSISTENCE "pmix.persist"** (**pmix_persistence_t**)
    Value for calls to **PMIx_Publish**.

▲------------------------------------------------------------------▲

▼------------------ Optional Attributes ------------------▼

The following attributes are optional for host environments that support this operation:

**PMIX_TIMEOUT "pmix.timeout"** (**int**)
    Time in seconds before the specified operation should time out (*0* indicating infinite) in error. The timeout parameter can help avoid "hangs" due to programming errors that prevent the target process from ever exposing its data.

▲------------------------------------------------------------------▲

**Description**

Publish data per the **PMIx_Publish** specification. The callback is to be executed upon completion of the operation. The default data range is left to the host environment, but expected to be **PMIX_RANGE_SESSION**, and the default persistence **PMIX_PERSIST_SESSION** or their equivalent. These values can be specified by including the respective attributed in the *info* array.

The persistence indicates how long the server should retain the data.

———————————— Advice to PMIx server hosts ————————————

The host environment is not required to guarantee support for any specific range - i.e., the environment does not need to return an error if the data store doesn't support a specified range so long as it is covered by some internally defined range. However, the server must return an error (a) if the key is duplicative within the storage range, and (b) if the server does not allow overwriting of published info by the original publisher - it is left to the discretion of the host environment to allow info-key-based flags to modify this behavior.

The **PMIX_USERID** and **PMIX_GRPID** of the publishing process will be provided to support authorization-based access to published information and must be returned on any subsequent lookup request.

## 11.2.8 `pmix_server_lookup_fn_t`

**Summary**

Lookup published data.

**Format**

*PMIx v1.0*

———————————————————— C ————————————————————

```
typedef pmix_status_t (*pmix_server_lookup_fn_t)(
                                const pmix_proc_t *proc,
                                char **keys,
                                const pmix_info_t info[],
                                size_t ninfo,
                                pmix_lookup_cbfunc_t cbfunc,
                                void *cbdata)
```

1   **IN**   `proc`
2   **`pmix_proc_t`** structure of the process seeking the data (handle)
3   **IN**   `keys`
4   (array of strings)
5   **IN**   `info`
6   Array of info structures (array of handles)
7   **IN**   `ninfo`
8   Number of elements in the *info* array (integer)
9   **IN**   `cbfunc`
10   Callback function **`pmix_lookup_cbfunc_t`** (function reference)
11   **IN**   `cbdata`
12   Data to be passed to the callback function (memory reference)

13 Returns one of the following:

14 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
15   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
16   prior to returning from the API.

17 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
18   returned *success* - the *cbfunc* will not be called

19 • a PMIx error constant indicating either an error in the input or that the request was immediately
20   processed and failed - the *cbfunc* will not be called

▼----------------- Required Attributes -----------------▼

21 PMIx libraries are required to pass any provided attributes to the host environment for processing.
22 In addition, the following attributes are required to be included in the passed *info* array:

23 **PMIX_USERID** `"pmix.euid"` (`uint32_t`)
24   Effective user id.

25 **PMIX_GRPID** `"pmix.egid"` (`uint32_t`)
26   Effective group id.

27 ———————————————————————————————————————

28 Host environments that implement this entry point are required to support the following attributes:

29 **PMIX_RANGE** `"pmix.range"` (`pmix_data_range_t`)
30   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

31 **PMIX_WAIT** `"pmix.wait"` (`int`)
32   Caller requests that the PMIx server wait until at least the specified number of values are
33   found (*0* indicates all and is the default).
▲---▲

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
    Time in seconds before the specified operation should time out (*0* indicating infinite) in
    error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
    the target process from ever exposing its data.

Description

Lookup published data. The host server will be passed a **NULL**-terminated array of string keys
identifying the data being requested.

The array of *info* structs is used to pass user-requested options to the server. The default data range
is left to the host environment, but expected to be **PMIX_RANGE_SESSION**. This can include a
wait flag to indicate that the server should wait for all data to become available before executing the
callback function, or should immediately callback with whatever data is available. In addition, a
timeout can be specified on the wait to preclude an indefinite wait for data that may never be
published.

──────────────── Advice to PMIx server hosts ────────────────

The **PMIX_USERID** and **PMIX_GRPID** of the requesting process will be provided to support
authorization-based access to published information. The host environment is not required to
guarantee support for any specific range - i.e., the environment does not need to return an error if
the data store doesn't support a specified range so long as it is covered by some internally defined
range.

11.2.9 `pmix_server_unpublish_fn_t`

Summary
Delete data from the data store.

Format

```
typedef pmix_status_t (*pmix_server_unpublish_fn_t)(
                                   const pmix_proc_t *proc,
                                   char **keys,
                                   const pmix_info_t info[],
                                   size_t ninfo,
                                   pmix_op_cbfunc_t cbfunc,
                                   void *cbdata)
```

IN   proc
        pmix_proc_t structure identifying the process making the request (handle)
IN   keys
        (array of strings)
IN   info
        Array of info structures (array of handles)
IN   ninfo
        Number of elements in the *info* array (integer)
IN   cbfunc
        Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
        Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼------------------ Required Attributes ------------------▼

PMIx libraries are required to pass any provided attributes to the host environment for processing. In addition, the following attributes are required to be included in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
        Effective user id.

PMIX_GRPID "pmix.egid" (**uint32_t**)
        Effective group id.

Host environments that implement this entry point are required to support the following attributes:

PMIX_RANGE **"pmix.range"** (**pmix_data_range_t**)
    Value for calls to publish/lookup/unpublish or for monitoring event notifications.

▲--▲

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
    Time in seconds before the specified operation should time out (*0* indicating infinite) in
    error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
    the target process from ever exposing its data.

▲--▲

Description
Delete data from the data store. The host server will be passed a **NULL**-terminated array of string
keys, plus potential directives such as the data range within which the keys should be deleted. The
default data range is left to the host environment, but expected to be **PMIX_RANGE_SESSION**.
The callback is to be executed upon completion of the delete procedure.

———————— Advice to PMIx server hosts ————————

The **PMIX_USERID** and **PMIX_GRPID** of the requesting process will be provided to support
authorization-based access to published information. The host environment is not required to
guarantee support for any specific range - i.e., the environment does not need to return an error if
the data store doesn't support a specified range so long as it is covered by some internally defined
range.

11.2.10 **pmix_server_spawn_fn_t**

Summary
Spawn a set of applications/processes as per the **PMIx_Spawn** API.

Format

───────────────────── C ─────────────────────

```
typedef pmix_status_t (*pmix_server_spawn_fn_t)(
                                    const pmix_proc_t *proc,
                                    const pmix_info_t job_info[],
                                    size_t ninfo,
                                    const pmix_app_t apps[],
                                    size_t napps,
                                    pmix_spawn_cbfunc_t cbfunc,
                                    void *cbdata)
```

───────────────────── C ─────────────────────

IN   **proc**
  pmix_proc_t structure of the process making the request (handle)
IN   **job_info**
  Array of info structures (array of handles)
IN   **ninfo**
  Number of elements in the *jobinfo* array (integer)
IN   **apps**
  Array of **pmix_app_t** structures (array of handles)
IN   **napps**
  Number of elements in the *apps* array (integer)
IN   **cbfunc**
  Callback function **pmix_spawn_cbfunc_t** (function reference)
IN   **cbdata**
  Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼------------------   Required Attributes   ------------------▼

PMIx libraries are required to pass any provided attributes to the host environment for processing. In addition, the following attributes are required to be included in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
    Effective user id.

1 **PMIX_GRPID** **"pmix.egid"** (**uint32_t**)
2   Effective group id.

3 _____

4 Host environments that provide this module entry point are required to pass the **PMIX_SPAWNED**
5 and **PMIX_PARENT_ID** attributes to all PMIx servers launching new child processes so those
6 values can be returned to clients upon connection to the PMIx server. In addition, they are required
7 to support the following attributes when present in either the *job_info* or the *info* array of an
8 element of the *apps* array:

9 **PMIX_WDIR** **"pmix.wdir"** (**char***)
10   Working directory for spawned processes.

11 **PMIX_SET_SESSION_CWD** **"pmix.ssncwd"** (**bool**)
12   Set the application's current working directory to the session working directory assigned by
13   the RM - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the
14   rank to discover the session working directory assigned to the provided namespace

15 **PMIX_PREFIX** **"pmix.prefix"** (**char***)
16   Prefix to use for starting spawned processes.

17 **PMIX_HOST** **"pmix.host"** (**char***)
18   Comma-delimited list of hosts to use for spawned processes.

19 **PMIX_HOSTFILE** **"pmix.hostfile"** (**char***)
20   Hostfile to use for spawned processes.
   ▲--▲

   ▼------------------ Optional Attributes ------------------▼

21 The following attributes are optional for host environments that support this operation:

22 **PMIX_ADD_HOSTFILE** **"pmix.addhostfile"** (**char***)
23   Hostfile listing hosts to add to existing allocation.

24 **PMIX_ADD_HOST** **"pmix.addhost"** (**char***)
25   Comma-delimited list of hosts to add to the allocation.

26 **PMIX_PRELOAD_BIN** **"pmix.preloadbin"** (**bool**)
27   Preload binaries onto nodes.

28 **PMIX_PRELOAD_FILES** **"pmix.preloadfiles"** (**char***)
29   Comma-delimited list of files to pre-position on nodes.

30 **PMIX_PERSONALITY** **"pmix.pers"** (**char***)
31   Name of personality to use.

32 **PMIX_MAPPER** **"pmix.mapper"** (**char***)

Mapping mechanism to use for placing spawned processes - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping mechanism used for the provided namespace.

PMIX_DISPLAY_MAP "pmix.dispmap" (bool)
Display process mapping upon spawn.

PMIX_PPR "pmix.ppr" (char*)
Number of processes to spawn on each identified resource.

PMIX_MAPBY "pmix.mapby" (char*)
Process mapping policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the mapping policy used for the provided namespace

PMIX_RANKBY "pmix.rankby" (char*)
Process ranking policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the ranking algorithm used for the provided namespace

PMIX_BINDTO "pmix.bindto" (char*)
Process binding policy - when accessed using **PMIx_Get**, use the **PMIX_RANK_WILDCARD** value for the rank to discover the binding policy used for the provided namespace

PMIX_NON_PMI "pmix.nonpmi" (bool)
Spawned processes will not call **PMIx_Init**.

PMIX_STDIN_TGT "pmix.stdin" (uint32_t)
Spawned process rank that is to receive **stdin**.

PMIX_FWD_STDIN "pmix.fwd.stdin" (bool)
Forward this process's **stdin** to the designated process.

PMIX_FWD_STDOUT "pmix.fwd.stdout" (bool)
Forward **stdout** from spawned processes to this process.

PMIX_FWD_STDERR "pmix.fwd.stderr" (bool)
Forward **stderr** from spawned processes to this process.

PMIX_DEBUGGER_DAEMONS "pmix.debugger" (bool)
Spawned application consists of debugger daemons.

PMIX_TAG_OUTPUT "pmix.tagout" (bool)
Tag application output with the identity of the source process.

PMIX_TIMESTAMP_OUTPUT "pmix.tsout" (bool)
Timestamp output from applications.

PMIX_MERGE_STDERR_STDOUT "pmix.mergeerrout" (bool)

1   Merge **stdout** and **stderr** streams from application processes.

2   **PMIX_OUTPUT_TO_FILE** **"pmix.outfile"** (**char***)
3   Output application output to the specified file.

4   **PMIX_INDEX_ARGV** **"pmix.indxargv"** (**bool**)
5   Mark the **argv** with the rank of the process.

6   **PMIX_CPUS_PER_PROC** **"pmix.cpuperproc"** (**uint32_t**)
7   Number of cpus to assign to each rank - when accessed using **PMIx_Get**, use the
8   **PMIX_RANK_WILDCARD** value for the rank to discover the cpus/process assigned to the
9   provided namespace

10   **PMIX_NO_PROCS_ON_HEAD** **"pmix.nolocal"** (**bool**)
11   Do not place processes on the head node.

12   **PMIX_NO_OVERSUBSCRIBE** **"pmix.noover"** (**bool**)
13   Do not oversubscribe the cpus.

14   **PMIX_REPORT_BINDINGS** **"pmix.repbind"** (**bool**)
15   Report bindings of the individual processes.

16   **PMIX_CPU_LIST** **"pmix.cpulist"** (**char***)
17   List of cpus to use for this job - when accessed using **PMIx_Get**, use the
18   **PMIX_RANK_WILDCARD** value for the rank to discover the cpu list used for the provided
19   namespace

20   **PMIX_JOB_RECOVERABLE** **"pmix.recover"** (**bool**)
21   Application supports recoverable operations.

22   **PMIX_JOB_CONTINUOUS** **"pmix.continuous"** (**bool**)
23   Application is continuous, all failed processes should be immediately restarted.

24   **PMIX_MAX_RESTARTS** **"pmix.maxrestarts"** (**uint32_t**)
25   Maximum number of times to restart a job - when accessed using **PMIx_Get**, use the
26   **PMIX_RANK_WILDCARD** value for the rank to discover the max restarts for the provided
27   namespace

28   **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
29   Time in seconds before the specified operation should time out (*0* indicating infinite) in
30   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
31   the target process from ever exposing its data.
        ▲---▲

Description

Spawn a set of applications/processes as per the **PMIx_Spawn** API. Note that applications are not required to be MPI or any other programming model. Thus, the host server cannot make any assumptions as to their required support. The callback function is to be executed once all processes have been started. An error in starting any application or process in this request shall cause all applications and processes in the request to be terminated, and an error returned to the originating caller.

Note that a timeout can be specified in the job_info array to indicate that failure to start the requested job within the given time should result in termination to avoid hangs.

11.2.11 `pmix_server_connect_fn_t`

Summary

Record the specified processes as *connected*.

Format

PMIx v1.0

```
typedef pmix_status_t (*pmix_server_connect_fn_t)(
                                const pmix_proc_t procs[],
                                size_t nprocs,
                                const pmix_info_t info[],
                                size_t ninfo,
                                pmix_op_cbfunc_t cbfunc,
                                void *cbdata)
```

IN   **procs**
    Array of **pmix_proc_t** structures identifying participants (array of handles)
IN   **nprocs**
    Number of elements in the *procs* array (integer)
IN   **info**
    Array of info structures (array of handles)
IN   **ninfo**
    Number of elements in the *info* array (integer)
IN   **cbfunc**
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   **cbdata**
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

PMIx libraries are required to pass any provided attributes to the host environment for processing.

The following attributes are optional for host environments that support this operation:

PMIX_TIMEOUT **"pmix.timeout"** (**int**)
> Time in seconds before the specified operation should time out (*0* indicating infinite) in error. The timeout parameter can help avoid "hangs" due to programming errors that prevent the target process from ever exposing its data.

PMIX_COLLECTIVE_ALGO **"pmix.calgo"** (**char***)
> Comma-delimited list of algorithms to use for the collective operation. PMIx does not impose any requirements on a host environment's collective algorithms. Thus, the acceptable values for this attribute will be environment-dependent - users are encouraged to check their host environment for supported values.

PMIX_COLLECTIVE_ALGO_REQD **"pmix.calreqd"** (**bool**)
> If **true**, indicates that the requested choice of algorithm is mandatory.

Description

Record the processes specified by the *procs* array as *connected* as per the PMIx definition. The callback is to be executed once every daemon hosting at least one participant has called the host server's **pmix_server_connect_fn_t** function, and the host environment has completed any supporting operations required to meet the terms of the PMIx definition of *connected* processes.

The PMIx server library is required to aggregate participation by local clients, passing the request to the host environment once all local participants have executed the API.

The host will receive a single call for each collective operation. It is the responsibility of the host to identify the nodes containing participating processes, execute the collective across all participating nodes, and notify the local PMIx server library upon completion of the global collective.

11.2.12 `pmix_server_disconnect_fn_t`

Summary

Disconnect a previously connected set of processes.

Format

PMIx v1.0

```
typedef pmix_status_t (*pmix_server_disconnect_fn_t)(
                                    const pmix_proc_t procs[],
                                    size_t nprocs,
                                    const pmix_info_t info[],
                                    size_t ninfo,
                                    pmix_op_cbfunc_t cbfunc,
                                    void *cbdata)
```

IN **procs**
   Array of **pmix_proc_t** structures identifying participants (array of handles)
IN **nprocs**
   Number of elements in the *procs* array (integer)
IN **info**
   Array of info structures (array of handles)
IN **ninfo**
   Number of elements in the *info* array (integer)
IN **cbfunc**
   Callback function **pmix_op_cbfunc_t** (function reference)
IN **cbdata**
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

------------------ Required Attributes ------------------

PMIx libraries are required to pass any provided attributes to the host environment for processing.

1 The following attributes are optional for host environments that support this operation:

2 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
3   Time in seconds before the specified operation should time out (*0* indicating infinite) in
4   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
5   the target process from ever exposing its data.

6 **Description**
7 Disconnect a previously connected set of processes. The callback is to be executed once every
8 daemon hosting at least one participant has called the host server's has called the
9 **pmix_server_disconnect_fn_t** function, and the host environment has completed any
10 required supporting operations.

━━━━━━━━━━━━━━━━ Advice to PMIx library implementers ━━━━━━━━━━━━━━━━

11 The PMIx server library is required to aggregate participation by local clients, passing the request
12 to the host environment once all local participants have executed the API.

━━━━━━━━━━━━━━━━ Advice to PMIx server hosts ━━━━━━━━━━━━━━━━

13 The host will receive a single call for each collective operation. It is the responsibility of the host to
14 identify the nodes containing participating processes, execute the collective across all participating
15 nodes, and notify the local PMIx server library upon completion of the global collective.

16 A **PMIX_ERR_INVALID_OPERATION** error must be returned if the specified set of *procs* was
17 not previously *connected* via a call to the **pmix_server_connect_fn_t** function.

11.2.13 `pmix_server_register_events_fn_t`

19 **Summary**
20 Register to receive notifications for the specified events.

Format

```
                                            C
2   typedef pmix_status_t (*pmix_server_register_events_fn_t)(
3                                    pmix_status_t *codes,
4                                    size_t ncodes,
5                                    const pmix_info_t info[],
6                                    size_t ninfo,
7                                    pmix_op_cbfunc_t cbfunc,
8                                    void *cbdata)
                                            C
```

9 **IN   codes**
10   Array of **pmix_status_t** values (array of handles)
11 **IN   ncodes**
12   Number of elements in the *codes* array (integer)
13 **IN   info**
14   Array of info structures (array of handles)
15 **IN   ninfo**
16   Number of elements in the *info* array (integer)
17 **IN   cbfunc**
18   Callback function **pmix_op_cbfunc_t** (function reference)
19 **IN   cbdata**
20   Data to be passed to the callback function (memory reference)

21 Returns one of the following:

22 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
23   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
24   prior to returning from the API.

25 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
26   returned *success* - the *cbfunc* will not be called

27 • a PMIx error constant indicating either an error in the input or that the request was immediately
28   processed and failed - the *cbfunc* will not be called

▼------------------   Required Attributes   ------------------▼

29 PMIx libraries are required to pass any provided attributes to the host environment for processing.
30 In addition, the following attributes are required to be included in the passed *info* array:

31 **PMIX_USERID "pmix.euid"** (**uint32_t**)
32   Effective user id.

33 **PMIX_GRPID "pmix.egid"** (**uint32_t**)
34   Effective group id.

▲--▲

Description

Register to receive notifications for the specified status codes. The *info* array included in this API is reserved for possible future directives to further steer notification.

———————————————— Advice to PMIx library implementers ————————————————

The PMIx server library must track all client registrations for subsequent notification. This module function shall only be called when:

- the client has requested notification of an environmental code or a code that lies outside the defined PMIx range of constants; and

- the PMIx server library has not previously requested notification of that code - i.e., the host environment is to be contacted only once a given unique code value

———————————————— Advice to PMIx server hosts ————————————————

The host environment is must to pass to its PMIx server library all non-environmental events that directly relate to a registered namespace without the PMIx server library explicitly requesting them. Environmental events are to be translated to their nearest PMIx equivalent code.

11.2.14 `pmix_server_deregister_events_fn_t`

Summary

Deregister to receive notifications for the specified events.

Format

2 ──────────────────────── C ────────────────────────

```
typedef pmix_status_t (*pmix_server_deregister_events_fn_t)(
                                   pmix_status_t *codes,
                                   size_t ncodes,
                                   pmix_op_cbfunc_t cbfunc,
                                   void *cbdata)
```
──────────────────────── C ────────────────────────

IN   codes
    Array of **pmix_status_t** values (array of handles)
IN   ncodes
    Number of elements in the *codes* array (integer)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

Description
Deregister to receive notifications for the specified events to which the PMIx server has previously registered.

──────────── Advice to PMIx library implementers ────────────

The PMIx server library must track all client registrations. This module function shall only be called when:

- the library is deregistering an environmental code or a code that lies outside the defined PMIx range of constants; and

- no client (including the server library itself) remains registered for notifications on any included code - i.e., a code should be included in this call only when no registered notifications against it remain.

1 **11.2.15** `pmix_server_notify_event_fn_t`

2 **Summary**
3 Notify the specified processes of an event.

4 **Format**

PMIx v2.0

—————————————————————— C ——————————————————————

```
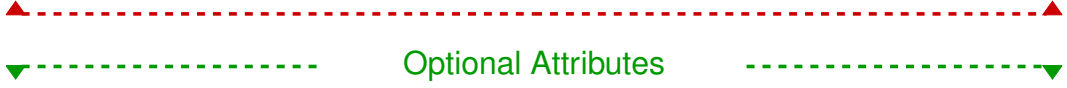5   typedef pmix_status_t (*pmix_server_notify_event_fn_t)(pmix_status_t code,
6                                     const pmix_proc_t *source,
7                                     pmix_data_range_t range,
8                                     pmix_info_t info[],
9                                     size_t ninfo,
10                                    pmix_op_cbfunc_t cbfunc,
11                                    void *cbdata);
```

—————————————————————— C ——————————————————————

12 **IN   code**
13   The **`pmix_status_t`** event code being referenced structure (handle)
14 **IN   source**
15   **`pmix_proc_t`** of process that generated the event (handle)
16 **IN   range**
17   **`pmix_data_range_t`** range over which the event is to be distributed (handle)
18 **IN   info**
19   Optional array of **`pmix_info_t`** structures containing additional information on the event
20   (array of handles)
21 **IN   ninfo**
22   Number of elements in the *info* array (integer)
23 **IN   cbfunc**
24   Callback function **`pmix_op_cbfunc_t`** (function reference)
25 **IN   cbdata**
26   Data to be passed to the callback function (memory reference)

27 Returns one of the following:

28 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
29   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
30   prior to returning from the API.

31 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
32   returned *success* - the *cbfunc* will not be called

33 • a PMIx error constant indicating either an error in the input or that the request was immediately
34   processed and failed - the *cbfunc* will not be called

1   PMIx libraries are required to pass any provided attributes to the host environment for processing.

2

3   Host environments that provide this module entry point are required to support the following
4   attributes:

5   **PMIX_RANGE** **"pmix.range"** (**pmix_data_range_t**)
6   Value for calls to publish/lookup/unpublish or for monitoring event notifications.

7   **Description**
8   Notify the specified processes (described through a combination of *range* and attributes provided in
9   the *info* array) of an event generated either by the PMIx server itself or by one of its local clients.
10   The process generating the event is provided in the *source* parameter, and any further descriptive
11   information is included in the *info* array.

— Advice to PMIx server hosts —

12   The callback function is to be executed once the host environment no longer requires that the PMIx
13   server library maintain the provided data structures. It does not necessarily indicate that the event
14   has been delivered to any process, nor that the event has been distributed for delivery

15   ## 11.2.16 `pmix_server_listener_fn_t`

16   **Summary**
17   Register a socket the host server can monitor for connection requests.

18   **Format**

PMIx v1.0

C

19   ```
     typedef pmix_status_t (*pmix_server_listener_fn_t)(
20   int listening_sd,
21   pmix_connection_cbfunc_t cbfunc,
22   void *cbdata)
     ```

C

23   **IN**   **incoming_sd**
24   (integer)
25   **IN**   **cbfunc**
26   Callback function **pmix_connection_cbfunc_t** (function reference)
27   **IN**   **cbdata**
28   (memory reference)

29   Returns **PMIX_SUCCESS** indicating that the request is accepted, or a negative value corresponding
30   to a PMIx error constant indicating that the request has been rejected.

Description

2 Register a socket the host environment can monitor for connection requests, harvest them, and then
3 call the PMIx server library's internal callback function for further processing. A listener thread is
4 essential to efficiently harvesting connection requests from large numbers of local clients such as
5 occur when running on large SMPs. The host server listener is required to call accept on the
6 incoming connection request, and then pass the resulting socket to the provided cbfunc. A **NULL**
7 for this function will cause the internal PMIx server to spawn its own listener thread.

8 11.2.17 `pmix_server_query_fn_t`

9 **Summary**
10 Query information from the resource manager.

11 **Format**
PMIx v2.0 ───────────────────── C ─────────────────────

```
12 typedef pmix_status_t (*pmix_server_query_fn_t)(
13                                     pmix_proc_t *proct,
14                                     pmix_query_t *queries, size_t nqueries,
15                                     pmix_info_cbfunc_t cbfunc,
16                                     void *cbdata)
```
───────────────────── C ─────────────────────

17 **IN   proct**
18   **pmix_proc_t** structure of the requesting process (handle)
19 **IN   queries**
20   Array of **pmix_query_t** structures (array of handles)
21 **IN   nqueries**
22   Number of elements in the *queries* array (integer)
23 **IN   cbfunc**
24   Callback function **pmix_info_cbfunc_t** (function reference)
25 **IN   cbdata**
26   Data to be passed to the callback function (memory reference)

27 Returns one of the following:

28 • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
29   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
30   prior to returning from the API.

31 • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
32   returned *success* - the *cbfunc* will not be called

33 • a PMIx error constant indicating either an error in the input or that the request was immediately
34   processed and failed - the *cbfunc* will not be called

1   PMIx libraries are required to pass any provided attributes to the host environment for processing.
2   In addition, the following attributes are required to be included in the passed *info* array:

3   **PMIX_USERID** **"pmix.euid"** (**uint32_t**)
4   Effective user id.

5   **PMIX_GRPID** **"pmix.egid"** (**uint32_t**)
6   Effective group id.

7   The following attributes are optional for host environments that support this operation:

8   **PMIX_QUERY_NAMESPACES** **"pmix.qry.ns"** (**char***)
9   Request a comma-delimited list of active namespaces.

10   **PMIX_QUERY_JOB_STATUS** **"pmix.qry.jst"** (**pmix_status_t**)
11   Status of a specified, currently executing job.

12   **PMIX_QUERY_QUEUE_LIST** **"pmix.qry.qlst"** (**char***)
13   Request a comma-delimited list of scheduler queues.

14   **PMIX_QUERY_QUEUE_STATUS** **"pmix.qry.qst"** (**TBD**)
15   Status of a specified scheduler queue.

16   **PMIX_QUERY_PROC_TABLE** **"pmix.qry.ptable"** (**char***)
17   Input namespace of the job whose information is being requested returns
18   (**pmix_data_array_t**) an array of **pmix_proc_info_t**.

19   **PMIX_QUERY_LOCAL_PROC_TABLE** **"pmix.qry.lptable"** (**char***)
20   Input namespace of the job whose information is being requested returns
21   (**pmix_data_array_t**) an array of **pmix_proc_info_t** for processes in job on same
22   node.

23   **PMIX_QUERY_SPAWN_SUPPORT** **"pmix.qry.spawn"** (**bool**)
24   Return a comma-delimited list of supported spawn attributes.

25   **PMIX_QUERY_DEBUG_SUPPORT** **"pmix.qry.debug"** (**bool**)
26   Return a comma-delimited list of supported debug attributes.

27   **PMIX_QUERY_MEMORY_USAGE** **"pmix.qry.mem"** (**bool**)
28   Return information on memory usage for the processes indicated in the qualifiers.

29   **PMIX_QUERY_LOCAL_ONLY** **"pmix.qry.local"** (**bool**)
30   Constrain the query to local information only.

31   **PMIX_QUERY_REPORT_AVG** **"pmix.qry.avg"** (**bool**)
32   Report only average values for sampled information.

PMIX_QUERY_REPORT_MINMAX **"pmix.qry.minmax"** (**bool**)
  Report minimum and maximum values.

PMIX_QUERY_ALLOC_STATUS **"pmix.query.alloc"** (**char***)
  String identifier of the allocation whose status is being requested.

PMIX_TIME_REMAINING **"pmix.time.remaining"** (**char***)
  Query number of seconds (**uint32_t**) remaining in allocation for the specified namespace.

▲---▲

Description

Query information from the host environment. The query will include the namespace/rank of the process that is requesting the info, an array of **pmix_query_t** describing the request, and a callback function/data for the return.

——————————— Advice to PMIx library implementers ———————————

The PMIx server library should not block in this function as the host environment may, depending upon the information being requested, require significant time to respond.

▲

11.2.18 `pmix_server_tool_connection_fn_t`

Summary

Register that a tool has connected to the server.

Format

PMIx v2.0

```
typedef void (*pmix_server_tool_connection_fn_t)(
                                    pmix_info_t info[], size_t ninfo,
                                    pmix_tool_connection_cbfunc_t cbfunc,
                                    void *cbdata)
```

IN info
  Array of **pmix_info_t** structures (array of handles)
IN ninfo
  Number of elements in the *info* array (integer)
IN cbfunc
  Callback function **pmix_tool_connection_cbfunc_t** (function reference)
IN cbdata
  Data to be passed to the callback function (memory reference)

1   PMIx libraries are required to pass the following attributes in the *info* array:

2   **PMIX_USERID** **"pmix.euid"** (**uint32_t**)
3   Effective user id.

4   **PMIX_GRPID** **"pmix.egid"** (**uint32_t**)
5   Effective group id.

------------------ Optional Attributes ------------------

6   The following attributes are optional for host environments that support this operation:

7   **PMIX_FWD_STDOUT** **"pmix.fwd.stdout"** (**bool**)
8   Forward **stdout** from spawned processes to this process.

9   **PMIX_FWD_STDERR** **"pmix.fwd.stderr"** (**bool**)
10   Forward **stderr** from spawned processes to this process.

11   **PMIX_FWD_STDIN** **"pmix.fwd.stdin"** (**bool**)
12   Forward this process's **stdin** to the designated process.

Description
14   Register that a tool has connected to the server, and request that the tool be assigned a
15   namespace/rank identifier for further interactions. The **pmix_info_t** array is used to pass
16   qualifiers for the connection request, including the effective uid and gid of the calling tool for
17   authentication purposes.

————————— Advice to PMIx server hosts —————————

18   The host environment is solely responsible for authenticating and authorizing the connection, and
19   for authorizing all subsequent tool requests. The host must not execute the callback function prior
20   to returning from the API.

21   ## 11.2.19 `pmix_server_log_fn_t`

Summary
23   Log data on behalf of a client.

```
2       typedef void (*pmix_server_log_fn_t)(
3                                        const pmix_proc_t *client,
4                                        const pmix_info_t data[], size_t ndata,
5                                        const pmix_info_t directives[], size_t ndirs,
6                                        pmix_op_cbfunc_t cbfunc, void *cbdata)
```

                                              C

7   **IN   client**
8   **pmix_proc_t** structure (handle)
9   **IN   data**
10   Array of info structures (array of handles)
11   **IN   ndata**
12   Number of elements in the *data* array (integer)
13   **IN   directives**
14   Array of info structures (array of handles)
15   **IN   ndirs**
16   Number of elements in the *directives* array (integer)
17   **IN   cbfunc**
18   Callback function **pmix_op_cbfunc_t** (function reference)
19   **IN   cbdata**
20   Data to be passed to the callback function (memory reference)

▼------------------   Required Attributes   ------------------▼

21   PMIx libraries are required to pass any provided attributes to the host environment for processing.
22   In addition, the following attributes are required to be included in the passed *info* array:

23   **PMIX_USERID   "pmix.euid"** (**uint32_t**)
24   Effective user id.

25   **PMIX_GRPID   "pmix.egid"** (**uint32_t**)
26   Effective group id.

27   ──

28   Host environments that provide this module entry point are required to support the following
29   attributes:

30   **PMIX_LOG_STDERR   "pmix.log.stderr"** (**char***)
31   Log string to **stderr**.

32   **PMIX_LOG_STDOUT   "pmix.log.stdout"** (**char***)
33   Log string to **stdout**.

34   **PMIX_LOG_SYSLOG   "pmix.log.syslog"** (**char***)

1   Log data to syslog. Defaults to **ERROR** priority. Will log to global syslog if available,
2   otherwise to local syslog

▲--▲

▼------------------   Optional Attributes   ------------------▼

3 The following attributes are optional for host environments that support this operation:

4 **PMIX_LOG_MSG "pmix.log.msg"** (**pmix_byte_object_t**)
5   Message blob to be sent somewhere.

6 **PMIX_LOG_EMAIL "pmix.log.email"** (**pmix_data_array_t**)
7   Log via email based on **pmix_info_t** containing directives.

8 **PMIX_LOG_EMAIL_ADDR "pmix.log.emaddr"** (**char***)
9   Comma-delimited list of email addresses that are to receive the message.

10 **PMIX_LOG_EMAIL_SUBJECT "pmix.log.emsub"** (**char***)
11   Subject line for email.

12 **PMIX_LOG_EMAIL_MSG "pmix.log.emmsg"** (**char***)
13   Message to be included in email.

▲--▲

Description
15 Log data on behalf of a client. This function is not intended for output of computational results, but
16 rather for reporting status and error messages. The host must not execute the callback function prior
17 to returning from the API.

11.2.20 **pmix_server_alloc_fn_t**

Summary
20 Request allocation operations on behalf of a client.

Format

```
typedef pmix_status_t (*pmix_server_alloc_fn_t)(
                                 const pmix_proc_t *client,
                                 pmix_alloc_directive_t directive,
                                 const pmix_info_t data[], size_t ndata,
                                 pmix_info_cbfunc_t cbfunc, void *cbdata)
```

IN   **client**
    pmix_proc_t structure of process making request (handle)
IN   **directive**
    Specific action being requested (**pmix_alloc_directive_t**)
IN   **data**
    Array of info structures (array of handles)
IN   **ndata**
    Number of elements in the *data* array (integer)
IN   **cbfunc**
    Callback function **pmix_info_cbfunc_t** (function reference)
IN   **cbdata**
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

----------------- Required Attributes -----------------

PMIx libraries are required to pass any provided attributes to the host environment for processing. In addition, the following attributes are required to be included in the passed *info* array:

PMIX_USERID **"pmix.euid"** (**uint32_t**)
    Effective user id.

PMIX_GRPID **"pmix.egid"** (**uint32_t**)
    Effective group id.

Host environments that provide this module entry point are required to support the following attributes:

PMIX_ALLOC_ID **"pmix.alloc.id"** (**char***)
    A string identifier (provided by the host environment) for the resulting allocation which can later be used to reference the allocated resources in, for example, a call to **PMIx_Spawn**.

PMIX_ALLOC_NUM_NODES **"pmix.alloc.nnodes"** (**uint64_t**)
    The number of nodes.

PMIX_ALLOC_NUM_CPUS **"pmix.alloc.ncpus"** (**uint64_t**)
    Number of cpus.

PMIX_ALLOC_TIME **"pmix.alloc.time"** (**uint32_t**)
    Time in seconds.

▲--▲

▼----------------- Optional Attributes -----------------▼

The following attributes are optional for host environments that support this operation:

PMIX_ALLOC_NODE_LIST **"pmix.alloc.nlist"** (**char***)
    Regular expression of the specific nodes.

PMIX_ALLOC_NUM_CPU_LIST **"pmix.alloc.ncpulist"** (**char***)
    Regular expression of the number of cpus for each node.

PMIX_ALLOC_CPU_LIST **"pmix.alloc.cpulist"** (**char***)
    Regular expression of the specific cpus indicating the cpus involved.

PMIX_ALLOC_MEM_SIZE **"pmix.alloc.msize"** (**float**)
    Number of Megabytes.

PMIX_ALLOC_NETWORK **"pmix.alloc.net"** (**array**)
    Array of **pmix_info_t** describing requested network resources. This must include at least: **PMIX_ALLOC_NETWORK_ID**, **PMIX_ALLOC_NETWORK_TYPE**, and **PMIX_ALLOC_NETWORK_ENDPTS**, plus whatever other descriptors are desired.

PMIX_ALLOC_NETWORK_ID **"pmix.alloc.netid"** (**char***)
    The key to be used when accessing this requested network allocation. The allocation will be returned/stored as a **pmix_data_array_t** of **pmix_info_t** indexed by this key and containing at least one entry with the same key and the allocated resource description. The type of the included value depends upon the network support. For example, a TCP allocation might consist of a comma-delimited string of socket ranges such as *"32000-32100,33005,38123-38146"*. Additional entries will consist of any provided resource request directives, along with their assigned values. Examples include:
    PMIX_ALLOC_NETWORK_TYPE - the type of resources provided;
    PMIX_ALLOC_NETWORK_PLANE - if applicable, what plane the resources were assigned

1 from; **PMIX_ALLOC_NETWORK_QOS** - the assigned QoS; **PMIX_ALLOC_BANDWIDTH** -
2 the allocated bandwidth; **PMIX_ALLOC_NETWORK_SEC_KEY** - a security key for the
3 requested network allocation. NOTE: the assigned values may differ from those requested,
4 especially if **PMIX_INFO_REQD** was not set in the request.

5 **PMIX_ALLOC_BANDWIDTH** **"pmix.alloc.bw"** (**float**)
6   Mbits/sec.

7 **PMIX_ALLOC_NETWORK_QOS** **"pmix.alloc.netqos"** (**char***)
8   Quality of service level.

▲ - ▲

9 **Description**
10 Request new allocation or modifications to an existing allocation on behalf of a client. Several
11 broad categories are envisioned, including the ability to:

12 • Request allocation of additional resources, including memory, bandwidth, and compute for an
13   existing allocation. Any additional allocated resources will be considered as part of the current
14   allocation, and thus will be released at the same time.
15 • Request a new allocation of resources. Note that the new allocation will be disjoint from (i.e., not
16   affiliated with) the allocation of the requestor - thus the termination of one allocation will not
17   impact the other.
18 • Extend the reservation on currently allocated resources, subject to scheduling availability and
19   priorities.
20 • Return no-longer-required resources to the scheduler. This includes the *loan* of resources back to
21   the scheduler with a promise to return them upon subsequent request.

22 The callback function provides a *status* to indicate whether or not the request was granted, and to
23 provide some information as to the reason for any denial in the **pmix_info_cbfunc_t** array of
24 **pmix_info_t** structures.

11.2.21 `pmix_server_job_control_fn_t`

26 **Summary**
27 Execute a job control action on behalf of a client.

Format

```
typedef pmix_status_t (*pmix_server_job_control_fn_t)(
                                const pmix_proc_t *requestor,
                                const pmix_proc_t targets[], size_t ntargets,
                                const pmix_info_t directives[], size_t ndirs,
                                pmix_info_cbfunc_t cbfunc, void *cbdata)
```

IN   requestor
    pmix_proc_t structure of requesting process (handle)
IN   targets
    Array of proc structures (array of handles)
IN   ntargets
    Number of elements in the *targets* array (integer)
IN   directives
    Array of info structures (array of handles)
IN   ndirs
    Number of elements in the *info* array (integer)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼------------------ Required Attributes ------------------▼

PMIx libraries are required to pass any attributes provided by the client to the host environment for processing. In addition, the following attributes are required to be included in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
    Effective user id.

PMIX_GRPID "pmix.egid" (**uint32_t**)
    Effective group id.

2 Host environments that provide this module entry point are required to support the following
3 attributes:

4 **PMIX_JOB_CTRL_ID** **"pmix.jctrl.id"** (**char***)
5   Provide a string identifier for this request.

6 **PMIX_JOB_CTRL_PAUSE** **"pmix.jctrl.pause"** (**bool**)
7   Pause the specified processes.

8 **PMIX_JOB_CTRL_RESUME** **"pmix.jctrl.resume"** (**bool**)
9   Resume ("un-pause") the specified processes.

10 **PMIX_JOB_CTRL_KILL** **"pmix.jctrl.kill"** (**bool**)
11   Forcibly terminate the specified processes and cleanup.

12 **PMIX_JOB_CTRL_SIGNAL** **"pmix.jctrl.sig"** (**int**)
13   Send given signal to specified processes.

14 **PMIX_JOB_CTRL_TERMINATE** **"pmix.jctrl.term"** (**bool**)
15   Politely terminate the specified processes.

▲--▲

▼----------------- Optional Attributes -----------------▼

16 The following attributes are optional for host environments that support this operation:

17 **PMIX_JOB_CTRL_CANCEL** **"pmix.jctrl.cancel"** (**char***)
18   Cancel the specified request (**NULL** implies cancel all requests from this requestor).

19 **PMIX_JOB_CTRL_RESTART** **"pmix.jctrl.restart"** (**char***)
20   Restart the specified processes using the given checkpoint ID.

21 **PMIX_JOB_CTRL_CHECKPOINT** **"pmix.jctrl.ckpt"** (**char***)
22   Checkpoint the specified processes and assign the given ID to it.

23 **PMIX_JOB_CTRL_CHECKPOINT_EVENT** **"pmix.jctrl.ckptev"** (**bool**)
24   Use event notification to trigger a process checkpoint.

25 **PMIX_JOB_CTRL_CHECKPOINT_SIGNAL** **"pmix.jctrl.ckptsig"** (**int**)
26   Use the given signal to trigger a process checkpoint.

27 **PMIX_JOB_CTRL_CHECKPOINT_TIMEOUT** **"pmix.jctrl.ckptsig"** (**int**)
28   Time in seconds to wait for a checkpoint to complete.

29 **PMIX_JOB_CTRL_CHECKPOINT_METHOD**
30 **"pmix.jctrl.ckmethod"** (**pmix_data_array_t**)
31   Array of **pmix_info_t** declaring each method and value supported by this application.

32 **PMIX_JOB_CTRL_PROVISION** **"pmix.jctrl.pvn"** (**char***)

1	Regular expression identifying nodes that are to be provisioned.
2	**PMIX_JOB_CTRL_PROVISION_IMAGE "pmix.jctrl.pvnimg"** (**char***)
3	Name of the image that is to be provisioned.
4	**PMIX_JOB_CTRL_PREEMPTIBLE "pmix.jctrl.preempt"** (**bool**)
5	Indicate that the job can be pre-empted.

▲--▲

Description

7 Execute a job control action on behalf of a client. The *targets* array identifies the processes to
8 which the requested job control action is to be applied. A **NULL** value can be used to indicate all
9 processes in the caller's namespace. The use of **PMIX_RANK_WILDCARD** can also be used to
10 indicate that all processes in the given namespace are to be included.

11 The directives are provided as **pmix_info_t** structures in the *directives* array. The callback
12 function provides a *status* to indicate whether or not the request was granted, and to provide some
13 information as to the reason for any denial in the **pmix_info_cbfunc_t** array of
14 **pmix_info_t** structures.

11.2.22 **pmix_server_monitor_fn_t**

Summary
17 Request that a client be monitored for activity.

Format

PMIx v2.0

— C —

```
typedef pmix_status_t (*pmix_server_monitor_fn_t)(
                              const pmix_proc_t *requestor,
                              const pmix_info_t *monitor, pmix_status_t error
                              const pmix_info_t directives[], size_t ndirs,
                              pmix_info_cbfunc_t cbfunc, void *cbdata);
```

— C —

24 **IN   requestor**
25   **pmix_proc_t** structure of requesting process (handle)
26 **IN   monitor**
27   **pmix_info_t** identifying the type of monitor being requested (handle)
28 **IN   error**
29   Status code to use in generating event if alarm triggers (integer)
30 **IN   directives**
31   Array of info structures (array of handles)
32 **IN   ndirs**
33   Number of elements in the *info* array (integer)

1   **IN   cbfunc**
2   Callback function **pmix_op_cbfunc_t** (function reference)
3   **IN   cbdata**
4   Data to be passed to the callback function (memory reference)

5   Returns one of the following:

6   • **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result
7   will be returned in the provided *cbfunc*. Note that the host must not invoke the callback function
8   prior to returning from the API.

9   • **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and
10   returned *success* - the *cbfunc* will not be called

11   • a PMIx error constant indicating either an error in the input or that the request was immediately
12   processed and failed - the *cbfunc* will not be called

13   This entry point is only called for monitoring requests that are not directly supported by the PMIx
14   server library itself.

▼----------------- Required Attributes   -------------------▼

15   If supported by the PMIx server library, then the library must not pass any supported attributes to
16   the host environment. Any attributes provided by the client that are not directly supported by the
17   server library must be passed to the host environment if it provides this module entry. In addition,
18   the following attributes are required to be included in the passed *info* array:

19   **PMIX_USERID "pmix.euid"** (**uint32_t**)
20   Effective user id.

21   **PMIX_GRPID "pmix.egid"** (**uint32_t**)
22   Effective group id.

23   _____

24   Host environments are not required to support any specific monitoring attributes.
     ▲---▲

     ▼----------------- Optional Attributes   -------------------▼

25   The following attributes may be implemented by a host environment.

26   **PMIX_MONITOR_ID "pmix.monitor.id"** (**char***)
27   Provide a string identifier for this request.

28   **PMIX_MONITOR_CANCEL "pmix.monitor.cancel"** (**char***)
29   Identifier to be canceled (**NULL** means cancel all monitoring for this process).

30   **PMIX_MONITOR_APP_CONTROL "pmix.monitor.appctrl"** (**bool**)
31   The application desires to control the response to a monitoring event.

32   **PMIX_MONITOR_HEARTBEAT "pmix.monitor.mbeat"** (**void**)

Register to have the PMIx server monitor the requestor for heartbeats.

PMIX_MONITOR_HEARTBEAT_TIME **"pmix.monitor.btime"** (**uint32_t**)
Time in seconds before declaring heartbeat missed.

PMIX_MONITOR_HEARTBEAT_DROPS **"pmix.monitor.bdrop"** (**uint32_t**)
Number of heartbeats that can be missed before generating the event.

PMIX_MONITOR_FILE **"pmix.monitor.fmon"** (**char***)
Register to monitor file for signs of life.

PMIX_MONITOR_FILE_SIZE **"pmix.monitor.fsize"** (**bool**)
Monitor size of given file is growing to determine if the application is running.

PMIX_MONITOR_FILE_ACCESS **"pmix.monitor.faccess"** (**char***)
Monitor time since last access of given file to determine if the application is running.

PMIX_MONITOR_FILE_MODIFY **"pmix.monitor.fmod"** (**char***)
Monitor time since last modified of given file to determine if the application is running.

PMIX_MONITOR_FILE_CHECK_TIME **"pmix.monitor.ftime"** (**uint32_t**)
Time in seconds between checking the file.

PMIX_MONITOR_FILE_DROPS **"pmix.monitor.fdrop"** (**uint32_t**)
Number of file checks that can be missed before generating the event.

Description
Request that a client be monitored for activity.

— Advice to PMIx server hosts —

If this module entry is provided and called by the PMIx server library, then the host environment must either provide the requested services or return **PMIX_ERR_NOT_SUPPORTED** to the provided *cbfunc*.

11.2.23 `pmix_server_get_cred_fn_t`

Summary
Request a credential from the host environment

Format

```
typedef pmix_status_t (*pmix_server_get_cred_fn_t)(
                                    const pmix_proc_t *proc,
                                    const pmix_info_t directives[],
                                    size_t ndirs,
                                    pmix_credential_cbfunc_t cbfunc,
                                    void *cbdata);
```

IN   proc
> **pmix_proc_t** structure of requesting process (handle)

IN   directives
> Array of info structures (array of handles)

IN   ndirs
> Number of elements in the *info* array (integer)

IN   cbfunc
> Callback function to return the credential (**pmix_credential_cbfunc_t** function reference)

IN   cbdata
> Data to be passed to the callback function (memory reference)

Returns **PMIX_SUCCESS** or a negative value corresponding to a PMIx error constant. In the event the function returns an error, the *cbfunc* will not be called.

▼------------------ Required Attributes ------------------▼

If the PMIx library does not itself provide the requested credential, then it is required to pass any attributes provided by the client to the host environment for processing. In addition, it must include the following attributes in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
> Effective user id.

PMIX_GRPID "pmix.egid" (**uint32_t**)
> Effective group id.

▲--▲

1 The following attributes are optional for host environments that support this operation:

2 **PMIX_CRED_TYPE** **"pmix.sec.ctype"** (**char***)
3   When passed in **PMIx_Get_credential**, a prioritized, comma-delimited list of desired
4   credential types for use in environments where multiple authentication mechanisms may be
5   available. When returned in a callback function, a string identifier of the credential type.

6 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
7   Time in seconds before the specified operation should time out (*0* indicating infinite) in
8   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
9   the target process from ever exposing its data.

---------------- Advice to PMIx library implementers ----------------

10 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
11 environment due to race condition considerations between completion of the operation versus
12 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
13 directly in the PMIx server library must take care to resolve the race condition and should avoid
14 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
15 created.

16 **Description**
17 Request a credential from the host environment

---------------- Advice to PMIx server hosts ----------------

18 If this module entry is provided and called by the PMIx server library, then the host environment
19 must either provide the requested credential in the callback function or immediately return an error
20 to the caller.

11.2.24   `pmix_server_validate_cred_fn_t`

22 **Summary**
23 Request validation of a credential

Format

```
                                                    C
typedef pmix_status_t (*pmix_server_validate_cred_fn_t)(
                                    const pmix_proc_t *proc,
                                    const pmix_byte_object_t *cred,
                                    const pmix_info_t directives[],
                                    size_t ndirs,
                                    pmix_validation_cbfunc_t cbfunc,
                                    void *cbdata);
                                                    C
```

IN **proc**
   pmix_proc_t structure of requesting process (handle)
IN **cred**
   Pointer to **pmix_byte_object_t** containing the credential (handle)
IN **directives**
   Array of info structures (array of handles)
IN **ndirs**
   Number of elements in the *info* array (integer)
IN **cbfunc**
   Callback function to return the result (**pmix_validation_cbfunc_t** function reference)
IN **cbdata**
   Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼----------------- Required Attributes -----------------▼

If the PMIx library does not itself validate the credential, then it is required to pass any attributes provided by the client to the host environment for processing. In addition, it must include the following attributes in the passed *info* array:

PMIX_USERID **"pmix.euid"** (**uint32_t**)
   Effective user id.

PMIX_GRPID **"pmix.egid"** (**uint32_t**)
   Effective group id.

1

2 Host environments are not required to support any specific attributes.

▲--▲

▼----------------- Optional Attributes -----------------▼

3 The following attributes are optional for host environments that support this operation:

4 **PMIX_TIMEOUT** **"pmix.timeout"** (**int**)
5   Time in seconds before the specified operation should time out (*0* indicating infinite) in
6   error. The timeout parameter can help avoid "hangs" due to programming errors that prevent
7   the target process from ever exposing its data.

▲--▲

━━━━━━━━━━━━━━ Advice to PMIx library implementers ━━━━━━━━━━━━━━

8 We recommend that implementation of the **PMIX_TIMEOUT** attribute be left to the host
9 environment due to race condition considerations between completion of the operation versus
10 internal timeout in the PMIx server library. Implementers that choose to support **PMIX_TIMEOUT**
11 directly in the PMIx server library must take care to resolve the race condition and should avoid
12 passing **PMIX_TIMEOUT** to the host environment so that multiple competing timeouts are not
13 created.

▲━━━▲

14 **Description**
15 Request validation of a credential obtained from the host environment via a prior call to the
16 **pmix_server_get_cred_fn_t** module entry.

17 **11.2.25 pmix_server_iof_fn_t**

18 **Summary**
19 Request the specified IO channels be forwarded from the given array of processes.

```
typedef pmix_status_t (*pmix_server_iof_fn_t)(
                            const pmix_proc_t procs[], size_t nprocs,
                            const pmix_info_t directives[], size_t ndirs,
                            pmix_iof_channel_t channels,
                            pmix_op_cbfunc_t cbfunc, void *cbdata);
```

— C —

IN   procs
    Array **pmix_proc_t** identifiers whose IO is being requested (handle)
IN   nprocs
    Number of elements in *procs* (**size_t**)
IN   directives
    Array of **pmix_info_t** structures further defining the request (array of handles)
IN   ndirs
    Number of elements in the *info* array (integer)
IN   channels
    Bitmask identifying the channels to be forwarded (**pmix_iof_channel_t**)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

▼----------------- Required Attributes -----------------▼

The following attributes are required to be included in the passed *info* array:

PMIX_USERID "pmix.euid" (**uint32_t**)
        Effective user id.

PMIX_GRPID "pmix.egid" (**uint32_t**)
        Effective group id.

Host environments that provide this module entry point are required to support the following attributes:

`PMIX_IOF_CACHE_SIZE` **`"pmix.iof.csize"`** (**`uint32_t`**)
 The requested size of the server cache in bytes for each specified channel. By default, the server is allowed (but not required) to drop all bytes received beyond the max size.

`PMIX_IOF_DROP_OLDEST` **`"pmix.iof.old"`** (**`bool`**)
 In an overflow situation, drop the oldest bytes to make room in the cache.

`PMIX_IOF_DROP_NEWEST` **`"pmix.iof.new"`** (**`bool`**)
 In an overflow situation, drop any new bytes received until room becomes available in the cache (default).

▲--▲

▼------------------ Optional Attributes ------------------▼

The following attributes may be supported by a host environment.

`PMIX_IOF_BUFFERING_SIZE` **`"pmix.iof.bsize"`** (**`uint32_t`**)
 Controls grouping of IO on the specified channel(s) to avoid being called every time a bit of IO arrives. The library will execute the callback whenever the specified number of bytes becomes available. Any remaining buffered data will be "flushed" upon call to deregister the respective channel.

`PMIX_IOF_BUFFERING_TIME` **`"pmix.iof.btime"`** (**`uint32_t`**)
 Max time in seconds to buffer IO before delivering it. Used in conjunction with buffering size, this prevents IO from being held indefinitely while waiting for another payload to arrive.

▲--▲

Description

Request the specified IO channels be forwarded from the given array of processes. An error shall be returned in the callback function if the requested service from any of the requested processes cannot be provided.

▼------------------ Advice to PMIx library implementers ------------------▼

The forwarding of stdin is a *push* process - processes cannot request that it be *pulled* from some other source. Requests including the **`PMIX_FWD_STDIN_CHANNEL`** channel will return a **`PMIX_ERR_NOT_SUPPORTED`** error.

▲--▲

11.2.26 `pmix_server_stdin_fn_t`

Summary

Pass standard input data to the host environment for transmission to specified recipients.

Format

――――――――――― C ―――――――――――
```
typedef pmix_status_t (*pmix_server_stdin_fn_t)(
                                const pmix_proc_t *source,
                                const pmix_proc_t targets[],
                                size_t ntargets,
                                const pmix_info_t directives[],
                                size_t ndirs,
                                const pmix_byte_object_t *bo,
                                pmix_op_cbfunc_t cbfunc, void *cbdata);
```
――――――――――― C ―――――――――――

IN   source
    pmix_proc_t structure of source process (handle)
IN   targets
    Array of **pmix_proc_t** target identifiers (handle)
IN   ntargets
    Number of elements in the *targets* array (integer)
IN   directives
    Array of info structures (array of handles)
IN   ndirs
    Number of elements in the *info* array (integer)
IN   bo
    Pointer to **pmix_byte_object_t** containing the payload (handle)
IN   cbfunc
    Callback function **pmix_op_cbfunc_t** (function reference)
IN   cbdata
    Data to be passed to the callback function (memory reference)

Returns one of the following:

- **PMIX_SUCCESS**, indicating that the request is being processed by the host environment - result will be returned in the provided *cbfunc*. Note that the library must not invoke the callback function prior to returning from the API.

- **PMIX_OPERATION_SUCCEEDED**, indicating that the request was immediately processed and returned *success* - the *cbfunc* will not be called

- a PMIx error constant indicating either an error in the input or that the request was immediately processed and failed - the *cbfunc* will not be called

1   The following attributes are required to be included in the passed *info* array:

2   **PMIX_USERID** **"pmix.euid"** (**uint32_t**)
3   Effective user id.

4   **PMIX_GRPID** **"pmix.egid"** (**uint32_t**)
5   Effective group id.

Description

6

7   Passes stdin to the host environment for transmission to specified recipients. The host environment
8   is responsible for forwarding the data to all locations that host the specified *targets* and delivering
9   the payload to the PMIx server library connected to those clients.

10   If this module entry is provided and called by the PMIx server library, then the host environment
11   must either provide the requested services or return **PMIX_ERR_NOT_SUPPORTED** to the
12   provided *cbfunc*.

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10   • Dirk Schubert

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19   • Argonne National Laboratory

20   • Allinea (ARM)

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24 • University of Tennessee, Knoxville

25 • Mellanox, Inc.

26 • Research Organization for Information Science and Technology

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Index

Definition, **60**
PMIX_WAIT, 134–136, 261
    Definition, **68**
PMIX_WDIR, 143, 148, 266
    Definition, **71**

rank, 122, 232
    Definition, **14**
resource manager
    Definition, **15**

session, 9, 10, 12, 64, 65, 112, 120, 173, 228
    Definition, **14**
slot
    Definition, **14**
slots
    Definition, **14**

workflow
    Definition, **14**