

SMPD PMI Wire Protocol Reference Manual
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1 Introduction

When a user builds MPICH they have the option to choose the SMPD process manager to launch and manage processes in MPICH jobs. MPICH provides an implementation of `smpd` and `mpiexec` to launch MPICH jobs. MPICH applications communicate with the process manager using the PMI interface. The PMI library for `smpd` provides an implementation of PMI for communicating with SMPD process managers. This document describes the environment and wire protocol between the MPICH application and the SMPD manager.

If a process manager implementor replicates the environment and protocol described in this document, they would be able to launch and manage MPICH jobs compiled for SMPD.

An SMPD manager communicates with its child process through environment variables and a socket. This document describes the environment and the wire protocol on that socket.

2 SMPD manager topology

This section describes how SMPD is organized in MPICH. An implementation of a process manager that uses the protocol described in this document is not required to use this topology. It is provided for reference.

In the idle state, SMPDs reside on each node unconnected. When a new job is to be launched, `mpiexec` first selects a list of hosts to launch a job on. Then it connects to the SMPDs and they fork or spawn new managers resulting in a connected tree with `mpiexec` at the root. See figure 1. This tree remains for the duration of the job. It can grow as a result of spawn commands. Each SMPD manager has a `id` in the tree used to route commands. Each manager can manage multiple child processes. The control socket connections between the SMPD manager and the child processes are referenced by context `ids`. The SMPD manager provides the context `id` to the child when it launches a process.



Figure 1: SMPD Manager tree

3 Child process environment

SMPD managers launch and manage child processes in an MPICH job. MPICH processes compiled with the SMPD PMI library expect the following environment variables to be set:

PMI_RANK = my rank in the process group (0 to N-1)

PMI_SIZE = process group size (N)

PMI_KVS = my keyval space name unique to my process group

PMI_DOMAIN = my keyval space domain name

*PMI_CLIQUE = my node neighbors in the form of a clique. A clique is a comma separated list of ranges and numbers. Example: 0,2..4,7

PMI_SMPD_ID = my smpd manager node id

PMI_SMPD_KEY = ctx_key value to be included with PMI commands from this process.

PMI_SPAWN = 0 or 1 if this process was started by a PMI_Spawn_multiple command.

PMI_APPNUM = index of the command that started the local process

**PMI_SMPD_FD = file descriptor/handle to convert into the PMI socket context.

**PMI_HOST = host description as specified by the MPIDU_Sock interface

**PMI_PORT = port PMI_Host is listening on

**PMI_ROOT_HOST = root host to connect to to establish the PMI socket context.

**PMI_ROOT_PORT = root listening port number

**PMI_ROOT_LOCAL = 0 or 1 if the root process is to act as the root smpd manager. If PMI_ROOT_LOCAL is specified and it is 1, the root MPICH process starts a separate thread or process to act as the smpd manager. This manager listens on the specified port for pmi socket contexts to connect from all the processes in the job and handles smpd pmi commands for them. It is an error if PMI_ROOT_HOST is not the same as the host where rank 0 is launched.

* If not specified, default clique contains only the local process.

** Only one set of options may be specified.

The three options, `PMI_SMPD_FD`, `PMI_ROOT_HOST/PMI_ROOT_PORT` and `PMI_HOST/PMI_PORT` are mutually exclusive. If `PMI_SMPD_FD` exists then the process uses that handle as its connection to the SMPD manager otherwise it makes a socket connection to the host/port described by `PMI_ROOT_HOST/PMI_ROOT_PORT` or `PMI_HOST/PMI_PORT`.

4 SMPD wire commands

This section describes the wire protocol for PMI commands from the child process to the `smpd` manager.

4.1 Comand Format

Commands are variable length. Each command begins with a 13 byte header. The header is a NULL terminated ascii string representation of the length of the command to follow the header. After the header is a string of the length described by the header. Both the header and the command are NULL terminated. The header is always 13 bytes no matter where the NULL character falls. The command string begins at the 14th byte and the length of the command must include the NULL character.

Commands contain `key=value` strings to describe the components of the command. All commands will have the following keys:

- `cmd=command`
- `src=my_smpd_id`
- `dest=dest_smpd_id`
- `tag=command_tag`
- `ctx_key=pmi_smpd_key`

Additional command specific keys are described in the following section.

4.2 Commands

init

Add `name=kvsname` `key=rank` `value=nproc` `node_id=smpd_node_id`.

The init command is sent to the root from each process. This lets mpiexec know that the processes have started and made it to PMI.Init.

Example: `cmd=init src=1 dest=0 tag=101 ctx_key=0 name=mykvsname key=0 value=3 node_id=1`

finalize

Add `name=kvsname` `key=rank` `node_id=smpd_node_id`.

The finalize command is sent to the root from each process when PMI_Finalize is called. This lets mpiexec know that when the process exits it is a successful exit.

Example: `cmd=finalize src=2 dest=0 tag=123 ctx_key=0 name=mykvsname key=1 value=3 node_id=2`

done

No more PMI commands, close the context. This command is sent from the child directly to its SMPD manager and does not receive a reply.

Example: `cmd=done src=3 dest=3 tag=14 ctx_key=0`

exit_on_done

The root smpd manager can and should exit when all done commands are received. This command is sent by the root process.

Example: `cmd=exit_on_done src=1 dest=1 tag=13 ctx_key=0`

Is this command necessary? Shouldn't the root smpd know that it is a root smpd and exit automatically when all its pmi contexts close?

barrier

Barrier across a set of processes. Add `name=barrier_name` `value=number_of_participants`. The result command returns SUCCESS or FAIL.

Example: `cmd=barrier src=2 dest=1 tag=3 ctx_key=1 name=kvsname value=2`

dbcreate

Create a new keyval space. If `name=kvsname` is added to the command then the keyval space is created with the provided name, otherwise

the implementation chooses a name. The result command returns SUCCESS or FAIL and `name=kvsname`.

Example: `cmd=dbcreate src=1 dest=1 tag=100 ctx_key=0`

`dbdestroy`

Destroy a keyval space. Add `name=kvsname`. The result command returns SUCCESS or FAIL.

Example: `cmd=dbdestroy src=4 dest=1 tag=13 ctx_key=1 name=kvsname`

`dbput`

Put a keyval into a kvs space. Add `name=kvsname key=user_key value=user_value`. The result command returns SUCCESS or FAIL.

Example `cmd=dbput src=3 dest=1 tag=100 ctx_key=0 name=kvsname key=foo value=bar`

`dbget`

Get a keyval from a kvs space. Add `name=kvsname key=user_key`. The result command returns SUCCESS or FAIL and `value=val`.

Example: `cmd=dbget src=4 dest=1 tag=0 ctx_key=0 name=kvsname key=foo`

`dbfirst`

Start the keyval space iterator. Add `name=kvsname`. The result command returns SUCCESS or FAIL and `key=key value=val`.

Example: `cmd=dbfirst src=1 dest=1 tag=22 ctx_key=0 name=kvsname`

`dbnext`

Get the next keyval from the iterator. Add `name=kvsname`. The result command returns SUCCESS or FAIL and `key=key value=val`.

Example: `cmd=dbnext src=2 dest=1 tag=12 ctx_key=0 name=kvsname`

`spawn`

Spawn a new process group. See the next section for a complete description.

`result`

The result of a previous command. Result commands will always have two fields, `cmd_tag=command_tag` and `result=result_string`. The `command_tag` matches the tag of the command the result command refers to. The `result_string` is SUCCESS or a failure message. Other return fields will be present as specified by the issued command.

`abort_job`

Add name=kvsname rank=rank error=error message exit_code=exit code.

`abort_job` is sent from any node to the root to abort the entire job. This command represents a user abort usually caused by an `MPI_Abort` call.

Example: `cmd=abort_job src=3 dest=0 tag=1 ctx_key=0 rank=4 error=''user abort'' exit_code=13`

4.3 spawn command

The `spawn` command is issued by a single node to launch a set of processes in a new process group.

The `spawn` command is used to implement `PMI_Spawn_multiple`.

The keys to the `spawn` command are the following:

`ncmds = x number of commands`

`cmd0 = command`

`cmd1 = command`

...

`argv0 = string1 string2 string3 ...`

`argv1 = string1 string2 string3 ...`

...

`maxprocs = n0 n1 n2 ... nx-1`

`nkeyvals = n0 n1 n2 ... nx-1`

`keyvals0 = '0='\''key=val\'\' 1='\''key=val\'\' ... n0-1='\''key=val\'\'\'`

`keyvals1 = '0='\''key=val\'\' 1='\''key=val\'\' ... n1-1='\''key=val\'\'\'`

...

`npreput = number of preput keyvals`

`preput = '0='\''key=val\'\' 1='\''key=val\'\' ... n-1='\''key=val\'\'\'`

The `ncmds` key represents the size of the rest of the vector arguments. There will be `ncmds cmd` and `argv` keys. `maxprocs` and `nkeyvals` will contain `ncmds` entries. The values in `maxprocs` represent the requested number of processes to launch for the corresponding `cmd` command. There will be `ncmds keyvals` keys and each `keyvals` key will contain `nx` keys where `nx` is the corresponding value in `nkeyvals`. `npreput` represents the number of keys in the `preput` key. The keys in the `preput` key are to be put in the keyval space of the spawned process group before any of the processes are launched.

Example: `cmd=spawn src=3 dest=0 tag=4 ctx_key=0 ncmds=1 cmd0=myapp
argv0='one \'two args\' three' maxprocs=4 nkeyvals=2 keyvals0='0=\'host=toad\'',
1=\'path=/home/me\'', npreput=1 preput='0=\'port=1244\'','`

5 string format

This section describes the format of key=value elements in a stream.

`stream` := `frame` | `frame stream`

`frame` := `element frame_char` | `element separ_char frame`

`element` := `key delim_char value`

`key` := `string`

`value` := `string`

`string` := `literal` | `quoted`

`literal` := array of chars without separators, delimiters, or quotes

`quoted` := `quote_char array-of-escaped-characters quote_char`

`chars` := `ascii characters`

`escaped chars` := `ascii characters` with escaped `quote_chars` and `escape_chars`

`quote_char` := `"`

`escape_char` := `\`

`delim_char` := `=`

```
separ_char := ' '
```

```
frame_char := '\0'
```

Example:

```
a=b "my name"="David Ashton" foo="He said, \"Hi there.\""
```