



# **Intel® MPI Library Developer Reference for Linux\* OS**

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# Intel® MPI Library Developer Reference for Linux\* OS

Documentation for older versions of the Intel® MPI Library are available for download only. For a list of available documentation downloads by product version, see [Download Documentation for Intel Parallel Studio XE](#). To download the previous versions of Intel MPI Library documentation, refer to [this page](#).

## What's New

This Developer Reference provides you with the complete reference for the Intel MPI Library. It is intended to help a user fully utilize the Intel MPI Library functionality. For examples and detailed functionality description, please refer to the Intel MPI Library Developer Guide.

The following are some popular topics in the Intel MPI Library Developer Reference:

### Command Reference

[Command Reference](#) provides reference information on compilation and runtime commands ([mpirun](#), [cpuinfo](#), [impi\\_info](#)) and describes how to use these commands.

### Environment Variable Reference

[Environment Variable Reference](#) provides syntax, arguments, and descriptions for [Fabrics Control](#), [Tuning](#), [Autotuning](#), [Process Pinning](#), and [I\\_MPI\\_ADJUST Family](#) environment variables.

### Global Options and Environment Variables for mpiexec.hydra

Describes the [Global Options](#) and provides [Environment Variables](#) used with the Hydra process manager.

### mpitune\_fast

[mpitune\\_fast](#) tunes the Intel MPI Library to the cluster configuration using the [Autotuning](#) functionality.

### Mpitune Configuration Options

Tune your MPI application with the [mpitune](#) utility.

# Introduction

This Developer Reference provides you with the complete reference for the Intel® MPI Library. It is intended to help an experienced user fully utilize the Intel MPI Library functionality. You can freely redistribute this document in any desired form.

## Document Organization

Section	Description
<b>Section 1.</b> <a href="#">Introduction</a>	Introduces this document and the Intel MPI Library.
<b>Section 2.</b> <a href="#">Command Reference</a>	Describes compilation and job startup commands and their options.
<b>Section 3.</b> <a href="#">Environment Variable Reference</a>	Describes environment variables .
<b>Section 4.</b> <a href="#">Miscellaneous</a>	Contains information not related to the sections above.

## Introducing Intel® MPI Library

Intel® MPI Library is a multi-fabric message passing library that implements the Message Passing Interface, v3.1 (MPI-3.1) specification. It provides a standard library across Intel® platforms that enable adoption of MPI-3.1 functions as their needs dictate.

Intel® MPI Library enables developers to change or to upgrade processors and interconnects as new technology becomes available without changes to the software or to the operating environment.

You can get the latest information for the Intel® MPI Library at <https://software.intel.com/intel-mpi-library>.

## What's New

This page lists changes to the product that are reflected in the documentation. For a list of all changes, refer to the [Release Notes](#).

### Intel® MPI Library 2021.6 (Intel® oneAPI 2022.2)

- `I_MPI_OFFLOAD` enables all GPU features including Intel MPI GPU pinning
- Multi-rail support: `I_MPI_MULTIRAIL` enables multi-rail capability and is used to identify NICs serviced by the provider and to pick one on the same NUMA.

### Intel® oneAPI 2021.5

- Converged `release` and `release_mt` libraries. All features previously available in `release_mt` only are available in `release` library.
- Added `hcoll` argument for `I_MPI_COLL_EXTERNAL`.
- Added `-prepend-timestamp` option to Global Options topic.
- Added `I_MPI_COLL_DIRECT` variable to `I_MPI_ADJUST` Family Environment Variables topic.

### Intel® oneAPI 2021.4

- Changed the `I_MPI_STARTUP_MODE` default value to `pmi_shm_netmod`.

### Intel® oneAPI 2021.3

- Changed the default pinning order to `bunch`.
- Added new value for the `I_MPI_SHM` variable (`icx`).

Additionally, minor updates have been made to fix inaccuracies in the document and improve user experience.

## Intel® oneAPI 2021.2

- No documentation changes.

## Intel® oneAPI Gold

- Removed all content specific to Intel® Parallel Studio XE (see notice on title page).
- Added Intel® Ethernet 800 Series support.
- Added MPI + OpenMP offload examples.
- Added new algorithm for MPI\_Sendrecv\_replace (I\_MPI\_ADJUST\_SENDRECV\_REPLACE=2).
- Added I\_MPI OFFLOAD variable to GPU Support topic.
- Reworked directory layout:
  - Removed intel64/.
  - Mpivars.[c]sh and mpi modulefile moved to env/.
  - Mpivars.[c]sh renamed to vars.[c]sh.
- Removed deprecated symbolic links.
- Removed static libraries for debug configurations.

## Notational Conventions

The following conventions are used in this document.

<i>This type style</i>	Document names
<a href="#">This type style</a>	Hyperlinks
This type style	Commands, arguments, options, file names
THIS_TYPE_STYLE	Environment variables
< <i>this type style</i> >	Variables or placeholders for actual values
[ items ]	Optional items
{ item   item }	Selectable items separated by vertical bar(s)

## Related Information

Description of some of the Intel® MPI Library functionality is available in man1 pages: `mpiexec.hydra`, `hydra_nameserver`, and compiler wrappers.

The following related documents that might be useful to the user:

- [Product Web Site](#)
- [Intel® MPI Library Support](#)
- [Intel® Cluster Tools Products](#)
- [Intel® Software Development Products](#)

# Command Reference

This section provides information on different command types and how to use these commands:

- [Compilation Commands](#) lists the available Intel® MPI Library compiler commands, related options, and environment variables.
- [mpirun](#) provides the description and examples for the `mpirun` command.
- [mpiexec.hydra](#) gives full information on the `mpiexec.hydra` command, its options, environment variables, and related features and utilities.
- [cpuinfo](#) provides the syntax, arguments, description and output examples for the `cpuinfo` utility.
- [impi\\_info](#) provides information on available environment variables.
- [mpitune\\_fast](#) provides information on configuration options for the `mpitune_fast` utility.
- [mpitune](#) provides information on configuration options for the `mpitune` utility.

## Compiler Commands

The following table lists the available Intel® MPI Library compiler commands with their underlying compilers and programming languages.

### Intel MPI Library Compiler Wrappers

Compiler Command	Default Compiler	Supported Languages
<b>Generic Compilers</b>		
<code>mpicc</code>	gcc, cc	C
<code>mpicxx</code>	g++	C/C++
<code>mpifc</code>	gfortran	Fortran77*/Fortran 95*
<b>GNU* Compilers</b>		
<code>mpigcc</code>	gcc	C
<code>mpigxx</code>	g++	C/C++
<code>mpif77</code>	gfortran	Fortran 77
<code>mpif90</code>	gfortran	Fortran 95
<b>Intel® Fortran, C++ Compilers</b>		
<code>mpiicc</code>	icc	C
<code>mpiicpc</code>	icpc	C++
<code>mpiifort</code>	ifort	Fortran77/Fortran 95

### Notes on Compiler Commands

- Compiler commands are available only in the Intel MPI Library Software Development Kit (SDK).
- For the supported versions of the listed compilers, refer to the [Intel® MPI Library System Requirements](#).
- To display mini-help of a compiler command, execute it without any parameters.
- Compiler wrapper scripts are located in the `<install-dir>/bin` directory, where `<install-dir>` is the Intel MPI Library installation directory.
- The environment settings can be established by sourcing the `<install-dir>/env/vars.[c]sh` script. To use a specific library configuration, pass one of the following arguments to the script to switch to the corresponding configuration: `release` or `debug`.
- Ensure that the corresponding underlying compiler is already in your `PATH`. If you use Intel® compilers, source the `vars.sh` script from the installation directory to set up the compiler environment.

## Compilation Command Options

### **-nostrip**

Use this option to turn off the debug information stripping while linking the Intel® MPI Library statically.

### **-config=<name>**

Use this option to source a compiler configuration file. The file should contain the environment settings to be used with the specified compiler.

Use the following naming convention for configuration files:

```
<install-dir>/etc/mpi<compiler>-<name>.conf
```

where:

- `<compiler>={cc,cxx,f77,f90}`, depending on the language compiled.
- `<name>` is the name of the underlying compiler with spaces replaced by hyphens; for example, the `<name>` value for `cc -64` is `cc--64`.

### **-profile=<profile\_name>**

Use this option to specify an MPI profiling library. `<profile_name>` is the name of the configuration file (profile) that loads the corresponding profiling library. The profiles are taken from `<install-dir>/etc`.

The Intel MPI Library comes with several predefined profiles for the Intel® Trace Collector:

- `<install-dir>/etc/vt.conf` — regular tracing library
- `<install-dir>/etc/vtfs.conf` — fail-safe tracing library
- `<install-dir>/etc/vtmc.conf` — correctness checking tracing library
- `<install-dir>/etc/vtim.conf` — load imbalance tracing library

You can also create your own profile as `<profile-name>.conf`. You can define the following environment variables in a configuration file:

- `PROFILE_PRELIB` - libraries (and paths) to load before the Intel MPI Library
- `PROFILE_POSTLIB` - libraries to load after the Intel MPI Library
- `PROFILE_INCPATHS` - C preprocessor arguments for any include files

For example, create a file `myprof.conf` with the following lines:

```
PROFILE_PRELIB="-I<path_to_myprof>/lib -lmyprof"
PROFILE_INCPATHS="-I<paths_to_myprof>/include"
```

Use the `-profile=myprof` option for the relevant compiler wrapper to select this new profile.

### **-t or -trace**

Use the `-t` or `-trace` option to link the resulting executable file against the Intel® Trace Collector library. Using this option has the same effect as the `-profile=vt` option.

You can also use the `I_MPI_TRACE_PROFILE` environment variable to `<profile_name>` to specify another profiling library. For example, set `I_MPI_TRACE_PROFILE` to `vtfs` to link against the fail-safe version of the Intel Trace Collector.

To use this option, include the installation path of the Intel® Trace Collector in the `VT_ROOT` environment variable. Source the `vars.[c]sh` script provided in the Intel® Trace Analyzer and Collector installation folder.

## **-trace-imbalance**

Use the `-trace-imbalance` option to link the resulting executable file against the load imbalance tracing library of Intel Trace Collector. Using this option has the same effect as the `-profile=vtim` option.

To use this option, include the installation path of the Intel Trace Collector in the `VT_ROOT` environment variable. Source the `vars.[c]sh` script provided in the Intel® Trace Analyzer and Collector installation folder.

## **-check\_mpi**

Use this option to link the resulting executable file against the Intel® Trace Collector correctness checking library. The default value is `libVTmc.so`. Using this option has the same effect as the `-profile=vtmc` option.

You can also use the `I_MPI_CHECK_PROFILE` environment variable to `<profile_name>` to specify another checking library.

To use this option, include the installation path of the Intel Trace Collector in the `VT_ROOT` environment variable. Source the `vars.[c]sh` script provided in the Intel® Trace Analyzer and Collector installation folder.

## **-ilp64**

Use this option to enable partial ILP64 support. All integer arguments of the Intel MPI Library are treated as 64-bit values in this case.

## **-no\_ilp64**

Use this option to disable the ILP64 support explicitly. This option must be used in conjunction with `-i8` option of Intel® Fortran Compiler.

If you specify the `-i8` option for the separate compilation with Intel Fortran Compiler, you still have to use the `i8` or `ilp64` option for linkage.

## **-dynamic\_log**

Use this option in combination with the `-t` option to link the Intel Trace Collector library dynamically. This option does not affect the default linkage method for other libraries.

To run the resulting programs, include `$VT_ROOT/slib` in the `LD_LIBRARY_PATH` environment variable.

## **-g**

Use this option to compile a program in debug mode and link the resulting executable file against the debugging version of the Intel MPI Library. See `I_MPI_DEBUG` for information on how to use additional debugging features with the `-g` builds.

The optimized library is linked with the `-g` option by default.

Use `vars.{sh|csh} [debug|debug_mt]` at runtime to load a particular `libmpi.so` configuration.

## **-link\_mpi=<arg>**

Use this option to always link the specified version of the Intel MPI Library. See the `I_MPI_LINK` environment variable for detailed argument descriptions. This option overrides all other options that select a specific library .

Use `vars.{sh|csh} [debug|debug_mt]` during runtime to load particular `libmpi.so` configuration.

## **-O**

Use this option to enable compiler optimization.



**-fast**

Use this option to maximize speed across the entire program. This option forces static linkage method for the Intel MPI Library.

This option is supported only by the `mpiicc`, `mpiicpc`, and `mpiifort` Intel® compiler wrappers.

**-echo**

Use this option to display everything that the command script does.

**-show**

Use this option to learn how the underlying compiler is invoked, without actually running it. Use the following command to see the required compiler flags and options:

```
$ mpiicc -show -c test.c
```

Use the following command to see the required link flags, options, and libraries:

```
$ mpiicc -show -o a.out test.o
```

This option is particularly useful for determining the command line for a complex build procedure that directly uses the underlying compilers.

**-show\_env**

Use this option to see the environment settings in effect when the underlying compiler is invoked.

**-{cc,cxx,fc}=<compiler>**

Use this option to select the underlying compiler. The tables below list the available LLVM and IL0 compiler options and commands used to invoke them.

**LLVM Compiler Options for Intel® oneAPI**

Language/Model	Product Name	Compiler Driver	Compiler Wrapper	Command	Example
C	Intel® oneAPI DPC++/C++ Compiler	icx	mpiicc	-cc=icx	\$ mpiicc -cc=icx -c test.c
C++	Intel® oneAPI DPC++/C++ C	icpx	mpiicpc	-cxx=icpx	\$ mpiicpc -cxx=icpx -c test.cpp
SYCL*/DPC++	Intel® oneAPI DPC++/C++ Compiler	dpcpp	mpiicpc	-cxx=dpcpp	\$ mpiicpc -cxx=dpcpp -c test.cpp
Fortran	Intel® oneAPI Fortran Compiler	ifx	mpiifort	-fc=ifx	\$ mpiifort -fc=ifx -c test.

**NOTE** Make sure that the wrapper name is in your `PATH`. Alternatively, you can specify the full path to the compiler.

**-nofortbind, -nofortran**

Use this option to disable `mpiicc` linking with Fortran bindings. This has the same effect as the `I_MPI_FORT_BIND` variable.

**-v**

Use this option to print the compiler wrapper script version and its underlying compiler version.

**-norpath**

Use this option to disable `rpath` for the compiler wrapper for the Intel® MPI Library.

## mpirun

---

Launches an MPI job and provides integration with job schedulers.

### Syntax

```
mpirun <options>
```

### Arguments

<code>&lt;options&gt;</code>	<code>mpiexec.hydra</code> options as described in the <code>mpiexec.hydra</code> section. This is the default operation mode.
------------------------------	--

### Description

Use this command to launch an MPI job. The `mpirun` command uses Hydra as the underlying process manager.

The `mpirun` command detects if the MPI job is submitted from within a session allocated using a job scheduler like Torque\*, PBS Pro\*, LSF\*, Parallelnavi\* NQS\*, Slurm\*, Univa\* Grid Engine\*, or LoadLeveler\*. The `mpirun` command extracts the host list from the respective environment and uses these nodes automatically according to the above scheme.

In this case, you do not need to create a host file. Allocate the session using a job scheduler installed on your system, and use the `mpirun` command inside this session to run your MPI job.

### Example

```
$ mpirun -n <# of processes> ./myprog
```

This command invokes the `mpiexec.hydra` command (Hydra process manager), which launches the `myprog` executable.

## mpiexec.hydra

---

Launches an MPI job using the Hydra process manager.

### Syntax

```
mpiexec.hydra<g-options> <l-options> <executable>
```

or

```
mpiexec.hydra<g-options> <l-options> <executable1> : <l-options> <executable2>
```

### Arguments

<code>&lt;g-options&gt;</code>	Global options that apply to all MPI processes
<code>&lt;l-options&gt;</code>	Local options that apply to a single argument set
<code>&lt;executable&gt;</code>	<code>./a.out</code> or <code>path/</code> name of the executable file

### Description

Use the `mpiexec.hydra` utility to run MPI applications using the Hydra process manager.

Use the first short command-line syntax to start all MPI processes of the `<executable>` with the single set of arguments. For example, the following command executes `a.out` over the specified processes and hosts:

```
$ mpiexec.hydra -f <hostfile> -n <# of processes> ./a.out
```

where:

- `<# of processes>` specifies the number of processes on which to run the `a.out` executable
- `<hostfile>` specifies a list of hosts on which to run the `a.out` executable

Use the second long command-line syntax to set different argument sets for different MPI program runs. For example, the following command executes two different binaries with different argument sets:

```
$ mpiexec.hydra -f <hostfile> -env <VAR1> <VAL1> -n 2 ./a.out : \
-env <VAR2> <VAL2> -n 2 ./b.out
```

---

**NOTE** You need to distinguish global options from local options. In a command-line syntax, place the local options after the global options.

---

## Global Hydra Options

This section describes the global options of the Intel® MPI Library's Hydra process manager. Global options are applied to all arguments sets in the launch command. Argument sets are separated by a colon ':'.

### **-tune <filename>**

Use this option to specify the file name that contains the tuning data in a binary format.

### **-usize <usize>**

Use this option to set `MPI_UNIVERSE_SIZE`, which is available as an attribute of the `MPI_COMM_WORLD`.

<code>&lt;size&gt;</code>	Define the universe size
SYSTEM	Set the size equal to the number of cores passed to <code>mpiexec</code> through the hostfile or the resource manager.
INFINITE	Do not limit the size. This is the default value.
<code>&lt;value&gt;</code>	Set the size to a numeric value $\geq 0$ .

### **-hostfile <hostfile> or -f <hostfile>**

Use this option to specify host names on which to run the application. If a host name is repeated, this name is used only once.

See also the `I_MPI_HYDRA_HOST_FILE` environment variable for more details.

---

**NOTE** Use the following options to change the process placement on the cluster nodes:

- Use the `-perhost`, `-ppn`, and `-grr` options to place consecutive MPI processes on every host using the round robin scheduling.
  - Use the `-rr` option to place consecutive MPI processes on different hosts using the round robin scheduling.
-

## **-machinefile <machine file> or -machine <machine file>**

Use this option to control process placement through a machine file. To define the total number of processes to start, use the `-n` option. For example:

```
$ cat ./machinefile
node0:2
node1:2
node0:1
```

## **-hosts-group**

Use this option to set node ranges using brackets, commas, and dashes (like in Slurm\* Workload Manager). For more details, see the `I_MPI_HYDRA_HOST_FILE` environment variable in [Hydra Environment Variables](#).

## **-silent-abort**

Use this option to disable abort warning messages.

For more details, see the `I_MPI_SILENT_ABORT` environment variable in [Hydra Environment Variables](#).

## **-nameserver**

Use this option to specify the nameserver in the `hostname:port` format.

For more details, see the `I_MPI_HYDRA_NAMESERVER` environment variable in [Hydra Environment Variables](#).

## **-genv <ENVVAR> <value>**

Use this option to set the `<ENVVAR>` environment variable to the specified `<value>` for all MPI processes.

## **-genvall**

Use this option to enable propagation of all environment variables to all MPI processes.

## **-genvnone**

Use this option to suppress propagation of any environment variables to any MPI processes.

---

**NOTE** The option does not work for localhost.

---

## **-genvexcl <list of env var names>**

Use this option to suppress propagation of the listed environment variables to any MPI processes.

## **-genvlist <list>**

Use this option to pass a list of environment variables with their current values. `<list>` is a comma separated list of environment variables to be sent to all MPI processes.

## **-pmi-connect <mode>**

Use this option to choose the caching mode of process management interface (PMI) message. Possible values for `<mode>` are:

<code>&lt;mode&gt;</code>	The caching mode to be used
<code>nocache</code>	Do not cache PMI messages.

cache	Cache PMI messages on the local <code>pmi_proxy</code> management processes to minimize the number of PMI requests. Cached information is automatically propagated to child management processes.
lazy-cache	cache mode with on-request propagation of the PMI information.
alltoall	Information is automatically exchanged between all <code>pmi_proxy</code> before any get request can be done. This is the default mode.

See the `I_MPI_HYDRA_PMI_CONNECT` environment variable for more details.

### **-perhost <# of processes >, -ppn <# of processes >, or -grr <# of processes >**

Use this option to place the specified number of consecutive MPI processes on every host in the group using round robin scheduling. See the `I_MPI_PERHOST` environment variable for more details.

---

**NOTE** When running under a job scheduler, these options are ignored by default. To be able to control process placement with these options, disable the `I_MPI_JOB_RESPECT_PROCESS_PLACEMENT` variable.

---

### **-rr**

Use this option to place consecutive MPI processes on different hosts using the round robin scheduling. This option is equivalent to "`-perhost 1`". See the `I_MPI_PERHOST` environment variable for more details.

### **-trace [<profiling\_library>] or -t [<profiling\_library>]**

Use this option to profile your MPI application with Intel® Trace Collector using the indicated `<profiling_library>`. If you do not specify `<profiling_library>`, the default profiling library `libVT.so` is used.

Set the `I_MPI_JOB_TRACE_LIBS` environment variable to override the default profiling library.

### **-trace-imbalance**

Use this option to profile your MPI application with Intel® Trace Collector using the `libVTim.so` library.

### **-aps**

Use this option to collect statistics from your MPI application using Application Performance Snapshot. The collected data includes hardware performance metrics, memory consumption data, internal MPI imbalance and OpenMP\* imbalance statistics. When you use this option, a new folder `aps_result_<date>-<time>` with statistics data is generated. You can analyze the collected data with the `aps` utility, for example:

```
$ mpirun -aps -n 2 ./myApp
$ aps aps_result_20171231_235959
```

---

### **NOTE**

1. To use this option, set up the Application Performance Snapshot environment beforehand. See the tool's <https://software.intel.com/content/www/us/en/develop/documentation/application-snapshot-user-guide/top.html> *User Guide*.
  2. If you use the options `-trace` or `-check_mpi`, the `-aps` option is ignored.
-

## **-mps**

Use this option to collect only MPI and OpenMP\* statistics from your MPI application using Application Performance Snapshot. Unlike the `-aps` option, `-mps` doesn't collect hardware metrics. The option is equivalent to:

```
$ mpirun -n 2 aps -c mpi,omp ./myapp
```

## **-trace-pt2pt**

Use this option to collect the information about point-to-point operations using Intel® Trace Analyzer and Collector. The option requires that you also use the `-trace` option.

## **-trace-collectives**

Use this option to collect the information about collective operations using Intel® Trace Analyzer and Collector. The option requires that you also use the `-trace` option.

---

### **NOTE**

Use the `-trace-pt2pt` and `-trace-collectives` to reduce the size of the resulting trace file or the number of message checker reports. These options work with both statically and dynamically linked applications.

---

## **-configfile <filename>**

Use this option to specify the file `<filename>` that contains the command-line options with one executable per line. Blank lines and lines that start with '#' are ignored. Other options specified in the command line are treated as global.

You can specify global options in configuration files loaded by default (`mpiexec.conf` in `<installdir>/etc`, `~/mpiexec.conf`, and `mpiexec.conf` in the working directory). The remaining options can be specified in the command line.

## **-branch-count <num>**

Use this option to restrict the number of child management processes launched by the Hydra process manager, or by each `pmi_proxy` management process.

See the `I_MPI_HYDRA_BRANCH_COUNT` environment variable for more details.

## **-pmi-aggregate or -pmi-noaggregate**

Use this option to switch on or off, respectively, the aggregation of the PMI requests. The default value is `-pmi-aggregate`, which means the aggregation is enabled by default.

See the `I_MPI_HYDRA_PMI_AGGREGATE` environment variable for more details.

## **-gdb**

Use this option to run an executable under GDB\* (GNU debugger). You can use the following command:

```
$ mpiexec.hydra -gdb -n <# of processes><executable>
```

## **-gdba <pid>**

Use this option to attach the GNU\* debugger to the existing MPI job. You can use the following command:

```
$ mpiexec.hydra -gdba <pid>
```

**-nolocal**

Use this option to avoid running the `<executable>` on the host where `mpiexec.hydra` is launched. You can use this option on clusters that deploy a dedicated main node for starting the MPI jobs and a set of dedicated compute nodes for running the actual MPI processes.

**-hosts <nodelist>**

Use this option to specify a particular `<nodelist>` on which the MPI processes should be run. For example, the following command runs the executable `a.out` on the hosts `host1` and `host2`:

```
$ mpiexec.hydra -n 2 -ppn 1 -hosts host1,host2 ./a.out
```

---

**NOTE** If `<nodelist>` contains only one node, this option is interpreted as a local option. See [Local Options](#) for details.

---

**-iface <interface>**

Use this option to choose the appropriate network interface. For example, if the IP emulation of your InfiniBand\* network is configured to `ib0`, you can use the following command.

```
$ mpiexec.hydra -n 2 -iface ib0 ./a.out
```

See the `I_MPI_HYDRA_IFACE` environment variable for more details.

**-demux <mode>**

Use this option to set the polling mode for multiple I/O. The default value is `poll`.

**Arguments**

<code>&lt;spec&gt;</code>	Define the polling mode for multiple I/O
<code>poll</code>	Set <code>poll</code> as the polling mode. This is the default value.
<code>select</code>	Set <code>select</code> as the polling mode.

See the `I_MPI_HYDRA_DEMUX` environment variable for more details.

**-enable-x or -disable-x**

Use this option to control the Xlib\* traffic forwarding. The default value is `-disable-x`, which means the Xlib traffic is not forwarded.

**-l, -prepend-rank**

Use this option to insert the MPI process rank at the beginning of all lines written to the standard output.

**-ilp64**

Use this option to preload the ILP64 interface.

**-s <spec>**

Use this option to direct standard input to the specified MPI processes.

**Arguments**

<code>&lt;spec&gt;</code>	Define MPI process ranks
<code>all</code>	Use all processes.

none	Do not direct standard output to any processes.
<l>, <m>, <n>	Specify an exact list and use processes <l>, <m> and <n> only. The default value is zero.
<k>, <l>-<m>, <n>	Specify a range and use processes <k>, <l> through <m>, and <n>.

## **-noconf**

Use this option to disable processing of the `mpiexec.hydra` configuration files.

## **-ordered-output**

Use this option to avoid intermingling of data output from the MPI processes. This option affects both the standard output and the standard error streams.

---

**NOTE** When using this option, end the last output line of each process with the end-of-line '\n' character. Otherwise the application may stop responding.

---

## **-path <directory>**

Use this option to specify the path to the executable file.

## **-tmpdir <dir>**

Use this option to set a directory for temporary files. See the `I_MPI_TMPDIR` environment variable for more details.

## **-version or -V**

Use this option to display the version of the Intel® MPI Library.

## **-info**

Use this option to display build information of the Intel® MPI Library. When this option is used, the other command line arguments are ignored.

## **-localhost**

Use this option to explicitly specify the local host name for the launching node.

## **-rmk <RMK>**

Use this option to select a resource management kernel to be used. Intel® MPI Library only supports `pbs`.

See the `I_MPI_HYDRA_RMK` environment variable for more details.

## **-outfile-pattern <file>**

Use this option to redirect `stdout` to the specified file.

## **-errfile-pattern <file>**

Use this option to redirect `stderr` to the specified file.

## **-gpath <path>**

Use this option to specify the path to the executable file.



**-gwdir <dir>**

Use this option to specify the working directory in which the executable file runs.

**-gumask <umask>**

Use this option to perform the "umask <umask>" command for the remote executable file.

**-gdb-ia**

Use this option to run processes under Intel® architecture specific GNU\* debugger.

**-prepend-pattern**

Use this option to specify the pattern that is prepended to the process output.

**-prepend-timestamp**

Use this option to prepend timestamp to stdout or stderr line.

**-verbose or -v**

Use this option to print debug information from `mpiexec.hydra`, such as:

- Service processes arguments
- Environment variables and arguments passed to start an application
- PMI requests/responses during a job life cycle

See the `I_MPI_HYDRA_DEBUG` environment variable for more details.

**-print-rank-map**

Use this option to print out the MPI rank mapping.

**-print-all-exitcodes**

Use this option to print the exit codes of all processes.

**-bootstrap <bootstrap server>**

Use this option to select a built-in bootstrap server to use. A bootstrap server is the basic remote node access mechanism that is provided by the system. Hydra supports multiple runtime bootstrap servers such as `ssh`, `rsh`, `pdsh`, `fork`, `persist`, `slurm`, `ll`, `lsf`, or `sge` to launch MPI processes. The default bootstrap server is `ssh`. By selecting `slurm`, `ll`, `lsf`, or `sge`, you use the corresponding `srun`, `llspawn.stdio`, `blaunch`, or `qcrsh` internal job scheduler utility to launch service processes under the respective selected job scheduler (Slurm\*, LoadLeveler\*, LSF\*, and SGE\*).

**Arguments**

<code>&lt;arg&gt;</code>	String parameter
<code>ssh</code>	Use secure shell. This is the default value.
<code>rsh</code>	Use remote shell.
<code>pdsh</code>	Use parallel distributed shell.
<code>pbs</code>	Use Torque* <code>pbsdsh</code> command.
<code>pbsdsh</code>	Alias for <code>pbs</code> bootstrap.
<code>fork</code>	Use fork call.
<code>persist</code>	Use Hydra persist server. See below for details.
<code>slurm</code>	Use Slurm* <code>srun</code> command.

ll	Use LoadLeveler* llspawn.studio command.
lsf	Use LSF blaunch command.
sge	Use Univa* Grid Engine* qrsh command.

See [I\\_MPI\\_HYDRA\\_BOOTSTRAP](#) for details.

## **-bootstrap-exec <bootstrap server>**

Use this option to set the executable to be used as a bootstrap server. The default bootstrap server is ssh. For example:

```
$ mpiexec.hydra -bootstrap-exec <bootstrap_server_executable> -f hosts -env <VAR1> <VAL1> -n 2 ./a.out
```

See [I\\_MPI\\_HYDRA\\_BOOTSTRAP](#) for more details.

## **-bootstrap-exec-args <args>**

Use this option to provide the additional parameters to the bootstrap server executable file.

```
$ mpiexec.hydra -bootstrap-exec-args <arguments> -n 2 ./a.out
```

For tight integration with the Slurm\* scheduler (including support for suspend/resume), use the method outlined on the Slurm page here: [http://www.schedmd.com/slurmdocs/mpi\\_guide.html#intel\\_mpi](http://www.schedmd.com/slurmdocs/mpi_guide.html#intel_mpi)

See [I\\_MPI\\_HYDRA\\_BOOTSTRAP\\_EXEC\\_EXTRA\\_ARGS](#) for more details.

## **-v6**

Use this option to force using the IPv6 protocol.

## **Local Hydra Options**

This section describes the local options of the Intel® MPI Library's Hydra process manager. Local options are applied only to the argument set they are specified in. Argument sets are separated by a colon ':':

### **-n <number-of-processes> Or -np <number-of-processes>**

Use this option to set the number of MPI processes to run with the current argument set.

### **-env <envar> <value>**

Use this option to set the <envar> environment variable to the specified <value> for all MPI processes in the current argument set.

### **-envall**

Use this option to propagate all environment variables in the current argument set. See the [I\\_MPI\\_HYDRA\\_ENV](#) environment variable for more details.

### **-envnone**

Use this option to suppress propagation of any environment variables to the MPI processes in the current argument set.

---

**NOTE** The option does not work for localhost.

---

**-envexcl** <list-of-envvar-names>

Use this option to suppress propagation of the listed environment variables to the MPI processes in the current argument set.

**-envlist** <list>

Use this option to pass a list of environment variables with their current values. <list> is a comma separated list of environment variables to be sent to the MPI processes.

**-host** <nodename>

Use this option to specify a particular <nodename> on which the MPI processes are to be run. For example, the following command executes `a.out` on hosts `host1` and `host2`:

```
$ mpiexec.hydra -n 2 -host host1 ./a.out : -n 2 -host host2 ./a.out
```

**-path** <directory>

Use this option to specify the path to the <executable> file to be run in the current argument set.

**-wdir** <directory>

Use this option to specify the working directory in which the <executable> file runs in the current argument set.

## gtool Options

**-gtool**

Use this option to launch such tools as Intel® VTune™ Amplifier XE, Intel® Advisor, Valgrind\*, and the GDB\* (GNU Debugger) for the specified processes through the `mpiexec.hydra` and `mpirun` commands. An alternative to this option is the `I_MPI_GTOOL` environment variable.

### Syntax

```
-gtool "<command line for tool 1>:<ranks set 1>[=launch mode 1][@arch 1]; <command line for tool 2>:<ranks set 2>[=exclusive][@arch 2]; ... ;<command line for a tool n>:<ranks set n>[=exclusive][@arch n]" <executable>
```

or:

```
$ mpirun -n <# of processes> -gtool "<command line for tool 1>:<ranks set 1>[=launch mode 1][@arch 1]" -gtool "<command line for a tool 2>:<ranks set 2>[=launch mode 2][@arch 2]" ... -gtool "<command line for a tool n>:<ranks set n>[=launch mode 3][@arch n]" <executable>
```

In the syntax, the separator ';' and the `-gtool` option are interchangeable.

### Arguments

<arg>	Parameters
<rank set>	Specify the range of ranks that are involved in the tool execution. Separate ranks with a comma or use the '-' symbol for a set of contiguous ranks. To run the tool for all ranks, use the <code>all</code> argument.

**NOTE** If you specify incorrect rank index, the corresponding warning is printed and the tool continues working for valid ranks.

<code>[=launch mode]</code>	Specify the launch mode (optional). See below for the available values.
<code>[@arch]</code>	Specify the architecture on which the tool runs (optional). For a given <code>&lt;rank set&gt;</code> , if you specify this argument, the tool is launched only for the processes residing on hosts with the specified architecture. This parameter is optional.

**NOTE** Rank sets cannot overlap for the same `@arch` parameter. Missing `@arch` parameter is also considered a different architecture. Thus, the following syntax is considered valid: `-gtool "gdb:0-3=attach;gdb:0-3=attach@hsw;/usr/bin/gdb:0-3=attach@knl"` Also, note that some tools cannot work together or their simultaneous use may lead to incorrect results. The following table lists the parameter values for `[=launch mode]`:

<code>[=launch mode]</code>	Tool launch mode (optional). You can specify several values for each tool, which are separated with a comma <code>,</code> .
<code>exclusive</code>	Specify this value to prevent the tool from launching for more than one rank per host.
<code>attach</code>	Specify this value to attach the tool from <code>-gtool</code> to the executable. If you use debuggers or other tools that can attach to a process in a debugger manner, you need to specify this value. This mode has been tested with debuggers only.
<code>node-wide</code>	Specify this value to apply the tool from <code>-gtool</code> to all ranks where the <code>&lt;rank set&gt;</code> resides or for all nodes in the case of all ranks. That is, the tool is applied to a higher level than the executable (to the <code>pmi_proxy</code> daemon).  Use the <code>-remote</code> argument for ranks to use the tool on remote nodes only.

**NOTE** The tool attached to an MPI process may be executed without having access to `stdin`. To pass input to it, run a rank under the tool directly, for example: `-gtool "gdb --args:0"`

## Examples

The following examples demonstrate different scenarios of using the `-gtool` option.

### Example 1

Launch the Intel® VTune™ Amplifier XE and Valgrind\* through the `mpirun` command:

```
$ mpirun -n 16 -gtool "vtune -collect hotspots -analyze-system \  
-r result1:5,3,7-9=exclusive@bdw;valgrind -log-file=log_%p:0,1,10-12@hsw" a.out
```

This command launches `vtune` for the processes that are run on the Intel® microarchitecture codenamed Broadwell. Only one copy of `vtune` is launched for each host, the process with the minimal index is affected. At the same time, Valgrind\* is launched for all specified processes that are run on the Intel® microarchitecture codenamed Haswell. Valgrind's results are saved to the files `log_<process ID>`.

### Example 2

Set different environment variables for different rank sets:

```
$ mpirun -n 16 -gtool "env VARIABLE1=value1 VARIABLE2=value2:3,5,7-9; env VARIABLE3=value3:0,11"
a.out
```

### Example 3

Apply a tool for a certain process through the `-machinefile` option.

In this example, suppose `m_file` has the following content:

```
$ cat ./m_file
hostname_1:2
hostname_2:3
hostname_3:1
```

The following command line demonstrates how to use the `-machinefile` option to apply a tool:

```
$ mpirun -n 6 -machinefile m_file -gtool "vtune -collect hotspots -analyze-system \
-r result1:5,3=exclusive@hsw;valgrind:0,1@bdw" a.out
```

In this example, the use of `-machinefile` option means that processes with indices 0 and 1 are located on the `hostname_1` machine, process 3 is located on the `hostname_2` machine, and process 5 - on the `hostname_3` machine. After that, `vtune` is applied only ranks 3 and 5 (since these ranks belong to different machines, the `exclusive` option matches both of them) in case if `hostname_2` and `hostname_3` machines have Intel® microarchitecture codenamed Haswell. At the same time, the Valgrind\* tool is applied to both ranks allocated on `hostname_1` machine in case if it has Intel® microarchitecture codenamed Broadwell.

`-gtoolfile <gtool_config_file>`

Use this option to specify the `-gtool` parameters in a configuration file. All the same rules apply. Additionally, you can separate different command lines with section breaks.

For example, if `gtool_config_file` contains the following settings:

```
env VARIABLE1=value1 VARIABLE2=value2:3,5,7-9; env VARIABLE3=value3:0,11
env VARIABLE4=value4:1,12
```

The following command sets `VARIABLE1` and `VARIABLE2` for processes 3, 5, 7, 8, and 9 and sets `VARIABLE3` for processes 0 and 11, while `VARIABLE4` is set for processes 1 and 12:

```
$ mpirun -n 16 -gtoolfile gtool_config_file a.out
```

---

**NOTE** The options and the environment variable `-gtool`, `-gtoolfile` and `I_MPI_GTOOL` are mutually exclusive. The options `-gtool` and `-gtoolfile` are of the same priority and have higher priority than `I_MPI_GTOOL`. The first specified option in a command line is effective and the second one is ignored. Therefore, use `I_MPI_GTOOL` if you do not specify `-gtool` or `-gtoolfile`.

---

## cpuinfo

Provides information on processors used in the system.

### Syntax

```
cpuinfo [[-]<options>]
```

### Arguments

<code>&lt;options&gt;</code>	Sequence of one-letter options. Each option controls a specific part of the output data.
<code>g</code>	General information about single cluster node shows:

	<ul style="list-style-type: none"> <li>• the processor product name</li> <li>• the number of packages/sockets on the node</li> <li>• core and threads numbers on the node and within each package</li> <li>• SMT mode enabling</li> </ul>
i	<p>Logical processors identification table identifies threads, cores, and packages of each logical processor accordingly.</p> <ul style="list-style-type: none"> <li>• <i>Processor</i> - logical processor number.</li> <li>• <i>ThreadId</i> - unique processor identifier within a core.</li> <li>• <i>CoreId</i> - unique core identifier within a package.</li> <li>• <i>PackageId</i> - unique package identifier within a node.</li> </ul>
d	<p>Node decomposition table shows the node contents. Each entry contains the information on packages, cores, and logical processors.</p> <ul style="list-style-type: none"> <li>• <i>Package Id</i> - physical package identifier.</li> <li>• <i>Cores Id</i> - list of core identifiers that belong to this package.</li> <li>• <i>Processors Id</i> - list of processors that belong to this package. This list order directly corresponds to the core list. A group of processors enclosed in brackets belongs to one core.</li> </ul>
c	<p>Cache sharing by logical processors shows information of sizes and processors groups, which share particular cache level.</p> <ul style="list-style-type: none"> <li>• <i>Size</i> - cache size in bytes.</li> <li>• <i>Processors</i> - a list of processor groups enclosed in the parentheses those share this cache or no sharing otherwise.</li> </ul>
s	<p>Microprocessor signature hexadecimal fields (Intel platform notation) show signature values:</p> <ul style="list-style-type: none"> <li>• extended family</li> <li>• extended model</li> <li>• family</li> <li>• model</li> <li>• type</li> <li>• stepping</li> </ul>
f	<p>Microprocessor feature flags indicate what features the microprocessor supports. The Intel platform notation is used.</p>
n	<p>Table shows the following information about NUMA nodes:</p> <ul style="list-style-type: none"> <li>• <i>NUMA Id</i> - NUMA node identifier.</li> <li>• <i>Processors</i> - a list of processors in this node.</li> </ul> <p>If the node has no processors, the node is not shown.</p>
A	Equivalent to <code>gidcsf</code>
<code>gidc</code>	Default sequence
<code>?</code>	Utility usage info

**Description**

The `cpuinfo` utility prints out the processor architecture information that can be used to define suitable process pinning settings. The output consists of a number of tables. Each table corresponds to one of the single options listed in the arguments table.

**NOTE**

The architecture information is available on systems based on the Intel® 64 architecture.

The `cpuinfo` utility is available for both Intel microprocessors and non-Intel microprocessors, but it may provide only partial information about non-Intel microprocessors.

An example of the `cpuinfo` output:

```
$ cpuinfo -gdcs
===== Processor composition =====
Processor name   : Intel(R) Xeon(R)  X5570
Packages(sockets) : 2
Cores           : 8
Processors(CPUs) : 8
Cores per package : 4
Threads per core : 1
===== Processor identification =====
Processor      Thread Id.   Core Id.   Package Id.
0              0             0          0
1              0             0          1
2              0             1          0
3              0             1          1
4              0             2          0
5              0             2          1
6              0             3          0
7              0             3          1
===== Placement on packages =====
Package Id.    Core Id.      Processors
0              0,1,2,3      0,2,4,6
1              0,1,2,3      1,3,5,7
===== Cache sharing =====
Cache  Size      Processors
L1     32 KB      no sharing
L2     256 KB     no sharing
L3     8 MB       (0,2,4,6) (1,3,5,7)
===== Processor Signature =====
| xFamily | xModel | Type | Family | Model | Stepping |
|-----|-----|-----|-----|-----|-----|
| 00      | 1      | 0    | 6      | a     | 5        |
```

## impi\_info

Provides information on available Intel® MPI Library environment variables.

**Syntax**

`impi_info <options>`

**Arguments**

<code>&lt;options&gt;</code>	List of options.
<code>-a   -all</code>	Show all IMPI variables.
<code>-h   -help</code>	Show a help message.
<code>-v   -variable</code>	Show all available variables or description of the specified variable.

-c   -category	Show all available categories or variables of the specified category.
-e   -expert	Show all expert variables.

## Description

The `impi_info` utility provides information on environment variables available in the Intel MPI Library. For each variable, it prints out the name, the default value, and the value data type. By default, a reduced list of variables is displayed. Use the `-all` option to display all available variables with their descriptions.

The example of the `impi_info` output:

```
$ ./impi_info
```

NAME	DEFAULT VALUE	DATA TYPE
I_MPI_THREAD_SPLIT	0	MPI_INT
I_MPI_THREAD_RUNTIME	none	MPI_CHAR
I_MPI_THREAD_MAX	-1	MPI_INT
I_MPI_THREAD_ID_KEY	thread_id	MPI_CHAR

## mpitune

Tunes the Intel® MPI Library parameters for the given MPI application.

### Syntax

```
mpitune <options>
```

### Arguments

mpitune Options	Options
-c   --config-file <file>	Specify a configuration file to run a tuning session.
-d   --dump-file <file>	Specify a file that stores the collected results. The option is used in the analyze mode.
-m   --mode {collect   analyze}	Specify the <code>mpitune</code> mode. The supported modes are <code>collect</code> and <code>analyze</code> : <ul style="list-style-type: none"> <li>the <code>collect</code> mode runs the tuning process and saves results in temporary files;</li> <li>the <code>analyze</code> mode transforms temporary files into a JSON-tree, which is used by the Intel MPI Library, and generates a table that represents algorithm values in a human-readable format.</li> </ul>
-h   --help	Display the help message.
-v   --version	Display the product version.

## Description

The `mpitune` utility allows you to automatically adjust Intel MPI Library parameters, such as collective operation algorithms, to your cluster configuration or application.

The tuner iteratively launches a benchmarking application with different configurations to measure performance and stores the results of each launch. Based on these results, the tuner generates optimal values for the parameters being tuned.



**NOTE** Starting with the Intel MPI Library 2019 Update 4 release, you must specify two `mpitune` configuration files, which differ in their mode and dump-file fields. A simpler alternative may be to use one of the single configuration file templates shipped with the Intel MPI Library. In this case, you must use the command line to define the mode and dump-file fields.

- The `-mode` option defines one of two possible MPI tune modes: `collect` or `analyze`.
- The `-dump-file` option defines the path to the temporary files when in `analyze` mode. This path is returned by `mpitune` after the first iteration.

The configuration files should specify all tuner parameters, which are passed to the tuner with the `--config-file` option. A typical configuration file consists of the main section, specifying generic options, and search space sections for specific library parameters (for example, for specific collective operations). To comment a line, use the hash symbol `#`. All configuration file examples are available at `<installdir>/etc/tune_cfg`. Please note that configuration files for Intel® MPI Benchmarks are already created.

The tuning process consists of two steps: data collection (the `collect` mode) and data analysis (the `analyze` mode):

```
$ mpitune -m collect -c <path-to-config-file2>
$ mpitune -m analyze -c <path-to-config-file1>
```

Another variant of the launch is:

```
$ mpitune -m analyze -c <path-to-config-file1>
```

where the path to the dump-file received in the first step is used in the config file with templates inside.

The tuning results are presented as a JSON tree and can be added to the library with the `I_MPI_TUNING` environment variable.

## MPI Options Support

The following MPI options are available within the utility:

MPI Options	Description
<code>-f &lt;filename&gt;</code>	Specify a file containing host names.
<code>-hosts &lt;hostlist&gt;</code>	Specify a comma-separated list of hosts.
<code>-np &lt;value&gt;</code>	Specify the number of processes.

## Examples

```
$ mpitune -np 2 -ppn 1 -hosts HOST1,HOST2 -m collect -c <path-to-config-file2>
$ mpitune -np 2 -ppn 1 -hosts HOST1,HOST2 -m analyze -c <path-to-config-file1>
```

## Configuration File Format

All tuner parameters should be specified in two configuration files, passed to the tuner with the `--config-file` option. A typical configuration file consists of the main section, specifying generic options, and search space sections for specific library parameters (for example, for specific collective operations). Configuration files differ in mode and dump-file fields only. To comment a line, use the hash symbol `#`.

You can also specify MPI options to simplify `mpitune` usage. MPI options are useful for Intel® MPI Benchmarks that have special templates for `mpitune` located at `<install-dir>/etc/tune_cfg`. The templates require no changes in configuration files to be made.

For example, to tune the `Bcast` collective algorithm, use the following option:

```
$ mpitune -np 2 -ppn 2 -hosts HOST1 -m analyze -c <path-to-Bcast.cfg>
```

Experienced users can change configuration files to use this option for other applications.

## Output Format

The tuner presents results in a JSON tree view (since the 2019 release), where the `comm_id=-1` layer is added automatically for each tree:

```
{
  "coll=Reduce": {
    "ppn=2": {
      "comm_size=2": {
        "comm_id=-1": {
          "msg_size=243": {
            "REDUCE=8": {}
          },
          "msg_size=319": {
            "REDUCE=11": {}
          },
          "msg_size=8192": {
            "REDUCE=8": {}
          },
          "msg_size=28383": {
            "REDUCE=9": {}
          },
          "msg_size=-1": {
            "REDUCE=1": {}
          }
        }
      }
    }
  }
}
```

To add the resulting JSON tree to the library, use the `I_MPI_TUNING` environment variable.

## Old Output Format

The old output format is only valid for Intel MPI Library 2018 and prior versions:

```
I_MPI_ADJUST_BCAST=2:0-0;1:1-64;2:65-509;1:510-8832;3:8833-0
```

Use the resulting variable value with the application launch to achieve performance gain.

### See Also

[MPI Tuning](#) in the Developer Guide.

For available configuration options, refer to [mpitune Configuration Options](#).

## mpitune Configuration Options

### Application Options

#### -app

Sets a template for the command line to be launched to gather tuning results. The command line can contain variables declared as `@<var_name>@`. The variables are defined further on using other options.

For example:

```
-app: mpirun -np @np@ -ppn @ppn@ IMB-MPI1 -msglog 0:@logmax@ -npmin @np@ @func@
```

---

**NOTE** The application must produce output (in `stdout` or file or any other destination) that can be parsed by the tuner to pick the value to be tuned and other variables. See the `-app-regex` and `-app-regex-legend` options below for details.

---

### **-app-regex**

Sets a regular expression to be evaluated to extract the required values from the application output. Use regular expression groups to assign the values to variables. Variables and groups associations are set using the `-app-regex-legend` option.

For example, to extract the `#bytes` and `t_max[usec]` values from this output:

```
#bytes #repetitions t_min[usec] t_max[usec] t_avg[usec]
0      1000        0.06      0.06      0.06
1      1000        0.10      0.10      0.10
```

use the following configuration:

```
-app-regex: (\d+)\s+\d+\s+([\d.+-]+\s+)([\d.+-]+)
```

### **-app-regex-legend**

Specifies a list of variables extracted from the regular expression. Variables correspond to the regular expression groups. The tuner uses the last variable as the performance indicator of the launch. Use the `-tree-opt` to set the optimization direction of the indicator.

For example:

```
-app-regex-legend: size,time
```

### **-iter**

Sets the number of iterations for each launch with a given set of parameters. Higher numbers of iterations increase accuracy of results.

For example:

```
-iter: 3
```

### **Search Space Options**

Use these options to define a search space, which is a set of combinations of Intel® MPI Library parameters that the target application uses for launches. The library parameters are generally configured using run-time options or environment variables.

---

**NOTE** A search space line can be very long, so line breaking is available for all the search space options. Use a backslash to break a line (see examples below).

---

### **-search**

Defines the search space by defining variables declared with the `-app` option and by setting environment variables for the application launch.

For example:

```
-search: func=BCAST, \
np=4,ppn={1,4},{,I_MPI_ADJUST_BCAST=[1,3]},logmax=5
```

The `-app` variables are defined as `<var1>=<value1>[,<var2>=<value2>][, ...]`. The following syntax is available for setting values:

Syntax	Description	Examples
<code>&lt;value&gt;</code>	Single value. Can be a number or a string.	4
<code>{&lt;value1&gt;[,&lt;value2&gt;][, ...]}</code>	List of independent values.	{2,4}
<code>[&lt;start&gt;,&lt;end&gt;[,&lt;step&gt;]]</code>	Linear range of values with the default step of 1.	[1, 8, 2] — expands to {1, 2, 4, 6, 8}
<code>(&lt;start&gt;,&lt;end&gt;[,&lt;step&gt;])</code>	Exponential range with the default step of 2.	(1, 16) — expands to {1, 2, 4, 8, 16}

To set environment variables for the command launch, use the following syntax:

Syntax	Description	Examples
<code>&lt;variable&gt;=&lt;value&gt;</code>	Single variable definition. Any type of the syntax above can be used for the value: single values, lists or ranges.	<code>I_MPI_ADJUST_BCAST=3</code> <code>I_MPI_ADJUST_BCAST=[1, 3]</code>
<code>{, &lt;variable&gt;=&lt;value&gt;}</code>	A special case of the syntax above. When set this way, the variable default value is first used in an application launch.	<code>{, I_MPI_ADJUST_BCAST=[1, 3]}</code>
<code>&lt;prefix&gt;{&lt;value1&gt;[, &lt;value2&gt;][, ...]}</code>	Multi-value variable definition. Prefix is a common part for all the values, commonly the variable name. A value can be a singular value or a combination of values in the format: <code>&lt;prefix&gt;(&lt;value1&gt;[, &lt;value2&gt;][, ...])</code> . Prefix is optional and a value in the combination is a string, which can utilize the list and range syntax above.	<code>I_MPI_ADJUST_ALLREDUCE{=1, =2, (=9, _KN_RADIX=(2, 8))}</code>  See below for a more complete example.

The following example shows a more complex option definition:

```
I_MPI_ADJUST_BCAST{=1, =2, (=9, _KN_RADIX=(2, 8)), (= {10, 11}, _SHM_KN_RADIX=[2, 8, 2])}
```

This directive consecutively runs the target application with the following environment variables set:

```
I_MPI_ADJUST_BCAST=1
I_MPI_ADJUST_BCAST=2
I_MPI_ADJUST_BCAST=9, I_MPI_ADJUST_BCAST_KN_RADIX=2
I_MPI_ADJUST_BCAST=9, I_MPI_ADJUST_BCAST_KN_RADIX=4
I_MPI_ADJUST_BCAST=9, I_MPI_ADJUST_BCAST_KN_RADIX=8
I_MPI_ADJUST_BCAST=10, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=2
I_MPI_ADJUST_BCAST=10, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=4
I_MPI_ADJUST_BCAST=10, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=6
I_MPI_ADJUST_BCAST=10, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=8
I_MPI_ADJUST_BCAST=11, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=2
I_MPI_ADJUST_BCAST=11, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=4
I_MPI_ADJUST_BCAST=11, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=6
I_MPI_ADJUST_BCAST=11, I_MPI_ADJUST_BCAST_SHM_KN_RADIX=8
```

## -search-excl

Excludes certain combinations from the search space. The syntax is identical to that of the `-search` option. For example:

```
-search-excl: I_MPI_ADJUST_BCAST={1,2}
```

or

```
-search-excl: func=BCAST,np=4,ppn=1,I_MPI_ADJUST_BCAST=1
```

## -search-only

Defines a subset of the search space to search in. Only this subset is used for application launches. The syntax is identical to the `-search` option.

This option is useful for the second and subsequent tuning sessions on a subset of parameters from the original session, without creating a separate configuration file.

## Output Options

Use these options to customize the output. The tuner can produce output of two types:

- `table`— useful for verifying the tuning results, contains values from all the application launches
- `tree`— an internal output format, contains the optimal values

## -table

Defines the layout for the resulting output table. The option value is a list of variables declared with the `-app` option, which are joined in colon-separated groups. Each group denotes a specific part of the table.

For example:

```
-table: func:ppn,np:size:*:time
```

The last group variables (`time`) are rendered in table cells. The second last group variables are used for building table columns (`*`, denotes all the variables not present the other variable groups). The third last group variables are used for building table rows (`size`). All other variable groups are used to make up the table label. Groups containing several variables are complex groups and produce output based on all the value combinations.

For example, the option definition above can produce the following output:

```
Label: "func=BCAST,ppn=2,np=2"
```

```
Legend:
```

```
set 0: ""
```

```
set 1: "I_MPI_ADJUST_BCAST=1"
```

```
set 2: "I_MPI_ADJUST_BCAST=2"
```

```
set 3: "I_MPI_ADJUST_BCAST=3"
```

```
Table:
```

	set 0	set 1	set 2	set 3
"size=0"	"time=0.10"	"time=0.08"	"time=0.11"	"time=0.10"
	"time=0.12"	"time=0.09"	"time=0.12"	"time=0.11"
		"time=0.10"		
"size=4"	"time=1.12"	"time=1.11"	"time=1.94"	"time=1.72"
	"time=1.35"	"time=1.18"	"time=1.97"	"time=1.81"
	"time=1.38"	"time=1.23"	"time=2.11"	"time=1.89"

```

-----|-----|-----|-----|-----
"size=8" | "time=1.21" | "time=1.10" | "time=1.92" | "time=1.72"
        | "time=1.36" | "time=1.16" | "time=2.01" | "time=1.75"
        | "time=1.37" | "time=1.17" | "time=2.24" | "time=1.87"
-----|-----|-----|-----|-----
...

```

Cells include only unique values from all the launches for the given parameter combination. The number of launches is set with the `-iter` option.

## **-table-ignore**

Specifies the variables to ignore from the `-table` option definition.

## **-tree**

Defines the layout for the resulting tree of optimal values of the parameter that is tuned (for example, collective operation algorithms). The tree is rendered as a JSON structure. The option value is a list of variables declared with the `-app` option, which are joined in colon-separated groups. Each group denotes a specific part of the tree. Groups containing several variables are complex groups and produce output based on all the value combinations.

Example:

```
-tree: func:ppn,np:size:*:time
```

The first two groups (`func` and `ppn,np`) make up the first two levels of the tree. The last group variables (`time`) are used as the optimization criteria and are not rendered. The second last group contains variables to be optimized (`*`, denotes all the variables not present the other variable groups). The third last group variables are used to split the search space into intervals based on the optimal values of parameters from the next group (for example, `I_MPI_ADJUST_<operation>` algorithm numbers).

For example, the option definition above can produce the following output:

```

{
  "func=BCAST":
  {
    "ppn=1,np=4":
    {
      "size=0":
        {"I_MPI_ADJUST_BCAST": "3"},
      "size=64":
        {"I_MPI_ADJUST_BCAST": "1"},
      "size=512":
        {"I_MPI_ADJUST_BCAST": "2"},
      ...
    }
  }
}

```

This tree representation is an intermediate format of tuning results and is ultimately converted to a string that the library can understand. The conversion script is specified with `-tree-postprocess` option.

## **-tree-ignore**

Specifies the variables to ignore from the `-tree` option definition.

**-tree-intervals**

Specifies the maximum number of intervals where the optimal parameter value is applied. If not specified, any number of intervals is allowed.

**-tree-tolerance**

Specifies the tolerance level. Non-zero tolerance (for example, 0.03 for 3%) joins resulting intervals with the performance indicator value varying by the specified tolerance.

**-tree-postprocess**

Specifies an executable to convert the resulting JSON tree to a custom format.

**-tree-opt**

Specifies the optimization direction. The available values are `max` (default) and `min`.

**-tree-file**

Specifies a log file where the tuning results are saved.

**-tree-view**

Specify the mode to present the json-tree. The available values are "simple" and "default". The "default" mode enables an interpolation mechanism; the "simple" mode disables the interpolation mechanism. The resulting tree contains message sizes used during the launch.

**-mode**

Specifies the mpitune mode. The available values are "collect" for gathering data and "analyze" for converting this data to a JSON-tree. Note that the `-mode` field can be defined in the configuration file as macros `@-mode@`, although the real value must be defined in the command line.

**-dump-file**

Specifies the path for the dump-file, which is returned by mpitune after the first iteration. The first iteration can be initialized by way of "" (an empty string). Note that the `-dump-file` field can be defined in the configuration file as macros `@-dump-file@`, although the real value must be defined in the command line.

**mpitune\_fast**

This utility tunes the Intel® MPI Library to the cluster configuration using the [Autotuning](#) functionality.

**Syntax**

```
mpitune_fast <options>
```

**Arguments**

Options	Description
<code>-c   --colls</code>	Set custom collective operations to tune, delimited by commas.
<code>-d   --results_dir &lt;path-to-results-dir&gt;</code>	Set custom directory for tuning results, host files, and logs. Default: the current working directory.
<code>-h   --help</code>	Display the help message.
<code>-n &lt;n&gt;</code>	Specify the number of nodes. This can be a comma-delimited set of values to set up several launches.
<code>-pd &lt;path-to-performance-results-dir&gt;</code> ,	Set a custom directory for validation performance results.

Options	Description
<code>--perf_results_dir &lt;path-to-performance-results-dir&gt;</code>	Default: <code>performance_results_&lt;timestamp&gt;</code> .
<code>-ppn &lt;n&gt;</code>	Specify the number of processes per node. This can be a comma-delimited set of values to set up several launches.
<code>-val &lt;path-to-tuning-file&gt;</code> ,	Run the tuning file validation cycle to validate the existing tuning file.
<code>--validate &lt;path-to-tuning-file&gt;</code>	

## Description

The `mpitune_fast` utility allows you to automatically set up the Intel MPI Library and launch with Autotuning enabled and configured for your cluster configuration.

The tool iteratively launches the [Intel® MPI Benchmarks](#) utility with the proper autotuner environment and generates a `.dat` file with the tuning parameters for your cluster configuration.

After generation the tuning file, set it as `I_MPI_TUNING_BIN`:

```
$ export I_MPI_TUNING_BIN=./tuning_results.dat
$ mpiexec <args>
```

## Workload Managers Support

`mpitune_fast` supports Slurm and LSF workload managers. It automatically defines job allocated hosts and performs launches.

## MPI Options Support

The following MPI options are available within the utility:

Options	Description
<code>-f &lt;filename&gt;</code>	Specify a file containing host names.
<code>-hosts HOSTS, --hosts HOSTS</code>	Set the host names, delimited by commas. Example: <code>--hosts host1,host2</code>

### Example (default launch):

```
$ mpitune_fast -f ./hostfile
```

### Example (customized launch):

```
$ mpitune_fast -ppn 8,4,2,1 -f ./hostfile -c alltoall,allreduce,barrier
```

## See Also

[Autotuning](#)

[mpitune](#)

[MPI Tuning in the Intel MPI Library Developer Guide](#)

For available configuration options, refer to [mpitune Configuration Options](#).

[Cluster-Wide MPI Tuning Using Intel® MPI Library](#)



# Environment Variable Reference

This section provides information on different variables:

- [Compilation Environment Variables](#)
- [Hydra Environment Variables](#)
- [I\\_MPI\\_ADJUST Family Environment Variables](#)
- [Tuning Environment Variables](#)
- [Environment Variables for Process Pinning](#)
- [Environment Variables for Fabrics Control](#)
- [Environment Variables for Asynchronous Progress Control](#)
- [Environment Variables for Multi-EP](#)
- [Other Environment Variables](#)

## Compilation Environment Variables

### I\_MPI\_{CC,CXX,FC,F77,F90}\_PROFILE

Specify the default profiling library.

#### Syntax

```
I_MPI_CC_PROFILE=<profile-name>
```

```
I_MPI_CXX_PROFILE=<profile-name>
```

```
I_MPI_FC_PROFILE=<profile-name>
```

```
I_MPI_F77_PROFILE=<profile-name>
```

```
I_MPI_F90_PROFILE=<profile-name>
```

#### Argument

```
<profile-name>
```

Specify a default profiling library.

#### Description

Set this environment variable to select a specific MPI profiling library to be used by default. This has the same effect as using `-profile=<profile-name>` as an argument for `mpiicc` or another Intel® MPI Library compiler wrapper.

### I\_MPI\_TRACE\_PROFILE

Specify the default profile for the `-trace` option.

#### Syntax

```
I_MPI_TRACE_PROFILE=<profile-name>
```

#### Argument

```
<profile-name>
```

Specify a tracing profile name. The default value is `vt`.

#### Description

Set this environment variable to select a specific MPI profiling library to be used with the `-trace` option of `mpiicc` or another Intel MPI Library compiler wrapper.

The `I_MPI_{CC,CXX,F77,F90}_PROFILE` environment variable overrides `I_MPI_TRACE_PROFILE`.

## I\_MPI\_CHECK\_PROFILE

Specify the default profile for the `-check_mpi` option.

### Syntax

`I_MPI_CHECK_PROFILE=<profile-name>`

### Argument

<code>&lt;profile-name&gt;</code>	Specify the checking profile name. The default value is <code>vtmc</code> .
-----------------------------------	---

### Description

Set this environment variable to select a specific MPI checking library to be used with the `-check_mpi` option to `mpiicc` or another Intel MPI Library compiler wrapper.

The `I_MPI_{CC,CXX,F77,F90}_PROFILE` environment variable overrides `I_MPI_CHECK_PROFILE`.

## I\_MPI\_CHECK\_COMPILER

Turn on/off compiler compatibility check.

### Syntax

`I_MPI_CHECK_COMPILER=<arg>`

### Arguments

<code>&lt;arg&gt;</code>	Binary indicator.
<code>enable   yes   on   1</code>	Enable checking the compiler.
<code>disable   no   off   0</code>	Disable checking the compiler. This is the default value.

### Description

If `I_MPI_CHECK_COMPILER` is set to `enable`, the Intel MPI Library compiler wrapper checks the underlying compiler for compatibility. Normal compilation requires using a known version of the underlying compiler.

## I\_MPI\_{CC,CXX,FC,F77,F90}

Set the path/name of the underlying compiler to be used.

### Syntax

`I_MPI_CC=<compiler>`

`I_MPI_CXX=<compiler>`

`I_MPI_FC=<compiler>`

`I_MPI_F77=<compiler>`

`I_MPI_F90=<compiler>`

### Arguments

<code>&lt;compiler&gt;</code>	Specify the full path/name of compiler to be used.
-------------------------------	--

### Description

Set this environment variable to select a specific compiler to be used. Specify the full path to the compiler if it is not located in the search path.

---

**NOTE** Some compilers may require additional command line options.

---

---

**NOTE** The configuration file is sourced if it exists for a specified compiler. See [-config](#) for details.

---

## I\_MPI\_ROOT

Set the Intel MPI Library installation directory path.

### Syntax

```
I_MPI_ROOT=<path>
```

### Arguments

<path>	Specify the installation directory of the Intel MPI Library.
--------	--

### Description

Set this environment variable to specify the installation directory of the Intel MPI Library.

---

**NOTE** If you are using the Visual Studio integration, you may need to use `I_MPI_ONEAPI_ROOT`.

---

## VT\_ROOT

Set Intel® Trace Collector installation directory path.

### Syntax

```
VT_ROOT=<path>
```

### Arguments

<path>	Specify the installation directory of the Intel Trace Collector.
--------	--

### Description

Set this environment variable to specify the installation directory of the Intel Trace Collector.

## I\_MPI\_COMPILER\_CONFIG\_DIR

Set the location of the compiler configuration files.

### Syntax

```
I_MPI_COMPILER_CONFIG_DIR=<path>
```

### Arguments

<path>	Specify the location of the compiler configuration files. The default value is <code>&lt;install-dir&gt;/etc</code>
--------	--

### Description

Set this environment variable to change the default location of the compiler configuration files.

## I\_MPI\_LINK

Select a specific version of the Intel MPI Library for linking.

### Syntax

```
I_MPI_LINK=<arg>
```

### Arguments

Argument	Library Version
opt	Multi-threaded optimized library (with the global lock). This is the default value
dbg	Multi-threaded debug library (with the global lock)
opt_mt	Multi-threaded optimized library (with per-object lock for the thread-split model)
dbg_mt	Multi-threaded debug library (with per-object lock for the thread-split model)

## Description

Set this variable to always link against the specified version of the Intel MPI Library.

## I\_MPI\_DEBUG\_INFO\_STRIP-

Turn on/off the debug information stripping while linking applications statically.

### Syntax

I\_MPI\_DEBUG\_INFO\_STRIP=<arg>

### Arguments

<arg>	Binary indicator
enable   yes   on   1	Turn on. This is the default value
disable   no   off   0	Turn off

## Description

Use this option to turn on/off the debug information stripping while linking the Intel MPI Library statically. Debug information is stripped by default.

## I\_MPI\_{C,CXX,FC,F}FLAGS

Set special flags needed for compilation.

### Syntax

I\_MPI\_CFLAGS=<flags>

I\_MPI\_CXXFLAGS=<flags>

I\_MPI\_FCFLAGS=<flags>

I\_MPI\_FFLAGS=<flags>

### Arguments

<flags>	Flag list
---------	-----------

## Description

Use this environment variable to specify special compilation flags.

## I\_MPI\_LDFLAGS

Set special flags needed for linking.

### Syntax

I\_MPI\_LDFLAGS=<flags>

### Arguments

<flags>	Flag list
---------	-----------

**Description**

Use this environment variable to specify special linking flags.

**I\_MPI\_FORT\_BIND**

Disable `mpicc` linking with Fortran bindings.

**Syntax**

```
I_MPI_FORT_BIND=<arg>
```

**Arguments**

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Enable linking. This is the default value
<code>disable   no   off   0</code>	Disable linking

**Description**

By default, the `mpicc` also links against the Fortran bindings even if Fortran is not used. Use this environment variable to change this default behavior. Has the same effect as the `-nofortbind` option.

## Hydra Environment Variables

**I\_MPI\_HYDRA\_HOST\_FILE**

Set the host file to run the application.

**Syntax**

```
I_MPI_HYDRA_HOST_FILE=<arg>
```

**Argument**

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;hostsfile&gt;</code>	The full or relative path to the host file

**Description**

Set this environment variable to specify the hosts file.

**I\_MPI\_HYDRA\_HOSTS\_GROUP**

Set node ranges using brackets, commas, and dashes.

**Syntax**

```
I_MPI_HYDRA_HOSTS_GROUP=<arg>
```

**Argument**

<code>&lt;arg&gt;</code>	Set a node range.
--------------------------	-------------------

**Description**

Set this variable to be able to set node ranges using brackets, commas, and dashes (like in Slurm\* Workload Manager). For example:

```
I_MPI_HYDRA_HOSTS_GROUP="hostA[01-05],hostB,hostC[01-05,07,09-11]"
```

You can set node ranges with the `-hosts-group` option.

## I\_MPI\_HYDRA\_DEBUG

Print out the debug information.

### Syntax

`I_MPI_HYDRA_DEBUG=<arg>`

### Argument

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Turn on the debug output
<code>disable   no   off   0</code>	Turn off the debug output. This is the default value

### Description

Set this environment variable to enable the debug mode.

## I\_MPI\_HYDRA\_ENV

Control the environment propagation.

### Syntax

`I_MPI_HYDRA_ENV=<arg>`

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>all</code>	Pass all environment to all MPI processes

### Description

Set this environment variable to control the environment propagation to the MPI processes. By default, the entire launching node environment is passed to the MPI processes. Setting this variable also overwrites environment variables set by the remote shell.

## I\_MPI\_JOB\_TIMEOUT

Set the timeout period for `mpiexec.hydra`.

### Syntax

`I_MPI_JOB_TIMEOUT=<timeout>`

`I_MPI_MPIEXEC_TIMEOUT=<timeout>`

### Argument

<code>&lt;timeout&gt;</code>	Define <code>mpiexec.hydra</code> timeout period in seconds
<code>&lt;n&gt; ≥ 0</code>	The value of the timeout period. The default timeout value is zero, which means no timeout.

### Description

Set this environment variable to make `mpiexec.hydra` terminate the job in `<timeout>` seconds after its launch. The `<timeout>` value should be greater than zero. Otherwise the environment variable setting is ignored.

## I\_MPI\_JOB\_STARTUP\_TIMEOUT

Set the `mpiexec.hydra` job startup timeout.

### Syntax

`I_MPI_JOB_STARTUP_TIMEOUT=<timeout>`

**Argument**

<code>&lt;timeout&gt;</code>	Define <code>mpiexec.hydra</code> startup timeout period in seconds
<code>&lt;n&gt; ≥ 0</code>	The value of the timeout period. The default timeout value is zero, which means no timeout.

**Description**

Set this environment variable to make `mpiexec.hydra` terminate the job in `<timeout>` seconds if some processes are not launched. The `<timeout>` value should be greater than zero.

**I\_MPI\_JOB\_TIMEOUT\_SIGNAL**

Define the signal to be sent when a job is terminated because of a timeout.

**Syntax**

`I_MPI_JOB_TIMEOUT_SIGNAL=<number>`

**Argument**

<code>&lt;number&gt;</code>	Define the signal number
<code>&lt;n&gt;&gt; 0</code>	The signal number. The default value is 9 (SIGKILL)

**Description**

Define a signal number to be sent to stop the MPI job if the timeout period specified by the `I_MPI_JOB_TIMEOUT` environment variable expires. If you set a signal number unsupported by the system, the `mpiexec.hydra` command prints a warning message and continues the task termination using the default signal number 9 (SIGKILL).

**I\_MPI\_JOB\_ABORT\_SIGNAL**

Define a signal to be sent to all processes when a job is terminated unexpectedly.

**Syntax**

`I_MPI_JOB_ABORT_SIGNAL=<number>`

**Argument**

<code>&lt;number&gt;</code>	Define signal number
<code>&lt;n&gt;&gt; 0</code>	The default value is 9 (SIGKILL)

**Description**

Set this environment variable to define a signal for task termination. If you set an unsupported signal number, `mpiexec.hydra` prints a warning message and uses the default signal 9 (SIGKILL).

**I\_MPI\_JOB\_SIGNAL\_PROPAGATION**

Control signal propagation.

**Syntax**

`I_MPI_JOB_SIGNAL_PROPAGATION=<arg>`

**Argument**

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Turn on propagation
<code>disable   no   off   0</code>	Turn off propagation. This is the default value

**Description**

Set this environment variable to control propagation of the signals (SIGINT, SIGALRM, and SIGTERM). If you enable signal propagation, the received signal is sent to all processes of the MPI job. If you disable signal propagation, all processes of the MPI job are stopped with the default signal 9 (SIGKILL).

## I\_MPI\_HYDRA\_BOOTSTRAP

Set the bootstrap server.

### Syntax

I\_MPI\_HYDRA\_BOOTSTRAP=<arg>

### Argument

<arg>	String parameter
ssh	Use secure shell. This is the default value
rsh	Use remote shell
pdsh	Use parallel distributed shell
pbsdsh	Use Torque* and PBS* pbsdsh command
fork	Use fork call
slurm	Use Slurm* srun command
ll	Use LoadLeveler* llspawn.studio command
lsf	Use LSF* blaunch command
sge	Use Univa* Grid Engine* qcrsh command

### Description

Set this environment variable to specify the bootstrap server.

## I\_MPI\_HYDRA\_BOOTSTRAP\_EXEC

Set the executable file to be used as a bootstrap server.

### Syntax

I\_MPI\_HYDRA\_BOOTSTRAP\_EXEC=<arg>

### Argument

<arg>	String parameter
<executable>	The name of the executable file

### Description

Set this environment variable to specify the executable file to be used as a bootstrap server.

## I\_MPI\_HYDRA\_BOOTSTRAP\_EXEC\_EXTRA\_ARGS

Set additional arguments for the bootstrap server.

### Syntax

I\_MPI\_HYDRA\_BOOTSTRAP\_EXEC\_EXTRA\_ARGS=<arg>

### Argument

<arg>	String parameter
<args>	Additional bootstrap server arguments

### Description

Set this environment variable to specify additional arguments for the bootstrap server.



---

**NOTE** If the launcher (blaunch, lsf, pdsh, pbsdsh) falls back to ssh, pass the arguments with the invocation of ssh.

---

## I\_MPI\_HYDRA\_BOOTSTRAP\_AUTOFORK

Control the usage of `fork` call for local processes.

`I_MPI_HYDRA_BOOTSTRAP_AUTOFORK = <arg>`

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>enable   yes   on   1</code>	Use <code>fork</code> for the local processes. This is default value for <code>ssh</code> , <code>rsh</code> , <code>ll</code> , <code>lsf</code> , and <code>pbsdsh</code> bootstrap servers
<code>disable   no   off   0</code>	Do not use <code>fork</code> for the local processes. This is default value for the <code>sge</code> bootstrap server

### Description

Set this environment variable to control usage of `fork` call for the local processes.

---

**NOTE** This option is not applicable to `slurm` and `pdsh` bootstrap servers.

---

## I\_MPI\_HYDRA\_RMK

Use the specified value as the resource management kernel to obtain data about available nodes, externally set process counts.

### Syntax

`I_MPI_HYDRA_RMK=<arg>`

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;rmk&gt;</code>	Resource management kernel. The supported values are <code>slurm</code> , <code>ll</code> , <code>lsf</code> , <code>sge</code> , <code>pbs</code> , <code>cobalt</code> .

### Description

Set this environment variable to use the resource management kernel.

## I\_MPI\_HYDRA\_PMI\_CONNECT

Define the processing method for PMI messages.

### Syntax

`I_MPI_HYDRA_PMI_CONNECT=<value>`

### Argument

<code>&lt;value&gt;</code>	The algorithm to be used
<code>nocache</code>	Do not cache PMI messages
<code>cache</code>	Cache PMI messages on the local <code>pmi_proxy</code> management processes to minimize the number of PMI requests. Cached information is automatically propagated to child management processes.
<code>lazy-cache</code>	cache mode with on-demand propagation.

<code>alltoall</code>	Information is automatically exchanged between all <code>pmi_proxy</code> before any get request can be done. This is the default value.
-----------------------	--

**Description**

Use this environment variable to select the PMI messages processing method.

## I\_MPI\_PERHOST

Define the default behavior for the `-perhost` option of the `mpiexec.hydra` command.

**Syntax**

`I_MPI_PERHOST=<value>`

**Argument**

<code>&lt;value&gt;</code>	Define a value used for <code>-perhost</code> by default
<code>integer &gt; 0</code>	Exact value for the option
<code>all</code>	All logical CPUs on the node
<code>allcores</code>	All cores (physical CPUs) on the node. This is the default value.

**Description**

Set this environment variable to define the default behavior for the `-perhost` option. Unless specified explicitly, the `-perhost` option is implied with the value set in `I_MPI_PERHOST`.

**NOTE**

When running under a job scheduler, this environment variable is ignored by default. To control process placement with `I_MPI_PERHOST`, disable the `I_MPI_JOB_RESPECT_PROCESS_PLACEMENT` variable.

## I\_MPI\_JOB\_TRACE\_LIBS

Choose the libraries to preload through the `-trace` option.

**Syntax**

`I_MPI_JOB_TRACE_LIBS=<arg>`

**Argument**

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;list&gt;</code>	Blank separated list of the libraries to preload. The default value is <code>vt</code>

**Description**

Set this environment variable to choose an alternative library for preloading through the `-trace` option.

## I\_MPI\_JOB\_CHECK\_LIBS

Choose the libraries to preload through the `-check_mpi` option.

**Syntax**

`I_MPI_JOB_CHECK_LIBS=<arg>`

**Argument**

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;list&gt;</code>	Blank separated list of the libraries to preload. The default value is <code>vtmc</code>

**Description**

Set this environment variable to choose an alternative library for preloading through the `-check_mpi` option.

**I\_MPI\_HYDRA\_BRANCH\_COUNT**

Set the hierarchical branch count.

**Syntax**

```
I_MPI_HYDRA_BRANCH_COUNT = <num>
```

**Argument**

<code>&lt;num&gt;</code>	Number
<code>&lt;n&gt; &gt;= 0</code>	The default value is 16. This value means that hierarchical structure is enabled if the number of nodes is more than 16.  If <code>I_MPI_HYDRA_BRANCH_COUNT=0</code> , then there is no hierarchical structure.  If <code>I_MPI_HYDRA_BRANCH_COUNT=-1</code> , then branch count is equal to default value.

**Description**

Set this environment variable to restrict the number of child management processes launched by the `mpiexec.hydra` operation or by each `pmi_proxy` management process.

**I\_MPI\_HYDRA\_PMI\_AGGREGATE**

Turn on/off aggregation of the PMI messages.

**Syntax**

```
I_MPI_HYDRA_PMI_AGGREGATE=<arg>
```

**Argument**

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Enable PMI message aggregation. This is the default value.
<code>disable   no   off   0</code>	Disable PMI message aggregation.

**Description**

Set this environment variable to enable/disable aggregation of PMI messages.

**I\_MPI\_HYDRA\_GDB\_REMOTE\_SHELL**

Set the remote shell command to run the GDB debugger. This command uses the Intel® Distribution for GDB.

**Syntax**

```
I_MPI_HYDRA_GDB_REMOTE_SHELL=<arg>
```

**Argument**

<code>&lt;arg&gt;</code>	String parameter
<code>ssh</code>	Secure Shell (SSH). This is the default value
<code>rsh</code>	Remote shell (RSH)

**Description**

Set this environment variable to specify the remote shell command to run the GNU\* debugger on the remote machines. You can use this environment variable to specify any shell command that has the same syntax as SSH or RSH.

## I\_MPI\_HYDRA\_IFACE

Set the network interface.

### Syntax

```
I_MPI_HYDRA_IFACE=<arg>
```

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;network interface&gt;</code>	The network interface configured in your system

### Description

Set this environment variable to specify the network interface to use. For example, use "-iface ib0", if the IP emulation of your InfiniBand\* network is configured on `ib0`.

## I\_MPI\_HYDRA\_DEMUX

Set the demultiplexer (demux) mode.

### Syntax

```
I_MPI_HYDRA_DEMUX=<arg>
```

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>poll</code>	Set <code>poll</code> as the multiple I/O demultiplexer (demux) mode engine. This is the default value.
<code>select</code>	Set <code>select</code> as the multiple I/O demultiplexer (demux) mode engine

### Description

Set this environment variable to specify the multiple I/O demux mode engine. The default value is `poll`.

## I\_MPI\_TMPDIR

Specify a temporary directory.

### Syntax

```
I_MPI_TMPDIR=<arg>
```

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;path&gt;</code>	Temporary directory. The default value is <code>/tmp</code>

### Description

Set this environment variable to specify a directory for temporary files.

## I\_MPI\_JOB\_RESPECT\_PROCESS\_PLACEMENT

Specify whether to use the process-per-node placement provided by the job scheduler, or set explicitly.

### Syntax

```
I_MPI_JOB_RESPECT_PROCESS_PLACEMENT=<arg>
```

**Argument**

<code>&lt;value&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Use the process placement provided by job scheduler. This is the default value
<code>disable   no   off   0</code>	Do not use the process placement provided by job scheduler

**Description**

If the variable is set, the Hydra process manager uses the process placement provided by job scheduler (default). In this case the `-ppn` option and its equivalents are ignored. If you disable the variable, the Hydra process manager uses the process placement set with `-ppn` or its equivalents.

**I\_MPI\_GTOOL**

Specify the tools to be launched for selected ranks. An alternative to this variable is the `-gtool` option.

**Syntax**

```
I_MPI_GTOOL="<command line for a tool 1>:<ranks set 1>[=exclusive][@arch 1]; <command line for a tool 2>:<ranks set 2>[=exclusive][@arch 2]; ... ;<command line for a tool n>:<ranks set n>[=exclusive][@arch n]"
```

**Argument**

<code>&lt;arg&gt;</code>	Parameters
<code>&lt;command-line-for-a-tool&gt;</code>	Specify a tool's launch command, including parameters.
<code>&lt;rank set&gt;</code>	Specify the range of ranks that are involved in the tool execution. Separate ranks with a comma or use the '-' symbol for a set of contiguous ranks. To run the tool for all ranks, use the <code>all</code> argument.
	<b>NOTE</b> If you specify incorrect rank index, the corresponding warning is printed and the tool continues working for valid ranks.
<code>[=exclusive]</code>	Specify this parameter to prevent launching a tool for more than one rank per host. This parameter is optional.
<code>[@arch]</code>	Specify the architecture on which the tool runs (optional). For a given <code>&lt;rank set&gt;</code> , if you specify this argument, the tool is launched only for the processes residing on hosts with the specified architecture. This parameter is optional.

**Description**

Use this option to launch the tools such as Intel® VTune™ Amplifier XE, Valgrind\*, and GNU\* Debugger for the specified processes.

**Examples**

The following command line examples demonstrate different scenarios of using the `I_MPI_GTOOL` environment variable.

Launch Intel® VTune™ Amplifier XE and Valgrind\* by setting the `I_MPI_GTOOL` environment variable:

```
$ export I_MPI_GTOOL="vtune -collect hotspots -analyze-system -r result1:5,3,7-9=exclusive@bdw;\
valgrind -log-file=log_%p:0,1,10-12@hsw"
$ mpiexec.hydra -n 16 a.out
```

This command launches `vtune` for the processes that are run on the Intel® microarchitecture codenamed Broadwell. Only one copy of `vtune` is launched for each host, the process with the minimal index is affected. At the same time, `Valgrind*` is launched for all specified processes that are run on the Intel® microarchitecture codenamed Haswell. Valgrind's results are saved to the files `log_<process ID>`.

Launch GDB by setting the `I_MPI_GTOOL` environment variable (for Intel® oneAPI, this launches the Intel® Distribution for GDB):

```
$ mpiexec.hydra -n 16 -genv I_MPI_GTOOL="gdb:3,5,7-9" a.out
```

Use this command to apply GDB to the given rank set.

---

**NOTE** The options and the environment variable `-gtool`, `-gtoolfile` and `I_MPI_GTOOL` are mutually exclusive. The options `-gtool` and `-gtoolfile` are of the same priority and have higher priority than `I_MPI_GTOOL`. The first specified option in a command line is effective and the second one is ignored. Therefore, use `I_MPI_GTOOL` if you do not specify `-gtool` or `-gtoolfile`.

---

## I\_MPI\_HYDRA\_TOPOLIB

Set the interface for topology detection.

### Syntax

```
I_MPI_HYDRA_TOPOLIB=<arg>
```

### Argument

<code>&lt;arg&gt;</code>	String parameter
<code>hwloc</code>	The <code>hwloc*</code> library functions are invoked for topology detection.

### Description

Set this environment variable to define the interface for platform detection. The `hwloc*` interface is used by default, but you may explicitly set the variable to use the native Intel MPI Library interface:

```
I_MPI_HYDRA_TOPOLIB=ipl.
```

## I\_MPI\_PORT\_RANGE

Specify a range of allowed port numbers.

### Syntax

```
I_MPI_PORT_RANGE=<range>
```

### Argument

<code>&lt;range&gt;</code>	String parameter
<code>&lt;min&gt;:&lt;max&gt;</code>	Allowed port range

### Description

Set this environment variable to specify a range of the allowed port numbers for the Intel® MPI Library.

## I\_MPI\_SILENT\_ABORT

Control abort warning messages.

### Syntax

```
I_MPI_SILENT_ABORT=<arg>
```

### Argument

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Do not print abort warning message
<code>disable   no   off   0</code>	Print abort warning message. This is the default value

**Description**

Set this variable to disable printing of abort warning messages. The messages are printed in case of the `MPI_Abort` call.

You can also disable printing of these messages with the `-silent-abort` option.

**I\_MPI\_HYDRA\_NAMESERVER**

Specify the nameserver.

**Syntax**

```
I_MPI_HYDRA_NAMESERVER=<arg>
```

**Argument**

<code>&lt;arg&gt;</code>	String parameter
<code>&lt;hostname&gt;:&lt;port&gt;</code>	Set the hostname and the port.

**Description**

Set this variable to specify the nameserver for your MPI application in the following format:

```
I_MPI_HYDRA_NAMESERVER = hostname:port
```

You can set the nameserver with the `-nameserver` option.

**I\_MPI\_ADJUST Family Environment Variables****I\_MPI\_ADJUST\_<opname>**

Control collective operation algorithm selection.

**Syntax**

```
I_MPI_ADJUST_<opname>="<presetid>[:<conditions>][;<presetid>:<conditions>[...]]"
```

**Arguments**

<code>&lt;presetid&gt;</code>	Preset identifier
<code>&gt;= 0</code>	Set a number to select the desired algorithm. The value 0 uses basic logic of the collective algorithm selection.
<code>&lt;conditions&gt;</code>	A comma separated list of conditions. An empty list selects all message sizes and process combinations
<code>&lt;l&gt;</code>	Messages of size <code>&lt;l&gt;</code>
<code>&lt;l&gt;-&lt;m&gt;</code>	Messages of size from <code>&lt;l&gt;</code> to <code>&lt;m&gt;</code> , inclusive
<code>&lt;l&gt;@&lt;p&gt;</code>	Messages of size <code>&lt;l&gt;</code> and number of processes <code>&lt;p&gt;</code>
<code>&lt;l&gt;-&lt;m&gt;@&lt;p&gt;-&lt;q&gt;</code>	Messages of size from <code>&lt;l&gt;</code> to <code>&lt;m&gt;</code> and number of processes from <code>&lt;p&gt;</code> to <code>&lt;q&gt;</code> , inclusive

**Description**

Set this environment variable to select the desired algorithm(s) for the collective operation `<opname>` under particular conditions. Each collective operation has its own environment variable and algorithms.

## Environment Variables, Collective Operations, and Algorithms

Environment Variable	Collective Operation	Algorithms
I_MPI_ADJUST_ALLGATHER	MPI_Allgather	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Bruck's</li> <li>3. Ring</li> <li>4. Topology aware Gather + Bcast</li> <li>5. Knomial</li> </ol>
I_MPI_ADJUST_ALLGATHERV	MPI_Allgatherv	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Bruck's</li> <li>3. Ring</li> <li>4. Topology aware Gather + Bcast</li> </ol>
I_MPI_ADJUST_ALLREDUCE	MPI_Allreduce	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Rabenseifner's</li> <li>3. Reduce + Bcast</li> <li>4. Topology aware Reduce + Bcast</li> <li>5. Binomial gather + scatter</li> <li>6. Topology aware binomial gather + scatter</li> <li>7. Shumilin's ring</li> <li>8. Ring</li> <li>9. Knomial</li> <li>10. Topology aware SHM-based flat</li> <li>11. Topology aware SHM-based Knomial</li> <li>12. Topology aware SHM-based Knary</li> </ol>
I_MPI_ADJUST_ALLTOALL	MPI_Alltoall	<ol style="list-style-type: none"> <li>1. Bruck's</li> <li>2. Isend/Irecv + waitall</li> <li>3. Pair wise exchange</li> <li>4. Plum's</li> </ol>
I_MPI_ADJUST_ALLTOALLV	MPI_Alltoallv	<ol style="list-style-type: none"> <li>1. Isend/Irecv + waitall</li> <li>2. Plum's</li> </ol>
I_MPI_ADJUST_ALLTOALLW	MPI_Alltoallw	Isend/Irecv + waitall
I_MPI_ADJUST_BARRIER	MPI_Barrier	<ol style="list-style-type: none"> <li>1. Dissemination</li> <li>2. Recursive doubling</li> <li>3. Topology aware dissemination</li> <li>4. Topology aware recursive doubling</li> <li>5. Binomial gather + scatter</li> <li>6. Topology aware binomial gather + scatter</li> <li>7. Topology aware SHM-based flat</li> </ol>



Environment Variable	Collective Operation	Algorithms
I_MPI_ADJUST_BCAST	MPI_Bcast	<ol style="list-style-type: none"> <li>8. Topology aware SHM-based Knomial</li> <li>9. Topology aware SHM-based Knary</li> <li>1. Binomial</li> <li>2. Recursive doubling</li> <li>3. Ring</li> <li>4. Topology aware binomial</li> <li>5. Topology aware recursive doubling</li> <li>6. Topology aware ring</li> <li>7. Shumilin's</li> <li>8. Knomial</li> <li>9. Topology aware SHM-based flat</li> <li>10. Topology aware SHM-based Knomial</li> <li>11. Topology aware SHM-based Knary</li> <li>12. NUMA aware SHM-based (SSE4.2)</li> <li>13. NUMA aware SHM-based (AVX2)</li> <li>14. NUMA aware SHM-based (AVX512)</li> </ol>
I_MPI_ADJUST_EXSCAN	MPI_Exscan	<ol style="list-style-type: none"> <li>1. Partial results gathering</li> <li>2. Partial results gathering regarding layout of processes</li> </ol>
I_MPI_ADJUST_GATHER	MPI_Gather	<ol style="list-style-type: none"> <li>1. Binomial</li> <li>2. Topology aware binomial</li> <li>3. Shumilin's</li> <li>4. Binomial with segmentation</li> </ol>
I_MPI_ADJUST_GATHERV	MPI_Gatherv	<ol style="list-style-type: none"> <li>1. Linear</li> <li>2. Topology aware linear</li> <li>3. Knomial</li> </ol>
I_MPI_ADJUST_REDUCE_SCATTER	MPI_Reduce_scatter	<ol style="list-style-type: none"> <li>1. Recursive halving</li> <li>2. Pair wise exchange</li> <li>3. Recursive doubling</li> <li>4. Reduce + Scatterv</li> <li>5. Topology aware Reduce + Scatterv</li> </ol>
I_MPI_ADJUST_REDUCE	MPI_Reduce	<ol style="list-style-type: none"> <li>1. Shumilin's</li> <li>2. Binomial</li> <li>3. Topology aware Shumilin's</li> <li>4. Topology aware binomial</li> <li>5. Rabenseifner's</li> </ol>

Environment Variable	Collective Operation	Algorithms
		<ol style="list-style-type: none"> <li>6. Topology aware Rabenseifner's</li> <li>7. Knomial</li> <li>8. Topology aware SHM-based flat</li> <li>9. Topology aware SHM-based Knomial</li> <li>10. Topology aware SHM-based Knary</li> <li>11. Topology aware SHM-based binomial</li> </ol>
I_MPI_ADJUST_SCAN	MPI_Scan	<ol style="list-style-type: none"> <li>1. Partial results gathering</li> <li>2. Topology aware partial results gathering</li> </ol>
I_MPI_ADJUST_SCATTER	MPI_Scatter	<ol style="list-style-type: none"> <li>1. Binomial</li> <li>2. Topology aware binomial</li> <li>3. Shumilin's</li> </ol>
I_MPI_ADJUST_SCATTERV	MPI_Scatterv	<ol style="list-style-type: none"> <li>1. Linear</li> <li>2. Topology aware linear</li> </ol>
I_MPI_ADJUST_SENDRECV_REPLACE	MPI_Sendrecv_replace	<ol style="list-style-type: none"> <li>1. Generic</li> <li>2. Uniform (with restrictions)</li> </ol>
I_MPI_ADJUST_IALLGATHER	MPI_Iallgather	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Bruck's</li> <li>3. Ring</li> </ol>
I_MPI_ADJUST_IALLGATHERV	MPI_Iallgatherv	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Bruck's</li> <li>3. Ring</li> </ol>
I_MPI_ADJUST_IALLREDUCE	MPI_Iallreduce	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. Rabenseifner's</li> <li>3. Reduce + Bcast</li> <li>4. Ring (patarasuk)</li> <li>5. Knomial</li> <li>6. Binomial</li> <li>7. Reduce scatter allgather</li> <li>8. SMP</li> <li>9. Nreduce</li> </ol>
I_MPI_ADJUST_IALLTOALL	MPI_Ialltoall	<ol style="list-style-type: none"> <li>1. Bruck's</li> <li>2. Isend/Irecv + Waitall</li> <li>3. Pairwise exchange</li> </ol>
I_MPI_ADJUST_IALLTOALLV	MPI_Ialltoallv	Isend/Irecv + Waitall
I_MPI_ADJUST_IALLTOALLW	MPI_Ialltoallw	Isend/Irecv + Waitall
I_MPI_ADJUST_IBARRIER	MPI_Ibarrier	Dissemination
I_MPI_ADJUST_IBCAST	MPI_Ibcast	<ol style="list-style-type: none"> <li>1. Binomial</li> <li>2. Recursive doubling</li> </ol>

Environment Variable	Collective Operation	Algorithms
		<ol style="list-style-type: none"> <li>3. Ring</li> <li>4. Knomial</li> <li>5. SMP</li> <li>6. Tree knomial</li> <li>7. Tree kary</li> </ol>
I_MPI_ADJUST_IEXSCAN	MPI_Iexscan	<ol style="list-style-type: none"> <li>1. Recursive doubling</li> <li>2. SMP</li> </ol>
I_MPI_ADJUST_IGATHER	MPI_Igather	<ol style="list-style-type: none"> <li>1. Binomial</li> <li>2. Knomial</li> </ol>
I_MPI_ADJUST_IGATHERV	MPI_Igatherv	<ol style="list-style-type: none"> <li>1. Linear</li> <li>2. Linear ssend</li> </ol>
I_MPI_ADJUST_IREDUCE_SCATTER	MPI_Ireduce_scatter	<ol style="list-style-type: none"> <li>1. Recursive halving</li> <li>2. Pairwise</li> <li>3. Recursive doubling</li> </ol>
I_MPI_ADJUST_IREDUCE	MPI_Ireduce	<ol style="list-style-type: none"> <li>1. Rabenseifner's</li> <li>2. Binomial</li> <li>3. Knomial</li> </ol>
I_MPI_ADJUST_ISCAN	MPI_Iscan	<ol style="list-style-type: none"> <li>1. Recursive Doubling</li> <li>2. SMP</li> </ol>
I_MPI_ADJUST_ISCATTER	MPI_Iscatter	<ol style="list-style-type: none"> <li>1. Binomial</li> <li>2. Knomial</li> </ol>
I_MPI_ADJUST_ISCATTERV	MPI_Iscatterv	Linear

The message size calculation rules for the collective operations are described in the table. In the following table, "n/a" means that the corresponding interval  $\langle l \rangle - \langle m \rangle$  should be omitted.

**NOTE** The I\_MPI\_ADJUST\_SENDRECV\_REPLACE=2 ("Uniform") algorithm can be used only in the case when datatype and objects count are the same across all ranks.

To get the maximum number (range) of presets available for each collective operation, use the `impi_info` command:

```
$ impi_info -v I_MPI_ADJUST_ALLREDUCE
I_MPI_ADJUST_ALLREDUCE
MPI Datatype:
  MPI_CHAR
Description:
  Control selection of MPI_Allreduce algorithm presets.
Arguments
  <presetid> - Preset identifier
range: 0-27
```

### Message Collective Functions

Collective Function	Message Size Formula
MPI_Allgather	$recv\_count * recv\_type\_size$

Collective Function	Message Size Formula
MPI_Allgatherv	total_recv_count*recv_type_size
MPI_Allreduce	count*type_size
MPI_Alltoall	send_count*send_type_size
MPI_Alltoallv	n/a
MPI_Alltoallw	n/a
MPI_Barrier	n/a
MPI_Bcast	count*type_size
MPI_Exscan	count*type_size
MPI_Gather	recv_count*recv_type_size if MPI_IN_PLACE is used, otherwise send_count*send_type_size
MPI_Gatherv	n/a
MPI_Reduce_scatter	total_recv_count*type_size
MPI_Reduce	count*type_size
MPI_Scan	count*type_size
MPI_Scatter	send_count*send_type_size if MPI_IN_PLACE is used, otherwise recv_count*recv_type_size
MPI_Scatterv	n/a

## Examples

Use the following settings to select the second algorithm for MPI\_Reduce operation:

```
I_MPI_ADJUST_REDUCE=2
```

Use the following settings to define the algorithms for MPI\_Reduce\_scatter operation:

```
I_MPI_ADJUST_REDUCE_SCATTER="4:0-100,5001-10000;1:101-3200;2:3201-5000;3"
```

In this case, algorithm 4 is used for the message sizes between 0 and 100 bytes and from 5001 and 10000 bytes, algorithm 1 is used for the message sizes between 101 and 3200 bytes, algorithm 2 is used for the message sizes between 3201 and 5000 bytes, and algorithm 3 is used for all other messages.

## I\_MPI\_ADJUST\_<opname>\_LIST

### Syntax

```
I_MPI_ADJUST_<opname>_LIST=<presetid1>[-<presetid2>][,<presetid3>][,<presetid4>-<presetid5>]
```

### Description

Set this environment variable to specify the set of algorithms to be considered by the Intel MPI runtime for a specified <opname>. This variable is useful in autotuning scenarios, as well as tuning scenarios where users would like to select a certain subset of algorithms.

---

**NOTE** Setting an empty string disables autotuning for the <opname> collective.

---

## I\_MPI\_COLL\_INTRANODE

### Syntax

```
I_MPI_COLL_INTRANODE=<mode>
```

### Arguments

<mode>	Intranode collectives type
pt2pt	Use only point-to-point communication-based collectives
shm	Enables shared memory collectives. This is the default value

**Description**

Set this environment variable to switch intranode communication type for collective operations. If there is large set of communicators, you can switch off the SHM-collectives to avoid memory overconsumption.

**I\_MPI\_COLL\_INTRANODE\_SHM\_THRESHOLD****Syntax**

```
I_MPI_COLL_INTRANODE_SHM_THRESHOLD=<nbytes>
```

**Arguments**

<nbytes>	Define the maximal data block size processed by shared memory collectives
> 0	Use the specified size. The default value is 16384 bytes.

**Description**

Set this environment variable to define the size of shared memory area available for each rank for data placement. Messages greater than this value will *not* be processed by SHM-based collective operation, but will be processed by point-to-point based collective operation. The value must be a multiple of 4096.

**I\_MPI\_COLL\_EXTERNAL****Syntax**

```
I_MPI_COLL_EXTERNAL=<arg>
```

**Arguments**

<arg>	Description
enable   yes   on   1	Enable the external collective operations functionality using available collectives libraries.
disable   no   off   0	Disable the external collective operations functionality. This is the default value.
hcoll	Enable the external collective operations functionality using HCOLL library.

**Description**

Set this environment variable to enable external collective operations. For reaching better performance, use an autotuner after enabling I\_MPI\_COLL\_EXTERNAL. This process gets the optimal collectives settings.

To force external collective operations usage, use the following I\_MPI\_ADJUST\_<opname> values:

```
I_MPI_ADJUST_ALLREDUCE=24, I_MPI_ADJUST_BARRIER=11, I_MPI_ADJUST_BCAST=16,
I_MPI_ADJUST_REDUCE=13, I_MPI_ADJUST_ALLGATHER=6, I_MPI_ADJUST_ALLTOALL=5,
I_MPI_ADJUST_ALLTOALLV=5, I_MPI_ADJUST_SCAN=3, I_MPI_ADJUST_EXSCAN=3,
I_MPI_ADJUST_GATHER=5, I_MPI_ADJUST_GATHERV=4, I_MPI_ADJUST_SCATTER=5,
I_MPI_ADJUST_SCATTERV=4, I_MPI_ADJUST_ALLGATHERV=5, I_MPI_ADJUST_ALLTOALLW=2,
I_MPI_ADJUST_REDUCE_SCATTER=6, I_MPI_ADJUST_REDUCE_SCATTER_BLOCK=4,
I_MPI_ADJUST_IALLGATHER=5, I_MPI_ADJUST_IALLGATHERV=5, I_MPI_ADJUST_IGATHERV=3,
I_MPI_ADJUST_IALLREDUCE=9, I_MPI_ADJUST_IALLTOALLV=2, I_MPI_ADJUST_IBARRIER=2,
I_MPI_ADJUST_IBCAST=5, I_MPI_ADJUST_IREDUCE=4.
```

For more information on HCOLL tuning, refer to NVIDIA\* documentation.

**I\_MPI\_COLL\_DIRECT****Syntax**

I\_MPI\_COLL\_DIRECT=<arg>

## Arguments

<arg>	Description
on	Enable direct collectives. This is the default value.
off	Disable direct collectives.

## Description

Set this environment variable to control direct collectives usage. Disable this variable to eliminate OFI\* usage for intra-node communications in case of shm:ofi fabric.

## I\_MPI\_CBWR

Control reproducibility of floating-point operations results across different platforms, networks, and topologies in case of the same number of processes.

## Syntax

I\_MPI\_CBWR=<arg>

## Arguments

<arg>	CBWR compatibility mode	Description
0	None	Do not use CBWR in a library-wide mode. CNR-safe communicators may be created with <code>MPI_Comm_dup_with_info</code> explicitly. This is the default value.
1	Weak mode	Disable topology aware collectives. The result of a collective operation does not depend on the rank placement. The mode guarantees results reproducibility across different runs on the same cluster (independent of the rank placement).
2	Strict mode	Disable topology aware collectives, ignore CPU architecture, and interconnect during algorithm selection. The mode guarantees results reproducibility across different runs on different clusters (independent of the rank placement, CPU architecture, and interconnection)

## Description

Conditional Numerical Reproducibility (CNR) provides controls for obtaining reproducible floating-point results on collectives operations. With this feature, Intel MPI collective operations are designed to return the same floating-point results from run to run in case of the same number of MPI ranks.

Control this feature with the `I_MPI_CBWR` environment variable in a library-wide manner, where all collectives on all communicators are guaranteed to have reproducible results. To control the floating-point operations reproducibility in a more precise and per-communicator way, pass the {"I\_MPI\_CBWR", "yes"} key-value pair to the `MPI_Comm_dup_with_info` call.

**NOTE**

Setting the `I_MPI_CBWR` in a library-wide mode using the environment variable leads to performance penalty.

CNR-safe communicators created using `MPI_Comm_dup_with_info` always work in the strict mode. For example:

```
MPI_Info hint;
MPI_Comm cbwr_safe_world, cbwr_safe_copy;
MPI_Info_create(&hint);
MPI_Info_set(hint, "I_MPI_CBWR", "yes");
MPI_Comm_dup_with_info(MPI_COMM_WORLD, hint, & cbwr_safe_world);
MPI_Comm_dup(cbwr_safe_world, & cbwr_safe_copy);
```

In the example above, both `cbwr_safe_world` and `cbwr_safe_copy` are CNR-safe. Use `cbwr_safe_world` and its duplicates to get reproducible results for critical operations.

Note that `MPI_COMM_WORLD` itself may be used for performance-critical operations without reproducibility limitations.

## Tuning Environment Variables

### `I_MPI_TUNING_MODE`

Select the tuning method.

#### Syntax

```
I_MPI_TUNING_MODE=<arg>
```

#### Arguments

<b>&lt;arg &gt;</b>	<b>Description</b>
<code>none</code>	Disable tuning modes. This is the default value.
<code>auto</code>	Enable autotuner.
<code>auto:application</code>	Enable autotuner with application focused strategy (alias for auto).
<code>auto:cluster</code>	Enable autotuner without application specific logic. This is typically performed with the help of benchmarks (for example, IMB-MPI1) and proxy applications.

#### Description

Set this environment variable to enable the autotuner functionality and set the autotuner strategy.

### `I_MPI_TUNING_BIN`

Specify the path to tuning settings in a binary format.

#### Syntax

```
I_MPI_TUNING_BIN=<path>
```

#### Argument

<b>&lt;path &gt;</b>	A path to a binary file with tuning settings. By default, Intel® MPI Library uses the binary tuning file located at <code>&lt;\$I_MPI_ONEAPI_ROOT/etc&gt;</code> .
----------------------	--

#### Description

Set this environment variable to load tuning settings in a binary format.

## [I\\_MPI\\_TUNING\\_BIN\\_DUMP](#)

Specify the file for storing tuning settings in a binary format.

### Syntax

```
I_MPI_TUNING_BIN_DUMP=<filename>
```

### Argument

<filename>	A file name of a binary that stores tuning settings. By default, the path is not specified.
------------	---

### Description

Set this environment variable to store tuning settings in binary format.

## [I\\_MPI\\_TUNING](#)

Load tuning settings in a JSON format.

### Syntax

```
I_MPI_TUNING=<path>
```

### Argument

<path>	A path to a JSON file with tuning settings.
--------	---

### Description

Set this environment variable to load tuning settings in a JSON format.

---

**NOTE** The tuning settings in the JSON format are produced by the [mpitune](#) utility.

---

By default, the Intel® MPI Library loads tuning settings in a binary format. If it is not possible, the Intel MPI Library loads the tuning file in a JSON format specified through the `I_MPI_TUNING` environment variable. Thus, to enable JSON tuning, turn off the default binary tuning: `I_MPI_TUNING_BIN=""`. If it is not possible to load tuning settings from a JSON file and in a binary format, the default tuning values are used.

You do not need to turn off binary or JSON tuning settings if you use `I_MPI_ADJUST` family environment variables. The algorithms specified with `I_MPI_ADJUST` environment variables always have priority over binary and JSON tuning settings.

## See Also

- [Autotuning](#)
- [Environment Variables for Autotuning](#)

## Autotuning

If an application spends significant time in MPI collective operations, tuning might improve its performance.

Tuning is very dependent on the specifications of the particular platform. Autotuner searches for the best possible implementation of a collective operation during application runtime. Each collective operation has its own presets, which consist of the algorithm and its parameters, that the autotuning function goes through and then evaluates the performance of each one. Once autotuning has evaluated the search space, it chooses the fastest implementation and uses it for the rest of the application runtime, and this improves application performance. The autotuner search space can be modified by the

`I_MPI_ADJUST_<opname>_LIST` variable (see [I\\_MPI\\_ADJUST Family Environment Variables](#)).



Autotuner determines the tuning parameters and makes them available for autotuning using `I_MPI_TUNING_MODE` and the `I_MPI_TUNING_AUTO` family environment variables to find the best settings (see [Tuning Environment Variables](#) and [I\\_MPI\\_TUNING\\_AUTO Family Environment Variables](#)).

---

**NOTE** `I_MPI_TUNING_MODE` and the `I_MPI_TUNING_AUTO` family environment variables support only Intel processors, and cannot be used on other platforms.

---

The collectives currently available for autotuning are: `MPI_Allreduce`, `MPI_Bcast`, `MPI_Barrier`, `MPI_Reduce`, `MPI_Gather`, `MPI_Scatter`, `MPI_Alltoall`, `MPI_Allgatherv`, `MPI_Reduce_scatter`, `MPI_Reduce_scatter_block`, `MPI_Scan`, `MPI_Exscan`, `MPI_Iallreduce`, `MPI_Ibcast`, `MPI_Ibarrier`, `MPI_Ireduce`, `MPI_Igather`, `MPI_Iscatter`, `MPI_Ialltoall`, `MPI_Iallgatherv`, `MPI_Ireduce_scatter`, `MPI_Ireduce_scatter_block`, `MPI_Iscan`, and `MPI_Iexscan`.

Using autotuner involves these steps:

1. Launch the application with autotuner enabled and specify the dump file that stores results:

```
I_MPI_TUNING_MODE=auto
```

```
I_MPI_TUNING_BIN_DUMP=<tuning-results.dat>
```

2. Launch the application with the tuning results generated at the previous step:

```
I_MPI_TUNING_BIN= ./tuning-results.dat
```

Or use the `-tune` Hydra option.

If you experience performance issues, see [I\\_MPI\\_TUNING\\_AUTO Family Environment Variables](#).

### Examples

```
•$ export I_MPI_TUNING_MODE=auto
  $ export I_MPI_TUNING_AUTO_SYNC=1
  $ export I_MPI_TUNING_AUTO_ITER_NUM=5
  $ export I_MPI_TUNING_BIN_DUMP=<tuning_results.dat>
  $ mpirun -n 128 -ppn 64 IMB-MPI1 allreduce -iter 1000,800 -time 4800
•$ export I_MPI_TUNING_BIN=./tuning_results.dat
  $ mpirun -n 128 -ppn 64 IMB-MPI1 allreduce -iter 1000,800 -time 4800
```

---

**NOTE** To tune collectives on a communicator identified with the help of Application Performance Snapshot (APS), execute the following variable at step 1:

```
I_MPI_TUNING_AUTO_COMM_LIST=comm_id_1, ... , comm_id_n.
```

---

### See Also

[I\\_MPI\\_TUNING\\_AUTO Family Environment Variables](#)

[mpitune\\_fast](#)

[Make HPC Clusters More Efficient Using Intel® MPI Library Tuning Utilities](#)

### I\_MPI\_TUNING\_AUTO Family Environment Variables

---

**NOTE** You must set `I_MPI_TUNING_MODE` to use any of the `I_MPI_TUNING_AUTO` family environment variables.

---



---

**NOTE** The `I_MPI_TUNING_AUTO` family environment variables support only Intel processors, and cannot be used on other platforms.

---

## I\_MPI\_TUNING\_AUTO\_STORAGE\_SIZE

Define size of the per-communicator tuning storage.

### Syntax

`I_MPI_TUNING_AUTO_STORAGE_SIZE=<size>`

### Argument

<code>&lt;size&gt;</code>	Specify size of the communicator tuning storage. The default size of the storage is 512 Kb.
---------------------------	---

### Description

Set this environment variable to change the size of the communicator tuning storage.

## I\_MPI\_TUNING\_AUTO\_ITER\_NUM

Specify the number of autotuner iterations.

### Syntax

`I_MPI_TUNING_AUTO_ITER_NUM=<number>`

### Argument

<code>&lt;number&gt;</code>	Define the number of iterations. By default, it is 1.
-----------------------------	---

### Description

Set this environment variable to specify the number of autotuner iterations. The greater iteration number produces more accurate results.

---

**NOTE** To check if all possible algorithms are iterated, make sure that the total number of collective invocations for a particular message size in a target application is at least equal the value of `I_MPI_TUNING_AUTO_ITER_NUM` multiplied by the number of algorithms.

---

## I\_MPI\_TUNING\_AUTO\_WARMUP\_ITER\_NUM

Specify the number of warmup autotuner iterations.

### Syntax

`I_MPI_TUNING_AUTO_WARMUP_ITER_NUM=<number>`

### Argument

<code>&lt;number&gt;</code>	Define the number of iterations. By default, it is 1.
-----------------------------	---

### Description

Set this environment variable to specify the number of autotuner warmup iterations. Warmup iterations do not impact autotuner decisions and allow to skip additional iterations, such as infrastructure preparation.

## I\_MPI\_TUNING\_AUTO\_SYNC

Enable the internal barrier on every iteration of the autotuner.

### Syntax

`I_MPI_TUNING_AUTO_SYNC=<arg>`

### Argument

<code>&lt;arg&gt;</code>	Binary indicator
--------------------------	------------------

enable   yes   on   1	Align the autotuner with the IMB measurement approach.
disable   no   off   0	Do not use the barrier on every iteration of the autotuner. This is the default value.

**Description**

Set this environment variable to control the IMB measurement logic. Setting this variable to 1 may lead to overhead due to an additional MPI\_Barrier call.

**I\_MPI\_TUNING\_AUTO\_COMM\_LIST**

Control the scope of autotuning.

**Syntax**

I\_MPI\_TUNING\_AUTO\_COMM\_LIST=<comm\_id\_1, ..., comm\_id\_n>

**Argument**

<comm_id_n, ...>	Specify communicators to be tuned.
------------------	------------------------------------

**Description**

Set this environment variable to specify communicators to be tuned using their unique id. By default, the variable is not specified. In this case, all communicators in the application are involved into the tuning process.

**NOTE** To get the list of communicators available for tuning, use the [Application Performance Snapshot \(APS\)](#) tool, which supports per communicator profiling starting with the 2019 Update 4 release. For example:

1. Source `apsvars.sh`:

```
$ source <path_to_aps>/apsvars.sh
```

2. Gather APS statistics:

```
$ export MPS_STAT_LEVEL=5
$ export APS_COLLECT_COMM_IDS=1
mpirun -aps -n 128 -ppn 64 IMB-MPI1 allreduce -npmin 128 -iter 1000,800 -time 4800
```

3. Generate an APS report:

```
$ aps-report aps_result_20190228/ -lFE
```

4. Get the results:

```
| Communicators used in the application
|-----|
| Communicator Id      Communicator Size      Time (Rank Average) (sec) Ranks
|-----|-----|-----|
| 4611686018431582688  4                      1.80 (0.45)             0,1,2,3
|-----|-----|-----|
| 4611686018431582208  4                      0.59 (0.15)             0,1,2,3
|-----|-----|-----|
| 4611686018429485552  2                      0.51 (0.25)             0,1
|-----|-----|-----|
| 4611686018429485520  2                      0.01 (0.00)             0,1
|-----|-----|-----|
| 4611686018431582672  4                      0.00 (0.00)             0,1,2,3
|-----|-----|-----|
```

5. Specify the communicators to be tuned:

```
$ export I_MPI_TUNING_AUTO_COMM_LIST=4611686018431582688
$ export MPS_STAT_LEVEL=5
$ export APS_COLLECT_COMM_IDS=1
$ export I_MPI_TUNING_AUTO=1
$ mpirun -aps -n 128 -ppn 64 IMB-MPI1 allreduce -iter 1000,800 -time 4800
```

## I\_MPI\_TUNING\_AUTO\_COMM\_DEFAULT

Mark all communicators with the default value.

### Syntax

`I_MPI_TUNING_AUTO_COMM_DEFAULT=<arg>`

### Argument

<arg>	Binary indicator
enable   yes   on   1	Mark communicators.
disable   no   off   0	Do not mark communicators. This is the default value.

### Description

Set this environment variable to mark all communicators in an application with the default value. In this case, all communicators will have the identical default `comm_id` equal to `-1`.

## I\_MPI\_TUNING\_AUTO\_COMM\_USER

Enable communicator marking with a user value.

### Syntax

```
I_MPI_TUNING_AUTO_COMM_USER=<arg>
```

### Argument

<arg>	Binary indicator
enable   yes   on   1	Enable marking of communicators.
disable   no   off   0	Disable marking of communicators. This is the default value.

### Description

Set this environment variable to enable communicator marking with a user value. To mark a communicator in your application, use the MPI\_Info object for this communicator that contains a record with the comm\_id key. The key must belong to the 0...UINT64\_MAX range.

## I\_MPI\_TUNING\_AUTO\_ITER\_POLICY

Control the iteration policy logic.

### Syntax

```
_MPI_TUNING_AUTO_ITER_POLICY=<arg>
```

### Argument

<arg>	Binary indicator
enable   yes   on   1	Reduce the number of iterations with a message size increase after 64Kb (by half). This is the default value.
disable   no   off   0	Use the I_MPI_TUNING_AUTO_ITER_NUM value. This value affects warmup iterations.

### Description

Set this environment variable to control the autotuning iteration policy logic.

## I\_MPI\_TUNING\_AUTO\_ITER\_POLICY\_THRESHOLD

Control the message size limit for the I\_MPI\_TUNING\_AUTO\_ITER\_POLICY environment variable.

### Syntax

```
I_MPI_TUNING_AUTO_ITER_POLICY_THRESHOLD=<arg>
```

### Argument

<arg>	Define the value. By default, it is 64KB.

### Description

Set this environment variable to control the message size limit for the autotuning iteration policy logic (I\_MPI\_TUNING\_AUTO\_ITER\_POLICY).

## I\_MPI\_TUNING\_AUTO\_POLICY

Choose the best algorithm identification strategy.

### Syntax

```
I_MPI_TUNING_AUTO_POLICY=<arg>
```

### Argument

<arg>	Description
max	Choose the best algorithm based on a maximum time value. This is the default value.

min	Choose the best algorithm based on a minimum time value.
avg	Choose the best algorithm based on an average time value.

### Description

Set this environment variable to control the autotuning strategy and choose the best algorithm based on the time value across ranks involved into the tuning process.

## Process Pinning

Use this feature to pin a particular MPI process to a corresponding set of CPUs within a node and avoid undesired process migration. This feature is available on operating systems that provide the necessary kernel interfaces.

This page describes the pinning process. You can simulate your pinning configuration using the [Pinning Simulator for Intel MPI Library](#).

### Processor Identification

The following schemes are used to identify logical processors in a system:

- System-defined logical enumeration
- Topological enumeration based on three-level hierarchical identification through triplets (package/socket, core, thread)

The number of a logical CPU is defined as the corresponding position of this CPU bit in the kernel affinity bit-mask. Use the `cpuinfo` utility, provided with your Intel MPI Library installation or the `cat /proc/cpuinfo` command to find out the logical CPU numbers.

The three-level hierarchical identification uses triplets that provide information about processor location and their order. The triplets are hierarchically ordered (package, core, and thread).

See the example for one possible processor numbering where there are two sockets, four cores (two cores per socket), and eight logical processors (two processors per core).

---

**NOTE** Logical and topological enumerations are not the same.

---

### Logical Enumeration

0	4	1	5	2	6	3	7
---	---	---	---	---	---	---	---

### Hierarchical Levels

Socket	0	0	0	0	1	1	1	1
Core	0	0	1	1	0	0	1	1
Thread	0	1	0	1	0	1	0	1

### Topological Enumeration

0	1	2	3	4	5	6	7
---	---	---	---	---	---	---	---

Use the `cpuinfo` utility to identify the correspondence between the logical and topological enumerations. See [Processor Information Utility](#) for more details.

### Default Settings

If you do not specify values for any process pinning environment variables, the default settings below are used. For details about these settings, see [Environment Variables](#) and [Interoperability with OpenMP API](#).

- `I_MPI_PIN=on`
- `I_MPI_PIN_RESPECT_CPUSSET=on`

- I\_MPI\_PIN\_RESPECT\_HCA=on
- I\_MPI\_PIN\_CELL=unit
- I\_MPI\_PIN\_DOMAIN=auto:compact
- I\_MPI\_PIN\_ORDER=bunch

---

**NOTE** If hyperthreading is on, the number of processes on the node is greater than the number of cores and no one process pinning environment variable is set. For better performance, the "spread" order will automatically be used instead of the default "compact" order.

---

## Environment Variables for Process Pinning

### I\_MPI\_PIN

Turn on/off process pinning.

#### Syntax

I\_MPI\_PIN=<arg>

#### Arguments

<arg>	Binary indicator
enable   yes   on   1	Enable process pinning. This is the default value.
disable   no   off   0	Disable process pinning.

#### Description

Set this environment variable to control the process pinning feature of the Intel® MPI Library.

### I\_MPI\_PIN\_PROCESSOR\_LIST (I\_MPI\_PIN\_PROCS)

Define a processor subset and the mapping rules for MPI processes within this subset.

This environment variable is available for both Intel and non-Intel microprocessors, but it may perform additional optimizations for Intel microprocessors than it performs for non-Intel microprocessors.

#### Syntax Forms

I\_MPI\_PIN\_PROCESSOR\_LIST=<value>

The environment variable value has three syntax forms:

1. <proclist>
2. [<procset> ][:[grain=<grain> ] [, shift=<shift> ] [, preoffset=<preoffset> ]  
[, postoffset=<postoffset> ]
3. [<procset> ][:map=<map> ]

The following paragraphs provide detailed descriptions for each of these syntax forms.

---

**NOTE** The postoffset keyword has offset alias.

---

**NOTE** The second form of the pinning procedure has three steps:

1. **Circular shift** of the source processor list on `preoffset*grain` value.
2. **Round robin shift** of the list derived on the first step on `shift*grain` value.
3. Circular shift of the list derived on the second step on the `postoffset*grain` value.

**NOTE** The `grain`, `shift`, `preoffset`, and `postoffset` parameters have a unified definition style.

### Syntax 1: `<proclist>`

```
I_MPI_PIN_PROCESSOR_LIST=<proclist>
```

#### Arguments

<code>&lt;proclis t&gt;</code>	A comma-separated list of logical processor numbers and/or ranges of processors. The process with the <code>i</code> -th rank is pinned to the <code>i</code> -th processor in the list. The number should not exceed the number of processors on a node.
<code>&lt;l&gt;</code>	Processor with logical number <code>&lt;l&gt;</code> .
<code>&lt;l&gt;-&lt;m&gt;</code>	Range of processors with logical numbers from <code>&lt;l&gt;</code> to <code>&lt;m&gt;</code> .
<code>&lt;k&gt;,&lt;l&gt;- &lt;m&gt;</code>	Processors <code>&lt;k&gt;</code> , as well as <code>&lt;l&gt;</code> through <code>&lt;m&gt;</code> .

### Syntax 2: `[<procset> ][:[grain=<grain> ][,shift=<shift> ][,preoffset=`

```
I_MPI_PIN_PROCESSOR_LIST=[<procset>][:[grain=<grain>][,shift=<shift>]  
[,preoffset=<preoffset>][,postoffset=<postoffset>]
```

#### Arguments

<code>&lt;procset &gt;</code>	Specify a processor subset based on the topological numeration. The default value is <code>allcores</code> .
<code>all</code>	All logical processors. Specify this subset to define the number of CPUs on a node.
<code>allcores</code>	All cores (physical CPUs). Specify this subset to define the number of cores on a node. This is the default value.
	If Intel® Hyper-Threading Technology is disabled, <code>allcores</code> equals to <code>all</code> .
<code>allsockets</code>	All packages/sockets. Specify this subset to define the number of sockets on a node.
<code>&lt;grain&gt;</code>	Specify the pinning granularity cell for a defined <code>&lt;procset&gt;</code> . The minimal <code>&lt;grain&gt;</code> value is a single element of the <code>&lt;procset&gt;</code> . The maximal <code>&lt;grain&gt;</code> value is the number of <code>&lt;procset&gt;</code> elements in a socket. The <code>&lt;grain&gt;</code> value must be a multiple of the <code>&lt;procset&gt;</code> value. Otherwise, the minimal <code>&lt;grain&gt;</code> value is assumed. The default value is the minimal <code>&lt;grain&gt;</code> value.
<code>&lt;shift&gt;</code>	Specify the granularity of the round robin scheduling shift of the cells for the <code>&lt;procset&gt;</code> . <code>&lt;shift&gt;</code> is measured in the defined <code>&lt;grain&gt;</code> units. The <code>&lt;shift&gt;</code> value must be positive integer. Otherwise, no shift is performed. The default value is no shift, which is equal to 1 normal increment.
<code>&lt;preoffse t&gt;</code>	Specify the circular shift of the processor subset <code>&lt;procset&gt;</code> defined before the round robin shifting on the <code>&lt;preoffset&gt;</code> value. The value is measured in the defined <code>&lt;grain&gt;</code> units. The <code>&lt;preoffset&gt;</code> value must be non-negative integer. Otherwise, no shift is performed. The default value is no shift.
<code>&lt;postoffs et&gt;</code>	Specify the circular shift of the processor subset <code>&lt;procset&gt;</code> derived after round robin shifting on the <code>&lt;postoffset&gt;</code> value. The value is measured in the defined <code>&lt;grain&gt;</code> units. The <code>&lt;postoffset&gt;</code> value must be non-negative integer. Otherwise no shift is performed. The default value is no shift.

The following table displays the values for `<grain>`, `<shift>`, `<preoffset>`, and `<postoffset>` options:

<code>&lt;n&gt;</code>	Specify an explicit value of the corresponding parameters. <code>&lt;n&gt;</code> is non-negative integer.
<code>fine</code>	Specify the minimal value of the corresponding parameter.



core	Specify the parameter value equal to the amount of the corresponding parameter units contained in one core.
cache1	Specify the parameter value equal to the amount of the corresponding parameter units that share an L1 cache.
cache2	Specify the parameter value equal to the amount of the corresponding parameter units that share an L2 cache.
cache3	Specify the parameter value equal to the amount of the corresponding parameter units that share an L3 cache.
cache	The largest value among <code>cache1</code> , <code>cache2</code> , and <code>cache3</code> .
socket   sock	Specify the parameter value equal to the amount of the corresponding parameter units contained in one physical package/socket.
half   mid	Specify the parameter value equal to <code>socket/2</code> .
third	Specify the parameter value equal to <code>socket/3</code> .
quarter	Specify the parameter value equal to <code>socket/4</code> .
octavo	Specify the parameter value equal to <code>socket/8</code> .

**Syntax 3:** [`<procset>`] [:map=<map>]

`I_MPI_PIN_PROCESSOR_LIST`=[<procset>] [:map=<map>]

**Arguments**

<map>	The mapping pattern used for process placement.
bunch	The processes are mapped proportionally to sockets and the processes are ordered as close as possible on the sockets.
scatter	The processes are mapped as remotely as possible so as not to share common resources: FSB, caches, and core.
spread	The processes are mapped consecutively with the possibility not to share common resources.

**Description**

Set the `I_MPI_PIN_PROCESSOR_LIST` environment variable to define the processor placement. To avoid conflicts with different shell versions, the environment variable value may need to be enclosed in quotes.

---

**NOTE** This environment variable is valid only if `I_MPI_PIN` is enabled.

---

The `I_MPI_PIN_PROCESSOR_LIST` environment variable has the following different syntax variants:

- Explicit processor list. This comma-separated list is defined in terms of logical processor numbers. The relative node rank of a process is an index to the processor list such that the *i*-th process is pinned on *i*-th list member. This permits the definition of any process placement on the CPUs.

For example, process mapping for `I_MPI_PIN_PROCESSOR_LIST=p0,p1,p2,...,pn` is as follows:

Rank on a node	0	1	2	...	n-1	N
Logical CPU	p0	p1	p2	...	pn-1	Pn

- `grain/shift/offset` mapping. This method provides circular shift of a defined `grain` along the processor list with steps equal to `shift*grain` and a single shift on `offset*grain` at the end. This shifting action is repeated `shift` times.

For example: `grain = 2` logical processors, `shift = 3` grains, `offset = 0`.

Legend:

gray - MPI process grains

A) red - processor grains chosen on the 1<sup>st</sup> pass

B) cyan - processor grains chosen on the 2<sup>nd</sup> pass

C) green - processor grains chosen on the final 3<sup>rd</sup> pass

D) Final map table ordered by MPI ranks

A)

0 1			2 3			...	2n-2 2n-1		
0 1	2 3	4 5	6 7	8 9	10 11	...	6n-6 6n-5	6n-4 6n-3	6n-2 6n-1

B)

0 1	2n 2n+1		2 3	2n+2 2n+3		...	2n-2 2n-1	4n-2 4n-1	
0 1	2 3	4 5	6 7	8 9	10 11	...	6n-6 6n-5	6n-4 6n-3	6n-2 6n-1

C)

0 1	2n 2n+1	4n 4n+1	2 3	2n+2 2n+3	4n+2 4n+3	...	2n-2 2n-1	4n-2 4n-1	6n-2 6n-1
0 1	2 3	4 5	6 7	8 9	10 11	...	6n-6 6n-5	6n-4 6n-3	6n-2 6n-1

D)

0 1	2 3	...	2n-2 2n-1	2n 2n+1	2n+2 2n+3	...	4n-2 4n-1	4n 4n+1	4n+2 4n+3	...	6n-2 6n-1
0 1	6 7	...	6n-6 6n-5	2 3	8 9	...	6n-4 6n-3	4 5	10 11	...	6n-2 6n-1

- Predefined mapping scenario. In this case, popular process pinning schemes are defined as keywords selectable at runtime. There are two such scenarios: `bunch` and `scatter`.

In the `bunch` scenario the processes are mapped proportionally to sockets as closely as possible. This mapping makes sense for partial processor loading. In this case, the number of processes is less than the number of processors.

In the `scatter` scenario the processes are mapped as remotely as possible so as not to share common resources: FSB, caches, and cores.

In the example, there are two sockets, four cores per socket, one logical CPU per core, and two cores per shared cache.

Legend:

gray - MPI processes

cyan - 1<sup>st</sup> socket processors

green - 2<sup>nd</sup> socket processors

Same color defines a processor pair sharing a cache

0	1	2			3	4		
0	1	2	3		4	5	6	7

bunch scenario for 5 processes

0	4	2	6		1	5	3	7
0	1	2	3		4	5	6	7

scatter scenario for full loading

## Examples

To pin the processes to CPU0 and CPU3 on each node globally, use the following command:

```
$ mpirun -genv I_MPI_PIN_PROCESSOR_LIST=0,3 -n <number-of-processes><executable>
```

To pin the processes to different CPUs on each node individually (CPU0 and CPU3 on host1 and CPU0, CPU1 and CPU3 on host2), use the following command:

```
$ mpirun -host host1 -env I_MPI_PIN_PROCESSOR_LIST=0,3 -n <number-of-processes> <executable> : \
-host host2 -env I_MPI_PIN_PROCESSOR_LIST=1,2,3 -n <number-of-processes> <executable>
```

To print extra debugging information about process pinning, use the following command:

```
$ mpirun -genv I_MPI_DEBUG=4 -m -host host1 \
-env I_MPI_PIN_PROCESSOR_LIST=0,3 -n <number-of-processes> <executable> : \
-host host2 -env I_MPI_PIN_PROCESSOR_LIST=1,2,3 -n <number-of-processes> <executable>
```

---

**NOTE** If the number of processes is greater than the number of CPUs used for pinning, the process list is wrapped around to the start of the processor list.

---

## I\_MPI\_PIN\_PROCESSOR\_EXCLUDE\_LIST

Define a subset of logical processors to be excluded for the pinning capability on the intended hosts.

### Syntax

```
I_MPI_PIN_PROCESSOR_EXCLUDE_LIST=<proclist>
```

### Arguments

<proclist>	A comma-separated list of logical processor numbers and/or ranges of processors.
<l>	Processor with logical number <l>.
<l>-<m>	Range of processors with logical numbers from <l>to <m>.
<k>,<l>-<m>	Processors <k>, as well as <l>through <m>.

### Description

Set this environment variable to define the logical processors that Intel® MPI Library does not use for pinning capability on the intended hosts. Logical processors are numbered as in `/proc/cpuinfo`.

## I\_MPI\_PIN\_CELL

Set this environment variable to define the pinning resolution granularity. `I_MPI_PIN_CELL` specifies the minimal processor cell allocated when an MPI process is running.

### Syntax

```
I_MPI_PIN_CELL=<cell>
```

### Arguments

<code>&lt;cell&gt;</code>	Specify the resolution granularity
<code>unit</code>	Basic processor unit (logical CPU)
<code>core</code>	Physical processor core

### Description

Set this environment variable to define the processor subset used when a process is running. You can choose from two scenarios:

- all possible CPUs in a node (`unit` value)
- all cores in a node (`core` value)

The environment variable has effect on both pinning types:

- one-to-one pinning through the `I_MPI_PIN_PROCESSOR_LIST` environment variable
- one-to-many pinning through the `I_MPI_PIN_DOMAIN` environment variable

The default value rules are:

- If you use `I_MPI_PIN_DOMAIN`, the cell granularity is `unit`.
- If you use `I_MPI_PIN_PROCESSOR_LIST`, the following rules apply:
  - When the number of processes is greater than the number of cores, the cell granularity is `unit`.
  - When the number of processes is equal to or less than the number of cores, the cell granularity is `core`.

---

**NOTE** The `core` value is not affected by the enabling/disabling of Intel® Hyper-Threading Technology in a system.

---

## I\_MPI\_PIN\_RESPECT\_CPUSSET

Respect the process affinity mask.

### Syntax

```
I_MPI_PIN_RESPECT_CPUSSET=<value>
```

### Arguments

<code>&lt;value&gt;</code>	Binary indicator
<code>enable   yes   on</code> <code>  1</code>	Respect the process affinity mask. This is the default value.
<code>disable   no   off</code> <code>  0</code>	Do not respect the process affinity mask.

### Description

If you set `I_MPI_PIN_RESPECT_CPUSSET=enable`, the Hydra process launcher uses job manager's process affinity mask on each intended host to determine logical processors for applying Intel MPI Library pinning capability.

If you set `I_MPI_PIN_RESPECT_CPUSET=disable`, the Hydra process launcher uses its own process affinity mask to determine logical processors for applying Intel MPI Library pinning capability.

## I\_MPI\_PIN\_RESPECT\_HCA

In the presence of Infiniband architecture\* host channel adapter (IBA\* HCA), adjust the pinning according to the location of IBA HCA.

### Syntax

```
I_MPI_PIN_RESPECT_HCA=<value>
```

### Arguments

<value>	Binary indicator
enable   yes   on   1	Use the location of IBA HCA if available. This is the default value.
disable   no   off   0	Do not use the location of IBA HCA.

### Description

If you set `I_MPI_PIN_RESPECT_HCA=enable`, the Hydra process launcher uses the location of IBA HCA on each intended host for applying Intel MPI Library pinning capability.

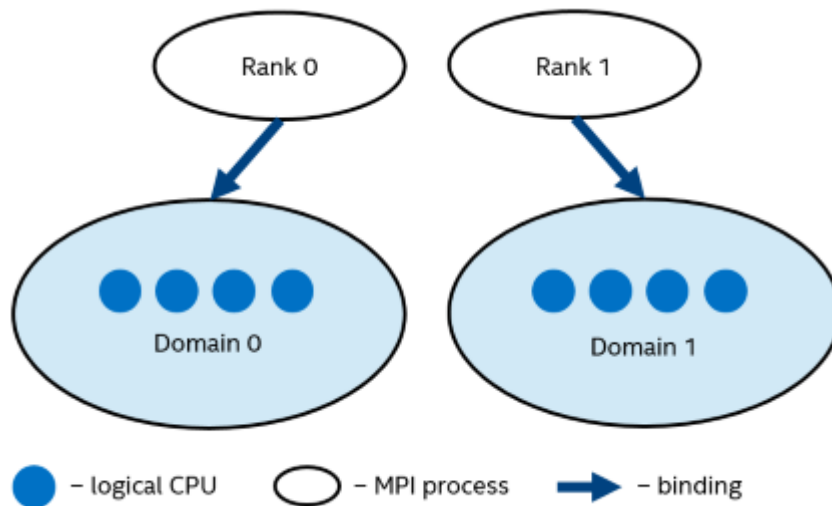
If you set `I_MPI_PIN_RESPECT_HCA=disable`, the Hydra process launcher does not use the location of IBA HCA on each intended host for applying Intel MPI Library pinning capability.

## Interoperability with OpenMP\* API

### I\_MPI\_PIN\_DOMAIN

Intel® MPI Library provides an additional environment variable to control process pinning for hybrid MPI/OpenMP\* applications. This environment variable is used to define a number of non-overlapping subsets (domains) of logical processors on a node, and a set of rules on how MPI processes are bound to these domains by the following formula: *one MPI process per one domain*. See the picture below.

Figure 1 Domain Example



Each MPI process can create a number of children threads for running within the corresponding domain. The process threads can freely migrate from one logical processor to another within the particular domain.

If the `I_MPI_PIN_DOMAIN` environment variable is defined, then the `I_MPI_PIN_PROCESSOR_LIST` environment variable setting is ignored.

If the `I_MPI_PIN_DOMAIN` environment variable is not defined, then MPI processes are pinned according to the current value of the `I_MPI_PIN_PROCESSOR_LIST` environment variable.

The `I_MPI_PIN_DOMAIN` environment variable has the following syntax forms:

- Domain description through multi-core terms `<mc-shape>`
- Domain description through domain size and domain member layout `<size>[:<layout>]`
- Explicit domain description through bit mask `<masklist>`

The following tables describe these syntax forms.

### Multi-Core Shape

`I_MPI_PIN_DOMAIN=<mc-shape>`

<code>&lt;mc-shape&gt;</code>	Define domains through multi-core terms.
<code>core</code>	Each domain consists of the logical processors that share a particular core. The number of domains on a node is equal to the number of cores on the node.
<code>socket   sock</code>	Each domain consists of the logical processors that share a particular socket. The number of domains on a node is equal to the number of sockets on the node. This is the recommended value.
<code>numa</code>	Each domain consists of the logical processors that share a particular NUMA node. The number of domains on a machine is equal to the number of NUMA nodes on the machine.
<code>node</code>	All logical processors on a node are arranged into a single domain.
<code>cache1</code>	Logical processors that share a particular level 1 cache are arranged into a single domain.
<code>cache2</code>	Logical processors that share a particular level 2 cache are arranged into a single domain.
<code>cache3</code>	Logical processors that share a particular level 3 cache are arranged into a single domain.
<code>cache</code>	The largest domain among <code>cache1</code> , <code>cache2</code> , and <code>cache3</code> is selected.

**NOTE** If `Cluster on Die` is disabled on a machine, the number of NUMA nodes equals to the number of sockets. In this case, pinning for `I_MPI_PIN_DOMAIN = numa` is equivalent to pinning for `I_MPI_PIN_DOMAIN = socket`.

### Explicit Shape

`I_MPI_PIN_DOMAIN=<size>[:<layout>]`

<code>&lt;size&gt;</code>	Define a number of logical processors in each domain (domain size)
<code>omp</code>	The domain size is equal to the <code>OMP_NUM_THREADS</code> environment variable value. If the <code>OMP_NUM_THREADS</code> environment variable is not set, each node is treated as a separate domain.
<code>auto</code>	The domain size is defined by the formula <code>size=#cpu/#proc</code> , where <code>#cpu</code> is the number of logical processors on a node, and <code>#proc</code> is the number of the MPI processes started on a node
<code>&lt;n&gt;</code>	The domain size is defined by a positive decimal number <code>&lt;n&gt;</code>

<code>&lt;layout&gt;</code>	Ordering of domain members. The default value is <code>compact</code>
<code>platform</code>	Domain members are ordered according to their BIOS numbering (platform-dependent numbering)
<code>compact</code>	Domain members are located as close to each other as possible in terms of common resources (cores, caches, sockets, and so on). This is the default value
<code>scatter</code>	Domain members are located as far away from each other as possible in terms of common resources (cores, caches, sockets, and so on)

### Explicit Domain Mask

`I_MPI_PIN_DOMAIN=<masklist>`

<code>&lt;masklist&gt;</code>	Define domains through the comma separated list of hexadecimal numbers (domain masks)
<code>[m<sub>1</sub>, ..., m<sub>n</sub>]</code>	For <code>&lt;masklist&gt;</code> , each <code>m<sub>i</sub></code> is a hexadecimal bit mask defining an individual domain. The following rule is used: the <code>i<sup>th</sup></code> logical processor is included into the domain if the corresponding <code>m<sub>i</sub></code> value is set to 1. All remaining processors are put into a separate domain. BIOS numbering is used.
	<hr/> <p><b>NOTE</b> To ensure that your configuration in <code>&lt;masklist&gt;</code> is parsed correctly, use square brackets to enclose the domains specified by the <code>&lt;masklist&gt;</code>. For example: <code>I_MPI_PIN_DOMAIN=[55, aa]</code></p> <hr/>

**NOTE** These options are available for both Intel® and non-Intel microprocessors, but they may perform additional optimizations for Intel microprocessors than they perform for non-Intel microprocessors.

To pin OpenMP\* processes or threads inside the domain, the corresponding OpenMP feature (for example, the `KMP_AFFINITY` environment variable for Intel® compilers) should be used.

**NOTE** The following configurations are effectively the same as if pinning is not applied:

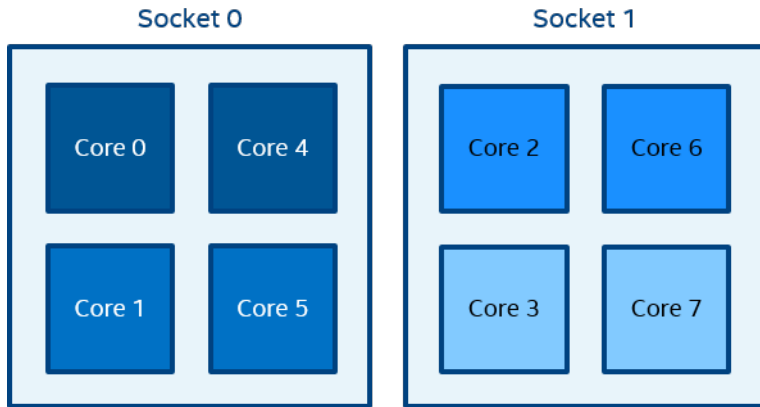
- If you set `I_MPI_PIN_DOMAIN=auto` and a single process is running on a node (for example, due to `I_MPI_PERHOST=1`)
- `I_MPI_PIN_DOMAIN=node`

If you do not want the process to be migrated between sockets on a multi-socket platform, specify the domain size as `I_MPI_PIN_DOMAIN=socket` or smaller.

You can also use `I_MPI_PIN_PROCESSOR_LIST`, which produces a single-cpu process affinity mask for each rank (the affinity mask is supposed to be automatically adjusted in presence of IBA\* HCA).

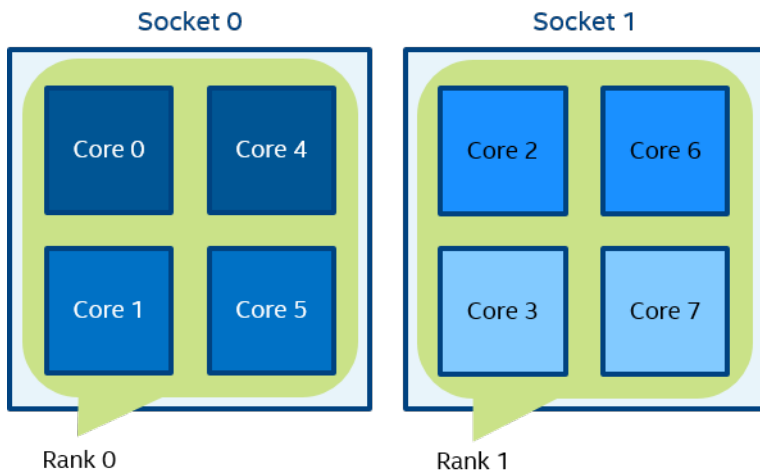
See the following model of a symmetric multiprocessing (SMP) node in the examples:

*Figure 2 Model of a Node*



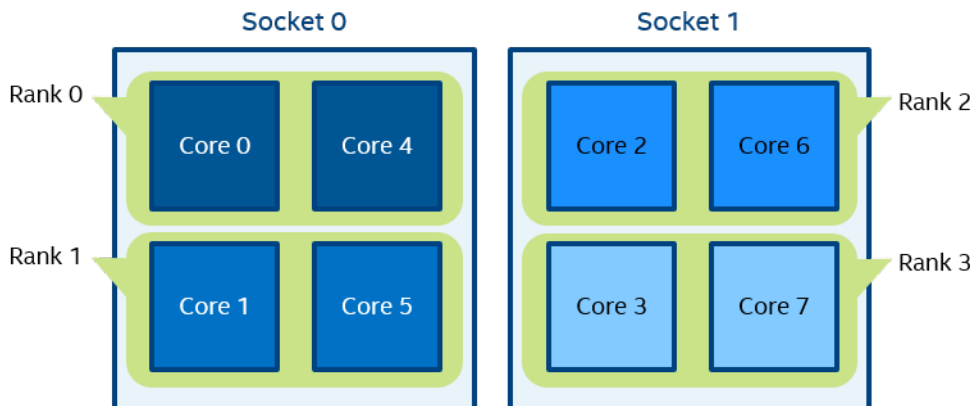
The figure above represents the SMP node model with a total of 8 cores on 2 sockets. Intel® Hyper-Threading Technology is disabled. Core pairs of the same color share the L2 cache.

Figure 3 `mpi run -n 2 -env I_MPI_PIN_DOMAIN socket ./a.out`



In Figure 3, two domains are defined according to the number of sockets. Process rank 0 can migrate on all cores on the 0-th socket. Process rank 1 can migrate on all cores on the first socket.

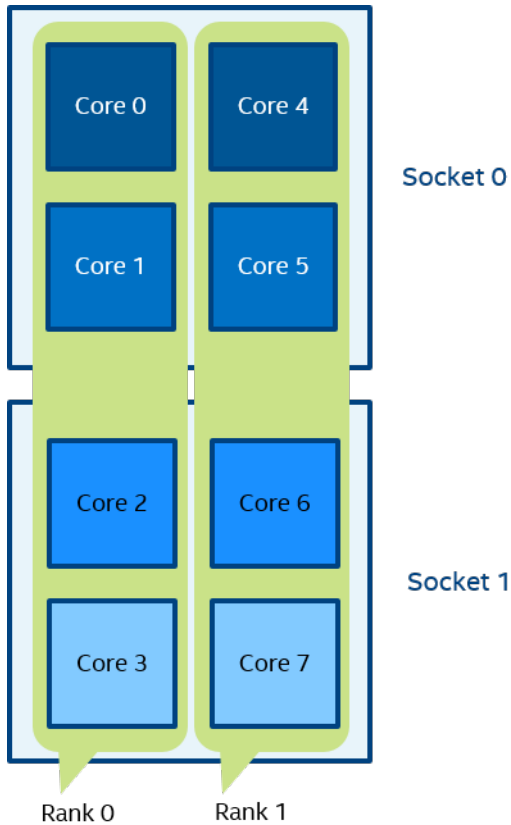
Figure 4 `mpi run -n 4 -env I_MPI_PIN_DOMAIN cache2 ./a.out`



In Figure 4, four domains are defined according to the amount of common L2 caches. Process rank 0 runs on cores {0,4} that share an L2 cache. Process rank 1 runs on cores {1,5} that share an L2 cache as well, and so on.

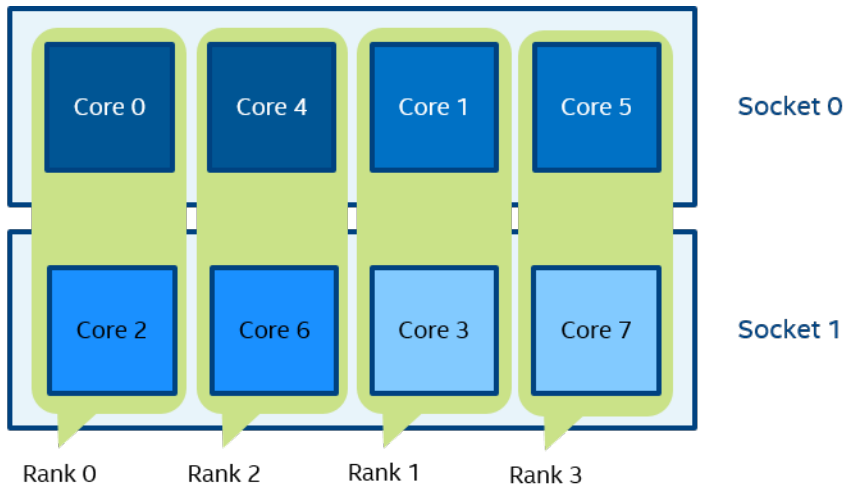


Figure 5 `mpi run -n 2 -env I_MPI_PIN_DOMAIN 4:platform ./a.out`



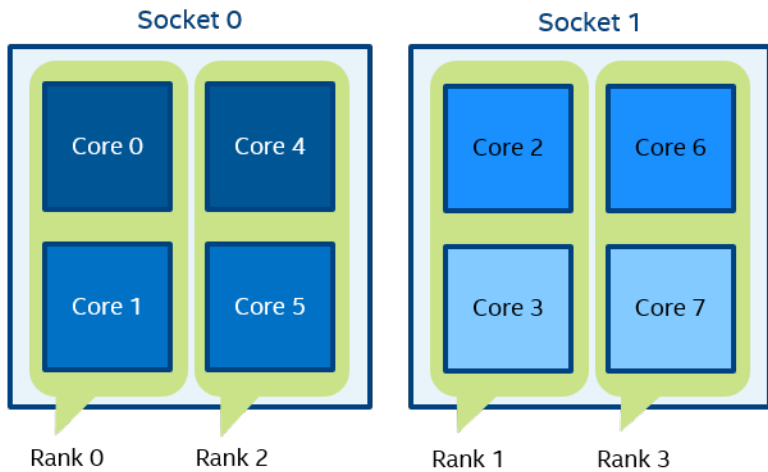
In Figure 5, two domains with size=4 are defined. The first domain contains cores  $\{0,1,2,3\}$ , and the second domain contains cores  $\{4,5,6,7\}$ . Domain members (cores) have consecutive numbering as defined by the `platform` option.

Figure 6 `mpi run -n 4 -env I_MPI_PIN_DOMAIN auto:scatter ./a.out`



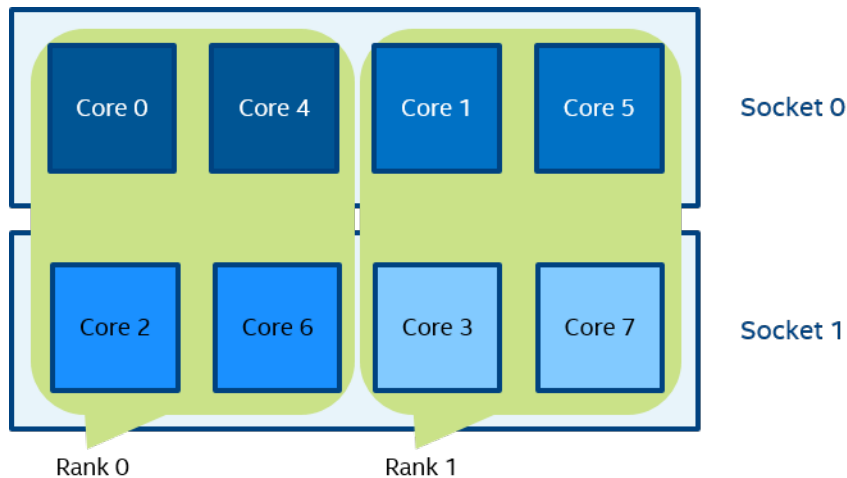
In Figure 6, domain size=2 (defined by the number of CPUs=8 / number of processes=4), `scatter` layout. Four domains  $\{0,2\}$ ,  $\{1,3\}$ ,  $\{4,6\}$ ,  $\{5,7\}$  are defined. Domain members do not share any common resources.

Figure 7 `setenv OMP_NUM_THREADS=2 mpi run -n 4 -env I_MPI_PIN_DOMAIN omp:platform ./a.out`



In Figure 7, domain size=2 (defined by `OMP_NUM_THREADS=2`), platform layout. Four domains {0,1}, {2,3}, {4,5}, {6,7} are defined. Domain members (cores) have consecutive numbering.

Figure 8 `mpi run -n 2 -env I_MPI_PIN_DOMAIN [55,aa] ./a.out`



In Figure 8 (the example for `I_MPI_PIN_DOMAIN=<masklist>`), the first domain is defined by the 55 mask. It contains all cores with even numbers {0,2,4,6}. The second domain is defined by the AA mask. It contains all cores with odd numbers {1,3,5,7}.

### I\_MPI\_PIN\_ORDER

Set this environment variable to define the mapping order for MPI processes to domains as specified by the `I_MPI_PIN_DOMAIN` environment variable.

#### Syntax

`I_MPI_PIN_ORDER=<order>`

#### Arguments

<code>&lt;order&gt;</code>	Specify the ranking order
<code>range</code>	The domains are ordered according to the processor's BIOS numbering. This is a platform-dependent numbering.
<code>scatter</code>	The domains are ordered so that adjacent domains have minimal sharing of common resources, whenever possible.

compact	The domains are ordered so that adjacent domains share common resources as much as possible.
spread	The domains are ordered consecutively with the possibility not to share common resources.
bunch	The processes are mapped proportionally to sockets and the domains are ordered as close as possible on the sockets. This is the default value.

**Description**

The optimal setting for this environment variable is application-specific. If adjacent MPI processes prefer to share common resources, such as cores, caches, sockets, FSB, use the compact or bunch values. Otherwise, use the scatter or spread values. Use the range value as needed. For detail information and examples about these values, see the Arguments table and the Example section of I\_MPI\_PIN\_ORDER in this topic.

The options scatter, compact, spread and bunch are available for both Intel® and non-Intel microprocessors, but they may perform additional optimizations for Intel microprocessors than they perform for non-Intel microprocessors.

**Examples**

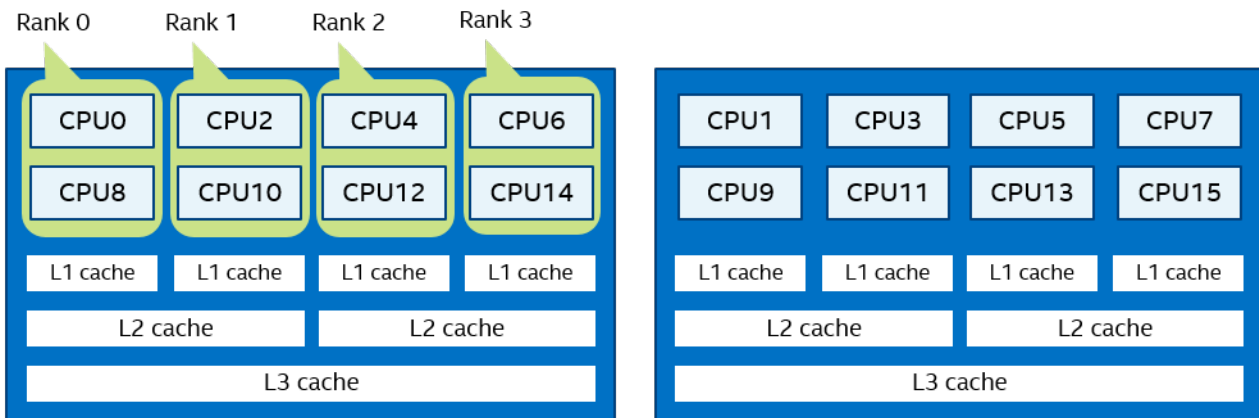
For the following configuration:

- Two socket nodes with four cores and a shared L2 cache for corresponding core pairs.
- 4 MPI processes you want to run on the node using the settings below.

**Compact order:**

```
I_MPI_PIN_DOMAIN=2 I_MPI_PIN_ORDER=compact
```

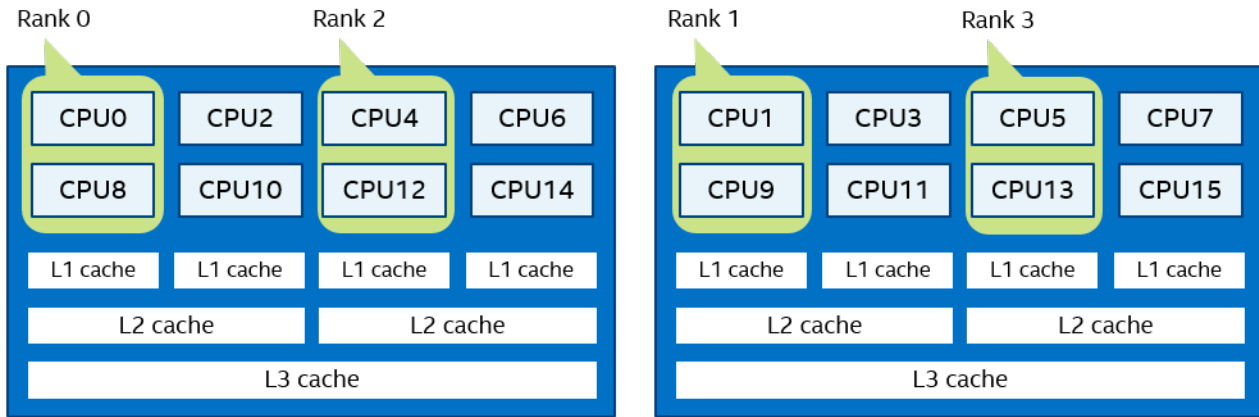
Figure 9 Compact Order Example



**Scatter order:**

```
I_MPI_PIN_DOMAIN=2 I_MPI_PIN_ORDER=scatter
```

Figure 10 Scatter Order Example

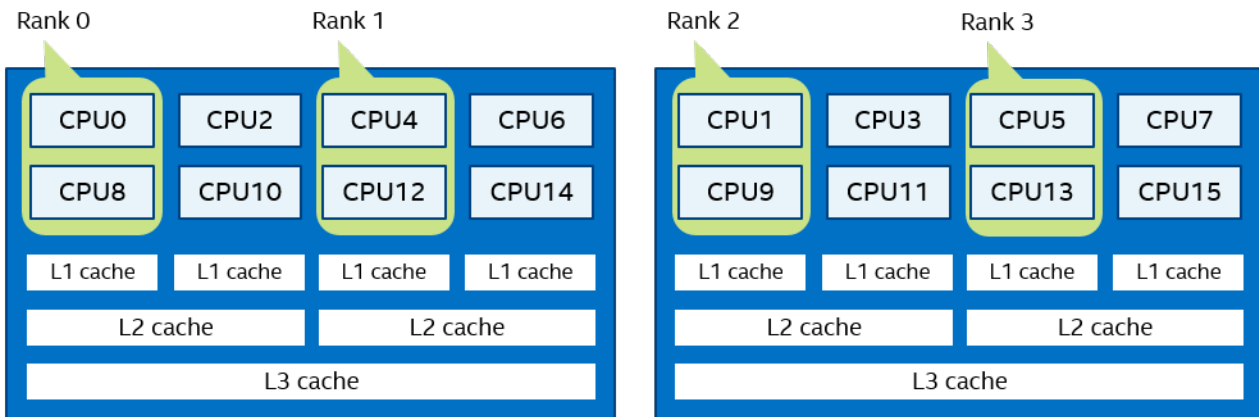


**Spread order:**

```
I_MPI_PIN_DOMAIN=2 I_MPI_PIN_ORDER=spread
```

**NOTE** For I\_MPI\_PIN\_ORDER=spread, the order will be switched to 'compact' if there are not enough CPUs to emplace all domains.

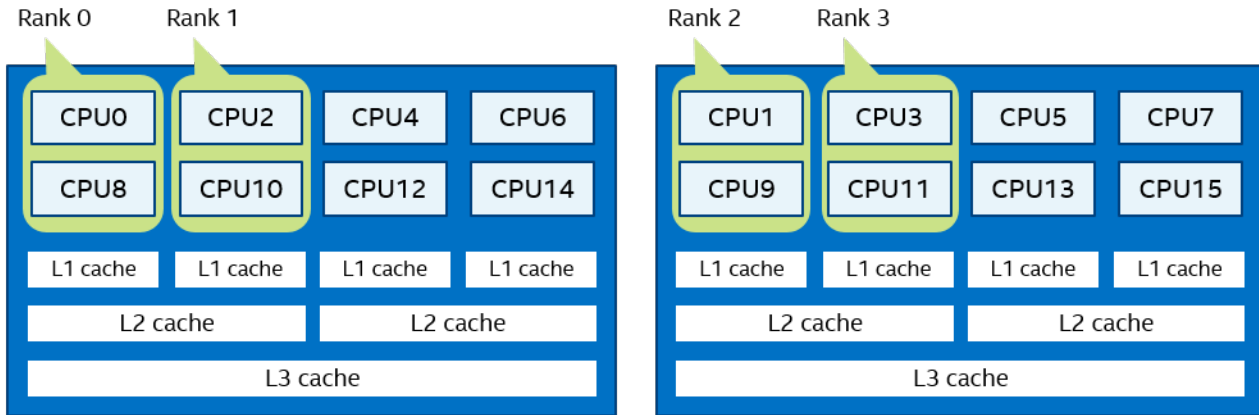
Figure 11 Spread Order Example



**Bunch order:**

```
I_MPI_PIN_DOMAIN=2 I_MPI_PIN_ORDER=bunch
```

Figure 12 Bunch Order Example



## GPU Support

This section provides information about the following GPU devices support in Intel® MPI Library:

1. GPU pinning
2. GPU buffers support

These features require the Level-Zero\* library to be installed on the nodes. All environment variables have `I_MPI_OFFLOAD_*` prefix.

Current support is limited to Intel® GPUs only.

### I\_MPI\_OFFLOAD

Set this environment variable to enable all GPU features.

#### Syntax

```
I_MPI_OFFLOAD=<value>
```

#### Arguments

Value	Description
0	Disabled (default value)
1	Auto. Intel MPI expects that <code>libze_loader.so</code> is already loaded and does not load it twice
2	Enabled. Intel MPI loads <code>libze_loader.so</code>

#### Description

Set this environment variable to enable all GPU features such as GPU pinning and GPU buffers support, which give you ability to distribute devices between MPI ranks and provide a pointer of an offloaded memory to MPI functions.

### I\_MPI\_OFFLOAD\_LEVEL\_ZERO\_LIBRARY

Specify the name and full path to the Level-Zero library.

#### Syntax

```
I_MPI_OFFLOAD_LEVEL_ZERO_LIBRARY="<path>/<name>"
```

#### Arguments

`<path>` Full path to the Level-Zero library.

`<name>` Name of the Level-Zero library.

## Description

Set this environment variable to specify the name and full path to Level-Zero library. Set this variable if Level-Zero is not located in the default path. Default value: `libze_loader.so`.

## Environment Variables for Fabrics Control

This section provides description of the general environment variables for controlling fabrics, as well as description of variables for controlling specific fabrics:

- [Communication Fabrics Control](#)
- [Shared Memory Control](#)
- [OFI\\*-capable network fabrics](#)

### Communication Fabrics Control

#### I\_MPI\_FABRICS

Select the particular fabrics to be used.

#### Syntax

```
I_MPI_FABRICS=ofi | shm:ofi | shm
```

#### Arguments

<code>&lt;fabric&gt;</code>	Define a network fabric.
<code>shm</code>	Shared memory transport (used for intra-node communication only).
<code>ofi</code>	OpenFabrics Interfaces* (OFI)-capable network fabrics, such as Intel® Omni-Path Architecture, InfiniBand*, and Ethernet (through OFI API).

#### Description

Set this environment variable to select a specific fabric combination.

The default values are `shm:ofi` for the regular mode and `ofi` for the multiple endpoints mode. In the multiple endpoints mode, the default value `ofi` cannot be changed.

#### NOTE

This option is not applicable to `slurm` and `pdsh` bootstrap servers.

#### NOTE

DAPL, TMI, and OFA fabrics are deprecated.

### Shared Memory Control

#### I\_MPI\_SHM

Select a shared memory transport to be used.

#### Syntax

```
I_MPI_SHM=<transport>
```

#### Arguments

<code>&lt;transport&gt;</code>	Define a shared memory transport solution.
--------------------------------	--

<code>disable   no   off   0</code>	Do not use shared memory transport.
<code>auto</code>	Select a shared memory transport solution automatically.
<code>bdw_sse</code>	The shared memory transport solution tuned for Intel® microarchitecture code name Broadwell. The SSE4.2. instruction set is used.
<code>bdw_avx2</code>	The shared memory transport solution tuned for Intel® microarchitecture code name Broadwell. The AVX2 instruction set is used.
<code>skx_sse</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Skylake. The CLFLUSHOPT and SSE4.2 instruction set is used.
<code>skx_avx2</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Skylake. The CLFLUSHOPT and AVX2 instruction set is used.
<code>skx_avx512</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Skylake. The CLFLUSHOPT and AVX512 instruction set is used.
<code>knl_ddr</code>	The shared memory transport solution tuned for Intel® microarchitecture code name Knights Landing.
<code>knl_mcdram</code>	The shared memory transport solution tuned for Intel® microarchitecture code name Knights Landing. Shared memory buffers may be partially located in the Multi-Channel DRAM (MCDRAM).
<code>clx_sse</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake. The CLFLUSHOPT and SSE4.2 instruction set is used.
<code>clx_avx2</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake. The CLFLUSHOPT and AVX2 instruction set is used.
<code>clx_avx512</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake. The CLFLUSHOPT and AVX512 instruction set is used.
<code>clx-ap</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake Advanced Performance.
<code>icx</code>	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Ice Lake.

## Description

Set this environment variable to select a specific shared memory transport solution.

Automatically selected transports:

- `icx` for Intel® Xeon® processors based on Intel® microarchitecture code name Ice Lake
- `clx-ap` for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake Advanced Performance
- `bdw_avx2` for Intel® microarchitecture code name Haswell, Broadwell and Skylake
- `skx_avx2` for Intel® Xeon® processors based on Intel® microarchitecture code name Skylake
- `ckx_avx2` for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake
- `knl_mcdram` for Intel® microarchitecture code name Knights Landing and Knights Mill
- `bdw_sse` for all other platforms

The value of `I_MPI_SHM` depends on the value of `I_MPI_FABRICS` as follows: if `I_MPI_FABRICS` is `ofi`, `I_MPI_SHM` is disabled. If `I_MPI_FABRICS` is `shm:ofi`, `I_MPI_SHM` defaults to `auto` or takes the specified value.

## I\_MPI\_SHM\_CELL\_FWD\_SIZE

Change the size of a shared memory forward cell.

### Syntax

```
I_MPI_SHM_CELL_FWD_SIZE=<nbytes>
```

### Arguments

<nbytes>	The size of a shared memory forward cell in bytes
> 0	The default <nbytes> value depends on the transport used and should normally range from 64K to 1024K.

### Description

Forward cells are in-cache message buffer cells used for sending small amounts of data. Lower values are recommended. Set this environment variable to define the size of a forward cell in the shared memory transport.

## I\_MPI\_SHM\_CELL\_BWD\_SIZE

Change the size of a shared memory backward cell.

### Syntax

```
I_MPI_SHM_CELL_BWD_SIZE=<nbytes>
```

### Arguments

<nbytes>	The size of a shared memory backward cell in bytes
> 0	The default <nbytes> value depends on the transport used and should normally range from 64K to 1024K.

### Description

Backward cells are out-of-cache message buffer cells used for sending large amounts of data. Higher values are recommended. Set this environment variable to define the size of a backward cell in the shared memory transport.

## I\_MPI\_SHM\_CELL\_EXT\_SIZE

Change the size of a shared memory extended cell.

### Syntax

```
I_MPI_SHM_CELL_EXT_SIZE=<nbytes>
```

### Arguments

<nbytes>	The size of a shared memory extended cell in bytes
> 0	The default <nbytes> value depends on the transport used and should normally range from 64K to 1024K.

### Description

Extended cells are used in the imbalanced applications when forward and backward cells are run out. An extended cell does not have a specific owner - it is shared between all ranks on the computing node. Set this environment variable to define the size of an extended cell in the shared memory transport.

## I\_MPI\_SHM\_CELL\_FWD\_NUM

Change the number of forward cells in the shared memory transport (per rank).

### Syntax

```
I_MPI_SHM_CELL_FWD_NUM=<num>
```



**Arguments**

<num>	The number of shared memory forward cells
> 0	The default value depends on the transport used and should normally range from 4 to 16.

**Description**

Set this environment variable to define the number of forward cells in the shared memory transport.

**I\_MPI\_SHM\_CELL\_BWD\_NUM**

Change the number of backward cells in the shared memory transport (per rank).

**Syntax**

I\_MPI\_SHM\_CELL\_BWD\_NUM=<num>

**Arguments**

<num>	The number of shared memory backward cells
> 0	The default value depends on the transport used and should normally range from 4 to 64.

**Description**

Set this environment variable to define the number of backward cells in the shared memory transport.

**I\_MPI\_SHM\_CELL\_EXT\_NUM\_TOTAL**

Change the total number of extended cells in the shared memory transport.

**Syntax**

I\_MPI\_SHM\_CELL\_EXT\_NUM\_TOTAL=<num>

**Arguments**

<num>	The number of shared memory backward cells
> 0	The default value depends on the transport used and should normally range from 2K to 8K.

**Description**

Set this environment variable to define the number of extended cells in the shared memory transport.

**NOTE**

This is not "per rank" number, it is total number of extended cells on the computing node.

**I\_MPI\_SHM\_CELL\_FWD\_HOLD\_NUM**

Change the number of hold forward cells in the shared memory transport (per rank).

**Syntax**

I\_MPI\_SHM\_CELL\_FWD\_HOLD\_NUM=<num>

**Arguments**

<num>	The number of shared memory hold forward cells
> 0	The default value depends on the transport used and must be less than I_MPI_SHM_CELL_FWD_NUM.

**Description**

Set this environment variable to define the number of forward cells in the shared memory transport a rank can hold at the same time. Recommended values are powers of two in the range between 1 and 8.

## **I\_MPI\_SHM\_MCDRAM\_LIMIT**

Change the size of the shared memory bound to the multi-channel DRAM (MCDRAM) (size per rank).

### **Syntax**

`I_MPI_SHM_MCDRAM_LIMIT=<nbytes>`

### **Arguments**

<code>&lt;nbytes&gt;</code>	The size of the shared memory bound to MCDRAM per rank
<code>1048576</code>	This is the default value.

### **Description**

Set this environment variable to define how much MCDRAM memory per rank is allowed for the shared memory transport. This variable takes effect with `I_MPI_SHM=kn1_mcdram` only.

## **I\_MPI\_SHM\_SEND\_SPIN\_COUNT**

Control the spin count value for the shared memory transport for sending messages.

### **Syntax**

`I_MPI_SHM_SEND_SPIN_COUNT=<count>`

### **Arguments**

<code>&lt;count&gt;</code>	Define the spin count value. A typical value range is between 1 and 1000.
----------------------------	---

### **Description**

If the recipient ingress buffer is full, the sender may be blocked until this spin count value is reached. It has no effect when sending small messages.

## **I\_MPI\_SHM\_RECV\_SPIN\_COUNT**

Control the spin count value for the shared memory transport for receiving messages.

### **Syntax**

`I_MPI_SHM_RECV_SPIN_COUNT=<count>`

### **Arguments**

<code>&lt;count&gt;</code>	Define the spin count value. A typical value range is between 1 and 1000000.
----------------------------	--

### **Description**

If the receive is non-blocking, this spin count is used only for safe reorder of expected and unexpected messages. It has no effect on receiving small messages.

## **I\_MPI\_SHM\_FILE\_PREFIX\_4K**

Change the mount point of the 4 KB pages size file system (`tmpfs`) where the shared memory files are created.

### **Syntax**

`I_MPI_SHM_FILE_PREFIX_4K=<path>`

### **Arguments**

<code>&lt;path&gt;</code>	Define the path to the existed mount point of the 4 KB pages size file system ( <code>tmpfs</code> ). By default, the path is not set.
---------------------------	--

**Description**

Set this environment variable to define a new path to the shared memory files. By default, the shared memory files are created at `/dev/shm/`.

This variable affects shared memory transport buffers and RMA windows.

Example

```
I_MPI_SHM_FILE_PREFIX_4K=/dev/shm/intel/
```

**I\_MPI\_SHM\_FILE\_PREFIX\_2M**

Change the mount point of the 2 MB pages size file system (`hugetlbfs`) where the shared memory files are created.

**Syntax**

```
I_MPI_SHM_FILE_PREFIX_2M=<path>
```

**Arguments**

<code>&lt;path&gt;</code>	Define the path to the existed mount point of the 2 MB pages size file system ( <code>hugetlbfs</code> ). By default, the path is not set.
---------------------------	--

**Description**

Set this environment variable to enable 2 MB huge pages on the Intel MPI Library.

The variable affects shared memory transport buffers. It may affect RMA windows as well if the windows size is greater than or equal to 2 MB.

Example

```
I_MPI_SHM_FILE_PREFIX_2M=/dev/hugepages
```

**NOTE**

The root privileges are required to configure the huge pages subsystem. Contact your system administrator to obtain permission.

**I\_MPI\_SHM\_FILE\_PREFIX\_1G**

Change the mount point of the 1 GB pages size file system (`hugetlbfs`) where the shared memory files are created.

**Syntax**

```
I_MPI_SHM_FILE_PREFIX_1G=<path>
```

**Arguments**

<code>&lt;path&gt;</code>	Define the path to the existed mount point of the 1 GB pages size file system ( <code>hugetlbfs</code> ). By default, the path is not set.
---------------------------	--

**Description**

Set this environment variable to enable 1 GB huge pages on the Intel MPI Library.

The variable affects shared memory transport buffers. It may affect RMA windows as well if the windows size is greater than or equal to 1 GB.

Example

```
I_MPI_SHM_FILE_PREFIX_1G=/dev/hugepages1G
```

**NOTE**

The root privileges are required to configure the huge pages subsystem. Contact your system administrator to obtain permission.

## OFI\*-capable Network Fabrics Control

### I\_MPI\_OFI\_PROVIDER

Define the name of the OFI provider to load.

**Syntax**

`I_MPI_OFI_PROVIDER=<name>`

**Arguments**

<code>&lt;name&gt;</code>	The name of the OFI provider to load
---------------------------	--------------------------------------

**Description**

Set this environment variable to define the name of the OFI provider to load. If you do not specify this variable, the OFI library chooses the provider automatically. You can check all available providers by using the `I_MPI_OFI_PROVIDER_DUMP` environment variable. If you set the wrong name for an available provider, use `FI_LOG_LEVEL=debug` to get a hint to set the name correctly.

### I\_MPI\_OFI\_PROVIDER\_DUMP

Control the capability of printing information about all OFI providers and their attributes from an OFI library.

**Syntax**

`I_MPI_OFI_PROVIDER_DUMP=<arg>`

**Arguments**

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Print the list of all OFI providers and their attributes from an OFI library
<code>disable   no   off   0</code>	No action. This is the default value

**Description**

Set this environment variable to control the capability of printing information about all OFI providers and their attributes from an OFI library.

### I\_MPI\_OFI\_DRECV

Control the capability of the direct receive in the OFI fabric.

**Syntax**

`I_MPI_OFI_DRECV=<arg>`

**Arguments**

<code>&lt;arg&gt;</code>	Binary indicator
<code>enable   yes   on   1</code>	Enable direct receive. This is the default value
<code>disable   no   off   0</code>	Disable direct receive

**Description**

Use the direct receive capability to block `MPI_Recv` calls only. Before using the direct receive capability, ensure that you use it for single-threaded MPI applications and check if you have selected OFI as the network fabric by setting `I_MPI_FABRICS=ofi`.

## I\_MPI\_OFI\_LIBRARY\_INTERNAL

Control the usage of libfabric\* shipped with the Intel® MPI Library.

### Syntax

```
I_MPI_OFI_LIBRARY_INTERNAL=<arg>
```

### Arguments

<arg>	Binary indicator
enable   yes   on   1	Use libfabric from the Intel MPI Library
disable   no   off   0	Do not use libfabric from the Intel MPI Library

### Description

Set this environment variable to disable or enable usage of libfabric from the Intel MPI Library. The variable must be set before sourcing the `vars.sh` script.

### Example

```
$ export I_MPI_OFI_LIBRARY_INTERNAL=1
$ source <installdir> /env/vars.sh
```

Setting this variable is equivalent to passing the `-ofi_internal` option to the `vars.sh` script.

For more information, refer to the Intel® MPI Library Developer Guide, section [Libfabric\\* Support](#).

## I\_MPI\_OFI\_TAG\_DYNAMIC

Enable dynamic tag partitioning.

### Syntax

```
I_MPI_OFI_TAG_DYNAMIC=<arg>
```

### Arguments

<arg>	Binary indicator
enable   yes   on   1	Enable automatic OFI tag partitioning
disable   no   off   0	Use static OFI tag layout. This is the default value

### Description

Set this environment variable to enable dynamic OFI Netmod tag partitioning based on the run configuration. You can use it to get larger MPI tag space or to improve scalability in large-scale runs.

## Environment Variables for Memory Policy Control

Intel® MPI Library supports non-uniform memory access (NUMA) nodes with high-bandwidth (HBW) memory (MCDRAM) on Intel® Xeon Phi™ processors (codenamed Knights Landing). Intel® MPI Library can attach memory of MPI processes to the memory of specific NUMA nodes. This section describes the environment variables for such memory placement control.

## I\_MPI\_HBW\_POLICY

Set the policy for MPI process memory placement for using HBW memory.

### Syntax

`I_MPI_HBW_POLICY=<user memory policy>[,<mpi memory policy>][,<win_allocate policy>]`

In the syntax:

- `<user memory policy>` - memory policy used to allocate the memory for user applications (required)
- `<mpi memory policy>` - memory policy used to allocate the internal MPI memory (optional)
- `<win_allocate policy>` - memory policy used to allocate memory for window segments for RMA operations (optional)

Each of the listed policies may have the values below:

### Arguments

<code>&lt;value&gt;</code>	The memory allocation policy used.
<code>hbw_preferred</code>	Allocate the local HBW memory for each process. If the HBW memory is not available, allocate the local dynamic random access memory.
<code>hbw_bind</code>	Allocate only the local HBW memory for each process.
<code>hbw_interleave</code>	Allocate the HBW memory and dynamic random access memory on the local node in the round-robin manner.

### Description

Use this environment variable to specify the policy for MPI process memory placement on a machine with HBW memory.

By default, Intel MPI Library allocates memory for a process in local DDR. The use of HBW memory becomes available only when you specify the `I_MPI_HBW_POLICY` variable.

### Examples

The following examples demonstrate different configurations of memory placement:

- `I_MPI_HBW_POLICY=hbw_bind,hbw_preferred,hbw_bind`  
Only use the local HBW memory allocated in user applications and window segments for RMA operations. Use the local HBW memory internally allocated in Intel® MPI Library first. If the HBW memory is not available, use the local DDR internally allocated in Intel MPI Library.
- `I_MPI_HBW_POLICY=hbw_bind,,hbw_bind`  
Only use the local HBW memory allocated in user applications and window segments for RMA operations. Use the local DDR internally allocated in Intel MPI Library.
- `I_MPI_HBW_POLICY=hbw_bind,hbw_preferred`  
Only use the local HBW memory allocated in user applications. Use the local HBW memory internally allocated in Intel MPI Library first. If the HBW memory is not available, use the local DDR internally allocated in Intel MPI Library. Use the local DDR allocated in window segments for RMA operations.

### I\_MPI\_BIND\_NUMA

Set the NUMA nodes for memory allocation.

#### Syntax

`I_MPI_BIND_NUMA=<value>`

#### Arguments

<code>&lt;value&gt;</code>	Specify the NUMA nodes for memory allocation.
<code>localalloc</code>	Allocate memory on the local node. This is the default value.
<code>Node_1,...,Node_k</code>	Allocate memory according to <code>I_MPI_BIND_ORDER</code> on the specified NUMA nodes.

**Description**

Set this environment variable to specify the NUMA node set that is involved in the memory allocation procedure.

**I\_MPI\_BIND\_ORDER**

Set this environment variable to define the memory allocation manner.

**Syntax**

`I_MPI_BIND_ORDER=<value>`

**Arguments**

<code>&lt;value&gt;</code>	Specify the allocation manner.
<code>compact</code>	Allocate memory for processes as close as possible (in terms of NUMA nodes), among the NUMA nodes specified in <code>I_MPI_BIND_NUMA</code> . This is the default value.
<code>scatter</code>	Allocate memory among the NUMA nodes specified in <code>I_MPI_BIND_NUMA</code> using the round-robin manner.

**Description**

Set this environment variable to define the memory allocation manner among the NUMA nodes specified in `I_MPI_BIND_NUMA`. The variable has no effect without `I_MPI_BIND_NUMA` set.

**I\_MPI\_BIND\_WIN\_ALLOCATE**

Set this environment variable to control memory allocation for window segments.

**Syntax**

`I_MPI_BIND_WIN_ALLOCATE=<value>`

**Arguments**

<code>&lt;value&gt;</code>	Specify the memory allocation behavior for window segments.
<code>localalloc</code>	Allocate memory on the local node. This is the default value.
<code>hbw_preferred</code>	Allocate the local HBW memory for each process. If the HBW memory is not available, allocate the local dynamic random access memory.
<code>hbw_bind</code>	Allocate only the local HBW memory for each process.
<code>hbw_interleave</code>	Allocate the HBW memory and dynamic random access memory on a local node in the round-robin manner.
<code>&lt;NUMA node id&gt;</code>	Allocate memory on the given NUMA node.

**Description**

Set this environment variable to create window segments allocated in HBW memory with the help of the `MPI_Win_allocate_shared` or `MPI_Win_allocate` functions.

**MPI\_Info**

You can control memory allocation for window segments with the help of an `MPI_Info` object, which is passed as a parameter to the `MPI_Win_allocate` or `MPI_Win_allocate_shared` function. In an application, if you specify such an object with the `numa_bind_policy` key, window segments are allocated in accordance with the value for `numa_bind_policy`. Possible values are the same as for

`I_MPI_BIND_WIN_ALLOCATE`.

A code fragment demonstrating the use of MPI\_Info:

```
MPI_Info info;
...
MPI_Info_create( &info );
MPI_Info_set( info, "numa_bind_policy", "hbw_preferred" );
...
MPI_Win_allocate_shared( size, disp_unit, info, comm, &baseptr, &win );
```

**NOTE**

When you specify the memory placement policy for window segments, Intel MPI Library recognizes the configurations according to the following priority:

1. Setting of MPI\_Info.
2. Setting of I\_MPI\_HBW\_POLICY, if you specified <win\_allocate policy>.
3. Setting of I\_MPI\_BIND\_WIN\_ALLOCATE.

## Environment Variables for Asynchronous Progress Control

### I\_MPI\_ASYNC\_PROGRESS

Control the usage of progress threads.

**Syntax**

```
I_MPI_ASYNC_PROGRESS=<arg>
```

**Arguments**

<arg>	Binary indicator
disable   no   off   0	Disable asynchronous progress threads for each rank. This is the default value.
enable   yes   on   1	Enable asynchronous progress threads.

**Description**

Set this environment variable to enable asynchronous progress. If disabled, the I\_MPI\_ASYNC\_PROGRESS\_\* knobs are ignored.

### I\_MPI\_ASYNC\_PROGRESS\_THREADS

Control the number of asynchronous progress threads.

**Syntax**

```
I_MPI_ASYNC_PROGRESS_THREADS=<arg>
```

**Arguments**

<nthreads>	Define the number of progress threads. The default value is 1.
------------	--

**Description**

Set this environment variable to control the number of asynchronous progress threads for each rank.

### I\_MPI\_ASYNC\_PROGRESS\_PIN

Control the asynchronous progress threads pinning.

**Syntax**



```
I_MPI_ASYNC_PROGRESS_PIN=<arg>
```

### Arguments

<arg>	Comma-separated list of logical processors
<CPU list>	Pin all progress threads of local processes to the listed CPUs. By default, N progress threads are pinned to the last N logical processors.

### Description

Set this environment variable to control pinning for all progress threads of local processes.

#### Example

```
I_MPI_ASYNC_PROGRESS_THREADS=3
I_MPI_ASYNC_PROGRESS_PIN="0,1,2,3,4,5"
```

In case of three MPI processes per node, progress threads of the first process are pinned to 0, 1, second are pinned to 2, 3, and third are pinned to 4, 5.

### [I\\_MPI\\_ASYNC\\_PROGRESS\\_ID\\_KEY](#)

Set the MPI info object key that is used to explicitly define the progress thread id for a communicator.

### Syntax

```
I_MPI_ASYNC_PROGRESS_ID_KEY=<arg>
```

### Arguments

<key>	MPI info object key. The default value is <code>thread_id</code> .
-------	--

### Description

Set this environment variable to control the MPI info object key that is used to define the progress thread id for a communicator. The progress thread id is used for work distribution between progress threads. By default, communication goes over the first progress thread.

#### NOTE

Exclude selected processors for progress threads from pinning of computational threads to avoid oversubscription of cores.

For more information and examples, refer to the Intel® MPI Library Developer Guide, section [Asynchronous Progress Control](#).

## Environment Variables for Multi-EP

### [I\\_MPI\\_THREAD\\_SPLIT](#)

### Syntax

```
I_MPI_THREAD_SPLIT=<value>
```

### Arguments

Value	Binary Indicator
0   no   off   disable	Disable the <code>I_MPI_THREAD_SPLIT</code> model support. This is the default value.
1   yes   on   enable	Enable the <code>I_MPI_THREAD_SPLIT</code> model support.

### Description

Use this environment variable to control the `I_MPI_THREAD_SPLIT` programming model.

For more information on `MPI_THREAD_SPLIT`, refer to the Intel® MPI Library Developer Guide, section [MPI\\_THREAD\\_SPLIT Programming Model](#).

## I\_MPI\_THREAD\_RUNTIME

### Syntax

`I_MPI_THREAD_RUNTIME=<value>`

### Arguments

Value	Thread Runtime
generic	Enable runtime support (for example, pthreads, TBB). This is the default value if OpenMP* cannot be detected at runtime.
openmp	Enable OpenMP runtime support. This is the default value if OpenMP is detected at runtime.

### Description

Use this environment variable to control threading runtime support.

---

**NOTE** `I_MPI_THREAD_SPLIT` model support is enabled.

---

## I\_MPI\_THREAD\_MAX

### Syntax

`I_MPI_THREAD_MAX=<int>`

### Arguments

<code>&lt;int&gt;</code>	The maximum number of threads per rank. The default value is <code>omp_get_max_threads()</code> if <code>I_MPI_THREAD_RUNTIME</code> is set to <code>openmp</code> . The value is 1 otherwise
--------------------------	---

### Description

Use this environment variable to set the maximum number of threads to be used in each process concurrently.

## I\_MPI\_THREAD\_ID\_KEY

### Syntax

`I_MPI_THREAD_ID_KEY=<string>`

### Arguments

<code>&lt;string&gt;</code>	Define the MPI info object key. The default value is <code>thread_id</code>
-----------------------------	---

### Description

Use this environment variable to set the MPI info object key that is used to explicitly define the logical thread number `thread_id`.

## Other Environment Variables

### I\_MPI\_DEBUG

Print out debugging information when an MPI program starts running.

#### Syntax

```
I_MPI_DEBUG=<level>[,<flags>]
```

#### Arguments

<i>&lt;level&gt;</i>	Indicate the level of debug information provided.
0	Output no debugging information. This is the default value.
1	Output libfabric* version and provider.
2	Output information about the tuning file used.
3	Output effective MPI rank, pid and node mapping table.
4	Output process pinning information.
5	Output environment variables specific to the Intel® MPI Library.
> 5	Add extra levels of debug information.
<i>&lt;flag s&gt;</i>	Comma-separated list of debug flags
pid	Show process id for each debug message.
tid	Show thread id for each debug message for multithreaded library.
time	Show time for each debug message.
date	Show time and date for each debug message.
ime	
host	Show host name for each debug message.
level	Show level for each debug message.
scope	Show scope for each debug message.
line	Show source line number for each debug message.
file	Show source file name for each debug message.
nofun	Do not show routine name.
c	
noran	Do not show rank.
k	
nousr	Suppress warnings for improper use case (for example, incompatible combination of controls).
warn	
flock	Synchronize debug output from different process or threads.
nobuf	Do not use buffered I/O for debug output.

#### Description

Set this environment variable to print debugging information about the application.

---

**NOTE** Set the same *<level>* value for all ranks.

---

You can specify the output file name for debug information by setting the `I_MPI_DEBUG_OUTPUT` environment variable.

Each printed line has the following format:

```
[<identifier>] <message>
```

where:

- `<identifier>` is the MPI process rank, by default. If you add the '+' sign in front of the `<level>` number, the `<identifier>` assumes the following format: `rank#pid@hostname`. Here, `rank` is the MPI process rank, `pid` is the UNIX\* process ID, and `hostname` is the host name. If you add the '-' sign, `<identifier>` is not printed at all.
- `<message>` contains the debugging output.

The following examples demonstrate possible command lines with the corresponding output:

```
$ mpirun -n 1 -env I_MPI_DEBUG=2 ./a.out
...
[0] MPI startup(): shared memory data transfer mode
```

The following commands are equal and produce the same output:

```
$ mpirun -n 1 -env I_MPI_DEBUG=2,pid,host ./a.out
...
[0#1986@mpicluster001] MPI startup(): shared memory data transfer mode
```

---

**NOTE** Compiling with the `-g` option adds a considerable amount of printed debug information.

---

## I\_MPI\_DEBUG\_OUTPUT

Set output file name for debug information.

### Syntax

```
I_MPI_DEBUG_OUTPUT=<arg>
```

### Arguments

Argument	String Value
<code>stdout</code>	Output to <code>stdout</code> . This is the default value.
<code>stderr</code>	Output to <code>stderr</code> .
<code>&lt;file_name&gt;</code>	Specify the output file name for debug information (the maximum file name length is 256 symbols).

### Description

Set this environment variable if you want to split output of debug information from the output produced by an application. If you use format like `%r`, `%p` or `%h`, rank, process ID or host name is added to the file name accordingly.

## I\_MPI\_DEBUG\_COREDUMP

Controls core dump files generation in case of failure during MPI application execution.

### Syntax

```
I_MPI_DEBUG_COREDUMP=<arg>
```

### Arguments

Argument	Binary Indicator
----------	------------------

enable yes on 1	Enable coredump files generation.
disable no off 0	Do not generate coredump files. Default value.

**Description**

Set this environment variable to enable coredump files dumping in case of termination caused by segmentation fault. Available for both release and debug builds.

**I\_MPI\_STATS**

Collect MPI statistics from your application using Application Performance Snapshot.

**Syntax**

```
I_MPI_STATS=<level>
```

**Arguments**

<level>	Indicate the level of statistics collected
1,2,3,4,5	Specify the level to indicate amount of MPI statistics to be collected by Application Performance Snapshot (APS).  The full description of levels is available in the official <a href="#">APS documentation</a> .

**Description**

Set this variable to collect MPI-related statistics from your MPI application using Application Performance Snapshot. The variable creates a new folder `aps_result_<date>-<time>` containing statistics data. To analyze the collected data, use the `aps` utility. For example:

```
$ export I_MPI_STATS=5
$ mpirun -n 2 ./myApp
$ aps-report aps_result_20171231_235959
```

**I\_MPI\_STARTUP\_MODE**

Select a mode for the Intel® MPI Library process startup algorithm.

**Syntax**

```
I_MPI_STARTUP_MODE=<arg>
```

**Arguments**

Argument	String Value
<code>pmi_shm</code>	Use shared memory to reduce the number of PMI calls.
<code>pmi_shm_netmod</code>	Use the <code>netmod</code> infrastructure for address exchange logic in addition to PMI and shared memory. This is the default value.

**Description**

The `pmi_shm_netmod` mode reduce the application startup time. The efficiency of the modes is more clearly observed with the higher `-ppn` value, while there is no improvement at all with `-ppn 1`.

**I\_MPI\_PMI\_LIBRARY**

Specify the name to third party implementation of the PMI library.

**Syntax**

```
I_MPI_PMI_LIBRARY=<name>
```

**Arguments**

<code>&lt;name&gt;</code>	Full name of the third party PMI library
---------------------------	--

### Description

Set `I_MPI_PMI_LIBRARY` to specify the name of third party PMI library. When you set this environment variable, provide full name of the library with full path to it.

Currently supported PMI versions: PMI1, PMI2

## I\_MPI\_PMI\_VALUE\_LENGTH\_MAX

Control the length of the value buffer in PMI on the client side.

### Syntax

`I_MPI_PMI_VALUE_LENGTH_MAX=<length>`

### Arguments

<code>&lt;length&gt;</code>	Define the value of the buffer length in bytes.
<code>&lt;n&gt; &gt; 0</code>	The default value is -1, which means do not override the value received from the <code>PMI_KVS_Get_value_length_max()</code> function.

### Description

Set this environment variable to control the length of the value buffer in PMI on the client side. The length of the buffer will be the lesser of `I_MPI_PMI_VALUE_LENGTH_MAX` and `PMI_KVS_Get_value_length_max()`.

## I\_MPI\_OUTPUT\_CHUNK\_SIZE

Set the size of the `stdout/stderr` output buffer.

### Syntax

`I_MPI_OUTPUT_CHUNK_SIZE=<size>`

### Arguments

<code>&lt;size&gt;</code>	Define output chunk size in kilobytes
<code>&lt;n&gt;&gt; 0</code>	The default chunk size value is 1 KB

### Description

Set this environment variable to increase the size of the buffer used to intercept the standard output and standard error streams from the processes. If the `<size>` value is not greater than zero, the environment variable setting is ignored and a warning message is displayed.

Use this setting for applications that create a significant amount of output from different processes. With the `-ordered-output` option of `mpiexec.hydra`, this setting helps to prevent the output from garbling.

---

**NOTE** Set the `I_MPI_OUTPUT_CHUNK_SIZE` environment variable in the shell environment before executing the `mpiexec.hydra/mpirun` command. Do not use the `-genv` or `-env` options for setting the `<size>` value. Those options are used only for passing environment variables to the MPI process environment.

---

## I\_MPI\_REMOVED\_VAR\_WARNING

Print out a warning if a removed environment variable is set.

### Syntax

`I_MPI_REMOVED_VAR_WARNING=<arg>`

### Arguments

Argument	Binary Indicator
enable   yes   on   1	Print out the warning. This is the default value
disable   no   off   0	Do not print the warning

### Description

Use this environment variable to print out a warning if a removed environment variable is set. Warnings are printed regardless of whether `I_MPI_DEBUG` is set.

## I\_MPI\_VAR\_CHECK\_SPELLING

Print out a warning if an unknown environment variable is set.

### Syntax

`I_MPI_VAR_CHECK_SPELLING=<arg>`

### Arguments

Argument	Binary Indicator
enable   yes   on   1	Print out the warning. This is the default value
disable   no   off   0	Do not print the warning

### Description

Use this environment variable to print out a warning if an unsupported environment variable is set. Warnings are printed in case of removed or misspelled environment variables.

## I\_MPI\_LIBRARY\_KIND

Specify the Intel® MPI Library configuration.

### Syntax

`I_MPI_LIBRARY_KIND=<value>`

### Arguments

Value	Description
release	Multi-threaded optimized library (with the global lock). This is the default value
debug	Multi-threaded debug library (with the global lock)

### Description

Use this variable to set an argument for the `vars.[c]shscript`. This script establishes the Intel® MPI Library environment and enables you to specify the appropriate library configuration. To ensure that the desired configuration is set, check the `LD_LIBRARY_PATH` variable.

### Example

```
$ export I_MPI_LIBRARY_KIND=debug
```

Setting this variable is equivalent to passing an argument directly to the `vars.[c]sh` script:

### Example

```
$ . <installdir>/bin/vars.sh release
```

## I\_MPI\_PLATFORM

Select the intended optimization platform.

### Syntax

I\_MPI\_PLATFORM=<platform>

### Arguments

<platform>	Intended optimization platform (string value)
auto	Use only with heterogeneous runs to determine the appropriate platform across all nodes. May slow down MPI initialization time due to collective operation across all nodes.
ivb	Optimize for the Intel® Xeon® Processors E3, E5, and E7 V2 series and other Intel® Architecture processors formerly code named Ivy Bridge.
hsw	Optimize for the Intel Xeon Processors E3, E5, and E7 V3 series and other Intel® Architecture processors formerly code named Haswell.
bdw	Optimize for the Intel Xeon Processors E3, E5, and E7 V4 series and other Intel Architecture processors formerly code named Broadwell.
knl	Optimize for the Intel® Xeon Phi™ processor and coprocessor formerly code named Knights Landing.
skx	Optimize for the Intel Xeon Processors E3 V5 and Intel Xeon Scalable Family series, and other Intel Architecture processors formerly code named Skylake.
clx	Optimize for the 2nd Generation Intel Xeon Scalable Processors, and other Intel® Architecture processors formerly code named Cascade Lake.
clx-ap	Optimize for the 2nd Generation Intel Xeon Scalable Processors, and other Intel Architecture processors formerly code named Cascade Lake AP Note: The explicit clx-ap setting is ignored if the actual platform is not Intel.

### Description

Set this environment variable to use the predefined platform settings. The default value is a local platform for each node.

The variable is available for both Intel and non-Intel microprocessors, but it may utilize additional optimizations for Intel microprocessors than it utilizes for non-Intel microprocessors.

---

**NOTE** The values `auto[:min]`, `auto:max`, and `auto:most` may increase the MPI job startup time.

---

## I\_MPI\_MALLOC

Control the Intel® MPI Library custom allocator of private memory.

### Syntax

I\_MPI\_MALLOC=<arg>

### Argument

Argument	Binary Indicator
1	Enable the Intel MPI Library custom allocator of private memory. Use the Intel MPI custom allocator of private memory for MPI_Alloc_mem/MPI_Free_mem.
0	Disable the Intel MPI Library custom allocator of private memory.



Use the system-provided memory allocator for `MPI_Alloc_mem/`  
`MPI_Free_mem`.

### Description

Use this environment variable to enable or disable the Intel MPI Library custom allocator of private memory for `MPI_Alloc_mem/MPI_Free_mem`.

By default, `I_MPI_MALLOC` is enabled if `I_MPI_ASYNC_PROGRESS` and `I_MPI_THREAD_SPLIT` are disabled.

**NOTE** If the platform is not supported by the Intel MPI Library custom allocator of private memory, a system-provided memory allocator is used and the `I_MPI_MALLOC` variable is ignored.

## I\_MPI\_SHM\_HEAP

Control the Intel® MPI Library custom allocator of shared memory.

### Syntax

`I_MPI_SHM_HEAP=<arg>`

### Argument

Argument	Binary Indicator
1	Use the Intel MPI custom allocator of shared memory for <code>MPI_Alloc_mem/</code> <code>MPI_Free_mem</code> .
0	Do not use the Intel MPI custom allocator of shared memory for <code>MPI_Alloc_mem/MPI_Free_mem</code> .

### Description

Use this environment variable to enable or disable the Intel MPI Library custom allocator of shared memory for `MPI_Alloc_mem/MPI_Free_mem`.

By default, `I_MPI_SHM_HEAP` is disabled. If enabled, it can improve performance of the shared memory transport because in that case it is possible to make only one memory copy operation instead of two copy-in/copy-out memory copy operations. If both `I_MPI_SHM_HEAP` and `I_MPI_MALLOC` are enabled, the shared memory allocator is used first. The private memory allocator is used only when required volume of shared memory is not available.

### Details

By default, the shared memory segment is allocated on `tmpfs` file system on the `/dev/shm/` mount point. Starting from Linux kernel 4.7, it is possible to enable transparent huge pages on the shared memory. If Intel MPI Library shared memory heap is used, it is recommended to enable transparent huge pages on your system. To enable transparent huge pages on `/dev/shm`, please contact your system administrator or execute the following command:

```
sudo mount -o remount,huge=advise /dev/shm
```

In order to use another `tmpfs` mount point instead of `/dev/shm/`, use `I_MPI_SHM_FILE_PREFIX_4K`, `I_MPI_SHM_FILE_PREFIX_2M`, and `I_MPI_SHM_FILE_PREFIX_1G`.

---

**NOTE** If your application does not use `MPI_Alloc_mem/MPI_Free_mem` directly, you can override standard `malloc/calloc/realloc/free` procedures by preloading the `libmpi_shm_heap_proxy.so` library:

---

```
export LD_PRELOAD=$I_MPI_ROOT/lib/libmpi_shm_heap_proxy.so
export I_MPI_SHM_HEAP=1
```

In this case, the `malloc/calloc/realloc` is a proxy for `MPI_Alloc_mem` and `free` is a proxy for `MPI_Free_mem`.

---

**NOTE**  
If the platform is not supported by the Intel MPI Library custom allocator of shared memory, the `I_MPI_SHM_HEAP` variable is ignored.

---

## I\_MPI\_SHM\_HEAP\_VSIZE

Change the size (per rank) of virtual shared memory available for the Intel MPI Library custom allocator of shared memory.

### Syntax

```
I_MPI_SHM_HEAP_VSIZE=<size>
```

### Argument

<size>	The size (per rank) of shared memory used in shared memory heap (in megabytes).
>0	If shared memory heap is enabled for <code>MPI_Alloc_mem/MPI_Free_mem</code> , the default value is 4096.

### Description

Intel MPI Library custom allocator of shared memory works with fixed size virtual shared memory. The shared memory segment is allocated on `MPI_Init` and cannot be enlarged later.

The `I_MPI_SHM_HEAP_VSIZE=0` completely disables the Intel MPI Library shared memory allocator.

## I\_MPI\_SHM\_HEAP\_CSIZE

Change the size (per rank) of shared memory cached in the Intel MPI Library custom allocator of shared memory.

### Syntax

```
I_MPI_SHM_HEAP_CSIZE=<size>
```

### Argument

<size>	The size (per rank) of shared memory used in Intel MPI Library shared memory allocator (in megabytes).
>0	It depends on the available shared memory size and number of ranks. Normally, the size is less than 256.

### Description

Small values of `I_MPI_SHM_HEAP_CSIZE` may reduce overall shared memory consumption. Larger values of this variable may speed up `MPI_Alloc_mem/MPI_Free_mem`.

## I\_MPI\_SHM\_HEAP\_OPT

Change the optimization mode of Intel MPI Library custom allocator of shared memory.

### Syntax

`I_MPI_SHM_HEAP_OPT=<mode>`

### Argument

Mode	Optimization Mode
rank	In this mode, each rank has its own dedicated amount of shared memory. This is the default value when <code>I_MPI_SHM_HEAP=1</code>
numa	In this mode, all ranks from NUMA-node use the same amount of shared memory.

### Description

It is recommended to use `I_MPI_SHM_HEAP_OPT=rank` when each rank uses the same amount of memory, and `I_MPI_SHM_HEAP_OPT=numa` when ranks use significantly different amounts of memory.

Usually, the `I_MPI_SHM_HEAP_OPT=rank` works faster than `I_MPI_SHM_HEAP_OPT=numa` but the `numa` optimization mode may consume smaller volume of shared memory.

## I\_MPI\_WAIT\_MODE

Control the Intel® MPI Library optimization for oversubscription mode.

### Syntax

`I_MPI_WAIT_MODE=<arg>`

### Arguments

Argument	Binary Indicator
0	Optimize MPI application to work in the normal mode (1 rank on 1 CPU). This is the default value if the number of processes on a computation node is less than or equal to the number of CPUs on the node.
1	Optimize MPI application to work in the oversubscription mode (multiple ranks on 1 CPU). This is the default value if the number of processes on a computation node is greater than the number of CPUs on the node.

### Description

It is recommended to use this variable in the oversubscription mode.

## I\_MPI\_THREAD\_YIELD

Control the Intel® MPI Library thread yield customization during MPI busy wait time.

### Syntax

`I_MPI_THREAD_YIELD=<arg>`

### Arguments

Argument	Description
0	Do nothing for thread yield during the busy wait (spin wait). This is the default value when <code>I_MPI_WAIT_MODE=0</code>
1	Do the <code>pause processor</code> instruction for <code>I_MPI_PAUSE_COUNT</code> during the busy wait.
2	Do the <code>shied_yield()</code> system call for thread yield during the busy wait.

3 This is the default value when `I_MPI_WAIT_MODE=1`  
 Do the `usleep()` system call for `I_MPI_THREAD_SLEEP` number of microseconds for thread yield during the busy wait.

### Description

`I_MPI_THREAD_YIELD=0` or `I_MPI_THREAD_YIELD=1` in the normal mode and `I_MPI_THREAD_YIELD=2` or `I_MPI_THREAD_YIELD=3` in the oversubscription mode.

## I\_MPI\_PAUSE\_COUNT

Control the Intel® MPI Library pause count for the thread yield customization during MPI busy wait time.

### Syntax

`I_MPI_PAUSE_COUNT=<arg>`

### Argument

Argument	Description
<code>&gt;=0</code>	Pause count for thread yield customization during MPI busy wait time.  The default value is 0. Normally, the value is less than 100.

### Description

This variable is applicable when `I_MPI_THREAD_YIELD=1`. Small values of `I_MPI_PAUSE_COUNT` may increase performance, while larger values may reduce energy consumption.

## I\_MPI\_SPIN\_COUNT

Control the spin count value.

### Syntax

`I_MPI_SPIN_COUNT=<scout>`

### Argument

<code>&lt;scout&gt;</code>	Define the loop spin count when polling fabric(s).
<code>&gt;=0</code>	The default <code>&lt;scout&gt;</code> value is equal to 1 when more than one process runs per processor/core. Otherwise the value equals 2000. The maximum value is equal to 2147483647.

### Description

Set the spin count limit. The loop for polling the fabric(s) spins `<scout>` times before the library releases the processes if no incoming messages are received for processing. Smaller values for `<scout>` cause the Intel® MPI Library to release the processor more frequently.

Use the `I_MPI_SPIN_COUNT` environment variable for tuning application performance. The best value for `<scout>` can be chosen on an experimental basis. It depends on the particular computational environment and application.

## I\_MPI\_THREAD\_SLEEP

Control the Intel® MPI Library thread sleep microseconds timeout for thread yield customization while MPI busy wait progress.

**Syntax**

```
I_MPI_THREAD_SLEEP=<arg>
```

**Argument**

Argument	Description
>=0	Thread sleep microseconds timeout. The default value is 0. Normally, the value is less than 100.

**Description**

This variable is applicable when `I_MPI_THREAD_YIELD=3`. Small values of `I_MPI_PAUSE_COUNT` may increase performance in the normal mode, while larger values may increase performance in the oversubscription mode

**I\_MPI\_EXTRA\_FILESYSTEM**

Control native support for parallel file systems.

**Syntax**

```
I_MPI_EXTRA_FILESYSTEM=<arg>
```

**Argument**

Argument	Binary Indicator
enable   yes   on   1	Enable native support for parallel file systems.
disable   no   off   0	Disable native support for parallel file systems. This is the default value.

**Description**

Use this environment variable to enable or disable native support for parallel file systems.

**I\_MPI\_EXTRA\_FILESYSTEM\_FORCE****Syntax**

```
I_MPI_EXTRA_FILESYSTEM_FORCE=<ufs|nfs|gpfs|panfs|lustre|daos>
```

**Description**

Force filesystem recognition logic. Setting this variable is equivalent to prefixing all paths in MPI-IO calls with the selected filesystem plus colon.

**I\_MPI\_MULTIRAIL****Syntax**

```
I_MPI_MULTIRAIL=<arg>
```

**Argument**

Argument	Binary Indicator
1	Enable multi-rail capability.
0	Disable multi-rail capability. This is the default value.

**Description**

Set this variable to enable multi-rail capability and identify NICs serviced by the provider. Pick this variable on the same NUMA.



# Miscellaneous

This topic provides the following information:

- [Java\\* Bindings for MPI-2 Routines](#) describes the Java language support by Intel® MPI Library.

## Java\* Bindings for MPI-2 Routines

Intel® MPI Library provides an experimental feature to enable support for Java\* MPI applications. Intel MPI Library provides Java bindings for a subset of MPI-2 routines.

You can find all supported MPI routines in the table below. All the classes below belong to the `mpi` package.

**NOTE**

- For static methods, parameters fully correspond to the ones of C routines.
- For non-static methods, the object that calls the method corresponds to the `OUT` parameter of the original C routine.

### Java\* Bindings for MPI-2 Routines

Java Class	Public Fields and Methods	Original C Routine
MPI	<pre>static int Init(String[] args) static void Finalize() static double wTime() static void abort(Comm comm, int errorCode) String getProcessorName()</pre>	<pre>MPI_Init MPI_Finalize MPI_Wtime MPI_Abort</pre>
Aint	<pre>String getProcessorName() static void getExtent(Datatype dt, Aint lb, Aint extent) static void getTrueExtent(Datatype dt, Aint true_lb, Aint true_extent) static void getAddress(long location, Aint address) static void getContents(Datatype dt, int maxIntegers, int maxAddresses, int maxDatatypes, int[] integers, Aint[] addresses, Datatype[] datatypes)</pre>	<pre>MPI_Get_processor_name MPI_Type_get_extent MPI_Type_get_true_extent MPI_Get_address MPI_Type_get_contents</pre>
Collective	<pre>static void allToAll(Object sendbuf, int sendcount, Datatype sendtype, Object recvbuf, int recvcount, Datatype recvtype, Comm comm)</pre>	<pre>MPI_Alltoall</pre>

Java Class	Public Fields and Methods	Original C Routine
	static void reduce(Object sendbuf, Object recvbuf, int count, Datatype type, Op op, int root, Comm comm)	MPI_Reduce
	static void bcast(Object buffer, int count, Datatype type, int root, Comm comm)	MPI_Bcast
	static void gather(Object sendBuffer, int sendCount, Datatype sendType, Object recvBuffer, int recvCount, Datatype recvType, int root, Comm comm)	MPI_Gather
	static void gatherv(Object sendBuffer, int sendCount, Datatype sendType, Object recvBuffer, Object recvCount, Object displs, Datatype recvType, int root, Comm comm)	MPI_Gatherv
	static void allGather(Object sendBuffer, int sendCount, Datatype sendType, Object recvBuffer, int recvCount, Datatype recvType, Comm comm)	MPI_Allgather
	static void allGatherv(Object sendBuffer, int sendCount, Datatype sendType, Object recvBuffer, Object recvCount, Object displs, Datatype recvType, Comm comm)	MPI_Allgatherv
	static void allReduce(Object sendbuf, Object recvbuf, int count, Datatype type, Op op, Comm comm)	MPI_Allreduce
	static void allToAllv(Object sendbuf, Object sendCount, Object sdispls, Datatype sendType, Object recvbuf, Object recvCount, Object rdispls, Datatype recvType, Comm comm)	MPI_Alltoallv
	static void reduceScatter(Object sendbuf, Object recvbuf, Object recvcnts, Datatype type, Op op, Comm comm)	MPI_Reduce_scatter
	static void scatter(Object sendBuffer, int sendCount, Datatype sendType, Object	MPI_Scatter

Java Class	Public Fields and Methods	Original C Routine	
Comm	recvBuffer, int recvCount, Datatype recvType, int root, Comm comm)		
	static void scatterv(Object sendBuffer, Object sendCount, Object displs, Datatype sendType, Object recvBuffer, int recvCount, Datatype recvType, int root, Comm comm)	MPI_Scatterv	
	static void barrier(Comm comm)	MPI_Barrier	
	<b>Static field:</b> Comm WORLD	MPI_COMM_WORLD	
	<b>Static field:</b> Comm SELF	MPI_COMM_SELF	
	int getSize()	MPI_Comm_size	
	int getRank()	MPI_Comm_rank	
	Comm create(Group group)	MPI_Comm_create	
	static Comm create(Comm comm, Group group)	MPI_Comm_create	
	Comm dup()	MPI_Comm_dup	
	Comm split(int color, int key)	MPI_Comm_split	
	Group	<b>Static field:</b> int MPI_PROC_NULL	MPI_PROC_NULL
		<b>Static field:</b> int MPI_IDENT	MPI_IDENT
<b>Static field:</b> int MPI_CONGRUENT		MPI_CONGRUENT	
<b>Static field:</b> int MPI_SIMILAR		MPI_SIMILAR	
<b>Static field:</b> int MPI_UNEQUAL		MPI_UNEQUAL	
<b>Static field:</b> Group WORLD		MPI_GROUP_WORLD	
void group(Comm comm)		MPI_Comm_group	
int getSize()		MPI_Group_size	
int getRank()		MPI_Group_rank	
int MPI_Group_translate_ranks(int[] ranks1, Group group2, int[] ranks2)		MPI_Group_translate_ranks	
static int MPI_Group_translate_ranks(Group group1, int[] ranks1, Group group2, int[] ranks2)		MPI_Group_translate_ranks	
int MPI_Group_compare(Group group2)		MPI_Group_compare	
int MPI_Group_union(Group group1, Group group2)		MPI_Group_union	
int MPI_Group_intersection(Group group1, Group group2)		MPI_Group_intersection	
int MPI_Group_difference(Group group1, Group group2)		MPI_Group_difference	
int MPI_Group_incl(Group group, int n, int[] ranks)		MPI_Group_incl	
int MPI_Group_excl(Group group, int n, int[] ranks)		MPI_Group_excl	



Java Class	Public Fields and Methods	Original C Routine
Datatype	Static field: Datatype NULL	MPI_DATATYPE_NULL
	Static field: Datatype BYTE	MPI_UINT8_T
	Static field: Datatype CHAR	MPI_CHAR
	Static field: Datatype SHORT	MPI_INT16_T
	Static field: Datatype BOOLEAN	MPI_UINT8_T
	Static field: Datatype INT	MPI_INT32_T
	Static field: Datatype LONG	MPI_INT64_T
	Static field: Datatype FLOAT	MPI_FLOAT
	Static field: Datatype DOUBLE	MPI_DOUBLE
	Static field: Datatype PACKED	MPI_PACKED
	Static field: Datatype INT2	MPI_2INT
	Static field: Datatype SHORT_INT	MPI_SHORT_INT
	Static field: Datatype LONG_INT	MPI_LONG_INT
	Static field: Datatype FLOAT_INT	MPI_FLOAT_INT
	Static field: Datatype DOUBLE_INT	MPI_DOUBLE_INT
	Static field: Datatype FLOAT_COMPLEX	MPI_C_FLOAT_COMPLEX
	Static field: Datatype DOUBLE_COMPLEX	MPI_C_DOUBLE_COMPLEX
	void contiguous(int count, Datatype type)	MPI_Type_contiguous
	void commit()	MPI_Type_commit
	int getTypeSize()	MPI_Type_size
	void free()	MPI_Type_free
	void vector(int count, int blockLength, int stride, Datatype baseType)	MPI_Type_vector
	void hvector(int count, int blockLength, int stride, Datatype oldType)	MPI_Type_create_hvector
	void indexed(int count, int[] blockLength, int[] displacement, Datatype oldType)	MPI_Type_indexed
	void hindexed(int count, int[] blockLength, Aint[] displacement, Datatype oldType)	MPI_Type_create_hindexed
	void struct(int count, int[] blockLength, Aint[] displacement, Datatype[] oldTypes)	MPI_Type_struct
	Op	Static field: Op MPI_OP_NULL
Static field: Op MPI_MAX		MPI_MAX
Static field: Op MPI_MIN		MPI_MIN
Static field: Op MPI_SUM		MPI_SUM
Static field: Op MPI_PROD		MPI_PROD
Static field: Op MPI_LAND		MPI_LAND
Static field: Op MPI_BAND		MPI_BAND
Static field: Op MPI_LOR		MPI_LOR

Java Class	Public Fields and Methods	Original C Routine
	Static field: Op MPI_BOR	MPI_BOR
	Static field: Op MPI_LXOR	MPI_LXOR
	Static field: Op MPI_BXOR	MPI_BXOR
	Static field: Op MPI_MINLOC	MPI_MINLOC
	Static field: Op MPI_MAXLOC	MPI_MAXLOC
	Op (UserFunction uf)	-
	void	-
	setUserFunction (UserFunction userFunction)	
	void createOP (boolean commute)	MPI_Op_Create
UserFunction (abstract)	UserFunction (Datatype type, int length)	-
	void setInoutvec (ByteBuffer inoutvec)	-
	void setInvec (ByteBuffer invec)	-
	abstract void call (int type, int length)	-
PTP	static void send (Buffer buffer, int count, Datatype type, int dest, int tag, Comm comm)	MPI_Send
	static void send (<java array> buffer, int count, Datatype type, int dest, int tag, Comm comm)	MPI_Send
	static Status recv (Buffer buf, int count, Datatype type, int source, int tag, Comm comm)	MPI_Recv
	static Status recv (<java array> buf, int count, Datatype type, int source, int tag, Comm comm)	MPI_Recv
	static Request isend (Buffer buffer, int count, Datatype type, int dest, int tag, Comm comm)	MPI_Isend
	static Request isend (<java array> buffer, int count, Datatype type, int dest, int tag, Comm comm)	MPI_Isend
	static Request irectv (Buffer buf, int count, Datatype type, int source, int tag, Comm comm)	MPI_Irecv
	static Request irectv (<java array> buf, int count, Datatype type, int source, int tag, Comm comm)	MPI_Irecv
	static Status sendRecv (Buffer sendbuf, int sendcount, Datatype	MPI_Sendrecv

Java Class	Public Fields and Methods	Original C Routine
Request	<pre> sendtype, int senddest, int sendtag, Buffer recvbuf, int recvcount, Datatype recvtype, int recvsource, int recvtag, Comm comm) Status Wait() static Status[] waitAll(int count, Request[] reqs) static Status waitAny(int count, Request[] reqs, int[] index) static Status[] waitSome(int count, Request[] reqs, int[] outcount, int[] indexes) boolean test(Status status) </pre>	<pre> MPI_Wait MPI_Waitall MPI_Waitany MPI_Waitsome MPI_Test </pre>

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