Intel® MPI Library Developer Reference for Linux* OS

Contents

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1

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 descriptions, refer to the Intel® MPI Library Developer Guide for Linux* OS.

What's New

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.

Package Layout

You can find MPI benchmark sources, compiler configs, and MPI binding at`<I_MPI_install_dir>/opt/mpi` .

Documentation for Older Versions

Documentation for some older versions of the Intel® MPI Library is available as downloads only.

To download specific versions of prior Intel MPI Library documentation, refer to one of the following locations:

- Downloadable Documentation: Intel® oneAPI Toolkits and Components
- Intel® MPI Library - Legacy Documentation
- Download Documentation: Intel® Parallel Studio XE

Developer Reference Sections

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
Section 1. Introduction	Introduces this document and the Intel MPI Library.
Section 2. Command Reference	Describes compilation and job startup commands and their options.
Section 3. Environment Variable Reference	Describes environment variables .
Section 4. Miscellaneous	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://www.intel.com/content/www/us/en/developer/tools/oneapi/mpi-library.html.

What's New

This page lists some important changes to the product that are reflected in the documentation. For a list of all changes, refer to the Intel® MPI Library Release Notes or Intel® MPI Library Release Notes for Linux* OS .

Intel® MPI Library 2021.11 (Intel® oneAPI 2024.0)

- Added new environment variables to GPU Buffers Support page: `I_MPI_OFFLOAD_COLL_PIPELINE`, `I_MPI_OFFLOAD_COLL_PIPELINE_ALLREDUCE_SEGMENTS_SIZE`, and `I_MPI_OFFLOAD_ONESIDED_DEVICE_INITIATED`.
- Added new environment variable to GPU Support page targeting CUDA* support: `I_MPI_OFFLOAD_CUDA_LIBRARY` and `I_MPI_OFFLOAD_MODE`.
- Added new environment variable to GPU Pinning page: `I_MPI_OFFLOAD_PRINT_TOPOLOGY`.
- Added new environment variables to Other Environment Variables page: `I_MPI_FILESYSTEM`, `I_MPI_FILESYSTEM_FORCE`, `I_MPI_FILESYSTEM_CB_NODES`, `I_MPI_FILESYSTEM_CB_CONFIG_LIST`, `I_MPI_FILESYSTEM_NFS_DIRECT`, and `I_MPI_FILESYSTEM_GPFS_DIRECT`.
- Deprecated environment variables: `I_MPI_EXTRA_FILESYSTEM` and `I_MPI_EXTRA_FILESYSTEM_FORCE`.
- Deprecated environment variable: `I_MPI_EXTRA_FILESYSTEM_NFS_DIRECT`.

Intel® MPI Library 2021.10 (Intel® oneAPI 2023.2)

- Added new environment variable `_MPI_OFI_MATCH_COMPLETE` to the OFI*-capable Network Fabrics Control page.
- Added the compiler-specific MPI wrappers: `mpiicpx` and `mpiicx` to the Compiler Commands page.
- Added new environment variable `I_MPI_OFFLOAD_PIN` to the GPU Pinning page.
- Added the `I_MPI_OFI_NIC_LIST CVAR` to the Other Environment Variables page.
- Added new `Cray's PALS` PMIx feature to the Job Schedulers Support.

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

Intel® MPI Library 2021.9 (Intel® oneAPI 2023.1)

- Added new environment variable `I_MPI_EXTRA_FILESYSTEM_NFS_DIRECT` to Other Environment Variables page.

- Added the following CVARs:`I_MPI_OFFLOAD_COPY_COLL_MAX_SIZE`, `I_MPI_OFFLOAD_FAST_MEMCPY_COLL`, `I_MPI_OFFLOAD_FAST_MEMCPY_COLL_MAX_SIZE` to GPU Buffers Support page.

Intel® MPI Library 2021.8 (Intel® oneAPI 2023.0)

- Added `I_MPI_SPAWN` function.
- Added the following CVARs: `I_MPI_OFFLOAD_SYMMETRIC`, `I_MPI_OFFLOAD_RDMA`, `I_MPI_OFFLOAD_FAST_MEMCPY`, `I_MPI_OFFLOAD_IPC`.
- Changed default value of `I_MPI_OFFLOAD_PIPELINE_THRESHOLD` variable.

Intel® MPI Library 2021.7.1 (Intel® oneAPI 2022.4)

- No documentation changes.

Intel® MPI Library 2021.7 (Intel® oneAPI 2022.3)

- No documentation changes.

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.

This type style	Document names
This type style	Hyperlinks
`This type style`	Commands, arguments, options, file names
`THIS_TYPE_STYLE`	Environment variables
<*this type style*>	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.

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
Generic Compilers		
`mpicc`	gcc, cc	C
`mpicxx`	g++	C/C++

Compiler Command	Default Compiler	Supported Languages
`mpifc`	gfortran	Fortran77*/Fortran 95*
GNU* Compilers		
`mpigcc`	gcc	C
`mpigxx`	g++	C/C++
`mpif77`	gfortran	Fortran 77
`mpif90`	gfortran	Fortran 95
Intel® Fortran, C++ Compilers		
`mpiicc`	icc	C
`mpiicx`	icx	C
`mpiicpc`	icpc	C++
`mpiicpx`	icpx	C++
`mpiifort`	ifort	Fortran77/Fortran 95
`mpiifx`	ifx	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>/opt/mpi/etc/<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>/opt/mpi/etc` .

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

- `<install-dir>/opt/mpi/etc/vt.conf` — regular tracing library
- `<install-dir>/opt/mpi/etc/vtfs.conf` — fail-safe tracing library
- `<install-dir>/opt/mpi/etc/vtmc.conf` — correctness checking tracing library
- `<install-dir>/opt/mpi/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="-L<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 table below lists the recommended product default 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*	Intel® oneAPI DPC++/C++ Compiler	$ -cxx=icpx -fsycl	mpiicpc	$ -cxx=icpx -fsycl	$ mpiicpc -cxx=icpx -fsycl -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

<options>	`mpiexec.hydra` options as described in the `mpiexec.hydra` 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

<g-options>	Global options that apply to all MPI processes
<l-options>	Local options that apply to a single argument set
<executable>	`./a.out` or `path/ 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`.

<size>	Define the universe size
`SYSTEM`	Set the size equal to the number of cores passed to `mpiexec` through the hostfile or the resource manager.
`INFINITE`	Do not limit the size. This is the default value.
`<value>`	Set the size to a numeric value ≥ 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:

<mode>	The caching mode to be used
`nocache`	Do not cache PMI messages.
`cache`	Cache PMI messages on the local `pmi_proxy` 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 `pmi_proxy` 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://www.intel.com/content/www/us/en/docs/vtune-profiler/user-guide-application-snapshot-linux/current/overview.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

<spec>	Define the polling mode for multiple I/O
`poll`	Set `poll` as the polling mode. This is the default value.
`select`	Set `select` 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

<spec>	Define MPI process ranks
`all`	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 outut 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 `qrsh` internal job scheduler utility to launch service processes under the respective selected job scheduler (Slurm*, LoadLeveler*, LSF*, and SGE*).

Arguments

<arg>	String parameter
`ssh`	Use secure shell. This is the default value.
`rsh`	Use remote shell.
`pdsh`	Use parallel distributed shell.
`pbs`	Use Torque* `pbsdsh` command.
`pbsdsh`	Alias for `pbs` bootstrap.
`fork`	Use fork call.
`persist`	Use Hydra persist server. See below for details.
`slurm`	Use Slurm* `srun` command.
`ll`	Use LoadLeveler* `llspawn.stdio` 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

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 `all` argument. **NOTE** If you specify incorrect rank index, the corresponding warning is printed and the tool continues working for valid ranks.
`[=launch mode]`	Specify the launch mode (optional). See below for the available values.
`[@arch]`	Specify the architecture on which the tool runs (optional). For a given *<rank set>*, 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]`:

`[=launch mode]`	Tool launch mode (optional). You can specify several values for each tool, which are separated with a comma ','.
`exclusive`	Specify this value to prevent the tool from launching for more than one rank per host.
`attach`	Specify this value to attach the tool from `-gtool` 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.

node-wide	Specify this value to apply the tool from `-gtool` to all ranks where the `<rank set>` 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 `pmi_proxy` daemon). Use the `-remote` 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 `-machinefie` 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

`<options>`	Sequence of one-letter options. Each option controls a specific part of the output data.
`g`	General information about single cluster node shows: • the processor product name • the number of packages/sockets on the node • core and threads numbers on the node and within each package • SMT mode enabling
`i`	Logical processors identification table identifies threads, cores, and packages of each logical processor accordingly. • *Processor* - logical processor number. • *ThreadId* - unique processor identifier within a core. • *CoreId* - unique core identifier within a package. • *PackageId* - unique package identifier within a node.
`d`	Node decomposition table shows the node contents. Each entry contains the information on packages, cores, and logical processors. • *Package Id* - physical package identifier. • *Cores Id* - list of core identifiers that belong to this package. • *Processors Id* - 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.
`c`	Cache sharing by logical processors shows information of sizes and processors groups, which share particular cache level. • Size - cache size in bytes. • Processors - a list of processor groups enclosed in the parentheses those share this cache or no sharing otherwise.

`s`	Microprocessor signature hexadecimal fields (Intel platform notation) show signature values: • extended family • extended model • family • model • type • stepping
`f`	Microprocessor feature flags indicate what features the microprocessor supports. The Intel platform notation is used.
`n`	Table shows the following information about NUMA nodes: • NUMA Id - NUMA node identifier. • Processors - a list of processors in this node. If the node has no processors, the node is not shown.
`A`	Equivalent to `gidcsf`
`gidc`	Default sequence
`?`	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

`<options>`	List of options.
`-a | -all`	Show all IMPI variables.
`-h | -help`	Show a help message.
`-v | -variable`	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_fast

This utility tunes the Intel® MPI Library to the cluster configuration using the Autotuning functionality.

Syntax

`mpitune_fast <options>`

Arguments

Options	Description
`-c | --colls`	Set custom collective operations to tune, delimited by commas.
`-d | --results_dir <path-to-results-dir>`	Set custom directory for tuning results, host files, and logs. Default: the current working directory.
`-h | --help`	Display the help message.
`-n <n>`	Specify the number of nodes. This can be a comma-delimited set of values to set up several launches.
`-pd <path-to-performance-results-dir>`, `--perf_results_dir <path-to-performance-results-dir>`	Set a custom directory for validation performance results. Default: `performance_results_<timestamp>`.
`-ppn <n>`	Specify the number of processes per node. This can be a comma-delimited set of values to set up several launches.
`-val <path-to-tuning-file>`, `--validate <path-to-tuning-file>`	Run the tuning file validation cycle to validate the existing tuning file.

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
`-f <filename>`	Specify a file containing host names.
`-hosts HOSTS, --hosts HOSTS`	Set the host names, delimited by commas. Example: `--hosts host1,host2`

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

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

`<profile-name>`	Specify the checking profile name. The default value is `vtmc`.

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

<arg>	Binary indicator.
`enable	yes	on	1`	Enable checking the compiler.
`disable	no	off	0`	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

<compiler>	Specify the full path/name of compiler to be used. • `I_MPI_CC=<compiler>` affects `mpiicx` and `mpicc` • `I_MPI_CXX=<compiler>` affects `mpiicpx` and `mpicxx` • `I_MPI_FC=<compiler>` affects `mpifc` • `I_MPI_F77=<compiler>` affects `mpif77` • `I_MPI_F90=<compiler>` affects `mpiifx` and `mpif90`

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 *<install-dir>*`/etc`

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 `mpiicc` linking with Fortran bindings.

Syntax

`I_MPI_FORT_BIND=`*`<arg>`*

Arguments

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

Description

By default, the `mpiicc` 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

`<arg>`	String parameter
`<hostsfile>`	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

`<arg>`	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

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on the debug output
`disable | no | off | 0`	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

`<arg>`	String parameter
`all`	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

`<timeout>`	Define `mpiexec.hydra` timeout period in seconds
`<n>` ≥ 0	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

`<timeout>`	Define `mpiexec.hydra` startup timeout period in seconds
`<n>` ≥ 0	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

`<number>`	Define the signal number
`<n>> 0`	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

`<number>`	Define signal number
`<n>> 0`	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

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on propagation
`disable | no | off | 0`	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.stdio` command
`lsf`	Use LSF* `blaunch` command
`sge`	Use Univa* Grid Engine* `qrsh` 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

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

<arg>	String parameter
<rmk>	Resource management kernel. The supported values are `slurm`, `ll`, `lsf`, `sge`, `pbs`, `cobalt`.

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

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

`alltoall`	Information is automatically exchanged between all `pmi_proxy` 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

`<value>`	Define a value used for `-perhost` by default
`integer > 0`	Exact value for the option
`all`	All logical CPUs on the node
`allcores`	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

<arg>	String parameter
`<list>`	Blank separated list of the libraries to preload. The default value is `vt`

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

<arg>	String parameter
`<list>`	Blank separated list of the libraries to preload. The default value is `vtmc`

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

`<num>`	Number
`<n> >= 0`	The default value is 16. This value means that hierarchical structure is enabled if the number of nodes is more than 16. If I_MPI_HYDRA_BRANCH_COUNT=0, then there is no hierarchical structure. If I_MPI_HYDRA_BRANCH_COUNT=-1, 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

`<arg>`	Binary indicator
`enable | yes | on | 1`	Enable PMI message aggregation. This is the default value.
`disable | no | off | 0`	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

<arg>	String parameter
`ssh`	Secure Shell (SSH). This is the default value
`rsh`	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

`<arg>`	String parameter
`<network interface>`	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

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

`<arg>`	String parameter
`<path>`	Temporary directory. The default value is `/tmp`

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

<value>	Binary indicator
`enable	yes	on	1`	Use the process placement provided by job scheduler. This is the default value
`disable	no	off	0`	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

<arg>	Parameters
<command-line-for-a-tool>	Specify a tool's launch command, including 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 `all` argument. **NOTE** If you specify incorrect rank index, the corresponding warning is printed and the tool continues working for valid ranks.
`[=exclusive]`	Specify this parameter to prevent launching a tool for more than one rank per host. This parameter is optional.
`[@arch]`	Specify the architecture on which the tool runs (optional). For a given *<rank set>*, 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

<arg>	String parameter
`hwloc`	The `hwloc`* 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

<range>	String parameter
`<min>:<max>`	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

<arg>	Binary indicator
`enable | yes | on | 1`	Do not print abort warning message
`disable | no | off | 0`	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

<arg>	String parameter
`<hostname>:<port>`	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

`<presetid>`	Preset identifier
`>= 0`	Set a number to select the desired algorithm. The value 0 uses basic logic of the collective algorithm selection.

<conditions>	A comma separated list of conditions. An empty list selects all message sizes and process combinations
`<l>`	Messages of size *<l>*
`<l>-<m>`	Messages of size from *<l>* to *<m>*, inclusive
`<l>@<p>`	Messages of size *<l>* and number of processes *<p>*
`<l>-<m>@<p>-<q>`	Messages of size from *<l>* to *<m>* and number of processes from *<p>* to *<q>*, 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`	**1.** Recursive doubling **2.** Bruck's **3.** Ring **4.** Topology aware Gatherv + Bcast **5.** Knomial
`I_MPI_ADJUST_ALLGATHERV`	`MPI_Allgatherv`	**1.** Recursive doubling **2.** Bruck's **3.** Ring **4.** Topology aware Gatherv + Bcast
`I_MPI_ADJUST_ALLREDUCE`	`MPI_Allreduce`	**1.** Recursive doubling **2.** Rabenseifner's **3.** Reduce + Bcast **4.** Topology aware Reduce + Bcast **5.** Binomial gather + scatter **6.** Topology aware binominal gather + scatter **7.** Shumilin's ring **8.** Ring **9.** Knomial **10.** Topology aware SHM-based flat **11.** Topology aware SHM-based Knomial **12.** Topology aware SHM-based Knary
`I_MPI_ADJUST_ALLTOALL`	`MPI_Alltoall`	**1.** Bruck's **2.** Isend/Irecv + waitall **3.** Pair wise exchange **4.** Plum's
`I_MPI_ADJUST_ALLTOALLV`	`MPI_Alltoallv`	**1.** Isend/Irecv + waitall **2.** Plum's
`I_MPI_ADJUST_ALLTOALLW`	`MPI_Alltoallw`	Isend/Irecv + waitall
`I_MPI_ADJUST_BARRIER`	`MPI_Barrier`	**1.** Dissemination **2.** Recursive doubling **3.** Topology aware dissemination **4.** Topology aware recursive doubling **5.** Binominal gather + scatter **6.** Topology aware binominal gather + scatter **7.** Topology aware SHM-based flat

Environment Variable	Collective Operation	Algorithms
		8. Topology aware SHM-based Knomial **9.** Topology aware SHM-based Knary
`I_MPI_ADJUST_BCAST`	`MPI_Bcast`	**1.** Binomial **2.** Recursive doubling **3.** Ring **4.** Topology aware binomial **5.** Topology aware recursive doubling **6.** Topology aware ring **7.** Shumilin's **8.** Knomial **9.** Topology aware SHM-based flat **10.** Topology aware SHM-based Knomial **11.** Topology aware SHM-based Knary **12.** NUMA aware SHM-based (SSE4.2) **13.** NUMA aware SHM-based (AVX2) **14.** NUMA aware SHM-based (AVX512)
`I_MPI_ADJUST_EXSCAN`	`MPI_Exscan`	**1.** Partial results gathering **2.** Partial results gathering regarding layout of processes
`I_MPI_ADJUST_GATHER`	`MPI_Gather`	**1.** Binomial **2.** Topology aware binomial **3.** Shumilin's **4.** Binomial with segmentation
`I_MPI_ADJUST_GATHERV`	`MPI_Gatherv`	**1.** Linear **2.** Topology aware linear **3.** Knomial
`I_MPI_ADJUST_REDUCE_SCATTER`	`MPI_Reduce_scatter`	**1.** Recursive halving **2.** Pair wise exchange **3.** Recursive doubling **4.** Reduce + Scatterv **5.** Topology aware Reduce + Scatterv
`I_MPI_ADJUST_REDUCE`	`MPI_Reduce`	**1.** Shumilin's **2.** Binomial **3.** Topology aware Shumilin's **4.** Topology aware binomial **5.** Rabenseifner's

Environment Variable	Collective Operation	Algorithms
		6. Topology aware Rabenseifner's **7.** Knomial **8.** Topology aware SHM-based flat **9.** Topology aware SHM-based Knomial **10.** Topology aware SHM-based Knary **11.** Topology aware SHM-based binomial
`I_MPI_ADJUST_SCAN`	`MPI_Scan`	**1.** Partial results gathering **2.** Topology aware partial results gathering
`I_MPI_ADJUST_SCATTER`	`MPI_Scatter`	**1.** Binomial **2.** Topology aware binomial **3.** Shumilin's
`I_MPI_ADJUST_SCATTERV`	`MPI_Scatterv`	**1.** Linear **2.** Topology aware linear
`I_MPI_ADJUST_SENDRECV_REPLACE`	`MPI_Sendrecv_replace`	1. Generic 2. Uniform (with restrictions)
`I_MPI_ADJUST_IALLGATHER`	`MPI_Iallgather`	**1.** Recursive doubling **2.** Bruck's **3.** Ring
`I_MPI_ADJUST_IALLGATHERV`	`MPI_Iallgatherv`	**1.** Recursive doubling **2.** Bruck's **3.** Ring
`I_MPI_ADJUST_IALLREDUCE`	`MPI_Iallreduce`	**1.** Recursive doubling **2.** Rabenseifner's **3.** Reduce + Bcast **4.** Ring (patarasuk) **5.** Knomial **6.** Binomial **7.** Reduce scatter allgather **8.** SMP **9.** Nreduce
`I_MPI_ADJUST_IALLTOALL`	`MPI_Ialltoall`	**1.** Bruck's **2.** Isend/Irecv + Waitall **3.** Pairwise exchange
`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`	**1.** Binomial **2.** Recursive doubling

Environment Variable	Collective Operation	Algorithms
		3. Ring 4. Knomial 5. SMP 6. Tree knominal 7. Tree kary
`I_MPI_ADJUST_IEXSCAN`	`MPI_Iexscan`	1. Recursive doubling 2. SMP
`I_MPI_ADJUST_IGATHER`	`MPI_Igather`	1. Binomial 2. Knomial
`I_MPI_ADJUST_IGATHERV`	`MPI_Igatherv`	1. Linear 2. Linear ssend
`I_MPI_ADJUST_IREDUCE_SCATTER`	`MPI_Ireduce_scatter`	1. Recursive halving 2. Pairwise 3. Recursive doubling
`I_MPI_ADJUST_IREDUCE`	`MPI_Ireduce`	1. Rabenseifner's 2. Binomial 3. Knomial
`I_MPI_ADJUST_ISCAN`	`MPI_Iscan`	1. Recursive Doubling 2. SMP
`I_MPI_ADJUST_ISCATTER`	`MPI_Iscatter`	1. Binomial 2. Knomial
`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 *<l>-<m>* 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_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 `MPI_Comm_dup_with_info` 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_CBW", "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

<arg >	**Description**
none	Disable tuning modes. This is the default value.
`auto`	Enable autotuner.
`auto:application`	Enable autotuner with application focused strategy (alias for auto).
`auto:cluster`	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

<path >	A path to a binary file with tuning settings. By default, Intel® MPI Library uses the binary tuning file located at <`$I_MPI_ONEAPI_ROOT/etc`>.

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.

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

<size>	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

<number>	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

<number>	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

<arg>	**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 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_CPUSET=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 or 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

<proclist>	A comma-separated list of logical processor numbers and/or ranges of processors. The process with the i-th rank is pinned to the i-th processor in the list. The number should not exceed the number of processors on a node.
<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>*.

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

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

Arguments

<procset>	Specify a processor subset based on the topological numeration. The default value is `allcores`.
`all`	All logical processors. Specify this subset to define the number of CPUs on a node.
`allcores`	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, `allcores` equals to `all`.
`allsocks`	All packages/sockets. Specify this subset to define the number of sockets on a node.

<grain>	Specify the pinning granularity cell for a defined *<procset>*. The minimal *<grain>*value is a single element of the *<procset>*. The maximal *<grain>* value is the number of *<procset>* elements in a socket. The *<grain>*value must be a multiple of the *<procset>* value. Otherwise, the minimal *<grain>* value is assumed. The default value is the minimal *<grain>* value.
<shift>	Specify the granularity of the round robin scheduling shift of the cells for the *<procset>*. *<shift>*is measured in the defined *<grain>*units. The *<shift>*value must be positive integer. Otherwise, no shift is performed. The default value is no shift, which is equal to `1` normal increment.
<preoffset>	Specify the circular shift of the processor subset *<procset>*defined before the round robin shifting on the *<preoffset>*value. The value is measured in the defined *<grain>*units. The *<preoffset>*value must be non-negative integer. Otherwise, no shift is performed. The default value is no shift.
<postoffset>	Specify the circular shift of the processor subset *<procset>*derived after round robin shifting on the *<postoffset>*value. The value is measured in the defined *<grain>*units. The *<postoffset>*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:

<n>	Specify an explicit value of the corresponding parameters. *<n>*is non-negative integer.
`fine`	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 `cache1`, `cache2`, and `cache3`.
`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 `socket/2`.
`third`	Specify the parameter value equal to `socket/3`.
`quarter`	Specify the parameter value equal to `socket/4`.
`octavo`	Specify the parameter value equal to `socket/8`.

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 1st pass

B) cyan - processor grains chosen on the 2nd pass

C) green - processor grains chosen on the final 3rd 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)

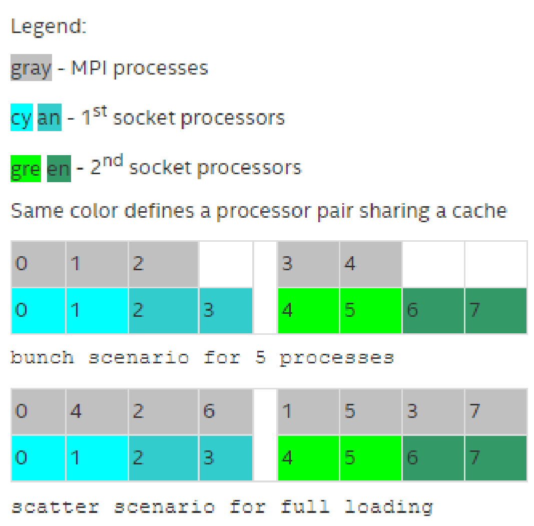
0 1	2 3	...	2n-2 2n-1	2n 2n+1	2n+2 2n+3	...	4n-2 4n-1	4n 4n+1	4n+2 4n+3	...	6n-2 6n-1
0 1	6 7	...	6n-6 6n-5	2 3	8 9	...	6n-4 6n-3	4 5	10 11	...	6n-2 6n-1

- 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
cy an - 1st socket processors
gre en - 2nd 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

`<cell>`	Specify the resolution granularity
`unit`	Basic processor unit (logical CPU)
`core`	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_CPUSET

Respect the process affinity mask.

Syntax

`I_MPI_PIN_RESPECT_CPUSET=<value>`

Arguments

<value>	Binary indicator
`enable | yes | on | 1`	Respect the process affinity mask. This is the default value.
`disable | no | off | 0`	Do not respect the process affinity mask.

Description

If you set `I_MPI_PIN_RESPECT_CPUSET=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.

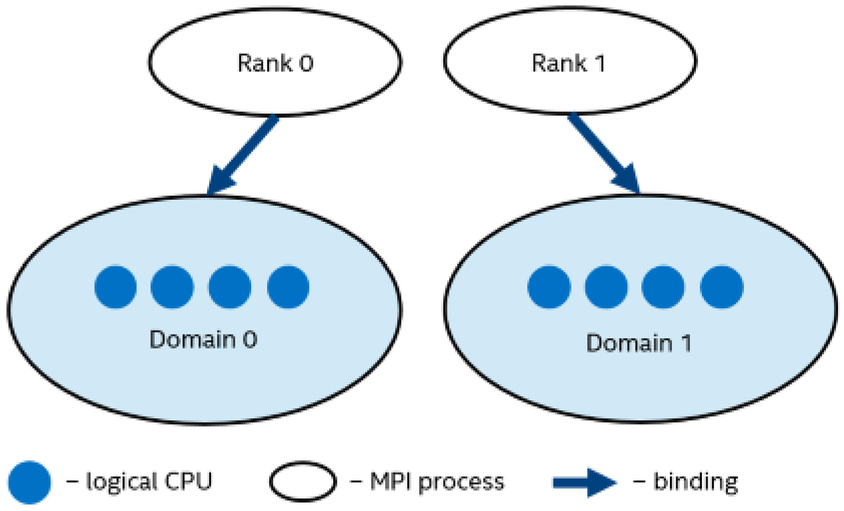
If you set `I_MPI_PIN_RESPECT_HCA=disable`, the Hydra process launcher does not use the location of IBA HCA on each intended host for applying Intel MPI Library pinning capability.

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>`*

`<mc-shape>`	Define domains through multi-core terms.
`core`	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.
`socket | sock`	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.
`numa`	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.
`node`	All logical processors on a node are arranged into a single domain.
`cache1`	Logical processors that share a particular level 1 cache are arranged into a single domain.
`cache2`	Logical processors that share a particular level 2 cache are arranged into a single domain.
`cache3`	Logical processors that share a particular level 3 cache are arranged into a single domain.
`cache`	The largest domain among `cache1`, `cache2`, and `cache3` 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>]`*

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

`<layout>`	Ordering of domain members. The default value is `compact`

`platform`	Domain members are ordered according to their BIOS numbering (platform-depended numbering)
`compact`	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
`scatter`	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>`

`<masklist>`	Define domains through the comma separated list of hexadecimal numbers (domain masks)
`[m1,...,mn]`	For `<masklist>`, each `mi` is a hexadecimail bit mask defining an individual domain. The following rule is used: the `i`th logical processor is included into the domain if the corresponding `mi` value is set to `1`. All remaining processors are put into a separate domain. BIOS numbering is used. **NOTE** To ensure that your configuration in `<masklist>` is parsed correctly, use square brackets to enclose the domains specified by the `<masklist>`. For example: `I_MPI_PIN_DOMAIN=[55,aa]`

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:

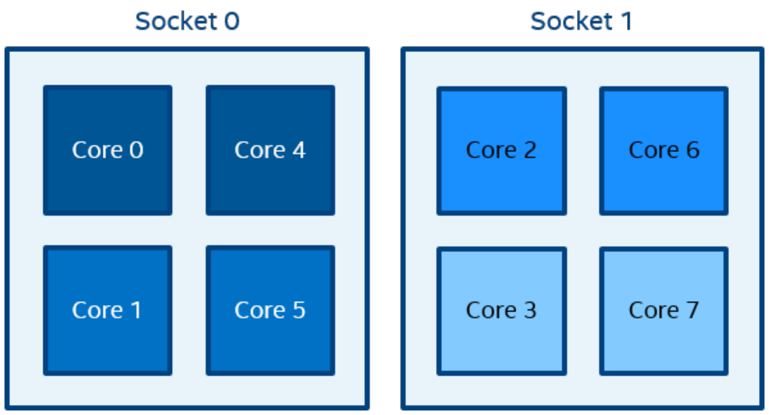
- If you set `I_MPI_PIN_DOMAIN=auto` and a single process is running on a node (for example, due to `I_MPI_PERHOST=1`)
- `I_MPI_PIN_DOMAIN=node`

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).

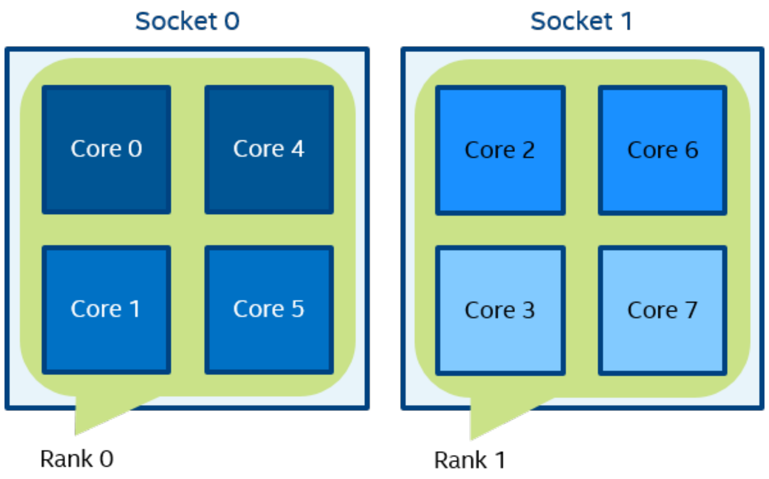
See the following model of a symmetric multiprocessing (SMP) node in the examples:

Figure 2 Model of a Node



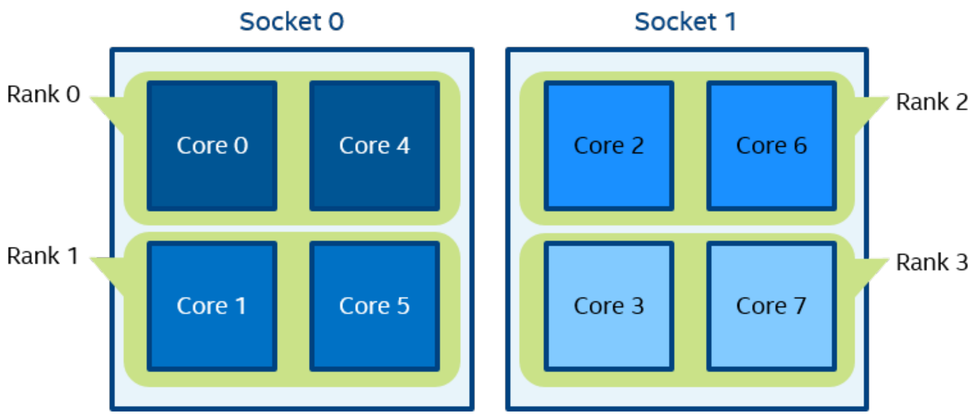
The figure above represents the SMP node model with a total of 8 cores on 2 sockets. Intel® Hyper-Threading Technology is disabled. Core pairs of the same color share the L2 cache.

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



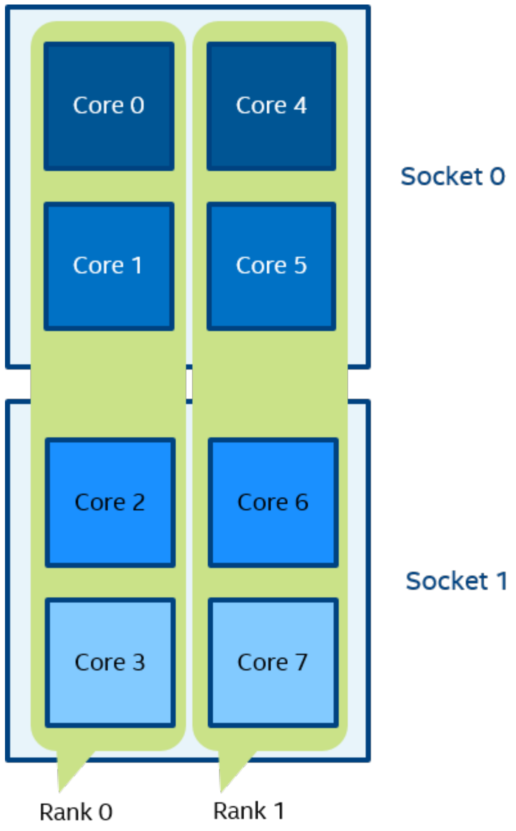
In Figure 3, two domains are defined according to the number of sockets. Process rank 0 can migrate on all cores on the 0-th socket. Process rank 1 can migrate on all cores on the first socket.

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



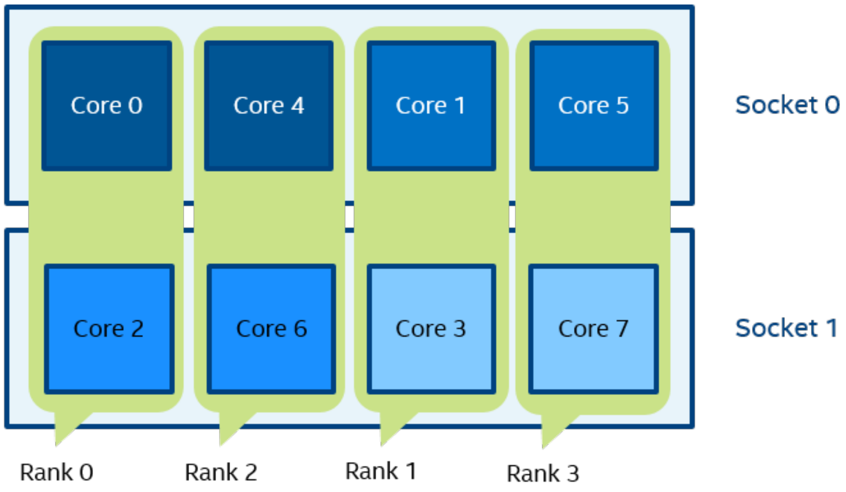
In Figure 4, four domains are defined according to the amount of common L2 caches. Process rank 0 runs on cores {0,4} that share an L2 cache. Process rank 1 runs on cores {1,5} that share an L2 cache as well, and so on.

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



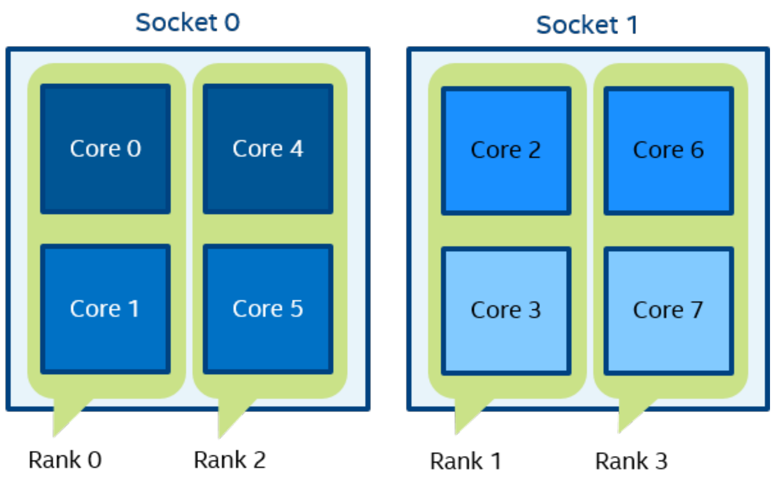
In Figure 5, two domains with size=4 are defined. The first domain contains cores {0,1,2,3}, and the second domain contains cores {4,5,6,7}. Domain members (cores) have consecutive numbering as defined by the `platform` option.

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



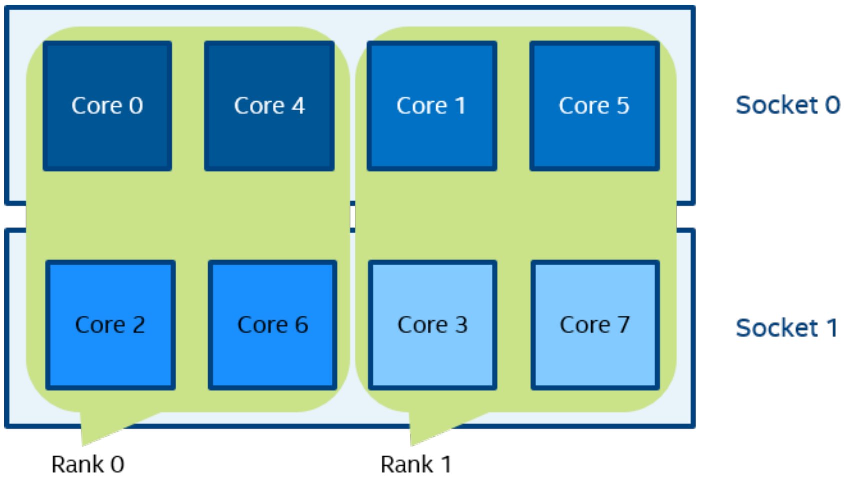
In Figure 6, domain size=2 (defined by the number of CPUs=8 / number of processes=4), `scatter` layout. Four domains {0,2}, {1,3}, {4,6}, {5,7} are defined. Domain members do not share any common resources.

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

`<order>`	Specify the ranking order
`range`	The domains are ordered according to the processor's BIOS numbering. This is a platform-dependent numbering.
`scatter`	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

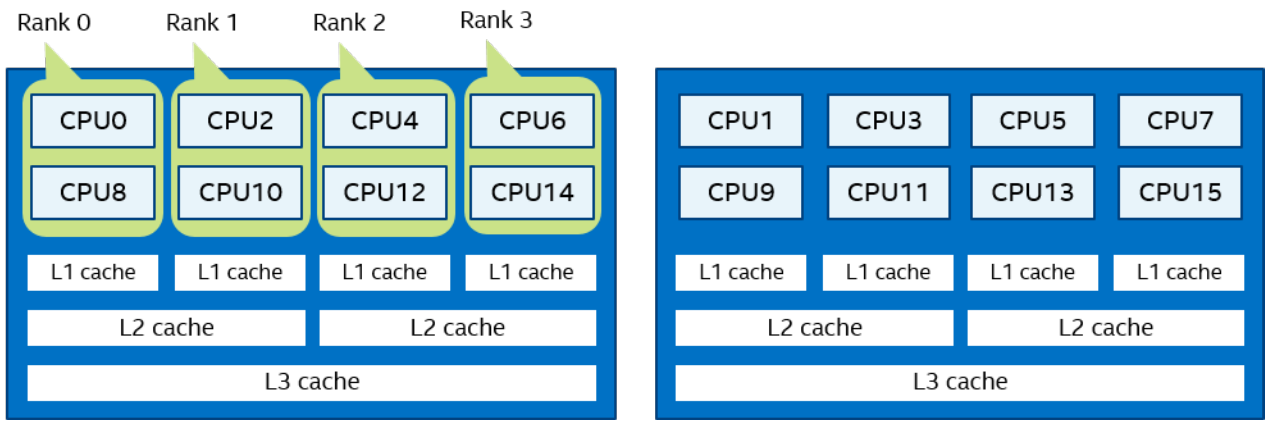
For the following configuration:

- 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
```

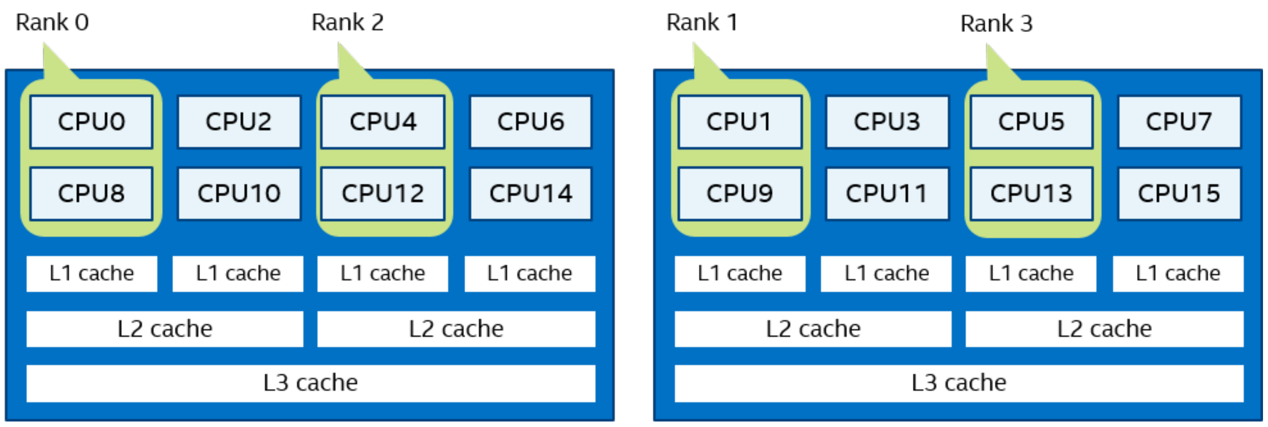
Figure 9 Compact Order Example



Scatter order:

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

Figure 10 Scatter Order Example

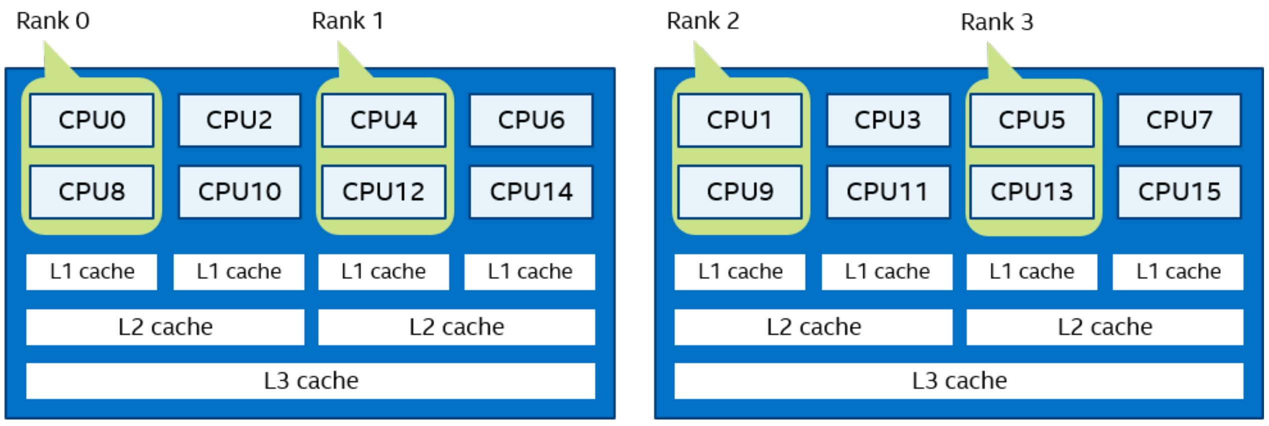


Spread order:

```
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.

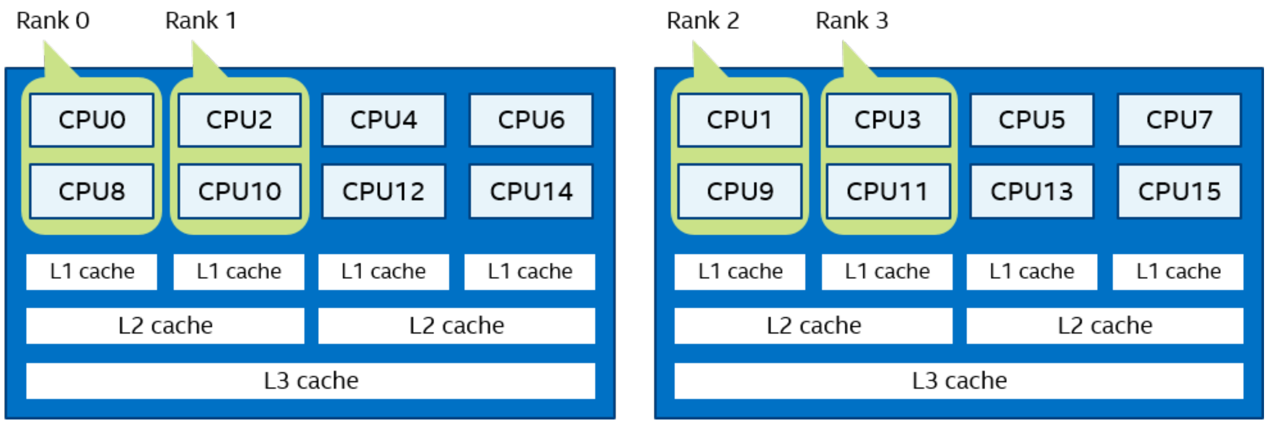
Figure 11 Spread Order Example



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:

- GPU Pinning
- GPU Buffers Support

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

Current support is limited to Intel GPUs and Nvidia* GPUs only.

I_MPI_OFFLOAD

Set this environment variable to enable all GPU features.

Syntax

`I_MPI_OFFLOAD=<value>`

Arguments

Value	Description
`0`	Disabled. This is the default value.
`1`	Enabled.

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_MODE

Select the API for GPU/accelerator offloading.

Syntax

`I_MPI_OFFLOAD_PRINT_TOPOLOGY=<value>`

Arguments

Value	Description
`auto`	Automatically identify GPU backend. This is the default value.
`level_zero`	Use Level-Zero API and library for GPU operations.

Value	Description
`cuda`	Use CUDA Driver API and library for GPU operations.

Description

Set this environment variable to select the API for GPU/accelerator offloading.

I_MPI_OFFLOAD_SYMMETRIC

Enable/disable an assumption that all buffers in an operation have the same type.

Syntax

`I_MPI_OFFLOAD_SYMMETRIC=<value>`

Arguments

Value	Description
`0`	Disabled. This is the default value.
`1`	Enabled.

Description

Set this environment variable to enable/disable an assumption that all buffers in an operation have the same type. That is, buffers are allocated on GPU or HOST only.

Setting this variable optimizes `device->device communications` but disables handling of `host->device` and `device->host cases`.

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

Argument	Description
`<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`.

I_MPI_OFFLOAD_CUDA_LIBRARY

Specify the name and full path to the CUDA Driver library.

Arguments

Value	Description
`<path>`	Full path to the CUDA Driver library.
`<name>`	Name of the CUDA Driver library.

Description

Set this environment variable to specify the name and full path to CUDA Driver library. Set this variable if CUDA is not located in the default path. Default value: ** libcuda.so.

GPU Pinning

Use this feature to distribute Intel GPU devices between MPI ranks.

To enable this feature, set `I_MPI_OFFLOAD_PIN`. This feature requires that the Level-Zero* library be installed on the nodes.

NOTE This feature is not yet supported by CUDA backend.

Default Settings

`I_MPI_OFFLOAD_CELL=tile`

`I_MPI_OFFLOAD_DOMAIN_SIZE=-1`

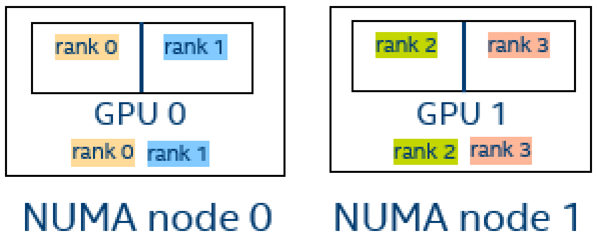
`I_MPI_OFFLOAD_DEVICES=all`

By default, all available resources are distributed between MPI ranks as equally as possible given the position of the ranks; that is, the distribution of resources takes into account on which NUMA node the rank and the resource are located. Ideally, the rank will have resources only on the same NUMA node on which the rank is located.

Examples

All examples below represent a machine configuration with two NUMA nodes and two GPUs with two tiles.

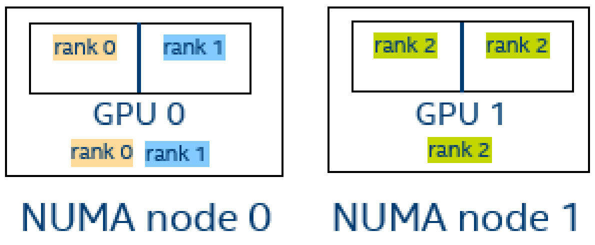
Figure 1. Four MPI Ranks



Debug output I_MPI_DEBUG=3:

```
[0] MPI startup(): ===== GPU pinning on host1 =====
[0] MPI startup(): Rank Pin tile
[0] MPI startup(): 0       {0}
[0] MPI startup(): 1       {1}
[0] MPI startup(): 2       {2}
[0] MPI startup(): 3       {3}
```

Figure 2. Three MPI Ranks



Debug output `I_MPI_DEBUG=3`:

```
[0] MPI startup(): ===== GPU pinning on host1 =====
[0] MPI startup(): Rank Pin tile
[0] MPI startup(): 0        {0}
[0] MPI startup(): 1        {1}
[0] MPI startup(): 2        {2,3}
```

I_MPI_OFFLOAD_TOPOLIB

Set the interface for GPU topology recognition.

Syntax

`I_MPI_OFFLOAD_TOPOLIB=<arg>`

Arguments

`<arg>` is a string parameter

Value	Description
`level_zero`	Use Level-Zero library for GPU topology recognition.
`none`	Disable GPU recognition and GPU pinning.

Description

Set this environment variable to define the interface for GPU topology recognition.

I_MPI_OFFLOAD_CELL

Set this variable to define the base unit: tile (subdevice) or device (GPU).

Syntax

`I_MPI_OFFLOAD_CELL=<cell>`

Arguments

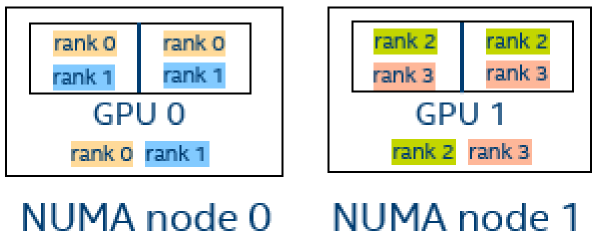
Value	Description
`<cell>`	Specify the base unit.
`tile`	One tile (subdevice). This is the default value.
`device`	Whole device (GPU) with all subdevices

Description

Set this variable to define the base unit. This variable may affect other GPU pinning variables.

Example

Figure 3. Four MPI ranks, I_MPI_OFFLOAD_CELL=device



I_MPI_OFFLOAD_DOMAIN_SIZE

Control the number of base units per MPI rank.

Syntax

`I_MPI_OFFLOAD_DOMAIN_SIZE=<value>`

Arguments

<*value*> is an integer number.

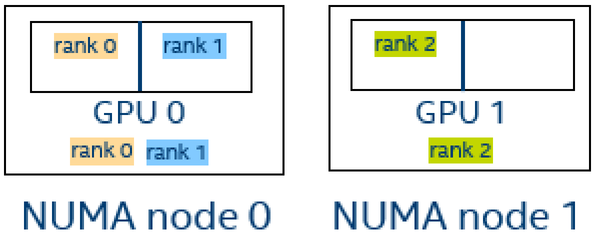
Value	Description
`-1`	Auto. Each MPI rank may have a different domain size to use all available resources. This is the default value.
`> 0`	Custom domain size.

Description

Set this variable to define how many base units will be pinned to the MPI rank. I_MPI_OFFLOAD_CELL variable defines the base unit: tile or device.

Examples

Figure 4. Three MPI ranks, I_MPI_OFFLOAD_DOMAIN_SIZE=1



I_MPI_OFFLOAD_DEVICES

Define a list of available devices.

Syntax

`I_MPI_OFFLOAD_DEVICES=<devicelist>`

Arguments

<*devicelist*> is a comma-separated list of available devices.

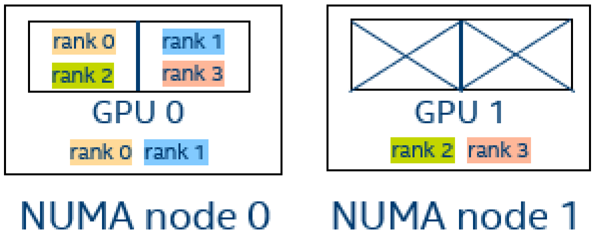
Value	Description
all	All devices are available. This is the default value.
<*l*>	Device with logical number <*l*>.
<*l*>-<*m*>	Range of devices with logical numbers from <*l*> to <*m*>.
<*k*>,<*l*>-<m>	Device <*k*> and devices from <*l*> to <*m*>.

Description

Set this variable to define the available devices. This variable also gives you the ability to exclude devices.

Example

Figure 5. Four MPI ranks, I_MPI_OFFLOAD_DEVICES=0



I_MPI_OFFLOAD_CELL_LIST

Define a list of base units to pin for each MPI rank.

Syntax

```
I_MPI_OFFLOAD_DEVICE_LIST=<base_units_list>
```

Arguments

`<base_units_list>` is a comma-separated list of base units. The process with the i-th rank is pinned to the i-th base unit in the list.

Value	Description
`<l>`	Base unit with logical number `<l>`.
`<l>-<m>`	Range of base units with logical numbers from `<l>` to `<m>`.
`<k>,<l>-<m>`	Base unit `<k>` and base units from `<l>` to `<m>`.

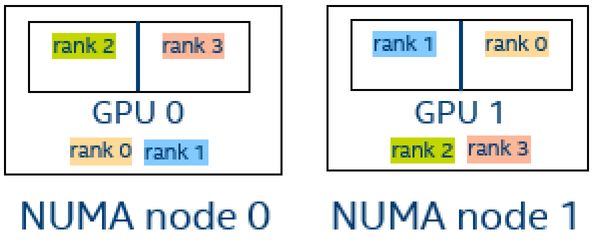
Description

Set this variable to define the list of base units to pin for each MPI rank. The process with the i-th rank is pinned to the i-th base unit in the list.

- I_MPI_OFFLOAD_CELL variable defines the base unit: tile or device.
- I_MPI_OFFLOAD_DEVICE_LIST variable has less priority than the I_MPI_OFFLOAD_DOMAIN variable.

Example

Figure 6. Four MPI ranks, I_MPI_OFFLOAD_DEVICE_LIST=3,2,0,1



I_MPI_OFFLOAD_DOMAIN

Define domains through the comma separated list of hexadecimal numbers for each MPI rank.

Syntax

```
I_MPI_OFFLOAD_DOMAIN=<masklist>
```

Arguments

<masklist> is a comma-separated list of hexadecimal numbers.

Value	Description
`[m1,...,mn ]`	For <*masklist*>, each mi is a hexadecimal bit mask defining an individual domain.

The following rule is used: the i-th base unit is included into the domain if the corresponding bit in mi value is set to 1.

Description

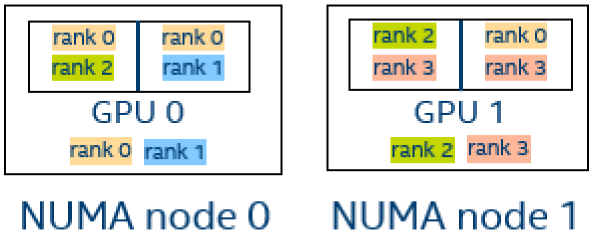
Set this variable to define the list of hexadecimal bit masks. For the i-th bit mask, if the j-th bit set to 1, then the j-th base unit will be pinned to the i-th MPI rank.

I_MPI_OFFLOAD_CELL variable defines the base unit: tile or device.

I_MPI_OFFLOAD_DOMAIN variable has higher priority than the I_MPI_OFFLOAD_DEVICE_LIST.

Example

Figure 7. Four MPI ranks, I_MPI_OFFLOAD_DOMAIN=[B,2,5,C]. Parsed bit masks: [1101,0100,1010,0011]



I_MPI_OFFLOAD_PIN

Control whether GPU pinning is enabled.

Syntax

`I_MPI_OFFLOAD_PIN=<value>`

Arguments

Value	Description
<0>	Disabled.
<1>	Enabled.

I_MPI_OFFLOAD_PRINT_TOPOLOGY

Print GPU pinning and GPU topology regardless of the the I_MPI_DEBUG level.

Syntax

`I_MPI_OFFLOAD_PRINT_TOPOLOGY=<value>`

Arguments

Value	Description
0	GPU pinning and GPU topology printing depends on I_MPI_DEBUG level: • If `I_MPI_DEBUG >= 3`, print GPU information only from the first host • If `I_MPI_DEBUG >= 120`, print GPU information from all hosts
1	Print GPU pinning and GPU topology from all hosts.

Description

Set this environment variable to enable GPU pinning and GPU topology printing regardless of the I_MPI_DEBUG level.

GPU Buffers Support

This feature enables handling of device buffers in MPI functions such as `MPI_Send`, `MPI_Recv`, `MPI_Bcast`, `MPI_Allreduce`, and so on by using the Level Zero* library or the CUDA* Library.

To pass a pointer of an offloaded memory region to MPI, you may need to use specific compiler directives or get it from corresponding acceleration runtime API. For example, `use_device_ptr` and `use_device_addr` are useful keywords to obtain device pointers in the OpenMP environment, as shown in the following example.

OpenMP Example

```
/* Copy data from host to device */
#pragma omp target data map(to: rank, values[0:num_values]) use_device_ptr(values)
{
    /* Compute something on device */
    #pragma omp target parallel for is_device_ptr(values)
    for (unsigned i = 0; i < num_values; ++i) {
        values[i] *= (rank + 1);
    }
    /* Send device buffer to another rank */
    MPI_Send(values, num_values, MPI_INT, dest_rank, tag, MPI_COMM_WORLD);
}
```

To achieve the best performance, use the same GPU buffer in MPI communications if possible. It helps Intel® MPI Library cache necessary structures to communicate with the device and reuse them in next iterations.

Set `I_MPI_OFFLOAD=0` to disable this feature if you do not provide device buffers to MPI primitives, since handling of device buffers can affect performance.

Device buffer may be used as a parameter of `MPI_Win_create` function to create a RMA-window placed in device memory. Alternatively, device buffer and/or device-allocated window may be passed to the `MPI_put` or `MPI_Get` primitives.

OpenMP Example

```
/* Allocate device memory */
char win_buffer = (char) omp_target_alloc(win_size, device_id);
/* Create MPI One-sided Window uisng GPU memory */
mpi_errno = MPI_Win_create(win_buffer, win_size, 1, MPI_INFO_NULL, MPI_COMM_WORLD, &win);
```

SYCL* Example

```
sycl::queue q;
/* Allocate device memory */
char *win_buffer = sycl::malloc_device<char>(win_size, q);
/* Create MPI One-sided Window uisng GPU memory */
mpi_errno = MPI_Win_create(win_buffer, win_size, 1, MPI_INFO_NULL, MPI_COMM_WORLD, &win);
```

NOTE Only contiguous MPI datatypes are supported.

I_MPI_OFFLOAD_MEMCPY_KIND

Set this environment variable to select the GPU memcpy kind.

Syntax

`I_MPI_OFFLOAD_MEMCPY_KIND=<`*`value`*`>`

Arguments

Value	Description
cached	Cache created objects for communication with GPU so that they can be reused if the same device buffer is later provided to the MPI function. Default value.
blocked	Copy device buffer to host and wait for the copy to be completed inside MPI function.
nonblocked	Copy device buffer to host and do not wait for the copy to be completed inside MPI function. Wait for the operation completion in MPI_Wait.

Description

Set this environment variable to select the GPU memcpy kind. The best performed option is chosen by default. Nonblocked memcpy can be used with MPI non-blocked point-to-point operations to achieve the overlap with compute part. Blocked memcpy can be used if other types are not stable.

I_MPI_OFFLOAD_PIPELINE

Set this environment variable to enable pipeline algorithm.

Syntax

```
I_MPI_OFFLOAD_PIPELINE=<value>
```

Arguments

Value	Description
0	Disable pipeline algorithm.
1	Enable pipeline algorithm. Default value.

Description

Set this environment variable to enable pipeline algorithm, which can improve performance for large message sizes. The main idea of the algorithm is to split user buffer into several segment, and copy the segments to the host and send them to another rank.

I_MPI_OFFLOAD_PIPELINE_THRESHOLD

Set this environment variable to control the threshold for pipeline algorithm.

Syntax

```
I_MPI_OFFLOAD_PIPELINE_THRESHOLD=<value>
```

Arguments

Value	Description
0	Threshold in bytes. The default value is 65536.

I_MPI_OFFLOAD_COLL_PIPELINE

Turn on GPU pipelining implementations for MPI collective functions.

Syntax

```
I_MPI_OFFLOAD_COLL_PIPELINE=<arg>
```

Arguments

Value	Description
disable | no | off | 0	Disables GPU pipelining for MPI collective functions.
enable | yes | on | 1	Enables GPU pipelining for MPI collective functions. This is the default value.

I_MPI_OFFLOAD_COLL_PIPELINE_ALLREDUCE_SEGMENTS_SIZE

Explicitly set the GPU pipelining data size in bytes per stage for the Allreduce operation.

Syntax

`I_MPI_OFFLOAD_COLL_PIPELINE_ALLREDUCE_SEGMENTS_SIZE=<`*`arg`*`>`

Arguments

Value	Description
Positive integer	Number of bytes per iteration in the pipeline.
-1	Dynamically set the optimal size in runtime by Intel MPI. This is the default value.

I_MPI_OFFLOAD_RDMA

Set this environment variable to enable GPU RDMA.

Syntax

`I_MPI_OFFLOAD_RDMA=<value>`

Arguments

Value	Description
0	Disable RDMA. This is the default value.
1	Enable RDMA.

Description

Set this environment variable to enable GPU-direct transfer using GPU RDMA. When this capability is supported by the network, enabling this environment variable enables direct data transfer between two GPUs.

NOTE Before setting this environment variable to use GPU-direct transfer, ensure that a GPU-aware provider with `FI_HMEM` capability is available in the `FI_PROVIDER_PATH`.

I_MPI_OFFLOAD_FAST_MEMCPY

Set this environment variable to enable/disable fast memcpy for GPU buffers.

NOTE This feature is not yet supported by CUDA backend.

Syntax

`I_MPI_OFFLOAD_FAST_MEMCPY=<value>`

Arguments

Value	Description
0	Disable fast memcpy.
1	Enable fast memcpy. This is the default value.

Description

Set this environment variable to enable/disable fast memcpy to optimize performance for small message sizes.

I_MPI_OFFLOAD_IPC

Set this environment variable to enable/disable GPU IPC.

Syntax

`I_MPI_OFFLOAD_IPC=<value>`

Arguments

Value	Description
0	Disable IPC path.
1	Enable IPC path. This is the default value.

Description

Set this environment variable to enable/disable GPU IPC. When this capability is supported by the system and devices, enabling this environment variable enables direct data transfer between two GPUs on the same node.

NOTE The default permissions for the cross-process access on Linux* OS Ubuntu* may prevent GPU IPC from working. To resolve this, enable the `CAP_SYS_PTRACE` capability on the system. Otherwise, you can disable GPU IPC by setting `I_MPI_OFFLOAD_IPC=0`, but it affects the intra-node performance.

I_MPI_OFFLOAD_COPY_COLL_MAX_SIZE

NOTE The `I_MPI_OFFLOAD_COPY_COLL_MAX_SIZE` variable is under technology preview.

Set this environment variable to control the threshold, over which `copy-in/copy-out` is used for collectives on GPU buffers.

Syntax

`I_MPI_OFFLOAD_COPY_COLL_MAX_SIZE=<value>`

Arguments

Value	Description
Threshold in bytes	The default value is `-1` (all sizes).

Description

Set this environment variable to control the message size, over which `copy-in/copy-out` is used for collectives on GPU buffers. When `CBWR` is disabled using `I_MPI_OFFLOAD_CBWR=0`, for message sizes <= `I_MPI_OFFLOAD_COPY_COLL_MAX_SIZE`, GPU buffers are copied into the host before executing the collective and back to the device after the collective complete.

When `CBWR` mode is enabled (default), this environment variable has no effect.

I_MPI_OFFLOAD_FAST_MEMCPY_COLL

NOTE The `I_MPI_OFFLOAD_FAST_MEMCPY_COLL` variable is under technology preview.

Set this environment variable to control the threshold, over which `copy-in/copy-out` is used for collectives on GPU buffers.

Syntax

`I_MPI_OFFLOAD_FAST_MEMCPY_COLL=<value>`

Arguments

Value	Description
0	Disabled.
1	Enabled. Collectives with GPU buffers use the fast-copy if applicable. This is the default value.

Description

Set this environment variable to enable the fast-copy for collectives on GPU buffers.

I_MPI_OFFLOAD_FAST_MEMCPY_COLL_MAX_SIZE

NOTE The `I_MPI_OFFLOAD_FAST_MEMCPY_COLL_MAX_SIZE` variable is under technology preview.

Set this environment variable to control the threshold, over which `fast-copy` is used for collectives on GPU buffers.

Syntax

`I_MPI_OFFLOAD_FAST_MEMCPY_COLL_MAX_SIZE=<value>`

Arguments

Value	Description
Threshold in bytes	The default value is 512.

Description

Set this environment variable to control the message size, over which fast-copy is used for collectives on GPU buffers.

When you enable it using `I_MPI_OFFLOAD_FAST_MEMCPY_COLL=1`, the fast-copy is used for message sizes `<= I_MPI_OFFLOAD_FAST_MEMCPY_COLL_MAX_SIZE`.

I_MPI_OFFLOAD_ONESIDED_DEVICE_INITIATED

NOTE The `I_MPI_OFFLOAD_ONESIDED_DEVICE_INITIATED` variable is under technology preview.

Set this environment variable to enable device-initiated MPI one-sided communications.

Syntax

`I_MPI_OFFLOAD_ONESIDED_DEVICE_INITIATED=<value>`

Arguments

Value	Description
0	Disabled. Default value.
1	Enabled.

Description

Set this environment variable to enable device-initiated MPI one-sided communications. This feature allows direct calls to MPI primitives listed below from OpenMP offload section or SYCL* kernel.

Supported primitives:

- `MPI_Put`
- `MPI_Get`
- `MPI_Win_lock`
- `MPI_Win_lock_all`
- `MPI_Win_unlock`
- `MPI_Win_unlock_all`
- `MPI_Win_flush/MPI_Win_flush_all`
- `MPI_Win_fence`

NOTE Only contiguous MPI datatypes are supported.

Host-initiated Communications Example

```
sycl::queue q;
/* Allocate device memory */
char *win_buffer = sycl::malloc_device<char>(win_size, q);
char *local_buffer = sycl::malloc_device<char>(win_size, q);

/* Create MPI One-sided Window uisng GPU memory */
mpi_errno = MPI_Win_create(win_buffer, win_size, 1,
                                        MPI_INFO_NULL, MPI_COMM_WORLD, &win);

for (int iteration =0; iteration < num_iterations; ++iteration ) {
   q.submit([&](sycl::handler &h) {
      h.single_task([=]() {
          /* Perform compute using local_buffer */
            ...
      });
   }).wait();
   /* Lock target window copy to place data */
   mpi_errno = MPI_Win_lock(MPI_LOCK_EXCLUSIVE, target_rank, 0,  win);

   /* Perform one-sided communication using device-allocated window. */
   mpi_errno = MPI_Put(local_buffer, win_count, MPI_CHAR, target_rank, 0, win_size, MPI_CHAR,
win);

   /* Unlock target window */
   mpi_errno = MPI_Win_unlock(target_rank, win);
 }
```

Device-initiated Communications Example

```
sycl::queue q;
/* Allocate device memory */
char *win_buffer = sycl::malloc_device<char>(win_size, q);
char *local_buffer = sycl::malloc_device<char>(win_size, q);

/* Create MPI One-sided Window uisng GPU memory */
mpi_errno = MPI_Win_create(win_buffer, win_size, 1,
                                         MPI_INFO_NULL, MPI_COMM_WORLD, &win);

q.submit([&](sycl::handler &h) {
   h.single_task([=]() {
          for (int iteration =0; iteration < num_iterations; ++iteration ) {
                 /* Perform compute using local_buffer */
                 ...
                 /* Lock target window copy to place data */
                 mpi_errno = MPI_Win_lock(MPI_LOCK_EXCLUSIVE, target_rank, 0,  win);

                 /* Perform one-sided communication using device-allocated window. */
                 mpi_errno = MPI_Put(local_buffer, win_count, MPI_CHAR, target_rank, 0,
win_size, MPI_CHAR, win);

                 /* Unlock target window */
                 mpi_errno = MPI_Win_unlock(target_rank, win);
         }
     });
}).wait();
```

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

<fabric>	Define a network fabric.
`shm`	Shared memory transport (used for intra-node communication only).
`ofi`	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

`<transport>`	Define a shared memory transport solution.
`disable | no | off | 0`	Do not use shared memory transport.
`auto`	Select a shared memory transport solution automatically.
`bdw_sse`	The shared memory transport solution tuned for Intel® microarchitecture code name Broadwell. The SSE4.2. instruction set is used.
`bdw_avx2`	The shared memory transport solution tuned for Intel® microarchitecture code name Broadwell. The AVX2 instruction set is used.
`skx_sse`	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.
`skx_avx2`	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.
`skx_avx512`	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.
`clx_sse`	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.
`clx_avx2`	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.
`clx_avx512`	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.
`clx-ap`	The shared memory transport solution tuned for Intel® Xeon® processors based on Intel® microarchitecture code name Cascade Lake Advanced Performance.
`icx`	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 backwrad 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

<nbytes>	The size of the shared memory bound to MCDRAM per rank
1048576	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=knl_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

`<count>`	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

`<count>`	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

`<path>`	Define the path to the existed mount point of the 4 KB pages size file system (`tmpfs`). 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

`<path>`	Define the path to the existed mount point of the 2 MB pages size file system (`hugetlbfs`). 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

`<path>`	Define the path to the existed mount point of the 1 GB pages size file system (`hugetlbfs`). 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

<name>	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

<arg>	Binary indicator
`enable | yes | on | 1`	Print the list of all OFI providers and their attributes from an OFI library
`disable | no | off | 0`	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

<arg>	Binary indicator
`enable	yes	on	1`	Enable direct receive. This is the default value
`disable	no	off	0`	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_MATCH_COMPLETE

Control the capability of the match complete in the OFI fabric for all providers if applicable.

Syntax

`I_MPI_OFI_MATCH_COMPLETE=<arg>`

Arguments

<arg>	Binary indicator
`enable	yes	on	1`	Enable match complete if applicable. This is the default value
`disable	no	off	0`	Disable match complete

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

<value>	The memory allocation policy used.
`hbw_preferred`	Allocate the local HBW memory for each process. If the HBW memory is not available, allocate the local dynamic random access memory.
`hbw_bind`	Allocate only the local HBW memory for each process.
`hbw_interleave`	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

`<value>`	Specify the NUMA nodes for memory allocation.
`localalloc`	Allocate memory on the local node. This is the default value.
`Node_1,…,Node_k`	Allocate memory according to `I_MPI_BIND_ORDER` 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

`<value>`	Specify the allocation manner.
`compact`	Allocate memory for processes as close as possible (in terms of NUMA nodes), among the NUMA nodes specified in `I_MPI_BIND_NUMA`. This is the default value.
`scatter`	Allocate memory among the NUMA nodes specified in `I_MPI_BIND_NUMA` 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

`<value>`	Specify the memory allocation behavior for window segments.
`localalloc`	Allocate memory on the local node. This is the default value.

`hbw_preferred`	Allocate the local HBW memory for each process. If the HBW memory is not available, allocate the local dynamic random access memory.
`hbw_bind`	Allocate only the local HBW memory for each process.
`hbw_interleave`	Allocate the HBW memory and dynamic random access memory on a local node in the round-robin manner.
`<NUMA node id>`	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 `thread_id`.

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 `MPI_THREAD_SPLIT` model support. This is the default value.
`1 | yes | on | enable`	Enable the `MPI_THREAD_SPLIT` 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

<int>	The maximum number of threads per rank. The default value is `omp_get_max_threads()` if `I_MPI_THREAD_RUNTIME` is set to `openmp`. 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

<string>	Define the MPI info object key. The default value is `thread_id`

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

Argument	Description
<level>	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.

Argument	Description
<flags>	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.
`datetime`	Show time and date for each debug message.
`host`	Show host name for each debug message.
`level`	Show level for each debug message.

Argument	Description
`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.
`nofunc`	Do not show routine name.
`norank`	Do not show rank.
`nousrwarn`	Suppress warnings for improper use case (for example, incompatible combination of controls).
`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	Description
`stdout`	Output to `stdout`. This is the default value.
`stderr`	Output to `stderr`.
`<file_name>`	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	Description
`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

Argument	Description
`<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 APS documentation.

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	Description
`pmi_shm`	Use shared memory to reduce the number of PMI calls.
`pmi_shm_netmod`	Use the `netmod` 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

Argument	Description
`<name>`	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, and PMIx.

Example

To launch an application using Intel MPI and PMIx, you can use Cray's PALS*.

For that, you need the following environment variables:

- `I_MPI_OFI_LIBRARY=<path-to-crays>/libfabric.so.1`
- `I_MPI_OFI_PROVIDER=cxi`
- `I_MPI_PMI_LIBRARY=<path-to>/libpmix.so`
- `I_MPI_PMI=pmix`

The following example shows how to launch an application using Intel MPI and PMIx with Cray's PALS*, CXI*, and PBS*:

```
I_MPI_OFI_LIBRARY=<path-to-crays>/libfabric.so.1 I_MPI_OFI_PROVIDER=cxi  I_MPI_PMI_LIBRARY=<path-
to>/libpmix.so  I_MPI_PMI=pmix <path-to-crays-pals>/<version>/bin/mpirun --pmi=pmix -n 2 -ppn 1
--hostfile $PBS_NODEFILE  ./myprog
```

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

Argument	Description
`<length>`	Define the value of the buffer length in bytes.
`<n> > 0`	The default value is -1, which means do not override the value received from the `PMI_KVS_Get_value_length_max()` 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

Argument	Description
`<size>`	Define output chunk size in kilobytes
`<n>> 0`	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	Description
`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	Description
`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 misprinted 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]sh`script. 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

Argument	Description
`<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.

Argument	Description
`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	Description
`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	Description
`1`	Use the Intel MPI custom allocator of shared memory for `MPI_Alloc_mem/ MPI_Free_mem`.
`0`	Do not use the Intel MPI custom allocator of shared memory for `MPI_Alloc_mem/MPI_Free_mem`.

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_SH M_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

Argument	Description
<size>	The size (per rank) of shared memory used in shared memory heap (in megabytes).
`>0`	If shared memory heap is enabled for `MPI_Alloc_mem/MPI_Free_mem`, 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

Argument	Description
<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 `I_MPI_SHM_HEAP=1`
`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	Description
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 `I_MPI_WAIT_MODE=0`
1	Do the `pause processor` instruction for `I_MPI_PAUSE_COUNT` during the busy wait.
2	Do the `shied_yield()` system call for thread yield during the busy wait. This is the default value when `I_MPI_WAIT_MODE=1`
3	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
`>=0`	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=<scount>`

Argument

Argument	Description
<scount>	Define the loop spin count when polling fabric(s).
`>=0`	The default <scount> 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 *<scount>* times before the library releases the processes if no incoming messages are received for processing. Smaller values for *<scount>* 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 *<scount>* 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	Description
`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. This environment variable is deprecated.

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. This environment variable is deprecated.

I_MPI_EXTRA_FILESYSTEM_NFS_DIRECT

Syntax

`I_MPI_EXTRA_FILESYSTEM_NFS_DIRECT=<arg>`

Argument

Argument	Description
`enable | yes | on | 1`	Enable native support for parallel file systems. This is the default value.
`disable | no | off | 0`	Disable native support for parallel file systems.

Description

Turn on NFS bypassing cache to achieve sequential consistency among all accesses using a single file handle. This environment variable is deprecated.

I_MPI_FILESYSTEM

Turn on/off native parallel file systems support. If set, I_MPI_EXTRA_FILESYSTEM is ignored.

Syntax

`I_MPI_FILESYSTEM=<arg>`

Argument

Argument	Description
`disable | no | off | 0`	Disable native support for parallel file. This is the default value.
`enable | yes | on | 1`	Enable native support for parallel file.

I_MPI_FILESYSTEM_FORCE

Force Intel MPI to use a specific driver for a file system. If set, I_MPI_EXTRA_FILESYSTEM_FORCE is ignored.

Syntax

`I_MPI_FILESYSTEM_FORCE=<ufs|nfs|gpfs|panfs|lustre|daos>`

I_MPI_FILESYSTEM_CB_NODES

Explicitly set the MPI-IO hint cb_nodes for all MPI-IO file handles, overriding user info set at runtime. Non-positive values are ignored.

Syntax

`I_MPI_FILESYSTEM_CB_NODES=<arg>`

Argument

Argument	Description
Any positive integer	Maximum number of collective I/O aggregators for all collective I/O operations.
Non-positive integer	Ignored. The default value is -1.

I_MPI_FILESYSTEM_CB_CONFIG_LIST

Explicitly set the MPI-IO hint cb_config_list for all MPI-IO file handles, which overrides user information set at runtime.

Syntax

`I_MPI_FILESYSTEM_CB_CONFIG_LIST=<arg>`

Argument

Argument	Description
`"*:<proc>"`	Place *<proc>* number of I/O aggregators per node. *<proc>* should be a positive integer.
`""`	Ignored. This is the default value.

I_MPI_FILESYSTEM_NFS_DIRECT

Enable NFS bypassing cache to achieve sequential consistency among all accesses using a single file handle. If set, I_MPI_FILESYSTEM_NFS_DIRECT is ignored.

Syntax

`I_MPI_FILESYSTEM_NFS_DIRECT=<arg>`

Argument

Argument	Description
`disable | no | off | 0`	Disable native support for parallel file systems.
`enable | yes | on | 1`	Enable native support for parallel file systems. This is the default value.

I_MPI_FILESYSTEM_GPFS_DIRECT

Enable GPFS bypassing cache to achieve sequential consistency among all accesses using a single file handle.

Syntax

```
I_MPI_FILESYSTEM_GPFS_DIRECT=<arg>
```

Argument

Argument	Description
`disable | no | off | 0`	Disable native support for GPFS sequential consistency. This is the default value.
`enable | yes | on | 1`	Enable native support for GPFS sequential consistency.

I_MPI_MULTIRAIL

Syntax

```
I_MPI_MULTIRAIL=<arg>
```

Argument

Argument	Description
`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.

I_MPI_OFI_NIC_LIST

Define a list of NICs to map a local rank to a NIC. The list should contain at least as many entries as the number of local ranks. The individual values should be between 0 and the NIC number of the last NIC in the node. The process with the i-th rank is pinned to the i-th NIC in the list.

Syntax

```
I_MPI_OFI_NIC_LIST=<niclist>
```

Argument

Argument	Description
`<niclist>`	A comma-separated list of the NIC numbers and/or NIC number ranges.
`<l>-<m>`	Range of NICs with numbers from *l* to *m*.
`<k>,<l>-<m>`	NIC with the number *k*, NICs with numbers *l* to *m*.

Description

The NIC number is not the logical NIC index but the absolute NIC number. For example, if a node has three NICs, which are registered on the machine as *cxi2, cxi1 and cxi0*, in that order, specifying the value of the cvar as 0,2,1 for a 3 process run results in Rank 0 using cxi0, Rank 1 using cxi2, and Rank 3 using cxi1.

This environment variable is only relevant when the multi-rail capability is enabled by the user with `I_MPI_MULTIRAIL=1`.

In most cases, the default NIC-selection logic performs best. Use this environment variable only to override default NIC-selection logic.

I_MPI_SPAWN

Syntax

`I_MPI_SPAWN=<arg>`

Argument

Argument	Description
`enable | yes | on | 1`	Enable support of dynamic processes.
`disable | no | off | 0`	Disable support of dynamic processes. This is the default value.

Description

Use this environment variable to enable or disable dynamic processes and MPI-port support.

When dynamic processes infrastructure conflicts with optimization or require extra communication during bootstrap, this feature is disabled by default. This control is mandatory for applications that use dynamic processes.

Note

Due to limitations, MLX provider does not support MPI-port operations (e.g. `MPI_Open_port`, `MPI_Comm_connect`) out of box with `I_MPI_SPAWN` enabled.

To support these operations, set `FI_MLX_NS_ENABLE=1`.

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`	`static int Init(String[] args)`	`MPI_Init`
	`static void Finalize()`	`MPI_Finalize`
	`static double wTime()`	`MPI_Wtime`
	`static void abort(Comm comm, int errorCode)`	`MPI_Abort`
	`String getProcessorName()`	`MPI_Get_processor_name`
`Aint`	`static void getExtent(Datatype dt, Aint lb, Aint extent)`	`MPI_Type_get_extent`

Java Class	Public Fields and Methods	Original C Routine
	`static void getTrueExtent(Datatype dt, Aint true_lb, Aint true_extent)`	`MPI_Type_get_true_extent`
	`static void getAddress(long location, Aint address)`	`MPI_Get_address`
	`static void getContents(Datatype dt, int maxIntegers, int maxAddresses, int maxDatatypes, int[] integers, Aint[] addresses, Datatype[] datatypes)`	`MPI_Type_get_contents`
`Collective`	`static void allToAll(Object sendbuf, int sendcount, Datatype sendtype, Object recvbuf, int recvcount, Datatype recvtype, Comm comm)`	`MPI_Alltoall`
	`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`

Java Class	Public Fields and Methods	Original C Routine
	`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 recvcounts, Datatype type, Op op, Comm comm)`	`MPI_Reduce_scatter`
	`static void scatter(Object sendBuffer, int sendCount, Datatype sendType, Object recvBuffer, int recvCount, Datatype recvType, int root, Comm comm)`	`MPI_Scatter`
	`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`
`Comm`	Static field: `Comm WORLD`	`MPI_COMM_WORLD`
	Static field: `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`	Static field: `int MPI_PROC_NULL`	`MPI_PROC_NULL`
	Static field: `int MPI_IDENT`	`MPI_IDENT`
	Static field: `int MPI_CONGRUENT`	`MPI_CONGRUENT`
	Static field: `int MPI_SIMILAR`	`MPI_SIMILAR`
	Static field: `int MPI_UNEQUAL`	`MPI_UNEQUAL`
	Static field: `Group WORLD`	`MPI_GROUP_WORLD`
	`void group(Comm comm)`	`MPI_Comm_group`
	`int getSize()`	`MPI_Group_size`
	`int getRank()`	`MPI_Group_rank`

Java Class	Public Fields and Methods	Original C Routine
	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
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

Java Class	Public Fields and Methods	Original C Routine
	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	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
	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

Java Class	Public Fields and Methods	Original C Routine
	`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 irecv(Buffer buf, int count, Datatype type, int source, int tag, Comm comm)`	`MPI_Irecv`
	`static Request irecv(<java array> buf, int count, Datatype type, int source, int tag, Comm comm)`	`MPI_Irecv`
	`static Status sendRecv(Buffer sendbuf, int sendcount, Datatype sendtype, int senddest, int sendtag, Buffer recvbuf, int recvcount, Datatype recvtype, int recvsource, int recvtag, Comm comm)`	`MPI_Sendrecv`
`Request`	`Status Wait()`	`MPI_Wait`
	`static Status[] waitAll(int count, Request[] reqs)`	`MPI_Waitall`
	`static Status waitAny(int count, Request[] reqs, int[] index)`	`MPI_Waitany`
	`static Status[] waitSome(int count, Request[] reqs, int[] outcount, int[] indexes)`	`MPI_Waitsome`
	`boolean test(Status status)`	`MPI_Test`

Notices and Disclaimers