Intel® MPI Library for Linux* OS Reference Manual

Contents

Disclaimer and Legal Notices

Revision History

Document Number	Revision Number	Description	Revision Date
315399-001	3.1 Beta	Some new options and variables were added, three new sections “Statistics Gathering Mode”, “Unified Memory Management”, and “Integration into Eclipse* PTP” were created	/07/10/2007
315399-002	3.1	New names of variables were added, new section “Processor Information Utility” was added. Updated and reviewed for style	/10/02/2007
315399-003	3.1 build 038	Local options were added. Sections “Index”, “Glossary”, “Process Identification”, and “Interoperability with OpenMP*” were added	/03/05/2008
315399-004	3.2	Sections “Process pinning”, Automatic Tuning Utility, and “Statistic Gathering Mode” were updated	/09/05/2008

1 About this Document

This *Reference Manual* provides you with a complete command and tuning reference for the Intel MPI Library.

The Intel® MPI Library is a multi-fabric message passing library that implements the Message Passing Interface, v2 (MPI-2) specification. It provides a standard library across Intel® platforms that:

- Delivers best in class performance for enterprise, divisional, departmental and workgroup high performance computing. The Intel® MPI Library focuses on making applications perform better on IA based clusters.
- Enables to adopt MPI-2 functions as their needs dictate.

The Intel® MPI Library enables you to change or upgrade processors and interconnects as new technology becomes available, and achieve maximum application performance without changes to the software or to the operating environment.

The library is provided in the following kits:

- *The Intel® MPI Library Runtime Environment* (RTO) has the tools you need to run programs, including MPD daemons and supporting utilities, shared (.so) libraries, and documentation.
- *The Intel® MPI Library Development Kit* (SDK) includes all of the Runtime Environment components plus compilation tools, including compiler commands such as `mpiicc`, include files and modules, static (.a) libraries, debug libraries, trace libraries, and test codes.

1.1 Intended Audience

This *Reference Manual* helps an experienced user understand the full functionality of the Intel® MPI Library and get the best possible application performance.

1.2 Using Doc Type Field

This *Reference Manual* contains the following sections

Table 1.2-1 Document Organization

Section	Description
Section 1 About this Document	Section 1 introduces this document
Section 2 Command Reference	Section 2 describes options and variables for compiler commands, job startup commands, and MPD daemon commands as well
Section 3 Tuning Reference	Section 3 describes environment variables used to influence program behavior and performance at run time
Section 4 Statistics Gathering Mode	Section 4 describes how to obtain statistics of MPI communication operations
Section 5 Unified Memory Management	Section 5 describes the unified Intel memory management subsystem (`i_malloc`)
Section 6 Integration into Eclipse* PTP	Section 6 describes the procedure for integration into Eclipse* Parallel Tools Platform

Section 7 Glossary	Section 7 explains basic terms used in this document
Section 8 Index	Section 8 references options and variable names

1.3 Conventions and Symbols

The following conventions are used in this document.

Table 1.3-1 Conventions and Symbols used in this Document

This type style	Document or product names
This type style	Hyperlinks
`This type style`	Commands, arguments, options, file names
`THIS_TYPE_STYLE`	Environment variables
`<this type style>`	Placeholders for actual values
`[ items ]`	Optional items
`{ item | item }`	Selectable items separated by vertical bar(s)
(SDK only)	For Software Development Kit (SDK) users only

1.4 Related Information

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

2 Command Reference

2.1 Compiler Commands

(SDK only)

The following table lists available MPI compiler commands and the underlying compilers, compiler families, languages, and application binary interfaces (ABIs) that they support.

Table 2.1-1 The Intel® MPI Library compiler drivers

Compiler command	Default compiler	Supported language(s)	Supported ABI(s)
Generic compilers			
`mpicc`	`gcc, cc`	C	32/64 bit
`mpicxx`	`g++`	C/C++	32/64 bit
`mpifc`	`gfortran`	Fortran77/Fortran 95	32/64 bit
GNU* compilers versions 3 and higher			
`mpigcc`	`gcc`	C	32/64 bit
`mpigxx`	`g++`	C/C++	32/64 bit
`mpif77`	`g77`	Fortran 77	32/64 bit
`mpif90`	`gfortran`	Fortran 95	32/64 bit
Intel® Fortran, C++ compilers versions 9.1, 10.0, 10.1 or 11.0			
`mpiicc`	`icc`	C	32/64 bit
`mpiicpc`	`icpc`	C++	32/64 bit
`mpiifort`	`ifort`	Fortran77/Fortran 95	32/64 bit

NOTE:

- Compiler commands are available only in the Intel® MPI Library Development Kit.
- Compiler commands are in the `<installdir>/bin` directory. For the Intel® 64 architecture in a 64-bit-enabled compiler, commands are in the `<installdir>/bin64` directory and 32-bit compiler commands are in the `<installdir>/bin` directory.
- Ensure that the corresponding underlying compilers (32-bit or 64-bit, as appropriate) are already in your `PATH`.
- To port existing MPI-enabled applications to the Intel® MPI Library, recompile all sources.
- To display mini-help of a compiler command, execute it without any parameters.

2.1.1 Compiler Command Options

-mt_mpi

Use this option to link the thread safe version of the Intel® MPI library at the following levels: `MPI_THREAD_FUNNELED`, `MPI_THREAD_SERIALIZED`, or `MPI_THREAD_MULTIPLE`.

The `MPI_THREAD_FUNNELED` level is provided by default by the threat safe version of the Intel® MPI library.

NOTE: If you specify either the `-openmp` or the `-parallel` options for the Intel® C Compiler, the thread safe version of the library is used.

NOTE: If you specify one of the following options for the Intel® Fortran Compiler, the thread safe version of the library is used:

- `-openmp`
- `-parallel`
- `-threads`
- `-reentrancy`
- `-reentrancy threaded`

-static_mpi

Use this option to link the Intel® MPI library statically. This option does not affect the default linkage method for other libraries.

-profile=<*profile_name*>

Use this option to specify an MPI profiling library. The profiling library is selected using one of the following methods:

- Through the configuration file `<`*`profile_name`*`>.conf` located in the `<`*`installdir`*`>/etc` directory (`<`*`installdir`*`>/etc64` directory for the Intel® 64 architecture in 64-bit mode). See *Profiles* for details.
- In the absence of the respective configuration file, by linking the library `lib<`*`profile_name`*`>.so` or `lib<`*`profile_name`*`>.a` located in the same directory as the Intel® MPI library.

-t or -trace

Use the `-t` or `-trace` option to link the resulting executable against the Intel® Trace Collector library. This has the same effect as if `-profile=vt` is used as an argument to `mpiicc` or another compiler script.

Use the `-t=log` or `-trace=log` option to link the resulting executable against the logging Intel® MPI and the Intel® Trace Collector libraries. The logging libraries trace internal Intel® MPI library states in addition to the usual MPI function calls.

Include the installation path of the Intel® Trace Collector in the `VT_ROOT` environment variable to use this option. Set `I_MPI_TRACE_PROFILE` to the `<`*`profile_name`*`>` environment variable 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.

-check_mpi

Use this option to link the resulting executable against the Intel® Trace Collector correctness checking library. This has the same effect as if `-profile=vtmc` is used as an argument to `mpiicc` or another compiler script.

Include the installation path of the Intel® Trace Collector in the `VT_ROOT` environment variable to use this option. Set `I_MPI_CHECK_PROFILE` to the `<`*`profile_name`*`>` environment variable to specify another checking library.

-dynamic_log

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

Include `$VT_ROOT/slib` in the `LD_LIBRARY_PATH` environment variable to run the resulting programs.

-g

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

-O

Use this option to enable optimization.

-echo

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

-show

Use this option to learn how the underlying compiler is invoked. For example, 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 is particularly useful for determining the command line for a complex build procedure that directly uses the underlying compilers.

-{cc,cxx,fc,f77,f90}=<*compiler*>

Use this option to select the underlying compiler.

For example, use the following command to select the Intel® C++ Compiler:

```
$ mpicc -cc=icc -c test.c
```

Make sure `icc` is in your path. Alternatively, you can specify the full path to the compiler.

-gcc-version=<*nnn*>

Use this option for compiler drivers `mpicxx` and `mpiicpc` when linking an application running in a particular GNU* C++ environment. The valid <*nnn*> values are:

<*nnn*> value	**GNU* C++ version**
`320`	3.2.x
`330`	3.3.x
`340`	3.4.x

`400`	4.0.x
`410`	4.1.x

By default, the library compatible with the detected version of the GNU* C++ compiler is used. Do not use this option if the GNU* C++ version is older than 3.2.

-compchk

Use this option to enable compiler setup checks. In this case each compiler command performs checks to ensure that the appropriate underlying compiler is set up correctly.

2.1.2 Configuration Files

You can create compiler configuration files using the following file naming convention:

> `<installdir>/etc/mpi<compiler>-<name>.conf`
>
> `<installdir>/etc64/mpi<compiler>-<name>.conf` for the Intel® 64 architecture in 64-bit mode

where:

> `<compiler> = {cc,cxx,f77,f90}`, depending on the language being compiled
>
> `<name> =` name of underlying compiler with spaces replaced by hyphens

For example, the `<name>` value for `cc -64` is `cc--64`

Source this file, if it exists, prior to compiling or linking to enable changes to the environment on a per-compiler-command basis.

2.1.3 Profiles

You can select a profile library through the `-profile` option of the Intel® MPI Library compiler drivers. The profile files are located in the `<installdir>/etc` directory (`<installdir>/etc64` directory for the Intel® 64 architecture in 64-bit mode). The Intel® MPI Library comes with several predefined profiles for the Intel® Trace Collector:

> `<installdir>/etc/vt.conf` - regular Intel® Trace Collector library
>
> `<installdir>/etc/vtfs.conf` - fail-safe Intel® Trace Collector library
>
> `<installdir>/etc/vtmc.conf` – correctness checking Intel® Trace Collector library

You can also create your own profile as `<profile_name>.conf`

The following variables can be defined there:

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

For instance, 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 command-line argument `-profile=myprof` for the relevant compile driver to select this new profile.

2.1.4 Environment Variables

I_MPI_{CC,CXX,FC,F77,F90}_PROFILE

(MPI{CC,CXX,FC,F77,F90}_PROFILE)

Specify a default profiling library.

Syntax

`I_MPI_{CC,CXX,FC,F77,F90}_PROFILE=<profile_name>`

Deprecated Syntax

`MPI{CC,CXX,FC,F77,F90}_PROFILE=<profile_name>`

Arguments

<profile_name>	Specify a default profiling library

Description

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

I_MPI_TRACE_PROFILE

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

Syntax

`I_MPI_TRACE_PROFILE=<profile_name>`

Arguments

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

Description

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

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

I_MPI_CHECK_PROFILE

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

Syntax

`I_MPI_CHECK_PROFILE=<profile_name>`

Arguments

<profile_name>	Specify a checking profile name. The default value is `vtmc`

Description

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

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 compiler drivers check the underlying compiler for compatibility. Normal compilation will be performed only if known version of underlying compiler is used.

I_MPI_{CC,CXX,FC,F77,F90}

(MPICH_{CC,CXX,FC,F77,F90})

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

Syntax

`I_MPI_{CC,CXX,FC,F77,F90}=`*`<compiler>`*

Deprecated Syntax

`MPICH_{CC,CXX,FC,F77,F90}=`*`<compiler>`*

Arguments

`<compiler>`	Specify the full path/name of compiler to be used

Description

Set this 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.

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 variable to specify the installation directory of the Intel® MPI Library.

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 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 is `<installdir>/etc` or `<installdir>/etc64`

Description

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

2.2 Job Startup Commands

mpiexec

Syntax

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

or

```
mpiexec <g-options> <l-options> <executable> : \
<l-options> <executable>
```

or

`mpiexec -configfile <file>`

Arguments

<g-options>	Global options that apply to all MPI processes
<l-options>	Local options that apply to a single arg-set
<executable>	`./a.out` or `path/name` of the executable file
<file>	File with command-line options

Description

In the first command-line syntax, run the specified *<executable>* with the specified options. All global and/or local options apply to all MPI processes. A single arg-set is assumed. For example, the following command executes `a.out` over the specified *<# of processes>*:

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

In the second command-line syntax, divide the command line into multiple arg-sets, separated by colon characters. All the global options apply to all MPI processes, but the various local options and *<executable>* can be specified separately for each arg-set. For example, the following command would run each given executable on a different host:

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

In the third command-line syntax, read the command line from specified *<file>*. For a command with a single arg-set, the entire command should be specified on a single line in *<file>*. For a command with multiple arg-sets, each arg-set should be specified on a single, separate line in *<file>*. Global options should always appear at the beginning of the first line in *<file>*.

MPD daemons must already be running in order for `mpiexec` to succeed.

NOTE: If "**.**" is not in the path on all nodes in the cluster, specify *<executable>* as `./a.out` rather than `a.out`.

2.2.1 Global Options

-version or -V

Use this option to display Intel® MPI Library version information.

-h or –help or --help

Use this option to display the `mpiexec` help message.

-tune [<*configuration_file*>]

Use this option to optimize the Intel® MPI Library performance using the data collected by the `mpitune` utility. If *<configuration_file>* is not mentioned, the best-fit tune options will be selected for the given configurations. Otherwise the given configuration file will be used.

For the Intel® 64 architecture in 64-bit mode the default location of the configuration files are located in the *<installdir>*`/etc64` directory. For 32-bit mode and Itanium® the files are located in the *<installdir>*`/etc` directory. Set the `I_MPI_TUNER_DATA_DIR` environment variable to override the default location.

See *Automatic Tuning Utility* for more details.

-rdma

Use this option to select an RDMA-capable network fabric. This option is equivalent to the `-genv I_MPI_DEVICE rdma` setting.

-RDMA

Use this option to select an RDMA-capable network fabric. The application will fail if no such fabric is found. This option is equivalent to the `-genv I_MPI_DEVICE rdma -genv I_MPI_FALLBACK_DEVICE 0` setting.

-ib

Use this option to select OFED-1.3 capable network fabrics. This option is equivalent to the `-genv I_MPI_DEVICE rdma:ofa-v2-ib0` setting.

-IB

Use this option to select OFED-1.3 capable network fabrics. The application will fail if no such fabric is found. This option is equivalent to the `-genv I_MPI_DEVICE rdma:ofa-v2-ib0 -genv I_MPI_FALLBACK_DEVICE 0` setting.

-gm

Use this option to select Myrinet* GM* network fabric. This option is equivalent to the `-genv I_MPI_DEVICE rdma:GmHca0` setting.

-GM

Use this option to select Myrinet GM network fabric. The application will fail if no such fabric is found. This option is equivalent to the `-genv I_MPI_DEVICE rdma:GmHca0 -genv I_MPI_FALLBACK_DEVICE 0` setting.

-mx

Use this option to select Myrinet MX* network fabric. This option is equivalent to the `-genv-I_MPI_DEVICE rdma:mx -genv I_MPI_RDMA_TINY_PACKET 1` setting.

-MX

Use this option to select Myrinet MX network fabric. The application will fail if no such fabric is found. This option is equivalent to the `-genv I_MPI_DEVICE rdma:mx -genv I_MPI_RDMA_TINY_PACKET 1 -genv I_MPI_FALLBACK_DEVICE 0` setting.

-nolocal

Use this option to avoid running *`<executable>`* on the host where the `mpiexec` is launched. This option is useful, for example, on clusters that deploy a dedicated master node for starting the MPI jobs, and a set of compute nodes for running the actual MPI processes.

-perhost *<# of processes>*

Use this option to place the indicated number of consecutive MPI processes on every host in group round robin fashion. The total number of processes to start is controlled by the `-n` option as usual.

The `mpiexec` command controls how the ranks of the processes are allocated to the nodes in the cluster. By default, `mpiexec` uses group round-robin assignment of ranks to nodes, putting consecutive MPI processes on all processor cores.

In order to change this default behavior, set the number of processes per host using the `-perhost` option, and set the total number of processes by using the `-n` option (See *Local Options*). Then the first *`<# of processes>`* indicated by the `-perhost` option are executed on the first host, the next *`<# of processes>`* are executed on the next host, and so on.

See also the *I_MPI_PERHOST* variable.

-rr

Use this option to place consecutive MPI processes onto different host in round robin fashion. This option is equivalent to `-perhost 1`.

-grr <*# of processes*>

Use this option to place the indicated number of consecutive MPI processes on every host in group round robin fashion. This option is equivalent to `-perhost <# of processes>`.

-ppn <*# of processes*>

Use this option to place the indicated number of consecutive MPI processes on every host in group round robin fashion. This option is equivalent to `-perhost <# of processes>`.

-machinefile <*machine file*>

Use this option to control the process placement through `<machine file>`. The total number of processes to start is controlled by the `-n` option as usual.

A machine file is a list of fully qualified or short host names, one name per line. Blank lines and lines that start with # as the first character are ignored.

By repeating a host name you will place additional processes on this host. You can also use the following format to avoid repetition of the same host name: `<host name>:<number of processes>`. For example, the following machine file:

```
host1

host1

host2

host2

host3
```

is equivalent to:

```
host1:2

host2:2

host3
```

It is also possible to specify the network interface used for communication for each node: `<host name>:<number of processes> [ifhn=<interface_host_name>]`.

NOTE: The `-machinefile`, `-ppn`, `-rr`, and `-perhost` options are intended for process distribution. Do not use them simultaneously. Otherwise `-machinefile` will take precedence.

-g<*l-option*>

Use this option to apply the named local option `<l-option>` globally. See Local Options for a list of all local options. During the application startup, the default value is the `-genvuser` option. The options `-genvnone, -genvuser, -genvall` have the lowest priority, `-genvlist, -genvexcl` have higher priority than the previous set. The `-genv` option has the highest priority. Local options have higher priority then the global options.

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

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

-genvuser

Use this option to propagate all user environment variables to all MPI processes, with the exception of the following system variables: `$HOSTNAME, $HOST, $HOSTTYPE, $MACHTYPE, $OSTYPE`. This is the default setting.

-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.

(SDK only) -trace [<*profiling_library*>] or -t [<*profiling_library*>]

Use this option to profile your MPI application using the indicated *<profiling_library>*. If the *<profiling_library>* is not mentioned, the default profiling library `libVT.so` will be used.

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

NOTE: It is not necessary to link your application against the profiling library before execution.

(SDK only) -check_mpi [<*checking_library*>]

Use this option to check your MPI application using the indicated *<checking_library>*. If *<checking_library>* is not mentioned, the default checking library `libVTmc.so` will be used.

Set the `I_MPI_JOB_CHECK_LIBS` environment variable to override the default checking library.

NOTE: It is not necessary to link your application against the checking library before execution.

-tv

Use this option to run *<executable>* under the TotalView* debugger. For example:

```
$ mpiexec -tv -n <# of processes> <executable>
```

See Environment Variables for information on how to select the TotalView* executable file.

-tva <*jobid*>

Use this option to attach the TotalView* debugger to existing *<jobid>*. For example:

```
$ mpiexec -tva <jobid>
```

-tvsu

Use this option to run *<executable>* for later attachment with the TotalView* debugger. For example:

```
$ mpiexec -tvsu -n <# of processes> <executable>
```

NOTE: To debug the running Intel® MPI job, attach the TotalView* to the Python instance that is running the `mpiexec` script.

-idb

Use this option to run *<executable>* under the Intel® Debugger. For example:

```
$ mpiexec -idb -n <# of processes> <executable>
```

Include the installation path of the Intel® Debugger in the `IDB_HOME` environment variable.

-idba *<jobid>*

Use this option to attach the Intel® Debugger to the existing *<jobid>*. For example:

```
$ mpiexec -idba <jobid>
```

-gdb

Use this option to run *<executable>* under the GNU* debugger. For example:

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

-gdba *<jobid>*

Use this option to attach the GNU* debugger to the existing *<jobid>*. For example:

```
$ mpiexec -gdba <jobid>
```

-a *<alias>*

Use this option to assign *<alias>* to the job.

-ordered-output

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

NOTE: For this option to work, the last line output by each process must end with the end-of-line ('\n') character. Otherwise the application may stop responding.

-m

Use this option to merge output lines.

-l

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

-s *<spec>*

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

Arguments

<spec>	Define MPI process ranks
`all`	Use all 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` configuration files described in the section *Configuration Files.*

-ifhn <*interface/hostname*>

Use this option to specify the network interface for communication with the local MPD daemon. The `<interface/hostname>` should be an IP address or a hostname associated with the alternative network interface.

-ecfn <*filename*>

Use this option to output XML exit codes to the file `<filename>`.

-configfile <*filename*>

Use this option to specify the file `<filename>` that contains command-line options. Blank lines and lines that start with '#' as the first character are ignored. For example, the configuration file contains the following commands to run the executables `a.out` and `b.out` using the `rdssm` device over `host1` and `host2` respectively:

```
-host host1 -env I_MPI_DEBUG 2 -env I_MPI_DEVICE rdssm -n 2 ./a.out

-host host2 -env I_MPI_DEBUG 2 -env I_MPI_DEVICE rdssm -n 2 ./b.out
```

To launch a MPI application according to the parameters above, use:

```
$ mpiexec –configfile <filename>
```

NOTE: This option may only be used alone. It terminates parsing of the `mpiexec` command line.

2.2.2 Local Options

-n <*# of processes*> or -np <*# of processes*>

Use this option to set the number of MPI processes to run the current arg-set.

-env <*ENVVAR*> <*value*>

Use this option to set the *<ENVVAR>* environment variable to specified `<value>` for all MPI processes in the current arg-set.

-envuser

Use this option to propagate all user environment variables with the exception of the following variables: `$HOSTNAME, $HOST, $HOSTTYPE, $MACHTYPE, $OSTYPE`. This is the default setting.

-envall

Use this option to propagate all environment variables in the current environment.

-envnone

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

-envlist <*list of env var names*>

Use this option to pass a list of environment variables with their current values. `<list of env var names>` is a comma separated list of variables to be sent into the processes. If this option is used several times in the command line, all variables listed in the arguments will be included into one list.

-envexcl *<list of env var names>*

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

-host *<nodename>*

Use this option to specify a particular *<nodename>* on which the MPI processes in the current arg-set are to be run. For example, the following will run the executable `a.out` on host `host1` only:

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

-path *<directory>*

Use this option to specify the path to *<executable>* that is to be run in the current arg-set.

-wdir *<directory>*

Use this option to specify the working directory in which *<executable>* is to be run in the current arg-set.

-umask *<umask>*

Use this option to perform the `umask` *<umask>* command for the remote process.

2.2.3 Configuration Files

The `mpiexec` configuration files specify the default options applied to all `mpiexec` commands.

If any of these files exist, their contents are prepended to the command-line options for `mpiexec` in the following order:

1. System-wide *<installdir>*`/etc/mpiexec.conf`. For the Intel® 64 architecture in 64-bit mode the default location of the configuration file is the `<installdir>/etc64` directory and in 32-bit mode is the `<installdir>/etc` directory.
2. User-specific `$HOME/.mpiexec.conf`
3. Session-specific `$PWD/mpiexec.conf`

You can override these files by defining environment variables and using command line options. You can skip these configuration files by using the `mpiexec -noconf` option.

You can create or modify these files. They contain `mpiexec` command-line options. Blank lines and lines that start with `'#'` are ignored. For example, to specify a default device, add the following line to the respective `mpiexec.conf` file:

```
-genv I_MPI_DEVICE <device>
```

2.2.4 Environment Variables

I_MPI_DEVICE

Select the particular network fabric to be used.

Syntax

```
I_MPI_DEVICE=<device>[:<provider>]
```

Arguments

<device>	Define a network fabric
`sock`	Sockets
`shm`	Shared-memory only (no sockets)
`ssm`	Combined sockets + shared memory (for clusters with SMP nodes)
`rdma`	RDMA-capable network fabrics including InfiniBand*, Myrinet* (via DAPL*)
`rdssm`	Combined sockets + shared memory + DAPL* (for clusters with SMP nodes and RDMA-capable network fabrics)
<provider>	Optional DAPL* provider name (only for rdma and rdssm devices)

Description

Set this variable to select a specific fabric combination. If the `I_MPI_DEVICE` variable is not defined, Intel® MPI Library selects the most appropriate fabric combination automatically.

For example, to select shared-memory as the chosen fabric, use the following command:

```
$ mpiexec -n <# of processes> -env I_MPI_DEVICE shm <executable>
```

Use the *<provider>* specification only for the `{rdma,rdssm}` devices.

For example, to select the OFED* InfiniBand* device, use the following command:

```
$ mpiexec -n <# of processes> \
          -env I_MPI_DEVICE rdssm:OpenIB-cma <executable>
```

For these devices, if *<provider>* is not specified, the first DAPL* provider in the `/etc/dat.conf` file is used. If *<provider>* is set to `none`, the `rdssm` device establishes sockets connections between the nodes without trying to establish DAPL* connections first.

NOTE: **(SDK only)** If you build the MPI program using `mpiicc -g`, the debug-enabled version of the library is used.

NOTE: **(SDK only)** If you build the MPI program using `mpiicc -t=log`, the trace-enabled version of the library is used.

I_MPI_FALLBACK_DEVICE

Set this environment variable to enable fallback to the available fabric. It is valid only for `rdssm` and `rdma` modes.

Syntax

`I_MPI_FALLBACK_DEVICE=`*<arg>*

Arguments

<arg>	Binary indicator
`enable | yes | on | 1`	Fall back to the shared memory and/or socket fabrics if initialization of the DAPL* fabric fails. This is the default value
`disable | no | off | 0`	Terminate the job if the fabric selected by the `I_MPI_DEVICE` environment variable cannot be initialized

Description

Set this variable to control fallback to the available fabric.

If `I_MPI_FALLBACK_DEVICE` is set to `enable` and an attempt to initialize the specified fabric fails, the library falls back to the shared memory and/or socket fabrics. The exact combination of devices depends on the number of processes started per node. For example, the library can use only sockets or a mix of sockets plus shared memory (`ssm`) per node. This device ensures that the job will run but it may not provide the highest possible performance for the given cluster configuration.

If `I_MPI_FALLBACK_DEVICE` is set to `disable` and an attempt to initialize the specified fabric fails, the library terminates the MPI job.

I_MPI_DEBUG

Print out debugging information when an MPI program starts running.

Syntax

`I_MPI_DEBUG=`*`<level>`*

Arguments

`<level>`	Indicate level of debug information provided
`0`	Print no debugging information. This is the default value
`1`	Output verbose error diagnostics
`2`	Confirm which `I_MPI_DEVICE` was used
`3`	Output effective MPI rank, pid and node mapping table
`4`	Print process pinning information
`5`	Print Intel MPI-specific environment variables
`> 5`	Add extra levels of debug information

Description

Set this variable to control the output of the debugging information.

The `I_MPI_DEBUG` mechanism extends the MPICH2* `MPICH_DBG_OUTPUT` debug mechanism by overriding the current value and setting `MPICH_DBG_OUTPUT=stdout`.

Each printed line has the following format:

`[<identifier>] <message>`

where *`<identifier>`* identifies the MPI process that produced the message, while *`<message>`* contains the debugging output.

The *`<identifier>`* is an MPI process rank if *`<level>`* is an unsigned number. If the `'+'` sign is added in front of the *`<level>`* number, the *`<identifier>`* contains a `rank#pid@hostname` tuple. Here, `rank` is the MPI process rank, `pid` is the UNIX process id, and `hostname` is the host name as defined at process launch time.

For example, the following command:

```
    $ mpiexec –n 1 -env I_MPI_DEBUG 2 ./a.out
```

may produce the following output:

```
[0] MPI startup(): shared memory data transfer mode
```

while the command

```
$ mpiexec –n 1 -env I_MPI_DEBUG +2 ./a.out
```

may produce the following output:

```
[0#1986@mpicluster001]  MPI startup(): shared memory data transfer mode
```

NOTE: Compiling with `mpiicc -g` causes considerable amount of additional debug information to be printed.

I_MPI_PERHOST

Define default settings for the `-perhost` option in the `mpiexec` command.

Syntax

`I_MPI_PERHOST=`*`<value>`*

Arguments

`<value>`	Define default process layout
`<n>` `> 0`	*`<n>`* processes per node
`all`	All logical CPUs on a node
`allcores`	All cores (physical CPUs) on a node

Description

Set this variable to define the default setting for the `-perhost` option. If `-perhost` is explicitly called in the command line, the `I_MPI_PERHOST` variable has no effect. The `-perhost` option assumes the value of the `I_MPI_PERHOST` variable if this variable is defined.

NOTE: `I_MPI_PERHOST` is incompatible with the `mpiexec -host` option. The `I_MPI_PERHOST` environment variable will be ignored in this case.

I_MPI_NETMASK

Choose the network interface for MPI communication over sockets.

Syntax

`I_MPI_NETMASK=`*`<arg>`*

Arguments

`<arg>`	Define the network interface (string parameter)
`<interface_mnemonic>`	Mnemonic of the network interface: `ib` or `eth`
`ib`	Select IPoIB
`eth`	Select Ethernet. This is the default value
`<interface_name>`	Name of the network interface Usually the UNIX* driver name followed by the unit number
`<network_address>`	Network address. The trailing zero bits imply netmask
`<network_address/netmask>`	Network address. The *`<netmask>`* value specifies the netmask length
`<list of interfaces>`	A colon separated list of network addresses and interface names

Description

Set this variable to choose the network interface for MPI communication over sockets in the `sock` and `ssm` communication modes. If you specify a list of interfaces, the first available interface on the node will be used for communication.

Examples

1. Use the following setting to select the IP over InfiniBand (IPoIB) fabric:
   `I_MPI_NETMASK=ib`
2. Use the following setting to select particular network interface for socket communications:
   `I_MPI_NETMASK=ib0`
3. Use the following setting to select particular network for socket communications. This setting implies the `255.255.0.0` netmask:
   `I_MPI_NETMASK=192.169.0.0`
4. Use the following setting to select a particular network for socket communications with netmask set explicitly:
   `I_MPI_NETMASK=192.169.0.0/24`
5. Use the following setting to select the specified network interfaces for socket communications:
   `I_MPI_NETMASK=192.169.0.5/24:ib0:192.169.0.0`

(SDK only) I_MPI_JOB_TRACE_LIBS

(MPIEXEC_TRACE_LIBS)

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

Syntax

`I_MPI_JOB_TRACE_LIBS=`*`<arg>`*

Deprecated Syntax

`MPIEXEC_TRACE_LIBS=`*`<arg>`*

Arguments

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

Description

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

(SDK only) I_MPI_JOB_CHECK_LIBS

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

Syntax

`I_MPI_JOB_CHECK_LIBS=`*`<arg>`*

Arguments

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

Description

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

I_MPI_JOB_STARTUP_TIMEOUT

Set the `mpiexec` job startup timeout.

Syntax

`I_MPI_JOB_STARTUP_TIMEOUT=<timeout>`

Arguments

`<timeout>`	Define `mpiexec` job startup timeout period in seconds
`<n>` ≥ 0	The default timeout value is 20 seconds

Description

Set this variable to make `mpiexec` wait for the job to start in `<timeout>` seconds after its launch. The `<timeout>` value should be greater than zero. Otherwise the variable setting is ignored and a warning message is printed. Setting this variable may make sense on large clusters with a lot of nodes where the job startup time may exceed the default value.

NOTE: Set the `I_MPI_JOB_STARTUP_TIMEOUT` variable in the shell environment before executing the `mpiexec` command. Do not use the `-genv` or `-env` options for setting the `<timeout>` value. Those options are used only for passing variables to the MPI process environment.

I_MPI_JOB_TIMEOUT

(MPIEXEC_TIMEOUT)

Set the `mpiexec` timeout.

Syntax

`I_MPI_JOB_TIMEOUT=<timeout>`

Deprecated Syntax

`MPIEXEC_TIMEOUT=<timeout>`

Arguments

`<timeout>`	Define `mpiexec` timeout period in seconds
`<n>` ≥ 0	The default timeout value is zero, meaning no timeout

Description

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

NOTE: Set the `I_MPI_JOB_TIMEOUT` variable in the shell environment before executing the `mpiexec` command. Do not use the `-genv` or `-env` options for setting the `<timeout>` value. Those options are used only for passing variables to the MPI process environment.

I_MPI_JOB_TIMEOUT_SIGNAL

(MPIEXEC_TIMEOUT_SIGNAL)

Define a signal to be used when a job is terminated due to a timeout.

Syntax

`I_MPI_JOB_TIMEOUT_SIGNAL=<number>`

Deprecated Syntax

`MPIEXEC_TIMEOUT_SIGNAL=<number>`

Arguments

<number>	Define signal number
<n> > 0	The default value is 9 (SIGKILL)

Description

Define a signal number for killing the processes of the task if the timeout pointed to by `I_MPI_JOB_TIMEOUT` is over. If a signal number unsupported by the system is set, `mpiexec` prints a warning message and continues task termination using the default signal number `9` (`SIGKILL`).

I_MPI_JOB_SIGNAL_PROPAGATION

(MPIEXEC_SIGNAL_PROPAGATION)

Control signal propagation.

Syntax

`I_MPI_JOB_SIGNAL_PROPAGATION=<arg>`

Deprecated Syntax

`MPIEXEC_SIGNAL_PROPAGATION=<arg>`

Arguments

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

Description

Set this variable to control signal propagation. If it is turned on, the signal is applied to all processes of the task. If signal propagation is disabled, only the process with rank #0 is killed with the given signal. The remaining processes are killed with the default signal `9` (`SIGKILL`).

NOTE: `I_MPI_JOB_TIMEOUT_SIGNAL and I_MPI_JOB_SIGNAL_PROPAGATION` can work independently.

I_MPI_OUTPUT_CHUNK_SIZE

Set the size of the `stdout/stderr` output buffer.

Syntax

`I_MPI_OUTPUT_CHUNK_SIZE=<size>`

Arguments

<size>	Define output chunk size in kilobytes
<n> > 0	The default chunk size value is 1 KB

Description

Set this 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 variable setting is ignored and a warning message is displayed.

Use this setting for applications that create significant amount of output from different processes. With the `-ordered-output mpiexec` option, this setting helps to prevent the output from garbling.

NOTE: Set the `I_MPI_OUTPUT_CHUNK_SIZE` variable in the shell environment before executing the `mpiexec` command. Do not use the `-genv` or `-env` options for setting the `<size>` value. Those options are used only for passing variables to the MPI process environment.

I_MPI_PMI_EXTENSIONS

Turn on/off the use of the Intel® MPI Library Process Management Interface (PMI) extensions.

Syntax

`I_MPI_PMI_EXTENSIONS=<arg>`

Arguments

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

Description

The Intel® MPI Library automatically detects if your process manager supports the PMI extensions. If supported, the extensions substantially decrease task startup time. Set the `I_MPI_PMI_EXTENSIONS` to `disable` if your process manager does not support these extensions.

I_MPI_JOB_FAST_STARTUP

(I_MPI_PMI_FAST_STARTUP)

Turn on/off the faster Intel® MPI Library process startup algorithm.

Syntax

`I_MPI_JOB_FAST_STARTUP=<arg>`

Deprecated Syntax

`I_MPI_PMI_FAST_STARTUP=<arg>`

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on the algorithm for fast startup. This is the default value
`disable | no | off | 0`	Turn off the algorithm for fast startup

Description

The new algorithm significantly decreases the application startup time. Some DAPL providers may be overloaded during startup of large number of processes (greater than 512). To avoid this problem, turn off this algorithm by setting the `I_MPI_JOB_FAST_STARTUP` environment variable to `disable`.

I_MPI_DAT_LIBRARY

Select a particular DAT library to be used.

Syntax

`I_MPI_DAT_LIBRARY=<library>`

Arguments

<library>	Specify the exact library to be used instead of the default `libdat.so`

Description

Set this variable to select a specific DAT library to be used. Specify the full path to the DAT library if it is not located in the dynamic loader search path.

NOTE: Use this variable only if you are going to utilize a DAPL provider.

TOTALVIEW

Select a particular TotalView* executable file to use.

Syntax

`TOTALVIEW=<path>`

Arguments

<path>	Path/name of the TotalView* executable file instead of the default `totalview`

Description

Set this variable to select a particular TotalView* executable file.

IDB_HOME

Set the Intel® Debugger installation directory path.

Syntax

`IDB_HOME=<path>`

Arguments

<path>	Specify the installation directory of the Intel® Debugger

Description

Set this variable to specify the installation directory of the Intel® Debugger.

I_MPI_TUNER_DATA_DIR

Set an alternate path to the directory with the tuning configuration files.

Syntax

`I_MPI_TUNER_DATA_DIR=<path>`

Arguments

<path>	Specify the automatic tuning utility output directory. The default value is *<mpiinstalldir>*`/etc64` or *<mpiinstalldir>*`/etc`

Description

Set this variable to specify an alternative location of the tuning configuration files.

2.3 Simplified Job Startup Command

mpirun

Syntax

```
mpirun [ <mpdboot options> ] <mpiexec options>
```

Arguments

<mpdboot options>	`mpdboot` options as described in the `mpdboot` command description below, except `-n`
<mpiexec options>	`mpiexec` options as described in the `mpiexec` section above

Description

Use this command to start an independent ring of `mpd` daemons, launch an MPI job, and shut down the `mpd` ring upon job termination.

The first non `mpdboot` option (including `-n` or `-np`) delimits the `mpdboot` and `mpiexec` options. All options up to this point, excluding the delimiting option, are passed to the `mpdboot` command. All options from this point on, including the delimiting option, are passed to the `mpiexec` command.

All configuration files and environment variables applicable to the `mpdboot` and `mpiexec` commands are also pertinent to `mpirun`.

The set of hosts is defined by the following rules, which are checked in this order:

1. All host names from the `mpdboot` host file (either `mpd.hosts` or the file specified by the `-f` option).
2. All host names returned by the `mpdtrace` command, if there is an `mpd` ring running.
3. Local host (a warning is issued in this case).

The `mpirun` command also detects if the MPI job is submitted in a session allocated using a job scheduler like Torque*, PBS Pro*, OpenPBS*, LSF*, Parallelnavi* NQS*, SLURM*, or Sun* Grid Engine*. In this case, 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 have to create the `mpd.hosts` file yourself. Just allocate the session you need using the particular job scheduler installed on your system, and use the `mpirun` command inside this session to run your MPI job.

2.4 Multipurpose Daemon Commands

mpd

Start `mpd` daemon.

Syntax

```
mpd  [ --help ] [ -V ] [ --version ] [ --host=<host> --port=<portnum> ] \
     [ --noconsole ] [ --trace ] [ --echo ] [ --daemon ] [ --bulletproof ] \
     [ --i fhn <interface/hostname> ] [ --listenport <listenport> ]
```

Arguments

`--help`	Display a help message

`-V | --version`	Display the Intel® MPI Library version information

`-h <host> -p <portnum> |`
`--host=<host> --port=<portnum>`
	Specify the host and port to be used for entering an existing ring. The `--host` and `--port` options must be specified together

`-n | --noconsole`	Do not create a console at startup
`-t | --trace`	Print internal MPD trace information
`-e | --echo`	Print a port number at startup to which other `mpds` may connect
`-d | --daemon`	Start `mpd` in daemon mode. By default, the interactive mode is enabled
`--bulletproof`	Turn MPD bulletproofing on
`--ifhn=<interface/hostname>`	Specify `<interface/hostname>` to use for MPD communications

`-l <listenport> |`
`--listenport=<listenport>`
	Specify the `mpd` listening port

Description

Multipurpose Daemon* (MPD) is the Intel® MPI Library process management system for starting parallel jobs. Before running a job, start `mpd` daemons on each host and connect them into a ring. Long parameter names may be abbreviated to their first letters by using only one hyphen and no equal sign. For example,

```
$ mpd -h masterhost -p 4268 -n
```

is equivalent to

```
$ mpd --host=masterhost --port=4268 -noconsole
```

If a file named `.mpd.conf` is presented in the user's home directory, only the user can have read and write privileges. The file must minimally contain a line with `secretword=<secretword>`. Create the `mpd.conf` file in the `/etc` directory instead of `.mpd.conf` in the root's home directory to run `mpd` as root. We do not recommend starting the MPD ring under the root account.

mpdboot

Start `mpd` ring.

Syntax

```
mpdboot   [ -h ] [ -V ] [ -n <#nodes> ] [ -f <hostsfile> ] [ -r <rshcmd> ] \
          [ -u <user> ] [ -m <mpdcmd> ] [ --loccons ] [ --remcons ] \
          [ -s ] [ -d ] [ -v ] [ -1 ] [ --ncpus=<ncpus> ] [ -o ]
```

or

```
mpdboot   [ --help ] [ --version ] [ --totalnum=<#nodes> ] \
          [ --file=<hostsfile> ] [ --rsh=<rshcmd> ] [ --user=<user> ] \
          [ --mpd=<mpdcmd> ] [ --loccons ] [ --remcons ] [ --shell ] \
          [ --debug ] [ --verbose ] [ -1 ] [ --ncpus=<ncpus> ] [ --ordered ]
```

Arguments

`-h | --help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`-d | --debug`	Print debug information
`-v | --verbose`	Print extra verbose information. Show the *<rshcmd>* attempts
`-n` *<#nodes>* `|` `--totalnum=`*<#nodes>*	Number of nodes in `mpd.hosts` on which daemons are started
`-r` *<rshcmd>* `| --rsh=`*<rshcmd>*	Specify remote shell to start daemons and jobs. `rsh` is the default value
`-f` *<hostsfile>* `|` `--file=`*<hostsfile>*	Path/name of the file that has the list of machine names on which the daemons are started
`-1`	Remove the restriction of starting only one `mpd` per machine
`-m` *<mpdcmd>* `| --mpd=`*<mpdcms>*	Specify the full path name of the `mpd` on the remote hosts
`-s | --shell`	Specify the shell
`-u` *<user>* `| --user=`*<user>*	Specify the user
`--loccons`	Do not create local MPD consoles
`--remcons`	Do not create remote MPD consoles
`--ncpus=`*<ncpus>*	Indicate how many processors to use on the local machine (other nodes are listed in the hosts file)
`-o | --ordered`	Start all the `mpd` daemons in the exact order as specified in the `mpd.hosts` file

Description

Start the `mpd` daemons on the specified number of nodes by providing a list of node names in *<mpd.hosts>*.

The `mpd` daemons are started using the `rsh` command by default. If the `rsh` connectivity is not enabled, use the `-r ssh` option to switch over to `ssh`. Make sure that all nodes in the cluster can connect to each other via the `rsh` command without a password or, if the `-r ssh` option is used, via the `ssh` command without a password.

NOTE: The `mpdboot` command will spawn an MPD daemon on the host machine, even if the machine name is not listed in the `mpd.hosts` file.

mpdexit

Shut down a single `mpd` daemon.

Syntax

```
mpdexit [ --help ] [ -V  ] [--version ] <mpdid>
```

Arguments

`--help`	Display a help message

`-V | --version`	Display Intel® MPI Library version information
`<mpdid>`	Specify the `mpd` daemon to kill

Description

Use this command to cause the single `mpd` daemon to exit. Use *<mpdid>* obtained via the `mpdtrace -l` command in the form *<hostname>_<port number>*.

mpdallexit

Shut down all `mpd` daemons on all nodes.

Syntax

```
mpdallexit [ --help ] [ -V  ] [ --version ]
```

Arguments

`--help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information

Description

Use this command to shutdown all MPD rings you own.

mpdcleanup

Cleanup the environment after an `mpd` crash.

Syntax

```
mpdcleanup  [ -h ] [ -V ] [ -f <hostsfile> ] [ -r <rshcmd> ] [ -u <user> ] \
            [ -c <cleancmd> ] [ -a]
```

or

```
mpdcleanup  [ --help ] [ --version ] [ --file=<hostsfile> ] \
             [ --rsh=<rshcmd> ] [ --user=<user> ] [ --clean=<cleancmd> ] \
             [ --all]
```

Arguments

`-h | --help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`-f <hostsfile> |` `--file=<hostsfile>`	Specify the file containing a list of machines to clean up
`-r <rshcmd> |` `--rsh=<rshcmd>`	Specify the remote shell to use
`-u <user> |` `--user=<user>`	Specify the user
`-c <cleancmd> |` `--clean=<cleancmd>`	Specify the command to use for removing the UNIX* socket. The default command is `/bin/rm -f`

`-a | --all`	Kill all `mpd` daemons related to the current settings of the `I_MPI_JOB_CONTEXT` environment variable on all hosts specified in *`<hostsfile>`*

Description

Use this command to cleanup the environment after an `mpd` crash. It removes the UNIX* socket on local and remote machines or kills all `mpd` daemons related to the current environment controlled by the `I_MPI_JOB_CONTEXT` environment variable.

For instance, use the following command to remove the UNIX sockets on machines specified in the `hostsfile` file:

```
$ mpdcleanup --file=hostsfile --rsh=ssh
```

Use the following command to kill the `mpd` daemons on the machines specified in the `hostsfile` file:

```
$ mpdcleanup --file=hostsfile --all
```

mpdtrace

Determine whether an `mpd` is running.

Syntax

`mpdtrace [ --help ] [ -V  ] [ --version ] [ -l ]`

Arguments

`--help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`-l`	Show MPD identifiers instead of the hostnames

Description

Use this command to list the hostnames or identifiers of all `mpd`s in the ring. The output identifiers have the form *`<hostname>_<port number>`*.

mpdcheck

Check for configuration problems on the host or print configuration information about this host.

Syntax

`mpdcheck [ -v ] [ -l ] [ -h ] [ --help ] [ -V ] [ --version ]`

`mpdcheck -pc [ -v ] [ -l ]`

`mpdcheck -f` *`<host_file>`* `[ -ssh ] [ -v ] [ -l ]`

`mpdcheck -s [ -v ] [ -l ]`

`mpdcheck -c` *`< server_host> <server_port>`* `[ -v ] [ -l ]`

Arguments

`-h | --help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`-pc`	Print configuration information about a local host
`-f` *`<host_file>`*	Print information about the hosts listed in *`<host_file>`*
`-ssh`	Invoke testing of `ssh` on each remote host. Use in conjunction with the `-f` option

`-s`	Run `mpdcheck` as a server on one host
`-c <server_host> <server_port>`	Run `mpdcheck` as a client on the current or different host. Connect to the `<server_host> <server_port>`
`-l`	Print diagnostic messages in extended format
`-v`	Print the actions that `mpdcheck` is performing

Description

Use this command to check configuration problems on the cluster nodes. Any output started with *** indicates a potential problem.

If you have problems running parallel jobs via `mpd` on one or more hosts, try to run the script once on each of those hosts.

mpdringtest

Test the MPD ring.

Syntax

```
mpdringtest [ --help ] [ -V  ] [ --version ] <number of loops>
```

Arguments

`--help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`<number of loops>`	Number of loops

Description

Use this command to test how long it takes for a message to circle the `mpd` ring.

mpdlistjobs

List the running processes for a particular set of MPI jobs.

Syntax

```
mpdlistjobs [ -h ] [ -V ] [ -u <username> ] [ -a <jobalias> ] [ -j <jobid> ]
```

or

```
mpdlistjobs [ --help ] [ --version ] [ --user=<username> ] \
            [ --alias=<jobalias> ] [ --jobid=<jobid> ]
```

Arguments

`-h | --help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`-u <username> |` `--user=<username>`	List jobs of a particular user
`-a <jobalias> |` `--alias=<jobalias>`	List information about the particular job specified by `<jobalias>`
`-j <jobid> |` `--jobid=<jobid>`	List information about the particular job specified by `<jobid>`

Description

Use this command to list the running processes for a set of MPI jobs. All jobs for the current machine are displayed by default.

mpdsigjob

Apply a signal to a process running an application.

Syntax

```
mpdsigjob [ --help ] [ -V ] [ --version ] <sigtype>  \
          [-j <jobid> | -a <jobalias> ] [-s | -g ]
```

Arguments

`--help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`<sigtype>`	Specify the signal to send
`-a <jobalias>`	Send a signal to the job specified by `<jobalias>`
`-j <jobid>`	Send a signal to the job specified by `<jobid>`
`-s`	Deliver a signal to a single user process
`-g`	Deliver a signal to a group of processes. This is the default behavior

Description

Use this command to deliver a specific signal to the processes of a running job. The desired signal is the first argument. Specify only one of two options: `-j` or `-a`.

mpdkilljob

Kill a job.

Syntax

```
mpdkilljob [ --help ] [ -V ] [ --version ] [ <jobnum> ] [ -a <jobalias> ]
```

Arguments

`--help`	Display a help message
`-V | --version`	Display Intel® MPI Library version information
`<jobnum>`	Kill the job specified by `<jobnum>`
`-a <jobalias>`	Kill the job specified by `<jobalias>`

Description

Use this command to kill the job specified by `<jobnum>` or by `<jobalias>`. Obtain `<jobnum>` and `<jobalias>` from the `mpdlistjobs` command. The `<jobid>` field has the following format: `<jobnum>@<mpdid>`.

mpdhelp

Print brief help concerning MPD commands.

Syntax

```
mpdhelp [ -V ] [ --version ]
```

Arguments

`-V | --version`	Display Intel® MPI Library version information

Description

Use this command to obtain a brief help message concerning MPD commands.

2.4.1 Configuration Files

$HOME/.mpd.conf

This optional configuration file contains an `mpd` daemon password. Create it before setting up the `mpd` daemons. Use it to control access to the daemons by various Intel® MPI Library users.

Syntax

The file has a single line:

`secretword=<mpd password>`

or

`MPD_SECRETWORD=<mpd password>`

Description

An arbitrary *<mpd password>* string only controls access to the `mpd` daemons by various cluster users. Do not use Linux* OS login passwords here.

Place the `$HOME/.mpd.conf` file on a network-mounted file system, or replicate this file so that it is accessible as `$HOME/.mpd.conf` on all nodes of the cluster.

When `mpdboot` is executed by some non-root *<user>*, this file should have user and ownership set to *<user>* and *<<user>'s group>* accordingly. The access permissions should be set to `600` mode (only user has read and write privileges).

NOTE: `MPD_SECRETWORD` is a synonym for `secretword`.

mpd.hosts

This file has a list of node names which the `mpdboot` command uses to start `mpd` daemons.

Ensure that this file is accessible by the user who runs `mpdboot` on the node where the `mpdboot` command is actually invoked.

Syntax

The format of the `mpd.hosts` file is a list of node names, one name per line. Blank lines and the portions of any lines that follow a `#` character are ignored.

2.4.2 Environment Variables

I_MPI_JOB_CONFIG_FILE

(I_MPI_MPD_CONF)

Set the path/name of the `mpd` configuration file.

Syntax

`I_MPI_JOB_CONFIG_FILE=<path/name>`

Deprecated Syntax

`I_MPI_MPD_CONF=<path/name>`

Arguments

<path/name>	Absolute path of the MPD configuration file

Description

Set this variable to define the absolute path of the file that is used by the `mpdboot` script instead of the default value `${HOME}/.mpd.conf`.

I_MPI_JOB_CONTEXT

(MPD_CON_EXT)

Set a unique name for the `mpd` console file. This enables you to run several `mpd` rings under the same user account.

Syntax

`I_MPI_JOB_CONTEXT=<tag>`

Deprecated Syntax

`MPD_CON_EXT=<tag>`

Arguments

<tag>	Unique MPD identifier

Description

Set this variable to different unique values to allow several MPD rings to co-exist. Each MPD ring is associated with a separate `I_MPI_JOB_CONTEXT` value. Once this variable is set, you can start one MPD ring and work with it without affecting other available MPD rings. Set the appropriate `I_MPI_JOB_CONTEXT` value to work with a particular MPD ring. See *Simplified Job Startup Command* to learn about an easier way to run several Intel® MPI Library jobs at once.

I_MPI_JOB_TAGGED_PORT_OUTPUT

Turn on/off the use of the tagged `mpd` port output.

Syntax

`I_MPI_JOB_TAGGED_PORT_OUTPUT=<arg>`

Arguments

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

Description

The tagged output format works at the `mpdboot` stage and prevents a failure during startup due to unexpected output from `ssh`. `mpdboot` sets this variable to 1 automatically. Set `I_MPI_JOB_TAGGED_PORT_OUTPUT` to `disable` if you do not want to use the new format.

I_MPI_MPD_CHECK_PYTHON

Turn on/off the Python versions check at the MPD ring startup stage.

Syntax

`I_MPI_MPD_CHECK_PYTHON=<arg>`

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Check for Python version compatibility
`disable | no | off | 0`	Do not check the Python version compatibility. This is the default value

Description

Set this variable to `disable` to turn off compatibility checking of Python versions installed on the cluster nodes. This may lead to reduced MPD ring startup time. The MPD behavior is undefined if incompatible Python versions are installed on the cluster.

If `I_MPI_MPD_CHECK_PYTHON` is set to `enable` and the compatibility check fails, `mpdboot` will exit abnormally and print a diagnostic message. An MPD ring will not be started.

I_MPI_MPD_TMPDIR

TMPDIR

Set a temporary directory for the MPD subsystem.

Syntax

`I_MPI_MPD_TMPDIR=<arg>`

`TMPDIR=<arg>`

Arguments

`<arg>`	String parameter
`<directory name>`	A string that points to a scratch space location. Default value is `/tmp`

Description

Set one of these variables to specify an alternative scratch space location. The MPD subsystem creates its own files in the directory specified by these environment variables. If both variables point to valid directories, the value of the `TMPDIR` environment variable is ignored.

NOTE: The `mpd2.console_*` file full path length can be limited in some operating systems. You hit this limitation if you get the following diagnostic message: `socket.error: AF_UNIX path too long`. Decrease the length of the `<directory name>` string to avoid this issue.

2.5 Processor Information Utility

cpuinfo

Use the `cpuinfo` utility to display processor architecture information.

Syntax

`cpuinfo`

Description

The `cpuinfo` utility prints out processor architecture information that can be used to define a suitable process pinning settings.

The output consists of a number of tables:

1. General data
   Architecture – one of **i686**, **x86_64**, **ia64**
   Hyperthreading – one of **enabled**, **disabled**, **not supported**
   Packages – the number of physical packages
   Cores – the number of all cores
   Processors – the number of logical processors
2. Processor identification table. The table represents three-level identification for threads, cores, and packages of each logical processor accordingly
   Thread – unique processor identifier within a core.
   Core – unique core identifier within a package.
   Package – unique package identifier within a node.
3. Processor placement table. The table represents a map of processor placement by packages and cores. It is an inversion of the processor identification table. Each entry contains:
   Package – a physical package identifier.
   Cores – a list of core identifiers that belong to this package.
   Processors – a list of processors that belong to this package. This list order directly corresponds to the core list. A group of processors enclosed in the brackets belongs to one core.
4. Cache sharing table. For each cache level the table contains:
   Size – cache size in bytes.
   Processors – a list of processor groups enclosed in the parentheses that shared this cache or **no sharing** otherwise.

NOTE: Only the architecture information is printed for Itanium-based machines.

Examples

1. `cpuinfo` output for Dual-Core Intel® Xeon® Processor 5100 series:

```
Architecture   : x86_64
Hyperthreading: disabled
Packages      : 2
Cores         : 4
Processors : 4

=====  Processor identification  =====
Processor        Thread  Core    Package
0                0       0       0
1                0       0       3
2                0       1       0
3                0       1       3

=====  Processor placement  =====
Package Cores            Processors
0       0,1              0,2
3       0,1              1,3

=====  Cache sharing  =====
Cache   Size             Processors
L1      32  KB           no sharing
L2      4   MB           (0,2)(1,3)
```

2. `cpuinfo` output for Quad-Core Intel® Xeon® processor 5300 series:

```
Architecture   : x86_64
Hyperthreading: disabled
Packages    : 2
Cores       : 8
Processors : 8

=====  Processor identification  =====
Processor       Thread  Core    Package
0               0       0       0
1               0       2       0
2               0       0       1
3               0       2       1
4               0       1       0
5               0       3       0
6               0       1       1
7               0       3       1

=====  Processor placement  =====
Package Cores           Processors
0       0,2,1,3         0,1,4,5
1       0,2,1,3         2,3,6,7

=====  Cache sharing  =====
Cache   Size            Processors
L1      32  KB          no sharing
L2      4   MB          (0,4)(1,5)(2,6)(3,7)
```

3. `cpuinfo` output for a machine with Hyper-Threading Technology enabled:

```
Architecture   : x86_64
Hyperthreading: enabled
Packages    : 2
Cores       : 2
Processors : 4

=====  Processor identification  =====
Processor       Thread  Core    Package
0               0       0       0
1               1       0       0
2               0       0       3
3               1       0       3

=====  Processor placement  =====
Package Cores           Processors
0       0               (0,1)
3       0               (2,3)

=====  Cache sharing  =====
Cache   Size            Processors
L1      16  KB          (0,1)(2,3)
L2      1   MB          (0,1)(2,3)
```

3 Tuning Reference

The Intel® MPI Library provides an automatic tuning utility and many environment variables that can be used to influence program behavior and performance at run time.

3.1 Automatic Tuning Utility

mpitune

Use the `mpitune` utility to find optimal settings for the Intel® MPI Library relevant to your cluster configuration or your application.

Syntax

```
mpitune   [ -h ] [ -V ] [ -e <envfile> ] [ -r <rulesfile> ] \
          [ -f <hostsfile> ] [ -w <workdir> ] [ -o <outputdir> ] [ -d ] \
          [ -i <count> ] [ -v ] [ -s ] [ -c <name> ] \
          [ --app <application command line>]
```

or

```
mpitune   [ --help ] [ --version] [ --env <envfile> ] \
          [ --rules <rulesfile> ] [ --file <hostsfile> ] \
          [ --wdir <workdir> ] [ --outdir <outputdir> ] [ --debug ] \
          [--iterations <count>] [ --verbose ] [ --strict ] \
          [ --configfile <name> ] [ --silent ] [ --logs ] \
          [ --app <application command line> ]
```

Arguments

`-h | --help`	Display a help message
`-V | --version`	Display the Intel® MPI Library version information
`-e <envfile> |` `--env <envfile>`	Specify path/name of the file with hardware and software environment information. `<installdir>/etc/env.xml` or `<installdir>/etc64/env.xml` are used by default
`-r <rulesfile> |` `--rules <rulesfile>`	Specify path/name of the file with the tuning rules. `<installdir>/etc/rules.xml` or `<installdir>/etc64/rules.xml` are used by default
`-f <hostsfile> |` `--file <hostsfile>`	Specify path/name of the file containing a list of machine names to be used in the tuning process. `$PWD/mpd.hosts` is used by default. If the host file list is omitted, availability of a suitable MPD ring is expected.
`-w <workdir> |` `--wdir <workdir>`	Specify the location of the benchmarking program(s). `<installdir>/bin` or `<installdir>/bin64` are used by default
`-o <outputdir> |`	Specify the output directory for the `mpiexec` configuration files.

`--outdir <outputdir>`	`<installdir>/etc` or `<installdir>/etc64` are used by default
`-d | --debug`	Print debug information
`-i <count> |` `--iterations <count>`	Define how many times to run each tuning step. One iteration is the default value. Higher iteration counts increase tuning time but may also increase the accuracy of the results
`-v | --verbose`	Print detailed information on the progress of the tuning process
`-s | --strict`	Stop execution if any of the test units failed
`-c <name> |` `--configfile <name>`	Set the name of the tuned configuration file. The default name for the application tuning is `app.conf`. A configuration name for the cluster-specific tuning is selected automatically. A configuration file will be stored in `<outputdir>`
`--silent`	Run tuner silently, dumping output of a single iteration at the end
`--logs`	Save application output at each iteration for debugging reasons
`--app <application command line>`	Switch on application tuning mode. Default mode is the cluster-specific tuning. The rest of the arguments list beyond the `--app` flag is treated as the application command line to be used for tuning

Description

Use the `mpitune` utility to create a set of Intel® MPI Library configuration files that contain optimal settings for a particular cluster or application. You can reuse these configuration files in the `mpiexec` job launcher by using the `-tune` option.

The MPI tuner utility operates in two modes:

- Cluster-specific, evaluating a given cluster environment with a standard benchmark to find the most suitable configuration for the Intel® MPI Library. This mode is used by default.
- Application-specific, evaluating performance of a given MPI application to find the best configuration for the Intel® MPI Library for this particular application. Application tuning is enabled with the `--app` command line option.

3.1.1 Cluster-specific tuning

Run this utility once after the Intel® MPI Library installation and after every cluster configuration change (processor or memory upgrade, network reconfiguration, etc.). Do this under the user account that was used for the Intel® MPI Library installation or set the tuner data directory with the `--outdir` command line option or the `I_MPI_TUNER_DATA_DIR` environment variable.

The recorded Intel® MPI Library configuration settings will be reused automatically by the `mpiexec -tune` option.

For example:

1. Make sure the Intel® MPI Library environment is set up properly

```
$ source <installdir>/bin64/mpivars.sh
```

2. Collect configuration settings for the cluster nodes listed in the `./mpd.hosts` file

```
$ mpitune -f ./mpd.hosts
```

3. Reuse recorded values

```
$ mpiexec -tune -n 32 ./your_app
```

The job launcher will find a proper set of configuration options based on the execution conditions: communication device, number of nodes and processes, etc.

3.1.2 Application-specific tuning

Run the tuning process for any kind of MPI application specifying its command line to the tuner. Performance is measured as inversed execution time of the given application. To reduce overall tuning time use the shortest representative application workload (if applicable).

For example:

1. Make sure the Intel® MPI Library environment is set up properly

   ```
   $ source <installdir>/bin64/mpivars.sh
   ```

2. Collect configuration settings for the given application

   ```
   $ mpitune --configfile your_app.cfg --app mpiexec -n 32 ./your_app
   ```

3. Reuse recorded values

   ```
   $ mpiexec –tune your_app.cfg -n 32 ./your_app
   ```

`mpiexec` will load configuration options recorded in the `your_app.cfg` file.

Based on the default tuning rules, automated tuning utility evaluates a full set of the library configuration parameters to minimize application execution time. Customize tuning rules file to change test criteria and a set of tune options in accordance with the description below.

3.1.3 Tuning Rules File Format

MPI tuning rules define the way Intel MPI Library tuning utility to proceed: a list of the library parameters to tune, tune order, and test criteria applying on each step. A rules file is an XML document of the following structure:

```
<?xml version="1.0"?>
<TUNERULES>
  <test_list>
    <test .../>
    <test .../>
  </test_list>

 <var_list>
    <var .../>
    <var .../>
  </var_list>
</TUNERULES>
```

Each `<test/>` entity defines criteria to apply for tuning iteration:

```
<test
    alias    = "name"
    kind     = {"stats"|"time"|"min"|"max"}
    cmd_line = "%command%"
    re_begin = ".*"
    re_match = ""
/>
```

`'name'` a name of the test.

`'kind'` one of four test kinds supported by Intel MPI tuning utility:

- **stats** – test is based on Intel MPI Library lightweight statistics. Tuning framework appends statistics to the application output. In this case each line of statistics begins with token `"IMPI stats:"`. Regular expressions must match three values: message size, message count, and time taken. For example:
  `re_match = "^IMPI stats:.*,.*,.*,Reduce,(\d+),(\d+),(\d+.\d+)$"`

- **time** – time-based criteria. The Intel MPI Library tuning utility works to minimize application execution time. No regular expressions are required as application output is not in use.

- **min** – custom minimization criteria. Regular expression matches single value. Intel MPI Library tuning utility works to minimize this value.

- **max** – custom maximization criteria. Regular expression matches single value. Intel MPI Library tuning utility works to maximize this value.

`'cmd_line'` complete application command line to run. The special value `'%command%'` references the one given with the `--app` option of the Intel MPI Library tuning utility.

`'re_begin'` and `'re_match'` regular expressions that are matched against application output for all test kinds except `"time"`. The expression `'re_begin'` indicates a line of the output to start lookup of `'re_match'`. The expression `'re_match'` matches one or three values depending on the test kind. Matching values must be parenthesized. For example, this expression matches single value:

```
re_match = " Time in seconds = +(\d+.\d+)"
```

To reduce the size of rules notation, test attributes `'re_begin'` and `'re_match'` are expanded with the arguments given by the correlated `'var'` entity. The arguments are listed as `%1%`, `%2% ...` in the attribute string. For example:

```
re_match = "^IMPI stats:.*,.*,.*,%1%,(\d+),(\d+),(\d+.\d+)$"
```

Each `<var/>` entity of Intel MPI Library tuning rules file correlates a tuning parameter with specific criteria to apply:

```
<var
      name = "I_MPI_*"
      test = "test_alias"
      args = "arg1 ..."
/>
```

`'name'` a name of the Intel MPI Library tuning variable. A list of variables available for tune, their valid value ranges and iteration methods are encoded in the tuning utility as they remain the property of the Intel MPI Library. The following library parameters are enabled for the automated tune: `I_MPI_DYNAMIC_CONNECTION`, `I_MPI_RDMA_SCALABLE_PROGRESS`, `I_MPI_RDMA_TRANSLATION_CACHE`, `I_MPI_WAIT_MODE`, `I_MPI_EAGER_THRESHOLD`, `I_MPI_INTRANODE_EAGER_THRESHOLD`, `I_MPI_RDMA_EAGER_THRESHOLD`, `I_MPI_SPIN_COUNT`, `I_MPI_CONN_SPIN_COUNT`, `I_MPI_READ_SPIN_COUNT`, `I_MPI_RDMA_RNDV_BUF_ALIGN`, `I_MPI_ADJUST_REDUCE`, `I_MPI_ADJUST_ALLREDUCE`, `I_MPI_ADJUST_REDUCE_SCATTER`, `I_MPI_ADJUST_ALLGATHER`, `I_MPI_ADJUST_ALLGATHERV`, `I_MPI_ADJUST_ALLTOALL`, `I_MPI_ADJUST_ALLTOALLV`, `I_MPI_ADJUST_BCAST` and `I_MPI_ADJUST_BARRIER`.

`'test'` a test name to apply, one from the list `<test/>` entities.

`'args'` a space-separated list of arguments to substitute `%1%, %2%` etc. in the test `'re_begin'` and the `'re_match'` attribute values. For example:

```
<var name = "I_MPI_ADJUST_REDUCE" test = "app_stats" args = "Reduce"/>
```

Here is a sample rules file instructing the Intel MPI Library tuning utility to search the appropriate value for the `I_MPI_DYNAMIC_CONNECTION` parameter using custom application output and value for `I_MPI_ADJUST_REDUCE` using Intel MPI Library lightweight statistics:

```
<?xml version="1.0"?>
<TUNERULES>
  <test_list>
    <test
        alias    = "app_stats"
        kind     = "stats"
        cmd_line = "%command%"
        re_begin = ".*"
        re_match = "^IMPI stats:.*,.*,.*,%1%,(\d+),(\d+),(\d+.\d+)$"
    />
    <test
        alias    = "app_time"
        kind     = "min"
        cmd_line = "%command%"
        re_begin = ".*"
        re_match = " Time in seconds = +(\d+.\d+)"
    />
  </test_list>
  <var_list>
    <var name = "I_MPI_DYNAMIC_CONNECTION"        test = "app_time"/>
    <var name = "I_MPI_ADJUST_REDUCE"             test = "app_stats" args =
"Reduce"/>
  </var_list>
</TUNERULES>
```

3.1.4 Tuning utility output

Upon completion Intel MPI Library tuning utility records chosen values to the configuration file in the form of the `'-genv'` variables list:

```
-genv I_MPI_DYNAMIC_CONNECTION 1
-genv I_MPI_ADJUST_REDUCE ‘1:0-8’
```

The Intel MPI Library tuning utility reasonably ignores variables having no effect on the application when the difference between probes is at the noise level (1%). In this case it sets no value to the variable and preserves library heuristics.

In case of tuning application having significant run-to-run performance variation, Intel MPI Library tuning utility is expected to select different values for the same variable under the same conditions. To improve decision accuracy, increase a number of iterations for each test run with the `-i` command line option.

3.2 Process Pinning

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

3.2.1 Process Identification

Two schemes are used to identify logical processors in a system:

1. System-defined logical enumeration
2. 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 or the `cat /proc/cpuinfo` command to find out the logical CPU numbers.

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

See example below for 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.

Table 3.2-1 Logical enumeration

0	4	1	5	2	6	3	7

Table 3.2-2 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

Table 3.2-3 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.

3.2.2 Environment variables

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 processes pinning

Description

Set this variable to turn off the process pinning feature of the Intel® MPI Library.

I_MPI_PIN_MODE

Choose the pinning method.

Syntax

`I_MPI_PIN_MODE=`*`<pinmode>`*

Arguments

`<pinmode>`	Choose the CPU pinning mode
`mpd`	Pin processes inside MPD. Default on the SGI* Altix* platform
`lib`	Pin processes inside the Intel MPI Library. Default on other platforms

Description

Set the `I_MPI_PIN_MODE` variable to choose the pinning method. This variable is valid only if the `I_MPI_PIN` environment variable is enabled.

Set this variable to `lib` to make the Intel® MPI Library pin the processes. In this mode there is no chance to co-locate the process CPU and its memory.

Set the `I_MPI_PIN_MODE` variable to `mpd` to make the `mpd` daemon pin processes via system specific means, if they are available. The pinning is done before the MPI process launch. Hence, it is possible to co-locate the process CPU and memory in this case. This pinning method has an advantage over a system with Non-Uniform Memory Architecture (NUMA) like SGI* Altix*. Under NUMA, a processor can access its own local memory faster than non-local memory.

NOTE: It is not recommended to change the default settings.

I_MPI_PIN_PROCESSOR_LIST (I_MPI_PIN_PROCS)

Define a processor subset and mapping rules for MPI processes pinning to separate processors of this subset.

Syntax

```
I_MPI_PIN_PROCESSOR_LIST=

{ <proclist> | \

[ <procset> ][ :[ grain=<grain> ] [ ,shift=<shift> ][ ,offset=<offset> ]] \

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

Deprecated Syntax

`I_MPI_PIN_PROCS=`*`<proclist>`*

Arguments

<proclist>	A comma-separated list of logical processor numbers and/or ranges. Process with the i-th rank is pinned to the i-th processor in the list order
<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>*

<procset>	A processor subset that corresponds to one of three hierarchal identification levels
`all`	Use all logical processors
`allcores`	Use all logical processors that belong to different cores. This is the default value
`allsocks`	Use all logical processors that belong to different physical packages

<grain>	Specify pinning granularity cell
`fine`	One element from the corresponding processor subset: one logical processor if `all` is defined, one core if `allcores` is defined, one socket if `allsocks` is defined, `fine` is the default value for *<grain>*
`core`	Amount of elements from the corresponding processor subset that shares one processor core: amount of logical processors per core if `all` is defined, one core if `allcores` is defined, equal to `fine` if `allsocks` is defined
`sock`	Amount of elements from the corresponding processor subset that share one socket: amount of logical processors per socket if `all` is defined, amount of cores per socket if `allcores` is defined, one socket if `allsocks` is defined
`cache1`	Amount of elements from the corresponding processor subset that shares L1 cache, or `fine` if this number is less than two
`cache2`	Amount of elements from the corresponding processor subset that shares L2 cache, or `fine` if this number is less than two
`cache3`	Amount of elements from the corresponding processor subset that shares L3 cache, or `fine` if this number is less than two
`cache`	The largest number of elements among `cache1`, `cache2`, and `cache3` is used

<shift>	Specify shift of grains measured in the corresponding `grain` units
`fine`	Specify shift equal to one grain. The grains are placed sequentially. This is the default value
<n> `> 0`	Specify shift equal to *<n>* grains
`core`	Specify shift equal to the number of grains contained in one core, or `fine` if this number is less than two
`sock`	Specify shift equal to a number of grains contained in one socket
`mid`	Specify shift equal to `sock/2`
`cache1`	Specify shift equal to a number of grains sharing one L1 cache, or `fine` if this number is less than two
`cache2`	Specify shift equal to a number of grains sharing one L2 cache, or `fine` if this number is less than two
`cache3`	Specify shift equal to a number of grains shared one L3 cache, or `fine` if this number is less than two
`cache`	The largest number of grains among `cache1`, `cache2`, and `cache3` is used

<offset>	Specify startup grain number. All next grains are shifted accordingly
<n> `> 0`	Specify offset equal to *<grain>***<n>*, where *<n>* is a positive integer value

<map>	Pattern used for process placement
`bunch`	The processes are mapped proportionally to sockets as close as possible
`scatter`	The processes are mapped as remotely as possible to not share common resources: FSB, caches, cores

Description

Set the `I_MPI_PIN_PROCESSOR_LIST` variable to define the processor placement on processors. In order to avoid conflicts with shells, the variable value may be enclosed in quotes.

NOTE: This variable is valid only if `I_MPI_PIN` is enabled.

The `I_MPI_PIN_PROCESSOR_LIST` variable has three different variants:

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

For example, process mapping for `I_MPI_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

2. Grain/shift/offset mapping. This method provides cyclic shift of the defined grain along the processor list with step 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

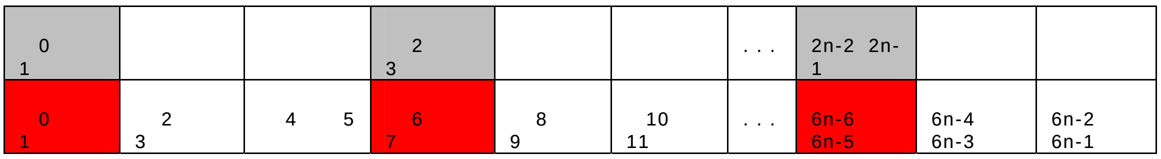
A) red – processor grains chosen on the 1st pass

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

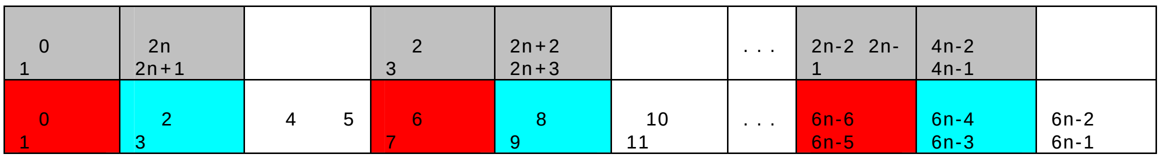
C) green - processor grains chosen on the final 3rd pass

D) Final map table ordered by MPI ranks

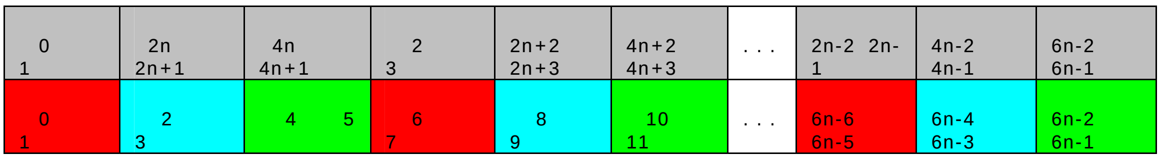
A)



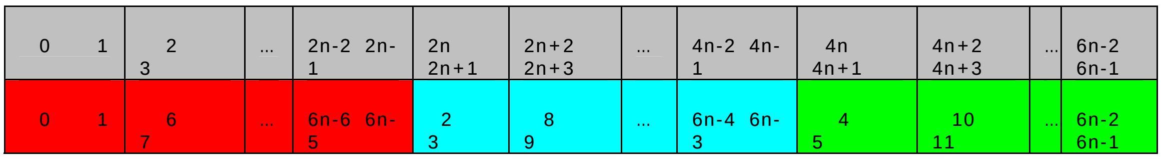
B)



C)



D)



3. Predefined scenario. In this case the most popular schemes of process pinning get unique names and these names are used for selection. Currently there are two such scenarios: `bunch` and `scatter`.

In the `bunch` scenario the processes are mapped proportionally to sockets as closely as possible. This 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 to not share common resources: FSB, caches, cores.

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

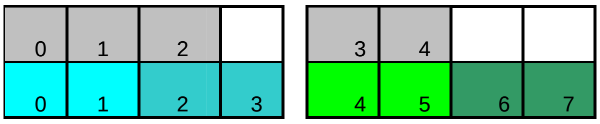
Legend:

gray – MPI processes

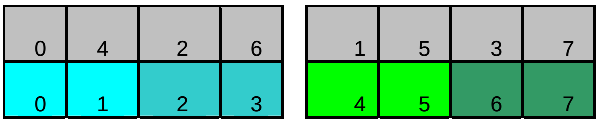
cyan – 1st socket processors

green – 2nd socket processors

The same color – processor pair share one cache



`bunch` scenario for 5 processors



`scatter` scenario for full loading

Examples

1. To pin the processes to the CPU0 and CPU3 on each node globally, use the following command:
```
$ mpirun -genv I_MPI_PIN_PROCESSOR_LIST 0,3 \
   -n <# of processes> <executable>
```
2. 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 <# of processes> <executable> : \
   -host host2 -env I_MPI_PIN_PROCESSOR_LIST 1,2,3 \
   -n <# of processes> <executable>
```
3. To print extra debug information about the process pinning, use the following command:
```
$ mpirun -genv I_MPI_DEBUG 4 -m -host host1 \
   -env I_MPI_PIN_PROCESSOR_LIST 0,3 -n <# of processes> <executable> :\
   -host host2 -env I_MPI_PIN_PROCESSOR_LIST 1,2,3 \
   -n <# of processes> <executable>
```

NOTE: If a number of processes is greater than a number of CPUs for pinning, a process list is wrapped on a processor list.

3.2.3 Interoperability with OpenMP*

I_MPI_PIN_DOMAIN

The Intel MPI Library provides additional options to control process pinning for hybrid Intel MPI/OpenMP* applications.

Syntax

`I_MPI_PIN_DOMAIN=<domain>`

Arguments

`<domain>`	Specify processor domains. There are no domains defined by default
`core`	Specify each core of a multi-core system as a separate domain
`sock`	Specify each physical package (socket) as a separate domain

node	Specify all logical processors on a node as one domain
cache1	Specify logical processors that share particular level 1 cache as a separate domain
cache2	Specify logical processors that share particular level 2 cache as a separate domain
cache3	Specify logical processors that share particular level 3 cache as a separate domain
cache	The largest domain among those defined by cache1, cache2, and cache3 above
omp	Specify domain based on the value of the OMP_NUM_THREADS environment variable. The most suitable domain among the previous core, sock, node, and cache domains is selected. The node domain is selected if the OMP_NUM_THREADS environment variable is not set
<n>	Specify domain size no less than *<n>* value. *<n>* is a positive decimal number that defines a number of logical processors in each domain. The <m>/*<n>* number of domains is defined: {0,1, …, *<n>*-1}, {*<n>*, *<n>*+1, …, 2**<n>*-1}, …, {*<n>**(<m>/*<n>*-1), …, *<m>*-1}, where *<m>* is the number of available logical processors on a node. *<n>* should not exceed the *<m>* value. The *<n>* value is truncated otherwise. The last domain is larger than *<n>* size if *<m>*%<n> is not equal to 0
[m1,…,mn]	Specify domains based on a colon separated list of hexadecimal numbers. Each mi number defines one separate domain. The following rule is used: ith logical processor included to the domain if corresponding bit of mi value is set to 1. All uncovered processors are joined one extra domain. Make sure that the same processor is not present in several domains
auto	Specify Nppn domains with size = Np/Nppn, where Np is a number of logical processors on a node, Nppn is a number of MPI processes started on the node

Description

Use this variable to define a number of non-overlapping subsets (domains) of logical processors on a node. The Intel® MPI Library allows hybrid applications to pin MPI process and its threads/children to separate domains within a node. The process threads can freely migrate from one logical process to another within a particular domain. There are no domains defined by default.

Use the OpenMP* thread affinity interface to pin processes/threads inside each domain. Set the KMP_AFFINITY environment variable to control it. It is recommended to use this feature with I_MPI_PIN_DOMAIN=node.

NOTE: The ordinary process pinning list does not make sense when the pin domain is defined. The I_MPI_PIN_PROCESSOR_LIST environment variable is not applicable in this case.

Examples of modifier usage for a system based on Clovertown platforms: two sockets, eight cores, four cores per socket; every core pair (0,1) and (2,3) shares own L2 cache:

Legend:

MPI process ranks – **bold black** numbers

0th socket processors/cores – **bold blue** numbers

1st socket processors/cores – **bold green** numbers

```
$ mpiexec -n 2 -env I_MPI_PIN_DOMAIN sock ./a.out
```

Rank	**0**				**1**			
Core	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Socket	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
Logical processor	**0**	**4**	**1**	**5**	**2**	**6**	**3**	**7**

Domain unit is socket. There are two domains (gray and yellow). Process rank 0 can migrate between all cores on the 0-th socket. Process rank 1 can migrate between all cores on the first socket.

```
$ mpiexec -n 1 -env I_MPI_PIN_DOMAIN node ./a.out
```

Rank	**0**							
Core	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Socket	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
Logical processor	**0**	**4**	**1**	**5**	**2**	**6**	**3**	**7**

Domain unit is node. There is one domain (gray). Process rank 0 can migrate between all cores on the node.

```
$ mpiexec -n 4 -env I_MPI_PIN_DOMAIN cache ./a.out
```

Rank	**0**		**1**		**2**		**3**	
Core	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**
Socket	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
Logical processor	**0**	**4**	**1**	**5**	**2**	**6**	**3**	**7**

Domain unit is cache. In this case it is L2 cache. There are four domains. Process rank 0 can migrate between core 0 and 1 on the 0-th socket. Process rank 1 can migrate between cores 2 and 3 cores on the 0-th socket, and so long.

```
$ mpiexec -n 2 -env I_MPI_PIN_DOMAIN 2 ./a.out
```

Rank	**0**				**1**			
Core	**0**	**2**	**0**	**2**	**1**	**3**	**1**	**3**
Socket	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**1**
Logical processor	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**

The variable defines two domains. The fist domain contains logical processors from zero to three, and the second domain contains logical processors from four to seven. Sequential numbering of logical processors is used here. Process rank 0 can migrate inside the first domain. Process rank 1 can migrate inside the second domain.

```
$ mpiexec -n 2 -env I_MPI_PIN_DOMAIN [55,aa] ./a.out
```

Rank	**0**				**1**			
Core	0	0	1	1	2	2	3	3
Socket	0	1	0	1	0	1	0	1
Logical processor	0	2	4	6	1	3	5	7

The fist domain is defined by mask `0x55`. It contains all logical processors with even numbers. The second domain is defined by mask `0xAA`. It contains all logical processors with odd numbers. Sequential numbering of logical processors is used here. Process rank 0 can migrate inside the first domain. Process rank 1 can migrate inside the second domain.

```
$ mpiexec -n 4 -env I_MPI_PIN_DOMAIN auto ./a.out
```

Rank	**0**		**1**		**2**		**3**	
Core	0	2	0	2	1	3	1	3
Socket	0	0	1	1	0	0	1	1
Logical processor	0	1	2	3	4	5	6	7

The variable defines four domains according to the number of running MPI processes. `I_MPI_PIN_DOMAIN=auto` is identical to `I_MPI_PIN_DOMAIN=4` in this case.

3.3 Device Control

I_MPI_EAGER_THRESHOLD

Change the eager/rendezvous cutover point for all devices.

Syntax

`I_MPI_EAGER_THRESHOLD=`*`<nbytes>`*

Arguments

`<nbytes>`	Define eager/rendezvous cutover point
`> 0`	The default *`<nbytes>`* value is equal to 262 144 bytes

Description

Set this variable to control the point-to-point protocol switchover point. Data transfer algorithms are selected based on the following scheme:

- Messages shorter than or equal in size to *`<nbytes>`* are sent using the eager protocol.
- Larger messages are sent using the more memory efficient rendezvous protocol.

I_MPI_INTRANODE_EAGER_THRESHOLD

Change the eager/rendezvous cutover point for intranode communication mode.

Syntax

`I_MPI_INTRANODE_EAGER_THRESHOLD=<nbytes>`

Arguments

`<nbytes>`	Define the threshold for DAPL* intranode communication
`> 0`	The default `<nbytes>` value is equal to 262 144 bytes

Description

Set this variable to change the threshold for communication within the node. Data transfer algorithms are selected based on the following scheme:

- Messages shorter than or equal in size to `<nbytes>` are sent using the eager protocol.
- Larger messages are sent by using the more memory efficient rendezvous protocol.

If `I_MPI_INTRANODE_EAGER_THRESHOLD` is not set, the value of `I_MPI_EAGER_THRESHOLD` is used.

I_MPI_WAIT_MODE

Turn on/off a wait mode.

Syntax

`I_MPI_WAIT_MODE=<arg>`

Arguments

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

Description

Set this variable to control the wait mode. If this mode is enabled, the processes wait for receiving messages without polling of the fabric(s). This can save CPU time for other tasks.

Use the Native POSIX Thread Library with wait mode for `shm` devices.

NOTE: Use the following command to check what version of the thread library installed on your system:

```
$ getconf GNU_LIBPTHREAD_VERSION
```

I_MPI_WAIT_TIMEOUT

Define the timeout for wait mode.

Syntax

`I_MPI_WAIT_TIMEOUT=<time>`

Arguments

`<time>`	Define the timeout for wait mode in milliseconds
`>0 or -1`	`-1` means infinite timeout. `-1` is the default value

Set this variable to specify the timeout for wait mode. If the timeout is expired, the Intel MPI Library will be woken up and continue execution. This variable allows avoiding problems related to wait mode when waiting MPI process do not wake up as expected.

I_MPI_SPIN_COUNT

Control the spin count value.

Syntax

`I_MPI_SPIN_COUNT=<scount>`

Arguments

`<scount>`	Define the loop spin count when polling fabric(s)
`> 0`	The default `<scount>` value is equal to 1 time for `sock`, `shm`, and `ssm` devices, and equal to 250 times for `rdma` and `rdssm` devices

Description

Set the spin count limit. The loop for polling the fabric(s) will spin `<scount>` times before freeing 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.

NOTE: Use the `I_MPI_SPIN_COUNT` environment variable with caution. Keep in mind that three different effects are possible: no effect, performance improvement, or performance degradation.

I_MPI_CACHE_BYPASS

Control a message transfer algorithm for the `shm` device.

Syntax

`I_MPI_CACHE_BYPASS=<arg>`

Arguments

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

Description

Set this variable to control the message transfer algorithm for the `shm` device. The default messages greater than or equal in size to the value specified by the `I_MPI_CACHE_BYPASS_THRESHOLD` environment variable are sent via the bypass cache. This feature is enabled on the IA-32 architecture and Intel® 64 architectures by default. It does not affect Itanium®-based systems.

I_MPI_CACHE_BYPASS_THRESHOLDS

Change the messages copying algorithm cutover point.

Syntax

`I_MPI_CACHE_BYPASS_THRESHOLDS=`*`<nb_send>,[<nb_recv>,[<nb_send_l2>,\`*

`[<nb_recv_l2>,[<nb_send_pk>,[<nb_recv_pk>]]]]]`

Arguments

<nb_send>	Define cutover point for sent messages when processes are pinned on cores without shared L2 cache and are not located in the same physical processor package, or when processes are not pinned
`≥ 0`	The default *<nb_send>* value is 16384 bytes
<nb_recv>	Define cutover point for received messages when processes are pinned on cores without shared L2 cache and are not located in the same physical processor package, or when processes are not pinned
`≥ 0`	The default *<nb_send>* value is 1/3 of the size of the L2 cache
<nb_send_l2>	Define cutover point for sent messages when processes are pinned on cores with shared L2 cache
`≥ 0`	The default *<nb_send_l2>* value is `-1` (copying bypass cache is disabled
<nb_recv_l2>	Define cutover point for received messages when processes are pinned on cores with shared L2 cache
`≥ 0`	The default *<nb_recv_l2>* value is 1/3 of the size of the L2 cache
<nb_send_pk>	Define cutover point for sent messages when processes are pinned on cores without shared L2 cache but located in the same physical processor package
`≥ 0`	The default *<nb_send_pk>* value is `-1` (copying bypass cache is disabled)
<nb_recv_pk>	Define cutover point for received messages when processes are pinned on cores without shared L2 cache but located in the same physical processor package
`≥ 0`	The default *<nb_recv_pk>* value is 1/3 of the size of the L2 cache

Description

Set this variable to control the switchover point for the message copying algorithm. Messages greater than or equal in size to the defined threshold values are copied so that they bypass the cache. The value of `-1` value disables cache bypass. This variable is valid only if the `I_MPI_CACHE_BYPASS` is enabled.

I_MPI_SHM_NUM_BUFFERS

Change the number of shared memory buffers for each process pair.

Syntax

`I_MPI_SHM_NUM_BUFFERS=<num>`

Arguments

`<num>`	Number of shared memory buffers for each process pair
`> 0`	The default value is 16

Description

Set this variable to define the number of shared memory buffers between each process pair.

I_MPI_SHM_BUFFER_SIZE

Change the size of shared memory buffers for each pair of processes.

Syntax

`I_MPI_SHM_BUFFER_SIZE=<nbytes>`

Arguments

`<nbytes>`	Size of shared memory buffers in bytes
`> 0`	The default `<nbytes>` value is equal to 16 384 bytes

Description

Set this variable to define the size of shared memory buffers for each pair of processes.

I_MPI_SHM_SINGLE_SEGMENT_THRESHOLD

(I_MPI_SHM_PROC_THRESHOLD)

Change the static/dynamic shared memory segment(s) allocation mode for the `shm` device.

Syntax

`I_MPI_SHM_SINGLE_SEGMENT_THRESHOLD=<nproc>`

Deprecated Syntax

`I_MPI_SHM_PROC_THRESHOLD=<nproc>`

Arguments

`<nproc>`	Define static/dynamic mode switch point for the `shm` device
`> 0`	The default `<nproc>` value depends on the values of the `I_MPI_SHM_NUM_BUFFERS` and `I_MPI_SHM_BUFFER_SIZE`

Description

Set this variable to change the allocation mode for the `shm` device.

The following modes are available for the allocation of the shared memory segment(s) for the `shm` device:

- If the number of processes started on the system is less than the value specified by `<nproc>`, the static mode is used. In that case only one common shared memory segment is allocated for all processes during the initialization stage.
- Otherwise, the dynamic mode is used and the shared memory segments are allocated for each connection individually.

The default value depends on the values of the `I_MPI_SHM_NUM_BUFFERS` and `I_MPI_SHM_BUFFER_SIZE` environment variables. It is equal to 90 in the case of default settings for `I_MPI_SHM_NUM_BUFFERS` and `I_MPI_SHM_BUFFER_SIZE`.

NOTE: The dynamic connection establishment mode does not make sense when the static allocation mode is used. The `I_MPI_DYNAMIC_CONNECTION` environment variable is not applicable in this case.

I_MPI_DYNAMIC_CONNECTION

(I_MPI_USE_DYNAMIC_CONNECTIONS)

Turn on/off the dynamic connection establishment.

Syntax

`I_MPI_DYNAMIC_CONNECTION=`*`<arg>`*

Deprecated Syntax

`I_MPI_USE_DYNAMIC_CONNECTIONS=`*`<arg>`*

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on the dynamic connection establishment. This is the default value for 64 or more processes
`disable | no | off | 0`	Turn off the dynamic connection establishment. This is the default value for less than 64 processes

Description

Set this variable to control dynamic connection establishment.

- If this mode is enabled, all connections are established at the time of the first communication between each pair of processes. This is the default behavior.
- Otherwise all connections are established upfront.

The default value depends on a number of processes in the MPI job. The dynamic connection establishment is off if a total number of processes is less than 64.

3.4 RDMA and RDSSM Device Control

I_MPI_RDMA_TRANSLATION_CACHE

Turn on/off the use of the memory registration cache.

Syntax

`I_MPI_RDMA_TRANSLATION_CACHE=`*`<arg>`*

Arguments

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

Description

Set this variable to turn off the memory registration cache.

The cache substantially increases performance but may lead to correctness issues in certain rare situations. See product *Release Notes* for further details.

I_MPI_RDMA_EAGER_THRESHOLD

(RDMA_IBA_EAGER_THRESHOLD)

Change the eager/rendezvous cutover point.

Syntax

`I_MPI_RDMA_EAGER_THRESHOLD=<nbytes>`

Deprecated Syntax

`RDMA_IBA_EAGER_THRESHOLD=<nbytes>`

Arguments

<nbytes>	Define eager/rendezvous cutover point
> 0	The default *<nbytes>* value is equal to 16456 bytes

Description

Set this variable to control low-level point-to-point protocol switchover point. Data transfer algorithms for the `rdma` and `rdssm` devices are selected based on the following scheme:

- Messages shorter than or equal to *<nbytes>* are sent using the faster eager protocol through the internal pre-registered buffers.
- Larger messages are sent using the more memory efficient rendezvous protocol.

I_MPI_DYNAMIC_CONNECTION_MODE

(I_MPI_DYNAMIC_CONNECTIONS_MODE)

Choose the algorithm for establishing of the DAPL* connections.

Syntax

`I_MPI_DYNAMIC_CONNECTION_MODE=<arg>`

Deprecated Syntax

`I_MPI_DYNAMIC_CONNECTIONS_MODE=<arg>`

Arguments

<arg>	Mode selector
`reject`	Deny one of the two simultaneous connection requests. This is the default value
`disconnect`	Deny one of the two simultaneous connection requests after both connections have been established

Description

Set this variable to choose the algorithm for handling dynamically established connections for DAPL*-capable fabrics according to the following scheme:

- In the `reject` mode, one of the requests is rejected if two processes initiate the connection simultaneously.
- In the `disconnect` mode both connections are established, but then one is disconnected. The `disconnect` mode is provided to avoid a bug in certain DAPL* providers.

I_MPI_RDMA_SCALABLE_PROGRESS

Turn on/off scalable algorithm for RDMA read progress.

Syntax

`I_MPI_RDMA_SCALABLE_PROGRESS=<arg>`

Arguments

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

Description

Set this variable to select scalable algorithm for the RDMA read progress. In some cases this provides advantages for large number of processes.

I_MPI_INTRANODE_SHMEM_BYPASS

(I_MPI_USE_DAPL_INTRANODE)

Turn on/off the DAPL* intranode communication mode.

Syntax

`I_MPI_INTRANODE_SHMEM_BYPASS=<arg>`

Deprecated Syntax

`I_MPI_USE_DAPL_INTRANODE=<arg>`

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on the DAPL* intranode communication
`disable | no | off | 0`	Turn off the DAPL* intranode communication. This is the default value

Description

Set this variable to specify the communication mode within the node. If the DAPL* intranode communication mode is enabled, data transfer algorithms are selected according to the following scheme:

- Messages shorter than or equal in size to the threshold value of the `I_MPI_INTRANODE_EAGER_THRESHOLD` variable are transferred using shared memory.
- Larger messages are transferred via the DAPL* layer.

NOTE: This variable is applicable only when shared memory and the DAPL* layer are turned on either by default or by setting the `I_MPI_DEVICE` environment variable to the `rdssm` value.

I_MPI_RDMA_BUFFER_NUM

(NUM_RDMA_BUFFER)

Change the number of internal pre-registered buffers for each process pair.

Syntax

`I_MPI_RDMA_BUFFER_NUM=<nbuf>`

Deprecated Syntax

`NUM_RDMA_BUFFER=<nbuf>`

Arguments

<nbuf>	Define the number of buffers for each pair in a process group
`> 0`	The default value is 16

Description

Set this variable to change the number of the internal pre-registered buffers for each process pair.

NOTE: The more pre-registered buffers are available, the more memory is used for every established connection.

I_MPI_RDMA_BUFFER_SIZE

(I_MPI_RDMA_VBUF_TOTAL_SIZE)

Change the size of internal pre-registered buffers for each process pair.

Syntax

`I_MPI_RDMA_BUFFER_SIZE=<nbytes>`

Deprecated Syntax

`I_MPI_RDMA_VBUF_TOTAL_SIZE=<nbytes>`

Arguments

<nbytes>	Define the size of pre-registered buffers
`> 0`	The default *<nbytes>* value is equal to 16 640 bytes

Description

Set this variable to define the size of the internal pre-registered buffer for each process pair. The actual size is calculated by adjusting the *<nbytes>* to align the buffer to an optimal value.

I_MPI_RDMA_BUFFER_ENLARGEMENT

(I_MPI_TWO_PHASE_BUF_ENLARGEMENT)

Turn on/off the use of two-phase buffer enlargement.

Syntax

`I_MPI_RDMA_BUFFER_ENLARGEMENT =<arg>`

Deprecated Syntax

`I_MPI_TWO_PHASE_BUF_ENLARGEMENT=<arg>`

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on the mode of using two-phase buffer enlargement
`disable | no | off | 0`	Turn off the mode of using two-phrase buffer enlargement. This is the default value

Description

Set this variable to control the use of the two-phase buffer enlargement according to the following algorithm:

- If this mode is enabled, small internal pre-registered RDMA buffers are allocated and enlarged later if the data transfer size exceeds the threshold defined by the `I_MPI_RDMA_BUFFER_ENLARGEMENT_THRESHOLD`
- Otherwise, the pre-registered buffers immediately assume their full size defined by the `I_MPI_RDMA_BUFFER_SIZE`.

I_MPI_RDMA_BUFFER_ENLARGEMENT_THRESHOLD

(I_MPI_RDMA_SHORT_BUF_THRESHOLD)

Change threshold for the two-phase buffer enlargement mode.

Syntax

`I_MPI_RDMA_BUFFER_ENLARGEMENT_THRESHOLD=<nbytes>`

Deprecated Syntax

`I_MPI_RDMA_SHORT_BUF_THRESHOLD=<nbytes>`

Arguments

`<nbytes>`	Define the threshold for starting enlargement of the RDMA buffers
`> 0`	The default value is 580

Description

Set this variable to define the threshold for increasing the size of the two-phase RDMA buffers. This variable is valid only if the `I_MPI_RDMA_BUFFER_ENLARGEMENT` is enabled.

I_MPI_RDMA_RNDV_BUFFER_ALIGNMENT

(I_MPI_RDMA_RNDV_BUF_ALIGN)

Define send buffer alignment for the RDMA rendezvous transfers.

Syntax

`I_MPI_RDMA_RNDV_BUFFER_ALIGNMENT=<arg>`

Deprecated Syntax

`I_MPI_RDMA_RNDV_BUF_ALIGN=<arg>`

Arguments

`<arg>`	Define send buffer alignment
`> 0 and a power of 2`	The default value is 128

Set this variable to define send buffer alignment for RDMA rendezvous transfers. When a buffer specified in a RDMA operation is aligned to an optimal value, this may increase data transfer bandwidth.

I_MPI_RDMA_TINY_PACKET

Turn on/off the use of small packets.

Syntax

`I_MPI_RDMA_TINY_PACKET=<arg>`

Arguments

`<arg>`	Binary indicator
`enable	yes	on	1`	Turn on the use of small packets
`disable	no	off	0`	Turn off the use of small packets. This is the default value (the regular packet size is used instead)

Description

Set this variable to use the small packets for short messages. The regular packet sizes are used by default.

Certain DAPL* providers are sensitive to the packet size on certain hardware. Switching on the usage of the small packets for short messages may increase performance in these cases.

I_MPI_RDMA_RNDV_WRITE

(I_MPI_USE_RENDEZVOUS_RDMA_WRITE)

Turn on/off the rendezvous RDMA Write protocol.

Syntax

`I_MPI_RDMA_RNDV_WRITE=<arg>`

Deprecated Syntax

`I_MPI_USE_RENDEZVOUS_RDMA_WRITE=<arg>`

Arguments

`<arg>`	Binary indicator
`enable	yes	on	1`	Turn on the RDMA Write rendezvous protocol
`disable	no	off	0`	Turn off the RDMA Write rendezvous protocol

Description

Set this variable to select the RDMA Write-based rendezvous protocol. Certain DAPL* providers have a slow RDMA Read implementation on certain platforms. Switching on the rendezvous protocol based on the RDMA Write operation may increase performance in these cases. The default value depends on the DAPL provider attributes.

The Intel® MPI Library automatically switches to the rendezvous protocol based on the RDMA Write operation if the DAPL* intranode communication is on and the DAPL provider name contains substrings `Openib` or `OpenIB`. Set the `I_MPI_RDMA_RNDV_WRITE` to `disable` to avoid this behavior.

I_MPI_RDMA_CHECK_MAX_RDMA_SIZE

(I_MPI_DAPL_CHECK_MAX_RDMA_SIZE)

Check the value of the DAPL* attribute `max_rdma_size`.

Syntax

`I_MPI_RDMA_CHECK_MAX_RDMA_SIZE=`*`<arg>`*

Deprecated Syntax

`I_MPI_DAPL_CHECK_MAX_RDMA_SIZE=`*`<arg>`*

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Check the value of the DAPL* attribute `max_rdma_size`
`disable | no | off | 0`	Do not check the value of the DAPL* attribute `max_rdma_size`. This is the default value

Description

Set this variable to control message fragmentation according to the following scheme:

- If this mode is enabled, the Intel® MPI Library fragments messages of size greater than the value of the DAPL* attribute `max_rdma_size`
- Otherwise, the Intel® MPI Library does not take into account the value of the DAPL* attribute `max_rdma_size` for message fragmentation

I_MPI_RDMA_MAX_MSG_SIZE

Control message fragmentation threshold.

Syntax

`I_MPI_RDMA_MAX_MSG_SIZE=`*`<nbytes>`*

Arguments

`<nbytes>`	Define the maximum message size that can be sent through RDMA without fragmentation
`> 0`	If the `I_MPI_RDMA_CHECK_MAX_RDMA_SIZE` variable is enabled, the default *`<nbytes>`* value is equal to the `max_rdma_size` DAPL* attribute value. Otherwise the default value is `MAX_INT`

Description

Set this variable to control message fragmentation size according to the following scheme:

- If the `I_MPI_RDMA_CHECK_MAX_RDMA_SIZE` variable is set to `disable`, the Intel® MPI Library fragments messages of size greater than *`<nbytes>`*.
- If the `I_MPI_RDMA_CHECK_MAX_RDMA_SIZE` variable is set to `enable`, the Intel® MPI Library fragments messages of size greater than the minimum of *`<nbytes>`* and the `max_rdma_size` DAPL* attribute value.

I_MPI_RDMA_CONN_EVD_SIZE

(I_MPI_CONN_EVD_QLEN)

Define the event queue size of the DAPL* event dispatcher for connections.

Syntax

`I_MPI_RDMA_CONN_EVD_SIZE=<size>`

Deprecated Syntax

`I_MPI_CONN_EVD_QLEN=<size>`

Arguments

`<size>`	Define the length of the event queue
`> 0`	The default value is 2*number of processes + 32 in the MPI job

Description

Set this variable to define the event queue size of the DAPL event dispatcher that handles connection related events. If this variable is set, the minimum value between `<size>` and the value obtained from the provider is used as the size of the event queue. The provider is required to supply a queue size that is at least equal to the calculated value, but it can also provide a larger queue size.

I_MPI_RDMA_WRITE_IMM

Enable/disable RDMA Write with immediate data InfiniBand (IB) extension.

Syntax

`I_MPI_RDMA_WRITE_IMM==<arg>`

Arguments

`<arg>`	Binary indicator
`enable	yes	on	1`	Turn on RDMA Write with immediate data IB extension
`disable	no	off	0`	Turn off RDMA Write with immediate data IB extension. This is the default value

Description

Set this variable to utilize RDMA Write with immediate data IB extension. The algorithm is enabled if this environment variable is set and a certain DAPL provider attribute indicates that RDMA Write with immediate data IB extension is supported.

NOTE: This variable is applicable only when wait mode is turned on by setting the `I_MPI_WAIT_MODE` environment variable to `enable`.

3.5 Sock Device Control

I_MPI_SOCK_SCALABLE_OPTIMIZATION

Turn on/off scalable optimization of the sockets communication.

Syntax

`I_MPI_SOCK_SCALABLE_OPTIMIZATION=<arg>`

Arguments

`<arg>`	Binary indicator
`enable | yes | on | 1`	Turn on scalable optimization sockets communication. This is the default value for 16 or more processes
`disable | no | off | 0`	Turn off scalable optimization of sock path. This is the default value for less than 16 processes

Description

Set this variable to select scalable optimization of the sock path. In most cases this increases bandwidth for a large number of processes for the `sock` and `ssm` devices.

3.6 Collective Operation Control

Each collective operation in the Intel® MPI Library supports a number of communication algorithms. In addition to highly optimized default settings, the library provides two ways to control the algorithm selection explicitly: the novel `I_MPI_ADJUST` environment variable family and the deprecated `I_MPI_MSG` environment variable family. They are described in the following sections.

3.6.1 I_MPI_ADJUST family

I_MPI_ADJUST_*<opname>*

Control collective operation algorithm selection.

Syntax

`I_MPI_ADJUST_<opname>=<algid>[:<conditions>][;<algid>:<conditions>[…]]`

Arguments

`<algid>`	Algorithm identifier
`≥ 0`	The default value of zero selects reasonable default settings

`<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 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. See below.

Table 3.6-1 Environment variables, collective operations, and algorithms

Environment variable	Collective operation	Algorithms
`I_MPI_ADJUST_ALLGATHER`	`MPI_Allgather`	1. Recursive doubling algorithm 2. Bruck's algorithm 3. Ring algorithm 4. Topology aware Gatherv + Bcast algorithm
`I_MPI_ADJUST_ALLGATHERV`	`MPI_Allgatherv`	1. Recursive doubling algorithm 2. Bruck's algorithm 3. Ring algorithm 4. Topology aware Gatherv + Bcast algorithm
`I_MPI_ADJUST_ALLREDUCE`	`MPI_Allreduce`	1. Recursive doubling algorithm 2. Rabenseifner's algorithm 3. Reduce + Bcast algorithm 4. Topology aware Reduce + Bcast algorithm 5. Binomial gather + scatter algorithm 6. Topology aware binominal gather + scatter algorithm 7. Ring algorithm
`I_MPI_ADJUST_ALLTOALL`	`MPI_Alltoall`	1. Bruck's algorithm 2. Isend/Irecv + waitall algorithm 3. Pair wise exchange algorithm 4. Plum's algorithm
`I_MPI_ADJUST_ALLTOALLV`	`MPI_Alltoallv`	1. Isend/Irecv + waitall algorithm 2. Plum's algorithm
`I_MPI_ADJUST_ALLTOALLW`	`MPI_Alltoallw`	1. Isend/Irecv + waitall algorithm
`I_MPI_ADJUST_BARRIER`	`MPI_Barrier`	1. Dissemination algorithm 2. Recursive doubling algorithm 3. Topology aware dissemination algorithm 4. Topology aware recursive doubling algorithm 5. Binominal gather + scatter algorithm 6. Topology aware binominal gather + scatter algorithm

`I_MPI_ADJUST_BCAST`	`MPI_Bcast`	1. Binomial algorithm 2. Recursive doubling algorithm 3. Ring algorithm 4. Topology aware binomial algorithm 5. Topology aware recursive doubling algorithm 6. Topology aware ring algorithm 7. Shumilin's bcast algorithm
`I_MPI_ADJUST_EXSCAN`	`MPI_Exscan`	1. Partial results gathering algorithm 2. Partial results gathering regarding algorithm layout of processes
`I_MPI_ADJUST_GATHER`	`MPI_Gather`	1. Binomial algorithm 2. Topology aware binomial algorithm 3. Shumilin's algorithm
`I_MPI_ADJUST_GATHERV`	`MPI_Gatherv`	1. Linear algorithm 2. Topology aware linear algorithm
`I_MPI_ADJUST_REDUCE_SCATTER`	`MPI_Reduce_scatter`	1. Recursive having algorithm 2. Pair wise exchange algorithm 3. Recursive doubling algorithm 4. Reduce + Scatterv algorithm 5. Topology aware Reduce + Scatterv algorithm
`I_MPI_ADJUST_REDUCE`	`MPI_Reduce`	1. Shumilin's algorithm 2. Binomial algorithm 3. Topology aware Shumilin's algorithm 4. Topology aware binomial algorithm
`I_MPI_ADJUST_SCAN`	`MPI_Scan`	1. Partial results gathering algorithm 2. Topology aware partial results gathering algorithm
`I_MPI_ADJUST_SCATTER`	`MPI_Scatter`	1. Binomial algorithm 2. Topology aware binomial algorithm 3. Shumilin's algorithm
`I_MPI_ADJUST_SCATTERV`	`MPI_Scatterv`	1. Linear algorithm 2. Topology aware linear algorithm

The message size calculation rules for the collective operations are described in the table below. Here, "n/a" means that the corresponding interval `<l>-<m>` should be omitted.

Table 3.6-2 Message Collective functions

Collective function	Message size formula
`MPI_Allgather`	`recv_count*recv_type_size`
`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

1. Use the following settings to select the second algorithm for `MPI_Reduce` operation:
   `I_MPI_ADJUST_REDUCE=2`
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 will be used for the message sizes from 0 up to 100 bytes and from 5001 to 10000 bytes, algorithm 1 will be used for the message sizes from 101 up to 3200 bytes, algorithm 2 will be used for the message sizes from 3201 up to 5000 bytes, and algorithm 3 will be used for all other messages.

3.6.2 I_MPI_MSG family

These variables are deprecated and supported mostly for backward compatibility. Use the `I_MPI_ADJUST` environment variable family whenever possible.

I_MPI_FAST_COLLECTIVES

Control default library behavior during selection of the most appropriate collective algorithm.

Syntax

`I_MPI_FAST_COLLECTIVES=<arg>`

Arguments

<arg>	Binary indicator
enable | yes | on | 1	Fast collective algorithms are used. This is the default value
disable | no | off | 0	Slower and safer collective algorithms are used

Description

The Intel® MPI Library uses advanced collective algorithms designed for better application performance by default. The implementation makes the following assumptions:

- It is safe to utilize the flexibility of the MPI standard regarding the order of execution of the collective operations to take advantage of the process layout and other opportunities.
- There is enough memory available for allocating additional internal buffers.

Set the `I_MPI_FAST_COLLECTIVES` variable to `disable` if you need to obtain results that do not depend on the physical process layout or other factors.

NOTE: Some optimizations controlled by this variable are of an experimental nature. In case of failure, turn off the collective optimizations and repeat the run.

I_MPI_BCAST_NUM_PROCS

Control `MPI_Bcast` algorithm thresholds.

Syntax

`I_MPI_BCAST_NUM_PROCS=<nproc>`

Arguments

<nproc>	Define the number of processes threshold for choosing the `MPI_Bcast` algorithm
> 0	The default value is 8

I_MPI_BCAST_MSG

Control `MPI_Bcast` algorithm thresholds.

Syntax

`I_MPI_BCAST_MSG=<nbytes1,nbytes2>`

Arguments

<nbytes1,nbytes2>	Define the message size threshold range (in bytes) for choosing the `MPI_Bcast` algorithm
> 0 nbytes2 >= nbytes1	The default pair of values is 12288,524288

Description

Set these variables to control the selection of the three possible `MPI_Bcast` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected if the message size is less than *<nbytes1>*, or the number of processes in the operation is less than *<nproc>*.
2. The second algorithm is selected if the message size is greater than or equal to *<nbytes1>* and less than *<nbytes2>*, and the number of processes in the operation is a power of two.
3. If none of the above conditions is satisfied, the third algorithm is selected.

I_MPI_ALLTOALL_NUM_PROCS

Control `MPI_Alltoall` algorithm thresholds.

Syntax

`I_MPI_ALLTOALL_NUM_PROCS=`*<nproc>*

Arguments

<nproc>	Define the number of processes threshold for choosing the `MPI_Alltoall` algorithm
`> 0`	The default value is 8

I_MPI_ALLTOALL_MSG

Control `MPI_Alltoall` algorithm thresholds.

Syntax

`I_MPI_ALLTOALL_MSG=`*<nbytes1,nbytes2>*

Arguments

<nbytes1,nbytes2>	Defines the message size threshold range (in bytes) for choosing the `MPI_Alltoall` algorithm

`> 0`
`nbytes2 >= nbytes1`
	The default pair of values is 256,32768

Description

Set these variables to control the selection of the three possible `MPI_Alltoall` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected if the message size is greater than or equal to *<nbytes1>*, and the number of processes in the operation is not less than *<nproc>*.
2. The second algorithm is selected if the message size is greater than *<nbytes1>* and less than or equal to *<nbytes2>*, or if the message size is less than *<nbytes2>* and the number of processes in the operation is less than *<nproc>*.
3. If none of the above conditions is satisfied, the third algorithm is selected.

I_MPI_ALLGATHER_MSG

Control `MPI_Allgather` algorithm thresholds.

Syntax

`I_MPI_ALLGATHER_MSG=`*<nbytes1,nbytes2>*

Arguments

<nbytes1,nbytes2>	Define the message size threshold range (in bytes) for choosing the `MPI_Allgather` algorithm

`> 0`
`nbytes2 >= nbytes1`
	The default pair of values is 81920,524288

Description

Set this variable to control the selection of the three possible `MPI_Allgather` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected if the message size is less than *<nbytes2>* and the number of processes in the operation is a power of two.
2. The second algorithm is selected if the message size is less than *<nbytes1>* and number of processes in the operation is not a power of two.
3. If none of the above conditions is satisfied, the third algorithm is selected.

I_MPI_ALLREDUCE_MSG

Control `MPI_Allreduce` algorithm thresholds.

Syntax

`I_MPI_ALLREDUCE_MSG=`*<nbytes>*

Arguments

<nbytes>	Define the message size threshold (in bytes) for choosing the `MPI_Allreduce` algorithm
`> 0`	The default value is 2048

Description

Set this variable to control the selection of the two possible `MPI_Allreduce` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected if the message size is less than or equal *<nbytes>*, or the reduction operation is user-defined, or the count argument is less than the nearest power of two less than or equal to the number of processes.
2. If the above condition is not satisfied, the second algorithm is selected.

I_MPI_REDSCAT_MSG

Control the `MPI_Reduce_scatter` algorithm thresholds.

Syntax

`I_MPI_REDSCAT_MSG=`*<nbytes1,nbytes2>*

Arguments

<nbytes>	Define the message size threshold range (in bytes) for choosing the `MPI_Reduce_scatter` algorithm
`> 0`	The default value is 512,524288

Description

Set this variable to control the selection of the three possible `MPI_Reduce_scatter` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected if the reduction operation is commutative and the message size is less than *<nbytes2>*.

2. The second algorithm is selected if the reduction operation is commutative and the message size is greater than or equal to *<nbytes2>*, or if the reduction operation is not commutative and the message size is greater than or equal to *<nbytes1>*.
3. If none of the above conditions is satisfied, the third algorithm is selected.

I_MPI_SCATTER_MSG

Control `MPI_Scatter` algorithm thresholds.

Syntax

`I_MPI_SCATTER_MSG=`*<nbytes>*

Arguments

<nbytes>	Define the buffer size threshold range (in bytes) for choosing the `MPI_Scatter` algorithm
`> 0`	The default value is 2048

Description

Set this variable to control the selection of the two possible `MPI_Scatter` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected on the intercommunicators if the message size is greater than *<nbytes>*.
2. If the above condition is not satisfied, the second algorithm is selected.

I_MPI_GATHER_MSG

Control `MPI_Gather` algorithm thresholds.

Syntax

`I_MPI_GATHER_MSG=`*<nbytes>*

Arguments

<nbytes>	Define the buffer size threshold range (in bytes) for choosing the `MPI_Gather` algorithm
`> 0`	The default value is 2048

Description

Set this variable to control the selection of the two possible `MPI_Gather` algorithms according to the following scheme (See Table 3.6-1 for algorithm descriptions):

1. The first algorithm is selected on the intercommunicators if the message size is greater than *<nbytes>*.
2. If the above condition is not satisfied, the second algorithm is selected.

3.7 Miscellaneous

I_MPI_TIMER_KIND

Select the timer used by the `MPI_Wtime` and `MPI_Wtick` calls.

Syntax

`I_MPI_TIMER_KIND=`*<timername>*

Arguments

`<timername>`	Define the timer type
`gettimeofday`	If this setting is chosen, the `MPI_Wtime` and `MPI_Wtick` functions will work through the function `gettimeofday(2)`. This is the default value
`rdtsc`	If this setting is chosen, the `MPI_Wtime` and `MPI_Wtick` functions will use the high resolution RDTSC timer

Description

Set this variable to select either the ordinary or RDTSC timer.

NOTE: The resolution of the default `gettimeofday(2)` timer may be insufficient on certain platforms.

4 Statistics Gathering Mode

Intel® MPI Library has a built-in statistics gathering facility that collects essential performance data without disturbing the application execution. The collected information is output onto a text file. This section describes the environment variables used to control the built-in statistics gathering facility, and provides example output files.

I_MPI_STATS

Control statistics collection.

Syntax

`I_MPI_STATS=<level>`

Arguments

`<level>`	Indicate level of statistics information provided
`0`	Do not collect any statistics. This is the default value
`1`	Output the amount of data sent by each process
`2`	Output the number of calls and amount of transferred data
`3`	Output statistics combined according to the actual arguments
`4`	Output statistics defined by a buckets list
`10`	Output collective operation statistics for all communication contexts

Description

Set this variable to control the amount of the statistics information collected and output onto the log file. No statistics are output by default.

I_MPI_STATS_SCOPE

Select the subsystem(s) to collect statistics for.

Syntax

`I_MPI_STATS_SCOPE=<subsystem>[:<ops>][;<subsystem>[:<ops>][…]]`

Arguments

`<subsystem>`	Define the target subsystem(s)
`all`	Collect statistics data for all operations. This is the default value
`coll`	Collect statistics data for all collective operations
`p2p`	Collect statistics data for all point-to-point operations

`<ops>`	Define the target operations as a comma separated list
`Allgather`	`MPI_Allgather`

`Allgatherv`	`MPI_Allgatherv`
`Allreduce`	`MPI_Allreduce`
`Alltoall`	`MPI_Alltoall`
`Alltoallv`	`MPI_Alltoallv`
`Alltoallw`	`MPI_Alltoallw`
`Barrier`	`MPI_Barrier`
`Bcast`	`MPI_Bcast`
`Exscan`	`MPI_Exscan`
`Gather`	`MPI_Gather`
`Gatherv`	`MPI_Gatherv`
`Reduce_scatter`	`MPI_Reduce_scatter`
`Reduce`	`MPI_Reduce`
`Scan`	`MPI_Scan`
`Scatter`	`MPI_Scatter`
`Scatterv`	`MPI_Scatterv`
`Send`	Standard transfers (`MPI_Send`, `MPI_Isend`, `MPI_Send_init`)
`Bsend`	Buffered transfers (`MPI_Bsend`, `MPI_Ibsend`, `MPI_Bsend_init`)
`Csend`	Point-to-point operations inside the collectives. This internal operation serves all collectives
`Rsend`	Ready transfers (`MPI_Rsend`, `MPI_Irsend`, `MPI_Rsend_init`)
`Ssend`	Synchronous transfers (`MPI_Ssend`, `MPI_Issend`, `MPI_Ssend_init`)

Description

Set this variable to select the target subsystem to collects statistics for. All collective and point-to-point operations, including the point-to-point operations performed inside the collectives are covered by default.

Examples

1. The default settings are equivalent to:
   `I_MPI_STATS_SCOPE=coll;p2p`
2. Use the following settings to collect statistics for the `MPI_Bcast`, `MPI_Reduce`, and all point-to-point operations:
   `I_MPI_STATS_SCOPE=p2p;coll:bcast,reduce`
3. Use the following settings to collect statistics for the point-to-point operations inside the collectives:
   `I_MPI_STATS_SCOPE=p2p:csend`

I_MPI_STATS_BUCKETS

Identify a list of ranges for message sizes and communicator sizes that will be used for collecting statistics.

Syntax

`I_MPI_STATS_BUCKETS=<msg>[@`*`<proc>`*`][,<msg>[@`*`<proc>`*`]]…`

Arguments

`<msg>`	Specify range of message sizes in bytes
`<l>`	Single value of message size
`<l>-<m>`	Range from *`<l>`* to *`<m>`*

`<proc>`	Specify range of processes (ranks) for collective operations
`<p>`	Single value of communicator size
`<p>-<q>`	Range from *`<p>`* to *`<q>`*

Description

Set the `I_MPI_STATS_BUCKETS` variable to define a set of ranges for message sizes and communicator sizes.

Level 4 of the statistics provides profile information for these ranges.

If `I_MPI_STATS_BUCKETS` variable is not used, then level 4 statistics is not gathered.

If a range is omitted then the maximum possible range is assumed.

Examples

To specify short messages (from 0 to 1000 bytes) and long messages (from 50000 to 100000 bytes), use the following setting:

```
-env I_MPI_STATS_BUCKETS 0-1000,50000-100000
```

To specify messages that have 16 bytes in size and circulate within four process communicators, use the following setting:

```
-env I_MPI_STATS_BUCKETS “16@4”
```

NOTE: When the *@* symbol is present, the variable value must be enclosed in quotes.

I_MPI_STATS_FILE

Define the statistics output file name.

Syntax

`I_MPI_STATS_FILE=`*`<name>`*

Arguments

`<name>`	Define the statistics output file name

Description

Set this variable to define the statistics output file. The stats.txt file is created in the current directory by default.

The statistics data is blocked and ordered according to the process ranks in the `MPI_COMM_WORLD` communicator. The timing data is presented in microseconds. For example, with the following settings in effect

```
I_MPI_STATS=4
I_MPI_STATS_SCOPE=p2p;coll:allreduce
```

the statistics output for a simple program that performs only one `MPI_Allreduce` operation may look as follows:

```
Intel(R) MPI Library Version 3.2
____ MPI Communication Statistics ____

Stats level: 4
P2P scope:< FULL >
Collectives scope:< Allreduce >

~~~~ Process 0 of 2 on node svlmpihead01 lifetime = 414.13

Data Transfers
Src      Dst    Amount(MB)    Transfers
-----------------------------------------
000 --> 000    0.000000e+00 0
000 --> 001    7.629395e-06 2
=========================================
Totals         7.629395e-06 2

Communication Activity
Operation      Volume(MB)    Calls
-----------------------------------------
P2P
Csend          7.629395e-06 2
Send           0.000000e+00 0
Bsend          0.000000e+00 0
Rsend          0.000000e+00 0
Ssend          0.000000e+00 0
Collectives
Allreduce       7.629395e-06      2
=========================================

Communication Activity by actual args
P2P
Operation      Dst    Message size Calls
---------------------------------------------
Csend
1       1      4             2
Collectives
Operation      Context       Comm size    Message size Calls  Cost(%)
------------------------------------------------------------------------
Allreduce
1       0      2             4             2      44.96
```

```
========================================================================

~~~~ Process 1 of 2 on node svlmpihead01 lifetime = 306.13

Data Transfers
Src      Dst    Amount(MB)    Transfers
-----------------------------------------
001 --> 000    7.629395e-06 2
001 --> 001    0.000000e+00 0
=========================================
Totals         7.629395e-06 2

Communication Activity
Operation      Volume(MB)    Calls
-----------------------------------------
P2P
Csend          7.629395e-06 2
Send           0.000000e+00 0
Bsend          0.000000e+00 0
Rsend          0.000000e+00 0
Ssend          0.000000e+00 0
Collectives
Allreduce       7.629395e-06      2
=========================================

Communication Activity by actual args
P2P
Operation      Dst    Message size Calls
---------------------------------------------
Csend
1       0      4             2
Collectives
Operation      Context       Comm size    Message size Calls  Cost(%)
------------------------------------------------------------------------
Allreduce
1       0      2             4             2      37.93
========================================================================

____ End of stats.txt file ____
```

In the example above all times are measured in microseconds. The message sizes are counted in bytes. **MB** means megabyte equal to 2^{20} or 1 048 576 bytes. The process life time is calculated as a stretch of time between `MPI_Init` and `MPI_Finalize`. The **Cost** field represents a particular collective operation execution time as a percentage of the process life time.

5 Unified Memory Management

Intel® MPI Library provides a way to replace the memory management subsystem by a user-defined package. The following function pointers may optionally be set by the user:

- `i_malloc`
- `i_calloc`
- `i_realloc`
- `i_free`

These pointers also affect the C++ new and delete operators.

The respective standard C library functions are used by default.

The following contrived source code snippet illustrates the usage of the unified memory subsystem:

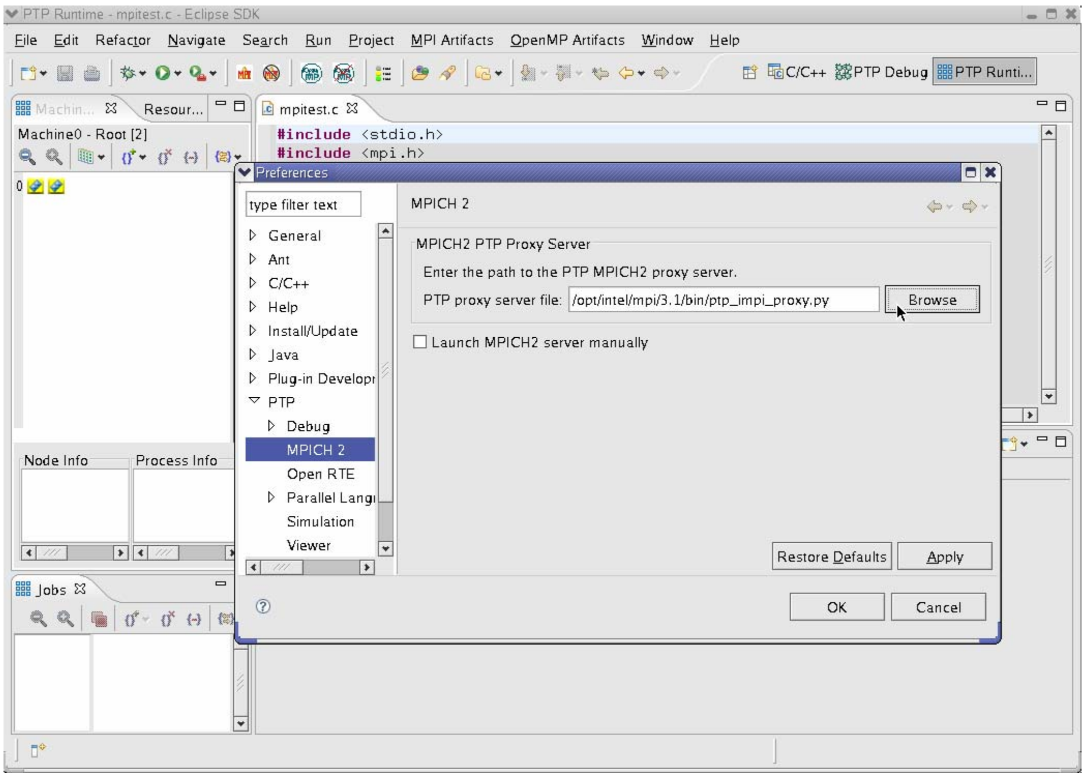
```
#include <i_malloc.h>
#include <my_malloc.h>

int main( int argc, int argv )
{
    // override normal pointers
    i_malloc = my_malloc;
    i_calloc = my_calloc;
    i_realloc = my_realloc;
    i_free = my_free;

#ifdef _WIN32
    // also override pointers used by DLLs
    i_malloc_dll = my_malloc;
    i_calloc_dll = my_calloc;
    i_realloc_dll = my_realloc;
    i_free_dll = my_free;
#endif

    // now start using Intel(R) libraries
}
```

6 Integration into Eclipse* PTP

The Intel® MPI Library can be used with the Eclipse Parallel Tools Platform (PTP). You can launch parallel applications on the existing MPD ring from the Eclipse PTP graphical user interface. The MPD ring must be started prior to the PTP startup.

Perform the following configuration steps to use PTP with the Intel® MPI Library:

1. Set the `PTPPATH` environment variable to specify the location of the `ptplib.py` module.
2. Select Window->Preferences from the Eclipse main menu. Select PTP->MPICH 2 preference page.
3. Specify the full path to the `ptp_impi_proxy.py` file, for example, `<installdir>/bin/ptp_impi_proxy.py`. Click the **Apply** button.



MPICH 2

MPICH2 PTP Proxy Server

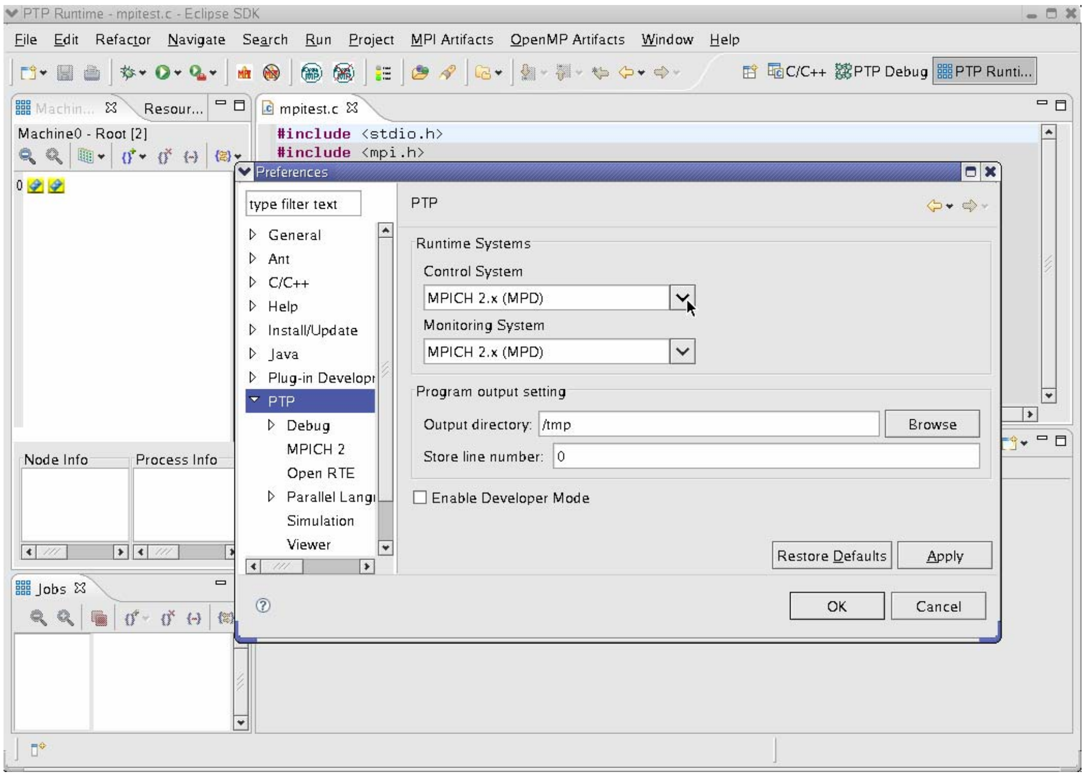
Enter the path to the PTP MPICH2 proxy server.

PTP proxy server file: /opt/intel/mpi/3.1/bin/ptp_impi_proxy.py

☐ Launch MPICH2 server manually

```
#include <stdio.h>
#include <mpi.h>
```

4. Go to the PTP preference page.
5. Select MPICH2* (MPD) in both Control System and Monitoring System drop down menus. If MPICH2* (MPD) is already selected, click the **OK** button and restart Eclipse.



```
#include <stdio.h>
#include <mpi.h>
```

PTP

Runtime Systems

Control System: MPICH 2.x (MPD)

Monitoring System: MPICH 2.x (MPD)

Program output setting

Output directory: /tmp

Store line number: 0

☐ Enable Developer Mode

6. Switch to the PTP Runtime perspective.
7. In the Machines view you will see the cluster nodes on which the MPD ring is currently working.
8. Refer to the PTP User's Guide for more information. The PTP documentation is available at: http://www.eclipse.org/ptp/doc.php

7 Glossary

hyper-threading technology	A feature within the IA-32 family of processors, where each processor core provides the functionality of more than one logical processor.
logical processor	The basic modularity of processor hardware resource that allows a software executive (OS) to dispatch task or execute a thread context. Each logical processor can execute only one thread context at a time.
multi-core processor	A physical processor that contains more than one processor core.
multi-processor platform	A computer system made of two or more physical packages.
processor core	The circuitry that provides dedicated functionalities to decode, execute instructions, and transfer data between certain sub-systems in a physical package. A processor core may contain one or more logical processors.
physical package	The physical package of a microprocessor capable of executing one or more threads of software at the same time. Each physical package plugs into a physical socket. Each physical package may contain one or more processor cores.
processor topology	Hierarchical relationships of “shared vs. dedicated” hardware resources within a computing platform using physical package capable of one or more forms of hardware multi-threading.

8 Index