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A Test Implementation of the MPI Draft Message-Passing Standard

by

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Mathematics and Computer Science Division

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MASTER

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A Test Implementation of the MPI Draft Message-Passing Standard

by

William Gropp and Ewing Lusk

Abstract

Message passing is a common method for programming parallel computers. The lack of a standard has significantly impeded the development of portable software and libraries for these machines. Recently, an ad-hoc committee was formed to develop a standard for message-passing software for parallel computers. This group first met in April 1992 at a workshop sponsored in part by the Center for Research on Parallel Computation (CRPC). Four of the attendees at that meeting produced a draft standard, henceforth referred to as the MPI (Message-Passing Interface) draft standard. After review by a larger group, and significant changes in the document, a meeting was held in November to discuss the MPI draft standard. This document is a result of those discussions; it describes a running implementation of most of the proposed standard, plus additional routines that were suggested by the discussions at the November meeting.

1 Introduction

This document describes a test implementation of the Message-Passing Interface (MPI) draft standard. Supplying an implementation along with the standard itself provides several benefits. It allows the draft standard to be tested for expressivity and implementability. It brings to light potential inconsistencies and omissions in the draft standard as the draft standard develops. It allows experiments that measure possible restrictions on performance imposed by the draft standard.

Subject to the small number of restrictions and omissions cited below, it is an implementation of all of the draft standard. It also includes other routines that might be considered for inclusion in the draft standard as it develops.

1.1 Structure of the Send and Receive Library

This implementation provides a relatively large number of simple operations that are small and therefore easy to describe precisely. Larger operations can then be implemented and defined in terms of these operations. The basic send and receive operations are broken down as follows:

$$\begin{bmatrix} c \\ s \\ g \end{bmatrix} \begin{bmatrix} n \\ b \\ s \end{bmatrix} \begin{bmatrix} send \\ recv \end{bmatrix} \begin{bmatrix} _ \\ h \end{bmatrix} \begin{bmatrix} _ \\ rr \end{bmatrix},$$

where the first letter specifies the layout of the data, the second specifies the extent to which the calling process synchronizes with the local message-passing subsystem and with the remote one, the next four letters specify a send or receive operation, and the final letter(s) specify optional additional functionality.

- Data layout

- c (contiguous) The bytes are to be sent from or received into a contiguous region of memory, described by starting address and length.
- s (stride) The data to be sent consists of data items of the same type and size, separated by a constant distance (stride) in memory, described by a starting address, length of a single item, and number of items.

g (gather) The data to be sent consists of data items of varying lengths and addresses, described by an array of addresses and lengths.

- Synchronization

n (nonblocking) The operation returns control to the user immediately, to facilitate overlapping computation and communication.

b (blocking) the operation does not return until the message area is available for reuse.

s (synchronous) The operation does not return until the message has been received by the destination process (in the case of a send) or the acknowledgment has been sent (in the case of a receive).

- Send or Receive

send (send) Transfer a message from the calling process to the specified one.

recv (receive) Transfer a message into memory if specified conditions are met.

- Heterogeneity

⌊ (default) This is the default.

h (heterogeneous) The message will be processed in such a way that differing data representations on different machines will be taken into account. On the [c] and [s] routines this requires a data type parameter. On the [g] operations, it requires data type information in the vector describing the data location.

- Alternate Protocol

⌊ (default) This is the default.

rr (receiver ready) The operation will take advantage of any underlying protocol that is available when the receiver of a message is known to have issued the receive before the corresponding send is executed.

The routines specified in the current draft standard, which use a mode argument to specify the synchronization level, can easily be defined (and implemented) in terms of these operations, and we have done so. This organization makes it easy to experiment with and understand capabilities not currently in the draft, such as the **rr** and **h** options.

1.2 C and Fortran

The implementation described here is for the C language. Enough of the Fortran versions of these routines have been provided to write and run a simple program. These are the routines **MPI_csend**, **MPI_crecv**, a few inquiry routines (e.g., **MPI_getid**), and **MPI_main**.

1.3 Additions

In order to write actual programs, it was necessary to add a few routines for program management. We have added the routines **MPI_main** and **MPI_stopall** for this purpose.

We also have suggested a small set of routines (see Section 4) that are at a higher level than the draft standard, in order to meet the needs of users who wish to express a message-passing algorithm, but who do not need to know about the more complex performance issues this implementation and the draft standard itself tries to address, such as overlapping communication and computation with **n** or reducing latency with **rr**.

We also added an error value for “unknown mode.”

1.4 Omissions

We have not implemented the time and date routines since there seemed to be a consensus that they need not be part of this standard. We can add them if they are desired. We did not implement the `MPI_pack`, etc., routines because they now seem to be subsumed by the [s] and [g] versions of send and receive. The man pages do not yet include the “Description” section; this can in most cases be taken from the draft standard.

1.5 Restrictions

This is a very preliminary, fast implementation, designed to allow experimentation with at least some of the ideas in the draft standard. In the interest of getting it out very quickly, we have taken some shortcuts. We intend to remove these as time goes by. Currently (November 25, 1992) the following restrictions apply to the implementation of the draft standard:

- There is only one process group. Since the draft standard does not specify that there be more than one, this implementation is (draft) standard-conforming. However, it is not currently possible to run a program that uses more than one group. (You are likely to get the “too many groups” error.)
- There is only one communication context. Again, this conforms to the letter but not the spirit of the draft standard.
- Neither selection on source nor selection on type range (that is, the negative type values) is implemented. This restriction allows us to use existing (vendor-supplied) message-passing implementations on a variety of machines.

2 Comments on the Draft Standard

One reason for doing a prototype implementation is to identify potential problems with the specification of the standard. In this section, we detail some of the problems that we have detected.

- The routines that take mode for “blocking,” “nonblocking,” or “synchronous” return a value whose meaning depends on the value of mode.
- The routines to get information on “the last message” are tricky to specify precisely, because the notion of “the last message” is imprecise. In particular, “the last message” means the last message received, probed, or otherwise looked at. This means that an `MPI_probe` will change the values that these routines will return. It is also unclear how process groups and communications contexts affect the meaning of “the last message.”
- The standard specifies a 32 bit type field. With 64 bit systems on the horizon, this seems shortsighted.
- Because there are no minimum number of communications contexts or process groups specified, an implementation can conform to the standard by providing a single communication context and a single process group. This is in fact what our implementation does.
- Were process groups to be implemented, the interpretation of the destination field (`dest`) and the return value from `MPI_infos` is unclear. Is it the process id? Is it the rank of the process in the current group? What is the meaning of receive-from-any-processor as a selection in a receive routine?
- There is no way for the user to control the ranking of processes in a process group.

- There is no way to discover the length of a message before receiving it into a user buffer. This prohibits using dynamic memory allocation (either by `malloc` in C or by explicit allocation of work areas in Fortran 77) to manage messages that are of unknown length at compile time.
- As the examples demonstrate, there is no attractive way to determine such simple things as the process id or the number of processes.
- Error handling is unattractive. As written, the user must check return codes. While we agree that users (particularly software library writers) need this option, not all users will be diligent about checking the return codes. One of the examples below emphasizes this.

3 Starting and Stopping Processes

In this section we give the specifications for routines needed to support the creation and destruction of the processes that will be communicating. We have added a routine `MPI_stopall` that causes all processes in an application to exit.

It has been our experience that a major source of portability problems is in how a parallel program is started up and initializes its environment. We have added `MPI_main` as a standardized way to accomplish this. This replaces `main` in C and `PROGRAM` in Fortran 77. In addition, it may be useful to provide a subroutine-level interface for initializing the MPI package.

4 Very Simple User Interface

A very simple interface can be defined that consists of the routines

```
MPI_numpids = MPI_infog( 0, 0, 0 )
MPI_mypid   = MPI_getid(0)
MPI_send    = MPI_cbsend
MPI_recv    = MPI_cbrecv
```

as well as `MPI_main` for defining a program.

5 Examples

We present here two programs that send a message around a ring of processors. The Fortran version of this program is

```
c
integer function MPI_main()
integer buf, size, type, np, right, left
integer actlen

size = 4
type = 3
np = MPI_infog( 0, 0, 0 )
right = mod( MPI_getid(0) + 1, np )
left = mod( MPI_getid(0) - 1 + np, np )

if (MPI_getid(0) .eq. 0) then
  buf = 1
  actlen = MPI_csend( 'blocking', buf, right, type, size )
  actlen = MPI_crecv( 'blocking', buf, left, type, size )
else
```

```

        actlen = MPI_crecv( 'blocking', buf, left, type, size )
        actlen = MPI_csend( 'blocking', buf, right, type, size )
    endif
    MPI_main = 0
    return
end

```

The C version of this program is

```

#include "../include/mpi.h"

int MPI_main( argc, argv )
int  argc;
char **argv;
{
    int buf, siz = sizeof(int), type = 3, np, right, left;

    np    = MPI_infog( 0, 0, (int *)0 ); /* Number of processes */
    right = (MPI_getid(0) + 1) % np;
    left  = (MPI_getid(0) - 1 + np) % np;

    if (MPI_getid(0) == 0) {
        buf = 1;
        MPI_csend( "blocking", &buf, right, type, siz );
        MPI_crecv( "blocking", &buf, left,  type, siz );
    }
    else {
        MPI_crecv( "blocking", &buf, left, type, siz );
        MPI_csend( "blocking", &buf, right, type, siz );
    }
    return 0;
}

```

6 Availability

This implementation is available by anonymous ftp from info.mcs.anl.gov. In the directory `pub/mpi` the file `mpi.man.ps.Z` is this document. The file `mpi.tar.Z` contains a compressed tar file of this implementation. The implementation is built on top of the Chameleon system; the file `chameleon.tar.Z` is all that is needed to build Chameleon for a variety of parallel computers (including groups of workstations). To use MPI on a system of workstations, either `p4` or `pvm` are needed. Both are available from netlib (netlib@cornl.gov); we have included a recent version of `p4` in the file `p4-1.2.tar.Z` in the `/pub/mpi` directory for convenience.

7 Basic Routines for Point-to-Point Messages

In this section we describe the routines that form the lowest level of the implementation. They are designed to be consistent with the upper-level routines.

7.1 General Communication Control

MPI_cancel	MPI_cancel
-------------------	-------------------

MPI_cancel — Cancel a previously initiated nonblocking send or receive

Input Parameter

msgid Message id returned by a call to a nonblocking send or receive

Synopsis

```
int MPI_cancel( msgid )
int msgid;
```

Location

`mpi.c`

MPI_infos	MPI_infos
------------------	------------------

MPI_infos — Determine the source process of a pending receive

Synopsis

```
int MPI_infos()
```

Returns

The source of the just received message.

Location

`mpi.h`

MPI_infot	MPI_infot
------------------	------------------

MPI_infot — Determine the type of the last receive

Synopsis

```
int MPI_infot()
```


Returns

The source of the just received message.

Location

`mpi.h`

MPI_probe

MPI_probe

MPI_probe -- Check for pending messages

Input Parameters

source the PID of the process sending the message
type the message type

Returns

Length of pending message if available, else -1.

Synopsis

```
int MPI_probe( source, type )
int source, type;
```

Location

`mpi.c`

MPI_stats

MPI_stats

MPI_stats -- Check the status of a nonblocking send or receive

Input Parameter

msg_id Message id returned by a call to a nonblocking send or receive

Returns

Length of available message if it is pending, else -1.

Synopsis

```
int MPI_stats( msg_id )
int msg_id;
```

Location

`mpi.c`

MPI_wait

MPI_wait

MPI_wait --- Block until a nonblocking send or receive operation has completed

Input Parameter

msg_id id returned by a nonblocking send or receive routine (of any type)

Returns

Number of bytes sent or received, or -1 on error.

Synopsis

```
int MPI_wait( msg_id )
int msg_id;
```

Location

`mpi.c`

7.2 Contiguous Communications

7.2.1 General Routines

MPI_crecv

MPI_crecv

MPI_crecv --- Draft standard contiguous receive

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_crecv( mode, buf, source, type, maxlen )
char *mode;
void *buf;
int source, type, maxlen;
```

Location

mpic.c

MPI_crecvh

MPI_crecvh

MPI_crecvh — Friendly contiguous heterogeneous receive

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_crecvh( mode, buf, source, type, maxlen,datatype )
char *mode;
void *buf;
int source, type, maxlen,datatype;
```

Location

mpic.c

MPI_crecvhrr

MPI_crecvhrr

MPI_crecvhrr — Friendly contiguous heterogeneous receive for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
-------------	--

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_crecvrr( mode, buf, source, type, maxlen, datatype )
char *mode;
void *buf;
int  source, type, maxlen, datatype;
```

Location

`mpic.c`

MPI_crecvrr

MPI_crecvrr

MPI_crecvrr --- Friendly contiguous receive for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_crecvrr( mode, buf, source, type, maxlen )
char *mode;
void *buf;
int  source, type, maxlen;
```

Location

mpic.c

MPI_csend

MPI_csend

MPI_csend — Draft standard contiguous send

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
len	length in bytes of message

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_csend( mode, buf, dest, type, len )
char *mode;
void *buf;
int dest, type, len;
```

Location

mpic.c

MPI_csendh

MPI_csendh

MPI_csendh — Friendly contiguous heterogeneous send

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
len	length in bytes of message
datatype	type of data

Returns

If the mode is "nonblocking," returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_csendh( mode, buf, dest, type, len, datatype )
char *mode;
void *buf;
int dest, type, len, datatype;
```

Location

`mpic.c`

MPI_csendhrr

MPI_csendhrr

MPI_csendhrr — Friendly contiguous heterogeneous send for ready receivers

Input Parameters

mode	one of "blocking," "nonblocking," or "synchronous"
buf	buffer to send
dest	destination processor
type	message type
len	length in bytes of message
datatype	type of data

Returns

If the mode is "nonblocking," returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_csendhrr( mode, buf, dest, type, len, datatype )
char *mode;
void *buf;
int dest, type, len, datatype;
```

Location

`mpic.c`

MPI_csendrr — Friendly contiguous send for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
len	length in bytes of message

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_csendrr( mode, buf, dest, type, len )
char *mode;
void *buf;
int dest, type, len;
```

Location

`mpic.c`

7.2.2 Blocking Routines

MPI_cbrece — Blocking contiguous receive

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

Number of bytes actually received.

Synopsis

```
int MPI_cbrecv( buf, source, type, maxlen )
void *buf;
int source, type, maxlen;
```

Location

mpic.c

MPI_cbrecvh

MPI_cbrecvh

MPI_cbrecvh — Blocking contiguous heterogeneous receive

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

Number of bytes actually received.

Synopsis

```
int MPI_cbrecvh( buf, source, type, maxlen, datatype )
void *buf;
int source, type, maxlen, datatype;
```

Location

mpic.c

MPI_cbrecvhrr

MPI_cbrecvhrr

MPI_cbrecvhrr — Blocking contiguous heterogeneous receive for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

Number of bytes actually received.

Synopsis

```
int MPI_cbrechrr( buf, source, type, maxlen, datatype )
void *buf;
int  source, type, maxlen, datatype;
```

Location

mpic.c

MPI_cbrechrr

MPI_cbrechrr

MPI_cbrechrr — Blocking contiguous receive for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

Number of bytes actually received.

Synopsis

```
int MPI_cbrechrr( buf, source, type, maxlen )
void *buf;
int  source, type, maxlen;
```

Location

mpic.c

MPI_cbsend

MPI_cbsend

MPI_cbsend — Blocking contiguous send

Input Parameters

buf	buffer to send
dest	destination

type	message type
len	length in bytes of message

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_cbsend( buf, dest, type, len )
void *buf;
int dest, type, len;
```

Location

mpic.c

MPI_cbsendh

MPI_cbsendh

MPI_cbsendh --- Blocking contiguous heterogeneous send

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message
datatype	type of data

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_cbsendh( buf, dest, type, len, datatype )
void *buf;
int dest, type, len, datatype;
```

Location

mpic.c

MPI_cbsendhrr

MPI_cbsendhrr

MPI_cbsendhrr --- Blocking contiguous heterogeneous send for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message
datatype	type of data

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_cbsendrr( buf, dest, type, len, datatype )
void *buf;
int dest, type, len, datatype;
```

Location

mpic.c

MPI_cbsendrr

MPI_cbsendrr

MPI_cbsendrr --- Blocking contiguous send for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_cbsendrr( buf, dest, type, len )
void *buf;
int dest, type, len;
```

Location

mpic.c

7.2.3 Nonblocking Routines

MPI_cnrecv

MPI_cnrecv

MPI_cnrecv -- Nonblocking contiguous receive

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_cnrecv( buf, source, type, maxlen )
void *buf;
int source, type, maxlen;
```

Location

mpic.c

MPI_cnrecvh

MPI_cnrecvh

MPI_cnrecvh -- Nonblocking contiguous heterogeneous receive

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_cnrecvh( buf, source, type, maxlen, datatype )
void *buf;
int source, type, maxlen, datatype;
```

Location

mpic.c

MPI_cnrecvhrr

MPI_cnrecvhrr

MPI_cnrecvhrr — Nonblocking contiguous heterogeneous receive for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message
datatype	type of data

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_cnrecvhrr( buf, source, type, maxlen, datatype )
void *buf;
int  source, type, maxlen, datatype;
```

Location

mpic.c

MPI_cnrecvrr

MPI_cnrecvrr

MPI_cnrecvrr — Nonblocking contiguous receive for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_cnrecvrr( buf, source, type, maxlen )
void *buf;
int  source, type, maxlen;
```

Location

mpic.c

MPI_cnsend

MPI_cnsend

MPI_cnsend — Nonblocking contiguous send

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_cnsend( buf, dest, type, len )
void *buf;
int  dest, type, len;
```

Location

mpic.c

MPI_cnsendh

MPI_cnsendh

MPI_cnsendh — Nonblocking contiguous heterogeneous send

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message
datatype	type of data

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_csendh( buf, dest, type, len, datatype )
void *buf;
int dest, type, len, datatype;
```

Location

`mpic.c`

MPI_csendhrr

MPI_csendhrr

MPI_csendhrr — Nonblocking contiguous heterogeneous send for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
len	length in bytes of message
datatype	type of data

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_csendhrr( buf, dest, type, len, datatype )
void *buf;
int dest, type, len, datatype;
```

Location

`mpic.c`

MPI_csendrr

MPI_csendrr

MPI_csendrr — Nonblocking contiguous send for ready receivers

Input Parameters

buf	buffer to receive into
------------	------------------------

source	sending processor
type	message type
maxlen	maximum length in bytes of message

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_csendrr( buf, dest, type, len )
void *buf;
int dest, type, len;
```

Location

`mpic.c`

7.3 Constant Stride Communications

7.3.1 General Routines

MPI_srecv	MPI_srecv
------------------	------------------

MPI_srecv – Draft standard receive into buffer with constant stride

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_srecv( mode, buf, source, type, lenblk, stride, nblks )
char *mode;
void *buf;
int source, type, lenblk, stride, nblks;
```


Location

mpis.c

MPI_srecvh

MPI_srecvh

MPI_srecvh — Friendly heterogeneous receive into buffer with constant stride

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_srecvh( mode, buf, source, type, lenblk, stride, nblks, datatype )
char *mode;
void *buf;
int source, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_srecvhrr

MPI_srecvhrr

MPI_srecvhrr — Friendly heterogeneous receive into a buffer with constant stride for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block

nblks	maximum number of data blocks
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_srecvrr( mode, buf, source, type, lenblk, stride, nblks, datatype )
char *mode;
void *buf;
int source, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_srecvrr

MPI_srecvrr

MPI_srecvrr — Friendly receive into buffer with constant stride for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_srecvrr( mode, buf, source, type, lenblk, stride, nblks )
char *mode;
void *buf;
int source, type, lenblk, stride, nblks;
```

Location

`mpis.c`

MPI_ssend — Draft standard send with constant stride

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_ssend( mode, buf, dest, type, lenblk, stride, nblks )
char *mode;
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

`mpis.c`

MPI_ssendh — Friendly heterogeneous send with constant stride

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_ssendh( mode, buf, dest, type, lenblk, stride, nblks, datatype )
char *mode;
void *buf;
int  dest, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_ssendhrr

MPI_ssendhrr

MPI_ssendhrr — Friendly heterogeneous send with constant stride for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
buf	buffer to send
dest	destination processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_ssendhrr( mode, buf, dest, type, lenblk, stride, nblks, datatype )
char *mode;
void *buf;
int  dest, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_ssendrr -- Friendly send with constant stride for ready receivers

Input Parameters

mode	one of "blocking," "nonblocking," or "synchronous"
buf	buffer to send
dest	destination processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks

Returns

If the mode is "nonblocking," returns the integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_ssendrr( mode, buf, dest, type, lenblk, stride, nblks )
char *mode;
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

`mpis.c`

7.3.2 Blocking Routines

MPI_sbrece -- Blocking receive into buffer with constant stride

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_sbrecv( buf, source, type, lenblk, stride, nblks )
void *buf;
int  source, type, lenblk, stride, nblks;
```

Location

mpis.c

MPI_sbrecvh

MPI_sbrecvh

MPI_sbrecvh — Blocking heterogeneous receive into buffer with constant stride

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks
datatype	type of data

Returns

Number of bytes actually received.

Synopsis

```
int MPI_sbrecvh( buf, source, type, lenblk, stride, nblks, datatype )
void *buf;
int  source, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_sbrecvhrr

MPI_sbrecvhrr

MPI_sbrecvhrr — Blocking heterogeneous receive into buffer with constant stride for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks
datatype	type of data

Returns

Number of bytes actually received.

Synopsis

```
int MPI_sbrecvrr( buf, source, type, lenblk, stride, nblks, datatype )
void *buf;
int  source, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_sbrecvrr**MPI_sbrecvrr**

MPI_sbrecvrr — Blocking receive into buffer with constant stride for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_sbrecvrr( buf, source, type, lenblk, stride, nblks )
void *buf;
int  source, type, lenblk, stride, nblks;
```

Location

mpis.c

MPI_sbsend	MPI_sbsend
-------------------	-------------------

MPI_sbsend --- Blocking send with constant stride

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_sbsend( buf, dest, type, lenblk, stride, nblks )
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

mpis.c

MPI_sbsendh	MPI_sbsendh
--------------------	--------------------

MPI_sbsendh --- Blocking heterogeneous send with constant stride

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_sbsendh( buf, dest, type, lenblk, stride, nblks, datatype )
void *buf;
int dest, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_sbsendhrr

MPI_sbsendhrr

MPI_sbsendhrr — Blocking heterogeneous send with constant stride for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_sbsendhrr( buf, dest, type, lenblk, stride, nblks, datatype )
void *buf;
int dest, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_sbsendrr

MPI_sbsendrr

MPI_sbsendrr — Blocking send with constant stride for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block

stride	number of bytes between the start of each data block
nblks	number of data blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_sbsendrr( buf, dest, type, lenblk, stride, nblks )
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

mpis.c

7.3.3 Nonblocking Routines

MPI_snrecv

MPI_snrecv

MPI_snrecv — Nonblocking receive into buffer with constant stride

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_snrecv( buf, source, type, lenblk, stride, nblks )
void *buf;
int source, type, lenblk, stride, nblks;
```

Location

mpis.c

MPI_snrecvh — Nonblocking heterogeneous receive into buffer with constant stride

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks
datatype	type of data

Returns

Integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snrecvh( buf, source, type, lenblk, stride, nblks, datatype )
void *buf;
int  source, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_snrecvhrr — Nonblocking heterogeneous receive into buffer with constant stride for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks
datatype	type of data

Returns

Integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snrecvrr( buf, source, type, lenblk, stride, nblks, datatype )
void *buf;
int source, type, lenblk, stride, nblks, datatype;
```

Location

mpis.c

MPI_snrecvrr

MPI_snrecvrr

MPI_snrecvrr --- Nonblocking receive into buffer with constant stride for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	maximum number of data blocks

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_snrecvrr( buf, source, type, lenblk, stride, nblks )
void *buf;
int source, type, lenblk, stride, nblks;
```

Location

mpis.c

MPI_snrecvrr

MPI_snrecvrr

MPI_snrecvrr --- Nonblocking receive into buffer with constant stride

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block

nblks number of data blocks

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snsend( buf, dest, type, lenblk, stride, nblks )
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

`mpis.c`

MPI_snsendh**MPI_snsendh**

MPI_snsendh — Nonblocking heterogeneous send with *constant* stride

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snsendh( buf, dest, type, lenblk, stride, nblks, datatype )
void *buf;
int dest, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_snsendhrr**MPI_snsendhrr**

MPI_snsendhrr — Nonblocking heterogeneous send with constant stride for ready receivers

Input Parameters

buf	buffer to send
dest	destination
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks
datatype	type of data

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snsendhrr( buf, dest, type, lenblk, stride, nblks, datatype )
void *buf;
int dest, type, lenblk, stride, nblks, datatype;
```

Location

`mpis.c`

MPI_snsendrr**MPI_snsendrr**

MPI_snsendrr — Nonblocking send with constant stride for ready receivers

Input Parameters

buf	buffer to receive into
source	sending processor
type	message type
lenblk	size in bytes of each data block
stride	number of bytes between the start of each data block
nblks	number of data blocks

Returns

Integer id of send to be used in `MPI_wait`, etc., or -1 on error.

Synopsis

```
int MPI_snsendrr( buf, dest, type, lenblk, stride, nblks )
void *buf;
int dest, type, lenblk, stride, nblks;
```

Location

`mpis.c`

7.4 General Scatter/Gather

These routines use structures named **MPI_DATAVEC** and **MPI_HDATAVEC** (for heterogeneous communication). The definitions of these are in **mpi.h**. **MPI_DATAVEC** is the same as **struct iovec**; this is a structure that contains a pointer to data and the size of that data in bytes. **MPI_HDATAVEC** adds a value that is the type of the data, in **MPI** format.

7.4.1 General Routines

MPI_grecv	MPI_grecv
------------------	------------------

MPI_grecv --- Draft standard receive into buffer with arbitrary scatter

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_grecv( mode, source, type, desc, bcnt )
char          *mode;
int           source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_grecvh	MPI_grecvh
-------------------	-------------------

MPI_grecvh --- Friendly heterogeneous receive into buffer with arbitrary scatter

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format

bcnt number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_grecvh( mode, source, type, desc, bcnt )
char           *mode;
int            source, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

`mpig.c`

<code>MPI_grecvhrr</code>	<code>MPI_grecvhrr</code>
---------------------------	---------------------------

`MPI_grecvhrr` — Friendly heterogeneous receive into a buffer with arbitrary scatter for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “asynchronous”
source	sending processor
type	message type
desc	description of data to be scattered, in <code>MPI_DATAVECT</code> format
bcnt	number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of receive to be used in `MPI_wait`, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_grecvhrr( mode, source, type, desc, bcnt )
char           *mode;
int            source, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

`mpig.c`

MPI_grecvrr Friendly receive into buffer with arbitrary scatter for ready receivers

Input Parameters

mode	one of "blocking," "nonblocking," or "synchronous"
source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC' format
bcnt	number of blocks

Returns

If the mode is "nonblocking," returns the integer id of receive to be used in MPI_wait, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error

Synopsis

```
int MPI_grecvrr( mode, source, type, desc, bcnt )
char            *mode;
int             source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gsend Draft standard send with arbitrary gather

Input Parameters

mode	one of "blocking," "nonblocking," or "synchronous"
dest	destination processor
type	message type
desc	description of data to be gathered, in MPI_DATAVEC' format
bcnt	number of blocks

Returns

If the mode is "nonblocking," returns the integer id of send to be used in MPI_wait, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error

Synopsis

```
int MPI_gsend( mode, dest, type, desc, bcnt )
char          *mode;
int           dest, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gsendh

MPI_gsendh

MPI_gsendh — Friendly heterogeneous send with arbitrary gather

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
dest	destination processor
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_gsendh( mode, dest, type, desc, bcnt )
char          *mode;
int           dest, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gsendhrr

MPI_gsendhrr

MPI_gsendhrr — Friendly heterogeneous send with arbitrary scatter for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
dest	destination processor

type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in MPI_wait, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_gsendhrr( mode, dest, type, desc, bcnt )
char             *mode;
int              dest, type, bcnt;
MPI_HDATAVEC    *desc;
```

Location

mpig.c

MPI_gsendrr

MPI_gsendrr

MPI_gsendrr --- Friendly send with arbitrary gather for ready receivers

Input Parameters

mode	one of “blocking,” “nonblocking,” or “synchronous”
dest	destination processor
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

If the mode is “nonblocking,” returns the integer id of send to be used in MPI_wait, etc., or -1 on error.

Otherwise, returns the actual length of the message in bytes, or -1 on error.

Synopsis

```
int MPI_gsendrr( mode, dest, type, desc, bcnt )
char             *mode;
int              dest, type, bcnt;
MPI_DATAVEC     *desc;
```

Location

mpig.c

7.4.2 Blocking Routines

MPI_gbrecv

MPI_gbrecv

MPI_gbrecv — Blocking receive into buffer with arbitrary scatter

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_gbrecv( source, type, desc, bcnt )
int          source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gbrecvh

MPI_gbrecvh

MPI_gbrecvh — Blocking heterogeneous receive into buffer with arbitrary scatter

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_HDATAVEC format
bcnt	number of blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_gbrecvh( source, type, desc, bcnt )
int          source, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gbrecvhrr

MPI_gbrecvhrr

MPI_gbrecvhrr --- Blocking heterogeneous receive into buffer with arbitrary scatter for ready receivers

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_gbrecvhrr( source, type, desc, bcnt )
int      source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gbrecvrr

MPI_gbrecvrr

MPI_gbrecvrr --- Blocking receive into buffer with arbitrary scatter for ready receivers

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes actually received.

Synopsis

```
int MPI_gbrecover( source, type, desc, bcnt )
int      source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gbsend

MPI_gbsend

MPI_gbsend --- Blocking send with arbitrary gather

Input Parameters

dest	destination
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_gbsend( dest, type, desc, bcnt )
int      dest, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gbsendh

MPI_gbsendh

MPI_gbsendh --- Blocking send with arbitrary gather

Input Parameters

dest	destination
type	message type
lenblk	size in bytes of each data block
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_gbsendh( dest, type, desc, bcnt )
int      dest, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gbsendhrr

MPI_gbsendhrr

MPI_gbsendhrr --- Blocking heterogeneous send with arbitrary gather for ready receivers

Input Parameters

dest	destination
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_gbsendhrr( dest, type, desc, bcnt )
int      dest, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gbsendrr

MPI_gbsendrr

MPI_gbsendrr --- Blocking send with arbitrary gather for ready receivers

Input Parameters

dest	destination
type	message type

desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Number of bytes sent, or -1 for an error.

Synopsis

```
int MPI_gbsendrr( dest, type, desc, bcnt )
int             dest, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

7.4.3 Nonblocking Routines

MPI_gurecv	MPI_gurecv
-------------------	-------------------

MPI_gurecv -- Nonblocking receive into buffer with arbitrary scatter

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of receive to be used in MPI_wait, etc., or -1 on error.

Synopsis

```
int MPI_gnrecv( source, type, desc, bcnt )
int             source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gnrecvh	MPI_gnrecvh
--------------------	--------------------

MPI_gnrecvh -- Nonblocking heterogeneous receive into buffer with arbitrary scatter

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of receive to be used in MPI_wait, etc., or -1 on error.

Synopsis

```
int MPI_gnrecvh( source, type, desc, bcnt )
int             source, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gnrecvhrr

MPI_gnrecvhrr

MPI_gnrecvhrr -- Nonblocking heterogeneous receive into buffer with arbitrary scatter for ready receivers

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of receive to be used in MPI_wait, etc., or -1 on error.

Synopsis

```
int MPI_gnrecvhrr( source, type, desc, bcnt )
int             source, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gnrecvrr

MPI_gnrecvrr

MPI_gnrecvrr --- Nonblocking receive into buffer with arbitrary scatter for ready receivers

Input Parameters

source	sending processor
type	message type
desc	description of data to be scattered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of receive to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_gnrecvrr( source, type, desc, bcnt )
int             source, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gnsend

MPI_gnsend

MPI_gnsend --- Nonblocking send with arbitrary gather

Input Parameters

dest	destination
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_gnsend( dest, type, desc, bcnt )
int             dest, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

MPI_gsendh

MPI_gsendh

MPI_gsendh — Nonblocking heterogeneous send with arbitrary gather

Input Parameters

dest	destination
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_gsendh( dest, type, desc, bcnt )
int            dest, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gsendhrr

MPI_gsendhrr

MPI_gsendhrr — Nonblocking heterogeneous send with arbitrary gather for ready receivers

Input Parameters

dest	destination
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_gnsendhrr( dest, type, desc, bcnt )
int          dest, type, bcnt;
MPI_HDATAVEC *desc;
```

Location

mpig.c

MPI_gnsendrr

MPI_gnsendrr

MPI_gnsendrr — Nonblocking send with arbitrary gather for ready receivers

Input Parameters

source	sending processor
type	message type
desc	description of data to be gathered, in MPI_DATAVEC format
bcnt	number of blocks

Returns

Integer id of send to be used in **MPI_wait**, etc., or -1 on error.

Synopsis

```
int MPI_gnsendrr( dest, type, desc, bcnt )
int          dest, type, bcnt;
MPI_DATAVEC *desc;
```

Location

mpig.c

7.5 Process Groups

MPI_child

MPI_child

MPI_child — Get information about the children of a specified group

Input Parameters

gid	process group id
maxlis	size of clist

Output Parameter

`clist` array containing process group id

Returns

Number of children in the group, or -1 on error.

Synopsis

```
int MPI_child( gid, maxlis, clist )
int gid, maxlis, *clist;
```

Location

`group.c`

MPI_copyg

MPI_copyg

MPI_copyg — Create a root group from an existing group

Input Parameter

`gid` process group id

Returns

The gid of the new root group, or -1 on error.

Synopsis

```
int MPI_copyg( gid )
int gid;
```

Location

`group.c`

MPI_defrg

MPI_defrg

MPI_defrg — Define a root group

Input Parameters

`nprocs` number of processes in the group
`plist` array of PID that are members of the group

Returns

The gid of the new root group, or -1 on error.

Synopsis

```
int MPI_defrg( nprocs, plist )
int nprocs, *plist;
```

Location

group.c

MPI_freed

MPI_freed

MPI_freed -- Discard the descendants of a specified group

Input Parameter

gid group id

Returns

0 on success, or -1 on error.

Synopsis

```
int MPI_freed( gid )
int gid;
```

Location

group.c

MPI_freeg

MPI_freeg

MPI_freeg -- Discard a specified group and all of its descendents

Input Parameter

gid group id

Returns

0 on success, or -1 on error.

Synopsis

```
int MPI_freeg( gid )
int gid;
```

Location

group.c

MPI_getid

MPI_getid

MPI_getid Determine the group context PID of the calling process for a specified group id number.

Input Parameter

gid group id

Synopsis

```
int MPI_getid( gid )
int gid;
```

Returns

Relative process number of the calling process in the specified group.

Location

mpi.h

MPI_infog

MPI_infog

MPI_infog Determine the number of processes in a group and return the PID numbers of the group members

Input Parameters

gid group id
maxlis size of plist
plist integer array to hold the members of the group

Returns

The number of members in the group, or -1 on error.

Synopsis

```
int MPI_infog(gid,maxlis,plist)
int gid, maxlis, *plist;
```

Location

mpi.c

MPI_parent

MPI_parent

MPI_parent — Determine the group id number of the parent of a specified group

Input Parameter

gid group whose parent is to be found

Returns

The group id of the parent, or -1 on error.

Synopsis

```
int MPI_parent( gid )
int gid;
```

Location

group.c

MPI_partg

MPI_partg

MPI_partg — Partition a group into subgroups

Input Parameters

gid group to be partitioned
key key whose value determines the partitioning

Returns

The gid of the subgroup to which the calling process belongs, otherwise -1.

Synopsis

```
int MPI_partg( gid, key )
int gid, key;
```


Location

group.c

MPI_popg

MPI_popg

MPI_popg — Reestablish the process group context

Returns

The process group id that is reestablished as the root, otherwise -1.

Synopsis

```
int MPI_popg()
```

Location

group.c

MPI_pushg

MPI_pushg

MPI_pushg — Establish the process group context

Input Parameter

gid The group context to establish

Returns

The number of processes in the group gid, or -1 on error.

Synopsis

```
int MPI_pushg( gid )
int gid;
```

Location

group.c

MPI_rootg

MPI_rootg

MPI_rootg — Get information about root groups

Input Parameter

maxlis size of rlist

Output Parameter

rlist array of the process group id numbers

Returns

Number of defined root groups, or -1 on error.

Synopsis

```
int MPI_rootg( maxlis, rlist )
int maxlis, *rlist;
```

Location

group.c

MPI_siblg**MPI_siblg**

MPI_siblg -- Get information about the siblings of a group

Input Parameters

gid process group id
maxlis size of slist

Output Parameter

slist array of the process group ids

Returns

Number of siblings, or -1 on error.

Synopsis

```
int MPI_siblg( gid, maxlis, slist )
int gid, maxlis, slist;
```

Location

group.c

7.6 Communication Contexts

MPI_infoc	MPI_infoc
------------------	------------------

MPI_infoc --- Get information about valid communication contexts

Input parameter

maxlis maximum size of ilist

Output parameter

ilist array containing communication context ID numbers

Synopsis

```
int MPI_infoc( maxlis, ilist )
int maxlis, *ilist;
```

Location

`mpi.c`

MPI_newc	MPI_newc
-----------------	-----------------

MPI_newc --- Create a new communication context

Returns

The id number of a new communication context, or -1 on error.

Synopsis

```
int MPI_newc()
```

Location

`mpi.c`

MPI_popc	MPI_popc
-----------------	-----------------

MPI_popc --- Reestablish former communication context

Returns

The id number of a new communication context, or -1 on error.

Synopsis

```
int MPI_popc()
```

Location

mpi.c

MPI_pushc

MPI_pushc

MPI_pushc — Establish a new communication context

Input Parameter

ccid the ID number of communication context to establish

Returns

0 on success or -1 on error.

Synopsis

```
int MPI_pushc( ccid )
int ccid;
```

Location

mpi.c

7.7 Program Management

MPI_main

MPI_main

MPI_main — Name of main program for MPI applications

Note

Use “MPI_main” instead of “main” in C programs, and instead of “PROGRAM <name>” in Fortran programs.

Synopsis

```
(C)
int MPI_main( argc, argv )
int argc;
char **argv;
```

Synopsis

(Fortran)
integer function MPI_main()

Location

mpi.c

MPI_stopall

MPI_stopall

MPI_stopall — stop all processes

Input Parameter

rc return code to pass back to calling environment

Synopsis

void MPI_stopall(rc)

Location

mpi.c

7.8 Utility Routines

MPI_error

MPI_error

MPI_error — Determine the error status

Returns

Integer giving the error status for the preceding call to an MPI routine.

Synopsis

int MPI_error()

Location

mpi.c

MPI_etext	MPI_etext
------------------	------------------

MPI_etext -- Return the text corresponding to an error value

Input Parameter

ierrno Value returned by MPI_error

Synopsis

```
char *MPI_etext( ierrno )
int ierrno;
```

Location

mpi.c

MPI_machine	MPI_machine
--------------------	--------------------

MPI_machine -- Get machine name, version, and related information

Returns

A character string giving the name, etc., of the machine.

Synopsis

```
char *MPI_machine( )
```

Location

mpi.c

MPI_info	MPI_info
-----------------	-----------------

MPI_info -- Get information on the machine configuration

Input Parameter

maxlis the size of ilist

Output Parameter

ilist integer array containing information about the system.

ilist[0] - number of physical processors in the machine
ilist[1] - total number of processors in the machine

Synopsis

```
int MPI_infonm( maxlis, ilist )  
int maxlis, *ilist;
```

Location

mpi.c

MPI_sync

MPI_sync

MPI_sync --- Synchronize all processes

Synopsis

```
int sync
```

Location

mpi.h

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