D R A F T

Document for a Standard Message-Passing Interface

Message Passing Interface Forum

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Chapter 1

Language Binding

1.1 Introduction

In this section we summarize the specific bindings for both Fortran and C. We present first the C bindings, then the Fortran bindings. Listings are alphabetical within chapter.

1.2 Defined Constants for C and Fortran

These are required defined constants, to be defined in the files `mpi.h` (for C) and `mpif.h` (for Fortran).

```
/* return codes (both C and Fortran) */
MPI_SUCCESS
MPI_ERR_BUFFER
MPI_ERR_COUNT
MPI_ERR_TYPE
MPI_ERR_TAG
MPI_ERR_COMM
MPI_ERR_RANK
MPI_ERR_REQUEST
MPI_ERR_ROOT
MPI_ERR_GROUP
MPI_ERR_OP
MPI_ERR_TOPOLOGY
MPI_ERR_DIMS
MPI_ERR_ARG
MPI_ERR_UNKNOWN
MPI_ERR_TRUNCATE
MPI_ERR_OTHER
MPI_ERR_INTERN
MPI_PENDING
MPI_ERR_IN_STATUS
MPI_ERR_LASTCODE

/* assorted constants (both C and Fortran) */
```

```
MPI_BOTTOM
MPI_PROC_NULL
MPI_ANY_SOURCE
MPI_ANY_TAG
MPI_UNDEFINED
MPI_BSEND_OVERHEAD
MPI_KEYVAL_INVALID

/* status size and reserved index values (Fortran) */
MPI_STATUS_SIZE
MPI_SOURCE
MPI_TAG
MPI_ERROR

/* Error-handling specifiers (C and Fortran) */
MPI_ERRORS_ARE_FATAL
MPI_ERRORS_RETURN

/* Maximum sizes for strings */
MPI_MAX_PROCESSOR_NAME
MPI_MAX_ERROR_STRING

/* elementary datatypes (C) */
MPI_CHAR
MPI_SHORT
MPI_INT
MPI_LONG
MPI_UNSIGNED_CHAR
MPI_UNSIGNED_SHORT
MPI_UNSIGNED
MPI_UNSIGNED_LONG
MPI_FLOAT
MPI_DOUBLE
MPI_LONG_DOUBLE
MPI_BYTE
MPI_PACKED


/* elementary datatypes (Fortran) */
MPI_INTEGER
MPI_REAL
MPI_DOUBLE_PRECISION
MPI_COMPLEX
MPI_DOUBLE_COMPLEX
MPI_LOGICAL
MPI_CHARACTER
MPI_BYTE
```

```
MPI_PACKED

/* datatypes for reduction functions (C) */
MPI_FLOAT_INT
MPI_DOUBLE_INT
MPI_LONG_INT
MPI_2INT
MPI_SHORT_INT
MPI_LONG_DOUBLE_INT

/* datatypes for reduction functions (Fortran) */
MPI_2REAL
MPI_2DOUBLE_PRECISION
MPI_2INTEGER

/* optional datatypes (Fortran) */
MPI_INTEGER1
MPI_INTEGER2
MPI_INTEGER4
MPI_REAL2
MPI_REAL4
MPI_REAL8

/* optional datatypes (C) */
MPI_LONG_LONG_INT

/* special datatypes for constructing derived datatypes
MPI_UB
MPI_LB

/* reserved communicators (C and Fortran) */
MPI_COMM_WORLD
MPI_COMM_SELF

/* results of communicator and group comparisons */

MPI_IDENT
MPI_CONGRUENT
MPI_SIMILAR
MPI_UNEQUAL

/* environmental inquiry keys (C and Fortran) */
MPI_TAG_UB
MPI_IO
MPI_HOST
MPI_WTIME_IS_GLOBAL

/* collective operations (C and Fortran) */
```

```
MPI_MAX
MPI_MIN
MPI_SUM
MPI_PROD
MPI_MAXLOC
MPI_MINLOC
MPI_BAND
MPI_BOR
MPI_BXOR
MPI_LAND
MPI_LOR
MPI_LXOR

/* Null handles */
MPI_GROUP_NULL
MPI_COMM_NULL
MPI_DATATYPE_NULL
MPI_REQUEST_NULL
MPI_OP_NULL
MPI_ERRHANDLER_NULL

/* Empty group */
MPI_GROUP_EMPTY

/* topologies (C and Fortran) */
MPI_GRAPH
MPI_CART
```

The following are defined C type definitions, also included in the file `mpi.h`.

```
/* opaque types (C) */
MPI_Aint
MPI_Status

/* handles to assorted structures (C) */
MPI_Group
MPI_Comm
MPI_Datatype
MPI_Request
MPI_Op

/* prototypes for user-defined functions (C) */
typedef int  MPI_Copy_function(MPI_Comm oldcomm, int keyval,
                    void *extra_state, void *attribute_val_in,
                    void *attribute_val_out, int *flag);
typedef int  MPI_Delete_function(MPI_Comm comm, int keyval,
                          void *attribute_val, void *extra_state)
```

```
typedef void MPI_Handler_function(MPI_Comm *, int *, ...);
typedef void MPI_User_function( void *invec, void *inoutvec, int *len,
                      MPI_Datatype *datatype);
```

For Fortran, here are examples of how each of the user-defined functions should be declared.

The user-function argument to MPI_OP_CREATE should be declared like this:

```
FUNCTION USER_FUNCTION( INVEC(*), INOUTVEC(*), LEN, TYPE)
<type> INVEC(LEN), INOUTVEC(LEN)
 INTEGER LEN, TYPE
```

The copy-function argument to MPI_KEYVAL_CREATE should be declared like this:

```
 PROCEDURE COPY_FUNCTION(OLDCOMM, KEYVAL, EXTRA_STATE,
              ATTRIBUTE_VAL_IN, ATTRIBUTE_VAL_OUT, FLAG, IERR)
 INTEGER OLDCOMM, KEYVAL, EXTRA_STATE, ATTRIBUTE_VAL_IN,
         ATTRIBUTE_VAL_OUT, IERR
 LOGICAL FLAG
```

The delete-function argument to MPI_KEYVAL_CREATE should be declared like this:

```
PROCEDURE DELETE_FUNCTION(COMM, KEYVAL, ATTRIBUTE_VAL, EXTRA_STATE, IERR)
 INTEGER COMM, KEYVAL, ATTRIBUTE_VAL, EXTRA_STATE, IERR
```

1.3 C bindings for Point-to-Point Communication

These are presented here in the order of their appearance in the chapter.

```
int MPI_Send(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm)

int MPI_Recv(void* buf, int count, MPI_Datatype datatype, int source,
             int tag, MPI_Comm comm, MPI_Status *status)

int MPI_Get_count(MPI_Status *status, MPI_Datatype datatype, int *count)

int MPI_Bsend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm)

int MPI_Ssend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm)

int MPI_Rsend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm)

int MPI_Buffer_attach( void* buffer, int size)

int MPI_Buffer_detach( void* buffer, int* size)

int MPI_Isend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Ibsend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)
```

```
int MPI_Issend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Irsend(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Irecv(void* buf, int count, MPI_Datatype datatype, int source,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Wait(MPI_Request *request, MPI_Status *status)

int MPI_Test(MPI_Request *request, int *flag, MPI_Status *status)

int MPI_Request_free(MPI_Request *request)

int MPI_Waitany(int count, MPI_Request *array_of_requests, int *index,
             MPI_Status *status)

int MPI_Testany(int count, MPI_Request *array_of_requests, int *index,
             int *flag, MPI_Status *status)

int MPI_Waitall(int count, MPI_Request *array_of_requests,
             MPI_Status *array_of_statuses)

int MPI_Testall(int count, MPI_Request *array_of_requests, int *flag,
             MPI_Status *array_of_statuses)

int MPI_Waitsome(int incount, MPI_Request *array_of_requests, int *outcount,
             int *array_of_indices, MPI_Status *array_of_statuses)

int MPI_Testsome(int incount, MPI_Request *array_of_requests, int *outcount,
             int *array_of_indices, MPI_Status *array_of_statuses)

int MPI_Iprobe(int source, int tag, MPI_Comm comm, int *flag,
             MPI_Status *status)

int MPI_Probe(int source, int tag, MPI_Comm comm, MPI_Status *status)

int MPI_Cancel(MPI_Request *request)

int MPI_Test_cancelled(MPI_Status *status, int *flag)

int MPI_Send_init(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Bsend_init(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Ssend_init(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Rsend_init(void* buf, int count, MPI_Datatype datatype, int dest,
             int tag, MPI_Comm comm, MPI_Request *request)

int MPI_Recv_init(void* buf, int count, MPI_Datatype datatype, int source,
             int tag, MPI_Comm comm, MPI_Request *request)
```

```
int MPI_Start(MPI_Request *request)

int MPI_Startall(int count, MPI_Request *array_of_requests)

int MPI_Sendrecv(void *sendbuf, int sendcount, MPI_Datatype sendtype,
             int dest, int sendtag, void *recvbuf, int recvcount,
             MPI_Datatype recvtype, int source, MPI_Datatype recvtag,
             MPI_Comm comm, MPI_Status *status)

int MPI_Sendrecv_replace(void* buf, int count, MPI_Datatype datatype,
             int dest, int sendtag, int source, int recvtag, MPI_Comm comm,
             MPI_Status *status)

int MPI_Type_contiguous(int count, MPI_Datatype oldtype,
             MPI_Datatype *newtype)

int MPI_Type_vector(int count, int blocklength, int stride,
             MPI_Datatype oldtype, MPI_Datatype *newtype)

int MPI_Type_hvector(int count, int blocklength, MPI_Aint stride,
             MPI_Datatype oldtype, MPI_Datatype *newtype)

int MPI_Type_indexed(int count, int *array_of_blocklengths,
             int *array_of_displacements, MPI_Datatype oldtype,
             MPI_Datatype *newtype)

int MPI_Type_hindexed(int count, int *array_of_blocklengths,
             MPI_Aint *array_of_displacements, MPI_Datatype oldtype,
             MPI_Datatype *newtype)

int MPI_Type_struct(int count, int *array_of_blocklengths,
             MPI_Aint *array_of_displacements, MPI_Datatype *array_of_types,
             MPI_Datatype *newtype)

int MPI_Address(void* location, MPI_Aint *address)

int MPI_Type_extent(MPI_Datatype datatype, MPI_Aint *extent)

int MPI_Type_size(MPI_Datatype datatype, int *size)

int MPI_Type_lb(MPI_Datatype datatype, MPI_Aint* displacement)

int MPI_Type_ub(MPI_Datatype datatype, MPI_Aint* displacement)

int MPI_Type_commit(MPI_Datatype *datatype)

int MPI_Type_free(MPI_Datatype *datatype)

int MPI_Get_elements(MPI_Status *status, MPI_Datatype datatype, int *count)

int MPI_Pack(void* inbuf, int incount, MPI_Datatype datatype, void *outbuf,
             int outsize, int *position, MPI_Comm comm)

int MPI_Unpack(void* inbuf, int insize, int *position, void *outbuf,
             int outcount, MPI_Datatype datatype, MPI_Comm comm)
```

```
int MPI_Pack_size(int incount, MPI_Datatype datatype, MPI_Comm comm,
          int *size)
```

1.4 C Bindings for Collective Communication

```
int MPI_Barrier(MPI_Comm comm )

int MPI_Bcast(void* buffer, int count, MPI_Datatype datatype, int root,
          MPI_Comm comm )

int MPI_Gather(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int recvcount, MPI_Datatype recvtype, int root,
          MPI_Comm comm)

int MPI_Gatherv(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int *recvcounts, int *displs,
          MPI_Datatype recvtype, int root, MPI_Comm comm)

int MPI_Scatter(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int recvcount, MPI_Datatype recvtype, int root,
          MPI_Comm comm)

int MPI_Scatterv(void* sendbuf, int *sendcounts, int *displs,
          MPI_Datatype sendtype, void* recvbuf, int recvcount,
          MPI_Datatype recvtype, int root, MPI_Comm comm)

int MPI_Allgather(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int recvcount, MPI_Datatype recvtype,
          MPI_Comm comm)

int MPI_Allgatherv(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int *recvcounts, int *displs,
          MPI_Datatype recvtype, MPI_Comm comm)

int MPI_Alltoall(void* sendbuf, int sendcount, MPI_Datatype sendtype,
          void* recvbuf, int recvcount, MPI_Datatype recvtype,
          MPI_Comm comm)

int MPI_Alltoallv(void* sendbuf, int *sendcounts, int *sdispls,
          MPI_Datatype sendtype, void* recvbuf, int *recvcounts,
          int *rdispls, MPI_Datatype recvtype, MPI_Comm comm)

int MPI_Reduce(void* sendbuf, void* recvbuf, int count,
          MPI_Datatype datatype, MPI_Op op, int root, MPI_Comm comm)

int MPI_Op_create(MPI_User_function *function, int commute, MPI_Op *op)

int MPI_Op_free( MPI_Op *op)

int MPI_Allreduce(void* sendbuf, void* recvbuf, int count,
          MPI_Datatype datatype, MPI_Op op, MPI_Comm comm)

int MPI_Reduce_scatter(void* sendbuf, void* recvbuf, int *recvcounts,
```

```
              MPI_Datatype datatype, MPI_Op op, MPI_Comm comm)
```

```
int MPI_Scan(void* sendbuf, void* recvbuf, int count,
              MPI_Datatype datatype, MPI_Op op, MPI_Comm comm )
```

1.5 C Bindings for Groups, Contexts, and Communicators

```
int MPI_Group_size(MPI_Group group, int *size)

int MPI_Group_rank(MPI_Group group, int *rank)

int MPI_Group_translate_ranks (MPI_Group group1, int n, int *ranks1,
              MPI_Group group2, int *ranks2)

int MPI_Group_compare(MPI_Group group1,MPI_Group group2, int *result)

int MPI_Comm_group(MPI_Comm comm, MPI_Group *group)

int MPI_Group_union(MPI_Group group1, MPI_Group group2, MPI_Group *newgroup)

int MPI_Group_intersection(MPI_Group group1, MPI_Group group2,
              MPI_Group *newgroup)

int MPI_Group_difference(MPI_Group group1, MPI_Group group2,
              MPI_Group *newgroup)

int MPI_Group_incl(MPI_Group group, int n, int *ranks, MPI_Group *newgroup)

int MPI_Group_excl(MPI_Group group, int n, int *ranks, MPI_Group *newgroup)

int MPI_Group_range_incl(MPI_Group group, int n, int ranges[][3],
              MPI_Group *newgroup)

int MPI_Group_range_excl(MPI_Group group, int n, int ranges[][3],
              MPI_Group *newgroup)

int MPI_Group_free(MPI_Group *group)

int MPI_Comm_size(MPI_Comm comm, int *size)

int MPI_Comm_rank(MPI_Comm comm, int *rank)

int MPI_Comm_compare(MPI_Comm comm1,MPI_Comm comm2, int *result)

int MPI_Comm_dup(MPI_Comm comm, MPI_Comm *newcomm)

int MPI_Comm_create(MPI_Comm comm, MPI_Group group, MPI_Comm *newcomm)

int MPI_Comm_split(MPI_Comm comm, int color, int key, MPI_Comm *newcomm)

int MPI_Comm_free(MPI_Comm *comm)

int MPI_Comm_test_inter(MPI_Comm comm, int *flag)

int MPI_Comm_remote_size(MPI_Comm comm, int *size)

int MPI_Comm_remote_group(MPI_Comm comm, MPI_Group *group)
```

```
int MPI_Intercomm_create(MPI_Comm local_comm, int local_leader,
            MPI_Comm peer_comm, int remote_leader, int tag,
            MPI_Comm *newintercomm)

int MPI_Intercomm_merge(MPI_Comm intercomm, int high,
            MPI_Comm *newintracomm)

int MPI_Keyval_create(MPI_Copy_function *copy_fn, MPI_Delete_function
            *delete_fn, int *keyval, void* extra_state)

int MPI_Keyval_free(int *keyval)

int MPI_Attr_put(MPI_Comm comm, int keyval, void* attribute_val)

int MPI_Attr_get(MPI_Comm comm, int keyval, void* attribute_val, int *flag)

int MPI_Attr_delete(MPI_Comm comm, int keyval)
```

1.6 C Bindings for Process Topologies

```
int MPI_Cart_create(MPI_Comm comm_old, int ndims, int *dims, int *periods,
            int reorder, MPI_Comm *comm_cart)

int MPI_Dims_create(int nnodes, int ndims, int *dims)

int MPI_Graph_create(MPI_Comm comm_old, int nnodes, int *index, int *edges,
            int reorder, MPI_Comm *comm_graph)

int MPI_Topo_test(MPI_Comm comm, int *status)

int MPI_Graphdims_get(MPI_Comm comm, int *nnodes, int *nedges)

int MPI_Graph_get(MPI_Comm comm, int maxindex, int maxedges, int *index,
            int *edges)

int MPI_Cartdim_get(MPI_Comm comm, int *ndims)

int MPI_Cart_get(MPI_Comm comm, int maxdims, int *dims, int *periods,
            int *coords)

int MPI_Cart_rank(MPI_Comm comm, int *coords, int *rank)

int MPI_Cart_coords(MPI_Comm comm, int rank, int maxdims, int *coords)

int MPI_Graph_neighbors_count(MPI_Comm comm, int rank, int *nneighbors)

int MPI_Graph_neighbors(MPI_Comm comm, int rank, int maxneighbors,
            int *neighbors)

int MPI_Cart_shift(MPI_Comm comm, int direction, int disp, int *rank_source,
            int *rank_dest)

int MPI_Cart_sub(MPI_Comm comm, int *remain_dims, MPI_Comm *newcomm)

int MPI_Cart_map(MPI_Comm comm, int ndims, int *dims, int *periods,
            int *newrank)
```

```
int MPI_Graph_map(MPI_Comm comm, int nnodes, int *index, int *edges,
              int *newrank)
```

1.7 C bindings for Environmental Inquiry

```
int MPI_Get_processor_name(char *name, int *resultlen)

int MPI_Errhandler_create(MPI_Handler_function *function,
              MPI_Errhandler *errhandler)

int MPI_Errhandler_set(MPI_Comm comm, MPI_Errhandler errhandler)

int MPI_Errhandler_get(MPI_Comm comm, MPI_Errhandler *errhandler)

int MPI_Errhandler_free(MPI_Errhandler *errhandler)

int MPI_Error_string(int errorcode, char *string, int *resultlen)

int MPI_Error_class(int errorcode, int *errorclass)

int double MPI_Wtime(void)

int double MPI_Wtick(void)

int MPI_Init(int *argc, char ***argv)

int MPI_Finalize(void)

int MPI_Initialized(int *flag)

int MPI_Abort(MPI_Comm comm, int errorcode)
```

1.8 C Bindings for Profiling

```
int MPI_Pcontrol(const int level, ...)
```

1.9 Fortran Bindings for Point-to-Point Communication

```
MPI_SEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, IERROR

MPI_RECV(BUF, COUNT, DATATYPE, SOURCE, TAG, COMM, STATUS, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, SOURCE, TAG, COMM, STATUS(MPI_STATUS_SIZE),
    IERROR

MPI_GET_COUNT(STATUS, DATATYPE, COUNT, IERROR)
    INTEGER STATUS(MPI_STATUS_SIZE), DATATYPE, COUNT, IERROR

MPI_BSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, IERROR)
    <type> BUF(*)
```

```
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, IERROR

MPI_SSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, IERROR

MPI_RSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, IERROR

MPI_BUFFER_ATTACH( BUFFER, SIZE, IERROR)
    <type> BUFFER(*)
    INTEGER SIZE, IERROR

MPI_BUFFER_DETACH( BUFFER, SIZE, IERROR)
    <type> BUFFER(*)
    INTEGER SIZE, IERROR

MPI_ISEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_IBSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_ISSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_IRSEND(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_IRECV(BUF, COUNT, DATATYPE, SOURCE, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, SOURCE, TAG, COMM, REQUEST, IERROR

MPI_WAIT(REQUEST, STATUS, IERROR)
    INTEGER REQUEST, STATUS(MPI_STATUS_SIZE), IERROR

MPI_TEST(REQUEST, FLAG, STATUS, IERROR)
    LOGICAL FLAG
    INTEGER REQUEST, STATUS(MPI_STATUS_SIZE), IERROR

MPI_REQUEST_FREE(REQUEST, IERROR)
    INTEGER REQUEST, IERROR

MPI_WAITANY(COUNT, ARRAY_OF_REQUESTS, INDEX, STATUS, IERROR)
    INTEGER COUNT, ARRAY_OF_REQUESTS(*), INDEX, STATUS(MPI_STATUS_SIZE),
    IERROR

MPI_TESTANY(COUNT, ARRAY_OF_REQUESTS, INDEX, FLAG, STATUS, IERROR)
    LOGICAL FLAG
```

```
    INTEGER COUNT, ARRAY_OF_REQUESTS(*), INDEX, STATUS(MPI_STATUS_SIZE),
    IERROR

MPI_WAITALL(COUNT, ARRAY_OF_REQUESTS, ARRAY_OF_STATUSES, IERROR)
    INTEGER COUNT, ARRAY_OF_REQUESTS(*),
    ARRAY_OF_STATUSES(MPI_STATUS_SIZE,*), IERROR

MPI_TESTALL(COUNT, ARRAY_OF_REQUESTS, FLAG, ARRAY_OF_STATUSES, IERROR)
    LOGICAL FLAG
    INTEGER COUNT, ARRAY_OF_REQUESTS(*),
    ARRAY_OF_STATUSES(MPI_STATUS_SIZE,*), IERROR

MPI_WAITSOME(INCOUNT, ARRAY_OF_REQUESTS, OUTCOUNT, ARRAY_OF_INDICES,
             ARRAY_OF_STATUSES, IERROR)
    INTEGER INCOUNT, ARRAY_OF_REQUESTS(*), OUTCOUNT, ARRAY_OF_INDICES(*),
    ARRAY_OF_STATUSES(MPI_STATUS_SIZE,*), IERROR

MPI_TESTSOME(INCOUNT, ARRAY_OF_REQUESTS, OUTCOUNT, ARRAY_OF_INDICES,
             ARRAY_OF_STATUSES, IERROR)
    INTEGER INCOUNT, ARRAY_OF_REQUESTS(*), OUTCOUNT, ARRAY_OF_INDICES(*),
    ARRAY_OF_STATUSES(MPI_STATUS_SIZE,*), IERROR

MPI_IPROBE(SOURCE, TAG, COMM, FLAG, STATUS, IERROR)
    LOGICAL FLAG
    INTEGER SOURCE, TAG, COMM, STATUS(MPI_STATUS_SIZE), IERROR

MPI_PROBE(SOURCE, TAG, COMM, STATUS, IERROR)
    INTEGER SOURCE, TAG, COMM, STATUS(MPI_STATUS_SIZE), IERROR

MPI_CANCEL(REQUEST, IERROR)
    INTEGER REQUEST, IERROR

MPI_TEST_CANCELLED(STATUS, FLAG, IERROR)
    LOGICAL FLAG
    INTEGER STATUS(MPI_STATUS_SIZE), IERROR

MPI_SEND_INIT(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER REQUEST, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_BSEND_INIT(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER REQUEST, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_SSEND_INIT(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_RSEND_INIT(BUF, COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, TAG, COMM, REQUEST, IERROR

MPI_RECV_INIT(BUF, COUNT, DATATYPE, SOURCE, TAG, COMM, REQUEST, IERROR)
    <type> BUF(*)
```

```
    INTEGER COUNT, DATATYPE, SOURCE, TAG, COMM, REQUEST, IERROR

MPI_START(REQUEST, IERROR)
    INTEGER REQUEST, IERROR

MPI_STARTALL(COUNT, ARRAY_OF_REQUESTS, IERROR)
    INTEGER COUNT, ARRAY_OF_REQUESTS(*), IERROR

MPI_SENDRECV(SENDBUF, SENDCOUNT, SENDTYPE, DEST, SENDTAG, RECVBUF,
             RECVCOUNT, RECVTYPE, SOURCE, RECVTAG, COMM, STATUS, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, DEST, SENDTAG, RECVCOUNT, RECVTYPE,
    SOURCE, RECVTAG, COMM, STATUS(MPI_STATUS_SIZE), IERROR

MPI_SENDRECV_REPLACE(BUF, COUNT, DATATYPE, DEST, SENDTAG, SOURCE, RECVTAG,
             COMM, STATUS, IERROR)
    <type> BUF(*)
    INTEGER COUNT, DATATYPE, DEST, SENDTAG, SOURCE, RECVTAG, COMM,
    STATUS(MPI_STATUS_SIZE), IERROR

MPI_TYPE_CONTIGUOUS(COUNT, OLDTYPE, NEWTYPE, IERROR)
    INTEGER COUNT, OLDTYPE, NEWTYPE, IERROR

MPI_TYPE_VECTOR(COUNT, BLOCKLENGTH, STRIDE, OLDTYPE, NEWTYPE, IERROR)
    INTEGER COUNT, BLOCKLENGTH, STRIDE, OLDTYPE, NEWTYPE, IERROR

MPI_TYPE_HVECTOR(COUNT, BLOCKLENGTH, STRIDE, OLDTYPE, NEWTYPE, IERROR)
    INTEGER COUNT, BLOCKLENGTH, STRIDE, OLDTYPE, NEWTYPE, IERROR

MPI_TYPE_INDEXED(COUNT, ARRAY_OF_BLOCKLENGTHS, ARRAY_OF_DISPLACEMENTS,
             OLDTYPE, NEWTYPE, IERROR)
    INTEGER COUNT, ARRAY_OF_BLOCKLENGTHS(*), ARRAY_OF_DISPLACEMENTS(*),
    OLDTYPE, NEWTYPE, IERROR

MPI_TYPE_HINDEXED(COUNT, ARRAY_OF_BLOCKLENGTHS, ARRAY_OF_DISPLACEMENTS,
             OLDTYPE, NEWTYPE, IERROR)
    INTEGER COUNT, ARRAY_OF_BLOCKLENGTHS(*), ARRAY_OF_DISPLACEMENTS(*),
    OLDTYPE, NEWTYPE, IERROR

MPI_TYPE_STRUCT(COUNT, ARRAY_OF_BLOCKLENGTHS, ARRAY_OF_DISPLACEMENTS,
             ARRAY_OF_TYPES, NEWTYPE, IERROR)
    INTEGER COUNT, ARRAY_OF_BLOCKLENGTHS(*), ARRAY_OF_DISPLACEMENTS(*),
    ARRAY_OF_TYPES(*), NEWTYPE, IERROR

MPI_ADDRESS(LOCATION, ADDRESS, IERROR)
    <type> LOCATION(*)
    INTEGER ADDRESS, IERROR

MPI_TYPE_EXTENT(DATATYPE, EXTENT, IERROR)
    INTEGER DATATYPE, EXTENT, IERROR

MPI_TYPE_SIZE(DATATYPE, SIZE, IERROR)
    INTEGER DATATYPE, SIZE, IERROR
```

```
MPI_TYPE_LB( DATATYPE, DISPLACEMENT, IERROR)
    INTEGER DATATYPE, DISPLACEMENT, IERROR

MPI_TYPE_UB( DATATYPE, DISPLACEMENT, IERROR)
    INTEGER DATATYPE, DISPLACEMENT, IERROR

MPI_TYPE_COMMIT(DATATYPE, IERROR)
    INTEGER DATATYPE, IERROR

MPI_TYPE_FREE(DATATYPE, IERROR)
    INTEGER DATATYPE, IERROR

MPI_GET_ELEMENTS(STATUS, DATATYPE, COUNT, IERROR)
    INTEGER STATUS(MPI_STATUS_SIZE), DATATYPE, COUNT, IERROR

MPI_PACK(INBUF, INCOUNT, DATATYPE, OUTBUF, OUTSIZE, POSITION, COMM, IERROR)
    <type> INBUF(*), OUTBUF(*)
    INTEGER INCOUNT, DATATYPE, OUTCOUNT, POSITION, COMM, IERROR

MPI_UNPACK(INBUF, INSIZE, POSITION, OUTBUF, OUTSIZE, DATATYPE, COMM,
             IERROR)
    <type> INBUF(*), OUTBUF(*)
    INTEGER INSIZE, POSITION, OUTCOUNT, DATATYPE, COMM, IERROR

MPI_PACK_SIZE(INCOUNT, DATATYPE, COMM, SIZE, IERROR)
    INTEGER INCOUNT, DATATYPE, COMM, SIZE, IERROR
```

1.10 Fortran Bindings for Collective Communication

```
MPI_BARRIER(COMM, IERROR)
    INTEGER COMM, IERROR

MPI_BCAST(BUFFER, COUNT, DATATYPE, ROOT, COMM, IERROR)
    <type> BUFFER(*)
    INTEGER COUNT, DATATYPE, ROOT, COMM, IERROR

MPI_GATHER(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNT, RECVTYPE,
             ROOT, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNT, RECVTYPE, ROOT, COMM, IERROR

MPI_GATHERV(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNTS, DISPLS,
             RECVTYPE, ROOT, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNTS(*), DISPLS(*), RECVTYPE, ROOT,
    COMM, IERROR

MPI_SCATTER(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNT, RECVTYPE,
             ROOT, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNT, RECVTYPE, ROOT, COMM, IERROR
```

```
MPI_SCATTERV(SENDBUF, SENDCOUNTS, DISPLS, SENDTYPE, RECVBUF, RECVCOUNT,
             RECVTYPE, ROOT, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNTS(*), DISPLS(*), SENDTYPE, RECVCOUNT, RECVTYPE, ROOT,
    COMM, IERROR

MPI_ALLGATHER(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNT, RECVTYPE,
             COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNT, RECVTYPE, COMM, IERROR

MPI_ALLGATHERV(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNTS, DISPLS,
             RECVTYPE, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNTS(*), DISPLS(*), RECVTYPE, COMM,
    IERROR

MPI_ALLTOALL(SENDBUF, SENDCOUNT, SENDTYPE, RECVBUF, RECVCOUNT, RECVTYPE,
             COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNT, SENDTYPE, RECVCOUNT, RECVTYPE, COMM, IERROR

MPI_ALLTOALLV(SENDBUF, SENDCOUNTS, SDISPLS, SENDTYPE, RECVBUF, RECVCOUNTS,
             RDISPLS, RECVTYPE, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER SENDCOUNTS(*), SDISPLS(*), SENDTYPE, RECVCOUNTS(*), RDISPLS(*),
    RECVTYPE, COMM, IERROR

MPI_REDUCE(SENDBUF, RECVBUF, COUNT, DATATYPE, OP, ROOT, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER COUNT, DATATYPE, OP, ROOT, COMM, IERROR

MPI_OP_CREATE( FUNCTION, COMMUTE, OP, IERROR)
    EXTERNAL FUNCTION
    LOGICAL COMMUTE
    INTEGER OP, IERROR

MPI_OP_FREE( OP, IERROR)
    INTEGER OP, IERROR

MPI_ALLREDUCE(SENDBUF, RECVBUF, COUNT, DATATYPE, OP, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER COUNT, DATATYPE, OP, COMM, IERROR

MPI_REDUCE_SCATTER(SENDBUF, RECVBUF, RECVCOUNTS, DATATYPE, OP, COMM,
             IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER RECVCOUNTS(*), DATATYPE, OP, COMM, IERROR

MPI_SCAN(SENDBUF, RECVBUF, COUNT, DATATYPE, OP, COMM, IERROR)
    <type> SENDBUF(*), RECVBUF(*)
    INTEGER COUNT, DATATYPE, OP, COMM, IERROR
```

1.11 Fortran Bindings for Groups, Contexts, etc.

```
MPI_GROUP_SIZE(GROUP, SIZE, IERROR)
    INTEGER GROUP, SIZE, IERROR

MPI_GROUP_RANK(GROUP, RANK, IERROR)
    INTEGER GROUP, RANK, IERROR

MPI_GROUP_TRANSLATE_RANKS(GROUP1, N, RANKS1, GROUP2, RANKS2, IERROR)
    INTEGER GROUP1, N, RANKS1(*), GROUP2, RANKS2(*), IERROR

MPI_GROUP_COMPARE(GROUP1, GROUP2, RESULT, IERROR)
    INTEGER GROUP1, GROUP2, RESULT, IERROR

MPI_COMM_GROUP(COMM, GROUP, IERROR)
    INTEGER COMM, GROUP, IERROR

MPI_GROUP_UNION(GROUP1, GROUP2, NEWGROUP, IERROR)
    INTEGER GROUP1, GROUP2, NEWGROUP, IERROR

MPI_GROUP_INTERSECTION(GROUP1, GROUP2, NEWGROUP, IERROR)
    INTEGER GROUP1, GROUP2, NEWGROUP, IERROR

MPI_GROUP_DIFFERENCE(GROUP1, GROUP2, NEWGROUP, IERROR)
    INTEGER GROUP1, GROUP2, NEWGROUP, IERROR

MPI_GROUP_INCL(GROUP, N, RANKS, NEWGROUP, IERROR)
    INTEGER GROUP, N, RANKS(*), NEWGROUP, IERROR

MPI_GROUP_EXCL(GROUP, N, RANKS, NEWGROUP, IERROR)
    INTEGER GROUP, N, RANKS(*), NEWGROUP, IERROR

MPI_GROUP_RANGE_INCL(GROUP, N, RANGES, NEWGROUP, IERROR)
    INTEGER GROUP, N, RANGES(3,*), NEWGROUP, IERROR

MPI_GROUP_RANGE_EXCL(GROUP, N, RANGES, NEWGROUP, IERROR)
    INTEGER GROUP, N, RANGES(3,*), NEWGROUP, IERROR

MPI_GROUP_FREE(GROUP, IERROR)
    INTEGER GROUP, IERROR

MPI_COMM_SIZE(COMM, SIZE, IERROR)
    INTEGER COMM, SIZE, IERROR

MPI_COMM_RANK(COMM, RANK, IERROR)
    INTEGER COMM, RANK, IERROR

MPI_COMM_COMPARE(COMM1, COMM2, RESULT, IERROR)
    INTEGER COMM1, COMM2, RESULT, IERROR

MPI_COMM_DUP(COMM, NEWCOMM, IERROR)
    INTEGER COMM, NEWCOMM, IERROR

MPI_COMM_CREATE(COMM, GROUP, NEWCOMM, IERROR)
    INTEGER COMM, GROUP, NEWCOMM, IERROR
```

```
MPI_COMM_SPLIT(COMM, COLOR, KEY, NEWCOMM, IERROR)
    INTEGER COMM, COLOR, KEY, NEWCOMM, IERROR

MPI_COMM_FREE(COMM, IERROR)
    INTEGER COMM, IERROR

MPI_COMM_TEST_INTER(COMM, FLAG, IERROR)
    INTEGER COMM, IERROR
    LOGICAL FLAG

MPI_COMM_REMOTE_SIZE(COMM, SIZE, IERROR)
    INTEGER COMM, SIZE, IERROR

MPI_COMM_REMOTE_GROUP(COMM, GROUP, IERROR)
    INTEGER COMM, GROUP, IERROR

MPI_INTERCOMM_CREATE(LOCAL_COMM, LOCAL_LEADER, PEER_COMM, REMOTE_LEADER, TAG,
             NEWINTERCOMM, IERROR)
    INTEGER LOCAL_COMM, LOCAL_LEADER, PEER_COMM, REMOTE_LEADER, TAG,
    NEWINTERCOMM, IERROR

MPI_INTERCOMM_MERGE(INTERCOMM, HIGH, INTRACOMM, IERROR)
    INTEGER INTERCOMM, INTRACOMM, IERROR
    LOGICAL HIGH

MPI_KEYVAL_CREATE(COPY_FN, DELETE_FN, KEYVAL, EXTRA_STATE, IERROR)
    EXTERNAL COPY_FN, DELETE_FN
    INTEGER KEYVAL, EXTRA_STATE, IERROR

MPI_KEYVAL_FREE(KEYVAL, IERROR)
    INTEGER KEYVAL, IERROR

MPI_ATTR_PUT(COMM, KEYVAL, ATTRIBUTE_VAL, IERROR)
    INTEGER COMM, KEYVAL, ATTRIBUTE_VAL, IERROR

MPI_ATTR_GET(COMM, KEYVAL, ATTRIBUTE_VAL, FLAG, IERROR)
    INTEGER COMM, KEYVAL, ATTRIBUTE_VAL, IERROR
    LOGICAL FLAG

MPI_ATTR_DELETE(COMM, KEYVAL, IERROR)
    INTEGER COMM, KEYVAL, IERROR
```

1.12 Fortran Bindings for Process Topologies

```
MPI_CART_CREATE(COMM_OLD, NDIMS, DIMS, PERIODS, REORDER, COMM_CART, IERROR)
    INTEGER COMM_OLD, NDIMS, DIMS(*), COMM_CART, IERROR
    LOGICAL PERIODS(*), REORDER

MPI_DIMS_CREATE(NNODES, NDIMS, DIMS, IERROR)
    INTEGER NNODES, NDIMS, DIMS(*), IERROR

MPI_GRAPH_CREATE(COMM_OLD, NNODES, INDEX, EDGES, REORDER, COMM_GRAPH,
             IERROR)
```

```
    INTEGER COMM_OLD, NNODES, INDEX(*), EDGES(*), COMM_GRAPH, IERROR
    LOGICAL REORDER

MPI_TOPO_TEST(COMM, STATUS, IERROR)
    INTEGER COMM, STATUS, IERROR

MPI_GRAPHDIMS_GET(COMM, NNODES, NEDGES, IERROR)
    INTEGER COMM, NNODES, NEDGES, IERROR

MPI_GRAPH_GET(COMM, MAXINDEX, MAXEDGES, INDEX, EDGES, IERROR)
    INTEGER COMM, MAXINDEX, MAXEDGES, INDEX(*), EDGES(*), IERROR

MPI_CARTDIM_GET(COMM, NDIMS, IERROR)
    INTEGER COMM, NDIMS, IERROR

MPI_CART_GET(COMM, MAXDIMS, DIMS, PERIODS, COORDS, IERROR)
    INTEGER COMM, MAXDIMS, DIMS(*), COORDS(*), IERROR
    LOGICAL PERIODS(*)

MPI_CART_RANK(COMM, COORDS, RANK, IERROR)
    INTEGER COMM, COORDS(*), RANK, IERROR

MPI_CART_COORDS(COMM, RANK, MAXDIMS, COORDS, IERROR)
    INTEGER COMM, RANK, MAXDIMS, COORDS(*), IERROR

MPI_GRAPH_NEIGHBORS_COUNT(COMM, RANK, NNEIGHBORS, IERROR)
    INTEGER COMM, RANK, NNEIGHBORS, IERROR

MPI_GRAPH_NEIGHBORS(COMM, RANK, MAXNEIGHBORS, NEIGHBORS, IERROR)
    INTEGER COMM, RANK, MAXNEIGHBORS, NEIGHBORS(*), IERROR

MPI_CART_SHIFT(COMM, DIRECTION, DISP, RANK_SOURCE, RANK_DEST, IERROR)
    INTEGER COMM, DIRECTION, DISP, RANK_SOURCE, RANK_DEST, IERROR

MPI_CART_SUB(COMM, REMAIN_DIMS, NEWCOMM, IERROR)
    INTEGER COMM, NEWCOMM, IERROR
    LOGICAL REMAIN_DIMS(*)

MPI_CART_MAP(COMM, NDIMS, DIMS, PERIODS, NEWRANK, IERROR)
    INTEGER COMM, NDIMS, DIMS(*), NEWRANK, IERROR
    LOGICAL PERIODS(*)

MPI_GRAPH_MAP(COMM, NNODES, INDEX, EDGES, NEWRANK, IERROR)
    INTEGER COMM, NNODES, INDEX(*), EDGES(*), NEWRANK, IERROR
```

1.13 Fortran Bindings for Environmental Inquiry

```
MPI_GET_PROCESSOR_NAME(NAME, RESULTLEN, IERROR)
    CHARACTER*(*) NAME
    INTEGER RESULTLEN, IERROR

MPI_ERRHANDLER_CREATE(FUNCTION, HANDLER, IERROR)
    EXTERNAL FUNCTION
```

```
    INTEGER ERRHANDLER, IERROR

MPI_ERRHANDLER_SET(COMM, ERRHANDLER, IERROR)
    INTEGER COMM, ERRHANDLER, IERROR

MPI_ERRHANDLER_GET(COMM, ERRHANDLER, IERROR)
    INTEGER COMM, ERRHANDLER, IERROR

MPI_ERRHANDLER_FREE(ERRHANDLER, IERROR)
    INTEGER ERRHANDLER, IERROR

MPI_ERROR_STRING(ERRORCODE, STRING, RESULTLEN, IERROR)
    INTEGER ERRORCODE, RESULTLEN, IERROR
    CHARACTER*(*) STRING

MPI_ERROR_CLASS(ERRORCODE, ERRORCLASS, IERROR)
    INTEGER ERRORCODE, ERRORCLASS, IERROR

DOUBLE PRECISION MPI_WTIME()

DOUBLE PRECISION MPI_WTICK()

MPI_INIT(IERROR)
    INTEGER IERROR

MPI_FINALIZE(IERROR)
    INTEGER IERROR

MPI_INITIALIZED(FLAG, IERROR)
    LOGICAL FLAG
    INTEGER IERROR

MPI_ABORT(COMM, ERRORCODE, IERROR)
    INTEGER COMM, ERRORCODE, IERROR
```

1.14 Fortran Bindings for Profiling

```
MPI_PCONTROL(level)
    INTEGER LEVEL, ...
```