

3.2.2 Message Data

The send buffer specified by the `MPI_SEND` operation consists of `count` successive entries of the type indicated by `datatype`, starting with the entry at address `buf`. Note that we specify the message length in terms of number of *elements*, not number of *bytes*. The former is machine independent and closer to the application level.

The data part of the message consists of a sequence of `count` values, each of the type indicated by `datatype`. `count` may be zero, in which case the data part of the message is empty. The basic datatypes that can be specified for message data values correspond to the basic datatypes of the host language. Possible values of this argument for Fortran and the corresponding Fortran types are listed in Table 3.1.

MPI datatype	Fortran datatype
<code>MPI_INTEGER</code>	<code>INTEGER</code>
<code>MPI_REAL</code>	<code>REAL</code>
<code>MPI_DOUBLE_PRECISION</code>	<code>DOUBLE PRECISION</code>
<code>MPI_COMPLEX</code>	<code>COMPLEX</code>
<code>MPI_LOGICAL</code>	<code>LOGICAL</code>
<code>MPI_CHARACTER</code>	<code>CHARACTER(1)</code>
<code>MPI_BYTE</code>	
<code>MPI_PACKED</code>	

Table 3.1: Predefined MPI datatypes corresponding to Fortran datatypes

Possible values for this argument for C and the corresponding C types are listed in Table 3.2.

The datatypes `MPI_BYTE` and `MPI_PACKED` do not correspond to a Fortran or C datatype. A value of type `MPI_BYTE` consists of a byte (8 binary digits). A byte is uninterpreted and is different from a character. Different machines may have different representations for characters, or may use more than one byte to represent characters. On the other hand, a byte has the same binary value on all machines. The use of the type `MPI_PACKED` is explained in Section 4.2.

MPI requires support of these datatypes, which match the basic datatypes of Fortran and ISO C. Additional MPI datatypes should be provided if the host language has additional data types: `MPI_DOUBLE_COMPLEX` for double precision complex in Fortran declared to be of type `DOUBLE COMPLEX`; `MPI_REAL2`, `MPI_REAL4` and `MPI_REAL8` for Fortran reals, declared to be of type `REAL*2`, `REAL*4` and `REAL*8`, respectively; `MPI_INTEGER1`, `MPI_INTEGER2` and `MPI_INTEGER4` for Fortran integers, declared to be of type `INTEGER*1`, `INTEGER*2` and `INTEGER*4`, respectively; etc.

Rationale. One goal of the design is to allow for MPI to be implemented as a library, with no need for additional preprocessing or compilation. Thus, one cannot assume that a communication call has information on the datatype of variables in the communication buffer; this information must be supplied by an explicit argument. The need for such datatype information will become clear in Section 3.3.2. (*End of rationale.*)

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MPI datatype	C datatype
MPI_CHAR	[ticket63.] signed char (treated as printable character)
MPI_SHORT	signed short int
MPI_INT	signed int
MPI_LONG	signed long int
MPI_LONG_LONG_INT	signed long long int
MPI_LONG_LONG (as a synonym)	signed long long int
MPI_SIGNED_CHAR	signed char (treated as integral value)
MPI_UNSIGNED_CHAR	unsigned char (treated as integral value)
MPI_UNSIGNED_SHORT	unsigned short int
MPI_UNSIGNED	unsigned int
MPI_UNSIGNED_LONG	unsigned long int
MPI_UNSIGNED_LONG_LONG	unsigned long long int
MPI_FLOAT	float
MPI_DOUBLE	double
MPI_LONG_DOUBLE	long double
MPI_WCHAR	wchar_t (defined in <stddef.h>)
	(treated as printable character)
[ticket18.]MPI_C_BOOL	_Bool
[ticket18.]MPI_INT8_T	int8_t
[ticket18.]MPI_INT16_T	int16_t
[ticket18.]MPI_INT32_T	int32_t
[ticket18.]MPI_INT64_T	int64_t
[ticket18.]MPI_UINT8_T	uint8_t
[ticket18.]MPI_UINT16_T	uint16_t
[ticket18.]MPI_UINT32_T	uint32_t
[ticket18.]MPI_UINT64_T	uint64_t
[ticket18.]MPI_C_COMPLEX	float_Complex
[ticket18.]MPI_C_FLOAT_COMPLEX (as a synonym)	float_Complex
[ticket18.]MPI_C_DOUBLE_COMPLEX	double_Complex
[ticket18.]MPI_C_LONG_DOUBLE_COMPLEX	long double_Complex
MPI_BYTE	
MPI_PACKED	

Table 3.2: Predefined MPI datatypes corresponding to C datatypes

Rationale. The datatypes MPI_C_BOOL, MPI_INT8_T, MPI_INT16_T, MPI_INT32_T, MPI_UINT8_T, MPI_UINT16_T, MPI_UINT32_T, MPI_C_COMPLEX, MPI_C_FLOAT_COMPLEX, MPI_C_DOUBLE_COMPLEX, and MPI_C_LONG_DOUBLE_COMPLEX have no corresponding C++ bindings. This was intentionally done to avoid potential collisions with the C preprocessor and namespaced C++ names. C++ applications can use the C bindings with no loss of functionality. (*End of rationale.*)

MPI datatype	C datatype	Fortran datatype
MPI_AINT	MPI_Aint	INTEGER (KIND=MPI_ADDRESS_KIND)
MPI_OFFSET	MPI_Offset	INTEGER (KIND=MPI_OFFSET_KIND)

Table 3.3: Predefined MPI datatypes corresponding to both C and Fortran datatypes

The datatypes `MPI_AINT` and `MPI_OFFSET` correspond to the MPI-defined C types `MPI_Aint` and `MPI_Offset` and their Fortran equivalents `INTEGER (KIND=MPI_ADDRESS_KIND)` and `INTEGER (KIND=MPI_OFFSET_KIND)`. This is described in Table 3.3. See Section 16.3.10 for information on interlanguage communication with these types.

3.2.3 Message Envelope

In addition to the data part, messages carry information that can be used to distinguish messages and selectively receive them. This information consists of a fixed number of fields, which we collectively call the **message envelope**. These fields are

source
destination
tag
communicator

The message source is implicitly determined by the identity of the message sender. The other fields are specified by arguments in the send operation.

The message destination is specified by the `dest` argument.

The integer-valued message tag is specified by the `tag` argument. This integer can be used by the program to distinguish different types of messages. The range of valid tag values is $0, \dots, \text{UB}$, where the value of `UB` is implementation dependent. It can be found by querying the value of the attribute `MPI_TAG_UB`, as described in Chapter 8. MPI requires that `UB` be no less than 32767.

The `comm` argument specifies the **communicator** that is used for the send operation. Communicators are explained in Chapter 6; below is a brief summary of their usage.

A communicator specifies the communication context for a communication operation. Each communication context provides a separate “communication universe:” messages are always received within the context they were sent, and messages sent in different contexts do not interfere.

The communicator also specifies the set of processes that share this communication context. This **process group** is ordered and processes are identified by their rank within this group. Thus, the range of valid values for `dest` is $0, \dots, n-1$, where n is the number of processes in the group. (If the communicator is an inter-communicator, then destinations are identified by their rank in the remote group. See Chapter 6.)

A predefined communicator `MPI_COMM_WORLD` is provided by MPI. It allows communication with all processes that are accessible after MPI initialization and processes are identified by their rank in the group of `MPI_COMM_WORLD`.

Advice to users. Users that are comfortable with the notion of a flat name space for processes, and a single communication context, as offered by most existing communication libraries, need only use the predefined variable `MPI_COMM_WORLD` as the