also provided, even though the new functions are equivalent to the old functions. The old names are deprecated.

Some of the deprecated constructs are now removed, as documented in Chapter 16 on page 597. They may still be provided by an implementation for backwards compatibility, but are not required.

Table 2.1 shows a list of all of the deprecated and removed constructs. Note that some C typedefs and Fortran subroutine names are included in this list; they are the types of callback functions.

Deprecated or removed construct	deprecated since	removed since	Replacement
MPI_ADDRESS	MPI-2.0	MPI-3.0	MPI_GET_ADDRESS
MPI_TYPE_HINDEXED	MPI-2.0	MPI-3.0	MPI_TYPE_CREATE_HINDEXED
MPI_TYPE_HVECTOR	MPI-2.0	MPI-3.0	MPI_TYPE_CREATE_HVECTOR
MPI_TYPE_STRUCT	MPI-2.0	MPI-3.0	MPI_TYPE_CREATE_STRUCT
MPI_TYPE_EXTENT	MPI-2.0	MPI-3.0	MPI_TYPE_GET_EXTENT
MPI_TYPE_UB	MPI-2.0	MPI-3.0	MPI_TYPE_GET_EXTENT
MPI_TYPE_LB	MPI-2.0	MPI-3.0	MPI_TYPE_GET_EXTENT
MPI_LB[1]	MPI-2.0	MPI-3.0	MPI_TYPE_CREATE_RESIZED
MPI_UB[1]	MPI-2.0	MPI-3.0	MPI_TYPE_CREATE_RESIZED
MPI_ERRHANDLER_CREATE	MPI-2.0	MPI-3.0	MPI_COMM_CREATE_ERRHANDLER
MPI_ERRHANDLER_GET	MPI-2.0	MPI-3.0	MPI_COMM_GET_ERRHANDLER
MPI_ERRHANDLER_SET	MPI-2.0	MPI-3.0	MPI_COMM_SET_ERRHANDLER
MPI_Handler_function[2]	MPI-2.0	MPI-3.0	MPI_Comm_errhandler_function[2]
MPI_KEYVAL_CREATE	MPI-2.0		MPI_COMM_CREATE_KEYVAL
MPI_KEYVAL_FREE	MPI-2.0		MPI_COMM_FREE_KEYVAL
MPI_DUP_FN[3]	MPI-2.0		MPI_COMM_DUP_FN[3]
MPI_NULL_COPY_FN[3]	MPI-2.0		MPI_COMM_NULL_COPY_FN[3]
MPI_NULL_DELETE_FN[3]	MPI-2.0		MPI_COMM_NULL_DELETE_FN[3]
MPI_Copy_function[2]	MPI-2.0		MPI_Comm_copy_attr_function[2]
COPY_FUNCTION[3]	MPI-2.0		COMM_COPY_ATTR_FUNCTION[3]
MPI_Delete_function[2]	MPI-2.0		MPI_Comm_delete_attr_function[2]
DELETE_FUNCTION[3]	MPI-2.0		COMM_DELETE_ATTR_FUNCTION[3]
MPI_ATTR_DELETE	MPI-2.0		MPI_COMM_DELETE_ATTR
MPI_ATTR_GET	MPI-2.0		MPI_COMM_GET_ATTR
MPI_ATTR_PUT	MPI-2.0		MPI_COMM_SET_ATTR
MPI_COMBINER_HVECTOR_INTEGER[4]	-	MPI-3.0	MPI_COMBINER_HVECTOR[4]
MPI_COMBINER_HINDEXED_INTEGER[4]	-	MPI-3.0	MPI_COMBINER_HINDEXED[4]
MPI_COMBINER_STRUCT_INTEGER[4]	-	MPI-3.0	MPI_COMBINER_STRUCT[4]
MPI::....	MPI-2.2	MPI-3.0	C language binding

[1] Predefined datatype.
[2] Callback prototype definition.
[3] Predefined callback routine.
[4] Constant.
Other entries are regular MPI routines.

Table 2.1: Deprecated and Removed constructs

2.6.2 Fortran Binding Issues

Originally, MPI-1.1 provided bindings for Fortran 77. These bindings are retained, but they are now interpreted in the context of the Fortran 90 standard. MPI can still be used with most Fortran 77 compilers, as noted below. When the term "Fortran" is used it means

Fortran 90 or later; it means Fortran 2008 + TR 29113 and later if the `mpi_f08` module is used.

All MPI names have an `MPI_` prefix, and all characters are capitals. Programs must not declare names, e.g., for variables, subroutines, functions, parameters, derived types, abstract interfaces, or modules, beginning with the prefix `MPI_`. To avoid conflicting with the profiling interface, programs must also avoid subroutines and functions with the prefix `PMPI_`. This is mandated to avoid possible name collisions.

All MPI Fortran subroutines have a return code in the last argument. With `USE mpi_f08`, this last argument is declared as `OPTIONAL`, except for user-defined callback functions (e.g., `COMM_COPY_ATTR_FUNCTION`) and their predefined callbacks (e.g., MPI_NULL_COPY_FN). A few MPI operations which are functions do not have the return code argument. The return code value for successful completion is MPI_SUCCESS. Other error codes are implementation dependent; see the error codes in Chapter 8 and Annex A.

Constants representing the maximum length of a string are one smaller in Fortran than in C as discussed in Section 17.2.9.

Handles are represented in Fortran as `INTEGER`s, or as a `BIND(C)` derived type with the `mpi_f08` module; see Section 2.5.1 on page 12. Binary-valued variables are of type `LOGICAL`.

Array arguments are indexed from one.

The older MPI Fortran bindings (`mpif.h` and `use mpi`) are inconsistent with the Fortran standard in several respects. These inconsistencies, such as register optimization problems, have implications for user codes that are discussed in detail in Section 17.1.16.

2.6.3 C Binding Issues

We use the ISO C declaration format. All MPI names have an `MPI_` prefix, defined constants are in all capital letters, and defined types and functions have one capital letter after the prefix. Programs must not declare names (identifiers), e.g., for variables, functions, constants, types, or macros, beginning with the prefix `MPI_`. To support the profiling interface, programs must not declare functions with names beginning with the prefix `PMPI_`.

The definition of named constants, function prototypes, and type definitions must be supplied in an include file mpi.h.

Almost all C functions return an error code. The successful return code will be MPI_SUCCESS, but failure return codes are implementation dependent.

Type declarations are provided for handles to each category of opaque objects.

Array arguments are indexed from zero.

Logical flags are integers with value 0 meaning "false" and a non-zero value meaning "true."

Choice arguments are pointers of type `void *`.

Address arguments are of MPI defined type MPI_Aint. File displacements are of type MPI_Offset. MPI_Aint is defined to be an integer of the size needed to hold any valid address on the target architecture. MPI_Offset is defined to be an integer of the size needed to hold any valid file size on the target architecture.

2.6.4 Functions and Macros

An implementation is allowed to implement MPI_WTIME, MPI_WTICK, PMPI_WTIME, PMPI_WTICK, and the handle-conversion functions (MPI_Group_f2c, etc.) in Section 17.2.4, and no others, as macros in C.

Annex B

Change-Log

This annex summarizes changes from the previous version of the MPI standard to the version presented by this document. Only significant changes (i.e., clarifications and new features) that might either require implementation effort in the MPI libraries or change the understanding of MPI from a user's perspective are presented. Editorial modifications, formatting, typo corrections and minor clarifications are not shown.

B.1 Changes from Version 2.2 to Version 3.0

B.1.1 Errata to Previous Versions of MPI

1. Sections 2.6.2 and 2.6.3 on pages 18 and 19, and
   MPI-2.2 Section 2.6.2 on page 17, lines 41-42, Section 2.6.3 on page 18, lines 15-16, and Section 2.6.4 on page 18, lines 40-41.
   This is an MPI-2 erratum: The scope for the reserved prefix `MPI_` and the C++ namespace `MPI` is now any name as originally intended in MPI-1.

2. Sections 3.2.2, 5.9.2, 13.5.2 Table 13.2, and Annex A.1.1 on pages 25, 176, 538, and 663, and
   MPI-2.2 Sections 3.2.2, 5.9.2, 13.5.2 Table 13.2, 16.1.16 Table 16.1, and Annex A.1.1 on pages 27, 164, 433, 472 and 513
   This is an MPI-2.2 erratum: New named predefined datatypes MPI_CXX_BOOL, MPI_CXX_FLOAT_COMPLEX, MPI_CXX_DOUBLE_COMPLEX, and MPI_CXX_LONG_DOUBLE_COMPLEX were added in C and Fortran corresponding to the C++ types `bool`, `std::complex<float>`, `std::complex<double>`, and `std::complex<long double>`. These datatypes also correspond to the deprecated C++ predefined datatypes MPI::BOOL, MPI::COMPLEX, MPI::DOUBLE_COMPLEX, and MPI::LONG_DOUBLE_COMPLEX, which were removed in MPI-3.0. The non-standard C++ types `Complex<...>` were substituted by the standard types `std::complex<...>`.

3. Sections 5.9.2 on pages 176 and MPI-2.2 Section 5.9.2, page 165, line 47.
   This is an MPI-2.2 erratum: MPI_C_COMPLEX was added to the "Complex" reduction group.

4. Section 7.5.5 on page 302, and
   MPI-2.2, Section 7.5.5 on page 257, C++ interface on page 264, line 3.