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FP16

Virtual MPI Forum Meeting
MPI Forum, Feb., 2018

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An Important Issue to be discussed

- When shall we introduce the new datatypes?
  - As soon as,
    - ISO/IEEE/ANSI standardizes them, or
    - Major compilers accept them, or
    - An implementor decides to do so, …
- It may take (more than ?) one year to put new datatypes into the standard, if we follow the normal procedure (passing two readings)
  - It is almost IMPOSSIBLE to have datatypes in the standard as soon as XYZ happens

New Ticket #74

- Replacement of ticket-65 and -66
- Stop introducing new types into the standard MPI standard only defines *fundamental* datatypes such as MPI_INT, MPI_FLOAT, and so on
  - decouple type definition from standard
  - give implementors the freedom of choice when to add and what to add (new basic datatypes)
- Instead,
  - Standard defines the *naming rule* of basic datatype names
  - Implementors can add new basic datatypes having the names following the naming tule

Related Tickets

- #65 16-bit floating-point support for C/C++
  - ➡ MPI standard will not define FP16, but implementor can decide to support or not

- #66 define language-agnostic, IEEE types
  - ➡ Implementors can decide to implement new types

- #69 Definition and Explanation of External32
  - ➡ Left unchanged because of backward compatibility (wording might be updated)

Definition of Terms

- *Basic datatypes*
  - primitive datatypes
    - can be appeared in the type maps
  - Two kinds
    - *~~Fundamental~~ Predefined datatypes*
    - *~~Additional~~ Optional datatypes*
- *Predefined datatypes*
  - Defined in the standard
- *Optional datatypes*
  - Added by an implementor

Modification to the standard

- Adding one section into Chapter 4. Datatypes

- Fundamental data type definition
- Addition of fundamental data type names
  - Data type naming rule
  - Old basic data type names become synonyms (and deprecated ?)

➡ If deprecated, then ALL deprecated datatypes in the current standard must be renamed to the new ones !!!!

- Introducing some new functions

Impact to users

- Old datatype names are left unchanged as synonyms and no impact to current users

Details (1)

- **Predefined Datatypes (in old names here)**
  - **C** MPI_CHAR, MPI_INT, MPI_LONG, …
  - **Fortran** MPI_CHARACTER, MPI_INTEGER, …
  - **MPI** MPI_BYTE, MPI_PACKED, MPI_AINT,

    …
- ***Implementation-defined* Optional Datatypes**
  - ***Data Type Naming Rule*** **(later)**
  - **An implementation may add basic datatype(s) if the implementation and associated compiler support it (them).**
  - **The current data type names not compliant with the rule are thought to be synonyms.**

Details (2)

- Advice to users (draft)
  - Excepting external32, MPI standard only defines the datatype names, regardless to the sizes of datatypes, data representation format, and if the data type is computed as is or any format conversion(s) is (are) accompanied with basics computations [4 calculus, bit ops, etc.]. An implementation may add basic datatypes supported by the accompanied compiler. The datatype names added by an implementation must follow the datatype naming rule in the standard so that users can identify the datatypes of the underlying programming language from the datatype names used in MPI. Documentation on these additional datatypes should be provided by the implementor.
  - Actual storage size of a datatype depends on an implementation, and accompanied compiler (see also MPI_Type_size(x)). For example, MPI_LONG_INT has the size of 4 bytes or 8 bytes depending on the compiler and/or processor. In the usage of MPI-IO with "external32," however, datatype sizes and formats are explicitly defined in this standard for compatibility and portability (see also MPI-IO Chapter XYZ).
- Advice to implementors (draft)
  - If some or all global reduction operations are offloaded to a device other than the host processor, e.g., network device, then the data sizes and binary formats of all datatypes must be exactly the same with the ones of the processor.

New Data Type Function

- int MPI_Type_equivalent(type0, type1, *flag)
  - *flag* is set, if *type0* and *type1* are having the same binary format and size. Otherwise *flag* is reset.
  - If derived datatypes are given, then the type maps of both types must be equivalent. Here, "equivalent type maps" means all basic datatype and offset pairs in two type maps are the "equivalent" defined by MPI_Type_equivalent().
- ex)
  - MPI_Type_equivalent(MPI_SHORT_FLOAT, MPI_FLOAT, flag)
  - MPI_Type_equivalent(MPI_REAL, MPI_FLOAT, flag)

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New Data Type Functions

- int MPI_Type_match(type0, type1, *flag)
  - On basic datatypes, if type0 and type1 have the same binary format and size, then it returns true.
  - On derived datatypes, if they have the same *datatype signatures* (not *type maps*), then it returns true.

- Or, MPI_Type_match() works on both basic and derived datatypes.

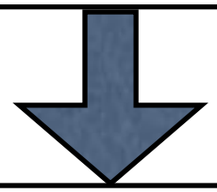
MPI_Type_match

- **This leads to change the current type matching rule in the standard**

3.3 Data Type Matching and Data Conversion

3.3.1 Type Matching Rules

The types of a send and receive match (phase two) if both operations use ***identical names***. That is, MPI_INTEGER matches MPI_INTEGER, MPI_REAL matches MPI_REAL, and so on. There is one exception to this rule, discussed in Section 4.2: the type MPI_PACKED can match any other type.



3.3 Data Type Matching and Data Conversion

3.3.1 Type Matching Rules

The types of a send and receive match (phase two) if both operations use **the types on which MPI_Type_match() returns true**. That is, MPI_INTEGER matches MPI_INTEGER, MPI_REAL matches MPI_REAL, and so on. There is one exception to this rule, discussed in Section 4.2: the type MPI_PACKED can match any other type.

MPI_TYPE_GET_NAME()

- Advice to implementors
  - A high quality implementation returns the distinct type name of equivalent types.

- Example
  - on MPI_INT and MPI_INT32_T
  - HQI: returned string depends on the type specified
  - LQI: returned string does NOT depend on the type specified

Naming Rule Requirements

- From users' viewpoint
  - Users can identify the underlying datatypes from the MPI datatype names
- From implementors' viewpoint
  - Implementors can easily make new unique datatype name when they want to introduce new datatype.

Type Naming Rule (1/3)

- **MPI_<KIND>_<TYPENAME>[_<EXTRA>], or MPI_<KIND>__<TYPENAME>[__<EXTRA>]**
  - **examples**
    - MPI_C_LONG_LONG **or** MPI_C__LONG_LONG
    - MPI_CXX_FLOAT **or** MPI_CXX__FLOAT
    - MPI_F_DOUBLE **or** MPI_F__DOUBLE
    - MPI_F_REAL_2 **or** MPI_F__REAL__2, …
- **MPI-defined types**
  - MPI_MPI_BYTE **or** MPI_MPI__BYTE
  - MPI_MPI_PACKED, **or** MPI_MPI__PACKED, …
- **Language agnostic types**
  - MPI_IEEE_BINARY32 **or** MPI_IEEE__BINARY32
  - MPI_ISO_DECIMAL64 **or** MPI_ISO__DECIMAL64, …

Type Naming Rule (2/3)

- **MPI_<KIND>_<TYPENAME>[_<EXTRA>] or MPI_<KIND>__<TYPENAME>[__<EXTRA>]**
- KIND
  - Language “C”, “CXX”, “F”, … (filename extension?)
  - MPI-defined “MPI”
  - Standard “ISO”, “IEEE”, “ANSI”, …
- Type Name (defined by language, shortest one)
  - C/C++ “int”, “long long”, …
  - Fortran “INTEGER”, “REAL”, …
  - ISO/IEEE “binary16”, “decimal32”, ..
- Extra
  - Fortran “REAL(4)”, “COMPLEX(8)”, …

Type Naming Rule (3/3)

- MIN_LOC, MAX_LOC (if still needed)
  - **<TYPENAME0>__AND__<TYPENAME1>** or **<TYPENAME0>__AT__<TYPENAME1>**

  - MPI_C_FLOAT_AND_MPI_C_INT or MPI_C__FLOAT__AND__MPI_C__INT
  - MPI_C_FLOAT_AT_MPI_C_INT **or** MPI_C__FLOAT__AT__MPI_C__INT

Old and New Type Names (1/2)

C Kind		Ext32
Current Name	**Proposed New Name**	**Size**
MPI_CHAR	**MPI_C_CHAR**	1
MPI_SHORT	**MPI_C_SHORT**	2
MPI_INT	**MPI_C_INT**	4
MPI_LONG	**MPI_C_LONG**	4
MPI_LONG_LONG_INT	**MPI_C_LONG_LONG**	8
MPI_LONG_LONG	**MPI_C_LONG_LONG**	8
MPI_SIGNED_CHAR	**MPI_C_SINGED_CHAR**	1
M:PI_UNSIGNED_CHAR	**MPI_C_UNSIGNED_CHAR**	1
MPI_UNSIGNED_SHORT	**MPI_C_UNSIGNED_SHORT**	2
MPI_UNSIGNED	**MPI_C_UNSIGNED**	4
MPI_UNSIGNED_LONG	**MPI_C_UNSIGNED_LONG**	4
MPI_UNSIGNED_LONG_LONG	**MPI_C_UNSIGNED_LONG_LONG**	8
MPI_FLOAT	**MPI_C_FLOAT**	4
MPI_SHORT_FLOAT	**MPI_C_SHORT_FLOAT**	(2)
MPI_DOUBLE	**MPI_C_DOUBLE**	8
MPI_LONG_DOUBLE	**MPI_C_LONG_DOUBLE**	16
MPI_WCHAR	**MPI_C_WCHAR**	2
MPI_C_BOOL	**MPI_C_BOOL**	1
MPI_INT8_T	**MPI_C_INT8_T**	1
MPI_INT16_T	**MPI_C_INT16_T**	2
MPI_INT32_T	**MPI_C_INT32_T**	4
MPI_INT64_T	**MPI_C_INT64_T**	8
MPI_UINT8_T	**MPI_C_UINT8_T**	1
MPI_UINT16_T	**MPI_C_UINT16_T**	2
MPI_UINT32_T	**MPI_C_UINT32_T**	4
MPI_UINT64_T	**MPI_C_UINT64_T**	8
MPI_C_COMPLEX	**MPI_C_COMPLEX**	2*4
MPI_C_FLOAT_COMPLEX	**MPI_C_COMPLEX**	2*4
MPI_C_SHORT_COMPLEX	**MPI_C_SHORT_COMPLEX**	(2*2)
MPI_C_DOUBLE_COMPLEX	**MPI_C_DOUBLE_COMPLEX**	2*8
MPI_C_LONG_DOUBLE_COMPLEX	**MPI_C_LONG_DOUBLE_COMPLEX**	2*16

Fortran Kind		Ext32
Current Name	**Proposed New Name**	**Size**
MPI_CHARACTER	**MPI_F_CHARACTER**	1
MPI_LOGICAL	**MPI_F_LOGICAL**	4
MPI_INTEGER	**MPI_F_INTEGER**	4
MPI_REAL	**MPI_F_REAL**	4
MPI_DOUBLE_PRECISION	**MPI_F_DOUBLE_PRECISION**	8
MPI_COMPLEX	**MPI_F_COMPLEX**	2*4
MPI_DOUBLE_COMPLEX	**MPI_F_DOUBLE_COMPLEX**	2*8
(followings are optional datatypes)		
MPI_INTEGER1	MPI_F_INTEGER_1	1
MPI_INTEGER2	MPI_F_INTEGER_2	2
MPI_INTEGER4	MPI_F_INTEGER_4	4
MPI_INTEGER8	MPI_F_INTEGER_8	8
MPI_INTEGER16	MPI_F_INTEGER_16	16
MPI_REAL2	MPI_F_REAL_2	2
MPI_REAL4	MPI_F_REAL_4	4
MPI_REAL8	MPI_F_REAL_8	8
MPI_REAL16	MPI_F_REAL_16	16
MPI_COMPLEX4	MPI_F_COMPLEX_4	2*2
MPI_COMPLEX8	MPI_F_COMPLEX_8	2*4
MPI_COMPLEX16	MPI_F_COMPLEX_16	2*8
MPI_COMPLEX32	MPI_F_COMPLEX_32	2*16

- **The new type names in blue are *fundamental datatypes***
- **Ext32 sizes in brackets are not defined in the current standard (and future)**

Old and New Type Names (2/2)

C++ Kind		Ext32
Current Name	**Proposed New Name**	**Size**
MPI_CXX_BOOL	**MPI_CXX_BOOL**	1
MPI_CXX_FLOAT_COMPLEX	**MPI_CXX_FLOAT_COMPLEX**	2*4
MPI_CXX_DOUBLE_COMPLEX	**MPI_CXX_DOUBLE_COMPLEX**	2*8
MPI_CXX_LONG_DOUBLE_COMPLEX	**MPI_CXX_LONG_DOUBLE_COMPLEX**	2*16

MPI Kind		Ext32
Current Name	**Proposed New Name**	**Size**
MPI_BYTE	**MPI_MPI_BYTE**	1
MPI_PACKED	**MPI_MPI_PACKED**	(1)
MPI_AINT	**MPI_MPI_AINT**	8
MPI_COUNT	**MPI_MPI_COUNT**	8
MPI_OFFSET	**MPI_MPI_OFFSET**	8

Straw Votes (1/)

- Do you agree that the overall of this proposal ?
  - Implementors can define any arbitrary optional basic datatypes.
  - Old datatype names are left unchanged as synonyms and no impact to current users

Straw Votes (2/)

- Definition of terms
  - *Predefined datatypes*
    - Defined in the standard
  - *Optional datatypes*
    - Added by an implementor

Straw Votes (3/)

- **int MPI_Basic_type_equivalent(type0, type1, *flag)**
  - *flag* is set, if *type0* and *type1* are basic datatypes and having the same binary format and size. Otherwise *flag* is set to false.

Straw Votes (4/)

- **int MPI_Type_match(type0, type1, *flag)**
  - **On basic datatypes, if** MPI_Basic_type_equivalent() **with type0 and type1, then it returns true**
  - **On derived datatypes, if they have the same *datatype signatures* (not *type maps*), then it returns true.**

Straw Votes (5/)

- **int MPI_Type_get_name(MPI_Datatype datatype, char *type_name, int *resultlen)**

  - Advice to implementors
    - A high quality implementation returns the distinct type name in the equivalent types.

Straw Votes (6/)

- MPI_<KIND>_<TYPENAME>[_<EXTRA>] or MPI_<KIND>__<TYPENAME>[__<EXTRA>]
- KIND
  - Language "C", "CXX", "F", … (filename extension?)
  - MPI-defined "MPI"
  - Standard "ISO", "IEEE", "ANSI", …
- Type Name (defined by language, shortest one)
  - C/C++ "int", "long long", …
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  - ISO/IEEE "binary16", "decimal32", ..
- Extra
  - Fortran "REAL(4)", "COMPLEX(8)", …

Straw Votes (7/)

- MIN_LOC, MAX_LOC (if still needed)
  - <TYPENAME0>__AND__<TYPENAME1> or
  - <TYPENAME0>__AT__<TYPENAME1>