XcalableMP : Directive-based language eXtension for Scalable and performance-aware Parallel Programming

XcalableMP Specification Working Group

▣ What's XcalableMP?

XcalableMP [1][2] is a programming model and language for distributed memory systems, proposed by XcalableMP Specification Working Group(XMP WG). XMP WG is a special interest group, which is organized to make a draft on "petascale" parallel language. XMP WG consists of members from academia (U. Tsukuba, U. Tokyo, Kyoto U. and Kyusyu U.), research labs(RIKEN, NIFS, JAXA, JAMSTEC/ES) and industries(Fujitsu, NEC, Hitachi) in Japan.

XcalableMP is a directive-based language extension which allows users to develop parallel programs easily and to tune the performance by having minimal and simple notations.

Features of XcalableMP are summarized as follows:

● XcalableMP supports typical parallelization based on the data parallel paradigm and work mapping under global view programming model.

   ◆ A set of threads are started as a logical task. Work mapping constructs are used to map work and iteration with affinity to data explicitly.

   ◆ Rich communication and sync directives such as "*gmove*" and "*shadow*".

   ◆ Many concepts are inherited from HPF.

● Co-array feature of CAF is adopted as a part of the language spec for local view programming (also defined in C).

● XcalableMP APIs are defined on C and Fortran 95 as base languages.

A XcalableMP Prototype compiler and tools are being developed in "Seamless and Highly-productive Parallel Programming Environment for High performance computing" project funded by MEXT in Japan.

▣ Example

All variables except those specified by XcalableMP directives as a distributed object are private and cannot be directly referenced from other nodes. Distributed array is defined by the "align" directive to align the object to the template distributed onto nodes.

The work sharing loop iteration is described by the "loop" directive as in OpenMP and HPF. For work sharing in a loop, each iteration must be assigned by "on" clause so that each node refers to a partial region of the array to be assigned to that node. The programmer can specify the reduction operation on the variable by "reduction" clause.

A fragment of HPCC Stream code is shown in the box.

```
1 double a[SIZE], b[SIZE], c[SIZE];
2 #pragma xmp nodes p(*)
3 #pragma xmp template t(0:SIZE-1)
4 #pragma xmp distribute t(block) onto p
5 #pragma xmp align [i] with t(i) :: a,b,c
  ...
6 #pragma xmp loop on t(i)
7 for(i = 0; i < SIZE; i++)
8    a[i] = b[i] + scalar*c[i];
```

Code Fragments indicated in Red are XcalableMP directives. Lines 2-5 directives define a data distribution for each global data(array a [], b[] and c[]). Line 6 directive is to parallelize the loop of statements.

You can download XcalableMP compiler from *http://www.xcalablemp.org*

For more information about XcalableMP, please visit the following booths.

● T2K Open Supercomputer Alliance (#1321@HALL F)

● Center for Computational Sciences, University of Tsukuba(#3213@HALL H)

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