

XcalableMP

Directive-Based Language eXtension for Scalable and Performance-Aware Parallel Programming



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What's XcalableMP?

MPI is widely used as a parallel programming model. However, the programming cost of MPI is high.

XcalableMP [1][2] is a directive-based language extension which allows users to easily develop parallel programs for distributed memory systems and to tune the performance by having minimal and simple notations.

The specification has been being designed by XcalableMP Specification Working Group which consists of members from academia and research labs to industries in Japan. 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.
- The important design principle of XcalableMP is performance awareness. All actions of communication and synchronization are taken by directives.
- XcalableMP also includes CAF-like feature as local-view programming.
- XcalableMP APIs are defined on C and Fortran 95 as a base language.

Current Solution for parallel programming

```
int array[MAX];
main(int argc, char **argv){
  MPI_Init(&argc, &argv);
  MPI_Comm_rank(MPI_COMM_WORLD, &rank);
  MPI_Comm_size(MPI_COMM_WORLD, &size);
  dx = MAX/size; llimit = rank * dx;
  if(rank != (size - 1)) ulimit = llimit + dx;
  else ulimit = MAX;

  for(temp_res = 0, i=llimit; i < ulimit; i++){
    array[i] = func(i);
    temp_res += array[i];
  }

  MPI_Allreduce(&temp_res, &res, 1, MPI_INT, ...);
  MPI_Finalize();
}
```

Only way to program is MPI, but MPI programming seems difficult... we have to rewrite almost entire program and it is time-consuming and hard to debug... mmm



We need better solutions !!

```
int array[MAX];
#pragma xmp nodes p(*)
#pragma xmp template t(0:MAX-1)
#pragma xmp distribute t(block) o
#pragma xmp align array[i] with t

main(){
  #pragma xmp loop on t(i) reduction (+:res)
  for(i = 0; i < MAX; i++){
    array[i] = func(i);
    res += array[i];
  }
}
```

XcalableMP enables users to easily develop parallel programs and to tune performance with minimal and simple notation !!



Related Works

Existing parallel programming languages or models for distributed memory system, such as Co-Array Fortran (CAF), HPF, and XPF (Fujitsu VPP Fortran) provide various features to describe parallel programs and to execute them efficiently. However, these features are often too complicated for most users to write parallel programs.

HPF provides many useful directives to describe parallel programs. HPF makes it easier to write parallel programs from serial programs. However, it is not always easy to achieve high performance. In HPF, inter-nodes communications are automatically inserted by the compiler. That makes it difficult for the end user to optimize performance.