

Title	Cray XT5 における数値流体プログラミングの Hybrid 並列による高速化について
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# Performance Improvement of CFD programs with Hybrid MPI Parallelism on Cray XT5

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## 1 Background and Purpose

The architecture of HPCs are roughly divided into three types: Shared memory type (many processors share whole memory address), Distributed memory type (many processors communicate with network) and Distributed Shared memory type (combination of shared and distributed one). Nowadays, most of HPCs are Distributed Shared memory type.

The distributed shared memory parallel computer is made of the computation nodes which have shared memory, connected by the network. It is said that the Hybrid Parallelism is effective for parallel computing with such a distributed shared memory machine. The hybrid parallelism is mixed type parallelism: shared memory parallelism on a shared memory type computation node and the message passing computing among distributed nodes.

But the effectivity of the hybrid parallelism is not clear yet. Its performance is changeable by the memory bandwidth, network capability and even the hybrid programming models.

The OpenMP is used for shared memory parallelism as de-facto standard. The way of OpenMP parallelization is embedding parallel directives into the programming codes. This can influence the performance of hybrid parallelized codes.

## 2 Purpose

We used the Cray XT5 as to investigate the effectiveness of hybrid parallelism. The specification of Cray XT5 in JAIST introduced since 2009 is 2-socket AMD Quadcore CPU (8 cores), 16 GB main memory per node and 256 node available. In this research, we investigated the parallel performance of OpenMP on 1 node and of MPI communication performance among the nodes.

## 3 Results

In this report, We investigate the Cray XT5 parallel performance and as using the several benchmarks. And we construct the potential problem solver by FEM and CG method with 2 hybrid programming models.

The results are:

- When the program uses the many cores and the MPI communication time is very high, hybrid MPI outperforms pure MPI.
- We used the 2-dimension potential solver as parallel CFD application and compared master-only hybrid model and MPI+OpenMP SPMD hybrid model. When the problem size is small, Hybrid MPI slightly outperforms Pure MPI. When the problem size is large and the number of cores are high, Hybrid MPI is almost same as Pure MPI.