Performance test of CFD code in the Grid environment

Man Yeong Ha[1*], Seung Do Hong[1], Dae Sung Lee[1], Jae Ryong Lee[1], Sang San Lee[2]

[1] School of Mechanical Engineering, Pusan National University,
San 30, Chang Jeon Dong, 609-735, South Korea

[2] Korea Advanced Institute of Science and Technology,
52, Eoeun-dong, Yuseong-gu, Daejeon, 305-806, South Korea

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Introduction

For simulation of three-dimensional turbulent flow with DNS, we need grid points as much as $Re^{\frac{9}{4}}$ where Re is the Reynolds number. Because it takes much time and expense with current available computing resources, it is nearly impossible to simulate turbulent flow with high Reynolds number. So, the emerging alternative is the Grid computing for needed computation power and working environment.

The Grid is an integrated environment of computing resources that is connected to network but physically distributed. In this study, we want to check current status and problems of current Grid environment by running test CFD codes.

Testbed for Grid

Small Grid environment was setup for a testbed. The Globus from Argonne National Laboratory was used as Grid middleware. There are three different environments for this study. The first is Beoribs in PNU (Pusan National University), 'LAN without Globus'. The second is clusters in KISTI (Korea Information Science and Technology Institute), 'LAN with Globus'. The last, 'WAN with Globus' is connecting Eddy in PNU and clusters in KISTI. Specifications of clusters are listed in Table 1.

Table 1. Specifications of clusters.

System	Globus 2.0 installation	CPU	RAM	Network	OS
Beoribs, PNU	No	P3 550 MHz	SDRAM 512 MB	Myrinet, 66/33 MHz	Alzza Linux 6.1
KISTI	Yes	P4 2.0 GHz	DDR 512 MB	FastEthernet	Redhat Linux 7.3
Eddy, PNU	Yes	P4 2.0 GHz	DDR 512 MB	FastEthernet	Redhat Linux 7.3

Case study

The case 1 and case 2 use code for the unsteady driven cavity flow with spectral method. The cavity code has 40,000~70,000 grid points. In the case 1, the total grid points are fixed and the number of grid points per node gets smaller as the number of nodes increases. In the case 2, the number of grid points per node is fixed. The case 3uses code for DNS of cylinder with circular fins with spectral and multi-domain method. The cylinder code has about 700,000 grid

*E-mail: myha@pusan.ac.kr

points. The case 4 uses code for LES of tube bank with FVM. The tube bank code has about 2,000,000 grid points.

Results and discussions

Case 1 (figure 1). As expected, WAN takes much more time than LAN because of increased communication time. All cases showed bad speed-up due to small grid points, network characteristics. 'LAN w/o Globus' showed a little bit different trend. With fast network, myrinet, run time may be decreased when 9 processors are used for calculation.

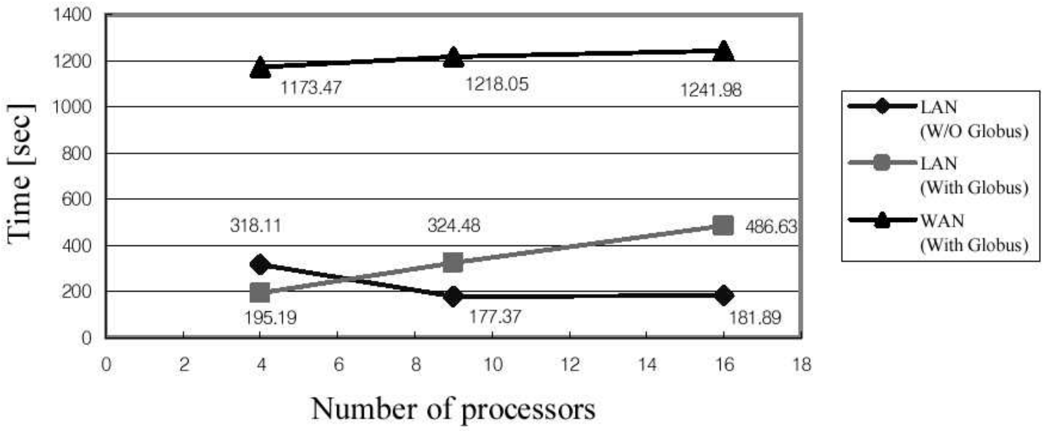

Fig. 1. Total run time of case 1.

Case 2 (figure 2). In cases of LAN, it is not scalable. In case of WAN, it seems to be saturated with more processors. It may be scalable with more processors and more frid points per node are applied. So, we can expect scalability of Grid environments. To make it sure, more experiments are needed.

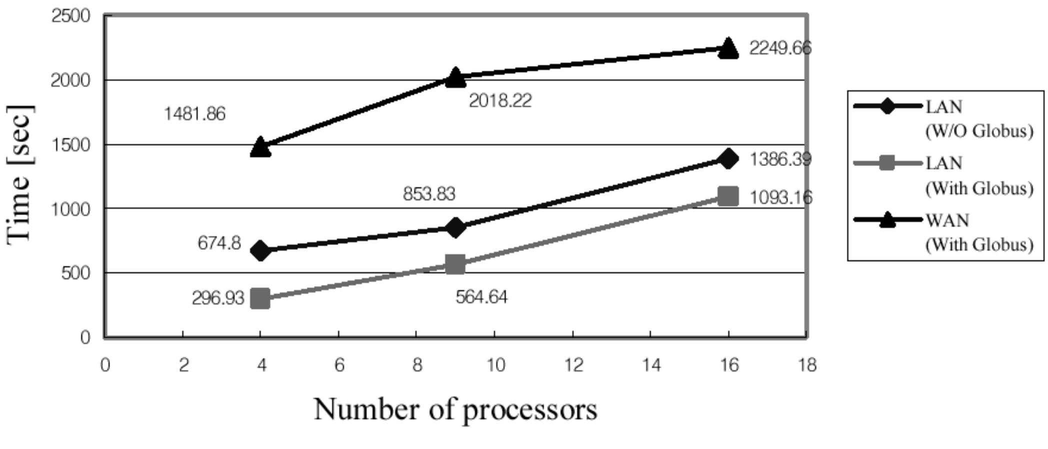

Fig. 2. Total run time of case 2.

Case 3 (figure 3). The number of processors is fixed as 12. 'WAN with Globus' takes time five fold more than 'LAN with Globus'. Main reason of the increased time is increased communication time. So, the feasibility of the Grid depends much on the improvement of the network performance.

Case 4 (figure 4). The number of processors is fixed as 24. 'WAN with Globus' takes time about sixteen fold more than 'LAN with Globus'. The case 4 shows bigger gap in total run time than case 3, because the numerical method and the number of grid points are different. So, there are more appropriate method and algorithm for Grid environments, especially network performance.

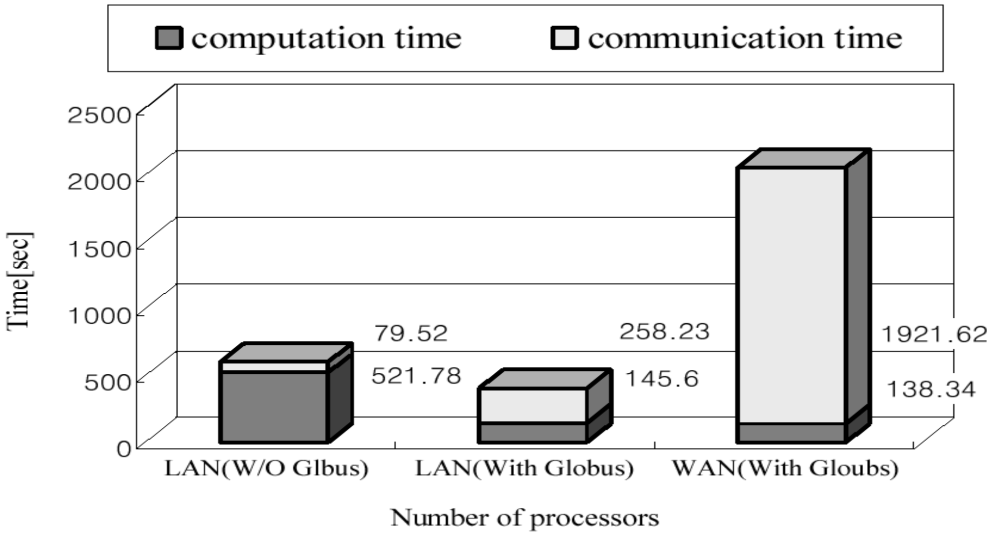

Fig. 3. Total run time of case 3.

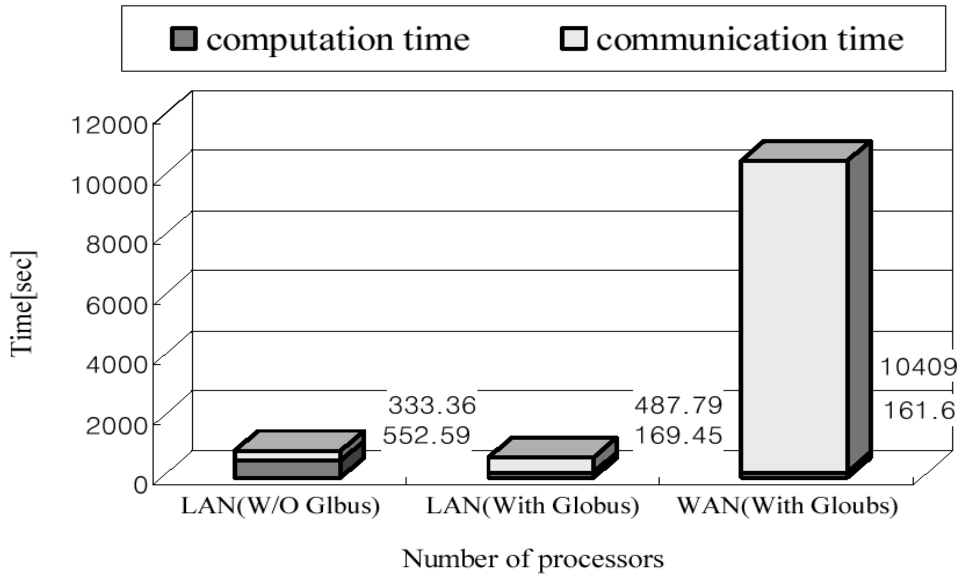

Fig. 4. Total run time of case 4.

Conclusions

Small test bed for Grid environment was setup and ran CFD code in the Grid environment. As expected, it takes more time in WAN by 5 ~ 12 times due to increased communication time. As it shows scalability, running large problem in Grid environment may be reasonable. So, to make Grid feasible, the network is to be improved and CFD code is to be optimized for the Grid. It needs more case studies on network characteristics such as latency, bandwidth and on frequency and size of communication to optimize CFD code to the Grid.