Acceleration of I/O data transfer with RDMA for massively large-scale GPU simulation

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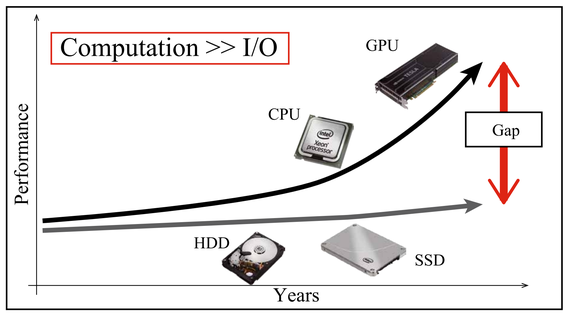
1. Introduction

Recently, Amount of I/O data for numerical simulations becomes very huge due to rapid increase of simulation scale and accuracy. However, there is a large gap between the computational performance of the processor units; i.e., CPU, GPU, and so on and the I/O performance of persistent/non-volatile storage devices such as HDD (Hard Disk Drive), SSD (Solid State Drive). Therefore, the ratio of latency time in I/O processes has been increasing, in comparison with that of computation time, in massively large-scale GPU simulati



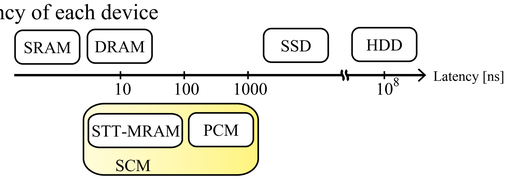
Studies on reduction of the latency time of I/O process

- Acceleration of I/O data transfer with parallel I/O
  - Lustre, Glusterfs etc.
- Using non-volatile memory instead of HDD (Hard Disk Drive)
  - SSD (Solid State Drive)
  - SCM (Storage Class Memory)[1][2]

In our reaserch, we focus on SCM.

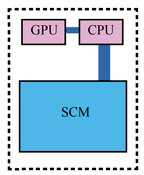
Schematic of SCM (Storage Class Memory)

Access Latency of each device



Features
- Non-volatility
- Low latency
- connectable to a memory bus
- low power consumption

Introduction of SCMs into computer architecture
- as a main mamory
- as a storage device



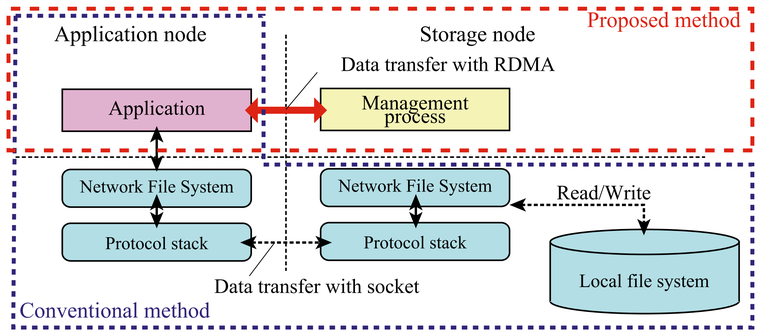
SCM has both features of main memory and storage device.

Purpose

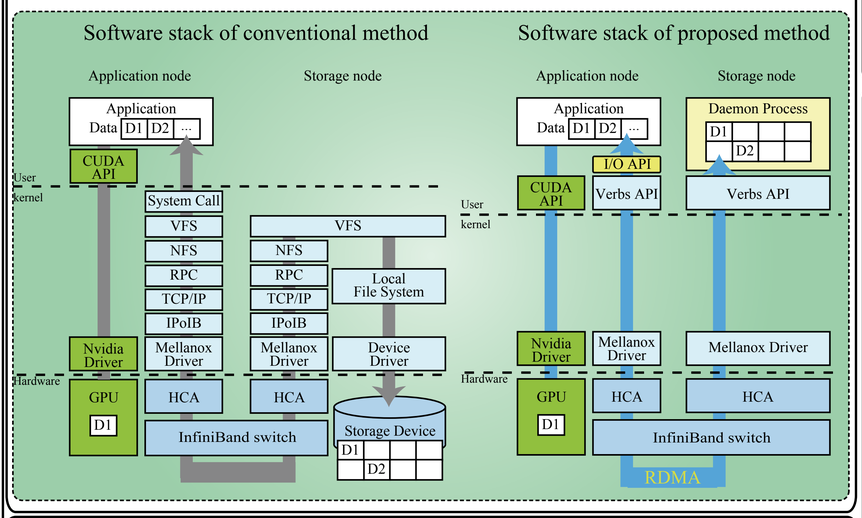
To propose a novel high performance network I/O, in order to achive a reduction of latency time for I/O process in large-scale GPU simulation.

- Using RDMA [3] on InfiniBand [4] interconnection between application node and storage node
- Assuming the introduction of SCMs as a main memory into the computer architecture

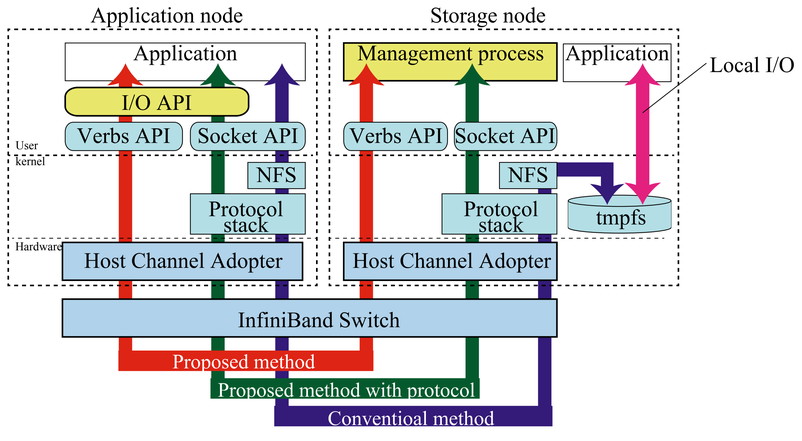
2. Design and implemention proposed method



- Management process is running as a daemon in a storage node which has a huge memory pool for data storage.
- Using RDMA on InfiniBand interconnection between application node and storage node
- Our proposed method bypasses software stacks such as network file system, TCP/IP and IPoIB. Therefore, it eliminates overhead of them.



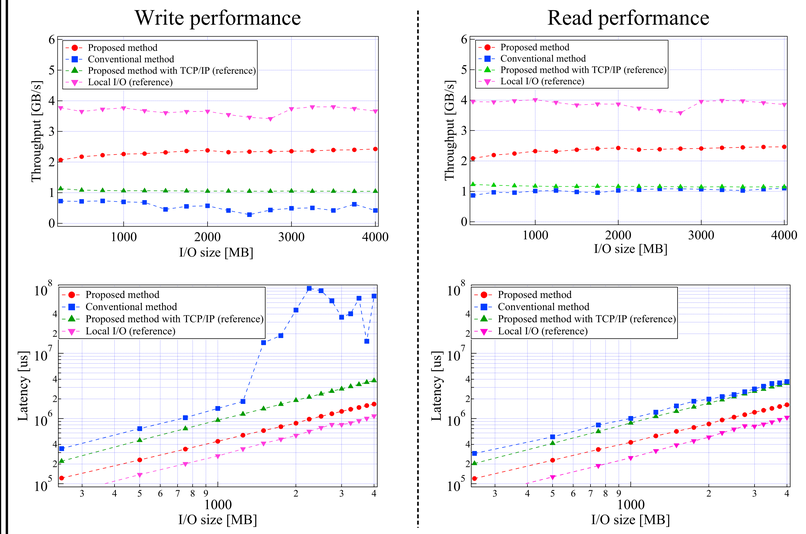
3.Measurement



Procesure of measurement
1) Preparing data array in application
2) following sequences were carried on ten times
   - Copy data from/to storage node using each method
   - Measure I/O latencies during data transfer.

CPU	Intel Xeon X5670
Main memory	16 GB
Network	InfiniBand QDR, 40 Gbps
OS	CentOS 6.3
Network file system	NFS
Local file system	tmpfs [5]

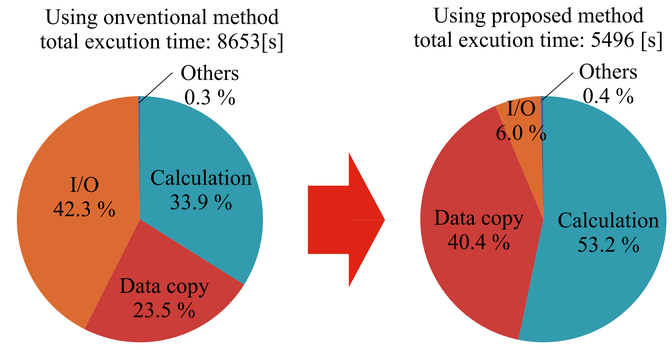
4. Results



- Write performance: approximately 2.4 GB/s, x5.7 compare to conventional method
- Read performance: approximately 2.5 GB/s, x2.7 conpare to conventional method
  * (I/O size: 4 GB)

5. Example of latency time of I/O process

Terget:
- 3 dimensional FDTD (Finite-Difference Time-Domain) method
- parallel computation using 4 GPUs (Tesla M2090 x4) in 1 node
- I/O size: 9.2 GB
- Number of calculation loop: 2000
- Number of I/O process: 200 (at each 10 step)



The latency time of I/O processes was reduced by approximately 6 %.

6. Conclusion

- We proposed the novel high performance network I/O, in order to achive the reduction of the latency time of I/O process in massively large-scale GPU simulation.
- We implemented the orignal I/O API which bypasses the software stacks such as network file system, TCP/IP and IPoIB.
- We found that the latency time of the I/O processes is reduced to approximately 6 % of total execution time by applying our proposed method to large-scale FDTD simulation.

References

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