ABSTRACT
In this paper, we present our empirical study of building a low-powered cluster called SLAP by leveraging mobile processors. To investigate the reliability and usability of our system, we have conducted various performance analyses based on HPL benchmark, a real semiconductor engineering application and the application of distributed file system. Our experience can show potential benefits, possibilities and limits of applying energy efficient alternative solutions to supercomputing which can result in many interesting research issues.

Keywords
Low-powered cluster, Mobile processor, ARM, High-performance computing

1. Motivation and Experience of SLAP
In the operation of leadership-class supercomputing facilities, efficient management of power consumption is becoming a challenging issue that can affect not only the total cost but also the amount of space for cooling systems. Moreover, with the upcoming era of Exascale computers that are expected delivered in 2019-2020, we need to devise effective solutions that can fulfill 20MW of power consumption [1]. However, traditional multi-core processors will not be sufficient to satisfy the limited energy consumption requirement so that many-core coprocessors such as GPU or Xeon Phi should be appropriately utilized as we can see from the Top 500 list of supercomputers [2].

An alternative approach can be leveraging low-powered and lightweight mobile processors which have been mainly used in portable devices such as smartphones, tablet PCs. Although mobile processors are not originally designed to support High-Performance Computing, they are optimized to maintain sustainable performance under a certain degree of power consumption (i.e. batteries). Therefore, the European project called Mont-Blanc [3] has been conducted to design a new type of system built from energy efficient solutions used in embedded and mobile devices. Additionally, relatively low energy consuming ARM server processors are also becoming prevalent. Despite the potential computing powers of emerging mobile processors for HPC should be more investigated, effectively leveraging low-powered and lightweight processor technologies to build a supercomputing cluster can substantially minimize the overall system size along with the cooling device.

In this paper, we present our empirical study of building a small scale cluster called SLAP (Scalable, Low-powered, Autonomous & Robust, Pluggable) based on mobile processor technologies under different use cases and scenarios. Although mobile processor based cluster can have advantages in terms of physical space and energy efficiency, they have not mainly used for HPC servers so that we especially focus on the reliability and usability of our system.

We built a total 10 nodes of SLAP cluster (as we can see from Figure 1) where each node is an ODROID-XU board [4] which consists of Samsung Exynos 5410 SoC CPU, 2GB LPDDR3 RAM, 10/100 Ethernet Controller, USB 3.0 and 2.0 ports as seen from Figure 2.
InAs/GaAs quantum dots. More than CPU or Memory such as board, we could find potential benefits, supercomputing.

By using GlusterFS, a scalable network file system, we can distribute the data efficiently across multiple nodes, reducing the amount of data that needs to be transferred around the cluster. This not only increases the speed of data access but also reduces the energy consumption associated with communication.

Increasing MTU (Maximum Transmission Unit) improves the performance, causing reduction in both energy consumption and computing time due to less communication loads. The aggregated throughput of 10 storage nodes in SLAP cluster for scientific computing is 5~10 times greater than the individual node's performance, representing a significant improvement.

In addition to basic HPL benchmark tests, we also performed evaluations based on a real application from semiconductor engineering and the application of the GlusterFS. The performance has been benchmarked with a parallel 3D Schrödinger-equation solver, where we have computed five eigenvalues of a complex, symmetric 393040x393040 matrix with the LANCZOS algorithm to find the optical gap of InAs/GaAs quantum dots. While the computing time increases by 3~6 times, the energy consumption reduces by 5~10 times representing the potential strength of the SLAP cluster for scientific computing. Increasing MTU (Maximum Transmission Unit) improves the performance, causing reduction in both energy consumption and computing time due to less communication loads. The aggregated throughput of 10 storage nodes in SLAP cluster (based on GlusterFS) shows 5GByte/s which is very competitive compared to the results with traditional CPU architectures.

In the near future, we plan to build a SLAP-v2 cluster with 64-bit ARM processors as well. Lately we complete a preliminary design and thermal analysis of the next-version cluster which is a server appliance type as shown in Figure 6.

2. REFERENCES


