【Grant-in-Aid for Scientific Research(S)】
Integrated Science and Innovative Science (Comprehensive fields)

Title of Project：Fault Tolerant Infrastructure Toward Billion of Parallelization and Exa-scale Supercomputer

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Research Area：Comprehensive fields – Computer science
Keyword：Exa-scale system, Fault tolerant

【Purpose and Background of the Research】

"Simulation" is becoming attractive tools as 3th methodology following after theoretical and experimental basis methodology. Thanks to Supercomputers, the large-scale simulations can be achieved. Recently, the performance of Supercomputers increases exponentially every year with increasing demands for computational power. In 2018, exa (10^{18}) flops supercomputers are expected to emerge.

However, the constant increasingly number of nodes and components will lead to a very high failure frequency for Exa-scale supercomputers. In an optimistic scenario, where the reliability of each component increases several times, the failure frequency will still be dozens of times higher, therefore, the mean time between failures will be no more than tens of minutes, which means computing node doesn't work in effect. A lot of fault-tolerance techniques are proposed, but current techniques can't accommodate Exa-scale systems.

We will seek a solution to the problem by using post-petascale TSUBAME3.0, which is successor to TSUBAME2.0 and expected to emerge in 2014.

【Research Methods】

We will focus on the following five techniques to establish fault-tolerant infrastructure for Exa-scale supercomputers. (1) Extension of our mathematical fault tolerant models for Exa-scale system: We extend our mathematical models for fault tolerant to accommodate billions of threads. We validate applicability of the fault tolerant model to Exa-scale system from historical records of fault of TSUBAME1, which is predecessor to TSUBAME2.0, in the past four and half years and validate (2) Development of new fault-tolerant method for large-scale and fine-grain heterogeneous supercomputer: We apply our extended fault tolerant model to hybrid supercomputer consisting many core processor (e.g. GPU) and multi core processor (e.g. CPU), which is most promising architecture for exa-scale systems. (3) Overhead minimization of the fault-tolerant system: We archive high dependable but high performance computation with minimization of the overhead in fault tolerant system by using next-generation non-volatile memory (e.g. SSD) distributed among nodes. (4) Development of fault recovery methods: We add autonomous fault detection, prediction and dynamic fault recovery selection mechanism to our fault tolerant model. (5) System integration and the performance evaluation: We integrate our fault tolerant systems and conduct performance evaluation toward TSUBAME3.0.

【Expected Research Achievements and Scientific Significance】

Our research achievements are expected to contribute to development of TSUBAME3.0 and Exa-scale supercomputer. Nowadays, supercomputers are used in a wide range of scientific fields, such as biology, geology and statistics and becoming an essential tool for simulations and data analysis. Exa-scale supercomputers enable high precision and high performance simulation and have a significant impact on science academic fields.

【Publications Relevant to the Project】

- Hideyuki Jitsumoto, Toshio Endo, Satoshi Matsuoka."Environmental-Aware Optimization of MPI Checkpointing Intervals", Proc. IEEE Int'l Conf. Cluster Computing (Cluster 2008)
- Leonardo Bautista Gomez, Naoya Maruyama, Franck Cappello, Satoshi Matsuoka. "Distributed Diskless Checkpoint for Large Scale Systems", Proc. 10th IEEE/ACM Cluster, Cloud and Grid Computing (CCGrid 2010)

【Term of Project】 FY2011-2015

【Budget Allocation】 164, 400 Thousand Yen

【Homepage Address and Other Contact Information】

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