Fusion ioMemory™ Solutions by SanDisk®
Plow the Way for "Smart" Snow Removal in Sapporo

Real-time social Cyber Physical Systems implemented with Fusion ioMemory™ drives and MongoDB

Solution Focus

- IoT Social infrastructure solutions
- Big Data
- MongoDB

Summary of Benefits

- High-speed processing of vast amounts of data
- Fast response for analysis
- Service building at a reasonable cost

Product

- Fusion ioMemory™ ioDrive®2 PCIe drive

"We would not have been able to perform this field trial at the cost performance that we hoped for, without MongoDB and Fusion ioMemory solutions."

Mr. Hajime Imura, Assistant Professor, Graduate School of Information Science and Technology Meme Media Laboratory, Hokkaido University

Summary

The Meme Media Laboratory, located in the Hokkaido University Graduate School of Information Science and Technology, was founded in 1996 for the purpose of original research and developing creative talent. As part of his research on Cyber Physical Systems (CPS), Assistant Professor Hajime Imura of the Laboratory has been working on field trials that strive to optimize social systems, which fuse cyberspace and the real world. These field trials aim to optimize and improve the efficiency of snow removal in Sapporo, Japan. The Laboratory has introduced Fusion ioMemory™ drives in order to analyze, in real time, the massive amounts of environmental and road information that is collected via mobile sensing.

Background

Research on cyber physical IT integration infrastructure for the optimization of social systems and services

Since 2012, the Meme Media Laboratory of Hokkaido University has been involved in research on cyber physical IT integration infrastructure for the optimization of social systems and services. This is an experiment to realize a more efficient and advanced society by connecting information on sensor networks—which penetrate real world (physical) systems—with the power of cyberspace computing capabilities. As part of this research, Assistant Professor Hajime Imura of the Laboratory has been working on applications for optimizing and improving efficiency of waste snow removal in smart federation integrated environments and snowfall regions.

"Our research theme is the application of the IT integration infrastructure, which we built through our research, to the optimization of waste snow removal in Sapporo. Sapporo has the most snowfall of any metropolis with a population of over one million people in the world. Because of this, the budget for snow removal per year can reach 15 billion yen ($126 million), and the total distance that snow removers must travel in a single night is over 5000km. Even with such a high budget, the city of Sapporo has received over 40,000 complaints and requests in regards to snow removal. In order to resolve these issues and decrease the yearly snow removal budget, we are working on a CPS structure aimed at smart waste snow removal social services," Mr. Imura told us regarding his research.

The Challenge

In field trials of smart snow removal, road and traffic data, weather data, and city government data, are collected in real time. For example, road and traffic data allow the Laboratory to obtain the GPS location and speed of the 1000 taxis and cars actually driving through the city every few minutes. Weather data allow the Laboratory to obtain the Hokkaido mesh snowfall, as well as X band MP radar, in real time. In addition, the team also collects Sapporo City Transportation Bureau subway passenger numbers, and records of snow removal performed over the last nine years in the database to use for analysis.
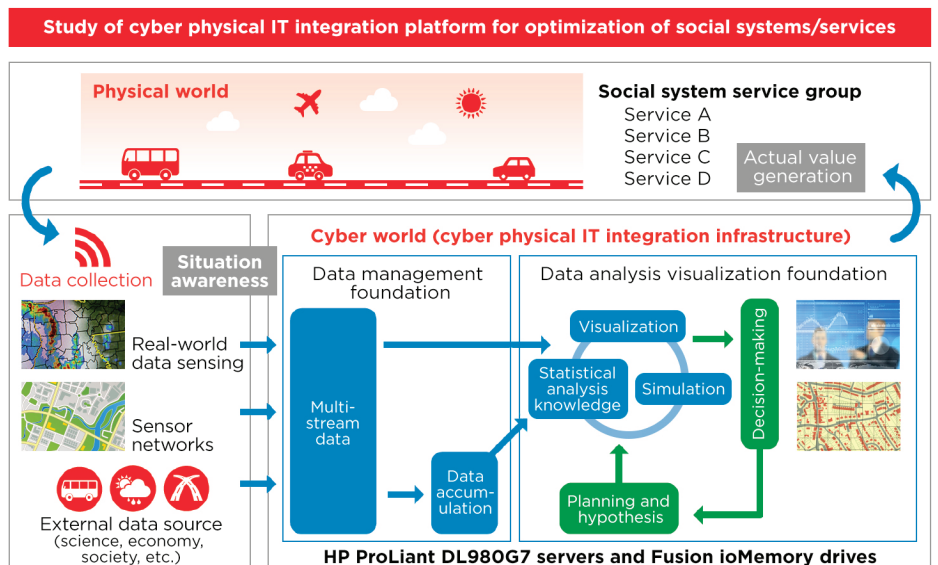
"In our field trials, we have obtained cooperation not only from the government and police department, but also from private taxi companies and automobile manufacturers, to construct a framework that can collect a massive amount of social data," Mr. Imura explained about the challenges of building the system for smart waste snow disposal. "Every five minutes we receive GPS location information and speed from cooperating taxis and other vehicles, which we call probe cars. Just by analyzing these data in real time, we can understand the traffic jam conditions on the roads that result from snowfall. However, in order to do so, we needed a system infrastructure that could record and analyze the data that are collected at high speed, in real time."
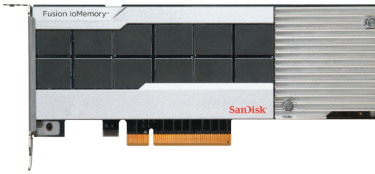
Superior throughput of Fusion ioMemory solutions bring out the full functionality of MongoDB

In order to realize a smart waste snow removal system, it was necessary to store a massive amount of data and analyze them in real time, and then link this analysis to instructions for actual waste snow removal work. In order to do this, the team met many challenges on the system side. Mr. Imura described those challenges, commenting, "The database we chose in order to store the data acquired through social sensing was the NoSQL-type MongoDB database, which excels at the processing of unstructured data. However, when we first began the research, we needed to make a huge hardware investment in order to process in real time the large capacity data that we needed with the MongoDB."

Databases that handle unstructured data have to perform disk access more frequently than relational-type databases, for data storage, reading, and retrieval. In other words, while the MongoDB is flexible, accessing the storage placed a strain on it.

"While we knew that we needed CPU power for searching and analysis, even more important was reducing the I/O strain occurring from data storage and retrieval. When we first began our research, we looked into raising the I/O processing speed through hard disk configurations and the parallelization of arithmetic processing via

Study of cyber physical IT integration platform for optimization of social systems/services

HP ProLiant DL980G7 servers and Fusion ioMemory drives

Fusion ioMemory™ ioDrive®2

a distributed environment," Mr. Imura said about the deliberation process. "However, we learned that we would not be able to obtain adequate speed with a normal hard disk. Also, if we made the CPU into a distributed environment, we would need to make modifications to speed up the parallel processing, which would make operation complicated. In that case, we thought maybe we could solve the problem just with a high-speed CPU, and retaining an I/O throughput that can follow the CPU. At that point, we learned about the existence of Fusion ioMemory™ drives."

The Solution

Around 2012, Mr. Imura looked into procuring the HP ProLiant DL 980 G7 server and noted that integrated Fusion ioMemory drives were an option for realizing high-speed I/O. "By using Fusion ioMemory drives, all of our problems were solved at once. Without having to consider other products such as complex raid configuration and parallel processing, it became possible to read and write the data as the laboratory needed to, using a high-speed I/O throughput," said Mr. Imura, regarding the reason for introducing the product.

The Result

Enhanced Fusion ioMemory solutions to meet the increased data from social sensing

Mr. Imura's laboratory, which has been smoothly proceeding with their research on applications for optimizing and improving efficiency of waste snow removal in smart federation integrated environments and snowfall regions—thanks to the HP ProLiant DL980 G7 server and Fusion ioMemory solutions—plans on an additional enhancing of their social sensing next year.

"The preparation stage of our field trials has been proceeding smoothly, and we are planning an additional development. For this, we decided to increase the types of probe cars, in order to understand road conditions in more detail. An example of this is a framework called crowd sourcing, where we ask citizens to place a drive recorder application in their family car, and they send us the imaging from this. By collecting such images, we can gather travel information such as GPS, and our understanding of roads will also drastically improve. However, we now require more storage capacity than before to accumulate and process the image data. It was right then when the second generation Fusion ioMemory drives appeared," said Mr. Imura. The current version of Fusion ioMemory drives has been expanded to twice the storage capacity of the original PCIe drive, and its functionality has also been improved.

"In addition to image data, since we are now able to calculate 3D road shapes from laser range finder measurement data, the amount of information for recording and analyzing has become massive. That's why we decided to introduce the 1.2TB and 785GB Fusion ioMemory drives," adds Mr. Imura, in regards to the adoption of the new version.

Outlook

Going forward, the team will make models of speed changes, based on weather conditions, and will expand their work to forecasting traffic conditions and disaster control.

"I do not believe we would have been able to realize this field trial at the cost performance that we hoped for, without MongoDB and Fusion ioMemory solutions. With the social CPS that we are aiming for, our research success depends on whether we can collect massive and intricate city data, and make accurate analyses and predictions. If we continue to expand this research, we believe we will be able to apply it not only to predicting traffic conditions, but also for city disaster control. In order to do this, we will depend on Fusion ioMemory drives to continue to improve its throughput, so that we can collect even more data and access them more quickly," said Mr. Imura.

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