Kyushu University optimizes urban traffic control with HPE Moonshot

Researchers use analytics of the Internet of Things to alleviate traffic congestion and improve quality of life

Objective
Demonstrate the feasibility of using graph analysis to enable intelligent, optimal traffic control within an Urban OS for the city of Fukuoka, Japan

Approach
Run Graph analytics on the HPE Moonshot System configured with HPE ProLiant m710 Servers, using data feeds from city streets, traffic networks, people, vehicles, and weather information to optimize urban traffic control

IT Matters
- Analyzed 320,000 nodes and 700,000 edges of a transportation network graph in just 2 minutes, 30 seconds
- Reduced data center footprint by 90% and energy consumption by 88% compared to traditional 1U servers built to the same specifications
- Performs supercomputer analytics while drawing an average of only 2,800 Watts—comparable to a small home appliance

Business Matters
- Enables sensor data to be collected every 15 to 30 minutes to control traffic signaling and digital displays in near real time for optimal traffic routing or emergency evacuations
- Demonstrates how the Internet of Things can be used to redesign urban infrastructures and improve quality of life
- Sets the stage for using graph analysis to solve large societal issues such as population, environment, energy, natural disasters, and global cultural institutions

Challenged to solve major urban issues such as traffic control, Kyushu University launched an Urban OS project, applying advanced graph analysis to demonstrate how to optimize traffic for the city of Fukuoka, Japan.

By running the analysis on the Hewlett Packard Enterprise (HPE) Moonshot System, the University analyzed 320,000 nodes and 700,000 edges of a transportation network graph in just 2 minutes, 30 seconds. This achievement will ultimately enable Fukuoka to collect and analyze sensor data every 15 to 30 minutes to control traffic signaling and digital displays in near real time for optimal traffic routing or emergency evacuations.

As the Internet of Things becomes reality, many researchers and municipal planners are now looking to build on this vast interconnected web of data and devices to create the "Urban Operating System" (Urban OS). Seen as the foundation for 21st century smart cities, the Urban OS is a technological nervous system wirelessly connecting everything from traffic flow and energy consumption to weather and social events. All this data is fed into a massive analytical engine that can feed back out to things like traffic signals or generating stations—even individual smart phones—to improve the efficiency and quality of life for the people living and working in the city.

> "The biggest attraction of the HPE Moonshot System is that the cluster environment built with 45 server nodes and 180 cores can be housed in just 4.3U of space," observes Professor Fujisawa. "We were surprised to be operating at such low power consumption levels for the entire system, which averages about 2,800W. That is comparable to the power needed for small home appliances."
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> – Professor Katsuki Fujisawa, Institute of Mathematics for Industry, Kyushu University

Researchers at Kyushu University in Japan are bringing this futuristic concept to the city of Fukuoka today. Led by Professor Katsuki Fujisawa from the Institute of Mathematics for Industry, Kyushu University is using advanced graph analysis to demonstrate how to predict traffic congestion across Fukuoka's entire transportation network. The compute engine driving this Urban OS project: the HPE Moonshot System.

The University's Urban OS project applies a three-layered approach to graph analysis that plots data collection points and target points across time. Professor Fujisawa explains, "In descending order, the macro analysis layer would be used for long-term measures such as transportation networks and urban planning. The mid-level analysis layer would apply to medium-term traffic control such as elimination of congestion. Lastly is the microanalysis layer, which is for real-time localized control such as disaster evacuation. Each has different lead times based on size and data calculations. Computational resources and technology should be utilized with respect to the data`s unique characteristics. There is no need to run everything on huge supercomputers."

Professor Fujisawa evaluated several options for Graph clusters to perform the required analytics, including supercomputers, scale-up servers, and scale-out systems equipped with a graphics processor unit (GPU). Ultimately, he chose the HPE Moonshot System as the optimal compute platform for the mid-level analysis layer.

"The biggest advantage of the HPE Moonshot System is its capability to provide highly efficient computational resources for the mid-level graph analysis layer," says Professor Fujisawa. "Traditional 1U servers would require two racks and much more power consumption. In addition, we devised a way to use part of the onboard SSD memory for additional storage capacity. Because the Moonshot System is built on an industry-standard x86 server, we could use existing resources such as compilers and libraries interchangeably. The HPE Moonshot System greatly exceeded others in comprehensive strength as a server."

The Professor has many years of experience working with supercomputers, frequently using the TSUBAME supercomputer at the Tokyo Institute of Technology. He noted that the systems designers at Hewlett Packard Enterprise demonstrated great innovation in the architecture and technology of the HPE Moonshot System.

Supercomputer performance in a fraction of the space

Graphs—also referred to as complex networks—consist of dots (nodes) and lines between dots (edges). Graph analysis requires highly advanced computations to plot all the nodes and edges in a complex network to uncover trends and insights that can then be used to optimize the network. By way of example, the U.S. road network has 24 million nodes and 58 million edges; the neuron network of the human brain contains 89 billion nodes and 100 trillion edges.

Professor Fujisawa notes, "The application range of graph analysis has been very widespread—for example, to research traffic route data, measure the dynamic impact of social networks, implement cyber security, predict the diffusion of diseases, and plan infrastructure lifecycles. Graphs can be broad in scope and they don't limit the number of applicable fields. They are very similar to the architecture of modern parallel computing systems."

For the Urban OS project, Kyushu University deployed 45 HPE ProLiant m710 servers with Intel® Xeon® Processor E3-1200 v3 and Intel Iris™ Pro Graphics 5200. The ProLiant m710 servers are housed in the HPE Moonshot 1500 chassis, which consumes just 4.3U of physical space and draws a fraction of the power of traditional servers. The ProLiant m710 servers provide 32GB of memory and a 480GB solid state drive (SSD) to achieve 1.44TB of memory and 21.6TB combined internal storage per chassis. With this configuration, HPE Moonshot was able to graphically analyze 320,000 nodes and 700,000 edges in just 2 minutes, 30 seconds.

"The ability of HPE Moonshot to complete the graph analysis so quickly definitely exceeded my expectations," declares Professor Fujisawa. "This result means that it is possible to collect sensor data every 15 to 30 minutes to analyze and display the data required for traffic control on digital signage. For example, the current operating traffic information system can only deliver accident information. However, with this new system, it is possible to derive optimum guidance routes and display them. Moreover, if it is a localized analysis, it would be possible to do all this in close to real time."

Societal impact from the Internet of Things

The processing capability of HPE Moonshot marks a big step forward in the social implementation of urban traffic control in Fukuoka. Professor Fujisawa's team is carrying out this project in partnership with Kyushu University's Center of Innovation (COI), which is focused on the practical application of technology to solve real-world issues.

Yoichi Korehisa, COI Program Project Leader working with the Center of Co-Evolutional Social Systems at Kyushu University, explains, "There are many issues surrounding our lives, such as population, environment, energy, natural disasters, and global cultural institutions. While facing these interwoven issues, we aspire to achieve a symbiosis and evolution in diversity. It is a part of my mission for the COI program to take the lead in demonstrating cooperation between industry, government, and academia to implement, operate, and maintain new technology to benefit society. In this case we will need to work together to develop infrastructure with updated media distribution and new digital signage to enable an intelligent traffic system."

The graph analysis powered by HPE Moonshot is a real-world application of the Internet of Things, using data from city streets, traffic networks, people, vehicles, and weather information to optimize urban traffic control for Fukuoka.

"The analysis performed by Professor Fujisawa clearly demonstrated the functions of the Urban OS and marked a milestone toward societal implementation of urban traffic control," states Mr. Korehisa. "Specifically, it would be possible to forecast traffic congestion for an entire city every few minutes. In the next several years, it will also be possible to formulate the optimal

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planning of transportation infrastructure. This technology would make it possible to alleviate traffic congestion, guide and reroute traffic if specific roads or bridges became impassible, or even direct disaster evacuations."

Professor Fujisawa suggests that the results of this early analysis could have even further implications. "Intentionally inducing light traffic patterns could lead to the elimination of major congestion that frequently occurs in trucking roads," he proposes. "If your aim is overall optimization, then even if a driver encounters short delays at an intersection, it could still result in an overall shortest time to reach the destination."

Big impact in a compact form factor

In addition to the societal impact, HPE Moonshot is demonstrating how researchers can achieve unprecedented infrastructure efficiency for performing advanced graph analysis. For example, with its compact form factor, HPE Moonshot reduced the data center footprint by 90% and uses nearly 88% less energy compared to traditional 1U servers built to the same specifications.

"The biggest attraction of the HPE Moonshot System is that the cluster environment built with 45 server nodes and 180 cores can be housed in just 4.3U of space," observes Professor Fujisawa. "We were surprised to be operating at such low power consumption levels for the entire system, which averages about 2,800W. That is comparable to the power needed for small home appliances."

Broad implications for global change

Mr. Korehisa of Kyushu University's COI program sees the Urban OS as a steppingstone to realizing sustainable societal growth and development by revolutionizing the way information and technology can be used to optimize municipal systems. The COI has planned three years for element technology development, three years for demonstrating a proof of concept, and three years for social implementation. The project expects to see results from the proof of concept by 2017.

"We have to further develop the Urban OS to successfully integrate it into the city infrastructure and see a real impact on people's lives," says Mr. Korehisa. "We expect Professor Fujisawa to be instrumental not only in the development of big data analytics from various sensors and devices, but also to elevate the Internet of Things as an integral part of everyday life, breathing new life into the new technology all around us."

Professor Fujisawa concludes, "When we think of an Urban OS we should not be forced into thinking of rigid uniform values based on the assumption of using products and technologies. It is an operating system that allows various applications to be developed and grow freely. With additional research, we will be able to implement the Urban OS at Fukuoka and lead the way in showing results that have great social impact and the possibility of broad societal change all over the world."

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