About Us: Cybermedia Center, Osaka University

Cybermedia Center, Osaka University, Japan

About Us: Cybermedia Center, Osaka University

As a resource provider of knowledge and technology derived from advanced researches conducted in Osaka University, the Cybermedia Center (CMC) offers support in the areas of large-scale computation, information communication, multimedia content and education. The center also works closely with educational and research organizations within Osaka University, as well as with industries and institutes outside the University. By sharing its resources and encouraging local communities to use its facilities for public lectures and other events, CMC has helped to create a more internationally-oriented IT society for the region.

Toyonaka Campus

Suita Campus

Minoh Campus

HPC System

Research Divisions

Informedia Education Division develops an advanced environment for information processing education; offers educational programs on information processing and information ethics; and also conducts educational research, including faculty development programs for teaching staffs in information processing.

Multimedia Language Education Division develops an environment for language education using multimedia and provides assistance in the development of multimedia-based language education materials, such as for internationalized education using networks and foreign language programs as common subjects in Osaka University.

Large-Scale Computational Science Division supports the operation of CMC's supercomputer system, disseminates technology for visualization of computational results, and facilitates advanced utilization technology for large-scale computing systems. This division also offers educational programs and studies on computing science and related subjects.

Computer Assisted Science Division supports the operation of general-purpose computer systems; hosts faculty development programs to improve efficient computer applications for setting up and solving scientific problems; also offers educational programs and conducts research on subjects related to learning processes for setting up and solving scientific problems.

Cybercommunity Division supports the planning and operation of SCS-based distance learning, plans and operates distance training in the field of advanced technology, and studies the operation and promotion of cybercommunity plans.

Advanced Network Environment Division supports the operation and utilization of ODINS (Osaka Daigaku Information Network System) to introduce new network technologies such as high-speed networks and mobile computing environments, to facilitate the utilization technologies of large-scale wide-area computer networks, and to carry out research on network-related education.

Applied Information Systems Division develops and provides education on utilization technology for large-scale information systems; digitalizes libraries; supports the management of various databases; implements education on information systems and multimedia systems; and undertakes education on information explorer.

Communication Network Analysis, NTT DOCOMO Collaborative Research Division, was founded last year in collaboration with the largest mobile communications operator in Japan.

PetaFlow Project: A project towards an ultraparallel synergy Internet system for scientific applications

Cybermedia Center Osaka University

Strategic Japanese-French Cooperative Program

Overview:

It is a reality that “contemporary society and science is faced with the challenge of dealing with increasing amounts of data.” Today, continuous developments occur in measurement technologies and computational resources in various fields of science and society. They have facilitated the collection as well as generation of petascale data. High-performance computational (HPC) resources need to be made remotely accessible through long-distance, high-performance networking for the efficient generation or processing of petascale data. The PetaFlow project enables the representation of these data as an interactive scientific visualization. Consequently, the emergence of adequate “information and communication technologies (ICTs)” has been beneficial for the generation and processing of petascale data with respect to high-performance computing-networking visualization and their mutual “awareness.”

We organize our project into three functions; PetaFlow Application, PetaFlow Visualization, and PetaFlow Network and Middleware as follows.

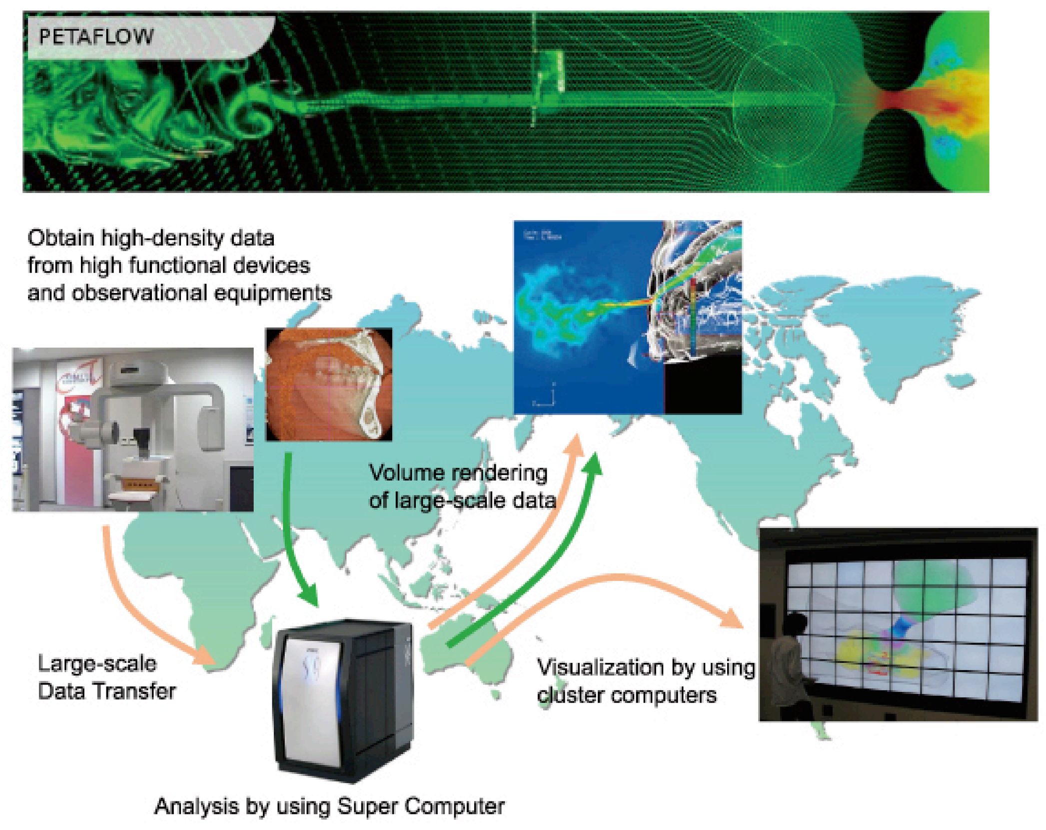

Figure 1: Overview of PetaFlow scheme.

PetaFlow Application:

Interactive super computing helps oral practitioners (dentists) to demonstrate a predictive orthodontic surgery or fabrication of dentures that enable patients to know the change of pronunciation before his operation, such as tooth movements. To do this, appropriate HPC packaging is necessary, so as to avoid strange movements due to the losing frames, because the package includes heavy simulations, CFD etc. Smooth and useful computational oral therapies required the profluent information flow by using the advancing internet technologies (see Fig. 2).

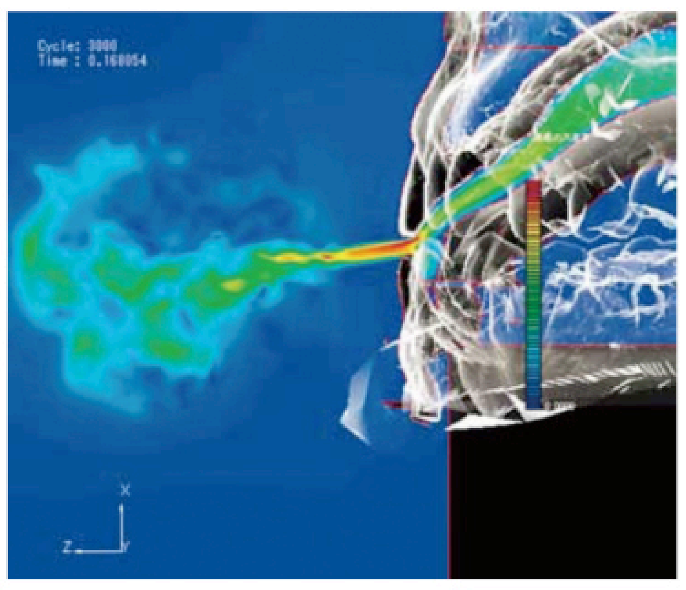

Figure 2: Application example.

PetaFlow Visualization:

We utilize the FlowVR library to visualize computing results in world-wide large-scale visualization. The FlowVR library provides users with the necessary tools to develop and run high performance interactive applications on PC clusters and Grids. The main target applications include virtual reality and scientific visualization. FlowVR enforces a modular programming that leverages software engineering issues, while enabling high performance executions on distribued and parallel architectures. The FlowVR software suite has today three main components; FlowVR, FlowVR Render, and VTK FlowVR (see Fig. 3).

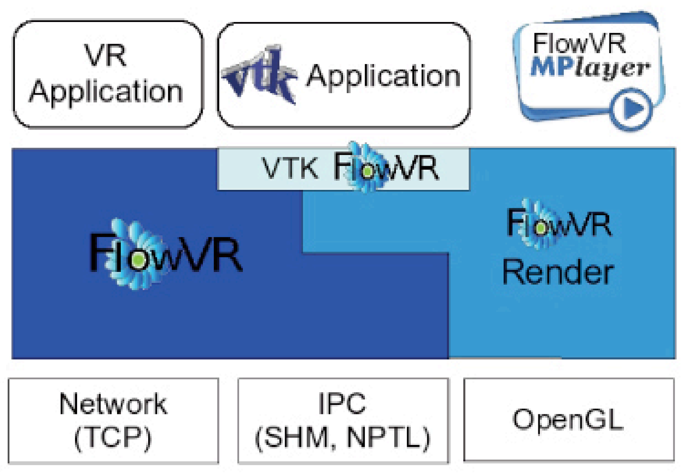

Figure 3: Architecture of FlowVR.

We also utilize Particle-based volume rendering (PBVR). PBVR is one of the effective rendering techniques applicable to huge volumes of data. It is based on Sabella’ s density emitter model, in which the scalar field is characterized as a cloud of opaque and self-emitting particles with single-level scattering. PBVR, being different from the ray-casting method, does not require sorting of elements, and thus, it facilitates handling of huge amounts of data, which could be of the magnitude of several gigabyte. We show an example in Fig. 4, where oral flow sound simulation results in higher-level complexities of 3D phenomena and huge volume datasets on Tiled Display Wall in Fig. 4.

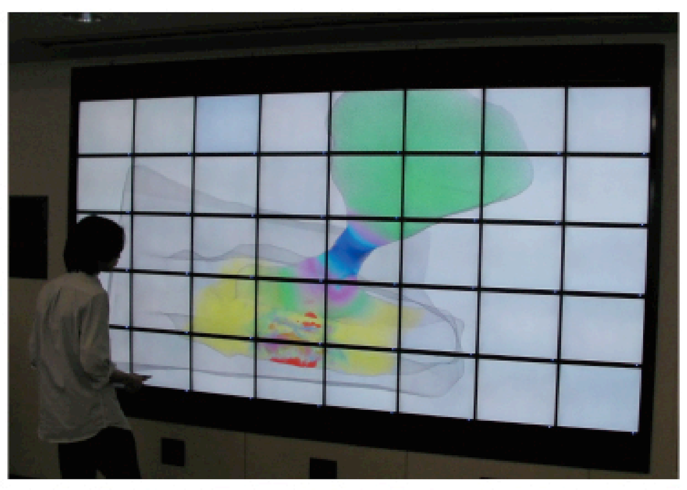

Figure 4: Particle-based volume rendering (PBVR) on tiled display wall (TDW).

PetaFlow Network and Middleware:

The PetaFlow network testbed is a layer-2 virtual private network (VPN). It has been developed from the NAREGI-Grid5000 network testbed (2006–2009) and constructed through a collaboration among SINET, JGN-X, RENATER, GEANT, and MAN LAN. Figure 5 shows the topology of the PetaFlow network testbed. On the Japanese side, the network is composed of SINET and JGN-X networks, which are connected at Tokyo. The NII and Kyoto University connect with SINET, and Osaka University connects with JGN-X. The international network operated by SINET is used to connect the Japanese research foothold with Grid5000, and this network extends to MAN LAN (New York, USA) via GEANT (Europe). The Grid5000 backbone network is provided by RENATER.

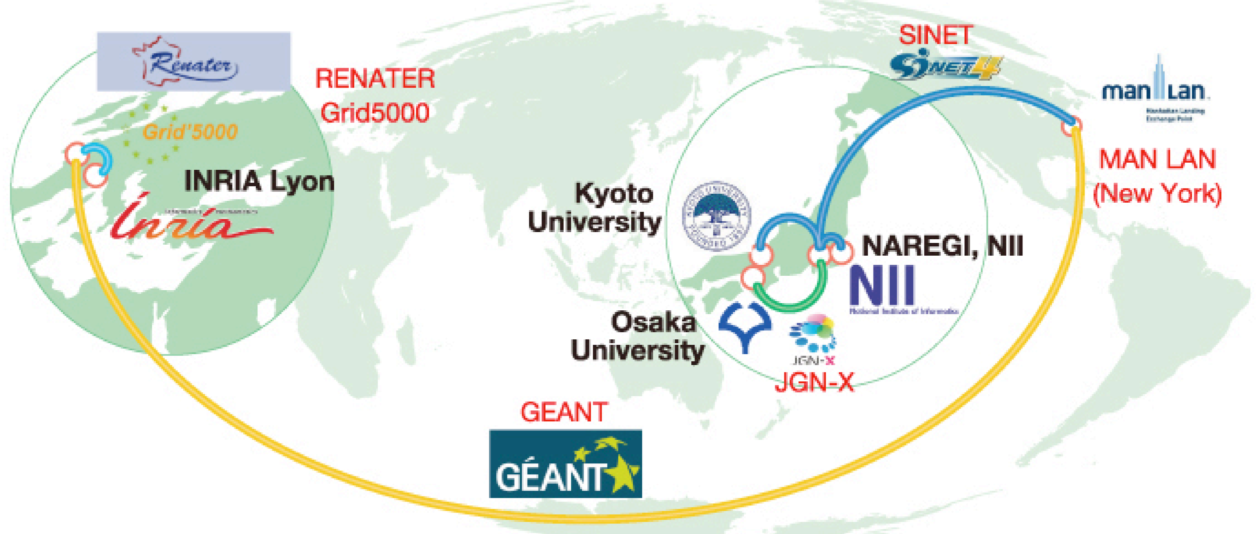

Figure 5: Network topology in PetaFlow testbed.

RESO (ENS Lyon, INRIA Grenoble) is focused on metrology equipment synchronization and Bulk Data Transfer software. The metrology equipment that will be connected at INRIA Grenoble and Osaka University, consist of two servers that each have Endace DAG7.5G2 network monitoring card installed over one 10 Gbps interconnection Grid5000 (France) and NAREGI (Japan) and one 1Gbps cluster at Osaka University. EndAce DAG card provides a synchronized sub-10 nanosecond timestamp capability over 2Gbps capture and inspection. For synchronization and accuracy of network traffic, we are using two Trimble Acutime Gold GPS smart antenna mounted at both locations. Acutime Gold GPS system is set with L1 frequency, C/A code (SPS), continuous tracking receiver, static overdetermined clock mode, Update Rate of 1Hz, Event Update maximum of 5 Hz/second and External Event Capture of 455 nanoseconds.

For bandwidth reservation and co-ordination of bulk data transfer of large medical images, the RESO team is using FlowVR library at both servers to view these large data file images, while using jBDTS to set and handle bandwidth reservations and proper application scheduling to ensure the data images have enough bandwidth to be sent at an efficient and effective rate (see Fig. 6). This is accomplished by profiling the availability of the whole bandwidth available to the system so that fair sharing is incorporated amongst interactive applications set by jBDTS profile.

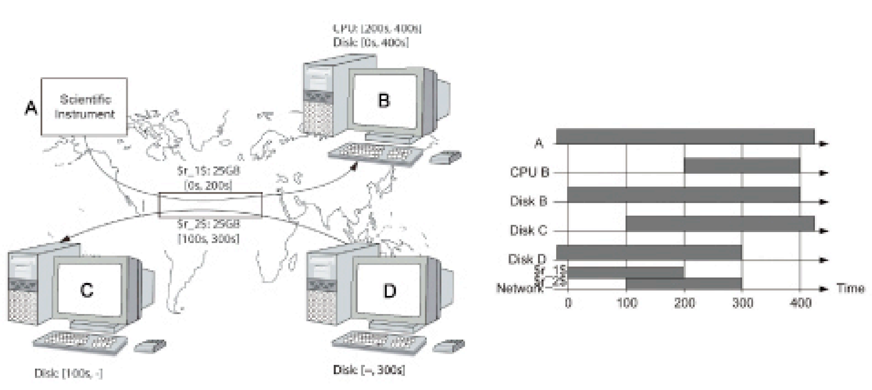

Figure 6: Design of bulk data transfer scheduling (jBDTS).

Member of PetaFlow Project

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Ken-ichi Baba: Network (Osaka University, JAPAN)
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PetaFlow Project: A project towards an ultraparallel synergy Internet system for scientific applications

Advantages of Vector Supercomputer Maintained in Japanese Joint-Use for Academia

Cybermedia Center, Osaka University, Japan

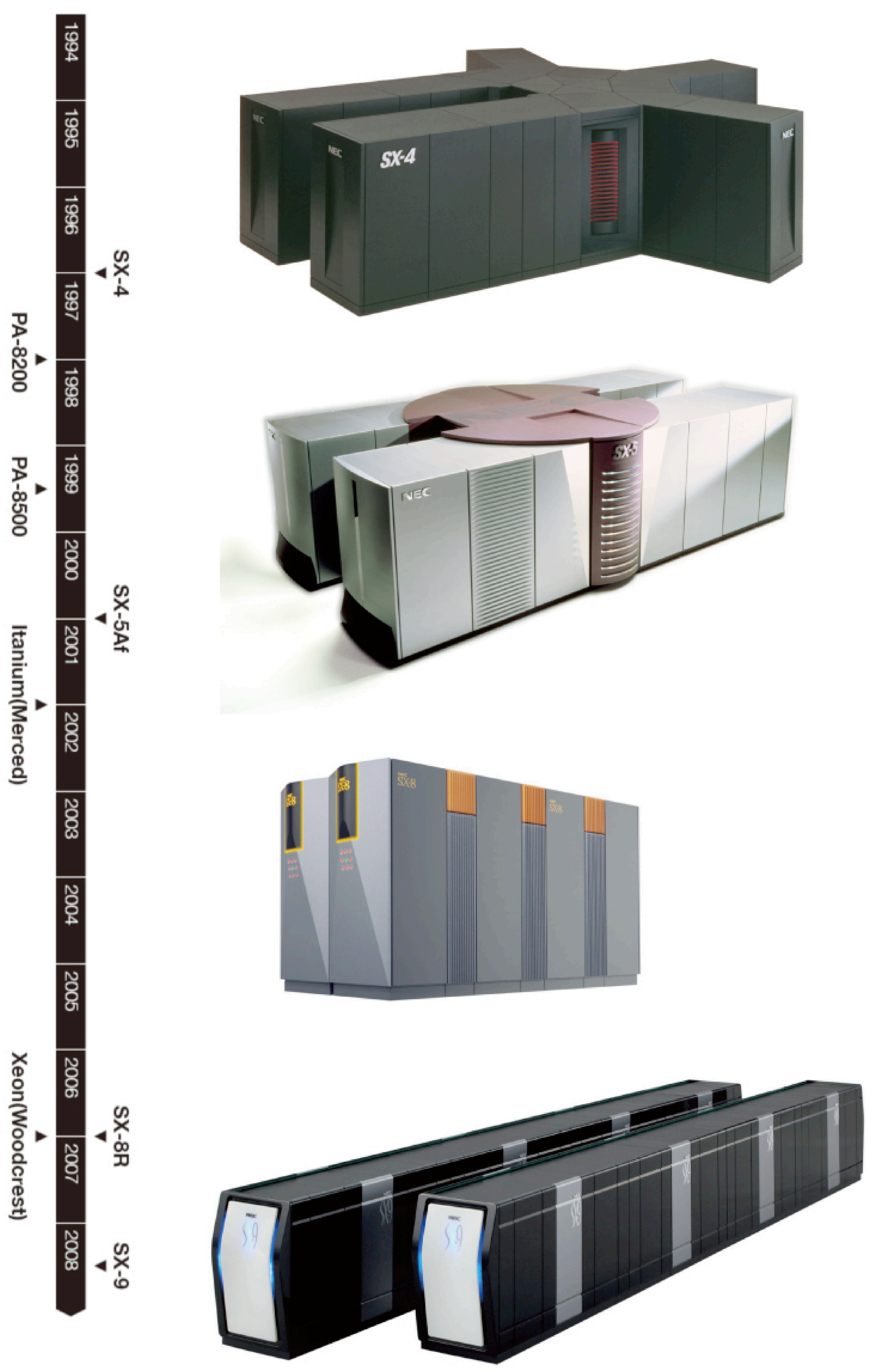
The Cybermedia Center at Osaka University was founded by merging the former Computation Center, the former Education Center for Information Processing and part of the university library in April 2000. Such reorganization was conducted in order to comprehensively promote educational study in view of rapid developments in the field of information technology.

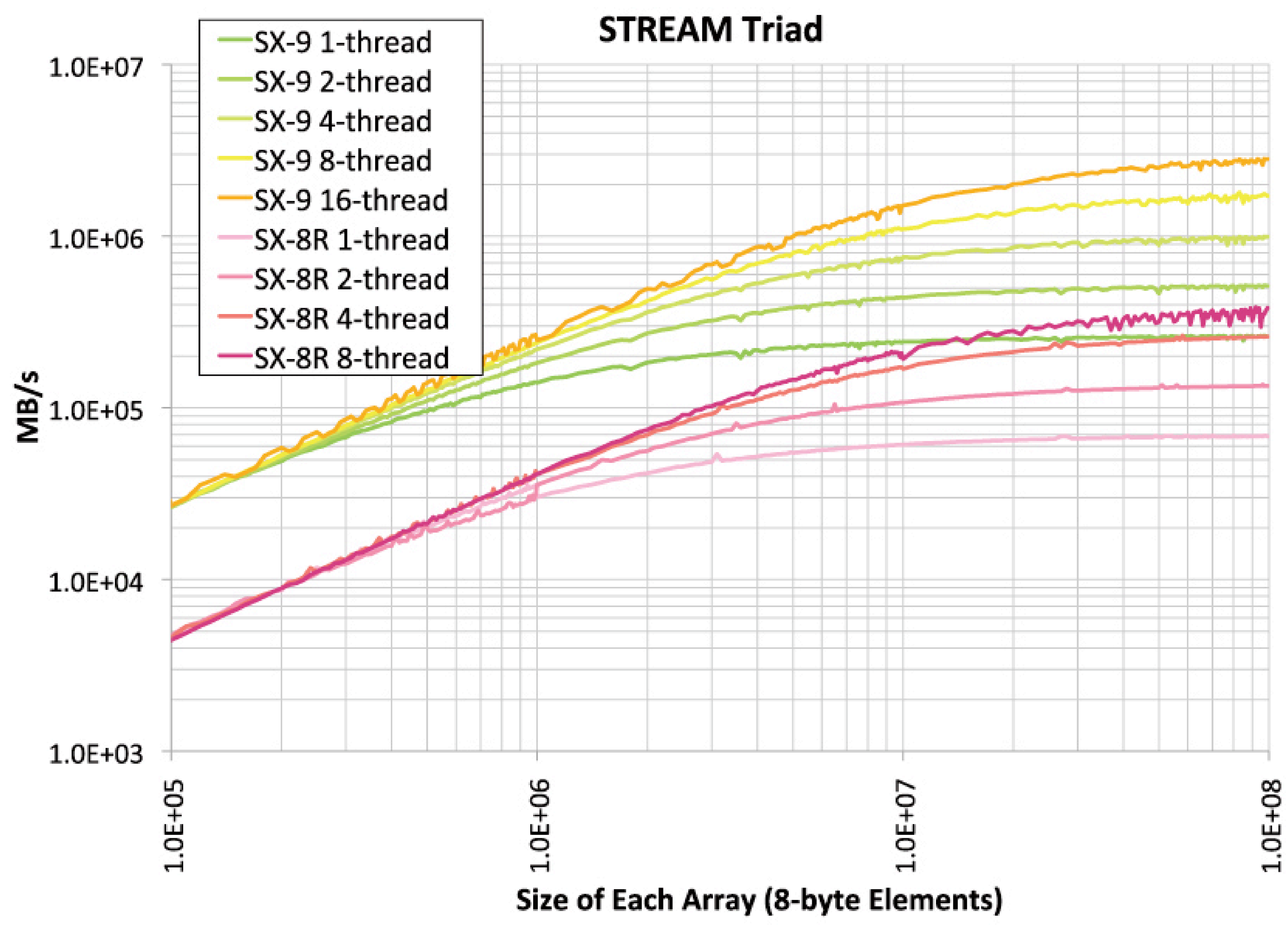
The goal of our center is twofold: 1) to continue providing stable infrastructure services as well as technical knowledge about supercomputers, information education systems and networks used around the world, and 2) to pursue research that enables the most advanced infrastructure services.

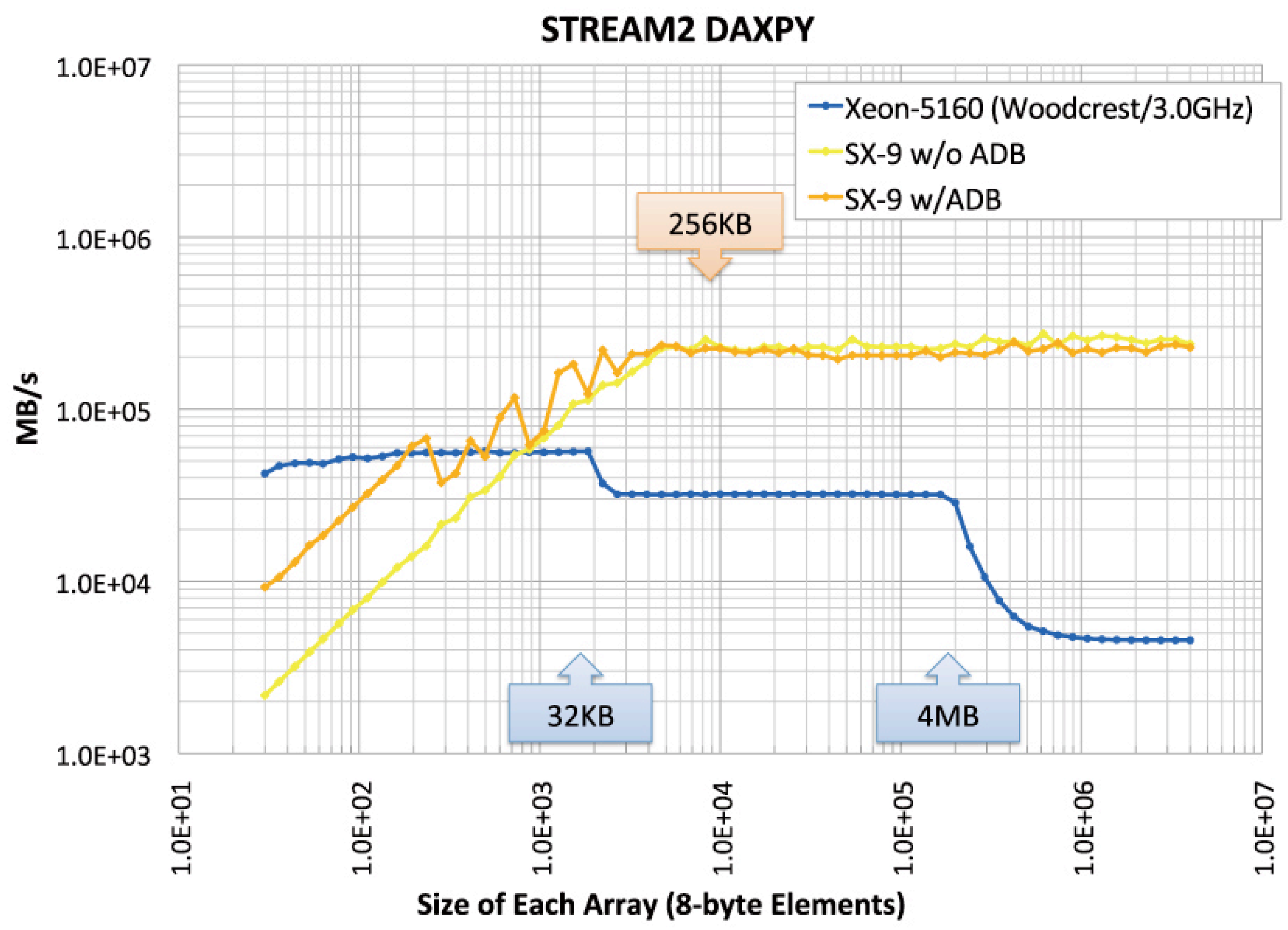
Advantages of Historical Vector Computing Maintained

At our center, we introduced 20-nodes of SX-8R in January, 2007. It replaced SX-5/128M8 which had stunned the HPC community with its peak performance of more than 1TFLOPS for the first time ever as a vector-type supercomputer and the 8th rank on the TOP500 list in 2001. While we have witnessed a phenomenal increase in the computational performance on the TOP500 list after this SX-5, we now give first priority to the users' benefits gained through the continuous improvement in performance rather than mere performance index. In line with such a policy, we decided to upgrade this system in a phased manner with an additional 10-node SX-9 system for July, 2008.

The performance in running real application programs has been improved by the sophisticated compiler technology. While the recent microprocessors can realize the improved performance as long as their caches are effective, the supremacy of vector machines is still remarkable. Especially, multi-threaded performance with automatic parallelization of the SX-9 is outstanding.







In these ten years, the technology of past high-end microprocessors has been inherited to budget-price products, and the low power consumption technology has been spread simultaneously. Although the large-scale cluster system based on PC is getting popular, it has also left the issues surrounding operation and maintenance. We built a cluster system that can closely be co-operated with the vector machine in order to gain benefits from both architectures. It became a good example which demonstrates a synergistic effect by different architectures.

In terms of the STREAM2 benchmark, the performance of vector computers is rather excellent even for very short loop lengths partly due to the automatic loop collapse by the compiler. For the SX-9, 256KB of ADB (Assignable Data Buffer) acts like a secondary cache to increase the bandwidth for short loop lengths. The efficiency of the cache of a microprocessor can now be grasped. In fact, it became clear that the vector machine is superior to conventional scalar processors also for the case with short loop lengths that was thought to be tailored to microprocessors: vector operations can be effective even for the range of very short array lengths where the L1 cache of the microprocessor is effective.

Advantages of Vector Supercomputer Maintained in Japanese Joint-Use for Academia

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Interactive Visualization for Aero-Acoustic Analysis in Sibilant [s]

Cybermedia Center, Osaka University, Japan

Introduction

This work presents a study of flow characteristics of sibilant [s] (Fig. 1) using a three-dimensional flow visualization provided by a Large Eddy Simulation (LES). We visualize volume data with Particle-Based Volume Rendering (PBVR)[1] to observe three dimensional structure of the result of the LES. While the PBVR enables fast transparent rendering to treat large-scale unstructured volume data, its computational cost in a preprocessing step can become a bottleneck in concurrent simulation and real-time rendering.

In this poster, we describe a customized PBVR for real-time simulation, a visualization technique for time-series data, and interactive rendering parameter settings to observe the volume data. We also report on new scientific findings obtained by our visualization system.

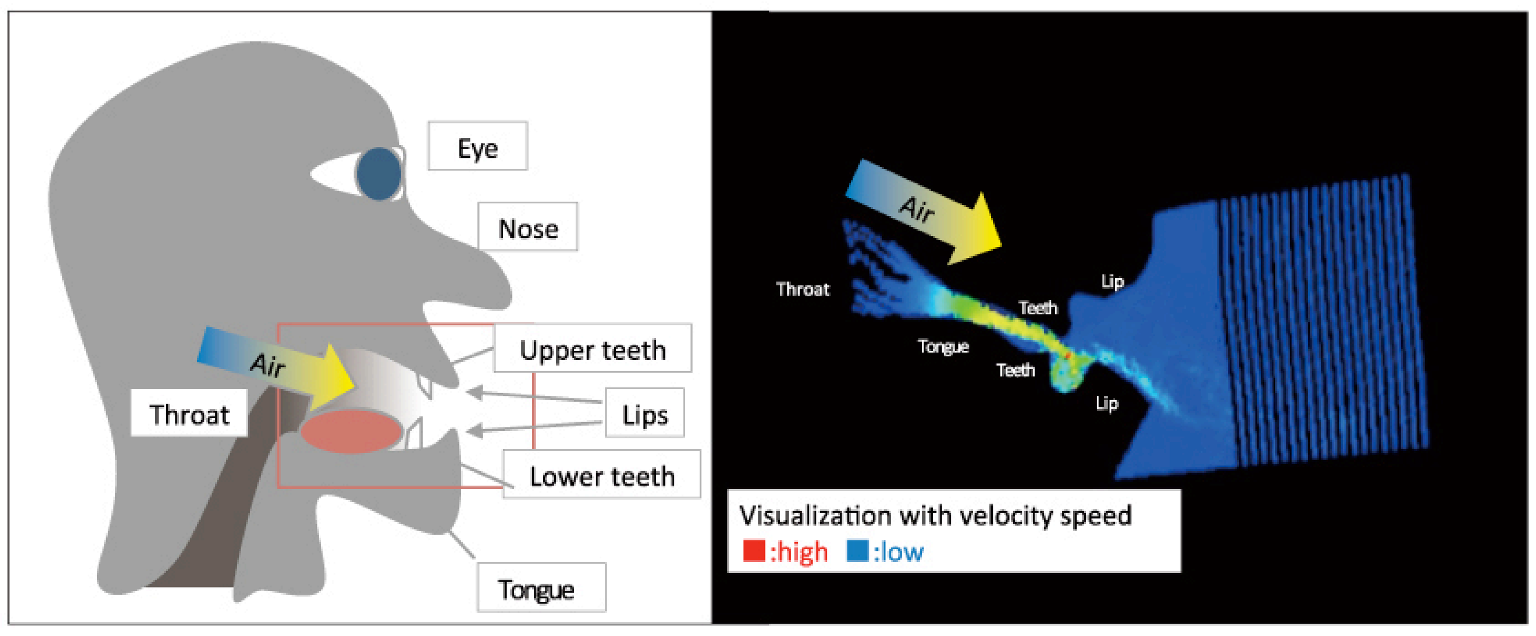

Figure 1: Turbulence Flow in Oral Cavity

Simplified PBVR

The PBVR generates particles by using a density function in a preprocessing step. To reduce the computational cost of the preprocessing step, the Simplified PBVR does not generate particles. instead it simply uses computational mesh vertices as points to render. The Simplified PBVR enables fast preprocessing so that concurrent simulation and real-time rendering. Visualization results have some artifacts reflecting mesh structure (Fig.2). However, the rendering results of the central region of the volume data are comparable to those by a conventional PBVR as its mesh density is high and uniform enough to get a good transparent effect. The Simplified PBVR provides interactive frame rates (73.53fps) for our target volume data (3.69 million particles) with a commercial machine. (Intel Xeon @3.20GHz CPU, 8.0GB RAM, and Quadro 5000 GPU.)

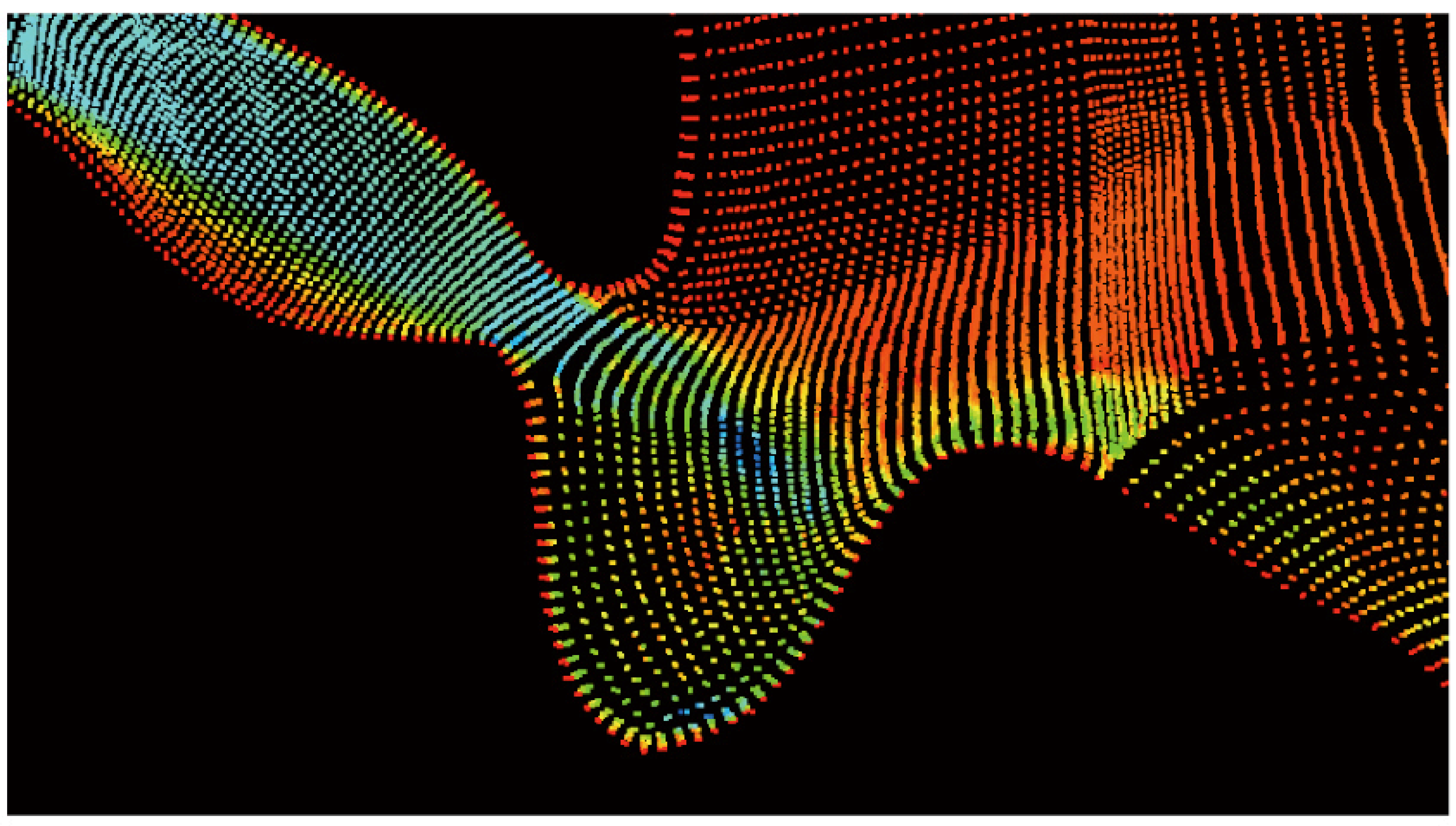

Figure 2: Visualization Result in Simplified PBVR

Interactive Parameter Setting

In time rendering, it' s desirable to render each frame within a fixed interval, since our target volume data is generated by a simulation model based on constant time. We apply a time-critical rendering technique to control rendering time. Specifically, a number of particles drawn is modified to render within a certain amount of time. Figure 3 shows the results of time-critical rendering.

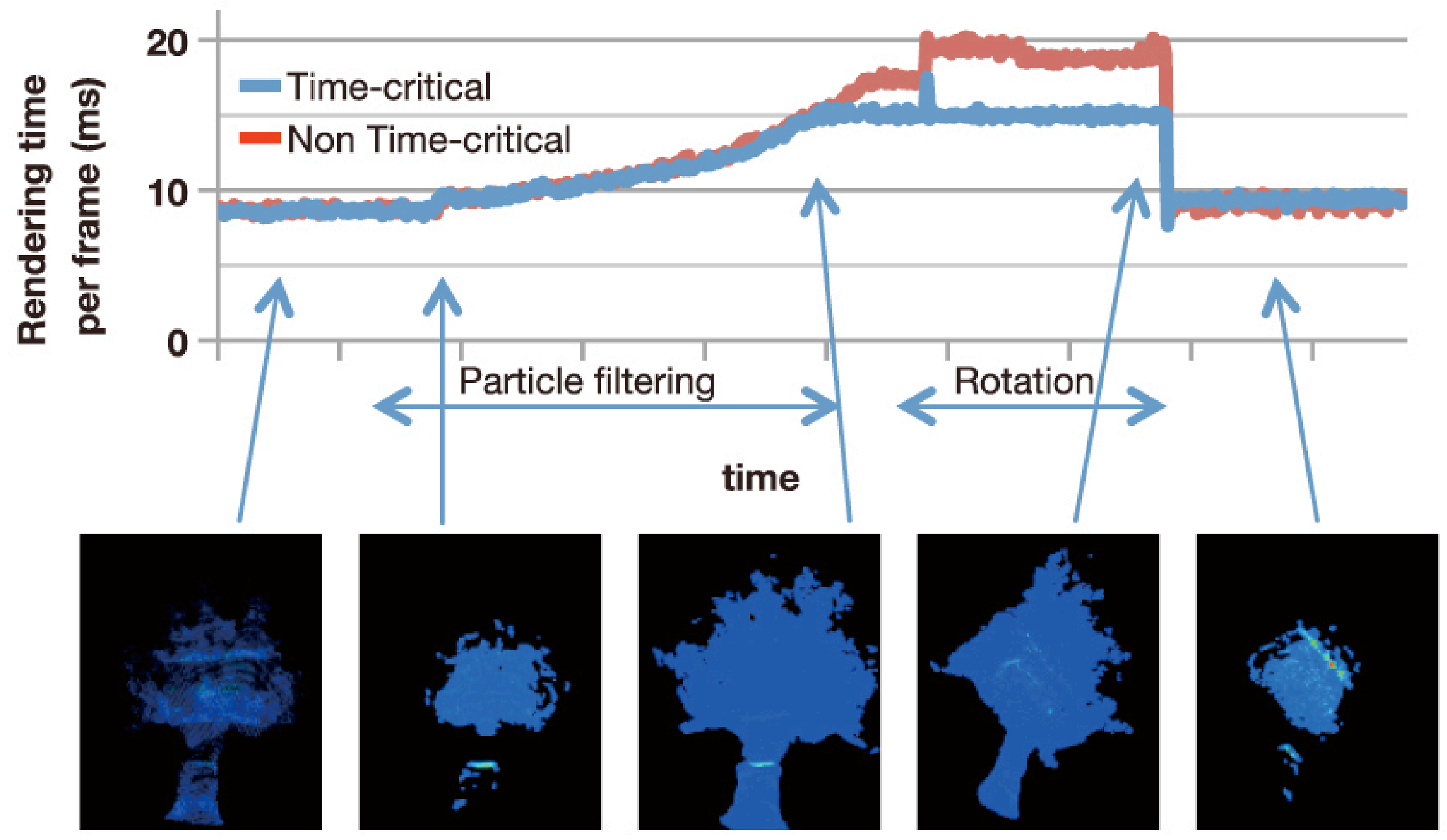

Figure 3: Time-critical Rendering

Visualization of Time-series Volume Data

For efficient observation of the volume data, rendering parameters should be applied immediately. By using a GPU and CUDA, our application allows for the changing of visualization parameters in real-time. For example, selecting a part of the volume data, moving the selected part (Fig. 4), temporarily hiding of a part of the volume and so on. Color mapping can also be directly changed in real-time.

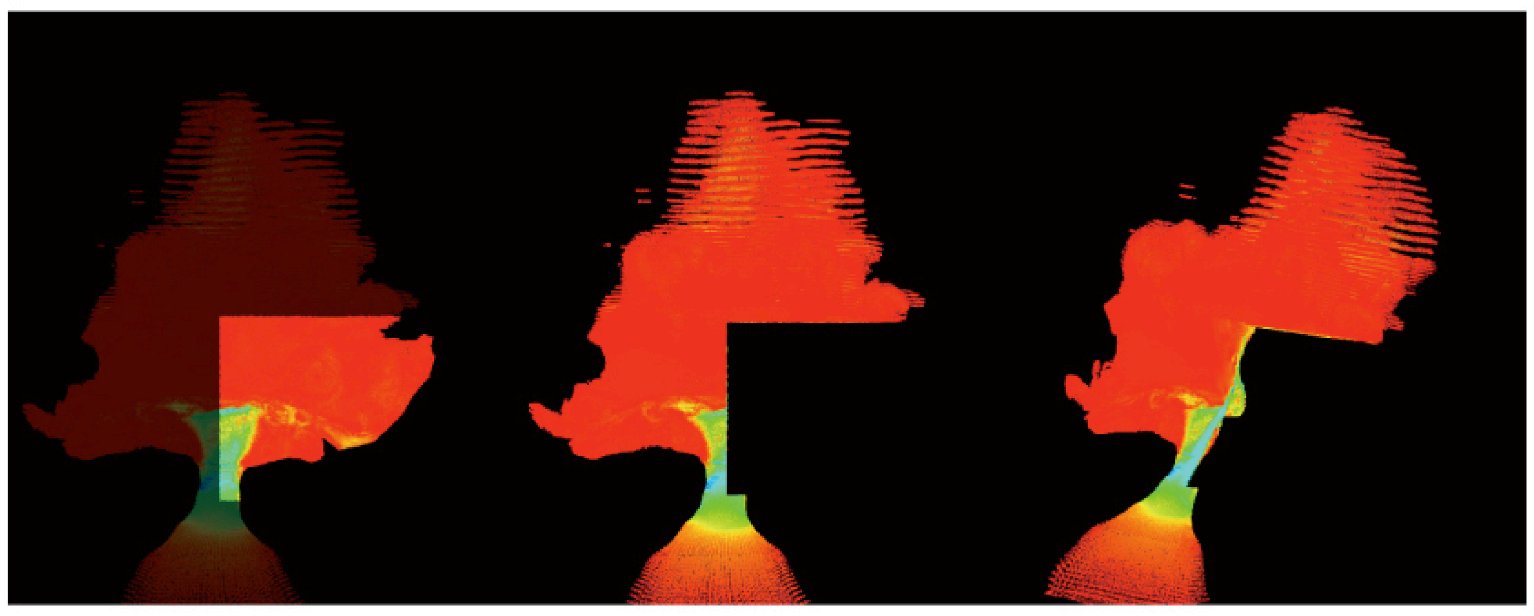

Figure 4: Interactive Parameter Setting

Scientific Findings

Using our visualization system, we made some new scientific discoveries. Figure 5 shows that the fluctuating jet is being generated at the constriction between the base of the tongue and the upper jaw.

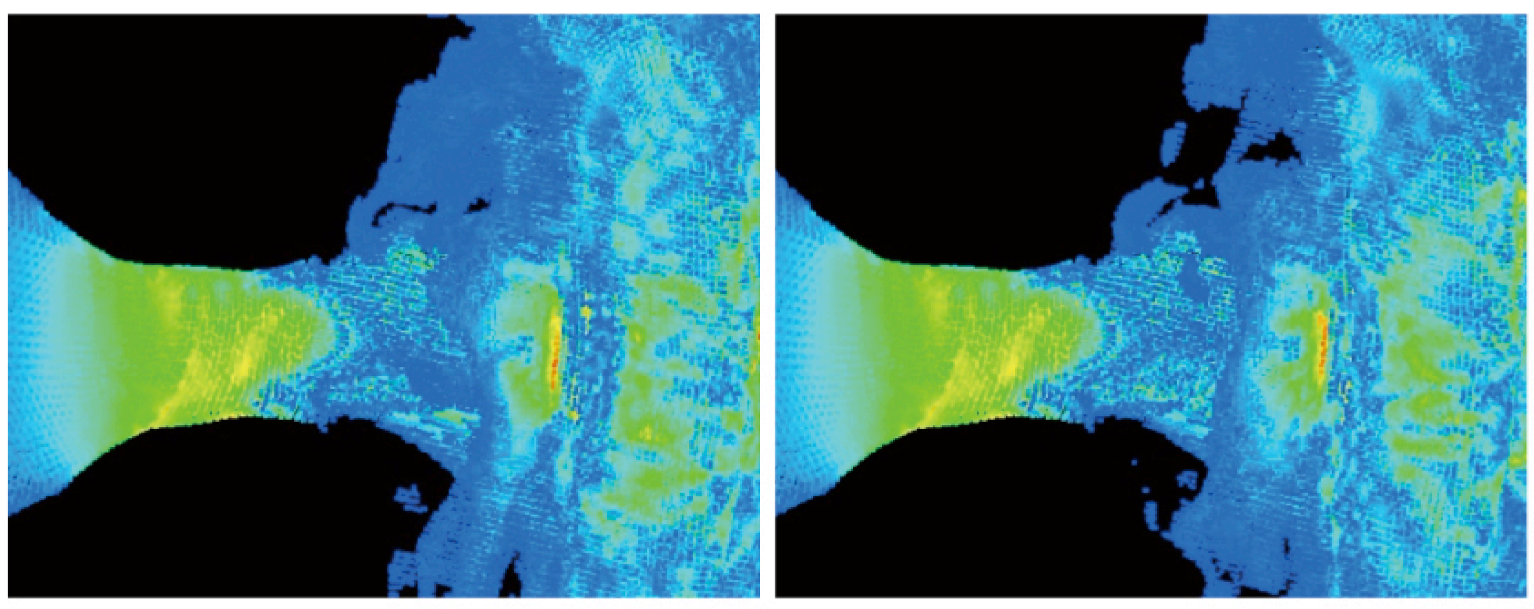

Figure 5: Fluctuating Jet on Tongue

Conclusion

We proposed an interactive visualization system for large-scale volume data. As future work, we are planning to control not only rendering parameters but also real-time simulation parameters such as mesh structure and oral cavity shape.

[1] Z. Ding, T. Kawamura, N. Sakamoto, K. Koyamada: "Particle-based Multiple Irregular Volume Rendering on CUDA," Simulation Modelling Practice and Theory, 2009.

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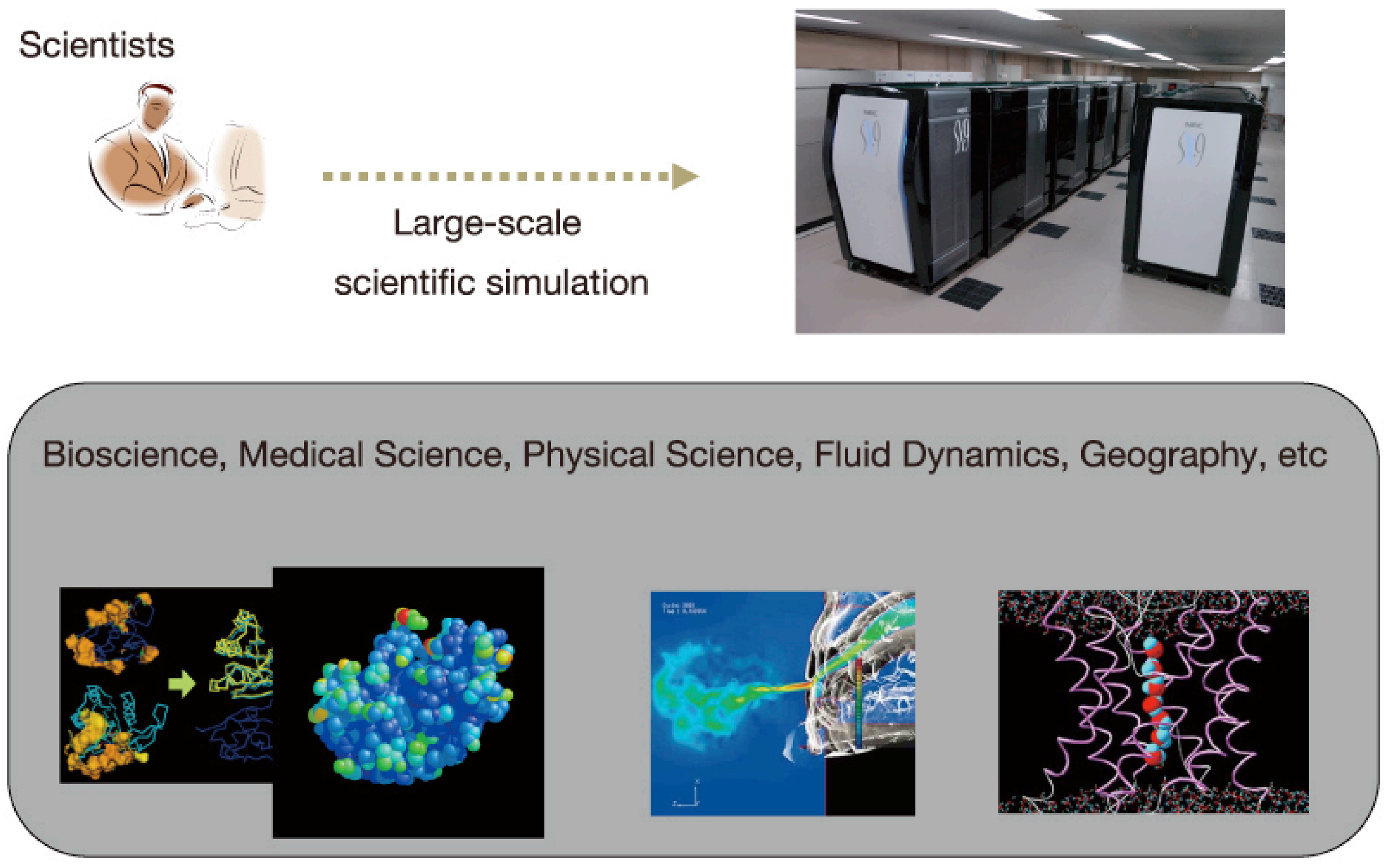
Interactive Visualization for Aero-Acoustic Analysis in Sibilant [s]

Toward Multi-site Virtual Cluster toolkit

Cybermedia Center, Osaka University, Japan



Background

Recently, virtual cluster technology, which allows scientists to build their private computational environments that can be customized as they like, has attracted attention. However, although it is becoming relatively easy to build a virtual cluster on a single physical cluster, building and managing a virtual cluster spanned over multiple physical clusters on multiple sites is hard despite that it is expected to be useful for in various computational scientific fields.

A reason can be explained from the fact that each physical node composing the virtual cluster can be, in general, isolated by the Firewalls or NATs deployed based on organizational administrative policies. Also, it causes the situation that virtual machines deployed on different physical nodes cannot be connected directly with each other.

To tackle the problem, we propose a solution that allows scientists to build a virtual cluster spanned over multiple physical clusters easily, by seamlessly integrating virtual machine technology and overlay network technology.

Toward Multi-site Virtual Cluster toolkit

Proposed Method for Deploying Multi-site Virtual Clusters

In our solution, each virtual machine composing a virtual cluster automatically establishes an overlay network for dedicated and secure use of it, irrespective of the underlying physical network structure. For the functionality of the overlay network, N2N, which provides an encrypted P2P based L2 virtual network solution, is utilized. The P2P based virtual network enables to build an unified network over multiple sites, regardless of the deployed policies of Firewalls and NATs.

Leveraging the N2N, we have been developing Multi-site Virtual Cluster (MVC) Toolkit. The toolkit realizes virtual clusters on multiple Rocks-based physical clusters which are ready to accommodate virtual machines composing virtual clusters. Rocks is exploited to automate the construction of virtual clusters on the N2N network.

Technology for realizing a multi-site virtual cluster

Rocks cluster toolkit: Cluster management tool

- Installing and managing clusters
- By PXE boot, setting up clusters automatically
- Clusters are customizable by Rolls
- Xen roll is available to deploy virtual clusters based on Xen hypervisor

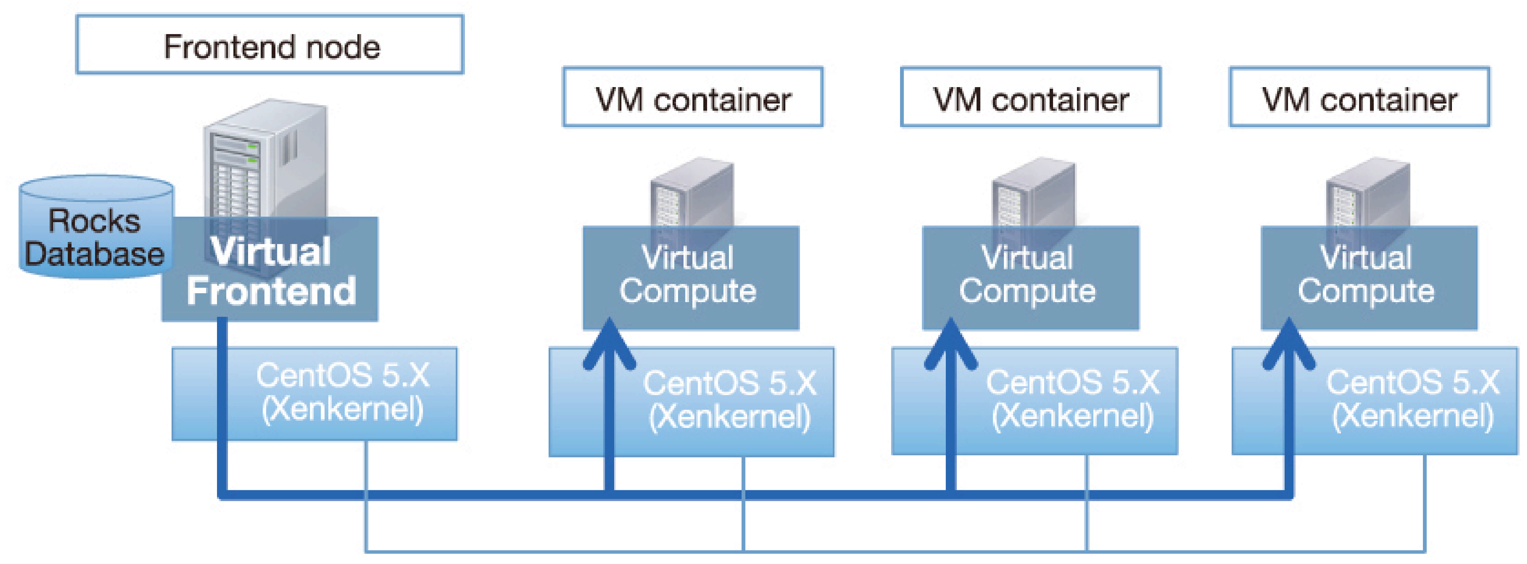


Figure1. Architecture of Rocks cluster toolkit

N2N: Layer 2 overlay networking software

- A secure Layer 2 network
- NAT traversal
- Decentralzed overlay network
- Isolated each overlay network

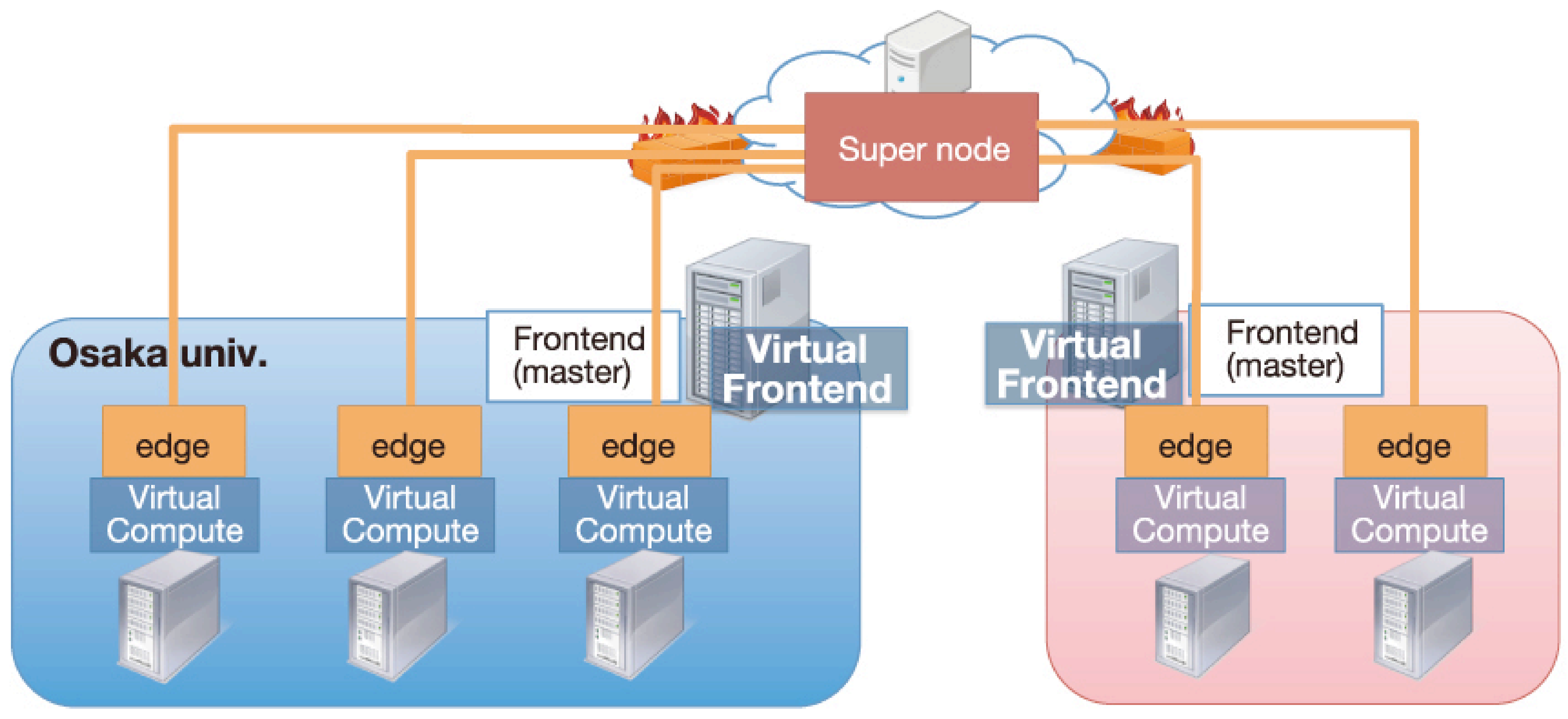


Figure2. Architecture of N2N

How to deploy a multi-site virtual cluster

1. Request a virtual cluster deployment
2. Select virtual machines from each domains
3. Register the selected virtual machine to the MVC database
4. Establish the overlay network among the virtual machines
5. Install OS and Software requested
6. Login the depolyed virtual clusterFeatures Features

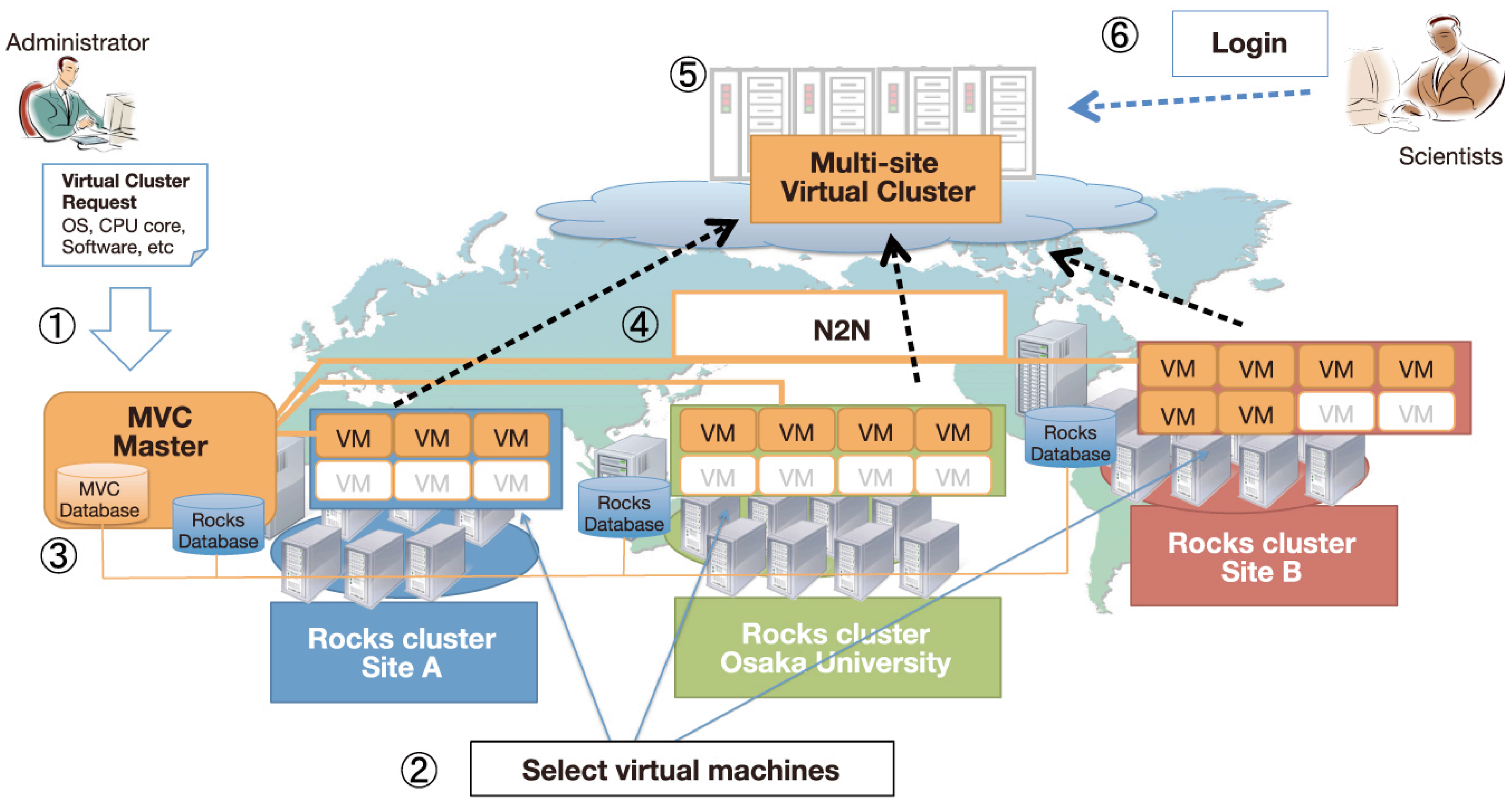


Figure3. Architecture of multisite virtual cluster toolkit

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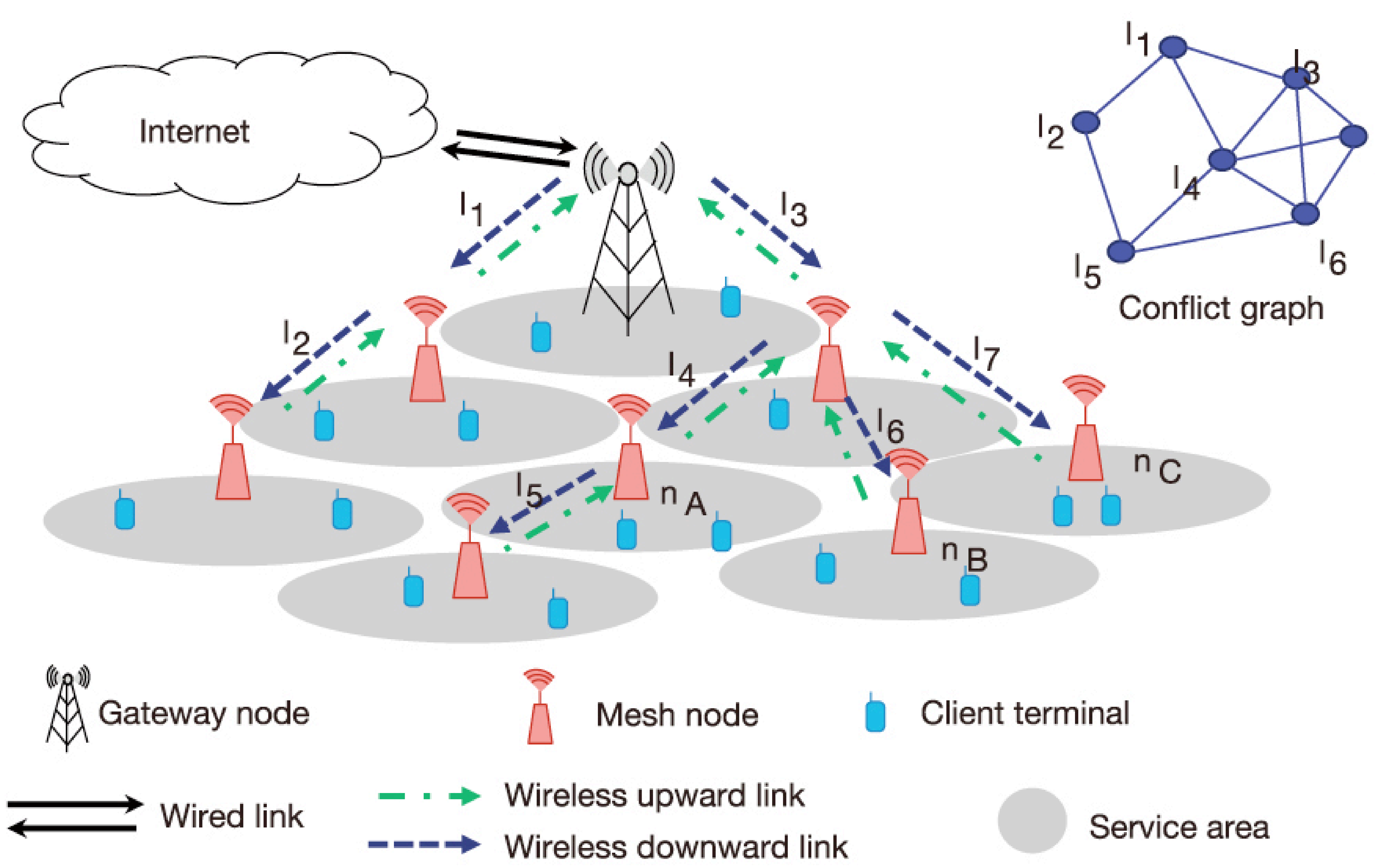
Kohei Ichikawa, Abe Hirotake, Susumu Date, Shinji Shimojo

Performance improvement of TDMA-based wireless mesh networks

Cybermedia Center, Osaka University, Japan

TDMA-based wireless mesh networks

Wireless mesh networks (WMNs), which are used for providing a wide-area wireless broadband access environment (e.g., IEEE 802.16j relay networks), have attracted much attention because of their expandability and cost efficiency. WMNs consist of a gateway node, which is connected to a wired network, and mesh nodes. A mesh node provides wireless broadband access service to client terminals within its service area. Mesh nodes are connected through a wireless link when they are within transmission range of each other.



When closely located links in a wireless network are used simultaneously, a receiver node cannot correctly receive radio signals from the corresponding sender node because of radio interference. In time division multiple access (TDMA) protocols, time is divided into frames, each frame consists of time slots of a constant duration, and different time slots are assigned to links that interfere with each other.

Our research group has proposed a variety of methods for improving the performance of TDMA-based WMNs:

- Topology construction methods for gateway load balancing
- Power control methods for improving spatial reuse
- Time slot assignment methods for reducing transmission latency [1]
- Methods for improving service area quality based on geometric algorithms [2]
- Node repositioning methods for reducing transmission latency

For more details on each method, please visit our group' s web site (http://www.ane.cmc.osaka-u.ac.jp/). We briefly introduce two of the methods in the following section.

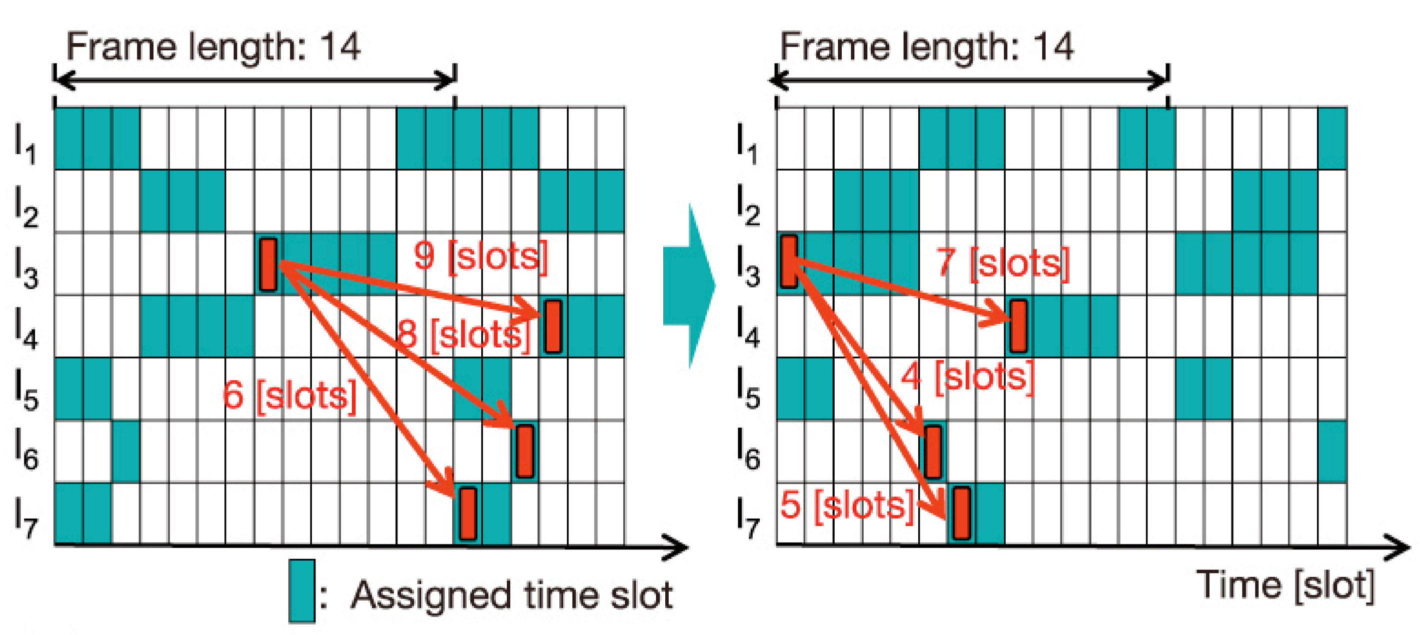
Time slot assignment methods for reducing transmission latency [1]

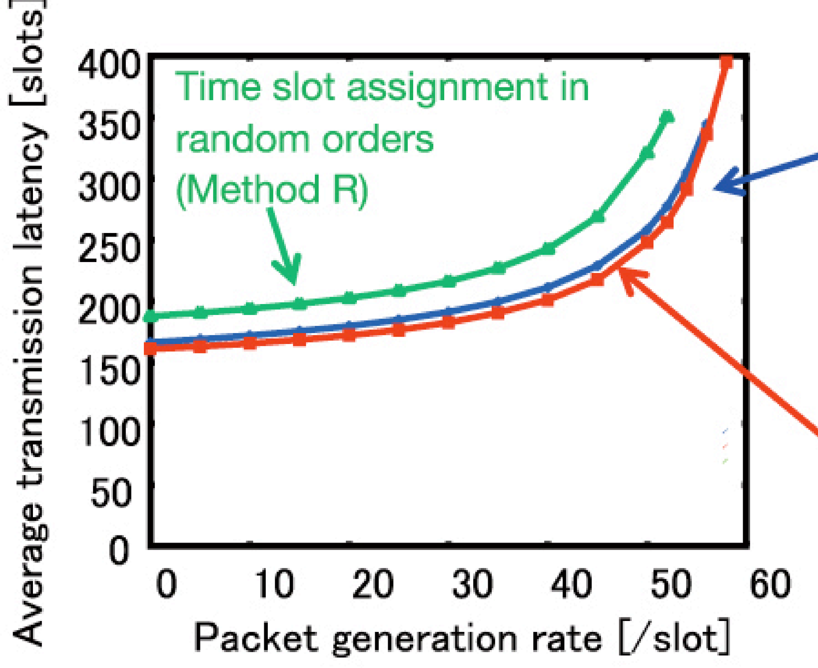
TDMA protocols cause scheduling delays. A scheduling delay is the period of time between the arrival of a packet at a mesh node and the departure of the packet at the scheduled time slot for the mesh node. Therefore, in multi-hop WMNs, end-to-end transmission latency between a mesh node and a gateway node can be increased by accumulating the scheduling delay at each hop on the path between the client terminal and the gateway node.

We have proposed time slot assignment methods for reducing transmission latency in WMNs by extending the existing method [3], which aims at better network throughput and a small frame length. In our proposed methods, the set of interference relationships among links, i.e., a conflict graph, is first obtained. Then, the order of links for time slot assignment is determined. Finally, time slots are assigned to the links according to the determined order. Unlike in [3], our methods configure the order of time slot assignment by considering the hop count from the gateway node, and as a result, the transmission latency decreases without increasing the frame length. Our proposed methods also accommodate the weighted time slot assignment, which is consistent with IEEE 802.16j specifications.

Link	l_7	l_6	l_4	l_3	l_5	l_1	l_2
Link order	1	1	1	1	2	2	3
Assignment orders	1	2	3	4	5	6	7

Link	l_7	l_6	l_4	l_3	l_5	l_1	l_2
Link order	1	1	1	1	2	2	3
Assignment orders	3	2	4	1	6	5	7





Proposal utilizing weighted time slot assignment
Compared with Method R, the transmission latency is decreased by up to 20%.

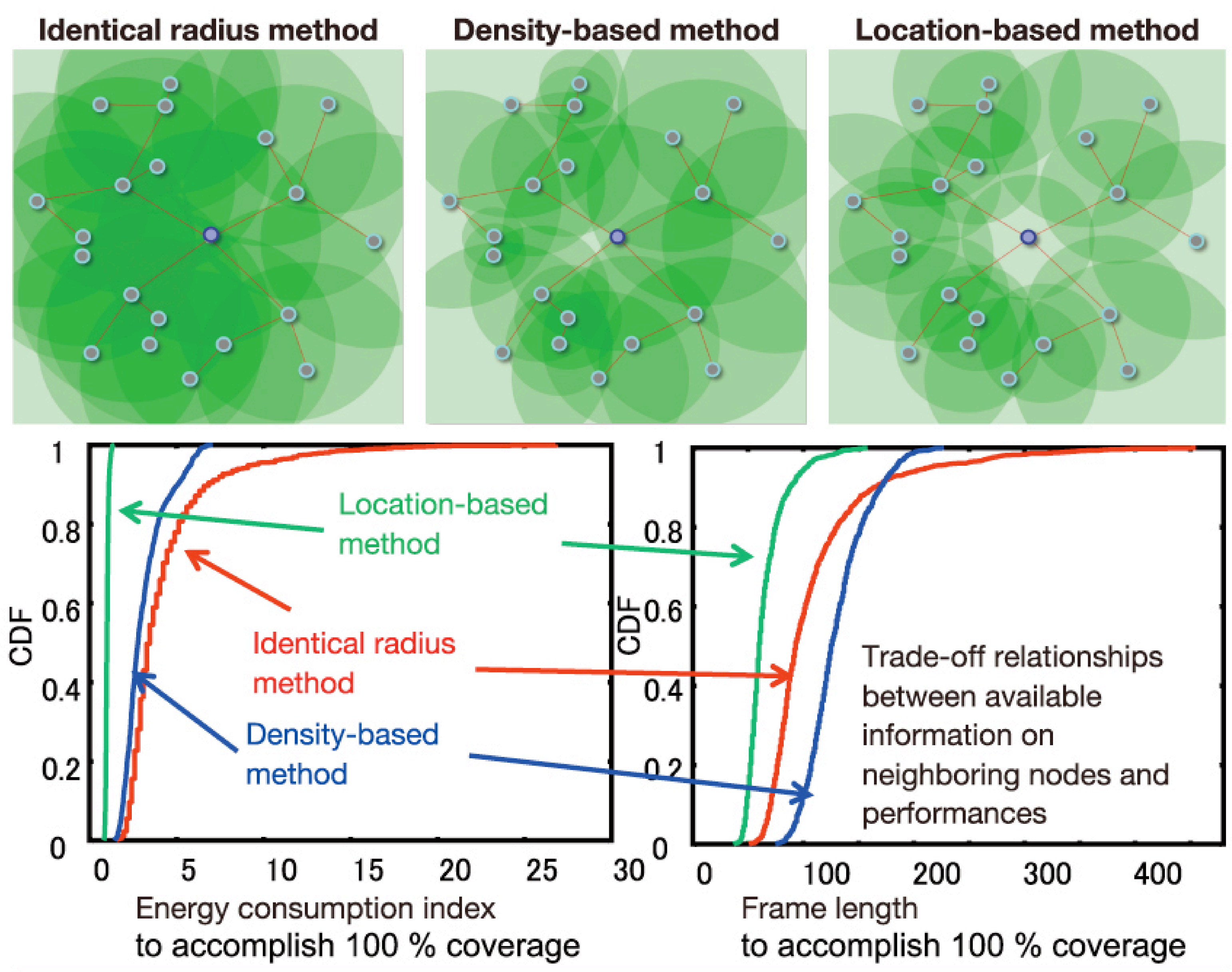
Proposal utilizing weighted time slot assignment and the refined time slot assignment orders
Compared with Method R, the transmission latency is decreased by up to 25%.

Methods for improving service area quality based on geometric algorithms [2]

The performance metrics of wireless mesh networks, such as communication quality and energy consumption, are significantly affected by service area size and its overlap degree. In order to adequately determine the service area size for each node, it is important to use the location information of neighboring nodes. However, due to the environments where the WMN is deployed, such information is not always available, or is only partially available.

We have proposed several methods for determining the service area size according to various kinds of available information on neighboring nodes:

- Identical radius method: All nodes use an identical service radius. This method is suitable for situations in which each node is unable to obtain information.
- Density-based method: Each node estimates the nearest neighbor' s distance and sets its service radius based on the estimation results. This method is for situations in which each node can obtain the number of its neighboring nodes.
- Location-based method: Each node sets its service radius to cover its Voronoi area. This method is for situations in which each node can obtain precise location information for neighboring nodes.



[1] R. Ishii et al., "Time slot assignment algorithms in IEEE 802.16 multi-hop relay networks," Proc. ICNS 2010.
[2] S. Takemori et al., "Service area deployment of IEEE 802.16j wireless relay networks: service area coverage, energy consumption, and resource utilization efficiency," Int. J. Advances in Internet Tech. 3(1-2):43-52 (2010)
[3] W. Wang et al., "Efficient interference-aware TDMA link scheduling for static wireless networks," Proc. ACM MobiCom 2006.

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Performance improvement of TDMA-based wireless mesh networks

Interactive Visualization of Large-scale Evacuation Simulation using GPU Computing

Cybermedia Center, Osaka University, Japan

Introduction

Evacuation simulations are designed and used for estimating crowd movement in buildings or urban environments in the event of a disaster. Agent-based simulations are particularly suitable for modeling each person's evacuation behavior by following a set of simple individual rules. Moreover, real-time simulation tools are effective for interactively analyzing crowd behaviors. However, computing data for and visualizing massive crowds in real time is a computationally intensive task. This complexity was reduced in previous research by employing special data structures, such as mesh models or network models. Additionally, researchers have significantly increased computational performance by adapting existing CPU-oriented algorithms to parallel processing architectures. A promising new parallel architecture uses commodity graphics processing units (GPUs) having many cores, offering the performance benefits of parallel processing at a low cost.

In this study, we describe our novel approach to the real-time visualization of crowd flow using a large-scale, agent-based evacuation simulation that is suitable for execution on GPUs.

Large-scale Evacuation Simulation

The evacuation simulation uses an agent-based system. Namely, an evacuee is modeled as an agent. The modeling of each agent's behavior consists of (1) the route choice model: setting a destination and calculating the route, and (2) the crowd walking model: approaching the destination and avoiding collisions with other agents and obstacles. In our research, we implemented the shortest route choice model and the social force model.

Conventional methods implement agent-based modeling using CPU-oriented algorithms. The social force model that we implemented previously was also calculated using a CPU, and the agents were rendered on the GPU only after they updated their position. However, the use of GPUs for general purpose computing has become a new area of research in the recent years. In our new simulation, the social force model operations were executed on a GPU using CUDA technology, which is a parallel-processing architecture for GPUs with many cores. In particular, one thread is allocated per agent to calculate the social forces on that agent. Although CPUs can only concurrently execute one thread per core, CUDA can run tens of thousands of threads simultaneously. Thus, the GPU's computational power is sufficient for updating the modeled behavior of massive crowds in real time.

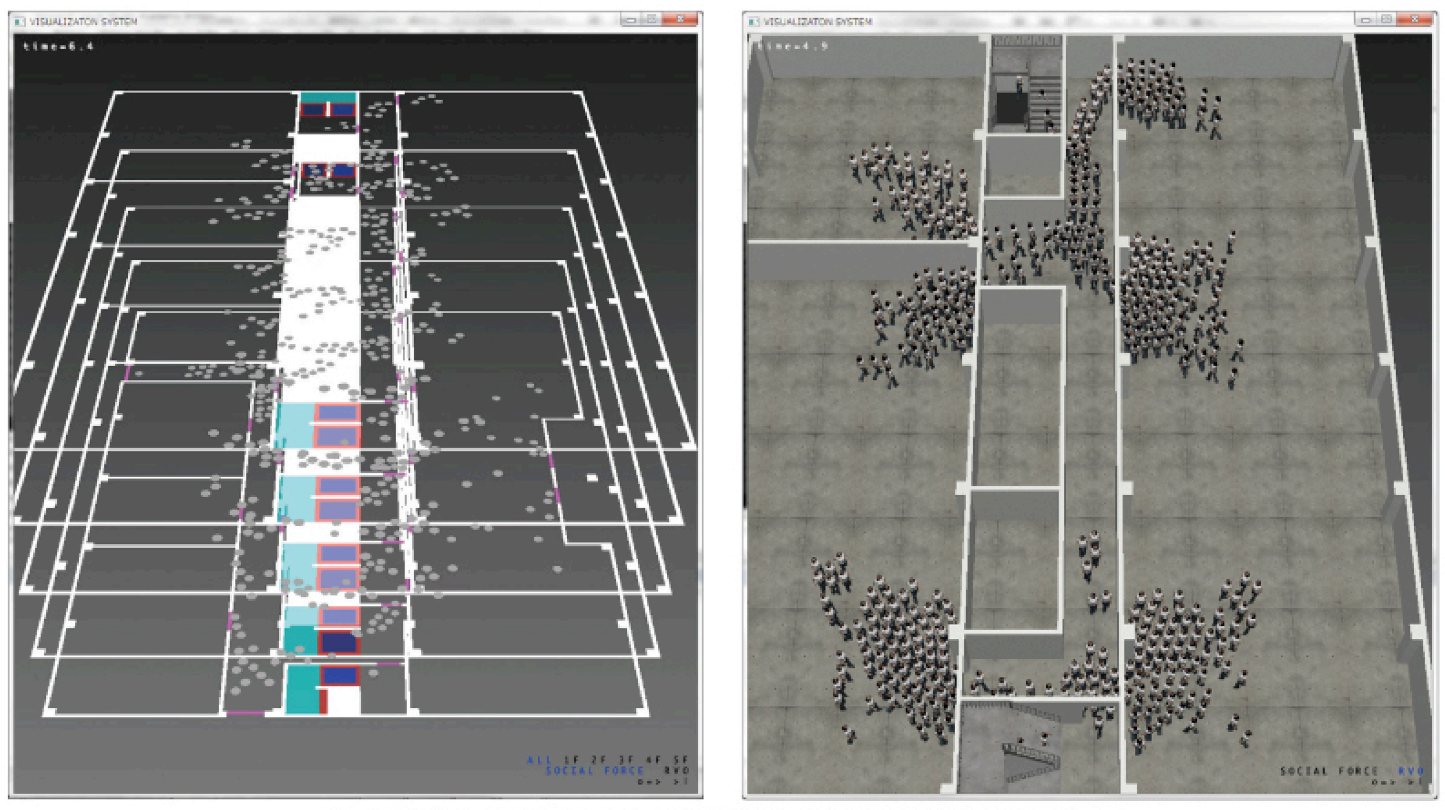

Figure1: Agent-based Evacuation Simulation

Figure2: Large-scale Evacuation Simulation using GPU computing

Interactive Visualization

Interactive visualization is effective for interactively analyzing evacuation behaviors in the trial-and-error stage of creating an evacuation plan. In this study, we visualized the evacuation simulation on a high-definition immersive projection display (CAVE), which contained a cluster of high-performance graphics PCs and high-definition projectors, in order to provide the user with an evacuation experience. This interactive visualization on a CAVE offers the following advantages: Such a virtual experience, in which the participant escapes from a disaster by interactive operation, contributes to that individual's disaster prevention education. It is also possible to recreate a participant's evacuation behavior in order to model the behavior characteristics for the evacuation simulation.

Figure3: Interactive Visualization on a CAVE

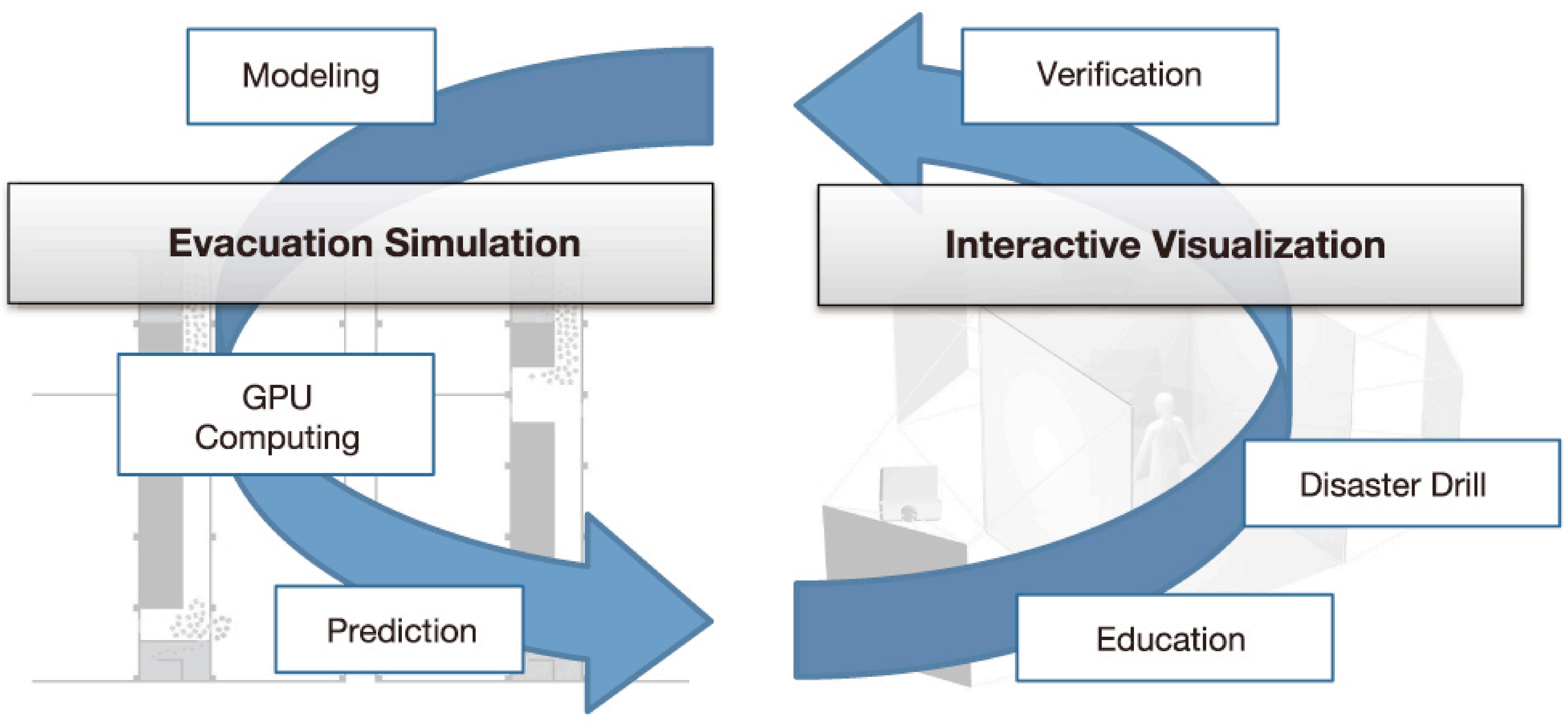

Figure4: Evacuation Simulation and Interactive Visualization

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Interactive Visualization of Large-scale Evacuation Simulation using GPU Computing