About Us：Cybermedia Center, Osaka University

Cybermedia Center, Osaka University, Japan

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.

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.

Vector supercomputer

PC cluster

Location

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.

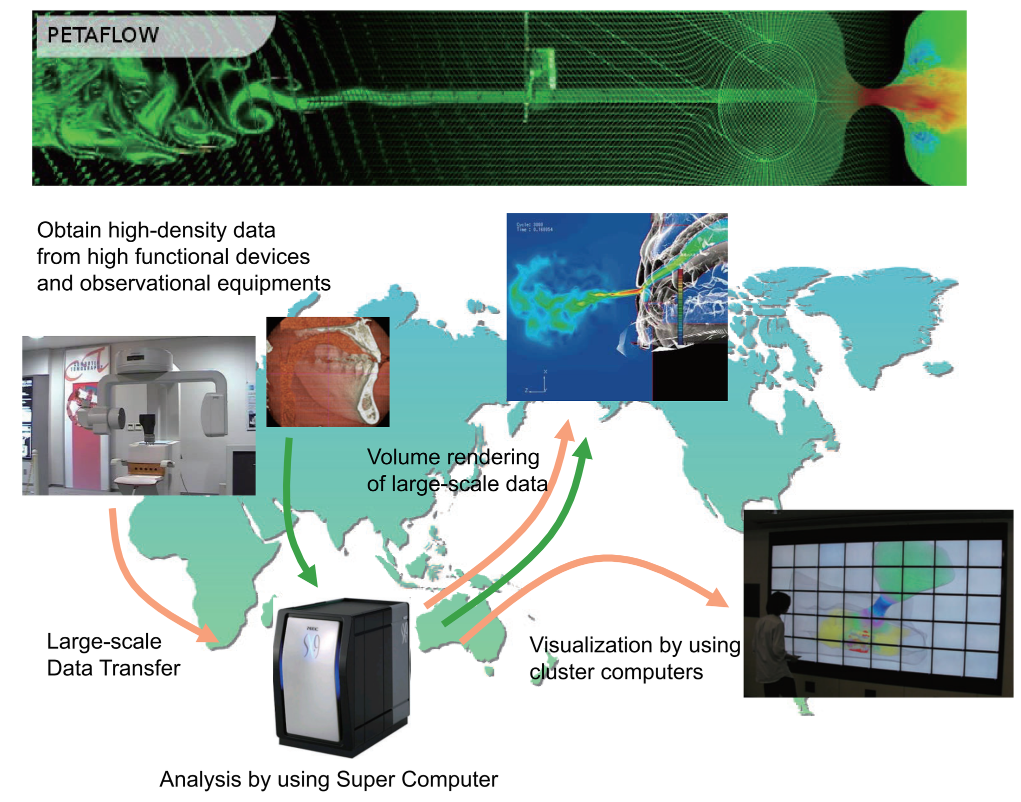

Figure 1: Overview of PetaFlow scheme.

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).

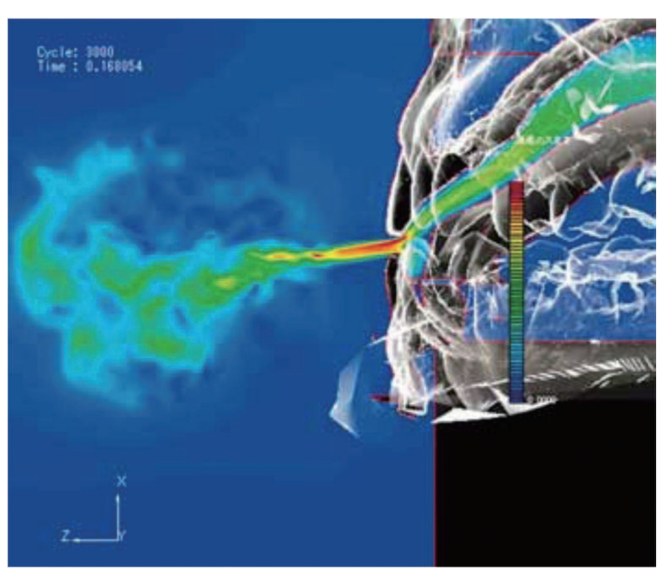

Figure 2: Application example.

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).

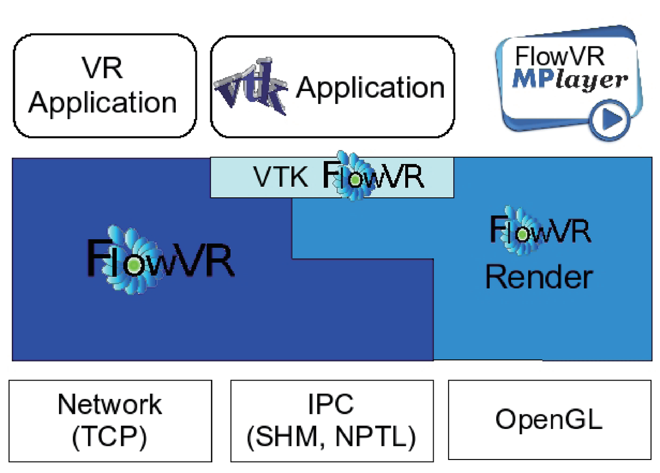

Figure 3: Architecture of FlowVR.

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.

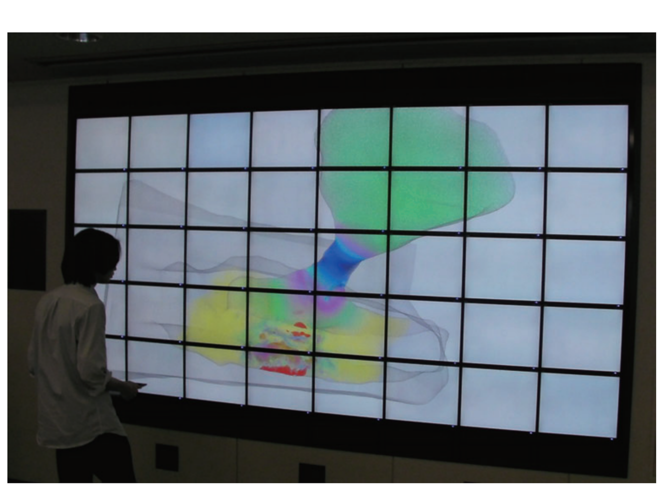

Figure 4: Particle-based volume rendering (PBVR) on tiled display wall (TDW).

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.

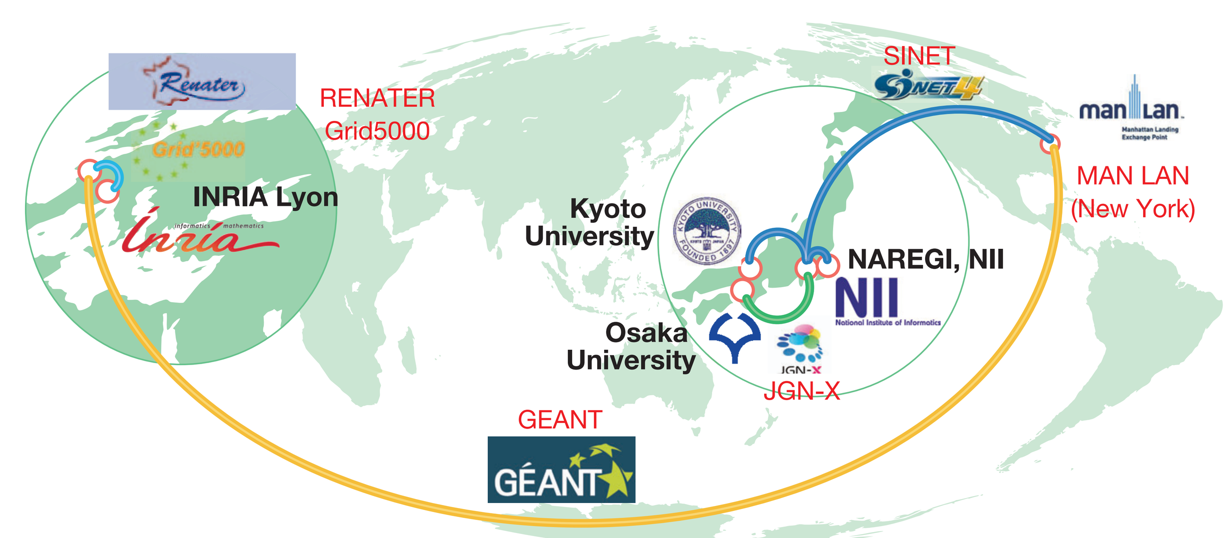

Figure 5: Network topology in PetaFlow testbed.

RESO (ENS Lyon, INRIA Grenoble) is focused on metrology equipment synchronization. We develop a synchronized distributed packet capture system which is a software-hardware based solution yielding a good compromise between accuracy and affordability [Collaboration with SyncLab from the University of Melbourne, Australia]. 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.

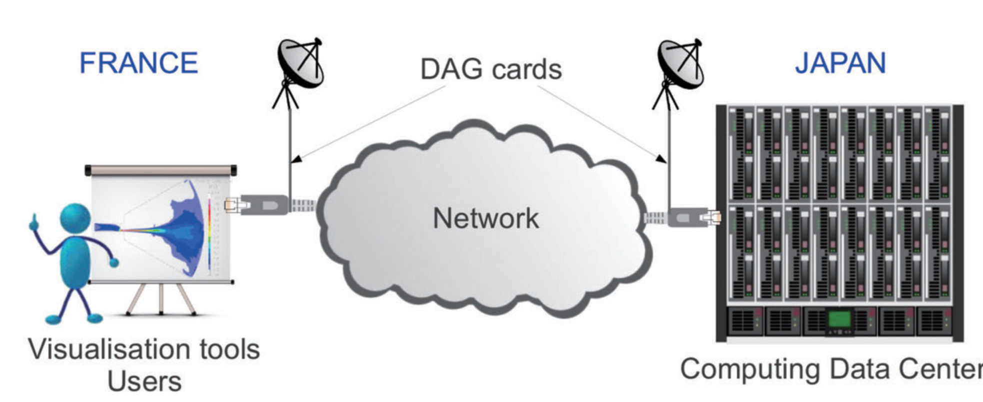

Figure 6: Network monitoring system by packet capture.

Osaka University also develops a traffic control method in long distance high-speed networks. We focus on fairness among high-speed transport protocols. So we control traffic at the router or switch in the network based on windowsizes of high-speed transport protocols by traffic monitoring.

Member of PetaFlow Project

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

Architecture of OpenFlow-based failure avoidance for SAGE

Cybermedia Center
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Architecture of OpenFlow-based failure avoidance for SAGE

Scientific data has been increasingly growing in size and complexity and therefore visualization technology has started to take a role of more importance. Tiled Display Wall (TDW, Fig.1), which is a single large display device composed of multiple sets of computers and displays, is such visualization technology. In particular, SAGE (Scalable Adaptive Graphics Environment) -based TDW allows scientists to display multiple series of scientific data, each of which might be located on a different site.

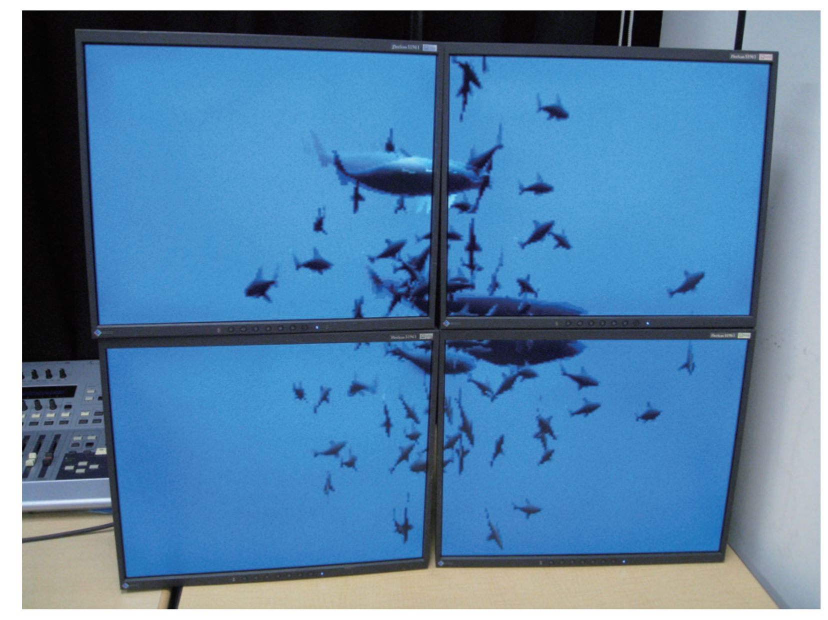

Fig.1 Tiled Display Wall

Problem

SAGE has a vulnerability to network failures. Specifically, if a network failure occurs on a network link between visualization application and display nodes, visualization on TDW partly stops (Fig.2).

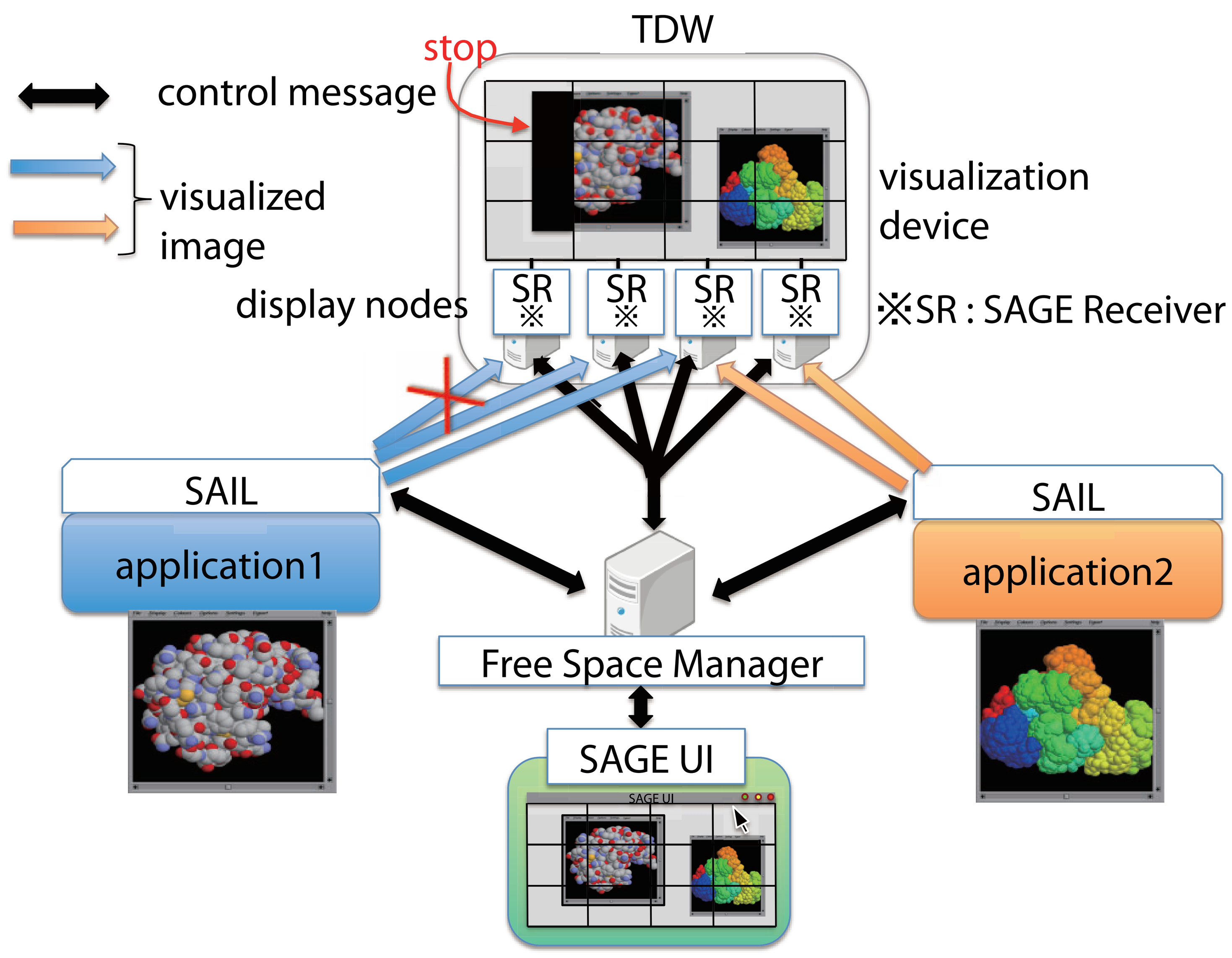

Fig.2 Network vulnerability in SAGE

Proposal

We propose a SAGE functionality that dynamically detects and avoids a network failure on a network link using OpenFlow, which allows to control network dynamically. The OpenFlow-based network failure avoidance functionality is composed of three functions.

- **Network failure detection function** detects the network failure between a visualization application and a display node.
- **Topology understanding function** grasps the network topology which OpenFlow Switches form.
- **Packet forwarding configuration function** discovers an alternate route and configures rules to OpenFlow Switches so that packets pass along the route.

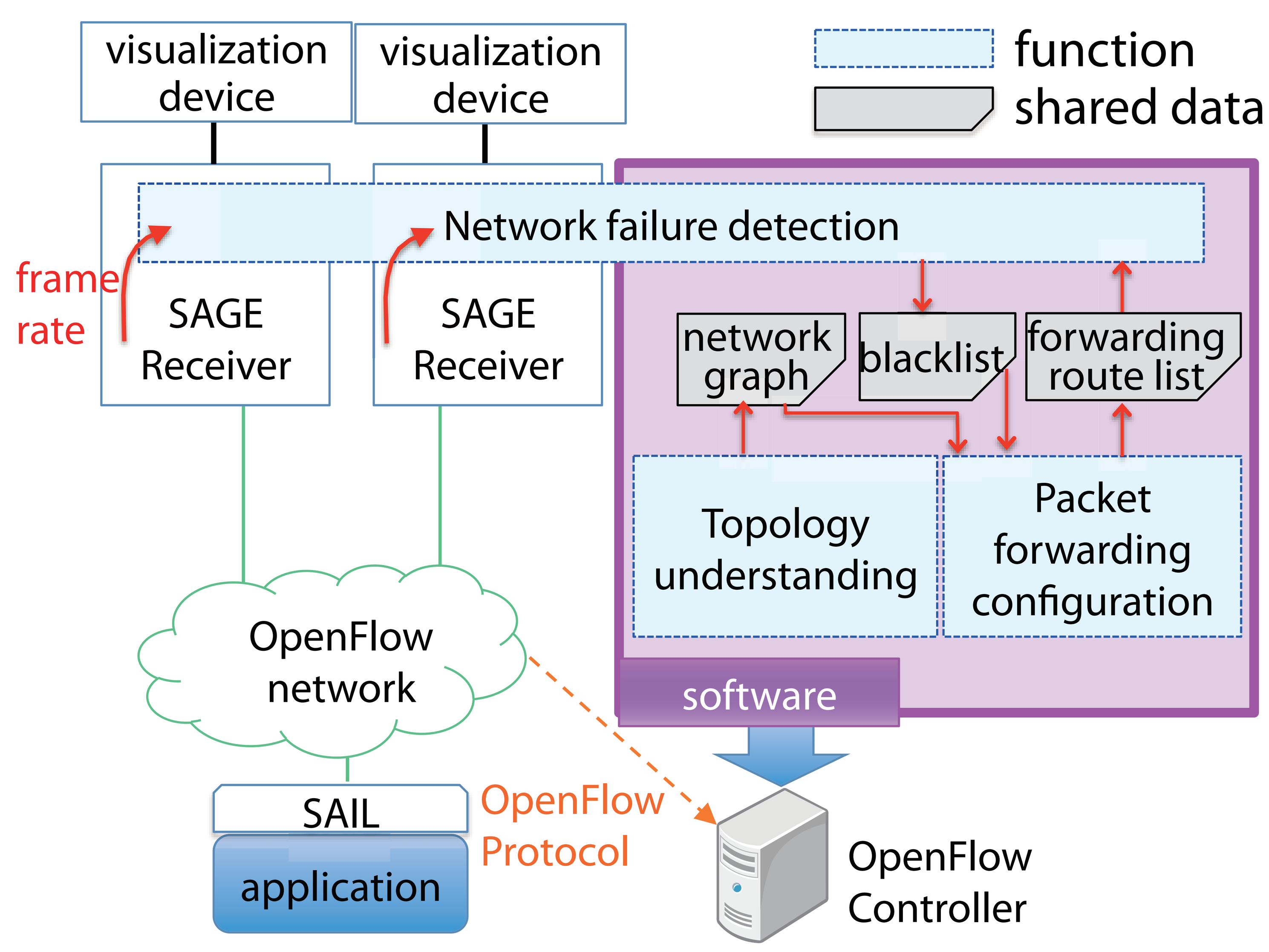

Fig.3 Proposed functionality

Demonstration Environment (at NICT booth)

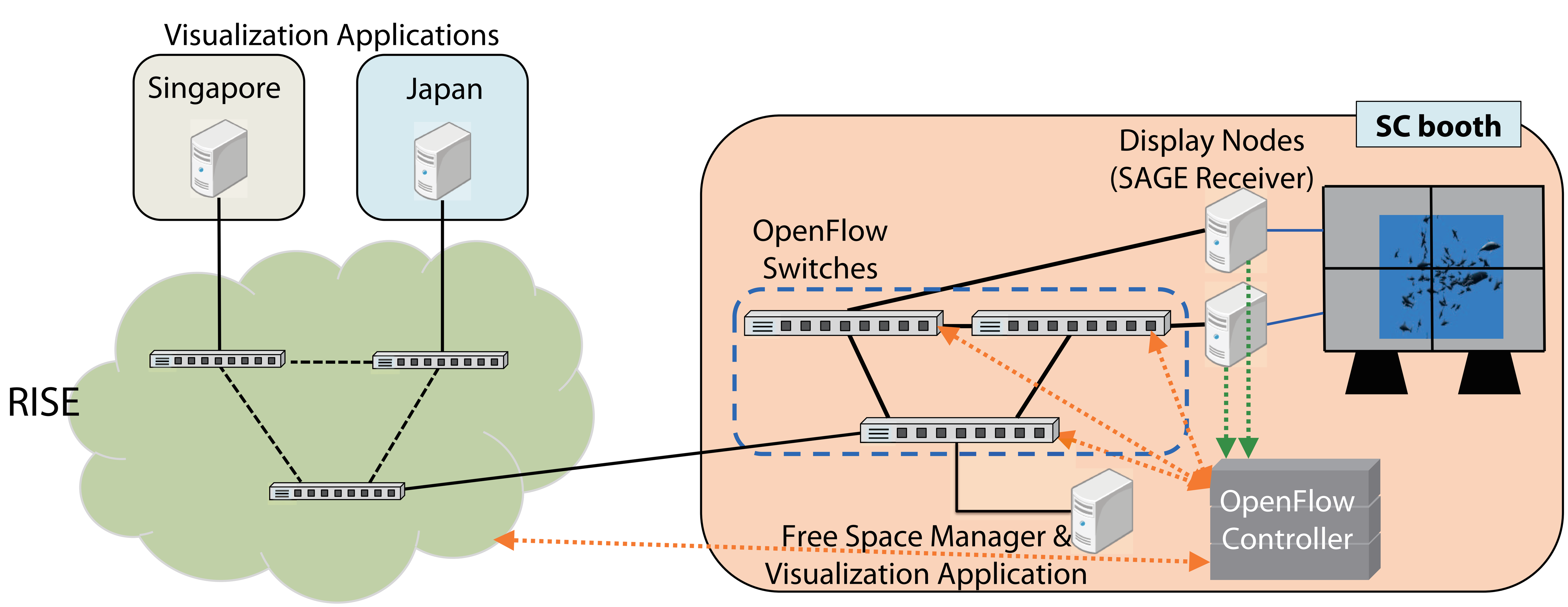

Fig.4 Demonstration Environment

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OSAKA UNIVERSITY

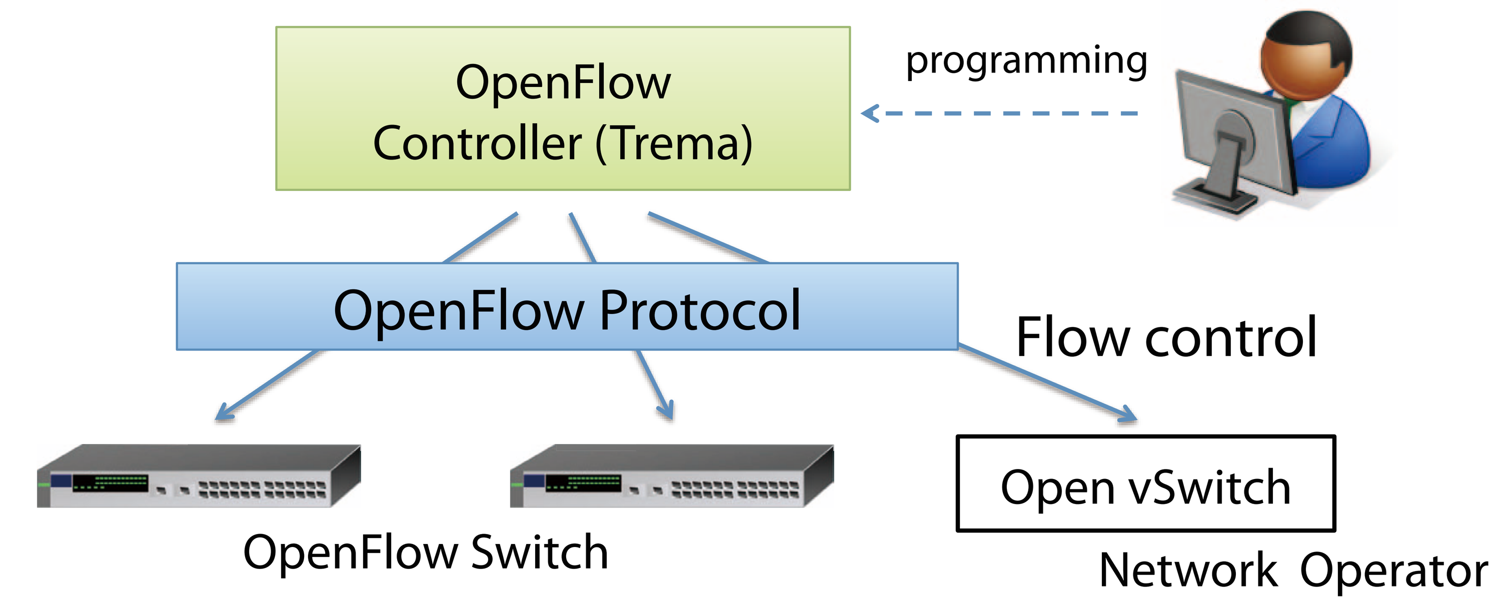
A proposal of SDN-based virtual network routing for virtual cluster deployment considering network throughput

Cybermedia Center Osaka University

Osaka University ／ Nara Institute of Science and Technology ／ National Institute of Information and Communications Technology, Japan

Background

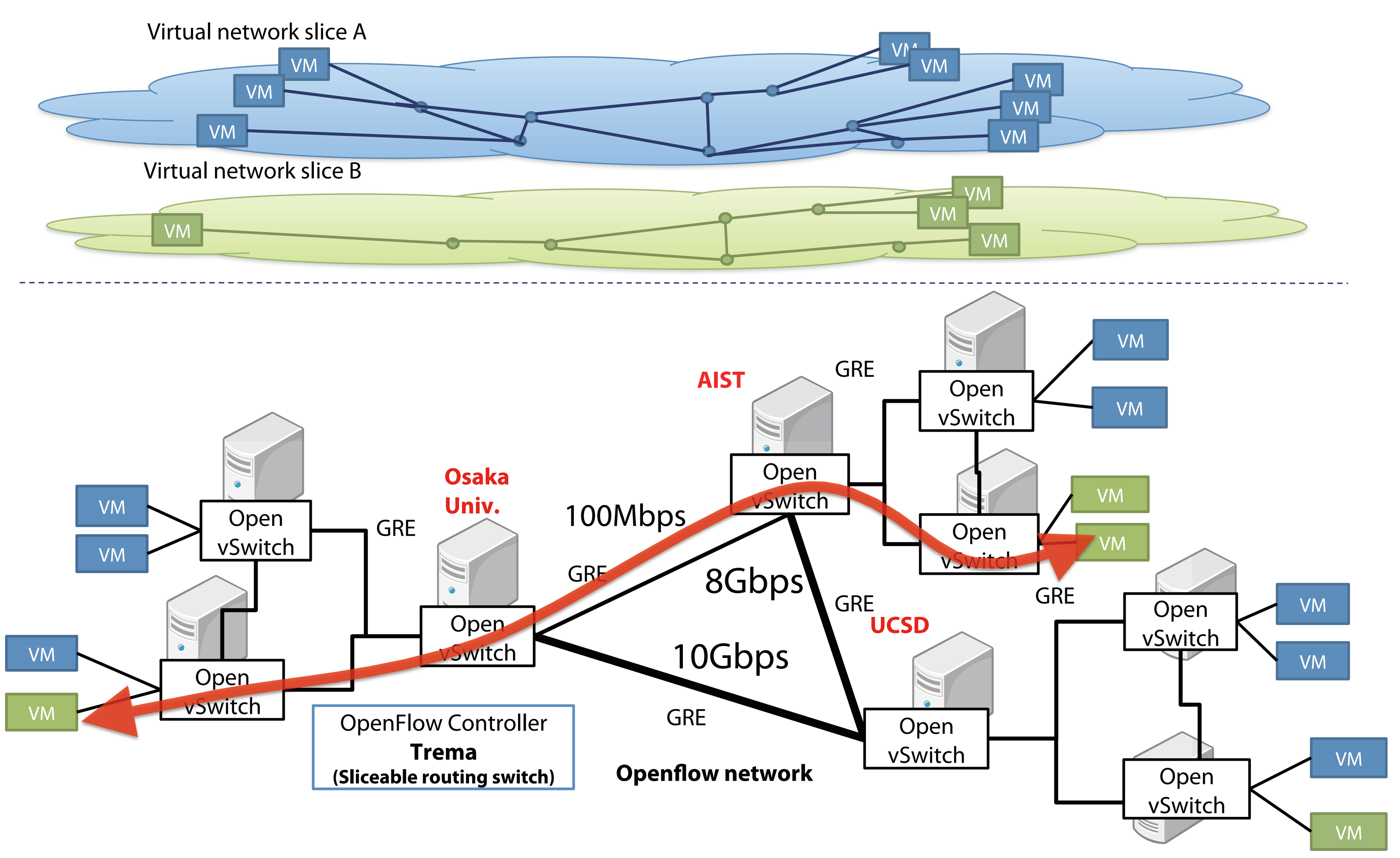
The recent development of virtualization technology enables us to easily build virtualized computational cluster aggregating computational resources from multiple sites. Network virtualization hiding heterogeneities of physical network resources is a key technology to realizing such a virtual cluster, because each site has its own management policy and network barrier like NAT and Firewall. Several approaches have therefore been proposed previously for network virtualization, such as using VPN and overlay network technologies. We have proved that we can provide multiple virtual network slices for each virtual cluster project through SDN-based virtual network in PRAGMA 22. In addition, we have found that the proposed SDN-based virtual network showed better network throughput than the existing virtual network solutions.



- **OpenFlow**
  A centralized programmable remote controller dictates the forwarding behavior to multiple OpenFlow switches. This architecture separating forwarding element from control element allows flexible management to network operator.
  - Trema
    A framework for developing OpenFlow controllers
  - Open vSwitch
    A software based implementation of OpenFlow switch

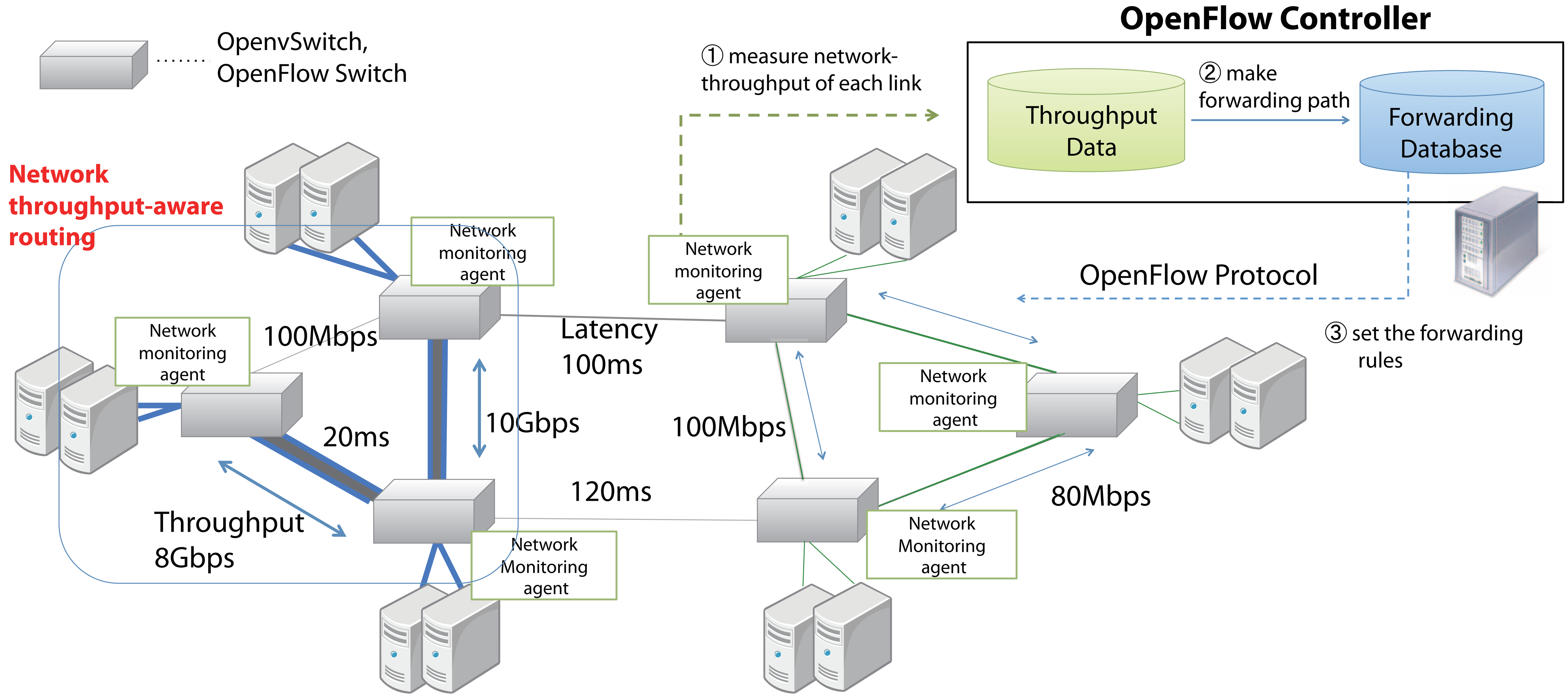
Problem

Although the SDN-based virtual network provide better performance than existing overlay network technologies, our proposed approach is not optimal in terms of wide-area network routing. The prototype method simply makes shortest path routing adapt to the communication among virtual machines in a virtual cluster. However, it does not consider the difference of the network performance of each link, although each network link shows a variety of different throughput and latency in the widely distributed network. ork solutions.



Network throughput-aware routing for virtual clusters

We propose a network throughput-aware routing method on SDN-based virtual network. The basic idea of the method is keeping track of physical network topology and dynamic network parameters, and then allocating appropriate network resources based on the demand of user's application. A virtual cluster for the user is then deployed over the allocated network resources.



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OSAKA UNIVERSITY

A proposal of SDN-based virtual network routing for virtual cluster deployment considering network throughput

Self-organizing transmission scheduling mechanisms for wireless sensor networks

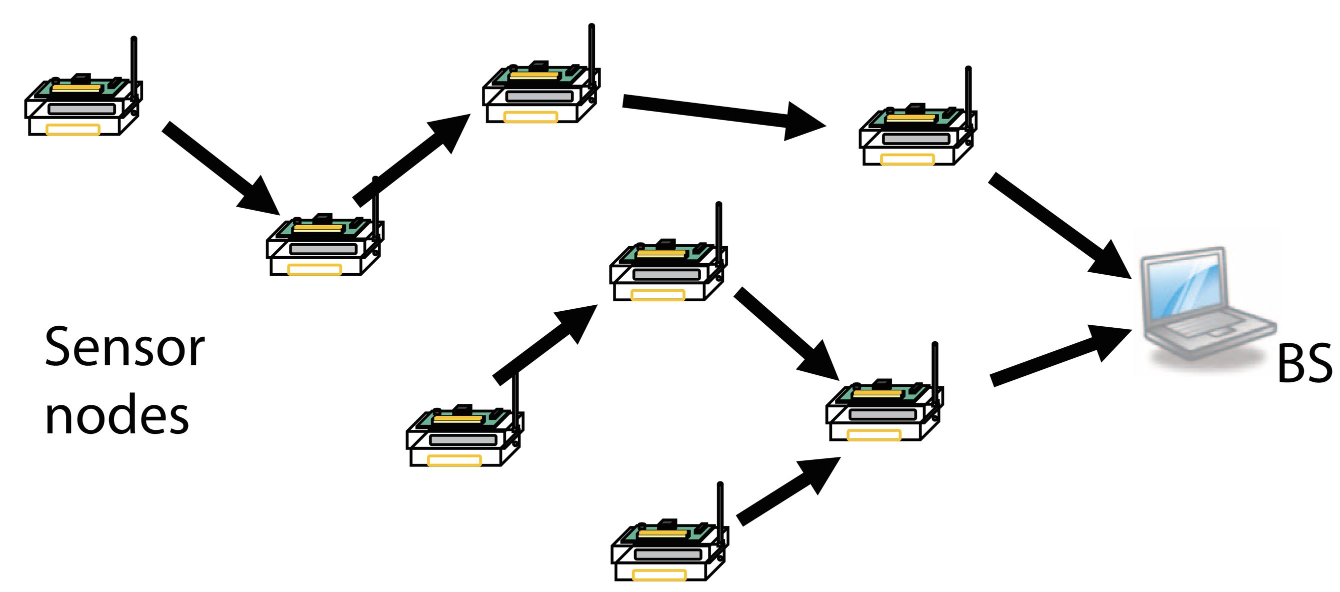
Cybermedia Center, Osaka University, Japan

Self-organizing transmission scheduling mechanisms for wireless sensor networks

Wireless sensor networks

Wireless sensor networks (WSNs) have attracted attention from many researchers and developers, particularly for monitoring applications. In typical monitoring applications, the WSN consists of a base station (BS) and many battery-powered sensor nodes, each with a general-purpose processor with limited computational capability, a small amount of memory, and a wireless communication device. Sensor node data are gathered at the BS through wireless multi-hop networks at regular intervals. In WSNs:

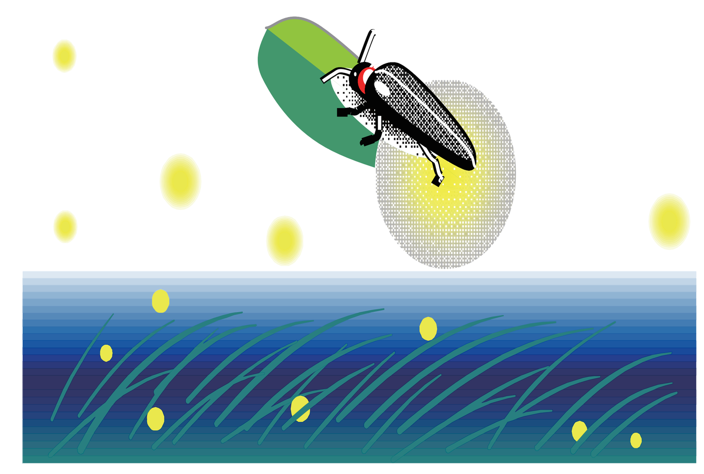
- **Energy-efficient** control mechanisms are required to prolong the lifetime of battery-powered WSNs. Sleep **scheduling**, i.e. turning off the wireless communication device when the device is not used, is highly efficient to save energy consumption.
- **Self-organizing** control mechanisms are required because many sensor nodes are randomly deployed and the network topology dynamically changes due to environmental noise, sensor node failures, and so on.

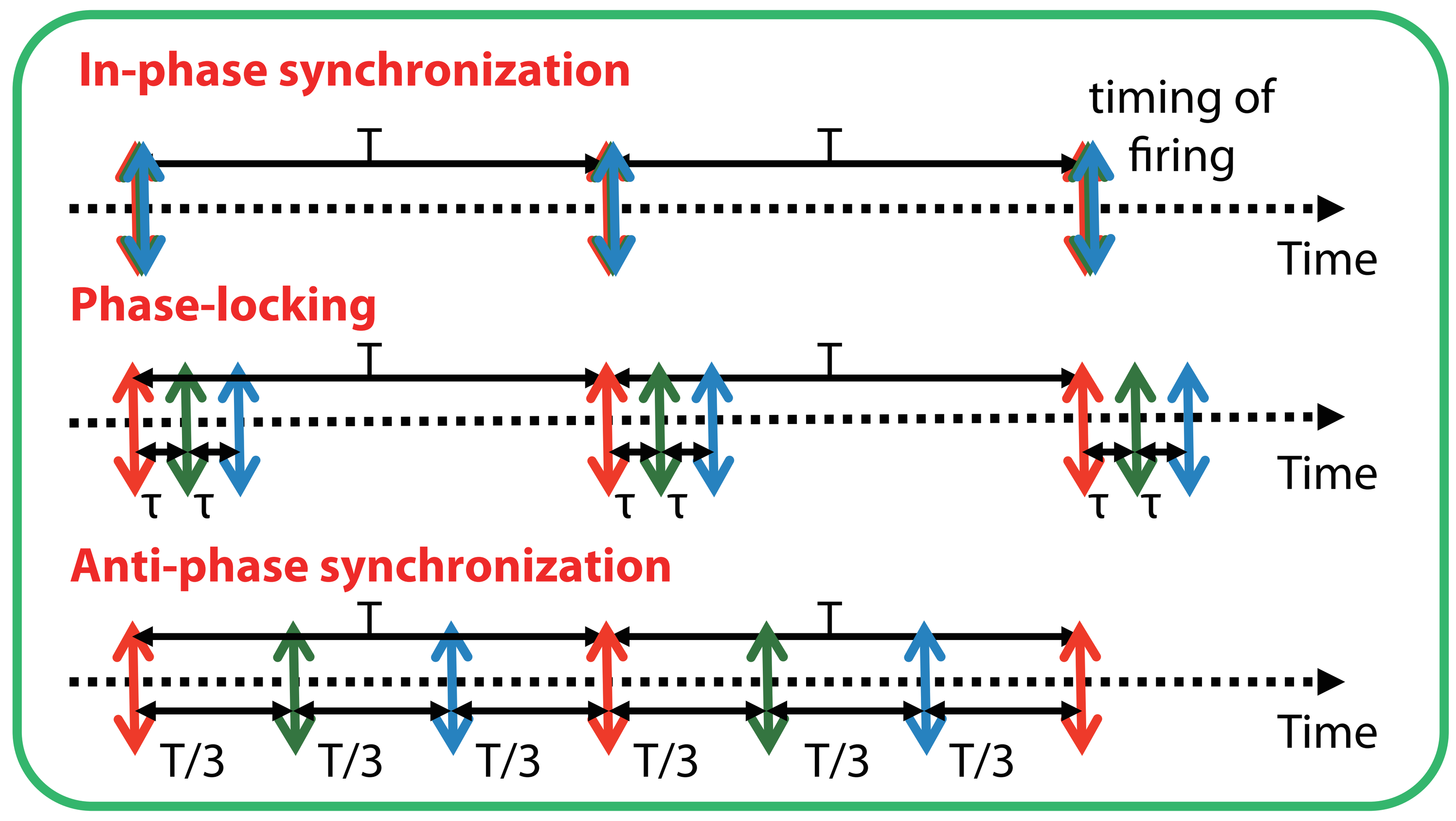


Wireless sensor networks

Pulse-coupled oscillator model

Pulse-coupled oscillator (PCO) models are models of biological **self-organizing** synchronization behavior such as observed in flashing fireflies. PCO models explain several kinds of synchronous behavior among oscillators, such as in-phase synchronization, where oscillators completely synchronize, phase-locking, where oscillators synchronize with a constant offset, and anti-phase synchronization, where oscillators synchronize with an equal interval.





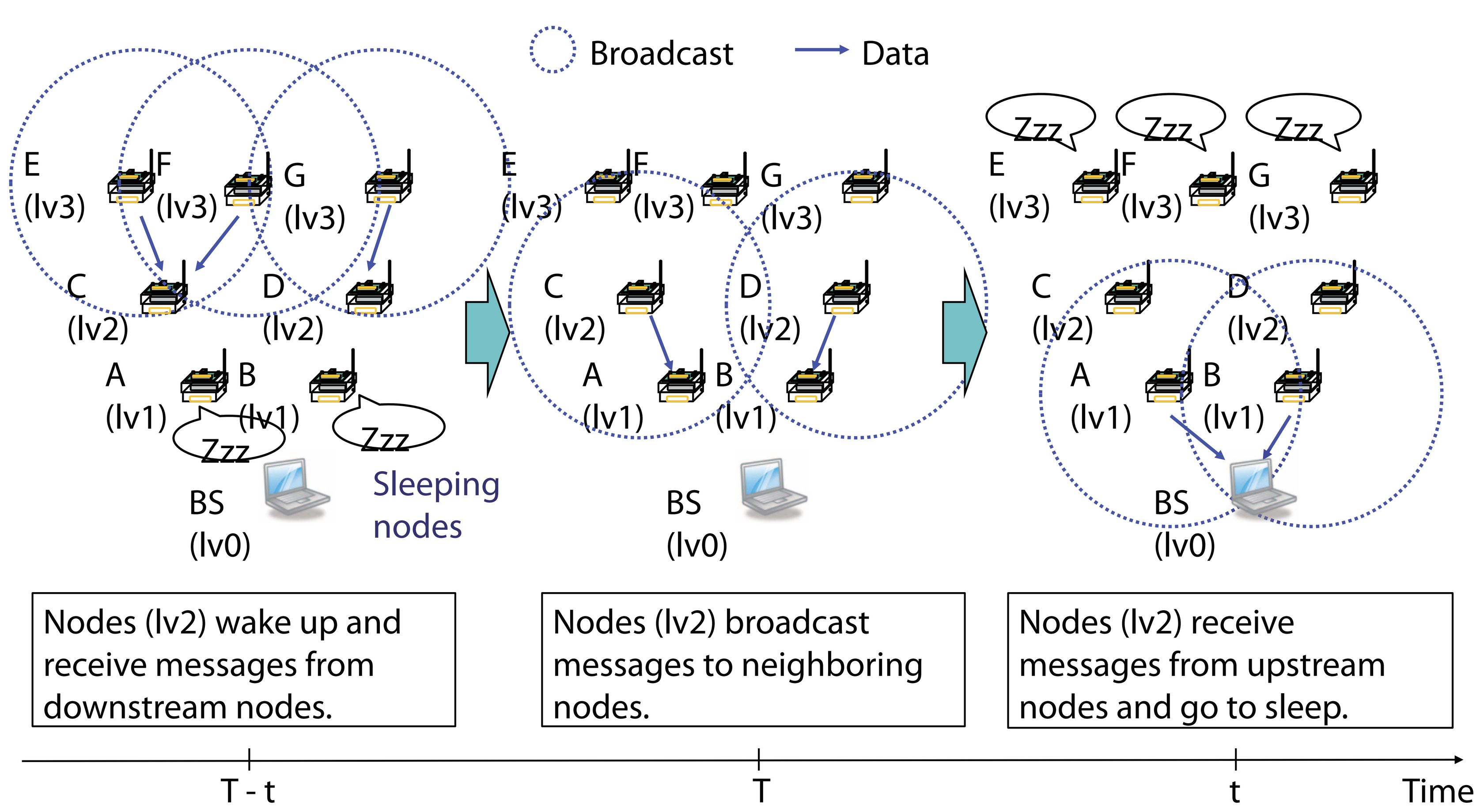
Three kinds of synchronization

Applying PCO models for WSN scheduling

Self-organizing communication mechanism using phase-locking (WAVE) [1]

We have proposed a self-organizing communication mechanism (WAVE) based on phase-locking that can organize two kinds of communication pattern in multi-hop WSNs, namely, diffusion and gathering. In WAVE, **a sensor node self-configures its message transmission and sleep timings.** For gathering, sensor nodes configure their transmission timing so that sensor nodes with the same hop count from the BS simultaneously wake up, receive messages from downstream sensor nodes, and forward the message to upstream sensor nodes. Sensor data from the edge of the WSN are therefore gathered at the BS.

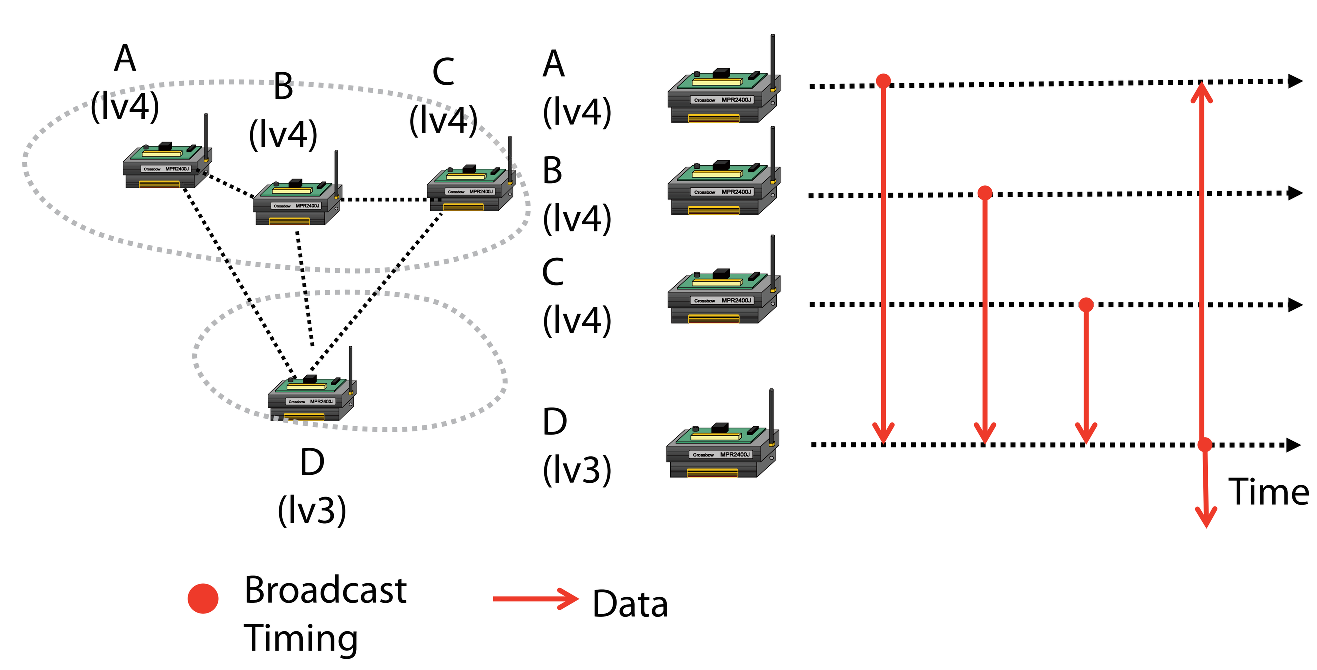
WAVE focuses on phase-locking applications to organize two kinds of WSN communication patterns, and detailed mechanisms for monitoring applications have not been well studied. For example, WAVE does not consider collisions due to simultaneous transmissions among sensor nodes with the same hop count, which lowers the data gathering ratio.



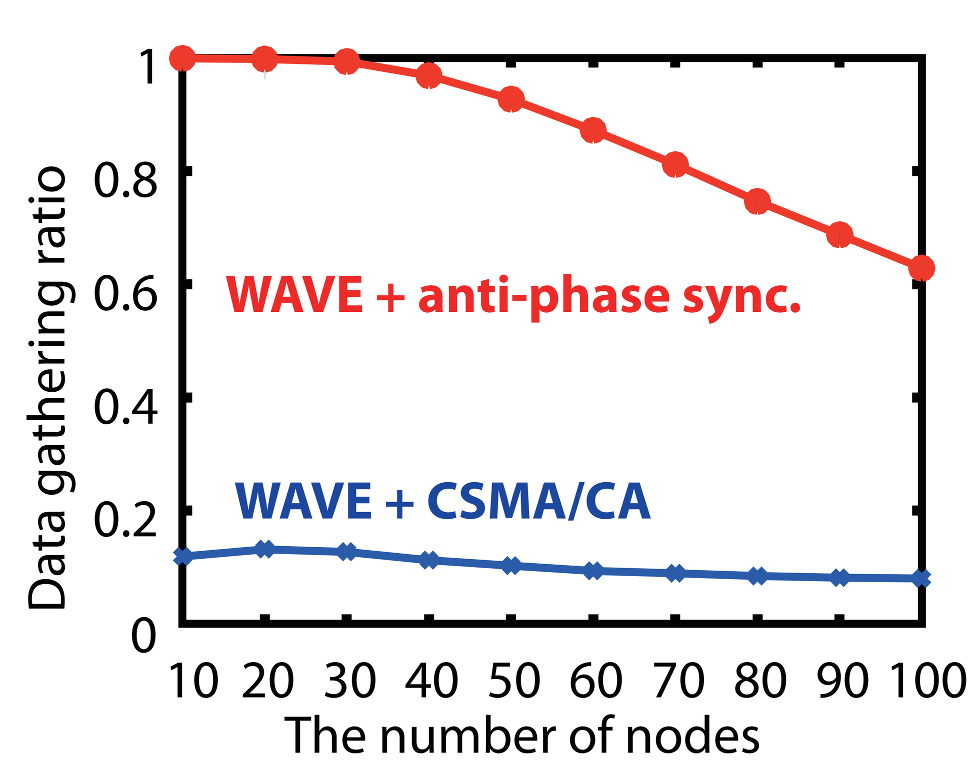
Basic behavior of WAVE in the case of gathering

Self-organizing data gathering mechanism using phase-locking and anti-phase synchronization [2]

To avoid collisions among sensor nodes with the same hop count in WAVE, we are now proposing a self-organizing data gathering mechanism by applying anti-phase synchronization in the PCO model to WAVE. Preliminary results show that the proposed mechanism significantly improves the data gathering ratio.



Example of message transmission timing



Data gathering ratio against the number of nodes

[1] Y. Taniguchi, et al., "A traveling wave based communication mechanism for wireless sensor networks," Journal of Networks, vol.2, no.5, pp.24-32, Sep. 2007.
[2] Y. Taniguchi, et al., "Self-organizing transmission scheduling mechanisms using a pulse-coupled oscillator model for wireless sensor networks," in Proceedings of ICDIPC 2012, pp.85-90, July 2012.

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A Bandwidth Control Method with Fairness of High-speed Protocol Flows in Long-distance Broadband Networks

Cybermedia Center, Osaka University, Japan

A Bandwidth Control Method with Fairness of High-speed Protocol Flows in Long-distance Broadband Networks

Background and Purpose

In long-distance broadband networks, TCP (Transmission Control Protocol) cannot transfer a huge amount of data at high speed. Therefore, many researchers have recently developed high-speed transport protocols that have replaced TCP. These protocols transfer data at high speed by increasing the rate of data-transfer speed when there is no congestion and decreasing the ratio of data-transfer speed when there is congestion. High-speed transport protocols can also achieve the high throughput when there is only one kind of high-speed protocol flows. However, as shown in Figure 1, the sum of throughputs for each flow sometimes decreases, and when multiple flows using different high-speed transfer protocols coexist, a particular flow dominates the bandwidth and the other flows decrease the bandwidth. To solve these problems, we propose a new method of controlling networks; the method helps maintain a high link utilization and decreases the difference between bandwidths of coexisting flows in a link.

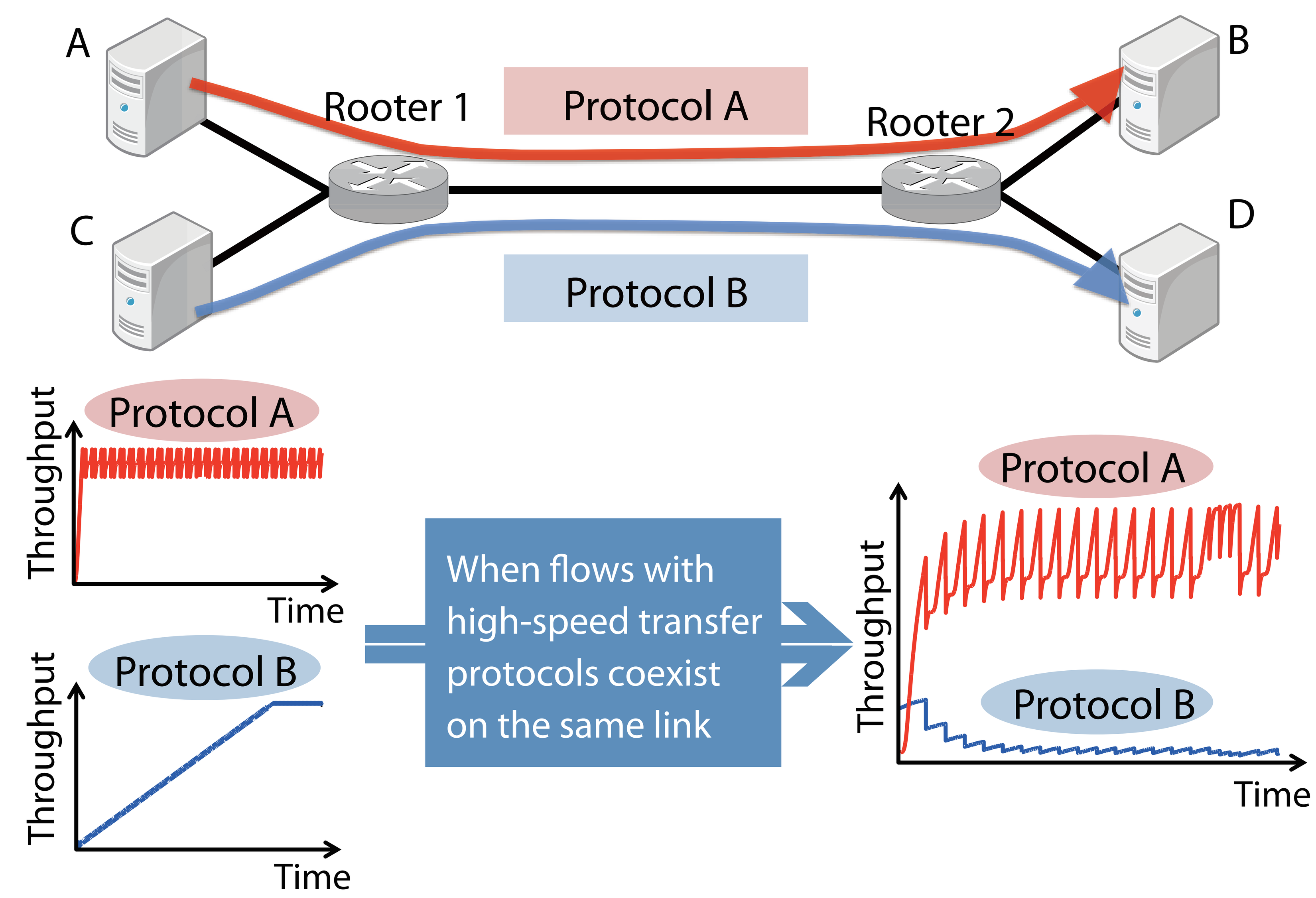

Figure 1: Protocol competition problem

Proposed Method

We focus on the dependence of the transfer rate on the RTT and the window size. We propose a new method for traffic control in the router. The method is devised by considering the characteristics of high-speed transport protocols, and it aims to decrease the difference between bandwidths of different flows. The method involves two types of control.

1. Estimation of the window size

Since the traffic in a long-distance broadband network is bursty, bursty packets arrive at the router every RTT. We propose a new control method that measures the packet arrival interval and estimates the window size and RTT. We consider the point of the end of the maximum packet interval as a cutting and dividing point of the RTT, as shown in Figure 2.

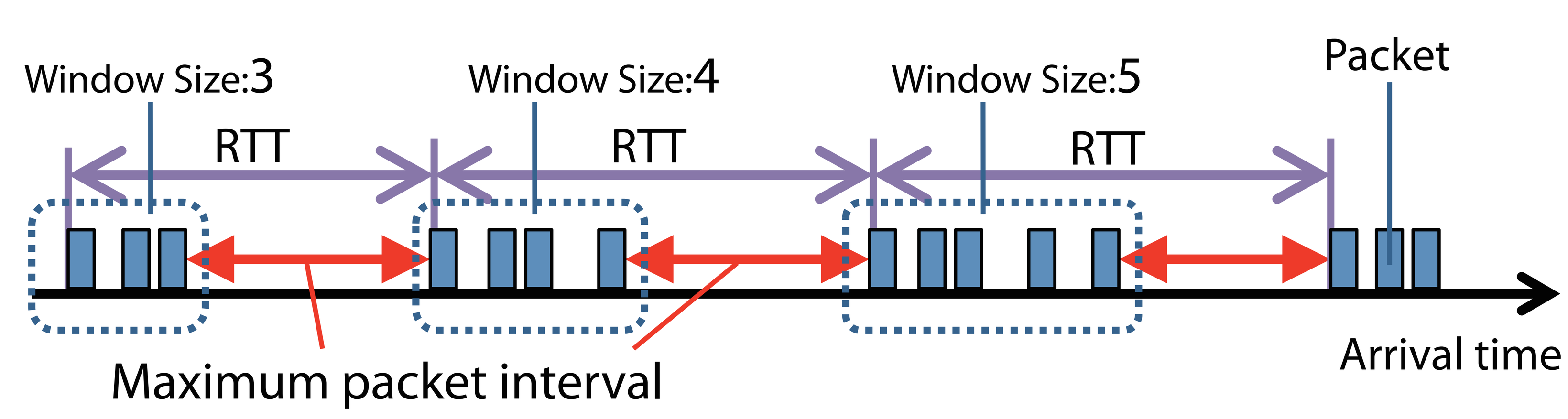

Figure 2: Estimation of the window size and RTT

2. Determination of dropping packets

First, the proposed method calculates the bandwidth to be allocated to each flow from the output bandwidth and the number of flows. Second, it determines the throughput from the estimated window size and RTT. Third, it calculates the moving average of the estimated throughput for each flow. Finally, since we drop packets when the moving average exceeds the allocated bandwidth, the average throughputs of the different flows are almost equal. The throughput may change as shown in Figure 3.

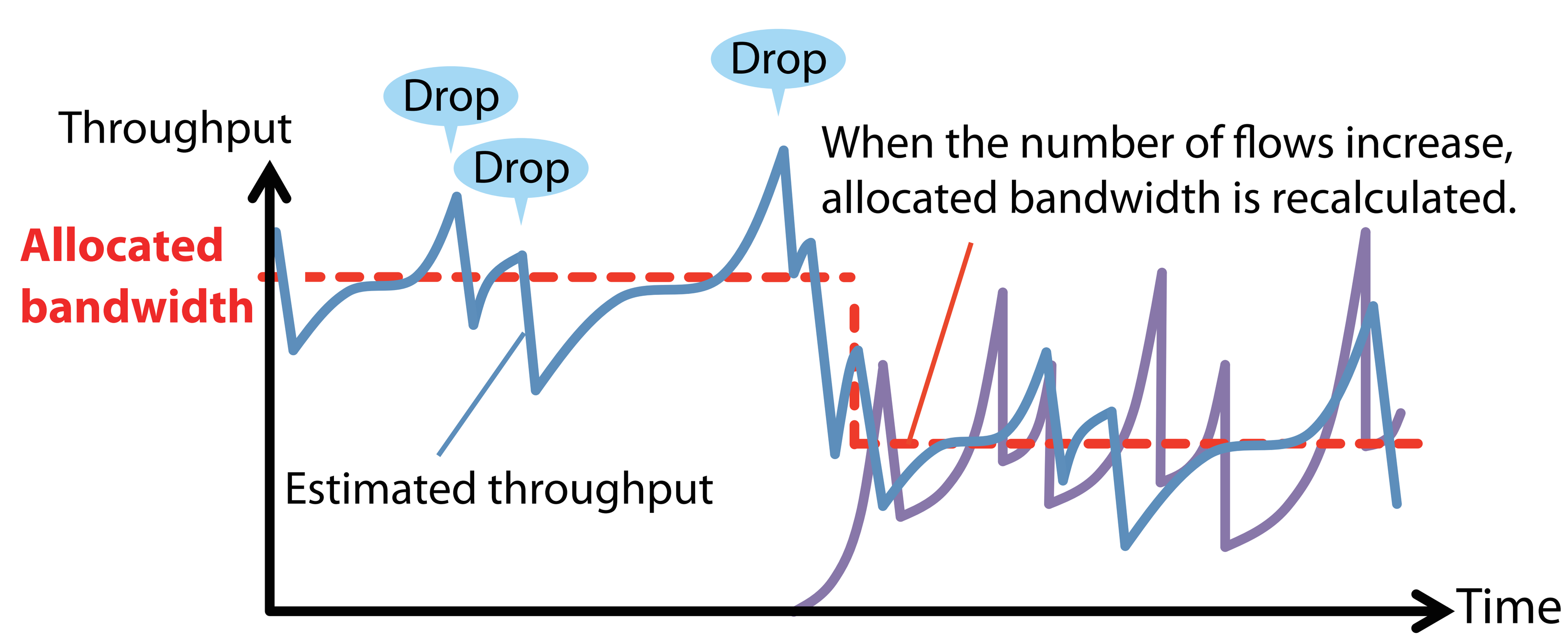

Figure 3: The image of time variation in estimated throughput

Performance Evaluation

We evaluate the performance of the proposed method by performing simulations with the network simulator ns-2. Figure 4 shows the network model used for the simulation. We use DropTail, RED, CSFQ, and the proposed method at the router. We also use HighSpeed TCP (HSTCP), CUBIC TCP, TCP Westwood, and Compound TCP (CTCP) as high-speed transport protocols. Figure 5 shows one of the simulation results obtained by using the average throughput and fairness index (FI) as performance measures. When the value of the FI is approximately 1, the link utilization is close to 100% and the difference between the bandwidths of flows is small.

Figure 5 shows that the total of the average throughputs of the flows obtained by using the proposed method is a little worse compared to those determined with other methods. On the other hand, we can achieve a high fairness index with the proposed method. Thus, the proposed method has high efficiency.

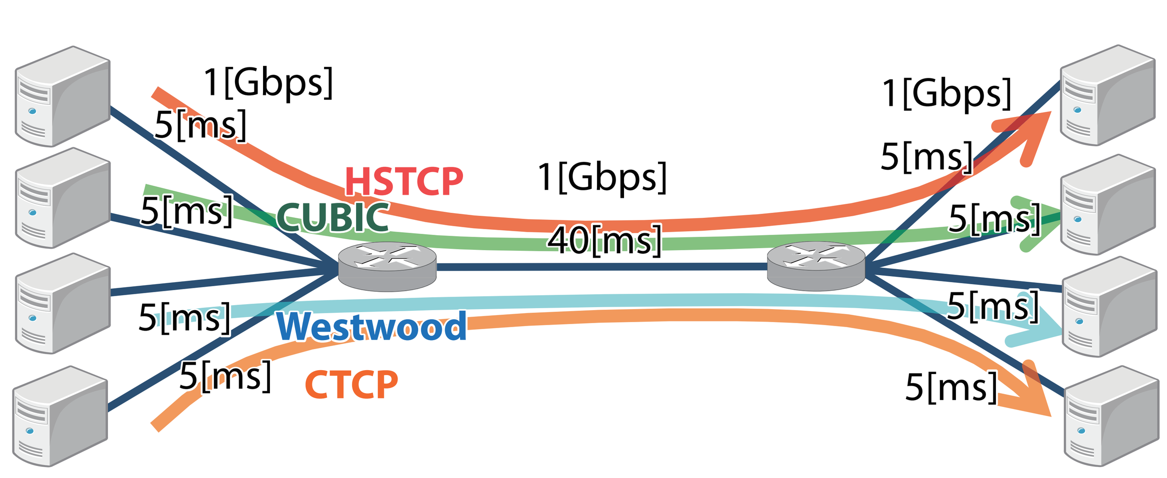

Figure 4: Simulation environment

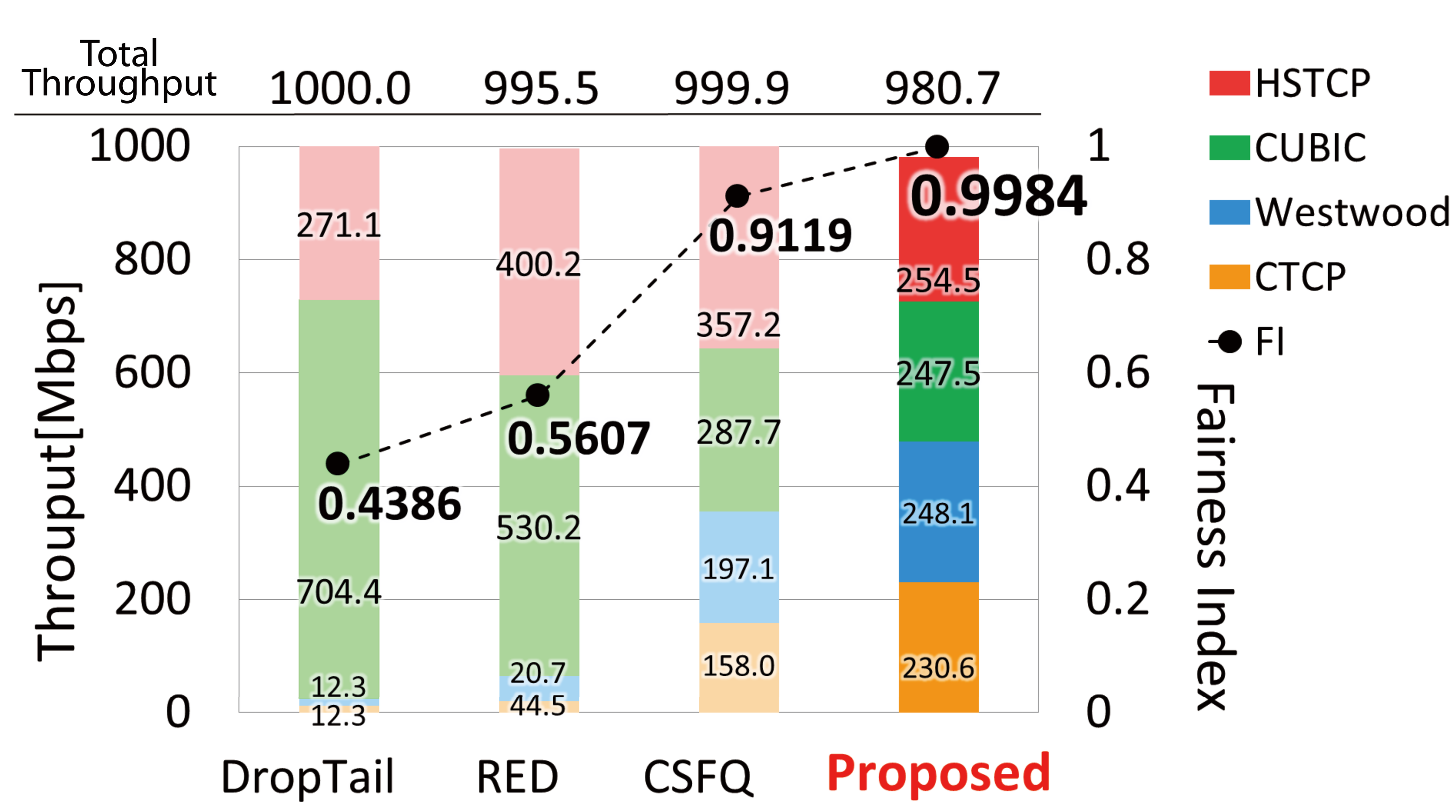

Figure 5: Average throughput and FI with four methods

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