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Nippon Telegraph and Telephone Corporation
Osaka University
The University of Electro-Communications

# The world's first development of bio-inspired "Yuragi" algorithm for network virtualization

- The world's first development of network virtualization technology enabling rapid recovery from large-scale disaster and congestion -

Nippon Telegraph and Telephone Corporation (NTT, CEO: Hiroo Unoura, Tokyo), Osaka University (President: Toshio Hirano, Osaka), and The University of Electro-Communications (UEC, President: Makoto Kajitani, Tokyo) have developed a biologically-inspired "Yuragi (fluctuations)" algorithm[*1] for a virtual network[*2] control technology (Fig. 1 ). By deploying the newly developed technology, we can provide the rapid recovery of a network service in case of unexpected disasters or congestions. This achievement was in part supported by the Strategic Information and Communications R&D Promotion Programme of the Ministry of Internal Affairs and Communications, Japan.
At the upcoming JGN-X[*3] demonstration event sponsored by the National Institute of Information and Communications Technology (NICT), during February 5-7, 2013, we plan to demonstrate a congestion avoidance experiment using the developed technology. In the demonstration, video streaming traffic will be transferred from Okinawa to Sapporo on JGN-X, and we will confirm the rapid recovery from a congestion caused by additional background traffic.

## 1. Background

The recent rapid spread of cloud computing and emerging applications such as M2M/IoT[*4] has led to sudden traffic demand changes. As multiple logical networks are operated on a common physical network infrastructure, it has become increasingly important to operate such networks in the stable manner in order to maintain the stability of each service from the view point of BCP (business continuity planning).
To cope with these issues, multiple virtual networks, each of which corresponds to a service network or a customer network, should be constructed on a common physical network infrastructure; at the same time, those networks should support the customization of network function and operation policies. Moreover, it is also necessary to accommodate unexpected sudden traffic demand changes imposed by cloud computing or emerging applications.
Thus, the research and development of a network virtualization technology based on the Yuragi algorithm, which is originally proposed by Osaka University, under the collaboration of NTT, Osaka University, and UEC.

## 2. Achievements

NTT, Osaka University, and UEC have successfully developed the world's first bio-inspired Yuragi algorithm to be applied for a network virtualization technology. Osaka University has been leading the research of biological fluctuations[*5] as well as the Yuragi algorithm and its application to ICT systems. NTT and UEC are advantageous in network virtualization technologies and network protocols, respectively. This remarkable achievement has been attained by integrating leading-edge technologies of those three institutes.
By deploying our achievements, each virtual network is able to autonomously find adequate route or network topology in response to unexpected environmental changes such as equipment failures or congestions. We have successfully demonstrated adaptive virtual network reconfigurations for quick recovery in case of sudden traffic demand changes or a large-scale disaster.

## 3. Technical Features

### (1) Managed self-organization

A network virtualization technology based on the Yuragi algorithm. As each virtual network is able to autonomously compute nearly optimal route or network topology, the computation time is much faster compared to conventional optimization technologies and ensure adaptability to unexpected environmental changes (Fig. 2 ). This enables rapid network recovery that satisfies practical requirements in case of a large-scale disaster or congestion. Osaka University carried out theoretical study and developed control algorithms, while

NTT improved control algorithm to be applied for an operational network and developed network control server to demonstrate the developed technology.

### (2) Virtual resource contention resolution scheme

A resource management technology that enables the rapid recovery from ICT resource contention among multiple virtual networks. Osaka University developed a scheme for stabilizing the behavior of multiple virtual networks through the feedback of other virtual network status, while NTT developed a resource access mechanism that isolates the behavior of a specific virtual network from others. Those two technologies enable efficient network resource usage by adequately distributing traffic load.

### (3) link load ranking (LLR) scheme

A scheme to reduce the number of advertisements in an open shortest path first traffic-engineering (OSPF-TE) network. The LLR scheme keeps the information of top-rank links, ordered by link load, in a ranking table. Only the information that relates to the ranking table is advertised. With the LLR scheme, the number of advertisements is 78% reduced, comparing to the general OSPF-TE network.

## 4. Future Plans

We will be working on further study issues for practical deployment of our achievement, expecting the deployment of our technologies in Future Networks*6 or New-Generation Networks which will be made practical around 2020.

## Footnote

*1 Yuragi algorithm

Biological systems, which have complex structures, are driven by fluctuations in response to environmental changes while maintaining lower power consumption. Such a mechanism is called as “Yuragi”, which means fluctuations in Japanese, and Osaka University has a worldwide reputation for the application of the “Yuragi” algorithm to artificial systems.

*2 Virtual network

A logical network constructed on a physical network infrastructure. Due the spread of cloud computing, there has been the clear and urgent need for constructing multiple logical networks over a common network infrastructure and providing flexible network reconfigurations and functional customization. Virtual networks enable such requirements through the virtualization of network infrastructures. ITU-T, which is an international standards organization, has standardized it as Recommendation Y.3011.

*3 JGN-X

A nation-wide testbed network operated by NICT for research and development. The network has been constructed and operated in order for the realization of New-Generation Networks promoted by NICT. Additionally, we can carry out advanced network technologies and emerging applications on the network.

*4 M2M/IoT

An environment which enables devices to communicate with others over wired or wireless networks. Unlike conventional communication technologies, human interaction is not necessary in M2M/IoT. A study group of MIC exemplifies “health care & social welfare”, “Environment”, “disaster prevention measures”, “Transportation”, “Industry”, and “life and entertainment” as use cases of IoT.

*5 Biological fluctuations

A mechanism that drives biological systems based on fluctuations or noise. The biological fluctuations can be observed in various types of biological systems such as a brain and genes. Biological systems with complex structures are driven in response to environmental changes while maintaining lower power consumptions. Noise caused by heat fluctuations is considered to play an important role in such characteristics.

*6 Future Network/New-Generation Network

To overcome limitations of the current Internet, the research development of future network technologies has been extensively undertaken in the United States, EU, and Asian countries including Japan. Such future networks are called as Future Networks or New-Generation Networks. Future Networks are expected to fulfill changing requirements into the future. The target time frame of the initial deployment or service trials of Future Networks is assumed to fall approximately around 2020. Future Networks have been being standardized at ITU-T.

**Attachment·Reference**

- Fig. 1: World’s first development of network virtualization technology based on “Yuragi” (fluctuations) algorithm
- Fig. 2: Overview of managed self-organizing network

**For further information, please contact:**

**NTT Information Network Laboratory Group**

PR Section, Planning Department
Tel. +81-422-59-3663
E-mail:inlg-pr@lab.ntt.co.jp

**Graduate School of Information Science and Technology, Osaka University**

Masayuki Murata
Shin'ichi Arakawa
Yuki Koizumi
TEL: +81-6-6879-4541
E-mail: contact-ana-lab@ist.osaka-u.ac.jp

**The University of Electro-Communications**

General Affairs Office
TEL: 042-443-5962
E-mail: kouhou-k@office.uec.ac.jp



NTT Press Releases Index

NTT Press Releases

Latest Press Releases

Back Number

Japanese is here

Search Among
NTT Press Releases

January 1997 -
November 2021

Search

▲ Page Top

Recent updates Site Map Copyright Privacy Policy Contact