5-8 Research Project for Ubiquitous Society with IPv6 at Technical High Schools

WATANABE Kenzi and KONDO Hiroki

In this project, technical high schools students try to create future ubiquitous society. They have been developed a couple of ubiquitous systems such as remote operate-able systems, small model of ubiquitous house, sensor systems and so on. During the developments, the students get experiences to create their future society by themselves.

Keywords
Education for ubiquitous society, Technical high school, IPv6, Ubiquitous electric household appliances

1 Introduction

It is predicted that the next stage of the IT revolution will bring ubiquitous computing and networking to society as a whole. In this ubiquitous society, networks will connect and combine not only PCs but also every type of household appliance and information device; this is turn is expected to improve the overall quality and convenience of daily life[1].

Accordingly, it is essential that we develop the key human resources today that will help usher in the coming ubiquitous society.

Traditionally, information education has been aimed at the people that will live in tomorrow's information society. In terms of developing the human resources that will be needed in such a society, information engineering departments at universities and colleges have been focusing their educational efforts mainly on software-related fields.

To create the myriad of information devices that will be needed in a ubiquitous society, it is important to develop professionals familiar with hardware and software as well as network and system development, professionals that will be able to make broad contributions to the coming society. Unfortunately, however, little effort has been devoted to these broad goals.

Since 2001, we have been conducting empirical research involving the ubiquitous society (for example, remote operation of robots and construction of small models of ubiquitous houses) using IPv6; these experiments have involved the joint participation of students at a number of technical high schools in Saga, Hiroshima, Miyazaki, Oita, Okinawa, Yamanashi, and Hokkaido Prefectures[2][3].

This project, which can be viewed essentially as a human resources initiative, is an important one: these high-school students will lead the next generation in the activities that will create the future ubiquitous society—their society.

Through the various project activities, we have found that these technical high schools can play a very important role in achieving the overall goals of the initiative. Technical high schools provide education programs focusing both on the hardware and on the software that will be essential in realizing the ubiquitous society, and as such are the ideal incubators for tomorrow's human resources.

In this paper, we will describe the significance of this project in more detail, including

specific activities of the project, entitled "Experiments for a Ubiquitous Society Using IPv6 at Technical High Schools".

2 Overview and progress of project

In 2001, the IPv6 Promotion Council implemented the TAO project entitled "Demonstration Experiments of the IPv6 Access Network and Ubiquitous Electric Household Appliances". In Saga Prefecture, NetCom Saga led this project, preparing an IPv6 access network using a CATV network and performing experiments on appliance operability and functions[2].

As part of this project, three technical high schools in Saga Prefecture (Arita Technical High School, Taku High School, and Saga Technical High School) conducted activities in 2001 and 2002 under the theme "Demonstration Experiments of Remote Operation of Robots Using IPv6 at Technical High Schools"[3]. The high-school students themselves took the initiative in these activities, performing a range of experiments: testing of remote operation of robots through an IPv6 network, as well as experiments on the use of a micro-node in remote power-on/off and operation of household appliances, motors, electronic music boxes, solar-powered cars, and robots. NetCom Saga and Saga University provided support in preparation and operation of the IPv6 network.

In 2003, with the support of the TAO project entitled "Comprehensive R&D of IPv6-Enabled Ubiquitous Electric Household Appliances", we conducted activities under the themes "R&D of Creation of Remote Operation Environment for Robots and Remote Operation Experiments, and Creation of Comprehensive Remote Operation Environment for Ubiquitous Electric Household Appliance Models and Remote Operation Experiments Using IPv6 at Technical High Schools". In addition to the three technical high schools mentioned above, four schools in Saga (Karatsu Technical High School, Shiota Technical High School, Tosu Technical High School, and Hokuryo High School) and two schools in Hiroshima (Attached Fukuyama Jr. and Sr. High School of Hiroshima University and Hiroshima Municipal Technical High School) joined the project. At these schools, students performed experiments on robots and other devices using the micro-node, and held meetings to study IPv6, with the cooperation of the relevant universities (Saga University, Hiroshima University, and Hiroshima City University).

In 2004, with support from the NICT project entitled "Commissioned R&D of IPv6-Enabled Ubiquitous Electric Household Appliances", we conducted activities under the theme of "Experiments for a Ubiquitous Society Using IPv6 at Technical High Schools". In addition to the 9 schools mentioned above, University of Miyazaki, Miyazaki Technical High School, and Miyakonojo National College of Technology joined the project. The research results were very well received at the "Kyushu JGNII Symposium in Saga"[7] held in December 2004.

Since 2005 is the final year of the "e-Japan Strategy", a broad range of activities have now become pressing in anticipation of the next "u-Japan Strategy". With support from the NICT project as in the previous year, we are pursuing activities under the theme "Experiments for a Ubiquitous Society Using IPv6 at Technical High Schools: National Expansion of Project and Greater Variety of Terminal Devices in Preparation for u-Japan". With the aim of achieving nationwide reach for our project, we have increased the number of participant schools in numerous prefectures: Miyazaki (Nobeoka Technical High School), Oita (Oita University, Ogata Technical High School), Okinawa (University of the Ryukyus, Okinawa National College of Technology, Urasoe Technical High School), Yamanashi (Yamanashi Prefectural University, Kofu Technical High School), and Hokkaido (Sapporo Medical University, Kushiro National College of Technology). In addition to selecting research subjects that all schools can

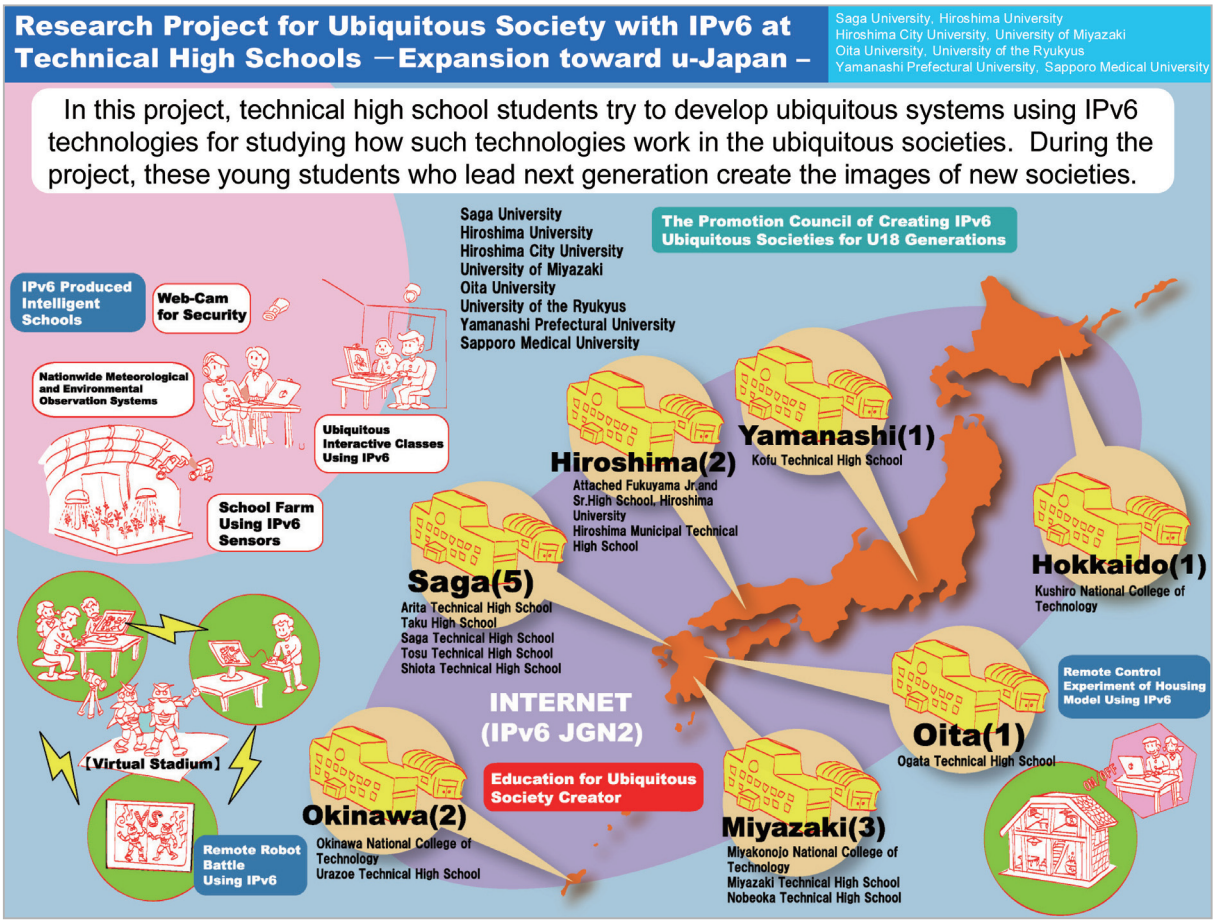

Fig.1 Overview of project

work on, we selected various subjects that they can study in collaboration with universities. We set up the "Promotion Council to Create IPv6 Ubiquitous Societies for the U18 Generation" to spread project activities to technical high schools throughout the country for u-Japan and to provide these schools with the necessary support (Fig.1).

We described these project activities in detail in a number of reports [4]-[6].

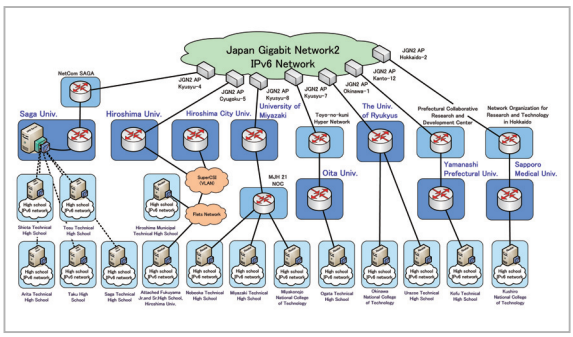

Fig.2 Network configuration

3 Network configuration

Figure 2 sketches out the network configuration used in this project. To conduct R&D using IPv6 over large areas, we used the JGNv6 network established on NICT's JGNⅡ as a backbone. JGNⅡ has access points in Saga, Hiroshima, Miyazaki, Oita, Okinawa, Yamanashi, and Hokkaido Prefectures. Communications lines with a speed of at least 100 Mbps are available in these regions.

Within individual regions, participant universities and technical high schools are connected to JGNⅡ access points through the use of regional networks, prefectural education networks, and NTT B FLET'S or FLET'S Group service.

4 Project activities

In this chapter, we will briefly explain some of the project results. Due to limitations of space, we cannot address all of the activities carried out at many schools. For details, please see the separate research documents[2] and reports[4]-[7].

4.1 Remote operation of bipedal robots

Connection of an infrared-operated bipedal robot and a micro-node[8] with built-in IPv6 followed by remote operation through the IPv6 network

At the start of this project in fiscal 2001, participant schools worked together to develop this bipedal robot. However, to connect the micro-node and the robot's infrared controller, the micro-node needs to feature a circuit that uses eight-channel (8-ch) parallel outputs to control the infrared controller. At each school, students made this circuit by themselves.

Figure 3 shows a robot built by Taku High School (in Saga). Students made an 8-ch relay output circuit and built it into the micro-node. This enabled remote control of the robot's movements (backward and forward) and sounds.

At the "Kyushu JGNII Symposium in Saga"[7], the students remotely controlled this robot while watching images sent from a wireless microcamera mounted on its head.

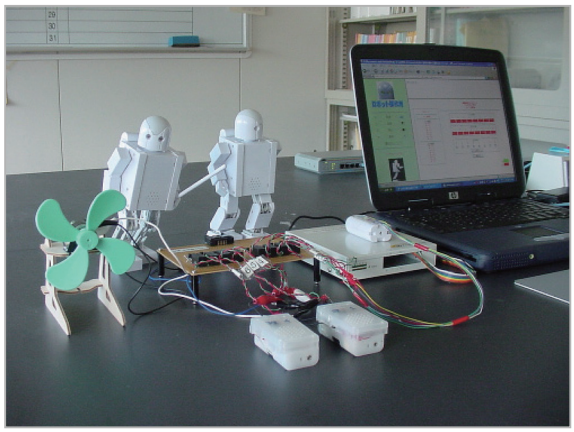

Fig.3 *Bipedal robot (Taku High School)*

4.2 Small models of a ubiquitous house

Arita Technical High School (in Saga) made a small model of a ubiquitous house, with ubiquitous electric household appliances such as lights, the TV, an electric fan, and bathroom equipment operated remotely through the IPv6 network (Fig.4).

More specifically, a web interface is used to operate household appliances via the micro-node, with a built-in circuit controlling the various devices.

At the SAINT2004 International Conference, the students who developed this model made a presentation in English.

Fig.4 *Small model of ubiquitous house (Arita Technical High School)*

4.3 Remote-operated sumo robot wrestling

For its part, the Hiroshima Municipal Technical High School made a sumo robot, which can be operated from a remote location using a joystick (Fig.5).

Students at the Information and Electronics Club at this school enabled operation of a radio-controlled sumo robot through the IPv6 network using a multi-purpose compact node, MicroRAC[9]. They controlled the robot via a proportional radio control employing a circuit that converts the MicroRAC's parallel output into AM radio waves. The robot's movements (back, forth, and all around) can be remote-controlled using a joystick connected to MicroRAC.

At the "Kyushu JGNII Symposium in Saga"[7], students staged a sumo match: robots

were located at Hiroshima Municipal Technical High School, and the battling parties controlled the robots from Saga and Miyazaki.

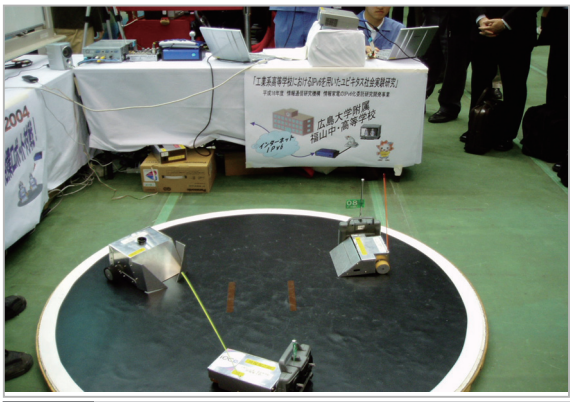

Fig.5 Remote-operated sumo robot wrestling (Hiroshima Municipal Technical High School)

4.4 Remote operation of shuttle-game robots

Miyazaki Technical High School developed a shuttle-game robot (Fig.6), which can launch shuttles using its two high-speed rotors.

The shuttle launch angle can be adjusted remotely. Moreover, the robot can move flexibly—back, forth, and all around—using its motor-driven wheels. Students constructed a circuit to connect the robot to MicroRAC's parallel outputs.

At the "Kyushu JGNII Symposium in Saga"[7], students played a match: shuttle-game robots were located at the venue in Miyazaki, and the competing student groups controlled the robots from Saga and Hiroshima.

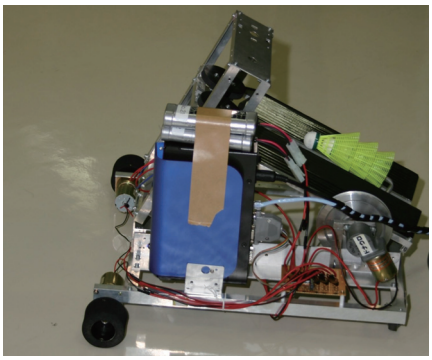

Fig.6 Shuttle-game robot (Miyazaki Technical High School)

4.5 Creation of household-appliance control devices

Hiroshima Municipal Technical High School developed a "household-appliance control device" that regulates classroom conditions by gathering various types of information using the LonWorks protocol[10].

Standardization of the LonWorks protocol is now under active discussion in the field of facility networking. Students used a LonWorks kit to make a control board to monitor lights, temperature, humidity, and motion-detection sensors; the students then created a test environment for their devices (Fig.7).

The students also developed a user interface for remote PC operation of the control board via the IPv6 network.

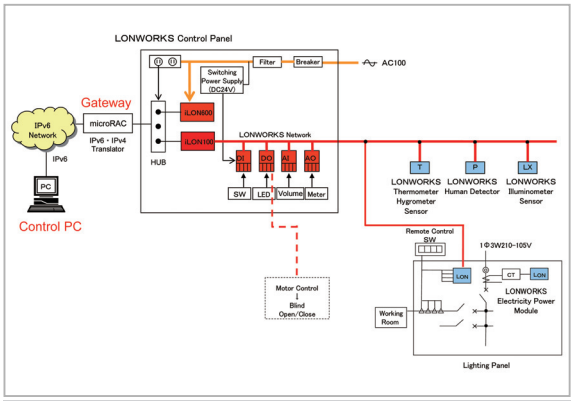

Fig.7 Household-appliance control device (Hiroshima Municipal Technical High School)

5 Discussion

5.1 Developing human resources for a ubiquitous society

In a ubiquitous networking society, we can expect to see networked terminal devices everywhere, helping to improve the quality and convenience of daily life. The essential challenge lies in our taking the initiative to create this society in concrete ways, on our own.

In this project, students at technical high schools or technical junior colleges in Saga, Hiroshima, Miyazaki, Oita, Okinawa, Yamanashi, and Hokkaido Prefectures are enthusiastically pursuing R&D of IPv6-

enabled terminal devices, with support from a number of universities.

These students are enjoying creating and operating devices by themselves, and communicating enthusiastically with other students via network communications. They are clearly delighted to be experiencing the future ubiquitous society right now, taking part in its establishment for everyone through leading-edge technology.

This project thus enables these young people to conduct research on ubiquitous networking/computing using IPv6 next-generation Internet technology. They are visualizing the elements of a future ubiquitous society and working to create and test various systems on their own. Hands-on experience with leading-edge technology is giving them confidence and enhancing their motivation to learn.

In short, this project is undeniably playing a meaningful role in the development of the human resources that will help bring about the ubiquitous society.

5.2 Roles of technical high schools

To cope with challenges of shifts in manufacturing and other rapid changes in the information society, Japanese technical high schools are now being forced to reorganize their educational programs. Specifically, to ensure job opportunities for students by addressing the increasingly segmented and complex businesses resulting from technological progress, these schools have been revising or consolidating their programs in specialized fields: electricity, machinery, information, chemistry, and so on.

This project deals with a wide range of fields—not only information, electricity and electronics, but also machinery and construction. Therefore, at many participant schools, students are setting up cross-disciplinary "theme research" projects or conducting research as part of various club activities.

To conduct empirical research for the ubiquitous society, students need a well-equipped classroom similar to a research lab or workshop. In this respect, technical high schools can provide necessary facilities, equipment, and knowledge.

In other words, technical high schools can cover the specific technical fields required for the creation of a ubiquitous society. By incorporating related subjects into their current educational programs, these schools will be more effective in meeting tomorrow's human-resource needs.

In this sense, we believe that this project is pointing toward a new form of education in technical high schools, specifically tailored to the needs of tomorrow.

6 Conclusions and acknowledgements

In this paper, we have described the significance and specific activities of the project entitled "Experiments for a Ubiquitous Society Using IPv6 at Technical High Schools".

A ubiquitous networking society is something that we must create, not something that we can simply wait for. In this project, technical high school students have been trying to find out how new types of ubiquitous electric household appliances and other terminal devices can be put to practical use in a ubiquitous society by creating and testing such devices on their own with the use of the IPv6 network protocol.

By conducting research on next-generation networks at technical high schools, these students are involved in the hands-on creation of their own future society. We believe that through these activities, these young people will indeed succeed in bringing about a future ubiquitous society.

Finally, we would like to express our gratitude to the National Institute of Information and Communications Technology (formerly the Telecommunications Advancement Organization of Japan) for their support through the following projects: TAO's "Demonstration Experiments on IPv6 Access Network and Ubiquitous Electric Household Appliances" conducted by the IPv6 Promotion Council in 2001; TAO's "Comprehensive R&D of IPv6-

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***WATANABE Kenzi**, Dr. Eng.*

Associate Professor, Department of Information Science, Faculty of Science and Engineering, Saga University

Intelligent Educational Systems, Internet Applications

***KONDO Hiroki**, Dr. Sci.*

Professor, Department of Information Science, Faculty of Science and Engineering, Saga University

Intelligent Educational Systems, Internet Applications