

## World's First Breakthrough Achieved for Long-Range Broadband Communications in TV White Space

### Abstract

The National Institute of Information and Communications Technology (NICT, President: Dr. Masao Sakauchi) and Hitachi Kokusai Electric Inc. (Hitachi Kokusai, President and Chief Executive Officer: Manabu Shinomoto) recently succeeded in the world's first field trial where long-range broadband communications in the TV white space\*<sup>1</sup> was confirmed by using IEEE 802.22-based\*<sup>2</sup> and IEEE 802.11af\*<sup>3</sup>-based systems. In this trial, NICT and Hitachi Kokusai observed successful downstream and upstream data transmission at 12.7 km distance between IEEE 802.22-based base station and customer premises equipment, at a speed of 5.2 Mbps and 4.5Mbps, respectively. In addition, NICT and Hitachi Kokusai constructed a multihop network by using IEEE 802.22 as a backbone link and IEEE 802.11af, which is connected to it, to expand its connection area. In this trial, they demonstrated some applications such as video monitoring of roads and cliffs and video telephone in mountain areas where there are no wired/wireless Internet connections available. These achievements showed feasibility of providing broadband services in rural areas and supporting radio communications during disasters relief activities.

This trial was conducted under a contract of R&D for broadband access in white space that was entrusted to NICT and Hitachi Kokusai by the Ministry of Internal Affairs and Communications, Japan.

### Background

Demand for broadband communication services has been growing in a rapidly diffused information society. Unfortunately, the broadband communication services have not sufficiently provided many rural areas such as mountain areas and remote islands. To realize the broadband communication services to the rural areas, a wireless system is required as a cost effective service comparing with wired networking. When disaster strikes and infrastructure has been damaged, the wireless system is also required for flexible and fast setup to construct an alternative network. White space in TV band (470-710 MHz, in Japan) is expected for long-range communication whereas legacy system using higher frequency band such as wireless LAN and cellular systems cover shorter range, since lower frequency has generally low impact on distance decay toward obstacles. In these circumstances, NICT and Hitachi Kokusai are developing IEEE 802.11af and IEEE 802.22 based wireless systems, respectively.

### Achievements

NICT and Hitachi Kokusai had confirmed a success in long-range wireless communications by using IEEE 802.22 and IEEE 802.11af based systems in Tono City, Iwate, Japan. They have observed the following results:

1. IEEE 802.22-based system successfully communicated over 12.7 km between base station and customer premises equipment. Throughput was 5.2 Mbps in downstream and 4.5 Mbps in upstream. (Fig. 1)
2. Multihop network is successfully constructed. The network is constructed using IEEE 802.22 wireless link and IEEE 802.11af wireless link. IEEE 802.22 is used for backbone link and IEEE 802.11af is used for expansion of service area. Wireless LAN, based on conventional IEEE 802.11b/g/n in 2.4 GHz band, is attached to IEEE 802.11af station through which conventional off-the-shelf devices are connected to the Internet. Using the devices, NICT and Hitachi Kokusai

- have demonstrated availability of web access and conversation with video telephone. (Figs.2, 3 and 4)
3. An original function has been developed based on IEEE 802.22 to operate in multiple channels. With two discontinuous TV channels to operate at the same time, they have succeeded in achieving throughput of 15.5 Mbps in downstream and 9.0 Mbps in upstream over 6.3 km. (Fig. 1)

Further information about the trial that will be presented at the Super Wi-Fi Summit in Miami, Florida, from January 29 to 31, 2014.

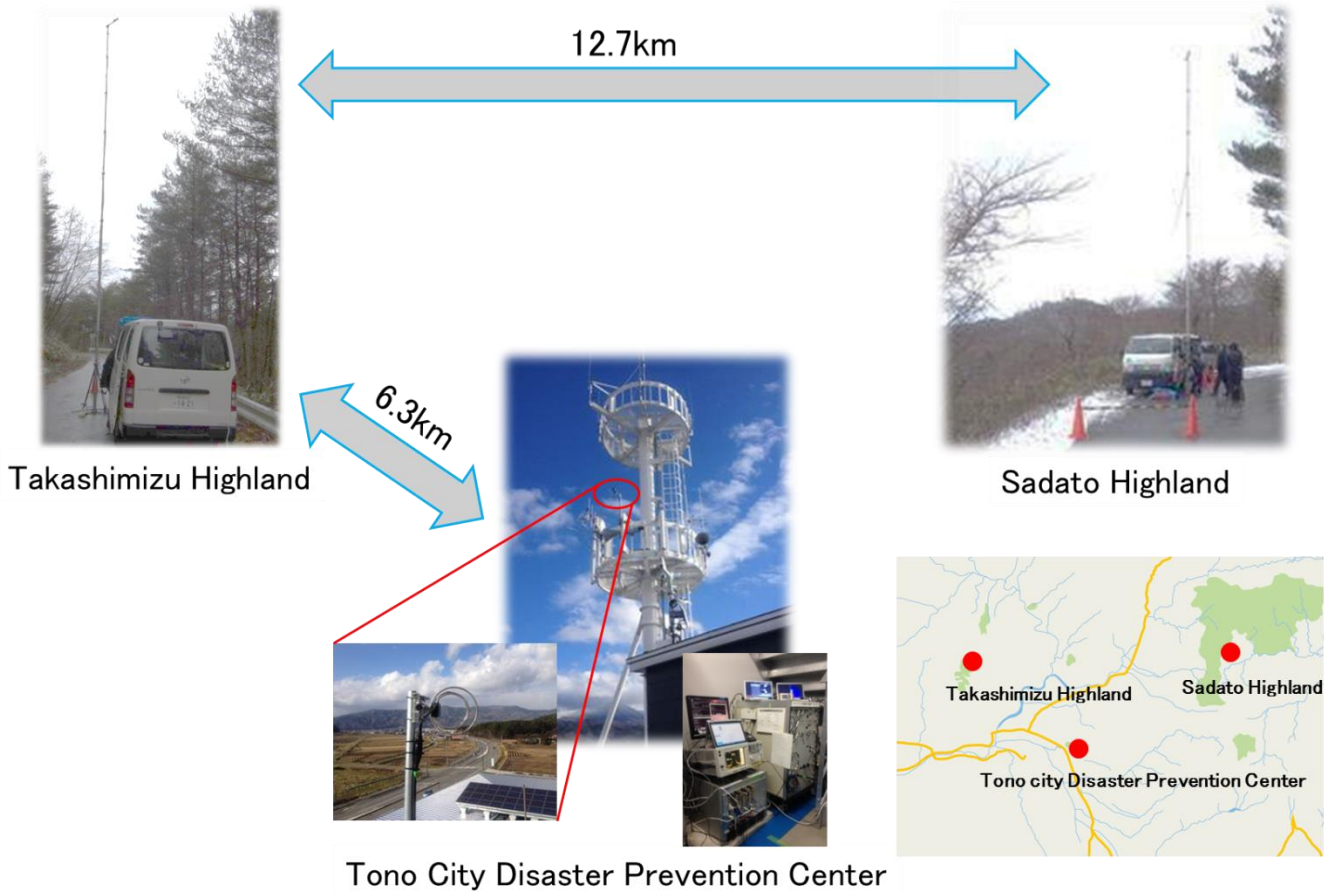


Figure 1: Location in long-range transmission trial



Figure 2: Monitoring camera (left) and monitoring view in the prevention center (right)

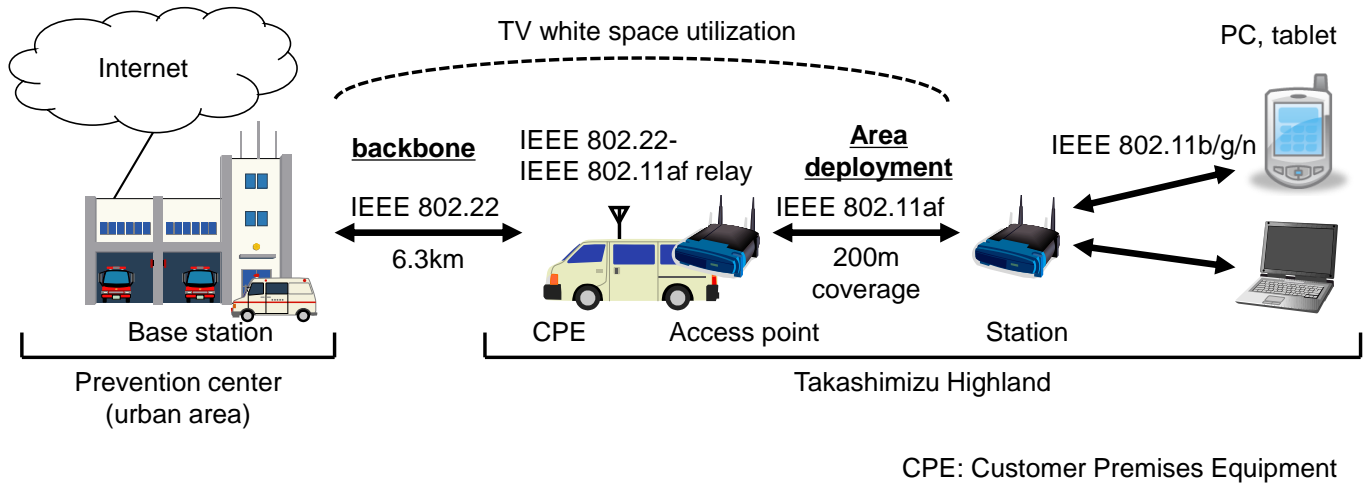


Figure 3: Construction of multihop network by IEEE 802.22 and IEEE 802.11af

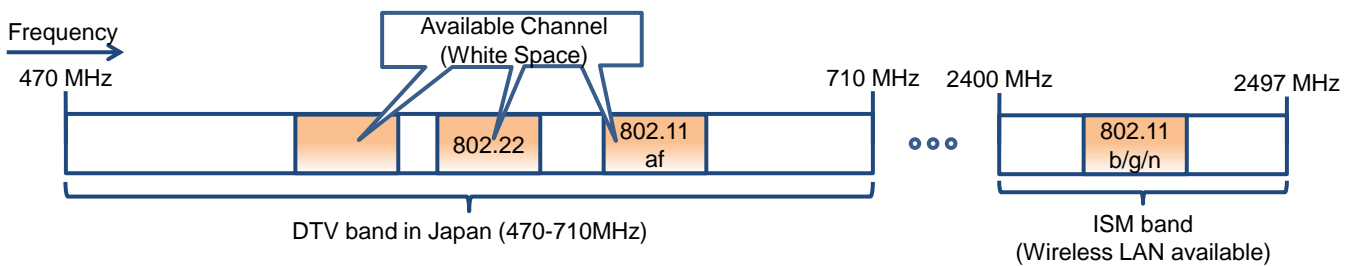


Figure4: General description of channel usage in multihop network trial

### <Glossary>

- \*1 **White space** is geographically or temporally unused licensed radio spectrum. Secondary utilization of the spectrum is permitted subject to ensuring that there is a low probability of harmful interference to incumbent service.
- \*2 **IEEE standard 802.22** is standardized for wireless regional area network (WRAN) on July 2011. WRAN is aimed at rural area broadband service and coverage within a radius of 10 km to 40 km.  
IEEE 802.22 working group: <http://www.ieee802.org/22/>
- \*3 **IEEE standard 802.11af** is aimed at wireless LAN operation in white space. IEEE 802.11af draft standard will update and complete the standard by 2014.  
IEEE 802.11af task group: [http://www.ieee802.org/11/Reports/tgaf\\_update.htm](http://www.ieee802.org/11/Reports/tgaf_update.htm)
- \*4 **Multihop network** is a network configuration using relay terminal to connect terminals which cannot directly transmit. Some multihop networks use different systems among links. It can provide flexible network construction and easily satisfy respective specifications of links such as distance, transmission speed.

### [References]

- [1] Press Release (October 17, 2012)  
“World’s First TV White Space WiFi Prototype Based on IEEE 802.11af Draft Standard Developed”  
<http://www.nict.go.jp/en/press/2012/10/17-1.html>

[2] Press Release (January 30, 2013) “World’s First TV White Space Prototype Based on IEEE 802.22 for Wireless Regional Area Network”

<http://www.nict.go.jp/en/press/2013/01/30-1.html>

<http://www.hitachi-kokusai.co.jp/global/news/news130130.html>

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