NEWS RELEASE

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World's First Successful Multiuser-MIMO (MU-MIMO) Transmission Above 1 Gbit/s

-Towards a next-generation wireless LAN (WLAN) (IEEE 802.11ac) home network-

Nippon Telegraph and Telephone Corporation (NTT, Chiyoda Ward, Tokyo, President and CEO: Satoshi Miura) developed a wireless transmission prototype that employs a Multiuser-MIMO (MU-MIMO)[*1] technique for Space Division Multiple Access (SDMA) that allows communication with multiple terminals at the same time and on the same radio frequency (channel). This prototype can be applied for a high-speed and high-capacity wireless LAN (WLAN) that allows wireless connection from a high-grade terminal suitable for high-definition video applications to many kinds of small portable terminals. We succeeded in processing and transmitting data in real time at more than one gigabit per second (Gbit/s) for the first time in the world. This success verifies that MU-MIMO is a promising technology for implementing a gigabit WLAN to meet the expectation that the future home network will transmit large and steadily increasing volumes of data fueled by the spreading popularity of IPTV, TV telephony, and other future services.
The prototype described here will be exhibited at the Wireless Technology Park 2010 (WTP2010) event held in Yokohama on May 13 and 14, 2010.

[Background of the Research]
The increasing popularity of the WLAN for homes, offices, and public areas, etc. stimulated improvements such as advanced functions and high speed up to about 100 Mbit/s throughput. Wired LANs already have data rates of 1 Gbit/s, so the demand for a WLAN capable of the same data rates is increasing. The newest WLAN (IEEE 802.11n[*2]) adopts singleuser-MIMO (SU-MIMO)[*3] for Space Division Multiplexing (SDM) that allows parallel transmission of data between a WLAN access point (AP) and a single terminal via multiple antennas. However, in communication with small portable terminals that have a small number of antennas, a channel is occupied at a low data rate to match the number of antennas of the terminal, so the full capability of the AP is not used and system throughput[*4] becomes low. For that reason, there is a demand for development of technology that allows the wireless networking of diverse types of terminals ranging from smart phones and other such IT terminals to high-definition TVs and other such home electronic equipment while making the utmost use of the AP capability. NTT Network Innovation Laboratories (NTT Labs) is contributing IEEE 802.11ac[*5] standardization activities that target system throughput of 1 Gbit/s or more since 2008, and engaging R & D on the MU-MIMO technique for SDMA (Fig. 1).

[Technical points]

In MU-MIMO, the AP performs beam-forming control*6 for precise aiming of the signal so that only the data addressed to a terminal reaches the antenna of that terminal. Previously, highly precise beam-forming control required a large amount of signal processing, and wireless transmission at over 1 Gbit/s with real time control was not possible. The MU-MIMO wireless transmission equipment developed by NTT Labs uses a zero-forcing*7 algorithm as the beam-forming control method. This algorithm reduces circuit scale and increases processing speed by using a recursive weight calculation algorithm, in which the same processing is done repeatedly. The algorithm can be implemented using FPGAs.*8 Also, the compressed CSI (channel state information) feedback technique is used when sending the channel state information that is required by beam-forming control from the terminal to the AP. This technique sends only the information that differs from a kind of base value, thus reducing overhead time.*9 As a result, we achieved real-time wireless transmission with up to six terminals connected by SDMA at a total maximum data rate of 1.62 Gbit/s (Fig. 2).

[Future schedule]

Interference control is required for installation of many APs at high density in environments such as condominium buildings; it is one of the standardization study items in the IEEE 802.11ac standardization activities, which are planned for completion in December 2012. We will continue with R & D on interference control and other technology for realizing a next-generation WLAN that has a system throughput of 1 Gbit/s or more and allows many different kinds of terminals to be networked from anywhere within the home without the constraints of wiring.

[Terminology]

*1 Multiuser-MIMO (MU-MIMO):
A technique that uses beam forming to control the directionality of radio signals and transmit multiple terminal address data at the same time and on the same channel without mutual interference, thus achieving highly efficient frequency utilization in wireless broadband systems.
The access point transmission-side beam-forming control prevents the receiver of each terminal from taking in the radio signals addressed to other terminals, so no signal separation processing is needed on the receiving side.

*2 IEEE 802.11n:
The newest WLAN standard that was set in Task Group n (TGn) of the IEEE 802.11 Working Group in the IEEE 802 LAN/MAN Standards Committee to provide a throughput of at least 100 Mbit/s in September 2009. The 2.4-GHz or 5-GHz frequency band is used.

*3 Singleuser-MIMO (SU-MIMO):
A technique for parallel transmission of data addressed to a single terminal from multiple antennas at the same time and on the same channel. The signals from the different antennas are separated on the receiving side.

*4 System throughput:
The throughput per WLAN AP. When an AP communicates with multiple terminals, this is the total throughput for all of the terminals. Throughput is the communication speed in the Media Access Control (MAC) sublayer of the data link layer, whereas the data rate is the communication speed in the physical layer. Throughput is close to the

speed experienced by the user.

*5 IEEE 802.11ac:
The next-generation WLAN specifications that are being discussed in Task Group ac (TGac) of the IEEE 802.11 Working Group in the IEEE 802 LAN/MAN Standards Committee. The target is a system throughput of at least 1 Gbit/s and a per-terminal throughput of at least 500 Mbit/s using 5-GHz frequency band.

*6 Beam-forming control:
A technique in which a transmitting station that has multiple antennas adjusts the amplitude and phase of the radio signal transmitted from each antenna to maximize the quality of the radio signal at the receiving station. Before transmission, the transmitting station must have CSI that holds information on the radio transmission path between the sending and receiving stations.

*7 Zero-forcing:
A beam-forming method in which a channel matrix is obtained from CSI between the sending and receiving stations, and the transmitted signal is multiplied by the inverse of that matrix for transmission. This prevents mutual interference among the received signals at receivers.

*8 FPGA (Field Programmable Gate Array):
An integrated circuit that can be programmed to simulate microprocessors or other integrated circuits given design diagrams.

*9 Overhead time:
The time required for control before data is transmitted.

- Figure 1. Multiuser-MIMO (MU-MIMO) technology
- Figure 2. Multiuser-MIMO (MU-MIMO) wireless transmission prototype

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