

Special Articles on Multi-dimensional MIMO Transmission Technology —The Challenge to Create the Future—

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DOCOMO Beijing Communications Laboratories Co., Ltd. opened in March, 2004, and has since been conducting research in the field of wireless communications. We have advanced research on Super 3G (LTE: Long-Term Evolution), a successor to the current W-CDMA and High-Speed Downlink Packet Access (HSDPA) standards, and also on transmission and systems-control implementation technology for a Fourth-Generation mobile communication systems called IMT-Advanced. In particular, we have been focusing on Multiple Input Multiple Output (MIMO) transmission technology, which increases transmission rate by multiplexing over an increased number of antennas, and Orthogonal Frequency Division Multiple Access (OFDMA), which is able to use bandwidth efficiently while being resistant to multi-path fading.

With respect to MIMO transmission technology, we are working on establishing an adaptive MIMO technology that optimizes the wireless signal characteris-

tics on the transmitter side for each user through precoding technology, extracts a high-quality wireless signal on the receiver side using signal detection technology, and is able to both multiply signals from individual users and distribute the signals to multiple users effectively. We are also working to establish wireless resource control and scheduling technology combining MIMO and OFDMA technologies to efficiently allocate the signals from multiple users using time and frequency as parameters. The key to improving performance with current MIMO transmission technology in this way is to consider the antenna (space), precoding, user multiplexing, time, frequency and other multi-dimensional elements simultaneously, selecting and combining them optimally according to the current transmission state. For the purposes of this special feature, we are calling this technology Multi-dimensional MIMO transmission.

This research and standardization work is being done in cooperation with

NTT DOCOMO's R&D departments, but in view of forming a base for the future, we are also conducting innovative new research. Examples of this include interworking technology between differing wireless systems, cooperative communication and relay transmission technology that can link multiple wireless base stations, cognitive wireless technology that is able to make more efficient use of bandwidth, and Self-X network^{*1} technology that can optimize itself autonomously. These involve long-term research but we believe it is very important to keep advancing this research as a branch from strategic technologies like LTE/IMT-Advanced.

This special articles are composed of five different papers which give an overview of the multi-dimensional MIMO transmission technology, the objective of the work at the DOCOMO Beijing Labs, and also provide explanations for each of the component technologies on which it depends, including MIMO signal detec-

^{*1} **Self-X network:** A type of network having functions like self-organization, self-configuration, self-optimization, self-repair, and self-protection.

tion, channel estimation, synchronization algorithms, and precoding and scheduling.

In China, Third-Generation mobile communications services have already begun with the Time Division-Synchronous Code Division Multiple Access (TD-SCDMA) system. Currently, industry, government and academia are all

actively studying LTE/IMT-Advanced. In particular, the Future Technologies for Universal Radio Environment (FuTURE) Forum^{*2}, which is an open platform for discussing IMT-Advanced technologies, is playing an important role in decision-making on Chinese standards. Thus we also regard making technical contribu-

tions to the FuTURE Forum and exchanging information with other members as important parts of our mission. Under mutual understanding and cooperation, we continuously hope to strengthen and deepen ties with China and other Asian countries toward the next generation.

*2 **FuTURE Forum:** A forum for technological information exchange and international cooperation in the area of future mobile communications, and with members from Chinese universities, research institutes, and domestic and foreign vendors and operators. NTT DOCOMO participates

in FuTURE Forum as one of the founding members.