3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Issues for Applying Fiber-Wireless Transmission Techniques to Mobile Communication Systems in Beyond-5G Era

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The capacity of mobile communication system has been rapidly grown, which is about ten times per generation, and the maximum user throughput for 5th Generation (5G) downlink is assumed to reach 20 Gbps. The capacity approaches that of optical access network that bolsters the mobile communication system as mobile backhaul (MBH) or mobile fronthaul (MFH). The fact implies that Beyond-5G system could not be put in practice without careful consideration of optical transmission scheme in MBH and/or MFH. The authors have been studying fiber-wireless transmission techniques aiming to apply them to MFH of 5G and beyond [1-4]. In this abstract, three major issues for applying the techniques to practical systems are described.

As for the mobile fronthaul (MFH) that connects the central office and antenna sites, we have proposed to carry a number of channels, which are frequency-division multiplexed (FDM) on different intermediate frequencies (IFs), by a single wavelength [1, 2]. We referred to such a transmission scheme as "IFoF" that stands for IF-over-Fiber. The virtue of the scheme is a high frequency utilization efficiency and simple configuration in the optical transmission part. However, in the downlink case for example, the channels should be demultiplexed and subsequently converted to the frequency transmitted in the air. On the other hand, passive optical multiplexing techniques such as wavelength division multiplexing (WDM) [3] and space division multiplexing (SDM) are also applicable to MFH conveying multiple channels. Analog Radio-over-Fiber (A-RoF) transmission scheme that conveys a single channel at the frequency in the air would be also useful for constructing densely distributed small cells, namely, distributed MIMO. The choice of multiplexing technique and fiber-wireless transmission scheme would depend on geographic system parameters, namely, size of cell area and its density. System parameters such as bandwidth of each channel, number of channels, distance of MFH link, and so on also affect the choice. Since these factors for Beyond-5G system are still under discussion, it is difficult to decide the choice right now, but the optical network side should be prepared for any kind of multiplexing scheme and the combination of them.

The architecture of photonic antenna [4], which should be utilized in conjunction with fiber-wireless transmission schemes, is another remaining issue. In the case of distributed MIMO, the beam "steering" would not be necessary due to the tininess of each cell area. However, beam "shaping" would be still necessary, and controlling scheme of relative phase shifts among multiple antenna elements would be required. The scheme is also one of the major issues remaining to be carefully studied.

For establishing distributed MIMO architecture, easiness for installation of antenna equipment would become also an important issue. The installation of new optical fibers to each tiny cell would not only push up construction cost but also extend construction period. One promising optical transmission technique for solving the problem is optical wireless transmission scheme. However, optical wireless transmission link can be easily cut off by small obstacles such as bird or drone, which results in instantaneous interruption. Geographic diversity by multiple links would be possible solution, but the diversity scheme is not well studied yet.

Part of the research results has been achieved by the Commissioned Research of National Institute of Information and Communications Technology (NICT), Japan.

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