Improving Resilience of Access Networks by the Synergistic Use of Wired and Wireless Technologies

Youichi Fukada[1], Jun-ichi Kani[1], Jun Terada[1], Naoto Yoshimoto[1], Katsumi Iwatsuki[2], Taiichi Otsuji[2]

[1]NTT Access Network Service Systems Labs, NTT, 1-1 Hikarinooka, Yokosuka, Kanagawa, 239-0847, Japan
fukada.youichi@lab.ntt.co.jp
[2]ROEC: Research Organization of Electrical Communication, Tohoku University, Sendai, Japan

Abstract

Optical Access Networks (OANs) have been widely deployed so that the fixed broadband services to provide 100 Mbit/s to 1 Gbit/s per home have been becoming very popular for the recent ten years [1]. At the same time, mobile broadband services have been taking off: Long Term Evolution (LTE) system that provides 100 Mbit/s class connection services are being constructed presently, and LTE-advanced system that provides a service of 1 Gbit/s class connection service will be built in the near future [2]. It is anticipated that the bandwidth over 10 Gbit/s will be realized in both of the fixed and mobile broadband communications in the next generation.

Meanwhile, when a major disaster occurs, it becomes very difficult to continue the broadband services in both of the fixed and mobile services. In fact, when the grand earthquake in Japan on March 11, 2011 occurred, a large part of fixed and mobile services stopped. To improve this, mobile operators are considering to construct Large-Zone Base Station systems [3, 4]. Even if some ordinary base stations are afflicted and become impossible to provisioning mobile service, the Large-Zone Base Station (consists of earthquake-resistant steel tower, and its zone includes the plural small cells of the ordinary base station) continues to provide the services instead of the afflicted ordinary base stations. The Large-Zone Base Station systems are important in terms of continuing to provide minimal mobile communication even in disaster. However, it is more desirable to construct the access network that has disaster resilience to make broader bandwidth available even in the disaster. This is because, if it is available, the broadband services are very effective to deal with the disaster in terms of sending and receiving lifeline information (for example [5]).

Considering the above background, we propose an access network in which the disaster resilience is realized by the synergistic use of wired and wireless technologies. With the proposed network, even if some base stations and/or fiber cables are failed, the broadband services will continue. When some optical links fail by the affliction of fiber cables and/or facilities, radio transmissions activate and substitute for the failed optical sections. The alternative radio transmissions may propagate by multi-hop between base stations and/or radio access technologies (RATs).

Since the target of the bandwidth per cell will be over 10 Gbit/s, millimeter-wave or sub-THz radio wave will be suitable for the alternative radio transmissions. The photonic frequency double-mixing device, that realizes conversion between optical-fiber and millimeter-wave or sub-THz-wave wireless communications, is the key device in the above mentioned network in terms of realizing the flexible substitution of an optical access with a millimeter-wave or sub-THz-wave wireless access in a simple way. We introduce the recent experimental results of the photonic frequency double-mixing device realized by the emerging ‘graphene’ technology [6].

References

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