Fixed Wireless Transport Technologies in the 5G and Beyond 5G Eras

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Abstract

5G and Beyond 5G technology requires even higher capacity in transport networks. Transport networks in countries other than Japan have used fixed wireless systems as the mobile backhaul for ease of installation and TCO (total cost of ownership) reduction. But now that the standard specifications for cross-haul (xHaul) networks have been established, the application of fixed wireless systems is expected to expand as various 5G or Beyond 5G situations develop. This paper gives an outline of fixed wireless transport in the eras of 5G and Beyond 5G and also introduces the technologies and products supporting it.

Keywords

fixed wireless transport, fixed microwave communication, microwave band, millimeter wave band, sub-terahertz band, cross-haul, channel aggregation, multiband aggregation, ETH-BN

1. Introduction

In the 5G and Beyond 5G eras, the increasing number of applications that require high-capacity data transmission demands an even higher capacity in transport networks. In addition, many transport network markets employ a large number of fixed wireless systems because of the low cost, high speed, and ease of installation. Also, with the establishment of standard specifications for fixed wireless transport in the xHaul requirements of the Open RAN (O-RAN) ALLIANCE, it is expected that fixed wireless systems will be applied to xHaul even in regions where fixed wireless systems are not common, such as the Japanese transport network market.

This paper provides an overview of fixed wireless transport and introduces the technologies and products supporting it.

2. Outline of Fixed Wireless Transport

Fixed wireless transport uses a fixed wireless system to construct a transport network. Compared to wired transport that utilizes optical fiber, etc., fixed wireless transport has the advantage of low cost and ease of installation that can be done in a short period of time and it has been widely used in the transport market. In the global market, some countries and regions have restrictions on cable installation, and the use of fixed wireless

Table Features of wired and fixed wireless transport networks.

	Wired transport	Fixed wireless transport
Major preferred domain	Core / Aggregation	Aggregation / Edge
Transmission rate	Up to approx. 400 Gbps	Microwaves: Up to approx. 10 Gbps Millimeter waves: Up to approx. 25 Gbps
Max. transmission distance	≤80 km	Microwaves: Up to approx. 50 km Millimeter waves: Up to approx. 3 km
Fault tolerance (risk)	Tradeoff with installation cost (cable cutting)	Relatively high (line quality degradation due to rain, interference, etc.)
Future extensibility	Relatively difficult (cable replacement, wavelength multiplexing)	Relatively easy (wireless channel extension)
Construction costs	High	Low
Construction time	Several months	Several days to several weeks
Approval & licensing	Construction approval	Wireless license
Operating costs	Land rent for cable laying	Spectrum license fees

transport is expected to continue in the future (**Table**).

New technologies are being applied to transport networks as mobile networks evolve. Whereas Ethernet permeated the transport networks of 4G, low-latency transmissions and highly accurate time synchronization are being employed in the 5G era to increase network capacity and implement the Time-Sensitive Networking (TSN) standards for a wide range of real-time applications. Beyond 5G is expected to further advance and open up the network.

In fixed wireless transport, there is a need to further increase capacity and improve availability in line with the advancement of transport network technology.

3. Introduction of Fixed Wireless Transport Products

NEC has a long history of launching microwave or millimeter wave products (iPASOLINK series) for fixed wireless transport into the global market. The product line includes the split mount type composed of an IDU (Indoor Unit: a unit with packet processing and a modem for indoor installation) and an ODU (Outdoor Unit: a unit with a wireless transceiver for outdoor installation) as well as the AOR (All Outdoor Radio) type that integrates the functions of the IDU and the ODU in a single unit (**Fig. 1**). The iPASOLINK VR is the main product for microwave bands (6 to 38 GHz) and can flexibly combine wireless channels for a maximum bandwidth of 10 Gbps. The iPASOLINK EX Advanced is the main product for millimeter-wave bands (E-band: 80 GHz) and can achieve a maximum wireless transmission of 20 Gbps by using the polarized multiplexing with a single device and a maximum wireless transmission of 25 Gbps when combined with several fixed wireless transmission systems.

4. Technologies Supporting Fixed Wireless Transport

4.1 Utilization of wider wireless channels

The need for greater capacity with 5G and Beyond 5G compared to 4G is leading to further advancement in the widening of wireless channels. While the wireless transmission in the microwave bands transferred approximately 500 Mbps of data with a bandwidth of no more than 56 MHz, studies to expand the bandwidth up to 224 MHz are gaining momentum to achieve higher capacity wireless transmission. This is expected to increase the capacity per wireless channel. In areas where large-capacity transmission is required, which is difficult to achieve with microwave bands, large-capacity transmissions are achieved by utilizing a bandwidth of 250 MHz to 2 GHz in the millimeter wave bands where a wider bandwidth can be secured. The expansion of this bandwidth is being actively studied, and it is expected that more and more wireless channels will rapidly become wider following the progress of discussions on standardization and legal regulations being made in various countries with consideration for 5G and Beyond 5G.

4.2 Improving TCO by integrating the fixed wireless transmission system

As discussed earlier, the rapid growth in demand for transmission capacity in Beyond 5G has led to significant need for substantial improvement in the capacity of wireless transmissions. To this end, multichannel technology that aggregates multiple wireless channels and transmits them through a single system is proposed for this purpose. To achieve multi-channel transmissions in conventional systems, it is necessary to configure the system with the same number of devices as the number of wireless channels used. Because this configuration does not only take high initial investments but also deteriorates the operating costs (mounting space, tower load, power consumption, etc.), the demand for miniaturization and the integration of equipment is increasing. NEC offers a product equipped with the transmission/reception functions of two channels (channel aggregation function) in a single wireless transceiver unit (**Fig. 2**). This product makes it possible to simplify the equipment configuration and contributes to TCO reduction.

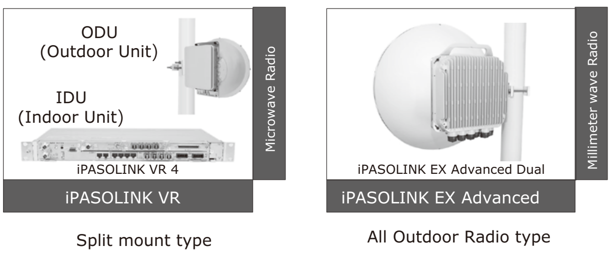

Fig. 1 iPASOLINK series products.

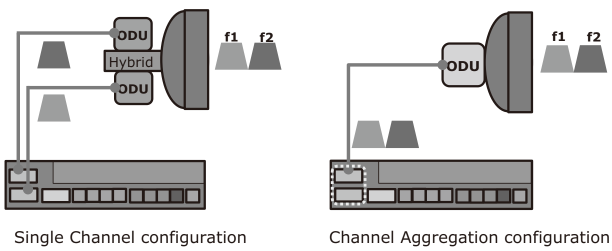

Fig. 2 Channel aggregation configuration.

4.3 High-capacity technology with multiband

In conventional fixed wireless transport, multiple wireless channels in the same frequency band are bundled into logical channels to achieve a high capacity. However, because the radio wave regulations in many countries restrict the number of channels available in a single frequency band, the demand for multiband configurations combining different frequency bands is increasing (**Fig. 3**). To deal with this trend, multiband aggregation technology is put into practical use by combining two different frequencies in microwave bands or frequencies in the microwave and millimeter-wave bands. Besides, multiband can be realized in a simpler configuration by combining it with microwave band equipment that supports the aforementioned channel aggregation.

Although millimeter-wave bands can use a wider channel width and transmit a larger capacity than microwave bands, they are prone to fluctuations in transmission capacity due to the effects of radio wave attenuation caused by rainfall and other factors. To solve this issue, NEC improves the availability of multiband aggregation configuration by using the ETH-BN (Ethernet Bandwidth Notification) technology defined in ITU-T G.8013/Y.1731. This technology makes it possible to identify the transmission capacity information of wireless channels in real time and also to efficiently allocate data to each wireless channel that constitutes a logical channel according to the transmission capacity (**Fig. 4**).

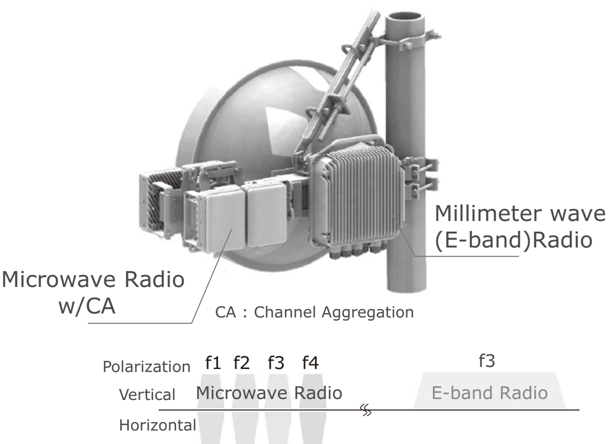

Fig. 3 Multiband configuration.

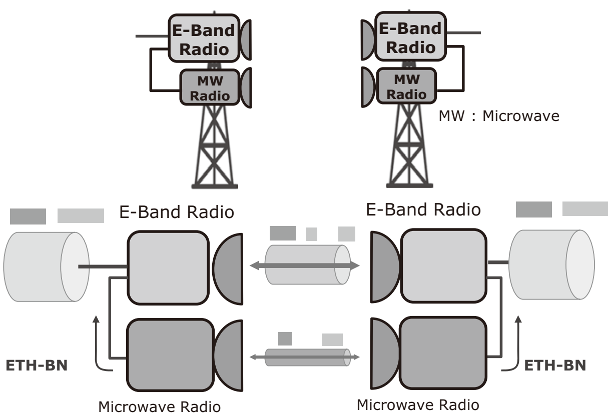

Fig. 4 Example of multiband aggregation configuration.

5. Beyond 5G Technologies Attracting Attention

For further increases in the wireless channel capacity in the future, in addition to promoting the use of the millimeter wave bands, the use of sub-terahertz bands (100 to 300 GHz) is attracting attention. In particular, the use of the D-band (130 to 174.8 GHz) and W-band (92 to 114.25 GHz), which are internationally allocated for fixed wireless communications, are expected to be utilized. As shown in **Fig. 5**, these frequency bands are characterized by the availability of a wider channel width than the microwave band (15 GHz). However, as the frequencies of the W-band are 130% of the E-band and those of the D-band are 200%, advanced technical development of high-frequency systems would be necessary for their commercial implementations.

NEC has developed a high-frequency device operating in the 150GHz band and a 10mW power amplifier with the world's highest level of output power to realize a fixed wireless transmission device using the D-band, which provides a wider channel width. Based on these technological developments, NEC will realize high-capacity wireless transmission for 5G and Beyond 5G through the promotion of advanced wireless technologies, including the promotion of Orbital Angular Momentum (OAM) mode multiplexing technology development to attain even greater capacity.

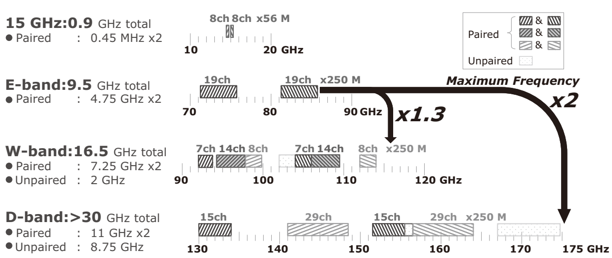

Fig. 5 Frequency relationship between microwave-band (15 GHz), E-band, W-band, and D-band.

6. Conclusion

With the increasing demand for higher capacity in transport networks, the move of fixed wireless systems to xHaul applications is expected to expand.

To meet these needs, NEC contributes to the further spread of wireless channels with larger capacity and higher-efficiency transmission by utilizing high frequency bands such as the W- and D-bands, developing advanced technologies such as OAM mode multiplexing and polarized multiplexing, and promoting standardization in addition to releasing the iPASOLINK series of products. In response to trends such as the use of multiple channels in fixed wireless transmission systems, we will provide products with higher ease of installation and operation and reduce power consumption for the expanding 5G and Beyond 5G market.

7. Acknowledgement

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