60GHz Ultra High Speed Wireless Cell Backbone in Urban Area

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***Abstract*—This paper is contents on that construct ultra high speed wireless communication cell backbone net of city using of wireless communication transceiver for millimeter wave band. A new type of 60GHz wave band wireless transceiver using NRD waveguide. A new type of 60GHz wave band wireless transceiver using NRD waveguide. This 60GHz transceiver has excellent signal's absorption characteristics of oxygen molecule than the other millimeter wave bands. we constructed 155.52Mbps ATM(OC-3) backbone node networks within 500m to 3Km by using 60GHz band transceivers, and constructed service area network to cell interval within about 400m respectively. The possible use of wireless backbone networks technology in a rainy day and a clear day was evaluated at 1Km data link distance. We can measured bit error rate(BER). BER is 10^{-11} at 155.52Mbps ATM(OC-3) in a clear day and 10^{-6} in a heavy rain more than 35mm per time. Also, we constructed wireless cell backbone networks distance to use several 60GHz transceivers and investigated data throughput between main center and local center of long distance. In proposed wireless cell backbone networks, the data throughput was approximately 80Mbit/sec. Therefore, if use transceiver, it is possible that city type ultra high speed wireless communication cell backbone networks construction of 100Mbps, 155.52Mbps ATM(OC-3), 622Mbps, 1Gbps and 1.2Gbps degrees.**

***Index Terms*—wireless cell back bone network, 60GHz band Transceiver, NRD waveguide, 155.52Mbps ATM(OC-3)**

I. Introduction

Up to the present advancement in information and communication technologies, all area of wireless communication network is reaching to data of high-capacity and real-time transmission of animation as well as character and audio communication. Recently, use frequency of wireless communication network for ultra high speed, wide band and high resolution data transmission are using millimeter wave band, and various technical developments of millimeter wave communication network are attempted much.

Otherwise, integrated wireless service networks that use millimeter wave band should be offered High QoS for real-time multimedia service. This integrated network should be secured, perfect security and stability mutually between net and service. And this must improve service ability of network because is consisted of integrated backbone network. Also, wireless link of existent LAN base was not designed for high speed data communication, and bandwidth is narrow as transmit a lot of data rapidly. This wireless link is shorted wireless link by propagation attenuation, air attenuation and impact of rainfall attenuation.

Specially, wireless link distance in a rainy day is about 1/20 than a clear day, and wireless nullity section of distance is happened.

In case of this designs wireless backbone network, need node in addition about 20 in wireless section at rainfall, and this occurs frequency interference signal between neighborhood node in a clear day and macro cell and micro cell backbone network composition are impossible[1]-[3].

In this paper, we fabricated 60GHz wave band wireless transceivers, and composed wireless communication backbone networks using this transceivers. The 60GHz wave band among the millimeter wave band is band that have high oxygen absorption characteristics in the air. Therefore, 60GHz wave band is advantage that interference signal between neighborhood frequency is not occurred. And wireless link distance difference of rainy day and clear day was about 1/2. we could construct wireless network that effective range of wireless data link is guaranteed much in rainfall environment using this transceivers. Also, we experiment on environmental test and data transmission test after construct ultra high speed wireless communication cell backbone networks.

II. Development of 60GHz wave band wireless transceiver

According to it is known, The millimeter wave can achieve high resolution and accuracy in tracing and searching the target because of its superior straight characteristic than microwave band. The Millimeter wave band is divided into shadow band that is absorbed well in water molecule or oxygen molecule of air and non-shadow band that attenuation of air is less relatively. Figure 1 shows average oxygen absorption characteristics per distance in millimeter wave band. As shown in figure 1, 60GHz wave band appears signal absorption characteristic of oxygen molecule higher than other band by about 16dB degrees. Transceiver that operating in this band is less interference signal between frequency by oxygen attenuation, and because wireless effective range in rainfall environment is guarantee, ultra high speed communication of Gbps is available[4]-[8].

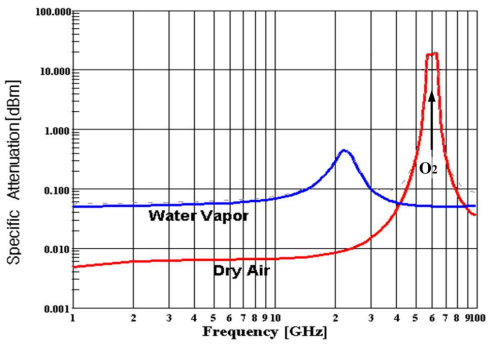

Fig. 1. Signal's absorption characteristics of oxygen molecule at millimeter wave bands.

In wireless communication, so that wireless effective range is guaranteed, noise level should be high, This is difference according to modulation method and the required system bandwidth. For ASK modulation and the bandwidth is 400MHz. We therefore can compute the noise power N of below equation (1).

$$N = kTB = 1.38 \times 10^{-23} J / K \times 290 K \times 400 MHz \quad (1)$$

where k denotes Boltzmann constant, T denotes absolute temperature and B denotes required system bandwidth.

Also, we can calculate gains of wireless communication system for transmission distance adding factor of antenna gain, output of system and air attenuation in 60GHzwave band transceiver. That is below equation (2).

$$Wr = 20 \times \log\left(\frac{\lambda}{4 \times \pi \times R}\right) + Gt + Gr + Wt \quad (2)$$

where R denotes transmission distance, λ denotes wavelength of free space at carrier frequency, Gt denotes antenna gain of transmitter, Gr denotes antenna of receiver, Wt denotes output power of transceiver system.

Therefore, we fabricated 60GHz wave band wireless communication transceiver that oxygen absorption characteristics has excellent, and effective wireless link distance. The 60GHz band transceiver have been fabricated by using NRD waveguide that is transmitter circuit device, receiver circuit device, duplexer and antenna between two parallel metal plates. Transmitter circuit device is composed of gunn oscillator, ASK modulator, circulator and receiver circuit device consists of local oscillator, balanced mixer and 3dB directional coupler.

The newly developed transceiver can guarantee 1Km communication distance under the conditions that insertion loss in 60GHz band is within 0.5dB, reflection loss is more than 20dB, bandwidth 2GHz, output power of transceiver is below 10mW.

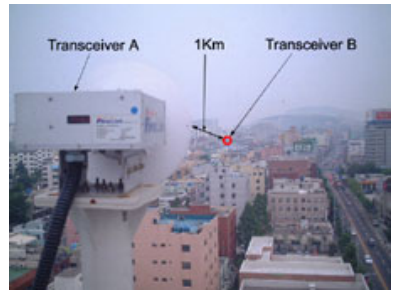

Fig. 2. Photograph of establishing two 60GHz band transceivers between rooftops of buildings.

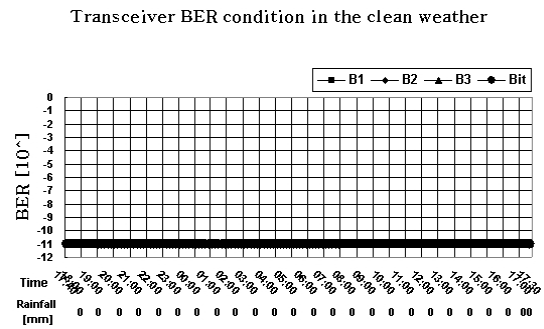

Fig. 3. BER of 60GHz band transceiver in a clean weather.

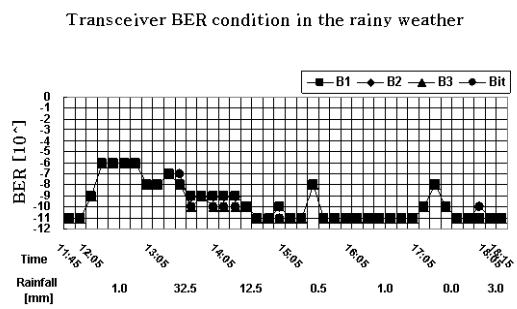

Fig. 4. BER of 60GHz band transceiver in a rainy weather.

Fig. 5. Busan site that construct cell backbone network to use 60GHz transceivers.

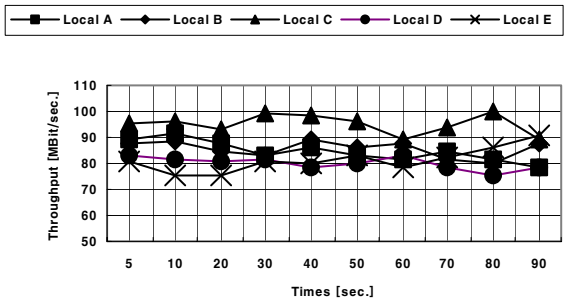

Fig. 6. The data throughput of each local centers.

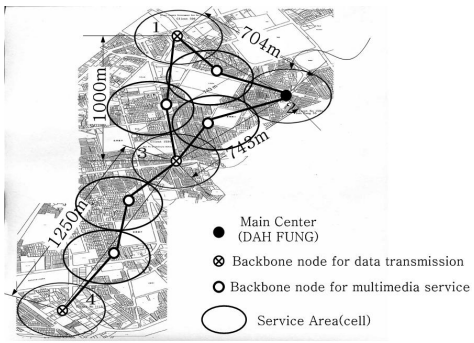

Fig. 7. Taiwan site that construct cell backbone network to use 60GHz transceivers.

III. Wireless Communication Network Construction and Experiment

In this section, we constructed communication network of point to point cross type and point to point parallel type on neighborhood building upper part, and experimented interference characteristics between actuality operating frequency using four 60GHz band transceivers.

Data transmission test is performed by locating two transceivers separately at the distance of 1Km. Figure 2 is photograph of establishing two 60GHz band transceivers between rooftops of buildings at the distance of 1Km. And data transmission speed was 155.52Mbps ATM(OC-3).

Figure 3 is BER of transceiver in the clean weather and figure 8 is that of a rainy weather. As shown in figure 3 and figure 4, since BER is 10^{-11} in a clear day, and 10^{-6} in a rainy day whose rainfall is as much as serious more than 35mm per time, wireless backbone network construction is available if use 60GHz millimeter wave band transceiver.

IV. Ultra High Speed Wireless Cell Backbone Networks Application and Estimation

In this paper, we constructed 155.52Mbps ATM(OC-3) backbone node networks within 500m to 3Km by using 60GHz band transceivers, and constructed service area network to cell interval within about 400m respectively. Also, remote client employed individual address system by being allocated each IP address. And Each backbone node is connected access point(AP), and this is connected with subscriber client, and did it so that multimedia data transmission may be available to indoor or outside local area network.

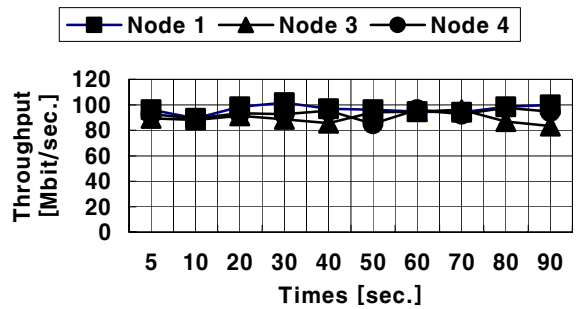

Fig. 8. The data throughput of backbone nodes.

V. Ultra High Speed Wireless Cell Backbone Networks Application and Estimation

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Figure 5 shows the site map that construct wireless communication cell backbone networks to building rooftops of application area in busan. As shown in figure 5, local centers are located in the 500m, 600m and 1000m distance on Main Center.

Figure 6 shows graph of the data throughput at each local centers. The size of received data is 100Mbps, and received time is 90 seconds. After we measured the throughput by received time, and analyzed performance of application network. As shown in figure 6, the throughput is fixed during 90 seconds relatively, and transmit approximately 80Mbps to 90Mbps per second. Also, throughput difference of short distance and long distance is less

Figure 7 shows the site map that construct wireless communication cell backbone networks to building rooftops of application area in Taiwan. As shown in figure 7, local centers are located in the 704m, 743m and 1250m distance on Main Center. And backbone node for multimedia service area located at each link range middle.

Figure 8 shows graph of the data throughput at each backbone nodes. The size of received data is 100Mbps, and received time is 90 seconds. After we measured the throughput by received time, and analyzed performance of backbone nodes. As shown in figure 8, the throughput is fixed during 90 seconds relatively, and transmit about 80Mbps per second.

VI. Proposal of Wireless Cell Backbone Networks

The 60GHz wave band among the millimeter wave band is

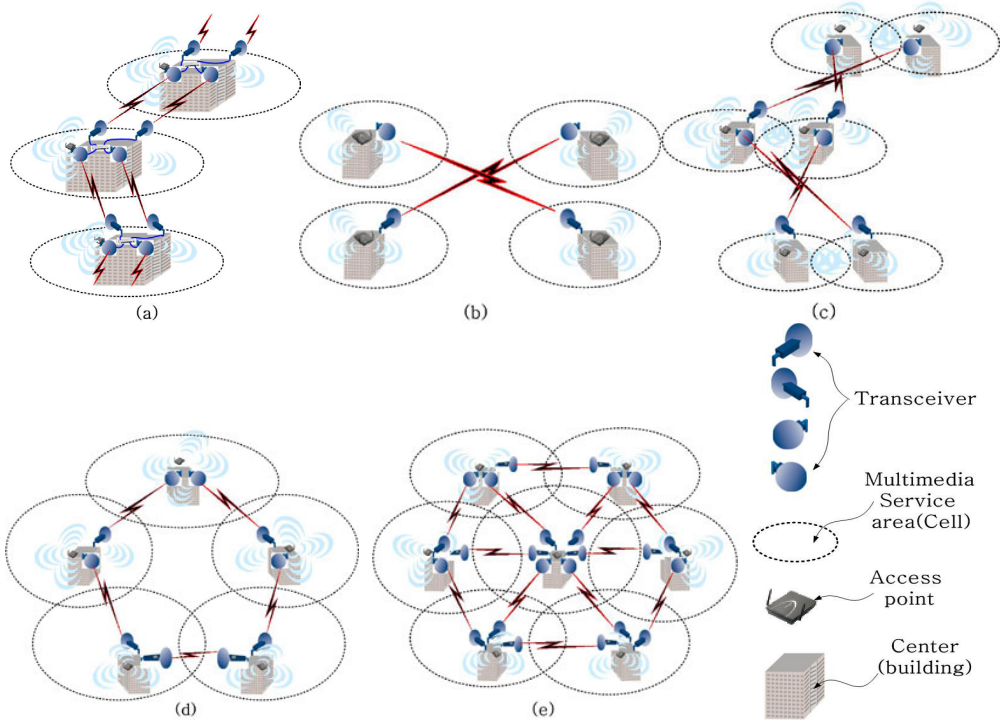

Fig. 9. Various type of ultra high speed wireless communication cell backbone networks (a) Parallel type, (b) Cross type, (c) Twist type, (d) Ring type, (e) Star type.

band that have high oxygen absorption characteristics in the air. Therefore, 60GHz wave band is advantage that interference signal between neighborhood frequency is not occurred. And wireless link distance difference of rainy day and clear day was about 1/2. Therefore, we proposed to construct ultra high speed wireless cell backbone networks of various type

Figure 9 shows various type of wireless communication cell backbone networks of parallel type, cross type, twist type, ring type and star type etc.

VII. Conclusion

In this paper, the millimeter wave band transceiver has been developed. This have been fabricated by using NRD waveguide that is proportional to wavelength of 60GHz. The newly developed transceiver can guaranteed transmission distance of 1Km in a rainy day. we constructed 155.52Mbps ATM(OC-3) backbone node networks within 500m to 3Km by using 60GHz band transceivers, and constructed service area network to cell interval within about 400m respectively. The possible use of wireless backbone networks technology in a rainy day and a clear day was evaluated at 1Km data link distance. We can measured bit error rate(BER). BER is 10^{-11} at 155.52Mbps ATM(OC-3) in a clear day and 10^{-6} in a heavy rain more than 35mm per time. Also, we constructed wireless cell backbone networks distance to use several 60GHz transceivers and investigated data throughput between main center and local center of long distance.

In addition, the 60GHz transceiver has excellent signal's absorption characteristics of oxygen molecule than the other millimeter wave bands. we constructed wireless cell backbone networks distance to use several 60GHz transceivers and investigated data throughput between main center and local center of long distance. In proposed wireless cell backbone networks, the data throughput was approximately 80Mbit/sec.

Therefore, if use transceiver, it is possible that city type ultra high speed wireless communication cell backbone networks construction of 100Mbps, 155.52Mbps, 622Mbps, 1Gbps and 1.2Gbps degrees.

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