

# High-Capacity Impulse Radio Equipment Using the 80 GHz, Millimeter-Wave Band

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## 1. Introduction

As mobile terminals have become more common and the amount of content available has increased, traffic on communications networks has increased explosively. Because of this, there is demand to increase capacity of radio transmission systems in telecommunications. High-capacity transportable radio systems are also promising for use as emergency lines, to provide rapid relief when optical cables are cut in disasters or other emergencies.

In light of these circumstances, Fujitsu has developed high-capacity radio equipment<sup>1</sup> using our own impulse radio technology in the 80 GHz band. The 80 GHz band is part of the millimeter-wave band, which is not strongly affected by atmospheric attenuation, and where wide bandwidths can be used.

## 2. Basic principals of impulse radio

“Impulse” refers to an extremely short pulse with sharp changes in the time domain, and with energy from low frequencies right up to over 100 GHz, in the frequency domain.

In the impulse radio scheme, impulses are generated according to the input digital signal, and the high-frequency components of the impulses are transmitted as a radio signal. The principles of impulse radio are shown in Figure 1.

The transmitter uses a pulse generator (PG) to generate an impulse signal based on the information source, which is a digital signal. A band pass filter then extracts the 80 GHz band frequency components. The resulting impulse signal is called a wave packet, which is transmitted through a

power amplifier (PA) and an antenna. At the receiver, the wave packet is amplified to the desired level using a low-noise amplifier (LNA), the envelope is recovered with a detector (DET), and the digital signal is identified.

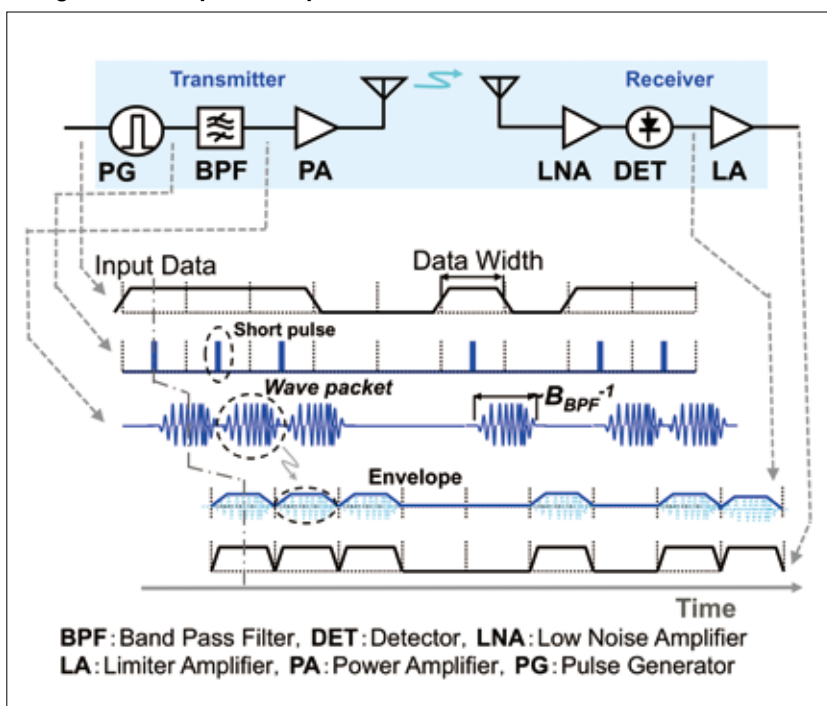
## 3. Eighty GHz band impulse radio equipment overview

The 80 GHz band impulse radio equipment is an all-in-one transmitter-receiver, including user interface, built to outdoor specifications. It is shown in Figure 2.

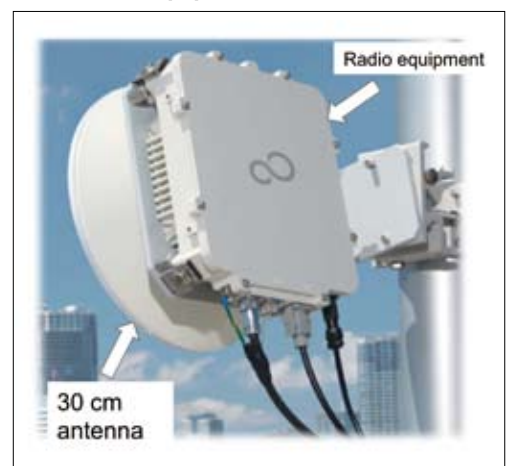
Using impulse radio technology eliminates the need for components normally required for radio, such as the modem, local oscillator, and mixer. Using a wide bandwidth, enables high-capacity transmission up to 3 Gbps. Combined, these allow a compact, light-weight, low-power implementation that can complement or substitute for optical cable communication.

The type and aperture of the antenna can be selected according to

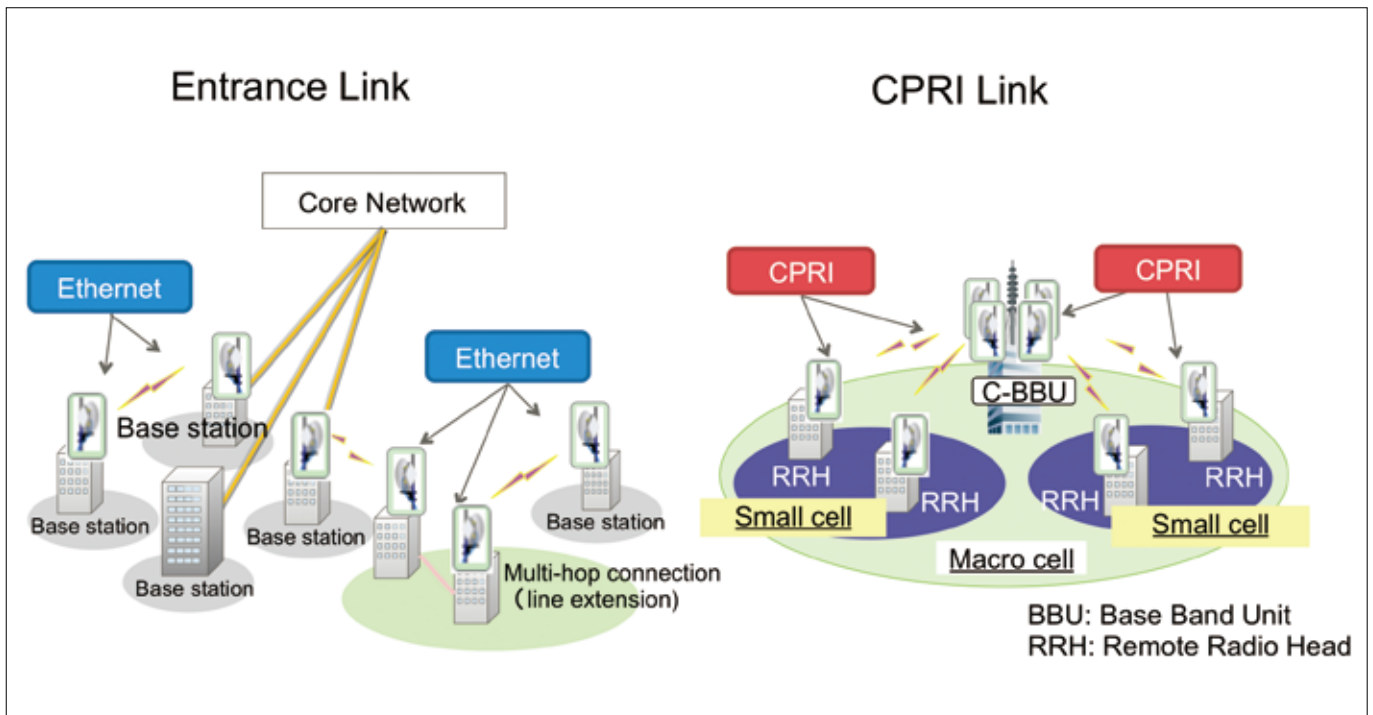
■ Figure 1: Principles of impulse radio



■ Figure 2: 80 GHz band impulse radio equipment



■ Figure 3: Application for mobile base-station networks



■ Table 1: Principal specifications

Item	Specification
Frequency band	Low group: 71 to 76 GHz, High group: 81 to 86 GHz
User rate	3,000 Mbps
Transmit power (point value)	+17 dBm
Line Interface	Ethernet: 10 GbE, GbE CPRI: 2.4 Gbps
Latency (1 Link, one direction)	Ethernet: 77 μsec CPRI: 15 μsec
Operations and Maintenance	Remote monitoring: SNMP Local monitoring: local terminal
Power consumption	20 W
Size	3 ℓ
Mass (console)	3.0 kg or less
Antenna aperture and gain	30cmφ: 43 dBi 60cmφ: 48 dBi

CPRI: Common Public Radio Interface  
SNMP: Simple Network Management Protocol

the transmission distance. The radio equipment and antenna can also be attached and detached easily, so installation and maintenance is easy. The principal specifications are shown in Table 1.

#### 4. Example applications

The 80 GHz band impulse radio equipment provides high-capacity transmission in a compact, light-weight, and low-power implementation which

can complement or replace optical cable communication. We now describe examples of applications utilizing these characteristics.

When constructing mobile base-station networks, this technology can be applied to common public radio interface (CPRI) or Ethernet signal transmission when it is difficult to install optical cables along public roads, or it takes a long time to prepare for construction of optical fiber links. Application for mobile base-station

networks is shown in Figure 3.

Also, due to its portability, it would be useful for emergency lines when disaster occurs, or for private intranets at facilities such as companies, universities or hospitals.

#### 5. Conclusion

The development and implementation of this 80 GHz band impulse radio equipment expands the range of applications of radio communications to include scenarios that were difficult with conventional radio systems due to inadequate transmission capacity.

The impulse radio scheme we have implemented and used establishes the basic technology resulting from the Research and Development Project for Expansion of Radio Spectrum Resources, sponsored by Japan's Ministry of Internal Affairs and Communications <sup>2</sup>.

#### References

- 1 Fujitsu press release: "Fujitsu Releases BroadOne GX4000 Series Radio System with 3 Gbps Transmission Speed," July 1, 2013. <http://pr.fujitsu.com/jp/news/2013/07/1.html>
- 2 Fujitsu Laboratories Ltd. press release: "Fujitsu Achieves World's First Impulse Radio-Based Millimeter-Band Transmissions Exceeding 10 Gbps," June 11, 2009. <http://pr.fujitsu.com/jp/news/2009/06/11-1.html>