



High-Security Rapid Response Applications Using E-Band

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Abstract— The E-Band is a high data rate point-to-point communications device optimized for 1 Gigabit of Ethernet traffic. E-band wireless communications is a new technology that allows gigabit per second (Gbps) data rates to be transmitted with very high weather availability over distances of a mile or more. This offers point-to-point wireless gigabit data with very high availability over distances of a mile or more. Being a highly directional wireless technology, with pencil beam transmissions, E-Band can be classified as LPD/LPI. It is a perfect technology to satisfy hostile territory battlefield situations where there's a need for high bandwidth, point-to-point, non-wire-line communications. Being a quick and easily deployable technology with an associated fast, online licensing scheme, E-Band products also satisfy rapid deployment or time critical homeland security and defense applications. A comparison of typical E-Band radio's performance against main competing technologies is illustrated in Table 1. It can be seen that of several technologies suitable for both LPD/LPI and rapid response situations, only E-Band radios offer the ability to reliably transmit at distances of a mile or more, plus provide the benefits of full license protection.

Keywords— GigaBeam, LPD/LPI, E-band, Free Space Optics, 60 GHz Radio

I. Introduction

E-band wireless communications is a new technology that allows gigabit per second (Gbps) data rates to be transmitted with very high weather availability over distances of a mile or more. Characterized as low probability of detect/low probability of intercept (lpd/lpi), it is a perfect technology to satisfy hostile territory battlefield situations where there's a need for high security, high speed, point-to-point, non-wire-line communications. A novel licensing structure coupled with an ability to quickly deploy links permits rapid response to homeland defence and other time critical security applications. We live in a digital world. Essentially all communications, from telephone calls to personal e-mails to commerce transactions, are carried on digital networks. The ubiquity and ease of access to digital networks coupled with the sensitivity of much of the transmitted data means that security is now a prerequisite for many digital systems. Wireless communication systems traditionally have not provided any level of security. In fact, the early value of wireless was its ability to be widely detected and decoded. However, the growth of data communications for Internet and e-commerce services has forced systems designers to start considering security as a primary system requirement. Operating in the relatively unused 70, 80, and 90 GHz regions of the spectrum, E-Band wireless communications is a new technology that offers both gigabit-speed wireless connectivity and a level of security that can be classified as LPD/LPI. Very high data rates, portability, and ease of deployment make E-Band communications ideal for rapid response and other time-critical homeland defence security purposes. The E-band system is a high data rate point-to-point communications device optimized for 1 Gigabit of Ethernet traffic. The system operates Dual Band FDD: one end of the link transmits within the 71 GHz band and receives within the 81 GHz band. The other end of the link does the inverse: transmits within the 81 GHz band and receives within the 71 GHz band, the radio bands used are 71-76 GHz and 81-86 GHz. The following block diagram illustrates the E-band radio operation-

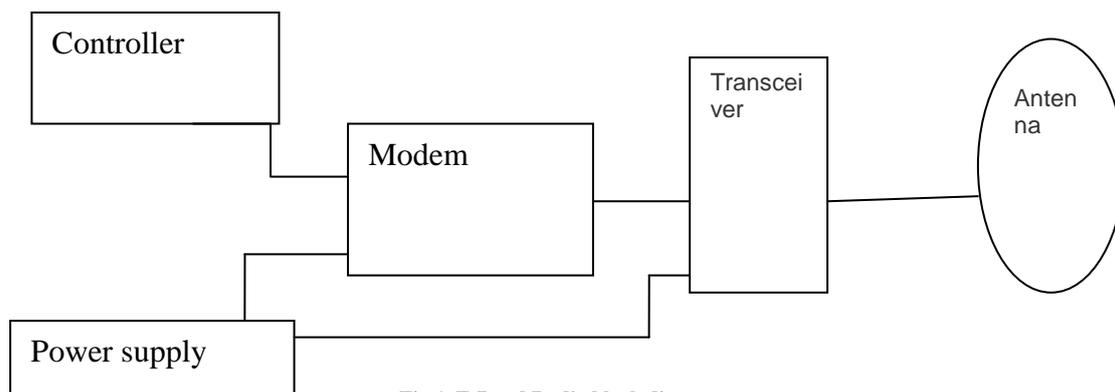


Fig 1. E-Band Radio block diagram.

II. Wireless E-Band: An overview

In October 2003, the Federal Communications Commission (FCC) made an historic ruling that 13 GHz of spectrum at 71 to 76 GHz, 81 to 86 GHz, and 92 to 95 GHz was available for commercial high-density fixed wireless services in the United States. The very high bandwidth allocated allows true giga bit speed wireless communications to be realized. Transmission at 1 Gbps or higher is possible, equivalent to 647 T1 links or 1,000 DSL connections. The FCC ruling also permitted a novel licensing scheme, allowing cheap and fast allocations to prospective users. License applications are made via a simple Web portal and are generally approved within 30 minutes of filing, providing the user with full federal protection against both unintentional and malicious interference. New commercial markets for fiber replacement or extension, point-to-point wireless local area networks, and broadband Internet access at gigabit data rates and beyond have been opened up. Then-FCC n Chairman Michael Powell heralded the ruling as opening a *new* frontier in commercial services and products for the American people. Although intended to enable high data rate, commercial point-to-point applications, E-Band atmospheric and propagation properties make equipment designed for these frequencies very useful for secure military applications.

III. Why 70 and 80 GHz?

Atmospheric absorption varies significantly with frequency, as shown in Figure 1[1]. At conventional microwave frequencies, atmospheric attenuation is reasonably low, until a peak is seen at around 60 GHz, where absorption by oxygen molecules results in 15 dB/km attenuation, seriously limiting radio transmission Distances. After this peak is a large window where attenuation drops to less than 1 dB/km (effectively negligible) before rising again due to other molecular effects. This window has a minimum at *Reprinted from* 94 GHz, which is why this frequency has been previously exploited for military applications.

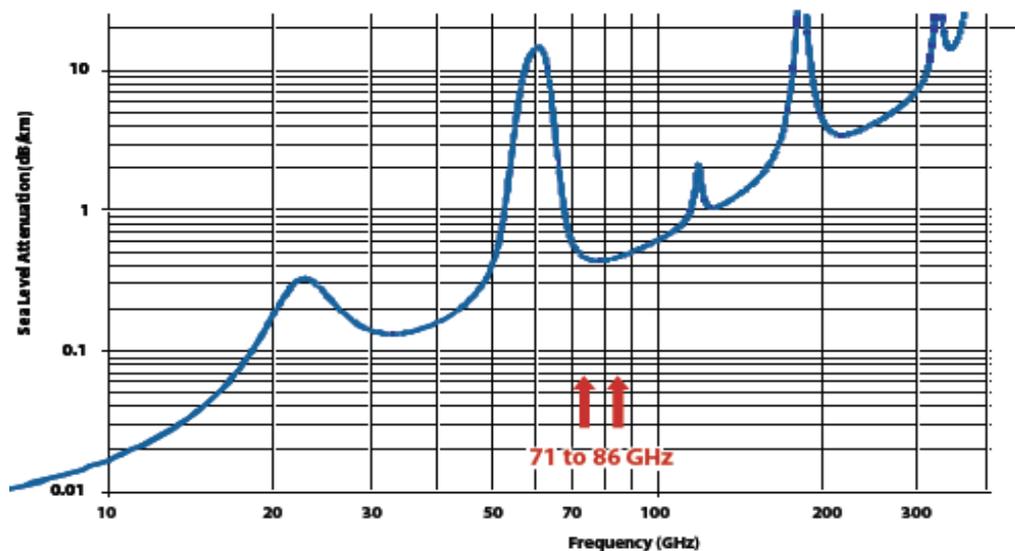


Fig 2

It can be seen that the spectrum from around 70 GHz up to around 120 GHz exhibits low atmospheric attenuation and fortunately is relatively unused. Due to the unprecedented bandwidths allocated by the FCC, the 70 and 80 GHz bands are ideal for very high capacity data distribution. With 5 GHz of bandwidth centered at both 73.5 and 83.5 GHz, gigabit and higher data rates can easily be accommodated with reasonably simple radio architectures and modulation schemes. This results in low-cost, high-reliability systems. As with all high-frequency radio propagation, rain will limit link distances. E-Band transmissions can experience 30 dB/km attenuation when in the presence of intense rain, as shown in Figure 2[2]. Such intense rain tends to form in small clusters within a lower intensity rain cloud, and is usually associated with a severe weather event that moves quickly across the link. Therefore, rain outages tend to be short and only occur on longer distance transmissions. Fortunately, the International Telecommunication Union (ITU) and other bodies have collected many decades of rain data from around the world, so rainfall characteristics are well understood. With such information, it is easy to engineer radio links to overcome even the worst weather or to predict the levels of weather outage on longer links. E-Band systems (70/80 GHz) are available for both commercial and military applications. One such product, GigaBeam's WiFiber radio [3], combines high output transmitters with advances in signal processing to overcome rain limitations and achieve the best link distances in the industry. Distances of one mile or more can be achieved across 80 percent of the United States with 99.999 percent weather availability, equivalent to five minutes of rain outages per year. Longer links can be engineered for less demanding weather availability. A comparison of typical E-Band radio's performance against main competing technologies is illustrated in Table 1. It can be seen that of several

technologies suitable for both LPD/LPI and rapid response situations, only E-Band radios offer the ability to reliably transmit at distances of a mile or more, plus provide the benefits of full license protection.

TABLE I
Comparative study of competing technologies

	E-Band (70/80 GHz)	WiMax	Microwave radio (18-38 GHz)	60GHz radio	Free Space Optics
Max data rates	1 Gbps	30-40 Mbps	322 Mbps	1 Gbps	1 Gbps
Typical link distances (99.999% availability/ 5 minutes outage per year)	1 mile	1 mile	3 miles	400 yards	200 yards
Typical link distances (99.9% availability/8 hours outage per year)	2.5 miles	3 miles	5+ miles	600 yards	500 yards
LPD/LPI	Yes	Yes	Not usually	Yes	Yes
Regulatory protection	Yes	Yes	Yes	No	No
Licensing, installation, and commissioning time	Hours	Half Hours	Weeks	Hours	Hours
Relative product complexity for max data rate and max link length	Simple	Comple x	Complex	Simple	Complex
Suitable for rapid deployment	Yes	No	No	Yes	No

IV. Secure applications

E-Band systems offer huge military and government potential. Very high data rates, portability, and ease of deployment make E-Band communications ideal for homeland defence and other security purposes. Rapidly deployable, high-definition video links for high data rate event security (for example, facial mapping for recognition purposes) is one such application. Another is high data rate battlefield data distribution from satellites. This list of possible applications is endless. E-Band systems excel in military applications since the millimetre-wave properties allow the radio to be classified as LPD/LPI. For any point-to-point technology, antennas generally have to be placed on high towers or masts, so a clear line of sight can be achieved. By necessity, this means that few buildings or possible interception points can be close to the radio path. However, the *ether* between any two antennas is never secure, and a determined hacker with a basic understanding of the particular radio system architecture will be able to *sniff* off part of the broad transmission radio signal. E-Band systems, however, are of a frequency much higher than conventional wireless systems, resulting in antennas that have much greater focusing ability. A typical application with a two foot dish antenna has a very narrow 0.3° beam width, meaning that transmitted signals propagate as highly focused and directional *pencil beams* from the antenna. Transmitted signals do not form broad diverging beams that illuminate large areas as at lower frequencies. Contrast this two-foot, 0.3° E-Band scenario to a similar two-foot dish at L-Band (1.5 GHz, a common military frequency). Here the beam will spread in a cone shape over 30°. Thus, an E-Band product's narrow pencil beams, which, of course, are invisible, are inherently much harder to locate and far more difficult to intercept.

V. Rapid deployment applications

The ease of deployment of E-Band wireless systems coupled with the fast and easy licensing scheme enables the technology to operate well as a rapid response system for defence or security applications. The E-Band system can be used as either the primary communication link or as backhaul to a lower data rate but longer range technology. An example of one such rapid response communication application is shown in Figures 3 and 4. Here two GigaBeam's WiFiber radios are installed on an Integrated Tower Systems mobile mast [4], each providing gigabit connectivity link to another mobile tower. An Adaptix WiMAX system [5] provides local point to multipoint coverage from the gigabit backhaul provided by the Wi-Fiber radios. This system, 106-foot-tall when extended, can be fully installed and commissioned within an hour and can withstand winds to 120 mph when properly secured with guy wires.

VI. Conclusion

E-Band is a new technology that offers point-to-point wireless gigabit data with very high availability over distances of a mile or more. Being a highly directional wireless technology, with pencil beam transmissions, E-Band can be classified as LPD/LPI. It is a perfect technology to satisfy hostile territory battlefield situations where there's a need for high bandwidth, point-to point, non-wire-line communications. Being a quick and easily deployable technology with an associated fast, online licensing scheme, E-Band products also satisfy rapid deployment or time critical homeland security and defense applications.

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