Q&A With the CIC Experts!

Commonly Asked Questions Regarding Point-to-Point Microwave Links: Part 1

By Harvey Lehpamer[1]

Communication Infrastructure Corporation® is a leading provider of infrastructure engineering and development services for the wireless telecommunications industry, specializing in the design and deployment of wireless backhaul solutions. We offer site development, microwave/RF engineering, installation, maintenance, and AWS relocation solutions for the efficient design and deployment of both large- and small-scale networks. Our expert team of 100+ professionals employs the latest appropriate technologies, the highest quality service, and the most up-to-date knowledge to meet the demands of wireless carriers.

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1. Are microwave links expensive to deploy?

Not necessarily; the cost of point-to-point microwave links varies according to a number of factors, such as distance between sites, capacity of the links, configuration, and link protection, among others. In most cases an investment in a point-to-point link can pay for itself within a year or so compared to the much more costly option of leasing multiple T1 circuits.

2. Isn't leasing T1 circuits much faster than designing, installing, and licensing microwave links?

Not any longer; the split-configuration microwave radio is easy to install, and licensing can be accomplished in a matter of days. On the other hand, dealing with local carriers to lease T1 circuits can be time-consuming as well as more costly due to additional installation requirements, i.e., construction charges.

3. Can a microwave link be affected by heavy rains?

Adverse weather conditions do not affect RF signals below 10GHz. Above 10 GHz, however, the influence of rain can easily be factored into the path design so that the link continues to perform even during exceptionally tough weather conditions.

4. Can flying birds affect my line-of-sight link?

No, radio communications rely on propagation through what is known as a Fresnel zone, which is one of a theoretically infinite number of concentric ellipsoids forming the radiation pattern between a transmitter and receiver. Each zone has a specific volume; the largest one is called the first Fresnel zone (F1). The zones are hyperboloid in shape; that is, somewhat like a football with their pointy ends facing each the transmitter and receiver. As long as 60% of this "football" is visible at both ends, the link should not be affected by birds or other objects passing through it.

5. What is multipath and when do I have to worry about it?

Multipath is a radio wave propagation phenomenon that occurs when signals hit the receiving antenna by two or more paths. A number of things can cause this to happen, including atmospheric ducting, ionospheric reflection and refraction, and reflection off terrestrial objects like mountains, trees, buildings, or even water. For example, when an electromagnetic wave strikes a nearly smooth large surface (such as a lake or a large building with many glass surfaces), a portion of that energy is sent along an angled path to its final target—the receiver. Reflection rays bouncing off different surfaces may interfere constructively (when the signal is enhanced) or destructively (when the signal is weakened) at a receiver, causing multipath propagation. In microwave point-to-point systems, multipath can be a problem at frequencies below 10 GHz.

6. We rent our office space and the landlord won't allow us to mount microwave equipment to the outside structure. Can we still have a microwave link?

Yes, although this is not a preferred practice of microwave link installation. Windows will attenuate (reduce the amplitude and intensity of) RF signals very slightly, but a good signal level and/or data rate can still be achieved. However, if the windows are tinted or have imbedded security wire, it can cause higher levels of RF attenuation, which must be taken into consideration when designing the path.

7. Is the multipath phenomenon common in the desert?

Deserts can cause ground reflections but sand does not have a high reflection coefficient. The most critical factor is the possibility of multipath fading and ducting caused by large temperature variations and/or temperature inversions, not ground reflections.

8. Does fog and snow affect microwave links the same way that rain does?

No, the effects of snow and fog on microwave propagation is negligible. Heavy snow can affect antenna loading and/or damage microwave antenna feeders, but that is another problem.

9. Are microwave links hazardous to human health?

Not unless you stand directly in front of a microwave antenna for long periods of time, which isn't likely. Microwave antennas are typically located high above the ground, and the intensity of radiation reaching the ground is negligible.

10. Do we need to conduct a thorough survey for every microwave path, or can we just use maps instead?

Detailed path surveys should be conducted on all microwave links to ensure optimum performance and take into account all potential obstructions that maps alone cannot indicate. Maps are used only for the initial planning as a first approximation.

11. I have a link that seems to perform better during autumn and winter than in spring or summer. How can this be?

This is a perfect example of why a thorough path survey should be conducted for every microwave link. More than likely there are trees in the link path, which shed their leaves from autumn through winter, thereby not creating as much obstruction as during spring and summer, when trees are leaved out. Leaves can absorb some—if not all—of the RF signal, deteriorating the system's performance. The effect is even worse when rain soaks the leaves. At frequencies below 10 GHz (usually longer paths) problems could also be caused by multipath, which is typically a summertime phenomenon.

12. Can I install microwave equipment on a flag pole or light pole?

It's possible as long as the twist and sway (e.g., how much the structure moves under high wind conditions) is sufficiently low for that particular antenna size and operation frequency. Some flag and light poles are specially designed to accommodate cellular/microwave equipment.

13. What is the "near field" of an antenna?

The terms "far field" and "near field" describe the electromagnetic fields around an antenna, or for that matter, around any electromagnetic radiation source. The names imply that two regions (near and far) exist within the vicinity of an antenna and have a boundary between them. Actually, as many as three regions and two boundaries exist, and it is important to note that these boundaries are not fixed in space. Usually, two- and three-region models are used in RF propagation analysis. In the near field, the field strength does not necessarily decrease steadily with distance away from the antenna but may exhibit an oscillatory characteristic; therefore, it is difficult to predict the antenna gain and radiation pattern in that region. Engineers analyze the link, including looking at Fresnel zone clearances and path profiles, based on the assumption that microwave antennas are in the far field region, e.g., the distance between them is sufficiently large. Any large object in the near field may distort the radiation pattern and should be avoided.

14. What is the difference between true north and magnetic north?

Although true north coordinates are used on engineering documents, a magnetic compass does not, in most cases, point to true north. In fact, over most of the Earth, magnetic north is at some angle east or west of true (geographic) north. The direction in which the compass needle points is referred to as magnetic north, and the angle between magnetic north and true north is called magnetic declination. The terms "variation," "magnetic variation," and "compass variation" are often used in place of the term "magnetic declination." In addition, the magnetic declination changes from place to place and throughout time.

15. What is the typical cost of an installed microwave link?

The cost will vary anywhere from a few thousand dollars to hundreds of thousands of dollars, depending on the radio capacity, path length, diversity scheme, configuration/protection, etc.

16. Would the cost of a turnkey project for five links in the same geographical area be five times more than the cost of one link?

No, in fact it is probably significantly less on a per-link basis. This is because engineering costs, project management costs, and field crew mobilization costs, among others, do not increase that much as links are added, especially if all five links are designed and installed at the same time.

17. Can I use old topographical maps for the path profile and the microwave link design?

Because magnetic declination, as well as the terrain itself, can change drastically in a short time, it's best to use maps that are not more than one year old. Additionally, everyone on a project should be using the same maps, data, and coordinate systems. The data, or reference ellipsoid selection, must be the same for the site data, image, and elevation. The same map projection must be used for the image and elevation files as well.

18. Why are my GPS positions in the wrong place in Google Earth?

In Google Earth (GE), a photo image is stretched over the terrain, the latter of which is not detailed enough to be an exact match, thus stretching the photo differently. GE uses 30-meter terrain data for the United States but 90-meter for most of the rest of the world. So in areas of extreme topography, images will not be "stretched" properly to fit the terrain. GE uses the standard elliptical WGS84 model, but even the elliptical model is too simplistic, and trying to wrap data in the geographic information on such a simple model of the Earth's shape will introduce additional errors. Further, errors are sometimes made in processing imagery data, leading to inaccuracies. Don't put much faith in the precision of Google Earth images for absolute positioning of objects and/or detailed path engineering. The positioning of objects relative to each other, however, could be determined using GE.

19. What is media diversity?

Media diversity is the practice of using different systems (media) to protect the transmission link against potential problems. For example, crucial microwave links can be protected by using completely different media, such as fiber optic systems, and vice versa—fiber optic systems can be protected by high-capacity microwave links. These solutions are expensive and have to be considered only in exceptional cases, such as when it is absolutely vital for a transmission link to be available at all times.

20. Can an experienced microwave engineer determine a tower's allowed loading and twist and sway just by looking at the tower?

It is important to use an expert tower company to calculate a tower's loading and its maximum allowed twist and sway. These decisions cannot be made on the basis of qualitative perceptions or "gut feeling." The chance for error in going with gut instinct could cause parts of the network to fail due to potential tower structural problems.

21. Do microwave links always require line-of-sight (LOS)?

Typical microwave links do require a clear LOS; however, in over-horizon—or tropospheric scatter—the sending and receiving antennas do not use an LOS transmission path, unlike a standard microwave radio link. Instead, the stray signal transmission, known as "troposcatter" or simply "scatter," from the sent signal is picked up by the receiving station. Using this method, signal clarity depends on the weather and other factors. As a result, it's very difficult to create a reliable over-horizon radio relay link. Thus, they are used only where standard microwave radio links are unsuitable, for example, in providing a microwave link to an island or in military applications.

22. What is the maximum length of a microwave link?

Typical microwave path lengths can be up to 40 miles, although 100-mile links have been implemented. The path length is related to the path reliability required by the user, which in turn will dictate the required frequency, transmitter power, receiver sensitivity, antenna diameters, radio configuration, and diversity scheme. For very long hops, one of the main restricting factors is available tower height; antennas have to be placed very high above the ground in order to clear the Earth's curvature as well as to clear the first Fresnel zone.

23. What is wireless backhaul?

Wireless backhaul is the network, either fiber or microwave, that connects wireless cell sites (base stations) to the mobile switching center (MSC). Traffic received and transmitted from the cell sites is "backhauled" through these access, metro, and core networks and "interconnected" with the PSTN or connected (backhauled) to other cell sites.

24. What is the difference between the Ethernet and legacy TDM wireless backhaul?

Traditionally, wireless backhaul has been provided over leased T1 links; however, technology is moving toward using Ethernet as bandwidth requirements per site dramatically increase for 3G and 4G (LTE and WiMAX) networks. Though in the past a best-effort service, Ethernet lacks the standardized operations, administration and maintenance (OAM), and service level agreement-backed performance guarantees required for wireless backhaul networks. To enable cost benefits and bandwidth efficiencies of Ethernet-based wireless backhaul, providers must establish carrier-grade Ethernet services and monitor them with packet performance assurance solutions.

25. How do we assess the quality of the Ethernet backhaul network?

Millisecond jitter and latency requirements, high availability, and committed throughput are some of the challenges facing wireless backhaul networks based on Ethernet technology. Establishing carrier-grade Ethernet Virtual Circuits (EVCs) with service mapping, bandwidth policing, traffic filtering, and shaping functionality creates the links required for emerging packet-based services, allowing providers to meet stringent wireless backhaul Service Level Agreements (SLAs). The ability to perform remote in-service testing, one-way delay and jitter monitoring, service assurance over mesh networks, and to establish end-to-end OAM is critical to ensuring quality of service and meeting SLAs.

26. What do T1, E1, and J1 mean?

T1 (ANSI), 1.544 Mbps, refers to the T-carrier signaling scheme used to transmit voice and data between devices. It is the communications standard primarily used in North America (but also in Jamaica and some other countries). E1 (CEPT), 2.048 Mbps, is its European counterpart and is also used in the rest of the world. The basic format for T1 transmission facilities in Japan is similar to the North American ANSI standard and is called J1. Germany and France impose a slight variation of the E1 and, thus, have unique formats compared to the rest of the market. Only one element remains constant and universal: the Digital Signal 0 (DS0). However, the form of PCM encoding differs between T1 (μ-law companding) and E1 (A-law companding). E1 to T1 conversion involves both the compression law and the signaling format.

27. In wireless backhaul, how is a Service Level Agreement (SLA) usually defined?

An SLA is a contract between the wireless backhaul provider and the mobile operator specifying performance and availability levels for the service provided. Typical SLA parameters specify Committed Information Rate (CIR, throughput), Excess Information Rate (EIR), as well as burst capabilities, delay and jitter (typically 1-5 milliseconds), and 99.99% to 99.999% availability.

For more questions regarding point-to-point microwave links, refer to Part 2.