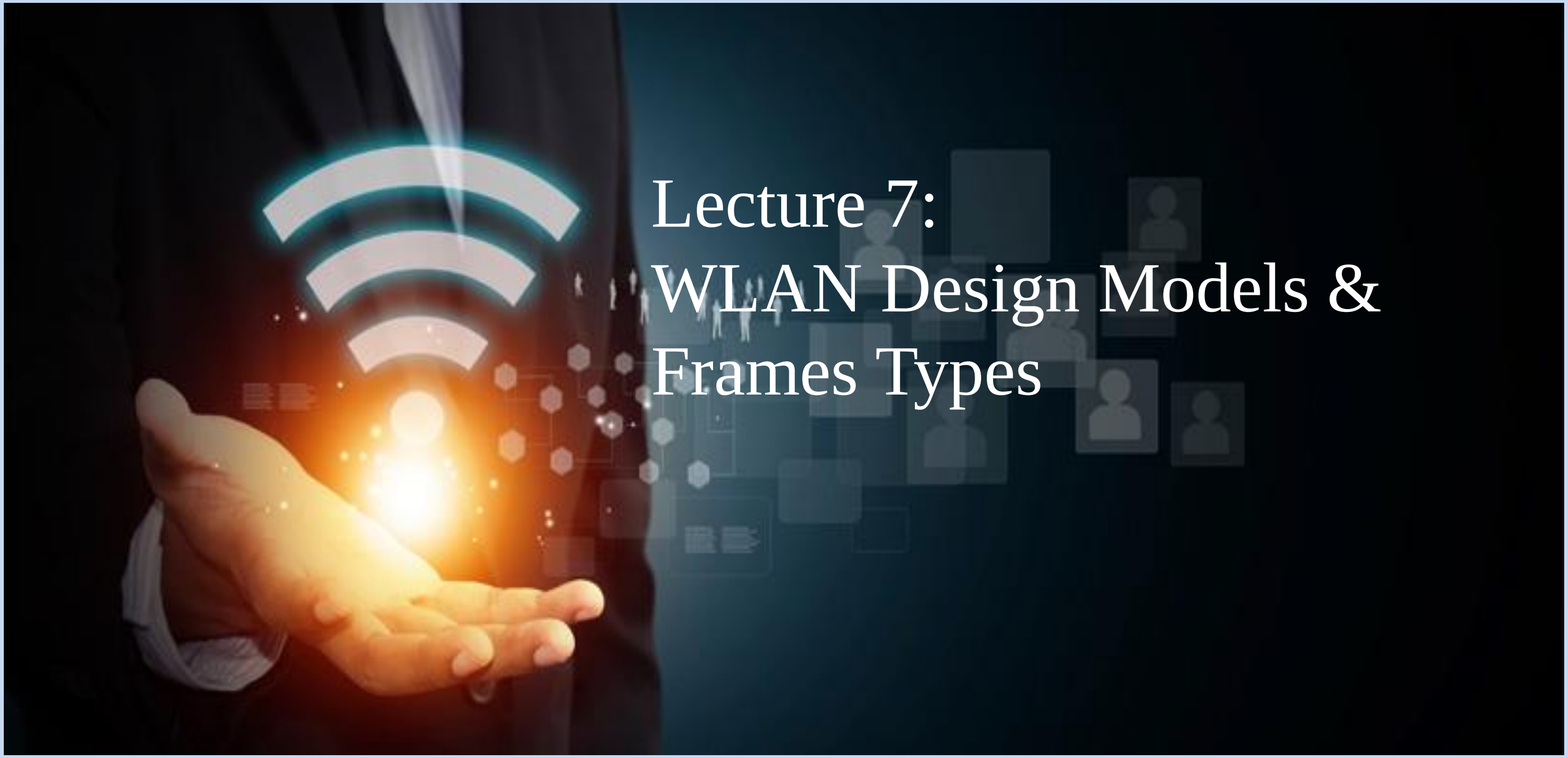
Wireless Networks



Site-to-Site Connections

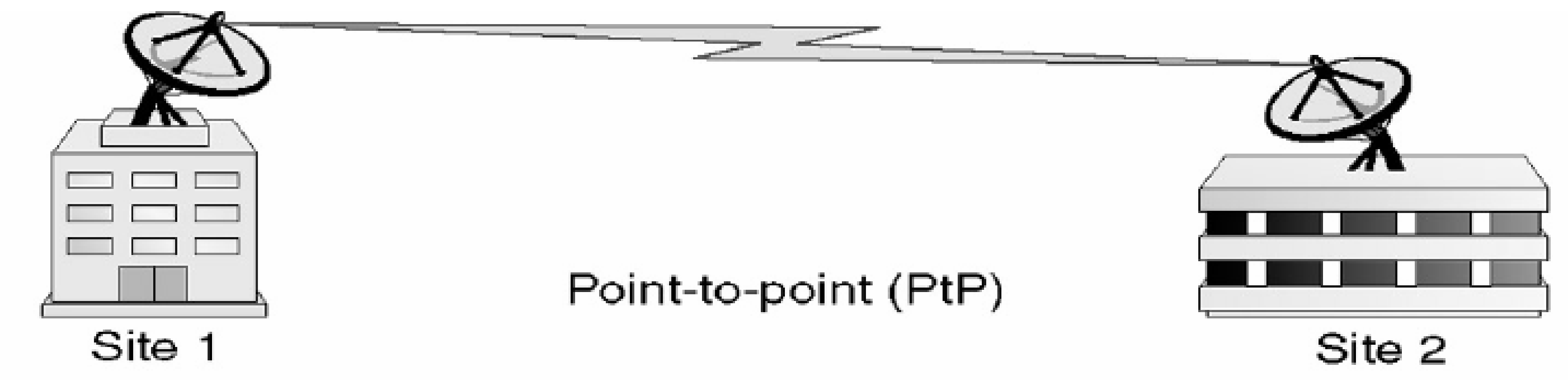
When using WLAN technology to form site to site links, you will either create **point-to-point (PtP)** or **point-to-multipoint (PtMP)** links.

Point-to-Point (PtP)

A PtP WLAN connection is a dedicated connection between two wireless devices. These two devices are usually bridges that allow for the bridging of two otherwise disconnected LANs.

These wireless connections allow for the creation of large-scale campus networks and may even be used to create metropolitan networks that span cities. They provide the benefit of connecting disconnected LANs over some distance without the need for leased lines or running cable when the connection is created within a large campus or otherwise owned area. The following figure shows a PtP connection.

Point-to-Point (PtP)



Point-to-Point (PtP)

These PtP connections will use semi-directional or highly directional antennas to form the connection. These antennas do focus the signal mostly in a desired direction so that more amplitude is available in that desired direction.

Point-to-Multipoint (PtMP)

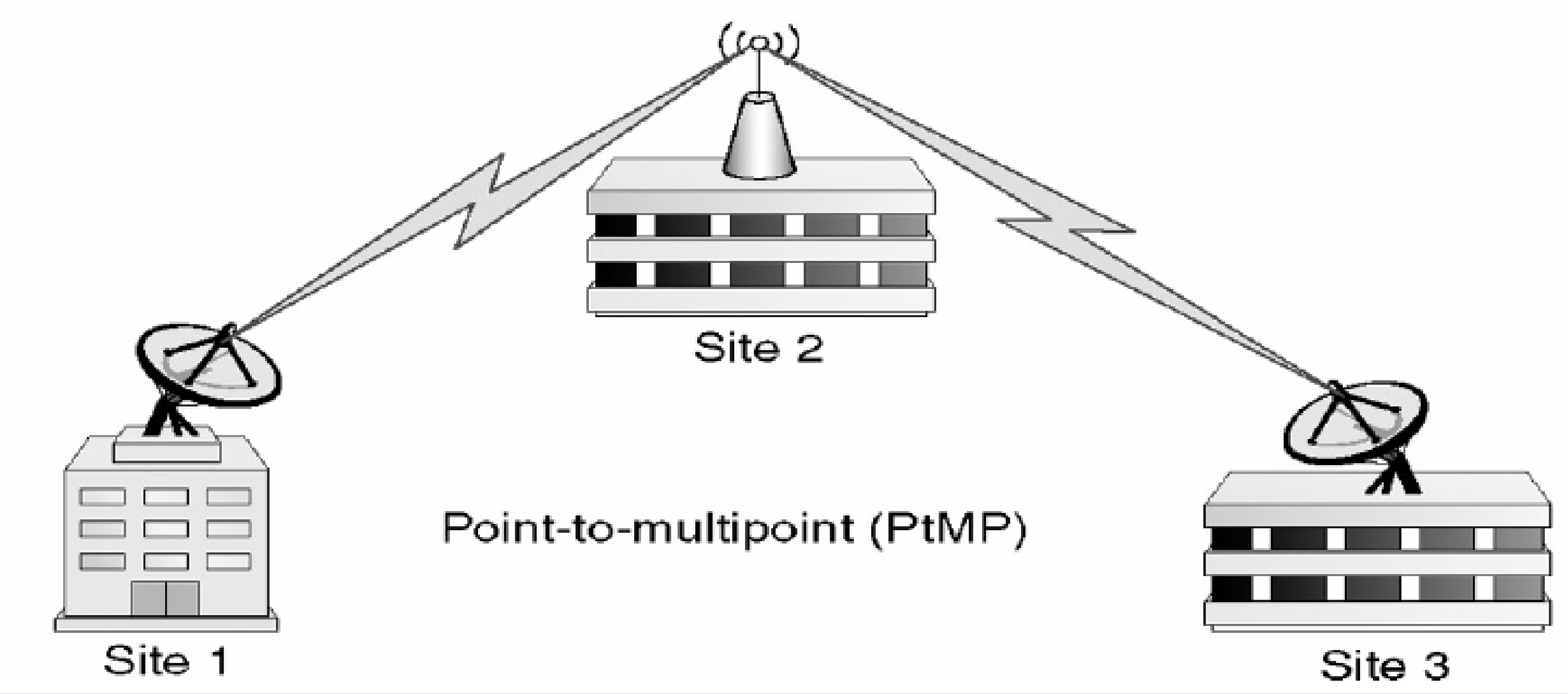
A PtMP wireless link is created when more than one link is made into a central link location like that represented in the following figure.

An omni- or semi-directional antenna is usually used at the central location, and semi-directional or highly directional antennas are used at the other locations.

Why there?

Question of thi

Point-to-Multipoint (PtMP)



Point-to-Multipoint (PtMP)

When only one connection is needed, you will usually choose the PtP model, and when there is a need for multiple locations to link back to a central location, you will usually choose the PtMP model.

However, there are times when multiple PtP links may be justified instead of using the PtMP model. Specifically, this may be needed when you cannot accept the throughput constraints imposed by having a single antenna positioned centrally that is accessed by all remote locations.

Wireless Mesh Networks

Another wireless networking model is the wireless mesh networking model. In the database world, you have a one-to-one relationship model, and this is like the PtP model in WLANs. You also have a one-to-many relationship model, and this is like the PtMP model in WLANs. However, database theory also presents a many-to-many relationship model, and this is much like the mesh networking model in WLANs. Therefore, you could say that mesh networking is like a multipoint-to-multipoint (MPtMP) model.

Wireless Mesh Networks

In a mesh network, all APs can connect to all other stations that are turned on and within the range of each other. Additionally, data travels through each node so that each node is both a router/repeater and an end node at the same time. The benefits of a mesh networking model include:

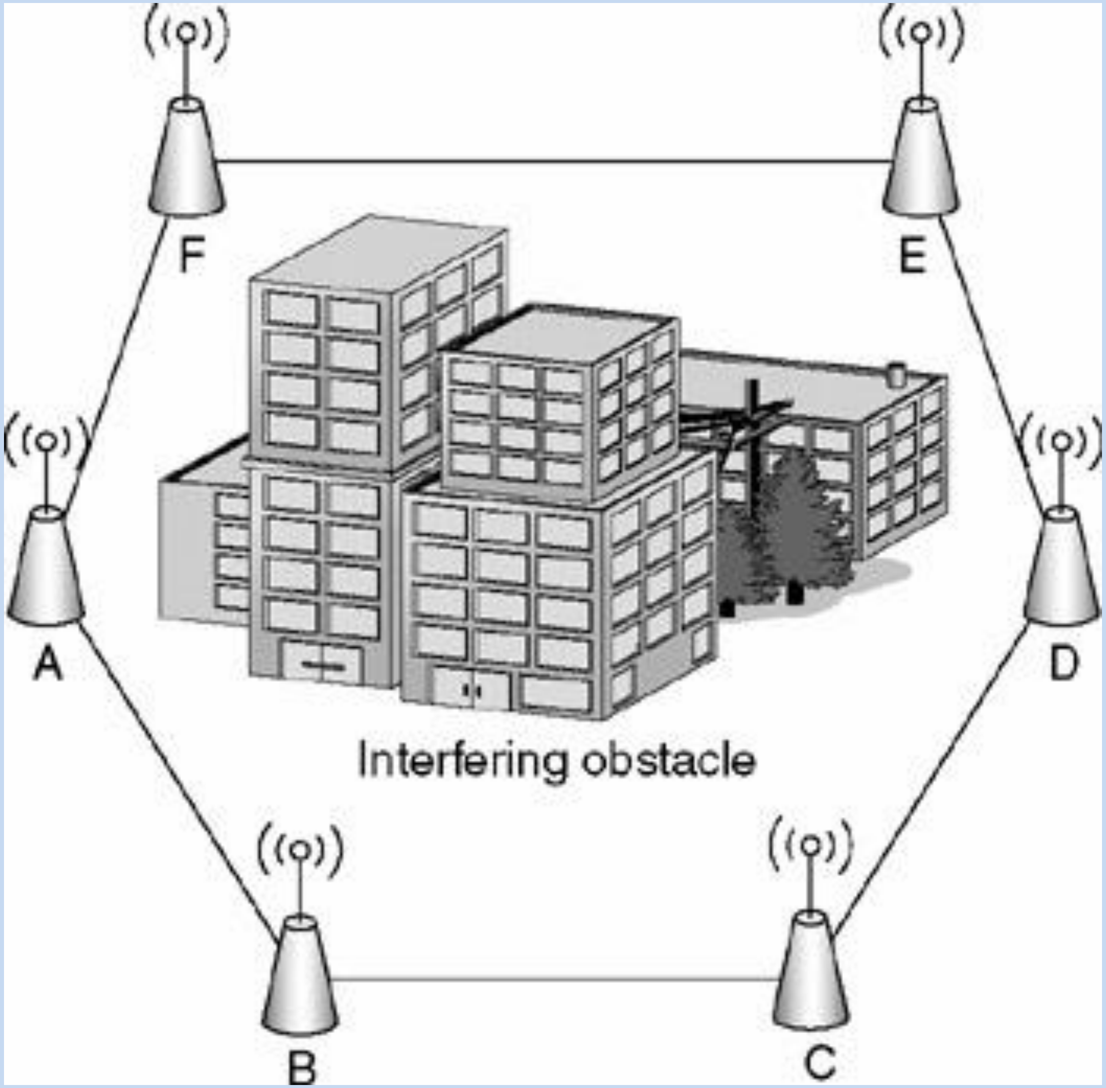
Wireless Mesh Networks

- Communications within areas that would normally have many LOS obstructions.

- Data routing redundancy.

The first benefit is seen because mesh nodes are placed close enough to each other that a path will always be available around obstructions that would normally prevent wireless links.

Wireless Mesh Networks



Wireless Mesh Networks

The previous figure illustrates this benefit. Notice that data can travel from node A to node B and then to node C and finally to node D. If this were not a mesh network, there would be no clear path from node A to node D.

Wireless Mesh Networks

The previous figure illustrates the second benefit also.

If the route mentioned previously (A to B to C to D) was to become unavailable, there is data routing redundancy in that the route from A to F to E to D could be utilized.

Visual LOS

If you stand on top of some tall building, you can see for a very great distance. You may even be able to see for many miles on a very clear day. If you can physically see something, it is said to be in your visual line of sight (visual LOS). **This LOS is actually the transmission path of the light waves from the object you are viewing (transmitter) to your eyes (receiver).**

RF LOS

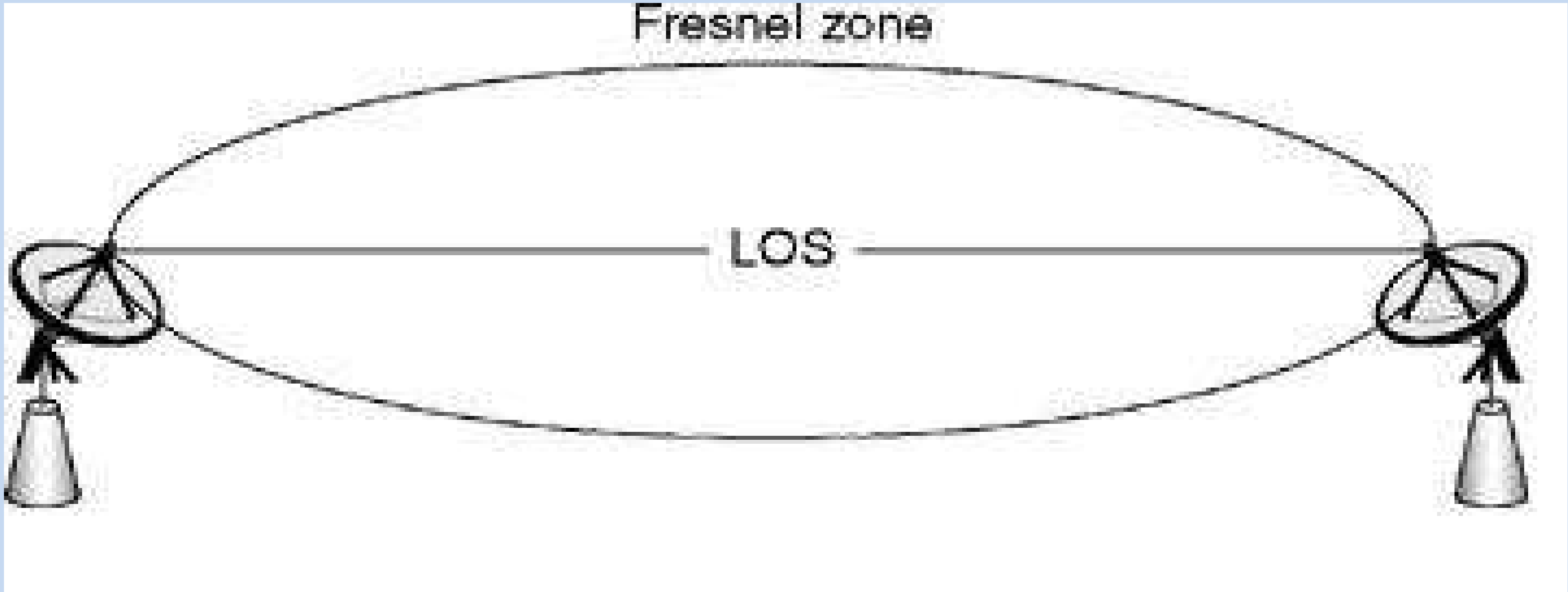
RF LOS is more sensitive than visible LOS to interference near the path between the transm … that more s … be seen by each end of the connection. This extra space can actually be calculated and has a name: the **Fresnel zone**.

Why there is more space?

The Fresnel Zone

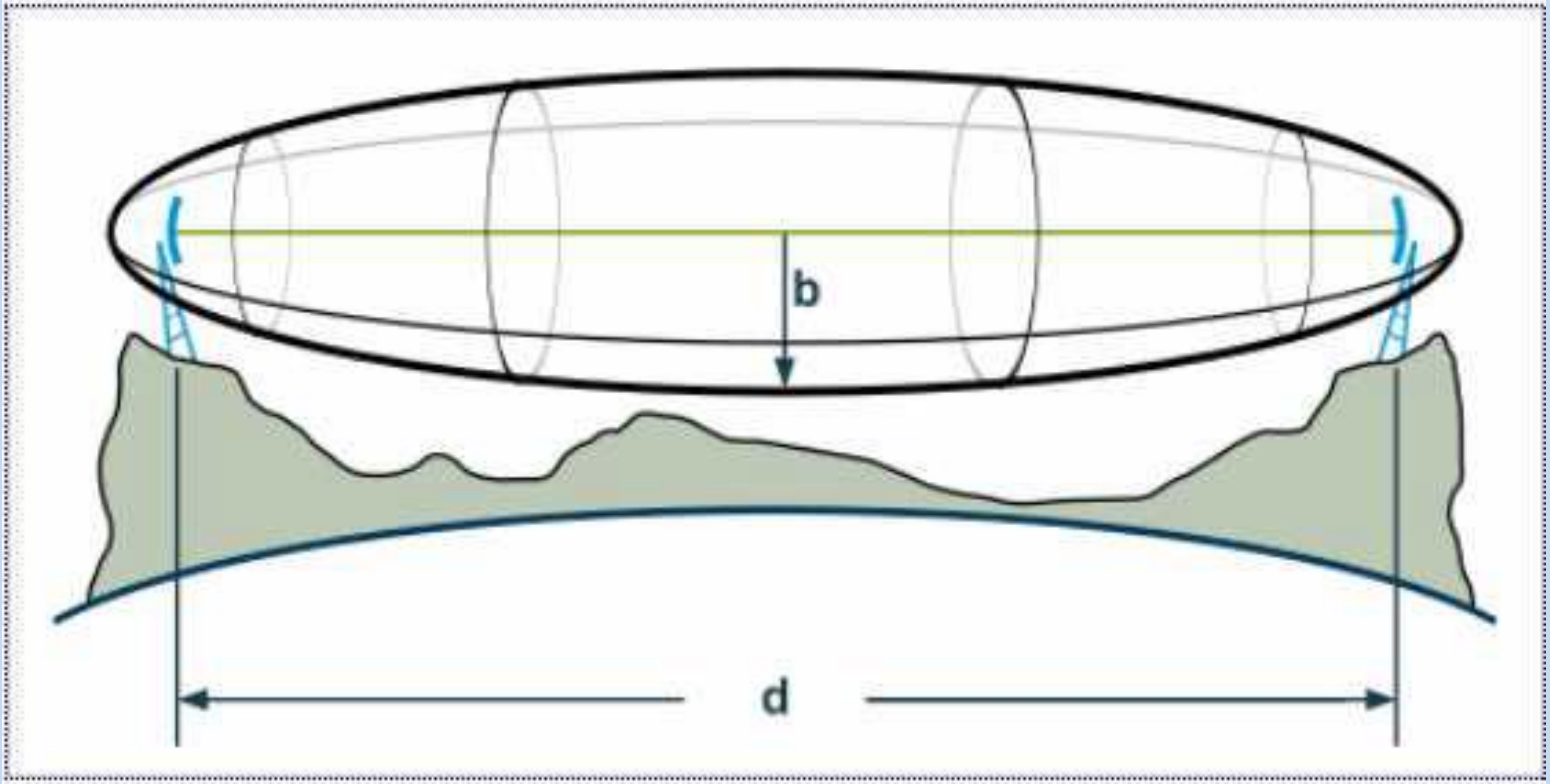
The Fresnel zones (pronounced frah-nell), named after the French physicist Augustin-Jean Fresnel, are a theoretically infinite number of ellipsoidal areas around the LOS in an RF link. Many WLAN administrators refer to the Fresnel zone when it is more proper to refer to the first Fresnel zone, according to the science of physics. While it may be the intention of most WLAN administrators to reference the first Fresnel zone when they speak of only the Fresnel zone, it is important that you understand the difference. The first Fresnel zone is the zone with the greatest impact on a WLAN link in most scenarios. The Fresnel zones have been referenced as an ellipsoid-shaped area, an American football-shaped area. The following figure shows the intention of this analogy.

The Fresnel Zone



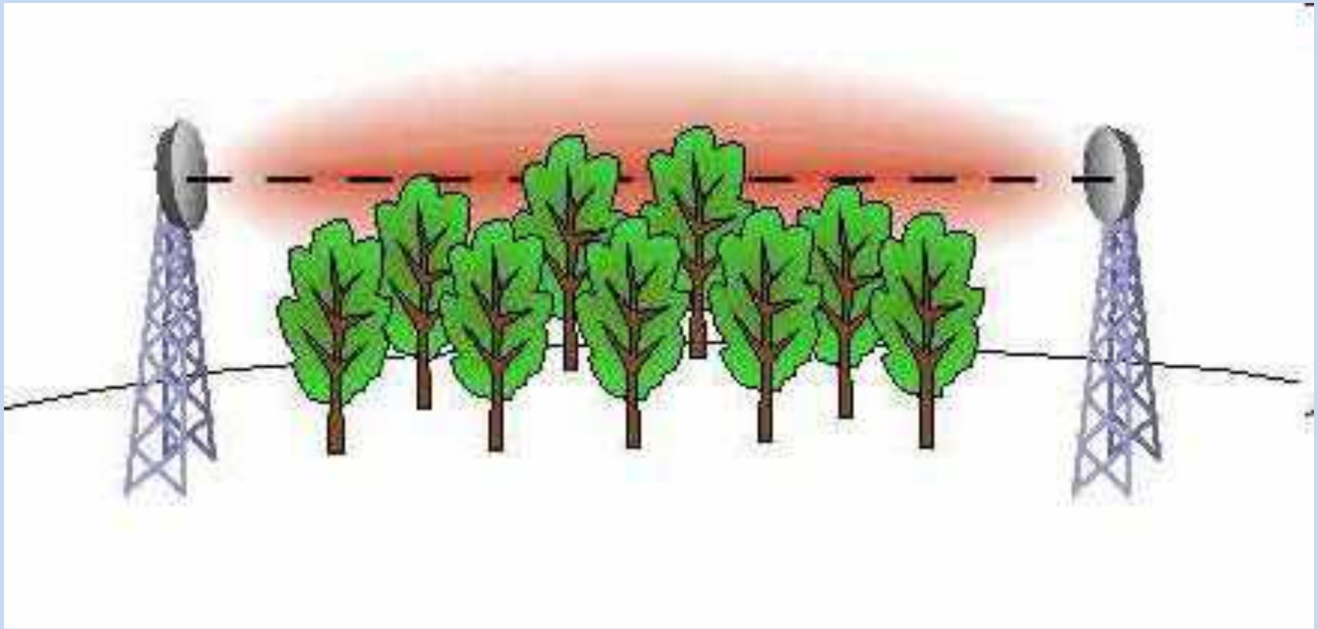
A Fresnel zone is a cylindrical ellipse drawn between transmitter and receiver. The size of the ellipse is determined by the frequency of operation and the distance between the two sites.

The Fresnel Zone



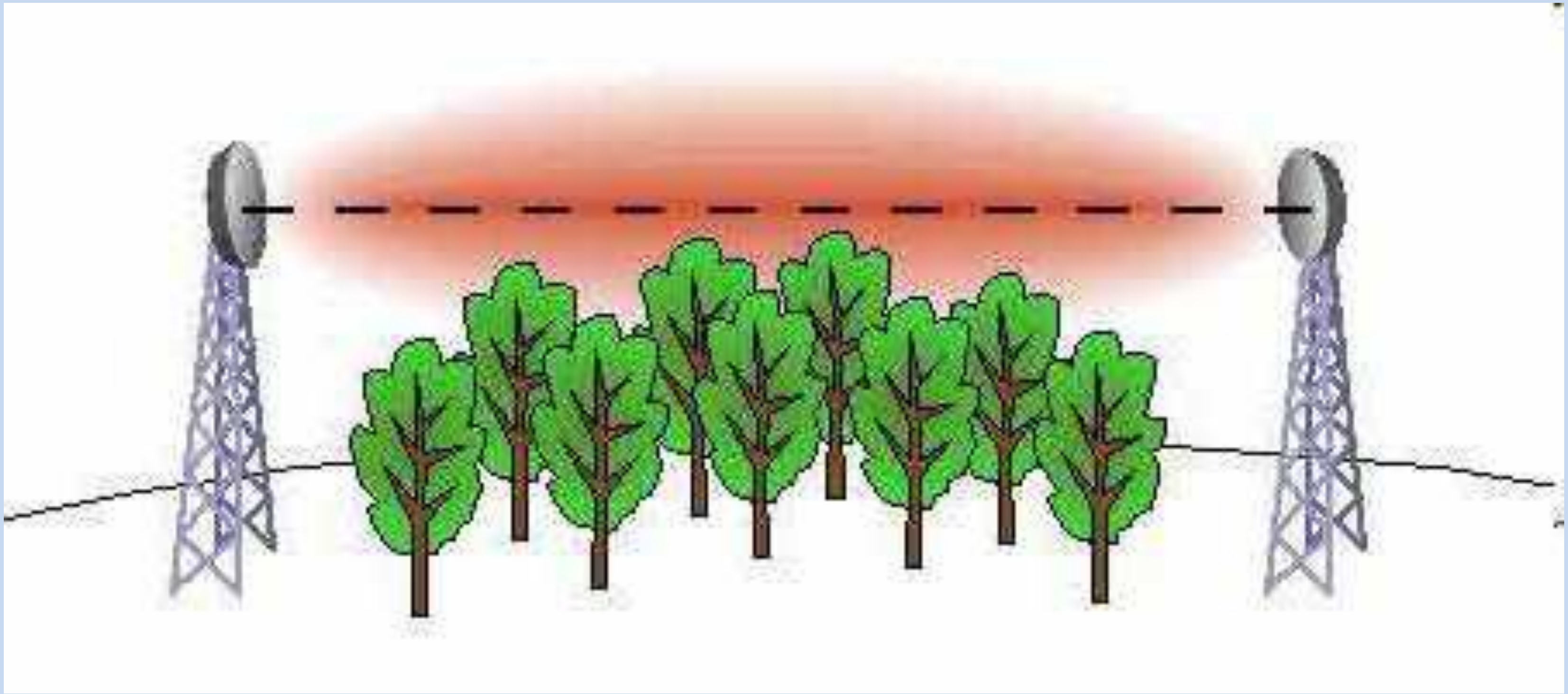
Fresnel zone: *d* is the distance between the transmitter and the receiver; *b* is the radius of the Fresnel zone.

Fresnel Zone



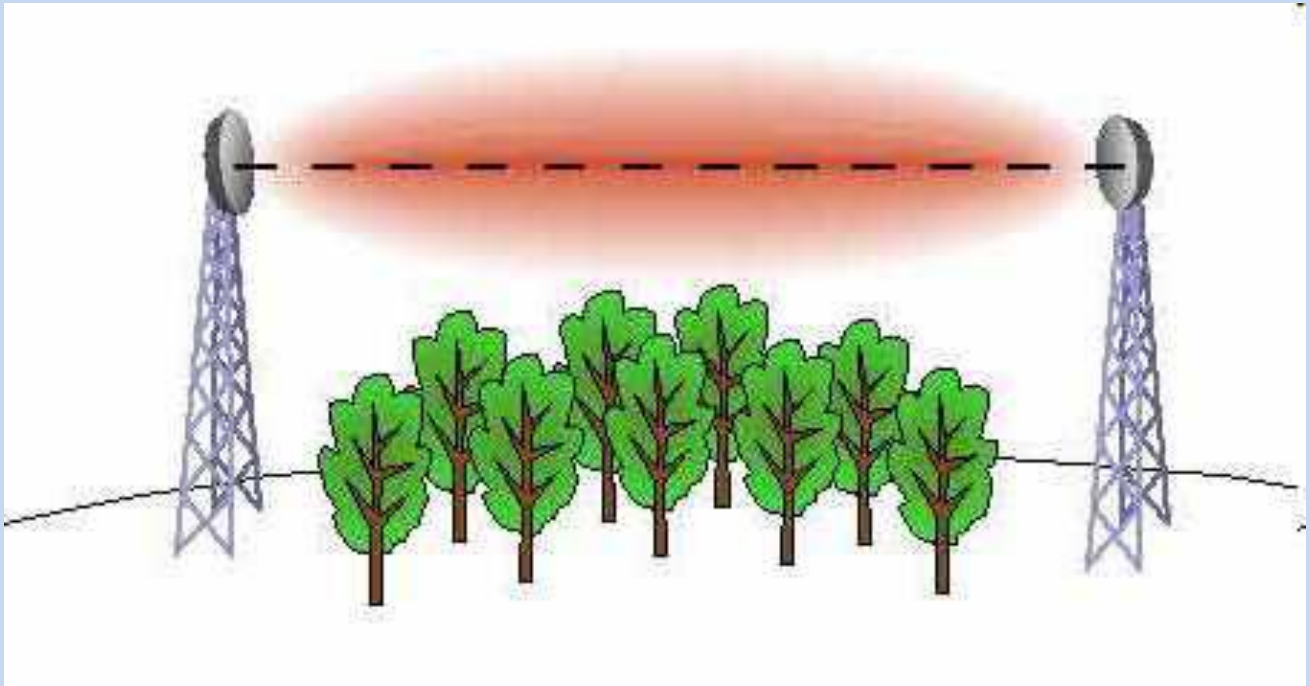
Incorrect installation, the trees obstruct the line of sight .The received signal will be severely attenuated .

Fresnel Zone



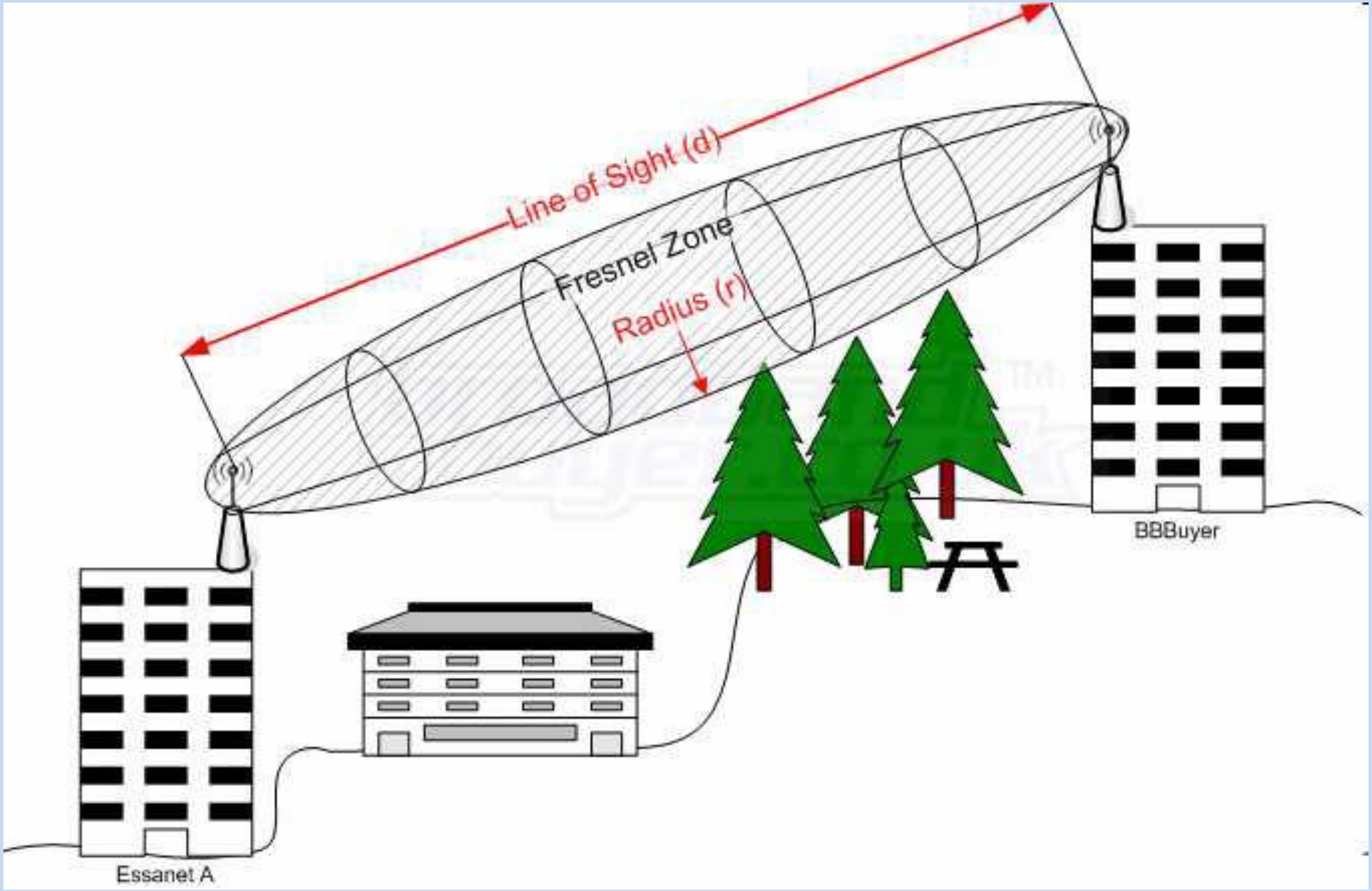
Incorrect Installation, the first Fresnel zone is partially obscured. The received signal will suffer attenuation path from node to node.

Fresnel Zone



Correct installation. The first Fresnel zone clears the trees .

Fresnel Zone



Fresnel Zone

Fresnel zone 1 is called “1FZ” .

Since 1FZ is an area surrounding the LOS and this area cannot be largely blocked and still provide a functional link, it is important that you know how to calculate the size of 1FZ for your links. You'll also need to consider the impact of Earth bulge on the link and 1FZ.

Fresnel Calculations

To calculate the radius of the 1FZ, use the following formula:

$$Radius\ (mts.) = 17.31 \times \sqrt{\frac{D\ (in\ km)}{4 \times f\ (in\ GHz)}}$$

$$Radius\ (ft.) = 72.05 \times \sqrt{\frac{D\ (in\ miles)}{4 \times f\ (in\ GHz)}}$$

Where D is the distance of the link in miles or foot and F is the frequency used for transmission in GHz and radius is reported in feet.

Fresnel Calculations

It is important to realize that a blockage of the 1FZ of more than 40 percent can cause the link to become nonfunctional.

To calculate the 60 percent radius, so that you can ensure it remains clear, use the following formula:

$$Clearance\ radius = 43.3 \times \sqrt{(D/(4 \times F))}$$

Fresnel Calculations

However, this leaves no room for error or change. For example, trees often grow into the 1FZ and cause greater blockage than they did at the time of link creation.

- For this reason, some WLAN engineers choose to use a 20 percent blockage or 80 percent clearance guideline, and this is the recommended minimum clearance. So how would you calculate this? Use the following formula:

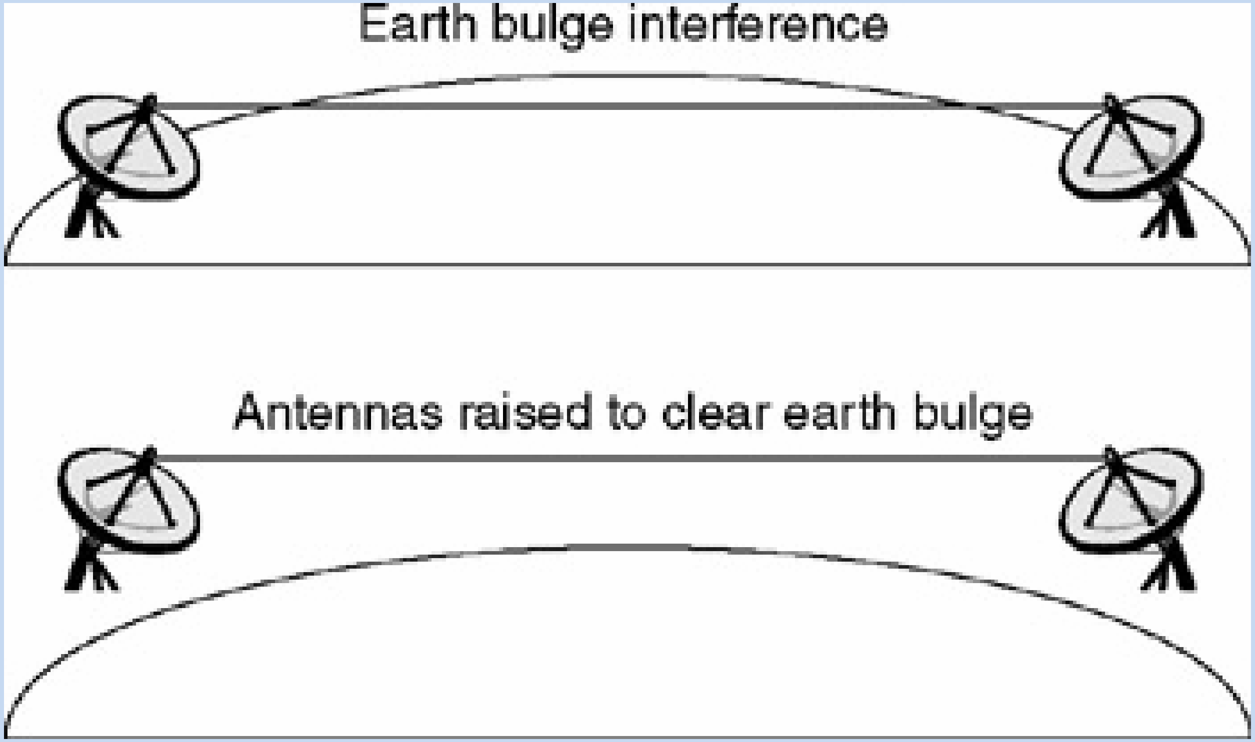
$$\textit{Recommended radius} = 57.8 \times \sqrt{D / (4 \times F)}$$

Earth Bulge and the Fresnel Zone

Another factor that should be considered in 1FZ blockage is the Earth itself. As you know, the Earth—it turns out—is round.

This means that the farther apart you and I are (or any two objects for that matter), the greater will be the likelihood that the Earth is between us. This is demonstrated in the following figure.

Earth Bulge and the Fresnel Zone



Earth Bulge and the Fresnel Zone

If you are creating wireless links over distances greater than 7 miles using WLAN technologies, you will need to account for Earth bulge in your antenna positioning formulas. Earth bulge is a potential problem in outdoor wireless links over greater distances. The formula to calculate the extra height your antennas will need to compensate for Earth bulge is:

$$\text{Height} = D^2 / 8$$

Earth Bulge and the Fresnel Zone

where height is the height of Earth bulge in feet and D is the distance between antennas in miles. Therefore, if you are creating an 8-mile link, you would process the following formula:

$11^2 / 8 = 15.12$ feet

Using our guideline of rounding up, I would raise the antenna height by 15.5-16 feet to accommodate Earth bulge

Solving 1FZ Obstructions

- If the obstructions are coming up from the ground into the 1FZ and there are no obstructions anywhere above it, you can often solve the problem by simply raising the antennas involved in the communication link.
- For example, if there is a forest with maximum tree height of 23 feet that is between the two antennas and there is a distance of 11 miles that must be spanned, we can calculate the needed height for the antennas, including Earth bulge, with the following formula:
- **Minimum antenna height = $(57.8 \times \sqrt{11 / (4 \times 2.4)}) + (112 / 8)$**

Thank You