

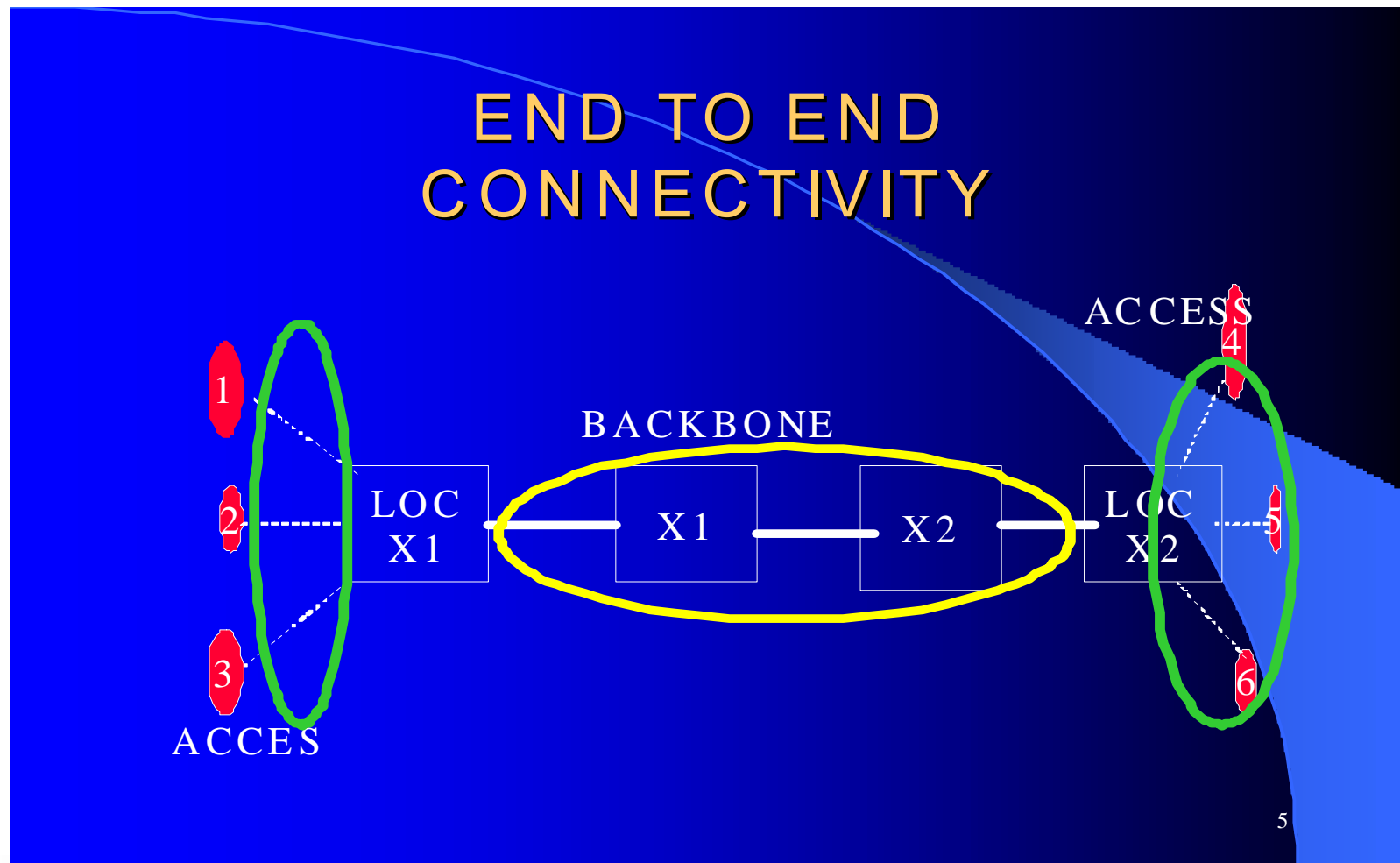
Gemini Communication Ltd.

Training Manual *RF Basics*

Components of a point to point connectivity system

1. Access network – also called last mile or local loop is the connection between the customer premises to the nearest exchange or gateway point.
2. Backbone network – the connection between two exchanges which may be in kms linked either by optic cable or satellite communication or underground or undersea cable links

END TO END CONNECTIVITY



Access network

Wired network

- a. Dial up line
- b. leased line

Wireless network

- a. WiLL wireless local loop

Analog vs. digital Voice transmission

- Voice is nothing but vibration at different frequencies.
- Audible range is 20 to 20,000 Hz.
- Necessary or used frequency bandwidth is just 4kHz.
- Analog transmission gives good voice quality as signal is continuous but signal is different to handle and picks up noise easily.

- When analog signal is amplified for long distance transmission noise also gets amplified.
- Digital signal is easy to process and transmit. The signal is regenerated at intervals for long distance transmission so there is not much distortion. Quality depends on sampling frequency.
- Sampling frequency should be at least twice the max. frequency to get good regeneration.

E1 signal

- Analog signal of bandwidth 4kHz is sampled at a frequency of 8 kHz. This is then coded using 8 bits per signal. So the no. of bits per second is 64,000. This 64kbps signal channel is then clubbed together, so that 32 channel is sent as one E1 signal. One E1 signal contains 30 channels of voice and 2 channels for signaling and synchronization. One E1 channel consists of $32 \times 64\text{kbps} = 2048\text{kbps}$ data, which is nothing but 2mbps data.

Transmission modes

- Simplex communication- where the communication is one way in a line. Example – mike to loud speaker
- Half duplex communication – one line but communication in one direction at a time. Example – walkie talkie
- Full duplex communication—TDD or FDD
- TDD- one frequency is used but transmission is time multiplexed
- FDD- two different frequencies are used but transmission takes place at the same time
- We use TDD communication which needs synchronization if multiple modems are used.
- TDD is slower in data transfer rate but is cheaper than FDD.

Units frequently used

- Resistance --- Ohms.(Ω)
- Current --- Amperes (A)
- Potential difference --- Volts (V)
- Power --- Watts (W)
- UPS power --- (VA)

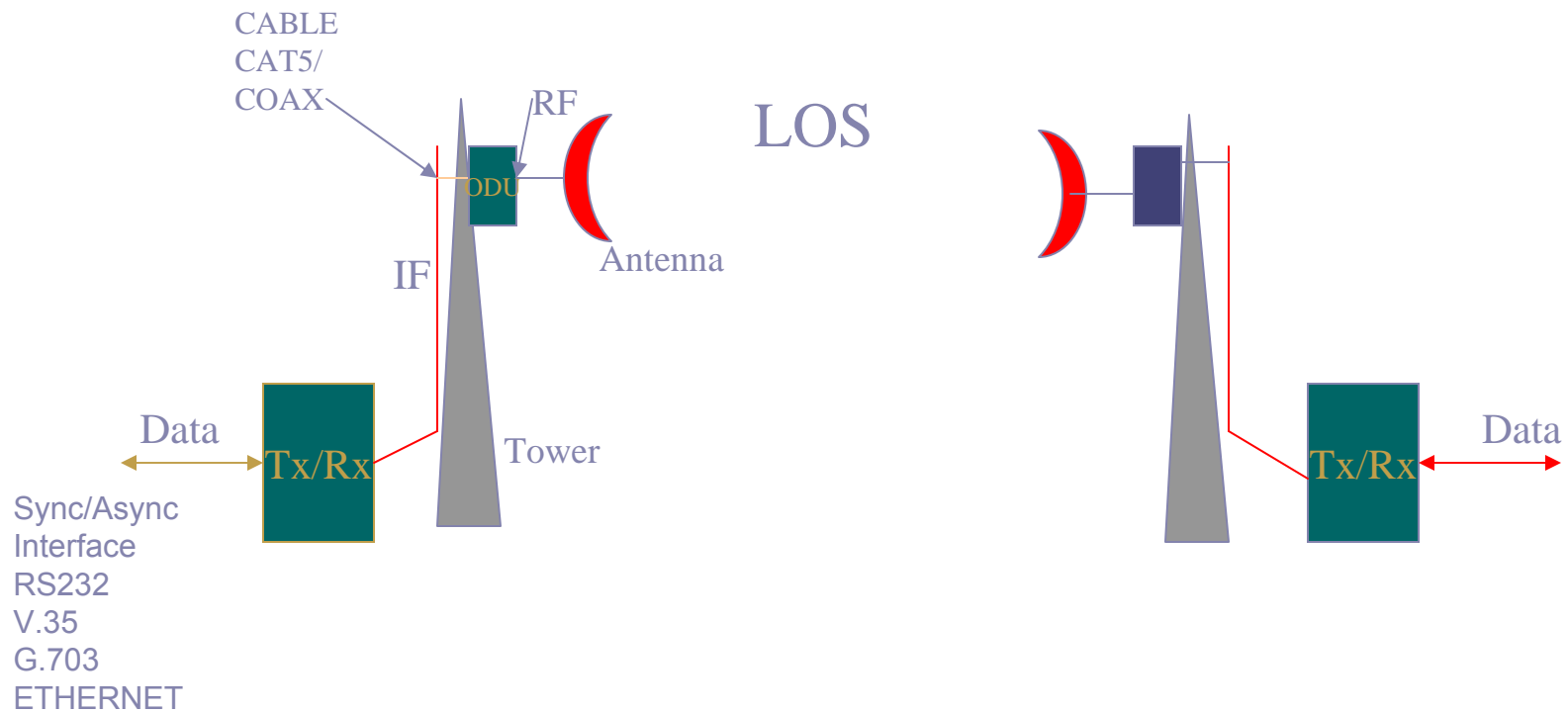
Logarithmic measurements

- Log measurements are used as it is easy to use them when calculations are to be done. By using log terms we just add or subtract instead of multiplying or dividing.
- $\text{dB} = \log_{10} (P2 / P1)$
- If there is an input and output value involved as in the loss of an cable then the gain in db is mentioned.
- The gain of an transmitter is mentioned in dBm. When the gain of an transmitter is mentioned then the output is always measured against input power of 1mW. A dBm is a standard unit for measuring levels of power in relation to a 1 milliwatt reference signal
- The gain of an antenna is always defined as dBi Which is the gain of an directional antenna against the gain of an isotropic antenna used in the same configuration. (an isotropic antenna is one which radiates equally in all directions). **dBi**— the forward gain of an antenna compared to the hypothetical isotropic antenna which uniformly distributes energy in all directions.

- Threshold (sensitivity)—The minimum signal which can be received without signal degradation
- BER--- Bit error ratio
- Fade margin =Threshold-RL (receive level)
- Data transmission – sync / async
- In Asynchronous data transfer there is a start bit and a stop bit sent with every transmission. Ex. Keyboard to system, RS232
- In Synchronous data transfer the clocks of both the transmitter and receiver are synchronised using a PLL (phase locked loop) and data transfer is very fast. Ex. V.35, G703

Elements of an RF link

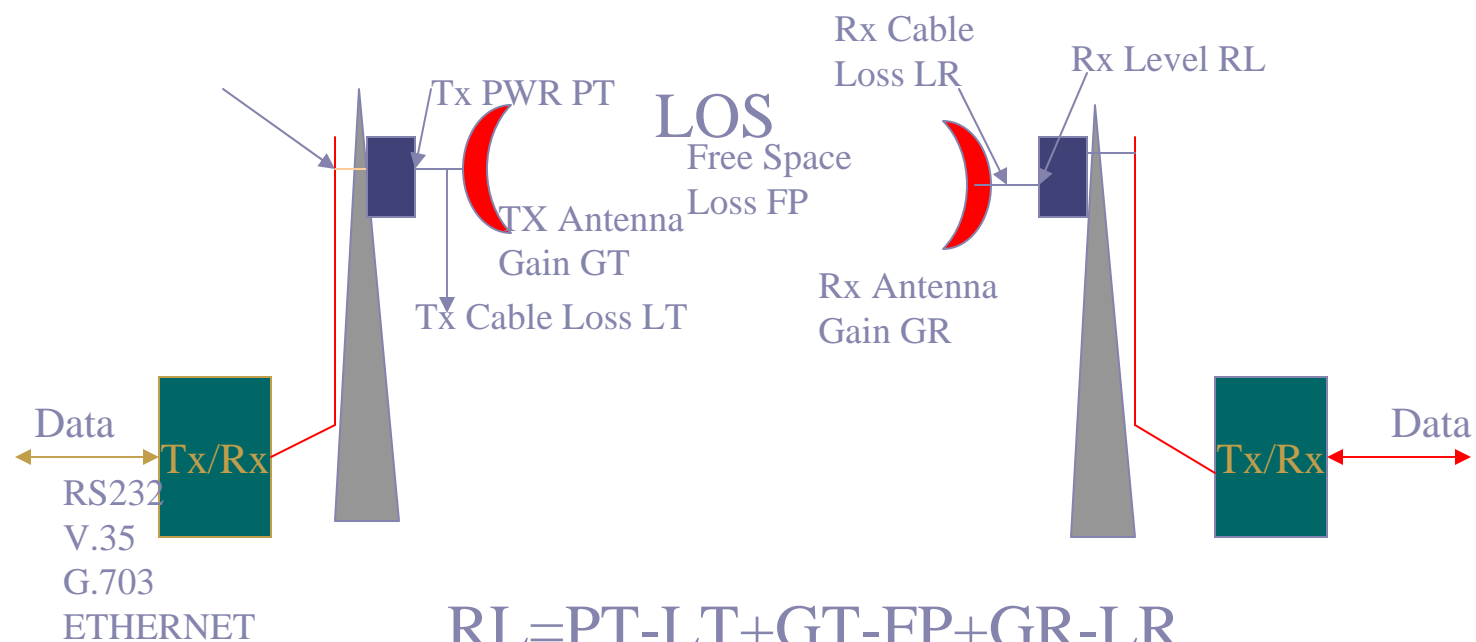
Interface



Stable link

- To determine if a link is stable RL of the link is calculated.
- Fade margin is then calculated.
- The higher the fade margin the more stable the link stays.

Link Budget



$$RL = PT - LT + GT - FP + GR - LR$$

$$FP = 36.56 + 20 \log f(\text{MHz}) + 20 \log d(\text{miles})$$

RF wave as a band of electromagnetic wave

- Frequency ranges
- 0-3 KHz -VLF
- 3-300KHz -LF
- 300-3000 KHz -MF
- 3-30 MHz -HF
- 30-300 MHz -VHF
- 300-3000 MHz -UHF
- 3-30 GHz -SHF
- 30-300 GHz -EHF

APPLICATION

- 10 – 110 kHz: Ships for navigation
- 535 -1,700 kHz: AM radio
- 5.9 - 26.1 MHz: Short wave radio
- 26.96 - 27.41 MHz: Citizens band (CB) radio
- 40 – 50 MHz: Standard Cordless Phones
- 54 - 88 MHz: Television stations for channels 2-6
- 88 MHz - 108 MHz: FM radio
- 174 to 220 MHz: Television stations for channels 7 through 13

APPLICATION

- 824 - 849 MHz: Cell Phones
- 900-MHz: Cordless phones
- 960 -1,215 MHz: Air traffic control radar
- 1,227 - 1,575 MHz: GPS
- 2290 MHz - 2300 MHz: Deep space radio communications
- 2400 – 2483.5 MHz: ISM Band

Line Of Sight (LOS)

- Radio transmission requires a clear path between antennas known as radio **line of sight**.
- Line of sight is the direct free-space path that exists between two points. Using binoculars on a clear day, it is easy to determine if visual line of sight exists between two points that are miles apart. To have a clear line of sight there must be no obstructions between the two locations. Often this means that the observation points must be high enough to allow the viewer to see over any ground-based obstructions.
- **The following obstructions might obscure a visual link:**
 - Topographic features, such as mountains
 - The curvature of the Earth
 - Buildings and other man-made objects
 - Trees

Obstructions that can interfere with visual line of sight can also interfere with radio line of sight. But one must also consider the Fresnel zone.

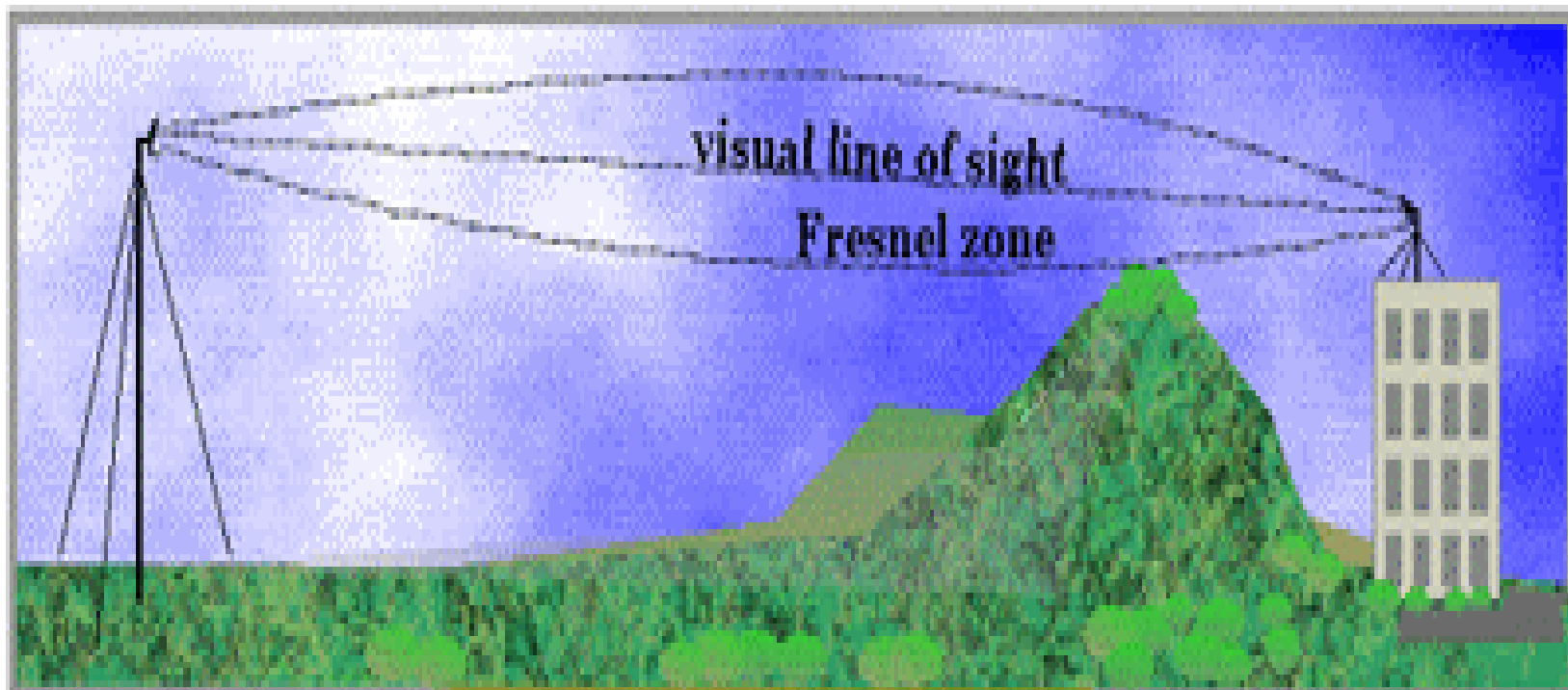
The Fresnel zone for a radio beam is an elliptical area immediately surrounding the visual path. It varies in thickness depending on the length of the signal path and the frequency of the signal. The necessary clearance for the Fresnel zone can be calculated, and it must be taken into account when designing a wireless link.



Visual Line Of Sight- Fresnel Zone



Visual LOS- Fresnel Zone



Several options to establish or improve the line of sight:

- Raise the antenna mounting point on the existing structure
- Build a new structure, i.e. radio tower, which is tall enough to mount the antenna
- Increase the height of an existing tower
- Locate a different mounting point, i.e. building or tower, for the antenna
- Cut down problem trees

Different types of connectivity

- P2P - Point to point connectivity
- MMDS – Multichannel multipoint distribution service
- WiMAX – Worldwide interoperability for Microwave access

Thank you