Basic Issues in Wireless Networking

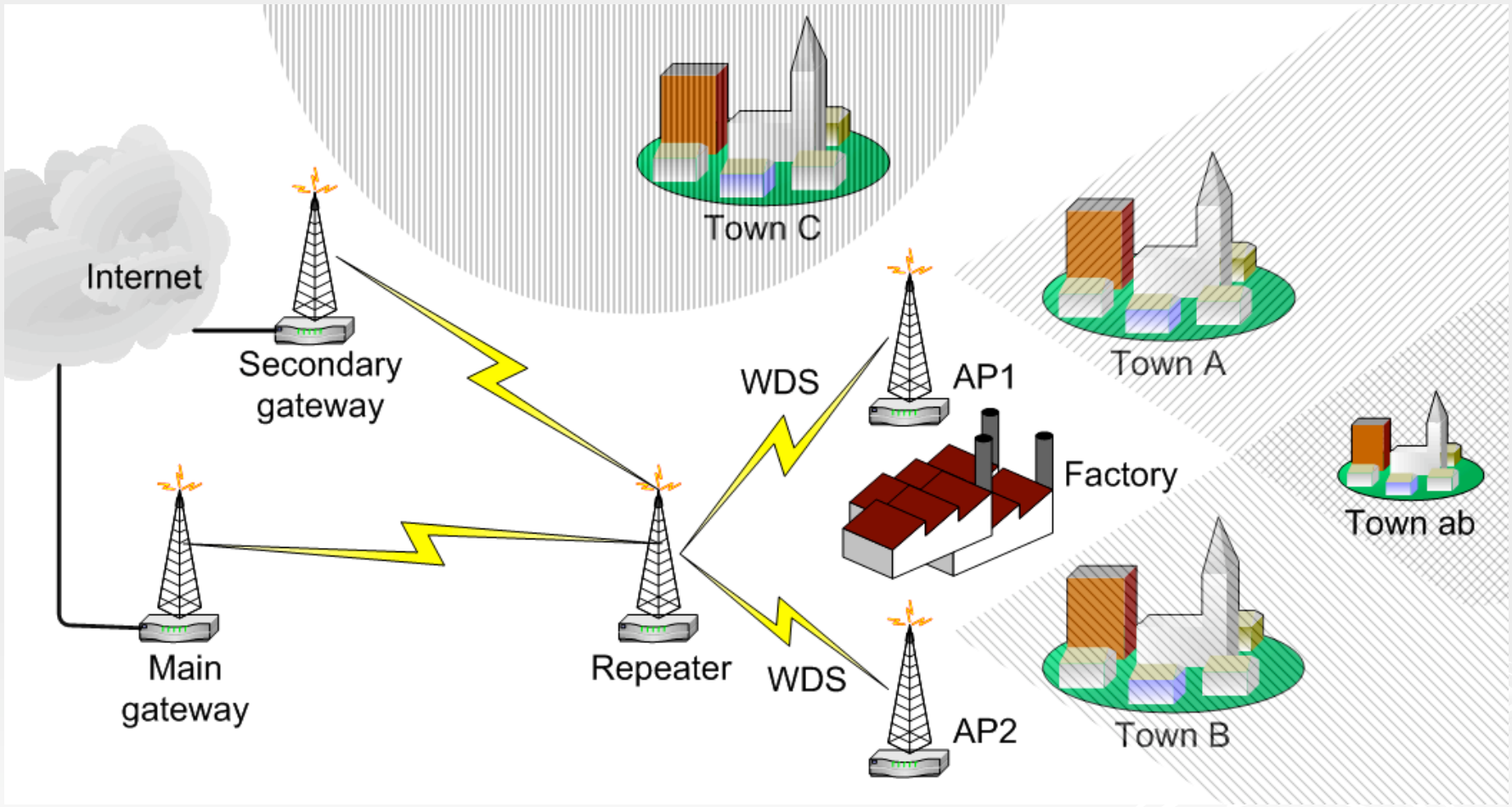
Sunday A Folayan

Bamidele R Amire

General Data Engineering Services [SKANNET]

Ibadan, Nigeria

Typical Wireless Network



Outline of Presentation

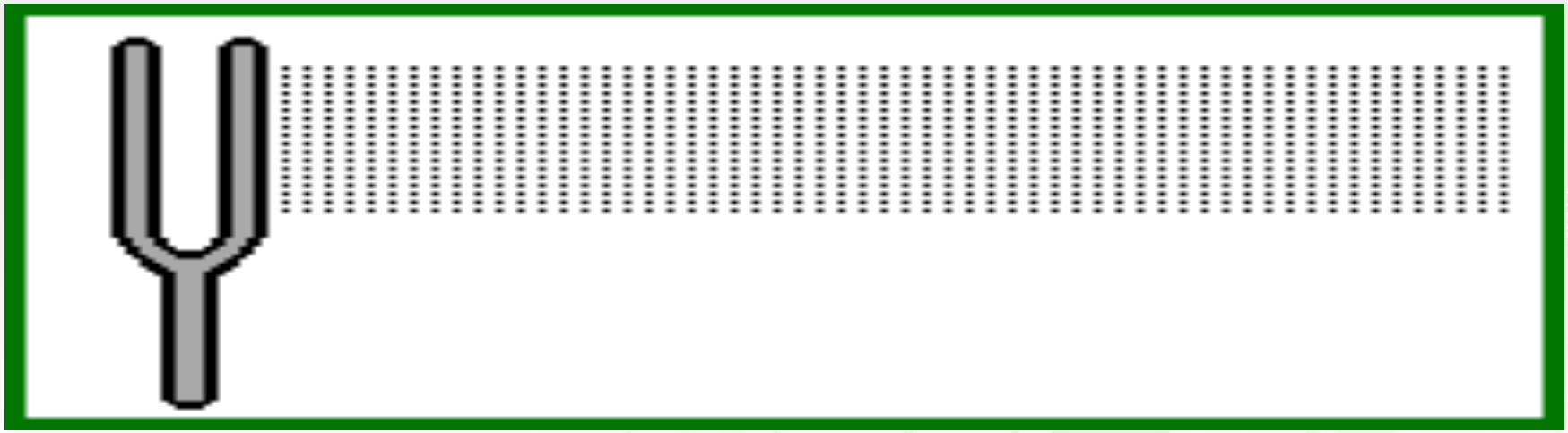
- Wireless Networking Terminologies
- Wireless Path
  - Transceivers
  - Connectors
  - Cables
  - Antennas
  - Free Space
- Link Budget Calculation
- Questions and Answers

Wireless Networking Terminologies

Energy

- Electrical Energy
- Sound Energy
- Magnetic Energy
- Light Energy

Radio signals are magnetic waves, and have similar characteristics to Light Energy



Frequency

- The rate of pulses in a Magnetic Wave is called the Frequency.
- The higher the Frequency, the more difficult it is to propagate the signal.
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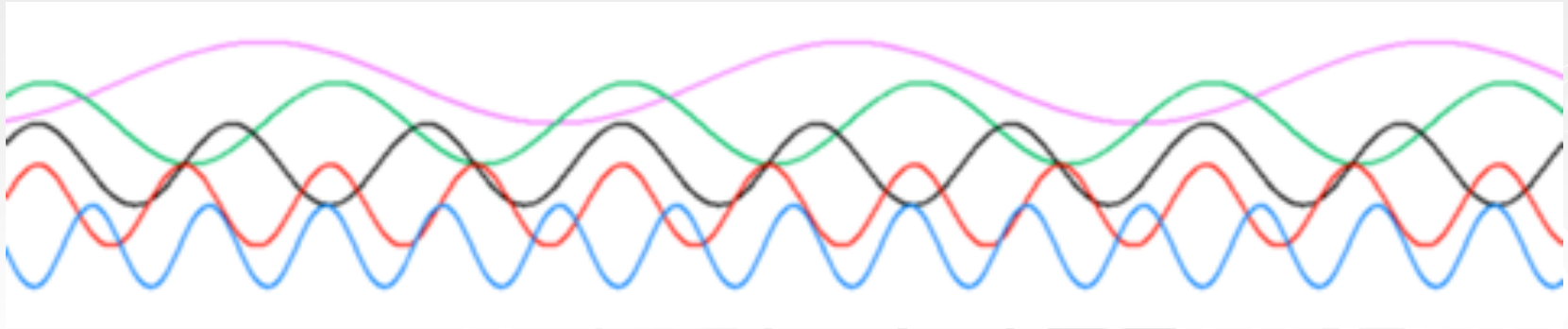
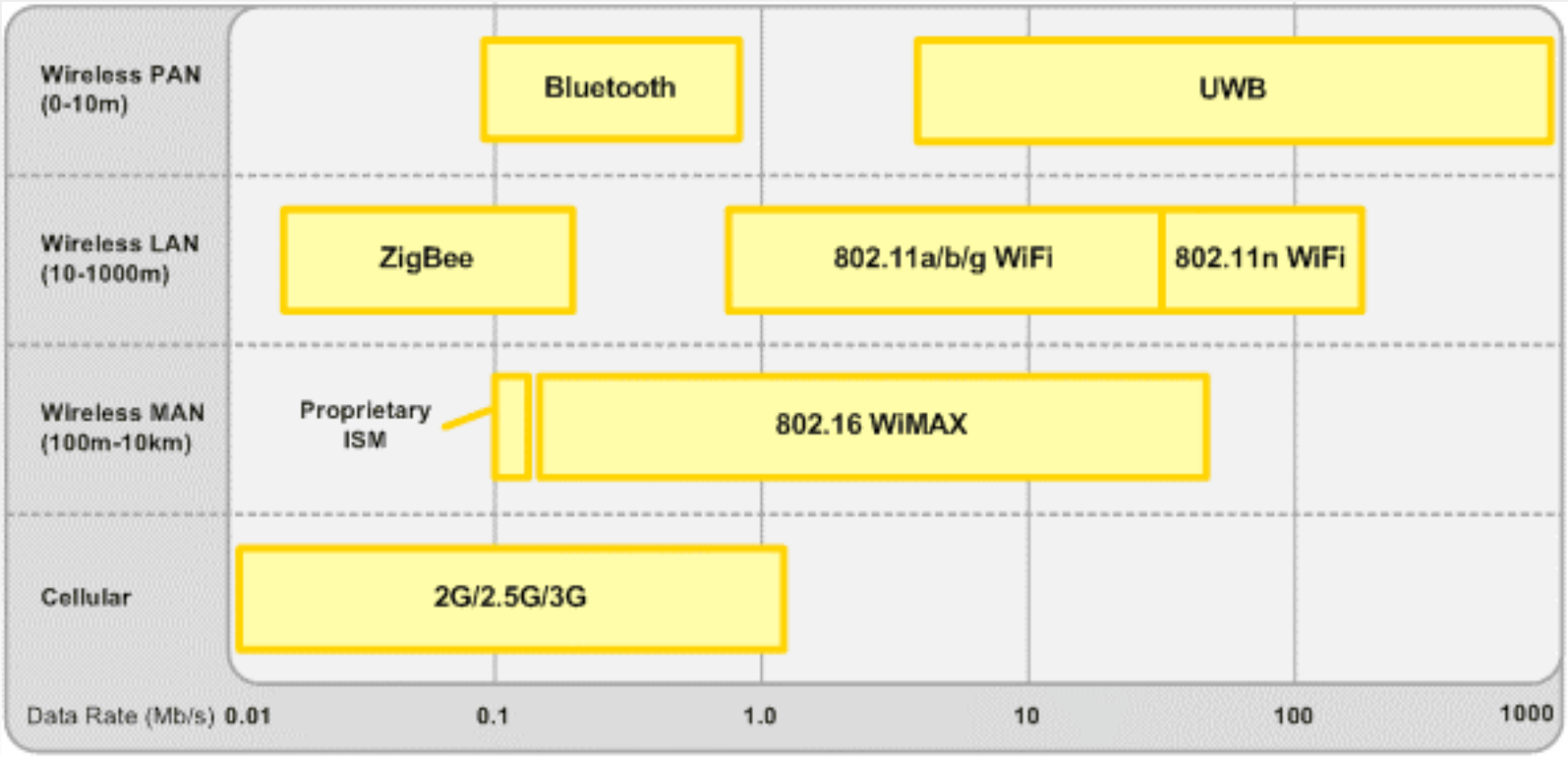
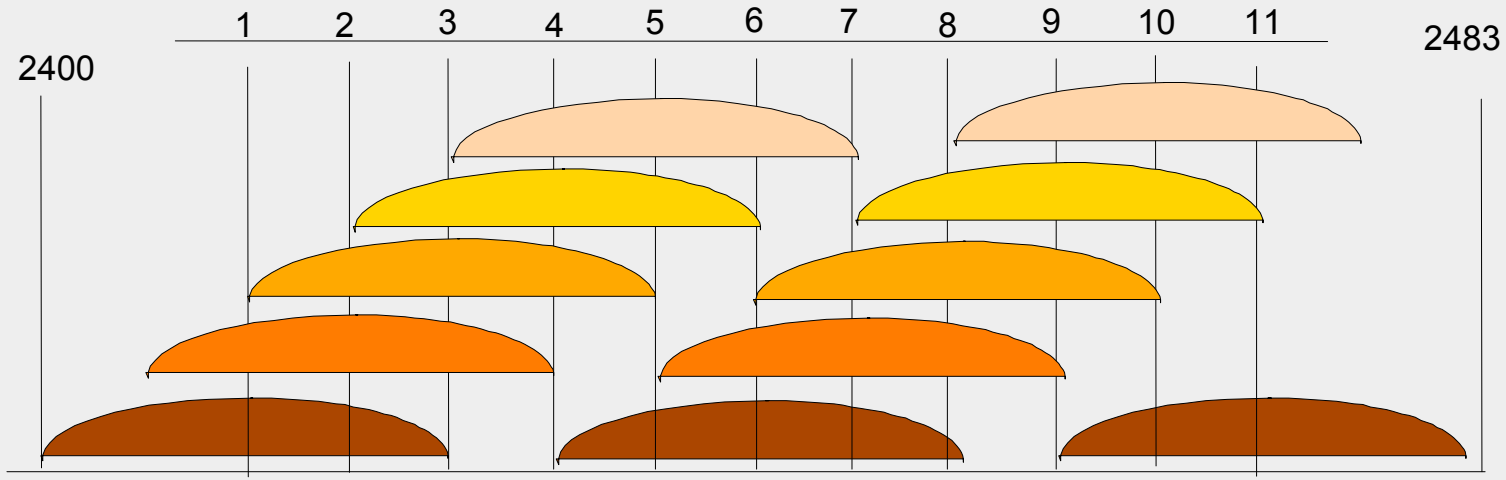


Wireless Technologies

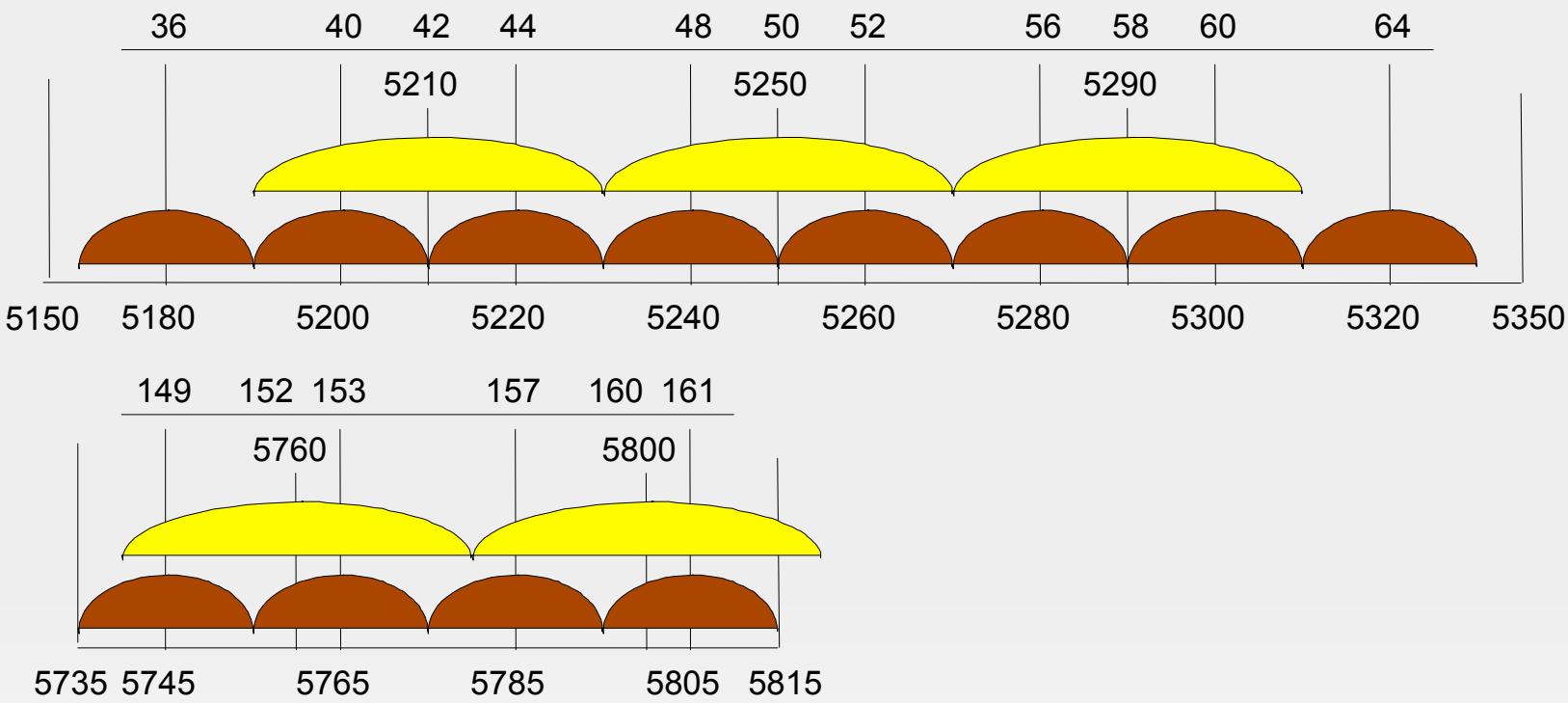


Channels- 802.11b/g



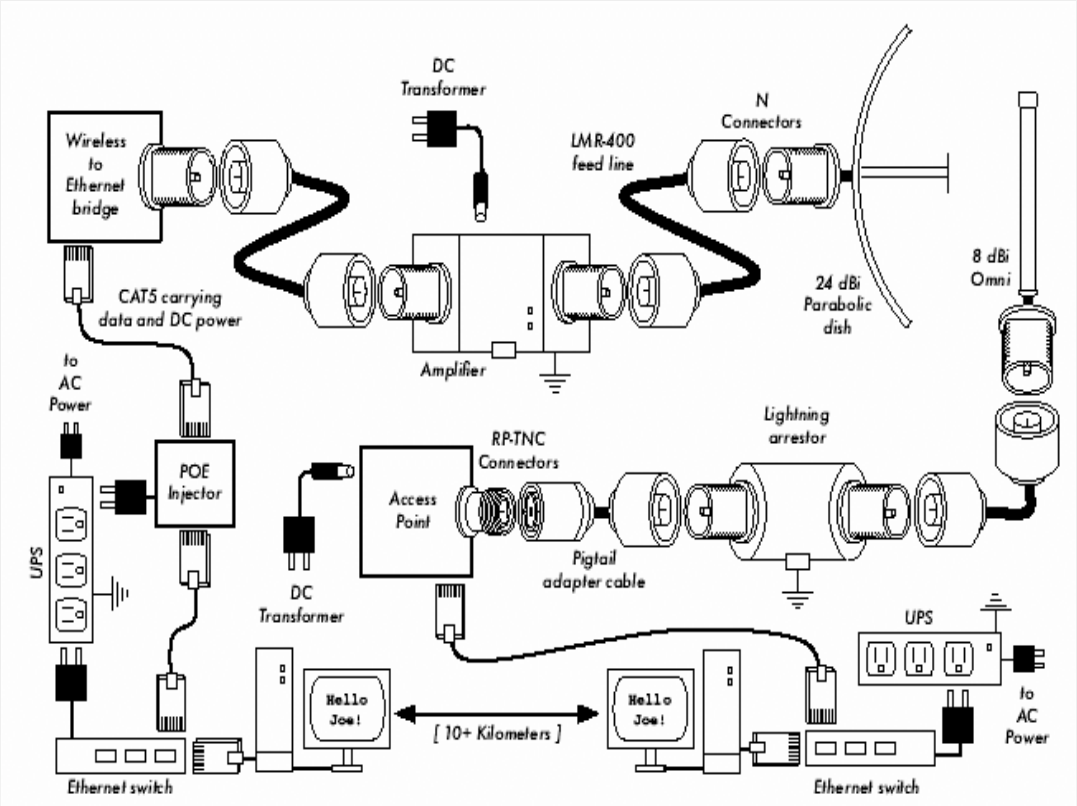
- 2412Mhz – 2484Mhz
- (14) different 22 MHz (b) wide channels (US)
- However, 3 non-overlapping (g) channels
- Only 3 Access Points can occupy the same area without interfering

Channels- 802.11a



- 5170Mhz – 5805Mhz
- (16) 20 MHz wide channels

Elements in a WiFi Network



The RF portion of the network is the most difficult to setup, operate and debug

Wireless Path

- Transceiver
- Antenna
- Cables
- Connectors
- Amplifiers (not recommended)

dBm vs Watts

Power is measured either in Watts or Decibels and can be freely converted between these two measures

MilliWatts is written mW

$dBm = 10 \log_{10} mW$

0dBm = 1mW

$Watts = 10^{((dBm - 30)/10)}$

$mW = 10^{(dBm/10)}$

Transceivers

- Basic Transceivers are based on either of
  - Prism Chipsets
  - Atheros Chipsets
- Chipset power may vary from 30mW to 200mW depending on the manufacturer, and regulation available within the country of use. Consult your regulation before deployment

Antenna Types

Antenna type and directivity

- The ability of an antenna to focus energy in a particular direction when transmitting, or to receive energy from a particular direction when receiving is called directivity.

Two broad classifications

- Omni directional – Radiates in all directions
- Unidirectional – Radiates in a particular direction

Antenna Gain

- . the amount of energy radiated in a direction compared to the energy a standard reference antenna would radiate in the same direction when driven with the same input power.
- It is measured in dBi for standard Isotropic antenna and
- measured in dBd when compared with standard dipole antenna

Antenna polarization

The orientation of the electric field of an electromagnetic wave.

TYPES

Linear polarized: stays on a plane

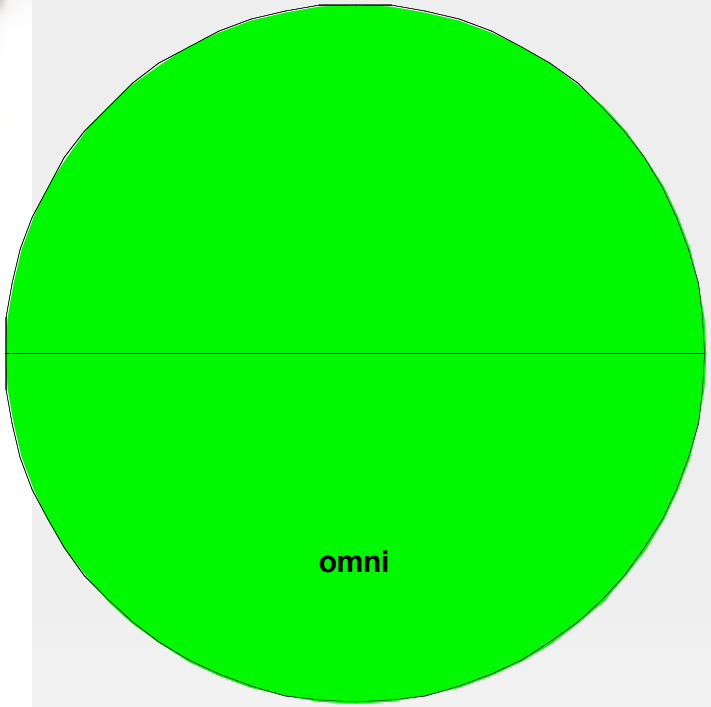
- Vertical
- Horizontal

Circular polarized: the electric field vector appears to be rotating with circular motion about the direction of propagation, making one full turn for each RF cycle. This rotation may be right-hand-or left-hand.

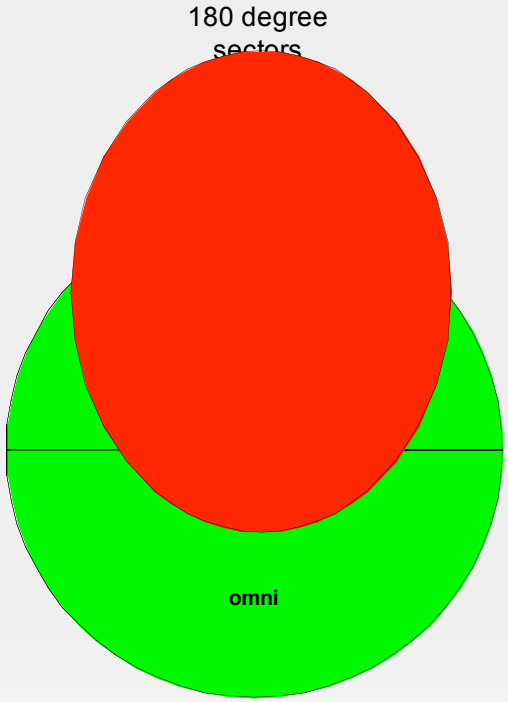
Choosing an Antenna

- Need to consider the optimal Gain
- Higher gain is more difficult to install
- Consider the Target coverage
- Consider the range to cover
- Choose Desired Polarization (horizontal preferred because it is free from most forms of interference)

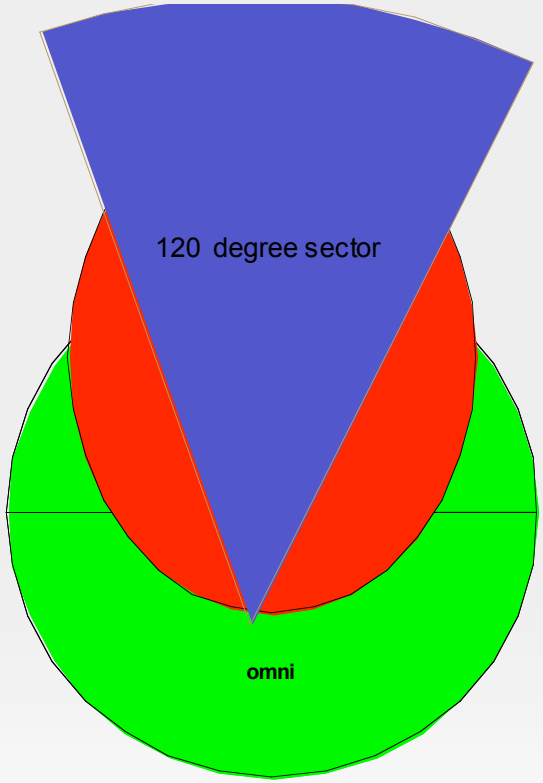
Omni directional



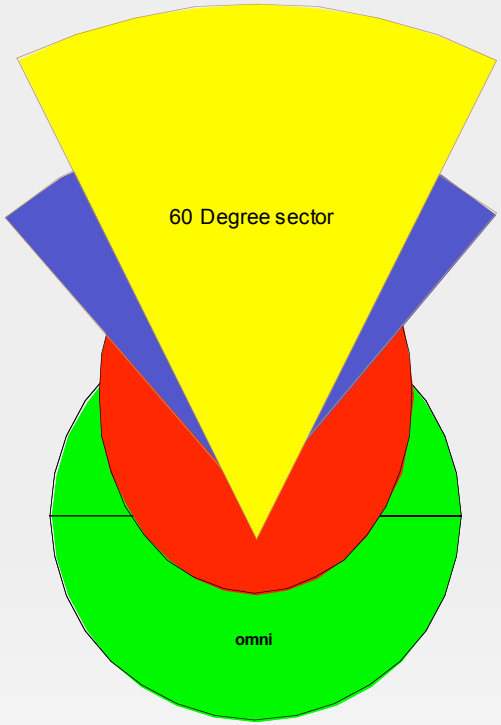
180 degree sector



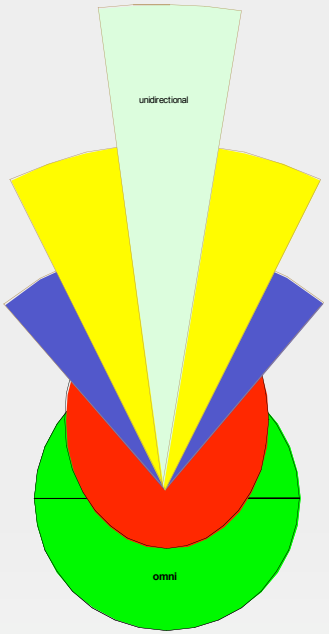
120 Degree sector



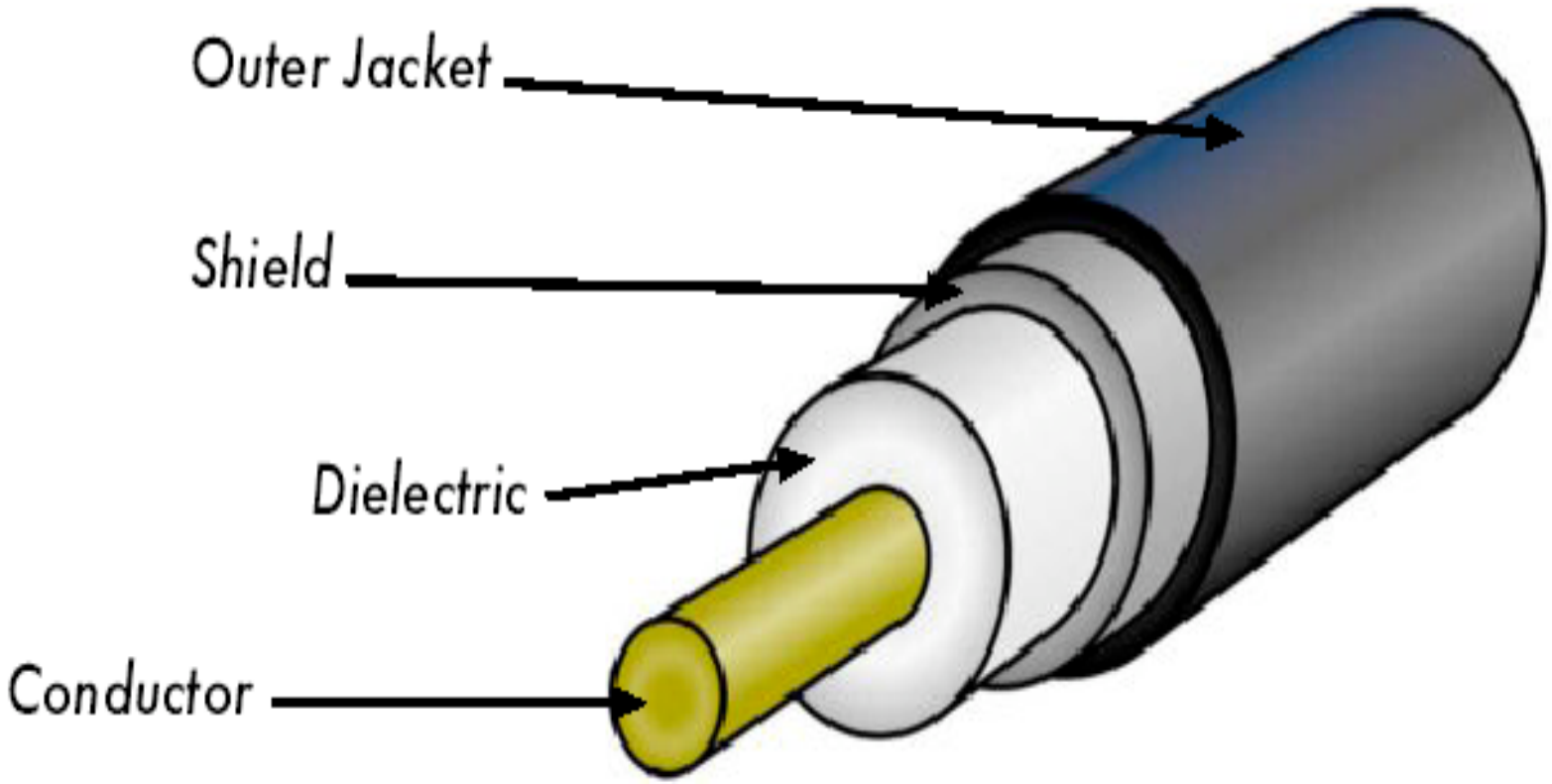
60 DEGREE SECTOR



Unidirectional antenna



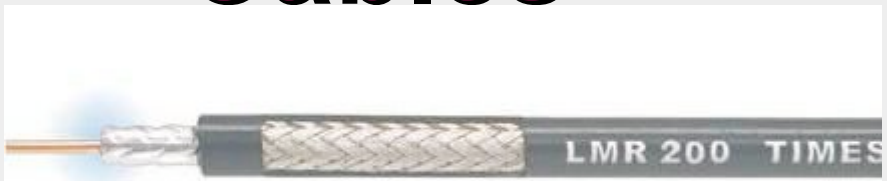
CABLES



Coaxial cable with jacket, shield, dielectric, and core conductor e conductor.

Cables

LMR200



LMR400

LMR600

CABLE : Selection and Handling

- The larger the central conductor, the better signal will flow (skin effect).
- The shorter the cable, the better
- The cheaper the cable, the worse off
- Always avoid RG58- It is good for ethernet, VHF radio, but not microwave
- LMR400, LMR600 or Heliax Cable
- Crimp cables properly with the right tools
- Avoid over twisting the cable

Connectors

- BNC

- TNC / RP-TNC

- N Type (Male/Female)

Connectors

- SMA Connector

Choice of connector

- Avoid the use of adaptors
- The less the number of connectors, the better.
- Do not use BNC for 2.4GHz or 5.8Ghz
- Handle with care
- Impedance must be same with that of cable and antenna for best performance (often 50 Ohms)
-

Pigtails

- A pigtail will usually have one of the regular connectors discussed in the previous slides at one end, and any of the following connectors at the other end
  - MCX
  - U.FL
  - MMCX

Connector Loss

- Each connector used in a wireless link, introduces a loss of 0.2dBm.

Why Amplifiers are not recommended:

Whereas they extend the range of the transmitted signal, Using Amplifiers has the following drawbacks

- They are expensive
- They are needed on both TX side and RX side for effectiveness
- Amplifies both desired signal and noise and hence most times increases interference
- Generates Interference for other users of the same band
- Reduces aggregate bandwidth available on the network
- Maximum power regulation in various countries.

Link Budget Calculation

Link Budget is a means of estimating the usability/Reach of a wireless network, considering the different parts of the Network.

- Items that enhance the signal power (Gain) have a positive value
- Items that reduce the signal power (Loss) have a negative value

Power Gain/Loss

Gain

- Transceiver
- Antenna
- Amplifiers

Loss

- Connectors
- Cables
- Free Space

Note that Items should be computed twice, if they are repeated in the network. For example, there will be two (2) Antennas in a typical path

Sample Losses

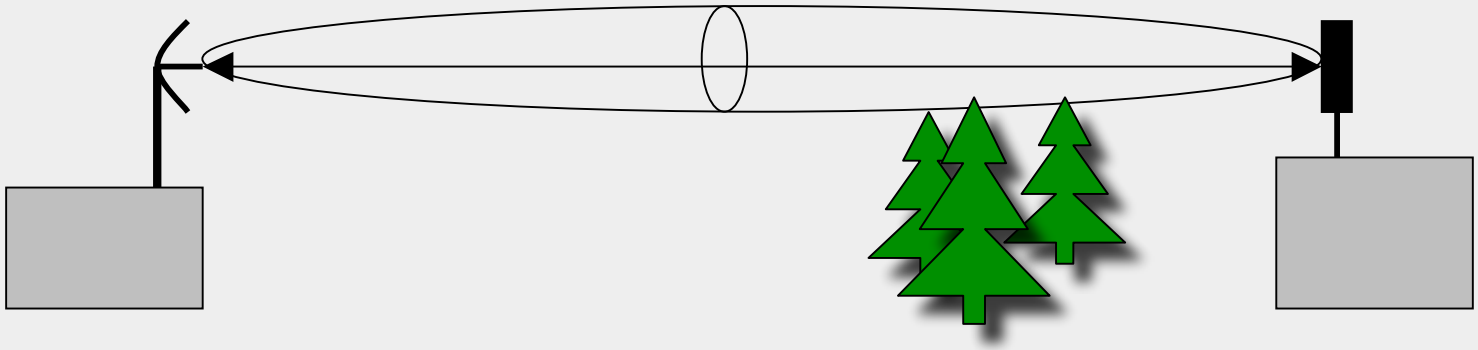
- Connectors – 0.2dBm each
- LMR400 – 0.204dBm per Meter
- Free Space Loss is a function of:
  - Frequency of Operation
  - Distance between AP and Client

Free Space Loss

- Free Space Loss (FSL) is computed using the following formula

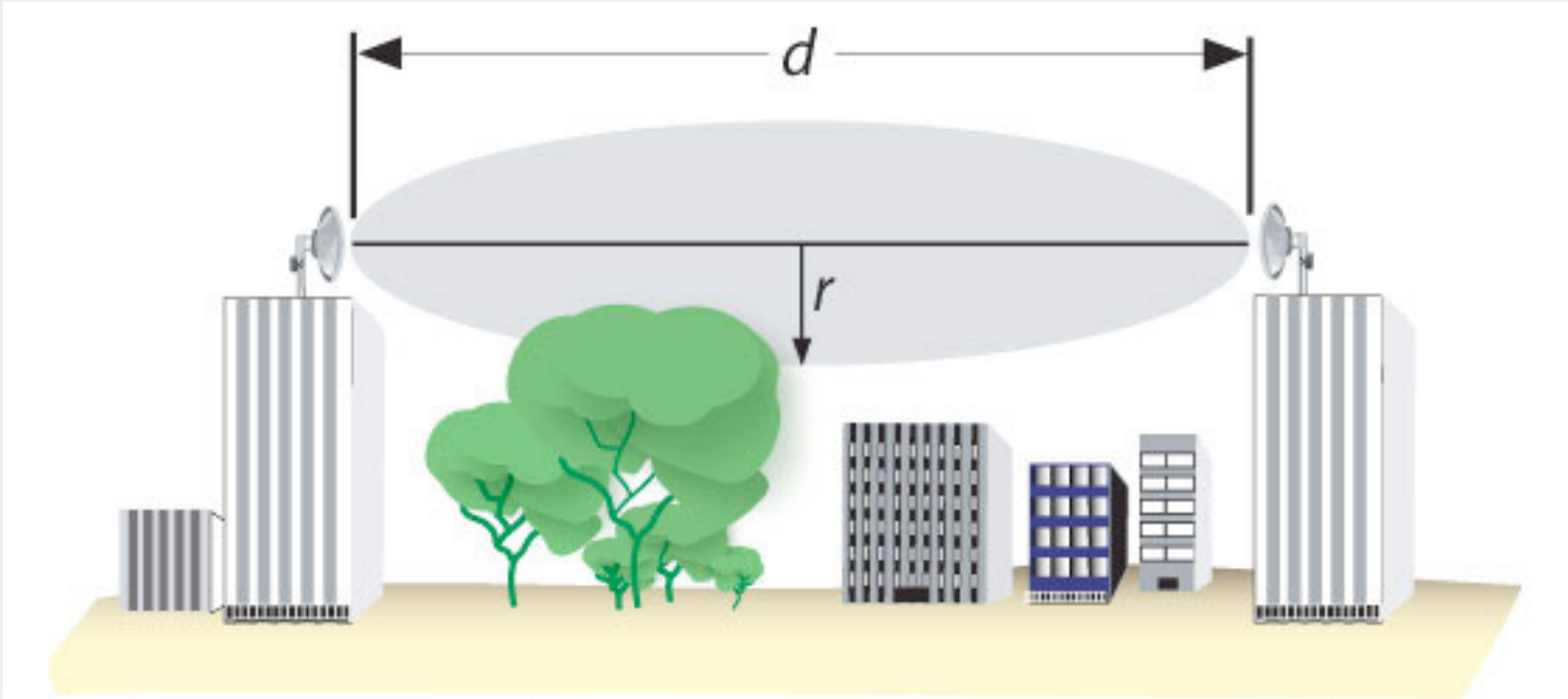
FSL = 20 * Log (Freq) + 20 * log (D/1600) + 36.6

Fresnel Zone



- Fresnel Zone is the area around the line of sight that radio waves spread out.
- This area must be clear of obstacles. Otherwise the signal strength is going to be weakened.

Fresnel Zone



$$r_{(\text{in mts})} = 17.32 \times \sqrt{\frac{d_{(\text{in Km})}}{4f_{(\text{in GHz})}}} \qquad r_{(\text{in ft})} = 72.05 \times \sqrt{\frac{d_{(\text{in miles})}}{4f_{(\text{in GHz})}}}$$

Class Exercise

- Link Budget Calculation Spreadsheet

Some important considerations

- As much as possible
  - Avoid Amplification. It reduces throughput
  - If it must be a large distance, use an antenna with the least Signal Beam width
  - Route in your wireless Infrastructure, do not bridge
  - Use Access points capable of Authorization, Authentication and Accounting, such as the Mikrotik Routerboards
  - Firewall/Filter at the Access Point to limit the saturation on the backhaul
  - Use a dynamic routing protocol, for networks with more than 4 Access points
  - Consider a topology with redundancy built in

Questions (?)

References

- Wireless Networking in Developing World http://wndw.net
- Mikrotik Wireless Networking http://www.mikrotik.com
- How WiFi works http://electronics.howstuffworks.com/municipal-wifi.htm
- How WiMax Works http://computer.howstuffworks.com/wimax.htm