Basic Wireless Infrastructure and Topologies

Developed by Sebastian Buettrich

## and Alberto Escudero Pascual

Goals

- To be aware of the most common wireless topologies

- To be able to identify and plan suitable topologies for real scenarios

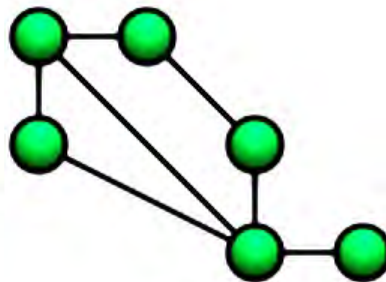- To give a brief introduction to practical setup

Table of Contents

- Basic Network Topologies

- Topologies in wireless networking

- Wireless Components (AP, clients)

- Wireless Modes (ad hoc, infrastructure)

- Practical cases (incl. setup)
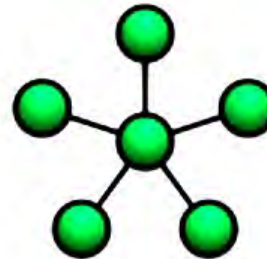
  – Ad hoc, Star, PtP, Repeating and Mesh

- Real life examples
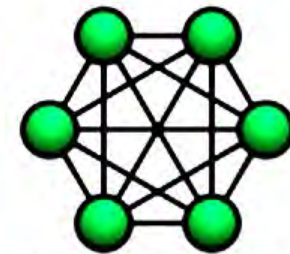
Basic Network Topologies
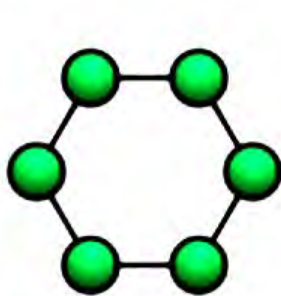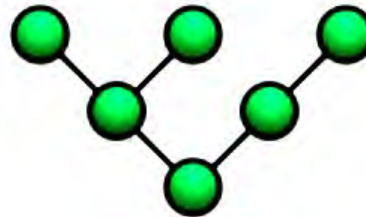
Ring

Mesh (partial)
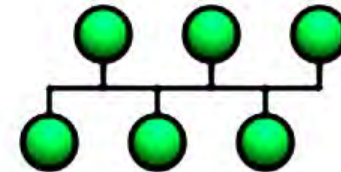
Star

Mesh Fully Connected

Line

Tree

Bus

Topologies Relevant for Wireless Networking

- Star   Yes, standard wireless topology

- Tree   Yes (a combination of star and line)

- Line   Yes, with two or more elements (PtP)

- Mesh   Yes, mainly partial mesh

- Ring   Possible, but rarely found

- Bus   Not applicable. Why?

Some General Remarks

- Wireless communication needs no medium

    - EM waves travel through "nothing"

    - The "line" in a network diagram is the connection that is being made

- Wireless communication is always 2-way

    - Except for passive sniffing

    - Applies to transmitters/receivers, clients/masters

Wireless Components

- Access Point

  - Wireless transmitter/receiver that bridges between wireless nodes and a wired network

  - IEEE 802.11 + Wired Ethernet connection

- Wireless clients

  - Any computer with a wireless network adapter card that transmits and receives RF signals

  - Laptop, PDA, surveillance equipment, VoIP phone

Two Basic Wireless Modes

1. Ad Hoc (IBSS)

2. Infrastructure (BSS)

Mode 1: Ad hoc (Peer-to-peer)

- Independent Basic Service Set (IBSS)

- No need of central access point

- All nodes need to use the same SSID and channel

- Not scalable

Mode 2: Infrastructure

- Extended Service Set (ESS)

- Central access point is needed

- "Connects" a WLAN to an Ethernet network

- Clients and AP's must use the same SSID

- Channel is set in AP and discovered by clients

- Scalable

Remarks about Wireless Modes

- In both modes, the SSID identifies the network

- Consider the SSID as the "label" of a Ethernet jack on the wall

- Modes (modes of operation) can be hidden and not noticeable in a topology

    – ex: A PtP link can be *ad hoc* or *infrastructure*

Ad hoc case 1: Point-to-point

- Connecting two wireless clients directly

- Building to building (when one has Internet connection and the other one does not)

- Inside an office

Ad hoc Case 1: Point-to-point

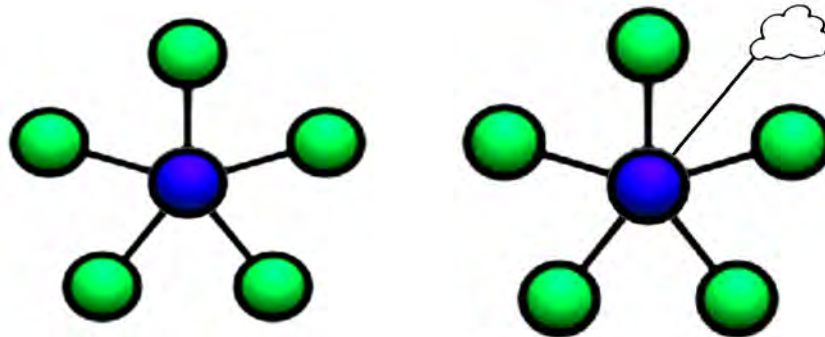| Setting	Node 1	Node 2
Mode	ad hoc	ad hoc
SSID	MY_SSID	MY_SSID
Channel	Need to agree and know each others	Need to agree and know each others
IP address	Typically fixed	Typically fixed

Infrastructure Case 1: Star

- Hotspots, Telecenters, Offices and WISP's

- Point to Multi-point

- The most common infrastructure in wireless networking
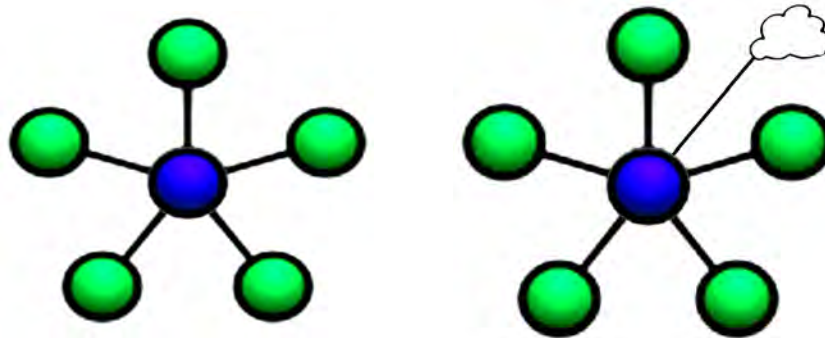
Infrastructure Case 1: Star

Setting	AP/Gateway	Node x
Mode	Infrastructure	Infrastructure
SSID	Sets MY_SSID	Connects to MY_SSID
Channel	Sets channel x	Discovers channel from AP
IP address	Typically runs DHCP server	Typically gets IP via DHCP lease

Infrastructure Case 2: Point to Point

- Standard element of wireless infrastructure

- A PtP link may be part of

 - a star, a tree, a two point line or other topology

Infrastructure Case 2: Point to Point

| Setting	Node 1	Node 2
Mode	Any	Any
SSID	MY_SSID	MY_SSID
Channel	Set the Channel	Discovers the channel
IP address	Typically fixed	Typically fixed
MAC address	Might be fixed to one another's MAC	Might be fixed to one another's MAC

Infrastructure Case 3: Repeating

- Necessary when direct line of sight (LOS) is obstructed
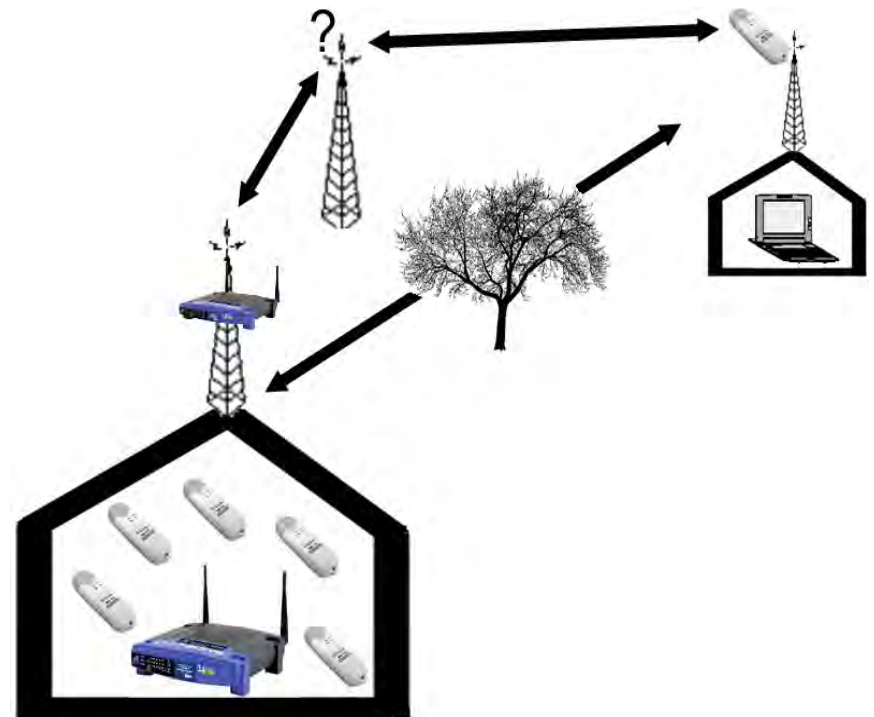
Infrastructure case 3: Repeating

• The repeating unit consist of

    • One or two physical devices

    • Two radios or one radio and "isolated antennas"

• Can be seen as a "receiving client and a re-transmitting access point"
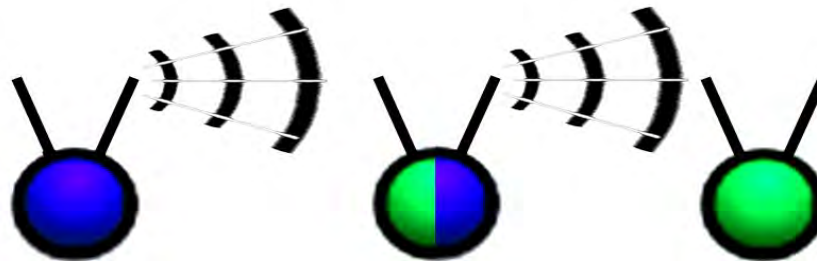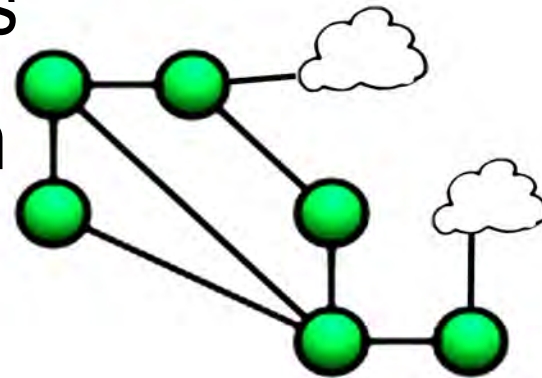
Infrastructure Case 4: Mesh

- Mesh topologies are an interesting option mainly in
  - dynamic environments (urban areas)
  - where central infrastructure is hard to implement
  - when redundancy is desired
- Typical cases are: municipal networks, campus networks and neighborhood communities

Infrastructure Case 4: Mesh

- Full mesh topology (each node is direct connected to all other nodes)

- Partial mesh topology (each node is direct connected to some but not all nodes)

- Nothing is necessarily dynamic in a mesh

- Used as synonym for "ad hoc" or "mobile" network

Infrastructure case 4: Mesh

- All mesh nodes need to run the same mesh routing protocol

- The nodes can be of different operating systems and hardware types if they comply with the mesh protocol specification

Infrastructure Case 4: Mesh

| Setting	Node x1	Node x2
Mode	ad hoc	ad hoc
SSID	MY_SSID	MY_SSID
Channel	Channel x	Channel x
IP address	Typically static and manually set	Typically static and manually set
MAC address	Might be fixed to one another's MAC	Might be fixed to one another's MAC
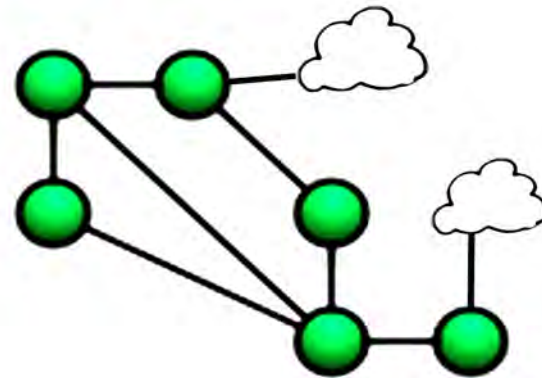
Real Life Examples of Wireless Infrastructure

- Real life wireless networks are very often combinations of more than one topology

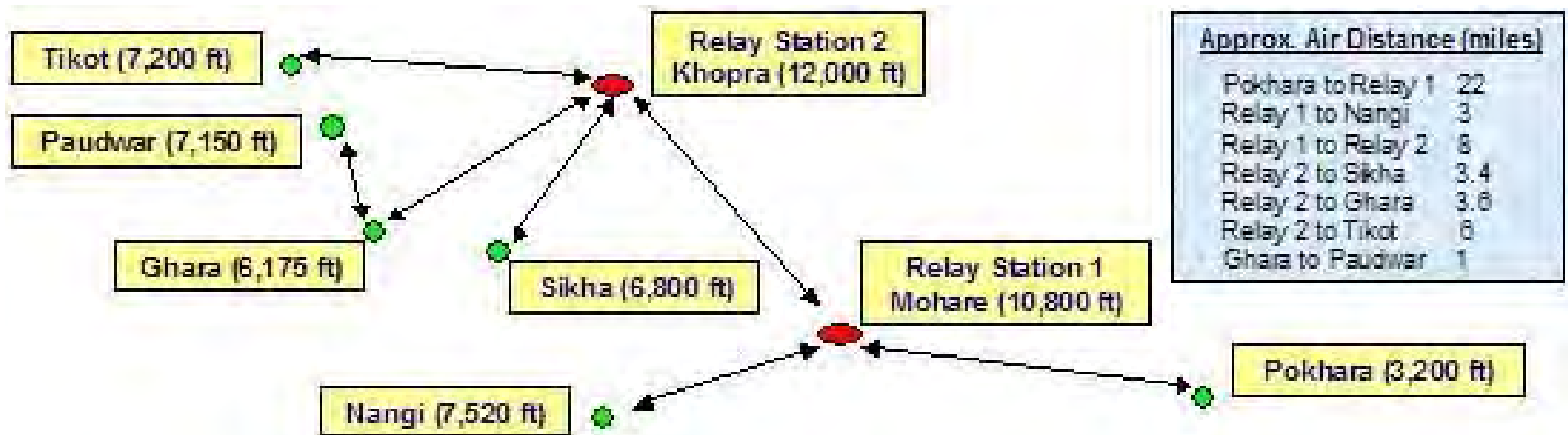- Graphical representations are totally arbitrary and different from one another

Typical office network
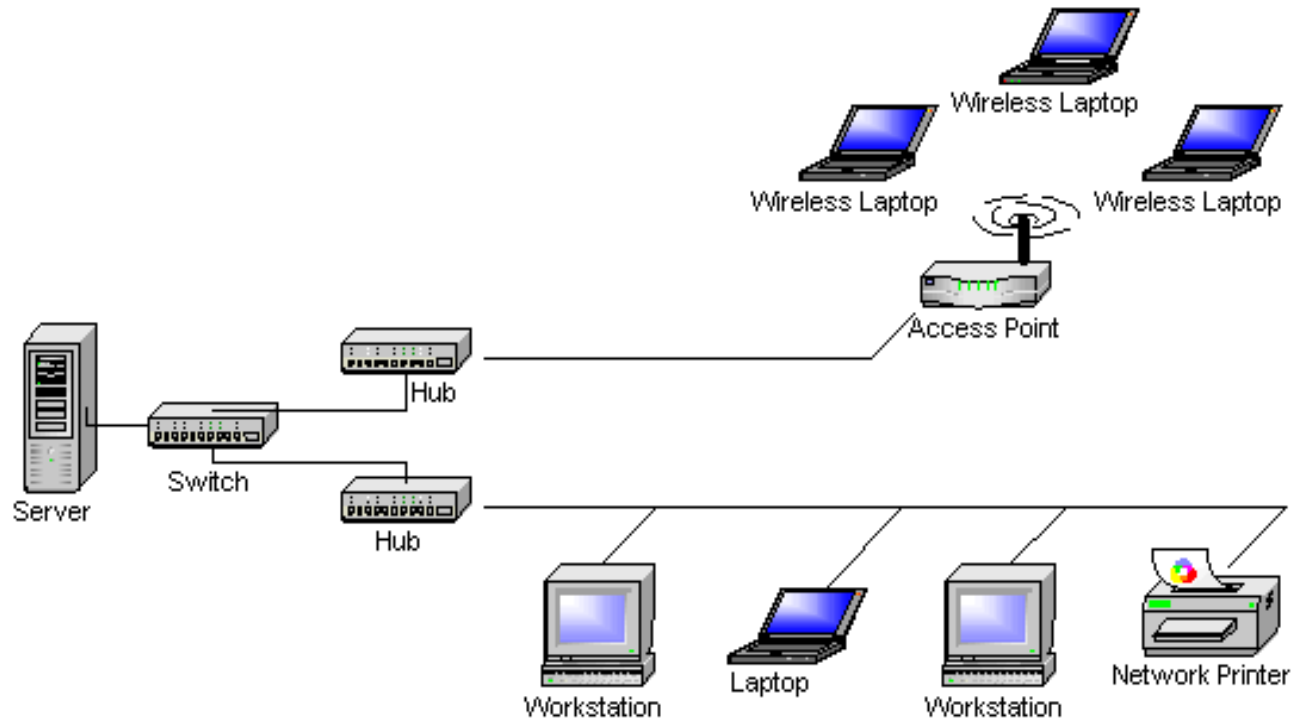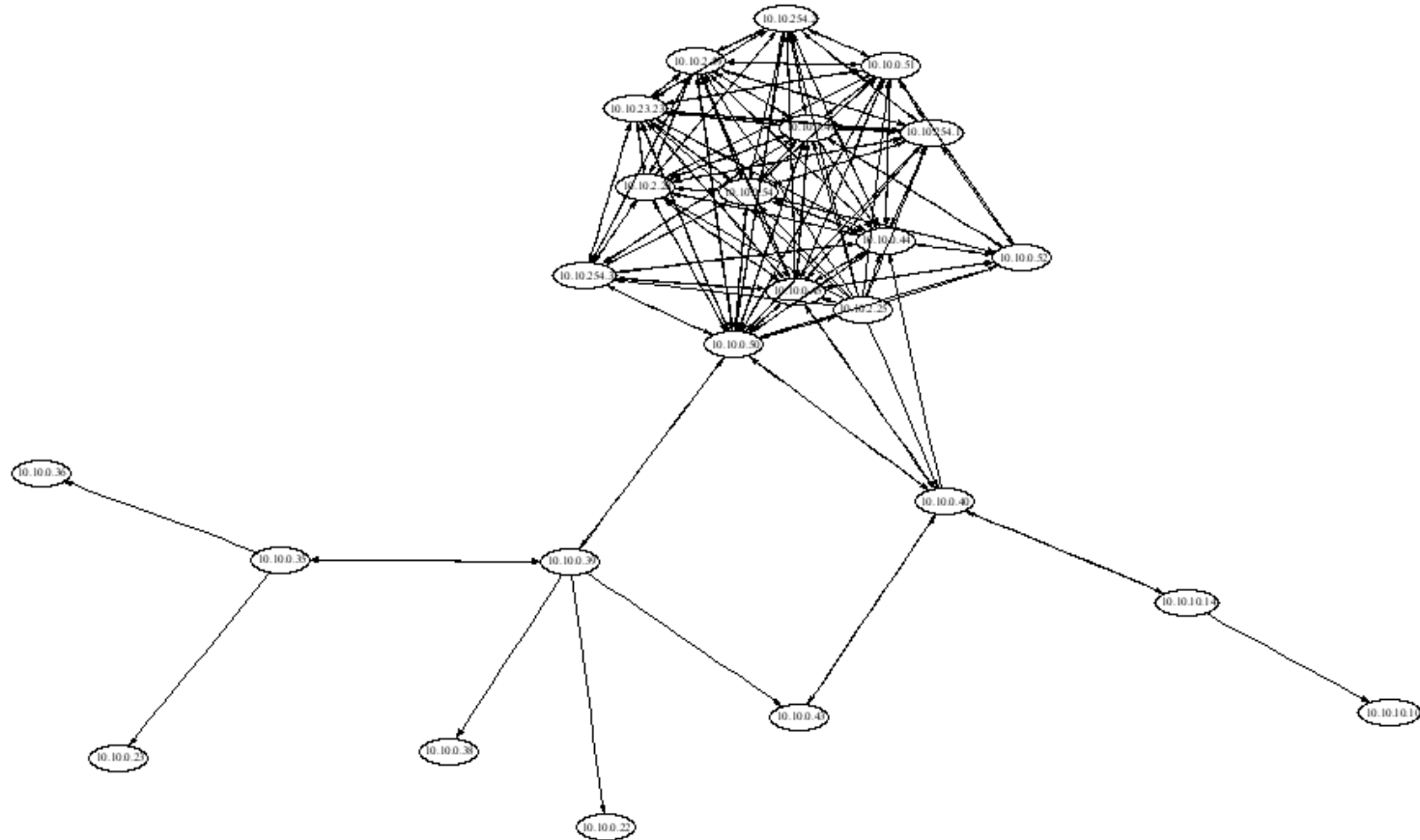
Wide-area Wireless backbone

Example backbone topology
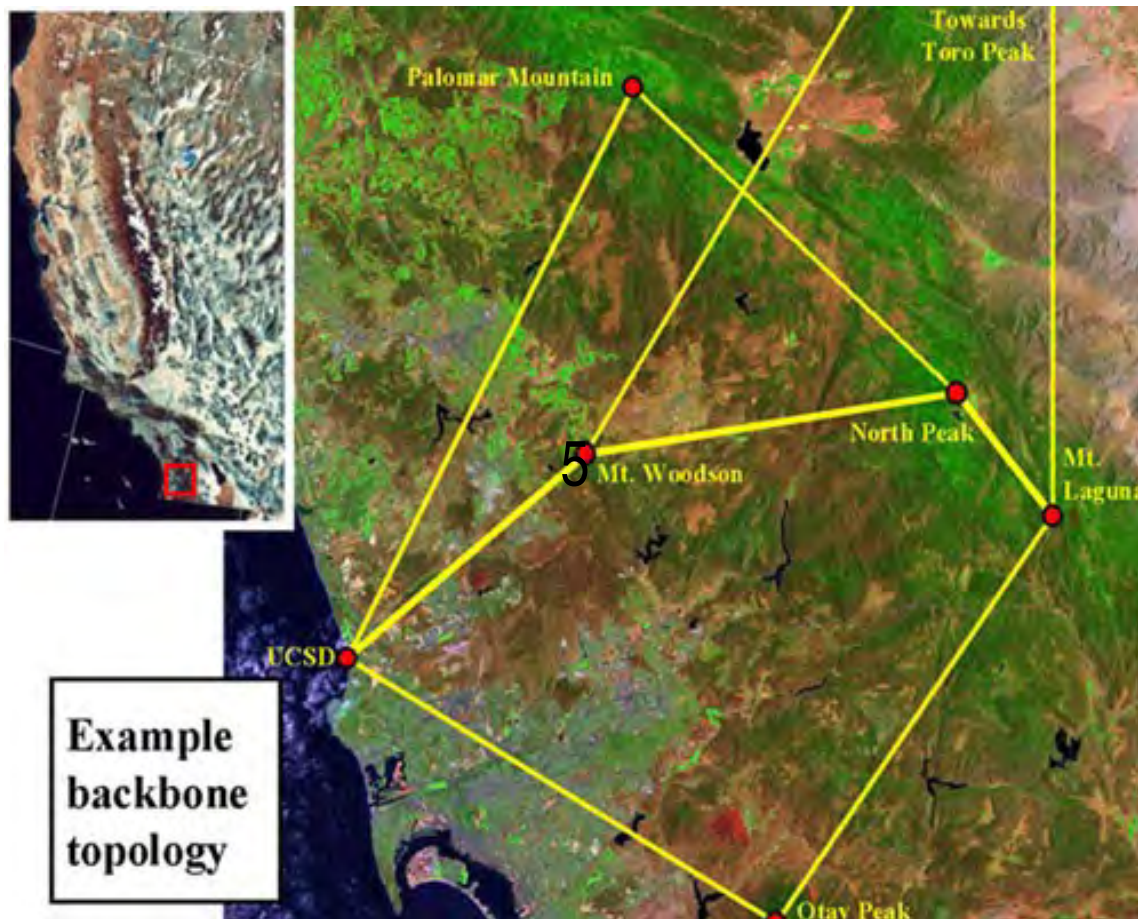
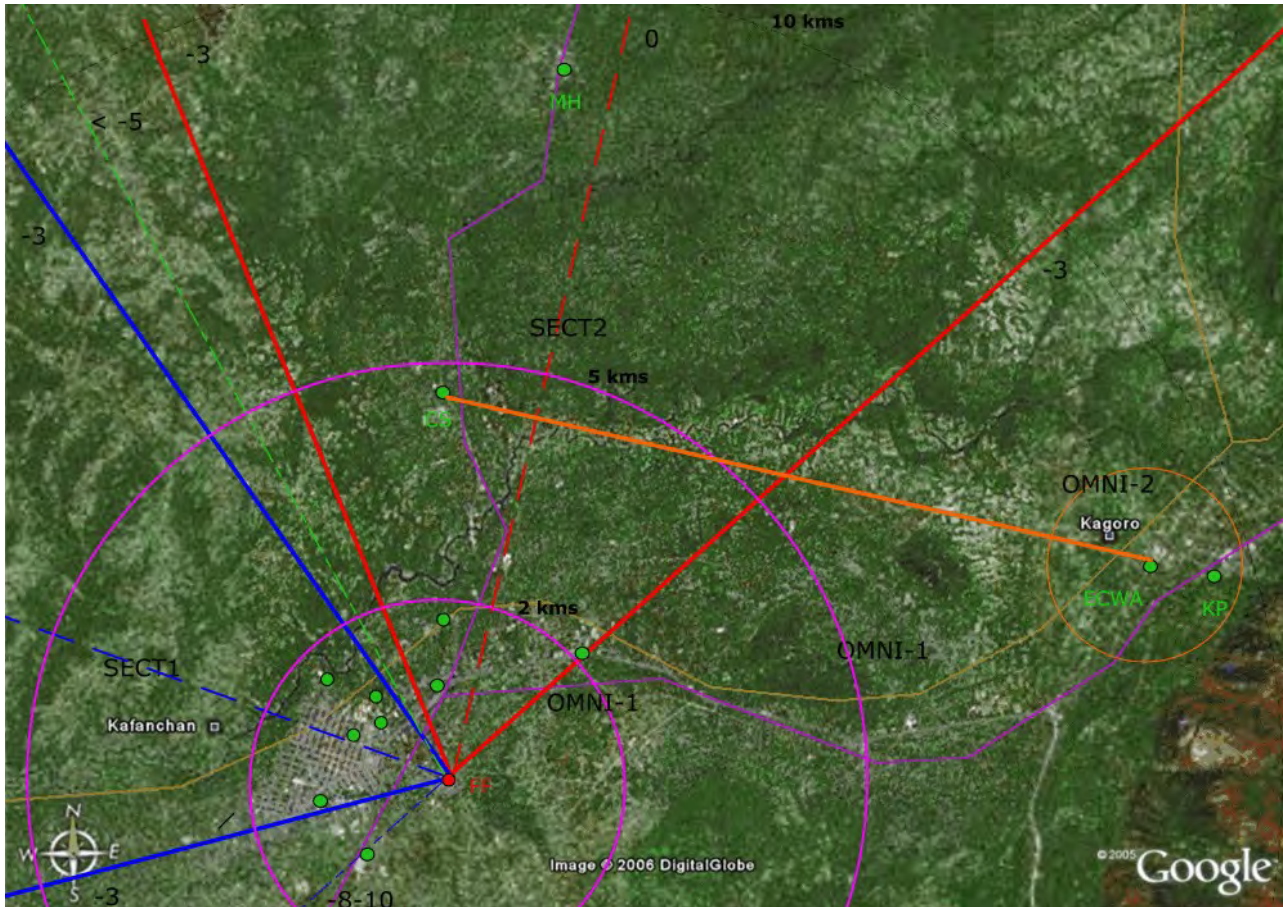# Nepalwireless.net Backbone Topology

Mesh Network (OLSR)
Berlin Wizards of OS 2004

Wireless Backbone, rural Nigeria

Conclusions

- Most wireless implementations are based on

  – Star, tree or line topology

- In implementations we can find two modes:

  – Ad hoc or infrastructure (more common)

- The basics of any setup includes:

  – Mode, SSID, Channel + MAC/auth + IP

- Many wireless implementations are based on more than one topology