

Basic IP for Radio Technicians

A Technician's Guide to the Technology



2010 APCO Summer
Training Conference
Wenatchee, WA

Goals for this class

- Provide basic introduction to IP networking
- Provide some hands on experience
- Provide tools for some basic troubleshooting and network information.

But I like dB's not IP's

- Analog seems to work ok.
- I control the radio network.
- The data network is always down.
- I don't have the right test equipment.
- Why can't I just keep things the same?
- I don't understand how the data stuff works.

Why change?

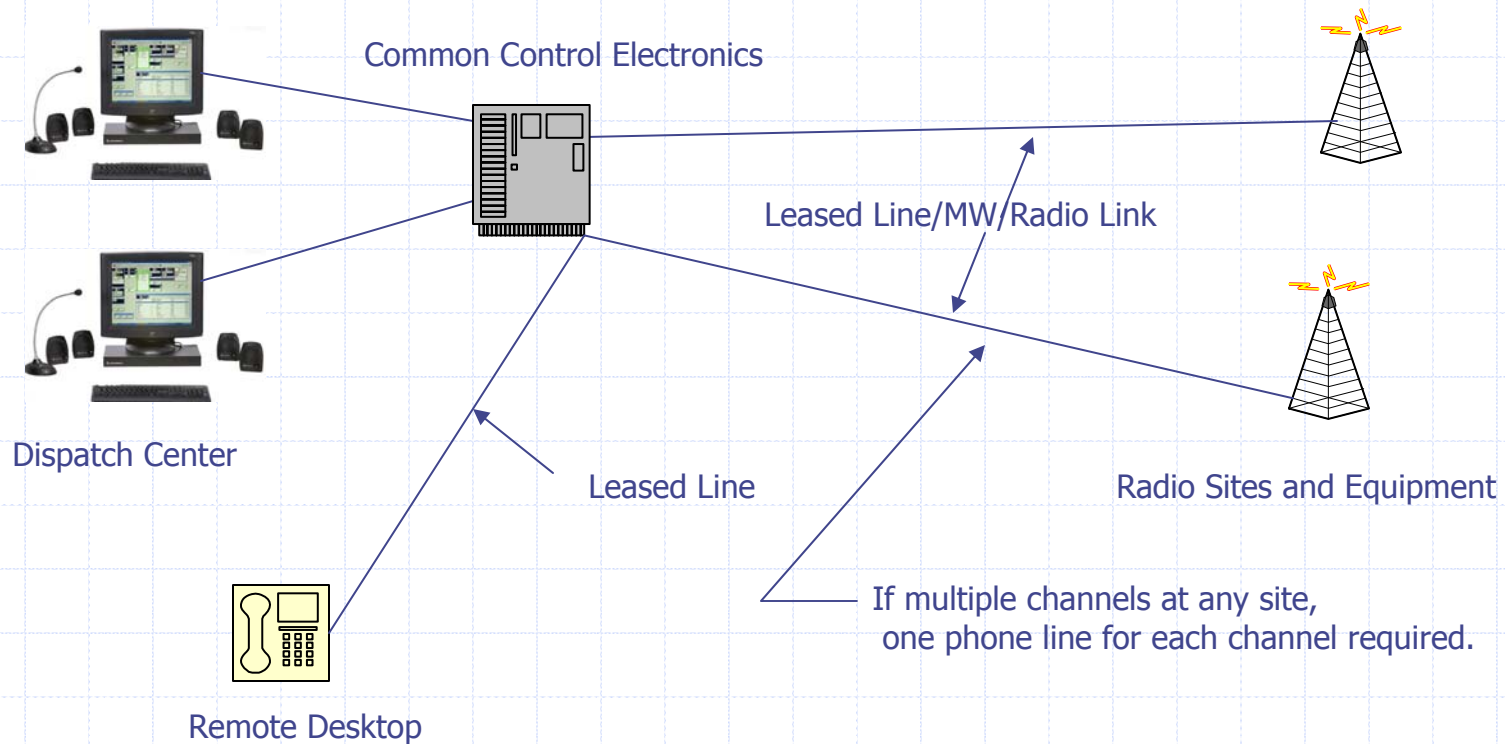
- Lots of good reason's to stay analog.
- All transport is migrating towards data.
 - Analog phone lines going away.
 - Data networks are everywhere.
 - Transport shared between voice and data.
- The world is computer centric.
- New products tend to be data oriented.

Where is it all going?

- Voice and data becoming one.
 - Transport is all data.
 - Analog voice only at the human interface.
 - Data and voice indistinguishable in the network.
- Digital interfaces are easy and cheap to design.
- Data networks require higher bandwidths for mixed traffic.
- When will this occur? Now for many modes of communications. In transition for public safety.

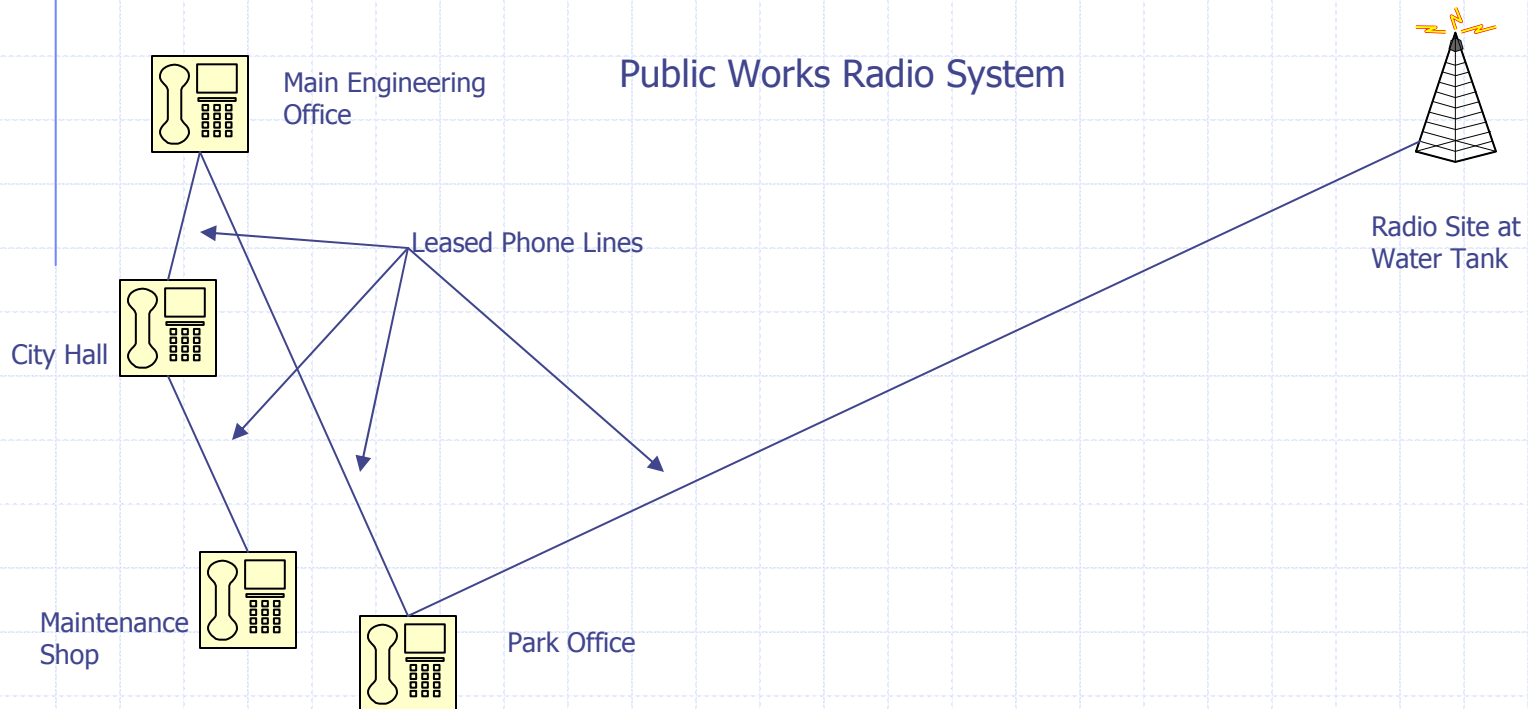
Why IP?

- Typical radio network today



Why IP?

- Analog connections today.

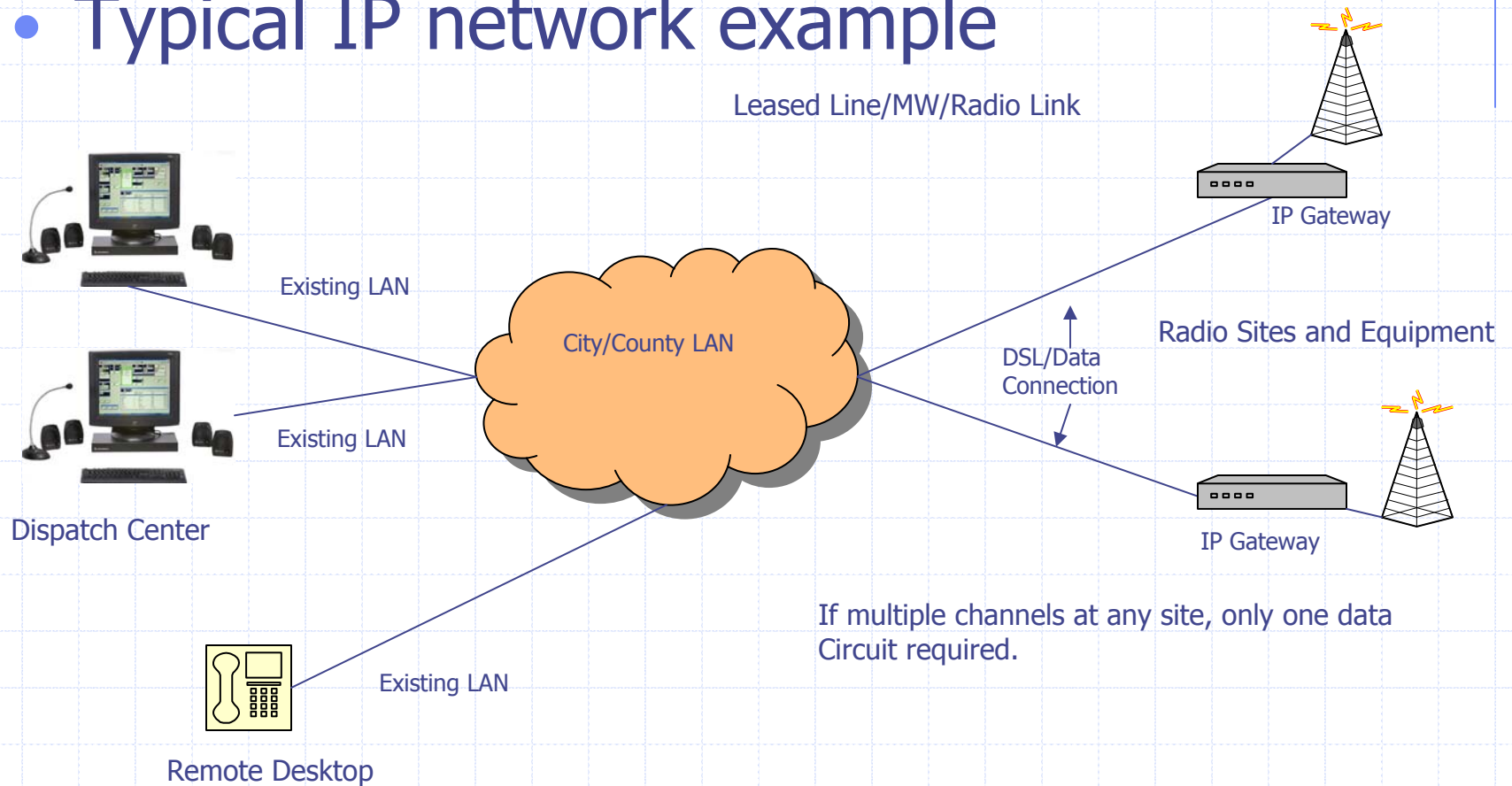


Why IP?

- What do those examples have in common?
 - Use of dedicated phone lines or other interconnection method for each site/channel
 - Use of dedicated phone lines to interconnect remote console positions
 - High on-going costs for dedicated facilities
 - Loss of one connection point could cause loss of communications
 - Dedicated facilities are expensive

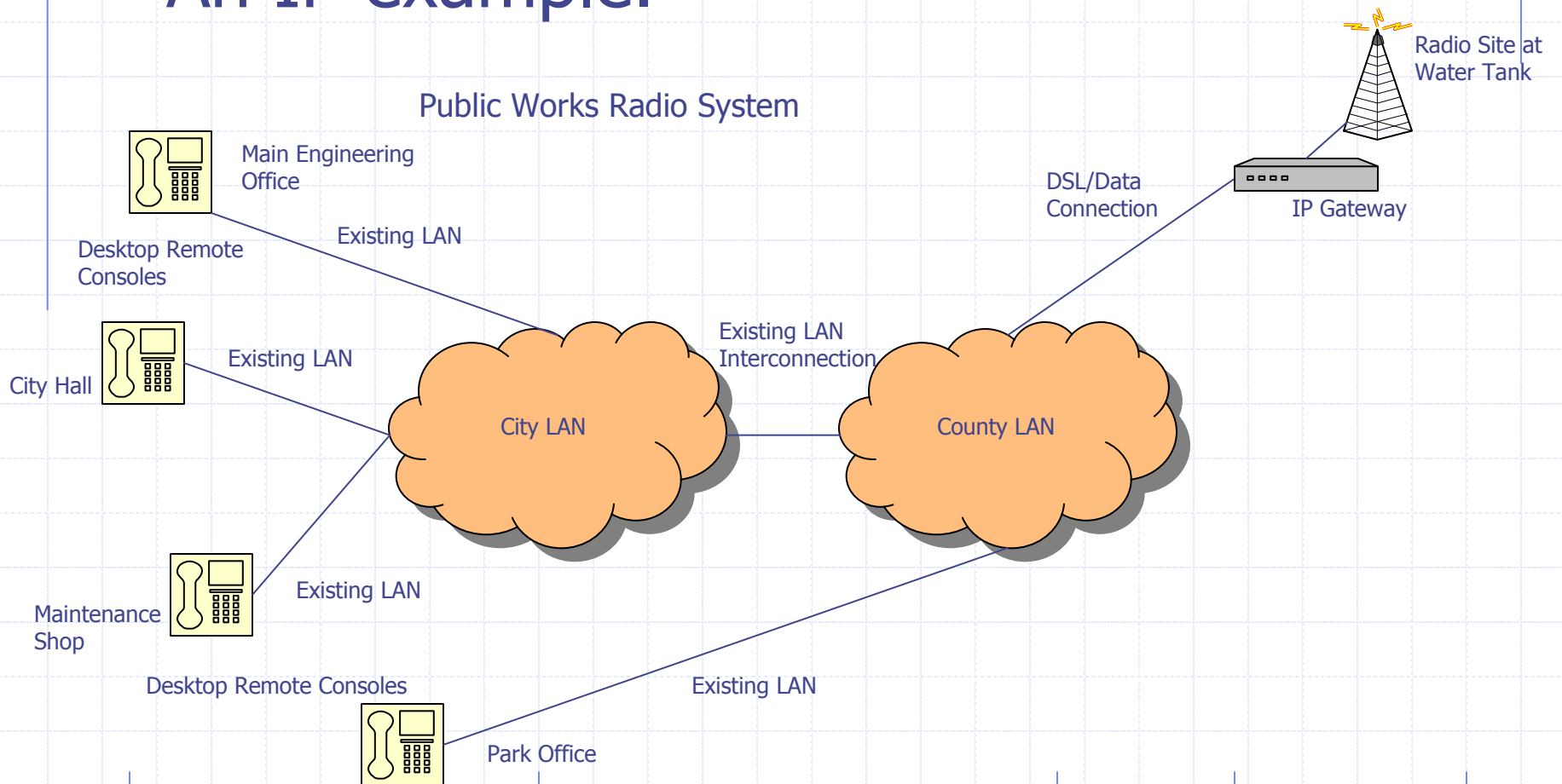
Why IP?

- Typical IP network example



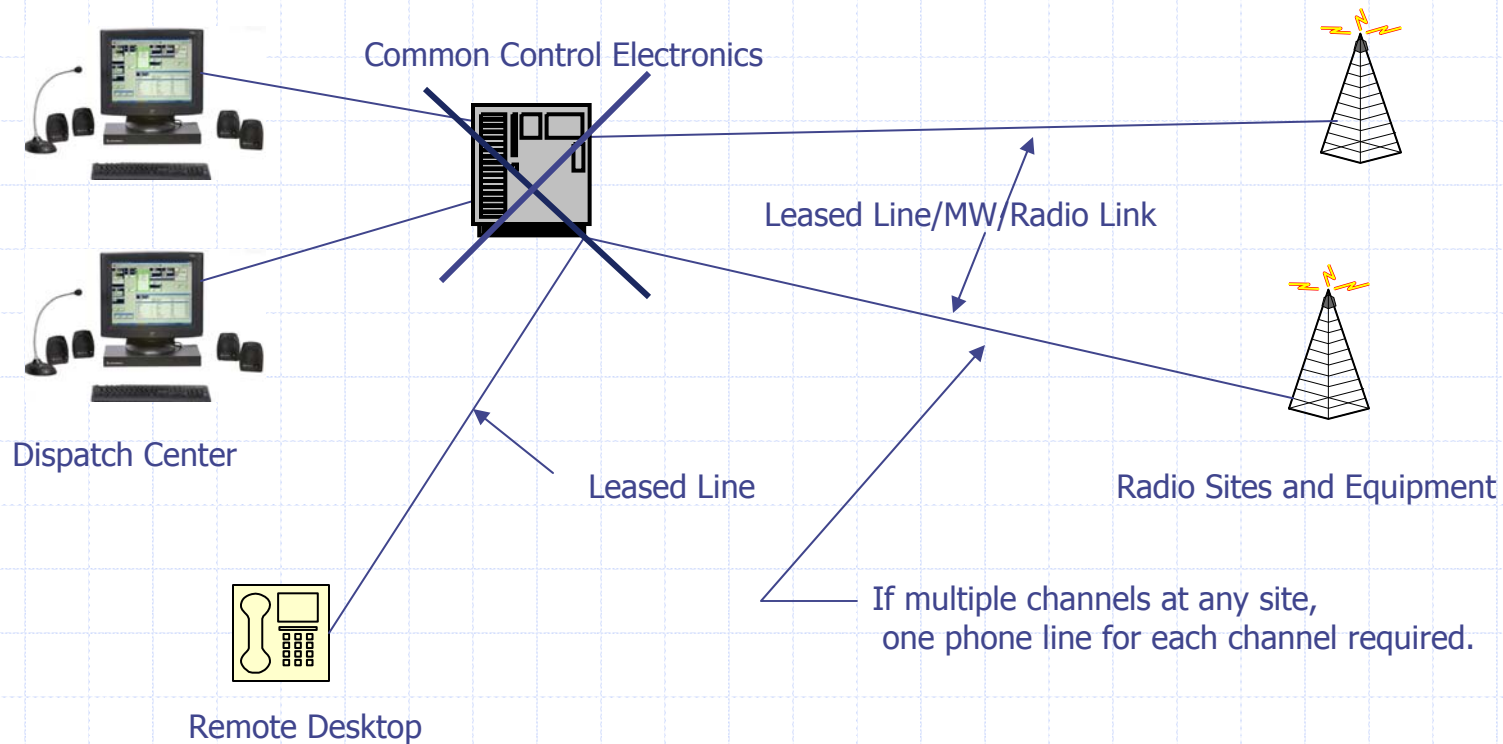
Why IP?

- An IP example.



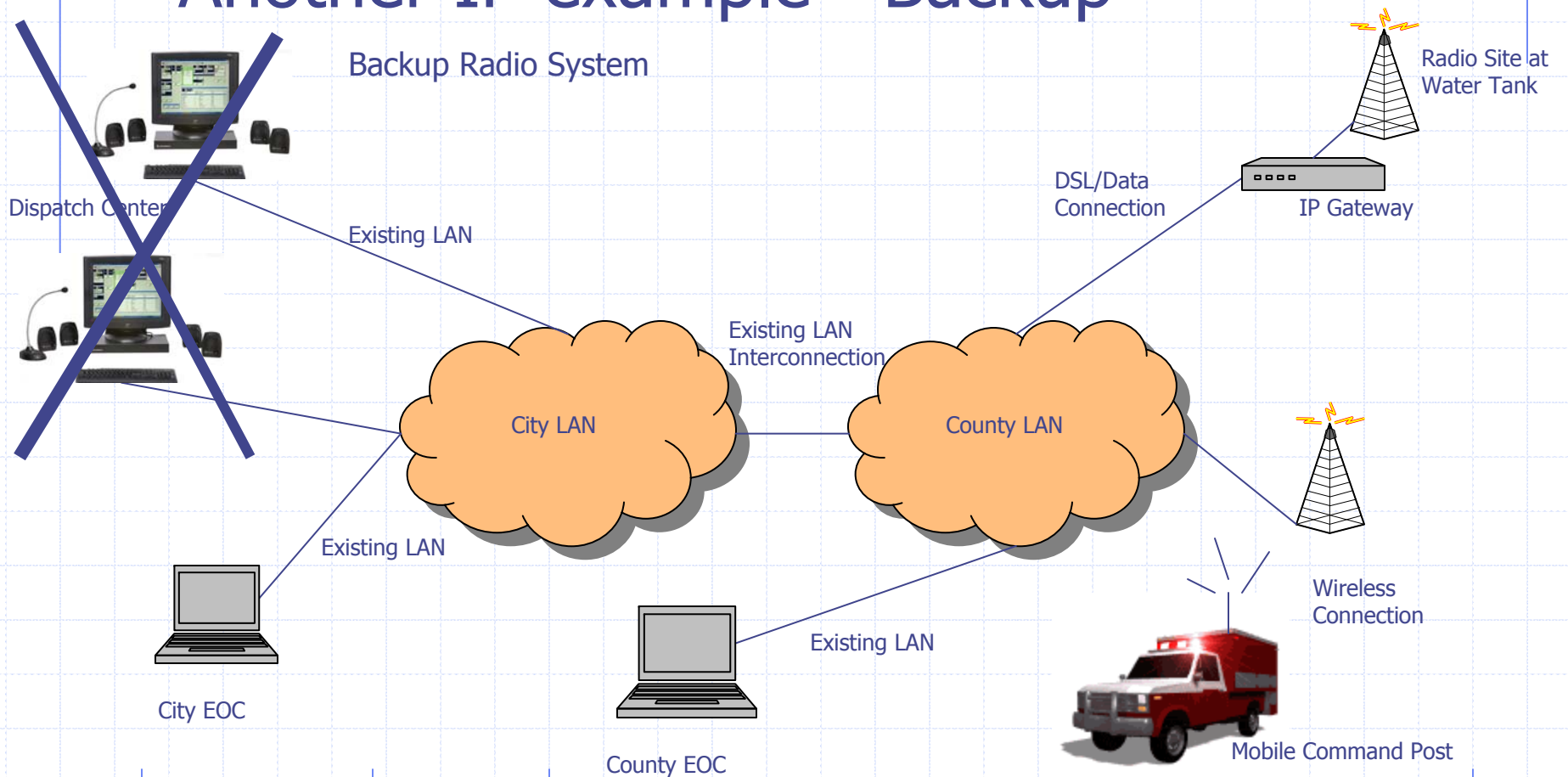
Why IP?

- Typical radio network today during failure



Why IP?

- Another IP example - Backup



How can IP be used for radio?

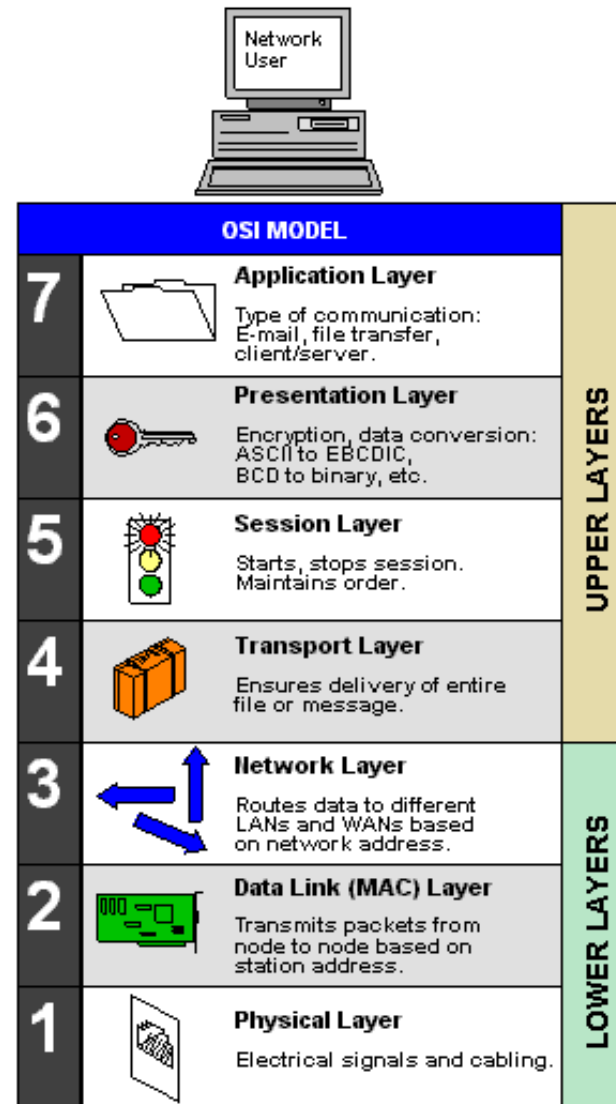
- It is a method of interconnecting consoles, radios, telephones, and other devices
- It is not transmitted over-the-air to the user radios
- IP \neq P25
- Uses standard Internet Protocols (IP)
 - TCP/IP – Most reliable format because provides guaranteed delivery but not generally used for voice because of bandwidth
 - UDP/IP – Uses less bandwidth but may be less reliable because no guaranteed delivery
 - Uses many of the standards and protocols available in most data networks but not necessarily allowed by the network manager

The Promise of IP

- Reduces costs because existing data networks can be used
- Easy to use, interconnects many different brands of equipment
- Control consoles can be located anywhere there is a data network and a simple laptop can be used
- Reduces costs because standard computer hardware can be used
- Great for disaster recovery and back up because data networks are often more resilient than voice or dedicated facilities
- Reduces costs because one data circuit can handle multiple base stations
- Interconnects many different kinds of equipment such as cell phones, 2-way radio, Nextel phones, Internet Phones, VoIP phones, etc.
- Plug and Play

OSI Model

- Open System Interconnection
- Seems esoteric but is important to understand how various network components work.
- Released in 1983



OSI Model

- Layer 1 – Physical Link
 - Voltage
 - Number of wires
 - Pin outs



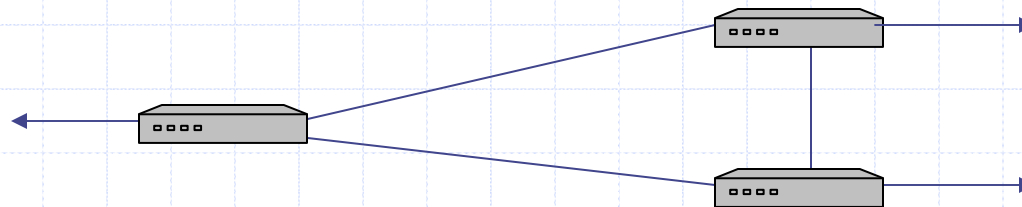
OSI Model

- Layer 2 – Data Link
 - Media Access Control (MAC) Addresses
 - Ethernet, Token Ring, Frame Relay, ATM
 - Data “Switches” usually work at this level
 - LAN Cards – Usually Layer 2 depending on card



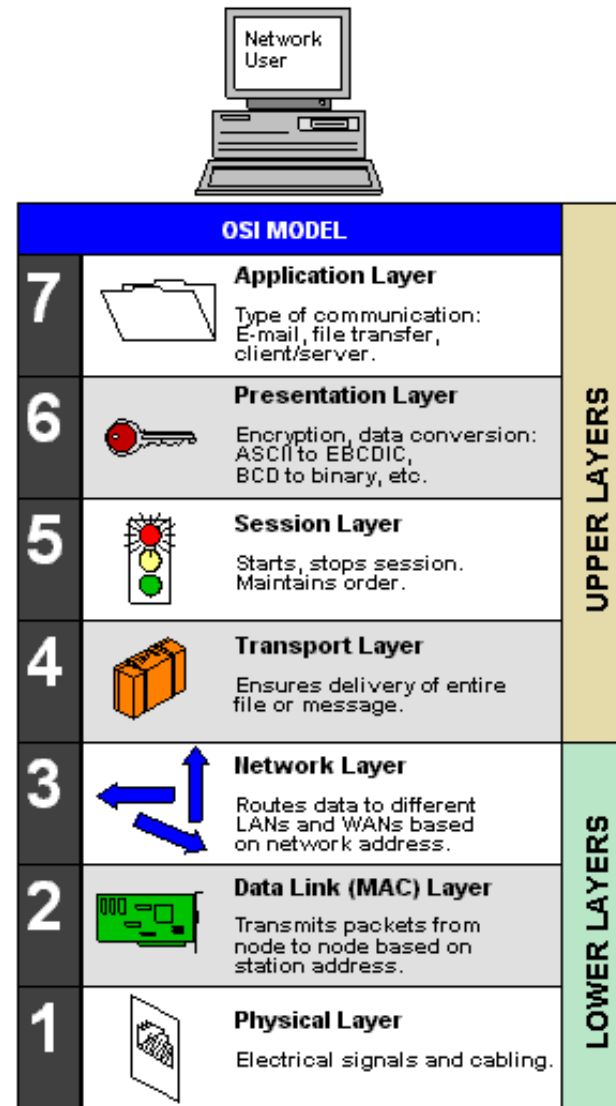
OSI Model

- Layer 3 – Network Layer
 - Higher level addressing
 - Handles communications between network switching points.
 - Routers generally operate at this level
 - IP, SNA, Apple Talk



OSI Model

- Lower Layers
 - Layer 1 - Cables, etc.
 - Layer 2 - Ethernet
 - Layer 3 - IP



OSI Model

- Layer 4 Transport Layer
 - Transmission Control Protocol (TCP)
 - Ensures data gets from one end to the other.
 - Counts packets, etc.
 - Part of the TCP/IP “Internet” protocol
 - Sometimes contains parts of Layer 5

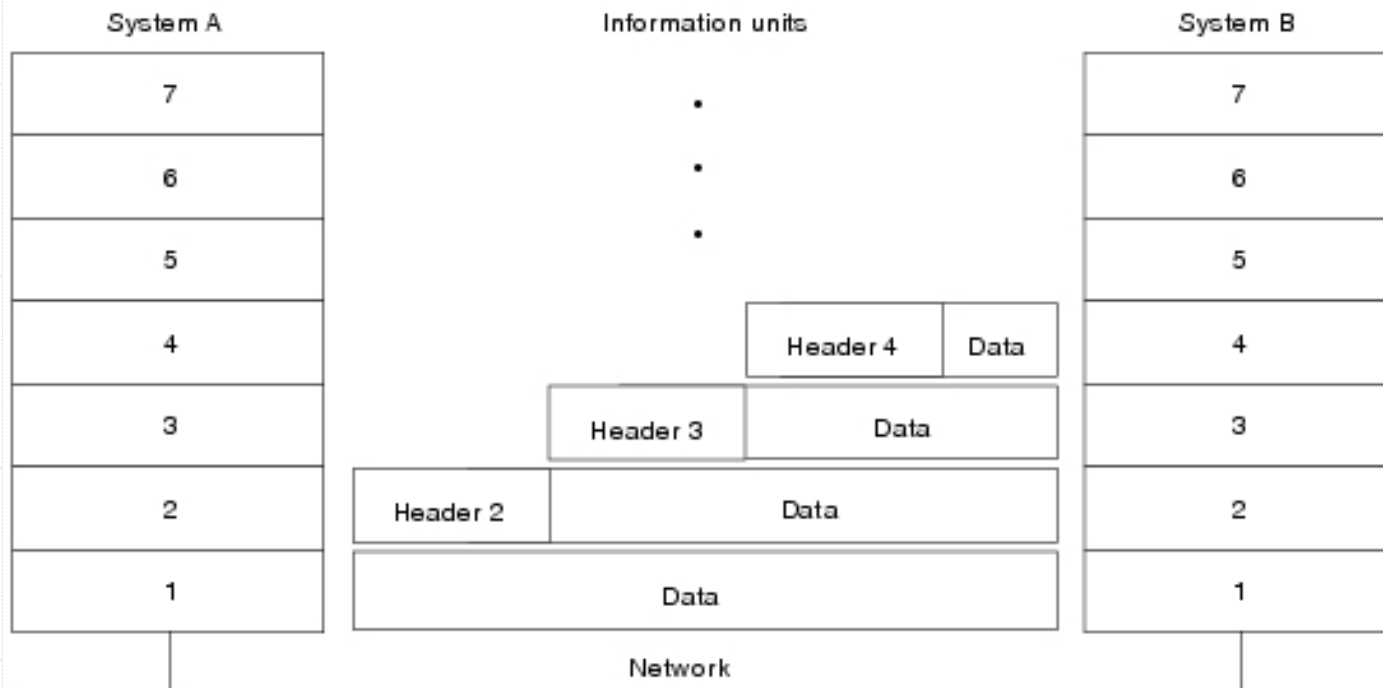
OSI Model

- Layer 5 – Session Layer
 - Manages two-way or one-way transmission
 - Provides communications coordination
 - Often incorporated in Layer 4
- Layer 6 – Presentation Layer
 - Use has changed over time
 - Generally used for encryption now.
- Layer 7 – Application Layer
 - Used to manage the applications such as file transfers, etc.
- Layers 5, 6, and 7 are often merged together in the operating system or applications in modern computers.

Network Data Flow

- Data flows through the OSI model elements.

Figure 1-6 Headers and Data Can Be Encapsulated During Information Exchange



Networking Equipment

- Hub
 - Layer 1 device
 - Network wire nut
 - All traffic flows to all ports



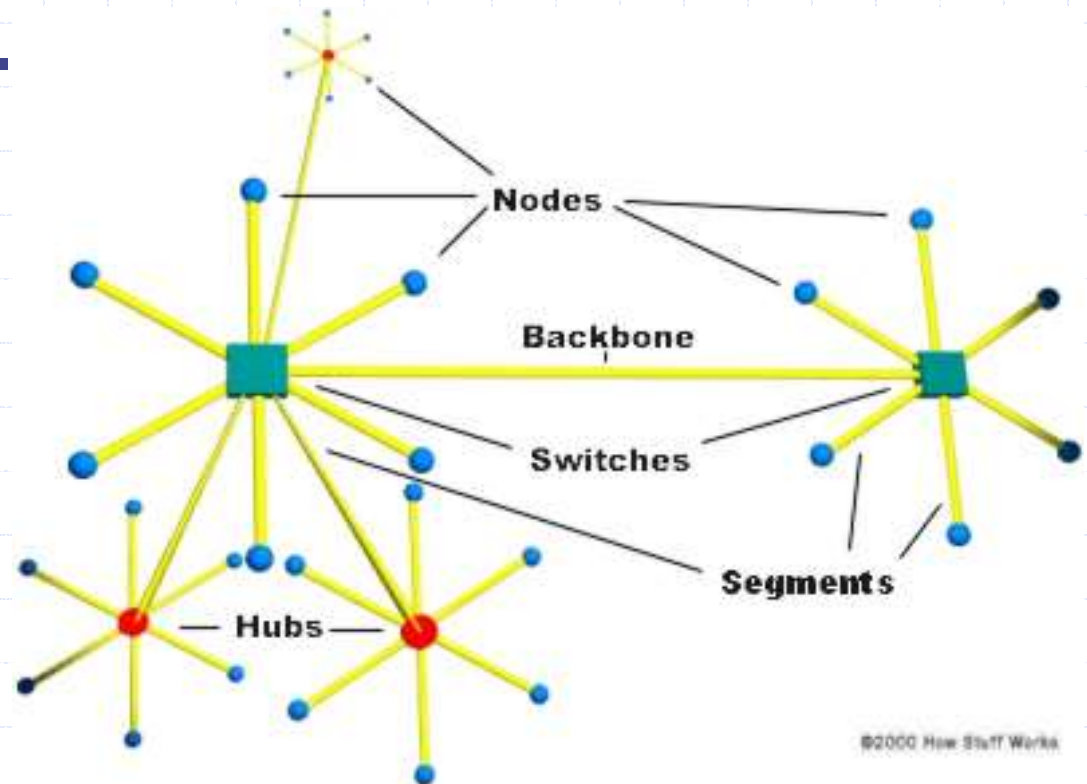
Network Equipment

- Switch
 - Layer 2 Device
 - Routes traffic to the network segment with the destination device
 - Reduces traffic and collisions on the network
 - Smart switches can provide enhanced switching and limited “Layer 3” functions



Switches and Hubs

- Nodes = End Devices
- Switches so cheap they have often replaced hubs.



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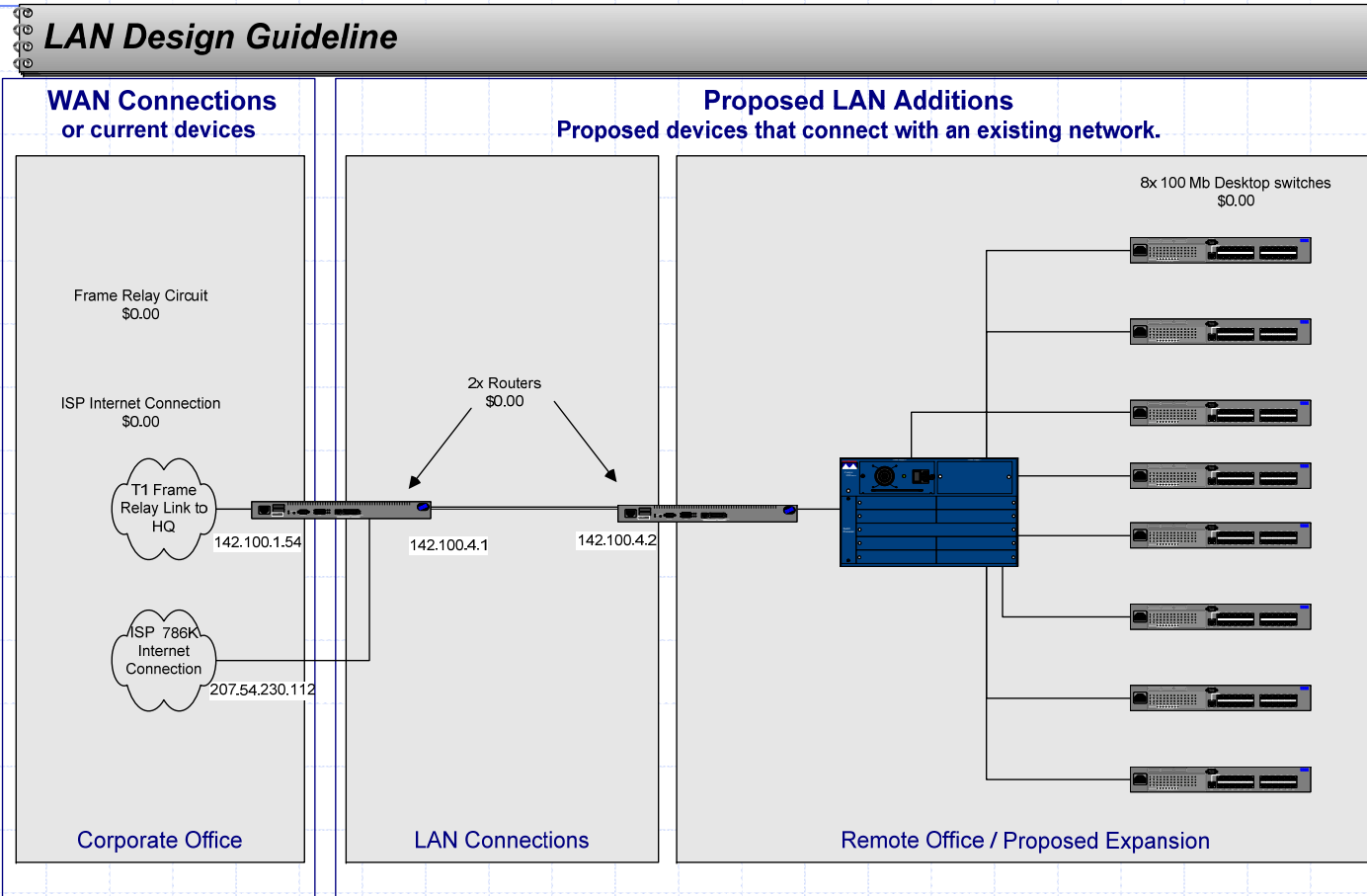
Networking Equipment

- Routers
 - Layer 3 Device
 - Connects one network to another
 - Usually provides transport conversion
 - Makes “intelligent” decisions about how to route data



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Putting it all together



Initial Considerations

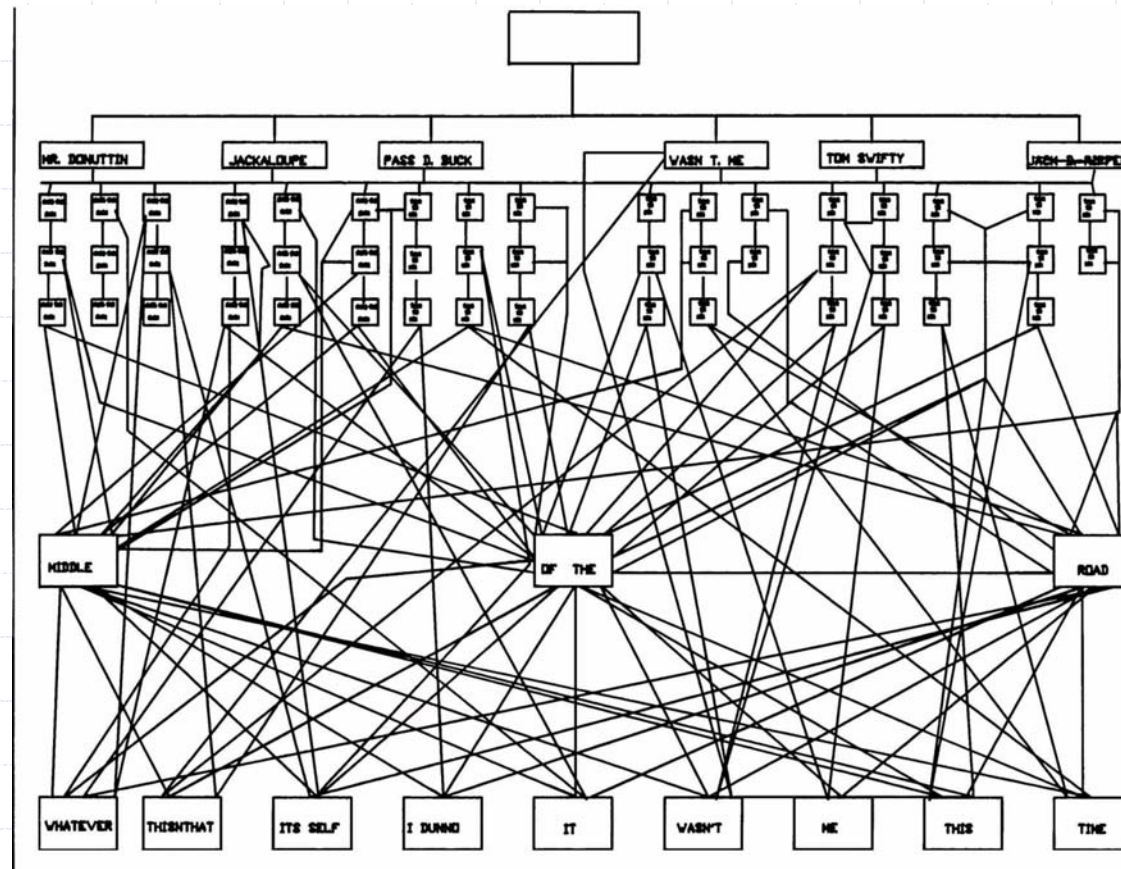
- Shared or dedicated network
- Shared network should support
 - Multicast – Transmits to multiple points simultaneously
 - Bandwidth – Depends on vocoding assume 50k per voice channel worst case
 - Fixed IP addresses
 - Dedicated bandwidth or Quality of Service
 - Virtual LAN's do not guarantee bandwidth
 - Delay must be controlled
 - Router/Firewall programming control
 - Security and virus protection

Technical Details

- Data Networking
 - Common use:
 - TCP/IP for control signals – More reliable
 - UDP/IP for voice data – Less bandwidth
 - Multicast – Routing data to multiple points
 - Fixed IP addresses
 - Be careful with any network assumptions as different vendors have implemented network interfaces differently.
 - Quality of service is generally required to ensure delivery of audio packets. (Remember they are UDP/IP.)
 - Multiple ports may need to be opened in firewalls, etc. for proper operation.
 - Virtual LANs do not guarantee bandwidth.
 - Network security must be managed.

Implementing IP

- Document your network!



IP – The Future is Now

- Good news
 - Can be a very cost effective solution in some situations
 - If limitations are not a problem, costs can be reduced
 - This technology will eventually become the dominate method for radio system interconnection because most communications are moving to an IP type network
 - Improvements in the interfaces are being made all the time
 - Some issues are resolved if implemented on a dedicated data network but that raises costs

Questions?



Thank you!

Joe Blaschka Jr. PE

j.blaschka@adcomm911.com

425-821-8827

www.adcommeng.com