Basic IP for Radio Technicians

A Technician's Guide to the Technology

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Training Conference
Wenatchee, WA

ADCOMM Engineering

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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?

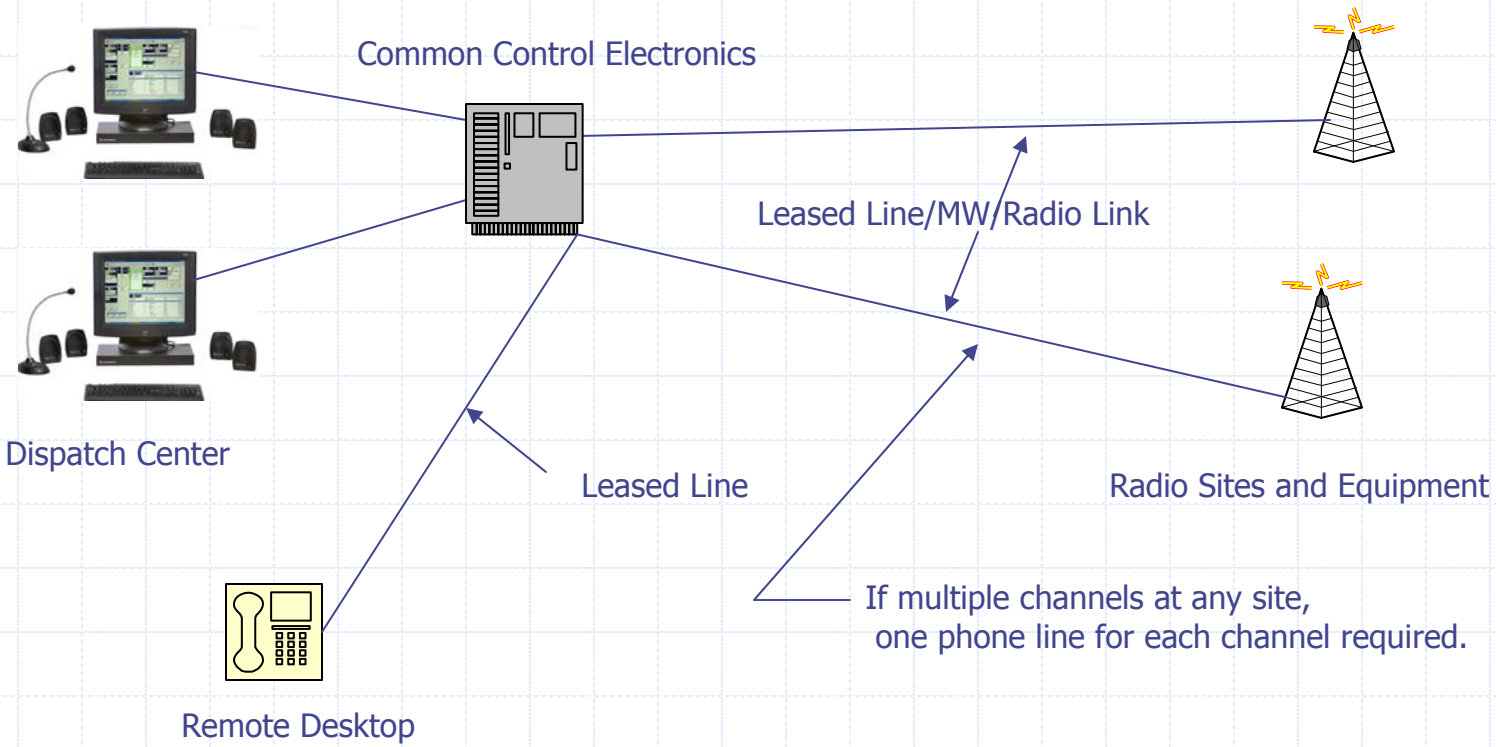
- Lots of good reason's to stay analog.
- All transport is migrating towards data.
  - Analog phone lines going away.
  - Data networks are everywhere.
  - Transport shared between voice and data.
- The world is computer centric.
- New products tend to be data oriented.

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. Not yet for public safety.

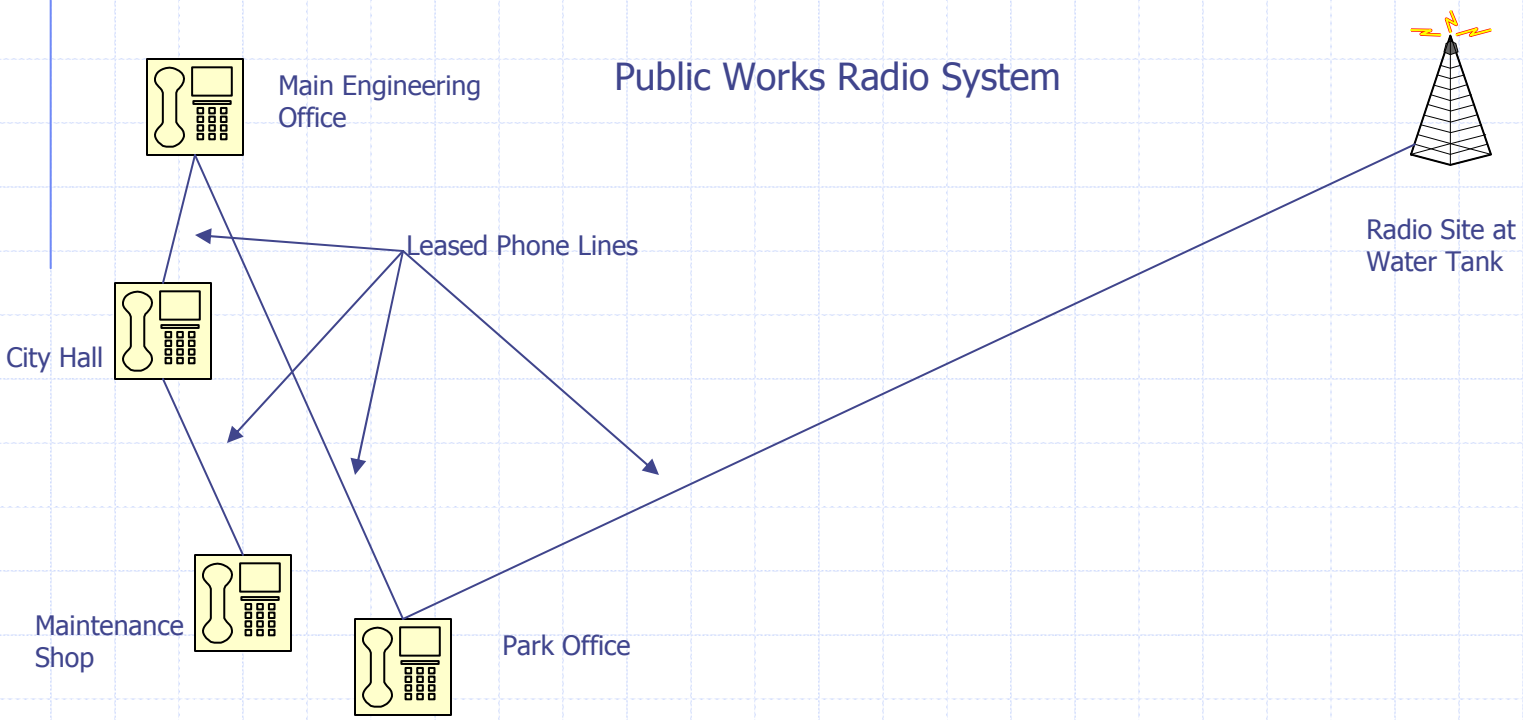
Why IP?

- Typical radio network today



Why IP?

- Analog connections today.

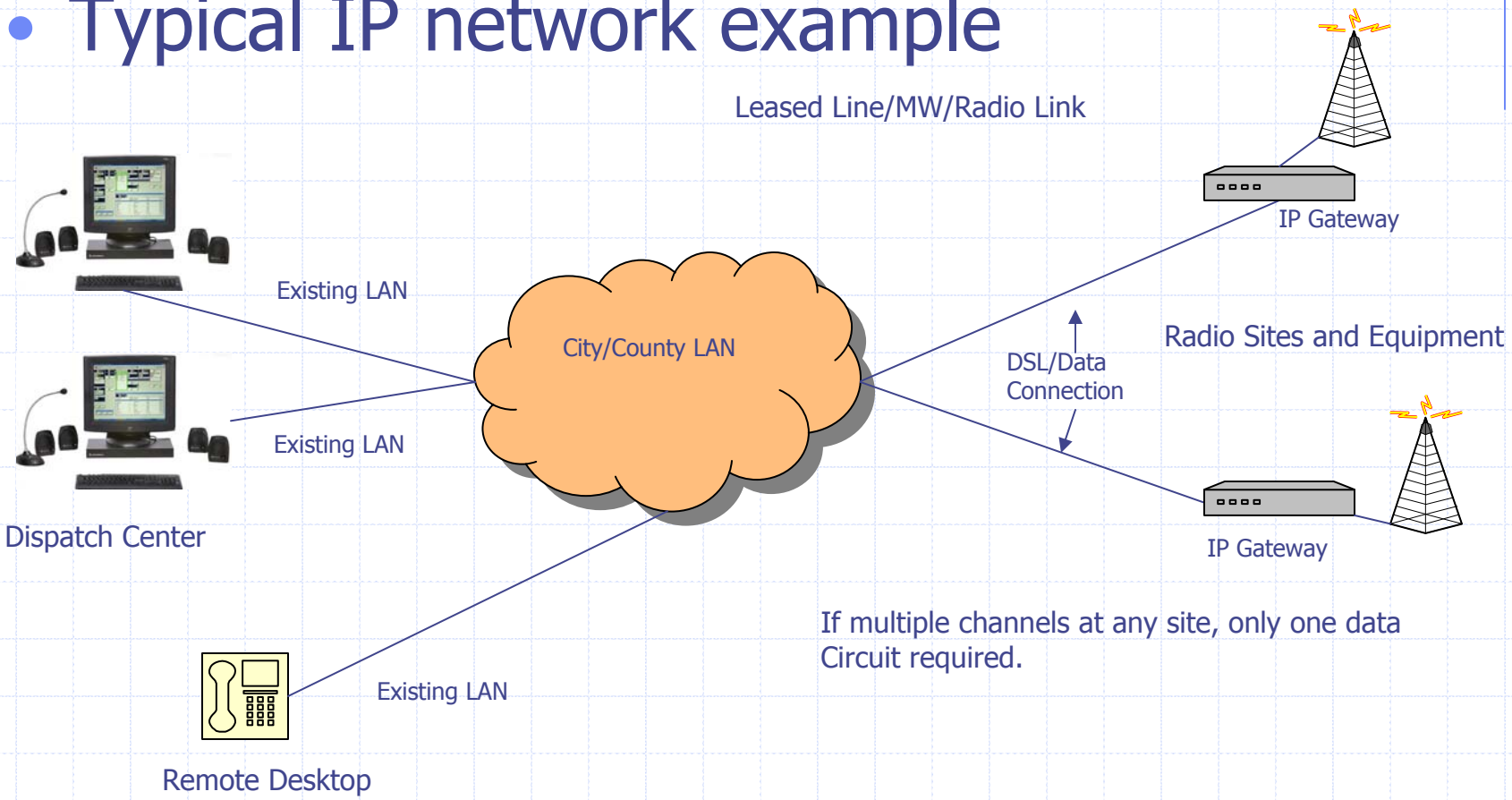


Why IP?

- 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

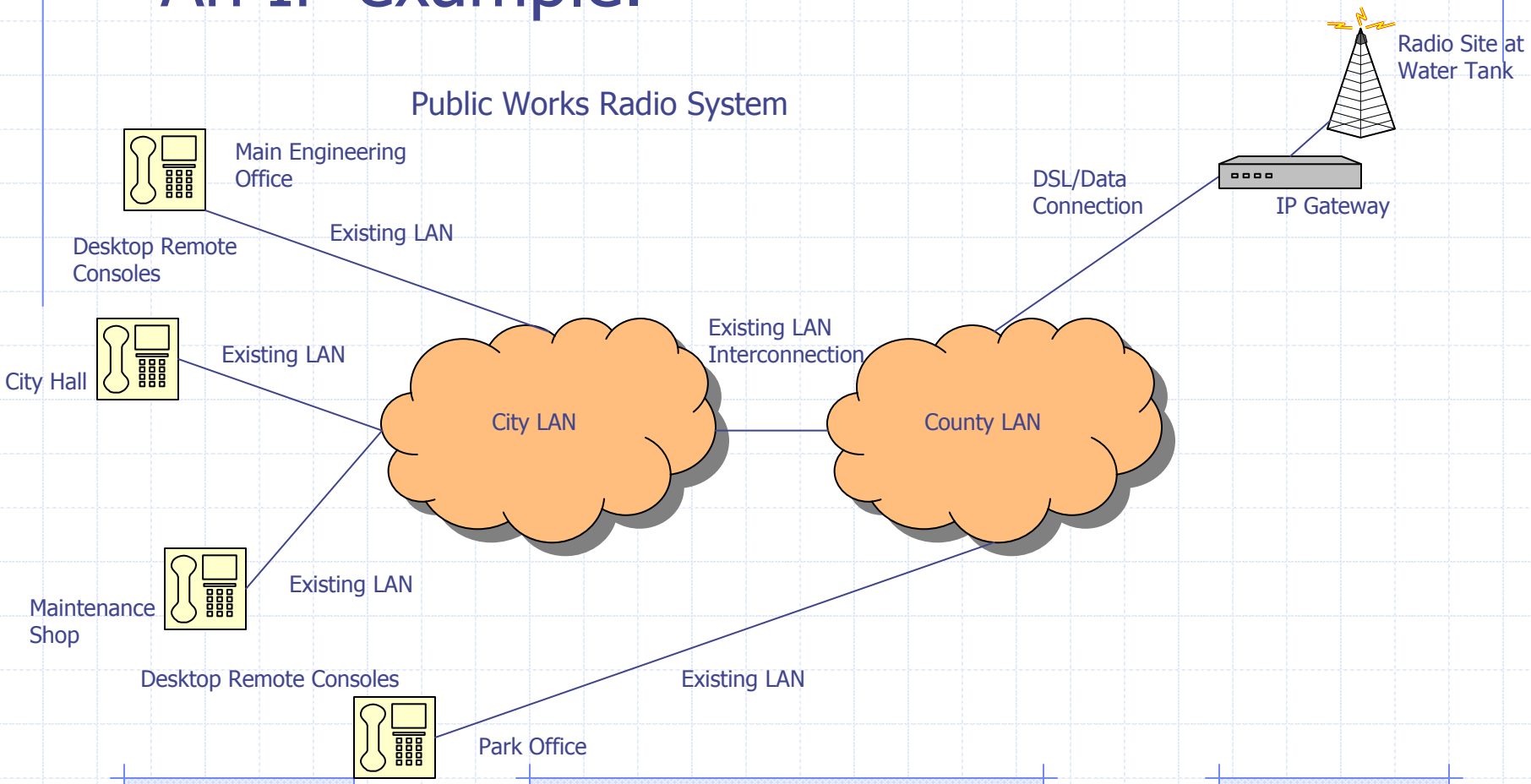
Why IP?

- Typical IP network example



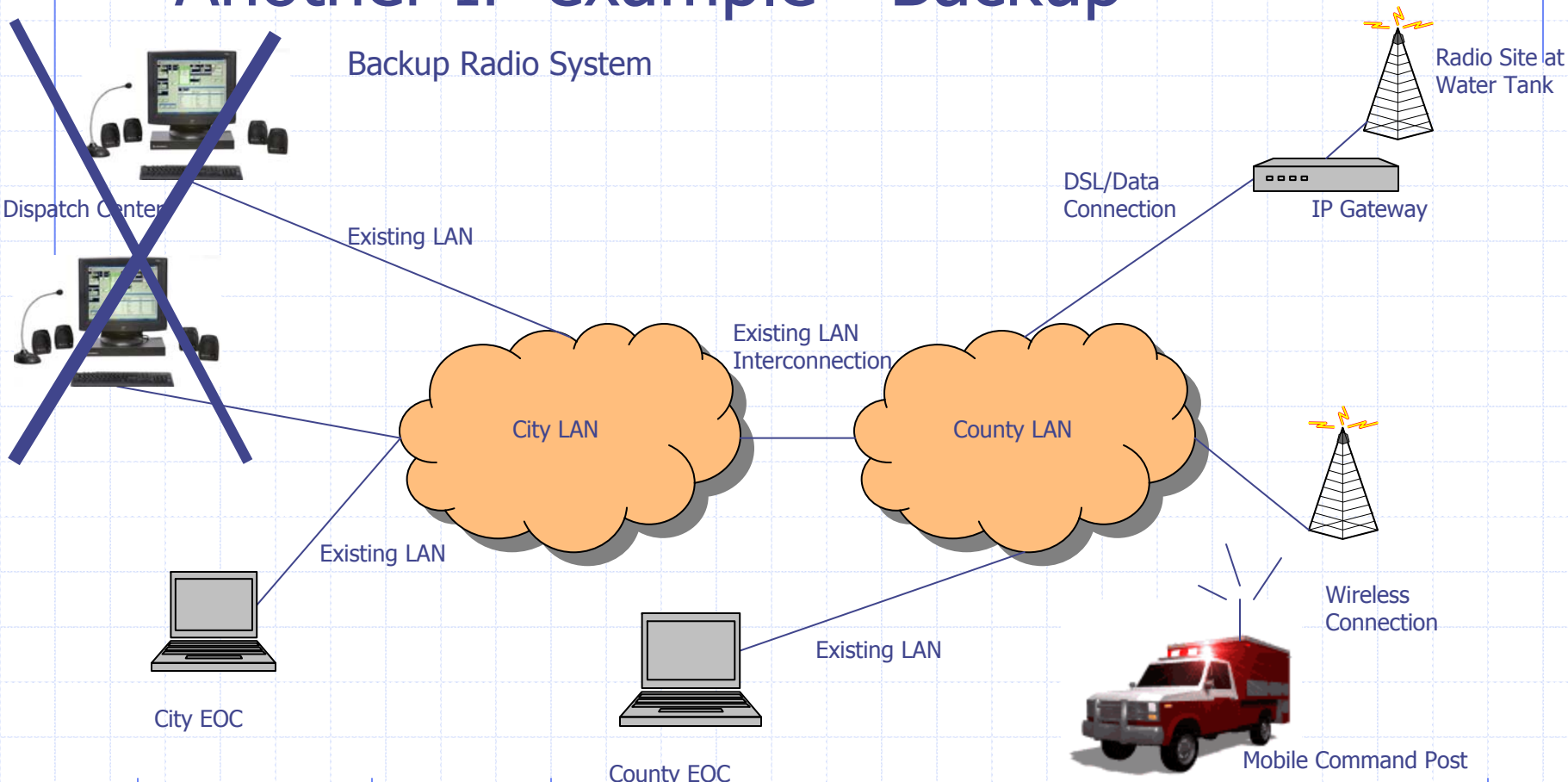
Why IP?

- An IP example.



Why IP?

- Another IP example - Backup



How can IP be used for radio?

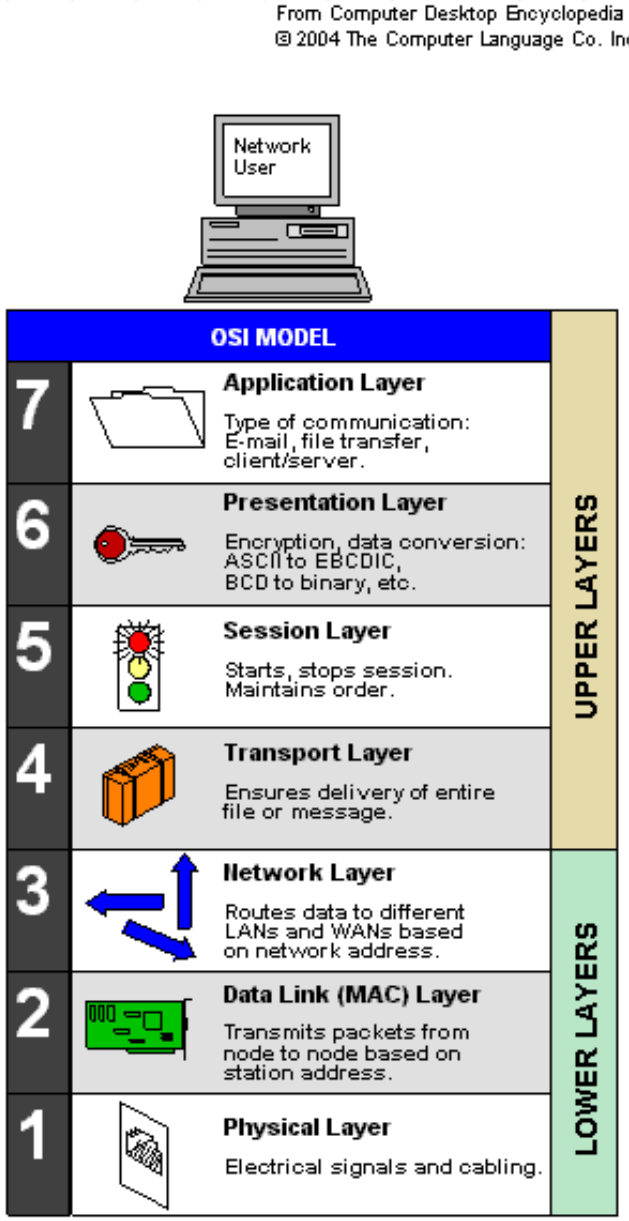
- It is a method of interconnecting consoles, radios, telephones, and other devices
- It is not transmitted over-the-air to the user radios
- IP ≠ P25
- Uses standard Internet Protocols (IP)
  - TCP/IP – Most reliable format because provides guaranteed delivery but not generally used for voice because 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

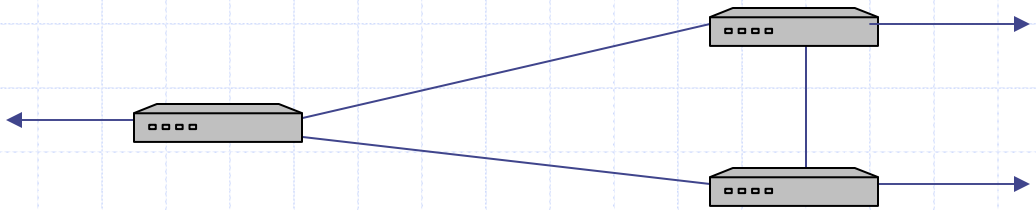
- Layer 1 – Physical Link
  - Voltage
  - Number of wires
  - Pin outs

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

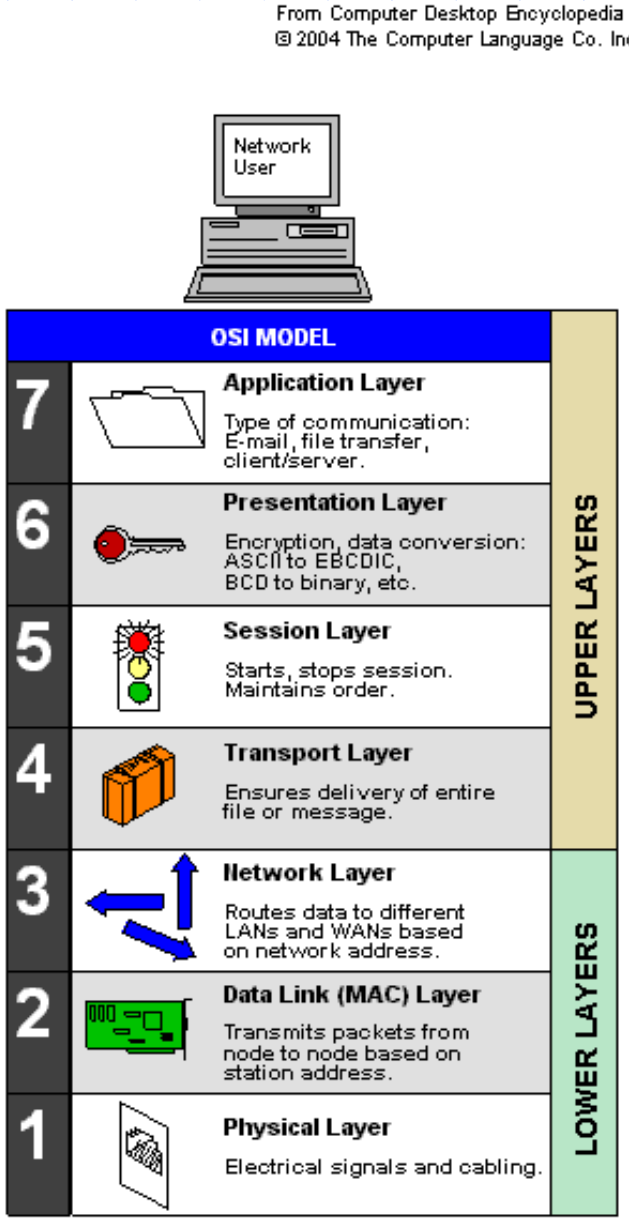
OSI Model

- 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

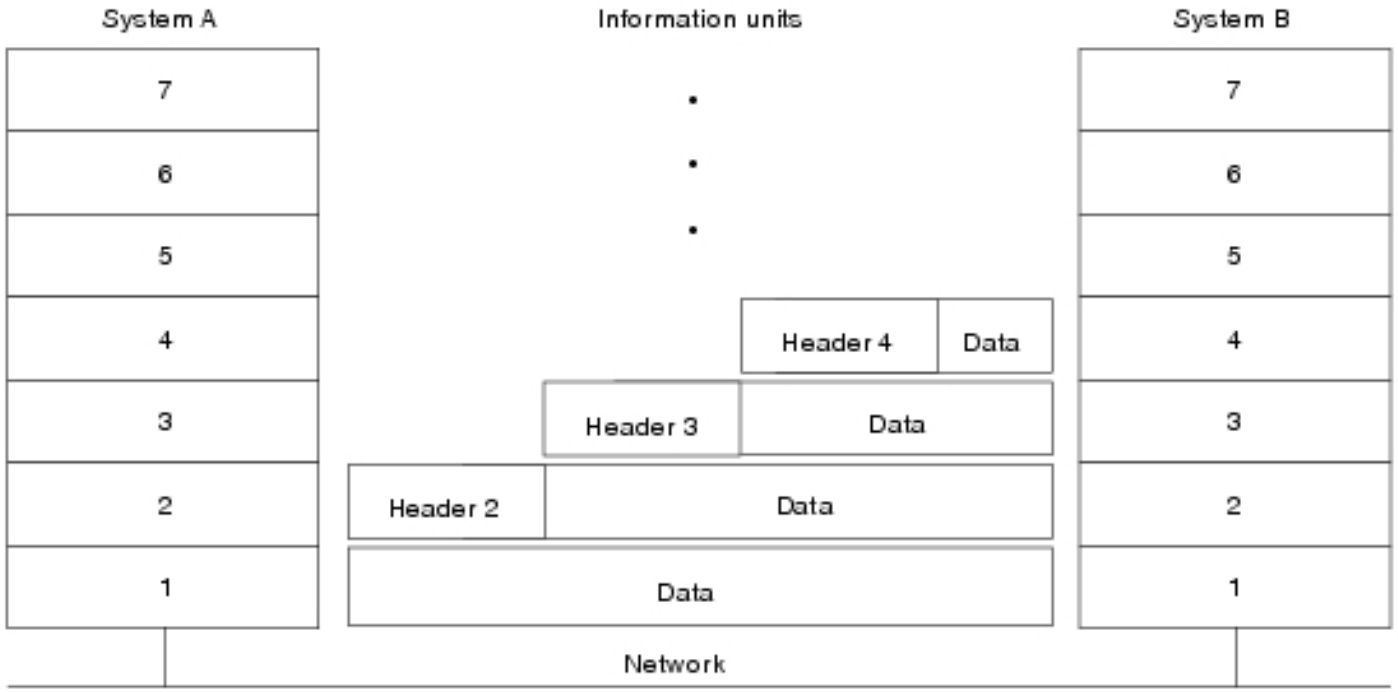
OSI Model

- 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

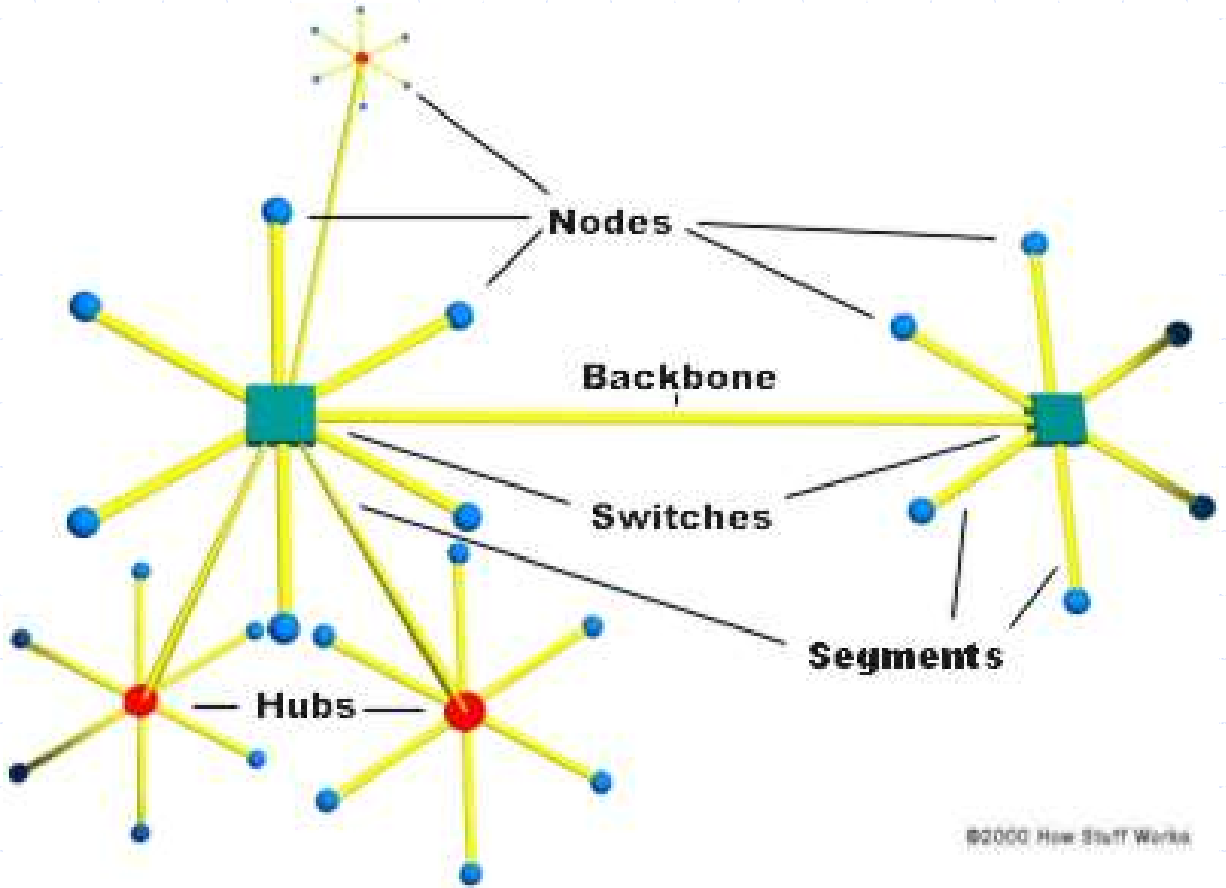
Network Equipment

- 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



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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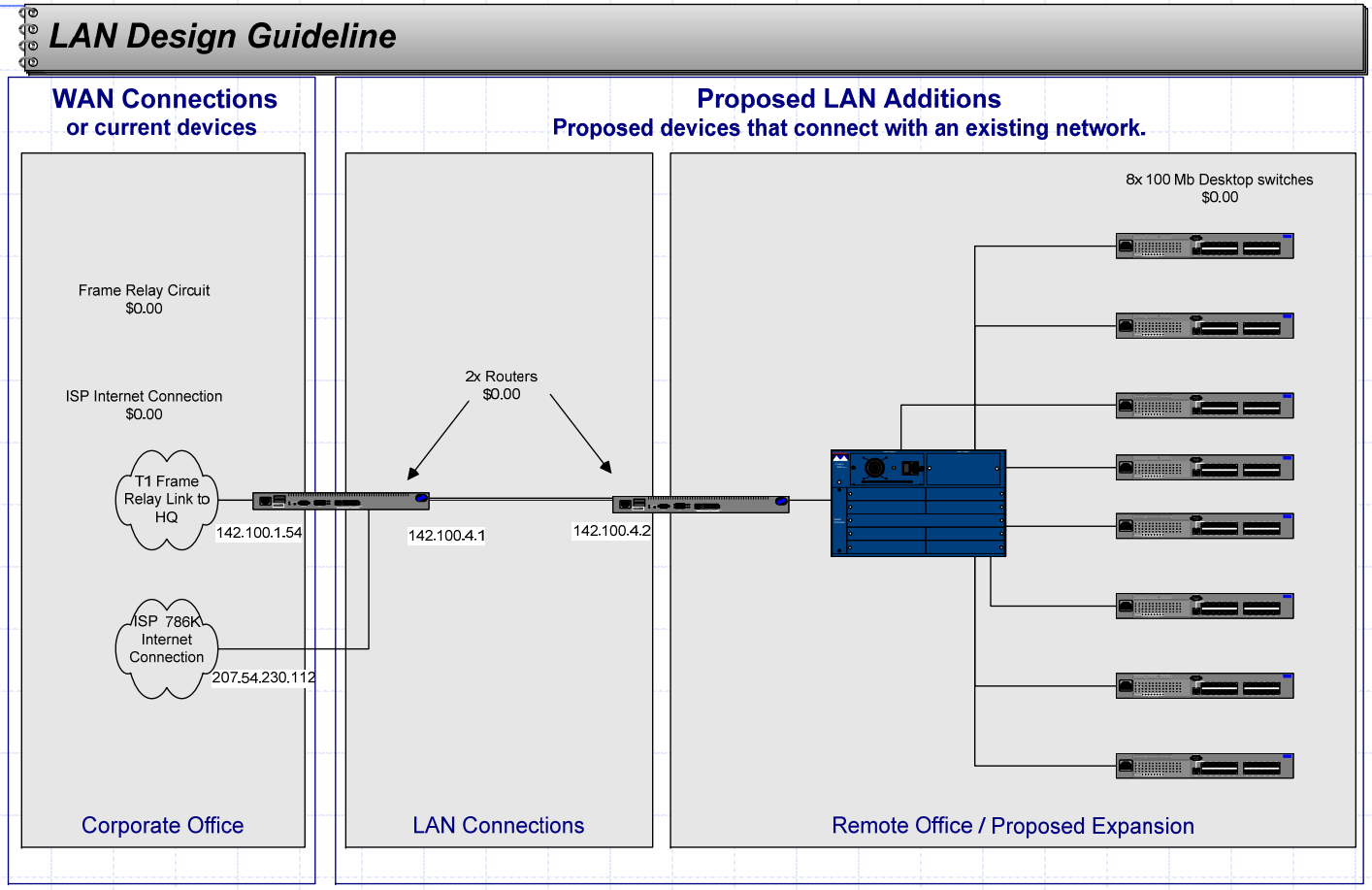
Putting it all together



Initial Considerations

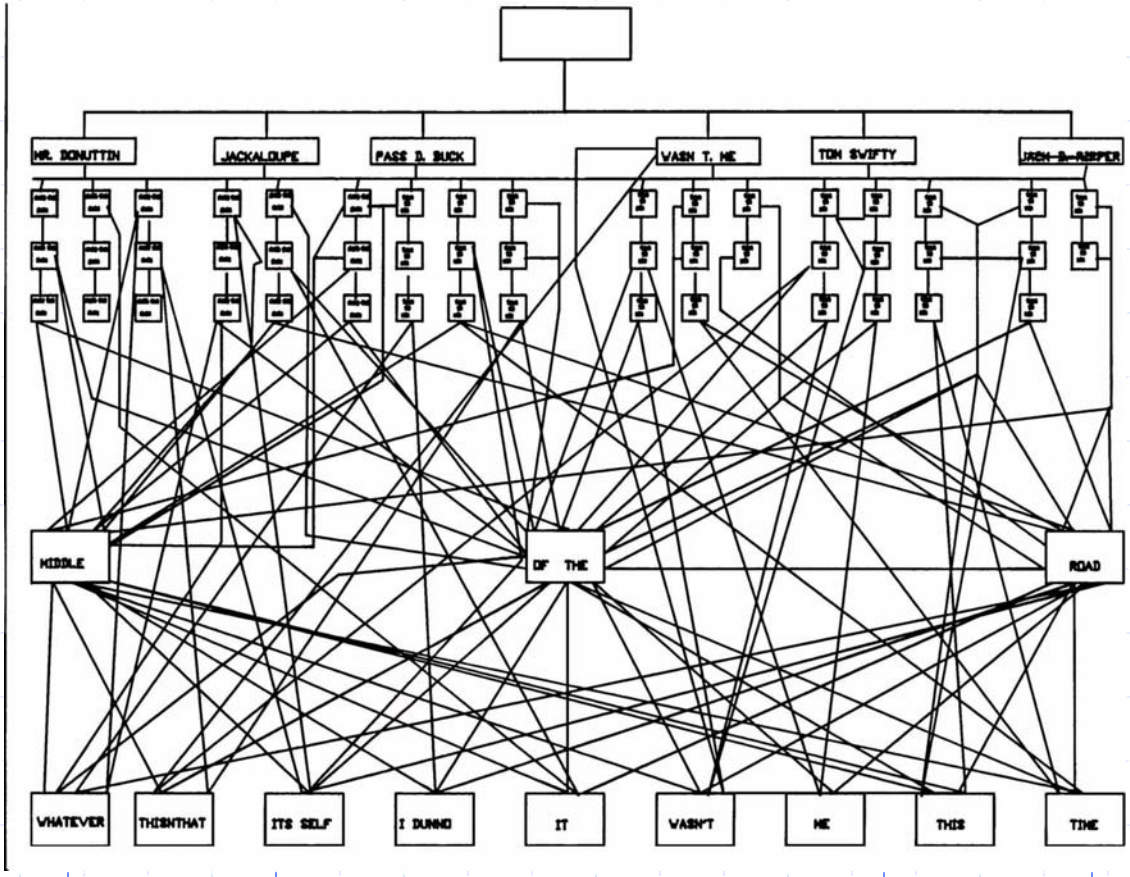
- Shared or dedicated network
- Shared network should support
  - Multicast – Transmits to multiple points simultaneously
  - Bandwidth – Depends on vocoding assume 50k per voice channel worst case
  - Fixed IP addresses
  - Dedicated bandwidth or Quality of Service
  - Virtual LAN's do not guarantee 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!

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