DANTE™ AV NETWORKING WORLD

infoComm15

Conference: June 13-19 | Exhibits: June 17-19

Orange County Convention Center | Orlando, Florida

Networking 101

Chris Ware
Audinate

IP NETWORKING

- Do you use one of these?

IP NETWORKING

- Everything you think of when you imagine a home network

AUDIO IP NETWORKING

- Do you use one of these?

PANDORA® internet rad
Spotify
skype™

WHY?

- Digital?
  - Copper!

WHY?

- Networking?
  - Digital Transport
    - Multiple channels of audio via a single connection

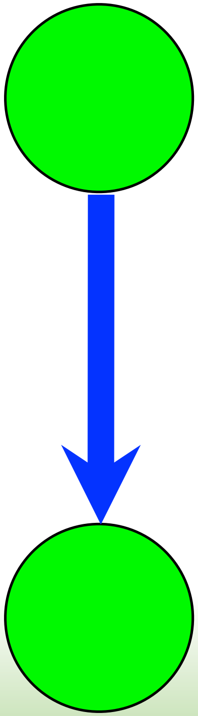
DIGITAL TRANSPORT

- S/PDIF (2 channels, optical or electrical cable)
- ADAT (8 channels, optical cable)
- AES3 (2 channels, electrical (balanced))

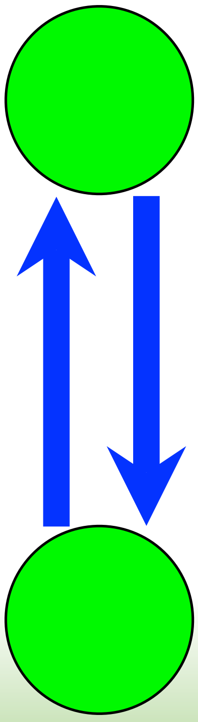
WHY?

- Networking?
  - Allows for easy routing of multiple sources to multiple destinations logically, without lots of wires

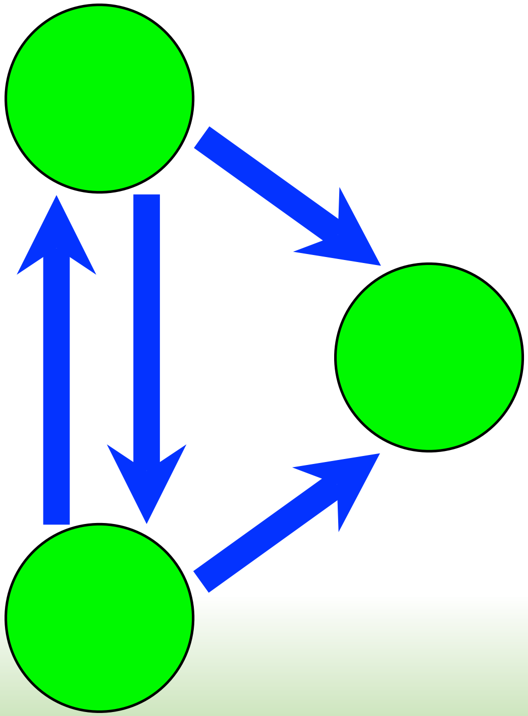
WHY?



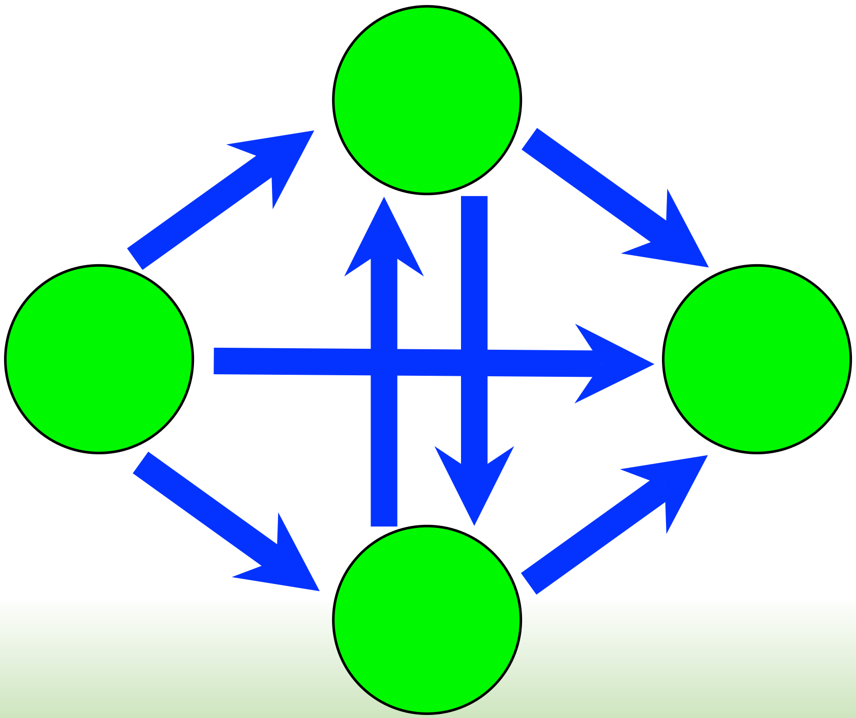
WHY?



WHY?



WHY?



WHY?

- Networking?

IP NETWORKS

- Packet switched

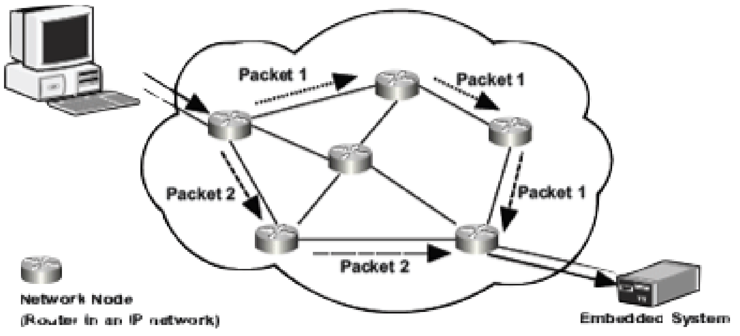
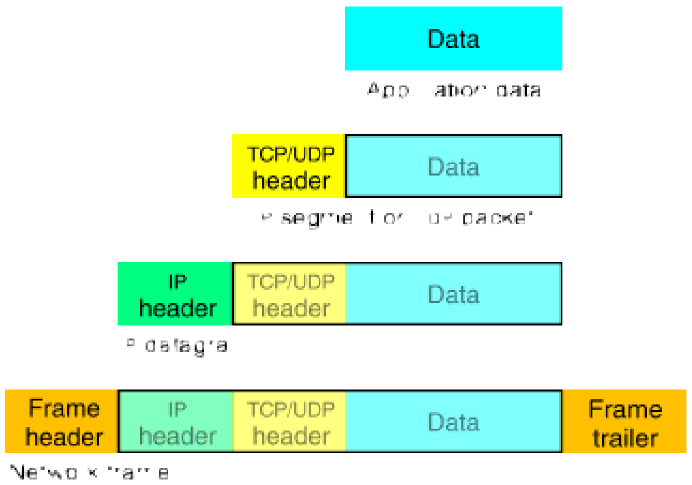


Figure 2.2 Packet Switched Network

- Messages (packets) are transmitted through cables
  - Switches receive and re-transmit messages

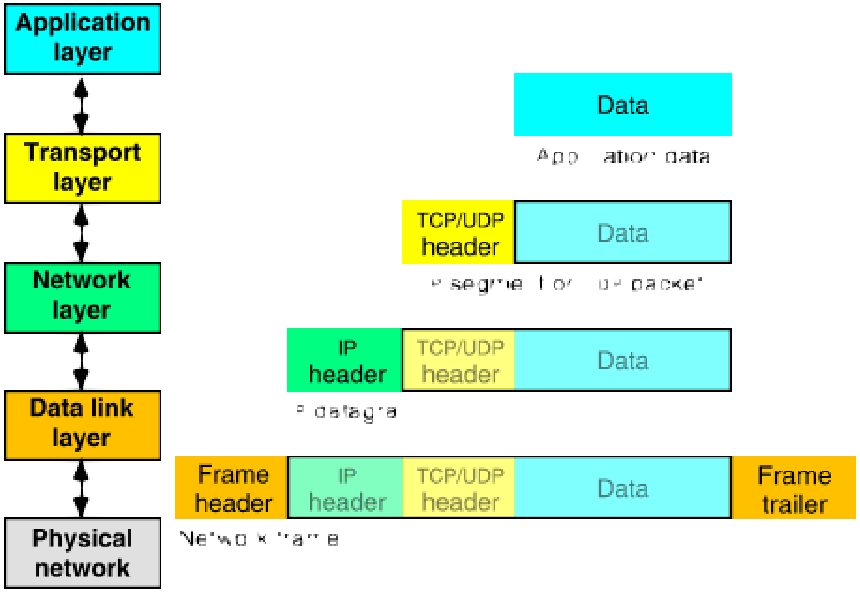
IP NETWORKS

- Messages are wrapped in several headers
  - Called encapsulation
    - Like putting a letter inside an addressed envelope



IP NETWORKS

- Encapsulation often described as network layers
- Allows a link to support many applications and services



VOCABULARY

- Understanding the terminology

jar·gon[1]
/ˈjärgən/

noun

special words or expressions that are used by a particular profession or group and are difficult for others to understand.
"legal jargon"
synonyms: specialized language, slang, cant, idiom, argot, patter; More

THE OSI MODEL

INTERNATIONAL STANDARD

ISO/IEC 7498-1

Second edition
1994-11-15

Corrected and reprinted
1996-06-15

Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model

Technologies de l'information — Modèle de référence de base pour l'interconnexion de systèmes ouverts (OSI): Le modèle de base

- ISO/IEC 7498-1

International Organization for Standardization

THE OSI MODEL

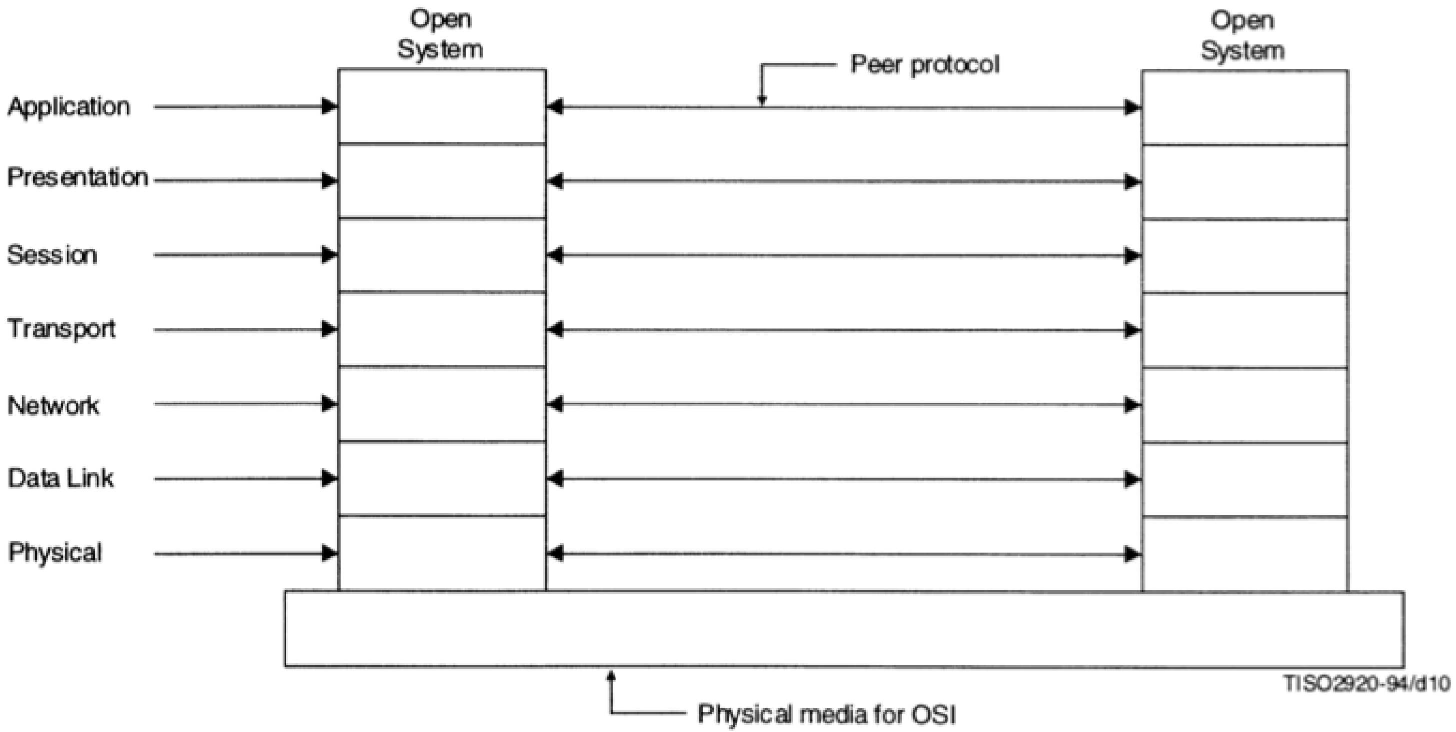
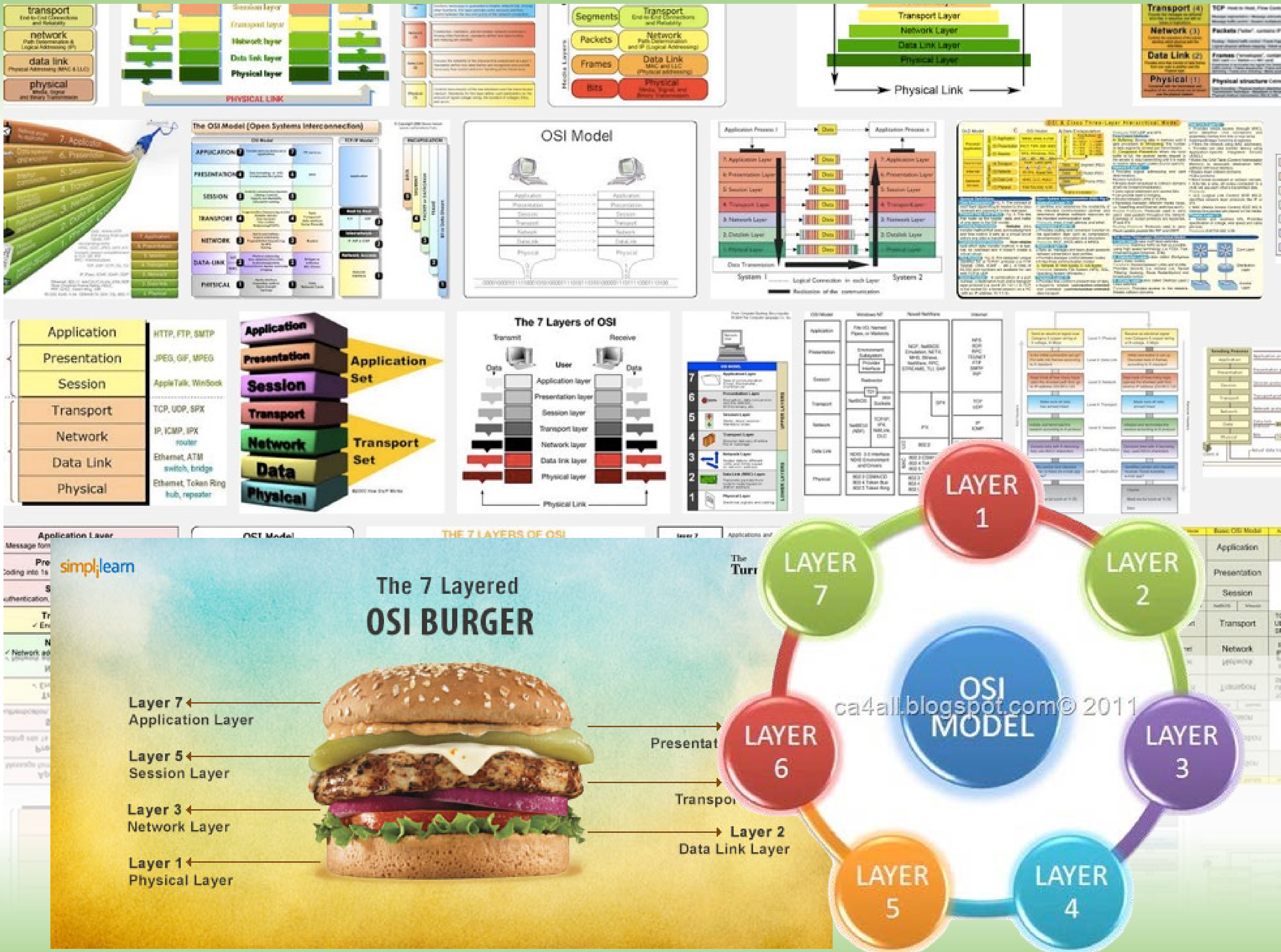


Figure 11 – Seven layer reference model and peer protocols



Physical Link
OSI Model
The 7 Layers of OSI
Application
Presentation
Session
Transport
Network
Data Link
Physical
HTTP, FTP, SMTP
JPEG, GIF, MPEG
AppleTalk, WinSock
TCP, UDP, SPX
IP, ICMP, IPX
Application Set
Transport Set
Segments
Packets
Frames
Bits
simplilearn
The 7 Layered
OSI BURGER
Layer 7
Application Layer
Layer 5
Session Layer
Layer 3
Network Layer
Layer 1
Physical Layer
Layer 2
Data Link Layer
LAYER 1
LAYER 2
LAYER 3
LAYER 4
LAYER 5
LAYER 6
LAYER 7
OSI MODEL
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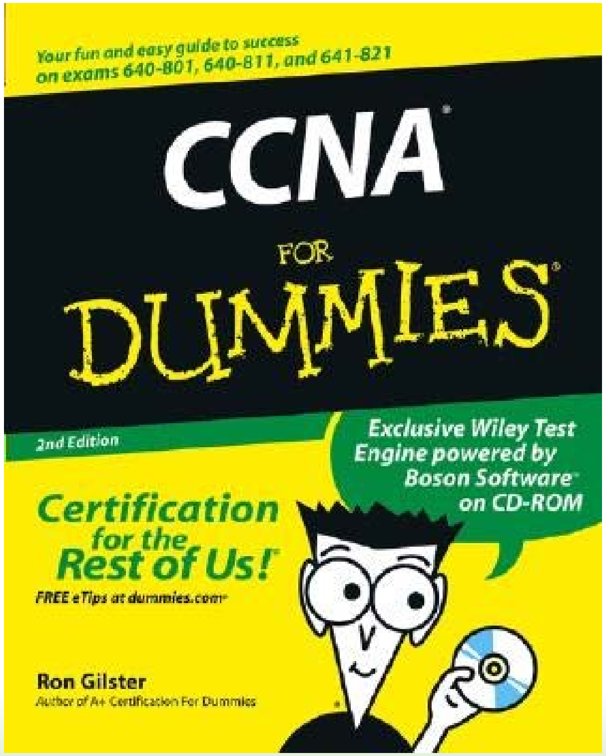
CCNA

Cisco Certified Network Administrator

CCNA FOR DUMMIES



CCNA FOR DUMMIES

The CCNA exam asks you to provide at least three reasons that the "industry" uses layered interconnection models. Examples of layered networking models include the seven-layer OSI model (which you need to know inside and out) and the Department of Defense (DOD) five-layer model (which you don't). The basic reason for using a layered networking approach is that a layered model takes a task, such as data communications, and breaks it into a series of tasks, activities, or components, each of which is defined and developed independently.

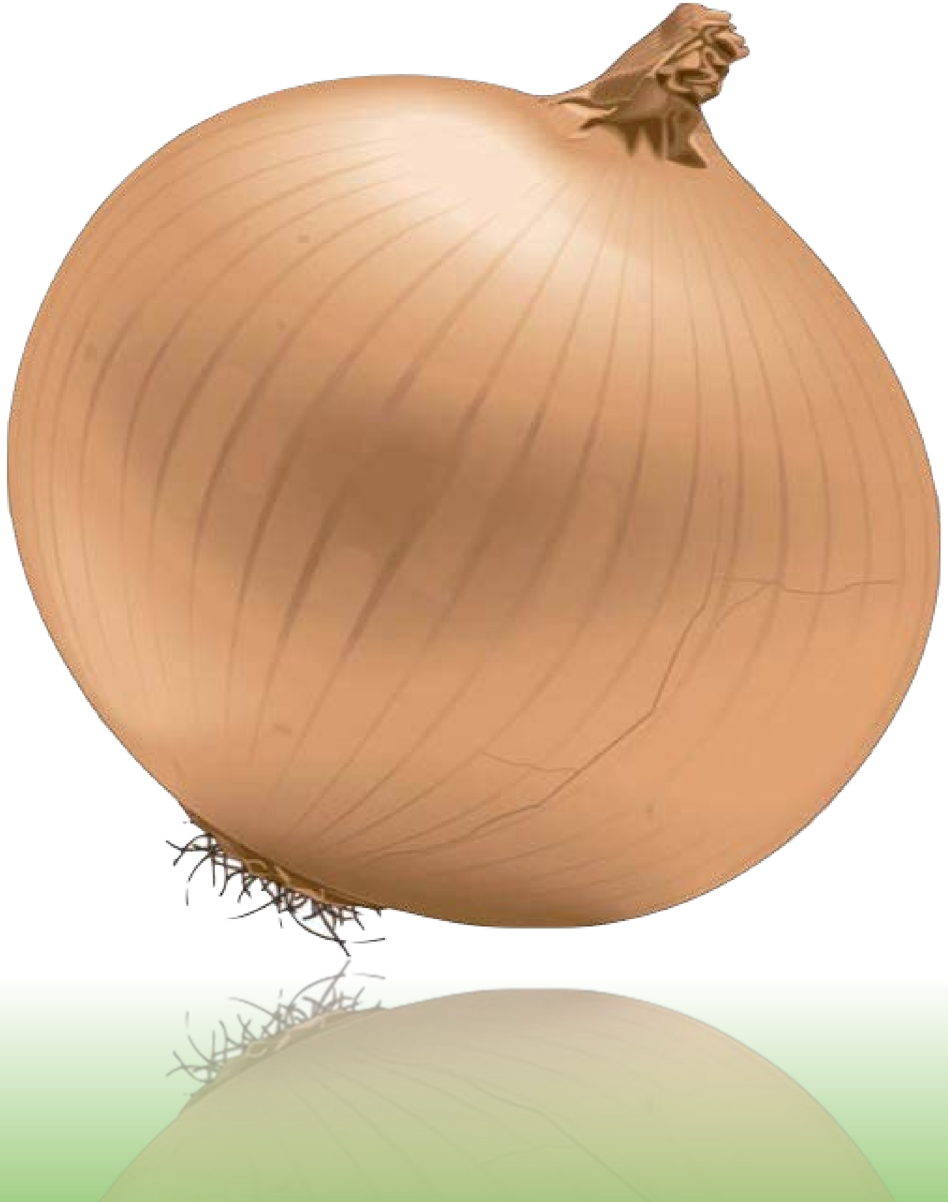
CCNA FOR DUMMIES

OSI model

- data communications
  - components
    - defined independently

OSI MODEL AS A “ ”

- Hundreds of examples
- Shown this way because it is always shown this way?
- Useful from a developers view, but...



LAYER 1 - PHYSICAL

- You can say it is the cable:
  - – CAT5/6
  - – fiber optic
  - – RF

LAYER 1 - PHYSICAL

- It is really the “electrical” signaling
- It is different from the other layers
  - Every other layer is logical and deals with chunks of data
  - This one is all “bits”, 1s and 0s

LAYER 1 - PHYSICAL

- Layer 1 Audio?
  - AES50

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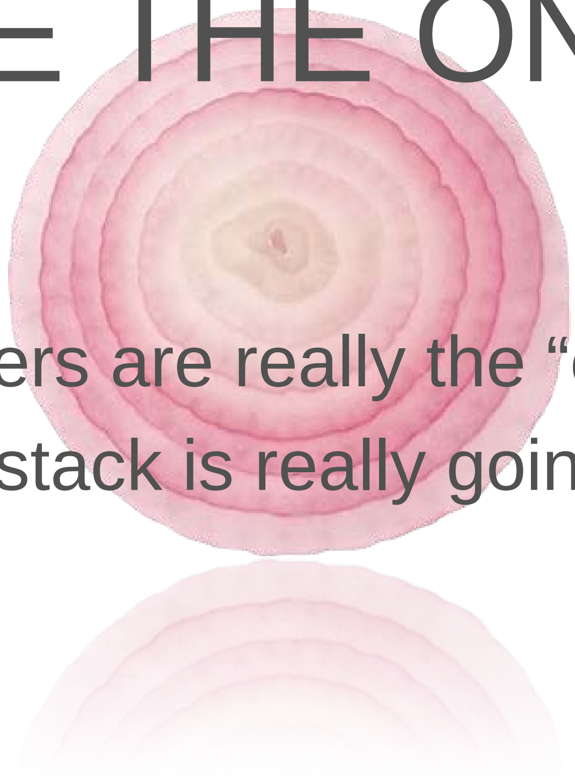
LAYER 1 - PHYSICAL

- This is the “skin” of my OSI Model onion
  - Like an onion, I’m going to discard it (from my talk)

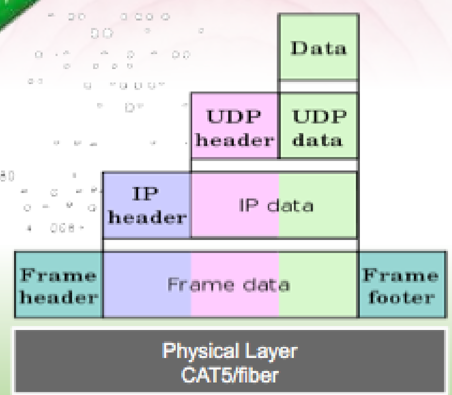
SLICE THE ONION

- The “lower” layers are really the “outer” layers
- Going “up” the stack is really going “in” to the center



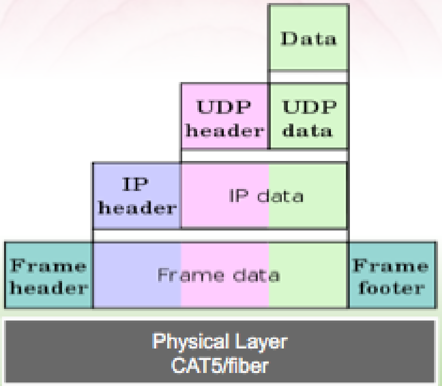
SLICE THE ONION

- 



LAYER 2 - DATALINK

- The “lowest” logical layer
  - The “outer most” wrapper of a chunk of data
    - (remember the onion)



LAYER 2 - DATALINK

- Responsible for reliable transmission of data over the communication medium
  - Detect bit transmission errors
- Local Area Network (LAN)

LAYER 2 - DATALINK

- Ethernet (IEEE802.3)
  - – Other - IEEE802.11, ITU-T G.hn

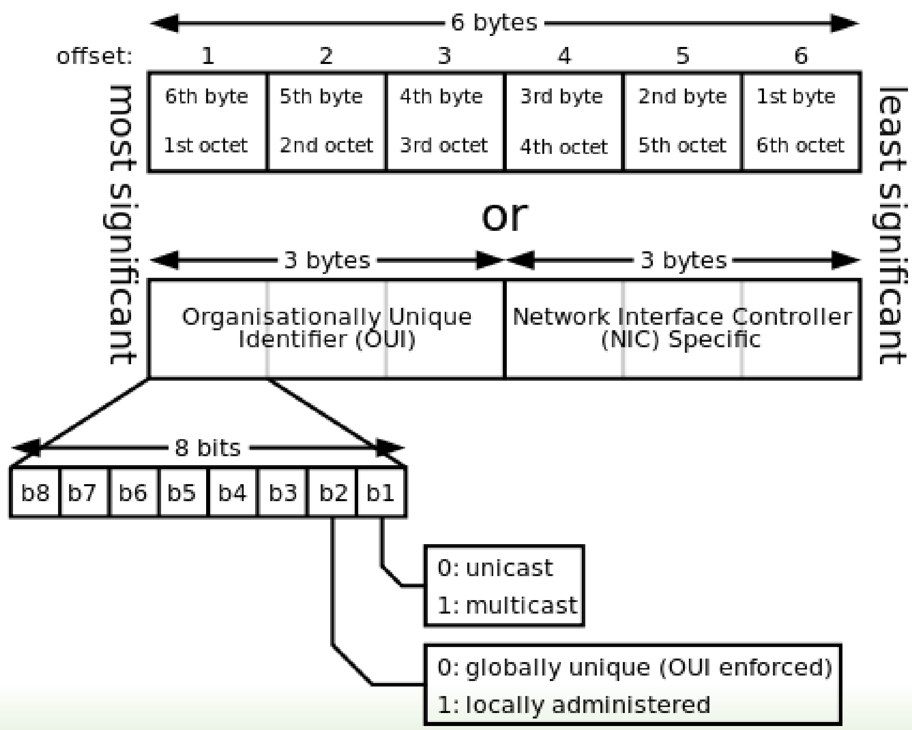
LAYER 2 - DATALINK

- Ethernet
  – “Frames”

Destination MAC						Source MAC						EtherType/ Size		PayLoad					CRC			
1	2	3	4	5	6	1	2	3	4	5	6	1	2						1	2	3	4

LAYER 2 - DATALINK

- MAC Addresses (Media Access Control)
  - e.g. **00-0F-1F-FE-3A-F8**
  - Unicast, globally unique)



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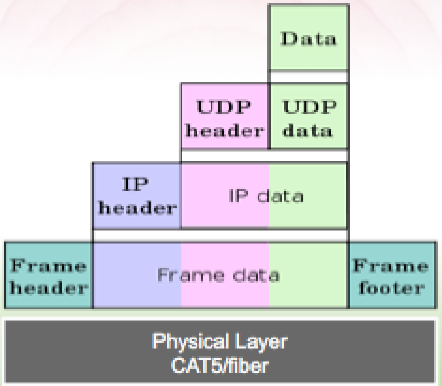
LAYER 2 - DATALINK

- Layer 2 Audio?
  - CobraNet
  - EtherSound
  - AVB

LAYER 3 NETWORK

- This is where pe familiar

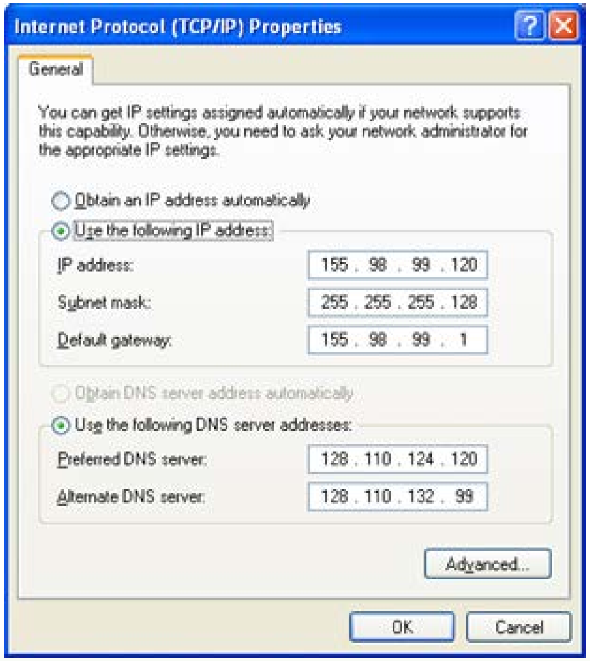


LAYER 3 - NETWORK

- Responsible for:
  - Addressing
  - Fragmentation and reassembly of data streams
  - Maintaining “Types of Service”
  - “Best effort” delivery

LAYER 3 - NETWORK

- IP Addresses



IP ADDRESSING

- IP addresses have 2 parts, defined by netmask
  - Network Prefix and Host Address
  - e.g. 192.168.25.100, Netmask 255.255.255.0
    - Network Prefix 192.168.25.0
    - Host Portion 0.0.0.100

IP ADDRESSING

- Addresses managed by Internet Assigned Numbers Authority (IANA)
- Legacy approach was to divide IPv4 into classes with a fixed network address

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IP ADDRESSING

CLass	First Octet Range	Default Subnet Mask	Max Hosts	Format
A	1-126	255.0.0.0	16M	NETID: Network (1 Octet) . HOSTID: Host . Host . Host (3 Octet)
B	128-191	255.255.0.0	64K	NETID: Network . Network (2 Octet) . HOSTID: Host . Host (2 Octet)
C	192-223	255.255.255.0	254	NETID: Network . Network . Network (3 Octet) . HOSTID: Host (1 Octet)
D	224-239	N/A	N/A	Multicast Address: [ ] . [ ] . [ ] . [ ]
E	240-255	N/A	N/A	Experimental: [ ] . [ ] . [ ] . [ ]

IP ADDRESSING

- Reserved by the IETF / IANA:
  - Private address ranges:
    - 192.168.0.0, 10.0.0.0, 172.16.0.0
  - Zeroconf address range: 169.254.0.0
  - Multicast range: 224.0.0.0 - 239.255.255.255

IP ADDRESSING

- Classless Inter-Domain Routing (CIDR) was introduced to greatly expand the number of addresses
  - Allow the netmask to be variable length
  - Addresses written in the format: a.b.c.d/24
  - Seamless upgrade from legacy approach

IP ADDRESSING

- For example:
  - 192.168.1.0 with a netmask 255.255.255.0 becomes 192.168.1.0/24
  - The “old” Class A, B and C ranges are now:
    - /8, /16 and /24

IP ADDRESSING

- Addresses can be set static (manual) or dynamic
  - Static schemes require someone to design, manage, configure, and maintain
    - Error prone, time consuming

IP ADDRESSING

- DHCP (Dynamic Host Control Protocol)
  - Most devices will use DHCP if one is present on the network
- Often DHCP servers will also allow you to create a "reservation" for a particular address

IP ADDRESSING

- What if there is no DHCP server?
- IPv4 Link Local is an automatic scheme for zeroconf networks
  - Supported by OSX and Windows

IP ADDRESSING

- Hosts use an algorithm to find an IP address in the range of: 169.254.X.Y
  - Ask if the address is already in use
    - If the address is in use, the owner responds
  - If no response, free to start using

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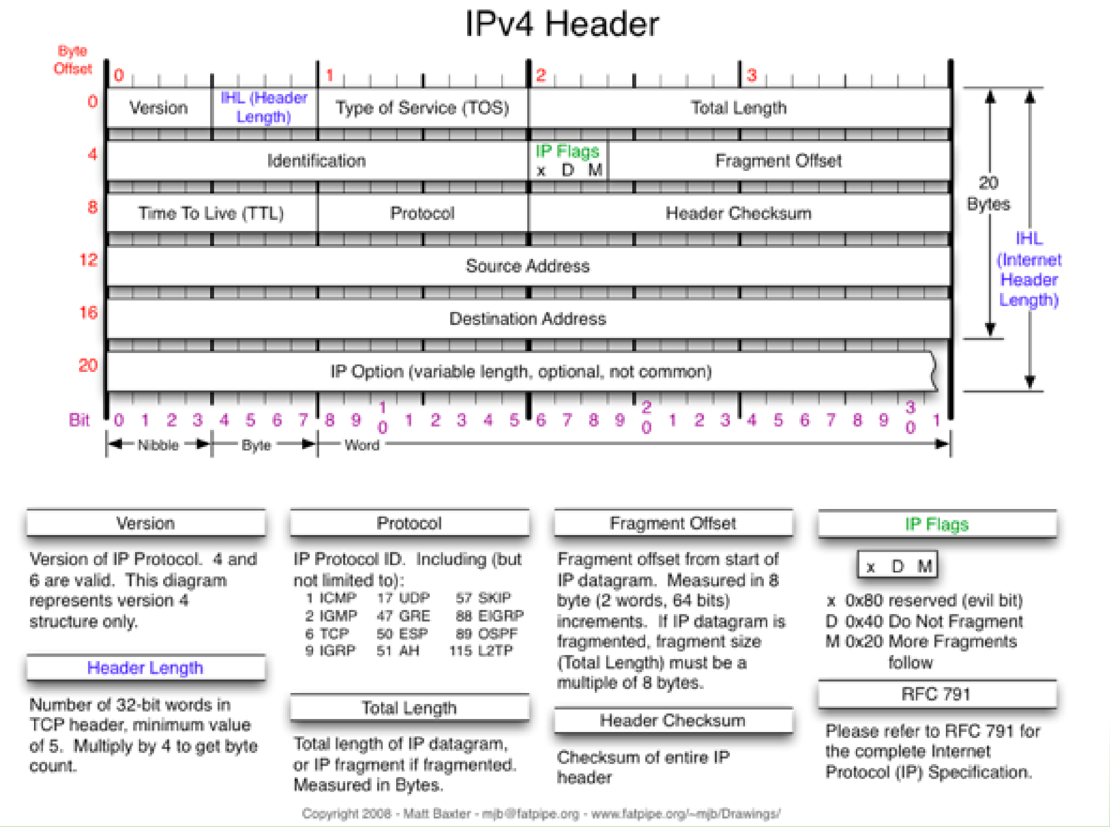
LAYER 3 - NETWORK

- IP Header



LAYER 3 - NETWORK

- Layer 3 enables “routing” of data
  - Routing is how networks are connected together
- Layer 3 enables the creation of "logical" networks
  - Separate networks can share physical infrastructure

LAYER 3 - NETWORK

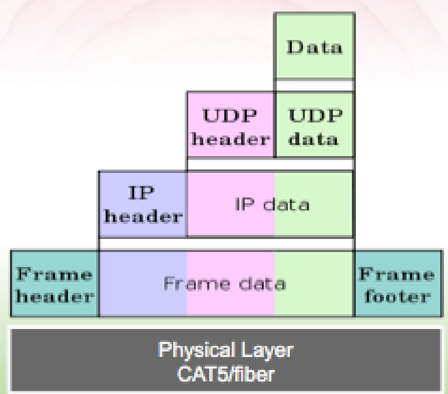
- Layer 3 Audio?
  - Dante
  - AES67
  - RTP

LAYERS 1,2,3

- The level of detail in the OSI model is largely unnecessary for most
- These three layers are the most useful to the AV engineer
- There is very little practical choice or configuration available to the user above Layer 3

LAYER 4 - TRANSPORT

- The “TCP” in TC



TCP

- Makes sure that data arrives
  - Re-transmits lost data
- Takes care of packet ordering
  - Presents data to the application in the order that it was transmitted, not necessarily the order it was received
- Flow control
  - Only transmit at a rate that the network can support

UDP

- Lightweight
- No re-transmitting lost packets by the protocol
- Good for streaming media

LAYER 4 - TRANSPORT

- Layer 4 Audio?
  - All Layer 3 Audio is actually “full stack”
    - Layer 3, 4, 5, 6, and 7

LAYER 5 - SESSION

- How we identify the start and end, defines a “conversation”

TCP

- TCP (yes it is both Layer 4 and Layer 5)

LAYER 6 - PRESENTATION

- The context with which data is presented
  - – Encryption
    - SSL

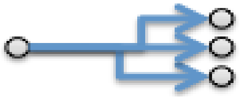
LAYER 7 - APPLICATION

- What you are actually doing!
  - HTTP

NETWORKING CONCEPTS

- Unicast
- Multicast
- QoS

NETWORKING CONCEPTS

- Unicast 
  - – Useful for point-to-point signals
- Multicast 
  - – Useful for one-to-many signals

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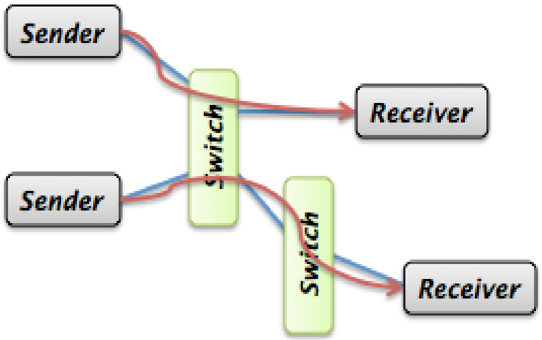
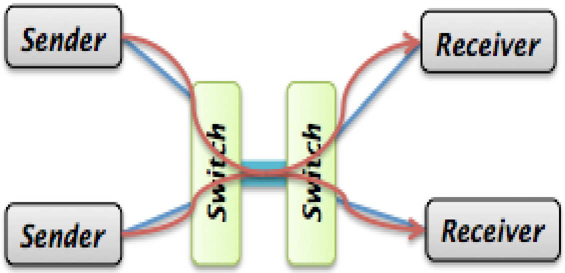
UNICAST

- Point-to-point efficiency
  - – Channels are transmitted once for each receiver

UNICAST

- Packets stay on a narrow path between the sender and the receiver
- Packets only interfere with each other when paths cross
  - Make cross points gigabit!



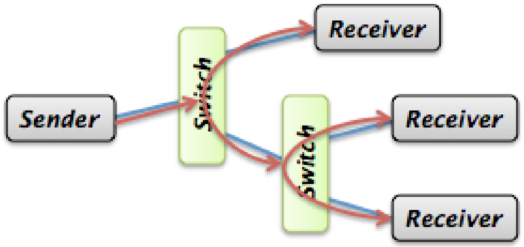


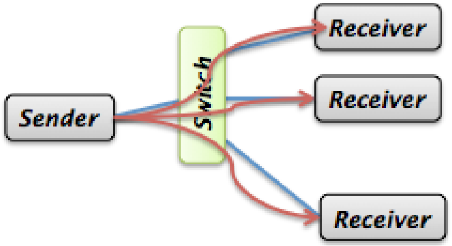
MULTICAST

- One-to-many efficiency
  – Channel are transmitted once to all receivers

MULTICAST

- Packets flood throughout the network, duplicated by switches
- Assume that multicast channels will use up bandwidth on all network links
- Compare to multi-Unicast





IGMP

- Internet Group Management Protocol
  – Manages membership of multicast groups
  – Used between IP hosts and multicast router

IGMP SNOOPING

- Allows a layer 2 (Ethernet) switch to listen in on IGMP protocol messages
- Switch can then route multicast traffic instead of broadcasting it to every port

QOS

QUALITY OF SERVICE

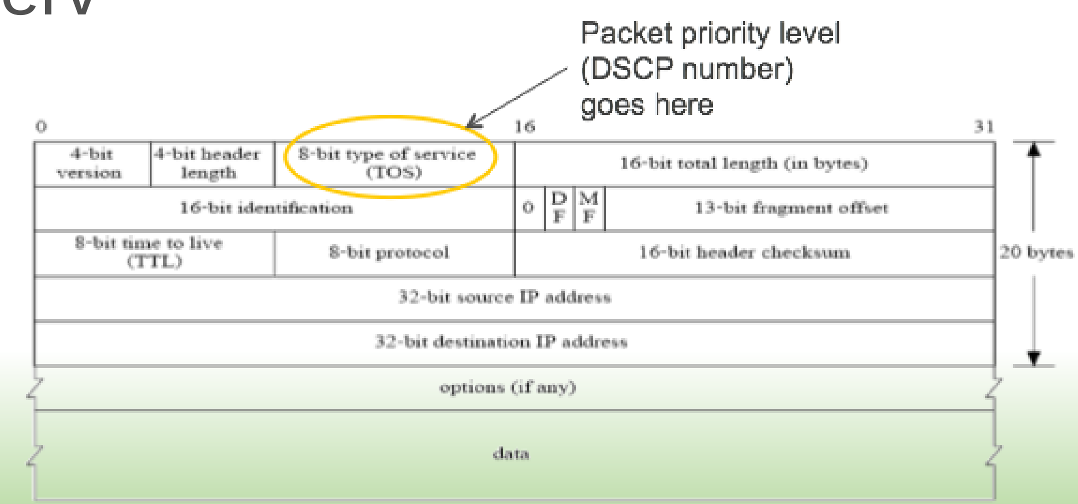
- QoS is a large area with lots of jargon
  - Bottom line is to ensure that some application traffic gets preferred treatment from the network

QOS

- Usually achieved by marking packets with a priority field
  - Just a number which reflects the relative importance of each packet
  - E.g. Diffserv Code Point (DSCP)

QOS

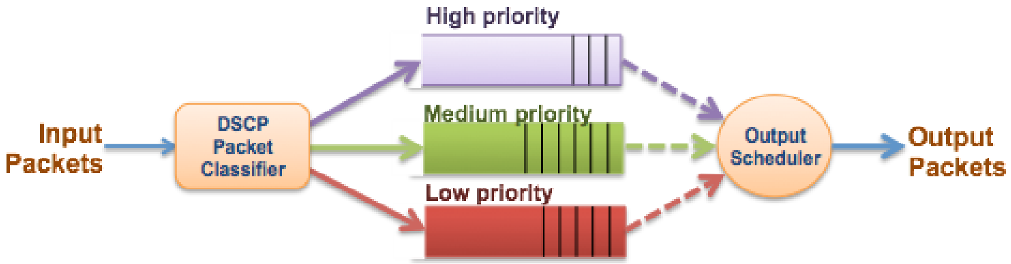
- Diffserv Code Point (DSCP)
- TCP/IP Priority
  - Diffserv



QOS

- Switches can look at the priority value and:
  - Prioritize some packets over others
  - Assign high priority to important traffic
    - E.g. voice packets in a VoIP system
  - The method used in VoIP today

QOS



- Packets can be prioritized and forwarded preferentially

QOS

- Strict Priority
  - Packets are drained from higher priority queues before lower priority queues

EXAMPLE

- Adding networked audio to expand or replace existing
  - Either a common use network or dedicated infrastructure
    - IT will own or manage the infrastructure
- Of course, it will be a Dante networked system

EXAMPLE

- Does Dante require any special network infrastructure?
  - – No, special network infrastructure is not required.
    - Since Dante is based upon universally accepted networking standards, Dante-enabled devices can be connected using inexpensive off-the-shelf Ethernet switches and cabling

EXAMPLE

- Does Dante require a dedicated network infrastructure?
  - – No, a dedicated network infrastructure is not required.
    - Dante-enabled devices can happily coexist with other equipment making use of the network, such as general purpose PCs sending and receiving email and other data

EXAMPLE

- Dante uses DHCP for addressing when available, and will auto-assign an IP address if it is not, exactly like a PC/Mac
  - Dante devices will continue to "look" for DHCP even after auto-assigning an IP address
- Some, but not all, Dante devices allow the setting of static IP addresses

EXAMPLE

- Dante uses mDNS and DNS-SD for discovery and enumeration of other Dante devices
  - Including Dante Controller and Dante Virtual Soundcard
  - Originally known as Apple's Bonjour, this is a low traffic, multicast protocol.

EXAMPLE

- Dante uses Precision Time Protocol (PTP) for time synchronization
  - Dante uses the IEEE1588-2002 version, which uses both unicast and multicast UDP transport
  - This is generally a few small packets a few times a second

EXAMPLE

- Dante uses UDP for audio distribution, both unicast and multicast
  - By default they are sent using unicast addressing, but the user can change this to multicast using Dante Controller
  - Typical bandwidth is about 5Mbps for each audio flow, which can contain up to 8 audio channels, but 4 channels per flow is typical

EXAMPLE

- When does it make sense to use multicast rather than unicast?
  - When a particular audio channel or group of audio channels is being sent to multiple receivers (typically three or more)
  - It is a more efficient use of available network bandwidth to send a single multicast packet to many receivers than to send individual packets with identical payloads to each receiver

EXAMPLE

- Dante implements IGMP to assist with multicast management
  - Support for IGMP is not required in a network
  - It is in Dante to make integration into mixed-use networks simpler

EXAMPLE

- Dante uses standard Voice over IP (VoIP) Quality of Service (QoS) switch features to prioritize clock sync and audio traffic over other network traffic
- Any switch that supports Diffserv (DSCP) QoS with strict priority and 4 queues, and has Gigabit ports for inter-switch connections should be appropriate for use with Dante

EXAMPLE

- Dante will tag packets and its tags can be integrated into an existing IT network QoS scheme

Priority	Usage	DSCP Label	Hex	Decimal	Binary
High	Time critical PTP events	CS7	0x38	56	111000
Medium	Audio, PTP	EF	0x2E	46	101110
Low	(reserved)	CS1	0x08	8	001000
None	Other traffic	BestEffort	0x00	0	000000

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Chris Ware
Audinate