CSCD 433/533
Advanced Networks

Lecture 2
Network Review
Winter 2017

Reading: Chapter 1

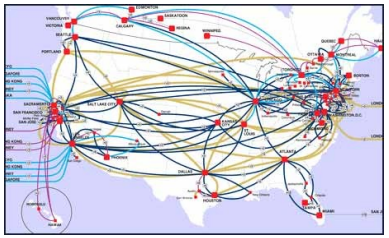
Topics

- Network Topics Some Review from CSCD330
  - Applications
  - Common Services
  - Architecture
  - OSI Model
  - AS and Routing Review
  - Packet vs. Circuit Switching
- Review concepts for Design Goals

Review Topics for Design

- Useful to review topics we covered in CSCD330 with respect to their design
- This course will be exploring how network components fit together to form a complex system
- Where in this system can we increase efficiency, change design for the better, look at continuing trends for networks

Review



- Most of you know or recall many of the things we learned in CSCD330

- See how much you remember

Building Blocks of Networks Applications

- Look at network applications we all use
- Look at network services they need

Building Blocks of Networks Applications

- Two main types of applications
  1. Data transfer
     - Web pages
     - File transfer
  2. Streaming Audio and Video
     - Real-time Audio and Video
     - Voice Over IP

  Some have elements of both ….

  Online games.

- Network Design Issues
  - Where to put common network services

Common Services

- Network Applications
  - What we want is to have common set of network services
    - Otherwise ….
  - Each application needs to build its own network communications
  - Why is this bad?
    - Makes applications more complicated than necessary
    - Redundant to build communications into each application

Common Services

- Challenge
  - To provide useful set of services that gives choices to applications
  - Need to understand “design patterns” of network applications
  - What are some common needs of network applications?

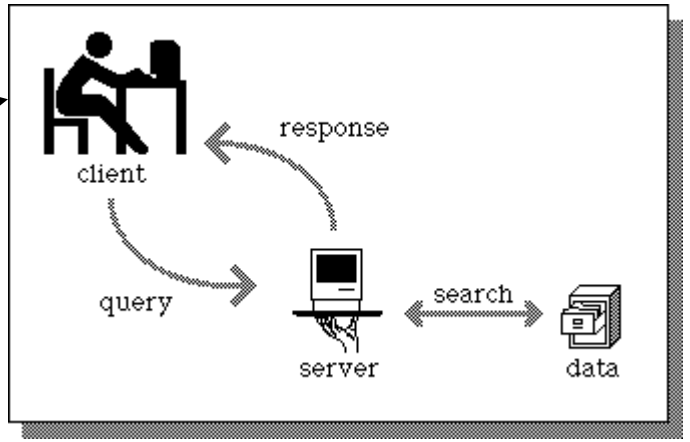
Common Services

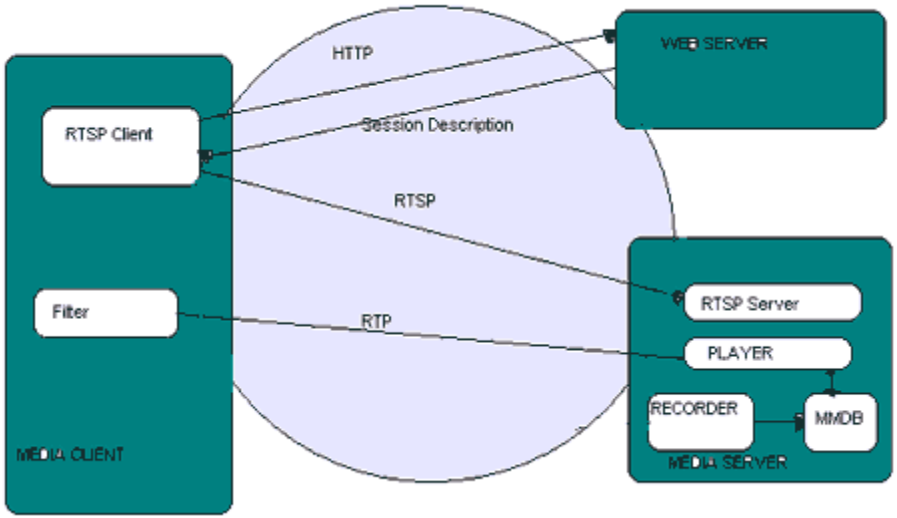
- File Transfer
  - Important use of networks from the beginning
  - Involves a client sending a request and a server responding with data or Peers providing file chunks

Video or Audio Streaming or Static Text/Image Transfer

- Two general types of channels

Request/Reply channel





Message Stream channel

Common Services

- Reliability
  - Networks can fail
  - Machines crash, network lines are cut, electrical interference, deliberate interference, hardware problems
  - Ideally, network design should incorporate error correction so network applications don't need to be aware of failures

Common Services

- Security

  Network applications need security

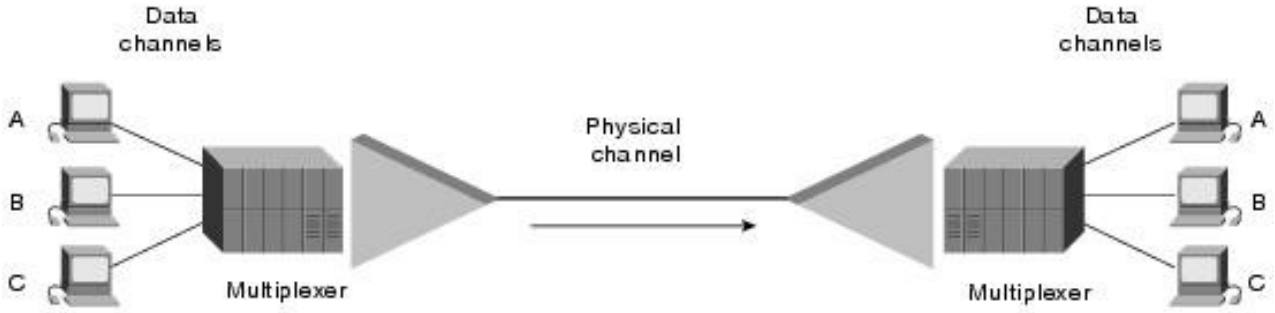
  Question is … should every application do their own encryption and other security protocols or

  Should security be a service offered

  - Network level
  - Application level

Common Services

- Shared Resources
  - Need to accommodate each application
    - Fair use of network
    - Regulate or stop traffic if too much
    - Allow full network use when traffic is light
    - Possible priority for some applications



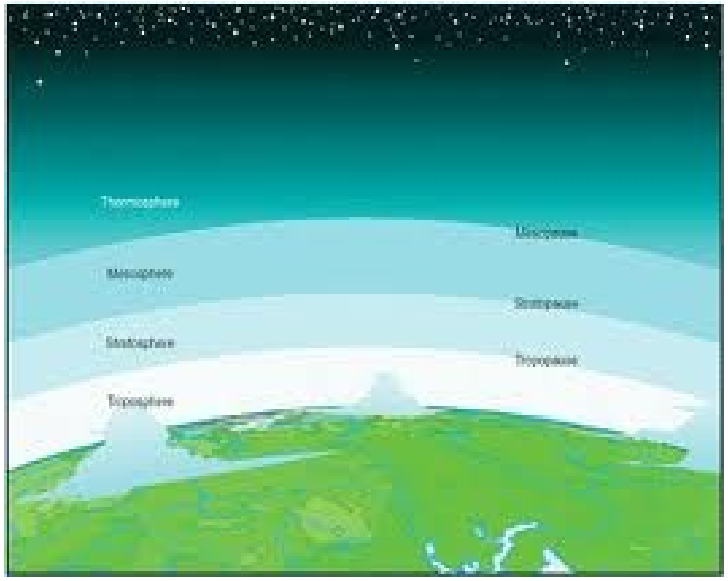
Network Architecture

- Layering and Protocols
  - Abstraction

    How does abstraction work in software?
    - Hides details behind an interface
    - Manages complexity
    - Provides an interface that can be manipulated by other components of the system
    - Hides details of how object is implemented

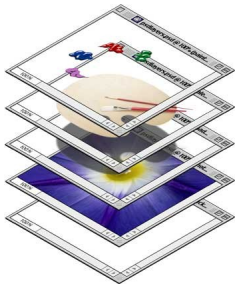
Network Architecture

- Challenge
  - Identify useful abstractions to provide universal service and
  - Do it efficiently



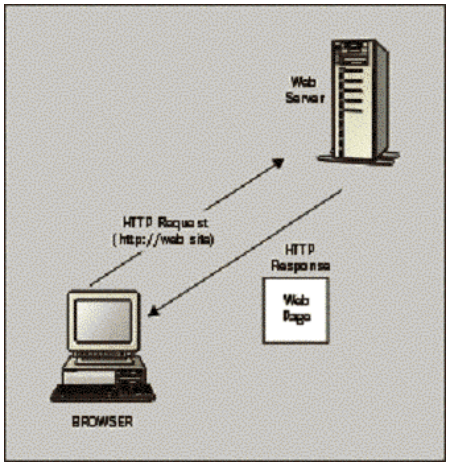
- Abstractions in Networks
  - How do networks do abstraction?
    - Layers !!!!

Layering



- Start with services provided by the hardware, then add layers, each providing services to the layer just above it
- Why is this an advantage for networks?
  - Decomposes complex problem
  - Makes pieces more manageable
  - More modular design
    - Easier to add a new service or to modify functionality of a layer

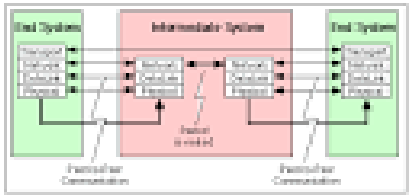
Layering Example



- Example of protocol layering
  - HTTP - Web Browsing
    - Uses services from TCP, reliable delivery
    - Uses services provided by IP, unique addressing
    - Uses services provided by Ethernet, ARP address mapping from IP to MAC address
  - How do we refer to this set of Protocols?
    - Network Stack

Network Architecture

- Abstract Objects within a Network
  - Protocols
    - Each layer, protocols use encapsulation
    - Attach headers/trailers to packets
      - Instructions for Peer protocols on receiving end
    - Body of message - data

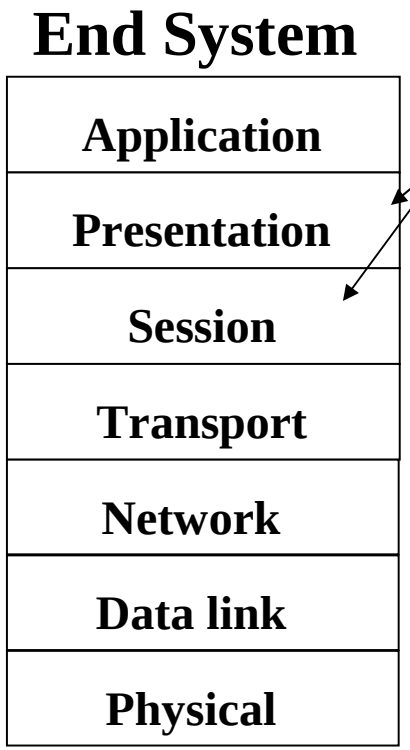


Network Architecture

OSI Model

- Original OSI model and
- Its Current or Modern Form
- Who can draw these models on the board?

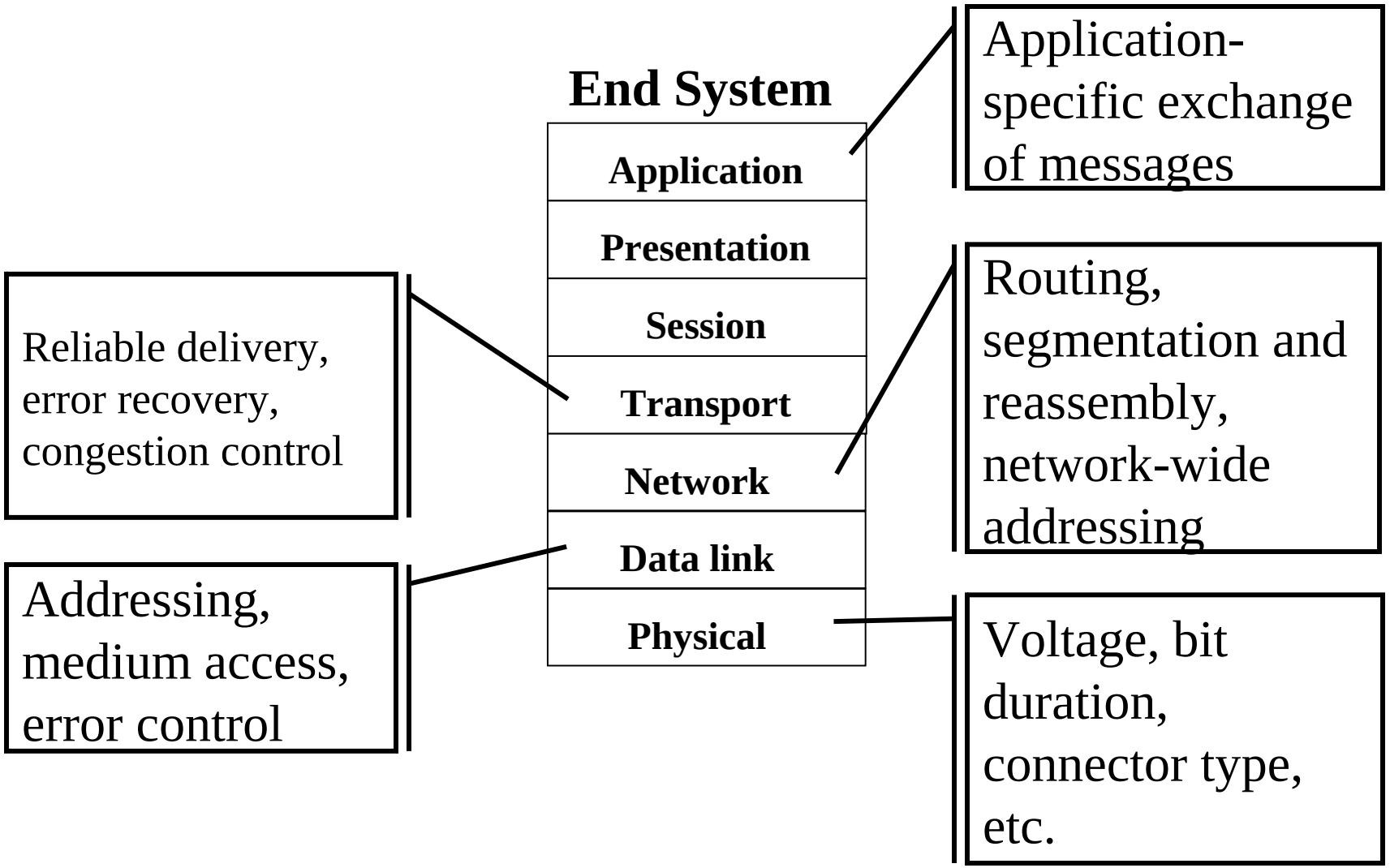
Original OSI Model, 7 Layers



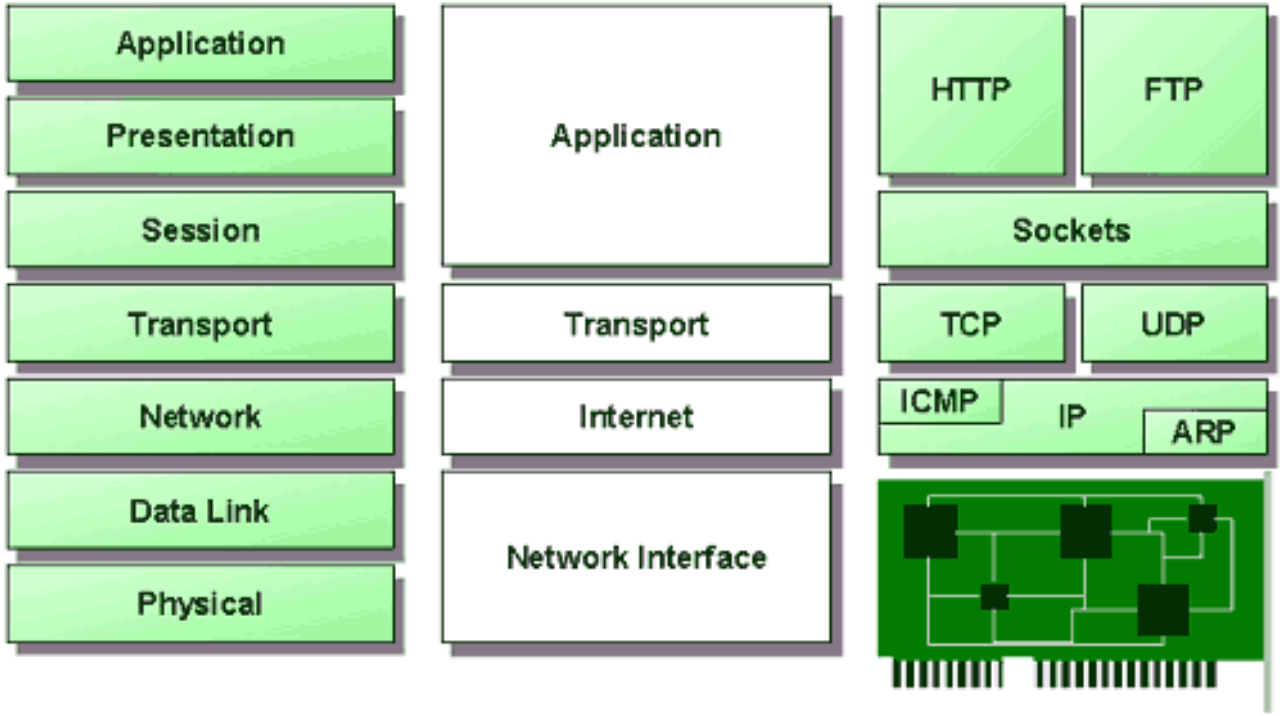
Ignore the two extra layers

What does each layer do?

Original OSI Model



OSI and the TCP/IP Suite



OSI and TCP/IP

Source: “Introducing TCP/IP,” by FindTutorials.com

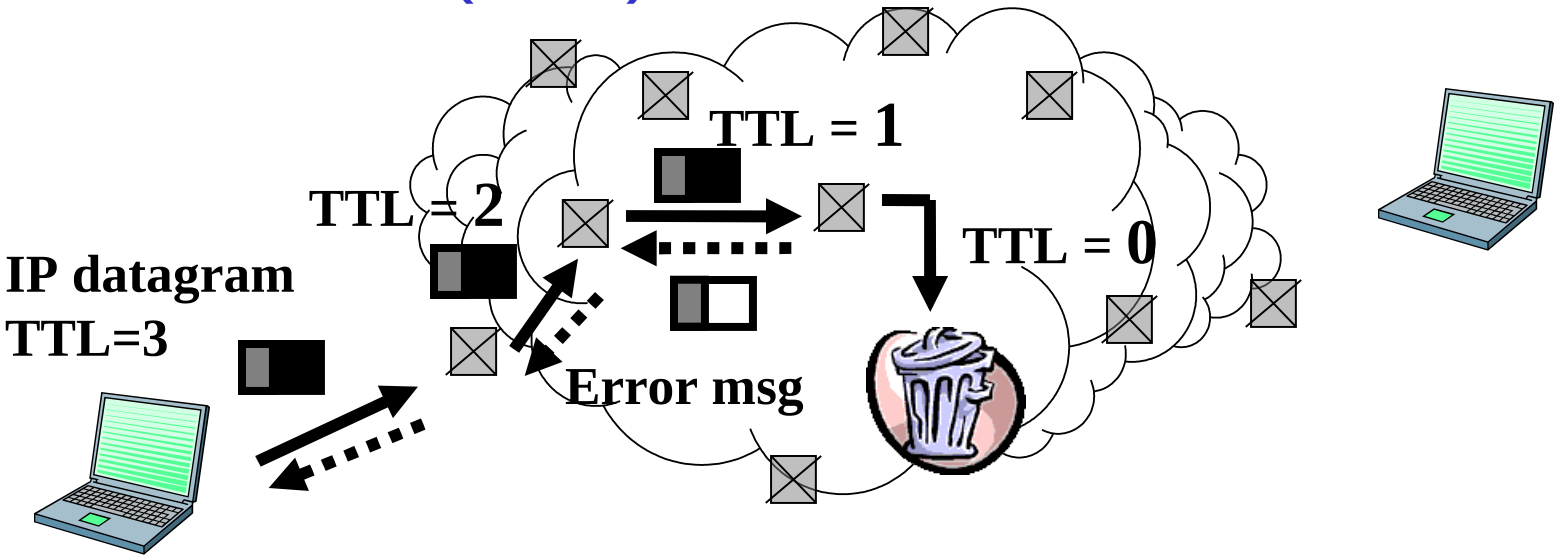
Essential Characteristics of IP

What are they?

- Connectionless
  - Each IP datagram is treated independently and may follow a different path
- Best effort
  - No guarantees of timely delivery, ordering, or even delivery
- Globally Unique 32-bit Addresses
  - Usually expressed in dot-decimal notation: 128.17.75.0
  - Each interface has its own IP address

Essential Characteristics of IP

Time to Live (TTL)

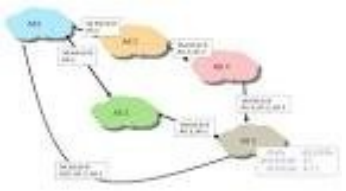


- IP datagram headers contain a TTL field
  - At each router, this field is decremented; if it reaches 0, datagram is discarded and an error message is generated
- Original purpose was to prevent datagrams from endlessly circulating within the network

ICMP

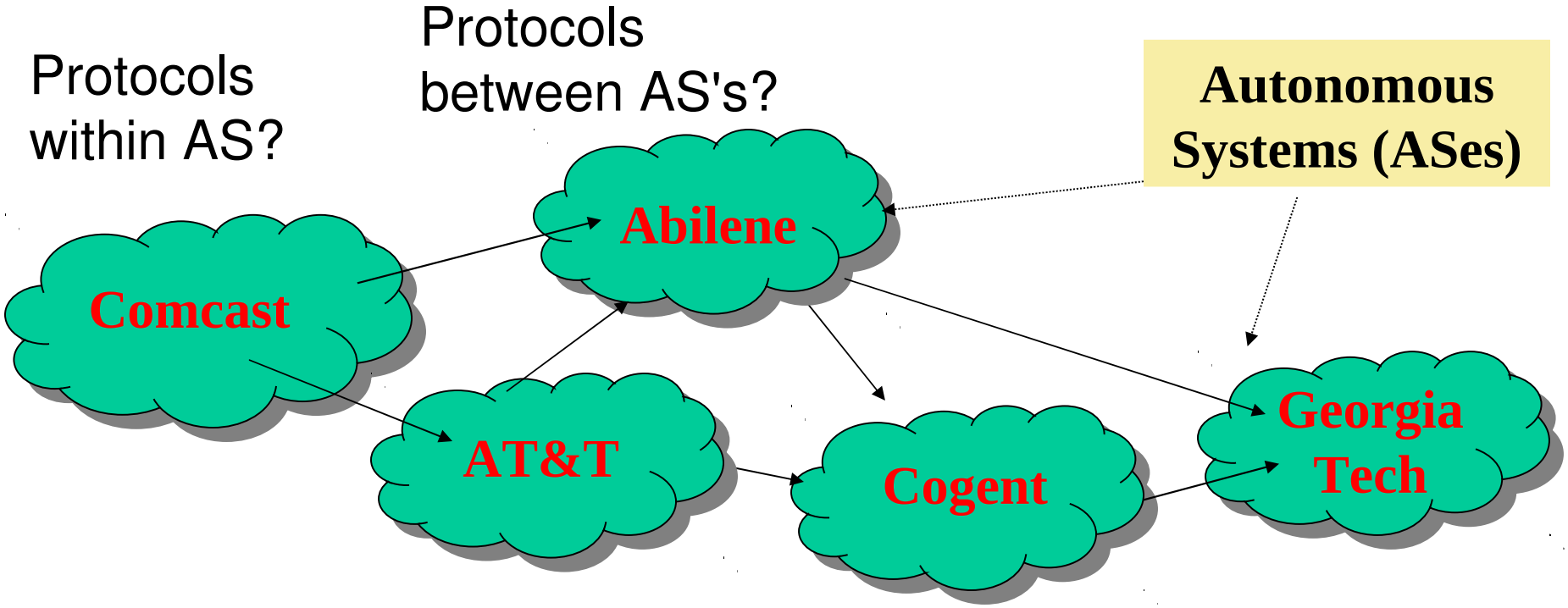
- Internet Control Message Protocol (ICMP)
  - Used by hosts, routers and gateways to communicate network layer information to each other
  - Typically used for error reporting
- Uses IP Delivery
  - ICMP messages are carried as IP payload
- ICMP messages
  - Type and code - contain first 8 bytes of IP datagram that caused ICMP message to be generated
- Many Common Utilities
  - Ping, and Traceroute
    - Implemented by ICMP messages

Autonomous Systems (AS's)



- What are they?
- Autonomous system (AS) is unit of router policy
  - Either single network or group of networks controlled by a common network administrator
  - On behalf of a single administrative entity
  - Such as a university, a business enterprise, or a business division

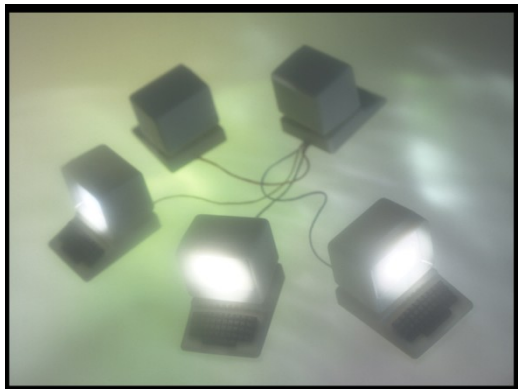
The Internet: A Network of Networks



- **ISPs and Telephone Companies**
  - Have their Networks, connected using routers that support communication in a hierarchy
  - Companies contract with each other for mutual use of backbone resources
- Define protocols for communication between and within AS's

Network Trends and Open Problems

- Making networks easier to manage
  - Has been strong interest in “self-managing” networks
- Improving trust/identity in networks
  - Spam, phishing attacks, etc.
- Policy-related issues (net neutrality, government censorship, spying on civilians)
- Meeting increasing demands of diverse set of applications
  - Real-time needs, bandwidth consumptive
  - Streaming video, VOIP, Television over IP



Network Models

Network Communication Models

Recall, What are the two main ways networks communicate? Two types of models …

1. Circuit Switching
2. Packet Switching

Circuit Switching

- Resources are reserved
- Establishes a connection (circuit) to the destination
- Source sends data over circuit
  - Constant transmission rate
- Example: Telephone Network
  - Very early versions: Human-mediated switches.
  - Early versions: End-to-end electrical connection
  - Today: Virtual circuits

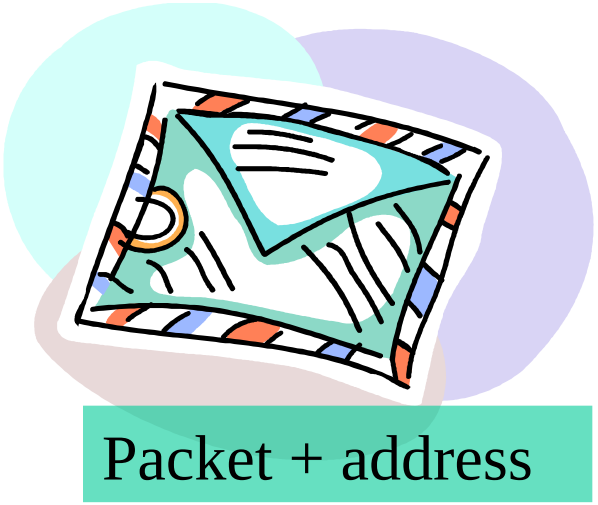
Circuit Switching

- **Advantages and Disadvantages?**
- **Advantages**
  - Fast and simple data transfer, once circuit has been established
  - Predictable performance since circuit provides isolation from other users
  - Guaranteed bandwidth

Circuit Switching

- **Advantages and Disadvantages?**
- **Disadvantages**
  - Does not handle bursty traffic very well
  - Users have differing needs for bandwidth
  - What if all resources are allocated?

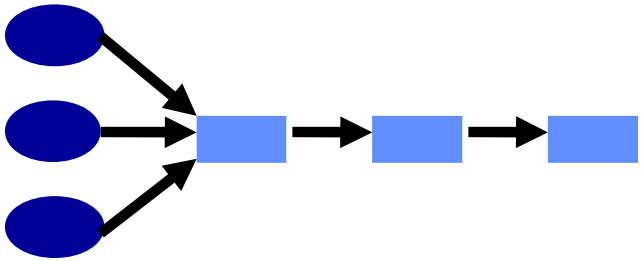
Packet Switching



- Resources are not reserved
- Packets are self-contained
  - Each has a destination address
  - Source may have to break up single message
- Each packet travels independently to the destination host
  - Routers and switches use the address in the packet to determine how to forward the packets

Resource Sharing: Packet Switching

- **Statistical multiplexing**
- Switches Arbitrate between inputs



- Can send from *any* input that's ready
  - Links are never idle when traffic to send
  - Efficient
  - Requires buffering/queues

Forwarding: Packet-Switched Networks

- Each packet contains a destination in the header
  - Much like a postal address on an envelope
- Each hop (“router” or “switch”) inspects the destination address to determine the next hop

Summary

Brief review of CSCD330 content

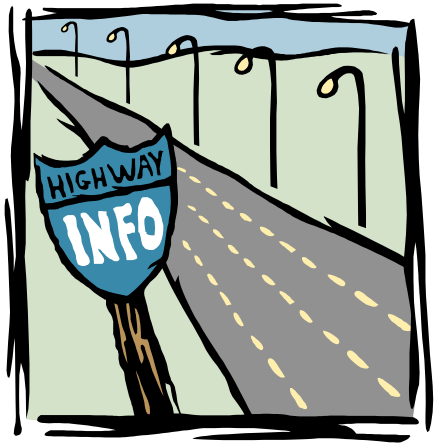
Beginning of Network Design

Network applications - Common Services

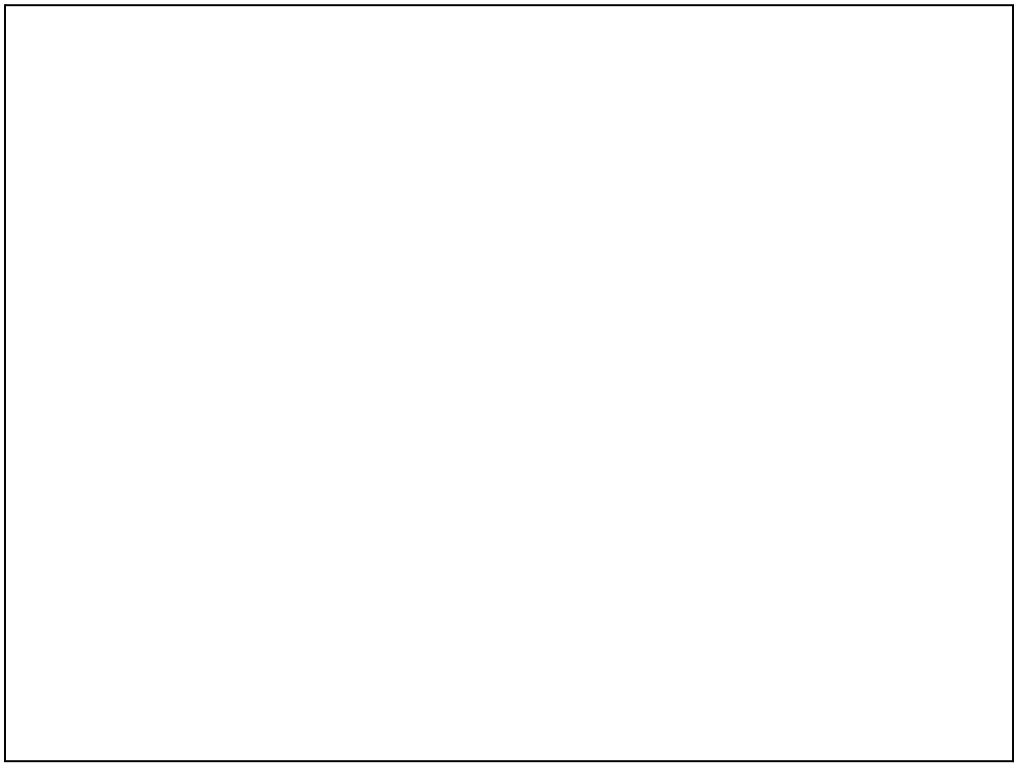
- Their needs for network services
- How we can optimally meet these needs

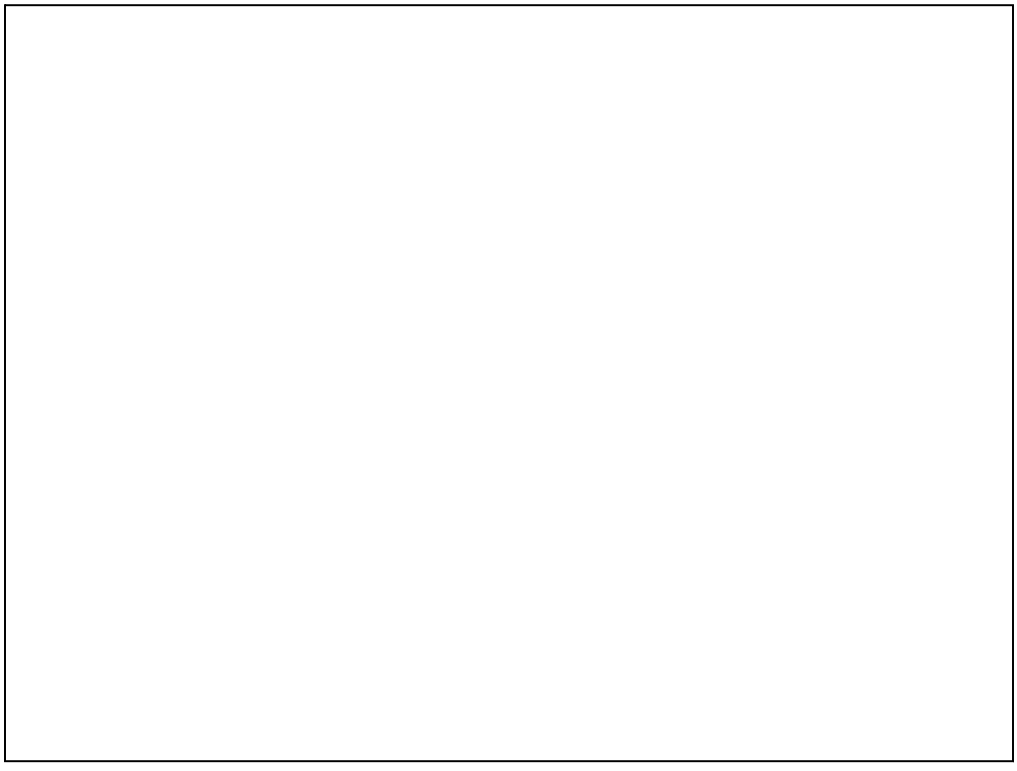
More topics later … Stay Tuned

Next time: Reading Chapter 1 for this lecture, Chapter 2 for next time



End





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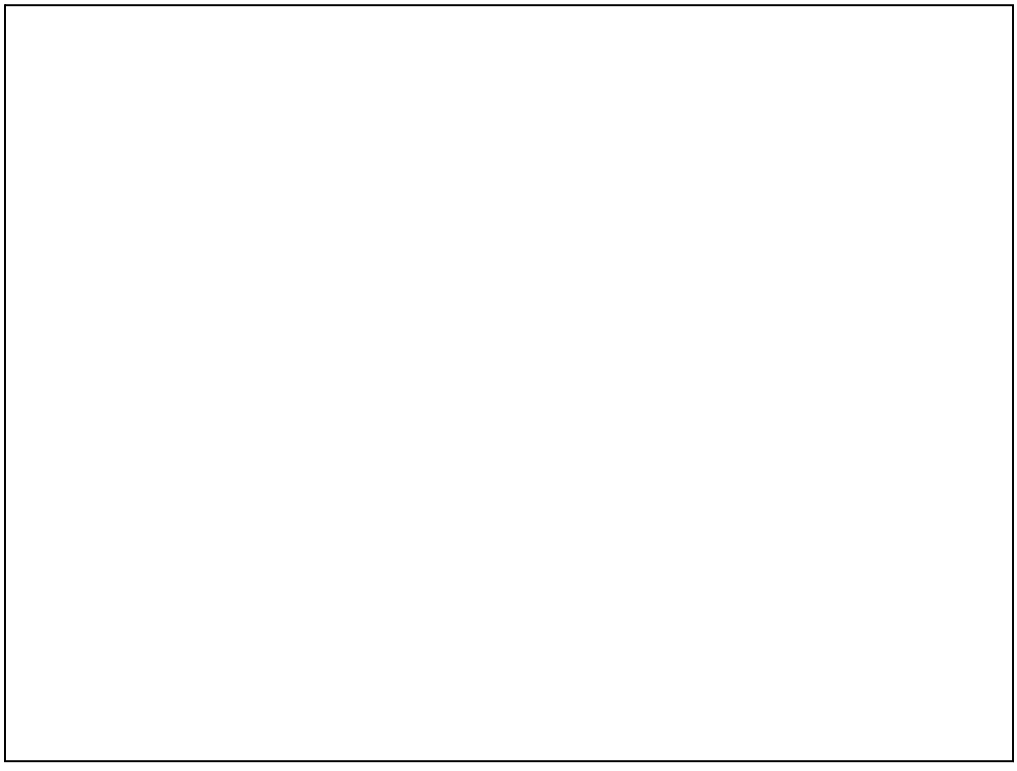

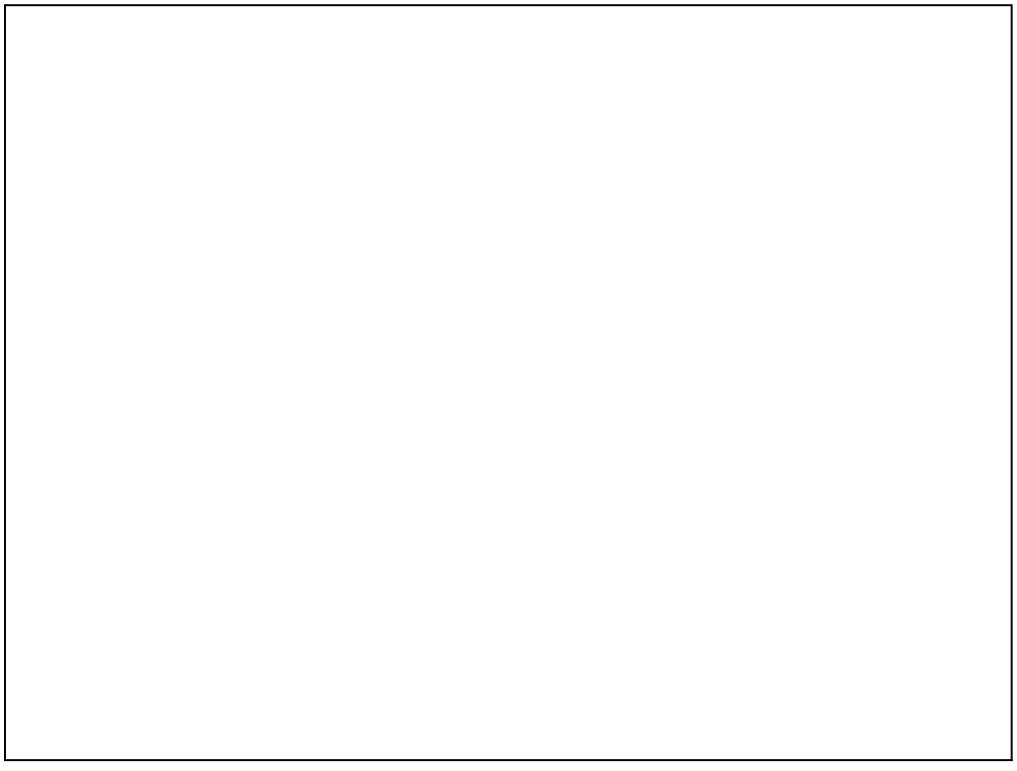

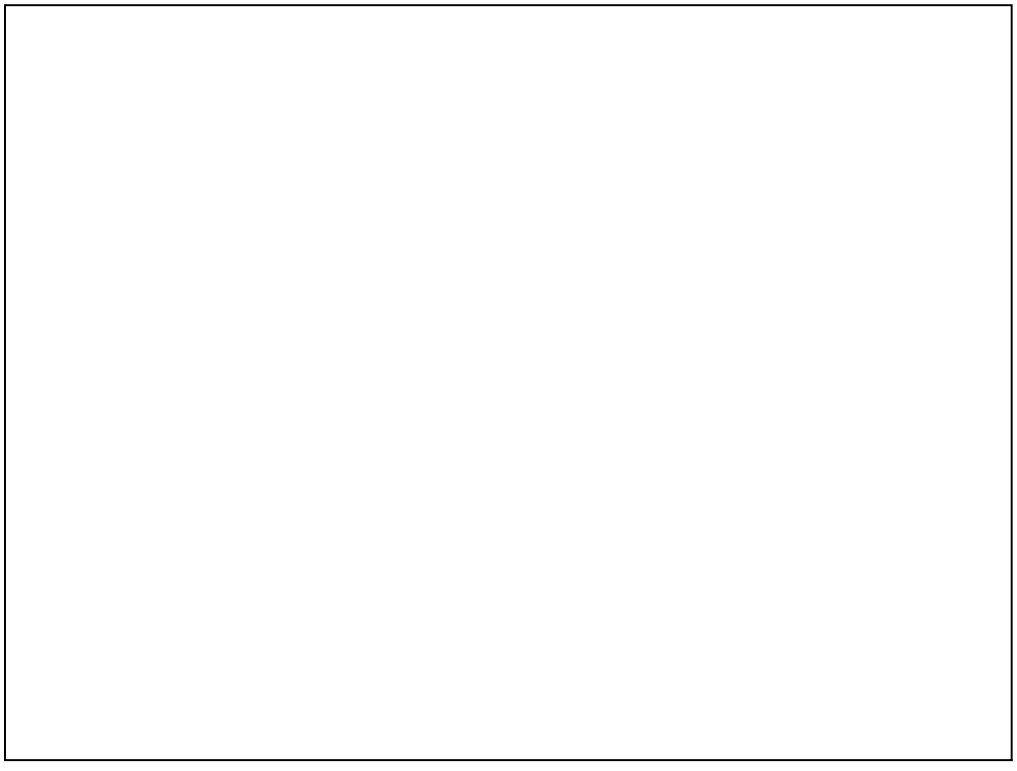

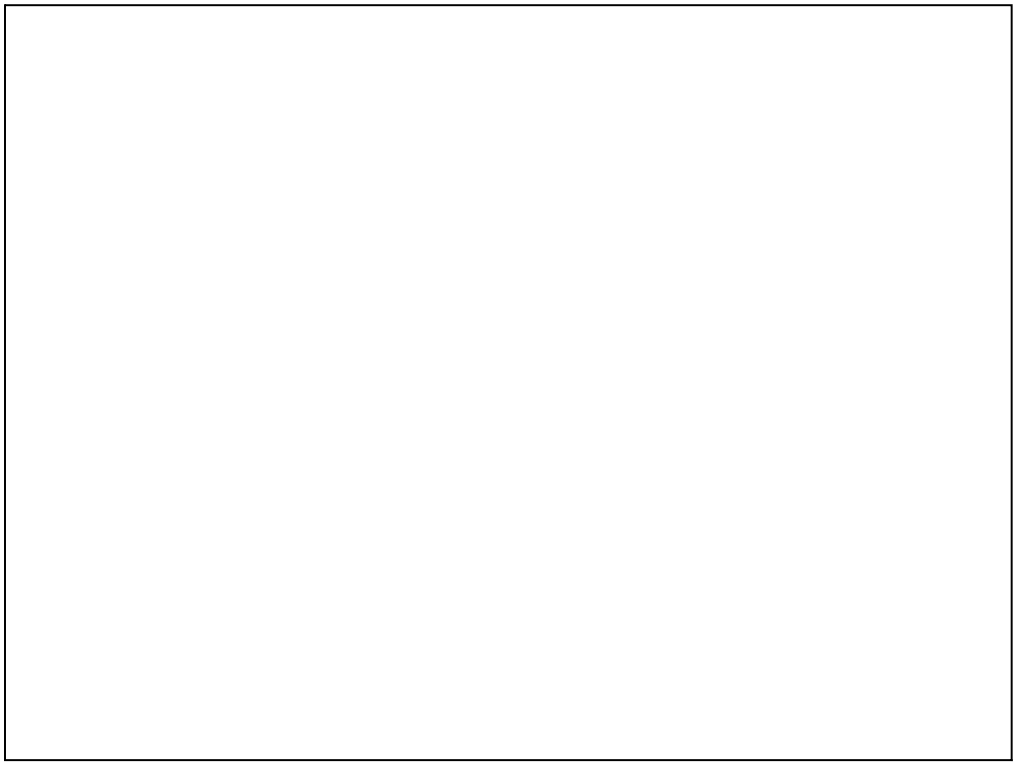

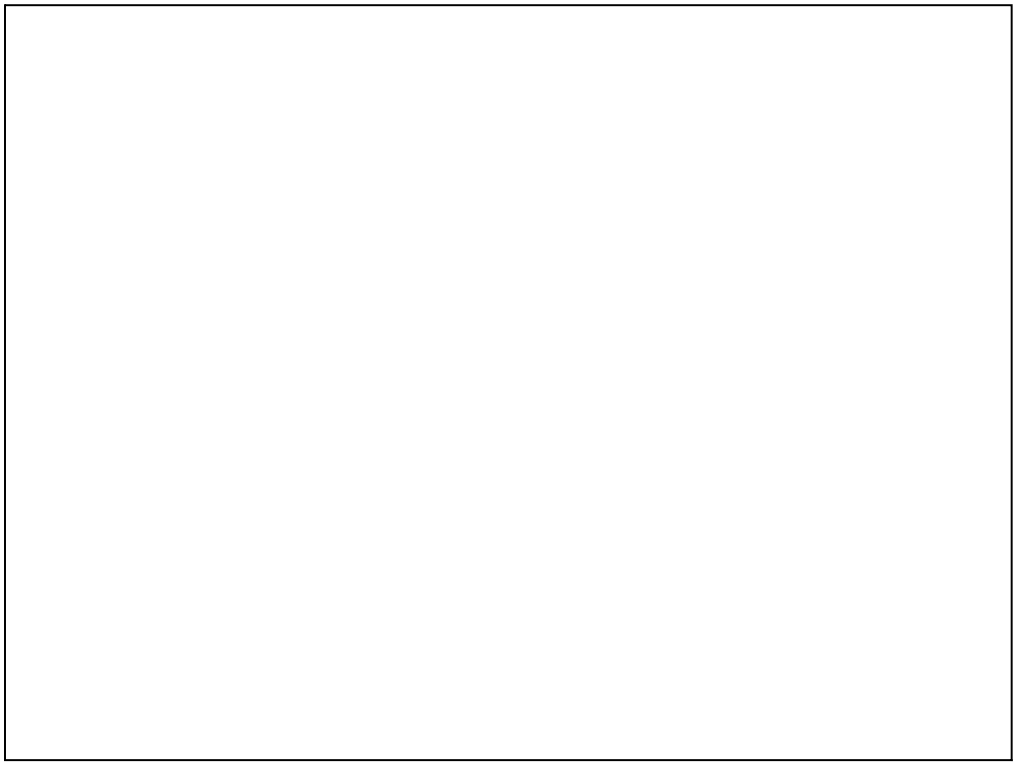

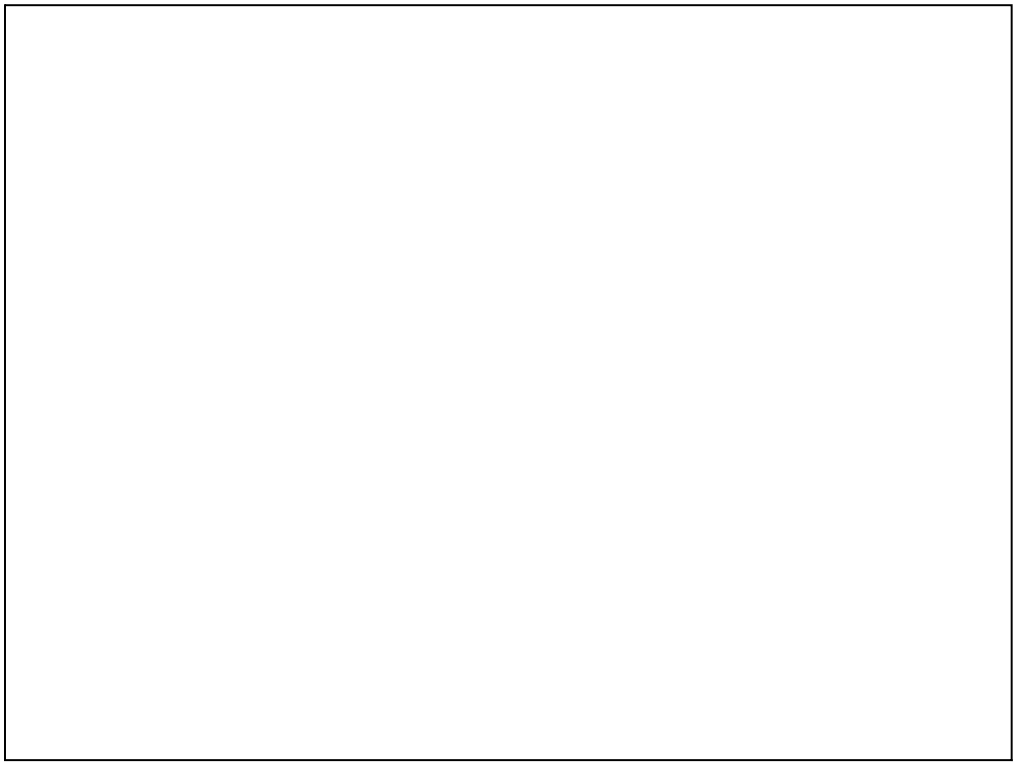

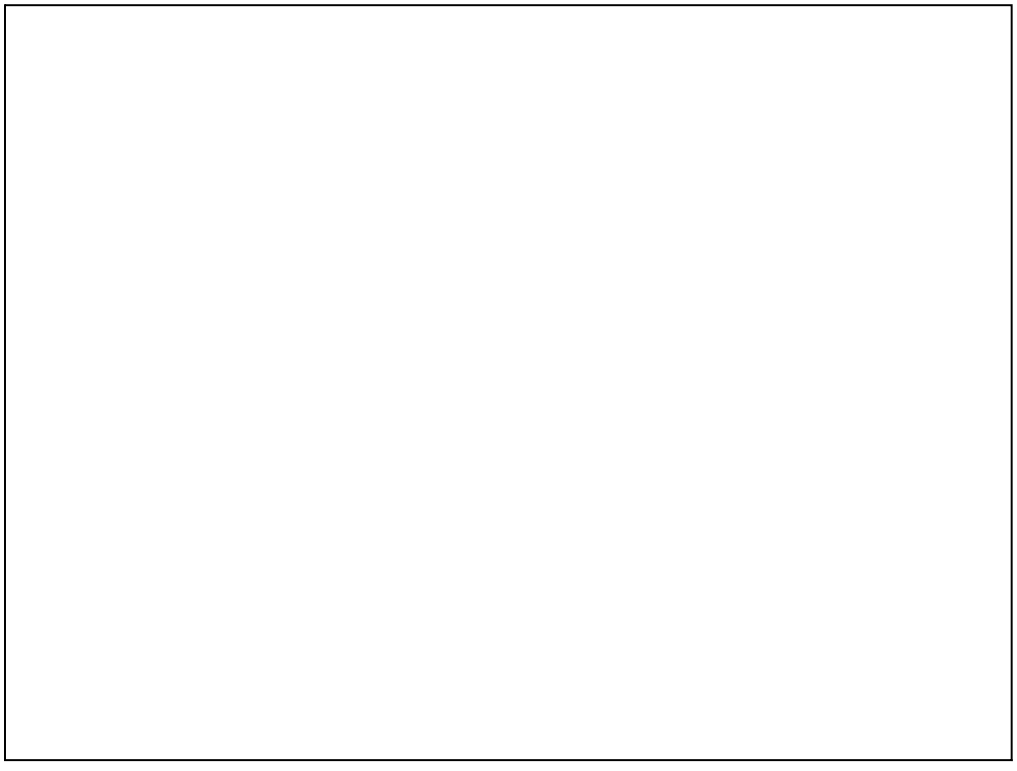

Common Services

- Security

  Network applications need security

  Question is … should every application do their own encryption and other security protocols or

  Should security be a service offered

  - Network level
  - Application level

Common Services

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  - Need to accommodate each application
    - Fair use of network
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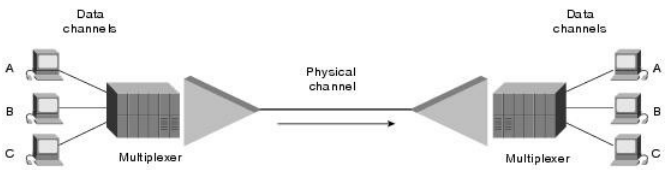
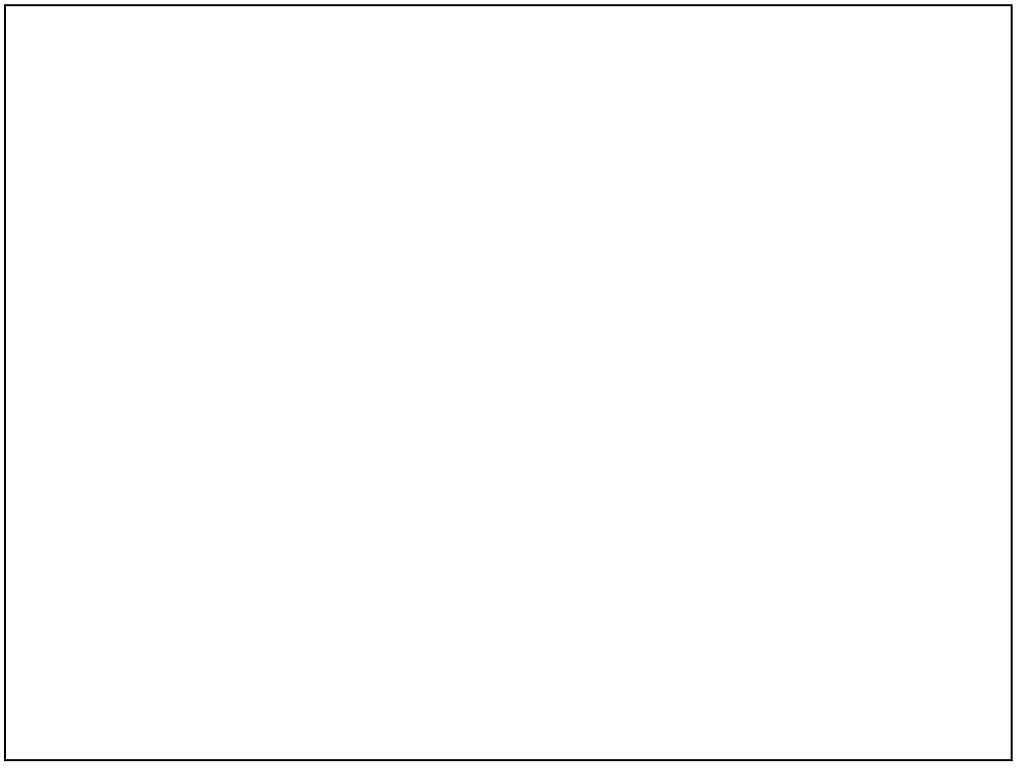
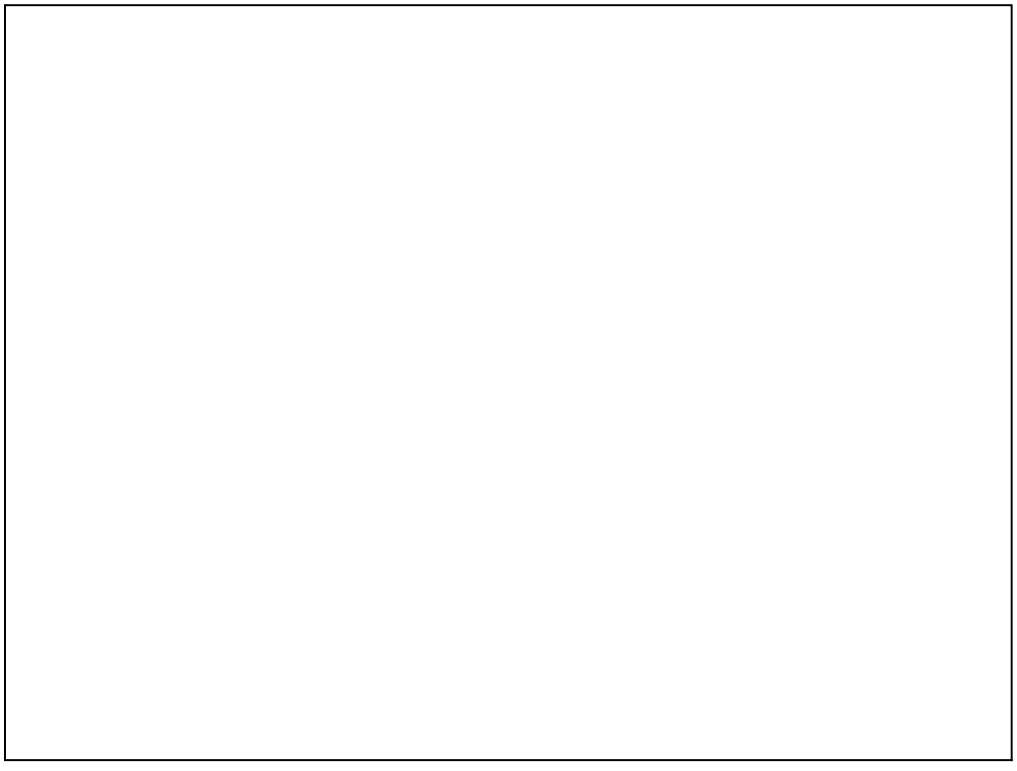
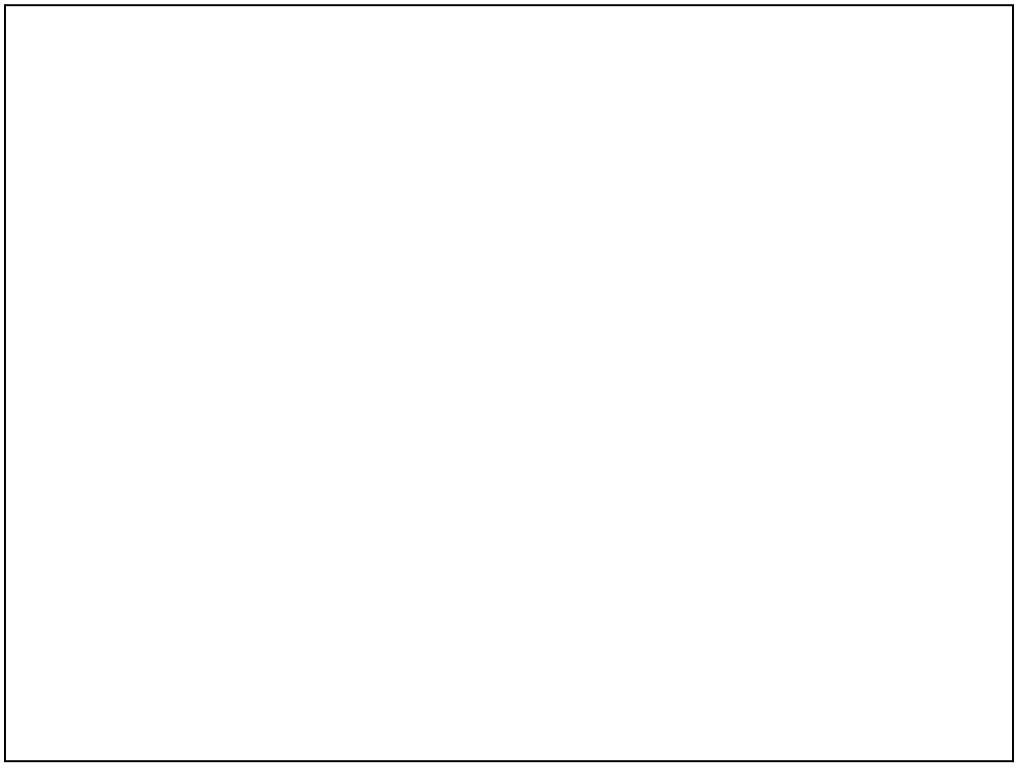
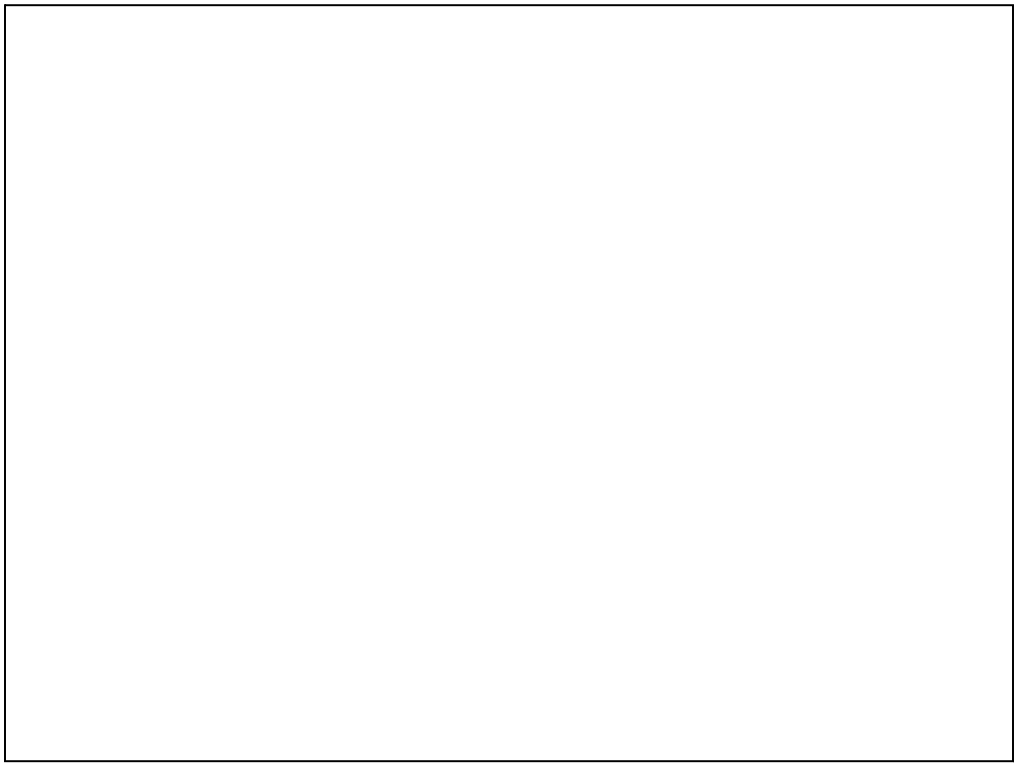
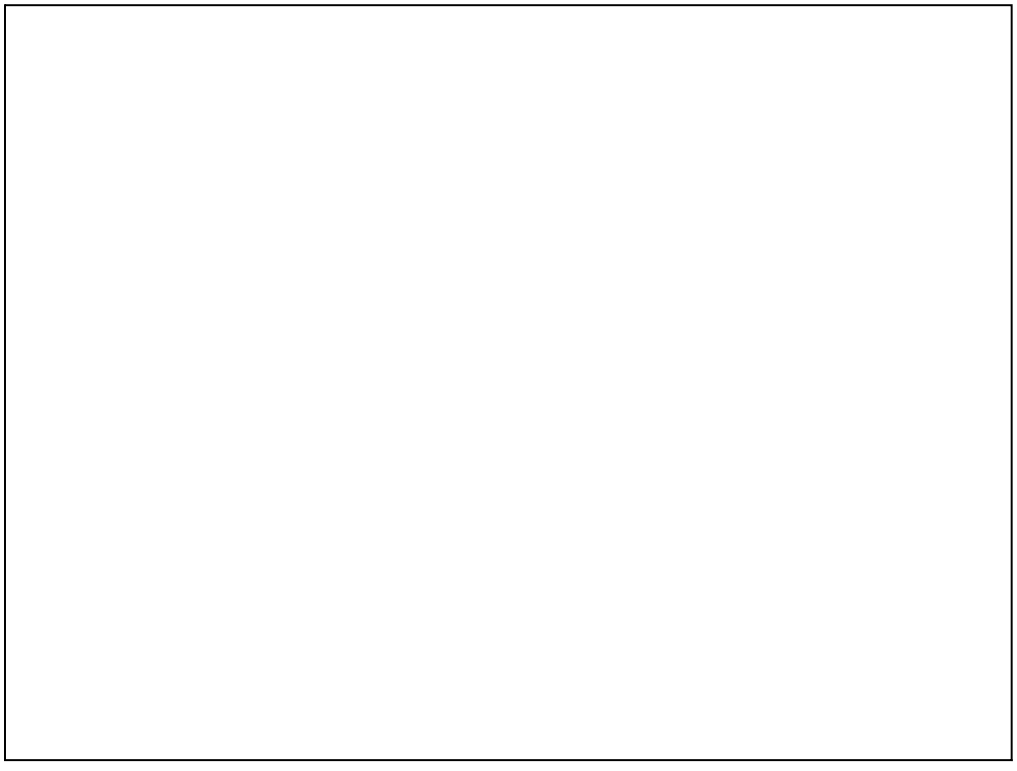


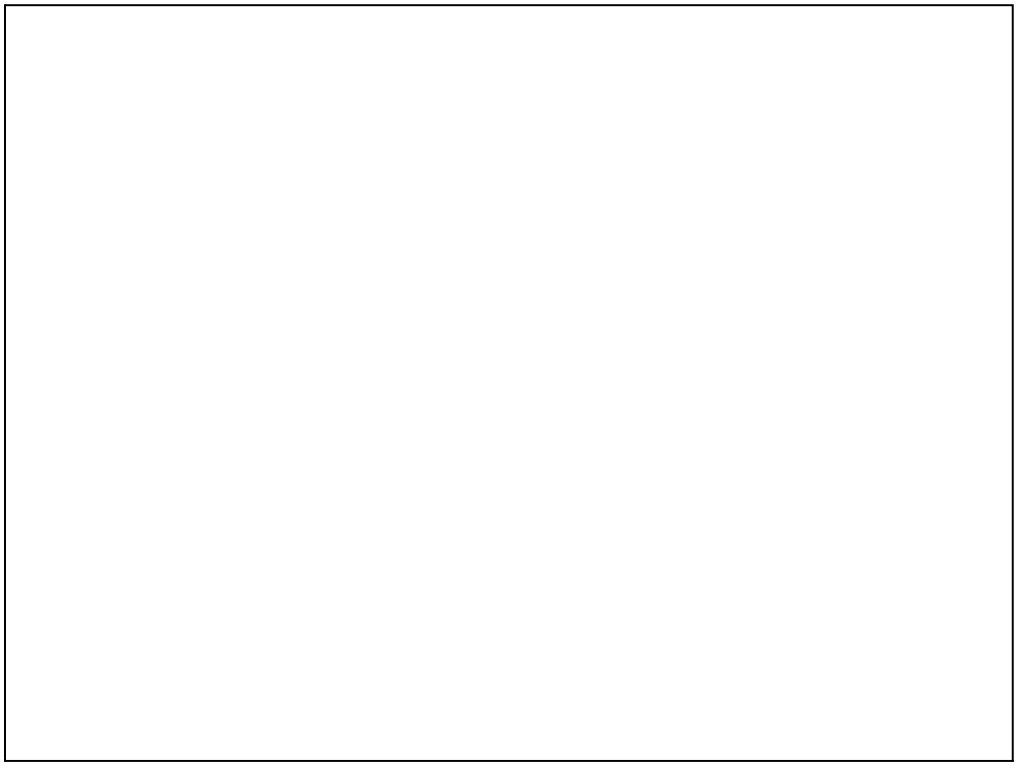


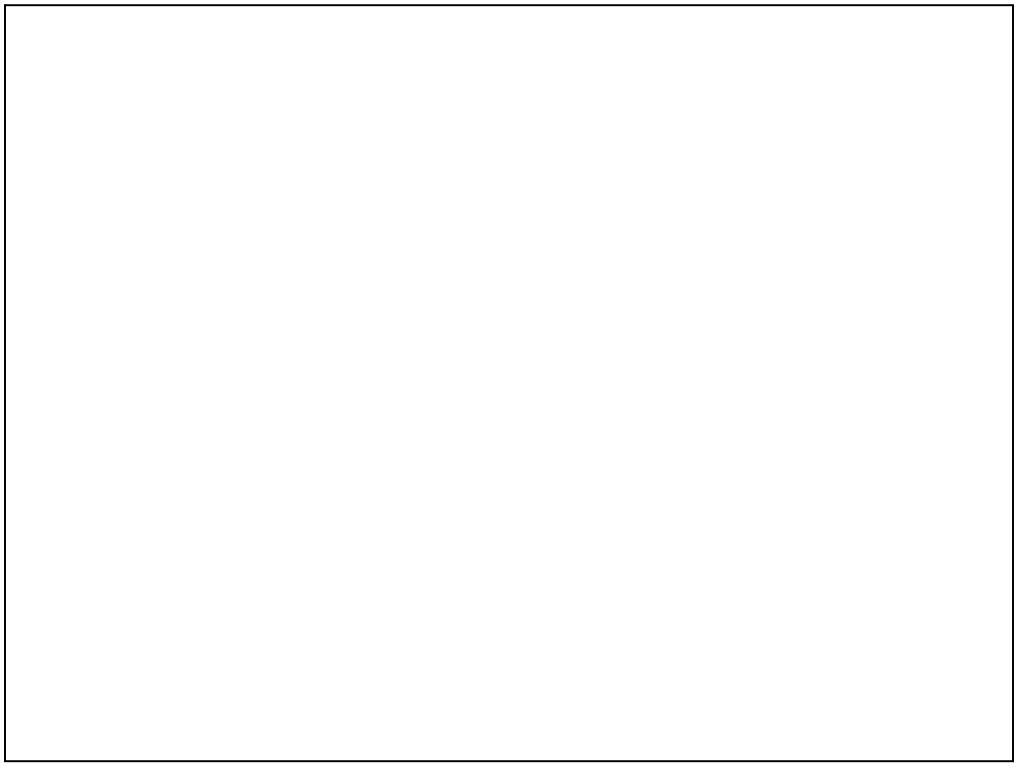


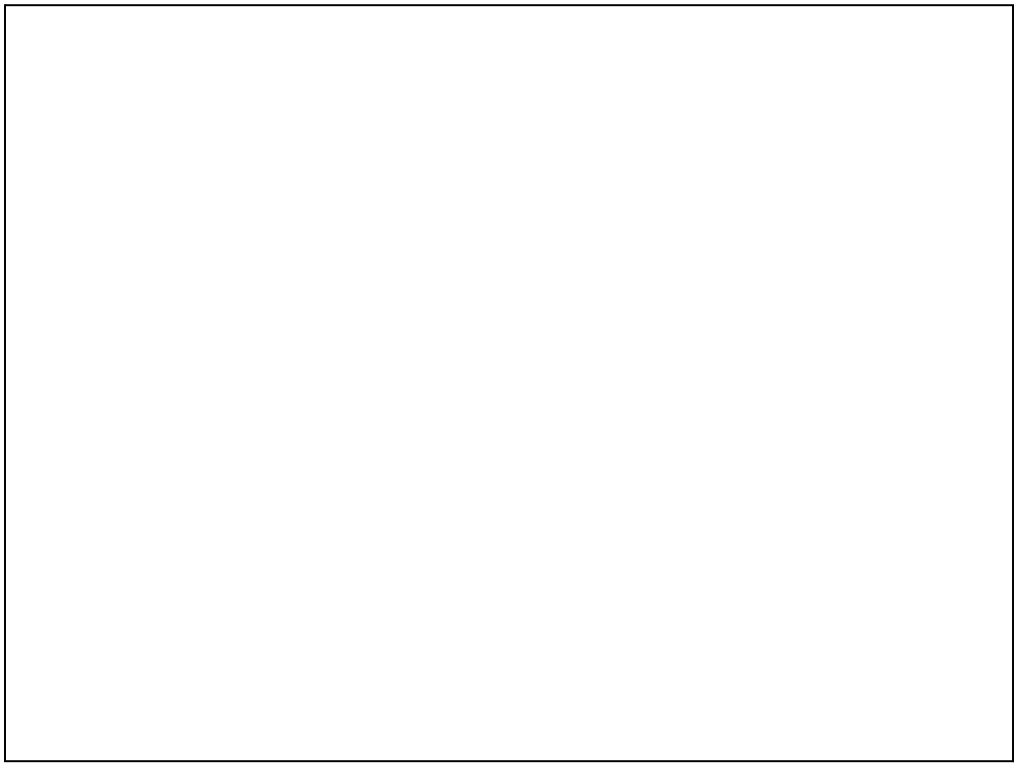


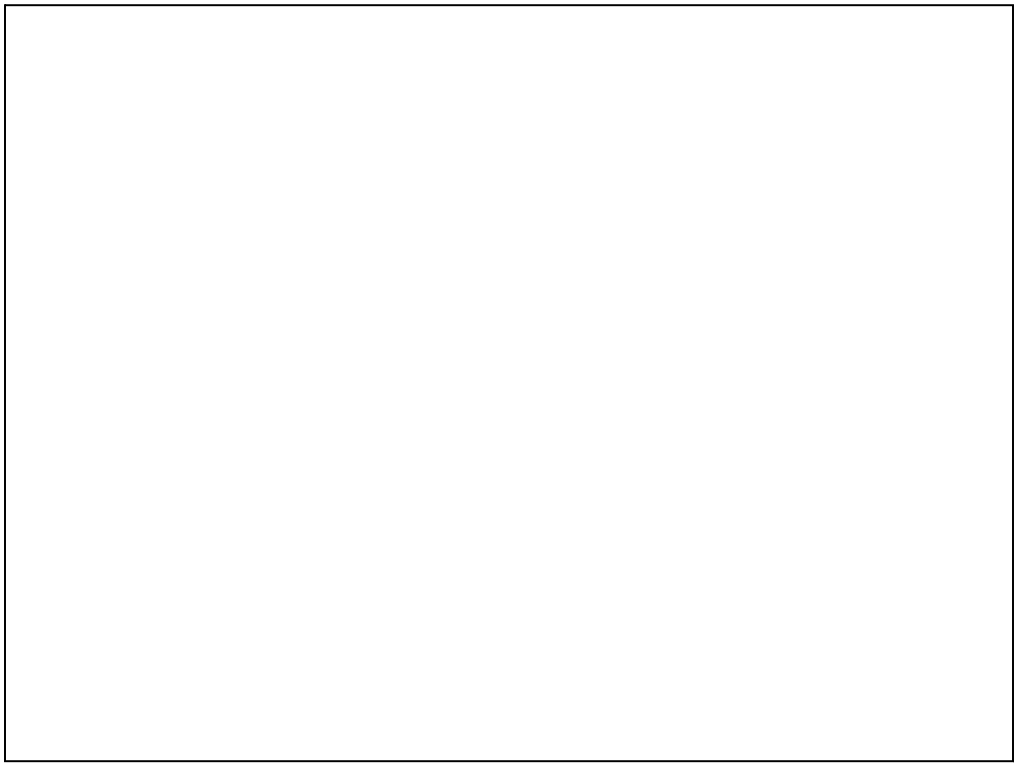


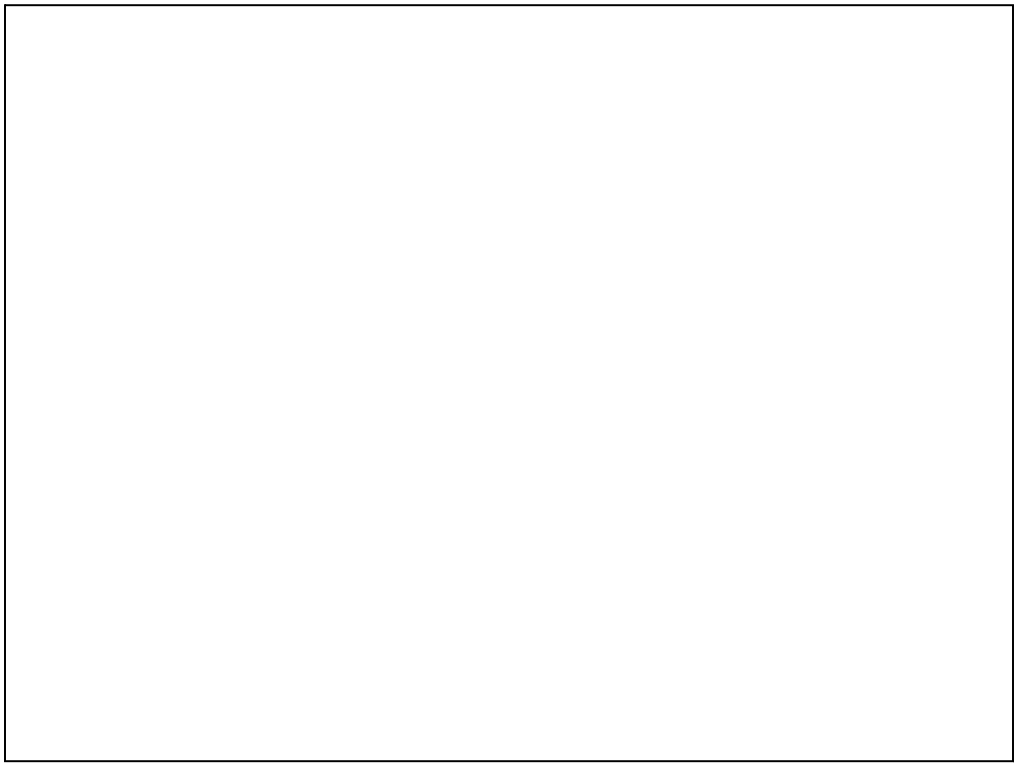


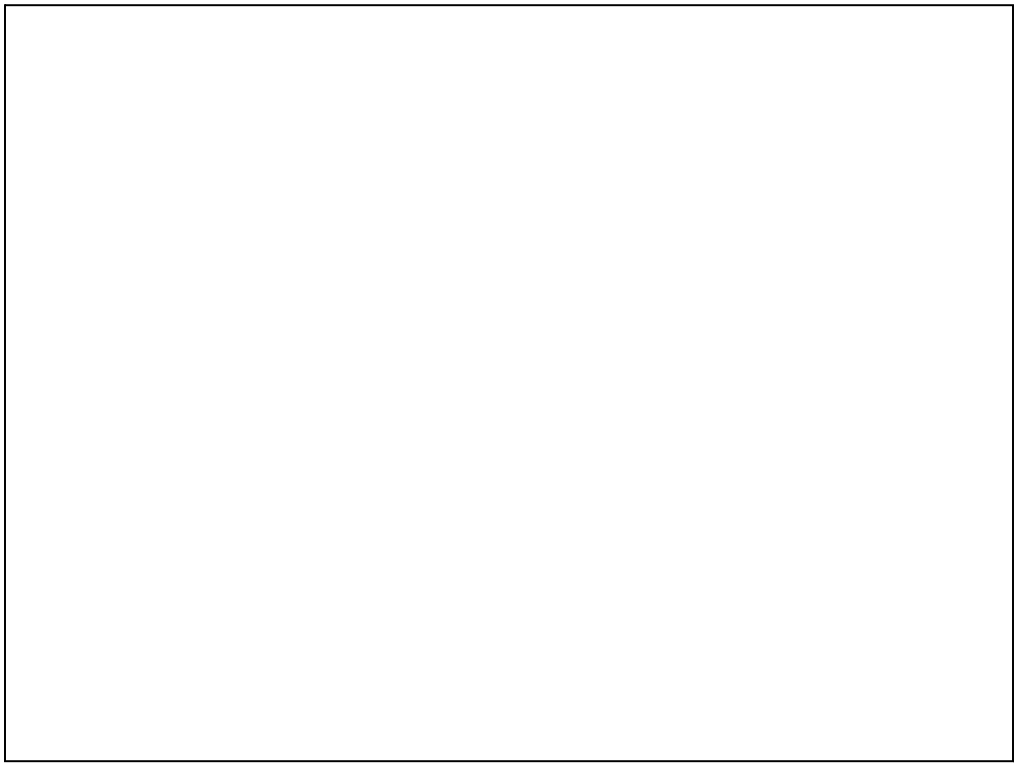


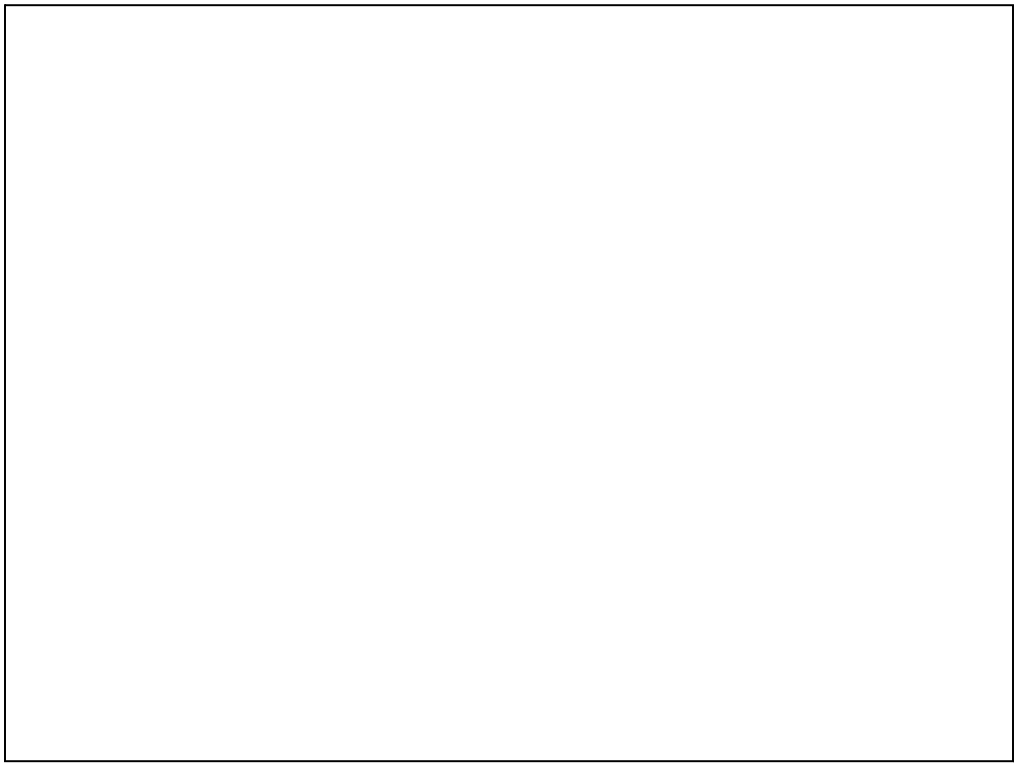


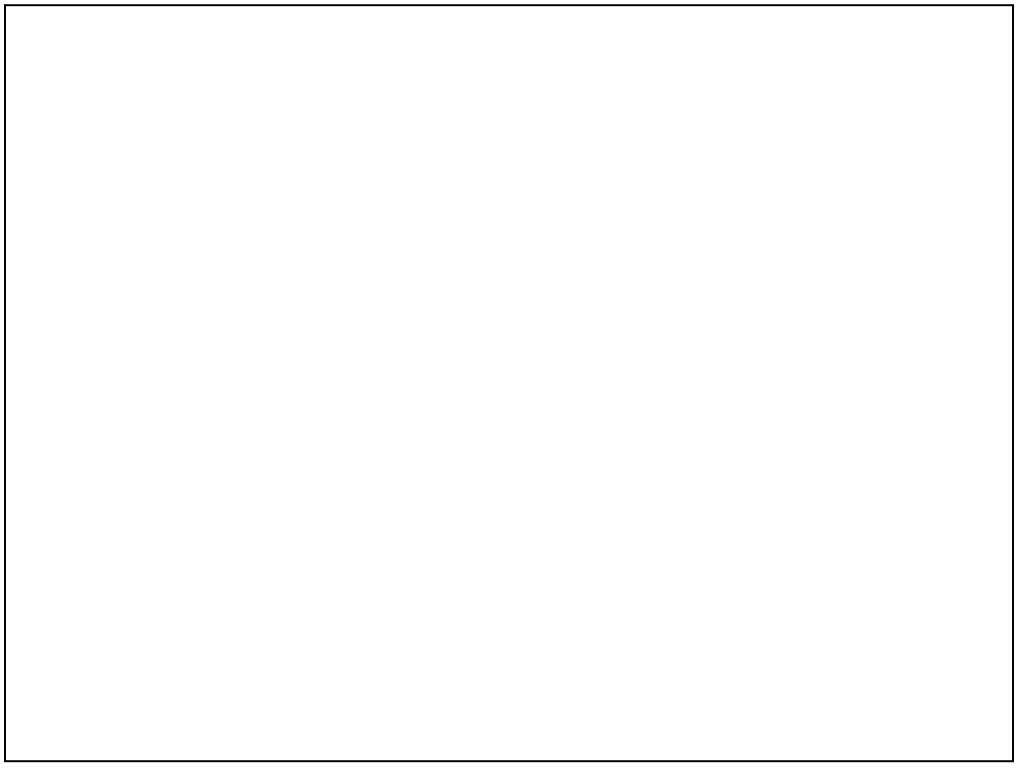


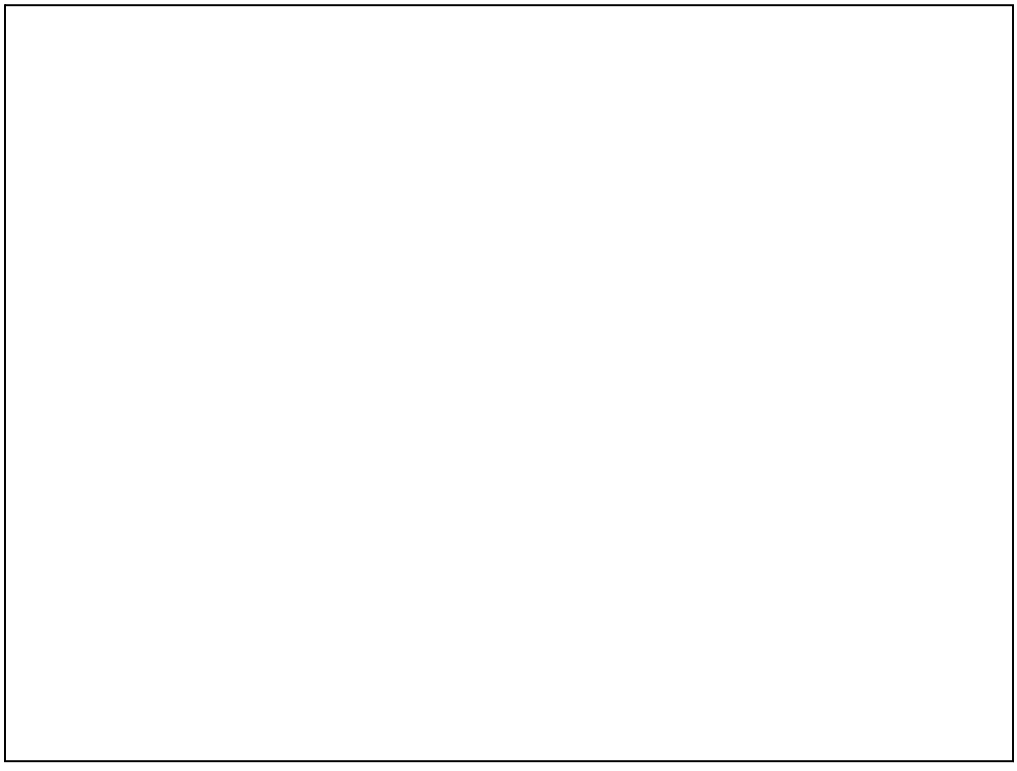


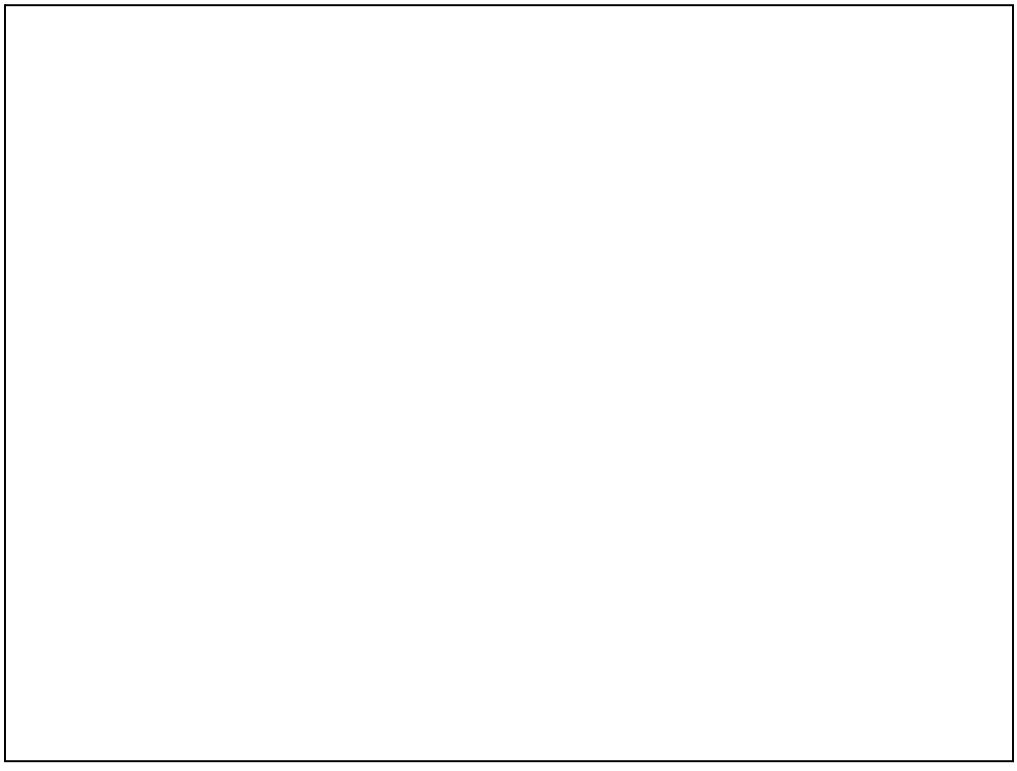


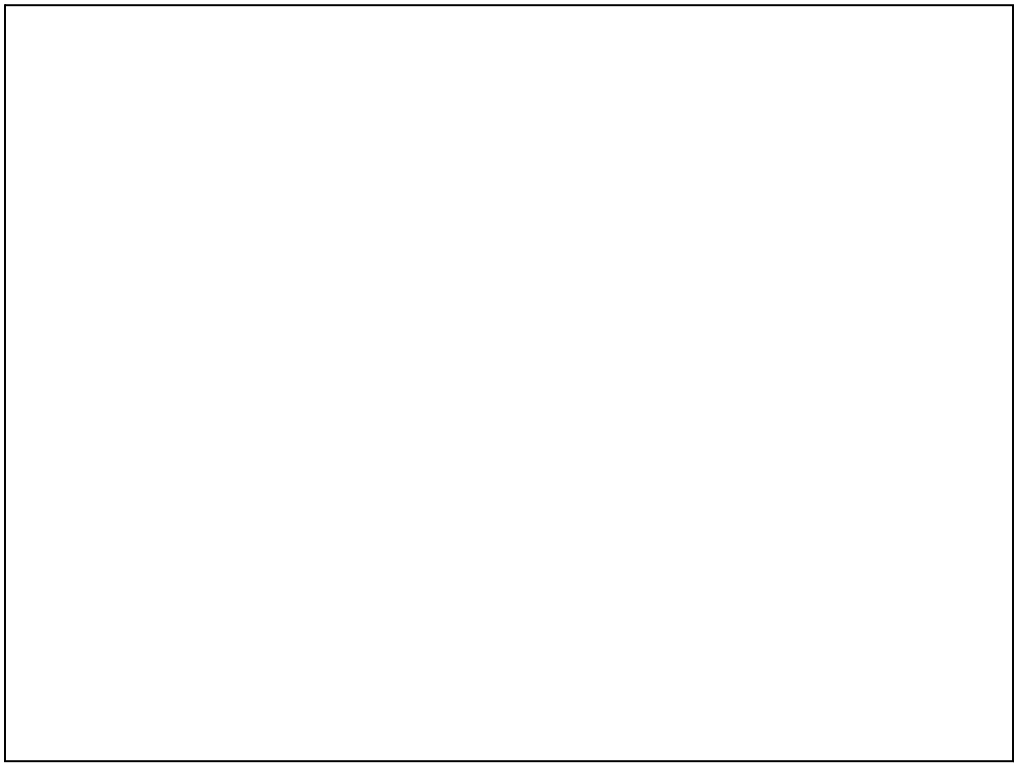








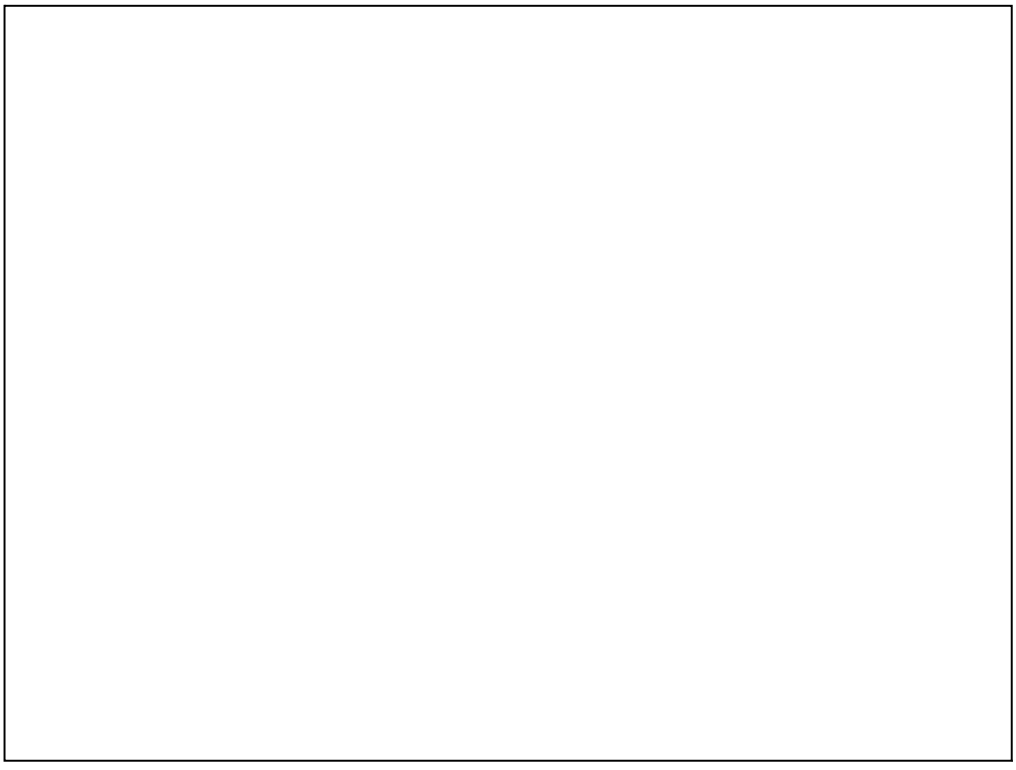


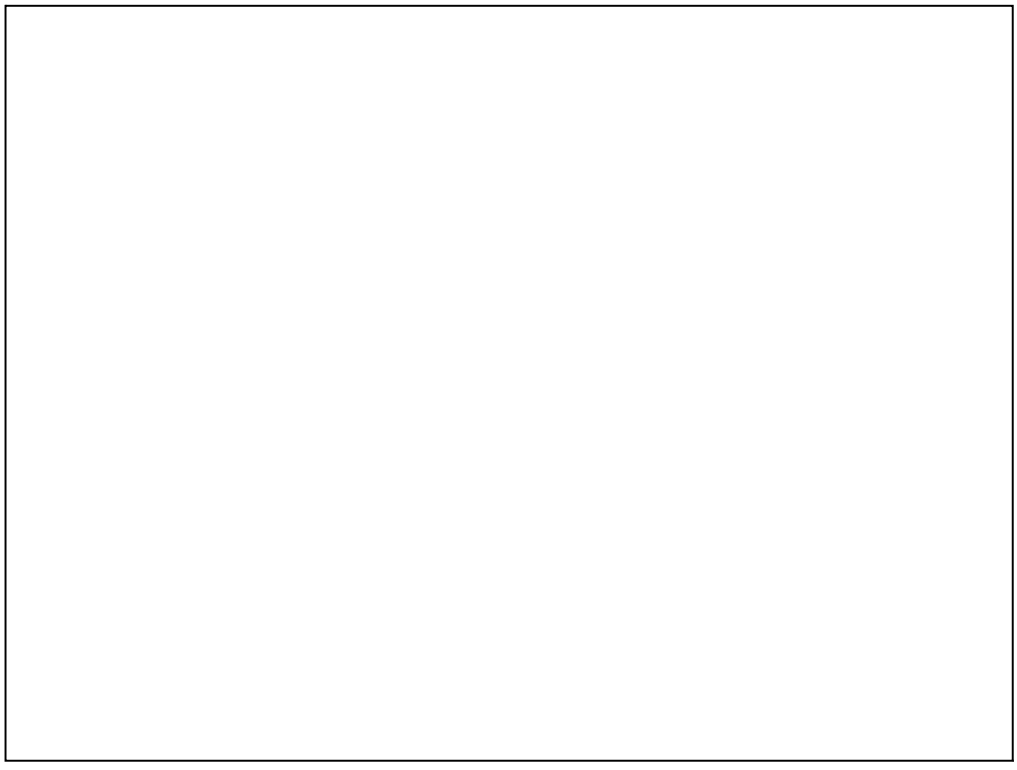


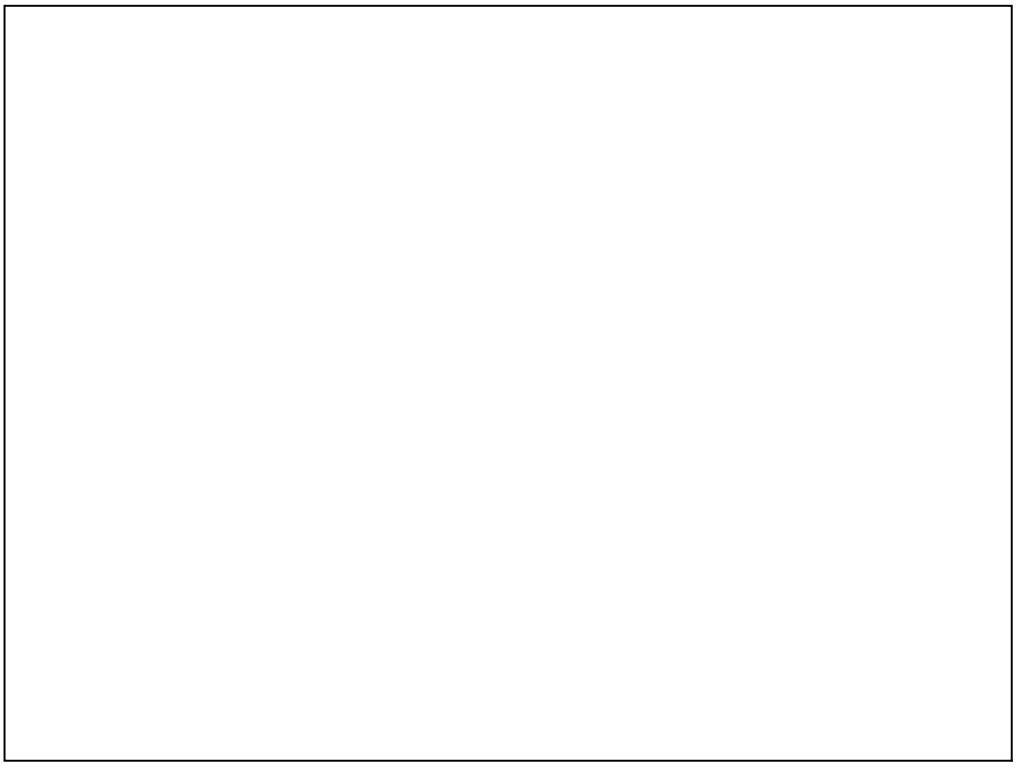
Network Communication Models

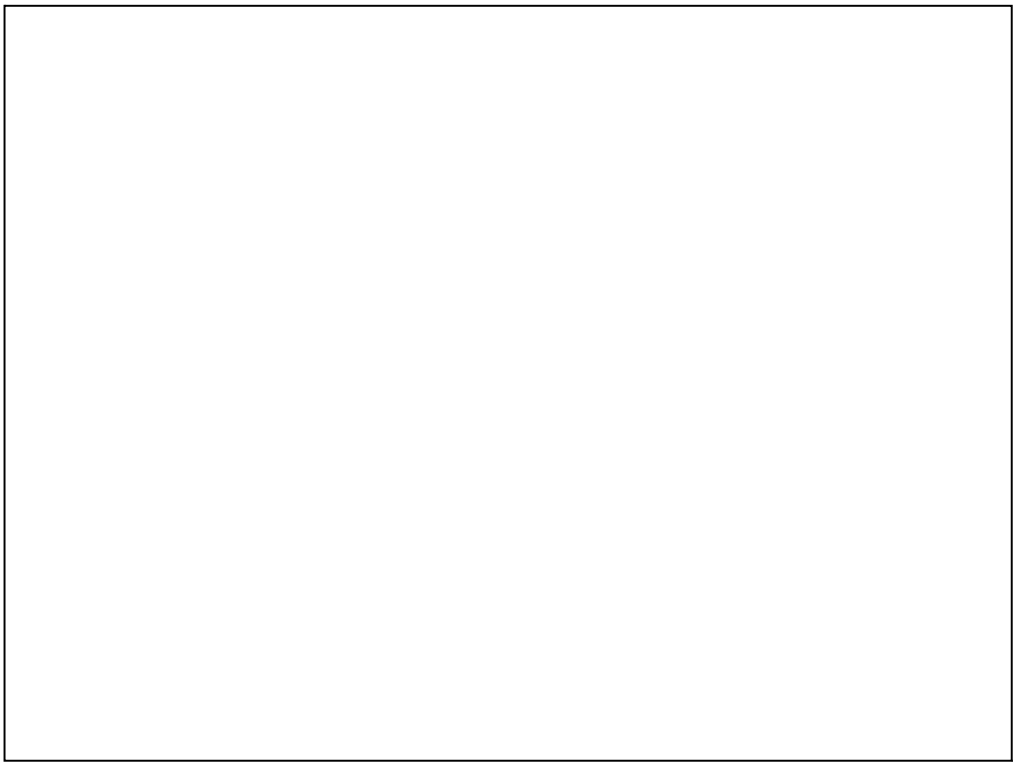
Recall, What are the two main ways networks communicate? Two types of models …

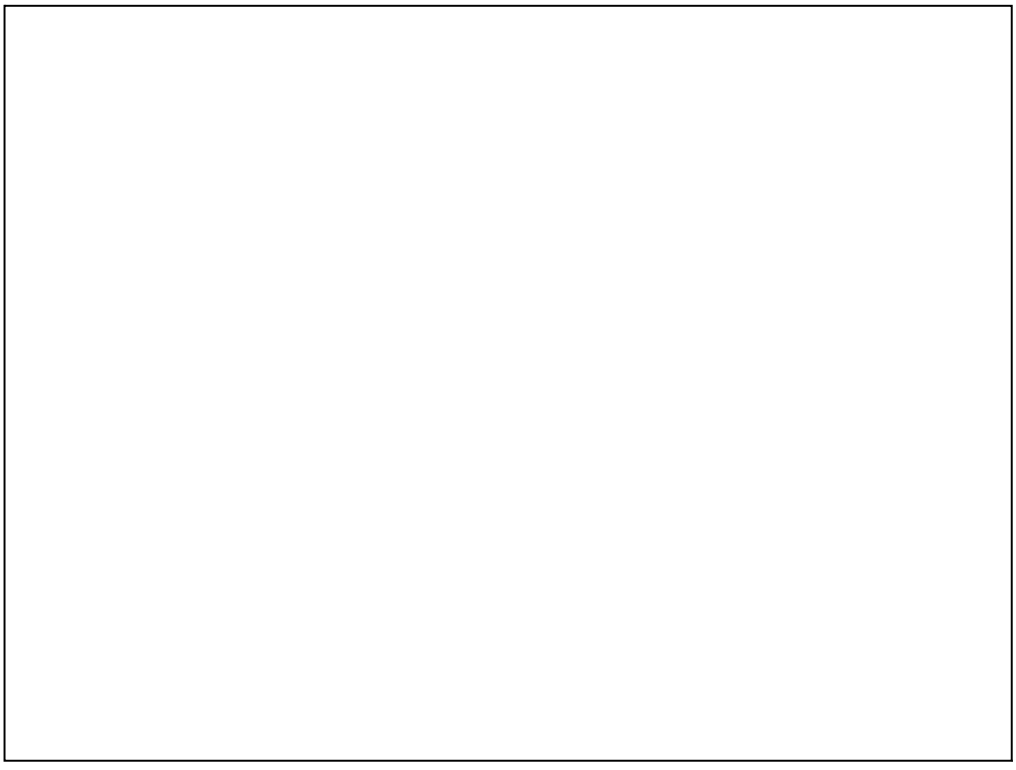
1. Circuit Switching
2. Packet Switching

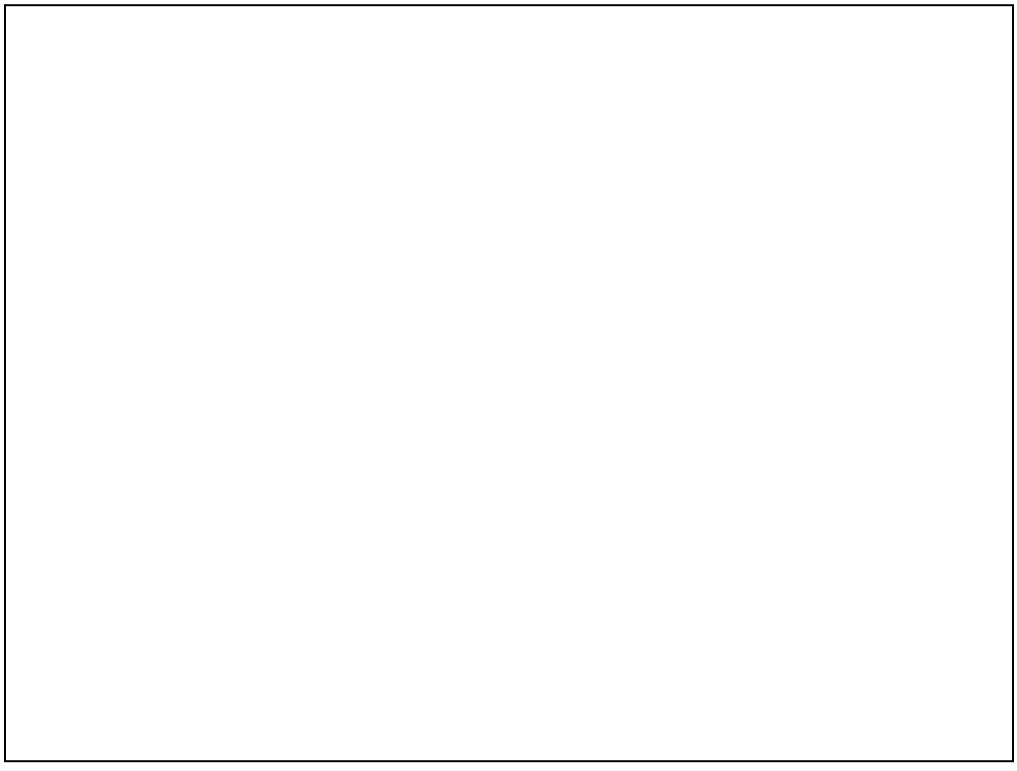












Summary

"Someone calling themselves a customer says they want something called service."

Brief review of CSCD330 content

Beginning of Network Design

Network applications - Common Services

- Their needs for network services
- How we can optimally meet these needs

More topics later … Stay Tuned