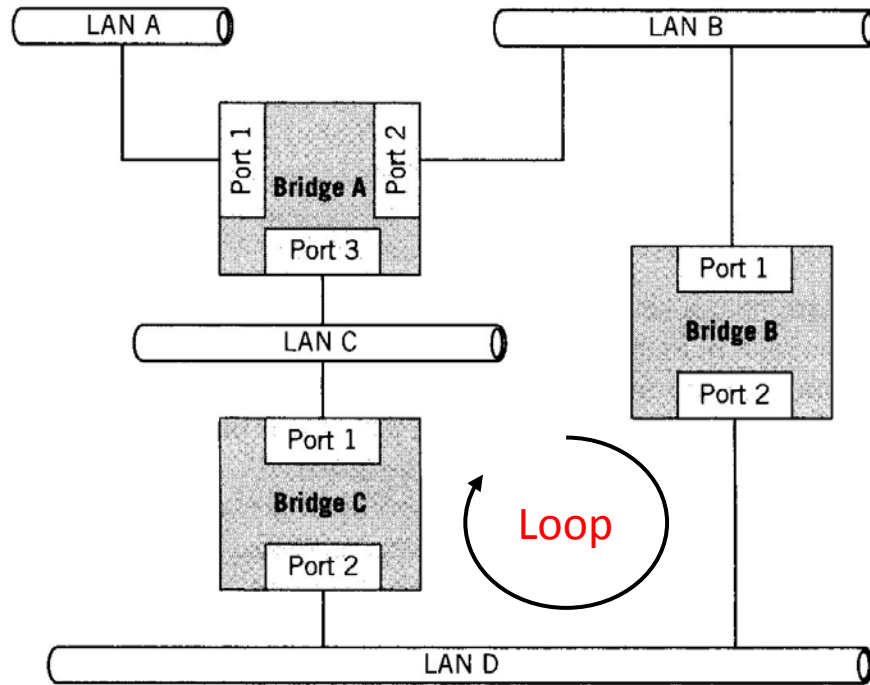


# Data Communication Networks and Converged Networks

- The OSI Model and Encapsulation
- Layer traversal through networks
- Protocol Stacks
- Converged Data/Telecommunication Networks
  - From Telecom to Datacom, Asynchronous Transfer Mode (ATM)
  - From Datacom to Telecom, Multiprotocol Label Switching
  - Evolving Converged Networks

# Loops in Bridged Ethernet Domains



From *Network Processors*, by Ran Giladi

- Loops make a network more robust, but
- Loops can create “data storms”

## "Data storm" blamed for nuclear-plant shutdown

Robert Lemos, SecurityFocus 2007-05-18

The U.S. House of Representative's Committee on Homeland Security called this week for the Nuclear Regulatory Commission (NRC) to further investigate the cause of excessive network traffic that shut down an Alabama nuclear plant.

During [the incident](#), which happened last August at Unit 3 of the Browns Ferry nuclear power plant, operators manually shut down the reactor after two water recirculation pumps failed. The recirculation pumps control the flow of water through the reactor, and thus the power output of boiling-water reactors (BWRs) like Browns Ferry Unit 3. An investigation into the failure found that the controllers for the pumps locked up following a spike in data traffic -- referred to as a "data storm" in the NRC notice -- on the power plant's internal control system network. The deluge of data was apparently caused by a separate malfunctioning control device, known as a programmable logic controller (PLC).

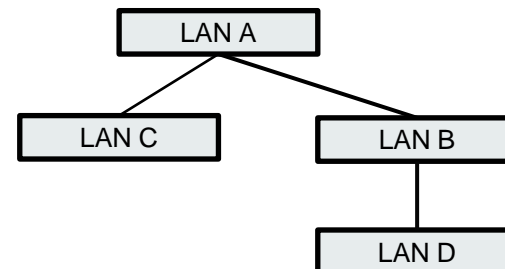
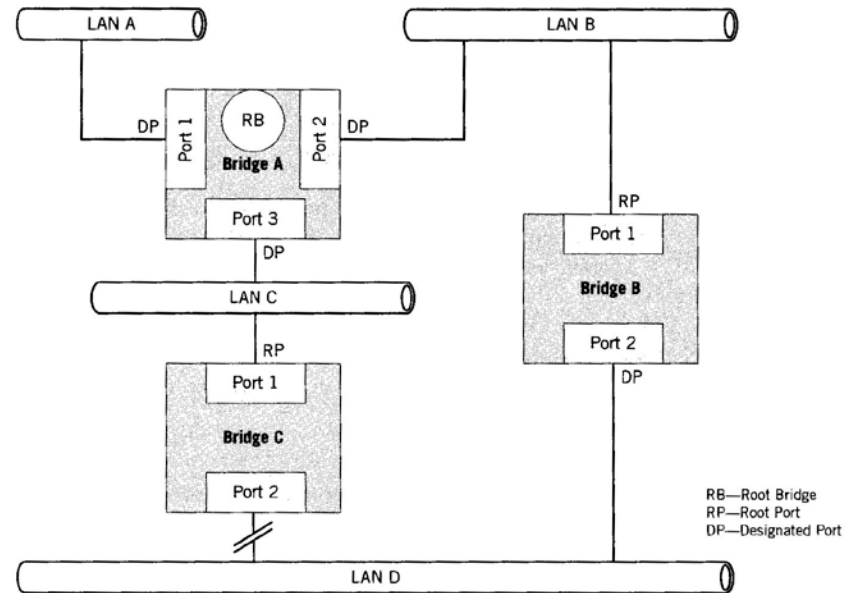
**" If you were to test any control systems that have any more than three or four (different) network-connected devices, they could be knocked over very easily. "**

Dale Peterson, CEO, DigitalBond

In a letter dated May 14 but released to the public on Friday, the Committee on Homeland Security and the Subcommittee on Emerging Threats, Cybersecurity, and Science and Technology asked the chairman of the U.S. Nuclear Regulatory Commission to continue to investigate the incident.

# Spanning Tree Approach to Loop Resolution

- Identify a unique Root Bridge for the entire network
- Identify a unique Root Port on each bridge through which the bridge is connected to the Root Bridge
- Identify a Designated Bridge and its Designated Port for each LAN through which the LAN prefers to be connected to the rest of the LANs



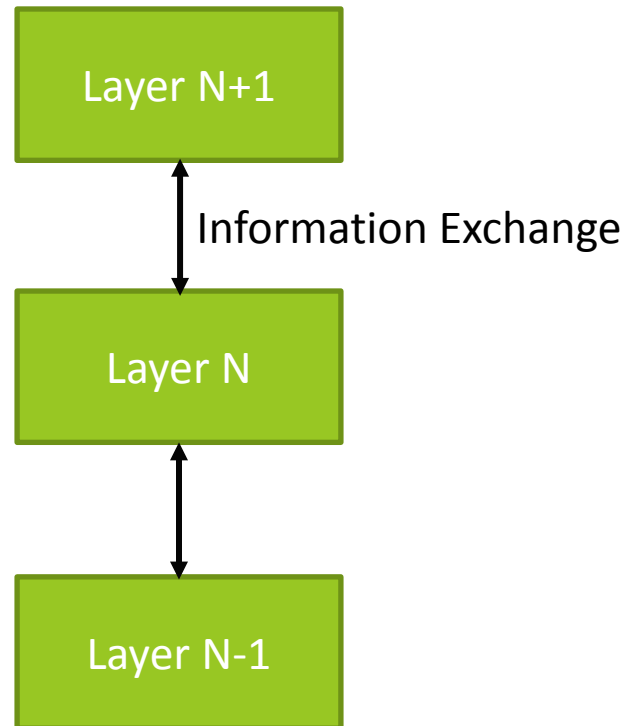
From *Network Processors*, by Ran Giladi

# The Open System Interconnection (OSI) Layered Network Model

	Layer Name	Function	Device
Host Layers	7 Application	Network entry point for data received from application	
	6 Presentation	Application based conversion, translation, encryption, and compression of data	
	5 Session	Establish a communication with another host	
	4 Transport	Breaks data into segments, flow control, ensure packet delivery	
Network Layers	3 Network	Address packets (logical address), route determination, determines physical addresses	IP Router
	2 Data Link	Frames packets (appends physical address and error detection bits), handles access to network media	Ethernet Switch
	1 Physical	Converts bits in frames to electrical/optical signals	Repeater

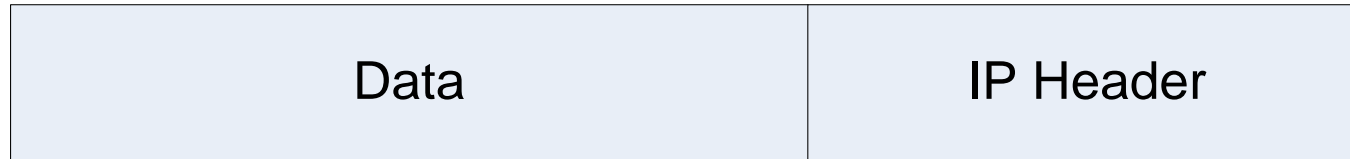
Based on *Network Routing Basics*, by James Macfarlane

# Intra-Node Layer Communication



- In the OSI model, layers communicate only with other layers that are immediately above or below them.
- CIAN is investigating “cross-layer” communication between non-adjacent layers

# Internet Protocol (IP) Packet Structure



Source Address  
(e.g. 172.16.2.32)  
Destination Address  
Sequence Number  
Time to Live  
Type of Service  
Total Length  
...

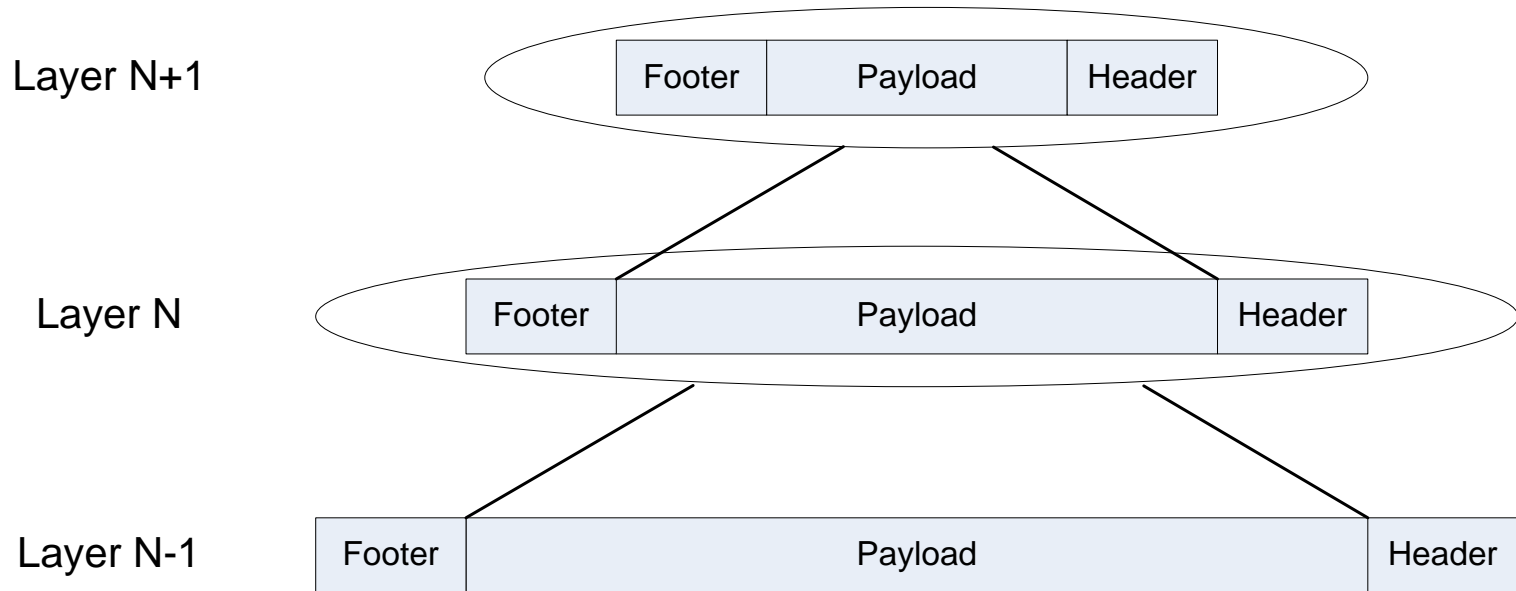
- IP packets contain address information that is used to direct the packets between hosts (e.g. computers) that may be in different networks

# General Packet Structure



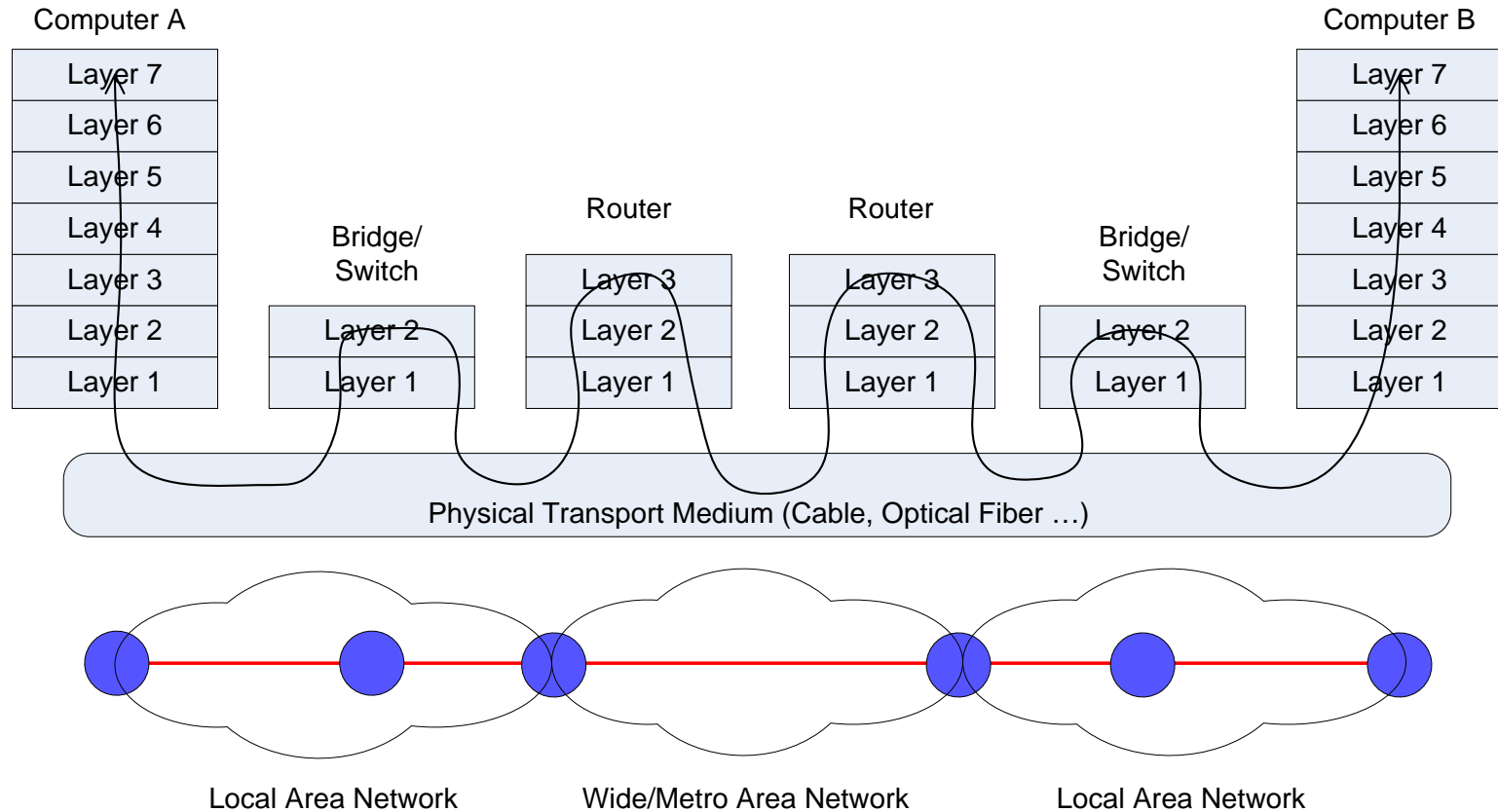


# Packet Encapsulation



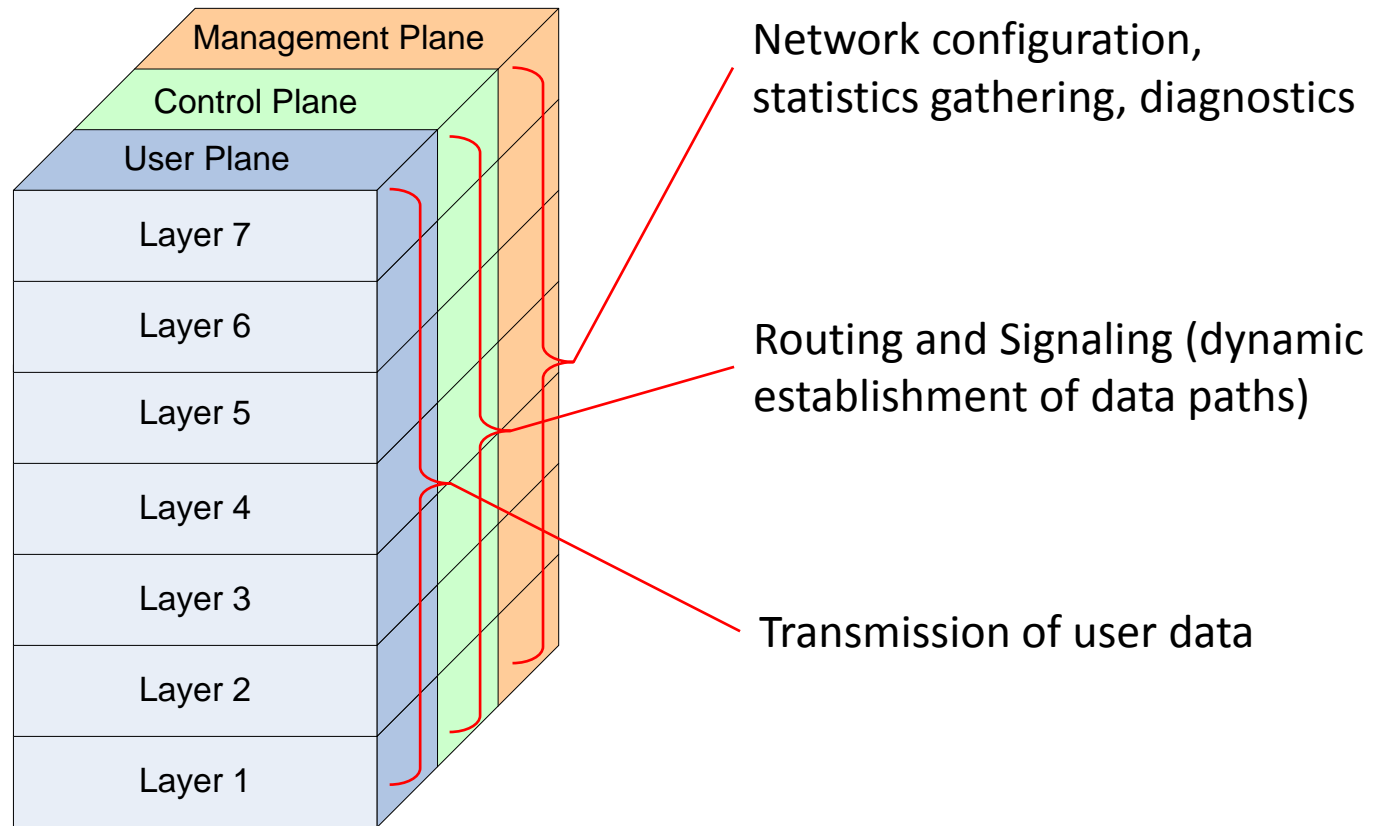
- A packet in one layer becomes the payload for the packet in the layer just below.
- Headers and footers are appended as you move down the OSI stack.
- Headers and footers are stripped off as you move up the stack.

# Traversing the Layer Stack



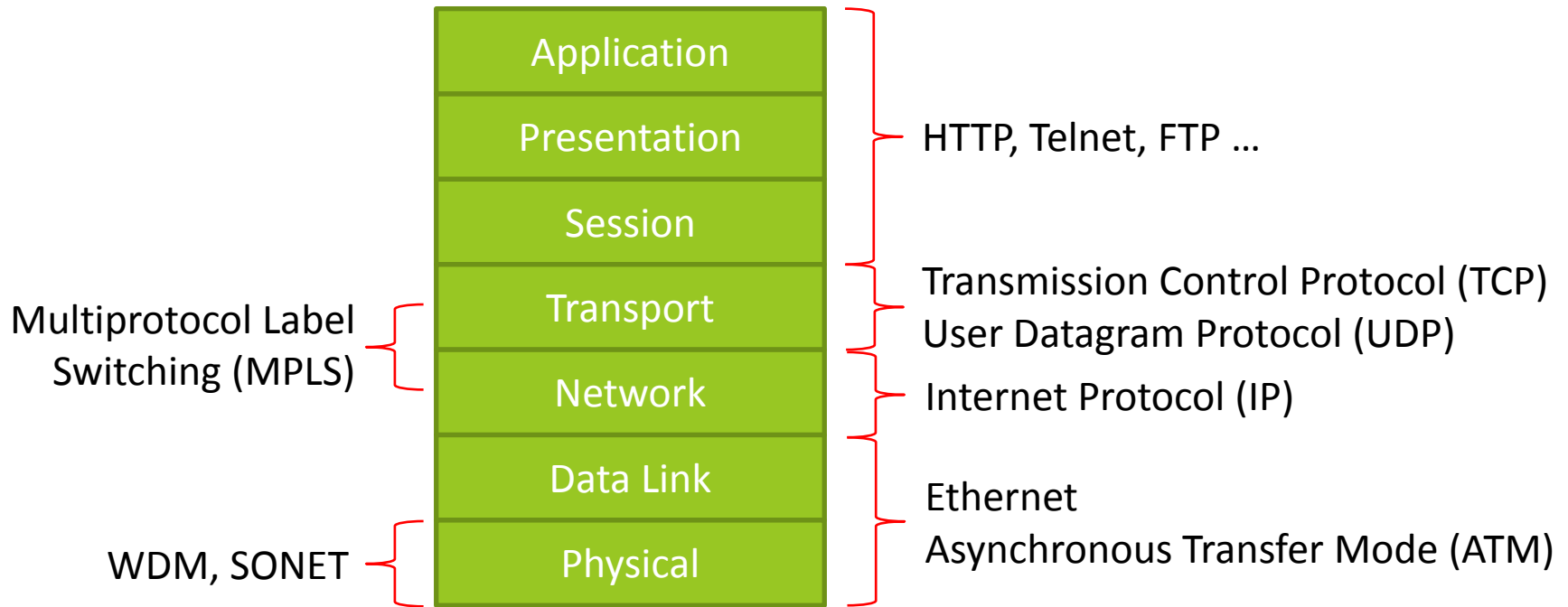
- You traverse the OSI stack as you traverse networks that connect hosts
- Within the networks, you traverse only the Network Layers

# The "Plane" Model of Networks



- The plane model collects layer functions into two or more groups

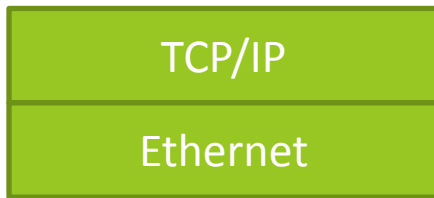
# Protocol Stacks



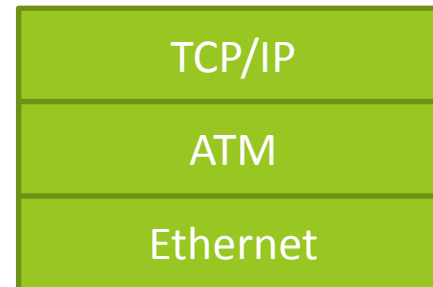
- Protocols have been developed to carry out the functions of the various layers
- Protocols do not always map perfectly into the OSI model

# Protocol Stacks

Internet “over” Ethernet



Internet over ATM over Ethernet



- We often represent the network operation by replacing the OSI layer names with the associated protocols.
- The protocols may represent multiple layers.
- Different protocols may represent the same layers.

# Network Convergence

- Network convergence refers to the use of both datacom and telecom protocols and hardware in the same network.
- The motivation is to share resources and to combine the flexibility of datacom networks with the high capacity of telecom networks.