GARR Integrated Networking Suite

Login

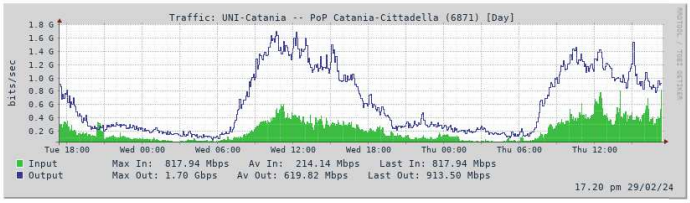
Home Statistics Weathermaps Reports TTS Search

Statistiche di traffico

Time scale: Day Week Month Year 5 Year Metrics: IPv6 Latency Traffic sum Actions: Set as default Get this url

UNI-Catania -- PoP Catania-Cittadella (6871) close

Link name	Use	BW	Side A	Side B	Target options
UNI-Catania -- PoP Catania-Cittadella	access	10,00 Gbps	UNI-Catania 193.206.137.66	CT01-Cittadella rl1.ct01.garr.net (MX480) xe-4/0/6.0 193.206.137.65	juniper_firewall fwf-user-unict-in UNI-CT-in fwf-user-unict-out UNI-CT-out



Interconnected systems

“Fun” Internet-connected devices

Amazon Echo

Internet refrigerator

IP picture frame

Pacemaker & Monitor

Tweet-a-watt: monitor energy use

Web-enabled toaster + weather forecaster

Security Camera

Slingbox: remote control cable TV

AR devices

Fitbit

Internet phones

sensorized, bed mattress

Smart TV

Università di Catania

IoT

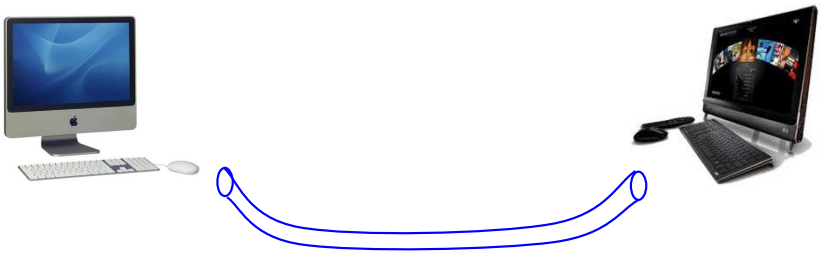
Cloud Computing

“The interesting thing about cloud computing is that we’ve redefined cloud computing to include everything that we already do…. I don’t understand what we would do differently in the light of cloud computing other than change the wording of some of our ads.” (Larry Ellison - CEO Oracle)

Structure of a communication system

A communication system consists by two parts:

1) A physical medium (hardware)
2) A logical structure (software)



What's a protocol?

Human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific messages sent

… specific actions taken when message received, or other events

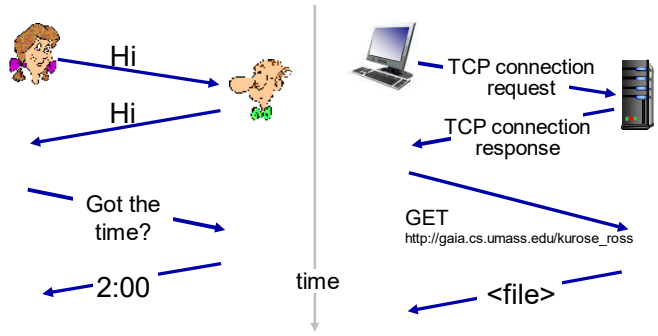
Network protocols:

- computers (devices) rather than humans
- all communication activity in Internet governed by protocols

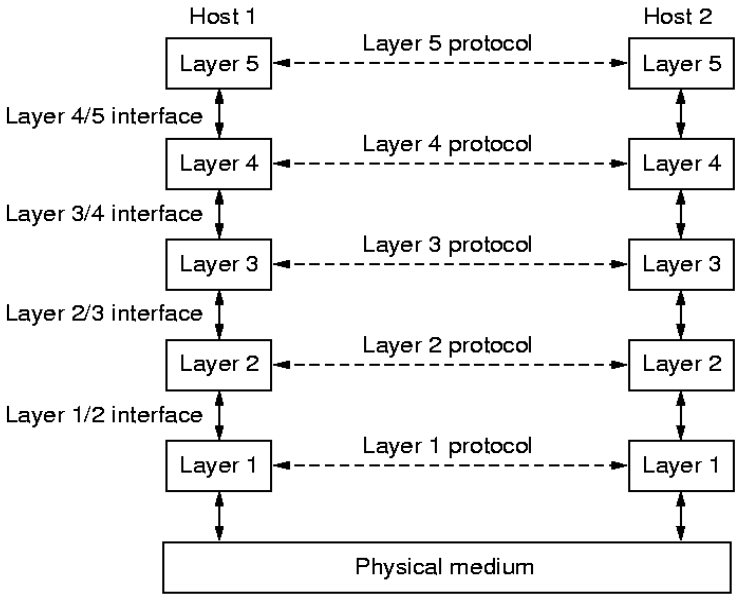
Protocols define the format, order of messages sent and received among network entities, and actions taken on msg transmission, receipt

What's a protocol?

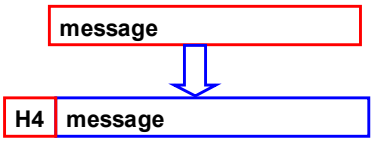
A human protocol and a computer network protocol:

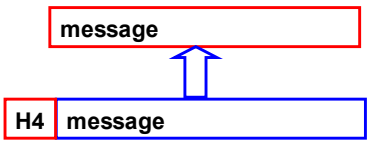


Protocols

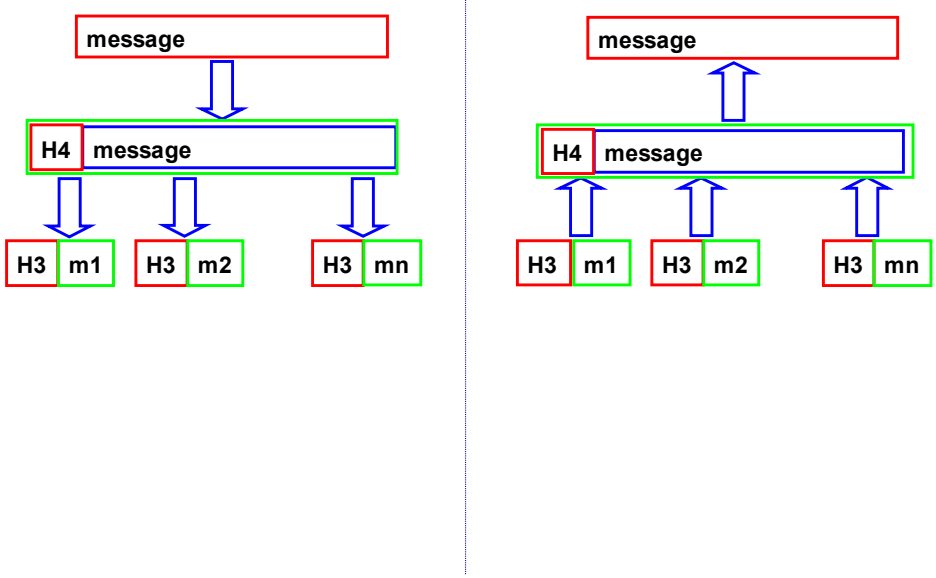

Host 1
Host 2
Layer 5
Layer 5 protocol
Layer 5
Layer 4/5 interface
Layer 4
Layer 4 protocol
Layer 4
Layer 3/4 interface
Layer 3
Layer 3 protocol
Layer 3
Layer 2/3 interface
Layer 2
Layer 2 protocol
Layer 2
Layer 1/2 interface
Layer 1
Layer 1 protocol
Layer 1
Physical medium

Communication Scheme

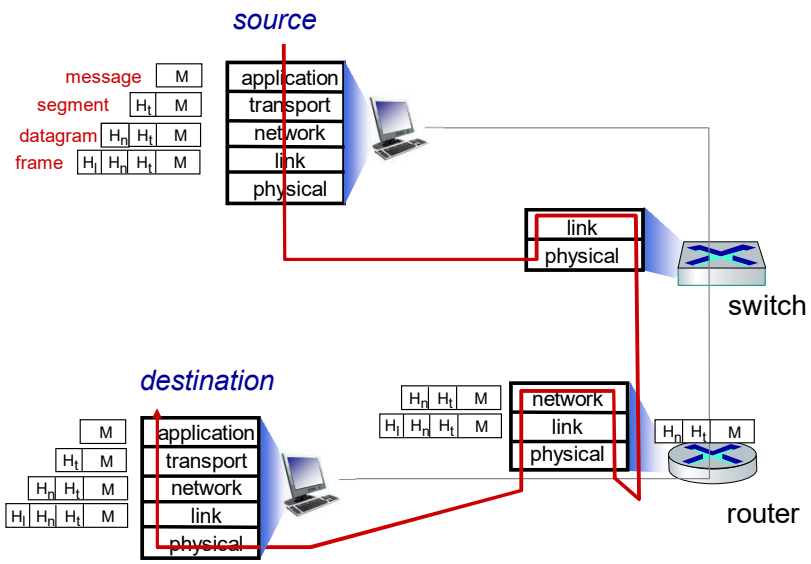




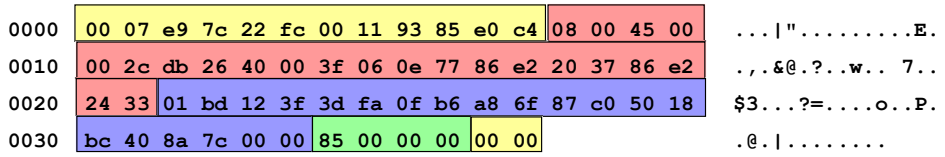
Communication Scheme



Encapsulation: an end-end view



Protocol Headers



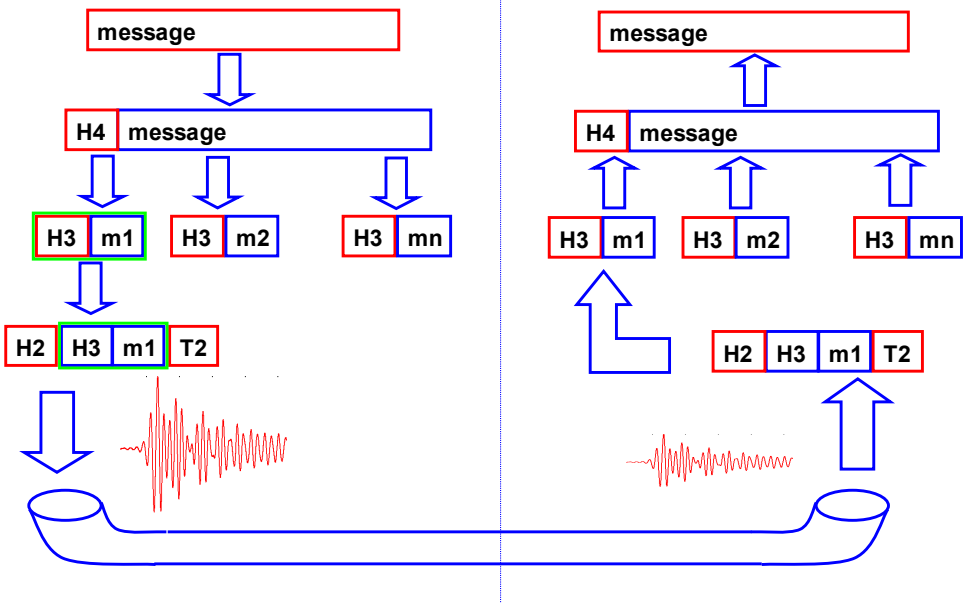

```
Ethernet Header:
src addr:  00 07 e9 7c 22 fc
dest addr: 00 11 93 85 e0 c4
IP Header:
src addr:  134.226.36.55
dest addr: 134.226.36.51
TCP Header:
src port:  445
dest port: 4671
NetBios Information
```

Header Information (56 bytes)

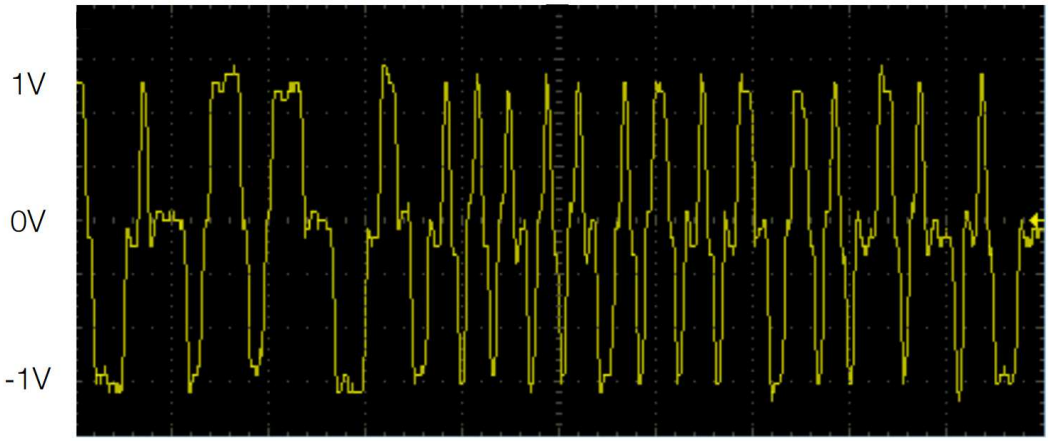
Communication overhead

Payload (4 bytes)

Communication Scheme



Signals



Problems

Users (applications) want a reliable and error-free (virtual) communication channel.

The virtual channel is implemented using physical channels

- The physical channel can be simplex, half-duplex, or full-duplex
- Low-level messages can't be arbitrary in length
- A fast transmitter doesn't have to drown a slow receiver
- We have to determine the (best?) route to get the destination
- The order of arrival of the messages must be the same as the order in which they were sent

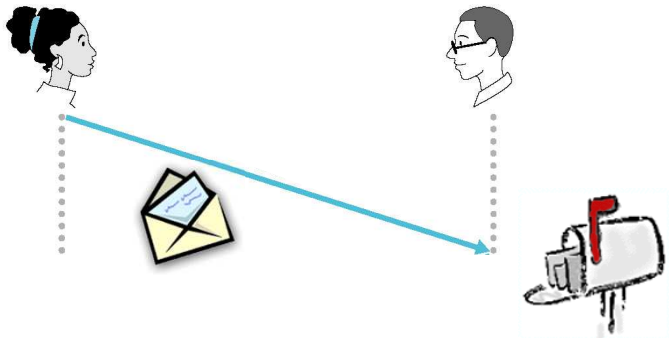
Communication type

Connectionless ⇔ **Connection oriented**

Reliable ⇔ **Not reliable**

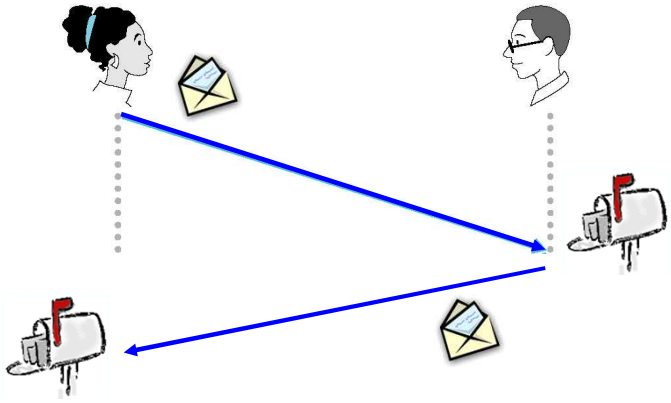
The Connection

Connectionless System

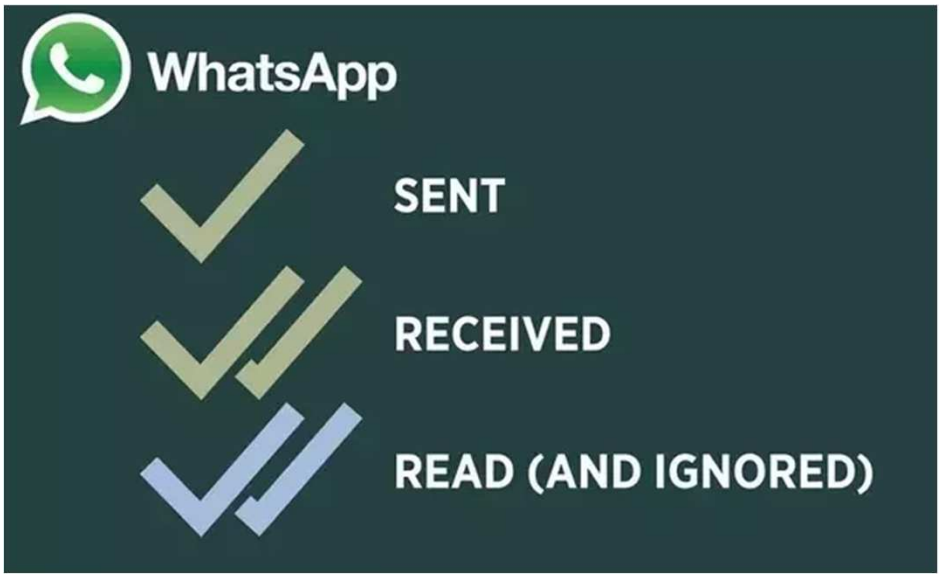


The Connection

Connectionless ⇔ Connection oriented

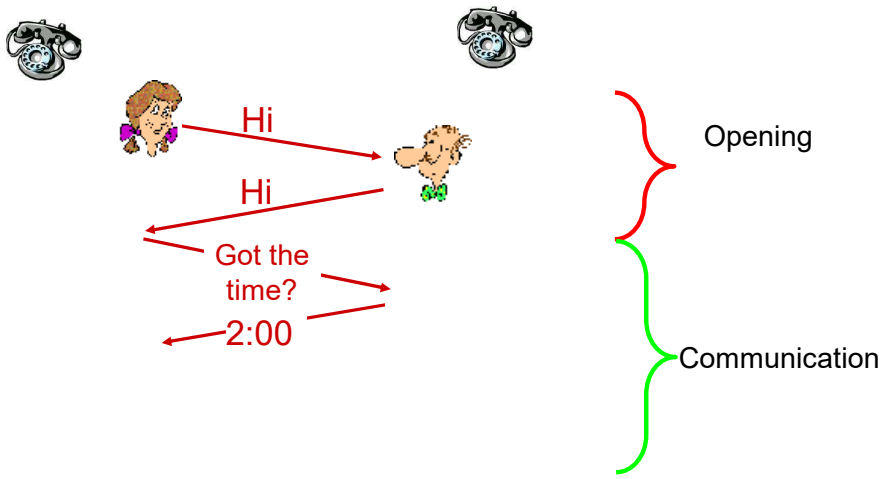


The Connection



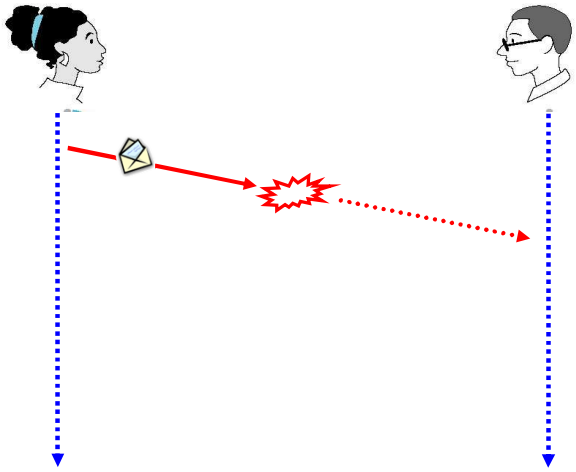
The Connection

Connection oriented system

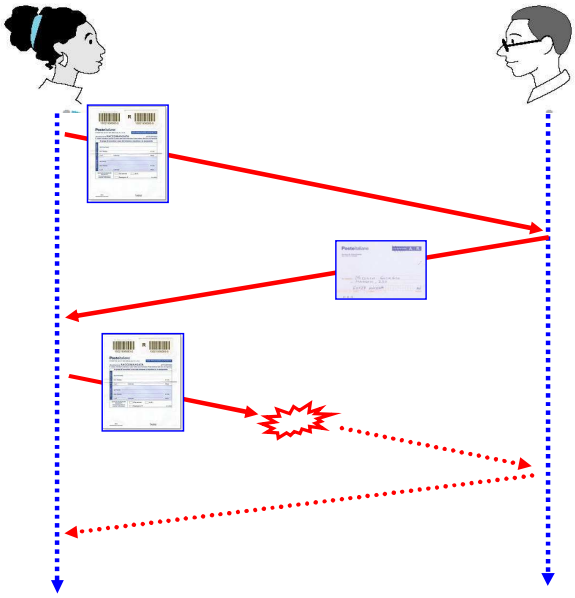


Reliability

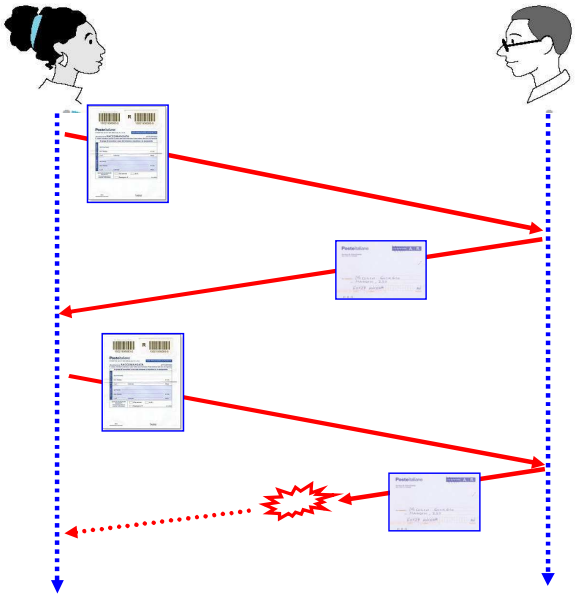
Reliable ⇔ Not Reliable



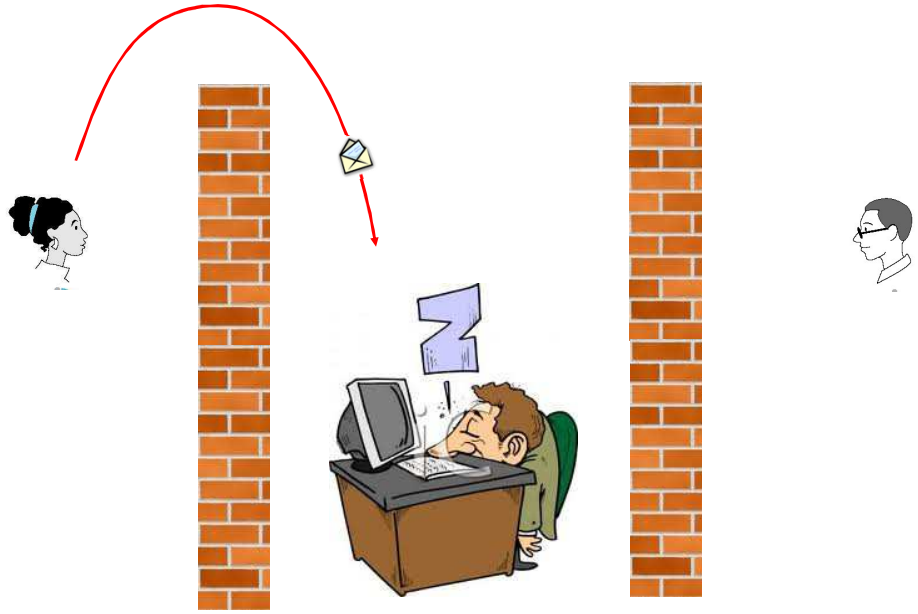
Reliability



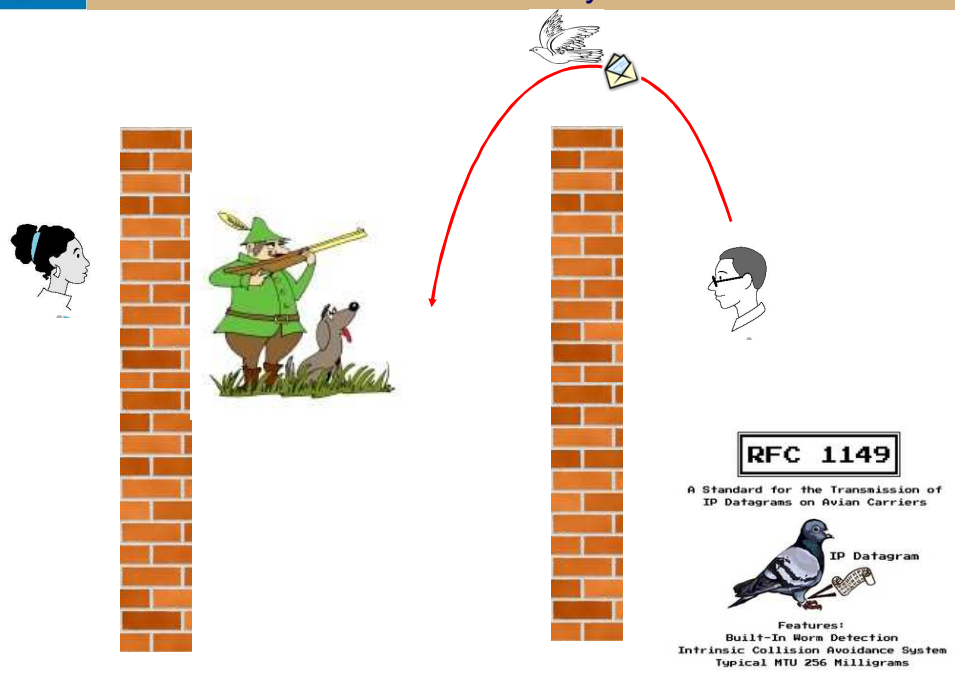
Reliability



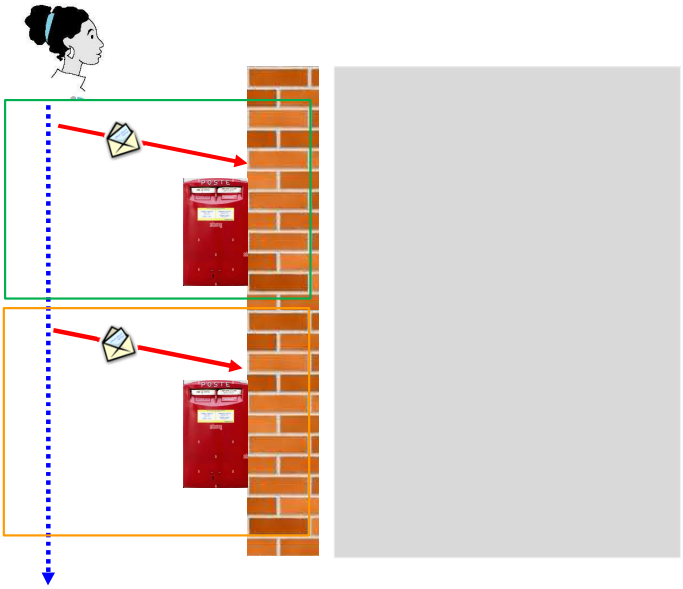
Reliability



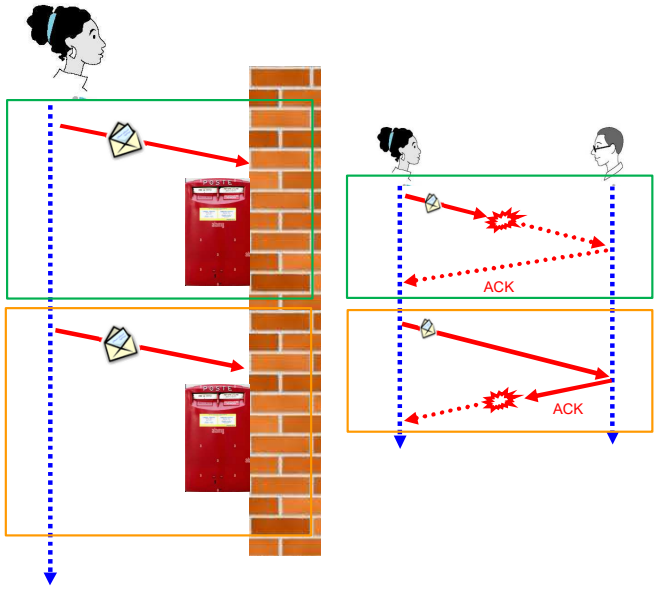
Reliability



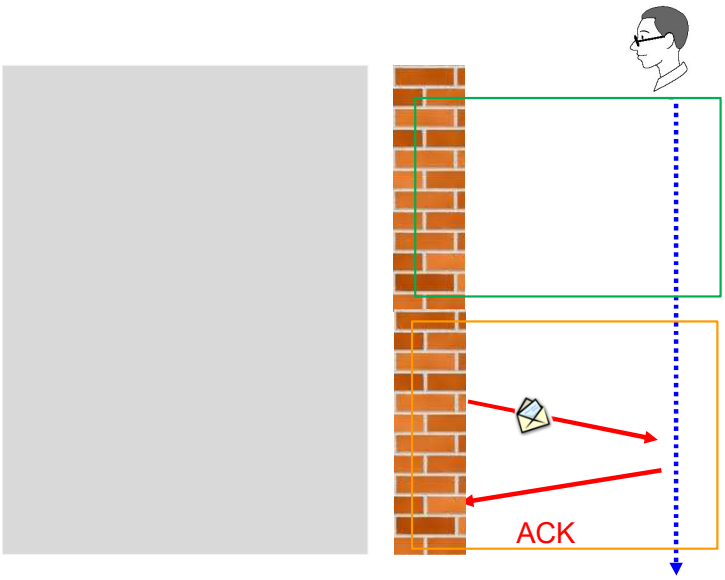
Reliability



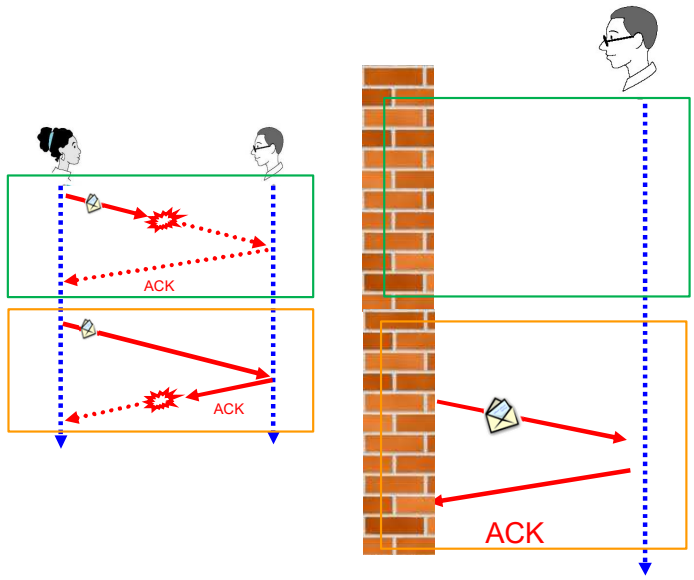
Reliability



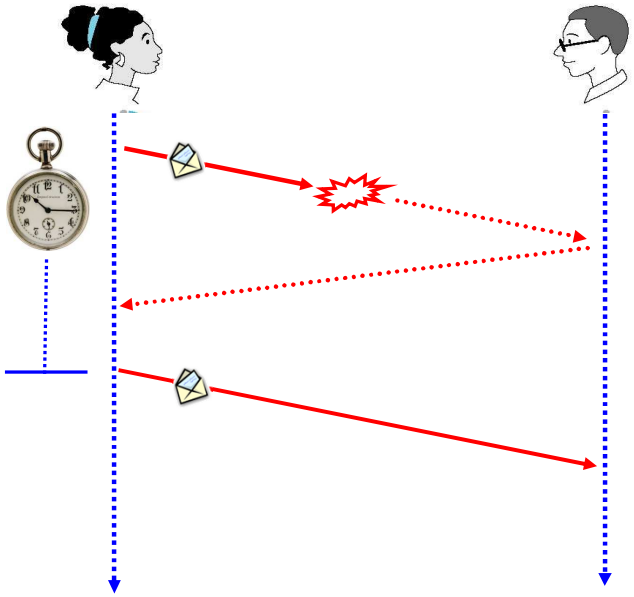
Reliability



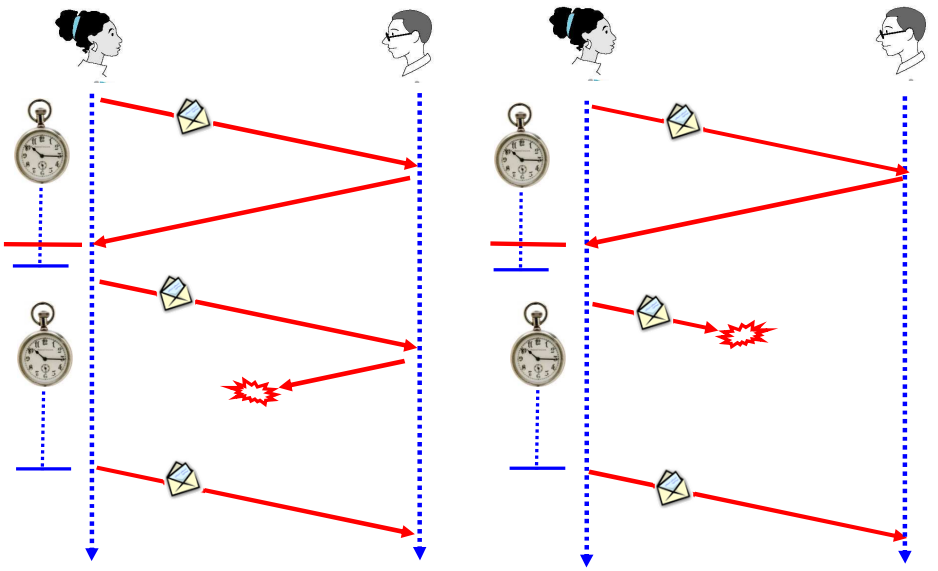
Reliability



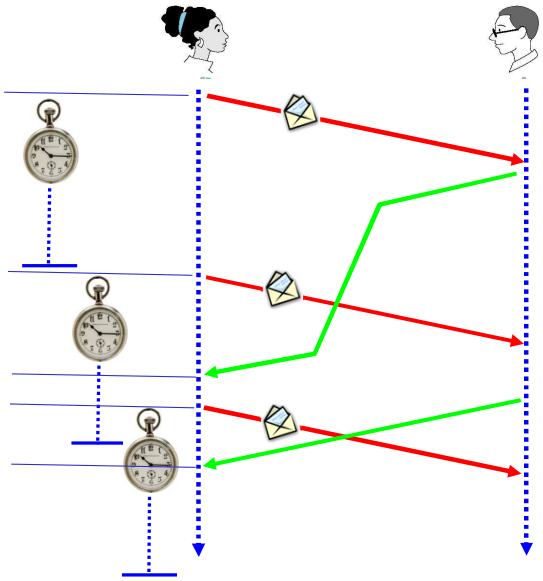
Reliability



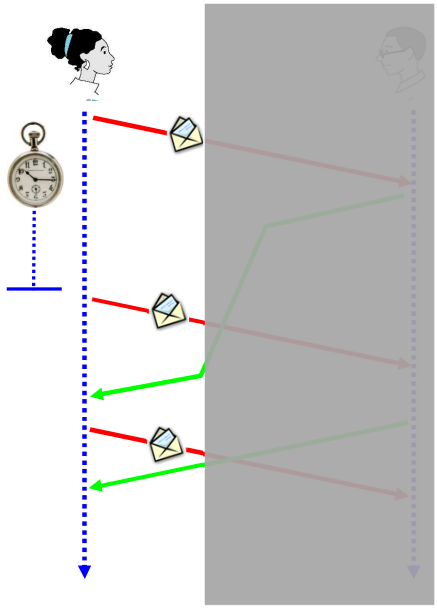
Reliability



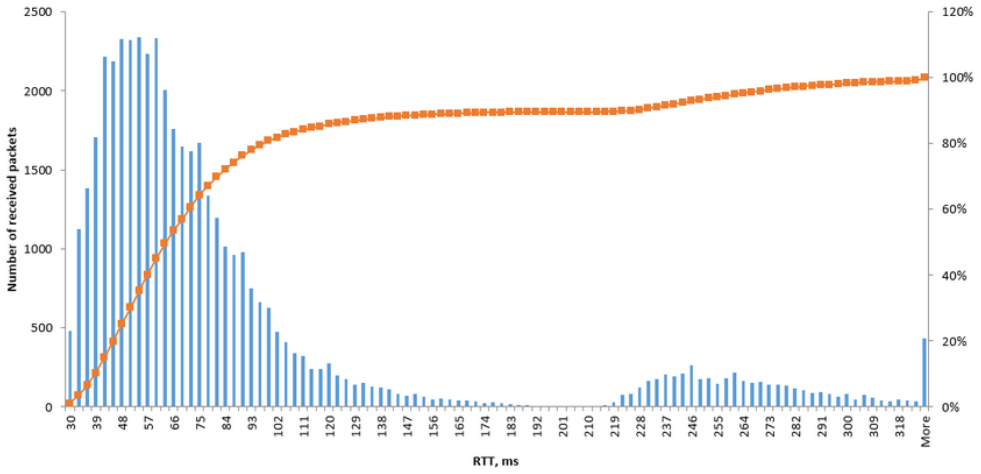
Reliability



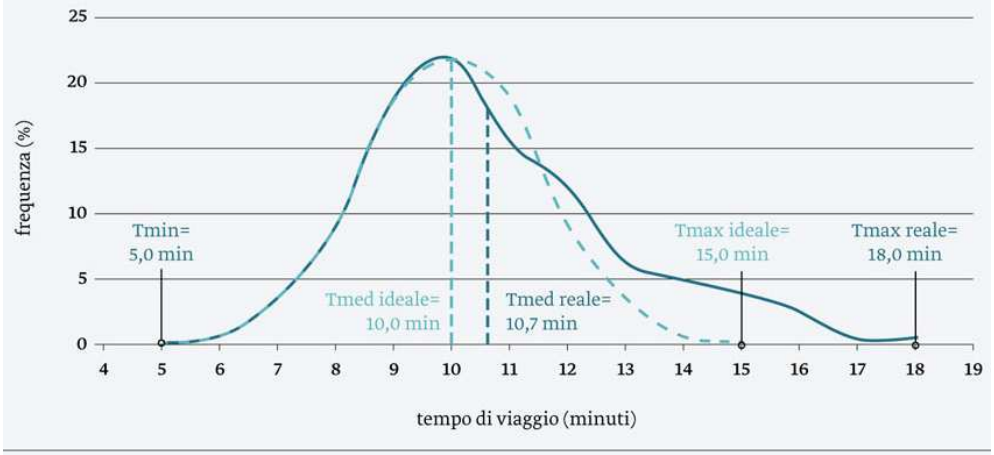
Reliability



Service Time distribution



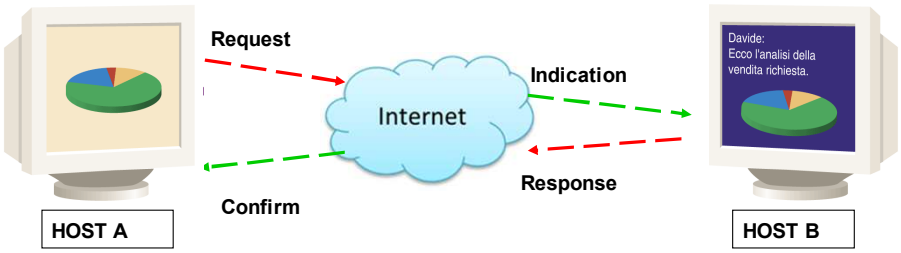
Service Time distribution



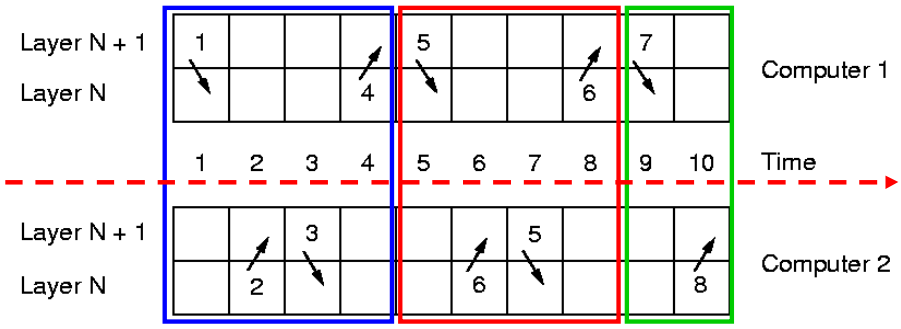
Types of Services

	Service	Example
Connection-oriented	Reliable message stream	Sequence of pages
	Reliable byte stream	Remote login
	Unreliable connection	Digitized voice
Connection-less	Unreliable datagram	Electronic junk mail
	Acknowledged datagram	Registered mail
	Request-reply	Database query

Service Primitives

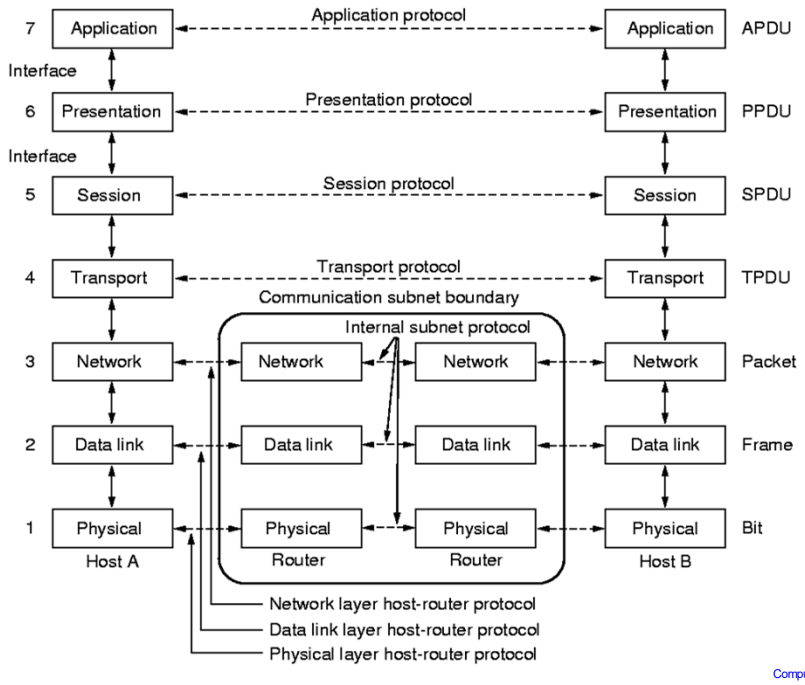


Service Primitives

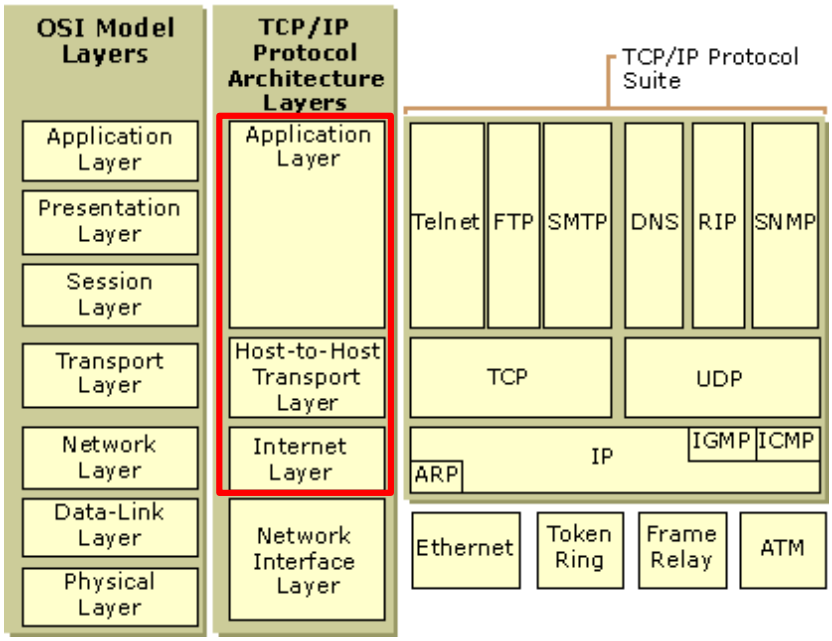


1) CONNECT.request
2) CONNECT.indication
3) CONNECT.respose
4) CONNECT.confirm
5) DATA.request
6) DATA.indication
7) DISCONNECT.request
8) DISCONNECT.indication

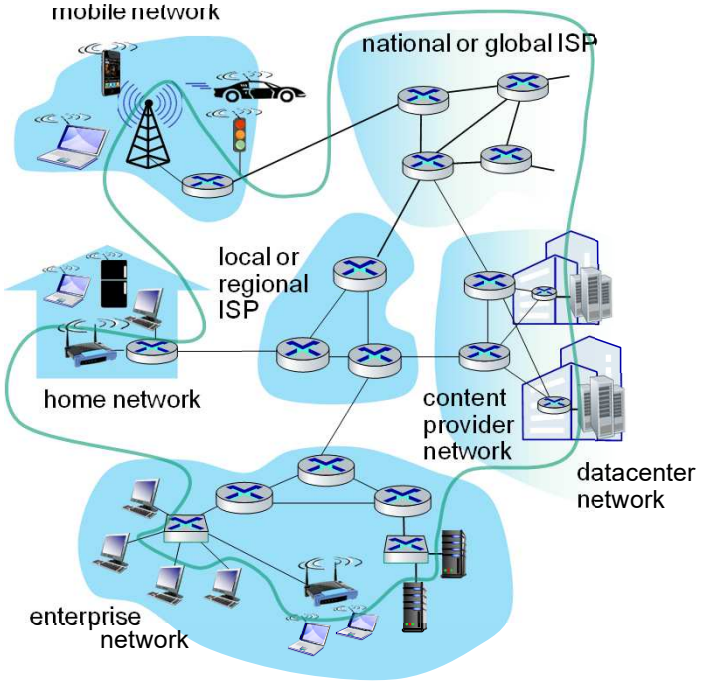
The OSI Model



OSI and TCP/IP

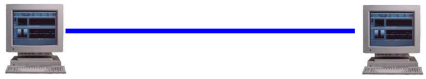


Types of networks



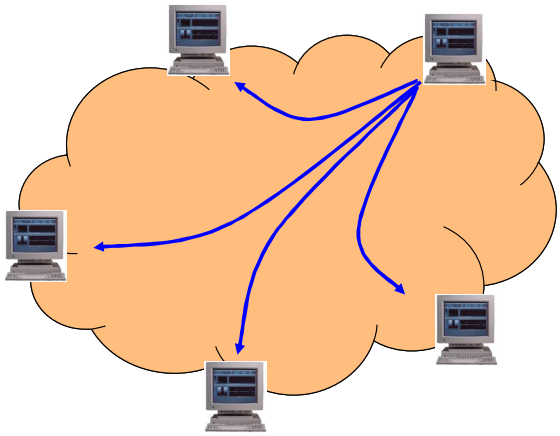
Types of Networks

Point to point

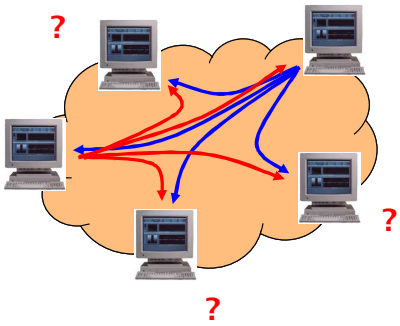


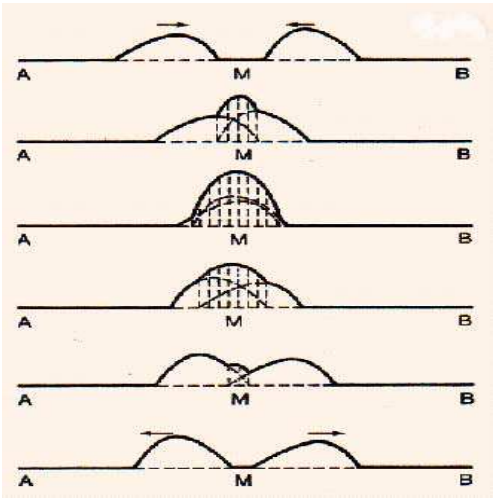
Broadcast

Types of Networks



Types of Networks

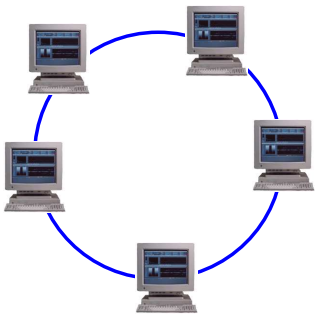




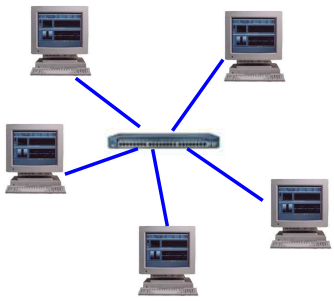
Broadcast

Shared Bus

Ring



Star



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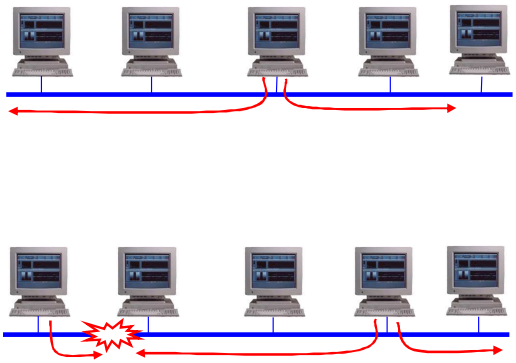
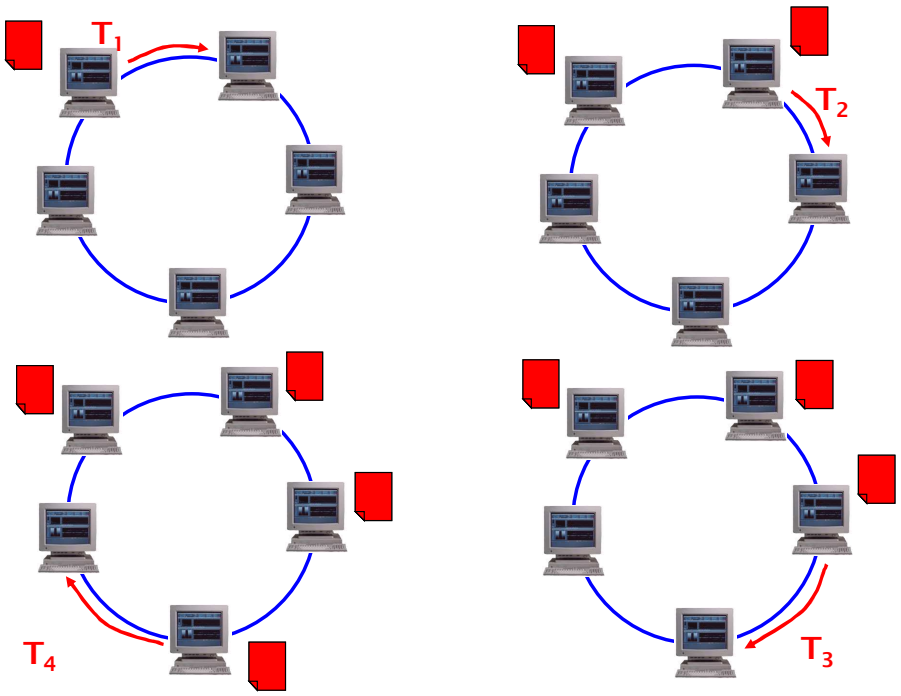


Università di Catania

Broadcast



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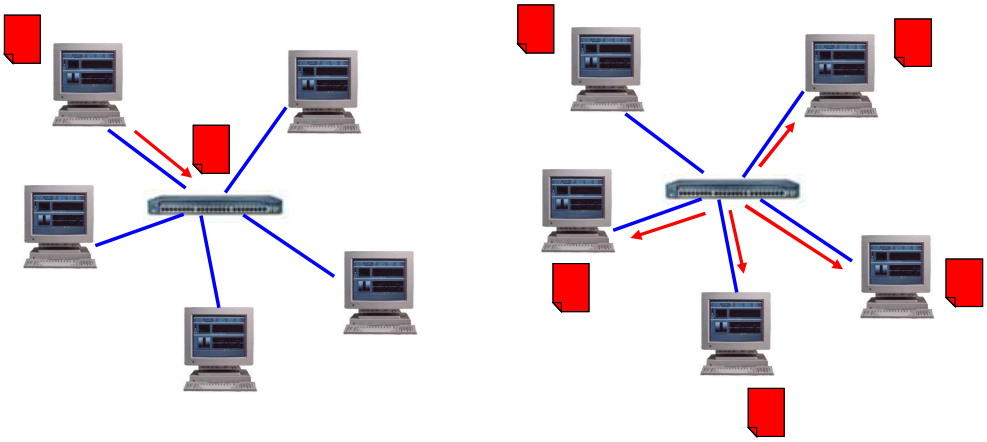

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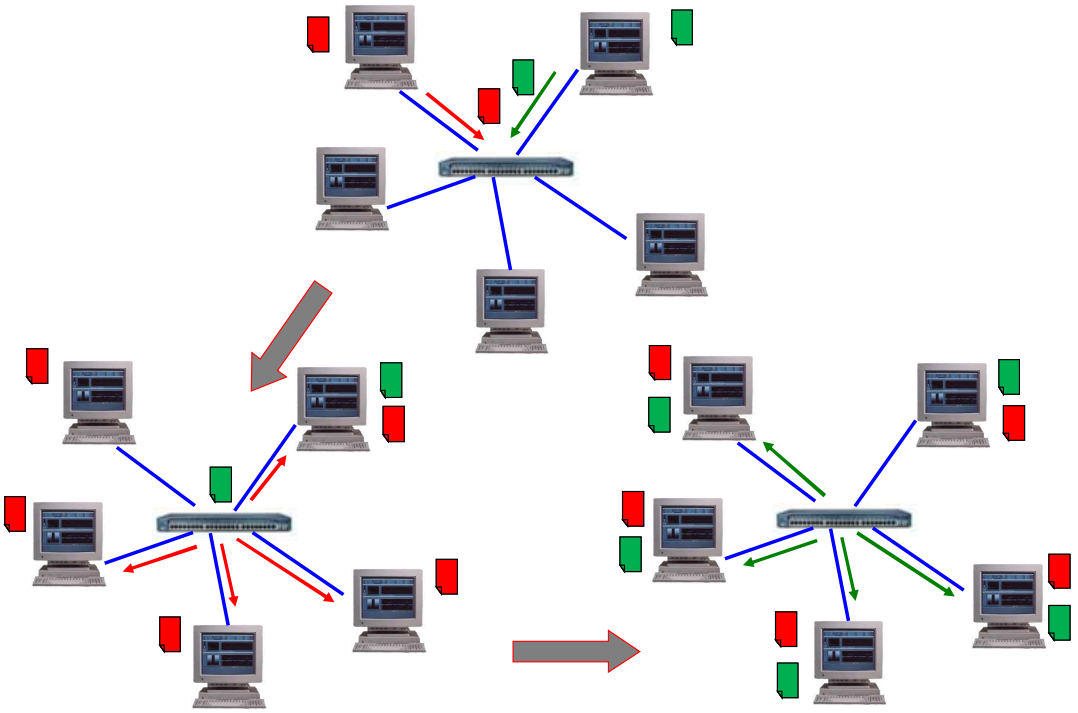
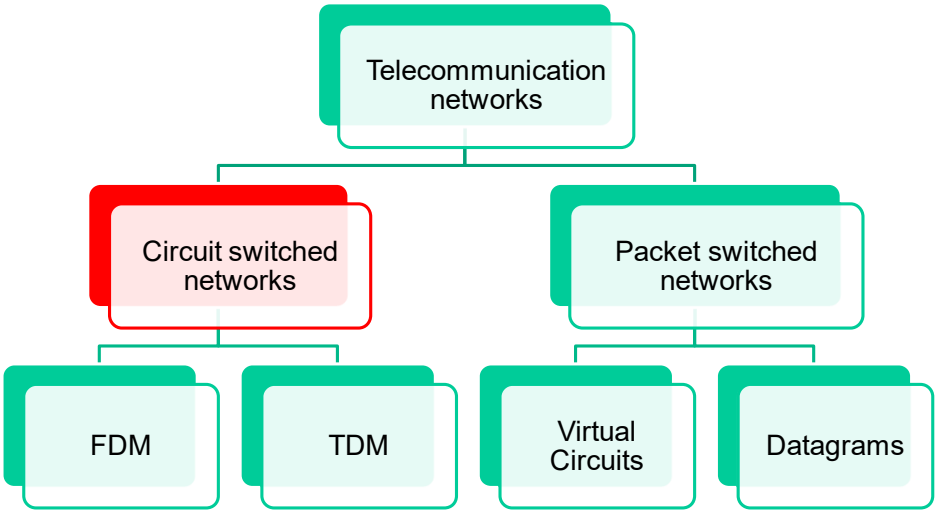


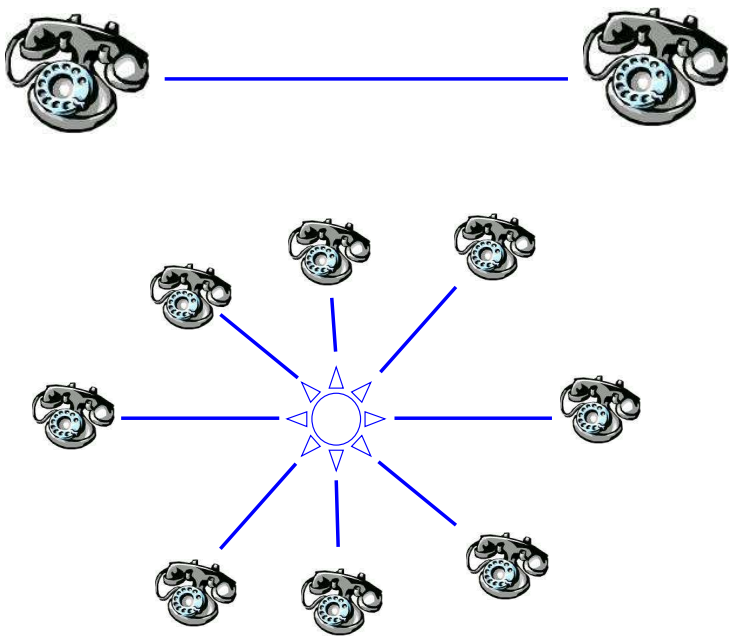
Taxonomy

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Taxonomy


Telecommunication networks
Circuit switched networks
Packet switched networks
FDM
TDM
Virtual Circuits
Datagrams

Telephone System

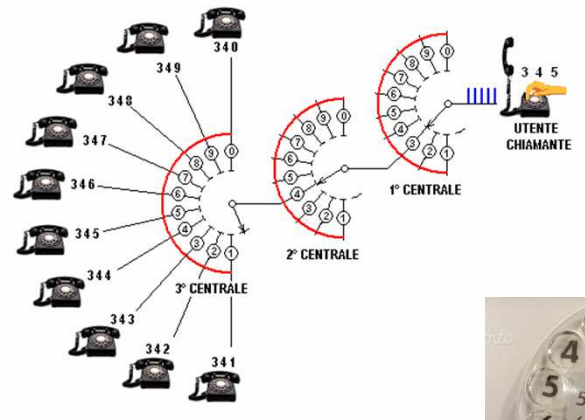


Telephone System

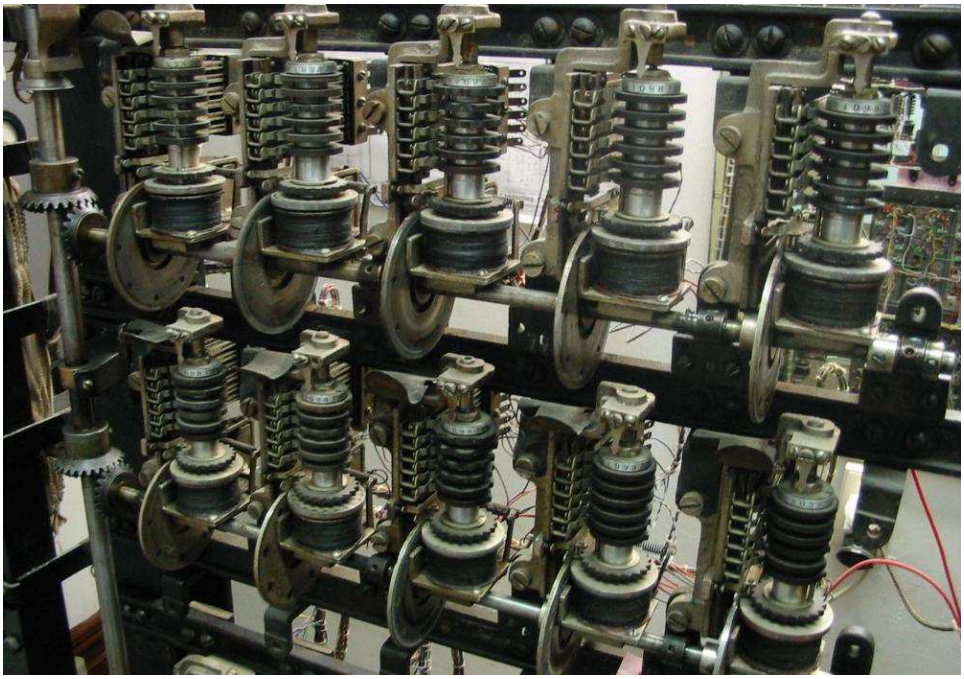
What's missing?

Telephone System

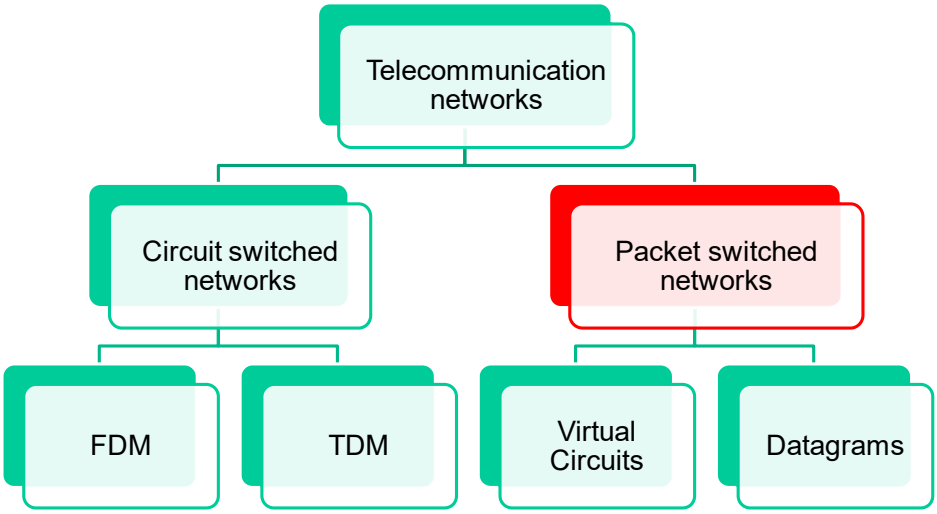
Circuit Switching



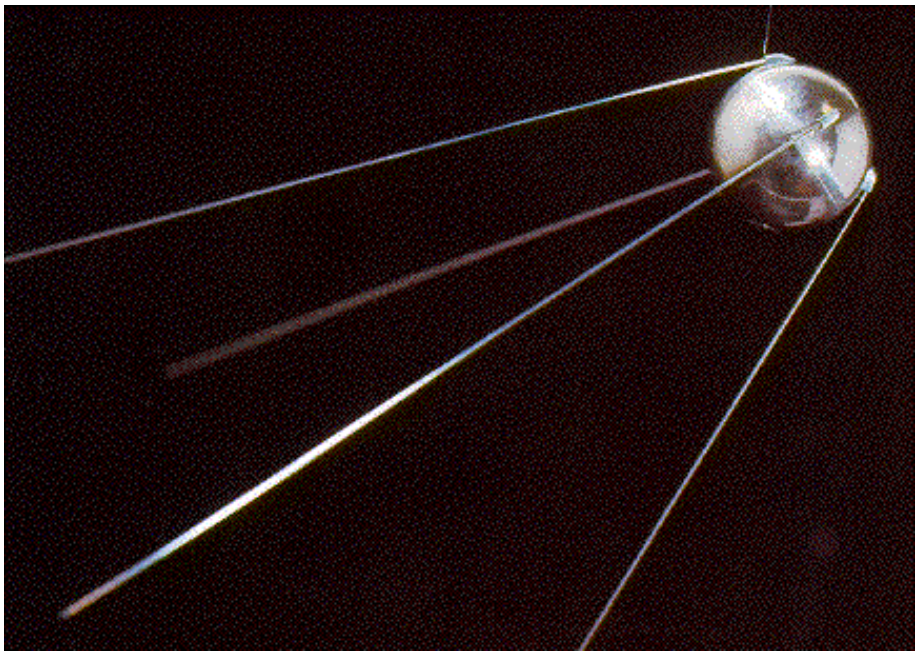
Circuit Switching



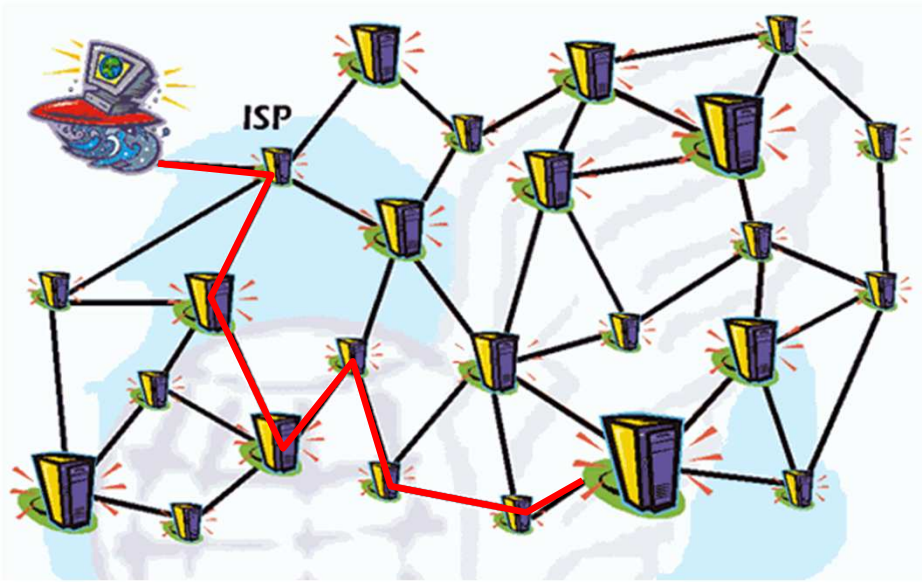
Taxonomy


Telecommunication networks
Circuit switched networks
Packet switched networks
FDM
TDM
Virtual Circuits
Datagrams

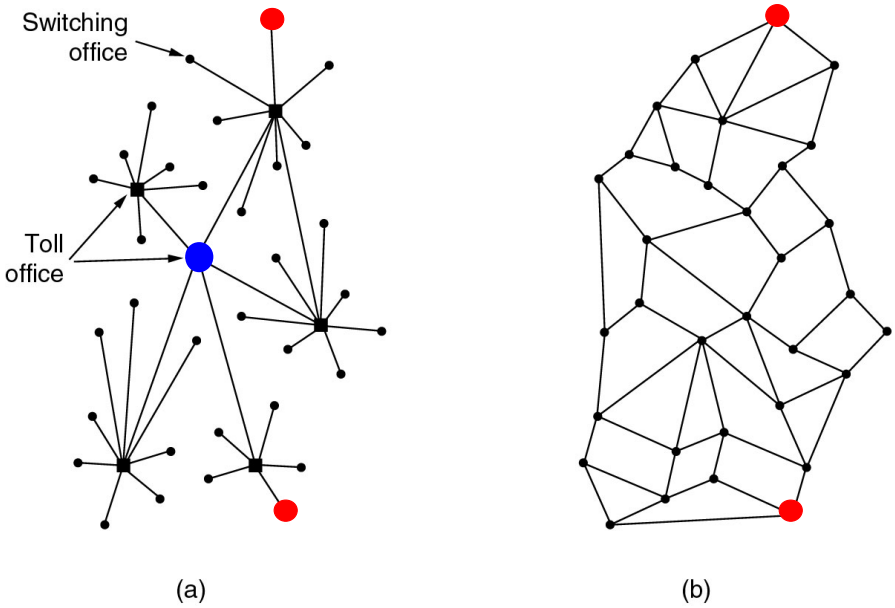
What is this?



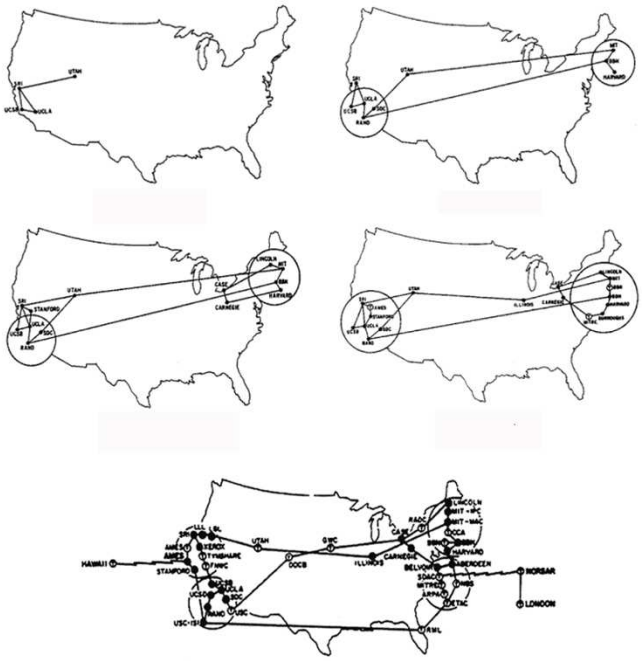
Packet Switching



Circuit vs packet switching



Arpanet



Arpanet

Leonard Kleinrock
and the first IMP

DATE	METER	PROBLEM & REMEDY	OPERATOR	DOWNTIME
29Oct69	1750	IMPTST RUNNING - TESTING LINE TO UCSB - LINE IS OPEN SO 'B' REG IS COUNTING ERRORS BUT SHOULD CEASE COUNTING IF TEL.Co. GETS LINE FIXED.	T. THACH	
		CHARLEY PLEASE CALL BEN AT SRI !		
29Oct69	2100	LOADED OP. PROGRAM FOR BEN BARKER BBN	CSK	
	22:30	Talked to SRI Host to Host	CSC	
		Left op. imp. program running after sending a host dead message to imp.	CSC	
30Oct69	1030	Stopped op. prog Started IMPTST to trace line trouble on TGW1 (UCSB)	T. THACH	

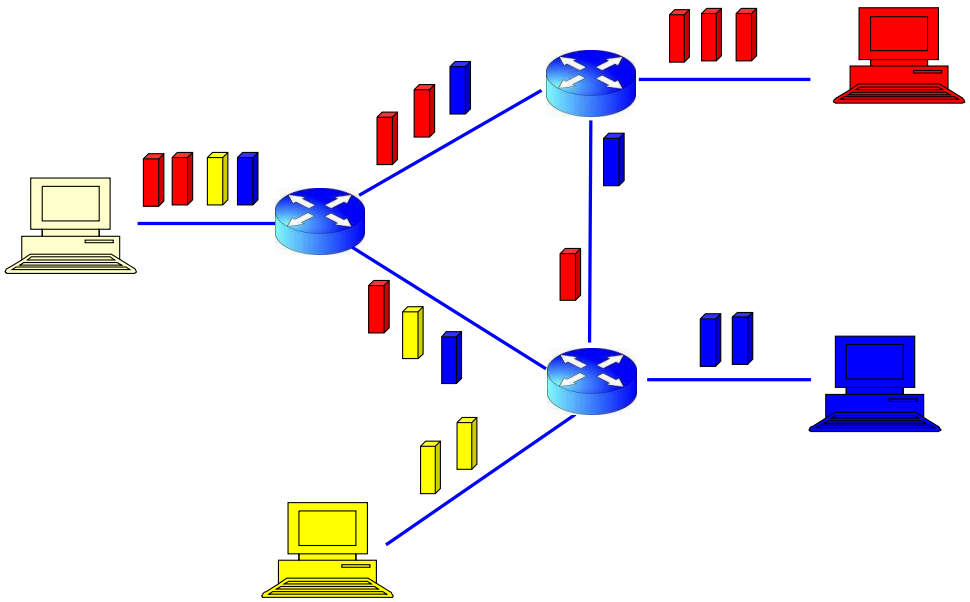
CUSTOMER SERVICE

SDS-S-324

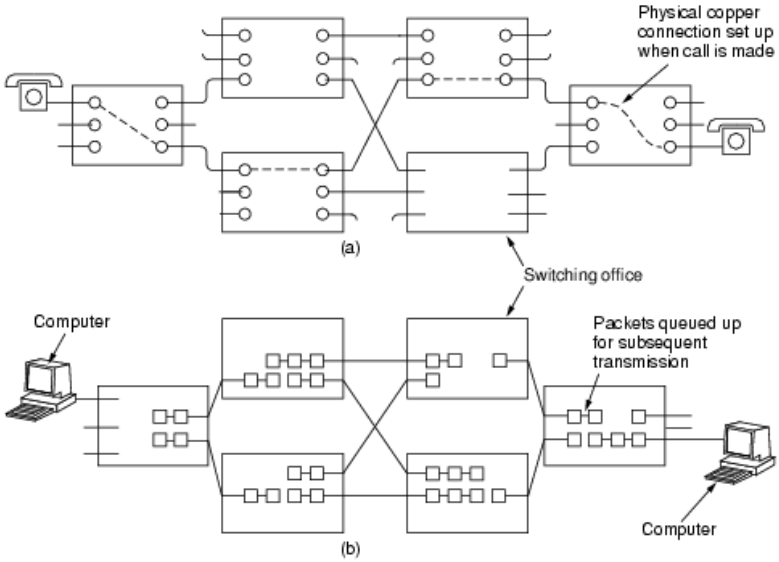
Interconnection

Università di Catania

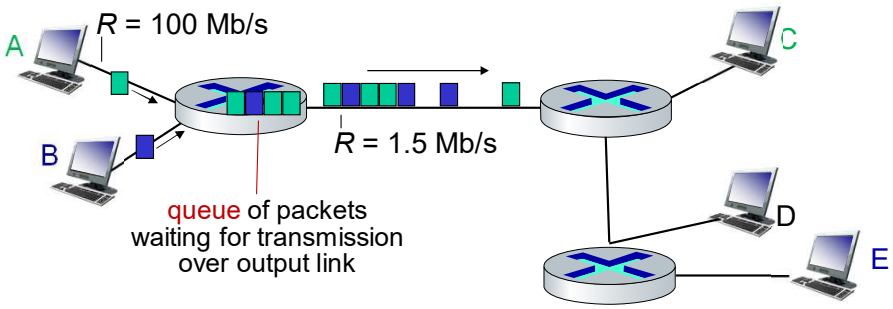
Interconnection



Packet Switching

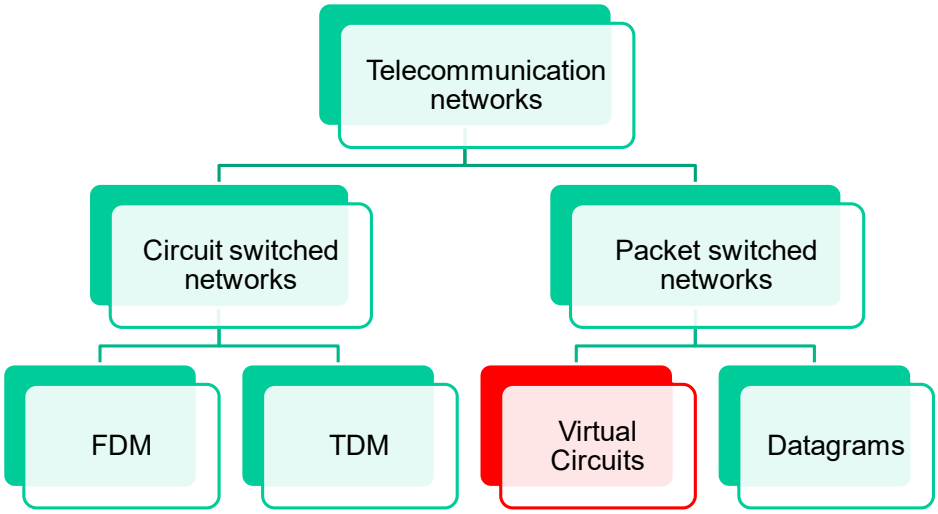


Packet Switching



Queueing occurs when work arrives faster than it can be serviced

Taxonomy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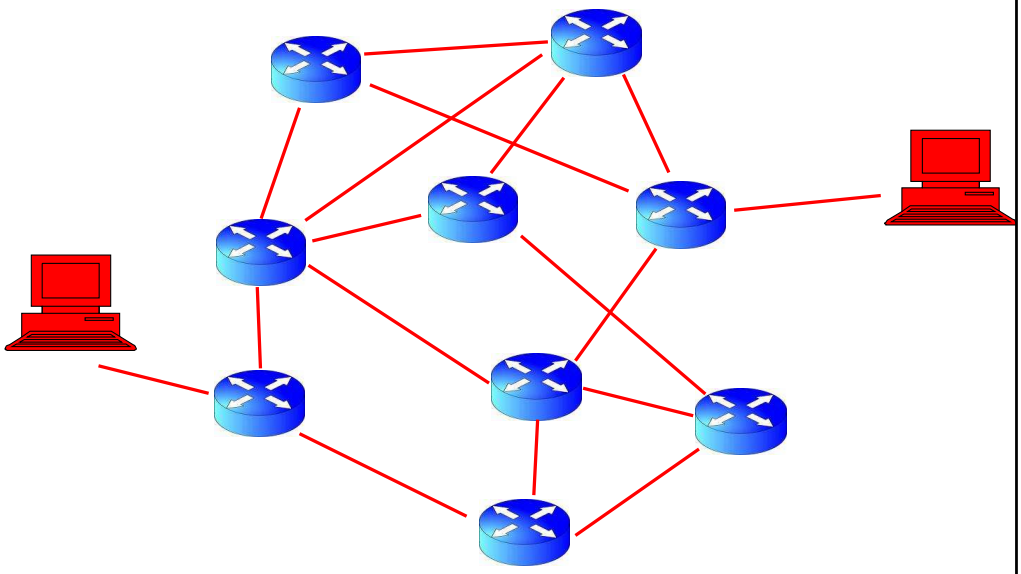
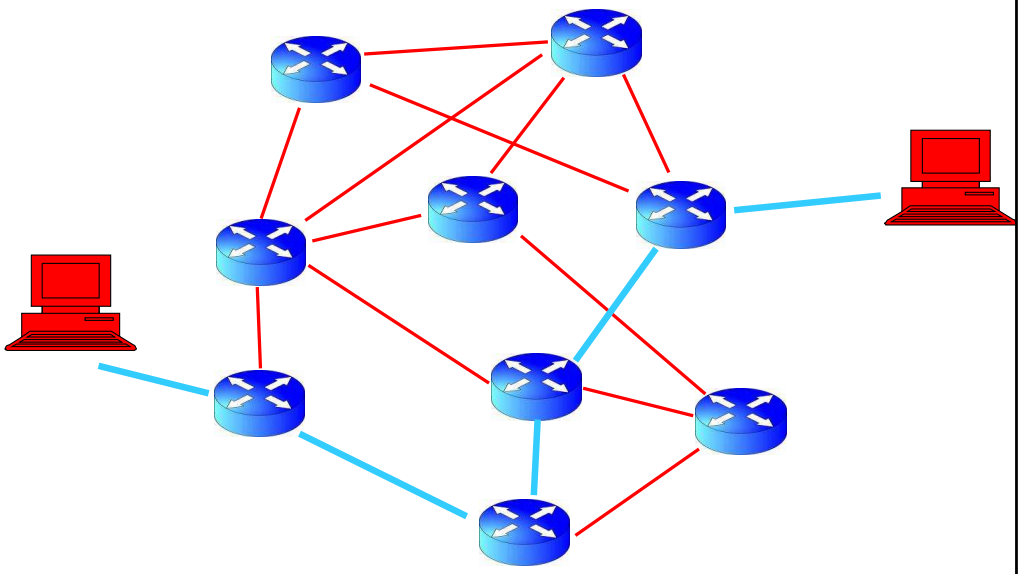
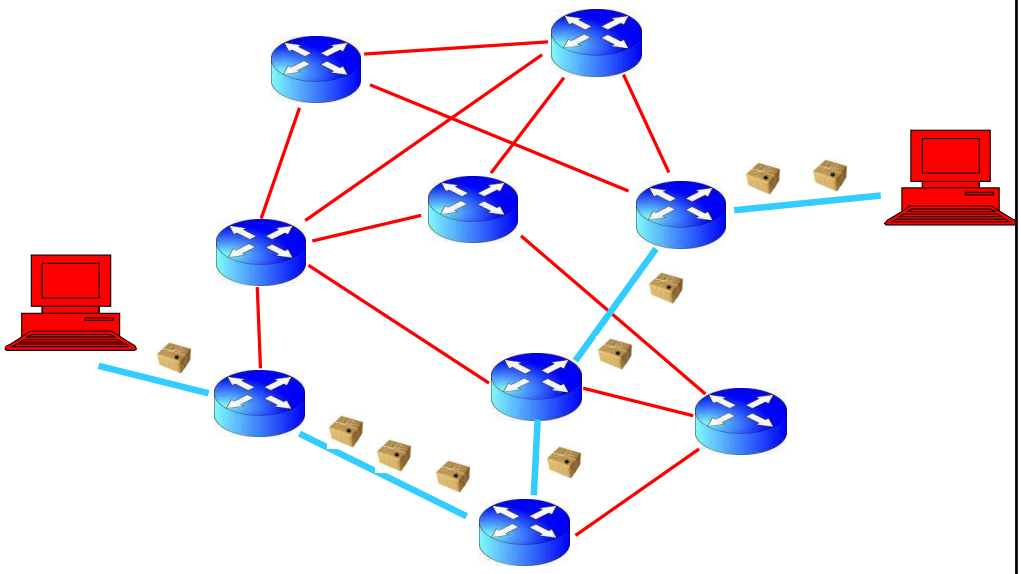
Virtual Circuits



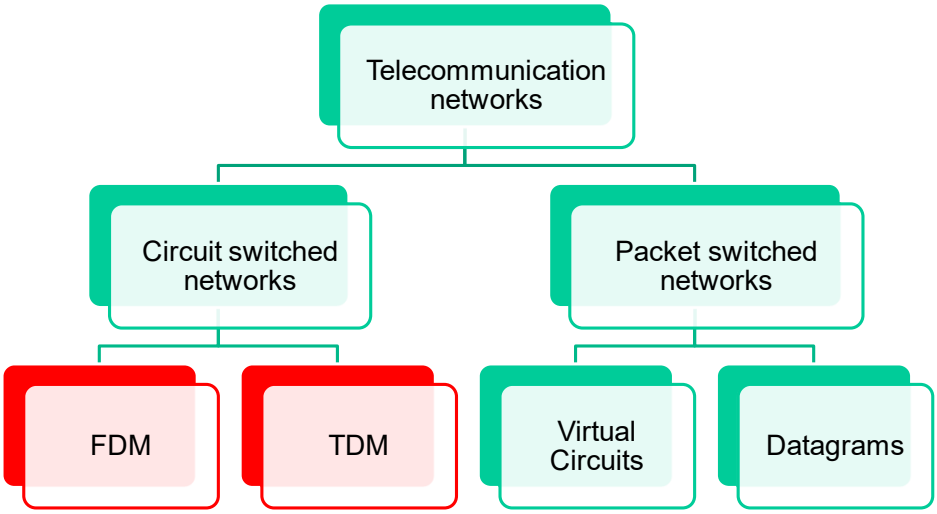
Virtual Circuits



Virtual Circuits



Taxonomy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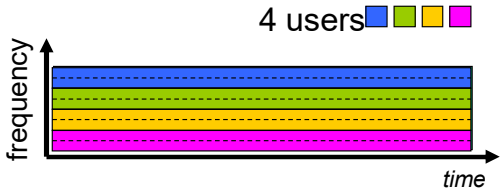
Circuit switching: FDM and TDM

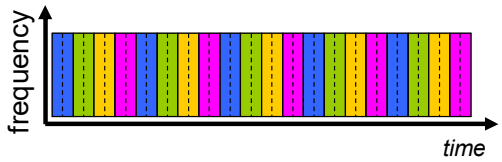
Frequency Division Multiplexing (FDM)

- optical, electromagnetic frequencies divided into (narrow) frequency bands
- each call allocated its own band, can transmit at max rate of that narrow band

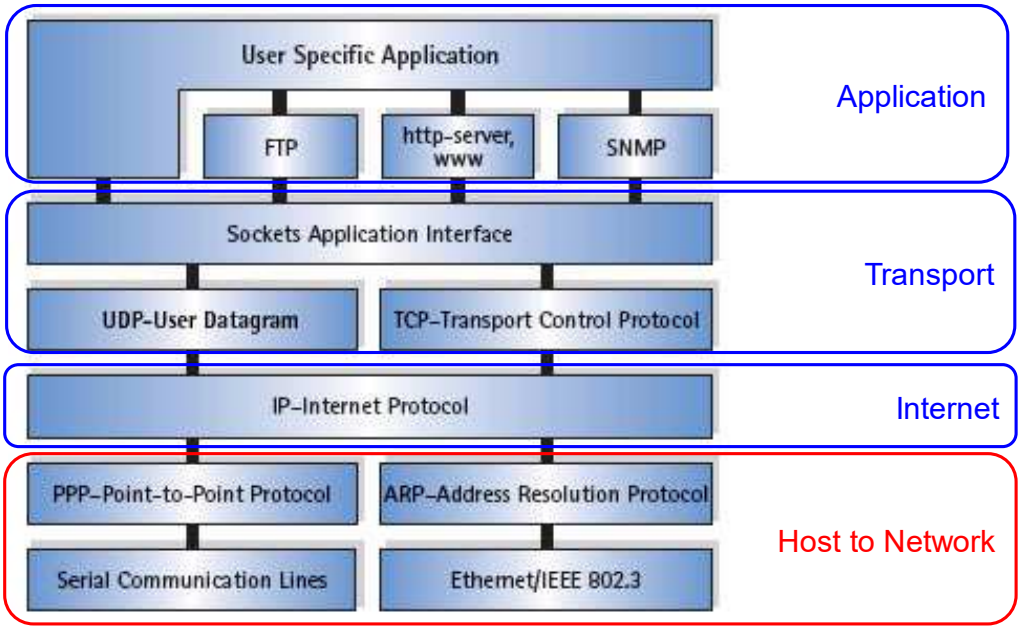


Time Division Multiplexing (TDM)

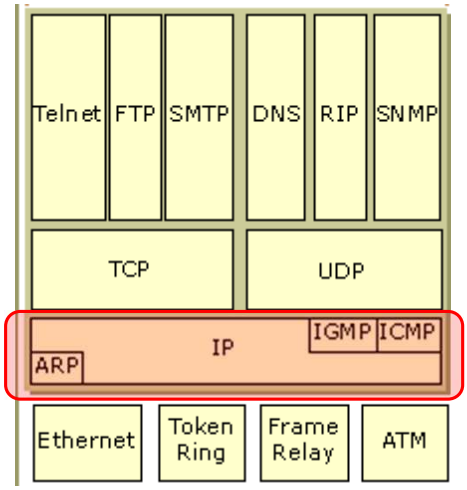
- time divided into slots
- each call allocated periodic slot(s), can transmit at maximum rate of (wider) frequency band (only) during its time slot(s)



TCP/IP


User Specific Application
FTP
http-server, www
SNMP
Application
Sockets Application Interface
UDP-User Datagram
TCP-Transport Control Protocol
Transport
IP-Internet Protocol
Internet
PPP-Point-to-Point Protocol
ARP-Address Resolution Protocol
Serial Communication Lines
Ethernet/IEEE 802.3
Host to Network

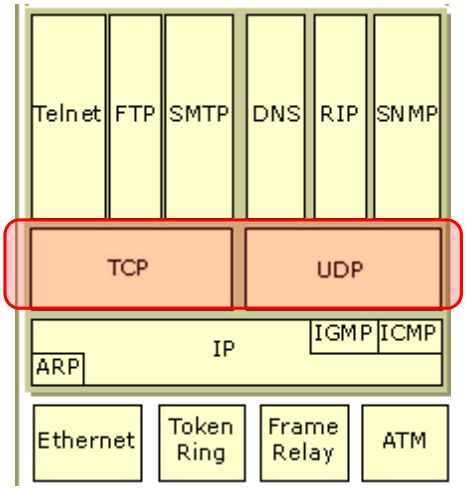
Internet Layer



It provides a Datagram service to reach a host connected to the Internet.

It requires a service at the bottom layer that can transport Datagram from one host to another directly connected

Transport Layer



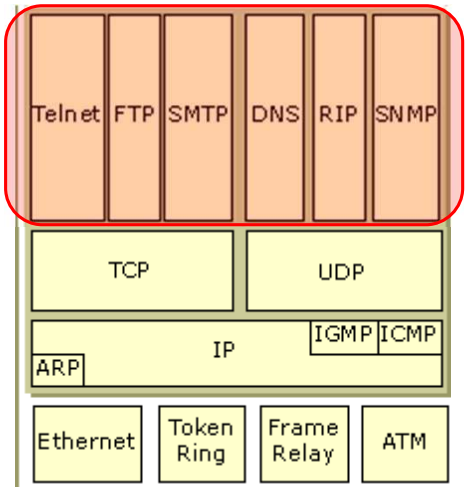
Provides:

- an unreliable, connectionless Datagram service (UDP)
- a reliable, connection-oriented service (TCP)

Introduces an identifier for each connection (port)

It requires a service at the bottom layer that can transport Datagram from one host to another that is not directly connected.

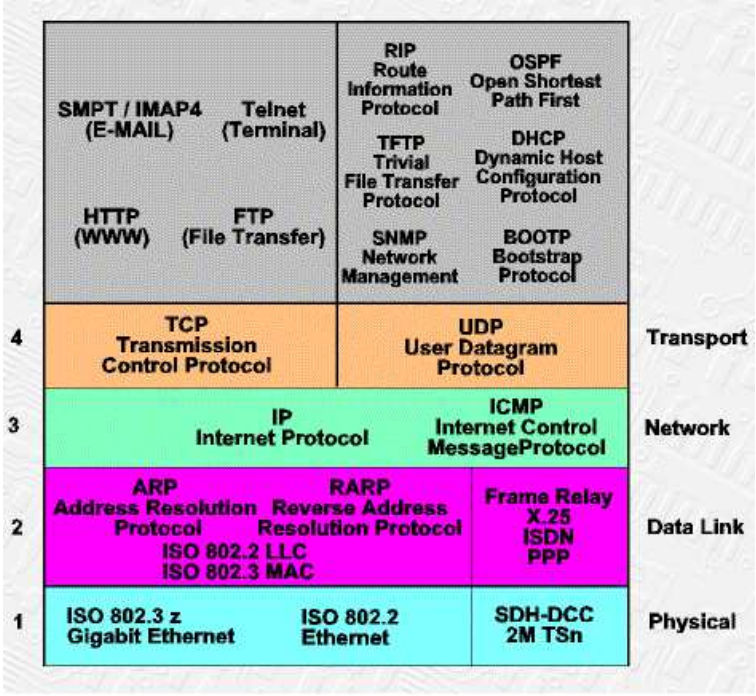
Application Layer



It interfaces directly with the user.
Requires a connection service at the bottom layer.

Reliability can be demanded at the layers below or implemented locally.

TCP/IP


SMPT / IMAP4 (E-MAIL)
Telnet (Terminal)
HTTP (WWW)
FTP (File Transfer)
RIP Route Information Protocol
OSPF Open Shortest Path First
TFTP Trivial File Transfer Protocol
DHCP Dynamic Host Configuration Protocol
SNMP Network Management
BOOTP Bootstrap Protocol
4
TCP Transmission Control Protocol
UDP User Datagram Protocol
Transport
3
IP Internet Protocol
ICMP Internet Control MessageProtocol
Network
2
ARP Address Resolution Protocol
RARP Reverse Address Resolution Protocol
ISO 802.2 LLC
ISO 802.3 MAC
Frame Relay
X.25
ISDN
PPP
Data Link
1
ISO 802.3 z Gigabit Ethernet
ISO 802.2 Ethernet
SDH-DCC
2M TSn
Physical

Network security

- field of network security:
  - how bad guys can attack computer networks
  - how we can defend networks against attacks
  - how to design architectures that are immune to attacks
- Internet not originally designed with (much) security in mind
  - *original vision:* “a group of mutually trusting users attached to a transparent network”
  - Internet protocol designers playing “catch-up”
  - security considerations in all layers!

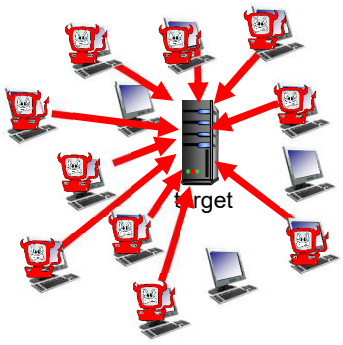
Bad guys: malware

- malware can get in host from:
  - *virus:* self-replicating infection by receiving/executing object (e.g., e-mail attachment)
  - *worm:* self-replicating infection by passively receiving object that gets itself executed
- spyware malware can record keystrokes, web sites visited, upload info to collection site
- infected host can be enrolled in botnet, used for spam or distributed denial of service (DDoS) attacks

Bad guys: denial of service

Denial of Service (DoS): attackers make resources (server, bandwidth) unavailable to legitimate traffic by overwhelming resource with bogus traffic

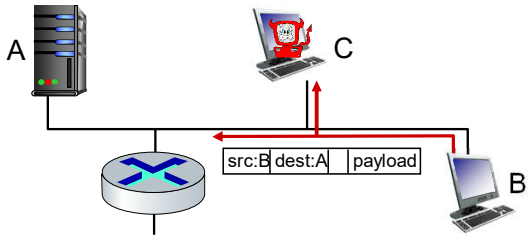
1. select target
2. break into hosts around the network
3. send packets to target from compromised hosts



Bad guys: packet interception

packet "sniffing":

- broadcast media (shared Ethernet, wireless)
- promiscuous network interface reads/records all packets (e.g., including passwords!) passing by



Wireshark software used for our end-of-chapter labs is a (free) packet-sniffer

Bad guys: fake identity

IP spoofing: send packet with false source address