Internet and Intranet

Lecture by:

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Chapter 1: Introduction

Topics to cover:

- History and Development of Internet and Intranet
- IANA, RIR/NIR/LIR and ISPs for internet number management
- Internet Domain and Domain Name System
- Internet Access Overview
- Internet Backbone Networks: Optical Backbone, Marine Cables, Teleports, Satellite and Terrestrial Links

The Internet

- The Internet is a global system of interconnected computer networks.
- Applications of the Internet
  - Traditional core applications:
    - Email
    - News
    - Remote Login
    - File Transfer
  - The killer application:
    - World-Wide Web (WWW)
  - New applications:
    - Videoconferencing
    - Telephony
    - P2P applications
    - Internet Broadcast

Internet History

- DARPA began as the Advanced Research Projects Agency (ARPA) created in 1958 by President Dwight D. Eisenhower for the purpose of research and development projects to expand the frontiers of technology and science and able to reach far beyond immediate military requirements.
- It was in response to the Soviet launching of Sputnik 1 in 1957, and ARPA's mission was to ensure U.S. military technology be more sophisticated than that of the nation's potential enemies.
- DARPA’s original mission, established in 1958, was to prevent technological surprise like the launch of Sputnik, which signaled that the Soviets had beaten the U.S. into space. The mission statement has evolved over time.
- ARPA was renamed to "DARPA" (for Defense) in March 1972, then renamed "ARPA" in February 1993, and then renamed "DARPA" again in March 1996

Internet History

- 1961-1972: Early packet-switching principles
- 1961: Kleinrock - queueing theory shows effectiveness of packet-switching
- 1964: Baran - packet-switching in military nets
- 1967: ARPAnet conceived by Advanced Research Projects Agency
- ARPA1969: first ARPAnet node operational
- 1972:
  - net public demonstration
  - NCP (Network Control Protocol) first host-host protocol
  - first e-mail program
  - ARPAnet has 15 nodes

Internet History

- 1972-1980: Internetworking, new and proprietary nets
  - 1970: ALOHA net satellite network in Hawaii
  - 1974: Cerf and Kahn - architecture for interconnecting networks
  - 1976: Ethernet at Xerox PARC
  - late70's: proprietary architectures: DECnet, SNA, XNA
  - late 70's: switching fixed length packets (ATM precursor)
  - 1979: ARPAnet has 200 nodes

Internet History

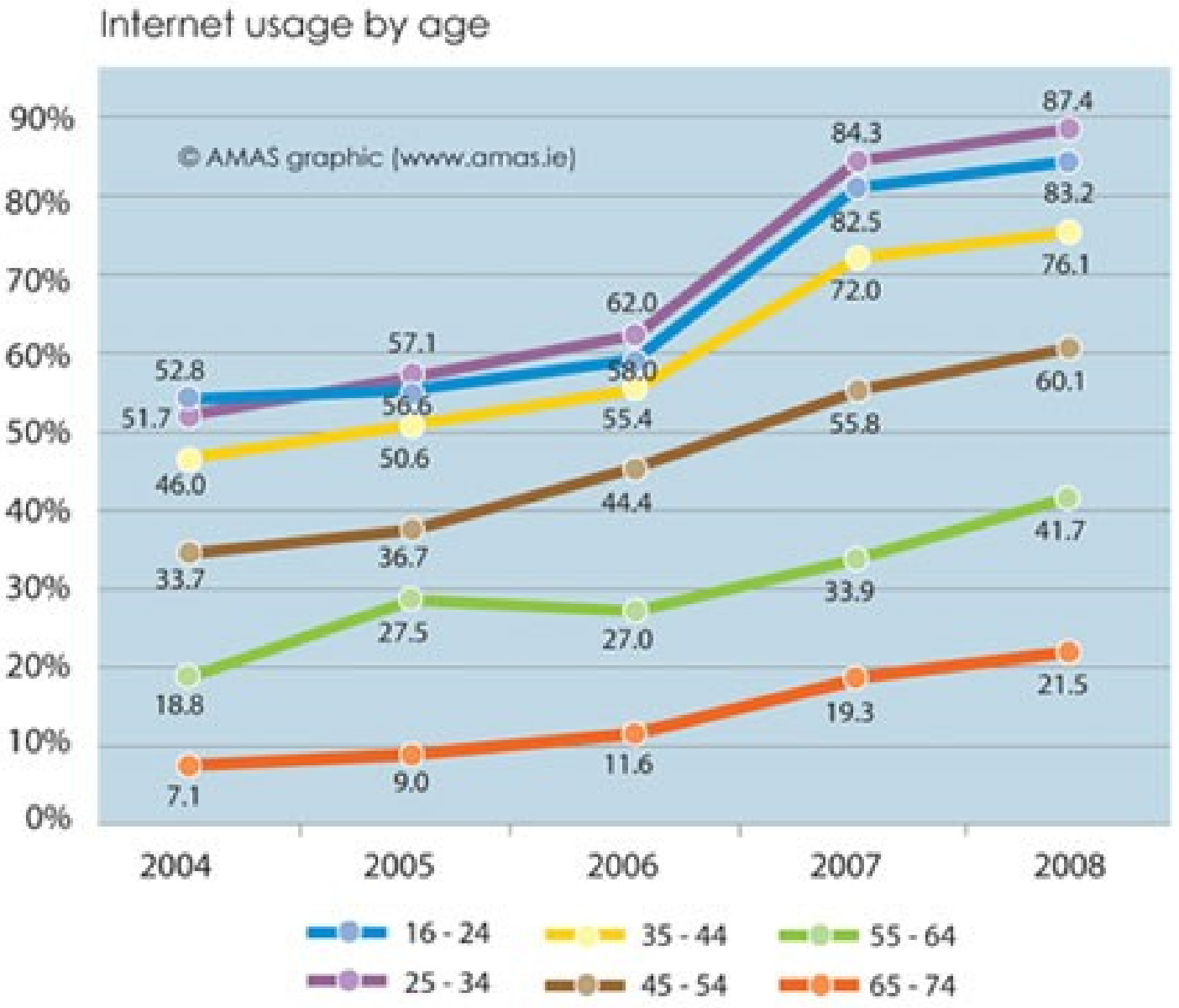
- 1983: deployment of TCP/IP
- 1982: smtp e-mail protocol defined
- 1983: DNS defined for name-to-IP-address translation
- 1985: ftp protocol defined
- 1988: TCP congestion control
  - new national networks: Csnet, BITnet, NSFnet, Minitel
  - 100,000 hosts connected to confederation of networks

Internet History

- 1990, 2000's: commercialization, the Web, new apps
  - Early 1990's: ARPAnet decommissioned
  - 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
  - early 1990s: Web
    - hypertext [Bush 1945, Nelson 1960's]
    - HTML, HTTP: Berners-Lee
    - 1994: Mosaic, later Netscape
    - late 1990's: commercialization of the Web

Internet History

- Late 1990's – 2000's:
  - more killer apps: instant messaging, P2P file sharing
  - network security to forefront
  - est. 50 million host, 100 million+ users
  - backbone links running at Gbps
- 2007:
  - ~500 million hosts
  - Voice, Video over IP
  - P2P applications: BitTorrent (file sharing) Skype (VoIP), PPLive (video)
  - more applications: YouTube, gaming
  - wireless, mobility


Internet usage by age
© AMAS graphic (www.amas.ie)
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2004
2005
2006
2007
2008
52.8
57.1
62.0
84.3
87.4
51.7
56.6
58.0
82.5
83.2
46.0
50.6
55.4
72.0
76.1
33.7
36.7
44.4
55.8
60.1
18.8
27.5
27.0
33.9
41.7
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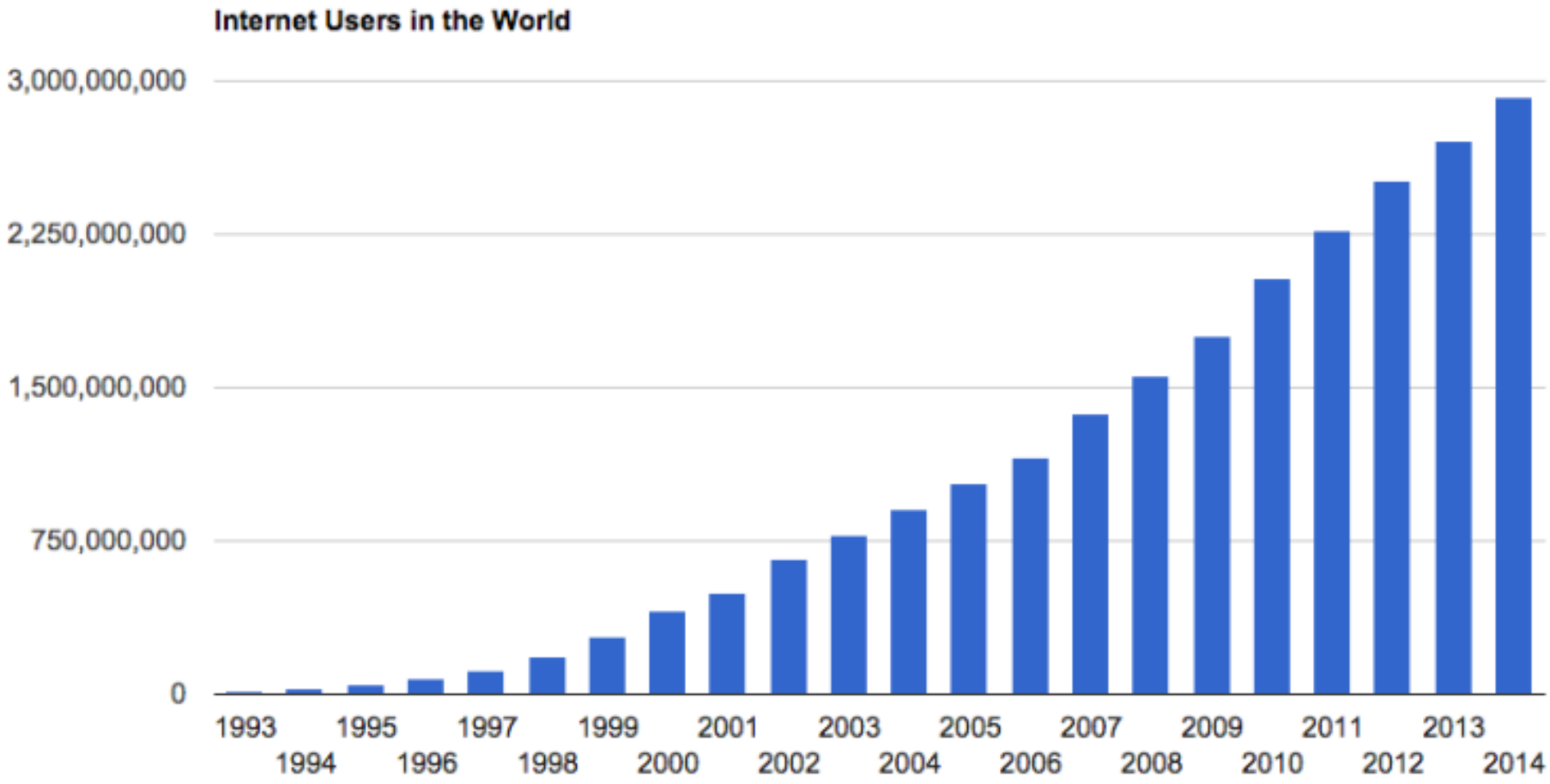
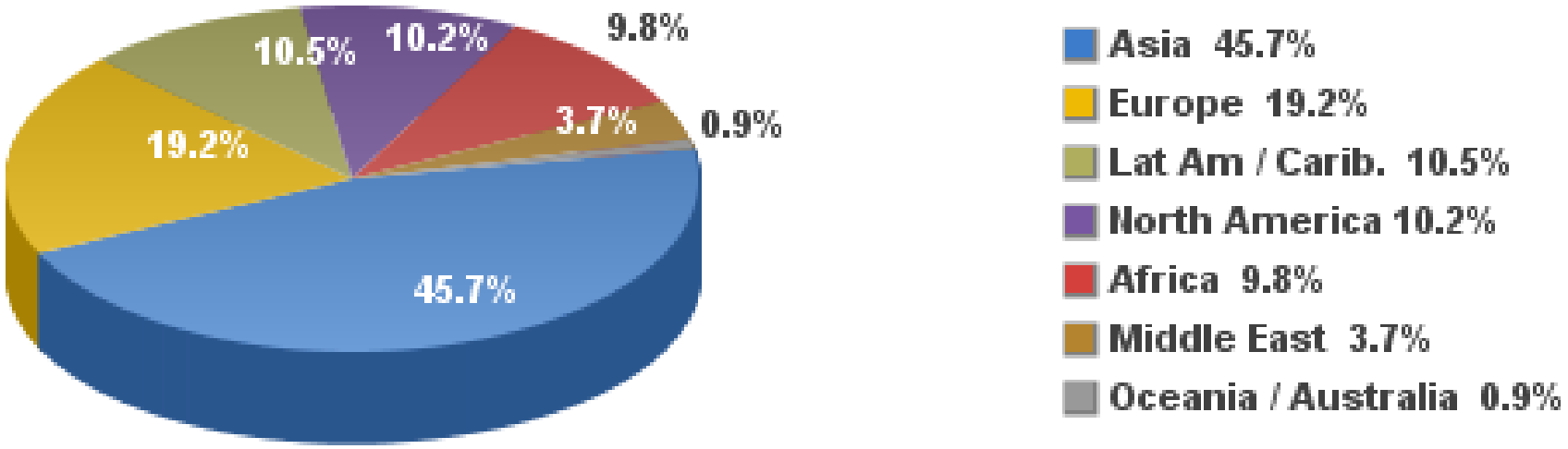
11.6
19.3
21.5
16 - 24
25 - 34
35 - 44
45 - 54
55 - 64
65 - 74


Internet Users in the World
3,000,000,000
2,250,000,000
1,500,000,000
750,000,000
0
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014

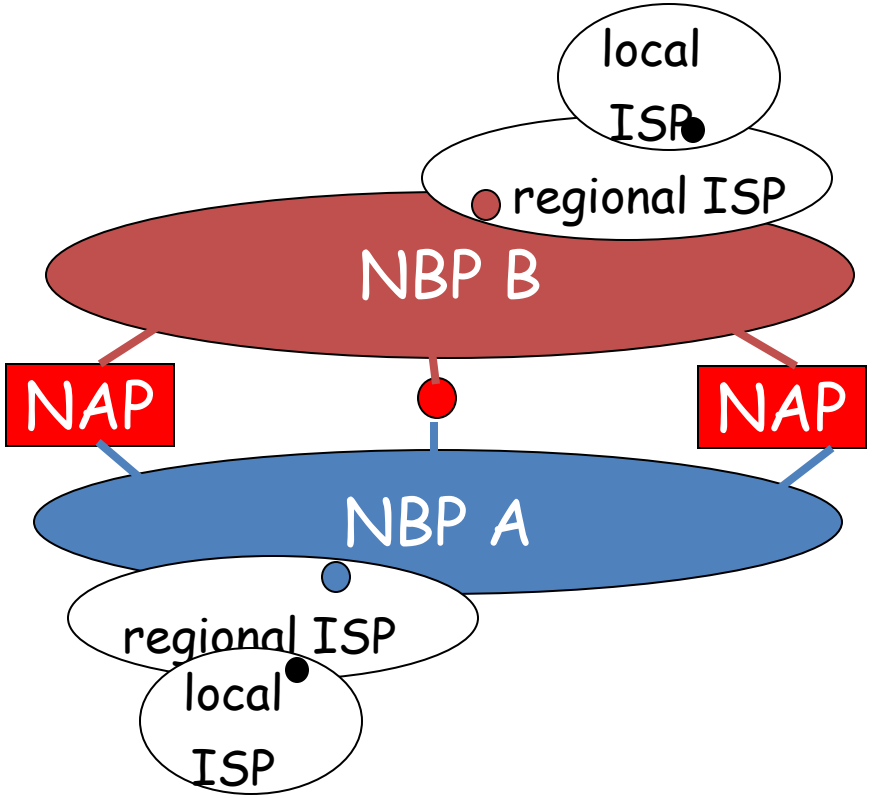
Internet Users in the World
Distribution by World Regions - 2014 Q2



Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 3,035,749,340 Internet users on June 30, 2014

Internet structure: network of networks

- roughly hierarchical
- national/international backbone providers (NBPs)
  - e.g. Sprint, MCI (previously UUNet/WorldCom), AT&T, Level3 (which acquired Genuity), Qwest and Cable & Wireless
  - interconnect (peer) with each other privately, or at public Network Access Point (NAPs)
- regional ISPs
  - connect into NBPs
- local ISP, company
  - connect into regional ISPs



What's a protocol?

Human protocols:

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

… specific msgs sent

… specific actions taken when msgs received, or other events

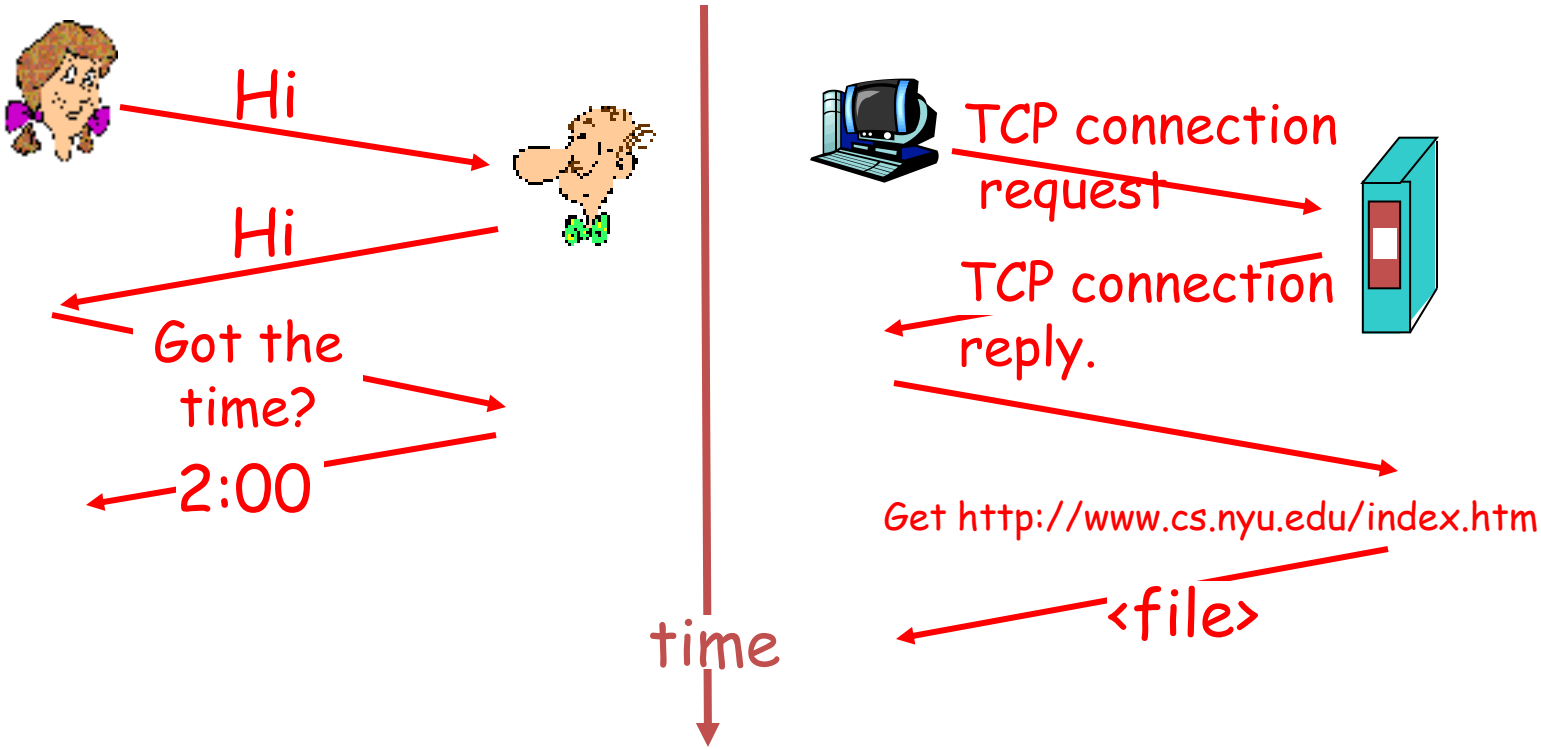
Network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of messages sent and received among network entities, and actions taken on messages receipt

What's a protocol?

A human protocol and a computer network protocol:

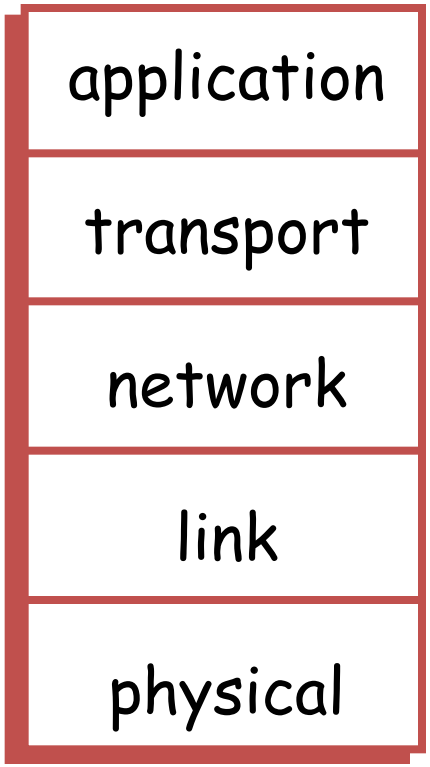


In Summary, a protocol is ....

- An agreement about communication between two or more entities
- It specifies
  - Format of messages
  - Meaning of messages
  - Rules for exchange
  - Procedures for handling problems

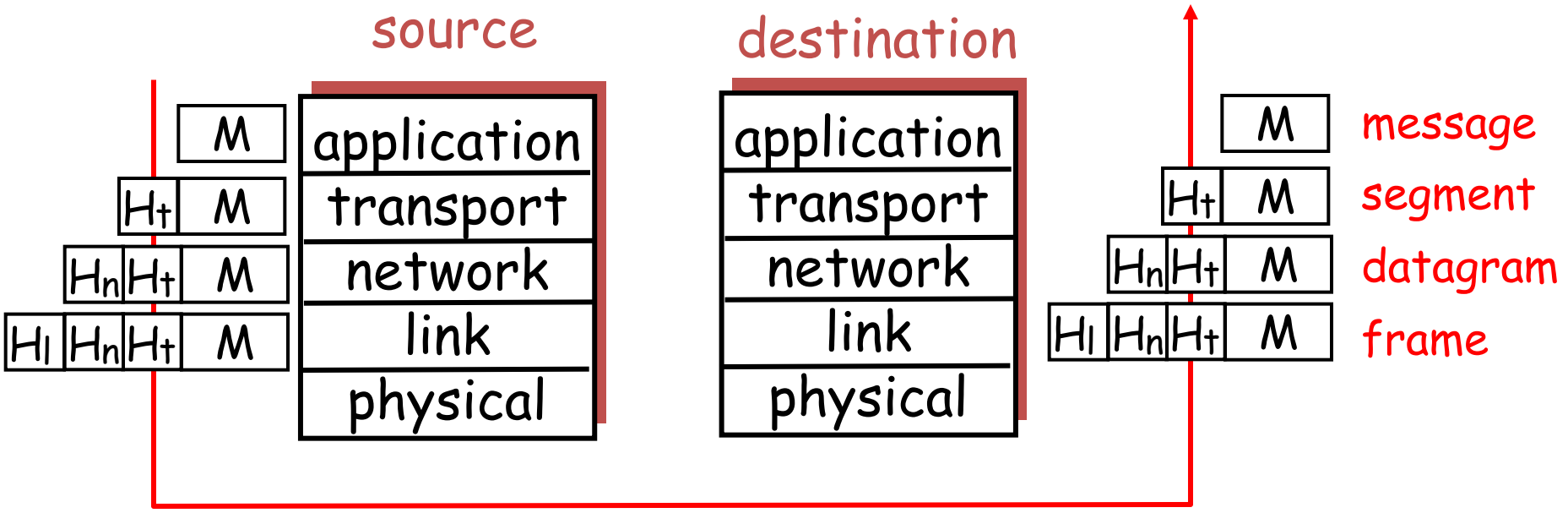
Internet protocol stack

- application: supporting network applications
  - FTP, SMTP, HTTP
- transport: host-host data transfer
  - TCP, UDP
- network: routing of datagram from source to destination
  - IP, routing protocols
- link: data transfer between neighboring network elements
  - PPP, Ethernet
- physical: bits “on the wire, in the fiber, or as electromagnetic waves”



Protocol layering and data

- Each layer takes data from above
  - adds header information to create new data unit
  - passes new data unit to layer below



Internet Resources

- IP Address
- Autonomous System Number
- root zone management in the Domain Name System (DNS)

- What is an IP Address?
  - An *Internet Protocol (IP) address is a number that identifies a device on a computer network.*
  - *Details of IP in next chapter*

AS Number

- An AS is a collection of networks under a common administration that share a common routing strategy.
- To the outside world, an AS is viewed as a single entity.
- The AS may be run by one or more operators while it presents a consistent view of routing to the external world.
- The American Registry of Internet Numbers (ARIN), a service provider, or an administrator assigns a 32-bit identification number to each AS.
- Each AS has its own set of rules and policies and an AS number that will distinguish it from all other autonomous systems.
- Until 2007, AS numbers were defined as 16-bit integers
- RFC 4893 introduced 32-bit AS numbers, which IANA has begun to allocate.

Domain Name System (DNS)

- A hierarchical, distributed database that contains mappings of DNS domain names to various types of data, such as IP addresses.
- DNS enables the location of computers and services by user-friendly names, and it also enables the discovery of other information stored in the database.

Root Zone Database

- The Root Zone Database represents the delegation details of top-level domains, including TLDs such as .com, and country-code TLDs such as .uk. As the manager of the DNS root zone, IANA is responsible for coordinating these delegations in accordance with its policies and procedures

IANA (Internet Assigned Number Authority)

- is the entity that oversees
  - global IP address allocation,
  - autonomous system number allocation,
  - root zone management in the Domain Name System (DNS),
  - media types, and other Internet Protocol-related symbols and numbers.
- IANA is a department operated by the Internet Corporation for Assigned Names and Numbers, also known as ICANN

IANA Contd..

- Prior to the establishment of ICANN for this purpose, IANA was administered primarily by Jon Postel at the Information Sciences Institute (ISI) of the University of Southern California (USC), under a contract USC/ISI with the United States Department of Defense, until ICANN was created to assume the responsibility under a United States Department of Commerce contract.

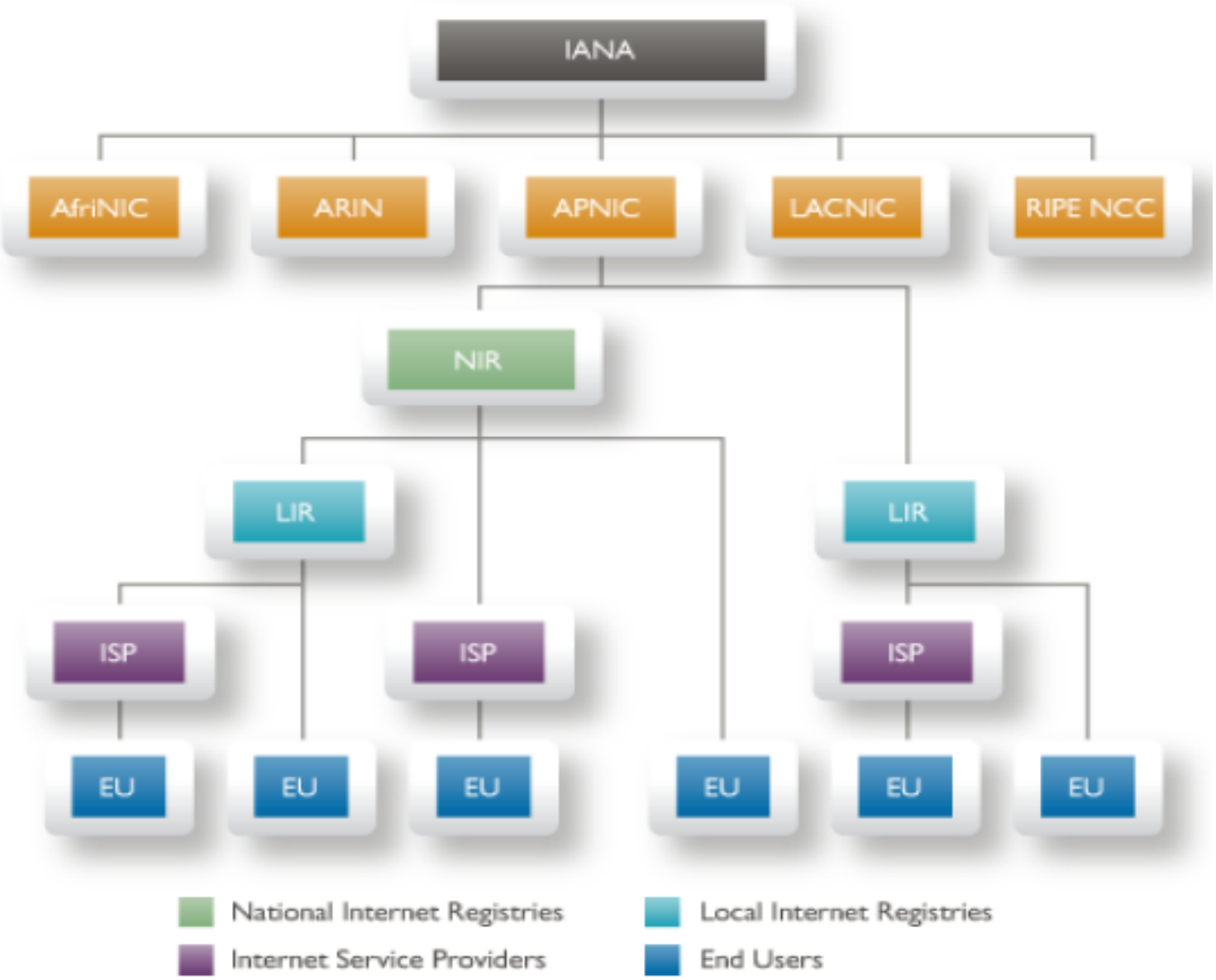
IANA Contd..

- Allocates and maintains unique codes and numbering systems used in the technical standards (“protocols”)
  - allow computers and other devices to talk to each other over the Internet.
- Unique codes and number is key to ensure that the Internet retains its interoperability.
- The various activities of IANA can be grouped broadly into three categories:
  - Number Resources
  - Domain Names
  - Protocol Assignments

Number Resources

- Internet works by passing data between different computers using a system of unique computer identifiers called IP addresses
- IANA's responsibility is to maintain the global pool of numbers, and to supply them to the Regional Internet Registries (RIR)
- There are five of these registries or RIRs
  - African Network Information Centre (AfriNIC)
  - Asia Pacific Network Information Centre (APNIC)
  - American Registry for Internet Numbers(ARIN)
  - Latin America and Caribbean Network Information Centre (LACNIC)
  - Reseaux IP Europe Network Co-ordination Centre(RIPE NCC)

RIR


IANA
AfriNIC
ARIN
APNIC
LACNIC
RIPE NCC
NIR
LIR
LIR
ISP
ISP
ISP
EU
EU
EU
EU
EU
EU
National Internet Registries
Local Internet Registries
Internet Service Providers
End Users

RIR

- In October 1992, the Internet Engineering Task Force (IETF) published RFC 1366, which described the “growth of the Internet and its increasing globalization” and set out the basis for an evolution of the registry process, based on a regionally distributed registry model.
- This document stressed the need for a single registry to exist in each geographical region of the world (which would be of “continental dimensions”)
- A regional Internet registry (RIR) is an organization that manages the allocation and registration of Internet number resources within a particular region of the world. Internet number resources include IP addresses and autonomous system (AS) numbers

NIR

- A National Internet Registry (or NIR) is an organization under the umbrella of a RIR with the task of coordinating IP address allocations and other Internet resource management functions at a national level within a country or economic unit.
- NIRs operate primarily in the Asia Pacific region, under the authority of APNIC, the RIR for that region.
- Some NIRs that are currently operating in the APNIC region:
  - APJII (Asosiasi Penyelenggara Jasa Internet Indonesia), Indonesian ISP Association
  - CNNIC, China Internet Network Information Center
  - JPNIC, Japan Network Information Center
  - KRNIC, National Internet Development Agency of Korea
  - SGNIC, Singapore Network Information Centre

LIR

- Local Internet registry
- A local Internet registry (LIR) is an organization that has been allocated a block of IP addresses by a regional Internet registry (RIR), and that assigns most parts of this block to its own customers.
- Most LIRs are Internet service providers, enterprises, or academic institutions.
- Membership in an RIR is required to become an LIR.

ISP

- An Internet service provider (ISP) is an organization that provides access to the Internet.
- Access ISPs directly connect clients to the Internet using copper wires, wireless or fiber-optic connections.
- Hosting ISPs are a kind of colocation center that leases server space to smaller businesses and other people.
- Transit ISPs provide large amounts of bandwidth for connecting hosting ISPs to access ISPs.

Domain Name System

- The Domain Name System provides a method of identifying resources on the Internet using easy-to-remember names.
- At a technical level, devices on the Internet are reached using IP numbers.
- As these numbers are difficult to remember, domain names such as “iana.org” provide more useful labels for connecting to these computers.
- Domain Name System provides the technical tools to convert these memorable names into the IP addresses

Protocol Parameters

- Internet standardization process involves the creation of a document which is part of the “Request for Comments”, or RFC series.
  - These RFC documents describe the technical standards used on the Internet.
- As the development of an RFC nears its conclusion,
  - IANA participates in the editorial process,
  - identifies where protocol assignments should be located within IANA’s registry.
  - This usually occurs when unique number systems are used within a protocol
  - and when there are elements that must be shared across multiple protocols

Example Protocol Registries

Port Numbers

- Many services on the Internet use a port number to differentiate between multiple applications running on the same computer.
- For example, web pages are delivered by the HTTP protocol, which is assigned to port number 80.
- The same computer can deliver email using the port assigned for that purpose, number 25.
- IANA maintains the master list of which protocols use which port numbers.

- Why does IANA exist?
  - There is no central control of the Internet
  - If computers did not use the same system of identifiers and numbers to talk to one another, the system would not interoperate
  - IANA coordinates the numbering systems needed to ensure the Internet interoperates globally
  - ICANN was devised to be the institutional home for the IANA

DNS (Domain Name System)

- DNS is usually used to translate a host name into an IP address
  - automatically converts the names we type in our Web browser address bar to the IP addresses of Web servers hosting those sites.
- Domain names comprise a hierarchy so that names are unique, yet easy to remember.
- DNS implements a distributed database to store this name and address information for all public hosts on the Internet.
- Most network operating systems support configuration of primary, secondary, and tertiary DNS servers, each of which can service initial requests from clients.

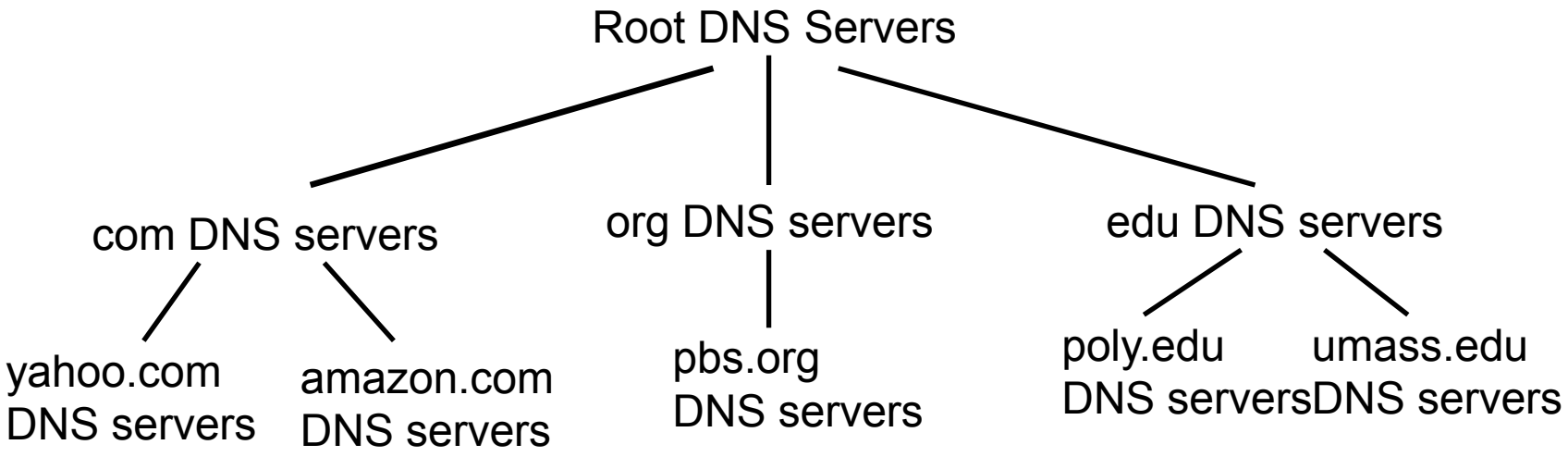
DNS Contd..

- Example :
  - Name used by human – www.example.com
  - translated to the addresses 93.184.216.119 (IPv4)
- Host name structure
  - Each host name is made up of a sequence of *labels* separated by periods.
    - Each label can be up to 63 characters
    - The total name can be at most 255 characters.
- Examples:
  - whitehouse.gov
  - Wikipedia.org
  - ioe.edu.np
  - Iamtheproudownerofthelongestlongestlongestdomainnameinthisworld.com

DNS Contd..

- Which applications use DNS?
  - HTTP
    - Browser extracts hostname
    - Sends hostname to DNS
    - DNS does lookup and returns IP address
    - Browser sends HTTP GET to IP address
- Why not centralize DNS?
  - single point of failure
  - traffic volume
  - distant centralized database
  - maintenance
  - doesn't *scale!*

Distributed, Hierarchical Database



Client wants IP for www.amazon.com:

- Client queries a root server to find com DNS server
- Client queries com DNS server to get amazon.com DNS server
- Client queries amazon.com DNS server to get IP address for www.amazon.com

DNS: Root name servers

- contacted by local name server that can not resolve name
- root name server:
  - contacts authoritative name server if name mapping not known
  - gets mapping
  - returns mapping to local name server

13 root name servers worldwide

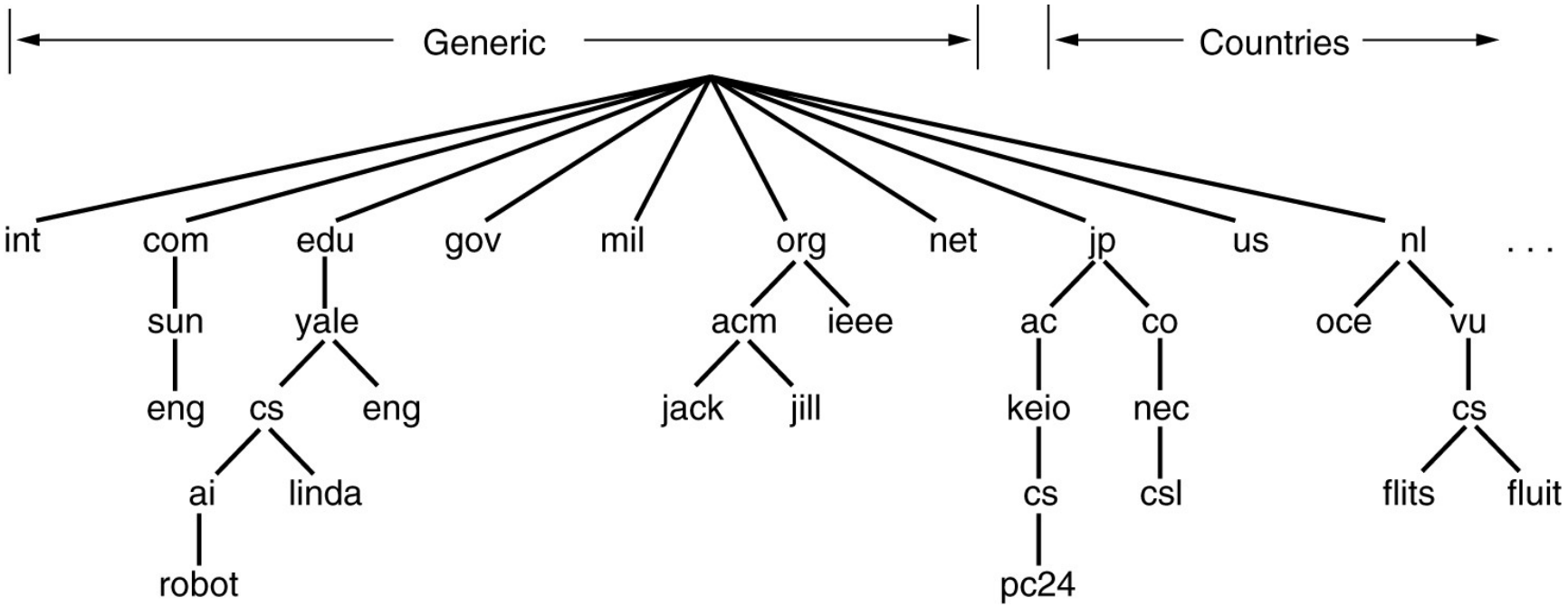
TLD and Authoritative Servers

- Top-level domain (TLD) servers:
  - Generic top level domains
    - responsible for .com, .org, .net, .edu, .gov, etc
  - Countries have a 2 letter top level domain
    - Example., uk, fr, np, ca, jp
  - Network solutions maintains servers for com TLD
- Authoritative DNS servers:
  - organization's DNS servers,
  - providing authoritative hostname to IP mappings for organization's servers (e.g., Web and mail)
    - Can be maintained by organization or service provider

Local Name Server

- Does not strictly belong to hierarchy
- Each ISP (residential ISP, company, university) has one.
  - Also called “default name server”
- When a host makes a DNS query, query is sent to its local DNS server
  - Acts as a proxy, forwards query into hierarchy.

The DNS Name Space

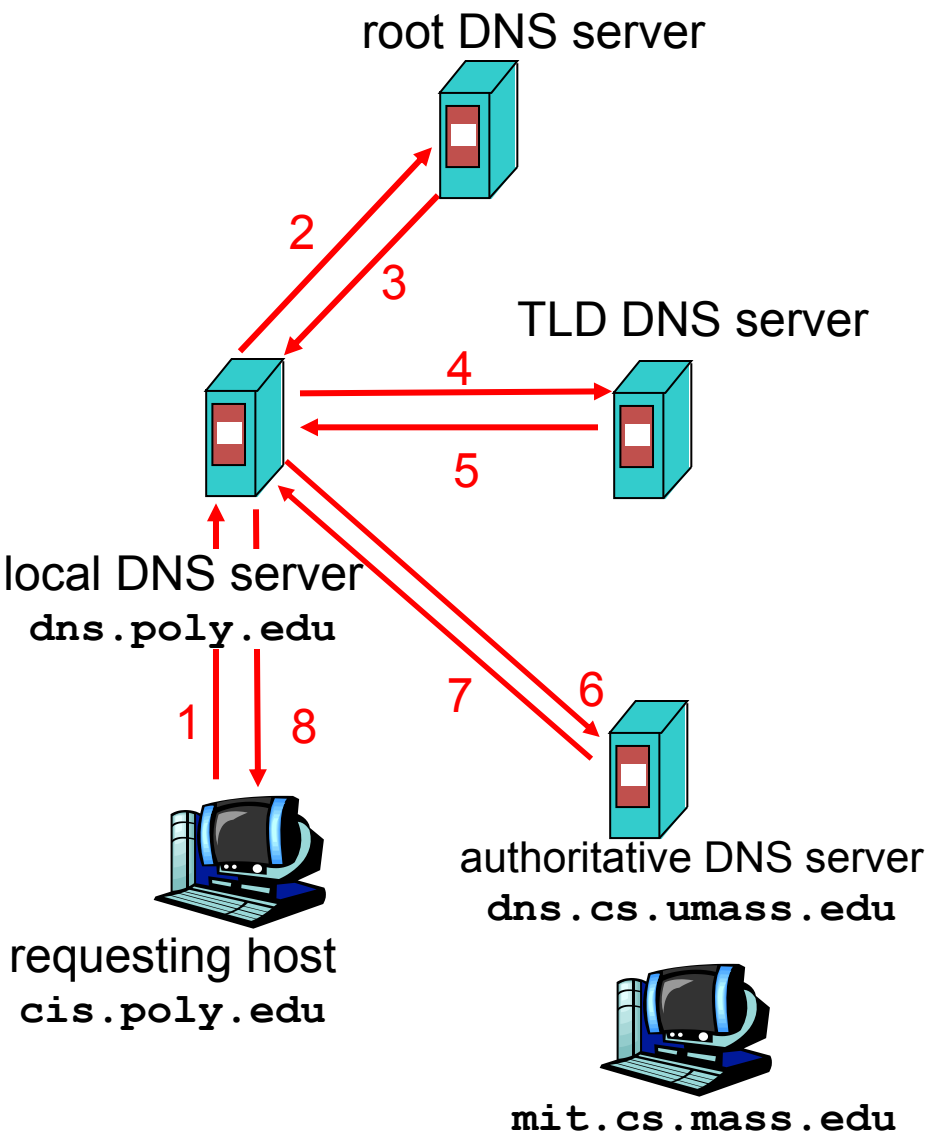


A portion of the Internet domain name space

Example

- Host at cis.poly.edu wants IP address for mit.cs.mass.edu

1. shows the query that is sent to the local name server.
2. start at the top of the name hierarchy by asking one of the root name servers.
3. name server for the *edu domain TLD*
4. sends the entire query to the *edu name server (mit.cs.mass.edu)*
5. *Returns the name server for authoritative DNS server*
6,7 . *authoritative DNS server resolves the query to local DNS server*
8. Host at cis.poly.edu gets IP address for mit.cs.mass.edu



DNS: caching and updating records

- once (any) name server learns mapping, it *caches* mapping
  - cache entries timeout (disappear) after some time
  - TLD servers typically cached in local name servers
    - Thus root name servers not often visited
- update/notify mechanisms under design by IETF
  - RFC 2136
  - http://www.ietf.org/html.charters/dnsind-charter.html

DNS Resource Records

distributed db storing resource records (RR)

RR format: **`(name, value, type, ttl)`**

Type=A

- **name** is hostname
- **value** is IP address

- Type=NS
  - **name** is domain (e.g. foo.com)
  - **value** is IP address of authoritative name server for this domain

Type=CNAME

- **name** is alias name for some "canonical" (the real) name
  www.ibm.com is really servereast.backup2.ibm.com
  value is canonical name

Type=MX

- **value** is name of mail server associated with **name**

Internet Access

- Internet access is positively correlated with
  - education level of a person
  - and annual income of family
  - As they increase, so does the likelihood of internet access
- Internet access is much lower in the most rural areas and under-developed countries.
- Internet connections overall are growing.
  - Growth is particularly high in mobile Internet subscriptions, but fixed-location connections also continue to increase.
  - Both fixed and mobile services are shifting to higher speeds.

Term	Definition
aDSL	Asymmetric Digital Subscriber Line: A digital local loop typically using copper facilities and providing greater bandwidth in one direction than the other.
Cable modem service	A service which offers customers access to the Internet over a cable system.
Downstream speed	Speed of transmission from the Internet to the end user.
End users	Residential, business, institutional, or government entities who use services for their own purposes and who do not resell such services to other entities.
Facilities-based provider	Entity that owns the portion of the physical facility that terminates at the end-user location, obtains an unbundled network element (UNE), special access line, or other leased facility that terminates at the end-user location and provisions/equips it as a connection that transfers information at rates over 200 kbps in at least one direction, or provisions/equips a wireless channel that transfers information at rates over 200 kbps in at least one direction to the end-user location over licensed spectrum or over spectrum that the provider uses on an unlicensed basis.
Fixed wireless	A radio communication service between specified fixed points.
Fixed-location technologies	All technologies other than terrestrial mobile wireless.
FTTH or FTTP	Fiber to the Home (Premises): A network access architecture in which optical fiber is deployed all the way to the customer's home (premises).

Internet Access Services

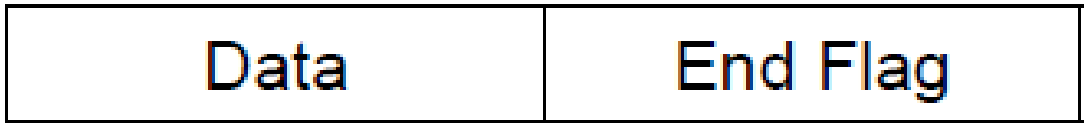
Wi-Fi hotspot	Wireless Fidelity: Generic term referring to any type of IEEE 802.11 wireless network. A hotspot is a small geographic area in which users can gain access to a Wi-Fi network which in turn connects to the Internet.
Wireless service	Telephone, Internet, data, and other services provided to customers through the transmission of signals over networks of radio towers.

Internet Access Services

- Residential Access to internet can be through traditional Dial up via modem, ADSL, cable modems, wireless LANs, wireless access point, etc
- Physical media used to access internet can be twisted pair cable, coaxial cable, optical fiber, satellite and radio waves.
- Most common protocols used for serial line connections are:
  - Serial Line Internet Protocol (SLIP)
  - Point-to-Point Protocol (PPP)

SLIP

- It is a means of sending Internet Protocol datagram over a serial link.
- It can be used by two systems to communicate via a direct cable connection or modem link.
- The initial purpose of this protocol was to connect Sun workstation to the Internet over a dial-up line using modem.
- **Data Format of SLIP**



- A special END character (equivalent to decimal 192) marks the end of data.

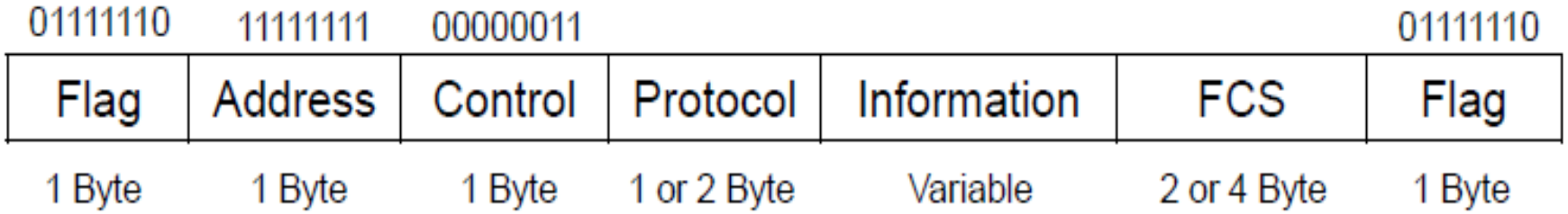
Problems with SLIP

- It does not perform any error detection and correction.
- It does not support the allocation of dynamic IP address.
- Both the communicating systems should be assigned a specific IP address before hand.
- It does not provide any authentication.
- It is not an approved Internet standard.

PPP

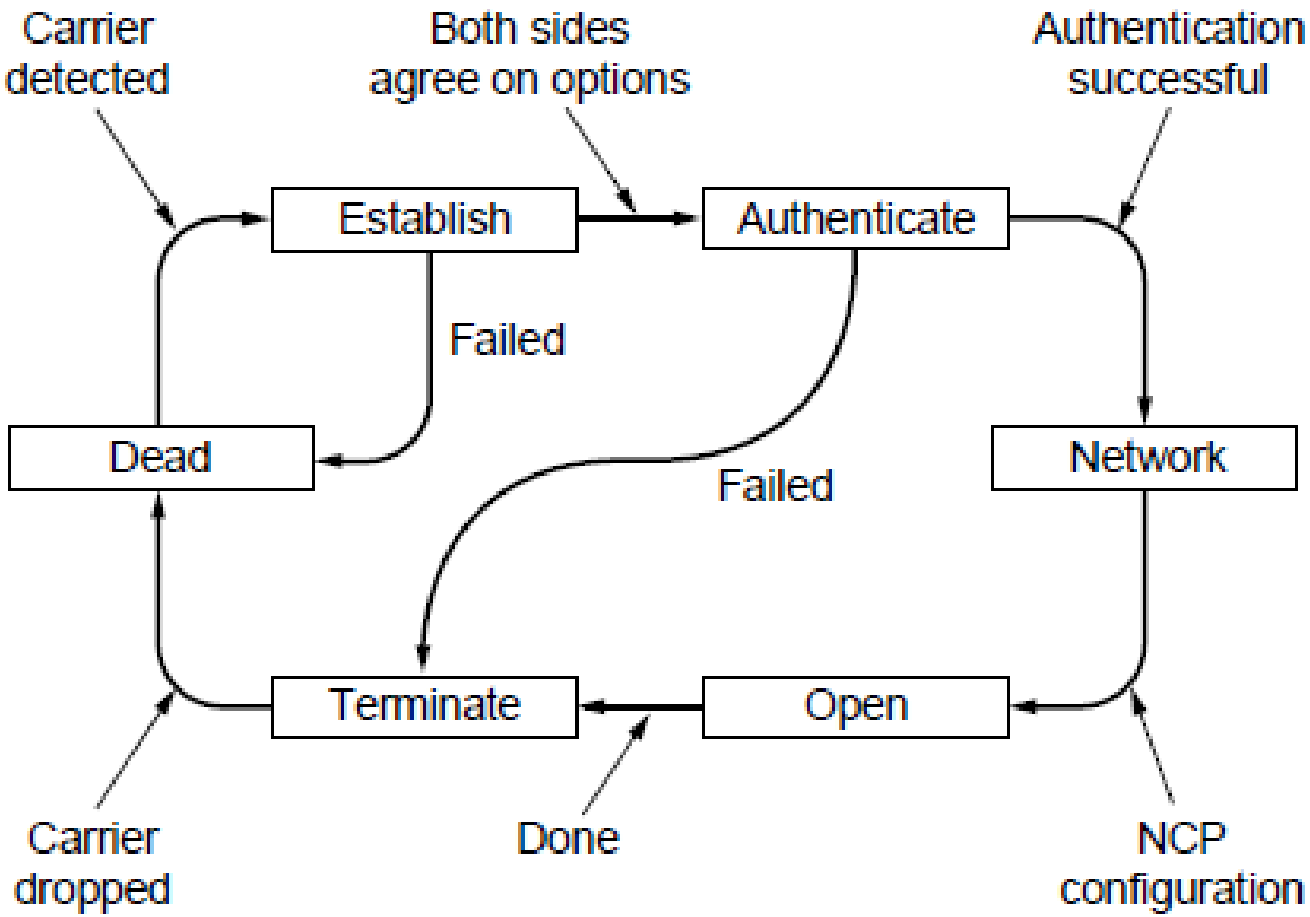
- It is the most commonly used data link protocol.
- It is used to connect the home PC to the ISP server.
- It provides error detection.
- It defines Link Control Protocol (LCP) for:
  - Establishing the link between two devices.
  - Maintaining this established link.
  - Configuring this link.
  - Terminating this link after the transfer.

PPP : Frame Format



Flag Field: It marks the beginning and end of the PPP frame. Flag byte is 01111110.
Address: 11111111, which means all stations can accept the frame
Control Field: It is also of 1 byte. The value is always 00000011 to show that the frame does not contain any sequence number and there is no flow control or error control
Protocol field: tells what kind of packet is in payload
Information Field: Its length is variable. It carries user data or other information.
FCS Field: It stands for Frame Check Sequence. It contains checksum. It is either 2 bytes or 4 bytes.

PPP : Operation/Phases



PPP Contd..

- PPP uses several other protocols to establish link, authenticate users and to carry the network layer data:
- The various protocols used are:
  - Link Control Protocol
  - Authentication Protocol
  - Network Control Protocol

Link Control Protocol

- It is responsible for establishing, maintaining, configuring and terminating the link.

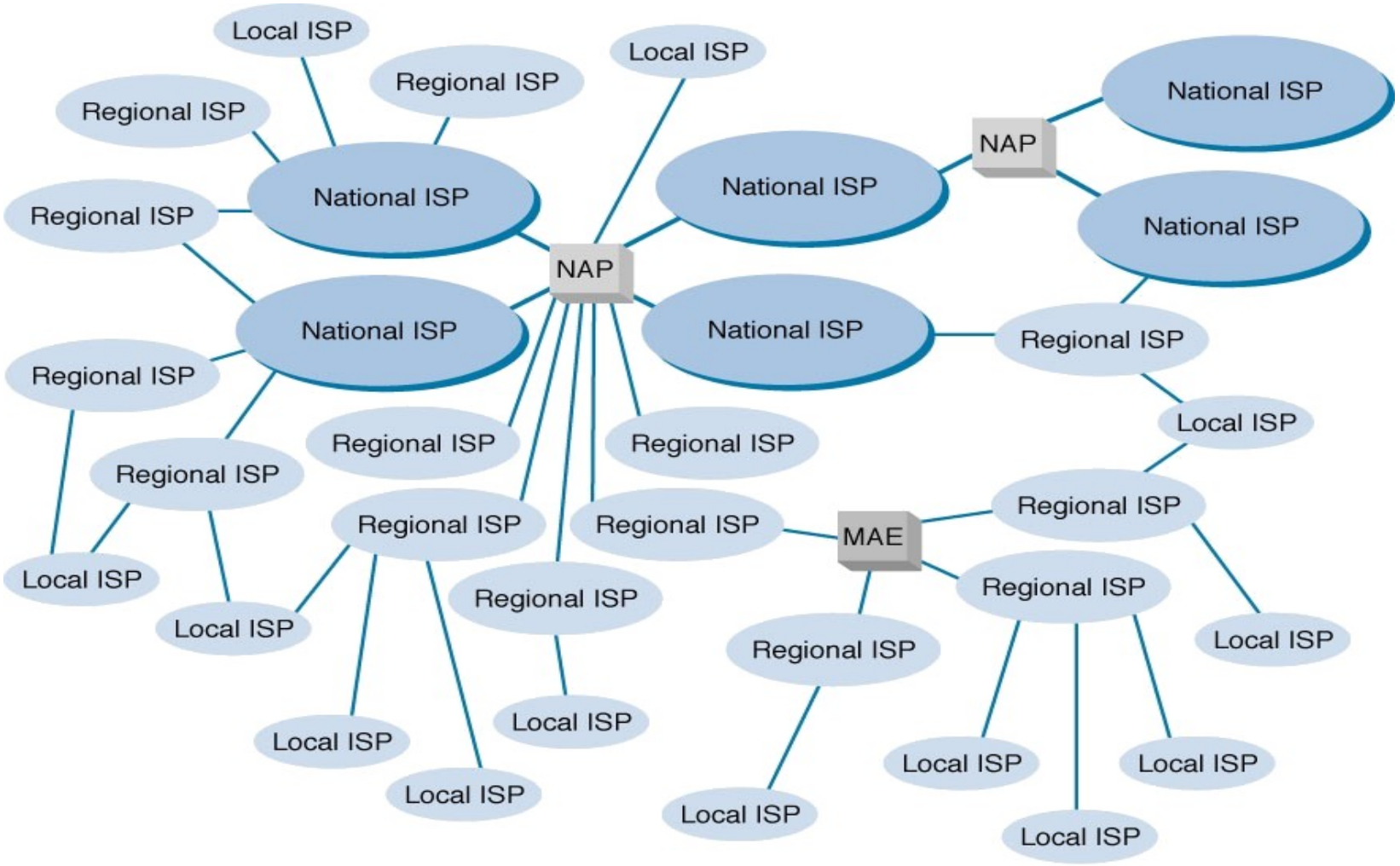
Authentication Protocol

- Authentication protocol helps to validate the identity of a user who needs to access the resources.

Network Control Protocol (NCP)

- After establishing the link & authenticating the user, PPP connects to the network layer.
- This connection is established by NCP.
- Therefore, NCP is a set of control protocols that allow the encapsulation of the data coming from the network layer.
- After the network layer configuration is done by one of the NCP, the user can exchange data from the network layer.

Basic Internet Architecture

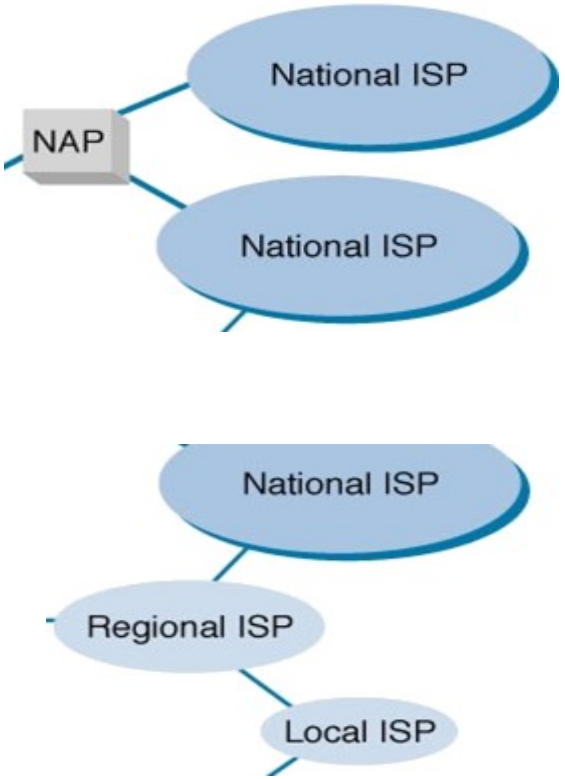


Internet's Access Points

- Network Access Points (NAPs)
  - Connect National ISPs together
  - Sometimes large regional and local ISPs also have access directly to NAPs
    - Indiana University, for example, which provides services to about 40,000 individuals, connects directly to the Chicago NAP
  - About a dozen NAPs in the U.S.
  - Run by common carriers such as Sprint and AT&T
- Metropolitan Area Exchanges (MAEs)
  - Connect Regional ISPs together
  - About 50 such MAEs in the U.S. today

Packet Exchange Charges

- Peering
  - ISPs at the same level usually do not charge each other for exchanging messages
- Higher level ISPs charge lower level ones
  - National ISPs charge regional ISPs which in turn charge local ISPs
- Local ISPs charge individuals and corporate users for access



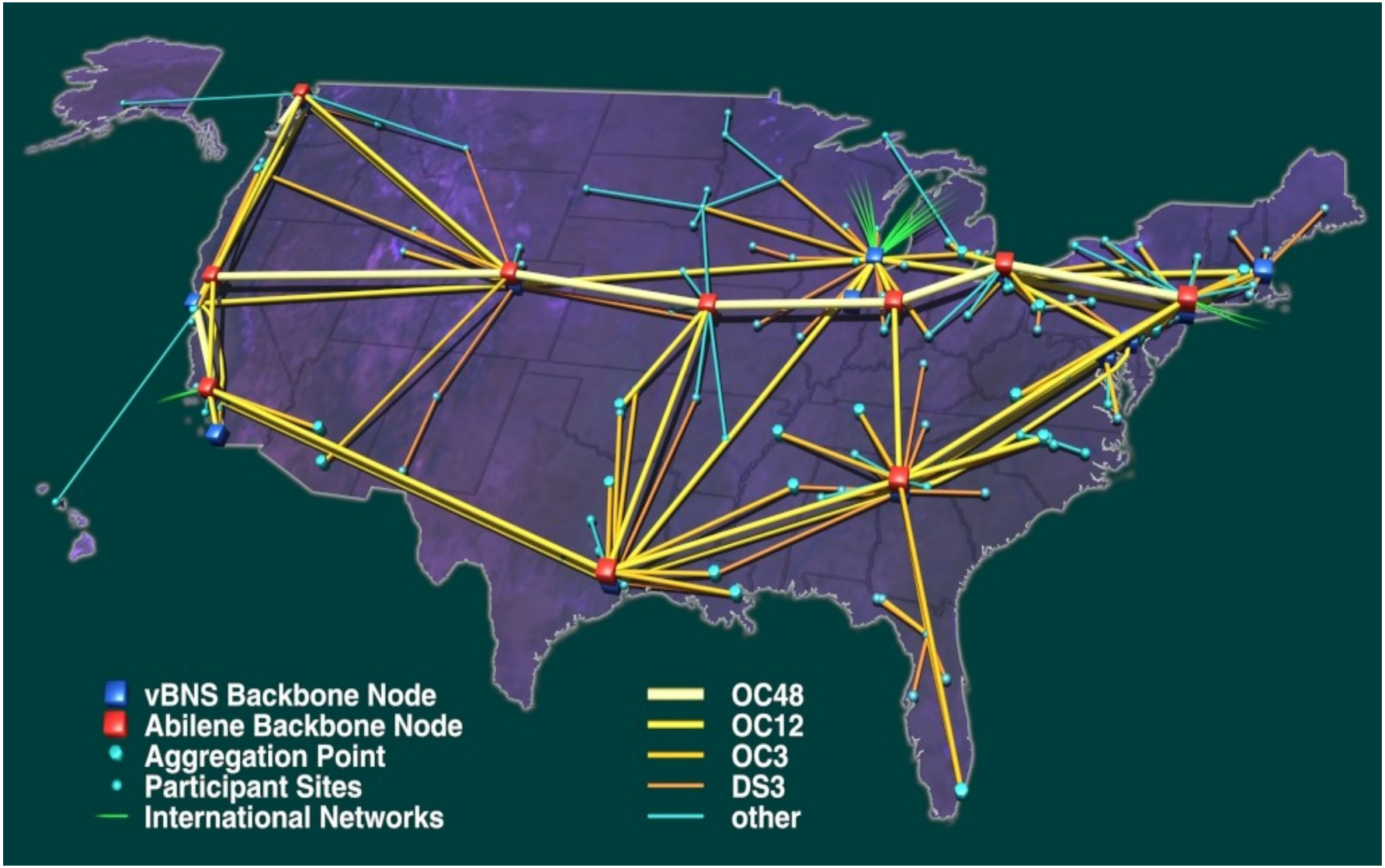
Connecting to an ISP

- Done through ISP's Point of Presence (POP)
  - A place ISP provides service to its customers
- Individual users
  - Typically through a dial-up line using the PPP protocol
    - Handled by the ISP's modem pool
      - ➢ User id and password checked by Remote Access Server (RAS)
    - Once logged in, the user can send packets over the phone line

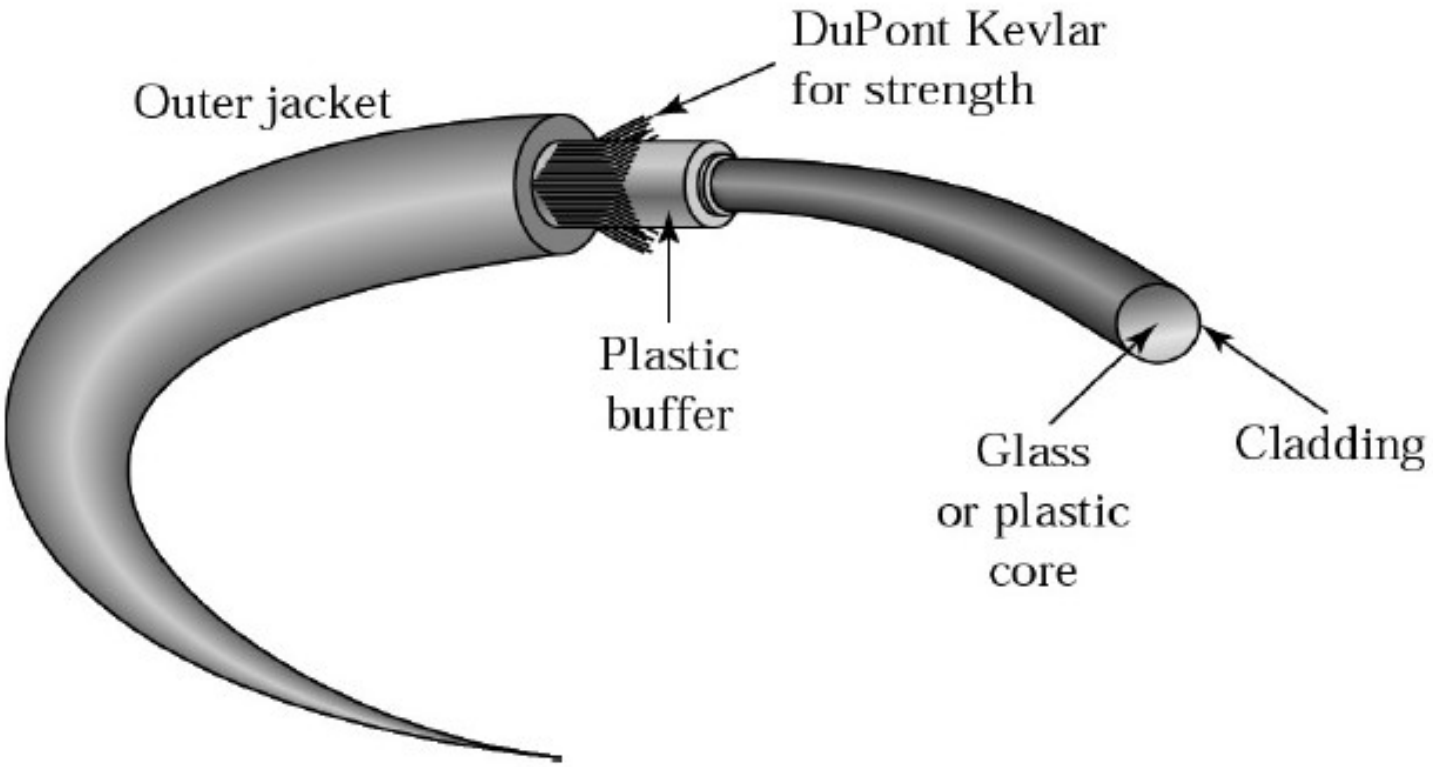
Internet Backbone Networks

- Backbone networks are high speed networks that link an organization's LANs and also provide connections to other backbones, MANs, WANs and the Internet.
- Internet Backbone refers to the principal data routes between large, strategically interconnected networks and core networks on the internet.
- These data routes are hosted by commercial, government, academic and other high capacity network centers.
- Internet Service Provider (ISPs) are example that participate internet backbone exchange of traffic.

Internet Backbone Networks Example



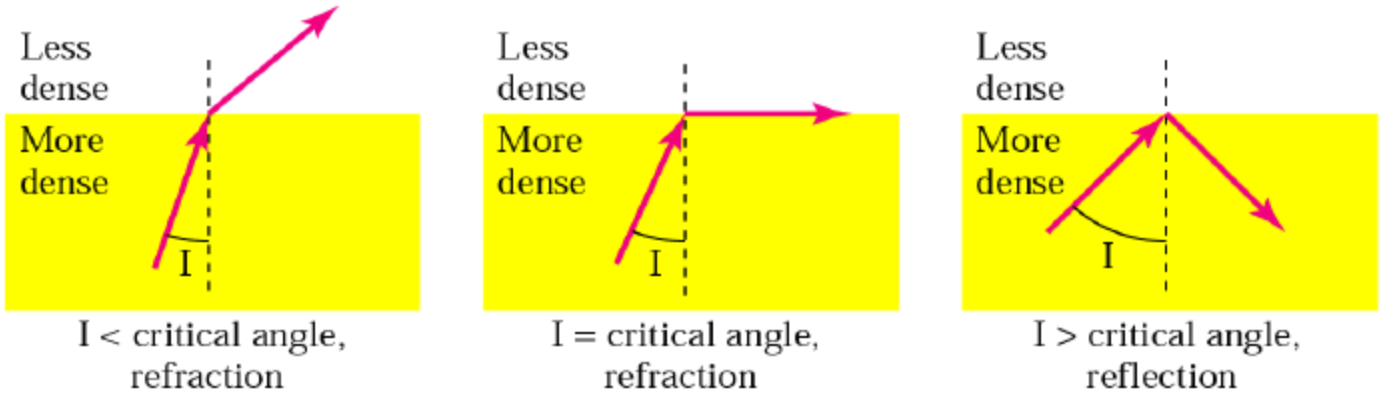
Optical fiber

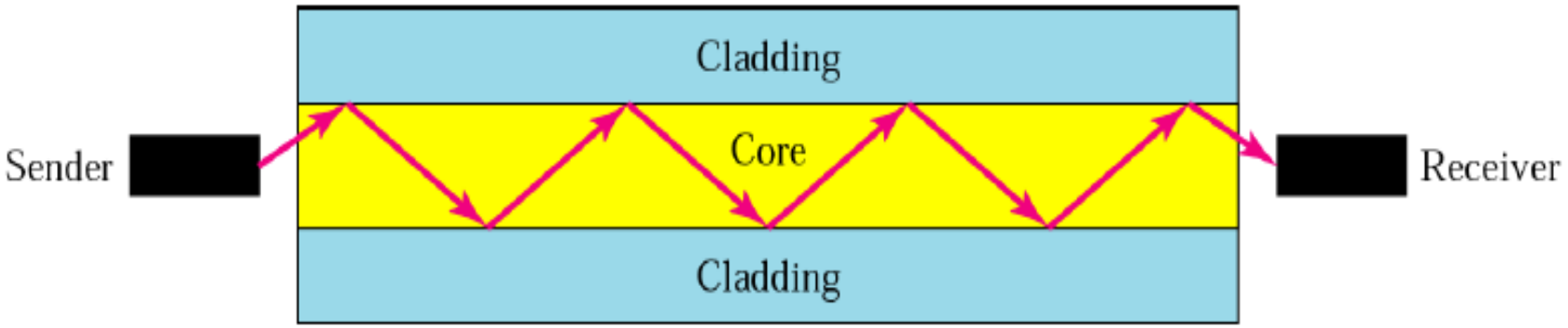


- We must have a light source in order to send the data. It sends a ray of light for each 1 bit, and no light for a 0 bit.
- We must have a detector to detect the light signal. The detector emits an electric pulse for each light ray it detects.
- The slowest part of the system is the conversion that happens at either end

Composition

- Consist extremely thin cylinder glass called Core
- Surrounded by a concentric layer known as cladding
- Each glass strand passes signals in only one direction, a cable includes two strands in separate jackets.


Less dense
More dense
I
I < critical angle, refraction
Less dense
More dense
I
I = critical angle, refraction
Less dense
More dense
I
I > critical angle, reflection


Cladding
Core
Cladding
Sender
Receiver

Optical Backbone Network

- Optical fiber technologies are the prime choices for transmitting the enormous bandwidth required by the traffic growth in backbone networks.
- The backbone of the world's information infrastructure is now preponderantly composed of fiber optic cables.
- For example,
  - Wavelength Division Multiplexing (WDM) can dramatically increase the capacity of fiber links by allowing many signals at different wavelengths to be multiplexed onto a single fiber.
  - Fine wavelength spacing of these signals is known as Dense Wavelength Division Multiplexing (DWDM).

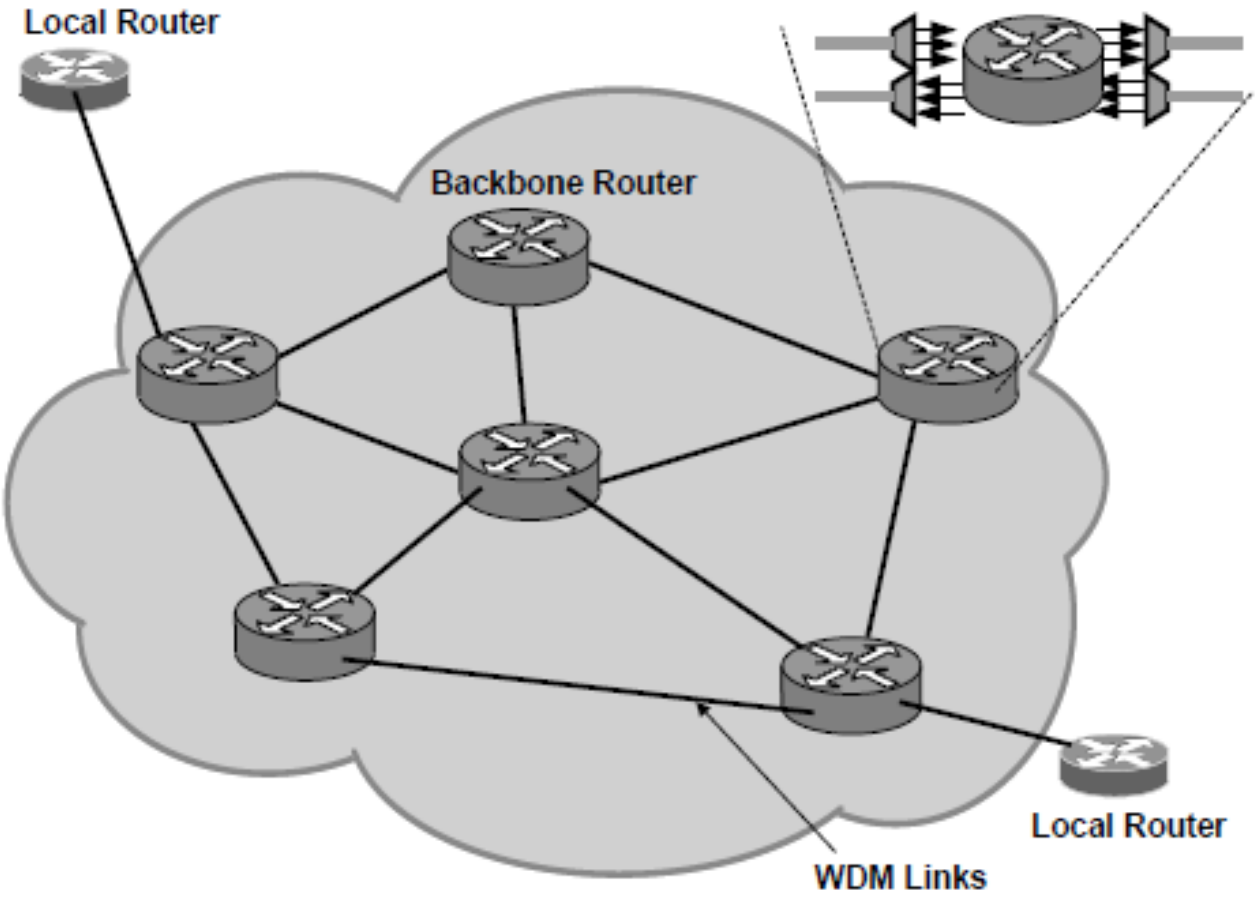


Figure : Point-to-Point WDM Network

- In Figure ,
  - local routers deliver data to/from customers.
  - This data is converted to light-paths and sent to a backbone router.
  - At each backbone router, light-paths are converted to Time Division Multiplexed (TDM) frames consisting of packets.
  - After the route and destination of these packets are identified, they are then converted back to light-paths before being sent through the WDM links.
  - TDM frames are processed in backbone routers in the electronic domain.

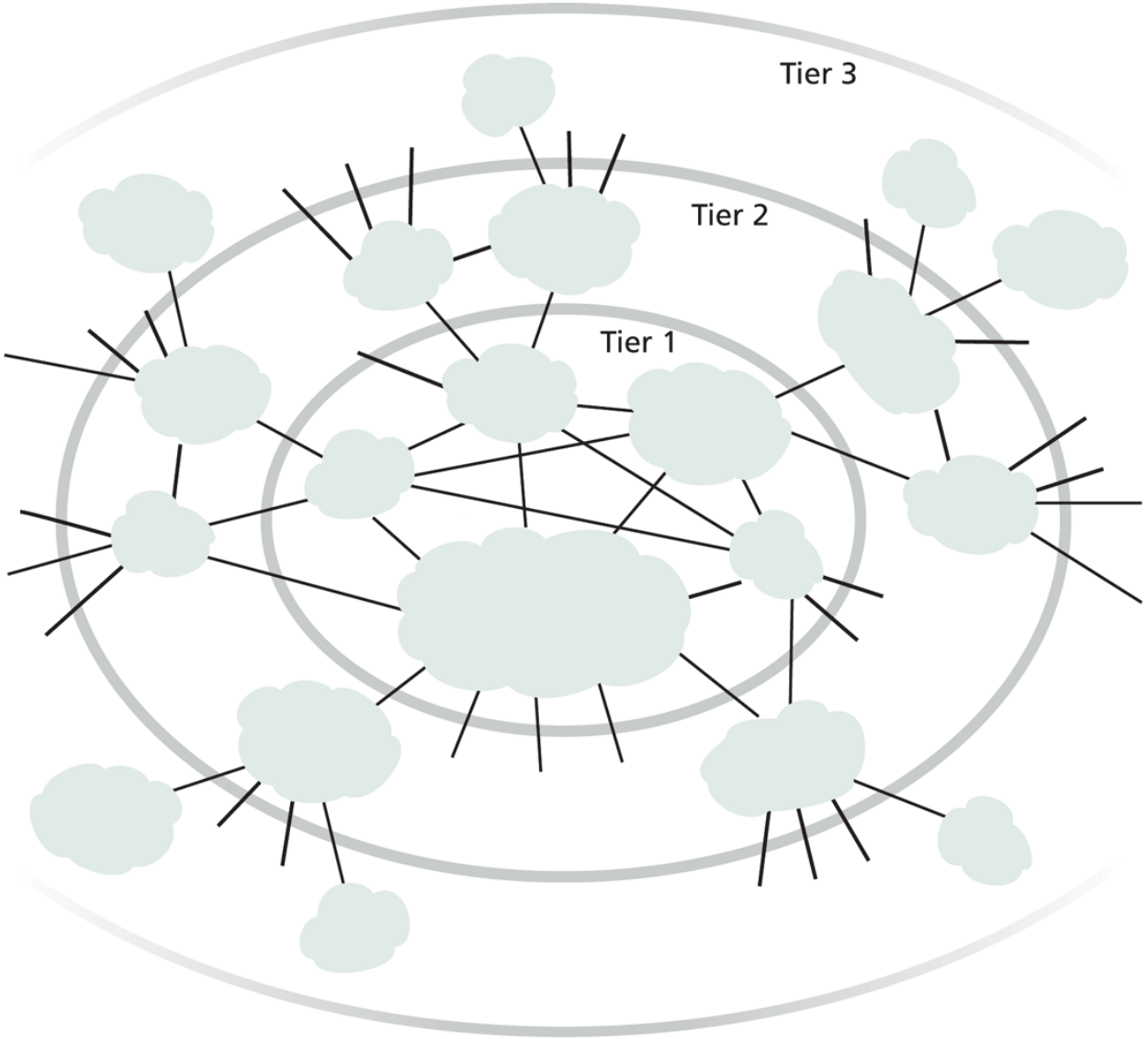
- The state-of-the-art optical broadband network that is widely deployed today has IP routers connected with WDM links.
- This network is a point-to-point WDM network where the optical layer simply provides bandwidth.
- The IP layer in this network is in charge of every management aspect such as resource management, routing of traffic and restoration.
- The optical layer has no intelligence with regards to these aspects

Internet service provider

- An Internet service provider (ISP) is an organization that provides access to the Internet.
- Access ISPs directly connect clients to the Internet using copper wires, wireless or fiber-optic connections.
- Hosting ISPs are a kind of colocation center that leases server space to smaller businesses and other people.
- Transit ISPs provide large amounts of bandwidth for connecting hosting ISPs to access ISPs

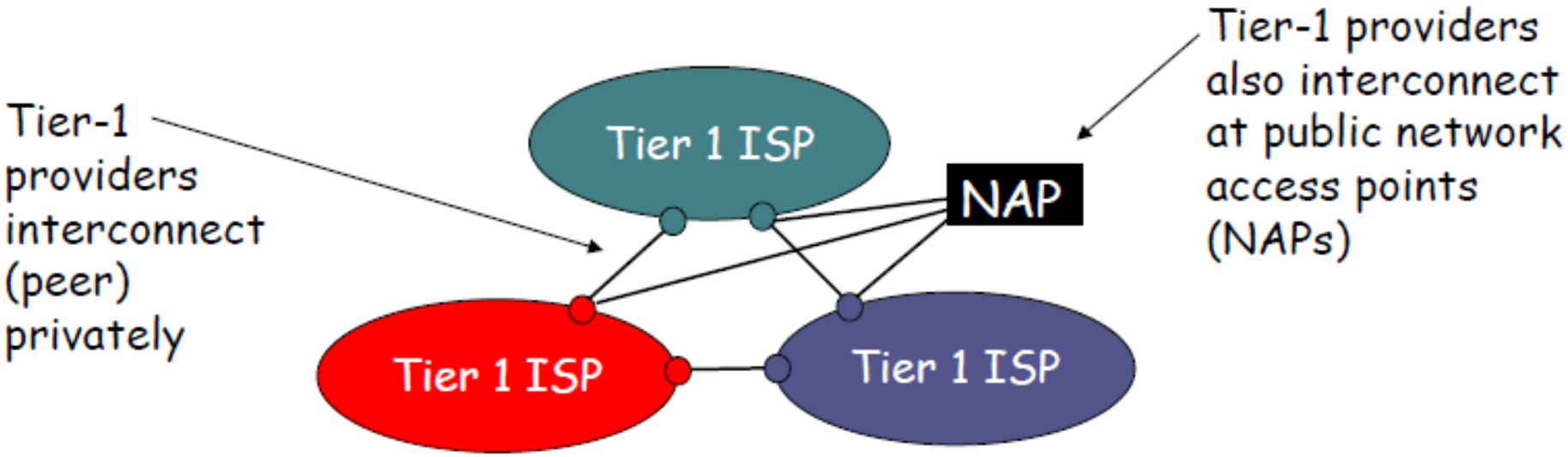
ISPs

- Tier1
- Tier2 and
- Tier3 ISPS



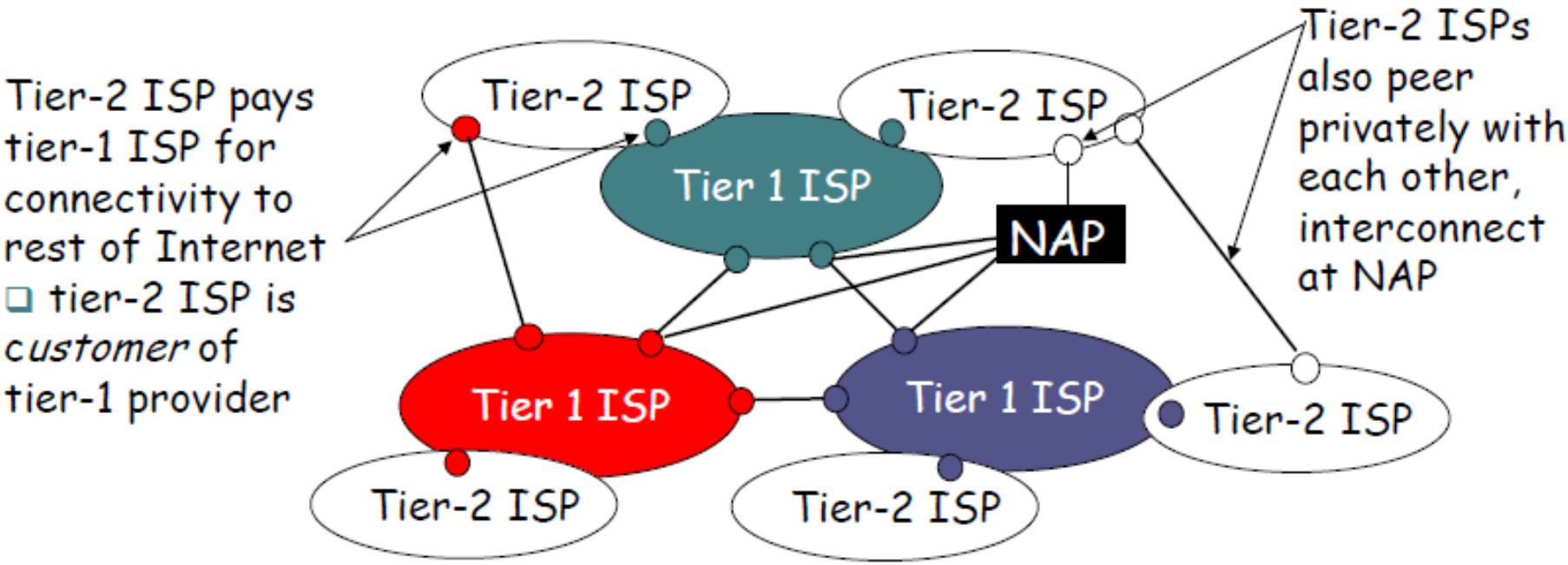
Tier 1 ISPs

- at center: “tier-1” ISPs (e.g., MCI, Sprint, AT&T, Cable and Wireless), national/international coverage
- treat each other as equals



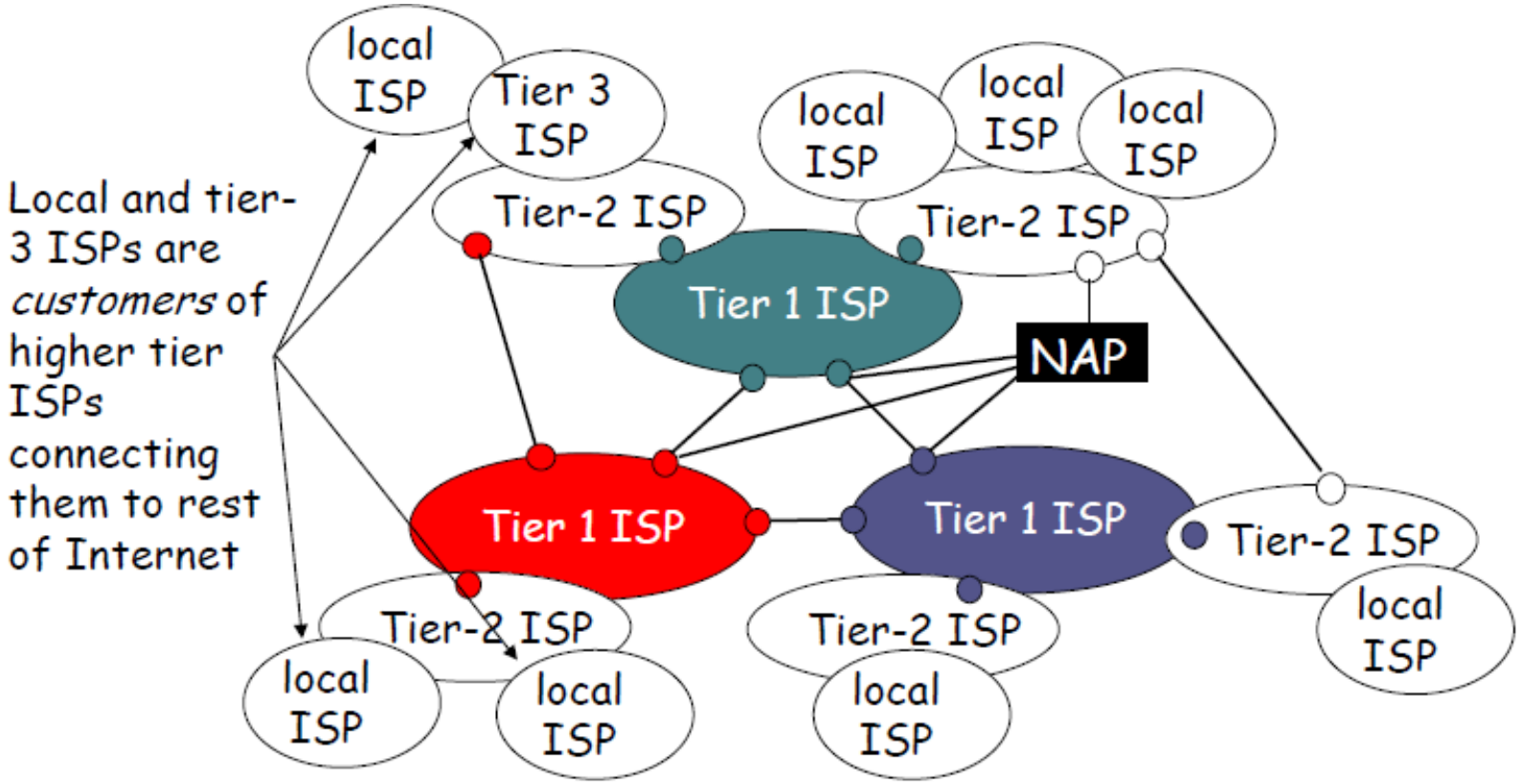
Tier 2 ISPs

- "Tier-2" ISPs: smaller (often regional) ISPs
- Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

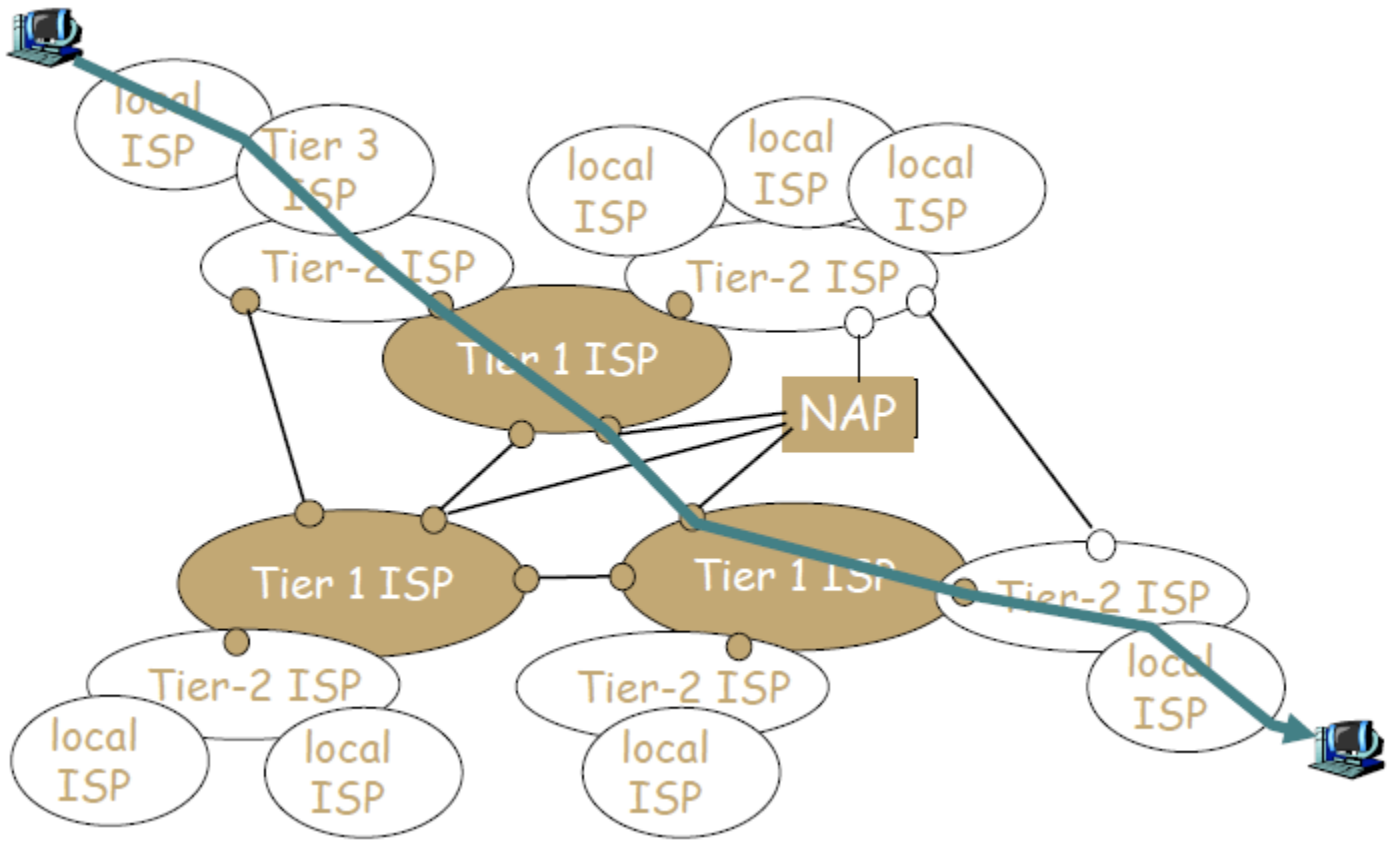


Tier 3 ISPs

- "Tier-3" ISPs and local ISPs
- last hop ("access") network (closest to end systems)



- a packet passes through many networks



Submarine Cables

- A submarine communications cable is a cable laid on the sea bed between land-based stations to carry telecommunication signals across stretches of ocean.
- The first submarine communications cables, laid in the 1850s, carried telegraphy traffic.
- Subsequent generations of cables carried telephone traffic, then data communications traffic.
- Modern cables use optical fiber technology to carry digital data, which includes telephone, internet and private data traffic.

- Modern cables are typically 69 millimeters (2.7 ”) in diameter and weigh around 10 kilograms per meter, although thinner and lighter cables are used for deep-water sections.
- As of 2010, submarine cables link all the world's continents except Antarctica.

- A cross section of a modern submarine communications cable.
  1 – Polyethylene
  2 – Mylar tape
  3 – Stranded steel wires
  4 – Aluminium water barrier
  5 – Polycarbonate
  6 – Copper or aluminium tube
  7 – Petroleum jelly
  8 – Optical fibers

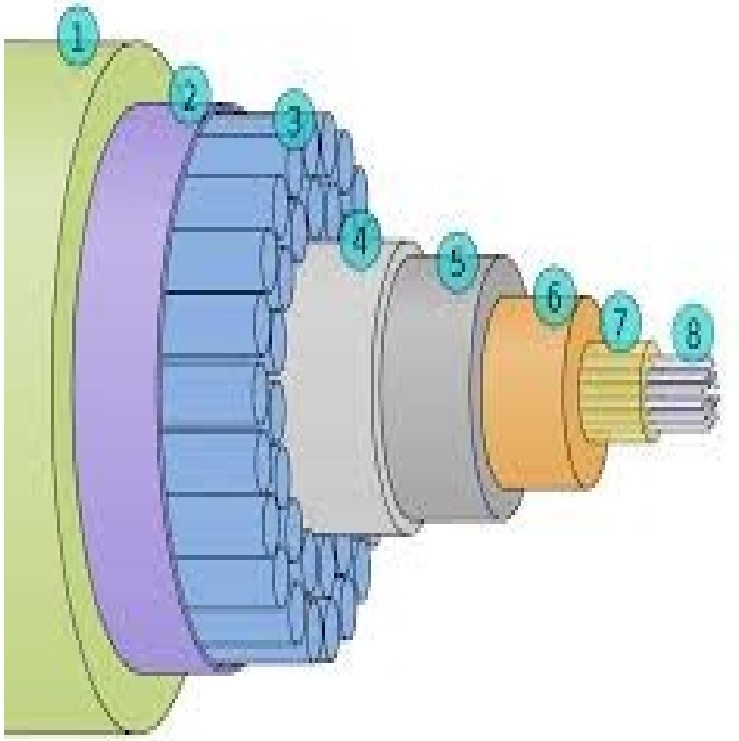


Figure: Submarine Repeater

Teleports

- A telecommunication port or more commonly teleport is a satellite ground station with multiple parallel antennas that functions as a hub connecting a satellite or geocentric orbital network with a terrestrial telecommunications network.
- Teleports may provide various broadcasting services among other telecommunications functions, such as uploading computer programs or issuing a commands over an uplink to a satellite

Example: Teleport

- Strategically located to connect five continents, Intelsat's teleports provide reliable and efficient access to new service regions.
- Over the years, the highest profile media and enterprise companies in the world have trusted Intelsat's winning combination of satellite and ground infrastructure to deliver their entertainment and information securely and seamlessly.

Figure: Atlanta teleport, Georgia

Satellites

Geostationary Earth Orbit (GEO)

- These satellites are in orbit 35,786 km above the earth's surface along the equator.
- Objects in Geostationary orbit revolve around the earth at the same speed as the earth rotates. This means GEO satellites remain in the same position relative to the surface of earth.
- Geostationary satellites are commonly used for communications and weather-observation.
- The typical service life expectancy of a geostationary satellite is 10-15 years.

GEO Contd..

- Advantages
  - A GEO satellite's distance from earth gives it a large coverage area, almost a fourth of the earth's surface.
  - GEO satellites have a 24 hour view of a particular area.
  - These factors make it ideal for satellite broadcast and other multipoint applications.
- Disadvantages
  - A GEO satellite's distance cause it to have both a comparatively weak signal and a time delay in the signal, which is bad for point to point communication.
  - Because geostationary satellites circle the earth at the equator, they are not able to provide coverage at the Northernmost and Southernmost latitudes.

Low Earth Orbit (LEO)

- LEO satellites are much closer to the earth than GEO satellites, ranging from 500 to 1,500 km above the surface.
- LEO satellites don’t stay in fixed position relative to the surface, and are only visible for 15 to 20 minutes each pass.
- A network of LEO satellites is necessary for LEO satellites to be useful

LEO Contd..

- Advantages
  - A LEO satellite's proximity to earth compared to a GEO satellite gives it a better signal strength and less of a time delay, which makes it better for point to point communication.
  - Eliminates need for bulky receiving equipment.
  - Less waste of bandwidth.
- Disadvantages
  - A network of LEO satellites is needed, which can be costly
  - Smaller coverage area.

Medium Earth Orbit (MEO)

- A MEO satellite is in orbit somewhere between 8,000 km and 18,000 km above the earth's surface.
- MEO satellites are similar to LEO satellites in functionality.
- MEO satellites are visible for much longer periods of time than LEO satellites, usually between 2 to 8 hours.
- MEO satellites have a larger coverage area than LEO satellites.
- GPS (Global Positioning System) satellite orbiting at about 18000 Km are examples of MEO satellites.

MEO Contd..

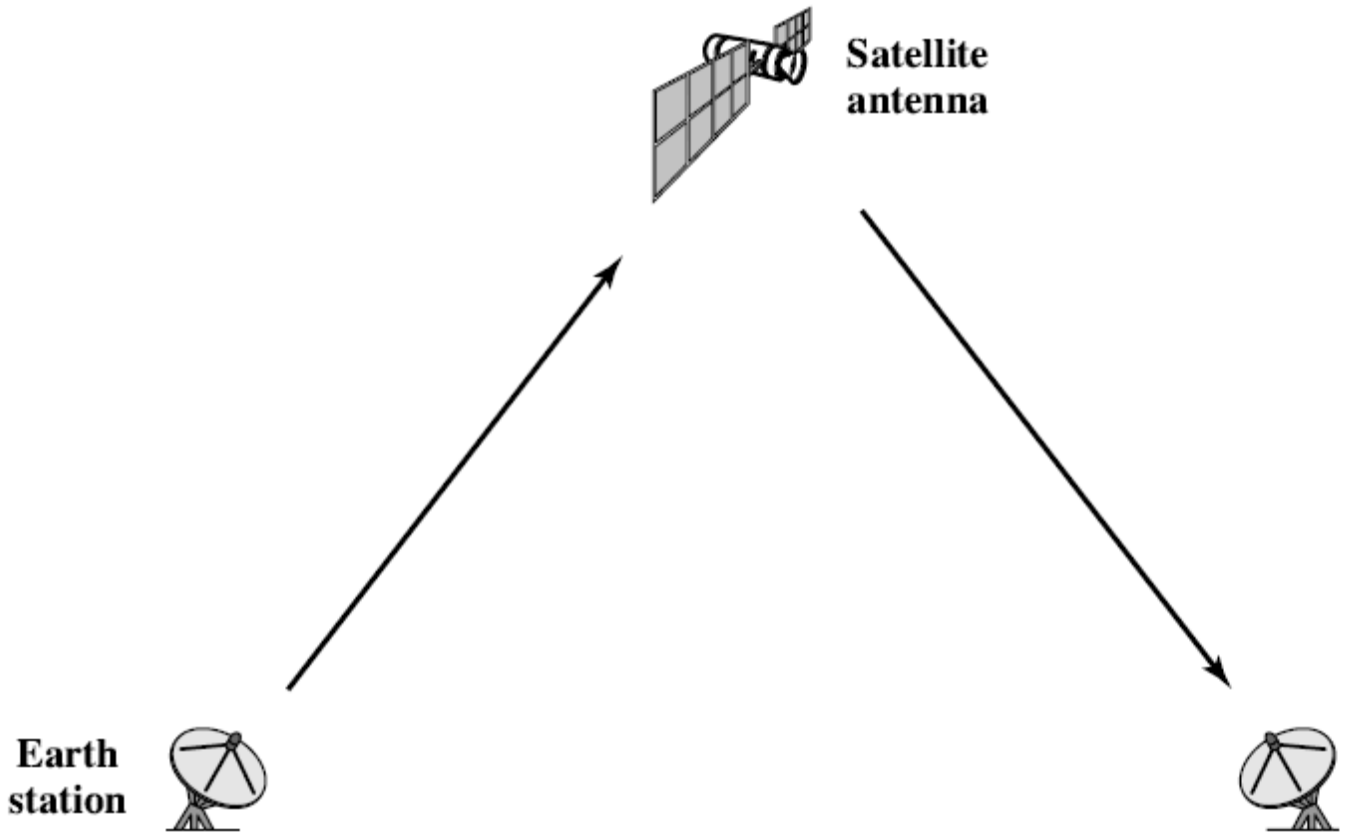
- Advantage
  - A MEO satellite's longer duration of visibility and wider footprint means fewer satellites are needed in a MEO network than a LEO network.
- Disadvantage
  - A MEO satellite's distance gives it a longer time delay and weaker signal than a LEO satellite, though not as bad as a GEO satellite.

Satellite Communication

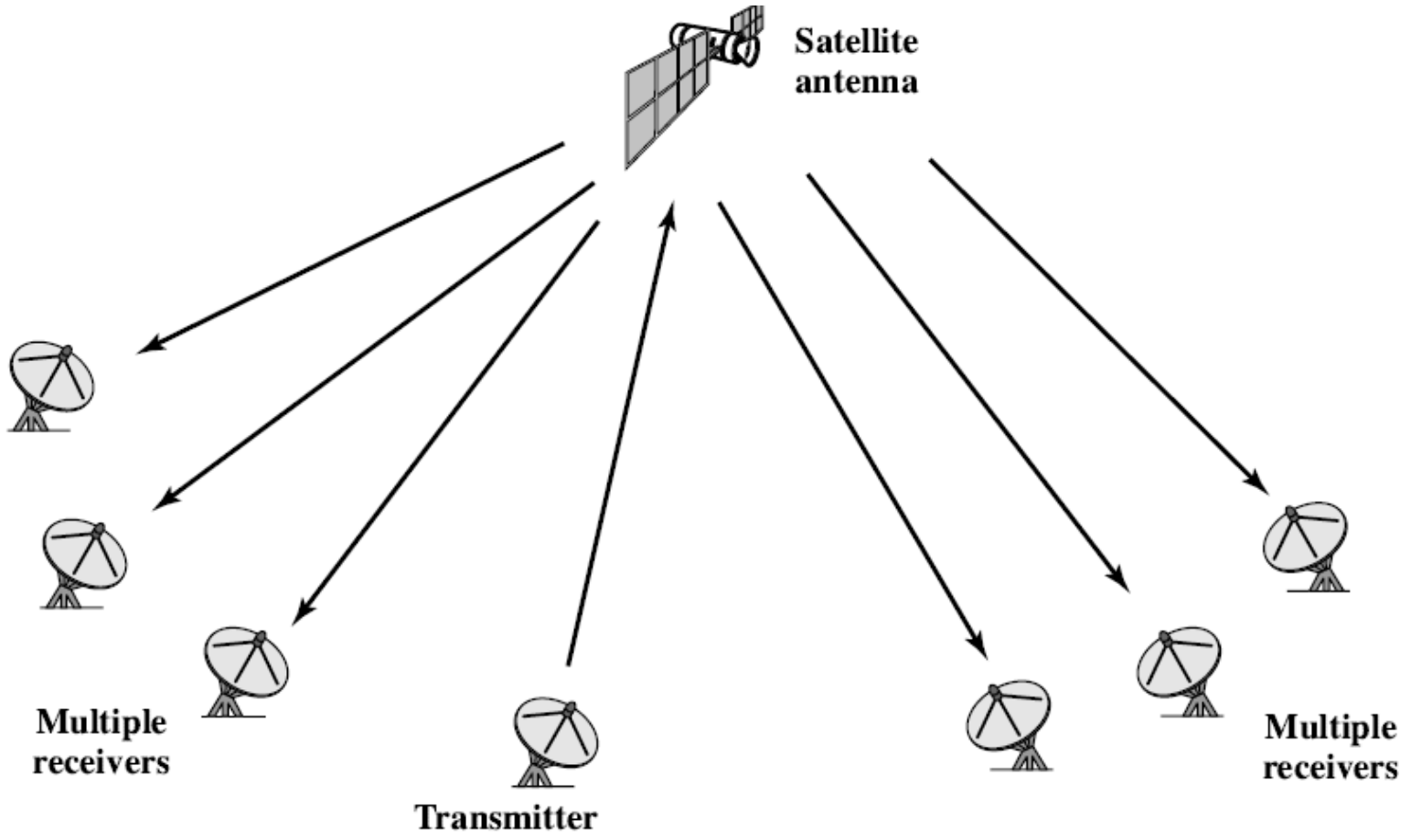
Basics: How do Satellites Work

- Two Stations on Earth want to communicate through radio broadcast but are too far away to use conventional means.
- The two stations can use a satellite as a relay station for their communication
- One Earth Station sends a transmission to the satellite. This is called a Uplink.
- The satellite Transponder converts the signal and sends it down to the second earth station. This is called a Downlink.

Satellite Communication : Point to Point



Satellite Communication: Broadcast link



Terrestrial Radio Links

- Radio channels carry signals in the electromagnetic spectrum
- They are an attractive media because require no physical “wire” to be installed, provide connectivity to a mobile user, and can potentially carry a signal for long distances.
- The characteristics of a radio channel depend significantly on the propagation environment and the distance over which a signal is to be carried.
- Environmental considerations determine path loss and shadow fading, multipath fading and interference

- Radio waves have frequencies from 3 KHz to as high as 300 GHz
- Transmitted through Omni-directional antennas
- Very sensible to interference
- Applications:
  - TV & radio broadcasting
  - Cordless phones

Microwave

- They range from 1 GHz to 300 GHz
- Unidirectional => Antennas must be aligned
- Propagation is line-of-sight (earth curvature is a problem)
- Cannot penetrate walls
- Higher data range than radio waves
- Part of the spectrum is regulated form authorities
- Application
  - long-distance telephone communication
  - mobile phones
  - television broadcast

Thank You

If you have any Queries write to me

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