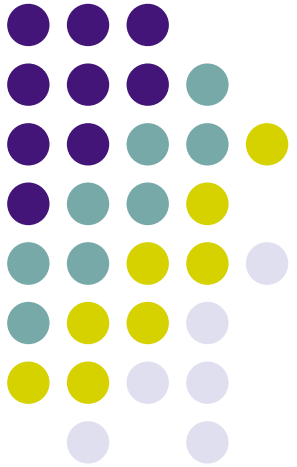
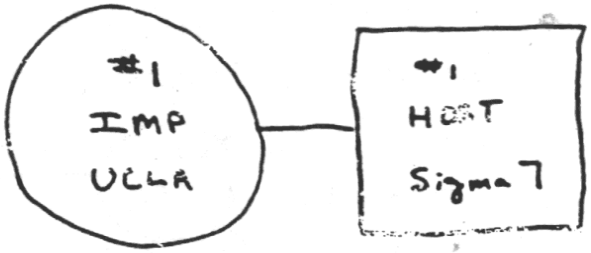
Concept of Computer networks

History of Internet
Concept of computer networks
Network architecture
Packet switching vs. circuit switching

Reading: Chapter 1, Computer Networks, Tanenbaum



History of the Internet



- Originated from an experiemental project of ARPA
- Intially having only two nodes (IMP atUCLA and IMP at SRI).

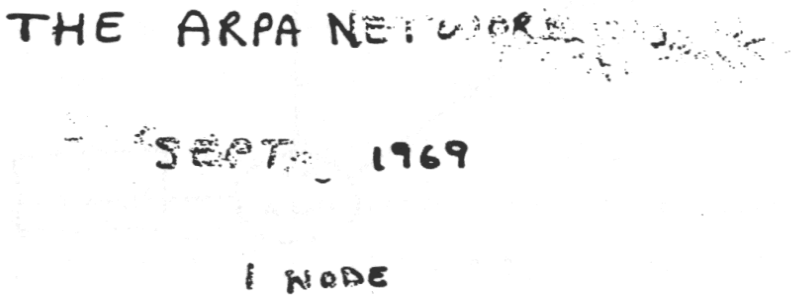
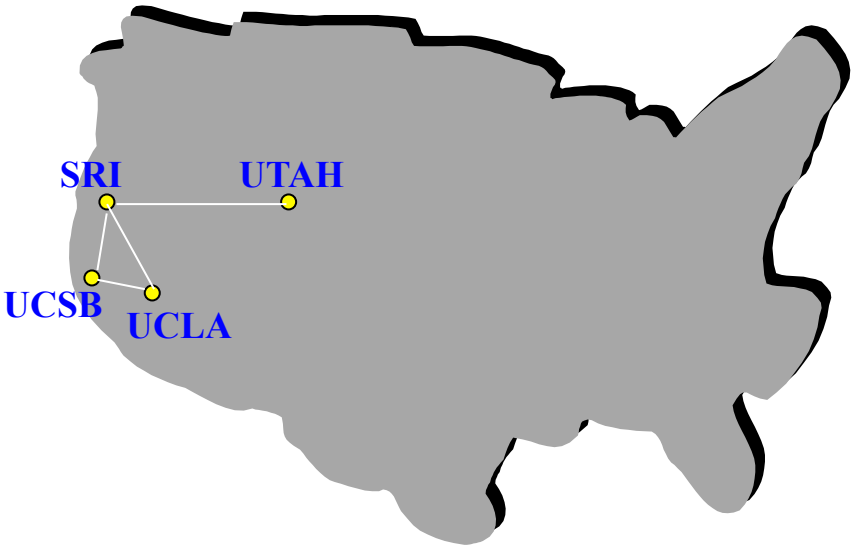


FIGURE 6.1 Drawing of September 1969 (Courtesy of Alex McKenzie)

ARPA: Advanced Research Project Agency
UCLA: University California Los Angeles
SRI: Stanford Research Institute
IMP: Interface Message Processor

Source: http://www.cybergeography.org/atlas/historical.html

In 12/1969, after 3 months



A network with 4 nodes, 56kbps

UCSB:University of California, Santa Barbara
UTAH:University of Utah

source: http://www.cybergeography.org/atlas/historical.html

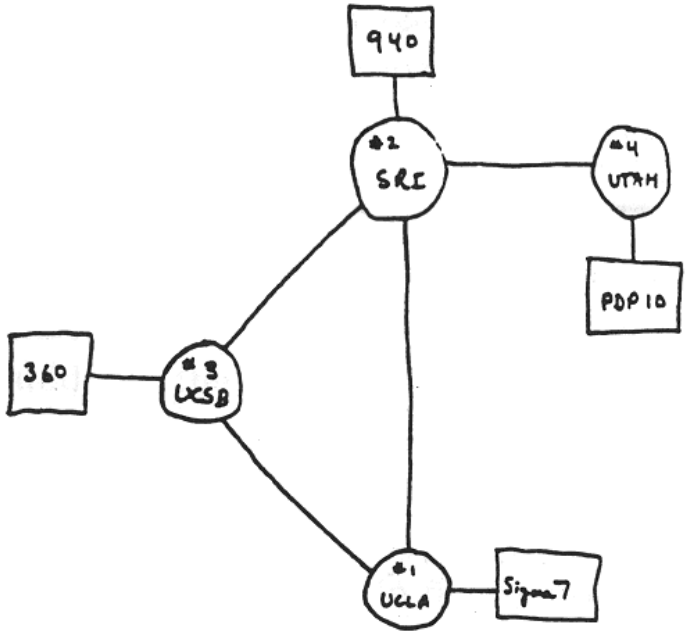
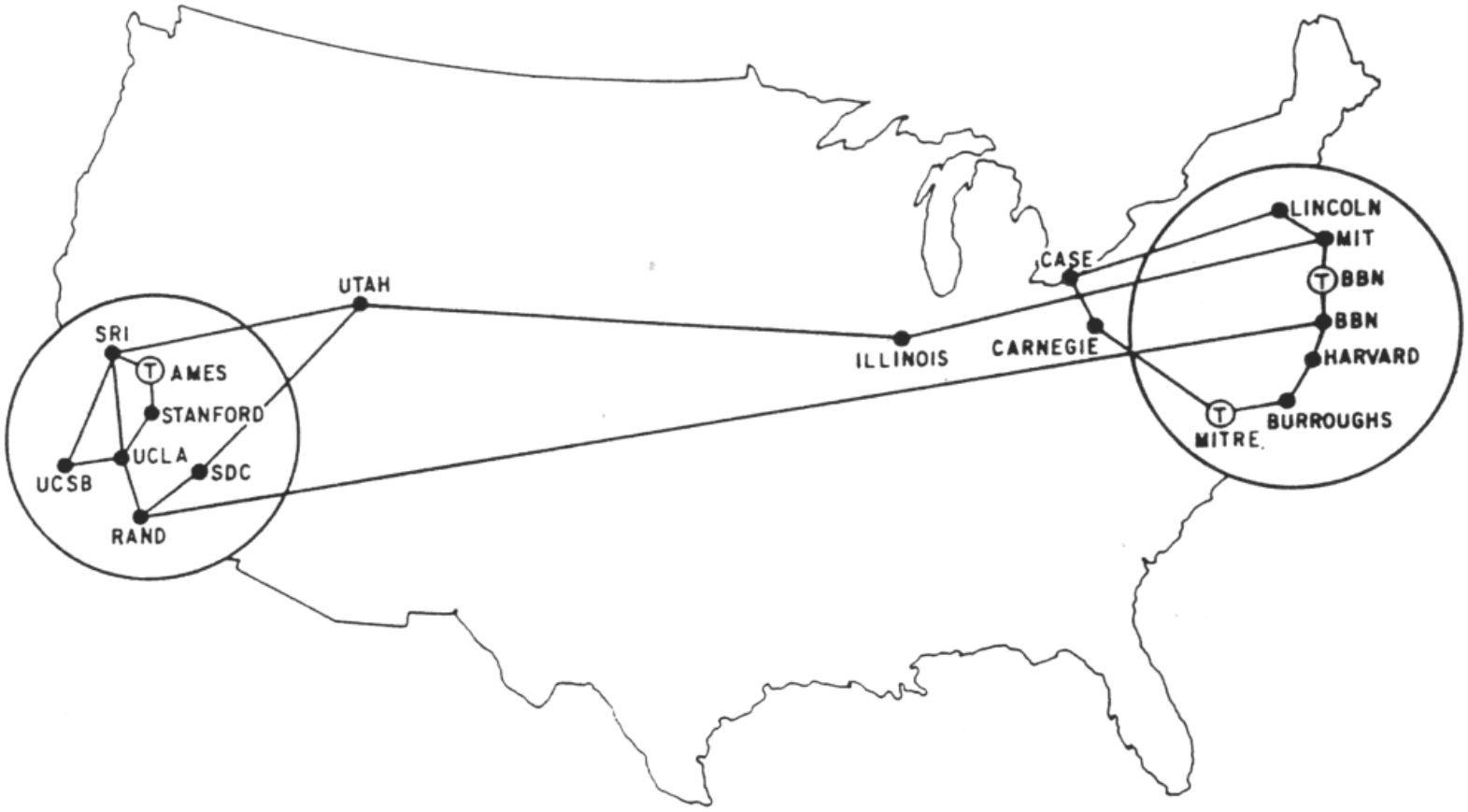


FIGURE 6.2 Drawing of 4 Node Network (Courtesy of Alex McKenzie)

ARPANET, 1971

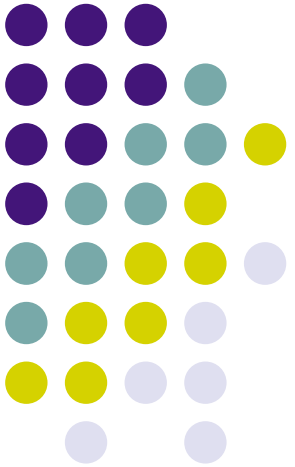


MAP 4 September 1971

Source: http://www.cybergeography.org/atlas/historical.html

One node was added each month

Years 70s: Interconnection, new network architecture and private architectures



Expansion of ARPANET, 1974

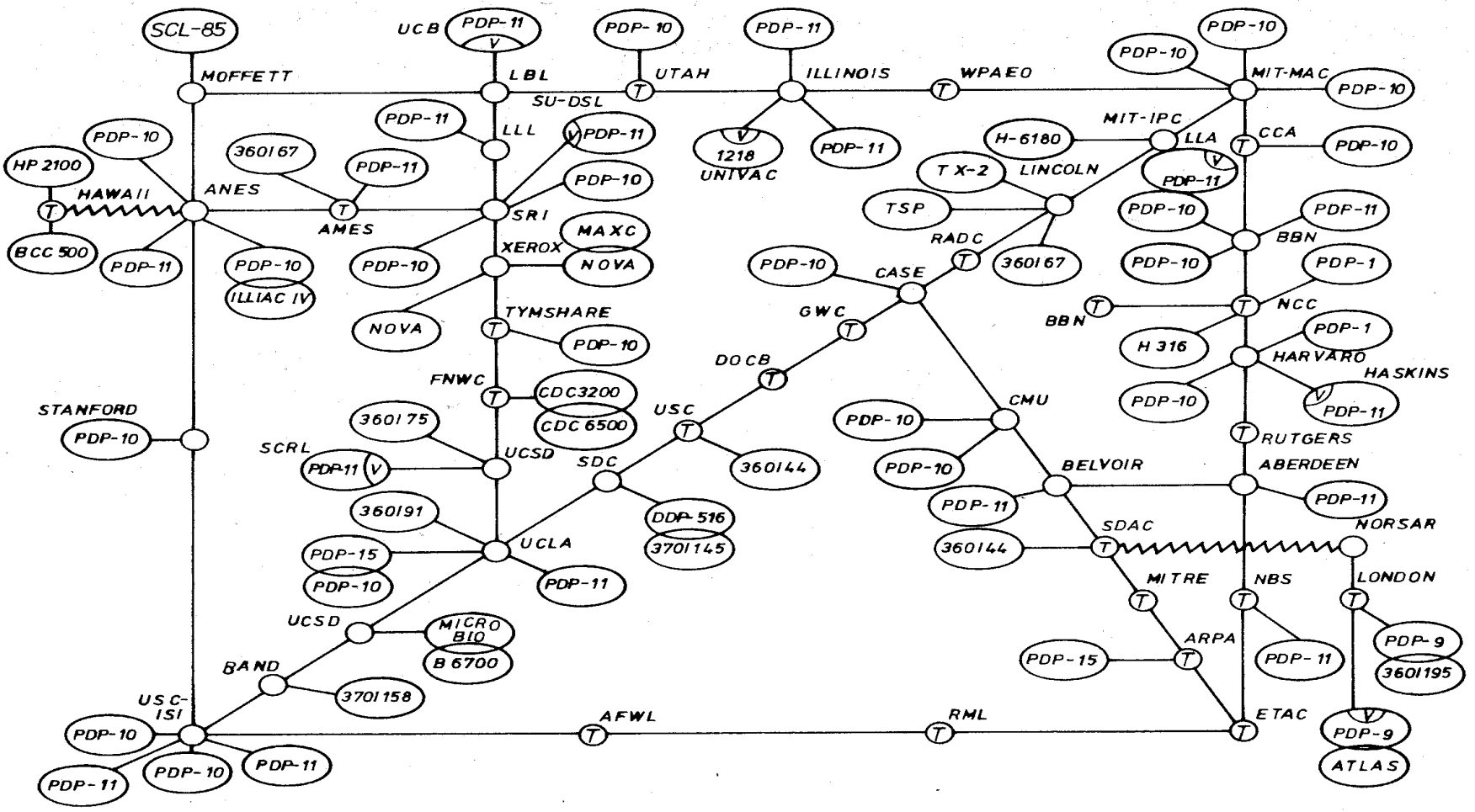
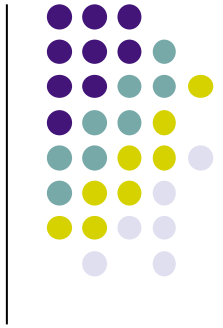


Abb. 4 ARPA NETwork, topologische Karte. Stand Juni 1974.

source:
http://www.cybergeography.org/atlas/historical.html

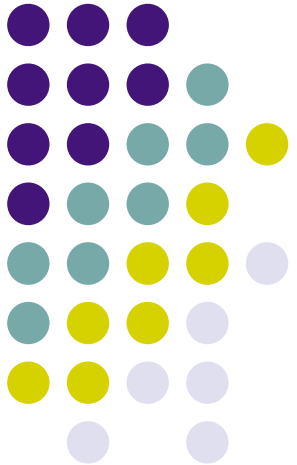
Traffic each day not more than 3.000.000 package

Years 70s



- Since 1970, new networks private architectures appear:
  - ALOHAnet in Hawaii
  - DECnet, IBM SNA, XNA
- 1974: Cerf & Kahn – principles of interconnection of open systems (Turing Awards)
- 1976: Ethernet, Xerox PARC
- End of 1970s: ATM

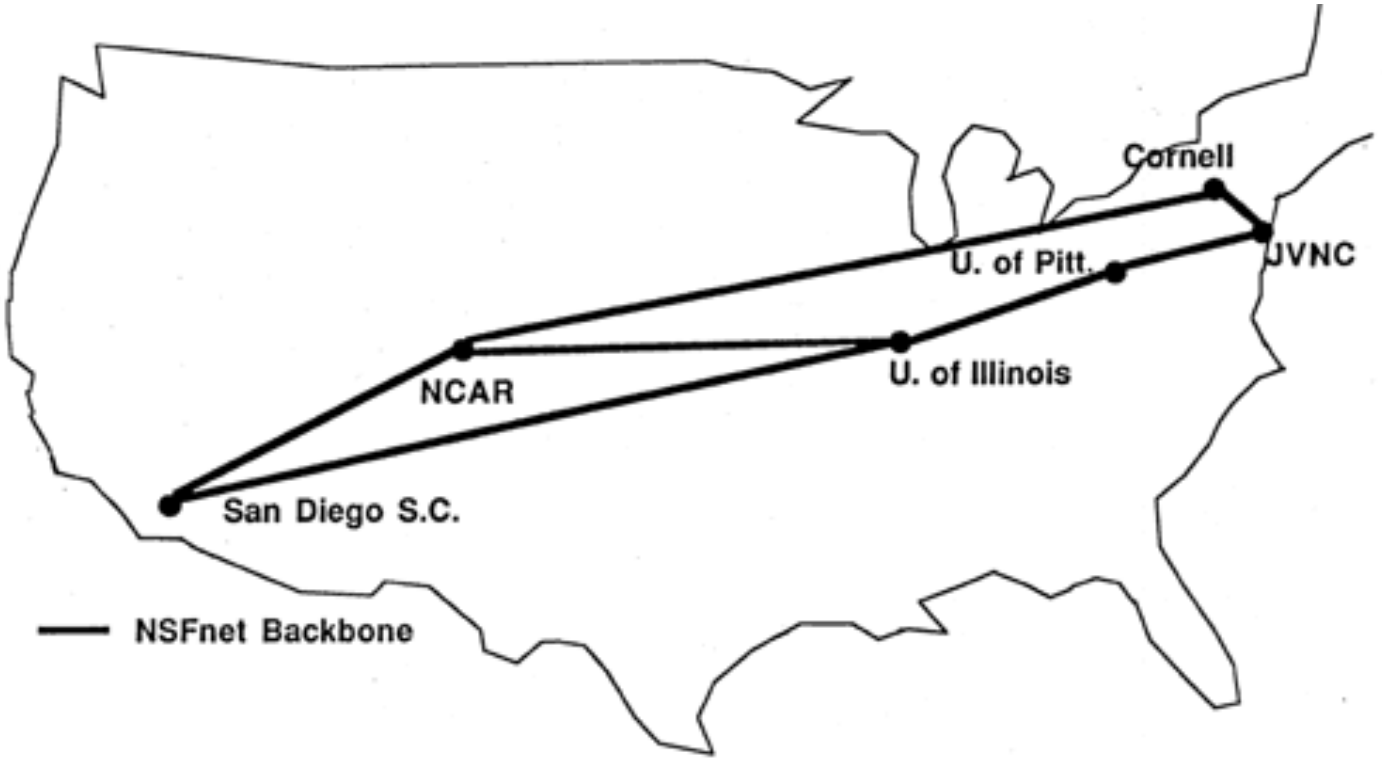
Years 80s: New protocols, more expansion



1981: Beginning of NSFNET

NSF: National Science Foundation

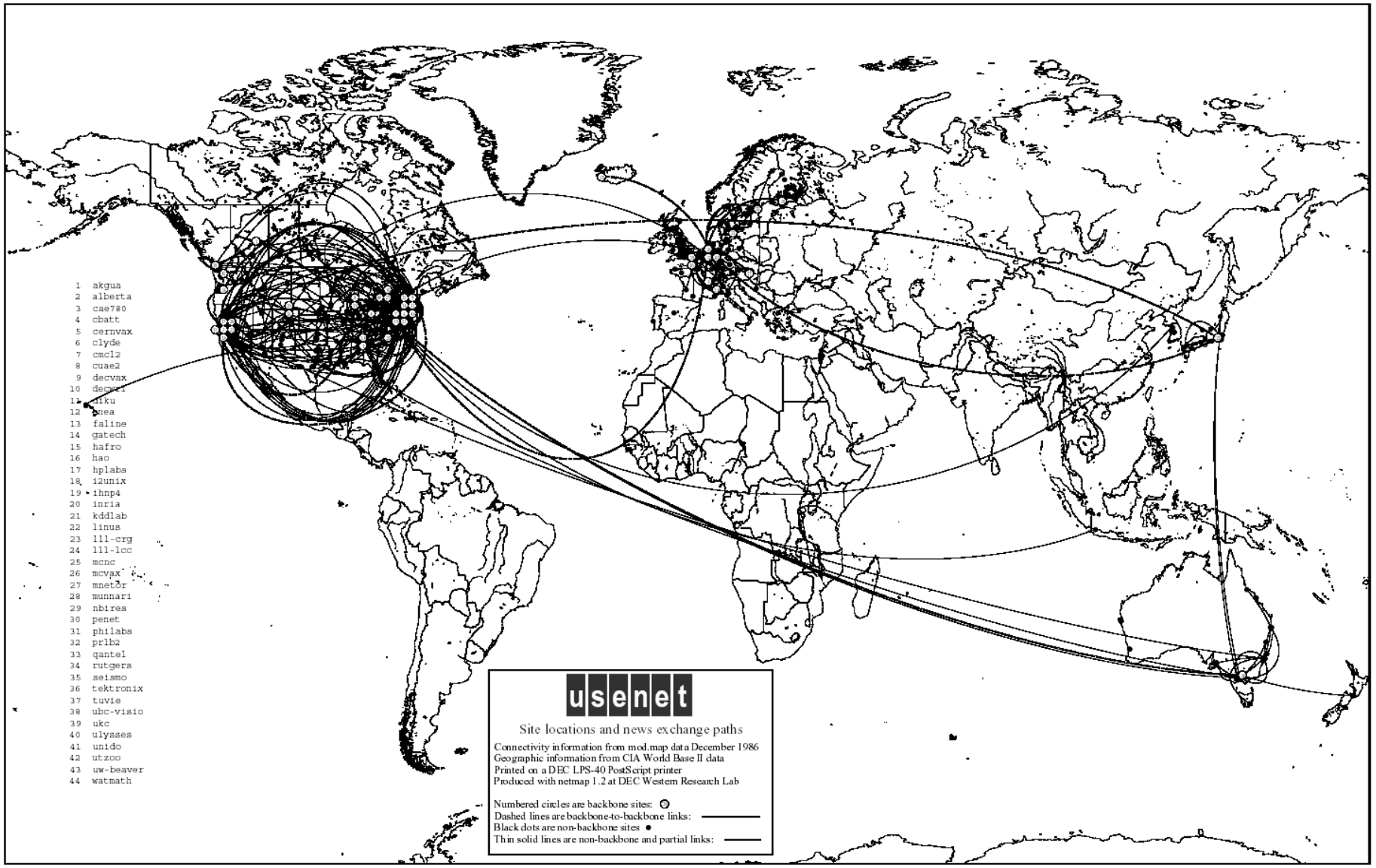
NSF network is separated from ARPANET for academic research uniquely



NSFnet Backbone Network

National Center For Atmospheric Research
March 19, 1986

1986: Connect USENET and NSFNET

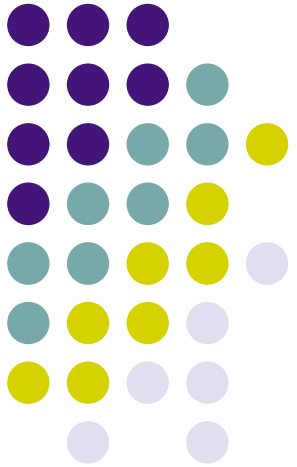


Source: http://www.cybergeography.org/atlas/historical.html

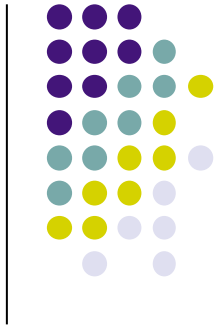
More network to join and more protocol

- More networks join in: MFENET, HEPNET (Dept. Energy), SPAN (NASA), BITnet, CSnet, NSFnet, Minitel …
- TCP/IP is standardized and becomes popular in 1980
- Berkeley integrate TCP/IP in BSD Unix
- Services: FTP, Mail, DNS …

Years 90s: Web and E-commerce over Internet



Years 90s

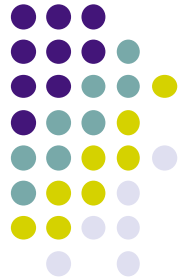


- Begining of 90s:
  Begining of Web
  - HTML, HTTP: Berners-Lee
  - 1994: Mosaic, Netscape
- End of 90s:
  Commercialized the Internet

End of 1990's – 2000's:

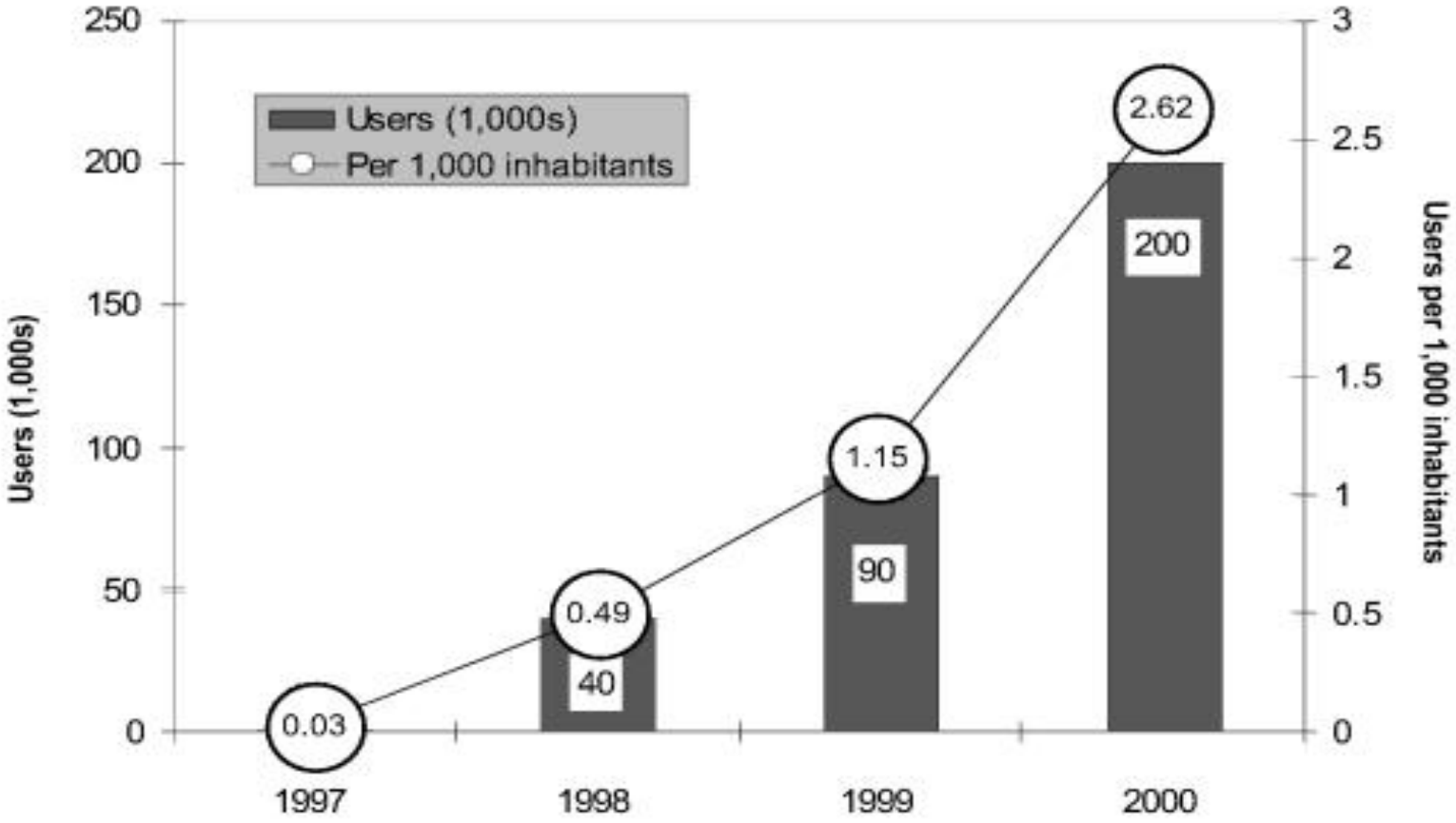
- Many new Internet applications was introduced:
  - Chat, file sharing P2P…
  - E-commerce, Yahoo, Ebay, Amazon, Google…
- > 50 millions hosts, > 100 millions users.

Internet in Việt Nam



- 1996: Preparation for the Internet infrastructure
  - ISP: VNPT
  - 64kbps, 01 connection to the world, few end users.
- 1997: Việt Nam connects to the Internet officially
  - 1 IXP (Internet Exchange Point): VNPT
  - 4 ISP (Internet Service Provider) : VNPT, Netnam (IOT), FPT, SPT
- 2007: After 10 years
  - 20 ISPs, 4 IXPs: VNPT, FPT, Viettel, EVN Telecom
  - 19 mil. users, 22.04% population

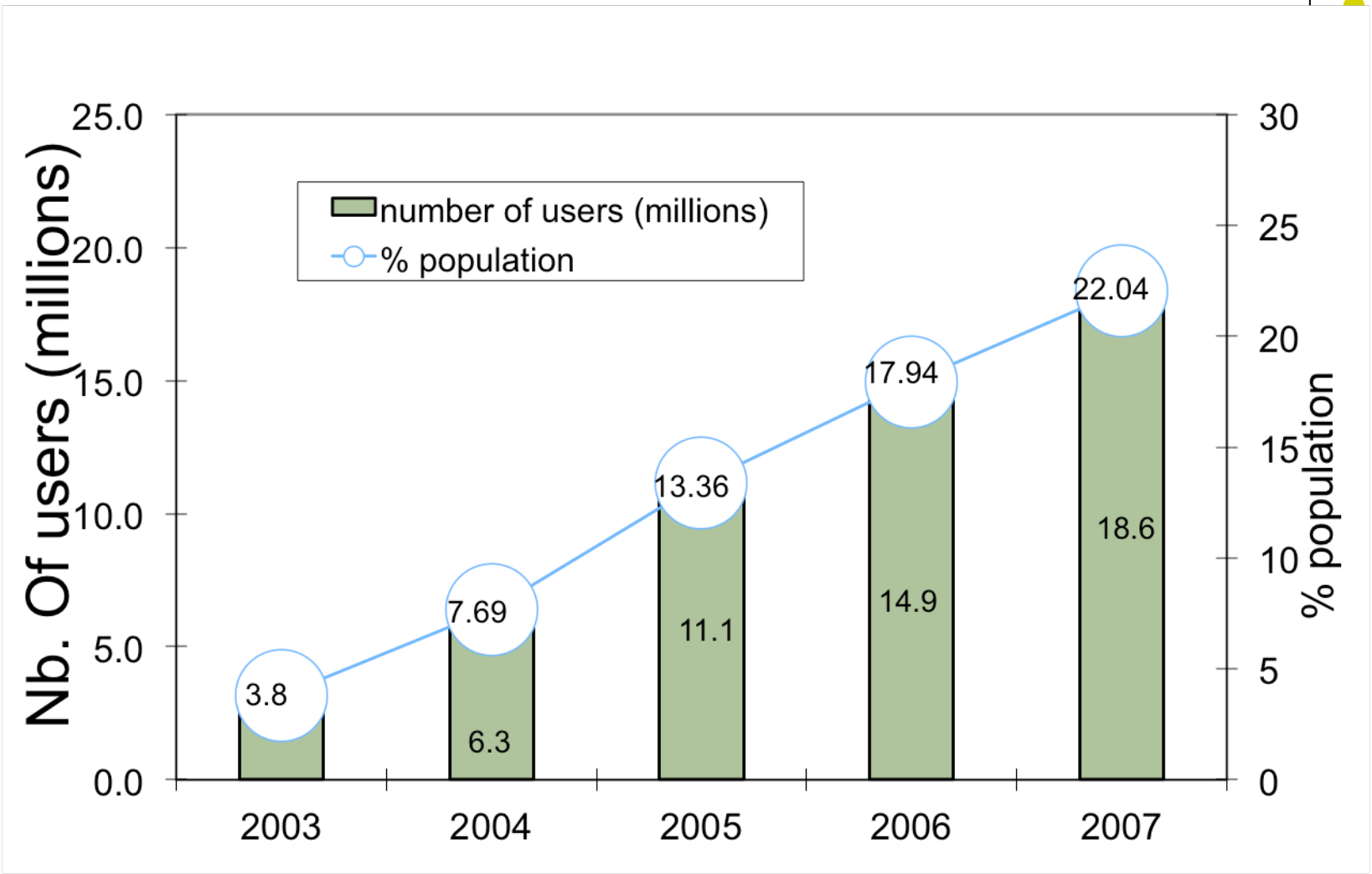
Development of the Internet in Vietnam



The numbers of users are estimated by 2 times the number of subscribers

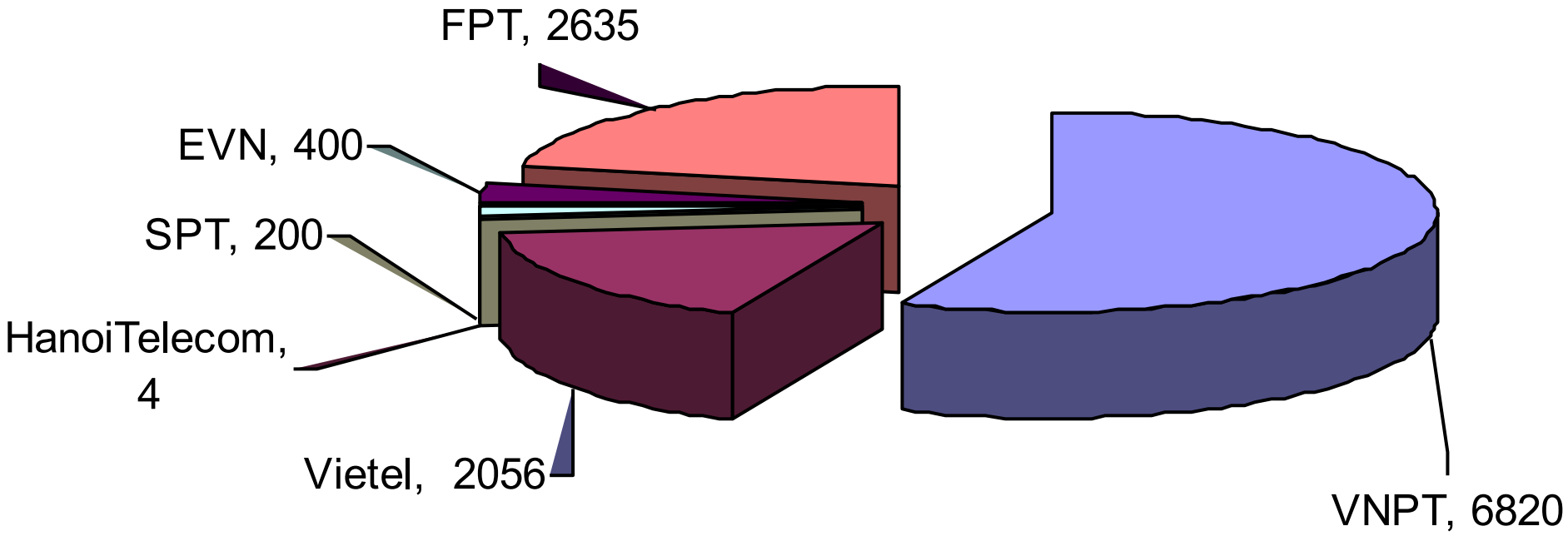
Source: Vietnam Internet Case Study, http://www.itu.int/asean2001/reports/material/VNM%20CS.pdf

Statistics until 2007



Source: *Vnnic*, http://www.thongkeinternet.vn

Bandwidth to the world (Mbps), 3rd Quarter 2007



Total: 12115.0 Mbps

Internet subscription, 2019

5 2019 Xem

Tình hình phát triển thuê bao băng rộng cố định tháng 5/2019	
Số thuê bao truy nhập Internet qua hình thức xDSL:	182,853
Số thuê bao truy nhập Internet qua kênh thuê riêng:	22,929
Số thuê bao truy nhập Internet qua hệ thống cáp truyền hình (CATV):	868,039
Số thuê bao truy nhập Internet qua hệ thống cáp quang tới nhà thuê bao (FTTH):	12,606,506
Tổng số thuê bao băng rộng cố định:	13,680,327

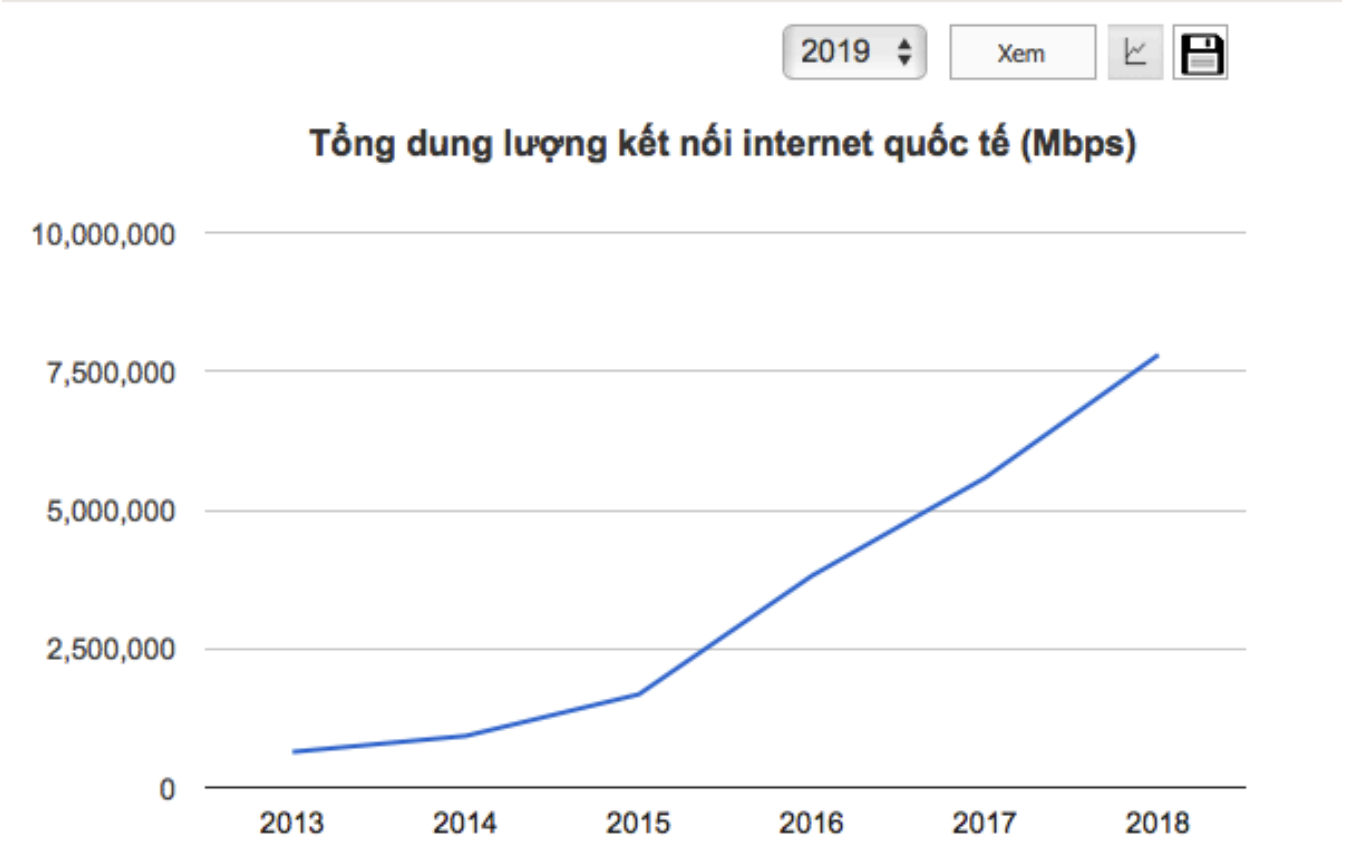
Statistics are provided by Department of Telecommunication, Ministry of Information and Communication.
http://vnta.gov.vn/thongke/Trang/dulieuthongke.aspx

Internet usage on Mobile phone 2019

Tình hình phát triển thuê bao điện thoại di động tháng 5/2019	
▸ Tổng số thuê bao điện thoại di động có phát sinh lưu lượng:	133,877,535
▸ Tổng số thuê bao điện thoại di động đang hoạt động chỉ sử dụng thoại, tin nhắn:	75,216,569
▪ Thuê bao trả trước:	70,448,710
▪ Thuê bao trả sau:	4,767,859
▸ Tổng số thuê bao điện thoại di động đang hoạt động có sử dụng dữ liệu:	58,660,966
▪ Thuê bao trả trước:	54,158,129
▪ Thuê bao trả sau:	4,502,837

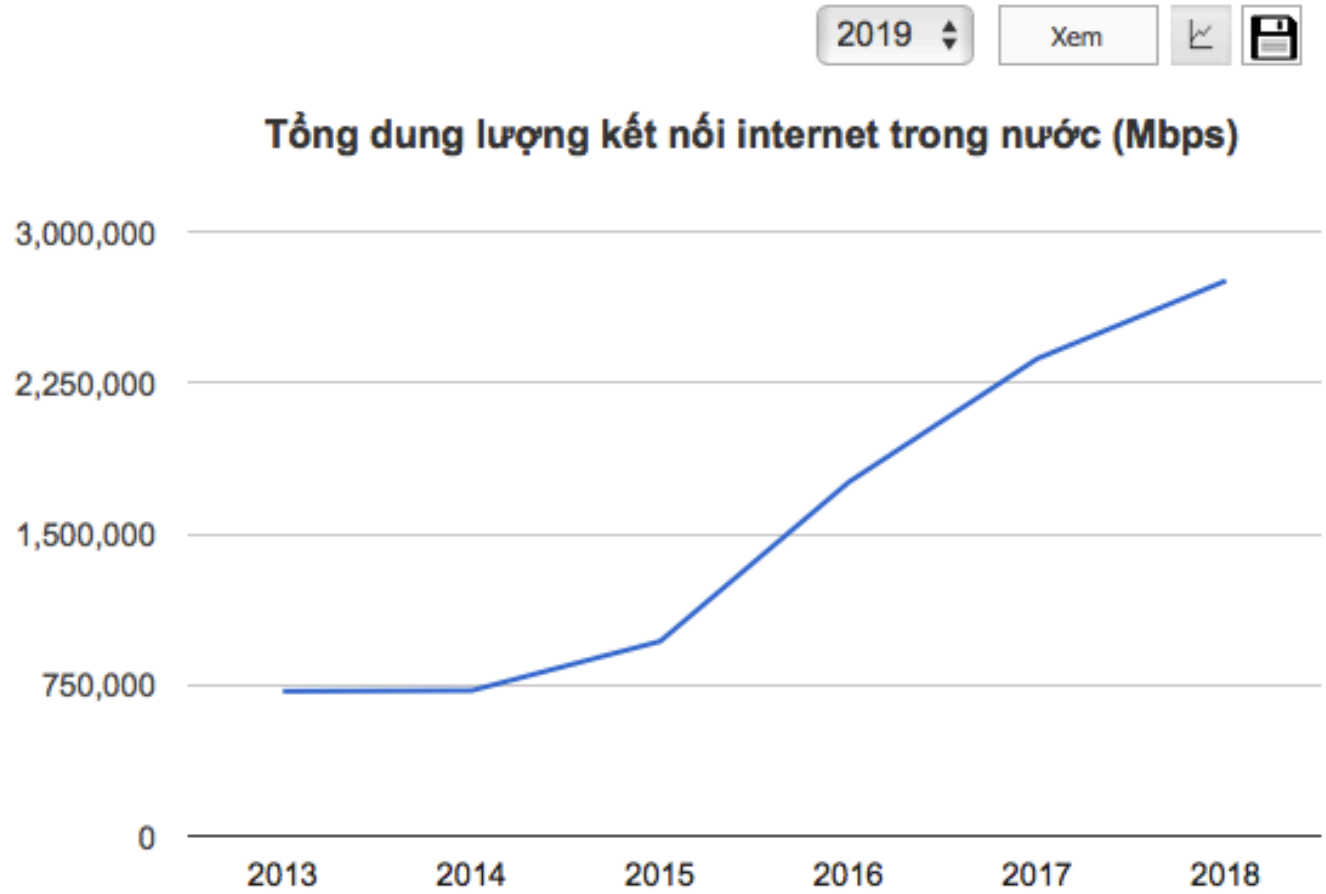
Statistics are provided by Department of Telecommunication, Ministry of Information and Communication.
http://vnta.gov.vn/thongke/Trang/dulieuthongke.aspx

International Internet data volume 2019



Statistics are provided by Department of Telecommunication, Ministry of Information and Communication.
http://vnta.gov.vn/thongke/Trang/dulieuthongke.aspx

Domestic Internet data volume



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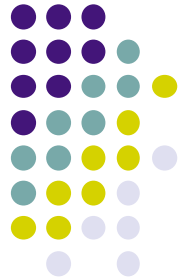
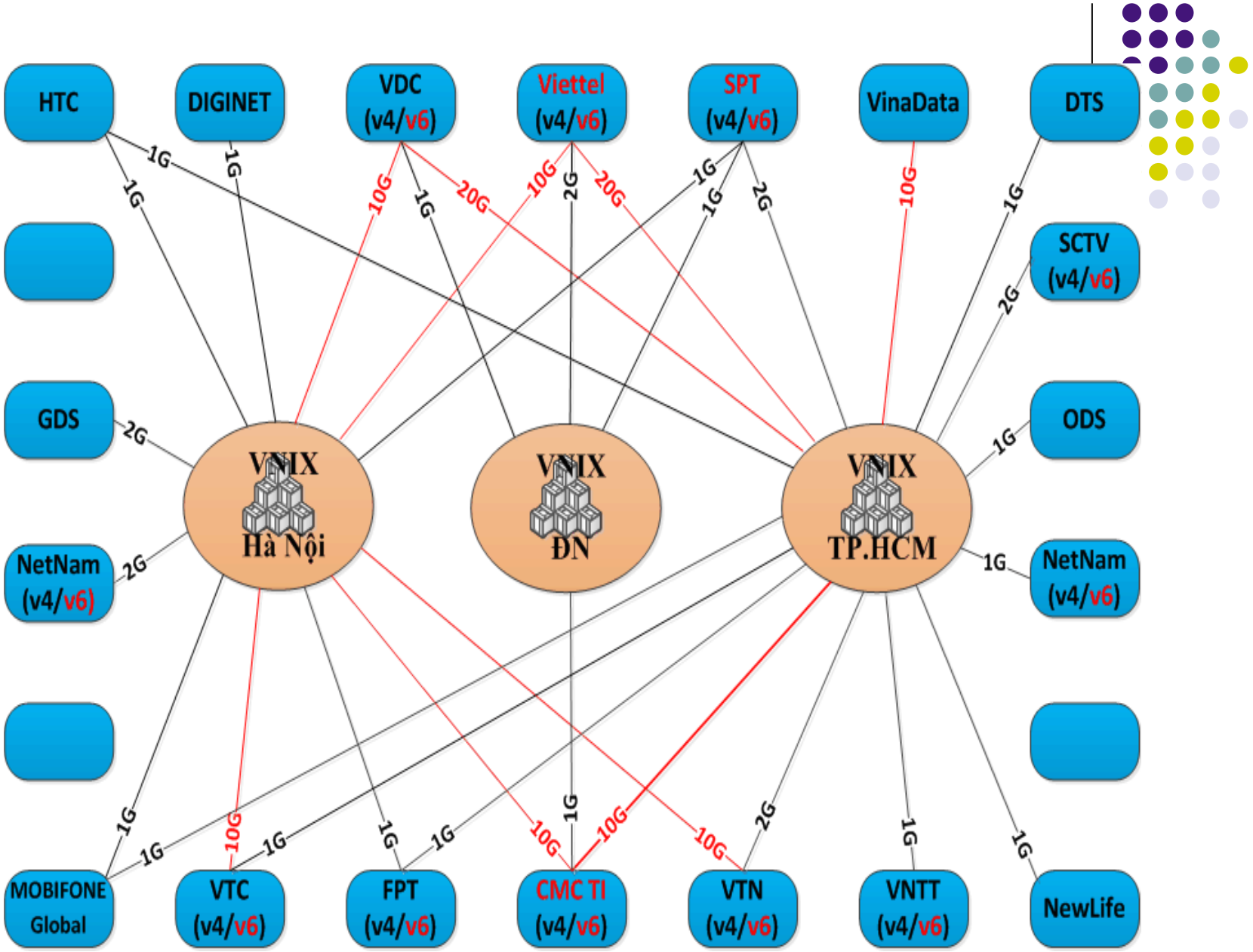
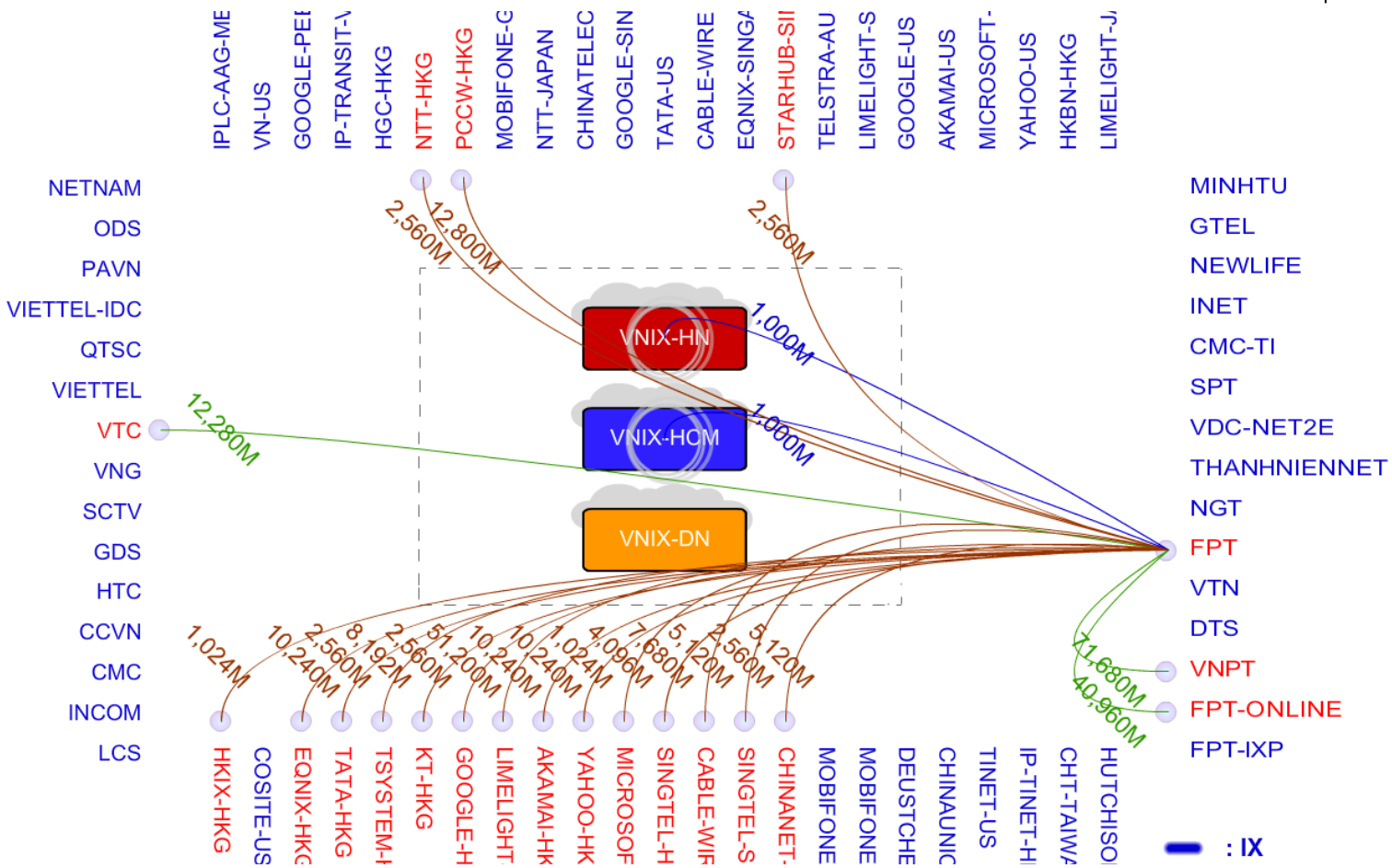
Internet management in Việt Nam



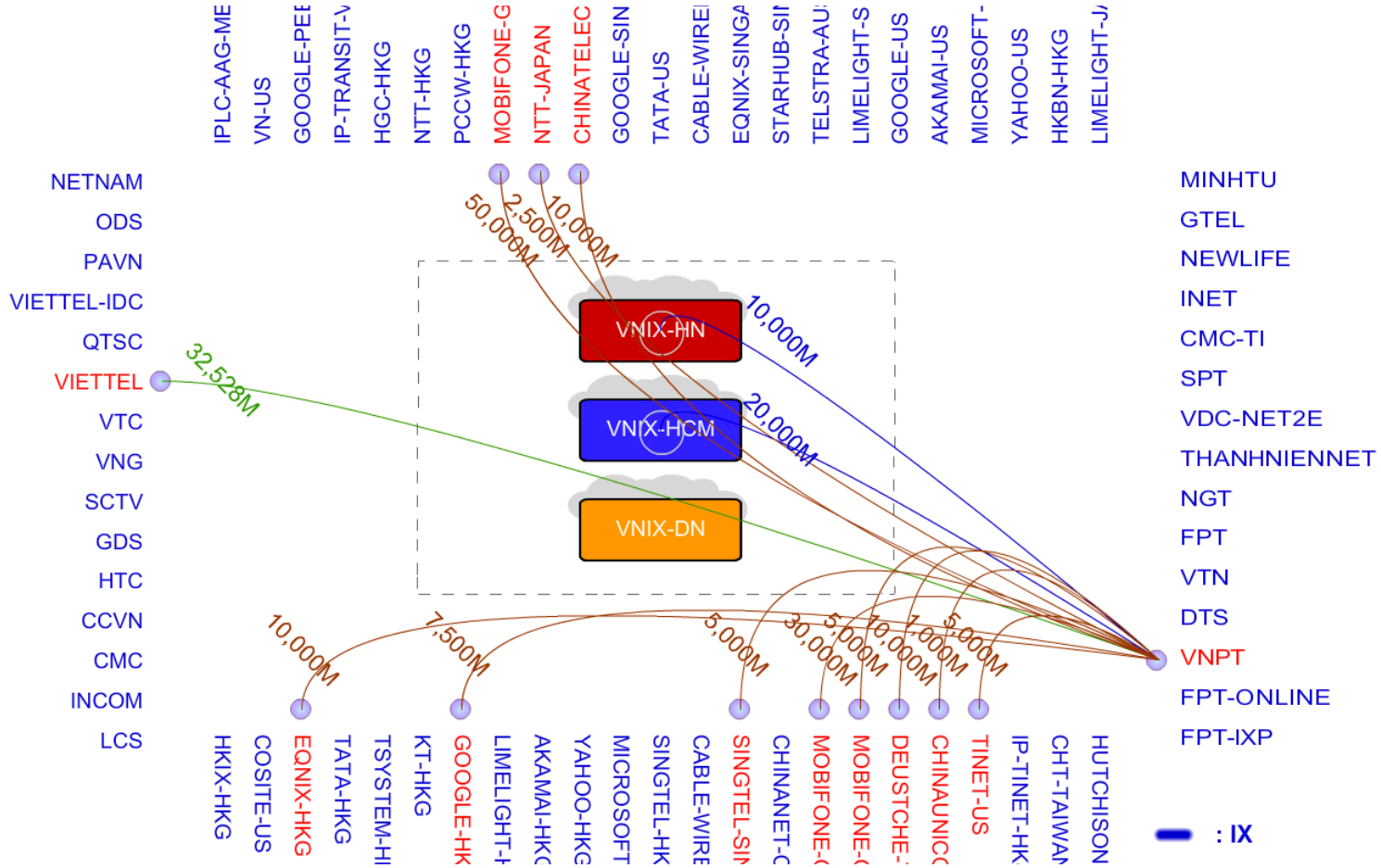
- VNNIC
  - Is responsible for managing the Internet domain name, address in Việt Nam;
  - Provides guidelines, statistics about Internet and participates in international activity about Internet.
- **VNIX: V**ietnam **N**ational **I**nternet e**X**change
  - switching system between national ISP.


HTC
DIGINET
VDC (v4/v6)
Viettel (v4/v6)
SPT (v4/v6)
VinaData
DTS
SCTV (v4/v6)
GDS
ODS
NetNam (v4/v6)
NetNam (v4/v6)
MOBIFONE Global
VTC (v4/v6)
FPT (v4/v6)
CMC TI (v4/v6)
VTN (v4/v6)
VNTT (v4/v6)
NewLife
VNIX Hà Nội
VNIX ĐN
VNIX TP.HCM
1G
2G
10G
20G

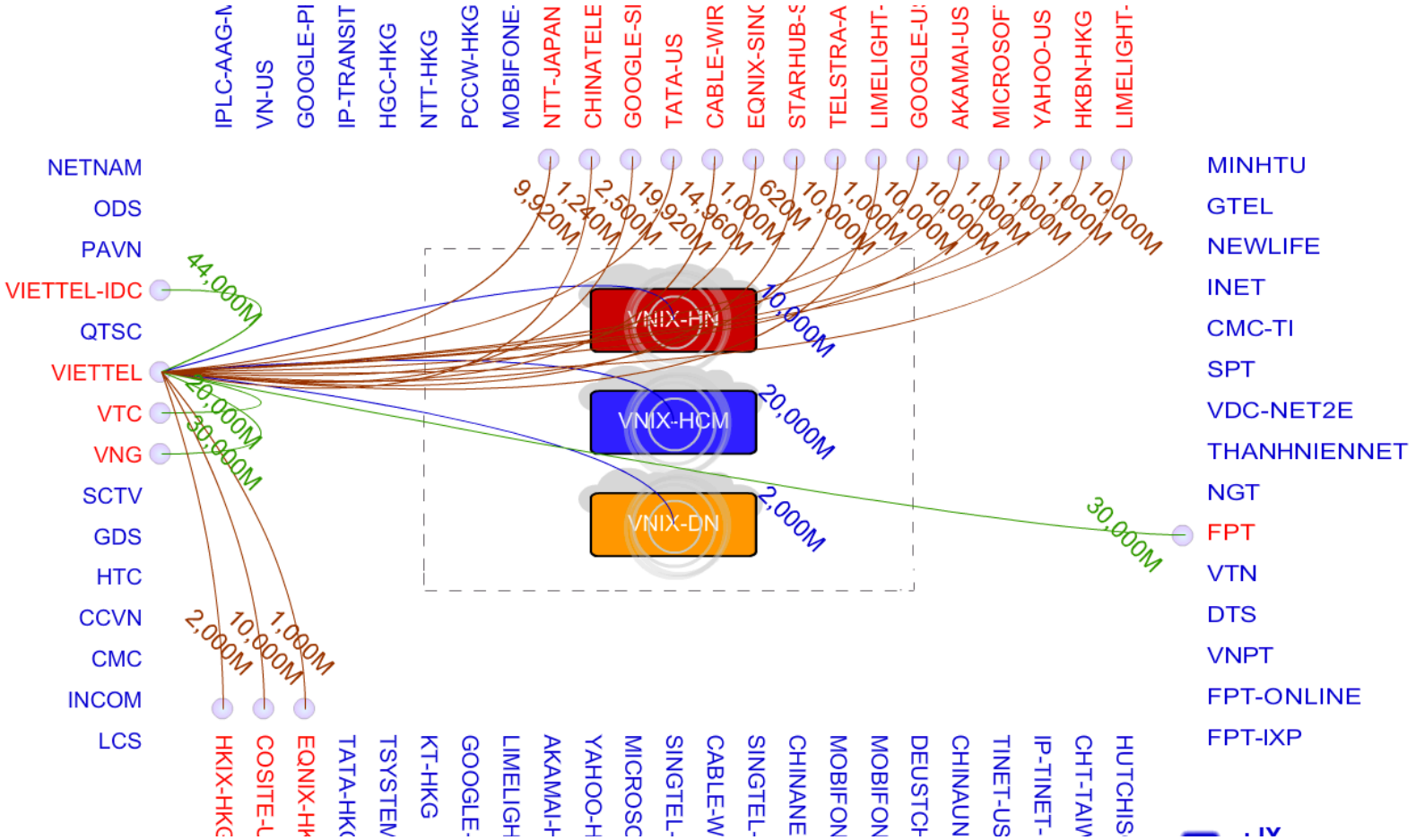
International connections



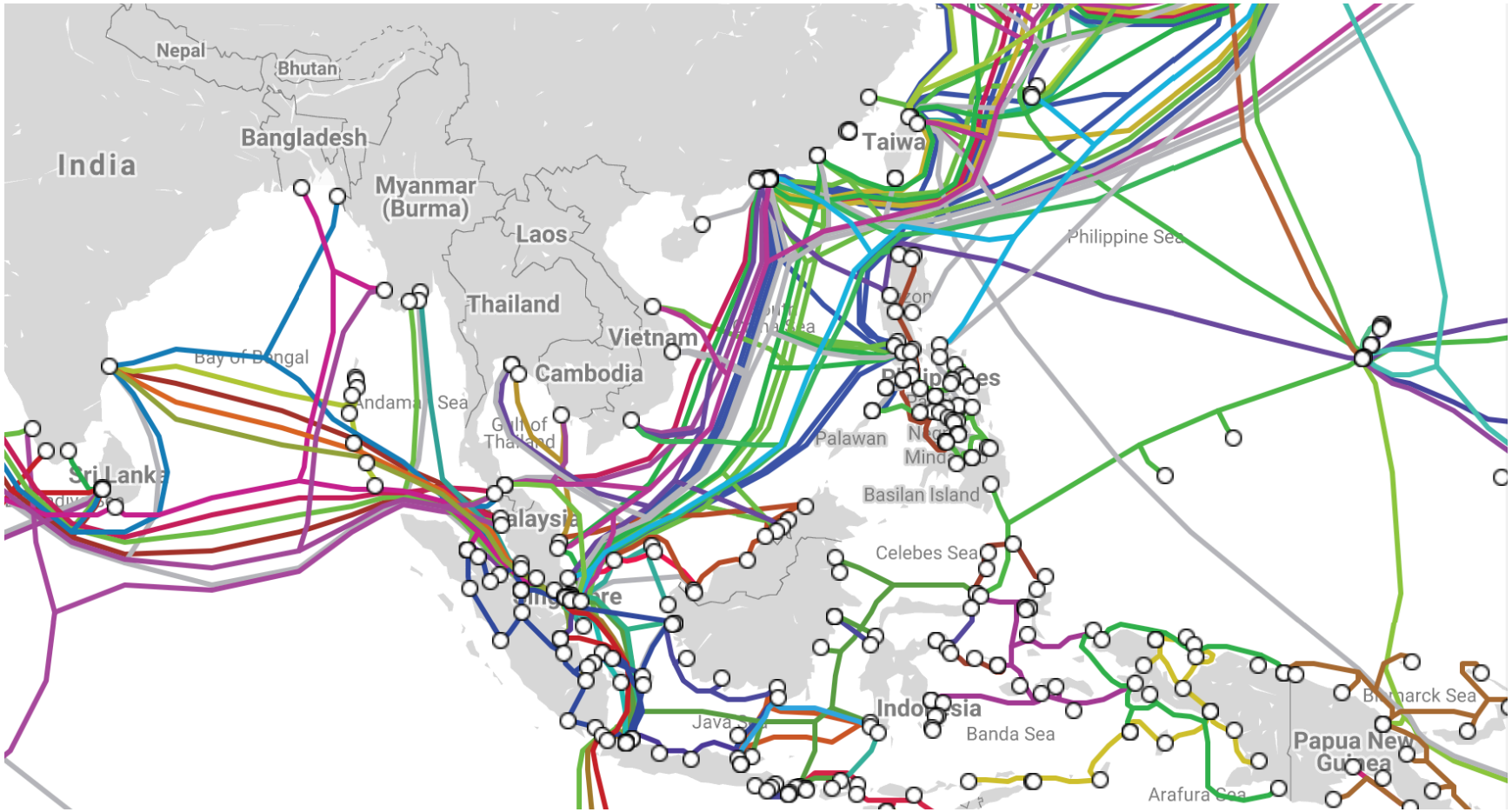
International connections



International connections

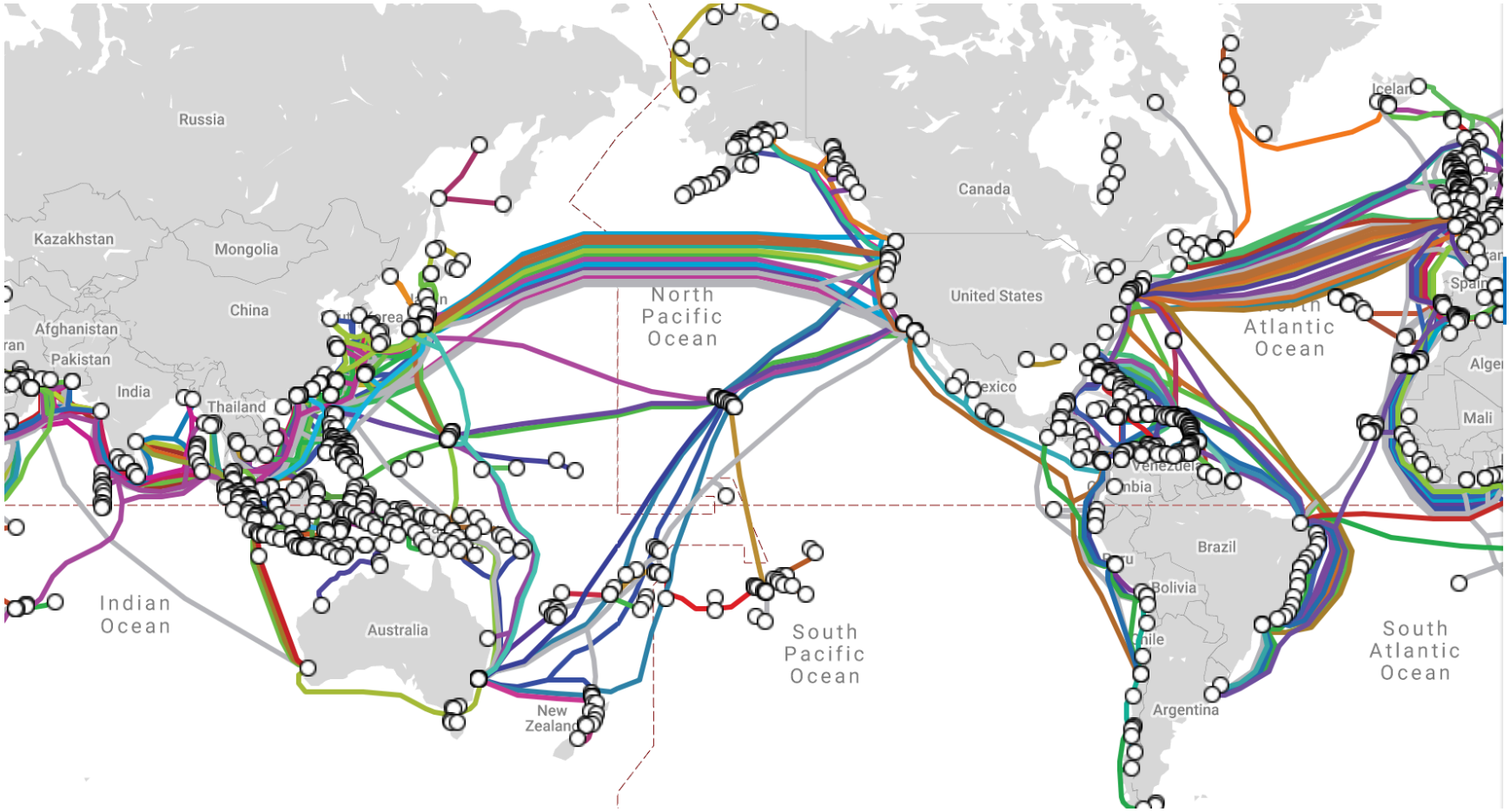


Optical fiber under the ocean



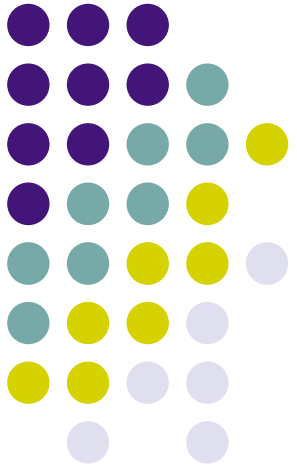
Source: https://www.submarinecablemap.com

Optical fiber under the ocean



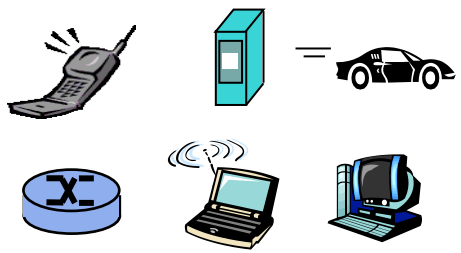
Source: https://www.submarinecablemap.com

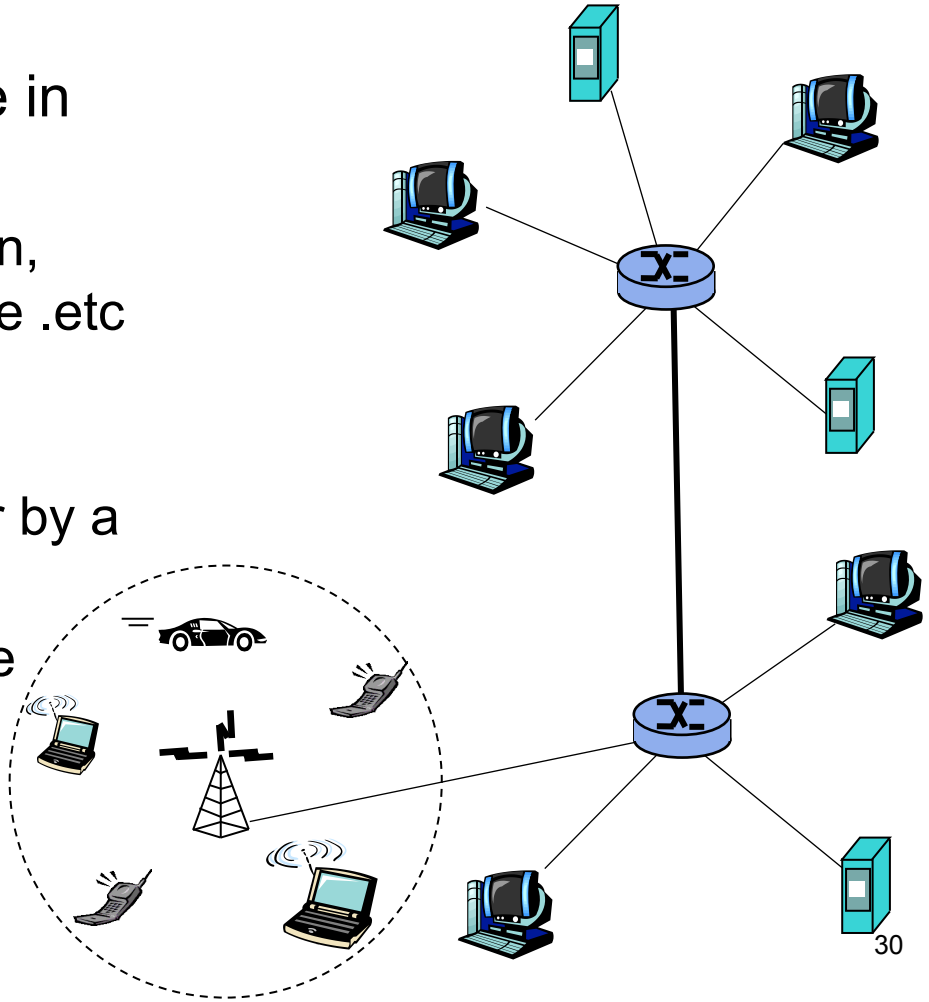
Concepts of computer networks



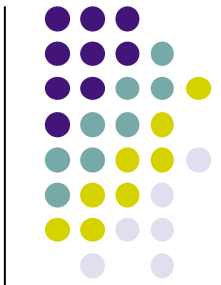
Concepts

- A set of computers/nodes connecting to each other according to an architecture in order to exchange data
  - Computer/node: workstation, server, router, mobile phone .etc with information processing capacity
  - They connect to each other by a media (wired or wireless)
  - Arcording to an archirecture
- Different kind of computers



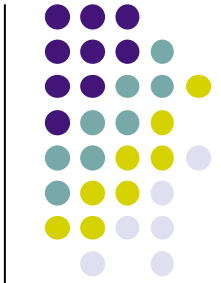


Example of computer networks

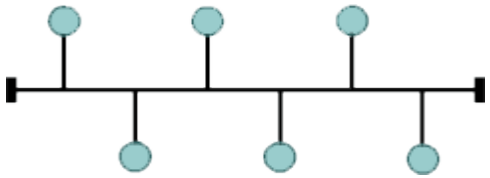


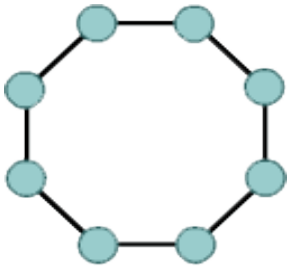
- The Internet
- A local network using Ethernet
- An wireless LAN in a cafe: using 802.11 standard
- A network connecting ATMs

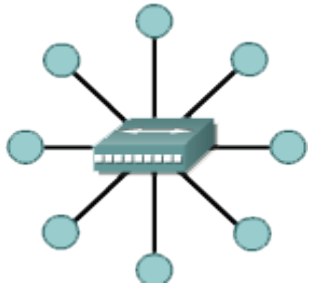
Network architecture



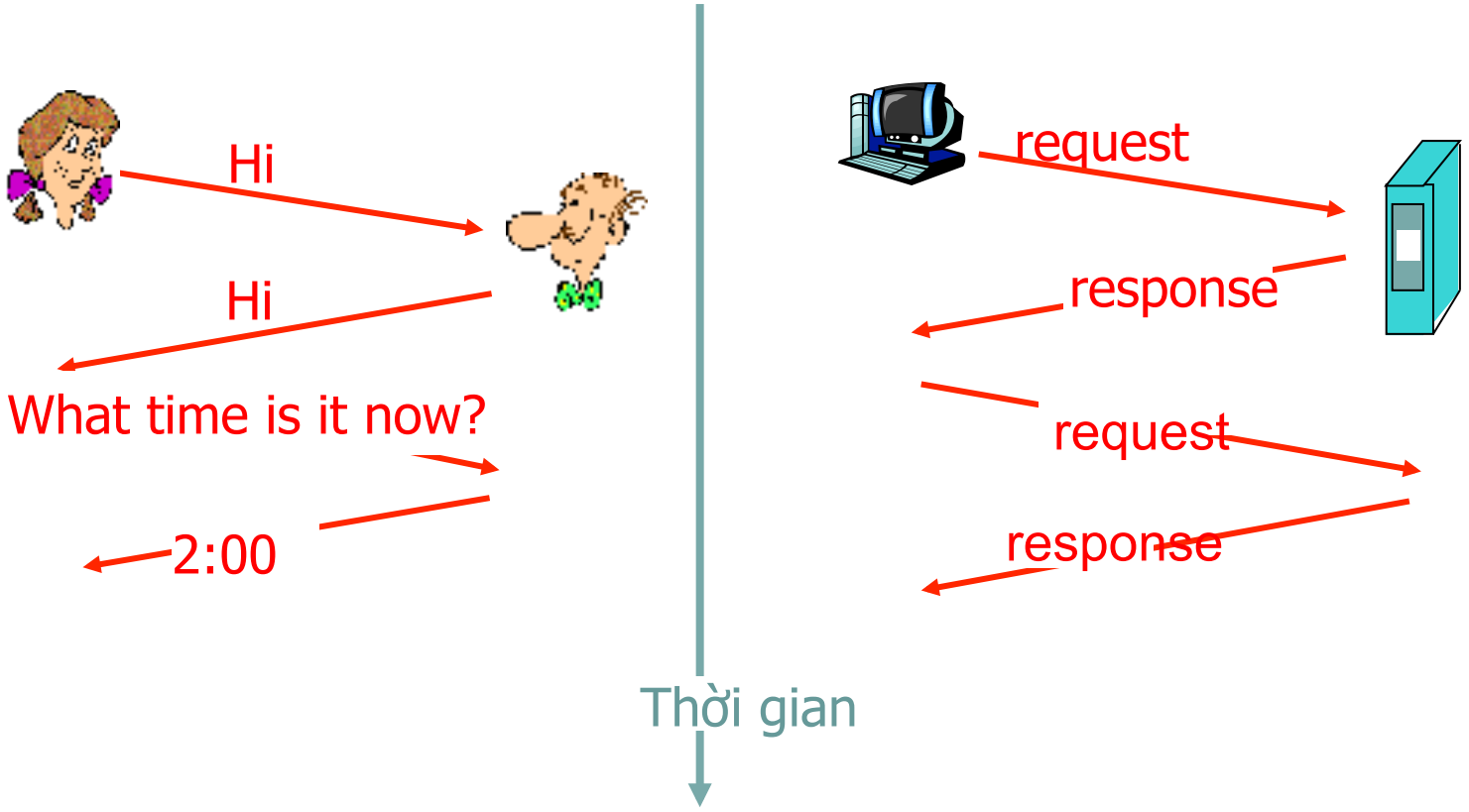
- Network architecture contain 2 aspects:
  - topology: the form that network nodes connects to each other
  - Protocol: language and procedure of communication between nodes.
- Topology
  - Bus, Ring, Star…







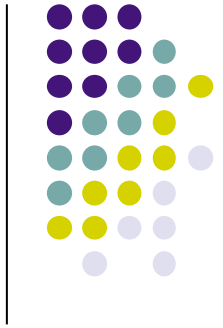
What is a protocol?



Protocol between human being: vocabulary, procedure

Protocol between machines

Network protocol

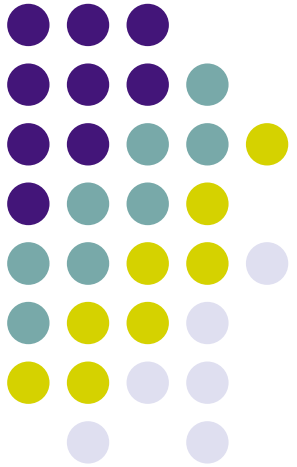


- Protocol: Communication rules
  - An entity/node sends a request
  - An entity/node receives some information or requests an action
  - Requests and information are under the form of messages.
- Protocol defines:
  - Format of messages/ information to be exchanged between nodes.
  - Order of messages sending between entities/nodes
  - Action should be performed when an entity receives a message.
- Example of protocols: TCP, UDP, IP, HTTP, Telnet, SSH, Ethernet, …

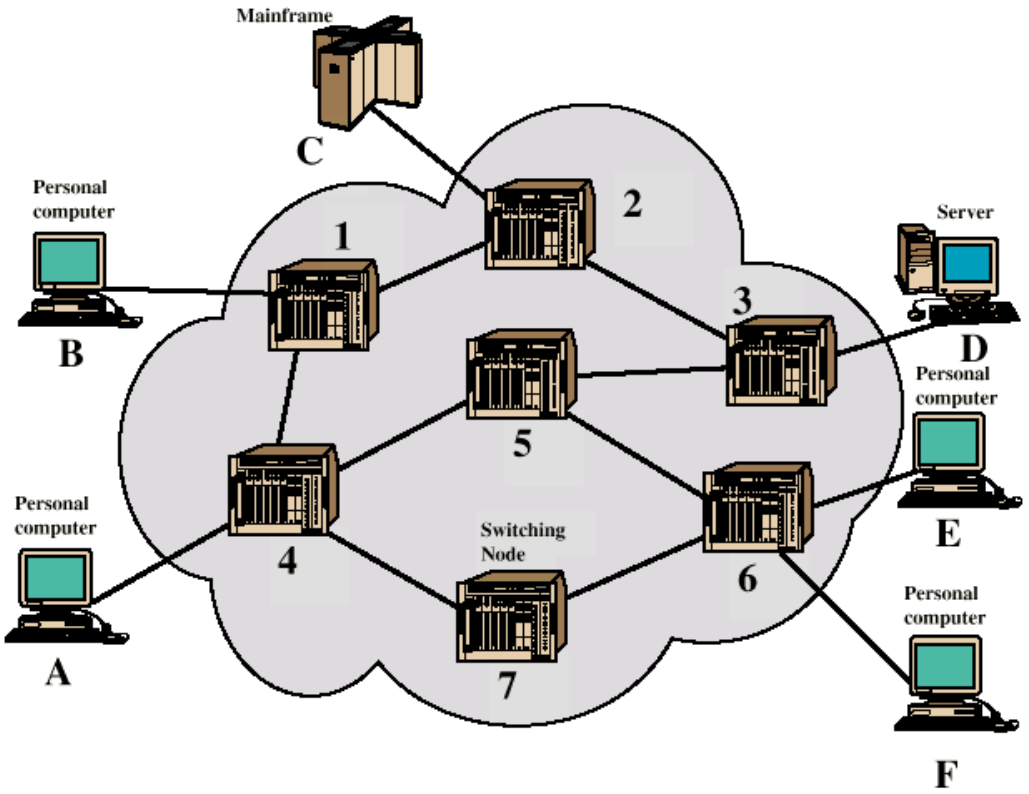
Transmission models

Packet switching vs. Circuit switching

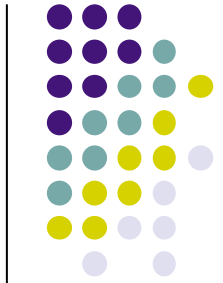
Connection oriented vs. Connectionless



Data switching network

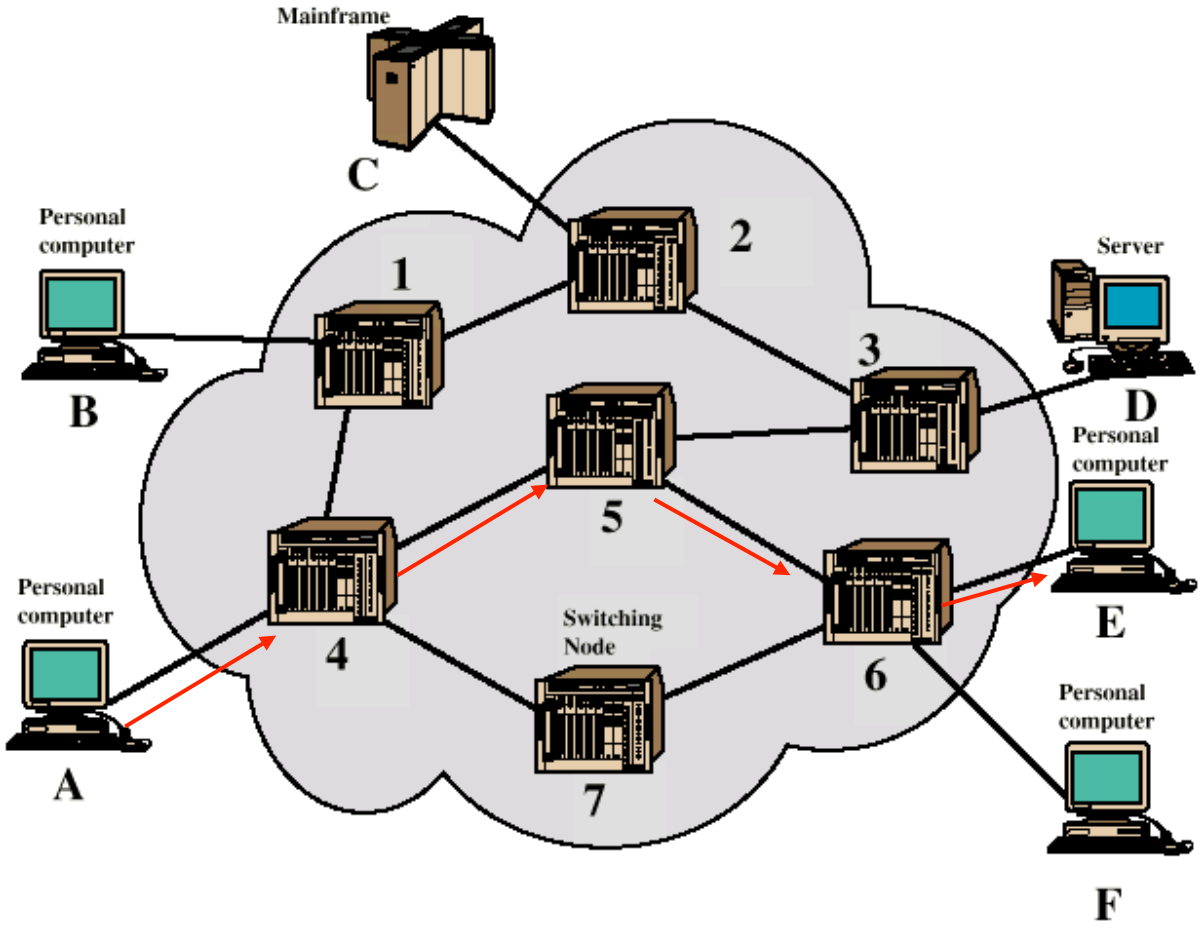


Circuit switching

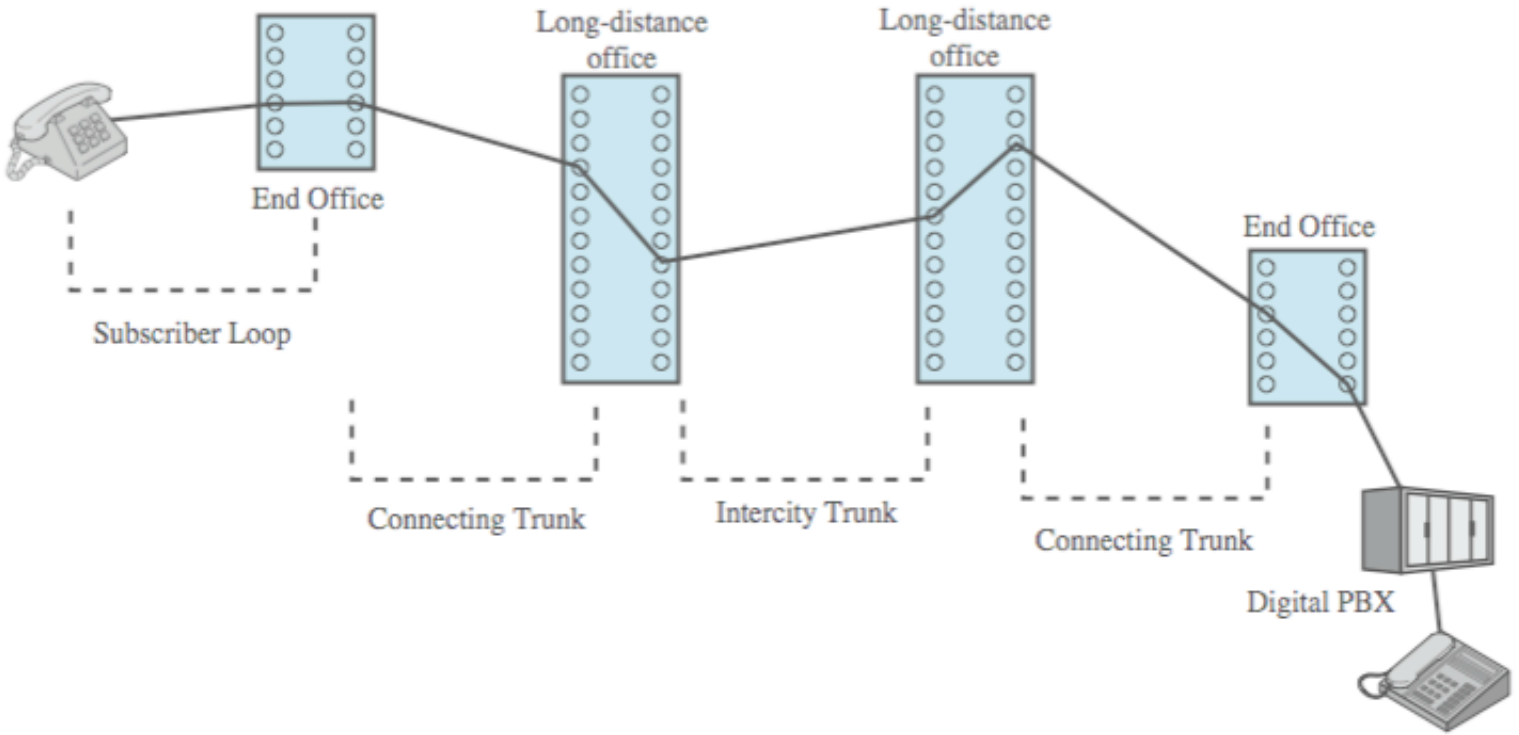


- Circuit is a path/channel over which data flows
- Resources (ex: bandwidth over a link) is dedicatedly assigned to each circuit. Consequently, when the circuit is unused (no data is transmitted), no other circuit can use the ressources.
- 3 phases of data transmission
  - Establish the circuit
  - Transmit data
  - Teardown the circuit
- Circuit switching guaranties that the circuits uses the whole available the bandwidth over each link for data transmission (good for audio/video transmission)
- Waste of bandwidth if the data transmission process does not consume the whole capacity of each link of the circuit.

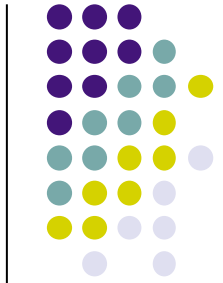
Circuit switching



Example of circuit switching: Public Switched Telephone Network PSTN

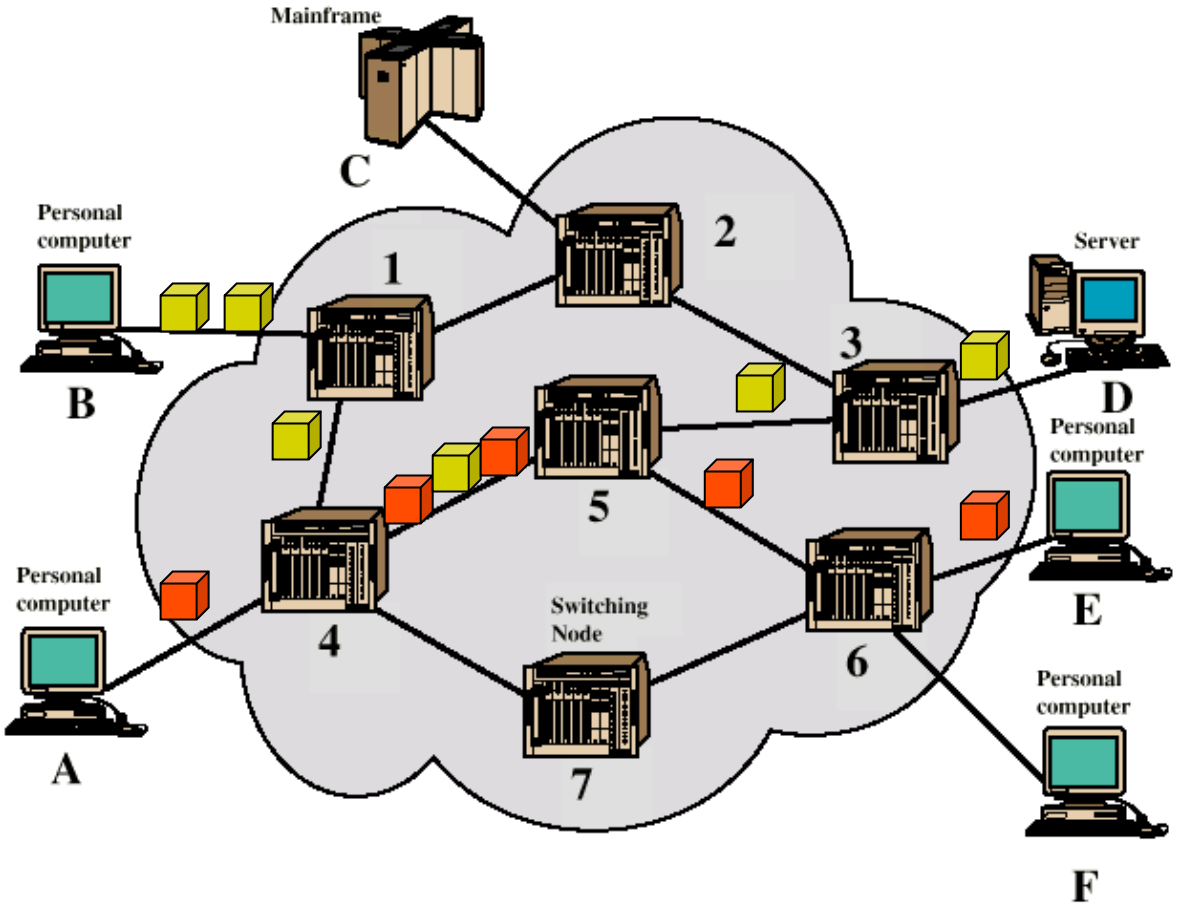


Packet switching



- Data is divided into small packets and transferred through the network
- Multiple connections can share a single chanel
  - Increase bandwidth utilization efficiency
- Each packet is routed individually
- Two packet switching techniques
  - Datagram switching
    - Packets can take different routes: example of IP
  - Virtual circuit switching
    - Packets follow a fixed path: example of MPLS

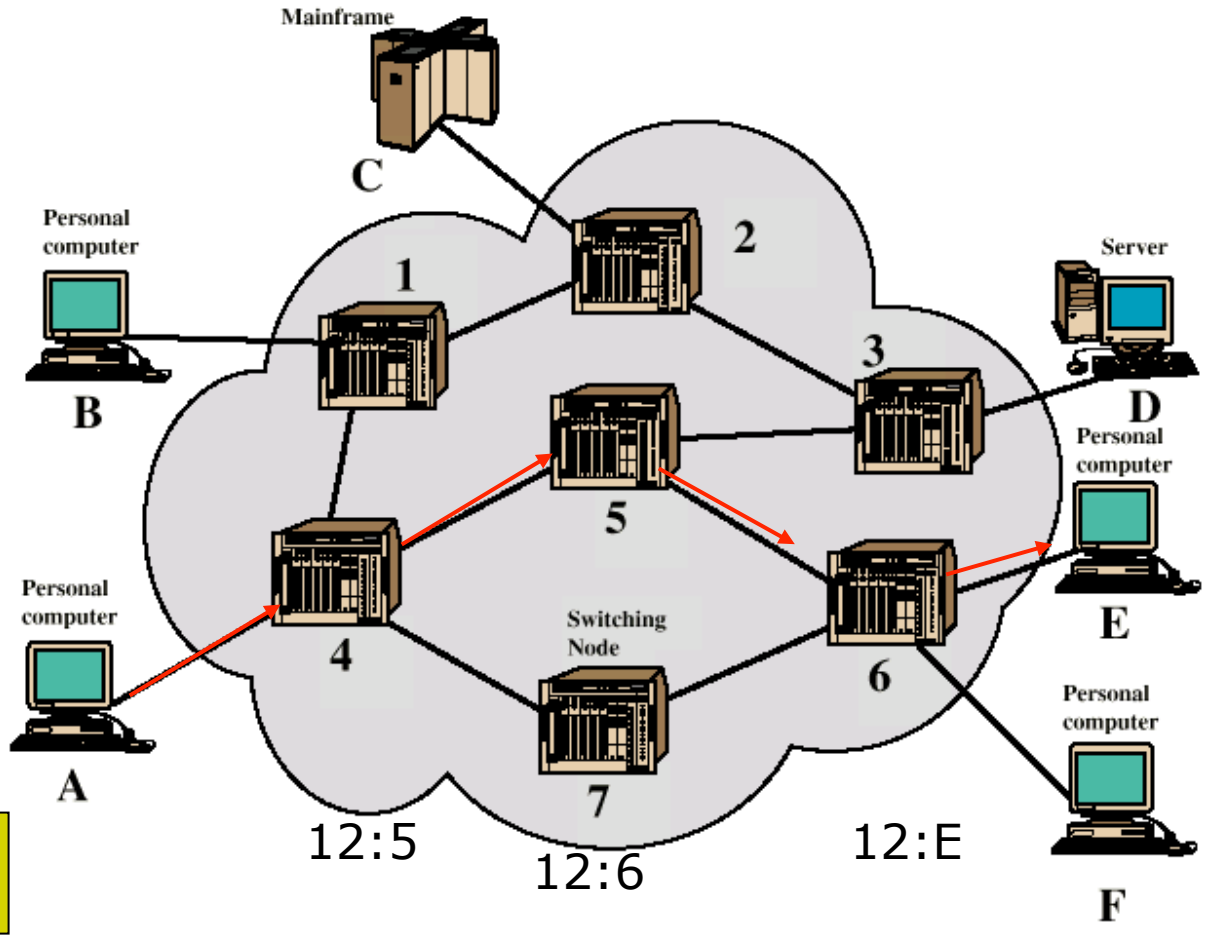
Example


Mainframe
C
Personal computer
B
1
2
3
Server
D
Personal computer
E
5
Personal computer
A
4
Switching Node
6
7
Personal computer
F

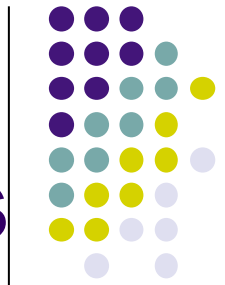
Virtual circuit switching

- Packets are forwarded using a fixed route → virtual circuit
- Different parts of the circuit (links) can still be shared between different connections
- Packets arrive to destination in order.
- Fast packet switching

Dữ liệu	12

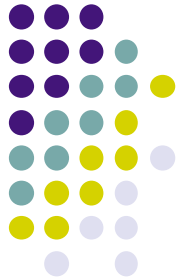


Connection oriented transmission vs. connectionless



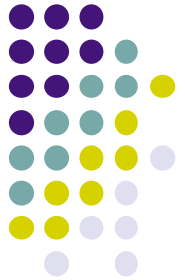
- Connection oriented transmission:
  - Data are transmitted over a connection already established
  - 3 working phases: Establishing a connection, data transmission, teardown the connection.
  - Reliable
- Connectionless transmision
  - No connection establishing phase
  - Only data transmission phase
  - Not reliable - “Best effort”

Summary



- Introduction to the course
- History of the Internet
- Concept of Computer Networks
- Architecture
  - Topology
  - Protocol
- Circuit switching vs. packet switching
  - Pros & cons

Next week…



- Layering architecture
- OSI reference model
- IP, MAC address, port number
- DNS service.