EITF25
Internet
Techniques and Applications

Stefan Höst
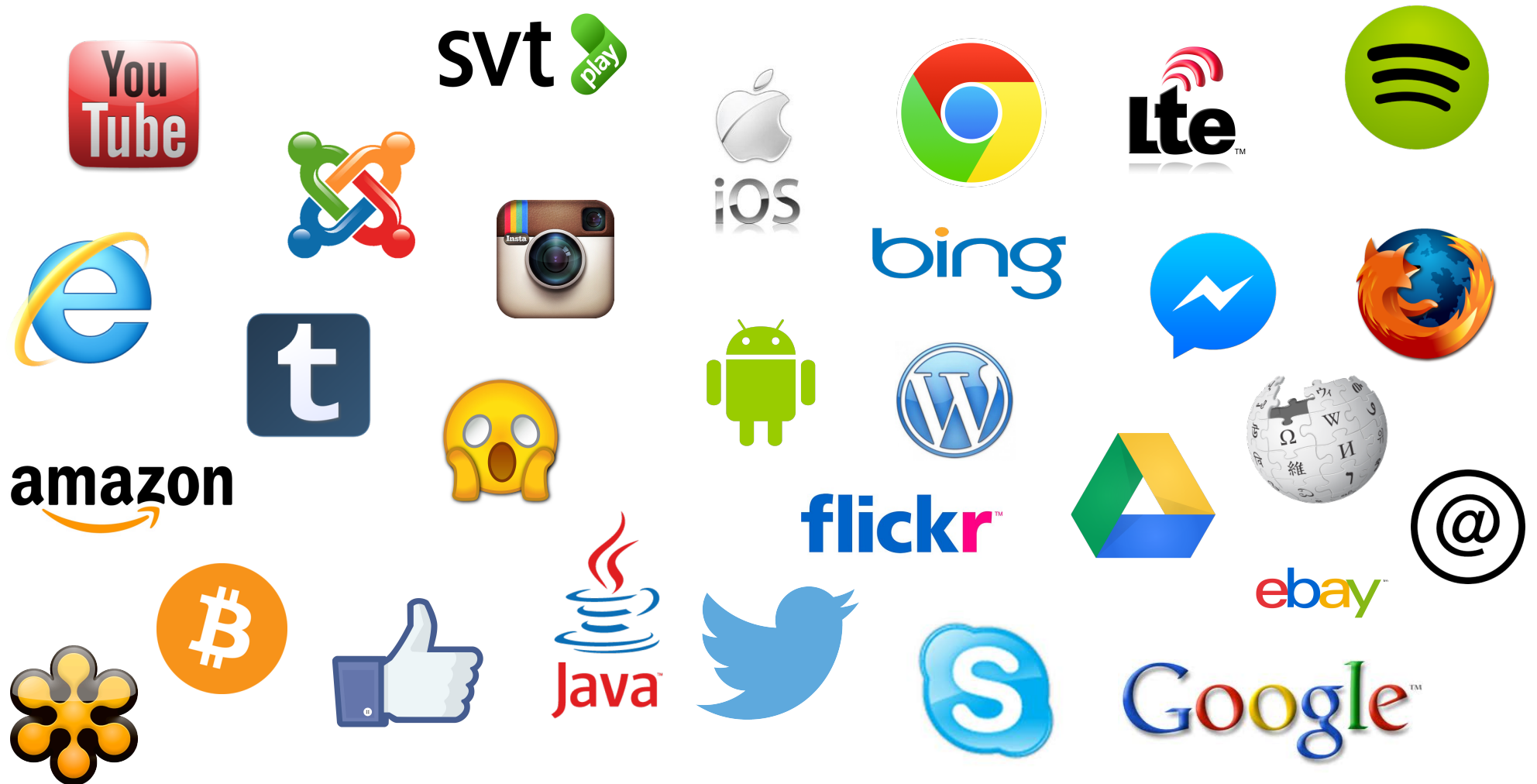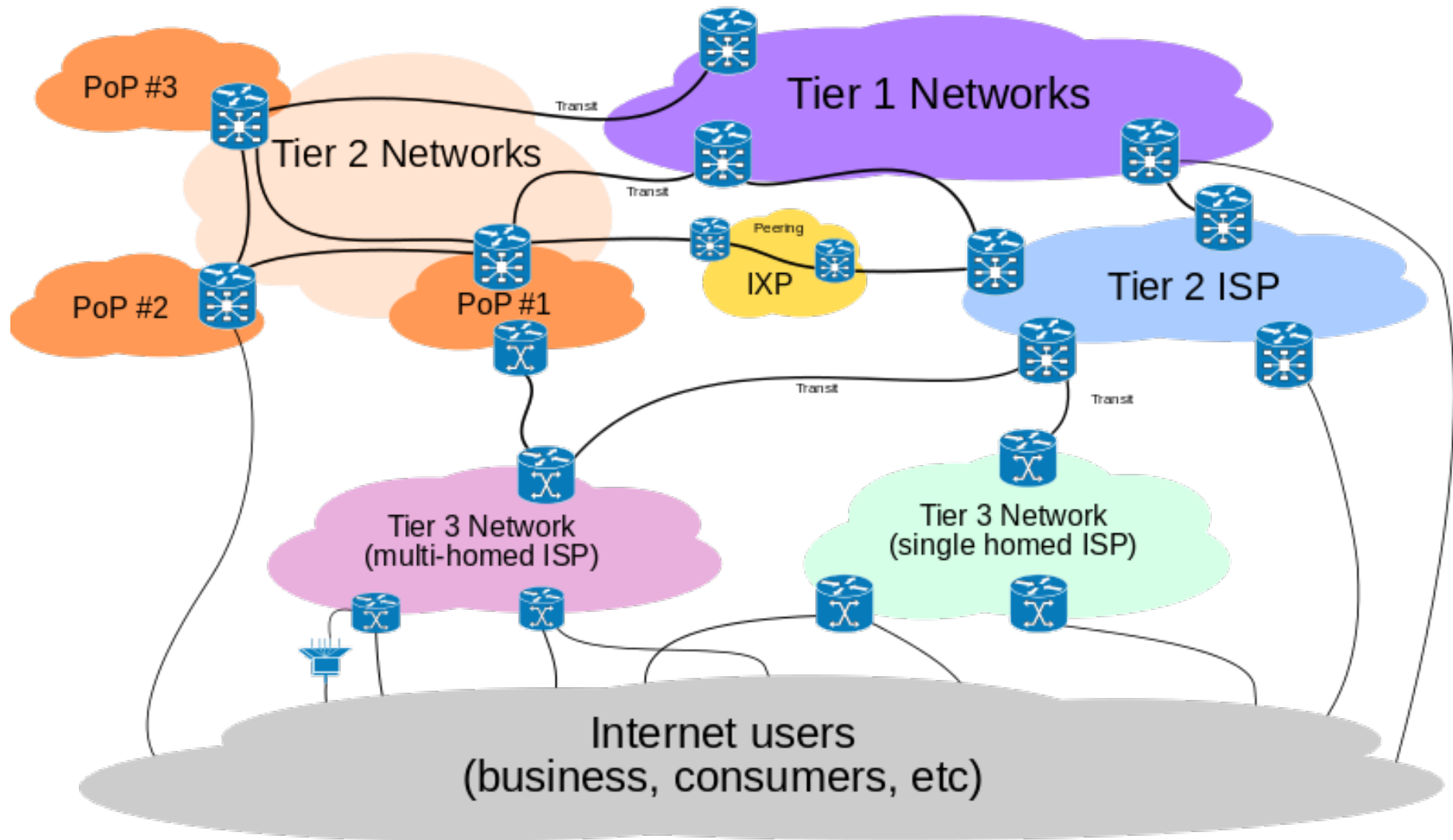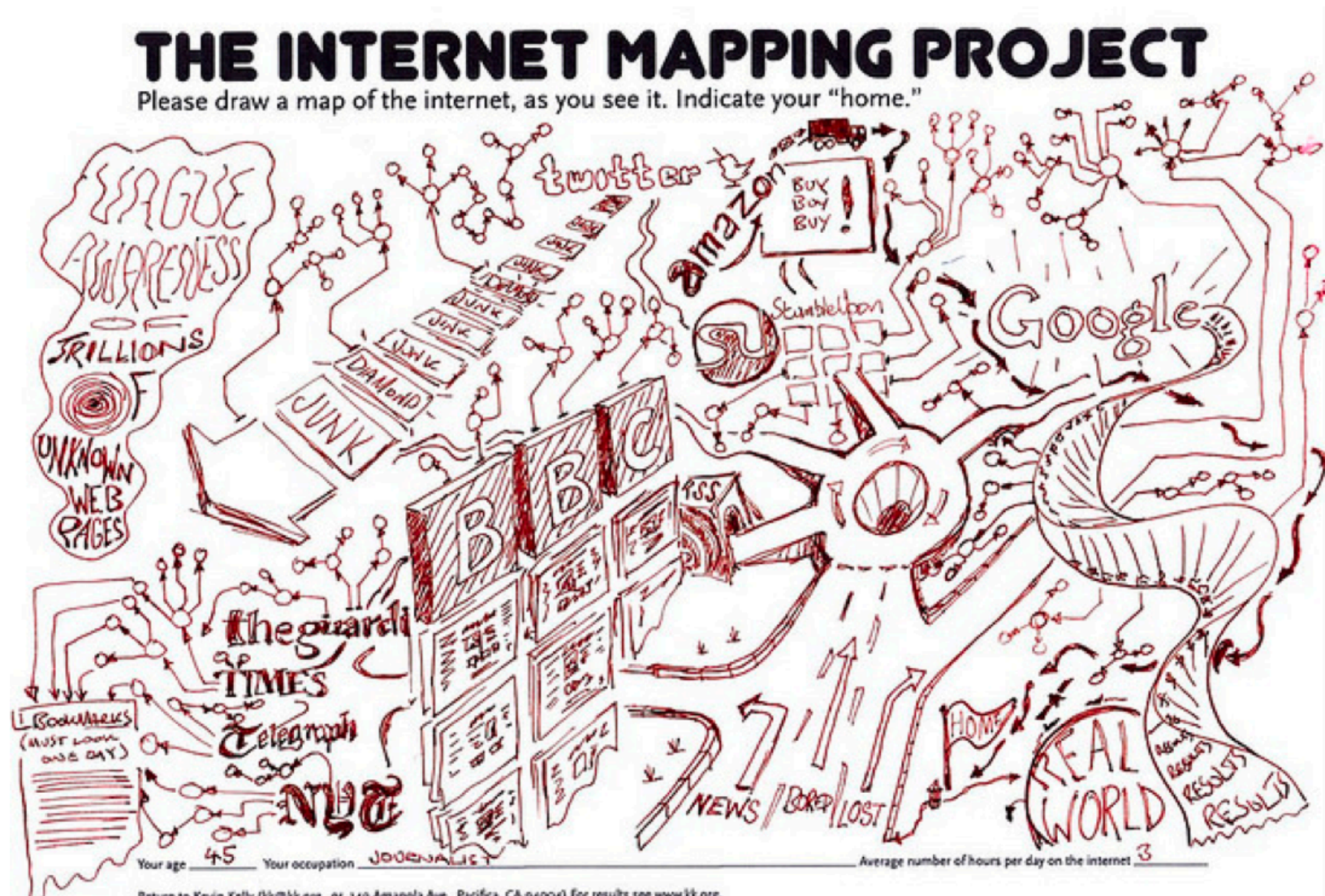
E:3135b

stefan.host@eit.lth.se

LUND UNIVERSITY
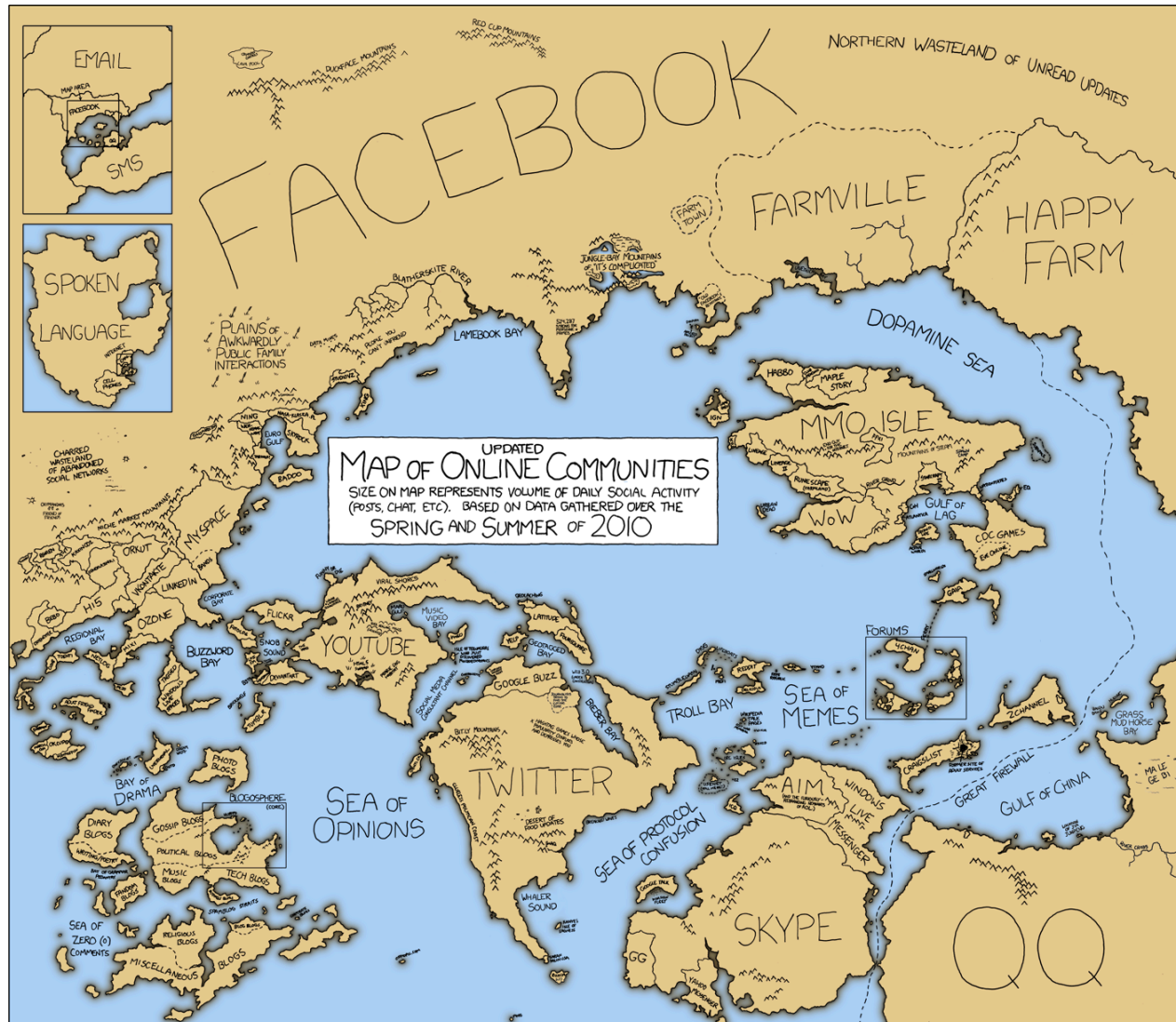
What is Internet? (1)

What is Internet? (2)

What is Internet? (3)

What is Internet? (4)

What is Internet?

- How did it start?
- What is Internet today?
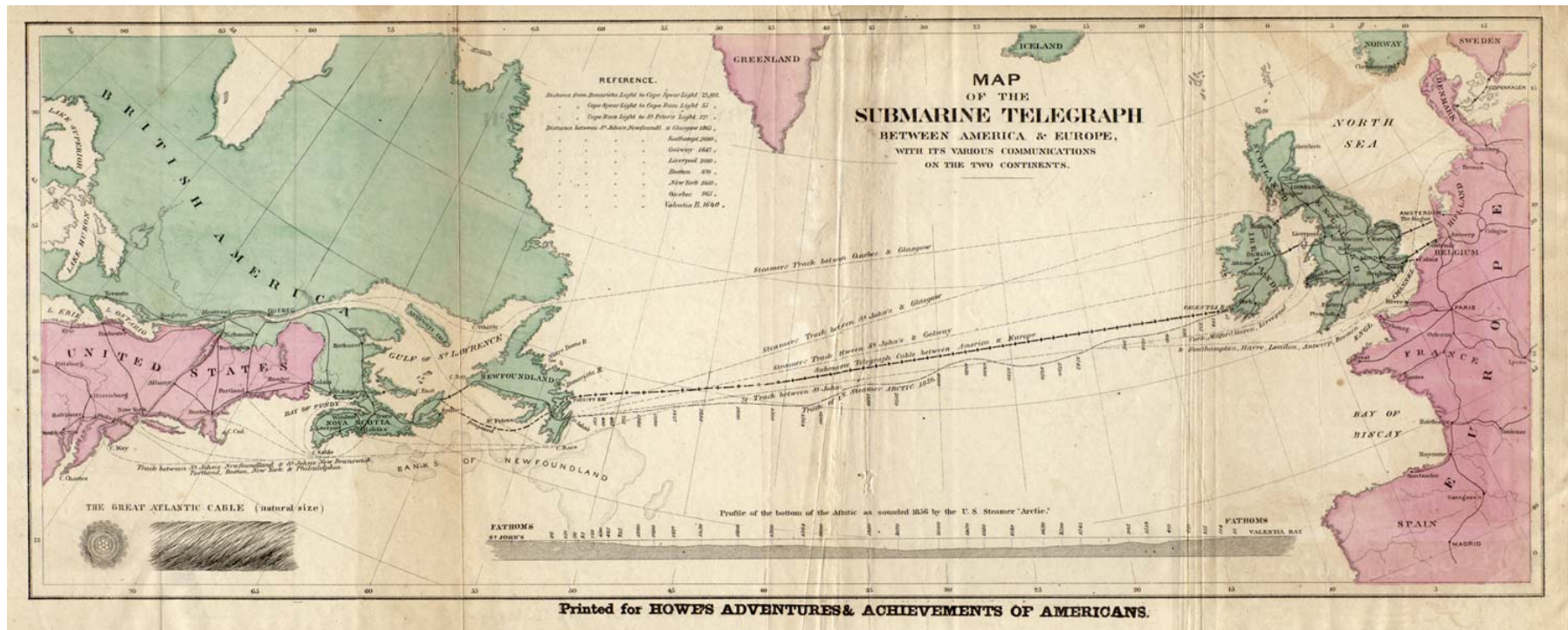- How does it work?

Data communication

After torches and smoke signals, the optical telegraph was invented in the 18th century.

Data communication

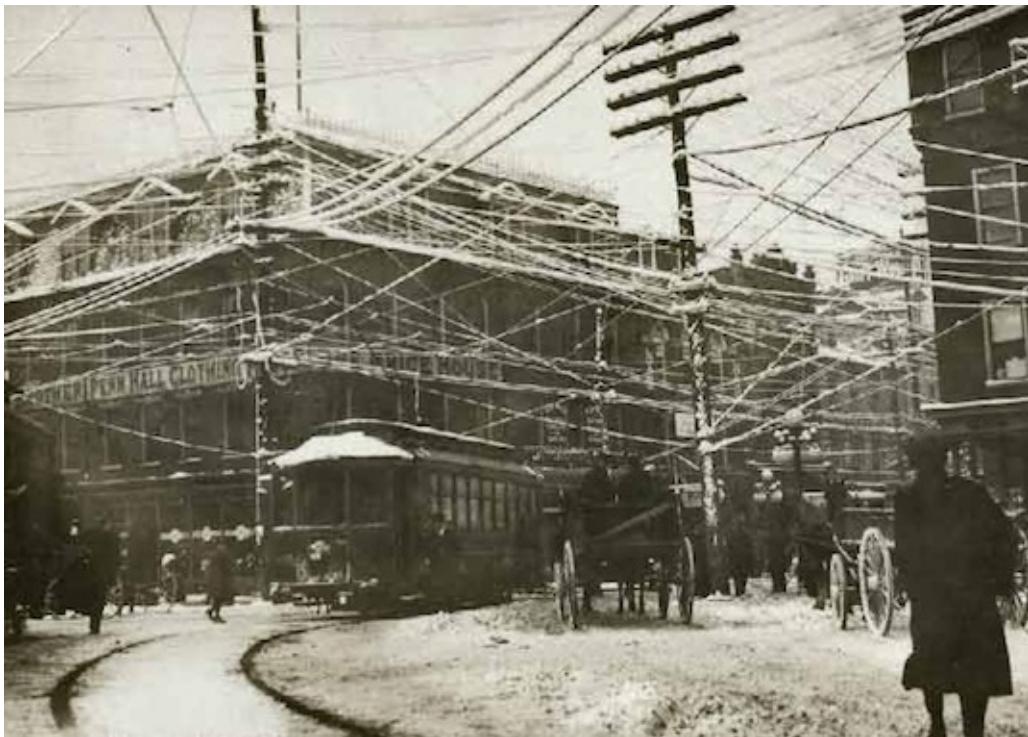Optical telegraphs evolved into electrical telegraphs, which quickly increased the available data communication speed and distance.

Telephone networks

The need for telephone networks became obvious in late 1800s

New York 1887

Basics of circuit switching

One link, n channels

Path
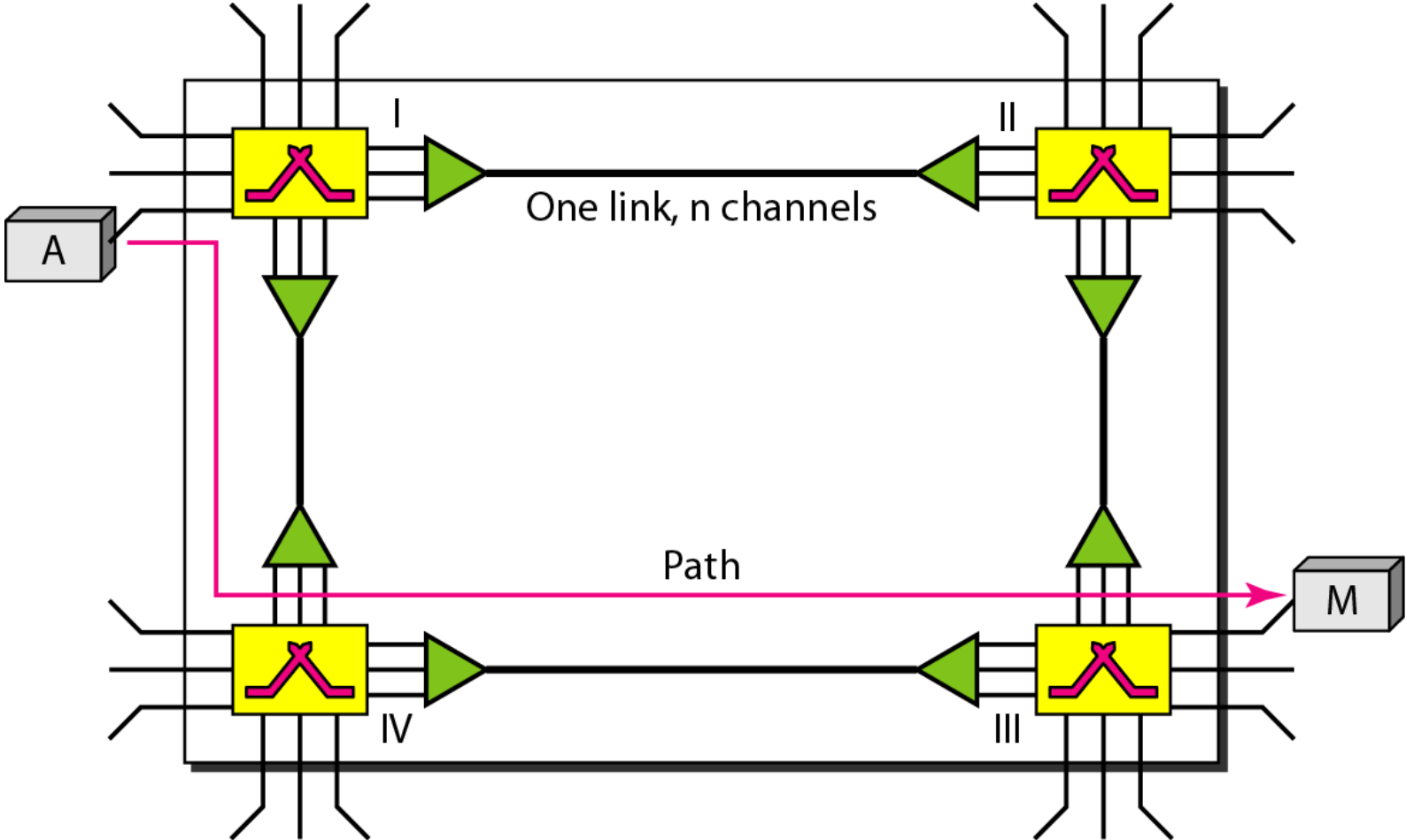
Telephone networks
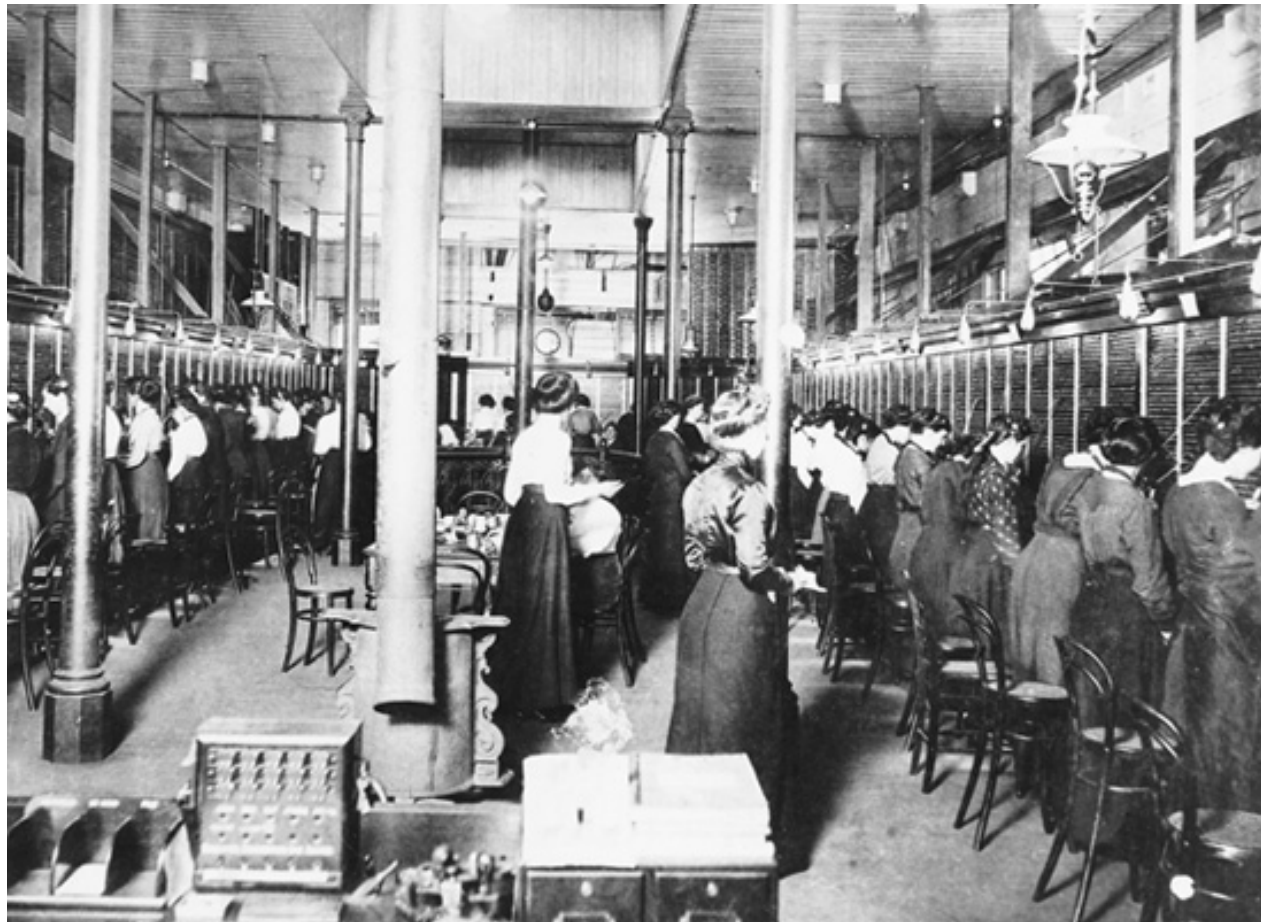
- Late 1940: 350 000 operators at AT&T, 98% women

Basics of packet switching
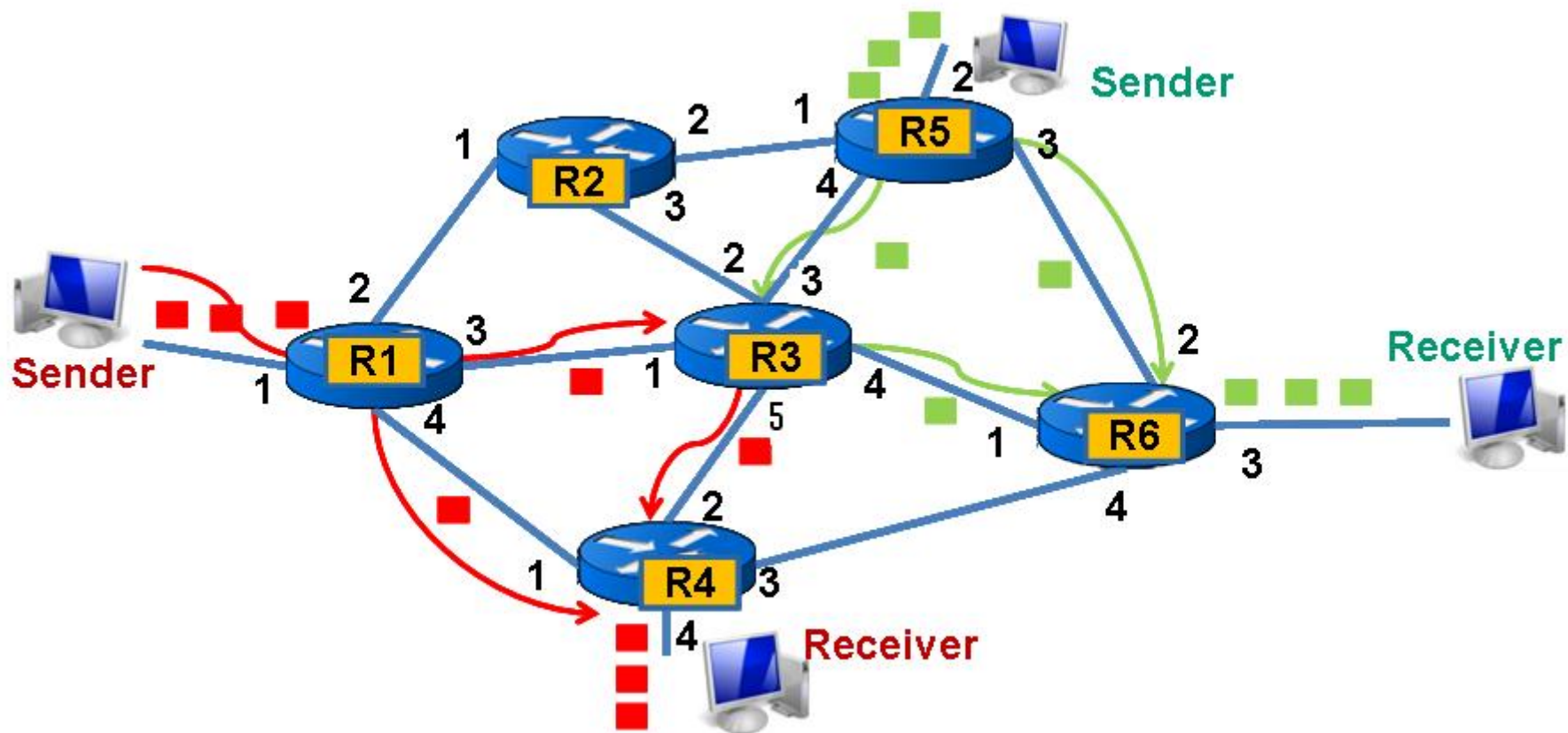
Internet start

- 1969 ARPANET
  - Advanced Research Projects Agency Network
  - First packet switched network
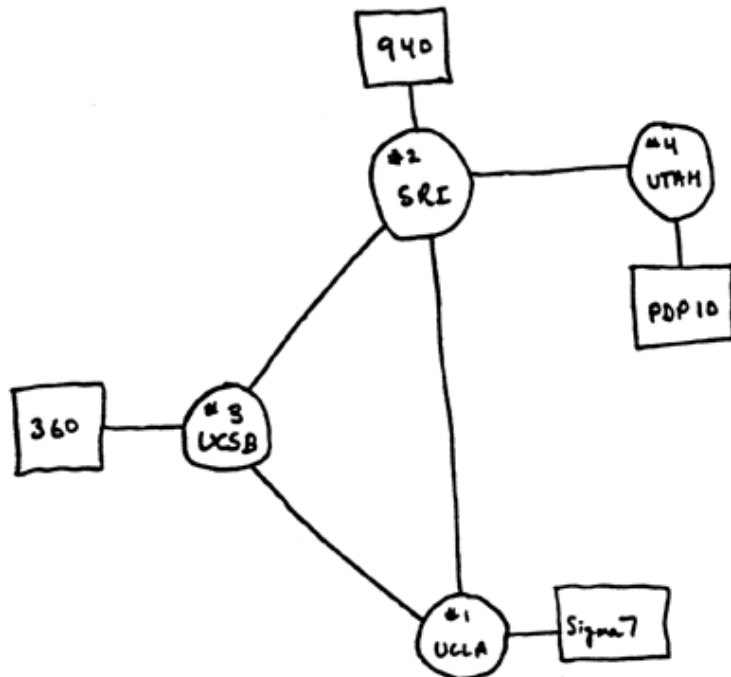
- UCLA
  - University of California, Los Angeles
- SRI
  - Stanford Research Institute
- UCSB
  - University of California, Santa Barbara
- UTAH
  - University of Utah

Internet growth

ARPANET LOGICAL MAP, MARCH 1977
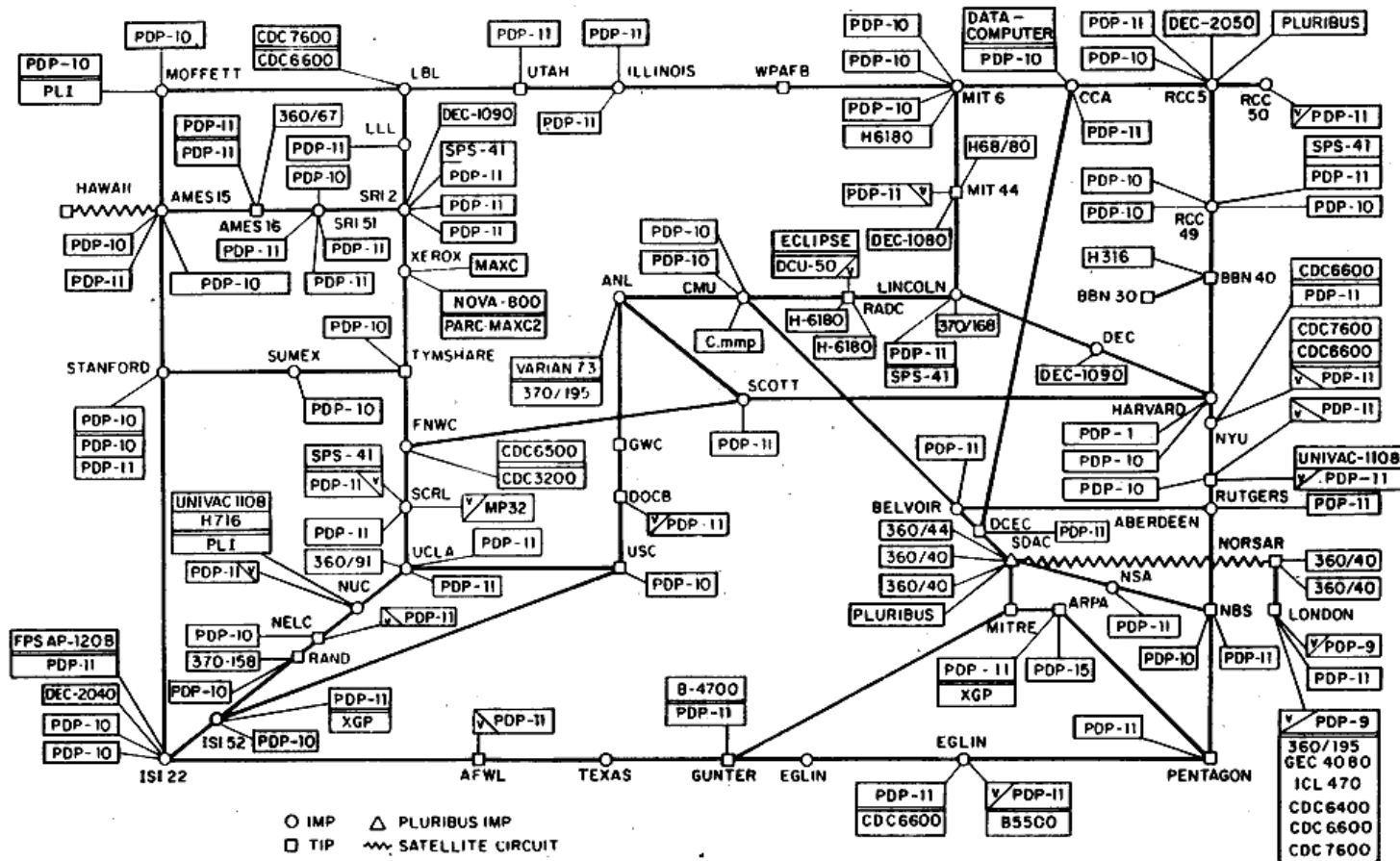
(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

14
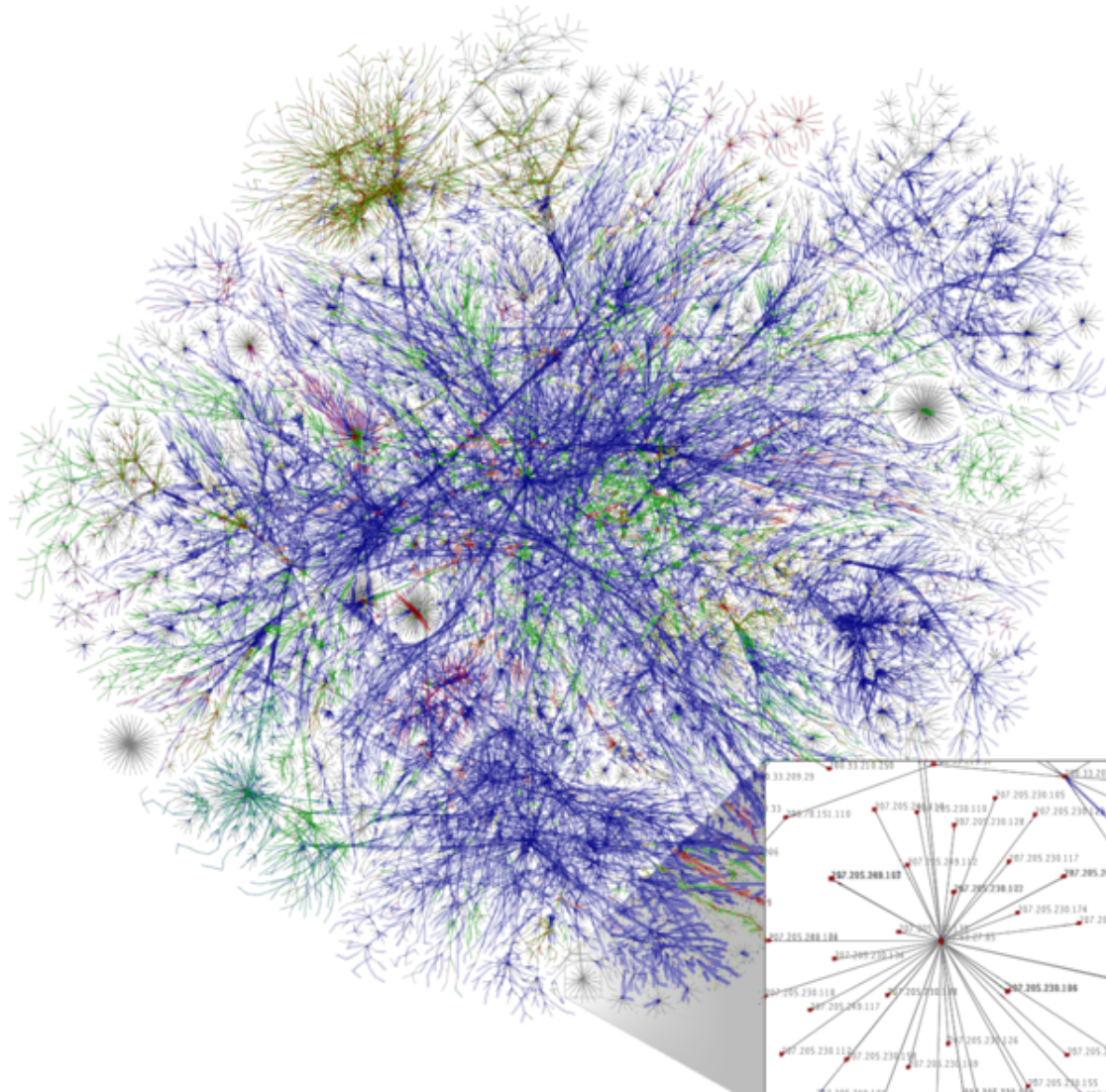
Internet growth

- Map of Internet 2003
- Color coding according to continents

Internet growth

- Connection density

Internet Map
Connection Density

ChrisHarrison.net
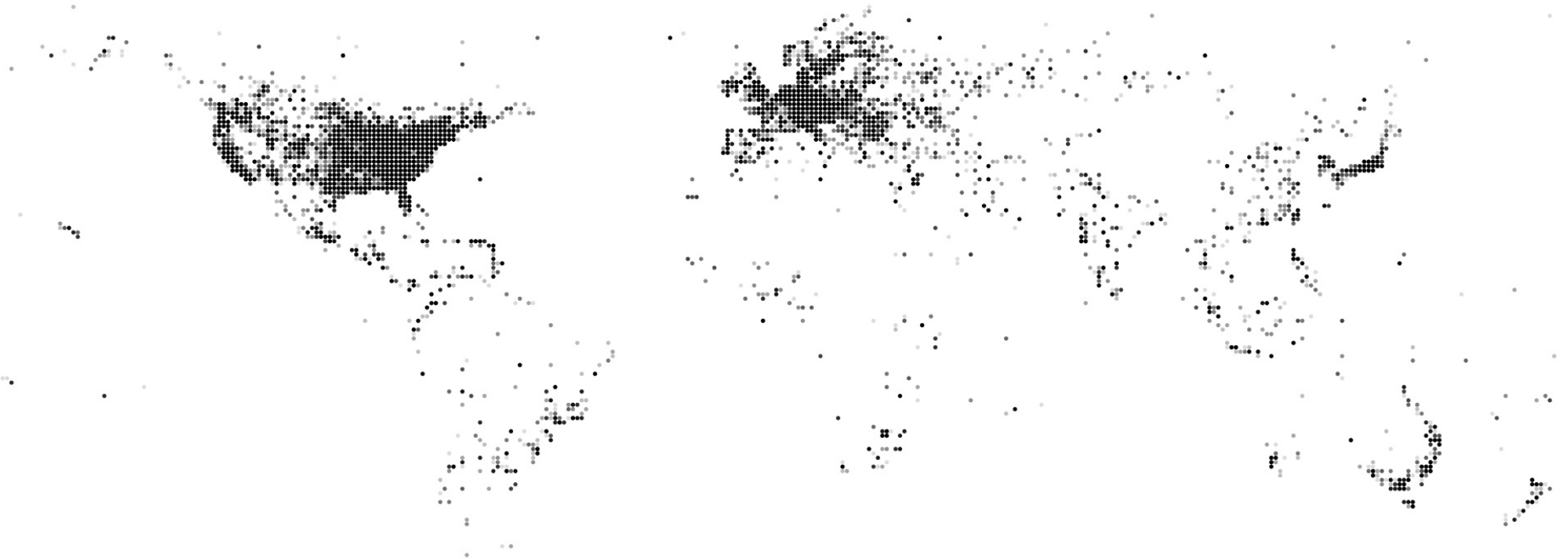
Nielsen's law

The end-user connectivity grows with 50% every year.
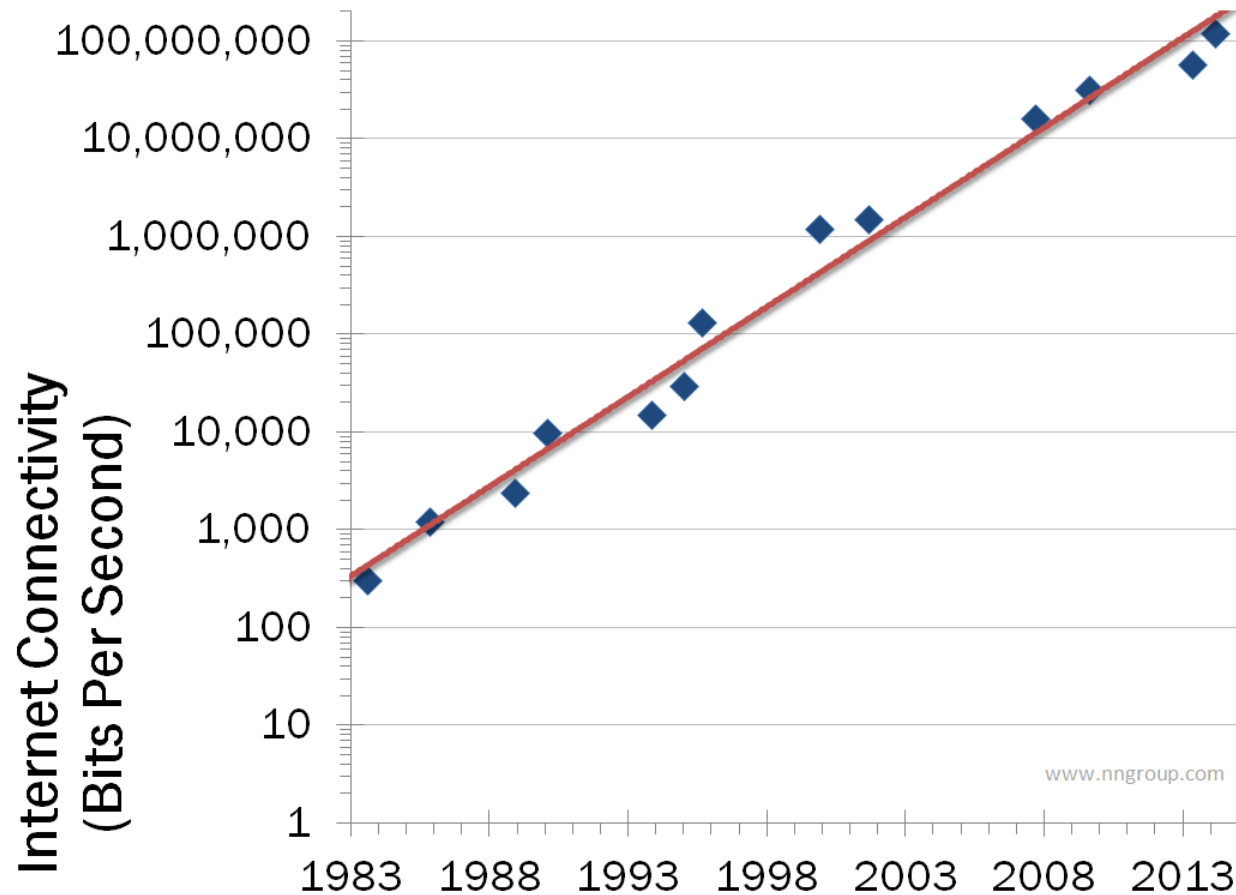
In the beginning

- 1978: First spam (by Gary Thuerk)

- 1982: Scott Fahlman introduces :-) and :-(

- 1985: lth.se registrerades

- 1988: Internet worm
  (by Robert Tappan Morris)

- 1990: Internet service provider
  (world.std.com)

The Morris Internet Worm source code

This disk contains the complete source code of the Morris Internet worm program. This tiny, 99-line program brought large pieces of the Internet to a standstill on November 2nd, 1988.

The worm was the first of many intrusive programs that use the Internet to spread.

The Computer History Museum

Boston Museum of Science.
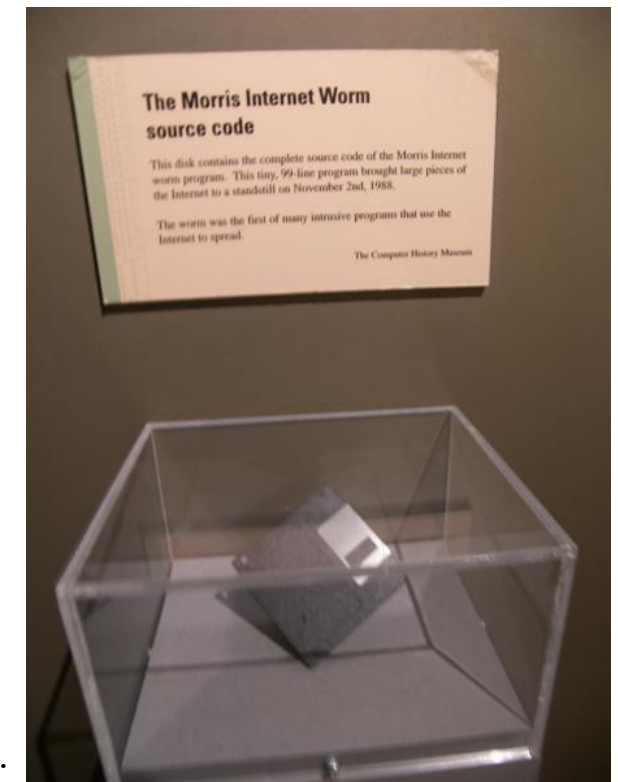
World wide web (www)

- 1990: Tim Berners-Lee developed
  - HTTP (Hypertext Transfer Protocol)
  - HTML (Hypertext Markup Language)
- 1991 he wrote a first web browser
- 1991 www goes public
- 1990: http://info.cern.ch/
- 1991: The Trojan Coffee room pot
  - First webcam (real time images)

World wide web (www)

- 1993 NCSA Mosaic (1994 Netscape)
  - 1995 IE
- 1994: Pizza Hut first online webshop
- 1994: Yahoo
- 1995: AltaVista
- 1997: AOL instant messanger
- 1997: Sixdegrees.com (first modern social network)
- 1997: Google.com
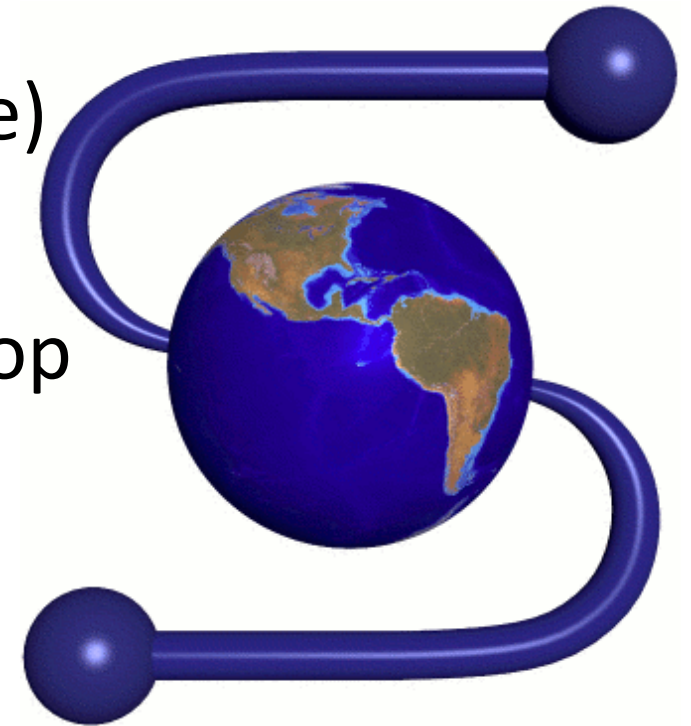
And then came the explosion…

- 1999: Blogger
- 2001: BitTorrent
- 2001: Wikipedia
- 2003: Skype
- 2003: WordPress
- 2004: Gmail
- 2004: Flickr
- 2005: YouTube
- 2005: Facebook

- 2006: Twitter
- 2008: Spotify
- 2009: Google Docs
- 2009: Angry Bird
- 2010 Instagram
- 2011 Hashtag (on Instagram)
- 2012 Google drive
- …

- 1998: ADSL standard
- 2001: UMTS service (3G)
- 2005: VDSL2 standard
- 2007: iPhone
- 2007: Android
- 2007: Amazone Kindle
- 2009: First LTE service (4G)
- 2010: iPad / tablet

Objectives of the course

- Understanding of data communication networks

- Logical levels of communication

  - Physical

    - How can data be transmitted?

  - Network

    - How does a packet find its way through the internet?

  - Application

    - How can we use it?

    - Is my data safe?

Course content

- 11 lectures

- 5 exercises

- 3 laboratory sessions

- Two hand in problem

- Home exam

- Home page: http://www.eit.lth.se/course/eitf25

Schedule of lectures (E:2311)

L	Date	Topic
1	3/11 13-15	Introduction, OSI, digital-analog
2	7/11 10-12	Physical layer
	10/11 13-15	Cancelled
3	14/11 10-12	Physical layer, Data link
4	17/11 13-15	Data Link
5	21/11 10-12	Layer 3, IP
6	24/11 13-15	Layer 4, TCP, UDP, etc
7	28/11 10-12	Routing
8	1/12 13-15	Application layers
9	5/12 10-12	Application layers / Reserve
10	8/12 13-15	Network security
11	12/12 10-12	Search engines

Laboratory exercises

Calender week	Topic
49	PPP
50	Networking
51	WWW

- Three groups per week
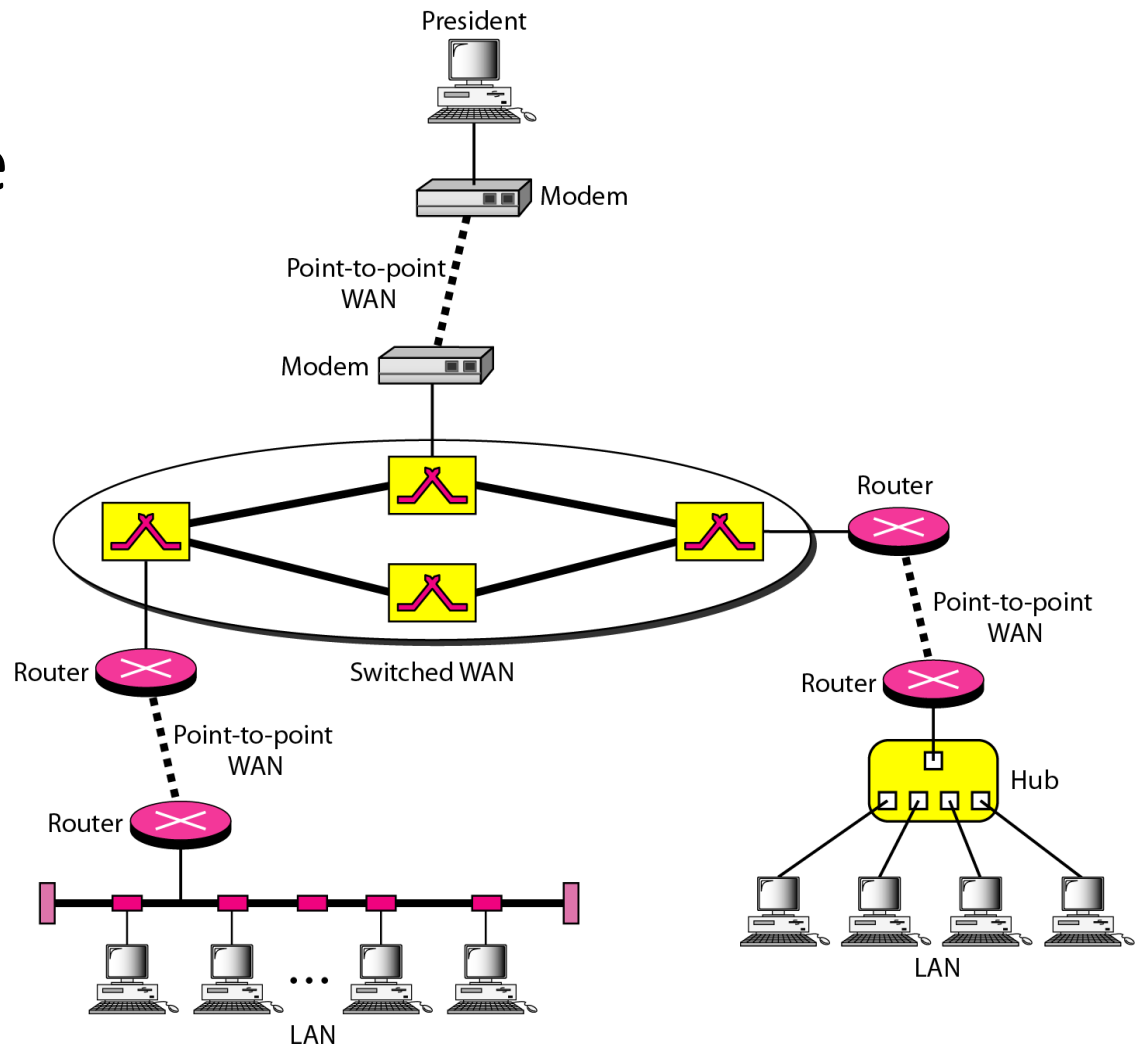- Sign up for groups on the web page
- Prepare before

Course material

- Two alternative books sold by KFS
  - Data and Computer Communications (10th Ed), William Stallings
  - Internet, M. Kihl and J. A. Andersson
- Slides published on web page
- Lab manuals
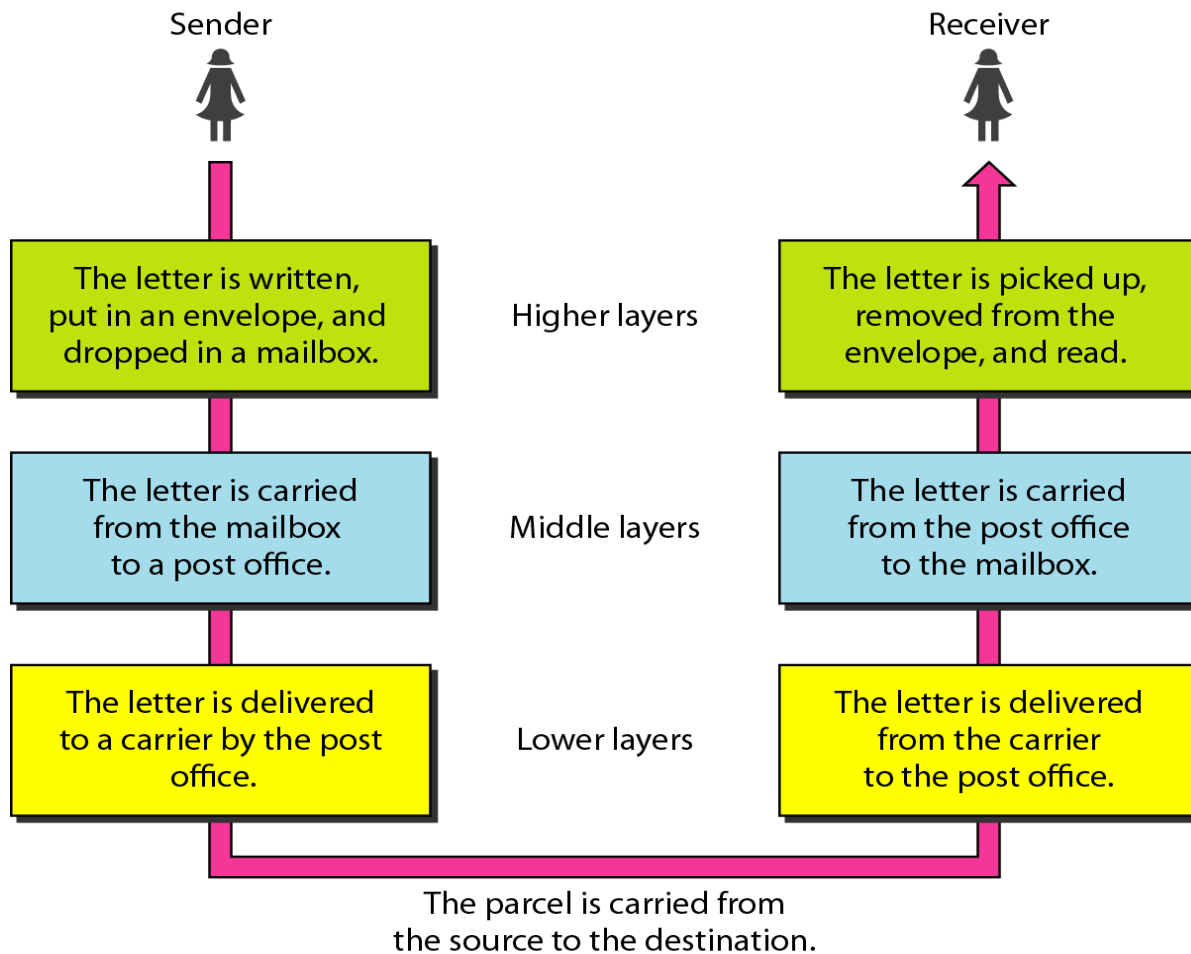- Exercises

How can Internet work?

- High performance
  - Reliability
  - Throughput
  - Speed
  - Security

Network models

- Why do we need models?
  - Too complicated
  - Divide and conquer
- Layered architecture
  - Hierarchy
  - Specialisation
  - Simplification
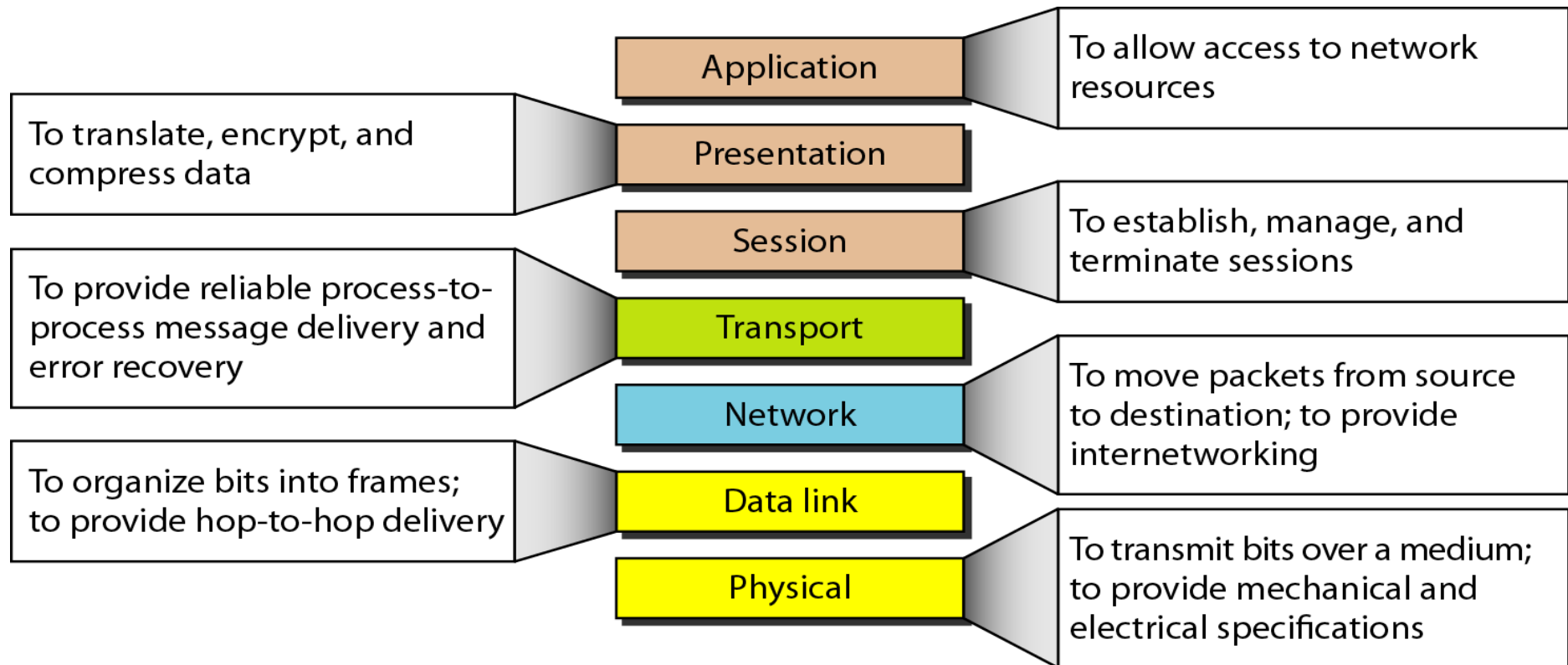
Layer concept in the old world

Sender

Receiver

Addressing/ transport

| The letter is written, put in an envelope, and dropped in a mailbox. | Higher layers | The letter is picked up, removed from the envelope, and read. |

- Person

| The letter is carried from the mailbox to a post office. | Middle layers | The letter is carried from the post office to the mailbox. |

- Mailbox

| The letter is delivered to a carrier by the post office. | Lower layers | The letter is delivered from the carrier to the post office. |

- Post office

The parcel is carried from the source to the destination.
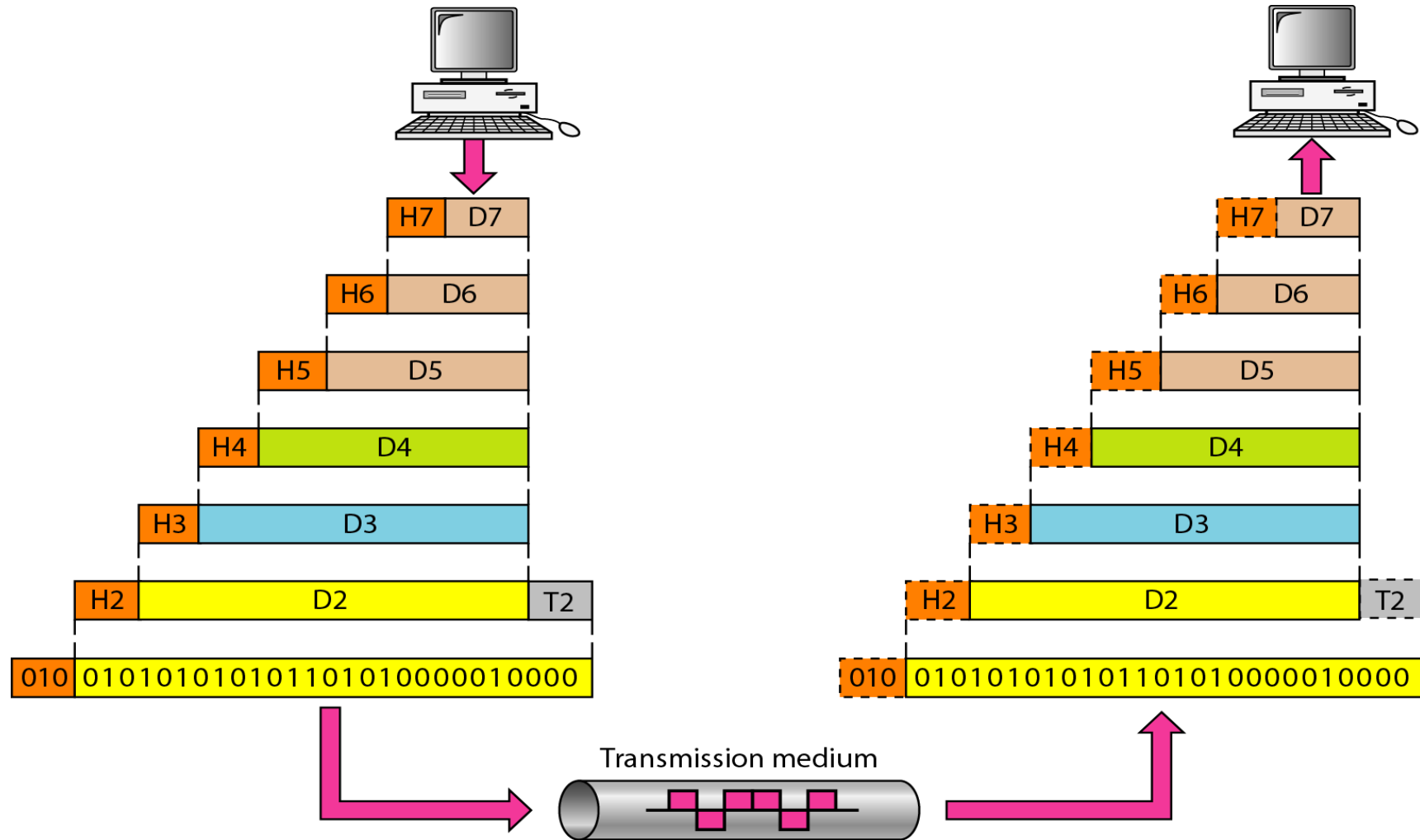
- Lorry

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OSI model
Open Systems Interconnection

- Developed by ISO, 1970~

Encapsulation

TCP/IP model

- Developed by DARPA, 1970~

Application	Applications						
Presentation	SMTP	FTP	HTTP	DNS	SNMP	TELNET	•••
Session							

Transport	SCTP	TCP	UDP

Network (internet)	ICMP IGMP IP RARP ARP

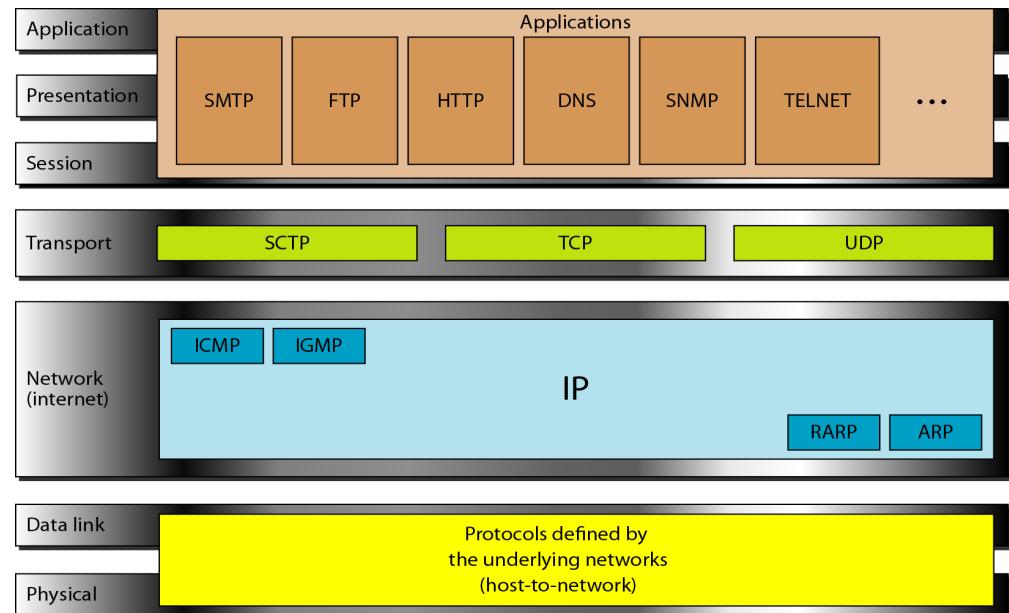| Data link	Protocols defined by the underlying networks (host-to-network)
Physical	
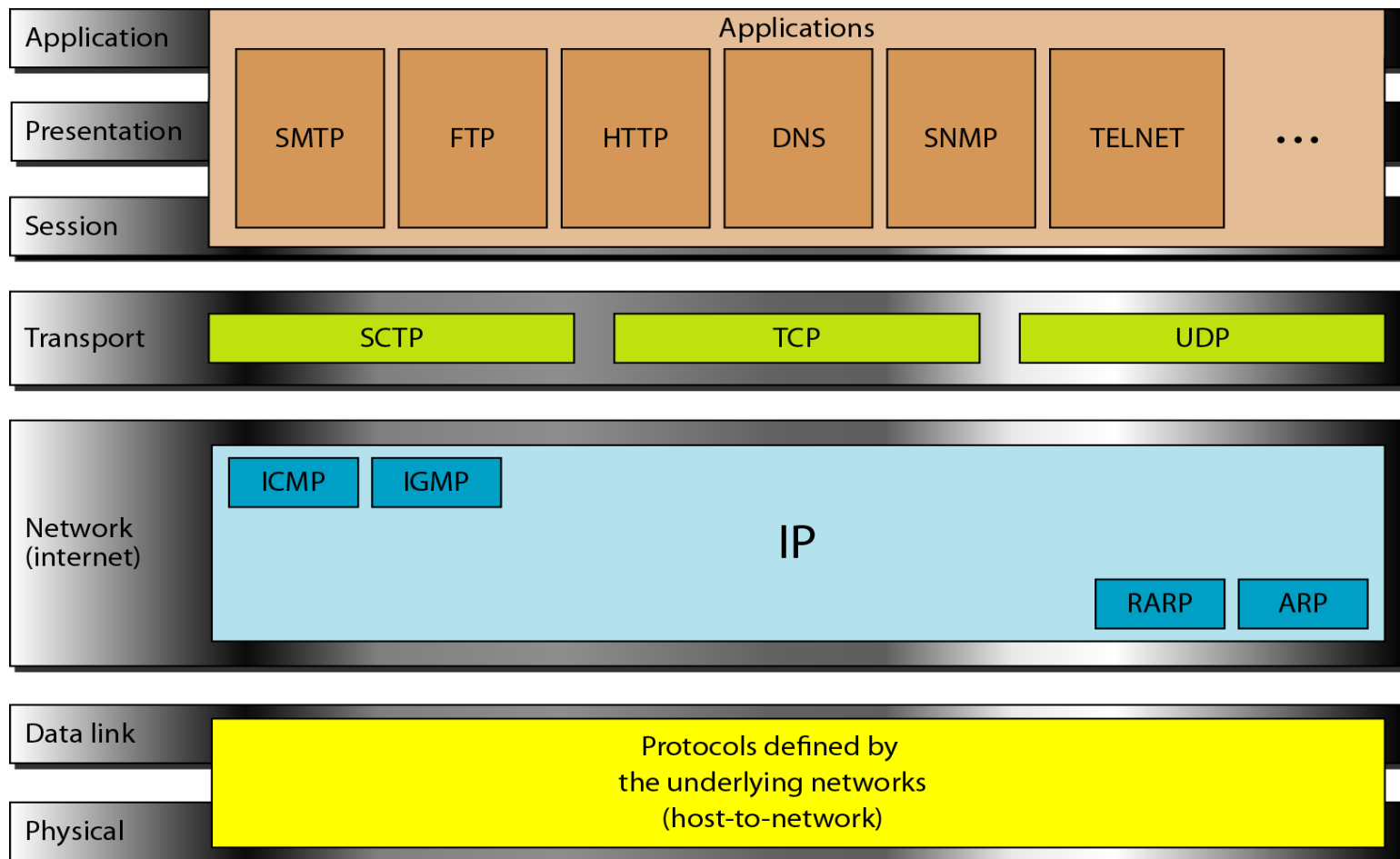
Addressing in TCP/IP
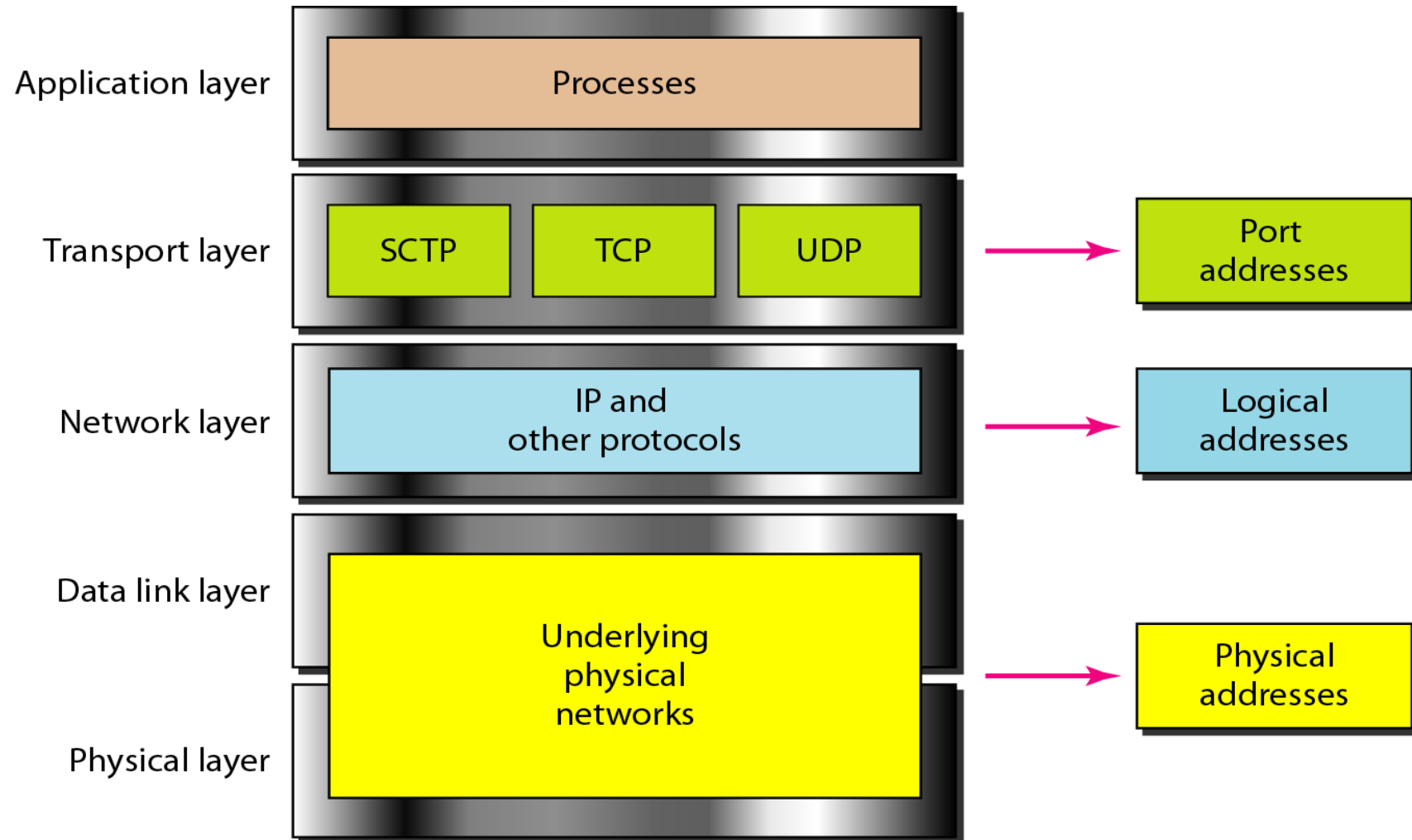
A bottom-up approach

- **Principles of digital communications**

  - **From electrical signals to bits to packets**

- Using the physical infrastructure

  - Network access

- Finding the way

  - Addressing, routing

- User interfaces

  - Applications

Physical layer

- Analog vs digital signals
  - Sampling, quantisation
- Modulation
  - Represent digital data in a continuous world
- Disturbances
  - Noise and distortion
- Transmission media
  - Cables and such

Data vs Signal

- Data: Static representation of information

  - For storage (often digital)

- Signal: Dynamic representation of information

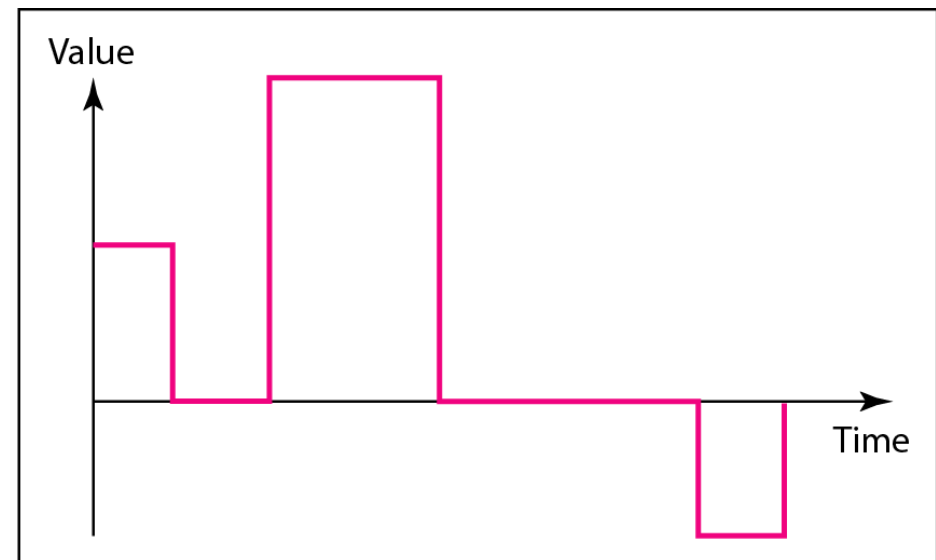 - For transmission (often analog)
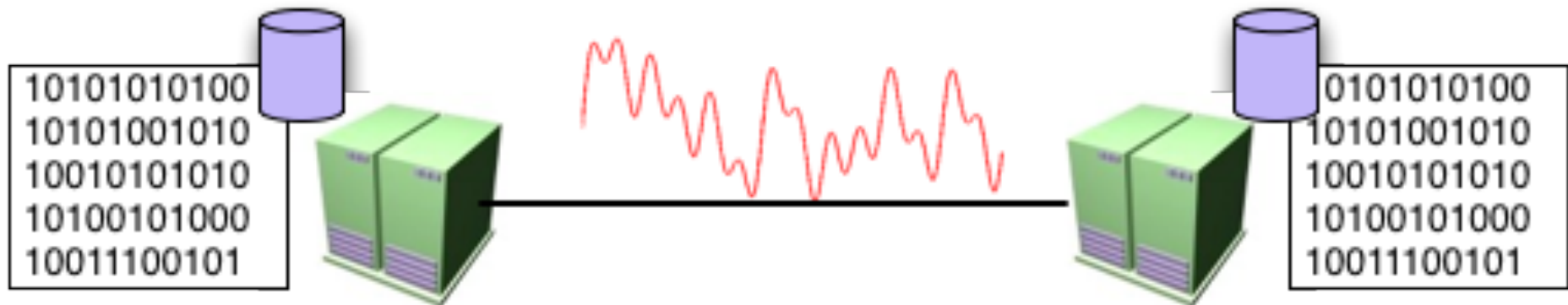
Analog vs digital

Analog

- Continuous time and amplitude signal

- Electrical/optical domain

Digital

- Discrete time and amplitude

- Binary representation

a. Analog signal

b. Digital signal

Digitalization of analog signals

Performed in three steps:

1. Sampling
    Discretization in time

2. Quantization
    Discretization in amplitude

3. Encoding
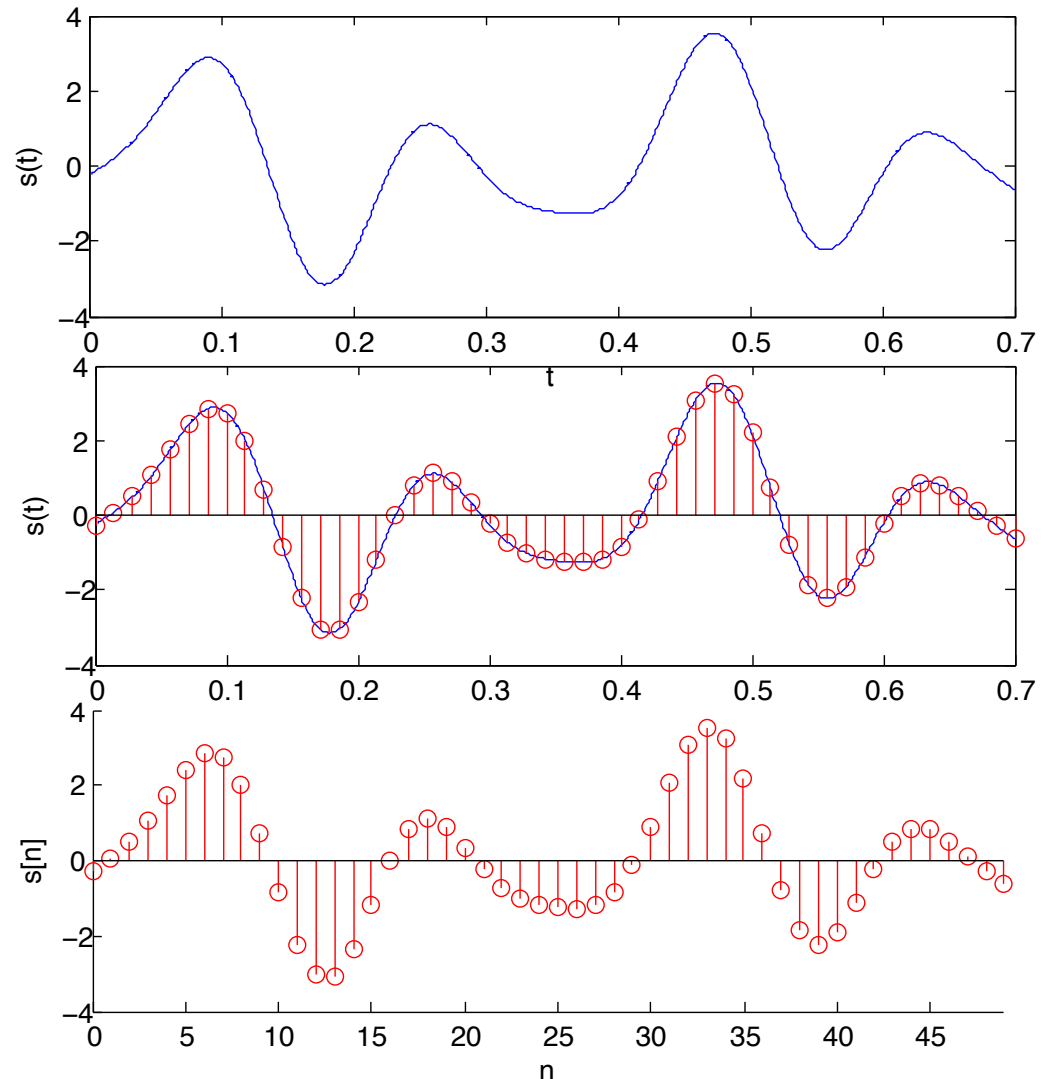   Binary representation of amplitude levels

Sampling

- The process of discretizing time of a continuous signal.

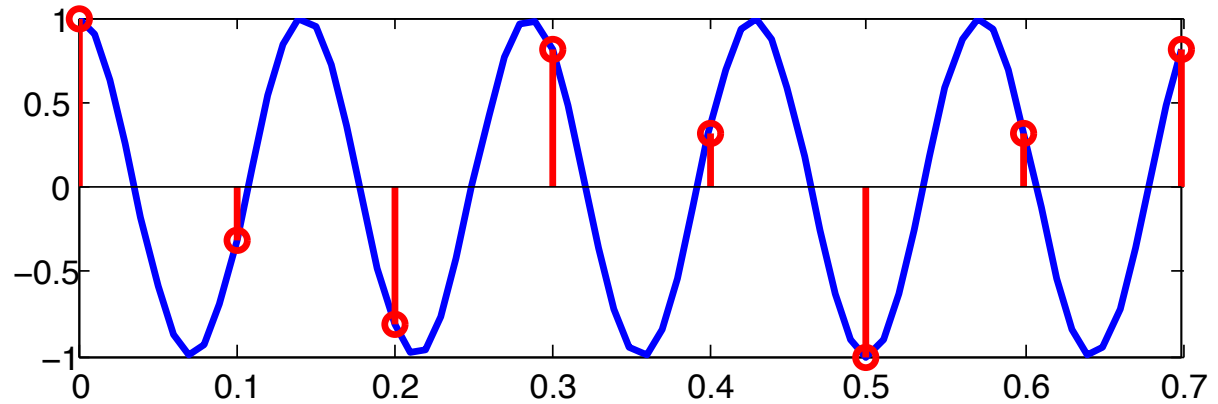$$s[n] = s(nT_s)$$

- Sampling time: T_s
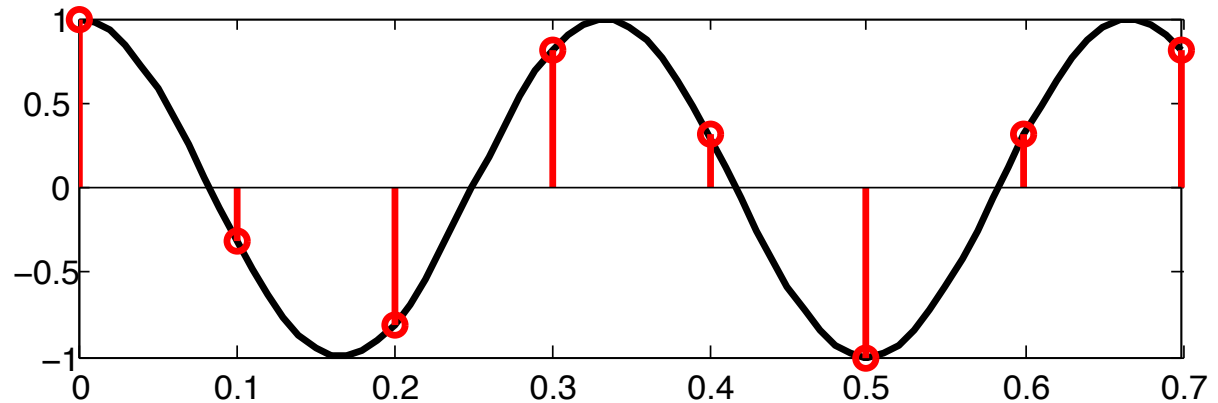- Sampling frequnecy:

$$F_s = 1/T_s$$

- Loose iformation about time

Aliasing

y(t)=cos(14πt)

Reconstruction to lowest possible frequency

y(t)=cos(6πt)

Shannon-Nyquist Sampling Theorem

If *s(t)* is a band limited signal with highest frequency component F_{max}, then *s(t)* is uniquely determined by the samples *s[n] = s(nT)* if and only if

$$F_s = \frac{1}{T} \geq 2F_{max}$$

The signal can be reconstructed with

$$s(t) = \sum_{n=-\infty}^{\infty} s[n] \sin c \left(\frac{t - nT_s}{T_s} \right)$$

$F_s/2$ is the Nyquist frequency and $2F_{max}$ the Nyquist rate