

Protocol, vad är det?

Human protocols

I have a question
What's the time?
Handshaking and
instructions

Network protocols

Machines rather than humans.
All communications activity
in Internet...

Network edge

Hosts: clients and servers
Runs applications
Client/Ser { Clients e.g. browser
Server, often in data center
P2P { Minimal use of dedicated servers.
IP-phone, file sharing

Access networks

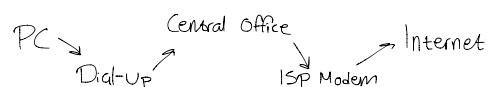
Physical media: wired or wireless
- Residential an
- Institutional an
- Mobile an
Connecting end system with access router (edge router)

Network core

Interconnected routers
Network of networks

Residential Access: Dial-up Modem

Uses existing telephony infrastructure
Home is connected to central office exchange
Up to 56-Kbps dial-up access to router via modem
Dial-Up ISP
Cannot surf while on the phone.



Digital Subscriber Line

ADSL: Asymmetric Digital Subscriber Line
Uses existing phone line by splitting the line's frequency.
Up to 2.5 Mbps UP
Up to 24 Mbps down
Point to point connection

VDSL: Very high speed DSL (13-55 Mbps, <1500 m)
Downstream often 10x faster

Residential Access: TV cable modem

Frequency division multiplexing: Different TV-channels transmitted in different freq. sub-bands

Cable Network Arch

CATV: Cable TV
Assymmetric: 30/2 Mbps
Network of cable, fiber attaches user to ISP router
Homes Share access to network
Unlike DSL cable is Multipoint Connection

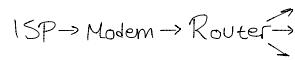
HFC: Hybrid Fiber Coax

Home Network

Wired connection

Wireless connection

One way to ISP, split when entering home by our own router.



Enterprise Access (Ethernet)

Typically in companies, institutions, LAN

10 Mbps → 10 Gbps

End systems typically connected to Ethernet switches

Wireless

WLAN: Within building

802.11x where x = b, g, a, n

Wide area wireless access

Provided by telecom operator

1-10 Mbps over cell

3G, 3GPP LTE, 4G, LTE Advanced

3rd Gen Partnership Project....

Physical Media

- ~ Bit (or block of bits) converted to electromagnetic signal that propagates between transmitter/receiver pairs.
- ~ Physical link: Intermediate medium between trans & rec
 - Guided Media: Copper, fiber, coax, signals propagate in solid media.
 - Un guided media: e.g. radio frequency, signals propagate freely.

Cables

Twisted Pair: TP

two insulated copper wires

CAT 5: 100 Mbps, 1 Gbps Ethernet

CAT 6A: 10 Gbps Ethernet

Coaxial

Two concentric copper conductors.

Bi-directional

Baseband: Single channel

Legacy Ethernet

Broadband: Multiple channels

HFC

Fiber

Glass fiber w/ light

High-speed operation 10s-100s Gbps

Unidirectional

Low error rate: Repeaters spaced apart

Immune to electromagnetic noise

Radio link

Signal carried in electromagnetic spectrum.
No Physical wire
Bi-directional
Propagation environment effects:
Reflection
Obstruction by objects
Interference

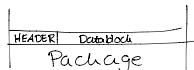
Types

Terrestrial microwave (45 Mbps)
WLAN (11 Mbps +)
WAN (3G ~few Mbps)
Satellite (Kbps to 45 Mbps, 270 msec delay)

The network core

Mesh of interconnected intermediate systems (IS).

Packet switching: Blocks of data sent through network in discrete packages.



Circuit switching: Dedicated circuit per call: Telephone network.

