Introduction

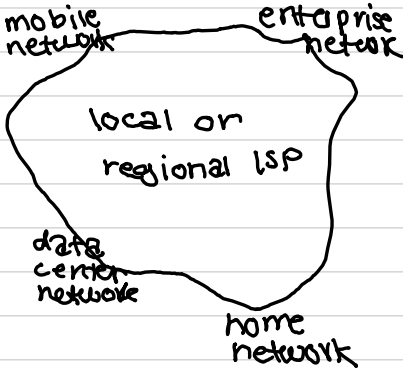
From a users perspective we see through a lens. Siri, alexa ect get information for us, but what happens? Between our phones and Netflix is the internet. But how do we access all this. Thats through search engines. There must be at least two parties (last-Mile)

Internet has billions of connected devices:
- hosts: end systems
- running network apps at internets "edge".

Packet switches: forward packets (chunks of data)
- routers, switches

These are the nodes.

Communication links:
- fiber, copper, radio, satellite
- transmission rate: bandwidth



Network: collections of devices, routes, links managed by organisations

Internet is "networks of networks"
protocols are everywhere
- control sending, receiving of messages
- make sure everyone are following the same rules
- e.g., HTTP (web), streaming video, skype, TCP, IP, wifi, 4G, Ethernet

LÆRINGSBYTTE

- Understand how information and data are moved/shared over a network
- Know and understand network structure, Internet protocols and relevant applications of computer networks
- Understand cloud computing, and networking in the cloud
- Be able to write network applications that communicate over the network

Internet standards:
- RCF: request for comments
- IETF: Internet engineering task force

Infrastructure that provide services to applications:
- web, streaming video, email, ...

provides programming interfaces to distributed applications
"hooks" allowing sending/receiving apps to "connect" to, use internet transport device.

what's a protocol?
Rules for:
- specific messages sent
- specitic actions taken, when message received or other events.

they define format, order of messages sent and received

- Network edge: clients and servers
  servers often in data centers
- Network access, physical media
  wired, wireless

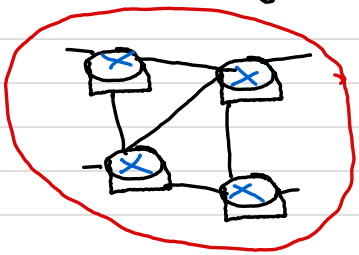
frequency division multiplexind (FDM): different channels transmitted in ...

use exissing telephone line to central office DSLAM

shared wireless access network connects end to router via base station aka "access point".

The network core:
You have national or global ISP and local or regional ISP.
These are mesh of interconnected routers.
Packet-switching: hosts break application-layer messages into **packets**

national or global ISP



Two key network-core functions:
1. **Forwarding**: aka "switching"
2. **Local actioning**: move arriving packets from router's input link to appropriate router output link

Routing: global action

packets transmission delay: takes L/R seconds to transmit (push out) L-bit packet into link at R bps.

queuing occurs when work arrives faster than it can be served.

One-hop numerical example:
- L = 10 Kbits
- R = 100 Mbps
- one-hop transmission delay = 0.1 msec

packet queuing and loss: if arrival rate (in bps) to link...

Frequency divided multiplexing or time divided...?

Packet switching vs circuit switching ← gjør research

excessive congestion possible viktig ord

Les om Internet exchange points (IXP)

How long does it take to send a packet from the sender to the destination

- Four components: transmission delay and propogation delay (depends on the link)
- processing delay and queuing delay (depends on the traffic and switch/router internals)

Transmission delay: how long does it take to push all the bits of a packet into the link. If the packet size is L..

Propogation delay: how long does it take to move one bit from one end one link to the other. Depends on the physical medium of the link (copper, fiber), distance between to links as well.

Bandwidth = Mbps (megabits per second)

Link bandwidth = also called throughput, number of bits sent/ received per unit time (bits/sec or bps)

roundtriptime = how many packets filling the pipe both ways, has to do with buffer.

transmission delay of the packet decreases as the bandwidth increases.

Queuing terminologies:

- A: average rate of packets arrival
- W: average packet waiting time in the queue
- L: avergae number of packets waiting in the queue

Traceroute program: provides delay measurment form source to router along end-end internet path forwards destination. For all i

- Sender sends three packets that will reach routher i on path towards destination (with time-to-live field value of i)
- Router i will return packets to sender
- Sender measures time interval between transmission and rely

1. Introduction:

I formelen for Jains Fairness Index står N for antall brukere eller strømmer som mottar ressurser i nettverket. N representerer totalt antall brukere eller strømmer som konkurrerer om nettverksressursene. Formelen bruker antallet brukere eller strømmer til å normalisere summen av ressursene som er tildelt hver enkelt bruker eller strøm.

I formelen for Jains Fairness Index står xi(t) for den totale mengden ressurser (for eksempel båndbredde eller CPU-tid) som er tildelt til bruker eller strøm i på tidspunktet t. Mer spesifikt representerer xi(t) den tidsvarianter av ressursallokeringen til en enkelt bruker eller strøm. Formelen beregner summen av xi(t) over alle brukere eller strømmer og benytter denne summen til å beregne Jains Fairness Index.

"xi" i Jains rettferdighetsindeks formel refererer til gjennomstrømningen av "ith" tilkobling. Gjennomstrømningen er en måling av mengden data som en kommunikasjonskanal kan overføre per tidsenhet. I denne sammenhengen refererer "ith" tilkobling til en spesifikk kommunikasjonskanal innen et nettverk, og "xi" representerer gjennomstrømningen av denne spesifikke kanalen. Så Jains rettferdighetsindeks beregnes basert på gjennomstrømningen av hver enkelt tilkobling i nettverket.

4 type addressing

① Physical address is the permanent hardware-level address embedded in the network.

most use 48 bit physical address → 12 hexadecimal digit kjent som Link Layer address, LAN address, MAC address.