Föreläsning 9 – del 1
ISDN, ATM, ADSL, Cable TV modems
Distributed applications

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ISDN Motivation

- Convergence of computing & communication
  - same technology used for voice, image, data, … transmission
  - development of Integrated Services Digital Networks
    - world wide network to replace existing telecommunications network
- First generation
  - narrow band ISDN
    - circuit switched based on 64 kb/s channels
- Second generation
  - broadband ISDN
    - packet switched, 100s of Mb/s
- In reality, ISDN is indeed used but normally for internet and telephone access.

Integrated Services Data Network
Overview

- Built on 64kb/s connections
- Variety of configurations
  - more than one ph. conf. possible
  - allows for differences in policies and technologies
- Designed to be a world wide public tele-communication standard
- Sever types of *channels*
- B-channel: 64 kb/s
  - user's basic channel
  - circuit switched, digital data: PCM coded voice, data, call establishment via D-channel
  - packet switched - user's connection to X.25 switch
  - frame mode - connection to frame relay node
  - semi-permanent - fixed pre-established connection

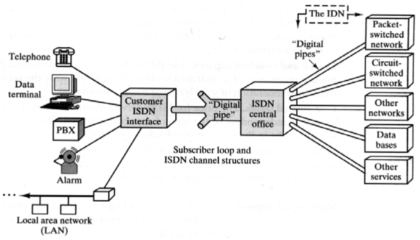
ISDN Channels II

- H-channel
  - 384/1536/1920 kb/s
- D-channel: 16/64 kb/s
  - used for signalling
- Basic service
  - 2B + D
  - 144 kb/s+framing+ synch+overhead
    - 192 kb/s
  - frame structure: 48 bits
    - 16 B1, 16 B2, 4 D, 12 ctrl

ISDN Channels III

- Primary service
  - 30B + D channels
- Examples:
  - Telia Access Duo
    - 2B + D
  - Telia Access Multi
    - 30B + D

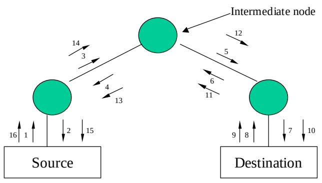
User Interface



Physical Layer

- Coding
  - basic access
    - pseudoternary
  - primary access
    - B8ZS or HDB3
- Full duplex
  - 192 kb/s in both directions
- Access control (multiple terminals)
  - idle terminal sends 1s
    - absence of signal
  - network echoes D-bit
    - all terminals can hear each other
  - to transmit
    - listen for idle channel
    - transmit (while listen to echo)
    - if collision occur, stop and go to listen

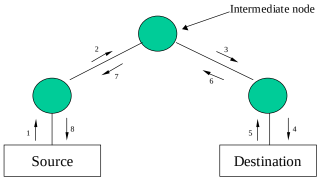
Packet Switching over ISDN



- X.25
  - flow and error control
  - each node
    - need to maintain state information regarding flow/error control
  - justified if high probability for errors

Frame relay in ISDN

- Today
  - high-quality, reliable links
  - optical fibres
    - high data rates
  - overhead of X.25
    - unnecessary
    - degrades utilisation
- Frame relay
  - no hop-to-hop flow or error control
  - much faster



Broadband ISDN

- Goal: digital network
  - to support all types of service and applications
  - independent of capacity requirements and information type
- Requirements
  - high capacity (> 150 Mb/s), efficient use of resources (switches and cables), low delay (< 250 ms), transfer format independent of information type, connection types
    - one-to-one, one-to-many, one-to-all
- Current recommendation: ATM
- However, quite a few ISPs are simply offering the end users IP over ethernet instead and use whatever technique they want in their (the ISPs) networks! It is the same with plain ISDN!

Asynchronous Transfer Mode

- Synchronous TDM (narrow-band ISDN)
  - based on 64 kb/s circuit switched channels
  - low utilisation of communication channels for bursty sources (data comm.)
- Asynchronous TDM
  - higher utilisation if sources are bursty
- ATM
  - based on virtual circuits
  - fixed packet size
  - Two major data rates 155Mbit/s and 622Mbit/s. Others are possible though.

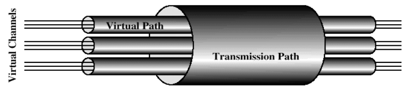
Assumptions

- ATM networks will
  - be built hierarchically
  - be connection oriented
  - be run over optical fibres
  - support low cost terminals
- ATM is used/used to be used for large backbones, I.e., networks connecting towns and cities. However, ethernet and related techniques are much cheaper today according to Utfors who recently built their own backbone in Sweden. Ericsson cancelled ATM AXE switch development? ATM is becoming obsolete in computer networks?

Fixed vs variable packet size

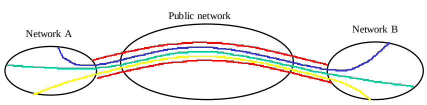
- Variable length
  - no need for padding
    - if short message
  - low over head percentage
    - if large message
  - minimise number of packages
    - minimising total processing needed
    - high throughput
      - no. of packages/second matters (rather than bits/s)
- Fixed length
  - facilitate hardware switches
    - simpler hardware
  - facilitate scalable switches
    - simpler to parallelise
  - finer control over queue behaviour
    - tied up shorter time for output

Addressing



- Virtual Channel (VC):
  - selected channel on a line or VP
  - VCI unique per VP and valid for time used
- Virtual Path (VP):
  - group of channels on a line
  - VPI unique on a line and valid for time used

Example



- Why two levels of addressing (VPI/VCI)?
  - can switch on VP in backbone network
    - faster: use VPI as index into routing table
    - smaller tables: route number of channels in each path
    - small VPI/VCI: may not be unique in network
  - can shorten connection set up time
    - if VP exists, no connection through network needed

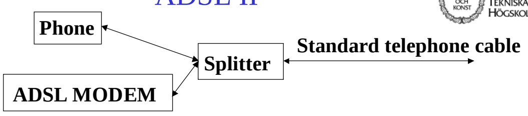
Frame formats

- ATM use multiple frameformats. Each format is used for different types of data.
  - Constant data rate, e.g. PCM (phone calls)
  - Variable data rate
  - Connection oriented data
  - Connection less data, TCP/IP
- ATM do SAR, error detection, traffic and congestion control

ADSL

- Makes it possible to share a standard telephone line between voice(phone) and computer data.
- The twisted pair cables used for telephones has a bandwidth of more than 1 MHz. However, only approximately 4 kHz is used for voice.
- In order to use ADSL you need a modem that gives you an ethernet port. Your ISP has to put a modem at your local telephone switch and connect that modem to the Internet. The modem itself or some other circuit multiplex the cable between phone and modem. (Simple low/high pass filters)

ADSL II

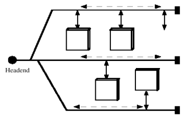


- There are several types of ADSL modems
  - Data rate downstream 512kbit->9Mbit and beyond
  - Data rate upstream 16kbit->640kbit and beyond
    - Note: asymmetric!
- However, ADSL needs good cables, not to long distance to the telephone switch/station (only a few kms), and enough space in the station for a modem. Thus, not all of us can actually get ADSL. Also, it is often better to build ethernet LANs in buildings!

ADSL II

- ADSL is based in FDM
  - One ”channel” for voice, one (upstream) from end user, and one (downstream) to end user
  - Each of the up and downstream channels are divided into several narrow channels
    - Avoid noise and other impairments
    - Some of the narrow channels might work!
  - QAM/QPSK is used, i.e., both phase and amplitude modulation
  - Use different symbols depending on how good each narrow channel is

Cable TV modems



- Idea: Use the coaxial cable that is used for Cable TV for computer communication
- Like ADSL asymmetrical broadband communication
  - End user must use a modem that provides an ethernet port
  - At least two separate frequencies are used (up and down stream).
  - TDM might also be used within these frequency bands.

Cable TV modems II

- Cable TV systems often use high quality cables but the electronics in the systems often need to be replaced
- The data transmision and the TV channels might interfere causing biterrors and lousy TV picture and sound. This can be aggravated by faulty cables used to connect TV sets
- Several different types of modems. QAM/QPSK is commonly used.

Distributed Applications

- Electronic Mail
  - SMTP
    - Simple Mail Transfer Protocol
  - MIME
    - Multipurpose Internet Mail Extensions
- HTTP
  - Hypertext Transfer Protocol
  - Uniform Resource Locators (URL)
  - Universal Resource Identifiers (URI)

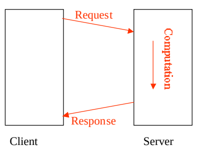
Distributed Applications II

- Distr. Appl. Are often described by RFC's which are documents describing Internet standards.
- FTP
  - File Transfer Protocol, RFC 959
  - Used to transfer (large) files between computers
- NNTP
  - Network News Transport Protocol, RFC 977
  - Used to read news
- Telnet, Rlogin
  - Used to log into (remote) computers, RFC 854 / RFC 1282
- DNS
  - Used to map "names" to IP numbers, RFC 1084

Server/Client Model

Many distributed applications are implemented using the client/server paradigm

- Server
  - program that offers a service (over a network)
  - runs continuously
  - accepts requests on well known address(es) (port(s))
- Client
  - sends requests, awaits response



- Examples
  - Remote login, email, web servers, ...

Electronic Mail (SMTP)

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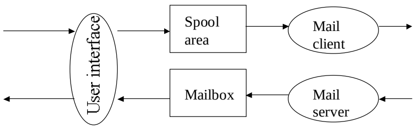
- Used to be most popular application on Internet
- Decouples user from communication facility
  - do not want to wait for mail to reach destination (machine unavailable, communication failures etc)
  - spooling technique



Email Client/Server

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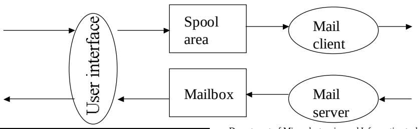
- Client
  - background process
  - maps dest. to IP addr.
  - opens TCP connection
  - removes message from spool area
  - in failure: tries again
- Server
  - accepts TCP connection
  - receives mail
  - deliver to mailbox



Internet Mail Services and Others

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- Internet mail
  - based on TCP
  - opens TCP connection from sender to receiver
  - universal delivery
    - if connected to Internet
  - reliable
    - mail rests at sender until copied to receivers machine
- Mail gateways
  - store and forward
    - c.f. IP datagrams
  - unreliable
    - if gateway crashes
  - introduces delay
    - mail can get stuck at gateway
  - Why mail gateways?
    - to provide Internet email connectivity!

Standard for Electronic Mail (RFC 822)

(Keyword : value)*

Blank line

[User data]

- Message format
  - header
    - To:
    - From:
    - Reply-To
    - …
  - body
    - user text
      - readable text

Simple Mail Transfer Protocol (SMTP)

Protocol between client and server

C: establishes TCP connection to known port (25) at destination
S: 220 it.kth.se Simple Mail Transfer Service Ready
C: HELO sics.se
S: 250 it.kth.se

C: MAIL FROM: <peter@sics.se>
S: 250 OK

C: RCPT TO:<fredrik@it.kth.se>
S: 250 OK

C: RCPT TO <hedvig@it.kth.se>
S: 550 No such user here

Example II

C: DATA
S: 354 Start mail input; end with <CR><LF> . <CR><LF>
C: … sends body of mail message…
C: <CR><LF> . <CR><LF>
S: 250 OK

C: QUIT
S: 221 it.kth.se Service closing transmission channel

- Most applications communicate in similar ways
  - ASCII lines

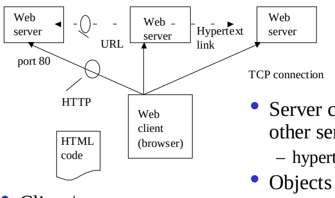
Multipurpose Internet Mail Extensions

- SMTP cannot
  - transfer executable files / binary objects
  - text including national characters
    - å, ä, ö etc
- Some mail servers may reject long emails

MIME

- Extension to RFC 822
- New header fields
  - to provide info about body of message
- Standardised representations
  - to support multimedia emails
- Transfer encodings
  - to prevent mail systems form alter content

HTTP/HTML/URL



- Client/sever communicate via TCP
  - HTTP
- Server can "point" to other servers
  - hypertext links - URL
- Objects communicated
  - HTML documents
  - pictures
  - sound, video, etc…

Hypertext Transfer Protocol

- Simple protocol
  - client opens TCP
  - issue request
  - reads response
    - e.g. HTML document
  - sever closes connection
- Simple to use
  - easy to follow links
    - "click"
- Client
  - provides simplicity
  - parsing and displaying HTML documents
- Server
  - returns object "pointed at"
- Client >>> Server
  - in lines of code

HTTP II

- Requests
  - ASCII lines similar to SMTP
  - GET URI
    - Uniform Resource Identifier
    - returns requested info
  - HEAD URI
    - as GET but no document returned
  - POST
    - to provide info to server
    - email, forms, etc
- Responses
  - success
  - redirection
    - resource has moved
    - document has not been modified, see below
  - client error
  - server error

HTTP III

- Client caching
  - documents may be cached at client
    - store time & date
  - subsequent requests are conditional
    - GET "if modified since"
    - server sends document only if modified

HTTP IV

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- Multiple TCP connections
  - if HTML document contains several URL
  - Netscape opens up to four TCP (as default)
- Performance problems
  - one TCP connection per resource!
    - documents may create many TCP connections
    - sever closes connection
      - TIME-WAIT delay on server
- Extensions in new versions of HTTP (v1.1) makes it possible to use one single TCP connection for several HTTP requests