INF 5210 - Information Infrastructures
2. lecture 29.08.03

Issues :

- Main points in 1. lecture
- The economics of network – network economics
- Standards and standardization processes
- Network Architectures
- Internet in an infrastructure perspective

Background literature:

» Hanseth, Ole: http://www.ifi.uio.no/~oleha/Publications/ib_ISR_3rd_resubm2.html

» Branscomb and Kahin: *Standard Processes..........*

» Gisle Hannemyr: Nettverksarkitektur, 1998. HTML.

» Leiner, Cerf, Clark, Kahn, et al The Past and Future History of the INTERNET, 1997. CACM, v40, ACM Lenke.

Main points from 1. lecture -1
(see full slides)

- **What is an Information Infrastructure (II)**
  - » A substructure or underlying foundation – basic installations &facilities to support various ICT applications
  - » Includes various type of hardware, basic software, also 'general' information, as standards and classification codes; furthermore people and organisation resources that support the infrastructure

- **II are different from Information Systems (IS)**
  - » Serves large communities
  - » Must be available at any time – enduring
  - » The are never build from scratch
  - » No day of birth or death

Main points from 1. Lecture-2

- ## Characteristics of NII

- ## McGarty and others (in designing NII i the US)
  - » Open , shared, enabling, standardized, evolving, sosiotechnincal , heterogeneous,...

- ## Star and Ruhleder
  - » Embeddedness, transparancy, reach or scope, learned as membership of practice, links with conventions of practice, embodyment of practice, build on an installed base, becomes visible upon breakdown

Main points from 1. lecture -2

Different types of infrastructures

- National and global II
  - » Internet, the phone network, GSM, UMTS (?)
- Business (sector) networks
  - » EDI, electronic pation records, flight booking systems(Amanda)..
- Corporate infrastructure
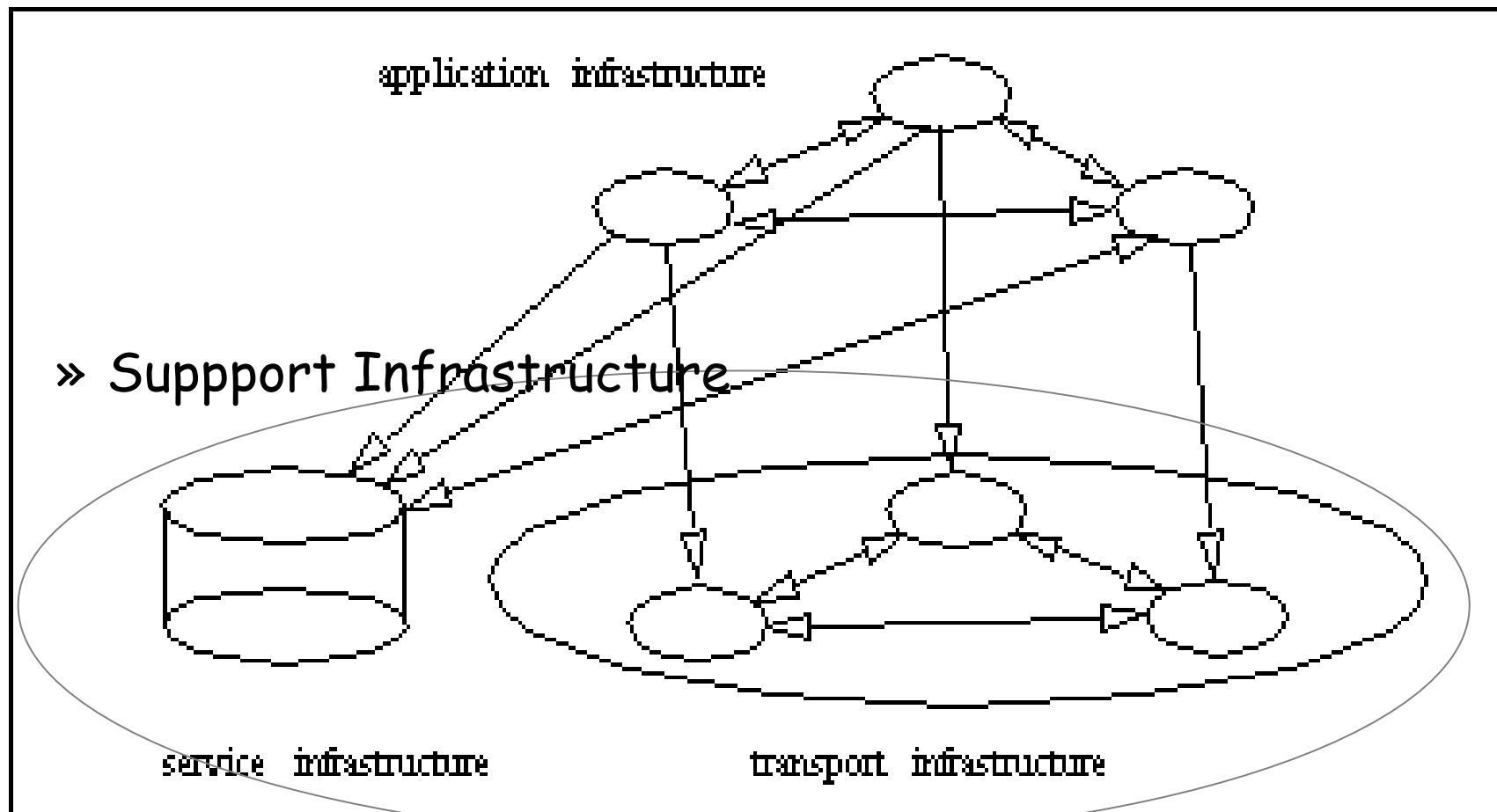 - » *E.g. Enterprise Resource Planning* like, SAP, Oracle, see e.g.

Decomposing heterogeneous infrastructures :

- » Support Infrastructures – that includes transport II (e.g IP/TCP)
- » and services II
- » Applications Infrastructures – that support other applications

These concepts are relative and apply recursively

Decomposing heterogeneous infrastructures

- The structure of infrastructures

» Suppport Infrastructure

application infrastructure

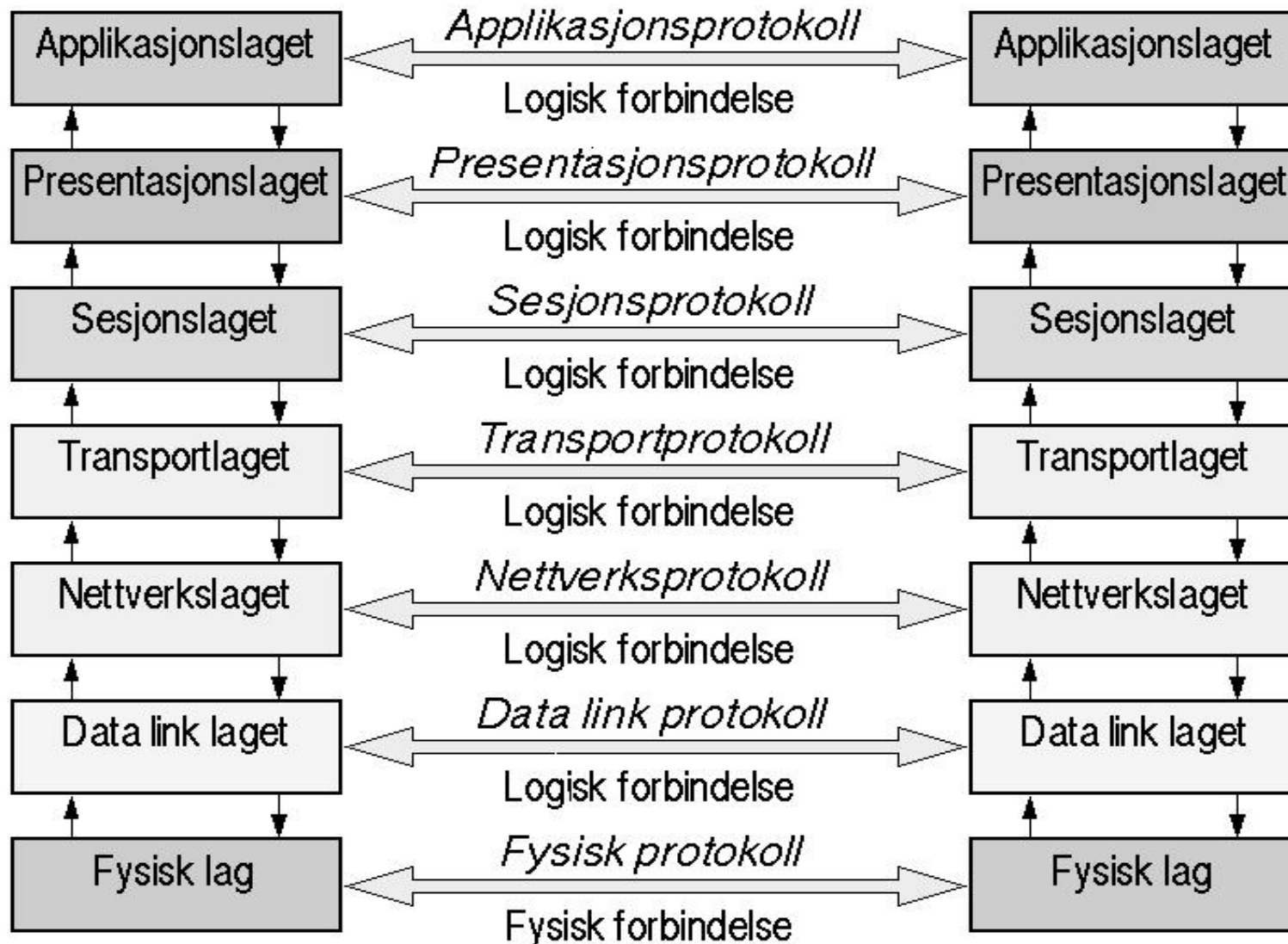service infrastructure

transport infrastructure

Interconnection and Interoperability

- Two networks are *interconnected,* but they may have no or limited *interoperability*

- *Interoperability :* Functions or services are provided across the networks

  » Interoperability can be achieved by using common technical solutions ('standards') or by gateways

- *Compatibility* between (service) layers : they have same level of functionality
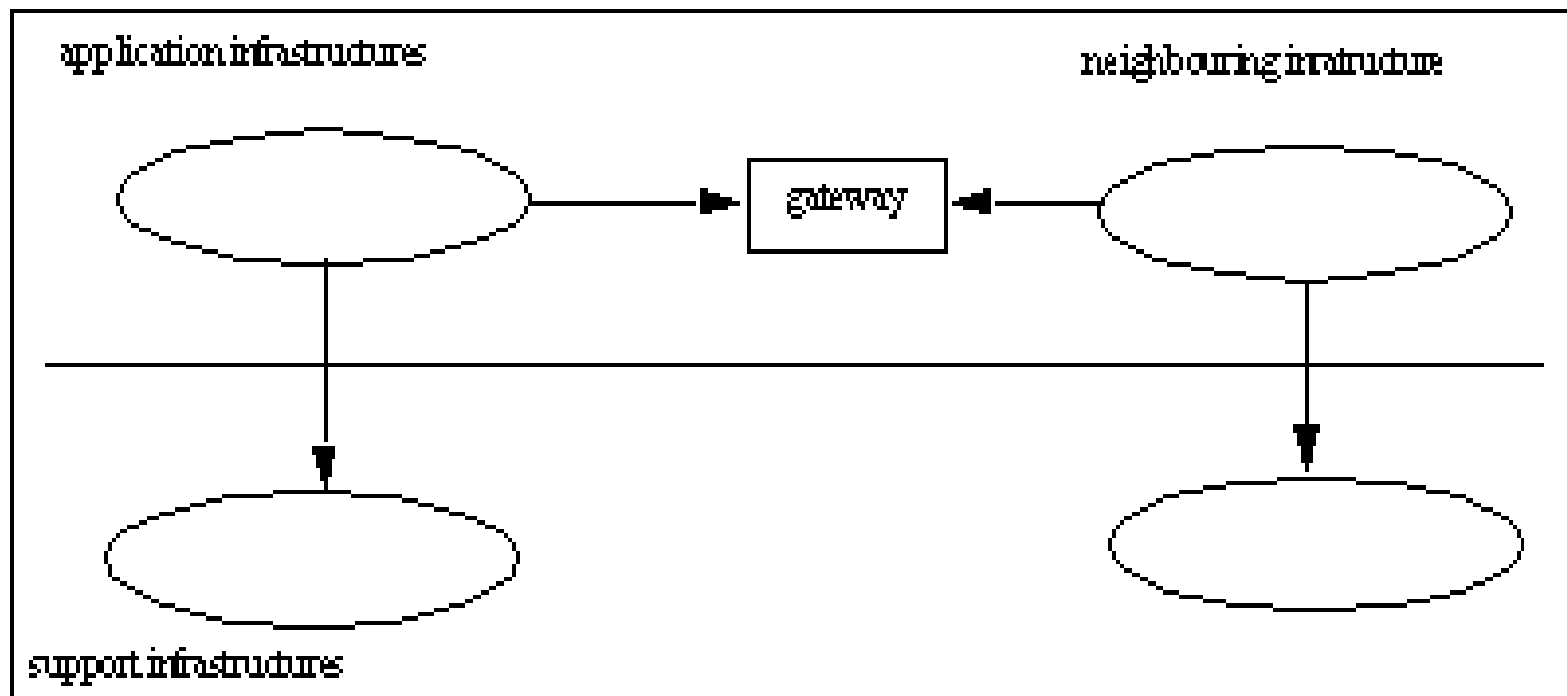
  » (compatible=in agreement, living together in harmony)

Network architecture
The OSI model

Applikasjonslaget	← Applikasjonsprotokoll →	Applikasjonslaget
	Logisk forbindelse	
Presentasjonslaget	← Presentasjonsprotokoll →	Presentasjonslaget
	Logisk forbindelse	
Sesjonslaget	← Sesjonsprotokoll →	Sesjonslaget
	Logisk forbindelse	
Transportlaget	← Transportprotokoll →	Transportlaget
	Logisk forbindelse	
Nettverkslaget	← Nettverksprotokoll →	Nettverkslaget
	Logisk forbindelse	
Data link laget	← Data link protokoll →	Data link laget
	Logisk forbindelse	
Fysisk lag	← Fysisk protokoll →	Fysisk lag
	Fysisk forbindelse	

Decomposing heterogeneous infrastructures

- **Ecologies of infrastructures**
  - » E.g. neighbouring infraastructures that provide same services, using different standards

Open Network Architecture

- Open, well-defined layers, protocols and service interfaces
  - » Each layers has distinct functions and services
- Non-proprietary protocol standards
- Each network can stand on its own, and connect to other networks without internal changes
  - » Different networks are connected through gateways

Comparison of Internet and ISO-protocols

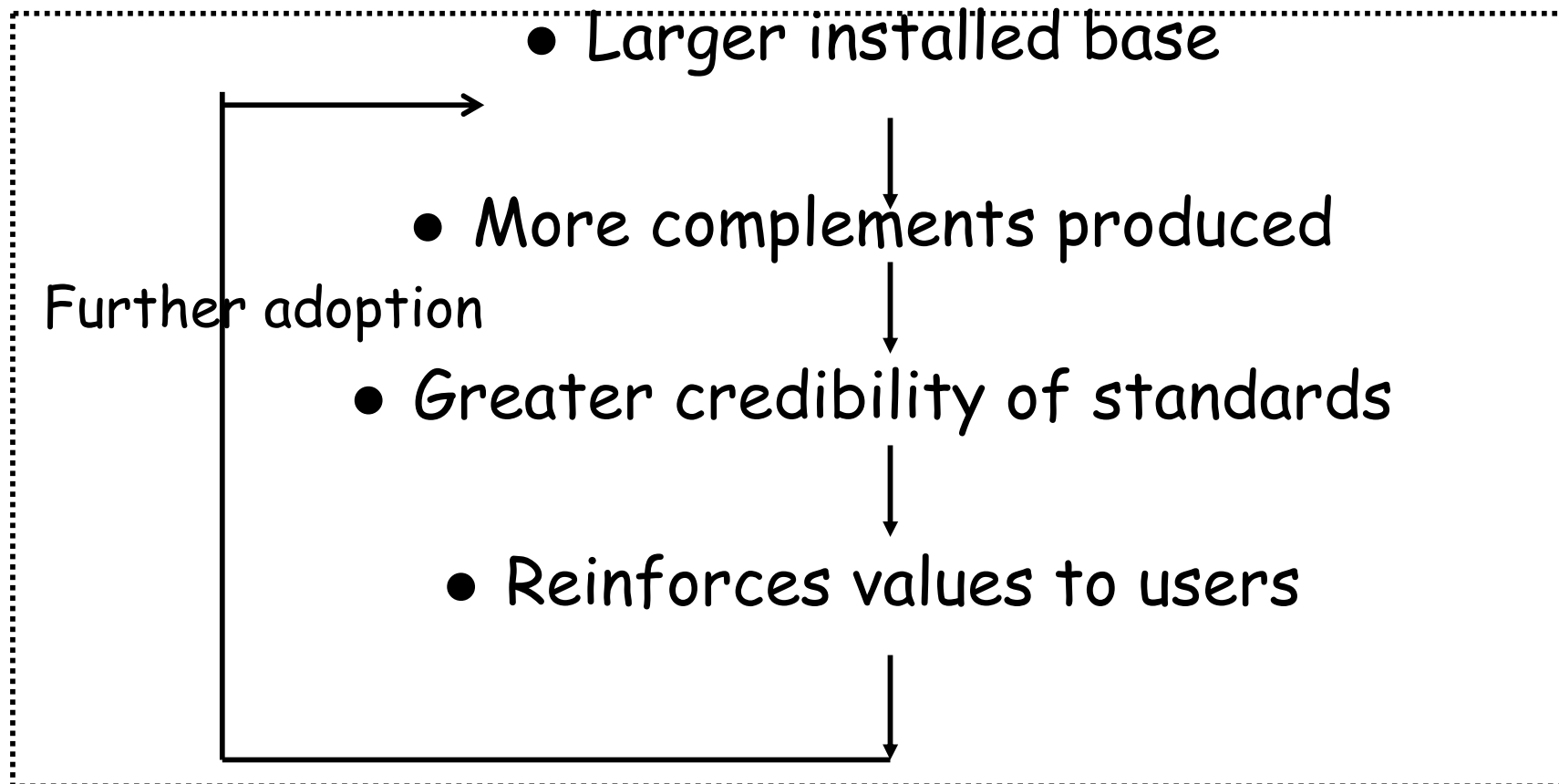| OSI	ISO	Internett	OSI
7	X.400, X.500, FTAM, CMISE, VT, TP	SMTP, NNTP, FTP, telnet, HTTP DNS, talk, ping, finger	7
6	ASN.1		6
5	ISO 8326/7		5
4	TP class 4 (CLTP), TP class 0 (COTP)	TCP UDP	4
3	CLNP, CONS/X.25	IP	3
2	LLC1, HDLC, LAPD	Grensesnitt mot ulike under-liggende netteknologier (faste digitale samband, ISDN, aDSL, Ethernet, etc.)	2
1	CSMA/CD, Token ring, ISDN, etc		1

Installed base

- **Infrastructures are never designed from scratch(?)**
  - » Something always exist
  - » We cannot bypass the history
  - ➔ Can only be modified and extended

- **The installed base includes:**
  - » Nodes in the network; equipment and software, vendors,..
  - » Protocols, standard and standard bodies, documentations, routines,
  - » Operations and support, documentations,
  - » Knowledge and experience, textbooks

- ➔ **The installed base as a heterogeneous actor-network**

Installed base as an actor

● Re-enforcing mechanisms
  – In order to work, it must be aligned with the existing

● Larger installed base

● More complements produced

Further adoption

● Greater credibility of standards

● Reinforces values to users

The economy of networks
or networks economy

- ## The economics of scale
  - » Increasing value by increasing number of users
- ## Positive
  - » E.g.the value of a standard increases by the no. of users
- ## Network externalities
  - » Externalities occurs one one market actor affects other without compensation being paid
  - » Positive and negative externalities
- ## Path-dependencies
  - » Historical 'accident' may play an important role in future developments
- ## Lock-in
  - » One choice may limit future alternatives

Standards and standardization

Standards:

- De jure – international agreement through legal processes
  - » E.g telecom standards, OSI
- De facto : one (set of) standards become the winner
  - » IP/TCP, Unix/Linux,....
- Proprietary standards : forced upon by dominant actors in the marketplace
  - » Microsoft products,...

Standardization approached

- ## Top-down
  - » Requirement analysis → Specification → Implementation → testing → use
  - » Enforced upon by powerful (monopolistic) organisations or institutions

- ## Bottom-up
  - » Some requirements → prototypes → user evaluations
  - » → new prototypes → pilot versions → acceptance or failure → continuously enhancements
  - »

Universialism and installed Base

Is universal design possible and desirable

- Examples: OSI-protocols (X.25, X.400), EDIFACT, SAP, electronic patient-journal
    - » Top-down development,
    - » Uniform and standardized network on all levels
    - » The goal is the perfect solution including most facilities
    - » 'Closed world
    - » Centralized control
    - » Monolithic organization

An alternative strategy: The Internet model

- **The TCP/IP approach:**
    - » Need to connect different networks
        - – Connectivity at meta-level
        - – Best efforts approach
    - » Balancing standards and flexibility
        - – Openness,
        - – Duplication, gateways
    - » Minimal standards
        - – Incompleteness, gradually improvement
    - » What aspects are relevant
        - – Technical
        - – Humans
    - » Internet has gained momentum and become an actor that influences society at all levels
        - – Serves many different user communities,...

Strategies

- ## Flexibility
  - » Flexible standards and technical solutions
- ## Modularisation and encapsulation
  - » E.g. The Internet IMPS and layered structure
- ## Minimal solutions
  - » E. g Internet versus OSI-protocols
- ## Gateways
  - » From N*(n-1) to M (= different protocols or subnets)
- ## Transitions strategies

Internet Standards

State of an protocol

> » Standard protocol

> » Draft standard protocol

> » Prposed Standard protocol

> » Experimental Protocol

> » Informational Protocol

> » Historic Protocol

Status

> » Required protocol

> » Recommended protocol

> » Limited use oritocol

> » Not recommended protocol

The case of Internet- some basic characteristics

- The idea of packet switching and datagrams (Kleinrock)
  - » Distributed, digital and redundancy (Baran)
  - » IMPs : how to avoid n*(n-1)/2 (Kahn)
  - » Symmetric protocols (NCP, SMTP. FTP….)
- Open Architecture Networking
  - » TCP/IP and black boxes: routers/gateways (Cerf, Kahn)
  - » Open network of independent network and No global control
  - » Best offer service – transmit and retransmit
  - » End-to-End responsibilities for error check, flow control
  - » Domain Name System
- Incorporation of TCP/IP in Unix BSD
- WWW: URL, HTTP and HTML

Basic ideas -2

- **Its roots in academic tradition and basic research philosophy**
- **The openness: free flow of ideas and innovations**
  - » Open access to all documents
  - » RFC (Request for proposals)
- **The public funding of the development (and diffusion)**
  - » Academic and research network infrastructures like NSFnet, HEPnet, JANET, NordUNet,..
- **The formation of open communities**
- **Peer institutions as IAB, IETF, W3C**
- **Open source movement**
- **The gift economy**

The history of Internet
Some important events..

- 1961: 4 nodes of Arpanet established as a research project
- 1969-70: The first IMP and NCP-implementation
- 1972 : First mail
- 1973 : Link to Norway (NDRE- Kjeller: P. Spilling)
- 1980-81: NSF-net connects Universities
- 1983: IP/TCP replaces NCP
- 1884: DNS
- 1987-88 : The Nordunet connected through the 'Nordunet-plug'
- 1989: Arpanet => Internet as a web of interconnected, but independent networks. It goes commercial
- 1991: Tim Berner-Lee deploys WWW.
- ....

Is Informations Infrastructure *a dichotomy :* an 'entity is either an II or it is not an II

- Infrastructure as a given property?
- Infrafrastructure by default or accident?
- Infrastructure as an dimension /a perspective
- Infrastructural aspects

Some Important links

- ODIN: http://odin.dep.no/odin/norsk/index-b-n-a.html

- Norge.no/Norway.no

- Standardisering/NOSIP:
  http://www.statskonsult.no/prosjekt/standsekr/index.htm

- Helsenett:
  - » Det nasjonale helsenettet bygges opp gjennom regionale **helsenett** i de 5 helseregionene. ...
    http://www2.telemed.no/telemed_i_bruk/tjenester/helsenett.html

- Utdanning.no
  http://www.utdanning.no/dep/portal/.cmd/ResetPage/_pagr/104/_pa.104/111?reset=true