S-38.041 Networking Business

Course introduction

Heikki Hämmäinen

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S-38.041 – Contacts

- Personnel
  - Lectures Heikki Hämmäinen (tel. 4516144)
  - Assistant Mathias Tallberg (tel. 4512462)

- Communications
  - Course web site
    http://www.netlab.hut.fi/opetus/s38041/k05/index.shtml
  - News group opinnot.sahko.s-38.tietoverkkotekniikka
  - Email: see course web site

S-38.041 - Completion

- Examination
  - An acceptable performance required in the examination
  - Exam includes 5 questions a 6 points
  - Exercise participation corresponds to 6 points in the exam, but the exercise cannot turn a failed exam to accepted
- Excercise
  - One day session of mobile operator business game
  - Voluntary participation
  - Organized in April
  - Register to Mathias Tallberg by email

Lecture schedule

01.02	Course introduction. Big picture.
08.02	Consumer customers.
15.02	Enterprise customers.
22.02	No lecture.
01.03	Operators.
08.03	Transport pricing.
15.03	Content pricing.
22.03	Charging and billing.
29.03	No lecture.
05.04	Investments.
12.04	Interconnect and roaming.
19.04	Regulation.
26.04	Mobile operator competition.
03.05	Differences between markets.

April
Game sessions

09.05
Examination

Course materials

- Lecture slides (to be available on web before each lecture)
- Core readings
  - *Pricing Communication Networks* (chapters 5-14), C Courcoubetis, R Weber, Wiley, 2003 (commercial)
  - *Telecommunication Regulation Handbook*, H Intven, M Tetrault, infoDev, 2000 (free)
  - Maybe some additional articles
- Other recommended readings
  - *Network Services Investment Guide*, Gaynor M, 2003
  - *The Telecom Managers Survival Guide*, Medcroft S, 2003
  - *The i-mode Wireless Ecosystem*, T.Natsuno, Wiley, 2003

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Introduction – Big Picture

Common aspects of networked industries

Problem	Description	Examples
Bottleneck	Traffic stacks because capacity is limited or temporarily blocked	Airport, telephone switch, damaged railroad bridge
Access	Physical availability, economical affordability	Electricity, water, Internet
Small vs large customers	Unit cost depends on the volume of contract	Prices of electricity, water, communications, etc
Short vs long haul	Unit cost depends on distance. International miles cheaper than local miles.	Prices of postal mail, telephone, etc

The modern infrastructure includes several types of networks such as water in pipes, cars on streets, letters in post, power in cables, and data packets in Internet. These networks exhibit similar techno-economic characteristics visible as capacity bottlenecks, access availability, volume discounts (small vs large customers), and distance costs (short vs long haul).

Networks carrying addressable items (e.g. cars, letters, data packets) present specific problems related to routing and queuing. These problems have triggered a special branch of mathematics called traffic theory.
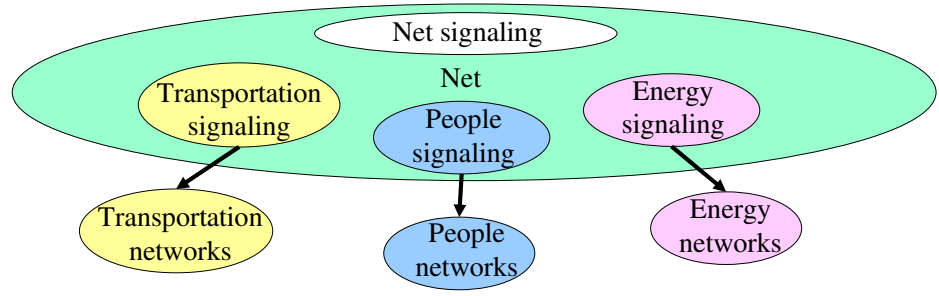
As a practical impact of similarity most governments have allocated the administrative responsibility of all networks to a single ministry. In Finland this ministry is called the Ministry of Transport and Communications.

Several research institutes have also structured their organization correspondingly by grouping all traffic issues close to each other.

About "signaling"
Core of information society

- Signaling controls the resources of a network
- Net enables signaling for physical networks
- Signaling of physical networks depends on signaling of Net

The architecture of traditional telephone networks can be divided into user plane, control plane, and management plane. Different types of traffic, that is, user traffic (e.g. voice calls), control traffic (e.g.. call set-up using SS7), and management traffic (e.g. configuration of new base stations), are isolated from each other to secure the reliable network operation.

Correspondingly the Internet (or Net) carries sensitive control traffic under the special protection of network operators. Examples include control messages (ICMP), routing protocols (OSPF, BGP), session initiation protocols (SIP), and network management protocols (SNMP).

This paradigm of control traffic can be extended to describe the relationship of the Net with other types of networks. The Net carries control messages for transportation networks (e.g. traffic lights, fleet management), energy networks (e.g. power plant control, power trading), and people networks (e.g. field engineers).

Thus, the Net can be seen as the "nervous system" that provides coordination functions for various functions of a modern society.
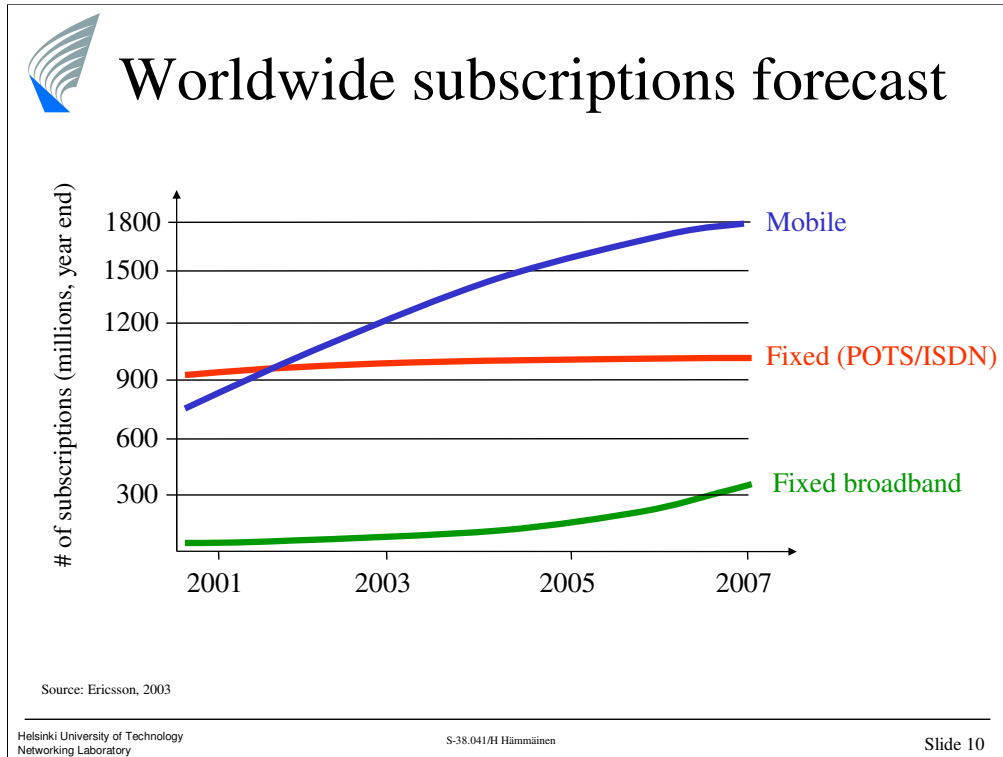
Technical development has enabled the convergence of different types of networks and terminals. When and how this will happen is an open question.

Big Pipe vision denotes the all-IP evolution which may attract broadcasting and telephony traffic to Internet.

Big Box vision highlights the integration of all terminal functions (phone, TV, PC) into a single platform, e.g. a pocket terminal. At least initially, a Big Box gets connected to different channels for voice (GSM), data (IP/GPRS), and video (DVB-H). Multiple operating system platforms (e.g. Windows, Mac OS X, Linux, Symbian) are implementing the Big Box, but the number of different platforms may decrease as the technology matures.

Big Company vision observes that the ICT industry involves strong network externalities visible as "winner takes it all". A Big Company controlling major parts of the communications value net may emerge from the Big Box scenario (e.g. Microsoft, Nokia) or from the Big Pipe scenario (e.g. Vodafone, NTT DoCoMo).

Governments are not likely to allow the dominance of Big Company. They may interfere using regulatory measures to adjust competition.

Worldwide subscriptions forecast

# of subscriptions (millions, year end)

Mobile

Fixed (POTS/ISDN)

Fixed broadband

2001 2003 2005 2007

Source: Ericsson, 2003

Subscription statistics show clearly that the life cycle of the traditional circuit-switched fixed telephony service (POTS, plain old telephony service) is ending. Subscriptions are decreasing in industrialized countries and increasing in only few developing countries.

Mobile subscriptions (GSM/WCDMA, CDMA/CDMA2000) are close to 100% penetration in industrialized countries but continue rapid increase in developing countries. The IP paradigm emerged too late to influence the mobile voice take-off, wherefore the global market will be filled with circuit-switched mobile voice capacity. The mobile voice-over-IP is likely to happen as an evolution in 3G and WLAN networks.

Subscriptions of fixed broadband Internet access at home are rapidly increasing in industrialized countries based on all available physical cables (copper, coax, fiber). Voice-over-IP works well over broadband and seems to take off. Some operators are offering TV service over IP. A fully converged IP service, or "triple play", including Internet, telephony, and TV broadcasting, is gradually emerging.

Voice traffic is going wireless. Some developing countries are skipping the POTS phase and going to mobile directly.

Source: Forrester Research, May 2001
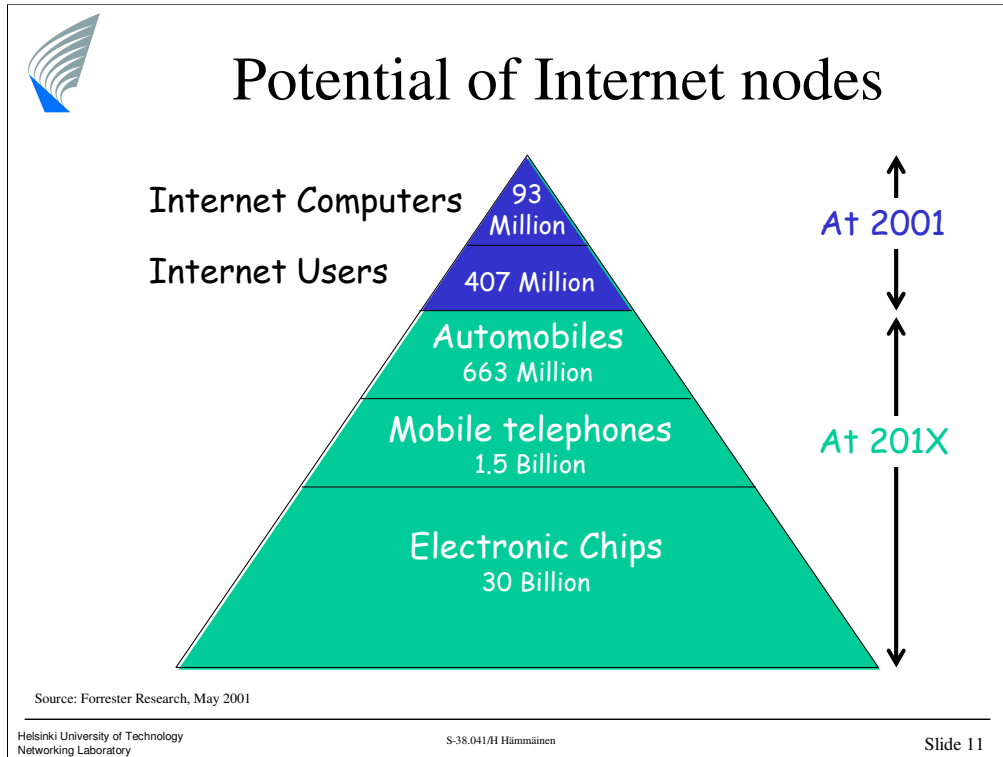
The potential of Internet subscriptions is proportional to the number of population in a country, but not limited to it.

It is likely that almost all homes will be connected to Internet via fast wireline access.

It is likely that almost all people will be connected to Internet via personal wireless devices.

It is likely that cars will be connected to Internet for navigation, comfort, and safety.

It is likely that valuable personal items (pets, boats, etc) will be connected for safety.

It is likely that complex electronic devices (cameras, TVs, fridges, etc) will be connected for fun, remote control, and maintenance.

Internet traffic – big picture
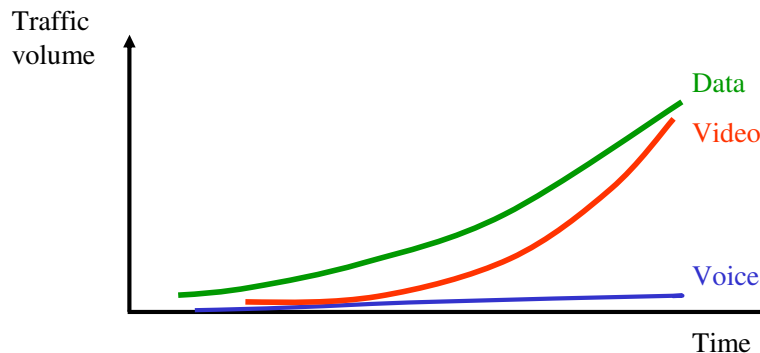
The Internet traffic continues doubling per year. This is because of more users, or sources, and more traffic per source.

Convergence of telephony and TV networks to Internet has remarkable business impacts, but it does not radically contribute to the Internet traffic. Traditional real-time telephony traffic is limited by the number of sources and by traffic per source. Traditional TV broadcasting traffic is limited by the number of sources.

Genuine Internet traffic such as email with large attachments (graphics, images, video, etc) and web sites with heavy content (software, video, etc) are significant traffic sources.

Automatic non-realtime traffic such as web crawlers and peer-to-peer file sharing are responsible of the latest traffic growth.

It is likely that new audio-visual information and services become a big traffic source as photo cameras, video cameras, and web cams get connected to Internet.

Evolution of network value
Positive Network Effect

1. Sarnoff's Law
   – Value $\approx N$ (viewers in TV/radio broadcast networks)
2. Metcalfe's Law
   – Value $\approx N^2$ (two-way connections in phone and data networks)
3. Reed's Law
   – Value $\approx 2^N$ (social groups in group-forming networks)

Value of Internet evolves favorably also because
   – N grows (PCs, cars, mobiles, automatic devices)
   – usage time per N grows (always-on)
   – new service types
      • new delivery techniques (datacasting, audio&video, multicast)
      • new interaction techniques (MMS, chat, conferencing)
   – more applications and content (commercial and user-created)

Investors need to assess the value of network and service operator companies. Mostly this is done based on direct metrics such as the balance sheet, profit&loss statement, average revenue per user (ARPU), and market position (market share, growth potential).

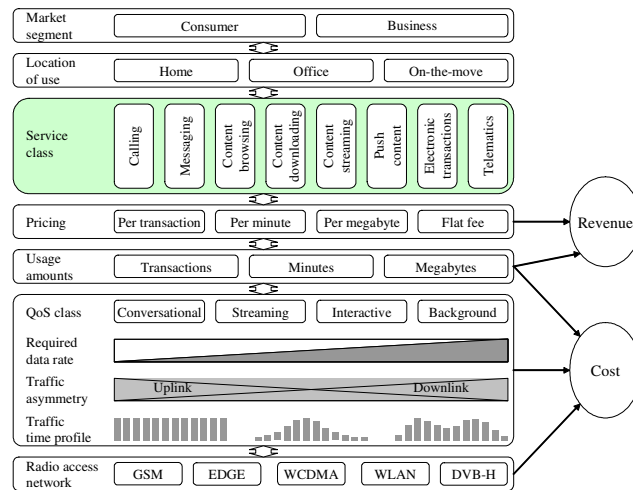The society may look at the indirect network value based on the connectivity opportunities created.

Sarnoff's Law describes the linearly increasing value (by viewer) of TV/radio broadcasting networks. This thinking was originally applied by David Sarnoff, CEO of RCA, "the Father of American Television", to assess the investor value of broadcasting networks.

Metcalfe's Law recognizes that the value of a two-way network increases proportionally to the number of possible connections, i.e. by square. This observation was made by Bob Metcalfe, the chief designer of Ethernet. Note that the connectivity is an option to user, not an obligation. Utility to users grows according to options, which creates a positive network effect.

Reed's Law applies to group-forming networks and says that the value of network increases proportionally to the number of possible social groups, i.e. exponentially. First formulated by David Reed, an MIT professor and spreadsheet pioneer.

Service Classification

Market segment	Consumer	Business
Location of use	Home	Office	On-the-move
Service class	Calling · Messaging · Content browsing · Content downloading · Content streaming · Push content · Electronic transactions · Telematics	
Pricing	Per transaction · Per minute · Per megabyte · Flat fee	→ Revenue
Usage amounts	Transactions · Minutes · Megabytes	
QoS class	Conversational · Streaming · Interactive · Background	
Required data rate		
Traffic asymmetry	Uplink — Downlink	→ Cost
Traffic time profile		
Radio access network	GSM · EDGE · WCDMA · WLAN · DVB-H	

Source: ECOSYS, T.Smura, 2001

A systematic classification of network services helps position and understand the different phenomena encountered in networking business.

Markets can be segmented in endless ways, but one of the basic separation is between consumer and business users. These segments differ in what applications and services they use and who pays the bill.

Location of use is relevant because it binds the type of network access technology. Note that both consumer and business users are relevant in all locations of use.

Usage of services is measured in time (minutes) or volume (transactions, megabytes). Correspondingly the pricing of services can be based on usage (transactions, minutes, megabytes) or flat fee (fixed monthly fee).

The transport service has some quality of service (QoS) characteristics. Currently only two QoS categories are widely available: conversational (circuit-switched) and interactive (best-effort packed-switched). Different symmetries (downlink/uplink) and time profiles (peak hour/no-peak) on different access network technologies.

Operator's service revenue is based on usage and its pricing, while costs relate to usage, QoS, and access technology.

The concrete services can be abstracted to a set of service classes for the purpose of easier comprehension.

Innovation model for Internet technologies
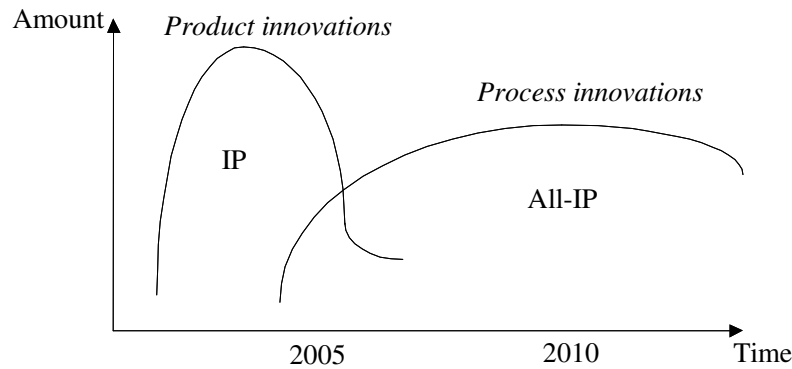
The communications industry is going through reincarnation. The period of privatization and liberalization of operator business keeps continuing (1990-2010). Wireless and Internet technologies are likely to evolve rapidly at least until 2015.

Diffusion of major technology innovations such as electricity and Internet can be modelled in several ways. One approach is to view the first phase as product innovations and the second phase as process innovations. Process innovations are needed in human organizations and existing functional processes to fully exploit the promise of a new technology. Note that process innovations are required to enable the mass delivery of a new technology.

A significant delay (c. 5 years) can be identified between the diffusion cycles of fixed Internet and mobile Internet. The mobile Internet is still clearly in the product innovation phase.

Technology vision
Wireless systems

2005
- – 28kb+ packet IP in all new handsets (GSM & WCDMA)
- – Multiradio handsets spreading (GPRS & WLAN & Bluetooth)
- – Bluetooth common in lightweight apps, and WLAN in heavy apps
- – GPRS handset positioning common (GSM, GPS)

2010
- – 100kb+ subscriber speed common in cellular (WCDMA)
- – Energy conservation efficiency only tripled (fuel cells, solar cells)
- – Seamless support for multiradio common (WCDMA & GSM & WLAN & PAN)
- – Spectral efficiency of antennas clearly improved (adaptive antennas, MIMO)
- – UWB (Ultra Wide Band) competing with BlueTooth and WLAN
- – 4G spec maturing if WRC2006 has allocated bandwidth

Battery and radio are the bottlenecks

Technology vision

Broadband packet networks

2005

- – 512kb+ packet IP common in homes (ADSL, HFC)
- – Access operators starting the prioritisation of traffic (diffserv, less than best effort)
- – Optics increased in core and access networks (DWDM, MPLS)
- – Ethernet changing the architecture of access networks

2010

- – 10Mb+ IP common in homes (VDSL, HFC)
- – Roaming common in fixed networks (WLAN/BlueTooth in homes)
- – Increased capacity and operability in optical networks (all-optical, switching)

Network is the bottleneck, not terminal

Source: TEKES NETS, 2003

Technology vision

Services and applications

2005

– Mobile Internet services as common as those of wireline Internet

– Users can access their files from home, office, and on the move

– IP audio delivery common (plus broadcast radio in wireline Internet)

– Voice-over-IP emerging in wireline (WWW push-to-talk, chat, SIP)

– New services are based on open standards (IETF, 3GPP, W3C, OMA), but applications remain proprietary

2010

– Content adapts to environment (place, radio, device, user profile)

– IP audio/video has become efficient (multicast) and controlled (QoS)

– Voice-over-IP common in public networks (wireline and wireless)

– User controls (home) devices independently of place and time

Usability is the bottleneck

Source: TEKES NETS, 2003