Selected themes of
Socio-Economic Research on the Future Internet

Martti Mäntylä

Professor, Director
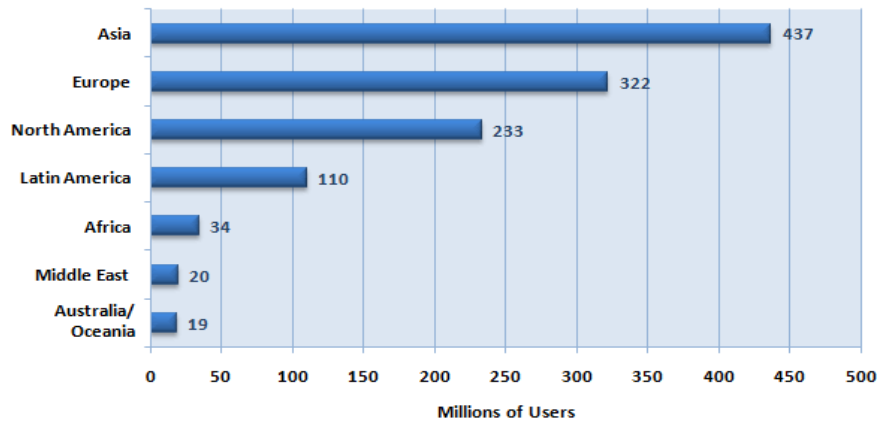
Helsinki Institute for Information Technology
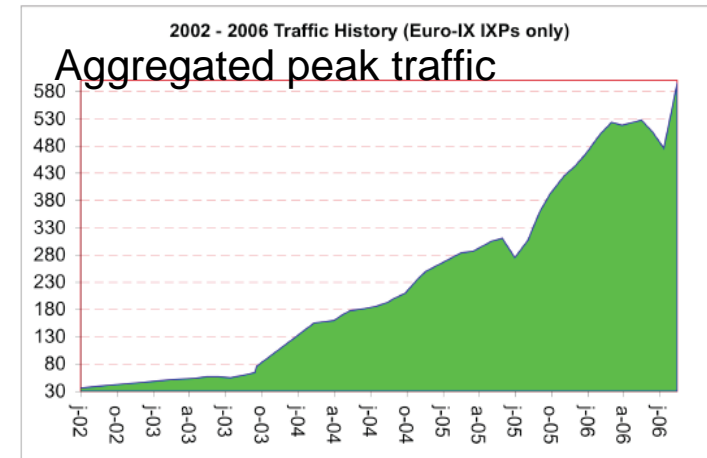
Helsinki University of Technology

Internet: Tremendous Success

Internet Usage by World Region

Region	Millions of Users
Asia	437
Europe	322
North America	233
Latin America	110
Africa	34
Middle East	20
Australia/Oceania	19

Copyright © 2007, www.internetworldstats.com

2002 - 2006 Traffic History (Euro-IX IXPs only)
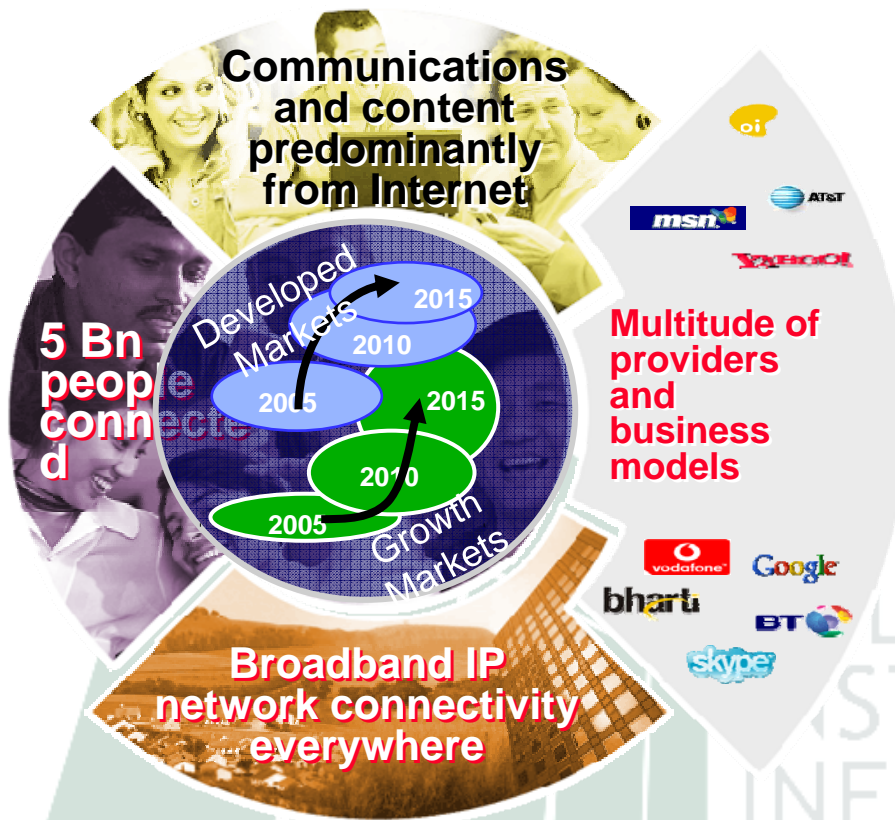
Aggregated peak traffic

Internet Domain Survey Host Count
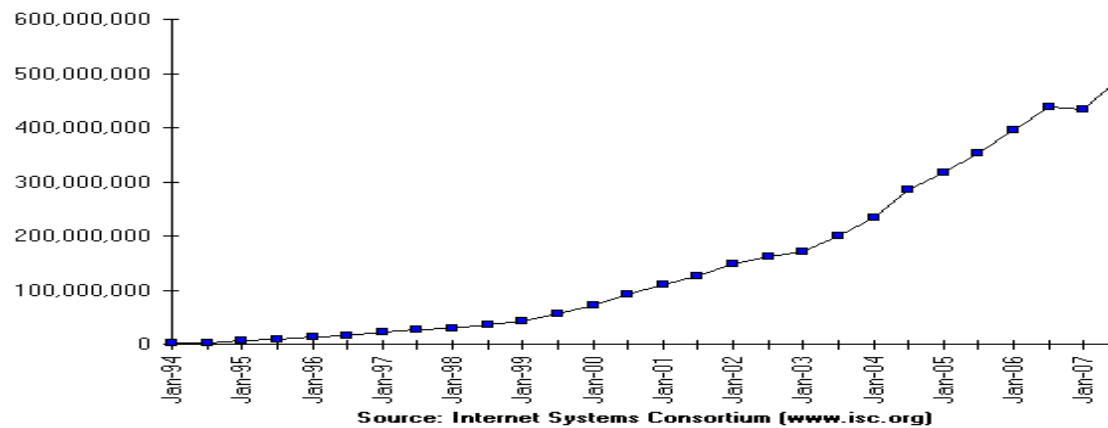
Source: Internet Systems Consortium (www.isc.org)

Source: European Internet Exchange Association 2006 Report on European IXPs

Impacts all Communication and Content Businesses

Communications and content predominantly from Internet

5 Bn people connected

Broadband IP network connectivity everywhere

Developed Markets
2015
2010
2005

2015
2010
2005
Growth Markets

Multitude of providers and business models

oi

msn

AT&T

YAHOO!

vodafone

Google

bharti

BT

skype

New services driven by Internet
- Global reach with 1 billion potential users
- Superior value for consumers and businesses
- World wide innovation community

New business models driven by Internet
1. Obtain big subscriber base with "free" service
2. Monetize with different business models

Broadband usage driven by Internet
- Services independent from access
- Exponential demand for network capacity
- Significant growth in network connectivity

So Where Is the Problem?

- Internet has grown out of its original design scope
- End users are not as the used to be:
  - Mutual trusting and co-operating community challenged by selfish behavior: security threats, SPAM, malware, unsolicited ads
  - Retrieval and unicast communication evolving into social networking
- Hosts are not as they used to:
  - Desk top hosts vs. multi-interface mobile hosts
- Huge variability of link layer characteristics:
  - from WLAN to satellite and 10+ G/bits Ethernet
- End to end design principle vs. firewalls, NATs

So Where Is the Problem?

- Popularity of the overlay network applications is a testimony of missing functionality
- Cost of success => scalability problems
  - Routing table growth
  - Address space exhausting
  - More middleboxes and management, complexity of application development
  - DNS overloading

Future Internet

- "Clean slate" path
  - Radical change based on redesigning the Internet to match the present and expected use patterns
  - US: FIND, GENI, Europe: FP7/PSIRP et al.
- "Evolutionary" approach
  - Incremental improvement to fix pressing problems: routing, addressing, mobility, security, ...
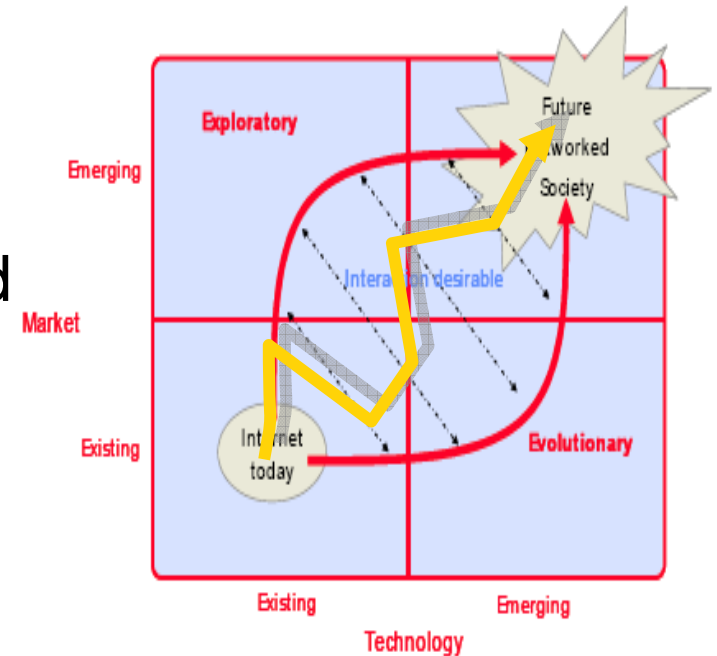 - Standardization (IETF, W3C, ...)

Figure 3: Different paths to the future   Source: Nokia

Three Waves of Networking

1930

1960

2020

First Wave: Wires

- Connect wires
  - Technically: line interfaces to other line interfaces
- Value creation: wires to every home and office
- Encouraged monopolies

Source: Pekka Nikander, Ericsson

Second Wave: Nodes

- Connect users to multiuser hosts
  - Remote access
- Slew of issues, e.g.
  - IP connectivity model
  - Suitability of TCP
- Encouraged distributed operations

Source: Pekka Nikander, Ericsson

Third Wave: Information

- Advertised heavily by <u>Van Jacobsen of PARC</u>
  - Build on top of the Internet, like the Internet was built on the top of wires
- Eventually to replace Internet like Internet is now replacing phones…
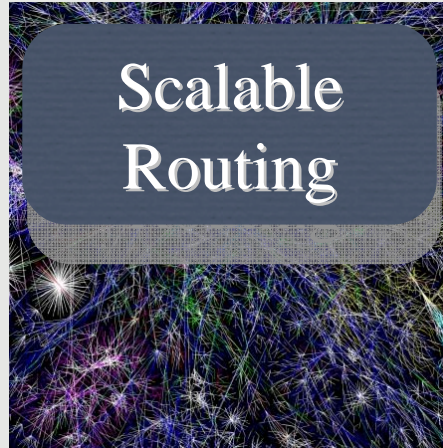- PSIRP FP7 project: publish-subscribe model
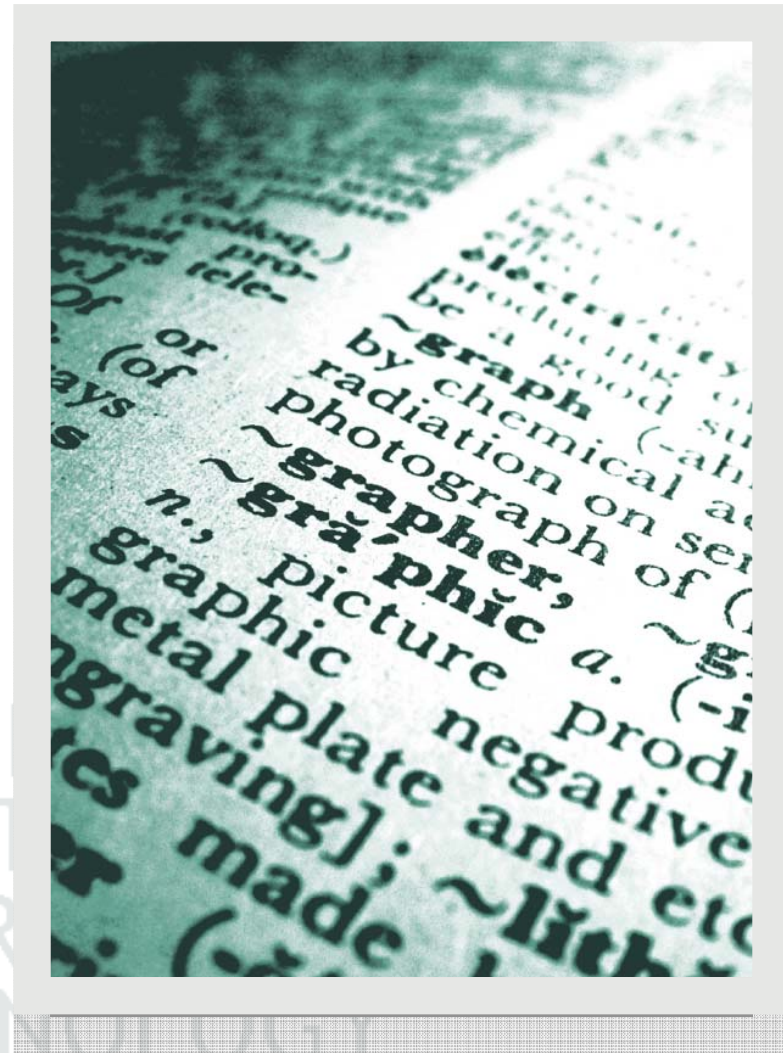
Present Problems

Unwanted traffic

Scalable Routing

Mobility & Multi-homing

Resources & Compensation

Privacy & Attribution

Trust & Reputation

Source: Pekka Nikander, Ericsson

Future Challenges

Information Networking

Usage Patterns
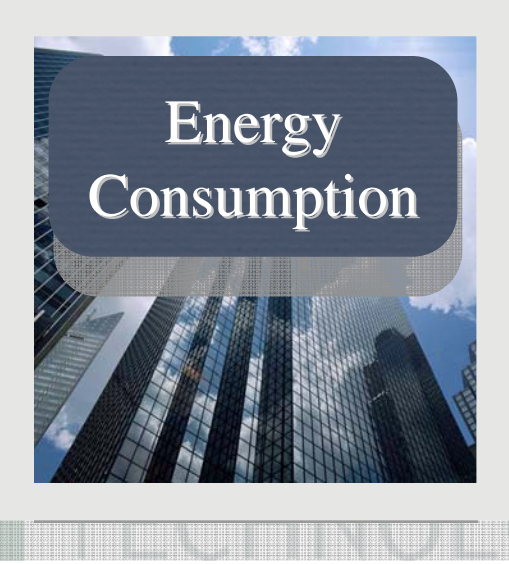
Socio-Economics

Autonomy & Resilience

Energy Consumption

Shifting Bottlenecks

Source: Pekka Nikander, Ericsson

Why is Socio-Economics Critical?

- Several issues of the present and challenges of tomorrow seem to be socio-economic at root
- Say, unwanted traffic:
  - Sending traffic is easy and cheap
  - Protecting oneself from unwanted traffic is expensive and complex
  - A sustainable solution should change this balance to the favour of the recipient
- It seems that fundamental solutions will require new insights requiring socio-economical modelling and analysis - indeed, socio-economics should be an integral part of the design effort of the Future Internet

The Layer Picture

Social	Impact on people's interactive behaviour; service innovation and diffusion; digital life and economy
Content	Social computing; user-generated content; novel forms of self-expression and communication
Applications	Community-oriented services; complexity to affordance to resource; ubiquity
Platform	Information networking; trust and reputation; incentives and economy; identities & privacy
Transport	Identity-locator split; network-level security, privacy, trust; post-IP; market structures
Network	Location privacy; novel routing; novel addressing; performance & behaviour

Viewpoints

- Users, groups, communities
- Privacy and publicity
- Techno-economics
- Legal issues

Users, Groups, Communities

- With novel applications ("Web 2.0", "Social Media"), the Internet has become a tool for everyday social communication amongst friends and family
- Thus, the Internet is no longer about communication with "third parties" - services, organisations, companies - but with "second parties" - real people, various kinds of groups and informal/formal communities
- In the future Internet, these characteristics are likely to be even more intense than today

Users, Groups, Communities

- What explains the use of the Internet? How do successful services "hook" their users and spread to new ones? What establishes user loyalty?
- To answer these questions, further research is needed:
  - social networking
  - personalisation/personification
  - personal service portfolios and their management
  - adaptation, auto-configuration
  - incentives and service economy
- At present, most work on "social networks" is based on naive and patently misleading assumptions on the nature of the social structures and links

Privacy and Publicity

- New use patterns also challenge the basic assumptions of most existing work in privacy and privacy management: privacy is not just about managing the visibility of one's personal information, but about constructing, managing, and displaying a public digital identity (or several thereof)
- Withdrawing from communications is not an option for "digital natives"

Internet as Market

- Ultimately, Internet's benefit to society stems from reduced transaction costs for communication and carrying out various processes
- Ideally, we'd like to create a modern version of Adam Smith's "invisible hand" that guides the various kinds of network users towards a behaviour that maximises the common good in accordance to values such as openness, democracy, equal access, and fairness
- One approach to this is the "code" approach of Lawrence Lessig: with enable the network to enforce rules of appropriate behaviour with appropriate technical solutions (akin to "policy-based" mechanisms)

Who Should Invest?

- How should the capital investment of building the future Internet be split?
- The network can be thought as a public good -> public funding
- How to incentify various stakeholders?
- Should operators be required to pay some kind of fees?
- How should users participate, if at all?
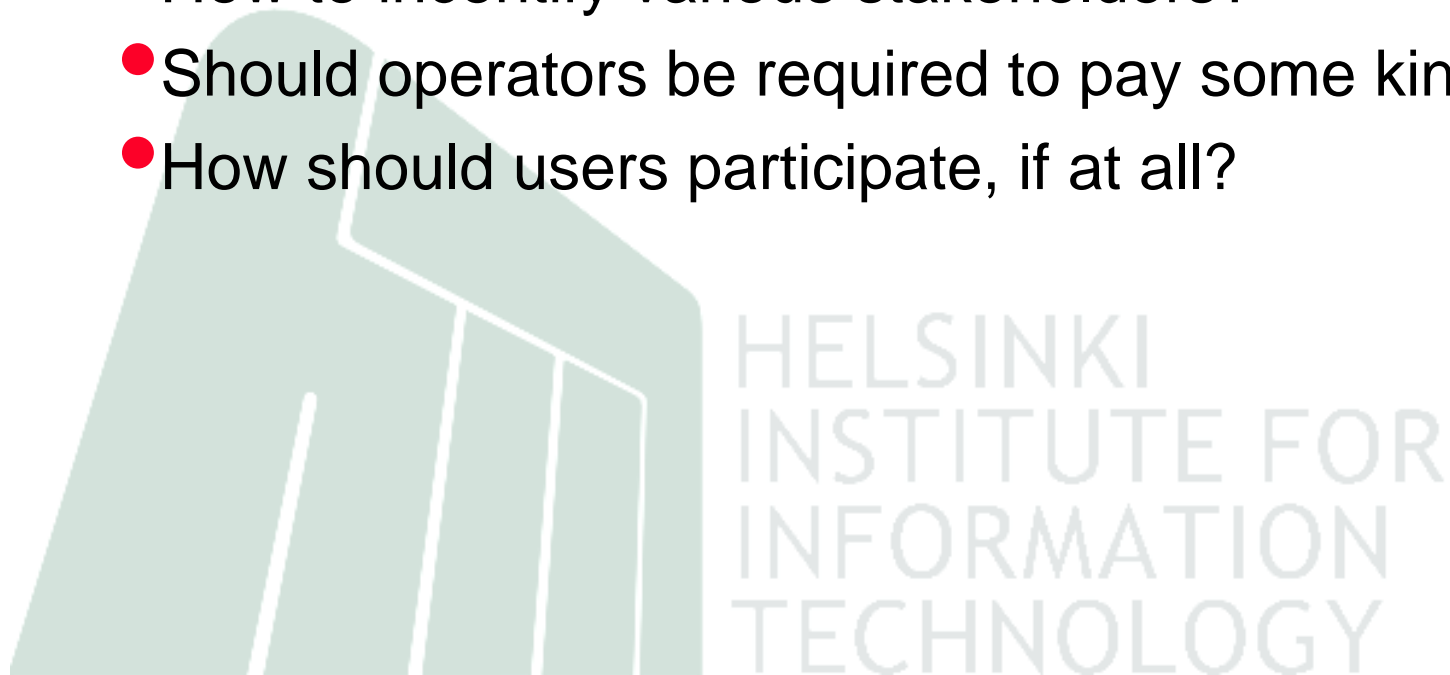
Using the Future Internet

- How well the future Internet works will be based on the various decisions and behaviours of the different stakeholders and end users
- How to make best use of the capacity and resources?
- What kinds of incentives can be deployed?
- How to achieve very low transaction costs?
- How to create efficient markets for network resources?

Economics of Privacy

- Economics offers a viewpoint to several questions involving privacy and privacy management:
- The level of privacy protection defines what kind of end user information can be collected and how it can be used (e.g., discriminatory pricing, service adaptation)
- If the market is efficient, end users have no incentives to manipulate artificially their profiles
- Is the level of privacy protection too high or too low from economics viewpoint?
- Should there be a market for privacy? How should it operate?
- Similar questions can be asked about trust and reputation

Economics of Information Networking

- How to create an efficient "information market" that facilitate the efficient use of distributed resources (network storage, caching) and make unwanted behaviours infeasible?

- What kinds of service contracts should be used between companies?

Rules of the Game

- The Future Internet, as the present, is supposed to be based on the co-operation of various kinds of stakeholders and entities that manage various kinds of network resources (transmission, network elements, caches, ...)
- However, we expect that the number and variety of these entities is far larger and wider than at present
- How is the co-operation between these stakeholders established? How are the responsibilities and expectations of each spelled out and managed? How are possible disputes handled?
- Apparently, we cannot assume all of these questions to be answered through contracts - they do not scale