A Perspective of the Networks of the Future and Smart Cities

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Outline

• A brief view into the past.
• Current technology.
• The networks of the future.
• Smart cities?!
• Applications and requirements.
Learning from PCs (1)

- Mainframes dominated, until PCs took over when computers were extended to the mass market.

- An operating system based on windows had a crucial importance in the spread of PCs.

- Easiness of use is essential for the mass market.
Learning from PCs (2)

- Initially, PCs had performance metrics that were orders of magnitude below the current ones (ZX Spectrum, 1982, 3.5 MHz, 16 kB, 0 GB).

- There is a race in wireless systems between services made available to users and data rates made available by phones/networks.

(Sinclair, 1982)

(Nadine Meade, 2000)
Learning from Cars

- In the beginning, the goal was for faster cars.

- Then, cars evolved for increased comfort and safety of passengers.

- Nowadays, cars are being sold for energy efficiency.

- Speed is no longer important!

(T Ford, 1927)

(BMW, 1978)

(Lexus, 2008)
Learning from today’s networks (1)

• Security is a key issue for the development of new services that make use of payments.

• Privacy has been introduced in GSM, in order to avoid eavesdropping.

• New developments may constitute a breach into consumers privacy (e.g., location, use of services, and origin of payments). A barrier?

(Artfile, 2007)

(MIT, 2005)

(Inmagine, 2007)
Learning from today’s networks (2)

• Possible radiation hazards have been a more or less acute problem.

• Will there be unforeseen problems that will endanger system developments?

• Risk acknowledgement and communication should be accepted as part of the introduction of new technologies.

• What about environmental issues?

(MobileCom, 2001)
Today’s Technology (1)

(Burton/Motorola, 2006)
Today’s Technology (2)

(Nike/Apple, 2006)
Today’s Technology (3)

(Voltaic Systems, 2006)
Today’s Technology (9)

(Ermenegildo Zegna, 2009)
Today’s Technology (4)

(iTech, 2005)
Today’s Technology (5)

(gadgetcraver, 2008)
Today’s Technology (6)

(Rimax, 2007)
Today’s Technology (7)

(withings, 2009)
Today’s Technology (8)

(Airvolt, 2010)
Today’s Technology (9)
Terminals (1)

• Today’s approach to selling PETs (Personal Enhanced Terminals), i.e., phones, may be changed in the future. You may:
  
  • buy a phone just to use for a few times, and then throw it away;

  • go to a shop and order the “construction” of a terminal according to your wishes.
Terminals (2)

- The terminal of tomorrow may be spectacles:
  - everyone will use one, like a wrist watch today;
  - they will carry your personal RF SIM, which will enable to use other devices, appropriate to other uses (in car, at home, in the air plane, at the office, etc.)

(Mobilemag, 2003)

(Minority Report, 2002)
Terminals (3)
Today, the phone represents the whole system for the user, i.e., it is the visible component, being the communications interface.

Future systems must deal with the easiness of use (networks complexity must be hidden from users) vs. giving users the power to establish their communication environment.
Information Access

- The paperless society will have a huge impact on networks:
  - media will be consumed in portable devices;
  - daily commuters will need a lot of information on an instantaneous basis.

(Apple, 2010)

(musingsfrommedway, 2010)
Location Awareness

• Location based services are being introduced these days, upon user demand.

• The opposite way may be introduced, i.e., the environment being aware that the user is present.

• Are we in danger of having a situation similar to spam or virus on mobile phones?

(Unwired, 2007)

(Minority Report, 2002)

(SpamSy, 2008)
Internet of Things

• Today’s systems are based on a person being the end user.

• Future systems must consider machine-to-machine communications as being, potentially, more important.

• Sensor networks are emerging as one of the “killer” network structures of the future.
What services? (1)

• Mobile 3D Internet: visualisation of 3D images from a terminal.

• Real-time ad hoc communities: extending social networks into happenings on the spot.

• Prosumers: users playing a decisive role as producers and consumers of contents.
What services? (2)

- Context aware mobile web: physical and social awareness of users’ experience.

- Interactive context aware games: games adapted to the user’s physical environment.

- Augmented reality: combination of virtual with real life objects.

(DanceInternational, 2005)

(UniversalStudios, 2007)

(Spectrum, 2008)
What services? (3)

• Some other ideas can be put forward:
  
  • objects and ideas based information: instead of using text to make searches;

  • parallel transmission: using all available networks simultaneously to transport data;

  • resilient connectivity: always connected, regardless of network.
Going up in Frequency

- Up to now, an increase in data rate implies an increase in bandwidth, hence, higher carrier frequencies.
- Is there a way to break this law?
- We need to move to communications in THz.

(Escher, 1962)

(U. Erlangen, 2004)
Body Area Networks

- Many propagation problems are raised by BANs:
  - in-body;
  - on-body;
  - off-body.

(qub, 2011)
Car Communications

- Car communications are a major area:
  - car-to-car;
  - car-to-infrastructure.

(awe, 2011)
(car2car, 2008)
MIMO for BANs

- The MIMO concept should be extended with the use of different multiple antennas, located at somehow random locations, e.g.:
  - buttons on clothes,
  - frames on spectacles.

(Ioffer, 2010)

(specsuperstore, 2010)
• Creation of methods for the location of base stations/access points in indoor/outdoor scenarios, for incorporation in architecture/civil engineering design of houses, offices, streets, and other environments.
The Evolution of the Internet

- The evolution of the Internet requires a fresh view into the problems and solutions

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*AWARD, 2009*
• Networks will be virtualised at both the radio and fixed components.

(4WARD, 2008)
Components for a New Architecture

- The building of network architectures will be based on basic components, allowing for customisation.

(4WARD, 2009)
In-Network Management

- Networks’ will evolve to “self-management”, coping with complexity.

(4WARD, 2009)
Network of Information

- Information centric networks will enable a new perspective to the delivery of information, based on objects.

(4WARD, 2010)
Cloud Networking

- Cloud computing and networking will provide a very efficient means to process and distribute information.

(SAIL, 2010)
Energy Efficiency

• The energy efficiency of networks became a key issue.

Energy Consumption

- Mobile Core Network: 10-20%
- Access Network: 70-80%
- Mobile Terminal: 2-10%

(EARTH, 2011)
Smart Cities? (1)

• The concept of Smart Cities can have different definitions, according to the sources that are used as a reference.

• Smart Cities involve quite a number of topics within ICT, but extend to other areas in a transdisciplinary approach.
Smart Cities? (2)

• Several dimensions have been identified:
  • economy (competitiveness),
  • people (social and human capital),
  • governance (participation),
  • mobility (transport and ICT),
  • environment (natural resources),
  • living (quality of life).
Smart Cities

- Smart Cities are getting a lot of attention lately, encompassing:
  - Public information and training
  - Emergency warnings
  - Health, inclusion and assisted living
  - Intelligent Transportation Systems
  - Environment, Energy Efficiency, and Smart Grids.

[colourdesign, 2010] (colourdesign, 2010)

[photoaki, 2010] (photoaki, 2010)
A Vision

• Smart Cities aim at:
  • increasing citizens’ quality of life, and
  • improving the efficiency and quality of the services provided by governing entities and businesses.

• One needs to have an integrated vision of a city and of its infrastructures, in all its components.

(foodallergens, 2007)

(articlesbase, 2008)
Too Many Players

• Many opportunities can be identified, as well as challenges and barriers.

• It extends beyond ICT, needing to incorporate the social and political dimensions.

• It is a very fragmented market, dealing with a high number of stakeholders and a huge variety of systems (interoperability!?).

(inetgiant, 2010)

(LynTopinka, 2006)
Vast Opportunities

• A large percentage of Europe’s population (80%) lives and works in cities of more than 10,000 people.

• Neelie Kroes (2010-May-28): “cities are absolutely critical units of administration for getting our new Digital Agenda for Europe up and running”.

(The Telegraph, 2008)

(EC, 2006)
• When dealing with the application of technology, one needs to have a broader view, beyond the technical aspects.
Business View

• The complexity of the value network increases quite a lot, with services and platforms playing an augmented role.

• New business models are required, namely based on open data.

• Additionally, the aspects of privacy, security and trust are very important.
Health, Inclusion and Assisted Living (1)

- The following key areas were identified:
  - wireless diagnostic and disease management,
  - hospital consultation and emergency scenarios,
  - assistive technologies,
  - well being and personalisation.
Health, Inclusion and Assisted Living (2)

- Application requirements can vary a lot:
  - wide range in the volume of data,
  - continuous measurement,
  - “error free” data,
  - delivery of alarms,
  - personalised devices,
  - ...

(answers, 2010)

(hermes, 2009)

(biojoblg, 2008)
Intelligent Transportation Systems (1)

- These key areas were identified:
  - urban and road traffic management,
  - efficient trip management,
  - communication services (V2V and V2I),
  - mobile prosumer.

(webcredible, 2010)
Intelligent Transportation Systems (2)

- Requirements include:
  - scalability of solutions,
  - heterogeneity of devices,
  - availability of accurate location information,
  - real-time exchange of data,
  - ...

(grundfos, 2009)

(USurrey, 2008)

(Apple, 2010)
Environment and Energy Efficiency (1)

- Several key areas were identified:
  - integration into infrastructures,
  - smart grids,
  - smart processes,
  - smart devices.

(allthingsgreen, 2010)
Environment and Energy Efficiency (2)

- Requirements encompass:
  - reliable real-time communications,
  - existence of standards,
  - specific sensor and actuator networks,
  - redundant communication channels,
  - …
Regulation & Standardisation

- Traditionally, Europe has had an approach to standardisation/regulation different from the US one.

- Concerning the Future Internet, which bodies should be addressed?

- Standardisation does not influence basic R&D, but it definitely guides its results.
Policy (1)

• Research on the Future Internet needs to interact with other areas (biology, sociology, psychology, construction, cars, ...).

• This interaction will increase the complexity concerning regulation and policy.

• Will there be ethical barriers, like those existing today in biology/medicine?
Policy (2)

- Whether we like it, or not, some policy aspects do need to be taken into consideration, e.g., the possibility of Governments having access to data.

- How to comply with the interests of so many players (telecom operators and vendors, service and content providers, banks, goods distribution, ...), with different development cycles?
Conclusions

• Technology development in the Networks of the Future and Future Internet is allowing for a “new world” in telecommunications.

• This area continues to present key challenges that need to be addressed in R&D, in order to have solutions for the problems of the future.

• Smart Cities appear as an excellent opportunity to integrate technologies, within and with other sectors.
The End

• “I think there is a world market for maybe 5 computers”, Thomas Watson (IBM), 1943.

• “There is no reason anyone would want a computer in their home”, Keneth Olsen (DEC), 1977.

• “The best way to predict the future is to invent it”, Alan Kay (UCLA), 1971.