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.

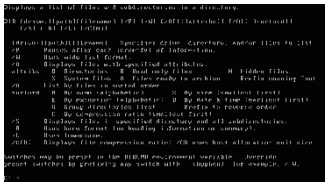
Learning from PCs (1)

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

(*IBM, 1972*)

(*Apple, 1986*)

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



(*Wikipedia, 1972*)

(*Microsoft, 2007*)

- Easiness of use is essential for the mass market.

(*PhotosCom, 2008*)

(*Nokia, 2007*)

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).

(*Sinclair, 1982*)

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

(*Nadine Meade, 2000*)

Learning from Cars

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

(*T Ford, 1927*)

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

(*BMW, 1978*)

- Nowadays, cars are being sold for energy efficiency.

(*Lexus, 2008*)

- Speed is no longer important!

Learning from today's networks (1)

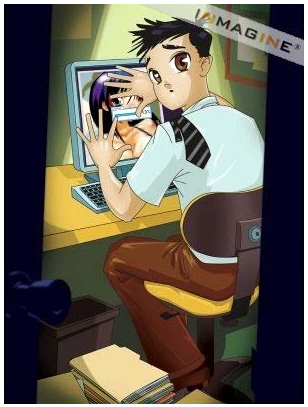
- Security is a key issue for the development of new services that make use of payments.

(*Artfile, 2007*)

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

(*MIT, 2005*)

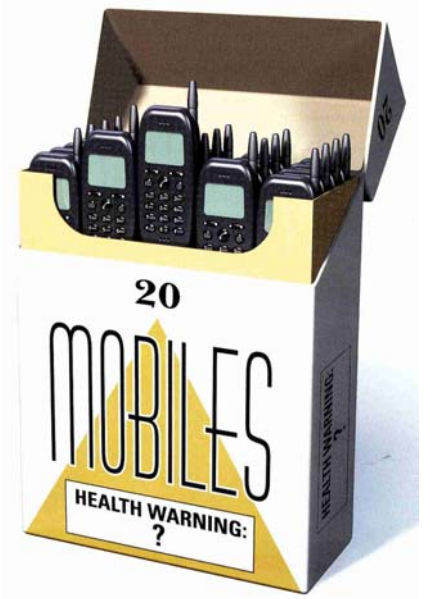
- New developments may constitute a breach into consumers privacy (e.g., location, use of services, and origin of payments). A barrier?



(*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*)

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Today's Technology (1)

(*Burton/Motorola, 2006*)

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Today's Technology (2)

(*Nike/Apple, 2006*)

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Today's Technology (3)

(*Voltaic Systems, 2006*)

Today's Technology (9)

(*Ermenegildo Zegna, 2009*)

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Today's Technology (4)

(*iTech, 2005*)

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Today's Technology (5)

(*gadgetcraver, 2008*)

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Today's Technology (6)

(*Rimax, 2007*)

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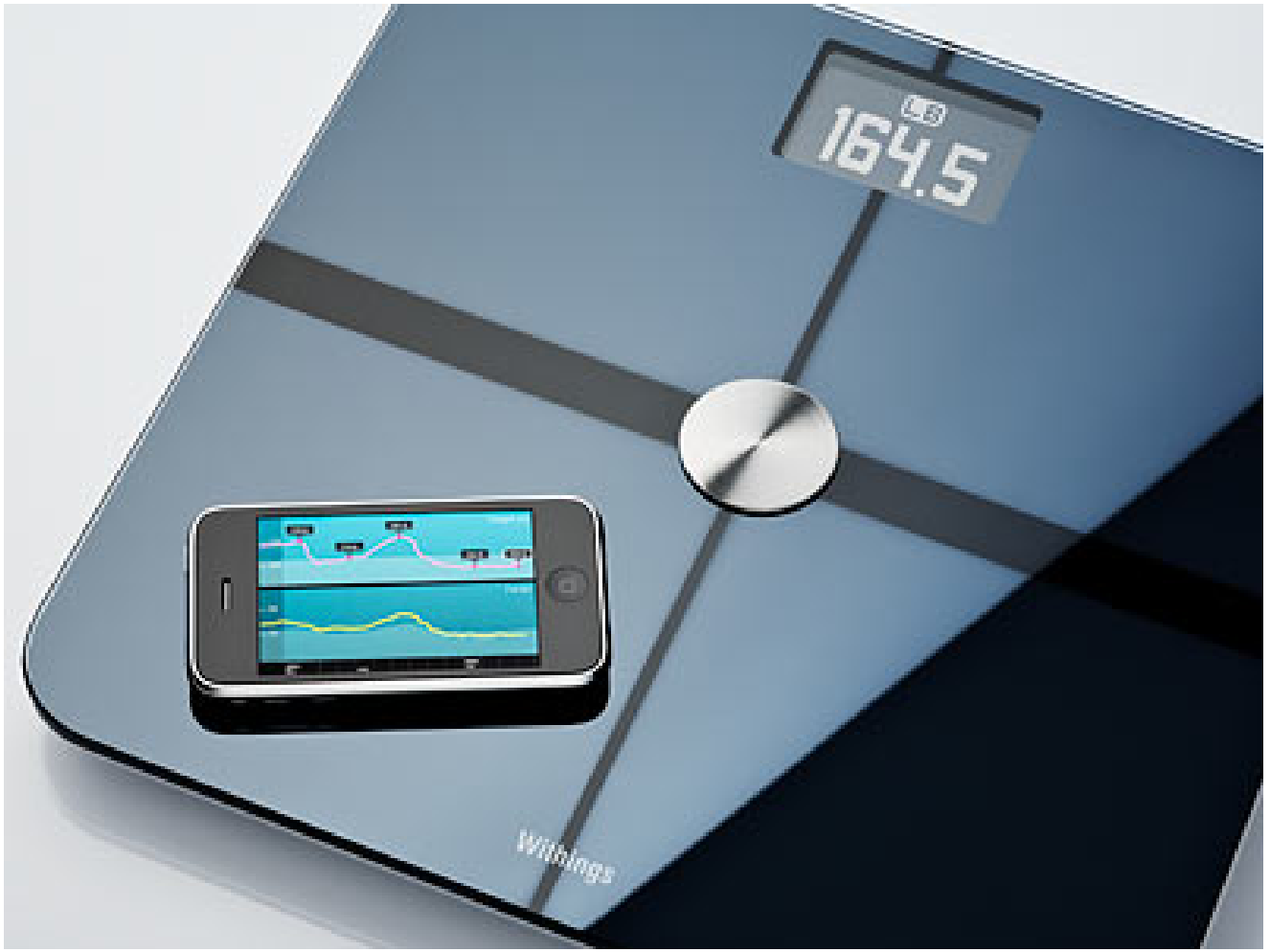
Today's Technology (7)



(*withings, 2009*)

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Today's Technology (8)

(*Airvolt, 2010*)

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Today's Technology (9)

(*GTech, 2010*)

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.

(*Kodak, 2008*)

(*ComputerDepot, 2008*)

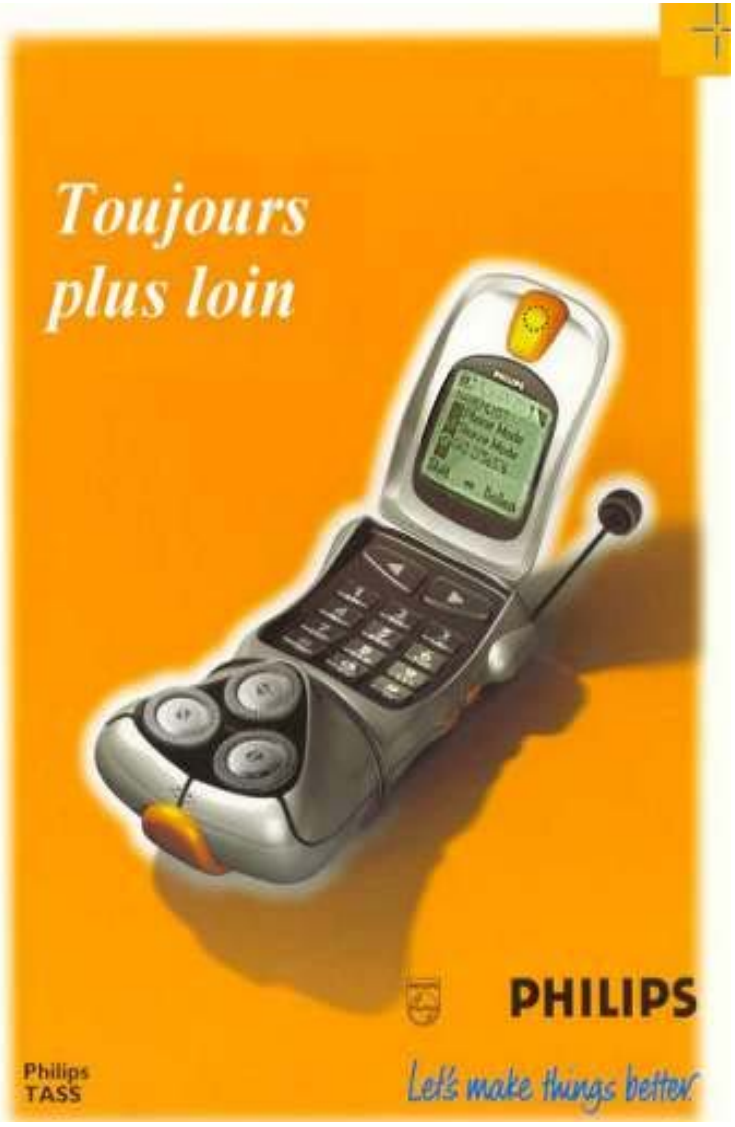
Terminals (2)

- 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)


Toujours
plus loin
PHILIPS
Philips
TASS
Let's make things better.

Terminals (4)

- Today, the phone represents the whole system for the user, i.e., it is the visible component, being the communications interface.

(*Nokia, 2006*)

- 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.

(*Jesse Stuart, 1948*)
(*Nokia, 2006*)
(*USP, 2008*)

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.

(*Unwired, 2007*)

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

(*Minority Report, 2002*)

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

(*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.

(*Kenwood, 2007*)

(*DHD, 1998*)

(*SensorProd, 2007*)

What services? (1)

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

(*Builder AU, 2008*)

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

(*FutureLab, 2008*)

- Prosumers:
  users playing a decisive role as producers and consumers of contents.

(*enriquedans, 2006*)

What services? (2)

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

(*DanceInternational, 2005*)

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

(*UniversalStudios, 2007*)

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

(*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.

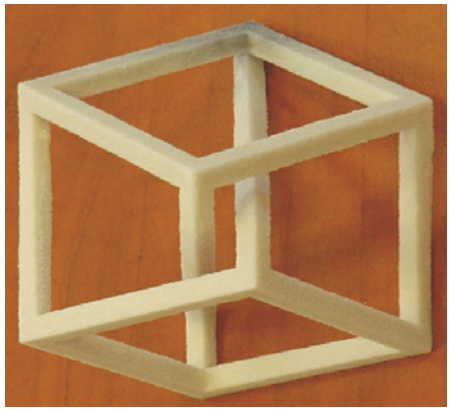
(*worldpress, 2008*)

(*pictjug, 20048*

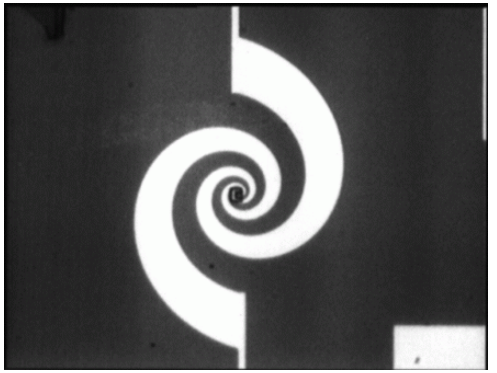
(*picasaweb, 2006*)

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.



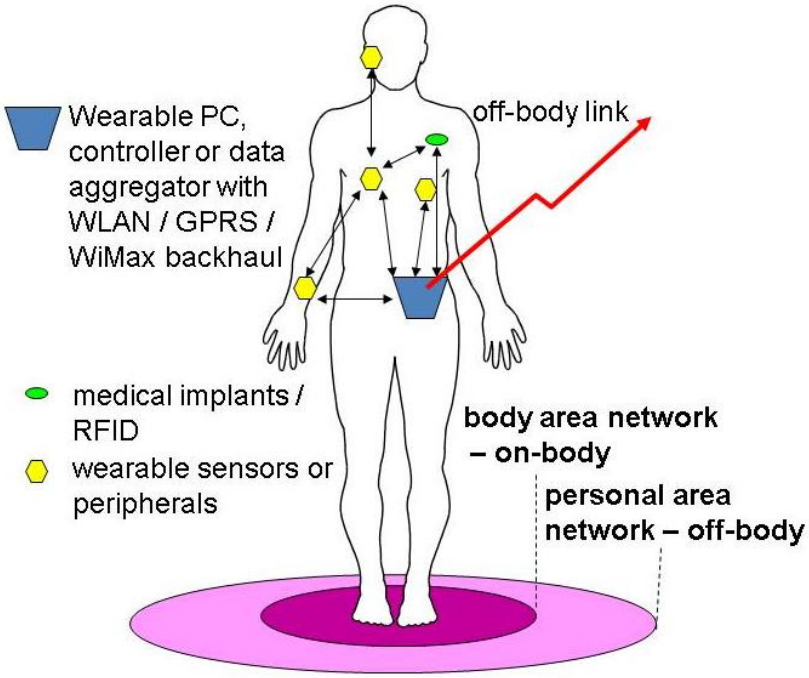
(*Escher, 1962*)



(*U. Erlangen, 2004*)

Body Area Networks

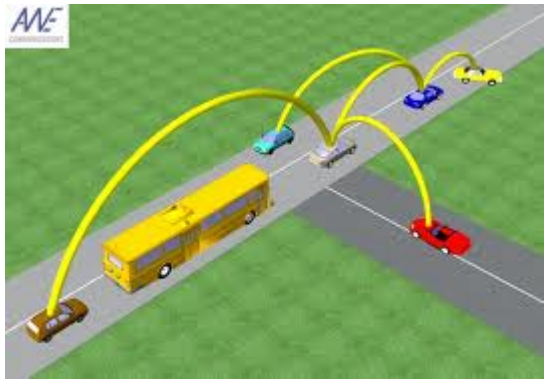
- Many propagation problems are raised by BANs:
  - in-body;
  - on-body;
  - off-body.



(*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.

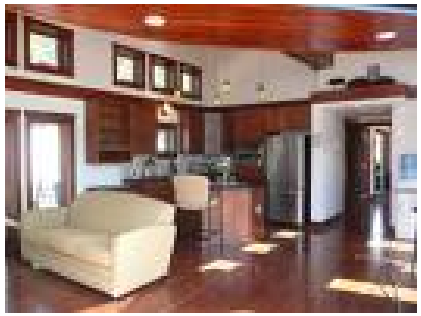
(*Ioffer, 2010*)

(*specsuperstore, 2010*)

Interior Design

- 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.

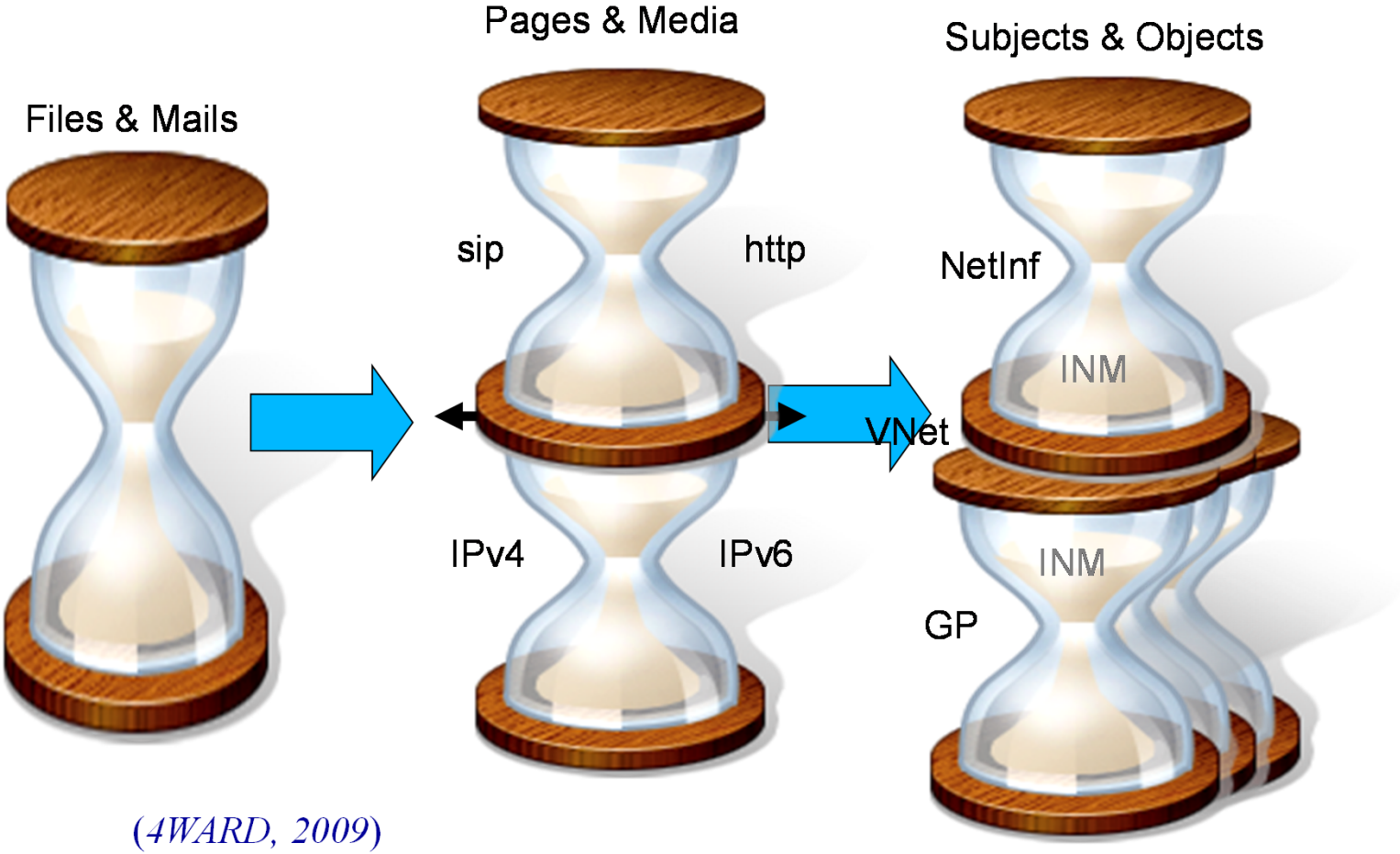
(*wallpaper-s, 2010*)



(*interiordesign, 2010*)

The Evolution of the Internet

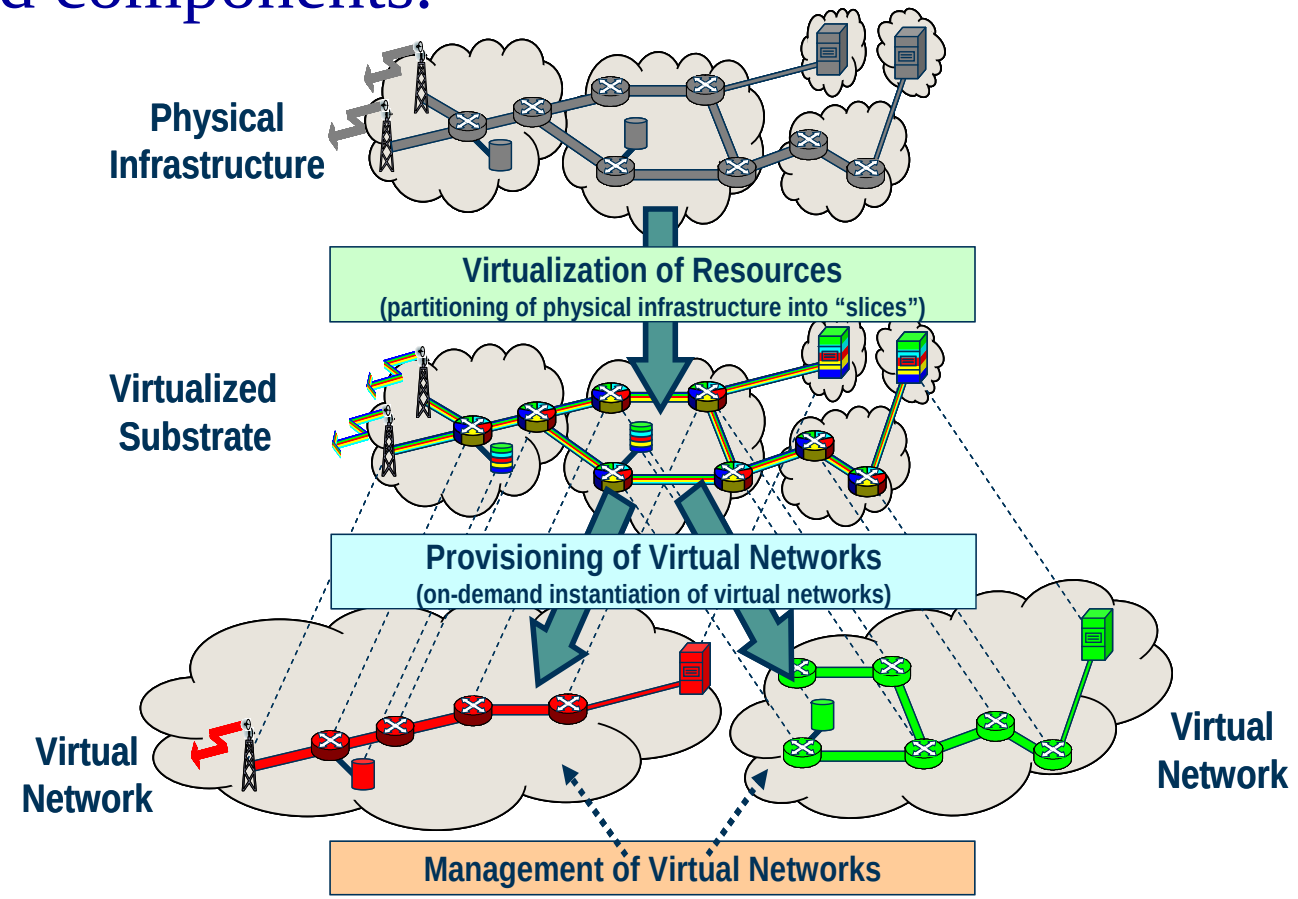
- The evolution of the Internet requires a fresh view into the problems and solutions



(*4WARD, 2009*)

Network Virtualisation

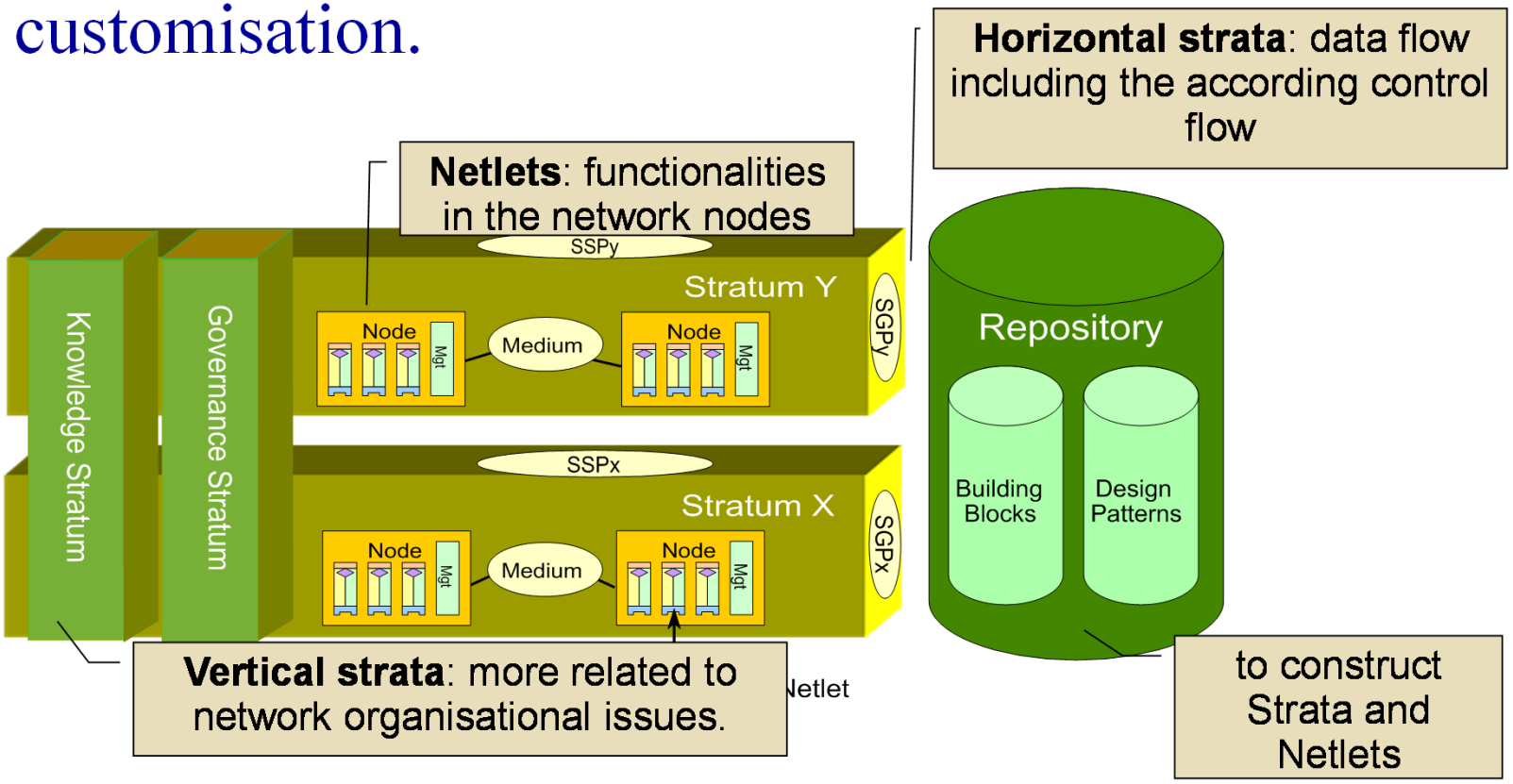
- Networks will be virtualised at both the radio and fixed components.



(*4WARD, 2008*)

Components for a New Architecture

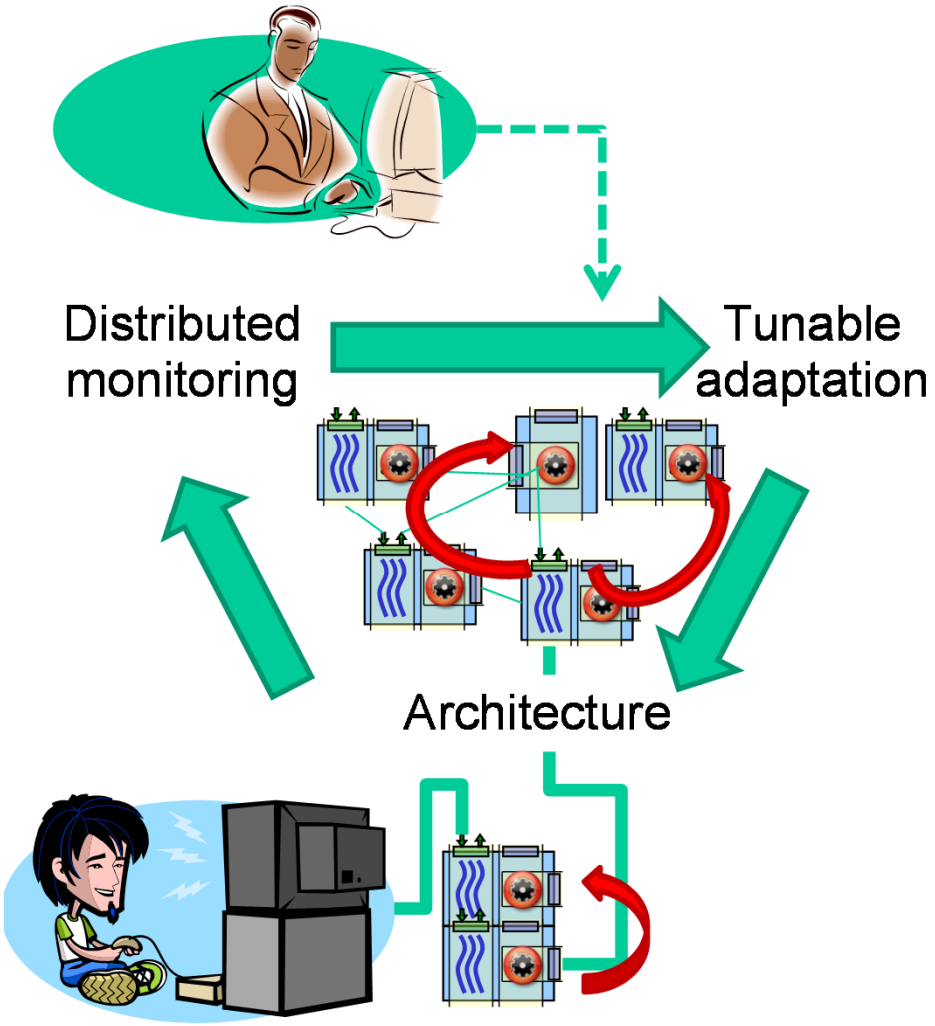
- The building of network architectures will be based on basic components, allowing for customisation.



(*4WARD, 2009*)

In-Network Management

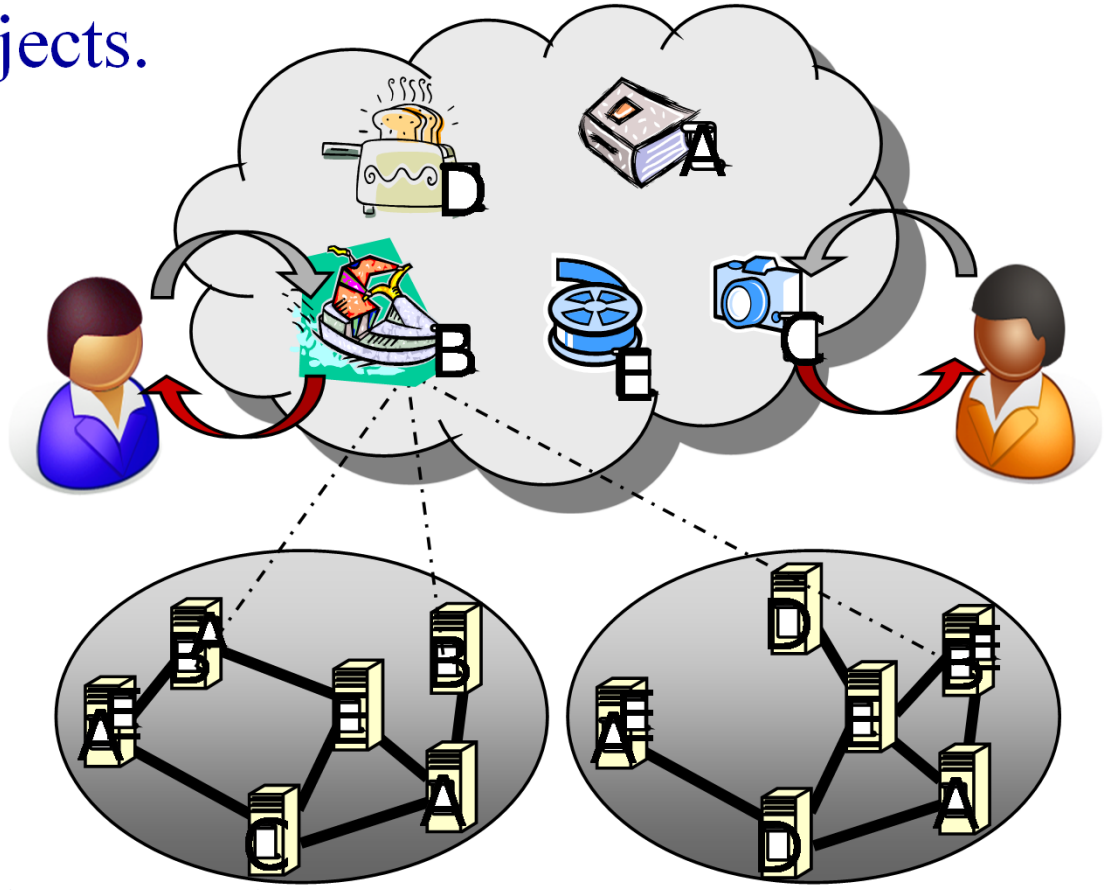
- Networks' will evolve to "self-management", coping with complexity.



(*4WARD, 2009*)

Network of Information

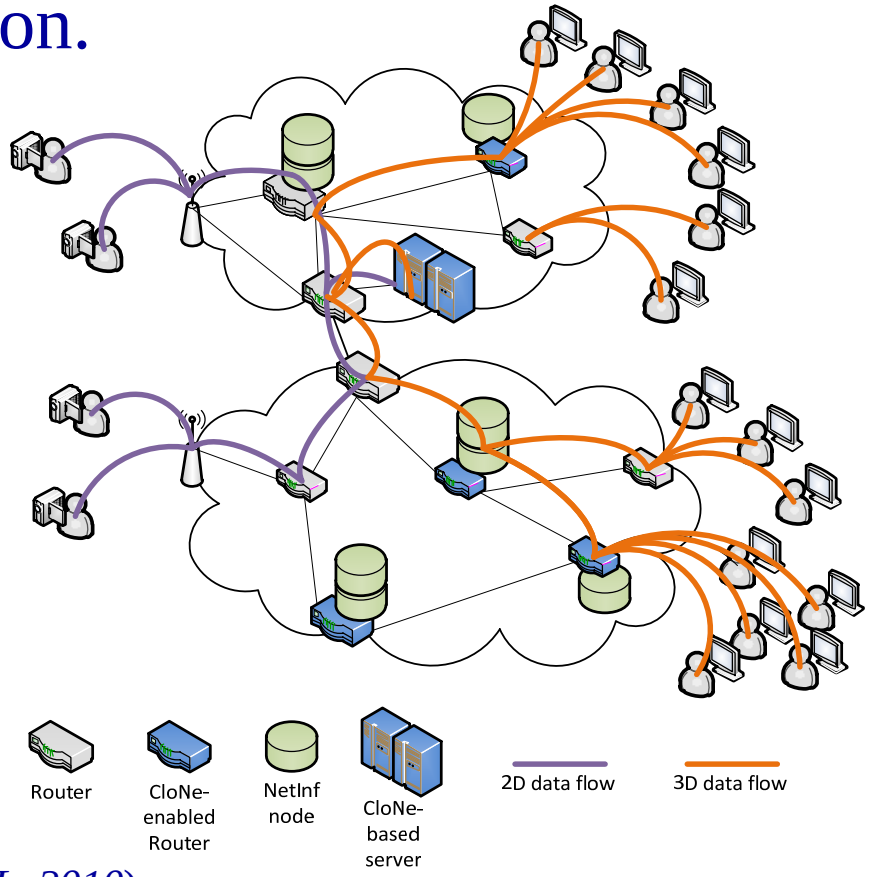
- Information centric networks will enable a new perspective to the delivery of information, based on objects.



(*4WARD, 2010*)

Cloud Networking

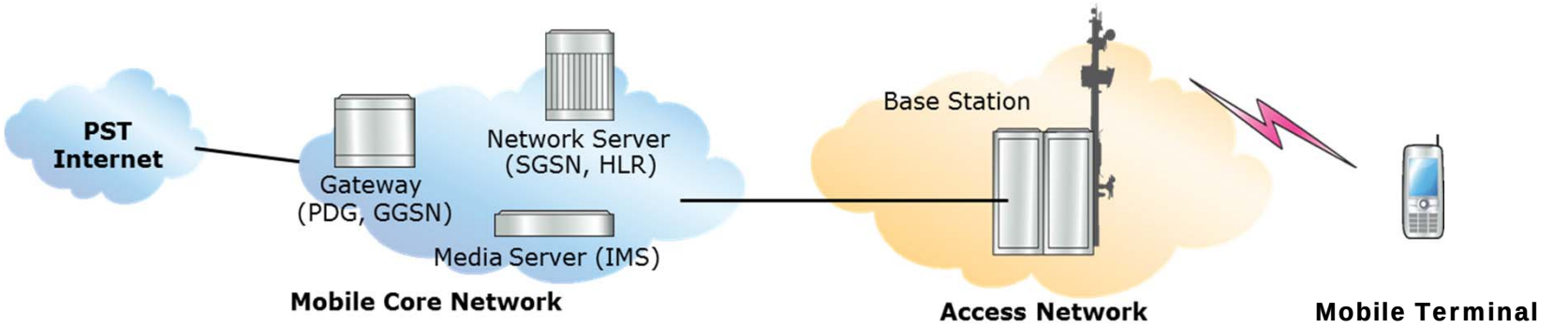
- Cloud computing and networking will provide a very efficient means to process and distribute information.



(*SAIL, 2010*)

Energy Efficiency

- The energy efficiency of networks became a key issue.



Energy Consumption

10-20% **70-80%** **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.

(*oneness4all, 2010*)

- Smart Cities involve quite a number of topics within ICT, but extend to other areas in a transdisciplinary approach.

(*artandecology, 2009*)

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).

SmartCities
(*smartcities, 2010*)

europeansmartcities
(*smart-cities, 2009*)

(*smartsantander, 2010*)

(*smartcityevent, 2011*)

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*)

(*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.

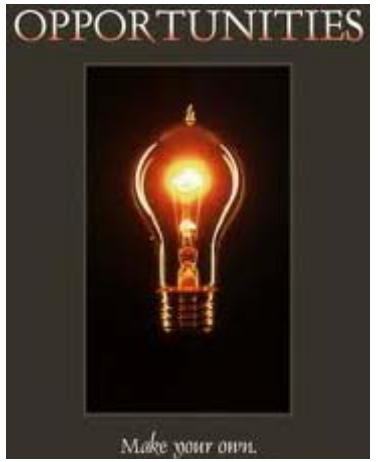
(*foodallergens, 2007*)

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

(*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.

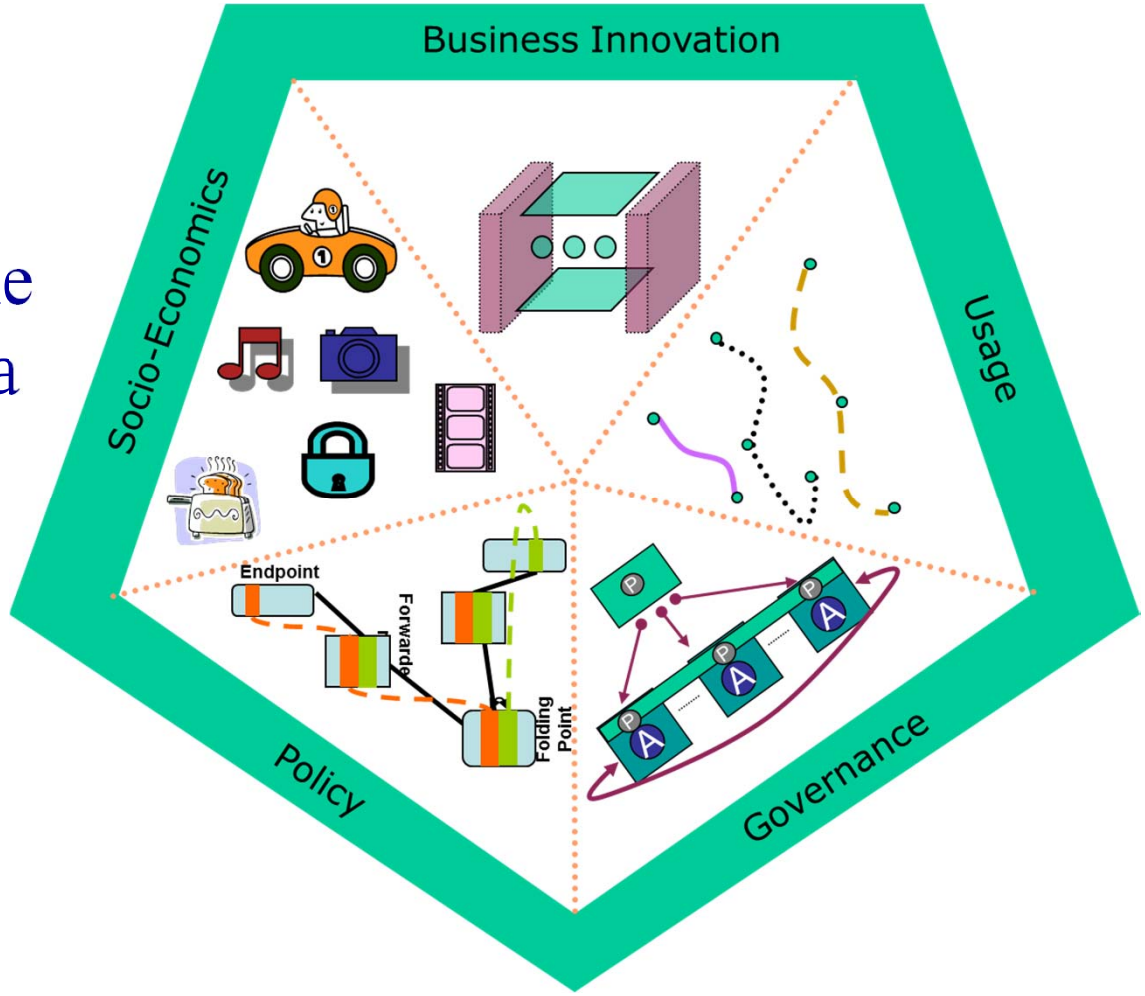
(*TheTelegraph, 2008*)

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

(*EC, 2006*)

A Broader View

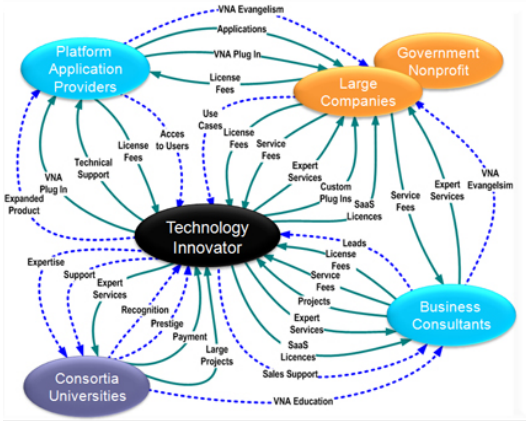
- When dealing with the application of technology, one needs to have a broader view, beyond the technical aspects.



(*4WARD, 2010*)

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.



(*vernaalle, 2010*)

(*digiphile, 2010*)

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.

(Techshout 2010)

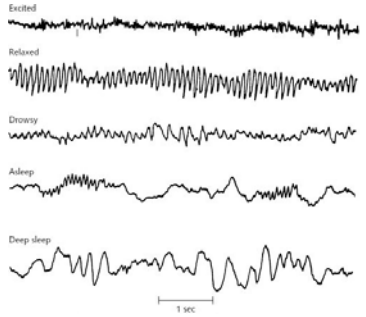
(Medgear 2010)

(Pricein c 2010)

(Ennoki 2010)

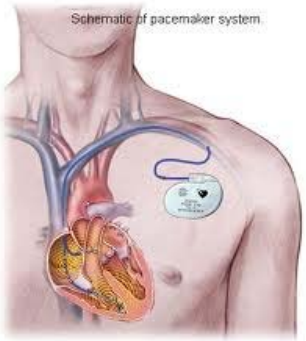
Health, Inclusion and Assisted Living (2)

- 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.

(*IDRC 2010*)

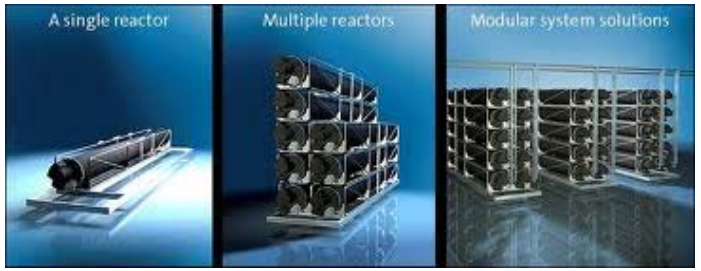
(*vehicletrack 2010*)

(*automk 2010*)

(*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*)

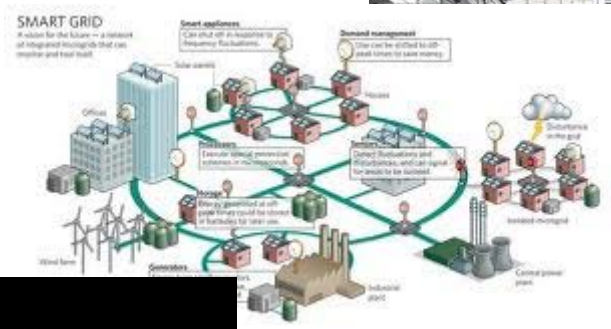
(*USurrey, 2008*)

(*Apple, 2010*)

Environment and Energy Efficiency (1)

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

(*best buildings 2010*)



(*consumerenergy 2010*)

(*solarstreet 2010*)

(*allthingsgreen, 2010*)

Environment and Energy Efficiency (2)

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

(*masternewmedia, 2009*)

(*digikey, 2009*)

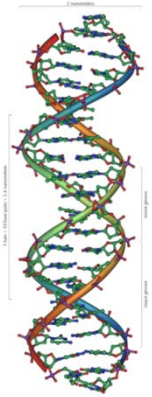
(*headway, 2010*)

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, ...).



(*Wikipedia, 2008*)

(*RICS, 2008*)

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

(*PBASE, 2008*)

- Will there be ethical barriers, like those existing today in biology/medicine?

(*Amazon, 2008*)

National Ethics Committee on Assisted Human Reproduction

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?

(*Tecnotrekos, 2008*)

(*Swissbank, 2008*)

(*GeeAyBee, 2007*)

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.