

“ICT research cooperation  
without Borders”  
11th International Conference  
on Telecommunications for  
Intelligent Transport Systems

23 – 25 August 2011  
Saint-Petersburg, Russia

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## Outline

- **Introduction to Net!Works**
- **Economic importance of broadband networks**
- **Net!Works vision**
- **Strategic Research Agenda**
- **Research cooperation**
  - **Research activities in Europe**
  - **FP7 Work program**
- **Success stories of collaborative research**
- **R&D priorities towards societal challenges**
  - **Network architecture, service platforms and interfaces**
  - **Radio access – Are we using the spectrum efficiently?**
- **Conclusion**

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## Introduction of Net!Works

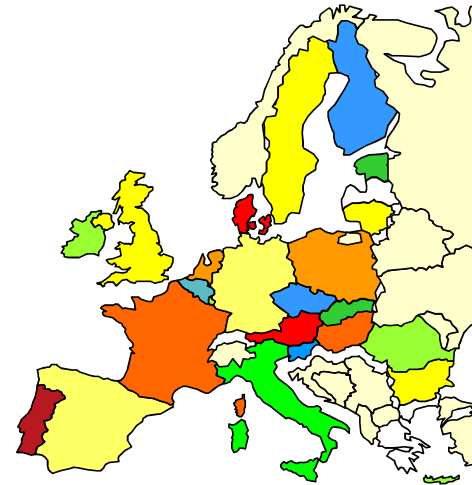


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## Contributions to European Innovation Roadmap

- European Technology Platforms contribute to
  - EU Framework Programs on
    - updates of the Work Program
    - new Framework Programs
    - review and potential design of new instruments
    - PPPs, JTIs or JUs, Joint Programming and ELSA's
  - Eureka Clusters
  - ERA-Nets
- Requires cooperation and finally agreements of Member States and the EU Commission



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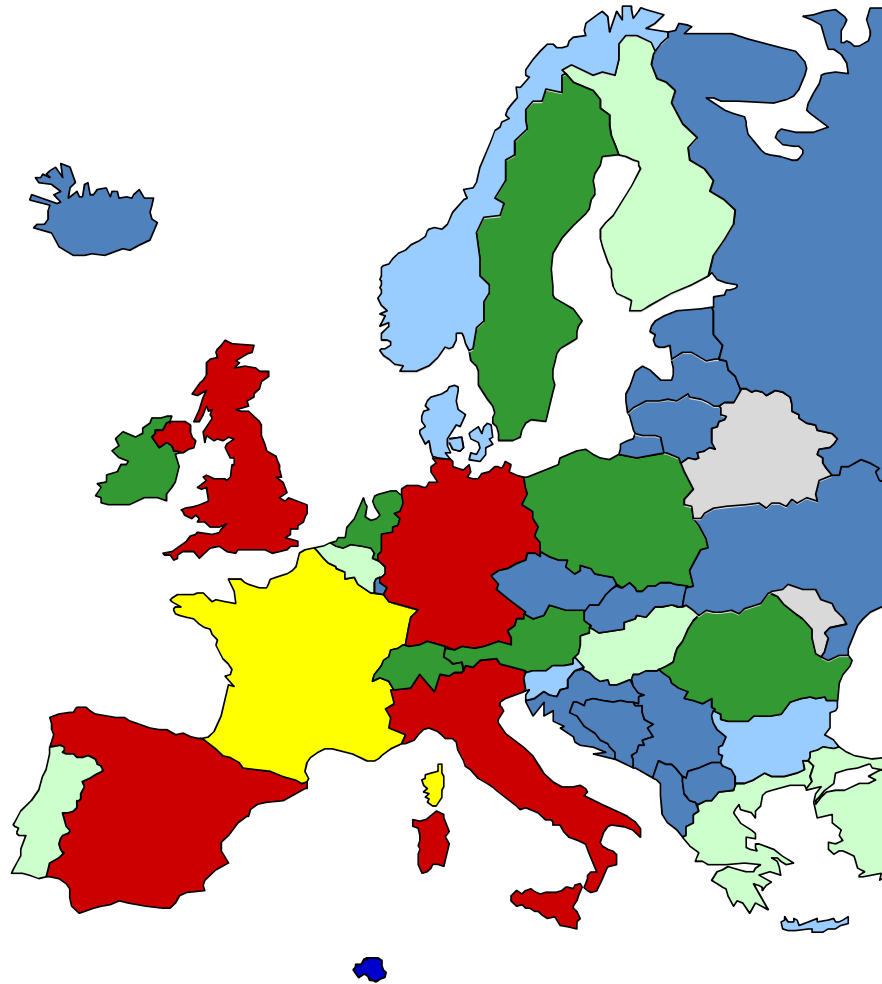
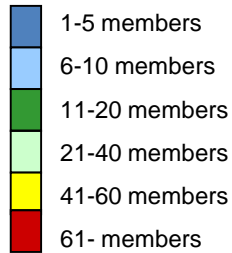




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## Membership – 795 members

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Total number of members **795**

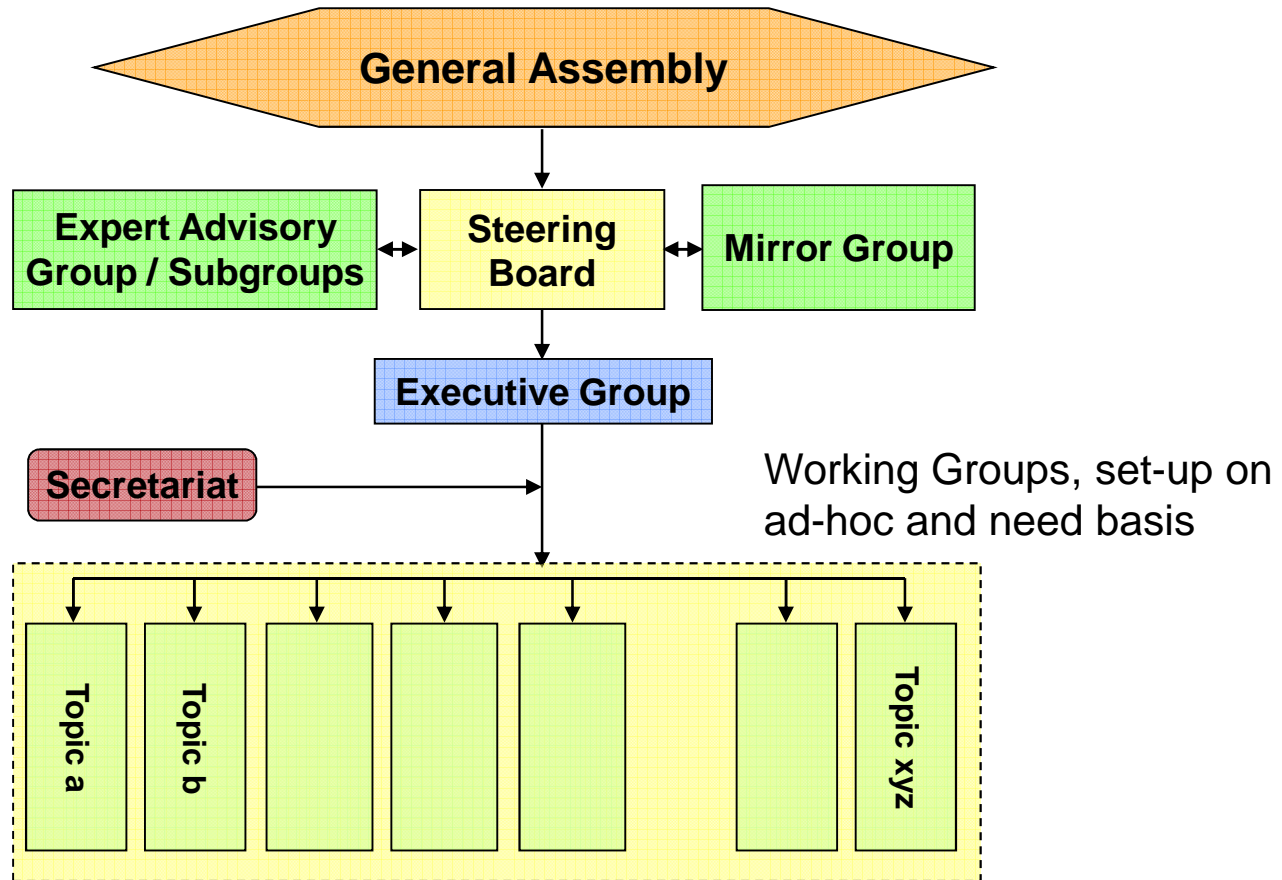
- Industry **141**
- Research **298**
- SME **298**
- Cooperation members **58**

Steering Board of 25 members (all elected)

- +
- Expert Group
  - Mirror Group
  - Executive Group



# Structure of Net!Works European Technology Platform



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## Net!Works is working for you!

- **Setting trends and giving you the latest information**
  - **Net!Works Vision**
  - **SRA Version 8** to be an eBook including
  - **Strategic Applications Agenda** (Health, Transport, Environment)
  - **Newsletters** and email **news**
  - **Presentations and special sessions** at conferences
  - **Exhibition stands** at major events
  - **White papers** contribute to SRA
- **Organising networking opportunities for you**
  - **Workshops** – Green Wireless, Future Internet, Applications ...
  - **Calls 4, 5, 6, 7, 8** networking meetings
  - Many active **expert groups** for SRA issues
  - Working closely with **Photonics21 WG 1** and ETP's in other domains
  - **ICT Future Network and Mobile Summit** – Net!Works the major sponsor for 2008 to 2012
- **Influencing priorities for public research funds for you – communicating our messages**
  - **“Europe has an untapped asset in it's network infrastructure and knowledge”**
  - **Priorities defined** by members for the use of research funds
  - Developing **consensus** on priorities with Mirror Group, ETP's, projects
  - **Consultations** by EU answered by Net!Works SB
  - Priorities of **SME's** in participating in FP 7 investigated

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## Net!Works and the Digital Agenda (1/2)

- The “Digital Single Market” Priority  
Net!Works supports the development of all new technologies that make possible a digital single market to exist.
- The “Interoperability and Standards” priority  
Net!Works cooperates with the Commission and with other ETPs in order to develop interoperable standards.
- The “Trust and Security” priority  
Net!Works-related research projects will help Europeans feel that they can fully rely upon their networks.
- The “Fast and Ultra Fast Internet Access” Priority  
Investing in R&D in this sector is the only solution to develop the appropriate innovative technologies.

Digital Agenda  
1001100101011101110000100 2010-2020  
for Europe

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## Net!Works and the Digital Agenda (2/2)

- The “Research and Innovation” priority  
Research and innovation on broadband fixed and mobile communication systems is the core of Net!Works.
- The “Enhancing Digital Skills, Literacy and inclusion” priority  
Bringing Internet access subscriptions above 100 Mbps to 50% of Europeans will ensure that websites providing public services are accessible to all citizens.
- The “ICT-enabled benefits for EU society” priority  
Supporting solutions for Grand Societal Challenges such as climate change, health, aging population

Digital Agenda  
1001100101011101110000100 2010-2020  
for Europe

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## Net!Works and the Grand Societal Challenges

- The “Environment and Energy Efficiency” Challenge  
Monitoring environmental parameters, and providing the means to have alarms; Efficient resources management; Technology waste.
- The “Health and Demographic Change” Challenge  
Future wireless diagnostic and disease management systems; hospital consultation and emergency scenarios; assistive technologies; well being and personalisation.
- The “Transport” Challenge  
Urban and road traffic control; efficient trip management; vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications; the mobile office.



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## Net!Works and the Innovation Union

- Net!Works is contributing to preparation of “Framework Program 8” on
  - Research priorities
  - Implementation of the program
- Cooperation with other European Technology Platforms towards a white paper on Innovation
  - How to cooperate on Innovation
  - How to improve bringing research results to the market
- How to contribute to Grand Societal Challenges



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## **Economic importance of broadband networks**

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## Economic importance of the telecoms sector (1/2)

- A strong European leadership in communication networks is important for Europe's economy:
  - In the European Union, ICT contributes to 50% of the economic growth (directly or indirectly).
- According to the Information Technology & Innovation Foundation, a \$10 billion investment in 1 year in broadband networks would create almost 500 000 jobs in the US.
- 7 of the 10 largest telecoms operators in the world are from Europe.

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## Economic importance of the telecoms sector (2/2)

- In 2007 the ICT sector represented <sup>1)</sup>
  - 4.8 % of GDP (€ 540 billion)
  - 3 % of total employment (6.1 million employees)
  - accounted for 25 % of overall business expenditure in R&D and employed 32.4 % of all business sector researchers
- Major manufacturers in communications based in Europe
- Global figures of Alcatel-Lucent, Ericsson and Nokia (including Nokia Siemens Networks <sup>2)</sup>
  - Total R&D: 10.1 billion € in 2009
  - Total sales: 76.3 billion € in 2009
  - Total employees: 287900



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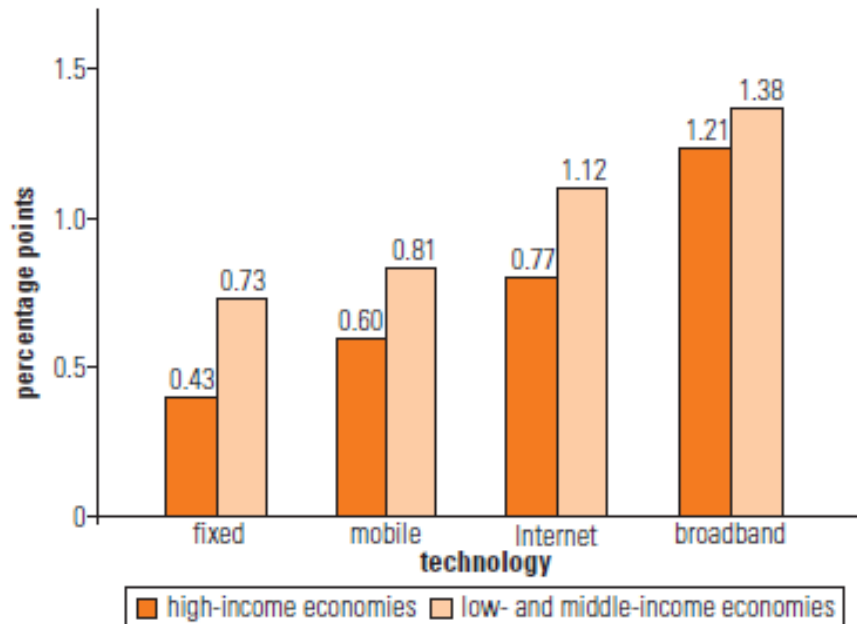
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- [1] European Commission: The 2010 report on R&D in ICT in the European Union. Joint Research Centre, Institute for Prospective Technological Studies, 2010. <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3239>
- [2] European Commission: Monitoring industrial research: the 2010 EU industrial R&D investment SCOREBOARD. Joint Research Centre. DG Research, 2010. [http://iri.jrc.ec.europa.eu/research/docs/2010/SB2010\\_final\\_report.pdf](http://iri.jrc.ec.europa.eu/research/docs/2010/SB2010_final_report.pdf)

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## Impact of broadband networks on GDP



Source: Qiang 2008

Note: The y axis represents the percentage-point increase in economic growth per 10-percentage-point increase in telecommunications penetration. All results are statistically at the 1 percent level except for that of broadband in developing countries, which is at the 10 percent level.

- [1] World Bank. Information and Communication for Development: Extending Reach and Increasing Impact. 2009, <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/EXTIC4D/0,,contentMDK:22229759~menuPK:5870649~pagePK:64168445~piPK:64168309~theSitePK:5870636,00.html>
- [2] Nokia Siemens Networks: Connectivity Scorecard – Broadband Impact Study. 2009, <http://www.oecd.org/dataoecd/32/43/43760161.pdf>.

- Study indicates that increased broadband penetration can generate GDP growth up to 1.38 percentage-points <sup>1)</sup>
- Nokia Siemens Networks Broadband Impact Study (2009) suggests that broadband strategies can increase national productivity growth potential up to 15 % <sup>2)</sup>
- For example, the US increased its GDP by \$100 billion with an increase of 10 additional broadband lines per 100 individuals (30 million lines)

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**Net!Works vision**

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## Vision for the next decade

"The improvement of the Individual's (Society) quality of life,



Individuals



Families



Groups



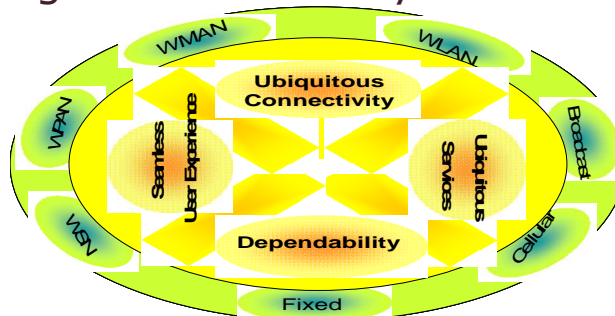
Social Communities



Achieved through the availability of an environment

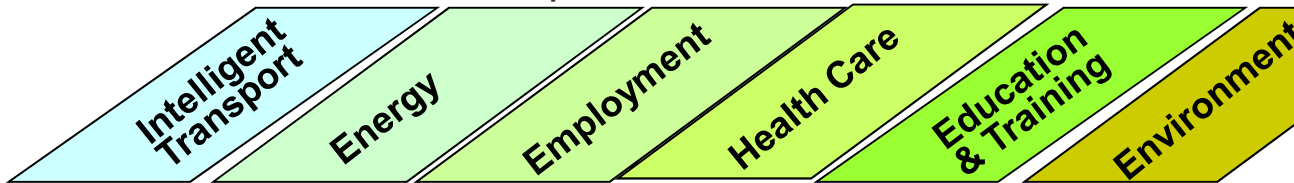


SMLEs

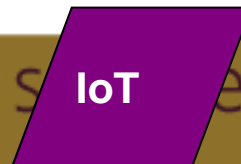


B2B

For instant provision and access



Meaningful, Multi-sensory information and content"



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## Vision 2022

- Empowered people – “**Your one life**”
  - Your life in “the cloud”
  - You have a voice in communities
  - You trust your services
- Empowered **Innovative** Societies
  - Networks enable innovation in services for ITS, environmental monitoring, eHealth, cultural experiences
- **Turbo-charged** systems
  - Focus on Simplicity to deal with growing complexity
  - Step improvements in efficiency in all parts of networks and the interactions with applications
  - Growth in short range and NFC
  - Roll out of broadband speeds up
- **Multi-disciplinary** research and innovation in focus!

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# Strategic Research Agenda

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## SRA basis

- Future of Mobile/Wireless roles
  - Vision of future from society’s needs perspective in next decade
  - Taking into account societal challenges
- Strategic Technologies and Research Challenges
  - Full connectivity of things (people, objects, machines)
  - Dependable and trusted ICT infrastructure
  - Cost reduction (multi-parameter)
  - Managing complexity automatically
  - Open and universal Interfaces to facilitate service innovation
  - High Efficiency solutions (Spectral and EE)

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## Networks of Future Towards Future Internet

- Integration of Physical and Digital worlds in 2D and 3D
  - Towards multi-sensory virtual reality integrating all human senses (smell, touch, etc.)
- One person with many devices with device to device and peer to peer connectivity
  - Short as well as long range connectivity (M2M Communications)
  - Simultaneous and parallel Connectivity
  - Personal Broadband Communications everywhere (Home & on the Move)
- Networks for both Information and Communication Technologies
- Ubiquitous connectivity for services networking
- More emphasis on security, privacy, trust and Dependability/Robustness
- Intelligent Networking, Self-organisation & network management & QoS complexity management leading to Energy, Spectral and Operational Efficiencies. (5th Generation of Mobile Systems)

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## **SARA – Table of content**

Executive Summary

Ch. 1 Introduction and Methodology

Ch. 2 Vision of the Future Mobile and Wireless Communications

Ch. 3 Research Methodology

3.1 SET Concept

3.2 Building on Europe’s Strengths

Ch. 4 Applications

Ch. 5 Context Provisioning and User Profiling for User-Centric Services

Ch. 6 Trust, Security, Dependability and Privacy

Ch. 7 Machine-to-Machine Communications

Ch. 8 Cognitive Radio Systems

Ch. 9 Broadband Mobile Systems

Ch. 10 Optical Fibre Technologies and Radio over Fibre

Ch. 11 Mediation Bus for Ubiquitous Services

Ch. 12 Future Internet, a Parallel Internet

Ch. 13 Green Wireless Communications

Ch. 14 Way Forward

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## White Papers and SARA chapters structure

- Rationale
- Research Priorities
- Recommendations (where appropriate)
  - Researchers (academia & Industry)
  - Research approach
  - Standardisation
  - Research funding organisations and agencies

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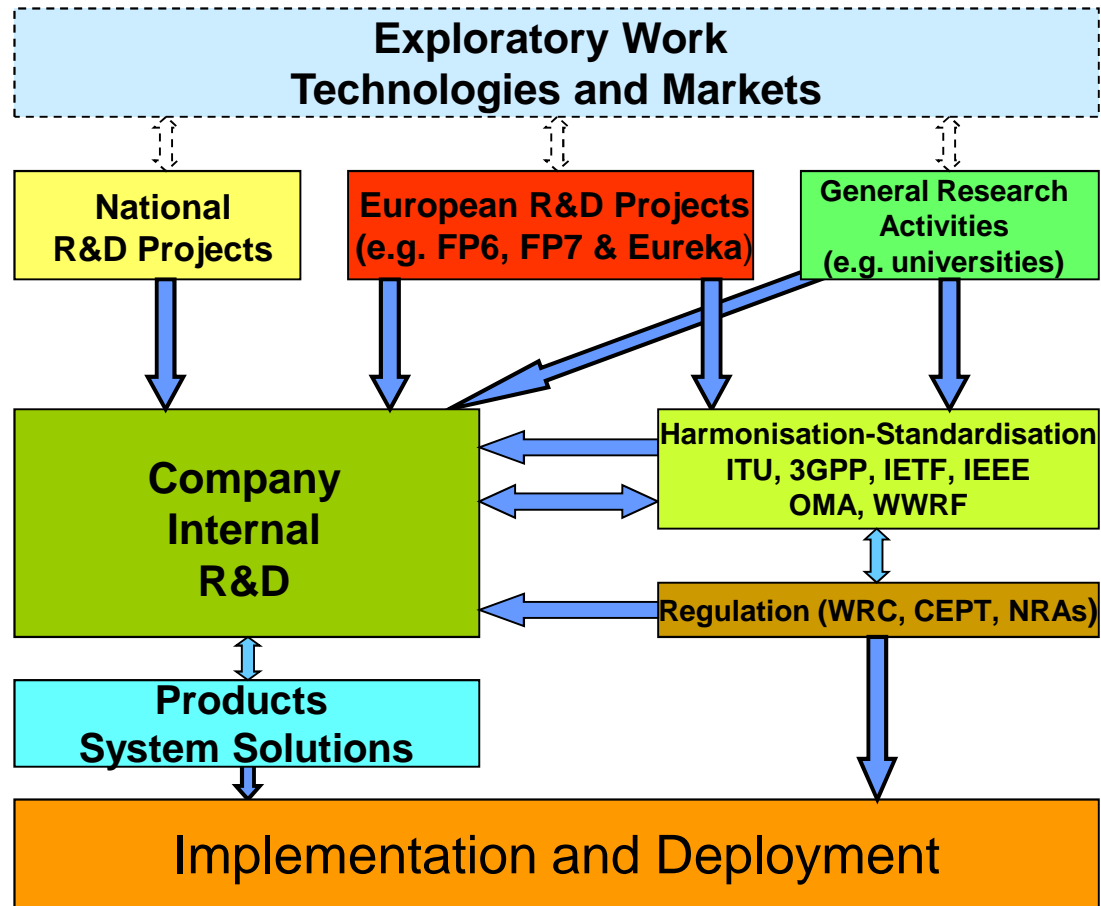


**Research cooperation**

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# The value chain from research to global products



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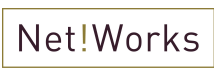






## Means for cooperation in funded projects in Europe

- Europe provides means for cooperation between stakeholders
    - manufacturers
    - network operators
    - service and content providers
    - SMEs
    - universities and R&D centers
- in funded projects on national and/or European level

### • Actual EU framework program

-  Sixth Framework Programme Framework program 6
-  Seventh Framework Programme Framework program 7
-  Celtic  ITEA e.g. Eureka clusters (Celtic, Itea 2)

### • European Technology Platforms and Joint Technology Initiatives

-  Net!Works  EPoSS  ETP  NEM  NESSY  PHOTONICS<sup>21</sup> 

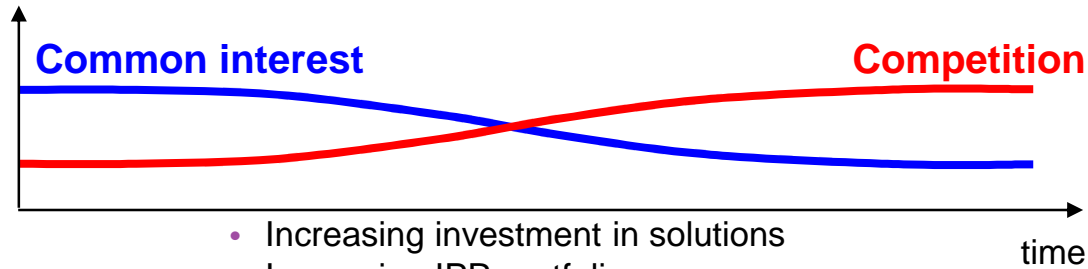
### • National programs (examples)

- e.g.  Bundesministerium für Bildung und Forschung  TEKES

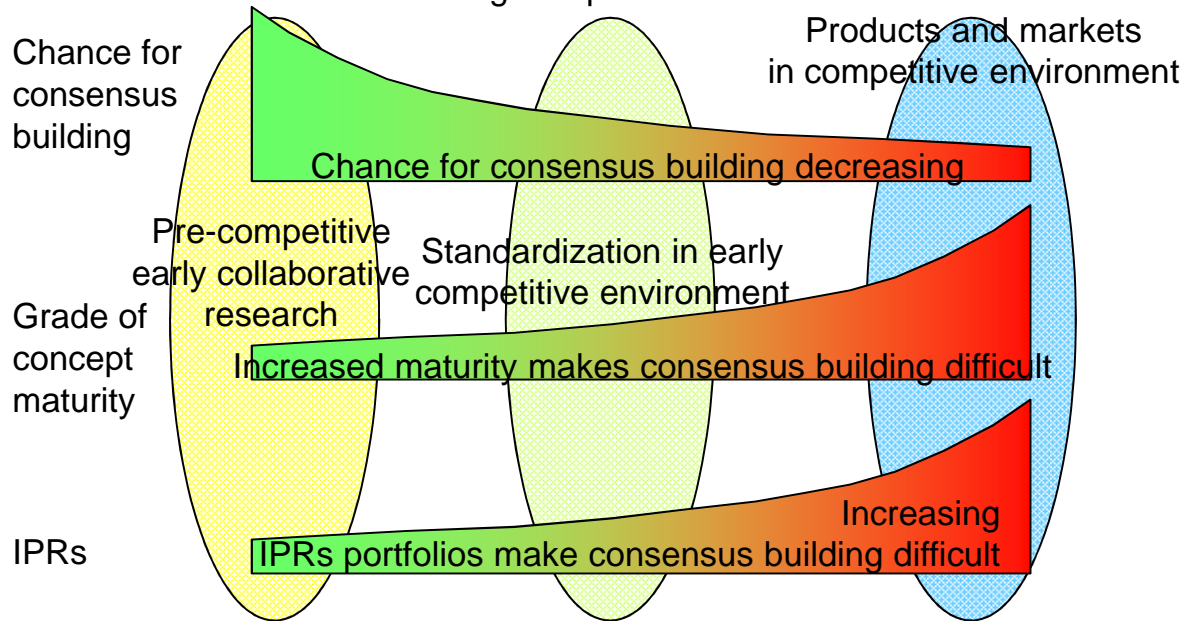
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# Collaborative research: International consensus building at an early stage



- Increasing investment in solutions
- Increasing IPR portfolios



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## EU Work Program 2011 - 2012

Overall objective of that period

- Improving the competitiveness of European industry and enabling Europe to master and shape future developments in ICT so that the demands of its society and economy are met
- ICT is at the very core of the knowledge-based society
- Activities will continue to strengthen Europe's scientific and technology base and ensure its global leadership in ICT, help drive and stimulate product, service and process innovation and creativity through ICT use and value creation in Europe, and ensure that ICT progress is rapidly transformed into benefits for Europe's citizens, businesses, industry and governments.
- These activities will also help reduce the digital divide and social exclusion.



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Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## Expected breakthroughs in period 2015 to 2020

- Alternative paths towards the next generation components and systems
- Multi-core architectures
- Future Internet
- Networked media and content technologies
- More intelligent and smart environments
- Future developments of ICT driven to a large extent by
  - emerging societal challenges
  - support targets for
    - lower carbon emissions not only with ultra low power consumption ICT devices and equipment
    - through ICT solutions for better energy efficiency, lighting, virtual mobility and more efficient environmental simulation and monitoring
  - strengthened substantially ICT's contribution to sustainability

Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## Challenges in the Work Program

- Challenge 1: Pervasive and Trustworthy Network and Service Infrastructures
- Challenge 2: Cognitive Systems and Robotics
- Challenge 3: Alternative Paths to Components and Systems
- Challenge 4: Technologies for Digital Content and Languages
- Challenge 5: ICT for Health, Ageing Well, Inclusion and Governance
- Challenge 6: ICT for a low carbon economy
- Challenge 7: ICT for the Enterprise and Manufacturing
- Challenge 8: ICT for Learning and Access to Cultural Resources
- Future and Emerging Technologies
- International Cooperation
- Horizontal Actions

Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## ICT technologies and infrastructures

- ***Pervasive and trusted network and service infrastructures:*** Covers tools and platforms for novel Internet application development and deployment through launch of a Public-Private Partnership on Future Internet. Key technological developments in networking, digital media and service infrastructures of the future addressed
- ***Cognitive systems and robotics:*** Aims to enhance performance and manageability of artificial cognitive systems and to expand and improve functionalities of robotic systems
- ***Alternative paths to components and systems:*** Focuses on further miniaturisation and increased performance in electronic and photonic components, in micro/nanosystems integrating functionalities like sensing, actuating, communicating, in alternative routes to new components and systems such as organic electronics and in multicore computing systems, embedded systems, monitoring and control, and cooperating complex systems
- ***Technologies for digital content and languages:*** Aims to enable individuals and small organisations to create quality content and innovative services and at allowing people to access and use online content and services across language barriers

Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## Europe's major socio-economic challenges

- **ICT for health, ageing well, inclusion and governance:** Focus on ICT for disease prediction, early diagnosis, prevention, minimally invasive treatment, and overall disease management and support to healthy lifestyles as well as ICT solutions for prolonging independent living and for extending active working life
- **ICT for a lower carbon economy:** Concentrates on development of ICT to achieve substantial efficiency gains in distribution and use of key resources such as energy and water, as well as application of ICT to decarbonise transport and make it safer. ICT contributions to Public-Private Partnerships on Energy Efficient Buildings and on Green Cars
- **ICT for manufacturing & factories of the future:** Incorporates ICT contributions to Public-Private Partnership on Factories of the Future. It aims to improve the technological base of manufacturing across a broad range of sectors
- **ICT for learning and access to cultural resources:** Objective to develop technologies and methodologies that make people learn more effectively and support acquisition of new skills. Aims to ensure effective use and exploitation of cultural resources

Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## Funding schemes

- Collaborative projects (CP)
  - IPs
  - STREPs
- Networks of Excellence (NoE)
- Coordination and support actions (CSA)

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Source: EU Commission: ICT – Information and Communication Technologies, Work Programme 2011-12.

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## Success stories of collaborative research

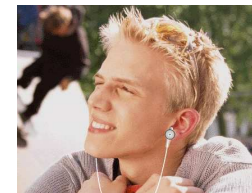
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## Communications success stories

- Most successes from the European networking industry projects are “invisible” for general public: mobile communication standards, ADSL, optical broadband ...
- European collaborative R&D projects have contributed in the development of
  - the third-generation mobile systems, the most widely adopted system in the world, and
  - the LTE and IMT-Advanced for broadband mobile.
- Cooperation of all sectors necessary along value chain from physical layer software technology, applications and enabling technologies for economic successful solutions

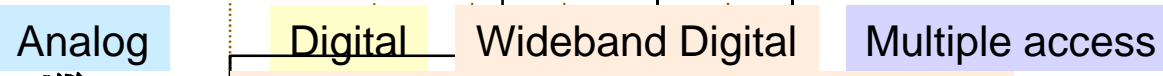
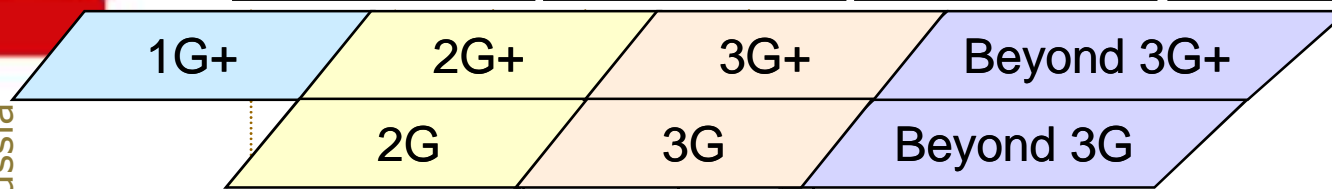
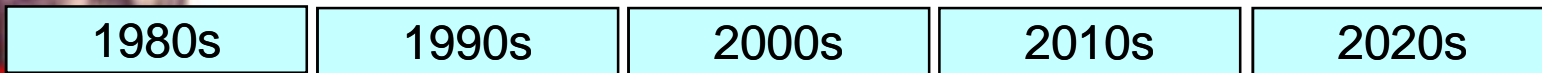


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# European research programs on mobile and wireless communications



European research on 3G started in 1989 within the RACE I program and 1991 in RACE II



European research on 3G continued in 1995 within the ACTS program



European research on systems beyond 3G started in 1999 within the IST program



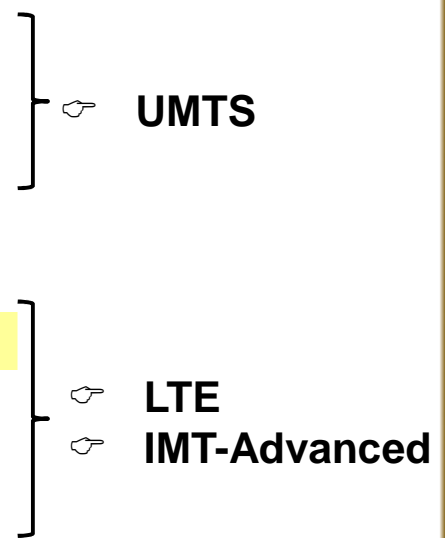
Framework Program 6 on future systems



Framework Program 7



Eureka Celtic Cluster



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Source: Nokia Siemens Networks

# Success stories



1991

The development of the **GSM** standard was part of the early formation of the European Union at the level of technology and mobile communications. For the first time, a solution was developed for Europe and the world enabling users to roam internationally using only one phone. Europe pooled its R&D, industrial base and services to provide the user with a mobile world without national borders. This initiative and the further collaborative R&D created a new generation of technologists focused on European and global needs.

The GSM group was formed in 1982. GSM networks are now accessible in more than 85% of the world's land area.

**First commercially introduced in 1991**



2001

European research projects developed the key contributions to the **3G UMTS** standard in the '90's. 3G systems provide users with broadband multi-media mobile communications, including voice and video services, mobile Internet access, mobile TV services and machine to machine communications services. Key Framework Programme co-funded project:

FRAMES (FP 4)

**First introduced in 2001**



2010

European research projects developed key contributions to the **LTE system** in the '00's. **LTE** provides high speed mobile broadband connectivity to laptops, smart phones, tablet PC's and other mobile devices. On-line gaming services, streamed video and cloud computing services are brought to life by LTE.

The LTE service is already commercially available in Stockholm and is being introduced widely in European cities in 2011.

Key Framework Programme co-funded projects:

WINNER (FP 6),  
WINNER II (FP 6)

**First introduced in 2010**



**future**

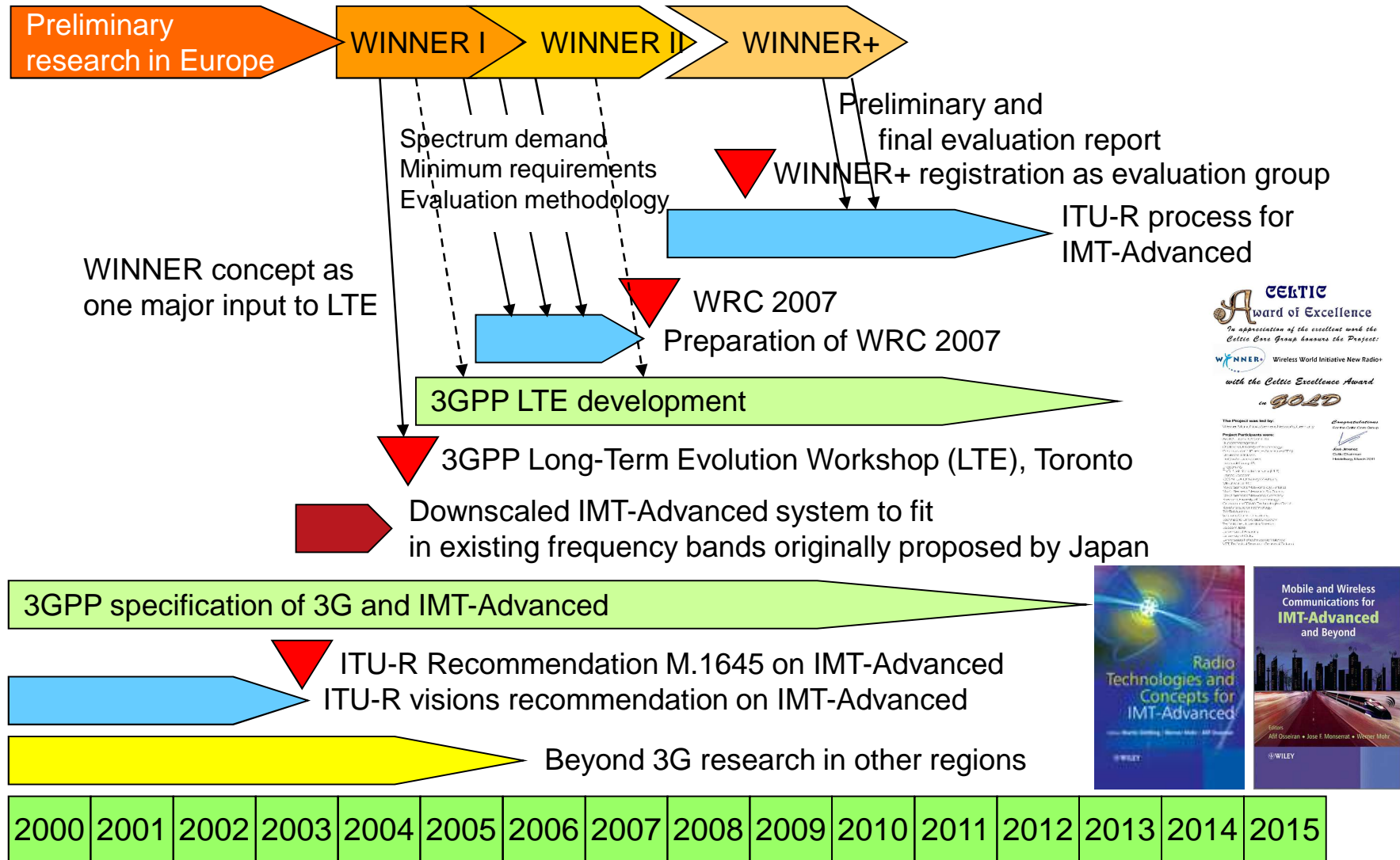
The technical basis for ultra high speed broadband and M2M communication using energy efficient techniques are research challenges being addressed in Framework Programme 7 projects at present. European research has to continue in Framework Programme 8 to ensure that European organisations further develop their leadership positions in communications technologies!

**2025 and beyond**

Source: Net!Works European Technology Platform

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# Impact of WINNER / WINNER+





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## **R&D priorities towards societal challenges**

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## Priorities in R&D (1/2)

- Europe must continue strengthen its position in the telecommunication sector in order to remain the worldwide leader
- ICT is essential for continued economic growth and job creation in Europe across all industry sectors and society
- Research on new networks and services has to start now to be ready
  - to support the mass market use of new applications in 2020 and
  - in particular to support solutions for Grand Societal Challenges



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## Priorities in R&D (2/2)

- With respect to Grand Societal Challenges research priorities in different areas
  - Applications (Health, transport, environment, Future Internet as key enabler)
  - Context provisioning, user profiling for user-centric services (Management, security, trust, privacy)
  - Roadmaps on standardisation, regulation and technology
  - Trust, security, dependability and privacy
  - Mobile and wireless communication (Complexity, connectivity, user devices, network management, roaming and routing, self-organising networks)
  - Machine-to-machine communications – Internet of Things (Autonomous operation, ubiquitous connectivity, interoperability, context awareness)
  - Cognitive radio systems (Cognitive networking, cognitive radio platforms)
  - Broadband mobile systems (Evolution of cellular mobile, new networking)
  - Optical fibre technologies and radio over fibre (Optical network switching, RoF subsystems and components, optical-wireless component integration)
  - Future Internet (Key enabler for Grand Societal Challenges)
  - Green wireless communications (Terminals, infrastructure, networking, deployment, operation)

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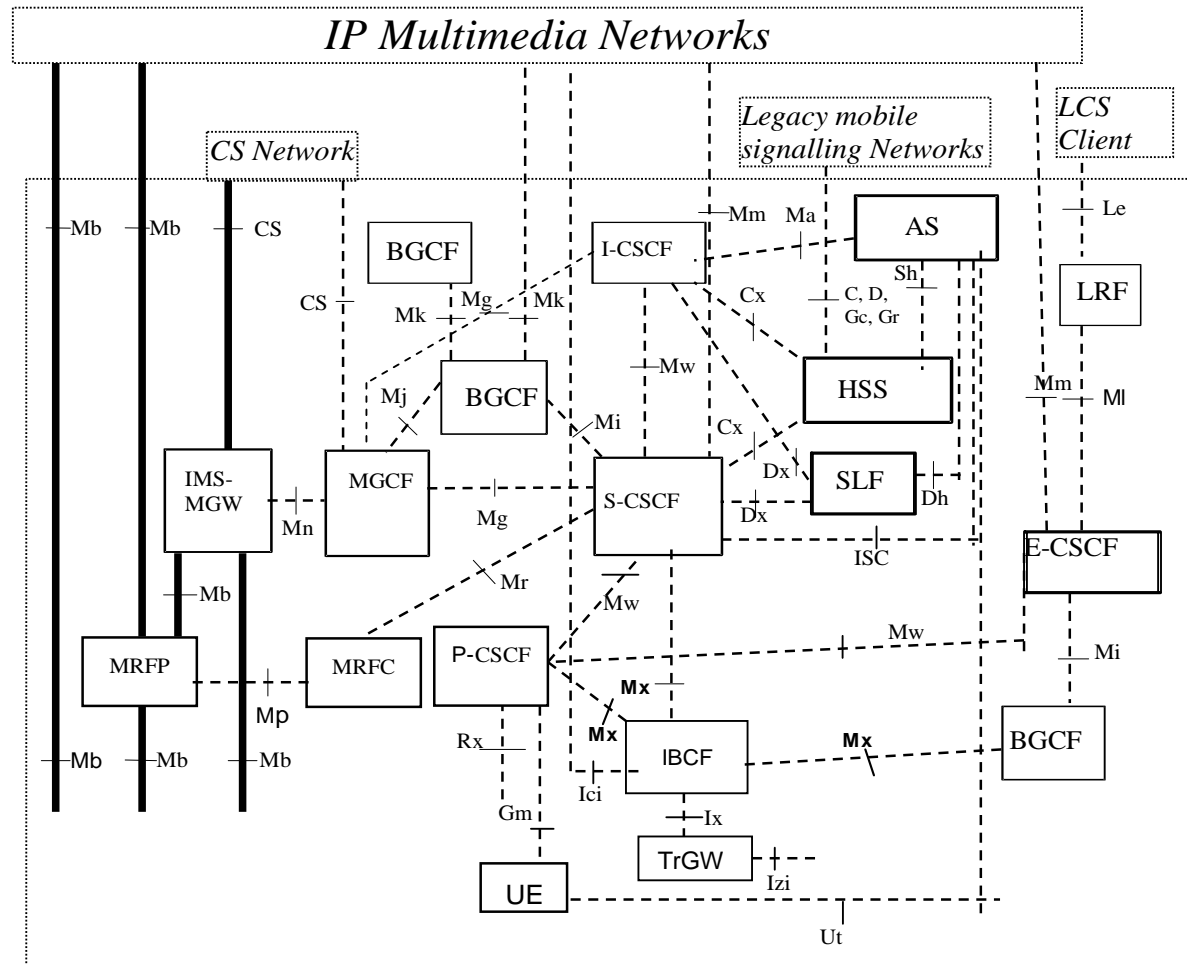
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# **Network Architecture, Service platforms and Interfaces**

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# Walled garden service approach (IMS)



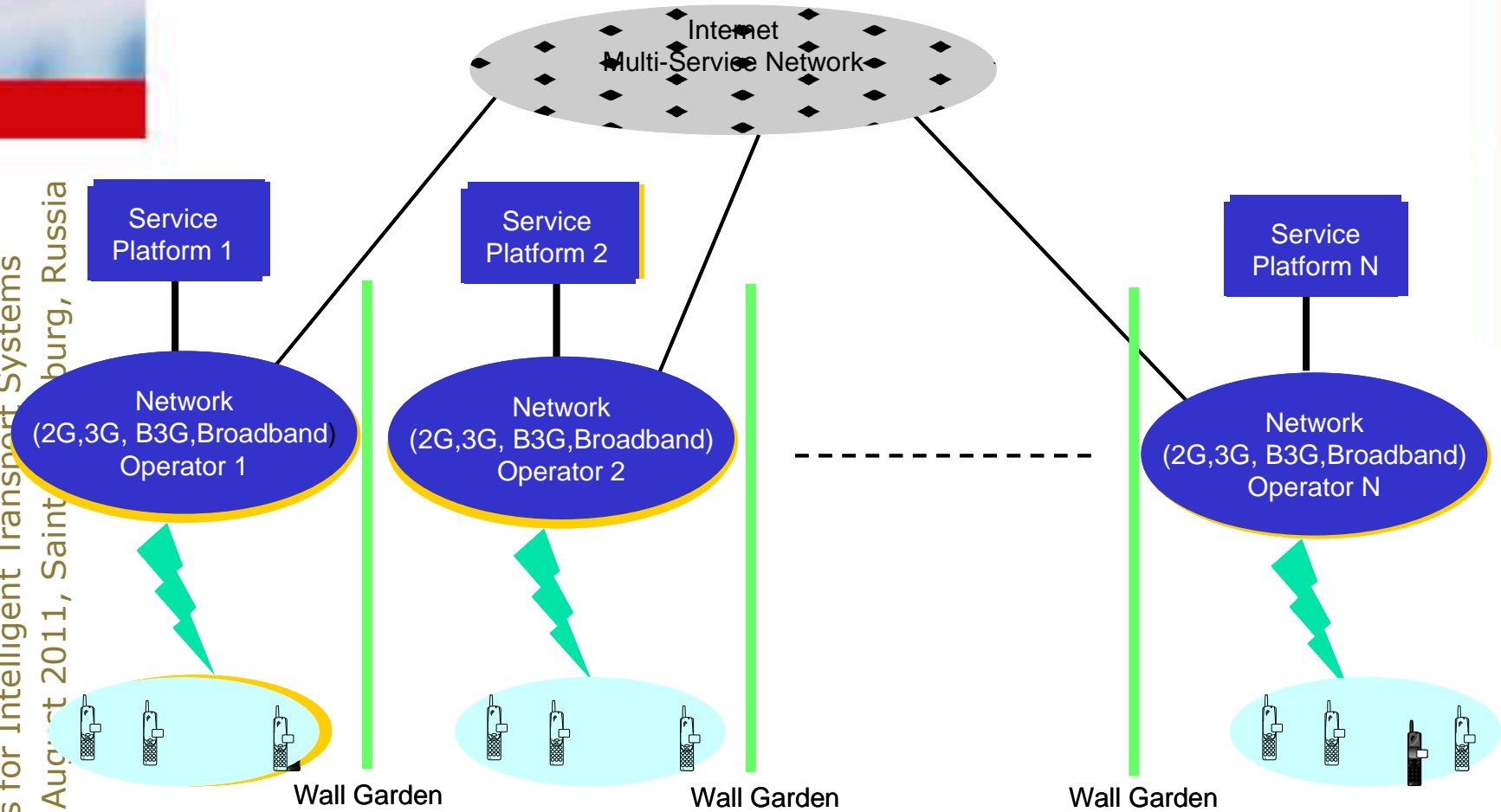
Source: 3GPP TS 23.002

Highly complex infrastructure: 17 logical elements and 24+ interfaces

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# Today's mobile networks



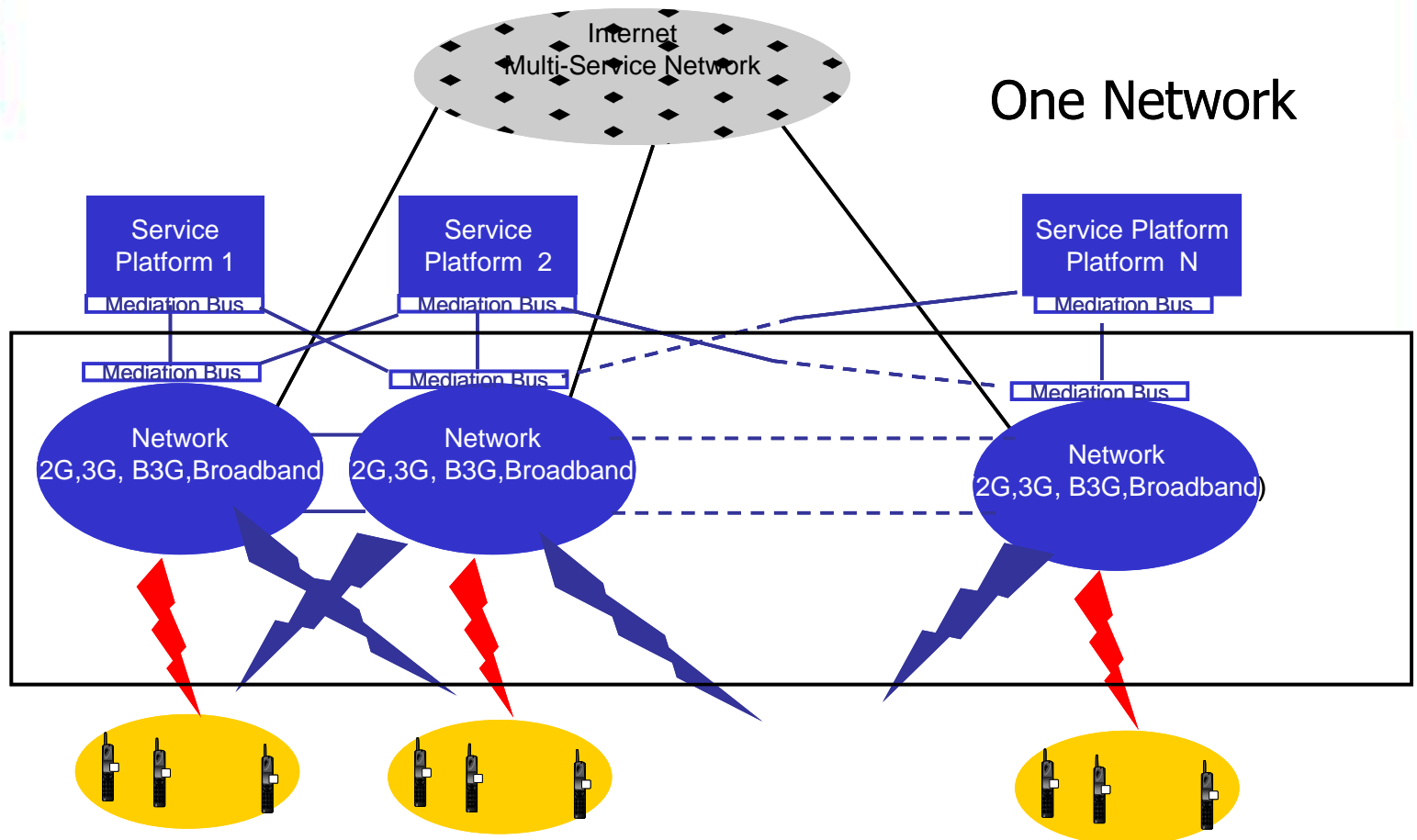
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# Tomorrow's mobile networks Complete network sharing

One Network



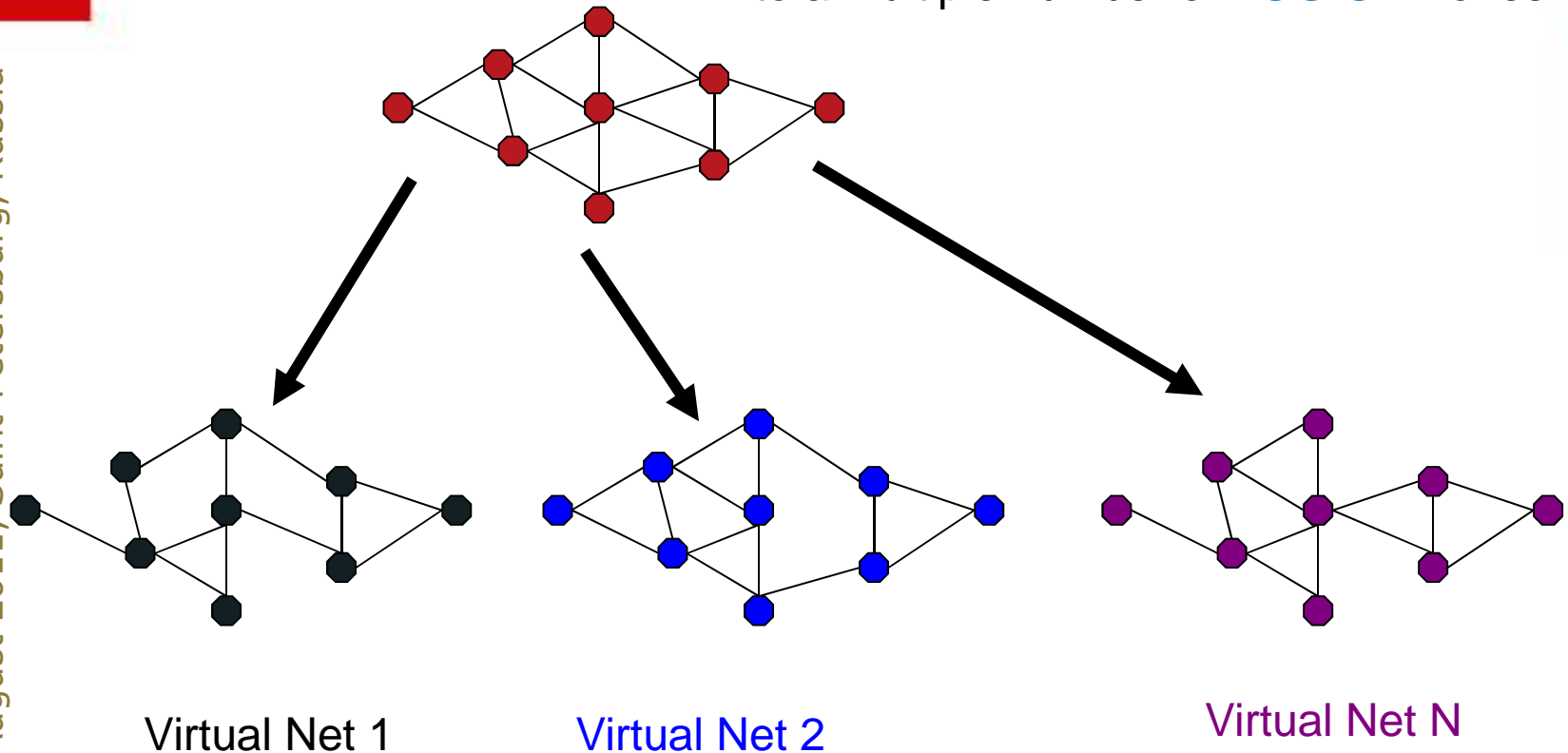
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# Evolution = One Network + Network Virtualization

Mapping a **PHYSICAL** Network into a multiple number of **LOGICAL** ones



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## Radio Access

**Are we using the spectrum  
efficiently?**

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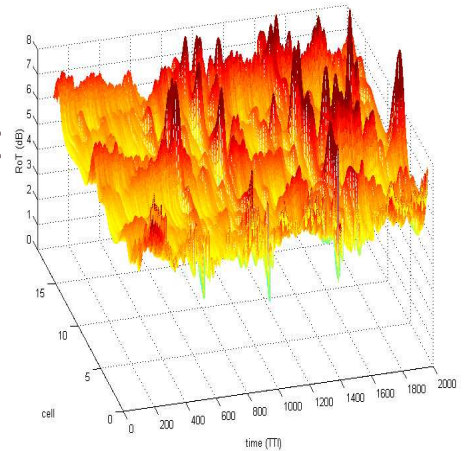
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## Spectrum and QoS

- Cost reduction
- Network planning practice driven by cost minimisation
- Do not need high capacity everywhere
  - Typically 10 % of the sites carry 50 % of all traffic
  - 50 % of sites are lightly loaded, carrying only 5 % of the traffic
- Cell dimensioning and operation on per cell basis
- Excellent adaptive techniques at link level but NOT at the system level
- Low utilisation of available capacity
  - Variable and poor over time and over cells but achieves average target



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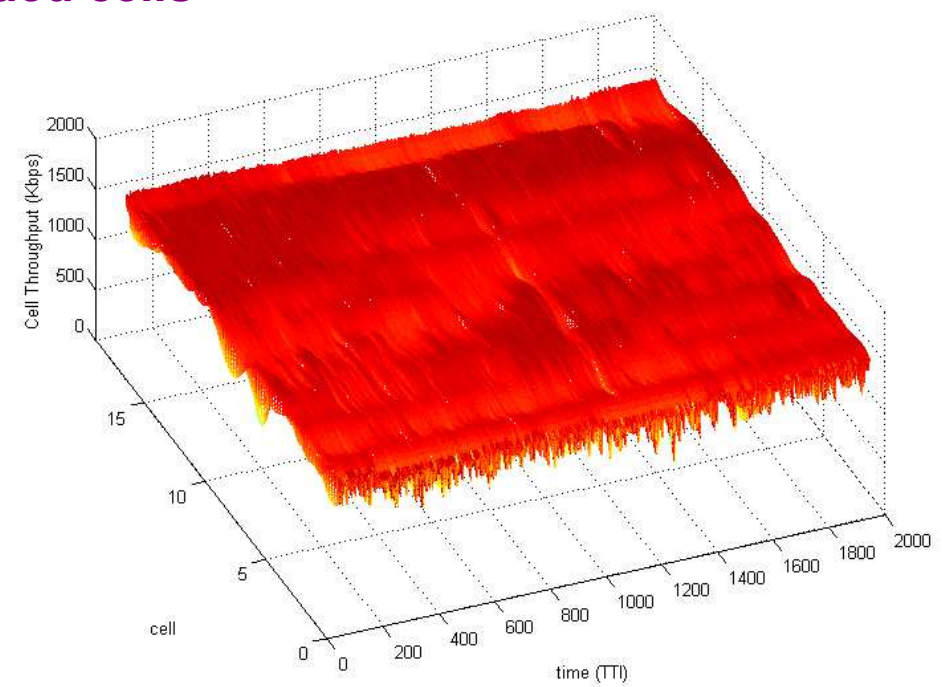
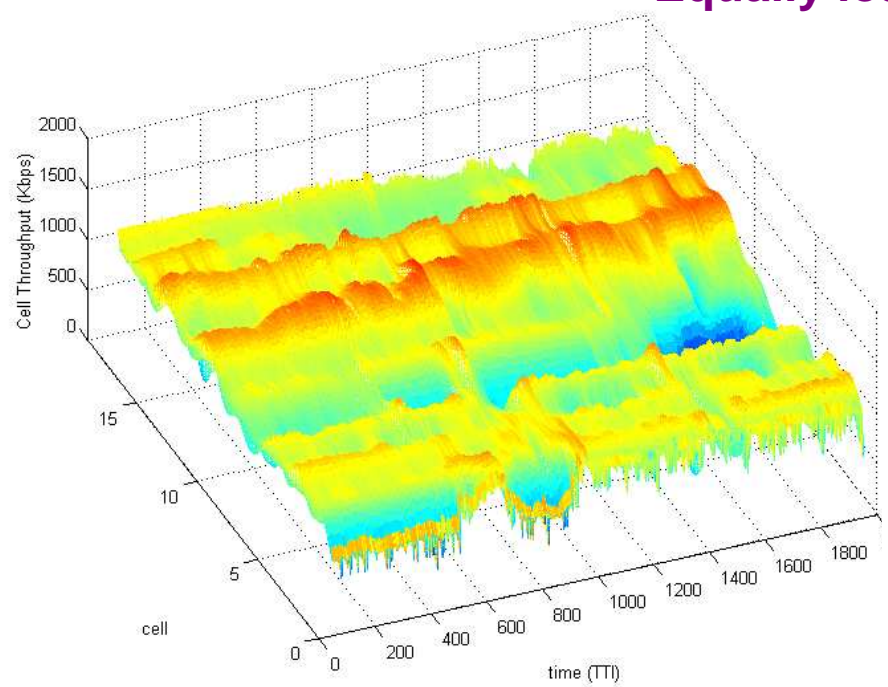


# Multi-cell Cooperation RM

Before

After

Equally loaded cells



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Stability over time and Multi-cell coverage → more than 30 % gain in capacity

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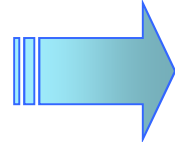
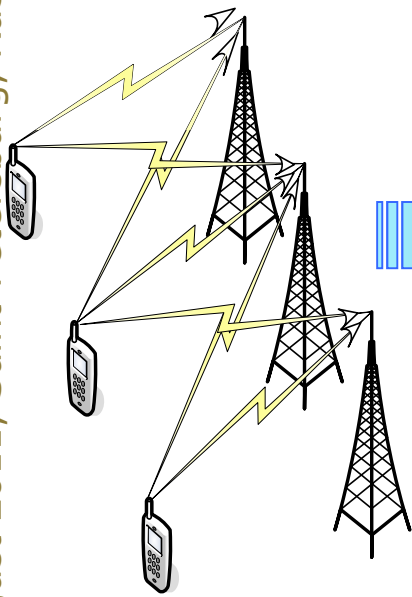


## New architectures

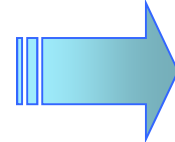
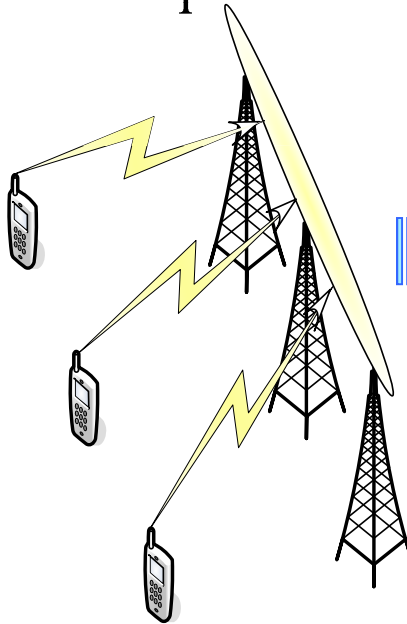
**Cooperation** converts the distributed cellular system into a MIMO system with distributed antennas

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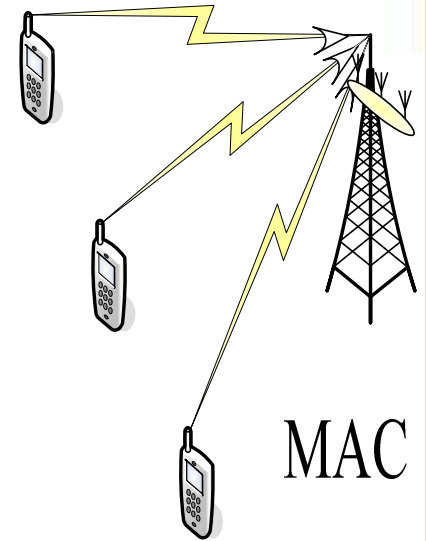
Conventional Uplink



Cooperative



MIMO



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## Conclusion



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## Overall recommendations and way forward

- **Future mobile and wireless communications industry challenges**
  - Cost
  - Complexity management
  - Ubiquitous and high capacity mobile broadband communications
  - Spectrum scarcity
  - Energy and Power consumption and cost
  - Horizontal support of other domains and industries
  - High robustness and resilience with service availability higher than five 9s
  - Services specific network architectures
  - Trusted services, user Privacy
  - Inter-operability
- **Enabling technologies and Research priorities**
  - Energy aware network management
  - Multi-cell self optimisation of optimum hybrid cell sizes and hierarchical cell architectures
  - Cognitive systems and efficient spectrum aggregation solutions
  - Hybrid of Fibre and wireless technologies
  - Users' Context capturing and integration in service delivery network
  - Intelligent human multi-sensory services
  - Accurate and evolvable user profiling
  - Open and Universal service-network interface
  - Full network and infrastructure sharing and new business models and interfaces
  - Network virtualisation and cloud computing
  - Service and information networking
  - Efficient Integration of Machine to machine communications with cellular networks
  - Trust models
- **Research approach**
  - End-to-end and integrated Multi-disciplinary (within Networking and between different domains) research and solutions aiming for simplicity, efficiency and trust.

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## Conclusion

- Net!Works is the European Technology Platform for communication networking technology
- Collaborative research is important for European economy
- Collaboration between national and European activities helps to align research agendas and to use resources efficiently
- Net!Works is facilitating networking and discussions between stakeholders to build consortia
- Identification of research topics
- Net!Works members will be informed about networking possibilities
- EU Framework Program 7 offers wide range of research challenges

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