



WEAVING THE NETWORK FOR THE SMART APPLICATIONS OF THE FUTURE

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EuroNF Vision (Dec. 2010)

Concertation Meeting – Brussels, February 10, 2011

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Foreword: EuroNGI, EuroFGI → EuroNF



- **How to approach the design of future networks and future applications and services?**
- **EuroNF vision:**
 - On-going discussions since Dec. 2003
 - May 2006 Initial document
 - July 2009 First update:
Architectural issues and (r-)evolutionary approaches
 - **Dec 2010 Second update:**
 - **Identification of trends, separation and enablers**
 - **Extrapolation to future (extendibility!)**



The Future Internet – The Foundation for Smart Applications



- Smart Applications
 - + Within **everyday life of people**
 - + Example domains: **health services, energy usage and distribution, environmental sensing, monitoring and analysis; logistics and transportation; personal entertainment** (see also FI-PPP)

- + Differentiator from NF/FGN/FI from current Web2.0
 - **Abilities for smart acquisition**
 - **New relationships between data and services**
 - **New and previously unavailable benefits for users (individual, companies) and society**

→ **Design Networks for Supporting Smart Applications**



Smart Applications – Characteristics and Challenges



- Highly autonomous operation → *Responsiveness*
 - Very different types of data (low volume sensor or interactive HD video) → *Variability*
 - machine-to-machine communication → *Highly scalable mechanisms (billions of communicating devices)*
 - Application-specific networks (own topologies, naming schemes, routing and resource mgmt techniques) → *Polymorphic networks and network virtualization*
- Very different transmission modes even in parallel (any mix of intermittent, delay-tolerant, multi-hop mesh, packet- and circuit-switched)
- Being agnostic whether wireless, mobile or wired connections are used → *Cooperative algorithms*
 - Multi-disciplinary and multiple stake-holders → *Being holistic*
 - Smart provider and connectivity selection (e.g. based on economic competition and ecological considerations) → *New protocols and operation mech., also new business and governance models*



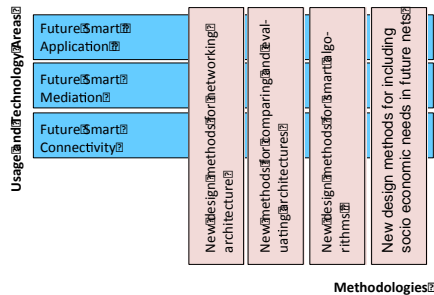
How to facilitate a systematic and holistic design and engineering approach for smart applications and the FN/FGN/FI?



- **Approach holism on various levels**
 - + Networks vs. applications (e.g. functional relationship between QoE and QoS) but also users vs. operators (mass market vs. premium)
- **Provide enablers**
 - + Hardware elements or software/services that enable applications to take advantage new FI features
 - + Mediate between network features and application requirements.
- **Use federated test facilities to transfer of pure research ideas into real world systems.**
 - + Run by researchers (G-Lab, FIRE)
- **Separation of Concerns (SoC) for functions and methodologies**
 - + Exploit and refine Dijkstra's SoC paradigm
 - + Layers vs. heaps?



A New Separation of Concerns

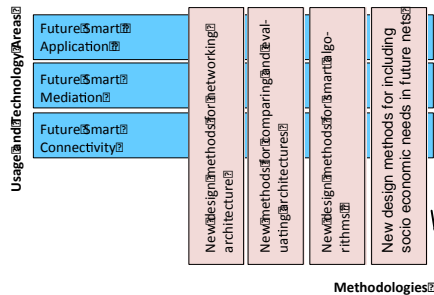


A. Functional Separation

- 1. Future smart applications**
- 2. Future smart mediation techniques:** e.g. former routing tasks, now enabling mediation for Publish/Subscribe techniques, delay-tolerant networking, application-specific topologies and resource management, etc.
- 3. Future smart connectivity techniques:** e.g. convergence of high speed optical and wireless transmission and energy efficiency



A New Separation of Concerns



B. Methodological Separation

1. **New design methods for networking architectures:**

- Which separation is appropriate, layering vs. heaps

2. **New methods for comparing and evaluating architectures:**

- Comparing FI architectures wrt. new qualitative (e.g. flexibility, adaptivity, or expandability) and quantitative metrics (e.g. the quality of cooperation, quality of pricing, quality of protection)

3. **New design methods for smart algorithms:**

- Models for self-organization, smartness and autonomy

4. **New design methods for including socio-economic needs in future networks:**

- Assessment of security and QoE, incorporating network and application governance/business models into mechanisms and protocols .



Seven Examples of Focus Areas for the Research on Future Networks for Smart Applications

1. **Virtualization and Federation for Polymorphic Networks** (short and medium timeframe)
2. **Cooperative Algorithms for Seamless Wired and Wireless Connectivity** (short and medium timeframe)
3. **Engineering for Cyber-Physical Systems** (medium timeframe)
4. **Design and Performance of Network-located Enablers for Smart Applications** (short and medium timeframe)
5. **Cyber Assurance** (medium and long timeframe)
6. **Multi-stakeholder Approaches to Governance in Networks of the Future** (long timeframe)
7. **Networking for Sustainable Energy Use and Sustainable Energy Use in Networks** (short and medium timeframe)



Summary

- **EuroNF continuously provides pre-standardization work and shapes visions of networks**
- **Technology change requires that extrapolation is extendable and adaptable**
 - + Futuristic vs. evolution, short vs. long timeframe
 - **New fabric needed for future smart networks and applications**
 - Weaving materialized by ***Enablers***
 - + Physical entities/mechanisms or intellectual methods and algorithms, the operation of future networks and future smart applications
 - **Concepts of how to achieve smart combinations of technologies and methodologies for supporting smart applications**
 - Current focus areas: **federation and polymorphic networks, cooperative algorithms, cyper-physical systems, network-located enablers, cyber assurance, multi-stakeholder in governance, networking for energy sustainability and energy sustainability for networking**