WEAVING THE NETWORK FOR THE SMART APPLICATIONS OF THE FUTURE

EuroNF Vision (Dec. 2010)

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Editors:
K. Tutschku (University of Vienna), M. Fiedler (BTH Karlskrona)

With contributions from:
D. Kofman, P. Müller, G. Haring, E. Dotaro, P. Tran-Gia, G. Polyzos,
A. Casaca, W. Kleinwächter
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.

→ Weaving a new fabric for network and applications
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, cyber-physical systems, network-located enablers, cyber assurance, multi-stakeholder in governance, networking for energy sustainability and energy sustainability for networking