PANEL - ICDT, CTRQ, MOPAS

Tendencies and Challenges in Signal Processing, Modeling and Telecommunications

INTRODUCTION

Eugen Borcoci,
University Politehnica Bucharest

PANEL – ICDT, CTRQ, MOPAS
Tendencies and Challenges in Signal Processing, Modeling and Telecommunications

Moderators:
Michel Diaz, LAAS-CNRS - Toulouse, France
Eugen Borcoci, University Politehnica of Bucarest, Romania

Panelists:
Andrei Alexandru Enescu, University Politehnica of Bucharest, Romania
António Nogueira, University of Aveiro, Portugal
Elena Troubitsyna, Abo Akademi University, Finland
Michel Diaz, LAAS-CNRS - Toulouse, France
Eugen Borcoci, University Politehnica of Bucarest, Romania

Panel topics

- **Short presentations:**
  - ***Andrei Alexandru Enescu:*** ***MIMO systems, their impact on digital communication systems and issues regarding complexity of implementation.***
  - ***António Nogueira:*** ***Traffic and network modeling***
  - ***Elena Troubitsyna:*** ***Model-driven development of fault tolerant communication systems***
  - ***Michel Diaz :*** ***Overlays, Intelligent ad-hoc networks, Embedded networked systems***
  - ***Eugen Borcoci:*** ***Telecommunication and Future Internet Convergence Challenges***
- **Q/As**

Tendencies and Challenges in Signal Processing, Modeling and Telecommunications

Michel Diaz

NexComm Panel

Athens June 2010

Main Open Questions

- High level network Overlays
- New intelligent ad-hoc networks
- Embedded Networked Systems

High level network Overlays

- **Overlays**
  - Do not follow the provider (physical) routing
  - Build a virtual new (higher level) layer
  - Include reliability, user optimisation, etc

- **Next generation of set-up up boxes**
  - Very efficient
  - Shared by the provider and the user
  - Will be the next internet P2P equipment
  - What size and what functions can it provide ?

New intelligent ad-hoc networks

- **Present ad-hoc networks are not related to applications**
  - As much as possible Independent
  - Improvements from Bottom-Up cross-layering
  - New intelligent actors (e.g. robots) appear
- **Can we drive protocols by applications**
  - Excellent Correlation
  - Optimisation and Adaptation
  - Can we add Cognition to the protocols
  - Top Down cross-layering added to Bottom-Up

Embedded Networked Systems - Step 1
Reliable communication systems

- **Formal Description techniques** (Petri nets, Algebraic Calculus, Estelle, LOTOS, SDL,…) for ISDN networking
  - FDTs went to Embedded Systems that increase in complexity
- **To come back to Networking needs**
  - Abstract Models for wireless comm & protocols
  - Models for network Architectures (for layers)
  - Models for (part of) the QoS internet

Embedded Networked Systems - Step 2
New generation of ENS

1. Define a Next generation of mobile and dynamic Embedded Systems based on Ad-hoc networks
2. Handle Complexity of Ad-hoc networks
   - Define the Certification properties needed for Embedded Systems
   - Develop Specification & Verification of Time constraints and Relialibility
   - Develop Code generation and certification (certifying the code, the compiler, etc)

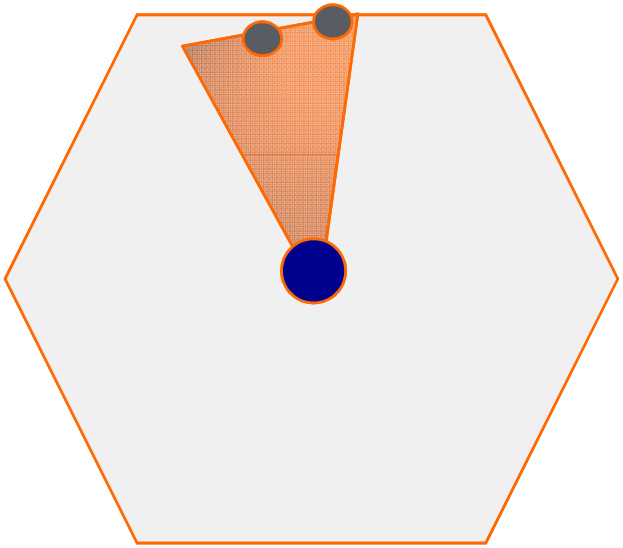
CHALLENGES IN 4G COMMUNICATION SYSTEMS FEATURING MIMO SYSTEMS

Lect. Andrei Alexandru Enescu, Ph. D
Politechnic University of Bucharest

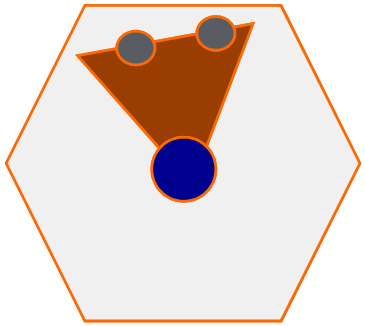
CHALLENGES IN SIGNAL PROCESSING

- "MIMO" is the word of the day
- MIMO systems
  - Beamforming
  - Space-time coding
  - Spatial multiplexing
  - Any combination of the techniques above
- Fast decoding algorithms
  - Need for parallelism
- Radio interface… new tendencies?
  - OBSAI / CPRI
- Fast memory access
  - DDR3 / QDR …?

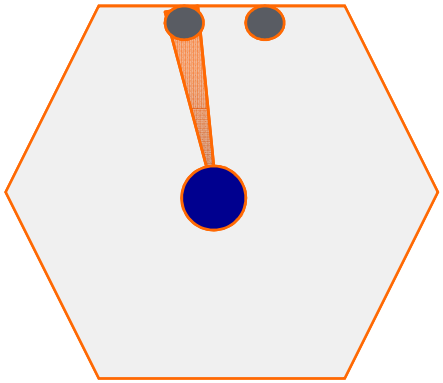
MIMO TRENDS



Space diversity –
increased coverage



Spatial multiplexing –
increased throughput



Beamforming–
interference mitigation

MIMO THROUGHPUT

- Spectral efficiency: N_t x M
  - N_t = number of transmit antennas
  - M = modulation intrinsic spectral efficiency (e.g. 1 b/s/Hz for QPSK ½, 5 b/s/Hz for 64QAM 5/6)
  - Example: MIMO 4x4 + 256 QAM 7/8 => 28 b/s/Hz!
    - 560Mbps @ 20MHz bandwidth
  - Some limitations will come from:
    - Training symbols
    - Implementation loss
    - Logical channels
- Who will carry all this throughput??
  - Fast DSPs
  - Fast digital interfaces (radio interfaces)
  - Rapid memory access

MIMO ALGORITHMS

- ML algorithms used for decoding have to deal with codewords of 2^M x N_t
  - 256QAM with 4x4 => 256^4 possibilities =2^{32} codewords (~= 2E+9 search space!!)
- MMSE and ZF algorithms exhibit tremendous implementation loss especially for large N_t
- Find hybrid solutions
  - Quasi-ML: Sphere decoders
  - Implementation-oriented algorithms (parallel features)

PANEL : ICDT CTRQ MOPAS

Tendencies and Challenges in Signal Processing, Modeling and Telecommunications

Telecommunication and Future Internet Convergence Challenges

Eugen Borcoci,
University Politehnica Bucharest

Telecommunication and Future Internet Convergence Challenges

- **FACTS**
  - **Telecommunication and Internet convergence- recognized and developed – last 15 years**
    - Full service integration- based on packet networks support and layered architectural stack
      - Intelligent terminals
      - Flexible IP –based transport
  - **Future Internet – hot topic in discussion**
  - **How to evolve?**
    - Evolution
    - Revolution
    - Something in the middle?
  - **How the Telecom "world" will participate in this initiative ?**
  - Many efforts to define/re-define the future directions of FI (seen from different point of views): Research groups, Academia, Industry, Standardization organizations, Governments, Users, ..
    - Still – there are many open FI issues, including discussion/revision of the basic concepts

Telecommunication and Future Internet Convergence Challenges

- **Telecommunication view**
- **Next Generation Networks Architecture (ITU-T, ETSI, 3GPP)**
- **NGN – Evolution of Telecom Networks (>2000)**

- **NGN**
  - *packet-based, broadband* network
  - provides Telecommunication *multiple services*
  - *QoS-enabled* transport technologies
  - service-related functions are independent from underlying transport-related technologies.
  - *flexible access* for users to networks and to competing service providers and/or services of their choice.
  - *generalized mobility* which will allow consistent and ubiquitous provision of services to users.

- **Standardization actors: ATIS NGN FG, ITU-T NGN FG, ETSI TISPAN, 3GPP, etc.**

Telecommunication view

Key requirements satisfied by the NGN Architecture

- **Trust and security:**
  - Operator should be able to trust the network.
  - User should be able to trust the operator
- **Reliability:** Users should find it reliable
- **Availability:** Network should always be available
- **Quality:** Able to control and guarantee the Quality of the Services
- **Accountability:** Determine usage of the Service
- **Legal:** Comply with laws in the local jurisdictions
- **Generalized** Mobility and services support

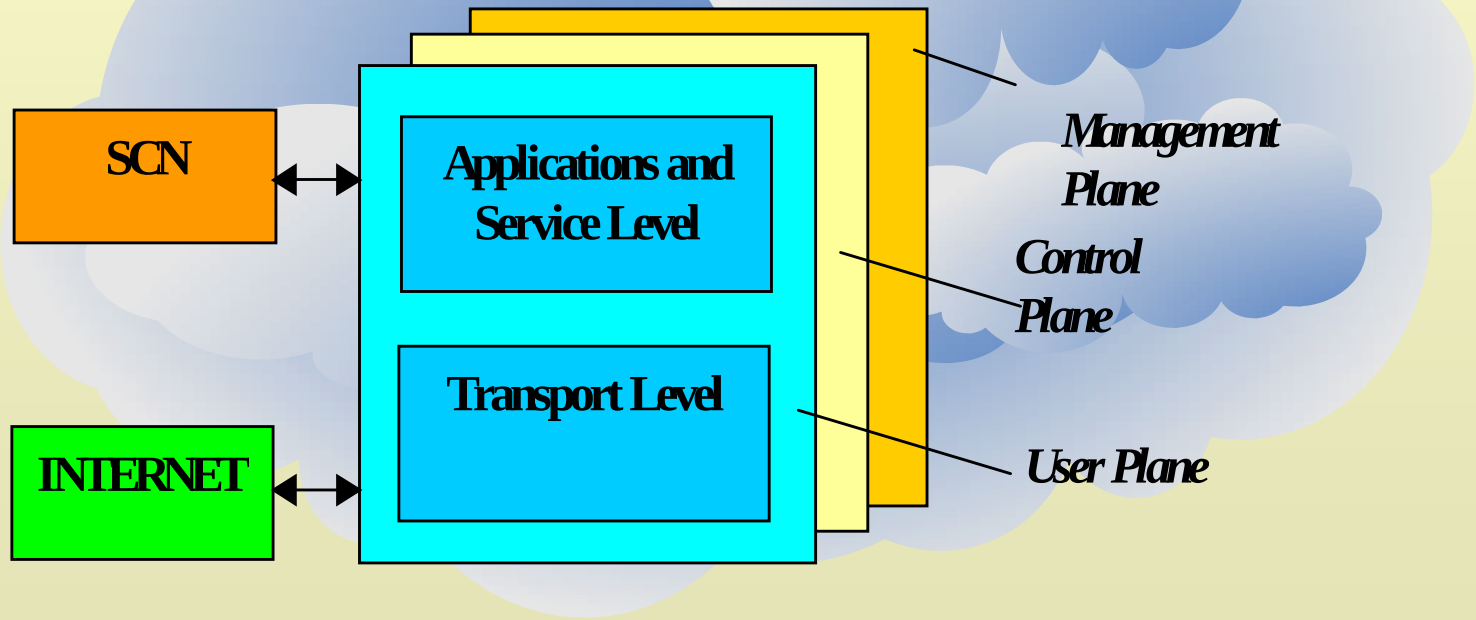
- Note: **Classical and current Internet only partially respond in very controllable manner to the above requirements**

- **Telecommunication view**
- NGN example:
- *3GPP release 6, 7, etc. :* IP Multimedia Subsystem *IMS*
  - telecomm. network for broadband fixed and mobile access
  - facilitates convergence of networks and services
  - enables different business models across access, core network and service domains
  - Is an IP based network
  - *Session Initiation Protocol (SIP)* and family are used for call & session control
    - enables any IP access to Operator IMS, from Mobile, Home, Enterprise domain
    - enables service mobility
    - enables interworking towards circuit switched networks
    - maintains Service Operator control for IMS signaling & media traffic.

Telecommunication view

NGN high level view of the architecture

- Some questionable features
  - Wall gardened- style (e.g. IMS) (restricted “democracy”??)
  - Do not mix the transport and application
  - Very complex architecture: many GWs,
  - Not enough flexible,
  - ...



- Future Internet
  - **Current Internet:**
  - **Some Critics:**
    - **Victim of its own success**
    - **Ossification (TCP/IP invariants)**
    - **Too many patches (routing, mobility, security, signalling, …)**
    - **Location/Identity unit**
    - **Neutral character of the network??**
    - **Low security and trust**
    - **Not powerful enough management and control**
    - **…see key features that NGN pretends to fulfill**

Future Internet

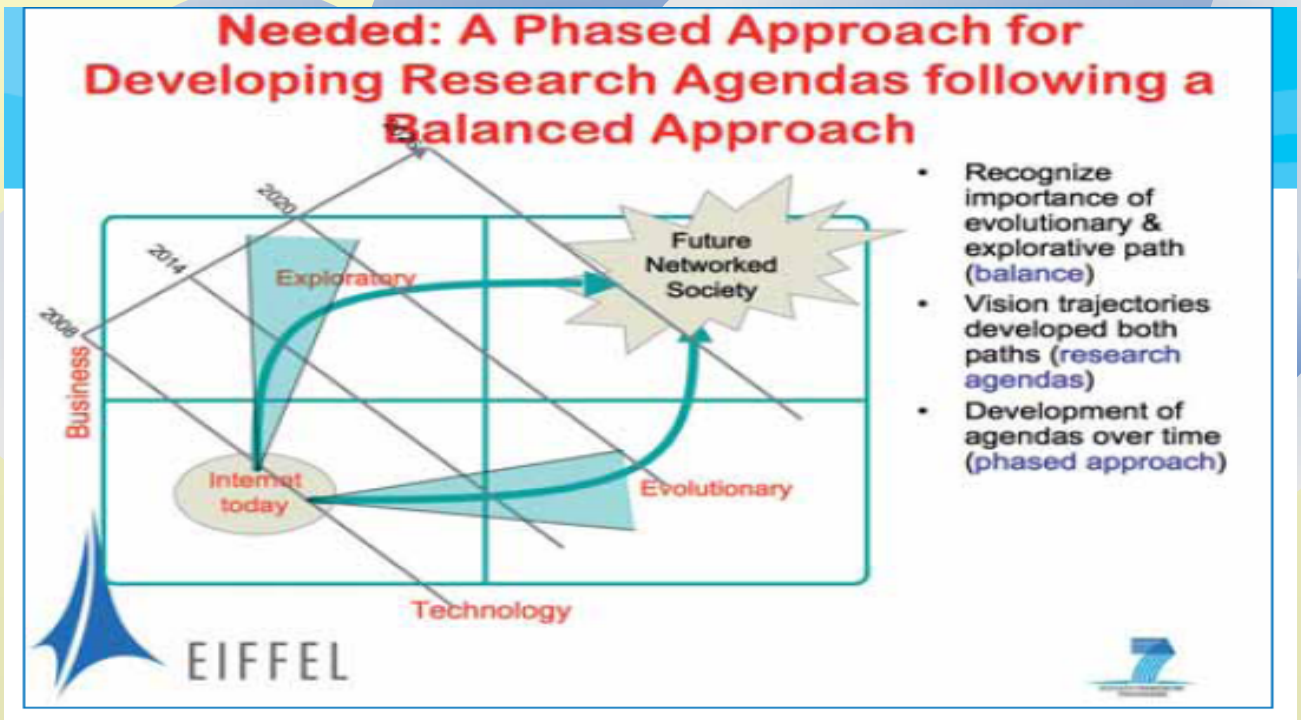
Needs/trends to be answered (partial list)

- **Connectivity**
  - Very high rate throughput- E2E, ubiquitous good/cheap network access
  - Universal connectivity of devices, coupling of virtual world data with physical world information (RFID, sensors)
  - Mobility needs (micro, macro, terminal/ session, network mobility)
- **Security and trust**
  - Need for much more *security*,*trust privacy, anonymity* capabilities
- **New services aspects:**
  - VoIP, P2P-based, IPTV, 3D, composable services, ..
  - User generated content and services, User controlled infrastructure,
  - Novel human-computer interaction techniques
  - Personalized services will become widespread on the FI.
  - **Serrvice-centric aware, content centric aware**
  - Computing and software as a network-centric service.
- **Management and control**
  - Negotiated management and control of resources, negotiated SLA's
  - More need for *Availability*, *reliability*, and *dependability*

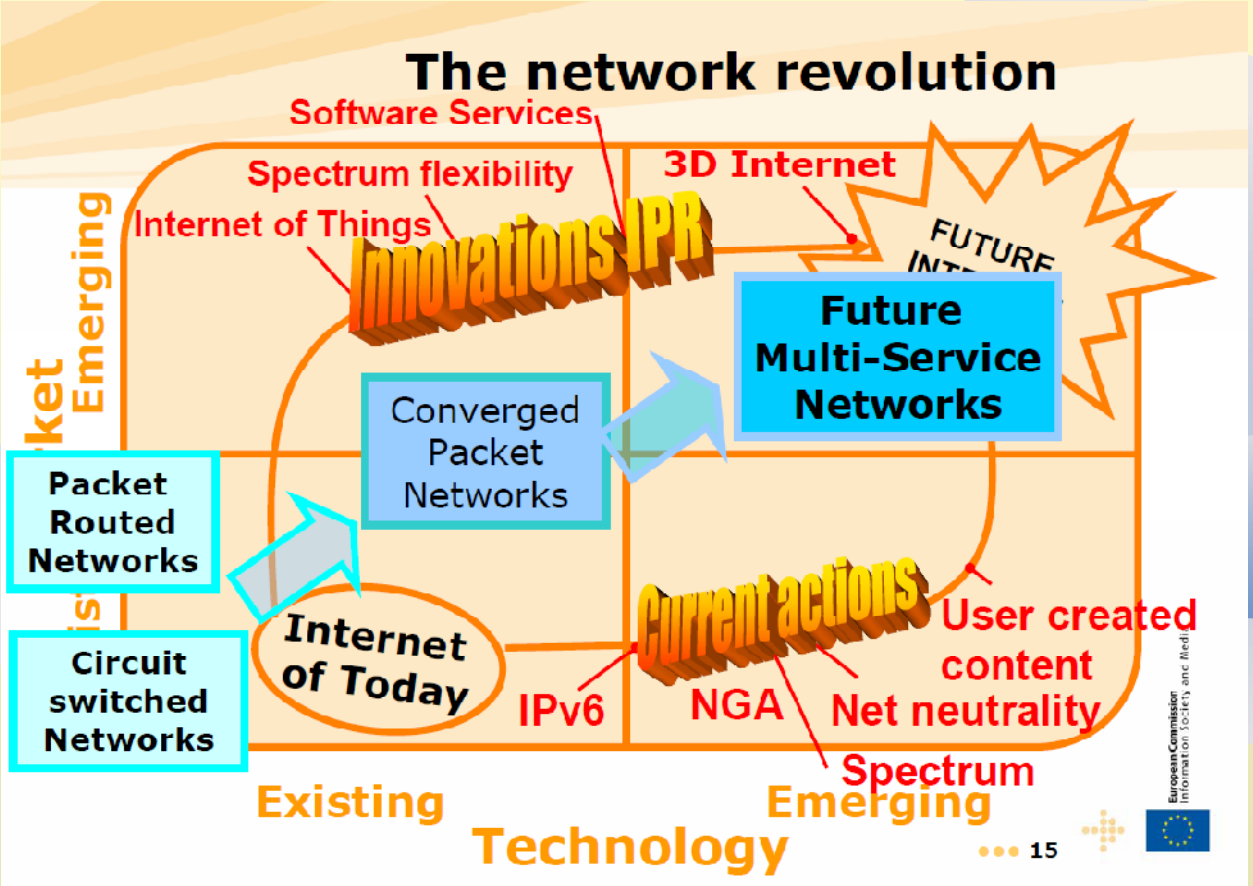
- Future Internet

KEY issues on FI concepts and design:

- **evolution? or clean slate approach? or something in the middle?**
- **Source:** Petri Mahönen, Project Coordinator, EIFFEL, RWTH Aachen University**" Evolved Internet Future for European Leadership (EIFFEL)", FI Conference, Bled, 2008**



- Future Internet



Telecommunication and Future Internet Convergence Challenges

- **FI Initiatives:**
- **Europe**
  - Networked European Software and Sevices Initiative
  - FIRE (Future Internet Research and Experimentation)
  - FP&, … research programs
  - Management and Service-aware Networking Architectures (MANA) for Future Internet
  - Forum of Member States, the "Future Internet Forum“
  - *National level initiatives* and programs oriented for FI (partial list): Belgium, France, Finland, Germany, Italy, Nederland, Spain, Sweden, UK, etc
  - …..
- **USA-** GENI/FIND - of the NSF (originated ~10 years ago)
  - GENI - Global Environment for Network Innovation
  - NetSE, Network Science and Engineering, launched in Sept. 2008
- **Japan:** "New Generation Network" initiative (NWGN) complemented with the creation of the NWGN promotion forum

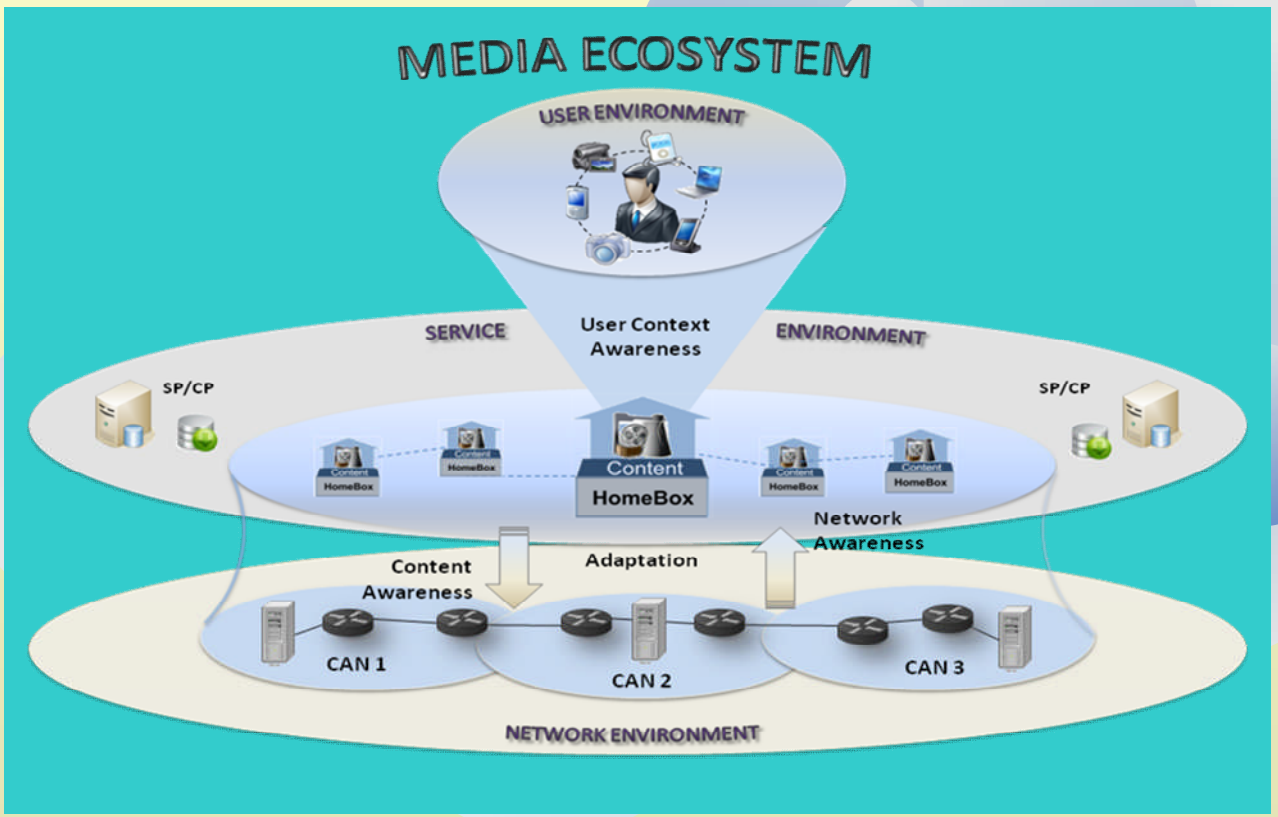
Future Internet Initiatives (cont'd)

- **Example of a FI-oriented project:**
- **ALICANTE, 2010-2013, Integrated Project (IP): MediA Ecosystem Deployment Through Ubiquitous Content-Aware Network Environments**

- Applying new challenging concepts (Future Internet – oriented) of
  - **Content Aware Networking**
  - **Network Aware Application**
- Proposal of a novel virtual Content-Aware Network (CAN) layer
  - as a part of a full layered architecture
  - focused, but not limited to, on multimedia distribution with Quality of Services (QoS) assurance
- The system supports on a flexible cooperation between
  - providers,
  - operators and end-users,
  - enabling users to access the offered multimedia services in various contexts and also to become private content providers.

Future Internet Initiatives (cont'd)

- **ALICANTE project:**
  - Architectural high level view



Thank you