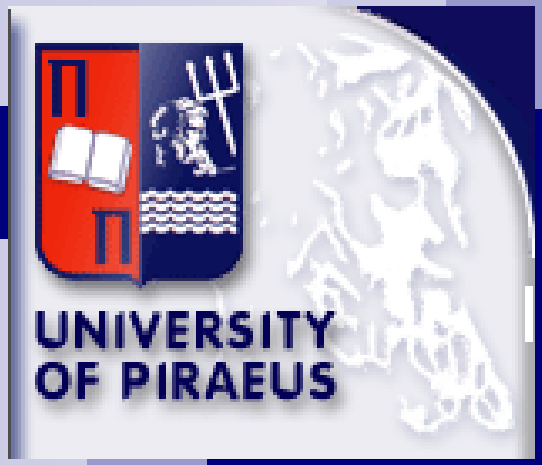

Evolution of Spectrum Management: New frontiers – Integration in the Context of Cognitive Wireless Networks

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Presentation Outline

- **Background**
  - B3G infrastructures
  - B3G realization by means of network cooperation
  - B3G realization by means of reconfigurability (software defined radio)

- **Future directions and objectives for the wireless world**
  - Cognitive networks for realization of B3G infrastructures
    - Evolution and integration of ***spectrum management*** schemes

- **Approach**
  - Reconfigurable elements: Development and validation
  - Management of reconfigurable elements: migration from adaptive to cognitive wireless access networks

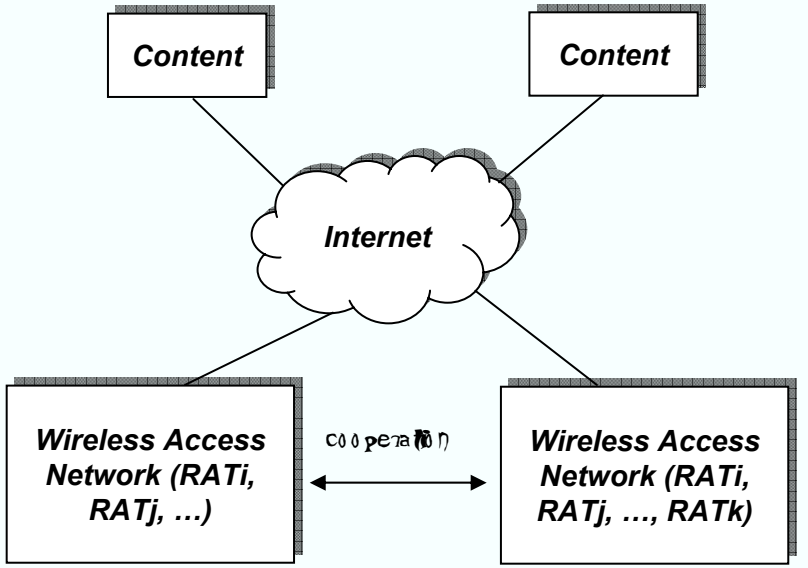
B3G infrastructures

- **Radio Access Technologies (RATs)**
  - 2G/2.5G, 3G+,
  - DVB,
  - WMANs (WiMax, IEEE 802.16),
  - WLANs (IEEE 802.11x),
  - WPANs (IEEE 802.15, 802.16, ZigBee, Bluetooth),
  - WBANs

- **Networking and middleware**
  - IP-based technologies
  - Management of networks and services
  - IT aspects: optimization, algorithm and complexity theory, learning, autonomic computing

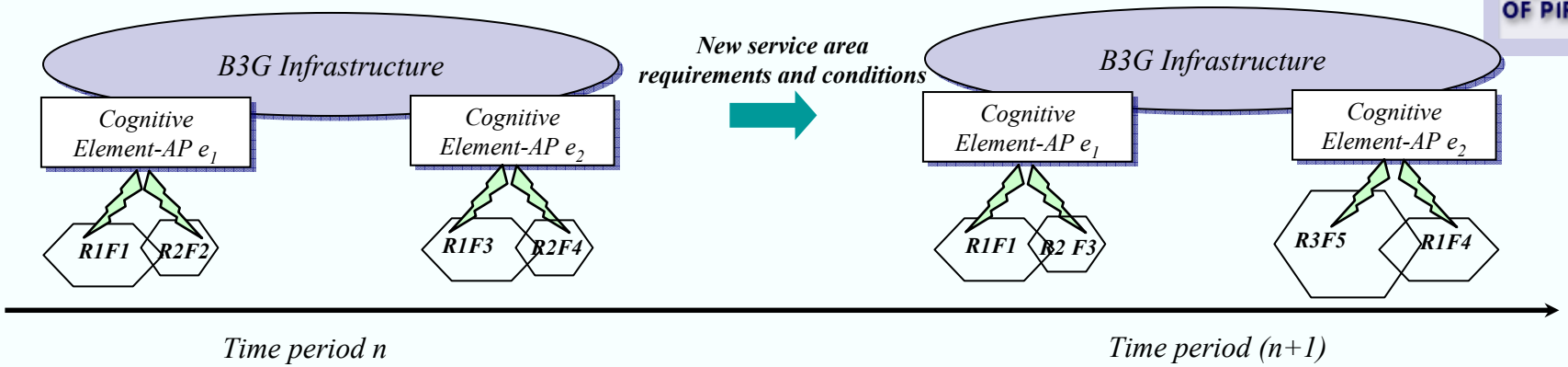
- **Main B3G concept**
  - Complementary use of RATs
  - For given context use "best" RATs, e.g., wrt capacity and QoS

- **Trends for B3G realization**
  - ***Network cooperation*:** Monasidre (IST-2000-26144), CREDO (IST-2001-33093)
  - ***Reconfigurability:*** SDR, TRUST, SCOUT



- **Potential drawbacks of network cooperation**
  - Extensive inter-NO dependencies and interactions
  - Massive deployment of RATs and networks -> increased CAPEX

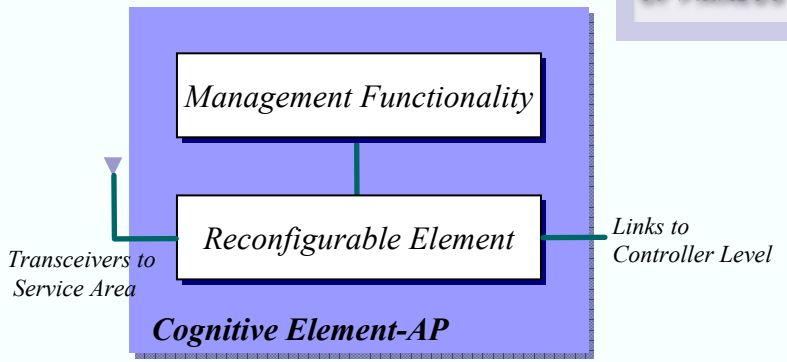
Reconfigurable wireless access networks

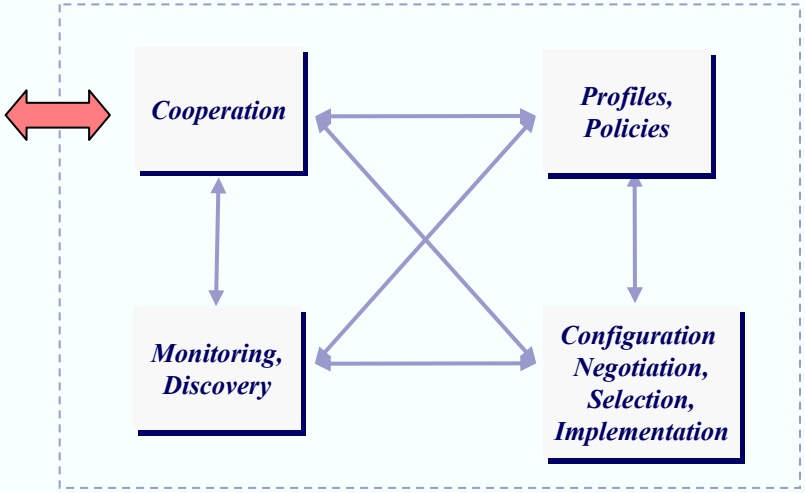


- **Realization of B3G infrastructure through reconfigurable elements**
- **Reconfigurable elements**
  - Capable of operating with various configurations (e.g., RAT and spectrum at PHY/MAC layer, etc.)
  - Selects the best configuration in order to adapt, proactively or reactively, to environment conditions
- **Transceiver reconfigurations in time and space**
  - Same RAT, different frequency
  - Change RAT, same frequency
  - Change RAT, change frequency

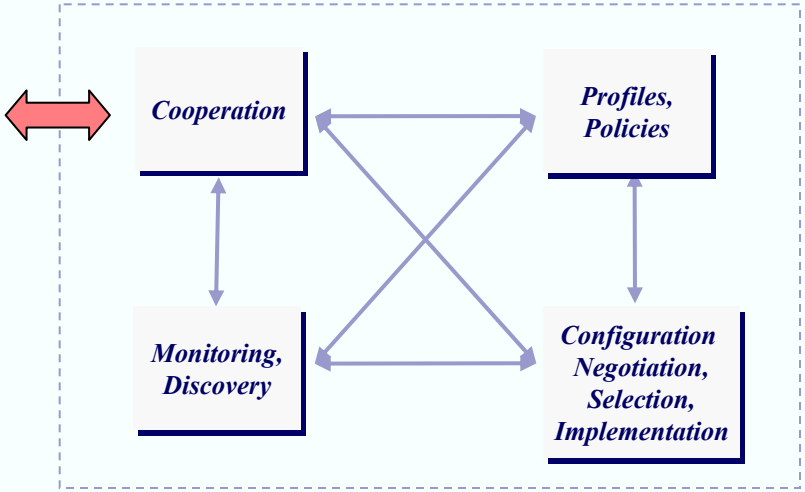
Objective: Cognitive networks for B3G realization

- **Cognitive elements (C-APs)**
  - Reconfigurable element
  - Management functionality
- **Reconfigurable Element**
  - Capable of operating with different alternate reconfigurations
    - PHY/MAC: RAT, spectrum selection
    - Network: IP QoS, routing, congestion control
    - Transport/Higher layers: adaptations of TCP, content, etc.
  - ***Currently developing prototypes of reconfigurable equipment*** (focus on PHY/MAC)
    (E2R 507995, E2R II 027714)
- **Management functionality**
  - Decides on best reconfigurations
  - ***Autonomic computing*** for scalability



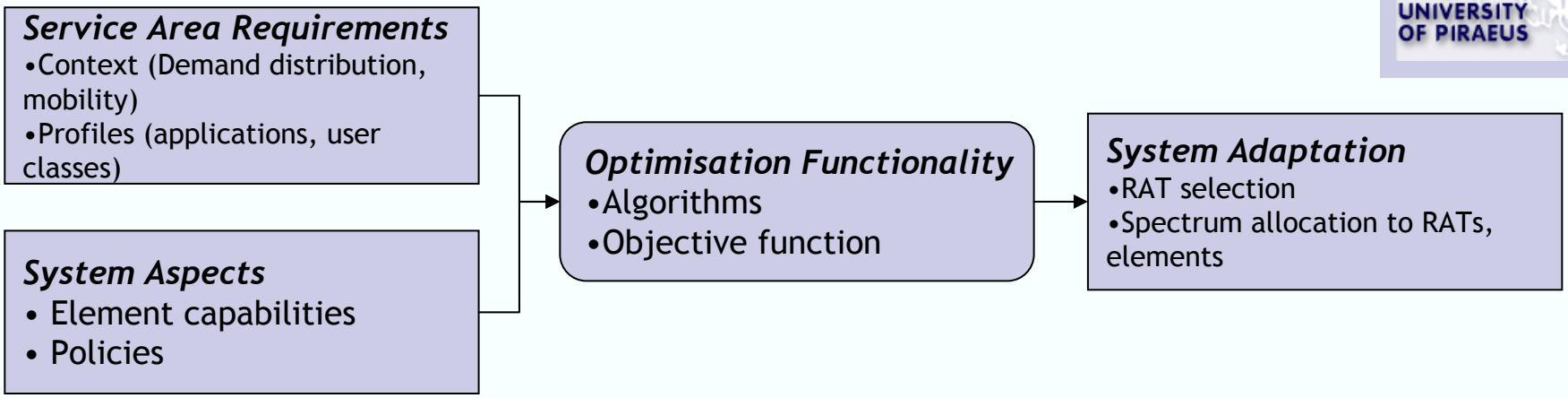


Approach: Autonomic management platform



- **Monitoring/Discovery**
  - Monitor the environment requirements and performance of configuration
  - Discover capabilities of alternate configurations
  - Enhance with perception, reasoning (learning) capabilities
  - Context acquisition
- **Cooperation**
  - Bidirectional information flow
  - Requests from other elements
  - Responses to other elements
- **Profiles, Policies**
  - Information on applications, user classes, terminals
  - Portfolio of policies
- **Configuration negotiation, selection implementation**
  - Policy-based selection of configurations
  - Negotiation strategies with other elements and entities (terminals, users)
  - Cost-efficient reconfiguration
  - Conflict resolution

Approach: Integration of spectrum management schemes



- **Policy-based open spectrum acquisition, in cognitive radio**
  - Unlincensed bands, opportunistic spectrum acquisition
- **Dynamic spectrum sharing, between NOs, priorities and negotiation**
  - Licensed bands, establishment of agreements for spectrum acquisition
  - Increased utilisation, higher revenues
- **Spectrum pooling**
  - Operators form alliance in order to share spectrum, lease and rent spectrum
  - Revenues when leasing, lower cost when in need to rent
- **Radio resource management based on IT**

Conclusions

- **Wireless World Research Forum (WWRF): Working Group 6 (WG6), Reconfigurability**

- **Publications**
  - P.Demestichas, D.Boscovic, V.Stavroulaki, A.Lee, J.Strassner, "ANGEL: Autonomic Management Platform for Seamless Wireless Cognitive Connectivity", **IEEE Communications Magazine**, June 2006
  - P.Demestichas, G.Dimitrakopoulos, J.Strassner, D,Bourse, "Introducing Reconfigurability and Cognitive Networks Concepts in the Wireless World: Research Achievements and Challenges ", **IEEE Vehicular Technology Magazine**, June 2006

- **Research**
  - Network cooperation and SDR for B3G realization
  - Reconfigurability
  - Cognitive wireless networks with integrated spectrum management