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Cognitive Networks

A paradigm for wireless communication in which networks adapt, in a self-aware manner, their topology and operational parameters to fulfill specific tasks.

Market forces and new technologies are fueling evolution in today's network ecosystem. IP architectures and services based on unlicensed wireless networks will fundamentally change the mobile landscape in the next five years. With barriers to entry breaking down, price competition and differentiating services will be the name of the game.

In order to preserve profitability, wireless service providers must cut costs and develop new revenue streams by deploying and operating a mixture of wireless radio access solutions.

This objective can be attained by two different, but not mutually exclusive network topologies:

Cooperative networks assume joint operation of two or more wireless networks that belong to affiliated network operators (NOs). The cooperation manifests itself in way of traffic sharing, dynamically migrating users/traffic to networks and technologies that can meet QoS and reliability requirements in a cost-efficient manner.

Cognitive networks use self-configuration capability to respond and dynamically adapt to the operational and context changes. Main function components of self-configuration are self-awareness and auto-learning that are implemented by means of network-aware middleware and normally distributed across the network components. Applications and devices adapt to exploit enhanced network performance, and are agnostic of the underlying reconfigurations, in accordance with the seamless service provision paradigm.

The realization of cognitive, wireless access networks requires intelligent management functionality, which will be in charge of finding the best reconfigurations (Figure 1).

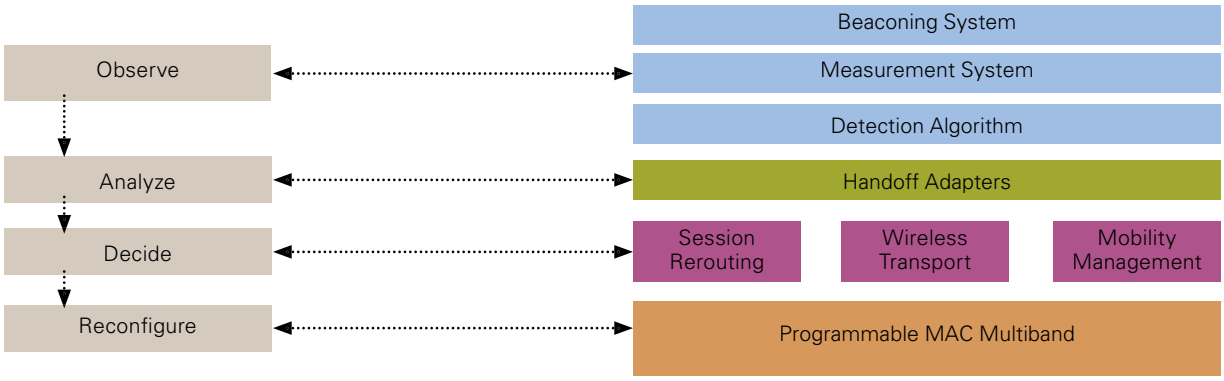

Figure 1. An example of cognitive network functionality as applied to selective deployment of available radio access technologies.

What Are Cognitive Networks

Cognitive, wireless access networks are those that can dynamically alter their topology and/or operational parameters to respond to the needs of particular user while enforcing operating and regulatory policies and optimizing overall network performance. A cognitive infrastructure consists of reconfigurable elements and intelligent management functionality that will progressively evolve the policies based on the past actions.

The current wireless ecosystem consists of wide area networks such as 2G/2.5G/3G/3.5G, wireless local/metropolitan area networks (WLANs/WMANs), wireless personal area networks (WPANs) and short range communications, as well as digital video/audio broadcasting DVB/DAB infrastructure.

Why Cognitive Networks

Wireless solutions based on cognitive network principles encompass technologies and products to ensure that the networks, network components, as well as networked devices and applications, can be deployed and managed (configured, optimized, healed and protected), in real-time. Cognitive networks feature a distributed management functionality that can be implemented in accordance with the autonomic computing paradigm. The holistic, collective cooperation and action of the distributed, autonomic components yields a self-healing and scalable solution that accounts for the potential evolution of services and growing user needs.

Wireless solutions based on cognitive network principles remove shortfalls of cooperative networks such as inter-operator dependencies, frequent infrastructure upgrades and challenges of split network management.

At the same time, cognitive networks maximize the operator's ability to:

- Benefit from economies of scale introduced by common hardware platforms and software architectures supporting evolution of radio access solutions
- Improve time-to-market performance by supporting new service offerings without the need to upgrade the infrastructure
- Maximize return-on-investment both in terms of CAPEX and OPEX by maximizing the exploitation of available/deployed resources
- Accelerate innovation by enabling opportunistic usage of spectrum resource, dynamically adjusting its Tx and Rx parameters to exploit unused spectrum at any given location at any point in time

Cognitive networks are important because they are capable of rendering efficient, ubiquitous, pervasive (ambient) and context-aware application provision. This can be referred to as a consistent seamless mobility experience, that bridge across the connectivity and content/application delivery solution domains.

Motorola Leadership

Motorola is a pioneer in the domain of cognitive networks. Its thought leadership has been captured within the End-to-End Reconfigurability (E2R) project; a Motorola led collaborative initiative comprised of 27 top academics, equipment suppliers, network operators and regulatory policy makers. The key objective of the E2R project is to devise, develop and trial architectural designs of reconfigurable devices, network components and supporting system functions in order to offer an expanded set of operational choices to service providers and network operators in support of the seamless mobility experience designed by users. This research activity is complemented with the practical demonstrations on the Motonomics platform, Motorola's version of autonomics, that features:

- Terminal aided, policy based monitoring
- Network and device diagnosis
- Troubleshooting and self-healing
- Measurement of service performance and quality metrics
- Time and location selective network topology and performance optimization through reconfiguration

Motorola's MotoMesh™ Networks solution deploys reconfigurable and cognitive technologies and features PHY and MAC architectural designs that allow for features like signaling and control in support of dynamic topology management, hierarchical scheduling, multi-antenna processing, spatial reuse strategies

To enable the concept of Cognitive Networks Motorola is a leading participant in defining relevant standards like the 3GPP/3GPP2 (3rd Generation Partnership Project), IEEE (Institute of Electrical and Electronic Engineers), WWRF (Wireless World Research Forum), DVB, IETF (Internet Engineering Task Force), and OMA (Open Mobile Alliance).

About the Author

Dr. Dragan Boscovic directs engineering and technology portfolios for Motorola Technology's New Networks and Cognitive Radio Strategic Growth Engines. Having been internationally recognized for his radio ecology vision, his current research interests are centered on technologies and architectural solutions surrounding scalability, seamlessness and stability performance of composite/heterogeneous wireless radio systems. Dr. Boscovic is expanding on Motorola's seamless mobility vision through his work in the areas of Mobile TV, broadband wireless, ad hoc wireless networks and adaptive platforms such as software defined/cognitive radio.

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