

Cognitive Networking Paradigm



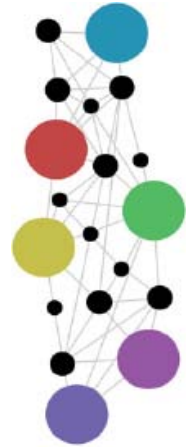
GISFI Workshop, Lonavala,
28, Feb, 2010

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TCS Innovation Labs, Bangalore



Outline

- Motivation
- Cognitive Networks
- Architecture
- Applications
- Summary

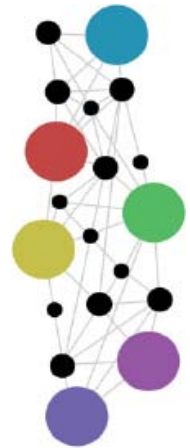
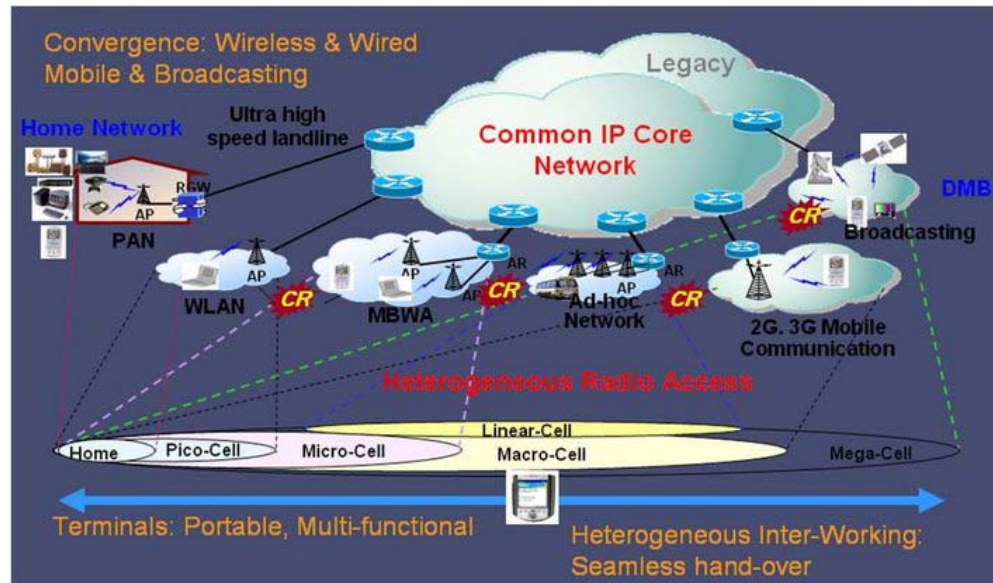


Vision

- Vision of self-adaptive and cognitive network elements that promise to radically change our networking experience

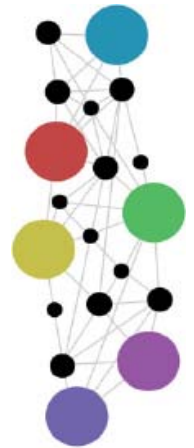


Motivation



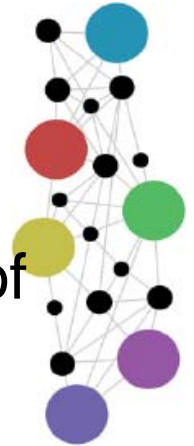
- Ever-increasing capabilities of wireless devices - how to put all of this capability to effective use
- Wireless devices have outpaced the ability of users to optimally configure them.
- Managing large complex systems
- Cognitive networks seeks to provide a solution
 - by embedding greater degrees of intelligence within the network itself.

Cognitive Networks – A Definition



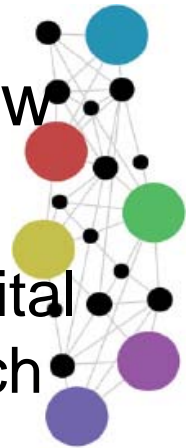
- A cognitive network is a network with a cognitive process that
 - can perceive current network conditions, and then plan, decide, and act on those conditions.
 - The network can learn from these adaptations and use them to make future decisions, all while taking into account end-to-end goals.

Value of Cognition in Networks



- Cognition can be used to improve the performance of many network goals.
 - resource management,
 - quality of service (QoS),
 - security, access control, etc.
- Dynamic in-network service differentiation still remains a dream that can be achieved by means of self-adaptation and cognition.
- Cognition makes sense for dynamic environments
- Cost of performance improvement is also a factor to be considered.

Cognitive Networking Concept — not new



- “...What is envisioned is a network of unmanned digital switches implementing a ***self-learning policy*** at each node so that overall traffic is effectively routed in a changing environment--***without need for a central and possibly vulnerable control point*** ... The network can be made rapidly responsive to the effects of destruction, repair, and transmission fades by a slight modification of the rules for computing the values on the handover number table...”

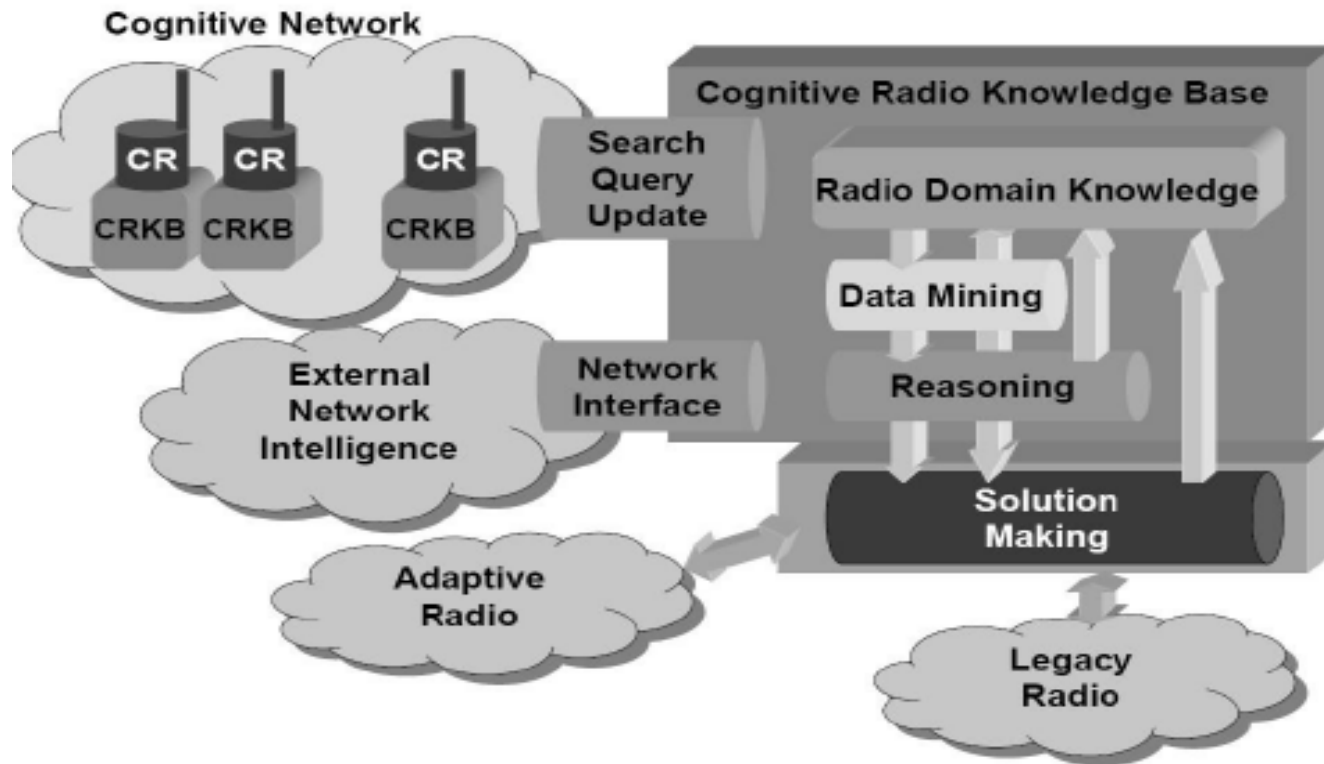
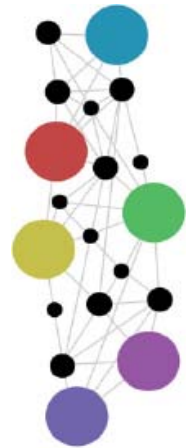
» *Paul Baran, ODC, 1964,*

An Abstraction



- Cognitive Networks as a Multi-Agent Distributed Plane
- Concept of a Cognitive Engine / Controller at the heart of the system for orchestration

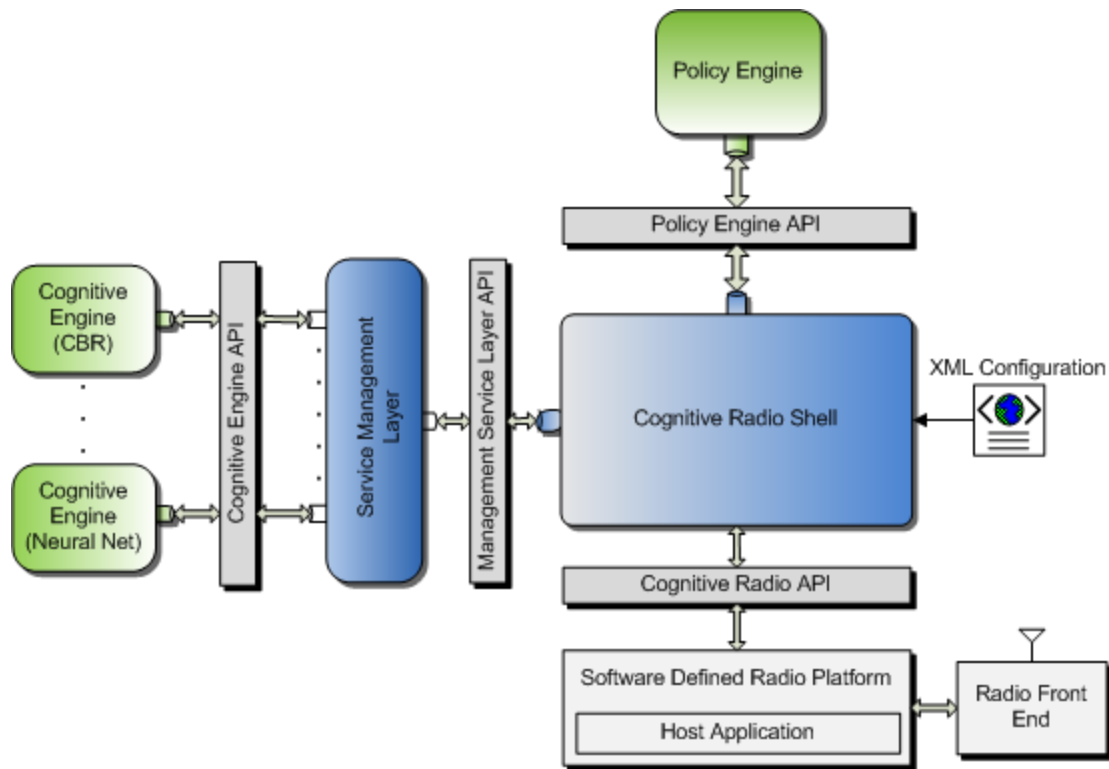
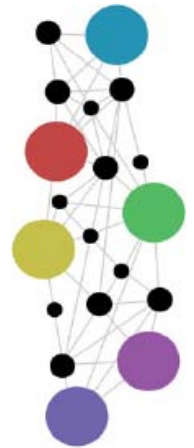
Cognitive Engine



Source Virginia Tech



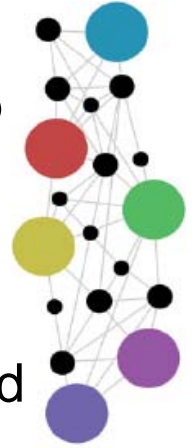
Architecture



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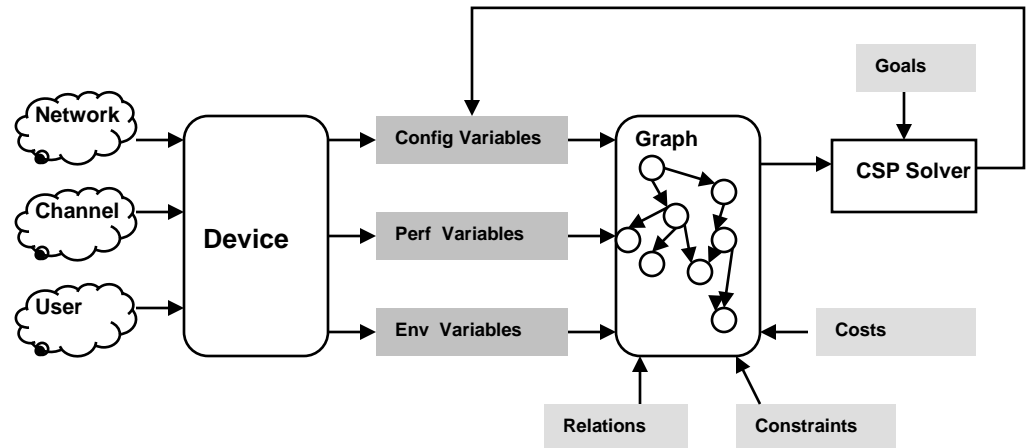
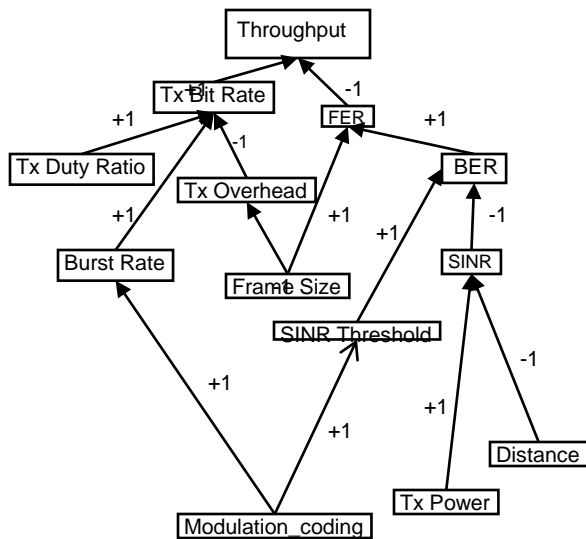
Important Self-* capabilities



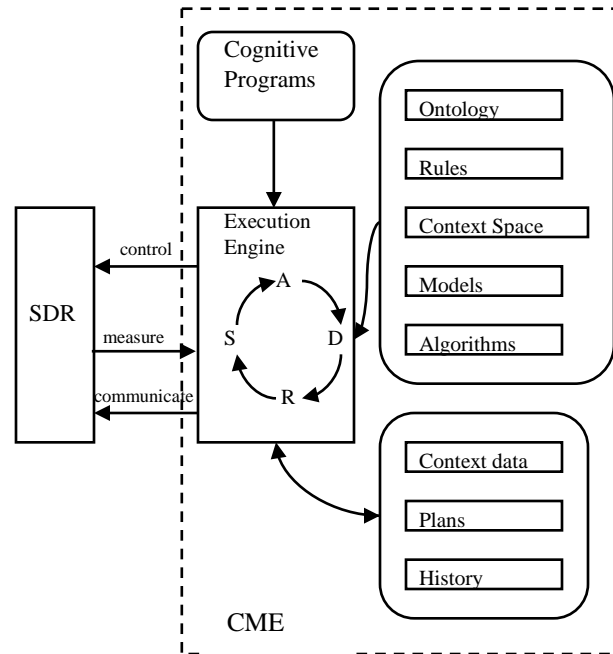
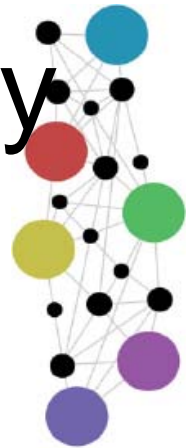
- **SelfConfiguration:** Given a set of goals, find best assignment for resource variables subject to the constraints and dependencies. This is a Constraint Satisfaction Problem.
- **SelfStabilization:** Given the state variables corresponding to the radio/network at equilibrium, a change detected in the environment variables. Find new assignments (reconfiguration) for the control variables so that it comes back to the equilibrium state.
- **SelfOptimization:** Given an equilibrium state, find the new configuration for a change in the goal or a change in constraints.

Require an adaptive optimization core supporting these capabilities

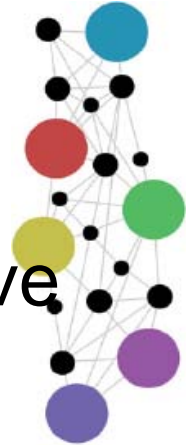
Cognitive Optimization Core



Cognitive Management Entity

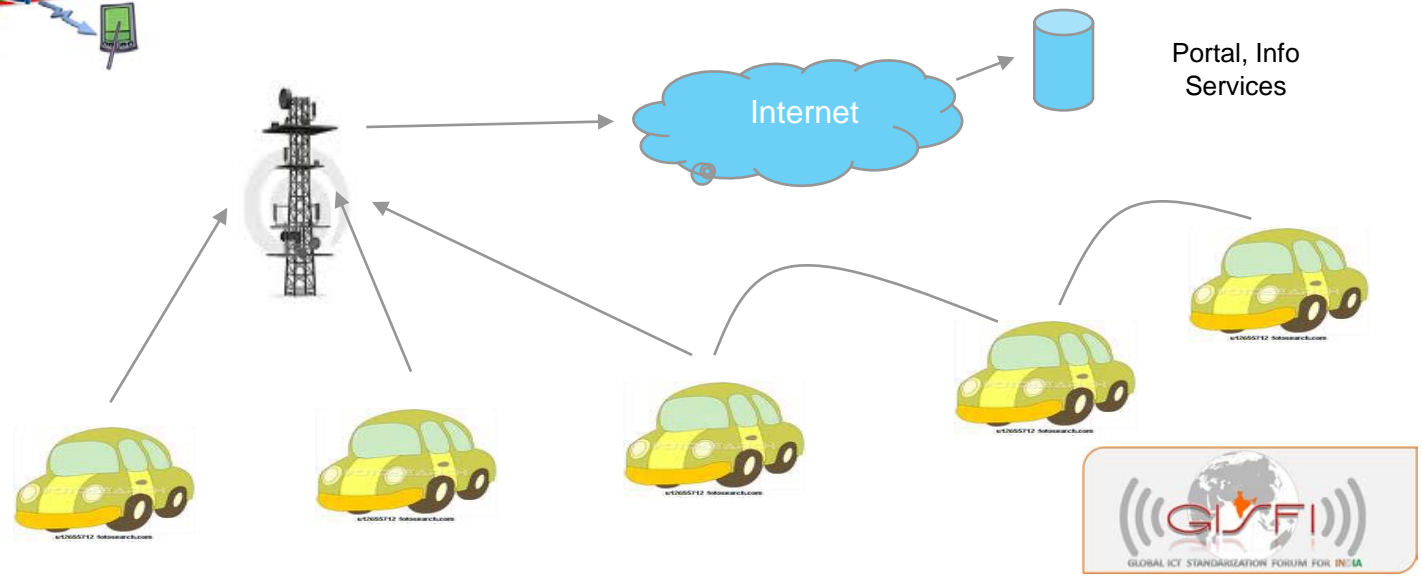
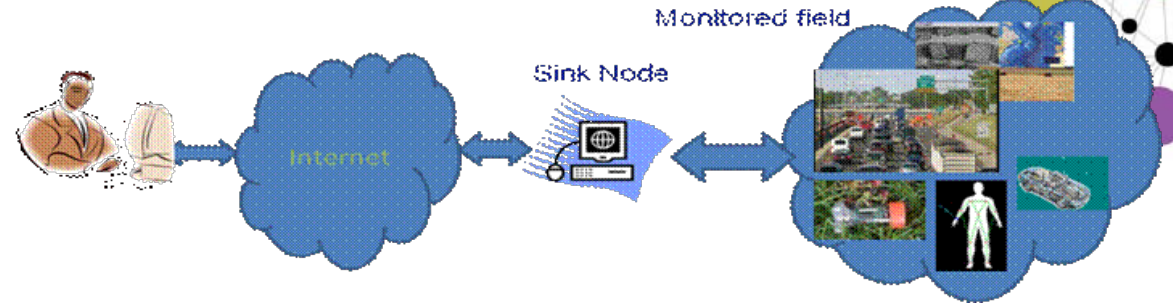
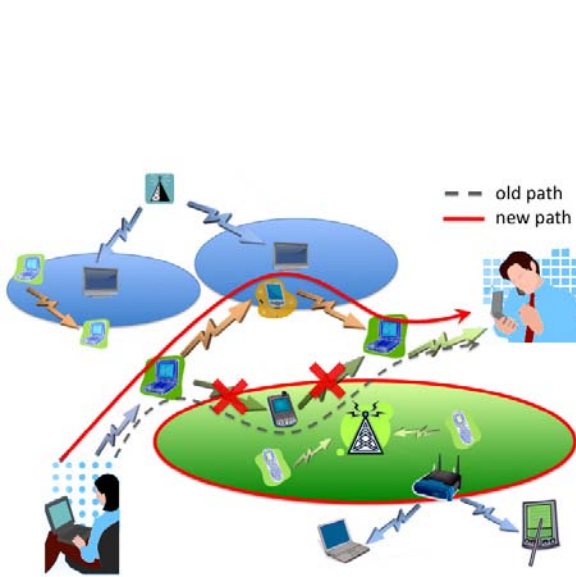


Context Sensing

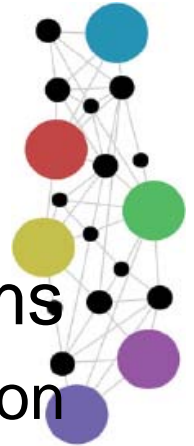


- Role of network state observations in cognitive networking
 - need a way to quantify how much information is needed regarding the state of the network to achieve a desired level of performance.
 - There is often a high cost to exchange this information, and it may even be impossible to know the instantaneous network state due to an inability to communicate state information before it changes.
 - This implies that a cognitive network will have to work with partial state information.
- What are the Channels for Context Communication?

Cognitive Networking – Some Impact Points



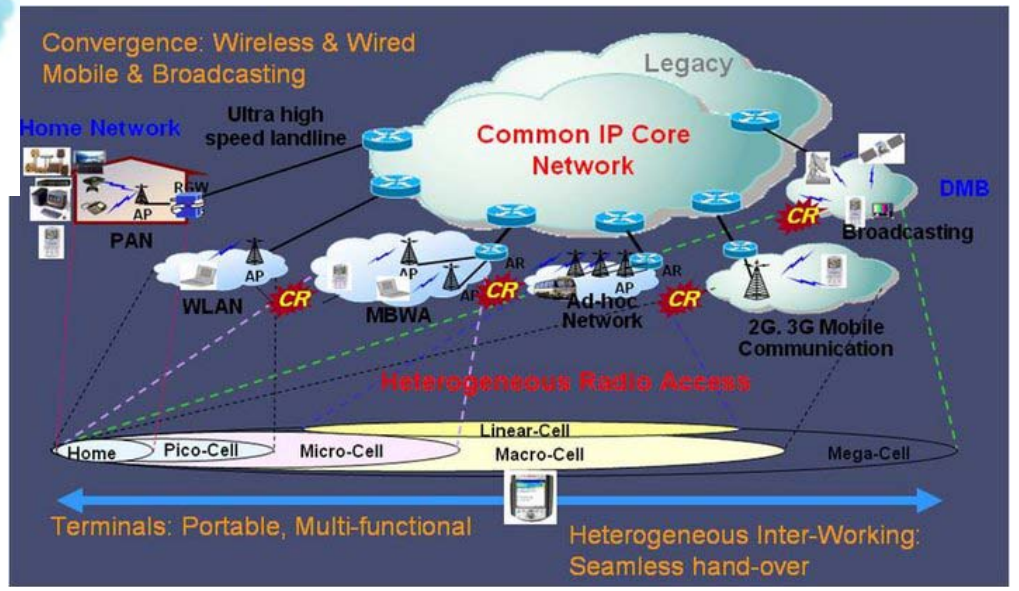
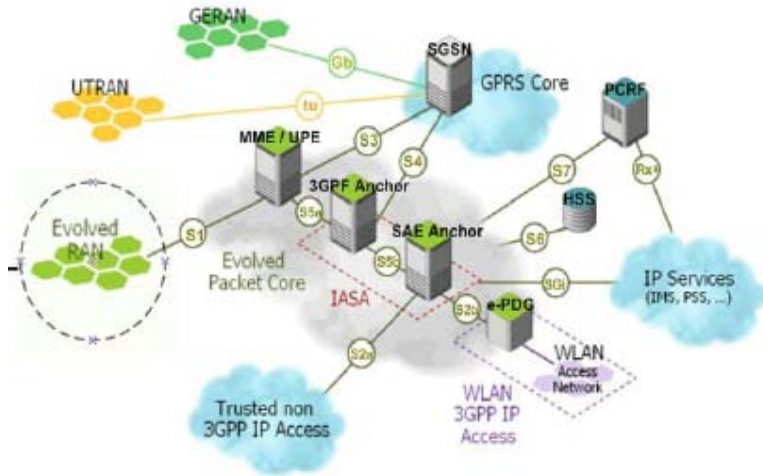
Summary



- Internet engineering- A patchwork of kingdoms
 - Cognitive Networking provides an end-to-end vision of autonomic capabilities into the network
- Policy interoperability, Context information sharing - between Autonomous Systems
 - Require Standardisation efforts
- How to balance between autonomic decisions and centralised control by policies?
 - Require further Research

Thank You

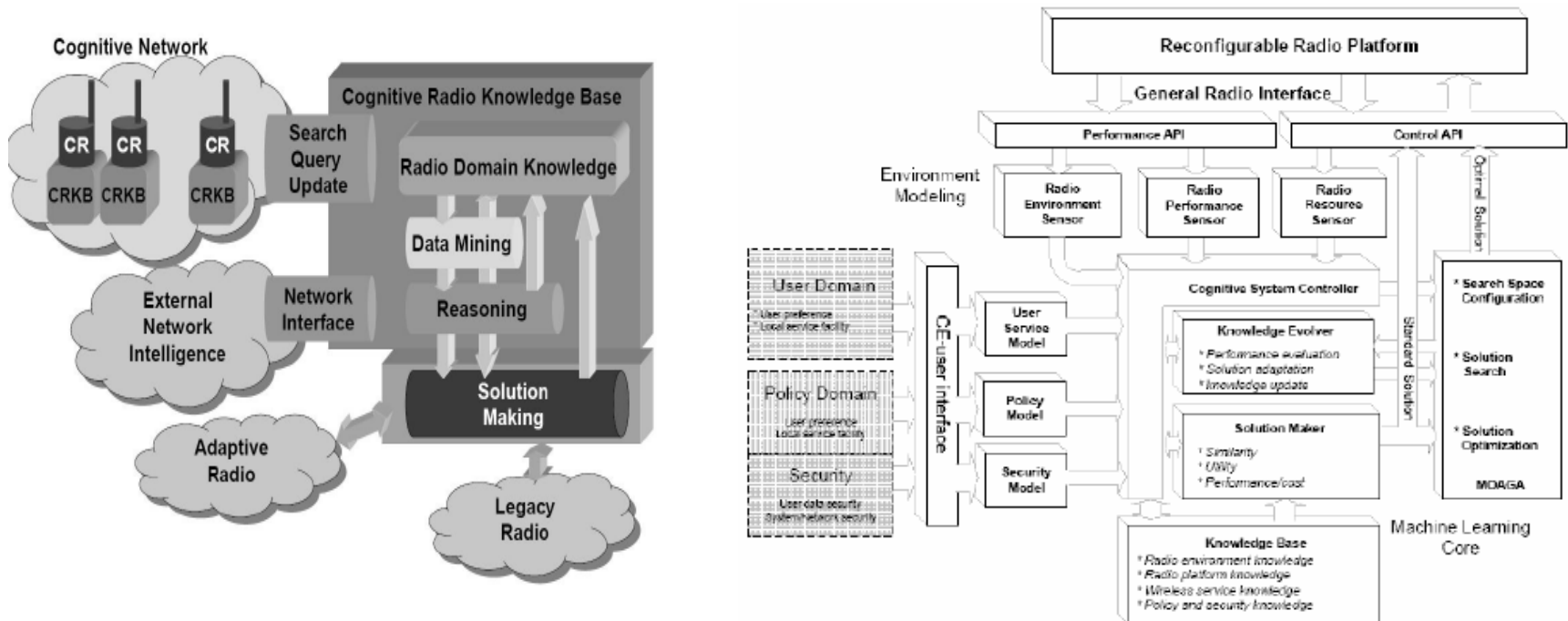
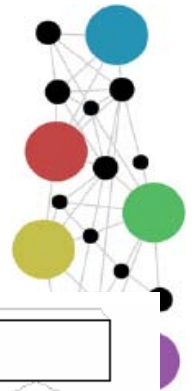
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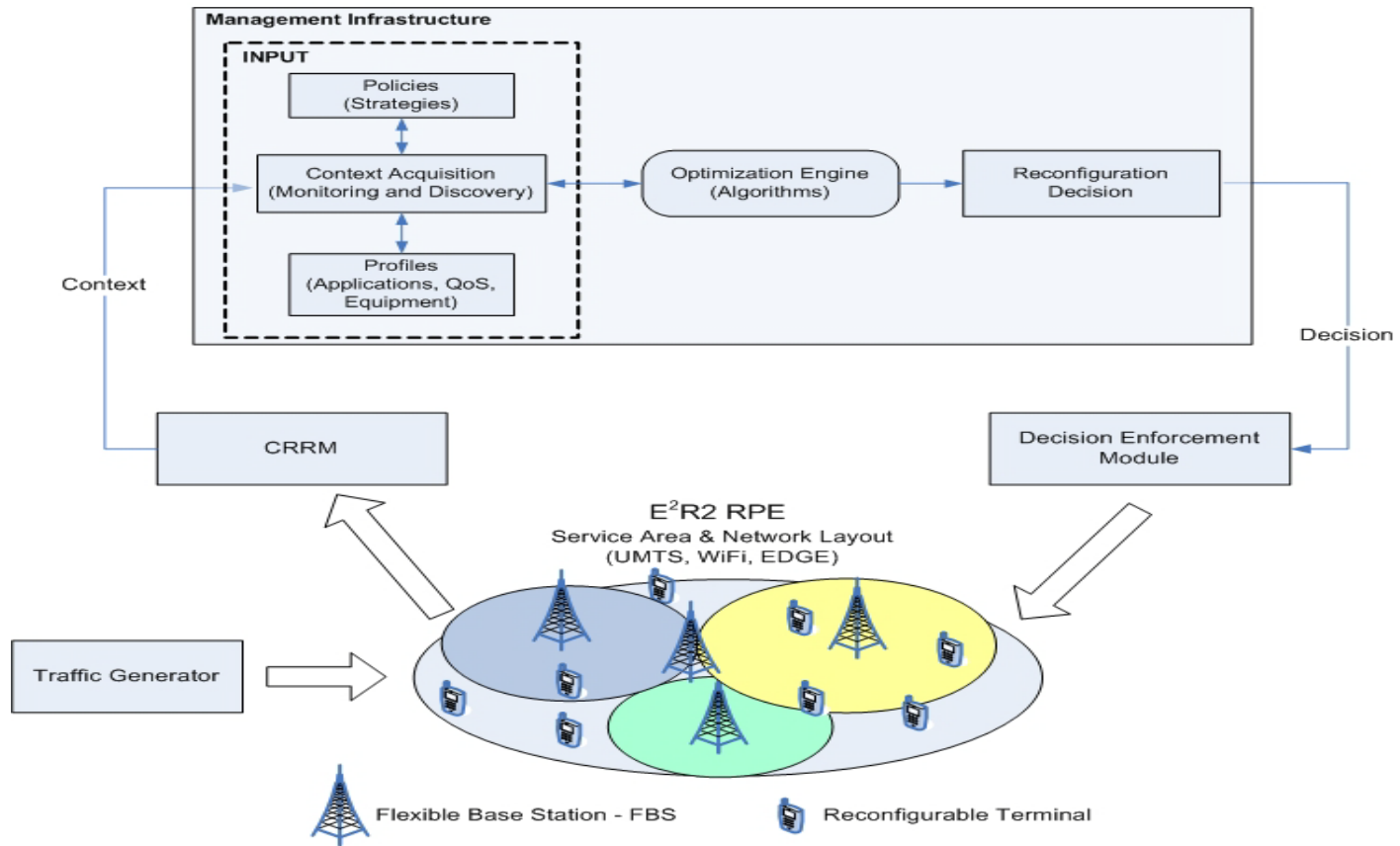


- all the network elements involved in the transmission of a data flow.
- For a unicast transmission, this might include the subnets, routers, switches, virtual connections, encryption schemes, mediums, interfaces, or waveforms
- The end-to-end goals are what give a cognitive network its network-wide scope, separating it from other adaptive approaches.

Cognitive Engine



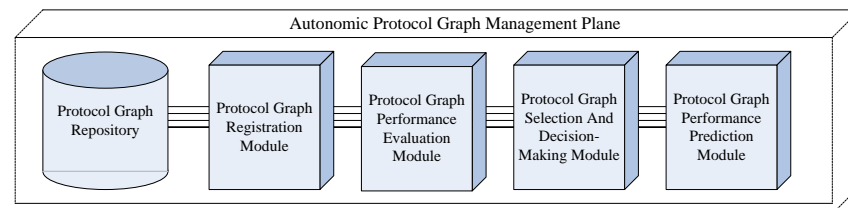
Source Virginea Tech



Reconfigurability through Protocol Graphs



- In order to realize the reconfigurability of future wireless mobile systems, the design of **flexible and multi-mode protocol stacks**
 - autonomic protocol graph management. The term “protocol graph” is used here to represent the interrelationship between different protocol components



CRN Roadmap

