ECODE Project

SEVENTH FRAMEWORK PROGRAMME - FP7-ICT-2007-2 - ICT-2007.1.6 - STREP

Cognitive Router/Routing System

*“**Machine learning** is a method for designing computer programs which are capable to improve their competence and/or performance through experience. The goal of machine learning is to build computer systems that can adapt and learn from their experience.”*

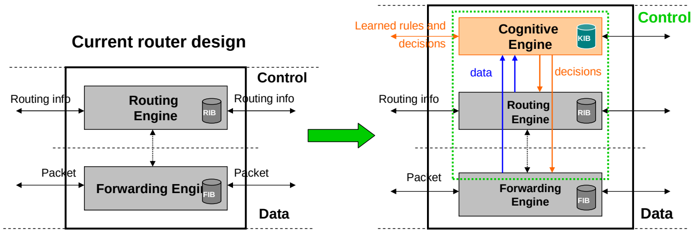
Driving Concept

Augment existing routing/control paradigm of (system &network) lower-level data collection and decision making, with a cognitive engine that

- Enables system & network to learn about its own behavior and environment over time
- Analyzes problems, tunes its operation and increases its functionality and performance

Cognitive engine using semi-supervised, online, and distributed machine learning

Router with cognitive engine

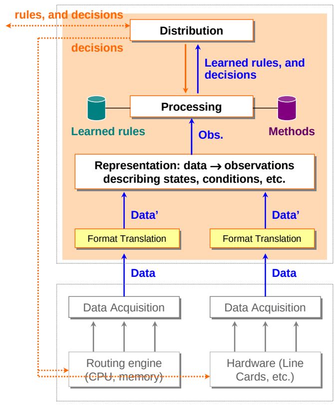


Building Blocks

Cognitive engine comprises

- ***Representation***: transforms uniformly encoded data from e.g. routing and forwarding engine, OS, drivers, etc. into observations describing network & system state
- ***Processing***: uses observations to train the ***learner*** that produces an hypothesis h on the prediction rule

  Using unseen observations, the ***performer*** determines if h is a good approximation of this rule
- ***Distribution***: directs derived decisions to local forwarding and routing engines, and disseminates learned rules and decisions to peers



Principles

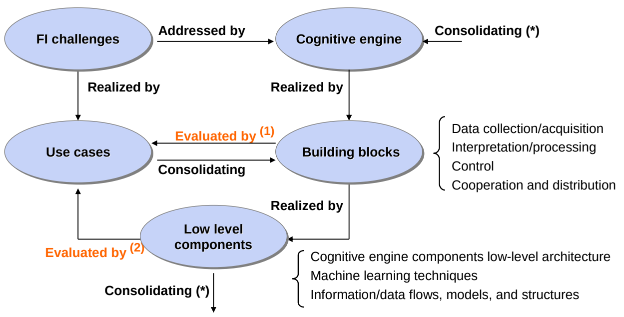
Cognitive routing system

1. Modular instead of relying on unified approach to ensure developability and adaptability (e.g. access vs core, edge vs intermediate router)
2. Rely on relative local view rather than a network global view to ensure scalability, robustness/resiliency, and organic deployment
3. Architected in accordance with inherent distributed properties and capabilities of routing system (e.g. intra- vs inter-domain) instead of a uniform and ubiquitous plane construction so as to ensure deployability

Methodology

- Set of networking use cases representative of Future Internet challenges: Manageability and Security, Availability and Accountability, Routing system scalability and quality
- Develop machine-learning techniques to address their specific needs

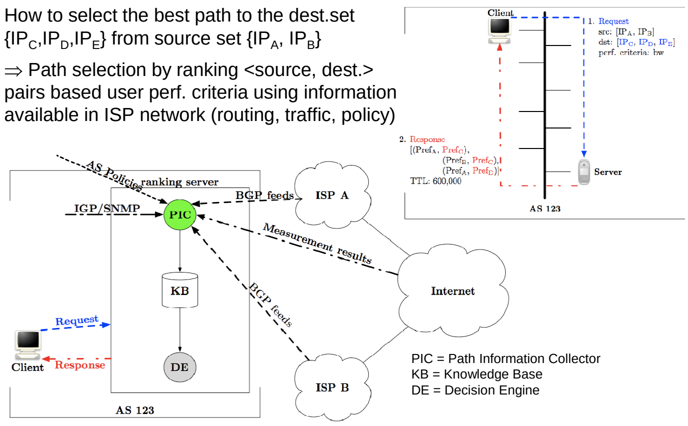
  Determine predictive value (→ decision directed to routing & forwarding engine)
- Combined experimental evaluation (1) physical facility: **iLAB Virtual Wall** (2) virtual facility: **OneLab**



Example 1: Path selection

How to select the best path to the dest.set $\{IP_C, IP_D, IP_E\}$ from source set $\{IP_A, IP_B\}$

⇒ Path selection by ranking <source, dest.> pairs based user perf. criteria using information available in ISP network (routing, traffic, policy)

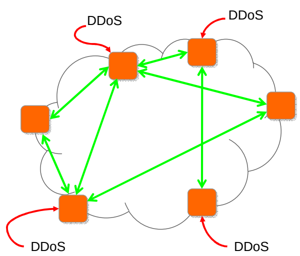


Example 2: Anomaly detection

How measurement systems cooperate to detect anomalies and attacks (up to now all methods are centralized)

Challenges:

- What additional information needed to obtain a global view from local view ?
- Which cooperative framework for distributed anomaly detection?
- Which decision making process for efficient anomaly identification and classification



Partners

Alcatel-Lucent · ULg · IBBT · INRIA · Lancaster University · LAAS

Website: http://www.ecode-project.eu

Alcatel-Lucent BELL (Contact: D.Papadimitriou - E-mail: dimitri.papadimitriou@alcatel-lucent.be)

Universite Catholique de Louvain (Contact: O.Bonaventure)

Universite de Liege (Contact: G.Leduc)

Interdisciplinair instituut voor BreedBand Technologie (Contact: P.Demeester)

Institut National de Recherche en Informatique et en Automatique (Contact: Ch.Barakat)

University of Lancaster (Contact: L.Mathy)

Centre National de la Recherche Scientifique (Contact: Ph.Owezarski)

ECODE - Experimental Cognitive Distributed Engine

http://www.ecode-project.eu