Traffic Management in the European Project UniverSelf

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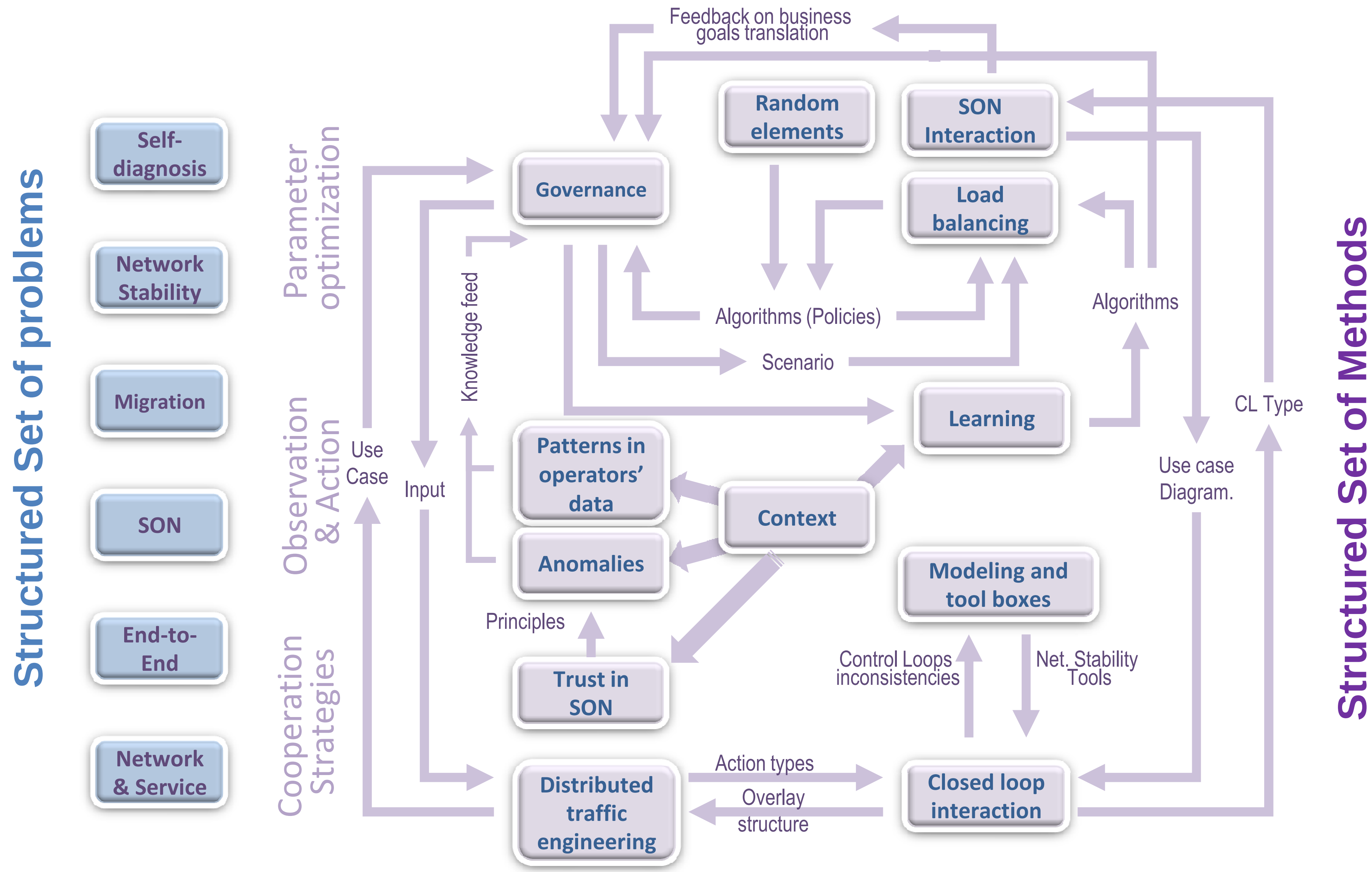
On behalf of UniverSelf

Factsheet UniverSelf

- Focus: Autonomic networks (wireline & wireless)
- Project start: September 2010
- Project duration: 3 years
- Manpower: ~1400 person months
- Budget: ~16.6 million € (~10.5 million € from European Commission)
- Coordinated by Alcatel-Lucent Bell Labs France
- Partners:

UNIVERSITY OF TWENTE.

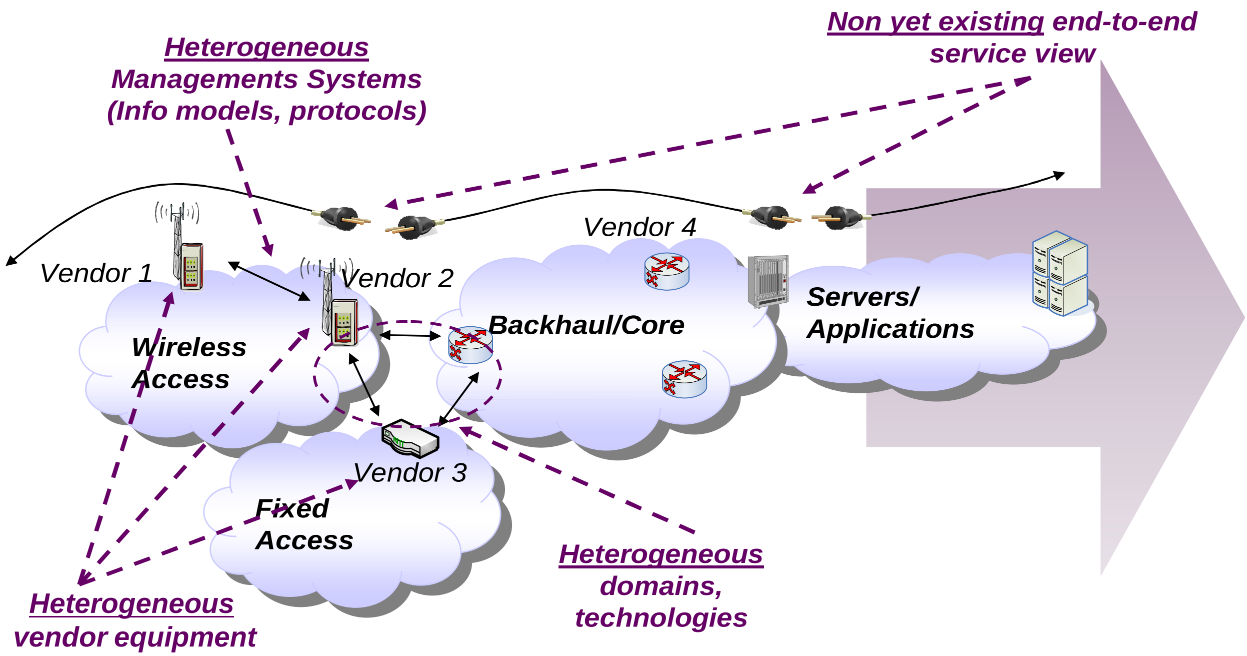
Finding the right method for a given problem



Governance and autonomic management of OFDM and MPLS segments

Courtesy of Kostas Tsagkaris,
University of Piraeus

- *"Operator-governed, end-to-end, autonomic joint network and service management"*



- Loose or **no integration**
- Partial or **no automation**
- **Manual** intervention
  - Strong expertise is needed
- **Over-provisioning** due to the worst-case planning

- Objective is to provide a unified, goal-based, autonomic management system for the **service deployment and/or new traffic accommodation** on top of heterogeneous networks encompassing both *OFDM-based RANs and MPLS-based backhaul/core segments*
- Requires solution of RAN and Backhaul/Core network optimization problems that take into account operator Goals - Policies
  - Autonomic management of OFDM-based segments
  - Autonomic management of MPLS-based segments
- Impact of governance – policies into the algorithms

Governance and autonomic management of OFDM and MPLS segments

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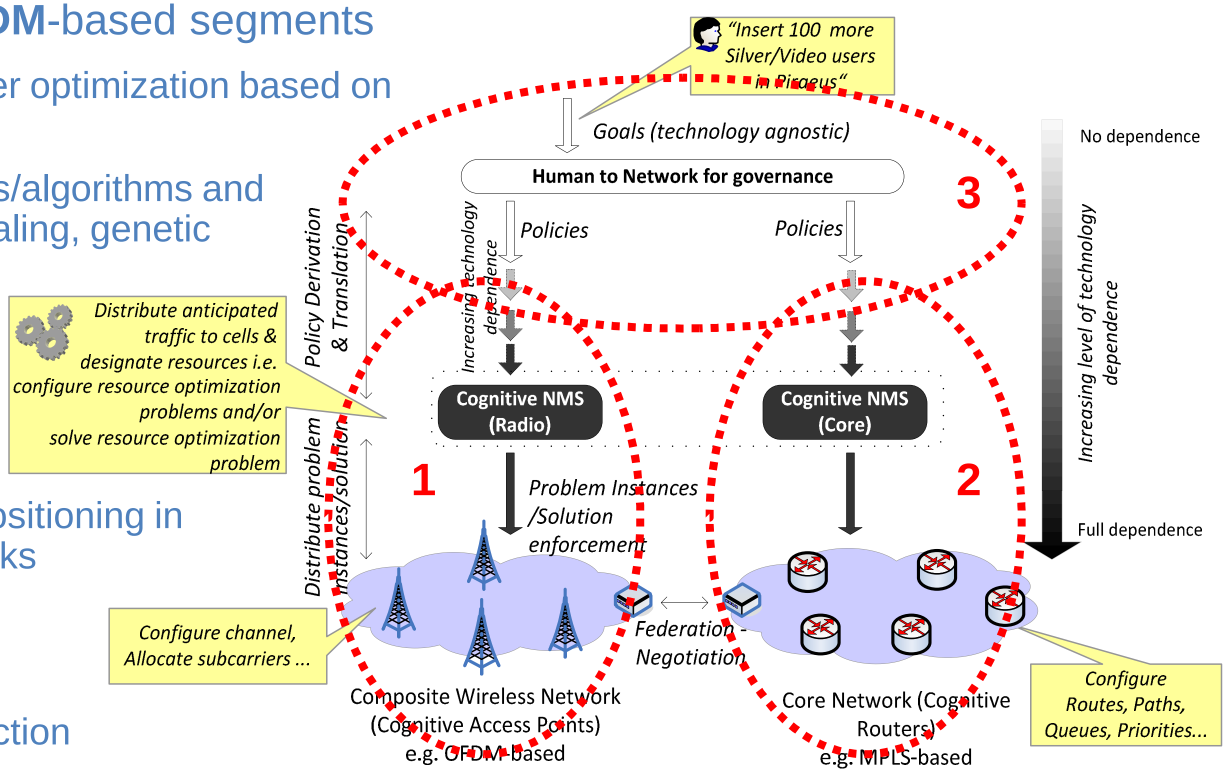
University of Piraeus

Autonomic management of **OFDM**-based segments

- Radio access network parameter optimization based on operator policies
- Stochastic optimization methods/algorithms and metaheuristics (simulated annealing, genetic algorithms, swarm intelligence and other bioinspired like ant-colony optimization)
- Game theoretic approaches
- Application to OFDM(A) resource allocation, relay link positioning in multi-hop cellular OFDM networks



Autonomic management of **MPLS**-based segments

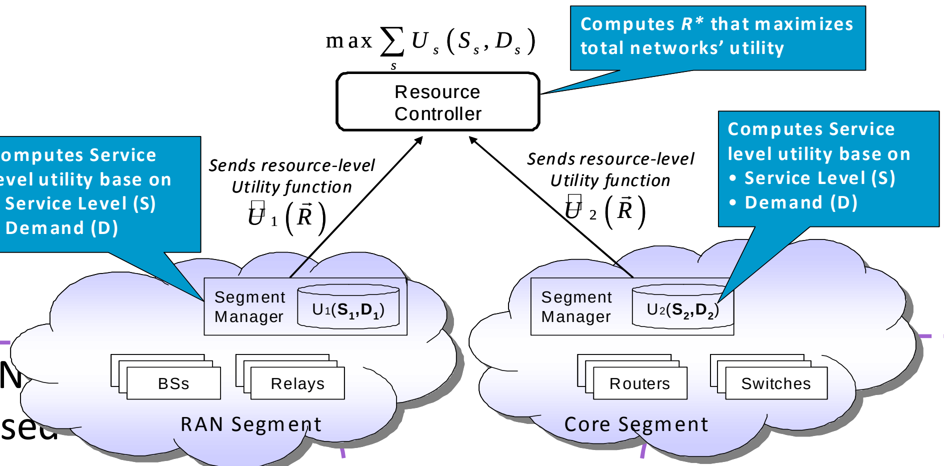
- Route optimization & node selection based on operator policies
- MPLS parameter optimisation: Load aware and optimal routing algorithms & protocols/Maximum-flow/Graph-theory
- Policy-based, green traffic engineering & Bio-inspired approaches

Impact of governance – policies into the algorithms

➢ Autonomic adaptation of objective functions, utility functions, constraints

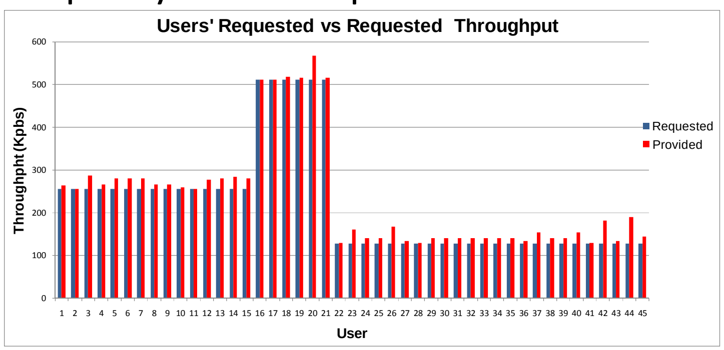
Governance and autonomic management of OFDM and MPLS segments

Courtesy of Kostas Tsagkaris and Panagiotis Vlacheas, University of Piraeus

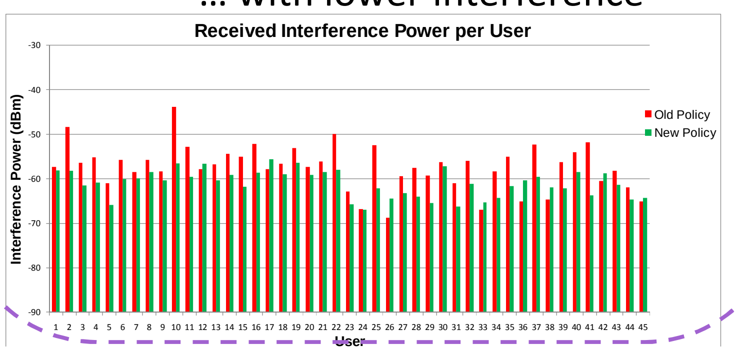


Co-optimisation problem is formalised and solution architecture is set-up

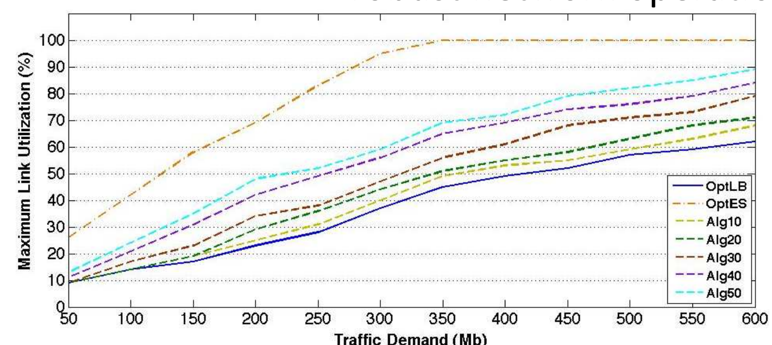
Simulations in RAN demonstrate increased quality of user experience …



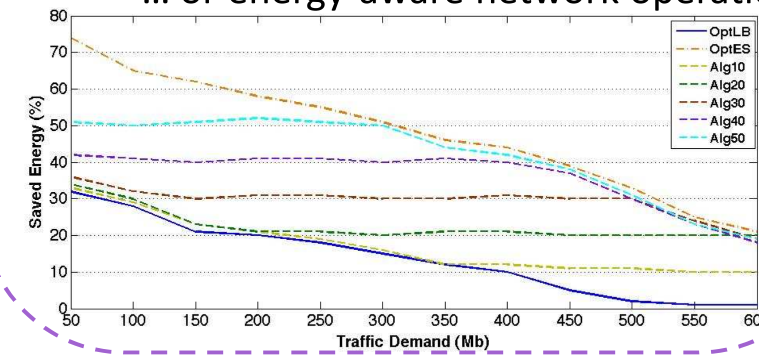
… with lower interference



Simulations in Core demonstrate balanced and robust network operation…



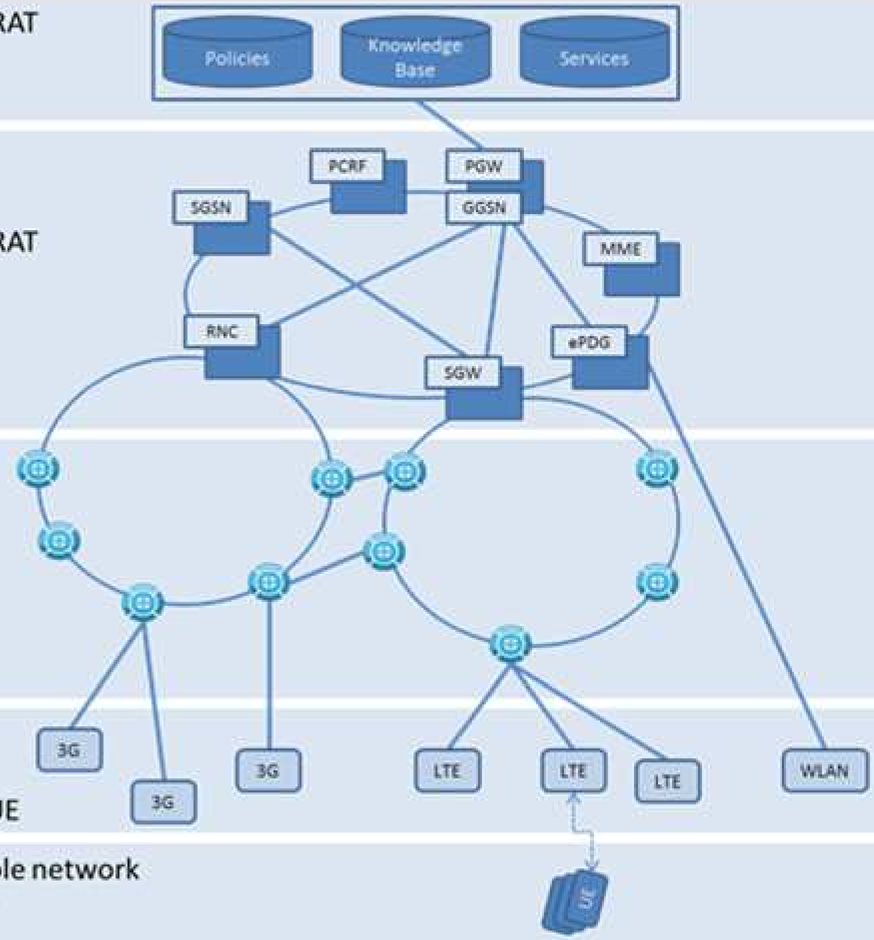
… or energy-aware network operation



Load balancing (general)

Courtesy of Johannes Lessmann, NEC

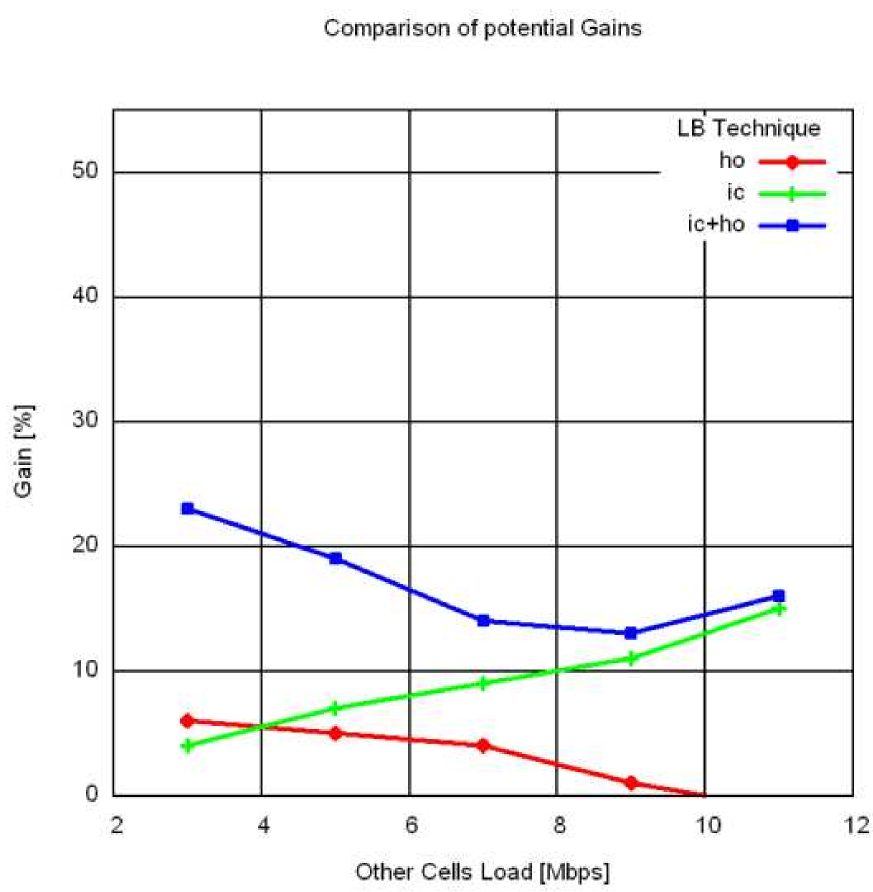
	Measured Context Information	Possible Load Balancing Actions
Service	➢ get available services per RAT	➢ adapt service to connection quality
Core	➢ measure node load ➢ measure link load ➢ get available services per RAT	➢ scale/migrate core functions ➢ scale/migrate services ➢ perform downlink traffic shaping ➢ perform admission control
Backhaul	➢ measure node load ➢ measure link load	➢ scale/migrate core functions ➢ scale/migrate services ➢ reroute traffic (e.g. reconfigure Label Switched Paths or Virtual LANs or adapt OSPF weights)
Access	➢ track user mobility ➢ measure capacity usage ➢ measure throughput per UE	➢ perform uplink traffic shaping ➢ change antenna tilt ➢ initiate intra-RAT handover
User	➢ measure SINR per reachable network ➢ get service access latency ➢ measure battery level	➢ perform intra-RAT handover ➢ perform inter-RAT handover ➢ (de-)activate additional interface

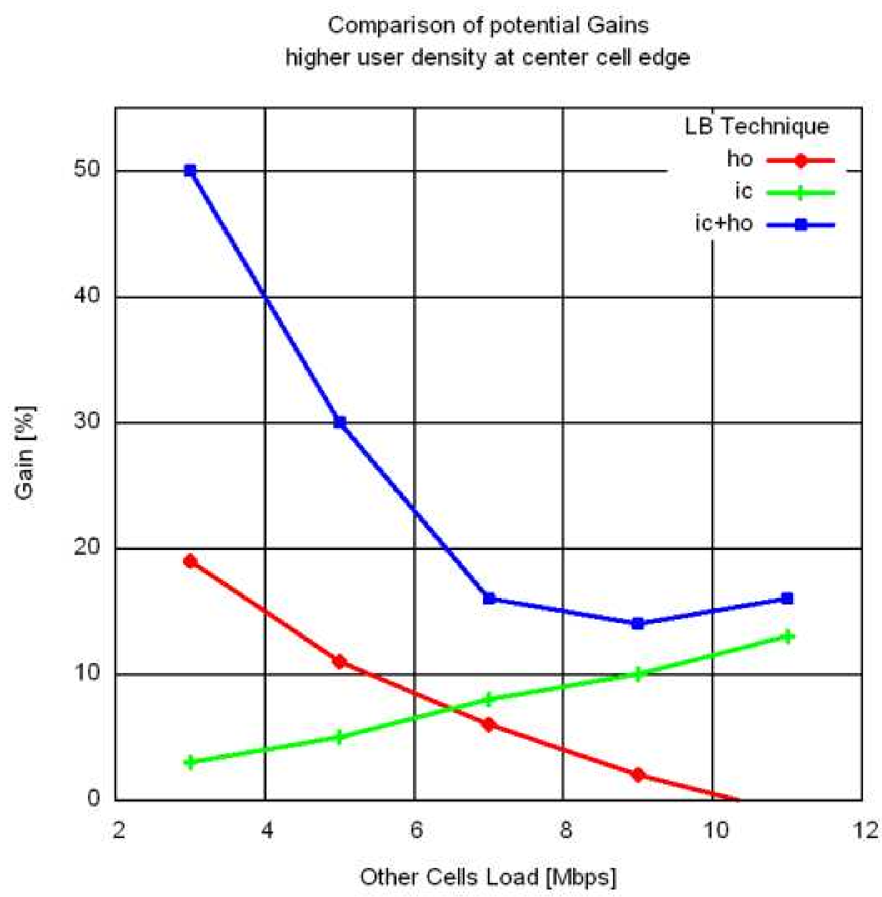


Load balancing (wireless)

Courtesy of Siegfried Klein,
Alcatel-Lucent Bell Labs

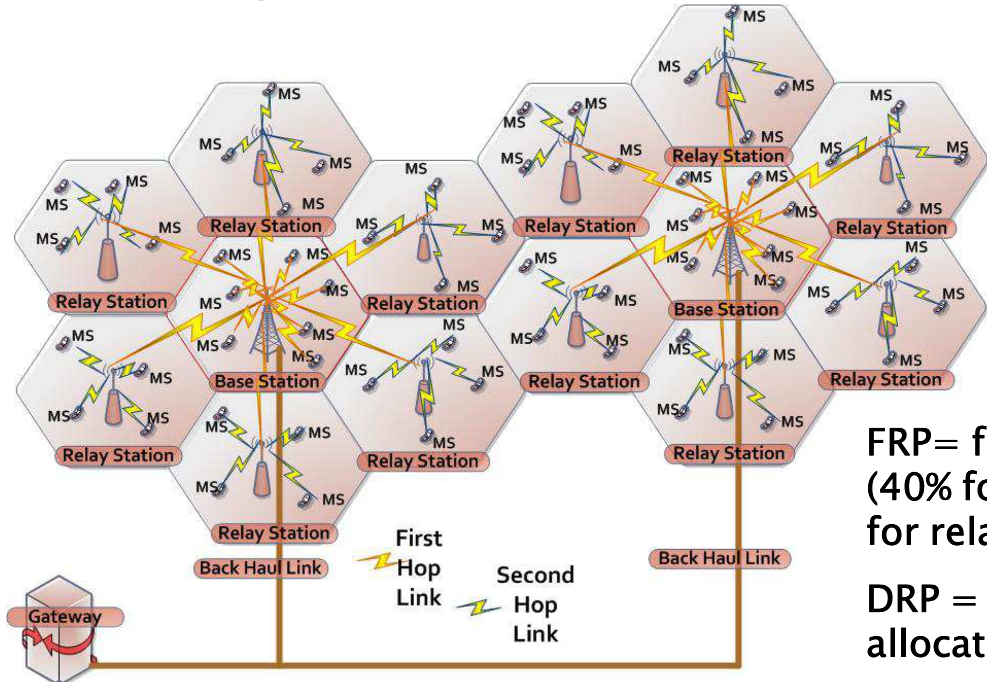
Comparison of the load balancing strategies handover (ho) and interference coordination (ic)





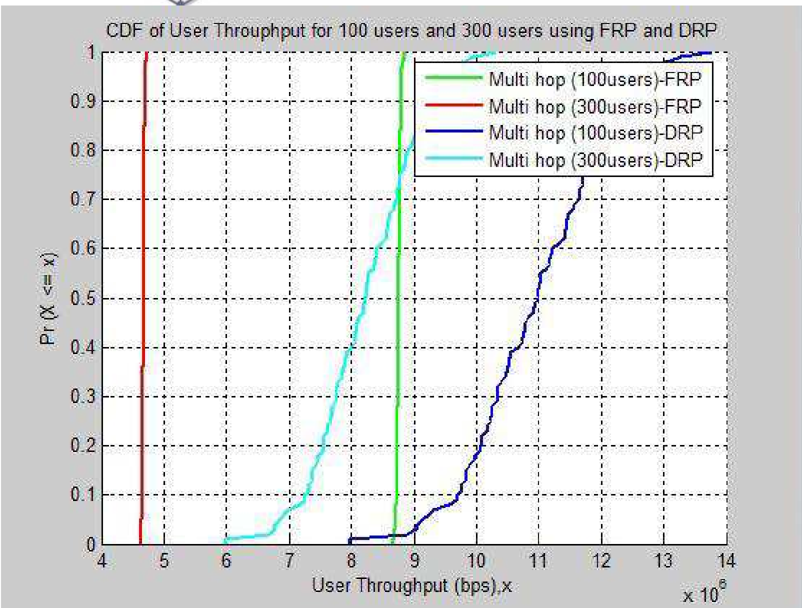
Heterogeneous networks – resource allocation

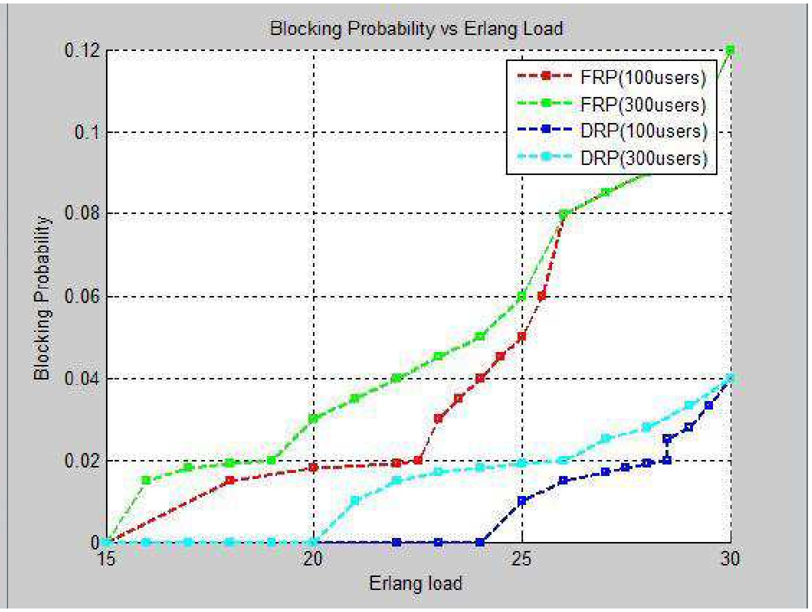
Courtesy of Velmurugan Ayyadurai,
University of Surrey



FRP= fixed resource allocation (40% for base station and 60% for relays)

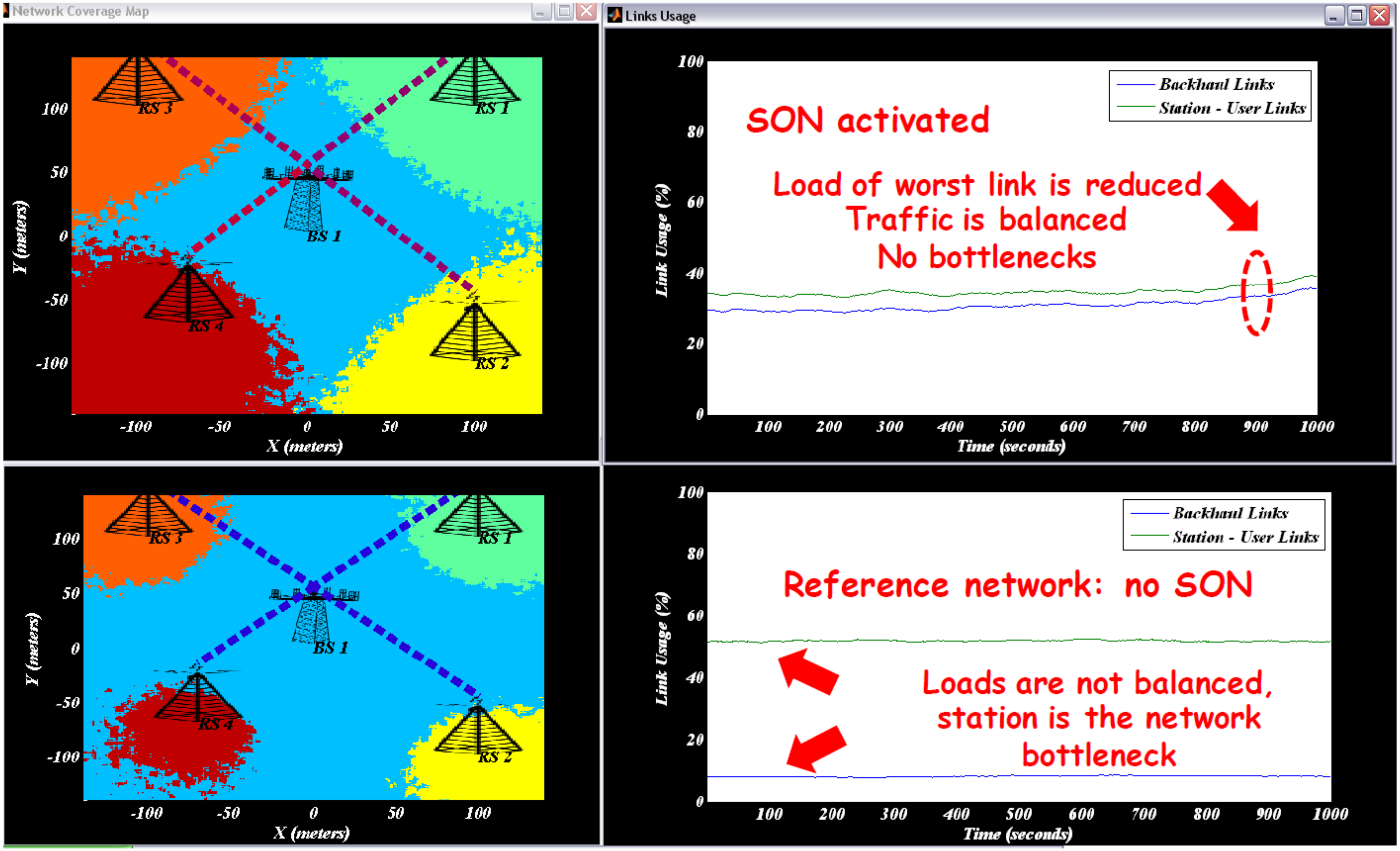
DRP = dynamic resource allocation



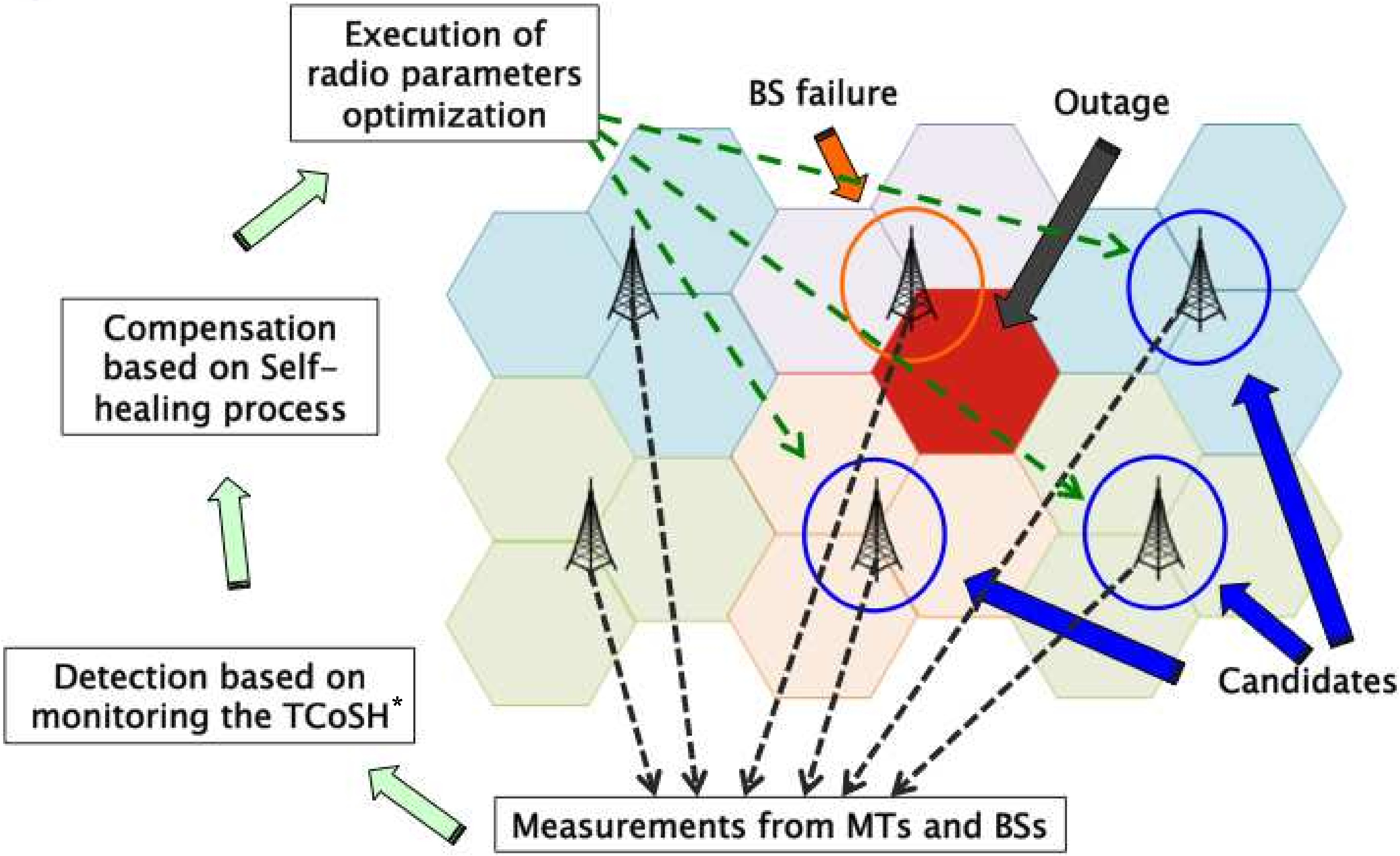


Heterogeneous networks – link usage

Courtesy of Zwi Altman and
Richard Combes, Orange Labs



Self-healing

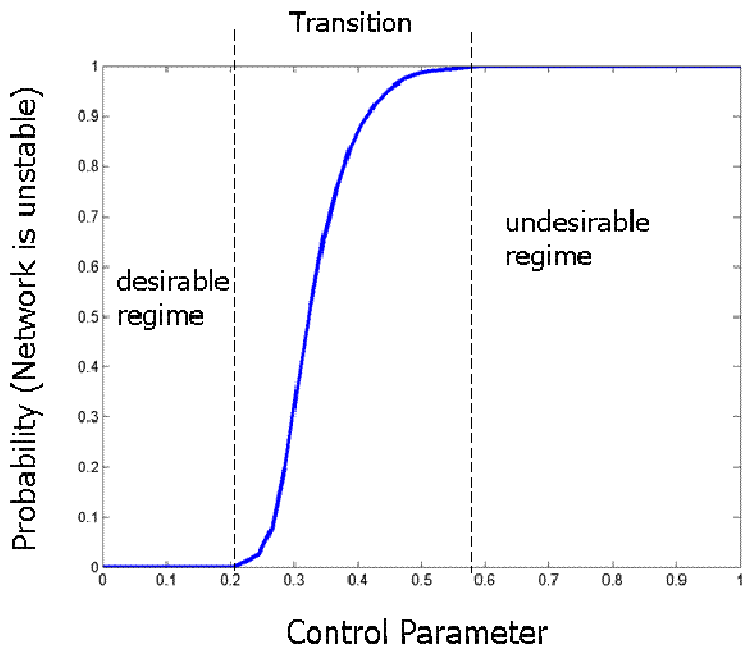


* Trigger Condition of Self Healing

Modeling (1/2)

Courtesy of Antonio Manzalini, Telecom Italia

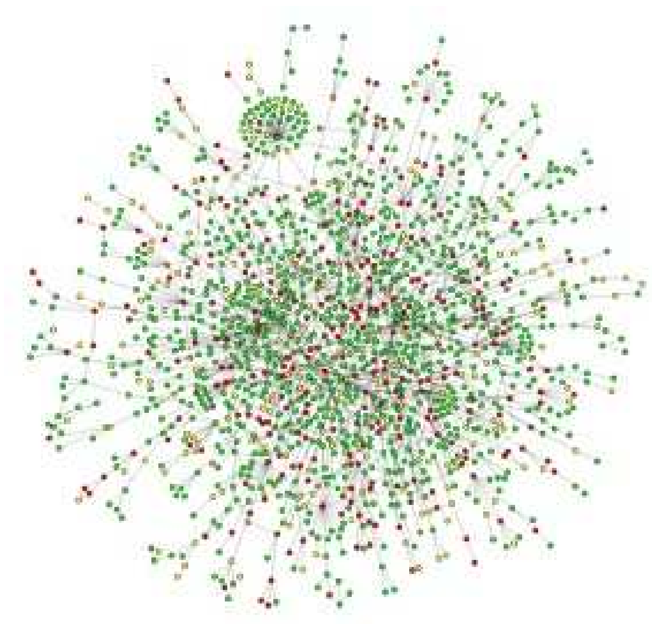
- Complexity of network management is dramatically increasing as networks are progressively becoming more heterogeneous, ubiquitous and dynamic
  - there a need of modelling and understanding the dynamic behaviours of future networks in order to predict and control such "complexity"
- Introducing self-management and self-control functions is way for contributing to tame such increasing complexity; on the other hand, cascading and nesting of control loops and self-* mechanisms could easily lead to the emergence of non-linear network behaviours and instabilities during transients.
  - multiple phases (i.e. identical local behaviours could give rise to widely different global dynamics) causing the risk of state-phase transitions, capable of jeopardizing network performance
- A phase transition is caused by a sudden change of an order parameter of the network when a control parameter is varied across the critical point
- Example:
  - Order parameter(s): certain QoS parameter(s), etc
  - Control parameter(s): network pressure, routing/forwarding strategies, etc



Modeling (2/2)

Courtesy of Antonio Manzalini, Telecom Italia

- Overall, network instabilities may have primary effects both jeopardizing the network performance and compromising an optimized use of resources
- There is a need to model and to make simulations and emulations for defining and validating the existence of stable states (with the related levels of performance) in a complex network, so to bring or maintain network behavior to desired states
- Loosely speaking, a network is said to be stable near a given state if one can construct a Lyapunov function that identifies the regions of the network state space over which such functions decrease along some smooth trajectories near the solution.
- Lyapunov stability theory can, in principle, provide us the required tools needed to define and analyze the stability problem of a network of FSMs.
  - An important advantage is that the approach doesn't require high complexity of computation, but on the other hand the difficulty lies in the definition of the proper Lyapunov function.



Future Networks: taming instabilities in highly dynamic and complex environments

→ Workshop *Future Network Stability* at FNMS, Berlin, June 2012

Further reading

http://www.univerself-project.eu/

Deliverables D3.1 and D3.4