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An Autonomic Framework for Self-Optimizing Next Generation Mobile Networks

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Research, Technology and Platforms

IEEE IWAS07, June 18th 2007

Outline

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Introduction

- Generic framework for self-optimizing mobile radio access networks
- Autonomic system assessment in terms of
  - Coping with unanticipated changes in the environment
  - Network performance (within limits)
- Level of autonomicity is evaluated through two case studies
  - Neighbor cell list (NCL) prune
  - Cell removal and redeployment

Autonomic framework

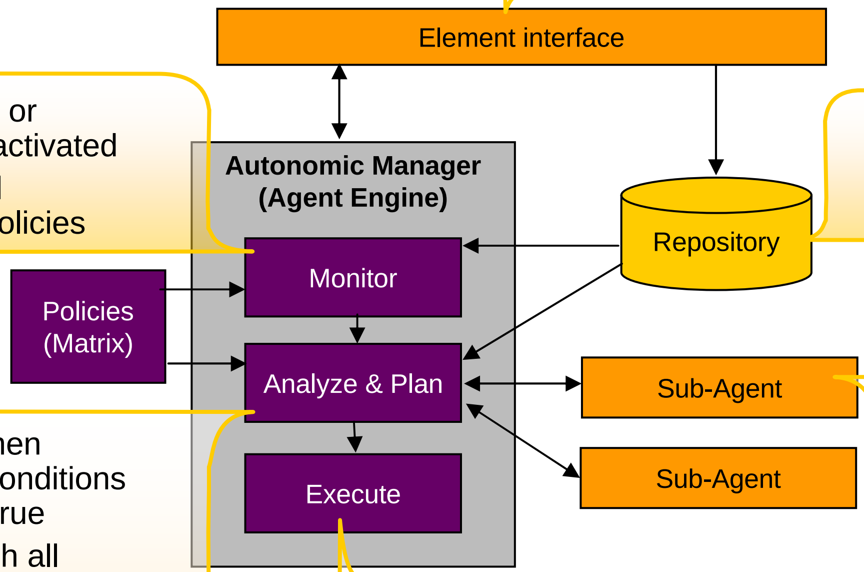
- Stable and flexible structure with various self-management functionalities
- The behavior is governed by a *policy matrix*
  - Monitoring policies (conditions) for **Monitoring** process
  - Analysis policies (conditions & functions) for **Analyze & Plan** process

Condition	**Function**
Monitoring Condition	-
Analysis Condition	*Analysis Function*

Autonomic Manager functional elements

- <u>Application</u> contained within a logical element of the autonomic system with <u>centralized or distributed architecture</u>

- To/from other elements
- To/from other agent engines



- Event based or periodically activated
- Evaluates all monitoring policies

- Measurements
- Parameters
- …

- Activated when monitoring conditions evaluate to true
- Goes through all analysis policies
- Initiates the functions (sub-agents) when condition evaluates to true
- Passes data to the Execute process

- Executes proposed actions
- Checks for and resolves conflicts
- Executes those actions that remain

- Scalability (content, multi-vendor and different elements)
- Handle different algorithmic analysis or functions using data from the repository provided by the AM
- Return a list of actions to the AM: E.g. **Add**, **Prune**, **Generate** and **Initialize**

Case studies and simulation assumptions

- Assess adaptability, time to react, stability and sensitivity of the *distributed* optimization function
- Case 1: **NCL prune**
  - Delete unnecessary adjacent cells based on predefined conditions

Condition	Function
HOshare < 1%	*Prune*

- Case 2: **cell removal and redeployment**
  - React when a cell is removed/re-deployed in the network
  - Adapt the NCLs of the affected cells to the new system configurations

Condition	Function
Cell state = off	*Prune*
Previous Cell state = off & *Cell state* = on	*Generate*
HOshare < 1%	*Prune*

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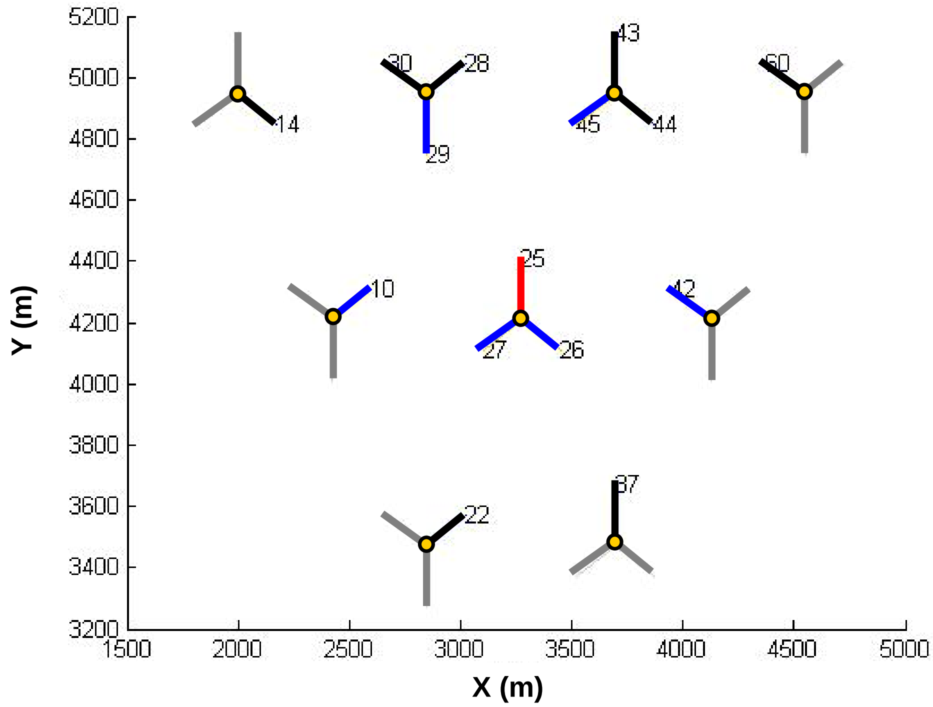
Simulation environment

- Simple mobility with reflection on the borders of the map
- 300 terminals uniformly randomly distributed
- 25 base stations with 3 cells each (75 cells in total)
- Two scenarios: dense and sparse



Case 2:

- **Generated NCL of Cell 25**: Cell **10, 14, 22, 26, 27, 28, 29, 30, 37, 42, 43, 44, 45**, and **60** (*Cluster Under Test*)
- **Pruned NCL of Cell 25:** Cell **10, 26, 27, 29, 42,** and **45**

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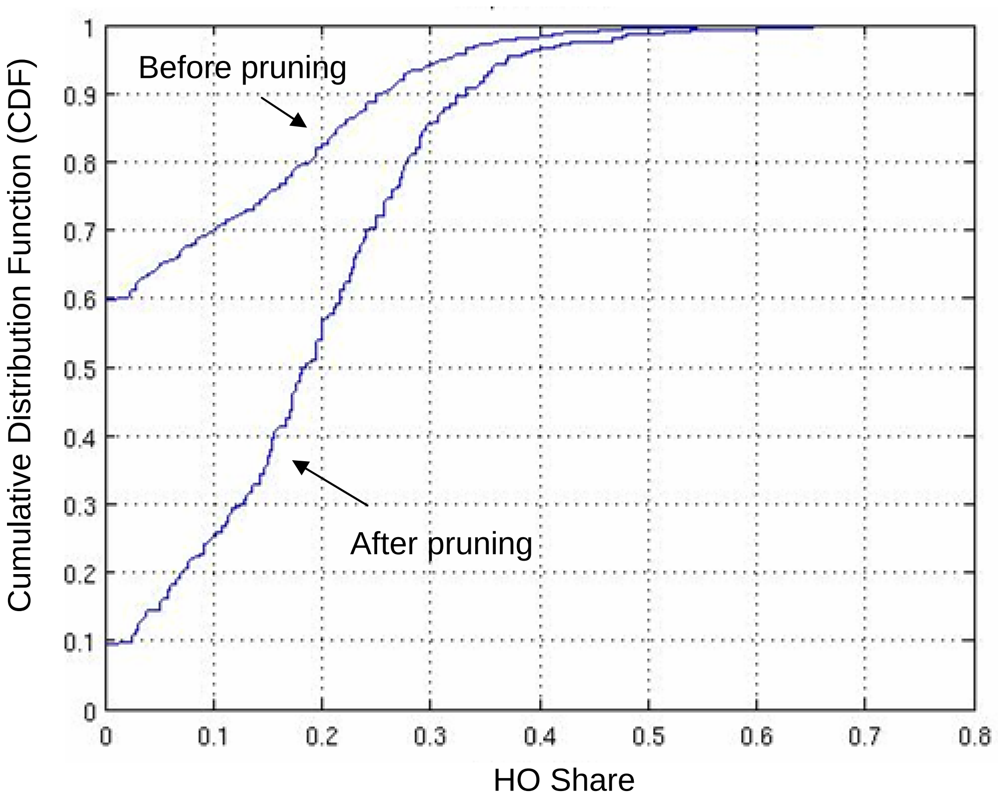
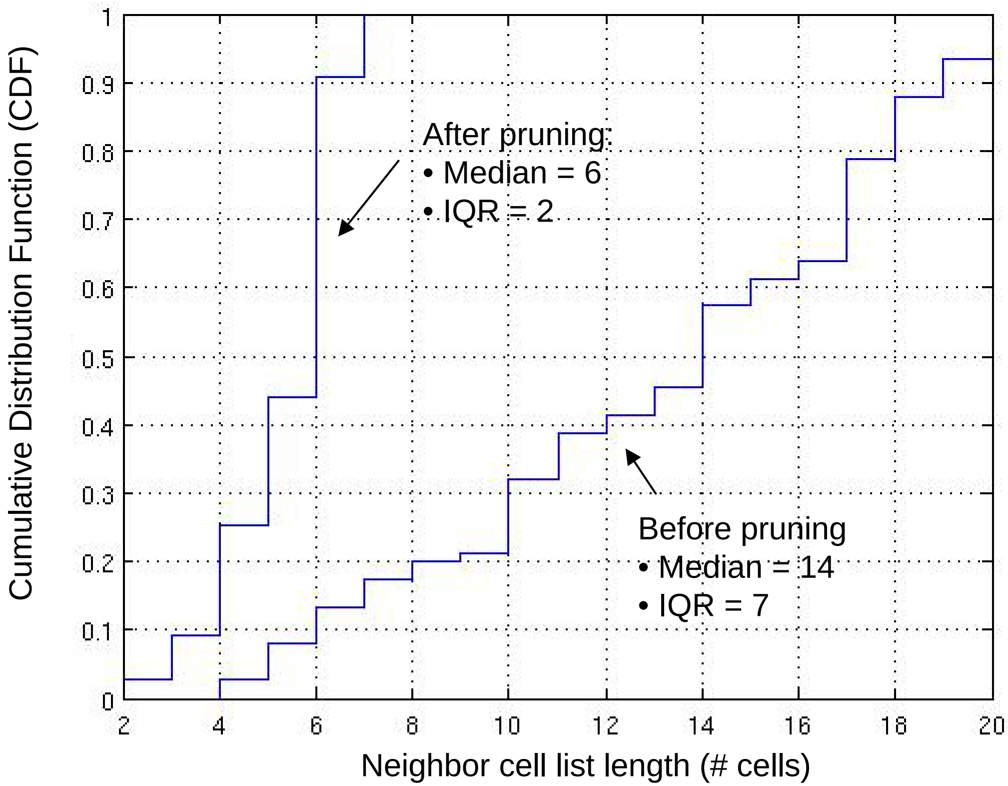
Case 1 - results: NCL Prune (1/3)

- This proves the ability of the AM to delete unnecessary adjacencies based on the input policy



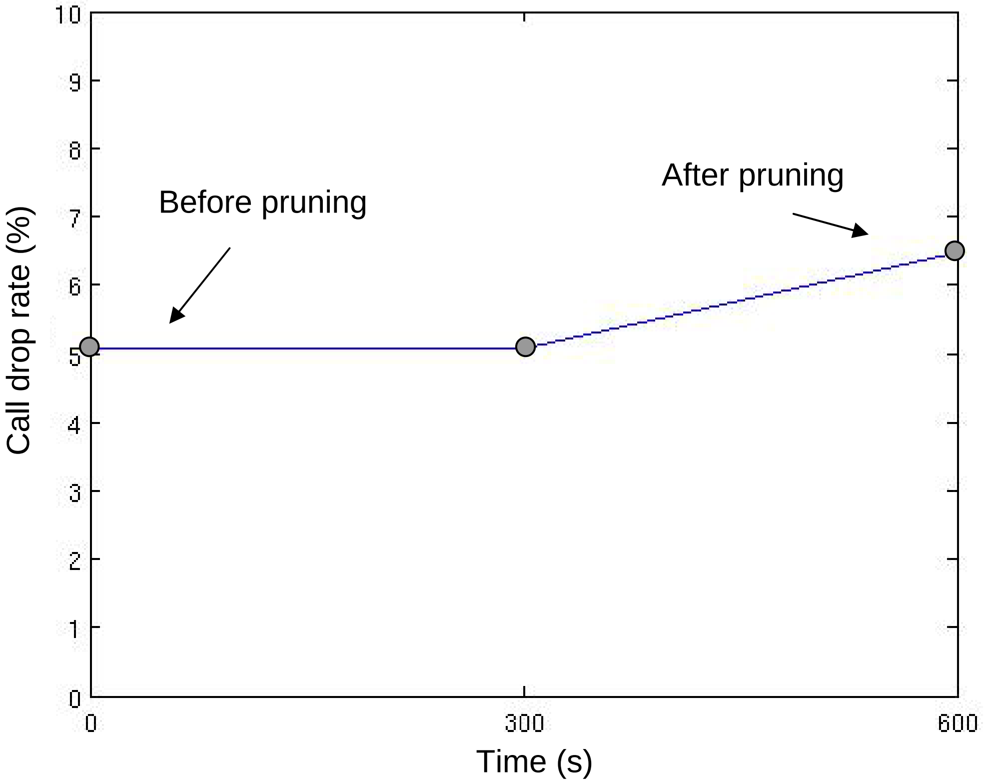
Case 1 - results: NCL Prune (2/3)

- Wasted resources are detected by the AM and every cell on the NCL with less than 1% of HO share is pruned from the list



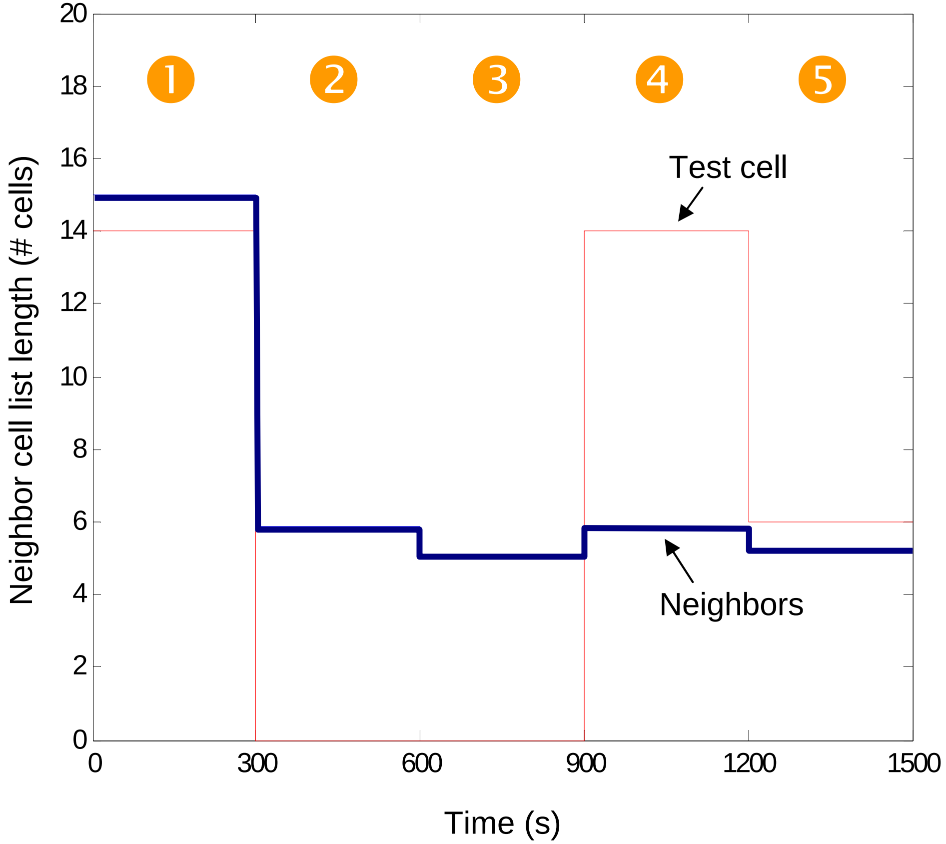
Case 1 - results: NCL Prune (3/3)

- The deterioration in performance can be eliminated by adjusting the policies (conditions and/or functions)



Case 2 - results: Cell removal & redeployment (1/2)

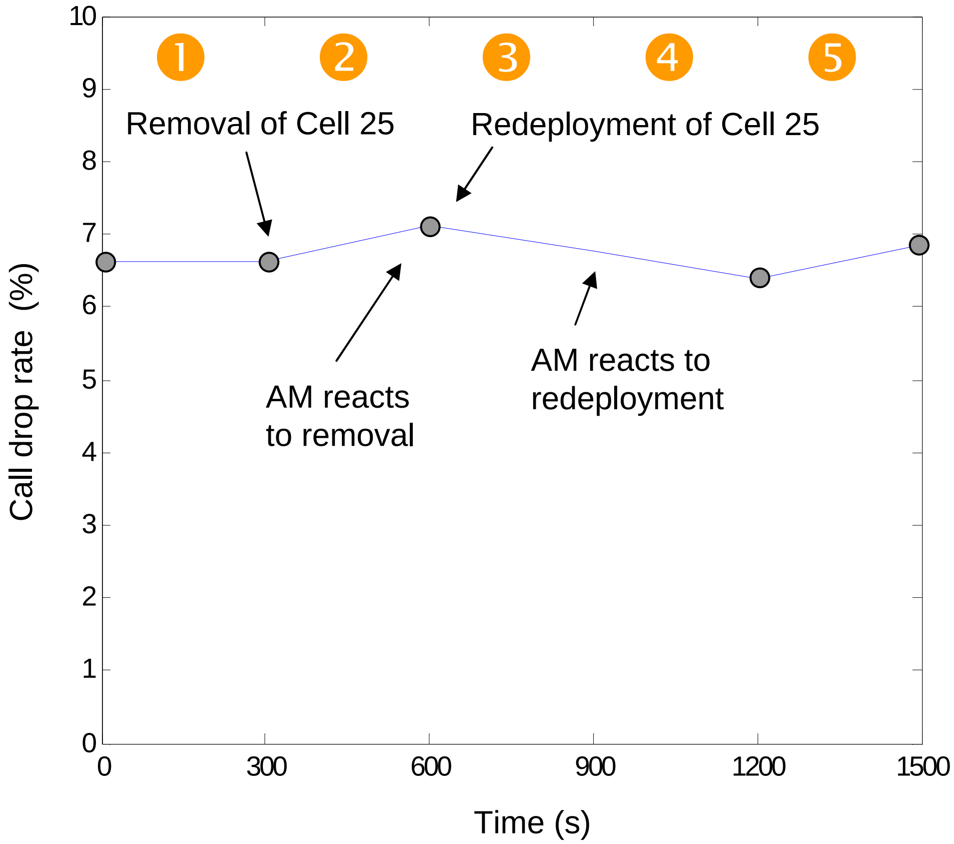
- Step by step representation of how the autonomic system copes with unexpected changes in the environment



1. Before pruning
2. When the neighborhood is pruned & Cell 25 is removed
3. When Cell removal is detected (⇨ Prune) & Cell 25 is redeployed
4. When Cell redeployment is detected (⇨ Generate & bidirectional enforcement)
5. After pruning

Case 2 - results: Cell removal & redeployment (2/2)

- Course of the call drop rate (measured in the cluster under test during the process)



1. Before pruning
2. When the Cell 25 is removed & neighborhood is pruned
3. When Cell removal is detected (⇨ Prune) & Cell 25 is redeployed
4. When Cell redeployment is detected (⇨ Generate & bidirectional enforcement)
5. After pruning

Conclusions and further studies

- Traditional O&M functionality may be seen as an integral part of this concept
- Solution scalable to autonomic functionalities in a real wireless networks and a multi-vendor environment
- System stability depends on the combination of policies and sub-agents
- It is for further study
  - "Plug and play" functionality for self-configuration
  - Performance in a real wireless network
  - Machine learning