

# Coordinating Self-Healing & Self-Optimizing Disciplines in Autonomic Elements: An Experiment

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# Problem Statement

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- Self-managing software through self-CHOPs disciplines
- Each discipline addresses a different concern of the autonomic element
  - Mostly monitoring and analyzing different information & symptoms
  - Mostly using different decision-making methods
- **Research problem:** How to coordinate disciplines with different natures toward a set of goals such as business objectives
- **Research focus:** Coordinating self-healing and self-optimizing at the element level

# Self-Healing Discipline

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## □ Parameters:

$E_h$ : Event set

$SD_h$ : State diagram of the system

$DM_h$ : Dependency model

$A_h$ : Actions (primitive/non-primitive)

$C(A_i)$ : Cost of action  $A_i$

$H$ : history of actions in states

$PS$ : Policy set

- **Problem:** returning to the previous healthy state (if possible) or going to another healthy state
- **Solution:** Planning especially AI-Planning seems to be appropriate, Probability network

# Self-Healing - Actions

| Action        | Entity                         | Adaptation        |
|---------------|--------------------------------|-------------------|
| Restarting    | Components, Servers, Services  | Weak Adaptation   |
| Restructuring | System, Subsystem, Application | Strong Adaptation |
| Redeploying   | Components, Servers            | Weak Adaptation   |
| Provisioning  | Servers, Machines              | Strong Adaptation |

**Weak Adaptation:** Modifying/tuning/adjusting parameters, variables or the actions that does not change drastically the system entities.

**Strong Adaptation:** Modifying/changing more significant system properties (in case of detecting fault/failure) such as architecture, or adding/deleting entities.

Self-Healing is mostly based on reactive actions

# Self-Optimizing Discipline

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- **Parameters:**
  - $E_o$ : Event set
  - $SD_o$ : State diagram of the system
  - $DM_o$ : Dependency model
  - $A_o$ : Actions (primitive/non-primitive)
  - $C(A_i)$ : Cost of action  $A_i$
  - $U(.)$ : Utility function
  - $PS$ : Policy set
- **Problem:** Adjusting attributes such as performance, response time and throughput regarding system policy/goals (i.e. QoS)
- **Solution:** Optimization (utility functions), Controlling (feedback & adaptive control methods)

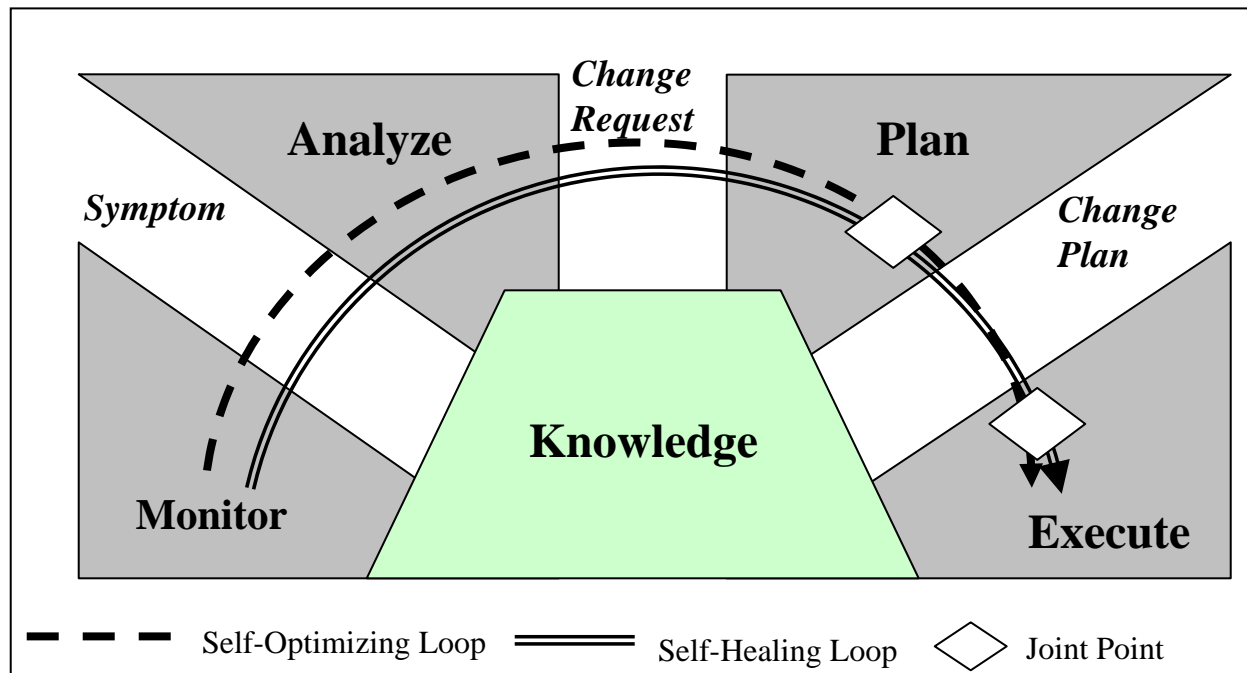
# Self-Optimizing Actions

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| Action         | Entity                             | Adaptation        |
|----------------|------------------------------------|-------------------|
| Tuning         | Generally resources and parameters | Weak Adaptation   |
| Restructuring  | System, Subsystem, Application     | Strong Adaptation |
| Load Balancing | Components, Servers, Services      | Strong Adaptation |
| Provisioning   | Servers, Machines                  | Strong Adaptation |

Self-Optimizing is a continuous process with proactive and reactive actions

# Coordination Joint Points



# Combinations of Adaptation Types

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## Self-Healing

## Self-Optimizing

Weak Adaptation

Weak Adaptation

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Weak Adaptation

Strong Adaptation

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Strong Adaptation

Weak Adaptation

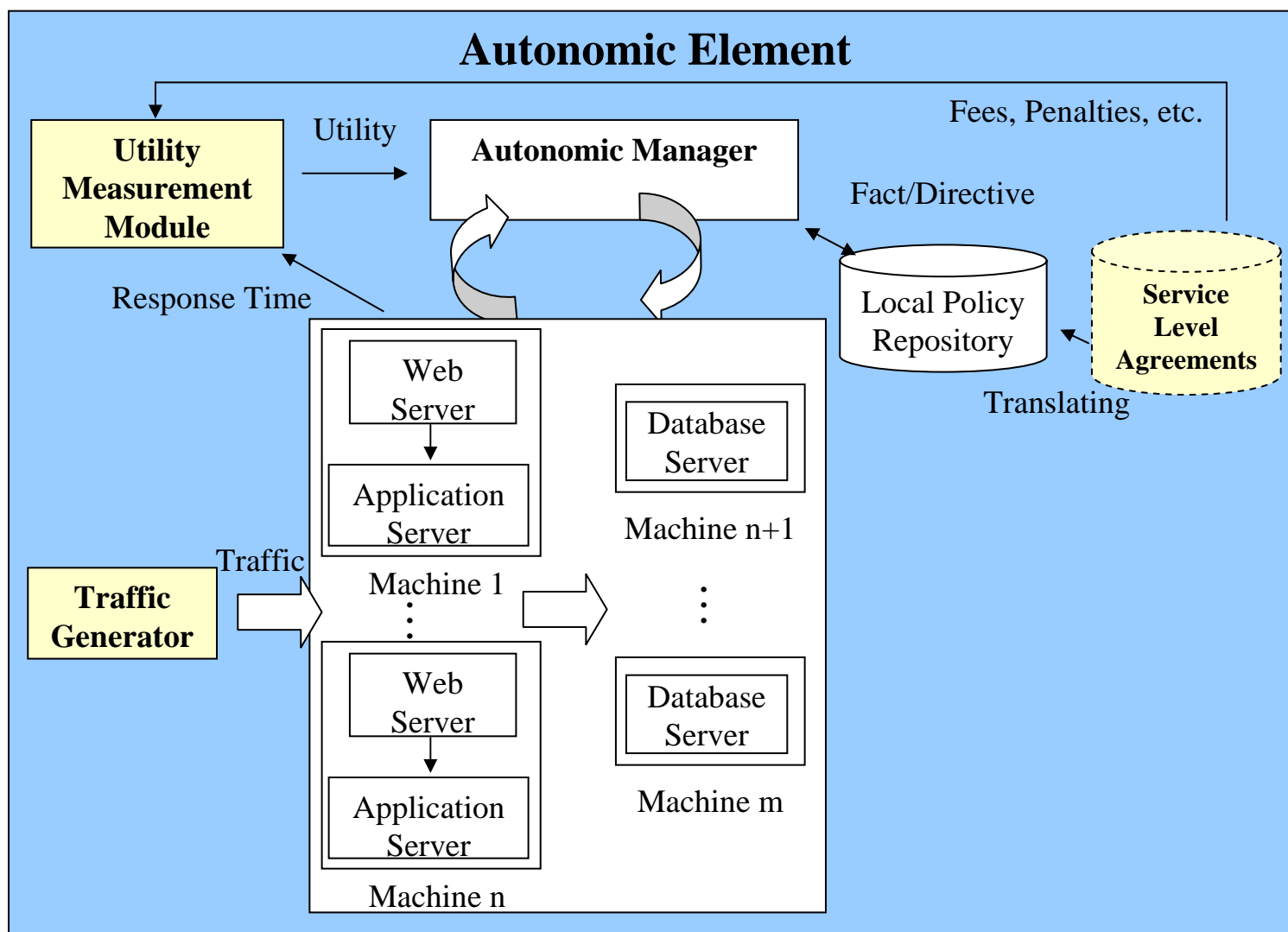
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Strong Adaptation

Strong Adaptation



# The Experimental Model

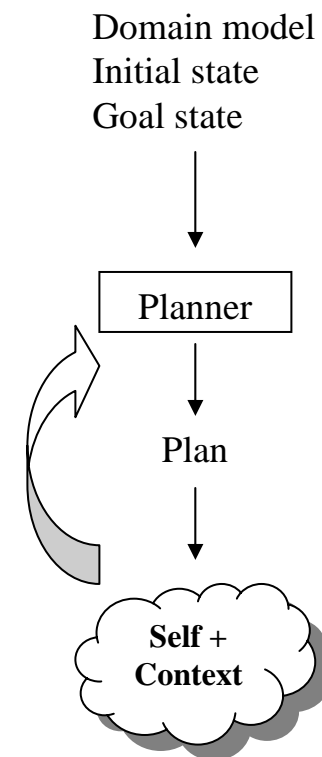
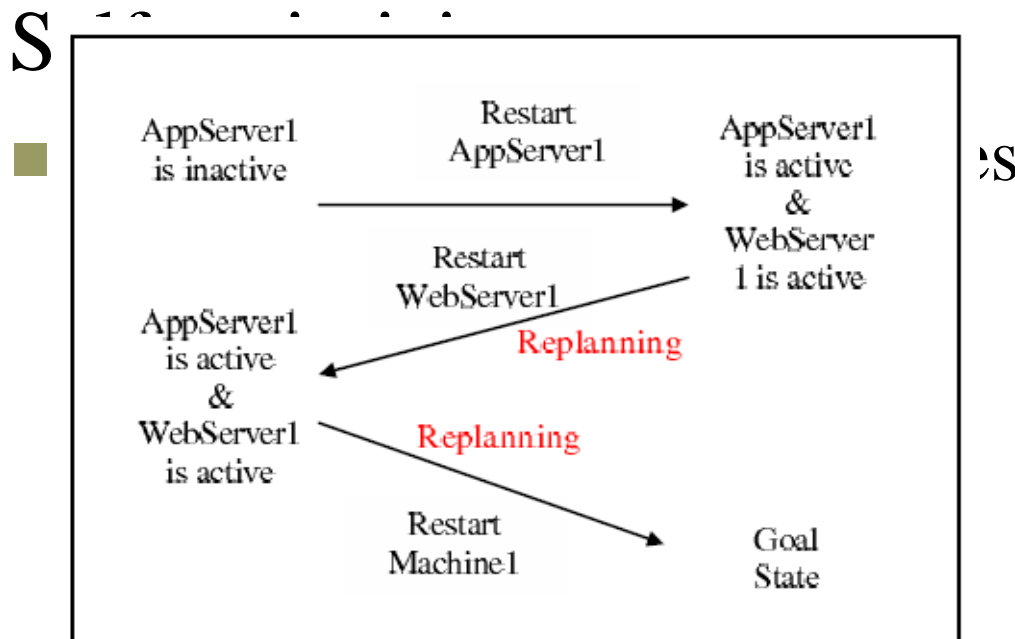


# Implementing Self-Healing & Self-Optimizing

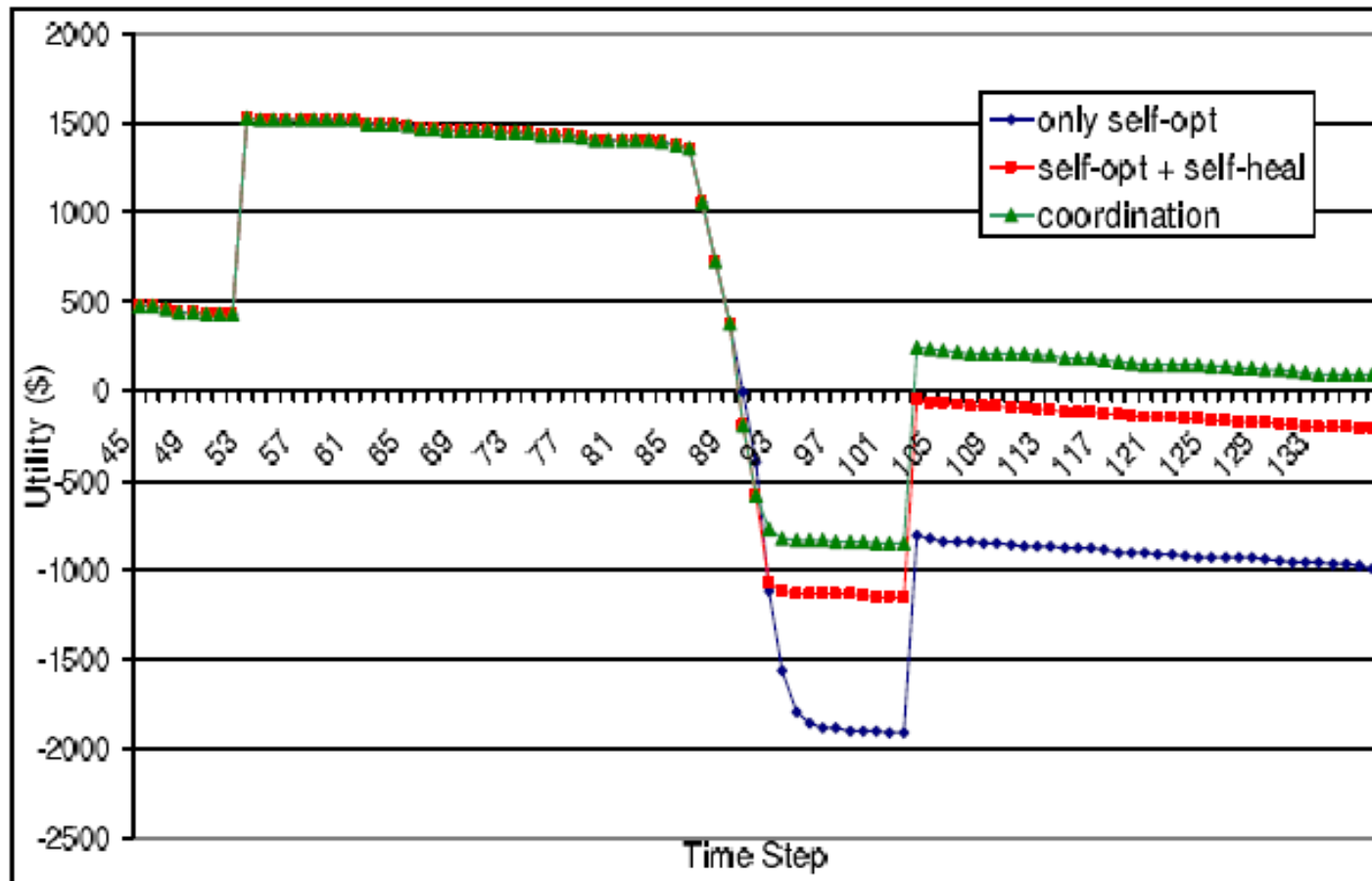
## □ Self-healing

- Using AI-planning (in ABLE)
- Continuous re-planning

## □ S



# A Sample Result



[http://www.stargroup.uwaterloo.ca/pubs/tech\\_report/TR-ECE-2006-06.pdf](http://www.stargroup.uwaterloo.ca/pubs/tech_report/TR-ECE-2006-06.pdf)

# Summary

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- Lessons learned
  - Coordinating autonomic disciplines can help autonomic managers to achieve goals such as business objectives.
  - Execution-based coordinating seems to be appropriate for weak-strong adaptation action trade-offs for self-healing and –optimizing
- Future works
  - Execution-based coordinating would change the rest of action plan for another discipline. How to update the action plan?
  - Solutions in strong-strong and weak-weak cases

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