Adaptive Agent-based Self-organization for Robust Hierarchical Topologies

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Motivation

Hierarchical topologies  ➔  Tree structures

- Aggregation
- Decision-making

- Search
- Information dissemination

Simple in principle

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Motivation (cont.)

Distributed systems and tree overlays

- Node / link failures
- Congestions
- Attacks
- Heterogeneity

Sensitive in principle

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Problem

Robustness
Minimization of the impact of failures in the topology

Self-organization
Nodes with local knowledge in dynamic environments

Application-dependence
Abstract application to self-organization requirements

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Propose

AETOS

The Adaptive Epidemic Tree Overlay Service

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Approach
Application requirements abstraction

- Optimization metrics
- Node degree

- Application-dependent
- Application-independent

- Robustness (rank)
- Max # of children

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Target topology

Optimization problem:

Sort nodes according to their robustness and max # of children

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AETOS Agent

3 type of views

Random View ➔ Proximity View ➔ Tree View

2 agent behaviors

Greedy ➔ Myopic

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Information flow

Local Self-organization

Local Robustness \( r = 58 \)

Random View
Candidate Parents
Candidate Children
Tree View

Gossip

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Proximity View Reconfigurations

Downgrade reconfiguration (rejection, removal)

Agent picks candidates with lower robustness than the ones it tried before
Example

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Example: Myopic Agents
Example: Greedy Agents
Conclusions & Future Work

- **Building & maintaining** hierarchical structures in distributed environments is **challenging**
- Importance: **Robustness, self-organization, application-independence**
- 3-layer architecture:
  - Bottom: randomness-> **proactive robustness**
  - Middle: proximity-> **reconfigurable knowledge**
  - Top: connectivity-> **reactivity**

- Further large-scale experimentation in dynamic settings, e.g. changing rank values
- Test in different applications, e.g. energy management, application-level multicast

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Questions?

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