Application of Multiple-Criteria Decision Analysis to Open Distributed Processing Systems Management

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Conformance of systems

- Conformance requirements: express what is expected from a system, in a specification.
- A system is conformant when conformance requirements are met by the system implementation.
- How to make a system conformant? Through design and systems management (need to combine both, to handle faults and runtime changes).

Design of systems

- Design: transformations of specifications, at different levels of abstraction, down to an implementation.
- Conformance assessment:
  1) check validity and consistency of specifications and transformations;
  2) test that requirements hold in implementation.
- Classical approach, standardized in ISO 12207, ISO RM-ODP, OMG MDA...

Systems management

- A management system (MS) makes a system conformant to requirements, at runtime.
- Standard general architecture (ISO ODMA):
- Autonomous system: a MS that has no human being in the loop.
- Related works on systems management: generally address only technological issues.
- Problem: how to design a MS to ensure that a managed system is conformant at runtime?
- Cannot be solved by classical design approaches:
  1) must consider the effects of management strategies on the managed system;
  2) requirements and strategies must be separately specified (not the case in most existing MS approaches).

Managing is deciding

- Systems management boils down to a decision problem:
  1) define a model of the state of the managed system;
  2) express the requirements in that model;
  3) identify a set of interesting management strategies;
  4) predict the effects of strategies on the managed system's state, and express the effects in the model;
  5) compare the effects to requirements, and choose and execute the strategy that best makes the system conformant.
- Secondary problem: which decision method to use? Many real-world decision methods exist and could be used.

Multiple-Criteria Decision Methods

- Classical methods: model = one criterion (e.g. "money"). Do not fit systems management because:
  1) uncertainty about effects of strategies, state of system...
  2) requirements must reflect multiple goals which cannot be simultaneously satisfied.
- Solution: use multiple criteria models and decision methods (MCDMs).
- Our proposal: a MS design method that is an application of MCDMs to autonomous systems management.

Example management system

- Managed system: two cache objects ("privileged" and "underprivileged")
- Model of state: two criteria: \(<C_1,C_2>\)
  C1: # entries in "privileged" cache
  C2: # entries in "underprivileged" cache
- Conformance requirements:
  preferred state: \(<10000,10000>\)
  constraints: \(C_1 \geq 8; C_2 \geq 0; C_1 \cdot C_2 \leq 15000\)
- Management strategies: (three)
  "do nothing"
  "remove entries from underprivileged" and "flush both caches"

Scenario 1:
  1) notify of 1000 new entries added
  2) ask strategists to predict effects of strategies for the current state (<5000,5000>)
  3) compare effects to requirements, and choose "remove from UPC" as the best strategy
  4) ask the strategist to execute the strategy, i.e. it removes entries from unprivileged cache

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