Adaptation for Dependability of Multi-Agent Systems

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Outline

- Dependability as a group property
- Representation of aggregate behaviors
  - *Parametric models of state*
- Approximations
- Real-time requirements

Actors and Dependability

- Localized data
- Unique naming tied to distinct identity
- Asynchronous and autonomous operation
- Fairness in message-passing

Dependability as a Group Property

- Dependable individual agents do *not* imply dependable groups of agents
  - *Run on banks*
  - *Failure of electric grid*
- Competition and cooperation between agents
  - *Game theoretic models*
  - *Incentive engineering*

Representing the Aggregated State

- Parametric models, e.g.:
- The ratio of deposits and liabilities in branches of a bank
- Total energy consumed by a collection of sensor nodes
- Total number of processor cycles used – *denial of service attacks*

Dependable Complex Systems

- Airplane design
- Monte Carlo simulations
  - *10^5 runs*
  - *Small part of the parameter space*
- Pick worst cases observed
  - *Stretch them by some limit*
- Design to these cases
  - *Insert safety envelopes*

The Hierarchy of Real-time

- Scales of time
- Asynchronous processors:
  - *Operate in microseconds*
- Actuators work on a global clock (synchronous time)
  - *Operate in milliseconds*
- Human response in seconds

Time as an approximation

Scalable Control Mechanisms for Dependability

- Economic Resource Control

Controlling Resource Consumption

- Agents negotiate terms of resource usage with host.
- Agents are either principals or sponsored by principals. A principal owns *cybercash* convertible to resources.
- Host provides resources to principals.
- Principals distribute resources between dependent agents.

Other Technologies

- Learning and dynamic program modification
- Reflection and dynamic adaptation of the environment
- Adaptation
  - *Evolutionary algorithms*