Evaluation of Real-Time S&R Systems

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CASE
CASE SCHOOL OF ENGINEERING

RT S&R

- Objective
  - Affect and control remote physical environment
  - Tele-epistemology [G01]
- Applications
  - Almost all S&R falls within definition
    - Control-engineering approach
  - Planetary autonomous networks
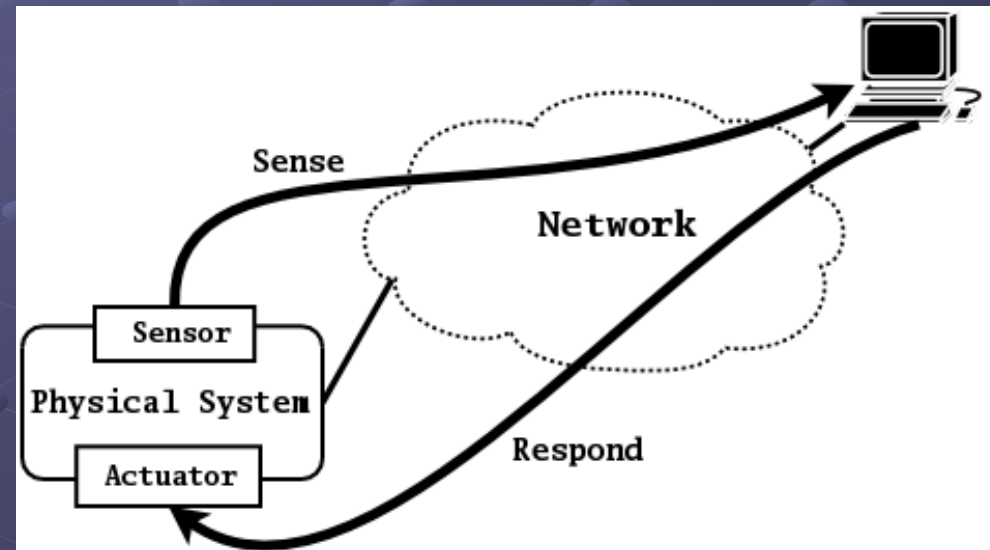 - Physically realistic distributed simulations

Approach and Evaluation

- Approach
  - Real-Time Networked Control
  - Play-back buffer
  - Congestion control
  - Quality-of-Service
- Evaluation
  - Metrics
  - Methodology

Why RT Networked Evaluation?

- S&R and real-time
  - Autonomy
    - Hide networked RT
    - Hard to build a fully reliable system
  - Tele-operation
    - Network non-determinism is serious problem
- S&R
  - Reduce time constants
  - Especially important for unexpected occurences

[NLN02]

S&R

Tele-operation   Autonomy

Metrics

- **Stability (and safety)**
  - Objective
    - Remote controller makes unstable system stable
  - Extensive research
    - [Z01] and references therein
  - Problem
    - Errors, network partitions, failures make stability impossible
- **Tracking**
  - Objective
    - The S&R system should do what it is supposed to
    - In spite of network non-determinism (failures, security, etc.)
  - Problem
    - Benchmarks (NIST?)

- **Disturbance cancellation**
  - Objective
    - The S&R system should do what it is supposed to do
    - In spite of network non-determinism and uncertainty in the environment
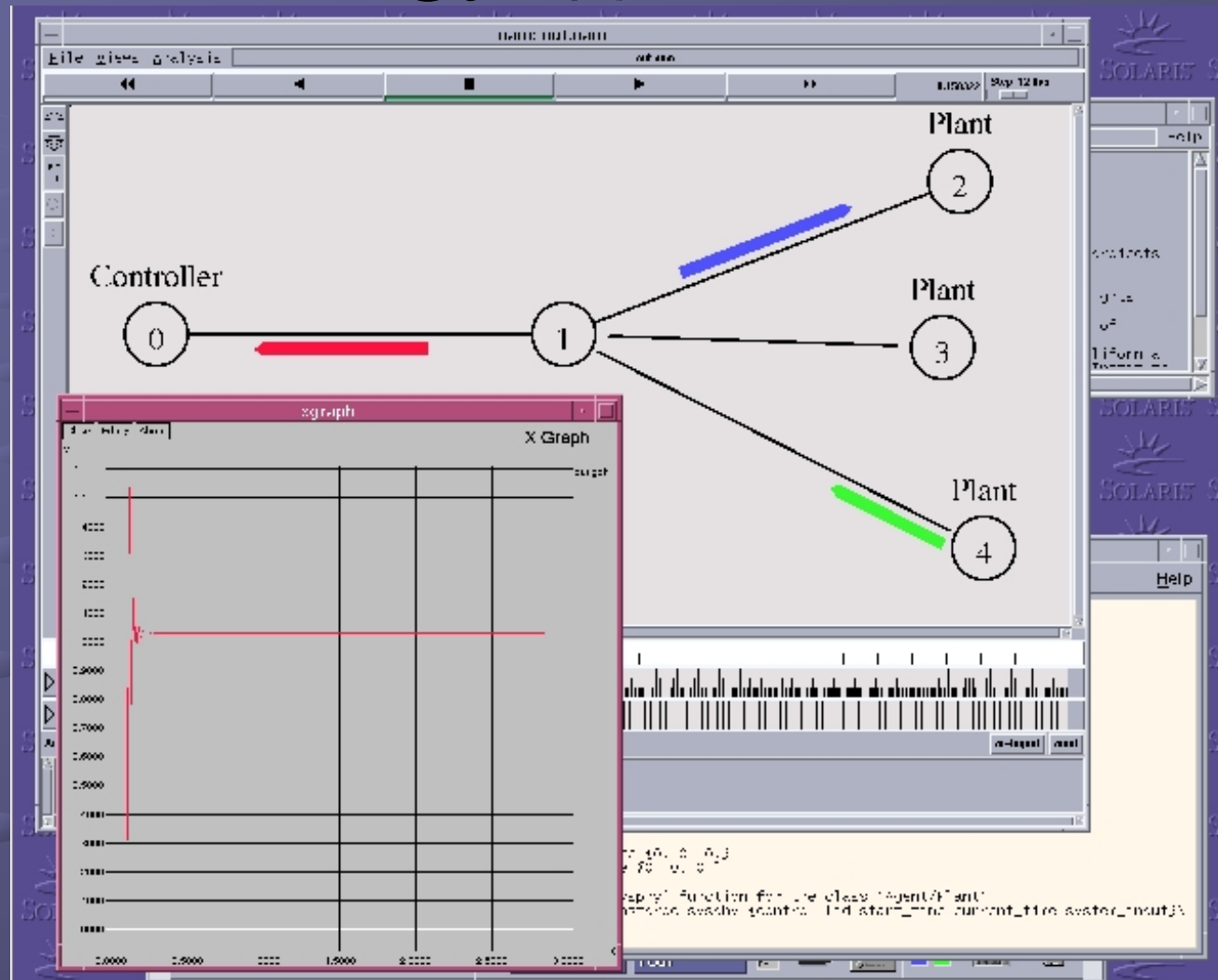 - Way out
    - Use simple tasks
- **Scalability [L04]**
  - Number of nodes
    - Space networks?
  - "Geographic"
  - Administrative
  - Functional
- **Conclusion**
  - RT S&R benchmarks needed!

Methodology (I): Co-Simulation

[BLP03, HLB05]

Methodology (II): Emulation

- Objective
  - Evaluate contribution on real wide-area network
- Approaches
  - GridWise
    - If you dare!
  - EmuLab
    - Internet in a lab
    - Flexible and reconfigurable
    - Controllable cross-traffic
  - PlanetLab
    - No Real-Time node support
    - No Network QoS

A Modest Proposal

- **Application benchmark**
- **National Lambda Rail**
  - "NLR is planned to be capable of supporting both production and experimental networks.
  - Not a single network or a single test bed but facilities to build multiple networks and multiple test beds at all of layers 1-3 including optical, switched, and routed.
  - Goal is to have both persistent and flexible infrastructure(s)
  - Foster network research"
  - Support QoS
- **Real-Time Overlay**
  - Support end-to-end RT S&R

NLR owned fiber
NLR WaveNet PoP
NLR WaveNet & FrameNet PoP
NLR WaveNet, FrameNet & PacketNet PoP