MIT9904-12: Cooperative Computing in Dynamic Environments

Nancy Lynch & Idit Keidar

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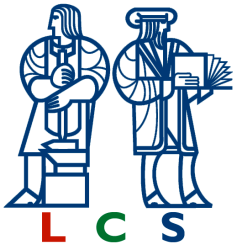

Project Overview

- Develop models, analysis and verification methods, and algorithms for distributed systems

- Focus on highly dynamic systems
  - Participants may join and leave the system and may change location
  - Network topology may change
  - Components may fail and recover

- Address the problems of such complex environments
  - By developing formal modeling and analysis techniques based on interacting state machines
  - By developing useful "building blocks" ---definitions of global services and efficient algorithms to implement them

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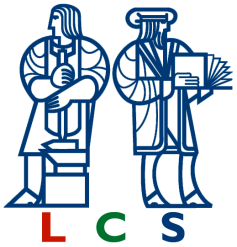
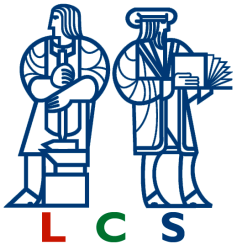


Progress Through December 2002

- **Formal modeling and analysis**
  - **Enhance the front-end of the IOA toolset with static checks related to composition [Garland, Tauber]**
  - **Design and implement syntactic transformations to expand a composite I/O automaton into an equivalent primitive I/O automaton [Garland, Tauber]**
  - **Investigate ways to combine executions, dynamic program analysis, and automated deduction for reducing the amount of human interaction required for proving the correctness of distributed systems [Ne Win, Ernst, Garland, Kirli, Lynch]**
  - **Case studies to evaluate our verification methodology [Ne Win, Ernst, Garland, Kirli, Lynch]**
  - **An interface between IOA and the Isabelle theorem prover [Luhrs, Ne Win]**

- **Algorithms for dynamic distributed systems**
  - **Dynamic Atomic Broadcast algorithm [Bar-Joseph, Keidar, Lynch]**
  - **RAMBO: Reconfigurable Atomic Memory for Basic Objects [Lynch, Shvartsman]**
  - **LAN implementations of RAMBO, optimizations for RAMBO [Fan, Gilbert, Fan, Musial et. al.]**
  - **MultiChord: An algorithm to implement a fault-tolerant overlay network for a dynamically-changing wide-area network [Lynch, Stoica]**
  - **Algorithms for new environments involving networks of sensors [Lynch et. al.]**
  - **Performance evaluation of distributed algorithms over the Internet [Bakr, Keidar]**
  - **Formalization and verification of reliable multicast with caching [Livadas]**



Research Plan for the Next Six Months

- **Formal modeling and analysis**

  - **Finish the implementation of static checks related to composition in the IOA front end**
  - **Finish a prototype implementation of the IOA code generator tool**
  - **Enhance the preliminary interface to Isabelle, to generate proof tactics appropriate for proofs of invariants and implementation relations**
  - **Enhance the interface between IOA and Daikon to suggest additional lemmas for use in proofs**
  - **Extensions to the IOA language and toolset for specifying and reasoning about timing behavior**

- **Algorithms for dynamic distributed systems**

  - **Performance analysis of RAMBO for a larger number of situations**
  - **Implementations of RAMBO targeted to mobile settings (such as Oxygen) and peer-to-peer settings (such as Chord)**
  - **Complete simulation and analysis of MultiChord, carry out experiments, and compare the experimental and theoretical results**
  - **Analyze the correctness and the performance of the LMS-based reliable multicast protocol of Papadopoulos et. al.**
  - **New algorithms for resource allocation, global snapshots, and leader election in highly dynamic networks**