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
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
  - Enhancements 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