



Project Overview

- Developing algorithms, models, and analysis methods for highly dynamic distributed systems
 - Participants may join, leave, may change location.
 - Network topology may change.
 - Components may fail, recover.
- Complex systems, difficult to design, understand, analyze.
- Two approaches:
 - (1) Design, global communication and data-management services, efficient algorithms.
 - (2) Develop formal modeling and analysis techniques, based on interacting state machines (I/O automata).



Progress Through December 2001

(1) Services for dynamic distributed systems.

- Real-Time Dynamic Atomic Broadcast (RT-DAB) algorithm [Bar Joseph, Keidar, Lynch]
 - Consistent message sequences received by different participants
 - Message delay linear in the number of failures that actually occur.
- RAMBO: Reconfigurable Atomic Memory of Basic Objects [Lynch, Shvartsman]
 - Use read and write quorums to cope with transient failures
 - Reconfiguration protocol, based on Paxos consensus, to cope with long-term changes.
- Theoretical study of time for consensus in practical system models [Keidar, Rajsbaum]
 - Lower bound of $f+2$ rounds.
- Empirical study of methods of implementing synchronous models in the Internet. [Keidar, Bakr].
- Reliable multicast with caching [Livadas].
- Group communication services for WANs [Khazan].



Progress continued...

2) Modeling and analysis

- IOA Toolset:
 - ioa2lsl translation to Larch theorem prover [Bogdanov]
 - Theorem-prover case studies [Bogdanov, Luhrs]
 - Simulator, including paired simulation [Dean, Ne Win]
 - Connection from simulator to Daikon [Dean, Ne Win]
 - Experiments in invariant discovery for IOA algorithms [Ne Win, Santos] [Kirli, Garland, Ernst, Lynch]
 - Comprehensive paper on simulator.
 - Near public release.
- Mathematics:
 - Dynamic I/O Automata (DIOA) [Attie, Lynch]



Research Plan for the Next Six Months

(1) Services for dynamic distributed systems

- Real-Time Dynamic Atomic Broadcast: Improve modularity, improve tolerance to variation in timing assumptions.
- RAMBO: Performance analysis, performance improvement, prototype implementations.
- Experimental study of other communication primitives over Internet.
- SRM, CESRM analysis
- GCS analysis

(2) Modeling and verification

- Improve IOA toolset for external users.
- New tools: Composer, connections with model-checkers, other provers.
- Experiments with Daikon invariant discovery; use in proofs.
- Case studies
- Use for agent languages (NePi2)
- DIOA, other extensions to basic I/O automaton model, language, tools