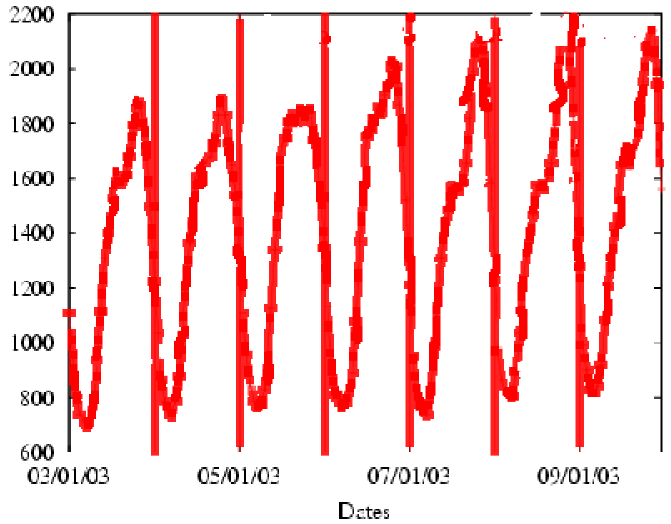
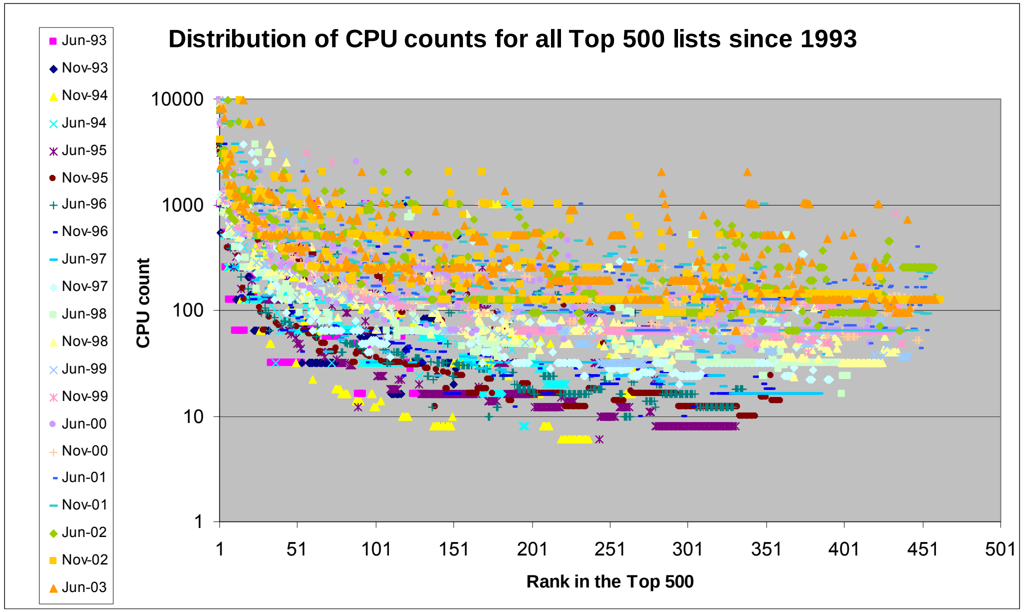
RPC-V: Toward Fault-Tolerant RPC for Internet Connected Desktop Grids for Volatile Nodes

Samir Djilali, Thomas Herault, Oleg Lodygensky, Tangui Morlier, Gilles Fedak and Franck Cappello

Fault Tolerant RPC



- RPC is one of the programming models envisionned for the GRID



- In Internet-Connected Large Scale Grids, failures are not rare events

The Challenges of Large Scale

- Volatility
- No Stable Components
- Intermittent Crashes
- Asynchronous (best effort) networks like Internet
- Connectionless Interactions
- Changes of the System Size

Crashes

Asynchrony

Crashes + Asynchrony

Impossibility of Conser

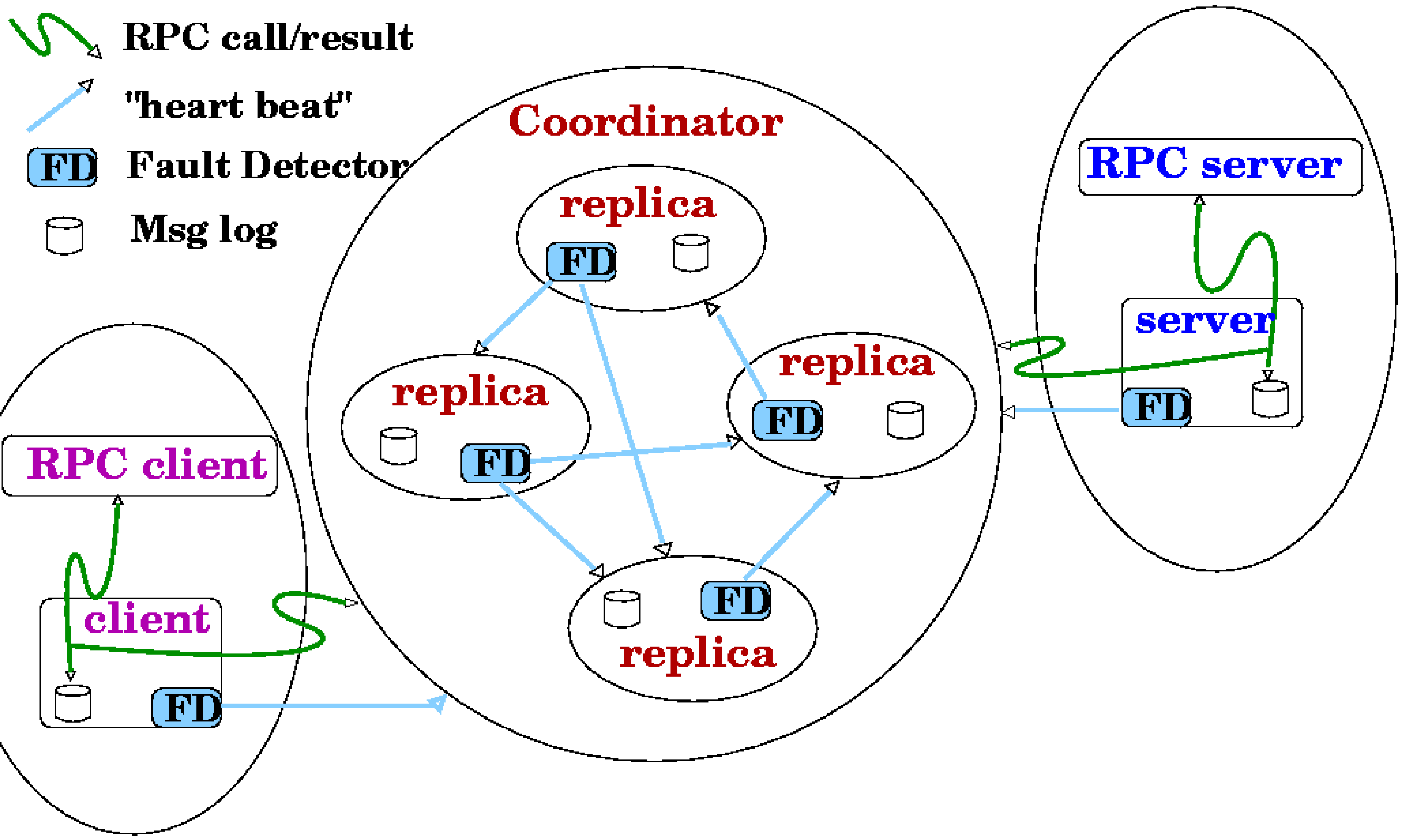
Consequences

- Theoretically impossible to do consensus in a deterministic way
- Consensus is simpler than Statefull RPC
  - By defining the order of RPCs for one server could solve a consensus problem
- Either circumvent the problem
- Or try to address another problem
  - Stateless RPC
  - (or per-client-basis statefull RPC)

Related Works

- Fault Tolerance for the Grid
  - 3 tier FT Arch.
  - GridRPC
  - Ninf, RCS, NetSolve
- Fault Tolerance & Large Scale
  - Probabilistic Solutions
- Fault Tolerance & Remote Procedure Calls
  - Mostly using reliable or LAN components

RPC-V Architecture



RPC-V FT-Protocol

- Preventive Actions
  - Each component locally logs every communication
  - Synchronizes and/or replay lost events on communications
  - Coordinators use passive replications
- On Suspicion
  - User may re-launch clients when they suspects clients to be unreachable
  - When server or client suspects coordinators they change of preferred one
  - When a coordinator suspects server failure, it schedules RPCs again
  - When a coordinator suspects another coordinator, it recomputes the topology

Implementation

- Over XtremWeb
  - Heart-Beat
  - Includes the three tiers : client, coordinator (dispatcher), server
  - Connection-less communication protocol
- Coordinators Topology
  - Ring (initially, faults may change the topology)
  - Initial list, updated using state synchronisation and/or user actions
- State Synchronization
  - Between Client and Coordinator, or Server and Coordinator : maximum timestamps
  - Between Coordinators : peer-wise timestamps comparisons

Implementation

- Message Logging
  - Pessimistic/Optimistic message logging (sender-based)
  - Garbage Collector, based on long delays or on user actions
- Coordinator Scheduling
  - First Come, First Served
  - Dates are shared to avoid unecessary re-submissions from replicas

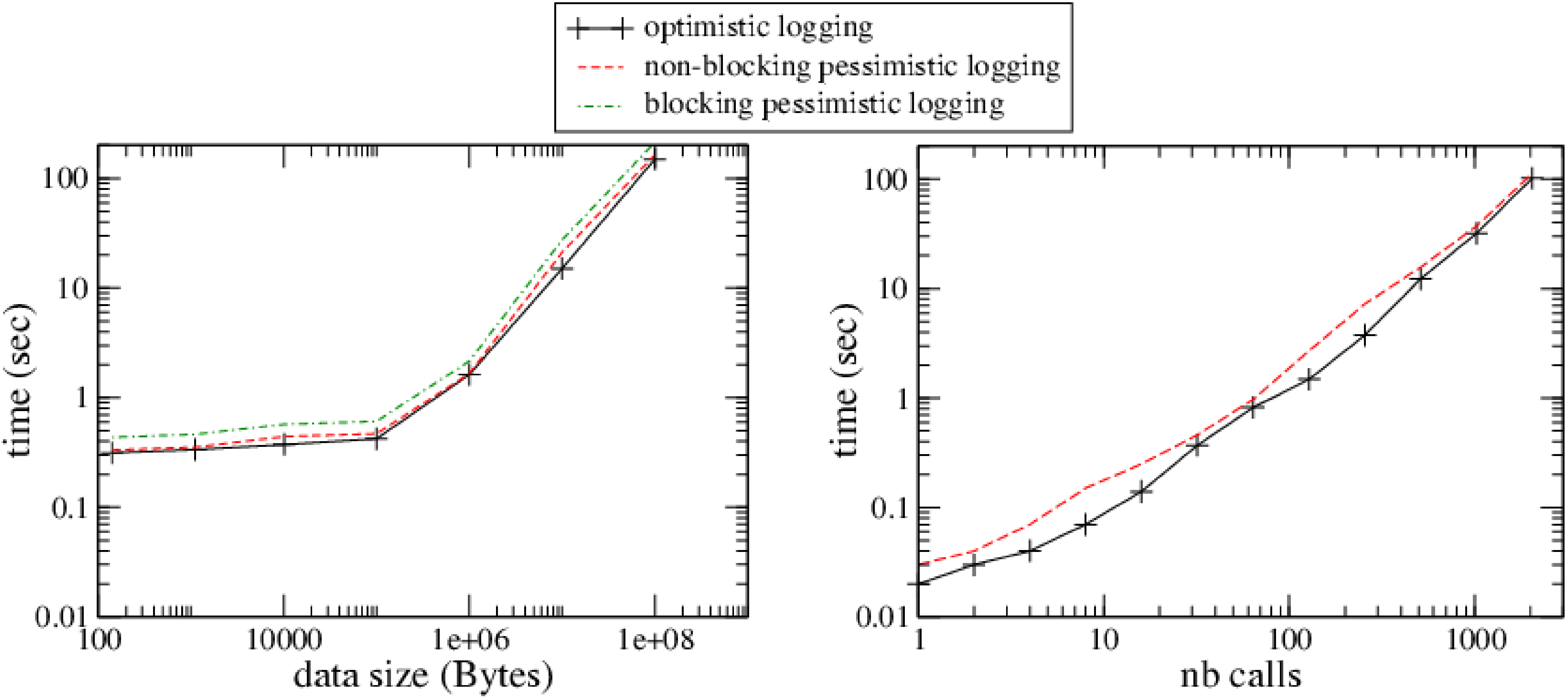
Performance Evaluation

- Experiments on Local Area Networks for parameter isolation
  - Reproducibility of experiments
  - To highlight System overhead and FT capabilities
- Real Life Experiments
  - Validity of the implementation
  - Scalability test

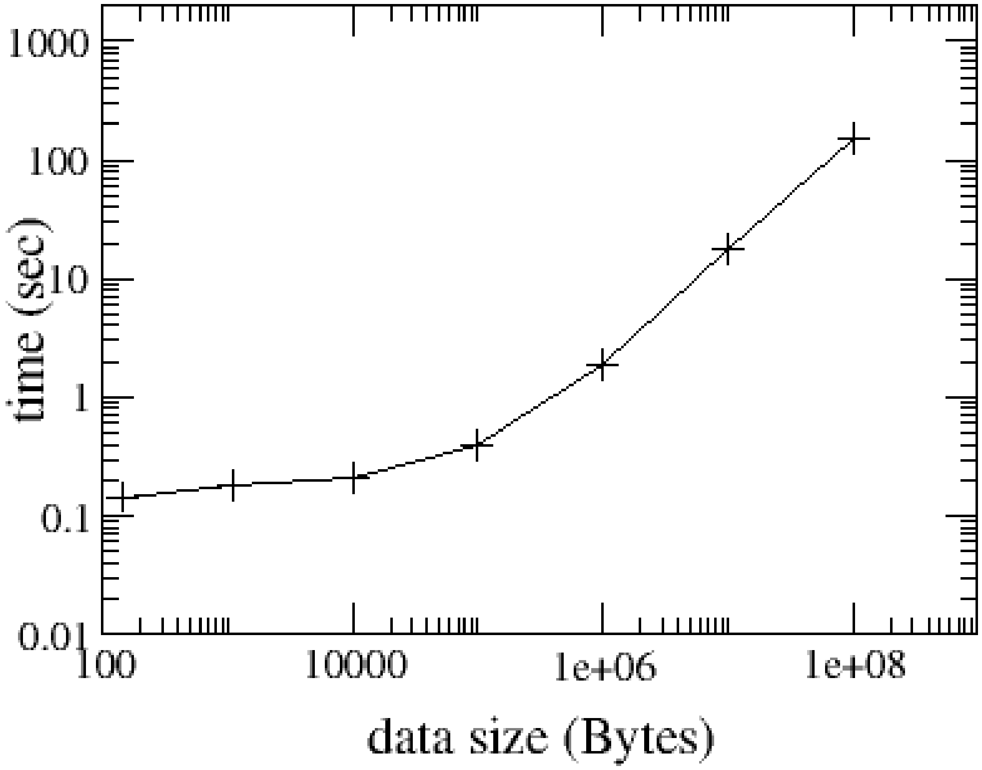
LAN Experiments

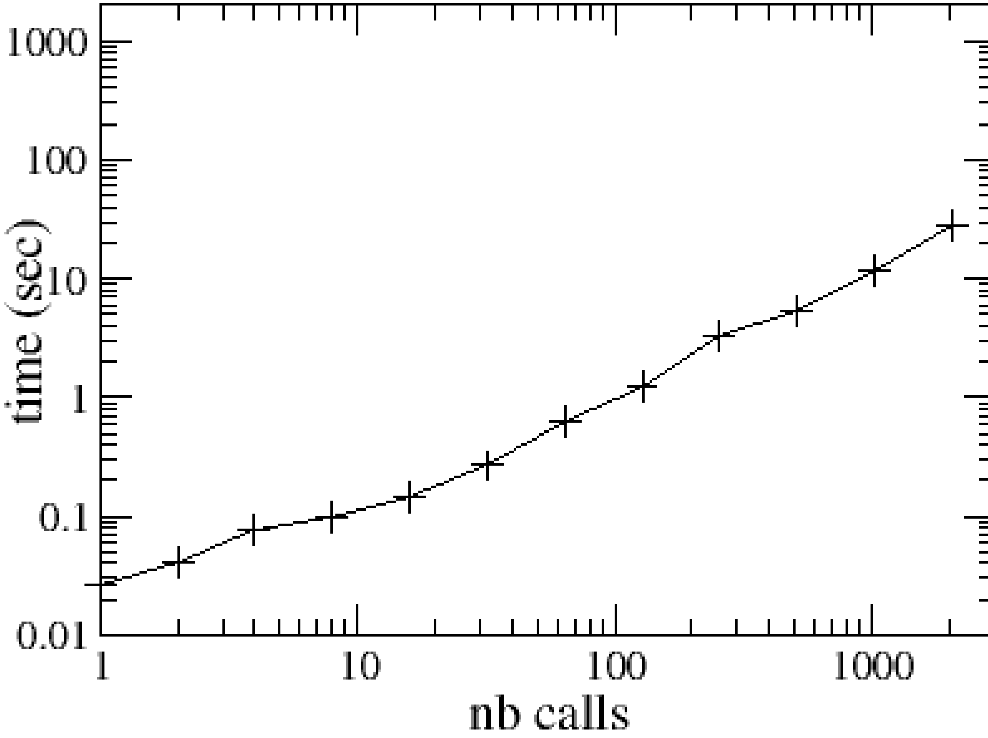
- Cluster, 16 Servers, 4 Coordinators, 1 Client
- Ethernet 100 Switch, homogeneous Athlon XP 1800+, 1Gb RAM, IDE Disks
- Synthetic Benchmark
  - non blocking RPC
  - execution time (low to stress the comm.)
  - parameter size
  - result size
- Fault Generator
  - Upon order, or regularly.
  - 5s heartbit / 6 miss => failure

Comparison of the three message logging strategies

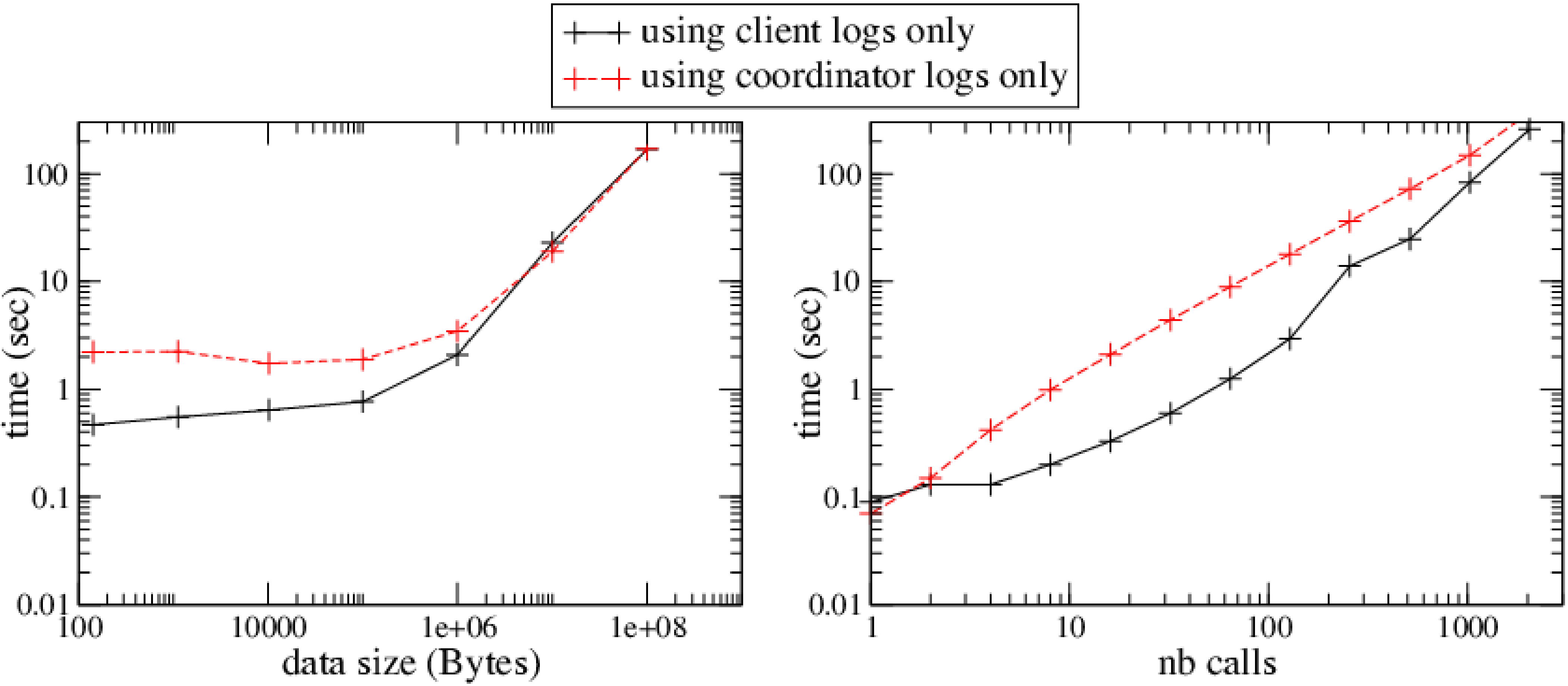


Coordinator Replication Time

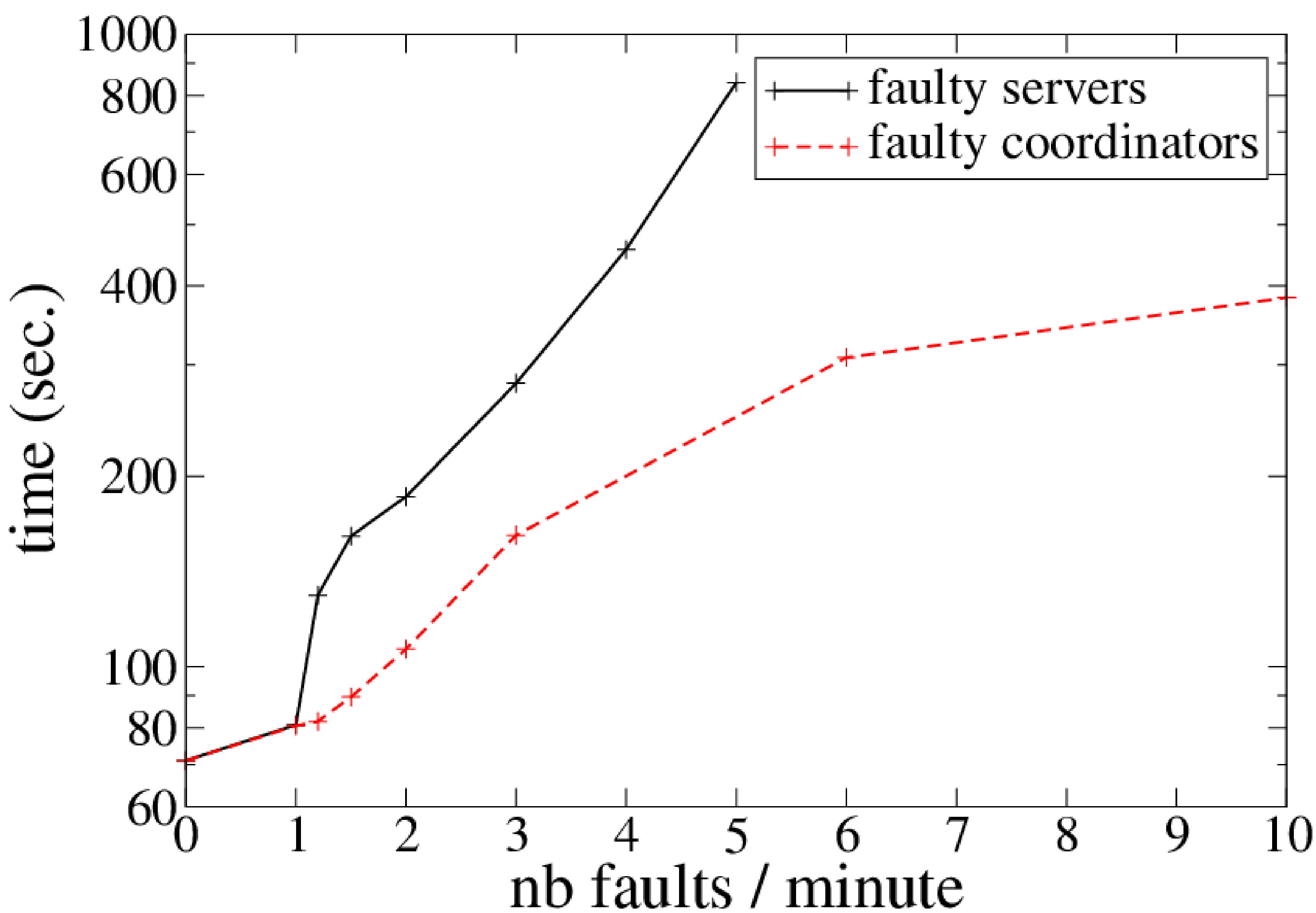




Synchronization Time



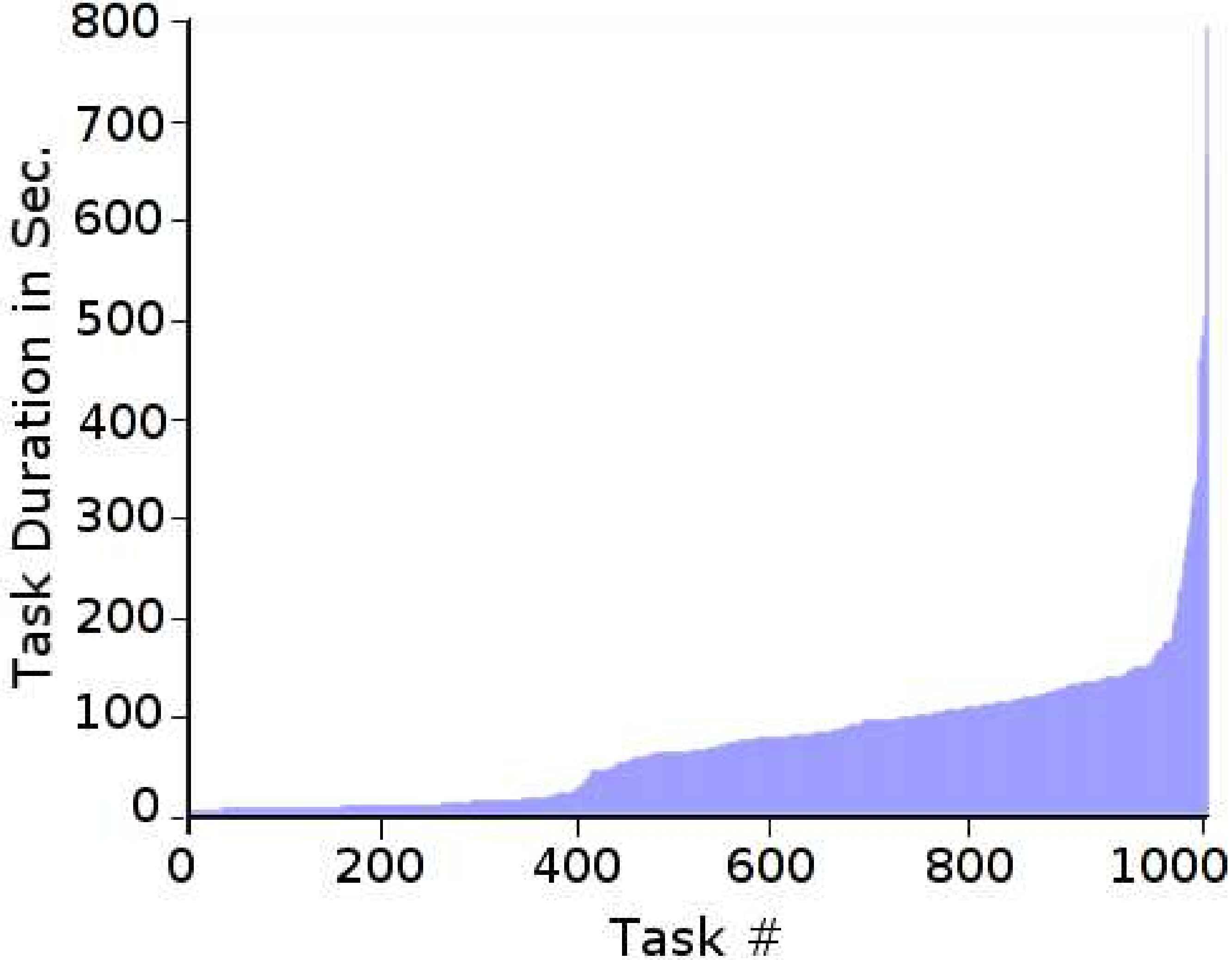
Fault Frequency Impact



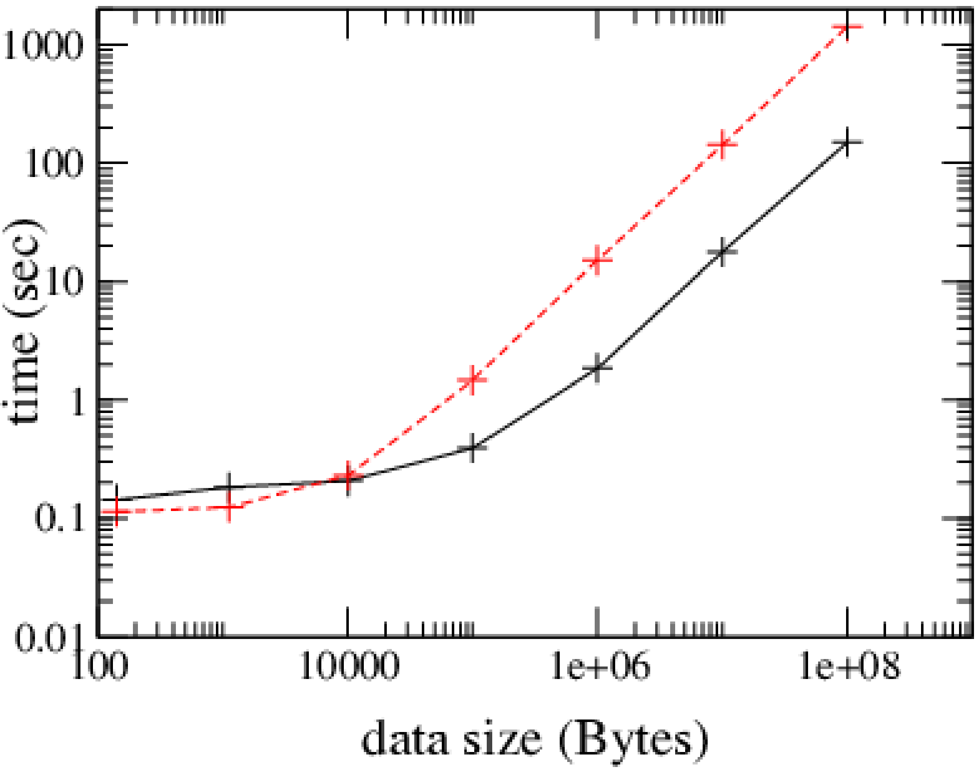
Real Life Experiments

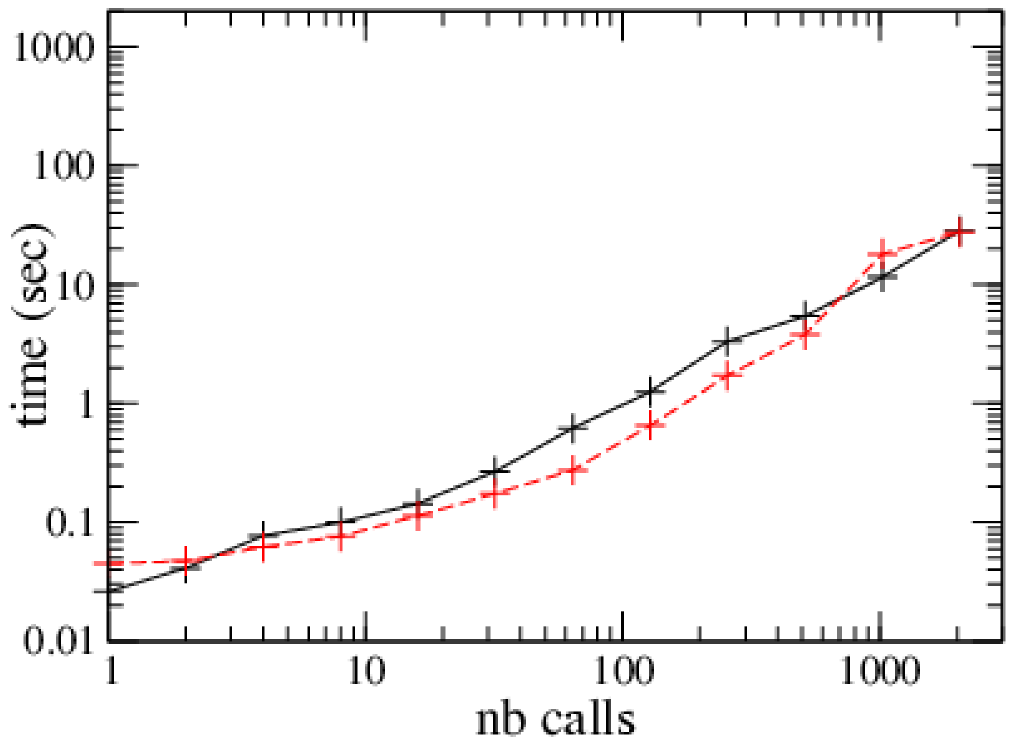
- International Wide Experiment
  - Polytechnic School of Lille (France)
  - University of Wisconsin (USA)
  - Paris-Sud University (France)
- ~120 Servers (160 CPUs)
- "Real life" production application of Alcatel (validation and evaluation of communication networks)

Distribution of Tasks Duration



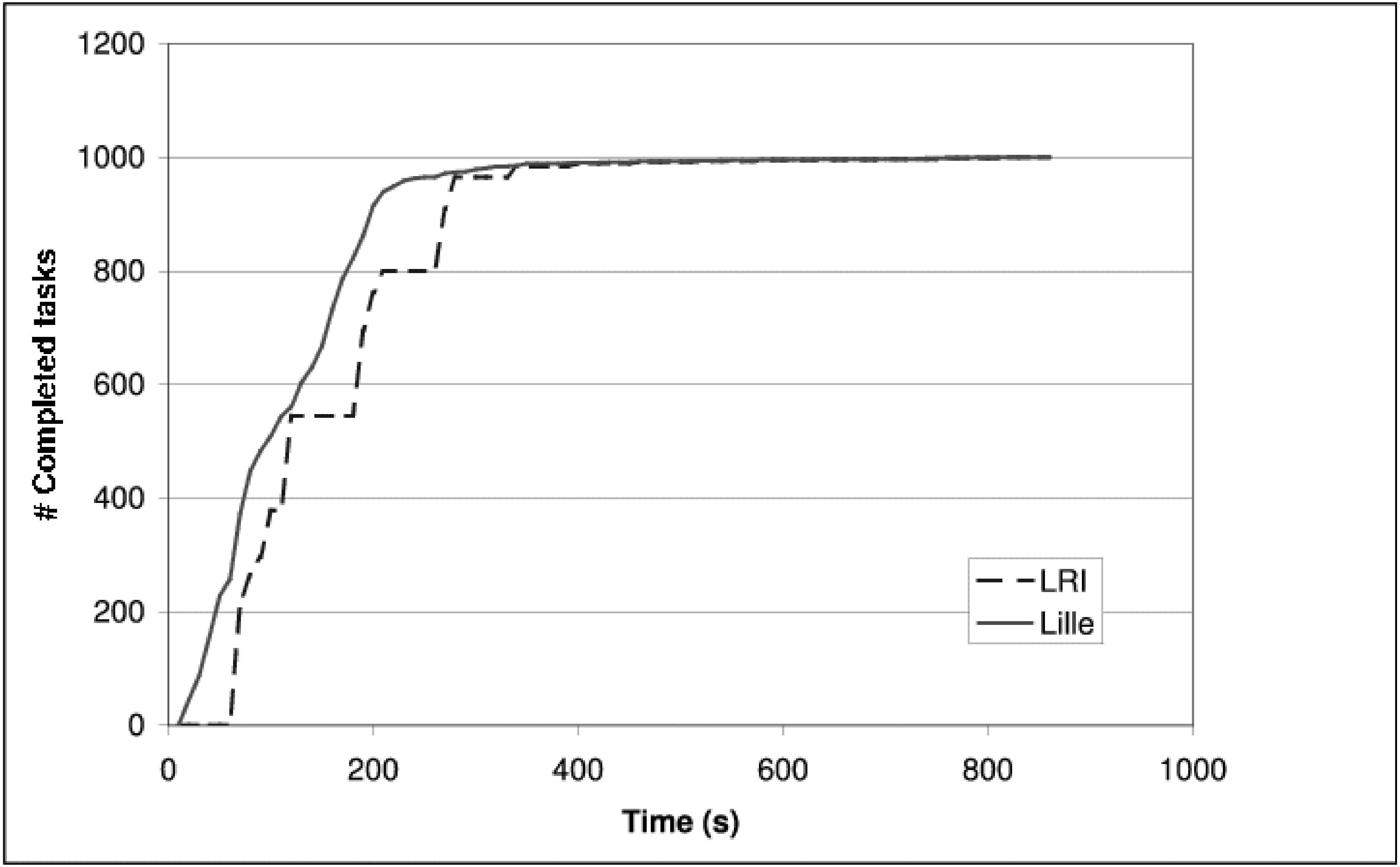
Coordinator Replication Time



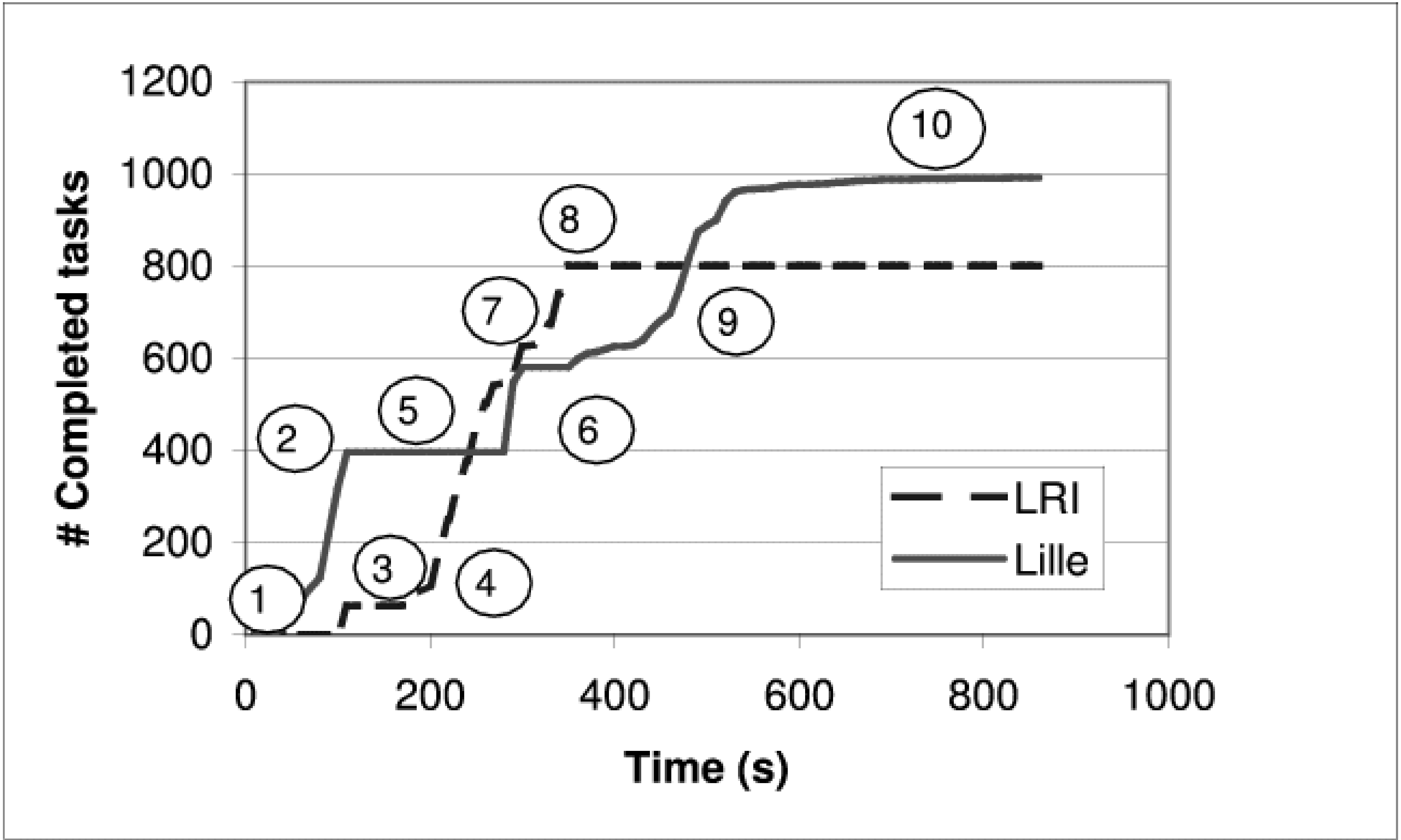


Real Life Confined

Reference Execution without Faults



Execution with two consecutive coordinator faults



Conclusions & Futur works

- Reserve most stable resources to computing nodes (servers) and not to architecture (coordinators)
  - Due to time gap between server execution and traversal of the system by a RPC
- Larger tests, optimization for larger scale
- Impact of checkpointing

Conclusion & Futur Works (with respect to asynchrony)

- Conservative assumption : Stateless RPC
  - “per-client-basis” statefull is OK
- Evaluate on GRIDs the asynchrony
  - Can we conceive better FD than TCP connection ?
- Use gossiping / probabilistic techniques to overcome the limitation