Secure Spread: Providing a Secure Infrastructure for Collaborative Applications

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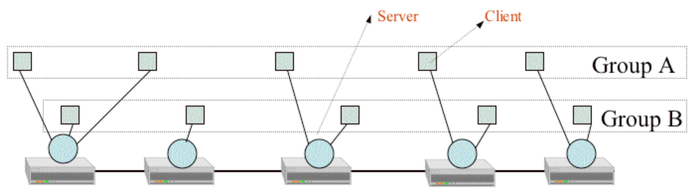
Why Group Communication Systems?

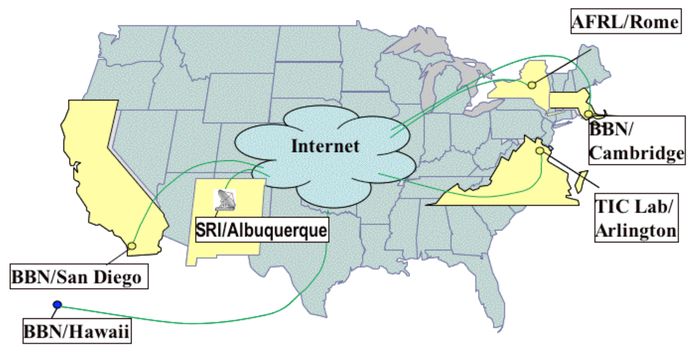
- Applications operating based on a group paradigm, requiring:
  - Efficient message dissemination to groups
  - Reliable and ordered (causal order, global order)
  - Membership service
  - Fault-tolerance
- Collaborative applications: computing, white-boards, video-conference
- Distributed transactions and database replication
- Cluster management and monitoring
- Highly available servers

Group Communication Systems



- Reliable and ordered message delivery
- Group membership service supporting process failures, network partitions and merges
- Data messages and membership notifications are interleaved

System Deployment



What About Security?

- Secure group communication:
  - Authentication and admission control.
  - Access control to system resources.
  - Key management to bootstrap other security services.
  - Encryption algorithms and integrity mechanisms.
- More challenging in a group setting:
  - Group membership changes over time.
  - Many parties can cause asynchronous events.

Group Key Management

- Computation:
  - one member selects the key (centralized)
  - all members contribute a share to the key (contributory)

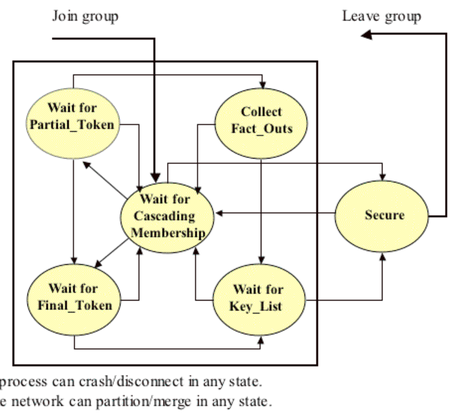
- Distribution (Transport):
  - one entity distributes the key (centralized)
  - more members can be involved, the goal is to minimize the number of secure channels (distributed)
- What is a ``good'' key management?

Group Key Agreement Properties

- Backward/Forward Secrecy: compromise of the group key does not compromise previous/subsequent group keys.
- Key Independence: compromise of any subset of group keys does not compromise other group keys (includes Backward and Forward Secrecy).
- Perfect Forward Secrecy: compromise of the long term private keys does not compromise any previous group keys (in contrast to most key distribution schemes).

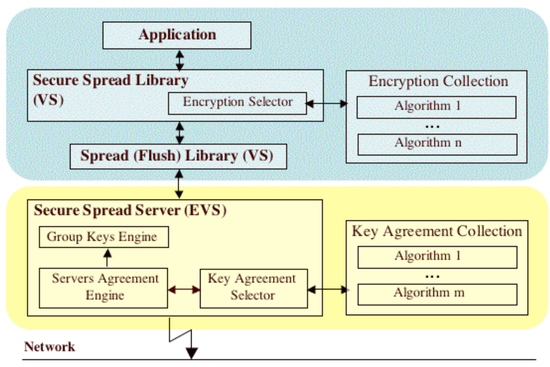
Robust Contributory Key Management

- Based on GDH Merge
- Uses membership service to make consistent decisions
- AGREED order delivery service used to ensure correctness

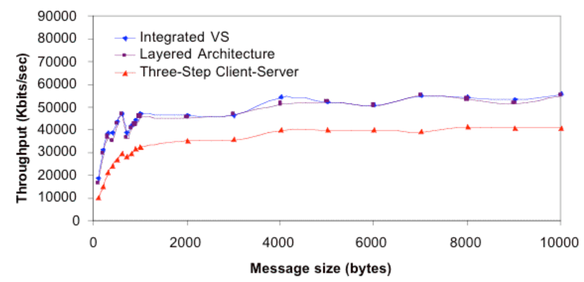


A process can crash/disconnect in any state.
The network can partition/merge in any state.

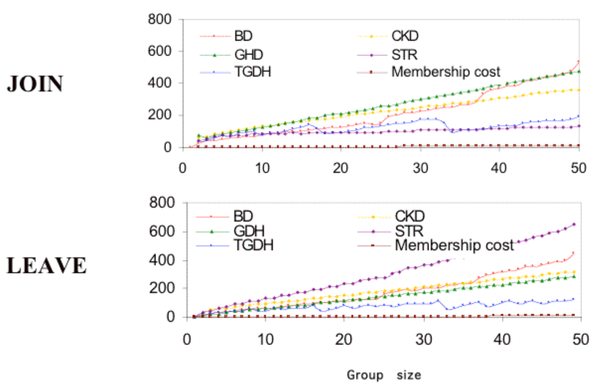
Integrated Architecture



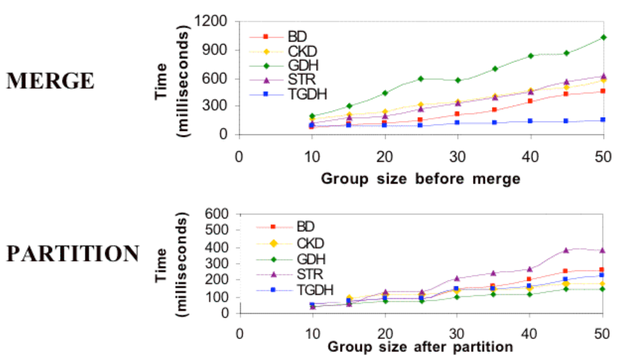
Encryption Overhead



Key Management Cost



Key Management Cost (cont.)



Impact

- Secure Spread Library (over 500 downloads) available at: *http://www.cnds.jhu.edu/securespread/*
- One of the 6 technologies selected by DARPA for a Red Team Experiment involving BBN and SRI.
- Secure Spread Library used by other researchers to develop and test their own protocols or to develop their own applications: Yalta project (NCSU/MCNC), Rome Labs, SRI - formal verification muCAPSL, UC Irvine – group admission control.

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