Building Primitives for a Reliable and Fault-Tolerant Distributed System over Wireless Networks

Shashank Gupta, Indian Institute of Technology, Kharagpur
ADVISORS: Prof. Sayan Mitra, Taylor Johnson

Wireless Networks:
- Transmitted packets could be dropped.
- Arbitrary message delays exist.
- More failure prone compared to wired counterparts.
- Long-Term Goal: Build reliable & fault-tolerant distributed services for distributed control.
  E.g.: Flocking -

  ![Flocking Diagram]

- Goal for Internship: Building primitives & services such as send & receives, & clock synchronization.
- Future Work: Leader Election, Reliable Multi-Casts & Group Communication.

Send & Receive Primitives:
- `end (message, size, destination_add)`
- `Receive (message, type, &size, &source_add)`

Clock Synchronization Service:
- Needed to perform operations simultaneously on different nodes (or computers).
- Synchronizing the values of the clocks of all the nodes ultimately.

Characteristic Features

Queuing system - Send & Receive:
- Capable of exchanging messages of all types and sizes.
- Queuing system should have the flexibility to be used by essentially all types of applications.

Clock synchronization:
- Algorithm should work even with the network structure changing.
- Values of clocks of different nodes should be bounded.

Approach & Implementation
- Implemented using socket programming & threads in C.
- Send & Receive Queues:

  ![Queue Diagram]

- Messages in send queue automatically sent to the network.
- Messages from network automatically queued into receive queue.
- Functions doing sending and receiving are easy to use.
- Only a few arguments need to be passed to these functions.

Clock Synchronization:
- Romer’s Algorithm modified.
- Use timestamps & round trip time delays to estimate the clock values at other nodes.

Research Results

- Drift rate of synchronized clock oscillates.
- Wavelength of oscillation is higher for lower synchronization frequency.
- Nodes with different starting time are also synchronized.

Future Work

Ongoing Work:
- Leader Election

Future Work:
- Fault Detection
- Reliable Multicast
- Group Communication

References:
- P. Kyasanur, C. Chereddi, N.H. Vaidya. Net-X: System eXtensions for Supporting Multiple Channels, Multiple Interfaces, & Other Interface Capabilities

Test Bed - Net X:
- Framework developed by Wireless Networking Group, UIUC to support wireless communication with multiple channels.
- Set of 26 nodes.
- Each contains two radios, 1 for sending, 1 for receiving.
- Communication using 802.11a standards.
- Net-X resets network topology about every 5 seconds.