Summer Research

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A Novel Framework for Model Checking UDP Network Interactions

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A Novel Framework for Model Checking UDP Network Interactions

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A **B**

Message not sent

Collision

Message Sent

Message sent

C
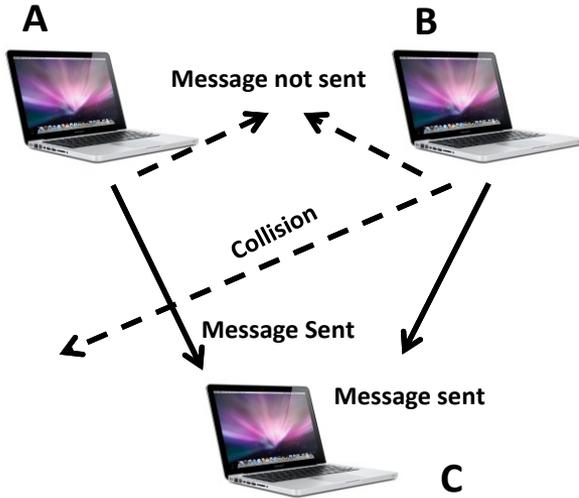
Model checking network interactions. Computer A attempts to send a message to C while B is not sending anything. To ensure the program can handle *all* states, the model must be checked for how it handles correct transmissions (A to C and B to C), as well as collisions, message loss, and all other possible input combinations.

THE

HE X

THE ✔

TEH X
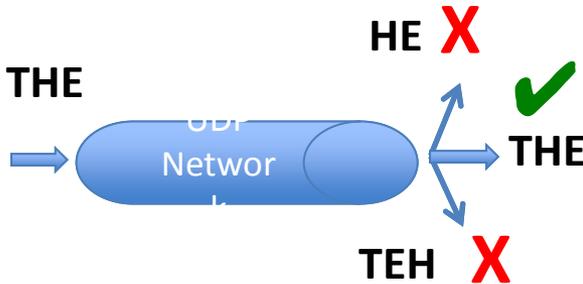
UDP Network

UDP networks send data along an unreliable channel. Trying to send the message "**THE**" can result in packet loss "HE' and reordering "TEH." To date, this framework is the only one to simulate these common transmission errors.

Objective:

• Extend the Java Pathfinder model checking system to verify that the wireless network simulator used in Brad Richards's networking class correctly handles all possible interactions between simulated clients.

Client   **Client**   **Client**

RF Wireless Simulator

Packet   Packet   Packet

Wired Network
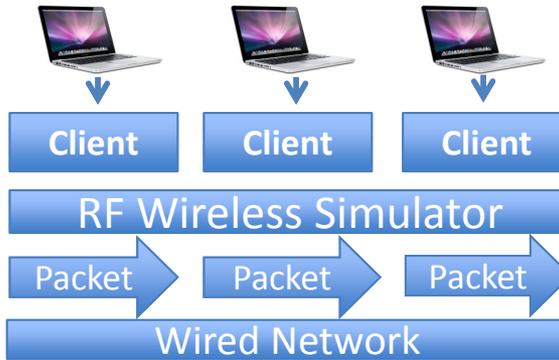
Methods

- Developed a novel framework for modeling realistic UDP transmissions (simulated packet loss and out-of-order transmissions). This extends the work of UCSB's Netstub.
- Adopted the protocol developed in Artho and Garoche to wrap sender and receiver client processes as threads.
- Framework utilizes the transformations developed in Stoller and Liu for simplifying distributed program models: 1) replacing remote method invocations with local methods and 2) centralizing processes as threads.
- Framework available at:
https://www.github.com/billyrathje/**Java-Pathfinder-UDP-Networking-Stubs**

Results

- Developed a library for modeling UDP networks with Java Pathfinder.
- Extended Brad Richards's RF network simulator for model checking.
- Verification of the simulator succeeded (no deadlocks or errors) for 1-4 clients.
- The model of the RF simulator is verified correct.

$R^2 = 0.9975$

Time (hr) vs Number of Threads
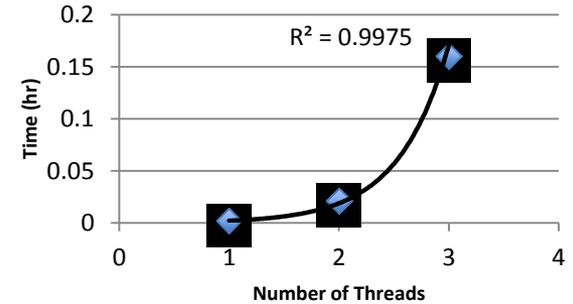
Verification times for the model increase exponentially with increasing number of threads. Run time is faster than NetStub by over a factor of 10 for comparable runs.

Summary

- Developed a novel framework for model checking UDP networks.
- Model checked RF networking simulator with Java Pathfinder.
- Verified model of networking simulator.