XSTP

The eXtended Satellite Transport Protocol: its Design and Evaluati

By

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http://www.scs.carleton.ca/~barbeau/Picosat.html

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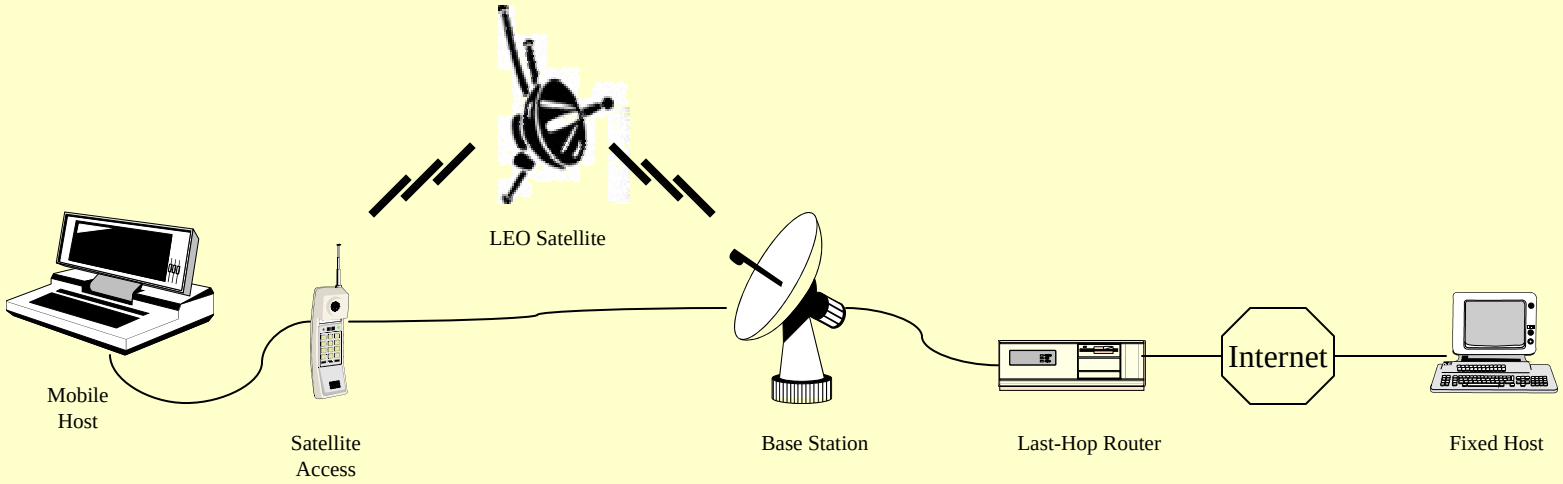
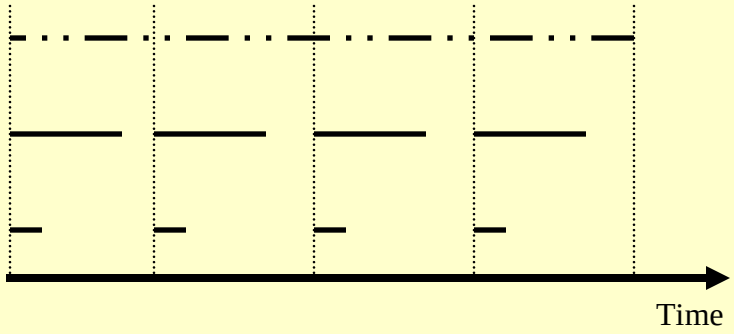
LEO Satellite Access Network

What is the target network? LEO-SAN



What are the error characteristics of LEO-SAN?

- Bit Corruption
- Handoff
- Limited Connectivity
- Congestion



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Data Transport over LEO-SAN

What is the goal?

- A reliable end-to-end data transport protocol for LEO-SAN that efficiently deals with its unique error characteristics.

What are the challenges?

1. **Congestion-centric** error control mechanisms
   - Slowing down transmission, underutilizing the link, affecting throughput/energy
2. Limited detection of the changing nature (duration, frequency) of error
   - Poor adaptation of error control, affecting throughput/energy

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LEO-SAN Data Transport Proposition

- **Different approaches to have a discriminating error control strategy**:
  - – Pure link layer: hide link error from transport protocol (ARQ)
  - – Cross layer signaling: inform transport protocol of error nature (ECN, ELN)
  - – Split path: wired and wireless connections each handling its error kinds (Snoo
  - ✓ End-to-end: sender / receiver detection heuristics (Probing, Wave & Wait)

- **Different approaches to have a LEO-SAN transport protocol**
  - – Add satellite extensions to existing protocols like TCP (complex design)
  - ✓ Design new satellite-centric transport protocols (highly integrated design)

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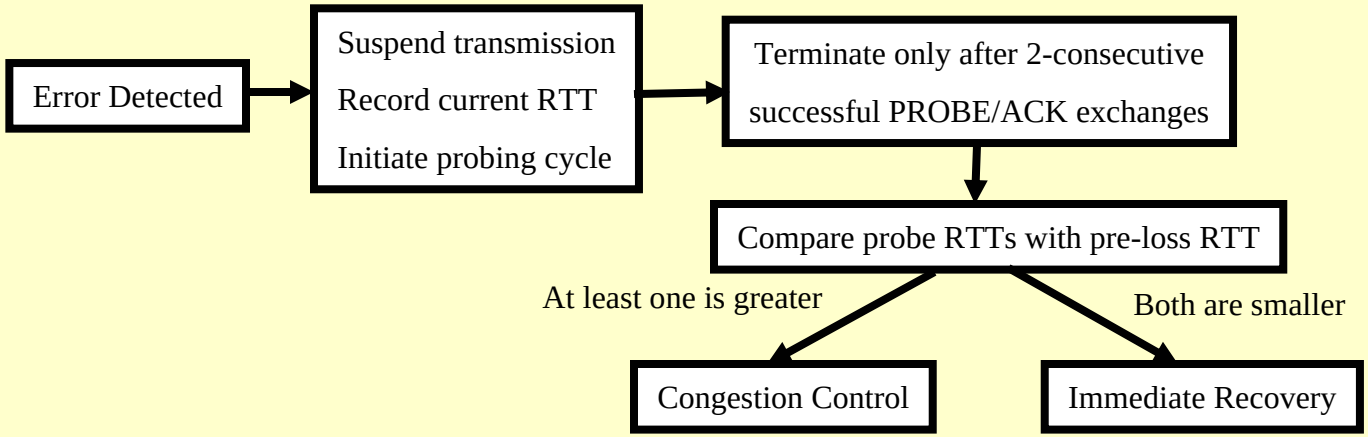
Selected Proposition

Selected Transport Protocol: Satellite Transport Protocol (STP)

- Highly integrated design incorporating a lot of known satellite extensions
  - Flow control: transmission pacing, byte counting
  - Error control: SNACK, ACK-polling, no ACK timeout
- Good performance in LEO-SAN (although it inherits the same congestion control bias)

Selected Error Control Mechanism: TCP Probing

- Investing some time and transmission effort to discover source of error



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eXtended Satellite Transport Protocol (XSTP

1. Implemented using the *Protocol Implementation Framework for Linux (PIX)*
   - Object-oriented architecture
   - Formal protocol interface
   - Ease of deployment and configuration
   - Access to light-weight libraries
2. Based on *the Satellite Transport Protocol (STP)*
3. Incorporates an extended adaptation of *the TCP Probing* algorithm.

Feature	XSTP Probing	TCP Probing
Deployment	Sender only	Sender / receiver
Semantics	Reuses Polling cycle	Introduces new cycle / segments
Triggers	SNACK (explicit) Early timeout (1 / polling-rate RTT)	DUPACK (heuristic) ACK timeout (min 1 RTT)
Integrity	Detects premature activation Slow-Start (idle transmission long enough)	Prone to premature activation Slow-Start (triggered by timeout)
Speed	Accepts pre-loss Probe ACK Tolerates a delayed Probe ACK	First Probe ACK after at least 1 RTT Ignores a delayed Probe ACK
Configurability	# required probe cycles # outstanding probe cycles RTT tolerance	no configuration

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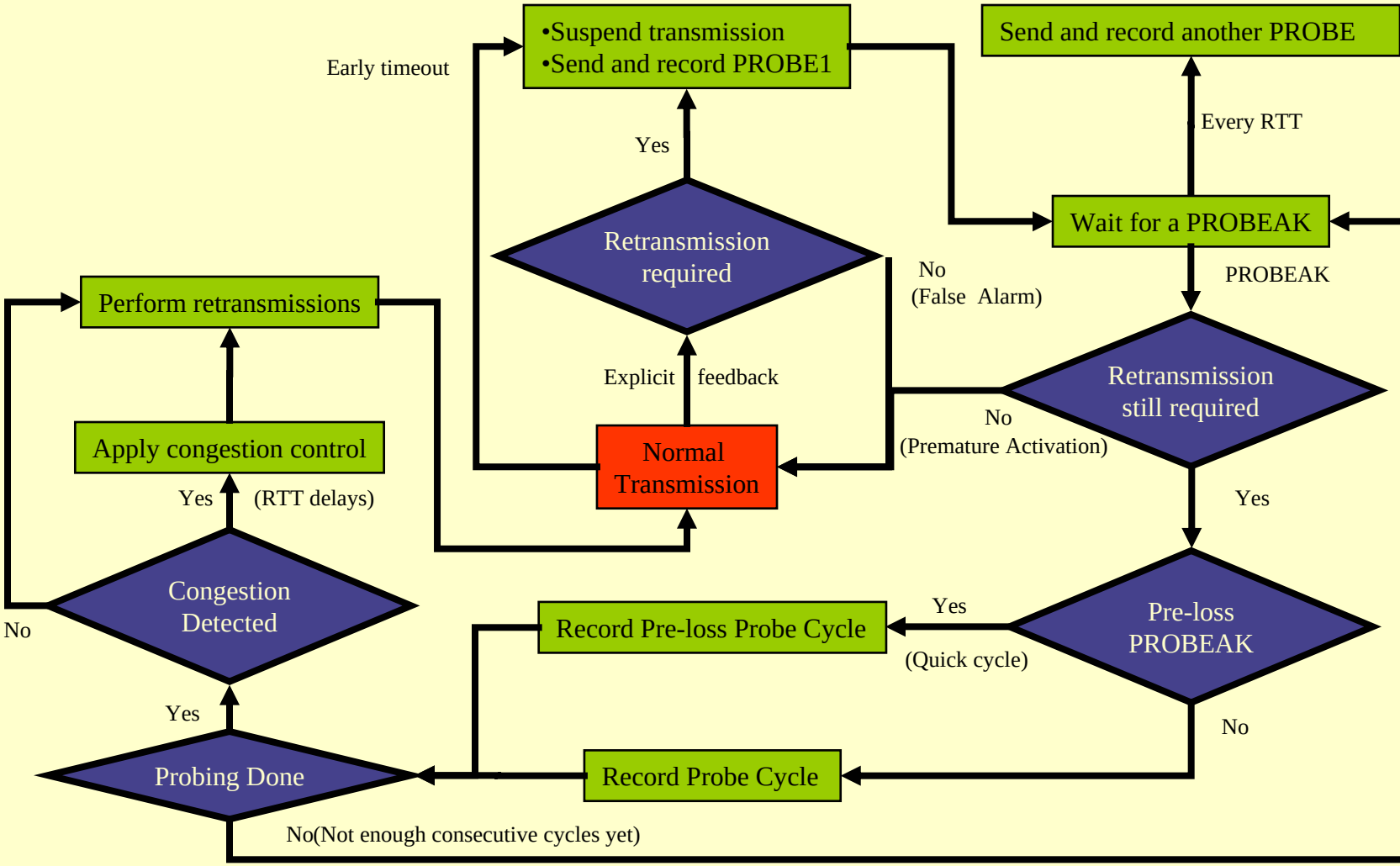
XSTP Probing Mechanis



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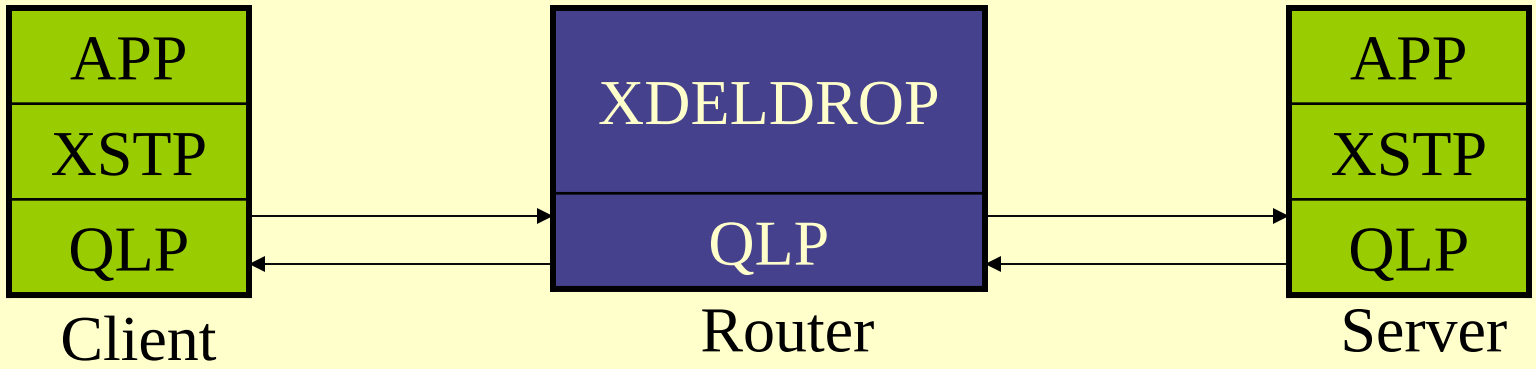
Simulation Framework

- Framework: Protocol Implementation Framework for Linux (PIX)
- Application Protocol (APP): sessions transmit end-to-end bulk data
- Queue Link Protocol (QLP): sessions forward packets through POSIX message queues
- eXtended Delay and Drop Algorithm (XDELDROP) after VDELDROP
  - Sessions are modeled as a continuous time Markov chain with 2 states
  - States are parameterized with Duration, Drop Rate, Delay Range [min, max]



Simulation Configuration

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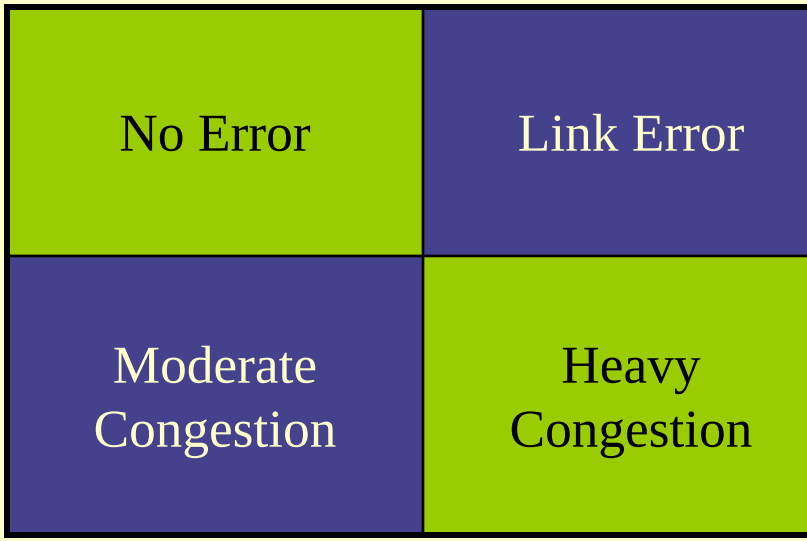
Three Simulation Experiments

- **Three experiment categories**: Bit corruption, Handoff, Limited Connectivity
- **Each category** simulates random phases of congestion and one kind of link error.
- **Individual experiments within a category** vary in the frequency and duration of error.
- **In each experiment**, the performance of XSTP with probing turned ON and OFF is compare
- **The performance metrics**:
  - Effective Throughput (bit/sec)
  - Transmission Overhead (%)
  - Throughput / Overhead ratio (bit/sec)



Simulated error states

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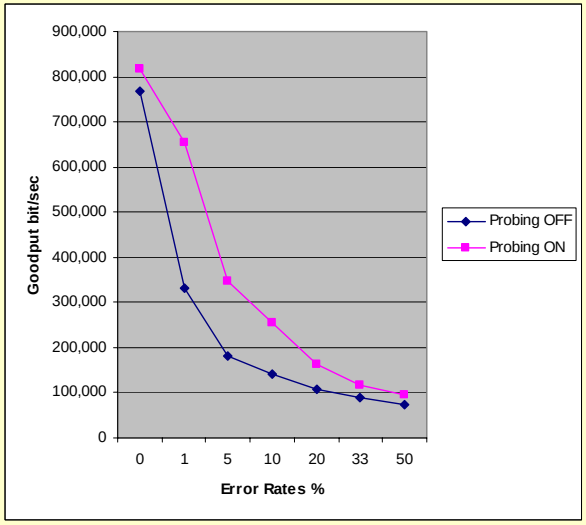
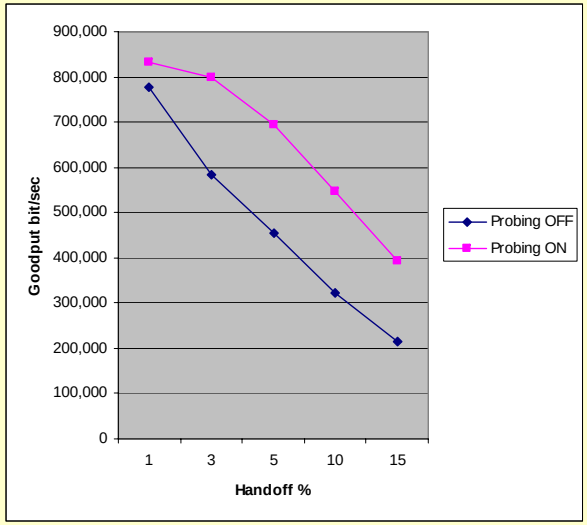
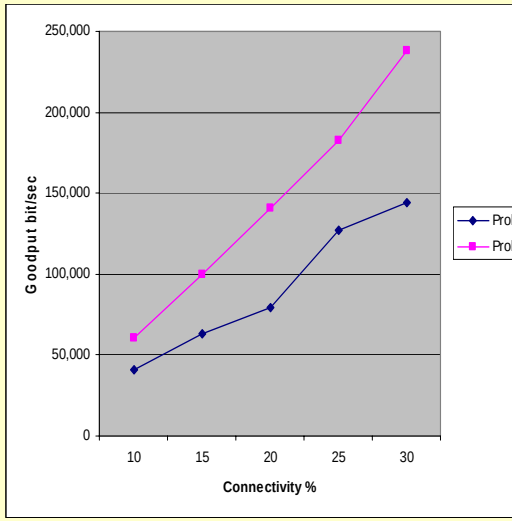
Up to 150% Gain in Throughpu



Bit-Corruption



Handoff



Limited Connectivity

1-sec random phases of congestion with one link error

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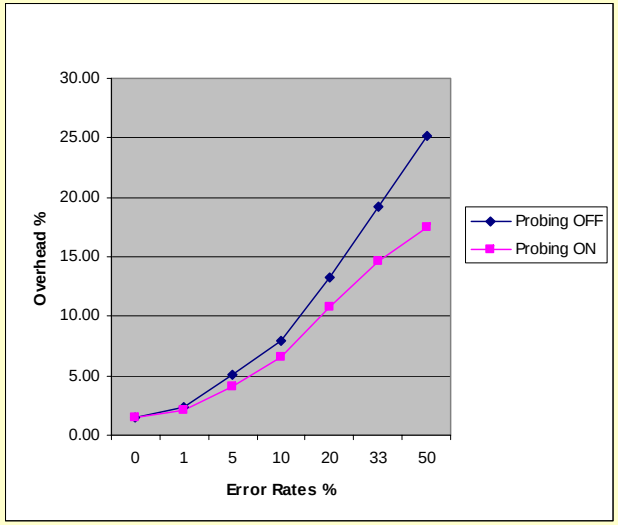
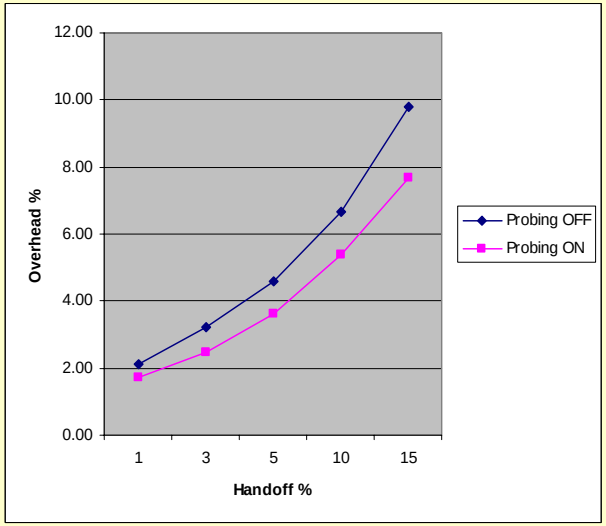
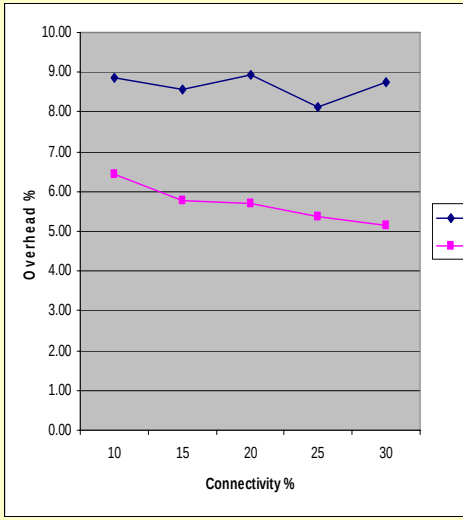
Up to 50% Reduction in Overhead



Bit-Corruption



Handoff



Limited Connectivity

1-sec random phases of congestion with one link error

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Conclusion & Future Work

• XSTP probing is an error control strategy that helps sessions get more conservative when error is persistent and more aggressive when error is found to be transient.

• XSTP probing was also integrated with other layers like FTP and IPv4 with DSR routing, and tested over a packet radio network running the AX.25 protocol as a link layer. For more information, please refer to our paper in the proceedings.

• Future work:

- •Enhanced decision making heuristic
- • Reduce probing overhead
- • Different traffic patterns (interactive, HTTP, full-duplex)
- • Different ways of measuring energy
- • Evaluating XSTP probing in TCP
- • Comparing TCP and XSTP probing