TCP Evaluation Suite for ns-3

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Outline of the presentation

- Motivation
- Existing implementations
- Design and implementation of tcp-eval in ns-3
- User interaction with ns-3 tcp-eval
- Comparing TCP extensions in ns-3
- Results and discussions
- Validation issues
- Conclusions and the next goals

Motivation

- Congestion control algorithms continue to evolve . . .
- . . . *and* so do TCP extensions!
- *Problem*: not feasible to evaluate every TCP extension *exhaustively*
- *Potential solution*:

  - derive some initial results and study the behaviour
  - consider the promising ones for thorough evaluation

What is TCP Evaluation Suite?

- a set of well-defined, standard test cases to compare TCP extensions
- initially proposed by Transport Modeling Research Group (TMRG)
- modified by Internet Congestion Control Research Group (ICCRG)
- widely used today for evaluating new TCP extensions

Existing implementations

- Wang, G., Y. Xia, and D. Harrison. “An NS2 TCP evaluation tool.” draftirtf-tmrg-ns2-tcp-tool, IETF Internet Draft (expired) (2007).
  - Two versions of code.
  - Version 2 source: https://sourceforge.net/projects/tcpeval

- Shimonishi, Hideyuki, M. Y. Sanadidi, and Tutomu Murase. “Assessing Interactions among Legacy and High-Speed TCPs.” PFLDnet 2007 (2007).
  - designed for evaluating High-speed TCP extensions using ns-2
  - Source: http://nrlweb.cs.ucla.edu/tcpsuite/index.html

Existing implementations

- Li, Yee-Ting, Douglas Leith, and Robert N. Shorten. “Experimental evaluation of TCP protocols for high-speed networks.” Networking, IEEE/ ACM Transactions on 15.5 (2007): 1109-1122.
  - designed for evaluating High-speed TCP extensions using ns-2
  - Source: http://www.hamilton.ie/net/eval/hi2005.htm

- Hayes, D., Ros, D., Andrew, L. and S. FLoyd, “Common TCP Evaluation Suite” draft-irtf-iccrg-tcpeval-01, IETF Internet Draft (expired) (2015).
  - The latest draft on TCP Evaluation Suite
  - Source: https://bitbucket.org/hayesd/tcp-evaluation-suite-public

Design and implementation of ns-3 tcp-eval

- Implemented as a separate model called `tcp-eval` in ns-3 (~5500 lines)
- Topologies:
  - Dumbbell (single bottleneck topology)
  - Parking lot (multiple bottlenecks topology)
- Traffic types:
  - Long lived FTP
  - Streaming video
  - Interactive voice
- Performance metrics:
  - Aggregate link utilization
  - Mean queue length, and Packet drop rate

Design and implementation of ns-3 tcp-eval

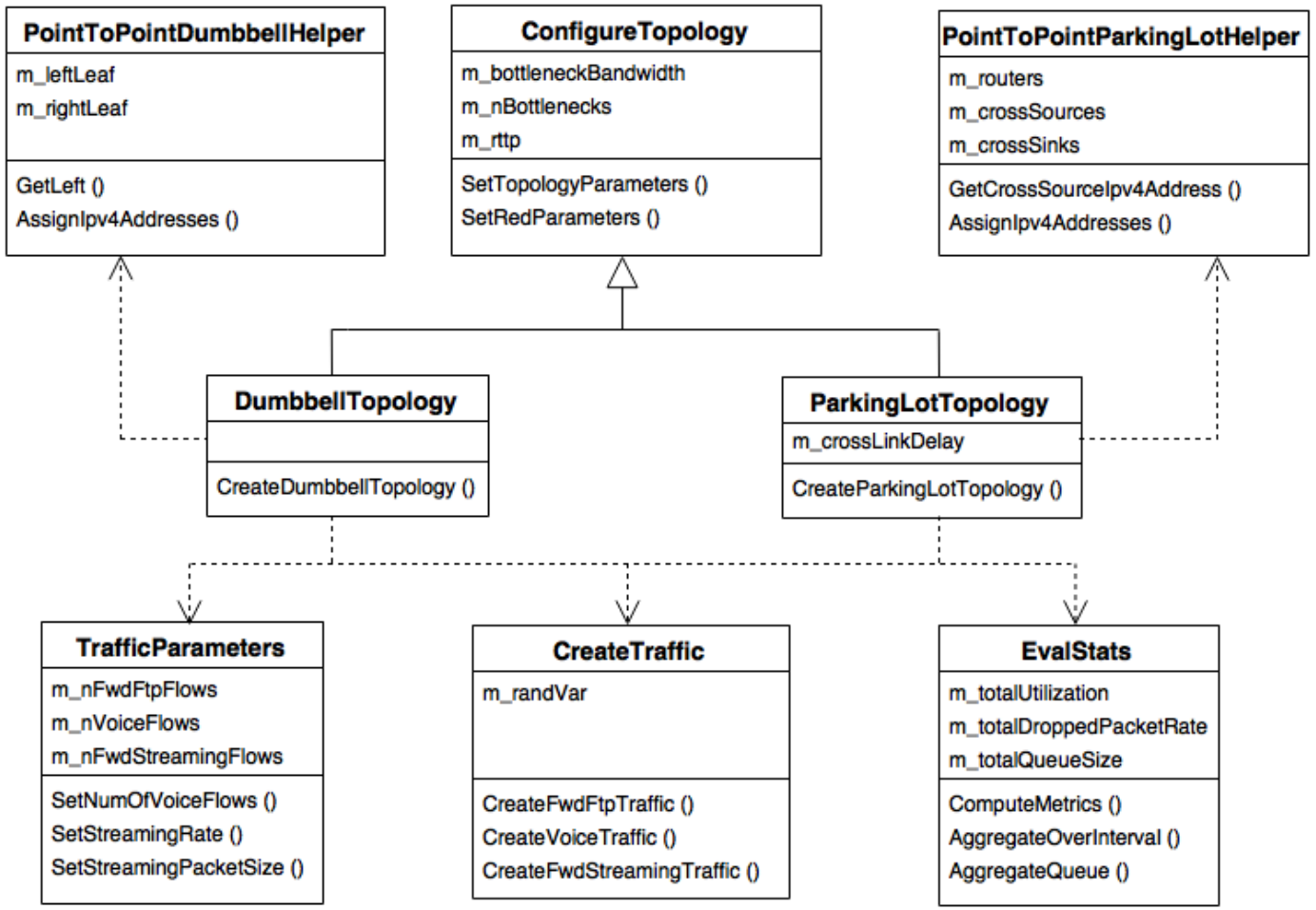


Figure: Class diagram of tcp-eval in ns-3

User interaction with ns-3 tcp-eval

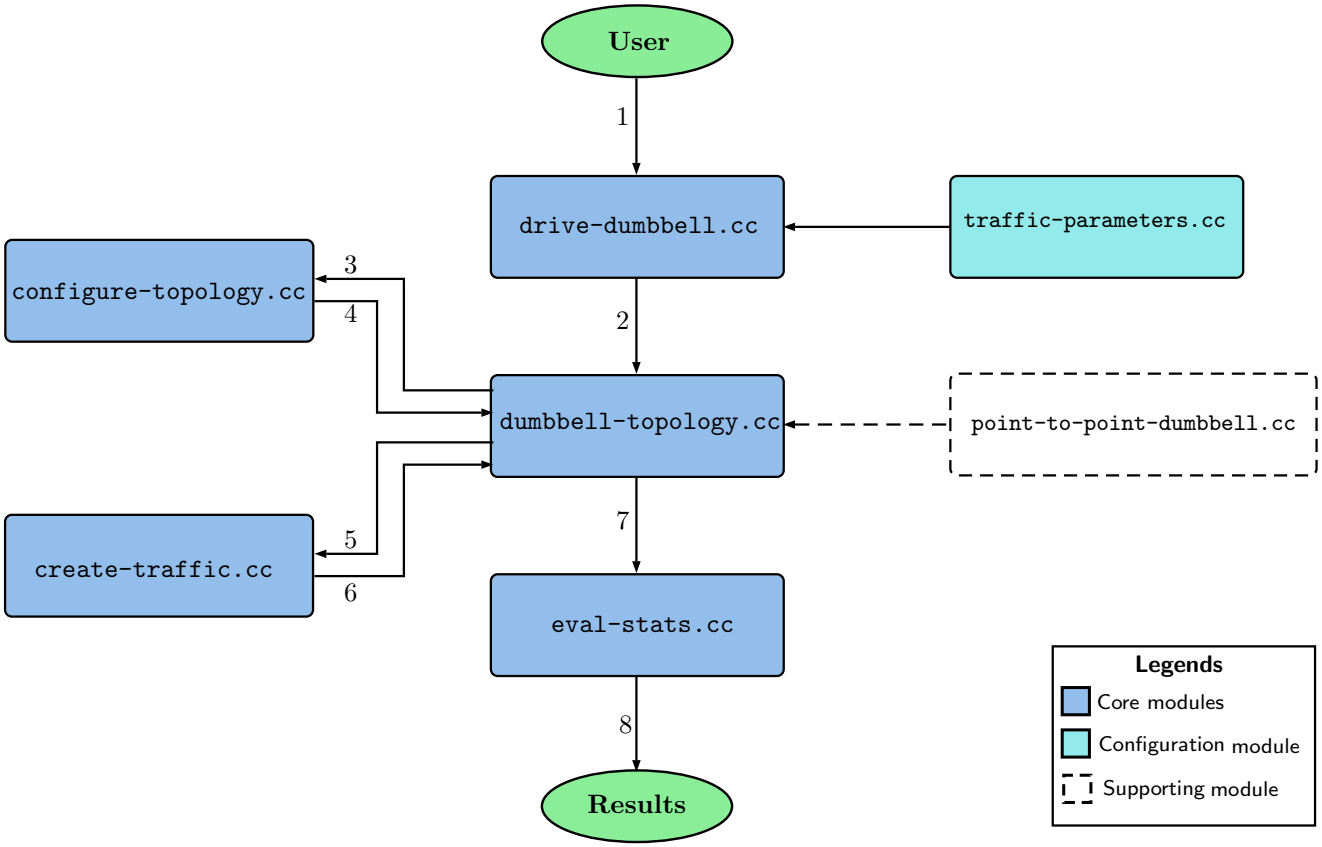


Figure: User interaction diagram of tcp-eval for dumbbell scenario

User interaction with ns-3 tcp-eval

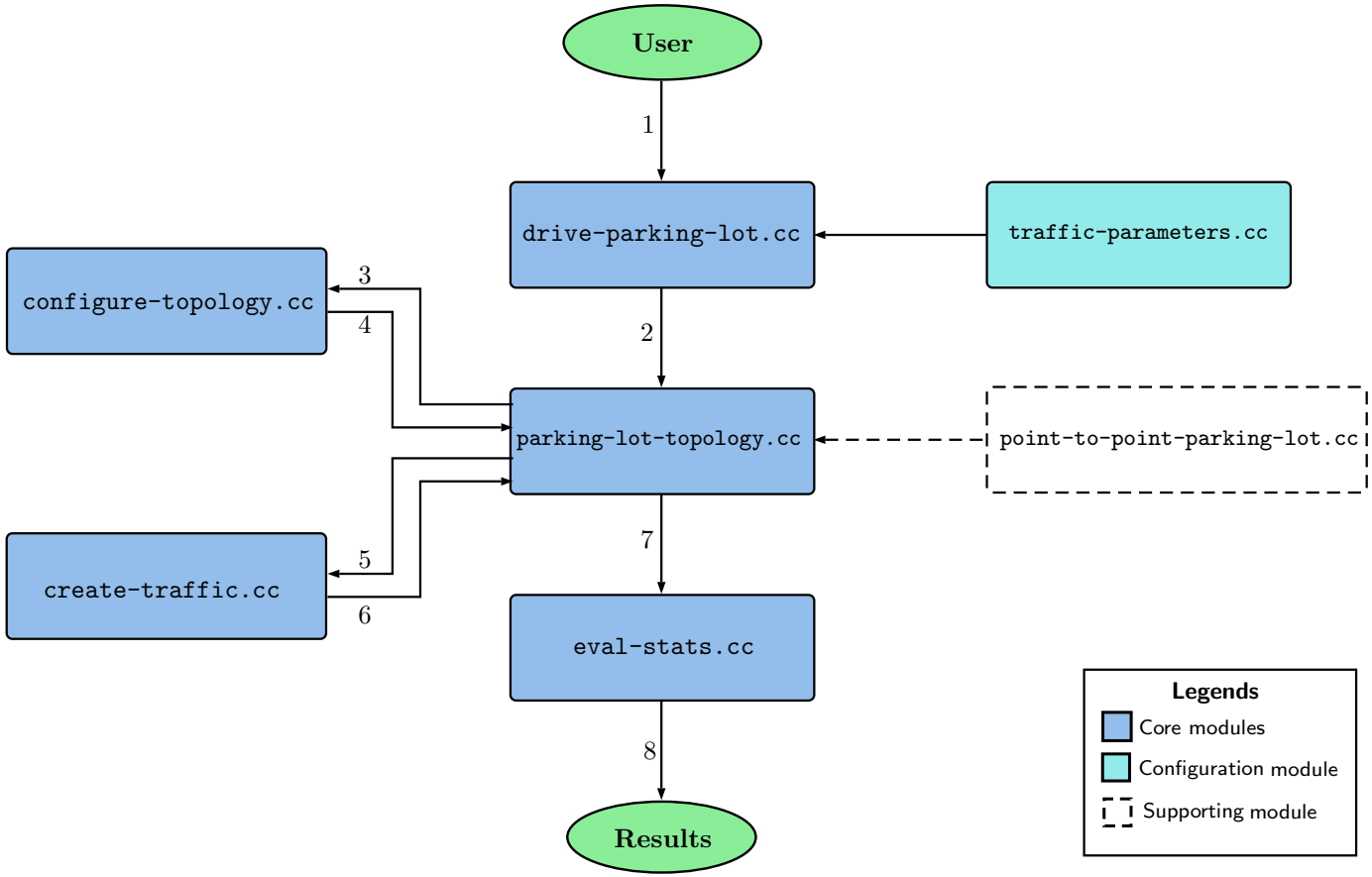


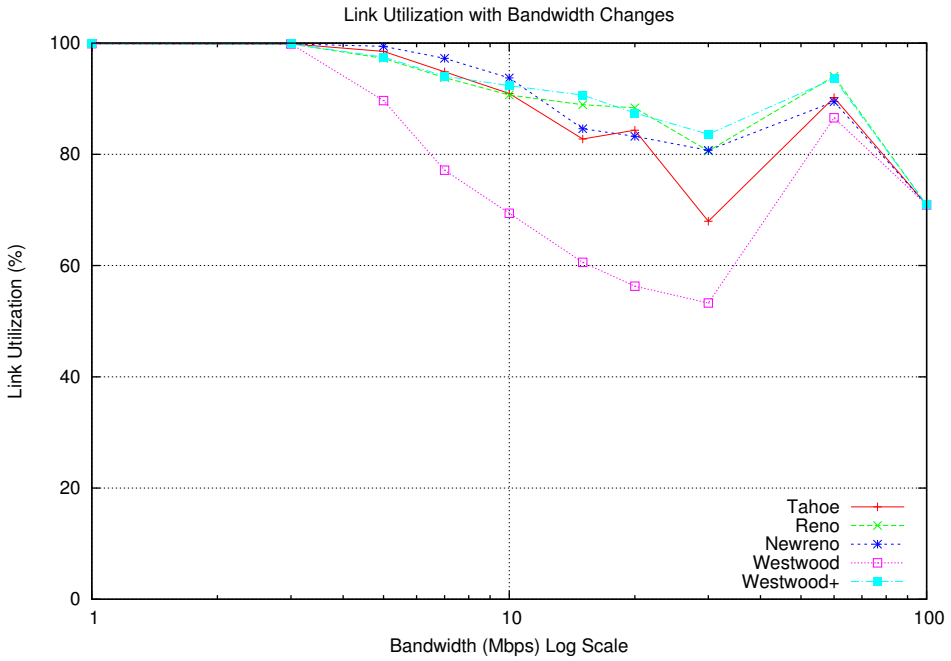
Figure: User interaction diagram of tcp-eval for parking-lot scenario

Comparing TCP extensions in ns-3

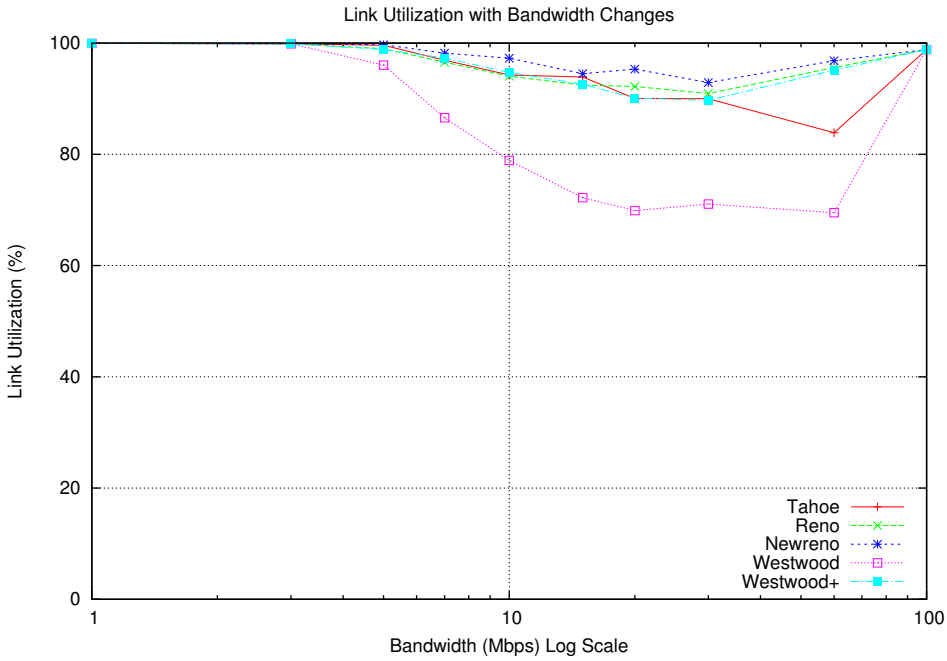
- Five TCP extensions: Tahoe, Reno, NewReno, Westwood, Westwood+
- Three scenarios:
  - Varying bottleneck bandwidth
  - Varying RTT
  - Varying the number of FTP flows
- Three Performance metrics:
  - Link utilization
  - Mean queue length
  - Packet drop rate
- Output:
  - PDF containing graphs (LaTex must be installed!)

Simulation Parameters	Values
Bottleneck bandwidth	10 Mbps
Round Trip Time	80 ms
Number of forward FTP flows	5
Number of reverse FTP flows	5
Number of voice flows	5
Number of forward streaming flows	5
Number of reverse streaming flows	5
Simulation time	100 seconds
Streaming rate	640 Kbps
Streaming packet size	840 bytes

Results and discussions: varying bottleneck bandwidth



Dumbbell topology



Parking lot topology

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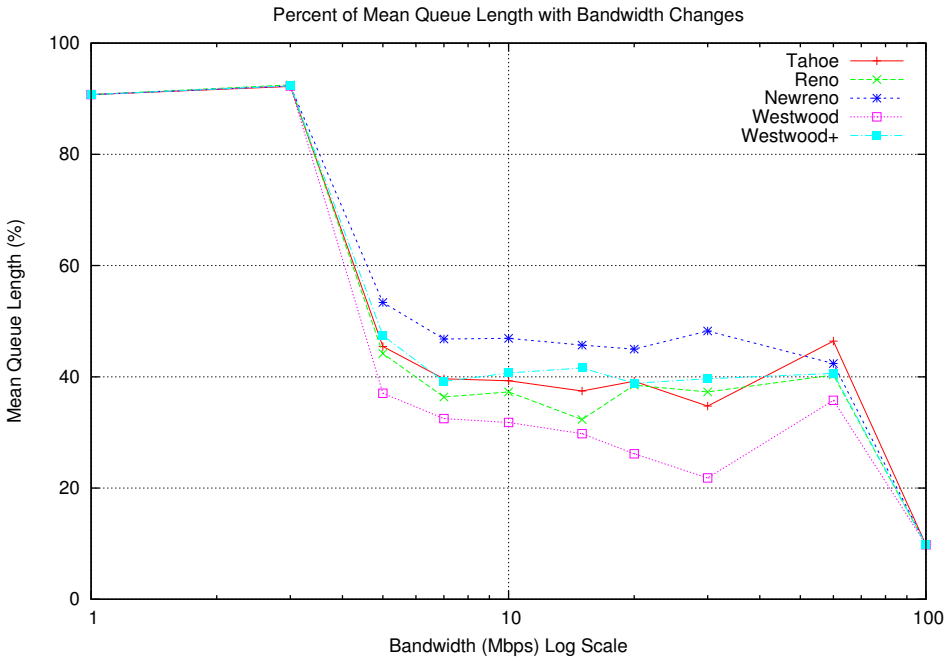

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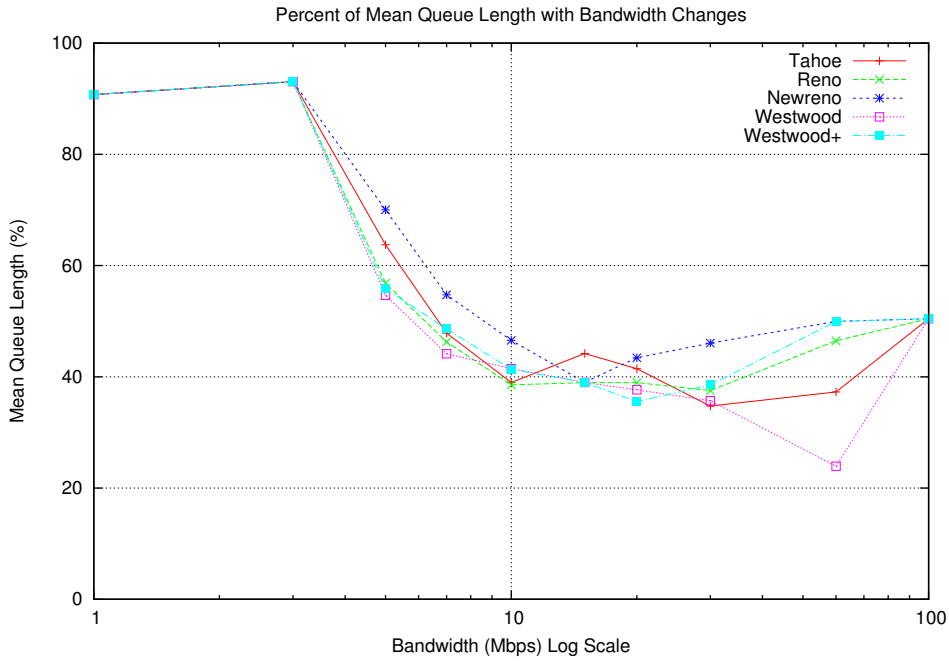

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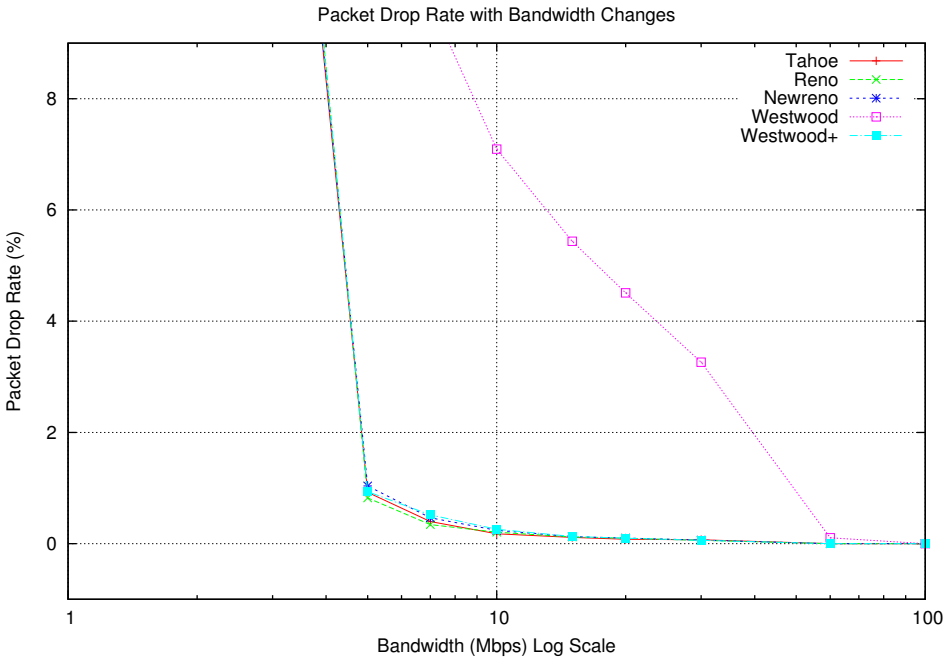

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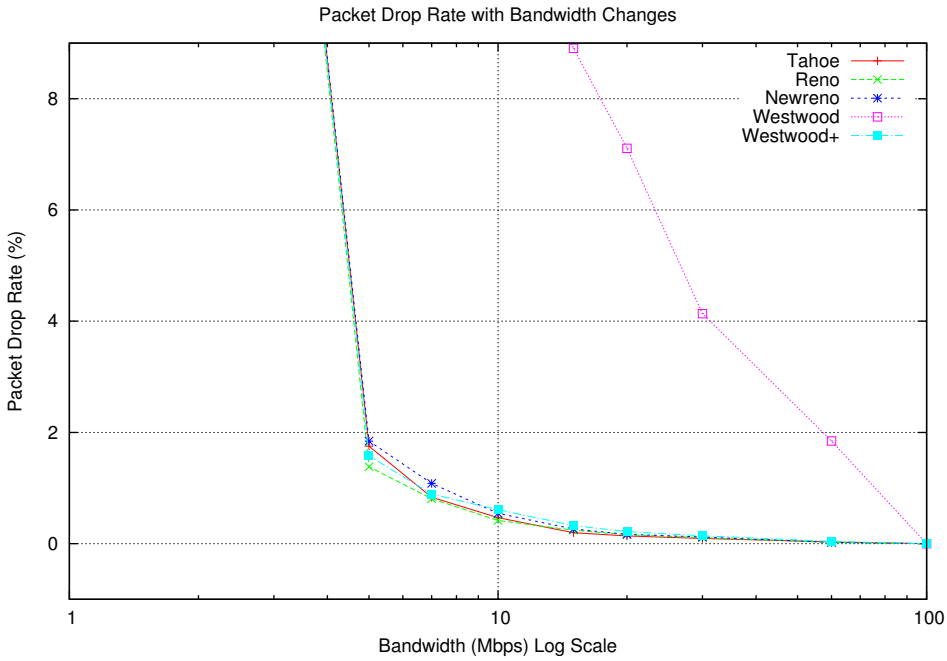
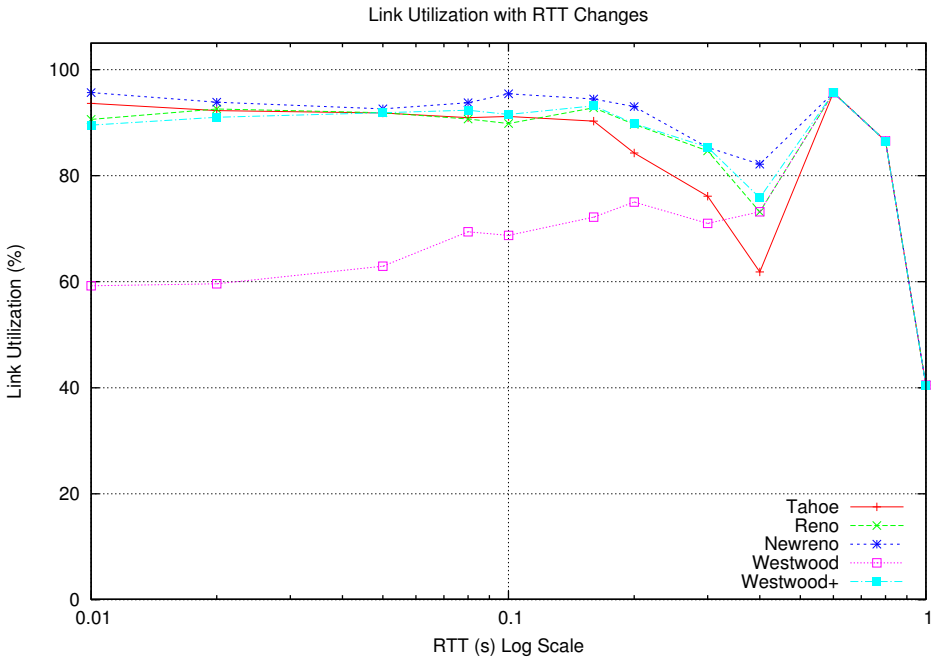


Parking lot topology

Results and discussions: varying RTT



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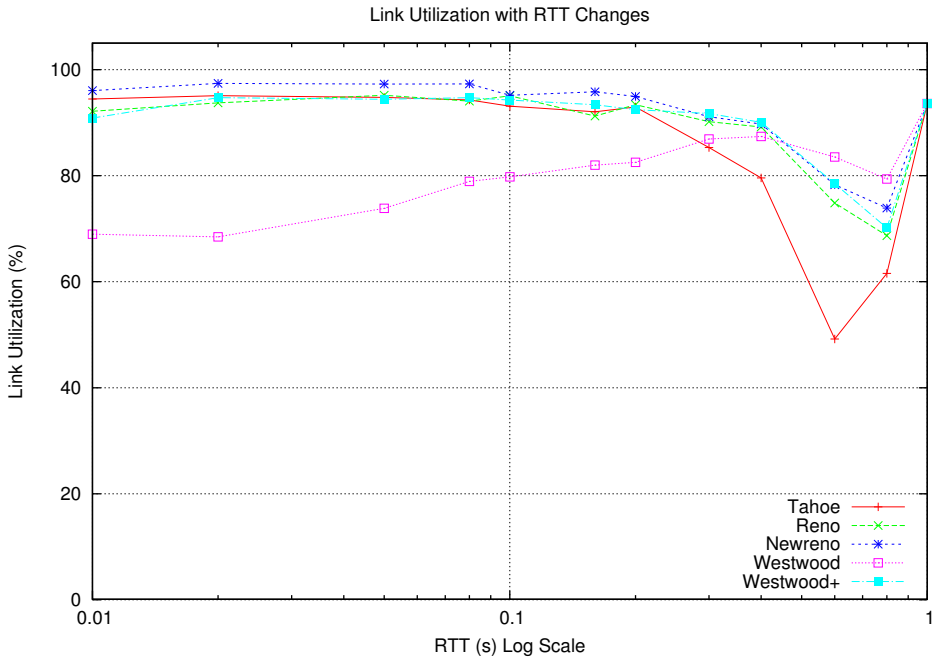

Parking lot topology

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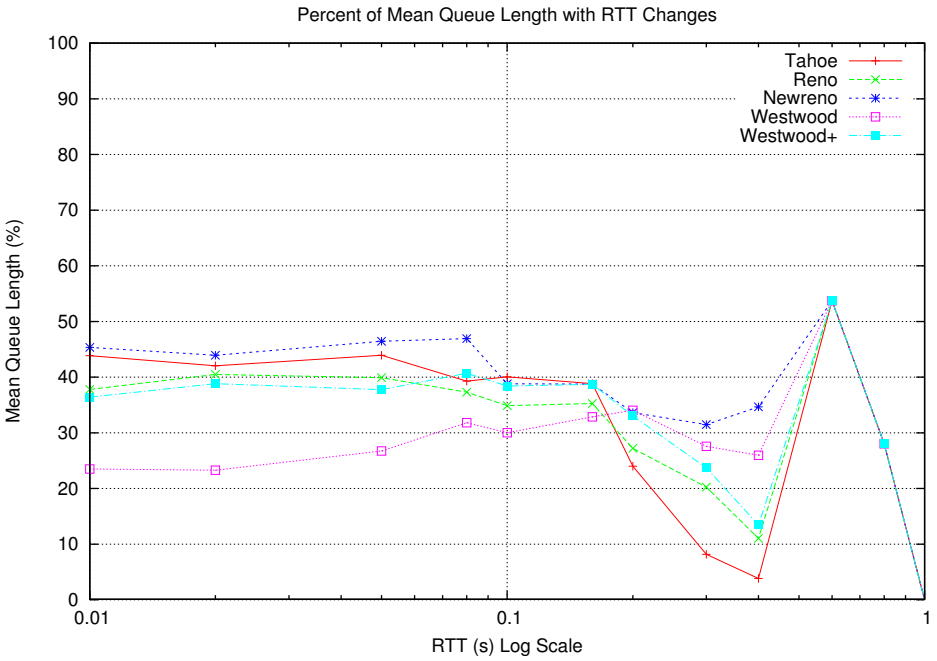

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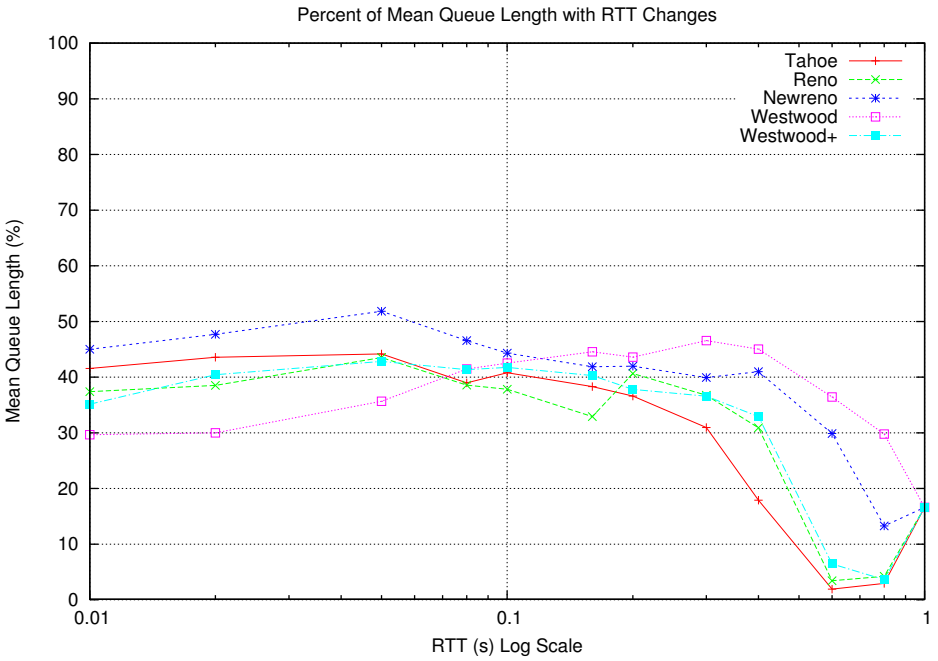

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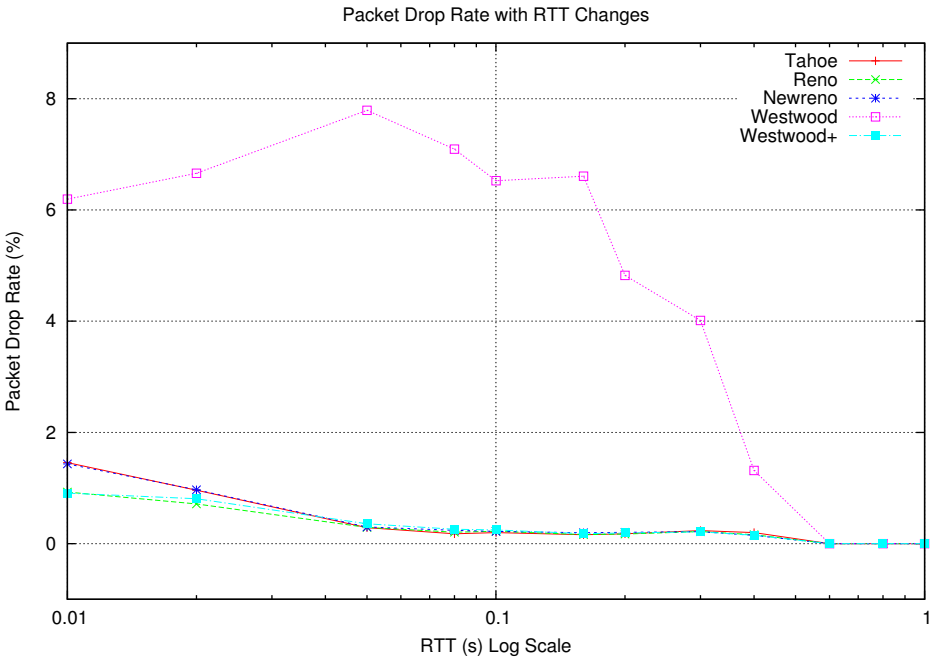

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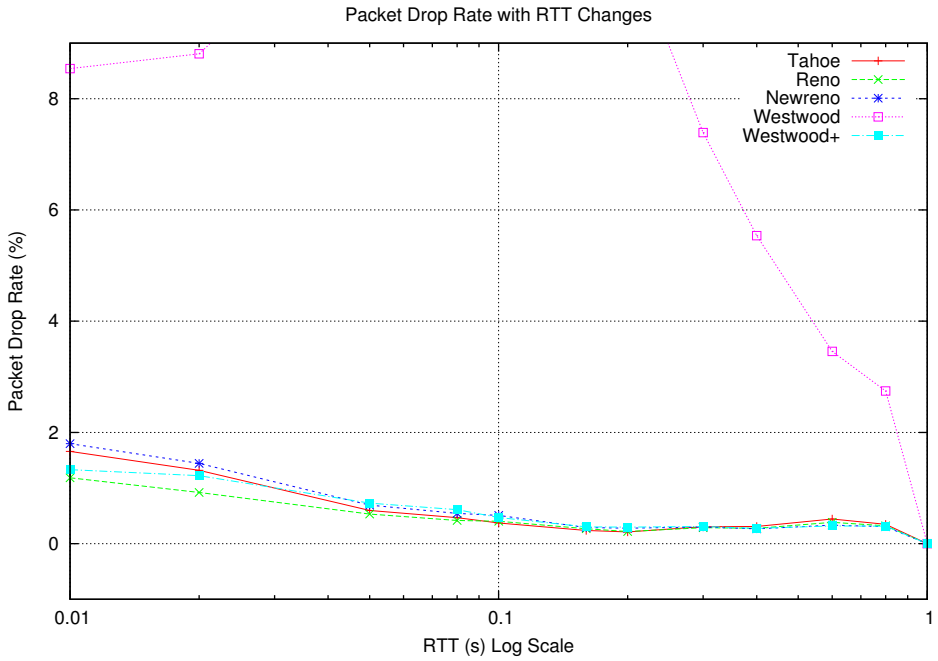
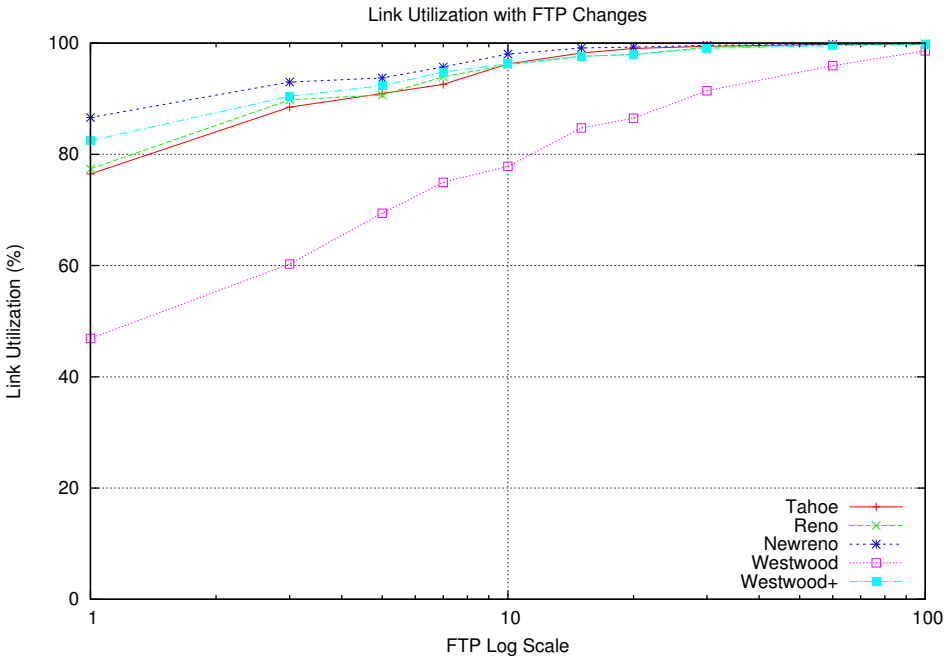


Parking lot topology

Results and discussions: varying number of FTP flows



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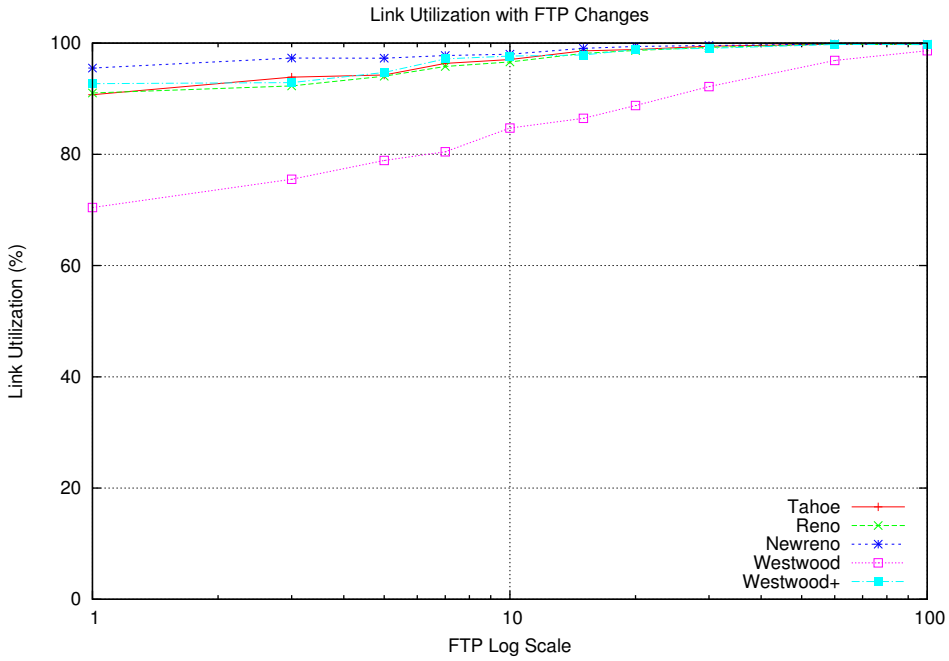

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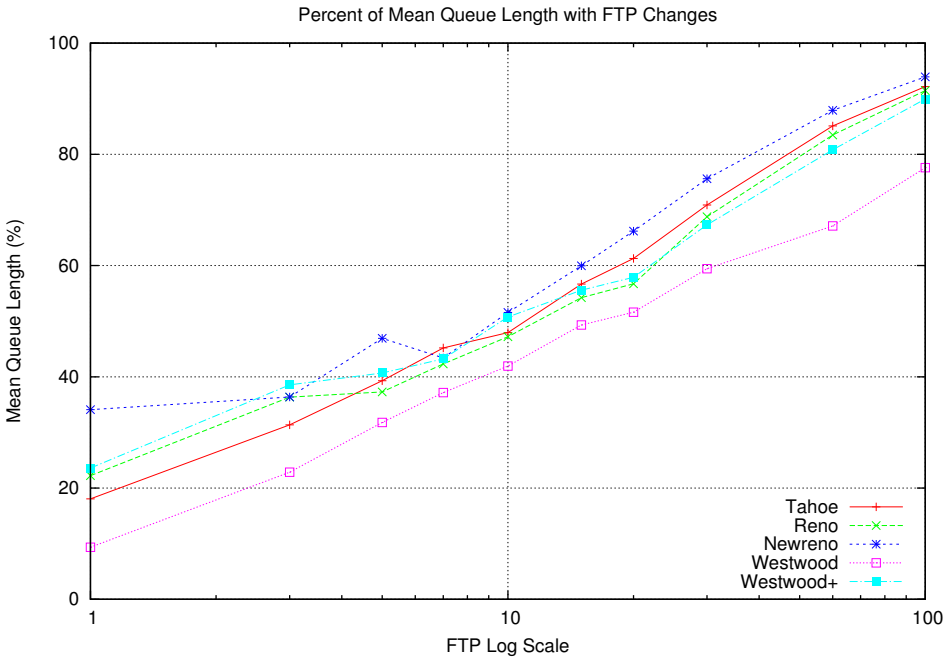

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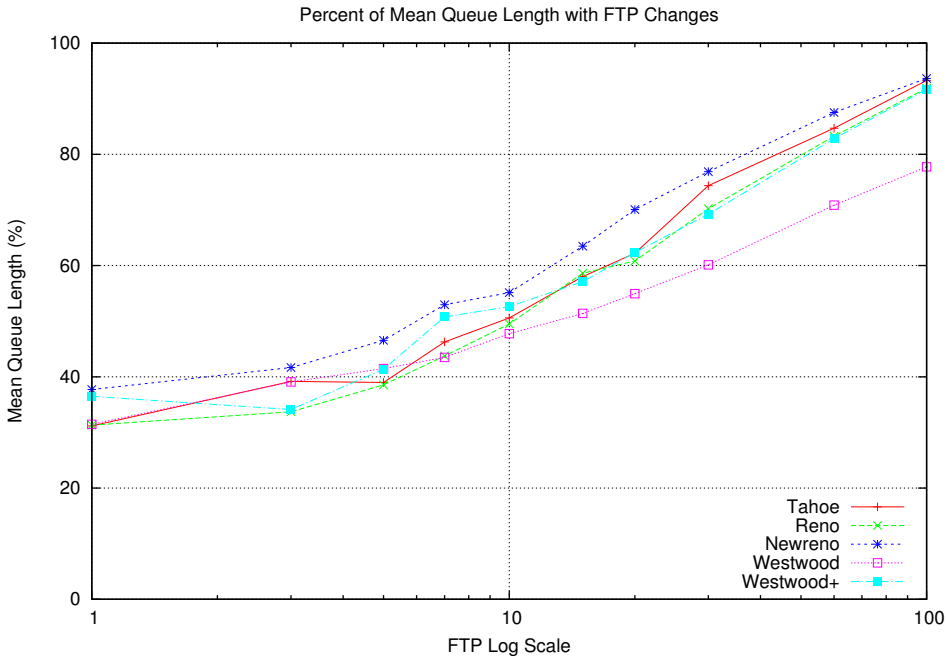

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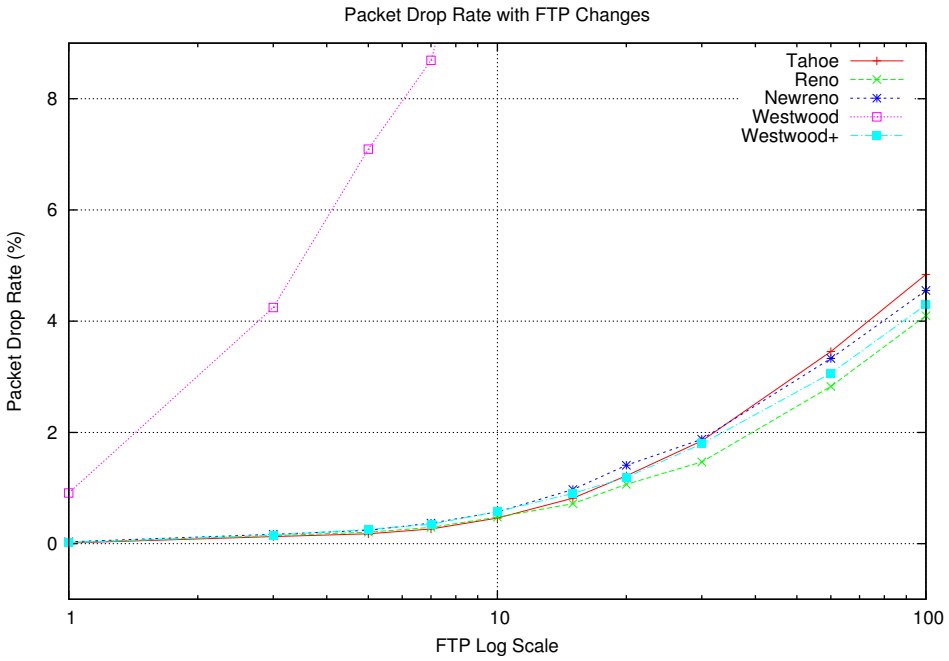

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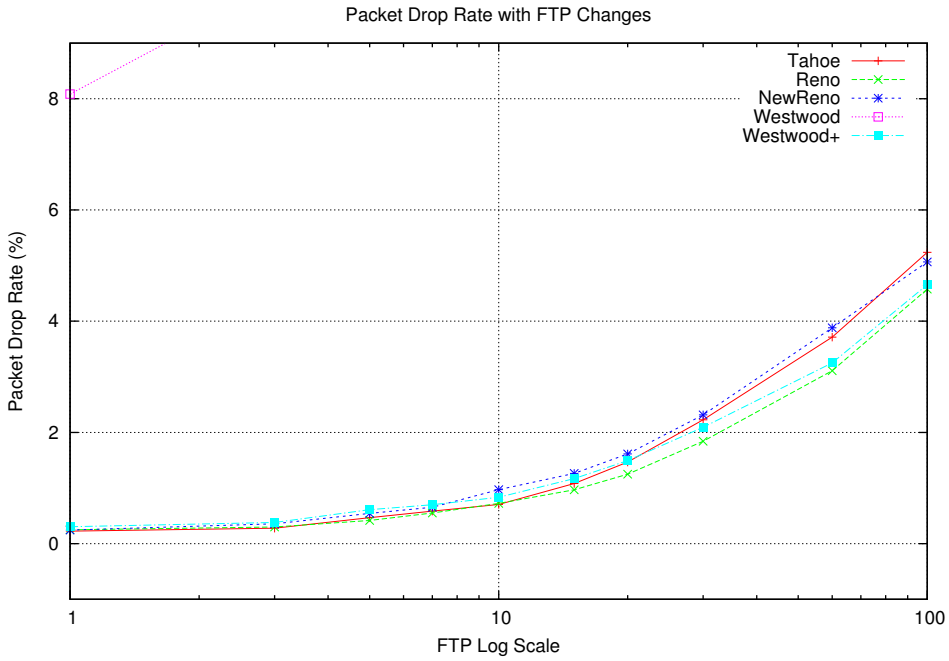

Parking lot topology

Validation issues

- Original tcp-eval is implemented in older version of ns-2 (ns-2.31!)
- ns-2.31 did not have many new TCPs
- Hence, tcp-eval contained custom implementations of new TCPs
- Latest tcp-eval implementation in ns-2 is on ns-2.35
- But there are several bugs identified, and its development has stopped
- Started aligning our implementation with that of tcp-eval for ns-2.35

Conclusions and the next goals

- A ns-3 model for tcp-eval has been implemented, but not validated.
- Automates the cycle from setting parameters to collecting results
- Steps to reproduce the results have been provided.

Next goals:

- Align the model to latest version of tcp-eval (2016 summer project!)
- Evaluate the model by comparing its results to those obtained from ns-2
- Include support for more topologies (wireless) and AQM algorithms
- Provide per-flow analysis to the user.

Acknowledgement

- All the reviewers, for the encouraging reviews!
- Tom Henderson, for guiding us through the validation procedure.
- All developers of TCP extensions in ns-3.
- The entire ns-3 community.
- Our research group at NITK Surathkal.

Thank you.