The Effects of a Performance Enhancing Proxy on TCP Congestion Control over a Satellite Network

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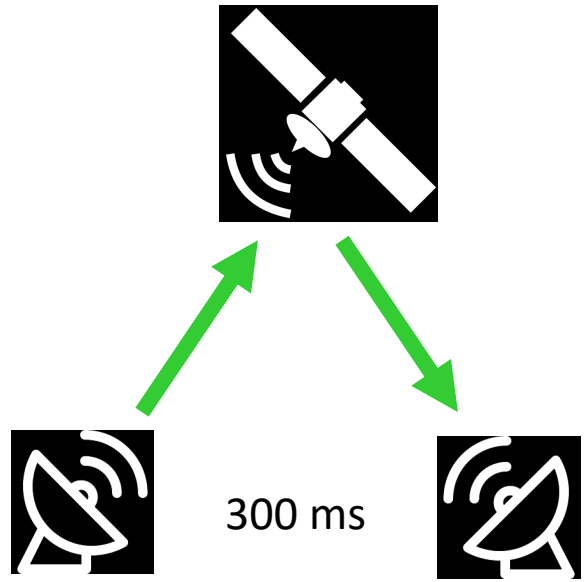
WPI

Viasat

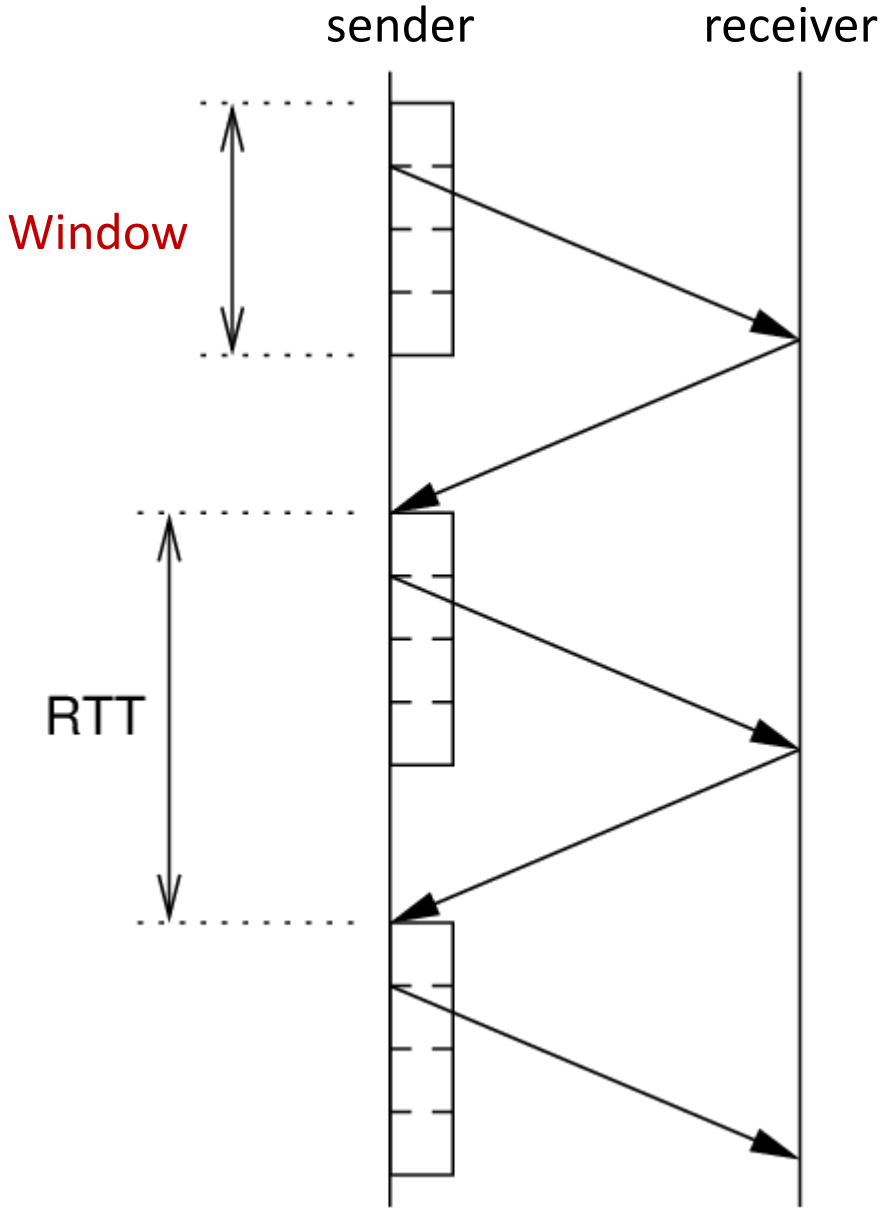
Extremely *long* pipe for GEO Satellites

- Satellites provide global networking
  - “Always on” connectivity for remote rural areas
  - Reliable connection during disasters or emergencies
  - Increased bandwidth (*150Mbps* or even higher)
- High Latencies,
  - 300 ms one-way
- Results in a *long fat* pipe

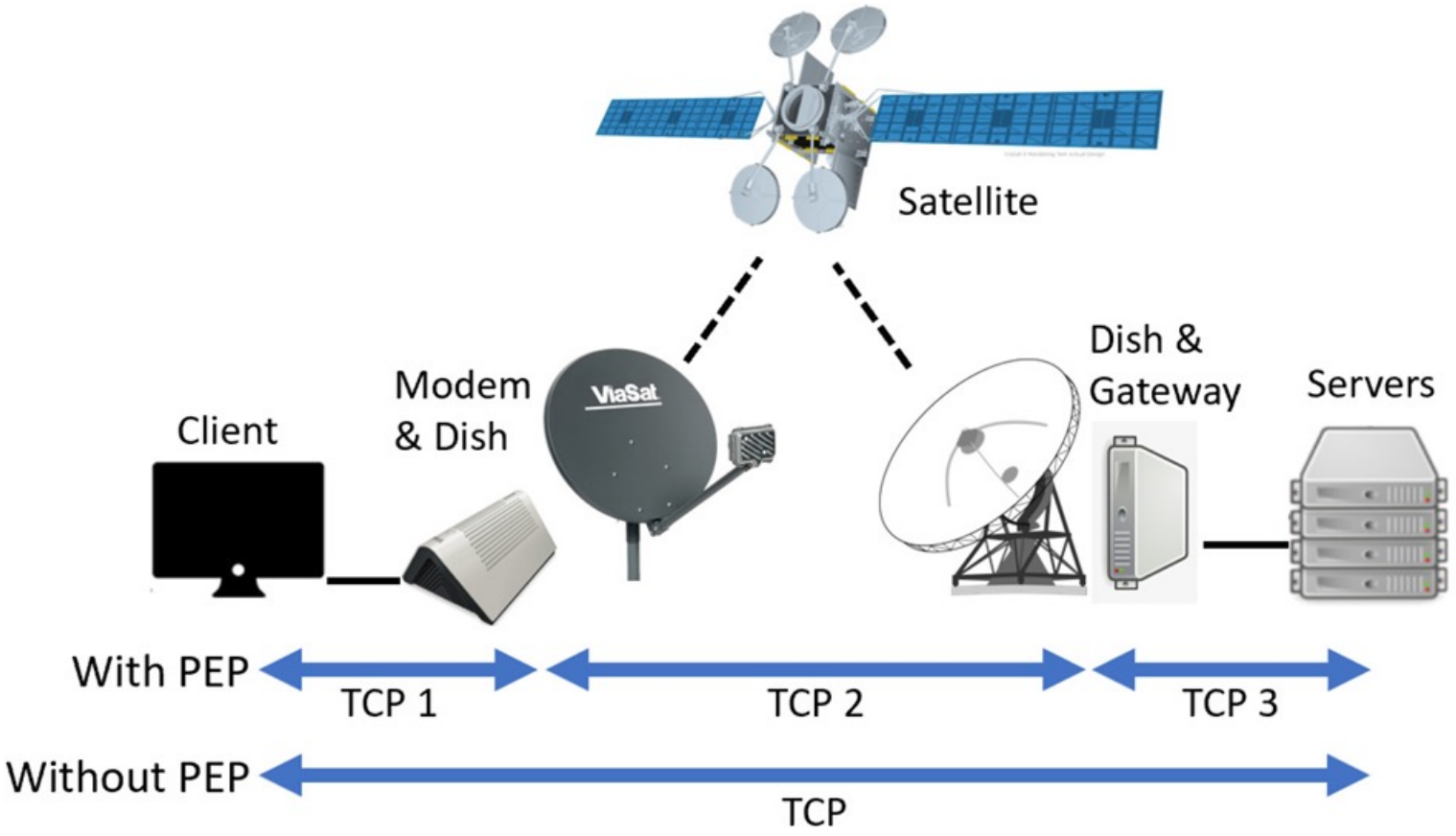


Satellite Network using PEPs

- Latency impacts TCP bitrates
  - One window of packets each RTT
  - Congestion window size depends on Congestion Control Algorithms (CCAs)
    - TCP CUBIC (loss based)
    - TCP BBR (BDP based, or rate and RTT based)
    - TCP PCC (utility function-based)
    - TCP Hybla (satellite optimized for RTT)
  - Loss detection or recovery
- Using TCP performance enhancing proxies (PEPs) to “short circuit” the round trip communication over satellite



TCP over a satellite w/ or w/o PEPs



- Viasat terminal
  - Ka Band outdoor antenna
  - Active Queue Management on Gateway
    - 36 MB queue per device
    - 2 sec max queuing delay
- Transparent PEPs can be enabled/disabled from terminal

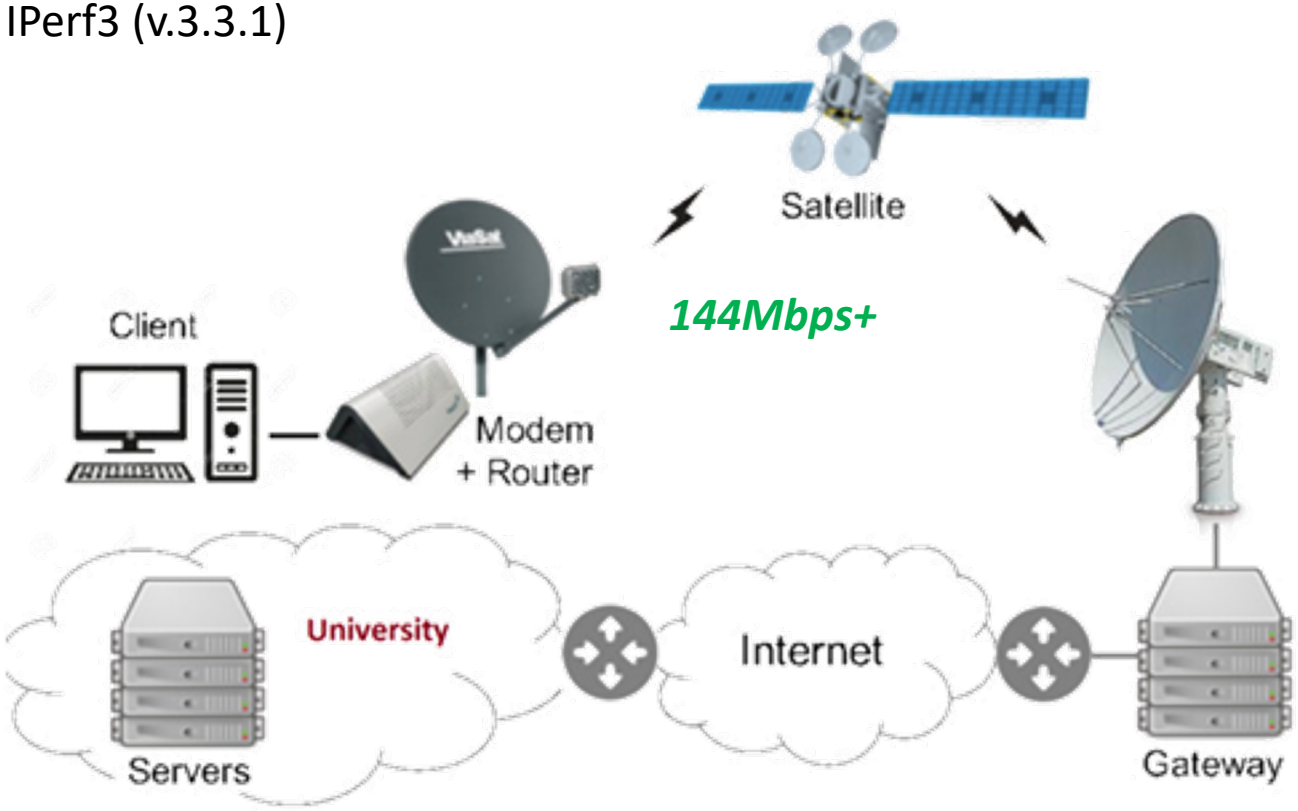
Outline

- Introduction (done)
- Methodology
- Results
- Conclusion

Methodology

Baseline:
- RTT: 560-625ms
- Avg loss rate: 0.05%, most single packet

Bulk-Downloading
- IPerf3 (v.3.3.1)



- Client
  - Linux PC, i7 CPU, 32GB RAM
- Four identical Servers
  - Intel Ken E312xx CPU, 32GB RAM
  - One of BBR, CUBIC, Hybla, PCC
- Client and Servers Linux Kernel 4.15.0, Ubuntu 18.04 LTS

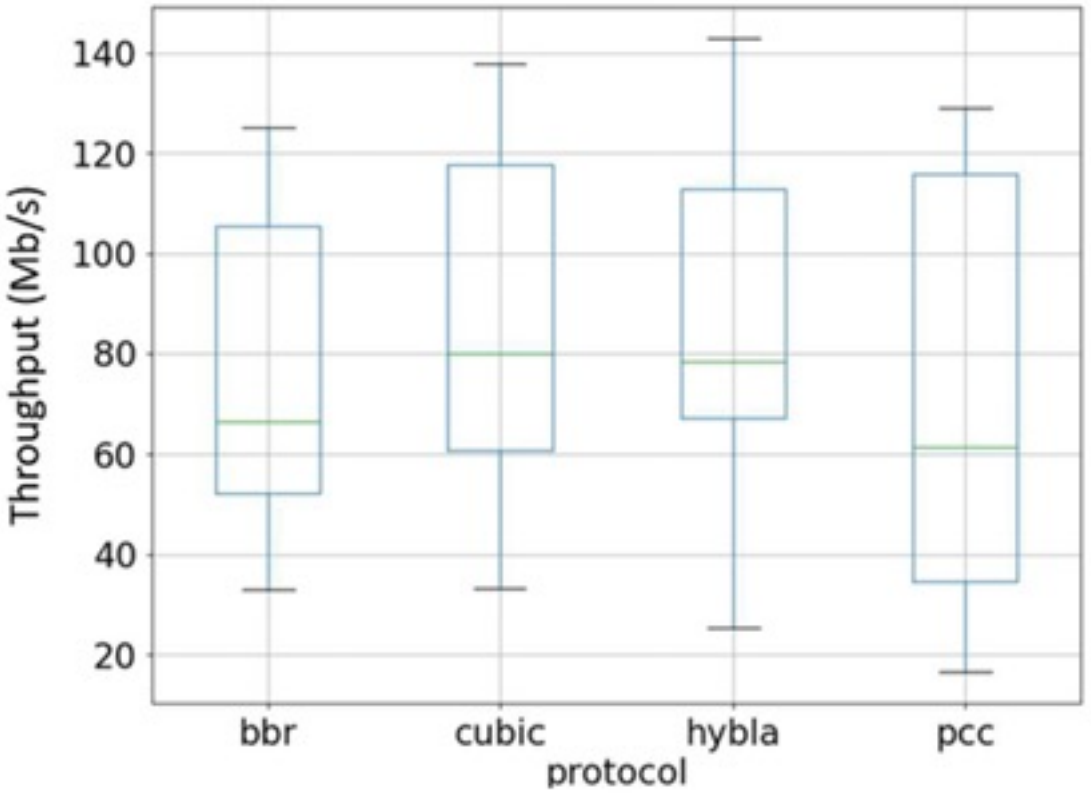
- iperf3 bulk downloading
  - 1 GByte bulk downloading
  - 40 iterations (PEP off and PEP on) with four servers.
  - 1 minute rest between each
- Whole test suite run a day, using only weekday results.

Total Tests: (PEP on, PEP off) * (4 Servers) * 40 Iterations

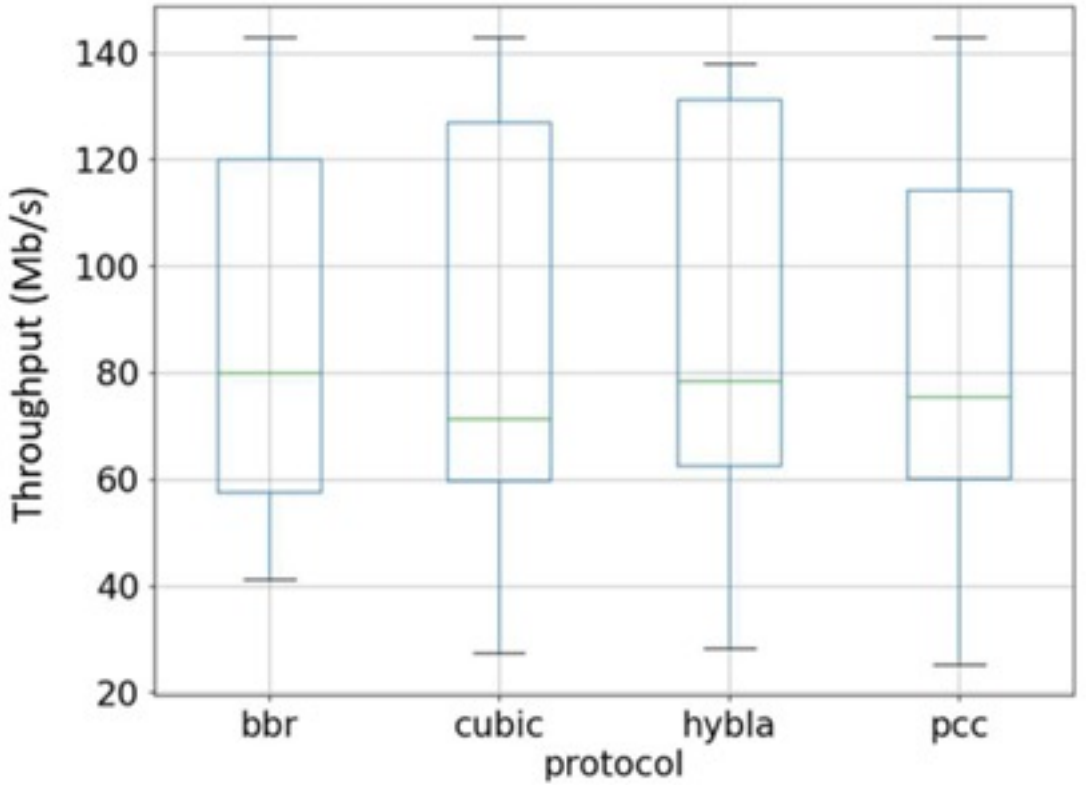
Outline

- Introduction (done)
- Methodology (done)
- Results
  - Steady State
  - Start-up
- Conclusions

Steady State

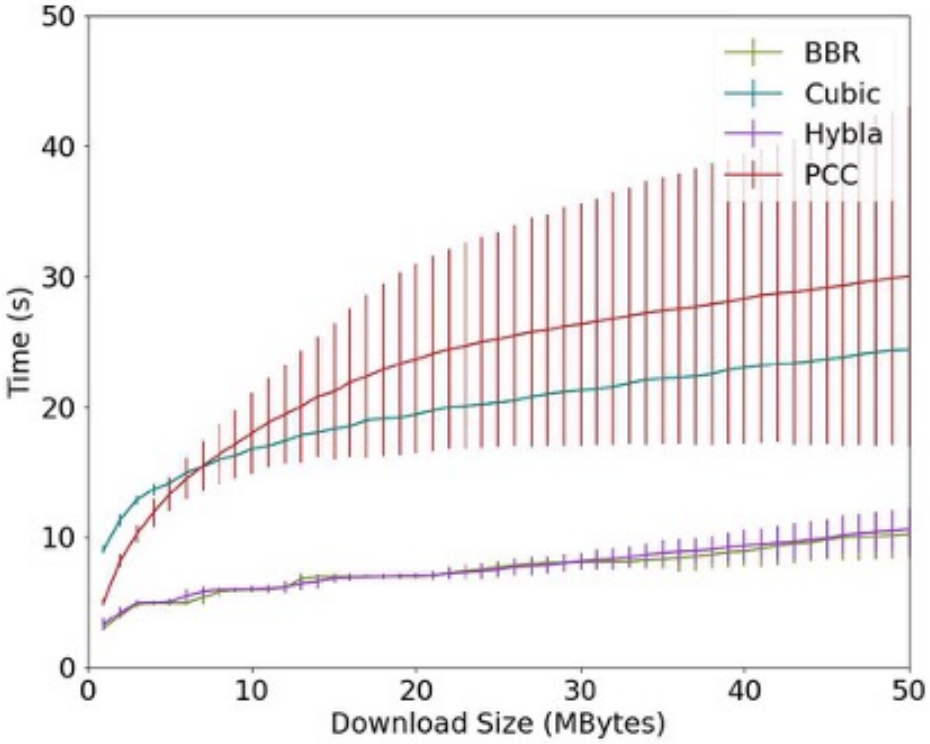


(a) Performance enhancing proxy off.



(b) Performance enhancing proxy on.

Slow Start



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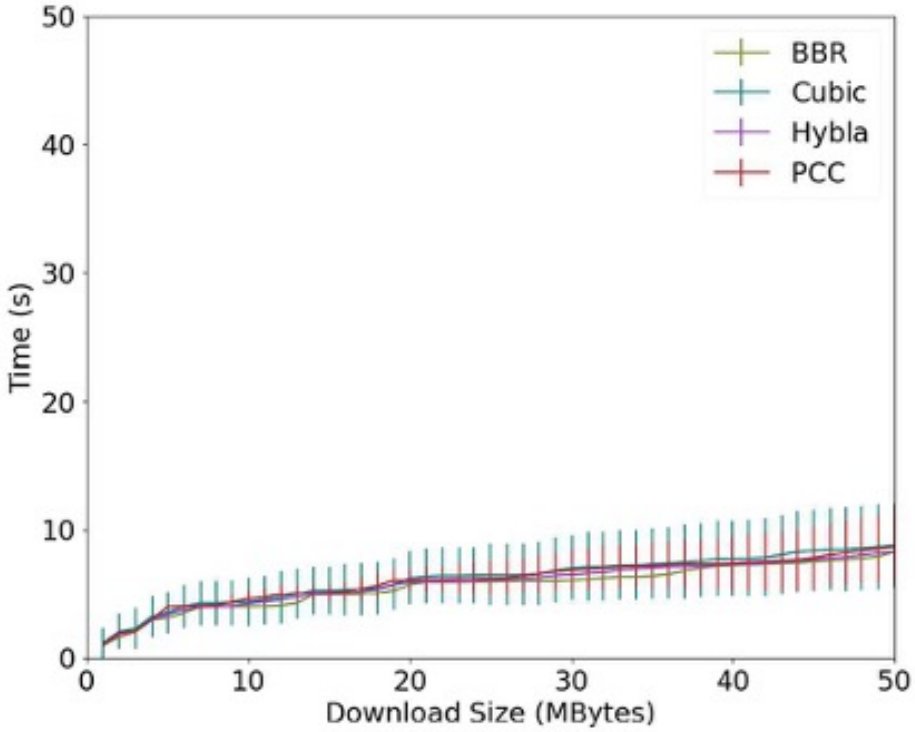

(b) Performance enhancing proxy on.

Comparison with Related Work

TABLE II: Performance Comparison Summary

Paper	Capacity	RTT	Gain	Notes
		PEP Comparison		
		PEP on vs. PEP off		
Ehsan et al. [14]	24 Mb/s	500 ms	**0.75x**	Satellite
Xu et al. [27]	1 Mb/s	200 ms	**2x**	Mobile
Ours	140 Mb/s	600 ms	**3x**	Gain depends on protocol

[14] N. Ehsan, M. Liu, and R. Ragland, "Evaluation of Performance Enhancing Proxies in Internet over Satellite," 2003.
[27] X. Xu, Y. Jiang, T. Flach, E. Katz-Bassett, D. Choffnes, and R. Govindan, "Investigating Transparent Web Proxies in Cellular Networks," 2015.

- Attempt to compare with other previous work is difficult
  - Different network condition, CCA used etc.
- Choose *close* condition from related work
  - Around 600ms RTT, 140 Mb/s capacity, and bottleneck queue 2 X BDP
  - Comparing CCAs including CUBIC

Conclusions & More…

- Comparing CUBIC/BBR/PCC/Hybla w/ and w/o PEP over production Satellite Network.
- PEP provides less benefits for flows in steady state.
- PEP provides large benefits for flows in slow-start.
  - CUBIC and PCC w/ PEP show 3 times faster than CUBIC w/o PEP.
- Improve TCP Slow Start behavior over large BDP links.
  - LEO(e.g. starlink) and GEO (WIP link)
  - mmWave links (5G)

Thank-you for your attention!

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Thank-you for your attention!

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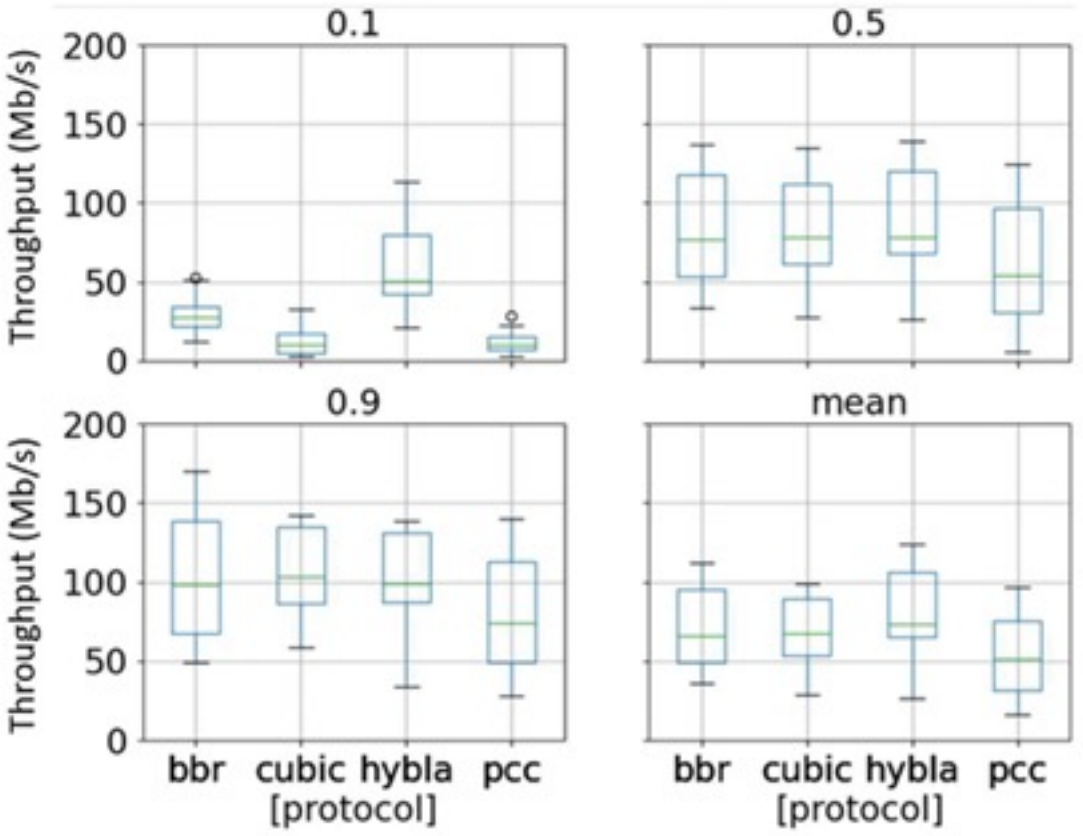
Overall Results



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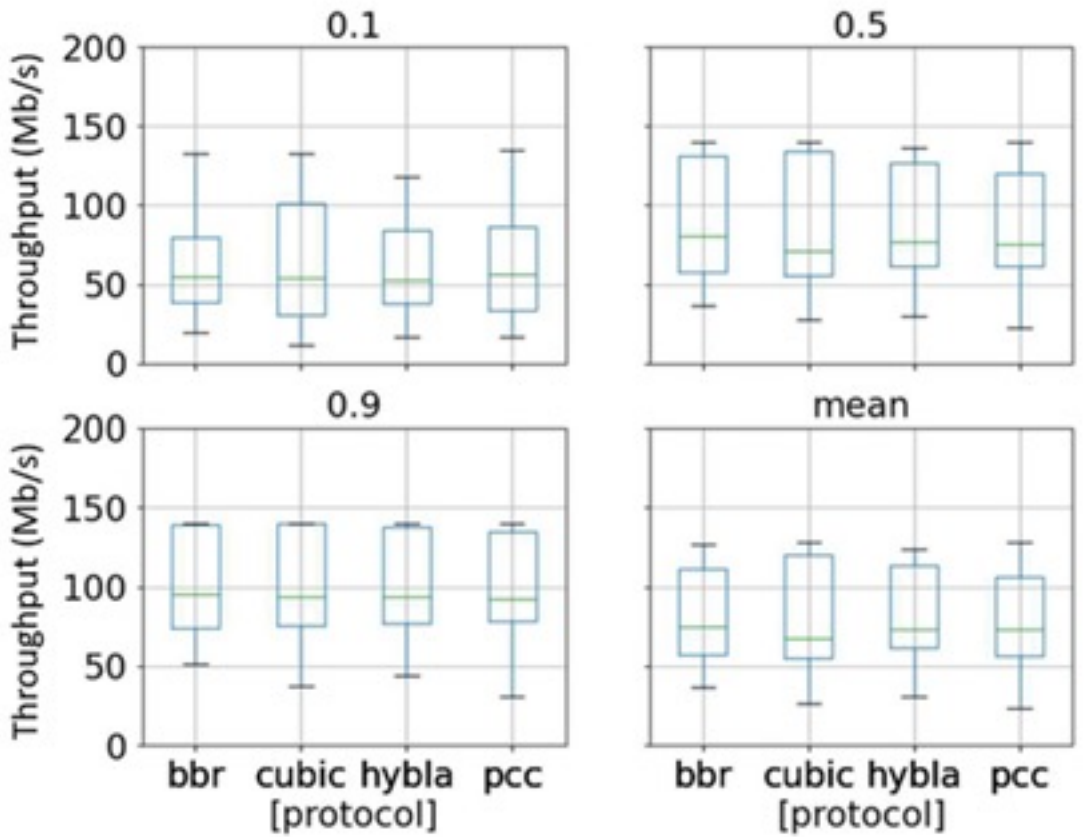

(b) Performance enhancing proxy on.