MPTCP and BBR performance over Internet satellite paths

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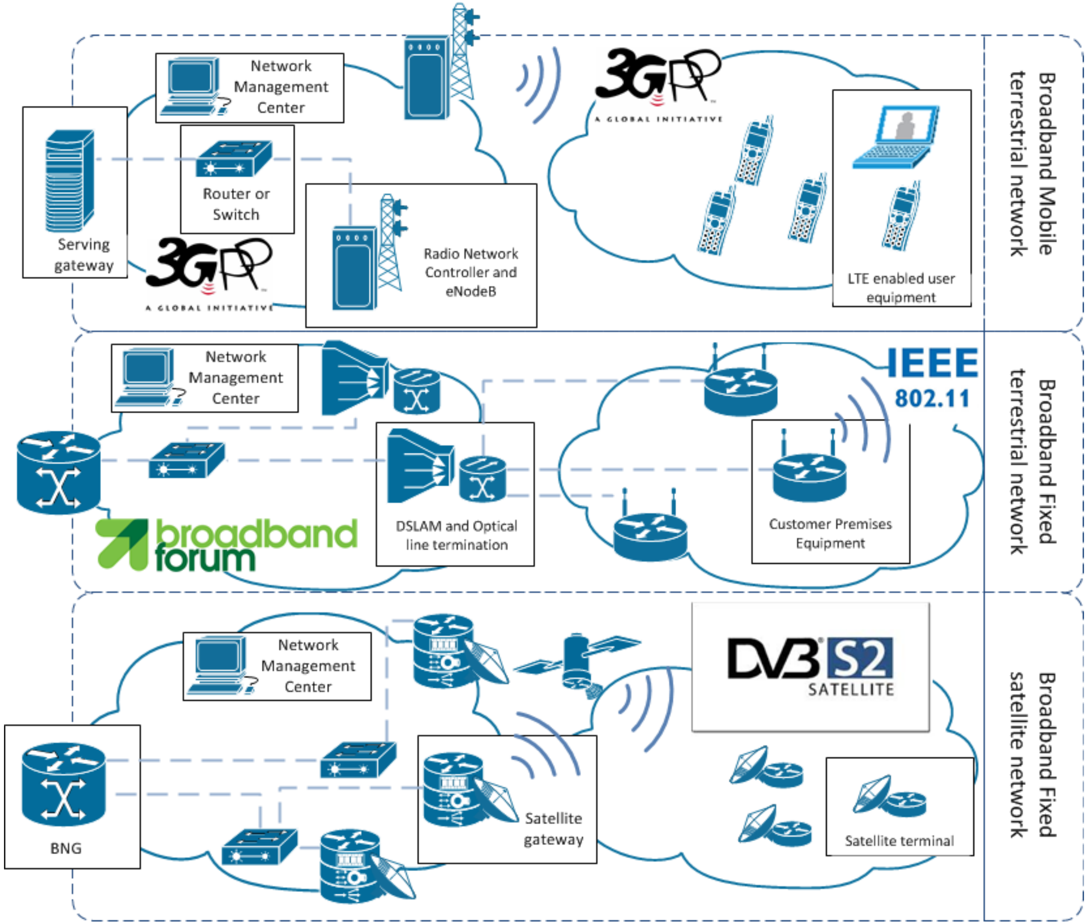
Myth #1: SATCOM systems are quite specific

Indeed:

- Limited frequency resource (regulation, etc.)
- Dish alignment
- No standards for network infrastructure (lack of interoperability)

BUT:

- High level architecture similar to other access networks



Myth #2: Latency is huge with SATCOM access

Indeed:

- For geostationary accesses, there is an important propagation delay (RTT of 500ms)

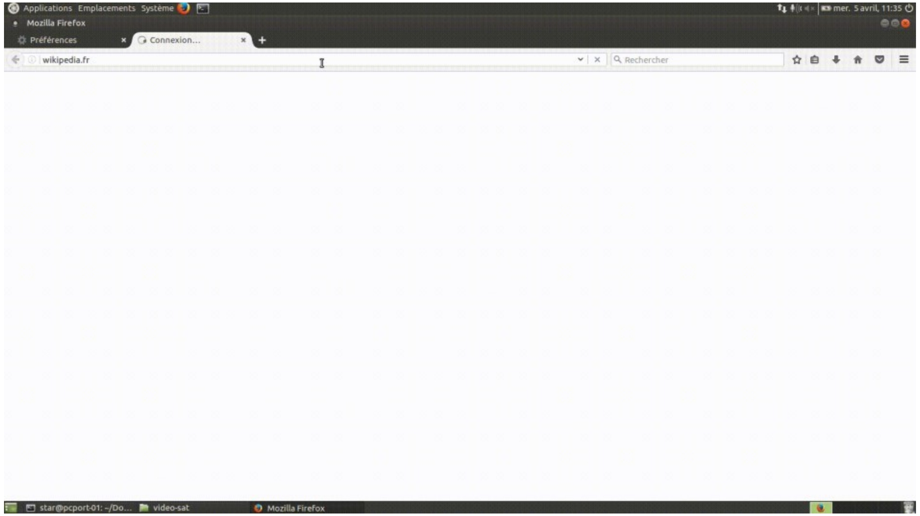
BUT:

- End-to-end latency is not *just* about signal propagation delay
  - See RITE FP7 survey on the sources of latency and its reduction [1]
  - See the Bufferbloat issue in cellular network
- For some cases (boat, planes, rural areas), there may not be alternatives
  - (honestly) it is not that bad

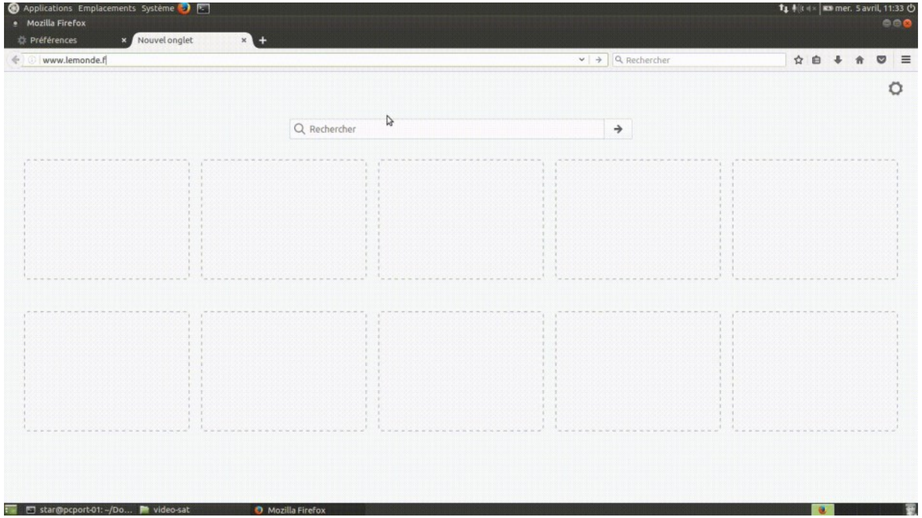
[1] B. Briscoe; A. Brunstrom; A. Petlund; D. Hayes; D. Ros; I. J. Tsang; S. Gjessing; G. Fairhurst; C. Griwodz; M. Welzl, "Reducing Internet Latency: A Survey of Techniques and their Merits," in IEEE Communications Surveys & Tutorials

Myth #2: Latency is huge with SATCOM access

Light page – Wikipedia type



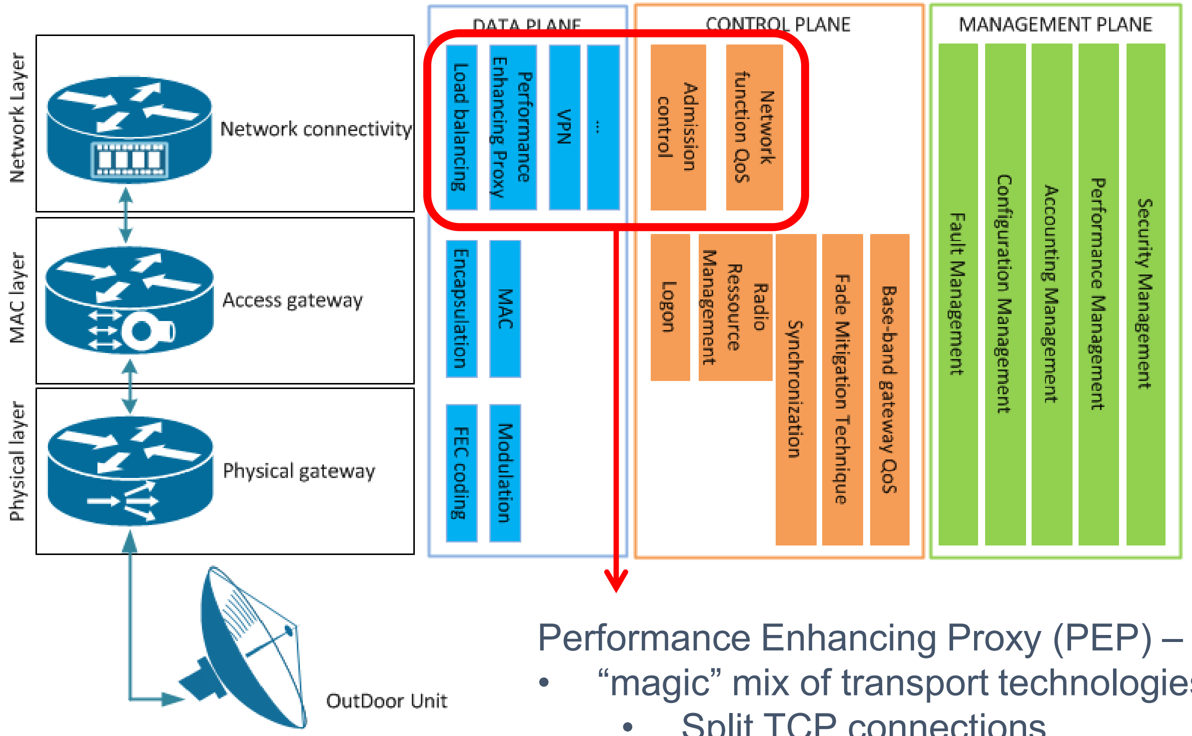
Heavy page – news media type



TOOWAY satellite Internet access :

- Solution furnished by ISP ALSATIS with EUTELSAT operator
- 20Mbps download / 6 Mbps upload

Not a Myth #3: SATCOM systems require 'middleboxes'



Performance Enhancing Proxy (PEP) – RFC 3135

- "magic" mix of transport technologies
  - Split TCP connections
  - Transparent compression
- No support of the most recent improvements at the servers or clients

Why do SATCOM systems introduce middleboxes?

1. Specific Satellite link characteristics (RFC 2488), subset* of the following:
   - Long feedback loop
   - Large delay / bandwidth product
   - Asymmetric use
   - Transmission errors
   - Variable RTT

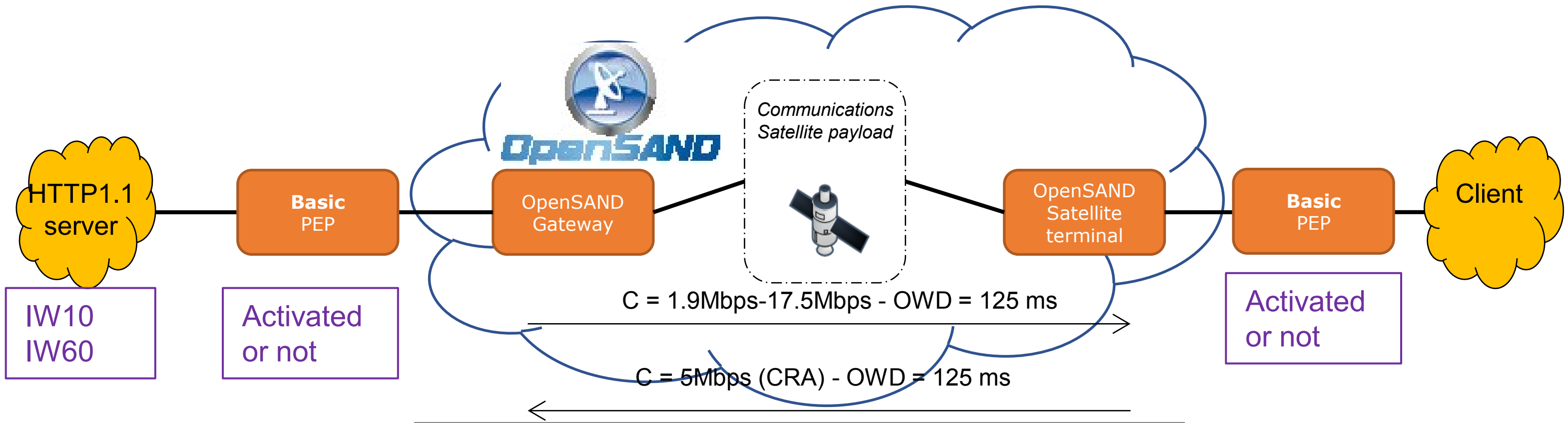
2. "Small" community making it hard to push specific modifications - such as those proposed in RFC 2760 – modifications may be:
   - Pushed in servers/clients if beneficial for "most" usage

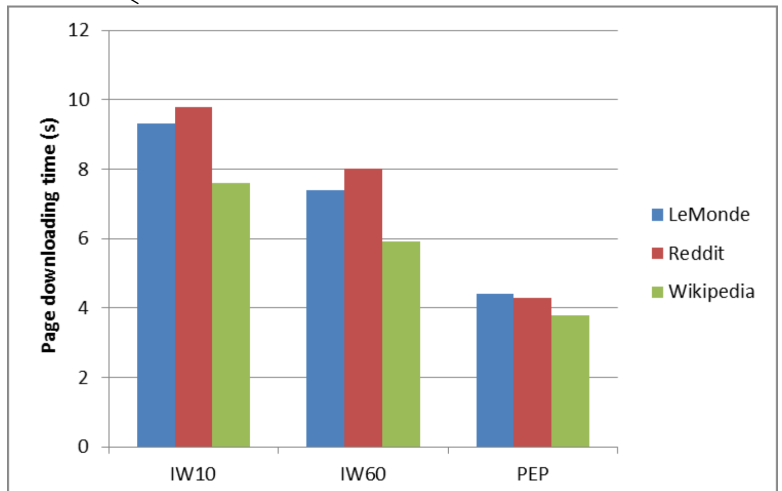
   AND/OR

   - Deployed in satellite-specific proxies
3. Optimize the "cost" of the satellite resource

* Satellite systems show huge variety (e.g. mega-constellation for a mobile access or geostationary fixed access) and so do the deployed satellite-specific proxies

Why do SATCOM systems introduce middleboxes?





Do SATCOM systems need middleboxes today?

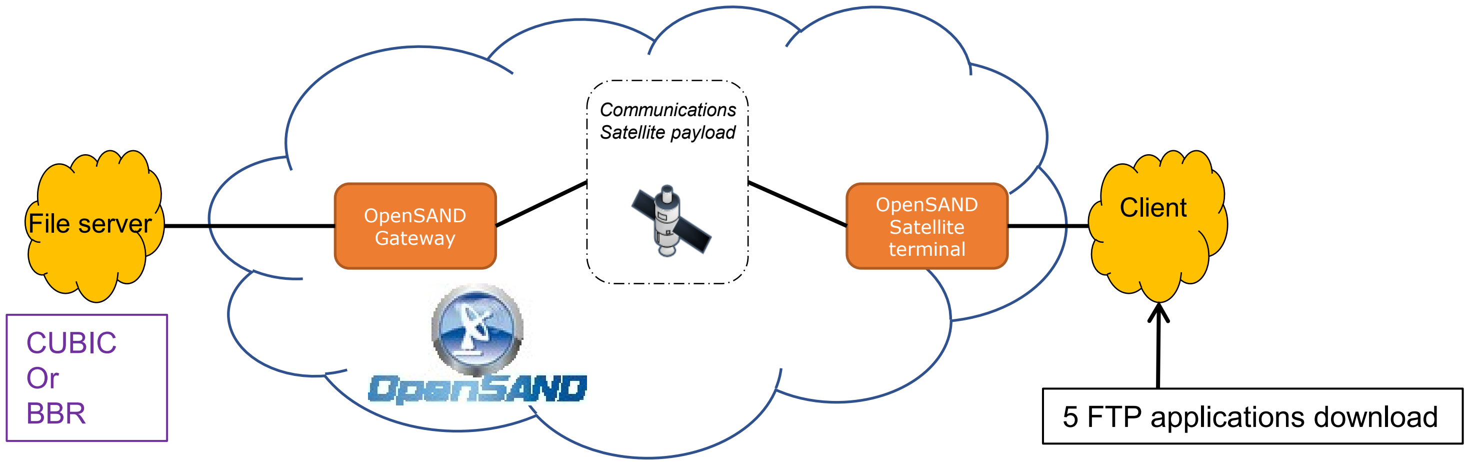
Recent transport-layer enhancements include some of RFC 2760 modifications

- Higher IW, packet pacing, …

To assess if SATCOM geostationary systems need middleboxes today:

- Assess BBR on SATCOM
- MPTCP as a middlebox: integration of SATCOM in terrestrial networks

Early results of BBR over SATCOM



Kernel version: 4.12
BBR version: v4

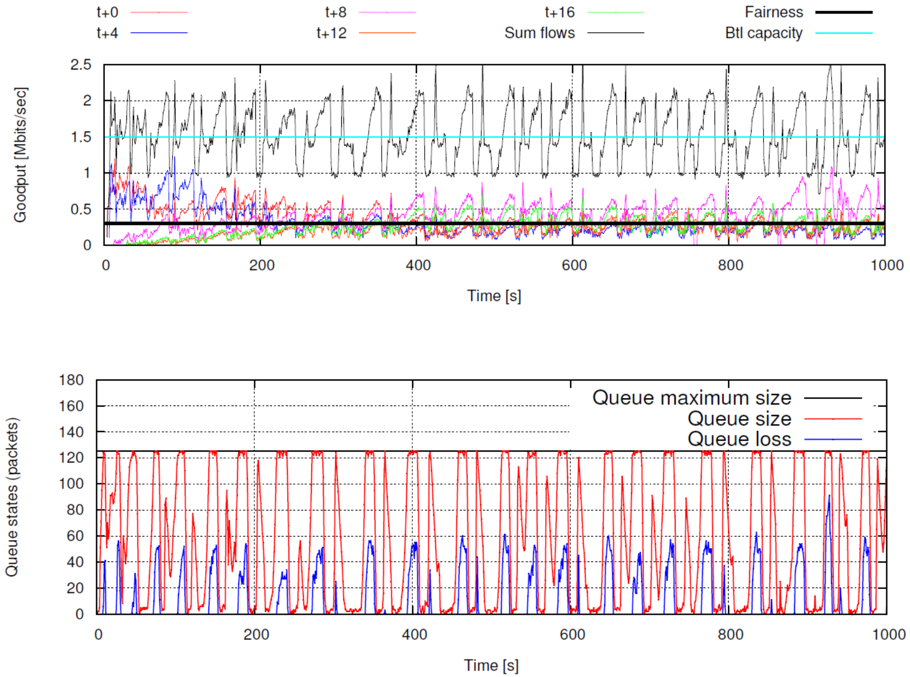
C = 1.5Mbps - OWD = 125 ms →

C = 100Kbps (CRA) + 5120 Kbps (RBDC) - OWD = 125 ms ←

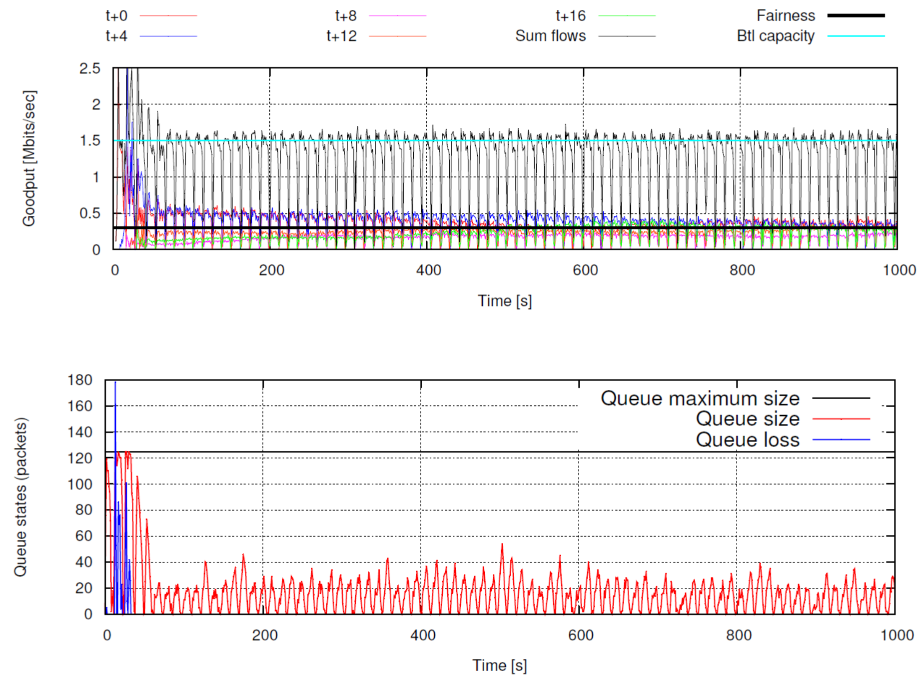
SMILE PROJECT. R&T CNES « New multimedia transport standards in a SATCOM context ». Guillaume Colombo, Cédric Baudoin, Fabrice Arnal, Renaud Sallantin, David Pradas, Gorry Fairhurst, Raffaello Secchi.

Early results of BBR over SATCOM

CUBIC

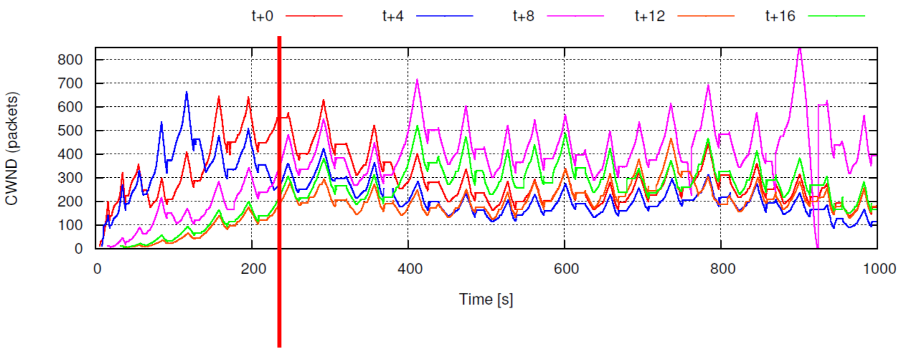


BBR

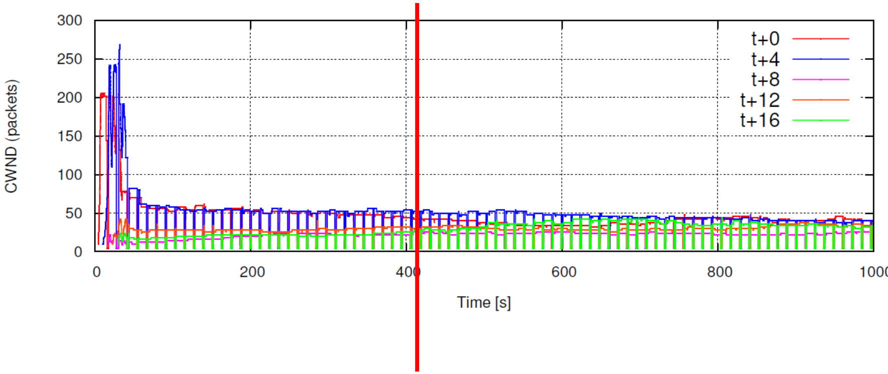


Early results of BBR over SATCOM

CUBIC



BBR

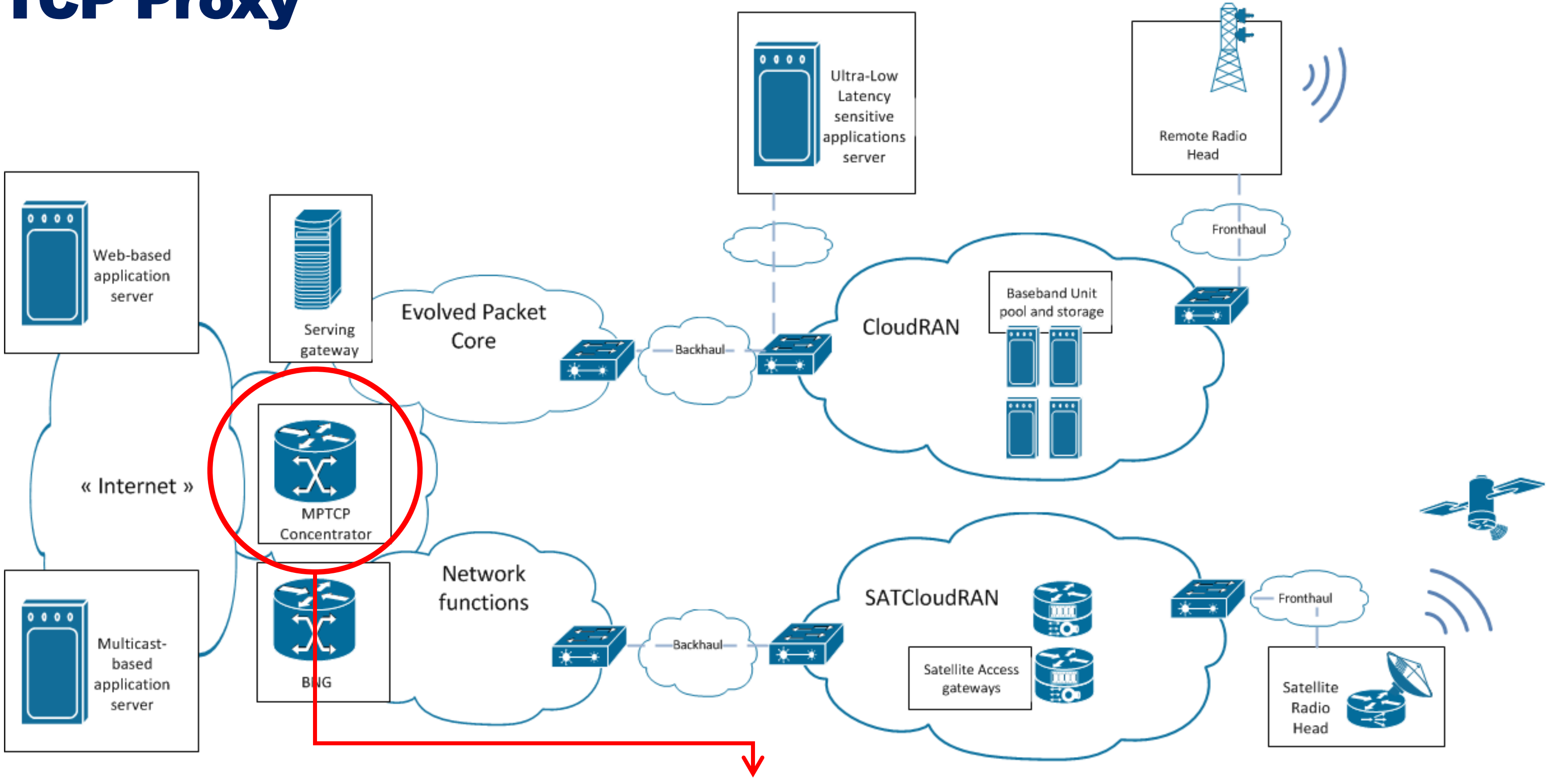


+ BBR exhibits low queue occupancy
+ BBR flows all together ‘match’ the available bottleneck capacity
- Late-comer fairness issue with BBR

≈ Difference between goodput of CUBIC and BBR over SATCOM link to be defined

➢ Further studies needed to assess the need for specific acceleration
  need to consider that all the traffic is not TCP BBR (yet?)

MPTCP Proxy

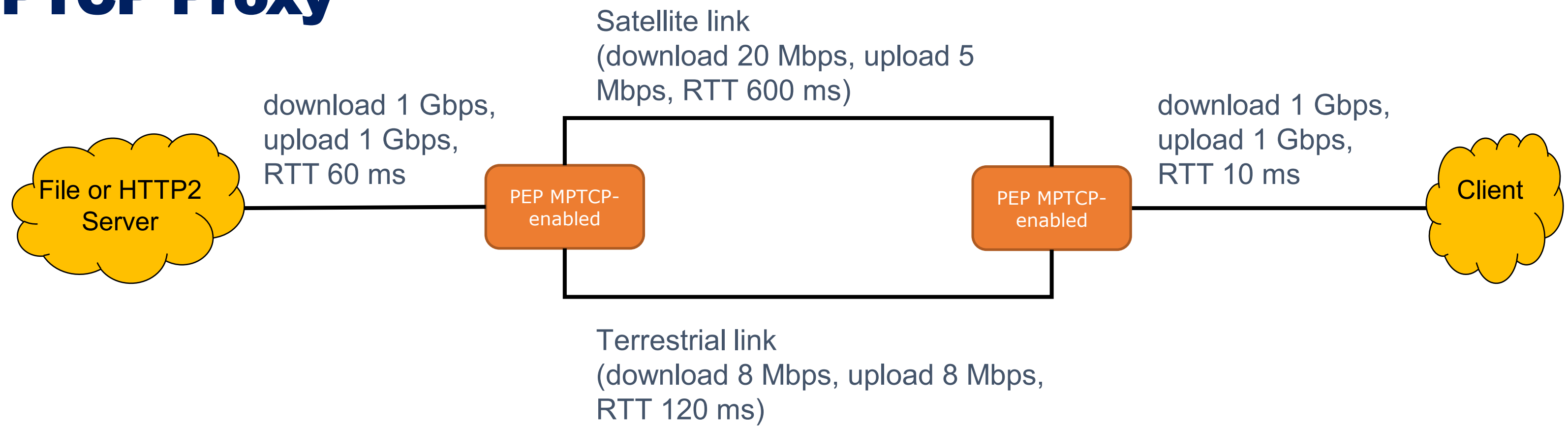


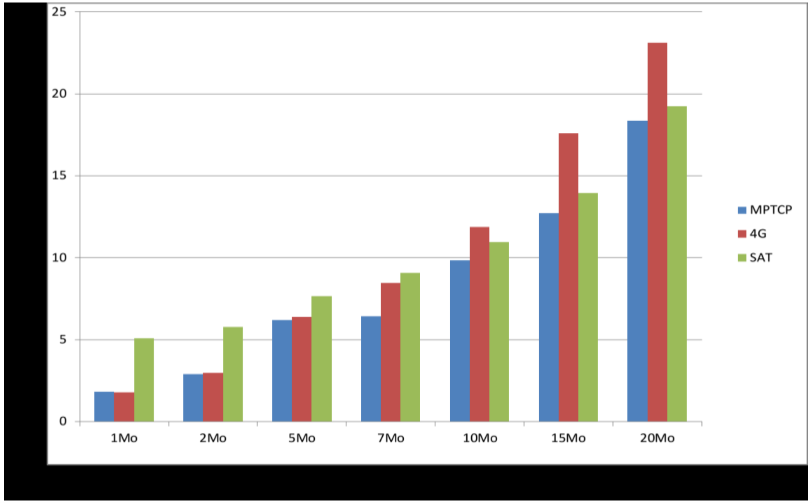
See "DHCP Options for Network-Assisted Multipath TCP (MPTCP)"

draft-boucadair-mptcp-dhc-08

R&T CNES « Load sharing and management ». Cédric Baudoin, Fabrice Arnal, Renaud Sallantin, David Pradas, Joaquín Muguerza, Emmanuel Chaput, Riadh Dhaou, Julien Fasson, Béatrice Paillassa

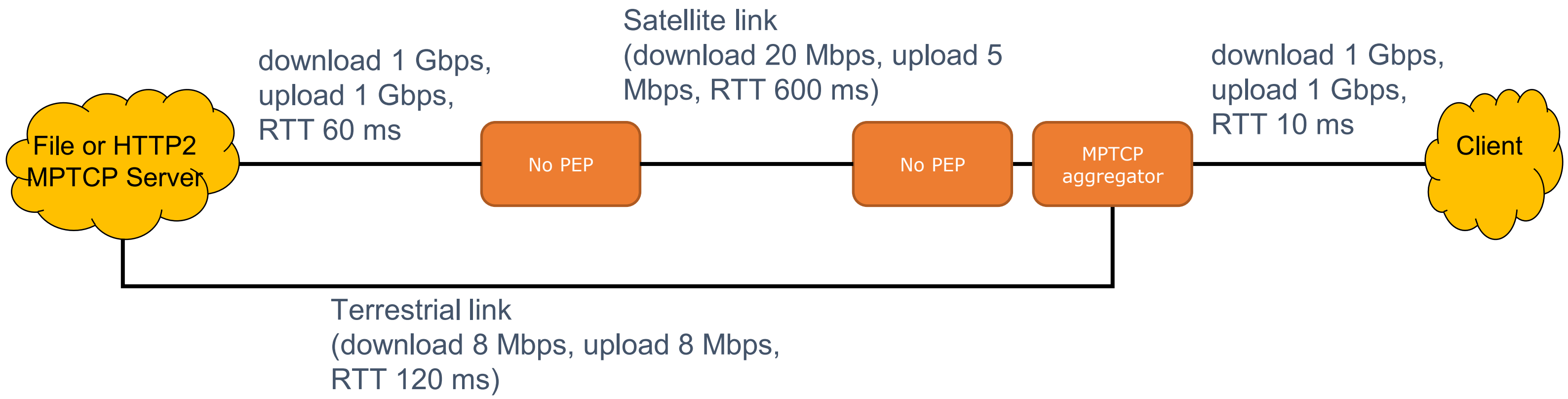
MPTCP Proxy

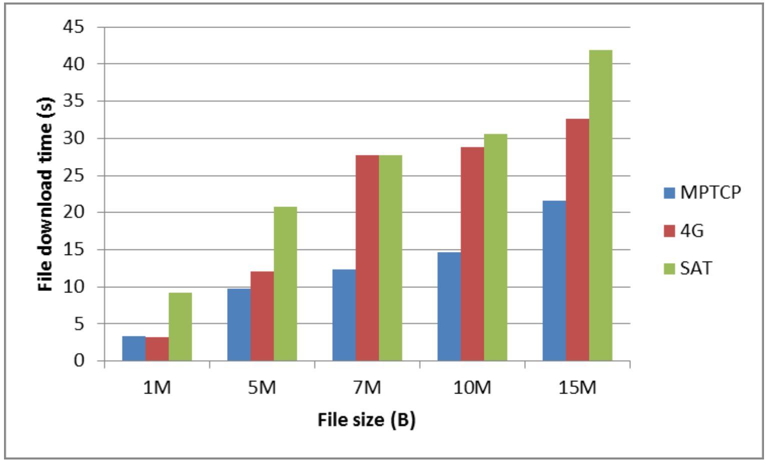




- Tests with a PEP MPTCP-enabled
- Despite the large asymmetry, MPTCP takes the best out of the cellular and SATCOM accesses (except for small files)

End-to-end MPTCP





- Results not directly comparable with previous ones (different traffic generation, no PEP)
- No PEP: not possible to accelerate MPTCP traffic (shared receive window)
- With MPTCP, despite the long completion time when the satellite link is not accelerated, the file downloading time is improved

Conclusion

Our tests on BBR showed:

- Interesting trade-off between link occupancy and queuing delay for SATCOM
- Some late-comer unfairness [1]
- The ‘need’ for satellite-specific proxies in this context has to be further assessed

MPTCP:

- MPTCP’s scheduler seems to manage important link asymmetry – could be further improved
- MPTCP proxy in core network ‘let us’ accelerate the traffic on satellite links – E2E MPTCP does not
- MPTCP proxy let us conjointly exploit available resource while MPTCP is not deployed at the servers

No transport-layer « silver bullet »:

- **“There will never be a conclusive victor to govern queue management and scheduling inside network hardware” [2]**
  - In the same way, specific TCP enhancement can better match the specificity of the wireless access
- **One « size fits them all » TCP can hardly be optimized for all specific wireless access**
  - E.g. RemyCC can be updated to achieve a specific goal but does not target all goals [3]

Side note:

- Any interest in updating RFC2760, conjointly with RFC 2488?

[1] Bob Briscoe. 2007. Flow rate fairness: dismantling a religion. SIGCOMM Comput. Commun. Rev. 37, 2 (March 2007), 63-74. DOI=http://dx.doi.org/10.1145/1232919.1232926
[2] Anirudh Sivaraman, Keith Winstein, Suvinay Subramanian, and Hari Balakrishnan. 2013. No silver bullet: extending SDN to the data plane. In Proceedings of the Twelfth ACM Workshop on Hot Topics in Networks (HotNets-XII). ACM, New York, NY, USA, Article 19, 7 pages. DOI: https://doi.org/10.1145/2535771.2535796
[3] Keith Winstein and Hari Balakrishnan. 2013. TCP ex machina: computer-generated congestion control. In Proceedings of the ACM SIGCOMM 2013 conference on SIGCOMM (SIGCOMM '13). ACM, New York, NY, USA, 123-134. DOI: http://dx.doi.org/10.1145/2486001.2486020

Acknowledgements

Contributors:

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Viveris

University of Aberdeen

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Tools:

- OpenBACH : open-source test orchestrator
  - http://www.openbach.org/content/home.php
- OpenSAND : open-source SATCOM emulator
  - http://opensand.org/content/home.php
- PEPSal : open-source PEP
- CESARS : CNES open plateforme for real satellite experiments
  - https://entreprises.cnes.fr/fr/accueil-cesars

Questions ?