

Study on NR Enhancements for TCP Motivation

RP-181128

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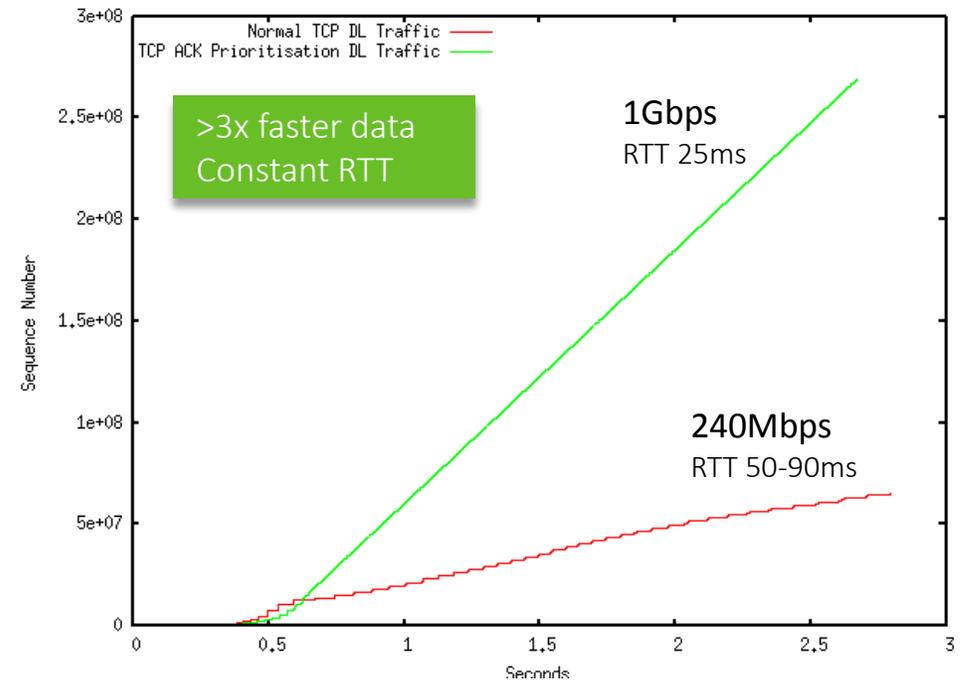
Background

- TCP
 - Pre-eminent internet transport protocol
 - Known performance bottlenecks
- Opportunity to provide a 3GPP-based solution to facilitate implementation and fully unleash NR data rates

Motivation 1: TCP ACK prioritization

- Scenario: UEs with bidirectional TCP data flows
 - UL TCP segments carrying “piggybacked” TCP ACKs are interspersed with TCP segments that carry only data
 - The resulting head-of-line blocking can delay TCP ACKs resulting in slower TCP connections
- Potential solutions
 - “Marking” of TCP segments carrying ACKs [R2-1700191](#)
 - Splitting TCP ACKs onto RLC UM bearers [R2-163775](#)
 - Using PDCP control PDUs to carry TCP ACKs [R2-1700287](#)

- Simulation assumptions
 - TCP NewReno, 1Gbps DL, 500Mbps UL, no mobility, AM bearer, IPv4, Fast ReTx

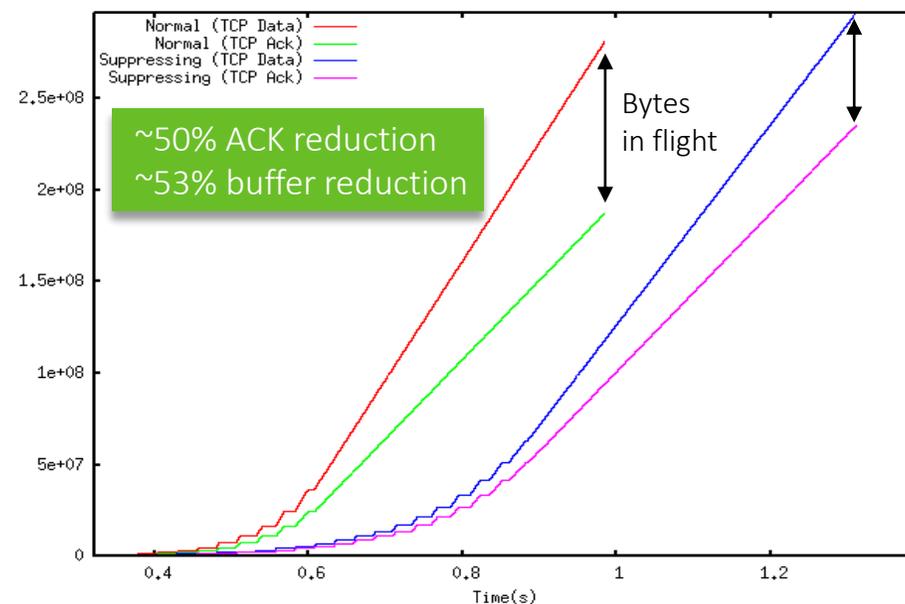


Motivation 2: Tackle excessive ACK Generation

- Scenario: High data rate DL TCP flow
 - High TCP ACK data rate to support high DL TCP data rate
 - TCP ACKs are cumulative: not all TCP ACKs are essential
 - TCP is clocked by ACKs: ACK suppression to be done carefully
- Potential solution
 - Careful TCP ACK suppression
 - [R2-163775](#) & [R2-1703311](#)

- Simulation assumptions
 - TCP NewReno, 5Gbps DL, no UL data, no mobility, AM bearer, IPv4

DL Simulation Tests		UL ACK data rate
1	Normal TCP ACK	62.2Mbps
2	Suppressing TCP ACK (FIFO)	33Mbps



Motivation 3: Tackle blocking at high frequencies

- Scenario: TCP in mmWave spectrum
 - High sensitivity to blockage by buildings, vehicles, and human movement
 - Frequent and unpredictable blockage harms TCP performance
 - TCP performance is very sensitive to the duration of interruption [R2-1703524](#)
- Potential solutions
 - UE-based autonomous switching to minimize packet loss

- Simulation assumptions

- TCP Cubic, 38 GHz carrier freq., 8Tx and 4Rx antennas, minimum RTO = 200ms

Blockage model	TCP Throughput	TCP Degradation
No blocking	807Mbps	0%
0.1s blocking every 5s	712Mbps	12%
0.2s blocking every 5s	371Mbps	54%
1s blocking every 5s	229Mbps	72%

NOTE: TCP performance ~holds with blockage shorter than 100ms.
Longer interruptions lead to severe degradation (TCP congestion control algorithms e.g. RTO timeout or congestion avoidance)

Proposal: Study

- Proposed components
 - Identify a common system model, scenarios of interest, and metrics to evaluate TCP performance
 - Open to consider promising non-TCP transport protocols like QUIC
 - Quantitative evaluation of RAN enhancements for TCP (including combinations of proposals) and down-selection of promising candidates
 - Identify impact on RAN2 specs including user plane and control plane aspects
- Lead: RAN2

Thanks!