



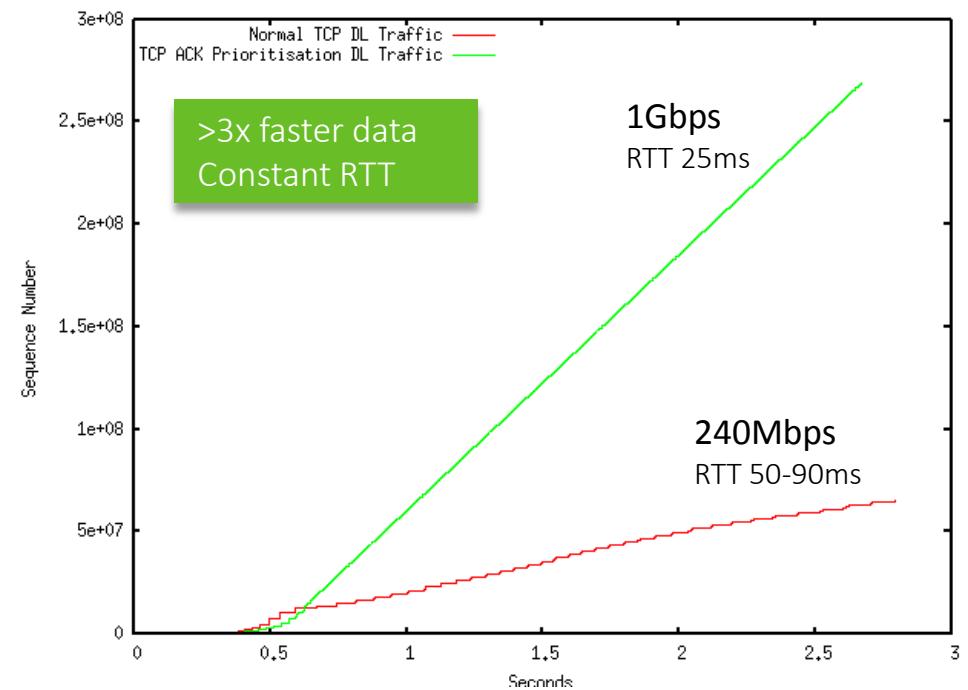
# Higher layer protocol enhancements

RP-190464

3GPP RAN#83, Shenzhen, 18-21 March 2019

# Motivation 1: 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  
[R2-163775](#)
- Simulation assumptions
  - TCP NewReno, 1Gbps DL, 500Mbps UL, no mobility, AM bearer, IPv4, Fast ReTx

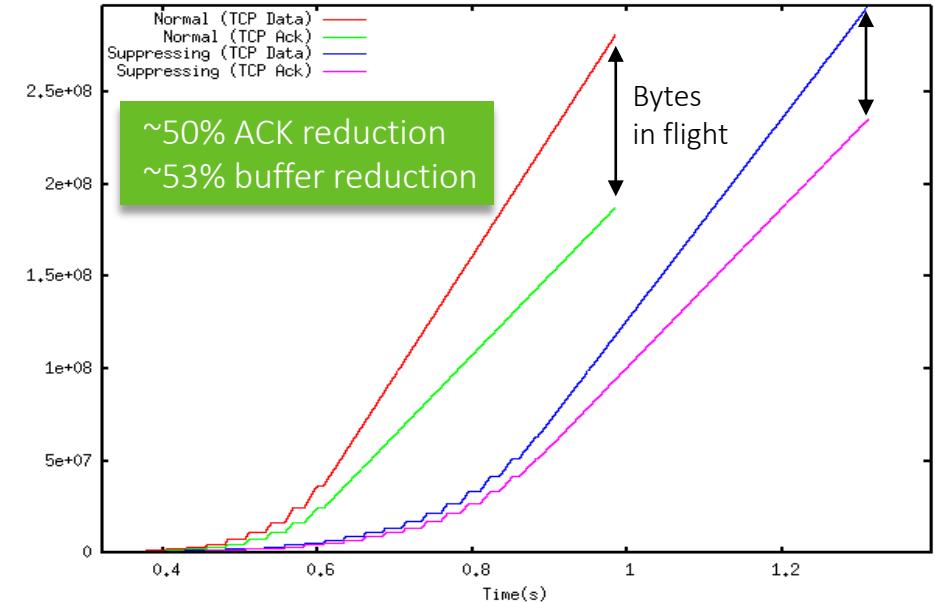


# Motivation 2: Tackle excessive ACK Generation

- 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 performance of higher layer protocols (e.g. TCP)
  - Quantitative evaluation of RAN enhancements and down-selection of candidates
  - Identify impact on RAN2 specs including user plane and control plane aspects
- Lead: RAN2

# Thanks!