ERICSSON

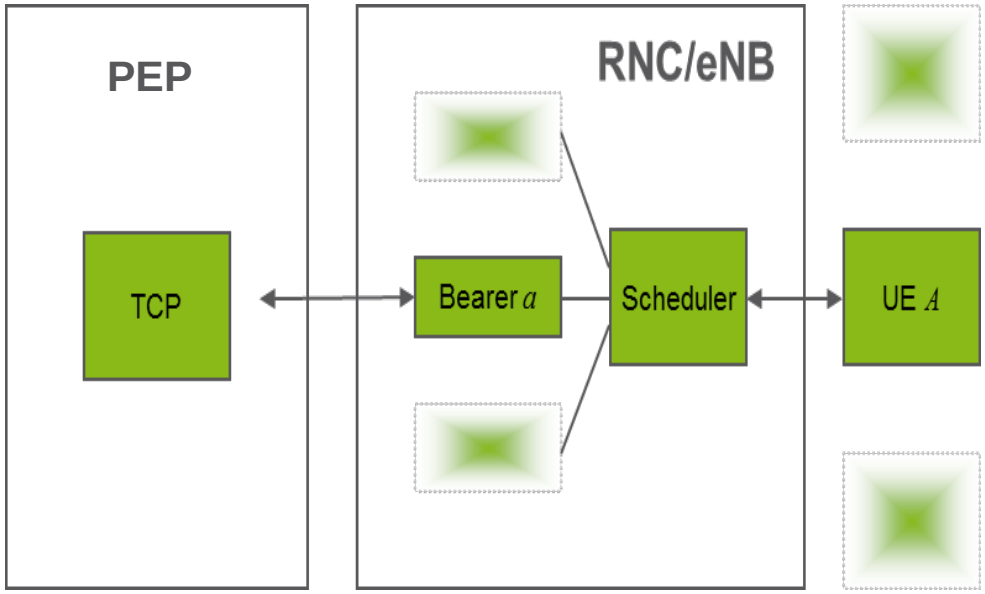
OPTIMIZING TCP FOR RADIO

RAN CHARACTERISTICS

- Congestion
  - Increasing number of users and/or increasing traffic in a cell
  - Lower possibility of overprovisioning than in fixed networks
- Reduced signal strength
  - when the device moves towards the edge of the cell, the Signal to Interference plus Noise Ratio (SINR) decreases
- Handovers
  - Between cells
  - Between radio technologies
- Varying channel conditions mean that it makes sense to wait.

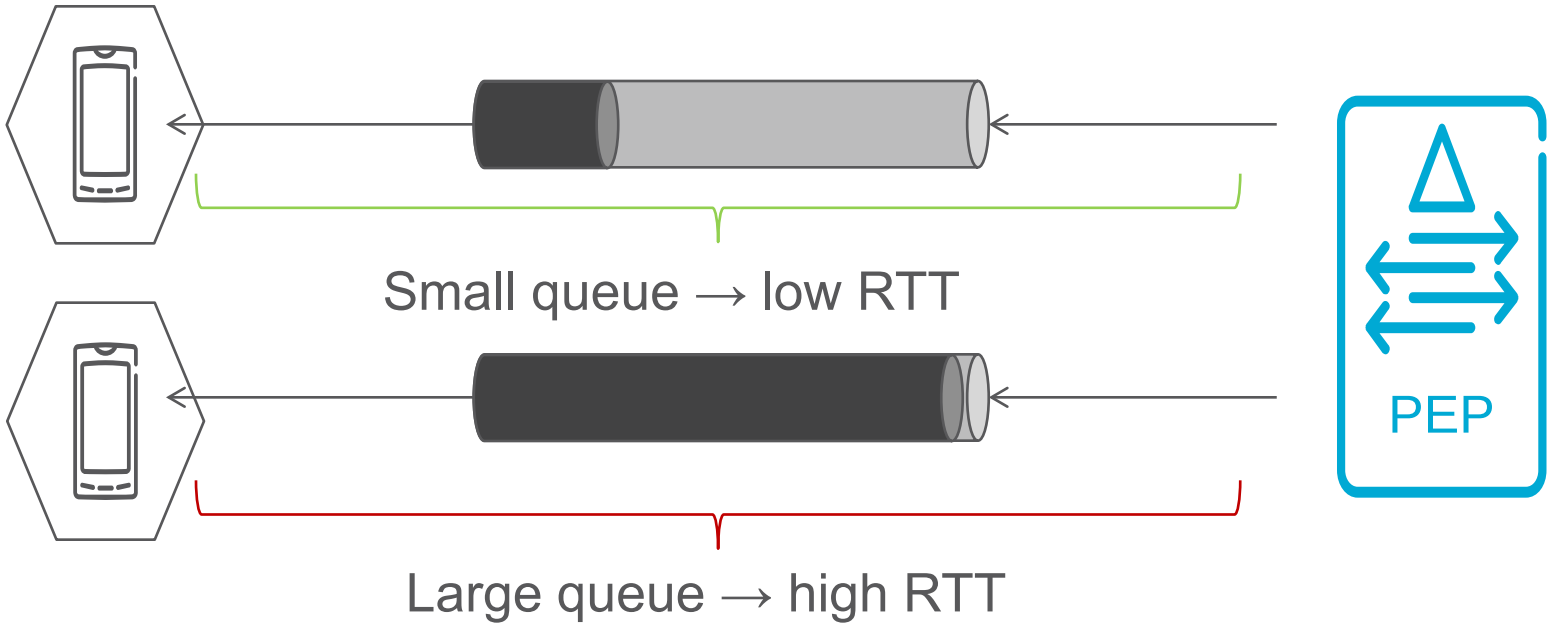
RAN TRANSPORT REQUIREMENTS

- Keep the RNC/eNB scheduler queues non-empty.
  - Unnecessarily empty buffers may reduce throughput.
- Keep the scheduler queues short.
  - Bloated buffers decrease responsiveness, increase waste when flows are abandoned and add delay to handovers.
- Balance flow rates to optimise user experience.
  - Higher throughputs for interactive flows than for background flows.



THEORY AND MODELS

- ↑Users in a cell → ↓Individual capacity per user → ↑Queues in RNC/eNB
- ↑Distance from a base station→↓Signal Strength →↑Queues in RNC/eNB
- ↑Queue length →↑ RTT per individual flow



TCP TRANSMISSION RATE

- TCP is designed to ”fill the pipe”.
  - Filled pipe → packet drops → TCP reduces transmission rate
- TCP losses are ”feared” by router designers
  - Modern equipment often comes with large buffers – including RNC/eNB
- TCP fills those buffers with packets.
  - Buffer bloat problematic for new or interrupted flows and handovers.

TCP OPTIMIZATION

- TCP optimization helps to mitigate congestion by protecting the network from aggressive traffic.
- During low to medium cell load, it is in general beneficial to push data fast.
- But when there are limitations in the radio network, aggressive TCP behavior can fill the buffers, provoke large loss rates and make TCP slow down considerably.
- End user pays for retransmitted data.

RADIO OPTIMIZED HYBRID CCA

- Treats both packet loss and increased RTT as congestion signal
- Separate back-off factors for loss and increased latency
- Sensitivity to RTT increase and back-off factors configurable per flow
- Configurable ICW

SINGLE POINT OF CONTROL

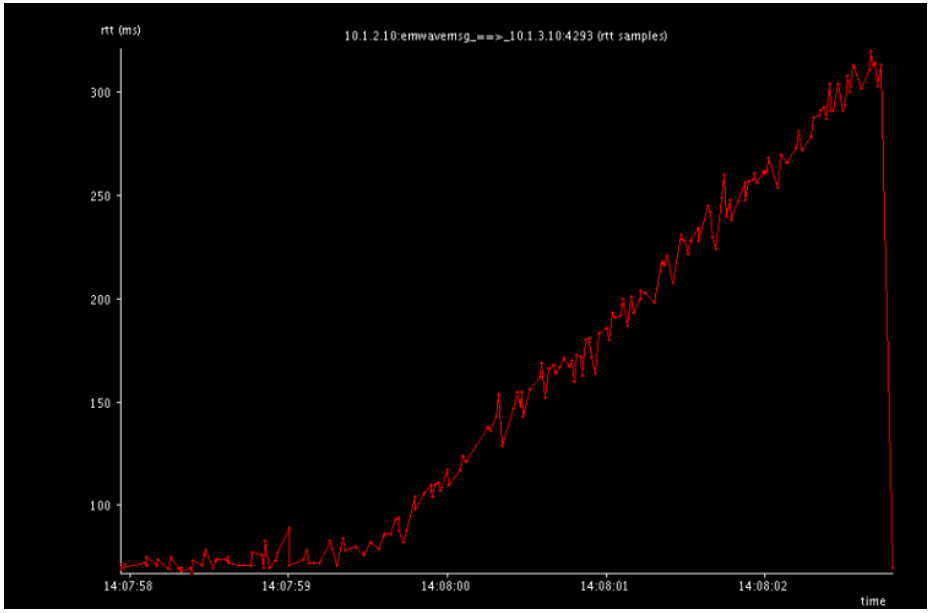
- Hybrid or delay sensitive algorithms typically yield to pure loss based flows.
- A single point of in the operator network that performs congestion control can ensure that overall fairness between flows.
- Initial window size can be auto-tuned based on knowledge about current conditions for specific user. TCP needs less time to probe the network.

- Simple to deploy

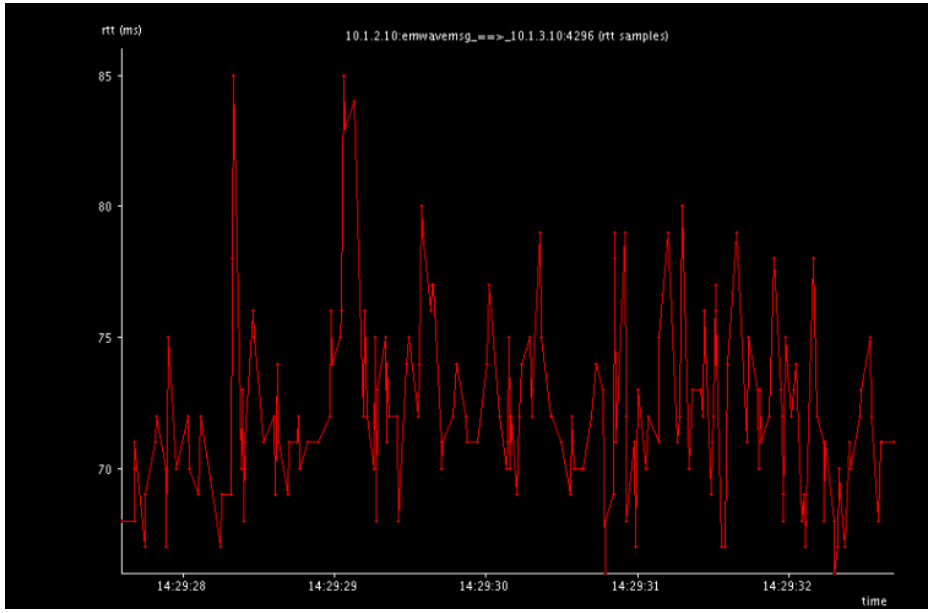
CCA EFFECTS ON RTT

Artificial example without proper AQM

New Reno



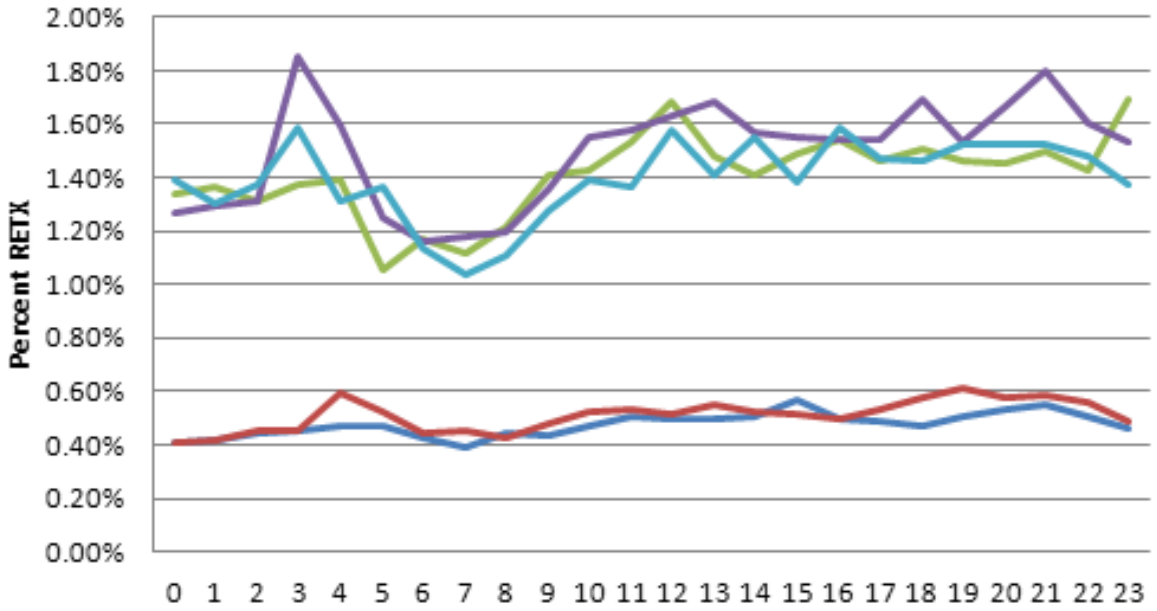
Ericsson Hybrid CCA



Note different scales!

LIVE DATA - RETRANSMISSIONS

Data collected at large site of Tier 1 operator in emerging market. Up to 70% reduction of retransmissions after introducing new CCA.



DYNAMIC ICW – RESULTS

Well dimensioned LTE network, European Operator.

Measurements on page load times for most popular sites in the country

Page load times reduced by 5 - 15% by using dynamic ICW.

RELATION TO ENCRYPTION & WAY FORWARD

- Current best practice is to deploy a “transparent” proxy outside the packet gateway.
- Transport protocols are being encrypted basically bypassing the PEP in its current form.
- Can we make a PEP explicit, how would we go on doing that?
  - Reverse proxy, origin consent?
  - Forward proxy, client consent?
- A PEP is deployed within an operator domain, thus simplifying the trust relationship, potentially allowing richer signaling.

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