Effect of no-LBT NB on 802.11 devices – Part 2

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Overview

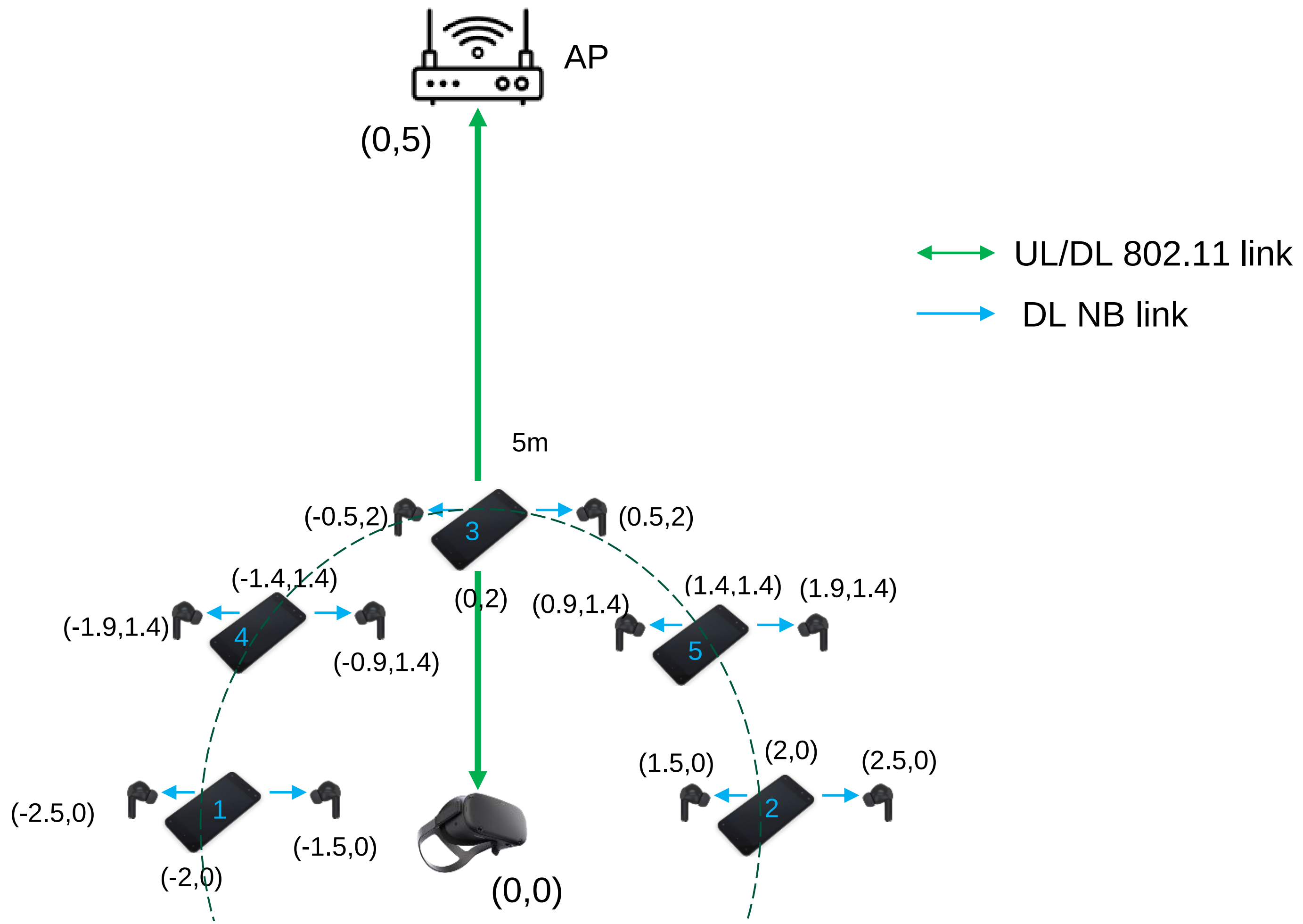
This work expands the work previously presented in 11-23/1259r1.

- In that work, we looked at the effect of a fixed duty cycle from a single NB pair of devices, affecting only the primary 20 MHz channel, on a 802.11 XR link with the following 802.11 traffic:100 Mbps DL @72 Hz and 3 Mbps UL @ 500 Hz

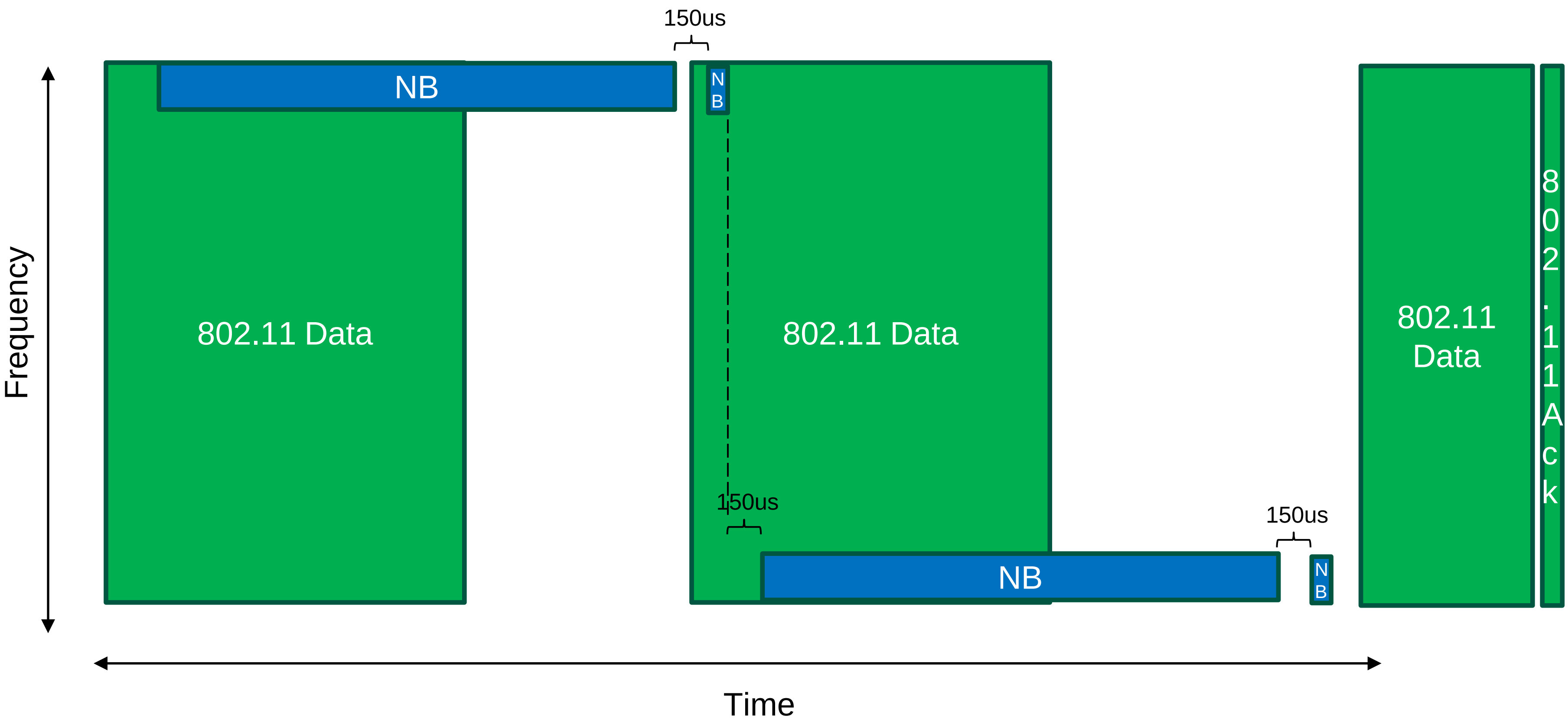
We now look at realistic frequency hopping NB traffic profile, with variable duty cycle, with different users streaming music @ 96 kbps to 2 earbuds and explore the effect of multiple NB sets of devices for different 802.11 channel utilizations.

- The AP is 5m away from the XR headset and the interfering users are 2m away from the XR headset.

Simulation Scenario

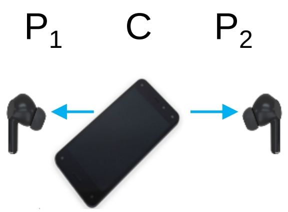


Example of 100% freq overlap



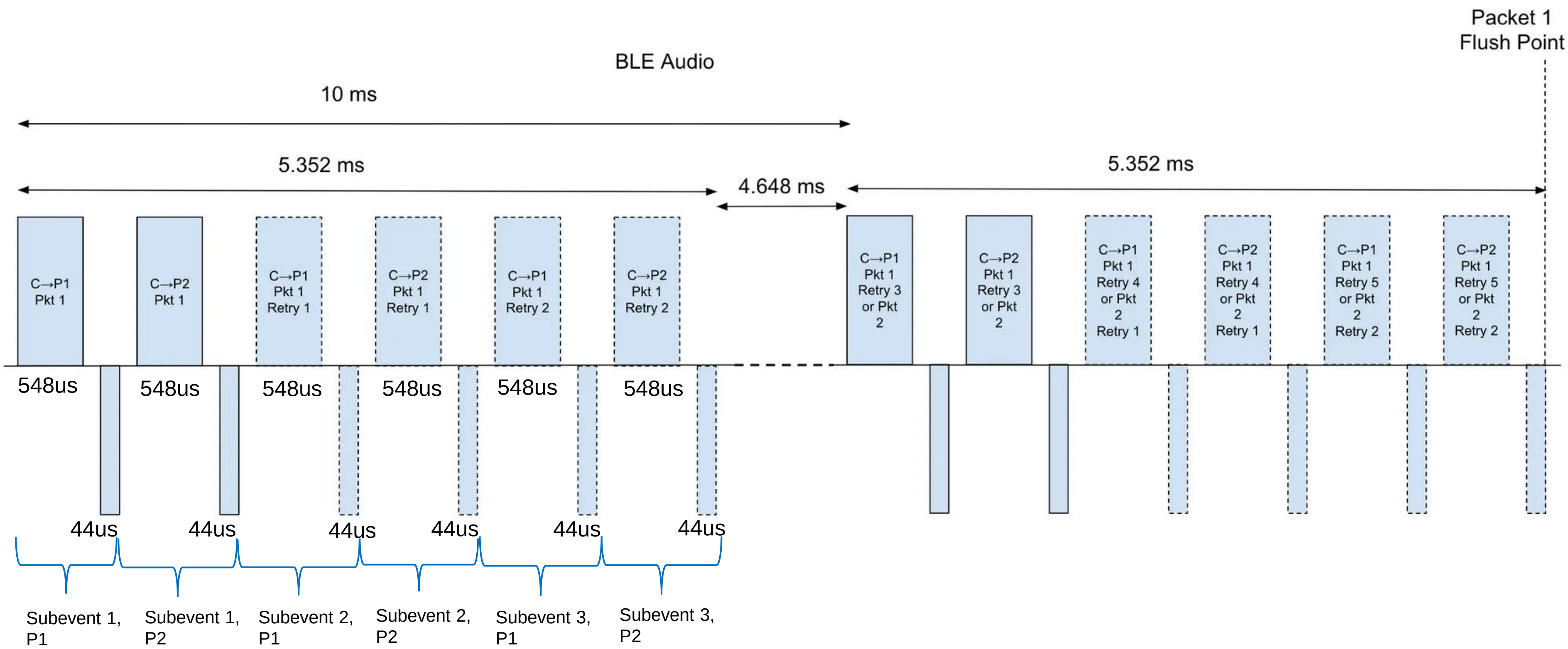
Assumptions

- 802.11
  - 14 dBm at both AP and STA
  - XR Traffic : 100 Mbps DL @72 Hz and 3 Mbps UL @ 500 Hz
  - BW=80 MHz, Nss=2
  - Traffic type : UDP, AC_BE
  - 0.8s GI, 2x HE-LTF, RTS/CTS on
  - BAwin = 256
- NB
  - BLE Audio Traffic (96 kbps DL, Number of SubEvents=3, Flush Timeout=2)
    - 1 main TX + 5 retry opportunities
    - ~5.92 * (1+retry) % Duty Cycle (DC) for each peripheral
  - 14 dBm at both Central and Peripheral
  - Each central, denoted by C transmits to 2 peripherals, denoted by P1 and P2
  - 2 MHz BW (40 channels) with 100% overlap with 802.11
  - 2 Mbps PHY
  - -75 dBm/MHz Max ED Threshold value
- 802.11 AWGN Channel model with dbp=5, fc = 6.425 GHz



Retry	0	1	2	3	4	5
DC per P	5.9	11.8	17.8	23.7	29.6	35.5

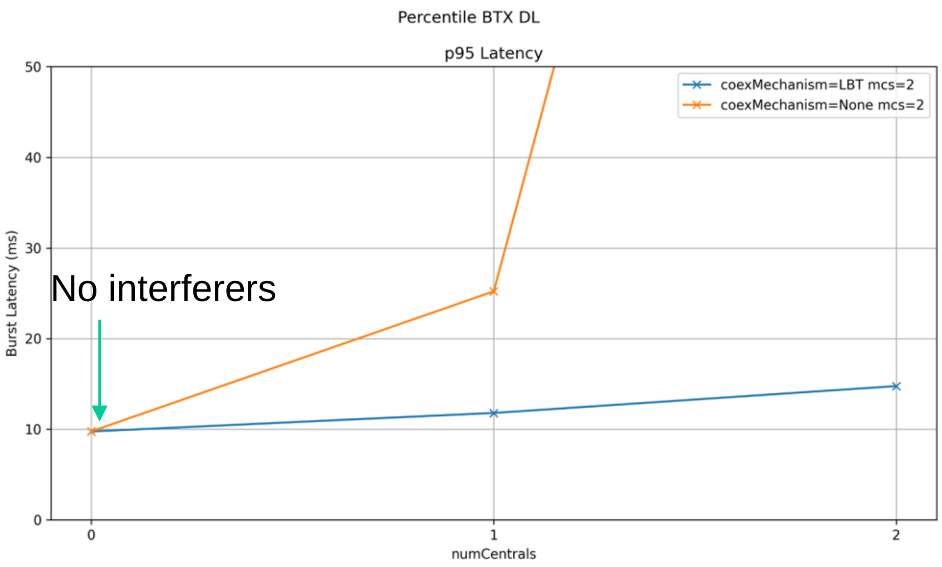
Bluetooth Timing Details

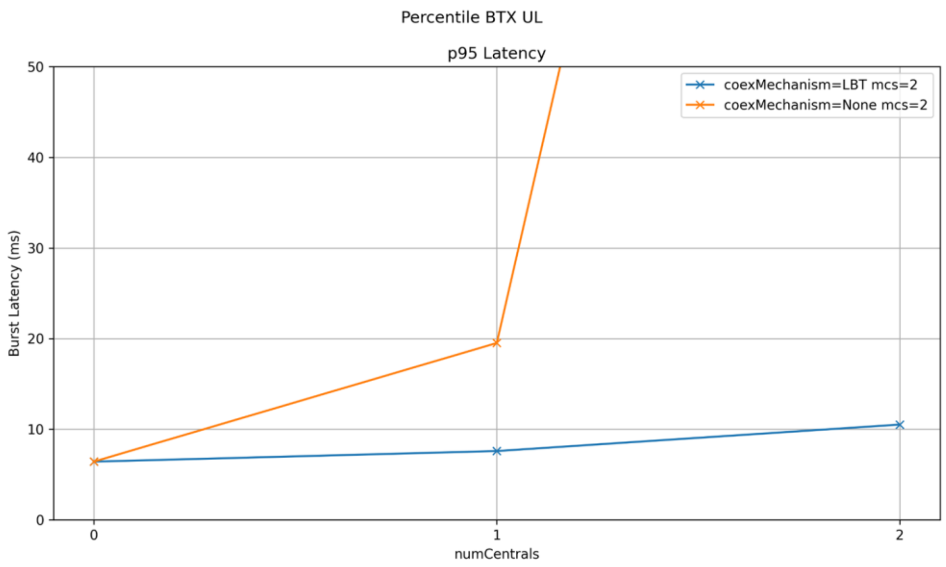


Each Subevent hops on a different NB channel
NOTE: IFS gap = 150 us

Figure not drawn to scale

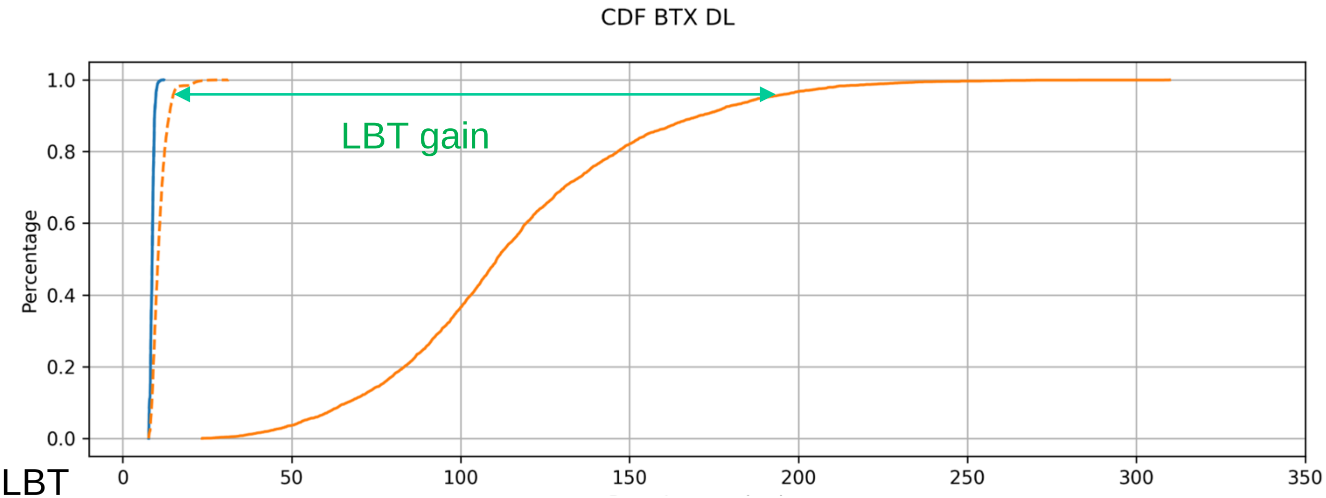
MCS 2 P95 Latency



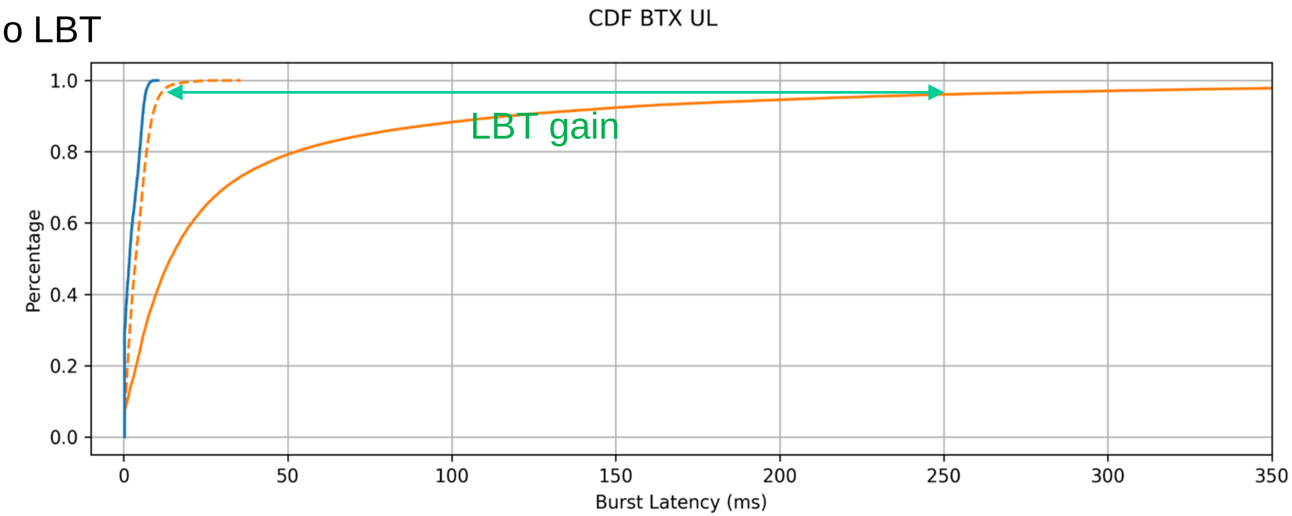


With a single central, there is an increase of ~220% for DL and around ~250% for UL

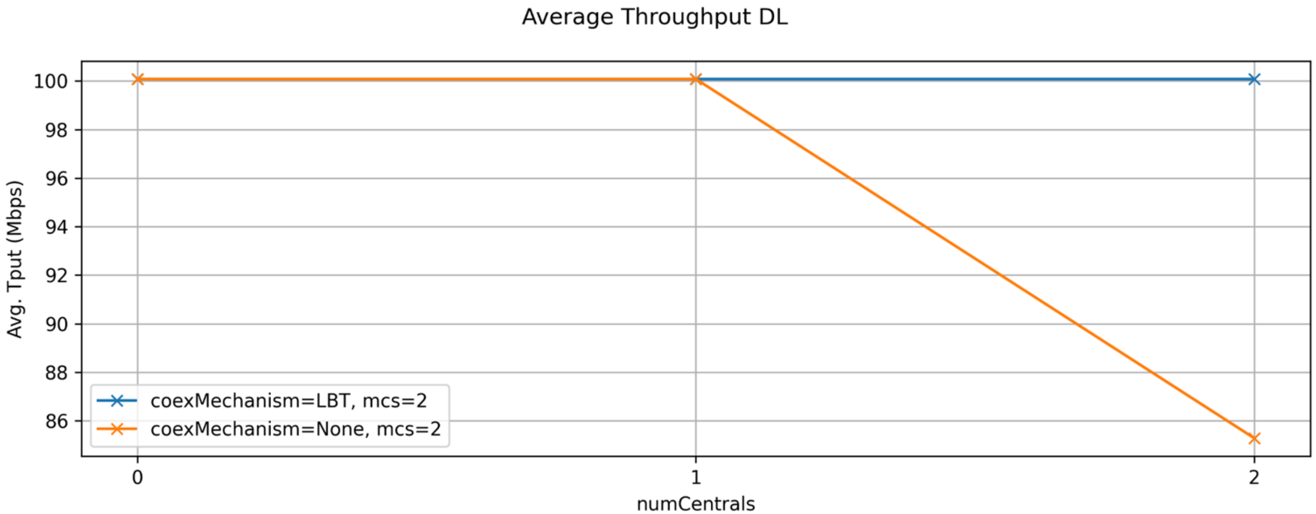
MCS 2 Latency CDF

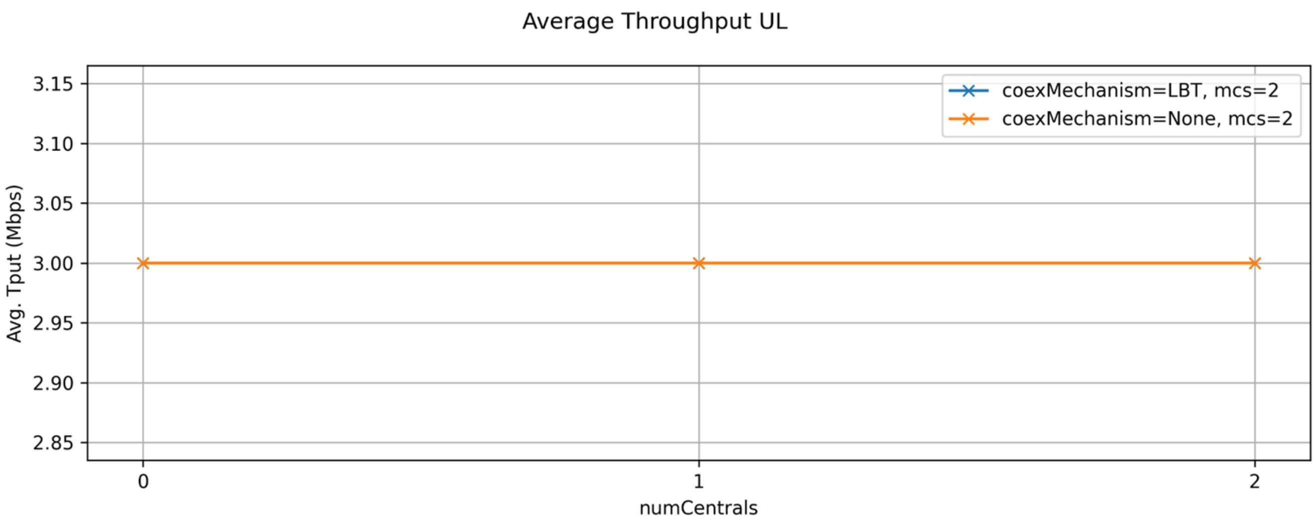


Solid: no NB devices
Dash: 2 NB centrals with LBT
Solid: 2 NB centrals with no LBT

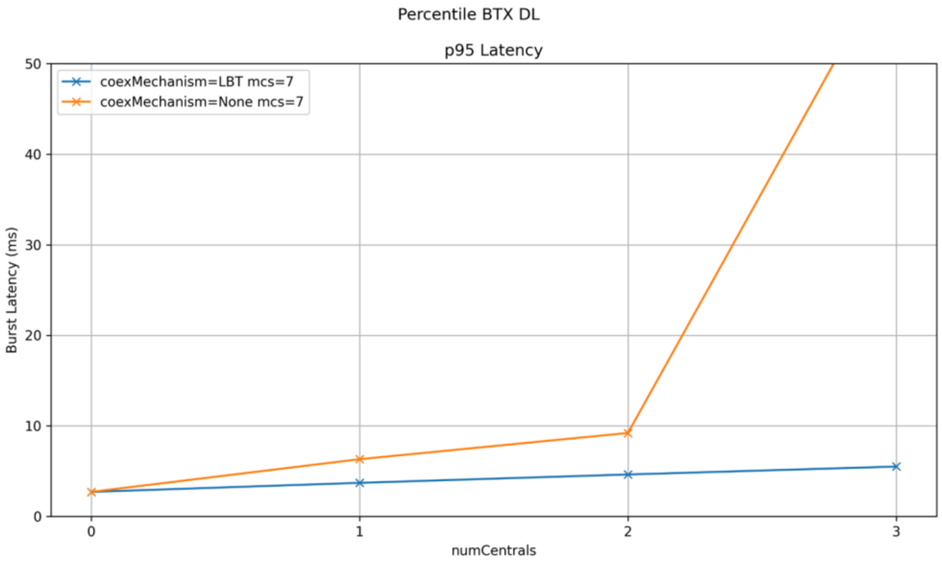


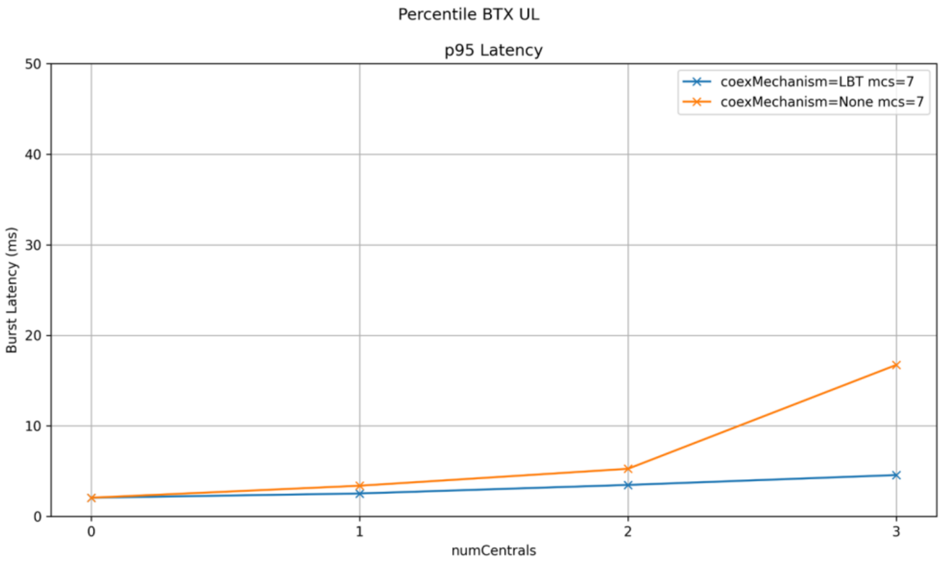
MCS 2 Throughput





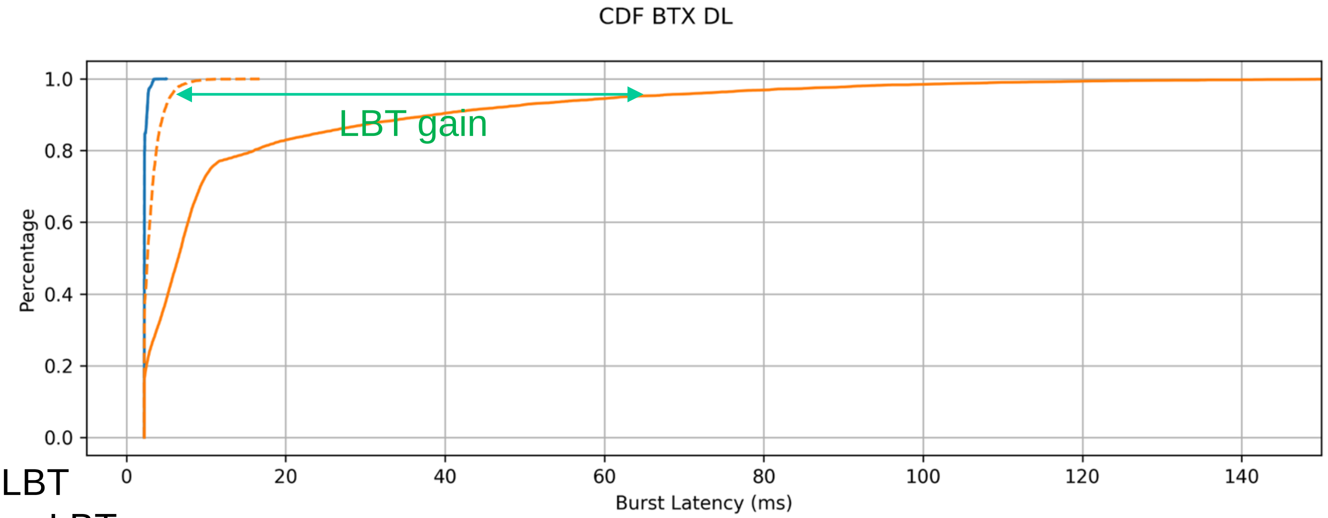
MCS 7 P95 Latency





In DL, with 3 centrals, there is an increase of > 10x of latency (from 5ms to >50ms)

MCS 7 Latency CDF



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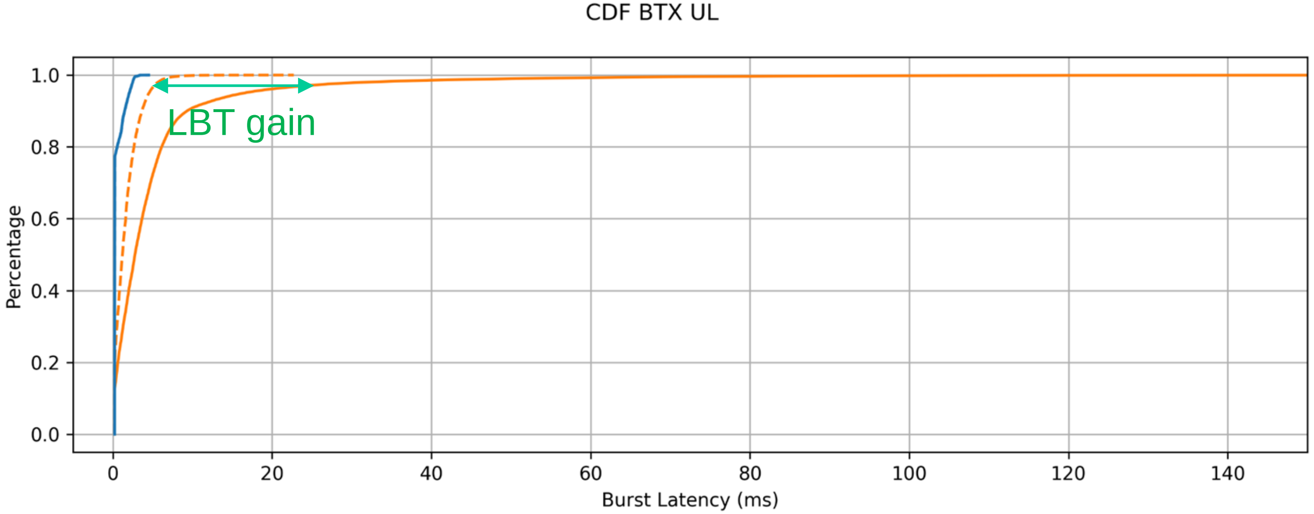
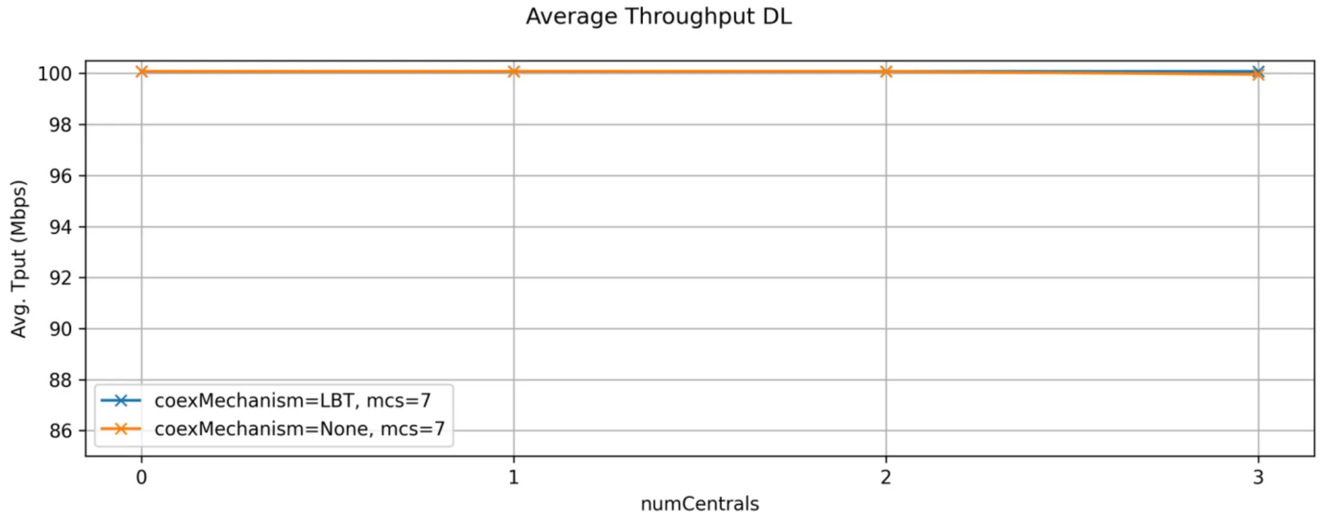
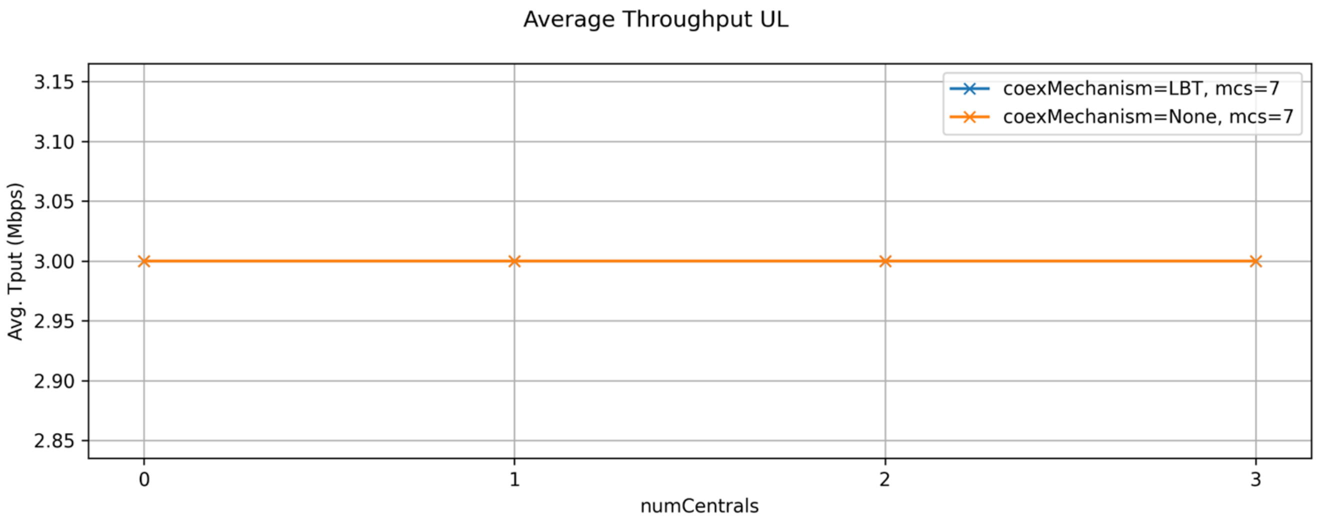
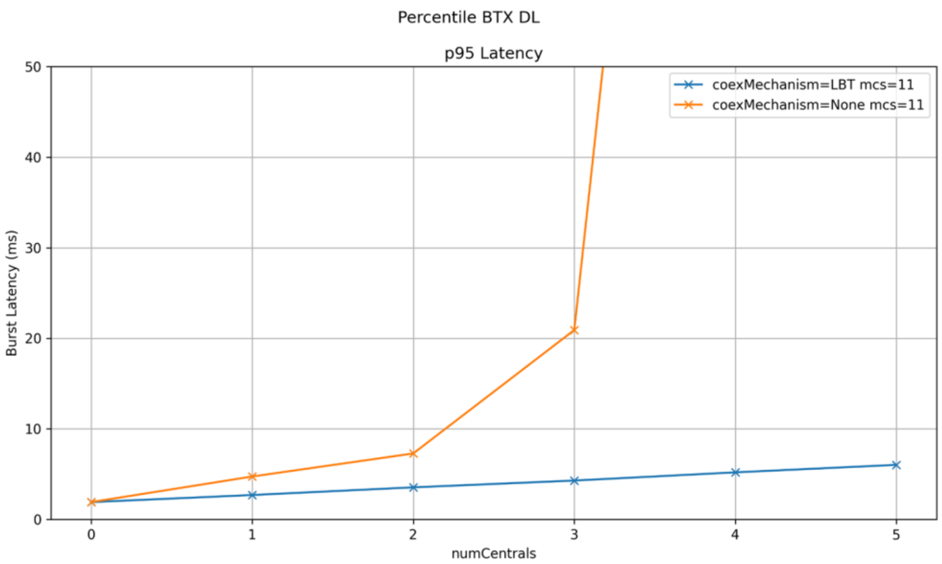


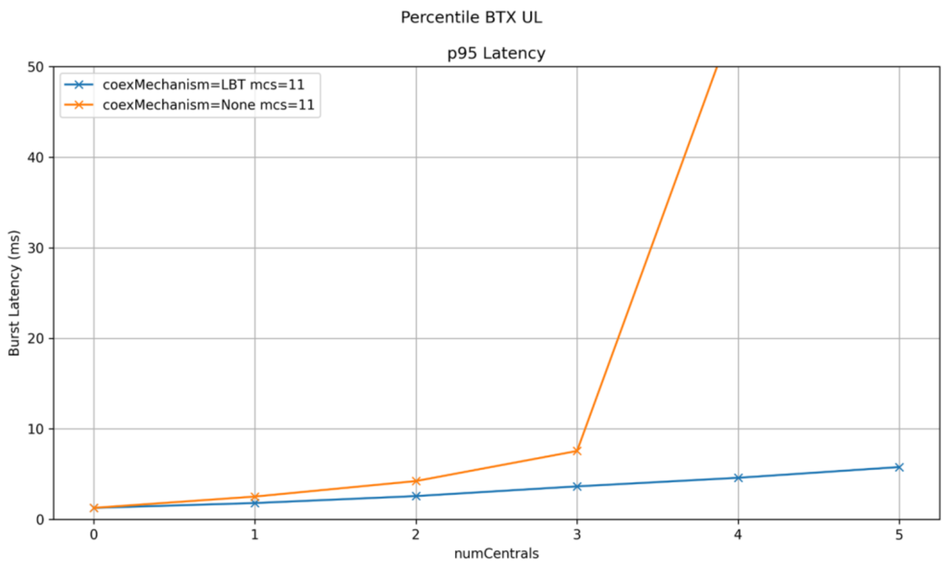
MCS 7 Throughput





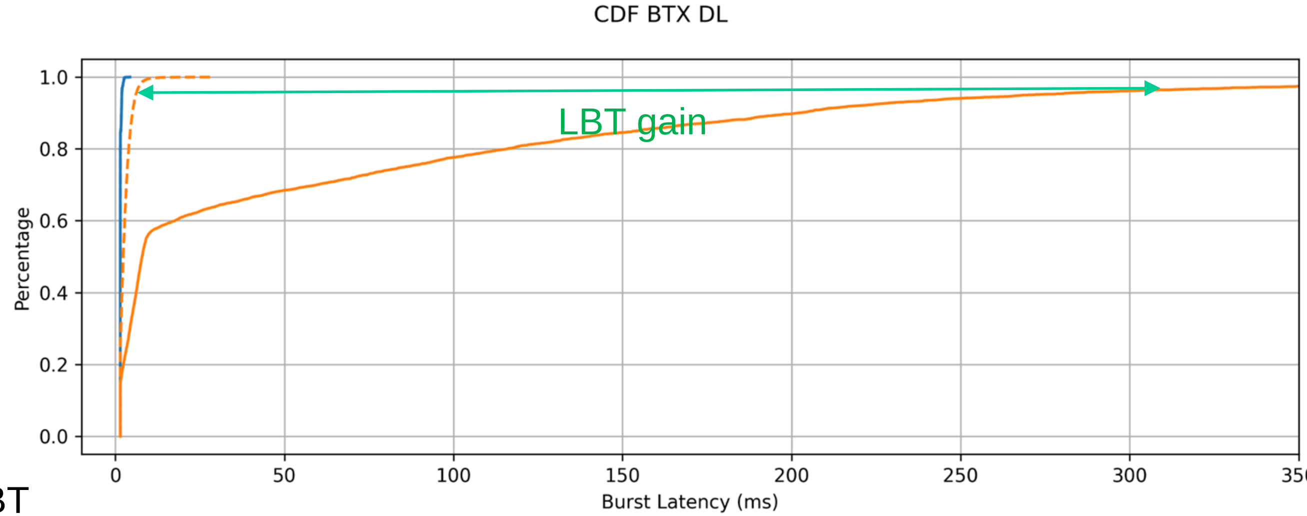
MCS 11 P95 Latency





In DL, with 3 centrals, there is an increase of ~4.2x of latency (from 5 to ~21)

MCS 11 Latency CDF



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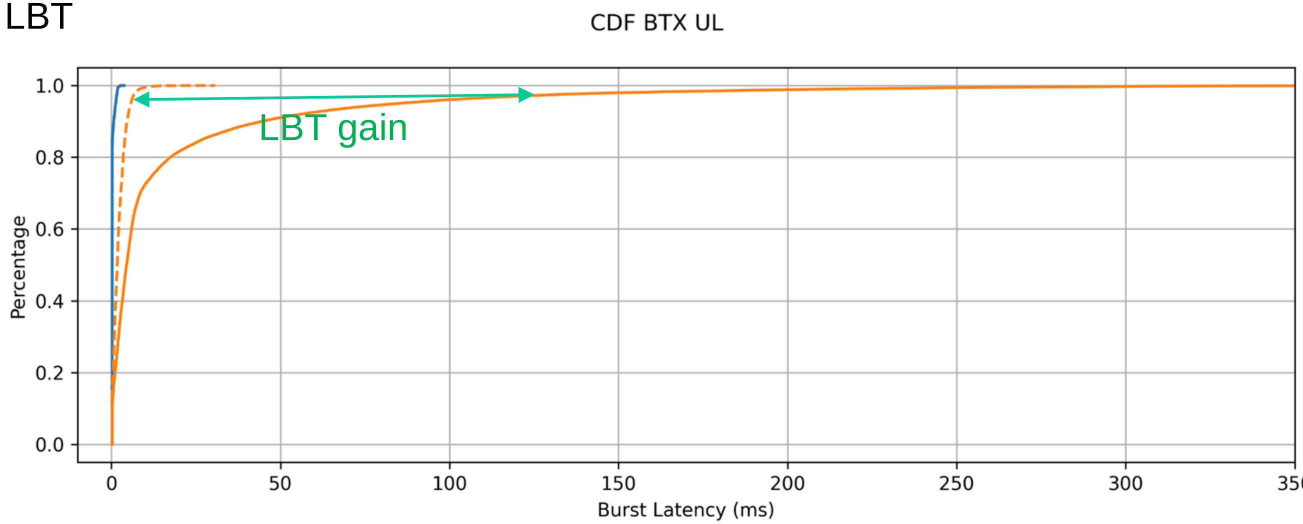
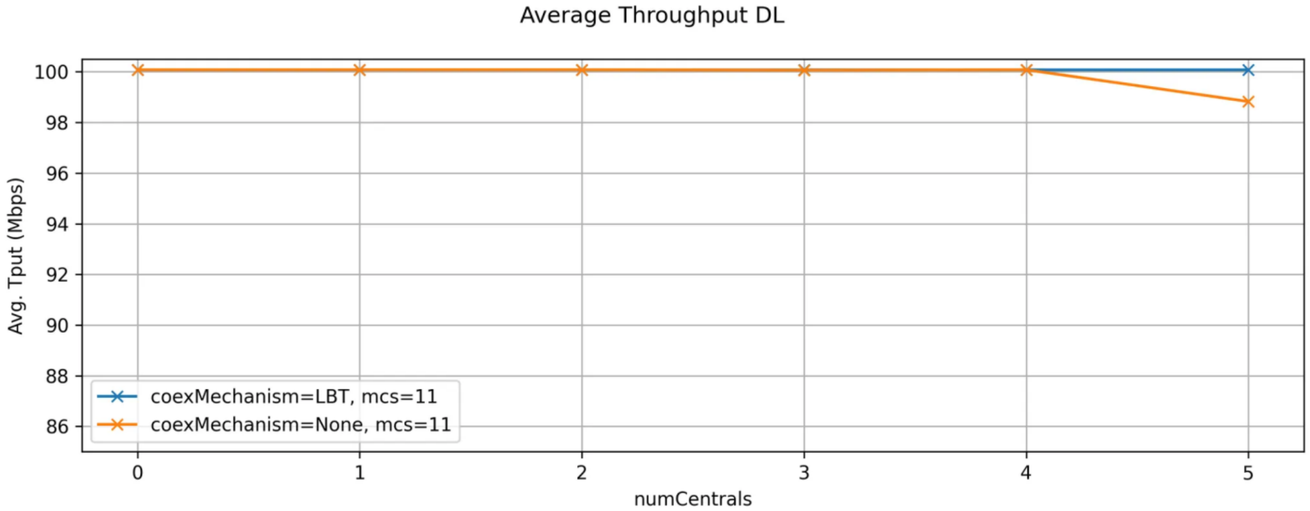
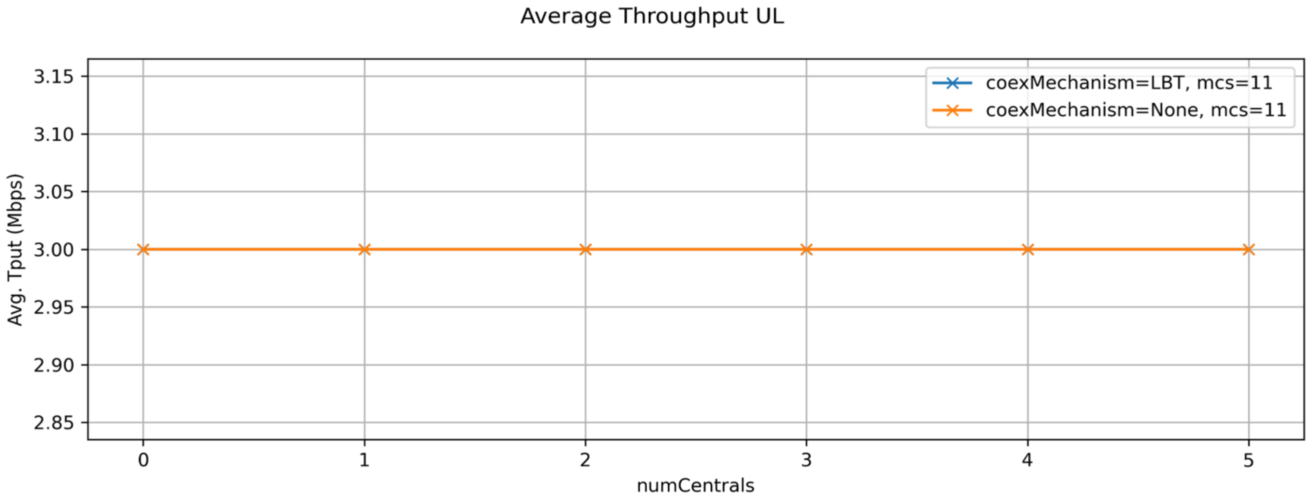


MCS 11 Throughput





Summary of Results

- XR use case targets p95 burst latency up to 10ms
- The table below summarizes the number of BLE music streaming centrals that meet target 802.11 XR requirements.

Interfering NB music streaming devices allowed	Low 802.11 Channel Utilization	Medium 802.11 Channel Utilization	High 802.11 Channel Utilization
No LBT	2	2	0
LBT	>=5	>=3	maybe 1

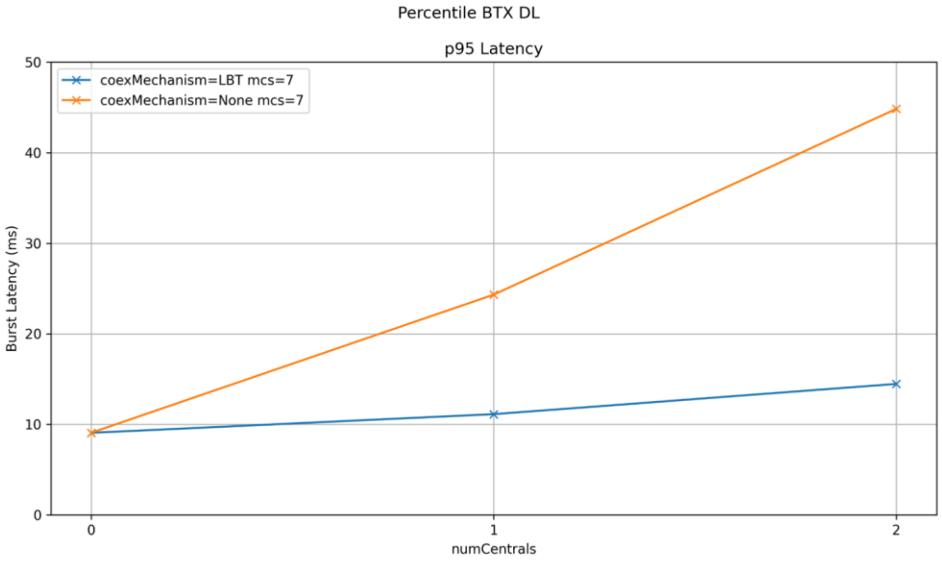
Observations

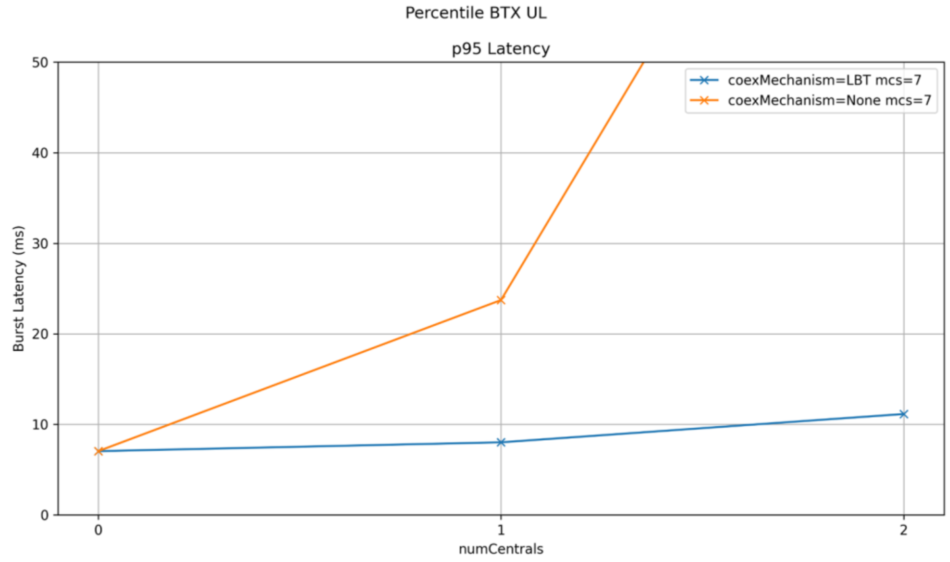
- For this scenario, 802.11 latency is again more sensitive than 802.11 throughput.
- Lower 802.11 duty cycle allows for increasing in-band LBT NB centrals, but up to 2 no-LBT NB centrals.
- NB LBT helps 802.11 latency in 802.11 low, medium, and high duty cycle scenarios.

Appendix

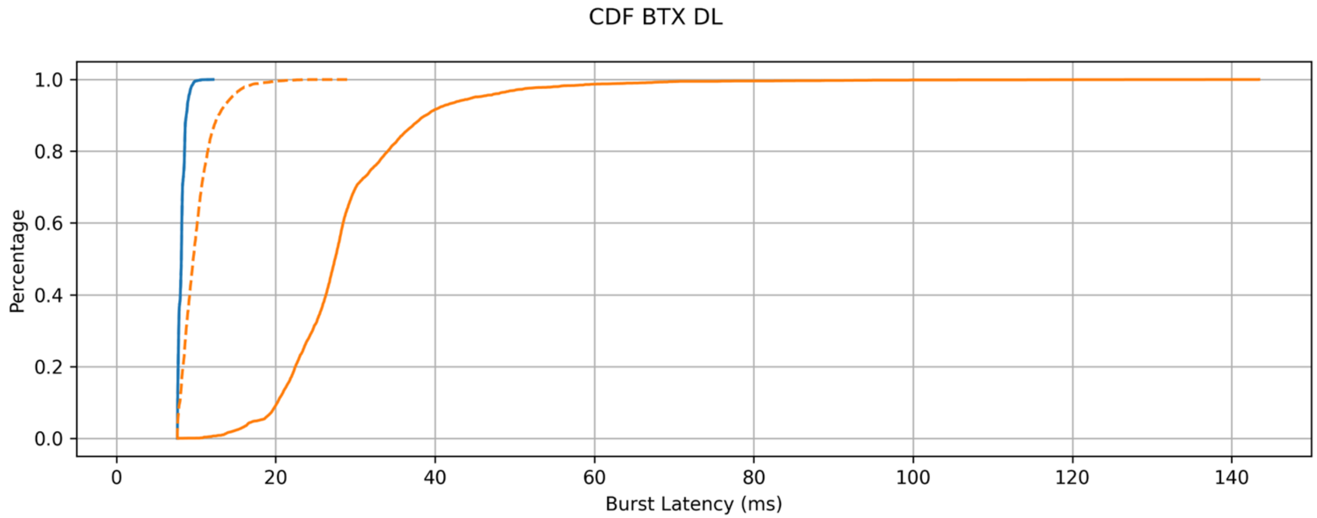
Impact of Higher MCS at same 802.11 Utilization

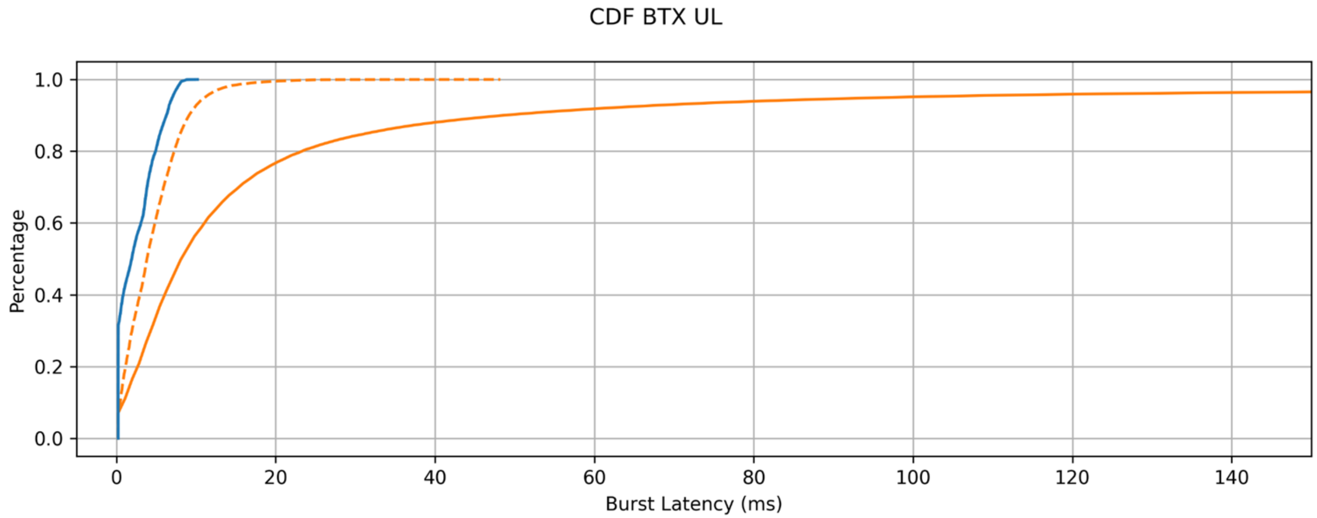
MCS 7 w/ 350 Mbps DL 802.11 Latency





MCS 7 w/ 350 Mbps DL 802.11 Latency CDF





MCS 7 w/ 350 Mbps DL 802.11 Throughput