Wi-Fi User's Video QoE in the Presence of Duty Cycled LTE-U

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Introduction

- The use of LTE in unlicensed spectrum(LTE-U) is a promising solution to satisfy the increasing mobile data demand.
- The fair coexistence of LTE-U with Wi-Fi is achieved by duty cycle (ON-OFF cycle) based transmission mechanism in LTE-U.
- Since, the video traffic demand is expected to reach 82% by the year 2021, it is essential to study and analyze the effect of LTE-U, with different duty cycles, on video QoE of Wi-Fi users.
- We study the video quality performance of a Wi-Fi user in the presence of LTE-U, in a testbed system.
- Video QoE is effected by various parameters like initial loading time, average video quality, number of stalls and total buffering time.

YouTube Player Working

- Dash encoded videos are chunked into small segments. YouTube player fetches these segments of appropriate quality in a playback buffer.
- λ(buffer threshold level) is the level up to which content should be fetched before rendering the content to the user.
- Therefore, if a stalling occurs YouTube player will first fill its buffer up to level λ before resuming the video.

Conclusion & Future Work

- There is degradation in video QoE of Wi-Fi user in the coexistence scenario.
- Poor video QoE in WL scenario as compared to WW scenario due to more packet collisions and less channel access time due to ON cycle of LTE-U.
- LTE-U selects ON fraction according to the load on the channel which results in poor QoE of Wi-Fi user. Therefore, LTE-U has to select ON fraction properly to have fair coexistence with Wi-Fi.
- In future, we can improve the video QoE of Wi-Fi users in coexistence scenario and analyse the effect of different LTE-U duty cycle periods on the video QoE of the user.

Acknowledgement

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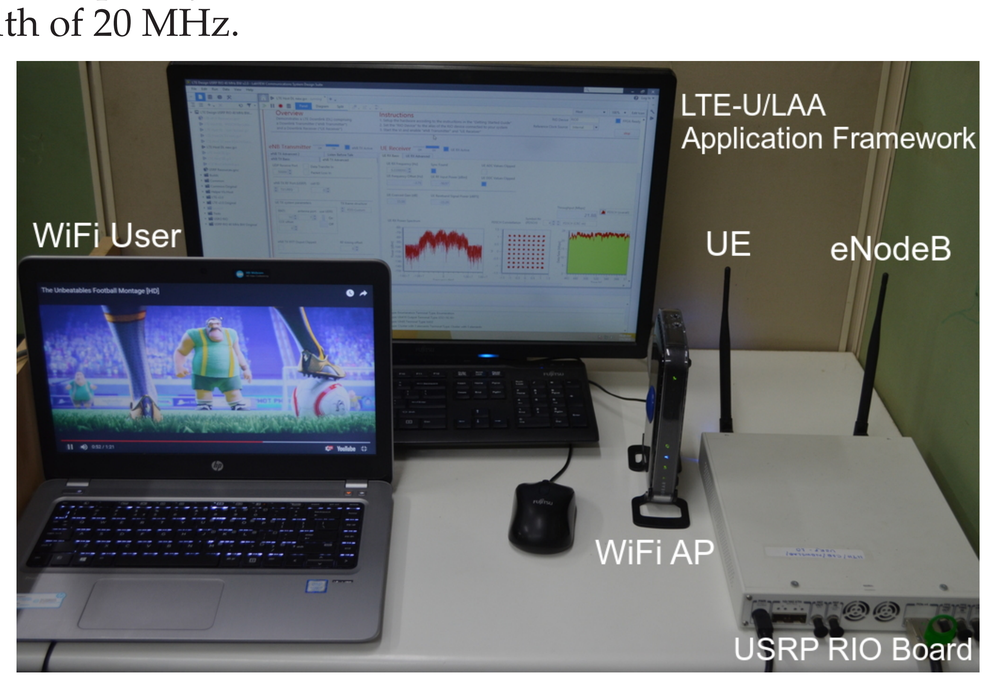
TestBed Setup

- The experiments are carried out on Wi-Fi – Wi-Fi (WW) and Wi-Fi – LTE-U (WL) scenarios, where two Wi-Fi AP's (WW) and Wi-Fi, LTE-U (WL) are set to operate on the same channel.
- The center frequency for LTE-U and Wi-Fi is set to 5.22 GHz (i.e., Wi-Fi channel 44) with bandwidth of 20 MHz.



- We developed an application using IONIC framework to calculate QoE in terms of Mean Opinion Score(MOS) for YouTube videos which considers the impairment being caused by various QoE deciding parameters.

Performance Metric

- **MOS Value:** Mean Opinion Score of the video includes the impairment being caused by various QoE deciding parameters.

$$MOS = 1 + 0.035R + 7.10^{-6}R(R-60)(100-R), \tag{1}$$

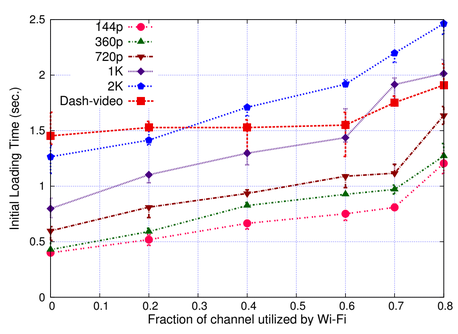
$$R = 100 - I_{ID} - I_{ST} - I_{LV} + C1 \cdot I_{ID} \cdot \sqrt{I_{ST} + I_{LV}} + C2 \cdot \sqrt{I_{ST} \cdot I_{LV}}, \tag{2}$$

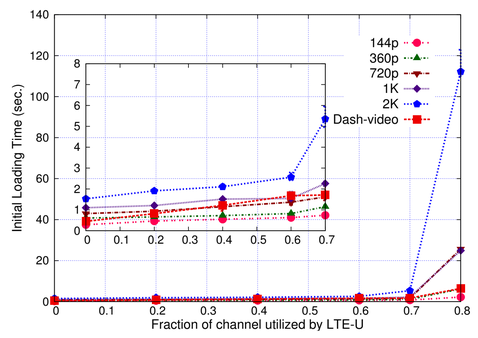
where I_{ID}, I_{ST}, and I_{LV} represent impairments due to the initial loading time, stalls, and level variation, respectively. C1, C2 are constants with values 0.15 and 0.82, respectively.

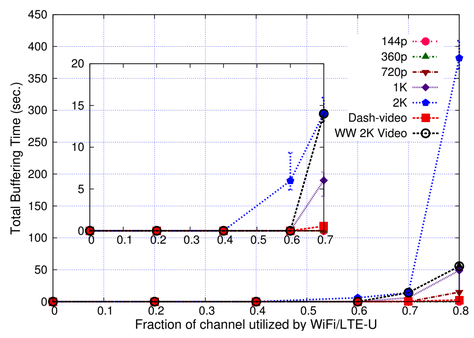
- MOS value can be analyzed while considering the effect of LTE-U ON fraction on QoE deciding parameters like **initial loading time** and **total buffering time**.

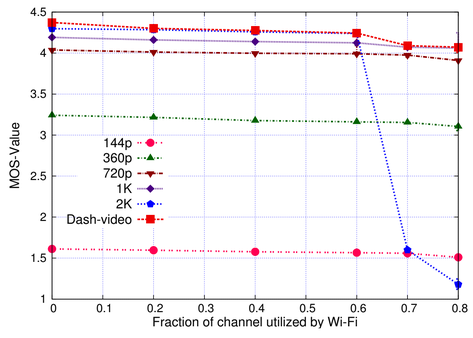
Results & Analysis

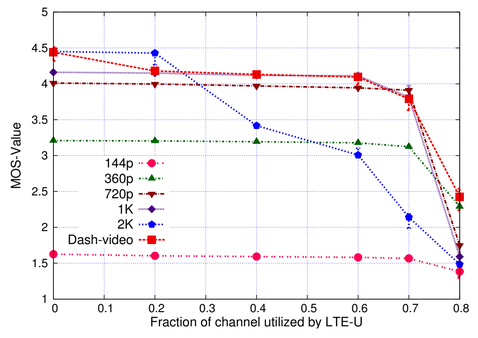
- We study the performance of MOS value and QoE deciding parameters in WW and WL scenarios for different video qualities like 144p, 360p, 720p, 1K, 2K and DASH.

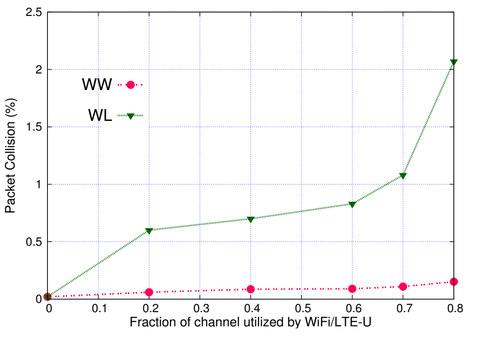












- As we increases LTE-U ON fraction, there are more number of packet collision in WL scenario as compared to WW scenario resulting in high back off time and less channel access time to Wi-Fi AP.
- QoE deciding parameters get adversely effected with the increase in ON fraction of LTE-U, resulting in lower MOS value and poor video QoE of the Wi-Fi user.