

Cisco/UDel Meeting Minutes
September 3, 2015

Attendees: Jim Seymour, Vikram Chandrasekhar, Len Cimini, Chien-Chung Shen, Li Li
Minutes Taken By: Li Li, Chien-Chung Shen

A. Proposal status

- Jim: Still waiting for the response from Megan.

B. Jim first reviewed "Multi-carrier LBT" from the 3GPP meeting on Aug. 24, 2015.

Slides #1-#2 – Overview of key differences between LTE and WiFi in multi-carrier LBT

Slide #3 – Multi-Carrier LBT (Contd.): Wi-Fi Principles. Combination of signal detection (SD) and energy detection (ED) for primary channel; SD is not mandatory for secondary channel.

- Len: So, there is nothing sophisticated. It just checks whether there is somebody there.
- Jim: Right. The standard allows a simple form for secondary channel. Maybe implementations can do both SD and ED.
- Chien-Chung: Are these special thresholds from the standard?
- Jim: Yes, they are for secondary channels.

Slide #4 – Multi-Carrier LBT for LAA: two options are being considered. Option 1: eNB performs Cat-4 LBT on more than one unlicensed carrier; Option 2: eNB performs Cat-4 LBT on one unlicensed carrier (it's a Wi-Fi like multi-channel channel access)

- Li: In Option 2, if one carrier is idle according to LBT, other carriers only need to wait for a period of PIFS.
- Jim: Right, with energy detection.
- Jim: I guess the meaning of "Option 1 + Option 2" is that one node is capable of doing both options, and may switch between them.
- Vikram: From my understanding, Option 1+ Option 2 means that Option 1 is mandatory, and Option 2 is optional.
- Chien-Chung: I am wondering whether some mathematical models can be developed for these two options from the probability perspective.
- Jim: Comparing the two options is complicated; it is hard to use mathematical model. A lot of companies in 3GPP are comparing them using simulation, for instance Ericsson and Intel.

C. Then, we started a detailed review of Li's slides on the coexistence of LAA and 802.11ac.

Slide #2 – Review the simulation results from the last meeting. There was an error, where DIFS should be included for each node when there is a new transmission or when the channel changes from busy to idle.

Slides #3, – CSMA/CA vs CAT 4.

1) For a new transmission, CAT-4 transmits immediately after the channel is idle for iCCA, but Wi-Fi has to experience a random backoff even for initial transmission.

- Jim: It does not sound to be correct. Need to double check.
- Vikram: There is no random backoff for initial transmission.

2) The contention window size of LAA varies from 4 to 32, the CW of Wi-Fi changes from 32 to 1024.

- Jim: It seems that the minimum CW size for WiFi can also be 4.
- Vikram: For DCF, the CW of Wi-Fi is from 15 to 1023. For EDCA, it is traffic dependent. For video data, q is from 7 to 15; for best effort data, q is from 15 to 1023.
- Li: Need to double check these two factors.

Slide #5, #6 – Review Simulation.

- Vikram: What kind of traffic model are you using?
- Li: I did not use a particular traffic model. I assumed the arrival time is Poisson distributed, and the package size is fixed.
- Vikram: I ask this question because how often iCCA and eCCA happen depends on the traffic model. If the data is continuous, there will be only one iCCA. To better understand this, maybe we need to use the same simulation setting as 3GPP.
- Li: By increasing the deferral slots in LAA, Wi-Fi will have more chances to access the channel. By increasing the load rate, LAA will become more aggressive.
- Vikram: If we want to do comparison, maybe we need to consider EDCA. For best effort in EDCA, the maximum CW size is 63 and not 1023.
- Chien-Chung: If we simulate EDCA, will WiFi perform better than the current results?
- Vikram: Correct. The difference between CAT 4 and CSMA/CA is not large to my understanding.
- Jim: I think the main difference is that the ACK for LAA and Wi-Fi are different.

Slide #9 – Different locations and load rates –The layout and path loss model follow the 3GPP.

- Vikram: When you say defer slots, what's the duration for this defer? Are you deferring 18 or 16+18 micro seconds?
- Li: One slot equals to 9 micro seconds, so the deferring period is 18 micro seconds.
- Vikram: That's not true. In EDCA, the deferring period is 16+ # slots* 9 micro seconds.
- Chien-Chung: Because we are not using EDCA, and we need to modify the simulation.
- Vikram: When I went to Workshop, a lot of APs do not use 18/23 dBm; they are using the power between 13-17 dBm. It will have some impact on the performance of Wi-Fi, because of lower power than LAA. Maybe it is a better value to simulate, even though most of current simulations are using 18 dBm.
- Vikram: What is the meaning of decoding threshold of -82 dBm for LAA? There is only energy detection for LAA now.

Slide # 10 Simulation results. The performance is better than the case of same location; the nodes in the margin have more chances to access the channel in the middle.

Slide # 11 Discussion.

- Li: LAA may be able to decode Wi-Fi signal, which leads to different CCA levels.
- Jim: The current standard does not mandate this.
- Li: Why 5 GHz band will be congested? There are 24 subchannels in total.
- Jim: Not all these channels can be used for Wi-Fi and LAA, and some of them are occupied by Radar systems.

Slide # 12 Channel selection. Channel selection depends on load rates. The model is developed from probability perspective.

- Vikram: Why should LAA select the same subchannel as WiFi in the first Wi-Fi?
- Li: If WiFi and LAA choose different subchannels, there is a probability that they transmit data at the same time. But for the low load rate case, if they choose the same subchannel, WiFi can always work in 80 MHz bandwidth.

Slide # 13, # 14 Channel selection: possible model.

- Vikram: It does not make too much sense for LAA to occupy the primary channel.
- Li: Because the load rate is very low, both WiFi and LAA can work very well in the same subchannel without too much competition.
- Vikram: So, if you change the load rate, the conclusion will be different?
- Li: Yes, different load rates lead to different channel selections.
- Vikram: WiFi do both energy detection and detection for primary channel, and only requires to do energy detection for secondary channels. This is also need to be considered, the current model is kind of uniform, not optimal in reality.

Slide #15 – Next Steps.

- Vikram: For downlink, adding more users is not so necessary.

Actions Items:

- **Continue Matlab simulation study, modify CSMA/CA and include EDCA.**

Next meeting: Thursday September 17 4:00 pm – 5:00 pm (EDT)