Cisco Cooperative Project

Start Recording

LAA with Multicarrier LBT

Student: Li Li
Advisors: Len Cimini, Chien-Chung Shen

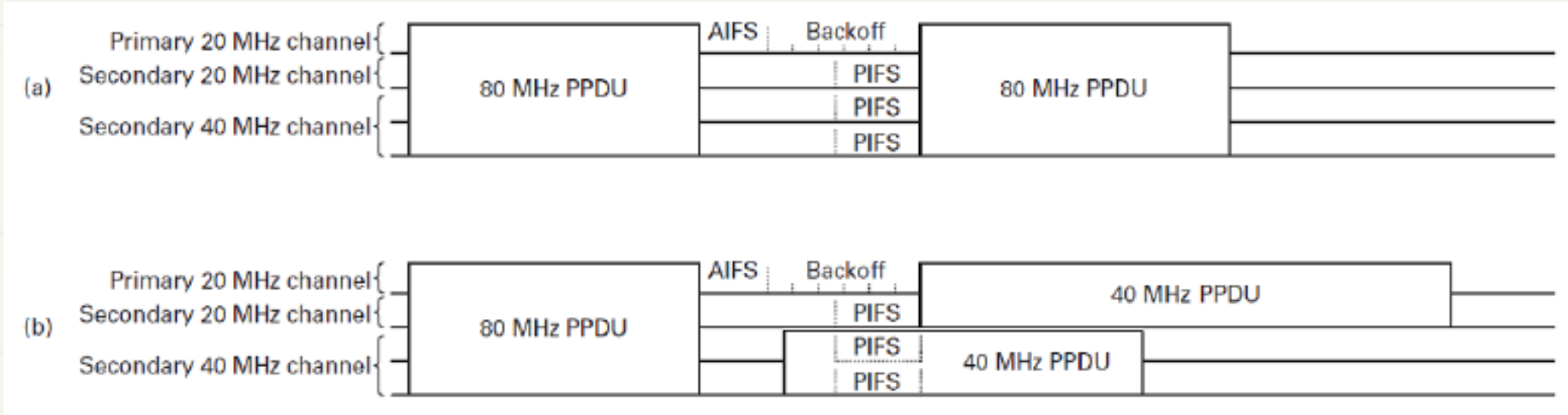
June 17, 2016

Outline

- Multi-carrier LBT: Option 1
- Simulation Results
  - ✓4 subchannels
  - ✓4 subchannels with “mixed traffic”
  - ✓8 subchannels
- Next Steps

Multi-carrier LBT

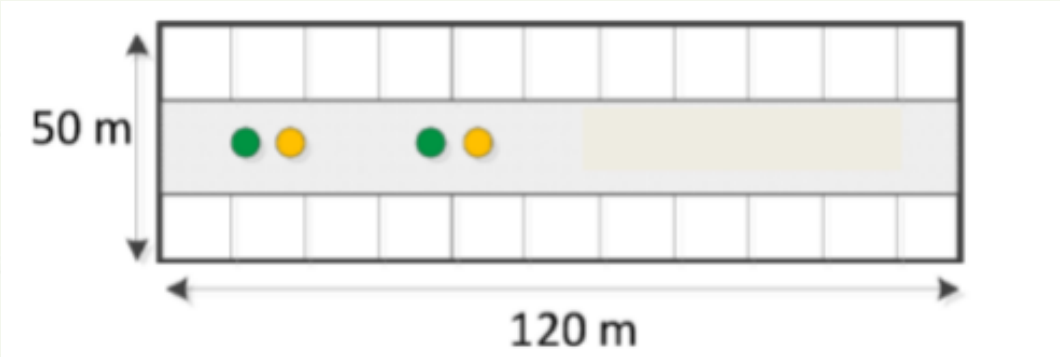
- 802.11ac's channel bonding



- ✓ The backoff procedure is only performed on the primary channel, secondary channel(s) perform a one-shot CCA.
- ✓ The primary channel should always be part of the channel bonding configurations.

Simulation Results

- Simulation Setting
  - ✓ 2 APs, 2 eNBs, and each AP/eNB has five users (each UE uniformly and randomly distributed around its associated transmitter)



  - ✓ 4/8 subchannels available, each subchannel is 20 MHz
  - ✓ FTP file size: 0.5 Mbytes, Poisson process: lambda = 2.5/10/20
  - ✓ One LAA eNB serves different UEs one by one.
  - ✓ Adaptive MCS

Simulation Results

- Single Channel, lambda = 2.5

LAA ED	WiFi #1	WiFi #3	LAA #2	LAA #4
-62 dBm	17.88	14.22	34.79	37.55
-72 dBm	25.37	14.56	18.94	36.13

- ✓ The nodes in the margin have some advantages;
- ✓ Decreasing LAA ED improves WiFi's performance, degrades LAA's performance
- ✓ Due to insufficient simulations/errors, the results shown in last meeting is not accurate

Simulation Results: 4 subchannels

- 4 subchannels, lambda = 2.5
  - ✓All transmitters share the same primary channel

LAA ED	WiFi #1	WiFi #3	LAA #2	LAA #4
-62 dBm	47.27	48.20	47.46	47.21
-72 dBm	47.67	47.53	47.61	47.65

  - ✓The primary channels are different (1, 2, 3, 4)

LAA ED	WiFi #1	WiFi #3	LAA #2	LAA #4
-62 dBm	47.64	47.57	47.70	47.71
-72 dBm	47.76	47.64	47.76	47.88

- Since there are 4 subchannels available, it will not be so congested, and different transmitters have similar performance.

Simulation Results: 4 subchannels

- 4 subchannels, lambda = 10
  - ✓All transmitters share the same primary channel

LAA ED	WiFi #1	WiFi #3	LAA #2	LAA #4
-62 dBm	71.65	51.93	127.86	149.73
-72 dBm	112.81	66.69	76.16	131.93

  - ✓The primary channels are different (1, 2, 3, 4)

LAA ED	WiFi #1	WiFi #3	LAA #2	LAA #4
-62 dBm	69.57	60.21	135.97	148.08
-72 dBm	118.18	73.54	59.46	129.69

- In these cases, all APs and LAA eNBs only transmit with 80 MHz bandwidth or not, even though channel bonding and carrier aggregation are adopted.

Simulation Results: 4 subchannels

- 4 subchannels, lambda = 10, -72 dBm, mixed traffic
  - ✓To avoid the case of transmitting with 80 MHz or nothing, we assume APs/eNBs will only occupy the primary channel (no extension) with a probability of p_1 (for example, voice traffic)
  - ✓All transmitters share the same primary channel, p1 = 0.3

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	85.31	50.71	52.61	114.10
80/60/40/20 MHz (# of transmissions)	45826/0/0/19700		46657/0/0/20025	

- Since it does not fully utilize the channels, performance is worse than before.

Simulation Results: 4 subchannels

- 4 subchannels, lambda = 10, mixed traffic, $p_1 = 0.3$
  - ✓The primary channels are different (1, 2, 3, 4)

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	65.92	61.89	111.82	96.18
80/60/40/20 MHz	5401/0/10310/117570		5163/19241/38086/66936	

  - ✓The primary channels are different (1, 3, 1, 3)

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	75.05	49.20	106.96	120.36
80/60/40/20 MHz	23514/0/20050/32220		34059/22108/16852/31276	

- ➢ LAA is more aggressive in these cases.

Simulation Results: 8 subchannels

- 8 subchannels, lambda = 20, -72 dBm, PC: 1,4,5,8
  - ✓LAA randomly choose 3 subchannels as SC in each trial

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	111.72	115.84	156.26	194.59
80/60/40/20 MHz	39697/0/44513/40368		60051/28802/20645/1863	

  - ➢ WiFi #1 and WiFi # 3 have similar performance: no competition between #1 and #3 in this case.
  - ✓LAA choose any idle subchannels (at most 3) as SC per transmission

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	113.70	95.42	207.40	227.33
80/60/40/20 MHz	23522/0/95693/15494		106970/4590/15010/20	

  - ➢ LAA's performance is even better when they can update SC per transmission.

Simulation Results: 8 subchannels

- 8 subchannels, lambda = 20, -72 dBm, PC: 1,2,5,6
  - ✓LAA randomly choose 3 subchannels as SC in each trial

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	102.80	111.71	148.34	169.19
80/60/40/20 MHz	47084/0/12/72560		48510/30393/23234/2780	

- Performance decreases a little bit. For WiFi, the number of transmissions with 40 MHz decreases a lot.
  - ✓LAA choose any idle subchannels (at most 3) as SC per transmission

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	82.40	88.24	213.53	213.49
80/60/40/20 MHz	29091/0/381/98986		97169/24410/65/12	

- WiFi's performance will decrease significantly, LAA is more aggressive.

Simulation Results: 8 subchannels

- 8 subchannels, lambda = 20, -72 dBm, PC: 1,1,5,5
  - ✓LAA randomly choose 3 subchannels as SC in each trial

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	136.03	136.27	99.77	117.74
80/60/40/20 MHz	82130/0/166/669		38862/17042/17445/1224	

- WiFi's performance is even better than that of LAA: #1 and #3 transmit without competition, #2 and #4 may happen to choose same SC.
  - ✓LAA choose any idle subchannels (at most 3) as SC per transmission

	WiFi #1	WiFi #3	LAA #2	LAA #4
Throughput	124.53	127.95	135.81	135.94
80/60/40/20 MHz	80072/0/260/246		76014/169/112/26	

- LAA's performance improves compare to the case above. The overall performance is bad: PC is necessary for data transmissions.

Discussion

- How to choose PC? Far from AC's PC?
- With PC, how to choose SC?
- Simulation is quite slow now, how to increase the network size and the number of subchannels?

Next steps

- Work on the problem of PC and SC selection
- Evaluate the performance of multi-carrier LBT with Option 2