IEEE P802.11
Wireless LANs

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| Minutes of the Extremely High Throughput (EHT) Study Group (SG) September 2018 meetings |
| Date: 2018-09-21 |
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Abstract

This document contains the meeting minutes of the 3 sessions of the EHT SG held in September 2018 IEEE 802.11 interim meeting.

Rev1: Updated a contribution number and the Date.

Rev2: Some minor editorial updates.

**Tuesday 11/09/2018 PM 2 Session**

**Introduction**

1. At 4:03 the chairman, Michael Montemurro calls the meeting to order.
	1. The chairman thanks Dennis Sundman for volunteering as the recording secretary.
2. The chairman asks attendees for potential essential patents. Nobody speaks up.
3. The chairman asks to approve the agenda 18/1409r3 and the minutes 18/1332r1 from the July meeting.
	1. The agenda and minutes are approved with unanimous consent.
4. The chairman discusses on the process to create PAR. We need to decide the scope of the PAR, time goals, feature sets, level of agreement on the feature set.
	1. Should we do one project or multiple projects for the PAR and CSD?

**Contributions**

1. “Extremely High Throughput (EHT) 802.11 – Features classification and early discussion on PAR”, 18/1215r1 – Laurent Cariou (Intel)

 **Summary:** Discusses the scope of the PAR and the timeframe.

**Q (Question/Comment):** Are you planning to consider latency?

**A (Answer):** We would need another objective that matches the latency feature.

**Q:** You talked about throughput, do you mean point-to-point throughput?

**A:** We actually consider BSS throughput, although this can be discussed.

1. “Recommended Development Process for EHT”, 18/1550r0 – Brian Hart (Cisco)

 **Summary:** Brings up the view that a too fast standardization process may increase the risk of solving the wrong problem and create a “buggy” stundard. One problem is that we get customer responses only two cycles ahead of time.

**Q:** I am in favour of the faster cadence approach. I don’t think this is a problem, rather I think you would speed up the customer feedback getting into the standards. **A:** I don’t think this is the case. Each cycle will take twice the time because we are splitting the work force into several places.
 **Q:** One reason to shorten the cycle is because the competition (3GPP) are doing it.
**A:** We have more generations quickly.

**Q:** I’m in favour of the traditional process. In the PHY group we always spend a lot of time to redefining the preamble.
**A:** This is a great Segway to my next presentation.

1. “Recommended Direction for EHT”, 18/1549r0 – Brian Hart (Cisco)

 **Summary:** 802.11 (+WFA) have introduced a number of great features, both mandatory and optional. Believes the following should be mandatory: 6 GHz, Multiband 80+80 MHz, HARQ, Implicit sounding, Low throughput PHY (remove legacy compatibility).
 **No time for questions.**

1. “Constrained Distributed MU-MIMO”, 18/1439r0 – Ron Porat (Broadcom)

 **Summary:** Go through further details on how distributed MU-MIMO can work. Distributed MU-MIMO essentially means joint transmission (“beamforming”) from multiple APs.

**Q:** There are many uncertainties about accuracy levels for frequency, phase compensations. How tightly does the timing need to be tracked? Impementation challenge is still unclear.

**A:** For this meeting we wanted to explain the scheme. It is a valid question how well it works. We will try to bring more results in the next meeting.

 **Q:** What do we need to estimate with the mid/pre-amble for the D-MU-MIMO to work?

**A:** The only thing you need to correct is the time/frequency drift and the rest should be standard MU-MIMO theory.

 **Q:** Do we need all the APs taking part of the D-MU-MIMO scheme to use the same channel? Because then they will be interfering with each other (when they are not cooperating in the beamforming).

**A:** They should all use the same frequency because this is the most efficient.

 **Q:** All data has to be transmitted in a two-hop scenario.

**A:** Our scheme supports also that the APs are connected to the Internet separately.
 **No time for further questions.**

1. “Technology Features for 802.11 EHT”, 18/1547 – Kome Oteri (InterDigital)

 **Summary:** Discusses features brought up in the July meeting to evaluate the feasibility of them. The conclusions is a proposal of features for EHT, mainly: MIMO Enhancnement, Multi-AP transmission, HARQ.
 **Q:** I have a question on MIMO enhancement. Zero forcing and non-linear precoding seems to be vendor specific. Do we have to specify anything of this?

**A:** If you do a non-linear precoder, you need to feedback some information.

 **Q:** My question is about HARQ. Most issues that you mention here have been seen in LTE (3GPP). So what are the issues here?

**A:** In LTE you are assuming a system with different eNB so the interference is known. In a typical Wi-Fi deployment, the interference is much less unpredictable and hard to manage.

1. The chairman recesses the meeting.

**Thursday 13/09/2018 AM 2 Session**

**Introduction**

1. At 10:31 the chairman, Michael Montemurro calls the meeting to order. Reminds everyone to take their attendance.
2. The chairman announces that we continue the contributions.

**Contributions**

1. “View on EHT Candidate Features”, 18/1533 – Yusuke Tanaka (Sony Corporation)
 **Summary:** Shows Sony’s views on the following features and proposes some way forwards to develop PAR/CSD: Multi-AP coordination and 6 GHz band support. For Multi-AP coordination they mention: Coordinated beamforming, distributed MU-MIMO, null-steering, resource sharing, enhancement of spatial reuse. For the 6 GHz operation, they propose to leverage on 802.11af.

**Q:** We do not know the regulatory framework in6 GHz, so hopefully 802.11af is not needed.

**Q:** All bands have various regulatory constraints, so I am not sure 802.11af is needed.

**Q:** On the Multi-AP side you mention dishtributed decision making. Can you elaborate on this?
**A:** Cognitive beamforming can make decision making better.
**Q:** So you mean features such as interference alignment.
2. “EHT features for Multi-band operation”, 18/1525r1 – Jeongki Kim (LGE)

**Summary:** Proposes full duplex over multi-band, which means that an AP can use multiple channels for both UL/DL simultaneously (note: not full duplex within one channel). An EHT AP has a primary channel called band specific primary channel (BSPC). The presentation goes through various rules and scheduling for multi-band operation in quite some detail.

**Q:** In 6 GHz there is scheduled access. Do you assume all STAs are multiband in order for this scheme to work?
**A:** It can be only single-band but then the scheme doesn’t work.

**Q:** IEEE has had problems with developing scheduled access. Also consider other technologies that other technologies are allowed to exist in the same bands.
3. “EHT Multi-Channel Opetarion”, 18/1518r0 – Liwen Chu (Marvell)

**Summary:** They propose to use multi-channel FDD, i.e. using some channels for UL and others for DL such that RX and TX can be performed at the same time. They point out that latency can be reduced due to reduced RTT.

**Q:** Wouldn’t it be fair to compare the multi-channel FDD 80 MHz / 20 MHz channel case with a case where the TDD system uses 100 MHz?
**A:** Yes, but the gain is 2.5 times, so it is still good.

**Q:** Question about the P2P TCP traffic. Did you enable TCP window scaling?
**A:** It is a fixed TCP window.

**Q:** In the FDD case, you assume that the channels are free. If one of the channels is busy at some point, it would bring the system out of sync.
**A:** I just want to show that this is a promising idea, the details are not solved yet.

**Q:** Does the data-blocks in the figure contain MAC layer?
**A:** Yes.
**Q:** So the one-directional communication actually contains communications in two directions.
(Editor’s note: I think there was a misunderstanding between the questioner and questionee in the above discussion)

**Q:** How do you address the hidden node problem?
**A:** By allowing for channel switching.
**Q:** So you assume synchronization?
**A:** You can see it this way.
4. “AP Coordinated Beamforming for EHT”, 18/1510r1 – Hongyuan Zhang, but presented by Rui Cao (Marvell)

**Summary:** Considers AP coordinated beamforming (distributed MIMO). This could be particularly useful in enterprise scenarios. Need perfect synchronization and coding/modulation support. Provides simulation results suggesting that large gains can be obtained. A second thing considered is independent vs synchronized sounding. Synchronized sounding is needed.

**Q:** On the result graph, you have distance on the x-axis. But you have two APs and one STA. What does the distance correspond to?
**A:** The distance is the same to both APs.
**Q:** If we move the STA so that it is close to one AP, will the gain still be there?
**A:** I think it should be smaller.

**Q:** What is the time corresponding to this CFO offset?
**A:** Microsecond level.

**Q:** An AP with twice the antennas to the STA is sufficient?
**A:** Yes.

**Q:** A question about the sounding. Is the independent sounding worse because you don’t have the cross-over information.
**A:** In the independent case you have to combine two feedbacks.

**Q:** From a MAC point of view it would be interesting to see how a not fully synchronized MAC would work.

**Q:** You assume that the same TX power is used for both APs. We need to consider different TX powers for the different APs. The reason is that the beamforming feedback is normalized. This should impact the overall performance. You didn’t consider this, right?
**A:** That is correct. This needs further study.

**Q:** How to synchronize among different APs? I think this is a challenging problem.
**A:** We have seen some contributions on this already. We assumed synchronization is possible.
5. “Discussions on Multi-AP coordination”, 18/1509r0 – Jianhan Liu (Mediatek Inc.)

**Summary:** They bring up that multi-AP in EHT should be done such that it has no contradiction with the multi-AP task from Wi-Fi Alliance. Clarification of terminology. In Wi-Fi Alliance: network architecture, MAC coordination, each STA associated with one AP, trans among APs is one-to-one. In EHT they want to enable joint transmission/reception by multiple APs within a single packet.

**Q:** Option 4 is essentially the same as option 5. The last bullet on option 4 is not correct. The use of the word coordinated should be restricted to options 1 and 2. Where the APs have the data available should be called “joint”. 3 is a special case of option 5. Option 5 should be called joint precoding.

**Q:** From the discussion I understand that you refer to mechanism. So the difference is not in complexity, but rather the accuracy.

**Q:** If there is an overlap BSS, you say in option 1 that each RU can only be used by 1 AP.
**A:** There is a group RU.

**Q:** Option 5 requires non-traditional kinds of APs, like super-accurate chrystals, and is outside the scope of this group. But option 4 can be solved by the EHT group.
**A:** We need similar accuracy for option 4 and 5, but how to achieve it is the difficulty.

1. “Technology for EHT”, 18/1481r1 – Stephane Baron (Canon)

**Summary:** Direct link use-cases for EHT: wireless control/operation, wireless display, direct printing, VR/AR applications. Carry large traffic, relaying through an AP is not efficient. Direct link is more easy to schedule than unpredicted traffic.

**No questions.**
2. The chairman asks if somebody can make their presentation in 15 minutes. Nobody speaks up. We are in recess.

**Thursday 13/09/2018 PM 2 Session**

**Introduction**

1. At 4:02 PM the chairman, Michael Montemurro, calls the meeting to order. Reminds everyone to take their attendance. We will start in a minute or two.
2. The chairman announces that we continue the contributions.

**Contributions**

1. “SOMA for EHT”, 18/1462r0 – Junghoon Suh (Huawei)

**Summary:** SOMA (semi-orthogonal multiple access) means superposition of constellation mapping. This closely resembles 3GPP technology MUST (multi-user superposition transmission). They claim that MUST is proven to provide gains in both link and system level.

**Q:** Regarding the CSMA. I don’t understand how you can get a gain versus MIMO. Furthermore, you should use link adaptation in the simulations to make a fair comparison.
2. “Discussions on PHY features for EHT”, 18/1461r1 – Xiaogang Chen (Intel)

**Summary:** EHT may work in 6 GHz, 5 GHz, and 2.4 GHz. Only have EHT/HE/non-HT PPDU in 6 GHz. Minimum CCA granularity is 20 MHz. Subchannel/RU puncturing can be used. 4096 QAM. Unequal MCS between different SS. UL CQI measurement / UL power control (with UL NDP). Propose to not have a greenfield design.

**Q:** In the performance curve you have 2 SS.
**A:** We don’t do power loading.
**Q:** I doubt you can get much gain.
**A:** We need to look more into it.

**Q:** We should discuss some details more.

**Q:** On slide 15, what does it mean “multiband” and why is it mostly MAC topics?
**A:** I am not sure exactly how the PHY will be, maybe there will be some more work also there.
3. “Further Study on Potential Features”, 18/1575r0 – Tianyu Wu (Samsung)

**Summary:** Provides further study on 16 SS support, Logic RU/Distributed logic RU, Multi-AP coordination. Sounding feedback overhead reduction for 16 SS needed: hybrid beamforming, don’t consider all subcarriers. Master AP / Slave AP / Virtual BSS.

**Q:** The sounding feedback, is it similar to LTE?
**A:** Yes.

**Q:** Why have you chosen the numbers in the second subbullet to the first bullet? Are you talking MU-MIMO? Feedback in MCS0 does not seem good…
**A:** I agree that we have chosen numbers that give large feedback sizes. Of course we can evaluate other numbers.
4. “Considerations on AP Coordination”, 18/1576r1 – Roger Marks (Huawei)

**Summary:** They look at the approaches on EHT TIG contributions for AP coordination. They consider MAC coordination and PHY coordination separately. Lists different sorts of coordinations.

**No questions.**
5. “HARQ for EHT”, 18/1587r1 – Ming Gan (Huawei)

**Summary:** They want to integrate HARQ into 802.11 while making as few changes to the existing protocols as possible. Effectively offers an extended set of MCSs. Simulation results show that HARQ yields a significant benefit of ~4dB.

**Q:** Why do you propose HARQ for EHT? Do you want to improve the performance for the STAs close to the BSS border?
**A:** HARQ provide better performance for all STAs under the appropriate conditions.
6. “Experiments on Wireless VR for EHT”, 18/1606r1 – John Son (WILUS)

**Summary:** Shows experimental results on latency. When the number of links goes up, the latency also increases. Some mechanism may help, but EHT SG should investigate additional methods to minimize latency.

**No questions.**

**Outroduction**

1. The chairman thanks the audience. The next meeting is going to be run differently. We need to draft a PAR.I don’t believe we need teleconferences. The meeting is adjourned.