IEEE P802.11
Wireless LANs

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| Minutes for the Extremely High Throughput (EHT) Study Group (SG) January 2019 Meeting |
| Date: 2019-01-14 |
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Abstract

This document contains the meeting minutes of the 4 EHT SG sessions held in January 2019 IEEE 802.11 interim meeting.

**Monday 14 January 2019, PM2 Session**

**Introduction**

1. At 4:16 PM, the chairman, Michael Montemurro (BlackBerry), calls the meeting to order. The delay was due to problem with connecting the computer to the projector. Approximately 150 people in the room.
2. Mike goes through the agenda. The agenda is approved with unanimous consent:
	1. **Approve EHT SG minutes from September session**
		1. <https://mentor.ieee.org/802.11/dcn/18/11-18-2102-00-0eht-eht-november-2018-teleconference-minutes.docx>
		2. <https://mentor.ieee.org/802.11/dcn/18/11-18-2071-00-0eht-meeting-minutes-november-2018.docx>
	2. **Discussion on PAR and CSD drafts (20 min)**
		1. PAR: <https://mentor.ieee.org/802.11/dcn/18/11-18-1231-01-0eht-eht-draft-proposed-par.docx>
		2. CSD: <https://mentor.ieee.org/802.11/dcn/18/11-18-1233-01-0eht-eht-draft-proposed-csd.docx>
	3. **Technical contributions (s.14) – (20 min for presentation/Q&A)**
3. The chairman asks if there is anyone who is aware of any patent holder of potentially essential patents. No potentially essential patents reported, and no questions asked.
4. Approve the teleconference minutes. The minutes are approved with unanimous consent.
5. Approve the minutes from the September session. The minutes are approved with unanimous consent.

**Discussion on PAR and CSD documents**

1. 802.11 EHT Proposed PAR, 11-18/1231r2 – Laurent Cariou (Intel)

**C (Comment/Question):** The Real Time Application (RTA) TIG will have a presentation on Thursday.
 **C:** Brian Hart (Cisco Systems) and Laurent Cariou (Intel) et al. will discuss and come up with some formulations for the PAR.

**C:** In the scope of the project it reads “modes”, can we change it to “at least one mode”?
2. EHT draft proposed CSD, 1233r2 – Laurent Cariou (Intel)

**C:** We need to work on some parts of the language.

**Presentations**

1. “Terminology for AP Coordination”, 11-18/1926r2 – Sameer Vermani (Qualcomm)

**Summary:** The purpose of this presentation is to cralify the terminology used for different levels of AP coordination. Use the term “coordination” when data of one user is sent from a single AP, and use “joint” when data of one user is sent from multiple APs.

**C:** I have two questions. Dynamic AP selection, would it be more coordinated or more joint processing?
**A (Answer):** It probably falls more under the coordinated technique.
**C:** The second question. You seem to focus more on downlink.
**A:** Yes.

**C:** Can you go to slide 8. Do you want to call it Distributed MU or joint transmission?
**A:** Distributed MU is a type of joint transmission.

1. “EHT Channel Modeling”, 11-18/1902r1 – Jianhan Liu (Mediatek)

**Summary:** How to incorporate the 16 spatial streams and 320 MHz bandwidth? Suggestion to add antenna correlation parameters.

**C:** I agree that we should go away from uniform linear array.
**A:** Next time we can discuss a few configurations.

**C:** Are you proposing a 640 MHz PPDU bandwidth?
**A:** Yes.
2. “HARQ Feasibility for EHT”, 11-18/1992r1 – Hongynan Zhang (Marvell)

**Summary:** Some simulations comparing ARQ with HARQ (chase combining). Gain can be seen in all setups studied.

**C:** When you mention that you operate at MPDU level. Do you assume that the whole A-MPDU is retransmitted or only the individual MPDUs? How do you index these things in PHY?
**C:** Some new signalling may be needed.

**C:** Can you go to slide 11. Higher and higher SNR gives better and better performance gain. How is this possible. How can you obtain almost two times the baseline at the high SNR.
**C:** It has to do that the baseline is not doing link adaptation.

**C:** I am not sure the simulation setup is accurate. I think you should divide by 4000, not 1000.

**C:** I like the results and believe this is an interesting direction.

**C:** For the ARQ retransmission, is everything identical?
**A:** Yes.

**Wednesday 16 January 2019, PM2 Session**

**Introduction**

1. The Chairman (Michael Montemurro) calls the meeting to order. About 150 people in the room. The chair discusses the agenda.
2. Laurent Cariou (Intel) speaks up. Can we take the presentation related to the PAR and CSD before we continue with the presentations? This is an agenda item from Thursday.
3. Nobody speaks up against that. The following agenda accepted:
	1. **Call to Order**
	2. Presentation of doc 11-19/0137r1 from RTA TIG
	3. **Continue working on PAR and CSD**
	4. Approval of PAR and CSD
	5. **Technical contributions (s.14) – (20 min for presentation/Q&A)**

**Presentation**

1. “RTA report summary”, 11-19/0137r1 from RTA TIG – Alan Jones (Activision)

**Summary:** Alan Jones goes through a summary of the RTA report. Main challenge seems to be latency and reliability. Recommendations: Implement QoS prioritization for RTA. Develop new MAC/PHY to address low latency, low jitter, and reliability.

**Straw poll:** “EHT SG should consider mechanisms to minimize the worst-case latency, low jitter and reliability requirements identified in the RTA TIG report (11-18-2009r4) as part of the scope of the EHT project.

**Yes / No / Abstain: 86 / 0 / 7**
2. “EHT draft proposed PAR”, 11-18/1231r3

**Summary:** Nothing is changed, but some parts were moved to the CSD.
3. “EHT draft proposed CSD”, 11-18/1233r3

**Summary:** Some new paragraphs added.

No comments. Laurent wants to run a motion to approve the PAR and CSD documents. 18/1231r4 and 18/1233r4 created as clean versions of the above.
4. **Motion**, “PAR Approval Motion” 11-19/2110r6 slide 15, to approve the PAR document 18/1231r4.

**No comments.**

**Yes: 97
No: 0
Abstain: 2**
5. **Motion**, “CSD Approval Motion”, 11-19/2110r6 slide 16, to approve the CSD document 18/1233r4.

**C:** We need to add several references.
**Resolution:** The references are to be added before March.

**Yes: 97
No: 0
Abstain: 3**

**Presentations**

1. “Consideration on multi-AP coordination for EHT”, 11-18/1982r1 – Kiseon Ryu (LG Electronics)

**Summary:** Definition of new type of devices (master AP, slave AP). Coordination features can be categorized in levels with different requirements. Going through some examples of the different levels.

**C:** On slide 6 are you trying to measure the channel?
**A:** I assume channel reciprocity.
2. “HARQ performance analysis”, 11-18/1979r1 – Tianyu Wu (Samsung)

**Summary:** Introduce the different modes of HARQ (chase combining and incremental redundancy). There is some extra complexity and cost required to introduce HARQ. Performance results show that HARQ provides improved performance. With bursty interference, the gain is negligible. They believe it is not clear that HARQ would provide the desired performance gain.
3. “Joint Processing MU-MIMO”, 11-19/0094r0 – Ron Porat (Broadcom)

**Summary:** Some simulations to evaluate if clock inaccuracies may prohibit joint transmission. The conclusion of the simulations is that the phase drifts can be compensated with enough accuracy. They believe that the joint transmission can work.

**C:** Question on slide 10. Here you assume that the links are all the same, this seems a bit optimistic.

**Thursday 17 January 2019, AM2 Session**

**Introduction**

1. The Chairman (Michael Montemurro) calls the meeting to order and informs that we are going to start immediately with the presentations. Agenda:
	1. **Call to Order**
	2. **Technical contributions (s.14) – (20 min for presentation/Q&A)**

**Presentations**

1. “EHT Use Case Discussion: VR Requirement Follow Up”, 11-18/1954r2 – Xun Yang (Huawei)

**Summary:** They present requirements for VR. In particular, the required transmission time for data is about 2 ms. Tests have been performed confirming that there is a challenge with the current standard.

**C:** You are treating the VR system as a wireless display. The actual problem is the rendering due to the head movements.

**C:** In your test, did you have one person? I would like to consider social gaming with more than one person in the room.

**C:** Did you consider direct transmission without going through the AP, i.e., directly from the PC.
**A:** You can consider the AP to be the PC.
2. “Overview of PHY features for EHT”, 11-18/1967r1, Eunsung Park (LG)

**Summary:** They list some of the features proposed for EHT. Some of these features require PHY updates.
- 320 MHz BW – They believe we need to define tone plans, pilots, STF and LTF sequences. They say we can reuse many things from the 80 MHz implementations. For the EHT SIG field, they believe that repeating the duplicate structure used previous suffers from large overhead.
- 16 SS – Feedback overhead reduction. They say we need some methods for overhead reduction. We need to design P-matrix and CSD tables than can cover 9 to 16 SS.
- Multi-AP coordination – They say that several factors need to be considered, such as: sampling frequency offset, carrier frequency offset, phase drift, transmission timing and power imbalance. AP selections and sounding procedures are required.
- Additional features to consider: PPDU format (we may need backwards compatibility), Higher MCS (for example 4096 QAM, non-uniform constellation), HARQ (if PHY header works but MPDU fails, NACK can be sent).

**C:** On slide 18. You say that even in the 6 GHz band we may want to use the same EHT PPDU as in the other bands. But for large bandwidths that would increaset he overhead significantly.

**C:** I have a question about the LTF overhead for the 16 SS. This sounds like the interpolation defined in .11n, but for 16 SS you need to run with 16 different combinations now and maybe the performance will drop severely.

**C:** I have a comment on the puncture point (slide 6). Maybe we should consider lower bandwidths, at least 20 MHz but maybe also smaller (5 MHz, 10 MHz, for example).
3. “HARQ in EHT”, 11-18/2029r1 – Imran Latif (Quantenna)

**Summary:** We want to test the pure PHY gain. We set up as simple scenario as possible. HARQ with Chase Combining (CC). The performance is better for HARQ-CC. They believe that the sweet spot for HARQ is for range extension. They look at implementation aspects of HARQ in EHT.

**C:** Did you consider preamble header?
**A:** No.
**C:** We have looked at this, and with the preamble header you don’t get the expected gain.

**C:** Are you going to consider incremental redundancy (IR) and do simulations for that?
**A:** Yes.

**C:** You mentioned link adaptation? Can you elaborate.

**A:** In this case the PER was 10% and ideal link adaptation.

**C:** I have a few questions on the simulations. Is this one retransmission results?
**A:** Yes.
**C:** Do you use any rate adaptation?
**A:** I use the same MCS for retransmissions.

**C:** Do you take the preamble into account when you count the throughput.
**A:** No, I only consider the actual data.

**C:** You say that in low SNR, it can be used for range extention. But I believe we are range limited by the preamble.
**A:** You are right, so we would have to send the preamble with more power or something like this.

1. “HARQ in Collision-Free and Collision-Dominated Environments”, 11-18/0080r1 – Kome Oteri (InterDigital)

**Summary:** They want to study the performance in collision-free versus collision-dominated environments. HARQ can also be adaptive (changing MCS / channel recources / etc) for retransmissions. HARQ may also be synchronous and non-synchronous. In the collision-free case they see a gain. For the collision-case, with a collision aware HARQ scheme there is always a gain, but for the high SNR region, the collision unaware HARQ does not show good performance.

**C:** In your evaluation did you test the preamble error.
**A:** No.

**C:** On the bit level there are simple schemes we would like to try.
**A:** True.

**C:** Can you go to slide 11. Is this long term SNR or short term SNR?
**A:** Long term.
**C:** One MCS for all the transmissions?
**A:** Yes.
**C:** When you say ideal link adaptation, what do you mean?
**A:** I go to the outer envelope. That is, I simulate all MCSs and then pick the MCS providing best performance for a particular point.
**C:** When you say BCC 1tx, do you mean BCC 4tx?
**A:** Yes.

**C:** I noticed that your packet sizes vary significantly. But the number of retransmissions stays the same.
**A:** Yes.

**C:** Based on simulations, you say that you have a collision aware system. How do you do that in practice.
**A:** There are methods to solve this.

**C:** These are AWGN results?
**A:** The first test simulations are AWGN, but the second simulation is TGnD channel model.
**C:** You have no gain in the higher SNRs, but in the lower you have. This is conflicting with what other companies have shown.
**A:** In the simulation 1 I have only 1 MCS.
2. “Coordinated Multi-AP Transmission for EHT”, 11-19/0071r0 – Kome Oteri (InterDigital)

**Summary:** We are looking at coordinated OFDMA. Two options. Option 1: coordinates RUs for all its STAs. Option 2: Only the STAs in the cell edge are coordinated.

No comments.
3. “Distributed MU-MIMO “, 11-19/0089r1 – David Lopez-Perez (Nokia)

**Summary:** We need a D-MIMO processing unit. There is a non-negligable requirement on the fronthaul. We need some centralized CSMA/CA. Existing architecture models cannot handle this.

**C:** What is the purpose of the fronthaul in the DL?
**A:** You carry the I/Q samples from the D-MIMO processing unit to the D-MIMO APs.
**C:** For uplink this is the case yes, but for downlink this is not needed. It is enough with the
**A:** Yes you are correct.

**C:** Comment to previous speaker. To enable this, there are many ways to do it. You want to use a precoding matrix, but you also need to distribute the data, which requires a huge backhaul. So, I agree with this presentation – this is a valid concern.

**C+A:** It is very vague what is an access point now, since we are splitting things on both the PHY and MAC layers.
4. “Beamforming Gain for Distributed MIMO”, 11-19/0091 – Sigurd Schelstraete (Quantenna)

Summary: We have more or less settled on the terminology of coordinated and joint transmissions. Joint beamforming applies BF precoding using all available antennas as a virtual single antenna array. This gives the beamforming gain, but also a power gain versus a single AP. How does the imbalance (i.e., different channel conditions to two APs)? Conclusion is that we need path loss between the two APs to the STA to be within ~10 dB of each other.

**C:** I am questioning the setup here. I think the reason for introducing the distributed MIMO is that we have severely overlapping BSSs with lots of STAs and much interference. I think those more practical scenarios are the interesting ones.
**A:** I agree we need to check the different use cases.

**C:** The Multi-AP topic is not a comparison to one AP. It is an extension to already deployed mesh-like scenarios.
**A:** The decision on which deployment you go for will be based on performance.

**C:** When you introduce the second AP it always comes as worse than the first AP. In practice, a second AP may in fact be better than the first AP.

**Thursday 17 January 2019, AM2 Session**

**Introduction**

1. The Chairman (Michael Montemurro) calls the meeting to order. Around 70 people in the room. Agenda:
	1. **Call to Order**
	2. **Contributions(s.14) – (20 min for presentation/Q&A)**
	3. **Preparation for March 2019 Session**
	4. **Teleconferences**
	5. **Old Business**
	6. **New Business**
	7. **Adjourn**

**Presentations**

1. “Joint Beamforming protocol simulation”, 11-19/0092 – Sigurd Schelstraete (Quantenna)

Summary: Constrained MU-MIMO: Master AP and slave APs introduces a slave trigger. There needs to be some backhaul mechanism. System simulations with the full MAC. Conclusion with a wireless backhaul is that there is no gain to be obtained. With a wired backhaul performance gain can be seen (particularly at cell edge), but coordinated operation (choosing the best AP of each transmission) may outperform joint BF.

**C:** Compared to having one AP with twice as many antennas, would we still see a gain?
**A:** In this case we also get a power gain since both APs are transmitting at full power, you would not see this power gain in the single AP case.
2. “AP-Coordination-in-EHT”, 11-19/0103r0 – Jason Yuchen Guo (Huawei)

**Summary:** There are AP coordination schemes that have not yet been considered. Coordinated spatial reuse.

**C:** Have you compared this scheme to the color bits available in TGax?
**A:** No.
3. “Functional Requirements”, 11-19/0105r1 – Yonggang Fang (ZTE)

**Summary:** This document provides an outline of functional requirements.

**C:** I think this presentation mentions many interesting aspects, which I don’t think we know the answer to yet. Therefore, I would discourage to run the strawpolls at this time.
**A:** I will not run the strawpolls.
4. “Discussion on multiband for EHT”, 11-19/0108r1 – Nan Li (ZTE)

**Summary:** Multi-band was initially introduced in TGad. There is a mechanism fast session transfer (FST). Transparent and nontransparent FST. FST may be reused for EHT. Further enhancements for multi-band operation for EHT.
5. “Discussion on Multi-AP Coordination Type”, 11-19/0104r1 – Yusuke Tanaka (Sony)

Summary: The presentation considers enhancement of handover, transmission scheduling (time/frequency coordination). Seamless handover between APs.

**C:** In the first usecase on slide 5. Typically, the AP1 and AP2 in an enterprise scenario will operate on different channels.
**A:** They may operate in the same channel.
**C:** Again on slide 5, enterprise vendors does something like this already to find the best AP. It’s not clear to me what’s going on here.

**Outroduction**

1. The chairman brings up the agenda. There is not much preparations to do for March. The chairman has asked for 4 sessions in March meeting. He is looking over what we are going to do inbetween handling the comments to the PAR and CSD.
2. Is there anything else we need to discuss to today?
3. At 5:15 PM, the meeting is adjourned.