IEEE P802.11
Wireless LANs

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| Minutes for Task Group (TG) 802.11 beExtremely High ThroughputSeptember 2019 Meeting, in Hanoi, Vietnam |
| Date: 2019-09-30 |
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Abstract

This document contains the meeting minutes of the 7 IEEE 802.11be TG sessions held in the September 2019 interim meeting.

Rev0: First version of the document. Thanks Alfred Asterjadhi (Qualcomm) for comments.

**Session 1: Monday 16 September PM1**

**Introduction**

1. The Chair calls the meeting to order at 13:32. The agenda is found in 1397r3, the agenda 1397r4 will be the document after this meeting.
2. The Chair remainds about attendance and recaps the procedures.
3. The Chair goes through the patent guidelines and asks if there is somebody that is aware of potentially essential patents. Nobody speaks up.
4. The Chair asks if there is any objection of approving the agenda on slide 13 in 1397r3. Nobody speaks up, agenda approved.
5. **Motion to approve TG Minutes.**

Move to approve TGbe minutes of meetings and teleconferences from July 2019 meeting to today:

<https://mentor.ieee.org/802.11/dcn/19/11-19-1356-00-00be-meeting-minutes-july-2019.docx>

<https://mentor.ieee.org/802.11/dcn/19/11-19-1401-08-00be-telephone-conference-meeting-minutes-august-and-september-2019.docx> **Move:** Dennis Sundman (Ericsson) **Second:** Srinivas Kandala

**Discussion:** No discussion. **Result:** Approved with unanimous consent.

**Discussion on ad-hoc groups**

1. 11-19/1623r0 (submitted to TGax document list), ”A Proposal for Structure of the ad-hoc Groups in 802.11be” – Osama Aboul-Magd (Huawei)

**Summary:** The author summarize how ad-hoc groups were used TGac and TGax. The author proposes to have the following ad-hoc groups: PHY, MAC, AP collaboration, HARQ. He proposes to have 3 co-chairs for each ad-hoc group.

**C:** Where goes distributed MIMO?
**A:** AP Collaboration.
**C:** Maybe we can have just MAC and PHY for now and we can create new ad-hocs if it becomes needed.
**A:** These categories are in the PAR.
**C:** I think to have 4 ad-hoc groups is about right. But I believe RTA should be a separate group. I guess that would require 5 ad-hoc groups.
**A:** I am open to this.
**C:** I suggest we only have 2 ad-hocs since we anyway don’t run more than 2 sessions in parallel.
**A:** Ok.
**C:** I agree with the previous speaker.
**A:** Ok.
**C:** I think it is way to early to create these 4 ad-hoc groups. 2 ad-hocs at this point is enough.

 **Straw poll 1:**
How many ad-hoc groups do you prefer?

* + Two ad-hoc groups
	+ Three ad-hoc groups
	+ Four ad-hoc groups
	+ Five ad-hoc groups
	+ None
	+ Abstain

**Result:** Two: 67 / Three: 9 / Four: 53 / Five: 12 / None: 1 / Abstain: 2.

 **Straw poll 2:**How many ad-hoc chairs do you prefer?

* + - One ad-hoc chair
		- Two ad-hoc chairs
		- Three ad-hoc chairs
		- Abstain

**Result:** One: 5 / Two: 65 / Three: 50 / Abstain: 5.

**Motion:**Move to create 2 ad-hoc groups for TGbe

* + One ad-hoc group for MAC
	+ One ad-hoc group for PHY

**Note- Each ad-hoc group has 2 ad-hoc chairs.**

**Mover:** Po-Kai Huang

**Second:** Jianhan Liu

**Result:** Yes: 69 / No: 3 / Abstain: 20 🡪 **Motion passes.**

1. The chair announces a call for ad-hoc chairs:
	* Candidates for MAC ad-hoc.
	* Candidates for PHY ad-hoc.

The call is open until Thursday.

**Submissions HARQ**

1. **11-19/1080r0, ”HARQ Complexity”, Steve Shellhammer (Qualcomm)**
**Summary:** The authors look at complexity in terms of storage, additional computational complexity, and ”chipset size” required for different HARQ mechanisms. They consider that each log-likelihood ratio (LLR) requires 5 bits of information.

**C:** Thank you for the contribution, I believe this is very useful.
**C:** We must consider here that a STA that supports for example 320 MHz and multi-link, etc, such a STA has large complexit. In a case where not all hardware is used, it would be good if we can spend it on for example complex HARQ processes.
**A:** I agree.
2. **11-19/1098r0, ”Acknowledgement for HARQ Transmission” – Ming Gan (Huawei)**

**Summary:** The authors look at ACK schemes for HARQ transmission. In particular they consider MPDU based HARQ feedback and codeword based HARQ feedback. They conclude that for the ACK mechanism, MPDU based ACK seems to be easiest.

**C:** You feedback which MPDU was in error?
**A:** Yes.
**C**: We have a submission on this topic also, and we came to the opposite conclusion. I believe you have a misunderstanding here that we cannot really track the MPDUs down to the codeword level. Therefore I believe CW based ACK is more suitable. Looking at the table on slide 6, I disagree with all of the disadvantages of CW based ACK feedback.
**A:** We want to keep the protocol as simple as possible. I think PHY and MAC layer should have internal communication.
**C:** (1) regarding MPDU based feedback, what do you do if there is an error in the delimiter? I.e., how does the receiver know the A-MPDU structure if we have errors in there? (2) can you run any simulation on the MPDU feedback vs and CW feedback with performance? Because CW typically gives better performance.
**A:** Yes, similar performance.
3. **11-19/1132r2, ”Channel Coding issue in HARQ” – Jinmin Kim (LGE)**

**Summary:** The authors use pessimisic assumptions, but show that HARQ still provide increased goodput performance compared to ARQ.

**C:** Can you describe what you mean with optimal and suboptimal MCS? I think there are many ways the link adaptation may be performed.
**A:** Suboptimal means PER is 10% on long term, and optimal means highest throughput. On the first transmission.

**Straw poll #1:**
Do you agree to add the following text into SFD?
* TGbe shall include HARQ for unicast data and management frame transmission.
* Other frames(control, multicast and broadcast) are TBD.

**C:** Can you remove the text ”motion” from the strawpoll.
**C:** Can you change ”support” to include.
**C:** I don’t know how to vote at this stage because we don’t know all the facts yet.
**C:** I also think we need more discussion and evaluation.
**C:** There are many issues we have not yet solved, so we should wait with this strawpoll and defer it.
**C:** I agree with previous comment.

**Straw poll deferred.**

**Recess.**

**Session 2: Monday September 16 EVE**

**Introduction**

1. At 19:31 the Chair, Alfred Asterjadhi (Qualcomm) calls the meeting to order.
2. The Chair informs about the IPR policy and asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The Chair reminds about attendence.
4. The agenda for the session is found 1397r5. In this meeting we will discuss the PHY category.

**Straw polls PHY from previous meetings**

1. **11-19/1099r1, ”Preamble structure in 11be” – Ross Jian Yu (Huawei)**

**Discussion:** No discussion.

**Straw poll #1**
Do you agree that for EHT PPDU, L-STF, L-LTF and L-SIG shall be transmitted at the beginning of the EHT PPDU?

**Discussion:**
**C:** I agree to this is for 2.4 GHz and 5 GHz, but for 6 GHz band we may want to do something different.
**A:** We need to decide some things in order to move on.
**C:** I think we already had a straw poll on this.
**A:** I believe the previous straw poll was slightly different.

**Result:** Yes: 62 / No: 4 / Abstain: 15.

**Straw poll #2**
Do you agree that for EHT PPDU, the first symbol after the L-SIG shall be BPSK modulated?

**Discussion:** No discussion.

**Result:** Yes: 56 / No: 2 / Abstain: 19.
2. **11-19/1126r0, ”Enhanced Resource Unit allocation schemes for 11be” – Jianhan Liu (Mediatek)**

**Discussion:** No discussion. **Straw poll #1**
Do you support to allow more than one Resaurce Units (RUs) to be assigned to a single STA in 11be?
* Coding and interleaving schemes for multiple RUs assigned to a single STA are TBD.
* Maximum number of RUs (>1) assigned to a single STA is also TBD.

**Result:** Yes: 63 / No: 0 / Abstain: 32.

1. **11-19/1190r0, ”Improved Preamble Puncuting in 802.11be” – Oded Redlich (Huawei)**

**Summary:** Some updates from the July meeting, so going through the presentation again.

**Discussion:** No discussion.

**Straw poll #1**
Do you agree to reuse the same preamble puncture pattern for 80 MHz, 160/80+80 MHz MU PPDU as in 802.11ax?

**Discussion:**
**C:** I don’t understand this straw poll? Do you mean you want to use a preamble puncture scheme?
**A:** I mean to use the same method as in 802.11ax.
**C:** This straw poll was modified to reflect the previous speakers comment in a previous session.
**C:** You cannot have precisely the same puncturing. And for 20 MHz there is no puncturing.
**A:** We want to have as similar as possible to 802.11ax but with needed changes.

Straw poll updated to remove 20 MHz and 40 MHz. The new straw poll available in 11-19/1190r1.
**C:** If you change scheme with pattern I vote yes.

**Straw poll updated again. The new straw poll available in 11-19/1190r1:**Do you agree to reuse the same preamble puncture schemes for 20 MHz, 40 MHz, 80 MHz 160/80+80 MHz MU PPDU as in 802.11ax?

 **Result:** Yes: 39 / No: 17 / Abstain: 46.

**Submissions PHY**

1. **11-19/1486r0, ”Further discussion for 11be preamble” – Dongguk Lim (LGE)**

**Summary:** The authors look into how autodetection of TGbe preamble can work. Two methods proposed. (1) By using a BPSK modulated symbol after L-SIG and RL-SIG. (2) By letting the length field modulo 3 be equal to 0.

**Discussion:**
**C:** My understanding is that option 2 will not work.
**A:** Maybe we need more discussion on this.
**C:** (1) I think we need reduce the receiver complexity. Option 1 does not seem to be good because it is not clear how 11ax devices will react to it. (2) Slide 9, you say late detection, why?
**A:** (1) Ok. (2) We can know after decoding of the two symbols. This is later than 11ax.
**C:** Option 1 means that we will need this additional SIG field for all future generations?
**A:** Yes.
**C:** Slide8. You mention that option 2 is not flexible.
**A:** Just using the length field does not consider the identifier, for example.

**Straw poll #2**
Do you agree that the preamble of 11be PPDU includes repeated L-SIG after L-SIG?

**Discussion:**
**C:** Could you clarify the meaning of repeated L-SIG?
**A:** It’s the exactly the same as 11ax.
**C:** I think we should defer this after other presentations.
**C:** The main point of RL-SIG was range extention.

**Result:** Yes: 39 / No: 11 / Abstain: 38.
2. **11-19/1488, ”Auto-detection in 11be” – Ross Jian Yu (Huawei)**
**Summary:** The authors consider 3 options for autodetection: (0) Add a masked RL-SIG. (1) Add a masked RL-SIG and detect the modulation type (QBPSK) of the 1st symbol after the masked RL-SIG. (2) Add a masked RL-SIG and a signature symbol.

**Discussion:**
**C:** Do you think the 11ax works fine? Why would we need the signature symbol?
**A:** We need to differentiate also from 11ax.
**C:** It is enough to change the RL-SIG variant. So why would we need it?
**A:** I don’t think that is enough.
**C:** Same comment as previous speaker.
**A:** Ok.
**C:** Slide9. Why do 11a and 11n have different performance?
**A:** Because they are slightly different.
3. **11-19/1511r0, ”Preamble autodetection for 11be” – Lei Huang (Panasonic)**

**Summary:** The authors present a detection procedure for 11be. They present two options, where option 2 is the preferred version. It means that a symbol after L-SIG is present which is BPSK modulated.

**Discussion:**
**C:** For option 2, have you checked the false detection for 11ba.
**A:** No. But I think that performance should be similar to 11ax.
**C:** This is an interesting idea. Even though you have flipped the a number of tones. So the performance should be dependent on how the 11ax implements its autodetection.
**A:** I don’t think its a problem.
**C:** For the group 2 what is that?
**A:** Some independent bits.

**Recess.**

**Session 3: Tuesday 17 September PM1**

**Introduction**

1. At 13:31 the Chair Alfred Asterjadhi (Qualcomm) calls the meeting to order. Around 200 people in the room.
2. The Chair goes through the patent policy and asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The agenda for the day is presentations. The agenda is in 11-19/1397r5. In this session we discuss multi-link and begin with straw polls.

**Straw polls Multi-link**

1. **11-19/0822r1, ”Extremely Efficient Multi-band Operation” – Po-Kai Huang (Intel)**

**Discussion:** No discussion.

**Straw poll #2**

Do you support the following definition:
**Multi-link AP logic entity**: A multi-link logical entity, where each STA affiliated with the multi-link logical entity is an AP.
**Multi-link non-AP logical entity**: A multi-link logical entity, where each STA affiliated with the multi-link logical entity is a non-AP STA.

**Discussion:**
**C:** I have a concern with this architecture. Multi-link is not new and there is an architecture in 802.1ax (!). We need to look at this before we start deciding the architecture, and I also think we need to consult the architecture group.

**A:** My understanding of the 802.1ax work is that it is higher layer.
**C:** Then I encourage people to vote no if you decide to go ahead with this straw poll.
A: Ok.
**C:** I agree with previous speaker that we should consider 802.1ax.
**A:** Ok.

**Result:** Yes: 55 / No: 16 / Abstain: 46

1. **11-19/0821r3, ”Multiple band discussion” – Liwen Chu (Marvell)**

**Discussion:** No discussion.

**Straw poll**
Do you support that 802.11be allows the following operation:
- An EHT multi-link non-AP STA logical entity does multi-link setup with an EHT multi-link AP logical entity over one link.
- The links between multi-link AP entity and multi-link STA entity can be disabled or enabled.

**Discussion:**
**C:** I would like to clarify the EHT multi-link vs multi-link (with no EHT)? I would prefer to remove the term EHT in the upper sentence.
**A:** Yes I can do that.
**C:** Who decide the disabling and enabling?
**A:** Both sides can do that.
**C:** Question to the Chair. Will these straw polls be turned into motions? When are the motions?
**A:** It’s up to the person running the straw poll. Motions will be run on Thursday.
**C:** In the first bullet you mention only one link, what does that mean?
**A:** TBD.
**C:** I have the sense that this is a bit against the multi-link concept. It is not clear if the setup is done over one link yet.

**Result:** Yes: 63 / No: 5 / Abstain: 38
2. **11-19/0773r4, ”Multi-link operation framework” – Po-Kai Huang (Intel)**

**Discussion:** No discussion.

**Straw poll #3**
Do you support the following:
- Define a multi-link setup signaling exchange executed over one link initiated by a multi-link non-AP logical entity with a multi-link AP logical entity as follows:
- Capability for one or more bidirectional links can be exchanged during the multi-link setup.
- The multi-link AP logical entity serves as the interface to the distribution system (DS) for the multi-link non-AP logical entity after successful multi-link setup

- NOTE- The link is bidirectional
- NOTE- The link identification is TBD
- NOTE- Details for non-infrastructure mode of operation TBD

**Discussion:**
**C:** You mention bidirectional link. I believe this is redundant and that we should remove it.
**A:** I have added the bidirectional because of offline discussion. I can put it as a note, it will be available in 0773r5.
**C:** Do you define somewhere logical entity?
**A:** Yes I refer to the straw poll #2 in the same document.

**Result:** Yes: 59 / No: 11 / Abstain: 35.
3. **11-19/1082r1, ”Multi-link Operation: Dynamic TID Transfer” -- Abhishek Patil (Qualcomm)**

**Discussion:** No discussion.

**Straw Poll 1**
Do you support that the 802.11be amendment shall define mechanism(s) for multi-link operation that enables the following:
- Negotiate capabilities and operating parameters for multiple links during a single setup signaling exchange.
- Signaling to dynamically enable/disable link(s)
- An operational mode for concurrently exchanging frames on more than one link for a TID
- An operational mode for restricting outstanding MPDUs of a TID to be on one link at a time
- Dynamically change the mapping of MPDUs of a TID from one set of links to another set of links

**Discussion:**
**C:** Can you have one option/feature per straw poll.
**A:** Ok.
**C:** One of these items is covered by another straw poll.

**Straw poll deferred.**
4. **11-19/0823r1, ”Multi-link Aggregation” – Abhishek Patil (Qualcomm)**

**Discussion:** No discussion.

**Straw poll 1**
Do you support that the 802.11 amendment shall add a new definition as follows:
- multi-link operation (MLO) device: A logical entity that enables common management signaling between a collection of one or more Multi-Link Logical Entities (MMLEs).

- NOTE- the exact name can be changed later

**Discussion:**
**C:** Is this only management signaling?
**A:** Yes.
**C:** In the straw poll you assume a logical entity, where is it?
**A:** Above the MMLEs.
**C:** What is a device here? We have a definition of device already in the spec which is not in line with this. For example the multi-band device.
**A:** We are not going into existing framework. We are not at a spec level discussion.
**C:** It is not clear if we need this concept.
**A:** What is lacking today is a power save mechanism when we have two MAC-SAPs.
**C:** Why do we need this?
**A:** This is for power save.

**Result:** Yes: 36 / No: 21 / Abstain: 57
5. **11-19/0979r0, ”Multi-link Operation Follow-up” – Yongho Seok (MediaTek)**

**Discussion:** No discussion.

**Straw poll 1**
Do you support defining a TID-to-link mapping mechanism among the enabled links of a multi-link logical entity.
-NOTE: TID-to-link mapping can be 1-to-1 or 1-to-many.

**Discussion:**
**C:** I suggest you update the wording to remove ”mechanism to negotiate” and add mechanism after mapping.
**A:** Ok, updated. In version 11-19/0979r1.
**C:** Is this mapping dynamic or static?
**A:** It can be both. But it is not specified here.
**C:** I think you should remove the device and just have logical entity.
**A:** Ok, updated. In version 11-19/0979r1.

**Result:** Yes: 56 / No: 9 / Abstain: 55.
6. **11-19/1082r2, ”Multi-link Operation: Dynamic TID Transfer” – Abhishek Patil (Qualcomm)**

**Discussion:** No discussion.

**Straw poll 1**
Do you support that the 802.11be amendment shall define mechanism(s) for multi-link operation that enables the following:
- An operational mode for concurrently exchanging frames on more than one link for a TID
- An operational mode for restricting outstanding MPDUs of a TID to be on one link at a time

**Discussion:** No discussion.

**Result:** Yes: 60 / No: 7 / Abstain: 34.
7. **11-19/1095r1, ”Multi-link requirement discussion” – Yonggang Fang (ZTE)**

**Discussion:** No discussion.

**Straw Poll 1**
Do you support a mode of single BSS over multi links?

**Discussion:**
**C:** I think you should update to have ”a mode of operation” because it is now not clear what happens when there are multiple BSS.
**A:** Updating the text, available in 1095r2.
**C:** I think we need to define what single BSS means in this context. Because we have the MLLE as defined by Po-Kai. We should update the text to have single MAC-SAP address.
**A:** This is high level. From a STA point it’s single. I prefer my text.

**Result:** Yes: 11 / No: 27 / Abstain: 68.

**Recess.**

**Session 4: Tuesday 17 September EVE**

**Introduction**

1. The Chair, Alfred Asterjadhi (Qualcomm), calls the meeting to order at 19:31.
2. The Chair goes through the patent policy and asks if somebody is aware of any potentially essential patents. Nobody speaks up.
3. The Chair reminds that we will have the final call for ad-hoc chairs on Thursday.
4. In this meeting we will have presentations from Latency category and HARQ if time permits.

**Submissions RTA/Latency**

1. **11-19/1523r0, ”Performance evaluation of deterministic service for EHT” – Suhwook Kim (LGE)**

**Summary:** The authors present simulation results where latency is compared with interference. They run only OFDMA scenario. They observe that it can be challenging in OBSS environment to support deterministic services.

**Discussion:**
**C:** Why is the latency for uplink traffic worse than the downlink?
**A:** It may be because of TF transmission.
**C:** Slide15. The last bullet. Why do you say that?
**A:** TF doesn’t affect the performance as seen in Slide 13.
**C:** If you have OBSS how can you guarentee that you can transmit a TF every 4 ms?
**A:** Sometimes the TF will be delayed a few ms.
**C:** Did you experience any hidden nodes problem?
**A:** Yes at some points.
**C:** Slide6. So the cloud gaming scenario, some packets are extremely small? And then you send trigger frames every 4 or 8 ms. Did you check occurance of retransmissions? I think by sending trigger frames more often can improve the performance.
**A:** Yes some packets are very small. We didn’t check retransmissions. Regarding the trigger frame frequency: ok.
2. **11-19/1524, ”Latency enhanchement for EHT” – Suhwook Kim (LGE)**

**Summary:** They address features to support low latency traffic in EHT. Among them, low latency queue EdCAF based on 802.11aa. Also OFDMA is considered.

**Discussion:**
**C:** Slide4. Do you believe .11aa can be used immediately or do we need new concepts?
**A:** I am open to it.
**C:** How do you define the worst-case scenario? Could it be that each BSS has different worst-case?
**A:** We have not defined that. In my opinion it means that each packet is almost bounded latency. Yes we need to figure out what to do with OBSS.

**Straw poll 1**
Do you agree to add the following into the TGbe SFD?
- An EHT non-AP STA may use a new EDCAF for low latency traffic when the worst case has occured.
- Definition of worst case is TBD.

**Discussion:**
**C:** Are you suggesting a new access category?
**A:** Yes
**C:** We have to define the worst case.
**A:** True.
**C:** Slide4. You are generating a new queue. You want to base the new queue on VO and VI. It seems complicated.
**A:** Ok.

**Straw poll deferred.**
3. **11-19/1538r1, ”Use of Uplink Persistent Allocation for RTA” – Xin Zuo (Tencent)**

**Summary:** The authors consider to use Uplink Persistent Allocation (UPA) to shorten the overhead of the trigger frame. They believe this may be used to improve the latency.

**Discussion:**
**C:** You have small packets. For real time gaming, will the packet be small still?
**A:** I can’t forsee the future. But I suspect it will be similar to what we have assumed here.
**C:** On slide6. Why do you assume 1 octet?
**A:** I just make some assumptions.

**Submissions HARQ**

1. **11-19/1133r0, ”Some results on HARQ performance in dense deployments” – Leif Wilhelmsson (Ericsson)**

**Summary:** The authors introduce a concept they call multi-layer approach. They claim that under varying channel conditions, the multi-layer approach performs better than the standard approach.

**Discussion:**
**C:** I can see why this is good for broadcast, but can you elaborate on if it really has a merit in a single link case?
**A:** Consider slide4, we see that typically Wi-Fi networks are interference limited. Therefore link adaptation is very difficult.
**C:** I understand the multi-layer aspect, but I don’t understand the HARQ aspect?
**A:** The concept with multi-layer can be used without HARQ, but the performance does not become so good. With HARQ the performance becomes better.
**C:** It sounds like we get something for free here. There is no such thing as a free lunch.
**A:** Performance wise it’s not a free lunch because we are operating at a non-optimal MCS.

**Straw poll 1**
Do you believe multi-layer transmission should be considered for EHT?

**Discussion:** No discussion.

**Result:** Yes: 9 / No: 0 / Abstain: Many.
2. **11-19/1146r0, ”HARQ Punctured CC Performance Evaluation” – Yanyi Ding (Panasonic)**
 **Summary:** The authors have performed some simulations and summarize that HARQ punctured CC performs better than HARQ regular CC.

**Discussion:** No discussion.
3. **11-19/1196r1, ”Combined HARQ and Rate Adaptation” – Sebastian Max (Ericsson)**
**Summary:** The authors have performed simulations to study link adaptation impact on HARQ. For moving environments, HARQ seems to be benificial. Aggressive link adaptation seems to perform better than less aggressive.

**Discussion:**
**C:** What impact does the packet size have to the result?
**A:** Nothing since we use A-MPDU. We could have chosen different size distribution.
**C:** Do you have frequency diversity?
**A:** No.

**Recess.**

**Session 5: Wednesday 18 September PM2**

**Introduction**

1. The Chair, Alfred Asterjadhi (Qualcomm) calls the meeting to order at 16:01 and mentions that the agenda can be found in 1397r6. Around 150 people in the room.
2. The Chair asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The Chair updates the nominees for ad-hoc chairs.
4. Today we have presentations related to Multi-AP coordination.

**Straw polls Multi-AP**

1. **11-19/1129r2, ”Consideration on Multi-AP Coordination” – Nan Li (ZTE)

Discussion:** No discussion.

**Straw poll**
Do you agree that a STA may inform its associated AP a set of recommended APs for joint/coordinated transmission?
- The detailed signaling is TBD.

**Discussion:** No discussion.

**Result:** Yes: 14 / No: 1 / Abstain: 48.
2. **11-19/1103r0, ”Efficient Operation for Multi-AP Coordination” – Sungjin Park (LGE)**

**Discussion:** No discussion.

**Straw poll**
Do you support to define the procedure to confirm APs participation in the Multi-AP transmission scheme?
- Multi-AP transmission scheme is TBD

**Discussion:**
**C:** Did we agree that there exist master-AP and slave-APs?
**A:** Yes.
**C:** Can you add ”to define”.
**A:** Yes. In 1103r1.
**C:** At some point there must be some data sharing going on between master-AP and slave-AP. Is this included?
**A:** Data sharing is on another band.
**C:** Can you change ”the procedure” to ”a procedure”?
**A:** Ok. In 1103r1.
**C:** Can you clarify what Multi-AP means?
**A:** Include joint transmission, etc. I can clarify, in 1103r1.
**C:** Can you say that Multi-AP is TBD?
**A:** Ok. I add a note.

**Result:** Yes: 26 / No: 5 / Abstain: 40

**Submissions Multi-AP**

1. **11-19/1451r1, ”Virtual BSS for Multi-AP Coordination Follow-up” – Sharan Naribole (Samsung)**

**Summary:** The authors study association and authentication procedures required in a Multi-AP setup.

**Discussion:**
**C:** If a STA is connected to more than 1 AP, how to deliver data?
**A:** Always a STA will have an anchor AP, which will take care of the uplink.
**C:** Why do you need a virtual-BSS?
**A:** It is conceptual.
**C:** Slide7. Who is driving the clock for STA, AP1 or AP2?
**A:** They can operate on the same channel.
**C:** Is it one BSS or many BSS?
**A:** There are severals APs, so multiple APs in the virtual BSS. Overlapping BSS exists.
2. **11-19/1534r1, ”Coordinated Spatial Reuse Performance Analysis” – Kosuke Aio (Sony)**

**Summary:** The authors consider coordinated spatial reuse in a Multi-AP scenario. With simulations they show that performance can be improved. Essentially the APs modify their TX power. Only DL.

**Discussion:**
**C:** So you coordinate the power on both sites?
**A:** Yes.
3. **11-19/1533r0, ”Consideration on Multi-AP Ack Protocol” – Kosuke Aio (Sony)**

**Summary:** The authors look at Multi-AP ACK protocol. ACK frames may collide. They provide a few options on how this can be solved. For example sequentially in time or through OFDMA.

**Discussion:**
**C:** We already have solutions for this with MU-MIMO and OFDMA.
**A:** Yes.

**Straw poll 1**
Do you agree that 11be should support a collision avoidance scheme of acknowledgement frames for Multi-AP coordination?

**Result:** Yes: 5 / No: 11 / Need more information: 65
4. **11-191535r0, ”Sounding for AP Collaboration” – Junghoon Suh (Huawei)**

**Summary:** The authors present ideas for how NDP frames can be sent for obtaining CSI. In particular we need to get CSI for all APs.

**Discussion:**
**C:** I have a contribution similar to yours, so I would like to present before you run straw polls. With compressed feedback you need the joint sounding. For serial sounding there is already a perfectly fine protocol in place.
**A:** Ok.
**C :** Can you go to option 2. Did you check the performance on this?
**A:** I am investigating this scheme.

**Recess.**

**Session 6: Wednesday 19 September AM2**

**Introduction**

1. The Chair, Alfred Asterjadhi (Qualcomm), calls the meeting to order 10:32.
2. The Chair asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. Final call for ad-hoc chairs. The call is closed at 10:34.
4. Today we will go through presentations related to MIMO and then backlogged strawpolls.
5. The Chair asks if there is any objection to approve the agenda. Nobody speaks up. Agenda approved.

**Submissions MIMO**

1. **11-19/1495r0, ”Further Discussion on Feedback Overhead Reduction” – Wook Bong Lee (Samsung), presented by Ruchen Duan (Samsung)**

**Summary:** The authors believe we need overhead feedback reduction scheme for MU-MIMO. They believe the overhead reduction scheme presented here provides 2-3 dB gain over conventional beamforming feedback.

**Discussion:** No discussion.

**Straw poll #1**
Do you support to have a SU compressed beamforming scheme in 11be?
- Number of rows (antennas), Nr = 2 – 16
- Number of columnns (streams), Nc = 1 – 16
- Develop simple extension/modification to 11ax compressed beamforming if necessary

**Discussion:**
**C:** Is there any reason why you map rows and columns to antennas and streams?
**A:** This map is in the spec.
**C:** Is the intent to have the compressed beamforming scheme as defined in 11ac/11ax in SU?
**A:** Yes.
**C:** So in this straw poll, do you want to introduce the new scheme or not?
**A:** In this straw poll we want to use the existing method.
**C:** Maybe you can add a modification to the straw poll to make it more clear.
**A:** Ok, good idea. I will defer this straw poll to update it.

**Straw poll #2**
Do you support to have an overhead reduction scheme for explicit feedback in 11be?
- Focusing on MU-MIMO feedback with number of columns/streams (Nc) 1-4 and number of rows/antennas (Nr) 9-16.
- Other cases. TBD.

**Discussion:**
**C:** It is very unclear to me what you want to achieve with this straw poll.
**A:** I will discuss with Wook Bong and come back.
2. **11-19/1555r0, ”Remarks on P matrices for EHT” – Miguel Lopez (Ericsson)**

**Summary:** The authors have designed new P-matrices. They provide examples of (+-1) matrices for sizes 12, 16, and examples of (+-1, +-j) of orders 10, 14.

**Discussion:**
**C:** Can you use DFT matrices instead?
**A:** Yes.
**C:** There are other approaches to do channel training than extending the P matrices. So we should study these other options further.
**A:** Good comment.
**C:** The M-10 and M-14, are they really orthogonal?
**A:** Yes.
**C:** I believe the DFT is good.
**A:** That is correct and the DFT is an excellent choice. But the fact remains that the (+-1) and (+-1, +-j) matrices require less complexity.
**C:** What is the baseline here?
**A:** This solution is at least as good as the DFT. I want to make sure we don’t consider matrices that are more complex than DFT.
3. **11-19/1585r1, ”Orthogonal Sequence based Reference Signal for LTF Reduction” – Junghoon Suh (Huawei)**

**Summary:** The authors propose to allocate non-overlapping subcarriers to different antennas to reduce the number of LTF symbols for channel training (i.e., wideband channel estimation).

**Discussion:**
**C:** You say that you have a shorter channel estimation section, and the performence is better.
**A:** I believe it is a smoothing gain.
**C:** But you can do smoothing even with a larger channel estimation section.
**A:** I don’t do smoothing, only interpolation. So interpolation gain.
**C:** I want to see results with more than 8 spatial streams since 8 SS is already there.
**A:** Ok.

**Submissions on HARQ**

1. **11-19/1172r1, ”Discussion on HARQ” – Ruchen Duan (Samsung)**

**Summary:** The authors discuss retransmission scheduling, HARQ control information and its exchange, HARQ Unit for retransmission, ACK/NACK channel.

**Discussion:**
**C:** Are the two retransmission strategies you have considered your contributions?
**A:** We are open for discussion, but these are the ones we could think of.
**C:** Slide10. The fragmentation mentioned is it on CW boundry or splitting CW.
**A:** It’s integer number of CW so CW boundry.

**Straw polls Multi-link**

1. **11-19/1144r3, ”Channel Acess for Mult-link Operation” – Insun Jang (LGE)**

**Discussion:** No discussion.

**Straw poll 1**
Do you agree that the 802.11be amendment defines Asynchronous mode for multi-link operation?
- Asynchronous mode means frames are transmitted independently over multiple links by STAs belonging to a multi-link logical entity (MLLE) regardless of downlink or uplink.
- Note: Exact name of mode can be changed.

**Discussion:**
**C:** In asynchronous mode TXOP is independent?
**A:** Yes.
**C:** In synchronous mode TXOP must be dependent?
**A:** I am not sure what you are aiming at.
**C:** Did you upload document?
**A:** No.
**C:** I believe the language here is too strong. The asynchronous mode should be considered together with the synchronous mode. I think these modes need to be discussed further. I also don’t think these should be mandatory.
**A:** Ok, thank you.
**C:** Can you change the text ”shall support” to defines. Ok,

**Result:** Yes: 42 / No: 12 / Abstain: 43
2. **11-19/1116r2, ”Channel Access in Multi-band operation” – Yunbo Li (Huawei)**

**Discussion:** No discussion.

**Straw poll #1**
Do you agree the PPDU bandwidths on multiple links between two multi-link logical entities follow below rules?
- The PPDU bandwidth on each link could be different
- The PPDU bandwidth on each link is only depends on the CCA results of its own link:
- The bandwidth of a PPDU in a TXOP shall be smaller than or equal to the bandwidth of initiate PPDU in the same TXOP.

**Discussion:**
**C:** On the third bullet I think you have to remove the previous.
**A:** Ok.

**SP is deferred.**

**Recess.**

**Session 7: Thursday 19 September PM2**

**Introduction**

1. At 16:01 the Chair, Alfred Asterjadhi (Qualcomm) calls the meeting to order. The agenda is in document 1397r9. Around 200 people in the room.
2. The Chair reminds to take attendence.
3. The Chair asks if anyone is aware of potentially essential patents. Nobody speaks up.
4. The Chair if there is any objection to approve the agenda with unanimous consent. Nobody speaks up.

**Ad-hoc chair election**

1. The voting process is explained in slide 31. The Chair asks if there is any objection to follow the process explained in slide 31. Nobody speaks up.
2. While the WG officers proceed with counting the votes, we (the TG) will proceed with the agenda.

**Straw poll MAC**

1. 11-19/1117r2, ”Direct Link MU-transmissions” – Stephane Baron (Canon)

**Discussion:** No discussion.

**Straw Poll #1**
Do you support that the 802.11be amendment shall define mechanism(s) for an AP to initiate a Direct Link (peer-to-peer) transmission?

**Result:** Yes: 36 / No: 0 / Abstain: 59.

**Motions**

1. **Motion 1:** Slide 55 in 1397r9
Move to add the followings to the 11be SFD:
- For EHT PPDU, L-STF, L-LTF and L-SIG shall be transmitted at the beginning of the EHT PPDU.
- For EHT PPDU, the first symbol after L-SIG shall be BPSK modulated.

**Move:** Ross Jian Yu
**Second:** Bin Tian

**Result:** Motion passes with unanimous consent.

1. **Motion 1a:** Slide 56 in 1397r9.
Move to table Motion 2

**Move:** Osama Aboul-Magd
**Second:** Jarkko Kneckt

**Result:** Yes: 43 / No: 29 / Abstain: 17 🡪 **Motion passes. Motion 2 is tabled.**
2. **Motion2:** Slide 57 in 1397r9
Move to add to the specification framework document:
- Define a TID-to-link mapping mechanism among the enabled links of a multi-link logical entity.
- Note: For each TID, TID-to-link mapping can be 1-to-1 or 1-to-many.

**Move:** Yongho Seok
**Second:** Po-Kai Huang

**Discussion:**
**C:** It’s not clear about the TID-to-link. I believe it should be 1-to-all. I don’t believe this motion is needed.
**A:** The motivation is that we want an architecture that supports what people are working on.
**C:** I don’t understand how to use this motion.
**A:** Ok.
**C:** Is this determined at association?
**A:** We just want to cover which operation is allowed.
**C:** I believe we should postpone this motion because we don’t know if we want/need this.
**A:** I don’t want to postpone.
**C:** What if this motion approved, but a motion for multi-link fails?
**A:** No comment.
**C:** I move to table the motion.

**Motion tabled.**
3. **Motion 3a:** Slide 58 in 1397r9
Move to table Motion 3.

**Move:** Osama Aboul-Magd
**Second:** Yunbo Li

**Result:** Yes: 26 / No: 40 / Abstain: 31 🡪 **Motion fails. Motion 3 is not tabled.**
4. **Motion 3:** Slide 59 in 1397r9.
Move to add the followings to the 11be SFD:
- Multi-link logical entity: A logical entity that has one or more affiliated STAs. The logical entity has one MAC data service interface and primitives to the LLC and a single address associated with the interface, which can be used to communicate on the DSM.
- NOTE – A Multi-link logical entity allows STAs affiliated with the multi-link logical entity to have the same MAC address
- NOTE – The exact name can be changed

**Move:** Po-Kai Huang
**Second:** Liwen Chu

**C:** I would like to have a motion to table this motion.
**A:** Motion failed.
**C:** What is an entity? I think we should change ”entity” to ”capable device”.
**A:** I prefer to keep entity because I prefer it. I have the note that it can be changed.
**C:** I believe entity conflicts existing terminology in spec, so why do we use it?
**A:** Ok.

**Result:** Yes: 51 / No: 29 / Abstain: 27. 🡪 **Motion fails.**

**Announcement:** The voting results are available. The chair asks if there is any objection to temporarily change topic, announce the voting results and confirm the ad-hoc chairs. Nobody speaks up.

**Ad-hoc chairs discussion**

1. Dorothy Stanley (WG chair) presents the results.
**PHY:**
Yongho Seok: 59, Jeongki Kim: 75, Liwen Chu: 66, Srinivas Kandala: 40.
**MAC:**
Bo Sun: 63, Sigurd Schelstraete: 68, Kate Meng: 51, Tianyu Wu: 77
2. **Confirmation** on slide 53 in 1397r9. Motion for ad-hoc chairs
Move to confirm the following ad-hoc chairs:
- Jeongki Kim, Liwen Chu for MAC ad-hoc group
- Sigurd Schelstraete, Tianyu Wu for PHY ad-hoc group

**Move:** Lei Wang
**Second:** Srinivas Kandala

**Confirmed by acclamation.**

 **Announcement:** Having concluded with the ad-hoc chairs confirmations, the Chair resumes the normal order of the agenda.

**Continue with Motions**

1. **Motion4:** Slide 60 in 1397r9
Move to add the followings to the 11be SFD:
- Multi-link AP logical entity: A multi-link logical entity, where each STA affiliated with the multi-link logical entity is an AP.
- Multi-link non-AP logical entity: A multi-link logical entity, where each STA affiliated with the multi-link logical entity is a non-AP STA.
- NOTE – The MAC addresses setting of STAs affiliated with the Multi-link AP logical entity or Multi-link non-AP logical entity is TBD

**Motion deferred.**
2. **Motion 5:** Slide 61
**Motion deferred.**
3. **Motion 6:** Slide 62 in 1397r9
Move to add the following text into 11be SFD:
- 11be shall allow more than one Resource Units (RUs) to be assigned to a single STA
- Coding and interleaving schemes for multiple RUs assigned to a single STA are TBD.
- Maximum number of RUs (>1) assigned to a single STA is also TBD.

**Move:** Jianhan Liu
**Second:** Bin Tian

**Discussion:** No discussion.

**Motion passed with unanimous consent.**
4. **Motion 7:** Slide 63 in 1397r9
Move to add the following text to the 11be SFD:
- The links between multi-link AP entity and multi-link STA entity may be disabled or enabled.

**Motion deferred.**
5. **Motion 8:** Slide 64 in 1397r9
Move to add the following text into the 11be SFD
- 11be PPDU shall include the repeated L-SIG after L-SIG

**Move:** Dongguk Lim
**Second:** Jianhan Liu
 **Discussion:**
**C:** I see many proposal in this direction. I think we need further evaluation. Therefore I would like you to defer this motion.
**A:** I see your comment, but I think it is very general. I don’t want to defer.
**C:** This motion does not make any sense why it differentiate 11be from 11ax. So I would like you to defer this motion.
**A:** We need another motion to differentiate 11be from 11ax. So I want to run the motion.

**Result:** Yes: 37 / No: 21 / Abstain: 26 🡪 **Motion fails.**
6. **Motion 9a:** Slide 65 in 1397r9.Move to table Motion 9.

**Move:** Huizhao Wang
**Second:** Srinivas Kandala

**Result:** Yes: 13 / No: 45 / Abstain: 26 🡪 **Motion fails. Motion 9 is not tabled.**
7. **Motion 9:** Slide 66 in 1397r9
Move to add the following to the 802.11be SFD:
- Define mechanism(s) for multi-link operation that enables the following:
- An operational mode for concurrently exchanging frames on more than one link for one or more TID(s)
- An operational mode for restricting exchanging frames of one or more TID(s) to be on one link at a time

**Move:** Abhishek Patil
**Second:** Po-Kai Huang

**Discussion:**
**C:** I would like to postpone this motion to the next session. We have a lot of material and need to work more on this.
**A:** This has been on mentor for more than a month.
**C:** I motion to table this motion.
**A:** Motion to table the motion fails.

**Result:** Yes: 63 / No: 11 / Abstain: 19 🡪 **Motion passes.**
8. **Motion 10:** Slide 67 in 1397r9Move to add the following to the 11be spec framework document
- 11be supports 320MHz and 160+160MHz PPDU.

**Move:** Bin Tian
**Second:** Jianhan Liu

**Discussion:** None.
 **Result: Motion passes with unanimous consent.**
9. **Motion 11:** Slide 68 in 1397r9
Move to add the following to the 11be spec framework document
- 11be uses the same subcarrier spacing for the data portion of EHT PPDU as 11ax data portion

**Move:** Bin Tian
**Second:** Jianhan Liu

**Discussion:** None.

**Result: Motion passes with unanimous consent.**
10. **Motion 12:** Slide 69 in 1397r9Move to add the following to the 11be spec framework document
- For 11be
 - Reuse 11ax tone plan for 20/40/80/160/80+80MHz PPDU
- 320MHz and 160+160MHz use duplicated HE160 for OFDMA tone plan
- Note:  puncturing design TBD. Non-OFDMA 320MHz/160+160MHz tone plan TBD

**Move:** Bin Tian
**Second:** Xiaogang Chen

**Discussion:**
**C:** I want to point out that I have submission on this topic. There I propose a method I believe is better than this. I would like to present. Therefore I would like to delay this motion.
**A:** I don’t think this is rushed, with a passed straw poll. Do you want to redesign the tone-plan.
**C:** Yes we have had a discussion. I’m offering an improvement and I believe the group deserves to see the different design.
**A:** I don’t want to defer.
**C:** I think we should defer this motion since there is submissions not yet presented.
**A:** Ok.
**C:** I have a similar comment. There are other contributions. We haven’t got the chance to present tone-plan related contributions.
**A:** I understand we have a backlog. There are 2-3 tone plans discussions. I’m fine with deferring.

**Deferred.**
11. **Motion 13:** Slide 70 in 1397r9Define the following multi-link operation
- Frames are transmitted independently over multiple links by STAs belonging to a multi-link capable device regardless of downlink or uplink

**Move:** Insun Jang
**Second:** Jeongki Kim

**Discussion:**
**C:** How can we move forward since we have not defined multi-link capable device.
**A:** Ok, I understand.
**C:** I believe we need to revisit the definition and thus I prefer/delay we defer this motion.
**A:** I will defer this motion.

**Deferred.**

**Open discussion**

* I would like to revisit motion 3 if there is time. Chair indicates that we need to go over teleconference plan first. If there is time we can revisit this motion.
* I don’t want to discuss features on the telephone conferences.

**Teleconference plan**

1. Straw poll on times slide 71 in 1397r9
Option 1: 19:30 – 22:00 🡪 61
Option 2: 17:00 – 19:30 🡪 43
2. 4 teleconference calls planned. Slide 72 in 1397r9.

**Adjourned.**