IEEE P802.11
Wireless LANs

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| Minutes for Task Group (TG) 802.11 beExtremely High ThroughputMay 2019 Meeting, in Atlanta, GA, USA |
| Date: 2019-05-18 |
| Author(s): |
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Abstract

This document contains the meeting minutes of the 5 IEEE 802.11be TG sessions held in the May 2019 interim meeting.

Rev0: First version of the document. Thanks to Alfred Asterjadhi for pointing out some details.

Rev1: Fixed some typos and added a motion text from the appropriate slide to the minutes. Thanks Leif Wilhelmsson for comments.

**Monday 13 May 2019, PM2 Session**

**Introduction**

1. At 4:00 PM, the Chair, Alfred Asterjadhi (Qualcomm), calls the meeting to order. Dennis Sundman (Ericsson) appointed secretary (pro tem). Alfred reminds the group to record attendance. (about 150 people in the room)
2. Alfred reminds members to report any standard essential patent claims (slides 6-8 in the agenda). Nobody speaks up.
3. Alfred goes through the remaining slides 9-11 in the agenda document 11-19/0601r1.
4. The agenda for this session:
* Call to order
* IEEE-SA IPR policy and Procedure
* Set and approve agenda
* Summary from March 2019 meeting
* TIG/SG motions
* Approve TIG/SG minutes from March meeting
* Final Call for TG officers
* TG Timeline and TG Documents
* Presentation of submissions
* Recess
1. Alfred shows the agenda for the rest of the week (slide 13).
	1. Agenda approved with unanimuous consent.
2. Alfred shows the list of submissions and asks if somebody has a presentation registered that is not listed in this list.
	1. Document 11-19/887r0 Sean Coffey (Realtek) has a presentation to add. Presentation added to the list.
	2. Document 11-19/810r0 Yusuke Tanaka (Sony) has a presentation to add. Presentation added to the list.
3. Slide 20, minutes from March EHT SG/TIG meeting:
 **Motion**: Move to approve EHT TIG/SG minutes from March meeting:

https://mentor.ieee.org/802.11/dcn/19/11-19-0531-00-0eht-meeting-minutes-march-2019.docx

**Mover**: Michael Montemurro **Second**: Dennis Sundman

**Discussion**: None.

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

1. Alfred makes the final call for TG officers.
	1. Michael Montemurro speaks up that he would like to be considered a candidate for TG vice chair.

**Discussion on TG timeline and TG documents**

1. 11-19/0787r0 “802.11 Timeline proposal” – Laurent Cariou (Intel)

**Summary:** Significant time was spent in the formation of TGax for simulation scenarios, calibration, functional requirements, evaluation methodology, higher level features. Many of these documents were then never used. He believes we should not make this mistake again. Realistically, TGbe should be possibly 6 months faster than TGax was.

**C (Comment/Question):** Probably we went too far with the documents in TGax. But maybe it would be useful with some documents. November 2021 would be a good target for draft 1.0.
**C:** Thank you for pointing out parts from the past that we can improve. I agree we should be more efficient. I think this is a good timeline.
**C:** I think the timeline looks reasonable. Since we evaluate it every 2 months, we can always adjust it if needed. I think this is a decent baseline.
**C:** I agree on most aspects in this presentation. I notice you have a shorter time for the SFD compared to TGax. Would you consider extending it to the same as TGax.
**A (Answer):** No, not at this point.
**C:** I was surprised to see the statement that TGbe would be simpler and TGax, I am not sure I buy this argument.
2. 11-19/0559r0, “IEEE 802.11 be Selection Procedure” – Alfred Asterjadhi (Qualcomm)

**Summary:** This document closely resembles the procedures used in TGax. Let’s take questions joint with the next presentation.
3. 11-19/0887r0, “ 802.11be Selection procedure clarifications”, Sean Coffey (Realtek)

**Summary:** It is always good to improve on procedures. Sean believes we can improve. Proposed clarifications to the SFD document.

**C:** What is your idea with the SFD, really?
**A:** The point is that we would like to move on to the letter ballot even if there are some SFD blocks that are not completely finished.

**Strawpoll:** Slide 24 in 11-19/0601r2. “Do you support to have 11-19/559r0 amended by the proposed clarifications in slide 4 of 11-19/887r0?”.
	1. No objections to the straw poll.
4. 11-19/719r0, “TGbe Channel Model Document” – Jianhan Liu (Mediatek)

**Summary:** For the 6 GHz channels, the propagation channels are likely very similar to the 5 GHz band. For the indoor channel models, the TGac and TGax channel models are used. For the outdoor channel models, the UMi channel models in TGax are used. We propose that we use an interpolation method on the 160 MHz channel to reach the 320 MHz channel (modifying the tap spacing). For the 16 antennas arrays, we need to spend some more work, maybe a 2D square is reasonable. Channel modelling for the Multiple AP systems we have local correlation matrices to model the surroundings of the AP and STA sides.

**C:** I have a question on section 5. In TGac, we defined a MU channel model that is different from what you propose here.
**A:** I will take a look there.
**C:** Now that we have a multiple AP, different transmit powers can be different for different APs.
**A:** The transmit power is not part of the channel, but should rather be part of the signal.
**C:** What is the proposal to model the channel between APs?
**A:** Similar way as is between AP and STA.
**C:** How do you generate the channel model for 320 MHz.
**A:** It’s the same as 802.11ac, but we interpolate to get wider bandwidth.
**C:** Is that really sufficient?
**A:** That is hard to say.
5. 11-19/722r0, “Functional Requirement Document” – Ming Gan (Huawei)

**Summary:** FRD derived from the PAR and CSD.

Some discussion on the various parts of the FRD.

**Technical submissions**

1. 11-19/780r0, “Consideration on HARQ” – Jinmin Kim (LG Electronics)

**Summary:** HARQ shows better performance than ARQ. Incremental redundancy shows better performance than chase combining in all settings except for MCS 0, 1 and 3. They believe that a max of 1 retransmission (2 transmissions in total) is sufficient to obtain most of the gains.

**C:** To use the same channel realization across all retransmissions is maybe not a good approach.
**A:** That may be correct.
**C:** I have a question on slide 9. You don’t see much difference between the CC and IR. Can you check the performance with 2-by-2?
**A:** Yes.
**C:** How was the puncturing pattern for the BCC?
**A:** I have to come back with that.
**C:** I also have a question regarding the puncturing the pattern. I believe you are retransmitting the information bits because the puncturing is not the best.
**A:** Maybe true.
**C:** Have you tried larger
**A:** No
**C:** Can you go to slide 5. MCS is selected independently for HARQ and ARQ, meaning the MCSs are different for these two?
**A:** Yes.
**C:** I’m surprised that the optimal and suboptimal MCS selection gives different results.

**Recess.**

**Tuesday 14 May 2019, AM1 Session (less than 1 hour after the WNG)**

1. Alfred calls the meeting to order at 9:05 AM.
2. Alfred asks for any potential essential patent claims. Nobody speaks up.
3. Agenda:
	1. Call meeting to order
	2. IEEE-SA IPR policy and Procedure
	3. ~~TG documents (cont.)~~
	4. Presentation of submissions
	5. Recess
4. The agenda modified and point 3 removed as shown above.

**Technical submissions**

1. 11-19/0777r1, “Performance on Multi-Band Operation” – Insun Jang (LG Electronics)

**Summary:** They show results that latency may increase by using multi-band operation for one of the BSSs (.11be BSS).
**C:** If I understand well, on slide 9, BSS2 is not colliding with BSS1 in the left side of the right test. This is not a fair test.
**A:** Ok.
**C:** It seems that the gain is coming from the fact that you move one of the BSS to a new clean spectrum. This is not showing the benefit of multi-band. I don’t think you are simulating what you want to simulate. What you have here could be designed with .11ax already.
**A:** Ok.
**C:** Have you considered the model where both APs have the same level of interference and see what are the gains in that context?
**A:** This is for showing channel access in separate band.
**C:** What kind of load did you put to the system? You had 1 AP and 10 STAs.
**A:** They could transmit at any time.
**C:** On slide 15, how come the results for these two scenarios are so similar?
**A:** The difference here is not large.
2. 11-19/0800r0, “Joint Processing MU-MIMO” – Ron Porat (Broadcom)

**Summary:** Additional simulations for assymetric links and more realistic parameters. Simulation results show that joint processing MU-MIMO provides large performance gain compared to baseline. They claim the proposed scheme is robust to various configurations.
**C:** Going back to slide 3, you are not using the maximum number of spatial streams. This is not really what we want to show. Both BSS should be working at their best (3 streams each).
**A:** I agree. We have preliminary new simulation results, but they are not fully ready yet. We can look into what you say.
**C:** What are you doing for precoding in the MU.
**A:** Zero-forcing.
**C:** If your APs are really separated, they may be operating in parallell. I.e., spatial reuse.
**A:** I agree. But here we are considering really dense network.
**C:** For total power fixed, what power did you fix to?
**A:** All APs together have the same power as the single baseline AP.
**C:** Have you checked the regulatory rules, what happens when the multiple APs are coordinated.
**A:** Yes we have checked it. There are no rules in FCC since this is a new setup. Our thought is that for MU-MIMO we think the rules should be to allow full power at each AP (since the beams go in different directions).
**C:** In slide 3 you have a model of X. Probably you should consider to extend this model so that some AP is always stronger for each STA.
**A:** I agree this can be interesting. We can discuss offline what cases are interesting.
**C:** In slide 4, I noticed that each STA has good link to at least two APs. I think you should consider random drops instead. We had some discussion on the regulatory side, a very first hint is that they are very positive to these ideas.
**A:** Good to know.

**Recess.**

**Tuesday 14 May 2019, Evening Session**

1. Alfred calls the meeting to order at 7:30 PM. Around 175 people in the room.
2. Alfred asks for any potential essential patent claims. Nobody speaks up.
3. Agenda:
	1. Call meeting to order
	2. IEEE-SA IPR policy and Procedure
	3. Presentation of submissions
	4. Recess

**Technical submissions**

1. 11-19/0766r1, “Enhanced Multi-Band/Multi-channel operation” – Yongho Seok (MediaTek)

**Summary:** They claim that a limitation for multi-band operation is that MSDUs belonging to a single TID can only use single bands. They consider sending They consider sending frames on multiple bands simultaneously. This requires some synchronization among the bands. Furthermore, they believe switching bands should be done with less/no overhead.

**C:** Can you go to slide 9. In the third case, TX and RX can not take place on different channels simultaneously?
**A:** Correct.
**C:** Can you go to slide 9. In the third example, is it possible for STAs to transmit to AP in those gaps? I don’t think the dual primary channel case solves any problem.
**A:** The STAs can transmit to AP in the gaps, but not simulated here. I agree with your assessment on the third example.
**C:** Is there interference between the bands?
**A:** No.
**C:** I have a comment on the simulation results. I don’t think it’s fair to compare the 15% with the 76% busy. For the synchronized architecture, if you put the primary channel on the 6 GHz you should get good improvement.
**A:** I agree with you.
2. 11-19/0791r1, “Effect of Preamble Decoding on HARQ in 802.11be” – Xiaofei Wang (InterDigital)

**Summary:** They consider the effect of imperfect SIG decoding for HARQ. The effect of preamble decoding depends on many parameters. If there are small data packets, low SNR, and or number of spatial streams is 1, there may be a need to improve the SIG. Conclusion is still that HARQ provides improved performance.

**C:** Can you go to slide 8. Here you mention that there is a 2 dB difference between real and ideal preamble decoding. I am not sure dB difference is a good measure since the slope may look different leading to different goodput.
**A:** You have a point.
**C:** I have a question on the simulation reference (blue curve). It’s a single transmission without any retransmission. How realistic is that?
**A:** The single transmission is only for comparison.
**C:** I would recommend that you create curves with 1, 2, 3, etc with retransmissions. And also adaptive algorithms would help.
**A:** Maybe we can do that.
3. 11-19/0811r1, “Coordinated Null Steering for EHT” – Adrian Garcia-Rodriguez (Nokia)

**Summary:** They believe null steering can provide significant benefits, but also come with significant challenges like obtaining channel knowledge. In particular the compare coordinated null steering with coordinated OFDMA.

**C:** Can you go to slide 12. On the left figure, how does AP1 know where to steer the null?
**A:** We have omitted some messages in the figure due to lack of space in the slide.
**C:** Can you go t o slide 7. You mention that null steering is effective when interference is high.
4. 11-19/0823r, “Multi-Link Operation: Design Discussion” – Abhishek P (Qualcomm)

**Summary:** We would like to agree on some terminology. “Multi Link Operation (MLO) entity”, “MLO device”, “Independent Multi Link Aggregation (MLA)”, “Simultaneous MLA”

**C:** What is the difference multi-link operation with multi-band operation?
**A:** I prefer the term link because they can be on the same band.
**C:** You don’t want to deliver the packet out of order. Where do you take care of the in order delivery.
**A:** These are details not shown. But on the receiver side we have a queue where things are ordered.
**C:** Slide 5. I don’t think we should call a logical entity for device. Because for me a device is physical.
**A:** Here is the concept.
**C:** All of a sudden we have a STA with multiple MAC.
**A:** The interface to the upper layer remains the same.
5. 11-19/0122, “Extremely efficient Multi-Band Operation” – Po-Kai Huang (Intel)

**Summary:** They are interested in extremely efficient multi-band operation which requires reducing overhead. They propose a multi-link setup which works as an association.

**C:** On slide 7, how different is the design compared to OFDMA design.
**A:** It is quite different, because in OFDMA, there is only one primary channel dictating all STAs. Here, there are different interfaces for each band.
**C:** Is this different from the the features from .11ad.
**A:** Yes.
**C:** Are you assuming half duplex of full duplex among the links?
**A:** There is no interference among them. So you can call them full duplex in that sense.
**C:** Is this extendible to the multi-AP discussions we have had also.
**A:** I think so, but it is clear that a lot of details is needed.
**C:** We don’t have clear objective on the MAC side. I don’t know if any solution presented actually solves the problem we have. We need a clear problem to solve.
**A:** I agree with you therefore it is extra important with unified framework.

**Recess.**

**Wednesday 15 May 2019, AM1 Session**

1. Alfred calls the meeting to order at 8:00 AM. The agenda document is 11-19/0601r4. Approximately 200 people in the room.
2. Alfred goes through voting procedures.
3. Alfred asks for any potential essential patent claims. Nobody speaks up.
4. Agenda:
	1. Call meeting to order
	2. IEEE-SA IPR policy and Procedure
	3. TG documents (cont.)
	4. Proposed TG structure
	5. TG officers election
	6. Presentation of submissions
	7. Recess

**TG Documents cont. (point c in the agenda)**

1. 11-19/787r1, “802.11be timeline proposal” – Laurent Cariou (Intel)

**Summary:** Minor updates to the timeline proposal.

**Motion:** **Move to adopt the following timeline for TGbe**
	* PAR approved Mar 2019
	* First TG meeting May 2019
	* D0.1 Sept 2020
	* D1.0 Letter Ballot May 2021
	* D2.0 LB Mar 2022
	* D3.0 LB Nov 2022
	* Initial Sponsor Ballot (D4.0) May 2023
	* Final 802.11 WG approval Mar 2024
	* 802 EC approval Mar 2024
	* RevCom and SASB approval May 2024

**Mover:** Laurent Cariou
**Second:** Michael Montemurro
Motion approved with unanimous consent.

1. 11-19/559r1, “TGbe Selection Procedure” – Alfred Asterjadhi (Qualcomm)

**Summary:** Some minor updates to the procedural document inspired by 11-19/0887r0.

**Motion:** Move to adopt 11-19/559r1 as the selection procedure document for TGbe.

**Mover:** Michael Montemurro
**Second:** Bin Tian
Motion approved with unanimous conent.

**Proposed TG structure**

1. The chair goes over the proposed TG structure and describes the process (appointed vs. elected roles) (11-19/0601r4, slide 34).
2. The chair appoints Dennis Sundman (Ericsson) as secretary and Edward Au (Huawei) as technical editor. Appointments need confirmation with TG majority.

**Motion:** Move to confirm Dennis Sundman as TGbe Secretary.
**Mover:** Michael Montemurro
**Second:** Lei Wang
Motion approved with unanimuous consent.

**Motion:** Move to confirm Edward Au as TGbe Technical Editor.
**Mover:** Ming Gan
**Second:** Carlos Cordeiro
Motion approved with unanimuous consent.
3. Vice chairs are elected by TG majority and confirmed by WG majority. The chair goes over the proposed election process for the TG Vice-Chairs and asks for thoughts and/or suggestions by the members for any parts of the election process

**C:** In the operations manual it says “the vice-chair”.
**A:** The operations manual is a guideline.
**C:** The main role of the vice-chair is to step in when the chair is unavailable.
**C:** These big groups run parallel sessions, so I think you need at least 2 vice-chairs.
**C:** Most likely there will be ad-hoc discussions. I suggest 2-3 vice-chairs.
**C:** I believe the ad-hoc groups are chaired by ad-hoc chairs.
**C:** If we are going to have ad-hoc chairs I believe one vice-chair is enough. But we could have the vice-chairs being the ad-hoc chairs.
**A:** The duty of the vice-chair is that if I am unavailable, a vice-chair steps in.

Alfred creates a straw poll, which can be found in slide 38 of 11-19/0601r5 to have an idea of what the groups’ preference is regarding the number of vice chairs. Members can vote for as many options as they prefer.

**Straw Poll:** How many Vice Chairs do you prefer for TGbe?
Option 1: One vice chair: 21
Option 2: Two vice chairs: 101
Option 3: Three vice chairs: 34

Since option 2 has majority of preferences, the TG chair proposes to have two Vice Chairs. No objections by the members to proceed with electing two vice chairs for TGbe.

Alfred presents the candidates for vice chairs in a separate document.

All present members are handed ballots with the candidate’s names. The names on the ballotshad the following typos; i.e., last entry was Michael Fischer, but should be Matthew Fischer and third entry was Kiseon Ryo, but should be Kiseon Ryu. These two typos were identified prior to the voting process. The WG chair (Dorothy Stanley) made all present members aware of the typos prior to distributing the ballots. Each member is to pick 1 or 2 candidates in the check-boxes to vote.

**The chair recesses the meeting until the WG officers (WG chair and two vice chairs) count the votes (estimated recess time is 15 mins).**

**Alfred calls the meeting back to order at 9:16 AM.**

The result of the voting is presented on Slide 39 in 11-19/0601r5, and has:
1) Laurent Cariou (60 votes),
2) Matthew Fischer (57 votes)
3) Jianhan Liu (48 votes)
4) Kiseon Ryu (47 votes)
5) Michael Montemurro (35 votes),
and 3 blank returns.

The Chair prepares the confirmation motions for the two candidates that have received the top two highest number of votes, namely Laurent Cariou and Matthew Fischer. No objection to the chair’s suggestion of vice chairs order depending on the number of votes received, i.e., Laurent Cariou as first vice chair and Matthew Fischer as second vice chair.

 **Motion:** Move to confirm Laurent Cariou as TGbe 1st Vice Chair
 **Mover:** Carlos Cordeiro

 **Second:** Sean Coffey

 Motion approved with unanimous consent

**Motion:** Move to confirm Matthew Fischer as TGbe 2nd Vice Chair

**Mover:** Sai Nandagopalan

**Second:** Ming Gan

Motion approved with unanimous consent

**Technical submissions**

1. 11-19/0778r0, “Consideration on 320 MHz Bandwidth an 16 Spatial Streams” – Eunsung Park (LG Electronics)

**Summary:** They have done some thinking on what is required for 320 MHz bandwidth and 16 spatial streams.
 **C:** The 240 MHz, do you consider it to be one single band or multiple bands?
**A:** I have some ideas on that.
**C:** Can you go to slide 3. If you look at the SS definition, this is not the traditional definition of SS.
**A:** Agree.
**C:** I also like the option 1 for the 320 MHz tone plan is good because we must consider OFDMA.
2. 11-19/0637r, “Feasibility of 4096QAM” – Sigurd Schelstraete (Quantenna)

**Summary:** Is it feasible to consider 4096 QAM? Without beamforming will be hard to use 4096 QAM, but already with 4 TX antennas, it may be manageable. About 35 dB RX EVM is needed to receive 4096. They believe TX BF is essential, Low number of SS and strict RX EVM requirements (and/or multiple RX antennas).
 **C:** Probably my system would go to lower modulation and instead increase the number of SS.
**A:** Agree.
**C:** Do you have any thoughts on TX EVM requirements?
**A:** I think we can stay with the current level and that it will not be a bottleneck. Without BF you may need to modify the TX EVM.

**Recess at 9:56 AM.**

**Thursday 16 May 2019, PM2 Session**

1. Alfred calls the meeting to order at 4:00 PM. Approximately 150 people in the room.
2. Alfred asks for any potential essential patent claims. Nobody speaks up.
3. Agenda:
	* Call meeting to order
	* IEEE-SA IPR policy and Procedure
	* Presentation of submissions
	* Teleconference Plan
	* Goals for July 2019
	* Any other business
	* Adjourn

**Technical Submissions**

1. 11-19/638r0, “Nulling and coordinated beamforming” – Sigurd Schelstaete (Quantenna)

**Summary:** Nulling produces small bursts of signal energy, at OFDM symbol transitions, in the “null” direction. If the system is synchronized, this is not a problem. But often we want to null in directions of other BSS, hence no synchronization.
**C:** How long is the burst?
**A:** It is only related to the impulse response of the channel.
2. 11-19/0804r0, “Multi-AP Transmission Procedure” – Sungjin Park (LG Electronics)

**Summary:** Master AP (M-AP) and Slave AP (S-AP). Sounding NDP sent from M-AP and S-AP simultaneously. Multi-AP selection by using unoccupied Slave APs.

**C:** Question on slide 7. Are the S-APs 1 and 2 sending their NDPs at the same time? How does that affect the channel estimates?
**A:** Yes.
3. 11-19/0821r1, “Multiple Band Operation Discussion” – Liwen Chu (Marvell)

**Summary:** Two options, dynamic band switch and band switch through negotiation. Synchronized and unsynchronized PPDUs. Each band has a primary channel, each primary channel has its own EDCA parameters.
 **C:** You may need some further additions to Option 1. I think it could be not just Option 1 or 2, but rather something inbetween.
4. 11-19/0801r0, “AP Coordination in EHT” – Jason Yuchen Guo

**Summary:** There are two levels of AP coordination, level 1: coordinated and level 2: joint. We introduce a new, coordinated spatial reuse. The coordination can be used together with OFDMA.
**C:** Have you compared this to the mechanism available in .11ax
**A:** No.
5. 11-19/0731r0, “EHT Multi-link Operation” – Yongho Seok (MediaTek)

**Summary:** Technical issues with multi-link operation: MSDU ordering, duplicate detection, replay detection, etc. MSDU ordering can be alleviated by a single block-ACK.
6. 11-19/0754r0, “11be Peak Data Rate Analysis” – Ross Jian Yu (Huawei)

**Summary:** They believe a peak data rate of 100 Gbps is feasible. They believe Wi-Fi should always provide higher data-rate than cellular.
 **C:** You mention VR applications and claim that they require >30 Gbit/s. Do you have any reference to this?
**A:** In reference 3.
7. 11-19/760r1, “Multi-band Opinion” – Alan Jauh (Unisoc)

**Summary:** They propose a joint MAC but with multiple PHY for the multi-band operation. The point is that packets are transmitted on the channels at which access is first obtained.
 **C:** It seems multiple channel queue. So it can be that the same data at the same time.
**A:** We need to consider that. One way to do that is to offset the slot times in the two channels.
**C:** This is an implementation issue. I don’t think we need to standardize this.
**A:** We think the standard may need to consider that the packet has the capability to use any channel.
**C:** Can you go to slide 8, where you consider legacy device. What do you mean? Are you expecting that the legacy devices will always be on one channel?
**A:** For example 1 channel in 2.4 GHz and 1 channel in 5 GHz. Packet ABE can be used on boths channels, but packets to legacy devices are only on one channel.

**Procedual continuation**

1. Teleconference plan according to Slide 46 in 11-19/0601r7.
 **C:** What is the planned agenda for the teleconferences?
**A:** The plan is technical contributions.
2. Goals for July 2019 presented on Slide 47 in 11-19/0601r7.
3. The chair asks if there is any other business for the group’s consideration. Nobody speaks up.
4. The chair thanks the group for the participation and contributions.
5. The meeting is adjourned at 6:00 PM.