IEEE P802.11
Wireless LANs

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| Minutes for Task Group (TG) 802.11 beExtremely High ThroughputPHY ad hoc Telephone Conferences in December 2019 and January 2020 |
| Date: 2020-01-09 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
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Abstract

This document contains the PHY ad hoc meeting minutes from TGbe telcos in December and January.

* Rev0: Added meeting minutes for PHY ad hoc meeting on Thursday December 12.
* Rev1: Added meeting minutes for PHY ad hoc meeting on Thursday December 19.
* Rev2: Added meeting minutes for PHY ad hoc meeting on Thursday January 9, 2020.

**Thursday 12 December 2019, 10:00 – 13:00 ET**

**Introduction**

1. The Chair (Sigurd Schelstraete, Quantenna) calls the meeting to order at 10:00.
2. The Chair follows the agenda in 11-19/2107r4. Agenda document updated to 11-19/2107r5 after the meeting.
3. The Chair goes through the IPR policy and asks if anyone is aware of any potentially essential patents. Nobody speaks up.
4. The Chair reminds everyone to report their attendance by sending an e-mail to the Cochair, Tianyu Wu (Apple) or the Chair himself. According to the Webex app, it appears to be around 40 people in the call.

**Recorded attendance through the Webex app and/or reported attendance through e-mail:**
	* Bin Tian (Qualcomm)
	* Chenhe Ji (Huawei)
	* Dandan Liang (Huawei)
	* Dennis Sundman (Ericsson)
	* Dongguk Lim
	* Eunsung Park
	* Greg Ko
	* Humengshi
	* Jinmin Kim
	* Jinsoo
	* John Son (WILUS)
	* L. Sun (idcc)
	* Lei Wang
	* Lily Yunping Lyu
	* Ming Gan (Huawei)
	* Myeongjin Kim
	* Paul Nikolich
	* Patrice Nezou
	* Ross Jian Yu
	* Ruchen Duan (Samsung)
	* Rui Yang (InterDigital)
	* Sameer Vermani
	* Shimini Shilo
	* Si-Chan Noh
	* Sindhu Verma
	* Steve Shellhammer (Qualcomm)
	* Steve Yang
	* Thomas Handte
	* Tianyu Wu (Apple)
	* Wook Bong Lee (Samsung)
	* Yan Xin
	* Yujin Noh
5. Announcements: This session is a PHY ad hoc session.
6. Presentation order update:
	* Move 1911r0 to the top since the author can’t attend Jan F2F meetings.
	* Group the contributions on Multi-RU allocation to present together.

**Contributions**

1. **[1911r0](https://mentor.ieee.org/802.11/dcn/19/11-19-1911-00-00be-11be-channelization-discussion.pptx), “11be channelization discussion” – Si-Chan Noh (Newratek)**

**Summary:** The authors propose using segment parser to support 320MHz channel and multiple RU allocation in 11be.

**Comments:**
No dicussions.

1. [**1579r1**](https://mentor.ieee.org/802.11/dcn/19/11-19-1579-01-00be-adapting-the-11be-channel-model-to-modern-doppler-use-cases.pptx)**, “Adapting the 802.11be Channel Model to Modern(Doppler) Use cases” – Shimi Shilo (Huawei)**

**Summary:** The authors presented some Doppler channel measurement results and show TGn/ac channel model Doppler PSD does not reflect the True PSD generated by STA movement. Suggest the group to work on accommodating real-life Doppler in the channel model.

**Comments:**
C (BinTian): In the measurement, the author gives ~4Hz Doppler. Given the short wi-fi PPDU length, will this small Doppler make a difference in the performance?
A: We observe MU-MIMO severely degrade the performance when some person entering a room. MU-MIMO is very sensitive to channel change.
C: There are two layers of problem: First layer problem is what is the real-world Doppler looks like. The author did a good job to prove the theory match the measurement results pretty good. But in more complicated environment, what does the Doppler looks like? It’s very hard to capture the dopper if there are many moving objectives. Second layer, what is the sounding interval? Once you have the Dopple model, how severe will the Doppler impact the performance?
A: We can surely do more measurement. However, I think 90% of the scenarios can be covered by our measurement. I agree we can work together and discuss the measurement and impact of Doppler.

C: Do you propose to include 1-5Hz Doppler to the channel model?

A: Currently it’s only 0.5Hz in channel model for 5GHz. It does not capture the moving STA’s channel. It’s worth discuss on this topic.
C(Sameer): Slide 8. Some results look strange. Why stationary case has wider Doppler spread than person moving case?

A: Could be some environment impact during the test.

C: It will be helpful if more results or statistics can be provided.

1. [**1606r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1606-00-00be-preamble-puncturing-and-sig-b-signaling.pptx)**, “Preamble puncturing and SIG B Signaling” – John Son (WILUS)**

**Summary:** The author presented 3 options for SIG B structure and compare the performance for preamble puncturing with each option .

**Comments:**
C(Sameer): Do you consider other option such as keep 1,2,1,2 structure in one 160 and triple in other 160MHz.
A: We did not compare the performance for other options but can further consider them.
C: (Comment to the commenter) The performance should be similar.

C: Asked an option similar to Sameer. It can be mandatory in 11be for STA to decode 160MHz.

1. [**1867r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1867-00-00be-performance-comparisons-for-ltf-designs-for-eht.pptx)**, “Performance Comparison of LTF Designs for EHT” – Sameer Vermani (Qualcomm)**

**Summary:** The author compared two approaches of LTF design to support 16SS: Tone interleaved and frequency domain P matrix. Analysis and simulation results are provided with a conclusion that P-matrix in frequency domain is not a good direction to go.

**Comments:**
C: It feels to me the performance of the two methods should be very similar. The Tone-interleaved method assumes the channel on adjacent tone is very similar. Some smoothing method is needed for this approach.
A: The cross-stream leakage is the problematic part for the freq P matrix mapping method.

C: It’s fair to also apply smoothing for freq P-matrix method for comparison.

A: With simple receiver, freq P-matrix performance is much worse.

C: The cross-stream leakage term in slide 6 is very close to zero. Further smoothing will help a lot for the performance of freq P matrix method.

A: You need to have very complicated receiver to improve the performance for freq P matrix method.

C: Smoothing will help. This is same for tone-interleaved method.

C: Do you consider apply the tone interleave method to 2xLTF and 1xLTF as well?

A: This presentation is NOT proposing tone-interleaved method. But we do provided results for all 4x, 2x and 1x LTF cases.

1. [**1869r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1869-00-00be-preamble-puncturing-and-ru-aggregation.pptx)**, “Preamble puncturing and RU aggregation” – Bin Tian (Qualcomm)**

**Summary:** The author discussed three options to support RU aggregation: Multiple PSDU, Single PSDU+pre-encoding parsing and Single PSDU + post-encoding parsing. The last option is preferred by the author.

**Comments:**
C: Opiton 3 is to make new combined RU with new RU sizes?
A: Yes, we can define new interleaver etc. This presentation is about high level concept.
C: Slide 3: If one 20MHz is interfered, adjacent channel may also be affected. So, we may not want to force using RU242 on adjacent channel.

A: Preamble puncturing generally apply to >=80MHz BW. Looking at entire PPDU there are many tones, a few interfered tones may not have significant impact on the performance.

C: Does Option 3 keep same existing archeteture at transmitter?

A: For each STA, before the parser part, everything is the same. Coding is per entire PSDU across multiple RUs.

C: Do you have any simulation results for option 2 and 3?

A: From past study, we have the knowledge that option 3 has some diversity gain over option 2. But how much diversity gain depends on many things such as what RUs are combined.

SP deferred to Jan f2f meeting.

1. [**1907r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1907-00-00be-multiple-ru-combinations-for-eht.pptx)**, “Multiple RU combinations for EHT” – Jianhan Liu (Mediatek)**

**Summary:** The author proposed a number of RU combination rules and proposed a set of allowed RU combinations.

**Comments:**
C: The proposed cases seem too restricted. We should also consider average throughput gain and efficiency. I doult whether we can get enough gain with such limited set of RU combinations.
A: We can further discuss if you can show some results in your contribution.
C: Do you separate SU and MU for RU combinations?

A: We can separate them. Need further discussions.

C: What about 320MHz?

A: We may have some different design for 320MHz case but we do not have detailed solution yet.

C: You proposed to improve efficiency but not diversity gain. I donot see problem to achieve both. For small RU, optimal one and bad one may have big SNR difference. Why not consider diversity gain?

A: If you find best 52 or 106, the additional 26 may not bring much diversity gain. It’s a tradeoff between complexity of more modes and diversity gain. Efficiency is more important metric comparing to 1-2dB diversity gain. I am open to designs with diversity gain though.

1. [**1908r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1908-00-00be-multi-ru-support.pptx)**, “Multi RU support” – Ron Porat (Broadcom)**

**Summary:** The author proposed conditional mandatory list of supported large RU combinations for BW up to 160MHz. Also presented a list of small RU combinations within 20MHz and a rule that not to mix small and large RUs in RU combination.

**Comments:**
C: Recommend author to provide some simulation result to decide contiguous or non-contiguous RU combination. Slide 5: Do you always assume primary 20 is on the left most 20MHz?

A: If there is 30MHz incumbent in the middle you can put primary 20 on the left most 20. C: Why is not a good idea for partially overlap 40MHz?

A: Starting from 11ac time, the group decided to design the channelization non-overlapping. There is some problem for channel access with partial overlapping 40.

C: Why supporting [1010] configuration is difficult? With other signalling method, [1010] could be easy to support.

A: Do you have contribution? We donot like this also because there are too many holes in this mode. Even without SIG B problem, we still donot like this mode.

C: Supporting non-contiguous small RU could be important. Similar to contiguous case and can also provide better diversity gain.

A: Supporting too many modes means too many testing and other complexity. We want to limit the modes.

C: You mentioned conditional mandatory. Do you think we should define some mandatory preamble puncturing modes as a differentiate point for 11be? This can be a good mandatory feature.

A: I think it’s a good direction. We can think more on it.

**Concluding remarks**

1. Telco adjourned.

**Thursday 12 December 2019, 10:00 – 13:00 ET**

**Introduction**

1. The Chair (Sigurd Schelstraete, Quantenna) calls the meeting to order at 19:00EST.
2. The Chair follows the agenda in 11-19/2107r10.
3. The Chair goes through the IPR policy and asks if anyone is aware of any potentially essential patents. Nobody speaks up.
4. The Chair reminds everyone to report their attendance by sending an e-mail to the Cochair, Tianyu Wu (Apple) or the Chair himself. According to the Webex app, it appears to be around 55 people in the call.

**Recorded attendance through the Webex app and/or reported attendance through e-mail:**
	* Abhishek Agrawal
	* Bin Tian (Qualcomm)
	* Boyce
	* Chenchen Liu
	* Chenhe Ji (Huawei)
	* Dandan Liang (Huawei)
	* Dongguk Lim
	* Dong Xiandong
	* Dylan
	* Eunsung Park (LG)
	* Feng Jiang (Intel)
	* Genadiy Tsodik
	* Jianhan Liu (Mediatek)
	* Jinmin Kim
	* Jinsoo Choi (LG)
	* Jiny
	* John Son (WILUS)
	* Junghoon Suh (Huawei)
	* L. Sun (idcc)
	* Leonardo Lanante
	* Lily Yunping Lyu
	* Louhx
	* Meihong Zhang
	* Mengshi Hu
	* Miguel Lopez
	* Paul Nikolich
	* Phillip Oni
	* Ron Porat
	* Ross Jian Yu
	* Roya
	* Ruchen Duan (Samsung)
	* Rui Cao (NXP)
	* Rui Du
	* Rui Yang (InterDigital)
	* Sameer Vermani
	* Srinath Puducheri Sundaravaradhan
	* Steve Yang
	* Sudhir Srinivasa
	* Tianyu Wu (Apple)
	* Wook Bong Lee (Samsung)
	* Yan Xin
	* Yin Yue
	* Yujin Noh
	* Yusuke Tanaka
5. Announcements: This session is a PHY ad hoc session.
6. Presentation order update: some agenda modification. No objection to the agenda change.

**Contributions**

1. [**1872r1**](https://mentor.ieee.org/802.11/dcn/19/11-19-1872-01-00be-joint-mu-analysis-simulations.pptx)**, “Joint MU performance with Impairments” – Sudhir Srinivasa (NXP)**

**Summary:** The authors provided simulation results for joint MU transmission with the presence of different impairments such as CFO, non-ideal timing sync, PA gain uncertainty and phase uncertainty at secondary AP.

**Comments:**
C: On slide 3, NDP tx power is the same right?
A: Yes.

C: How do you get the SIR on slide 5?

A: This is the SIR at STA 1. And the SIR will be very similar regardless which STA we look at. Just look at the total signal power over total interference power.

C: For slide 10 simulation results, for 8 antenna MU-MIMO in the baseline, are all the antenna used?

A: The result is 8 antenna AP serving 2 STAs each STA has 2 antennas.

C: What is the y in the result figure in slide 10?

A: y is -100dBm.

C: When you scale your received power, the SIR will not change right?

A: Yes. SINR will change but SIR will not.

C: Why the Rx power goes to 0dBm, the performance is worse?

A: The front-end start to saturating at such a high-power level.

1. [**1890r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1890-00-00be-phase-rotation-follow-up.pptx)**, “Phse Rotation Follow-up” – Eunsung Park (LG)**

**Summary:** The authors proposed various options for the phase rotation for legacy preamble in 320 / 160+160 MHz and have shown the simulation results for PAPR.

**Comments:**
C: Do you consider all possible 20MHz puncturing combinations?
A: Yes, we consider all the cases.
C: I wonder why the punctured case has such big PAPR difference? If we consider “reasonable” puncture modes, is it possible to make the PAPR drop to close to non-punctured cases?

C: Did you study the distribution of the PAPR vs puncturing modes to study whether this bad PAPR is due to some bad puncturing mode?

A: We can further study these cases.

C: Do the group want to consider for 320/160+160, whether we still keep the 20MHz duplicated preamble? This is very low efficiency.

A: Within each 80MHz, we are reusing 11ax 80MHz phase rotation.

Chair: The question is not related to the presentation.

C: Do you use the same phase rotation sequence for all puncturing pattern?

A: Yes.

C: We can apply different sequence to different puncturing patterns to optimize the PAPR.

A: We use different phase rotation sequence for punctured and non-punctured case.

A: Response to the previous commenter. Change of the legacy preamble will affect the legacy STAs.

C: We all know the pros and cons. But duplicate by 16 times is really a big burden. In some point we need to think about how to make it more efficient.

1. [**1981r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1981-00-00be-phase-rotations-design-for-eht.pptx)**, “Phase Rotations Design for EHT” – Dandan Liang (Huawei)**

**Summary:** The author proposed phase rotation for legacy preamble for 320MHz and 240MHz BWs.

**Comments:**
C: You did not consider any preamble puncturing case in your proposal right?
A: Yes. Since in 11ax, Phase rotation is not specially designed for preamble puncturing case. Also there are many preamble puncturing case, optimize for each of them are making the design to complicate.
C: Preamble puncturing mode is important in 11be. It will be better to optimize for this mode.

C: Do you have results? We want to see the results and compare with LG.
A: Will prepare results in a follow-up contribution.

1. [**1914r1**](https://mentor.ieee.org/802.11/dcn/19/11-19-1914-01-00be-multiple-ru-discussion.pptx)**, “Multiple RU discussion” – Ross Jian Yu (Huawei)**

**Summary:** The author presented a number of options to transmit data on multiple RUs and the singaling method.

**Comments:**
C: On slide 5, you proposed to signal with multiple user field but with your option 4, if you treated as a big contiguous RU, you do not need to signal with multiple user fields.
A: It looks like a big RU but still consist of multiple RUs. It may still include combination of non-contiguous RU.

C: In Jianhan’s contribution, only contiguous RU is allowed. Why we need discontiguous RU?

A: Jianhan’s contribution only considered efficiency but non-contiguous RU we can have additional benefit such as diversity gain.

C: With non-contiguous, maximum 1dB diversity gain. Allowing these modes, 52+52 and 26+26 will be also on the table since these modes has more diversity gain. That will be too many modes. Optimal case may not always happen.

C: Is Opt 4 assign the same RU to different STAs, each STA only occupy a subset of tones in the RU?

A: No. It’s combine neighboring RUs to a bigger contiguous RU to one STA.

C: If you signal independently, you may have very complicated cases. For example one RU is MU-MIMO, the other RU is not MU-MIMO or MU-MIMO with another set of users.

1. [**1926r1**](https://mentor.ieee.org/802.11/dcn/19/11-19-1926-01-00be-dynamic-thresholds-for-channel-bonding.pptx)**, “Dynamic Thresholds for Channel bonding” – Leonardo Lanante (Kyushu inst. Of Tech.)**

**Summary:** The authors proposed to have dynamic secondary CCA levels and provided simulation results to show throughput gain.

**Comments:**

No discussions.

1. [**1934r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1934-00-00be-precoding-performance-using-implicit-channel-estimation.pptx)**, “Precoding performance using implicit channel estimation” – Sigurd Schelstraete (Quantenna)**

**Summary:** The author presented simulation results for precoding based on implicit channel estimation with simple calibration algorithm. The results show little to no degradation for SU MIMO case and for MU MIMO case have major improvement compared to 4-stream feedback and minor degradation relative to 8-stream feedback.

**Comments:**

C: What is AP to STA power difference? Seem you assume offline calibration which is not always available.

A: We do not have the number of the first question. Offline calibration is just for the convenience. There is no problem to do calibration over the air.

C: For each pair of AP-STA, you want to do over the air calibration?

A: Yes.

C: Need to study the performance for more antennas

A: Yes we can further study.

C: In the simulation, it’s better to study PER instead of BER.

 C: On slide 13, NTx = 4 means 4 ss or only 4 antenna?

A: Here Ntx = 4 means 4ss but still AP has 8 antennas. Similarly Ntx = 8 means 8ss and still 8 antennas.

C: The results does not seem to be fair compare. Implicit has channel est for 8 antenna while explicit only have sounding fb for 4ss.

A: 8ss fb is optional and STA may only able to provide 4ss sounding fb. But for implicit, AP can do 8ss estimation and do not need to rely on STA’s capability. So it’s still fair.

C: Phase for calibration and transmission are using same measurement?

A: yes.

C: When you do calibration do you use one measurement or multiple measurement?

A: I believe it is one measurement.

C: How sensitive is which measurement you choose?

A: Not sure.

C: Do you build the circuit model when you do offline calibration?

A: No. We use the model in slide 7 for matlab calibration.

C: Without real circuit model, not sure how we can be confident on how good accuracy can be achieved?

A: We need to prove step by step. If the model works fine we can further study performance with actual measurements.

C: After the study from calculation/simuation, we need to feed the parameters to the circuit and in real world design, we may need some circuit design change to make Rx and Tx chain symmetric.

A: We may not need to make the front end symmetric.

1. [**1939r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1939-00-00be-calibration-of-implicit-sounding.pptx)**, “Calibration of Implicit sounding” – Lily Yunping Lv (Huawei)**

**Summary:** The author proposed relative calibration which only involves AP only and adding no complexity to the STAs. Also showed results that the channel estimation is accurate with implicity sounding and relative calibration.

**Comments:**

C: What is the SNR in sounding stage?

A: The results is the from the lab and I do not have the number here.

C: When you send 4 HE LTF, are you sounding 4 ss or 1ss?

A: STA only have 1 antenna and just send 1 LTF and repeat several rounds.

C: How often you need to do the calibration in the lab?

A: Calibration is good for several hours.

C: The relative calibration may change with STA of different range.

A: We can test that.

1. [**1877r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1877-00-00be-16-spatial-stream-support.pptx)**, “16 Spatial stream support” – Wood Bong Lee (Samsung)**

**Summary:** The author showed the benefit of supporting 16 streams for MU-MIMO and SU-MIMO cases in this contribution.

**Comments:**

C: On slide 4, I am concerned on SU MIMO case. If the receiver use MMSE receiver based on matrix inversion method, the eigen value difference can be 30dB and the performance is limited by the worse stream.

A: My results already incorporate this factor.

C: It should be wrong. I had simulation results and does not work for >4SS with zero forcing or MMSE. Only works for ML.

A: Bin support Wook Bong on the simulation results. It works.

C: Do you do power water filling?

A: No we donot do these fancy scheme. In this simulation, we select the rank that gives optimal throughput. If the channel donot support high rank, simulation will select lower rank.

C: Bin, what is your receiver?

A: When you have close loop, linear receiver and non-linear receiver does not have much performance difference.

C: Are you talking about same channel model?

A: Yes. All channel D.

A: Did you checked 16 Tx and 16 Rx antenna and the 8ss ?

C: No, I only check 16 Tx and 8 Rx antenna with 8ss. Need to double check.

**Concluding remarks**

Telco adjourned.

**Thursday January 9, 2020, 10:00 – 13:00 ET**

**Introduction**

1. The Chair (Sigurd Schelstraete, Quantenna) calls the meeting to order at 10:00EST.
2. The Chair follows the agenda in 11-19/2107r12.
3. The Chair goes through the IPR policy and asks if anyone is aware of any potentially essential patents. Nobody speaks up.
4. The Chair reminds everyone to report their attendance by sending an e-mail to the Cochair, Tianyu Wu (Apple) or the Chair himself. According to the Webex app, it appears to be around 30 people in the call.

**Recorded attendance through the Webex app and/or reported attendance through e-mail:**
	* Chenhe Ji (Huawei)
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	* Genadiy Tsodik
	* Jinsoo Choi (LG)
	* Jiny
	* Junghoon Suh (Huawei)
	* L. Sun (idcc)
	* Lasitaft
	* Lei Huang (Panasonic)
	* Lily Yunping Lyu
	* Louhx
	* Mengshi Hu
	* Oded Redlich
	* Ross Jian Yu (Huawei)
	* Ruchen Duan (Samsung)
	* Rui Yang (InterDigital)
	* Stephane Baron (Canon)
	* Steve Yang
	* Tianyu Wu (Apple)
	* Thomas Handte
	* Yan Xin

1. Announcements: This session is a PHY ad hoc session.

**Contributions**

1. **[1868r2](https://mentor.ieee.org/802.11/dcn/19/11-19-1868-02-00be-signaling-support-for-multi-ru-assignment.pptx), “Signaling support for Multi-RU Assignment” – Lei Huang (Panasonic)**

**Summary:** The authors provided two options for 11be user field design to support allocating multiple RUs to a single STA.

**Comments:**
C: How many bits for user field in option 2?
A: For both types of option 2, 24 bits per user field.

1. **[1980r1](https://mentor.ieee.org/802.11/dcn/19/11-19-1980-01-00be-eht-p-matrices-discussion.pptx), “EHT P matrices discussion” – Dandan Liang (Huawei)**

**Summary:** The authors proposed methods to define P matrices with larger than 8 dimensions to support up to 16 spatial streams.

**Comments:**
No discussions.

**Concluding remarks**

Telco adjourned ~ 10:30 EST.