IEEE P802.11
Wireless LANs

|  |
| --- |
| Minutes for Task Group (TG) 802.11 beExtremely High ThroughputTelephone conferences in August and September 2019 |
| Date: 2019-09-15 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Dennis Sundman | Ericsson |  |  | dennis.sundman@ericsson.com |
|  |  |  |  |  |

Abstract

This document contains the meeting minutes for the 7 Telephone conferences held in August and September 2019.

Revisions:

* Rev 0: Added the telephone conference held the 1st of August.
* Rev 1: Updated some style and typos. Thanks Joseph Levy (InterDigital) for comments.
* Rev 2: Added minutes from the telephone conference held the 8th of August.
* Rev 3: Added minutes from the telephone conference held the 15th of August. Also updated some typos, thanks to Leif Wilhelmsson (Ericsson) for pointing them out.
* Rev 4: Updated the attendance list for the meeting from 15th of August, fixed some minor typos. Added minutes from the telephone conference held the 22nd of August.
* Rev 5: Fixed some unclarities in the notes regarding the meeting held on 15th of August. Thanks to Yongho Seok (MediaTek) and Alfred Asterjadhi (Qualcomm) for pointing them out.
* Rev 6: Added minutes from the telephone conference held the 29th of August.
* Rev 7: Added minutes from the telephone conference held the 5th of September.
* Rev 8: Updated some typos from the telephone conference held the 5th of September. Thanks to Gaurav Patwardhan (Hewlett Packard Enterprise) for pointing them out. Added minutes from the telephone conference held the 12th of September.

**Thursday 1 August 2019, 19:30 – 22:00 ET

Introduction**

1. The Chair (Alfred Asterjadhi, Qualcomm) calls the meeting to order at 19:31.
2. The Chair goes through the IPR policy and procedure. He asks the members for any potentially essential patents. Nobody speaks up.
3. The Chair reminds members to report their attendance to Dennis Sundman (Ericsson). The Join.me software indicates up to 120 people to appear in the call.

**People signed in with their name and/or reported their attendance to the secretary:**
	* Akira Kishida (NTT)
	* Alfred Asterjadhi (Qualcomm)
	* Dennis Sundman (Ericsson)
	* Dorothy Stanley (HPE)
	* Edward Au (Huawei)
	* Frank Hsu
	* George Cherian
	* Insung Jang
	* Jeongki Kim (LG Electronics)
	* Jinsoo Choi
	* Joseph Levy (InterDigital)
	* Junghoon Suh (Huawei)
	* Kazuto Yano (ATR)
	* Lei Huang (Panasonic)
	* Ming Gan (Huawei)
	* Osama Aboul-Magd (Huawei)
	* Payam Torab
	* Rojan Chitrakar (Panasonic)
	* Rui Yang (InterDigital)
	* Sang Kim
	* Srinivas Kandala (Samsung)
	* Steve Shellhammer (Qualcomm)
	* Suhwook Kim (LG Electronics)
	* Woojin Ahn (WILUS)
	* Xin Zuo (Tencent)
	* Yan Zhang (Marvell)
	* Yongho Seok (MediaTek)
	* Yusuke Tanaka (Sony)
4. The chair asks if there is any objection to proceed with the presentations. Nobody objects.

**Submissions**

1. 11-19/0762r1, “Latency analysis for EHT” – Suhwook Kim (LG Electronics)

**Summary:** The authors have provided simulation results comparing different RU tone plans for 80 MHz using OFDMA.

**C (Comment/Question):** On slide 15, why does the persistent scheduler improve the results?
**A (Answer):** The latency improves for the persistent STAs but not for the others.
**C:** Regarding the setup, have all the 4 types of access categorizes been considered?
**A:** Generally, we considered the AC\_BE and AC\_VI.
**C:** Are you using single BSS? It would be more interesting with the OBSS case.
**A:** We will think about the OBSS case.
**C:** What types of traffic are you using, UDP or TCP?
**A:** UDP.
**C:** Probably you want to run also with TCP because this is used in reality.
**A:** Yes
**C:** How do you define latency? Maximum, average, or?
**A:** The average.
2. 11-19/1175r0, “ Considerations of new queue mechanisms for real-time applications” – Xin Zuo (Tencent)

**Summary:** The authors believe we need to target the worst case latency through some new mechanisms. The current EDCA mechansims cannot handle it. For this mechanism the authors believe we need to focus on certain types of data, namely frequent and small data. The critical data need to bypass the internal queues.

**C:** What is the difference between what you propose and .11aa?
**A:** I was not aware of .11aa, but would like to look at it.
**C:** Do you think the trigger based functionality from .11ax is insufficient?
**A:** I believe trigger based transmission still may not be sufficient for this kind of traffic.
**C:** The EDCA scheduler should be capable to do sufficient categorization.
**A:** I don’t think that is enough.
**C:** In slide 6, once the new queue is activated, does the access categories change?
**A:** No.
**C:** You mention that it is not good if a STA gets a large backoff size. Are you worried about collisions? Are you considering one or multiple RTA queues?
**A:** Regarding the collisions, I cannot say for certain, but we believe that since we limit the frames for this particular queue, it should not be fatal. For the queues, we would like to have it dynamically, so potentially one queue per service or something like this.
**C:** If there is only RTA data in the buffert. Will this improvement work well?
**A:** In that case it depends on how many STAs, interference, etc.
3. 11-19/1207r4, “Views on Latency and Jitter Features in TGbe” – Akira Kishida (NTT)

**Summary:** The authors believe we need to consider RTA mechanisms that can coexist with legacy systems as well as controlled systems.
4. 11-19/0806r2, “Enabling persistent allocation for EHT” – Lei Huang (Panasonic)

**Summary:** The authors want to consider reduction of control signalling for EHT UL MU transmissions.
5. 11-19/1242r0, “Wider Bandwidth Channel Access in EHT” – Woojin Ahn (WILUS)

**Summary:** The authors propose a new channel access mechanism for wider bandwidths. To this end they introduce an extended channel set. The extended channel set may not be the same as the primary channel set. EDCA in the primary 20 of the primary channel set.

**C:** Slide 8, when the primary channel set is busy, then AP switches to extended channel set. How does the STA know that the channel has switched?
**A:** In this case, the extended channel set will only be used if the primary is busy, so such STAs have to wait.
**C:** Slide 7, it seems you are proposing to duplicate the same behaviour on the second band. Is the secondary band contiguous or non-contiguous?
**A:** It can be both.

**Concluding remarks**

1. The Chair informs that the next telco will focus on Multi-AP.
2. The Chair mentions that if we want to run straw-polls on the telco, we need to use an e-poll system. For the e-poll system, the Chair asks for straw poll texts so that he can prepare e-polls before the meeting.

**Ajourn.**

**Thursday 8 August 2019, 10:00 – 12:30 ET**

**Introduction**

1. The Chair (Alfred Asterjadhi, Qualcomm) calls the meeting to order at 10:00.
2. The Chair goes through the IPR policy and procedure. He asks the members for any potentially essential patents. Nobody speaks up.
3. The Chair reminds members to report their attendance to the secretary Dennis Sundman (Ericsson). From the application, there appears to be about 100 participants.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Adrain Garcia Rodriguez
	* Al Petrick
	* Alfred Asterjadhi
	* Bo Sun
	* Carl Kain (Noblis/USDOT)
	* Dibakar
	* Dongguk Lim (LG)
	* Gaurav Patwardhan (HP Enterprises)
	* Insun Jang
	* Jason Yuchen Guo (Huawei)
	* Jeongki Kim (LG)
	* Jinsoo Choi
	* Joseph Levy (InterDigital)
	* Junghoon Suh (Huawei)
	* Kazuto Yano (ATR)
	* Kosuke Aio (Sony)
	* Lei Huang
	* Lei Wang
	* Li Nan (ZTE)
	* Li Yiqing
	* Miguel Lopez (Ericsson)
	* Ming Gan (Huawei)
	* Osama Aboul-Magd (Huawei)
	* Payam Torab
	* Rojan Chitrakar
	* Ross Jian Yu (Huawei)
	* Ryuichi Hirata (Sony)
	* Sameer Vermani (Qualcomm)
	* Sebastian Max (Ericsson)
	* Shimi Shilo
	* Sigurd Schelstraete
	* Steve Shellhammer (Qualcomm)
	* Suhwook Kim
	* Taewon Song
	* Thomas Handte (Sony)
	* Xiaogang Chen (Intel)
	* Yonggang Fang (ZTE)
4. The Chair asks for any announcements.

**Submissions**

1. 11-19/1118r1, “Enhancements for Time-Critical Data Transmissions” – Thomas Handte (Sony)

**Summary:** The authors have identified what they believe some key features for time-critical transmissions: channel diversity and efficient channel access. The authors propose resource unit (RU) hopping (besides OFDMA and MU-MIMO) as an example to obtain channel diversity. For efficient channel access the authors propose HE MU MIMO in DL and HE TB PPDU in UL.

**C:** Slide 10. 1) Are you trying to push ACK to upper layer? 2) Are you trying to split the MSDU into several parts, is this not possible with fragmentation?
**A:** 1) It can be achieved in higher layers, but we prefer to do it in lower layers. 2) Fragmentation is not enough for what we want.
**C:** Proposal 1. Is the target to improve the MU efficiency? How does this relate to our PAR document?
**A:** I think it fits well the real time latecy parts of the PAR.
2. 11-19/1092r1, “Evaluation of Multi-AP Joint Processing” – Xiaogang Chen (Intel)

**Summary:** The authors have identified and study two potential challenges for joint transmissions: synchronization and power imbalance across slave APs. The authors conclude that joint transmission may have challenges in high MCS. Power imbalance not a large problem.

**C:** Slide 7. Can you elaborate on the definition of the SNR.
**A:** The definition of SNR is based on the single AP SNR.
**C:** Slide 10. 1) This looks like SU MIMO? 2) What is this 8x4?
**A:** 1) No. 2) Each AP has 8 antennas and 4 spatial streams.
3. 11-19/1096r0, “EHT Multi-AP Feature Discussion” – Yonggang Fang (ZTE)

**Summary:** The authors have discovered that the fine timing measurement (FTM) mechanism used for positioning can be enhanced under the Multi-AP assumption.
4. 11-19/1102r0, “A Unified Procedure for Multi-AP Coordination” – Jason Yuchen Guo (Huawei)

**Summary:** The authors propose a slave trigger frame format to synchronize transmissions among slave APs. They believe the TGax trigger frame format can be reused to some extent.

**C:** Slide 5. The Basic TF, does it operate on the same channel?
**A:** Assuming OFDMA, they can be on different channels. For coordinated spatial reuse, they can be on the same channel. For joint transmission, I believe it is TBD.
5. 11-19/1097r0, “Sounding Procedure in AP Collaboration” – Ross Jian Yu (Huawei)

Summary: The authors provide 3 options for collecting CSI between STAs and APs.

**C:** Slide 6. Why are there two triggers after the NDP2?
**A:** This is just an example, in which there can be an error.
**C:** Slide 11. Do you have any idea of which option you believe is better?
**A:** I slightly prefer opt1 for coordinated beamforming. For a feature like joint beamforming it requires further study.
**C:** A conclusion is that certain modes are suitable for certain options?
**A:** Yes.
6. 11-19/1129, “Consideration on Multi-AP coordination” – Li Nan (ZTE)

**Summary:** The authors show examples on how Multi-AP coordination can work.
7. 11-19/1089r0, “Joint Transmissions: Backhaul and Gain State Issues” – Sameer Vermani (Qualcomm)

**Summary:** The authors highlight backhaul requirements and sensitivity to gain state errors at the STAs. The backhaul needs at least as much data as goes to the STA. The authors note that need more backhaul capacity is needed than the fronthaul capacity. Gain state mainly affects joint transmissions. The authors believe we need to maintain a gain state error less than 0.8 dB.

**C:** Slide 6. You require 4 SS and 160 MHz MCS 9. This sounds challenging? Unless wired backhaul.
**A:** I agree this is challenging. With a wired backhaul it is easier.
**C:** Slide 6. You assume that the master AP is connected to Ethernet.
**A:** Yes.

**Adjourn.**

**Thursday 15 August 2019, 19:30 – 22:00 ET**

**Introduction**

1. At 19:30 PM the Chair (Alfred Asterjadhi, Qualcomm) calls the meeting to order. He presents himself and the recording Secretary (Dennis Sundman, Ericsson).
2. The Chair informs that the meeting agenda can be found in document 1376r5.
3. The Chair goes through the 802 and 802.11 IPR policy and procedure and asks if there is anyone that are aware of potentially essential patents. Nobody speaks up.
4. The Chair reminds about attendance, send an e-mail to Dennis Sundman. Based on the join.me app, it appears that around 100 people are present in the call.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Abhishek Patil
	* Al Petrick
	* Alfred Asterjadhi (Qualcomm)
	* Bill Carney
	* Bin Tian
	* Dennis Sundman
	* Dongguk Lim (LGE)
	* Edward Au (Huawei)
	* Eunsung Park
	* Gaurav Patwardhan (HPE)
	* Insun Jang (LGE)
	* James Yee
	* Jeongki Kim (LGE)
	* John Son (WILUS)
	* Junghoon Suh (Huawei)
	* Kazuto Yano (ATR)
	* Kosuke Aio (Sony)
	* Lei Huang
	* Lei Wang
	* Liwen Chu
	* Nan Li
	* Osama Aboul-Magd
	* Ron Porat (Broadcom)
	* Rui Yang (InterDigital)
	* Ryuichi Hirata (Sony)
	* Sang Kim
	* Sharan Naribole (Samsung)
	* Sigurd Schelstraete (Quantenna)
	* Srinivas Kandala
	* Steve Shellhammer (Qualcomm)
	* Taewon Song
	* Wang Qian
	* Xiaofei Wang (InterDigital)
	* Yan Xin
	* Yongho Seok
	* Yusuke Tanaka (Sony)
5. The Chair explains that on the Monday in the September face to face meeting, we plan to have ad-hoc creation discussions, including discussions regarding ad-hoc chairs.
6. The Chair asks if there is any comment regarding the agenda. A comment that document 821r0 was already presented, but straw poll was deferred.
	1. A discussion follows whether to have prioritizations on straw polls. If a person wants to defer a straw poll to the f2f, the deferred straw poll will be run at the beginning of a session with the same topic as the straw poll. The deferred straw polls will be run in the order they were presented. Each straw poll will be given 10 minutes for recap and running the straw poll. Nobody objects.
7. No objections to approve the agenda.

**Submissions**

1. 11-19/1094r0, “Joint Beamforming Simulations” – Sudhir Srinivasa (Marvell)

**Summary:** The authors study CFO errors in joint beamforming. The authors believe introducing a midamble may solve the problem.
2. 11-19/1134r1, “Consideration on Multi-AP Sounding” – Kosuke Aio (Sony)

**Summary:** The authors bring up some discussion aspects regarding multi-ap sounding for joint transmissions (JTX) and coordinated beamforming (CBF): (a) sounding protocol, (b) feedback reduction. For (a), the authors believe that the Multi-AP sounding protocol needs to be different for JTX and CBF. For (b), collecting only CQI feedback before collecting BF feedback is good for both JTX and CBF.
 **C:** Slide 6, for CBF I believe that when the STAs have more than 1 antennas, all APs need to know all channels.
**A:** I would like to discuss this offline.
**C:** Both CBF (because of nulling) and JTX require the channel knowledge to all STAs. The second scheme on slide7 does not provide much improvement. I am not sure we need the joint protocol.
**A:** Ok.
3. 11-19/1143, “Efficient Operation for Multi-AP Coordination” – Sungjin Park (LGE)

**Summary:** The authors propose a scheme for choosing which APs to be part of a Multi-AP transmission.

**C:** Have you considered the overhead in the method you are suggesting?
**A:** Some additional overhead is required, but we believe it is necessary for the Multi-AP system to work.
4. 11-19/1214r0, “Preamble Design Consideration for 802.11be” – Ruy Yang (InterDigital)

**Summary:** The authors consider TXOP signalling in the SIG-A field. They believe this would be useful for both .11ax and .11be devices.

**C:** Slide6-8, the .11ax devices may disregard the whole SIG-A since some bits will be redefined.
5. 11-19/0818r1, “Discussion on Multi-band operation” – Ryuichi Hirata (Sony)

**Summary:** The authors look at QoS issues related to multi-band/channel aggregation: (1) Nonsequential order of MPDU reception, (2) Unnecessary retransmission, (3) Reception failure due to self interference. For (1), the authors believe a reordering mechanism needs to be introduced. For (2), the authors believe block ACKs should be introduced that operate over multiple links (and bands). For (3), the authors believe a synchronization between multiple links and bands should be available.

**C:** Q1 on slide6, will this block ACK affect the efficiency? Q2 on slide7, we need to consider that there may be both single link and multiple link STAs simultaneously.
**A:** Q1 will depend on the use case, in some cases you can send the block ACK immediately.

**AoB: None.**

**Adjourn.**

**Thursday 22 August 2019, 10:00 – 12:30 ET**

**Introduction**

1. At 10:01, the Chair, Alfred Asterjadhi (Qualcomm) opens the meeting.
2. The Chair goes through the 802 and 802.11 IPR policy and procedure and asks if there is anyone that are aware of potentially essential patents. Nobody speaks up.
3. The Chair reminds about attendance, send an e-mail to Dennis Sundman. Based on the join.me app, it appears that around 90 people are present in the call.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Abhishek Patil
	* Akira Kishida (NTT)
	* Al Petrick
	* Alan Jauh (Unisoc)
	* Albert Bredewoud (Broadcom)
	* Alfred Asterjadhi (Qualcomm)
	* Assaf Chair
	* David Lopez-Perez
	* Dennis Sundman (Ericsson)
	* Insun Jang (LGE)
	* Jianhan Liu (Mediatek)
	* Jinmin Kim
	* Jinsoo Choi
	* Junghoon Suh (Huawei)
	* Juongki Kim
	* Kazuto Yano (ATR)
	* Lei Huang
	* Lei Wang
	* Leif Wilhelmsson (Ericsson)
	* Lorenzo Gelati Giordano (Nokia)
	* Ming Gan (Huawei)
	* Osama Aboul-Magd
	* Patrice Nezou
	* Rojan Chitrakar
	* Ross Yu (Huawei)
	* Rui Yang
	* Ryuichi Hirata
	* Sang Kim
	* Stéphane Baron (Canon)
	* Taewon Song
	* Yongho Seok (MediaTek)
4. The Chair asks if there is any objection to approve the agenda, which can be found in 1376r6. Nobody speaks up.
5. The Chair informs about straw polls. We will use the ePoll system. In order to vote you must log in to the IEEE system.
	1. You can only vote Approve (YES) / Disapprove (NO) / Abstain.
	2. If a strawpoll has been run in the telephone conference, it can be run again in the F2F.

**Submissions**

1. 11-19/1212r1, “Coordinated Beamforming and Null Steering” – David Lopez-Perez (Nokia)

**Summary:** The authors believe coordinated beamforming and null steering should be used in dense scenarios with high interference, where additionally the served STAs enjoy high SNRs. The authors show good gainds when coordinated nulling steering is used. To enable coordinated nulling requires new methods to obtain CSI for STAs in other cells.

**C:** What is the synchronization situation for the simulations?
**A:** Ideal (perfect) synchronization.
**C:** How often do you update the CSI?
**A:** In every TXOP.
**C:** How many spatial streams are used?
**A:** Each STA has 1 antenna and consequently 1 spatial stream per user (and per null). Beamforming is used of course.
**C:** I believe you see the gain because you have 16 degrees of freedom at the AP and you are not using all of them.
2. 11-19/1117r0, “Direct Link MU transmissions” – Stéphane Baron (Canon)

**Summary:** The authors believe that direct link (STA to STA without AP) can be good in some scenarios, for example where low latency is important.

**C:** How is the scheduling done?
**A:** The AP helps with scheduling.
**C:** Usually when we consider peer-to-peer in 802.11, association is not required.
**A:** Here, we consider the STA to be associated to the AP.
**C:** Slide 6, what about this red box (Downlink)?
**A:** Please discard it.
**C:** It might help if yoo can compare with some existing scheme to argue why we need this.
**A:** Thanks for the comment.
3. 11-19/1126r0, “Enhanced Resource Allocation Schemes for 11be” – Jianhan Liu (Mediatek)

**Summary:** The authors have found that in TGax, one STA can only be allocated one RU. They propose to introduce multiple RU allocations to the same STA.

**C:** To enable multiple RU allocations we need new signalling.
**A:** Yes.
**C:** Depending on how to you divide the band in various RUs, different encoding schemes would be used.
**A:** We need to agree on how to do this.
**C:** Do you have any idea on how many combinations of RUs that are possible?
**A:** A valid question. We should look at this and solve it in the future.
4. 11-19/0979r0, “EHT Multi-Link Operation Follow-up” – Yongho Seok (MediaTek)

**Summary:** The authors present new results for Multi-Link Operation (MLO). There are synchronous and asynchronous schemes. Simulations show that they all perform better (throughput and latency) than legacy schemes.

**C:** Slide11. Why do you want to limit to the TID?
**A:** No particular reason except for the block ACK.
**C:** Performance seems to always be good with many links, but this contradicts with the proposal of limiting a TID to one link.
5. 11-19/1082r0, “Multi-Link Operation: Dynamic TID Transfer” – Abhishek Patil (Qualcomm)

**Summary:** The authors discuss how a unified MLO framework can support dynamic transfer of a TID between links.

**C:** Slide3. Assume we manage this link switching mechanisms, we should generalize it.
**A:** I agree.
**C:** Slide4. Those with different MAC addresses, do they also have different IP addresses?
**A:** Yes.
**C:** We have the FST to transfer TIDs fast. Why can we not use that?
**A:** I agree there are some existing features. Currently, I try to cover what features we need to support. Once we understand that we know what we can reuse and what we need to introduce.
**C:** Slide5. Are you assuming the packets on the two links are sent synchronously or asynchronously?
**A:** Both are possible.

**The Chair if there is AoB. No response.**

**Adjourned.**

**Thursday 29 August 2019, 19:30 – 22:00 ET**

**Introduction**

1. At 19:31 PM the Chair (Alfred Asterjadhi, Qualcomm) calls the meeting to order.
2. The Chair informs that the meeting agenda can be found in page 7, document 1376r6. The Chair asks if there is any objection to approve the agenda. Nobody speaks up.
3. The Chair goes through the 802 and 802.11 IPR policy and procedure and asks if there is anyone that are aware of potentially essential patents. Nobody speaks up.
4. The Chair reminds about attendance, send an e-mail to Dennis Sundman. Based on the join.me app, it appears that around 90 people are present in the call.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Abhishek Patil (Qualcomm)
	* Akira Kishida (NTT)
	* Al Petrick
	* Alan Jauh (Unisoc)
	* Alfred Asterjadhi (Qualcomm)
	* Carl Kain (USDOT)
	* David Kloper (Cisco)
	* Dennis Sundman
	* Dongguk Lim
	* Edward Au (Huawei)
	* Gaurav Patwardhan (HPE)
	* George Cherian
	* Huizhao Wang
	* Insun Jang (LGE)
	* Jinmin Kim
	* John Son
	* Junghoon Suh (Huawei)
	* Liuming Lu (ZTE)
	* Ming Gan (Huawei)
	* Nan Li
	* Rui Yang (InterDigital)
	* Ryuichi Hirata (Sony)
	* Sang Kim (LGE)
	* Steve Shellhammer (Qualcomm)
	* Suhwook Kim (LGE)
	* Taewon Song
	* Tomo Adachi
	* Yan Xin
	* Yanyi Ding
	* Yonggang Fang
	* Yongsu Gwak (KNUT)
	* Yunbo Li (Huawei)
	* Yusuke Tanaka (Sony)
5. The Chair asks if there are any announcements. Nobody speaks up.

**Submissions**

1. 11-19/1085r0, “High Level EHT Preamble Structure” – Rui Cao (Marvell)

**Summary:** The authors believe that the EHT preamble structure shall be L-STF + L-LTF + L-SIG + RLSIG + EHT-SIG. They believe the EHT-SIG should contain some static bits for future interoperability.

**C:** Slide 5. How do you want to define RLSIG?
**A:** The specific design is up for discussion, but the purpose is range extension.
**C:** Is it your intention that the EHT-SIG is decodable by future generations Wi-Fi?
**A:** Yes.
**C:** I believe it is important to keep some bits static for older and future generation coexistence.
**A:** Ok.
C: Slide 5. How would the .11ax STA behave when it detects a .11be signal?
A: We should study this.
2. 11-19/1081r1, “Multi-Link Aggregation: Latency Gains” – Abhishek Patil (Qualcomm)

**Summary:** The authors argue that by allowing multi-link usage, latency can be reduced. The reason for this is the channel access mechanisms.

**C:** Slide 4. You mention that the the traffic model is video traffic. Which traffic category did you use? Using multiple traffic categories may change the behaviour significantly.
**A:** We only used one traffic category. We have however done simulations with different traffic categories, with similar results as presented here.
**C:** What is the definition of worst case latency?
**A:** The 95 percentile latency.
3. 11-19/0951, “Discussion on Multi-band/Multi-channel Acess Method” – Liuming Lu (ZTE)

**Summary:** The authors believe that the current channel access methods are incapable to handle the multi-band and multi-channel setup in a good manner.

Comments via e-mail (through the reflector).
4. 11-19/1095, “Multi-Link Architecture and Requirement Discussion”

**Summary:** The authors discuss reference models and framework requirements for multi-link operation.

**C:** Slide4, with Multi-AP what do you mean?
**A:** Different APs, so not co-located APs.
**C:** Slide 11. What do you mean by joint communication?
**A:** With joint transmission I mean full retransmission of the packet on multiple links so that a receiver can combine the reception.
5. 11-19/1100r1, “Per-Packet Multiple Link Selection” – Alan Jauh (Unisoc)

**Summary:** This contribution provides additional justification for the proposed Joint MAC + multiple concurrent PHY presented in reference [1] of the presentation.

**C:** Slide11. Can you give example of what to use the control channel for.
**A:** No.
6. 11-19/1101r1, “Conditional Packet Duplication in Multiple Link System” – Alan Jauh (Unisoc)

**Summary:** The authors propose a scheme to enable packet duplication on multiple links for improving robustness.

Comments via e-mail (through the reflector).

**Wrap-up**

1. The Chair asks about preference on the ways forward with the presentations for the next meeting. The Multi-link category is not finished.
	1. After some discussion, it was decided that we continue with the list (i.e. Multi-link) and delay the HARQ presentations for a later meeting.

**Adjourned.**

**Thursday 5 September 2019, 10:00 – 12:30 ET**

**Introduction**

1. The Chair (Alfred Asterjadhi, Qualcomm) calls the meeting to order.
2. The Chair reminds that the agenda can be found in 1376r7. The Chair asks if there is any objection to approve the agenda. Nobody speaks up, agenda approved.
3. The Chair goes through the 802 and 802.11 IPR policy and procedure and asks if there is anyone that are aware of potentially essential patents. Nobody speaks up.
4. The Chair reminds about attendance, send an e-mail to Dennis Sundman. Based on the join.me app, it appears that around 110 people are present in the call.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Abhishek Patil
	* Akira Kishida (NTT)
	* Al Petrick
	* Albert Bredewoud
	* Alfred Asterjadhi (Qualcomm)
	* Brian Hart (Cisco)
	* Carl Kain (USDOT)
	* David Kloper (Cisco)
	* Dennis Sundman (Ericsson)
	* Eunsung Park (LG)
	* Gaurav Patwardhan (HPE)
	* George Calcev (Futurewei)
	* Hanseul Hong (Yonsei Univ.)
	* Huizhao Wang
	* Insun Jang (LG)
	* James Yee (MediaTek)
	* Jeongki Kim
	* Jinmin Kim
	* Jinsoo Choi
	* John Son (WILUS)
	* Joseph Levy (InterDigital)
	* Junghoon Suh (Huawei)
	* Kazuto Yano (ATR)
	* L. Sun (InterDigital)
	* Lei Huang
	* Lei Wang
	* Mark Hamilton (Ruckus/CommScope)
	* Mark Rison (Samsung)
	* Ming Gan (Huawei)
	* Minyoung Park
	* Osama Aboul-Magd
	* Po-Kai Huang
	* Rojan Chitrakar (Panasonic)
	* Rui Yang (InterDigital)
	* Sang Kim (LGE)
	* Sebastian Max (Ericsson)
	* Shimi Shilo
	* Stephane Baron
	* Xiaofei Wang
	* Yan Xin
	* Yifan Zhou (Huawei)
	* Yonggang Fang
	* Yongsu Gwak (KNUT)
	* Yunbo Li (Huawei)
	* Yusuke Tanaka (Sony)
5. The Chair asks if there are any announcements.
	* Liwen Chu (Marvell) speaks up and wants to present. Liwen Chu gets scheduled for the next conference call.

**Submissions**

1. 11-19/1116r1, “Channel Access in Multi-band operation” – Yunbo Li (Huawei)

**Summary:** The authors consider two types of multi link (ML) operation, synchronous and asynchronous. They believe both types of operation are needed and discuss parameters, ways of operation, etc.

**C:** Slide 9. Do you believe these types of operations have to be used by the whole network, or only parts, and who decides which type to use?
**A:** It is TBD.
**C:** Slide 9. In which case are the start time not aligned? I believed that in synchronized both start and end times need to be synchronized.
**A:** If one link is available at one time and on another link a transmission starts right after the transmission has started on the first link.
**C:** Do you plan to run any simulations?
**A:** If there is time I could try.
**C:** What is the difference between architecture 2 from 80+80 MHz already in the spec?
**A:** I need to look at this closer.
**C:** Architecture 1, do you even get the ML gain? If not, why even consider it?
**A:** Since the BW can be doubled, it has some benefit in some scenarios.
**C:** Are you suggesting using both the synchronized and asynchronized modes or both?
**A:** I believe it is better to support both since they both have pros and cons.
2. 11-19/1129r0, “Multi-link transmission” – Rojan Chitrakar (Panasonic)

**Summary:** The authors look a bit more into MAC layer details for multi link.

**C:** Slide 4. Are these 3 independent links, or where is the encryption applied.
**A:** We assume here that there is an upper MAC where the encryption is performed. The same key is used on all links. However, we need to study this further.
**C:** You said that we must support immediate block-ack. On slide 6, there is a delayed block ack. Do you mean we need to support both?
A: If the transmission is synchronized, we can have immediate block ack, but the delayed block ack is needed for the asynchronous case.
3. 11-19/1144r1, “Channel Acess for Multi-link Operation” – Insun Jang (LG)

**Summary:** The authors consider channel access mechanisms for asynchronous and synchronous multi-link operation.
4. 11-19/1181r1, “Consideration on Multi-link Operation” – Yongsu Gwak (KNUT)

**Summary:** The authors consider channel access and block ack mechanisms for Multi-link operation (independent and simultaneous). For independent operation, channel access can be independent, but other links should wait while block acks are sent.

**C:** We can get TXOP fromchannel access mechanism. I think block transmission should be synchronized indepentently if it is independent or simultaneous.
5. 11-19/1213r0, “Discussion on Multi-link Operation” – Xiaofei Wang (InterDigital)

**Summary:** The authors discuss some features for multi-link operation. They have a “high” MAC-SAP that split into different links. Therefore, the authors believe each “high” MAC-SAP should be identified by IDs or MAC addresses.

**C:** Do you have any ideas on where to have this address?
**A:** I have thought on several options. For example, it could be an address field in the header frame. Currently I just want to discuss the relevance of being able to identify the different “high” MAC-SAPs.
**C:** Would you need things such as group IDs to send to multiple MAC-SAPs?
**A:** This requires further study.

**The chair asks about AoB? Nobody speaks up.

Adjourned.**

**Thursday 12 September 2019, 19:30 – 22:00 ET**

**Introduction**

1. The vice Chair (Laurent Cariou, Intel) calls the meeting to order at 19:36. Alfred Asterjadhi (Qualcomm) in unable to attend the meeting today. Laurent Cariou will act as the Chair for this meeting.
2. The Chair goes through the 802 and 802.11 IPR policy and procedure and asks if there is anyone that are aware of potentially essential patents. Nobody speaks up.
3. The Chair reminds about attendance, send an e-mail to Dennis Sundman (Ericsson). Based on the join.me app, it appears that around 70 people are present in the call.

**Recorded attendance through the join.me app and/or reported attendance through e-mail:**
	* Al Petrick
	* Andrew Blanksby
	* Dennis Sundman (Ericsson)
	* Imran Latif
	* Insun Jang (LGE)
	* Jarkko Kneckt (Apple)
	* Junghoon Suh
	* Laurent Cariou (Intel)
	* Lei Huang
	* Rojan Chitrakar (Panasonic)
	* Ron Porat (Broadcom)
	* Ross Yu (Huawei)
	* Rui Yang (InterDigital)
	* Sang Kim (LGE)
	* Sharan Naribole
	* Shimi Shilo (Huawei)
	* Sigurd Schelstraete
	* Srinivas Kandala
	* Steve Shellhammer (Qualcomm)
	* Taewon Song (LGE)
	* Tianyu Wu
	* Tomo Adachi
	* Yifan Zhou (Huawei)
	* Yongsu Gwak (KNUT)
4. The agenda for the day is to continue the presentations of technical contributions.
5. The Chair asks if there is any objection to use this agenda. Nobody speaks up.

**Submissions**

1. 11-19/1038r1, “HARQ with A-MPDU in 11be” – Shimi Shilo (Huawei)

**Summary:** The authors point out that the misalignment between LDPC codewords and MPDUs is a problem. They provide three potential methods to combat this challenge: retransmit the whole A-MPDU, retransmit also codewords that overlap with previous and next MPDU, and finally a padding to the MPDUs such that they constitute a multiple of codewords.

**C:** Slide9. There is padding overhead. Have you considered the impact of overhead?
**A:** The main thing here is the assumptions. The overhead here could be large.
**C:** I think you may try to solve a problem that does not exist. I believe we should do this on the codeword based HARQ.
**A:** There are other drawbacks to codeword based HARQ, for example memory.
**C:** Did you consider fragmentation instead of padding?
**A:** Yes but we have no results at the moment.
2. 11-19/1078r0, “HARQ Simulation Results” – Steve Shellhammer (Qualcomm)

**Summary:** The authors try to quantify the gains of HARQ through simulations. With more channel uncertainty, HARQ improve the performance compared to ARQ. They also consider max-2 and max-4 HARQ transmission with the conclusion that max-2 gives most of the gain.

**C:** Are you retransmitting codewords or MPDUs?
**A:** In this simulation we are retransmitting the whole packet. We believe the codeword retransmission will be slightly better.
**C:** What link adaptation algorithm did you use?
**A:** We did an exhaustive search to find the best MCS selections. We don’t have a practical link adaptation.
3. 11-19/1079r0, “HARQ Gains with Overhead Considered” – Steve Shellhammer (Qualcomm)

**Summary:** Simulations comparing HARQ and ARQ. In this presentation the authors include protocol overhead. With the overhead, the gain between HARQ and ARQ is reduced, but there is in most cases still a gain.

**C:** Slide6. In this setup you are not padding the retransmission with new data?
**A:** Correct.
**C:** Slide6. Do you assume HARQ feedback and BA have same duration?
**A:** No, the figure is not to scale.
4. 11-19/1131r0, “Consideration on HARQ Unit” – Taewon Song (LGE)

**Summary:** The authors study whether the HARQ mechanism should be a PHY (codeword level) or MAC (MPDU level) unit. They favour the PHY unit.

**C:** Slide4. You have reserved a large TXOP. What if the transmission is successful, then you need to release the TXOP. That requires additional overhead.
**A:** We have not looked into this case.

**The chair asks for AoB. Nobody speaks up.**

**Adjourned.**