IEEE P802.11
Wireless LANs

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| TGbn July August 2024 Teleconference Minutes |
| Date: 2024-09-11 |
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Abstract

This document contains the minutes for TGbn July and August 2024 teleconferences.

Revision history:

* Rev0: First version of the document.
* Rev1: Add the links of the minutes for MAC ad-hoc teleconferences and the attendee lists for the Joint teleconferences.
* Rev2: Add the Joint teleconference minutes and the links of the minutes for MAC ad-hoc teleconference. Fixed typos and editorial errors.
* Rev3: Add the attendee list for the 29th August teleconference (Joint).
* Rev4: Revise erroneous hyperlinks.

Abbreviations:

* C: Comment.
* A: Answer.

# 1st Conf. Call: July 29th, Monday (19:00-21:00 ET) – MAC

* <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-00-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>

# 2nd Conf. Call: July 31st, Thursday (10:00-12:00 ET) - Joint

* Call the meeting to order
* IEEE 802 and 802.11 IPR policy and procedure
	+ Patent Policy: Ways to inform IEEE:
	+ Cause an LOA to be submitted to the IEEE-SA (patcom@ieee.org); or
	+ Provide the chair of this group with the identity of the holder(s) of any and all such claims as soon as possible; or
	+ Speak up now and respond to this Call for Potentially Essential Patents

If anyone in this meeting is personally aware of the holder of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please respond at this time by providing relevant information to the WG Chair.

**Nobody spoke/wrote up.**

* + Copyright Policy: Participants are advised that
	+ IEEE SA’s copyright policy is described in [Clause 7](https://standards.ieee.org/about/policies/bylaws/sect6-7.html#7) of the IEEE SA Standards Board Bylaws and [Clause 6.1](https://standards.ieee.org/about/policies/opman/sect6.html) of the IEEE SA Standards Board Operations Manual;
	+ Any material submitted during standards development, whether verbal, recorded, or in written form, is a Contribution and shall comply with the IEEE SA Copyright Policy.
	+ **Patent, Participation, Copyright and policy related subclause:** Please refer to the agenda document([11-24/1340r](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-03-00bn-july-to-sept-tgbn-teleconference-agenda.docx)3).

**Copyright Policy was presented.**

* Attendance reminder.
	+ Participation slide: <https://mentor.ieee.org/802-ec/dcn/16/ec-16-0180-05-00EC-ieee-802-participation-slide.pptx>
	+ Please record your attendance during the conference call by using the IMAT system:
		- 1) login to [imat](https://imat.ieee.org/attendance), 2) select “802 Wireless Interim/Plenary Session” entry, 3) select “C/LM/WG802.11 Attendance” entry, 4) click “TGbn conference call that you are attending.
		- If you are unable to record the attendance via [IMAT](https://imat.ieee.org/attendance) then please send an e-mail to:
		Yusuke Asai (yusuke.asai@ntt.com) & Alfred Asterjadhi (aasterja@qti.qualcomm.com)
	+ Please ensure that the following information is listed correctly when joining the call:
	+ "[voter status] First Name Last Name (Affiliation)"
* Agenda
	+ Chair reviews proposed agenda found in [11-24/1340r3](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-03-00bn-july-to-sept-tgbn-teleconference-agenda.docx).
	+ Discussion: None.
	+ The agenda approved with unanimous consent.
* Technical Submissions – Miscellaneous-Part 1:
	+ [11-24/0730r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0730-00-00bn-flow-control-over-the-air.pptx): Flow control over the air Peter Stephenson (Samsung)

C: How do you indicate multi-STA BlockACK?

A: My proposal puts a bit in the main header. It would apply to all STAs. The flow control applies to the originator of the BlockACK. Anything more specific than NACK would obviously require more intrusive updates to the header to supply that information.

C: I am a little bit confused about the motivation. Are you seeing the receiver requests more processing time?

A: In the current standard, a device knows that it is not going to be able to accept data because it knows that its buffer is full. There is no way of supplying that information to the other side. The only method is saying to the other as “I didn’t get that data.” The transmitter of the data will simply retransmit data, which the recipient of the data knows it cannot process. That is inefficient use of the wireless medium. That is my main motivation for this proposal.

C: In that case, if the receiver negotiates buffer size, and then you can adjust the issue.

A: The point is to my mind in real world devices. It is always going to be the case that there will be occasions where you simply don’t have enough resources. If you’re on a powerful AP, then you will have plenty of buffer size. But my argument is that typical mobile devices which may be blockages in the system getting the data out of the buffer. In the real situation, with mass markets and mobile devices, this is something happening quite a lot.

C: On the other hand, it is not just for the receiver and for the transmitter side. The transmitter also transmits by flow control based on that negotiated buffer size. In that case, I don’t really see why we have this issue.

C: In the slide 8, what you bring here is interesting and valuable. I think it might be used in the wider use cases that any internal issues not only the flow control issues. Besides the flow control issue, when coexistence event happens in the non-AP station, it can respond the bit. When the transmitter AP recognizes that the failure is due to the AP’s bad radio condition, the receiver STA expects to receiver later. So, it can also resolve the coexistence event issue.

A: Not just missing data, there are other things that can happen that have got a similar effect on the connection where you can provide information to the originator. I agree with your comment.

C: How can a receiver tell the transmitter to turn it on again? Do you have this design?

A: There are various ways on turning off and it is not mandatory because that has been historic behavior. So, it can resume by many ways it can learn and then resume later, or obvious way of doing it is then the any BlockACK transmitted subsequently is allowed. Even if the other STA of the link hasn’t changed, the flow control bit is allowed to change in a BlockACK. I am adding the possibility that gratuitous BlockACK, which is the bottom line how you can tell the other side “OK, I am ready to receive again.”

C: If you are not transmitting, how could I be so sure the receive can send the BlockACK if it is not like for the responding the upcoming transmission? Maybe you can be clearer about the mechanism how the receiver responds to the transmitter to restart the transmission again, and if you have more simulation to see what is the real benefit, it is more like a convincing synchronization.

A: OK.

* + [11-24/0848r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0848-00-00bn-adapted-trigger-based-uplink-transmission-follow-up.pptx): Adapted trigger-based uplink transmission follow up

Ming Gan (Huawei Technologies)

C: In the slide 4, the use case for this scheme is that an AP does not know the additional puncture pattern for the non-AP STAs and then we could allow the non-AP STAs to kind of additional puncture 80 MHz, is that correct?

A: The receiver can provide the uplink transmission in the U-SIG. And it lets the AP know which is not used and which is used for uplink transmission. But it has some limitation. So, as I mention on the second bullet in the slide 2, all of RUs of 996, 484, and 484 -tone are idle, we can allow this uplink transmission. Otherwise, the transmission is not allowed.

C: If U-SIG fields from multiple STAs which shared the same 80 MHz channel, they have the same ones. So, if only one STA is on the 80 MHz channel and they can allow the STA to signal, this transmission is now available.

A: Correct. If we allow multiple STA to transmit uplink transmissions within one 80 MHz, then we cannot guarantee they have the same puncturing information within the U-SIG.

C: I think maybe some frame exchanges before the real data transmission can also help for this additional punctured case for the responder.

* + [[11-24/0880r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0880-00-00bn-cbf-recap-and-way-forward.pptx)](https://mentor.ieee.org/802.11/dcn/24/11-24-0375-00-00bn-nav-protection-for-c-tdma.pptx): Co-BF Recap and Way Forward Okan Mutgan (Nokia)

(During presentation)

C: Are you aware that coordinated beamforming was already approved to be included in the SFD in the July meeting? Because it is seemed that the presentation is essentially saying, “let’s have coordinated beamforming to be included in the SFD.”

A: Yes. So, I want to give a general overview and provide the update with the additional details.

 I want to present this submission because this contribution is talking about latency point of view of coordinated beamforming, which is not discussed so much.

(After presentation)

C: In the slide 8, are you talking about low latency traffic for downlink or both of downlink and uplink?

A: Uplink.

C: How do we set the null to the uplink frames?

A: The nulling works two ways. The APs have the channel state information. In the uplink case, the STA’s transmission frame to the APs. Because the APs know the channel state information, so they can do a receiver beamforming. If you want to check the details, you can check the previous contribution, which is the reference [5].

C: For the OFDMA transmission, how many nodes can you serve in a single PPDU? I saw that you have 16 STAs in the setup. I just want to understand the total.

A: In the setup, there are 24 STAs in total. They are 16 broadband stations and eight low-latency stations. We chose the transmitting STAs randomly. For example, five broadband stations and three low-latency stations connect to the Ap1 and the rest connect to the AP2. We randomize access here.

C: In the bandwidth setup, how many STAs can you serve in a single PPDU? Traffic load depends on the setup. For example, when you say the offered load is 100 Mbps, is this per STA load?

A: I have to check, but we didn’t focus too much on throughput but latency.

C: I am wondering if it is oversaturated because the OFDMA transmission will typically be able to 100 STAs.

A: You can also check the references [5], which has all the parameters here.

C: In the slide 8, how can the AP know which low-latency stations should be made nulling? Do you need a negotiation in advance?

A: What we look here is general latency and the low-latency stations have data in their buffer and want to transmit data and we just put nulling in the environment. Because of nulling, the low-latency stations can have access to the channel more. That is why they reach low latency.

C: Regarding ACK frames, there are two types of traffic patterns, FTP and XR. One AP needs to send an ACK frame to a station in the middle of transmission from other station. In this case, how do you make nulling the ACK frame from the AP?

A: We look at uplink traffic only here, not downlink traffic.

C: But how about an ACK frame? It needs to protect an ACK frame from other APs.

A: It naturally happens but no data frames.

C: In terms of PHY level processing, it sounds like you are just relying on the preambles to obtain all the sounding information in order to perform nulling. So, that sounds an implicit sounding, or are we doing explicit sounding?

A: We assume perfect sounding here.

C: If you have got two APs each with 16 antennas, sounding takes a lot of time. And on the downlink, you would be looking for the clients to better support sounding across 16 spatial streams, which is large overhead. How sensitive are these results if the AP support only eight spatial streams of sounding?

A: The limited number of antennas at the AP is one thing we have to think about it. It is not possible to schedule all these stations at once. An AP with eight antenna supports eight stations with single antenna.

C: The simulation setup is still a little bit unclear. You simulated purely uplink traffic and you just use receiving information at the AP sides. In that case, what about the coordination aspect between the different APs? What is done exactly in order to coordinate between different APs?

A: The reference [5] shows the coordination process between APs.

C: Why do you need to do that sounding? If you are doing the nulling at the receivers, they can use the preamble in order to get the CSI. How is the sounding taking place exactly?

A: The two APs get the channel state information from the stations, then those APs can do receiver beamforming. That is how it is kind of a null. If it is downlink, of course, the APs can do transmit beamforming as well.

C: It is very clear why we need CSI at the transmitter side. But for the case of receive beamforming, it is not very clear how the sound is going to.

* + [[11-24/0892r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0892-00-00bn-integrating-wur-into-11bn.pptx)](https://mentor.ieee.org/802.11/dcn/24/11-24-0375-00-00bn-nav-protection-for-c-tdma.pptx): Integrating WUR into 11bn Ying Wang

C: Why do we need FDMA for the wake-up radio?

A: Do you mean FDMA as a frequency division multiple access? It is just a signal into different part of 20 MHz channels.

C: What is the use case?

A: You can transmit to multiple WUR signals to the multiple STAs at the same time. This will improve the spectrum efficiency.

C: I mean to reduce the packet length. Is this sent to the same STA?

A: No. It is sent to multiple STAs. If you have 80 MHz spectrum bandwidth available, then you can send four wake-up signals simultaneously to four STAs.

C: You can do that using just one wake-up frame that lists multiple STAs recipient.

A: Right. You can also send to even more WUR STA radios.

C: Each radio is actually wake-up radio, the center frequency can be different from the primary channel. When they are awakened by the wake-up radio reception, then their 802.11 main radio should exchange the packet through the primary channel.

A: Right. WUR is simply to receive a kind of a wake-up message and it will wake-up the memory and the main radio will operate. They can be on different to center frequencies.

C: WUR can be used to identified and applied to 11ax and beyond.

A: Yes.

C: So, basically even without further optimization or improvement, we can already use WUR for the UHR generation, right?

A: Right. That is what we are referring to as the method one. The current WUR standard only supports FDMA PPDUs up to 80 MHz of bandwidth. So, I guess you may want to extend to a wider bandwidth.

C: I think that is an important baseline which people need to be aware. Regarding this wider bandwidth support, I think at 11ax group already has agreed to have 80 MHz of bandwidth during TGba discussion. I think it is useful for the mandatory bandwidth support. And in my common sense, as for the 320 MHz, we want to have WUR in the 6 GHz bands, which I think it is not necessary to do this research.

A: Thank you for sharing the history.

C: I can see the necessary to involve the WUR in the UHR. Because currently power saving of existing 11be only has something like TWT. So, you can only negotiate the time to recover. But if you have really high priority transmission that need to wake the device up, you need this new kind of design. In the future, can it be cooperated directly or involving some other like power saving mechanisms such as TWT?

A: I think probably it is mainly as an independent feature. This is basically for a radio with WUR and you can turn off the main radio most of the time and basically use the WUR to monitor whether there is any data traffic coming in for you. I think the concept you mentioned is from the main radio side.

* + [[11-24/1038r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1038-00-00bn-channel-sounding-for-uhr-relay.pptx)](https://mentor.ieee.org/802.11/dcn/24/11-24-0375-00-00bn-nav-protection-for-c-tdma.pptx): Channel Sounding for UHR Relay Pei Zhou (TCL)

C: What is the different between the sounding PPDU and the NDP?

A: It can be the same. There may be some difference because in 11bf the sounding PPDU can be HE or VHT NDP. I am not provided the detailed in this contribution. The detailed format of the sounding PPDU is left for the next step.

C: OK. For the related topic, some members propose the TXOP sharing from an AP to a relay station. In this case, the AP1 can share TXOP to the relay station for sounding, which should be considered.

A: I agree with you. The sounding can be happened in a TXOP shared by the AP.

C: In the slide 6, the STA3 is supposed to compute the CSI between the Relay1 and the Relay2 both, right?

A: Yes.

C: Based on the report request, it needs to feedback this CSI but I think it requires a lot of processing time. Have you thought about that?

A: Yes, maybe we can. We can add more gap between the measurement and the report.

C: In the slide 9, two NDPs are transmitted in both direction, one from the STA side and the other one from the relay side. This measurement report is done by the Relay1 to the Relay2 based on the first NDP transmitted by the STA3. And the second NDPs are transmitted by the Relay1 and the Relay2. This downlink channel is also estimated and measured. The CSI is measured and fed back again to the relay or the AP. Is my understanding correct?

A: I think it is necessary because the sounding is initiated by the STA3 after the relay transmitted the second NDP, then the STA3 get the CSI. It is done how to report to anyone.

C: But the second NDP is for the downlink channel. So, the beamforming precoder is supposed to be computed by the AP. Assuming a relay does not have a capability to compute the beamforming precoder. So, the AP is supposed to compute the for the downlink channel.

A: It is possible but my intention is that the STA3 computes the matrix itself.

C: If the STA3 computes the precoder rather than CSI, then the STA3 needs to feedback that precoder to the Relay1 and the Relay2. This second NDP is for the downlink channel and not only for uplink channel.

A: I understand and agree with you.

C: It highlighted the benefit of relaying. Many contributions are focused on one relay. But this is a system view that the benefit of relay comes from having lots of these small, cheap devices spread around the system. You have multiple relays and address how we can efficiently and quickly select identify the correct relay to do the communication. So, the sounding can be initiated by an AP or an STA. In the slide 7, I think the AP was triggering relays to send NDPs. I suppose you could also have the AP triggered the STA3 to send the NDP and receive the feedback report, that can reduce the time.

A: In that case, the same as the uplink signing for the relay is applied.

* + Call for additional presentations
		- Chair called for the proposal for the presentation in the remaining time.
		- The presentation of the submission [11-23/2015r2](https://mentor.ieee.org/802.11/dcn/23/11-23-2015-02-00bn-ht-control-field-expansion.pptx) was proposed to add the agenda.
		- The modified agenda was approved without objection.
	+ [[11-23/2015r2](https://mentor.ieee.org/802.11/dcn/23/11-23-2015-02-00bn-ht-control-field-expansion.pptx)](https://mentor.ieee.org/802.11/dcn/24/11-24-0375-00-00bn-nav-protection-for-c-tdma.pptx): HT Control field expansion Xiangxin Gu (Spreadrum)

C: I commented on this proposal before. 11ax already extend the HT control type. Why do you propose a new method?

A: I remember your comment. It is just another way to expand A-control because of overhead and complexity.

C: I don’t think this has complexity. It is a mechanism that all the devices before UHR can understand the assumption. In the future there may be the control fields that an older generation station cannot understand and the new generation station can understand. So, it could be mixed together. By using your extension, HE or EHT stations could not understand the extension overriding the HTC. You may have some problems in that.

A: I think there is no backward compatibility issues.

C: Maybe individually addressed frame does not have that problem. I think we can first see if we consume the reserved field. After that, we can further decide either to use the existing method or new one.

A: That is OK. Thank you.

C: The original purpose of the retry bit is to indicate that a data or management frame is retransmitted form the early one. If we repurpose the field, how do we indicate the retransmission?

A: We have BlockACK agreements. So, there is no need because in the spec the retry field is reserved.

C: But A-control field is only transmitted in a management or a data frame.

A: I mean those frames are based on block ACK agreement and thus the field is reserved.

C: We already have once in the control ID, that is only for the future, no extension. So, if we repurpose the retry bit, we are wasting this old one. It is only defined for the future extension. So, why don’t use these old ones and just repurpose this additional retry bit?

A: That is my purpose.

* Any other business: None.
* Adjourned at 21:00.

# 3rd Conf. Call: August 5th, Monday (19:00-21:00 ET) – MAC/PHY

* MAC: <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-01-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>
* PHY: cancelled

# 4th Conf. Call: August 8th, Thursday (10:00-12:00 ET) – MAC

* <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-02-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>

# 5th Conf. Call: August 12th, Monday (19:00-21:00 ET) - Joint

* Call the meeting to order
* IEEE 802 and 802.11 IPR policy and procedure
	+ Patent Policy: Ways to inform IEEE:
	+ Cause an LOA to be submitted to the IEEE-SA (patcom@ieee.org); or
	+ Provide the chair of this group with the identity of the holder(s) of any and all such claims as soon as possible; or
	+ Speak up now and respond to this Call for Potentially Essential Patents

If anyone in this meeting is personally aware of the holder of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please respond at this time by providing relevant information to the WG Chair.

**Nobody spoke/wrote up.**

* + Copyright Policy: Participants are advised that
	+ IEEE SA’s copyright policy is described in [Clause 7](https://standards.ieee.org/about/policies/bylaws/sect6-7.html#7) of the IEEE SA Standards Board Bylaws and [Clause 6.1](https://standards.ieee.org/about/policies/opman/sect6.html) of the IEEE SA Standards Board Operations Manual;
	+ Any material submitted during standards development, whether verbal, recorded, or in written form, is a Contribution and shall comply with the IEEE SA Copyright Policy.
	+ **Patent, Participation, Copyright and policy related subclause:** Please refer to the agenda document([11-24/1340r](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-07-00bn-july-to-sept-tgbn-teleconference-agenda.docx)7).

**Copyright Policy was presented.**

* Attendance reminder.
	+ Participation slide: <https://mentor.ieee.org/802-ec/dcn/16/ec-16-0180-05-00EC-ieee-802-participation-slide.pptx>
	+ Please record your attendance during the conference call by using the IMAT system:
		- 1) login to [imat](https://imat.ieee.org/attendance), 2) select “802 Wireless Interim/Plenary Session” entry, 3) select “C/LM/WG802.11 Attendance” entry, 4) click “TGbn conference call that you are attending.
		- If you are unable to record the attendance via [IMAT](https://imat.ieee.org/attendance) then please send an e-mail to:
		Yusuke Asai (yusuke.asai@ntt.com) & Alfred Asterjadhi (aasterja@qti.qualcomm.com)
	+ Please ensure that the following information is listed correctly when joining the call:
	+ "[voter status] First Name Last Name (Affiliation)"
* Announcements
	+ Please submit contributions at least 24 hours in advance and if there are deferral request to be sent at least 24 hours in advance. Contributions that don’t follow these will be removed from the queues.
* Agenda
	+ Chair reviews proposed agenda found in [11-24/1340r7](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-07-00bn-july-to-sept-tgbn-teleconference-agenda.docx).
	+ Chair struck out several submissions from the original agenda because they had not been uploaded 24 hours before.
	+ Chair asked presenters to keep tracking their contributions in the queue.
	+ Chair announced MAC submission will be presented after the joint submissions because most of joint queue is cleaned up.
	+ Discussion: None.
	+ The agenda approved with unanimous consent.
* Technical Submissions – Miscellaneous Part 2 + MAP Part 2:
	+ [11-24/1122r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1122-00-00bn-vendor-specific-phy-options-follow-up.pptx): Vendor Specific PHY Options With Minimal PHY Changes – Follow-Up

Brian Hart (Cisco Systems)

C: Once you have a mechanism to signal a dynamic operation, do you still need the static operation?

A: Yes. If we think about like a canonical problem, one is transmitting with non-vendor specific behavior and the other is transmitting with vendor specific behavior with a dynamic instance. Sometimes the vendor specific behavior is present, maybe sometimes it is absent. So, it is vendor specific mode A or mode B. In that case, you definitely need to have a static indication and dynamic indication to indicate between the mode A and the mode B. If the dynamic behavior is dynamically on and then completely off, and it looks exactly like a standardized protocol, then I agree you are right at that point.

C: I mean the static could just uses that dynamic bit set as high all the time, so that makes it de facto static. And of course, you can disable it all the time, which also make it de facto static.

A: That is good clarification.

C: You mentioned the BSS color is useless for an AP. Could you please clarify that?

A: If an AP has multiple BSSIDs, the AP practically has to use the same BSS color. And if one wants to use vendor specific signal and the other doesn’t, it just can’t do the spatial reuse.

C: Regarding this general AID List Veto mechanism, do you know currently we have any requirements on the AID assignment?

A: Basically, no. The early AIDs are assigned to the broadcast and not transmitted BSSID broadcast indications. There is some sort of optional use of AIDs. In general, there is a goal for an AP to use close tightly allocated AIDs because that reduces the beacon size and given the existence of broadcast traffic, then it is just low AIDs. And 11bi talks about hiding in the crowd and switching AIDs and having a group of clients, possibly multiple groups of clients, and then switching AIDs between them. Typically, those groups are isolated. But I don’t believe there is any particular requirement for contiguousness of anything else.

C: I think this could be one mechanism, but they need the MAC folks to have some requirements of AIDs. Another thing may be to consider like the color collision mechanisms. If the AP or the STA finds some collision issues, then it tries to prevent the BSS color collision or to report saying that it is not safe usage.

A: In an enterprise deployment, the AP allocations are sort of three or five feet away. In such cases, you are just not going to get spatial reuse. It is better to have no color or just putting them to the same color. If these two different networks use the same BSS color, then using BSS color for the purpose of distinguish BSSs for this kind of purpose is dangerous.

C: Could you elaborate a little bit more about a few examples on what kind of vendor specific behavior that might be different or like a vendor specific PHY?

A: One example for the dynamic is to adjust appropriate MCS setting where you would not be using a super-high MCS all the time and the AP or client can decline it. For example, you are transmitting with especially low EVM or especially low phase noise, and if the recipient knows that, it could use a tighter tracking loop on carrier recovery, phase tracking or perhaps different algorithms for range estimation. My earlier documents on the references show more examples.

C: In the slide 5, in the cases B and D, you mentioned about this AID identification. The way I see it is probably like either happen between the AP and the station, typically. So, in an MU-PPDU, you see the signaling in the U-SIG field, where you have trigger frames in the user field. So, for example of the cases B and D, how would an AID assignment help in this particular case? You have one of them seem to be clearly a peer-to-peer communication.

A: Most of peer-to-peer in these days is using so-called infrastructure BSS, where one of these entities is an AP. And, in the corner case, which we need to be worried about, if this AP happens to assign the AID 10 to this client, and the other AP also assigns the AID 10 to this case, whenever it receives an PPDU with AID 10, it is not clear if it is coming from the AP or another AP. If it needs to do different receiver processing based on the vendor specific information, the communication to the STA which is aware of the information is achieved but the reception by other STA which is not aware of the information would be screwed up.

C: So, basically you are still assuming the EMLSR AP, which makes a little bit more sense to me. In this case, the AP is avoiding exactly the same AID assignment.

* + [11-24/1179r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1179-00-00bn-trigger-frame-expansion.pptx): Trigger frame expansion Vishnu V. Ratnam (Samsung Electronics)

C: In the slide 3, your proposal is to extend the current trigger frame compatible with the legacy device. I am thinking in which case the new trigger frame to make both 11bn and legacy devices respond. Because the list in the second bullet defined in 11bn. Which case do you need to make the response both from 11bn and legacy devices?

A: For example, in DSO you want to use the same trigger to both trigger legacy devices and UHR devices at the same time. And including all these proposals, they prefer to use the same trigger frames supposed to defining a new trigger frame. Even in the coexistence indication you would want, you could want to trigger a coupling OFDMA.

C: I understand the coexistence only for 11bn devices, right?

A: No. For example, if you are sending a BSRP trigger, legacy STAs might send a BSR. In some of the proposals and, the UHR STAs will just send multi-STA block ACK. The point is that it enables to get information from both of legacy and UHR STAs at the same time. Not all of it will be coexistence. Legacy STAs will provide normal BSR, and UHR STAs can provide the coexistence indication.

C: We do have some reserved bits in the common field for the trigger frames. Those bits can still be used like in slide the 4. We still have some room for the new signaling. And we can always use the new special user field for the future intention. I agree on that part. For the complexity regarding future generation indication, since we have this PHY version ID, those can be simply changed to UHR.

A: They are also reserved because legacy devices will copy these bits into the HE-SIG AID field for sending the trigger response. That is why an EHT AP always sets these bits to one to ensure backward compatibility. These large chunk bits are just individual bits. I am not fully sure if we could provide some other indications in UHR. Because if you are also triggering some of HE devices, it will impact what they want to transmit in their HE SIG-A.

C: I agree those points. They are copied to follow by the legacy devices. However, the legacy devices will copy no matter the value is zero or one, those bits are set to one because of the PAPR optimization by PHY. In 11be, we are using those reserved bits that will be copied by 11ax, so that we can always use that.

A: Thanks for that information. PHY version is used for indication for the PHY version of the trigger-based response. What we are trying to indicate is the version of the common info field itself. Because that would determine how many additional indications are present including some indications that you carry for UHR or beyond stations. So, the PHY version wouldn’t provide the exactly the same information.

C: The PHY version will be copied to the U-SIG. So, it takes the response. I think if the AP wants to select the UHR response, then the later user field shall be the same PHY version.

A: OK. We need more offline discussion.

* + [11-24/1244r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1244-00-00bn-sst-or-dso-support-for-wider-bandwidth-ofdma-and-a-ppdu.pptx): SST or DSO Support for Wider Bandwidth OFDMA and A-PPDU

Ross Jian Yu (Huawei)

C: In the enterprise with lots of APs, maybe stadium or the high-density environments, use of wider bandwidths is pretty uncommon, said in the 6 GHz bands, 80 MHz is typically the max and in the 5 GHz bands, 40 MHz is pretty much the maximum. The A-PPDU is a feature that only adds value until you are operating at 160 MHz or higher bandwidth. And I have a specific use case when we first introduce UHR, we have a UHR AP, a couple of UHR clients, and the whole bunch of VHT and HE and legacy clients. It makes sense from a PHY perspective, given the nature of how EHT and UHR SIG field have been defined here before, but I want to point out that it is not really what the market is looking for the enterprise market. I think it would add a lot of value if we try to use A-PPDU to deal with variable and mixed clients.

A: That sounds correct. I see similar case the enterprise scenarios currently want to use narrow bandwidth to prevent interference to achieve a larger capacity. Basically, we assume we need to have 160 MHz BSS operating channel with as a minimum and I think some of those features are mainly for the home scenarios. For enterprise, we can further see how to improve that part. Regarding the second comment, did you mentioned the flexibility related with the channel selection?

C: Let’s say we are operating 80 MHz and right now I want to give 20% of the bandwidth to UHR because I still have 80% for legacy. And then the next moment, the traffic is such that I want to use 40%, and then the next moment, a couple of TXOP later, maybe it is more like 10%.

I guess we can do it on a per TXOP basis and give more time to legacy depending on splitting legacy and UHR to give the TXOP shorter and longer. But ideally it would just be a single PPDU on the figures in the slide 5, creating a boundary between the different modes, those lines could move much more smoothly up and down. It might be 20 plus 60 or 10 plus 70 or something.

A: Do you mean that the AP controls the TXOP for the different generations?

C: Within a PPDU, the AP can have some flexibility. I just mentioned 10 MHz resolution, but that looks too extreme. At least if it had 20 MHz resolution, thing would be helpful for the enterprise market.

A: OK.

C: In general, I think it is a good direction to utilize the SST by defining secondary 160 MHz. In terms of use cases, do you think some high-level difference or some relationship with the DSO?

A: For the DSO, without considering the implementation details and complexity, they achieve the functions to move the stations to non-primary channels. So, the AP can send the different PPDUs in different channels, and the stations can receive the UHR PPDU portion in the center channel. That is why I have mentioned both SST and DSO.

C: So, this feature is not kind of the contradiction. The contradiction is a kind of supplementary to enhance the two features can be combined together.

A: I think SST is easier to achieve. At least for now, it does need some pre-negotiation compared with DSO. So, I prefer this direction for DSO. Its advantage is to do this operation directly at the beginning of a TXOP. You do not need some pre-negotiation, but on the other hand, it needs some hardware requirements for the non-AP stations to reduce the switching time. That is the difficult part.

* + [11-24/0874r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0874-00-00bn-discussion-on-terminology-sharing-and-shared-ap.pptx): Discussion on terminology: Sharing and Shared AP

Xiaofei WANG (InterDigital)

C: It is an interesting and important topic, but I would like to voice my opinion. It may be a little bit earlier. We could take some time to think about defining those particular coordination schemes more specifically. And then, it may be easier to define these qualifiers for each of the scheme. But I think that it would be clearer to have different terms depending on the type of coordination that is happening. On the slide 8, I think the initiating AP or the participating AP, these terms themselves are very general as well just saying coordinating AP. So, I align with the other line of thought that we should have separate terms depending on the type of coordination happening.

A: We can definitely keep discussing. Your opinion says that we want to have different terminology for different multi-AP operations, right?

C: Right.

A: It feels a little easier if we have similar things.

C: I have a similar concern with you for the sharing AP and the shared AP. There are several types of TXOP level coordination, for example, C-SR, C-BF and other things like C-TDMA. This term can be used in those schemes. but like C-TWT, there is alternate TXOP level coordination, and thus the sharing AP and the shared AP are not applied to the C-TWT scheme. My point is when you have some TXOP level coordination, you can use the terminologies of the sharing AP and the shared AP. Actually, it is better to say the TXOP sharing AP and the TXOP shared AP, which will be clearer because you mentioned the current terms are problematic. For other term, you mentioned the participating AP and the initiating AP, it looks like a long-term coordination. So, there will be some orthogonal with the sharing AP and the shared AP concept. But they are not in the same status.

A: Even if you have a transmit opportunity to sharing based things, I think we still have to look at different forms sharing AP. In addition, it is a little bit confusing and I’m not 100% sure adding TXOP in front of it is going to solve that problem. So, we may have to look deeper into this.

C: I agree with several aspects in your contribution. For case 2 in the slide 8, you are saying that you for example of coordinated beamforming, we do not necessarily depend on one single AP obtaining a TXOP first. Is your intention to say that an AP can become the coordinating AP or the initiating AP?

A: The question here is really about whether it is necessary of a sharing concept. They also have to have a transmit opportunity. But for example, at least it's not immediately clear coordinating beamforming has to depend on TXOP sharing. That could be based on other ways and another possibility also coordinated TWT. You already have a negotiated TWT, why would you have to necessarily obtaining a TXOP first and then share with another BSS?

C: I certainly agree that C-RTWT is longer-term thing, that lead to different terms. But I do find the sharing/shared nomenclature unnecessarily over similar. I would be happy if we had very different names for the two roles, initiator and then something different one.

A: Thank you for your comment. We can keep talking about the different possibilities.

C: I spent my time thinking about this terminology. I ended up like in an early presentation this year having like the coordinating and coordinated AP type of wording. But that was not very happy myself with that, since the “C” is basically leading to the same acronym. But in general, using the same terminology across all the coordinated access point scheme would be easier to refer to the two sides of the agreements, or any way the parties involved in the coordination in general if we adopt this approach.

A: Thank you. We can keep discussing on this topic.

C: This is actually a very interesting because the shared AP never quite made sense to me. I like the idea of terms that makes clear what the device is doing. I think that was the attempt with your case one for sharing and shared. I would be more in favor of something that would continue that rather than trying to make uniform terms, that would end up being very general. For the first case where the behavior is pretty clear, it could be beneficial. And adding “TXOP” as in the previous comment, that is longer but it makes very clear what behavior is expected from the AP when you are talking about it.

A: I can see the benefit for “sharing” but we try to avoid confusions. When you have little more general term for like initiating or anything like the ideas, it doesn’t lose more specific things. But I wonder whether it makes sense to have if we end up having four different multi-AP operations, that is going to have a specific term for all four different ones.

C: Maybe it would be initiating with some other word. “Initiating” is the same across all of them that start the process, but there is a difference of what they are initiating.

A: That could be one way to go.

(Chair recommended to initiate the discussion on the TGbn reflector.)

* Any other business: None.
* Adjourned at 20:45.

# 6th Conf. Call: August 19th, Monday (19:00-21:00 ET) – MAC

* <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-03-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>

# 7th Conf. Call: August 22nd, Thursday (10:00-12:00 ET) – MAC

* <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-04-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>

# 8th Conf. Call: August 26th, Monday (19:00-21:00 ET) – MAC

* <https://mentor.ieee.org/802.11/dcn/24/11-24-1344-06-00bn-802-11bn-mac-ad-hoc-minutes-july-sept-2024.doc>

# 9th Conf. Call: August 29th, Thursday (10:00-12:00 ET) - Joint

* Call the meeting to order
* IEEE 802 and 802.11 IPR policy and procedure
	+ Patent Policy: Ways to inform IEEE:
	+ Cause an LOA to be submitted to the IEEE-SA (patcom@ieee.org); or
	+ Provide the chair of this group with the identity of the holder(s) of any and all such claims as soon as possible; or
	+ Speak up now and respond to this Call for Potentially Essential Patents

If anyone in this meeting is personally aware of the holder of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance, please respond at this time by providing relevant information to the WG Chair.

**Nobody spoke/wrote up.**

* + Copyright Policy: Participants are advised that
	+ IEEE SA’s copyright policy is described in [Clause 7](https://standards.ieee.org/about/policies/bylaws/sect6-7.html#7) of the IEEE SA Standards Board Bylaws and [Clause 6.1](https://standards.ieee.org/about/policies/opman/sect6.html) of the IEEE SA Standards Board Operations Manual;
	+ Any material submitted during standards development, whether verbal, recorded, or in written form, is a Contribution and shall comply with the IEEE SA Copyright Policy.
	+ **Patent, Participation, Copyright and policy related subclause:** Please refer to the agenda document([11-24/1340r](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-13-00bn-july-to-sept-tgbn-teleconference-agenda.docx)13).

**Copyright Policy was presented.**

* Attendance reminder.
	+ Participation slide: <https://mentor.ieee.org/802-ec/dcn/16/ec-16-0180-05-00EC-ieee-802-participation-slide.pptx>
	+ Please record your attendance during the conference call by using the IMAT system:
		- 1) login to [imat](https://imat.ieee.org/attendance), 2) select “802 Wireless Interim/Plenary Session” entry, 3) select “C/LM/WG802.11 Attendance” entry, 4) click “TGbn conference call that you are attending.
		- If you are unable to record the attendance via [IMAT](https://imat.ieee.org/attendance) then please send an e-mail to:
		Yusuke Asai (yusuke.asai@ntt.com) & Alfred Asterjadhi (aasterja@qti.qualcomm.com)
	+ Please ensure that the following information is listed correctly when joining the call:
	+ "[voter status] First Name Last Name (Affiliation)"
* Announcements
* Agenda
	+ Chair reviews proposed agenda found in [11-24/1340r13](https://mentor.ieee.org/802.11/dcn/24/11-24-1340-13-00bn-july-to-sept-tgbn-teleconference-agenda.docx).
	+ Discussion:
		- [11-24-1115r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1115-00-00bn-channel-switching-rules-for-npca.pptx) was presented on the last MAC ad-hoc, and thus it was requested to put the submission first.
	+ The modified agenda approved with unanimous consent.
* Technical Submissions – Leftovers from previous Joint/MAC:
	+ [11-24/1115r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1115-00-00bn-channel-switching-rules-for-npca.pptx): Channel switching Rules or NPCA

Vishnu V. Ratnam (Samsung Electronics)

(The presentation was resumed from the end of the 8th teleconference (MAC ad-hoc).)

C: In the slide 5, you say PPDU duration minus T\*. Here is a MAC header duration. Do you mean you don’t need FCS check, just check the header?

A: We are seeing a PPDU duration. You are only using the L-SIG field from the PHY header to get the duration.

C: Even in pre-HE, we also have A-MPDU.

A: I have not fully considered the A-MPDU. Among pre-HE, at least non-HT, we should cover them where you don’t have aggregation. Whether we should consider HT/VHT, that is up for discussion.

C: In the slide 9, you mentioned the maximum bandwidth of an OBSS PPDU. Is this for the punctured case or both cases?

A: I was thinking of both.

C: For the non-punctured case, for example, if the BSS bandwidth is 160 MHz, how is the maximum bandwidth before we set it to 80 MHz?

A: If you set it to 80 MHz, you should have at least 80 MHz remaining. In the punctured case, I guess you have smaller bandwidth.

C: But if for non-puncturing case, the operation bandwidth of the AP is 60 MHz or less. Do we have a maximum bandwidth threshold? How to set the bandwidth?

A: This would be up to the AP to set for the BSS. For example, if only 20 MHz bandwidth is available after the switch in the non-punctured case, you should have at least a significant amount of bandwidth remaining to be able to use.

C: I think we are in full agreement for the triggering being a PPDU type of HE and above. For non-HT duplicate transmission, what we mentioned is triggering based on the intra-BSS frame exchange. This is an extremely important condition. This could probably be even a mode where this is the only way we would do NPCA. Because that provides you with the insurance that both the AP and the STA of the OBSS is transmitting something. You largely increase the chances that both of the NPCA based AP and STA will be seeing the same BSS activity on the medium and set the NAV accordingly at the same time and then they would be transitioning to the NPCA channel at the same time. I believe something is quite important you want something additional, which is non-HT group or any PPDU, for example of the beacon. You are struggling to get all the information to do it. How would you get the bandwidth of a bigger frame sent in non-HT group? If it is sent on 80 MHz in non-HT duplicate, can you even know that?

A: I assume that the beacon would be sent in non-HT and non-duplicated, but I can check back on that and get back to you. How to find the bandwidth, I am sore there should be a mechanism.

C: Please check it.

A: That is important both of devices are transmitting so that you don’t have this blindness issue. So, the same issue of only one device transmitting also happens for the HE+ PPDU. It is only the non-HT initial control frame where both device transmitting condition is within a short duration is happening.

C: We think about the possibly having a mode where only initial control frames would be the trigger-base to configure it.

C: You can add a triggering condition that is RSSI greater than a threshold. But I think it is difficult to do that. Because the AP and the STA will be on different locations. So, even if the STA knows the AP’s RSSI in the triggering condition on this RSSI report, it does not help the STA to check it whether the AP should switch or not.

C: I agree that the RSSI value that the AP and the STA will observe differently. We need to discuss whether we need such a threshold or not. My thinking was it should be more than -72 dBm or not because there is more chance that some devices do hear it, but other device don’t. If we set a higher threshold, devices on the edge of the BSS can still receive that PPDU with a higher chance. But, of course, we need some simulations to show the effectiveness.

A: The switching time decision may be conducted on different STAs which have different conditions. So, the AP can just decode the modulation and decode the second MPDU but the STA can decode the first one. There is still difference between the switching time points of the AP and the STAs in A-MPDU cases.

C: I am considering more on the line of either HE+ PPDUs or non-HT PPDUs. So where in HT+, we are still using only PHY header information. So, whether aggregation is happening inside the body does not matter. For non-HT, there is no aggregation involved. We need more discussion on that and can look into how to deal with aggregation issue.

-----(Discussion on the chat window of the Webex) -----

C: Does anyone send beacon in non-HT duplicated PPDU? I remember member mentioned that will cause confuse for legacy STA.

C: What's the confusion? it looks like a STA receive a Beacon from neighbor channel, e.g., power leakage case.

C: Some legacy STA may think there is a BSS setup on secondary channel.

C: You mean the STA doesn't decode the operating channel IE from the Beacon?

C: Dup beacons is far from best practice.

C: A 6 GHz AP transmits Beacon frames as defined in 11.1 (Synchronization), and they may be contained in a non-HT PPDU, non-HT duplicate PPDU, or HE SU PPDU.

C: But would bandwidth signaling using service bits not be used in this case by the AP?

C: Non-HT Dup beacons are widely used in 6 GHz \*LPI\* case there are no legacy STAs in 6 GHz (for some reasonable definition of "legacy").

C: Dup Beacon contains the BW signaling in an IE (I think HE 6G Op IE) rather than the service field, but I need to refresh my memory.

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* + [11-24/1058r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1058-00-00bn-discussion-on-aspects-in-dru-operation.pptx): Discussion on aspects in DRU operation Arik Klein

C: I guess two ways to solve the problem. One is the AP knows it was transmitting non-regular RU and so does a possibly that client have may a different headroom if it transmitted a distributed RU. I agree having the extra information is probably helpful. I have a similar issue that the uplink headroom is not fully informative and having some sort of extra reason codes using some of those reserved bits potentially does help. The two reserved bits could be used for four different reason codes. Do you have any thoughts along those directions?

A: We want to separate between the problem statement and the solution. We have several levels of solutions and have a follow-up presentation. In this presentation, we want to tightly couple it to the DRU because the DRU was already being discussed widely and accepted. We want to connect the MAC operation for the DRU.

C: In the second bullet of the slide 11, the access point does not have sufficient information to decide when to allocate the DRU. The DRU is proposed to help non-AP STAs that are far from the AP to overcome the PSD limitation. Do you think long-term measurement can help the access point to classify the non-AP STAs to non-AP STA that are far non-AP STAs and that are closer or does not have the PSD limitation problem?

A: I don’t think it is relevant for non-AP STAs that are far but not only non-AP STAs far from an AP can reduce the power. We can add some information relevant for the uplink power headroom to the current information of the uplink power headroom, it should be much quicker than long-term measurement. The update of allocation of DRU might need to be in much more dynamic way, rather than long-term measurement.

C: If you are considering a non-AP STAs that is moving, I am not sure even long-term measurements would help.

A: I will present the solution on the next follow-up presentation.

C: If the STA wants to help the AP to decide whether it is DRU or RRU, how do you organize all these uplink transmissions?

A: We are aiming for an indication in the MAC level, not in the PHY level. We are just trying that the AP needs some information to allocate RU.

C: AP will do the final decision?

A: The STA is assisting only indication because the STA is responsible for setting the output transmit power and it has to follow the one of the things it has to follow the regulation. The AP is not aware if the PSD is now the maximum limit or not, so we want to add that kind of indication.

* + [11-24/0655r0](https://mentor.ieee.org/802.11/dcn/24/11-24-0655-00-00bn-thoughts-on-smd-roaming-and-ft-roaming.pptx): Thoughts on SMD Roaming and FT Roaming Binita Gupta

C: This is very important topic. The shared PTK SA is not secure. The main reason is that currently this PTK sits inside of the AP’s chip or driver level and once you start to share the PTK-SA, you have to move the key all the way to the user plane and then distribute the PTK over some secure channel. Once you move the key to the user plane, it is much easier to get that PTK out from the AP than what it is in the driver level. Driver can protect the key inside of the AP pretty well. I agree that the rekeying is important, but what is not solving is also transmitted data with the old PTK. If you get the PTK and if you have stored the traffic that has been ongoing with the client, you can decrypt all that data with rekeyed PTK. So, it is like a mitigation for the future traffic but not for the past traffic and is catastrophe if we can get clear message out with the rekeyed PTK. That is really bad for the wireless LANs. I would be really in favor of always creating PTK for each AP separately and storing it in the driver level. The second comment was the implementation complexity. It is seemed that there are not many differences on the complexity whether there are two PTKs or one PTK.

A: Regarding complexity, it is much more complex to maintain multiple keys on a client side. It is desirable to keep one set of keys through the roaming. Regarding the concern about security, at the client side, the PTK should only be at the drive level and never be shared. At the AP side, it depends on the architecture, centralized or distributed architecture, and how AP is managing keys. In the split MAC architecture where MAC function is split across a controller and an AP, the PTK could be generated by the controller and shared with the AP, that depends on the AP architecture. I don’t see that as a concern. As you said, there is a secure channel between APs and that is required eve for FTE roaming today and the same secure channel would be used to install keys on the APs of the SMD.

C: Based on writing a lot of 11r and based on doing a lot of architecture work on the AP side in the past, there are so many claims in this presentation. You should check and make sure that all your statements in here are correct. Because a lot of them are either partially correct or are completely wrong. In term of moving 11bn forward, there is room to take a look at what you call SMD roaming as well as FT and essentially developed. We could enhance both and there is room to enhance both within this amendment. And I think there are a lot of other different aspects of the architecture that need to be taken into account as well. We should take a step back and define what the actual architecture is before we go into this evaluation of different proposals. I suggest we go back and discuss architecture and do this properly.

A: If there are specific points which you think are partially correct, we can have discussion.

C: I think what we really need to do is to define the architecture.

A: Defining architecture makes sense, I totally agree with you.

C: I don’t think most of your comparisons are correct. You ever stated the benefits of the SMD architecture over the enhanced FTE protocol, and there are many misleading points in your slides. The first example is in the slide 10. For the FTA protocol, the real associated request/response frames are protected by the new PDK. Because the PDK has been derived before exchanging real association request/response frames. The second misleading is in the slide 9. You mentioned that the client needed to exchange the FT request/response frames with each candidate target AP. But I think even for the SMD architecture, the client also needs to exchange ML reconfiguration, request/response frames with each candidate target AP, though the current AP over the DS. Because you mentioned roaming request/response framework are protected. Otherwise, the candidate target AP doesn’t know which PDK should be used for decryption. The reason is the candidate target AP cannot figure out the non-AP MLD’s MAC address just based on the station MAC address of the received frame. The third misleading is the FT protocol can achieve the seamless roaming because the client remains in “state 4” with the current AP MLD before receiving the reassociation response frame with successful state, the client will transition to “state 4” with the target AP. So, it means the fast motion on roaming approved in 11bn also can be applied to the FTA architecture that motion directly mentioned which architecture is applied to, and the last one is the FT architecture. The FT architecture cannot support the downlink data connection with serving and target APs. I think it is not true. The only requirement is the client needs to maintain two PDKs. This is not equivalent to associated with also serving. PDK sharing is a type of web protocol. I don’t find the corresponding text to allow the PDK sharing.

A: That depends on the architecture which is used. That is not in the implementation. I do see BSR can be PMF protected. And your second comment in the sending multiple keys in the SMD case, that is not true. Because in the SMD case, it can send one message and the do the setup with multiple target AP MLDs and then buffer downlink data. You cannot fetch buffer downlink data if you are not associate with the serving AP. That would be a violation of the architecture. That is true in the current architecture only associated with one AP at a time.

C: Regarding PTK, one point you are making is it can be negotiated or renegotiated before or after the roaming. Either one of them is problematic. Because if you do it after the roaming, then your previous communication is potentially exposed. If the roaming itself is problematic, then all future communication is exposed. It is problem with the roaming itself. So, you probably have to do two negotiations and that is just over engineering there. The other comment is discussed before. During the process of roaming itself, I have a preference to prepare the target APs as much as possible and reduce that uplink pause. My preference is to have a full link at the target AP ready and when the target AP has been decided and finalized, and then we can do a separate process to finalize the switching or dropping. It is a slightly different approach than what you are showing, which is roaming preparation with a number of APs.

A: You think the PTK sharing concern. Before and after leaking, I think the concern assumes that PTK is compromised. I think that is true in any architecture. Even today, if PTK is compromised, the transaction which were done with PTK would be exposed. We are saying to minimize the sharing of PTK by doing either leaking before or after or even if there are some scenarios where roaming continues to fail. Because there is a rogue station which is trying to do some attacks and trying to keep the old PTK. In the worst case, an AP or a station can disassociate and reassociate. There are such kinds of guardrails which can be put in place to address those cases.

C: I wonder how to make the SMD alignment between two MLDs. According to our analysis, it is very hard to keep SMD alignment. It’s easy to cause for the window shifting issue. So, I’m not sure this is relative action. If we allow these downlink data from the two MLD is in parallel, it seems FT key maintains only one single PTK. Is it right?

A: In the case of the FT, essentially the data which is receiving through serving will be using one PTK, and the data which is receiving through target is a different PTK. So, that is where the client has to maintain multiple PTKs and SNs. The sequence numbers need to be exchanged and synchronized as part of the context transfer between the two APs and that can be done. In our analysis, that can be achieved as part of doing that context transfer and achieving the data continuity. The client has to maintain at least two keys in the FT architecture versus in SMD.

-----(Discussion on the chat window of the Webex) -----

C: That is not correct. The PTK is never shared between different APs connected to the same controller.

C: Correct. There is no PTK sharing in the CAPWAP protocol.

C: It's not correct. In the FT protocol, The PTKSA is used to protect the subsequent reassociation transaction, including the optional RIC-Request.

C: Everyone is proposing enhancements to baseline; the main question is the basis and characteristics of those enhancements. So, comparing one set of enhancements to an unenhanced baseline protocol is not a fair comparison.

C: To be honest, I don’t think most of comparisons are correct.

C: Authentication messages are unprotected may be misleading - because I see that the nonces they exchange are bound to the new keys - e.g., in FT BSS transition.

C: A "seamless roaming" scheme would also need new AKM/signaling, so the same set of "compatibility issues" with legacy devices would apply either way.

C: I agree there are many misleading comparisons here.

C: Also, the roaming request/response is similar to reassociation request/response - so we are not eliminating the request/response. I do like the dual DL connection; however, note that some exchanges can be 3-message like PASN.

C: Of course, it can be supported as an extension - which is much less disruptive than an entirely new architecture.

C: There will be a new key hierarchy for SMD - we have too many already

C: We believe that in the SMD architecture, the way PTKs are generated and managed will be very different from what we have today. Will Legacy STAs benefit?

C: PTK refresh is a good step, but vulnerabilities still remain - vulnerabilities exploit small time windows and speed of processing like KRACK etc.

C: Do we already have consensus on sharing PTKs between APs?

C: Not yet.

C: Do we need more details for dual DL connection? basically, two APs trying to send DL data to the STA, it can’t be that straightforward.

C: I think sharing PTK or not will affect a lot.

C: Clients already maintain multiple keys in order to support multiple BSSs and other peer-peer connections.

C: Sharing PTK increases the attacking surface, and cause security regression compared with FT.

C: For FT based architecture, PMKr1 need only be distributed to the new possible AP neighborhood but not to all the APs in the mobility domain (I think).

C: I recall there are "push" or "pull" mode in the previous contribution.

C: It's not about FT architecture, it's about the current association rules that STA is connected to one AP at a time. But that rule can easily be modified to handle buffered data delivery from the (previous) source AP.

C: Push, pull distributed only to the neighborhood - only to target perhaps.

C: Either R0KH sends each PMKR1 to (each) AP proactively, or an AP requests a PMKR1 from the R0KH when it needs it.

C: That's my thought... thx.

C: I think a good message in this presentation is that cutting on reassociation/reauthentication and rather discuss roaming as a link reconfiguration is the enabler for full seamless experience. Similar takes have been presented by other members (e.g., non-collocated MLD). Certainly, FT can be used today when this is not possible (e.g., different links are not handled by a single logical entity). So, the two mechanisms may have to work together for 11bn mobility.

C: "association" per-se is not a bottleneck - the bottleneck is procedures that surround it (e.g., reestablishing BA, 4-way handshake etc.). If we optimize those, it really doesn't matter if the "reassociation" or "link reconfig/roam" is used - they are functionally the same imho "link reconfig" across different AP MLDs involves a lot of busywork to redefine all the states we already define for reassociation.

C: Like I mentioned, the roaming request/response is like the reassociation exchange. That exchange can be optimized.

C: The essence of the requirement on "association with only one AP" is there is only one data path.

C: Agree.

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* Adjourned at 12:00.

**Appendix**

* Attendee List for the 2nd Conf. Call:

|  |  |  |  |
| --- | --- | --- | --- |
| Breakout | Timestamp | Name | Affiliation |
| TGbn | 8/1 | Aio, Kosuke | Sony Corporation |
| TGbn | 8/1 | Ajami, Abdel Karim | Apple Inc. |
| TGbn | 8/1 | Asai, Yusuke | Nippon Telegraph and Telephone Corporation (NTT) |
| TGbn | 8/1 | Baek, SunHee | LG ELECTRONICS |
| TGbn | 8/1 | Baykas, Tuncer | Ofinno |
| TGbn | 8/1 | Byeon, Seongho | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Cha, Dongju | LG ELECTRONICS |
| TGbn | 8/1 | Chaturvedi, Abhishek | Samsung Electronics |
| TGbn | 8/1 | Chen, Junbin | TP-Link Corporation Limited |
| TGbn | 8/1 | CHENG, yajun | Xiaomi Communications Co., Ltd. |
| TGbn | 8/1 | Choi, JinHo | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Choi, Jinsoo | LG ELECTRONICS |
| TGbn | 8/1 | Dong, Xiandong | Xiaomi Communications Co., Ltd. |
| TGbn | 8/1 | Doppler, Klaus | Nokia |
| TGbn | 8/1 | Ekkundi, Manasi | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Fan, Shuang | Sanechips Technology Co., Ltd. |
| TGbn | 8/1 | Fang, Yonggang | MediaTek Inc. |
| TGbn | 8/1 | Fujimori, Yuki | Canon Research Centre France |
| TGbn | 8/1 | Ghosh, Chittabrata | Apple Inc. |
| TGbn | 8/1 | Gu, Jaheon | Samsung Electronics Co., Ltd. |
| TGbn | 8/1 | Gu, Junrong | Clourney Semiconductor |
| TGbn | 8/1 | Gu, Xiangxin | Spreadtrum Communications (Shanghai) Co., Ltd. |
| TGbn | 8/1 | Ha, Taeyoung | Samsung Electronics Co., Ltd. |
| TGbn | 8/1 | Hamilton, Mark | CommScope |
| TGbn | 8/1 | Handte, Thomas | Sony Group Corporation |
| TGbn | 8/1 | Hasabelnaby, Mahmoud | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Hedayat, Ahmadreza | Apple Inc. |
| TGbn | 8/1 | Ho, Duncan | Qualcomm Technologies, Inc |
| TGbn | 8/1 | Hsu, Ostrovsky | Xiaomi Communications Co., Ltd. |
| TGbn | 8/1 | Hsu, Yung Lin | National Taiwan University |
| TGbn | 8/1 | HUANG, CHIHAN | MediaTek Inc. |
| TGbn | 8/1 | huang, kaikai | Nokia |
| TGbn | 8/1 | Huang, Po-Kai | Intel Corporation |
| TGbn | 8/1 | Inohiza, Hirohiko | Canon |
| TGbn | 8/1 | Jang, Insun | LG ELECTRONICS |
| TGbn | 8/1 | Jee, Anand | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Kakani, Naveen | Qualcomm Incorporated; Qualcomm Technologies, Inc |
| TGbn | 8/1 | Kandala, Srinivas | Samsung |
| TGbn | 8/1 | Kim, Geon Hwan | LG ELECTRONICS |
| TGbn | 8/1 | Kim, Jeongki | Ofinno |
| TGbn | 8/1 | Kim, Jungjun | Samsung Electronics |
| TGbn | 8/1 | Kim, Sang Gook | LG ELECTRONICS |
| TGbn | 8/1 | Kim, Sanghyun | WILUS Inc. |
| TGbn | 8/1 | Kim, Suhwook | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Kim, Youhan | Qualcomm Technologies, Inc. |
| TGbn | 8/1 | Kishida, Akira | NTT |
| TGbn | 8/1 | Koo, Jonghoe | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Lee, Hong Won | LG ELECTRONICS |
| TGbn | 8/1 | LEE, JOONSOO | Newracom Inc. |
| TGbn | 8/1 | Levy, Joseph | InterDigital, Inc. |
| TGbn | 8/1 | Li, Haozheng | TP-Link Corporation Limited |
| TGbn | 8/1 | Li, Weiyi | Spreadtrum Communication USA, Inc |
| TGbn | 8/1 | Li, Yapu | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/1 | Li, Yunbo | Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Lim, Yeon Geun | Newracom Inc. |
| TGbn | 8/1 | LIU, QINGLAI | Panasonic Holdings Corporation |
| TGbn | 8/1 | Lorgeoux, Mikael | Canon Research Centre France |
| TGbn | 8/1 | Lou, Hanqing | InterDigital, Inc. |
| TGbn | 8/1 | Lu, Liuming | Guangdong OPPO Mobile Telecommunications Corp.,Ltd. |
| TGbn | 8/1 | LU, Yuxin | TCL Industries |
| TGbn | 8/1 | Luo, Chaoming | Beijing OPPO telecommunications corp., ltd. |
| TGbn | 8/1 | Ma, Yongsen | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Minotani, Jun | Panasonic Holdings Corporation |
| TGbn | 8/1 | Motozuka, Hiroyuki | Panasonic Holdings Corporation |
| TGbn | 8/1 | Mutgan, Okan | Nokia |
| TGbn | 8/1 | Nayak, Peshal | Samsung Research America |
| TGbn | 8/1 | Neishaboori, Azin | General Motors Company |
| TGbn | 8/1 | Noh, Si-Chan | Newracom Inc. |
| TGbn | 8/1 | Norouzi, Sara | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Park, Sungjin | Senscomm |
| TGbn | 8/1 | Patwardhan, Gaurav | Hewlett Packard Enterprise |
| TGbn | 8/1 | Petrick, Albert | InterDigital, Inc. |
| TGbn | 8/1 | Qi, Yue | Samsung Research America |
| TGbn | 8/1 | Quan, Yingqiao | Spreadtrum Communications (Shanghai) Co., Ltd.; Unisoc (Shanghai) Technologies Co., Ltd. |
| TGbn | 8/1 | Ratnam, Vishnu | Samsung Research America |
| TGbn | 8/1 | RISON, Mark | Samsung Cambridge Solution Centre |
| TGbn | 8/1 | Roy, Rishabh | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Ryu, Kiseon | NXP Semiconductors |
| TGbn | 8/1 | Sadiq, Bilal | Samsung Research America |
| TGbn | 8/1 | Schelstraete, Sigurd | MaxLinear |
| TGbn | 8/1 | Serizawa, Kazunobu | Advanced Telecommunications Research Institute International(ATR) |
| TGbn | 8/1 | Shafin, Rubayet | Samsung Research America |
| TGbn | 8/1 | Shi, Zhenpeng | Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Singh, Aditi | Charter Communications |
| TGbn | 8/1 | Smith, Luther | Cable Television Laboratories Inc. (CableLabs) |
| TGbn | 8/1 | SUH, JUNG HOON | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Sung, Hyeonjun | WILUS Inc. |
| TGbn | 8/1 | Tanaka, Yusuke | Sony Corporation |
| TGbn | 8/1 | Taori, Rakesh | Infineon Technologies |
| TGbn | 8/1 | Urabe, Yoshio | Panasonic Holdings Corporation |
| TGbn | 8/1 | Val, Inaki | MaxLinear, Inc. |
| TGbn | 8/1 | Verenzuela, Daniel | Sony Group Corporation |
| TGbn | 8/1 | Wang, Lei | Futurewei Technologies/Huawei Technologies |
| TGbn | 8/1 | Wang, Qi | Apple Inc. |
| TGbn | 8/1 | Wang, Ying | InterDigital, Inc. |
| TGbn | 8/1 | Wee, Gaius | Panasonic Holdings Corporation |
| TGbn | 8/1 | Wei, Dong | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/1 | Wilhelmsson, Leif | Ericsson AB |
| TGbn | 8/1 | Wullert, John | Peraton Labs |
| TGbn | 8/1 | Xiao, Tong | Xiaomi Communications Co., Ltd. |
| TGbn | 8/1 | Xu, Yanchao | Amlogic |
| TGbn | 8/1 | Yamada, Ryota | SHARP CORPORATION |
| TGbn | 8/1 | Yan, Aiguo | SAMSUNG ELECTRONICS |
| TGbn | 8/1 | Yan, Zhongjiang | Northwestern Polytechnical University |
| TGbn | 8/1 | Yang, Jay | ZTE Corporation |
| TGbn | 8/1 | Yang, Jimmy | Moxa Inc. |
| TGbn | 8/1 | YANG, RUI | InterDigital, Inc. |
| TGbn | 8/1 | Yano, Kazuto | Advanced Telecommunications Research Institute International (ATR) |
| TGbn | 8/1 | Yee, James | MediaTek Inc. |
| TGbn | 8/1 | Yoon, Yelin | LG ELECTRONICS |
| TGbn | 8/1 | Yu, Jian | Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Zhang, Maolin | Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Zhao, Yue | Huawei Technologies Co., Ltd |
| TGbn | 8/1 | Zhong, Ke | Ruijie Networks Co.,Ltd. |
| TGbn | 8/1 | Zhou, Pei | TCL |

* Attendee List for the 5th Conf. Call:

|  |  |  |  |
| --- | --- | --- | --- |
| Breakout | Timestamp | Name | Affiliation |
| TGbn | 8/12 | Aio, Kosuke | Sony Corporation |
| TGbn | 8/12 | Ajami, Abdel Karim | Apple Inc. |
| TGbn | 8/12 | Asai, Yusuke | Nippon Telegraph and Telephone Corporation (NTT) |
| TGbn | 8/12 | Bai, Jiyang | TCL |
| TGbn | 8/12 | Baykas, Tuncer | Ofinno |
| TGbn | 8/12 | Byeon, Seongho | SAMSUNG ELECTRONICS |
| TGbn | 8/12 | Cha, Dongju | LG ELECTRONICS |
| TGbn | 8/12 | Chen, Wei-Han | Mediatek Inc |
| TGbn | 8/12 | Chen, You-Wei | MediaTek Inc. |
| TGbn | 8/12 | CHENG, yajun | Xiaomi Communications Co., Ltd. |
| TGbn | 8/12 | Chisci, Giovanni | Qualcomm Technologies, Inc |
| TGbn | 8/12 | Cho, Hangyu | LG ELECTRONICS |
| TGbn | 8/12 | Choi, JinHo | SAMSUNG ELECTRONICS |
| TGbn | 8/12 | Choi, Jinsoo | LG ELECTRONICS |
| TGbn | 8/12 | Dezfouli, Behnam | Nokia |
| TGbn | 8/12 | Doppler, Klaus | Nokia |
| TGbn | 8/12 | Dunna, Manideep | Qualcomm |
| TGbn | 8/12 | Fan, Shuang | Sanechips Technology Co., Ltd. |
| TGbn | 8/12 | Fang, Juan | Intel Corporation |
| TGbn | 8/12 | Fang, Yonggang | MediaTek Inc. |
| TGbn | 8/12 | feng, Shuling | MediaTek Inc. |
| TGbn | 8/12 | Fischer, Matthew | Broadcom Corporation |
| TGbn | 8/12 | Gao, Ning | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/12 | Gu, Jaheon | Samsung Electronics Co., Ltd. |
| TGbn | 8/12 | Gu, Junrong | Clourney Semiconductor |
| TGbn | 8/12 | Gu, Xiangxin | Spreadtrum Communications (Shanghai) Co., Ltd. |
| TGbn | 8/12 | Gupta, Binita | Cisco Systems, Inc. |
| TGbn | 8/12 | Ha, Taeyoung | Samsung Electronics Co., Ltd. |
| TGbn | 8/12 | Hamilton, Mark | CommScope |
| TGbn | 8/12 | Hart, Brian | Cisco Systems, Inc. |
| TGbn | 8/12 | Hasabelnaby, Mahmoud | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Hedayat, Ahmadreza | Apple Inc. |
| TGbn | 8/12 | Ho, Duncan | Qualcomm Technologies, Inc |
| TGbn | 8/12 | Hsu, Chien-Fang | MediaTek Inc. |
| TGbn | 8/12 | Hsu, Yung Lin | National Taiwan University |
| TGbn | 8/12 | Hu, Chunyu | Spreadtrum Communications US |
| TGbn | 8/12 | HUANG, CHIHAN | MediaTek Inc. |
| TGbn | 8/12 | huang, kaikai | Nokia |
| TGbn | 8/12 | Huang, Po-Kai | Intel Corporation |
| TGbn | 8/12 | Jang, Insun | LG ELECTRONICS |
| TGbn | 8/12 | Kalamkar, Sanket | Qualcomm Incorporated; Qualcomm Technologies, Inc |
| TGbn | 8/12 | Kamel, Mahmoud | Interdigital Inc. |
| TGbn | 8/12 | Kim, Geon Hwan | LG ELECTRONICS |
| TGbn | 8/12 | Kim, Jungjun | Samsung Electronics |
| TGbn | 8/12 | Kim, Sang Gook | LG ELECTRONICS |
| TGbn | 8/12 | Kim, Sanghyun | WILUS Inc. |
| TGbn | 8/12 | Kim, Youhan | Qualcomm Technologies, Inc. |
| TGbn | 8/12 | Kishida, Akira | NTT |
| TGbn | 8/12 | Koo, Jonghoe | SAMSUNG ELECTRONICS |
| TGbn | 8/12 | Lanante, Leonardo | Ofinno |
| TGbn | 8/12 | Lee, Hong Won | LG ELECTRONICS |
| TGbn | 8/12 | LEE, JOONSOO | Newracom Inc. |
| TGbn | 8/12 | Lee, Wookbong | Apple Inc. |
| TGbn | 8/12 | Li, Weiyi | Spreadtrum Communication USA, Inc |
| TGbn | 8/12 | Li, Yapu | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/12 | Li, Yunbo | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Lim, Dong Guk | LG ELECTRONICS |
| TGbn | 8/12 | Lim, Yeon Geun | Newracom Inc. |
| TGbn | 8/12 | Liu, Yong | Apple Inc. |
| TGbn | 8/12 | Lu, Liuming | Guangdong OPPO Mobile Telecommunications Corp.,Ltd. |
| TGbn | 8/12 | LU, Yuxin | TCL Industries |
| TGbn | 8/12 | Luo, Chaoming | Beijing OPPO telecommunications corp., ltd. |
| TGbn | 8/12 | Ma, Yongsen | SAMSUNG ELECTRONICS |
| TGbn | 8/12 | Mehrnoush, Morteza | Apple Inc. |
| TGbn | 8/12 | Naik, Gaurang | Qualcomm Technologies, Inc |
| TGbn | 8/12 | Namvar, Nima | Charter Communications |
| TGbn | 8/12 | Nayak, Peshal | Samsung Research America |
| TGbn | 8/12 | Nogami, Toshizo | SHARP CORPORATION |
| TGbn | 8/12 | Noh, Si-Chan | Newracom Inc. |
| TGbn | 8/12 | Norouzi, Sara | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Palayur, Saju | Maxlinear Inc |
| TGbn | 8/12 | Park, Minyoung | Intel Corporation |
| TGbn | 8/12 | Park, Sungjin | Senscomm |
| TGbn | 8/12 | Patil, Abhishek | Qualcomm Incorporated |
| TGbn | 8/12 | Patwardhan, Gaurav | Hewlett Packard Enterprise |
| TGbn | 8/12 | Petrick, Albert | InterDigital, Inc. |
| TGbn | 8/12 | Qi, Yue | Samsung Research America |
| TGbn | 8/12 | Quan, Yingqiao | Spreadtrum Communications (Shanghai) Co., Ltd.; Unisoc (Shanghai) Technologies Co., Ltd. |
| TGbn | 8/12 | Ratnam, Vishnu | Samsung Research America |
| TGbn | 8/12 | Ryu, Kiseon | NXP Semiconductors |
| TGbn | 8/12 | Sadiq, Bilal | Samsung Research America |
| TGbn | 8/12 | Schelstraete, Sigurd | MaxLinear |
| TGbn | 8/12 | Sevin, Julien | Canon Research Centre France |
| TGbn | 8/12 | Shafin, Rubayet | Samsung Electronics |
| TGbn | 8/12 | Shi, Zhenpeng | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Shilo, Shimi | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | SUH, JUNG HOON | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Sung, Hyeonjun | WILUS Inc. |
| TGbn | 8/12 | Taori, Rakesh | Infineon Technologies |
| TGbn | 8/12 | Wang, Lei | Futurewei Technologies/Huawei Technologies |
| TGbn | 8/12 | Wang, Qi | Apple Inc. |
| TGbn | 8/12 | Wang, Xiaofei | InterDigital, Inc. |
| TGbn | 8/12 | Ward, Lisa | Rohde & Schwarz |
| TGbn | 8/12 | Wee, Gaius | Panasonic Holdings Corporation |
| TGbn | 8/12 | Wei, Dong | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/12 | Wullert, John | Peraton Labs |
| TGbn | 8/12 | Xia, Qing | Sony Corporation |
| TGbn | 8/12 | Xiao, Tong | Xiaomi Communications Co., Ltd. |
| TGbn | 8/12 | Xu, Yanchao | Amlogic |
| TGbn | 8/12 | Xu, Yue | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Yang, Jay | ZTE Corporation |
| TGbn | 8/12 | Yoon, Yelin | LG ELECTRONICS |
| TGbn | 8/12 | Zhang, Jiayi | Ofinno |
| TGbn | 8/12 | Zhang, John | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/12 | Zhang, Maolin | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Zhao, Yue | Huawei Technologies Co., Ltd |
| TGbn | 8/12 | Zhong, Ke | Ruijie Networks Co.,Ltd. |
| TGbn | 8/12 | Zhou, Huixuan | OPPO |
| TGbn | 8/12 | Zhou, Lei | H3C Technologies Co., Limited |
| TGbn | 8/12 | Zhou, Pei | TCL |

* Attendee List for the 9th Conf. Call:

|  |  |  |  |
| --- | --- | --- | --- |
| Breakout | Timestamp | Name | Affiliation |
| TGbn | 8/29 | Zhao, Xuwen | TCL |
| TGbn | 8/29 | CHENG, yajun | Xiaomi Communications Co., Ltd. |
| TGbn | 8/29 | Kim, Suhwook | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | Chung, Chulho | SAMSUNG |
| TGbn | 8/29 | Luo, Chaoming | Beijing OPPO telecommunications corp., ltd. |
| TGbn | 8/29 | Koo, Jonghoe | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | McCann, Stephen | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Ratnam, Vishnu | Samsung Research America |
| TGbn | 8/29 | Kim, Geon Hwan | LG ELECTRONICS |
| TGbn | 8/29 | Sung, Hyeonjun | WILUS Inc. |
| TGbn | 8/29 | Di Taranto, Rocco | Ericsson AB |
| TGbn | 8/29 | Ma, Yongsen | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | Noh, Si-Chan | Newracom Inc. |
| TGbn | 8/29 | Schelstraete, Sigurd | MaxLinear |
| TGbn | 8/29 | Zhou, Pei | TCL |
| TGbn | 8/29 | Fujimori, Yuki | Canon Research Centre France |
| TGbn | 8/29 | Chaturvedi, Abhishek | Samsung Electronics |
| TGbn | 8/29 | Handte, Thomas | Sony Group Corporation |
| TGbn | 8/29 | Derham, Thomas | Broadcom Corporation |
| TGbn | 8/29 | Inohiza, Hirohiko | Canon |
| TGbn | 8/29 | Hervieu, Lili | CableLabs |
| TGbn | 8/29 | Xiao, Tong | Xiaomi Communications Co., Ltd. |
| TGbn | 8/29 | Taori, Rakesh | Infineon Technologies |
| TGbn | 8/29 | Lee, Hong Won | LG ELECTRONICS |
| TGbn | 8/29 | VIGER, Pascal | Canon Research Centre France |
| TGbn | 8/29 | Shi, Zhenpeng | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Yang, Jimmy | Moxa Inc. |
| TGbn | 8/29 | Zhang, Maolin | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Fan, Shuang | Sanechips Technology Co., Ltd. |
| TGbn | 8/29 | Jang, Insun | LG ELECTRONICS |
| TGbn | 8/29 | Kabbinale, Aniruddh | Samsung Electronics Co., Ltd. |
| TGbn | 8/29 | Baek, SunHee | LG ELECTRONICS |
| TGbn | 8/29 | Cha, Dongju | LG ELECTRONICS |
| TGbn | 8/29 | Li, Yapu | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/29 | Kim, Sang Gook | LG ELECTRONICS |
| TGbn | 8/29 | Kishida, Akira | NTT |
| TGbn | 8/29 | Hasabelnaby, Mahmoud | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Zhong, Ke | Ruijie Networks Co.,Ltd. |
| TGbn | 8/29 | Yang, Jay | ZTE Corporation |
| TGbn | 8/29 | Wei, Dong | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/29 | Nayak, Peshal | Samsung Research America |
| TGbn | 8/29 | Zhou, Huixuan | OPPO |
| TGbn | 8/29 | baron, stephane | Canon Research Centre France |
| TGbn | 8/29 | Gu, Jaheon | Samsung Electronics Co., Ltd. |
| TGbn | 8/29 | Gu, Junrong | Clourney Semiconductor |
| TGbn | 8/29 | Gupta, Binita | Cisco Systems, Inc. |
| TGbn | 8/29 | Hamilton, Mark | CommScope |
| TGbn | 8/29 | Monajemi, Pooya | Apple Inc. |
| TGbn | 8/29 | Zhou, Lei | H3C Technologies Co., Limited |
| TGbn | 8/29 | Yano, Kazuto | Advanced Telecommunications Research Institute International (ATR) |
| TGbn | 8/29 | Ajami, Abdel Karim | Apple Inc. |
| TGbn | 8/29 | Quan, Li | ZTE Corporation |
| TGbn | 8/29 | Choi, Jinsoo | LG ELECTRONICS |
| TGbn | 8/29 | Hu, Chunyu | Spreadtrum Communications US |
| TGbn | 8/29 | Fu, Qingwei | TP-Link Systems Inc. |
| TGbn | 8/29 | Klein, Arik | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Patwardhan, Gaurav | Hewlett Packard Enterprise |
| TGbn | 8/29 | Cui, Yaoshen | TP-Link Systems Inc. |
| TGbn | 8/29 | Gao, Ning | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/29 | Kandala, Srinivas | Samsung |
| TGbn | 8/29 | RISON, Mark | Samsung Cambridge Solution Centre |
| TGbn | 8/29 | Sevin, Julien | Canon Research Centre France |
| TGbn | 8/29 | Zhang, Jiayi | Ofinno |
| TGbn | 8/29 | Choi, JinHo | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | Baykas, Tuncer | Ofinno |
| TGbn | 8/29 | Hart, Brian | Cisco Systems, Inc. |
| TGbn | 8/29 | Mutgan, Okan | Nokia |
| TGbn | 8/29 | Lorgeoux, Mikael | Canon Research Centre France |
| TGbn | 8/29 | Lu, kaiying | MediaTek Inc. |
| TGbn | 8/29 | Inoue, Kyosuke | SHARP CORPORATION |
| TGbn | 8/29 | LU, Yuxin | TCL Industries |
| TGbn | 8/29 | Gu, Xiangxin | Spreadtrum Communications (Shanghai) Co., Ltd. |
| TGbn | 8/29 | Hsu, Ostrovsky | Xiaomi Communications Co., Ltd. |
| TGbn | 8/29 | Byeon, Seongho | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | Li, Haozheng | TP-Link System Inc. |
| TGbn | 8/29 | Fischer, Matthew | Broadcom Corporation |
| TGbn | 8/29 | Singh, Aditi | Charter Communications |
| TGbn | 8/29 | Wee, Gaius | Panasonic Holdings Corporation |
| TGbn | 8/29 | Erkucuk, Serhat | Ofinno |
| TGbn | 8/29 | Roy, Rishabh | SAMSUNG ELECTRONICS |
| TGbn | 8/29 | Val, Inaki | MaxLinear, Inc. |
| TGbn | 8/29 | Yang, Haorui | China Mobile |
| TGbn | 8/29 | Aio, Kosuke | Sony Corporation |
| TGbn | 8/29 | Shilo, Shimi | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Yee, James | MediaTek Inc. |
| TGbn | 8/29 | Lim, Yeon Geun | Newracom Inc. |
| TGbn | 8/29 | Patil, Abhishek | Qualcomm Incorporated |
| TGbn | 8/29 | Norouzi, Sara | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/29 | Zhou, Renlong | Sanechips Technology Co., Ltd. |
| TGbn | 8/29 | Ryu, Kiseon | NXP Semiconductors |
| TGbn | 8/29 | Bai, Jiyang | TCL |
| TGbn | 8/29 | Lim, Dong Guk | LG ELECTRONICS |
| TGbn | 8/29 | Verenzuela, Daniel | Sony Group Corporation |
| TGbn | 8/29 | Yoon, Yelin | LG ELECTRONICS |
| TGbn | 8/29 | Neishaboori, Azin | General Motors Company |
| TGbn | 8/29 | Yan, Zhongjiang | Northwestern Polytechnical University |
| TGbn | 8/29 | Lu, Liuming | Guangdong OPPO Mobile Telecommunications Corp.,Ltd. |
| TGbn | 8/29 | Motozuka, Hiroyuki | Panasonic Holdings Corporation |
| TGbn | 8/29 | Hsu, Yung Lin | National Taiwan University |
| TGbn | 8/29 | Zhang, John | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/29 | Varshney, Prabodh | Nokia |
| TGbn | 8/29 | Kamel, Mahmoud | Interdigital Inc. |
| TGbn | 8/29 | Wang, Ying | InterDigital, Inc. |
| TGbn | 8/29 | Quan, Yingqiao | Spreadtrum Communications (Shanghai) Co., Ltd.; Unisoc (Shanghai) Technologies Co., Ltd. |
| TGbn | 8/29 | Hedayat, Ahmadreza | Apple Inc. |
| TGbn | 8/29 | Kakani, Naveen | Qualcomm Incorporated; Qualcomm Technologies, Inc |
| TGbn | 8/29 | Wullert, John | Peraton Labs |
| TGbn | 8/29 | SUH, JUNG HOON | Huawei Technologies Canada; Huawei Technologies Co., Ltd |
| TGbn | 8/29 | LIU, QINGLAI | Panasonic Holdings Corporation |
| TGbn | 8/29 | Chen, Junbin | TP-Link Systems Inc. |
| TGbn | 8/29 | Montemurro, Michael | Huawei Technologies Co., Ltd |
| TGbn | 8/29 | kamath, Manoj | Broadcom Corporation |
| TGbn | 8/29 | Wu, Zidong | Guangdong OPPO Mobile Telecommunications Corp.,Ltd |
| TGbn | 8/29 | Huang, Po-Kai | Intel Corporation |
| TGbn | 8/29 | Ho, Duncan | Qualcomm Technologies, Inc |
| TGbn | 8/29 | Lee, Wookbong | Apple Inc. |
| TGbn | 8/29 | Serizawa, Kazunobu | Advanced Telecommunications Research Institute International(ATR) |
| TGbn | 8/29 | LEE, JOONSOO | Newracom Inc. |
| TGbn | 8/29 | Vermani, Sameer | Qualcomm Incorporated; Qualcomm Technologies, Inc |
| TGbn | 8/29 | Li, Jialing | Qualcomm Technologies, Inc |
| TGbn | 8/29 | Dunna, Manideep | Qualcomm |
| TGbn | 8/29 | Asai, Yusuke | Nippon Telegraph and Telephone Corporation (NTT) |
| TGbn | 8/29 | Li, Weiyi | Spreadtrum Communication USA, Inc |
| TGbn | 8/29 | GUIGNARD, Romain | Canon Research Centre France |
| TGbn | 8/29 | Shafin, Rubayet | Samsung Electronics |
| TGbn | 8/29 | Das, Subir | Peraton Labs |
| TGbn | 8/29 | Lanante, Leonardo | Ofinno |
| TGbn | 8/29 | Kedem, Oren | Maxlinear |
| TGbn | 8/29 | huang, kaikai | Nokia |
| TGbn | 8/29 | Ha, Taeyoung | Samsung Electronics Co., Ltd. |
| TGbn | 8/29 | Kalamkar, Sanket | Qualcomm Incorporated; Qualcomm Technologies, Inc |
| TGbn | 8/29 | Fang, Yonggang | MediaTek Inc. |
| TGbn | 8/29 | Urabe, Yoshio | Panasonic Holdings Corporation |
| TGbn | 8/29 | Dezfouli, Behnam | Nokia |