IEEE P802.11
Wireless LANs

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| Minutes for Task Group (TG) 802.11 beExtremely High ThroughputTelephone Conferences in February and March 2020 |
| Date: 2020-04-03 |
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Abstract

This document contains the meeting minutes from TGbe telcos in February and March, 2020.

* Rev0: Added meeting minutes for Thursday February 6.
* Rev1: Addition of minutes for conference all of Thursday February 13, 2020.
* Rev3: Addition of minutes for confecence call Thursday March 19, 2020. Added links to ad-hoc phone conferences in February and March.
* Rev4: Added links to ad-hoc phone conferences held 23, 26, 30 March, 2020. Added heading and a content for easier navigation.

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# Thursday 30 January 2020, 19:00 – 22-00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0266-00-00be-11be-phy-ad-hoc-minutes-january-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0258-00-00be-11be-mac-ad-hoc-teleconference-minutes-jan-2020-to-mar-2020.docx>

# Thursday 6 February 2020, 10:00 – 12:00 ET

**Introduction**

1. At 10:00 the Chair Alfred Asterjadhi (Qualcomm), calls the meeting to order.
2. The Chair goes through the IPR policy and procedures. The Chair asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The chair reminds to take attendance through an e-mail to the Secretary, Dennis Sundman (Ericsson), or the Chair. According to the join.me application, it appears to be around 100 people on the call.

Registered through e-mail:

* 1. Alfred Asterjadhi (Qualcomm)
	2. Dennis Sundman (Ericsson)
	3. Gaurav Patwardhan (HPE)
	4. Kazuto Yano (ATR)
	5. Kiran Uln (Cypress)
	6. Kosuke Aio (Sony)
	7. Ross Yu (Huawei)
	8. William Carney (Sony)
	9. Yusuke Tanaka (Sony)
1. Announcements: The Chair informs about the MAC ad-hoc. It is TBD if the meeting will start at 8:00 or 9:00 AM. Currently no restriction due to the Corona virus. The Chair asks if there are any questions regarding the ad-hoc. There will be a join.me, or similar, for the ad-hoc.
2. The next item on the agenda is technical submissions. The Chair asks if there is any objection regarding the grouping of the technical submissions. No objection noted.
3. The chair asks if there is any objection to approve the agenda. Nobody objection noted.

**Technical Submissions**

1. [**0035r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0035-00-00be-discussion-on-expansion-of-multi-link-aggregation-to-multi-ap.pptx)**, “Discussion on Expansion of Multi-Link Aggr. to Multi-AP” – Yoshihisa Kondo (ATR)**

**Summary:** The authors discuss how Multi-Link can be combined with Multi-AP. They claim this may be of large interest for real-time applications.

**Discussion:**

None.

1. [**0068r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0068-00-00be-multi-link-and-multi-ap-reference-model-discussion.pptx)**, “Multi-link and multi-ap reference-model discussion” – Yonggang Fang (ZTE)**

**Summary:** The authors present new reference models supporting both multi-link and multi-ap.

**Discussion:**

C: On slide 7. The shared AP only borrows TXOP. I am confused about this diagram.

A: A shared AP has 2 or multiple communication links.

C: On slide 7. Are you assuming the APs are co-located?
A: The APs may be either co-located or not.
C: Do you need any synchronization between the different transmission modes?

A: That depends on the implementation.

1. [**0032r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0032-00-00be-consideration-on-multi-ap-home-mesh-scenario.pptx)**, “Consideration on Multi-AP Home Mesh Scenario” – Kosuke Aio (Sony)**

**Summary:** The authors propose a new residential reference scenario to evaluate home mesh scenarios.

**Discussion:**

C: Using RTS/CTS is common practice. How come you have not used it?
A: We have not used that here.
C: Are you mostly focusing the 3 APs at home, or are you also considering interference from APs in other homes?
A: Currently I haven’t considered APs in other homes because I want to look at a simple case.

C: What is your thought for the enterprise and hot-spot scenario regarding multi-AP operation?
A: They may be fine, but for this presentation, we focused on the residental one.

1. [**0064r1**](https://mentor.ieee.org/802.11/dcn/20/11-20-0064-01-00be-overview-of-multi-ap-operation-in-11be.pptx)**, “Overview of Multi-AP Operation in 11be” – Chenhe Ji (Huawei)**

**Summary:** The authors take a large view over multi-AP operation. To support all things that we have discussed, they argue that much work still needs to be done. Therefore they suggest to begin looking at non-AP STAs functionality.

**Discussion:**
None.

1. [**0033r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0033-00-00be-coordinated-spatial-reuse-operation.pptx)**, “Coordinated spatial reuse operation” – Jason Yuchen Guo (Huawei)**

**Summary:** The authors propose that coordination may be used to perform good power control. They present a transmission procedure and gives some examples.

**Discussion:**C: Can you go to slide 8. If AP1 wins the TXOP, that needs to be communicated to AP2, is that right?
A: Yes.
C: If one AP is doing downlink, does the other AP also do that?
A: Yes.
C: Slide 9. You assume a wireless backhaul, right?
A: I am not sure. There can be some wired backhaul.
C: Slide 5. There are lots of AP-AP communication in this slide. Are you planning that all this AP-AP signalling to be specified in the specification?
A: Yes.

C: How is this different from SRP?
A: The SRP scheme is a distributed one. This is coordinated.

**AoB:** No other business noted.

**Adjourned at 11:55.**

# Thursday 13 February 2020, 19:00 – 22:00 ET

**Introduction**

1. At 19:05 the Chair Alfred Asterjadhi (Qualcomm), calls the meeting to order.
	1. Minutes are to be recorded by Matthew Fischer
2. The Chair goes through the IPR policy and procedures as found in document 11-20-0240-06-00be-2020-feb-mar-tgbe-teleconference-agendas. The Chair asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The chair reminds to take attendance through an e-mail to the Secretary, Dennis Sundman (Ericsson), Vice Chair Matthew Fischer, or the Chair. According to the join.me application, there are 138 connections to the joinme app.

Names identified either through the participant list of joinme, or through the receipt of an email, or through self identification during the call:

* 1. Alfred Asterjadhi (Qualcomm)
	2. Matthew Fischer (Broadcom)
	3. Johnathan Segev (Intel)
	4. Dibakar Das (Intel)
	5. Dmitry Akhmetov (Intel)
	6. Dorothy Stanley (HPE)
	7. Guarav Patwardhan (HPE)
	8. Hirohiko Inohiza (Canon)
	9. Jinsoo Choi (LGE)
	10. Frank Hsu (Mediatek)
	11. Gnadiy (Huawei)
	12. Junghoon Suh (Huawei)
	13. John Yi (xxxx)
	14. Namyeong Kim (LGE)
	15. Myeongjin Kim (Samsung)
	16. Rojan Chitrakar (Panasonic)
	17. Ron Porat (Broadcom)
	18. Sang Kim (LGE)
	19. Sigurd Schelstraete (Quantenna, On)
	20. Jarkko Knecht (Apple)
	21. Steve Shellhammer (Qualcomm)
	22. Taewon Song (LGE)
	23. Al Petrick (Interdigital)
	24. Ross Yu (Huawei)
	25. Shimi Shilo (Huawei)
	26. Tomo Adachi (Toshiba)
	27. Jianhan Liu (Mediatek)
	28. Yan Xin (Huawei)
	29. Yonggang Fang (ZTE)
	30. Young Hoon Kwon (NXP)
	31. Yujin Noh (Newracom)
	32. Yunbo Li (Huawei)
	33. Yusuke Tanaka (Sony)
	34. Feng Jiang (Intel)
	35. Wookbong (Samsung)
	36. Rui Yang (Interdigital)
	37. Chunyu Hu (Facebook)
	38. Kazuto Yano (ATR)
	39. Kiran Uln (Cypress)
	40. Kosuke Aio (Sony)
	41. William Carney (Sony)
1. Announcements: The Chair provides the following information about the MAC ad-hoc:
	1. It will be held in Santa Clara, hosted by Intel
	2. There are US entrance restrictions due to the Coronavirus
	3. March 13, 09:00 – 18:00
	4. There will be a webex connection
	5. The Chair asks if there are any questions regarding the ad-hoc, there are none.
2. The next item on the agenda is technical submissions. The Chair asks if there is any objection regarding the listing and ordering of the technical submissions as proposed within xxxxx.
	1. No objection noted.
3. The chair asks if there is any objection to approve the agenda.
	1. Nobody objected.

**Technical Submissions**

1. [**0073r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0073-00-00be-on-coordinated-spatial-reuse-in-11be.pptx)**, “On Coordinated Spatial Reuse in 11be” – Jianhan Liu (Mediatek)**

**Summary:** The authors discuss the extension of existing Spatial Reuse to Coordinated Spatial Reuse which operates among a set of Aps, with simulated comparisons to coordinated OFDMA, spatial reuse (blind), spatial reuse using TPC, 11ax spatial reuse.

**Discussion:**

Q: Is this UL sim?

A: yes, no, DL, did not simulate UL

Q: How is power control performed?

A: AP sends a trigger to other APs to coordinate by examining pathloss

Q: How does each AP know the location of interferers?

A: each AP needs to know, each STA needs to report, other STA will report, so 2 pathloss numbers are known and then a calculation can be made

Q: to coordinate, need to schedule ahead of time

A: yes, need to exchange pathloss information

Q: how to calculate MCS?

A: based on pathloss during multiple transmissions, assuming no beamforming, omni assumed, STA calculates SINR based on presence of overlapping signal, calculates effective MCS possible, throughput determined based on that

Q: APs will send at the same time, then calculate SINR, then determine MCS

A: selection of optimal TX power, a search between many AP power combinations is performed, then power is chosen to yield highest overall throughput, in our simulation, we search for the best result

Q: what is the difference between SR and OBSS PD?

A: SR is no power control, every AP at max power, OBSS PD adjusts the threshold based on TX power, not interesting to include this

Q: what difference would there be if you had a realistic MCS adaptation?

Q: slide 6, configurations, if AP1 gains the medium, what if there is a STA transmitting to AP4 when AP1 wants to transmit?

A: that’s a natural spatial reuse event, no coordination needed, but in this slide, the AP-AP distance is only 40 meters, so your case should not occur in this configuration

Q: slide 7, coordinated OFDMA case, showing a straight line, each BSS has the same size RU, each AP will have the same, max MCS?

A: yes, it behaves the same as one AP with one STA per BSS, preamble not considered, SNR is always enough for highest MCS, configuration 3, the BSS radius is larger, and COFDMA is no longer a straight line

Q: slide 10 is also still almost straight, still high MCS?

A: yes, still very high MCS

Q: what sort of PPDUs? SU, or MU, DL?

A: AMPDU, SU

Q: except for the COFDMA

A: even for COFDMA, single user per RU

Q: multi-AP case, SU or MU?

A: always only SU in the simulations, but MU should have a similar result, assuming that each AP in multi-AP, each AP is TX to a different user

Q: not practical STA configurations, configuration 4 or 5, difficult to achieve this in real life

A: we just show that there are always gains, regardless of the configuration, might do better when a STA is close to the AP, for example

Q: random associations to the different APs might produce a different result

A: configuration 2 and 3 do this

Q: beamforming – you simulated only omni, what would happen with beamforming without coordination, each AP would potentially have less interference to other transmissions

A: we have those results, but in that case, the result would be inbetween the CBF and omni, coordinated BF outperforms coordinated SR, uncoordinated beamforming will help, we have those results as well

Q: agreed to have a two release approach in last meeting, with a single simple coordinated AP mechanism, would this meet that goal?

A: yes, this is simple, CSR is simpler than COFDMA and better gains, believe that it is suitable for wave one

No straw poll

1. [**0107r1**](https://mentor.ieee.org/802.11/dcn/20/11-20-0107-01-00be-multi-ap-coordination-for-spatial-reuse.pptx)**, “Multi-AP coordination for spatial reuse” – Dmitry Akhmetov (Intel)**

**Summary:** The authors present a proposal for coordinated spatial reuse between two APs and associated STAs.

**Discussion:**

Q: any UL?

A: no – only DL, same mechanism can be applied for UL

Q: assume completely controlled, no EDCA?

A: yes, a bit extreme

Q: contention is still present, but when an AP wins, it can perform CSR

Q: would it be possible to do both DL and UL within a CSR time period?

A: the exchanges should be symmetrical

Q: slide 4, is there Carrier sensing within the SIFS, if so, what happens when busy?

A: did not have Carrier sense in the simulation, if an invited AP does not transmit, then so be it, winning AP will always transmit anyway

Q: would prefer to see a simulation for carrier sensing included

A: if one AP is transmitting, the other AP will not be able to transmit on its own

Q: slide 5, do you assume that AP2 starts after receiving the ASR frame?

A: yes

Q: if there are 3 or 4 AP s, then what

A: scheme shown is only for 2 AP

Q: in the multi AP configurations, what happens?

A: any AP winning contention always only chooses one of the other AP

Q: what happens in the presence of UL?

A: might not have the invited AP share CSR, but the link is already busy anyway, so that is effectively an existing case of SR

Q: limited to 2 AP because too many paths to analyse, otherwise

A: yes

Q: announcement phase, AP1 tries to do CSR with AP2, what happens if AP2 already has something else going on?

A: could have an ACK to ASR, but even without an ACK, AP1 will go forward

Q: slide 5, learning phase, any special sounding? AP TX PWR levels need to be known.

A: might consider a sounding protocol, or use beacons, and collect responses, might consider routine beacon receptions for determining paths

Q: what is meant by complete control

A: could have total coordination which uses a master AP which collects all path information and then makes CSR decisions and dictates which can perform transmissions at any time, just for comparison, not focusing on that scheme

Q: slide 7, assume that initial winner does not use a reduced MCS to encourage SR possibility?

A: correct, AP will maximize local throughput, no compromise for the winner, but invite some other transaction if it still fits in the SINR

Q: without sharing, suppose the master is MCS5, and you maintain 10%, is that at MCS5?

A: stay at MCS5, if, for example, an AP is operating at MCS11 with a target STA, and the AP cannot identify any neighbour AP that can CSR without allowing the MCS11 to continue, then you do not invite any AP to share CSR

Q: if you have some MCS and TX PWR for 10%, you can drop power, then with perfect feedback, you need to leave some margin to support MCS5, in such a case, how much margin to you really have

A: simulation is perfect, so we could introduce some more realism as a follow up

No straw poll

1. [**0052r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0052-00-00be-multi-ap-sounding-discussion.pptx)**, “Multi-AP Sounding Discussion” – Yonggang Fang (ZTE)**

**Summary:** The authors present a proposal for using coded sounding symbols to reduce the overhead of the multi-AP joint sounding function.

**Discussion:**

Q: is the two inflection method actually a code based method?

A: depends on how you form the p matrix

Q: tone selection is better than a general coded method, with fading, different powers on different tones, dispreading at receiver, you will not get as good a result, will see a difference in high Doppler scenario

Q: slide 4, after trigger frame, coordinated AP sends a joint NDP at the same time?

A: if it is a coordinated AP, then it is joint sounding, so there will be a joint NDP

Q: but the time of departure of the frames will be different from the two Aps

A: yes

Q: the STA could have different distances to the Aps, so the arrival times will be different, in the freq domain, you will see a linear shift, this will hurt the orthogonality

A: depends on how large the timing error is, in our simulation, we did not include this

Q: compare overhead reduction vs the sequential method?

A: sequential sounding has higher overhead because of the multiple NDP, the total time of the sequence is much longer, for code based, does not introduce more overhead, similar to tone based joint sounding in terms of overhead

Q: perfect time synch is not realistic, this method was compared with tone interleaver method and orthogonality is not maintained with timing errors for this method, check that other contribution, from Samir

A: ok

Q: agree with previous commenters, need to see performance in the presence of some synchronization errors

Q: these codes are similar to BSS color, i.e. need to be different per AP, need to know the mask before receiving the sounding frames

A: code space is probably larger than BSS color space to achieve good performance

Q: need different set of sequences for differnt numbers of APs involved and a method to indicate what code is in use by each AP

A: agree

Q: echo comments on timing synchronization

Q: slide 5, what is the Ng assumption?

A: depends on how many APs are involved in the joint sounding

Q: what method is there for CFO adjustment among the AP s

A: if there is a difference in freq, then there will be degradation, but it is not much

Q: joint sounding LTF and single AP UL MU MIMO LTF will be the same or different?

A: did not study

Q: would object to having more than one type of LTF, prefer a solution with a single LTF for all purposes

A: understood

No straw poll

1. [**0123r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0123-00-00be-channel-sounding-for-multi-ap-cbf.pptx)**, “Channel Sounding for Multi-AP CBF” – Feng Jiang (Intel)**

**Summary:** The authors present a discussion of design considerations for channel sounding in multi-AP CBF using sequential channel sounding and explicit CSI FB, CSI from OBSS STA and modelled on 11ax sounding protocol.

**Discussion:**

Q: NDP1 and NDP2 are to be received by other BSS STA s, right?

A: yes

Q: need addressing to tell them to receive these sounding frames and for STA s to communicate to other APs

A: yes, detail not yet addressed

Q: how does AP2 know when to send NDPA2?

A: single TXOP requires some new method, maybe AP2 monitors BFRP trigger and reports

Q: maybe AP1 can send a frame to AP2 to share the TXOP

A: yes

Q: if not same TXOP, channel might drift between NDP1 and NDP2

A: agreed, cannot wait too long

Q: slide 9, NDPA1, NDPA2, similar information, why not combine and then master AP sends NDPA once, and no slave AP NDPA

A: if only master, then some STA in AP2 BSS might not hear that NDPA, NDPA from AP2 could be different as well

Q: STA needs a larger buffer as well, if he is not allowed to send FB before the next NDP reception

A: yes

Q: slide 9, two green arrows going up, CSI report is that including for NDP2?

A: no, first CSI report is only for NDP1, second CSI report for NDP2

Q: reason for the separation is that some STA from other BSS cannot hear, then how can those STA hear the BFRP trigger?

A: maybe before this multi-AP CBF sounding, master and slave exchange information on which STA s can be included in the CBF TX, so that only those STA will perform the sounding exchange

Q: if that is true, then if buffer space is not a problem, then only one NDPA is needed

A: still want separate NDPA1 and NDPA2 because they might include different sets of STA, some used for CBF and some not

No straw poll

1. [**0071r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0071-00-00be-joint-transmission-for-11be.pptx)**, “Joint Transmission for 11be” – Ron Porat (Broadcom)**

**Summary:** The authors present a contribution which contains a list of contributions that suggest that there is a general agreement that there are gains and that simulations have been performed and joint sounding NDP was already agreed, with a straw poll proposing that Joint transmission for single and multi user for the multi-AP topic be added to the SFD.

**Discussion:**

Q: is it possible for a non-AP STA to receive a jointly transmitted PPDU as if it is from a single AP without modifying the receiver requirements?

A: we believe it is possible to receive without making any receiver changes, assuming no particular per-AP adjustments, treat the PPDU as a normal reception, if the packets are too long, the relative error in the clocks at the AP s will eventually create a large enough error to reduce the performance

Q: do we need a new receive procedure, or a new one?

A: no new procedure for the recipient side, only for the transmitters

Q: difficult to decide, fundamental problem is the backhaul communication for passing data between joint transmitters, if the backhaul is wireless, then this might be a problem, especially if backhaul and fronthaul are sharing a channel, suggest a straw poll with an assumption about wired backhaul, modify the straw poll if the backhaul is wireless

A: we could modify the straw poll, ask you to examine 11-19-1909 which explores the wireless backhaul case, you can look there and see gains in that case, JT comes out ahead and does not fail – we do not want to exclude the wireless backhaul case, for a home mesh scenario

Q: generally in favour, assume that this is accepted as R2, what is the plan, for sounding procedure definition, set up procedure, should this be an independent design, or shared for other joint mechanisms? COFDMA, CSR, CJT, for R2, other mechanisms not commonly used, what is the plan for R1 vs R2

A: much of the procedures could be shared

Q: agree that some might be re-usable, some maybe not, needs further discussion

A: ok

Q: for JT, do you assume that the total number of streams is limited to 16?

A: yes, others have shown that 1 AP w 16 vs mAP w 16 total gives similar results, allows to share the single sounding procedure, for example with the multi case

Q: will you continue discussion or move forward with this SP?

A: will continue to discuss Release 1 topics first, we could still submit ppt for this item – possible to make the procedures similar to the single-AP case in R1 and then it is almost there

Q: support the position presented, note that previous presenters discussed CSR and CBF, 11be will eventually support these various coordinated mechanisms, one at a time, or all of them, in your view?

A: all will eventually exist in the specification and each implementer will have to make a decision as to which ones to support, varying complexity

Q: similar to previous question, in your opinion, there will be overlap between the procedures defined?

A: that is desired, yet, COFDMA has specific FB requirements, joint requires sounding differences, coordination process could be common, but FB information is likely to be different, AP requirements are tighter for some mechanisms, the framework seems similar

No straw poll

1. [**11-19-1923r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-1923-01-00be-revisiting-harq-complexity.pptx)**, “Revisiting HARQ Complexity” – Shimi Shilo (Huawei)**

**Summary:** The authors present a contribution which reviews various contributions on HARQ and provides a position that is a response to the summary of those contributions, including making modifications to earlier presentations from the author(s) on the HARQ topic.

**Discussion:**

Q: agree that HARQ is possible, memory is the biggest problem, no change in transmitter side, you assume chase combining case, what about IR?

A: minor design changes, on slide 3, think that if it can be done without encoder changes, do not change LDPC matrix, that is preferable, TX side changes can be minimal

Q: another solution, OFDMA, for example

A: we have discussed it, the main reason is that the scheduler has information about specific RU, but it has no idea about other RUs, could consider more sophisticated FB, how much can you trust the information, does the scheduler use optimized MCS? Most implementations actually use some type of rate adaptation which optimizes over time and do not want to create an immediate MCS estimate

Q: there could be other solutions

A: I agree

Q: memor shrink, 4.5, how did you get that? Totally linear would be 16

A: we had 10 previously, we had not talked to design guys, now, 28 v 7 nm is a different process, so it is not exactly 16:1, but it is not that significant, so we settled on something more like 4.5:1, based on TSMC

Q: number of iterations, is it less because you have better LLRs after combining?

A: yes, that is the expectation and slide 12 shows simulation results which confirm this

Q: slide 9, memory estimate, only for one single PPDU?

A: no, based on PER and CW Error Rate, number of bits, memory requirement is based on number of failing CW, not a complete PPDU

Q: these numbers are for a single link?

A: is it good for UL? I don’t know. Every row in slide 9 is for a different BW and MCS, the throughput per STA is not that high, long term, an AP UL would have to store data for many STA over time, yes, the memory requirement will increase

Q: some linear relationship for number of supported STAs

A: yes, but these are high throughputs and if you had multiple STAs UL, that would be an extreme scenario

No straw poll

**Call by the chair for AoB:** No other business noted.

**Adjourned at 22:03.**

# Thursday 20 February 2020, 10:00 – 12:00 ET

* PHY: Cancelled
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0258-00-00be-11be-mac-ad-hoc-teleconference-minutes-jan-2020-to-mar-2020.docx>

# Thursday 27 February 2020, 19:00 – 22:00 ET

**Introduction**

1. At 19:07 the Chair Alfred Asterjadhi (Qualcomm), calls the meeting to order.
	1. Minutes are to be recorded by Matthew Fischer
2. The Chair goes through the IPR policy and procedures as found in document [11-20-0240-08-00be-2020-feb-mar-tgbe-teleconference-agendas.docx](https://mentor.ieee.org/802.11/dcn/20/11-20-0240-08-00be-2020-feb-mar-tgbe-teleconference-agendas.docx). The Chair asks if anyone is aware of any potentially essential patents. Nobody speaks up.
3. The chair reminds to take attendance through an e-mail to the Secretary, Dennis Sundman (Ericsson), Vice Chair Matthew Fischer, or the Chair. According to the join.me application, there are 133 connections to the joinme app, some connections might represent multiple participants.

Names identified either through the participant list of joinme, or through the receipt of an email, or through self identification during the call:

* 1. Alfred Asterjadhi (Qualcomm)
	2. Matthew Fischer (Broadcom)
	3. Adrian Jose Garcia Rodriguez (Nokia)
	4. Li-Hsiang Sun (InterDigital)
	5. Mostafa Ibrahim (Samsung)
	6. Yan Zhang (NXP)
	7. Ruchen Duan (Samsung)
	8. Al Petrick (InterDigital)
	9. Bin Tian (Qualcomm)
	10. Bo Sun (ZTE)
	11. Chenhe Ji (Huawei)
	12. Chunyu Hu (Facebook)
	13. Dongguk Lim (LGE)
	14. Greg Ko (unknown)
	15. Guogang Huang (Huawei)
	16. Huizhao Wang (Quantenna a division of On Semiconductor)
	17. Insun Jang (LGE)
	18. Jarkko Kneckt (Apple)
	19. Jeongki Kim (LGE)
	20. John Son (xxxx)
	21. L. Sun (perhaps Li-Hsiang Sun from InterDigital)
	22. Lily Lyu (Huawei)
	23. Ming Gan (Huawei)
	24. Myeongjin Kim (Samsung)
	25. Roya Doostnejad (Intel)
	26. Sang Kim (LGE)
	27. Sanghyun Kim (WILUS)
	28. Shimi Shilo (Huawei)
	29. Sigurd Schelstraete (Quantenna a division of On Semiconductor)
	30. Srinivas Kandala (Samsung)
	31. Steve Shellhammer (Qualcomm)
	32. Taewon Song (LGE)
	33. Tomo Adachi (Toshiba)
	34. Xiaofei Wang (InterDigital)
	35. Yonggang Fang (ZTE)
	36. Young Hoon Kwon (NXP)
	37. Yujin Noh (Newracom)
	38. Yunbo Li (Huawei)
1. Announcements: The Chair provides the following information about the MAC ad-hoc:
	1. It will be held in Santa Clara, hosted by Intel
	2. There are US entrance restrictions due to the Coronavirus
		1. An email was sent out on 2/27 detailing these restrictions
	3. March 13, 09:00 – 18:00
	4. There will be a webex connection
	5. The Chair asks if there are any questions regarding the ad-hoc, there are none.
	6. The chair asks if there are any other annoucements
	7. In response to a comment, there will be an update to the email sent by the chair to correct geographical information regarding the coronavirus
2. The chair describes some changes to the agenda that was transmitted through email on 2/26 california time
	1. The chair asks if there are any other requests for agenda modifications
		1. A member indicates that the last contribution should be updated to r1
		2. The chair acknowledges
	2. The chair asks if there is any objection to approve the agenda.
		1. Nobody objected.
3. Next item is technical submissions

**Technical Submissions**

1. [**0091r5**](https://mentor.ieee.org/802.11/dcn/20/11-20-0091-05-00be-performance-of-parameterized-spatial-reuse-psr-with-coordinated-beamforming-null-steering-for-802-11be.pptx)**, “11-20-0091-05-00be-performance-of-parameterized-spatial-reuse-psr-with-coordinated-beamforming-null-steering-for-802-11be” – Adrian Jose Garcia Rodriguez (Nokia)**

**Summary:** The authors discuss the performance of a combination of parameterized spatial reuse (PSR) and coordinated beamforming.

**Discussion:**

Q: slide 9, maybe missing something, between STA21 and 22, did you make a prior decision, how do know that either 21 or 22 will win contention?

A: in phases 1 and 2, AP1 is telling AP2, I have two legacy STA close to you, if you are nice to me, you can place xxxx because they have low latency traffic every 10 ms, it is sensitive, help them to find SR opp

Q: if STA21 or 22 wins, then SR can be used, do STA21, 22 know this

A: yes, STA21, 22, need to transmit a pilot, a null packet, to identify a radiation null, know they know that they can use relaxed conditions

Q: AP1 is sending null signal to STA21, STA22 while AP2 sends null signal to STA11, STA12

A: AP1 is a slave placing a spatial filter, bf to STA11 and STA12, UL mimo, these two spatial filters are orthog to the channels between AP1 and STA21, STA22

Q: while AP RX UL traffic xxxx

Q: does the transmitter xxxx if energy is not from the AP, you have filter xxxx which asks STA to apply it

A: only receiving, wants to prevent UL from STA11, STA12 interference during transmission to STA21, STA22

Q: when you have null to STA21, STA22, adverse impact on other BSS, say BSS3, if you do not do this, then BSS3 might have SR opp, based on the detection threshold, but because you are doing null steering, then you get SR opp to BSS2, but then BSS3, not in the null, cannot do SR, is this a severe impact to BSS3

A: concern about prioritizing SR for some STA vs others, effectively, what would happen is the system is still fair, because if BSS3 is listening to 11 and 12, then he would backoff, if not listening, then contend, if BSS3 gains access, then yes, there is a benefit, but not when other BSS gains access

Q: AP uses spatial filter to apply null interference and then uses second filter to decode data

A: no, will, it could be, you can devise a STA filter in different ways, e.g. first detection filter, so that you can isolate your signal, second filter to eliminate interference, you could also have detection filter orthog by design to the other signals, implementation choice

Q: could use simplified forcing

Q: why do we need NDPA before first trigger frame

A: no real purpose – coming from a previous explicit example – need to remove

No straw poll

1. [**0099r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0099-00-00be-coordinated-beamforming-for-802-11be.pptx)**, “11-20-0099-00-00be-Coordinated-Beamforming-for-802.11be” – Roya Doostnejad (Intel)**

**Summary:** The authors discuss a straw poll that will be presented at the March meeting regarding adding coordinated beamforming as a feature of 11be.

**Discussion:**

Q: is there a req for coord bf, synch coord between multiple AP, or is it assumed no sync requirement

A: req are discussed in previous contributions, so sync coord multi-AP in that category, we do not put any requirement, but for the technical discussion, it is sync and requires multi-AP channel sounding

A: not against, supporting the straw poll, did you say this will be release 1 or release 2

Q: relase 2

Straw poll will occur at the march meeting

1. [**0101r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0101-00-00be-11be-harq-discussions.pptx)**, “11-20-0101-00-00be-11be-harq-discussions” – Hangqing Lo (InterDigital) (presented by: Li-Hsiang Sun, InterDigital)**

**Summary:** The authors discuss problems with using MPDU as the HARQ unit.

**Discussion:**

Q: could be reasonable to receive tx within a single cycle, will the packet fit into one TXOP, does HARQ need to be reduced to fit packet

A: yes

Q: slide 4, 6, as long as both sides understand that the PPDU is a retx, and know the locations of retx bits, regardless of whether it is retransmitted or not, as long as protocol is common at tx and rx, same coded bits can be retransmitted, same delimiters, mac header, duration, new mpdus would follow existing protocol, so that header is updated in ciphertext and so forth, protocol needs to ensure that exact same bits are retransmitted

A: meaning, you cannot use the DUR field in the MAC header because it would change, many other fields also change, so what do you do with those fields? E.g. more data, eosp bits, etc, after HARQ, rx order is different, so more data, how to interpret? Need to figure this out or move some signalling to phy layer

Q: do not believe it is a problem, as long as appropriate rules are created

A: ok

Q: CW or MPDU is a longstanding discussion, one variant is IR, any way you can make this work with MPDU?

A: for retransmission just transmit systematic bits with different coded bits, can combine systematic bits

Q: is this analysis based on chase combining?

A: not related to choice of HARQ style, will be a discrepancy in MAC headers either way

Straw poll will occur at a later time

1. [**2120r0**](https://mentor.ieee.org/802.11/dcn/19/11-19-2120-00-00be-link-adaptation-improvement.pptx)**, “11-19-2120-00-00be-Link-Adaptation-Improvement” – Mostafa Ibrahim (Samsung)**

**Summary:** The authors introduce new code rates to provide smaller granularity in MCS choices to improve rate adaptation.

**Discussion:**

Q: agree that some gain exists if you introduce intermediate MCS, previously proposed in HARQ context, you propose in addition to HARQ, main concern, adding 60% more, that has a major impact on rate adaptation mechanism, too many degrees of freedom to converge, did you consider

A: not certain how much added complexity, can study later

Q: complexity can be expressed as convergence time, assume you used optimal rate adapt, what happens when you do not have genie optimal, this was discussed, when you do not converge and choose the wrong value, this might degrade performance, you need to address this

A: we tried some algorithms, good point that convergence time is part of complexity

Q: do you have BER curves for each new MCS, would be interesting to see the new curves compared to the existing ones

A: yes, we do, not in the slides, can include later

Q: slide 3, MCS, SNR table, obtained for single stream channel D?

A: yes

Q: BW?

A: AWGN, 20 MHz

Q: LDPC?

A: Yes

Straw poll will occur at a later time.

1. [**0083r0**](https://mentor.ieee.org/802.11/dcn/20/11-20-0083-00-00be-impacts-of-mcs-set-expansion-on-11be-link-adaptation.pptx)**, “11-20-0083-00-00be-impacts-of-mcs-set-expansion-on-11be-link-adaptation” – Yan Zhang (NXP)**

**Summary:** The authors provide an examination of the impact of expanding the MCS set.

**Discussion:**

Q: last bullet, last slide, misleading, adding new MCS does not reflect impact on the adapatation algorithm, need to choose MCS dynamically, based on understanding of existing mechanisms, it will be more difficult to converge, another comment, throughput comparison, slide 8 or 16 maybe, 13, 18, all of them, slide 18, assuming optimal link adaptation

A: for both cases, yes

Q: how do you choose MCS? Optimal that yields max tput, right?

A: yes

Q: even when you do optimal, practical will not achieve optimal, this figure shows three small regions where 2-3 dB in narrow SNR regions, practical will be limited to that, at best, probably worse, could even be lower than this

A: today already need to converge – if there is a big gap, then you can never reach the higher level, if we add an intermediate level, then if you are stuck at the lower MCS, you will have a higher choice that works, do not know why you believe convergence takes more time, with a larger gap, you will do ping pong and always fail at the higher level

Q: convergence time depends on implementation, if you start from zero, you have to pass through more levels to converge, you have inbetween values, yes, and if everything was perfect, fine, but SNR estimation is not good and SINR changes constantly, always some movement in SINR, with more levels, you become more sensitive to these constant changes

A: can estimate SINR

Q: no, I do not think that you can estimate SINR

A: your algorithm does not estimate SINR?

Q: believe it is not possible to correctly estimate SINR

A: rough SINR is good enough, not necessary to start with MCS0 and increase by single MCS, can use rough SINR to start near the optimal value.

Q: when the gap between MCS is large, then as SINR varies, you

A: you can base on BA reception

Q: not estimating SINR, saying when SINR changes…

A: basing MCS changes on BA reception, so no difference in algorithm

A: if channel changes, will get many failures, has nothing to do with SINR change and gap size, it is based on PER statistics

Q: agree with previous commenter that more levels makes it harder to adapt, better method is HARQ, which allows you to correct wrong MCS, do not want to see any additionsn to MCS without having HARQ

A: easy to implement more MCS, can set initial MCS however I like, aim at performing correct TX on first TX, do not want to fall back on HARQ, which would encourage aggressive rate selection

A: we believe that HARQ does not add gain, but adding MCS levels takes care of the same problem that HARQ is trying to address

Q: slide 3, what is the meaning of the no preamble

A: no preamble in the simulation, no errors in preamble, LSIG, only in payload

Q: only one LTF for channel estimation

A: used HE LTF

Q: simulation results, slide 10, why so many curves are intersecting? E.g. MCS2, MCS3

A: because 2/3 v ¾ performance difference

Q: our results are different, you have no impairments, correct?

A: correct

Q: need more checking, MCS intersections

A: maybe we used a different receiver

Q: slide 4, does not go beyond 1K QAM, what about 4K QAM?

A: no plan

Q: why not?

A: 4K QAM not yet approved

A: trying to fill gaps, not add to the upper end

Q: between 2 MCS, the delta is too big, I do agree that adding more rates increases convergence time, but the delta in some places is too big, so the RVR is not smooth, not necessary to fill everywhere, only in some places, how about some criteria to add only in some places

A: plan to propose adding only MCS with lower code rates, not 5/6

Q: prefer to smooth the higher end only

A: yes, adding lower end does not have much gain

Q: also lower end can choose other BW and NSS

A: yes

Straw poll will occur at a later time.

1. [**0047r1**](https://mentor.ieee.org/802.11/dcn/20/11-20-0047-01-00be-feedback-enhancement.pptx)**, “11-20-0047-01-00be-feedback-enhancement” – Ruchen Duan (Samsung)**

**Summary:** The authors provide suggestions for protocol modification to improve link adaptation feedback.

**Discussion:**

Q: slide 5, this might provide some idea to reduce the convergence time issue from the previous ppts on additional MCS levels, but you do not provide a solution for accurate SINR measurement

Q: slide 3, you indicate SINR is not accurate and LA FB, less frequent than required for optimal performance, for CQI FB, the definition is eigen value, is it not? SINR is averaged.

A: transmitter can use the information however it wants, possible to use it adjust MCS

Q: narrow, wide is size of average, equation for SINR is HV divide by N0, that’s just eigenvalue, so average over narrow or wide band

A: need to double check

Q: slide 5, what is meant by MU MIMO

A: used MU MIMO scenario

Q: clarification requested, you are implying that in MU MIMO, difficult to understand what MCS should be used per user because of interference, but by examining FB, you can get better knowledge of best MCS in this case

A: yes

Q: true only if the STAs remain the same, otherwise the MU interference will change and that LA FB is no longer valid

A: yes, this is correct

A: FB we suggest HLA frame that can contain suggested MCS, so no need to rely on reported SINR

Q: right, no need for SINR, because you are supplying MCS, but from first DL, then FB LA report, how accurate is that? Depends on the SINR estimate

A: depends on receiver side estimate, more accurate

Q: LA is a good topic for improvement, but focusing on the mechanism is not sufficient, already have a bunch of such mechanisms, they are not being used, the only issue is not that the spec mechanism are insufficient, there are other issues to fix

A: current CQI and HLA are optional, but LA is crucial to tput, so do want to improve it

Straw poll will occur at a later time

1. [**0086r1**](https://mentor.ieee.org/802.11/dcn/20/11-20-0086-01-00be-opportunistic-implicit-channel-sounding.pptx)**, “11-20-0086-01-00be-opportunistic-implicit-channel-sounding” – Roya Doostnejad (Intel)**

**Summary:** The authors discuss the concept of implicit channel sounding based on UL PPDUs.

**Discussion:**

Q: who determines how many LTF?

A: AP indicates the number of LTF to be transmitted from each STA

Q: through the trigger frame, based on the known number of antennas at the STA

A: yes

Q: STA might transmit SU PPDU, maybe the AP will measure some channel information from the STA, how to return this information to the STA?

A: no FB needed, as this information is used to determine vectors for DL TX at the AP

Straw poll will occur at a later time

**Call by the chair for AoB:** No other business noted.

**Adjourned at 21:39.**

# Thursday 5 March 2020, 10:00 – 12:00 ET

* PHY: cancelled
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0258-00-00be-11be-mac-ad-hoc-teleconference-minutes-jan-2020-to-mar-2020.docx>

# Friday 13 March 2020, 12:00 – 15:00 ET

* MAC ad-hoc: <https://mentor.ieee.org/802.11/dcn/20/11-20-0467-01-00be-mac-ad-hoc-teleconference-minutes-march2020-april2020.docx>

# Monday 16 March 2020, 19:00-22:00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0526-01-00be-minutes-for-802-11be-phy-ad-hoc-conf-call-in-march-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0511-13-00be-minutes-for-tgbe-mac-ad-hoc-teleconferences-march-and-may-2020.docx>

# Wednesday 18 March 2020, 19:00 – 22:00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0526-01-00be-minutes-for-802-11be-phy-ad-hoc-conf-call-in-march-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0511-13-00be-minutes-for-tgbe-mac-ad-hoc-teleconferences-march-and-may-2020.docx>

# Thursday 19 March 2020, 10:00 – 13:00 ET

**Introduction**

1. At 10:01 the Chair Alfred Asterjadhi (Qualcomm), calls the meeting to order.
2. The Chair goes thorugh the IPR police and procedures and asks if somebody wants to discuss this item. Nobody speaks up.
3. The Chair reminds to take attendance. Send an e-mail to the Secreraty Dennis Sundman, and the Chair. The Chair also notifies that for the split sessions, the attendance notification is to be sent to the secretaries of the respective group. According to the Zoom app, there are about 140 people in the call.

**Attendance:**
	* Albert Bredewoud (Broadcom)
	* Alfred Asterjadhi (Qualcomm)
	* Allert van Zelst (Qualcomm)
	* Dandan Liang (Huawei)
	* Dennis Sundman (Ericsson)
	* Dongguk Lim (LGE)
	* Gaurav Patwardhan (HPE)
	* Hirohiko INOHIZA (Canon)
	* Jim Lansford (Qualcomm)
	* Jonas Sedin (Ericsson)
	* Junghoon Suh (Huawei)
	* Kazuto Yano (ATR)
	* Lei Wang (Futurewei)
	* Mark Hamilton (CommScope/Ruckus)
	* Massinissa Lalam (Sagemcom)
	* Miguel Lopez (Ericsson)
	* Patrice Nezou (Canon)
	* Prabodh Varshney (Nokia)
	* Ross Yu (Huawei)
	* Roya Doostnejad (Intel)
	* Sameer Vermani (Qualcomm)
	* Sanghyun Kim (Wilus)
	* Sebastian Max (Ericsson)
	* Sigurd Schelstraete (Quantenna/ON Semiconductor)
	* Stephane Baron (Canon)
	* Wook Bong Lee (Samsung)
	* Youhan Kim (Qualcomm)
4. **Announcements:** The chair goes over the progress on SPs.
5. **Teleconference schedules:** Dennis Sundman had brought up the concern about many telcos with inconvenient time and proposes to cluster the telcos to few weeks instead of over several months. Dennis and Alfred have some discussion. Nobody else speaks up and no particular conclusion is reached.
6. **Webex is full.** The Chair ressess for 5-10 minutes to set-up Zoom, which is another app for teleconferences.
	* At 10:23 the session is recalled to order.
7. Technical submissions is the next topic on the agenda.
	* First, there are some deferred SPs to run.
	* The Chair reminds to upload the document to mentor. Documents not uploaded will not be considered.
	* The Chair asks for comments/reordering etc.
	* Some discussion regarding how Zoom works.
8. The chair asks if there is any objection to approve the agenda. Nobody speaks up.

**Technical submissions**

1. [**11-19/1582r2**](https://mentor.ieee.org/802.11/dcn/19/11-19-1582-02-00be-coordinated-ap-time-and-frequency-sharing-in-a-transmit-opportunity-in-11be.pptx)**, “Coordinated AP Time and Frequency Sharing in a Transmit Opportunity in 11be” – George Cherian (Qualcomm)**

SP3:

In all modes of operation wherein an AP shares its frequency/time resource of an obtained TXOP with a set of APs,

* + Define a mechanism for the TXOP owner AP to solicit feedback from the set of APs to learn the resource needs and the intent to participate in a coordinated AP transmission

**Discussion:**
C: Do you believe this should be mandatory or optional?

A: Optional is fine

C: Is this within the TXOP?

A: Preferably it happens outside the TXOP

C: Can we modify the straw poll so that it is the AP who asks for something.

A: Ok.

C: I agree we need MAC features for the TXOP. This contribution is on the packet level am I correct?

A: We don’t really say at this point what the construction is.

C: I am concerned when in time this happens.

A: This SP doesn’t specify when it happens. It can be inside a TXOP, or earlier. As mentioned before, preferably earlier.

C: I have a related contribution and would like to harmonize straw polls before running.

A: I don’t think anything you say are precluded, so I see no problem running this strawpoll.

**New text 11-19/1582r3:**

In all modes of operation wherein an Ap shares its frequency/time resource of an obtained TXOP with a set of APs,

* Define a mechanism for the sharing AP to optionally solicit feedback from one or more APs from the AP candidate set to learn the resource needs and the intend to participate in a coordinated AP transmission.

**Y / N / A: 76/7/32**

 SP3:

In all modes of operation wherein an AP shares its frequency resource with a set of APs, the AP shall share its frequency resource in multiples of 20MHz channels with a set of APs in an obtained TXOP?

* + - PPDU format of the transmission on the shared resource is TBD

**Discussion:**

C: Does it mean contiguous multiples of 20 MHz.

A: What this says is that if we were to share, it would be in chunks of multiples of 20 MHz.

C: But this is also true for TDMA?

A: Yes of course.

**Y / N / A: 68/12/37**

1. [**11-19/1961r3**](https://mentor.ieee.org/802.11/dcn/19/11-19-1961-03-00be-multi-ap-group-establishment.pptx)**, ”Multi-AP Group Establishment” – Sun Bo (ZTE)**

SP1:

Do you support that any AP may deliver the information of the AP candidate set for coordinated AP transmission?

* Note: whether or not delivery of AP candidate set information for coordinated OFDMA transmission is FFS.

**Discussion:**

C: Can you elaborate a bit on to whom this information is delivered to.

A: We want to provide it generic.

C: It would make more sense to limit this SP to joint transmission. Are you assuming one AP is obtaining TXOP?

A: Yes.

C: Maybe we can use a different terminology than candidate set, and coordinate AP?
A: We based it like this because of comments.

C: You should clarify what candidate set means.

A: Do you have a suggestion?

C: No.

**Y / N / A: 22 / 29 / 46**

1. [**11-20/0033r1**](https://mentor.ieee.org/802.11/dcn/20/11-20-0033-01-00be-coordinated-spatial-reuse-operation.pptx)**, ”Coordinated Spatial Reuse Operation” – Jason Yuchen (Huawei)**

SP:
Do you support to introduce a coordinated spatial reuse operation in TGBe?

* A sharing AP that obtains a TXOP may grant one or more coordinated APs to use the same bandwidth under the control of the sharing AP.

**Discussion:**

C: With coordinated AP you mean shared AP?
A: Yes.

C: What do you mean with under control?
A: I remove.

C: The group have not agreed to include a coordinated spatial reuse yet. Maybe we should remove the sub-bullet?
C: I believe it should be an R2 feature. Therefore I think we should have it open.
A: This is even more simple that Co-TDMA etc.
C: Does coordinated spatial reuse include coordinated beamforming?
A: No.

**New text:**

Do you support to introduce a coordinated spatial reuse operation in TGBe?

* Whether it is in R1 or R2 is TBD.

Y/N/A: 97/6/25

1. [**11-20/0277**](https://mentor.ieee.org/802.11/dcn/20/11-20-0277-00-00be-coordinated-ofdma-protocol.pptx)**, ”Shared TXOP Operation” – Sharan Naribole (Samsung)**

**Summary:** The authors proposes some frames and rules for sharing a TXOP.

SPs deferred to a future meeting.

**AoB: None.**

**At 12:59 meeting ajourned.**

# Monday 23 March 2020, 10:00 – 13:00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0526-01-00be-minutes-for-802-11be-phy-ad-hoc-conf-call-in-march-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0511-13-00be-minutes-for-tgbe-mac-ad-hoc-teleconferences-march-and-may-2020.docx>

# Thursday 26 March 2020, 19:00 – 22:00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0526-01-00be-minutes-for-802-11be-phy-ad-hoc-conf-call-in-march-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0511-13-00be-minutes-for-tgbe-mac-ad-hoc-teleconferences-march-and-may-2020.docx>

# Monday 30 March 2020, 19:00 – 22:00 ET

* PHY: <https://mentor.ieee.org/802.11/dcn/20/11-20-0526-01-00be-minutes-for-802-11be-phy-ad-hoc-conf-call-in-march-2020.docx>
* MAC: <https://mentor.ieee.org/802.11/dcn/20/11-20-0511-13-00be-minutes-for-tgbe-mac-ad-hoc-teleconferences-march-and-may-2020.docx>