IEEE P802.11  
Wireless LANs

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| ARC SC teleconferences minutes March 2021 Plenary | | | | |
| Date: 2021-03-10 | | | | |
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Abstract

This document contains the minutes of the IEEE 802.11 ARC SC teleconferences during the March 802.11 Plenary meeting, held on 08 March 2021 at 13:30-15:30 h ET and 10 March 2021 at 11:15-13:15 h ET.

Note: Highlighted text are action items. A- precedes comments from the document’s author, C- precedes comments, R- precedes responses to comments.

**Contents:**

[Monday 08 March 2021 at 13:30-15:30 h ET 3](#_Toc66092151)

[Administration: 3](#_Toc66092152)

[Contributions: 3](#_Toc66092153)

[Wednesday 10 March 2021 at 11:15-13:15 h ET 3](#_Toc66092154)

[Next Steps: 3](#_Toc66092155)

[Adjourned: 13:42 h EDT 4](#_Toc66092156)

# Monday 08 March 2021 at 13:30-15:30 h ET

## Administration:

**Chair: Mark Hamilton, Ruckus/CommScope**

**Vice Chair: Joseph Levy, InterDigital**

**Secretary: Joseph Levy, InterDigital**

**Meeting called to order by the Chair 13:02 ET**

Agenda slide deck: [11-21/0195r2](https://mentor.ieee.org/802.11/dcn/21/11-21-0195-02-0arc-arc-sc-agenda-mar-2021.pptx)

**Call for Patents:**

The Chair reviewed the Patent policy and called for potentially essential patents – there was no response to the call.

**IEEE SA Copyright Policy:**

The chair reviewed the Copyright policy.

**Participation:**

The chair reviewed the participation policy.

**Approval of the Agenda:**

**Monday 8 March 2021**

* **Attendance, noises/recording, meeting protocol reminders**
* **Policies, duty to inform, participation rules**
* **Contribution/discussion topics:**
  + **Annex G way forward (including, especially, for TGbe and REVme’s integration of 11ax)**
  + 802.11 TGbe’s evolving multi-link architecture contributions

**Wednesday 10 March 2021**

* **Attendance, noises/recording, meeting protocol reminders**
* **Policies, duty to inform, participation rules**
* **Prior meeting minutes**
* **Contribution/discussion topics:**
  + **802.11 TGbe’s evolving multi-link architecture contributions**
  + **Annex G way forward (including, especially, for REVbe)**
  + **Other topic(s)?**
* **Next Steps**

The Chair reviewed the agenda and called for comments or amendments to the agenda - there was no response to the call.

The proposed agenda was accepted without comment.

Chair reviewed agenda deck slide 16 – The ARC other topics slide and discussed ongoing ARC activities. Attention was call to Annex G – will be on the agenda for the March meeting – 802.11be has asked questions regarding the need to provide Annex G text.

## Contributions:

**Annex G way forward (including, especially, for TGbe and REVme’s integration of 11ax)**

11-19/1513 minutes – discussion on Annex G.

Straw Polls:

– do you support removing Annex G – 7/6/5 – group very split.

* Do you support removing Annex G in principle 7/3/4
* Do you support replacing Annex G 7/3/3

Question – Should we would run the SPs again?

Chair - Annex G servers a useful purpose. It is very useful to have all the frame sequences in one location. Given the larger number of participants at this meeting, we may get more information and have productive discussions.

Question – Do the new amendments describe the new frame exchanges? If not, should we keep it? Should we allow new amendments to not provide annex G information?

C – Supporting allowing the new amendments to not provide annex G information. Is there a specific trigger for TGbe?

Chair – The TGbe editor asked if annex G information needs to be provided.

C – So there was no guidance, it would be quite a bit of work to take annex G out. We may have more work to take it out, then to fix it. We should go through the old presentations.

C – It seems to be easy for people to just say remove it, without understanding the associated work.

R – there are 200 references to frame sequence – which is defined in Annex G.

C – This is a concern – is it being suggested to make it informative?

C – We could, it may go with choice 3.

C – It takes a lot of work to do this properly. There are errors in the current specification. It is a lot of material. I don’t remember having any tool to validate this material.

C – Considering the comments made and looking at 802.11 G – Annex G is useful. But if it is not correct it could be harmful. The first dozen “mays” are problematic. It is useful information – maybe moved to a different document – which would be easier to be maintained. This is a possible option.

R – we need to define “frame exchanges sequences”.

C – Annex G is necessary – for spec reasons, and consistency.

C – TGbe needs to know if it needs to add this information or not. The current Annex G format makes it a lot of work. One of the earlier things is to replace Annex G – we may only want to replace it for 11be.

C – TGax tried to add to annex G – but it was very complex and difficult – there are all kind of sounding and complex frame sequences. It is probably worse for TGbe – MLO adds a level of complexity. There is a long table of attributes at the being of Annex G – some are very logical, but some seem too arbitrary. Propose having an Annex G editor or just delete Annex G.

C – I’ll put you down on the list for that position. 😊

C – There needs to be a definition of a frame exchange sequences – we need this.

C – We can keep Annex G normative – but only keep it normative up to a specific version of the spec. Beyond that we can make no decisions.

R – It will be easy if it only relates to certain PHYs – then limiting it would be an option. But other PHYs need to provide their definitions of frame sequences.

C – Annex G in its current format – using EBNF has out used it usefulness – I have some thoughts of how to simply the addition of frame exchanges sequences.

R – That may be helpful – an option to replace it instead of deleting it may be the solution.

C – The frame exchange sequence, if you look at the particular text – it is for the sequence in the text being discussed. There are only 21 locations where “see annex G” is stated. If there is a volunteer to fix it, have at it. But, since there doesn’t seem to be one, the simplest way is to figure out how to remove it. It is not worth the effort to fix it. The Annex is only mentioned 21 times in the spec – if it is normative then it must be correct.

C – We should limit the scope of Annex G going forward, we should state that this annex defines “these type of frames sequences” and Annex G does not apply to VHT device or something like that.

Question – Why was it put in in the first place or is it so complex that people just don’t want deal with it?

R – The reason it was created was to describe the frame exchange sequences in a precise language, so they are all described consistently. There is value in a consistent and precise description. Also, given the size of the document it is useful have all these consistent descriptions in one place.

C – That it is an excellent point – it is a central repository to feedback results of plug fests. Annex G would be a good way to provide the plug fest information. This would improve the specification.

C – This type of feedback and documentation is done in ISO and IETF.

C – I don’t hear an agreed way forward. Annex G is only as comprehensive and complete as the people who write it. What has happened over years is that we added all this complexity and many changes to protocol, these additional have caused problems in Annex G. Currently the protocols are not provided.

C – If I’m an implementor – I would want to see this information in one place.

C – I don’t know any implementor that looks at Annex G –

C – Well we can dump it and say read the spec. But if I was an implementor I would want to have the summary somewhere. I’m in favor of a formal description. Not having a formal description is a recipe for Hacks and confusion.

C – Calling for something between the strict format – but more structured that the free flowing text of the specification. A simpler kinder form of annex G.

Chair – Have I captured the views in the SP?

C – On item 4 – “Limit the scope” instead of “limit” –

C – I think we should limit it to specific STAs/types of STAs that it applies to.

C – If someone wanted to add a frame exchange it would be ok – the requirement to complete it would be removed.

C - The sequences would apply – The problem is none of the implementors are currently using it.

C – I can see how people can get confused by it.

C – Item number C – where are there indirect references?

R – there are references that say frame exchange sequences are the indirect reference – e.g., they don’t say see annex G, but they do say during a frame exchange sequence – which implies annex G.

In Clause 3 – we defined Frame exchange sequence as: Clause 3: "frame exchange sequence: A sequence of frames specified by Annex G."

C– If you are really confused by the statement – I think most people are not confused by these statement – I don’t see the need for these statements.

C – Is an RTS/CTS a frame exchange sequence? – Poll/ACK? Do we have normative behavior assigned with these sequences?

C - Only 10 times do they say – unless you are willing to do the work –

C – Most of the current references to annex G are just bad as they currently are. Irrespective of the references Annex G is normative. Annex G states that if is not in Annex G it is not a frame exchange sequence. There are normative statements in Annex G.

C – Not only does Annex G have issues and errors, but the overall standard also has errors and issues in the main text. I think we need a section of the specification where this information is maintained. This is the best way to maintain the specification.

R- That is a very scary statement. I can see the point of annex G clarifying ambiguities.

Will run the SP both ways Chicago and pick one.

1. Update Annex G – be correct and complete (in EBNF)
2. Replace Annex G with some other notation/style
   1. Still communicate the concepts, but simpler (maybe less rigorous)
3. Remove Annex G, replace references (direct or indirect) in text if/where needed.
4. Limit the scope of Annex G
   1. To certain PHYs? Or some other historical cut-off? Certain kinds of sequences? (done by excluding where it doesn’t apply?)
5. Change to informative
   1. Perhaps also “limit” it. Probably still needs to have references replaced.

Single Choice:

A/B/C/D/E 8/8/9/19/8 no answer:65

Multiple Choice:

A/B/C/D/E 20/16/21+1/25/15 no answer:66

C – Calling for a proposal.

C – If we can find something more manageable, what other notation/style may work better?

C - I could provide a style – spread sheet – that I think might work.

Chair – That may be very helpful.

C – If a style is provided, it may support option B.

C – Do we have a proposal for option C?

C – Volunteering to do some work for option D. Concern was expressed regarding option A, as it is clear there are errors in Annex G now.

R – Well I think it is clear what is meant by A is clear – but it is a lot of work.

C – It would be nice to know what is wrong with Annex G.

Chair – When will you provide the inputs for option B? By Wednesday?

R – I can do so tonight or tomorrow afternoon.

Chair - We will revisit on Wednesday.

**802.11 TGbe’s evolving multi-link architecture contributions**

Chair - Provided background on the current documents – 11-20/1639, and 11-21/0396 – We will start with 11-21/0396, which is a cleanup of 11-20/1639 – starting with Slide 3.

There are functions done at the MLD level, there are function done at the “per Link” level, and there is a box to decide where a decision is made. Block ACK score boarding is an implementation choice – and this is confusing, but I will be ignoring the implementation issue.

C – The fragmentation seems to be in the wrong place.

C – If I have two links – there is a single interface.

C – I the frame can go left or right – how is fragmentation managed.

C – One possibility is that fragmentation can allow to a common lowest delimiter and the fragments can be combined lower down.

C – We have not allowed fragmentation in TGbe.

C – We have not allowed fragmentation in TGbe, is it TBD. We don’t feel it is important – if you achieve big throughput, you don’t need fragmentation.

R- in ARC we should focus on high level concepts and what the interactions are. The detailed work should be left for the TG sort out. They have decided to TBD it for now. But it is their business.

C – There are different views on MLO fragmentation, it should matter which link a fragment goes out on. This is something that should be discussed in the TG not in ARC.

R – Currently in the standards there are fragments that are tied to PHYs.

C – This as an architectural issue. There are other architectures where fragmentation may work more transparently. Pushing it to R2 is going to cause potential architectural issues. We should make a good choice before we pour the cement.

R – We have debated around the architecture in several calls - the view shown seems to be the consensus view. There are strong desires in TGbe – build and MPDU that can be dealt with link independently. So, we need packet numbers assigned link independently, fragmentation needs to occur where it currently is in the stack. Is this the current consensus? Is this driven and correct for link independence.

C – In support of the statement. This architecture seems to have so many features – keying on one feature e.g., building up the MPDU and then decide where to send it. This yields inefficiencies. I’m thinking there are better ways to do this that don’t violate the flow and layer principal.

R – There are other things out there – like 802.1AX – which works for aggregation, but there are added efficiencies to make the link decision lower down, and more real time. If you want to provide some architecture inputs, please do so. We are also looking at how the legacy interacts with lower MAC and PHY. How do we glue the legacy on?

C – Gluing together is important for the AP, but not as important to the non-AP STA.

## Recess: 15:30 h EDT

# Wednesday 10 March 2021 at 11:15-13:15 h ET

## Administration:

**Chair: Mark Hamilton, Ruckus/CommScope**

**Vice Chair: Joseph Levy, InterDigital**

**Secretary: Joseph Levy, InterDigital**

**Meeting called to order by the Chair 11:15 h ET**

Agenda slide deck: [11-21/0195r3](https://mentor.ieee.org/802.11/dcn/21/11-21-0195-03-0arc-arc-sc-agenda-mar-2021.pptx)

**Call for Patents:**

The Chair reviewed the Patent policy and called for potentially essential patents – there was no response to the call.

**IEEE SA Copyright Policy:**

The chair reviewed the Copyright policy.

**Participation:**

The chair reviewed the participation policy.

**Approval of the Agenda:**

* **Attendance, noises/recording, meeting protocol reminders**
* **Policies, duty to inform, participation rules**
* **Prior meeting minutes**
* **Contribution/discussion topics:**
  + **802.11 TGbe’s evolving multi-link architecture contributions**
  + **Annex G way forward (including, especially, for REVbe)**
    - **Note: REVme discussion…**
    - [**11-21/0414r0**](https://mentor.ieee.org/802.11/dcn/21/11-21-0414-00-0arc-draft-examples-of-a-proposed-notation-for-frame-exchange-sequence-sequences-in-annex-g-of-802-11-2020.docx) **“Draft examples of a proposed notation for frame exchange sequence sequences in Annex G of 802.11-2020” – Harry Bims**
  + **Other topic(s)?**
* **Next Steps**

The Chair reviewed the agenda and called for comments or amendments to the agenda - there was no response to the call.

The proposed agenda was accepted without comment.

## Meeting Minutes Approval:

ARC SC teleconference Minutes 11 and 13 January 2021-Interim: <https://mentor.ieee.org/802.11/dcn/21/11-21-0059-00-0arc-arc-sc-teleconference-minutes-11-and-13-january-2021-interim.docx>

ARC SC teleconference Minutes 01 February 2021: <https://mentor.ieee.org/802.11/dcn/21/11-21-0158-00-0arc-arc-sc-teleconference-minutes-01-february-2021.docx>

ARC SC teleconference Minutes 08 February 2021: <https://mentor.ieee.org/802.11/dcn/21/11-21-0232-00-0arc-arc-sc-teleconference-minutes-08-february-2021.docx>

ARC SC teleconference Minutes 22 February 2021: <https://mentor.ieee.org/802.11/dcn/21/11-21-0308-00-0arc-arc-sc-teleconference-minutes-22-february-2021.docx>

ARC SC teleconference Minutes 01 March 2021: <https://mentor.ieee.org/802.11/dcn/21/11-21-0347-00-0arc-arc-sc-teleconference-minutes-01-march-2021.docx>

**Moved: Stephen McCann**

**Seconded: Carol Ansley**

The Chair called for comments or changes to these minutes - there was no response to the call.

The minutes were approved by unanimous consent.

## Contribution/discussion topics

**802.11 TGbe’s evolving multi-link architecture contributions**

[**11-21/316r0**](https://mentor.ieee.org/802.11/dcn/21/11-21-0316-00-0arc-mlo-architecture-reference-model.pptx) **–** “MLO Architecture Reference Model” - **Duncan Ho, Mike Montemurro, et. al.**

Question – Asking about M and P and the sequence numbers and how this all works.

R – There is a single stack

C – But there is a different MAC address for each link?

R – The MLD has a MAC address of P – all packets received at the MAC SAP from the DS is addressed to P - The AP keeps track of the individual links and knows the packets received are going to or from P.

C – For ax legacy – STA1 and STA2 are in one box – I don’t understand how this works with multi band?

R – The multi STA behavior is not changing – this is only about MLO.

C – At the MAC SAP you can clearly have something out of order. Let’s say AP2 is transmitting much faster – how do you keep balanced?

R – If you have one block ack session – the packet can go through either link and be reordered. The PN can be backtrack.

C – How does the STA deal with it?

R – The reordering occurs in MLD level.

C – So the PN order is checked – just as it is done now.

C – There are issues with the naming – as provided – we should discuss this – but not now.

Slide 7 – remaining functionalities – these are not delt with now. There is no fragmentation in R1 – Retransmission – also need to be addressed. So, retransmission may involve the MLD if the packet is retransmit on a different link.

Slide 8 – can be generalized to multiple links (but only two are shown).

Slide 9 –

C – On slide 8 – you call MLD Management – MLD belongs to the data plan to me.

A – The security needs to me managed with the authenticator or supplicant.

C – do you require two PHYs – here you have separate PHYs – the MLD model does not require you to have different PHYs?

A – this PHY can be thought about as separate beacons.

C – you may not have completely separate PHYs – but you may have a single PHY.

Slide 10 –

Slide 11 –

C – Why are you restricting it to management frames?

A – Using the MLD MAC address – we have a problem with replay – for management frames – you need to protect the TNRA –

C – is there an explicit difference between – link and broadcast management frames?

R – Slide 12 – left out the legacy probe req does include MLO capable. The probe response will include MLO capability – but not information about the “other” APs.

C – Probe request don’t go through the MLD – if we have enough information in the legacy probe response?

A – Unless you have connected to this MLD before – it will only have all the information in the MLD probe response.

The presenter switching to Mike on slide 13. Added the address of the non-AP MLD in the authentication request.

Slide 14 - 4 way handshake – will take place on 1 affiliated link (no link switching is allowed). The MAC addresses of the affiliated STAs are included in the Handshake. All of the GTKs are provided in the Handshake response, for all the affiliated STAs.

C – How is the reply attack prevented? Is it link specific? If the packet is on link 1, or can it happen anywhere?

A – There is a parameter that allows the authenticator in the supplicant to check if the message is being replayed.

C – In terms of any other flow it is blocked.

C – When does the STA get the address of the MLD?

A – In the probe response. (see the previous slide).

Slide 15, Group key – must use the MLD - there is a problem with the diagram – AP 3 should send to STA3

C – On the 4 way handshake – needing to know the ML MAC – do we need to always send probe requests.

A – TGbe has decided to keep it optional – there is debate if should always be carried in the beacon and non-ML probe response frame.

C – Whenever this is needed – but I want to make sure we don’t end up requiring we always send ML probes. Does this create a link restriction?

A – OCI would have to be associated with a single link.

C – What is the justification for that?

A – The chance of messages being replayed or lost – it made sense to restrict this to a single link.

C – Is it a security issue or something else?

A – I don’t remember – this is something to discuss in TGbe.

C – This isn’t currently in the spec, was this agreed?

A – You haven’t seen it yet because – it is being proposed – but not agreed yet. Only the 4 way handshake is restricted to a single link.

Slide 17 Proposals.

C – Slide 3 looks like an internal loop – this diagram is not useful as it is.

Ans – we want to have something

C – I’m very concerned about these figures – the MLD figure needs more work -slide 8

I also support slide 9. I will provide some inputs to the diagrams.

Chair – Called for people to contribute to this discussion and asked for his contributions be considered.

Slide 16 – you can use different links? Yes.

**Annex G way forward (including, especially, for REVbe)**

**Note: REVme discussion…**

**Straw Polls (and discussion):**

**In Sept 2019, see 11-19/1513**

**This week (March 2021), see next slide and minutes**

**Remove Annex G – 11-17/1261 – Graham Smith**

**Replace Annex G with some other notation/style – example(s)?**

**Limit the scope of Annex G?**

[**11-21/0414r1**](https://mentor.ieee.org/802.11/dcn/21/11-21-0414-01-0arc-draft-examples-of-a-proposed-notation-for-frame-exchange-sequence-sequences-in-annex-g-of-802-11-2020.docx) **“Draft examples of a proposed notation for frame exchange sequence sequences in Annex G of 802.11-2020” – Harry Bims**

C – How comprehensive? Would you include all frame sequences, or will we allow frame sequences to be in text?

R – Proposing that one would start with annex G – and then go to the clause to get more detail. Annex G will be only an overview.

C – So annex G would be informative and would be a set of examples.

R – Annex G would still be normative – as this would allow frame exchange sequences to be fed back from a Plugfest.

Chair – Thanks a lot Harry - right now in the main body we have frame exchange sequence in the spec – one of the concerns – how do we fix these normative sequences – but this would require every frame exchange sequence would need to be here.

R – It should be complete and include all frame exchange sequences.

C – BNSF is used in ASN1 and in other specs. So, which takes president – one of the two must take precedence.

R – I would say annex G would take precedence.

C – There are some cases where you have alternative behavior based on conditions.

R – Each condition could be provided separately.

C – Annex G should be kept simple.

C – There is a request for an example of a frame exchanges sequence that is based on a condition case.

R – I will try to find one.

Chair – asking the TGme Chair as to where these discussions should take place – in the ARC SC or in TGme? The TGme Chair was flexible, the Chairs will sort this out offline.

C – The devil will be in the details – how is multiuser handled – if there are multiple responders – error conditions related to trigger frames – medium busy – ADPDU formats for single users – should we try to capture this today. We need to define the comprehensiveness.

Chair – Let’s get this discussion going on the reflector. We seem to want this to be complete, and we should consider if this is do able.

## Next Steps:

* **Contributions requested/expected:**
  + **TGbe architecture topics, especially trying to consolidate security discussion to be liaised to TGbe**
* **Annex G**
* **Next Teleconference(s):**
  + **March to May Conflicts to avoid – TGbe, REVme, TBbd,**
  + **Two slots during March plenary session: Mar 8 (Monday) 13:30, Mar 10 (Wednesday) 11:15.**

## Adjourned: 13:16 h EDT

Note, the final agenda is [11-21/0195r4](https://mentor.ieee.org/802.11/dcn/21/11-21-0195-04-0arc-arc-sc-agenda-mar-2021.pptx), the closing report is [11-21/0457r0](https://mentor.ieee.org/802.11/dcn/21/11-21-0457-00-0arc-arc-closing-report-march-2021.pptx).