IEEE P802.11
Wireless LANs

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| Updates to REVmc 5.1.5 |
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**Discussion**

Revision History

R0 – First revision. Captures discussion from ARC SC face-to-face meeting, March 2015.

R1 – Green highlight on agreed changes to forward to REVmc. New discussion on AP’s role-specific behavior box, based on face-to-face discussion on May 12. (Thanks to Michael Fischer for the very useful argument, er, discussion… )

R2 – Added specific editing instructions (proposed). Also added some more updates to the AP model and text, based on discussions at F2F meetings.

R3 – Added an example of a DS with two APs to the AP model section. This needs more words, and is a work in progress.

R4 – New proposed diagram for the AP section, and updated the text wording. Simplified Mesh STA figure.

Abstract

This document is a follow-up to 11-13/113, with proposed updates to subclause 5.1.5 material (mostly the figures), for consideration by ARC SC, and then TGmc.

The material in 11-13/113 has been reviewed, discussed and considered by both ARC SC and TGmc, previously, and resulted in agreed changes adopted into REVmc D3.0. Since that time, the ARC SC has had further review, and believes some of the figures proposed in that document could be improved for clarity to the reader.

This document presents the latest thinking on this topic.

Two changes have been identified to date:

The first is to clarify the two-ended arrows that were used within the role-specific behavior blocks. The two-ended arrows have proved to be confusing, in terms of whether the “switching function” (or potentially other logical function) within the blocks is always applicable in both directions shown by the arrows.

To address this confusion, it is suggested to split the bi-directional arrows into two uni-directional arrows, and clearly show what functions or operations are applied in each direction.

The second change is to allow for entities “above the MAC”, but still within the MAC sublayer , Figure 5-1 is redrawn to move the role-specific behavior block down a bit, and create a space between this block and the LLC sublayer boundary.

This allows the role-specific block figures to show the architectural support for entities such as bridges and 802.1AC convergence functions, necessary as 11ak is introduced.

The newly proposed Figure 5-1:

Proposed changes: Replace Figure 5-1, with the following figure:



*Figure 540-1 – proposed update to Figure 5-1*

And, the matching updates to Figure 5-2:

Proposed changes: Replace Figure 5-2, with the following figure:



*Figure 540-2 – proposed update to Figure 5-2*

Proposed changes to Figures 5-3 through 5-6, and text changes to correspond to the changes, and add explanation to the figures.

**5.1.5.2 Non-AP STA role**

Proposed changes: Change the text in 5.1.5.2 as shown, and Replace Figure 5-3, with the figure below:

The MAC data plane architecture of a non-AP STA is completed by replacing the role-specific behavior block with that shown in Figure 5-3 (Role-specific behavior block for non-AP STA). The function of this block in a non-AP STA is to perform destination address filtering as described in 9.2.8 (MAC data service).

NOTE—In implementations, the DA address filtering function may be done “lower in the stack”. It is shown in the role-specific behavior block location for simplicity, and any implementation choice needs to provide equivalent behavior.



*Figure 540-3 – proposed update to Figure 5-3*

**Proposed changes below are still under discussion**

**5.1.5.3 AP role**

In an AP, the MAC data plane architecture includes distribution system access in its role-specific behavior block, as shown in Figure 5-4. This block performs destination address filtering as described in 9.2.8 (MAC data service), and provides access to the DS for associated non-AP STAs as described in 4.5.2.1 (Distribution)



*Originally proposed update to Figure 5-4*

***Discussion:***

To split the bi-directional arrows, and more accurately indicate the different processing that occurs in each direction, we end up with this with a brute-force replacement:

🡨-- Agreed, this is horrible

***New discussion:***

Consider the upper layers that are resident on the device we colloquially call an “AP” (the management interface, for example). Start by ignoring the interconnect to those upper layers from the wireless stack (greyed out), and rather focus on interconnecting to those upper layers via the Ethernet. To the 802.11 system, the Ethernet is beyond the Portal. So, below, we consider the orange connection. How do we model this connection in the architecture?



Does the “AP” connect to the DS, and \_also\_ connect to the Ethernet? Is this model accurate, or useful? What if the DS were implemented with a “controller” (which forms the DS)? From a real-world, implementation view, we think of the controller-DS as delivering the Ethernet service to the AP’s upper layers; is that accurate architecturally? Could it be? That is, the DS already has a “map” of non-AP STA addresses, and which AP “port” to deliver MSDUs to. Can it trivially extend that “map” to include the AP’s local upper layers, too?

Now, the AP is fully connected to the non-802.11 world trivially. Entities on the Ethernet (or beyond), see the APs’ local upper layers as being reached via the Portal, just like the non-AP STAs associated with the APs. When an AP’s upper layers want to communicate to any other device, they use the DS as their “port” to the world, regardless of whether the destination is within the WLAN or on the Ethernet. Note that if we don’t model it this way, the AP’s upper layers – at some point in the stack – need to make a decision to route the MSDU to the DS, or to some other connection to the Ethernet. This means the AP’s upper layers no longer see a single unified MAC below the LLC sublayer.

So, if we’re willing to take the leap to say that the orange connection is really delivered via the Portal to DS to AP local entity, are we willing to extend this same model to devices within the AP’s BSS? That is, have the AP’s upper layers always give transmitted MSDUs to the DS, and let the DS decide if the MSDU goes to the Ethernet, to a STA attached to the DS at another AP “port” (including to that AP itself), or to a non-AP STA in the transmitting AP’s BSS. The DS already has this knowledge, and the mechanisms to make this decision and delivery/routing. Why not let it do it, always?

Then, we end up viewing the AP’s local upper layers as a separate entity accessing the DS, thus:



And, so, the AP role-specific behavior box looks like this:



Now, the concern is that this results in a new SAP, of an unspecified service (a true “MAC SAP”?) between the AP and the DS, and a new service provided by the DS of delivering MSDUs among non-wireless devices. Something “feels wrong” about this.

So, let’s decide that this separate delivery service (to and from the AP’s upper layers) is not provided by the DS. It could, in an implementation, be provided over the same medium, of course. But, architecturally, it is provided by a LAN, outside of 802.11’s architecture. Logically, this entire service is “beyond the Portal” from 802.11’s point of view. This seems architecturally clean, and accurate.

The implication is that the connection to the AP’s upper layers (from a wireless station, or from the non-802.11 LAN) is beyond the scope of 802.11. Beyond saying that to make sure it is clear to the reader, we don’t need to address the AP upper layers interconnection at all without our architecture.

Thus, the AP’s role-specific behavior block is now:



As a separate, but matching, argument in support of this view, Michael Fischer noted the following:

There is no MAC SAP at an AP.  I have looked at several older documents, and the meaning of the words is unchanged since 802.11-1997 for the purposes we have been discussing.  The original standard said ToDS=0, FromDS=0 meant:

 A data frame direct from one STA to another STA within the same IBSS, as well as all management and control type frames

The current REVmc draft says:

 A Data frame direct from one STA to another STA within the same IBSS or the same PBSS, a Data frame direct from one non-AP STA to another non-AP STA within the same infrastructure BSS, or a Data frame outside the context of a BSS.

All of the additions are consistent with the original meaning:

* a PBSS is essentially an IBSS operating under a modified MAC that requires a (dynamically selectable) STA functioning as a control entity, but not providing AP functionality such as relay or access to the DS;
* the "direct from one non-AP STA to another non-AP STA" pertains to a direct link, whose definition explicitly states "... does not pass through a QoS access point (AP) ...";
* and "outside the context of a BSS" (from WAVE) directly excludes anything where an AP is involved.

Accordingly, there is NO MECHANISM by which a data frame on the WM can be addressed to a higher-layer entity located above a MAC SAP at the individual MAC address of the STA contained within the AP.  The Address 1 filtering function in the STA contained within the AP is required to reject frames with ToDS=0, FromDS=0.  Frames to said individual MAC address with ToDS=1, FromDS=0 are explicitly "destined for the DS" -- so if they end up at a SAP it has to be the DS SAP, not the MAC SAP.  Furthermore, because the STA contained with the AP never performs the Association Procedure, said STA is not a member of the ESS, and therefore cannot be reached using DSS.  Therefore, if a frame sent within an ESS reaches anything other than the AP functionality at the AP device, said frame must have transited a portal at some point.

 --Michael

Lastly, note that the DSS is a service provided by the DS, and used by the AP entity. So, to more correctly show an “up is up, and down is down” perspective of the DSS, the figure just above is redraw thusly:



This has the unfortunate side-effect of implying that the DS is “lower in the stack” than the DSAF. This is likely not the case, as the DS actually can be implemented with anything (that meets the requirements of the service provided). That includes, in particular, a more “complete” stack than just a MAC/PHY – for example, quite likely at least an IP layer, perhaps even TCP, or VPN (IPSec), etc, in many real implementations. In fact, I claim that what comes below the DSS interface is actually a full seven layer ISO stack, and the DSS is actually providing an Application Layer service. In real implementations, as many layers as you like can be null and collapsed away, but conceptually, they are all (or could be) there.

This leads to a suggestion to draw the figure like this:



A suggestion was made that the figure just above is confusing, because it only shows one AP accessing the DS, and that it would help to have another AP. This led to the figure below:



As an alternative, we could consider a more generalized figure, like the one below. This also helps avoid the confusion that we are trying to show the internal construction of a \_single\_ AP’s role-specific behaviour box here.



Proposed changes: Change the text in 5.1.5.3 as shown, and Replace Figure 5-4, with the figure below:

In an AP, the MAC data plane architecture includes distribution system access in its role-specific behavior block, as shown in Figure 5-4 (Role-specific behavior block for AP(#2434)).This block ~~performs destination address filtering as described in 9.2.8 (MAC data service), and~~ provides access to the DS for associated non-AP STAs as described in 4.5.2.1 (Distribution).

Note that this behavior block implies that there is no access through the controlled port to or from the local upper-layers (the LLC sublayer) at an AP. Any such access is logically achieved in the architecture via transition of the DS and Portal to an integrated LAN. In actual implementations, this is likely optimized, and data frames appear to be delivered directly to one or more local LLC sublayer entity(ies) on the same physical device as the AP. Such optimization is effectively distributing the functions of the DS and Portal, and it is the responsibility of the implementation to ensure the logical behavior of these entities is maintained.



*Figure 540-4 – proposed update to Figure 5-4*

**5.1.5.3 Mesh STA role**

The MAC data plane architecture of a mesh STA is completed by replacing the role-specific behavior block with that shown in Figure 5-5. The function of this block in a mesh STA is described in 9.34 (Mesh forwarding framework). This role is not applicable when transparent FST is used, and does not apply to Figure 5-2.



*Figure 540-5 – proposed update to Figure 5-5*

**5.1.5.4 Mesh gate role**

The MAC data plane architecture of a mesh gate is completed by replacing the role-specific behavior block with that shown in Figure 5-6. The function of this block in a mesh gate is described in 13.11 (Interworking with the DS). This role is not applicable when transparent FST is used, and does not apply to Figure 5-2.





*Figure 540-6 – proposed update to Figure 5-6*

For 11ak:



Questions for discussion:

* Is the MAC Service provided to the relay function (in the original figures) or the DS (in the new figures), the same as the MAC Service provided to LLC?
	+ *Proposed response: No. In fact, the MAC Service isn’t provided to the DS, it is provided to a selection function that decides between local and non-local destination. Non-local destination frames are passed to the DS via the Distribution System Service, which provides a different service from that provided by the MAC SAP. (See Annex R of IEEE 802.11-2012 for an informative discussion.)*
* Does the above question change if the relay function is doing local forwarding (within the BSS) or using the DS to get to the recipient’s AP?
	+ *The new figure’s approach would say ‘no’, as all non-local frames are treated the same and delivered to the DS, which may immediately loop the frame back in the local forwarding case.*
* How about the Portal case?
	+ *Here again, the DS is a homogeneous service, delivering MSDUs to and from the Portal in the same fashion as it does APs within the ESS.*
* Is a Portal an 802 Bridge? Is the combination of AP, DS and Portal, a logical collection that together form an 802 Bridge?
	+ *None of the components mentioned (AP, DS or Portal) perform the functions described for an 802 bridge per 802.1Q. Therefore, No. Rather, since the operation of these components is transparent to LLC, it seems more natural to model the collection – functionally – as something slightly more than a single end station (because there are multiple MAC Addressable entities within the WLAN system) but less (that is, simpler) than a bridge.*
	+ *Note that a WLAN system may use a bridged 802 network in the provisioning of its services. In particular, the DS explicitly can use any appropriate technology, including an 802 bridged network. This does not affect, nor it is reflected in the architecture, however, as it is left as an implementation option.*
	+ *There is value in recognizing that a WLAN system is not a single end station. In particular, the work of 802.11 TGak and 802.1Qbz has the goal of supporting the optional integration of 802.11 network systems into 802 bridged networks for general use. This requires developing a model (which uses or maps to 802 terminology and concepts) to describe the WLAN system, and which accounts for quality of service, reliability and hop cost metrics unique to wireless. The nature of this modeling is still being debated.*
* With the activities in TGak to add concepts of 802 Bridging to non-AP STAs (in an infrastructure BSS), do the APs also need concepts added to participate in the overall bridging architecture (including, for example, loop-detection)?
	+ *Per the above, this is TBD within TGak.*
* Is the new visualization useful to see that a non-AP STA, when bridging is added (per TGak), adds something like the data plane elements shown as “Unique to AP”. However, such a STA does not add the management plane items of starting or controlling the BSS. This seems to be helpful to scope the nature of the changes needed. Of course, the Distribution System is replaced by a full 802 MAC Relay, per the 802.1Q Figures above, but the concepts have a logical mapping.
	+ *Also, TBD.*
* The last proposal for a replacement Figure 5-1 shows a line that limits the 802.11 scope (to items below the line). In previous architecture discussions, such a limit of 802.11 scope was deemed limiting (particularly in the context of the Reference Model (5.7) discussion in IEEE 802.11-2007). Is this a concern for the new figure?
	+ *If this line is acceptable/desirable, is it in the right place? Note that the 802.1X PAC/SecY is “below” the line, but is arguably not in 802.11’s scope. Although, 802.11 somewhat defines its own Controlled/Uncontrolled port filtering, rather than strictly using 802.1X’s. This part of the figure may still be confusing and/or need work.*
* Note the location of the MAC SAP (designed with “(M)” in the figure). It is well below the “top of the 802.11 stack.” But, also note that above it is only “switching/filtering” type operations, that don’t change the service provided. Is this acceptable/agreed?
* Are the function blocks shown in the “stack” a complete set (and at the appropriate level of detail)? Are they in the right order?
* How many Portals are there in a WLAN system? Zero or one, or can there be multiple? Can there be multiple only if they connect to distinct non-802.11 networks (not two points of access to the same (bridged) network)? (What does “distinct” actually mean in this context, and can we define it?) Care needs to be taken here, or we end up with routing table issues, or their equivalent.
* How can we incorporate the concept of a Mesh STA, Mesh Gate, IBSS STA, or other STA types into the figure? (Or should we try?)

Finally, once decisions are made on the above, consider any updates needed to 802.1Q’s text from 802.1Q-2011, describing mapping of 802.1Q concepts to 802.11 behaviors:

**“6.7.2 Support by IEEE Std 802.11 (Wireless LAN)**

The wireless LAN access method is specified in IEEE Std 802.11, 1999 Edition. Clause 7 of that standard

specifies frame formats, Clause 9 specifies the MAC sublayer function, and Clause 11 specifies the

mandatory MAC sublayer management function.

A Bridge to an IEEE 802.11 LAN shall connect to an IEEE 802.11 Portal, which in turn connects to an IEEE

802.11 Distribution System. For the purposes of bridging, the service interface presented at the Portal is

identical to the service interface presented at the IEEE 802.11 MAC SAP. An instance of an 8802-11

Distribution System can be implemented from IEEE 802 LAN components. IEEE 802.11 STAs attach to the

Distribution System via an IEEE 802.11 Access Point. A bridge shall not connect to an IEEE 802.11

Independent BSS. For a description of the IEEE 802.11 architecture, see Clause 5 of IEEE Std 802.11.

On receipt of an M\_UNITDATA.request primitive, the portal constructs a MAC Service Data Unit and

passes it to the MAC Data service for transmission (in accordance with the frame formats and procedures

specified in IEEE Std 802.11 Clauses 6, 7, 9, and Annex C) using the parameters supplied as specified

below.

On receipt of a valid MAC Service Data Unit (see IEEE Std 802.11 Clauses 6, 7, 9, and Annex C), the portal

generates an M\_UNITDATA.indication primitive with parameter values derived from the frame fields as

specified below.

When processing MSDU\_from\_LLC, the Type subfield of the Frame Control field specified in 7.1.3.1 of

IEEE Std 802.11 shall be encoded as *Data* in MAC frames (see Table 1 in IEEE Std 802.11).

The destination\_address parameter is encoded in MAC frames as the DA described in Table 4 of 7.2.2 of

IEEE Std 802.11.

The source\_address parameter is encoded in MAC frames as the SA described in Table 4 of 7.2.2 of IEEE

Std 802.11.

The mac\_service\_data\_unit parameter is encoded in the Frame Body field (IEEE Std 802.11, 7.1.3.5) of

MAC frames. The length of the MSDU shall be \_ 2304 octets. The length is not encoded in MAC frames;

rather, it is conveyed in the PHY headers.

The user\_priority parameter is not encoded in MAC frames. The user\_priority parameter provided in an

M\_UNITDATA.indication primitive shall take the value of the Default\_User\_Priority parameter for the port

through which the MAC Service Data Unit was received. The default value of this parameter is 0, it may be

set by management, in which case the capability to set it to any of the values 0 through 7 shall be provided.

The Frame Check Sequence (FCS) field of MAC frames is calculated and encoded in accordance with IEEE

Std 802.11, 7.1.3.6.

No special action, above that specified in IEEE Std 802.11, is required for the support of the MAC Internal

Sublayer Service by the wireless LAN access method.”