IEEE P802.11
Wireless LANs

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| Proposed spec text for WUR frame format |
| Date: 2018-05-01 |
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Abstract

This submission proposes draft for WUR frame format for the following portions of the SFD:

1. [Assigned D0.1, D0.3] The Frame Control field is 8 bits and contains:
* …
* If the Frame Body presence subfield is 1, the Length/Misc subfield indicates the length of the Frame Body. Otherwise, the Length/Misc subfield indicates the Misc.

Type

Length/Misc

Reserved

Frame Body presence

3

3

1

1

Bits:

[Motion, Nov 2017 and March 2018, see [6] [63] [8] [64]]*(#M1)*

1. [Assigned D0.3] The Transmit ID is algorithmically obtained from the BSSID. The Embedded BSSID is algorithmically obtained from the BSSID.

[Motion 1, March 2018, see [8] [40]]*(#M2)*

1. [Assigned D0.3] The FCS field of all WUR frames has the same size.

[Motion 1, March 2018, see [8] [65]]*(#M3)*

1. [Assigned D0.3] The FCS field size of all WUR frames is 16 bits.

[Motion 2, March 2018, see [8] [65]]*(#M4)*

1. [Assigned D0.3] In WUR Beacon and wake-up frame, the embedded BSSID is used for the FCS calculation. In WUR Discovery frame, the embedded BSSID is not used for the FCS calculation. In Vendor Specific frame, it is up to the vendor to decide whether to include the embedded BSSID in the FCS calculation.

[Motion, March 2018, see [8] [67]] *(#M5)*

1. [Assigned D0.2, D0.3] The CRC of all WUR frames shall use ~~one of the following~~ the 16-bit CRC engines from IEEE 802.11
* ~~32-bit CRC, 16-bit CRC, 8-bit CRC~~

[Motion, Jan 2018 and March 2018, see [7] [66] [8] [65]]*(#M6)*

1. [Assigned D0.3] The Address field of WUR wake-up frame is set to a TBD value for indicating that the AP intends to transmit group addressed frames
* Whether the value is fixed or randomized is TBD

[Motion, March 2018, see [8] [68]]*(#M7)*

1. [Assigned D0.3] Compressed SSID (C-SSID) is based on an existing CRC over the SSID in the baseline spec (which CRC is TBD).

[Motion, March 2018, see [8] [72]]*(#M8)*

1. [Assigned D0.3] The value range of Group ID is a subset of consecutive values obtained from the identifier’s space.

[Motion, March 2018, see [8] [39]]*(#M9)*

1. [Assigned D0.3] A STA that declares support of Group IDs is required to store at least one group ID and shall declare the Group ID bitmap size that it is capable of storing.

[Motion 2, March 2018, see [8] [40]]*(#M10)*

1. [Assigned D0.1] The individual addressed wake-up frame contains a WUR identifier that identifies both the transmitter and the receiver.

[Motion, Sep 2017, see [4] [36] and [35]] *(#M11)*

Revisions:

* Rev 0: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGax Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGba Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGba Editor: Editing instructions preceded by “TGba Editor” are instructions to the TGba editor to modify existing material in the TGba draft. As a result of adopting the changes, the TGba editor will execute the instructions rather than copy them to the TGba Draft.***

* MAC frame format for Wake Up Radio (WUR) frames

9.10.1 Basic components

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

Each Wake Up Radio (WUR) frame consists of the following basic components:

* A *MAC header*, which comprises frame control, address, and type dependent (TD) control fields;
* A variable-length *frame body*, which, if present, contains information specific to the frame *type*;
* An *FCS*,which contains an IEEE 16-bit CRC*(#M4)*.
* General WUR frame format

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

Figure 9-747a (WUR frame format) depicts the general MAC frame format for WUR frames.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0   B7 | B8  B19 | B20  B31 |  |  |
|  | Frame Control | Address | TD Control | Frame Body | FCS |
| Bits: | 8 | 12 | 12 | variable | *16(#M4)* |
| * WUR frame format
 |

The MAC header of the WUR frame consists of the Frame Control, Address, and TD Control fields, and is defined in 9.10.2.1 (MAC header).

The Frame Body field is optionally present in certain WUR frame types*(#Ed)* and is defined in 9.10.2.4 (Frame Body field).

The FCS field is defined in 9.10.2.5 (Frame Check Sequence (FCS) field).

The MAC header and the last field (FCS) constitute the minimal WUR frame format and are present in all WUR frames, including reserved types.

A WUR frame that does not have a Frame Body field is referred to as a minimal-length (ML) WUR frame. A WUR frame that has a Frame Body field is referred to as a variable-length (VL) WUR frame.*(#Ed)*

NOTE—An ML WUR*(#Ed)* frame can be sent to any WUR STA while a VL WUR frame can be sent only to a WUR STA that has declared support of its reception.*(#Ed)*

* MAC header
* Frame Control field

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The format of the Frame Control field is illustrated in Figure 9-747b (Frame Control field format of WUR frame).*(#Ed)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0   B2 | B3 | B4  B6 | B7 |
|  | Type | Length Present | Length/Misc | Reserved |
| Bits: | 3 | 1 | 3 | 1 |
| * Frame Control field format of WUR frame*(#M1)*
 |

The Type field indicates*(#Ed)* the type of the WUR frame, as defined in Table 9-429a (WUR frame types).

|  |
| --- |
| * WUR frame types
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| Type  | Type description |
| 0 | WUR Beacon |
| 1 | WUR Wake Up |
| 2 | WUR Vendor Specific |
| 3 | WUR Discovery |
| 4-7*(#M1)* | Reserved |

The Length Present field indicates whether the Length/Misc field contains the Length field or not.*(#M1)* The Length/Misc field contains the Length field when the Length Present field is 1 and the Misc field when the Length Present field is 0.*(#M1)*

### AUTHOR’S TECHNICAL NOTE FOR AA1 CHANGE (REMOVES A TBD):

 ***It is obvious that a field contains bits that are expected to be used for other purposes. However, those other purposes are currently not defined, and when defined we can populate the bits accordingly. Since this is a TBD and we don’t have yet a use for these bits the proposal is to simply say that the Misc field is reserved, except of course for the Vendor Specific case.***

The Length field contains the length of the Frame Body field as defined in 9.10.2.4 (Frame Body field).

The Misc field is reserved unless explicitly stated otherwise.*(#AA1)*

* Address field

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The Address field contains an identifier for the WUR frame, which is selected from Table 9-429b (Identifiers of WUR frames). The identifier depends on the type of WUR frame (see 9.10.3 (Format of individual WUR frame types)).

|  |
| --- |
| * Identifiers of WUR frames
 |
| Address field  | Identifier description |
| Transmit ID | Identifier of the transmitting AP (see 31.1a.2 (Transmit ID))*(#M2)* |
| Group ID | Identifier of a group of receiving WUR STAs (see 31.1a.3(Group ID))*(#M9, 10)* |
| WUR ID | Identifier of an individual receiving WUR STA (see 31.1a.4 (WUR ID)) *(#Ed)* |
| OUI1 | The 12 MSBs of the OUI (see 9.4.1.32 (Organization Identifier field)) |

* TD Control field

The Type Dependent (TD) Control field contains control information that dependends on the WUR frame type (see 9.10.3 (Format of individual WUR frame types)).

* Frame Body field

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The Frame Body field is a variable-length field that contains information specific to individual WUR frame types. The Frame Body field is not present when the Length Present subfield of the Frame Control field is 0 (i.e., within ML WUR frames and is present when the Length Present subfield of the Frame Control field is 1 (i.e., within VL WUR frames).*(#M1, Ed)*

### AUTHOR’S TECHNICAL NOTE FOR AA2 CHANGE (REMOVES 3 TBDs):

***The change below is based on a SP that was ran in 11/18/0094r1 which had a result of 13Y/6N/15A. Based on feedback from the members additional considerations were added in 11/420r0 to address the concern that TX airtime for these frames may be too long. The additional consideration is that we already have a motion that limits the WUR PPPU “IEEE 802.11ba shall define an upper limit on the time duration of a WUR PPDU, to a TBD value that is less than the L-SIG LENGTH field”. As such, having this length of Frame Body is within our requirements since the aPPDUMaxTime (provided by L-SIG LENGTH field) is 5.484ms and the maximum WUR PPDU is 2.968 ms for the lowest rate (62.5Kbps) and longest Frame Body field (16 octets), i.e., a little bit longer than half the aPPDUMaxTime (Note: If we were to chose 8 octet FB then the WUR PPDUMaxTime would be 1.944 ms, however it would require 3.9ms (2xWURPPDU) to transmit the same information as 16 Octet Frame Body WUR PPDU).***

The length of the Frame Body field is in units of octets and is equal to 2 x (*L* + 1), where *L* is the value of the Length subfield in the Frame Control field. The minimum length and the maximum length of the frame body are 2 octets and 16 octets, respectively.*(#AA2)*

* Frame Check Sequence (FCS) field

The FCS field contains a *TBD*-bit CRC. The FCS is calculated over all the fields of the Frame Control, Address, TD Control, Frame Body field (if present), and Embedded BSSID field (if present). These fields are referred to as the *calculation fields*.

NOTE—The Embedded BSSID field, if present, is part of the *calculation fields* but is not part of the fields of the WUR frame transmitted over the *WM*.

The Frame Body field is present in the *calculation fields* only when the WUR frame is a variable-length WUR frame (9.10.2.4 (Frame Body field)); otherwise, the Frame Body field is not present.

The Embedded BSSID field is present in the *calculation fields* only for WUR frames that are post-association WUR frames; otherwise the Embedded BSSID field is not present. The Embedded BSSID field, if present, is the last field of the *calculation fields*. The size and contents of the Embedded BSSID field is *TBD*.

The FCS is the 1s complement of the remainder generated by the modulo 2 division of the *calculation fields* by the polynomial *TBD*, where the shift-register state is preset to all 1s.

NOTE—The order of transmission of bits within the FCS field is defined in 9.2.2 (Conventions).

The *calculation fields* are processed in the order they would have been transmitted.

NOTE—The Embedded BSSID field, if present, is part of the *calculation fields* but is not part of the fields of the WUR frame transmitted over the *WM*.

A schematic of the processing is shown in Figure X (CRC-*TBD* implementation), where the SERIAL DATA INPUT consists of the *calculation fields (BL, BL-1…, B1, B0),* with *BL* being the most significant bit of the *calculation fields*.

NOTE – THE CRC in the FCS is one of the CRC-8, CRC-16, or CRC-32. Which of these ones is still *TBD*.The FCS field contains a 16-bit CRC*(#M3, M4)*. The FCS is calculated over all the fields of the Frame Control, Address, TD Control, Frame Body field (if present), and Embedded BSSID field (if present). These fields are referred to as the *calculation fields*.

NOTE—The Embedded BSSID field, if present, is part of the *calculation fields* but is not part of the fields of the WUR frame transmitted over the *WM*.

The Frame Body field is present in the *calculation fields* only when the WUR frame is a VL*(#Ed)* WUR frame (see 9.10.2.4 (Frame Body field)); otherwise, the Frame Body field is not present.

The Embedded BSSID field is present in the *calculation fields* of a WUR Beacon and of a WUR Wake Up frame.The Embedded BSSID field is not present in the *calculation fields* of a WUR Discovery frame. Whether the Embedded BSSID field is present or not present in the *calculation fields* of a WUR Vendor Specific frame is vendor specific.*(#M5)*

### AUTHOR’S TECHNICAL NOTE FOR AA3 CHANGE (REMOVES ONE TBD):

***Since the FCS field is 16 bits then an Embedded BSSID field of 16 bits is sufficient to provide minimum false collision probability. Having longer Embedded BSSID field is not beneficial since it does not further reduce the collision probability and requires more information to be stored at the WUR STA. In addition, the proposal is to use the compressed BSSID which is obtained as a function of the CRC, inline with motion M8, so that same hashing function (or algorithm) is used for both cases (BSSID and SSID).***

The Embedded BSSID field, if present, is the last field of the *calculation fields*.The Embedded BSSID field is 16 bits in length and contains the 16 LSBs of the compressed BSSID, which is defined in 31.1a.1 (General).*(#M2, AA3)*

The FCS is the 1s complement of the remainder generated by the modulo 2 division of the *calculation fields* by the polynomial *x16* + *x12* + *x5* + *1(#M6)*, where the shift-register state is preset to all 1s.

NOTE—The order of transmission of bits within the FCS field is defined in 9.2.2 (Conventions).

The *calculation fields* are processed in the order they would have been transmitted.

A schematic of the processing is shown in Figure X (CRC-16 implementation for WUR MPDUs)*(#M6)*, where the SERIAL DATA INPUT consists of the *calculation fields (BL, BL-1…, B1, B0),* with *BL* being the most significant bit of the *calculation fields.* The CRC computation and transmission is the same as the one depicted in Figure 16-3 (CRC-16 implementation).*(#M6)*



**Figure X – CRC-16 implementation for WUR MPDUs** *(#M3, M4, M5, M6)*

* + 1. *(#M6)*Format of individual WUR frame types
* WUR Beacon frame format

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The frame format of the WUR Beacon frame is as defined in Figure 9-747a (WUR frame format).*(#Ed)*

The Frame Control field is as*(#Ed)* defined in 9.10.2.1.1 (Frame Control field).

The Address field of the WUR Beacon frame is set to the transmit ID.*(#Ed)*

### AUTHOR’S TECHNICAL NOTE FOR AA4 CHANGE (REMOVES ONE TBD):

***Normative behavior is expected to be located in 31.3.2 or in a dependent subclause of it. There were motions that passed in the March F2F that defined these rules, so expect this item to be taken care of in the May F2F meeting at the same time (synch up on the details with the author of that motion (Po-Kai).***

The TD Control field contains the partial TSF that is generated as defined in 31.3.2 (WUR beacon generation).*(#Ed, AA4)*

The Frame Body field is not present in the WUR Beacon frame. *(#Ed)*

* WUR Wake-up frame format

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The frame format of the WUR Wake-up*(#Ed)* frame is as defined in Figure 9-747a (WUR frame format).

The Frame Control field is as defined in 9.10.2.1.1 (Frame Control field), with the Length Present subfield set to 1 if the Frame Body field is present and the Length Present subfield set to 0 otherwise. *(#Ed, M1)*

 *(#M1)(#Ed)*The Address field of the WUR Wake-up frame is set to:

* The WUR ID when the frame is individually addressed
* The group ID when the frame is group addressed
* The transmit ID when the frame is broadcast addressed
* 0 when multiple WIDs are included in the Frame Body field of the frame*(#Ed)*

A counter subfield of a WUR Wake-up frame is defined as an unsigned integer initialized to 0, that increments when a critical update to the PCR’s BSS parameters has occurred. The size of the counter subfield is TBD.

* WUR Discovery frame format

The Frame Control field is set as defined in 9.10.2.1.1 (Frame Control field).

WUR Discovery frame includes compressed information of BSSID, SSID and information of PCR operating channel.

How to calculate compressed BSSID is TBD.

How to calculate compressed SSID is TBD.

How to signal PCR operating channel is TBD.

* WUR Vendor Specific frame format

**TGba Editor: *Change the paragraphs below of this subclause as follows:***

The frame format of the WUR Vendor Specific frame is as defined in Figure 9-747 (WUR frame format).*(#Ed)*

The Frame Control field is as defined in 9.10.2.1.1 (Frame Control field) with the Length Present subfield set to 1 if the Frame Body field is present and the Length Present subfield set to 0 otherwise.*(#Ed, M1)*

The Misc subfield in the Frame Control field, if present, contains vendor specific information that is out of scope of the standard.*(#Ed, M1, AA5)*

*(#Ed)*The Address field is set to the 12 MSBs of the OUI (see 9.4.1.32 (Organization Identifier field)).

The TD Control field is set to the 12 LSBs of the OUI.*(#Ed)*

The Frame Body field, if present, contains vendor specific information that is out of scope of the standard.*(#Ed, M1)*

*(#Ed, M1)***TGba Editor: *Insert new subclauses as follows:***

**31.1a Setting the identifiers of WUR frames**

**31.1a.1 General**

The Address field of WUR frames contains an identifier (ID) that is selected from the range 0 to 4095. Each identifier can be a transmit ID, which is obtained from the compressed BSSID (see 31.1a.2 (Transmit ID)), group ID (see 31.1a.3(Group ID)), or a WUR ID (see 31.1a.4(WUR ID)).

The compressed BSSID is equal to the 32-bit CRC calculated over the BSSID contained in Beacon frames transmitted by the WUR AP (calculation is performed as defined in 9.2.4.8 (FCS field) where the BSSID is the *calculation fields*).*(#M2, AA6)*

**31.1a.2 Transmit ID***(#M2, AA7)*

A transmit ID identifies the AP transmitting the WUR frame. A WUR frame with transmit ID in the Address field is a broadcast WUR frame that is addressed to all the WUR STAs that are associated with the transmitting AP.

A WUR AP shall use the 12 MSBs of the compressed BSSID as the transmit ID of WUR frames it transmits.

**31.1a.3 Group ID***(#M9, M10)*

A group ID identifies a group of one or more WUR STAs and is selected from a group ID space, obtained from the identifier’s space. A WUR frame with group ID in the Address field is a group addressed WUR frame that is addressed to all the WUR STAs identified by that group ID.

The WUR AP shall ensure that the lowest group ID of the group ID space is randomly selected from the identifiers’s space.

A WUR AP may assign one or more group IDs to a WUR STA that has set the Supported Group IDs field of the WUR Capabilities element it transmits to a nonzero value. The AP shall not assign a group ID to a WUR STA that has set the Supported Group IDs field of the WUR Capabilites element it transmits to zero.

The WUR AP shall indicate the group IDs assigned to a WUR STA in the Group ID List subfield of the WUR Parameters field of the WUR Mode element that is sends to the STA. The AP shall ensure that the difference between the largest group ID and the lowest group ID assigned to the WUR STA does not exceed the value indicated in the Supported Group IDs field of the WUR Capabilities element sent by the WUR STA, where the comparison performed between the two identifiers is circular modulo *212* (where the circular operation is described in 10.24.1( Introduction))*.*

A WUR STA that has indicated support for group IDs shall obtain the assigned group IDs from the Group ID List field of the most recent WUR Mode element received from the WUR AP.

### AUTHOR’S TECHNICAL NOTE FOR AA9 CHANGE (REMOVES ONE TBD):

***Normative behavior related to the WUR ID assignment procedure, which is missing in the current draft. Ensuring that the WUR ID assignment is as random as possible has been a vital discussion point since the early days we started the discussions on the amendment. To ensure this we allow the AP to either randomly select the WUR ID or to obtain the WUR ID from the AID of the STA after hashing it with a random value (transmit ID). This ensures an i.i.d distribution of identifiers across BSSs, minimizing the inter-BSS false wakes due to same ID selection.***

**31.1a.4 WUR ID** *(#AA8, M11)*

A wake-up radio (WUR) ID identifies the WUR STA that is the intended recipient of the WUR frame. A WUR frame with WUR ID in the Address field is an individually addressed WUR frame that is addressed to the WUR STA identified by that WUR ID.

A WUR AP shall assign to each WUR STA a WUR ID that uniquely identifies the WUR STA within the BSS of the AP. The AP shall either select the WUR ID randomly from the identifier’s space or calculate the WUR ID as *AID* + *transmit ID*, where the *AID* is the association identifier of the STA, the *transmit ID* is defined in 31.1a.2 (Transmit ID) and the addition performed between the two identifiers is circular modulo *212* (where the circular operation is described in 10.24.1( Introduction)). The AP shall indicate the WUR ID assigned to a WUR STA in the WUR ID field of the WUR Mode element it sends to the STA.

A WUR STA shall obtain the WUR ID from the WUR ID field of the most recent WUR Mode element received from the WUR AP.

**TGba Editor: *Insert a 2 bit field in the WUR Capabilities element that is named as “Supported Group IDs”, with short definition “Indicates Group IDs support”, and with the following encoding “ Set to 0 to indicate no support for group IDs; Set to 1 to indicate support for 16 group IDs; Set to 2 to indicate support for 32 group IDs; Set to 3 to indicate support for 64 group IDs.****(#M9, M10)*

**Lei Huang is defining *a Group ID List field in the WUR Mode element that contains the list of group IDs.*** *(#M9, M10)*