802.11ba Draft Specification

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| Spec Text for WUR Negotiation and WUR Mode |
| Date: 2018-01-17 |
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Abstract

This submission contains spec text to be incorporated in P802.11ba D0.1 related to these motions:

1. [Assigned D0.1] Define WUR Action frame to enable WUR negotiation and WUR mode signaling:
* Note that WUR Action frame is sent through primary connectivity radio.
1. [Assigned D0.1] The frame body of WUR Action frame can include the following:
* Category field that indicates WUR Action
* WUR Action field that includes the following indications: WUR Mode Setup and WUR Mode Teardown
* Dialog Token field
* WUR Mode Element includes necessary WUR parameters
1. [Assigned D0.1] The WUR Mode element can include the following:
* Element ID and Element ID Extension fields that indicate WUR Mode Element
* Length field
* Action Type field that includes the following indications:
	+ Enter WUR Mode Request
	+ Enter WUR Mode Response
	+ Enter WUR Mode Suspend Request
	+ Enter WUR Mode Suspend Response
	+ Enter WUR Mode Suspend
	+ Enter WUR Mode
* WUR Mode Response Status field that includes the following indications: Enter WUR Mode Accept, Enter WUR Mode Suspend Accept, and Denied
* WUR Parameters field that includes the indication for WUR parameters
1. [Assigned D0.1] WUR Parameters field of WUR Mode element, if present, may include either the following
* WUR ID information
	+ Individual ID
* Duty cycle information
* WUR channel information

or the following

* Preferred duty cycle parameter (e.g. ON Duration, Period, etc...)
1. [Assigned D0.1] The WUR Action frame sent by an AP through the PCR includes a WUR ~~receiver~~ identifier (WID):
* The WID uniquely identifies a WUR STA within ~~a~~the BSS of the AP.
* The WID is included in a unicast wake-up frame ~~as the receiver identifier~~ to identify the intended immediate recipient ~~wake up the~~ WUR STA within the BSS of the AP.
* The size of the WID is TBD, and how it is computed is TBD.
1. [Assigned D0.1] AP decides the WUR operating channel in the band(s) supported by the associated non-AP STA operating in WUR Mode.
2. [Assigned D0.1] IEEE 802.11ba shall define Information Element for WUR capability that include following information
* Supported operating class for WUR operating channel
* PCR transition delay from doze state to awake state after receiving wake-up frame at STA side
* Nonzero-length Frame Body support
1. [Assigned D0.1] STA can have duty cycle mode for wake-up receiver (WURx).

R.4.4.B: [Assigned D0.1] WUR Beacon interval can be indicated in WUR Mode element:

* Note that WUR mode element is sent through primary connectivity radio.
1. [Assigned D0.1] WUR mode signaling shall be defined for the WUR STA to enter the WUR mode by explicit signalling:
* ~~Explicit or implicit signaling is TBD~~
* ~~If signaling is explicit,~~ WUR mode signaling is done on the Primary connectivity radio.
* Wake-up operating parameter is ~~may be~~ notified in WUR mode signalling:
	+ Detailed parameters are TBD.
1. [Assigned D0.1] If a non-AP STA is in WUR mode, then:
* the non-AP STA’s WURx follows the duty cycle schedule (including WURx always on) agreed between AP and non-AP STA if the non-AP STA is in the doze state.
* the existing negotiated service period between AP and non-AP STA for the non-AP STA’s PCR schedule (e.g. TWT, schedule for WNM Sleep Mode) is suspended:
	+ STA is not required to wake up during the service period if the service period is suspended.
	+ The parameters of the negotiated service period for the non-AP STA’s PCR schedule is still saved by the AP and non-AP STA when the negotiated service period is suspended.
1. [Assigned D0.1] If a non-AP STA is in WUR mode, then:
* the non-AP STA may not listen for Beacon frames if the non-AP STA is in PS mode.
1. [Assigned D0.1] The STA may turn off the WURx after a successful frame exchange with AP, which informs the AP that the STA is the awake state, through its PCR in WUR mode.
2. [Assigned D0.1 Define WUR Mode Suspend, and if an non-AP STA is in WUR Mode Suspend, then
* The negotiated WUR parameters between AP and non-AP STA is maintained
* Non-AP STA may turn off the WURx
* Note that negotiated PCR schedule (if any) is active and is not suspended

**Reference slide deck(s):**

[1] 17/1302r7 WUR mode operation procedures

[2] 17/1627r2 WUR Action Frame Format Follow

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| [3] 17/379r4 SFD MAC proposal |
| [4] 17/954r2 WUR Mode Signaling[5] 17/972r2 Definition of WUR Mode |
| [6] 17/1349r4 Discussion on WUR mode |
| [7] 17/1369r3 Power save mode transition[8] 17/1657r7 MAC operation of WUR[9] 17/0977r4 Address structure in unicast wake-up frame[10] 17/1115r4 Wakeup Frame Format[11] 17/1333r2 WUR Operating Channel[12] 17/342r4 WUR Negotiation and Acknowledgement Procedure Follow up[13] 17/343r3 WUR Beacon |
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Revision History:

* Rev 0: Initial version of the document
* Rev 1: Revsion based on the comment received in the meeting. Track changes on with comments received during presentation
* Rev 2: Revision based on the offline discussion with George

***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 or insert 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.***

* Components of the IEEE Std 802.11 architecture
* Wake-up radio (WUR) STA

***TGba editor: Insert the following in 4.3.15a:***

WUR AP supports the features of HT AP, VHT AP, or HE AP.

WUR non-AP STA includes a PCR component, which supports the features of HT non-AP STA, VHT non-AP STA, or HE non-AP STA, and a WURx, which has the capability to receive WUR PPDU.

The main PHY features in a WUR STA are the following:

* <Texts to be filled>

The main MAC features in a WUR STA are the following:

* <Texts to be filled>

**TGba Editor: *Instruction: change subclause 9.4.1.11 Action field as the following:***

* Management and Extension frame body components
* Fields that are not elements
* Action field

TGba Editor: Instruction: Insert the following rows into Table 9-47 in numerical order and update the Reserved row:

|  |
| --- |
| * Category values
 |
| Code | Meaning | See subclause | Robust | Group addressed privacy  |
| <ANA>(#ANA) | WUR | 9.6.31 (WUR Action frame details) | Yes | No |

* Elements

**9.4.2.1 General**

***Insert the following new rows into Table 9-77 (Element IDs) (header row shown for convenience):***

**Table 9-77 – Element IDs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension**  | **Extensible** |
| **WUR Capabilities** | **255** | **<ANA>** | **Yes** |
| **WUR Mode** | **255** | **<ANA>** | **Yes** |

 ***TGba Editor: Instruction: Insert the following new subclauses after the last subclause in 9.4.2:***

* WUR Mode element

The WUR Mode element is used to negotiate the parameters related to WUR operation. The format of the WUR Mode element is shown in Figure 9-xxx (WUR Mode element format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  | Element ID | Length | Element ID Extension | Action Type | WUR Mode Response Status | WUR Parameters |
| Octets: | 1 | 1 | 1(#Ed) | 1 | TBD |  TBD |
|  |  | Figure 9-xxx - WUR Mode element format |

The Element ID, Length, and Element ID Extension fields(#Ed) are defined in 9.4.2.1 (General).

The Action Type field is a number that identifies the type of WUR mode operation. The Action Types are shown in Table 9-xxx (Action Type definitions).

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| --- |
| Table 9-xxx – Action Type definitions  |
| Action Type value | Meaning |
| 0 | Enter WUR Mode Request |
| 1 | Enter WUR Mode Response |
| 2 | Enter WUR Mode Suspend Request |
| 3 | Enter WUR Mode Suspend Response |
| 4 | Enter WUR Mode Suspend |
| 5 | Enter WUR Mode |
| 6-255 | Reserved |

The WUR Mode Response Status field indicates the status returned by the AP responding to the non-AP STA’s WUR Mode request operation as defined in Table 9-xxx (WUR Mode Response Status definition). This field is valid only when the Action Type field is set to “Enter WUR Mode Response” or “Enter WUR Mode Suspsend Response” and is reserved otherwise.

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| Table 9-xxx – WUR Mode Response Status definition |
| Value | Meaning |
| 0 | Accept. |
| 1 | Denied. |
| TBD | Reserved |

The subfields of the WUR Parameters field sent from WUR AP are defined in Table 9-xxx (Subfields of the WUR Parameters field from WUR AP).

**Table 9-xxx – Subfields of WUR Parameters field from WUR AP**

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Enconding |
| WUR ID | A WUR identifier that uniquely identifies the WUR STA within the BSS of the AP  | An WUR identifier provided by the AP. |
| WUR Operating Class | Indicates the operating class in use for transmission of WUR frame from the WUR AP to the WUR non-AP STA | The size and encoding is the same as the definition of Operating Class in 9.4.1.22 (Operating Class and Channel field)  |
| WUR Channel | Indicates the channel in use for transmission of WUR frame from the WUR AP to the WUR non-AP STA | The size and encoding is the same as the definition of Channel field in 9.4.1.22 (Operating Class and Channel field) |
| Duty cycle information | TBD | TBD |
| WUR Beacon Period | Indicates the period of WUR Beacon frame | Detail is TBD. |

The subfields of the WUR Parameters field sent from WUR non-AP STA are defined in Table 9-xxx (Subfields of the WUR Parameters field from WUR non-AP STA).

**Table 9-xxx - Subfields of the WUR Parameters field from WUR non-AP STA**

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Enconding |
| ON Duration | Indicates the preferred duration that WUR STA will be in WURx awake state in the WUR duty cycle mode. | Detail is TBD. |
| Duty Cycle Period | Indicates the preferred interval between two starting points of the successive ON Durations in the WUR duty cycle mode | Detail is TBD. |

9.4.2.263 WUR Capabilites element

A WUR STA declares that it has WUR capability by transmitting the WUR Capabilities element. The WUR Capabilities element contains a number of fields that are used to advertise WUR capabilities of a WUR STA.

The WUR Capabilities element is defined in Figure 9-xxx (WUR Capabilities element format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Supported Bands | PCR Transition Delay | Nonzero Length Frame Body Support |
| Octets: | 1 | 1 | 1 | TBD | TBD | TBD |

Figure 9-xxx – WUR Capabilities element format

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1 (General)

For WUR AP, the Band ID field is reserved.

For WUR non-AP STA, the Supported Bands field indicates the supported bands. The encoding of the field is TBD.

For WUR AP, the PCR Transition Delay field is reserved.

For WUR non-AP STA, the PCR Transition Delay field indicates the PCR transition delay from doze state to awake state of the WUR non-AP STA after the WUR non-AP STA receives wake-up frame.

For WUR AP, the Nonzero Length Frame Body Support field is reserved.

For WUR non-AP STA, the Nonzero Length Frame Body Support field indicates supportability of non-zero length frame body.

* Action frame format details

***TGba Editor: Instruction: Insert the following new subclause after the last subclause in 9.6:***

* WUR Action details

9.6.31.1 WUR Action field

Several Action frame formats are defined for wake-up radio (WUR) purposes. A WUR Action field, in the octet field immediately after the Category field, differentiates the formats. The WURAction field values associated with each frame format are defined in Table 9-xxx (WUR Action field values).

|  |
| --- |
| Table 9-xxx – WUR Action field values  |
| Value | Meaning |
| 0 | WUR Mode Setup |
| 1 | WUR Mode Teardown |
| 2-255 | Reserved |

9.6.31.2 WUR Mode Setup frame format

The WUR Mode Setup frame is an Action frame of category WUR. The Action field of a WUR Mode Setup frame contains the information shown in Table 9-xxx (WUR Mode Setup frame Action field format).

|  |
| --- |
| Table 9-xxx - WUR Mode Setup frame Action field format  |
| Order | Information |
| 1 | Category |
| 2 | WUR Action(#4911) |
| 3 | Dialog Token |
| 3 | WUR Mode element (see 9.4.2.262 (WUR Mode element))(#4911) |

The Category field is defined in Table 9-47 (Category values).

The WUR Action field is defined in Table 9-xxx (WUR Action field values).

The Dialog Token field is defined in 9.4.1.12 (Dialog Token field).

The WUR Mode element field contains a WUR Mode element as defined in 9.4.2.262 (WUR Mode element)).

9.6.31.3 WUR Mode Teardown frame format

The WUR Mode Teardwon frame is an Action frame of category WUR. The Action field of a WUR Mode Teardown frame contains the information shown in Table 9-xxx (WUR Teardown frame Action field format).

|  |
| --- |
| Table 9-xxx - WUR Mode Teardown frame Action field format  |
| Order | Information |
| 1 | Category |
| 2 | WUR Action(#4911) |

The Category field is defined in Table 9-47 (Category values).

The WUR Action field is defined in Table 9-xxx (WUR Action field values).

**TGba Editor: *Instruction: change subclause 11.2.3.1 as the following:***

**11.2.3 Power management in a non-DMG infrastructure network
11.2.3.1 General**

**(…existing texts…)**

A STA operating in PS mode that is neither in WNM sleep mode nor in WUR Mode shall periodically listen for Beacon frames, as determined by the ListenInterval parameter of the MLME-ASSOCIATE.request or MLMEREASSOCIATE.request primitive and the ReceiveDTIMs parameter of the MLME-POWERMGT.request primitive.

**(…existing texts…)**

**TGba Editor: *Instruction: Insert subclause 31.5 Power management with WUR as the following:***

* Power management with WUR ~~mode~~

WUR is a service that may be provided by a WUR AP to its associated WUR non-AP STAs.

31.5.1 WUR Mode Setup

A WUR non-AP STA can be in WUR Mode or WUR Mode Suspend while using WUR service provided by a WUR AP.

To use the WUR service, a WUR non-AP STA uses the PCR component to exchange WUR Mode Setup frame with a WUR AP within the same infrastructure BSS and the detail is defined in Table 31-xxx (WUR Mode setup frame exchange).

|  |  |
| --- | --- |
|  | Table 31-xxx - WUR Mode setup frame exchange  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Request frame: Action Type field within a WUR Mode Setup frame transmitted from a WUR non-AP STA to a WUR AP STA** | **Response frame: Action Type field within a WUR Mode Setup frame transmitted from a WUR AP STA to a WUR non-AP STA** | **Response frame: WUR Mode Response Status field within a WUR Mode Setup frame transmitted from a WUR AP STA to a WUR non-AP STA** | **Status after the completion of the exchange** |
| Enter WUR Mode Request | Enter WUR Mode Response | Accept | The WUR non-AP STA enters WUR Mode. |
| Enter WUR Mode Suspend Request | Enter WUR Mode Suspend Response | Accept | The WUR non-AP STA enters WUR Mode Suspend. |
| Enter WUR Mode Request | Enter WUR Mode Response | Denied | WUR service is not provided by the WUR AP to the WUR non-AP STA at this time. |
| Enter WUR Mode Suspend Request | Enter WUR Mode Suspend Response | Denied | WUR service is not provided by the WUR AP to the WUR non-AP STA at this time. |

After a WUR non-AP STA has negotiated WUR service with a WUR AP, the WUR non-AP STA may switch from WUR Mode to WUR Mode Suspend or switch from WUR Mode Suspend to WUR Mode by using the PCR component to initiate and complete a successful frame exchange, which includes a WUR Mode Setup frame with Action Type field of the carrying WUR Mode element set to “Enter WUR Mode Suspend” or “Enter WUR Mode” from the WUR non-AP STA and an Ack frame from the WUR AP.

The Action Type field in the WUR Mode element of the WUR Mode setup frame sent by the PCR component of the WUR non-AP STA inthis frame exchange indicates the status that the STA shall adopt upon successful completion of the frame exchange.

After a WUR non-AP STA negotiates WUR service with a WUR AP, the WUR non-AP STA may teardown WUR service by using the PCR component to initiate and complete a successful frame exchange, which includes a WUR Mode Teardown frame from the WUR non-AP STA and an Ack frame from the WUR AP.

After a WUR non-AP STA negotiates WUR service with a WUR AP, the WUR AP may teardown WUR service by using the PCR component to initiate and complete a successful frame exchange, which includes a WUR Mode Teardown frame from the WUR AP and an Ack frame from the WUR non-AP STA.31.5.2 non-AP STA operation

The WURx of a WUR non-AP STA can be in one of two states:
— WURx Awake: the WURx of the WUR non-AP STA is fully powered to receive WUR frame.
— WURx Doze: the WURx of the WUR non-AP STA is not able to receive WUR frame.

NOTE 1 – The PCR component of a WUR non-AP STA can be in awake or doze state as defined in 11.2.1 (General).

NOTE 2 – The PCR component of a WUR non-AP STA can be in active mode or power save (PS) mode as defined in 11.2.3.2 (STA power management modes).

If a WUR non-AP STA is in WUR Mode, then:

* The WURx of the WUR non-AP STA shall be in WURx awake state during the ON Duration of the duty cycle schedule agreed between WUR AP and WUR non-AP STA if the PCR component of the WUR non-AP STA is in the doze state.
* The WURx of the WUR non-AP STA may be in WURx doze state after the WUR non-AP STA uses the PCR component to complete a successful frame exchange with the WUR AP, which informs the WUR AP that the PCR component of the WUR non-AP STA is the awake state.
* The WUR non-AP STA may not listen for Beacon frame if the PCR component of the WUR non-AP STA is in PS mode (see 11.2.3.1 (General).
* The existing negotiated service period between WUR AP and WUR non-AP STA for the WUR non-AP STA’s PCR schedule is suspended:
	+ The PCR component of the WUR non-AP STA may not be in the awake state during the negotiated service period of PCR schedule between the WUR AP and the WUR non-AP STA.
	+ The parameters of the negotiated service period for the WUR non-AP STA’s PCR schedule between the WUR AP and the WUR non-AP STA are maintained by the WUR non-AP STA.

NOTE 1 – The WURx duty cycle schedule agreed between WUR AP and WUR non-AP STA may be that the WURx of the WUR non-AP STA is always in WURx awake state.

NOTE 2 – Examples of the negotiated service period between WUR AP and WUR non-AP STA for the WUR non-AP STA’s PCR schedule include TWT and schedule for WNM sleep mode.

If a WUR non-AP STA is in WUR Mode Suspend, then:

* The WURx of the WUR non-AP STA may be in WURx doze state.
* The negotiated WUR parameters between the WUR AP and the WUR non-AP STA are maintained by the WUR non-AP STA.

NOTE – If a WUR non-AP STA is in WUR Mode Suspend, the existing negotiated service period between WUR AP and WUR non-AP STA for the WUR non-AP STA’s PCR schedule is active and is not suspended.

31.5.3 AP STA operation

A WUR AP shall maintain for each associated WUR non-AP STA that requests WUR service a WUR status that indicates whether the WUR STA is in WUR Mode or WUR Mode Suspend.

When a WUR non-AP STA is in WUR Mode, then:

* The WUR AP may send a wake-up frame to the WUR non-AP STA if the WUR non-AP STA is in the doze state, and the WURx duty cycle schedule agreed between WUR AP and WUR non-AP STA indicates that the WURx of the WUR non-AP STA is in WURx awake state.
* the existing negotiated service period between WUR AP and WUR non-AP STA for the WUR non-AP STA’s PCR schedule is suspended:
* The parameters of the negotiated service period for the WUR non-AP STA’s PCR schedule between the WUR AP and the WUR non-AP STA are maintained by the WUR AP.

When a WUR non-AP STA is in WUR Mode Suspend, then:

* the negotiated WUR parameters between the WUR AP and the WUR non-AP STA are maintained by the WUR AP