IEEE P802.11
Wireless LANs

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| Wake-Up Receiver (WUR) Study GroupMeeting Minutes for November 2016 Meeting,San Antonio, TX, US |
| Date: 11-14-2016 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Leif Wilhelmsson | Ericsson AB | Mobilvägen 1, 22632 Lund, Sweden | +46-706-216956 | leif.r.wilhelmsson@ericsson.com |

Abstract

Meeting Minutes for the WUR SG sessions held in San Antonio, TX, US, November 6-11, 2016.

**Tuesday, November 8, 2016, 1:30-3:30 pm**

**Meeting Agenda:**

The meeting agenda is shown below, and also published in the agenda document:

<https://mentor.ieee.org/802.11/dcn/16/11-16-1324-03-0wur-wur-sg-november-2016-meeting-agenda.ppt>

* Call meeting to order
* WUR SG introduction
* Call for submissions
* Review agenda and approval
* IEEE 802 and 802.11 IPR Policy and procedure
* Summary from September 2016 plenary meeting and teleconferences
* Motion: September 2016 meeting minutes ([doc: IEEE 802.11-16/1248r0](https://mentor.ieee.org/802.11/dcn/16/11-16-1248-00-0wur-meeting-minutes-september-2016.docx))
* Review and resolve early comments from other WGs and EC on the PAR and CSD
* Presentations
* Recess

**Chair Minyoung Park (Intel) calls meeting to order at 1.30pm. (**About 100 persons in the room.)

Minyoung reminds about recording attendance and goes through the session schedule for the week.

Minyoung goes through the agenda document 11-16/1324r3 as well as the submission received in response to the Call for Submission.

The agenda is reviewed. The main topic for this week is to review comments from other WGs and EC members and revise the PAR and CSD accordingly.

Minyoung asks whether there is any more submission than those indicated in the list. There are currently nine presentations scheduled for this week. No more submissions announced.

The received submissions for this meeting are:

1. 11-16/1379, “On error rate performance of OOK in AWGN” Simon Qu (Blackberry)
2. 11-16/1400r0, “Power Efficient WUR AP Discovery” Xiaofei Wang (InterDigital)
3. 11-16/1445 “Overall MAC Procedure for WUR” Kiseon Ryu (LG Electronics)
4. 11-16/1501, “AP Discovery using WUR,” Igor Kim (ETRI)
5. 11-16/1504, “Discussion of WUR Packets Design,” Ke Yao (ZTE)
6. 11-16/1506r0, “Coexistence Mechanism for Wakeup Radio Signal Follow-up,” Yongho Seok (NEWRACOM)
7. 11-16/1465, “WUR usage model,” Ross (Huawei)
8. 11-16/1470, “Wake-up and Data Exchange Sequences,” John Son (WILUS)
9. 11-16/1460, “WUR MAC discussion,” Liwen Chu (Marvell)

**Motion to approve the Agenda, document number 11-16/1324r3.**

* + Moved: Yunsong Yang
	+ Seconded: Minho Cheong
	+ Motion passed by unanimous consent.

Minyoung reviews the Patent policy slides (slides 12-14) and make a call for potentially essential patents. No response.

Minyoung reviews Other Guidelines etc. and goes through the summary from the September meeting.

**Motion to approve minutes from September meeting**, <https://mentor.ieee.org/802.11/dcn/16/11-16-1248-00-0wur-meeting-minutes-september-2016.docx>

* + Moved: Yunsong Yang
	+ Seconded: Alfred Asterjadhi
	+ Motion passed by unanimous consent.

**Presentations:**

1. **11-16/1379r1, “On error rate performance of OOK in AWGN” Simon Qu (Blackberry):**

The presentation shows the performance for some different types of demodulators, both coherent and non-coherent when OOK is used.

Questions/Comments (Q): Any results with more than one sub-carrier.

Answer (A): No.

Q: I believe that the assumption of an ideal detector may not be very interesting. A WURx is a very simple device and it is not clear to me that you will get this kind of performance.

Q: It seems you assume the reception is in the frequency domain, but with a simple receiver it will typically be in the time domain. I think the performance will be different.

A: I don’t think the performance will be different.

1. **11-16/1400r0, “Power Efficient WUR AP Discovery” Xiaofei Wang (InterDigital)**

The contribution presents a procedure where a WUR in the AP allows for active scanning. The STA sends the wake-up signal similar to a probe request.

Q: Unsure about the use case, but I agree that the ideas are interesting.

A: I basically agree, but I think we are not done concerning use cases.

Q: How does the STA know the address of the AP?

A: Could be based on location knowledge as an example.

Q: Note that e.g. WFA tries to discourage the use of active scanning, so I still believe passive scanning may be preferred.

A: This is not a replacement for passive scanning, but a complement where one tries to obtain some of the advantages with active scanning, like shorter delay, without the same amount of channel usage as normal active scanning.

Q: How much impact would SSID decoding have on the total power consumption?

A: My assumption is that it should be negligible, but if someone has other information that is very appreciated.

1. **11-16/1445 “Overall MAC Procedure for WUR” Kiseon Ryu (LG Electronics)**

Some MAC procedures for e.g. knowing whether the WUR is in range are discussed.

Q: On the Keep Alive approach. It has to turn on the main transceiver, which may not be power efficient. Maybe it is better if AP sends wake-up packets periodically.

A: I agree. This was an alternative.

1. **11-16/1501, “AP Discovery using WUR,” Igor Kim (ETRI)**

Q: You assume that the range for the WUR is at least as large than the main receiver, otherwise it would not work. Also if the range of the WUR is larger, you may actually experience a ping-pong effect?

A: I assume the ranges to be identical.

Q: The wake-up packet has a transmitter address in addition to the receiver address?

A: Yes.

Q: I agree that we need to have some mechanism on the MAC level just as you suggest.

Q: Any thoughts of what size of intervals would be suitable?

 A: It is a trade-off. I don’t have any numerical values.

Q: Related to a previous question on range, I think we need to make a calibration. As long as we know the sensitivity of the main receiver, we can calibrate to get the same range also for the WUR.

1. **11-16/1504, “Discussion of WUR Packets Design,” Ke Yao (ZTE)**

Q: Actually the PAR says that the purpose it to wake up the main radio, and what you propose seems to maybe go a bit farther than that.

A: I think it is control information.

Q: Your intention is to already have some application specific information in the wake-up signal?

A: Yes, but the number of bits is very small.

**Minyoung declares the group to be in recess at 3.30 pm.**

**Tuesday, November 8, 2016, 7:30-9:30 pm**

**Meeting Agenda:**

The meeting agenda is shown below, and also published in the agenda document:

<https://mentor.ieee.org/802.11/dcn/16/11-16-1324-04-0wur-wur-sg-november-2016-meeting-agenda.ppt>

* Call meeting to order
* IEEE 802 and 802.11 IPR Policy and procedure
* Review and resolve comments from other WGs and EC on the PAR and CSD
* Recess

**Chair Minyoung Park (Intel) calls meeting to order at 7.30pm. (**About 65 persons in the room.)

Minyoung goes through the agenda. The document to be presented by Jon Rosdahl has been added at the end in the list of received contributions:

1. 11-16/1326r1, “Feedback from the 802.11 PAR Review SC,” Jon Rosdahl

Minyoung reviews the Patent policy slides and make a call for potentially essential patents. No response. Minyoung reviews Other Guidelines etc.

Jon Rosdahl goes through the comments received from the IEEE 802.3 WG, which also have been sent to Minyoung. Comments have been received both for the PAR and the CSD.

Jon Rosdahl goes thought the comments from the 802.11 PAR Review SC, which can be found in

<https://mentor.ieee.org/802.11/dcn/16/11-16-1326-01-0PAR-par-review-meeting-agenda-and-comment-slides-san-antonio-2016.pptx>

Osama goes through the CSD to address the two received comments form 802.3. The received comments and the corresponding resolutions are as follows:

**Comment:** 1.2.3 Distinct Identity — You may want to delete the second paragraph, because the title of a document does not create distinct identity of the specifications contained in the proposed amendment.

**Resolution:** Accepted. The paragraph is deleted.

**Comment:** 1.2.4,b) Technical Feasibility — The answer seems to contradict the response to Economic Feasibility, this response seems to say that technical feasibility is not known. Therefore, additional study time should be spent to determine with appropriate confidence WUR technical feasibility before a PAR is submitted. Based on the Economic Feasibility we assume enough is known about the technical feasibility that this question could be properly answered.

**Resolution:** The statement is adjusted by removing the first sentence of the paragraph in 1.2.4.b.

The CSD document is updated accordingly. These were the only comments received on the CSD document.

Shahrnaz, who will go through the PAR and address the comments, is not present and the Chair declares the group in recess 8.15 – 8.30 pm while waiting for Shahrnaz to arrive.

The meeting is resumed at 8.30 pm.

Shahrnaz goes through <https://mentor.ieee.org/802.11/dcn/16/11-16-1045-06-0wur-a-par-proposal-wur-sg.docx> to address the received comments.

From 802.3, the received comments and the corresponding resolutions are:

**Comment:** General — It would be helpful to reviewers if the PAR were output from the myProject system. Failure to use myProject also leads to errors, for example, the approval date is the approval by the SASB, which will not be November 2016; and the expiration date is based on the approval date. (Neither should be filled in at this point.)

**Resolution:** Agreed. The request date is corrected and the other dates are removed.

**Comment:** 5.2.b Project scope — As written the last sentence could be taken as requiring an implementation to be less than one milliwatt, or with an alternate parsing of words that the project is expected to allow WUR radios consuming less than one milliwatt. Rewrite to either clearly state as a requirement, or if not a requirement a possible implementation characteristics.

**Resolution:** Project scope was updated in 11-16-1045r7, <https://mentor.ieee.org/802.11/dcn/16/11-16-1045-07-0wur-a-par-proposal-wur-sg.docx>

From 802.11 PAR SC the received comments and suggestions were received concerning the PAR:

**Comments:** Project Number – change to “P802.11ba”

**Resolution:** Agreed.

**Minyoung declares the group to be in recess at 9.32 pm.**

**Wednesday, November 9, 2016, 8:00-10:00 pm**

**Meeting Agenda:**

The meeting agenda is shown below, and also published in the agenda document: <https://mentor.ieee.org/802.11/dcn/16/11-16-1324-05-0wur-wur-sg-november-2016-meeting-agenda.ppt>

* Call meeting to order
* IEEE 802 and 802.11 IPR Policy and procedure
* Complete comment resolution
* Revise the PAR and CSD
* SG motions: approve the revised PAR and CSD
* Presentations
* Recess

**Chair Minyoung Park (Intel) calls meeting to order at 8:00am. (**About 70 people in the room.)

The agenda is reviewed. No discussion on the agenda.

Minyoung reviews the Patent policy slides and make a call for potentially essential patents. No response.

Shahrnaz has updated the PAR document based on the discussion in the Tuesday evening session and sent out the document on the reflector. The uploaded document is <https://mentor.ieee.org/802.11/dcn/16/11-16-1045-07-0wur-a-par-proposal-wur-sg.docx>

Shahrnaz goes through the document and some minor editorial changes are made. Minyoung asks if there are any objections or if we can accept the text and move on. No objection to the modified Section 5.2b Scope of Project.

Section 5.5 Need for the Project is also updated. Essentially only editorial and removing some text.

**Comments:** 2.1 Title – need to quantify “Low-power”. suggest “Low-power (less than 1mill-watt)”

**Resolution:** Revised. The title is changed to “Wake-up radio operation”.

The change was made after a straw poll with the following options:

option 1) remove “low power” - Number of votes: 25

option 2) add 1 milliwatt in parenthesis - Number of votes: 2

option 3) “milliwatt wake up radio operation” - Number of votes: 5

**Comments:** 5.2.b. The scope uses “normal” which should be removed. Is it really a new PHY layer that uses both 2.4 GHz and 5 GHz bands? Use of “packets” seems odd to use rather than “frame”? Can this work in the 3 GHz, 60Ghz or Whitespace bands as well? The current scope statement seems to be a listing of market points for the amendment.

**Proposed Scope replacement text** 5.2.b Scope of the Project: This amendment defines physical (PHY) layer and medium access control (MAC) layer specifications that enables operation of a wake-up radio (WUR). The WUR defines an active receiver with expected power consumption of less than one milliwatt.

**Straw poll:** Do you agree to change the scope as follows:

5.2.b Scope of the Project:

This amendment defines physical (PHY) layer and medium access control (MAC) layer specifications that enables operation of a wake-up radio (WUR). The WUR defines an active receiver with expected power consumption of less than one milliwatt.

Results: Y/N/A: 5/22/6

**Straw poll:** Do you agree to remove the following sentences:

This amendment defines operations for 2.4 GHz and 5 GHz bands.

The specification can be expanded to the license-exempt sub-1GHz frequency bands if needed.

Results: Y/N/A: 22/2/11

**Straw poll:** Do you agree to remove the following section title and sentences in 8.1:

5.2.b

The new amendment utilizes the existing privacy and encryption methods, and if needed includes new functionality to alleviate the possibility of security vulnerabilities. In scenarios where low latency is a requirement, the WUR should decrease overall power consumption of the STA without significant increase in latency (relative to the current maximum latency of the nominal duration of one beacon interval, 102.4 ms) in transferring user data packets.

In order to enable a wider set of use cases, both AP and non-AP types of STAs can be equipped with a WUR that can receive wake-up packets.

Results: Y/N/A: 34/0/3

**Straw poll:** Do you agree to state 5.2.b as follows:

This amendment defines a physical (PHY) layer specification and defines modifications to the medium access control (MAC) layer specification that enables operation of a wake-up radio (WUR). The wake-up frames carry only control information. The reception of the wake-up frame by the WUR can trigger a transition of the primary connectivity radio out of sleep. The WUR is a companion radio to the primary connectivity radio and meets the same range requirement as the primary connectivity radio. The WUR devices coexist with legacy IEEE 802.11 devices in the same band. The WUR has an expected active receiver power consumption of less than one milliwatt.

Results: Y/N/A: 36/0/1

**Straw poll:** Do you agree to change the scope as follows:

5.2.b Scope of the Project:

This amendment defines a physical (PHY) layer and defines modifications to the medium access control (MAC) layer specifications that enables operation of a wake-up radio (WUR). The wake-up frames carry only control information. The reception of the wake-up packet by the WUR can trigger a transition of the primary connectivity radio (used for transfer of 802.11 frames) from sleep. The WUR, used as a companion radio to the primary connectivity radio, has an active receiver power consumption of less than one milliwatt.

This amendment defines operations for 2.4 GHz and 5 GHz bands. The new amendment enables coexistence with legacy IEEE 802.11 devices operating in the same band.

Unanimously accepted.

The resolutions to the received comments can be found in <https://mentor.ieee.org/802.11/dcn/16/11-16-1528-00-0wur-comments-on-wur-sg-par-and-csd.ppt>

**Motion to approve revision r9 of the PAR:**

* Believing that the PAR contained in the document referenced below meets IEEE-SA guidelines,
* Request that the PAR contained in [doc:802.11-16/1045r9] be submitted to the IEEE 802.11 WG approval and submit to IEEE 802 EC for approval to submit to NesCom.
* Moved: Shahrnaz Azizi
* Seconded: Leif Wilhelmsson
* Result: Y: 34, N: 0, A: 1, Motion passed

**Motion to approve revision r4 of the CSD:**

* Believing that the CSD contained in the document referenced below meets IEEE 802 guidelines,
* Request that the CSD contained in [doc:802.11-16/936r4] be submitted to the IEEE 802.11 WG approval and submit to IEEE 802 EC for approval.
* Moved:, Yongho Seok
* Seconded:, Bin Tian
* Result: Y: 28, N:0, A:0, Motion passed

**Minyoung declares the group to be in recess at 10.00 am.**

**Thursday, November 10, 2016, 10:30-12:30 am**

**Meeting Agenda:**

The meeting agenda is shown below, and also published in the agenda document:

<https://mentor.ieee.org/802.11/dcn/16/11-16-1324-06-0wur-wur-sg-november-2016-meeting-agenda.ppt>

* Call meeting to order
* IEEE 802 and 802.11 IPR Policy and procedure
* Motion: SG extension
* Presentations
* SG timeline
* Discussion on the task group formation meeting in January 2017
* Teleconference call schedule
* Adjourn

**Chair Minyoung Park (Intel) calls meeting to order at 10.30 am. (**About 90 people in the room.)

Minyoung reminds about recording attendance.

The agenda is reviewed. No objection to approve the agenda.

Minyoung reviews the Patent policy slides and make a call for potentially essential patents. No response.

Minyoung reminds about SG rules

**Motion for SG extension**

Moved: Steve Shellhammer

Seconded: Young Hoon Kwon

Y/N/A:45/0/3, Motion passed

Minyoung goes through the timeline.

Technical presentations:

1. **11-16/1506r1, “Coexistence Mechanism for Wakeup Radio Signal Follow-up,” Yongho Seok (NEWRACOM):**

The presentation is concerned with protecting the wake-up signal using the L-SIG, and in particular that there is overhead due to EIFS. As a remedy to reduce this overhead, it is proposed to compensate this in the L-SIG field by essentially use a length that is shorter than actually is the case for the wake-up signal.

Q: If you have a receiver that actually can decode the wake-up signal, how should that behave?

A: The assumption here is that the WUR cannot decode the legacy part.

Q: Nice observation. Some more work is probably needed:

A: Agree, this was more to highlight the potential problem and get feedback from the group.

Q: Maybe you want to have another value to actually protect what may come after the wake-up signal?

A: I want to have some flexibility for setting the value to allow for responses to the wake-up packet.

1. **11-16/1465, “WUR usage model,” Ross (Huawei):**

Use cases include smart home, warehouse, outdoor cattle farm, wearable devices

Q: The use cases do not seem to be delay sensitive, do we need a WUR?

A: I believe it still makes sense to save power.

Q: I expect you present this to set some requirements. What do you have in mind

A: Maybe we can take that in a follow-up contribution

Q: I believe in many use case you presented you don’t really need Wi-Fi, but maybe can use BLE instead. Would be good with more details why there is an advantage with Wi-Fi.

A: I don’t agree in general that Wi-Fi is not needed. Maybe for the use case with a smart watch and a smart phone you are correct.

1. **11-16/1470, “Wake-up and Data Exchange Sequences,” John Son (WILUS):**

Different data exchange sequences to deal with missed reception of the wake-up packets are discussed. The proposal is to use an immediate ACK.

Q: One should also add things like power consumption for sending packets and not just look at the delay when comparing the different alternatives.

A: Agreed.

Q: I believe we need to look into this more in detail. E.g. loss of other packets may be the reason for connection failure. I also agree with an earlier comment that we need to consider power consumption.

A: Agreed

Q: I believe we need a more comprehensive analysis of what happens if many packets are missed.

Q: I think we may also want to consider that the sensor node may not have a PA and therefore transmits at much lower power than the AP.

1. **11-16/1460, “WUR MAC discussion,” Liwen Chu (Marvell):**

Q: For the scheme on slide 3, how can you set up the second TXOP?

Q: Slide 5: both color and AID are non-unique would it not be better with unique addresses?

A: we assume that the probability of collision is low enough.

Q: About security. Encryption may also add considerable power consumption so that must be considered.

A: Agreed.

Q: Slide 4, do you assume that there is TX as well?

A: Yes.

Q: If you give higher priority, maybe this will have some impact on the ordinary traffic. Especially if you have many WURs.

A: I assume the wake-up signals are not very frequent. And also this kind of prioritization is already available in 802.11 today.

Q: You assume a corresponding MAC and a 20 MHz transmitter. So you really add a lot of complexity to what was thought as a very simple device. I don’t want to see any transmission from the WUR.

Minyoung goes through the goals for January 2017.

* Decide Task Group leadership structure
* Decide TG specification development process
* Review TG timeline
* Review technical presentations

No comments or objections to the proposed goals.

Proposed to schedule a teleconference on December 12th, 6 pm EDT, 1 hour. No objections.

**Meeting is adjourned at 12.13 am.**