IEEE P802.11
Wireless LANs

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| Wake-Up Receiver (WUR) Study GroupMeeting Minutes for July 2016 MeetingSan Diego, USA |
| Date: 07-28-2016 |
| Author(s): |
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Abstract

Meeting Minutes for the three WUR SG sessions held in San Diego, USA, July 24-29, 2016.

**Tuesday, July 26, 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/16/11-16-0794-01-0wur-july-2016-agenda.ppt>

* Call meeting to order
* Introduction to WUR SG
* Call for submissions
* Review agenda and approval
* IEEE 802 and 802.11 IPR Policy and procedure
* Overview of 802.11 OM on leadership election
* SG leadership structure
* Presentations
* Recess

**Chair Minyoung Park (Intel) calls meeting to order.**

Leif Wilhelmsson (Ericsson) appointed to take notes.

Minyoung goes through 11-16/0794r1, which includes an introduction to the WUR SG as well as the submission received in response to the Call for submission.

The agenda is reviewed. The major part of the meeting time will be devoted to the presentations and it is proposed to take the ones directly related to the PAR and CSD on Tuesday and the remaining ones on Thursday. There are in total 11 submissions. The authors of the 11 submissions are asked about how much time they expect are needed for their contributions. Based on this it is decided that Minyoung will ask for an additional time-slot for the WUR SG.

Motion to approve the Agenda, document number 11-16/0794r2.

* + Moved: Yongho Seok
	+ Seconded: Yunsong Yang
	+ Motion passed by unanimous consent

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

An overview of the Operation Manual (OM) and the leadership election is provided. The proposed structure is

* Chair
* Vice-chair
* Secretary

The election will be made during Thursday PM2. No discussion or question regarding the proposed structure.

The received submissions for this meeting are:

**PAR related submissions:**

1. 11-16/974r0, WUR usage scenarios and applications, Shahrnaz Azizi (Intel Corp.)
2. 11-16/970r0, Input on WUR PAR scope, Steve Shellhammer (Qualcomm)
3. 11-16/935r0, A PAR proposal for Wake-up Radio (WUR), Osama Aboul-Magd (Huawei)
4. 11-16/859r0, WUR SG Proposed PAR, Minyoung Park (Intel Corp.)

**CSD related submissions:**

1. 11-16/936r0, A CSD proposal for Wake-up Radio (WUR), Osama AboulMagd (Huawei)

**Other submissions:**

1. 11-16/865r0, Performance investigation on wake-up receiver, Eunsung Park (LGE)
2. 11-16/927r0, Securing the WUR, Yunsong Yang (Huawei), 20 min
3. 11-16/931r0, Demand on roaming for WUR, Bo Sun (ZTE), 15 min – not on the server
4. 11-16/939r0, WUR-based Power Save Operations of AP, John Son (WILUS)
5. 11-16/950r0, Considerations on WUR design, Igor Kim (ETRI)
6. 11-16/968r0, Discussion of Duty-Cycled Wake-Up Receivers, Leif Wilhelmsson (Ericsson)
* **11-16/974r0, “WUR usage scenarios and applications”, Shahrnaz Azizi (Intel Corp.):**

Intention is to summarize the background to the WUR and discuss three different use cases:

* 1. Quick message/incoming call notification scenario
	2. Quick status query/report, configuration change scenario
	3. Quick emergency/critical event report scenario.

In Scenario 3, the WUR is in the mobile gateway, e.g. AP, rather than in the non-AP STA. Next step is to translate these requirements into PAR and CSD.

Question(Q): You emphasize that this can also be used in the AP?

Answer(A): Yes.

* **11-16/970r0, “Input on WUR PAR scope”, Steve Shellhammer (Qualcomm):**

Contribution points out that the receiver will not be specified, but rather what needs to be specified is a PHY that allows for a power efficient WUR. Suggests that the WUR should operate in the same band as the main receiver in order not to require another antenna. Proposes operation in 2.4 and 5 GHz band, which may be extended in the future. Proposes that the required range should be at least as good as the range for legacy 802.11 STAs and it should also support coexistence with legacy 802.11

Q: How do you expect to test the range?

A: Some kind of link budget analysis. Probably some simulations. We need to do some modeling without specifying the receiver.

Q: Can you expand on the statement about MAC frame carrying paging?

A: You need to be able to wake up a specific device, or a group of devices. This is what is meant with paging. The assumption was that the device was associated, but we don’t necessarily need this.

Q: Does the word “ultra” refer to something in addition to low power?

A: No. We basically thought the use of the word ultra was accurate in this context.

Q: Does the several hundred microwatts refer to when the WUR is ON or is it the average for a duty-cycled WUR?

 A: It refers to when it is fully on.

Q: Regarding frequency band. In case it is for wake-up 60 GHz, would the WUR use 2.4 or 5 GHz?

A: Yes, either of the two. It would probably be using 2.4.

Q: If we want to achieve low power and low delay, don’t we need to specify the delay in the PAR?

A: My personal opinion is that it is not needed in the PAR, but in the next step.

Q: I have a basic question, is it only for waking up?

A: Yes, it is a control plane radio and not a data plane radio.

Q: Is there a need for a protocol between the receivers?

A: Yes, in some way, if you have e.g. an address for the data receiver this may have to be translated to something useful for the WUR.

Q: Will that internal protocol be specified?

A: No, this is implementation specific.

Q: Regarding range, what does this refer to?

A: All the way to the MCS with the best range, determined by e.g. link budget.

Q: Why do we need better range, is similar not sufficient?

A: OK with similar.

Q: What are your thoughts with respect to security aspects?

A: An important aspect. However, whether we need to put it in the PAR is unclear.

* **11-16/935r0, “A PAR proposal for Wake-up Radio (WUR)”, Osama Aboul-Magd (Huawei):**

Osama goes through the three sections he considers being of specific interest, namely 5.2b, 5.5, and 8.1.

Q: I believe it would be good to also include something about balancing power and delay in Section 5.5.

A: I see your point, but I would prefer to have less words rather than more in the section, so I would prefer to leave this out for now.

Q: Are there any reference number you can easily put for the TBDs?

A: We need to discuss and agree on this.

Q: What do you mean by primary receiver? 802.11n, 802.11ac?

A: Whatever the primary receiver is.

Q: If the transmitter is collocated with the AP, the range seems not to be a big issue. Is this assumed or can the transmitter of the Wake-up signal be another device? The point is really that if it is stand-alone there are certain regulatory requirements that must be met, and if stand-alone this must be considered.

A: This is a thing we need to consider.

Q: About scope, can the WUS be in 2.4 and data in 5 GHz?

A: Yes, that is the intention.

Q: Why was it precluded to have e.g. sub 1GHz or TVWS for the wake-up signal?

A: We need to start somewhere, and we can see how things go and we can let it evolve. It may also be good to limit the scope because of the tight time-schedule. Maybe there are other protection mechanisms in these bands, and we want to limit the scope.

* **11-16/859r0, “WUR SG Proposed PAR”, Minyoung Park (Intel Corp.):**

Minyoung goes through 5.2b and 5.5, illustrating with some numerical examples for the possible improvements. Suggests < 6 GHz, so less restrictive regarding bands compared to earlier presentations

Q: Related to scope, I don’t like to call this modification of the PHY and MAC. Also, there are some numbers, and I would like to be careful with this as we don’t want these numbers to hunt us in the future.

A: OK, I basically agree with your comment.

Q: I don’t agree with the statement just made, I think we are doing modifications to PHY and MAC. I also like numbers as these actually help you determine whether you have reached the goal. I would stress that the power consumption must be for the same delay, otherwise there are a lot of power saving modes already available that will be hard to be compared against.

A: We need to have more discussion, and maybe it is about how you define things.

Q: What do you mean with several PHYs?

A: A copy paste thing, don’t worry about it.

Q: How can you define relative improvement as different companies have different numbers?

A: There has to be a reference to compare to.

Q: In 5b, if you have a WUR do you fulfill this, as it says transmit?

A The intention was to say that there is a transmitter and a receiver for the operation. The WUR does not need to have a transmitter.

Q: What will determine whether you can use a coin cell battery is the peak current. But this is not specified.

A: Agreed.

Q: Any particular power saving mode you have in mind for comparison?

A: It should probably be compared to some of the most popular ones actually used. We can also use the numbers from the standardization of 802.11ax.

* **11-16/936r0, “A CSD proposal for Wake-up Radio (WUR)”, Osama AboulMagd (Huawei)**

Osama quickly goes through the document, pointing out that many things are very easy to fill in by reusing text from other amendments e.g. 11ac or 11ax.

No questions

**Minyoung declares the group to be in recess at 3.25 pm.**

**Thursday, July 29, 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/16/11-16-0794-03-0wur-july-2016-agenda.ppt>

* Call meeting to order
* IEEE 802 and 802.11 IPR Policy and procedure
* Presentations
* Other submissions (#2-6) in slide 9 of this doc.
* Recess

**Chair Minyoung Park (Intel) calls meeting to order at 8:00am**

Leif Wilhelmsson (Ericsson) appointed to take notes.

Minyoung goes through 11-16/0794r3,

Slide 10 is commented, in particular today’s agenda and also that an additional time-slot has been added. All remaining presentations except one is targeted for the AM1 session.

Minyoung also explains that he has asked for a volunteer to compile the different PAR contributions and that Shahrnaz volunteered. A numbered of people have signed up for taking part of this activity and the result will be reviewed in PM2.

Motion to approve the Agenda, document number 11-16/0794r3.

* + Moved: Shahrnaz Azizi
	+ Seconded: Yongho Seok
	+ Motion passed by unanimous consent

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

The remaining presentations are:

**Other submissions:**

1. 11-16/865r0, Performance investigation on wake-up receiver, Eunsung Park (LGE)
2. 11-16/927r0, Securing the WUR, Yunsong Yang (Huawei), 20 min
3. 11-16/931r0, Demand on roaming for WUR, Bo Sun (ZTE), 15 min – not on the server
4. 11-16/939r0, WUR-based Power Save Operations of AP, John Son (WILUS)
5. 11-16/950r0, Considerations on WUR design, Igor Kim (ETRI)
6. 11-16/968r0, Discussion of Duty-Cycled Wake-Up Receivers, Leif Wilhelmsson (Ericsson)
* **11-16/927r0, Securing the WUR, Yunsong Yang (Huawei):** The contribution discusses “denial-of service” attacks. Malicious attacks would here be to wake up the WUR very often in order to drain the battery. Suggests the WUR SG considers countermeasures in the WUR design to deal with these kind of attacks. Shows that under repeated attacks it would be possible to cause a coin cell battery to last for less than a day.

Q: What do other radios do to counteract such attacks?

A: I am not aware of similar technologies

Q: You mentioned coin-cell, but 20 MHz OFDM does not work out of coin-cell.

A: Still relevant, even if the battery of course may last longer.

Q: These kind of attacks are also work for current systems, what is the difference?

A: A difference is that it is so easy to generate the wake-up signal so that the price is much less to attack and still the price for the attacked device is high.

Q: Can you use these solutions also for normal Wi-Fi?

A; We don’t want to open up for this, but limit to WUR.

Q: I believe we need to understand the problem better first, before jumping into solutions.

A: Agree, but that was also what we intended with this contribution.

Q: There are many details associated with the problem you describe.

A: Agree, but this would be the next step and the subject of a detailed analysis.

Q You proposed to use long address and more advanced verification, but I think this may cause an increased delay. I would like to see the trade-off

A: I agree there is a trade-off, which we need to address in going forward.

Q: One approach is to detect the DoS attack at higher layer.

A. This presentation was really about what can be done on lower layers.

Q: Do you think security should be mentioned in the PAR?

A: We think it can be mentioned that there may be these kind of attacks. We just want to make people aware.

Q: What is the plan to address this?

A: We need to keep this in mind when designing the wake-up address as well as the MAC.

Q: Hard to address. This is very important but I don’t know how to solve it.

A: Agree.

Q: How much extra burden is your proposed solution in terms of battery consumption? Can this ruin the very idea with the very low power consumption?

A: It should not significantly increase the power consumption that much.

Q: Security adds another dimension, in addition to power and delay.

A: Agree

* **11-16/931r0, Demand on roaming for WUR, Bo Sun (ZTE)** As the terminal with the WUR may move when in deep sleep, the suggestion is that also this should be considered. Use case where this is considered relevant are e.g. Storage (Goods in a large warehouse may be moved) and Freight-forwarding/express delivery (During transportation there is no need to report anything, but at transfer stations for management). Although roaming requires higher layer network management, it is believed this should be considered for the WUR as well to be prepared.

Q: If it does not hear the wake-up beacon for a long time it will be disconnected.

A: There are other ways and a lot of parameters to consider. We don’t discuss detailed solutions.

Q: With roaming you mean that APs have some relation?

A: Yes, we view roaming as a network functionality, but we need to have support in the design of the WUR to support this.

Q: I believe this is related to range of the main receiver.

A: It is more related to longer range. The move can be much longer than the range of the main receiver.

Q: Is it really roaming or is it discovery? If discovery, have you looked at 11ai?

A: Maybe roaming is not the proper term.

Q: You want to verify that you have a link? I think you want to measure the link.
A: No this is not about measuring a link.

Q: Today they use optical barcode readers for the shipping. So there is already a technology using zero power, so I kind of question this user scenario. What would be gained by this?

A: By using an active way instead, you don’t need to have a handheld machine but can essentially do it from the AP.

Q: I don’t see anything with the roaming problem as such related to the WUR.

A: Roaming may not be the proper term, so maybe it is more discovery.

Q: So then it just how to wake up a device?

A: Yes.

Q: I don’t think moving necessarily has to be considered. I think we should spend more time on discussing the problem and requirements before discussing solutions.

A: Agree. This presentation was to hear people’s comments rather than giving a solution.

Q: I believe discovery is a better word then roaming. There can be similar problems because you e.g. run out of battery and then it is not roaming.

A: Agree

* **11-16/939r0, WUR-based Power Save Operations of AP, John Son (WILUS):** Usually power save relates to the non-AP STA only. Also power save for the AP is getting important. One example is tethering with a mobile phone. Other reasons why this may be needed could bd regulations/incentive programs for energy efficient AP. We believe that scope of WUR should not be limited to only the case that the non-AP STA has WUR, but also when instead the AP has WUR or both AP and non-AP STA have WUR. This should be considered so that the scope allows for a flexible protocol design.

Q: Maybe the case with only WUR in AP should be considered as a sub-set of the third?

A: Yes, also note these are just scenarios for discussion.

* **11-16/950r0, Considerations on WUR design, Igor Kim (ETRI):** Discussion of trade-off between delay and power saving. Also discusses impacts of different range for main receiver and WUR, and it is stated that the optimal is when the ranges are the same. Also discusses coexistence with legacy. Suggests reuse of antenna is important. Propose to support group wake-up, both multi-cast and broadcast.

Q: What about user scenario where AP want to wake up non-AP STA to transmit. Can you give an example?

A: E.g. the AP collects some data from sensors and then first wakes them up for this.

* **11-16/968r0, Discussion of Duty-Cycled Wake-Up Receivers, Leif Wilhelmsson (Ericsson)** Discussion of different trade-offs present when using a duty-cycled WUR.

Q: Related to metric for optimizing the total power consumption, I think the power consumption for the transmitter should be given lower weight.

A: Agree.

Q: By introducing duty-cycled WUR, you also add some power consumption for the logics related to it. Can this actually consume so much power it does not pay off?

A: We don’t have any exact numbers but it should not be that bad.

Q: I don’t think you want to keep sending wake-up beacons like in the figure. Instead one would periodically send some wake-up beacons that the receiver could use to resynchronize to.

A: Agree. The trade-off is in a sense still there as it means extra transmissions are needed for the resynchronization.

Q: I don’t believe you want to acknowledge wake-up beacons as depicted in the figure. That is not along the lines 802.11 operates. Instead you would send a PS-poll.

A: Agree. But then effectively the PS-poll can be seen as an acknowledgement of the wake-up beacon.

Q: I don’t believe you want to add a transmitter to be able to send an ACK.

A: The ACK is sent be main transmitter, so no additional transmitter is added.

**Minyoung declare the group to be in recess at 10.00 am**

**Thursday, July 29, 2016, 4:00-6:00 pm**

**Meeting Agenda:**

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

<https://mentor.ieee.org/802.11/dcn/16/11-16-0794-04-0wur-july-2016-agenda.ppt>

* Call meeting to order
* IEEE 802 and 802.11 IPR Policy and procedure
* SG officer election
* Presentations
	+ Other submissions (#1) in slide 9 of this doc.
	+ Draft PAR document review
* SG timeline
* SG extension
* Goals for September 2016
* Teleconference call schedule
* Adjourn

**Chair Minyoung Park (Intel) calls meeting to order at 4:00 pm.**

Leif Wilhelmsson (Ericsson) appointed to take notes.

The chair remembers people about taking attendance.

Minyoung goes through 11-16/0794r4,

No objection to approve the agenda.

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

Before going into the election, Minyoung goes through Operation Manual.

The two vice-chair candidates, Mike Montemurro (Blackberry) and Yunsong Yang (Huawei), introduce themselves.

Election of the vice-chair:

* Mike: 9 votes
* Yunsong: 39 votes.

Yunsong elected to be the vice chair of the SG.

The chair appoints Leif Wilhelmsson (Ericsson) as secretary for the WUR SG. No objection from the audience to this appointment.

* **11-16/865r0, Performance investigation on wake-up receiver, Eunsung Park (LGE):** The contribution shows simulations of the packet error rate for a WUR when OOK is the modulation used. The parameters for the simulations are those proposed in an earlier presentation by Intel.

Q: You show that the performance is improved for non-coherent reception if fewer sub-carrier is used, can you try to explain why as it does not seem intuitively clear as the power is the same and a receiver would typically be based on an envelope detection.

A: We need to check this. I have got a similar comment already.

Q: You are using 9 symbols for the preamble overall 100 symbols, so the duration is 0.4ms?

A: Yes

Q: My question somewhat relates to the first one, because the results seems somewhat surprising. Is your noise bandwidth always 20 MHz?

A: Need to check

Presentation of the WUR SG Timeline (slide 29). No discussion, so the timeline is kept.

Will request the IEEE 802 LMSC to extend the IEEE 802.11Wake-up Study group

Moved: Jonathan Segev

Second: Yunsong Yang

Results: Y/N/A: 69/0/0

Goals for September 2016 meeting

* Develop PAR and CSD document
* Complete PAR and CSD document for WG approval
* Submit PAR and CSD

Teleconferences

* August 15, 2pm EDT, 1 hour
* August 29, 2pm EDT, 1 hour

Shihrnaz goes through the current version of the PAR, which is based on some of the presentations and some off-line discussion.

Q: About range, if we take 802.11ax as example does this exclude the extended mode or not?

A: Added “payload” so that it reads “…at least 20 MHz payload bandwidth”.

Q: I think including both 2.4 and 5 GHz in the scope section is a concern.

Q: WUR should mean wake-up radio, but in some places it is referred to as wake-up receiver.

A: OK. Changed to radio.

Q: Sleep mode is not defined.

A: Maybe change sleep to power-save. We keep this in mind going forward.

Agreed that the current version should be used for further development. Shahrnaz will upload a new revision and Minyoung will send out a call for comments.

**Meeting adjourned at 6:00 pm**