IEEE P802.11
Wireless LANs

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| Minutes of the 2024-11-12 meeting of the IEEE 802.11 Enhanced Light Communication Study Group |
| Date: 2024-11-12 |
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Abstract

This document contains the minutes of the November 2024 meeting of the IEEE 802.11 Enhanced Light Communication (ELC) Study Group.

Abbreviations:

Q: Question

A: Answer

C: Comment

Revision history:

R0: Minutes for first meeting slot

R1: Removed non-presenters names from the minutes.

R2: Adding minutes for the second meeting slot

R3: Minor typos corrected

**ELC Meeting slot# 1 November 12, 2024, AM1**

1. The IEEE 802.11 ELC SG meeting was called to order at by the Chair, Nikola Serafimovski (pureLiFi).
2. The Chair reviewed the IEEE-SA patent policy, logistics, and reminders, including meeting guidelines and attendance recording procedures.
3. No essential patents claimed.
4. All are reminded to record their attendance through the IMAT system and pay the registration fee.
5. The chair introduced the overall agenda in doc. 11-24/1675r1 for the meeting.
6. Nikola Serafimovski: The main agenda is to discuss PAR and CSD.
7. Nikola Serafimovski: We also have two submissions to discuss:
* Low power Enhanced-Range PHY Mode for ELC (doc. 11-24/1926r1)
* Underwater Interoperability and Backwards Compatibility (doc. 11.1928r0)
1. **Motion to accept the agenda in 11-24/1675r1.**

**Approved with unanimous consent.**

1. Nikola Serafimovski: The Scope in the PAR has not changed from the last meeting, and it’s up for discussion.
2. Nikola Serafimovski: The “Need of the project” has been updated. Asked for comments/questions.

C: Matthias Wendt: reasonable changes and updates.

1. Nikola Serafimovski: Updated Section 8.1 Additional Explanatory Notes to include safety of Laser products.
2. Nikola Serafimovski: Proposed a motion to move PAR.

Q: Can we do this at the end after we discuss the other items on the agenda?

A: Yes.

1. Nikola Serafimovski: Presented and read the CSD with updates from previous meeting shown in ‘track changes’ mode.

C: PAR 1599r3: The title 2.1. is incorrect. It must include ELC (and not IMMW).

A: We’ll get back to that in a minute after we discuss CSD.

C: It would be better to quote something more recent than the 85% of indoor data traffic cited from the older Nature paper.

A: Opened a Cisco report shared by Volker to find an updated/ more recent figure: <https://www.cisco.com/c/dam/global/en_ca/solutions/enterprise-networks/xa-09-2023-networking-report.pdf>

A: Unless there is a strong objection, Nikola suggests that we keep it.

1. Nikola Serafimovski: Will move to Motion later after we discuss other items on the agenda.
2. Stefan Videv (Kyocera SLD Laser): Presented Underwater Interoperability and Backwards Compatibility (doc. 11.1928r0)
	* Discussed the attenuation of optical channels in underwater environments based on Jerlov scale.
	* Discussed the interoperability of working across different wavelength bands by using single transmit wavelength and broadband detectors with broad filters.
	* Backward compatibility implies that two emitters would be needed.
	* Backward compatibility does not offer any advantage in underwater environments, unless they are a must from the backword compatibility of the standard.

C: The challenge is that you can’t specify the use-case / intent within the standard.

C: You could make a distinction between environments. Not sure if this is a problem from the standard point of view. Certification would come at a later stage, and classes can be introduced.

C: Cost is also a factor as backward compatibility requires additional optoelectronics.

A: Added complexity is high, cost of added optoelectronics is not high. Size constraints could be an issue.

Q: One of the main compelling factors of the success of Wi-Fi is backward compatibility. The biggest challenge: There is no mechanism that bounds the operation/performance of the system to the environment.

A: I don’t oppose the backward compatibility. There could be technical questions that we can implement, and your argument is a strong one. Just wanted to discuss this issue in relevance to underwater communications.

1. Volker Jungnickel (Fraunhofer HHI) presented Low power Enhanced-Range PHY Mode for ELC (doc. 11-24/1926r1)
	* presented On-Off-Keying with Frequency Diman Equalization (FDE) and discussed higher reliability.
	* OOK allows more drive current to the emitter compared to OFDM due to OFDM’s high PAPR. OOK is promising to reduce power and increase range.
	* FET transistors consume high power which is not desired in mobile phone applications.
	* OOK suffers from the high pass of the OFE response. High pass does not allow constant signals. Line coding could help reduce long runs to reduce the effect of high-pass filtration.
	* FDE can be used to reduce the effects of baseline wander.
	* Functions need to be defined an implemented in new chipsets, but changes are not major as they only avoid few OFDM related functions, and IFFT needs to be shifted to the receiver side.
	* Requires some efforts, but it is reasonable efforts.

Q: What is the input data?

A: It’s coded data coming out of the FEC. Need to create bypass around some of the functions.

Q: Do you need to define additional preambles.?

A: We’ll use the same structure of the OFDM.
C: There might be some synergies with MM waves.

A: Only difference is that we have only I, and they have I&Q.

C: Suggest speaking to MM Wave group to check synergies. You could keep the Silicon the same, but you could switch the data through different paths.

C: No doubt about the technical variability. However, this could affect willingness to adopt.

A: We built this 15 years ago for LTE.

Q: Is there a comparison for the energy per bit under the same spectral efficiency and bandwidth?

A: There are already some studies available, but I agree that not everything has been done. The question is how to compare energy per bit (Electrical or optical). The comparison is assuming the same bandwidth.

Q: If this has been implemented in another standard (802.15.13), what is the motivation to implement it here.

A: The main difference is in the MAC. The discussion here is how can we use this in the same PHY.

C: It’s not the same PHY. It is a new PHY.

A: It’s a flexible PHY. 95% processing is the same.

Q: The waveform is not 95% similar. It’s different.

Q: If we need to compare OFDM with this method under same throughput at higher data rates, we’ll have to compare high order QAM with OOK with wider bandwidth?

A: In this example, I agree. However, the comparison is not fair as we need to compare for the same spectral efficiency.

C: The discussion is too detailed. The proposal is to discuss this topic as a proposal for the TG, and I am supporting that.

C: Suggest inviting contributions on this topic from Volker and Mohamed.

1. Motion to accept the ELC SG PAR in 11-24/1599r3. Approved but had to repeat again with Motion to accept after detecting a typo with IMMW needs to be changed to ELC 1599r4.
2. **Motion to accept the ELC SG PAR in 11-24/1599r4.**

**Mover: Volker Jungnickel**

**Seconded: Stefan Videv**

**Approved**

**Yes: 9**

**No: 0**

**Abstain: 0**

**Approved**

1. **Motion to accept the ELC SG CSD in 11-24/1600r2.**

**Mover: Stefan Videv**

**Seconded: Volker Jungnickel**

**Approved**

**Yes: 9**

**No: 0**

**Abstain: 0**

**Approved**

1. C: It doesn’t help to get the PAR and CSD approved in a plenary session as not a lot can be done in the January meeting. I’ll include the PAR in the NescCom and LMSC agendas. TG could potentially be in May.
2. Nikola Serafimovski: Let’s use the session on Thursday to get feedback from additional people from the wider working group and then decide whether we should plan for WG approval in January 2025.
3. At 09:55, the Chair declares the SG’s meeting adjourned.

**ELC Meeting slot# 2 November 14, 2024, AM2**

1. The IEEE 802.11 ELC SG meeting was called to order at by the Chair, Nikola Serafimovski (pureLiFi).
2. The Chair reviewed the IEEE-SA patent policy, logistics, and reminders, including meeting guidelines and attendance recording procedures.
3. No essential patents claimed.
4. All are reminded to record their attendance through the IMAT system and pay the registration fee.
5. The chair introduced the overall agenda in doc. 11-24/1675r2 for the meeting.
6. Nikola Serafimovski: We have new addition to the agenda:
	* ELC support for positioning (doc. 11-24/1956r0)
7. **Motion to accept the agenda in 11-24/1675r1.**

**Approved with unanimous consent.**

1. Volker Jungnickel presented ELC support for positioning (doc. 11-24/1956r0)
* Highlighted potential for positioning using ELC, including motivations and use-cases.
* One technique is focused on using time of flight (ToF). Signal is based on G.hn, but overall, it’s similar in structure to 802.11 OFDM based signalling.
* Presented results on accuracy depending on bandwidth and angle of Tx/Rx to line of sight (LoS). Root mean squared (RMS) of the error is in the few cm range.
* Tried out in industrial environments. Challenges on the real-time implementation and angle of Tx/Rx to LoS. However, systematic error correction can be applied through calibration measurements. This reduced errors from 12 cm to 3 cm in this environment/setup.
* High potential to industrial IoT.

Q: Slide 4, Rician fading model assumed. Timing based on the detection seems to show correlation between T\_C and T\_F. Why is there a variance?

A: Coarse timing is based on Autocorrelation function (ACF) showing a plateau which is not precise and depends on SNR, when you take another measurement at another timing position. When you look on the channel estimation response, there is no correction for the time-base.

Q: Is that just a problem due to the ACF?

A: It’s just the construction of the sequence defined in the standard.

Q: What are the fundamentals you’d need to do to get the positioning information.

A: Once you read measurements from modem, it’s just an implementation of the algorithm. We tried out with G.hn chipset, and we are trying to understand the results. An algorithm named MUSIC might depends on the front end (results are not yet ready).

Q: Many implementations don’t use MUSIC. Many of them are using the impulse response. Multiple techniques can be used to detect the peak. In RF, we have multipath that might affect precision. Curios to find the barrier.

A: Barrier is changing the algorithm on the chipset.

C: We can find and link you with vendors to share details about the algorithms that are being used in order to remove that as an uncertainty.

C: Y-intercept can never be zero due to delay of processing in chipsets. Bias can be at 0.5 m at 80 MHz. But in practice, it doesn’t matter too much as you solve for the bias using 4 APs.

Chair: What is required from ELC to enable fine time measurements. Is it a change of the algorithm from the chipset vendors?

C: The standard doesn’t specify anything related to this. Time for arrival and time of departure can be obtained. Appendix in AZ can be used to figure out what the slope is and figure out the distance. If you don’t have a multipath environment, the MUSIC algorithm can fail.

Chair: Do you think that by having different channelization mapping in order to differentiate between RF and LC, we can improve how this algorithm could work? Would that be sufficient in order to use this appendix for time fine measurement in order to make this positioning possible in ELC?

C: We are missing the information on why it is not working reliably. We need more data.

Chair: I’m trying to avoid massive changes to the PHY but trying to understand what changes would be needed to implement such features.

C: There could be some work that we can implement in order to enable this fine timing measurements by inserting additional information on the nature of the channel (RF/LC).

C: It doesn’t have to be in the preamble, it can even be in the payload.

1. The Chair started taking comments on the PAR.
	* C: Abbreviations should be avoided in the title 2.1.
	* C: Is there a timeline on this? Scope seems very broad. Maybe narrowing the focus to specific terminology.
	* Chair: We expanded the scope a little bit in points 6) and 7). I agree with this, but if the members are willing to contribute, that should be fine. Adding certain terminology would help narrowing the scope down.
	* C: It might be possible that we might need to introduce changes to existing PHYs. I would not limit it to only: reusing of existing IEEE 802.11 PHYs.
	* C: We need to have a narrowed down focus so that it does not take years to reach to the end.
	* C: Can we open the PAR from the millimetre waves as they have a relevant accepted PAR that we could use as an example? They use the word ‘leverages or reuses’
	* C: This is not an engineering language, I prefer the wording of Minor changes, as it is easier to agree on what could be minor or major. The word leverages do not hold any meaningful language.
	* C: The goal is not to create a completely new PHY, but to leverage and reuse as much as possible of the existing PHY. Point 7) might require substantial changes.
	* Multiple comments made to tighten down the PAR.
	* C: The list of 1) to 7) provides focus.
	* C: Advocate that the words ‘reuse and minor’ to be removed. There is better articulation by saying: This amendment introduces a new PHY by modifying this list.
	* C: There is still likely a lot of interpretations and work that could stem from point 7).
	* C: An input was proposed on point No. 7). It’s well-known technique that requires minor modifications. I would like to also narrow it down as there could be many techniques for PAPR reductions.
	* C: Suggestion around the PAR Scope wording structure and moving the MAC sentence to the paragraph below PHY.
	* C: Need to change wording on the MAC and move the MLO support to the MAC statement.
	* C: There are conflicting opinions on item No. 7, which is now No. 6 (PAPR reduction methods).
	* C: PAR cannot solve every problem that could come up later.
	* C: The WG need to decide if we keep item No. 6 (PAPR reduction methods) as its state-of-the-art minor modification to PHY.
	* C: The group could still consider this till January if it is good enough, or if there is a pressing need to keep it.
	* C: The motivation of ELC is to widen the market. Reduction PAPR reduces power and increases distance.
	* C: These motivations about power consumption and higher range needs to be added to the 5.5 under Need for the Project.
2. **Motion to accept the ELC SG PAR in 11-24/1599r5.**

**Mover: Volker Jungnickel**

**Seconded: Harry Bims**

**Approved**

**Yes: 11**

**No: 0**

**Abstain: 1**

**Approved**

1. Chair: Need to use sessions to finalize the PAR and get help from NesCom to finalize the CSD document.
2. At 12:27, the Chair declares the SG’s meeting adjourned.