IEEE P802.11
Wireless LANs

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| IEEE 802.11 TGbb Task Group on Light Communications July, 2018 San Diego Meeting Minutes |
| Date: 2018-07-12 |
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Abstract

This document contains the Task Group on Light Communications (TGbb) meeting minutes from the IEEE 802.11 San Diego meeting, July 2017.

**IEEE 802.11 Task Group TGbb**

**Monday, July 9, 2018, AM1 Session**

Attendance: around 25 people

1. The IEEE 802.11 TGbb meeting was called to order at by the Chair, Nikola Serafimovski (pureLiFi).

He explained this is similar to an ad-hoc, i.e. no motions can be made. Since officers were neither approved nor selected, the officers from the study group will run this meeting, i.e. John Li Quiang (Huawei) acted as Vice Chair.

1. The Chair Nikola Serafimovski (pureLiFi) reviewed the IEEE-SA patent policy, logistics, and reminders, including meeting guidelines and attendance recording procedures.
	* It is reminded all to record their attendance.
2. The Chair Nikola Serafimovski (pureLiFi) introduced the schedule for the meeting
	* Discuss the suitability of TG/SG results
		+ Usage model document doc. 11-18-1109/r0
		+ Specification Framework document doc. 11-18-1110/r0
		+ Reference channel modelling document for indoor environments doc. 11-18-1236/r0
3. Oliver Luo (Huawei) presented doc. 18/1109/r0 on the Usage Models for LC.
	* Industrial wireless
		+ Robustness to interferences is important
	* Wireless access in medical environments
		+ Use case has been revised
	* Enterprise network
		+ High-speed
	* Secure home network
		+ RF can be hacked, LC is good for users which have concerns of security
	* Backhaul network
		+ Light should be infrared
	* Q: Backaul should be included?
	* A: Yes.
	* C: Let us look again to the table on slide 9.
	* Q: Mobility aspects should be included in the KPI list.
	* A: Chair agrees that handover needs to be discussed. Rapid mobility is included in the industrial use case. What additional KPI should be added?
	* C: Key metrics have been derived from usage models. If the group requires more should be added.
	* Q: Mobility is a requirement, handover is a solution. Channel is highly dynamic due to the channel. Handover is to mitigate the latency and loss of packets. The parameters like latency will possibly not be met if high mobility is required.
	* A: How should the table be changed? Someone should come with a technical proposal.
	* Q: Range could be added and speed.
	* A: 5 use cases only involve very low-speed and low mobility so far.
	* Q: What about the missing lux number for IR used in the backhaul.
	* C: Lux may not be the appropriate measure in general. In the IR it may be counts per seconds.
	* A: Signal strength should be measured in Watts/sr or Candela which is more appropriate than lux.
	* C: Parameters in the list should be high-level and must not contain everything that can be contained in the rest of the document.
4. Oliver Luo (Huawei) presented doc. 11-18/1110/r0 on the Functional Requirements for LC.
	* Mainly compiled from PAR and CSD
	* System requirements
		+ Throughput 10 Mb/s to 5 Gb/s on a single link
		+ Security maintained through movement between lights, as well as the security implications for fast session transfers
		+ Optical safety should be given
		+ Supporting wavelength bands 380 nm to 5.000 nm
		+ Coexistence with other systems operating in the same wavelength bands including 802.15.13
		+ Interoperability between Solid State Light Sources with different modulation bandwidth
	* C: Security should cover the use of different PHYs. 11bb should cover similar security mechanisms as between the existing 802.11 PHYs.
	* C: Besides optical safety there should be health safety
	* A: If made available it will be included here.
	* Q: Where the coexistence with 802.15.13 comes from.
	* C: Could be replaced by “other light communication systems”
	* C: change wording from “support mechanisms for coexistence” to ”show that coexistence is possible”
	* Q: Where the 10 MB/s lower bound comes from.
	* A: Comes from the PAR and cannot be changed at this point in time.
	* C: Was chosen so that the scope of the project remains limited and the project can be completed in a reasonable timeframe. E.g., 10 Mbit/s excludes optical camera communications (OCC).
	* Q: Does it include ultraviolet?
	* A: Regulators stopped this to the lower end, the higher limit is the end of the visible range.
	* Q: Coexistence and Interoperability with other systems like RF.
	* A: Coexistence with RF is not problematic. Coexistence is usually a PHY issue. Interoperability includes systems in the same frequency range.
	* A: Everything which is out of scope of the PAR should not be included in the work of TGbb as it is not authorized.
	* C: One should also look up doc. 0948/r0 which was presented during the last meeting.

Oliver will upload revised versions of both documents including the changes made during the session.

1. Tuncer Baykas (Istanbul Medipol University) presented doc. 11-18/1236/r0 on the Reference Channel Models for Indoor Environments.
	* Empty room, office, home, manufacturing cell
	* Methodology is based on raytracing using Zemax
	* Delivers the Channel Impulse Responses (CIRs)
	* Similar approach was followed already in IEEE 802.15.7r1, references are in the slides
	* Performance evaluation in 802.15.13 is based on the same approach
	* New is including the LED response
	* Two LED models can be changed according to the needs of the group
	* Literature cut-off frequencies are below 20 MHz
	* Empty room is described, regular grid of LED lights 🡪 rather homogeneous illumination
	* Test points of receivers in 100 cells of 60x60 cm²
	* Seven possible locations were selected
	* One channel has only NLOS response, has 20 dB less power but considerable multi-path due to specular and diffuse reflections
	* Sample channel impulse responses will be made available for performance evaluation
	* Some channels show very frequency-selective characteristics is available for all locations
	* Cumulative distribution for path loss ranges from 49-56 dB
	* Same for open office, four columns of light, test points at the ear with a mobile device and on the desktop
	* Channel responses are flat in many cases
	* Include the effects of the LED as well, rms DS of several 10 ns
	* Office with secondary light acting as a relay
	* Channel characteristics are almost flat mainly determined by the LED
	* Home scenario
	* Channel impulse responses also determined by the LED and otherwise flat.
	* Manufacturing scenario, 6 Tx looking at all directions, 8 Rx at the walls
	* Optical channel responses for all LEDs driven together or driven individually
	* Q: Which model to use for which usage model?
	* A: Industrial wireless: manufacturing cell
	* A: Wireless access in medical environments: could be replaced by one indoor model for now
	* A: Enterprise network: indoor model
	* A: Secure home network: indoor model
	* A: Backhaul network: Still open
	* Q: Indoor scenarios will be using phosphor LEDs?
	* A: Yes.
	* Q: CIRs should be made available from individual light points to individual receivers
	* A: Yes this is possible upon request.
	* Q: What will be made available.
	* A: Group may want to select a few scenarios according to the usage models.
	* Q: CIRs are often very flat. Effective CIRs are not that flat due to the LED.
	* Q: Separate optical channel impulse response and impact of the LED.
	* A: This is easily possible.
	* Q: Have one scenario with wide beams overlapping more and another scenario using narrower beams with less overlap.
	* A: The group can decide on specific scenarios and the channels can be modelled accordingly.
	* C: Four different requirements for different usage models.
	* C: Effort should be limited to match the true needs of TGbb for performance evaluation.
	* C: Agree on the principle methodology and select the models needed.

Ad-hoc meeting was adjourned until PM2 on Tuesday July 10.

**Tuesday, July 10, 2018, PM2 Session**

Attendance: around 45 people

1. The IEEE 802.11 TGbb meeting was called to order at by the Chair, Nikola Serafimovski (pureLiFi).
2. The Chair Nikola Serafimovski (pureLiFi) reviewed the IEEE-SA patent policy, logistics, and reminders, including meeting guidelines and attendance recording procedures.
	* It is reminded all to record their attendance.
3. The Chair Nikola Serafimovski (pureLiFi) introduced the schedule for the meeting
	* Approve the agenda doc. 11-18/1063r1 with unanimous consent.
	* Approved the minutes from May 2018 in doc. 11-18/0910r2 with unanimous consent.
	* Officer votings
	* Technical presentations on channel models
4. Officer votings
	* There were three nominations for the two vice chair positions initially.
	* One of them was withdrawn by the candidate himself before the process started.
	* First candidate is Tuncer Baykas (Mediopol University Istanbul)
	* Second candidate is Pengfei Luo (Oliver) (Huawei)
	* After introducing themselves, the candidates were asked to leave the room.
	* The proposed candidates were accepted by unanimous consent.
	* There were two nominations for the Technical Editor
	* First candidate is Volker Jungnickel (Fraunhofer HHI)
	* Second candidate is Gaurav Patwardhan (Hewlett Packard)
	* Q: Why two Technical Editors?
	* A: The two have deep expertise, which is complementary. Volker has long-term experience in the optical wireless PHY and Gaurav is very experienced on the 802.11 MAC. The group can proceed faster by having experts in the two main objectives of the PAR acting as Technical Editors.
	* Q: Who of the two delivers the draft? Someone should have the lead.
	* A: They will do this based on unanimous consent. If not consent is possible, the Chair will aid to find consensus.
	* After introducing themselves, the candidates were asked to leave the room.
	* The candidates were accepted by unanimous consent.

1. Tuncer (Medipol University Istanbul) presented doc. 11-18/1109r2 on usage models
	* Proposal is to split between primary and secondary channel models
	* Primary is industrial wireless, medical environments, enterprise networks
	* Secondary are Underwater
	* Discussion about Backhaul to be secondary
	* C: Naming should be revised, not primary and secondary but indoor/outdoor or
	* Q: Key metrics are defined only for five models, why not for the others
	* A: Mass market applications are in the primary focus, because of that the task group was created. IEEE 802.11ay main application is backhaul. 90% of wireless applications are expected indoor.
	* There will be a revision of the document 11-18/1109r3 reflecting the outcomes of the discussion which will be discussed on Wednesday.
2. Tuncer Baykas presented several contributions on the channel model document.
* First model is indoor models is 11-18/1236r1
	+ Was presented in last meeting already, and is shortly reviewed.
	+ Major objective now is to define the models that will be prepared for SFD.
	+ Q: What about ambient light
	+ A: Sunlight is DC, but shot noise will be there. But this is approximately AWG and can be included by scaling the SNR.
	+ Q: Light sources are used for communication, which is not primary design focus. Should other light sources be considered
	+ A: The group hopes to get the best models which can be used.
	+ Q: Flickering includes low frequencies.
	+ A: Should be considered in the communication system design.
	+ Q: There might be more overlap between adjacent lights.
	+ A: Could be considered.
	+ Q: Can intense sunlight drive the receiver into saturation.
	+ A: This in fact a problem. That is one of the reasons why primary usage models are indoor.
	+ C: Non-linear aspects should be included already in the SFD as this was the case in 11n.
	+ Second model is vehicular communications in doc. 11-18/1237r1.
		- * New thing is including the weather conditions.
			* Rain and fog models are included, mainly cause attenuation.
			* Effect of multipath is visible in foggy weather model
			* C: Same generic model can be used like for backhaul. The main two parameters are visibility range and distance.
			* C: The power for the headlights should be much higher.
			* Q: Should the position of the photodiode be included.
			* C: Detectors will be placed in the rear lamps. Requirements are different depending on the country.
			* Q: Is it possible to model continuous channel variation?
			* A: No it is snapshot based. Interpolation is possible if channel is sampled frequent enough.
	+ Third model is gas pipeline in doc. 11-18/1239r1.
		- * Channel is dependent of the gas in the pipeline, very much wavelength dependent around 620 nm there is an absorption peak.
			* CIR is quite similar to single-tap channel, blue and white LEDs have lower path loss.
			* Almost same distance dependence of all media.
			* Q: Choosing the right LED is important, what about IR?
			* A: Should be considered in the future.
	+ Fourth model is underwater communications in doc. 11-18/1238r1
		- * Main effects are scattering and objects in the water
			* CIR is mainly a single tap (LOS) attenuated by the scattering dependent on distance.
			* C: The current channel model just includes the pure water, some more scattering should be included.
1. The agenda was updated, timeline discussion is shifted to Wednesday, July 11 AM1.

The meeting recessed.

**Wednesday, July 11, 2018, AM1 Session**

Attendance: around 30 people

1. TG chair called the meeting to order at 8:00 AM.
2. Nikola Seramovski read the IEEE 802 Participation slides.
3. Nikola Seramovski reviewed agenda 802.11-18/1063r1.
4. Nikola Seramovski presented 802.11-18/0908r2]

Strawpoll

Should the above timeline be accepted as an initial timeline for the Light Communications Task Group at the first 11bb TG meeting in July 2018.

Yes 17, No 0, Abstain 1

* + C: If a timeline motion will be created a separate document would be better.
1. Oliver Pengfei Luo (Huawei) presented 802.11-18/1109r3
	* C: Include Use Case names in Key Considerations.
	* C: The mobility values should be higher for industrial channel model.
	* Q: Asked for specific values.
	* A: Does not have those values at the moment.
	* Q: It is suggested to remove secondary use cases.
	* A: It is good to have secondary use cases as information
2. Nikola Seramovski presented the new time line document 802.11-17/1290r1
3. Motion

Should the above timeline be accepted as an initial timeline for the Light Communications Task Group?

Moved by Tuncer Baykas

Seconded by Volker Jungnickel

Yes 9

No 0

Abstain 0

Motion Passed

1. Oliver Pengfei Luo presented Use Case document 802.11-18/1109r4
	* The range for the indoor communication systems is discussed.
	* C: 50m could be added as the range.
	* C: It is beyond the indoor use cases.
	* C: 50m range is similar to backhaul applications.
	* No change is made in the key parameters
	* Group discussed if the signal strength should be included in the key parameters.
	* C: It is necessary for link budget calculation.
	* C: Wavelength could be necessary.
	* C: Signal strength is necessary from communication point of views and lux values are necessary for the illumination.
	* C: Keep signal strength.
2. Strawpoll

Should the Signal strength (lux) column in doc. 11-18/1109r4 remain as a Key consideration?

Discussion:

Suggested to changed the column to transmitted power. If not removed the name could be changed.

Yes: 0

No: 16

Abstain 8

1. Suggested to add a Reliabity column should be added. What is the definition. It is percentage of succesful transmissions.
2. Strawpoll

Should a Reliability column indicated by Packet Error rate at the MAC SAP, be added in doc. 11-18/1109r4 remain as a Key consideration?

Yes: 12

No: 1

Abstain 7

23. A. Asked for a strawpoll to add transmitted optical power.

C: Wavelength should be added.

C: Against adding the column.

C: It is suggested that the measurement should be done in W/m2/nm.

C: Suggested to change the name of the column Transmitted Spectrum Power Density?

1. Strawpoll

Should a “Transmitted Spectrum Power Density” column measured W in doc. 11-18/1109r4 remain as a Key consideration measured W/m2/nm ?

Yes: 3

No: 9

Abstain: 7

1. Oliver Pengfei Luo (Huawei) presented Use Case document 802.11-18/1109r4 with changes.

Group discussed about the reliability values. Suggested to continue discussion tomorrow.

The WG recessed at 10:00 AM.

**Thursday, July 9, 2018, AM1 Session**

Attendance: around 25 people

1. The IEEE 802.11 TGbb meeting was called to order at by the Chair, Nikola Serafimovski (pureLiFi).
2. The Chair Nikola Serafimovski (pureLiFi) reviewed the IEEE-SA patent policy, logistics, and reminders, including meeting guidelines and attendance recording procedures.
	* It is reminded all to record their attendance.
3. The Chair Nikola Serafimovski (pureLiFi) introduced the schedule for the meeting.
4. Oliver Luo (Huawei) presented doc. 18/1109/r0 on the Usage Models for LC.
	* A table was added showing requirements of major use cases regarding data rates, reliability etc.
	* There was a discussion in the room regarding the latency value being above 3-5 ms. This will be enough for most existing applications. But the technology competes with others and have a lower value here would bring LC into a better shape as candidate to be introduced besides RF.
5. The Chair run a straw poll if the latency measured using RFC 2544 test (pure physical layer w/o channel access) should be below 1 ms. The result was 10/0/7. The values were changed in all columns.
6. Tuncer run a motion

Accept “lc usage-model document” (doc. 11-18/1109r5) as the official Usage Model Document for TGbb.

Moved by Tuncer Baykas, Seconded by Oliver Pengfei Luo

Y/N/A: 6/0/1 Motion passed.

1. Oliver Pengfei Luo presented the revised TGbb Functional Requirements Model including a variety of comments from the discussion at the last meeting. It includes new references about eye and health safety, the statement that equivalent security level as compared to existing 802.11 PHYs. The group went once again over the entire document to see all the changes made. Few changes were made. Coexistence was limited to LC standards defined by IEEE 802. The final version was uploaded as a new document doc. 11-18/1309r0 was uploaded.
2. Motion

Accept “802.11bb Functional Requirements” (doc. 11-18/1XXXr0) a the official Functional Requirements document for TGbb.

Moved: Gaurav Patwardhan Seconded: Volker Jungnickel

Y/N/A: 7/0/0 Motion passed.

1. Discussion of teleconferences should be starting at 30 July and then weeky. The best times were discussed. 9 A.M. EDT was found as the best time. The agreed time slots are

9:00 AMEDT for 1 h on 31 July

9:00 AMEDT for 1 h on 7 Aug.

9:00 AMEDT for 1 h on 14 Aug.

9:00 AMEDT for 1 h on 21 Aug.

9:00 AMEDT for 1 h on 28 Aug.

The attendees will be invited via join.me. Go to 802.11 Meeting planner. Details how to join can be found [www.ieee802.org/11/joinme.htm](http://www.ieee802.org/11/joinme.htm).

1. Tuncer Baykas (Mediopol University Istanbul) reviewed. All should be provided as individual CIRs between each light and each receiver. Combined transmission can be obtained therefrom. The information on the spectrum should be added to the used transmitter. Worst-case models should be considered likewise. The channel models that are requested by the group were discussed. Sun interference should be added to one of the models
	* Industry: as is
	* Hospital: Operation Theater is preferred, but no new model will be created
	* Enterprise network: LC Meeting room: One model with isolated lights and one model with overlapping light beams
	* Secure home network: Use the existing models
	* C: Laser diode as a reference transmitter for transmission. Avalanche photodiode at the receiver.
	* C: Transmitter and receiver properties should be included in the impairment model i.e. outside of the propagation model.
	* C: This would allow enough diversity of Tx/Rx and in the channel for the purpose of performance evaluation.
	* C: For the Enterprise network, the rationale behind using two narrow and wide beams is to create more or less interference and study the performance in those cases.
2. The meeting adjourned until September in Kona.