**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **TG4q ULP November 2013 Meeting Minutes** |
| Date Submitted | 23 November 2013 |
| Source | [Jinesh Nair] [Samsung.] | E-mail:[jinesh.p@samsung.com] |
| Re: | Ultra Low Power amendment to IEEE 802.15.4 |
| Abstract | TG4q ULP Meeting minutes  |
| Purpose | Meeting minutes |
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**Task Group ULP Meeting Tuesday, 12 November 2013 AM1 session:**

**AM1 session:**

1. Chair (Shahriar Emami) called session to order at 08:10 am.

2. Opening report (DCN: 15-13-0634-01-004q) for ULP presented by Chair

3. March meeting minutes (DCN: 15-13-0618-01-004q) is approved

4. ULP Agenda (DCN: 15-13-0633-01-004q) presented by the Chair

Motion to approve the meeting minutes and agenda passed anonymously

Moved by: Guido Dolmans (IMEC-Holst Centre)

Seconded by: Frederik (FAU/IIS)

5. The Chair called the presenter Weidong Gao (Potevio) for the presentation “Transmission power control for ULP”. However, the presenter was absent.

6. Meeting was recessed at 09:00 am.

**Task Group ULP Meeting Wednesday, 13 November 2013 AM1 session:**

1. Chair (Shahriar Emami) called session to order at 08:10 am.

**2. Frederik Beer presented the presented the proposal titled “MSK with FEC PHY proposal” (DCN: 15-13-0702-00-004q)**

*Jinesh:* What is the reason for the preference of MSK over FSK as implementation of MSK transmitter is higher than FSK

*Beer:* To exploit the gains provided by MSK by using a more complex receiver and marginal increase in complexity at the transmitter.

*Jinesh:* True gains will be visible only once the synchronization performance is incorporated. Will the proposed 2 repetitions of the “01010101” be good enough to actually get the benefit of FEC which shows good BER at around 3 dB Eb/No. The preamble may not be energy efficient.

*Beer:* A good trade-off between energy efficient preamble and ultra-low power consumption by reducing the transmitter on-times using FEC has been considered.

*Kiran:* Please publish your synchronization results. The performance gains with FEC and pre-coded MSK and no FEC and no pre-coding seem too optimistic. Please elaborate on the pre-coded MSK and how it differs in performance when compared to coherent and non-coherent FSK. Please provide a reference for pre-coded MSK. What is the difference in performance between coherent MSK performance and pre-coded MSK performance? Please provide references for pre-coded MSK.

*Beer:* Some detailed explanation was given. Also the references were provided for pre-coded MSK (Bernard Sklar). It was agreed to provide the updates requested.

*Jinesh:* The optimal data rates in the proposal based on rate1/2 FEC is in excess of 3 Mbps for the data rates considered. This may not be achievable in any case in view of the signal bandwidths typically being a max. of 2 MHz. A lighter FEC may be good enough.

*Beer:* The impact of a ULP physical layer on the retransmissions needs to be considered. Reducing retransmissions is preferable.

*Kiran:* Instead of proposing different SFDs to detect the MSK pre-coding and “K” in the FEC code, how about providing a couple of bits in the preamble header to detect the pre-coding and FEC code and using a single SFD?

*Beer:* That is an alternative way of doing it but this is our recommendation

*Jinesh:* Please provide reference for the power consumption values revealed in slide 14.

*Beer:* TI CC1101

*Young-Jun Hong:* Impact of AGC settling time on the preamble design should be considered. Also, clarifications on the issue of variable packet sizes with rate have convolution codes were asked.

*Guido:* Why is the advantage of OOK/PPM, that is, reduced power consumption when communicating a 0 shown as a disadvantage?

*Beer:* As long as there is non-negligible power consumption while transmitting a “0” it is seen as a disadvantage.

*Kiran:* The claim is not at all clear as the power consumption associated with FSK receiver is also the same or more.

*Henk:* How does the proposal compare with that of 15.4g? What are the similarities and differences?

*Steve and Rick:* Questions on the MAC aspects were asked.

3. Meeting was recessed at 10.00 am

**Task Group ULP Meeting Wednesday, 13 November 2013 PM1 session:**

1. Chair (Shahriar Emami) called session to order at 1:40 pm.

**2. Guido Dolmans presented the proposal titled “IMEC PHY Layer Proposal” (DCN: 15-13-0629-01-004q)**

*Henk:* Please provide the link budget and make the proposal compliant with the TGD. Also the sensitivity figures should be disclosed. The proposal in its current form is very loose with no details provided.

*Guido:* Depending on the interest we can provide the details. Some older presentations by us have details.

*Kiran:* The phase to digital convertor and the phase to digital convertors are applicable for AM signals? Is this only applicable for constant envelope signals

*Guido:* Currently these devices have a constraint of have a constant envelope. The applicability of these devices for other modulations depends on the amount of AM and the required back off?

*Kiran:* The BER gains shown in slide14 suggests that the x-axis is SNR(dB) instead of Eb/No as claimed. Please examine and update the slides. Slide 16, for the (63,51) case with an error correcting capability of 2, there are better algorithms when compared to PGZ.

*Steve:* Are you proposing BPSK? This is non-constant envelope modulation. What is the PA back off when PPM is employed? With a 15 mW power constraint what could be the maximum Pt that could be achieved?

*Frederik:* The performance of PPM with block coding appears way too optimistic. Please show the link budget comparison for FSK and PPM. It is good for all to benchmark the performance in the fading channels with a fixed set of parameters.

*Kato*: Slide 6: Some doubts on the constant envelope nature of OQPSK, GFSK and BPSK were asked. In slide 8 clarifications on the meaning of quasi-orthogonal codes were asked.

*Kiran:* For block codes with BCH zero padding can be employed for different packet sizes but the RS codes have strict constraints on the packet size for efficient transmission.

*Steve:* Since you are looking at a constant envelope phy for the sub-GHz range why don’t you consider the FSK phy as in IEEE 802.15.4g?

*Guido:* 15.5g and 15.4k are for longer ranges with larger link budgets. We decided to consider the PHYs from IEEE 802.15.4-2012.

*Rick:* In Mode A, Energy/packet is not improved significantly. There is no significant advantage from spreading. In Mode B, any comments on the coding for payload and the preamble.

*Frederik:* What are the frequency bands that are of interest to you?

*Shahriar:* Please comment on the low power features of your proposal in Mode A and Mode B. Can the bit rate be scaled with the power consumption? Does the relay section require MAC changes?

3. Meeting was recessed at 3.30 pm

**Task Group ULP Meeting Wednesday, 13 November 2013 PM2 session:**

1. Chair (Shahriar Emami) called session to order at 4:10 pm.

**2. Kiran Bynam presented the proposal titled “Samsung's\_Physical\_Layer\_Proposal” (DCN: 15-13-0623-00-004q)**

*Henk/Beer:* Please reveal the link budget calculation for all modes.

*Steve:* Some questions related to slide 5. Please comment on the burst error correction capability in the presence of interference.

*Henk:* Please reveal the PA efficiency while implementing the schemes proposed.

*Dr. Hong:* The overall PA efficiency is 15% to 20% for 0 dBm transmit power.

*Henk:* Do you have the theoretical results for the power spectrum? Are the current results of the spectrum obtained from the spectrum analyzer? Please publish the PSDU efficiency?

*Kiran:* We shall present the theoretical results of the spectrum. The current power spectrum shown is simulation based and takes into account the implementation aspects. The PSDU efficiency is presented in the proposal.

*Rick:* Any coding/interleaving/shortening is carried out on the PHY header and preamble?

*Kiran:* No, this is not done to avoid latency issues and to prevent the correlation properties of the sequences from being affected.

*Rick*: What I find lacking in all proposals is a fair comparison for which reducing the energy/packet is as important as reducing the power consumption becomes necessary. Hence both results have to be published to ensure that the overall objective of the group which is to reduce power consumption and increase battery life is met. This is a request for all presentations for a fair comparison of proposals.

*Kiran:* The energy/packet can be inferred from the parameters revealed which are in compliance with the TGD.

*Guido:* Did you consider different FEC schemes to converge to BCH? What is the reason for preferring BCH? For properly understanding the gains due to coding, please publish the performance results in the absence of coding.

*Kiran:* For BCH schemes with error correction capability of 2 there are schemes to significantly reduce the decoding complexity.

*Henk:* Should the Transmit and Receiver powers totally have power consumption less than 15 mW or should it be individually less than 15 mW according to PAR?

*Kiran:* It should be less than 15 mW individually at the transmitter and receiver.

*Henk:* Could you reveal the Interference results after 5 channels?

*Steve:* The interference performance significantly exceeds the constraints? Any comments

*Kiran:* The adjacent channel interference results meets the constraints while the alternate channel rejection results do not meet the constraints.

*Guido:* So are you recommending the group to consider relaxation of the interference constraints in view the ULP advantage?

*Kiran:* Yes

*Frederik:* Do you have any patents on the related technology?

*Kiran:* No comments.

*Steve:* Most of the advantages shown are based on implementation which is out of scope of the standard. What is important is proposed physical layer able to adhere to the constraints set by the TG.

3. Meeting was recessed at 5.30 pm

**Task Group ULP Meeting Thursday, 14 November 2013 AM1 session:**

1. Chair (Shahriar Emami) called session to order at 8:10 am.

**2. Henk de Ruijter presented the proposal titled “ULP-GFSK PHY proposal” (DCN: 15-13-0709-00-004q)**

*Jinesh/Kiran:* Spectral lines are seen in the spectrum for 2-FSK implying need for PA back off.

*Henk:* This is not required as long as you meet the radiation limits within the frequency band.

*Steve/John Adams:* Spectral lines are not an issue as long as the bandwidth is less than 500 KHz. Beyond that it is a problem due to the FCC restrictions and some of the operating modes need to be discarded.

*Kiran:* After reducing the preamble length, is the reduced length good enough to achieve good synchronization performance results. Please reveal the probability of missed detection results. What motivates the choice of the “01010101” sequence?

*Henk:* The sequence is taken from IEEE 802.15.4g

*Kiran:* Please elaborate on the re-synchronization aspect of DDR mode.

*Beer:* Please elaborate on the simulation methodology of the fading channels and the time required for such channels. There should be a guideline for performance evaluation with commonly agreed set of parameters for channel models for fair comparison of proposals. Error floors are seen in the simulation results. What is the reason for the error floors.

*Henk:* These floors are due to the multi-path fading which leads to ISI and there are no equalizers employed. Hence the error floor is unavoidable. Moreover for ULP operation, it is not attractive to increase complexity and incorporate equalization.

*Jinesh:* There is a huge gap in performance when AWGN performance is compared to the fading channel case. It is approximately 30 dB even for low data rate modes. Is this correct? The lower data rates should not encounter ISI as all the paths arrive within the symbol duration. What are the signal bandwidths considered

*Henk:* The simulations are correct and the errors are significant due to the phase distortions. The signal bandwidths are as per the table in the proposal.

*Steve:* Are there any patents related to the proposal

*Henk:* No comments

*Steve:* What is the PSDU length used?

*Henk:* 32 bytes

*Steve:* The impact of reducing the preamble length on the performance should be described. Is there is any impact on the AGC which needs a sufficient time for settling down.

3. Meeting was recessed at 10.00 am

**Task Group ULP Meeting Thursday, 14 November 2013 AM2 session:**

1. Chair (Shahriar Emami) called session to order at 10:40 am.

Minimal set of work on the proposals required

1. Performance plots in flat LOS propagation
2. Synchronization Performance
3. Power consumption figures
4. Performance plots in all the modes
5. Link budget calculation in all the modes

*Rick:* The energy per payload is also important in view of the group attempting to improve battery life time and as an indication as the energy efficiency metric.

*Kiran:* This can be inferred from the TGD and it may not be needed.

*Steve:* Some of the proposals revealed very less of the PHY changes and are more of implementation. This is out of scope. What are important are the PHY mechanisms that significantly reduce the power and not the power reductions from the implementation.

*Kiran:* Significant PHY changes have been revealed that are required as a result of a certain implementation to reduce the power consumption.

*Beer:* There should be a common set of values for the implementation which everyone could use for fair evaluation of proposals.

*Kiran:* This is difficult because different PHYs have different pros and cons vis-à-vis different implementations. For example the PA efficiency figures of one implementation cannot be shown for the other. Each implementation will have its own power consumption figures.

*Jinesh:* The mobility of the channel models and the K factor of the Ricean fading have to be chosen.

3. TG4q meeting adjourned at 12.20 pm

Motion to adjourn the meeting

Moved by: Steve (Semtech)

Seconded by: Allan (Samsung)