**IEEE P802.15**

**Wireless Personal Area Networks**

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| Re: |  |
| Abstract | [This document lists the comments received from some of the 802.15.4 experts. It is TG4q’s intent to resolve all of these comments before going for the letter ballot] |
| Purpose | [The conditions listed in this document are to be met for approval of letter ballot in 802.15 working group] |
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Resolutions to Comments Received for TG4q Draft D0.1

TG4q is going to complete (or have already completed) the comment resolution of following received comments before balloting on its draft spec D1.0. We understand that these comments are representative and if there are any other similar appearances/issues we will also address them.

## Technical Comments

1. **Comment**: (on Table 11- Data-symbol-to-chip mapping for 1/1-TOOK)

**Commentor1**: Is it really a ternary sequence? It looks like a binary sequence.

**TG4q**: It’s a special case of ternary OOK, since chips are from the ternary alphabet

1. **Comment**: (on Table 12- Data-symbol-to-chip mapping for 2/4-TOOK)

**Commentor1**: This one is a binary sequence as well.

**TG4q**: same as above. The chips are from the ternary alphabet

1. **Comment**: (on 31. ULP GFSK PHY)

**Commentor1**: How, exactly, is this GFSK PHY ULP when compared with the other FSK PHYs already in the standard?

**TG4q**: this is addressed in the supporting document 15-14-0478-00-004q.

1. **Comment**: (on 31.2.2 Differential precoding)

**Commentor1**: The PIB is typically the wrong place to put this. Also, how is this communicated to other devices in the PAN so that they can correctly receive the packet?

**TG4q**: The communication of the feature is not necessary because the SFD reflects the usage of pre-coding.

1. **Comment**: (on Annex B.1 Asymmetric Link Capabilities)

**Commentor1**: OK, but an asymmetric link in terms of distance does you no good.

**TG4q**: This is different from the traditional concept of asymmetric link; which is about the maximum transmission ranges of the sending and receiving devices. It is more about different capabilities of the PAN Coordinator and the sensor devices.

**Commentor 2**: The assumption of a more capable coordinator than the end device creating the link asymmetry is also assumed for 15.4k. To be fair, this assumption has no bearing on the PHY modulation, rather it is based upon the device’s capability to adapt to these conditions.

**TG4q**: The adaption capabilities are the key in the ULP GFSK PHY.

1. **Comment**: (on Annex B.1 Asymmetric Link Capabilities)

**Commentor1**: But if the link margin supports the higher data rate, then it should be used in both directions

**Commentor 2**: (@**Commentor1** on “both directions”) Valid point, but the link margin’s higher energy per bit from the coordinator may arise from a higher TX power, while the from the end node may be a result of a lower data rate

**TG4q**: The Link Margin only allows it due to FEC and precoding which should NOT be employed at the ULP devices.

1. **Comment**: (on Annex B.3 Configuration)

**Commentor 2**: So, for the asymmetry, the device’s capabilities such as configurable data rate and transmit power are the principle tools, not the modulation.

**TG4q**: Agree, one modulation related parameter is the precoding though.

1. **Comment**: (on mapping the base-band processed chips to the phase modulated signal)

**Commentor 3:** In the last review we noted that it was not clearly stated how the base-band processed chips were mapped to the phase modulated signal. I see many processing steps but this seems omitted.

**TG4q**: We will move the content of Annex A.2 (the missing step) back to the normative text as it describes how the base-band processed chips were mapped to the phase modulated signal.

1. **Comment**: (on the MAC additions)

**Commentor 3:** The MAC additions are not complete. The IE content is defined but there are no MAC operations specified for how the IE is processed and/or when it might be sent.

**TG4q**: Complete the missing parts of MAC.

1. **Comment**: (on 5.2.4.38 ULP GFSK Transmission Power Control IE)

**Commentor 3:** Do not see this IE used anywhere in the draft. I can guess what action the receiver may take upon reception but it should really be specified. I’m guessing it’s an MLME function like “when you get a ULP GFSK Transmission Power Control IE the and the ULP GFSK PHY is in use, the transmit power used for subsequent transmissions shall be set according to the TX Power Change parameter value as follows…”

**TG4q**: we have fixed this.

1. **Comment**: (on “Choose the preamble format as P1 or P2, as determined by the modulation and coding format in Table 7, Table 8, or Table 9.”)

**Commentor 3**: Not sure what this means. Think it means the preamble is determined based on the MCF that is being used. Specify how the PHY knows what MCF to use and thus which preamble to generate.

**TG4q**: Based on the frequency band of operation and data rate, the transmitter can choose the combination of MCF and preamble as given in Table 7-9. We will make it clearer in the spec.

1. **Comment**: (on 30.5.1.2.2 Bits-to-message-symbol conversion)

**Commentor 3**: I’m missing where we say the value of M.

**TG4q**: Will define M clearly.

1. **Comment**: (on 30.5.1.1.3 BCH encoding)

**Commentor 3**: Expect some comments questioning the need for yet another block coding specified in the standard. How is this BCH more appropriate than the existing RS?

**TG4q**: BCH is simpler than the existing RS codes from implementation point of view. The class of the BCH codes that are selected are double-error-correcting codes which have several low complexity decoding mechanisms described in the literature. If required, we can give a presentation.

1. **Comment**: (on “The interleaving depth should be chosen based on the modulation”)

**Commentor 3**: must be clear how the transmitter decides what to use and how does the recipient know what was used by the transmitter.

**TG4q**: this is calculated based on PSDU length and modulation format. The parameters are given in Table 10. We will make it clear.

1. **Comment**: (on post spreading scrambling)

**Commentor 3**: In addition the language problem, I see several technical issues that will draw comments:  why is post spreading scrambling necessary?

**TG4q**: Since few of the modulation formats (MCS) yield unipolar sequence, chip-level scrambling is necessary for eliminating DC components

1. **Comment**: (on PN16)

**Commentor 3**: Is a PN16 PRBS really necessary – why is the already defined PN9 not adequate? And if it is really necessary with this modulation, is this a good modulation choice for ultra-low power?

**TG4q**: PRBD will not add significant power consumption to transceiver. 15.4 has PN16 already, for UWB PHY (we will refer the sub-clause where PN16 is used). We are not particular into PN16; any length could be fine, but the longer the better.

1. **Comment**: (on the RF specs)

**Commentor 3**: here are some questions every new PHY is going to have to answer (we’ve done this poorly in the past): is it necessary for the purpose of the standard (which is primarily to enable interoperability) or are we repeating regulatory requirements? If the latter, it is wrong to put in the standard.

**TG4q**: It is put here to prevent interference from adjacent channels. It is also designed to prevent interference from 802.11.

1. **Comment**: (on 30.7.10 Receiver energy detection (ED))

**Commentor 3**: This is another item being challenged in the revision. Some regulations require ED, and excessively long ED duration hurts in many ways. Someone will challenge the value (any value).

**TG4q**: There is a need for ED. But we will refer to the existing text.

## Editorial Comments

1. **Comment**: (on 5.2.4.40 ULP GFSK Link Specification IE)

**Commentor 1**: Why are these only related to GFSK? Why is there a difference between uplink and downlink?

**TG4q**: We have merged the up-/down-link into one IE.

1. **Comment**: (on 5.2.4.39 ULP GFSK Device Capabilities IE)

**Commentor 3:** The FEC K = 7 field shall – is there more than one optional FEC defined for FSK? I only find one for the FSK. Perhaps I missed it?

**TG4q**: There is only one FEC. We will make this clear.

1. **Comment**: (on Table 1—ULP PHY frequency band definitions)

**Commentor1**: The following table is not needed as it is already in the base standard, please delete.

**TG4q**: No, it is not included, because we have added some frequency bands, namely two new European bands: 870-876 (merged it with the 863-870 band into one big band) and 915-921.

**Commentor 2**: If this table adds rows to an existing table, then underline those rows

**TG4q**: These have been underlined. They are not easy to tell though.These are ID=5 and 9.

1. **Comment**: (on Figure 12—Functional diagram of the TOOK PHY modulation and encoding for PSDU)

**Commentor1**: Clearly these need to be in frames or pictures or something. Generate the figures in some other drawing program and then import the image by reference. Do not embed the image with OLE.

**TG4q**: We have re-drawn the figure in Visio

1. **Comment**: (on 30.5.3.1 Data-symbol-to-chip mapping)

**Commentor1**: Do we really need the above figure? It tells us nothing.

**Commentor1**: bit ordering should be uniform for the Clause, hence it should be deleted from here and other locations

**TG4q**: the figure in question has been deleted

1. **Comment**: (on 30.6 Pulse shaping)

**Commentor1**: OK, so you have a ternary output, how exactly do you propose to modulate this with on-off keying which only has 2 levels? My guess is that TOOK is a lot of complexity with no advantage over regular OOK

**TG4q**: These issues have been answered in annexure. Annex A.2 gives the baseband representation of the OOK to make the idea clearer. Annex C gives the benefits of TOOK.

**Commentor 2**: Ummm….where is “T”(in the equation)?

**TG4q**: we have updated the text to make it clear.

**Commentor 2**: Perhaps it would be better to create a presentation from the TG4q that explains the details and benefits of TOOK and compares its energy efficiency against typical modulations. This presentation could then be referenced by this standard rather than putting it into an annex.

1. **Comment**: (on 30.7.2 Receiver sensitivity)

**Commentor1**: D4?

**TG4q**: fixed; rewrote sentence.

1. **Comment**: (on 30.7.11 Link quality indicator (LQI))

**Commentor1**: ED is not an LQI measurement. Either specify an actual LQI or don’t require it.

**TG4q**: sentence has been re-written to avoid ambiguity.

1. **Comment**: (Table 21—ULP GFSK 4-GFSK modulation operating modes)

**Commentor1**: 1 and 1a? How about different names, or better yet a sequential set of number, 1-13?

**TG4q**: The names have been chosen intentionally this way, because 1a is the rate switch mode for OM 1. A switch from OM2 to OM3a is not allowed for example.

1. **Comment**: (on 31.4 ULP GFSK PHY RF requirements)

**Commentor1**: You have already stated this, no reason to put it here. If you want it here, then move it here.

**Commentor1**: This is already stated in the frontmatter, we don’t repeat it.

**TG4q**: We don’t understand the comment. Please clarify.

1. **Comment**: (on 31.4.2 Channel switch time)

**Commentor1**: This doesn’t belong here. What does belong here is the symbol timing accuracy.

**Commentor1**: If there is no spectral mask (and earlier, you imply that there is) then don’t say anything here.

**TG4q**: We deleted the sub-clause, “31.4.3 Transmitter symbol rate”, that was originally here, as you suggested.

1. **Comment**: (on the term “ternary on off keying”)

**Commentor 3**: The “ternary on off keying” is a confusing and, apparently inaccurate term to describe what was explained to be a tri-state phase modulation

**TG4q**: Find a better term for ternary on off keying (TOOK).

1. **Comment**: (on the misuse of normative language)

**Commentor 3:** There are a lot of misuses of normative language. I give a few examples only.

**TG4q**: We will correct the misuse of normative language.

1. **Comment**: (on referring to the existing text)

**Commentor 3:** A lot of text looks like cut and paste from other PHY clauses. Don’t – refer to the existing clause (reference, don’t replicate).

**TG4q**: We will remove duplicate or similar text of existing standard. Refer to them when necessary.

1. **Comment**: (on sub-clause 5.2)

**Commentor 3:** don’t change the title of clauses in the standard. It makes it very difficult to follow.

**TG4q**: It was an error. We have already fixed it.

1. **Comment**: (on sub-clause 5.2.x)

**Commentor 3:** The figures (correctly) show the IE content not the entire IE, for example: “The ULP Transmission Power Control IE is shall be formatted” s/b “The content of the ULP Transmission Power Control IE is shall be formatted” (fix for both).

**TG4q**: we have fixed this.

1. **Comment**: (on 30.1.2.1.2 Preamble field, First paragraph)

**Commentor 3:** there is a lot of justification and explanation which is obscuring what you need to say (or you left some things out?): I get that there are two preamble patterns/lengths and that “The preamble format implicitly specifies the spreading format (or spreading factor) for SFD/PHR and the coding format for PSDU, which is related with the throughput efficiency of PSDU format.”, but the paragraph does not tell us how we infer these things from preamble/length. This is a good place to put that information. In general, remove the justification text and focus on what needs to be specified.

**TG4q**: we will remove the justification text and do the same for other places.

1. **Comment**: (on 30.1.2.2 PHR Field)

**Commentor 3:** MCF sounds a lot like Modulation and Coding Scheme, which is the term used in the standard. Unless there is some fundamental difference, use the existing terms.

**TG4q**: it would be easier for the description if we use both “MFI” and “CFI”. But if you insist, we can change it.

1. **Comment**: (on 30.1.2.2.1 Structure of the PHR field)

**Commentor 3**: First sentence is a good example of the kind of extra text we should void. The second sentence is a good example of the preferred way to concisely capturing the essential information.

**TG4q**: We will delete the first sentence, and do the same thing elsewhere.

1. **Comment**: (on unnecessary introduction)

**Commentor 3**: Get rid of intro sentences like “This part describes the modulation procedure.”

**TG4q**: We will do that.

1. **Comment**: (on ambigious description)

**Commentor 3**: Phrases like “with an appropriate chosen depth” (30.5.1.1.4) are problematic – what is appropriate?

**TG4q**: We will replace words like “appropriate chosen” with specific references to where the appropriate value is specified.

1. **Comment**: (on referencing)

**Commentor 3**: There are a lot of examples like this. If the specifics are given somewhere in the amendment, then replace words like “appropriate chosen” with specific references to where the appropriate value is specified.

**TG4q**: we will check the document and correct this.Make sure every “shall” describe a specific observable behavior or object.

1. **Comment**: (on inappropriate usage of “shall”)

**Commentor 3**: Phrases like “To perform SPC encoding, each message symbol shall be uniquely mapped on to the elements of GF(Q). “ are not proper usage of “shall”. It reads like you are stating a requirement on the authors of the standard. more appropriate: When SPC coding is in use, each message symbol is processed as follows”

**TG4q**: We will follow the suggestion and change the spec.

1. **Comment**: (on editorial issues)

**Commentor 3**: A lot of editorial problems that make it really hard to read, for example: Once the codewords are generated, the coded symbols (which are the elements of GF(Q) shall be uniquely mapped on to the Q-ary alphabet A={0,1,2,…,Q-1}. The missing “)” makes it impossible to parse. This may be other example of where “shall” is used to state a requirement on the authors of the standard. This clause should be specifying how the coded symbols are uniquely mapped rather than just emphasizing that it must be done.

**TG4q**: we will change it and the likes.

1. **Comment**: (on editorial issues: another example: “the modulator shall output a unique sequence from a pre-defined set of L-length ternary sequences.”)

**Commentor 3**: what this says is any implementation of a modulator that outputs a unique sequence from a pre-defined set of arbitrary length tri-state sequences is compliant. I am sure this is not what you mean to say. Every “shall” should describe a specific observable behavior or object.

**TG4q**: We will correct this.

1. **Comment**: (on the use of “M-tuple”)

**Commentor 3**: Many places “M-tuple” is used way I don’t understand, like in Table 11 and 12. It looks like Table 11 shows how one bit is mapped to 2 chips and Table 12 maps 2 data bits to 4 bits. Why not just say that?

**TG4q**: we will say that explicitly.

1. **Comment**: (on proper wording)

**Commentor 3**: Phrases like “shall be performed only on the PSDU chips” are more clearly stated as “chip inversion shall be performed on the chips comprising the Data field of the PSDU”.

**TG4q**: we will reword it as suggested in comment.

1. **Comment**: (on Figure 17—Linear feedback shift register based implementation of the PRBS generator)

**Commentor 3**: The figure should clearly show what part of the PPDU this process is applied to. “The pseudo-random phase inversion of the chips shall be based on the output of the PRBS generator.” Is another example of how not to use “shall”, for several reasons. “shall be implemented” is a red flag for invalid specification. The implementation may be anything that produces the output we specify.  “The PRBS output shall be equivalent to the 16-bit PRBD illustrated in figure 18” is what you probably mean.

**TG4q**: we will remove “Shall”.  We will rewrite the sentence and carefully avoid mandating the implementation.

1. **Comment**: (on 30.7.6 Error vector magnitude)

**Commentor 3**: This appears to replicate what is in 8.2.3 in 15.4-2011 (9.2.3 in the revision draft). Reference instead of replicate.

**TG4q**: We will refer to the existing standard.

1. **Comment**: (on 30.7.8 Transmit center frequency tolerance)

**Commentor 3**: Is this a necessary specification? This has been done in every PHY but in the current revision we have comments challenging the need (and validity) of specifying a minimum transmit power. If there is not a good reason to specify something don’t. “because that is what all the other PHY amendments did” is not always a good reason. A better default when you are not sure of the value of specifying RF parameters is leave it out and see if anyone notices.

**TG4q**: We do have a reason: it is here because we need to make sure minimum link margin is possible for supporting targeted applications.

## Better Practice

1. **Comment**: (on 8.1.2.13 Channel numbering for ULP TOOK PHY)

**Commentor 1**: We may need to split these up or consider a table. The base standard should probably be re-formatted

**TG4q**: We will follow the way the base standard uses.

**Commentor 2**: The SCmain team needs to provide guidance to the ULP team on this matter

1. **Comment**: (on 8.1.2.15 Channel page structure)

**Commentor1**: Please do not spend any time on a channel page structure. That is a mistake from 802.15.4g, please don’t repeat it here.

**TG4q**: This was included because we tried to follow the way 4g spec was written. If 4g made a mistake here, we can skip this sub-clause. But where do we state the channel numbering then?

**Commentor 2**: The SCmain team needs to provide guidance to the ULP team on this matter

1. **Comment**: (on Table 19—ULP GFSK PHY SFD values for 2-GFSK)

**Commentor1**: Since the SFD determines the FEC, it should be passed as part of the MCPS-DATA.request and not as a PIB entry. Better still, let the MAC determine when to use FEC and what FEC to use.

**TG4q**: This method here has been copied from other amendments (e.g. 4g and 4k), both of them have a respective PIB attribute for FEC. Any changes to any MLME primitive could not been found in these amendments. If we have missed any mechenisms, please let us know.

1. **Comment**: (on 31.4.1 Radio frequency tolerance, the equation, where *h0* is 1)

**Commentor1**: Then just put 1 in the equation.

**TG4q**: this equation is in 4g, subclause 18.1.5.3. If it is wrong there please let us know.

1. **Comment**: (on 31.4.4 Receiver interference rejection)

**Commentor1**: Measured? Don’t you mean that it will meet that requirement? There is no reason to specify how it is measured if you are not going to also specify limits.

**TG4q**: This was taken from 4g. If it is wrong in 4g please provide a correct procedure

1. **Comment**: (on transmit order)

**Commentor 3:** Consult with the SCM revision editors for correct description of transmit order. The current practice of lifting text from 15.4-2003 doesn’t work (this is being worked in SCM, it’s wrong a lot of places).

**TG4q**: We will consult with the SCM revision editors for correct description of transmit order and adopt the right way of description.

1. **Comment**: (on the 15.4 new convention)

**Commentor 3:** A new convention is emerging form the revision to rename the PHY payload part of the PPDU “Data Field” (so change “PSDU” to “Data” in figure 8). The reason is that “PSDU” is elsewhere in the standard to be the payload provided to the PHY by the MAC (PSDU contains the MPDU). When you apply FEC what goes into the air is the encoded (processed) PSDU. This text really suffers from this as there is a lot of processing of the PSDU before it is transmitted, and it is hard to keep track of what is really being processed at each step. Consult the WG TE for the improved practice being applied to the revision project.

**TG4q**: We will consult the WG TE. If necessary, rename the PHY payload part of the PPDU “Data Field”.

1. **Comment**: (on PSD mask)

**Commentor 3**: “shall be measured” in the RF specs is often introducing an inappropriate statement, as in 30.7.1 – this is typical of how it has been done but we are in the process of trying to clean this up. In this case, the PSD mask may be an appropriate way to describe the transmitted symbol in which case “shall conform to the limits in table 15 measured using a 100 kHz resolution bandwidth” is better.

**TG4q**: we will change as suggested.