Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Resolutions to comments discussed at Taipei meeting]
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Re: [In response to TG3c comments (IEEE P802.15-08-0020-05-003c)]
Abstract: [Comment resolutions]

Purpose: [To be considered in TG3C baseline document.]

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Summary of Comments received in Taipei meeting

The table shown below summarizes the 40 comments received at the Taipei meeting.
This document addresses the comments colored "non-red".

Type of Comment	Total	Technical		Editorial	
		Responded	Open	Responded	Open
All	40	22	11	6	1
Closed before Teleconference	2	0	0	2	0
PHY	8	5	1	2	0
MAC	20	17	1	2	0
Beamforming BF	7	0	6	0	1
AV-OFDM And Different HCS design	3	0	3	0	0

Comments made after March 4th Teleconference

After the teleconference 15 extra comments were made 6 for PHY and 9 for MAC.

Type of Comment	Total	Technical		Editorial	
		Responded	Open	Responded	Open
PHY	6	0	6	0	0
MAC	9	0	9	0	0

Summary of Comments related to SC PHY from the last Teleconference

Below are discussed comments during last teleconference. The responses of COMPA starting with comment #10 are in following slides.

Index	Comment Number	Type of Comment	Description	Owners
1	10	Technical	We need to define the preferred fragment size mapping for each of the PHY modes or possibly one for all PHY modes.	H. Harada, J. Gilb, I. Lakkis
2	20	Editorial	Add requirement that MMC PNCs implement the common mode.	Sum, H. Harada, James Gilb
3	21	Technical	What PHY mode is used in the CAP	James Gilb, Sum, H. Harada
4	22	Editorial	Add a description of the MMC PNC to Clause 5 in relation to the beaconing and the CAP.	James Gilb, Sum, H. Harada
5	23	Technical	Each PHY needs to explicitly define the base rate that will be used	H. Harada, J. Gilb, I. Lakkis
6	28	Technical	Can we unify the use of FCS's and types of FCS (with HCS)?	Ismail Lakkis, James Gilb, H. Harada
7	30	Technical	Do we use one or two HCS for the headers, Including the extended MAC header.	Edwin Kwon, Pyo, James Gillb

Comment Number #10

Issue: We need to define the preferred fragment size mapping for each of the PHY modes or possibly one for all PHY modes.

Resolution:

- CoMPA has defined the preferred fragment size table as shown on the right side
  - Fragment size varies from 512 octets to 1Moctets to meet different application requirement
  - Subframe size varies from 512 to 1Moctets
  - Up to 8 subframes can be aggregated into one frame

Bits	Fragment Size
000	1 Moctets
001	256 Koctets
010	64 Koctets
011	16 Koctets
100	4Koctets
101	2 Koctets
110	512 octets
111	Reserved

Comment Number #20 (1/9)

Comment: Add a requirement that MMC-PNCs implement the Common Mode

Resolution:

1. The MMC-PNC is defined based on the agreement in Atlanta Meeting.
2. An MMC-PNC is a PNC supporting multiple PHY modes and Common Rate.
3. An MMC-PNC is able to communicate with DEVs operating in different air interfaces through Common Rate.
4. An MMC-PNC shall transmit Common Rate beacon and conduct CAP in Common Rate.

Comment Number #20 (2/9)

Proposal outline

- What is MMC-PNC
- Features of MMC-PNC
- Why is MMC-PNC needed
- What agreed on MMC-PNC in Atlanta Meeting
- Features of MMC-PNC
- Basic operational procedures for MMC-PNC

Comment Number #20 (3/9)

What is MMC-PNC

- An MMC-PNC is a PNC that supports multiple PHY modes and Common Rate. An MMC-PNC shall transmit Common Rate beacons and conduct the CAP in Common Rate

Comment Number #20 (4/9)

Features of MMC-PNC

- MMC-PNC shall support multiple PHY modes
- MMC-PNC shall support Common Rate
- Beacon and CAP of MMC-PNC shall be in Common Rate
- MMC-PNC shall be one of the following
  - SC (**Common Rate**) and HSI-OFDM
  - SC (**Common Rate**) and AV-OFDM
  - SC (**Common Rate**) and HSI-OFDM and AV-OFDM
  - SC (**Common Rate**) and other combinations

Comment Number #20 (5/9)

Why is MMC-PNC needed

- MMC-PNC mitigates potential interference among DEVs operating in different air interfaces
- MMC-PNC enables DEVs operating in different air interfaces to communicate with each other

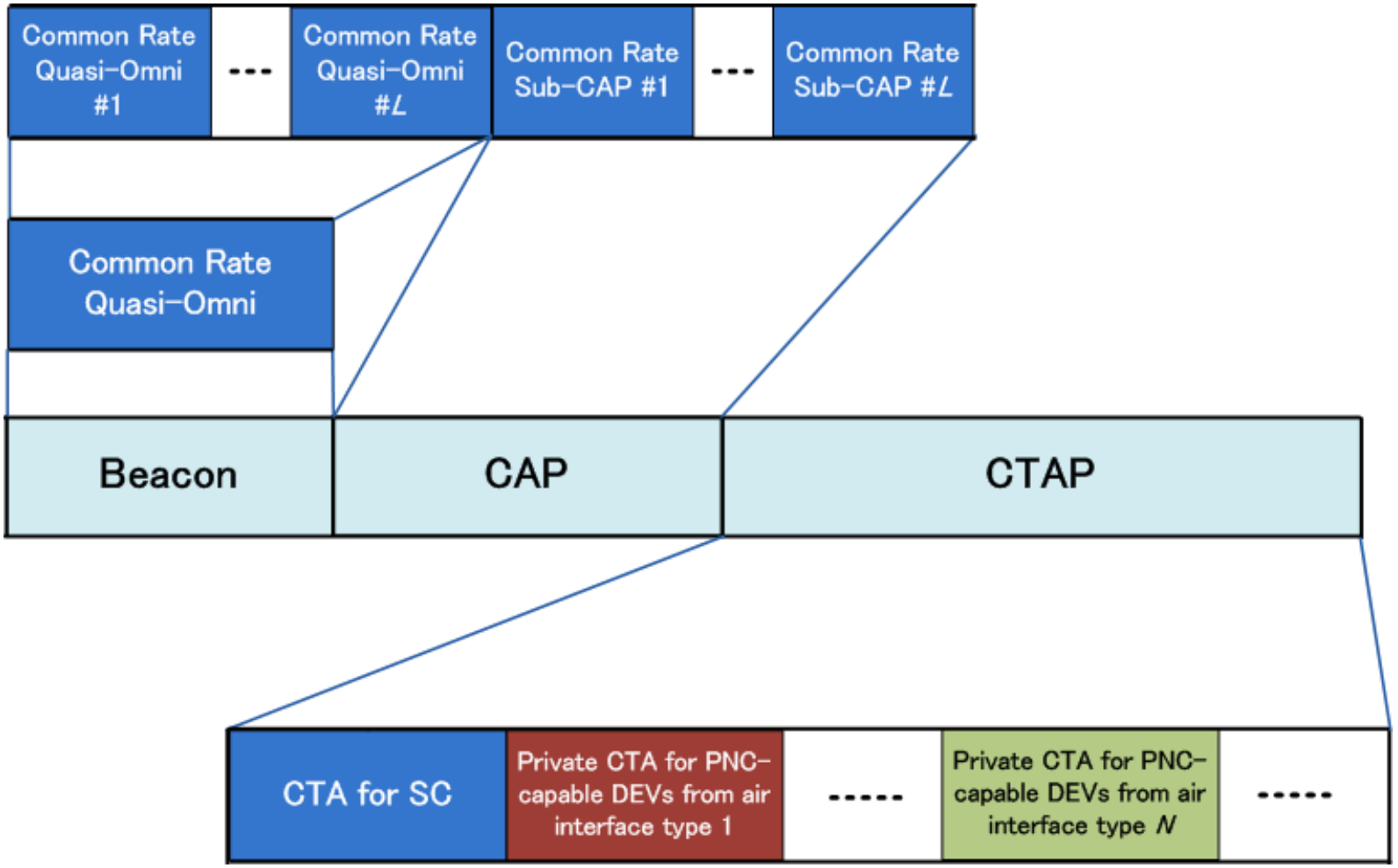
Comment Number #20 (6/9)

What agreed on MMC-PNC in Atlanta Meeting

- Common Rate shall be mandatory for MMC-PNC
- Common Rate is mandatory for SC DEVs and optional for OFDM DEVs
- A non-SC PNC-capable DEV **has to support Common Rate** if it wishes to communicate with MMC-PNC

Comment Number #20 (7/9)

Basic Operational Procedure of MMC-PNC



Comment Number #20 (8/9)

Basic Operational Procedure of MMC-PNC

- SC DEVs (blue CTA in the previous slide)
  - MMC-PNC transmits SC beacons by using Common Rate
  - SC DEVs will receive the SC beacons and associate with the MMC-PNC in the CAP (CAP is also using Common Rate)
  - In the CTAP, these SC DEVs will be allocated CTAs for data streaming
- DEVs with other air interfaces (brown and green CTAs the previous slide)
  - To be able to communicate with the MMC-PNC to borrow CTAs in the CTAP, the DEVs (normally PNC-capable DEVs) **has to support Common Rate**
  - These PNC-capable DEVs shall receive the SC beacons and associate with the MMC-PNC in the CAP by using Common Rate
  - In the CTAP, private CTAs will be allocated to these PNC-capable DEVs to start child piconet for local signaling and streaming

Comment Number #20 (9/9)

Conclusion

- The features of MMC-PNC is defined based on the agreement in Atlanta Meeting
- Common Rate shall be mandatory for MMC-PNC
- The MMC-PNC shall transmit Common Rate beacons and conduct the CAP in Common Rate

Comment Number #21

Comment: What PHY mode is used in the CAP

Resolution: SC mode shall be used in the CAP

Reasons:

- Mandatory use of Common rate in MMC-PNC for beaconing and CAP is agreed in Atlanta Meeting
- By using only one PHY mode, interference avoidance in CAP is more effective

Refer to the CoMPA MMC-PNC proposal.

Comment Number #22

Comment: Add a description of the MMC-PNC to Clause 5 in the relation to the beaconing and CAP

Resolution: The description in clause 5 will be provided based on the design of the MMC-PNC proposal.

Comment Number #23

Comment: Each PHY needs to explicitly define the base rate that will be used

Resolution: In SC PHY the signaling will be done in common rate (50 Mb/sec) and it will be explicitly defined in the document. There is also a mandatory rate of 1.5 Gb/sec.

Comment Number #28

Comment: Can we unify the use of FCS's and types of FCS (with HCS)?

Resolution: The 4 octet FCS is the same for all PHY modes and we will keep it unless the simulation results show that short FCS (2 octet HCS) is adequate.

For the HCS we don't need 4 octets in HCS,because 2 octets HCS generated by the CCITT cyclic-redundancy-check code (CRCC) offers good enough undetected-error probability P_{ud} of less than 10^{-20} with 20-octet header and P_{ud} of less than 10^{-18} with 80-octet header at BER=10^{-6}
(ref: IEEE 802.15-08-0042-01-003c Cyclic redundancy check codes for header check sequence).

Comment Number # 30

Comment: Do we use one or two HCS for the headers, including the extended MAC header.

Resolution: We will keep 2 HCS for the base header and optional header for the moment.

New PHY related Comments after the Teleconference

Below comments are created for low latency applications. A response to comment 42 is prepared for discussion.

Index	Comment Number	Type of Comment	Description	Owners
1	41	Technical	To enable low latency communication enable switching between RX and TX (SIFS) in a much shorter period than 1 usec. (See Comment Resolution 8 from the MAC Comments)	
2	42	Technical	In order to have low phy overhead shorten the short preamble. An example can be composed of 8 Syncs 2 SFDs and 1 CES	
3	5x	Technical	The cyclic prefix in 12.2.5.5.3 should be removed from the baseline document	
4	5x	Technical	More compact header design will enable lower latencies (unified header with HSI OFDM)	
5	5x	Technical	Is the optional BURST length of 512 for FDE necessary for SC PHY, if not it should be eliminated.	
6	5x	Technical	How simple Decision Feedback Equalization can be supported for SC PHY at high speeds.	

Comment Number 42# (1/6)
Preamble Modification

Requirements:

Shorter preamble: Comment 42 demanded a preamble of length around 1 us. Current shortest preamble is 1.48 us long.

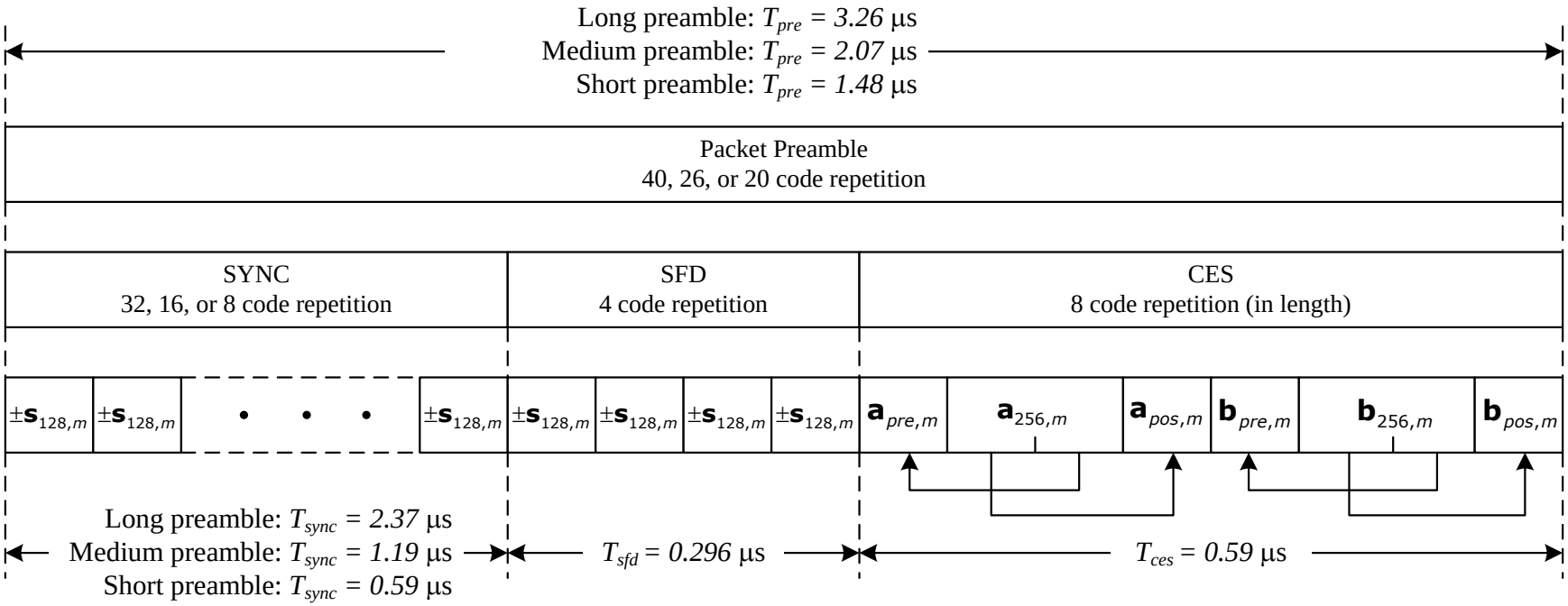
4 SFD codes for flexibility:

- 1 for Delimiter
- 1 for CES selection
- 2 for Header Selection

Suggestions:
Removing the cover codes which generate restriction in size of SYNC .

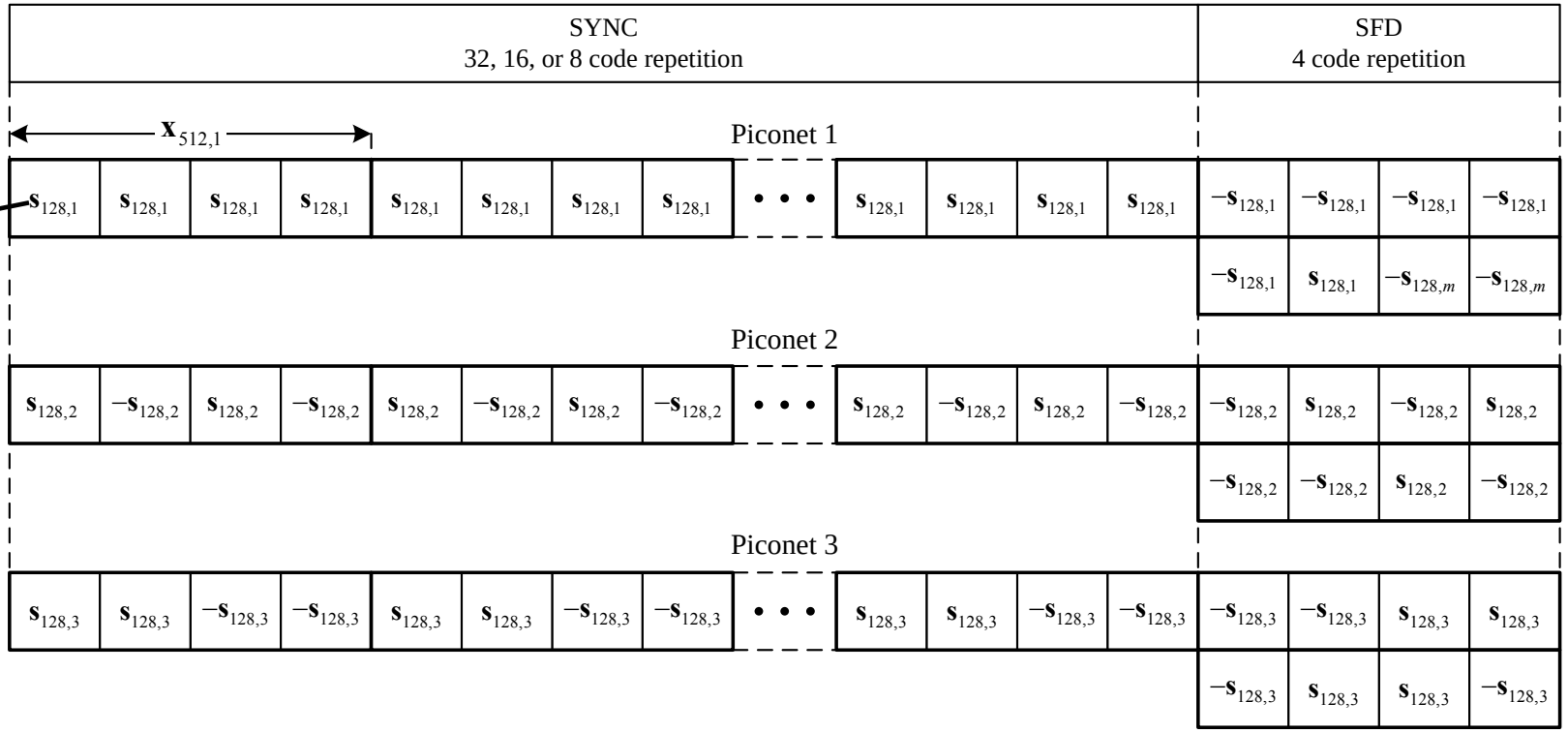
Comment Number 42# (2/6)
Preamble Modification

Current Preamble Designs



Comment Number 42# (3/6) Preamble Modification

Current SYNC and SFD fields :



$\mathbf{s}_{128,1}$	0x3663FAAFFA50369CC99CFAAF05AF369C
$\mathbf{s}_{128,2}$	0xC99C055005AFC963C99CFAAF05AF369C
$\mathbf{s}_{128,3}$	0x6C39A0F55FF5933993C6A0F5A00A9339

	Piconet 1	Piconet 2	Piconet 3
SFD pattern for beacon	0000	0101	0011
SFD pattern for data packet	0100	0011	0111
SYNC pattern	1111	1010	1100

Comment Number 42# (4/6)
Preamble Modification

SYNC and SFD modifications:

For SFD, we have 4 codes in the requirements.

For the SYNC we are suggesting to use 6 codes for detection, gain and frequency controls, since the cover codes are eliminated.

Comment Number 42# (5/6)
Preamble Modification

CES Modification:

We are suggesting to use Golay codes a(128) and b(128) with prefixes and postfixes. (Current CES uses a(256) and b(256)). The total length of CES will be equal to 4 128 chip Golay codes, which corresponds to a 50% length reduction in CES .

Comment Number 42# (6/6)
Preamble Modification

Total duration:

With SYNC consisting of 6 code repetitions and SFD 4 repetitions, and a CES with an equivalent length of 4 code repetitions, total duration of the new preamble will be 1.036 us.

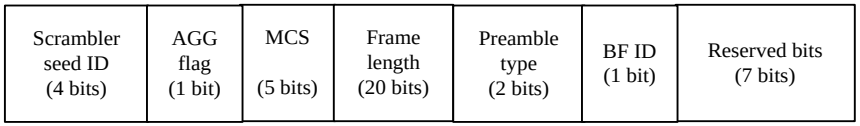
Comment 5x# CP Reduction

The cyclic prefix in 12.2.5.5.3 should be removed from the baseline document

The role of the cyclic prefix can be replaced by the mandatory pilot word in 12.2.5.5.1

By removing the cyclic prefix, a cleaner header design can be obtained, since the header needs to allocate bits for guard interval selection

Comments 5x# New PHY Header (1/2)



Change figure New PHY header length is 5 octets.

Scrambler seed ID (4 bits)

The MAC shall set bits S1-S4 according to the scrambler seed identifier value.

Agg Flag (1 bit)

The Agg Flag bit shows if there is aggregation exists or not.

Modulation and coding scheme ID (5 bits)

The bits show which MCS will be used.

Comment 5x# New PHY Header (2/2)

Frame length (20 bits)

The frame length field shall be an unsigned 20-bit integer number that indicates the number of octets in the frame payload (which does not include the FCS).

Next Preamble(2 bits)

The preamble type field bits P1-P2 indicate the type of the PHY preamble (long, medium, short, shorter) used in the next packet.

Beamforming ID (1 bit)

It is for beamforming tracking indication.

Reserved (7 bits)

This field consists of 7 bits reserved for future use and shall be set to zero, if not use.

Comment 5x# Elimination of BURST Length 512

Burst length 512 for SC-PHY could be eliminated since FDE for such a length is not necessary for SC devices.

Comment 5x# Decision Feedback Equalization Support

We should find out, if SC devices can support DFE easily at these high symbol rates.

Summary of MAC Comment Resolutions

- **20 MAC comments** consisting of **18 MAC technical comments** and **2 MAC editorial comments** are created in Taiwan
  - **17 MAC technical comments are resolved and 1 comment is open**
  - **2 MAC editorial comments are responded**
- **Superframe resolution and IFS comments are updated**
- **8 MAC comments are newly created after Taipei meeting**
  - **5 MAC comments** are created by Wilocity – solutions

  - **3 MAC comments** are created by ETRI
  - **1 MAC comment** is created by NICT (subhead reduction comment #5x)

Type of Comment	Total	Technical		Editorial	
		Responded	Open	Responded	Open
MAC	20 18 Technical 2 Editorial	17	1	2	0
New Comment from Wilocity	5 5 Technical 0 Editorial	5	0	0	0
New Comments from ETRI	3 3 Technical 0 Editorial	0	3	0	0
New comment by NICT	1 1 Technical 0 Editorial	1	0	0	0

18 Technical MAC comments in Taipei (1/2)

Index	Issue #	Description	Owner
1	2	Do we need a capability bit that indicates a DEV is MMC PNC capable?	J.G
2	5	Do we need reserved stream indices for beamforming and channel probing.	J.G, ZL
3	6	Does the resolution of the superframe timing need to be less than 1 us?	S.Kato
4	7	Will Dly-ACK do what is necessary for Blk-ACK or are there unique things that Blk-ACK needs to do. Also, can this concept be extended to include the AV PHY directional ACK.	S.Kato, E.Kwon
5	8	Do we add SIFS and MIFS capabilities here or in another information element.	I.Lakkis
6	9	How do we encode all of the supported data rates.	I.Lakkis
7	11	How do DEVs know when the superframe starts and when the last beacon ends if they receive one beacon in the middle of a set of beacons.	I.Lakkis, Pyo
8	12	How does a DEV know when the first symbol of the beacon is sent when there is repetition coding	J.G, I.Lakkis
9	16	What is the definition of the value of the Channel Status Information field?	S.Kato
10	17	Can this be done with an information element? Also, there are some updates to the frame format that need to be reviewed.	E.Kwon, Pyo
11	18	Why is handover optional? Should it be restricted to certain cases.	I.Lakkis, J.G, S.Kato

18 Technical MAC comments in Taipei (2/2)

Index	Issue #	Description	Owner
11	18	Why is handover optional? Should it be restricted to certain cases.	I.Lakkis, J.G, S.Kato
12	19	Need rules to describe that the beacon PHY mode shall not change while in operation. Also, that on handover, the new PNC uses the same PHY mode for the beacon as the old PNC. If so, we may be able to leave PNC Des-Mode as the top criteria for handover.	J.G, JY, ZL
13	26	Can all three PHY modes use the same SIFS and list this in the capabilities field to be used in an CTA.	I.Lakkis, Baykas, J. G
14	29	Can we unify the aggregation	E.Kwon, Pyo, J.G
15	31	The rules for Blk-ACK need to be filled out.	Pyo, S.Kato
16	35	There needs to be a way for the upper layer that is the source of data to say if the use of UEP is allowed for the data stream.	E.Kwon, J.G. ZL, Pyo
17	36	Rather than using commands, if the UEP capailities are exchanged as part of the normal capabilities exchange, then the commands are not needed.	E.Kwon, J.G. ZL, Pyo
18	38	Can we use the existing facilities in 802.15.3b to accomplish this in a manner that improves the performance.	J.G

2 Editorial MAC comments in Taipei

Index	Issue #	Description	Owner
1	25	Move the new text in this subclause to the informative annex	J.G
2	32	Table 58a does not need any changes	J.G

5 Additional MAC comments from Wilocity

Index	Description	Owner
1	Enable MSDU aggregation	GB
2	Enable Block Ack to be aggregated with data	GB
3	Consider adding compressed BA for efficiency	GB
4	Add new capability bit for bus_root and bus_endpoint, those devices will support low latency communication.	GB
5	Enable CTA to be bi-directional (meaning interchanging transmissions between 2 DEV at the same CTA)	GB

3 Additional MAC comments from ETRI (in Orlando)

Index	Description	Owner
1	Current UEP procedure doesn't seem to support various color depths of video data.	YK
2	Need to have an indication for the position of the middle point which separates MSBs from LSBs. (According to DF1, it seems that the default color depth is 8 bits which consist of 4 bits of MSBs and 4 bits of LSBs.)	YK
3	To make UEP be optimized for various types of video formats, UEP procedure needs to be applicable not only for MSBs and LSBs but also other classifications, for example, luminance and chrominance and so on.	YK

1 Additional MAC comment from NICT (in Orlando)

Index	Issue number	Description	Owner
1	5x	Sub-header size reduction	ZL

Resolutions modified during the 2nd conference call

#6 and #8 (#41 added later on)

Comment #6

-Superframe resolution-

- Comment
  - Does the resolution of the superframe timing need to be less than 1*us*?”
- Answer
  - No, There is no need to change super frame resolution.

Comment #8 and #41(1/3)

- Comment # 8
  - Do we add SIFS and MIFS capabilities here or in another information element.
- Comment # 41
  - To enable low latency communication enable switching between RX and TX in a much shorter period than 1 usec
- Resolution
  - Yes, SIFS and MIFS capabilities need to be included in capability IE, because multiple values of IFSs are planned to be used
  - It is better to select suitable value of IFSs according to the DEV specifications if multiple values of IFSs are available, because shorter value of IFSs can trigger quick retransmission by defining shorter RIFS, thereby improve frame efficiency and delay performance
  - This resolution proposes 4bits in capability IE to indicate IFS capabilities
  - Each value representing how many seconds shall be determined later

An example of IFSs (2/3)

- Common IFS table is proposed that provide 200ns to 2.5 us length of SIFS, including default values of both SC &HIS OFDM and AV-OFDM
  - 200 ns to 2.5 us lengths for SIFS are assumed in SC and HIS OFDM including a default value of 2.5us
  - 2us SIFS as well as MIFS assumed in AC-OFDM as a default

IFS ID (4bits)	SIFS	MIFS
0000	0.2 μs	0.2 μs
0001	0.4 μs	0.4 μs
0010	0.6 μs	0.6μs
0011	0.6 μs	0.6μs
0100	1.0 μs	1.0 μs
0101	2.0 μs	2.0 μs
0110	2.5 μs	0.5 μs
0111	Reserved	Reserved
...		
1111	Reserved	Reserved

Default value for AV-OFDM

Default value for SC, HIS OFDM

DEV capabilities field in capability IE (3/3)

- 4bits field shall be adequate to indicate IFS capabilities in DEV capabilities field

bit: 7	b6	b5	b4	b3	b2	b1	b0
Supported data rates (totally 14bits)							
Octet #1							

bit: 15	b14	b13	b12	b11	b10	b9	b8
Preferred fragment size	Supported data rates (totally 14bits)						
Octet #2							

bit: 23	b22	b21	b20	b19	b18	b17	b16
STP	CTA relinguish	Imp-ACK	Dly-ACK	Listen to multicast	Listen to source	Always AWAKE	Preferred fragment size
Octet #3							

bit: 31	b30	b29	b28	b27	b26	b25	b24
Supported IFS (totally 4bits)				OOK capable	HSI-OFDM capable	AV-OFDM capable	SC capable
Octet #4							

bit: 39	b38	b37	b36	b35	b34	b33	b32
Reserved						UEP capable	
Octet #5							

Comment #43

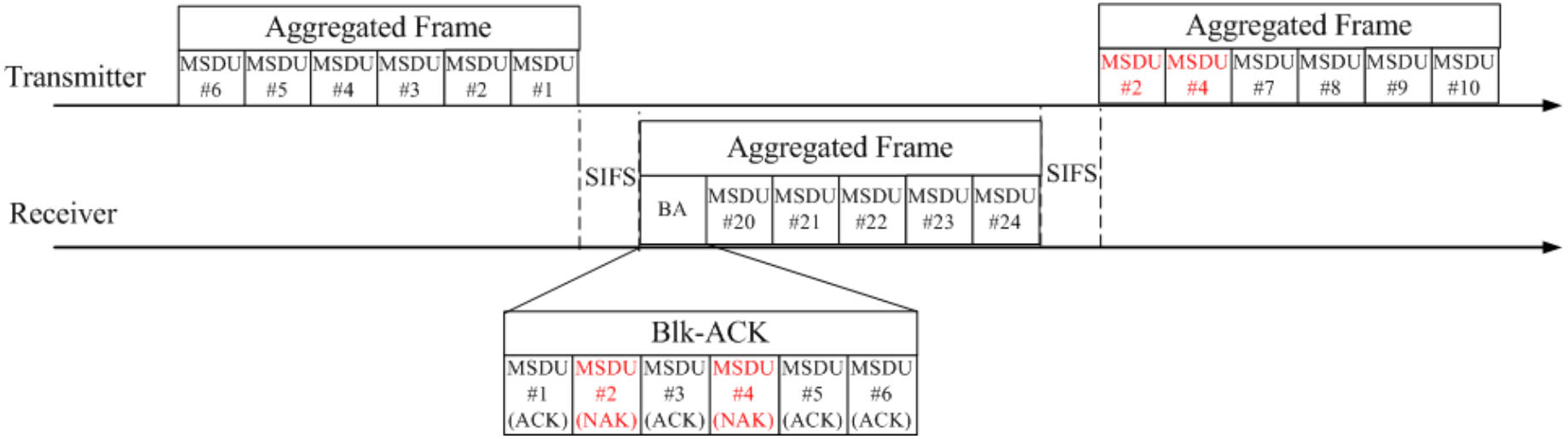
- Comment 1
  - Enable MSDU aggregation

- Response
  - Yes. One bit indication for standard mode (CoMPA's MSDU aggregation) and low latency mode (Willocity's MSDU aggregation) will be defined in base header to support both aggregation schemes

Comments #44 #45 (1/2)

- Comment 2
  - Enable Block Ack to be aggregated with data
- Comment 3
  - Consider adding compressed BA for efficiency
- Response
  - Blk-ACK integrated into Imp-ACK is proposed to support compressed Blk-ACK

Comments #44 #45 (2/2)



Comments #46

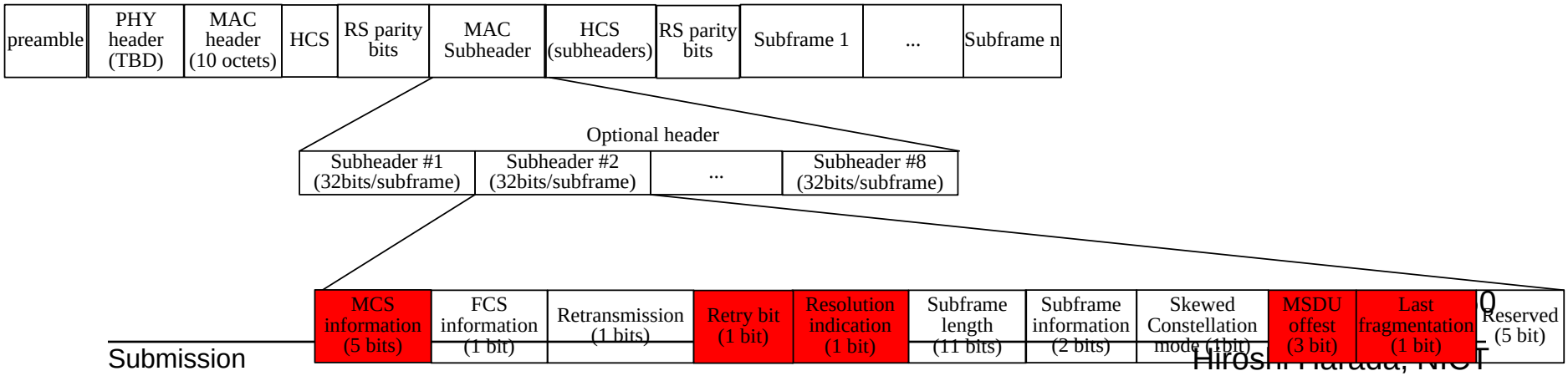
- Comment #46
  - Add new capability bit for bus_root and bus_endpoint, those devices will support low latency communication.
- Response
  - Capability bit for BUS ROOT and BUS ENDPOINT will be defined in Capability IE

Comment #47

- Comment #47
  - Enable CTA to be bi-directional (meaning interchanging transmissions between 2 DEV at the same CTA)
- Resolution
  - Add “CTA supports bi-directional communication” on baseline document

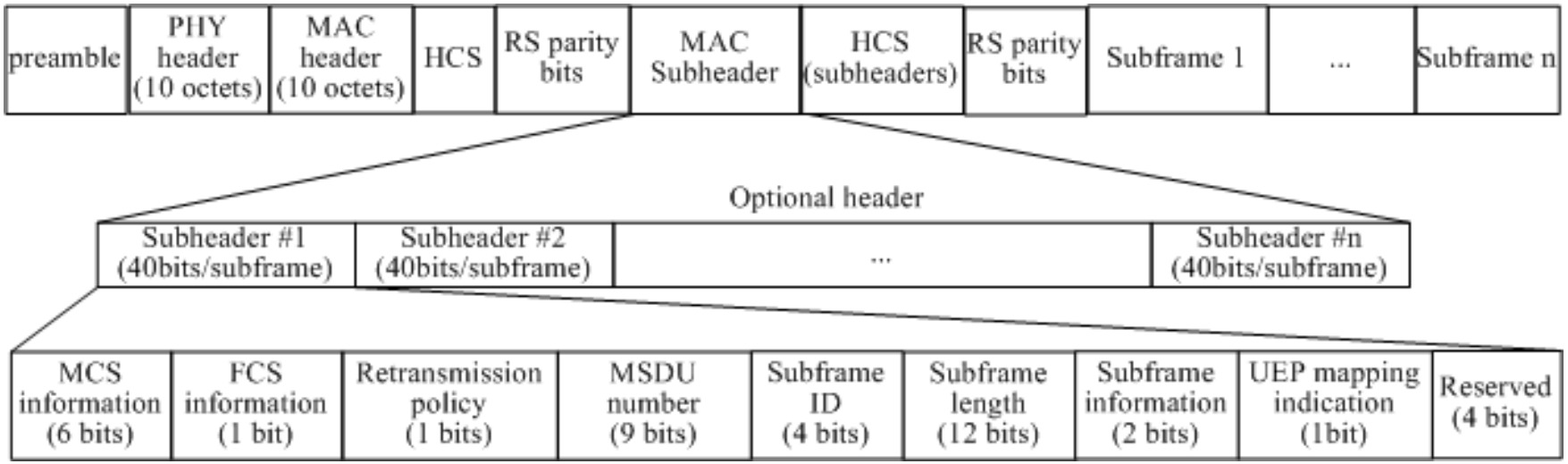
Resolution to Comment from NICT Sub-header size reduction (1/2)

- Subheader size per subframe is reduced from 80 octets (40bits x 16) to 32 octets (32bits x 8)
- Subheader is changed as following
  1. Changed the number of bits for MCS information from 6bits to 5bits
  2. Removed MSDU number (9bits) and Subframe ID (3bits)
  3. Added 1bit for Retry for checking subframe duplication
  4. Added 1bit for resolution to indicate the different subframes of long subframe (1Moctets) and short subframe (40 octets)
  5. Added 3bits for MSDU offset for subframe retransmission
  6. Added 1bit for last fragmentation to support fragmentation



Comment from NICT
Sub-header size reduction (2/2)

- Subheader in baseline document DF1



Comment #7 (1/2)

- Comment #7
  - (1)Will Dly-ACK do what is necessary for Blk-ACK or
  - (2)are there unique things that Blk-ACK needs to do.
  - (3)Also, can this concept be extended to include the AV PHY directional ACK.

- Resolution
  - (1)No, Dly-ACK can not do what is necessary for Blk-ACK
  - (2)Yes, Blk-ACK has ACK/NACK indication and MSB and LSB indication
    - ACK/NACK indication is necessary to be defined in Blk-ACK
    - Alternative of ACK/NACK bit is to use MSB indication bit in each subframe block
  - (3)Need to discuss with AV-PHY

Comment #7 (2/2)

Octets:4	2	...	2	1	1
FCS	SubFrame ID block-n	...	SubFrame ID block-1	ACK/NACK	Number of SubFrames blocked

10
MAC header

Bits: b15	b14	b13	b12-b9	b8-b0
Reserved	LSB retransmission	MSB retransmission	Subframe ID	MSDU number

- ACK/NACK indication is necessary to be defined in Blk-ACK

Octets: 4	2		2	1
FCS	Sub-frame Block-n	...	Sub-frame Block-1	Number of Subframes ACKed

10
MAC header

bits: b15	b 14	b 13	b 12 - b9	b8 - b 0
Reserved	LSB indication or Reserved	MSB indication or ACK/NACK	Subframe ID	MSDU Number

- Alternative of ACK/NACK bit is to use MSB indication bit in each subframe block

- Need to include a table in the draft spec:

	B13	B14
Data with UEP	MSB indication	LSB indication
Data with EEP	ACK/NACK	Reserved

Comment #31

- Comment
  - The rules for Blk-ACK need to be filled out.
- Resolution
  - The rule of Blk-ACK will be provided as long as the Blk-ACK frame format is finalized

Following slides show the uploaded resolutions on March 3, 2008 (up to Comment #32) – **no change**

Comment #2

- Comment
  - Do we need a capability bit that indicates a DEV is MMC PNC capable?

- Resolution:
  - No. Because SC (1bit), AV-OFDM (1bit) and HSI-OFDM (1bit) fields in the capability IE can be used as an indication of MMC capability
  - MMC PNC could be defined as either of the following three types
    - Support SC + AV-OFDM
    - Support SC + HSI-OFDM
    - Support SC + AV-OFDM + HSI-OFDM

    In any case, MMC capability can be indicated by using SC, AV-OFDM and HSI-OFDM capability fields in the capability IE

Comment #9 (1/4)

- Comment
  - How do we encode all of the supported data rates.

- Resolution
  - By using 14=7+1+6 bit field in DEV capabilities field all of the supported data rates for three PHY mode are encoded as in the current discussion below
    - 7 bits for capabilities in SC case
    - 1 bits for AV-OFDM case
    - 6 bits for HSI-OFDM case

Data rate encoding (2/4) SC case

- By using 7 = 3(for Modulation scheme)+3(for coding scheme)+1(for spreading factor) bits, MCS in SC case can be encoded.

- By using 3 bits in DEV capabilities field that reveal possible 7 cases data rate in SC case shall be indicated
  - BPSK: BPSK (1 case)
  - QPSK: BPSK + QPSK (1 case)
  - 8QAM: BPSK+QPSK+8QAM (1 case)
  - 16QAM: BPSK+QPSK+[8QAM or not] +16QAM(2cases)
  - OOK/DRB: [OOK or DRB] + BPSK (2cases)
- 3 bits to reveal capabilities of 5 FEC types, 2 bit indicate to which coding rate of LDPC (576, K) is possible, and 1bit to indicate capability of LDPC(1440, 1344)
  - RS(255, 239): mandatory
  - LDPC(576, 288)
  - LDPC(576, 432)
  - LDPC(576, 504)
  - LDPC(1440, 1344)
- 1 bit to reveal capabilities of spreading factors for OOK
  - 1 and 2

MCS Class	MCS ID	PHY-SAP rate (Mbs)	Modulation Scheme	Spreading factor	FEC Type	FEC Rate
Class 1	LR1	**50.6**(CR)/379.6/ 759.2/**1518.4**(MLR)	p/2-BPSK/(G)MSK	32/4/2/1	RS(255,239)	0.937
	LR2	607.5/1215.0	p/2-BPSK/(G)MSK	2/1	LDPC(576,432)	0.750
	LR3	810.0	p/2-BPSK/(G)MSK	1	LDPC(576,288)	0.500
Class 2	MR1	1620.0	p/2-QPSK	1	LPDC(576,288)	0.500
	MR2	2430.0	p/2-QPSK	1	LPDC(576,432)	0.750
	MR3	2835.0	p/2-QPSK	1	LDPC(576,504)	0.875
	MR4	3024.0	p/2-QPSK	1	LDPC(1440,1344)	0.933
	MR5	3036.7	p/2-QPSK	1	RS(255,239)	0.937
Class 3	HR1	4555.1	p/2-Star 8QAM	1	RS(255,239)	0.937
	HR2	6073.4	p/2-16QAM	1	RS(255,239)	0.937
Class 4	OOK1	1518.4/759.2	OOK	1/2	RS(255,239)	0.937
	DRB1	3036.7	Dual Rail Bipolar	1	RS(255,239)	0.937

Data rate encoding (3/4) AV-OFDM case

- By using 1 bit field, each capability of AV-OFDM data rates can be indicated
  - If all DEVs are assumed to support all modulation scheme of BPSK, QPSK, 16QAM, no bits are required to indicate the modulation capabilities
  - If all DEVs are assumed to support all coding rates (1/2, 1/3, 2/3), no bits are required to indicate the coding scheme capabilities
  - By using 1 bit, UEP capability can be indicated
    - UEP capable
    - UEP not capable

Table 95—HRP data rates and coding

HRP mode index	Coding mode	Modulation	Code rate		Raw data rate (Gb/s)
			MSB	LSB	
			[7] [6] [5] [4]	[3] [2] [1] [0]	
0	EEP	QPSK	1/3		0.952
1		QPSK	2/3		1.904
2		16-QAM	2/3		3.807
3	UEP	QPSK	4/7	4/5	1.904
4		16-QAM	4/7	4/5	3.807
5	MSB-only retransmission	QPSK	1/3	N/A	0.952
6		QPSK	2/3	N/A	1.904

Table 96—LRP data rates and coding

LRP mode index	Modulation	FEC	Raw data rate (Mb/s)	Repetition
0	BPSK	1/3	2.5	8×
1		1/2	3.8	8×
2		2/3	5.1	8×
3		2/3	10.2	4×

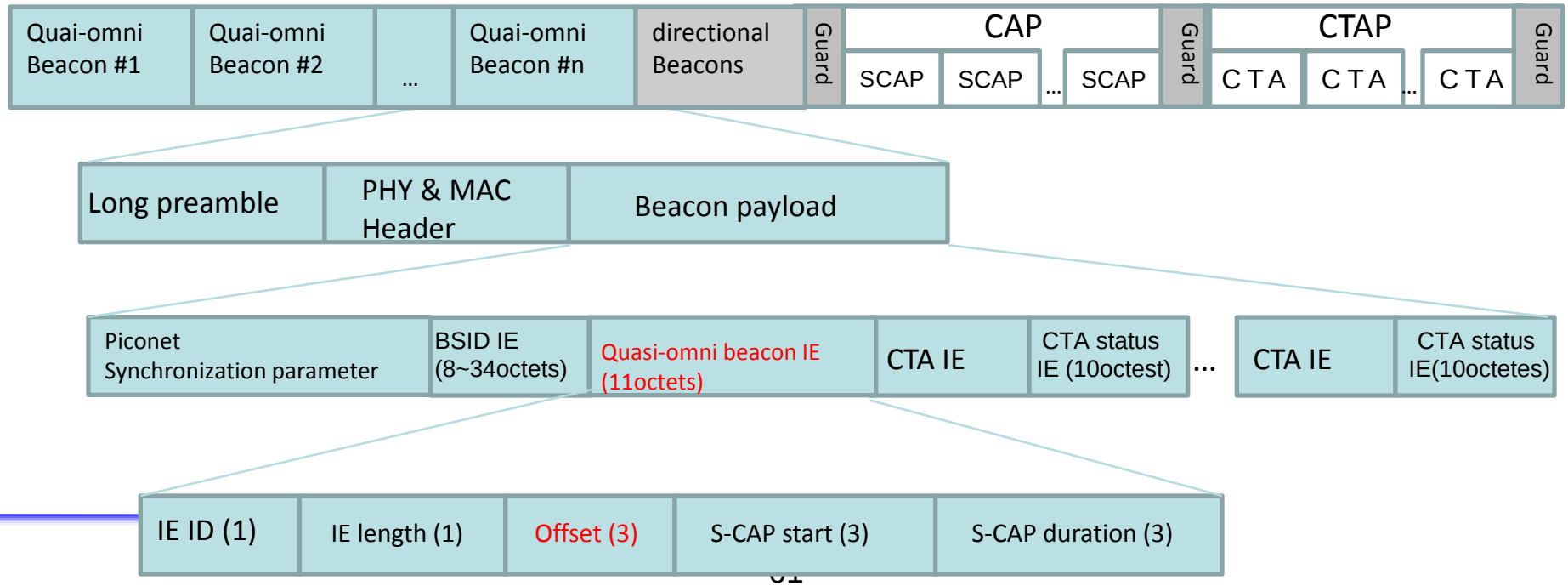
Data rate encoding (4/4) HSI-OFDM case

- 6 bits can adequately indicate capability of HSI-OFDM data rates
  - 1 bit is needed to indicate whether optional 16QAM is possible or not
    - QPSK, 16QAM: both mandatory
    - QPSK, 16QAM and 64QAM
  - 1 bit is needed to indicate whether capable of UEP or not
  - 1 bit is needed to indicate EEP without Reed Solomon is possible or not
  - 3 bits are adequate to indicate all possible capabilities of LDPC parameters and data rates

MCS	Data Rate (Mbps)	Modulation scheme	Coding mode	Outer FEC rate	Inner FEC rate (R_I)		Spreading factor	Spread & coded bits/sym.	Coded bits/sym.	Data info* bits/sym.	
					MSB 8b	LSB 8b				MSB 7:4	LSB 3:0
0	59	QPSK	EEP	0.94	1/2		24	672	28	14	
1	708	QPSK		0.94	1/2		2	672	336	168	
2	1416	QPSK		0.94	1/2		1	672	672	336	
3	2124	QPSK		0.94	3/4		1	672	672	504	
4	2478	QPSK		0.94	7/8		1	672	672	588	
5	2832	16-QAM		0.94	1/2		1	1344	1344	672	
6	4248	16-QAM		0.94	3/4		1	1344	1344	1008	
7	4956	16-QAM		0.94	7/8		1	1344	1344	1176	
8	6372	64-QAM		0.94	3/4		1	2016	2016	1512	
9	1512	QPSK	EEP	1	1/2		1	672	672	336	
10	2664	QPSK		1	7/8		1	672	672	588	
11	4536	16-QAM		1	3/4		1	1344	1344	1008	
12	1770	QPSK	UEP	0.94	1/2	3/4	1	672	672	336	504
13	2301	QPSK		0.94	3/4	7/8	1	672	672	504	588
14	3540	16QAM		0.94	1/2	3/4	1	1344	1344	672	1008
15	4602	16QAM		0.94	3/4	7/8	1	1344	1344	1008	1176

Comment # 11

- Comment
  - How do DEVs know when the superframe starts and when the last beacon ends if they receive one beacon in the middle of a set of beacons.
- Resolution
  - Quasi-omni beacon IE is defined to indicate the offset from the start of the superframe to the first symbol of the current received beacon



Comment # 12

- Comment
  - How does a DEV know when the first symbol of the beacon is sent when there is repetition coding.

- Resolution
  - If this Comment is addressed for SC, the answer is that, repetition coding (spreading?) only applies to beacon header and payload, but not preamble. As long as preamble is detected, the first symbol of the beacon is determined

Comment #16 and #38

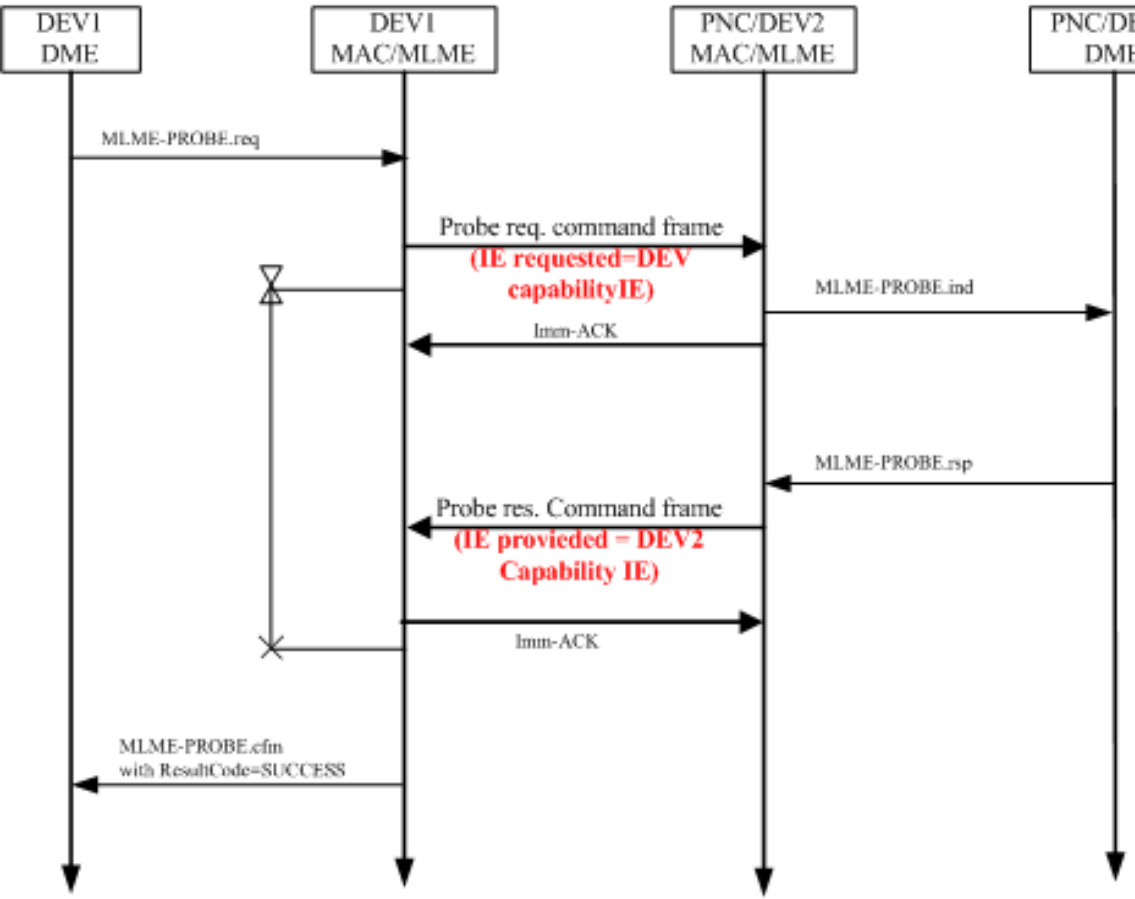
- Comment #16
  - What is the definition of the value of the channel status information field?
- Resolution
  - The definition of the channel status information value is **SNR, RSSI, FER (BER) and so on** to determine the highest available data rate in the current channel

- Comment #38
  - Can we use the existing facilities in 802.15.3b to accomplish this in a manner that improves the performance
- Resolution
  - No. 15.3b frame format (channel status request) needs to be modified to include SNR, RSSI, FER and so on
  - The modified frame format will be discussed at Orlando meeting

Comment #17 and #36

- Comment #17
  - Can this be done with an information element? Also, there are some updates to the frame format that need to be reviewed.
- Resolution
  - Yes, rather than creating new command frame, UEP (TBD) IE can be exchanged for the same purpose. This issue is related with Comment #36
- Comment #36
  - Rather than using commands, if the UEP capabilities are exchanged as part of the normal capabilities exchange, then the commands are not needed.
- Resolution
  - That is right. 802.15.3 already has the peer discovery function (use probe command) which can be used to exchange UEP information. What needed is just to exchange UEP (TBD) IE between DEVs which have intention of UEP streaming

Use 802.15.3 probe command for UEP information exchange



Probe request

octets: 2	4	2	2
Request index	Information requested	Length (=6)	Command type

bits: b31–b1	b0
IEs requested	IE request type

To request UEP IE

Probe response

octets: n	2	2
IEs provided	Length (=n)	Command type

Answer back UEP IE

Comment #18

- Comment
  - Why is handover optional? Should it be restricted to certain cases.
- Resolution
  - For Peer to Peer communication (e.g., cellular to cellular communication), PNC handover may not be necessary. In addition, Kiosk acting as PNC should not allow handover to any DEV in the piconet by reasons of security or accounting although the DEV is PNC capable and DES-mode. Thus, handover should be restricted to certain cases, which means that handover is optional.

Comment #19

- Comment
  1. Need rules to describe that the beacon PHY mode shall not change while in operation.
  2. Also, that on handover, the new PNC uses the same PHY mode for the beacon as the old PNC. If so, we may be able to leave PNC Des-Mode as the top criteria for handover.

- Resolution
  1. Add description “Beacon PHY mode shall not change while in operation” in baseline document
  2. Input the description “PNC handover is only allowed between the same PHY mode” in baseline document

Comment #26

- Comment
  - Can all three PHY modes use the same SIFS and list this in the capabilities field to be used in an CTA.

- Resolution
  - Yes. It is preferable that capability as for same SIFS set is commonly indicated among three PHY modes

Comment #29

- Comment
  - Can we unify the aggregation?

- Resolution
  - Yes. Modifications on SC aggregation can realize unification with AV-OFDM aggregation as show below
    - Modified SC : subframe size up to 1Moctets from 512octets, subframe number up to 8
    - AV-OFDM: subframe size up to 1Moctets, subframe number up to 7

Comment # 35

- Comment
  - There needs to be a way for the upper layer that is the source of data to say if the use of UEP is allowed for the data stream.

- Resolution
  - This is out of the scope of 802.15.3 standard. For implementation, MAC-SAP can be extended for this. In MAC-ISOCH-DATA.request primitive, a parameter to tell lower layer that upper layer requires to use UEP needs to be defined. The other direction, in the MAC-ISOCH-DATA.confirm primitive, the Result Code needs be extended to report back the UEP capability of lower layer.

MAC-SAP extension for UEP

- MAC-ISOCH-DATA.request
(
RequestID,
StreamIndex,
TransmitTimeout,
MaxRetries,
SNAPHeaderPresent,
ACKRequested,
ConfirmRequested,
UEPRequested,
Length,
Data
)

Name	Type	Valid range	Description
UEPRequested	Boolean	TRUE FALSE	Indicates if the request requires using UEP

- MAC-ISOCH-DATA.confirm
(
RequestID,
StreamIndex,
TransmitDelay,
ResultCode,
ReasonCode
)

Name	Type	Valid range	Description
ReasonCode	Enumeration	TRANSMIT_TIMEOUT, MAX_RETRIES, NOT_ASSOCIATED, UEP_NOT_SUPPORT, OTHER	The reason for the request failure

Comment #25 (Editorial)

- Comment
  - Move the text in this subclause (8.2.5a) to the informative annex
- Resolution
  - We agree to move the newly added text in 8.2.5a(Child piconet) to the informative annex

Comment #32 (Editorial)

- Comment
  - Table 58 does not need to any changes

- Resolution
  - Although Table 58 does not change from 802.15.3b, the description “PNC handover is only allowed between the same PHY mode” shall be input in the baseline document