802.3bn EPoC Ad-hoc
Multiple Modulation Profile (MMP)

We'll wait a few minutes for people to join the bridge – please stand-by

May 2, 2013

Jorge Salinger, Comcast – Chair

Instructions for the WG Chair

The IEEE-SA strongly recommends that at each WG meeting the chair or a designee:

- **Show slides #1 through #4 of this presentation**
- **Advise the WG attendees that:**
  - The IEEE's patent policy is described in Clause 6 of the *IEEE-SA Standards Board Bylaws*;
  - Early identification of patent claims which may be essential for the use of standards under development is strongly encouraged;
  - There may be Essential Patent Claims of which the IEEE is not aware. Additionally, neither the IEEE, the WG, nor the WG chair can ensure the accuracy or completeness of any assurance or whether any such assurance is, in fact, of a Patent Claim that is essential for the use of the standard under development.
- **Instruct the WG Secretary to record in the minutes of the relevant WG meeting:**
  - That the foregoing information was provided and that slides 1 through 4 (and this slide 0, if applicable) were shown;
  - That the chair or designee provided an opportunity for participants to identify patent claim(s)/patent application claim(s) and/or the holder of patent claim(s)/patent application claim(s) of which the participant is personally aware and that may be essential for the use of that standard
  - Any responses that were given, specifically the patent claim(s)/patent application claim(s) and/or the holder of the patent claim(s)/patent application claim(s) that were identified (if any) and by whom.
- The WG Chair shall ensure that a request is made to any identified holders of potential essential patent claim(s) to complete and submit a Letter of Assurance.
- It is recommended that the WG chair review the guidance in *IEEE-SA Standards Board Operations Manual* 6.3.5 and in FAQs 12 and 12a on inclusion of potential Essential Patent Claims by incorporation or by reference.

Note: **WG** includes Working Groups, Task Groups, and other standards-developing committees with a PAR approved by the IEEE-SA Standards Board.

(Optional to be shown)

Participants, Patents, and Duty to Inform

All participants in this meeting have certain obligations under the IEEE-SA Patent Policy.

- Participants [Note: Quoted text excerpted from IEEE-SA Standards Board Bylaws subclause 6.2]:
  - "Shall inform the IEEE (or cause the IEEE to be informed)" of the identity of each "holder of any potential Essential Patent Claims of which they are personally aware" if the claims are owned or controlled by the participant or the entity the participant is from, employed by, or otherwise represents
    - "Personal awareness" means that the participant "is personally aware that the holder may have a potential Essential Patent Claim," even if the participant is not personally aware of the specific patents or patent claims
  - "Should inform the IEEE (or cause the IEEE to be informed)" of the identity of "any other holders of such potential Essential Patent Claims" (that is, third parties that are not affiliated with the participant, with the participant's employer, or with anyone else that the participant is from or otherwise represents)
- The above does not apply if the patent claim is already the subject of an Accepted Letter of Assurance that applies to the proposed standard(s) under consideration by this group
- Early identification of holders of potential Essential Patent Claims is strongly encouraged
- No duty to perform a patent search

Patent Related Links

All participants should be familiar with their obligations under the IEEE-SA Policies & Procedures for standards development.

Patent Policy is stated in these sources:

IEEE-SA Standards Boards Bylaws

http://standards.ieee.org/develop/policies/bylaws/sect6-7.html#6

IEEE-SA Standards Board Operations Manual

http://standards.ieee.org/develop/policies/opman/sect6.html#6.3

Material about the patent policy is available at

http://standards.ieee.org/about/sasb/patcom/materials.html

If you have questions, contact the IEEE-SA Standards Board Patent Committee Administrator at patcom@ieee.org or visit http://standards.ieee.org/about/sasb/patcom/index.html

This slide set is available at https://development.standards.ieee.org/myproject/Public/mytools/mob/slideset.ppt

Call for Potentially Essential Patents

- If anyone in this meeting is personally aware of the holder of any patent claims that are potentially essential to implementation of the proposed standard(s) under consideration by this group and that are not already the subject of an Accepted Letter of Assurance:
  - Either speak up now or
  - Provide the chair of this group with the identity of the holder(s) of any and all such claims as soon as possible or
  - Cause an LOA to be submitted

Other Guidelines for IEEE WG Meetings

- **All IEEE-SA standards meetings shall be conducted in compliance with all applicable laws, including antitrust and competition laws.**
  - **Don't discuss the interpretation, validity, or essentiality of patents/patent claims.**
  - **Don't discuss specific license rates, terms, or conditions.**
    - Relative costs, including licensing costs of essential patent claims, of different technical approaches may be discussed in standards development meetings.
      - Technical considerations remain primary focus
  - **Don't discuss or engage in the fixing of product prices, allocation of customers, or division of sales markets.**
  - **Don't discuss the status or substance of ongoing or threatened litigation.**
  - **Don't be silent if inappropriate topics are discussed … do formally object.**

See *IEEE-SA Standards Board Operations Manual*, clause 5.3.10 and "Promoting Competition and Innovation: What You Need to Know about the IEEE Standards Association's Antitrust and Competition Policy" for more details.

Agenda

- Attendance
- Review IEEE Patent Policy
- MMP Definitions (for straw poll)

MMP Straw Polls to Date

Straw Polls

- Should MMP be required for TDD?
  - Yes: 21 No: 2 Undecided: 6
- Should MMP be specified for DS in FDD?
  - Yes: 9 No: 9 Undecided: 10
- Should MMP be REQUIRED for DS in FDD?
  - Yes: 3 No: 18 Undecided: 7
- Should MMP be optional for DS in FDD?
  - Yes: 7 No: 17 Undecided: 4

Straw Polls (Continued)

- Should MMP be specified for US in FDD?
  - Yes: 15 No: 3 Undecided: 9
- Should MMP be required for US in FDD?
  - Yes: 9 No: 9 Undecided: 10
- Should MMP be optional for US in FDD?
  - Yes: 8 No: 14 Undecided: 6
- MMP shall be used in bursting DS and US transmissions in the EPoC standard.
  - Yes: 20 No: 1 Undecided: 10

Straw Polls – May 2, 2013

- For DS TDD, the CNU will support at least 2 active downstream modulation profiles.
  - Agree: 7 Disagree: 0 Abstain: 5
- For DS TDD, the CLT will support at least six active downstream modulation profiles.
  - Yes: 7 No: 0 Abstain: 4

MMP Baseline Decisions

MMP Decisions

- Multiple Modulation Profiles will be used in the bursting downstream PHY (TDD) and in the bursting upstream PHY (TDD and FDD).
- Decision 19 (Motion 4 from Orlando): The EPoC standard shall support multiple modulation profiles for the bursting DS and US PHY and a single modulation profile for the continuous DS PHY.

Open Modulation Profile Topics

Modulation Profile Definition

Modulation Profile (MP) Definition

What parameters are defined within a Modulation Profile?

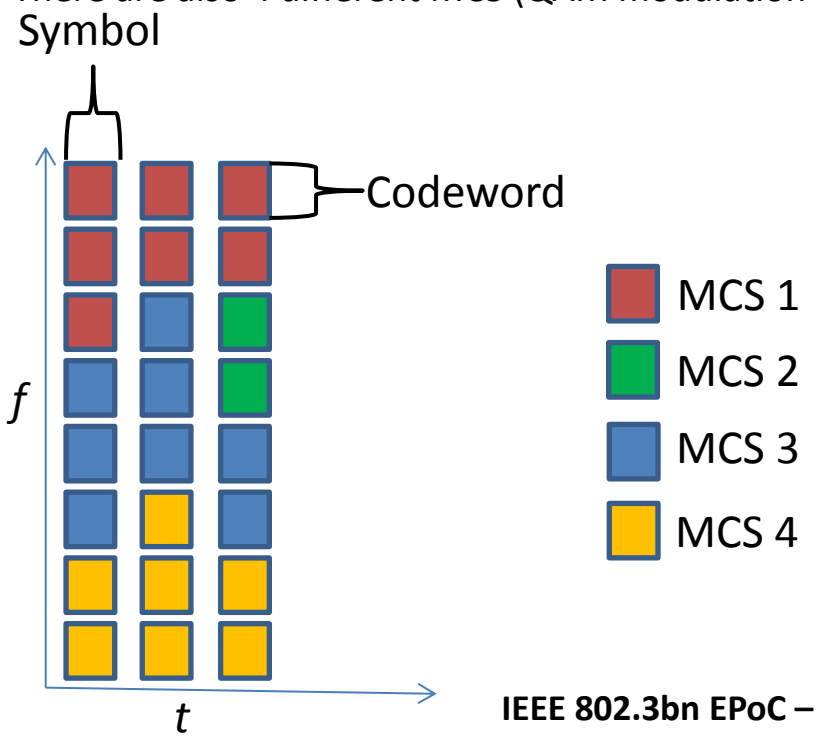
- Qualcomm Proposal: Modulation order and FEC code rate
  - Applies the same modulation and coding to all the subcarriers carrying the code word, matching the average channel quality.
- Will we use a different modulation profile for the DS than we use for the US?
  - Qualcomm: MCS for DS; MCS or bit loading for US
  - Was suggested on 4/25 call that US uses MCS and DS uses bit loading
- We need to create a list of the MPs that are supported in each direction (could be the same list)

What is an MCS

- A Modulation and Coding Scheme defines:
  - A fixed QAM modulation order
  - A fixed FEC Code rate and length
- An MCS is applied to FEC codewords

What is an MCS Modulation Profile?

- A Modulation Profile with Constant MCS
- An MCS Modulation Profile will define the MCS for each individual codeword in a symbol period.
- The QAM modulation order and FEC code rate applied to a codeword is based on the average channel characteristics of the subcarriers carrying an individual codeword.
  - In this example, there are 3 symbols; each has a different MCS Modulation Profiles applied to it.
  - There are also 4 different MCS (QAM modulation order + FEC rate) being used.



Straw Poll x
Defining Modulation Profiles

- A Modulation Profile based on MCS will be called an MCS Modulation Profile.
  - An MCS Modulation Profile applies the same MCS (QAM modulation order and FEC rate) to all of the subcarriers carrying an individual codeword. The MCS applied to each code word is determined by the average channel characteristics of the subcarriers carrying that codeword. Multiple codewords may have the same MCS.
- A Modulation Profile based on a Bit Loading scheme will be called a Bit-Loaded Modulation Profile.
  - A Bit-Loaded Modulation Profile applies a QAM modulation order for each subcarrier or group of subcarriers, based on the subcarrier's narrowband channel characteristics. Each subcarrier may have a different QAM modulation order.
  - The FEC code rate is determined by the size of the transmission.
  - ~~Typically, all subcarriers share the same FEC code rate.~~

- Agree:
- Disagree:
- Need more information

Straw Poll x

- For US (TDD and FDD), the CNU will support 1 active upstream modulation profile.

- For US (TDD and FDD), the CLT will support ?? Upstream modulation profiles.

Straw Poll x

- The TDD downstream will use multiple *MCS* Modulation Profiles.

- Agree:
- Disagree:
- Need more information

Straw Poll x

- The FDD downstream will use a single MCS Modulation Profile.

- Agree:
- Disagree:
- Need more information

Straw Poll x

- The TDD and FDD upstream will use multiple Bit-Loaded Modulation Profiles.

- Agree:
- Disagree:
- Need more information

Number of MPs Supported; MP Assignment and Switching

Number of MPs/Switching MPs

- How many MPs must the system support in the US direction (CNU to CLT)?
- How many MPs must the system support in the DS direction (CLT to CNU)?
- Minimum number of DS Profiles the CNU has to support: 2(LCD and optimal?)
- Minimum number of US Profiles the CNU has to support: 1 (?)
- Should we define a superset of MPs that are available, but only a subset of those can be “active” at any given time?
  - If there is a subset of MPs, can a MP be swapped out of the useable pool in a hitless fashion?
    - i.e., the subset is composed of 5 MPs and the superset is composed of 20 MPs. I swap MP number 5 out of the subset with MP number 20 from the superset.
  - How quickly can swaps be made?

Modulation Profile Assignment

- How are the modulation profiles a CNU has available for tx be communicated initially?
- How does the profile that a CNU should use get communicated and changed?
- Hitless movement between profiles for the CNU?

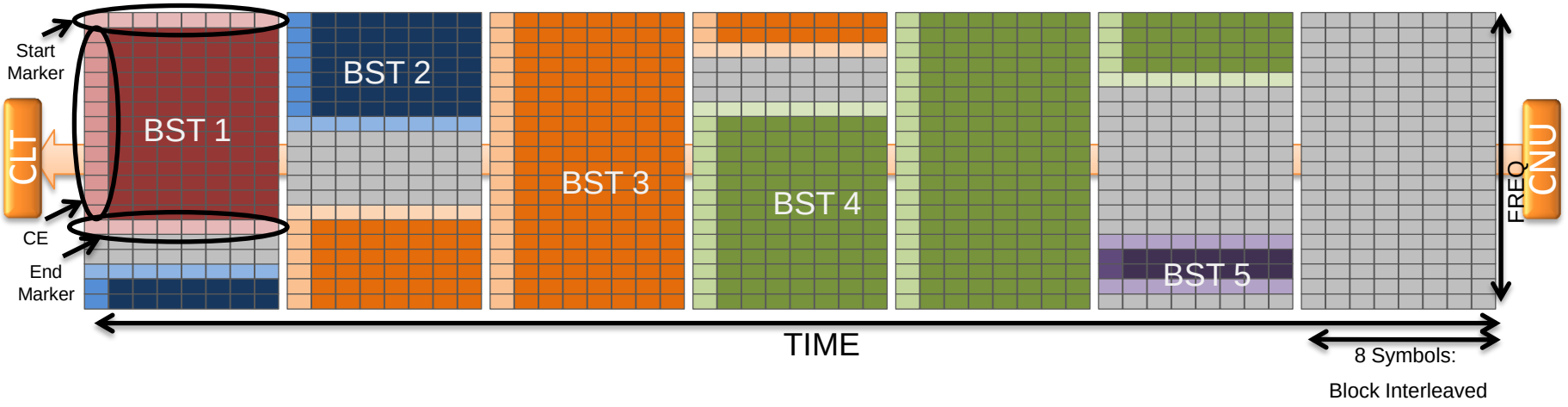
MP Signaling

MP Signaling

- How do we convey to the CLT the MP of the US burst?
- How do we convey to the CNU the MP of the DS burst?
- How do we convey the begin and end of a burst at a given modulation?

Upstream Burst Marker

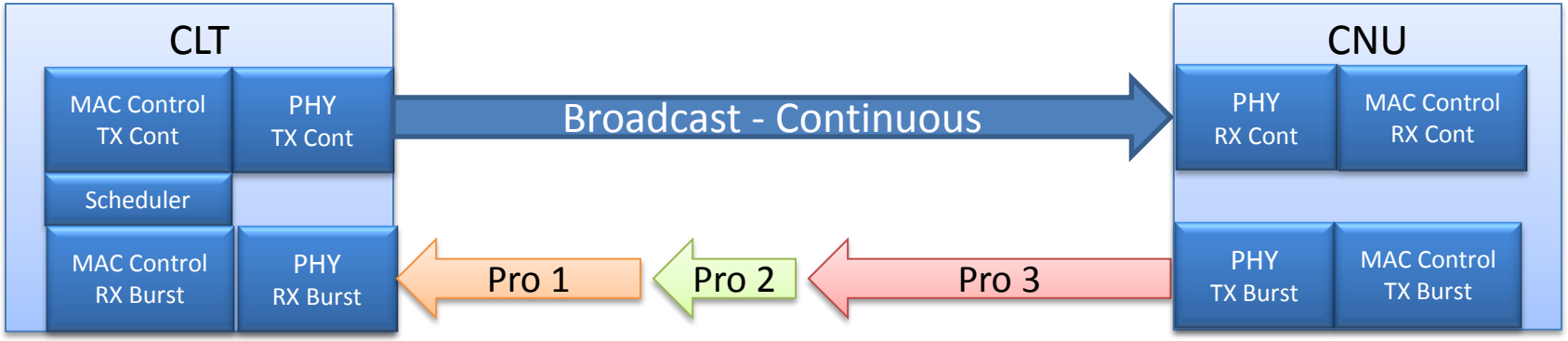
- From Ed Boyd, Broadcom. EPOC Upstream Mapping, Part 2, 2/26/13
- The exact carrier of a burst start is determined by the “Start Burst Marker”.
- The exact carrier of a burst end is determined by the “End Burst Marker”.
- The number of empty carriers between bursts is unknown due to discovery, idle upstream, or slight upstream jitter in the MAC transmit slot.
- Data from the burst is decoded by FEC decoder and last block size for shortened code word is determined by the end marker.
- Burst Marker Decoding should be simple so it can be done in parallel (on all carriers) before block de-interleaver.



Burst Marker Definition

- From Ed Boyd, Broadcom. EPOC Upstream Mapping, Part 2, 2/26/13
- Fixed Low Modulation Order Pattern (BPSK?)
- Easy to detect in bad channel conditions
- Simple Hamming Code to fix bit errors?
- Should be able to carry a small amount of data.
  - Profile ID that identifies the modulation profile used.
  - Different marker for each profile.
  - Distinct marker for start and end.
- Multiple Carriers for robustness?
- How can it be unique from normal data?
- Could we use a slightly different Channel Estimation Code or Pilots to signal the marker?

US Burst Characteristics



- From Ed Boyd, Broadcom. EPOC Upstream Mapping, Part 2, 2/26/13
- Upstream Bursts contain packets for a single modulation profile since they come from a single CNU. (Packet sorting is not required)
- Upstream Bursts will always end the FEC block so there is no additional penalty for shortened code words.
- Every CNU would store a single modulation profile for the upstream.
- CNUs on different profiles would have a different conversion equation from Byte to TQ. Only one conversion needed.
- CLT PHY needs to detect and decode multiple profiles.

CNU PHY should be simple, CLT PHY is more complex

Multicast

Multicast Details

- Multicast
  - Do we need multicast LLIDs, like DOCSIS 3.1?
  - Does multicast go on the LCD LLID?