Some Issues of Accommodation of TG1 MAC at TG3

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Purpose:
An input for 802.16 for a decision on the road map of TG3 MAC development

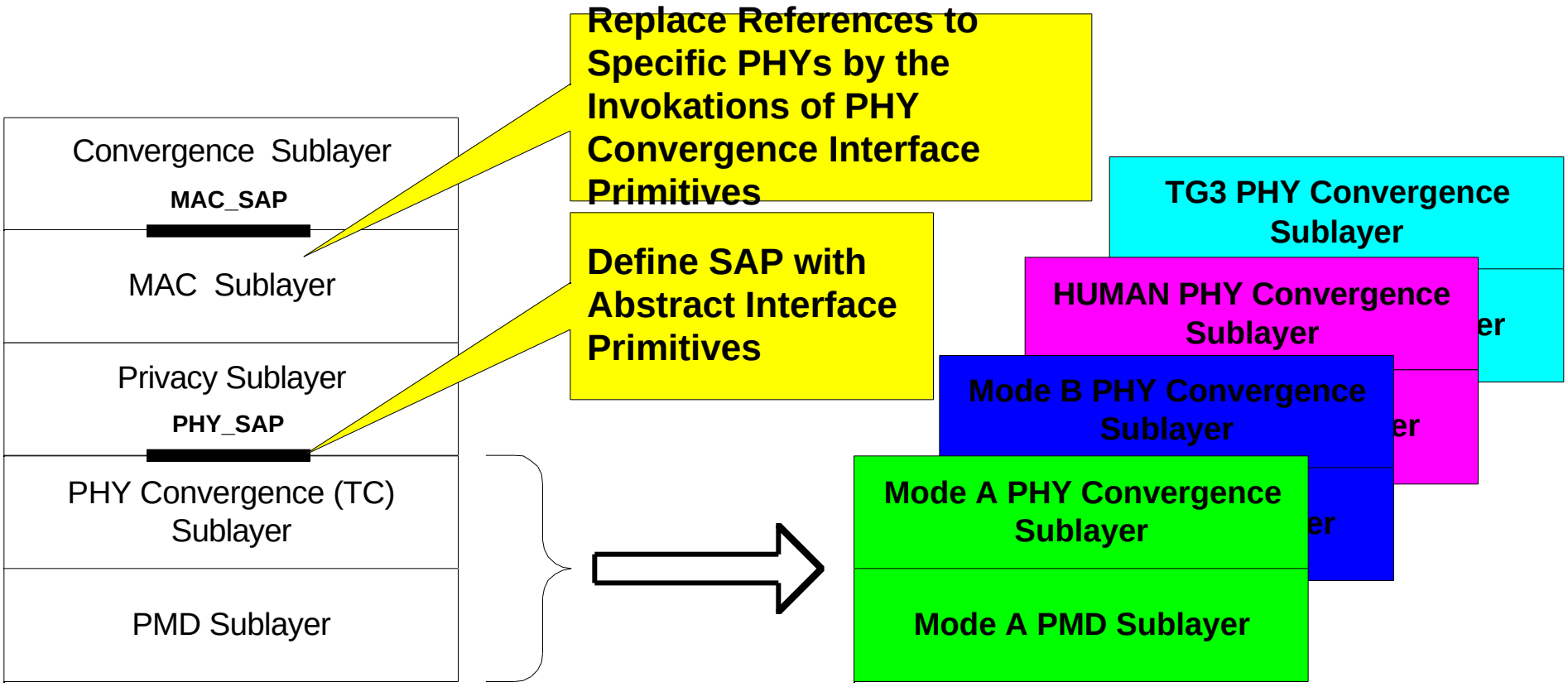
Some Issues of Accommodation of TG1 MAC at TG3

Vladimir Yanover

Main Issues

- MAC-PHY Separation:
  - PHY Convergence Sublayer and the corresponding SAP should be defined
  - References to the specific PHYs should be replaced with the references to generic PHY interface
- TG3 Specific Features to Be Added
  - Features Related to the Expected Differences in PHY and Channel Quality
  - Features Related to Specific Traffic Demand Statistics

MAC-PHY Separation:
Define PHY Convergence Sublayer



MAC-PHY Separation
PHY_SAP Primitives

- **Functions** of the PLCP sublayer and **PHY_SAP Primitives** should be defined for communication MAC ⇔ PHY, MAC ⇔ peer MAC etc.
- Example:
  - **PHY-TXSTART.request (TXTIME)** requires from PHY starting transmission at the given time, assuming the PHY parameters (like rate) have already been configured

MAC-PHY Separation

Parameters and Constants

Replace the explicit usage of PHY parameters with the references to PHY_SAP primitives MAC from the MAC document. Examples:

- "*The length of the preamble is 72 QAM symbols*" – 2.6.1.
- "*… each transmission associated with different SSs is required to start with a short preamble for phase re-synchronization*." – 2.6.4
- ……

MAC-PHY Separation
Parameters and Constants

Remove PHY Parameters from 2.3 "*Encodings for Configuration and MAC-Layer Messaging*" used in the configuration file, in SS registration requests and in Dynamic Service Messages e.g.

- 2.3.1.4 "*Downstream Modulation Configuration Setting*"
- 2.3.3.1.4 "*SS Modulator Types*"

Instead, we need a definition of generic information element that carry PHY specific information (Rate, coding, modulation, …) These elements will be then defined differently at the PHY Convergence parts for different PHYs.

MAC-PHY Separation

PHY Frame Structures

- Redefine the PHY frame structures, see e.g. 2.6.1.3 "*Time Division Duplexing (TDD)*" in clearly MAC terms. This includes a replacement for the specification of involved PHY parameters.
- Example: bursts with different types of ***QAM modulation*** at Figure 51 in [1] should be changed to bursts with different ***PHY parameters***.

MAC-PHY Separation
PHY Frame Structures

- Remove the definition of the Physical Layer Burst Profile Parameters (e.g. Table 9, Table 12, in 2.5.2.2) to the PHY sections of the standard

MAC-PHY Separation
PHY Frame Structures

- Definition of the Uplink Physical Channel Attributes (Table 7 in 2.5.2.1) should be removed to the PHY sections of the standard
- The same should be done for Downlink Physical Channel Attributes
- Redefine correspondently the PHY Control portion of the downlink subframe at 2.6.4.1

MAC-PHY Separation
MAC Frame Structures

- Reconsider the definition of the time unit (PS = Physical Slot) in the MAC Control portion of the downlink subframe (2.6.4.1). The time unit has to provide sufficient granularity in bandwidth allocation for all PHYs

TG3 Specific Features to be Added

Features Related to the Expected Differences in PHY

- Frame Length options in PHY Synchronization topic, [1], 2.5.3 are defined as 0.5, 1, 2 milliseconds.
- The TG3 applications require
  - Larger frame
  - More flexible frame size that may change e.g. in busy hours or even from frame to frame, dependently on bit rates and changes in demand granularity

TG3 Specific Features to be Added

Features Related to the Expected Differences in PHY

- MAC Control portion of the DL subframe in 2.6.4.1.

2.6.7.2. "***One mini-slot contains N PHY slots (PS), where N = 2^m (where m = 0..7). Since each PS contains 4 modulation symbols, …"***

4 symbols = up to 108 bytes in 802.11a OFDM

- Time unit(s) should be redefined to serve certain frame size quantization vs. bit rate options. The resolution should be sufficient to avoid serious padding overhead for Ethernet frames

TG3 Specific Features to be Added

Features Related to the Expected Differences in PHY

- 2.5.2.1: “An Uplink Channel Descriptor shall be transmitted by the BS at a periodic interval to define the characteristics of an upstream physical channel. A separate UCD Message shall be transmitted for each active uplink”.
- Because of the potentially more fast (comparatively to the frame length) changes in the propagation conditions (multipath at considerably low Radio frequencies) we need an additional mechanism to support more dynamic, ideally per packet, changes in the bit rate

TG3 Specific Features to be Added

Reasons for Lower Channel Quality

- Cheap CPEs with less budget to installation and less possibilities for an operator to place better antennas at proper places
- Lower Radio frequencies together with possible in-door deployment imply multipath interference
- Inter-cell interference in mass cellular deployment
- [HUMAN] Interference because of sharing the medium with e.g. “hidden” 802.11-UNII band terminals and simply non-IEEE devices

TG3 Specific Features to be Added

MAC Level ARQ

- Additional functions to avoid higher layer retransmissions which impact negatively the TCP applications (sensitive to the delay variations and packet loss)
- **MAC Level ARQ** including (see the comment at 2.5)
  - Checksum definition for a fragment
  - ARQ Feedback concept (ACK, NACK, ACK timeout, interaction with Convergence Layer entities, …) and the coding of the correspondent messages

TG3 Specific Features to be Added

Power and Rate Management

- Dynamic Rate Control (per packet), clearly associated in implementations with ARQ (packet failure requires retransmission at lower rate etc.)
- Transmit Power Control, designed to deal with long no-transmit periods and fast recovery. Possible solution could be, for example, a “RNG-RSP”-like packet sent by a BS as a response to an uplink packet at BS’s discretion.

TG3 Specific Features to be Added

Statistics of the Demand

- For the residential and SOHO the **Internet access** is the most important if not a dominant application
- The total demand per Base Station (sector) is an **integration of numerous streams** (tens or even hundreds) passing to/from CPEs

TG3 Specific Features to be Added

Statistics of the Demand

- The total uplink demand is a composition of a **large number of small elementary demands, with low duty cycle**, that appear **randomly** and independently at numerous CPEs
- Therefore strong efforts should be done to **discover and handle fast changes** of the origin and amount of the **demand**

TG3 Specific Features to be Added
Bursty Traffic: Possible Tools

- (If OFDM PHY Selected) Employ “Fast Polling” mechanism: CPE is choosing to transmit a fixed subcarrier so that BS has to encounter only the fact of transmission reducing the following polling to a small subset of the all SSs.
- Contention-based data frame transfers with exponential Backoff (as in 802.11 DCF).
- Slotted Aloha transmission of the data fragments