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Contact:	Denis Khotimsky	+1-978-614-3363	dkh@motorola.com
Contact:			
Contact:			

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Introduction

- 5 This document presents the editorial notes on the two XG-PON power management contributions submitted for consideration during the March 31 conference call

1 Preliminaries

1.1 Requirements

5 *NOTE: Editorial version of the operator requirements (March 5) signed off by Anna Cui, Albert Rafel, and Junichi Kani.*

The June 2010 version of G.987.3 SHALL contain a specification of **cyclic sleep** as an optional to implement feature that ensures that:

- 10 (1) an ONU can be periodically put to sleep so that both Rx and Tx as well as the other major functions are turned off;
 (2) the OLT can control the timing parameters of the sleep cycles of all associated ONUs;
 (3) any default parameters and attributes are specified in such a way that
 15 cyclic sleep is disabled;
 (4) any recommended values of parameters and attributes are left for further study.

In addition,

- 20 (5) the specification SHALL leave an operator a possibility to specify in the future an OLT that is capable of selectively buffering downstream data destined to each ONU in the sleep period and transmitting the data downstream when the respective ONU enters the active period.

25 Note that:

The word SHALL, of course, stands for a mandatory requirement.

- 30 Item (1) relies on the assumption that such a sleep operation allows substantial power saving at the expense of controlled and tolerable service impact. The validity of this assumption is out of scope of the TC layer spec. Item (5) requires the cyclic sleep feature specification to be compatible with the future buffering requirement, but the buffering requirement itself remains out of scope of the TC layer spec.

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In addition, the following has been previously agreed during the San Francisco face-to-face meeting

- 40 The June 2010 version of G.987.3 SHALL contain a specification of **dozing mode** as a MANDATORY to implement feature that ensures that an ONU can be periodically put to doze so that Tx, but NOT Rx, can be turned off, along with certain other functions. At the time the SFO decision was taken, the description of the doze mode had been long stable per G.Sup49.

45 1.2 Invitation to contribute

NOTE: Editorial email to the contributors (March 9 and March 11)

- 50 "I would like to invite you to draft a contribution towards the Power Saving clause of the spec... Please feel free to define the structure, but try to keep everything within the single file, identifying the text that in your view could belong to other parts of the spec or to the other specs.
 Please also try to stay as concise, precise and specific as possible."

2 Notes

2.1 Introduction and a word of caution

Two texts have been submitted for consideration: a contribution by Jeff Mandin and Hiroaki Mukai [PMC-MITS] and a contribution by Sam Sambasivan, Dave Eckard, and Dave Hood [ATT-ALU-ERIC].

The two texts approach the same problem with different signalling mechanisms. While discussing these texts, one has to distinguish the Cyclic sleep and Dozing as two types of the ONU power saving behaviour, on the one hand, and the associated sets of proposed signalling methods, on the other hand. It is the behaviours that are addressed in the operator requirements; it is the signalling mechanisms that are being proposed to fulfil those requirements. The discussion below applies the terms Cyclic sleep and Dozing to ONU behavioural types, while referring to the proposed signalling methods by the contribution names, or as PLOAM-based signalling [PMC-MITS] and embedded signalling [ATT-ALU-ERIC].

2.2 Conformance with the requirements

In treatment of Cyclic sleep both contributions successfully address the requirements specified in Section 1.1. In doing so [ATT-ALU-ERIC] applies the signaling mechanism previously discussed in the context Dozing to Cyclic sleep as well, specifying the distinctions between the two behavioral types. In its turn, [PMC-MITS] extends the proposed PLOAM-based signaling method to the Dozing mode, but no distinction between the two behavioral types is made.

Note the SFO decision to make the Dozing mode mandatory to support was based on the G.Sup45 specification of the associated signaling mechanism. The G.987.3 specification should either retain the light-weight G.Sup45 signaling for the Dozing behavior, or reconsider the mandatoriness of Dozing under PLOAM-based signaling method.

2.3 Completeness

Both proposed texts do not contain the discussion of the accelerated state transitions at the end of the sleep period (in O1..O7 terms). The state transitions are invariant to a particular signalling method and shall be included in to the G.987.3 specification following the G.Sup45 treatment.

[PMC-MITS] does not contain the discussion of the OMCI feature negotiation and configuration step. This step would have to be restored (following [ATT-ALU-ERIC], if necessary, with obvious attribute changes) as long as Cyclic sleep is optional to implement.

Both drafts fail to formulate the LOSi suppression and detection rules. In case of [ATT-ALU-ERIC], in particular, the LOSi declaration may depend on number of allocations that remain unanswered against the FG bit set. *[Pointed by Hiroaki Mukai]*

While both [ATT-ALU-ERIC] and [PMC-MITS] provide the diagrams with ideal signaling exchanges, they are largely missing a discussion of the non-ideal, unexpected events and corner cases. It appears that in the PLOAM-based case of [PMC-MITS], a stateful treatment with a considerable amount of yet-to-be-developed text is needed.

2.4 Embedded and PLOAM-based signalling mechanism

[PMC-MITS] introduces a set of four new PLOAM message types in support of Sleep cycle enter request, Sleep cycle enter acknowledgment, Sleep mode change indication, and broadcast Sleep instruction. [ATT-ALU-ERIC] achieves the same goal with reusing the embedded signaling mechanism previously discussed in the Dozing context and composed of the Ind bits and the Force response signal, for which the previously reserved bit of the allocation structure is designated.

While power management constitute a legitimate “future use” for the reserved bit, the alternative proposals to designate this bit should be checked (in particular, would it be needed to extend the Profile index field?).

- 5 Unlike [ATT-ALU-ERIC], [PMC-MITS] as contributed, prevents the ONU from waking up and returning to action early in the sleep cycle, should a local stimulus arise. This appears to be an issue of the provided implementation examples rather than an issue of the proposed signaling mechanism. It can be fixed by recommending continuous PLOAM allocations to the ONUs throughout their respective sleep cycles.

- 10 Unlike [PMC-MITS], [ATT-ALU-ERIC] does not provide for synchronized wake up of all sleeping ONUs. However, in the course of G.Sup45 discussion the synchronized wake up was emphasized as a deficiency of the proposed signaling method: the traffic engineering considerations call for any burst activity in the network to be spread and randomized in time. At that time the use of unicast Sleep messages was offered as an alternative.

- 15 Also, unlike [PMC-MITS], [ATT-ALU-ERIC] does not provide OLT with the exact knowledge of the wake up time of a sleeping ONU, guaranteeing instead that the ONU will wake up within the time limits specified by the OLT. Nevertheless, as the OLT cannot know when the downstream activity may resume, the effective knowledge of the upper bound on the elapsed time between the resumed downstream activity and the ONU wake up is common to both signaling mechanisms.

2.5 Power efficiency

- 20 The embedded signalling mechanism [ATT-ALU-ERIC] appears to be more power efficient than the PLOAM-based signalling mechanism [PMC-MITS], as the former avoids upstream transmissions during the active periods when neither side wishes to terminate the Cyclic sleep behaviour.