Minutes
IEEE 802.3av 10GEPON Task Force Meeting
San Francisco, California
July 17-19, 2007

Meeting minutes for Tuesday, 17 July 2007
Meeting commences at 9:00am (Glen, Kramer, Chair)

Presentation: Agenda and General Information
- Presented by Glen Kramer at 9:00am
- Lowell Lamb volunteered as recording secretary

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Motion 1 (9:02am)

Approve minutes from May 2007 meeting.

Moved: Daun Langston
Seconded: Denis Beaudoin
(Procedural, requires ≥ 50% approval)

Passed by voice vote without opposition

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Chair goes over Ground Rules:
- Chair covers Private Directory on Task Force Reflector
- Chair covers policy in IEEE-SA operations manual regarding disclosure of affiliation. It is mentioned that failure to properly disclose affiliation can lead to loss of membership privileges and attendance credit.
- IEEE patent policy is discussed at 9:07am.
- Chair makes Call for Patents at 9:09am. No responses were received.
- Timeline was reviewed at 9:10am.
- Schedule for meeting was reviewed at 9:11am.

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Motion 2 (9:15am)
Approve agenda as presented in 3av_0707_agenda.pdf.

Moved: Jeff Mandin
Seconded: Bidyut Parruck
(Procedural, requires ≥ 50% approval)

Passed by voice vote without opposition

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- Chair covers inappropriate topics for discussion
- Chair reviews future IEEE 802 plenary meetings
- Chair reviews next interim meeting in Seoul, September 2007

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Presentation: Broadcast in a coexistence-enabled PON

- Presented by Jeff Mandin at 9:20am
- Suggestion is made that 10G broadcast traffic should be handled differently from 1G broadcast traffic.
- Proposed changes to the RS are described.
- Proposed changes to MAC also are described
- Discussion of solution for broadcast LLID assignment

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Motion 3 (9:45am)

There shall be a Broadcast MAC instance for 10G distinct from the 1G Broadcast MAC instance:

Moved: Jeff Mandin
Seconded: Frank Effenberger
(Technical, requires ≥ 75% approval)

Yes: 19
No: 0,
Abstain: 11
Motion passed.

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Straw Poll 1 (9:50am)
Made by Jeff Mandin

I prefer:

10G ONUs receive broadcasts on LLID 0x7fff	**2**
10G ONUs receive broadcasts on LLID 0x7ffe	**6**
Something different	**0**

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- Chair asks Jeff to prepare a presentation describing differences among different choices in Straw Poll 1 for later in the meeting.

Presentation: Discovery for a coexistence-enabled PON

- Presented by Jeff Mandin at 9:52am

- This presentation reviews issues associated with registration of ONUs on a PON supporting mixed speeds.
- Modifications to the FLAGS field of the REGISTER_REQ message are proposed to address these issues.

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Straw Poll 2 (10:05am)
Made by Jeff Mandin

I prefer to:

Maintain the EPON Discovery scheme and identify the ONU upstream and downstream rates in REGISTER_REQUEST	**8**
Maintain the EPON Discovery scheme and identify the ONU in REGISTER_REQUEST. Also modify the Discovery GATE PDU to include a bitmap indicating the OLT listening rate(s) associated with the window.	**19**
Enhance Discovery so that it will use message arrival timing to identify the ONU.	**0**
No Opinion	**13**

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- Chair asks Jeff Mandin to prepare a detailed proposal regarding Discovery mechanisms for later in the meeting.

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Presentation: Report on 10GEPON Power Budget Discussion in Japan
- Presented by Motoyuki Takizawa at 10:19am
- This presentation covered
    - PIN@ONU vs APD @ONU
    - Enhanced FEC
    - Dual-rate PON feasibility
    - IEEE Formalism questions & power-budget proposal
- Discussion of need to include TDP and SRS definitions in 10G EPON standard.
- Discussion of whether IEEE or ITU-T formalism should be used for developing power budgets for 10G EPON.

- Chair asks Frank Effenberger to prepare presentation on differences between ITU-T and IEEE formalisms for optical budget specification.

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Attendance books are brought into the room at 10:33am

Recessed for break at 10:50am
Meeting resumed at 11:17am

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Straw Poll 3
Made by Chair
I will attend 802.3av meeting in Seoul on September 17-20, 2007
Yes: 32
No: 3

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Presentation: 10GEPON Power Budget in IEEE Formalism
- Presented by Hiroshi Hamano at 11:25 am
- This presentation covered definitions of optical budget penalties.
- Uncertainty in the definition and values of TDP are identified as key issues.
- Discussion of need for Ad Hoc committee to study differences in power-budget definitions.

Recessed for lunch break at 12:15pm
Meeting was called to order at 1:35pm

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- Hao Feng submitted a presentation from the floor and asked for 15 minutes.
- Chair asked for vote to allow this presentation: Yes 26, No, Abstentions: 9
- Time was allocated for this presentation at the end of the session.

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Presentation: PIN-PD based ONU for 10GE-PON
- Presented by Naoki Suzuki at 1:41pm
- This presentation discussed EDFA-equipped OLTs & PIN-PD-equipped ONU solutions for 10G EPON.
- Answers to the power-budget questions from the Geneva meeting also were discussed.
- Extended discussion of EDFA & SOA relative costs and availabilities.

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Motion 4

Allow David Piehler to make his presentation.

Moved: David Piehler
Seconded: Frank Chang
(Procedural, requires ≥ 50% approval)

Motion passed by voice vote without opposition.

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Motion 5

Presentations submitted from the floor shall be limited to the requested time.

Moved: Duane Remein
Second: Bidyut Parruck
(Procedural, requires ≥ 50% approval)

Motion passed by voice vote without opposition.

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Motion 6

Move presentation 3av_707_mao_1.pdf to Tuesday afternoon power discussion.

Moved: Robert Lingle
Seconded: Duane Remein
(Procedural, requires ≥ 50% approval)

Motion passed by voice vote without opposition.
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Presentation: APD@ONU for 10GE-PON
- Presented by Hiroshi Hamano at 2:42pm
- This presentation discussed high-power EML-equipped OLT and APD-equipped ONU solutions for 10G EPON.
- Extensive discussion of relative costs.

Recessed for break at 3:19pm
Meeting reconvened at 3:41pm

Presentation: Optic Cost Estimation for 10G EPON Downstream
- Presented by Dongsoo Lee at 3:42pm
- This presentation compares the relative costs of the proposed PIN-PD@ONU and APD@ONU solutions.

Presentation: Burst CDR performance under high BER
- Presented by Seiji Kozaki at 3:55pm
- This presentation discussed the performance of the PMA layer, especially upstream CDR in the presence of a BER higher than 1.0E-4.
- It was suggested that an additional penalty should be specified to account for CDR operation in the presence of a high BER.

Presentation: Impact of nonlinear optical crosstalk on 10GEPON architecture
- Presented by Erji Mao at 4:08pm

- This presentation covered various optical cross-talk issues that result from the interference of 10G EPON and CATV signals on the same fiber.
- 1310 nm was recommended for downstream transmission to reduce cross-talk.

Presentation: Several Statement on High Power EML and APD Rx
- Presented by Hao Feng at 4:37pm
- This presentation covered the utility of high-power, low-current EMLs for 10G EPON.

Presentation: SOA / PIN based OLT receiver update
- Presented by David Piehler at 4:55pm
- This presentation gave an update on SOA-based solutions, and contained responses to a number of issues discussed on the Reflector.

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Straw Poll 4

For the B++ case, I support adopting a baseline proposal for downstream receiver specifications corresponding to:

A) PIN-PD with amplified EML

B) APD with high power (~+3 dBm minimum output) EML

(Chicago Rules)

A) 18
B) 33
Total in Room: 46

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Motion 7

For the B++ case, adopt a baseline proposal for Downstream receiver specifications corresponding to an APD with high power (~+3 dBm minimum output) EML.

Moved: Frank Chang
Seconded: Duane Remein
(Technical, requires ≥ 75% approval)

Friendly amendment accepted to delete word "receiver."

Final Text:
For the B++ case, adopt a baseline proposal for downstream specifications corresponding to an APD with high power (~+3 dBm minimum output) EML.

Yes: 30
No: 11
Abstain: 5
Motion failed.

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Straw Poll 5

For the B++ case, I support adopting a baseline proposal for the upstream specifications corresponding to:

A) **APD with high output power (+3 to +5 dBm min. average) DML (likely cooled)**

B) **Pre-amplified PIN with lower-power DML**

(Chicago Rules)

A) 35
B) 14
Total in Room: 48

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Motion 8

For the B++ case, adopt a baseline proposal for the upstream specifications corresponding to an APD with high output power DML.

Moved: Frank Chang
Seconded: Ryan Hirth
(Technical, requires ≥ 75% approval)

Yes: 30
No: 10
Abstain: 5
Motion passes.
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Robert Lingle led discussion of Pros & Cons of PIN@ONU & APD@ONU table from Reflector discussion.

Meeting recessed at 6:15pm

Meeting minutes for Wednesday, 18 July 2007
Meeting commences at 9:04am (Glen, Kramer, Chair)

- Duane Remain assumed duties of chair for the duration of FEC discussion.

Presentation: Start-of-Frame Alignment Within 66-bit Block
- Presented by Glen Kramer at 9:06am
- This presentation continued a discussion started in Geneva.

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Straw Poll 6 (9:35am)
Made by Glen Kramer

A) Aligning the /S/ character saves up to 8 Mb/s of bandwidth (with 30 blocks per FEC codeword) but requires a more complicated state machine to re-package tx_raw<71:0> vector.

B) Not aligning /S/ characters results in some loss of throughput, but allows a simpler state machine.

(Chicago Rules)

I prefer to align /S/	: 41
I prefer to not align /S/	: 15
Number in Room	: 52

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Motion 9 (9:42am)

Idle Deletion State machine should align /S/ character of the first frame in the burst to the byte-0 position as shown in FSM1 on slide 7 in 3av_0707_kramer_1.pdf.

Moved: Daun Langston
Seconded: Brian Holden
(Technical, requires ≥ 75% approval)

Yes:	33
No:	1
Abstain:	14

Motion passes.

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Presentation: Idle insertion using Carrier Sense
- Presented by Eric Lynskey at 9:44am.

- This presentation discussed the use of the carrierSense function to insert IDLE frames to make room for parity.
- This mechanism was used in the EFM copper solution.

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Straw Poll 7 (10:00am)
Made by Eric Lynskey

I support using carrierSense to defer the MAC.

Yes: 25
No: 0
Abstain: 18
Number in room: 49

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Attendance books were brought into the room at 10:05.

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Motion 10 (10:07am)

Adopt as a baseline proposal the idle insertion mechanism set forth in 3av_0707_lynskey_2.pdf.

Moved: Eric Lynskey
Seconded: Bidyut Parruck
(Technical, requires ≥ 75% approval)

Yes: 22
No: 0
Abstain: 24
Motion passed

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Presentation: Considerations on the placement of parity blocks
- Presented by Frank Effenberger at 10:11am
- This presentation discussed the placement of parity blocks used by FEC.

Recessed for break at 10:50am
Meeting resumed at 11:09am

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Presentation: Considerations on FEC Code
- Presented by Fumio Daido at 11:09am

- This presentation enumerated and compared various candidates for an enhanced FEC code.

- Glen Kramer resumed duties of Chair.

- Hao Feng submitted a proposal from the floor and asked for time.

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Motion 11 (11:29am)

Allow 15 minutes for a presentation of 3av_0707_feng_2.pdf

Moved : Hao Feng
Seconded: Jeff Mandin
(Procedural, requires ≥ 50% approval)

Yes: 31
No: 5
Abstain: 8
Motion passed

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Presentation: Wavelength Plan Proposal - Activity Report
- Presented by Keiji Tanaka at 11:35am
- This presentation reported on recent activity regarding the recommendation of a 10G wavelength plan. Follow-up on action items from the Geneva meeting was presented.

Presentation: Wavelength Plan Proposal – Downstream Wavelength Allocation
- Presented by Kiyoshi Uematsu at 11:41am
- This presentation discussed a proposal for the downstream wavelength plan for 10G EPON.
- 1578-1580 nm was recommended for all PMD classes.

Recessed for lunch break at 12:10pm
Meeting was called to order at 1:32pm

- Lowell Lamb notified chair he would not be able to take minutes on Thursday.
- Brian Holden volunteered to act as recording secretary for Thursday, 19 July 2007.

Presentation: Wavelength Plan Proposal – Upstream Wavelength Allocation
- Presented by Kiyoshi Uematsu at 1:34pm
- This presentation discussed the impact of optical fiber losses and dispersion penalties on the selection of an upstream wavelength for 10G EPON.
- An upstream band of 1260-1280 nm was recommended.

Presentation: Considerations on the downstream wavelength and line coding

- Presented by Frank Effenberger at 1:41pm
- This presentation reviewed the current proposal.
- Four options were discussed for the downstream wavelength:
    - 1577 +/- 4 nm
    - 1490 & 1577 nm
    - 1590 nm
    - Compatible line code at one of the old wavelengths

- Glen Kramer began Wavelength Allocation discussion (2:15).
- Postponed motion #4 from Geneva is taken up.

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Motion 12 [Motion 4 from Geneva meeting] (2:18pm)

10Gbps upstream signal shall be centered at 1270 nm for all power budget classes.

Moved: Frank Effenberger
Seconded: Lowell Lamb
(Technical, requires ≥ 75% approval)

Yes: 34
No: 0
Abstain: 8
Motion passed

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Motion 13 (2:31pm)
Withdrawn

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Motion 14 (2:31pm)

Postpone discussion on downstream pass band until downstream power budget baseline is selected.

Moved: Hiroki Ikeda
Seconded: Keiji Tanaka
(Technical, requires ≥ 75% approval)

Yes: 27
No: 6
Abstain: 17
Motion passed

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Straw Poll 8 (2:52pm)

What is the downstream central wavelength preference for B++ when coexistence is required?

(Chicago rules)

- **1590 nm : 15**
- **1577 nm : 31**
- **1310 nm : 1**
- **1350 nm : 1**
- **Too early to decide : 16**

Number in Room : 56

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Straw Poll 9 (2:52pm)

What is the downstream central wavelength preference if coexistence were not required?

(Chicago rules)

- **1590 nm : 7**
- **1577 nm : 24**
- **1310 nm : 0**
- **1350 nm : 1**
- **1550 nm : 8**
- **1490 nm : 10**
- **Too early to decide : 12**

Number in Room : 56

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Recess for break at 3:17pm
Meeting reconvenes at 3:55pm

- Chair asks Keiji Tanaka to continue his ad hoc group on wavelength plan. Discussion should include different wavelength plans for different power budgets.

Presentation: λ-dependent Output power in L-Band DFB LD & Market Trend on APD Rx Cost

- Presented by Hao Feng at 4:02pm
- This presentation discussed DFB output power as a function of wavelength and market trends in APD costs.

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Motion 15: (4:35pm)

For the B++ case, adopt a baseline proposal for downstream specifications corresponding to an APD@ONU with high power EML at the OLT.

Moved: Hoa Feng
Seconded: Frank Chang
(Technical, requires ≥ 75% approval)

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Motion 16 (4:38pm)

Amend Motion 15 by adding text
"if the downstream wavelength is chosen to be above 1500 nm."

Moved: Wenbin Jiang
No second
Motion dies for lack of a second.
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A member asked chair to conduct vote separately among everyone in the room and 802.3 voters only

Vote on Motion 15, everyone in room:
Yes: 26
No: 18
Abstain: 9
Motion failed

Vote on Motion 15, 802.3 voters only:
Yes: 14
No: 11
Abstain: 3
Motion failed

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Motion 17: (4:57pm)

- **For the B++ case, adopt a baseline proposal for downstream specifications corresponding to an APD@ONU with high power EML at the OLT.**
- **For PX-10/PX-20 cases, adopt baseline proposals for the downstream specification corresponding to PIN at ONU.**

Moved: Ryan Hirth
Seconded: Frank Chang
(Technical, requires ≥ 75% approval)

Yes: 22
No: 18
Abstain: 10
Motion failed.

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Motion 18 (5:47pm)

- **For PX-10 case, adopt baseline proposal for the downstream specification corresponding to PIN at ONU.**

Moved: Frank Chang
Seconded: Bin Yeong Yoon
(Technical, requires ≥ 75% approval)

Yes: 23
No: 10
Abstain: 14
Motion failed.

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Presentation: Power Budget Slides
- Presented by Frank Effenberger at 5:52pm
- This presentation discussed the ITU-T and IEEE approaches to specifying optical budgets.

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Motion 19 (6:22pm)

For budget calculations, assume the following mapping function between ITU-T sensitivity and IEEE stressed sensitivity.

Sensitivity(ITU)[OMA] + Optical_Path_Penalty(ITU) = Stressed_Sensitivity(IEEE)[OMA]

Moved: Frank Effenberger
Seconded: Piers Dawe
(Technical, requires ≥ 75% approval)

Yes: 33
No: 0
Abstain: 9
Motion passed

Meeting recessed at 6:27pm

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Meeting minutes for Thursday, 19 July 2007
Meeting commences at 9:00am (Glen, Kramer, Chair)

- Bidyut Parruck volunteered as a recording secretary.
- Chair introduced the agenda for the day.

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Motion 20

Defer presentation of "How to submit comments – tutorial" to September meeting to allow additional time for wavelength plan (30 min.) and power budget (45 min.).

Moved: Duane Remein
Second: Frank Chang
(Procedural, requires ≥ 50% approval)

Passed by voice vote without opposition

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Keiji Tanaka recommended that we talk about the power budget before wavelength allocation discussion.

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Motion 21

Allow 15 minutes to present 3av_0707_chang_1.pdf "Understanding 1G EPON Power Budgets in IEEE formalism" into today's agenda

Moved: Frank Chang
Second: Martin Bossard
(Procedural, requires ≥ 50% approval)

Yes: 48
No: 2
Abstain: 0
Motion passed

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9:15AM: Duane Remein presented 3av_0707_c92_d0_8.pdf titled "Review of pre-draft v0.8". He gave an overview of the document in progress.

Glen Kramer notified the room that the document is available in the private folder.

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9:50AM: Jeff Mandin presented 3av_0707_mandin_3.pdf titled "10G Broadcast: Review and Motion".

9:55AM: Glen Kramer asked Duane Remein to take over chairmanship so he can participate in technical discussions for the duration of Jeff Mandin's presentation. Duane Remein assumed chairmanship.

Glen suggested that the presenter introduced a third scenario for upstream registration for 10G/1G ONU in which sends on 0x7FFF and receive 0x7FFE.

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Straw Poll 10
I prefer

- **10G broadcast channel scheme using option 1 (LLID 0x7FFE) __0__**

- **10G broadcast channel scheme using option 1 (LLID 0x7FFE; 10G/1G ONU receives 0x7FFE and sends on 0x7FFF) __20__**

- **10G broadcast channel scheme using option 2 (LLID 0x7FFE) __1__**

- **No Opinion __27__**

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Duane Remein sends the group on a 20 minute break and asked Jeff Mandin to modify his presentation for option 1.

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Motion 22

Each broadcast MAC instance shall be associated with an unique LLID. The 10G broadcast channel shall be associated with LLID 0x7FFE. The 1G broadcast channel shall be associated with LLID 0x7FFF.
The ONU transmits REGISTER_REQ with an LLID according to its upstream rate. A 10G/1G ONU receives broadcasts on LLID 0x7FFE and REGISTER_REQ to 0x7FFF.

Moved: Jeff Mandin
Second: Brian Holden
(Technical, requires ≥ 75% approval)

Yes: 17
No: 0
Abstain: 25
Motion passed

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10:41: Duane Remein turns the chairmanship back over to Glen Kramer. Glen invited Robert Lingle to lead the power budget discussions. Robert Lingle started the discussion with number of straw polls.

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Straw Poll 11

I voted against the B++, downstream baseline case corresponding to an APD at the ONU with high power EML at the OLT, for the PRIMARY reason of concern over:

A. Cost impact at the ONU from APD (higher cost for higher number of subscribers)
B. Technical feasibility of high power EML (~ +3dBm min. avg. power)
C. Cost impact at the OLT of a high power EML

Voting results
A: 15
B: 0
C: 0

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Straw Poll 12

I voted against the B++, downstream baseline case corresponding to a PIN at the ONU, with amplified EML at the OLT, for the PRIMARY reason of concern over:

A. Higher cost when system is first deployed (at lower number of subscribers)
B. Technical feasibility/reliability of amplified TX
C. Potential problems associated with high power (impact on analog video, safety, etc.)
D. Making power budget margin available for future upgrades (i.e. larger split ratios, longer distances etc.)

Voting results
A: 2
B: 2
C: 13
D: 3

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Glen Kramer made an observation that the main concern is potential problems with higher launch power and asked operators to comment on it.

Akihiro Otaka commented that the main reason is safety. He would prefer to see similar operations as 1G-EPON. Lower launch power is better for carriers. A comment was made that in case where ribbon cables are used with 8 fibers per cable, total power in the ribbon is limited to 21dBm, so maximum launch power should +12dBm per each fiber.

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Motion 23

For the B++ case, adopt a baseline proposal for Downstream specifications corresponding to an APD at ONU with higher power EML at the OLT.

Moved: Robert Lingle, Jr.
Seconded: Brian Holden
(Technical, requires ≥ 75% approval)

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Motion 24

Table motion 23

Moved: Frank Chang
Second: Denis Beaudoin
(Technical, requires ≥ 75% approval)

Yes: 15
No: 17
Abstain: 15
Motion failed
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Voting results for Motion 23:
Yes: 24
No: 15
Abstain: 8
Motion failed

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Glen Kramer noted short time left for the session and announced that he would start enforcing 2 minute time limit per comment

Glen Kramer asked Frank Chang to present 3av_0707_chang_1.pdf "Understanding 1G EPON Power Budgets in IEEE formalism"

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Motion 25

Postpone Frank Chang's presentation till September meeting

Moved: Ryan Hirth
Second: Bidyut Parruck
(Procedural, requires ≥ 50% approval)

Motion was withdrawn by Ryan Hirth before voting.

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Frank Chang presented 3av_0707_chang_1.pdf "Understanding 1G EPON Power Budgets in IEEE formalism"

Glen Kramer asked Frank Effenberger to lead ad hoc discussions on this subject after the meeting to reach consensus on the definitions.

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Glen Kramer asked Keiji Tanaka to lead the wavelength allocation discussions. Keiji Tanaka reminded the group that we reached agreement on upstream direction with motion 12.

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Motion 26

Rescind motion 14 and postpone the adoption of downstream pass band until downstream power budget baseline is selected

Moved: Bidyut Parruck
Second: Duane Remein
(Technical, requires ≥ 75% approval)

Yes: 30
No: 1
Abstain: 9

Motion passes

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Motion 27

Move to adjourn

Moved: Jeff Mandin
Seconded: Bidyut Parruck
(Procedural, requires ≥ 50% approval)

Motion passes with voice vote without opposition.

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Meeting is adjourned at 12:07 PM

List of Attendees and Affiliations

Name	Affiliation
Barrick, Scott	MentorGraphics
Beaudoin, Denis	Texas Instruments
Ben Amram, Haim	PMC Sierra
Bouda, Martin	Helix AG
Christian, Burt	Flextronics
Daido, Fumio	Sumitomo Electric
Effenberger, Frank	Huawei
Feng , Hao	Eudyna Devices
Feng, Dongning	Huawei
Hamano, Hiroshi	Fujitsu Labs
Hirth, Ryan	Teknovus
Hotta, Yoshifumi	Mitsubishi Electric
Ikeda, Hiroki	Hitachi
Kimura, Mitsunobu	Hitachi Communications Tech.
Konishi, Masahiro	Kawasaki Microelectronics
Kramer, Glen	Teknovus
Lamb, Lowell	Teknovus
Lee, Dongsoo	ETRI
Leung, Raymond	Huawei
Lingle, Robert	OFS
Longston, Daun	LEA
Lynskey, Eric	Teknovus
Mandin, Jeff	PMC Sierra
Mandkur, Vishy	Centillium Communications
Nomura, Takumi	NEC Communication Systems
Okamura, Toshihiko	NEC
OTAKA, Akihiro	NTT
Parruck, Bidyut	Cortina Systems
Pathak, Vijay	Kawasaki Microelectronics
Piehler, David	Alphion
Posthuma, Carl	Alcatel-Lucent
Remein, Duane	Alacatel-Lucent
Saeki, Naoto	NEC Corporation
Shiraishi, Ken	NEC
Stefanov, Boris	Alphion
Suzuki, Ken-Ichi	NTT
Suzuki, Naoki	Mitsubishi Electric

Takazawa, Hiei	OKI Electric
Takizawa, Motoyuki	Fujitsu Access
Tanaka, Keiji	KDDI R&D Labs
Tsuji, Shinji	Sumitomo Electric
UCHIKATA, Tatsuya	NEC
Uematsu, Kiyoshi	OKI Electric
Umnov, Alexander	Fujitsu
Yamashita, Hajime	NEC Access
Yokomoto, Tetsuya	Fujitsu Access
Yoon, Bin Yeong	ETRI
Zhang, Kevin	Eudyna Devices