

Unapproved Minutes  
**IEEE 802.3 400 Gb/s Ethernet Study Group**  
Plenary Meeting  
July 16 - 17, 2013  
Geneva, Switzerland  
Prepared by Ghani Abbas

Chair called IEEE 802.3 400 Gb/s Study Group Interim to order at 9.00 am, Tuesday, 16, July 2013.

Chair appointed Ghani Abbas to be Recording Secretary for the meeting.  
The Chair stated that he will try to speed up to allow participants to attend the p802.3bm meeting on Thursday. There were no objections

### **Agenda & General Information**

By – John D'Ambrosia

See - [http://www.ieee802.org/3/400GSG/public/13\\_07/agenda\\_400\\_01d\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/agenda_400_01d_0713.pdf)

- Chair reviewed the agenda.
- Introductions – Everyone introduced themselves and stated their affiliation.

### **Motion #1:** Move to approve the agenda

- Moved by: John McDonough
- Second by: Brian Holden
- Approved by voice vote without opposition

Chair asked if there were any reporters in the room. No reporters in the room. John D'Ambrosia will be talking with the press regarding IEEE activities but will only disclose high level details available from the published meeting minutes. Scott Kipp identified himself as he will be blogging without specific details.

### **Motion # 2:** Move to approve May Minutes

Moved by: Steve Trowbridge

Second by: Mark Gustlin

The May minutes approved without changes by voice without opposition.

Chair continued with the introductory presentation

- Goals for the meeting:
- Hear presentations (22) related to Objectives and 5 Criteria
- Develop consensus on PAR / Objectives
- Update on Time Sync Activities
- Liaisons and communications
  - ITU-T Study Group 15
  - Potential liaison to TIA on single-mode connector return loss (see next slide).

- Potential informal communication to IEEE 802.11
- Lay the ground work for the next meeting
- Ground Rules were reviewed
- IEEE Structure, Bylaws & Rules

Chair read the Guidelines for IEEE-SA meetings.

Chair gave an overview of the 802.3 Standards Process and emphasized the 5C requirements

## **Liaisons**

### **Liaison #1: ITU-T SG15 Liaison introduced by Steve Trowbridge**

Discussion: The liaison reported on the work in Q11 and Q6 on the evolving OTN beyond 100G. No firm decisions have been made yet. The ITU-T will be meeting after the IEEE 802.3 September Interim. It was agreed that no response is needed for this meeting. The chair appointed Steve Trowbridge is to progress and to write a response for approval in Sept., 2013 meeting

### **Liaison #2 : - Harmonizing Single mode Connection Return Loss**

Wait for a response after the presentation, see below.

### **Liaison #3: Internal Liaison to 802.11 for BW/BMP Data**

John D'Ambrosia is to discuss with IEEE 802.3 WG Chair regarding correct process – liaison or informal communication. Upon his conversation he will post a proposed response for consideration at the closing meeting

### **Presentation #1**

Title: LogicAd Hoc Update

Presented By – Mark Gustlin

See - [http://www.ieee802.org/3/400GSG/public/13\\_07/gustlin\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/gustlin_400_01_0713.pdf)

### Discussion

No comments or questions.

## **Presentation #2**

Title: Harmonizing Connector Return Loss

Presented By – Vipul Bhatt

See - [http://www.ieee802.org/3/400GSG/public/13\\_07/bhatt\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/bhatt_400_01a_0713.pdf)

### Discussion

Question was raised regarding the reflected power from the first connector (Slide 6) into the laser. This manifests itself as noise. The important part is the reflection that impacts the receiver. It was confirmed that the 35dB are needed for all PMDs solutions as they will all benefit from this return loss value. By harmonizing to single standard will reduce cost.

The chair asked if there is an objection for an ad hoc to produce a liaison to the TIA. There was no objection. It was agreed to generate a liaison to TIA on harmonization of return loss. Chair appointed Vipul Bhatt to lead the ad hoc to generate a draft letter for consideration by the Study Group during Closing plenary. The Chair asked Vipul to generate a draft prior to the Ad hoc meeting for consideration by all. The Ad Hoc will meet Wednesday afternoon at 1pm in the Study Group room to finalize a proposed response that will be considered by the Study Group during Closing Business.

Break at: 10.05

Reconvened at: 10.25

The Chair stepped out at 10.26 and Ghani Abbas Chaired the meeting in his absence.

## **Presentation #3**

Title: End User Perspective on 400 Gb/s Ethernet

Presented By – Arien Vijn

See - [http://www.ieee802.org/3/400GSG/public/13\\_07/vijn\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/vijn_400_01a_0713.pdf)

### Discussion

It was stated that parallel fibers have re-occurring cost over its lifetime and thus is not favored. Requirement for 400G is needed now at approx. 2.5 the 100G cost. Average reach is approximately 25km.

## **Presentation #4**

Title: 400G PMDs Requirements for Broad Market Potential

By – Tom Palkert

See - [http://www.ieee802.org/3/400GSG/public/13\\_07/palkert\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/palkert_400_01_0713.pdf)

### Discussion

No time prioritization on reaches is assumed. Perhaps consolidation of the reaches list is required. We need more data to highlight where (and when) the need is.

The chairman assumed the chair again at 11.10

## **Presentation #5**

Title: Perspective and Scenario of Core Router on 400 GbE

By – Song Xiaolu

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/song\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/song_400_01a_0713.pdf)

### Discussion

Three scenarios are listed in the slides. Is there an urgency for one over the others? 10km is the initial requirement. It was stated that no difference in urgency is seen between 2km and 10km solutions.

Break at 11.25

Reconvened at 13.00

## **Presentation #6**

Title: BER Objective for 400GE

By – David Ofelt

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/ofelt\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/ofelt_400_01_0713.pdf)

### Discussion

BER issue may be non-technical but a human perception which depends on application. Ethernet is used more and more in various applications. Customers may tell you the system is no good because of bad BER. For example security and banking applications, a low BER is mandatory. We often had BER requirements of 1E-12 or better but no one considers the better part. Need to bear in mind that adding FEC makes it harder. Additionally 1E-15 is quite hard to meet as well as cost associated with a lower BER.

## **Presentation #7**

Title: OTN Support: What is it why is it important?

By – Steve Trowbridge

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/trowbridge\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/trowbridge_400_01_0713.pdf)

### Discussion

Further support was expressed by the participants.

## **Presentation #8**

Title: 400GESMF Consideration

By – Zhao Wenyu

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/wenyu\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/wenyu_400_01_0713.pdf)

### Discussion

A question on Slide 4 regarding the support of 40G tributary was raised, as this is already standardized. It is not the Chinese standards. Slide 8 the timescales were questioned. Data is required to substantiate the claims made on the slide.

### **Presentation #9**

Title: Initial thought about Modulation format & FEC for “Long-reach” 400GbE

By – Riu Hirai

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/hirai\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/hirai_400_01_0713.pdf)

#### Discussion

No questions.

### **Presentation #10**

Title: Considerations on transmission distance of 400 GbE

By – Toshiki Tanaka

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/takahara\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/takahara_400_01_0713.pdf)

#### Discussion

No questions.

### **Presentation #11**

Title: Long Shelf-Life Electrical INterfaces

By – Jeff Maki

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/maki\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/maki_400_01_0713.pdf)

#### Discussion

Slide 8 the FEC selection was questioned. To choose a FEC that is future proof may be a challenge. It was stated that preference should be given to simpler objectives and no implementation. Given the global involvement in developing 400G standards we are not going to develop these standards to include implementation.

### **Presentation #12**

Title: MMF Capabilities for 400-Gigabit Ethernet, and Beyond

By – Jack Jewell

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/jewell\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/jewell_400_01a_0713.pdf)

#### Discussion

A question raised on the need for a higher speed for the longer wavelength VCSELs. This is basically needed to achieve performance. It was confirmed that bj FEC is needed for the proposed objective.

Break at: 15.17

Reconvened at: 15.37

### **Presentation #13**

Title: Global Networking Services - Representative Cloud Scale Data Center Design

By – Tom Issenhuth

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/issenhuth\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/issenhuth_400_01_0713.pdf)

### Discussion

Slide 5 indicates the use of SMF and not MMF was questioned. It was stated that SMF is cheaper and it is a long term asset. For trunk applications MMF is not used but MMF is used in AOC for example. SMF based technology offers the lowest cost structure.

### **Presentation #14**

Title: An exploration of the technical feasibility of the major technology options for 400GE backplanes

By – Brian Holden

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/holden\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/holden_400_01_0713.pdf)

### Discussion

It was stated that we are not ready to do 400G backplane yet. It may be the next project.

### **Presentation #15**

Title: EEE Overview and Proposal

By – Wael Diab and Mike Bennett

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/diab\\_400\\_01b\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/diab_400_01b_0713.pdf)

### Discussion

Need to include the upgrade path as the EEE is already included in 40G and 100G standards.

### **Presentation #16**

Title: Backplane Channels Using Embedded Capacitor Connectors as an Enabler for 400GE 40” System Measurements

By – Nathan Tracy

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/tracy\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/tracy_400_01a_0713.pdf)

### Discussion

These are measured data on a single card.

The meeting broke at 17.20

The meeting reconvened at 08.30 on Wed 17<sup>th</sup>., July, 2013

The chairman showed the guidelines for IEEE-SA meetings.

### **Presentation # 17**

Title: Scalable 400 GbE Architecture 400 GbE

By – Ali Ghiasi

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/ghiasi\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/ghiasi_400_01_0713.pdf)

### Discussion

A questions raised on Slide 5 regarding the FEC required in all as no decision made yet on the p802.3bm 500m reach. It was stated that the application 10X10 is important as it gives the highest density.

### **Presentation #18**

Title: 400 Gb/s PCS architectural options

By – Mark Gustlin

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/gustlin\\_400\\_02\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/gustlin_400_02_0713.pdf)

#### Discussion

For OTN support re-use of the OTN modules is important. It may become challenging when block multiplexing is used.

### **Presentation #19**

Title: 400 GbE Lane Configurations vs. FEC Options

By Ali Ghiasi

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/wang\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/wang_400_01_0713.pdf)

#### Discussion

The gains are all electrical gains. Latency options should be stated clearly.

Break at: 10.00

Reconvened at: 10.25

### **Presentation #20**

Title: Musings on FEC Objective for 400 Gb/s Ethernet

By – Gary Nicholl

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/nicholl\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/nicholl_400_01_0713.pdf)

#### Discussion

There is a support for not to have the FEC as an integral part of the PCS.

### **Presentation #21**

Title: The Requirement Analysis of 400GE FEC for Gen1 PMDs

By – Suping Zhai

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/zhai\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/zhai_400_01_0713.pdf)

#### Discussion

SOA stands for semiconductor Optical Amplifier.

Break at: 10.55

Reconvened at: 11.00

### **Presentation #22**

Title: Time Synch

By – Michael Teener

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/teener\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/teener_400_01_0713.pdf)

#### Discussion

Slide 6 multi-lane timestamp, who is going to do this work?. Need to pick a scheme /lane which end up with a deterministic delay.

Current work is 100M and 1G. The protocol .AS can run on any path including higher bit rates however the delay should be deterministic.

Break at: 11.46  
Reconvened at: 13.38

Mark Gustlin assumed the chair while John D'Ambrosia is giving his presentation.

### **Presentation #23**

Title: FEC and Architecture

By – John D'Ambrosia

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/dambrosia\\_400\\_02\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/dambrosia_400_02_0713.pdf)

#### Discussion

Need to look at many applications to help us understand the type of FEC codes that are needed. FEC is needed along the link.

John D'Ambrosia assumed the chair again at 13.57

### **Presentation #24**

Title: Parallel SMF (PSM) in the Data Centrein Centre- End User Survey-

By – Brad Booth

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/flatman\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/flatman_400_01_0713.pdf)

#### Discussion

This is a general survey which includes questions on cost regarding the use of ribbon SMF fibers. A question about volumes was also included but no tabulation of volumes is included. However, large data centres are in the survey. The respondents indicate the use of SMF and two use parallel MMF and one parallel SMF.

### **Presentation #25**

Title: 400G: Physics, Economics & Business

By – Randy Rannow

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/rannow\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/rannow_400_01_0713.pdf)

#### Discussion

No questions.

### **Presentation #26**

Title: Proposed PAR

By – David Law

See - [http:// www.ieee802.org/3/400GSG/public/13\\_07/dambrosia\\_400\\_01\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/dambrosia_400_01_0713.pdf)

#### Discussion

Proposed responses to PAR were discussed and edited. See [http://www.ieee802.org/3/400GSG/public/13\\_07/dambrosia\\_400\\_01a\\_0713.pdf](http://www.ieee802.org/3/400GSG/public/13_07/dambrosia_400_01a_0713.pdf).



### **Motion #3**

- The Study Group requests that IEEE 802.3 extends the 400 Gb/s Ethernet Study Group
- Moved Howard Frazier
- Second Paul Kolesar
- Procedural (>50%)

Motion passes by voice vote without opposition

### **Motion #4**

- Move that the 400 Gb/s Ethernet Study Group adopt the following objectives:
  - Support a MAC data rate of 400 Gb/s
  - Support full-duplex operation only
  - Preserve the Ethernet frame format utilizing the Ethernet MAC
  - Preserve minimum and maximum FrameSize of current Ethernet standard
  - Provide appropriate support for OTN
  - Specify optional Energy Efficient Ethernet (EEE) capability for 400Gb/s PHYs
- Moved By: Steve Trowbridge 2nd: Mike Bennett
- Technical :  $\geq 75\%$
- Results: Yes – 74 No – 0 Abstain – 1

Motion Passes

Bhatt presented ad hoc response. Updated per Study Group Discussion.

### **Motion #5**

- Move that IEEE 802.3 400Gb/s Ethernet Study Group approve the text in:
  - 802\_3 to 42\_11 liaison letter final draft per SG.pdf
- with editorial license granted to the Chair (or his appointed agent) as a liaison communication by the 802.3 WG Chair to TIA.
- M – Vipul Bhatt
- S – Howard Frazier
- Technical ( $\geq 75\%$ )

Approved by voice vote without opposition

D'Ambrosia presented proposed informal communication to IEEE 802.11 WG. Updated per Study Group discussion.

#### **Motion # 6**

- Move that IEEE 802.3 400Gb/s Ethernet Study Group approve the text in:
  - dambrosia\_400\_03a\_0713.pdfwith editorial license granted to the Chair (or his appointed agent) as an informal communication by the Study Group Chair to IEEE 802.11
- M – Steve Trowbridge
- S – Ghani Abbas
- Procedural (>50%)

Motion Passes by voice vote without objection

#### **Straw Poll # 1, York, UK Attendance for IEEE 802.1 / 802.3 Interim**

- I will attend the IEEE 802.3 400 Gb/s Ethernet Study Group meeting in September
  - Yes - 38
  - No - 16
  - Maybe – 18

#### Future Meetings

- See: <http://www.ieee802.org/3/interims/index.html>
- Sept 2013 Interim (hosted by ADVA)
  - Week of Sept 2
  - York, UK
- Nov 2013 Plenary
  - Week of Nov 10
  - Dallas, TX, USA
- January 2014 Interim
  - Week of January 20
  - Hyatt Regency Indian Wells, CA

#### **Motion # 7**

- Motion to adjourn.
- Moved by Steve Trowbridge
- Second by Ghani Abbas
- Procedural (>50%)

Motion passes by voice vote without objection.

The meeting was adjourned at 16.50

| IEEE 802.3 40GbE Study Group |            |                        | 7/16/2013 | 7/17/2013 |
|------------------------------|------------|------------------------|-----------|-----------|
| Last Name                    | First Name | Employer / Affiliation | Tues      | Wed       |
| Abbas                        | Ghani      | Ericsson, UK           | x         | x         |
| Baldwin                      | Thananya   | Ixia                   | x         | x         |
| Bennett                      | Mike       | LBNL                   | x         | x         |
| Bergey                       | Chris      | Luxtera                | x         |           |
| Bhatt                        | Vipul      | Cisco                  | x         | x         |
| Bliss                        | Will       | Broadcom               |           | x         |
| Booth                        | Brad       | Independent            |           | x         |
| Bouda                        | Martin     | Fujitsu                | x         | x         |
| Braun                        | Ralf-Peter | Deutsche Telekom       | x         | x         |
| Carlson                      | Steve      | HSD                    |           | x         |
| Chalupsky                    | David      | Intel                  | x         | x         |
| Chandoasekwan                | Srikarth   | IEEE                   | x         |           |
| Chang                        | Xin        | Huawei                 | x         | x         |
| Cibula                       | Pete       | Intel                  |           | x         |
| Cole                         | Chris      | Finisar                |           | x         |
| Cui                          | Kai        | Huawei                 | x         | x         |
| D'Ambrosia                   | John       | Dell                   | x         | x         |
| Diab                         | Wael       | Broadcom               | x         | x         |
| Farhoodfar                   | Arash      | Cortina Systems        | x         | x         |
| Forbes                       | Harry      | Nexans                 |           | x         |
| Frazier                      | Howard     | Broadcom               |           | x         |
| Gang                         | Zhigang    | JDSU                   | x         | x         |
| Garcia                       | Modesto    | Texas Instruments      |           | x         |
| Ghiasi                       | Ali        | Broadcom               | x         | x         |
| Gustlin                      | Mark       | Xilinx                 | x         | x         |
| Hirai                        | Riu        | Hitachi                | x         | x         |
| Hiramoto                     | Kiyo       | Oclaro Japan           | x         | x         |
| Holden                       | Brian      | Kandou Bus             | x         | x         |
| Hongchun                     | Xu         | Accelink               | x         | x         |
| Huang                        | Xi         | Huawei                 | x         | x         |
| Isono                        | Hideki     | Fujitsu Ltd.           | x         | x         |
| Issenhuth                    | Tom        | Microsoft              | x         | x         |
| Jewell                       | Jack       | JDSU                   | x         | x         |
| Jimenez                      | Andrew     | Anixter Inc.           |           | x         |
| Kawatsu                      | Yasuaki    | Hitachi-Metals         | x         | x         |
| Kelsen                       | Michael    | Time Warner Cable      | x         | x         |
| Kethacia                     | Kurma      | Cadence                | x         | x         |
| Kimmitt                      | Myles      | Emulex                 | x         | x         |
| Kipp                         | Scott      | Brocade                | x         |           |
| Kolesar                      | Paul       | CommScope              |           | x         |
| Langhammer                   | Martin     | Altera                 | x         | x         |
| Li                           | Mike       | Altera                 | x         |           |

|                |           |                          |   |   |
|----------------|-----------|--------------------------|---|---|
| Lingle, Jr.    | Robert    | OFS                      | x | x |
| Maguire        | Valerie   | Siemon / TIA             |   | x |
| Maki           | Jeffery   | Juniper Networks         | x | x |
| Martin         | Arlon     | Kotura                   | x | x |
| Mashimo        | Chris     | Marvell                  |   | x |
| Masuda         | Takeo     | Petra                    | x | x |
| McDermott      | Tom       | Fujitsu                  | x | x |
| McDonough      | John      | NEC America              | x | x |
| Meghelli       | Mounir    | IBM                      | x |   |
| Meier          | Wolfgang  | Emerson Network Power EC |   | x |
| Mooney         | Paul      | Spirent Communications   | x | x |
| Nakamoto       | Edward    | Spirent Communications   | x | x |
| Nicholl        | Gary      | Cisco                    | x | x |
| Ofelt          | David     | Juniper Networks         | x | x |
| Oguna          | Ichiro    | Petra                    | x | x |
| Palkert        | Tom       | Luxtera                  | x |   |
| Parthasarathay | Vasudevan | Broadcom                 | x | x |
| Pepper         | Gerald    | Ixia                     | x | x |
| Rabinovich     | Rick      | Alcatel-Lucent           |   | x |
| Rannow         | Randy     | APTC Corp                | x | x |
| Rao            | Ram       | Oclaro                   | x | x |
| Ressl          | Mike      | Hitachi Cable America    |   | x |
| Rotolo         | Salvatore | STM Microelectronics     | x | x |
| Sambasivan     | Sam       | AT&T                     |   | x |
| Sasaki         | Yasue     | TE Connectivity          | x |   |
| Sasaki         | Yasuo     | TE Connectivity          |   | x |
| Sommers        | Scott     | Molex                    | x | x |
| Song           | Xiaolu    | Huawei                   | x | x |
| Sprague        | Ted       | Infinera                 | x | x |
| Stevens        | Daniel    | Fujitsu Semiconductors   | x | x |
| Suping         | Zhai      | Huawei                   | x | x |
| Swanson        | Steve     | Corning                  | x |   |
| Szczepanek     | Andre     | Inphi                    |   | x |
| Tajima         | Akio      | NEC Corporation          | x | x |
| Takahara       | Tomoo     | Fujitsu Laboratories     | x | x |
| Takahata       | Kiyoto    | NTT                      | x | x |
| Tanaka         | Toshiki   | Fujitsu Laboratories     | x | x |
| Telxeira       | Antonio   | NSN (Coriant)            | x | x |
| Timmins        | Ian       | Optical Cable Corp.      |   | x |
| Tipper         | Alan      | Semtech                  | x | x |
| Tracy          | Nathan    | TE Connectivity          | x | x |
| Tremblay       | Francois  | Semtech                  | x | x |
| Trowbridge     | Steve     | Alcatel-Lucent           | x | x |
| Tsutsumi       | Satoshi   | Hitachi                  | x | x |

|            |         |                  |   |   |
|------------|---------|------------------|---|---|
| Ulrichs    | Ed      | Source Photonics | x | x |
| Vanderlaan | Paul    | Nexans           |   | x |
| Vijn       | Arien   | AMS-IX           | x | x |
| Wang       | Robert  | Intel            | x | x |
| Wang       | Xinyuan | Huawei           | x | x |
| Welch      | Brian   | Luxtera          | x | x |
| Wirtz      | Mike    | Semtech          | x | x |
| Wong       | CK      | FCI USA LLC      |   | x |
| Wong       | Henry   | Huawei           | x | x |
| Xu         | Yu      | Huawei           | x | x |
| Zhao       | Wenyu   | CATR.China       | x | x |