

Approved Minutes
IEEE 802.3 Next-generation 200 Gb/s and 400 Gb/s MMF PHYs Study Group Meeting
During IEEE 802.3 Plenary Meeting Week
March 06-07, 2018
Rosemont, IL, US
Prepared by Mabud Choudhury

Group Name: IEEE 802.3 Next-generation 200 Gb/s and 400 Gb/s MMF PHYs Study Group

Date/Location: Tuesday & Wednesday, March 06-07, 2018. Rosemont, IL, US

Chair: Robert Lingle, Jr.

Recording Secretary: Mabud Choudhury

Meeting Participants: Attendance is listed in Appendix A

Call to order:

IEEE 802.3 Next-generation 200 Gb/s and 400 Gb/s MMF PHYs (NGMMF) Study Group (SG) meeting convened at 3:49 pm Central Standard Time (CST, UTC -6), Tuesday, March 06, 2018 by Robert Lingle, Jr., Study Group Chair.

Mr. Lingle welcomes attendees to the IEEE 802.3 Next-generation 200 Gb/s and 400 Gb/s MMF PHYs Study Group meeting.

The Chair called for introductions and affiliations, the participants introduced themselves, and the Chair then proceeded with the agenda.

Presentation #1:

Title: "Next-Gen 200G & 400G PHYs for MMF Study Group Agenda and General Information"

Presenter: Robert Lingle, Jr., Chair

http://www.ieee802.org/3/NGMMF/public/Mar18/agenda_NGMMF_01a_mar18.pdf

Chair reviewed Agenda.

Motion #1: Chair moved to approve the Agenda, Slide 2 of

http://www.ieee802.org/3/NGMMF/public/Mar18/agenda_NGMMF_01a_mar18.pdf

Motion approved by voice vote without objection.

Chair read aloud and reviewed IEEE-SA Meeting Guidelines, including patent policy, and IEEE 802 Participation Policy. There were no questions from group based on guidelines and policy review.

Motion #2: Chair moved to approve meeting minutes, previously posted, from January 22-23 SG meeting and February 22, 2018 Ad Hoc meeting per Slide 6 of

http://www.ieee802.org/3/NGMMF/public/Mar18/agenda_NGMMF_01a_mar18.pdf

Motion approved by voice vote without objection.

Mr. Lingle provided Study Group information, access to the reflector and website.

Mr. Lingle reminded everyone to sign-in via IMAT on-line attendance and to sign-in on Attendance Book.

Chair reviewed ground rules, role of the Chair, overall IEEE structure, important bylaws, rules, & references links, overall IEEE 802.3 standards process focusing in on Study Group phase.

Mr. Lingle reviewed Study Group chartering motion and role of Study Group, emphasizing that we are drafting a complete Project Authorization Request (PAR), Criteria for Standards Development (CSD) and choosing objectives and not solutions.

Mr. Lingle provide Ad Hoc report, summarizing 2 teleconference meetings since January Interim.

Chair reviewed goals for the week:

- Review and respond to comments from the EC on our pre-submitted PAR and CSD Responses
- Review 4 contributions related to the proposed 200G objective over 1-pair MMF
- Consider motions that may be made regarding a 200G objective over 1-pair MMF
- Review 3 contributions related to our 400G objectives over 4-pairs and 8-pairs MMF
- Consider any modifications to project documentation required by comments from EC or motions adopted.
- Complete all work necessary to request approvals to become a Task Force

Schedule for Tuesday, March 06 and Wednesday, March 07, 2018 was reviewed.

Future meeting dates and locations were reviewed.

Presentation #2:

Title: "In Support of 200G over 1 pair MMF Objective: Broad Market Potential (BMP) & Economic Feasibility (EF)"

Presenter: Jim Young

http://www.ieee802.org/3/NGMMF/public/Mar18/young_NGMMF_01a_mar18.pdf

Presented voice of customer (VOC) view for large enterprise data center customers based on end-user input/perspective from presentation co-author, Carl Rumbolo, affiliated with Wells Fargo, with supporters from 13 data center experts affiliated with 10 large enterprise data center end-user companies.

Presented view supporting BMP and EF for 200 Gb/s over 1 pair MMF based on duplex (1 pair) uplinks enabling re-use of existing infrastructure as server speeds increase and contention ratios drop; avoiding increases in space, cost & complexity introduced when switching to parallel optics; history and timing of 40G duplex and 100G duplex solutions and need for 200G duplex uplinks to support server data rate upgrade path.

Discussion on different views of large enterprise data center market/customer needs.

Discussion on relative cost of existing duplex vs. parallel MMF links.

General discussion followed.

Presentation #3:

Title: "200GBASE-SR1.4 technical feasibility"

Presenter: Jonathan King

http://www.ieee802.org/3/NGMMF/public/Mar18/king_NGMMF_01_mar18.pdf

Technical feasibility for 200GBASE-SR1.4 shown by comparing with an existing 100Gb/s 4 wavelength SWDM product with 100m OM4 reach capability was presented.

Technical challenges of moving from 25 Gb/s NRZ to 50 Gb/s PAM4: PAM4 more sensitive to crosstalk and to RIN; slightly higher transmit bandwidth desirable for PAM4; extra link budget needed for PAM4. Toolbox to address 200G-SR1.4 technical challenges: use of stronger FEC per 802.3cd; improvements in PAM VCSELs providing better launch optics, RIN, output power and VCSEL rise-fall times; better designs for PAM4 receivers improves responsivity and TIA noise, and mitigates ISI. Extensive technical literature on technical feasibility of 50 Gb/s PAM4 and SWDM referenced. Discussion that technical feasibility of a 4 wavelength 200 Gb/s PMD with 100 m reach capability over OM4 is much stronger than technical feasibility of other technologies considered by other 802.3 optical Ethernet projects at Study Group phase. General discussion followed.

At 5:24 pm CST, Robert Lingle, Jr. placed himself in discussion queue and requested Pete Anslow to temporarily act as Chair. Mr. Lingle resumed as Chair at 5:31 pm CST.

Presentation #4:

Title: “BMP for 4-wavelength PMDs – evidence from 100G-SWDM4 modules”

Presenter: David Lewis

http://www.ieee802.org/3/NGMMF/public/Mar18/lewis_NGMMF_01_mar18.pdf

Presentation supports BMP in terms of having multiple vendors for 4-wavelength PMDs.

Overview and use cases for 100G-SR4 and 100G-SWDM4 presented.

Demonstration of interoperability of 100G-SWDM4 modules - error free operation over 100m OM4 duplex MMF (at ECOC 2016) - from 2 vendors reviewed.

Discussion followed.

Presenters and group agreed to modify order of presentations pulling up 400 Gb/s presentations to Tuesday, March 06 instead of originally scheduled Wednesday, March 07 timeslots.

Presentation #5:

Title: “In support of 400GBASE-SR8 Broad Market Potential”

Presenter: Rick Pimpinella

http://www.ieee802.org/3/NGMMF/public/Mar18/pimpinella_NGMMF_01_mar18.pdf

The contribution shows the utility of 400GBASE-SR8. It provides 400Gb/s communications for backbone, horizontal cabling, and breakout applications, at a competitive cost. However, looking ahead at higher data rates, the 50 Gb/s PMDs are not ideally suited for 100Gb/s lanes.

Showed 400GBASE-SR8 being supported over existing structured cabling – requiring only breakout cables to support all 802.3cd PMDs.

Author presented view that 400G-SR8 would be cost effective relative to 400G-SR4.2.

256 x 50G Switch Radix Application – 3:1 over subscription – for 400G-SR8 was presented.

Presenter raised concern about progress with upcoming 802.3ck 100 Gb/s per lane electrical Task Force, and potential new CFI for 100 Gb/s optical lane, and that 100 Gb/s lanes are not supported by either 400 Gb/s objectives being considered by NGMMF SG.

Discussion about relative cost of 400G-SR8 and 400G-SR4.2.

General discussion followed.

Presentation #6:**Title:** “400G-SR8 Broad Applications for Datacenters”**Presenter:** Zuowei Shenhttp://www.ieee802.org/3/NGMMF/public/Mar18/shen_NGMMF_01a_mar18.pdf

Broad market potential of 400G over 8-pair MMF (SR8) point-to-point and breakout/shuffle applications was presented.

Key benefits of 400G-SR8 in terms of low cost, flexibility, high density, backward compatibility, reach, fast time to market were reviewed.

8-pair MMF enables flexible BW between ToR to leaf switches in green field.

8-pair MMF design allows maximum port density and maximum efficiency in brown field upgrade.

400G-SR8 provides breakout flexibility between TOR/S1 switch and servers; breakout to: 8x 50GBASE-SR, 4x 100GBASE-SR2 (2x50), 2x 200GBASE-SR4 (4x50) and 2x 100GBASE-SR4 (4x25).

Presenter also reviewed the high technical feasibility for 400G-SR8.

Discussion focused on BMP for 400G-SR8 specifically since BMP for 50G-SR, 100G-SR2 and 200G-SR4 have been already established in 802.3cd.

General discussion followed. Broad consensus on presentation.

Robert Lingle, Jr. requested David Lewis to temporarily act as Chair at 6:36 pm CST, so Mr. Lingle could deliver Presentation #7 below.

Presentation #7:**Title:** “In support of Broad Market Potential (BMP) & Distinct Identity (DI) for both 4-pair & 8-pair MMF objectives at 400G”**Presenter:** Robert Lingle, Jr.http://www.ieee802.org/3/NGMMF/public/Mar18/lingle_NGMMF_01_mar18.pdf

Presenter reviewed need for a 4-pair objective to support end-users who have 4-pair infrastructure and 8 years of experience designing DCs around the quad paradigm, while an 8-pair objective is needed by end-users who wish to re-architect for the flexibility enabled by new octal paradigm.

VOC: experts from large global cloud companies have endorsed each of these 4-pair and 8-pair MMF objectives as best-suited to their architectures.

A 4-pair medium gave access to the SerDes (often the switch) rate for XLAUI-4, CAUI-4, 200GAUI-4, while an 8-pair medium gives access to the SerDes rate for 400GAUI-8 and future 800GAUI-8.

The need for defining a 400G-SR8 standard, instead of an MSA solution, was reviewed.

There is precedent in 802.3 for having multiple parallel solutions for the same speed (100G-SR2, 100G-SR4 and 100G-SR10).

The Broadest Market Potential is created by standardizing both 4-pair & 8-pair solutions for 400 Gb/s Ethernet over MMF.

Distinct Identity is maintained. These are not two solutions for the same problem.

Discussion followed. Broad consensus.

Mr. Lingle resumed as Chair at 6:56 pm CST.

Break at 7:21 pm CST. Resumed at 7:34 pm CST.

Responses to comments from EC members on pre-submitted PAR and CSD:

Chair led SG in responding to comments from EC members on pre-submitted “Standard for Ethernet Amendment Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber” <https://mentor.ieee.org/802-ec/dcn/18/ec-18-0017-01-00EC-ieee-p802-3cm-draft-par.pdf> and pre-submitted “CSD Responses in relation to the IEEE P802.3cm Standard for Ethernet Amendment: Physical Layer and Management Parameters for 400 Gb/s over Multimode Fiber PAR” <https://mentor.ieee.org/802-ec/dcn/18/ec-18-0018-01-00EC-ieee-p802-3cm-draft-csd.pdf>, which were approved by SG during January Interim meeting.

There were no comments from EC on pre-submitted PAR.

Comments from EC on pre-submitted CSD and SG responses/updates:

1. Comment: the technical feasibility is asserted at various data rates, but in no location is the reach, range or distance listed. Hence it is impossible to evaluate the technical feasibility of the approach. For P802.3cm. add connection length target for the standard to the CSD in Technical Feasibility.
 - Resolution: Added sub-bullet 4 of 2nd bullet of Technical Feasibility (CSD page 7) “Technical feasibility has been demonstrated up to a reach of at least 100 m.”
 - SG accepted comment resolution by voice without objection.
2. Comment: CSD page 2 – delete – “In addition, it is expected that the protocol-specific definition of managed objects will be added in a future amendment to an IEEE 802.3 Standard for Management.” Based on concern about offering future work in the CSD/PAR.
 - Resolution: Deleted “In addition, it is expected that the protocol-specific definition of managed objects will be added in a future amendment to an IEEE 802.3 Standard for Management.” from Managed Objects (CSD page 2).
 - SG accepted comment resolution by voice without objection.
3. Comment: CSD page 4 expand “QSFP”, “CO”, and “PMD” for first usage.
 - Resolution: For Broad Market Potential (CSD page 4) changed “QSFP” to “Quad Small Form-factor Pluggable (QSFP)”; changed “CO” to “central office”; changed “PMD” to “Physical Medium Dependents (PMDs)”
 - SG accepted comment resolution by voice without objection.
4. Comment: CSD page 5 – delete “In addition, it is expected that the protocol-specific definition of managed objects will be added in a future amendment to an IEEE 802.3 Standard for Management.” Based on same concern as point #2 above.
 - Resolution: Deleted “In addition, it is expected that the protocol-specific definition of managed objects will be added in a future amendment to an IEEE 802.3 Standard for Management.” from Compatibility (CSD page 5)
 - SG accepted comment resolution by voice without objection.
5. Comment: CSD page 6 – Reword to avoid using “Strong desire” and “Need to Support”
 - Resolution: For Distinct Identity (CSD page 6), replaced second bullet “Strong desire to use 8 pairs for new 400 Gb/s topologies and supporting breakout capability” and third bullet “Need to support 400 Gb/s Ethernet over existing parallel MMF deployments” with:
 - “There are no existing standards, or projects developing standards, addressing the specification of 400 Gb/s over:
 - 4 pairs of multimode fiber, supporting existing parallel multimode fiber topologies and installed base deployments;

- 8 pairs of multimode fiber, offering maximum flexibility for breakout topologies.”
 - SG accepted comment resolution by voice without objection.
- 6. Comment: CSD page 7 expand “PAM4” and “VCSEL”
 - Resolution: For Technical Feasibility (CSD page 7), replaced “PAM4” with “4-level pulse amplitude modulation (PAM4)” and replaced “VCSEL” with “vertical-cavity surface-emitting laser (VCSEL)”
 - SG accepted comment resolution by voice without objection.

All updates based on above responses to EC comments on CSD were posted on red-lined version of updated CSD:

http://www.ieee802.org/3/NGMMF/public/Mar18/CSD_Modified_per_EC_comments_NGMMF_01a_mar18.pdf

Break for the day at 9:43 pm CST.

Wednesday, March 07, 2018

Call to order:

Robert Lingle, Jr., Study Group Chair, convened second day of meeting at 9:06 am Central Standard Time (CST, UTC -6)

Presentation #8:

Title: “Evidence of Broad Market Potential for 200G over 1-pair MMF”

Presenters: Paul Kolesar, Flavio Marques and John Kamino

http://www.ieee802.org/3/NGMMF/public/Mar18/kolesar_NGMMF_01b_mar18.pdf

Contribution provided voice-of-the-customer (VOC) input from Large Enterprise end-user experts for BMP for 200G over 1-pair MMF.

Presentation provided testimonials and opinions of customers, located in different regions and representing multiple industries, regarding utility of 200G over 1-pair MMF and Ethernet standardization. Testimonials and supporters from 19 large enterprise and multi-tenant data center expert end-users affiliated with 15 different global companies.

Presenter reviewed market forecasts for data center Ethernet switch revenue by speed, strong growth of Private Cloud, and data center Ethernet switch revenue by market segment showing continued growth for large enterprises.

Discussion about combining 100+200G growth for one of the market forecasts, methodology of obtaining customer testimonials, and representativeness of VOC.

General discussion followed.

Motion #3 (initial version discussed):

Move that the NGMMF Study Group adopt the following objective:

- Define a physical layer specification that supports 200 Gb/s operation over 1 pair of OM4 MMF with lengths up to at least 100m
 - Moved by Paul Kolesar
 - Seconded by Jonathan King

Friendly amendment John Abbott to add 70m reach for OM3 accepted by Mover.

Motion #3:

Move that the NGMMF Study Group adopt the following objective:

- Define a physical layer specification that supports 200 Gb/s operation over 1 pair of MMF with lengths up to at least 100m on OM4 and 70m on OM3
 - Moved by: Paul Kolesar
 - Seconded by: Jonathan King
 - Y: 37 N: 22 A: 14 (Technical, >= 75%)
 - Motion Fails
 - Room Count: 76

Break at 9:20 am CST. Resumed at 10:03 am CST.

Presentation #9:

Title: "Link Model Spreadsheet for Optical PAM-4 Channels"

Presenter: Jose Castro

http://www.ieee802.org/3/NGMMF/public/Mar18/castro_NGMMF_01_mar18.pdf

Presentation proposed a link model for PAM-4 equalized multimode channels. Penalties such as eye skew, ISI and jitter were discussed. A spreadsheet, implemented in Excel and VBA was shown during the presentation.

While Link model spreadsheets have been used in past IEEE 802.3 and Fibre Channel projects, recent projects, FC-PI-7/64GFC and IEEE 802.3cd, PMDs have not adopted link model spreadsheets.

Implementation equalized PMA-4 eyes and penalties in a spreadsheet is challenging.

Previous link models were generally for PMDs using NRZ.

In Fibre Channel, there has been previous work for equalized channels (valid only for NRZ), but also PAM-4 modeling using Python, Matlab and Excel VBA.

Benefits of having a link model spreadsheet as a guidance during the standardization process of new PMDs were discussed.

Modeling based on multi-mode rate equation and Gaussian approximation for multi-level channels could be used, but have computational and accuracy limitations, respectively.

Gaussian channel, ISI-jitter penalties for equalization of PAM-4, eye skew as deterministic jitter, and noise penalties were reviewed.

Link model spreadsheet with limitations shown. Modified spreadsheet with VBA code was shown overcoming limitations, but additional work required.

Request from group for screen captures of modified spreadsheet link model that was shown.

General discussion followed. Broad consensus and positive feedback on collaboration going forward.

SG reviewed modifications to CSD based on responses/resolutions to comments from EC on CSD generated previous day, March 06, 2018. Minor edits made to DI, CSD page 6.

Motion #4:

Move that the NGMMF Study Group approves the modified CSD responses in

http://www.ieee802.org/3/NGMMF/public/Mar18/CSD_Modified_per_EC_comments_NGMMF_01a_mar18.pdf

- Moved by: Earl Parsons
- Seconded by: James Young
- Y: 20 N: 0 A: 2 (Technical, >= 75%)
- Motion Passes!
- Room Count: 24

Motion #5:

Move to Adjourn:

- Moved by: Paul Kolesar
- Seconded by: Paul Neveux
- Approved by voice vote without objection (Procedural > 50%)

The Meeting was adjourned at 11:17 am, Central Standard Time (CST, UTC -6), Wednesday, March 07, 2018.

Appendix A: Attendees at the IEEE 802.3 Next-generation 200 Gb/s and 400 Gb/s MMF PHYs Study Group, 06-07 March, 2018, Rosemont, IL, US.

92 individuals signed in over both days.

78 signed in on Tuesday, 06 March, 2018.

67 signed in on Wednesday, 07 March, 2018 (Note: Room Count was 76 on that day for Motion #3)

	Last Name	First Name	Employer	Affiliation	06-Mar-2018	07-Mar-2018
1	Abbott	John	Corning	Corning	x	x
2	Abbott	Justin	Lumentum	Lumentum	x	
3	Anslow	Pete	CIENA	CIENA	x	x
4	Baca	Rich	Microsoft	Microsoft	x	x
5	Baldwin	Thananya	Ixia/Keysight	Keysight	x	
6	Beauregard	Francois	Belden	Belden	x	x
7	Bernstein	Gary	Leviton	Leviton	x	x
8	Booth	Brad	Microsoft	Microsoft	x	
9	Braun	Ralf-Peter	Deutsche Telekom	Deutsche Telekom		x
10	Brooks	Paul	Viavi	Viavi	x	x
11	Brown	Matt	Macom	Macom	x	x
12	Calvin	John	VTM	VTM, Wilder	x	x
13	Carlson	Craig	Cavium	Cavium		x
14	Castro	Jose	Panduit	Panduit	x	x
15	Chang	Ayla	Huawei	Huawei	x	
16	Chang	Frank	Inphi	Inphi	x	
17	Chen	David	AOI	AOI	x	x
18	Cheng	Weiyong	Coriant	Coriant	x	
19	Choudhury	Mabud	OFS	OFS	x	x
20	Dawe	Piers	Mellanox	Mellanox	x	x
21	Diminico	Chris	MC Communication/Panduit	Panduit	x	
22	Dudek	Mike	Cavium	Cavium	x	x
23	Fu	Shiyong	Huawei	Huawei	x	x
24	Fukutoku	Mitsunori	NTT	NTT		x
25	Ghiasi	Ali	Ghiasi Quantum	Ghiasi Quantum / Huawei	x	x
26	Gong	Zhigang	O-Net	O-Net		x
27	Hess	Dave	CORD DATA	CORD DATA		x
28	Ingham	Jonathan	FIT	FIT	x	x
29	Jackson	Ken	Sumitomo	Sumitomo	x	x
30	Jiminez	Andy	Anixter	Anixter	x	x
31	Kamino	John	OFS	OFS	x	x
32	Kareti	Upen Reddy	Cisco	Cisco	x	
33	Katz	David	Phoenix Contact	Phoenix Contact		x

34	Kawatsu	Yasuaki	APRESIA Systems	APRESIA Systems	x	x
35	King	Jonathan	Finisar	Finisar	x	x
36	Kipp	Scott	Broadcom	Broadcom	x	x
37	Kolesar	Paul	CommScope	CommScope	x	x
38	Le Cheminant	Greg	Keysight Technologies	Keysight Technologies	x	
39	Lee	June Hee	Samsung Electronics	Samsung Electronics		x
40	Lewis	Dave	Lumentum	Lumentum	x	x
41	Lim	Jane	Cisco	Cisco	x	
42	Lingle	Robert	OFS	OFS	x	x
43	Liu	Karen	Kaiam	Kaiam	x	x
44	Liu	Zhenyu	Credo	Credo	x	
45	Maki	Jeff	Juniper Networks	Juniper Networks	x	
46	Malicoat	David	Malicoat Networking Solutions	SENKO/Aquantia	x	x
47	Marques	Flavio	Furukawa Electric LatAm	Furukawa Electric LatAm	x	x
48	Mazzini	Marco	Cisco	Cisco	x	x
49	McSorley	Greg	Amphenol	Amphenol	x	x
50	Mei	Richard	NFLEXON	NFLEXON	x	x
51	Mellitz	Rich	Samtec	Samtec	x	x
52	Nakamoto	Edward	Spirent Communications	Spirent Communications		x
53	Neveux	Paul	Superior Essex	Superior Essex	x	x
54	Nolan	John	Cavium	Cavium	x	
55	Nordin	Ron	Panduit	Panduit		x
56	Novick	Asher	Panduit	Panduit	x	x
57	Palkert	Tom	Macom	Macom	x	
58	Parsons	Earl	CommScope	CommScope	x	x
59	Pepper	Jerry	Ixia/Keysight	Keysight	x	
60	Piehler	David	Dell EMC	Dell EMC	x	
61	Pham	Phong	US Conec	US Conec	x	x
62	Pimpinella	Rick	Panduit	Panduit	x	x
63	Pondillo	Peter	Corning	Corning	x	x
64	Rabinovich	Rick	Keysight Technologies	Keysight Technologies	x	
65	Rechtman	Zvi	Mellanox	Mellanox	x	
66	Ressl	Michael	Hitachi Cable America	Hitachi/APRESIA	x	x
67	Samamra	Raed	Prysmian	Prysmian	x	x
68	Sayre	Ed	Samtec	Samtec	x	
69	Shariff	Masood	CommScope	CommScope	x	x
70	Shen	Zuwei	Google	Google	x	x
71	Shirao	Mizuki	Mitsubishi Electric	Mitsubishi Electric		x
72	Skiest	Stephen	Panduit	Panduit	x	x
73	Sprague	Ted	Infinera	Infinera	x	x
74	Strassar	Peter	Huawei	Huawei	x	x
75	Tooyserkani	Pirooz	Cisco	Cisco	x	

76	Tracy	Nathan	TE Connectivity	TE Connectivity	x	
77	Trowbridge	Steve	Nokia	Nokia	x	
78	Ulrichs	Ed	Source Photonics	Source Photonics	x	
79	Vaden	Sterling	Vaden Enterprise	Surtec		x
80	Vanderlaan	Paul	Berk-Tek	Berk-Tek	x	x
81	Voss	Bob	Panduit	Panduit		x
82	Wang	Haifei	Huawei	Huawei		x
83	Wang	Xinyuan	Huawei	Huawei	x	
84	Wen	Yida	Huawei	Huawei	x	x
85	Withey	James	Fluke Networks	Fluke Networks	x	x
86	Xu	Yu	Huawei	Huawei	x	x
87	Yamamoto	Shuto	NTT	NTT		x
88	Young	Adrian	Leviton	Leviton	x	x
89	Young	Jim	CommScope	CommScope	x	x
90	Zhang	Kevin	IDT	IDT	x	x
91	Zhuang	Yan	Huawei	Huawei	x	x
92	Zivny	Pavel	Tektronix	Tektronix	x	
					78	67