

**(Unconfirmed Minutes)**  
**IEEE 802.3 EPON Protocol over a Coax (EPoC) PHY Study Group**  
**July 17-18, 2012,**  
**Hyatt Manchester, San Diego, CA, USA**  
**Chair: Howard Frazier**  
**Recording Secretary: Edwin Mallette, Victor Hou**

**Tuesday, July 17, 2012**

Meeting was called to order by Howard Frazier (Chair) at approximately 9:00 AM PST.

The Chair began following the slides in the file Agenda and General Information ([http://www.ieee802.org/3/epoc/public/jul12/agenda\\_rev2\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/agenda_rev2_0712.pdf).)

Edwin Mallette was asked by the Chair (Howard Frazier) to be Recording Secretary. Mr. Mallette accepted. Kevin Noll indicated that additional recording secretaries – Kevin Noll and Victor Hou – would be in the recording secretary rotation as Edwin would be out of the room periodically over the entirety of the agenda.

Chair continued with agenda and general information slides.

Time was taken for all attendees to introduce themselves and their affiliation.

Howard started by Proposing the agenda, rules, patent issues, recap from last meeting and presentations.

Howard indicated that other working groups were allowed to submit comments to the PAR, Objectives, and 5 Criteria by 5PM Tuesday and that the study group would have to respond by the end of Wednesday. He pointed out that he had allocated time in the agenda.

- Jorge Salinger asked if Howard had received any comments yet. Howard stated that he had not yet received any comments from other working groups.

Howard asked if there were any changes or modification requests to the agenda.

- Steve Shellhammer asked if Juan Montojo had received time they had asked for on the agenda. The agenda item was a spreadsheet for delay analysis of TDD. Howard indicated that if there was time at the end of the agenda after all presentations and review of other working groups comments then Steve's request would be granted.

**Motion #**

Approve the agenda within agenda\_rev2\_0712.pdf.

Moved: Marek Hajduczenia

Seconded: Kevin Noll

Approved by voice vote without opposition.

Howard asked if there were any changes to the minutes of the May, 2012 meeting (located at [http://www.ieee802.org/3/epoc/public/may12/unconfirmed\\_minutes\\_0512.pdf](http://www.ieee802.org/3/epoc/public/may12/unconfirmed_minutes_0512.pdf).)

Victor Hou indicated there were changes to the minutes – indicating 8 typos and other errors to correct, (comments located at [http://www.ieee802.org/3/epoc/public/jul12/hou\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/hou_01_0712.pdf).)

- In specific, under Sam Chernak’s presentation, Alex Liu is attributed as making points but Alex Liu was not at the meeting.
- Alex Liu’s colleagues indicated that he was not at the meeting in Minneapolis.
- Howard suggested striking the name “Alex Liu” and replacing it with “unattributed”.
- Howard Frazier asked for objections to Victor’s changes. There were none.

**Motion #**

Motion to accept minutes of May, 2012 meeting with Victor’s changes included in hou\_01\_0712.doc.

Moved: Duane Remein

Seconded: Victor Hou

Approved by voice vote without opposition.

Howard Frazier indicated again that the study group had to respond to comments from other working groups received by 5PM Tuesday by 5PM Wednesday.

Howard Frazier indicated that there is a New “Tools” page at <http://www.ieee802.org/3/epoc/public/tools>.

Howard walked the study group through accessing the new IMAT site used for attendance tracking located at <http://imat.ieee.org>.

Howard reviewed the method and apparatus for tracking the attendance book with the study group.

Jorge Salinger read the IEEE-SA patent policy to the study group.

The Chair performed the call for potentially essential patents. No one responded to the call for potentially essential patents.

Howard asked if anyone in the study group wanted him to review the objectives and five criteria in detail. There were no requests to do so.

## PRESENTATIONS

### -- Presentation #1 --

**Title:** EPoC Draft Structure

**Presenter:** Marek Hajduczenia (ZTE Corp)

**See:** [http://www.ieee802.org/3/epoc/public/jul12/hajduczenia\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/hajduczenia_01_0712.pdf)

## QUESTIONS / COMMENTS

Jorge Salinger asked if the assignment of editors is done after the task force is started.

— Howard Frazier indicated that was correct.

Steve Shellhammer asked if the assignment of the editors would be done at the first task force meeting or the second.

— Howard Frazier indicated that normally at the first task force meeting you would appoint the editor-in-chief and then the editor-in-chief would decide how many editors we would need.

Steve Shellhammer asked what's generally done to coordinate with other groups on affected clauses.

— Marek responded that in completely new clauses (the suggested 95, 96, 97) it would be completely within the task force to define what they need. In existing clauses we would need to work within the working group to make changes.

Jim Chen asked if the task force would be trying to limit the changes to existing clauses.

— Marek indicated that yes, that was the goal – that the task force would only touch the existing clauses as necessary.

Howard indicated that he supported the placement of MPCP for EPoC in a separate clause (as Marek proposed) but he also pointed out that would be up to the task force.

Eugene Dai asked would placing MPCP for EPoC in a separate clause affect backward compatibility.

— Marek indicated that as we cannot at this time predict what we're going to do – maybe the changes will be small, perhaps they will be large – part of the job of the task force will be in making these changes in a way that doesn't break backward compatibility.

### -- Presentation #2 --

**Title:** Data Rate Adaptation

**Presenter:** Marek Hajduczenia (ZTE Corp)

**See:** [http://www.ieee802.org/3/epoc/public/jul12/hajduczenia\\_02\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/hajduczenia_02_0712.pdf)

## QUESTIONS / COMMENTS

Steve Shellhammer asked about the case where the data rate would change with time and if this can be done all through registers. He also inquired as to how frequently the registers are checked.

- Marek indicated that was implementation dependent on how frequently the registers can be checked and changed. In terms of how to make the dynamic rate adjustment, Marek added, there's auto-negotiation, there's also a new mechanism based on LLDP that can run continuously across the link after it's established.

Steve Shellhammer asked if auto-negotiation is only done at startup.

- Howard Frazier answered that was correct.
- Marek added that there is a trend now to use mechanisms other than auto-negotiation and that right now he's not advocating for any specific method, he's just pointing out that there are ways it can be done.

Duane Remein commented that it's likely that the upper layer will inform the PHY that it should run at X rate.

- Marek responded that if you run LLDP that's correct.

Ed Boyd clarified that the MDIO has to specify the rate at which it moves bits in and out. In auto-negotiation, there's a restart mechanism to restart auto-negotiation but it's traffic affecting.

#### **-- Presentation #3 --**

**Presentation:** MPCP Extension for EPoC

**Presenter:** Rick Li (Cortina Systems)

See: [http://www.ieee802.org/3/epoc/public/jul12/li\\_01a\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/li_01a_0712.pdf) (LINK to updated slides.)

Rick indicated that he added a slide at 10PM Monday night and sent out an email. He is presenting the updated slides.

### **QUESTIONS / COMMENTS**

Hesham ElBakoury pointed out that it sounds like some of the suggestions are not minimal changes to MPCP.

- Rick Li indicated that Hesham was correct. Rick went on to add that that his contribution includes a full spectrum of changes from minimal to extensive.

Ed Boyd directed Rick Li to slide 8. Ed indicated that he was not sure where Rick was going with the multiple GATEs. Ed went on to add that it's confusing because there's a different delay composition and that it seems this would cause issues because you can't do multiple CNUs in this scenario because they wouldn't have the same start time.

- Rick Li responded that the reason he saw is OFDM, which allows multiple CNUs to transmit upstream in the same DBA cycle. In EPoC four CNU's may be all transmitting simultaneously on different subcarriers – one possibility where the same gate has 4 grants, one for each of the receiving CNU's.

Ed Boyd asked why Rick wouldn't leave it the way it is where each grant is received by the CNU using it.

- Rick Li answered that one advantage is you could reduce the number of gates, for instance if you had 256 or 512 CNUs. Rick indicated that there would be bandwidth savings but they had not calculated how much or how significant the savings would be. But it could also reduce the latency because it could save one DBA cycle.

Ed Boyd stated that longer GATEs actually increase the response time. If I give out a grant for one second that's one second I can't respond for a high priority report.

- Rick Li responded that he had no objection to using today's normal GATE.

Ed Boyd directed Rick Li to [SLIDE 9]. Ed asked why isn't the depicted scheduler just one scheduler that's scheduling a slot that's addressed to the downstream? And further why is it in a separate DBA?

- Rick Li answered that he was trying to characterize today's DBA as really scheduling upstream transmission. That it would be a new DBA function to schedule the downstream TDD transmission. How do we control the TDD downstream transmission? Some entity would have to control the OCU start and stop transmission in the downstream.

Ed commented that it didn't have to be a separate DBA.

- Rick Li agreed that it's just a separate function.

Mark Laubach thanked Rick Li for the food for thought and then asked if gates can be encrypted.

- Rick responded, "Not really."
- Ed Boyd agreed, "Not in general, no."

Mark Laubach stated that if you're going to send an MPCP message to the OCU, then it's a MAC entity and then it's going to be a bridge. Outside the EPoC group, the group specifying the OCU would come back to us to request MPCP extensions. The other thing is some of these things in the presentation can be done in OAM.

- Rick Li answered that this cannot be done in OAM because it requires timing.

Marek Hajduczenia [SLIDE 8] asked what would be the case of multiple CNUs per gate – what would the destination address go?

- Rick Li responded that it would be a multicast address in the MAC. And you'd include the LLID in each grant.

Marek Hajduczenia [SLIDE 12] pointed out that in here you have an interesting concept of making MPCP aware of what's happening in the PHY. The point of MPCP is that it controls the MAC, not the PHY. This should be done at the lower layers. [SLIDE 13] Marek pointed out that IP had classful assignment and that we don't need to specify a classful LLID in here.

Eugene Dai asked what it means by classful LLID – do you want a type so the OLT would know which LLIDs come from which cable segment? Eugene went on to say that the problem in a very generic way is that LLID should be discovered from the physical topology.

— Rick Li responded that today LLID follows a specific policy but is vendor specific.

Eugene Dai followed up by saying that Rick Li mentioned today which LLID comes from which passive splitter – and that there's no way to know. This suggests that MPCP be aware of the subcarrier... Eugene agrees that MPCP should be aware of the subcarrier – but asked who's going to take care of the subcarrier awareness?

— Rick Li stated that he made a mistake in suggesting MPCP to handle the physical layer. That he's not clear what would be the best way in handling that.

#### **-- Presentation #4 --**

**Presentation:** Concurrent Upstream Transmission from Multiple CNUs in Single EPoC Coax Segment

**Presenter:** Rick Li (Cortina Systems)

See: [http://www.ieee802.org/3/epoc/public/jul12/li\\_02\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/li_02_0712.pdf)

### **QUESTIONS / COMMENTS**

Duane Remein stated that on the problem of concurrent transmissions – EPON allows current transmissions today. There are probably systems that do concurrent transmissions if you look at absolute time. So we can already support concurrent transmissions. Assuming FDD, which seems FDD is a given, we have to assume we have a way to allow CNUs to transmit simultaneously.

— Rick Li indicated that they're talking about different definitions of concurrency. Multiple EPON ONU's may be transmitting at the same time but as soon as the transmissions converge to the same physical fiber they're sequential.

Duane Remein agreed that there is nothing in the standard that specifies the transmissions must be sequential.

Marek Hajduczenia [*SLIDE 4*] pointed out that a lot of the discussion depends on what one does with the DBA, but since we don't specify the DBA this is outside of scope.

— Rick Li stated that whether we support concurrent upstream transmission for EPoC is not part of the specification.

Marek Hajduczenia added that what he's saying is that in both schemes the way one schedules the slots is DBA dependent.

— Rick Li disagreed – whether we use OFDM or OFDMA will be part of the PHY specification. If we say OFDMA is in then we are supporting concurrent transmission, otherwise why specify the A.

Marek Hajduczenia followed up that we're not going to change anything in the way EPON works. What the OCU translates those into (and the OCU is not specified in here) was still unknown.

**-- Presentation #5 --**

**Presentation:** An Example of designing a Coax Convergence Layer in EPoC

**Presenter:** Jim Chen (Huawei)

See: [http://www.ieee802.org/3/epoc/public/jul12/chen\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/chen_01_0712.pdf)

**QUESTIONS / COMMENTS**

Eugene Dai [SLIDE 4] asked about the section in the coax convergence layer – under that block labeled coax framing – and about what that meant.

— Jim Chen Framing into the OFDM frame or symbols.

Eugene pointed out that Jim had these blocks backwards. That the coax coding should be above the coax framing.

— Jim Chen responded that this is one of our research subjects – it's only a specific research stack.

Eugene Dai followed up that even for research it's entirely wrong. That block is reversed. Directing Mr. Chen to [PAGE 7] Eugene indicated that Mr. Chen was doing LLID buffering.

— Jim Chen answered that in upstream they were doing LLID buffering but not in the downstream.

Eugene Dai asked how Mr. Chen could get a fixed delay when doing LLID buffering upstream and downstream buffering. The buffering of packets would cause different delays – that delay cannot be controlled. In this kind of implementation how would Jim guarantee the delay?

— Jim Chen responded that he had another discussion that talks about RTT and that further extends the RTT from EPON between OLT and ONU from OLT to CMC to CNU.

Eugene Dai [PAGE 3] stated that Mr Chen was mapping between LLID 1 to N, so assuming on the coax segment that one maps the LLID into a different frame location then send out – when this is done this do you keep LLID or strip off LLID ?

— Jim Chen answered that the LLID will be kept.

Eugene Dai [PAGE 8] indicated that if all LLIDs are kept that he didn't understand why LLID insertion would be needed.

Victor Hou stated that perhaps it was not Mr. Chen's intent to go into all this detail of the EPoC UL- MAP., but he is not clear what aspects of MAC control would be included in this message.

— Jim Chen answered that in this case the CMC is not a simple repeater – the gate has to be translated and sent to the CNU.

Victor stated that he was hearing MAC control functionality at a message terminated at the PHY. This does not appear to involve proper layering.

— Jim Chen responded that was one reason they proposed the concept of the converged layer, in an attempt to try to resolve this complexity to push back to the OLT so we can do a really simple design on the CMC.

Marek Hajduczenia observed that the contribution has a lot of acronyms that are not explained anywhere. Marek Hajduczenia indicated explicit that he didn't know what UL-MAP is.

— Jim Chen answered that he explained that in the coax uplink map.

Marek Hajduczenia stated that he believed in the last meeting we had a whole conversation about the OCU, but we decided were not going to specify the OCU in here.

— Jim Chen stated that he was recommending this to be considered.

Marek Hajduczenia countered that the device is never going to be specified in here. Marek went on to add a technical comment that Jim's "convergence layer" is simply a MAC within the PHY.

Howard Frazier announced that he had updated Rick Li's slide deck to the one that Mr. Li had presented. Howard Frazier also announced that the agenda slide deck had been updated as well with an up-to-date patent policy page.

**Break for Lunch 12:23PM, per the chair to return at 1:30PM.**

**Session resumed at 1:40PM per chair.**

**-- Presentation #6 --**

**Presentation:** Delay Analyze of Ethernet Passive Optical Network Over Coax

**Presenter:** Eugene Dai (Cox Communications)

See: [http://www.ieee802.org/3/epoc/public/jul12/dai\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/dai_01_0712.pdf)

**QUESTIONS / COMMENTS**

Marek Hajduczenia [*SLIDE 7*] requested clarification on whether Eugene means round trip delay by total delay or one-way.

— Eugene Dai indicated that when he analyzed delay it was one-way.

Duane Remein asked if the window cycle is analogous to a grant cycle.

— Eugene Dai responded that it was.

Duane Remein pointed out that the equations Eugene ended up with are analogous with similar equations one could arrive at with EPON.

— Eugene Dai responded that Duane was correct.



Ed Boyd asked that as Eugene analyzed this and looked at it – where would he put in things like interleavers ? And does Eugene have any idea on interleaver sizes ?

— Eugene Dai indicated that his contribution includes only a very basic model – so interleavers are not considered. Even if interleavers were considered it would not affect the conclusion, it just makes things more complicated.

Andrea Garavaglia [*SLIDE 7*] asked where the jitter comes from.

— Eugene Dai answered that if the packet arrives outside of the TDD uplink transmission window – that’s where the jitter comes from.

**-- Presentation #7 --**

**Presentation:** EPON over Coax System Reference Model

**Presenter:** Eugene Dai (Cox Communications)

See: [http://www.ieee802.org/3/epoc/public/jul12/dai\\_02\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/dai_02_0712.pdf)

**QUESTIONS / COMMENTS**

Marek Hajduczenia [*SLIDE 5*] asked if the “E” in EXGMII stood for “Electrical” ?

— Eugene Dai responded that it stood for “Extended.”

Marek Hajduczenia asked about the 20km shown on the diagram and if it was between the OLRT and CNU. Marek then asked if the diagram would still work if the fiber was 20 kilometers and there was some X kilometer of copper ?

— Eugene Dai responded that the length of the coax was still to be decided.

Rick Li [*SLIDE 3*] stated that he was trying to understand the difference between model A and model B. In model A the ORT performs physical layer repeater function and model B the OE performs optical to electrical conversion.

Eugene Dai answered that Rick was correct and that model B moves the ORT to the headend.

**-- Presentation #8 --**

**Presentation:** Duplexing Methods for Ethernet Passive Optical Network Over Coax

**Presenter:** Eugene Dai (Cox Communications)

See: [http://www.ieee802.org/3/epoc/public/jul12/dai\\_03\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/dai_03_0712.pdf)

There were no questions or comments on this presentation.

**-- Presentation #9 --**

**Presentation:** Feasibility of TDD in EPoC

**Presenters:** Jorge Salinger, Hesham ElBakoury, Nicola Varanese, David Barr

See: [http://www.ieee802.org/3/epoc/public/jul12/salinger\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/salinger_01_0712.pdf)

The presenters each presented part of the section after which they took questions.

Jorge Salinger presented slides 1-10.

**QUESTIONS / COMMENTS**

Ed Boyd [PAGE 24] asked why wouldn't they just extend the idles to handle the lower rate and the FEC.

— Nicola Varanese answered that the reason is if you put idles here [highlighted the PAD] those would be transmitted over the medium.

Ed Boyd stated that idle deletion and insertion is already done in the PCS layer. Ed Boyd then asked why this layer is added.

— Nicola Varanese responded that considering the transmission window, this is created by the block processing if you consider OFDM modulation. This padding portion could be filled with idles, then those idles would need to be discarded by the PMA layers. It means this block would have to do the same job as the MAC layer and then the layer under that would have to delete these idles. The PMA layer discards the padding bits and takes the good bits and converts that into the transmit signal.

Ed Boyd indicated they would take this off-line.

Hesham ElBakoury presented slides 11-18

No questions were asked of Hesham.

Nicola Varanese presented slides 19-32

**QUESTIONS / COMMENTS**

Avi Kliger stated that he's not sure what single PHY means. In a high level it's the same as it has the same high level blocks and the same names of parameters, but the actual parameters are different.

— Nicola Varanese stated that he thinks this was an important comment. This is an important question also for FDD. Not every operator has the same frequency plan or same bandwidths available. So this rate adapter would be useful for FDD as well.

Ed Boyd disagreed that the rate adapter would be needed in FDD. Ed Boyd then asked that in TDD, what is the estimated size of the rate adapter in the upstream and downstream ?

— Nicola Varanese answered that it could be a shared block as in FTT. The size may depend on the TDD cycle, but it's something that's under control. You decide about the size of the TDD cycle. It can be clearly parameterized.

Ed Boyd indicated that the specs going to have a maximum and then he asked if Nicolo had an estimate. Ed put forward a guess of around 250-300 kbytes.

— Nicola Varanese stated that in this contribution they don't have an estimate because this is not really a technical proposal. That it depends on the dimension of the transmission window.

Juan Montojo stated that he made the quick calculation 1Gb/s with 100us per symbol is and it's 37 kBytes.

David Barr presented slides 33-43

### QUESTIONS / COMMENTS

Edwin Mallette [SLIDE 42] asked about the worst case delay of ~600us and if that wouldn't translate into a potential frame delay variation of up to 600us.

— Steve Shellhammer answered that since they are assuming the penalty of the worst case delay you get no incremental jitter but you always add 600us to the delay.

Avi Kliger [SLIDE 41] drew David Barr's attention to the last bullet about two PHYs for FDD. FDD would have a single transmitter for the upstream and a single receiver for the downstream while TDD would have a single transmitter and receiver for both upstream and downstream. TDD has a single transmitter and a single receiver that works at twice the speed so TDD would need to be more complex.

— David Barr answered that what he's saying today is in FDD you have two implementations of the PHY working concurrently – one OFDM machine running transmitter and one OFDM machine running receiver.

Avi Kliger stated that in every chip you have a single chip running transmitter and one running receiver. Then he asked if the 14 us does includes the turnaround time between being a transmitter and being a receiver in TDD.

— David Barr answered that it did.

Avi Kliger stated that David Barr would need turnaround time much larger than 14us.

Juan Montojo deferred on presenting the conclusion slides.

**-- Presentation #10 --**

**Presentation:** The Status of Bidirectional Network Transformation in China MSOs

**Presenters:** Dr. Gao

See: [http://www.ieee802.org/3/epoc/public/jul12/gao\\_01a\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/gao_01a_0712.pdf)

Dr. Gao presented the slides in Chinese. The slides are displayed in English. Rick Li translated for Dr. Gao as necessary.

**QUESTIONS / COMMENTS**

Jorge Salinger [*SLIDE 3*] asked about what was meant by the covered but not passed description by the pink box.

- Dr. Gao answered (via Rick Li) suppose you have a building – fiber is reached into the building. The EoC is already installed – there are 50 homes in the building. 50 would be considered covered but there may be only 4 apartments that have service. The user device is not installed in the other 46 but everything else for those 46 non-served homes is ready for service.

Jorge Salinger [*SLIDE 4*] asked if Dr. Gao could you talk about why the growth rate is slow for each category ?

- Dr. Gao (via Rick Li) answered that he did not think he could answer the question.

Jorge Salinger inquired about churn and if churn is a concern.

- Dr. Gao (via Rick Li) answered that customer churn is mostly in the broadband access and the ratio is not low (Rick Li provided a translator note that Dr. Gao didn't say "high.")

Jorge Salinger [*SLIDE 6*] asked if the reason that operators use more than one solution was because of different services or different plant conditions. He also asked what was the reason for more than one solution.

- Dr. Gao (via Rick Li) answered that initially they have all installed DOCSIS. But as FTTH is offered by the competition the MSO started to look for a technology that can offer better pricing per performance ratio so they can compete with FTTH.

Jorge Salinger asked about what FTTH mean in China.

- Dr. Gao (via Rick Li) answered that FTTH means to every home.

Jorge Salinger [*SLIDE 8*] asked about that blue box – which indicated that China plans to invest heavily in broadband network infrastructure ... Jorge asked if that meant Chinese government or Chinese MSOs.

- Dr. Gao answered directly China Telecom.

Mike Emmendorfer asked about when a telecom competitor goes to a building – do they rewire the building with fiber to each unit or do they look for coax or twisted pair to each unit.

— Dr. Gao (via Rick Li) answered that yes, the telcos are rewiring.

Kevin Noll inquired that if your competition is building fiber to the unit – what would Dr. Gao consider the longevity of a solution based on coax being.

— Dr. Gao (via Rick Li) responded that it's a difficult question to answer. He would need some time to consider. That Dr Gao is afraid of giving an inaccurate answer

— Mr. Yao (via Rick Li): --- answered the question posed to Dr. Gao --- Mr Yao believes the longevity of coax to be very long. Similar to the US Comcast and Cox and whoever can also deploy FTTH. Chinese MSOs have little chance (virtually no chance) to deploy fiber to each home, Mr. Yao believes a very small percentage of users will pick the MSOs.

Eugene Dai responded to Dr. Gao's contribution, indicating that Dr. Gao gave very interesting presentation. Eugene went on to say that it's very interesting Dr. Gao did not mention HiNOC. Eugene asked if HiNOC would be the unified standard in China going to 1Gbps?

— Dr. Gao (via Rick Li) answered that HiNOC is a standard in the making but it's endorsed by China SARFT. Based on the material Dr. Gao has seen, it's at version 1.0 and he believes there's an incomplete ecosystem – there's no HiNOC product today. Secondly also based on the material – Dr. Gao's knowledge – HiNOC 1.0 is also targeting 1 gigabit rate but from his perspective it's only a plan at this point. He does not want to comment on only a plan.

— Mr. Yao (via Rick Li) answered that the China MSO community is in the process of establishing a forum or alliance. All the members wish that HiNOC and EPoC would be unified.

Howard Frazier [*SLIDE 8*] pointed out that slide 8 lost a lot of impact when they made the slide safe. Originally slide 8 had absolute Yuan in it. Howard indicated that previously the number depicted was a very large number. Howard went on to state that even taking one-third of that number for the access network what remains is still a very large number. Howard lastly thanked the contributors, Rick Li and others who worked on the translation of the presentation.

**-- Presentation #11 --**

**Presentation:** Evaluation Criteria Beyond Objectives

**Presenters:** Mark Laubach (Broadcom Corporation)

See: [http://www.ieee802.org/3/epoc/public/jul12/laubach\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/laubach_01_0712.pdf)

**QUESTIONS / COMMENTS**

Glen Kramer asked about some higher layer functions – inquiring if Mark believed that will have an impact on what’s going on in SIEPON. Glen Kramer further indicated that SIEPON has been working on higher layer functions such as power saving.

— Mark Laubach responded that he was glad Glen Kramer was here because Mark would like Glen to work toward that.

Glen Kramer added that it would be good to know what to expect for the future.

— Mark stated that he thought the future task force would likely be liaising with SIEPON.

Duane Remein stated that he’d heard Mark say a couple times the PHY has to link up before we even think about MPCP. Duane indicated that he was not convinced and asked for details please. Duane Remein continued that he trusted Mark has some points here and he’d really like to understand that in terms of how much functionality a PHY needs to discover other PHYs without using another MAC entity.

— Mark Laubach said he understood that’s how it’s done in EPON but the EPON PHY is very simple. In a cable RF world the PHY is more complex. This is why DOCSIS does it as part of management. DOCSIS doesn’t allow the users to talk until the modem is online and configured.

Steve Shellhammer started by saying that he would call these “evaluation criteria” like delay. Steve then asked Mark about how the task force would sort of agree on what is a requirement ? Steve Shellhammer added that Mark had brought up auto-negotiation and a bunch of other things and would this something to be pushed to the agenda in September?

— Mark Laubach answered Yes, yes, and yes. Mark added that his contribution is a call for thought and a call for noodling.

Steve Shellhammer suggested that some groups put together a document as evaluation criteria and then vote on it.

— Mark Laubach answered that suggestion could work but added that the task force should look at how Howard Frazier has done it in the past or how Marek Hajduczenia done it in the past.

Marek Hajduczenia [*SLIDE 3*] asked if what Mark Laubach meant by “802.1af.”

— Howard Frazier clarified the reference as “802.1AS” – capital A capital S.

**Break for the day at 6:15PM, per the chair.**

### **Wednesday, July 18, 2012**

Meeting was called to order by Howard Frazier (Chair) at approximately 9:00 AM PST. The study group continued with the agenda laid out the previous day.

**-- Presentation #12 --**

**Presentation:** Comments on Channel Models

**Presenters:** Mark Laubach (Broadcom Corporation)

See: [http://www.ieee802.org/3/epoc/public/jul12/laubach\\_02\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/laubach_02_0712.pdf)

**QUESTIONS / COMMENTS**

Jorge Salinger [*SLIDE 10*] stated that he believed, contrary to what Mark Laubach had said, that Comcast will need to support non-contiguous chunks of spectrum and that will be important especially in the upstream. [*SLIDE 11*] Jorge Salinger stated his desire that the group use the term “passive overlay” rather than “Node+0”. [*SLIDE 17*] Jorge commented that he did not believe in terms of modeling in the home that there would be multiple EPOC devices in the home.

— Mark Laubach responded that was their thinking as well.

Jorge Salinger indicated that Comcast will have to support a model by which STBs hang off the input the same way they do today. So Comcast may have an EPOC device for IP content while there’s still STBs in the home, so it’s a bit of a dichotomy.

— Mark Laubach answered that where the cable operators network connects to the home there’s usually a diagram but we will have to decide what that diagram looks like.

Thomas Staniec stated that from his understanding the level of impairments that can happen when not isolated from the home can be fairly significant. So the channel model might account for one where there is isolation from the home and then another where the artifacts are present when there is not isolation from the home.

John Dickinson indicated that operators will ask for everything. And that there needs to be constraints on that. John Dickinson state that he thought that operators - day one - were going to ask for everything so the process needs to be collaborative.

— Mark Laubach stated that there’s working with the plant we have today and then there’s changes that might be needed in the pass band or other changes. Mark indicated that he did not see the group creating situations that are science fiction or outside the realm of feasibility.

Amarildo Vieira stated that he was wondering if those set of 802.14 documents can be made available.

— Howard Frazier answered that they’ve been in contact with Robert Russell (last chair of 802.14) as Robert used to retain those in a repository. They’re trying to find the 802.14 documents.

Hesham ElBakoury indicated that he had three questions – number 1 since the channel model is fundamental for what the group is doing, then nobody can bring in technical contributions until we agree on the channel model.

- Mark Laubach answered that technical contributions could be made that try to drive available spectrum needs. However if they to compare modulation math and forward error correction proposals they're going to want to see them run against the channel model.

Hesham ElBakoury second question was suppose three people propose three models, how would the group select one.

- Mark Laubach answered that it was the same as always – by consensus.

Hesham ElBakoury asked if there are examples for a channel model.

- Mark Laubach answered that he would search on the internet as there are channel models for the wireless network.

#### **-- Presentation #13 --**

**Presentation:** Examination of Spectral Limitations

**Presenters:** Leo Montreuil (Broadcom)

See: [http://www.ieee802.org/3/epoc/public/jul12/montreuil\\_01a\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/montreuil_01a_0712.pdf)

Howard Frazier noted that Leo Montreuil's presentation was updated to add a supporter – that presentation is on the web.

### **QUESTIONS / COMMENTS**

Avi Kliger asked if when Leo says simulation, were the tests in the simulation were measured or simulated?

- Leo Montreuil responded that the results were measured. Leo clarified that the tap measurement was done in parallel with this. So if the tap that was in the plant was measured – the same model, but not the same unit.

Avi Kliger [*SLIDE 16*] stated that the frequency response is not well-behaved if you start at 11, 12. You see lots of reflection here so this means we may need to have different channel models for above 1G and those below 1G.

- Leo Montreuil responded that they didn't know the behavior above 1G because it's not specified.

Eugene Dai [*SLIDE 17*] stated that he was trying to figure out from the group delay how much comes from tap and how much from transmission line.



- Leo Montreuil responded that there is some here from the connector but it's very minimal. There's some but the dominant is from the tap.

Eugene Dai pointed out that the high frequency tap some people claim can do 2gig.

- Leo Montreuil indicated that he had the analysis for four taps for this but he had to remove this because these high frequency taps are no longer available..

Kevin Noll indicated that he was not sure what you measured and he was not sure what Leo simulated.

- Leo Montreuil [SLIDE 15] responded that each of the pieces shown are characterized – one by one, individually. Slide 8 includes a table of what they measured – the S parameter input to output,

Kevin Noll asked if his understanding was correct - that Leo found the S parameters for each component and then put them into a simulation as a chain and that's what was simulated.

- Leo Montreuil answered that Kevin was correct.

Thomas Staniec: stated that he had one question and then a couple observations. Tom asked when Leo did the testing, were all ports at all times terminated with exception of the port under test.

- Leo Montreuil answered that all ports were terminated.

Tom Staniec indicated that one of the simulations needed is that cable operators don't actually terminate ports.

Steve Shellhammer asked if it would it be possible to make a model – that perhaps fits in with Marks discussion about channel models...something exactly as measured and then update parameters based on what others have developed.

- Leo Montreuil answered that it's possible to generate return loss based on the tap. In this case a mathematical model was done by hardline and tap. To get very accurate levels you have to have a physical tap.

Steve Shellhammer postulated that even the model would be sufficient for this group.

- Rich Prodan responded that the results of the model would be what one would need.

**-- Presentation #14 --**

**Presentation:** FDD vs TDD Comparison

**Presenters:** Avi Kliger (Broadcom)

See: [http://www.ieee802.org/3/epoc/public/jul12/kliger\\_01a\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/kliger_01a_0712.pdf)

**QUESTIONS / COMMENTS**

Jorge Salinger [SLIDE 3] pointed out that at 10bits/Hz in the downstream 10Gb/s requires 1GHz of spectrum. So saying that operators could run 10Gb/s down, it's mathematically correct but it's operationally impossible. Jorge stated that that this assumption is blatantly invalid.

— Avi Kliger responded that this is EPoC alone without the existing cable system.

Jorge Salinger followed up that if operators only had EPoC they would not be cable operators we'd be something else. In the case of upstream it would be even worse. At 8bits/Hz one gig requires 80MHz which no cable operators have.

— Avi Kliger commented that the 10G to 1G is optimal capacity. In the task force side we plan to propose 5G/1G option.

Steve Shellhammer [SLIDE 11] pointed out that Avi added 1.2 symbol time to save hardware which adds a lot to the turnaround time. Steve said that's not necessary. FDD has hardware for transmit and receive at the same time and a comparable TDD system could have separate hardware and reduce that significantly, so maybe it's terminology. [SLIDE 5] Steve Shellhammer asked if when Avi uses the term frame if he's talking about a group of symbols and when you say burst ...

— Avi Kliger responded that frame and burst are the same thing.

Dave Barr stated that Avi was using larger overheads for TDD than Dave had been presenting now and Dave's a little concerned by that. Dave asked to reserve the opportunity to explain how one could keep the low overhead and still retain the switching time.

— Avi Kliger responded that they tried their best to come to reasonable assumptions that take into account reasonable implementations.

Dave Barr added that when one has a source of overhead like that it's an opportunity for engineers to get very creative about this and engineer fast ways to do this turnaround. There's no need to exaggerate orders of magnitude.

— Rich Prodan asked if Dave was saying their numbers were an order of magnitude too large here.

Dave Barr responded that that debate should have been two meetings ago.

— Avi Kliger stated that they tried to find the best cases for TDD.

**Break at 11:05, per the chair for 10 minutes.**  
**Session resumed at 11:14AM.**

**-- Presentation #15 --**

**Presentation:** EPoC Delay

**Presenters:** Ed Boyd (Broadcom)

See: [http://www.ieee802.org/3/epoc/public/jul12/boyd\\_01a\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/boyd_01a_0712.pdf)

**QUESTIONS / COMMENTS**

Jorge Salinger commented that unless he was missing something in an EPON system there's an OLT, fiber, and then the ONU. In EPoC, there will be the same OLT, some of the same fiber, the OCU, the CNU and coax in the middle. Fundamentally the OLT is the same, the CNU is roughly the same as the ONU and the OCU is an extra box. So EPoC will be more expensive than EPON.

— Ed Boyd answered that EPON will be cheaper. If one increases the delay by a significant amount and thus the buffer multiplies up, that's going to impact the cost.

Jorge Salinger stated that they pay more for devices but they achieve things they couldn't previously achieve. So the fact that the CNU in the beginning cost more than the ONU is not a barrier.

— Ed Boyd answered that it's a bigger barrier than you might think – if one has to build a custom chip just for EPoC that has cost implications.

Jorge Salinger [*SLIDE 3*] suggested that Ed Boyd seemed to imply that there will be an EPON version 1 and an EPON version 2 just for EPOC and that's not okay.

Jorge followed up by clarifying that there will be some changes.

— Ed Boyd answered that yes, if one has to increase the report frame from 1ms to 2ms that has a massive ripple effect. Ed Boyd stated that he believes they can do it with no difference to the OLTs.

Andrea Garavaglia [*SLIDE 9*] stated that the information Ed Boyd showed referred to the maximum amount of time quanta you can report in the REPORT. Thus Ed would be looking at the peak data rate that a single user could achieve in that scenario.

— Ed Boyd answered that the peak data rate that is actually solicited.

Andrea Garavaglia stated that what he was getting at is that this is made with the assumption of a 1Gb/s OLT which belongs to a 1Gb/s system.

— Ed Boyd clarified that the most you can request is a 1ms block of time. The data rate within that could be 1Gb/s or 10Gb/s.

Steve Shellhammer said that if the optical side is limited to 1G, if the optical side is 10G this situation does not occur.

— Ed Boyd responded that if 100km is 1ms, if I go out 200km this exact situation occurs.

Steve Shellhammer said that on the coax side, Ed would give examples where the GATE command was interpreted differently. So it's completely possible on the coax side to interpret the message differently.

— Ed Boyd answered that yes, that's what he meant but there's no way to send that report frame up to the OLT.

Steve Shellhammer pointed to Ed Boyd's example in Hawaii which interpreted the GATE command differently, so a similar thing could be done.

— Ed Boyd stated that nothing changes on the OLT in that example.

Steve Shellhammer said that overall in terms of the delay analysis, they have similar methods, they just input different values there so they agree somewhat on the method. They used different values so our results ended up differently.

— Ed Boyd said that Steve Shellhammer provided the delta between FDD and TDD. Ed stated that he likes absolutes because he can work with absolutes.

Juan Montojo [*SLIDE 20*] asked if the only penalty on the delay is this extra delay for the switch.

— Ed Boyd answered that he had a few additional – that one has to use a block interleaver instead of a convolutional. The disruption is the main one.

Juan Montojo commented that there are delays that are unavoidable and there are delays that occur because of your implementation choice.

— Ed Boyd responded that they had to make a decision within the standard to either allow one to share the logic to keep cost down or not to to keep performance up. There's a choice that if one wants to keep the best performance and then they have to add complexity.

Juan Montojo asked where the 10% penalty for direction change come from – if it was the switch.

— Ed Boyd stated that he came up with 10%, but others could come up with smaller numbers but the delay gets longer.

Juan Montojo said that Ed Boyd seemed to suggest that one has to change MAC.

— Ed Boyd answered that it was the MAC control.

Juan Montojo asked if that would be inside of the current scope of the task force - Yes or no.

— Ed Boyd answered that he did not know. In his mind, the answer is no. Ed's point is that this would not be minimal augmentation and that it could create an incompatibility that he doesn't know how to reconcile.

Howard Frazier indicated that there were two more presentations from Mr. Yao, and that Marek's presentation about Energy efficiency was going to be pushed off into September. Howard emailed out proposed responses to the 802.3bn PAR.

**Break for lunch at 12:25, per the chair to return at 1:30PM.**

**Session resumed at 1:45PM.**

**-- Presentation #16 --**

**Presentation:** Feasibility of TDD & China Market Demand on EPoC

**Presenters:** Yong Yao (translated by Rick Li)

See: [http://www.ieee802.org/3/epoc/public/jul12/yao\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/yao_01_0712.pdf)

**QUESTIONS / COMMENTS**

Victor Hou asked a question for clarification – in an N+0 one-way plant why wouldn't the low frequency band be available for low bandwidth upstream?

— Mr. Yao (via Rick Li) answered that was a possibility. Mr. Yao also mentioned that even though HiNOC is officially TDD technology, one of the chip suppliers implementing HiNOC is also supporting a low frequency FDD as a potential. Mr. Yao believes that both FDD TDD modes are usable its really up to individual MSO requirements, they can pick and choose.

John Dickinson asked about the 750 MHz or EPoC 1GHz and above and what's running on 750MHz to 1GHz?

— Mr. Yao (via Rick Li) indicated that some Chinese MSOs are using that frequency band for either high frequency EoC frequency modulation WiFi adapted to 750.

Hesham ElBakoury said that Mr. Yao said MSOs can choose FDD or TDD as they like but that Mr. Yao would like EPoC group to develop a PHY to support FDD and TDD such that an MSO can configure EPoC to use FDD or TDD based on what they like.

— Mr. Yao (via Rick Li): Correct. Mr. Yao prefers this study group to include both TDD and FDD in the specification then the MSOs can pick and choose what they want.

Hesham ElBakoury commented that the OCU is that it's out of scope.

Mr. Yao (via Rick Li) asked Ed Boyd if OCU does not perform self-regulation or not, who tells OCU when to start and stop.

— Ed Boyd answered that when a packet is detected to be received on the coax, the laser will turn on. That is the assumption.

Q&A concludes.

Paul Nikolich congratulates group on holding the first bilingual session that he can remember in IEEE 802.

**Break at 3:05, per the chair to resume at 3:15PM.**

**Session resumed at 3:27PM.**

Howard Frazier reviewed the Comments on P802.3bn PAR & 5 Criteria from Jon Rosdahl and Paul Nikolich. Howard asked Steve Shellhammer to join him at the front of the room to help refine the responses to the comments.

See: [http://www.ieee802.org/3/epoc/public/jul12/frazier\\_01\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/frazier_01_0712.pdf)

Howard Frazier spoke about the changes from the 5 Criteria the study group used; the 802 EC made changes to the Compatibility criterion in March and the study group did not use the correct boiler plate.

**Motion #1**

Motion to accept the changes as made in frazier\_01\_0712.pdf

Moved: Jorge Salinger

Seconded: Tom Staniec

Y: 46 N: 0 A: 0

Passed July 17, 2012 4:08PM

The Study Group final remedy to the various comments is in document:

[http://www.ieee802.org/3/epoc/public/jul12/P802\\_3bn\\_response\\_to\\_comments.pdf](http://www.ieee802.org/3/epoc/public/jul12/P802_3bn_response_to_comments.pdf)

After the review of the comments against the P802.3bn PAR and 5 Criteria, Howard Frazier continued along the agenda with the final presentation.

**-- Presentation #17 --**

**Presentation:** TDD Analysis spreadsheet provided by Juan Montojo

**Presenters:** Juan Montojo

See: [http://www.ieee802.org/3/epoc/public/tools/montojo\\_01\\_0712.xlsx](http://www.ieee802.org/3/epoc/public/tools/montojo_01_0712.xlsx)

Juan Montojo presented this tool that exists in the public tools folder within the EPoC study group public tools folder.

At 4:42PM Howard Frazier needed to leave the room to make sure that the responses to comments on the PAR and 5 Criteria were delivered to the IEEE 802 LMSC Executive Committee email reflector.

Mark Laubach was asked to be acting Chair.

At 4:45PM, Howard Frazier returned and resumed Chair duties.

Howard Frazier asked the group if they would like to hear the presentation "The Path to Working Group Ballot" now, or at the September meeting. The group preferred to hear the presentation now.

**-- Presentation #18 --**

**Presentation:** The Path to Working Group Ballot

**Presenters:** Howard Frazier

See: [http://www.ieee802.org/3/epoc/public/jul12/frazier\\_02\\_0712.pdf](http://www.ieee802.org/3/epoc/public/jul12/frazier_02_0712.pdf)

Responding to a question, Howard said anyone in room can vote within a TF. The WG ballot is only for voting members.

Steve Shellhammer said that in other groups, only voting members can vote within a TF.

— Howard responded that was not true for 802.3.

Additional time was needed to respond to Paul Nikolich's email to Howard Frazier noting that his question was not answered. "I would like to ask if the WG at least considered opportunities to narrow the scope and potentially reduce the development time, and what was the rationale for settling on the current scope?"

Chair says: Someone brought up a concern about the response to Paul earlier. Who was it?"

It was Victor Hou. The Chair said: "Always listen to Victor." Someone says to put that in the minutes, so there it is.

Howard types on screen a proposed response to Paul that will answer the question: "The IEEE802.3 EPoC PHY study Group considered several different proposals for the scope statement in the PAR. Some had a broad scope, some had a very narrow scope. Our attempts to narrow the scope led to concerns that potential beneficial options would be precluded. We settled on the statement contained in the draft PAR as the best way of defining what we have to do, while leaving the Task Force enough freedom to define the optimal solution. We believe that the set of project objectives provides sufficient limits on the scope of the work to limit the development time of the standard to the minimum possible."

Then Howard Frazier e-mailed this response to Steve Shellhammer to forward to the EC reflector.

Howard Frazier announced details about the Future meetings:

September 2012 802.3 Interim

- Geneva, CH
- September 24-28 The two dates of the TF would be Thurs/Friday Sept 27-28.
- 2-day TF meeting
- If attend both days of TF meeting, then you get 100% credit. Applies to the Geneva meeting; not a plenary meeting.

November 2012 802 Plenary

- San Antonio, TX
- Nov. 11-16

Howard Frazier also indicated that they are also trying to work on another EPOC TF meeting in October. It is in development, not final. Being worked by Huawei--would be in China prior to ICTC meeting.

Jorge stated, "I want to go to Monthly meetings. Can we talk about December meeting?"

Howard answered that December is not good for people. Let's give people a break.



Motion: Extend the charter of the IEEE 802.3 EPOC PHY study group until the next plenary

**Motion #2**

Extend the charter of the IEEE 802.3 EPOC PHY study group until the next plenary

Moved: Mark Laubach

Seconded: Kevin Noll

Y: 45 N: 0 A: 1

Howard commented that the motion is needed in case disaster strikes and the PAR is not approved; this would allow the SG to continue meeting.

Polls:

Attend September 2012 Geneva 802.3 Interim:

I will attend the September interim: 16

I probably will attend the September interim: 19

I probably will not attend the September interim: 11

I will not attend the September interim: 0

Attend Interim meeting planned for Sunday, Monday, October 28 and 29 at Hangzhou, China before ICTC:

I will attend an October interim: 4

I probably will attend an October interim: 7

I probably will not attend an October interim: 16

I will not attend an October interim: 4

Attend November 2012 San Antonio Plenary:

I will attend the November plenary: 32

I probably will attend the November plenary: 8

I probably will not attend the November plenary: 3

I will not attend the November plenary: 0

Steve Shellhammer reported that Paul Nikolich said in email that he is now satisfied with Howard's response to his question/comment.

**Motion to adjourn.**

Moved: Jorge Salinger

Seconded: Marek Hajduczenia

**Adjournment 18 July 2012 6:05PM.**

**Adjourn.**

### EPOC Study Group List of Attendees

Lastname	Firstname	Affiliation	Tue	Wed
<b>Akio</b> Tajima	<b>Tajima</b> Akio	NEC	X	X
Allard	Michel	Cogeco Cable	X	X
Barr	David	Entropic Communications	X	X
Bevilacqua	John	Comcast	X	X
Boyd	Ed	Broadcom	X	X
Brophy	Tim	Cisco	X	X
Brown	Alan	Aurora Networks	X	X
Brun	Boris	Harmonic	X	X
Cates	Ron	PLX	X	
Chang	Phillip	Comcast	X	X
Chang	Xin	Huawei	X	X
Chen	Jim	Huawei R&D USA	X	X
Chernak	Sam	Comcast	X	
Cook	Charles	CenturyLink	X	X
Dai	Eugene	Cox	X	X
Daisuke	Umeda	Sumitomo Electric Industries	X	X
Darling	Mike	Shaw Cable	X	X
Dickinson	John	Bright House Networks	X	X
ElBakoury	Hesham	Huawei	X	X
Emmendorfer	Michael	ARRIS	X	X
Frazier	Howard	Broadcom	X	X
Gao	Xiao Jun	JSCN	X	
Garavaglia	Andrea	Qualcomm	X	X
Guo	Yong	ZTE Corp	X	X
Hajduczenia	Marek	ZTE Corp	X	X
Hanna	Charaf	ST Microelectronics	X	X
Hotta	Yoshifumi	Mitsubishi Electric	X	X
Hou	Victor	Broadcom	X	X
Howald	Robert	Motorola Mobility	X	X
Jain	Rajeev	Qualcomm	X	X
Joetten	Christoph	Qualcomm	X	X
Jones	Doug	Comcast	X	
Kelsen	Michael	Time Warner Cable	X	X
Kinnard	Brian	Commscope	X	X
Kliger	Avi	Broadcom	X	X
Ko	Dylan	Qualcomm	X	X
Kolze	Tom	Broadcom	X	X
Kramer	Glen	Broadcom	X	X
Laubach	Mark	Broadcom	X	X
Lei	Kaijun	SARFT	X	

Li	Rick	Cortina Systems	X	X
Li	Lin	KingType	X	
Liu	Alex	Qualcomm	X	X
Ma	Yiran	China Telecom Co. Ltd	X	X
Mallette	Edwin	Bright House Networks	X	X
Matsuda	Shougo	Hitachi	X	X
Montojo	Juan	Qualcomm	X	X
Montreuil	Leo	Broadcom	X	X
Noll	Kevin	Time Warner Cable	X	X
Parnaby	Gavin	Broadcom	X	X
Pietsch	Christian	Qualcomm	X	X
Powell	Bill	Alcatel-Lucent	X	X
Prodan	Rich	Broadcom	X	X
Rahman	Saifur	Comcast	X	X
Remein	Duane	Huawei	X	X
Salinger	Jorge	Comcast	X	X
Schmitt	Matt	CableLabs	X	X
Shariff	Masood	Comscope	X	
Sharpe	Randy	Alcatel-Lucent	X	X
Shellhammer	Steve	Qualcomm	X	X
Solomon	Joe	Comcast	X	X
Staniec	Thomas	Zera Corp	X	X
Sugawa	Jun	Hitachi	X	
Sundaresan	Karthik	CableLabs	X	X
Suzuki	Ken-Ich	NTT	X	X
Ulm	John	Motorola Mobility	X	X
Varanese	Nicola	Qualcomm	X	X
Vieira	Amarildo	Motorola Mobility	X	X
Wall	Bill	Cisco	X	X
Xu	Jidong	ZTE Corp	X	X
Yao	Yong	SARFT	X	X
Zang	Maggie	ZTE Corp	X	X