IEEE P802.11  
Wireless LANs

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| TGad Conference Call Minutes | | | | |
| Date: 2012-02-09 | | | | |
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Abstract

TGad conference call minutes for 2012.

# Conference Call Times

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| --- | --- | --- |
| **Date** | **Start Time** | **End Time** |
| January 5, 2012 | 10 AM Eastern Time | 12 PM Eastern Time |
| January 12, 2012 | 8 PM Eastern Time | 10 PM Eastern Time |
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# Minutes from January 5, 2012 Conference Call

## Agenda

* Check to see if anyone is not familiar with the IEEE patent policy <http://standards.ieee.org/board/pat/pat-slideset.pdf>
* Mark Hamilton (Polycom), 12/0005r0, TGad Architecture Discussion Topics

## Patent Policy

No one was not familiar with the IEEE patent policy.

No essential patent disclosure

## 12/0005r0, TGad Architecture Discussion Topics

* Comments are around Clause 4.9 in the draft
* Multiple MAC entities that share one PHY
  + Other advantages (slide 4)
    - i) some applications that already have built-in encryption (e.g., HDMI) may dismiss the need for double encryption at the MAC. This would allow better power saving. With multiple MAC this is possible, but it is not possible with a single MAC (encryption is per MAC); ii) concurrent WLAN/WPAN access, each with its own MAC entity
    - can extend range of TSPEC (via ADDTS), by having different TSPECs per MAC addresses
    - multiple MACs and single PHY can be viewed as contention for a single source
  + Slide 5
    - bullet one:
      * independent encryption is the major advantage (e.g. HDMI). Also, multiple MAC entities may ease the implementation complexity for concurrent WLAN/WPAN operation.
      * Main advantage is multiple security domains
    - Bullet two: Multiple MAC complements FST, in the sense that it is possible to do FST between MACs that are operating under the same PHY.
    - Bullet 3: The noted subclause basically describes the notion of the MM-SME. And, the concept of MM-SME is used in many places in the spec. So, it seems a subclause explaining this concept is definitely needed.
* Multi-band operation
  + Slide 6
    - Multiple MAC is about separate MACs over a single PHY. But yes, FST could be done over an implementation of multiple MACs.
    - Could be seen as multiple STAs within a device (note that the quoted sentence from the spec states “device”, not “STA”). Each MAC within a device could potentially be using the same MAC address. This would enable transparent FST.
    - No instance of a single MAC using multiple PHYs.
      * Diagram should be added: additional architectural entity, which is the FST end point that sits about two MACs and exports a single MAC end point; critical question to answer is where it sits in relation to 802.1X.
      * Single MAC/SAP for transparent FST
      * Multiple MAC/SAP for non-transparent FST
      * Brian Hart will draft up first version
  + Slide 7
    - Each MAC entity would share the same MAC address and MAC\_SAP. However, the RSNA management is different, since keys would be separately setup for each band.
    - Each MAC entity operates in a unique (operating class, channel number) combination. That’s the unique key, so to speak.
    - A single MAC entity would not allow simultaneous operation in different bands. Note that this is already allowed today in the context of Wi-Fi Direct, which allows concurrent WLAN/WPAN operation.
    - Can have more than one RSNA’s; but, cannot have two with transparent FST on both sides
      * Add table with source, destination, options for same or different RSNA; Carlos will draft up first version
  + Slide 8
    - The problem with this approach is that the DBand PHY is totally different than the PHYs in the lower bands. Similarly, there are many MAC differences too.
    - Problem is that the activities of PHYs are independent, would need to Tx/Rx, sense NAV
    - Intent is different MAC entities
    - There are use cases: 1) simultaneous streaming and web browsing 2) seamless transition from 60 to 2.4/5 when moving out of range
  + Slide 9
    - 802.21 is media independent, we are very media dependent
    - There is not much difference, except that the 11ad MAC provides explicit protocol support that can lead to, hopefully, a better handling at the upper layer. But, yes, in the end the upper would be needed to provide the complete solution.
    - In case of non-transparent, management entity that connects MAC/SAPs; discussion of single or multiple MAC/SAPs

# Minutes from January 12, 2012 Conference Call

## Agenda

* Check to see if anyone is not familiar with the IEEE patent policy <http://standards.ieee.org/board/pat/pat-slideset.pdf>
* Initial sponsor ballot responses, comment database 11-12/0020r0
* Brian Hart (Cisco), 12/0023r1, TSPEC Data Rates
* Payam Torab (Broadcom), 12/0047r0, Fixes and Clarifications
* Payam Torab (Broadcom), 12/0048r0, Wakeup Schedule Element
* Gaius Wee (Panasonic), 12/0051r0, GCMP Test Vector Revised
* Carlos Cordeiro (Intel), 11-12/0020r1, comment database
* Carlos Cordeiro (Intel), 12/0021r0, MLME interface for BF
* Carlos Cordeiro (Intel), 12/0022r0, MB and PCP selection fixes
* Planning for Jacksonville
  + Solomon Trainin (Intel), 12/0057r0, TGad sponsor ballot text changes part 2
  + Solomon Trainin (Intel), 12/0058r0, TGad sponsor ballot text changes part 3

## Patent Policy

No one was not familiar with the IEEE patent policy.

No essential patent disclosure

## Initial sponsor ballot results

The official results for this Sponsor Ballot follow:  
Ballot Opening Date:    Tuesday         December 06, 2011 - 23:59 ET  
Ballot Closing Date:       Thursday      January 05, 2012 - 23:59 ET

BALLOT RESULTS:  
  
214 eligible people are in this ballot group.  
     
141 affirmative votes

  23 negative votes with comments

    0  negative vote without comments

   11 abstention votes

=======

175  votes received  =  81.8 % valid returns  
                                =    6.3% valid abstentions  
    
APPROVAL RATE:  
141  affirmative votes          =      86.0 % affirmative  
 23  total negative votes    =         14.0  % negative

This ballot has met the >75% ballot return requirement

This ballot has met the <30% abstention requirement

The motion passes.

There were 499 comments received. 515 total comments

The document 11-12/0020r0 is the comment database containing all 515 comments.

Technical: 279

Editorial: 174

General: 62

## 12/0023r1, TSPEC Data Rates

* the Minimum Data Rate, Mean Data Rate and Peak Data Rates fields in the TSPEC only allow rates up to 4.2Gbps, but 11ac and 11ad go to ~6.8 Gbps. Meanwhile, MIMO and channel bonding at 60 GHz and the entire Terahertz band are untapped opportunities and could lead to much higher data rates. Given that 802.3 is looking at 400 Gbps, there are use cases for these high speeds. In order to keep 2.4/5/60 GHz all aligned, and noting that 11n could never have used more than 600e6 in this field (and even 11ac implementations presently under development are unlikely to exceed 2 Gbps), we should keep the same size of the field, but define the field in a piecewise linear fashion, with an aspirational coefficient:
* CID 6275, 6125, 6306, 6133
  + Modify “minimum PHY data rate” to “minimum PHY rate”
  + Modifying version of the document in the resolution
  + Comments:
    - Terminology “does not include” is ambiguous, but no better wording yet
* Move to approve to 12/0023r2 (r1 plus the two modifications above)
  + Move: Brian, second: Carlos
  + Motion #65 passes by unanimous consent

## 12/0047r0, Fixes and Clarifications

* Enhance TSPEC semantics to be able to uniquely identify a DBand allocation between two endpoints A and B. Specifically, with the current semantics, a TSPEC cannot differentiate between two airtime allocations created between A and B (one created by A, another created by B) that use the same Allocation ID. Direction semantics needs to be added to the TSPEC.
* For A-MPDUs sent in the data enabled immediate response context, data MPDUs that are sent under an HT-immediate Block Ack agreement should also include QoS Null.
* The “More Data” bit in the MAC header now has a new meaning associated with reverse direction access. The legacy text around the bit usage should be removed.
* CID ????
* Comments
  + Use CID 6001
  + No other comments
  + Will bring to motion in Jacksonville

## 12/0048r0, Wakeup Schedule Element

* To successfully track the Awake/Doze BIs of a peer non-PCP/non-AP STA as well as a PCP/AP, local MAC needs to know the start time of the next Awake/Doze BI and the sleep interval.
* Another improvement is increased flexibility in duty cycle patterns
* meanings of Awake Start Time and Awake Duration parameters have been clarified
* CID ????
* Comments
  + Are constants supposed to have dot11 in front of them?
    - No, only MIB variable. If constant then it starts with an “a”
  + Use CID 6001
  + Change WiGig editor to 802.11ad editor
  + No other comments
  + Will bring to motion in Jacksonville

## 12/0051r0, GCMP Test Vector Revised

* Add second GCMP test vector in Annex M
* CID ????
* Comments
  + Use CID 6001
  + No other comments
  + Will bring to motion in Jacksonville

## 12/0021r0, MLME interface for BF

* defines the MLME interface for BF
* CID 6001
* Comments
  + For antennaID, sectorID, SME doesn’t know valid values
    - Not part of MLME interface to do that
      * Need changes to MIB
  + BFFeedback, Ack: no practical use and without precedent
    - Need to separate implementation from specification
    - MLME is logical/instantaneous interface
    - Need it for completeness
      * Could replace with ISS confirm
  + Dean Armstrong will bring in counter proposal based on submission next conference call

## 12/0022r0, MB and PCP selection fixes

* Fixes issues with PCP selection and Multiband operation. A multi-band capable PCP/AP can redirect STAs to join a BSS on a particular band/channel. This will improve load balancing and network management on a pre-association basis. After association, FST can be used as is.
* CID 6001
* Comments
  + If SME issues a start request (in last paragraph added in doc) , should it be required to perform another scan?
    - Didn’t want a strict requirement for another scan, since one had been done
  + Will bring to motion in Jacksonville

## Planning for Jacksonville

* Four time slots right now
* Documents in queue
  + Solomon Trainin (Intel), 12/0057r0, TGad sponsor ballot text changes part 2
  + Solomon Trainin (Intel), 12/0058r0, TGad sponsor ballot text changes part 3
  + Carlos Cordeiro (Intel), 11-12/0020r1, comment database
  + Chris will have a submission
* Request minimum of 2 more time slots

# Minutes from January 26, 2012 Conference Call

## Agenda

* Check to see if anyone is not familiar with the IEEE patent policy <http://standards.ieee.org/board/pat/pat-slideset.pdf>
* Documents in queue
  + Solomon Trainin (Intel), 12/0057r0, TGad sponsor ballot text changes part 2
  + Solomon Trainin (Intel), 12/0058r0, TGad sponsor ballot text changes part 3
  + David Grieve (Agilent), 12/0077r0, Annex L update for the DBand
  + David Grieve (Agilent), 12/0078r0, DBand Encoding Examples
  + David Grieve (Agilent), 12/0133r0, DBand Encoding Examples
  + Gal Basson (Wilocity), 12/0177r0, Direction-Bit-CID6001
  + Gal Basson (Wilocity), 12/0180r0, BF Clarification DCN 6001
  + Carlos Cordeiro (Intel), 11-12/0020r6, comment database
  + Christopher Hansen (Broadcom), 12/0118r1, DC Compensated EVM in SCPHY (next call)
  + Graham Smith (DSP Group), 12/0164r0, Submission on acronyms in D 5.0
* Topics:
  + CID 6083. Whether to support Groupcast with Retries (GCR)? For 3 or 4 STAs, could just use Directed Multicast Service (DMS); GCR is only useful for larger number of STAs (Carlos work w/ Alex)
  + Architecture (converged on transparent, still reviewing non-transparent) (future call)
  + MLME interface for BF (next call) (Carlos Cordeiro (Intel), 12/0021r0, MLME interface for BF )

## Patent Policy

No one was not familiar with the IEEE patent policy.

No essential patent disclosure

## 12/0057r0

* CIDs 6001 and 6014
* Changes regarding fixes to A-MPDU and Block Ack regarding out of order MPDU delivery
* Fix to RD
* Editor will fix oband/dband when actioning edits
* Motion #70: move to approve 12/0057r1(only change is to fix file header)
  + Mover: Solomon Trainin, Second: Chris Hansen
  + No discussion on motion
  + Motion passes by unanimous consent

## 12/0058r0

* CIDs 6001 and 6015
* Changes to clarify aspects of Beamforming Link Maintenance
* Added figure as example of Beamforming Link Maintenance
* Clarification of CBAP allocation and access rules
* Informative Annex Z added on TSPEC aggregation
* Editor will fix ScS when actioning edits
* Editor will fix oband/dband when actioning edits
* Motion #71: move to approve 12/0058r0
  + Mover: Solomon Trainin, Second: Chris Hansen
  + No discussion on motion
  + Motion passes by unanimous consent

## 12/0133r0

* CIDs 6002 and 6293
* Presentation giving overview draft text in 12/0077 and 12/0078
* 12/0077 provides Annex L draft text
  + illustrates the PHY encoding steps so as to facilitate implementation.
  + Provides test vectors for Control, SC, OFDM, Low Power SC
* 12/0078 provides zip file of test vectors for reference in draft text
  + provides test vectors for design verification purposes.
* David has received feedback from George that this resolves his comment
* Motion #72: move to approve 12/0077r0 and 12/0078r0
  + Mover: Chris Hansen, Second: Carlos Cordeiro
  + No discussion on motion
  + Motion passes by unanimous consent

## 12/0180r0

* Presented by Amichai Sanderovich (Wilocity)
* CIDs 6001
* Beamforming clarifications
* Add antenna ID to sector ID
* MID clarifications
* Comment: figure number may not be correct. Editor will fix while editing draft
* Motion #73: move to approve 12/0180r1 (only change fix document title)
  + Mover: Chris Hansen, Second: James Wang
  + Discussion
    - To objection to amend motion to 12/180r1 to fix document title
    - No further discussion on motion
  + Motion passes by unanimous consent

## 12/0177r0

* CIDs 6001
* In order to avoid redundant BF retraining during CBAP operation, the direction bit which indicated who’s the initiator of the ScS is returned to the ScS frame.
* In the example,
  + STA-A receives STA-B initiator ScS as a responder ScS.
  + STA-A consider a WRONG BS feedback
  + This leads to a erroneous ScS flow which will result in loss of several mSecs; Bad network efficiency
  + NO, this is not a corner case in CBP
  + The direction bit prevents from this erroneous flow to happen
* Comment
  + Will the RXSS Length field be even?
    - It means you can not specify odd values to be consist with capability field
* Motion #74: move to approve 12/0177r0
  + Mover: Carlos Cordeiro, Second: Chris Hansen
  + No discussion on motion
  + Motion passes by unanimous consent

## 12/0020r6

* Comments reviewed in Jacksonville, but too late to motion
  + CIDs 6168 (duplicate of 6364)
  + CIDs 6307, 6279 (fixing beacon internal nomenclature)
  + 6476 (two letter acronyms)
  + Motion #75: move to approve resolutions to CIDs 6168, 6307, 6279, 6476 in 12/0020r6
    - Mover: Carlos Cordeiro, Second: Chris Hansen
    - No discussion on motion
    - Motion passes by unanimous consent
* Annex comments
  + CID 6261
    - No discussion
    - Will email Adrian for response to resolution
  + 6260; accepted
    - No discussion
  + 6482
    - No discussion
    - Will email Peter for response to resolution
  + 6481; accepted
    - No discussion
  + 6266; accepted
    - No discussion
  + 6265; accept
    - Deleted reference to 6264
    - No other discussion
  + 6263; change to revised
    - Specifying the location of the structure
    - No other discussion

# Minutes from February 2, 2012 Conference Call

## Agenda

* Check to see if anyone is not familiar with the IEEE patent policy <http://standards.ieee.org/board/pat/pat-slideset.pdf>
* Documents in queue
  + Christopher Hansen (Broadcom), 12/0118r1, DC Compensated EVM in SCPHY
  + Dean Armstrong (CSR), 12/0198r0, MLME interface for beamforming training
  + Graham Smith (DSP Group), 12/0164r0, Submission on acronyms in D 5.0
  + Zhou Lan (NICT), 12/0195r0, QAB comment resolution
  + Yongsun Kim (ETRI), 12/0196r1, Dband Relay comment resolution
  + Carlos Cordeiro (Intel), 11-12/0020r8, comment database
* Topics:
  + CID 6083. Whether to support Groupcast with Retries (GCR)? For 3 or 4 STAs, could just use Directed Multicast Service (DMS); GCR is only useful for larger number of STAs (Carlos work w/ Alex)
  + Architecture (future call)

## Patent Policy

No one was not familiar with the IEEE patent policy.

No essential patent disclosure

## Motions CIDs from last week

* Motion #76: move to approve resolutions to CIDs 6261, 6260, 6482, 6481, 6266, 6265, 6263 in 12/0020r8
  + Mover: Carlos Cordeiro, Second: Chris Hansen
  + No discussion on motion
  + Motion passes by unanimous consent

## 12/0118r1

* CID 6001
* Updated to show editing instruction
* Addressed concern about DC term chosen to minimized EVM
* Motion #77: move to approve resolutions to CID 6001 in 12/0118r1
  + Mover: Chris Hansen, Second: Carlos Cordeiro
  + Discussion
    - Concern about possibly allowing larger DC offset in transmitter by removing from EVM computation
      * another section specifies LO leakage at -23 dB
      * 802.11b also removes DC offset from EVM, common practice
  + Motion passes by unanimous consent

## 12/0198r1

* CID 6001
* This submission describes proposed additions to the MLME SAP to allow the SME to invoke the beamforming training mechanisms described in IEEE P802.11ad/D5.0. This submission represents an alternate proposal to that described in IEEE 802.11-12/0021r0
* Comments
  + Do we need to delete anything else?
    - No
  + Carlos, Brian happy with proposal
* Motion next week

## 12/0164r0

* Carlos presenting in Graham’s absence
* Proposals concerning acronyms used in P802.11ad D5.0
* Comments
  + Agree w/ not using SSH
  + Want to use some type of acronym for single carrier because PHY type is identified by acronym, could changed acronym
  + Want acronym for beamforming, happy with BF; but concerned about use of beamforming vs. beamform training
  + SC is widely known as single carrier in industry; 802.15.3c also uses SC as single carrier
  + No objection to HD-DF
  + No objection to FD-AF
  + Relay DMG STA won’t fit in figures easily; radio data service pretty separated from 60 GHz
  + Easier to change SSH to SPSH than delete; no objection to SPSH
* Eldad to email Graham results of discussion

## 12/0195r0

* CID 6390,  6389,  6103,  6101,  6430,  6429,  6102
* Comments related to QAB mechanism; comments propose to delete feature
* Two issues raised in comments 1) concern about the synchronization between APs, 2) STAs that don’t support QAB may generate interference
* Regarding 1) QAB doesn’t require APs that are involved fully synchronize with each other. Instead, all the timing in QAB is relative time instead of absolute time.
* Regarding 2) QAB only applies to 60GHz band where the number of adjacent BSSs are very small compared to that of 2.4GHz or 5GHz band.
* Propose to reject CID 6390, 6389, 6103, 6101, 6102, and 6429 based on above
* Discussion
  + Question frequency of quiet periods? If no end, may be issue with sync
    - May need indication of end of quiet periods
  + Issue maintaining timing?
    - Not if done in hardware
  + Aware of any examples of frames carrying timing besides beacon and probe response
    - 11v added time of departure field w/ nanosec accuracy
  + Why can’t we specify something relative to TSF?
    - Many ways to achieve goal, this is one way and implemented in real system and it works
    - This is between APs, TSF is for BSS
  + No objection to NOT removing QAB
  + Zhou will work with Brian to address end of quiet periods
* CID 6430

## 12/0196r1

* CID 6428, 6111, proposed change to delete REDS, use 11s
  + 802.11s does not provide beamforming and synch capability hop by hop needed in 60GHz
  + Comments
    - Could 802.11s be extended to work in 60GHz?
      * 11ad relay designed for simple 2 hop implementation
      * 11ad relays at PHY level, will be added to resolution
* CID 6516, add architecture description
  + Just another MAC function, does not change architecture
  + Comment
    - Anything that involves how stations connect together is an architecture change
    - When receiving something that was amplified and forwarded isn’t really matter about how connected, maybe in decode and forward
  + Carlos to email Mark to make suggested text
* CID 6324
  + Comment
    - Need to split stuff that talks about MLME and leave in clause 10, only move other part to 9
    - Only move 10.35.3, .4, .6 to clause 9

# Minutes from February 9, 2012 Conference Call

## Agenda

* Call chaired by Chris Hansen
* Check to see if anyone is not familiar with the IEEE patent policy <http://standards.ieee.org/board/pat/pat-slideset.pdf>
* Documents in queue:
  + Dean Armstrong (CSR), 12/0198r1, MLME interface for beamforming training
  + Carlos Cordeiro (Intel), 11-12/0202r0,
  + Carlos Cordeiro (Intel), 11-12/0020r8, comment database

## Patent Policy

No one was not familiar with the IEEE patent policy.

No essential patent disclosure

## 12/0198r1 MLME interface for beamforming training

* 6.3.93.4.2 was updated in the table
* Will motion on next conference call because latest text has been on the server for less than 48 hours.

## 12/0202r0 - Resolution to CIDs related to FST/architecture

* CIDs: 6505, 6276, 6503, 6277, 6384, 6175, 6082, 6323, 6151, 6504, 6257.
* Updated figures with transparent FST
* 4.94 – Reference model for multiband; new descriptions of transparent and non-transparent FST
* 5.16 – MAC data service architecture; clarifies multiplexing/demultiplexing with FST
* 11.5.16.1 – security for multiband RSNA; clarifies shared keys are used
* Question (Brian Hart, Cisco System) – Is the assumption that the number of buffers is the same at 5 GHz and 60 GHz?
* Carlos – not likely. STA may have to change BA agreement if they don’t have the same capabilities at each band. Not really different from 802.11 today.
* Brian – that gives some ideas for some optimizations, but we can discuss these at a later date.
* Mark Hamilton – the general direction helps a lot, but there are some more details that need to be clarified. For example, sometimes a new RSNA has to be established and sometimes it does not.
* Document will be motioned next week. Additional material will be brought in on later submissions.

## 12/0020r8 – Comment Resolution Spreadsheet

* CID 6147 – Beamforming – propose reject – easier to have state info in the packet
  + Erik Lingskog, CSR Transmitting from the same sector all the time
  + Carlos – convenience issue
  + Erik – doesn’t feel strongly
  + No objection to reject; marked ready for motion
* CID 6148 – Same situation as 6147 but for responder – propose reject
  + No objection to reject; marked ready for motion
* CID 6320 – Accept
  + No objection to accept
* CID 6301 – Revised – partial agreement with commenter
  + Text clarification, but no restriction on same BI
  + No objection to revise
* CID 6451 – Revised – definitions of this type are done in the baseline so there is precedence
  + No objection to revise
* CID 6450 – Revised
  + No objection to revise
* CID 6455- Reject
  + Information is not considered extraneous.
  + No objection to reject
* CID 6454 – Revised
  + Similar to previous CID; Move text to another section rather than deleting
  + No objection to revise
* CID 6452 – Rejected
  + No objection
* CID 6290 – Accepted
  + No objection
* CID 6463 – Rejected (Revised in current spreadsheet is incorrect) – definition follows from baseline
  + No objection
* CID 6458 – Revise (current spreadsheet says Accept) – makes text consistent in “source” of SP
  + No objection
  + CID 6462 – Reject – accurately describes the available options
    - A definition is necessary
    - No option other than the ones in the current definition have been suggested.
    - No objection
  + CID 6461 – Reject – definition of BTI is necessary as it is used multiple times
    - No objection
  + CID 6456 – Reject – reference to other CID not used
    - Expands definition of uplink and downlink to cover PBSS but does not impact definition as it related to infrastructure BSS
    - Brian Hart – I think this comment will come up again and again. It isn’t the right way to write a spec.
    - Carlos – Any suggestions for improvement?
    - Brian Hart – We can request a commenter to come up with a solution for each instance in the doc.
    - Carlos – Good point. Commenter is welcome to bring a contribution.
    - No objection to modified resolution
  + CID 6460 – Reject
    - Use same resolution as we had for CID 6456
    - No objections

# Attendance

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Participant** | **Jan 5** | **Jan 12** | **Jan 26** | **Feb 2** | **Feb 9** |  |  |  |  |  |  |  |  |  |  |  |  |
| Osama Aboul-Magd (Huawei) | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Dean Armstrong (CSR) |  | **x** |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Magued Barsoum (Fortress Technology) | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Gal Basson (Wilocity) |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Liwen Chu (ST) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Carlos Cordeiro (Intel) | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |
| David Grieve (Agilent) |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Mark Hamilton (Polycom) | **x** |  |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |
| Christopher Hansen (Broadcom) | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |
| Brian Hart (Cisco) | **x** | **x** | **x** | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |
| Reza Hedayat (Cisco) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| David Hunter (wirefi networks) | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Assaf Kasher (Intel) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Yongsun Kim (ETRI) |  |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Zhou Lan (NICT) |  |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Eric Lindskog (CSR) |  | **x** |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sai Nandagopalan (Tensorcom) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Eldad Perahia (Intel) | **x** | **x** | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Amichai Sanderovich (Wilocity) |  |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Adrian Stephens (Intel) | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Payam Torab (Broadcom) |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Solomon Trainin (Intel) | **x** |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Chao-Chun Wang (MediaTek) | **x** |  | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| James Wang (MediaTek) |  |  | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Gaius Wee (Panasonic) |  | **x** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| James Yee (Mediatek) | **x** | **x** |  | **x** | **x** |  |  |  |  |  |  |  |  |  |  |  |  |
| Chanho Yoon (ETRI) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |