TGn Sync Response to Questions

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Exhibit AXW-2016
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AXW-2016-001

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AXW-2016-005

Q&A 1.1.1 (PHY)

- *Transmit beam forming. Doc 1632, Icefyre, A8, please add data for basic BF.*
- At low data rates, 2x2 Basic BF is ~ 5dB better than 2x2 open loop MIMO. At high data rates, the two systems are comparable (ref: 11-04/891r4, Fig 4-11).
- *Doc 1632, WWise, A2: Please add open loop 4x2, and WWise open loop 4x2 with STBC*
- For all data rates, 4x2 Basic BF is ~ 9dB better than 2x2 open loop (ref: 11-04/891r4, Fig 4-12)
- We do not have simulation results for 4x2 Spatial Spreading yet.

AXW-2016-006

Q&A 1.1.2 (PHY)

- *Can basic beam forming be used with legacy devices (one antenna)?*
  - *Can the AP determine the channel without sounding packets?*
  - *If a legacy device has a receiver that uses smoothing will it have a problem?*

- Yes, Basic BF can be used with single-antenna client devices
  - Yes, the AP can determine the channel without a sounding packet, for example using RTS/CTS exchange
  - No, smoothing is not a problem with a single antenna legacy device

AXW-2016-007

Q&A 1.2 (PHY)

- *In table 31 why are MCS 0 – 6 needed? Why not use legacy rates with 2-RX ML receiver chains?*

➡ MCS 0 to 6 are legacy MCSs.

➡ However, a legacy PPDU does not support:

- MAC-level aggregation
- Transmit Beamforming / Sounding
- Advanced Coding
- etc …

➡ BTW, we have now adopted 56 tones for 20MHz channelization

AXW-2016-008

Q1.3 (MAC)

- Regarding rate feedback:
  - I do not understand why the AP cannot adequately determine the appropriate TX rate based on the need to avoid retries.
  - If a low power devices wants to use a low data rate modes to save power, would it not be simpler to just have a reduced 11n rate set for it?
  - Can the transmitter ALWAYS override RX rate recommendation? This seems to be important for an expensive and much more complex AP.
  - Is the RX feedback given to TX initiator immediately (AP) after MRQ? Is it before AP sends data? How much time does this whole process take? How much time does a retry take?

AXW-2016-009

A1.3.1 (MAC)

- There's lots of real-world experience with PER schemes with known weaknesses. These schemes have complex heuristics.
- Explicit MCS feedback provides faster adaptation to changes in the channel condition (it is hard to adapt "up" quickly in PER-based schemes).
- Significant benefit is gained at little overhead
- Tx PHY rate is maximized after a single exchange
  - Reference 11-05-1630r1

AXW-2016-010

A1.3.2 (MAC)

- We recommend that TGn defines a hand-held capability class for devices with a reduced rate set.
- Studying the trade-off between network performance and device power-saving is necessary.

AXW-2016-011

A1.3.3 (MAC)

- *Can the transmitter ALWAYS override RX rate recommendation? This seems to be important for an expensive and much more complex AP.*

➡ Answer:

- Yes.
- In the case of pairwise spoofing the initiator adjusts the byte length to maintain a constant duration.

AXW-2016-012

A1.3.4 (MAC)

- *Is the RX feedback given to TX initiator immediately (AP) after MRQ? Is it before AP sends data? How much time does this whole process take? How much time does a retry take?*
- Answer
  - The TGn Sync proposal does not constrain the timing of the MFB response to the MRQ.
  - The protocol supports both immediate and delayed responses
  - We'd be interested in hearing your opinion on the need to constrain the MRQ/MFB response delay, and whether it is necessary to timestamp MFB information to know how to use "old" feedback.

AXW-2016-013

Q1.4 (PHY)

- *Code rate: Please provide the range curves of 5/6 with ½ GI, 5/6 with full GI:*
  - *@ 2.4GHz*
    - *With and without ABF.*
    - *20MHz and 40MHz*
    - *With and without LPDC*
  - *@ 5GHz*
    - *With and without ABF.*
    - *20MHz and 40MHz*
    - *With and without LPDC*

AXW-2016-014

A1.4

- Since this question is beyond the scope of CC simulations, we do not have comprehensive results yet for these parameters

- The CC27 results show a goodput versus range curve that includes the effect of receiver assisted link adaptation. The 5/6 code rate will be selected for some channel realizations, but we don't have rate/range curves for specific MCSs.

AXW-2016-015

Q&A 1.5 (MAC)

- *Section 9.1.1 – how much memory buffer is recommended? Is this in host or on module?*
- Answer
  - This is implementation specific. For example, partitioning between host/module may occur at different levels and using different physical interfaces.
  - It is possible to trade-off forming longer aggregates with the amount of buffer space used for this purpose.
  - A total Tx buffer of 0.5KB per AC on the module is used in one implementation, but clearly this is highly implementation dependent.

AXW-2016-016

Q&A 1.6 (MAC)

- *889r4 table 31 indicates a device may use ½ GI or full GI. MFB does not seem to include GI feedback. How does the initiator determine which GI to use? How does a receiver feedback a GI change?*

➡ Thankyou for the question. MFB should include a GI selection, but this is an omission in the current document.

➡ The receiver can select use of GI based on its observed channel estimate (which includes the effect of channel and receiver and transmitter filters).

AXW-2016-017

Q&A 1.7 (PHY)

- *Should a longer GI be made available for outdoor use cases?*

➡ Answer:

- It is an interesting thought. This would constitute a new usage scenario.
- HTSG (pre cursor to 11n SG) adopted 150ns (channel model F) as the highest RMS delay spread.
- We should add that Time Domain Equalization (TEQ) at the receiver can be used to shorten the delay spread. This would be an alternative solution to handling longer delay spread without necessarily increasing the guard interval.

AXW-2016-018

Q&A 1.8 (PHY)

- *When will PHY receiver specifications be provided?*

➡ We believe that the proper way to specify RX sensitivity of a MIMO system is different from SISO 802.11a/g (as was done by WWiSE).

➡ RX sensitivity and ACI spec should be treated as "work in progress" for both proposals.

AXW-2016-019

Q1.9 (MAC)

- Doc 889r4 chapter 7:
  - Please clarify in 889 what functions are mandatory and optional, in AP and Station?

AXW-2016-020

A1.9.1 (MAC)

Feature	AP	STA
Base-20 mixed mode	Optional (40MHz AP) N/A otherwise	Mandatory (40MHz STA) N/A otherwise
Periodic RDR	Mandatory in the sense that 802.11e TSPEC response is mandatory	Optional
Channel Selection Rules / Coexistence	Mandatory rules are specified for selecting a channel based on observed BSSs. These apply to an AP and an IBSS STA.	

AXW-2016-021

A1.9.2 (MAC)

- Mandatory to Transmit and Receive
  - A-MPDU
  - Enhanced BA
  - 802.11e Support
- Support for Beam-forming
  - Sounding
  - Calibration

AXW-2016-022

A1.9.3 (MAC)

- Optional to Transmit, Mandatory to Receive
  - Top-of-MAC aggregation (A-MSDU)
  - Multi-Receiver Aggregation (MRA), Multiple Responders (MRMRA)
  - Initiator/Responder control frames (IAC/RAC)
  - Rx Assisted Rate Adaptation
  - Protection Mechanism (Long NAV, Spoofing)

AXW-2016-023

A1.9.4 (MAC)

- Optional to Transmit and Receive
  - Bi-Directional Data Transfer

AXW-2016-024

Q&A 2.1 (PHY)

- *Seeing that advanced coding is very modular in the system design do you think the advanced coding scheme should be selected separately?*

➡ The selection criteria in TGn is currently working with complete proposal specifications.

AXW-2016-025

Q&A 2.2 (PHY)

- *Accurate complexity estimates are a necessary criterion for proper advanced coding selection. When will you provide such information to the group?*

➡ There have been several LDPC complexity analysis contributions to TGn – for example, see 11-03/0865.

AXW-2016-026

Q&A 2.3

- *In the WiFi market, there is a constant push to get certified products out as fast as possible. How do you rationalize your position to include in your proposal a technology such as LDPC codes, with unclear implementation and complexity, especially when there are equal, if not better, solutions available with well-defined implementations?*

- We believe in selecting technologies based on technical merit. Alternatives have been given due consideration via the full and partial proposal process.

AXW-2016-027

Q&A 2.4

- *Due to the prolific research in the last few years within the field of LDPC coding there have been many patents filed; up to 152 have been found at the www.uspto.gov website since March 2001. Are all proprietary parts of your LDPC code covered by LOAs that have been accepted by the IEEE?*

- Each company has an independent obligation to supply LoA to IEEE.

AXW-2016-028

WWiSE – Q1

TGn Sync provides many modes with 256-QAM, rate ¾. How well does this mode work?

- Previous discussion has established that 64-QAM, rate ¾ for 2 spatial streams is already not easy; it seems that 256-QAM, rate ¾ will be far more difficult.

AXW-2016-029

WWiSE – A1

We have found that 256-QAM is quite effective when used with transmit beamforming.

At a given SNR, the quality of channel realizations varies dramatically in TGn channels. The ability of the TGn Sync proposal to fast link adaptation allows us to exploit good channel conditions when they occur.

Moreover, unlike WWiSE, TGn Sync can support APs with more than four antennas, and with the additional transmit diversity, indeed 256 QAM rate ¾ becomes a frequently used mode.

The support of 256 QAM is one of the many examples of the TGn Sync proposal's extensibility to leverage today's and tomorrow's technology advances.

AXW-2016-030

WWiSE – Q2

Why is the top open loop rate higher than the top closed loop rate?

- Within each configuration, the top rate is in closed loop ("Advanced Beamforming", Table 31) but with the same mode on each branch: this is effectively an open loop mode as it does not exploit any rate asymmetry between streams. If the modes are feasible in a reasonable number of cases, why not include them in open-loop operation? If not, why include them at all?

AXW-2016-031

WWiSE – A2

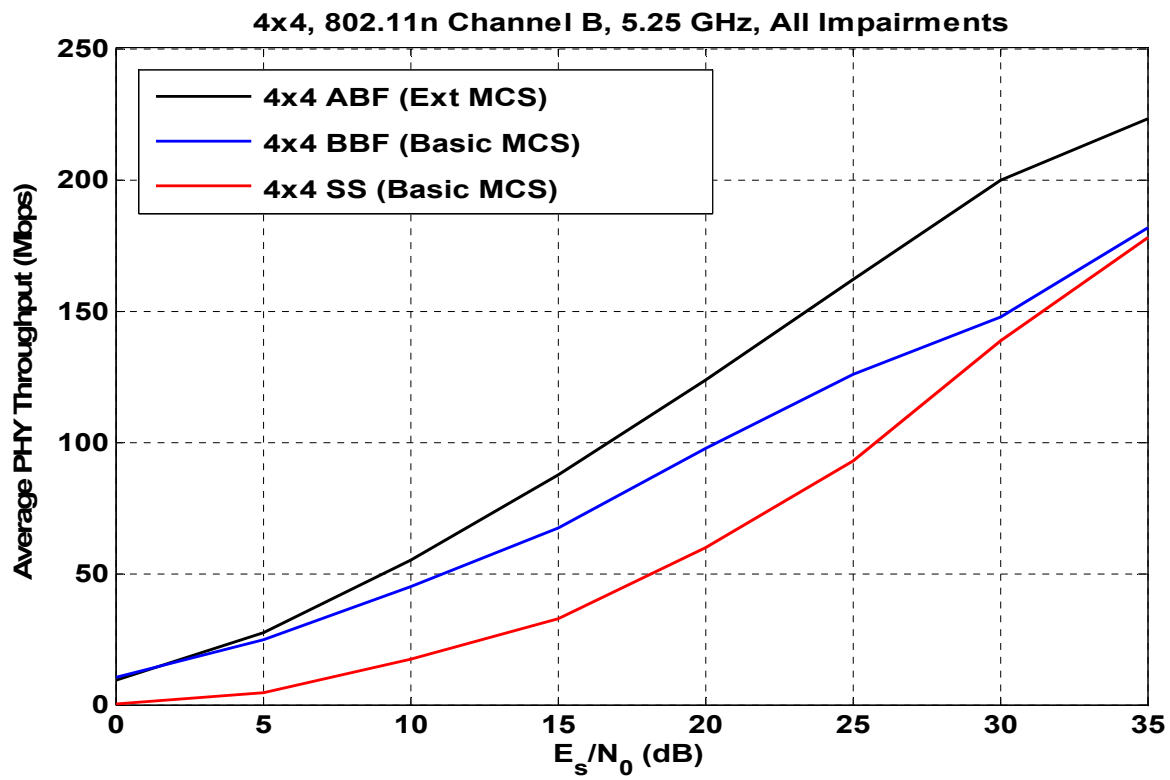
- There are a number of misconceptions in the question. To clarify:
  - Closed loop operation merely allows an STA to optimally select the most appropriate MCS.
  - The chosen MCS ***can*** be selected from the Basic MCS set, ***or*** the Extended MCS set (if supported).
  - Beamforming does not have to be applied in order to benefit from closed loop operation and the Extended MCS
  - The use of the same modulation type on each spatial stream does not imply open loop operation.

AXW-2016-032

WWiSE – Q3

In ABF, instead of having, for example, {256-QAM, 256-QAM, 256-QAM, QPSK}, why not just use 3 spatial streams if the streams are that different in quality?

Benefits of TGn Sync Extended MCS set (from presentation)



AXW-2016-033

WWiSE – Q4

Why are there two distinct methods for auto-detect of 11n packets (BPSK axis shift and pilot polarity inversion)? Is each method inadequate by itself?

- Assuming each method is inadequate, what are the probabilities of failing to detect for each, and how should they be combined?

Answer: HT packet detection must be timely and robust. Of the two methods offered one is fast, and the other is more robust at the expense of more computation. Neither method adds any complexity for the TX – the receiver can decide to detect one, or the other, or both. This is an example of "better safe than sorry."

AXW-2016-034

WWiSE – Q5

Why such a long HT-SIG field?

- This must affect the highest rate modes significantly. E.g., for 600 Mbps, 4095-byte PPDUs: these take 54 usec, so a longer SIG field costs about 8% here. *Why have a BPSK SIG field separating PPDUs at 600 Mbps?*

Answer: QPSK rate ½ SIG, as in WWiSE, provides an error rate that is roughly equivalent to the PER of a 1000 byte packet at BPSK rate ½. This is not sufficient, since the SIG must be more robust than the data part of the PPDU.

We believe that the simplicity of having a single HT-SIG mode to was critical to keep the number of different modes and preambles as limited as possible. We have concerns that the large number of different preambles in the WWiSE proposal will increase complexity, interoperability issues, and time to market.

AXW-2016-035

WWiSE – Q6

Why is there still a major "TBD"?

- The interaction between Advanced Beamforming and LDPC codes is listed as "TBD" (11-04-0889-04-000n, Section 11.2.4). Why and what problems are involved?

Answer: This was an editorial oversight in our technical specification. The interaction of LDPC with Tx BF is not TBD in our proposal since we have uniform code rate across all spatial streams.

AXW-2016-036

WWiSE – Q7

What constraints on filtering and performance does the ½-length cyclic prefix introduce?

- See *11-05-0222-00-000n, J. Gardner, "Delay spread tolerance of Half-GI systems*" for a description of the issues.

AXW-2016-037

WWiSE – A7

- The short-GI mode delivers an additional 11.1% of throughput in channels that support it. There are no additional constraints on filtering for use in typical indoor channels that support it. It is a low-complexity mode to deliver significant performance gains

AXW-2016-038

WWiSE – Q8

Why are there so many choices for ways to transmit legacy portion of preamble?

- Legacy portion may be transmitted either from a single antenna or from multiple; and if multiple, may be transmitted with any of several different shifts
- It seems this will exponentially increase the interoperability problem, as all choices will have to work with all receivers

AXW-2016-039

WWiSE – A8

- We prefer this flexibility w/o complexity to WWiSE's choice of many different preambles (MM , green field, single SIG-N, multiple SIG-N, etc) which necessesitate additional complexity

AXW-2016-040

WWiSE – Q9

Why are space-time block codes missing from the proposal?

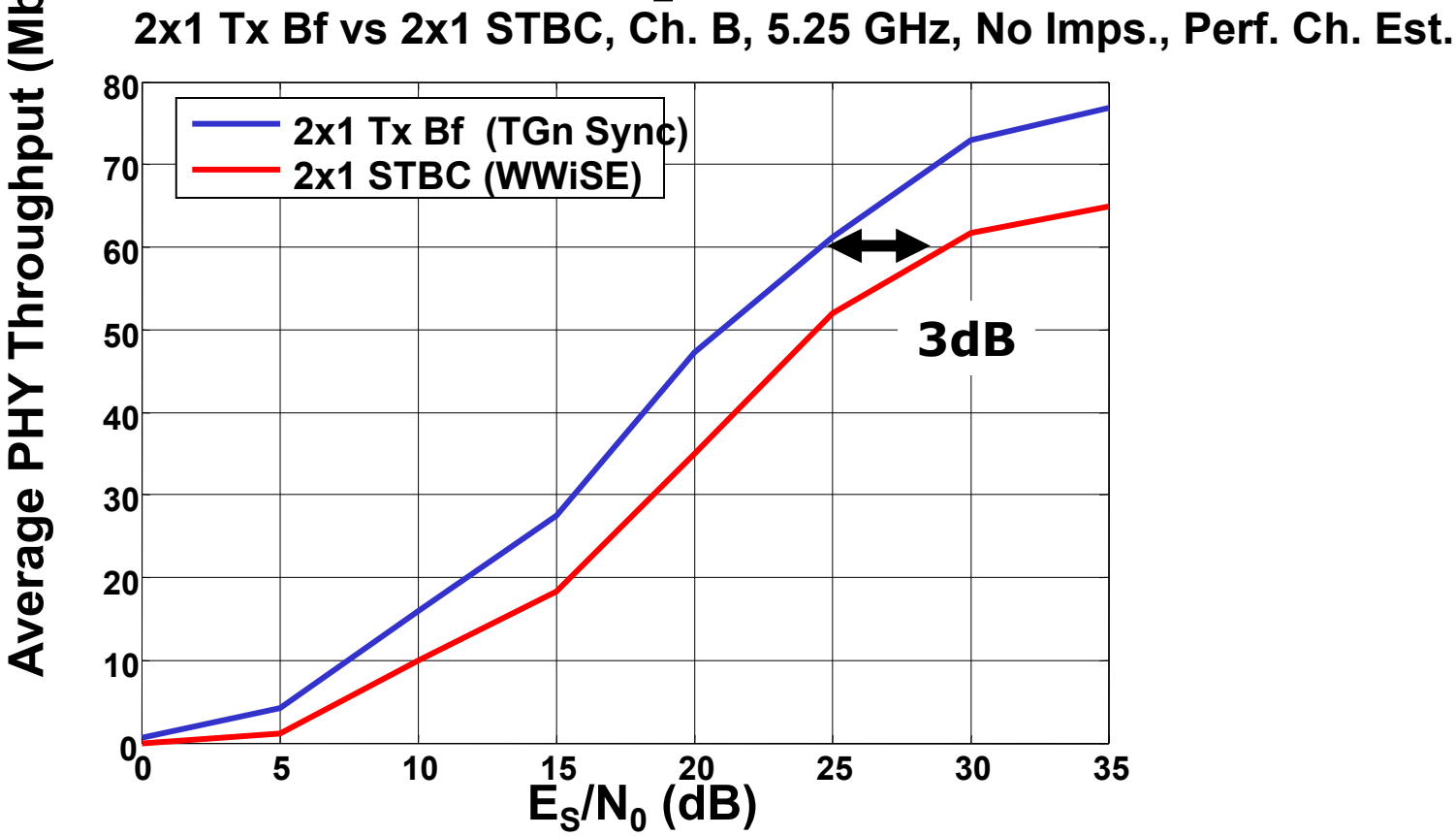
- Is there any technical reason why these have been omitted?

- Simplicity, not needed since TxBf outperforms it. Additional complexity of 2-symbol processing, overhead ofextra dead symbol etc.

AXW-2016-041

WWiSE – A9

Tx BF is superior to STBC



➡ Also complexity of dual symbol processing, more modes etc.