WWiSE IEEE 802.11n Proposal

Date: **2005-07-19**

Authors:

Name	Company	Address	Phone	Email
Sean Coffey	Realtek Semiconductor	16269 Laguna Canyon Rd., Irvine, CA 92618	+1 415 572 6221	coffey@realtek-us.com

Notice: This document has been prepared to assist IEEE 802.11. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release: The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.11.

Patent Policy and Procedures: The contributor is familiar with the IEEE 802 Patent Policy and Procedures <http:// ieee802.org/guides/bylaws/sb-bylaws.pdf>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <stuart.kerry@philips.com> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.11 Working Group. **If you have questions, contact the IEEE Patent Committee Administrator at <patcom@ieee.org>.**

INTEL-1030
10,554,459

Additional authors:

VK Jones	Airgo Networks	vkjones@airgonetworks.com
Richard van Nee	Airgo Networks	richardvannnee@airgonetworks.com
Ali Raissinia	Airgo Networks	aliraissinia@airgonetworks.com
Allert van Zelst	Airgo Networks	allertvanzelst@airgonetworks.com
Bruce Edwards	Broadcom	bedwards@broadcom.com
Matthew Fischer	Broadcom	mfischer@broadcom.com
Chris Hansen	Broadcom	chansen@broadcom.com
Tushar Moorti	Broadcom	tushar@broadcom.com
Chris Young	Broadcom	cyoung@broadcom.com
Takashi Ishidoshiro	Buffalo	doshir@melcoinc.co.jp
Masato Kato	Buffalo	mkato@melcoinc.co.jp
Dave Hedberg	Conexant	dave.hedberg@conexant.com
Cenk Kose	Conexant	cenk.kose@conexant.com
Jim Petranovich	Conexant	jim.petranovich@conexant.com

Additional authors:

Michael Seals	Conexant	michael.seals@conexant.com
Mark Webster	Conexant	mark.webster@conexant.com
Menzo Wentink	Conexant	menzo.wentink@conexant.com
Taehyun Jeon	ETRI	thjeon@etri.re.kr
Sok-kyu Lee	ETRI	sk-lee@etri.re.kr
Heejung Yu	ETRI	heejung@etri.re.kr
Tim Wakeley	HP	tim.wakeley@hp.com
Mustafa Eroz	Hughes Network Systems	feroz@hns.com
Lakshmi Iyer	Hughes Network Systems	liyer@hns.com
Lin-Nan Lee	Hughes Network Systems	llee@hns.com
Feng-Wen Sun	Hughes Network Systems	fsun@hns.com
Marc de Courville	Motorola	marc.de.courville@motorola.com
Markus Muck	Motorola	markus.muck@motorola.com
Alexandre Ribeiro-Dias	Motorola	alexandre.ribeirodias@motorola.com

Additional authors:

Stephanie Rouquette-Leveil	Motorola	stephanie.rouquette@motorola.com
Sebastien Simoens	Motorola	sebastien.simoens@motorola.com
Nico van Waes	Nokia	Nico.vanWaes@nokia.com
John Chang	Ralink	john_chang@ralinktech.com.tw
Sheng Lee	Ralink	shenghlee@ralinktech.com
Tom Pare	Ralink	tpare@ralinktech.com
David Tung	Ralink	dtung@ralinktech.com
Der-Zheng Liu	Realtek	dzliu@realtek.com.tw
Ravi Mahadevappa	Realtek	ravi@realtek-us.com
Stephan ten Brink	Realtek	stenbrink@realtek-us.com
Gabriella Convertino	STMicroelectronics	gabriella.convertino@st.com
Mike Moreton	STMicroelectronics	mike.moreton@st.com
Fabio Osnato	STMicroelectronics	fabio.osnato@st.com
Pratima Pai	STMicroelectronics	pratima.pai@st.com

Additional authors:

Vincenzo Scarpa	STMicroelectronics	vincenzo.scarpa@st.com
Massimiliano Siti	STMicroelectronics	massimiliano.siti@st.com
George Vlantis	STMicroelectronics	george.vlantis@st.com
Anuj Batra	Texas Instruments	batra@ti.com
Srikanth Gummadi	Texas Instruments	sgummadi@ti.com
Dale Hocevar	Texas Instruments	hocevar@ti.com
Richard Williams	Texas Instruments	richard@ti.com
Keith Chugg	TrellisWare	kchugg@trellisware.com
Paul Gray	TrellisWare	pgray@trellisware.com
Bob Ward	TrellisWare	bward@trellisware.com
Jeng-Hong Chen	Winbond Electronics	jhchen2@winbond.com
Pansop Kim	Winbond Electronics	pkim@winbond.com
Alfred Lin	Winbond Electronics	halin@winbond.com
Wei-Chung Peng	Winbond Electronics	wcpeng0@winbond.com

Abstract

The presentation summarizes the WWiSE proposal:

- What's new since the March meeting …
  - Membership update
  - Proposal updates
- The WWiSE proposal
  - Summary and overview
  - Details and technical information
- Conclusions
  - Towards Draft 1.0 …

Expanded membership

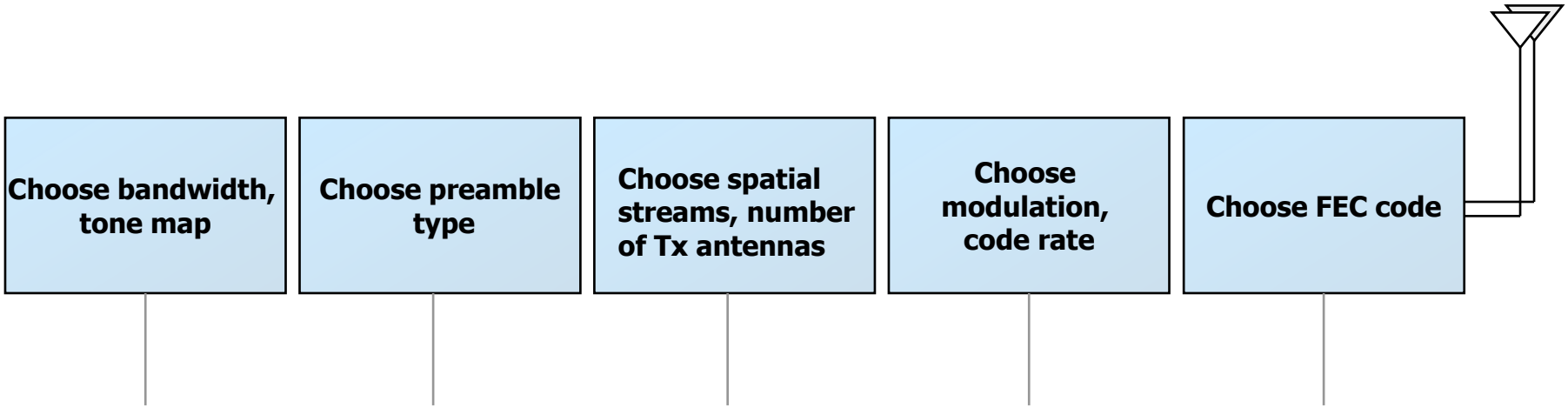
- Airgo Networks
- Broadcom
- Buffalo
- Conexant
- ETRI
- France Telecom
- *Hewlett Packard*
- Hughes Network Systems
- ITRI
- Motorola
- Nokia
- NTT
- Ralink
- Realtek Semiconductor
- *Siemens*
- STMicroelectronics
- Texas Instruments
- TrellisWare
- Winbond

Summary of proposal changes

- Coexistence of Extended Range (ER) devices with Non-extended Range (NR) devices
- Secondary Channel Element
- Allowance and rules for zero-length PPDUs
- New LDPC code design
- Further beacon refinement for longer range, low rate

WWiSE proposal summary

WWiSE proposal summary (PHY)



10, 20, 40 MHz

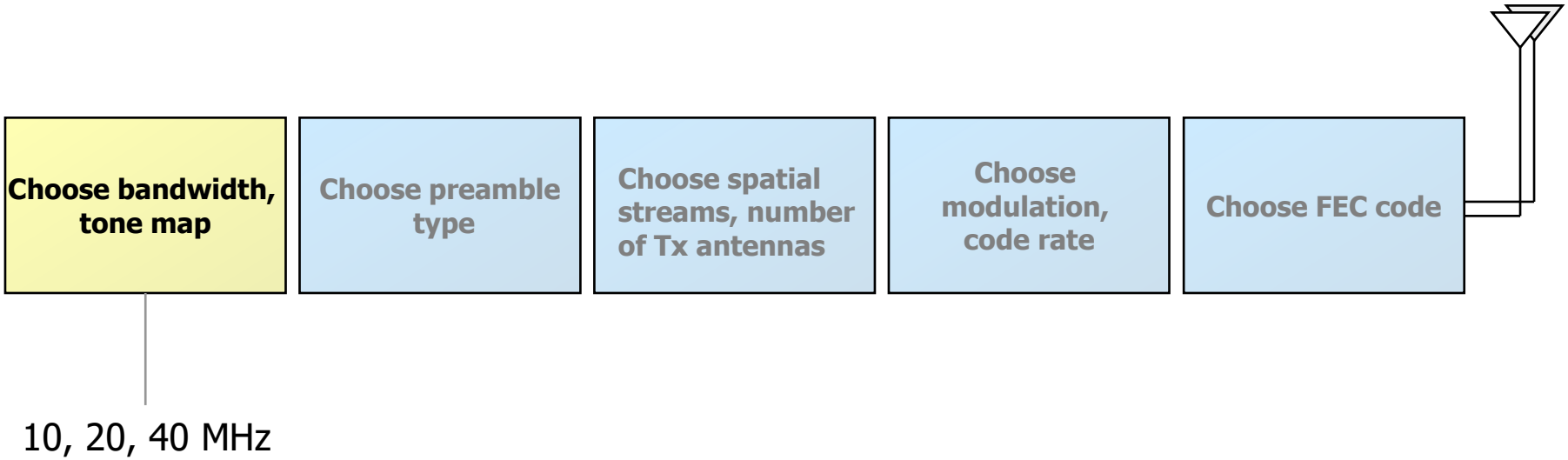
Mixed mode, green field

Spatial streams ≤ Tx antennas ≤ 4

Table I (1 stream)
Table II (> 1 stream)

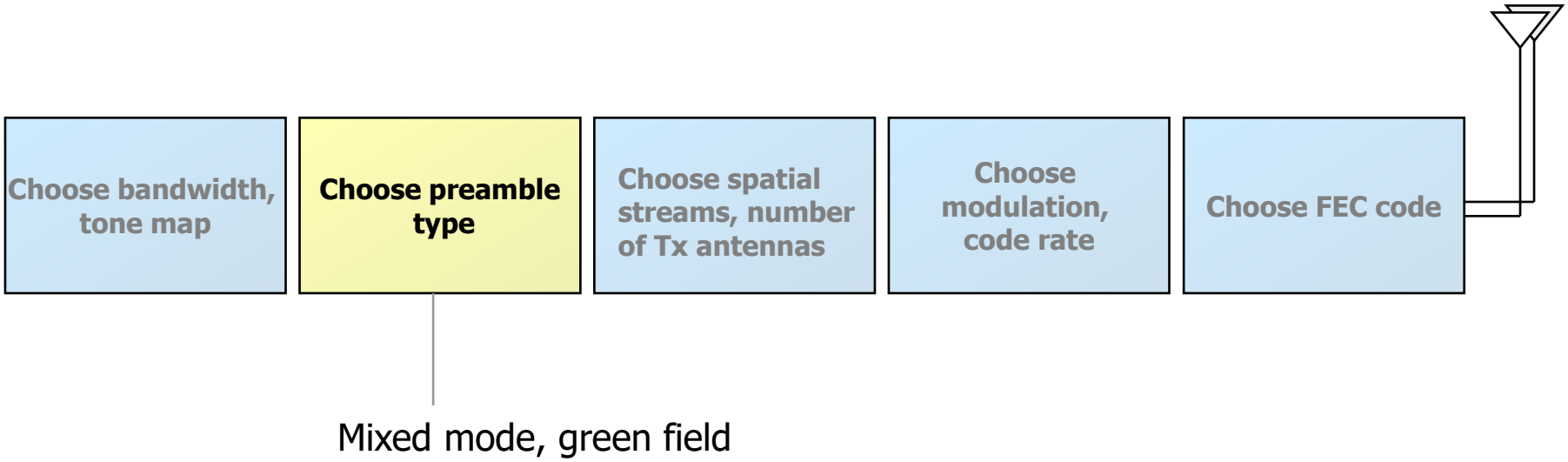
Convolutional, LDPC

WWiSE proposal summary, contd.



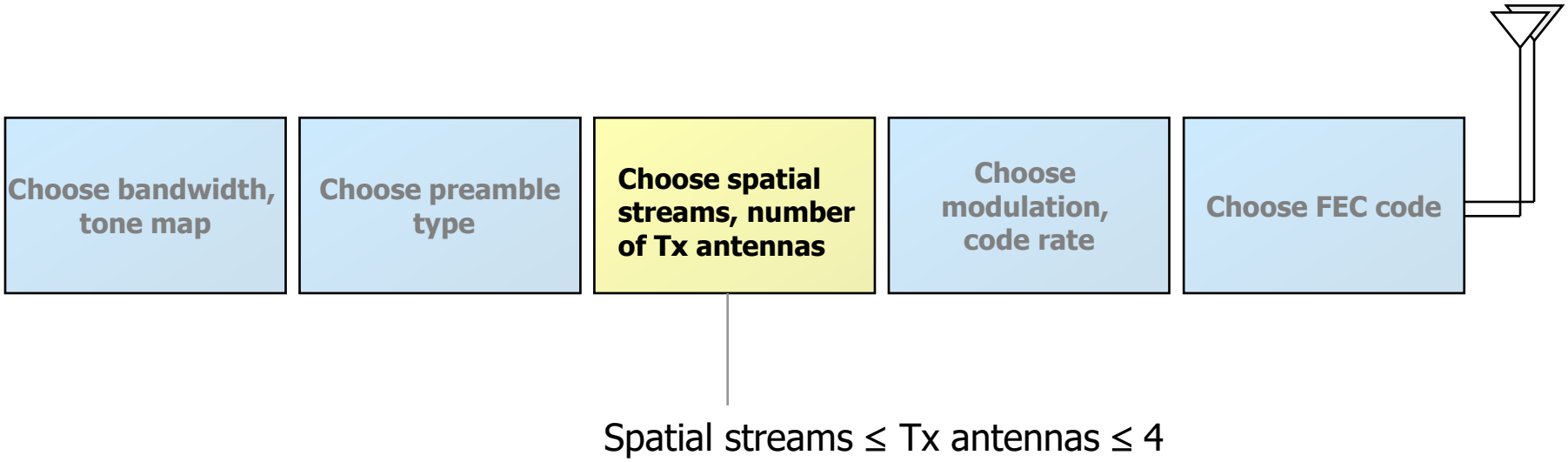
- Bandwidth determines tone map
- Increased efficiency for 10 & 20 MHz tone maps

WWiSE proposal summary, contd.



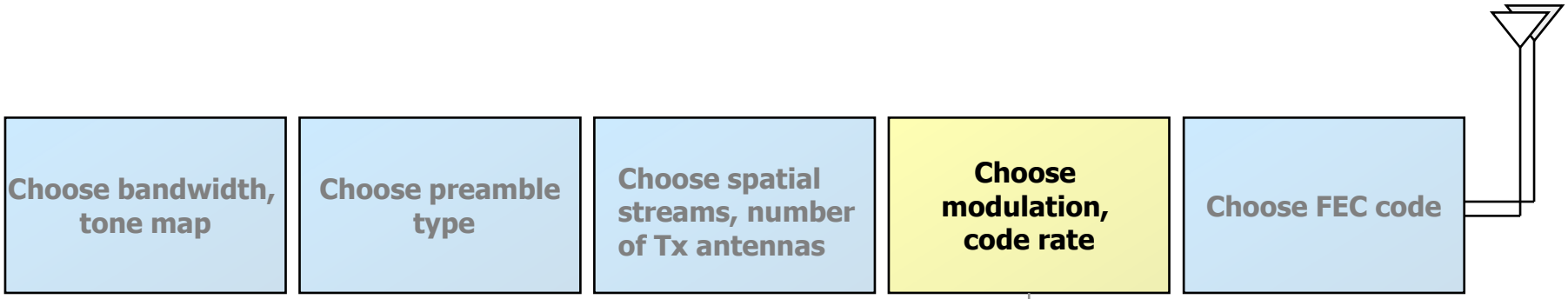
- Mixed mode preamble = green field preamble, with GF short replaced by full legacy preamble

WWiSE proposal summary, contd.



- Simple two-symbol space-time block codes
- Cycle through transmit antennas for 3, 4 transmit antennas and single receive antenna

WWiSE proposal summary, contd.



I

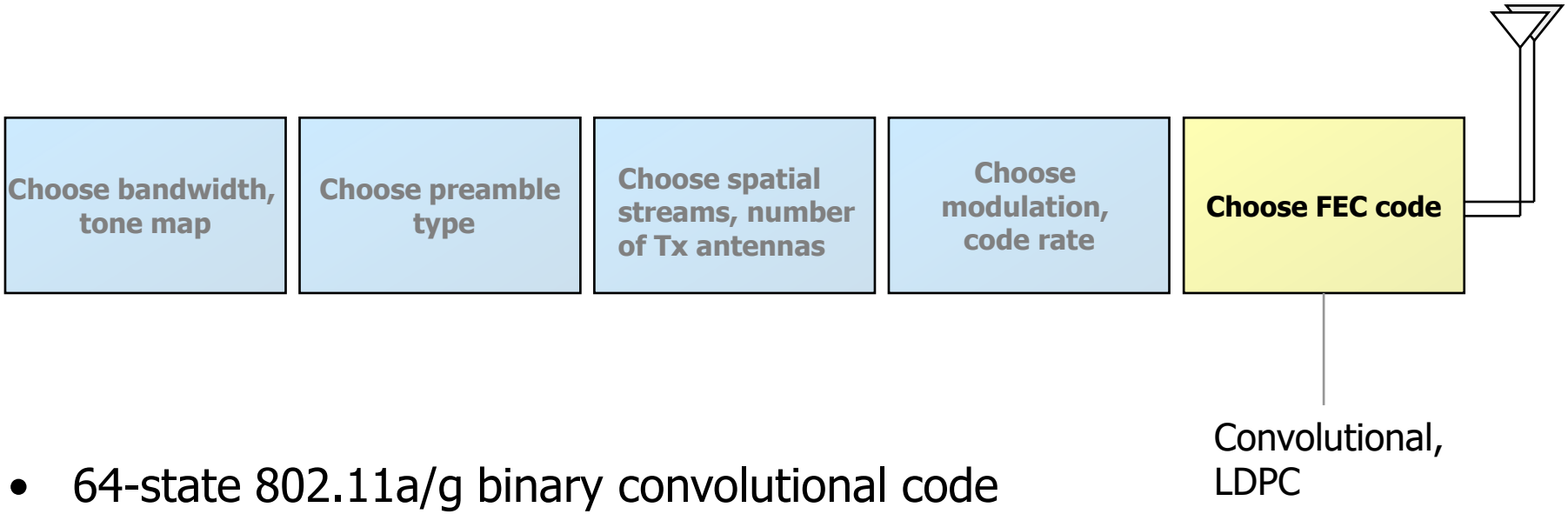
Rate	Constellation
1/2	BPSK
3/4	"
1/2	QPSK
3/4	"
1/2	16-QAM
3/4	"
2/3	64-QAM
3/4	"
5/6	"

II

Rate	Constellation
1/2	16-QAM
3/4	"
2/3	64-QAM
3/4	"
5/6	"

Table I (1 stream)
Table II (> 1 stream)

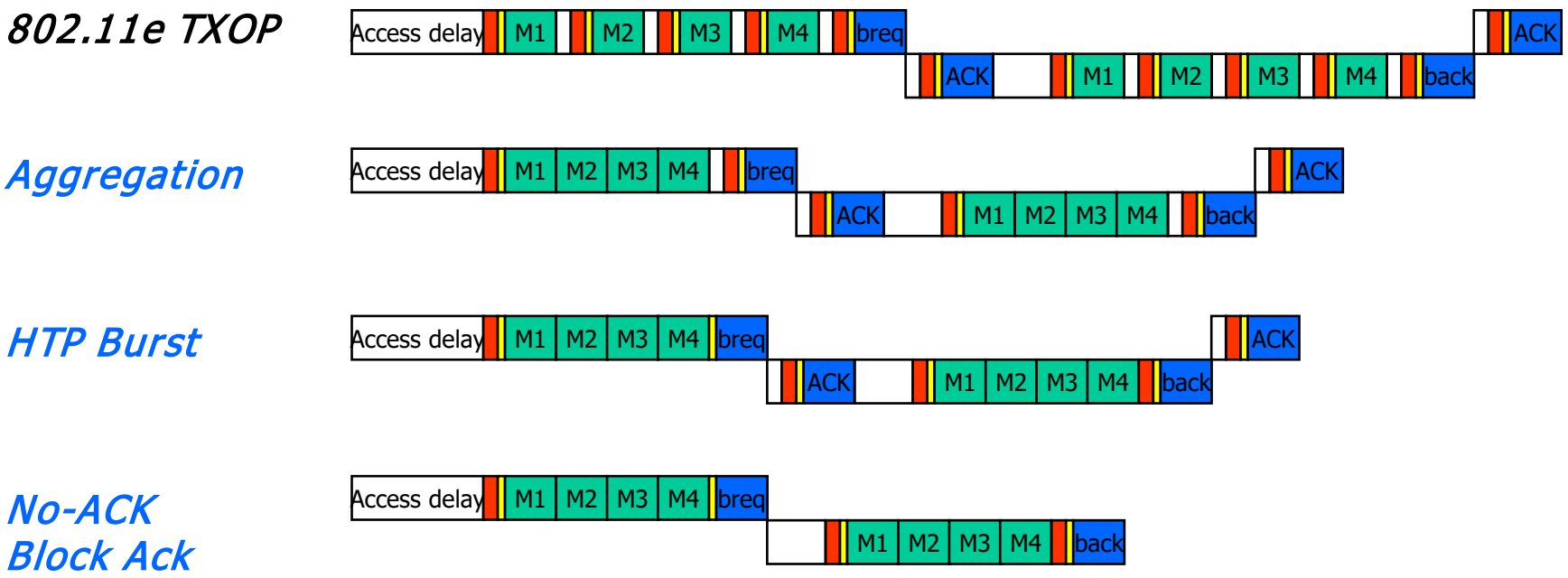
WWiSE proposal summary, contd.



- 64-state 802.11a/g binary convolutional code
- Parallelized for > 2 spatial streams in 40 MHz, to enable efficient decoding
- LDPC code

WWiSE proposal summary (MAC)

- WWiSE brings three simple efficiency enhancements over 802.11e:



WWiSE proposal summary, contd.

- *Other features:*
  - Rate recommendation from receiver
  - Channel state information from receiver
  - 20/40 coexistence mechanisms
  - n-beacon, Long SIG

Details and technical information on WWiSE proposal

LDPC highlights

- The WWiSE LDPC code has been changed so that the four code rates have the corresponding uniform base matrix dimensions:
  - R=1/2 with base matrix size 12x24
  - R=2/3 with base matrix size 8x24
  - R=3/4 with base matrix size 6x24
  - R=5/6 with base matrix size 4x24
- The WWiSE proposal's three codeword sizes now having the following corresponding submatrix sizes:
  - N = 1944 using z = 81 (submatrix size)
  - N = 1296 using z = 54
  - N = 648 using z = 27

LDPC highlights, contd.

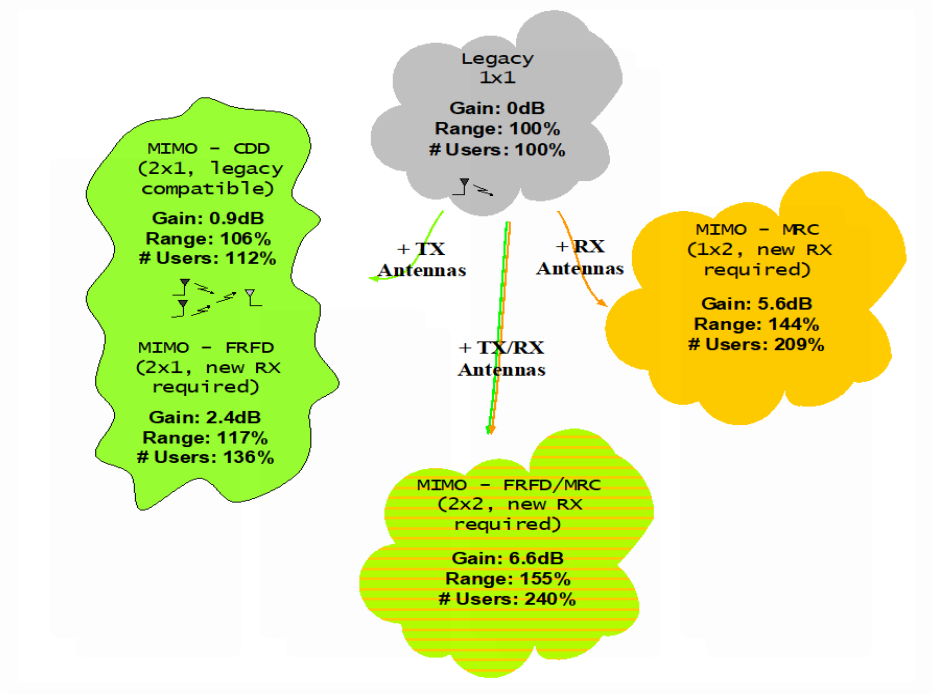
- Each code is designed with the following unified encoding structure:
  - Cyclically shifted identity matrices for the parity section
  - Modified block staircase for the information section
    - Modification allows for numerous high speed decoder architectures, including both high throughput Layered Belief Propagation and Turbo-like architectures
- The WWiSE proposal has improved error rate performance with no flooring exhibited across AWGN and fading channels.

Extended Range features

- New & modified ER features:
  - The (optional) doubled length SIG field now has in addition a frequency domain permutation
    - This exploits frequency diversity and has performance consistent with robust STBC modes
  - MAC protection mechanisms have been finalized to allow peaceful Normal Range (NR), Extended Range (ER) coexistence
    - Both multiple/single TxOP protection schemes

Range extension: from the PHY up to the MAC

- 4 main features need to be ensured to grant range extension
  - *Appropriate PHY modes:*
    - Enables enough coverage for handset applications: VoIP, video streaming
    - Allow a number of spatial streams lower than the number TX antennas!
  - *Beacon:* Enable association at extended range (ER): legacy beacon doesn't allow extended range stations to associate



- *Coexistence:* if PHY modes are not mandatory then MAC protection mechanisms are required to allow coexistence of extended/normal range (ER/NR) stations
- *Enable robust signaling:* define an 11n specific signal field that enables stations at a larger range to be able to understand the parameters of the incoming packets

MAC features summary

There were three significant MAC modifications between March and July, relating to:

- Coexistence of Extended Range (ER) devices with Non-extended Range (NR) devices
- Secondary Channel Element
- Allowance and rules for zero-length PPDUs.

ER Coexistence – issues

- WWISE proposal includes STBC rates for Extended Range
  - These rates are OPTIONAL
    - ER device
      - A device which optionally supports the STBC rates in addition to the mandatory rates
    - NR device
      - A device which optionally does NOT support the STBC rates, but supports the mandatory rates
  - Existence of two classes of devices (ER/NR) creates an opportunity for hidden nodes
    - ER devices can be attached to the BSS at a greater distance from the AP
    - At such range, the ER devices can no longer communicate with the AP at the non-ER rates (NR rates)
    - ER devices will miss NR "protective frames" e.g. RTS/CTS (any frame with a non-zero DUR field value)
    - This creates a hidden node situation

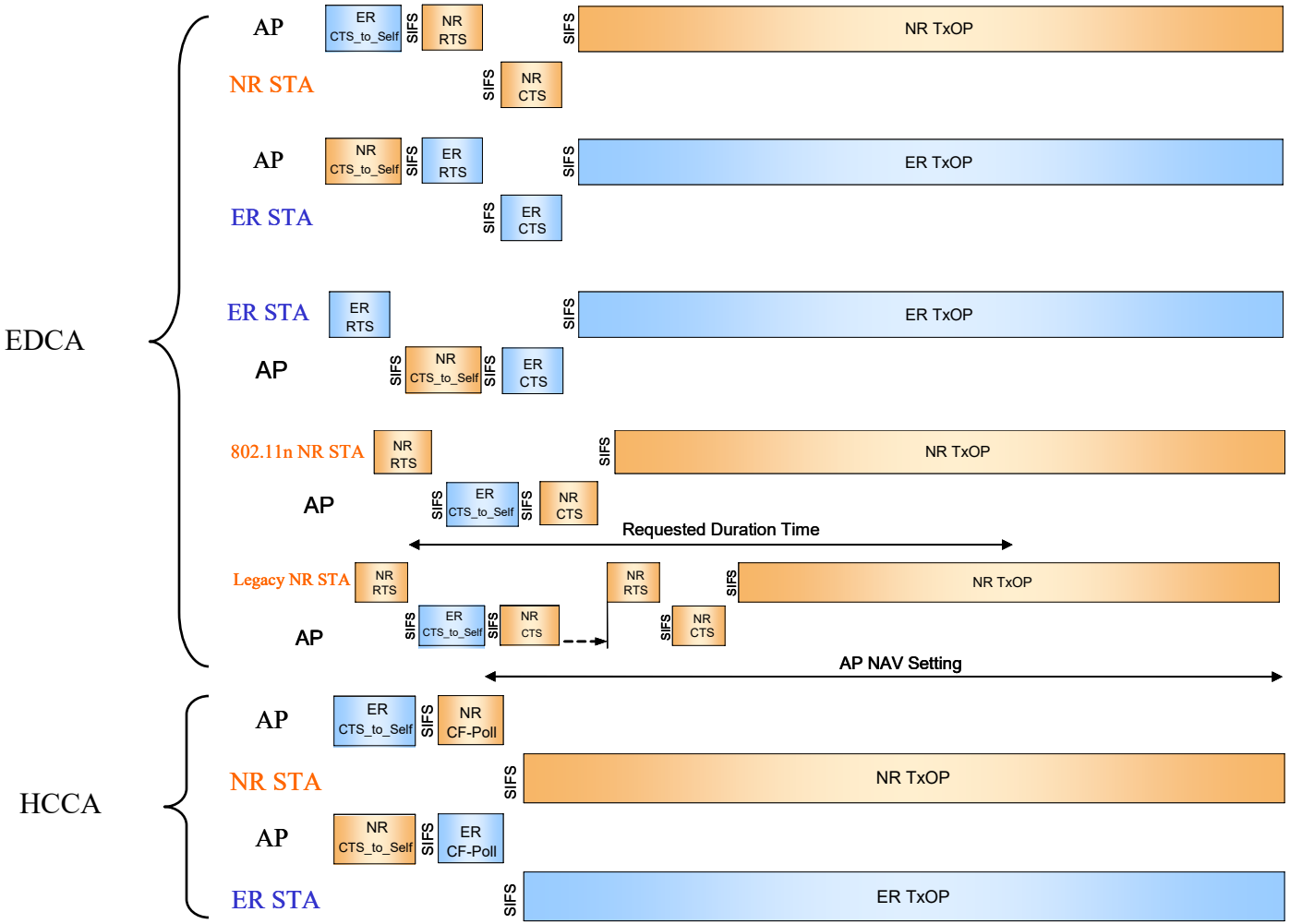
ER coexistence

- ER Beacon, NR Beacon
  - Separate beacons with same periodicity, but ER TBTT offset from NR TBTT
  - ER MCAST follows ER Beacon
  - NR MCAST follows NR Beacon
  - TSF value is common, offset describes shift
    - Offset contained in beacons (new field in ERP Information Element)
- Use_ER_Protection signal (a new bit added to existing ERP Information element)
  - This Element is included in Beacons, Probe Responses
- ER Protection mechanisms
  - Self-managed
  - AP-managed

ER-protection – Self-managed

- Self-managed protection
  - AP with ER STA associated
    - Sends NR CTS-to-self before ER exchange (either EDCA or HCCA)
    - Sends ER CTS-to-self before NR exchange (either EDCA or HCCA)
  - Non-AP ER STA send ER RTS, receive NR CTS followed by ER CTS
  - Non-AP NR STA send NR RTS, receive ER CTS followed by NR CTS
  - Legacy STA send NR RTS, receive ER CTS follwed by NR CTS
    - They either accept the "late CTS" and continue, or they declare a timeout and backoff and try again
      - Other devices in deferral due to the ER CTS and/or NR CTS during backoff

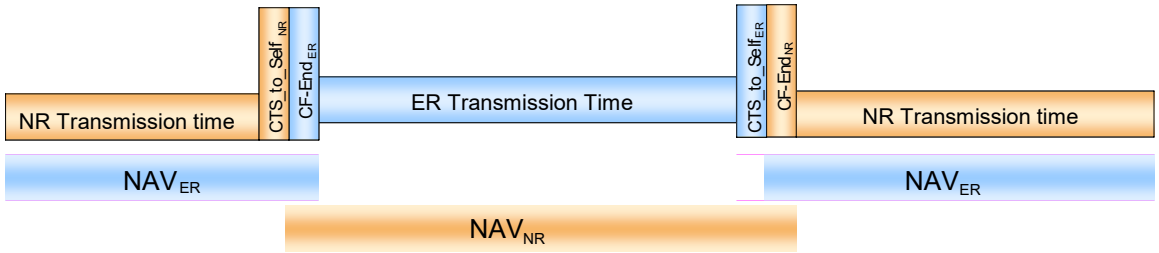
Self-managed ER Protection



ER-protection – AP-managed

- AP-managed protection
  - The AP creates separate time windows for ER operation and NR operation
    - Sends CTS-to-self/CF-end combination at the start of each period
      - E.g. NR CTS-to-self with ER CF-end to create ER-friendly period
    - Dynamic creation
    - Informatively described

AP-managed ER Protection



Zero-length PPDU

- Allow Zero-length PPDU
  - WWISE proposal includes A-PPDU aggregation
    - Aggregation of multiple PSDUs within a single PPDU
    - Each PSDU has its own signal field
    - New language allows use of signal fields with an indicated ZERO length
    - Allows for speculative A-PPDU aggregation
      - LP=0 for all frames
    - If TX FIFO underflow, then set LP=1 with ZERO length
    - LP shall be set to 1 when LEN=0
  - 20.3.4 (signal fields) – one sentence added:
    - When the LEN field is set to 0, no PSDU bits are present and the Last PSDU indicator (LPI) shall be set to 1 to end the current PPDU.

New Secondary Channel Element

- Addition of a new element to provide information regarding the secondary channel
  - For cases when:
    - BSS moves from one 40-MHz pair to a different 40-MHz pair
    - BSS moves from a 20-MHz pair to a 40-MHz pair
  - Description of appropriate behavior for transition from a 40-MHz pair to a 20-MHz channel is also given
  - This new element is added to some management frames as part of the existing channel switch mechanisms:
    - Beacons
    - Probe resopnses
    - Channel Switch Announcement frames

WWiSE proposal features, summary

- High-performance PHY and MAC
- Modularity and simplicity in PHY design
  - Eases interoperability and verification, enables faster time to market and provides true scalability
- Efficient, streamlined MAC extensions
  - High performance, no unnecessary complexity
- Well defined, stable technical specification
  - Suitable for immediate use as Draft 1.0

References and further information

1. IEEE 802.11/05-0149-05-000n, "WWiSE group PHY and MAC specification," C. Kose, B. Edwards, et al.
2. IEEE 802.11/04-0877-09-000n, "WWiSE proposal response to functional requirements and comparison criteria," C. Hansen, M. Fischer, et al.
3. IEEE 802.11/04-0935-r3-000n and –r4-000n, IEEE 802.11/05-1591r3, "WWiSE complete proposal presentation," S. Coffey et al.
4. IEEE 802.11/05-0016-02-000n, "WWiSE MAC proposal for TGn," M. Fischer et al.

See also www.wwise.org

Or send email to info@wwise.org