WWiSE IEEE 802.11n Proposal

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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

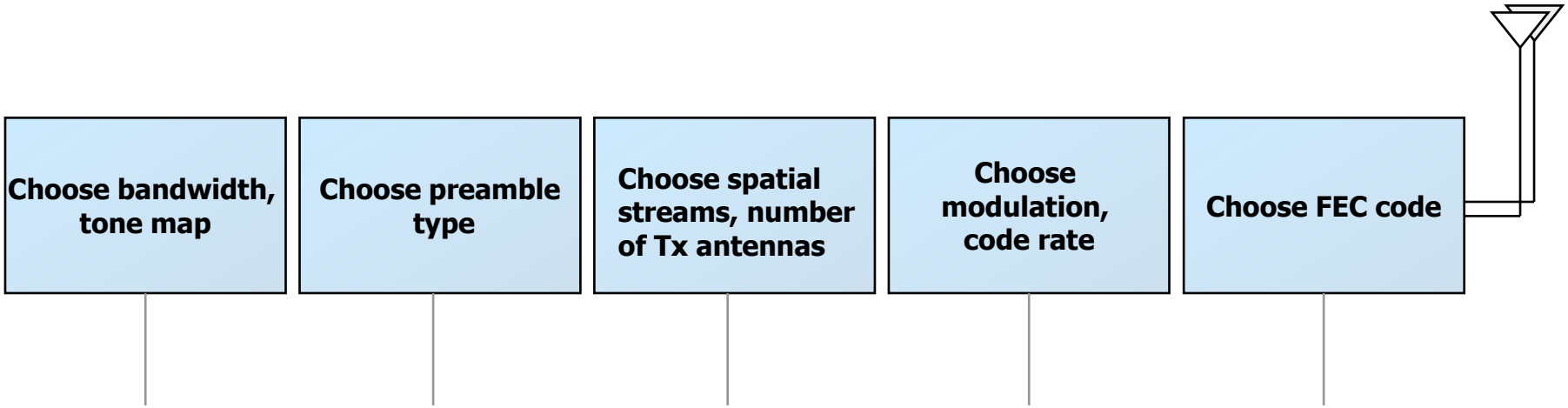
- Airgo Networks
- Broadcom
- Buffalo
- Conexant
- ETRI
- France Telecom
- *Hewlett Packard*
- Hughes Network Systems
- ITRI
- Motorola
- Nokia
- NTT
- Ralink
- Realtek Semiconductor
- *Siemens*
- STMicroelectronics
- Texas Instruments
- TrellisWare
- Winbond

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

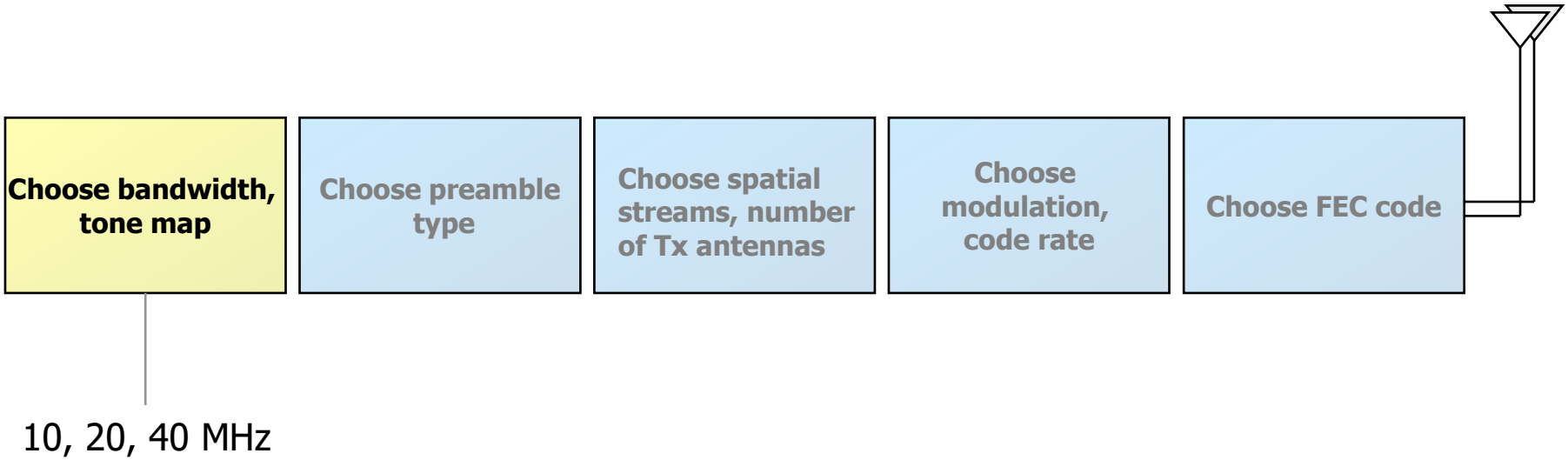
Mixed mode, green field

Spatial streams ≤ Tx antennas ≤ 4

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

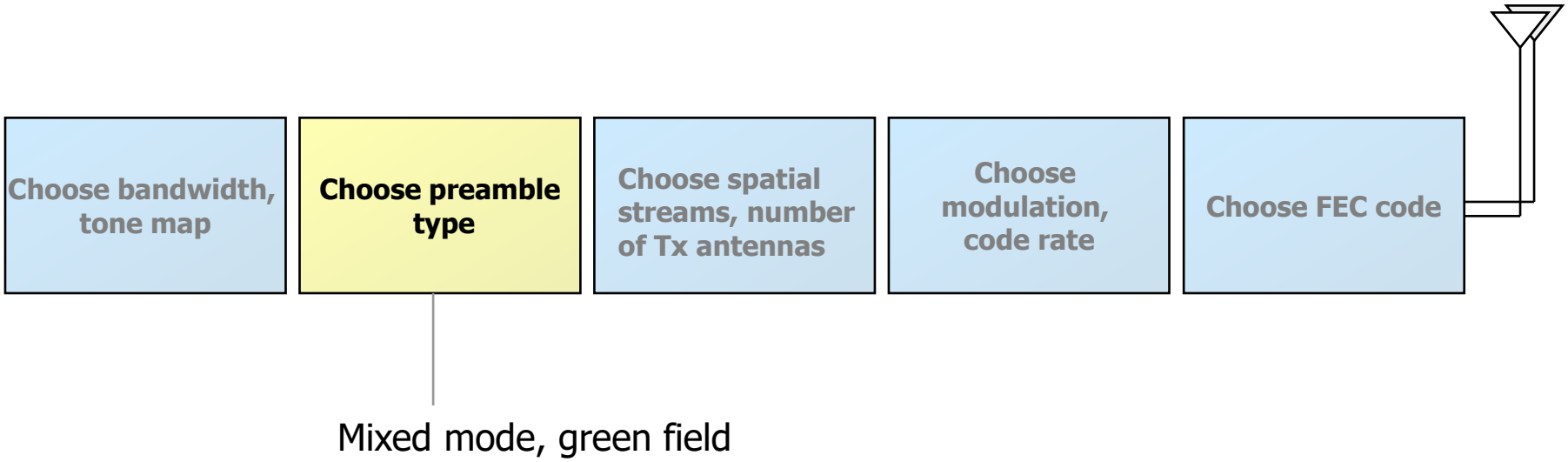
Convolutional, LDPC

WWiSE proposal summary, contd.



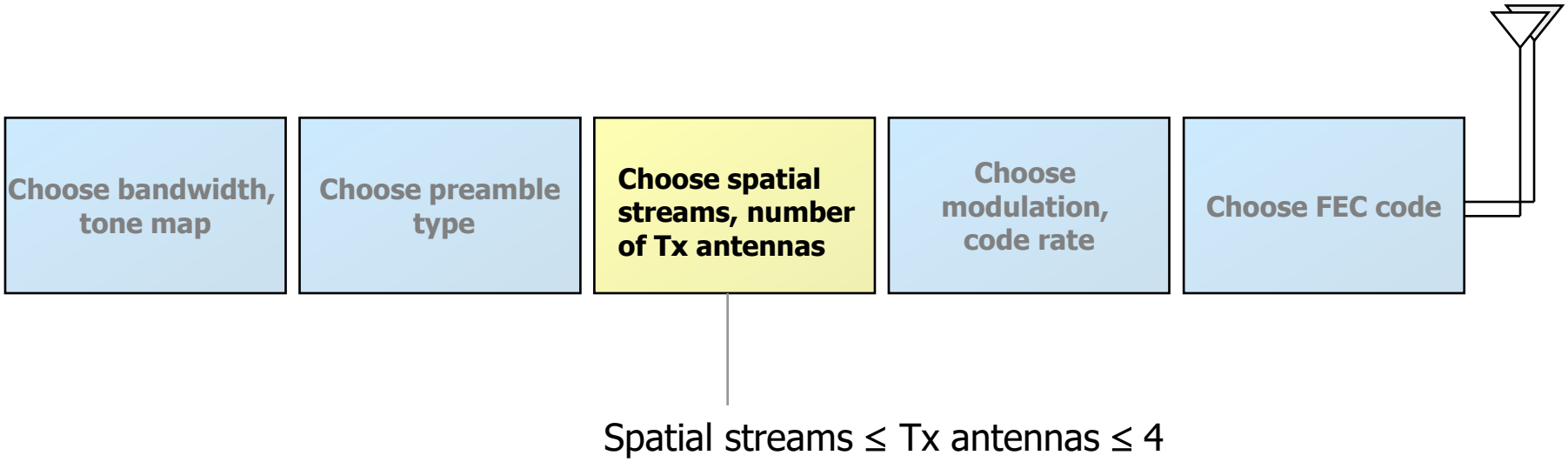
- Bandwidth determines tone map
- Increased efficiency for 10 & 20 MHz tone maps

WWiSE proposal summary, contd.



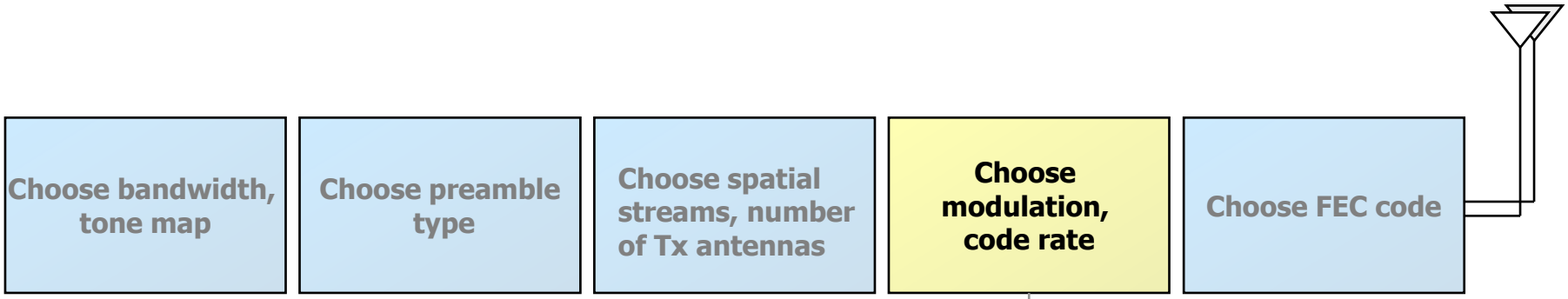
- Mixed mode preamble = green field preamble, with GF short replaced by full legacy preamble

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

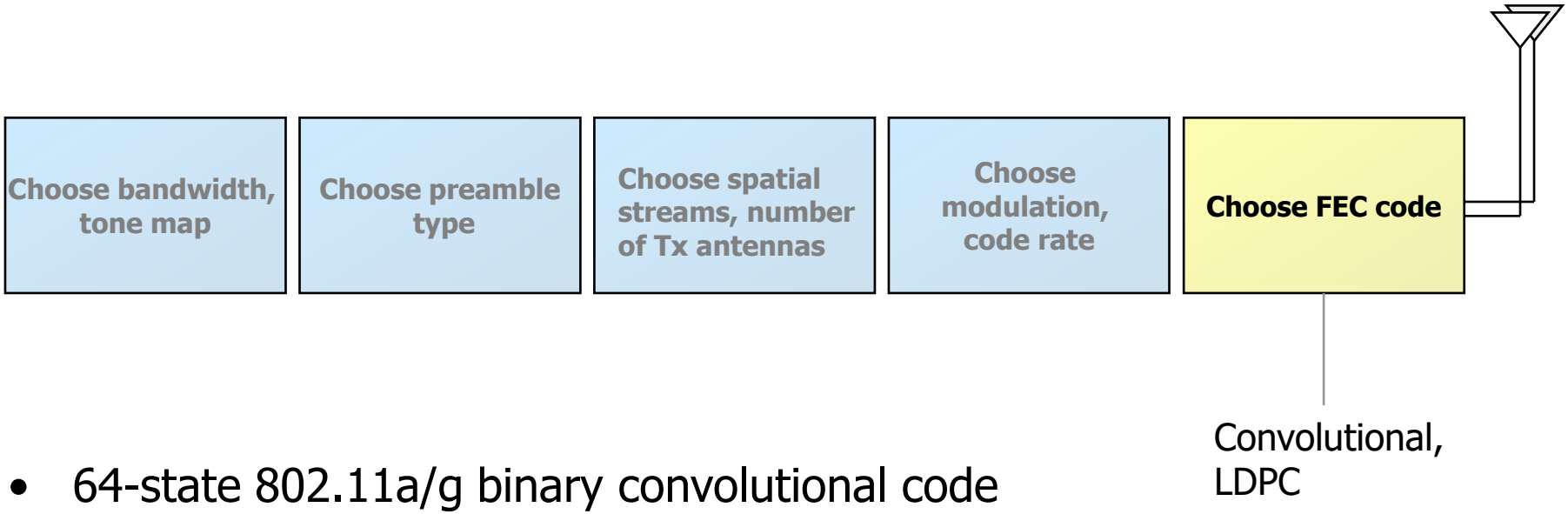
Rate	Constellation
1/2	BPSK
3/4	"
1/2	QPSK
3/4	"
1/2	16-QAM
3/4	"
2/3	64-QAM
3/4	"
5/6	"

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)

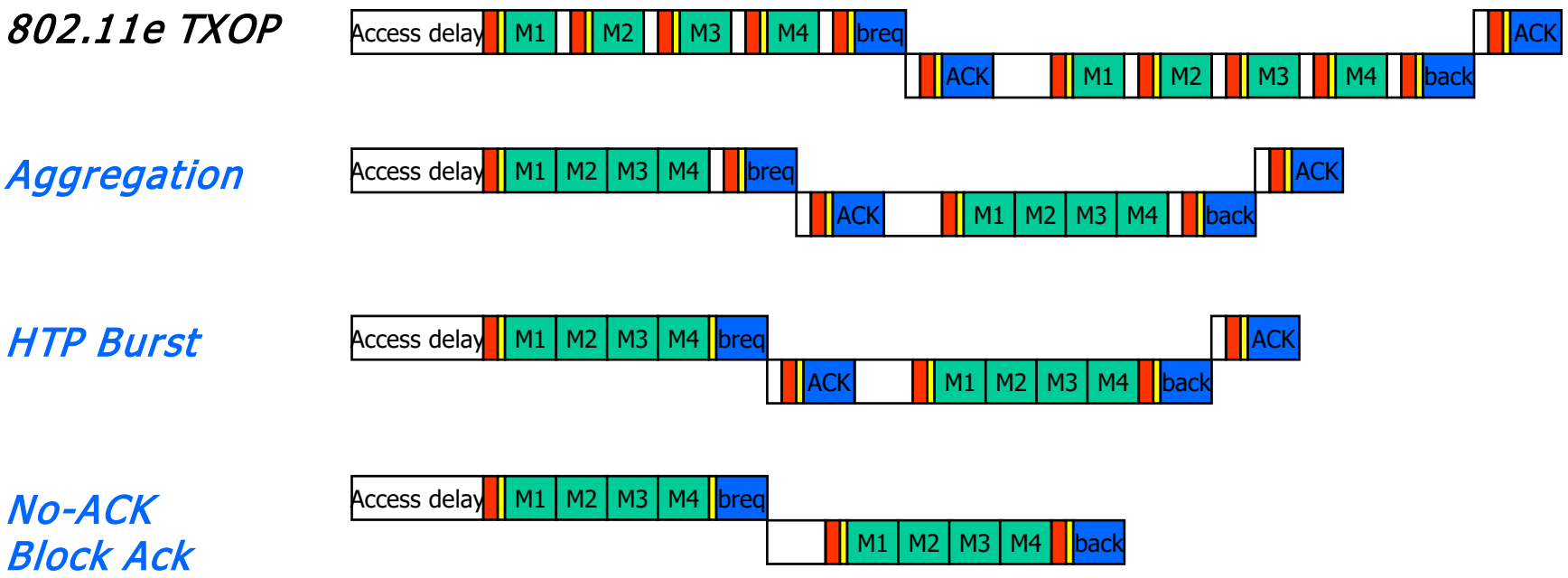
WWiSE proposal summary, contd.



- 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.

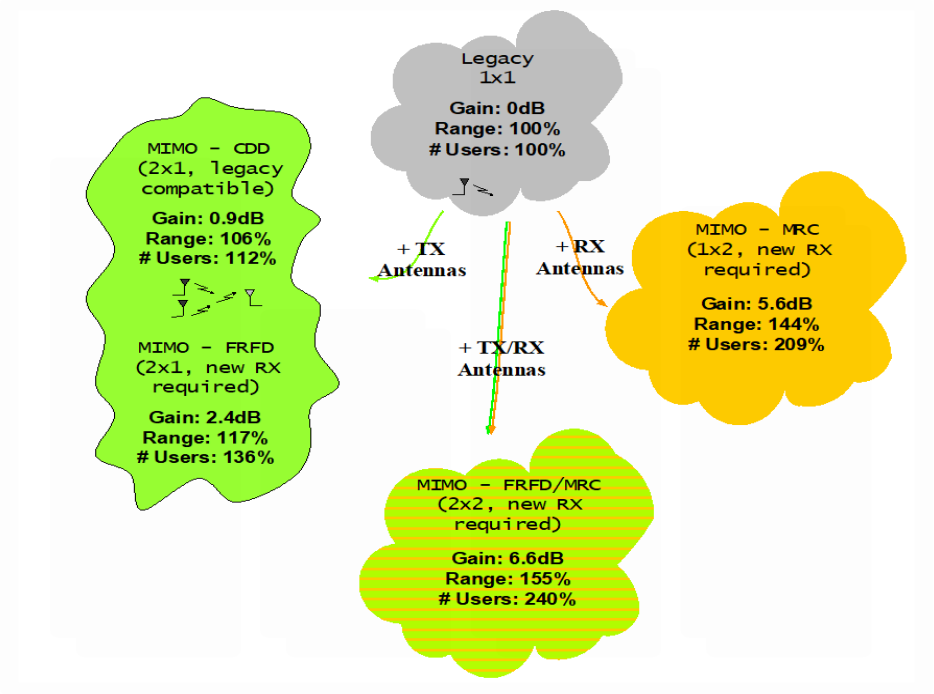
- Each code is designed with the following unified encoding structure:
  - Cyclically shifted identity matrices for the parity section
  - Modified block staircase for the information section
    - Modification allows for numerous high speed decoder architectures, including both high throughput Layered 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

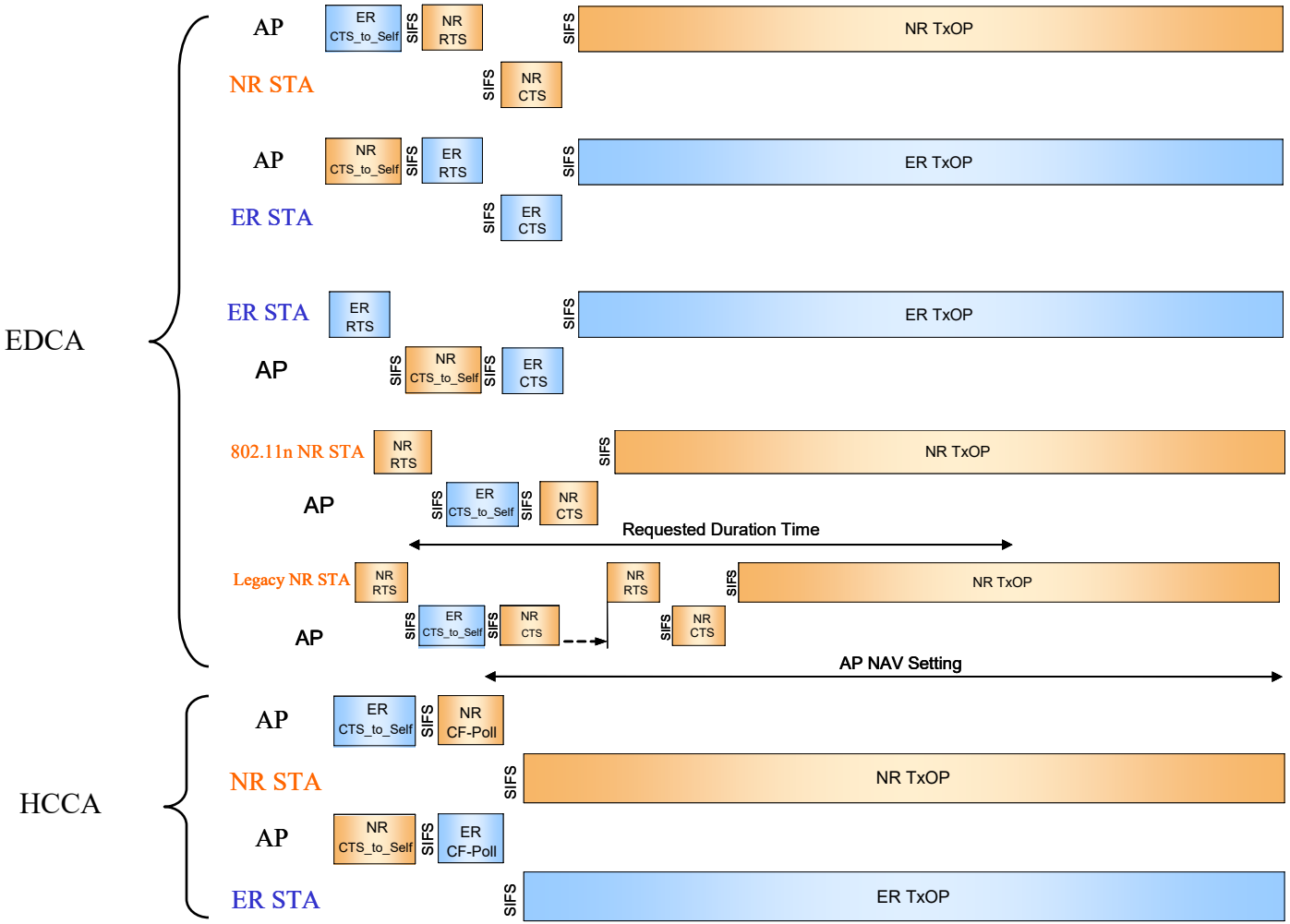
ER coexistence

- 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

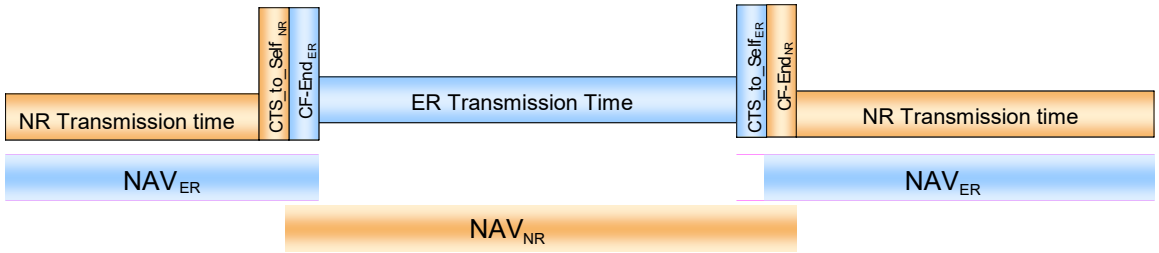
Self-managed ER Protection



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

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