



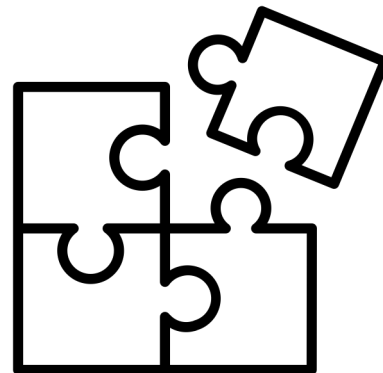
THE WI-FI PERFORMANCE COMPANY

# 802.11ax Channel Access

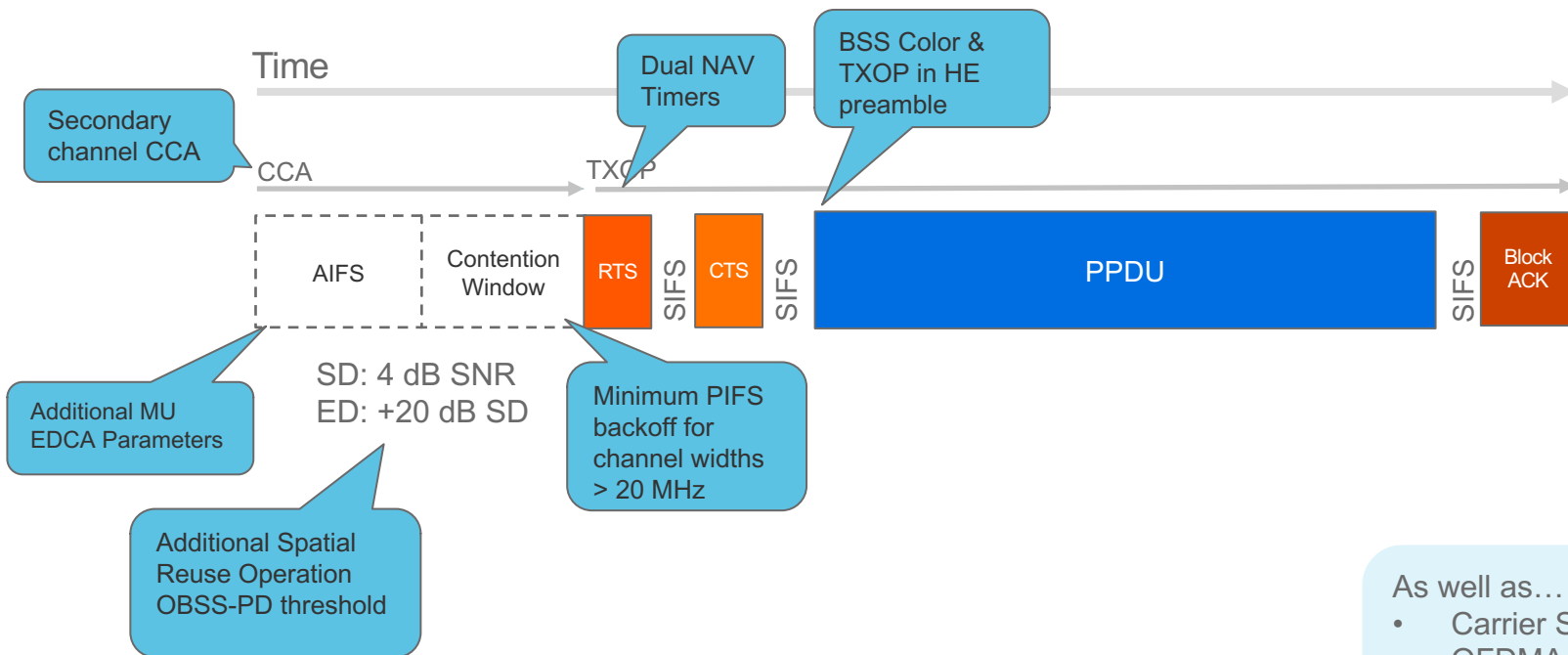
Jim Vajda, CWNE #183

# The Complete Picture

- Not just OFDMA
- The old and the new, the full channel access protocol
- Update on what's really happening in the air today, not all the methods 802.11 allows
- Understanding channel access is fundamental to making sound design decisions



# Legacy EDCA plus...

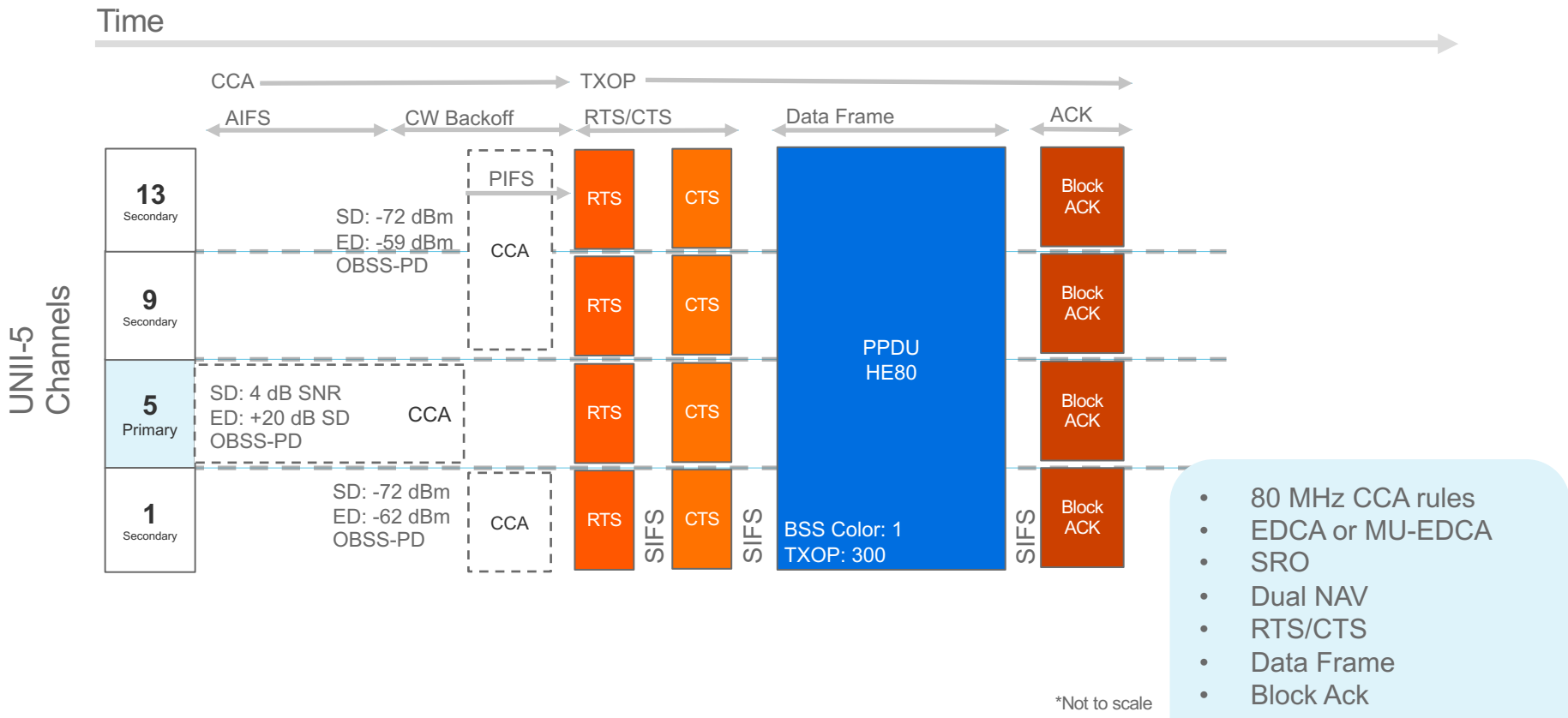


As well as...

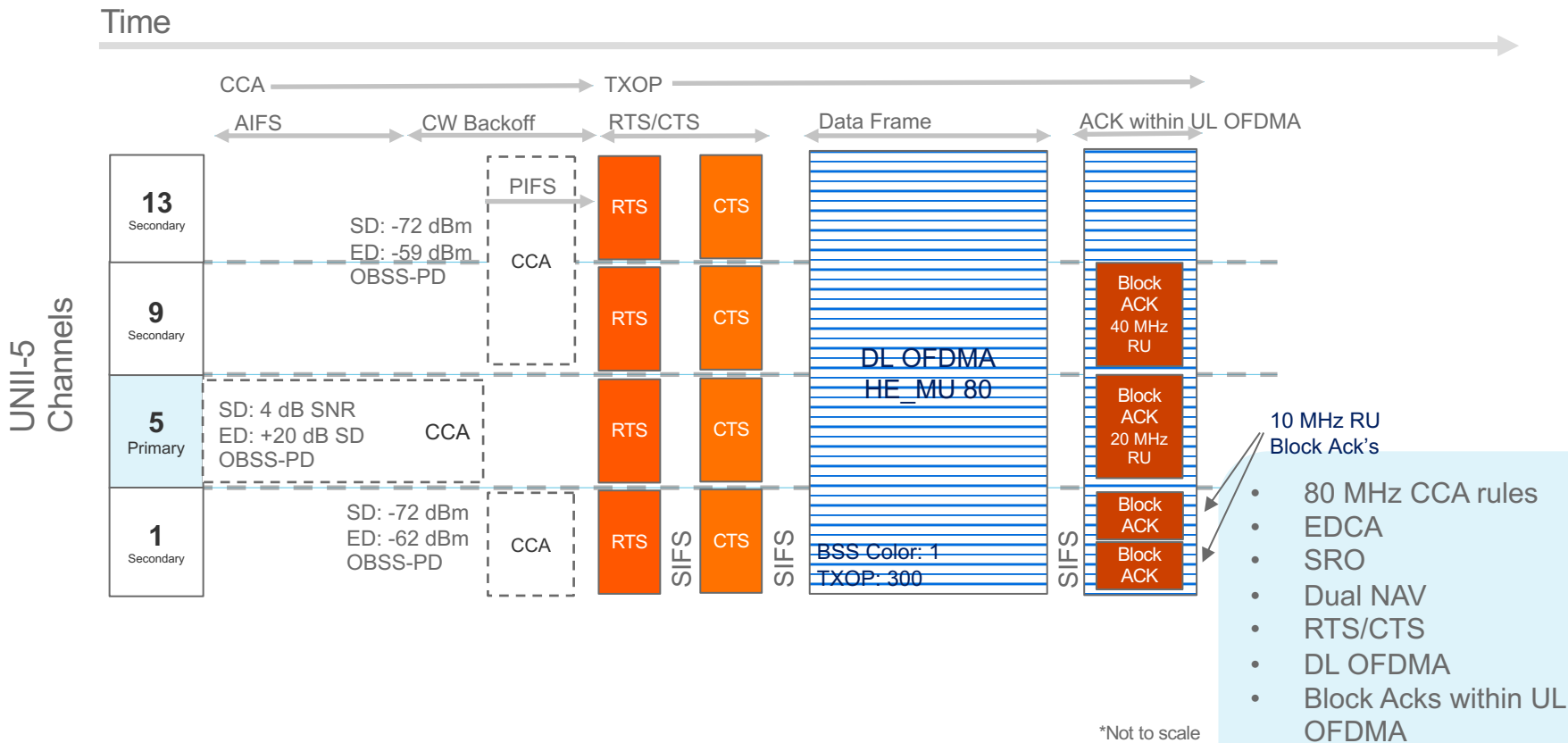
- Carrier Sense within an OFDMA Resource Unit

\*Not to scale

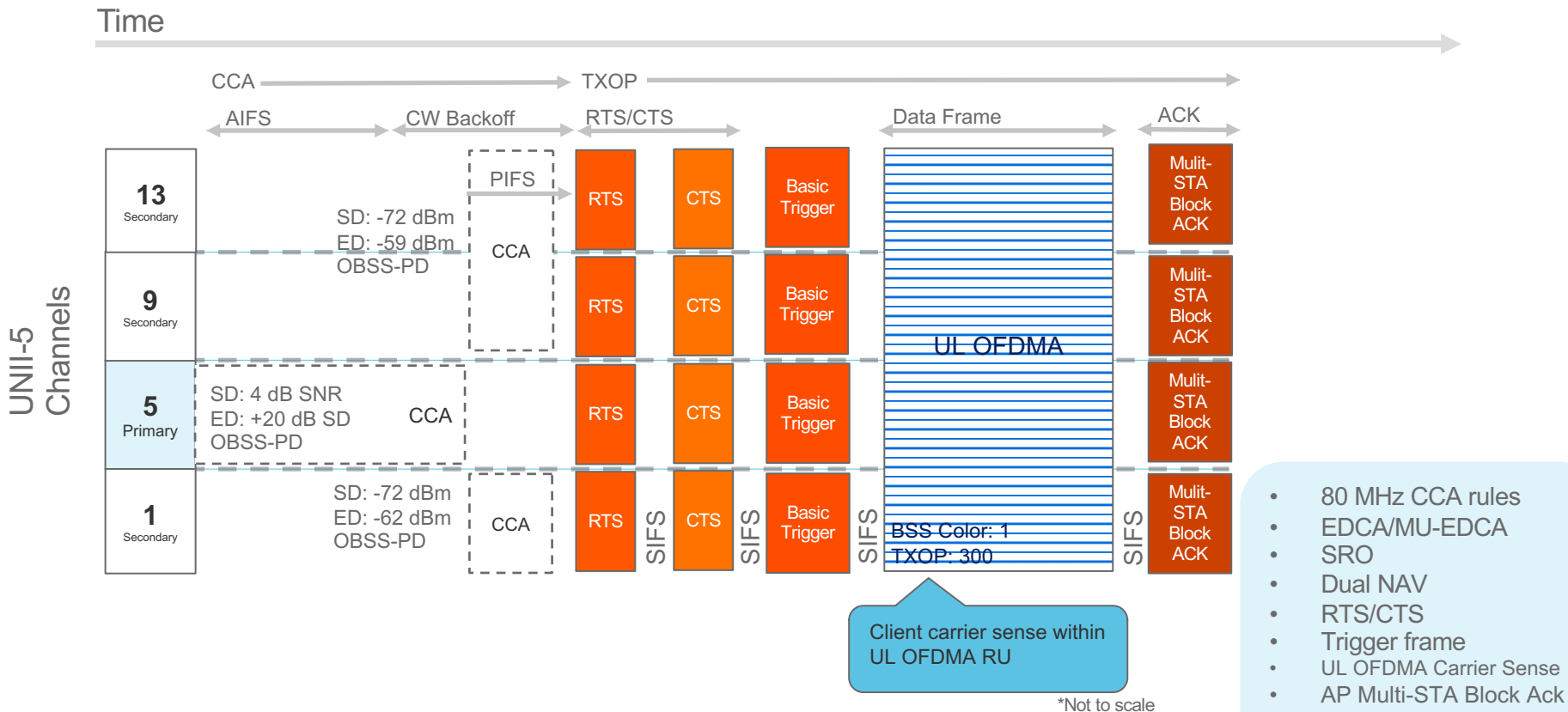
# 802.11ax HE SU Start to Finish



# Downlink OFDMA Start to Finish

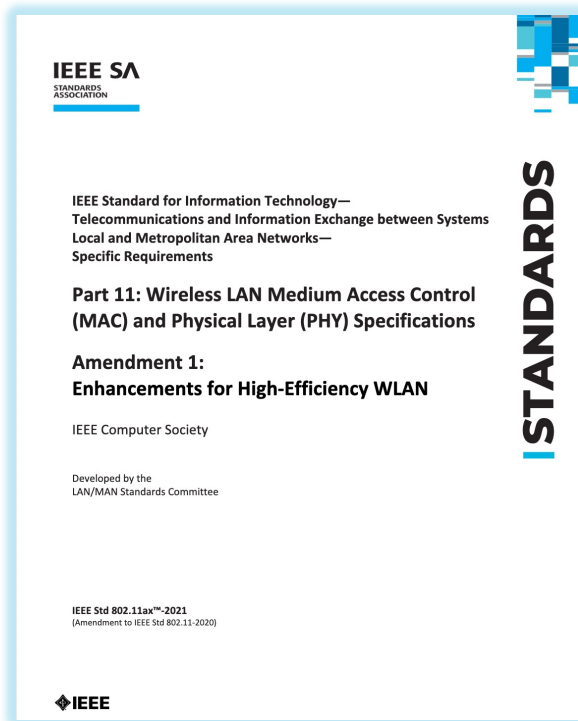


# Uplink OFDMA Start to Finish



# 802.11ax New Channel Access Features

- BSS Coloring
- Spatial Reuse Operation
- Dual NAV
- MU-EDCA Parameters
- ~~• Preamble Puncturing (not implemented)~~
- OFDMA
  - Carrier Sense within OFDMA
  - ~~– UL OFDMA Random Access (UORA, not implemented)~~
- Wide channel access procedures

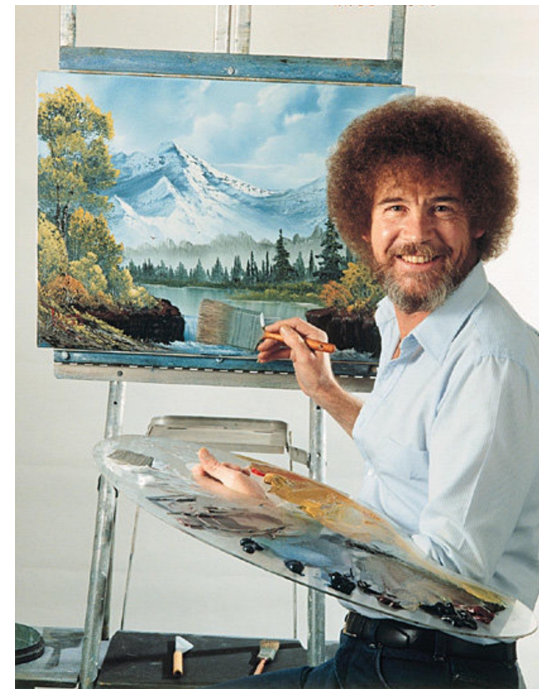


Available for free download via [IEEE GET Program](#)

# BSS Coloring

- Fuzzy term, but in 802.11 its just the BSS Color Fields
- Doesn't do anything on its own
- Mandatory for all HE STA's

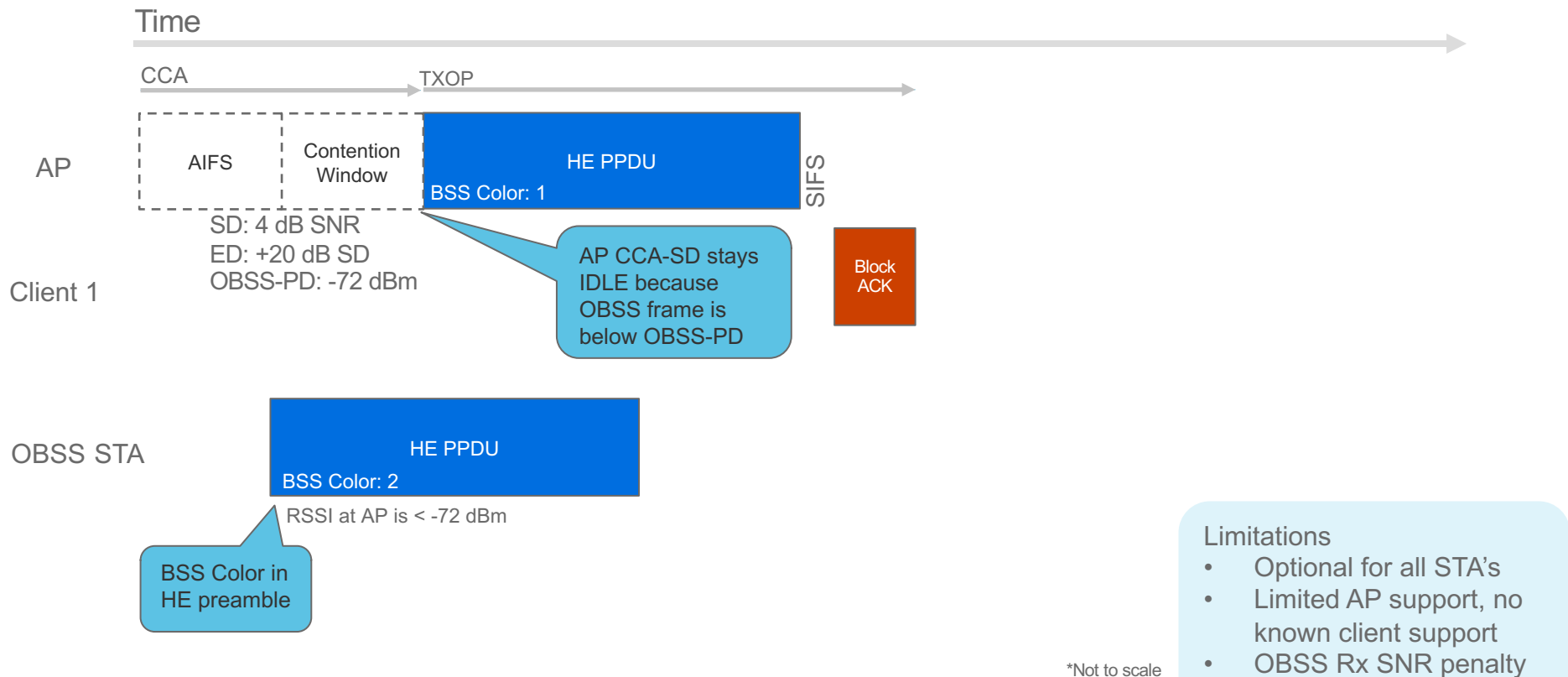
```
▼ Radiotap Header v0, Length 82
  Header revision: 0
  Header pad: 0
  Header length: 82
  > Present flags
  > Flags: 0x10
  Channel frequency: 5500 [A 100]
  > Channel flags: 0x0140, Orthogonal Frequency-Division Multiplexing (OFDM), 5 GHz spectrum
  Antenna signal: -17 dBm
  > RX flags: 0x0000
  > A-MPDU status
  > timestamp information
  ▼ HE information
    > HE Data 1: 0xc7fc, PPDU Format: HE_SU, BSS Color known, Beam Change known, UL/DL known, data MCS known, d
    > HE Data 2: 0x007e, GI known, LTF symbols known, Pre-FEC Padding Factor known, TxBF known, PE Disambiguity
    ▼ HE Data 3: 0x2be1, Coding: LDPC
      .... ..10 0001 = BSS Color: 0x21
      .... ..1.. .... = Beam Change: 0x1
      .... ..1... .... = UL/DL: 0x1
      .... 1011 .... = data MCS: 0xb
      ....0 .... = data DCM: 0x0
      ..1. .... = Coding: LDPC (0x1)
      .0.. .... = LDPC extra symbol segment: 0x0
      0... .... = STBC: 0x0
    > HE Data 4: 0x0000
    > HE Data 5: 0xb082, data Bandwidth/RU allocation: 80, GI: 0.8us, LTF symbol size: 2x, LTF symbols: 1x
    > HE Data 6: 0x0c02, NSTS: 2 space-time streams
  > L-SIG
```



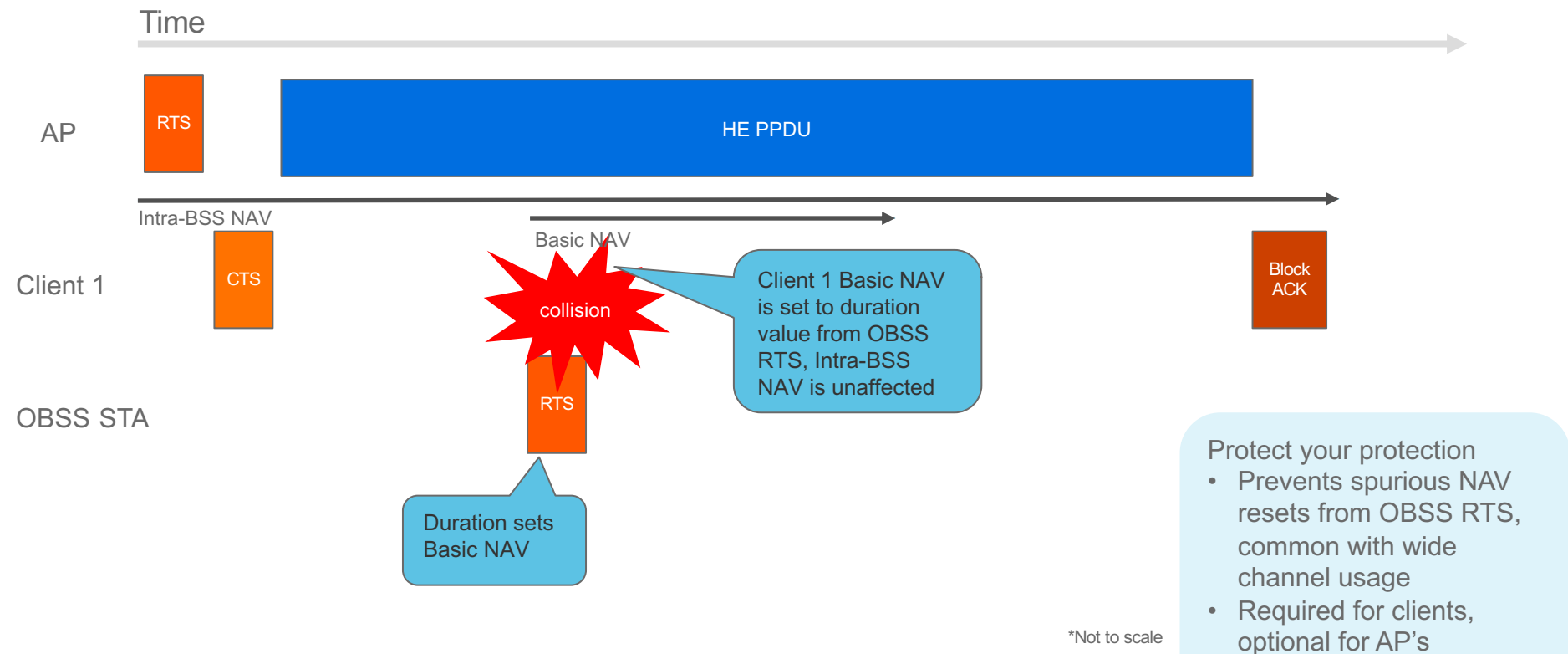
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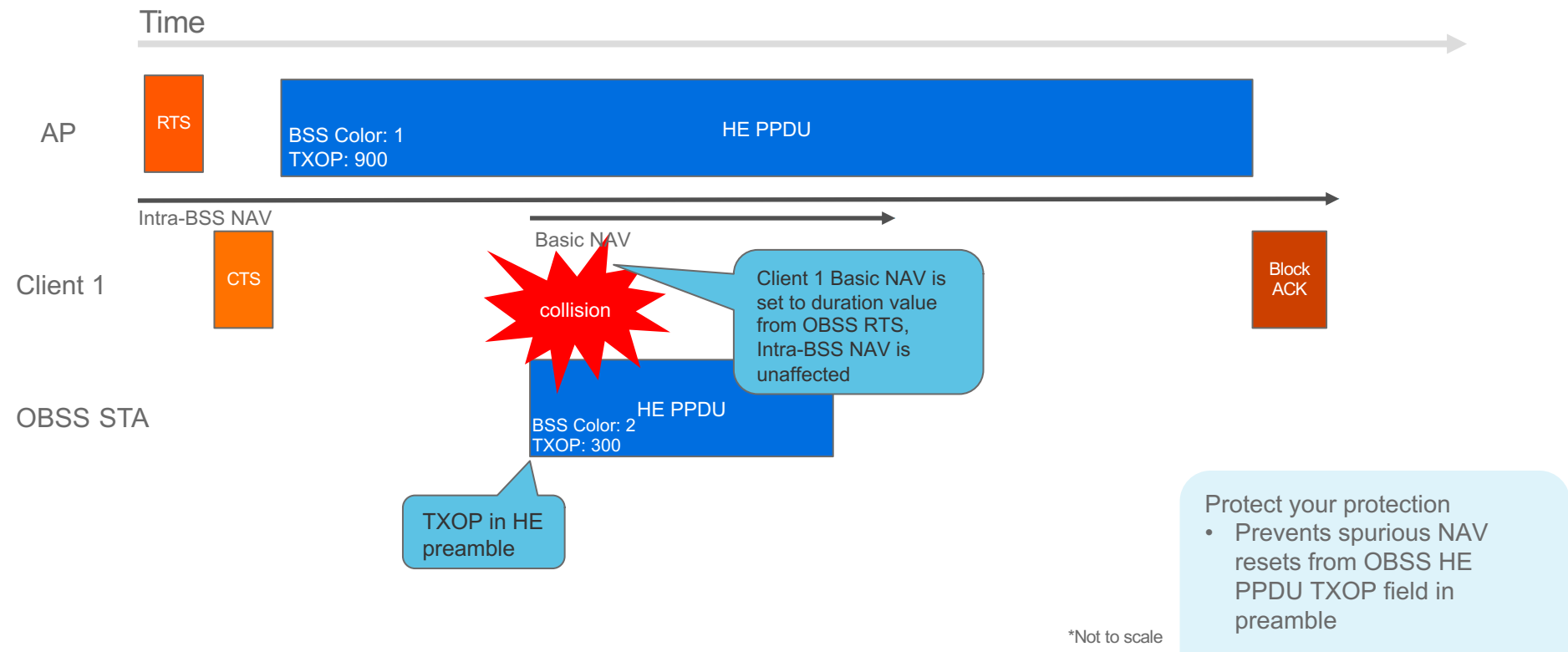
# Spatial Reuse Operation (SRO)



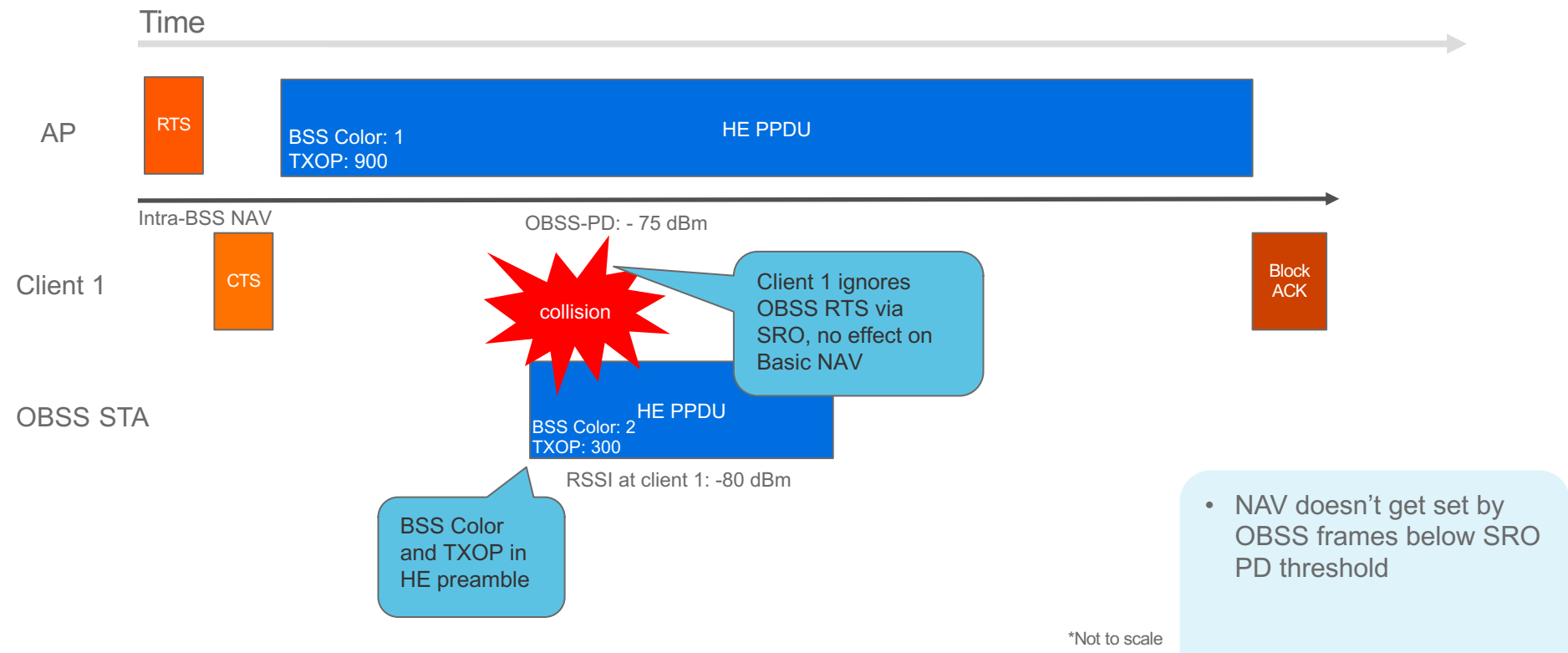
# Dual NAV



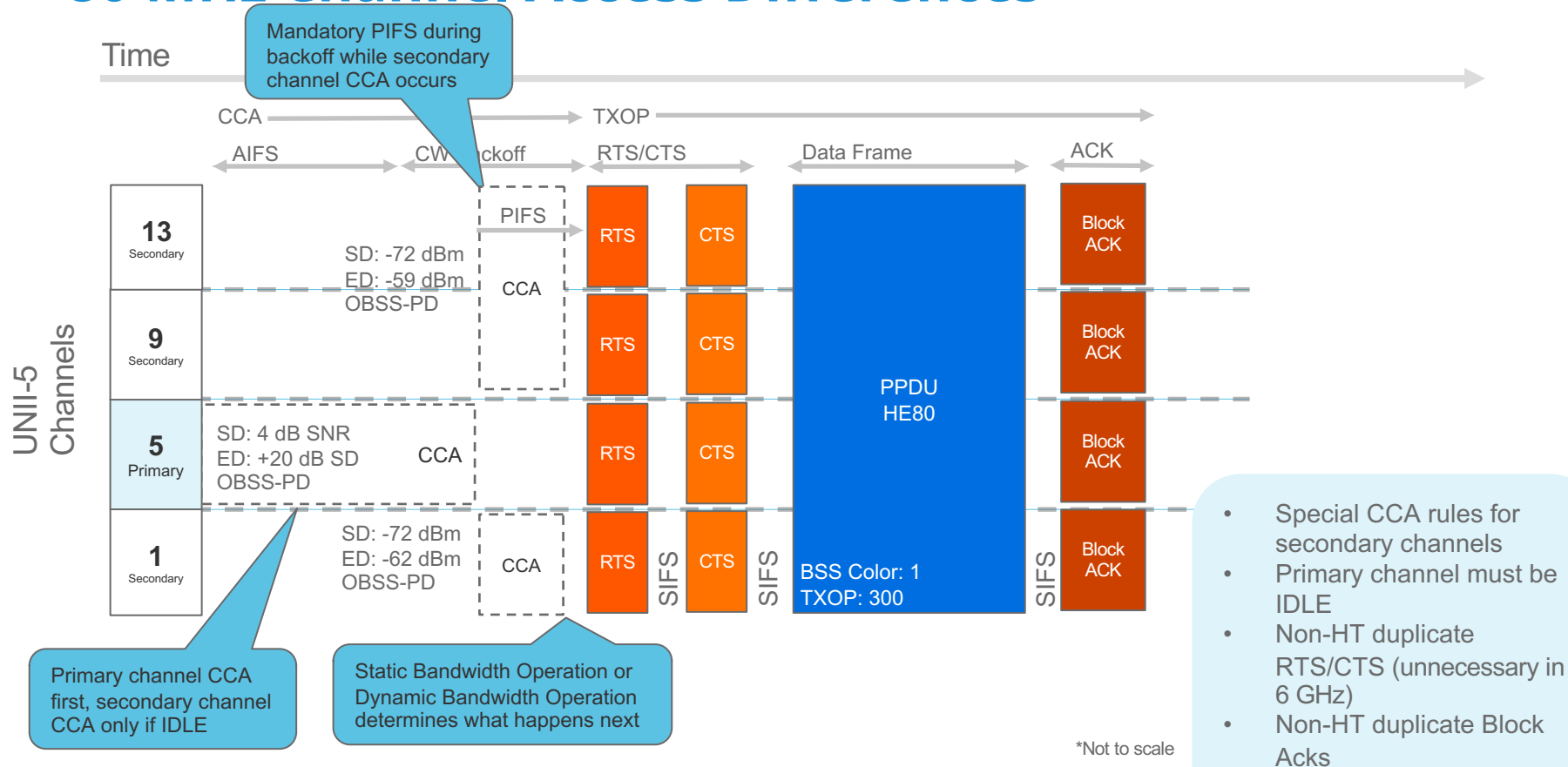
# Dual NAV



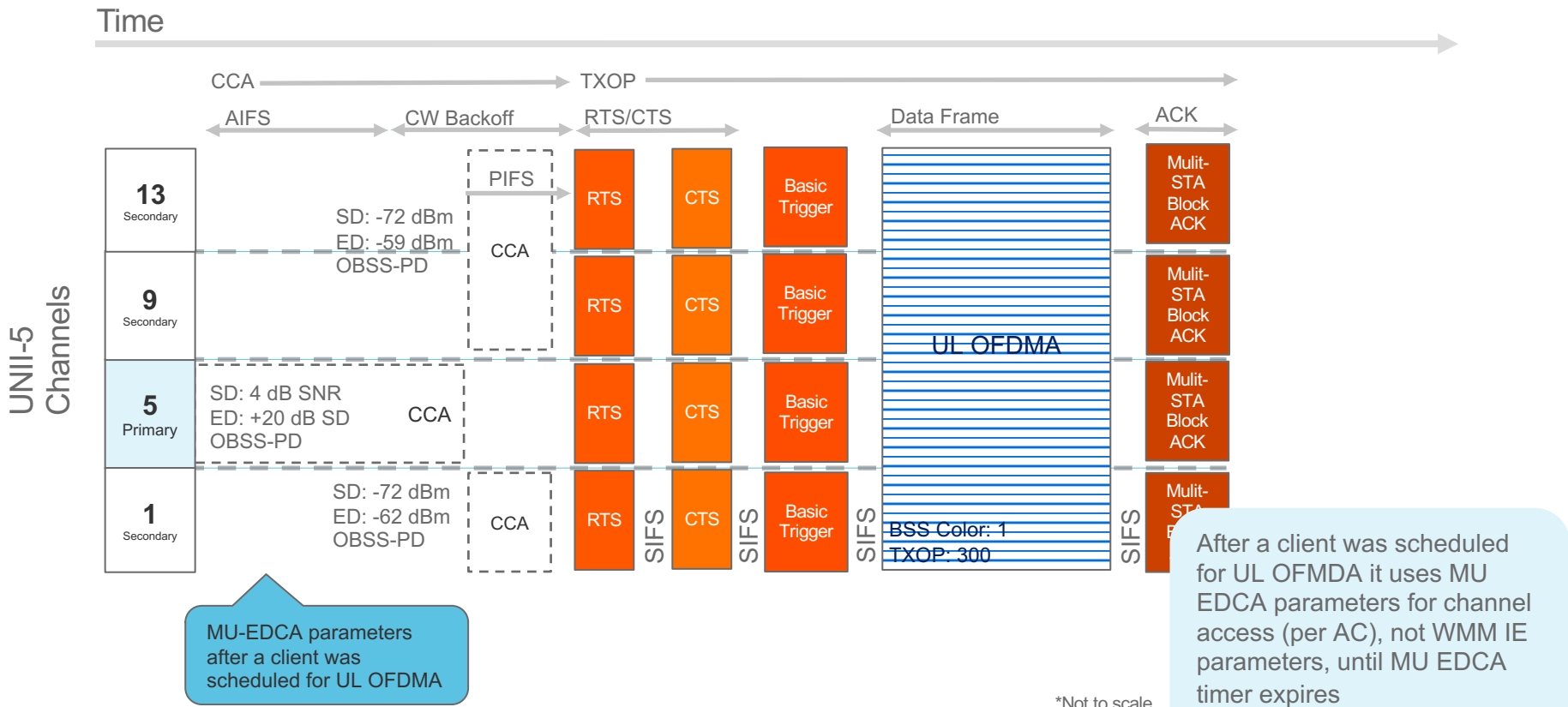
# Dual NAV & Spatial Reuse Operation



# 80 MHz Channel Access Differences



# MU-EDCA Parameters



# MU-EDCA Parameters

```
> Ext Tag: Spatial Reuse Parameter Set
< Ext Tag: MU EDCA Parameter Set
  Tag Number: Element ID Extension (255)
  Ext Tag length: 13
  Ext Tag Number: MU EDCA Parameter Set (38)
  > QoS Information (AP): 0x00
  < MUAC_BE Parameter Record
    < AIC/AIFSN: 0x08
      .... 1000 = AIFSN: 8
      ...0 .... = Admission Control Mandatory: No
      .00. .... = ACI: Best Effort (0)
      0... .... = Reserved: 0
      ECWmin/ECWmax: 0xa9 (9/10)
      MU EDCA Timer: 0xff (255 x 8 TU = 261 ms)
    > MUAC_BK Parameter Record
    > MUAC_VI Parameter Record
    > MUAC_VO Parameter Record
  < Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
    Tag Number: Vendor Specific (221)
    Tag length: 24
    OUI: 00:50:f2 (Microsoft Corp.)
    Vendor Specific OUI Type: 2
    Type: WMM/WME (0x02)
    WME Subtype: Parameter Element (1)
    WME Version: 1
    > WME QoS Info: 0x80
    Reserved: 00
  < Ac Parameters ACI 0 (Best Effort), ACM no, AIFSN 3, ECWmin/max 4/10 (CWmin/max 15/1023), TXOP 0
    < ACI / AIFSN Field: 0x03
      .... 0011 = AIFSN: 3
      ...0 .... = Admission Control Mandatory: No
      .00. .... = ACI: Best Effort (0)
      0... .... = Reserved: 0
    > ECW: 0xa4
    TXOP Limit: 0
```

MUAC\_BE parameters usually require longer AIFS and CW than WMM AC\_BE

After a client was scheduled for UL OFMDA it uses MU EDCA parameters for channel access (per AC), not WMM IE parameters, until MU EDCA timer expires

# MU-EDCA Parameters

```
> Ext Tag: HE Operation
  > Ext Tag: MU EDCA Parameter Set
    Tag Number: Element ID Extension (255)
    Ext Tag length: 13
    Ext Tag Number: MU EDCA Parameter Set (38)
  > QoS Information (AP): 0x00
  > MUAC_BE Parameter Record
    > AIC/AIFSN: 0x00
      .... 0000 = AIFSN: 0
      ...0 .... = Admission Control Mandatory: No
      .00. .... = ACI: Best Effort (0)
      0... .... = Reserved: 0
      ECWmin/ECWmax: 0xa4
      MU EDCA Timer: 0x08
    > MUAC_BK Parameter Record
      > AIC/AIFSN: 0x20
        .... 0000 = AIFSN: 0
        ...0 .... = Admission Control Mandatory: No
        .01. .... = ACI: Background (1)
        0... .... = Reserved: 0
        ECWmin/ECWmax: 0xa4
        MU EDCA Timer: 0x08
    > MUAC_VI Parameter Record
      > AIC/AIFSN: 0x40
        .... 0000 = AIFSN: 0
        ...0 .... = Admission Control Mandatory: No
        .10. .... = ACI: Video (2)
        0... .... = Reserved: 0
        ECWmin/ECWmax: 0x43
        MU EDCA Timer: 0x08
    > MUAC_VO Parameter Record
```

MU EDCA AIFSN = 0, no EDCA is allowed for that AC until timer expires (64 ms)

6 GHz only has HE clients, so we can be more aggressive with MU EDCA parameters to increase channel access for AP scheduled TXOP's



# Channel Access Complexity

- More time spent checking, more opportunity to be blocked
- More channels to check, more opportunity to be blocked
- OBSS band aids don't change WLAN design fundamentals
- **Good design is more important than ever to accommodate the increase in channel access complexity**



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Special thanks to Gjermund Raaen, Josh Schmelzle, and David Rice

Slides available on Twitter @7SIGNAL