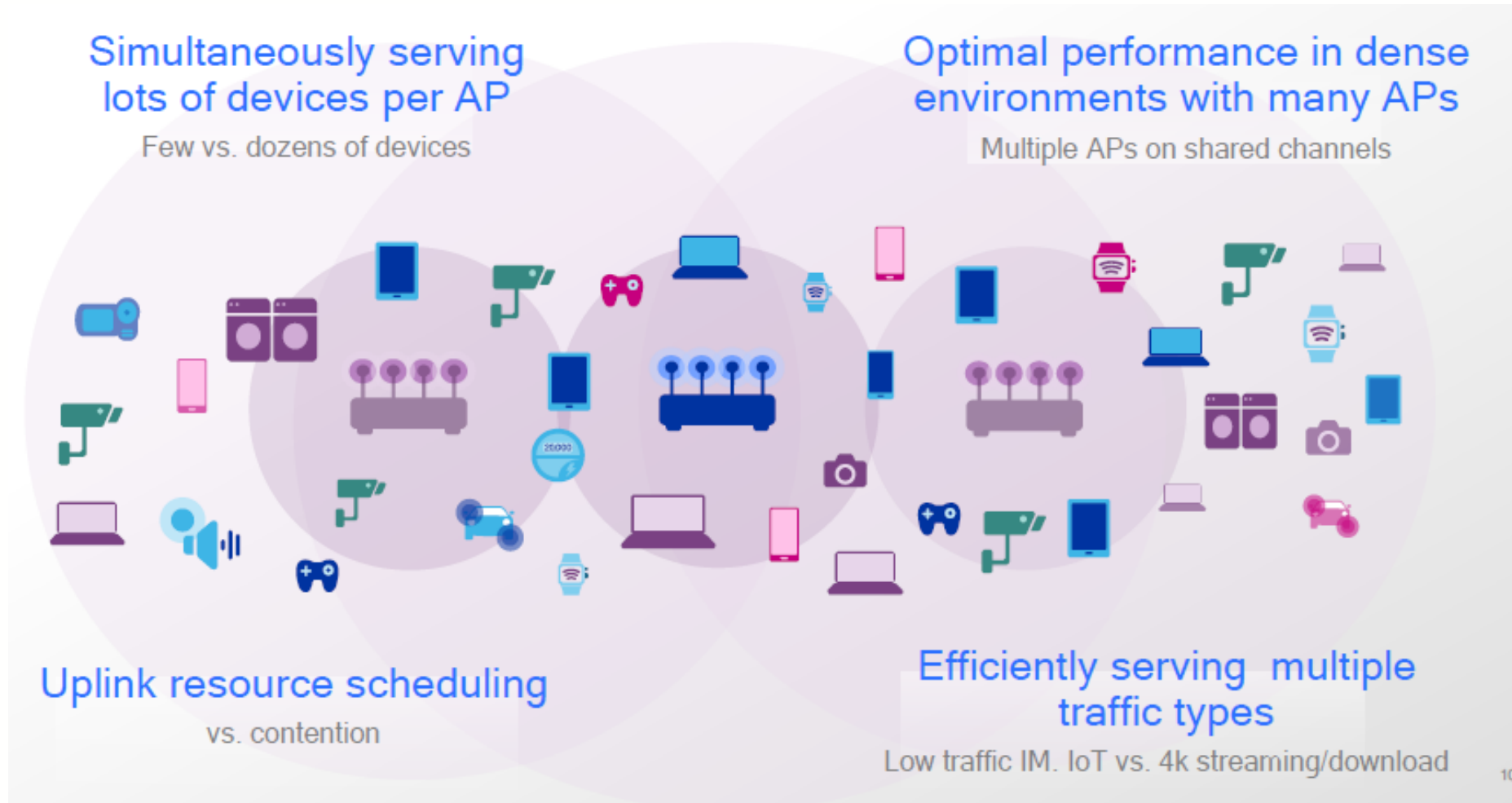


# 802.11ax: High Efficiency WLAN

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# 802.11ax Requirements



Source: Qualcomm

# 802.11ax Enhancements

## Spectral Efficiency

- 1024-QAM
- 8x8 MIMO
- Longer OFDM Symbol

## High Density

- OFDMA
- Spatial Reuse

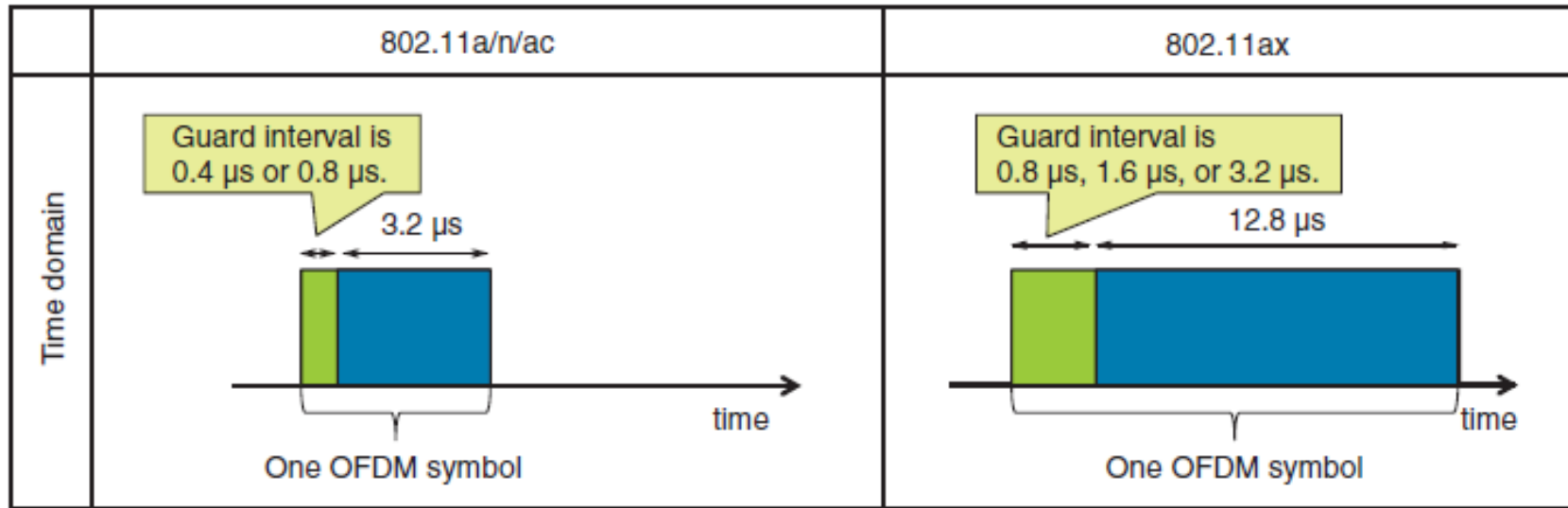
## Long Range

- Longer Cyclic Prefix

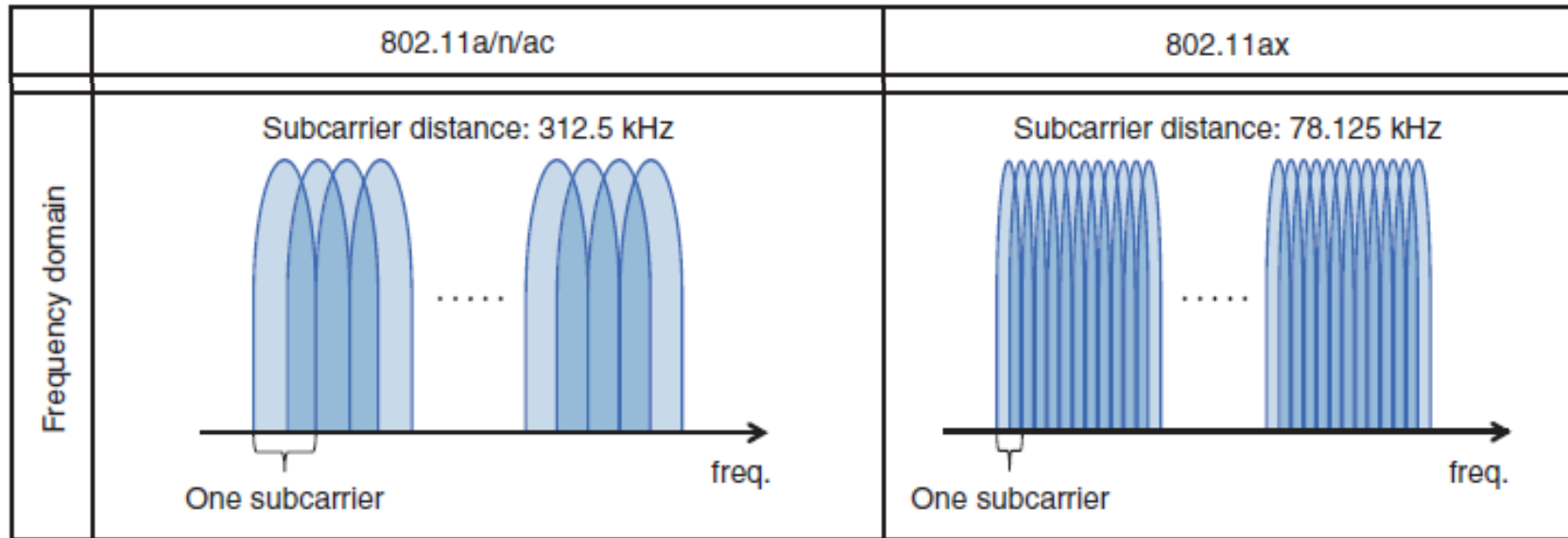
## Power Save

- Scheduled sleep and wake times

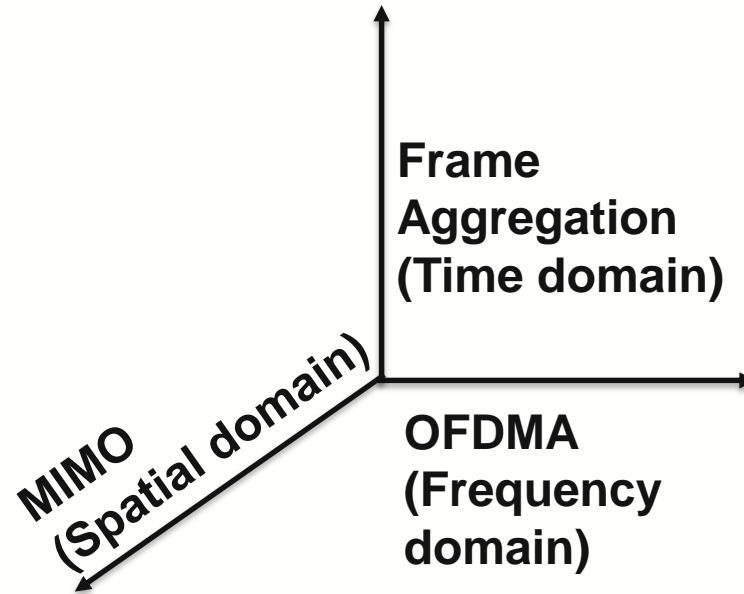
# Symbol Duration



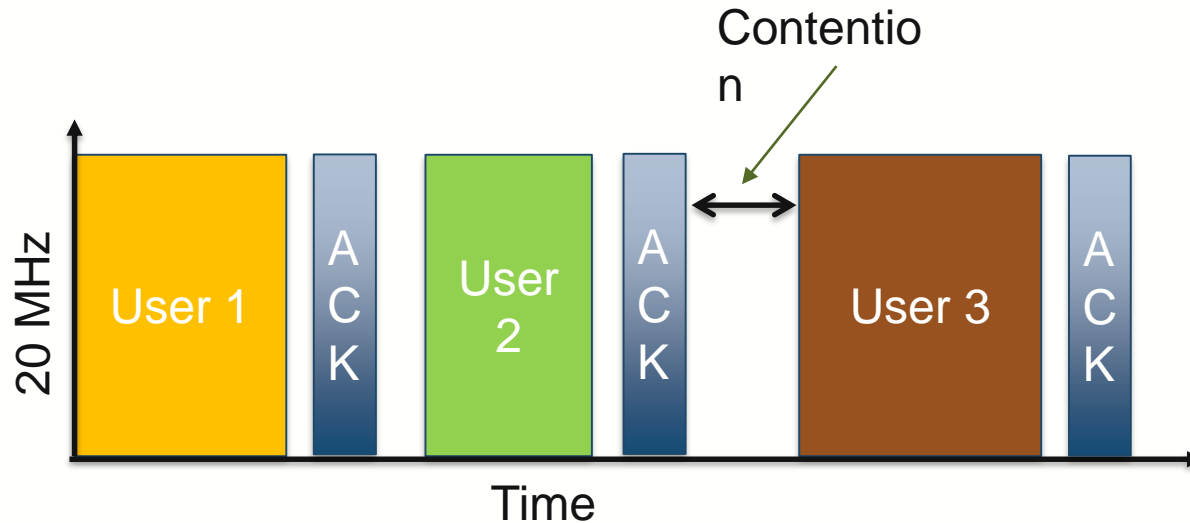
# Sub-carrier Spacing



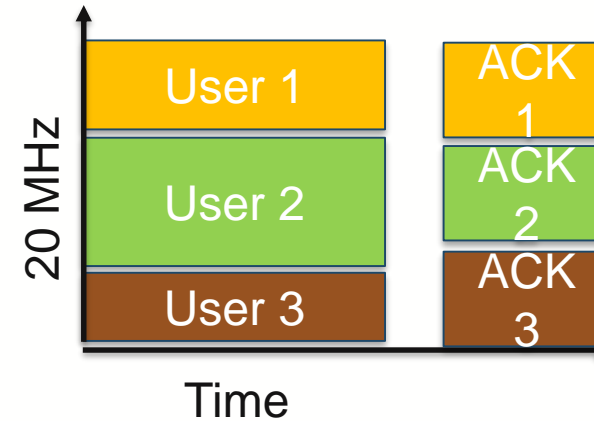
# OFDMA



# OFDM vs OFDMA



- **Fixed overhead independent of payload size**
- **Uses full channel bandwidth per user**



- **Overhead amortized among users**
- **Efficient use of resources**
- **Scales resources for different types of traffic (e.g. IM vs large download)**
- **Increases overall efficiency**

# OFDMA

## Downlink OFDMA

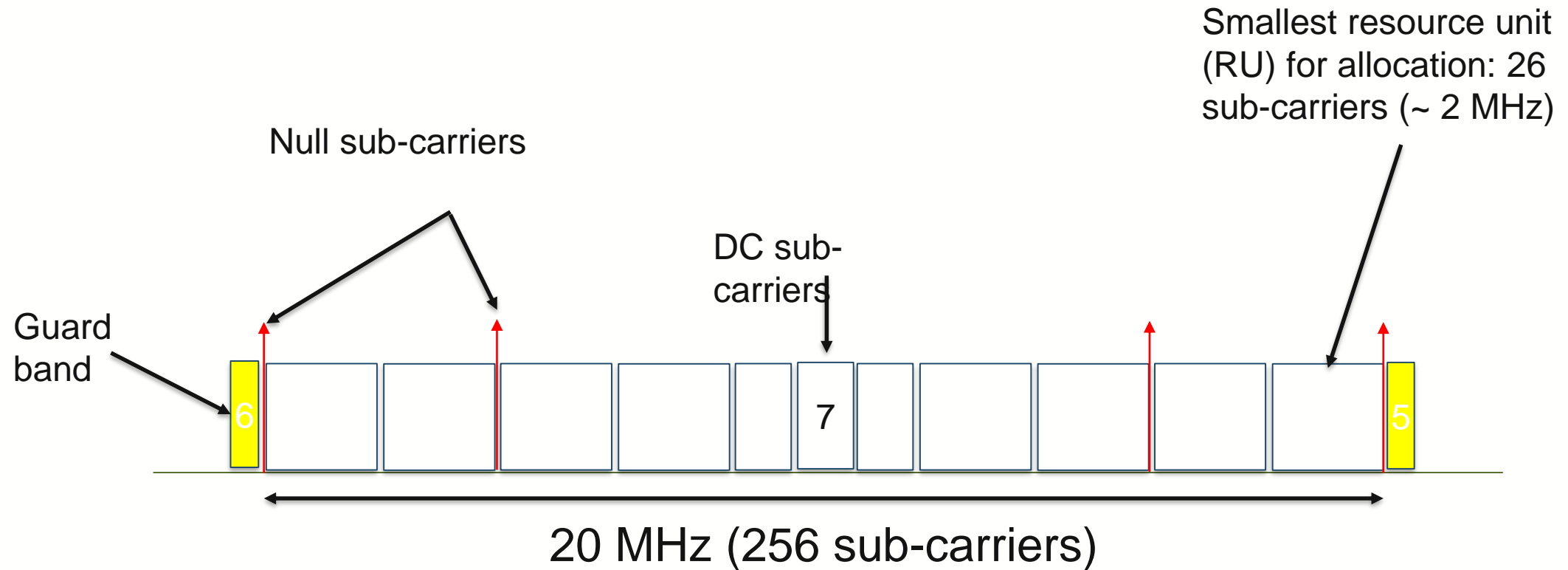
- AP groups users to maximize downlink transmission efficiency

## Uplink OFDMA

- Users are grouped together and transmit in sync to AP to maximize uplink transmission efficiency



# Resource Units

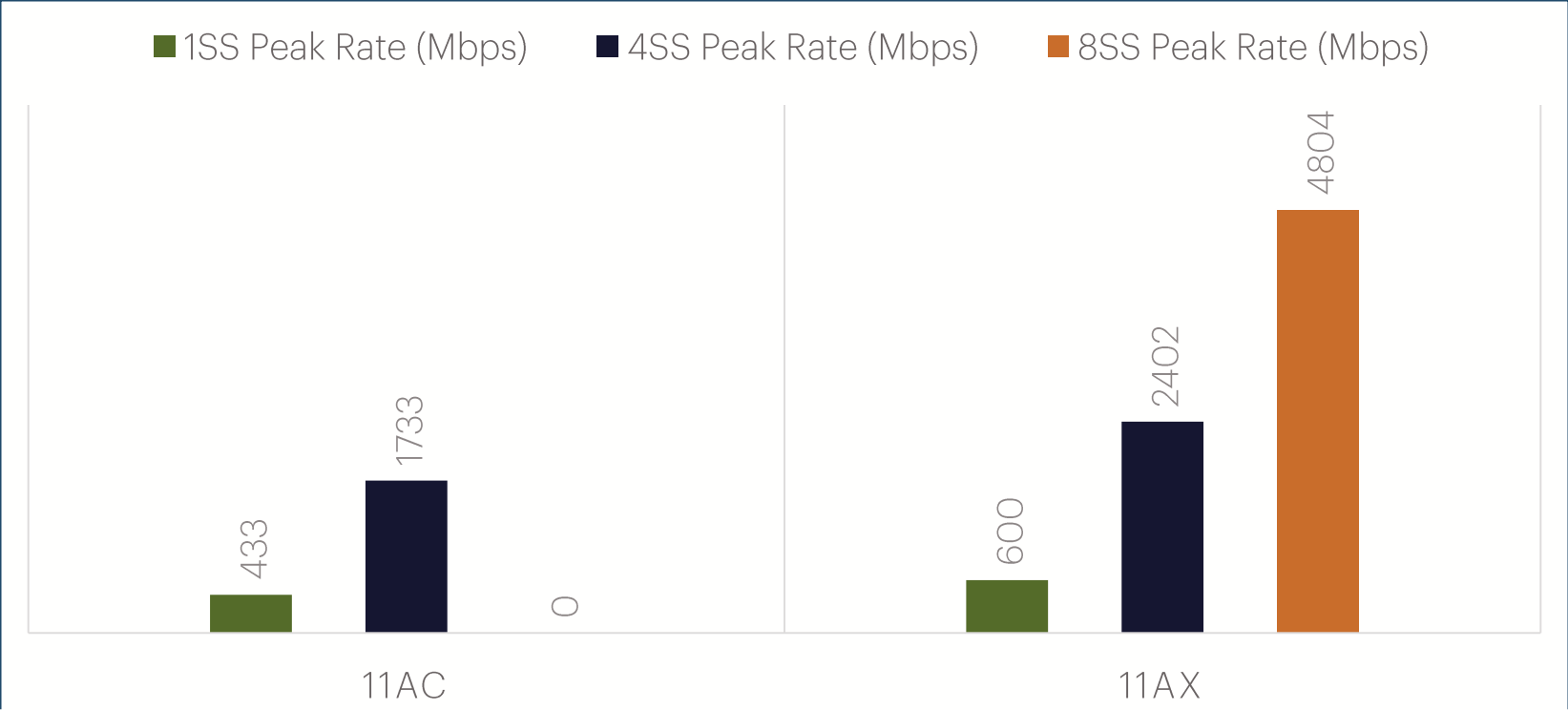


# RU per Bandwidth

RU type	CBW20	CBW40	CBW80	CBW160 and CBW80+80
26-subcarrier RU	9	18	37	74
52-subcarrier RU	4	8	16	32
106-subcarrier RU	2	4	8	16
242-subcarrier RU	1 SU/ MU-MIMO	2	4	8
484-subcarrier RU	N/A	1 SU/ MU-MIMO	2	4
996-subcarrier RU	N/A	N/A	1 SU/ MU-MIMO	2
2x996 subcarrier RU	N/A	N/A	N/A	1-SU/ MU-MIMO

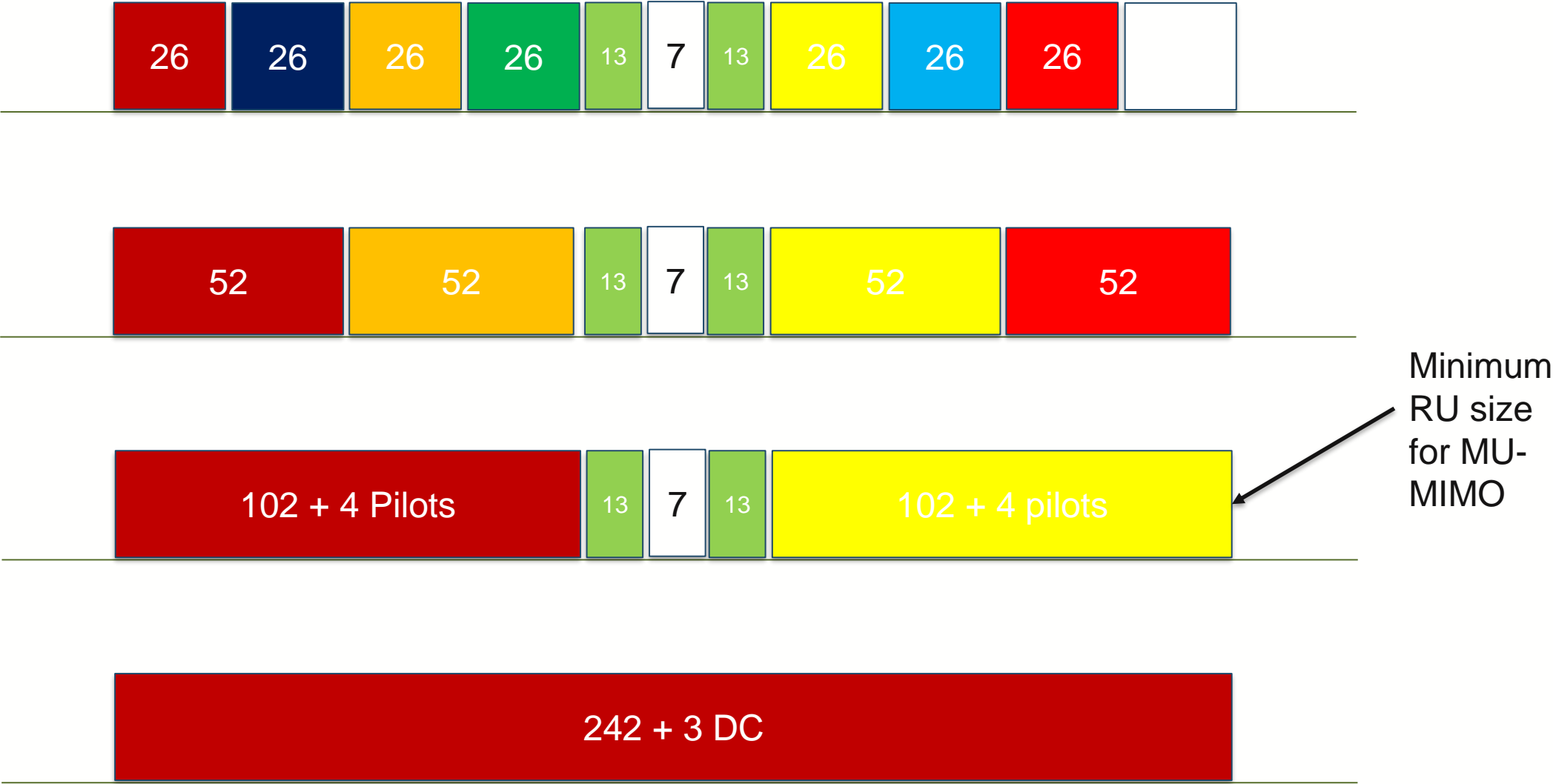
Source: Agilent

# Peak Rate Calculation

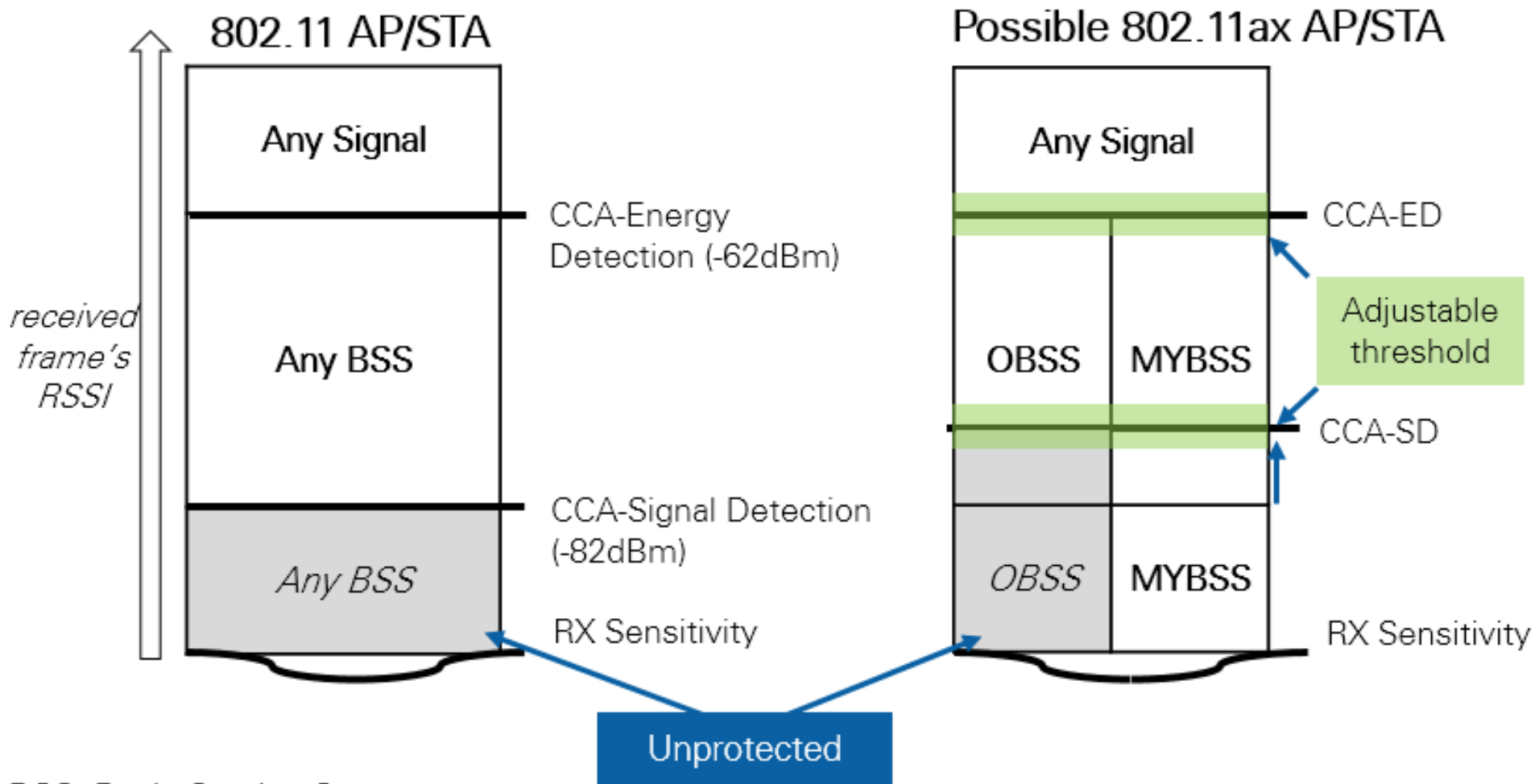


Standard	BW (MHz)	Data Sub-carriers	Max bits per Symbol	Code Rate	Data bits per sub-carrier	OFDM Symbol Duration (us)	1SS Peak Rate (Mbps)	4SS Peak Rate (Mbps)	8SS Peak Rate (Mbps)
11ac	80	234	8	5/6	6.67	3.6	433	1733	NA
11ax	80	980	10	5/6	8.333333	13.6	600	2402	4804

# Resource Allocation



# Spatial Reuse



BSS: Basic Service Set  
OBSS: Overlapping BSS

Source: NI