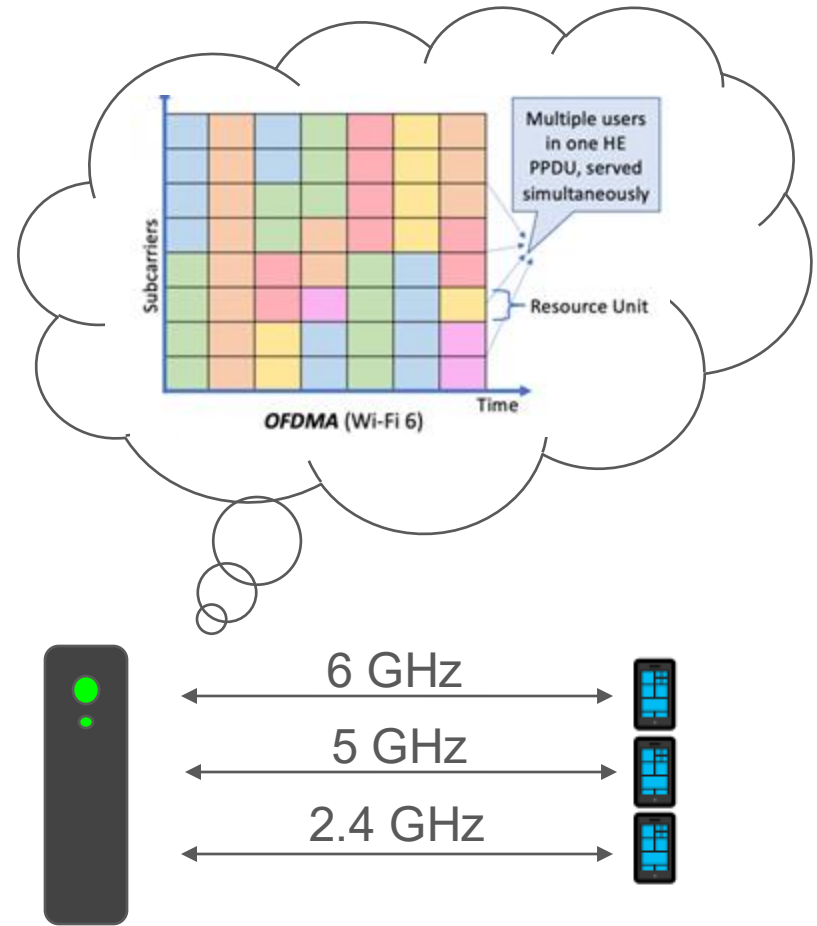# WiFi 7 - Casual Overview

Nishant Sheikh

Setting the Stage

- We have 3 bands: 2.4, 5, 6 GHz
- OFDMA: router controls scheduling
- Channels split into Resource Units (RUs) for better utilization

6 GHz

5 GHz

2.4 GHz

How can we improve things?

Better data rate?

- More frequency bands
- Wider channel width
- Denser modulation
- More spatial streams
- What else? Think outside the box

Better channel utilization?

- Big improvements with WiFi 6 OFDMA, but can we do better?
- What if a section if my channel is blocked?
- Is channel still underutilized?

How can we improve things?

Better data rate?

- More frequency bands
  - Not allowed...
- Wider channel width
  - More bandwidth available
- Denser modulation
  - More bits/symbol
- More spatial streams
  - More link capacity
- What else? Think outside the box

Better channel utilization?

- Big improvements with WiFi 6 OFDMA, but can we do better?
- What if a section if my channel is blocked?
  - Can we work around it?
- Is channel still underutilized?
 - If we are clever with RUs, what can we do?

WiFi 7 headliner features

- Multi-Link Operation (MLO)
- Multi-Resource Unit (multi-RU)
- Multi-RU puncturing
- General improvements
  - Wider channels
  - More MCS levels
  - More MIMO streams
  - etc.

Image: from a WiFi 7 card on Amazon

WiFi 7 MLO

- You can use multiple links to communicate with a pair of devices!
- Different configurations possible
- Capabilities vary from device to device
- What can we do with this?

6 GHz

5 GHz

2.4 GHz
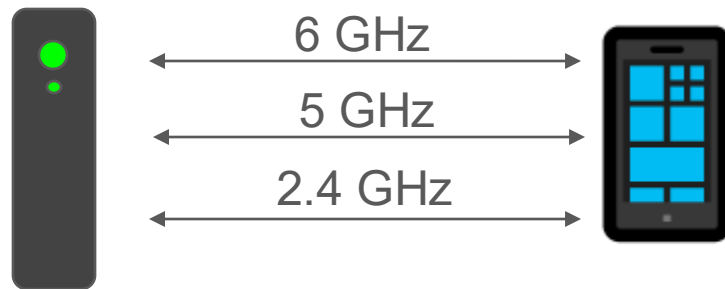
WiFi 7 MLO - how could we use this?

- Sending more data
  - Simultaneously send on multiple links
- Simultaneous Tx/Rx
  - Send on one link, listen on another
- Pick band based on task
  - Demanding tasks get higher data rate?
- Pick band based on channel conds
  - If one band is slammed, use another
- Redundant transmission
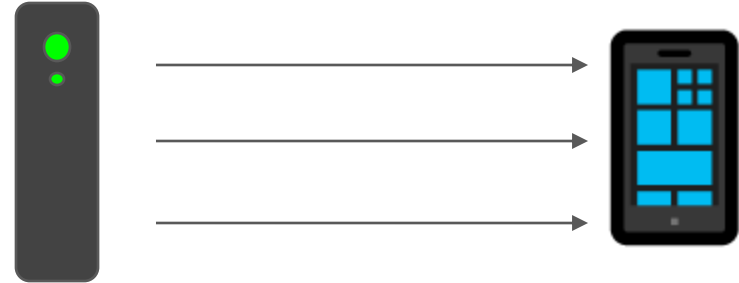- What do you think?

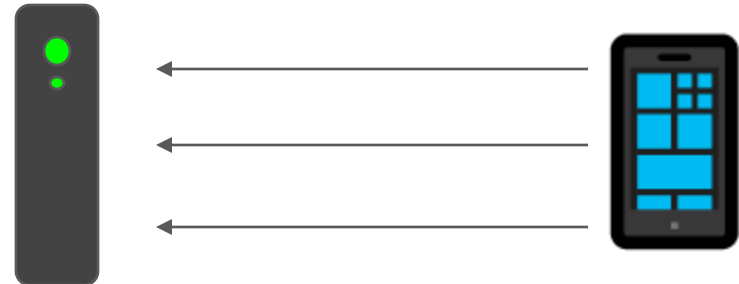# MLO w/ multiple radios: Multi Link Multiple Radio (MLMR)

STR: Simultaneous Tx & Rx
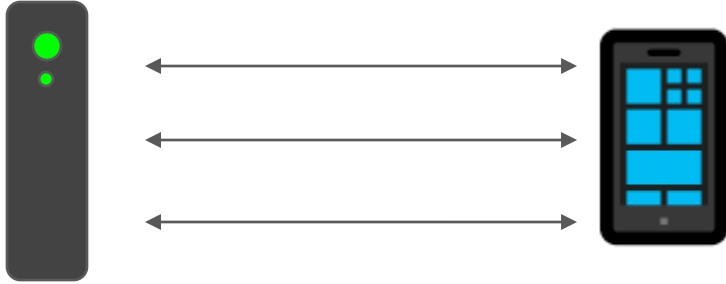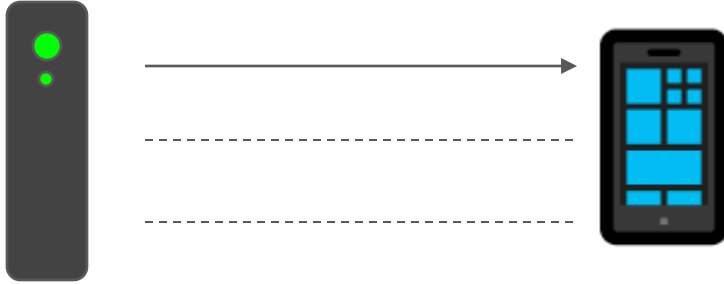
NSTR: Non-Simultaneous Tx & Rx

OR

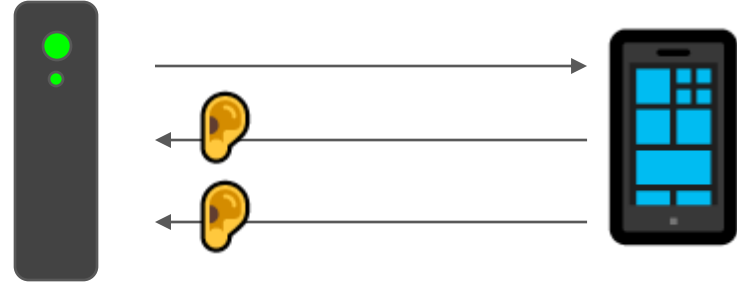# MLO w/ single radio - Multi Link Single Radio (MLSR)

MLSR: Multi Link Single Radio

E-MLSR: Extended MLSR

Tx or Rx on one link at a time

Tx on one link
Rx on (up to) two

Preamble puncturing

- Now required in WiFi 7
- Lets you "snip out" sections of channel which are in use
    - For example, by radar
- Don't need perfectly contiguous channel
- However:
    - Not supported for all channel sizes
    - May not be available on all bands
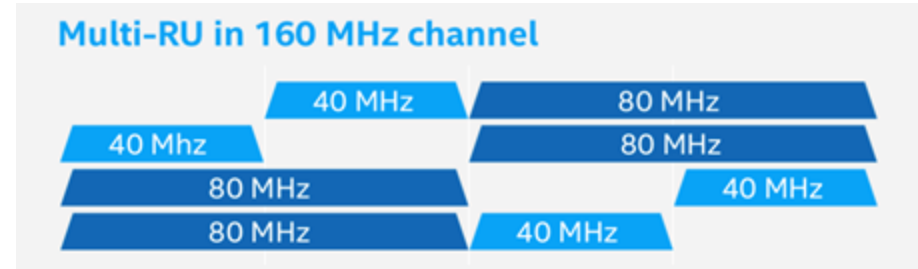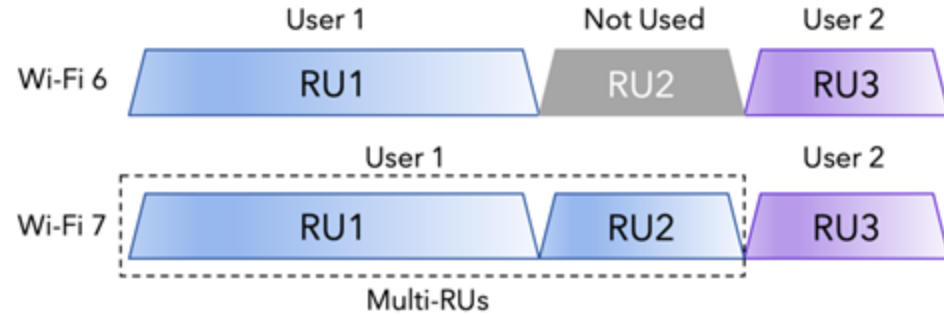

With Multi-RU Puncturing ⋇

Interferences
Usable

Without Multi-RU Puncturing ⋇

Interferences
Wasted

Multi-RU

- Multiple RUs can be assigned to a single user
- Potential for greater data rate and channel utilization
- RU allocation scheme dependent on the number of users to handle, channel bandwidth, etc.

WiFi 6/7 comparison Image: https://wifivitae.com/wp-content/uploads/2023/08/multiRU-1024x355.png
160 MHz channel image: https://www.intel.com/content/dam/www/central-libraries/us/en/documents/2022-07/wifi7-features-multi-ru-puncturing-infographic-1920-1080.pdf

Expectations vs reality

- Higher MCS nice, but can it really be used outside of ideal conditions?
- More MIMO is nice, but do devices support it?
- Devices support a wide range of features
- A previous CS 439 group did a project on this!

Image: https://pics.clipartpng.com/midle/Traffic_Cone_PNG_Clip_Art-2931.png

New challenges: time for research?

- Scheduling
  - Given two multi-link devices, which channel should you send traffic down at a given time?
  - What goal should we prioritize for scheduling? Maximize throughput, minimize power, etc.
- Power usage
  - Keeping multiple radios on takes up a lot of power. When is this worth it?
  - What is the overhead for radio startup, etc.
- Can you think of any?

Obstacles

- Much of the scheduling, rate adaptation, etc. is often in the firmware!
  - Firmware is usually closed-source
  - Hard to poke at
- Development boards still have immature drivers/firmware/etc.
  - Is device functioning suboptimally due to environment or bugs?

Image: https://wiki.banana-pi.org/images/thumb/6/6a/Banana_Pi_BPI-R4_1.jpg/600px-Banana_Pi_BPI-R4_1.jpg