11ax MU-MIMO; how is it different from 11ac?

Dr. Srikanth Subramanian, CKO, Nanocell Networks

www.nanocellnetworks.com
srikanth.s@nanocellnetworks.com

**802.11ac MU-MIMO**

- AP with maximum 8 streams and STAs with single and multiple streams allowed
- Maximum of 4 streams per user
- Block ACK from each user based on individual request from AP
- Up to 8 streams allowed
- LAN/Internet

- Simultaneous transmission to a max. of 4 users possible

- Only on Downlink
Channel Sounding in 802.11ac MU beamforming

- Order of sending feedback announced; SU and MU beamforming both use this frame with minor differences
- Compressed V matrix along with other information like subcarrier level SNR can be sent; Feedback for SU and MU cases are different; MU case has extra info.

Other 802.11ac users will defer access till all feedback is received; duration set in frame
Some bandwidth is consumed for the sounding procedure

802.11ac MU-MIMO Exchange

- Different MCS & streams allowed
- Only primary user can be asked for implicit BA
- BA policy set appropriately for other users
- Sent in response to BAR from AP for each user
- Traffic to different users can belong to different QoS category
Can 11ac MU-MIMO Solve the HD problems?

Expensive sounding process; polled feedback, large sizes

Client measurements, heavy duty processing to be done quickly, potential for errors in feedback

No UL mechanisms to support sending of 802.11 and TCP ACKs efficiently

High processing load to separate user transmissions by AP; works only in certain conditions, good SNR, no mobility etc.

MU-MIMO (802.11ac)

11ac MU-MIMO not a great fit for short-packet HD use cases

MU-MIMO in 11ac - Summary

MU-MIMO only on DL and in 5 GHz only

Can support up to 4 users on DL but 4x4 preferably up to 3, 3x3 up to 2, 2x2 - none

Along with a capable AP you need at least 2 active MU-MIMO capable clients to get benefits

Access Point wave 2

Sounding; NDPA, NDP

Client 1

Work only with high SNR clients and has no impact on range/coverage

Client 2

Client n

11ac MU-MIMO ACK and Feedback processes are inefficient
### Different Modes in 802.11ax

#### SU Transmission
- OFDM + MIMO (optional)
- 20/40/80/160 MHz bandwidth
- Better OFDM (efficiency)
- Longer range support

#### MU Transmission
- MU-MIMO
- DL and UL upto 8 users
- OFDMA
- DL and UL
- Division of channel bandwidth
- Can be combined with MU-MIMO

---

### 11ax MU-MIMO; how is it different than 11ac?

- **11ax DL MU-MIMO will use UL OFDMA for ACKs**
- **11ax DL MU-MIMO will use OFDMA for getting feedback efficiently**
- **UL MU schemes can be used for transporting TCP ACKs efficiently**
- **MU-MIMO has to be used selectively to get better results; larger packets are a better fit**
Final Shape of the HE Sounding Protocol

Announce list of STAs and the type of feedback needed; STAs get ready.

STAs measure using this NDP; HE-LTFs are used for the measurement; only a PHY preamble is sent.

AP sends resource information to send the feedback; beamforming report poll.

More triggers for sending feedback in case it cannot be sent in the earlier PPDU.

DL MU-MIMO in 11ax- Data Transmission

OFDMA can be used for efficient UL ACK transmission.

No polling and unnecessary wastage of time for ACKs.

TCP ACKs from multiple users can use OFDMA for efficiency.

802.11 ACKs can come back efficiently in parallel from the multiple users.

DL MU-MIMO with OFDMA for UL ACKs is a big plus.
UL – MU-MIMO

- No feedback needed for UL–MU-MIMO
- UL MU-MIMO involves extra work at AP, but the problem of multi-user handling has similarities to multi-stream handling.
- OFDMA on UL faces synchronization challenges but potentially simpler than UL MU-MIMO
- Synchronization across users and power is the biggest challenge in UL MU

AP processing framework not very different as compared to normal MIMO

Simultaneous transmissions from multiple users using the same time and frequency resources