802.11ax: A Primer

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What's up with 802.11ax?

	Residential		Enterprise		Indoor Hotspot		Outdoor	
	DL	UL	DL	UL	DL	UL	DL	UL
SISO	22	18	25	21	20	11	11	1
STBC	24	22	25	24	24	12	12	2
SM	21	13	20	14	13	3	6	0

PHY
- 1024 QAM
- Variable TPC / CCA Thresholds (ok, its MACish too)
- UL-MU-MIMO

MAC
- DSC / dynamic uplink RTS/CTS
- July 2016 – Initial draft
- January 2018 – Mandatory Draft Review completed
- May 2018 – Initial amendment draft
- March 2019 – Completed (yeah, right) amendment
- When will chips be available?
  - 2016 for consumer
  - Late 2017 enterprise

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When will chips be available?
  2016 for consumer
  Late 2017 enterprise

Modulation
- Make waves hit "targets" that equal a bit sequence

Coding
- Error checking on Number of bits that are data
- One bit for checksum
  - 3/4 coding (75% data, 25% overhead)
  - 5/6 coding (83% data, 17% overhead)

Next generation proposed <6GHz Wi-Fi PHY and MAC improvements
Improvement focus is on high density networks
Not just a faster PHY but a better system
  .11a/g is country road
  .11n is a highway
  .11ac is a freeway
  .11ax is a freeway with onramp metering (and som   e efficient contr

RTS/CTS is like toast
  Carries a NAV time
Realistically only configurable on APs

All Wi-Fi devices play by the same rules
STA will defer (not transmit) if:
  Any RF energy above –XXdBm (energy detect)
  Any intelligent Wi-Fi signal above –XXdBm (Clear channel assessment)
    The frame contains an amount of time for all devices to wait before attempting to transmit – Called a NAV timer
If you have something to say and the medium is clear, randomize a number, wait, then transmit when you get to 0.
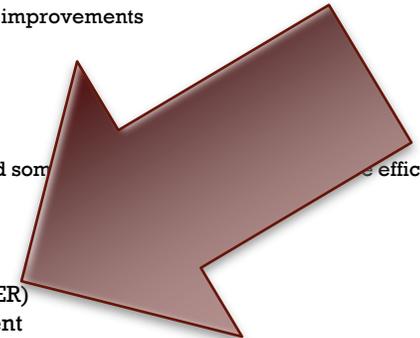
Make intelligent decisions based on Frame Error Rate (FER)
AP can instruct STA to use RTS / CTS based on environment

What's up with 802.11ax?

- 11ax At-a-Glance

- Timeline

- PHY and MAC Improvements

802.11ax At-A-Glance

- Next generation proposed <6 GHz Wi-Fi PHY and MAC improvements

- Improvement focus is on high density networks

- Not just a faster PHY but a better system
  - .11a/g is country road
  - .11n is a highway
  - .11ac is a freeway
  - .11ax is a freeway with onramp metering (and some other analogy that means more efficient control)

Timeline

- July 2016 – Initial draft

- January 2018 – Mandatory Draft Review completed

- May 2018 – Initial amendment draft

- March 2019 – Completed (yeah, right) amendment

- When will chips be available?
  - Could be by late 2016 for consumer
  - Late 2017 enterprise

Proposed Improvements

- **PHY**
  - 1024 QAM
  - Variable TPC / CCA Thresholds (ok, its MACish too)
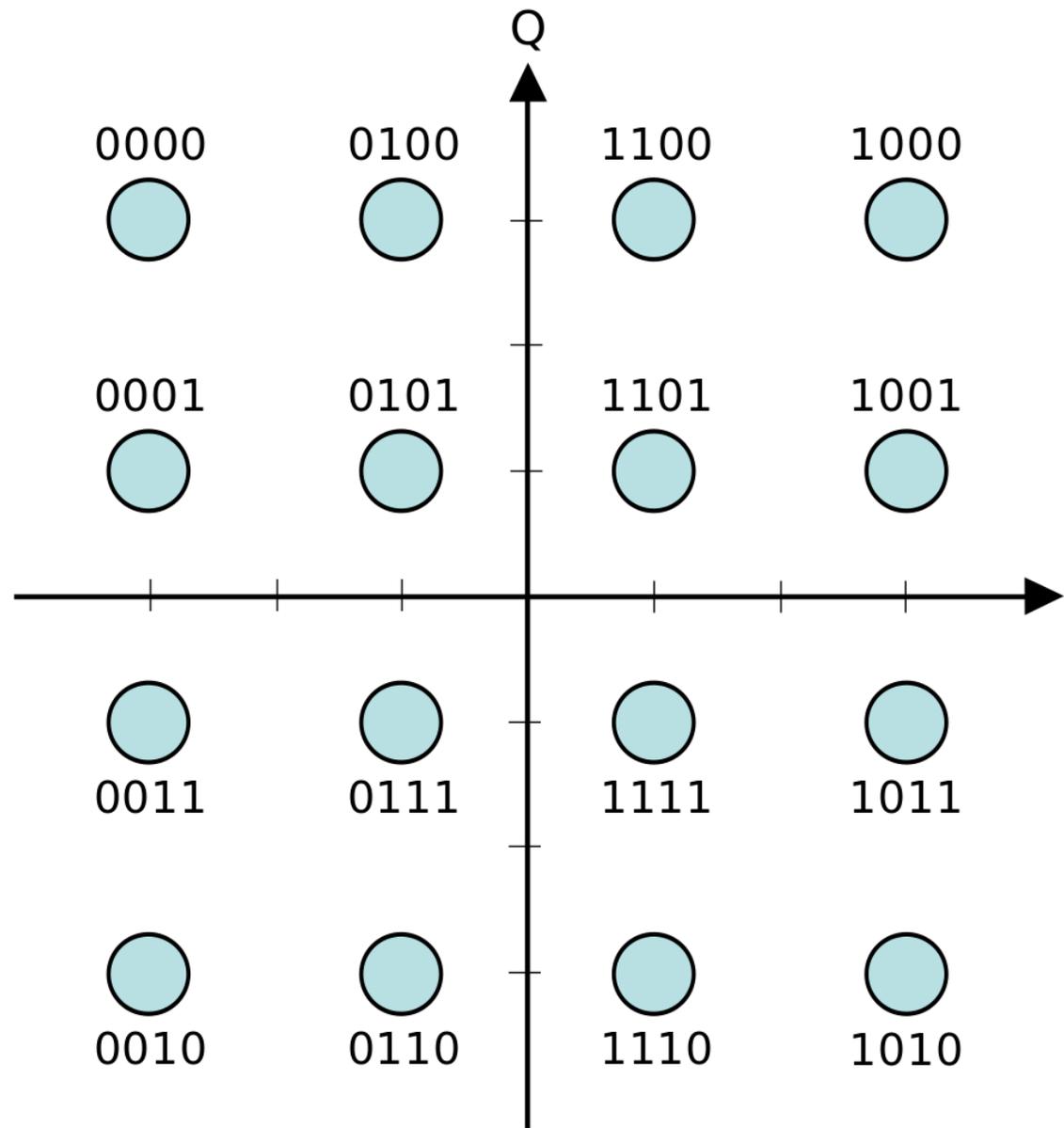 - UL-MU-MIMO

- **MAC**
  - DSC / dynamic uplink RTS/CTS

Modulation and Coding Fundamentals
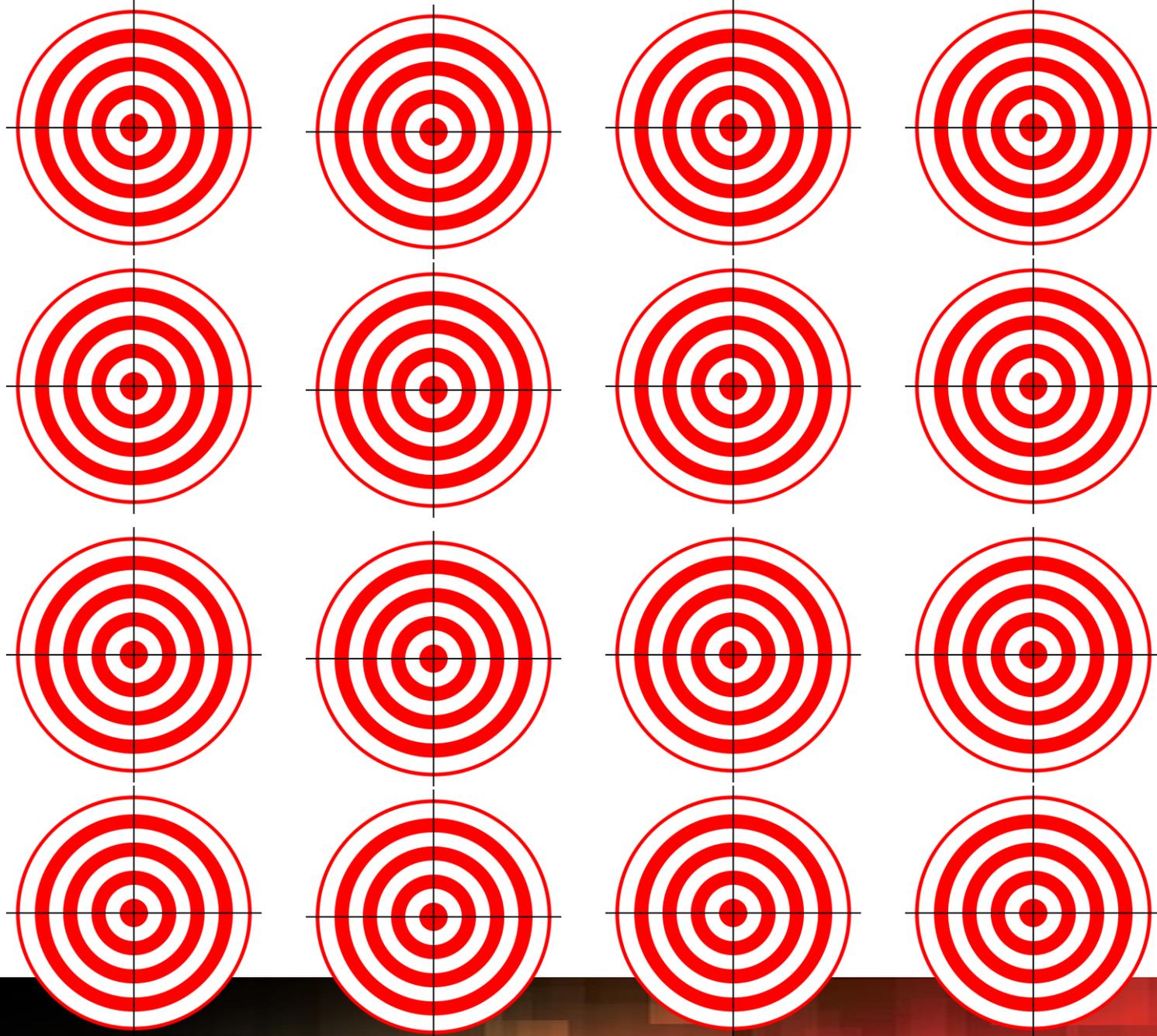
- **Modulation**
  - Make waves hit "targets" that equal a bit sequence

- **Coding**
  - Error checking on Number of bits that are data
  - One bit for checksum
    - 1/2 50% efficient
    - 2/3 66% efficient
    - 3/4 75% efficient
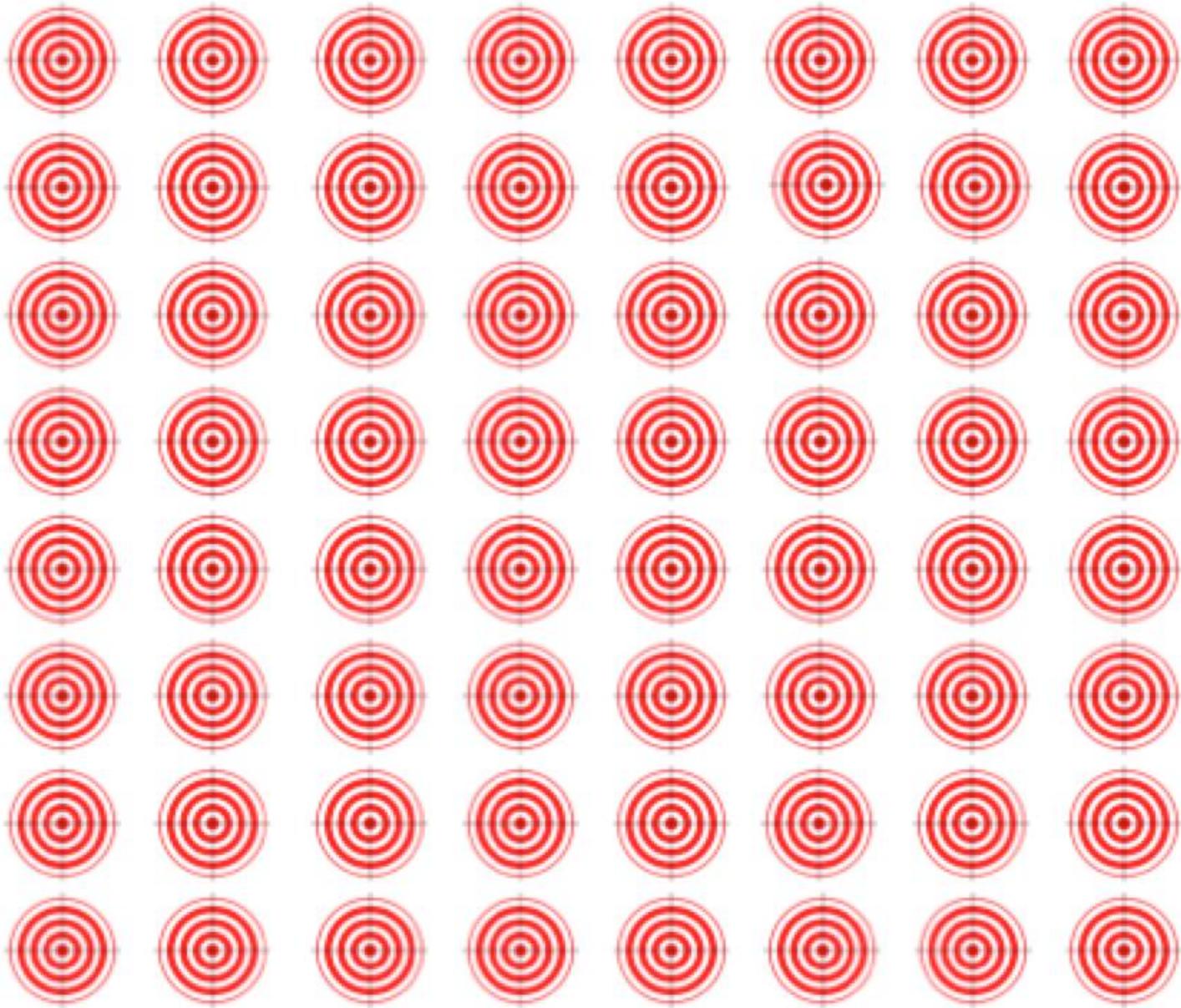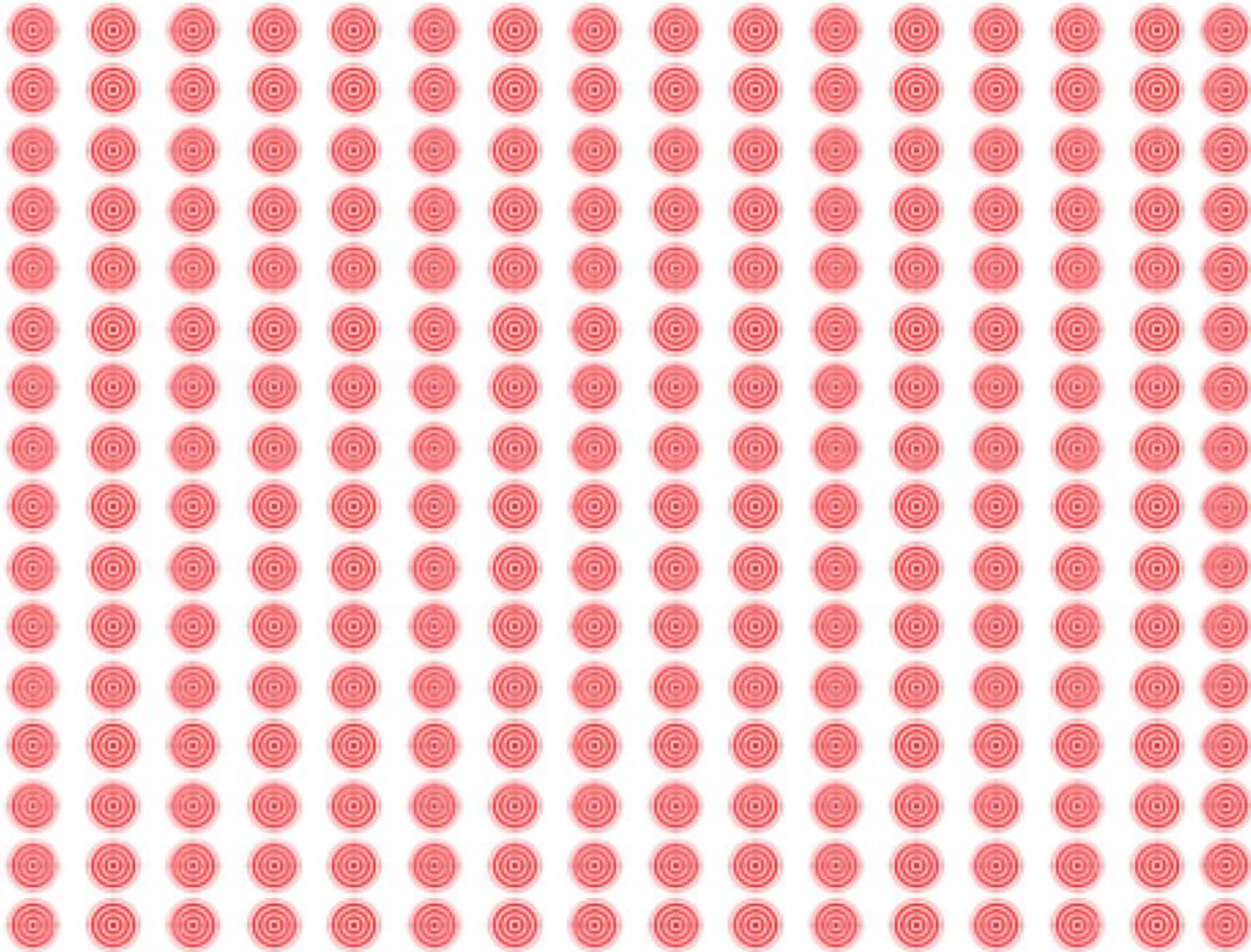   - 5/6 83% efficient

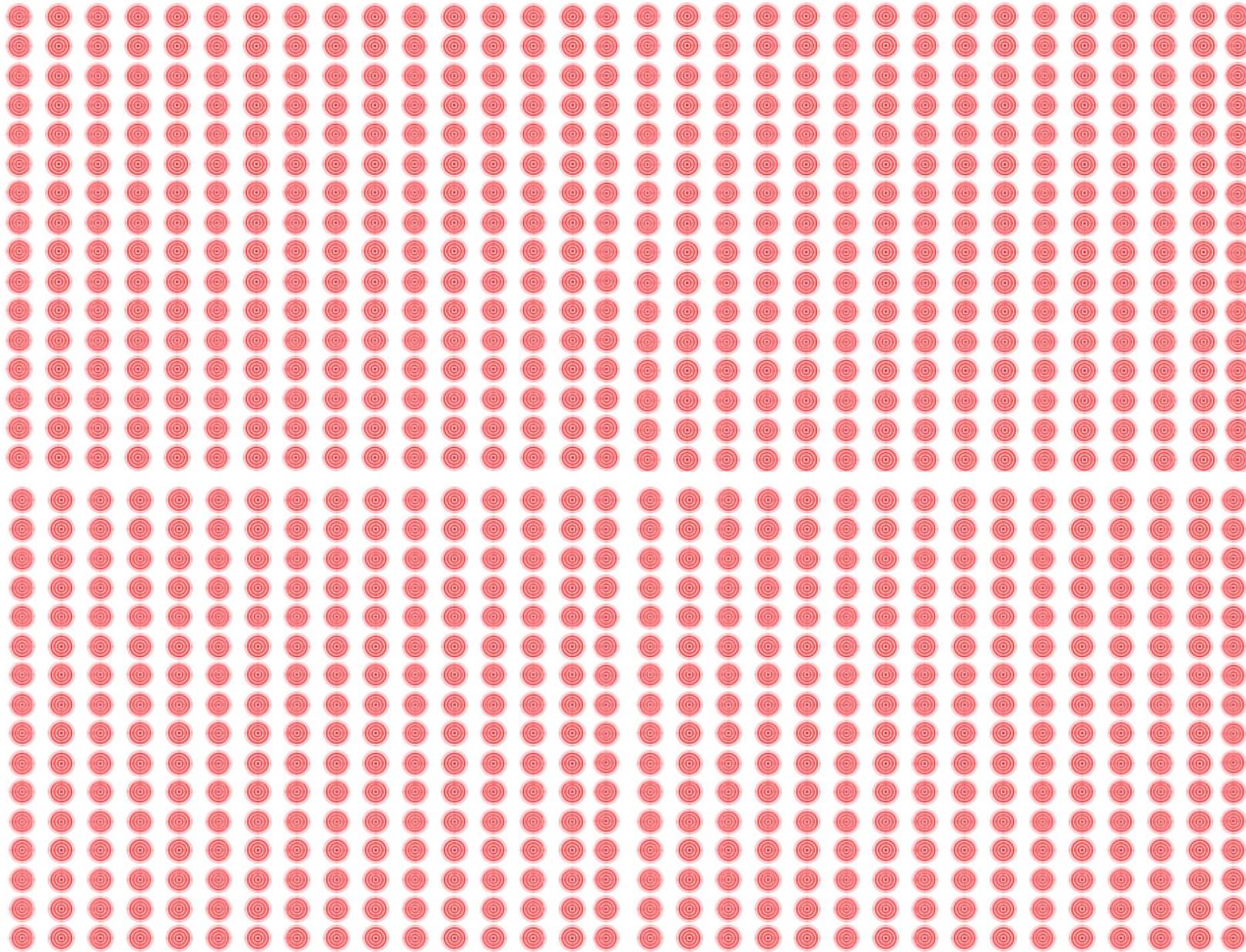4 Bits

16 QAM

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6 Bits

64 QAM

8 Bits

256 QAM

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10Bits

1024 QAM

#wifitrek

.11ax 1024 QAM – Simulated Throughput Improvements

	Residential		Enterprise		Indoor Hotspot		Outdoor	
	DL	UL	DL	UL	DL	UL	DL	UL
SISO	22	18	25	21	20	11	11	1
STBC	24	22	25	24	24	12	12	2
SM	21	13	20	14	13	3	5	0

Units in %

Proposal by: Eunsung Park, LG Electronics

MU-MIMO Decorrelation
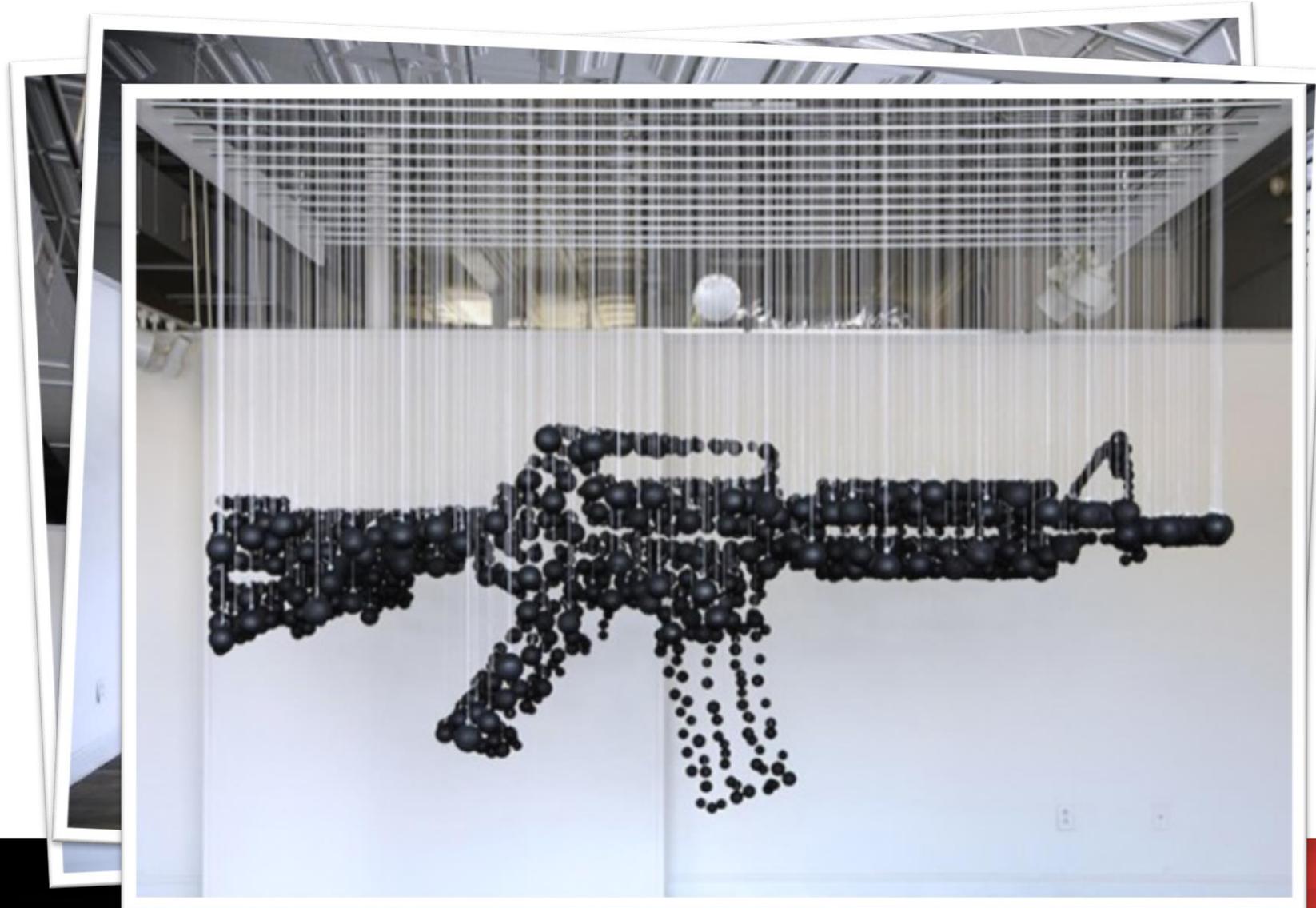
Artist
Michael
Murphy

MIMO Correlation

- MIMO has perfect decorrelated signal correlation
  - Yes, I meant to say that.

- MU-MIMO requires the AP to create decorrelation because they can't self correlate. Got that?

- UL-MU-MIMO
  - Requires sub microsecond level client Tx coordination
    - STAs provide buffer status, so AP can schedule MU uplinks
  - Like all MU-MIMO, group selection is paramount
 - STAs provide buffer status, so AP can schedule MU uplinks
  - Is it worth it?

Contention Fundamentals

- All Wi-Fi devices play by the same rules

- STA will defer (not transmit) if:
  - Any RF energy above -##dBm (energy detect)
  - Any intelligent Wi-Fi signal above -##dBm +20dB above energy detect (Clear channel assessment)
    - Most frames contain an amount of time for all devices to wait before attempting to transmit – Called a NAV timer

- Back the eff off.

Current RTS/CTS

- RTS/CTS is like toast
  - Carries a NAV time

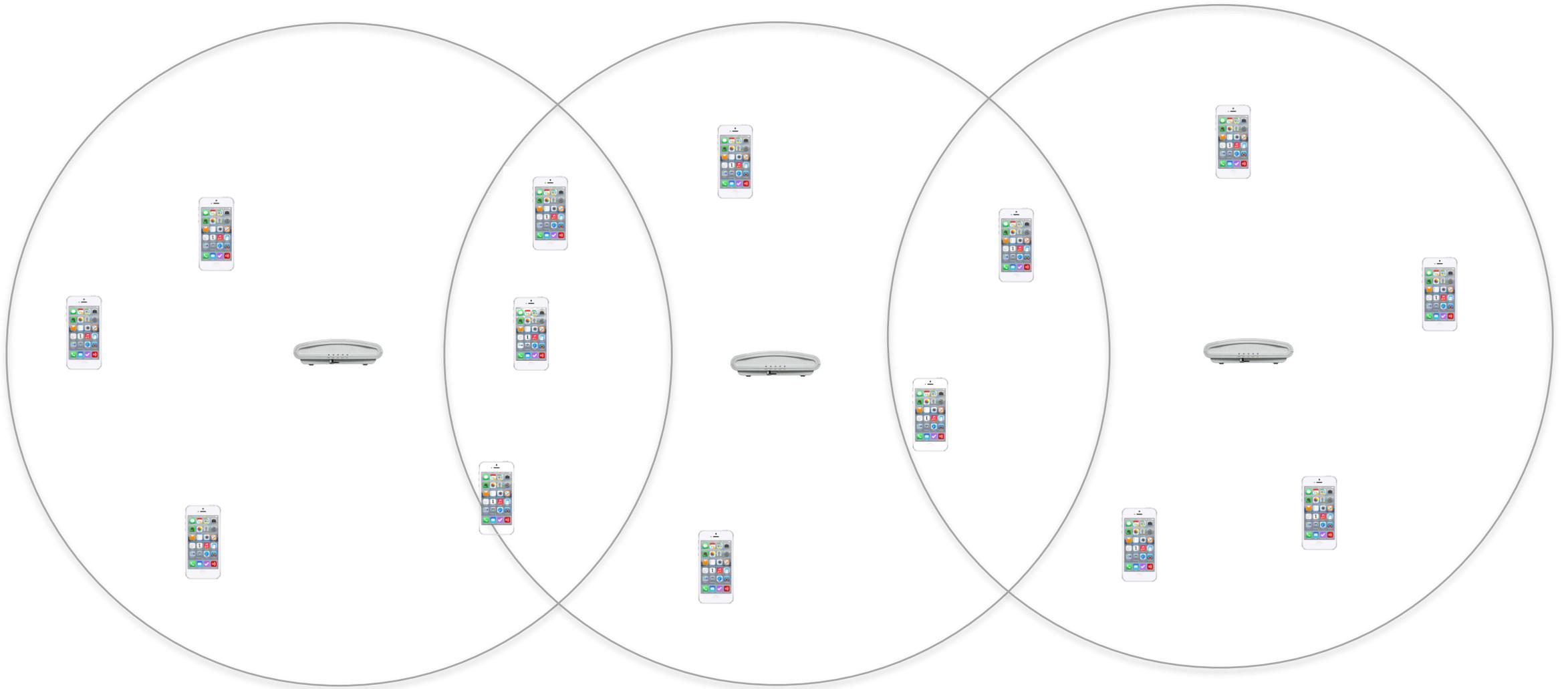- Realistically only configurable on APs
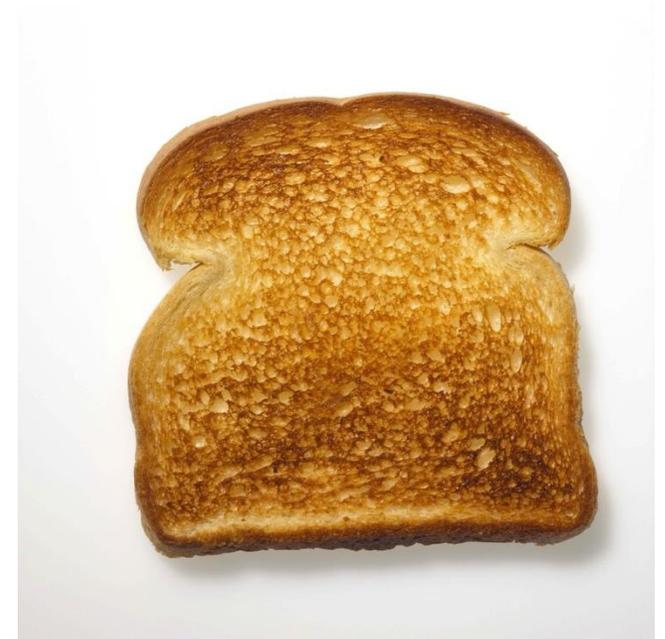
.11ax – A few MAC Notes

- RTS/CTS
  - Make intelligent decisions based on Frame Error Rate (FER)
  - AP can instruct STA to use RTS / CTS based on environment

- Variable transmit and CCA thresholds
  - Per packet adjustments
  - OBSS – Overlapping Basic Service Set

Oh, one other thing…

- Lobbying for new MIMO nomenclature

- 4x4:4
  - 4 Transmit chains
  - 4 Receive chains
  - 4 SU-spatial streams
  - But, how many MU-MIMO chains are supported?

- 4x4:4:3
  - Adds additional description for number of MU Streams

Heather said I had to give her this presentation NOW so… I guess that's it…..

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