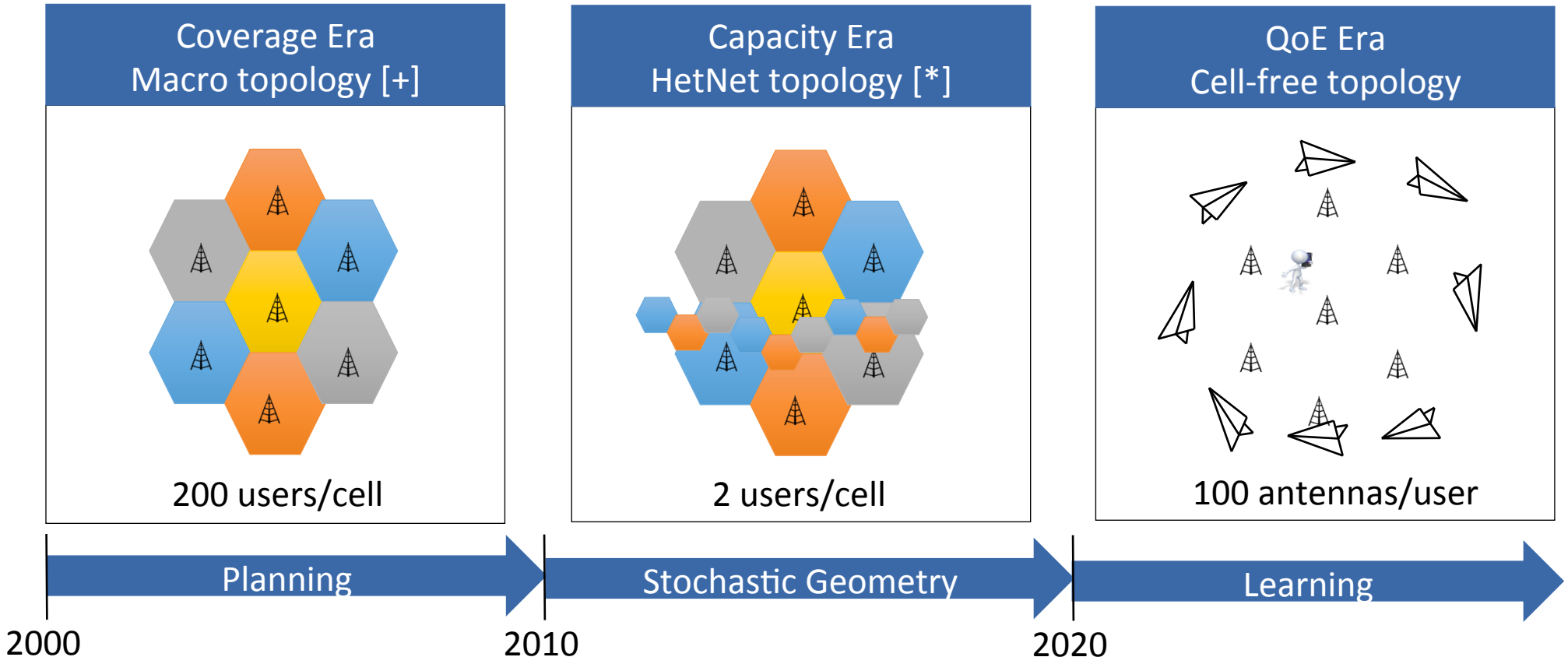
5G creativity: flexible radios in flexible network configurations

Sofie Pollin

5G and Beyond Testbed Workshop

NETWORKED SYSTEMS

Your Wireless QoS: beyond cells



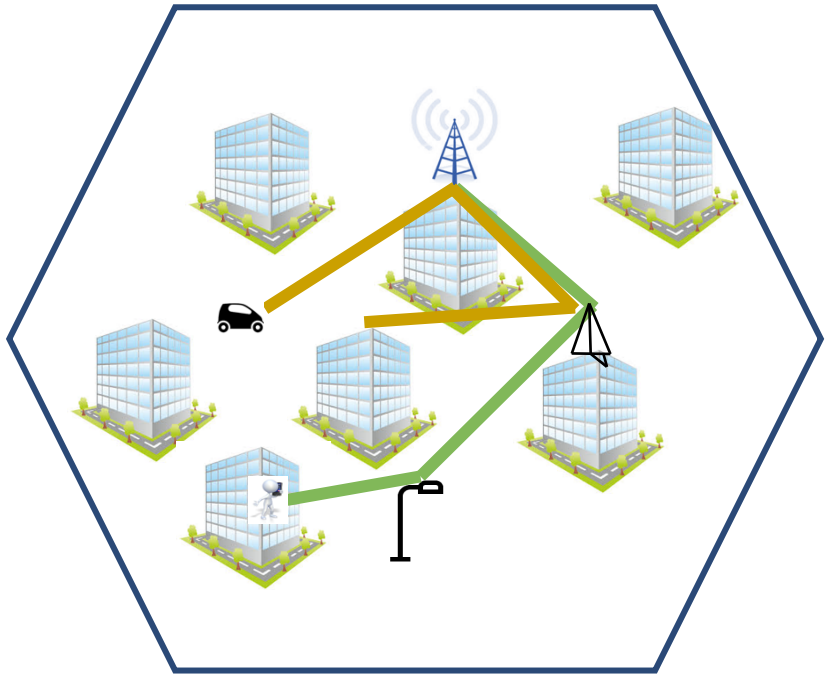
[+ Cooper's Law: capacity improvements due to densification]
[* WILL DENSIFICATION BE THE DEATH OF 5G? ,IEEE ComSoc Technology News, May 5th 2015]

Proactive and fast segment control

Share infrastructure and spectrum with 4G and WiFi

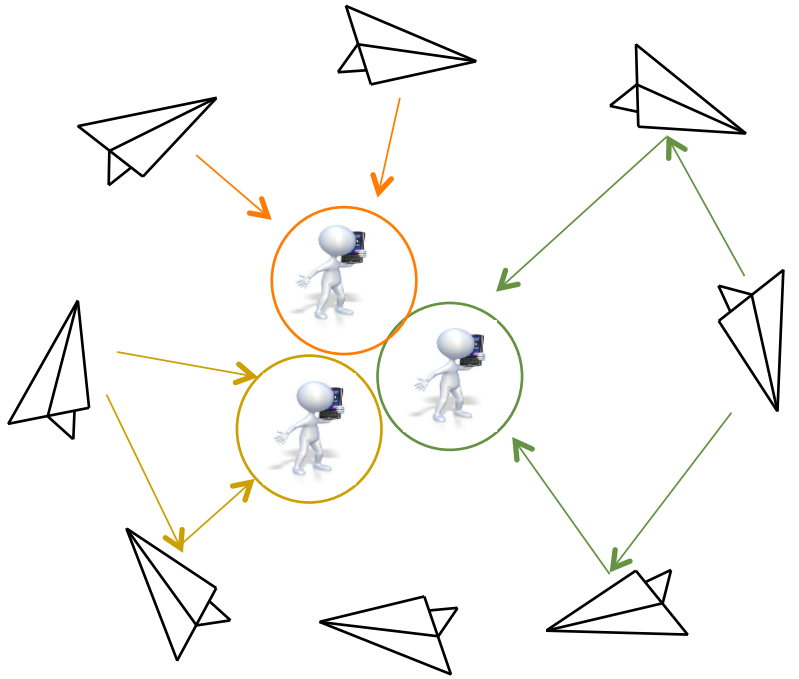
Densify infrastructure and conquer new bands

Need for cognitive n-hop wireless mesh access for dynamic multi-Gigabit service delivery



5G: personalized QoS from dense infrastructure

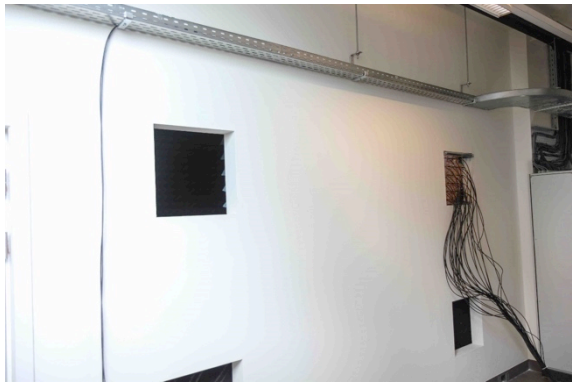
- Massive Distributed Cooperation
- Deep Cross-layer Cognitive Networking
- Fast Dedicated Learning and Control



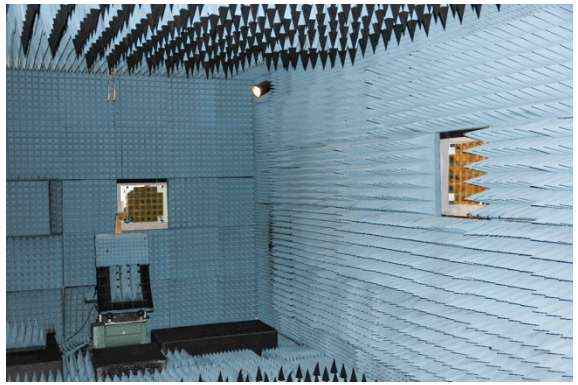
Throughput: Gbps … Tbps
Reliability: …. 99.999%
Latency: ms … us

Experimental evaluation: first indoor distributed Massive MIMO setup

Indoor lab



Anechoic



Fully reconfigurable

Dense Network

Available in H2020 FIRE project

Orca

https://www.orca-project.eu/open-calls/1st-orca-open-call-extension/

ORCA Open Cal 1 for Extensions

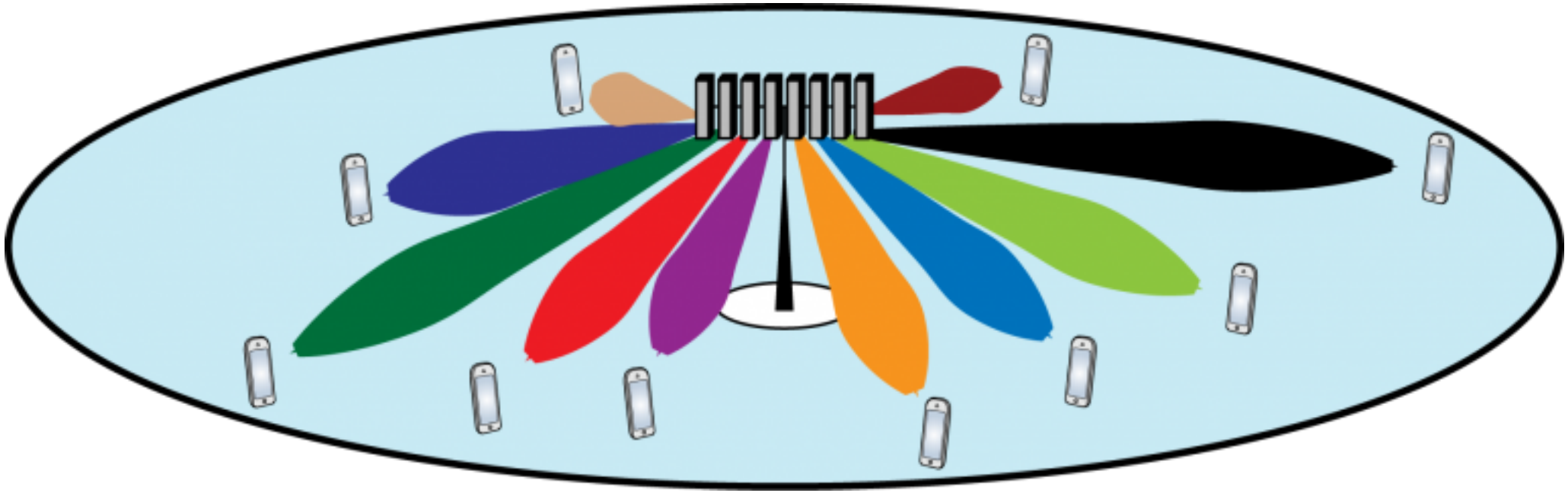
Call topics

EXT1	End-to-end slicing support for SDR and SDN
EXT2	LBT functionality on FPGA as an IP core
EXT3	RAT interworking on NS-3 based SDR Prototyping Platform
EXT4	Digital self-interference cancellation for In-Band Full Duplex

Selection process

- Only proposals with all scores above threshold are eligible for funding
- Select best proposal per topic

Illustration of downlink Massive MIMO in line-of-sight communication



Massive MIMO = always MU-MIMO

145.6 bit/s/Hz demonstrated!

Raw: 176 bit/s/Hz

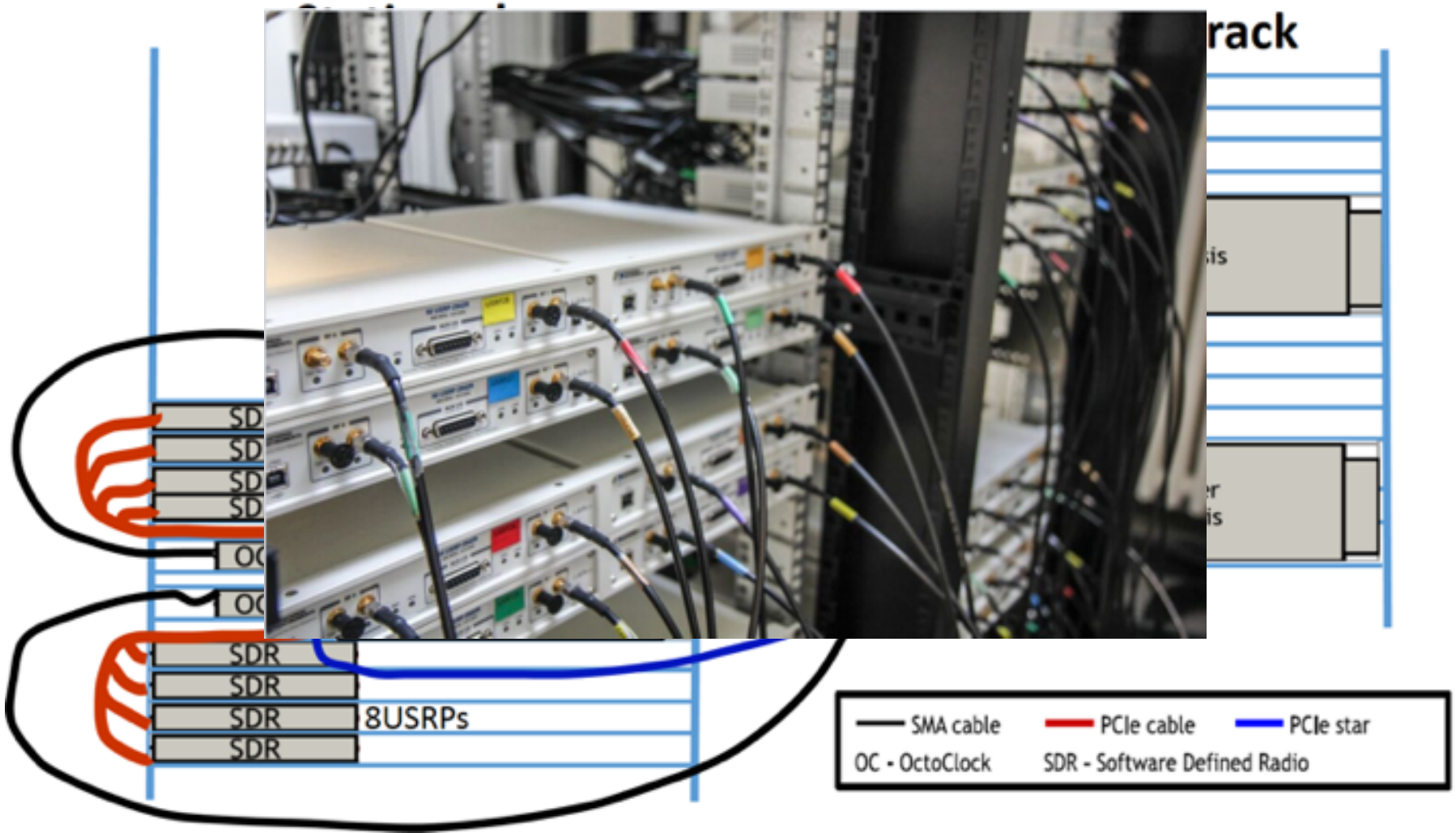
- 256 QAM, 22 users
- 17% was lost for practical reasons.
- 2 users omitted

4G IMT Advanced spec: 3 bit/s/Hz

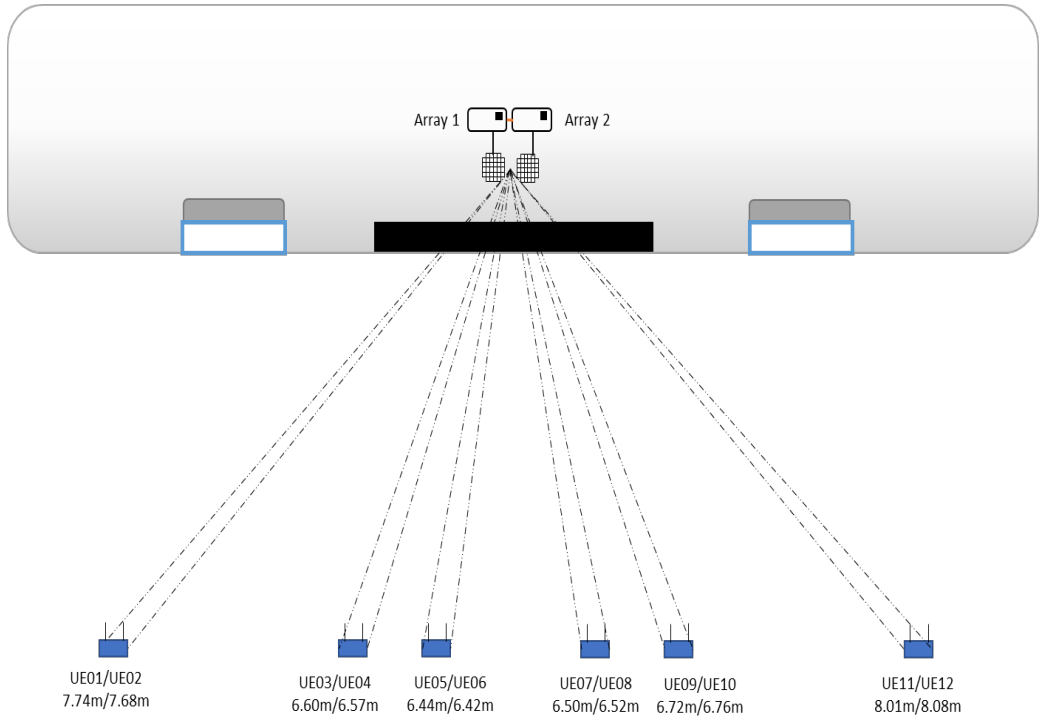
INDOOR

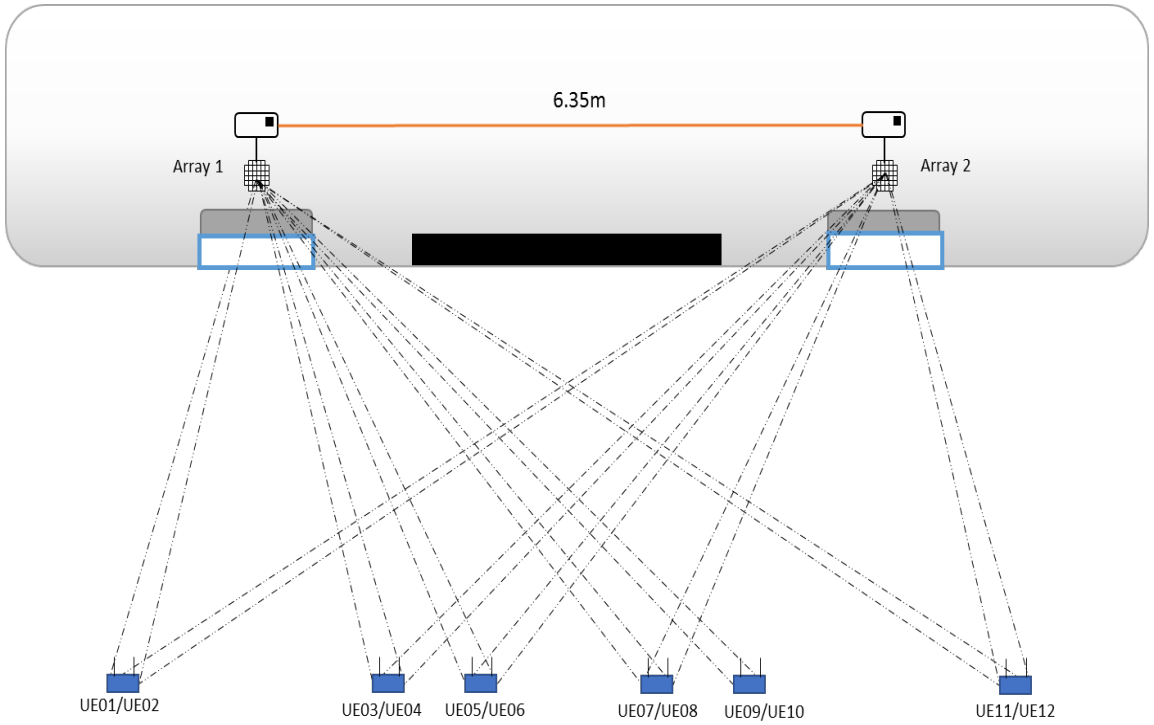
(Static, one cell)

KU Leuven MaMi (64 Antennas)



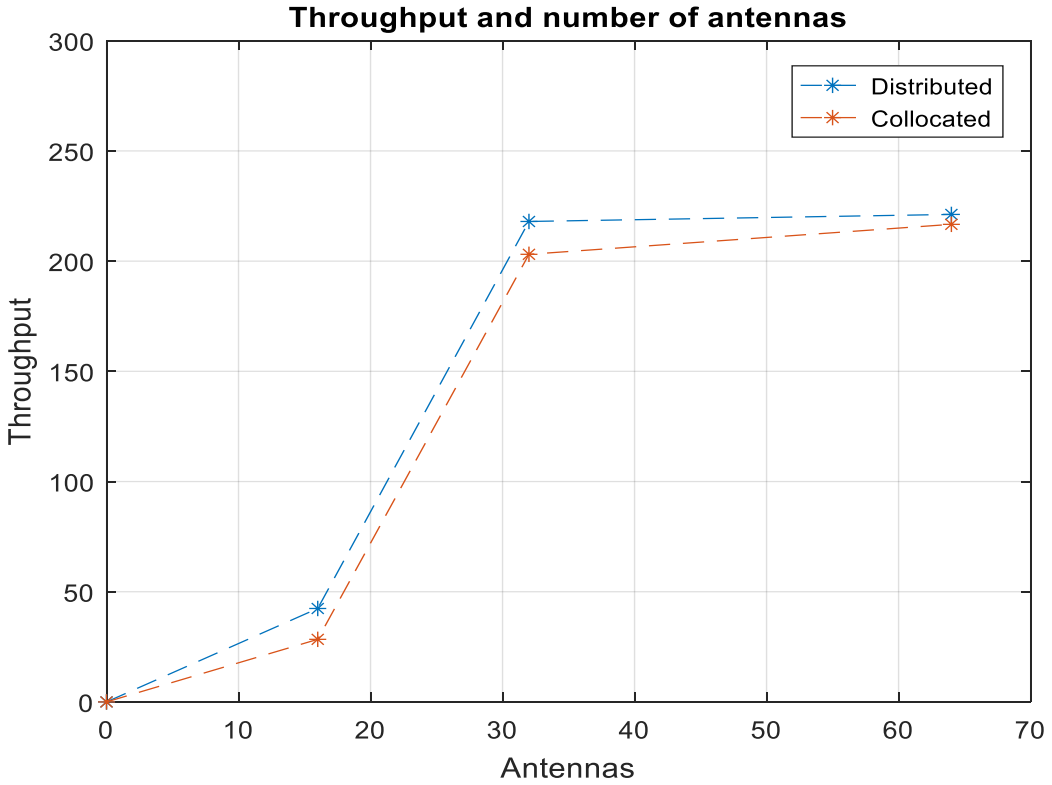
Measurement campaign: central versus distributed

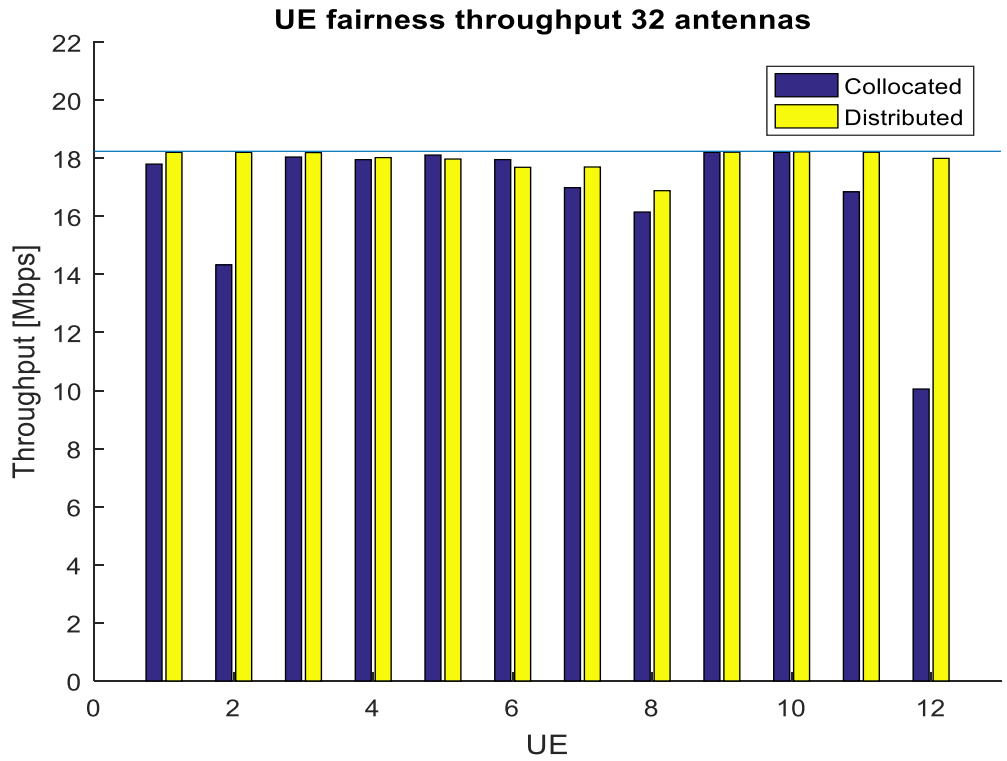




UE outdoor

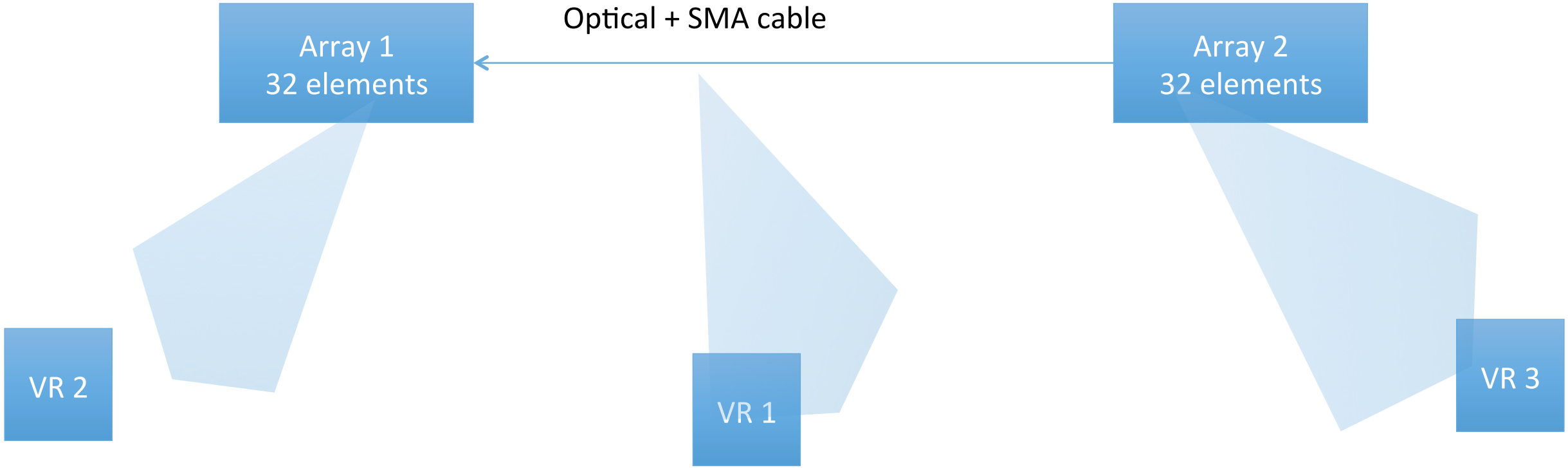
Distributed is slightly better & fairer



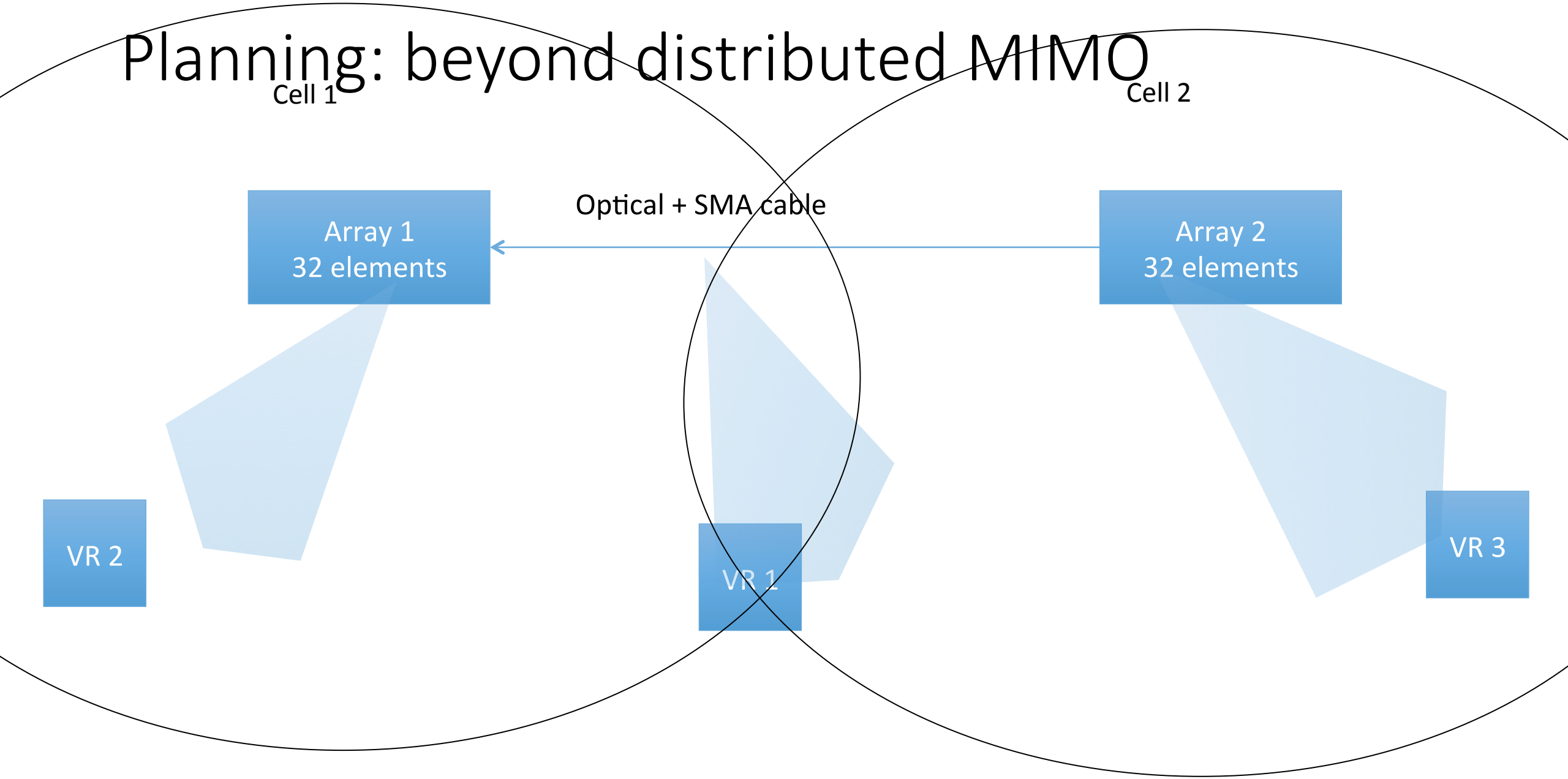


For this setup (12 users, 16 QAM): 32 antennas is ok

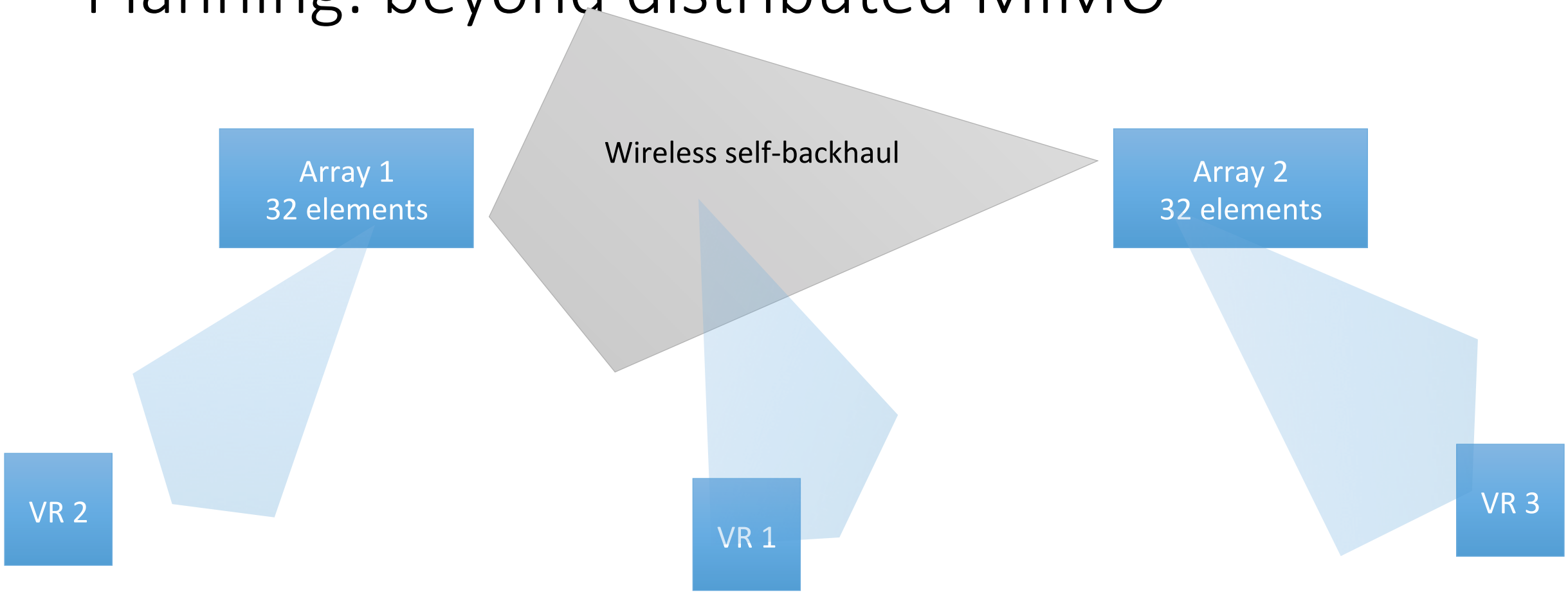
Beyond distributed MIMO



Planning: beyond distributed MIMO



Planning: beyond distributed MIMO



mmWave is key for 5G: Hybrid MIMO

MIMO 2x2.

32-antennas base station.

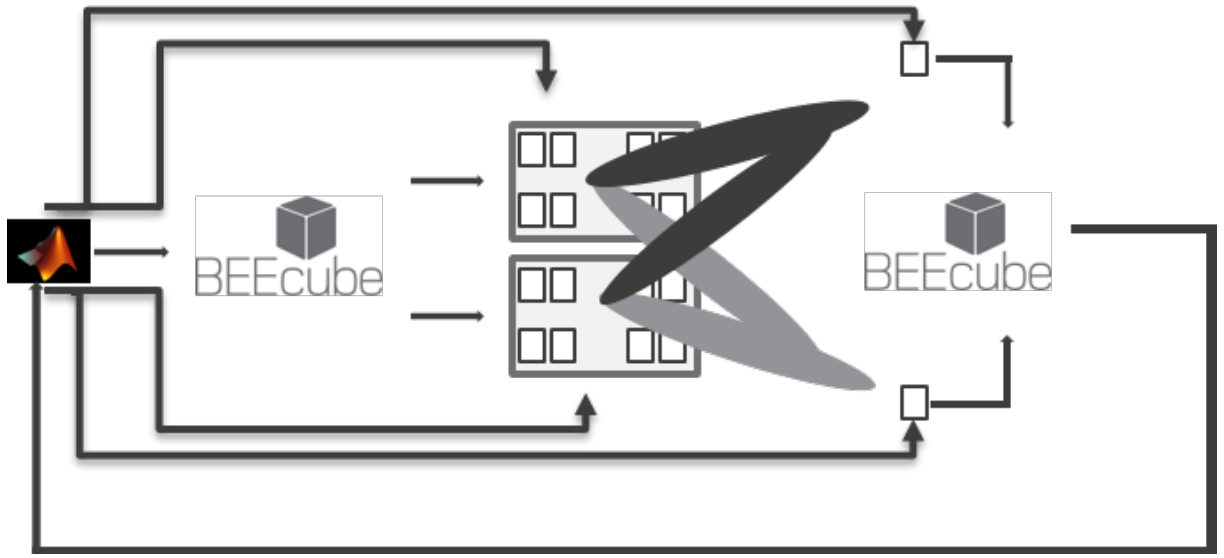
2 Receivers, each with 4 antennas.

Single carrier 802.11ad:

- Extended for multi-users.
- 2 side bandwidth: 1.76 GHz.

Analog beam-stearing.

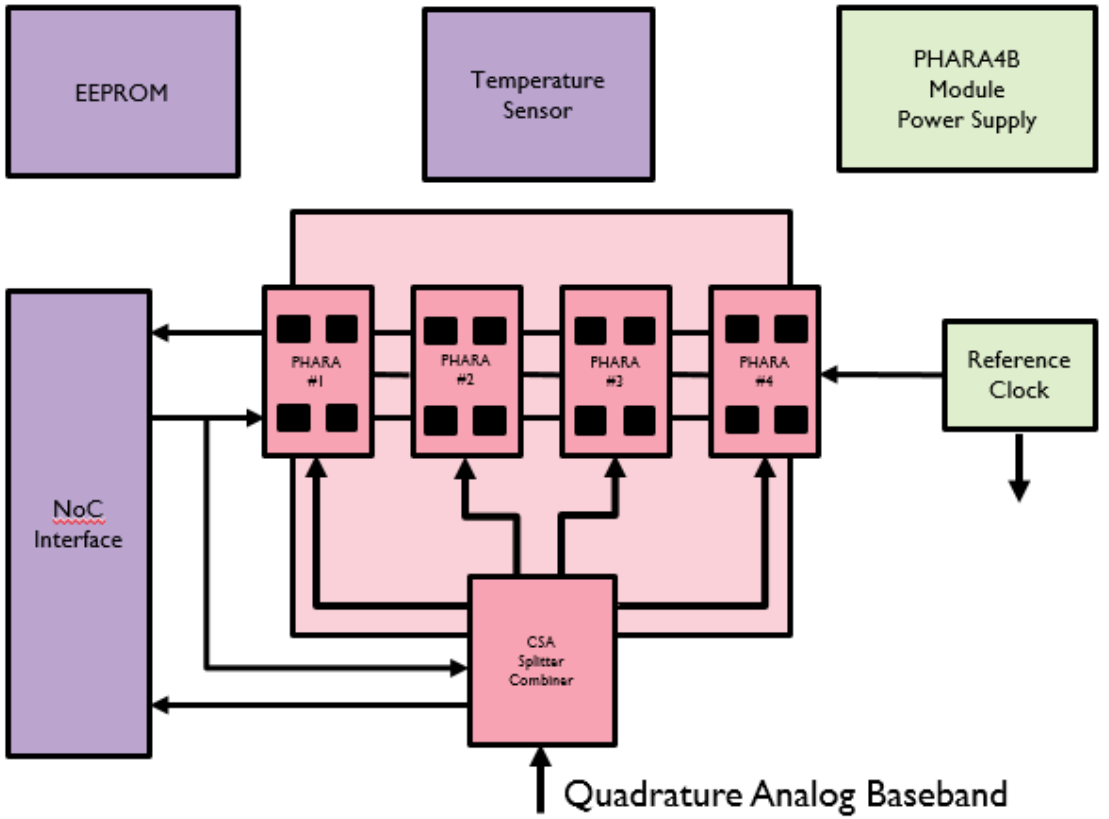
Digital precoding.




imec
CONFIDENTIAL

Baseband and front-end designed @ imec

Carrier frequency	60 GHz
Bandwidth	1.76 GHz
Sampling Frequency	3.52 GHz
Waveform	SC-FDE
FFT size	512
# of simultaneous UE	2
Antenna	16-,4- element phased array
MIMO Scheme	Hybrid beamforming
Modulation	QPSK
Coding	LDPC



Conclusions

- 5G testbeds ready to use
- Massive MIMO and beyond: Distributed cell-free Massive MIMO
- mmWave and beyond: Hybrid MIMO
- Unlimited flexibility by SDR (FPGA) and custom RF
  - But high data rates are still challenging to handle

Open for cooperation!

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