

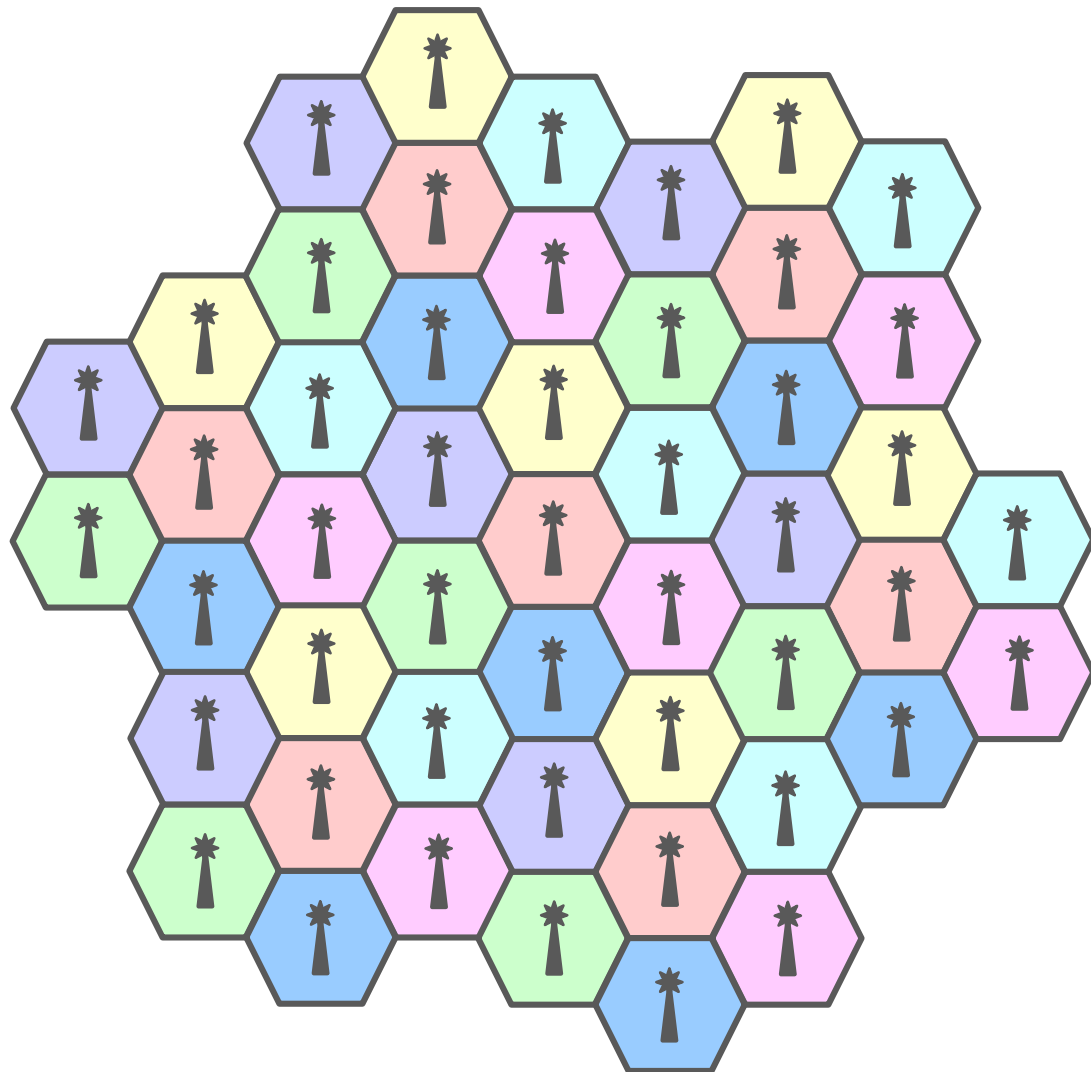
Spatio-Spectral Resource Sharing: *An AI Opportunity*

Bodhisatwa Sadhu, Ph.D.,

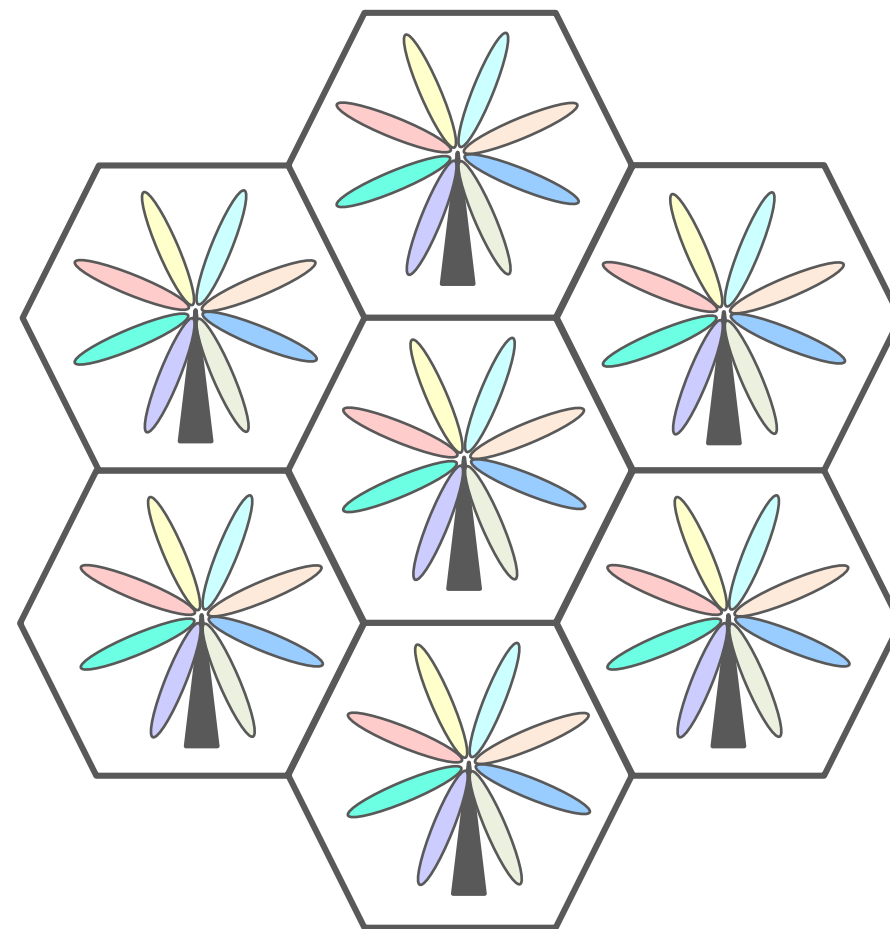
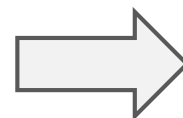
IBM T. J. Watson Research Center

From cells to spatial filters

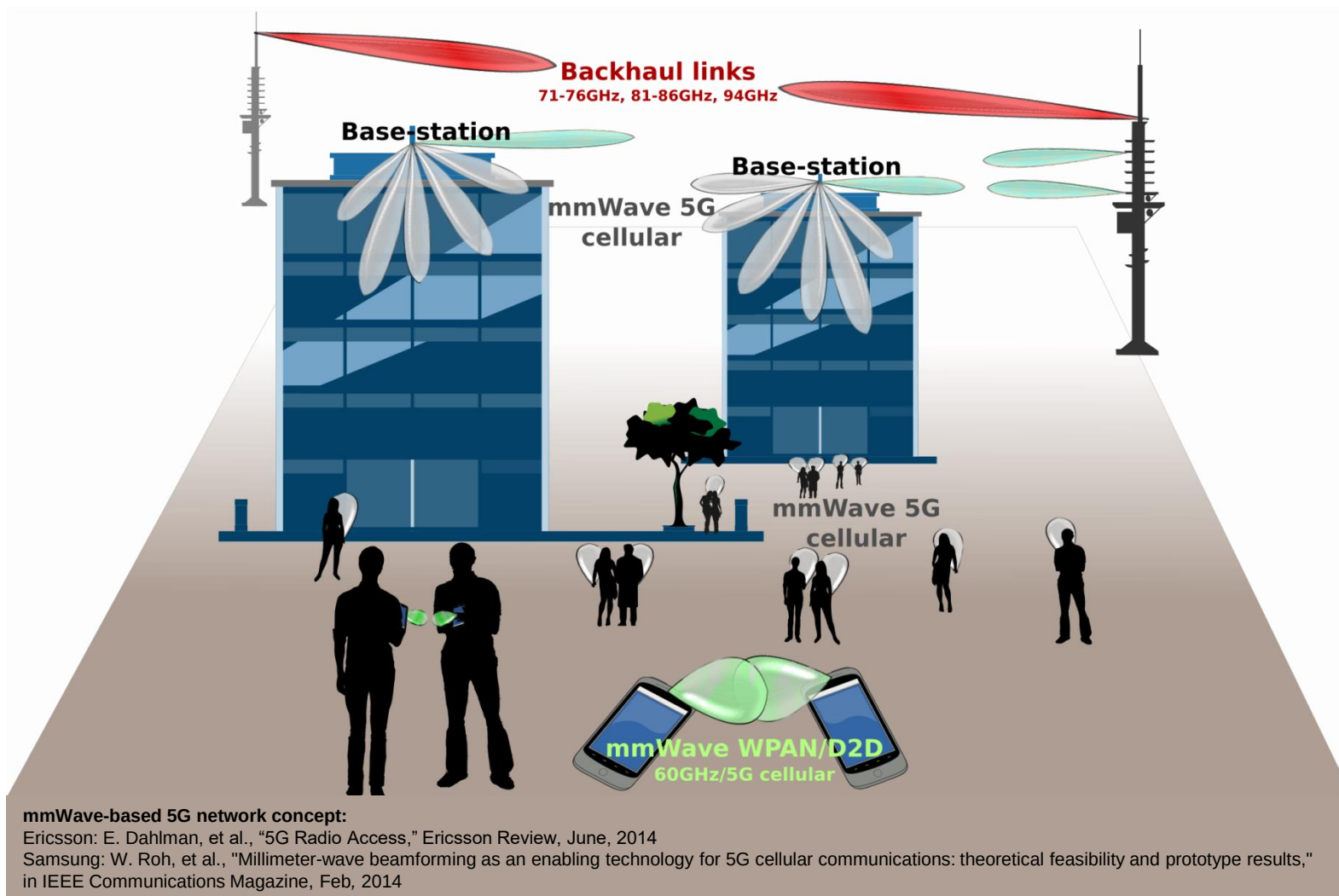
Cellular communications



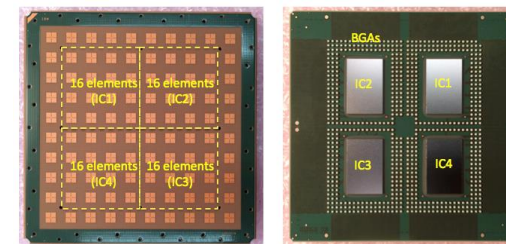
mmWave 5G cellular communications



5G era spatial filtering: capabilities



First silicon-based 5G phased array IBM-Ericsson 28-GHz 5G phased array¹



Best paper awards at the top IC conference and journal - 2017
 B. Sadhu et al., IEEE ISSCC 2017 (best paper)
 B. Sadhu et al., IEEE JSSC 2017 (best paper)

First ever commercial mobile broadband offering at millimeter wave²



Best mobile network infrastructure award at
 Mobile World Congress – 2019



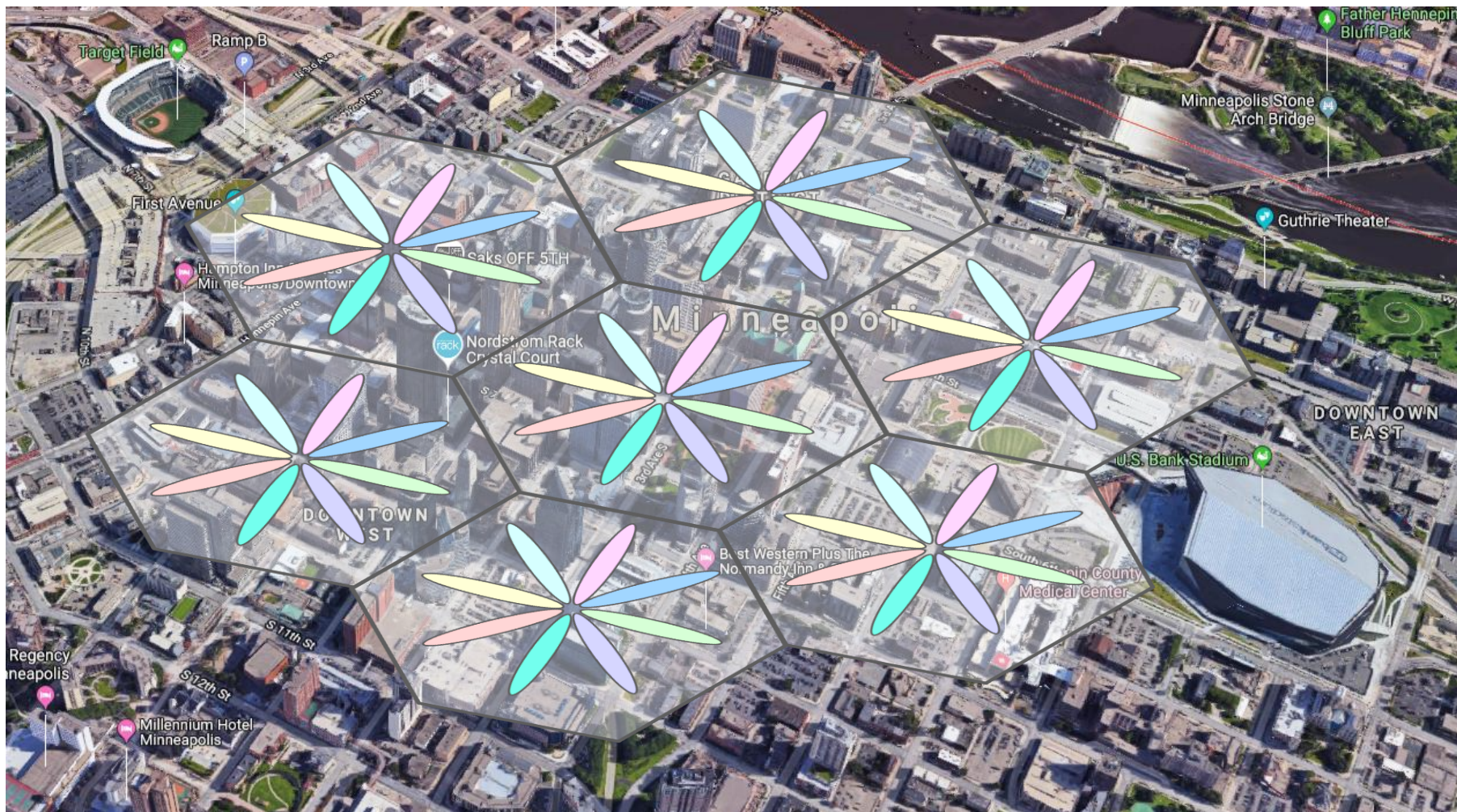
Verizon customers in ten
 U.S. cities experience 5G
 Ultra Wideband service

Peak internet speed 1.5Gbps - faster internet
 speeds than Verizon Fios

¹<https://www.ibm.com/blogs/research/2017/02/presented-today-at-ieee-conference-making-5g-a-reality/>

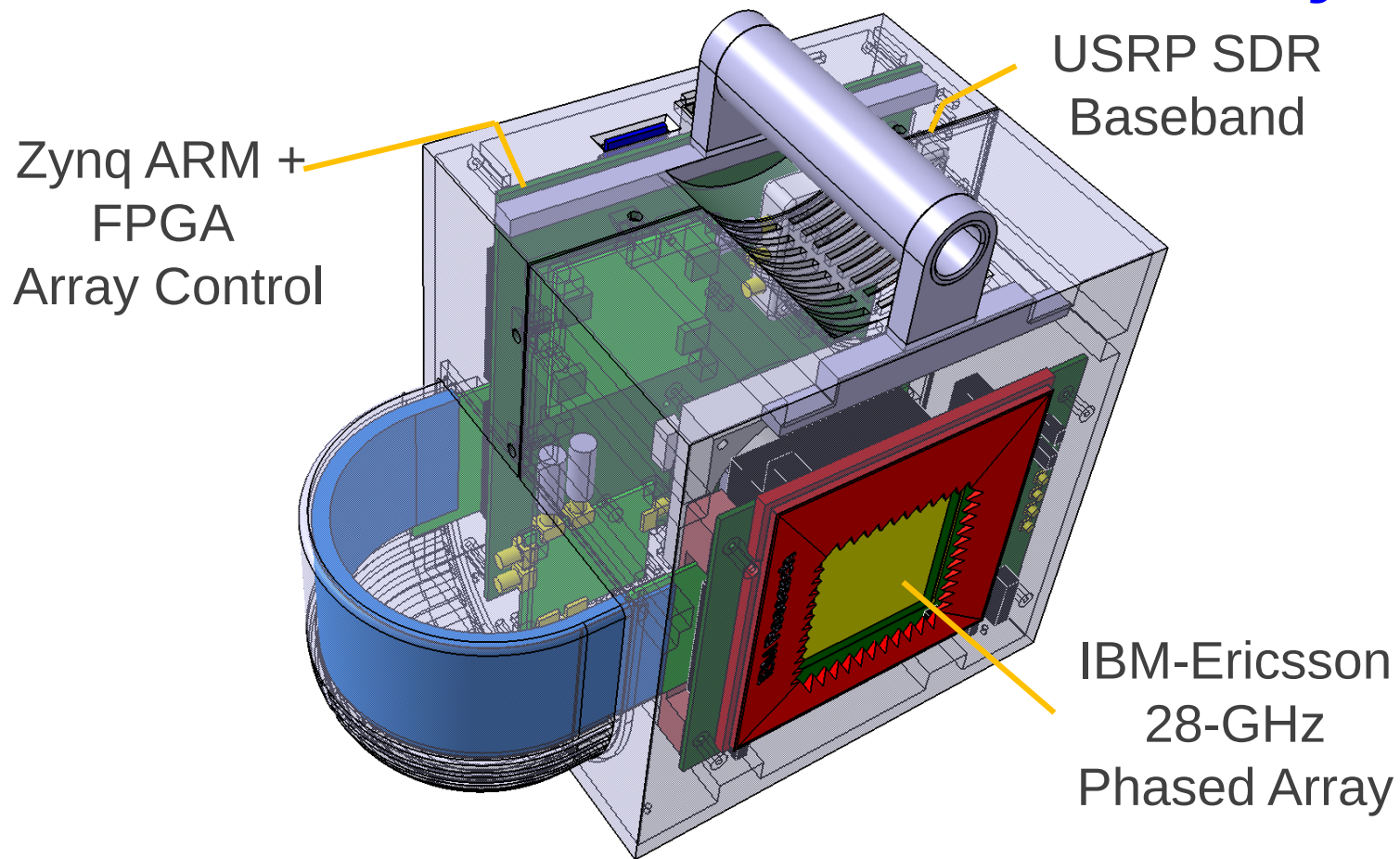
²MWC award: <https://www.mwcbasel.com/glomos/ericsson-for-5g-high-band-massive-mimo/>

5G era spatial filtering: challenges



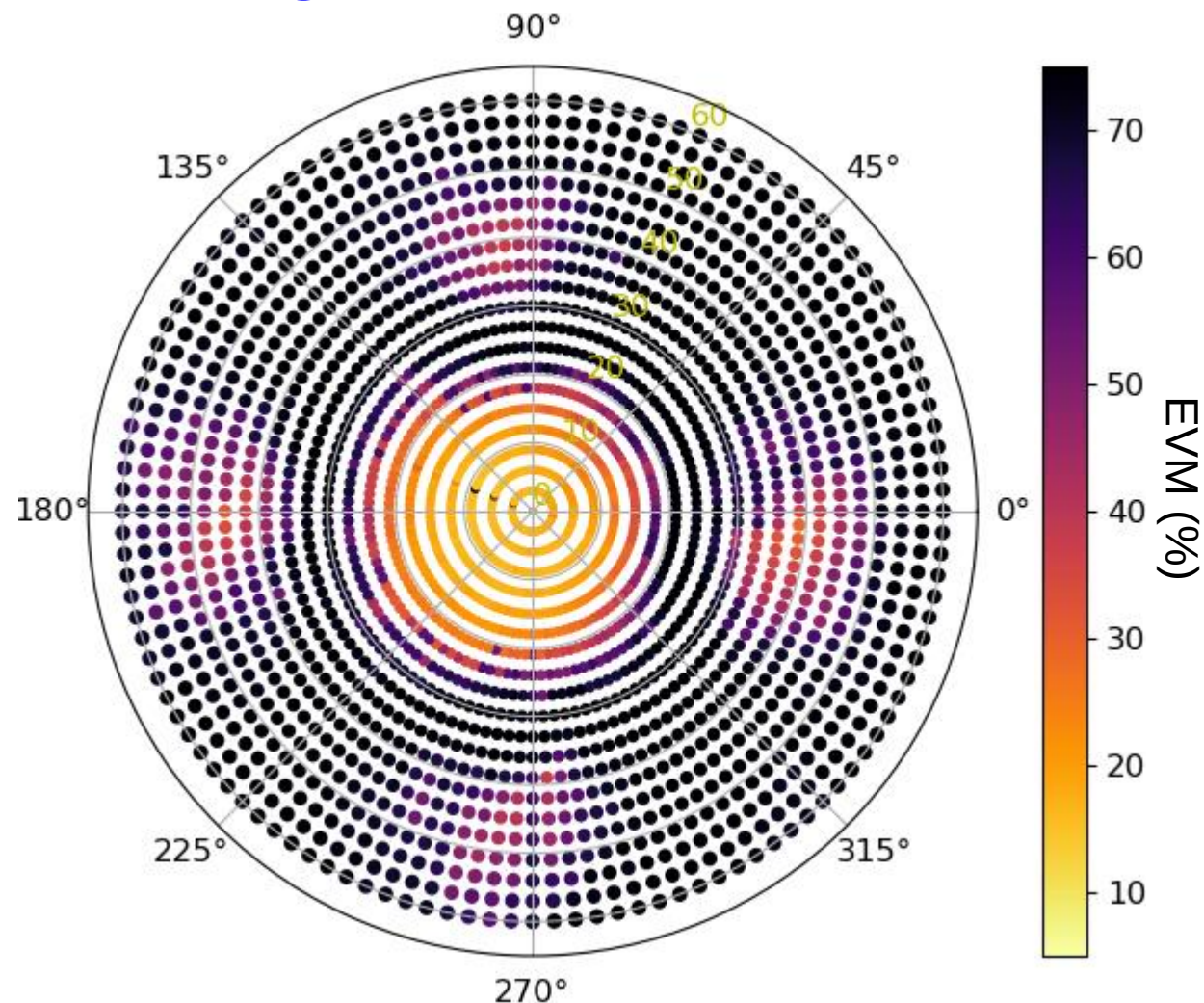
- Extremely complex spatio-spectral allocation challenge
- Amazing opportunity: access to 10^{180} unique spatial filters for IBM-Ericsson phased array
- Current limitation: 5G base-stations limited <100 spatial filter options at any given time

IBM Software Defined Phased Array Radio (SDPAR)

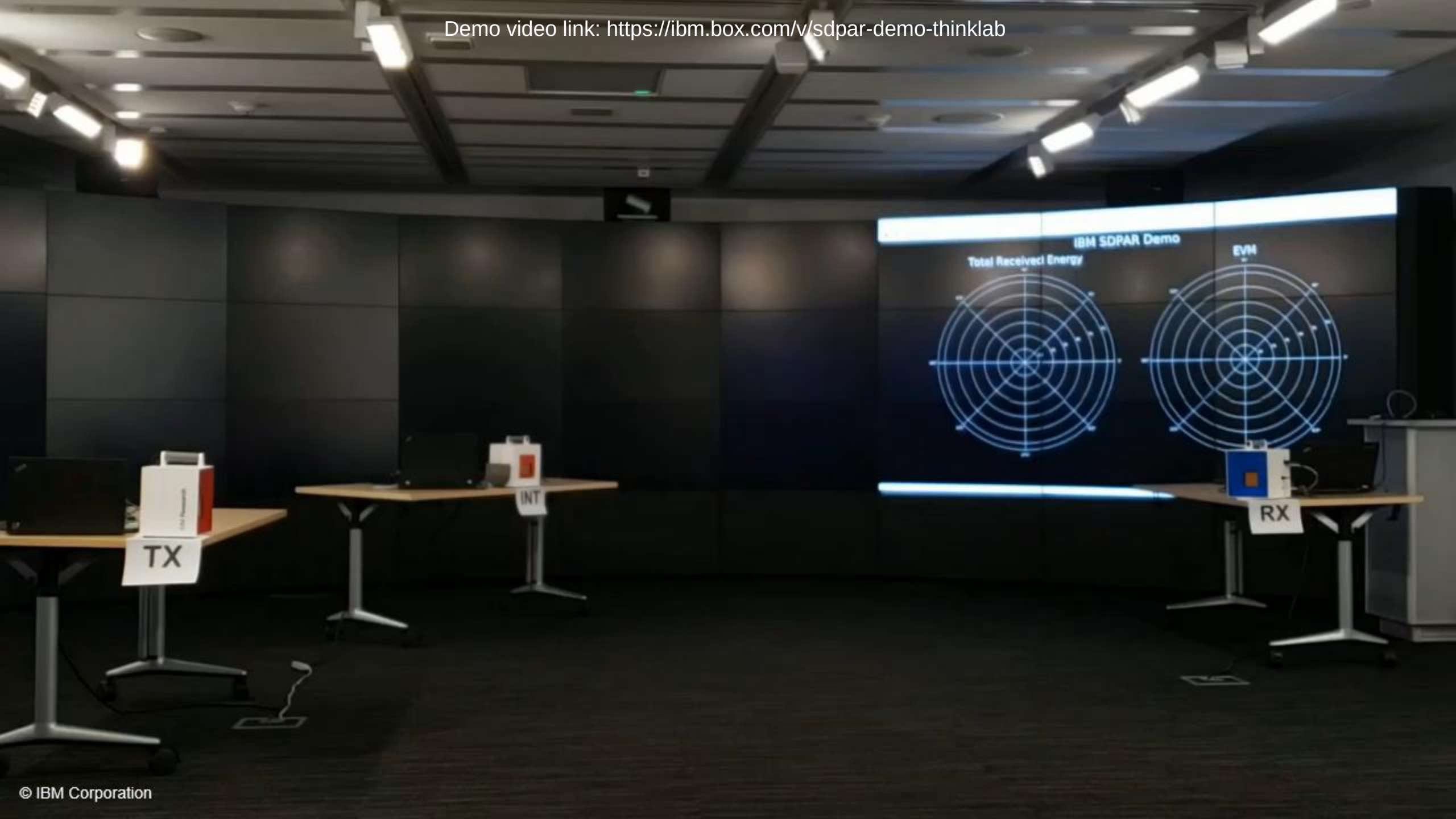


- Measures 20cm/side, weighs only 2kg
- Software controlled beamforming in Python
- 3 external connectors – 12V power and 2 USBs

Spatial filtering exploration using SDPAR



- Each dot is an EVM measurement in one direction
- 2400 EVM measurements at different angles takes <30 seconds



Data / AI Capabilities / Wireless Capabilities and Opportunity

- **Data**
 - Complex I/Q
 - Temporal
 - Multi-channel
- **AI/ML Functional Capabilities**
 - Prediction
 - Recommendation
- **Wireless Spectrum Capabilities**
 - Spatio-spectral Resource Allocation

Conclusion:

- **5G beamforming allows access to a massive spatio-spectral resource**
- **Spatio-spectral resource management is an extremely complex problem**
- **Opportunity for AI based resource management solutions**

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The Networking and Information Technology Research and Development
(NITRD) Program

Mailing Address: NCO/NITRD, 2415 Eisenhower Avenue, Alexandria, VA 22314

Physical Address: 490 L'Enfant Plaza SW, Suite 8001, Washington, DC 20024, USA Tel: 202-459-9674,
Fax: 202-459-9673, Email: nco@nitrd.gov, Website: <https://www.nitrd.gov>

