Spatio-Spectral Resource Sharing: An AI Opportunity

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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 array

First ever commercial mobile broadband offering at millimeter wave

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)

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

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2. MWC award: https://www.mwcbarcelona.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

B. Sadhu, et al., "A Software-Defined Phased Array Radio with mmWave to Software Vertical Stack Integration for 5G Experimentation," IEEE IMS, 2018
Spatial filtering exploration using SDPAR

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

B. Sadhu, et al., IEEE IMS, 2018
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
References - 1

IBM SDPAR:


- B. Sadhu, et al., “A 128-element Dual-Polarized Software-Defined Phased Array Radio for mm-wave 5G Experimentation,” ACM MobiCom mmNets, 2018, DOI: [https://doi.org/10.1145/3264492.3264506](https://doi.org/10.1145/3264492.3264506)
IBM 28 GHz scaled phased array:


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