Beamspace MIMO Technology
Gigabit mmWave Wireless for 5G and Beyond

5G Densification and Enabling Technologies
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mmWave Beamspace MIMO for 5G Gigabit Applications

Highly directive narrow beams

- 35 deg @ 3GHz (15dBi Gain)
- 6 deg @ 30GHz (45dBi Gain)

Large antenna gain

- 45dBi @ 80GHz

Multi-Gbps speeds sub-millisecond latency

Key 5G Use Cases:
- Backhaul
- Last Mile
- Small-Cell Mobile Access

mmWave: 30-300GHz
Orders-of-magnitude larger bandwidth (GHz)

Beamspace MIMO:
Multiplexing Data into Beams

Antenna space multiplexing
Spatial Fourier Transform

n-element array (\( \frac{\lambda}{2} \) spacing)

Beamspace multiplexing

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Dense Beamspace Multiplexing - Massive MIMO

6” x 6” antenna: 9 elements @3GHz vs. 6000 elements @80GHz

Key Functionality:
Multi-beam Steering & Data Multiplexing

Key Challenge:
Complexity (hardware & computational)

CAP-MIMO Architecture:
Lens-Array for Analog Beamforming

Potential power & spectral efficiency gains

mmWave (80 GHz)
5 GHz BW
10 Tbps (100 users)
100 Gbps/user

LTE-A (3 GHz)
100 MHz BW
10 Gbps (9 users)
1 Gbps/user

Scalable performance-complexity optimization
Competing mmW Beamforming MIMO Approaches

Conventional MIMO: Digital Beamforming

Prohibitive complexity

Phased Array Architecture (All Competing Prototypes)

Limited to single-beam (no MIMO)

CAP-MIMO Architecture

p << n active beams

performance-complexity optimization

16, single-beam Phased Arrays (16 total beams)
(7 users/beam)

100 User Small Cell: 28 GHz, 1GHz BW, 6"x6" Ant.

14-16 Gbps 100% BW/user
63 pJ/bit

CAP-MIMO

PHASED ARRAY

20dB

1-2 Gbps 1-7% BW/user 476 pJ/bit

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4, 25-beam CAP-MIMO Arrays (100 total beams)
(1 user/beam)

28 GHz CAP-MIMO prototype