

Small Cell vs MIMO

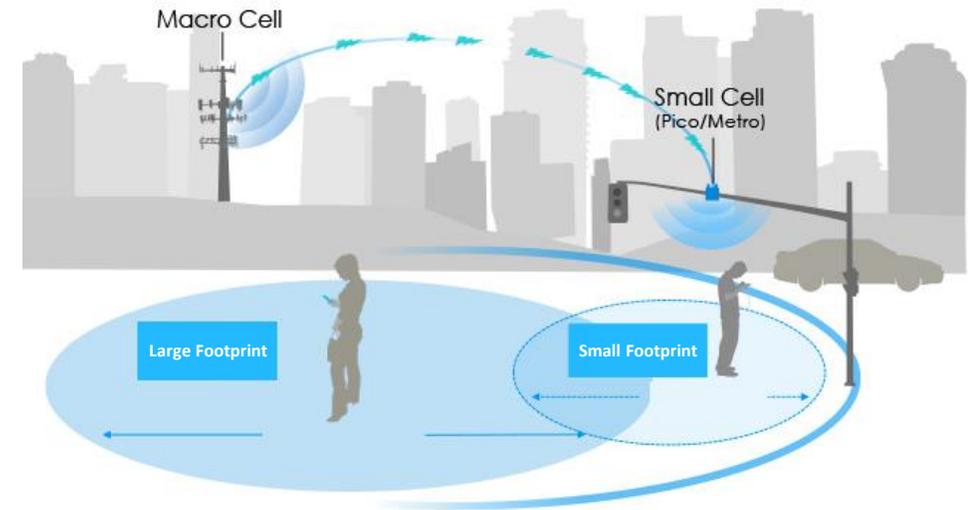
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February 8, 2017



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What are Small Cells?

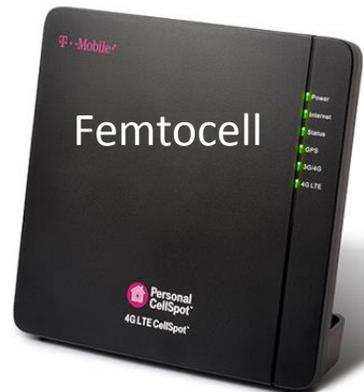
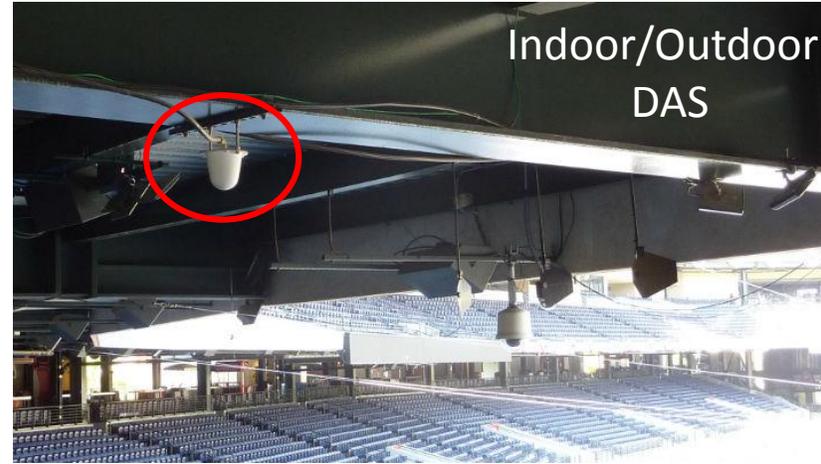
Small cells are low-powered radio access nodes that operate in licensed and unlicensed spectrum that have a range of 32 feet to 1 mile. They are "**small**" compared to a mobile macrocell, which may have a range of ~20 miles. Located "in the clutter" of the existing network.

- Outdoor DAS
- Indoor DAS
- Microcell
- MetroCell
- Picocell
- Wifi
- Femtocell

Small Cell Type	Cell Radius	Power Level (Watts)	Approximate Number of Users
Outdoor DAS	1 mile	20	3,000 per sector
Indoor DAS	Up to 200 feet per antenna	2	2,500-3,000 per sector
Microcell	1 mile	10	1,800 per baseband unit
Metrocell	500-1,000 feet	5	200
Picocell	750 feet	1	32
Wi-Fi	50-60 feet	0.1	Up to 200 per access point
Femtocell	50-60 feet	0.1	4-6

**<http://www.commscope.com/Blog/CommScope-Definitions-What-Is-a-Small-Cell/>
by Patrick Lau on Aug 27, 2015*

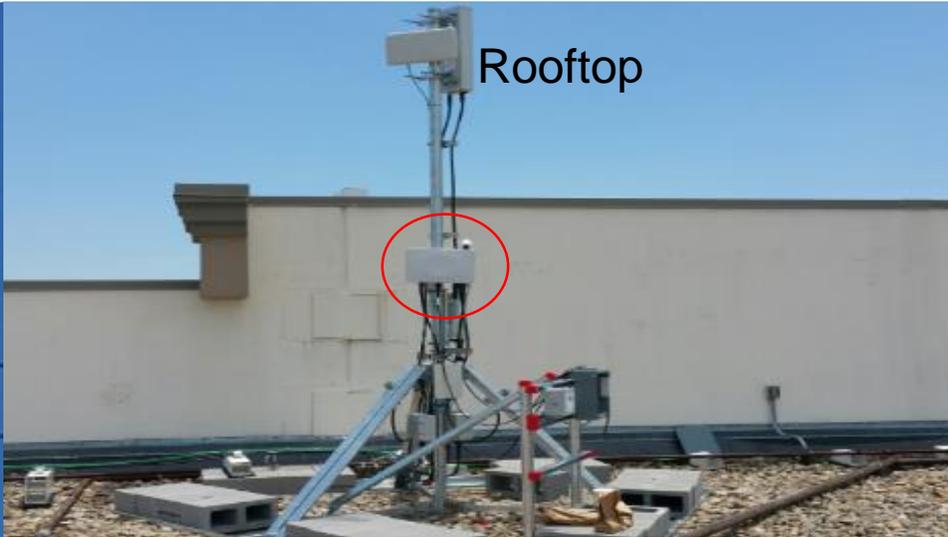
Small Cell - Examples:



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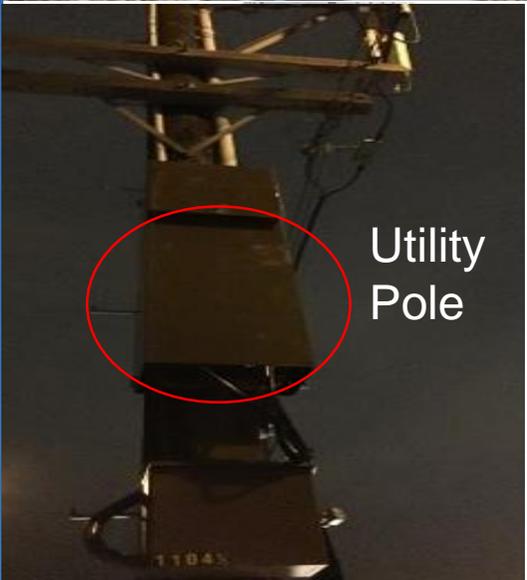
Street Pole



Rooftop



Strand



Utility Pole



Building



SC #7

Outdoor Small Cell Configuration:

Nokia Installation on a City of Chicago Lightpole

Location: Randolph & N Wells (NW corner), train tracks on N Wells

Installation type: 30ft Light pole, no pole replacement required

Small Cell: Flexi Zone, AWS, 10MHz, 5+5W, F1/F1 scenario

Antenna: External Kathrein XPol Omni 1710-2690MHz 5dBi

Backhaul: DragonWave Avenue Link (58GHz) , 300ft to donor site

Power: ComEd, 40ft trenching to manhole required

Synchronization: GPS

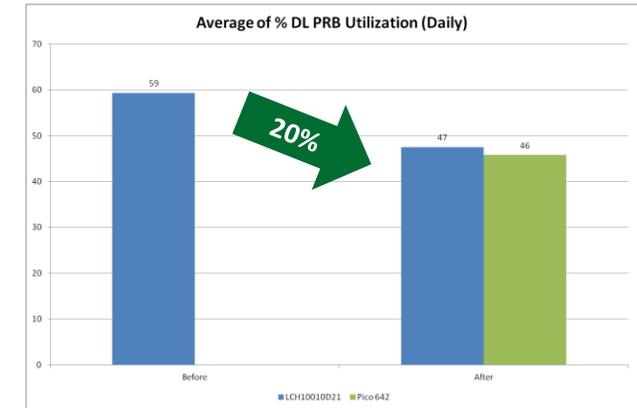
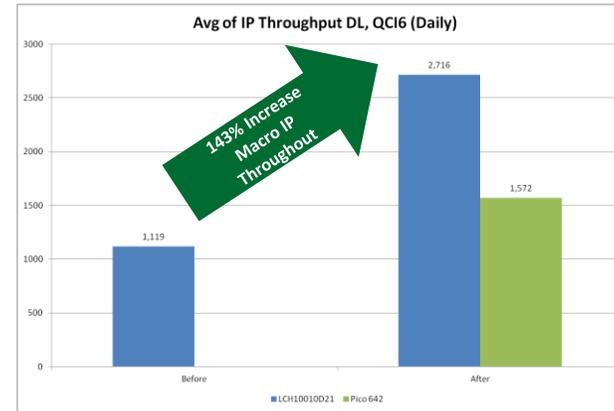
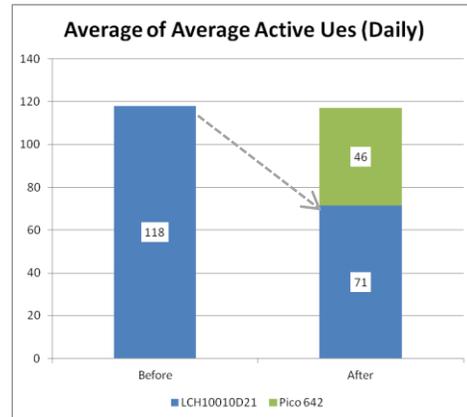
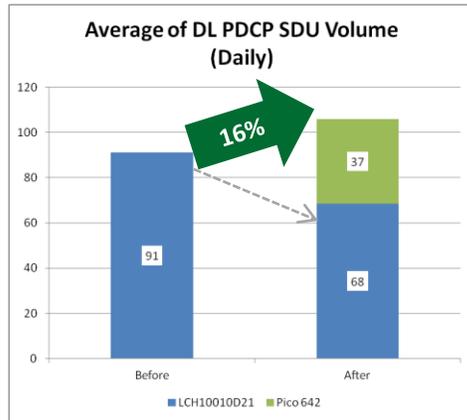
Total weight of added equipment: 50lbs



1. Antenna, 2. Microwave, 3. Flexi Zone, 4. AC panel

Outdoor Small Cell Performance:

Small Cell performance based on one live small cell



Macro offload –
data volume

22%

Macro offload –
Active UEs

32%

Traffic Increase

15%

End User Experience
– Higher IP Thput

143%

Resource Utilization
improvement

20%

Small Cells – Pros & Cons:

Pros	Cons
<ul style="list-style-type: none">• Lower cost to deploy• Lightweight / compact• Low RF power emission• Less visible• Instant coverage improvement• Time to deploy (pending type)• Increased network capacity• Increased user throughput	<ul style="list-style-type: none">• Feasibility<ul style="list-style-type: none">• Power & fiber backhaul• Network optimization<ul style="list-style-type: none">• Increased noise / interference• Increased site build required• Limited connected users• Single carrier deployment (most cases)• Small footprint• Limited upgrades

What is MIMO?

MIMO stands for **Multiple Input/Multiple Output**. Simply put, it is a data transfer accelerant by using more than one antenna to receive and transmit data. MIMO enables a variety of signal paths to carry data to and from a wireless device.

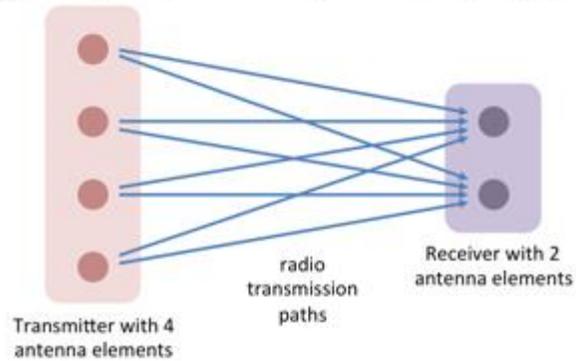
Spatial diversity: Multiple transmit and receive antennas improve the signal to noise ratio by reducing signal fade

Spatial multiplexing: Provides additional data capacity by utilizing the different paths to carry additional traffic resulting in increased throughput.

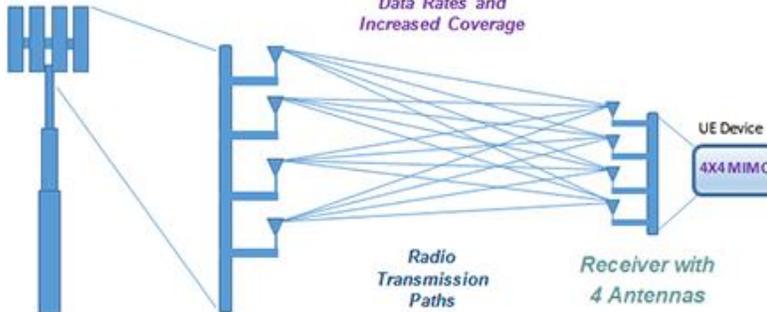


MIMO – Examples:

Types of MIMO 2x2, 4x2, 4x4



Improved Throughput, Higher Data Rates and Increased Coverage



LTE eNB with 4 Transmitters

Achievable LTE Peak Data Rates

Achievable LTE Peak Data Rates

Accounts for overhead at different bandwidths & antenna configurations

Bandwidth	DL		UL
	2x2	4x4	1x2
5 MHz	37 Mbps	72 Mbps	18 Mbps
10 MHz	73 Mbps	147 Mbps	36 Mbps
20 MHz	150 Mbps	300 Mbps	75 Mbps

Massive MIMO Antenna

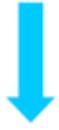


MIMO – Network Gain:

Single Stream (4 Antennas) ~75 Mbps

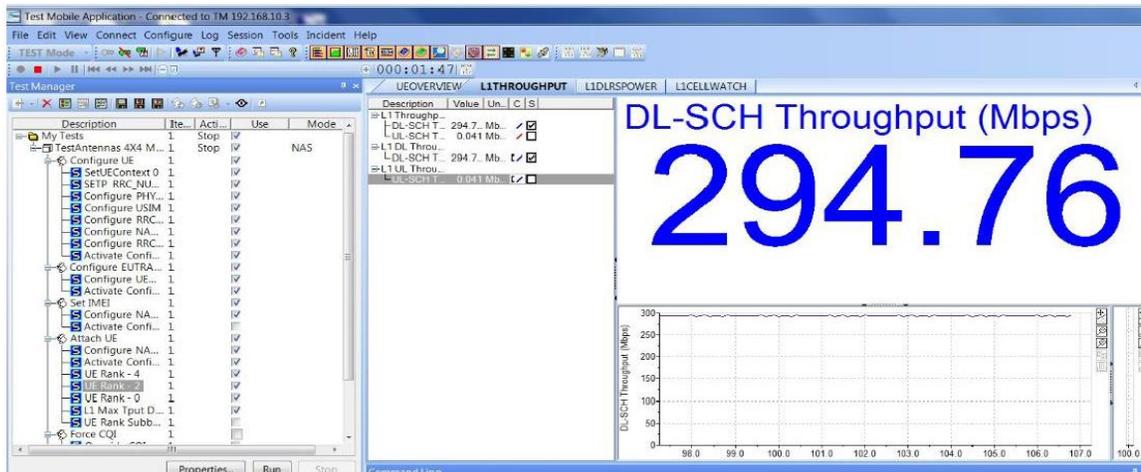
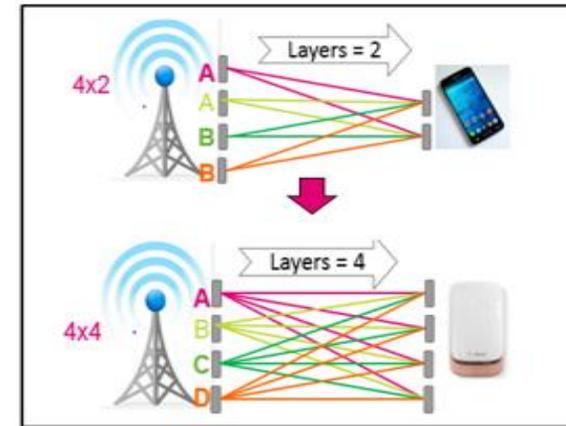


Dual Stream MIMO (4x2) ~150 Mbps



Quad Stream MIMO (4x4) ~300 Mbps

	TX-Antenna eNodeB (#)	RX-Antenna UE (#)	Peak Speeds on 20MHz (Mbps)	Unique Streams (#)
2x2 MIMO	2	2	150	2
4x2 MIMO	4	2	150	2
4x4 MIMO	4	4	300	4
4 Way Rx Diversity UE	4	4	150	2



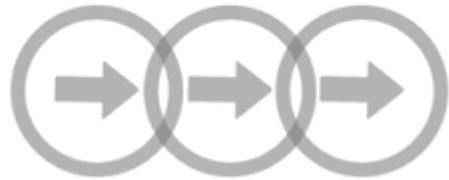
Peak DL throughput of 294+ Mbps with 20MHz BW

MIMO - Pros & Cons:

Pros	Cons
<ul style="list-style-type: none">• Improved coverage on cell edge• Reduce the need for additional Spectrum• Large coverage area• Increased network capacity• Increased user throughput• Improved network quality• Beamforming capabilities• Carrier Aggregation	<ul style="list-style-type: none">• Feasibility<ul style="list-style-type: none">• Location• Capacity• Site configuration• Handset compatibility• Massive MIMO is years away• RF Emissions• High cost to deploy

MIMO of Tomorrow:

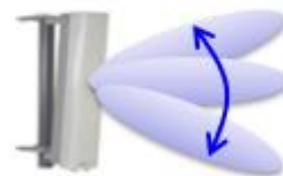
WHAT'S NEXT?



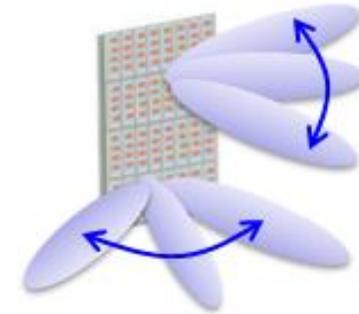
Electrical Tilting



Vertical Beamforming



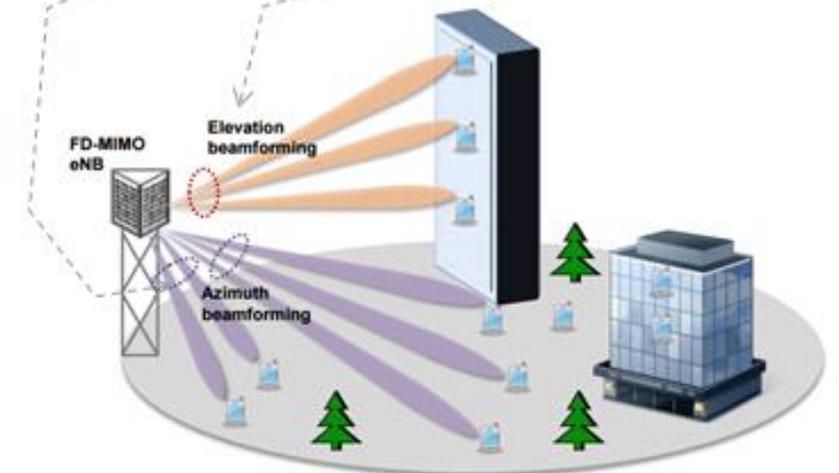
FD-MIMO



Elevation (Vertical) Beamforming

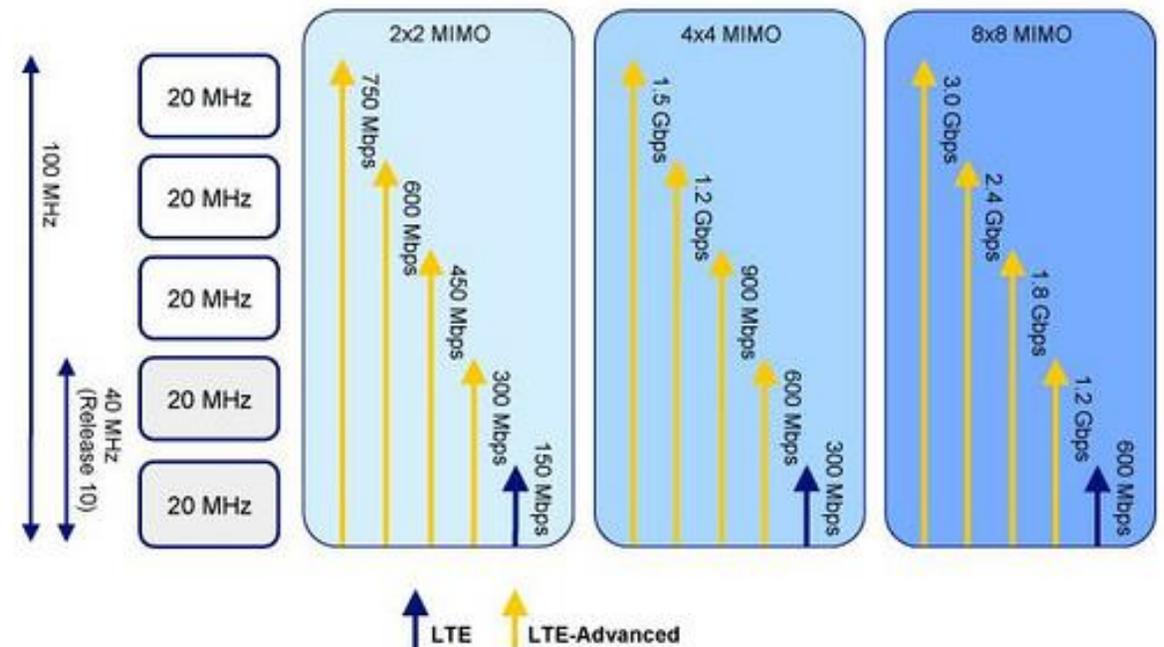
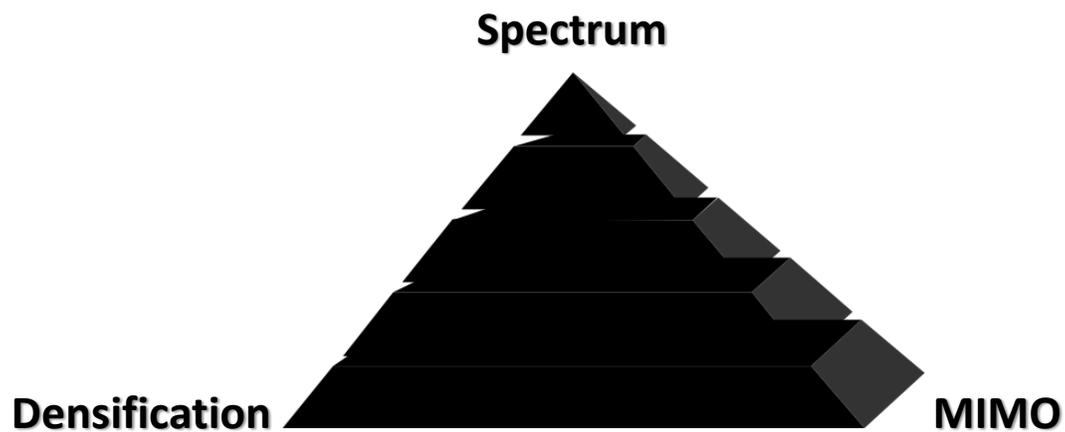
Azimuth (Horizontal) Beamforming

- Current passive antennas have fixed beamwidths to cover a specific area using separate transmit paths
- Future antenna deployments will deploy active beamforming to optimize signal to each user
- Full Dimension MIMO is years away from network deployment



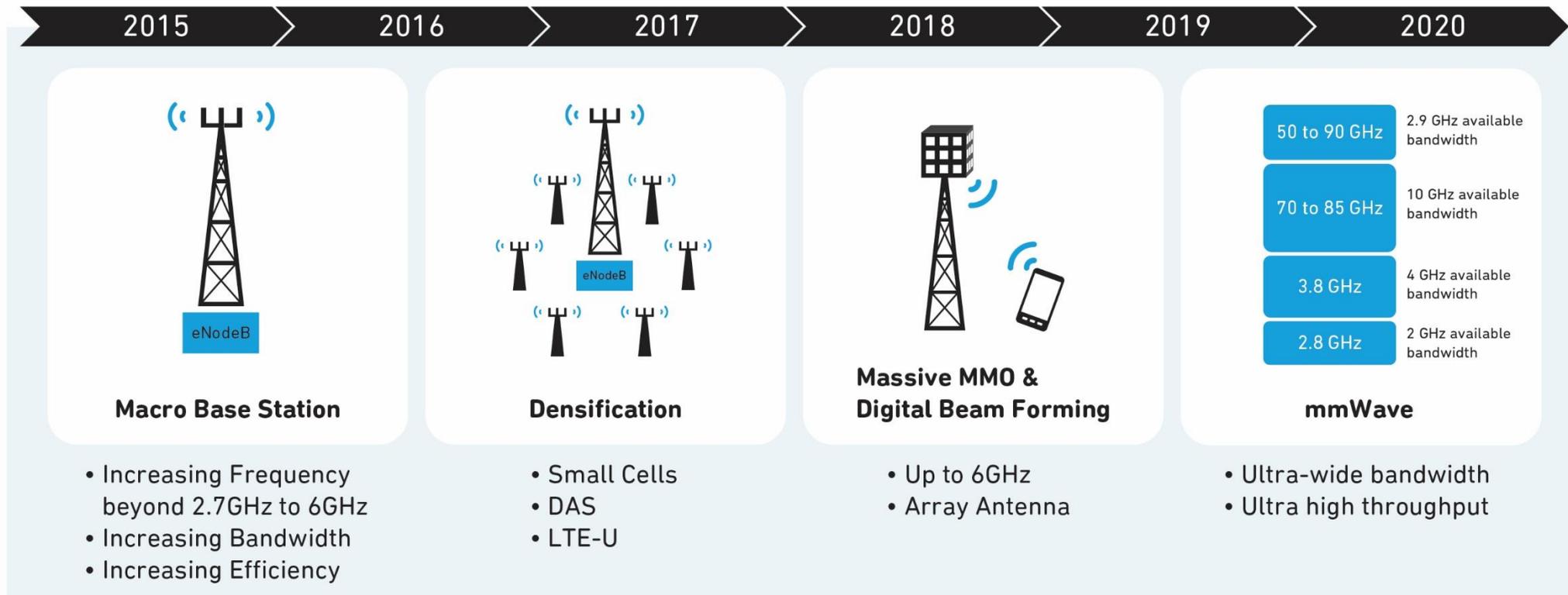
Coexistence of Small Cell & MIMO:

Wireless Carriers require 3 things to things to remain successful; **Spectrum**, **Densification**, and **MIMO**. Carriers continually monitor existing technologies, reform spectrum to LTE, and deploy “Carrier Aggregation” where possible.



Future / Coexistence of Small Cells & MIMO

The Evolution of 5G



Source: Qorvo

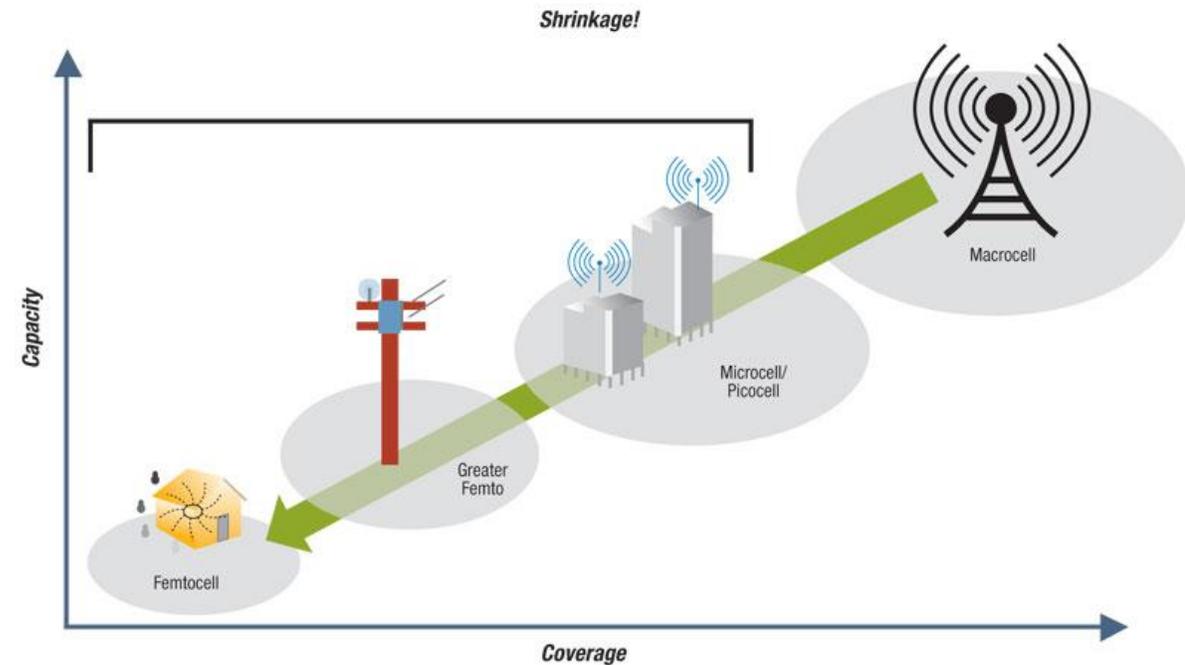
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QORVO

**<http://mwr.com/active-components/small-cells-help-keep-5g-connected>*

Conclusion:

- Customers data demand for increased network capacity will be a continued challenge for Wireless Carriers.
- Carriers need 3 things to be successful; Spectrum, Densification, and MIMO.
- Small Cells and MIMO (including Massive MIMO) can work seamlessly together.



Question & Answer:

