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A Pragmatic Approach to 5G!

5G India Conclave, Mumbai

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Recent Indian Media Headlines on 5G

Excitement

Apprehension

Anticipation

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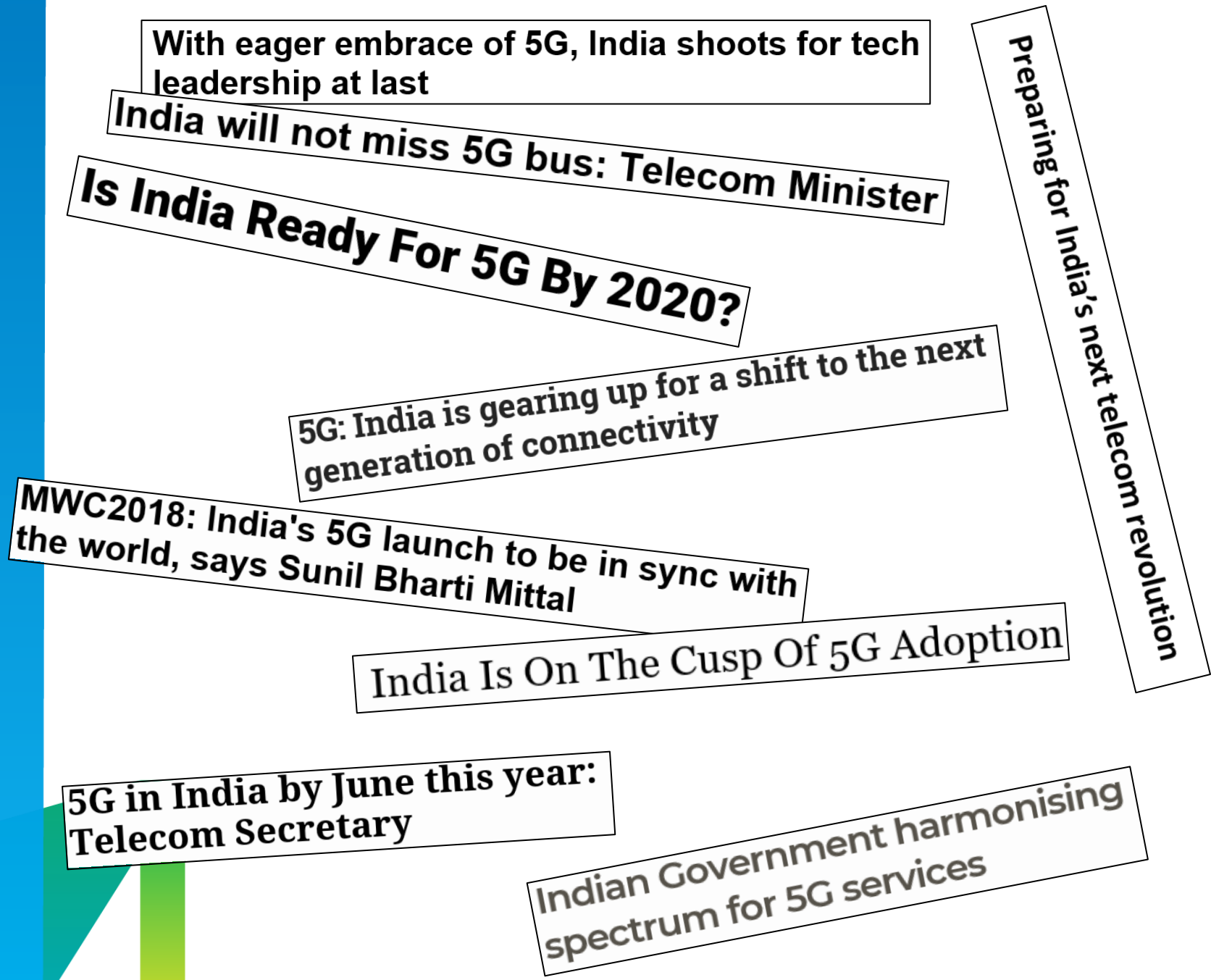
Pragmatism



5G: Network Capacity and More…

- **Wider Bandwidth**
- Multiband Antenna
- Higher port density
- TDD-FDD Antenna
- Unlicensed Band
- X-plexers

Agile, Flexible, Programmable and Open Network Features

NFV/SDN

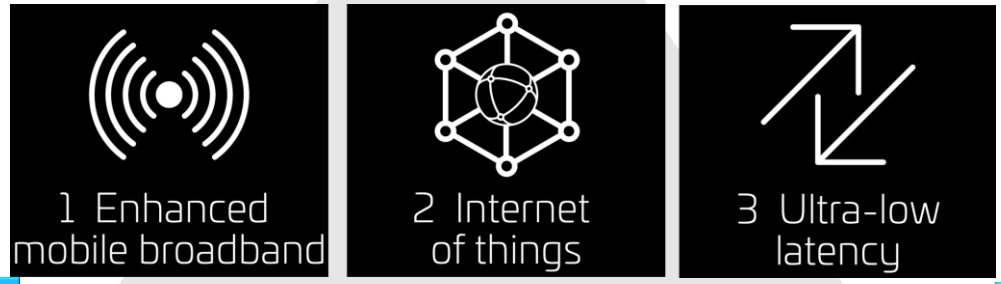
Mobile Edge Computing

Network Slicing

cRAN/xRAN/oRAN

…

Spectrum



- **Higher order MIMO**
- **Beamforming**
- **Scalable Air interface**
- Multi-beam
- Small Cells
- IMF Filters
- TMAs

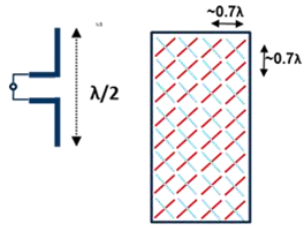
- **Small Cells**
- **mMTC**
- DAS

Spectral Efficiency

Densification

Spectrum Impacts on System Design

400 MHz	3 GHz	6 GHz	10GHz	30 GHz	100 GHz
		cm wave		mm wave	
n * 20 MHz	n * 100 MHz			1- 2 GHz	
FDD	TDD			TDD	
Macro Cells	Micro/Small Cells			Small Cells	
Passive Antennas	Passive & Active Antennas (8/16/32/64 TRX)			Active Antennas (128/256/512.. TRX)	



A typical antenna dipole is λ/2 in length

Frequency (MHz)	Wavelength (cm)	Antenna Width (mm)
700	43	1510
900	33	1160
1800	17	600
2100	14	490
2600	11	390
5000	6	210
28000	1.07	40

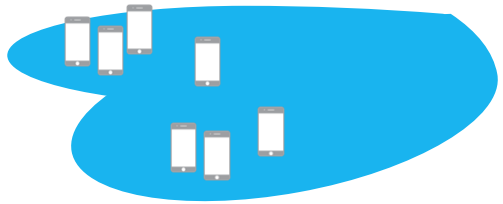
Large Scale Active Antenna Systems (LSAS) aka "Massive MIMO" start to become feasible only around 2GHz and above due to size, weight, power constraints at low bands…

Massive MIMO…

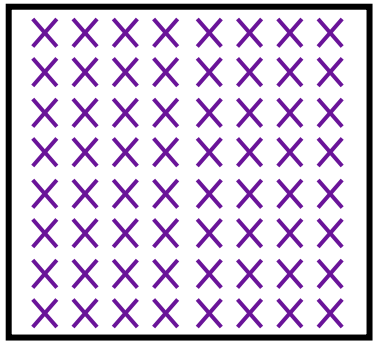
- Digital, analog and hybrid beamforming
- Horizontal and/or Vertical beamforming will be exploited
- Most gains expected in the horizontal plane
  - Except in high rise scenarios
- SU-MIMO and MU-MIMO
- FDD and TDD not equivalent
- Gains in reality may differ from trials

SU-MIMO for better SINR for single UE (load independent)

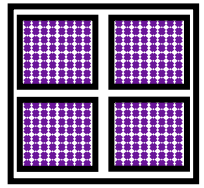
MU-MIMO for additional capacity in highly loaded environments



Cell shaping used to spotlight coverage and capacity where needed



<6GHz bands, Massive MIMO is used for capacity and improved coverage in some cases



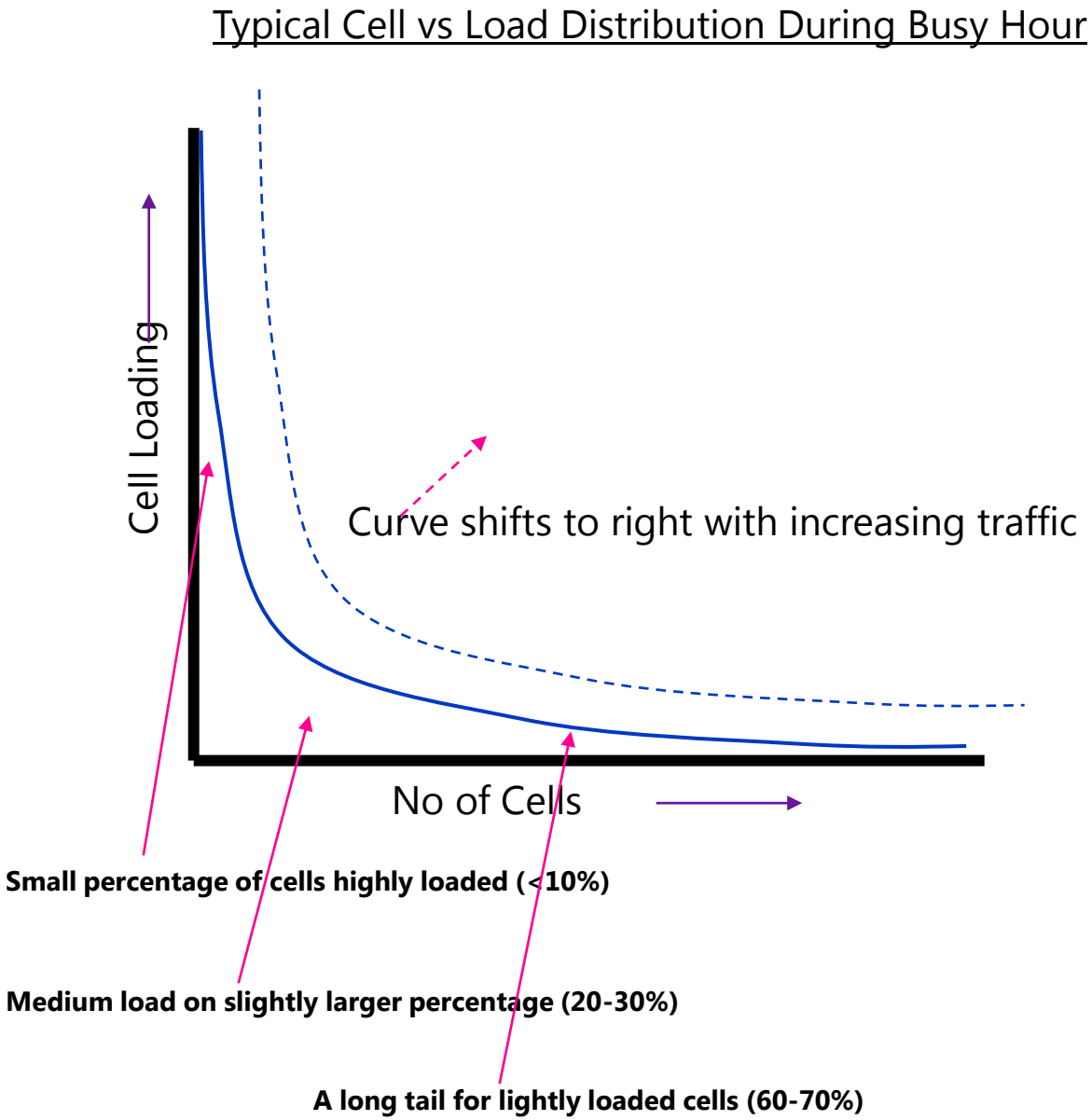
@mmWave bands, Massive MIMO is used to enable coverage (hybrid MIMO)

How many sites need Massive MIMO (Large Scale Antenna Systems) solution?

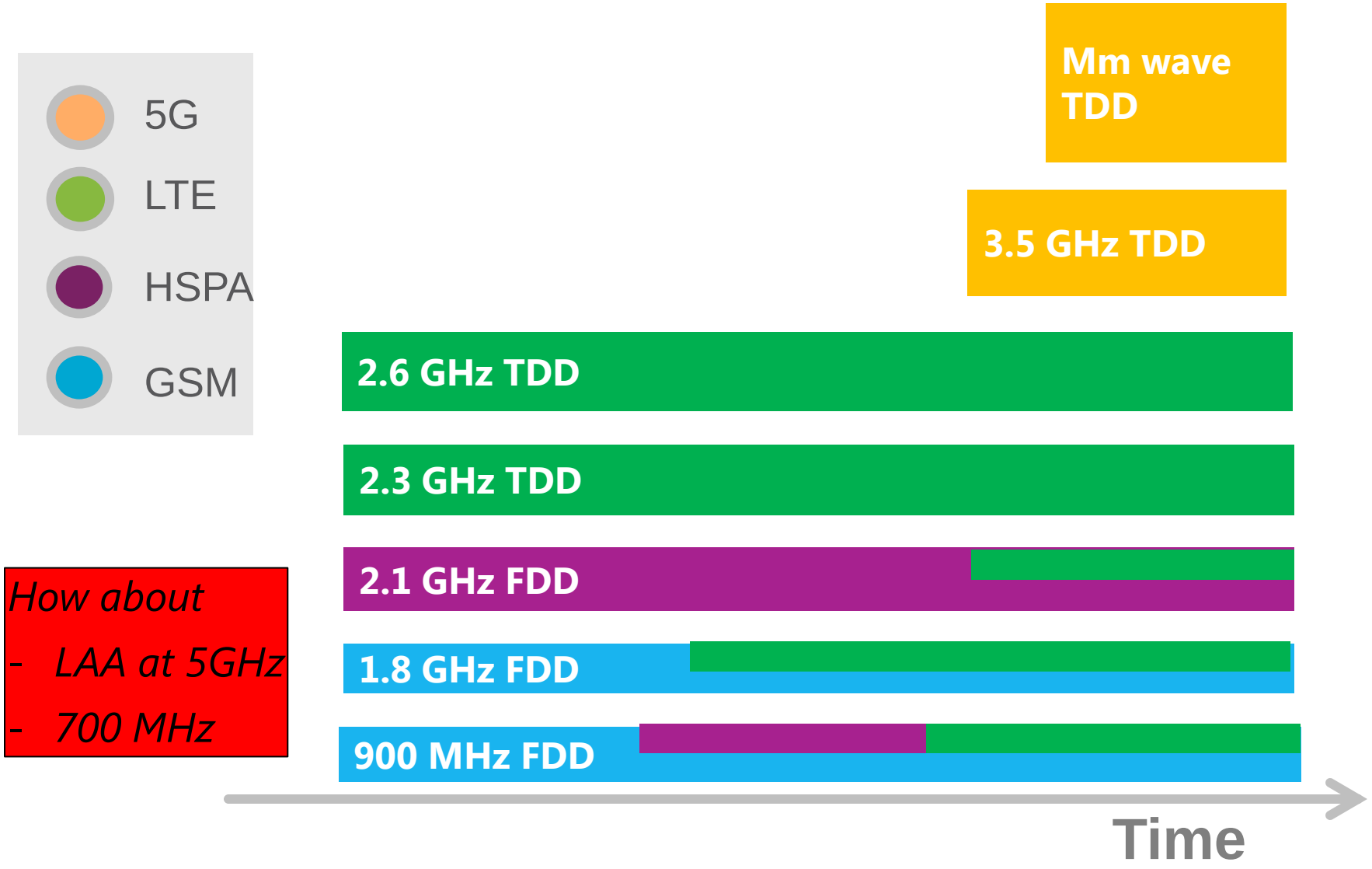
- Massive MIMO addresses less than 5-10% of cells in a typical network
- Massive MIMO Challenges on those 5%-10% sites:
  - Infrastructure (Power, Space, Load etc.)
  - ROI
  - EMF

Alternative capacity solutions, less glamourous but pragmatic at many locations:

4x4, Split beam, 8T8R Beamforming, Hybrid Solutions

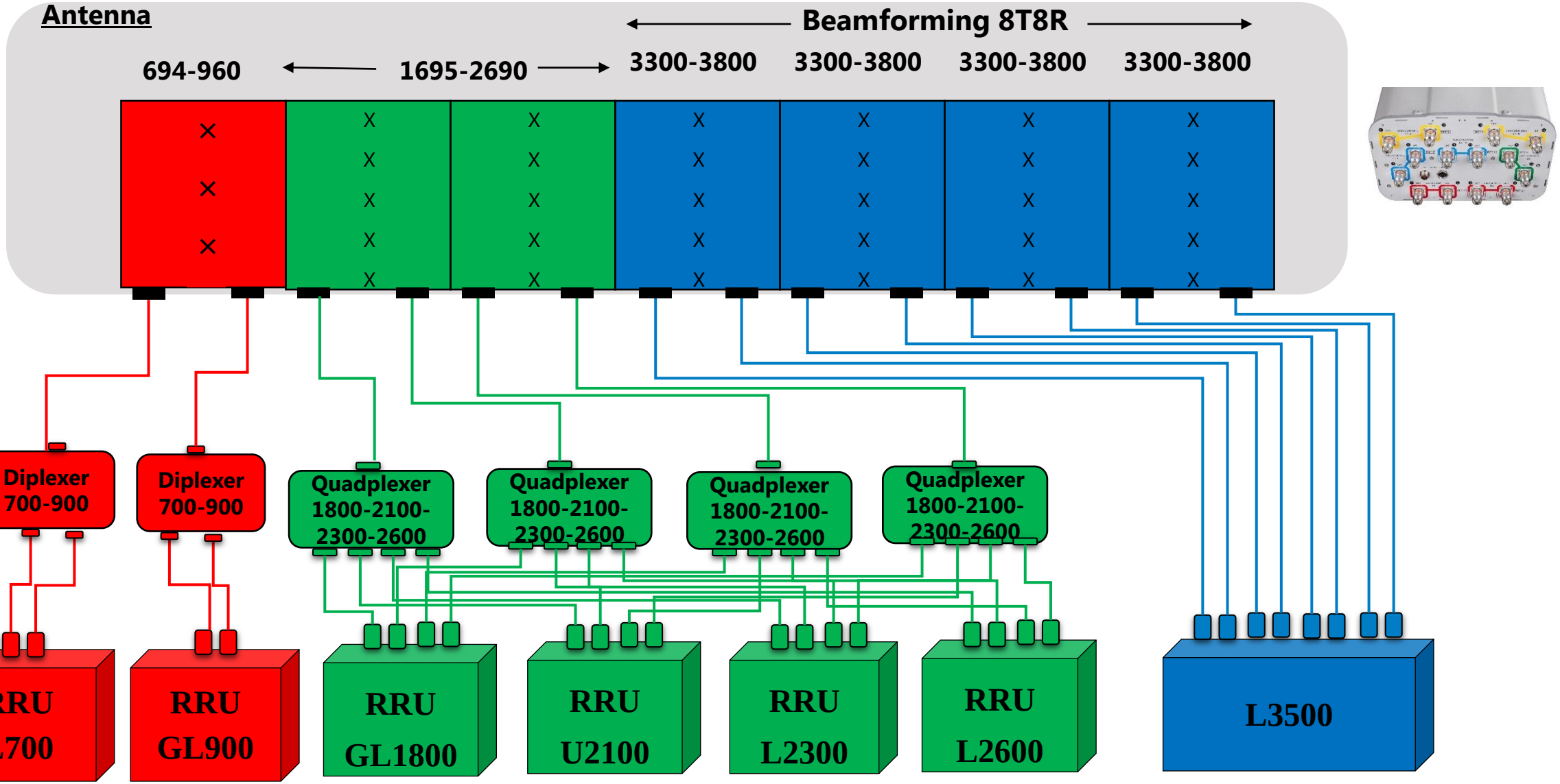


Typical Spectrum Evolution in India and Antenna Requirements



Passive Ant. /Ports	Active Antenna Possibility
	✓
4 to 8 ports	✓
4 ports	✓
4 ports	✓
2 to 4 ports	
2 to 4 ports	
2 ports	
14 to 22 ports	2-3 Active Antennas

Macro Site RF Path Evolution Example: 14 Port Antenna – 7 Bands – 4x4 MIMO - Beamforming



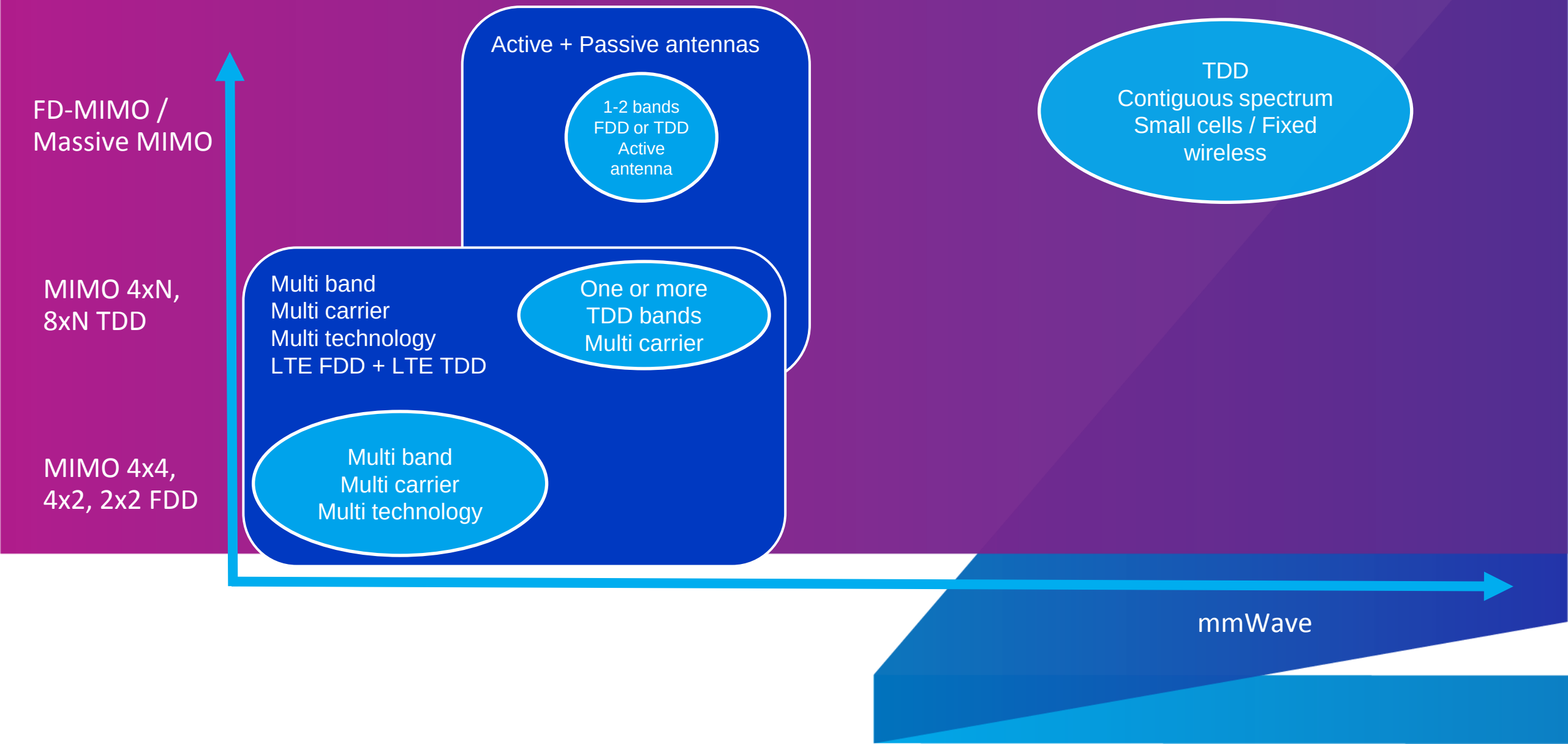
Small Cell RF Path Evolution

- External Antennas for **Spectrum, Capacity, RET**
  - Low Bands and High Bands
  - TDD and FDD Bands
  - Licensed and Unlicensed Bands
  - 3G, 4G and 5G Bands
- 4 x 4 MIMO in all Bands
- Small size for zoning

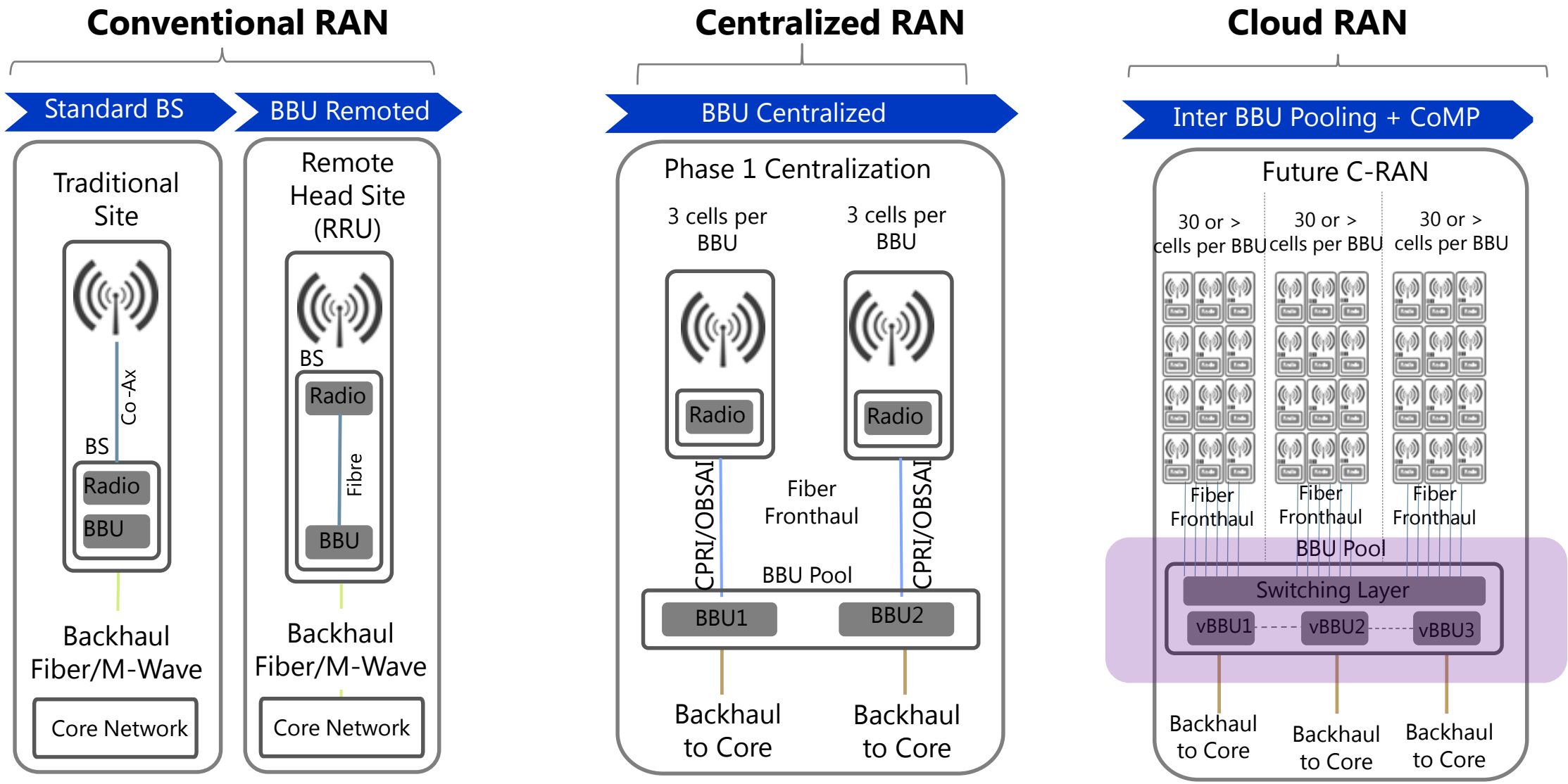
4x 694-960 MHz
4x 1695-2690 MHz
4x 3300-3800 MHz
2x 5150-5925 MHz

300 x 670 mm

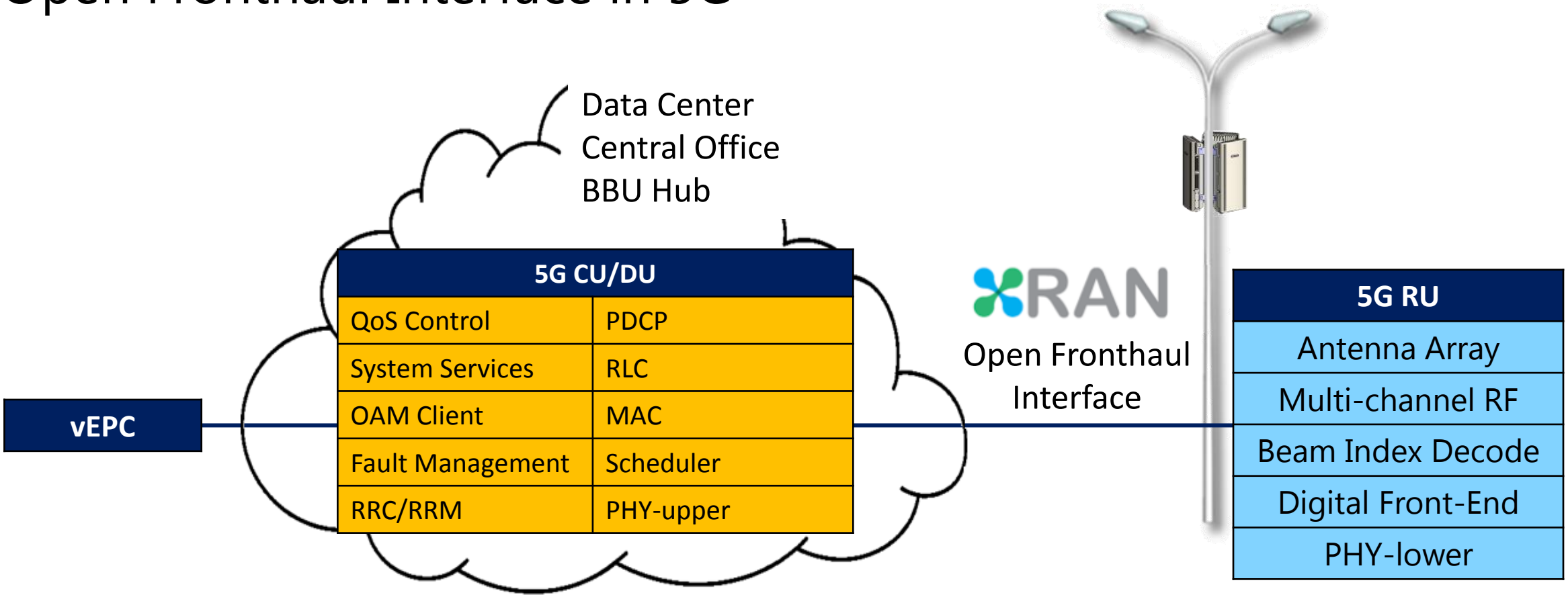
Antenna evolution into 5G



Evolution to CRAN Architecture



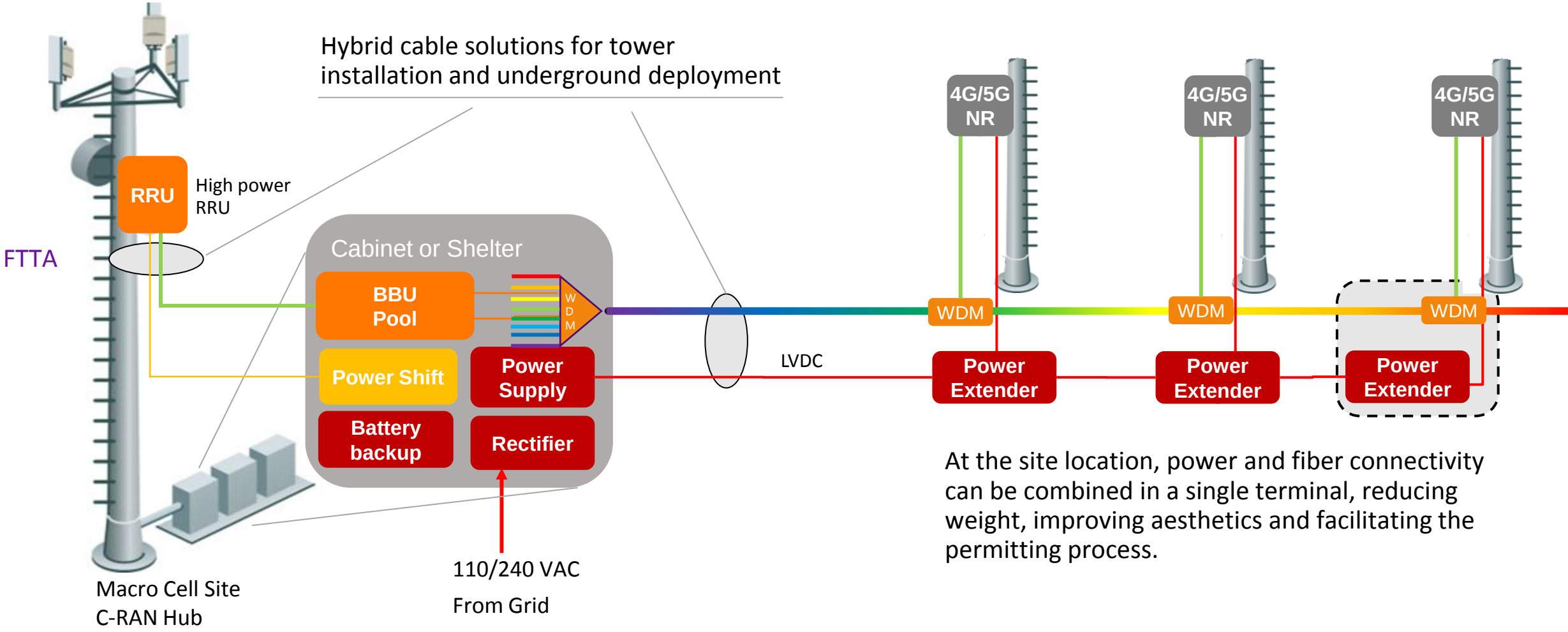
Open Fronthaul Interface in 5G



Open, Interoperable and Scalable Fronthaul

- Splits catering to multiple use-cases (Massive MIMO, C-RAN, LAA, 5G etc.)
- Full interoperability in data, control & OAM

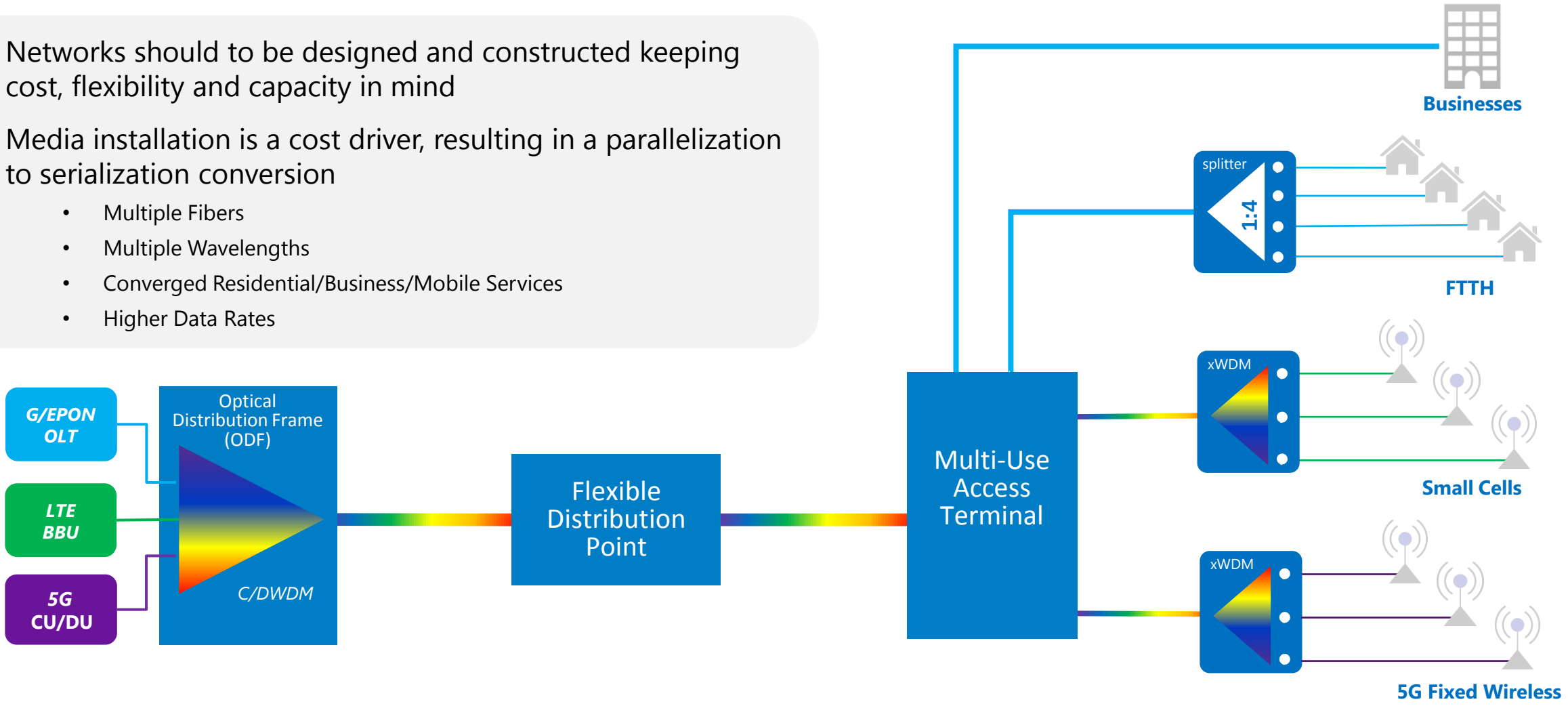
CRAN Architecture: Power and Backhaul



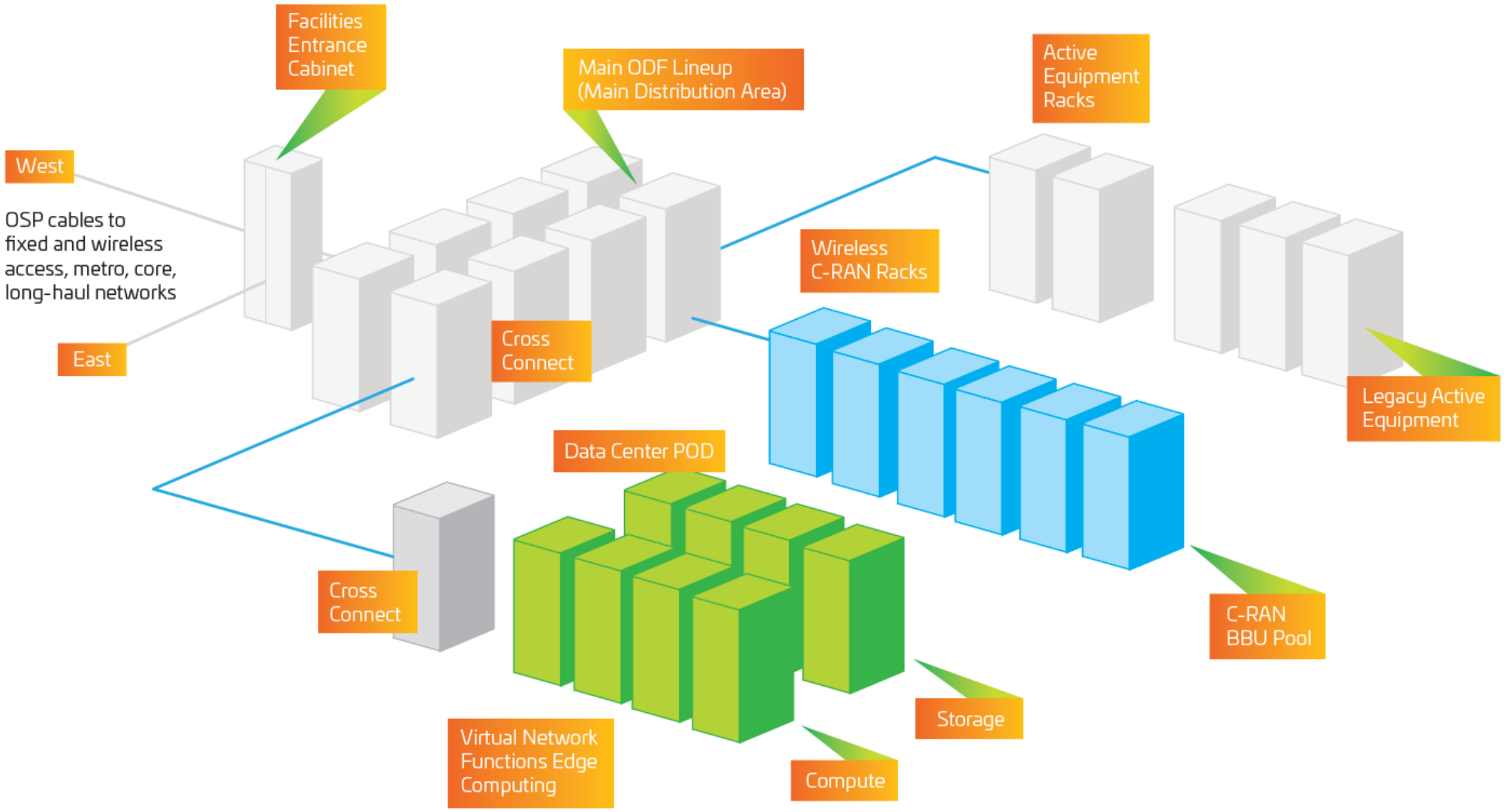
At the site location, power and fiber connectivity can be combined in a single terminal, reducing weight, improving aesthetics and facilitating the permitting process.

CRAN Architecture: Convergence of Access Network

- Networks should to be designed and constructed keeping cost, flexibility and capacity in mind
- Media installation is a cost driver, resulting in a parallelization to serialization conversion
  - Multiple Fibers
  - Multiple Wavelengths
  - Converged Residential/Business/Mobile Services
  - Higher Data Rates



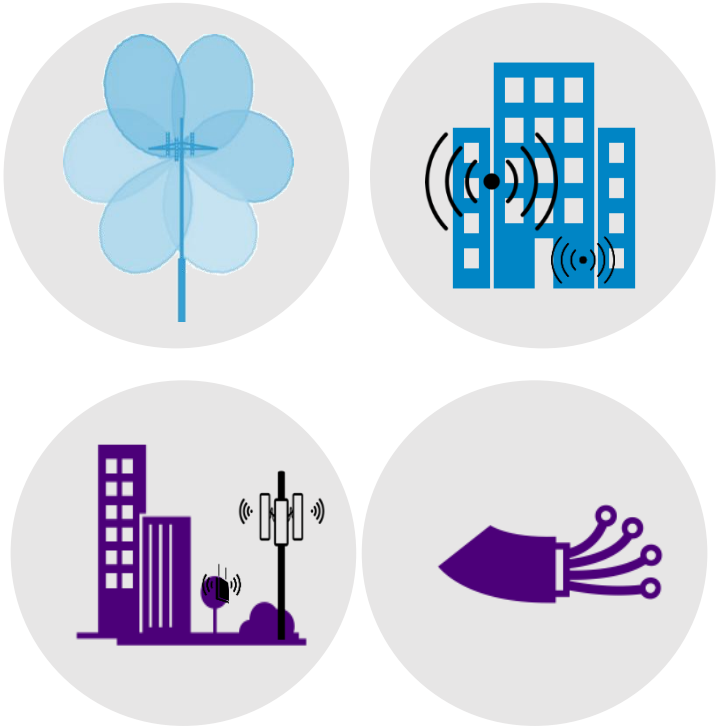
CRAN Architecture: Central Office Evolution



1. Use a structured cabling design with clear demarcation to connect VNF pod and legacy CO-ODF
2. Separate NFV from legacy central office
3. Use a modular approach

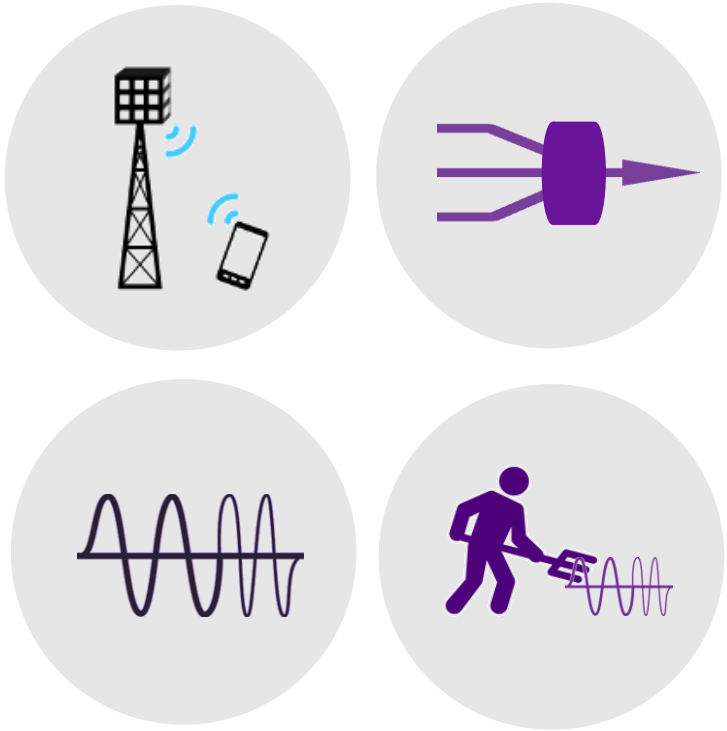
Preparing The Network for 5G & Beyond

Densification



Virtualization

Optimization



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