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A Teradyne Company

The next crucial roll out in 5G networks: Small Cells, CPEs, and RRHs

Contents

- Radio Access Network (RAN) Evolution
- Small Cell Deployment Scenarios and Architectures
- 5G Small Cell Test Solutions

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Radio Access Network (RAN) Evolution

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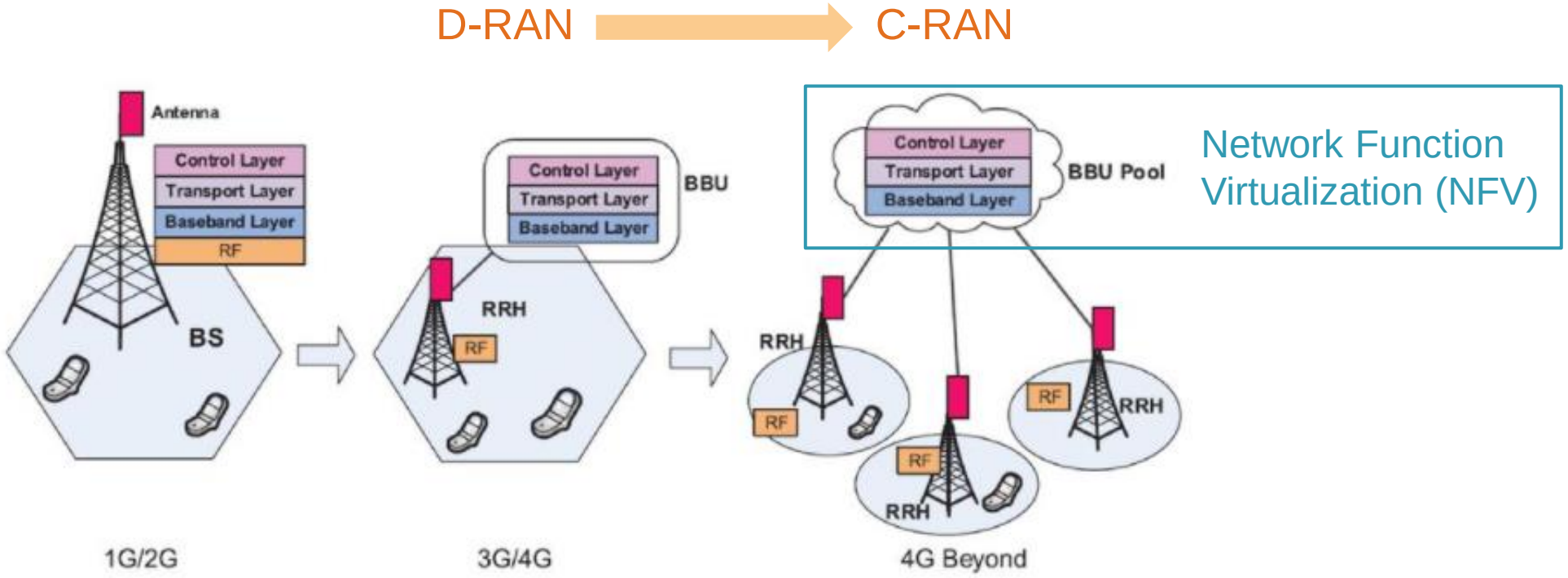
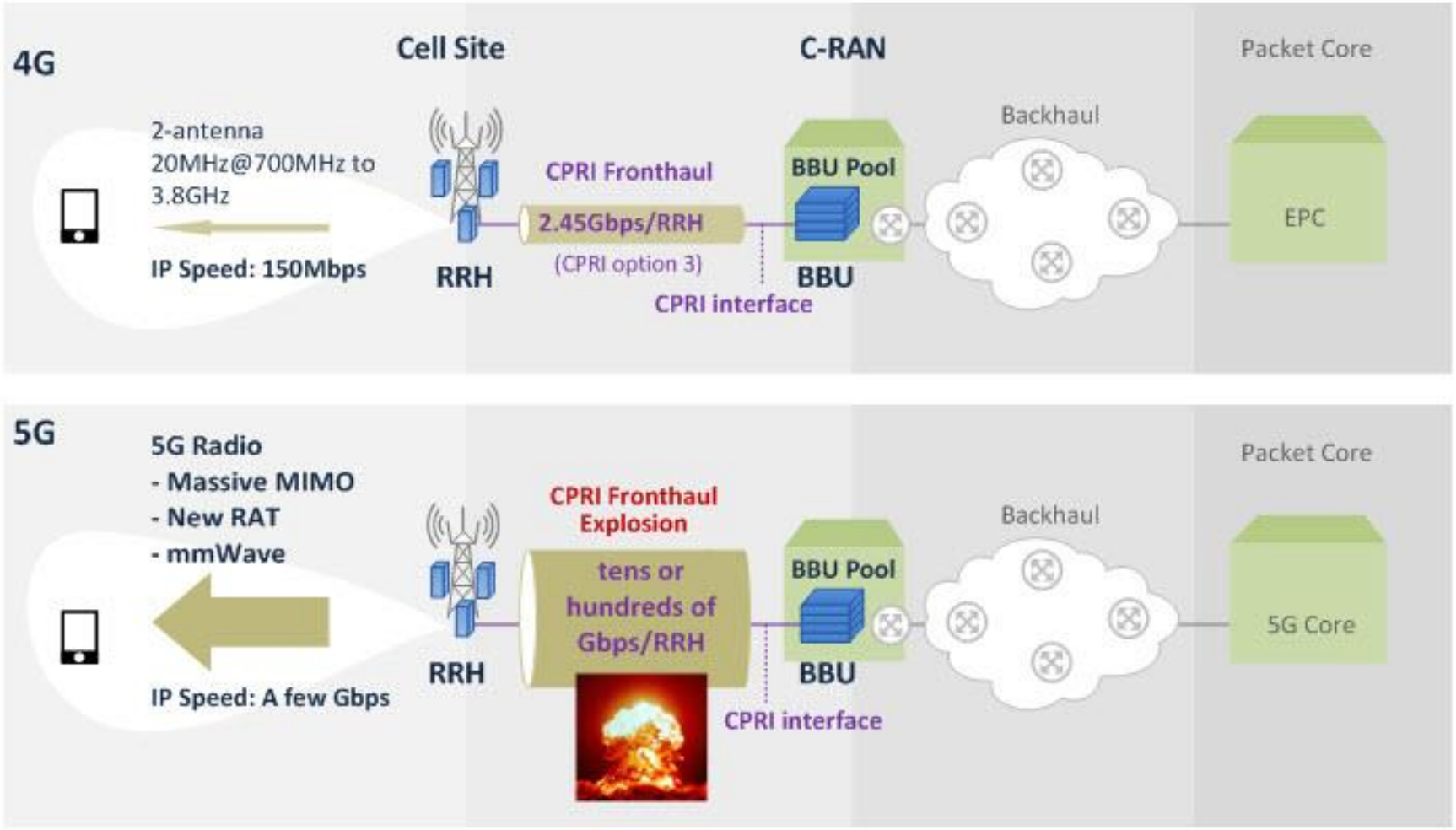
Evolution of Base Stations in RAN

- Distributed RAN (D-RAN) to Centralized RAN (C-RAN)
  - Centralized RAN paves the way for the eventual major shift to Cloud RAN or Virtual RAN (vRAN)



CRPI Fronthaul Explosion due to 5G Radio Speed



Source: Mobile Network Architecture for 5G Era - New C-RAN Architecture and Distributed 5G Core

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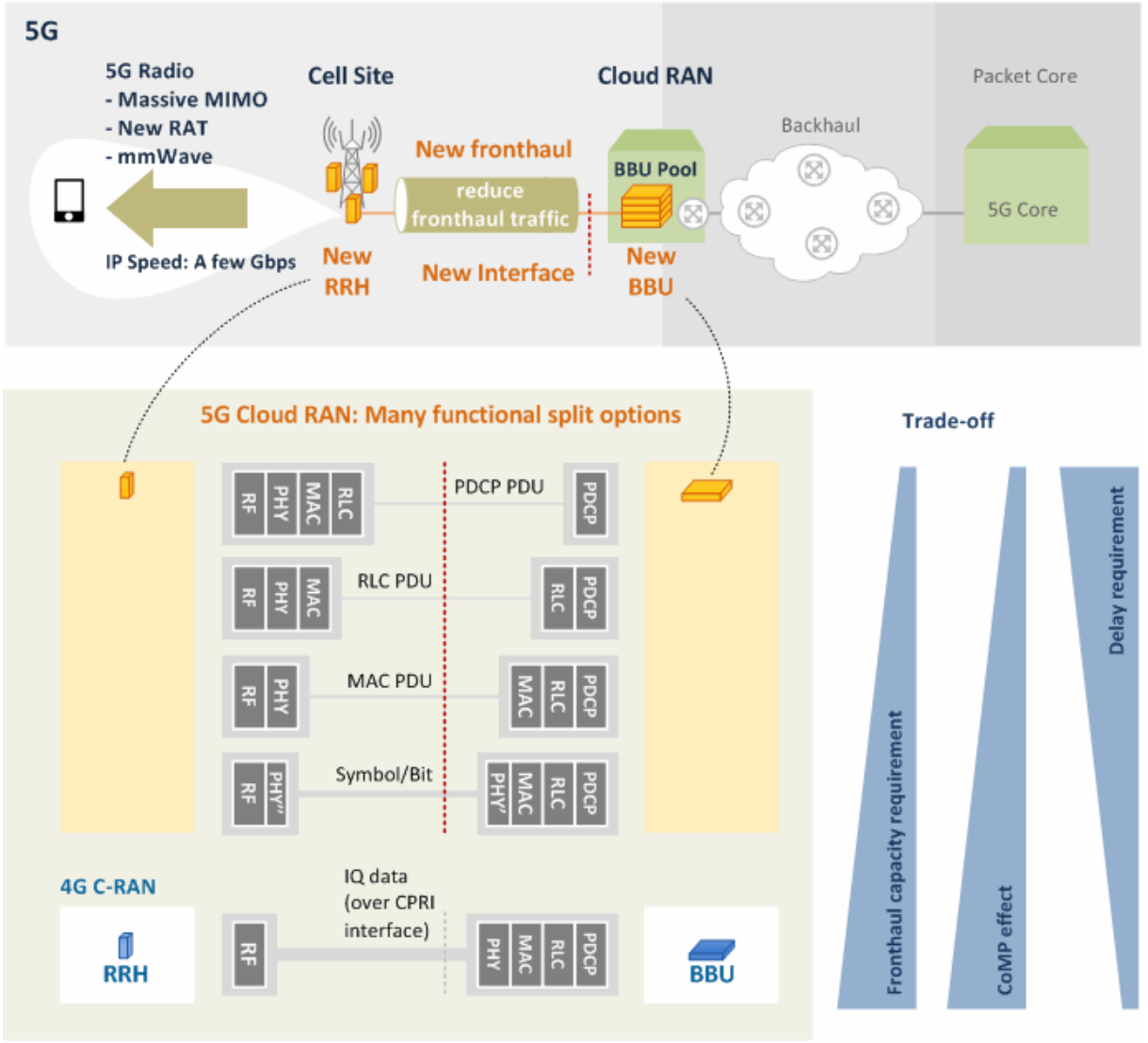
Functional Split between BBU and RRH



Source: Mobile Network Architecture for 5G Era - New C-RAN Architecture and Distributed 5G Core

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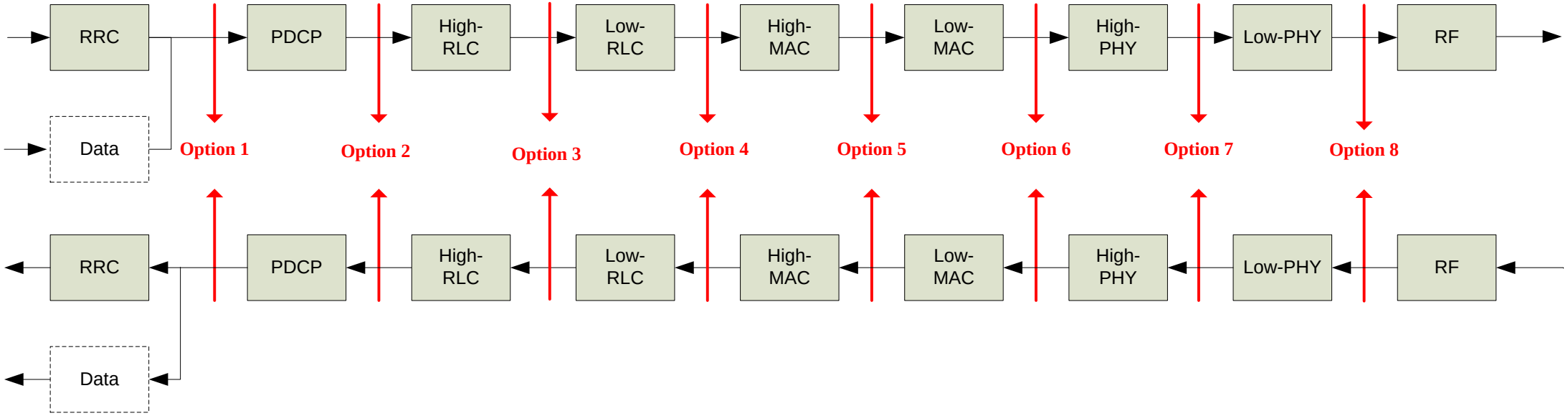
5G Functional Split

- 3GPP identified eight possible functional splits (FSs)



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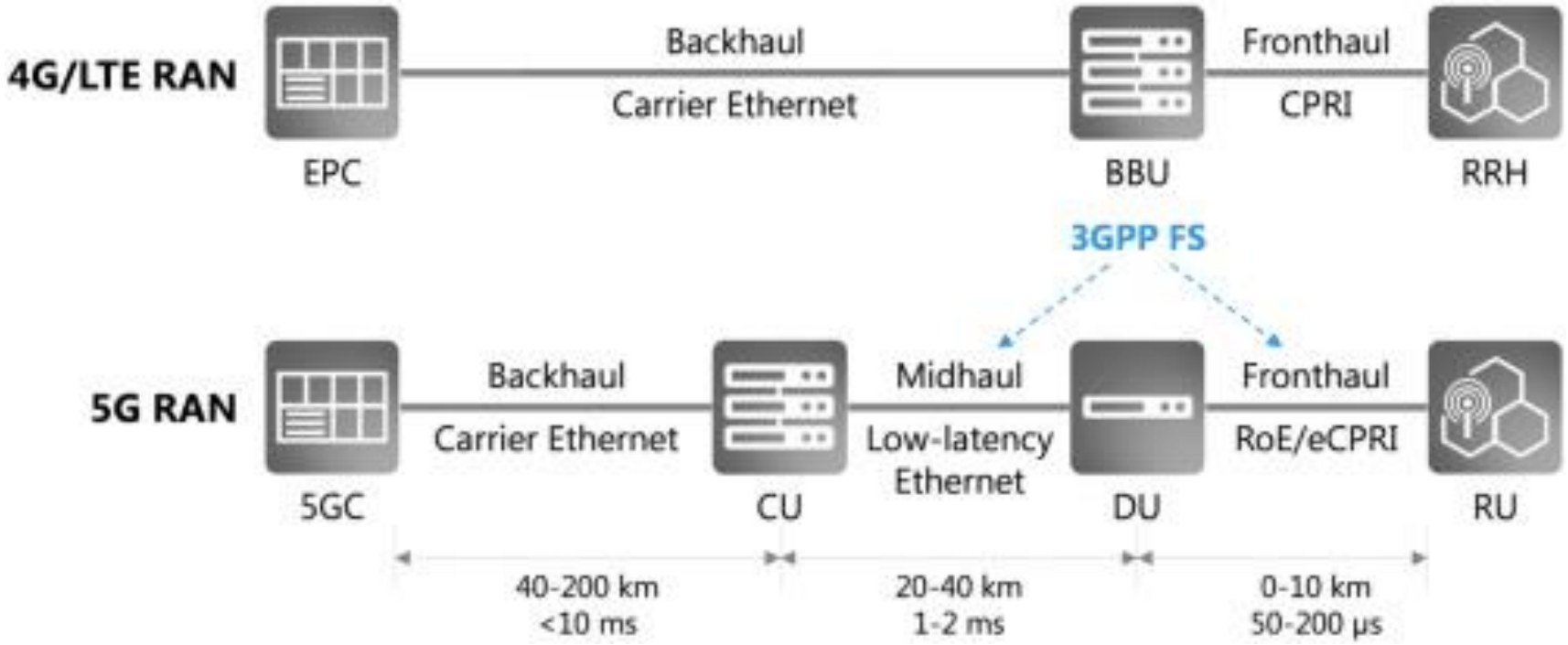
Evolution from 4G to New 5G RAN Architecture

- 3GPP introduced new functional blocks and interfaces for the 5G radio access network (RAN) architecture, a.k.a. next-generation RAN (NG-RAN), consisting of the 5G core network (5GC) and 5G radio base station next-generation NodeB (gNB).



Source: Advanced optical access technologies for next-generation (5G) mobile networks

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Small Cell Deployment Scenarios and Architectures

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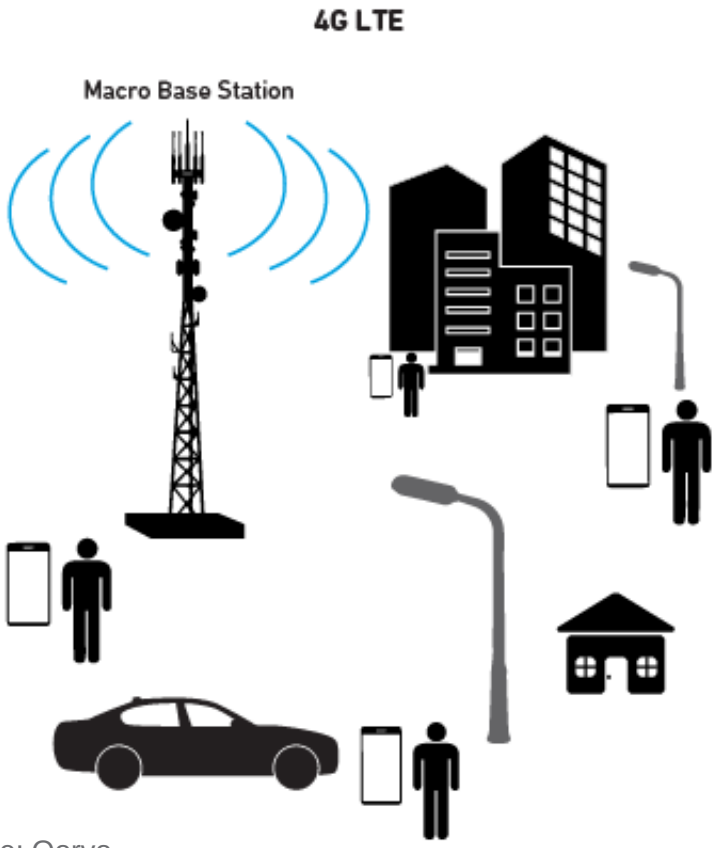
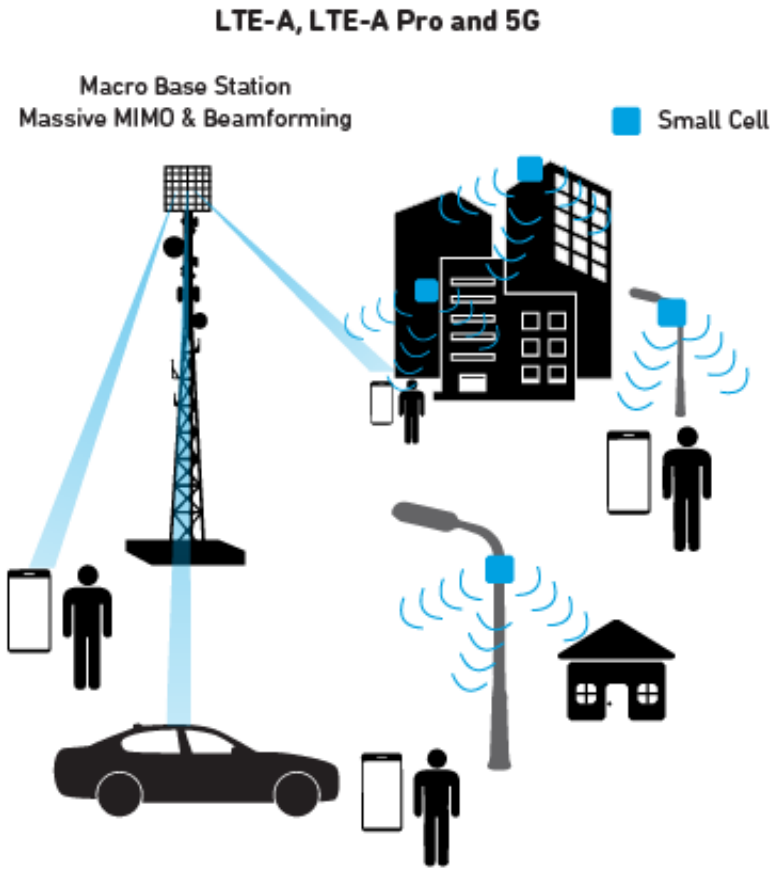
What is Small Cell?

- A small cell is a cellular base station that transmits & receives 3GPP-defined RF signals with small power and small form factor. In most cases, it services a small coverage area.





Source: Qorvo

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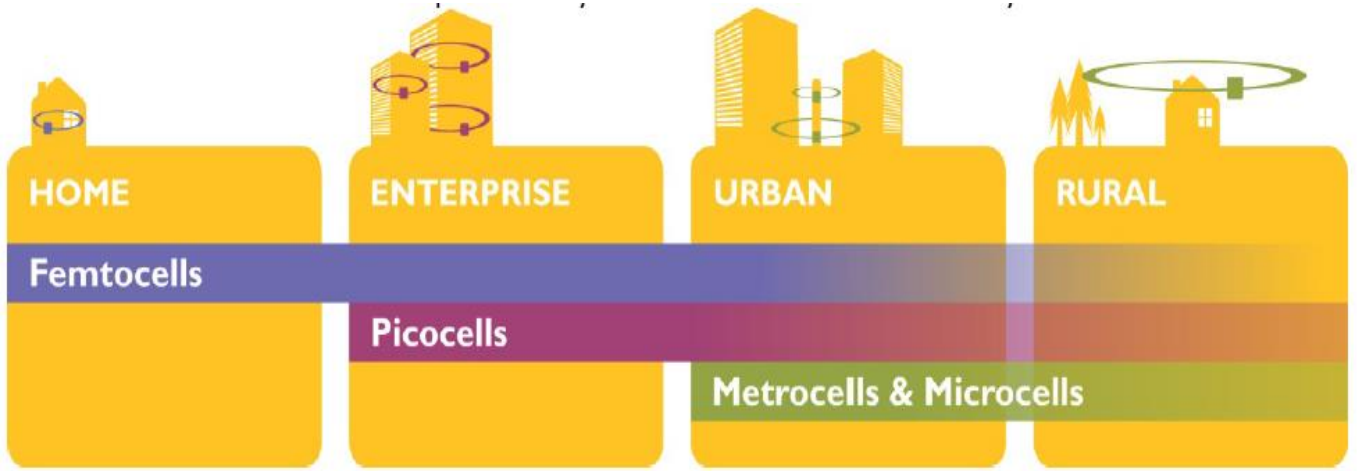
Small Cells Types and Use Case Applications

TABLE 1: SIZING UP SMALL CELLS				
Cell type	Output power (W)	Cell radius (km)	Users	Locations
Femtocell	0.001 to 0.25	0.010 to 0.1	1 to 30	Indoor
Picocell	0.25 to 1	0.1 to 0.2	30 to 100	Indoor/ outdoor
Microcell	1 to 10	0.2 to 2.0	100 to 2000	Indoor/ outdoor
Macrocell	10 to >50	8 to 30	>2000	Outdoor



Femtocell, Picocell and Microcell are called Small Cells

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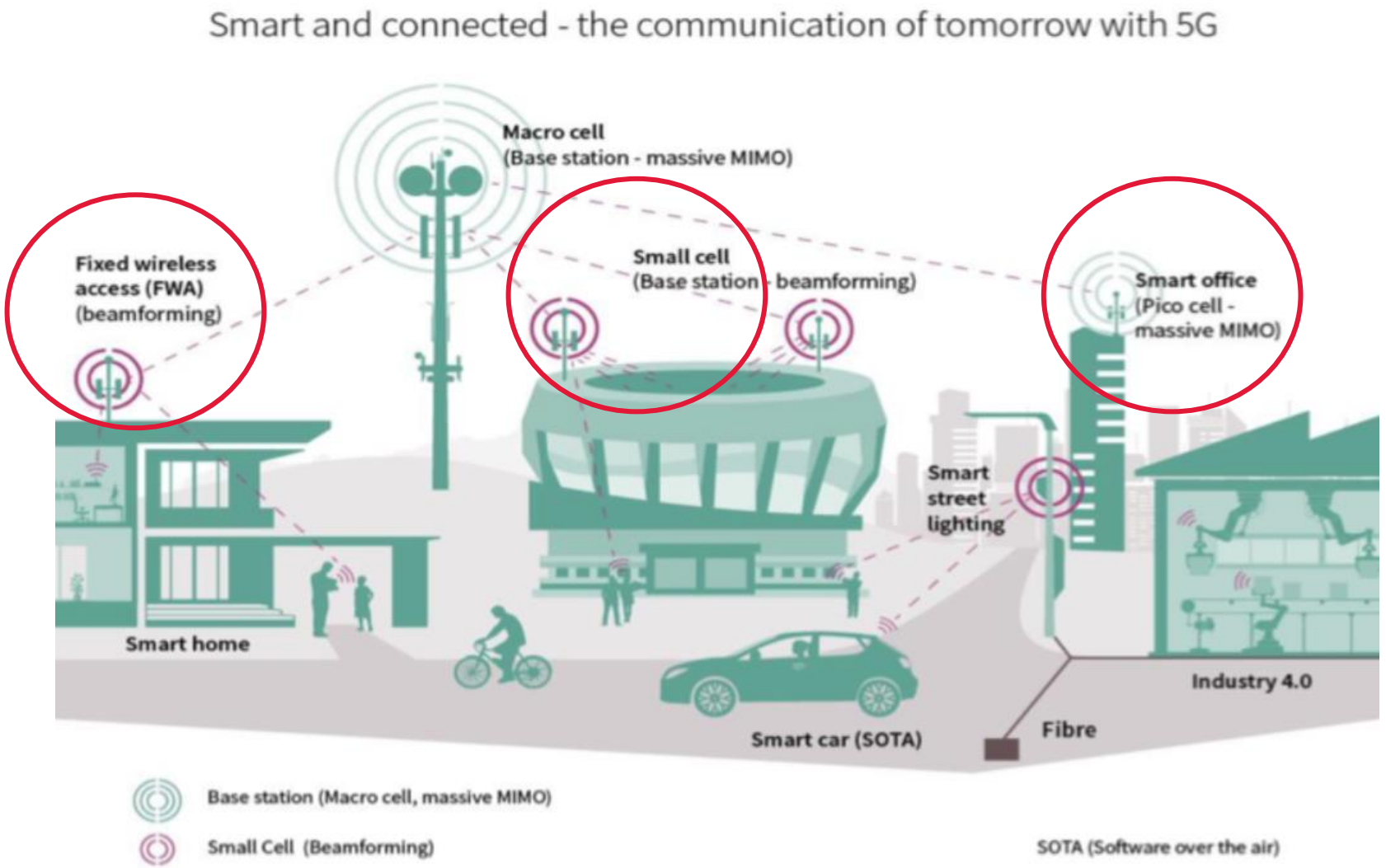
Small Cells and FWA CPEs in 5G Networks



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Small Cell Deployment Scenarios

These deployment scenarios are used to determine which architectures, splits and small cell product configurations operators and vendors are considering

Residential (or SOHO):
Indoor deployment

Indoor enterprise:
office spaces, commercial real estate, hotels, healthcare

Private Industrial:
Indoor/outdoor private networks to support enterprise and industrial applications

Campus environments venues, educational institutions and stadiums

Outdoor dense urban public

Outdoor rural public

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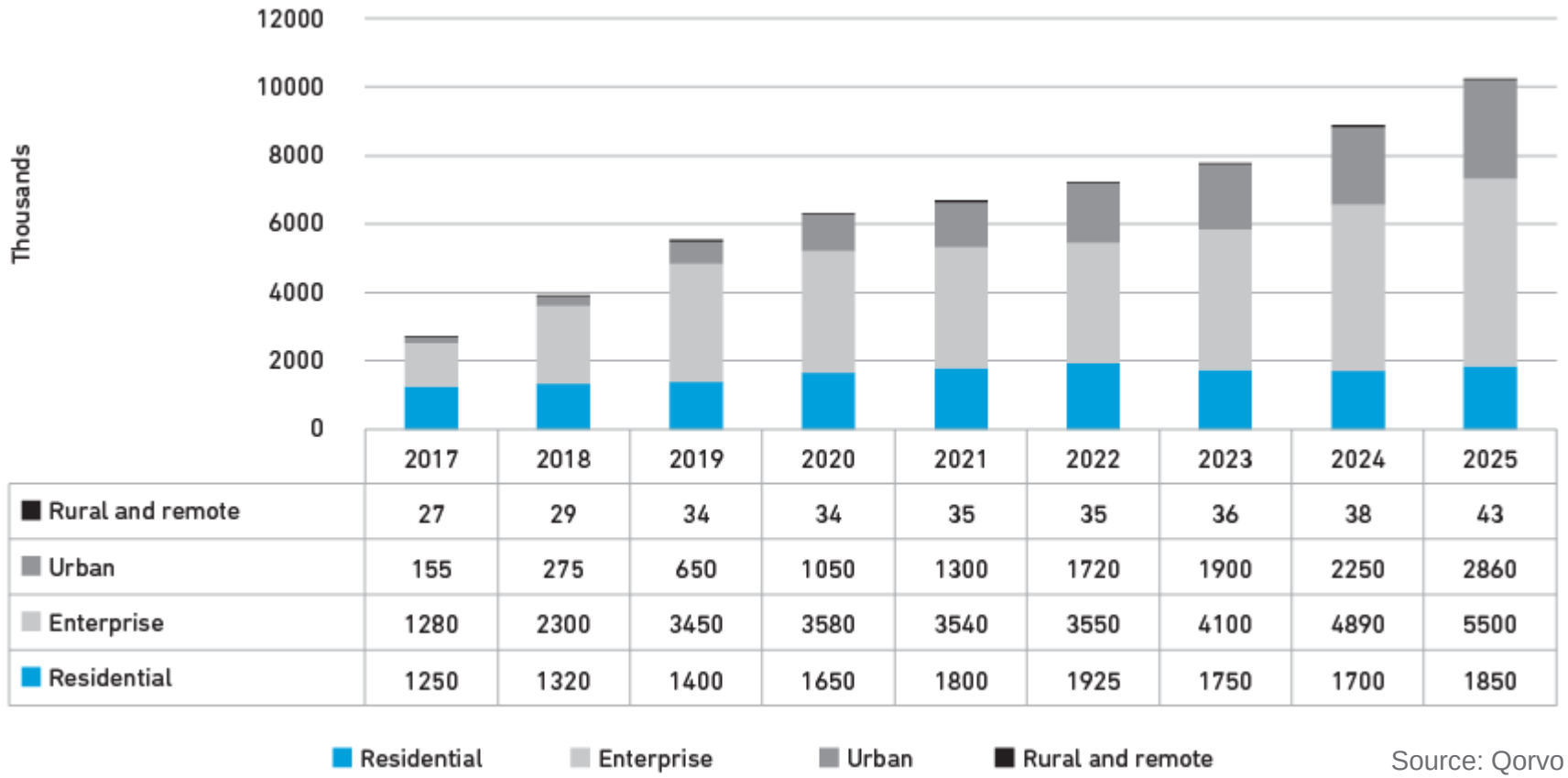
Small Cell Deployment Scenarios

Market segments: 50% for enterprise, 30% for urban, 20% for residential



	2017	2018	2019	2020	2021	2022	2023	2024	2025
Rural and remote	27	29	34	34	35	35	36	38	43
Urban	155	275	650	1050	1300	1720	1900	2250	2860
Enterprise	1280	2300	3450	3580	3540	3550	4100	4890	5500
Residential	1250	1320	1400	1650	1800	1925	1750	1700	1850

Source: Qorvo

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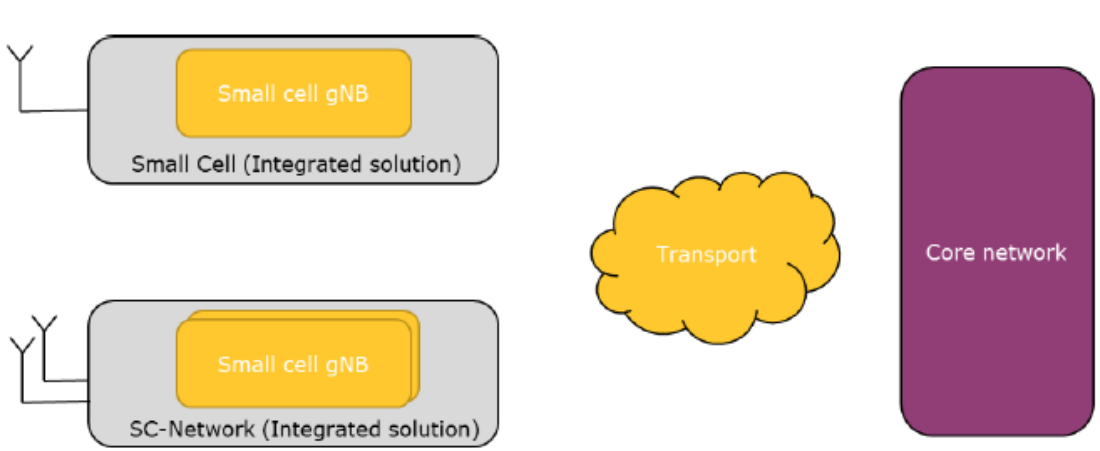
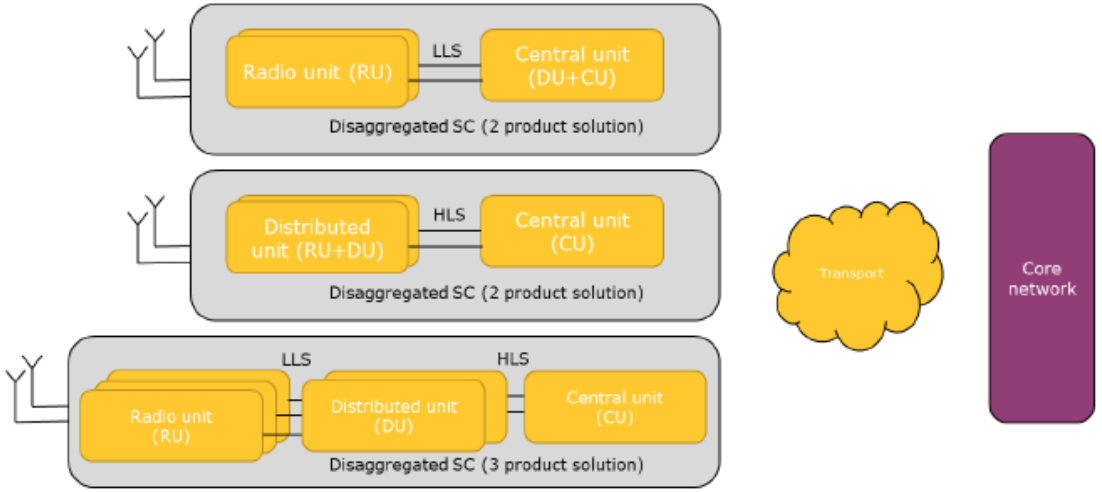
Integrated and Disaggregated Small Cell

Integrated



Integrated small cells with collapsed gNB/RAN functionality

Disaggregated



Disaggregated gNB/RAN architecture for different network splits

Source: Small Cell Forum

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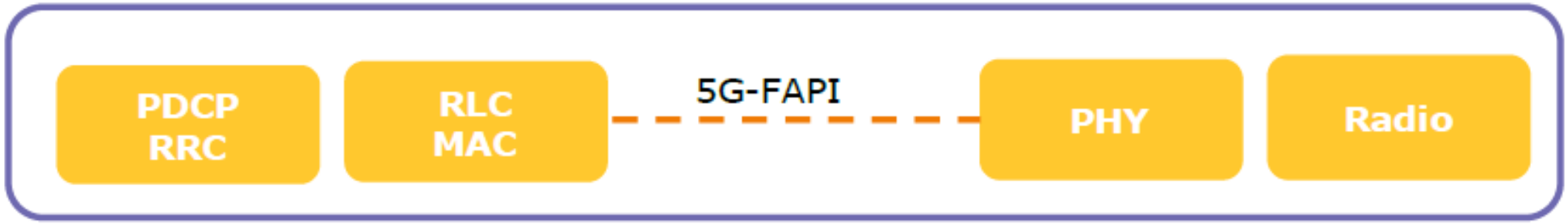
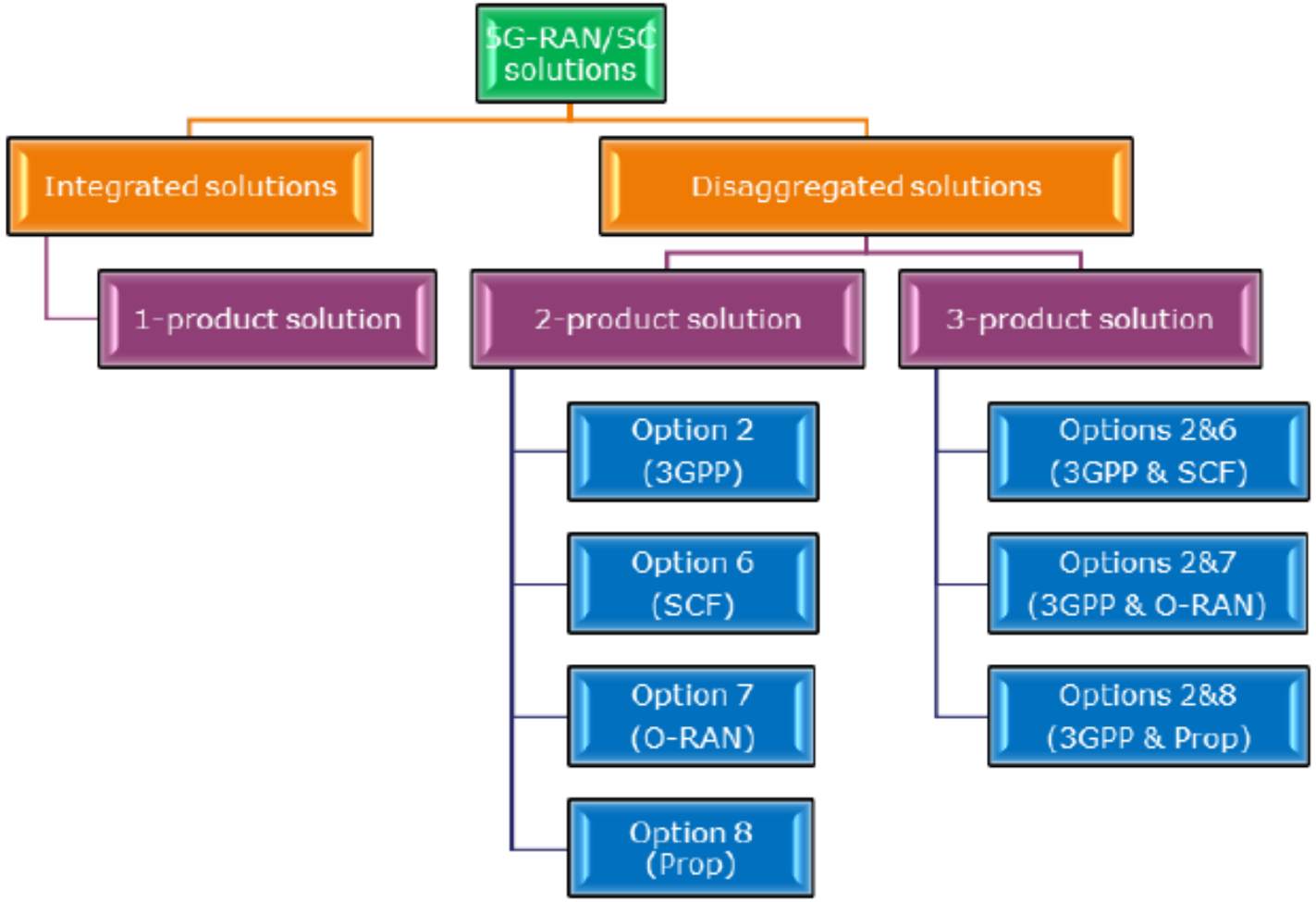
Integrated (All-In-One) Small Cells

- The integrated small cells provide RAN gNB layer 1,2,3, RF and antenna functionality within a single physical unit and interface with the core network through the 3GPP NG interface.
- Examples of these are products for residential, SME applications and industrial/private deployments
- Advantages include ease of installation (plug ‘n’ play) and suitability for low-bandwidth copper backhaul. Disadvantages include capability limitations and lack of scalability.



Source: Small Cell Forum

Disaggregated Small Cell Networks



- Disaggregation of RAN and Small Cell Networks can potentially bring several advantages:
  - Efficient operation of remote radio units via centralized units
  - Gains of pooling centralized resources
  - Potential cost reduction due to low complexity radio units & shared centralized units

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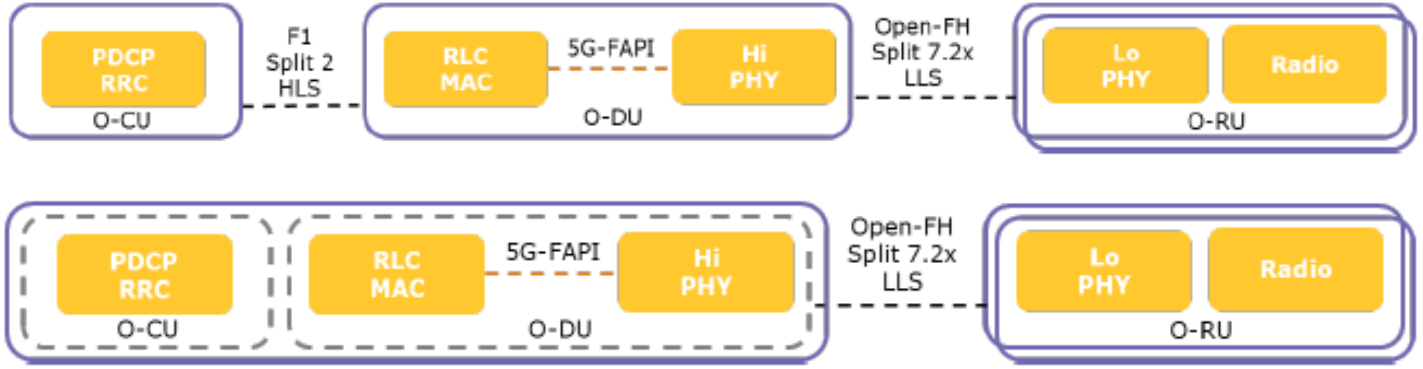
Disaggregated Small Cell Networks

- 3GPP Split Option-2 Solution

3GPP defines the higher layer split 2 with the F1 interface between the gNB-CU and one or more gNB-DUs.

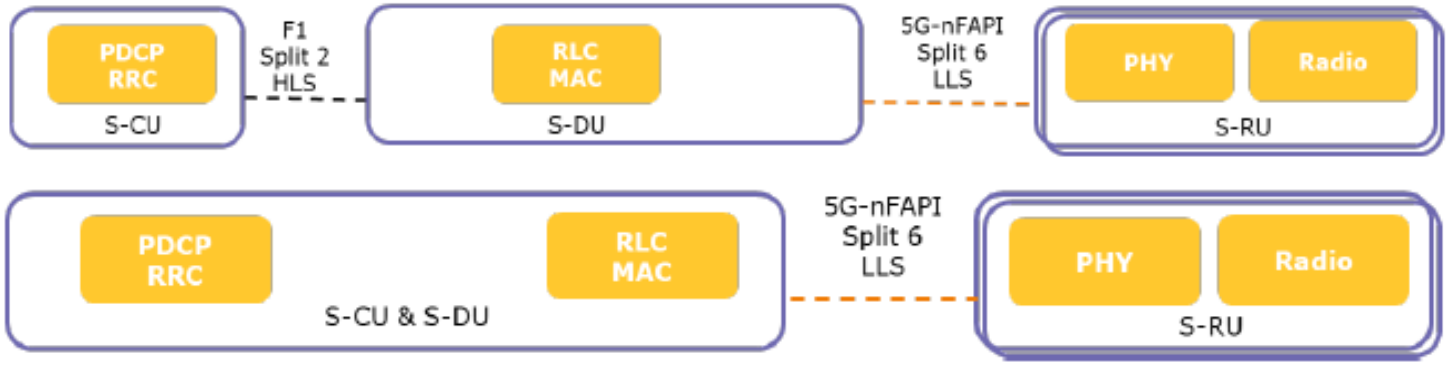
- O-RAN Split Option-7.2x Solutions



O-RAN has defined a two or three-product solution, with lower layer split option-7.2x and upper layer split option-2.
The 7.2x split is defined by the O-RAN open fronthaul Interface between the O-DU and O-RU, which uses the eCPRI protocol specification

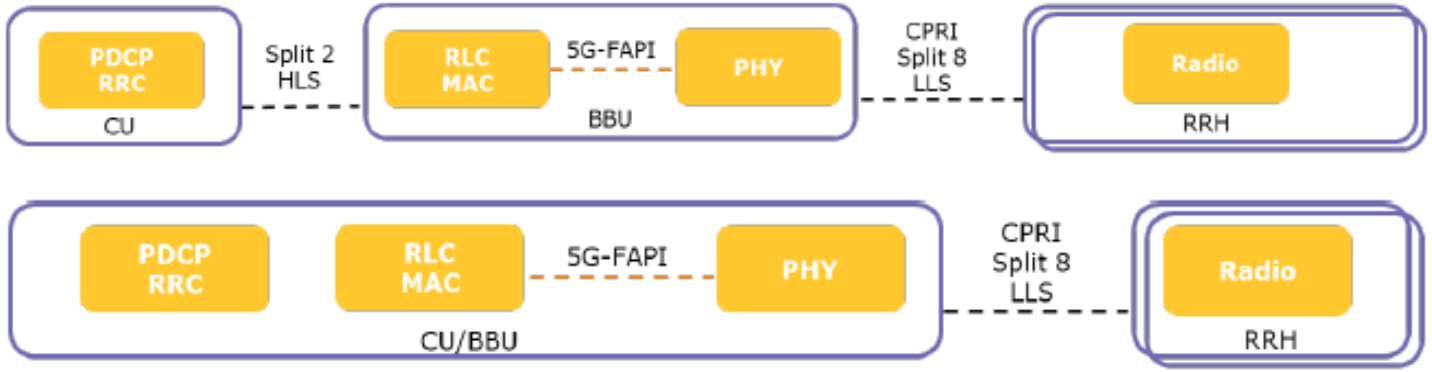
Disaggregated Small Cell Networks

- SCF Split Option-6 Solutions



In addition to the SCF FAPI interfaces which provide architecture agnostic APIs between the RF or PHY and higher layer software, the Small Cell Forum is defining the 5G nFAPI message open RAN interface between the S-DU and S-RU(s) over the low layer split 6 fronthaul.

- Proprietary Split Option-8 Solutions



The lowest lower layer split used in the industry is implemented for LTE, and in some early 5G deployments, particularly by MNOs in China where there is ideal fronthaul fiber availability. The fronthaul interface uses a proprietary CPRI specification

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5G Small Cell Test Solutions

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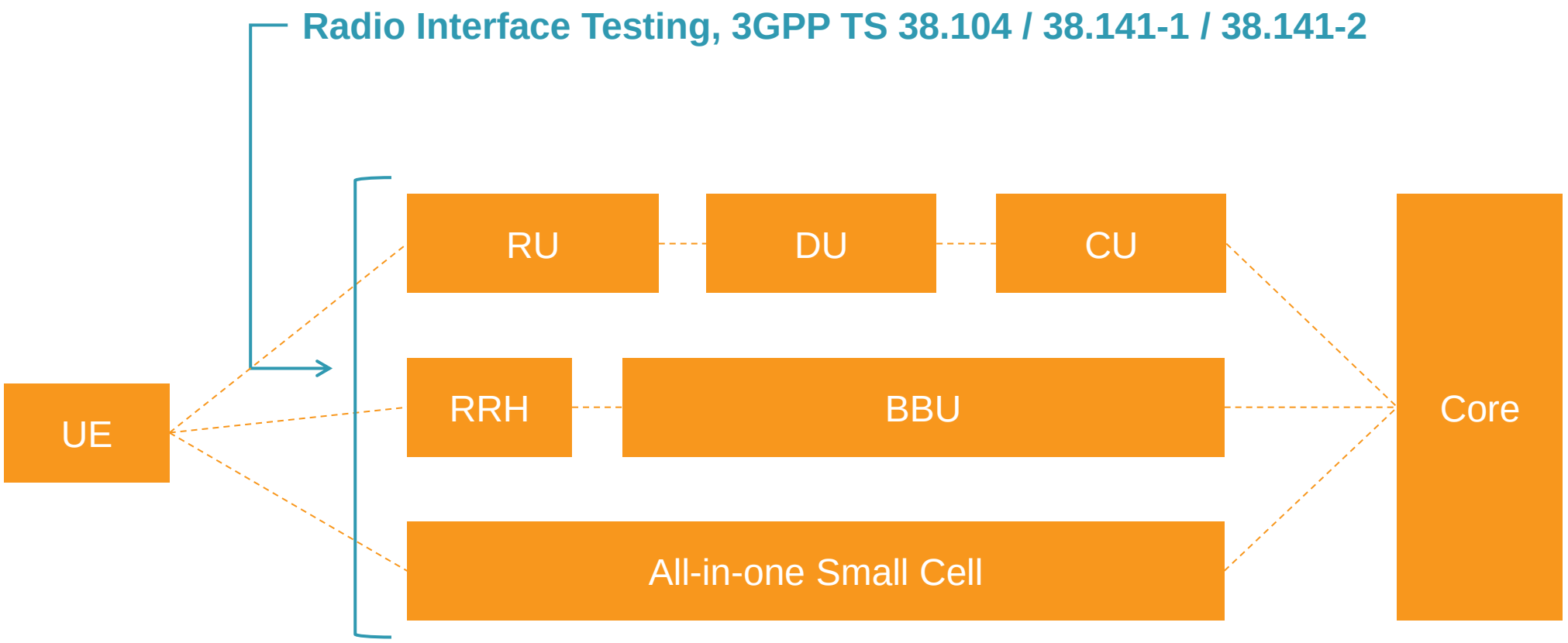
5G Small Cell Radio Interface Testing



LitePoint 5G Small Cell Test Solutions

IQxstream-5G

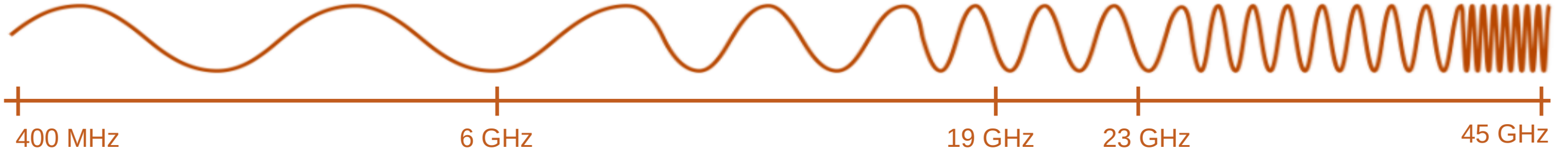
- Frequency Range 400 – 6000 MHz
- 200 MHz Bandwidth
- Sub 6GHz (FR1) 5G
- Supports existing 2G/3G/4G
- Supports WiFi 802.11n/ac/ax

IQgig-IF

- Frequency Range 5 – 19 GHz
- 1.7 GHz Bandwidth
- Module IF interface testing
- Supports 3GPP NR specifications
- Supports WiGig 802.11ad/ay

IQgig-5G

- Frequency Range 23 – 45 GHz
- 1.7 GHz Bandwidth
- Fully-integrated 3GPP NR 5G
- Supports 100MHz, 400 MHz & 8x100 MHz CA test cases



Comprehensive 5G Test Coverage for FR1 and FR2 Devices

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LitePoint Solution Highlights

- Comprehensive non-signaling 5G test coverage for FR1 and FR2 devices
- Single platform for UE (such like FWA CPE) and Small Cell testing
- Fully integrated VSA & VSG
- Multi technology support
- Easily scalable from R&D to production
- Intuitive GUI for real time RF parametric analysis
- Automated test tool for production

3GPP Small Cell/Radio Unit FR1 Test Item Support

Characteristics	3GPP Test Item		Section	
Conducted transmitter characteristics	Base station output power		6.2	Test Models, ex TM1.1, TM2, TM3.1, etc.
	Output power dynamics	Total power dynamic range	6.3.3	
	Transmit ON/OFF power	Transmitter OFF power	6.4.1	
		Transmitter transient period	6.4.2	
	Transmitted signal quality	Frequency error	6.5.2	
		Modulation quality	6.5.3	
		Time alignment error	6.5.4	
	Unwanted emissions	Occupied bandwidth	6.6.2	
		Adjacent Channel Leakage Power Ratio (ACLR)	6.6.3	
		Operating band unwanted emissions	6.6.4	
Conducted receiver characteristics	Reference sensitivity level		7.2	Reference meas channels, G-FR1-Ax-x
	In-band selectivity and blocking	Adjacent channel selectivity	7.4.1	
		In-band blocking	7.4.2	
	Receiver intermodulation		7.7	
	In-channel selectivity		7.8	

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3GPP Small Cell/Radio Unit FR2 Test Item Support

Characteristics	3GPP Test Item		Section	
Radiated transmitter characteristics	Radiated transmit power		6.2	Test Models, TM1.1, TM2, TM3.1
	OTA base station output power		6.3	
	OTA output power dynamics	OTA total power dynamic range	6.4.3	
	OTA transmit ON/OFF power	OTA transmitter OFF power	6.5.1	
		OTA transmitter transient period	6.5.2	
	OTA transmitted signal quality	OTA Frequency error	6.6.2	
		OTA modulation quality	6.6.3	
		OTA time alignment error	6.6.4	
	OTA unwanted emissions	OTA occupied bandwidth	6.7.2	
		OTA Adjacent Channel Leakage Power Ratio (ACLR)	6.7.3	
		OTA operating band unwanted emissions	6.7.4	
Radiated receiver characteristics	OTA reference sensitivity level		7.3	Reference meas channels, G-FR2-Ax-x
	OTA in-band selectivity and blocking	OTA adjacent channel selectivity	7.5.1	
		OTA in-band blocking	7.5.2	
	OTA receiver intermodulation		7.8	
	OTA in-channel selectivity		7.9	

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Press Release

Qualcomm and LitePoint Enter Into Agreement for Testing Small Cell Products

LitePoint 5G Test System Enabled to Test Qualcomm® 5G RAN Platform for Small Cells

SAN JOSE, California — May 4, 2021 — LitePoint, a leading provider of wireless test solutions, today announced it has signed an agreement with Qualcomm Technologies, Inc. to support LitePoint's development of its 5G test solutions for the Qualcomm 5G RAN Platform for Small Cells (FSM 100xx) to accelerate small cell deployment.

Small cells are crucial for mobile operator 5G network deployments, as they are designed to provide increased coverage and uniform 5G user experiences while delivering high data rate and low latencies. Specifically, 5G small cells offer superior power consumption and performance while enabling greater coverage and throughput in high-density, metropolitan areas and growing indoor enterprise environments.

To address the emerging 5G small cell market and accelerating 5G deployments in outdoor metropolitan and indoor enterprise locations, LitePoint offers its 5G test solutions, which have been updated to provide comprehensive non-signaling test coverage of small cell base stations.

"This 5G small cell engagement is built on the longstanding, trusted and successful cooperation between the companies for many years and leverages their in-depth expertise to enable 5G small cells," said Rex Chen, Director of Strategic Business Development at LitePoint. "We are pleased to work with Qualcomm to support product design through manufacturing test for its 5G small cell solution."

"We are pleased to be working with LitePoint to support the rapidly growing 5G industry with enhanced mobile broadband connectivity by improving network coverage, capacity, performance and power efficiency through our advanced 5G RAN solutions," said Victor Abramsky, vice president, engineering, Qualcomm Technologies, Inc. "By working with industry-leaders like LitePoint, we can accelerate the deployment of 5G small cells globally by providing customers with advanced 5G technologies."


Questions & Answers
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