EDGE Q

5G WITH AN **EDGE**

ADIL KIDWAI | HEAD OF PRODUCTS

5G Scaling Challenges: from Small Cell to ORAN

MANY APPS. MANY REQUIREMENTS. MANY SPLITS
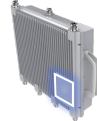
Enterprise
(Factory 4.0)

- 32 Active Users
- 4T 4R
- 5.0 Gbps
- Low Latency

Outdoor
(Fixed Wireless)

- 32 Active Users
- 2T 2R
- 2.5 Gbps
- Low Cost

Outdoor Macro
(Remote Areas)

- 128 Active Users
- 4T 4R / 8T 8R
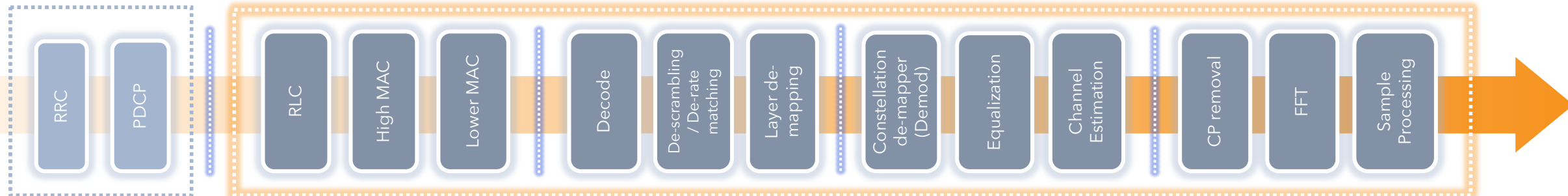- 5.0 Gbps
- High EIRP

Cell Site
(O-RAN Base Station)

- Up to 16 Carriers
- < 50Watts
- 20 Gbps User Rate

Pre-Aggregation
(Cloud Data Center)

- Up to 16 Carriers
- < 50Watts
- 20 Gbps User Rate

| RRC | PDCP | | RLC | High MAC | Lower MAC | | Decode | De-scrambling / De-rate matching | Layer de-mapping | | Constellation de-mapper (Demod) | Equalization | Channel Estimation | | CP removal | FFT | Sample Processing |

Option 0   Option 2   Option 6   Option 7.3x   Option 7.2x
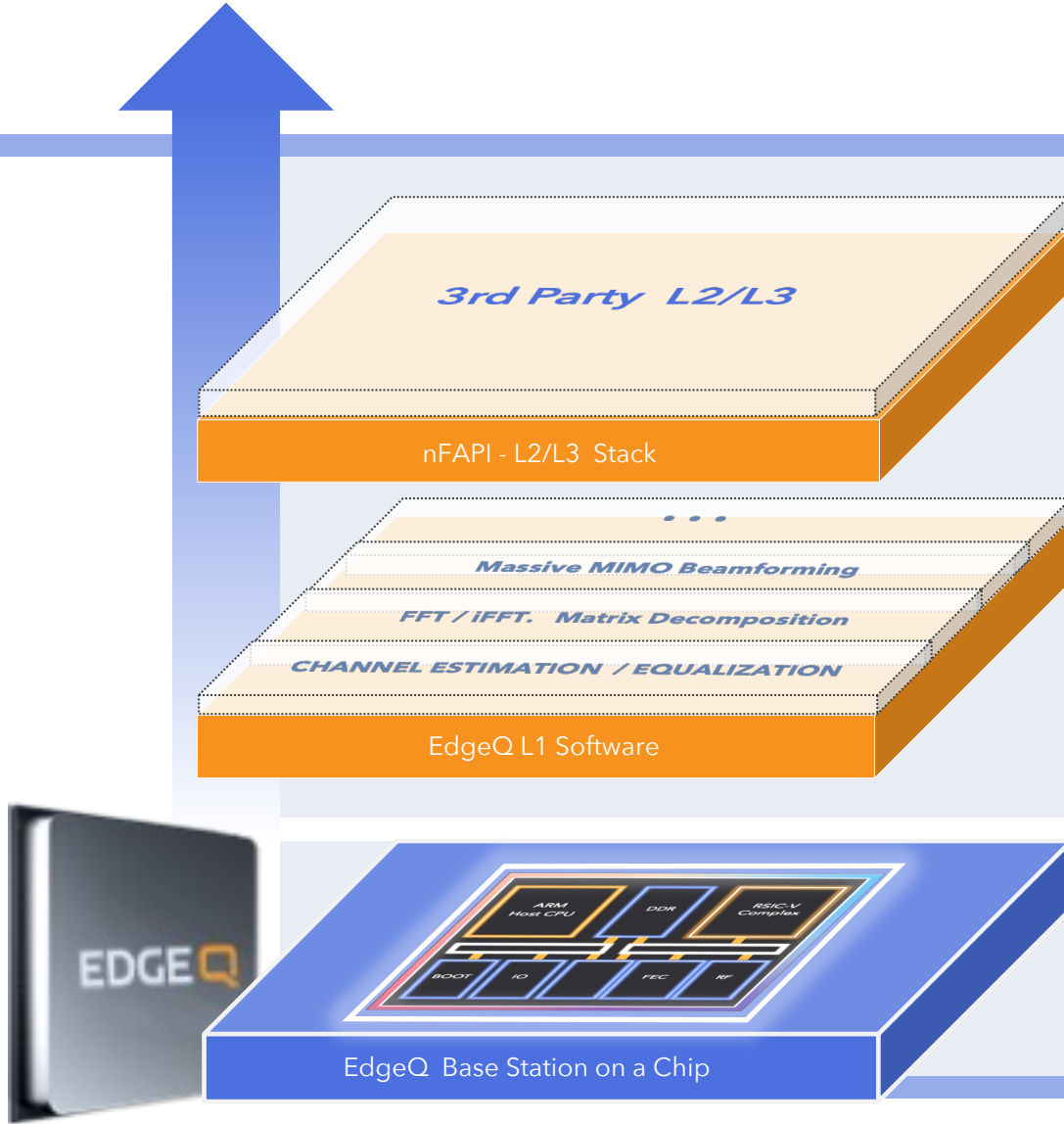
EDGEQ INC

EDGEQ

5G Challenges

4G to 5G transition

- Can Same Silicon Support 4G and 5G Simultaneously

- What Happens When a 4G band is Refarmed as 5G band
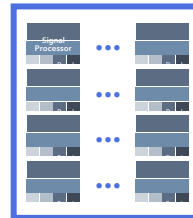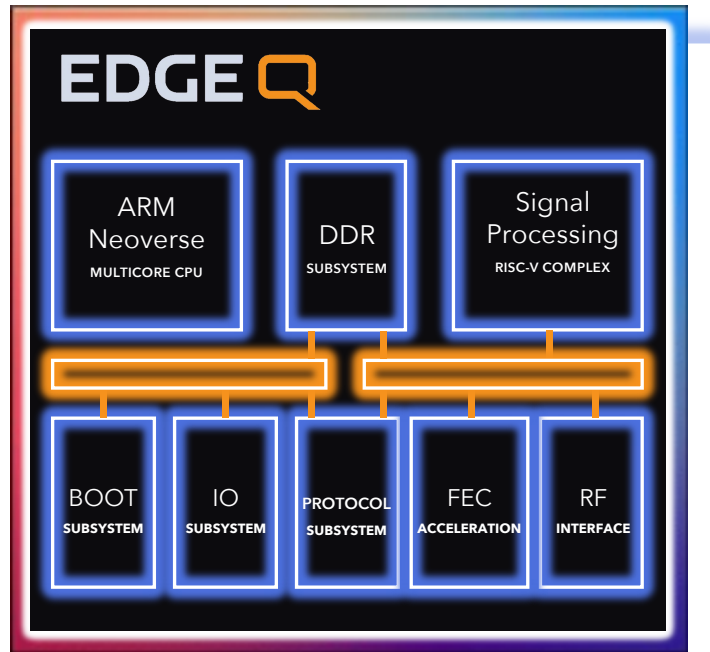
- No Rip or Replace

- Low Switching Cost

EDGE Q

A World's First.

ONE STOP SHOP: 4G+5G+AI.   ALL SOFTWARE DRIVEN

3rd Party L2/L3

nFAPI - L2/L3 Stack

. . .

Massive MIMO Beamforming

FFT / iFFT.   Matrix Decomposition

CHANNEL ESTIMATION / EQUALIZATION

EdgeQ L1 Software

EdgeQ Base Station on a Chip

ARM
Host CPU

DDR

RSIC-V
Complex

BOOT

IO

FEC

RF

Small Cell

**O-RAN
PCIe Card**

Integrated 4G+5G Software Defined Radio

High Capacity for Macro | Fraction of the Power and Cost

EdgeQ 5G Base Station-on-a-Chip

EDGE Q

- ARM Neoverse — MULTICORE CPU
- DDR — SUBSYSTEM
- Signal Processing — RISC-V COMPLEX
- BOOT SUBSYSTEM
- IO SUBSYSTEM
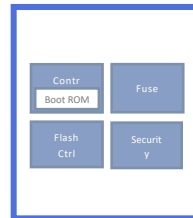- PROTOCOL SUBSYSTEM
- FEC ACCELERATION
- RF INTERFACE

Signal Processing Complex

Specialized Baseband Processor RISC-V ISA including 50+ custom instructions and extensions
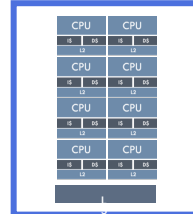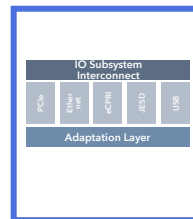
CPU Subsystem

Multi-Core, Multi-thread ARM Neoverse CPU Cluster for service provisioning and data processing
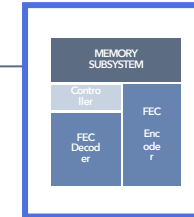
Boot Subsystem

Secure Boot Up via NOR / SPI/ NAND, Flash controller, Root of Trust Stored

IO Subsystem

Controllers for PCIe, USB, Ethernet, eCPRI, JESD, Inter-chip
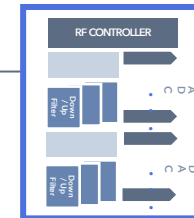
FEC Acceleration

Forward Error Correction (FEC) Engines and Bit Processing for 4G/5G
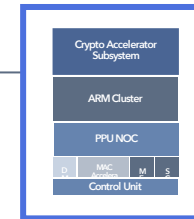
Protocol Accelerator

L2/L3 Accelerators for MAC and Cryptographic Processing

RF Interface

ADCs, DACs, and Up/Down Sampler Chains with Support for AGC/Channel Sense/Sigdet and DPD

MASSIVELY PARALLEL | FULLY PROGRAMMABLE | INTEGRATED (5G 4G + AI + NPU + CPU) | GNU TOOL CHAIN

EdgeQ Based 4G/G Small-Cell Solution

Seamless Integration, pre-tested in EdgeQ Lab, Interoperable with multiple devices

Crystal Oscillator · Flash Memory · DDR · USB · PMIC

Sensor 1 · Sensor 2 · Ethernet

EDGEQ

| ARM Neoverse | DDR | Signal Processing |
| MULTICORE CPU | SUBSYSTEM | RISC-V COMPLEX |

| BOOT | IO | PROTOCOL | FEC | RF |
| SUBSYSTEM | SUBSYSTEM | SUBSYSTEM | ACCELERATION | INTERFACE |

EdgeQ 4G/5G RFIC

EdgeQ 4G/5G RFIC

RFFE

EdgeQ Baseband

EdgeQ Deliverables
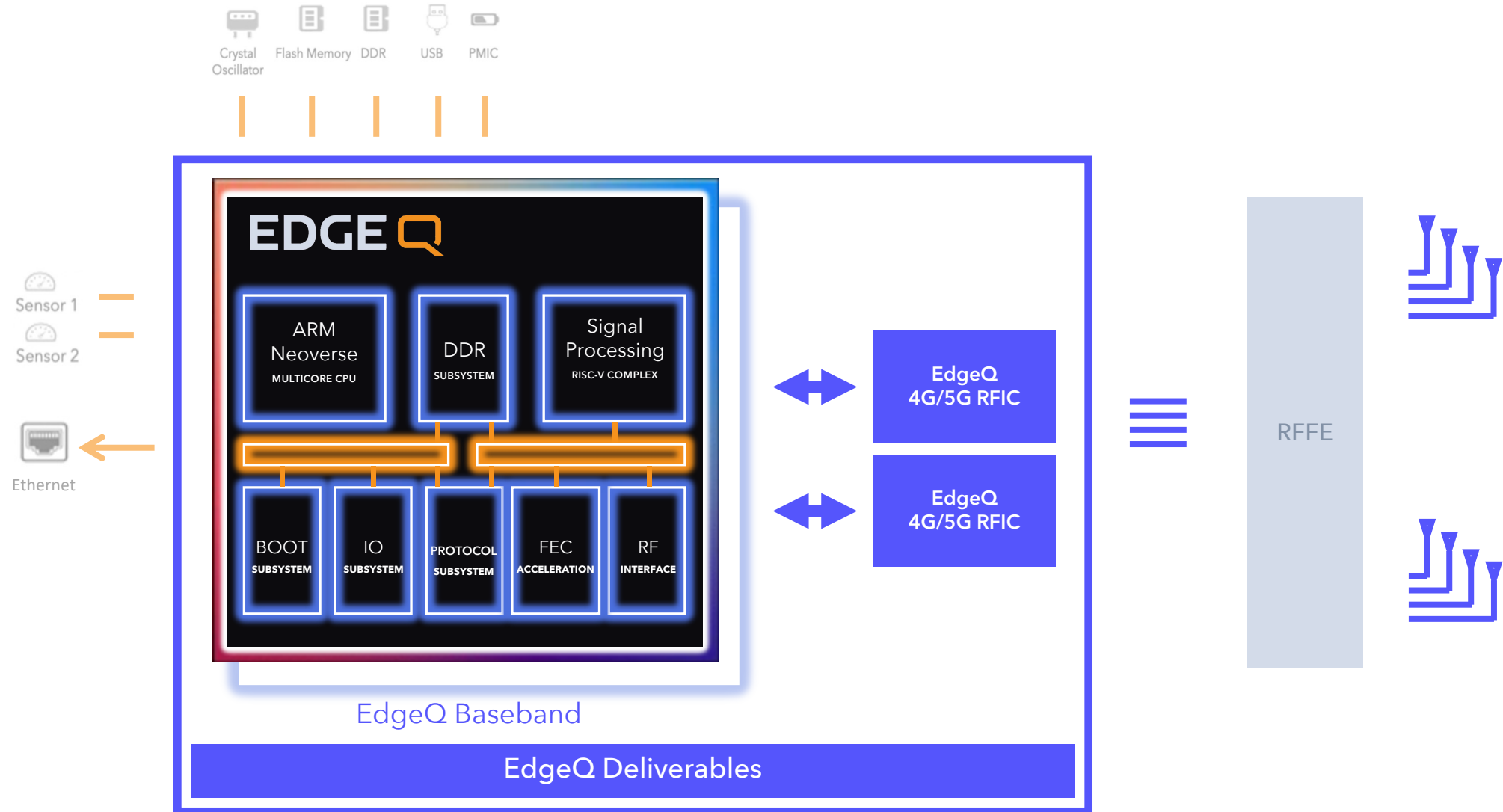
EDGEQ

EdgeQ Edge Compute Platform: 5G + Compute

GPU Host Driver

Virutal Machines

Linux Process
Linux Services

vSwitch
DPDK

3rd party L2/L3

Containers

Condensed Core
Network

Arm Neoverse CPUs

Memory Subsystem

Signal Processing & AI

Coherent Fabric

Coherent Fabric

Security

External Interfaces

Protocol Acceleration

FEC

RF Interface

5G Connectivity

4G Connectivity

Machine Learning

Others ...
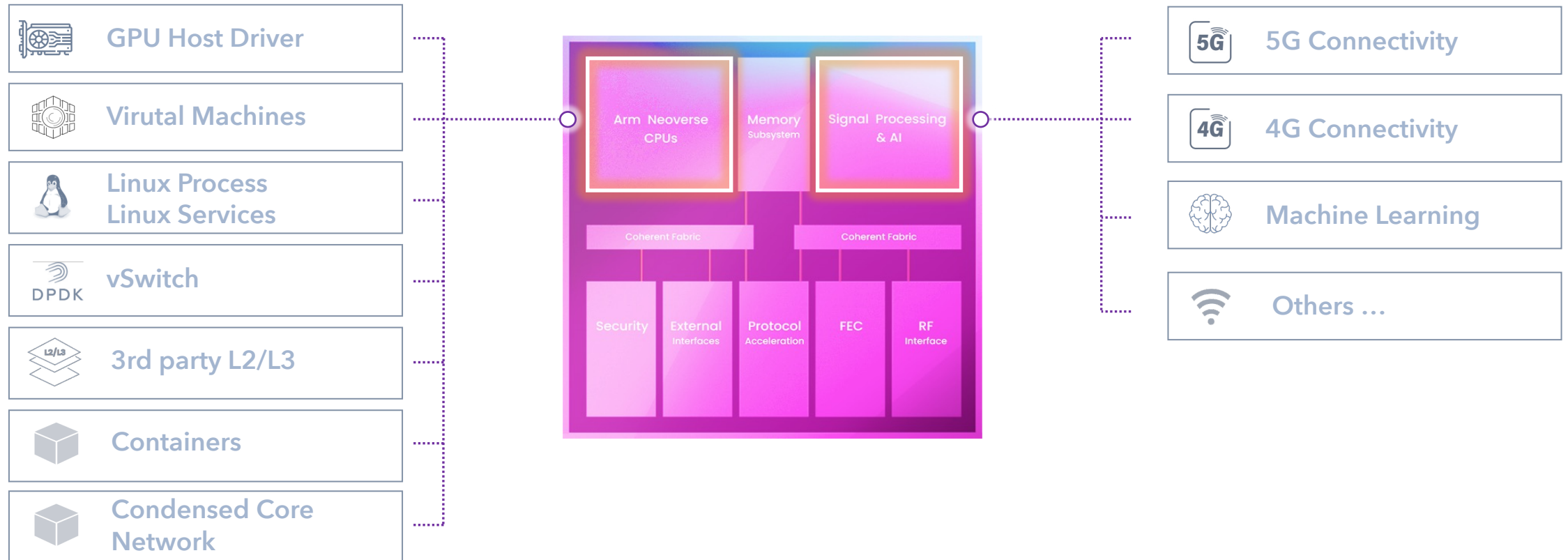
3rd Party Apps Running
on EdgeQ Integrated Host CPU

Polymorphic Connectivity + Compute
on EdgeQ RISC-V Complex

EDGEQ

EdgeQ gNB SW Upgradable from LTE to 5G

5G+LTE Dual-RAT gNB

DDR4   Flash   USB   PMIC   ETHERNET PHY

EDGEQ

4x4 RFIC
5G (N78)

5G PHY
(RISC-V)

5G L2/L3
(ARM Neoverse)

4x4 RFIC
LTE (Bx)

LTE PHY
(RISC-V)

LTE L2/L3
(ARM Neoverse)

to 5G/LTE
Core

Software Upgrade
4G Band Refarmed to 5G

5G Dual-Band gNB

DDR4   Flash   USB   PMIC   ETHERNET PHY

EDGEQ

4x4 RFIC
5G (N78)

4x4 RFIC
5G (Nx)

5G PHY
(RISC-V)

5G L2/L3
(ARM Neoverse)

to 5G Core
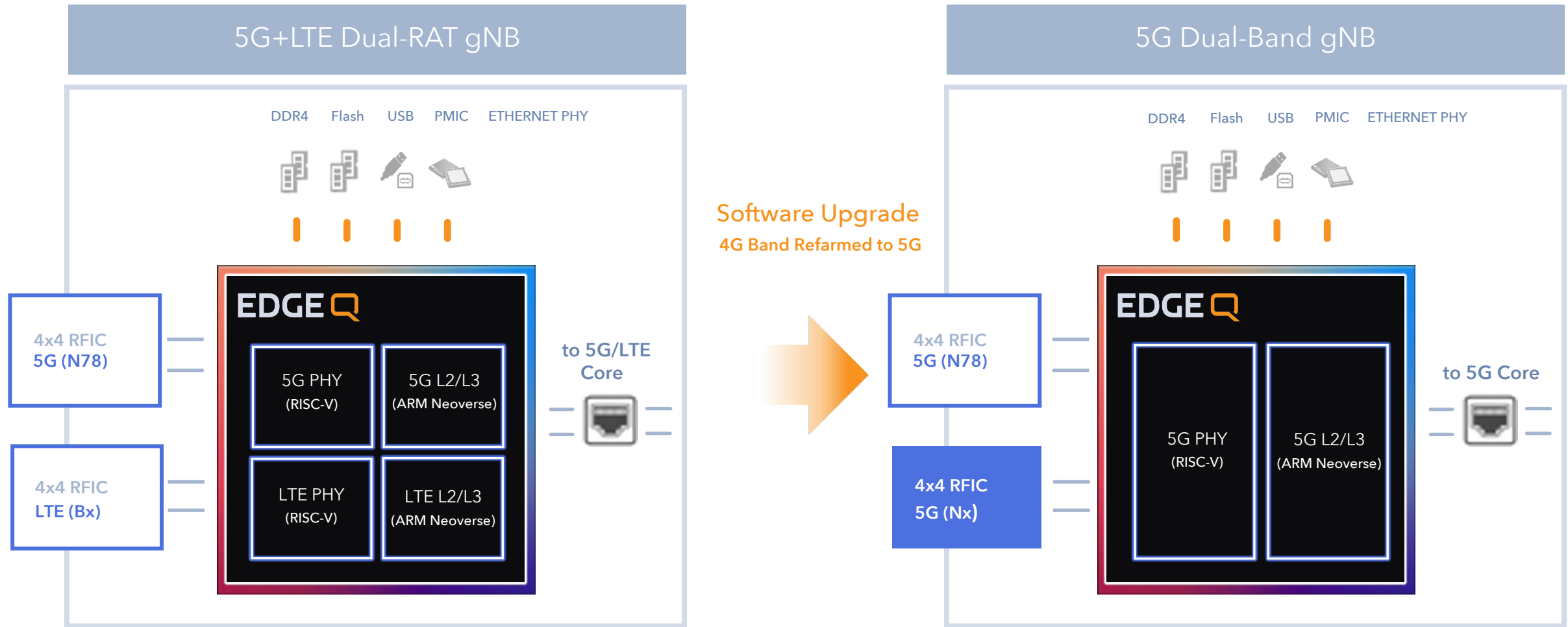
Same EdgeQ SoC.   Runs Both 4G and 5G PHY

EdgeQ based Small Cell Solution: Indoor and Outdoor

Femto Cell (Home Broadband)	**Enterprise Indoor** (Factory 4.0, Ports, City …)	**Outdoor** (Residential Fixed Wireless)	**Outdoor Macro** (Remote Areas)
5G Wireless CPE	5G + Edge Compute	5G Wireless Broadband	Unserved/Underserved 5G

Softwarize Everything | Drive 5G+4G towards WiFi Economics

Femto Cell		Enterprise Indoor		Outdoor		Outdoor Macro	
– 8 Active Users	– 2T 2R	– **32 Active, 256 Connected Users**	– 4T 4R	– 32 Active Users	– 2T 2R	– **128 Active Users**	– 4T 4R / 8T 8R
– 1.0 Gbps	– 256 QAM	– 5.0 Gbps	– 256 QAM	– 1.0 Gbps	– 256 QAM	– 5 Gbps	– 256 QAM
– **8.5 W***	– 100 MHz	– 12 W*	– 200 MHz	– **8.5W***	– 100 MHz	– 12W*	– 100 MHz
	– **24dBm Pout per chain**		– **24dBm Pout per chain**		– **24-30dBm Pout per chain**		– 2CA
							– **40dBm Pout per chain**

*SoC + RFIC Power

EDGEQ
THE TEAM THAT POWERED THE MOBILE FIRST REVOLUTION

EXPERIENCED MANAGEMENT TEAM

VINAY RAVURI
CEO | Founder

ADIL KIDWAI
Head of Products

SRIRAM RAJAGOPAL
Head of Systems & Firmware

200+
EMPLOYEES

Santa Clara, USA
San Diego, USA
Bangalore, India

RISC-V
SOFTWARE
PROGRAMMABLE
ARCHITECTURE

POWERING INDUSTRY'S MOST ADMIRED BRANDS

| **Qualcomm** Snapdragon 600/800 SERIES | **Qualcomm** QCA WIFI 802.11x | **Qualcomm** Snapdragon MDM (Apple) | **Broadcom** WiFi 802.11x | **Broadcom** LTE Modem Base Station | **Intel** XMM LTE Modem | **Intel** WIRELESS-N Modem | **Intel** Neural Net ML SoC |

LAUNCHED INDUSTRY'S LEADING PRODUCTS

8 GEN OF MODEMS IN ALL APPLE / ANDROID PRODUCTS

LUMINARY ADVISORS

PAUL JACOBS
ex-CEO, Qualcomm

MATT GROB
ex-CTO, Qualcomm

AJIT PAI
Ex-FCC Chairman

Thank You

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EDGEQ

Where Are We Today?

gNB Screenshot

DU screenshot

EDGEQ