Enea solutions for LTE/5G eNodeB

Portability and HW vendor agnosticism
Robustness and high QoS on baseband layer processing
Shorter Time-To-Market due to feature-rich RTOS and tools
Linear multicore scalability - lower expansion costs

The world is experiencing a tremendous data storm with exponential growth causing severe challenges on today's and tomorrow's networks.

A capacity growth of several exobytes monthly is needed to address the ever increasing number of handheld devices and mobile subscriptions, causing a worldwide CAPEX growth of more than $100bn in 2017.

Creating denser networks with higher spectral efficiency will be key, and besides offloading the networks with Wifi, we will see a clearer fronthaul capacity evolving, with centralized radio access networks (C-RAN) and remote radio heads (RRH).

The C-RAN has several advantages in resource pooling, greener infrastructure (re-use), base station virtualization, simplified management and operation, coordination for interference mitigation (ICIC), and multi technology support.

The main C-RAN challenge lies with the RRH's and the centralized BBU, which both depend on high capacity at low latency.

The RRH's are forced to contain an increased intelligence and capacity to manage LTE-A carrier aggregation and later increased radio carrier frequency bandwidth for 5G.

Co-ordinated multipoint, e.g. where devices (or user equipment, "UE") connects to several Remote Radio Heads (RRH), generates much more control signaling on the lower signaling protocol layers (L1/L2) with high requirements on real-time characteristics and flexibility in software upgrade.
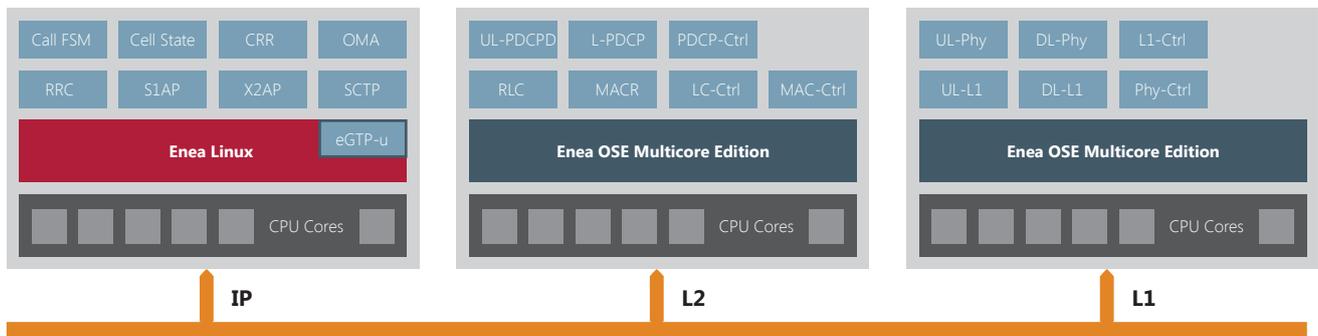
An LTE-A/5G eNodeB main controller must be based on Linux as this is the standard "must-have" operating system. The CPU load caused by protocol processing in LTE Layer 3, RRC and by other applications increases greatly with increased number of subscribers, or UEs.

High requirements on IP FastPath GTP-U termination/relaying bandwidth (on top of UDP). The Linux API and FastPath programming API has to scale well on multicore.

> *This means that Linux as control plane operating system needs to be highly optimized for throughput on multicore processors!*

The low level baseband processing software will increase in control complexity, including decreasing the TTI from 1ms to 0.2ms. It is too complex to be put in HW, and cannot run in Linux user space for real-time and scalability reasons.

> *This means that the radio baseband, i.e. the modem, will require a high-performance and scalable RTOS for the foreseeable future!*

Call FSM	Cell State	CRR	OMA
RRC	S1AP	X2AP	SCTP

| **Enea Linux** | | | eGTP-u |

| CPU Cores |

IP

UL-PDCPD	L-PDCP	PDCP-Ctrl
RLC	MACR	LC-Ctrl	MAC-Ctrl

| **Enea OSE Multicore Edition** |

| CPU Cores |

L2

UL-Phy	DL-Phy	L1-Ctrl
UL-L1	DL-L1	Phy-Ctrl

| **Enea OSE Multicore Edition** |

| CPU Cores |

L1

User plane L1-PHY processing is mainly supported by hardware accelerators since it is well specified in its behavior. The rest of Layer 1 and 2 requires a hardware agnostic, portable and scalable operating system that can meet the increasing requirements on determinism, low jitter, low latency, low overhead, and linear scaling performance. For the baseband low level layers we will still need a real-time operating system since Linux is not a suitable one as of today and within the foreseeable future. Running the real-time domain required for L1 and L2 by bypassing Linux with bare-metal implementations is not a sustainable system design in the end.

Multicore DSPs are replaced by general-purpose multicore processors, as the main signal processing moves from software to offloaded hardware (or FPGAs). Parts of L1 and most L2 code do not necessarily need DSP cores, and with today's evolving multicore and many-core SoCs (ARM, PPC, X86 etc.) the baseband processing requirements can be fulfilled and the solution becomes less complex, as long as you are able to provide a suitable OS runtime environment for the device.

We will continue to see three layers in an eNodeB:

■ The Main Controller part, based on Linux, candidate to be virtualized as VNF

■ The radio baseband modem (L1/L2) between cloud and radio network fronthaul

■ The radio network fronthaul, entirely in HW, or stratified via intelligent RRHs

ENEA OS SOLUTION FOR LTE-A/5G eNodeB

A customized solution that consist of:
- ■ Professional services including domain expertise
- ■ Enea SW components, e.g. Enea Linux and OSE MCE
  - - Other Linux distributions may be an option depending upon customer preferences
- ■ A BSP that is adapted to the customer reference target
  - - Including vendor specific SDKs
  - - The offering is a customer specific OS platform integration

Enea® Linux
- ■ Tuned and optimized for throughput (LLD or RT)
- ■ Featuring IPsec and Fast Path support

Enea® OSE Multicore Edition
- ■ POSIX SMP RTOS, including C++11 Thread Library Support
- ■ Proven linear performance scalability on multi/manycore
- ■ Low enough latency and jitter for 5G baseband processing
- ■ Companion real-time runtime to Linux on a multicore processor
- ■ Provides scalable and fast crypto and packet processing