OpenRAN & Open Source: The Cool Kids of Telecom

(Shaking Up 5G NR/LTE Networks)

Jakub Duchniewicz – FOSDEM 2024, Brussels

tietoevry

Agenda

- Introduction – me and Tietoevry
- Radio Networks meet Open Source, history and now
- Radio Networks 101
- Why L1 cannot tolerate delays?
- Overview of projects
- Resources

>whoami

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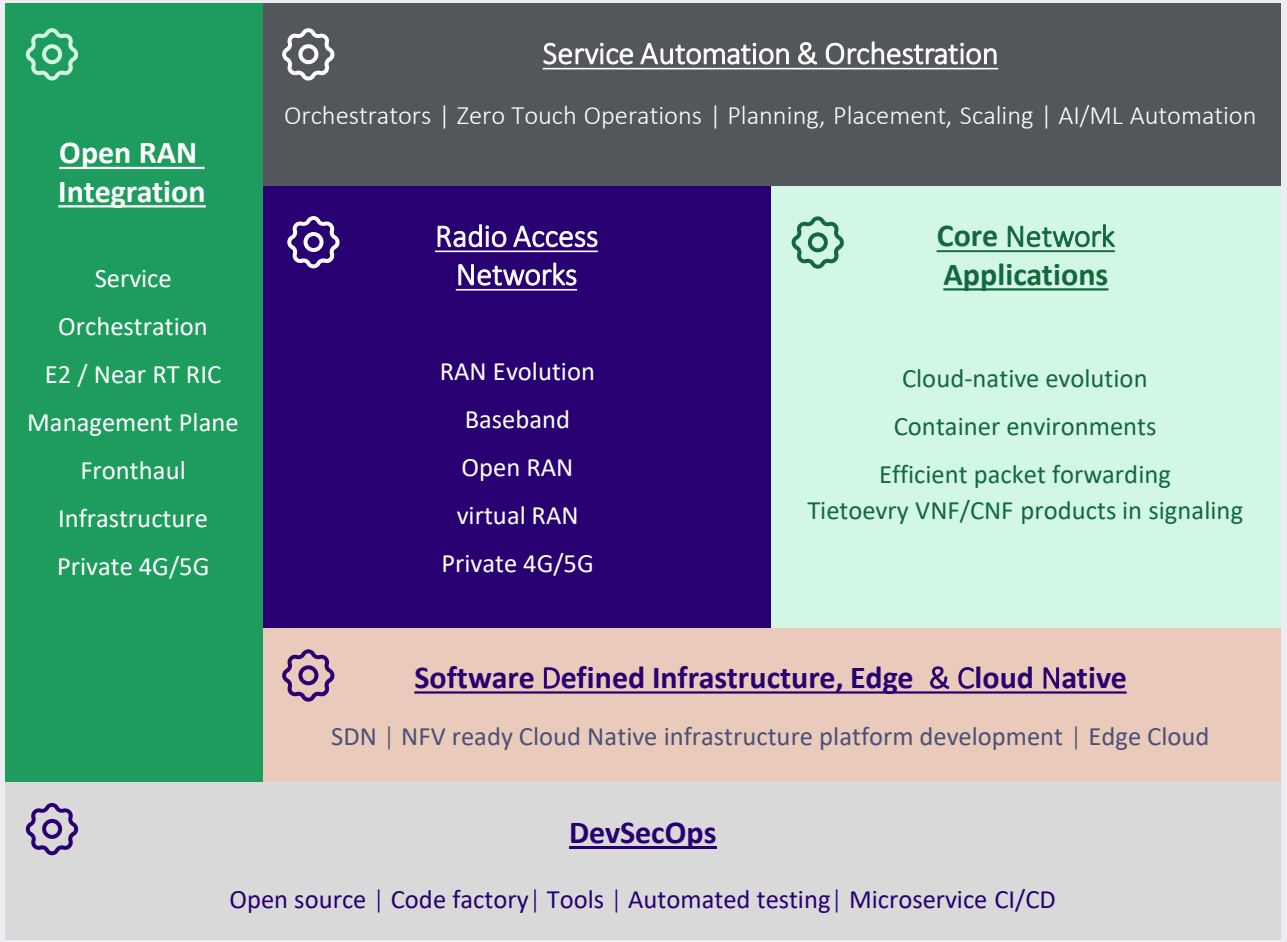
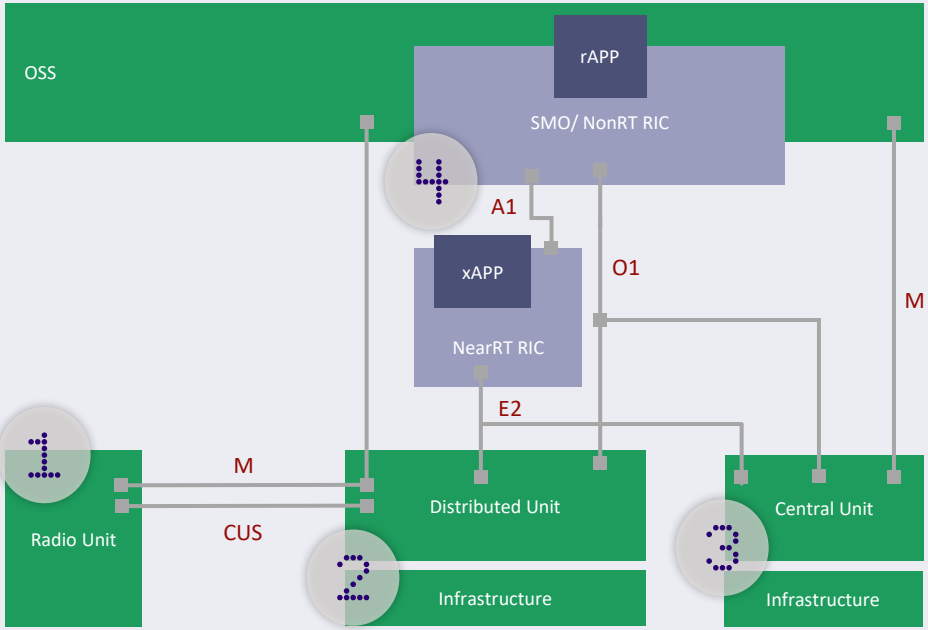
- Developing 5G NR L1 processing chip at **Tietoevry** for Undisclosed Client :)
  ex Samsung, ex Intel, ex GSoC
- Tinkering around with Zephyr, Rust, Game Engines and Linux on embedded devices
- Graduate of MSc in Embedded Systems at KTH Royal Institute of Technology and University of Turku
- In my free time doing a ton of sports: wind/kite/surf/skiing/climbing/unicycle back to surfing :) -> finishing ACLR rehab



R&D services for Telecom & Networks

Tietoevry OpenRAN Footprint



RU
L1 low, M-plane, RF SOCs, BSP & FPGA

DU
L1 High (several Architectures), L2 Commercial & Proprietary, OAM generic experience

CU
L3 development, packet processing

RIC
DU integration, E2 development & simulation, x/rApps integration and commercialization

Cloud Infra
Cloud Native Architecture & platforms development
Commercial and Bare Metal platforms use for Telecom workloads
Applications cloudification and deployment

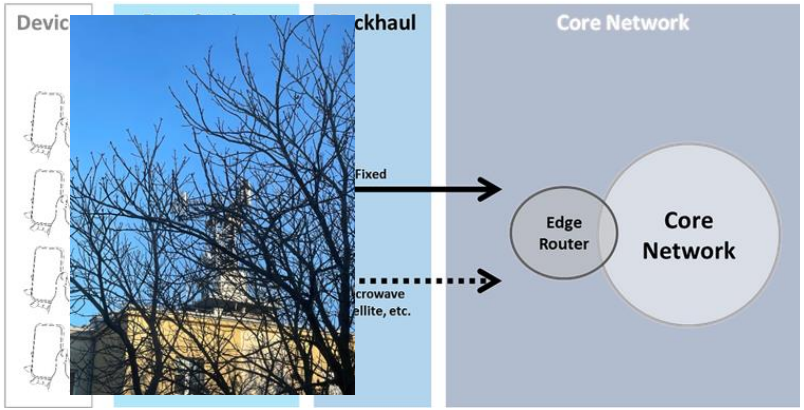
Open Source and Radio Networks - hot or not?

- No need to introduce Open Source here - it's FOSDEM after all :)
- Open Source is already prevalent in so many domains of our life - Linux/Android running your phone, train/tram, AI is (mostly) powered by OS tools, robotics, stock exchange - cryptocurrencies

- Others lag behind:
  - Medical
  - AI models (especially LLMs)
  - Telecom industry...

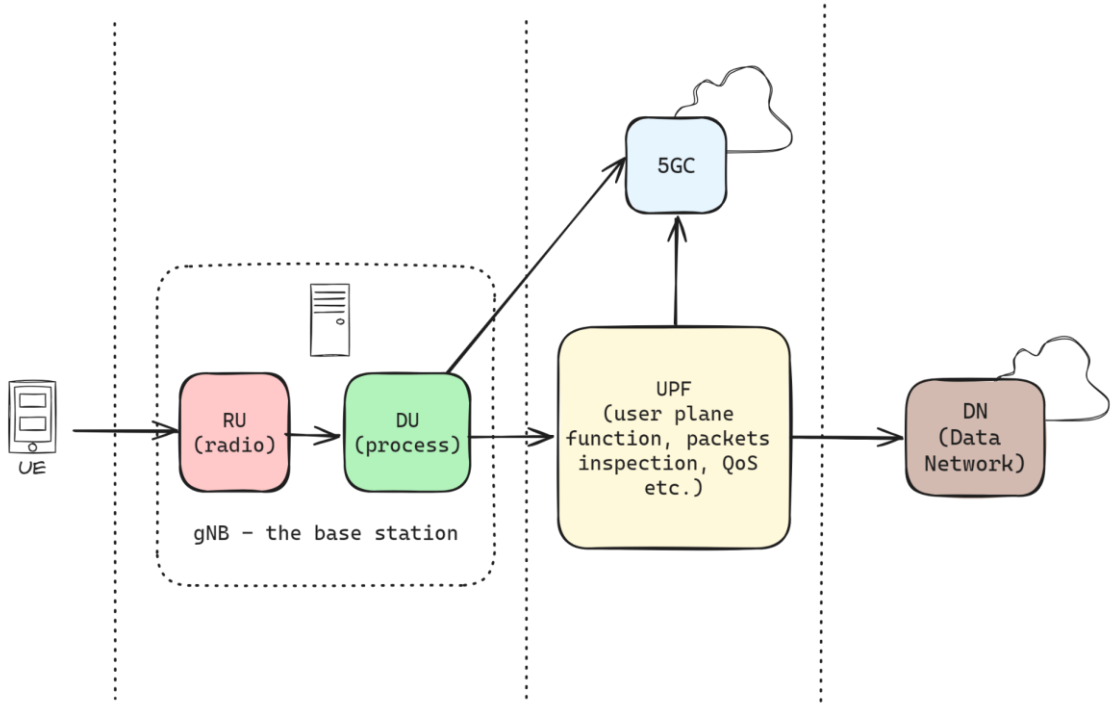
Radio Network 101

- 5G NR is the latest evolution of wireless telecommunications standard by 3GPP
- The path your memes travel is a long and a very complex one :)
- Every data fragment on the processing chain has to be processed **VERY** (<1ms) fast (or even faster if we need URLLC scenario)



https://medium.com/@miccowang/5g-c-ran-and-the-required-technology-breakthrough-a1b2babf774

Radio Network 101



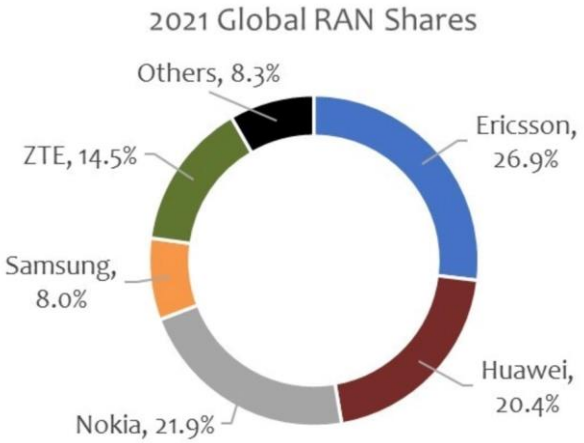
- A simplified view of the 5G network architecture:

- - L1 (L2/L3) is in the gNB
  - RU does more „physical” calculations
  - DU does more general ones
- Higher layers in UPF
- Very complex in reality

The problem? Oligopoly of the market - reinventing the wheel.

Few key players on the market, each of them producing:

- Own HW (usually ASICs)
- Proprietary algorithms
- Proprietary per-chip tooling
- Patents, patents, patents...
  yes - ONAP, but it's not enough



Sorry, no newer data :(

https://www.telecomtv.com/content/5g/what-s-up-with-ran-market-shares-vodafone-uk-bharti-airtel-43437/

Until...

Open Radio Access Network Alliance (ORAN) formed in early 2018 and decided to break the vendor lock-in stalemate.

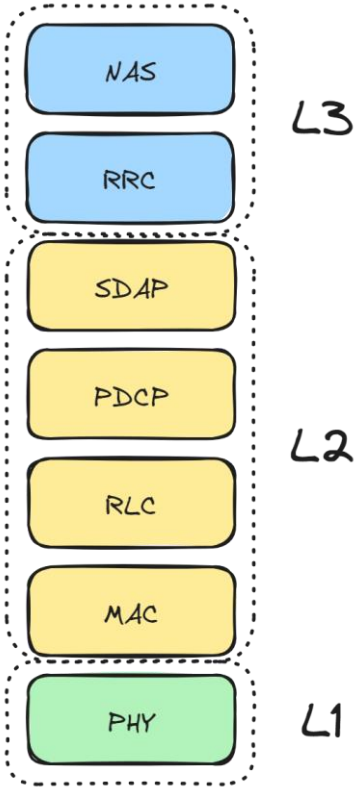
Open interfaces and cross-compatibility of RAN components.

We now have market for smaller players or non-telco companies.

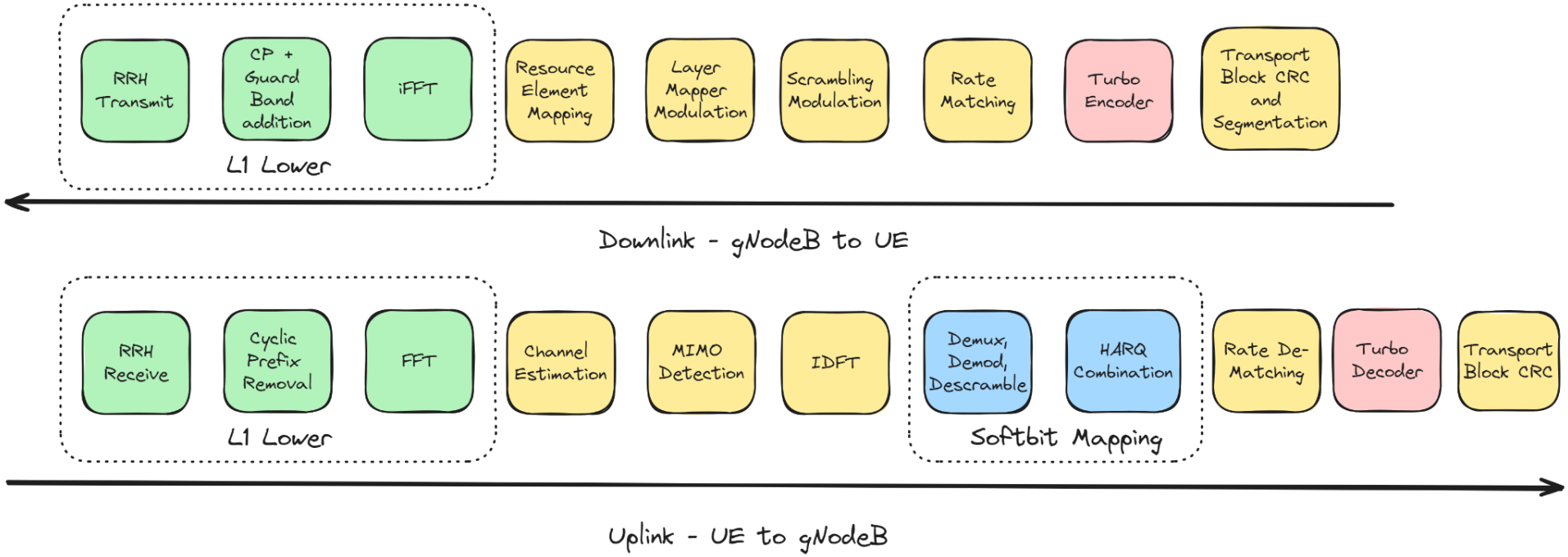
E.g: Intel FlexRAN - L1/L2/L3 implementation on commodity HW - x86 CPUs + some FPGAs/NICs for acceleration

L1 in 5G NR

- **L1** is the PHYSICAL layer – but not the physical link, which in our case is **radio waves**!
- Think of it as the Ethernet layer – modeling the physical bits on the wire **modulating** the waves to **transmit** data (*although Ethernet is Layer 2)
- Key responsibilities?
  - making sense of the incoming radio waves (**Low-PHY**)
  - performing all **pre-processing** before the digitized signal is intelligible bitstream (decoding, synchronization)
  - **very-precise time operations** and working in various channel conditions
  - communication with higher layer (**MAC**)
- Of course, everything in reverse as well! **Downlink** and **Uplink**

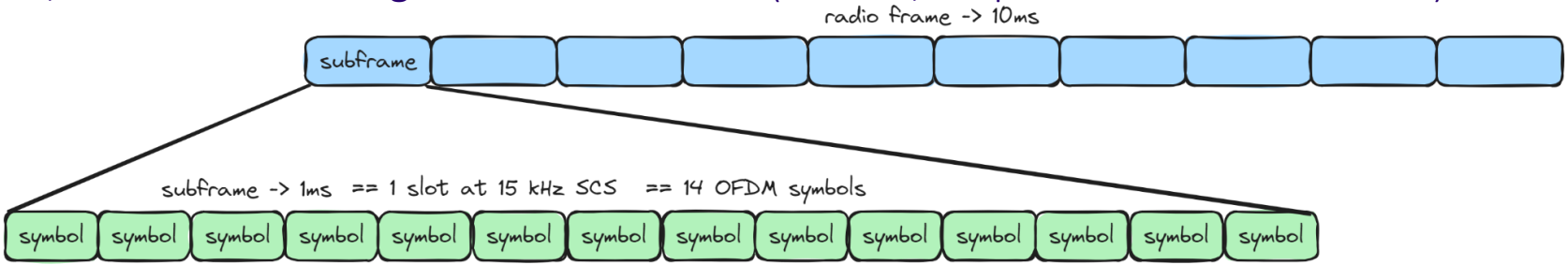


L1 PHY processing pipelines



Time to get real(-time)

- What are the usecases of real-time?
- Audio/Video delivery, online gaming, critical devices (drug injectors, remotely operated robots)
- What in our case is real-time? Usually, all processing **MUST** finish under 1ms or less e.g URLLC
- With specialized hardware with a very fast clock, we can meet them.
- However, how can a server-grade Linux do that? (Answer, RT-patched Linux and DPDK)



Room for Open Source

- Just look at Linux Kernel or Zephyr RTOS –
  Open Source has *very* **high standards** and **is very performant**
- Open source is usually the core component on top of which a business is built
- L1 is the *foundation* of all processing in 5G/L1 - increasing OS engagement **will benefit all** - both users and vendors – by doing it together we **accelerate the scientific progress**
- We **already** have a solid foundation of Open Source projects like **DPDK**, and Core Network cloud projects, like **ONAP** or **Sylva**

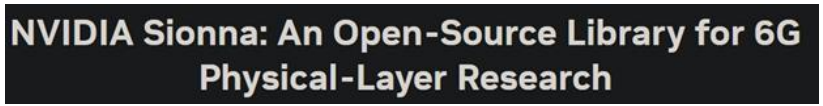
DPDK

Core Network projects

- **Sylva** - A Cloud Software Framework and the reference implementation that addresses the current needs of the ecosystem by using such components as **Nephio**
  https://gitlab.com/sylva-projects/sylva

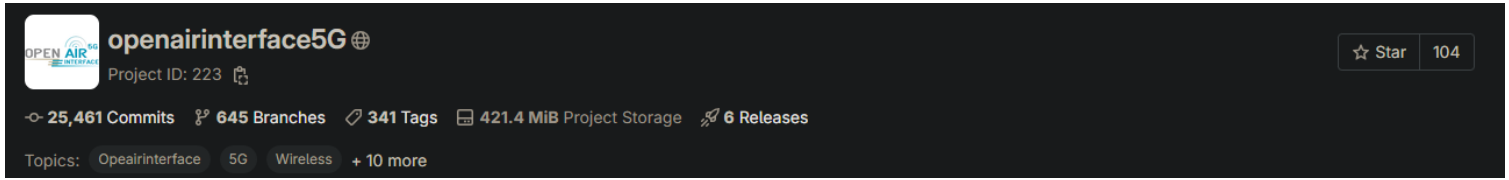
- **L3AF** - Management of eBPF programs in Linux kernel. Community eBPF programs marketplace.
  eBPF programs can be used in higher networking layers for packet filtering/QoS etc.
  https://l3af.io/

Lower layers projects



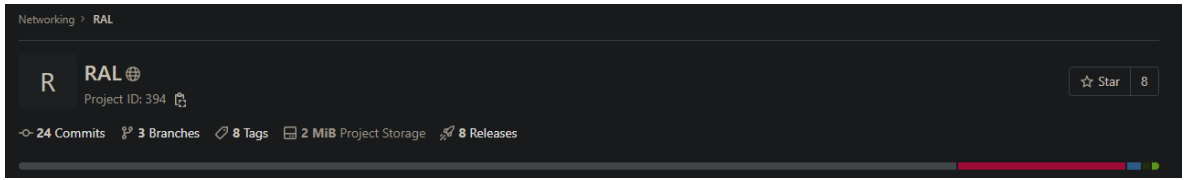
- 5G/6G LLS and research platform – https://github.com/NVlabs/sionna

- FlexRAN – like (not really an Open Source as available under specific licensing T&Cs) - https://developer.nvidia.com/aerial-sdk

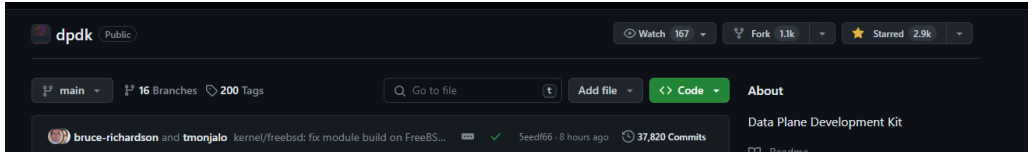


- Academy-heavy research framework that touches ALL aspects of 5G/6G/LTE including NTN and AI - https://gitlab.eurecom.fr/oai/openairinterface5g

Lower layers projects - continued



- FlexRAN SDK – like but on ARM – providing 5G processing functions on top of open ARM CMSIS libraries with intrinsics - https://gitlab.arm.com/networking/ral

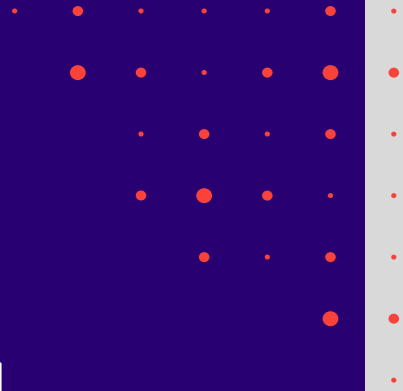


- X86 L1 acceleration, kernel network stack alternative – the powerhorse behind RAN revolution on commodity hardware - https://github.com/DPDK/dpdk

- ORAN M-Plane foundation projects - NETCONF/netopeer2/sysrepo/libyang – all developed by CESNET

Resources

- Great telco reference - https://www.sharetechnote.com/html/5G/Handbook_5G_Index.html
- DPDK guide - https://doc.dpdk.org/
- Intro to FlexRAN - https://www.intel.com/content/www/us/en/developer/topic-technology/edge-5g/tools/flexran.html
- Images – (where not specified)**mine**: License under „Feel Free to use them provided we have a beer together!”
- Repo links available in slides



Thank you

Questions?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