Nervion: a cloud native RAN emulator for scalable and flexible mobile core evaluation

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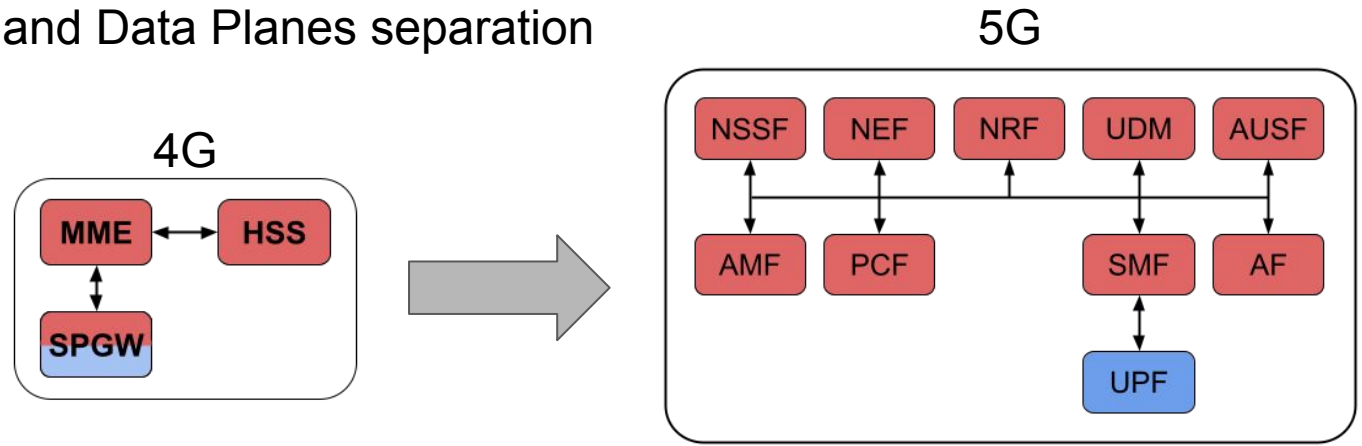
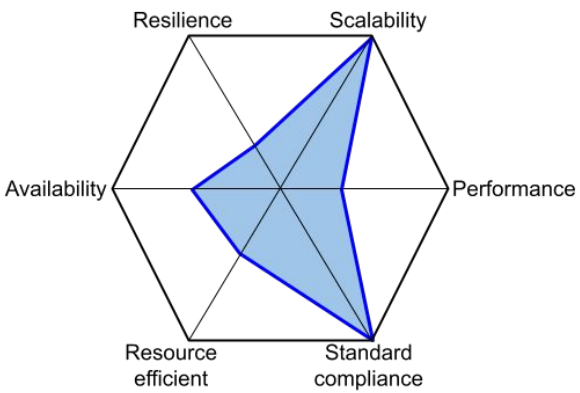
3GPP Standard (Release 15): New core network

- Softwarization
- Cloud-based architecture
- Microservices
- Control and Data Planes separation

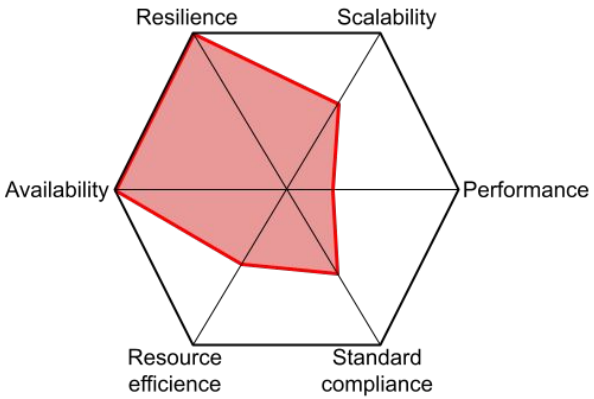


Alternative Core Network architectures

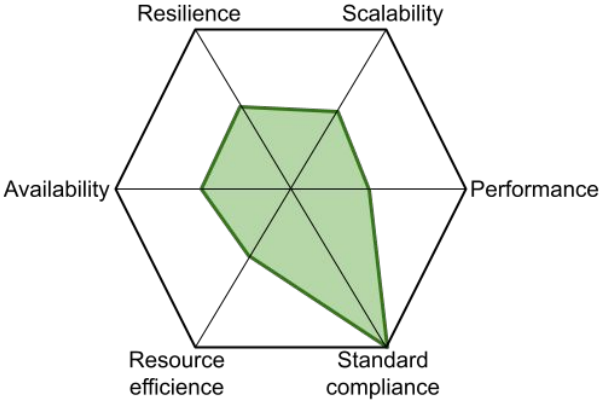
MobileStream



ECHO



Open5GS



Question: Which core is better?

How we can compare cores?

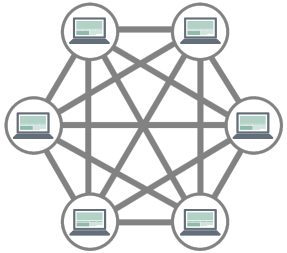
1. Select a common scenario
2. Stress the core
3. Get metrics and compare

The tools were **different**.

How the core can be evaluated?

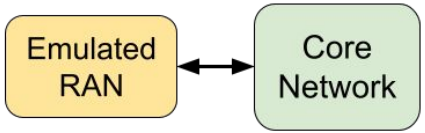
Real Devices

Simulation



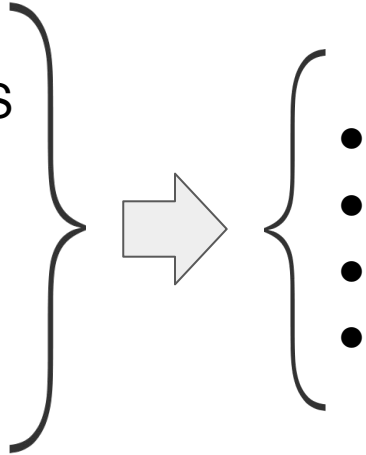
Trace-driven evaluations

RAN emulation



Limitations

- Limited number of UEs and BS
- Limited network patterns
- Limited scenarios
- Not standard-compliant
- Either 4G or 5G



Goals

- Scalability
- Flexibility
- Automation and programmability
- 4G and 5G standard-compliant

NERVION

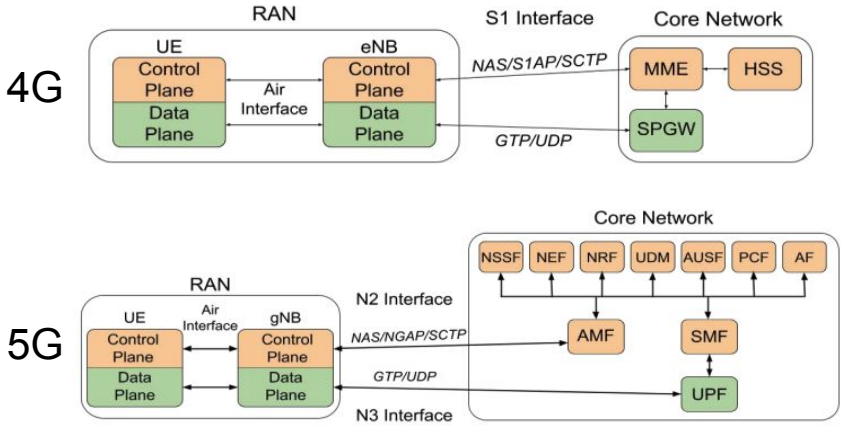
Nervion Overview

A *cloud native RAN emulator* that provides:

- Scalability:
  - Abstraction of the RAN internals
  - RAN refactoring
  - RAN element containerization
  - Orchestration with K8s
- Flexibility, Automation and Programmability (Reproducibility):
  - Nervion Scenario
- 4G and 5G standard-compliant:
  - Decoupling the RAN-Core interface

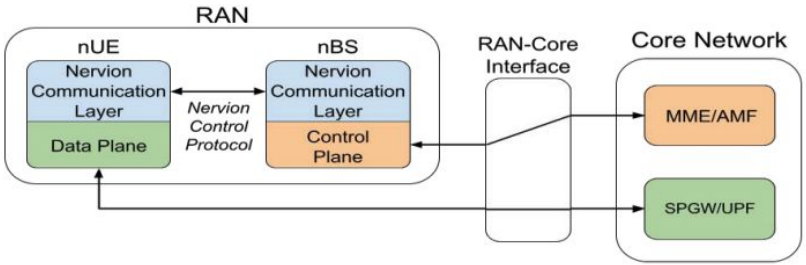
Nervion Design

Standard Architecture



VS.

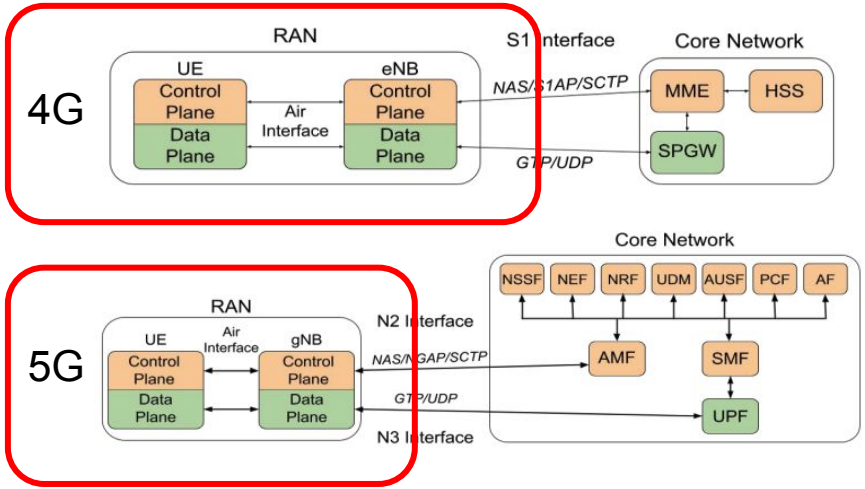
Nervion Architecture



4G and 5G

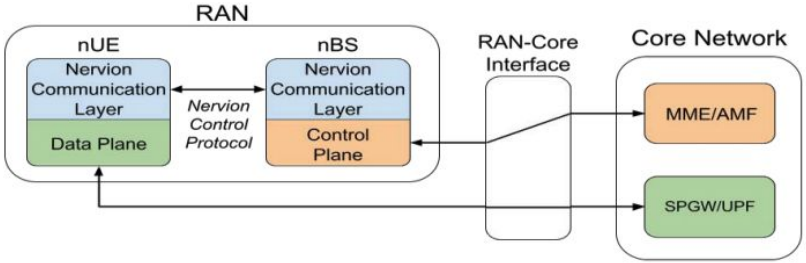
Nervion Design

Standard Architecture



VS.

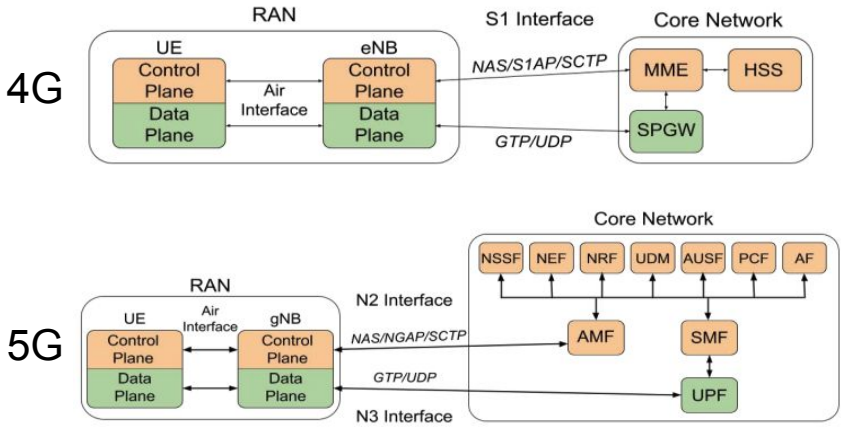
Nervion Architecture



4G and 5G

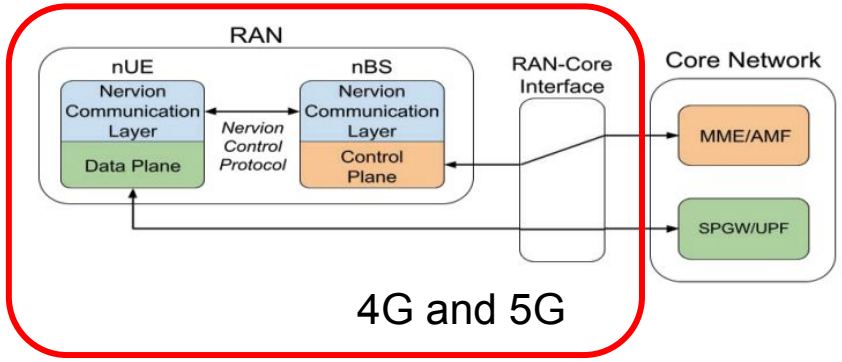
Nervion Design

Standard Architecture



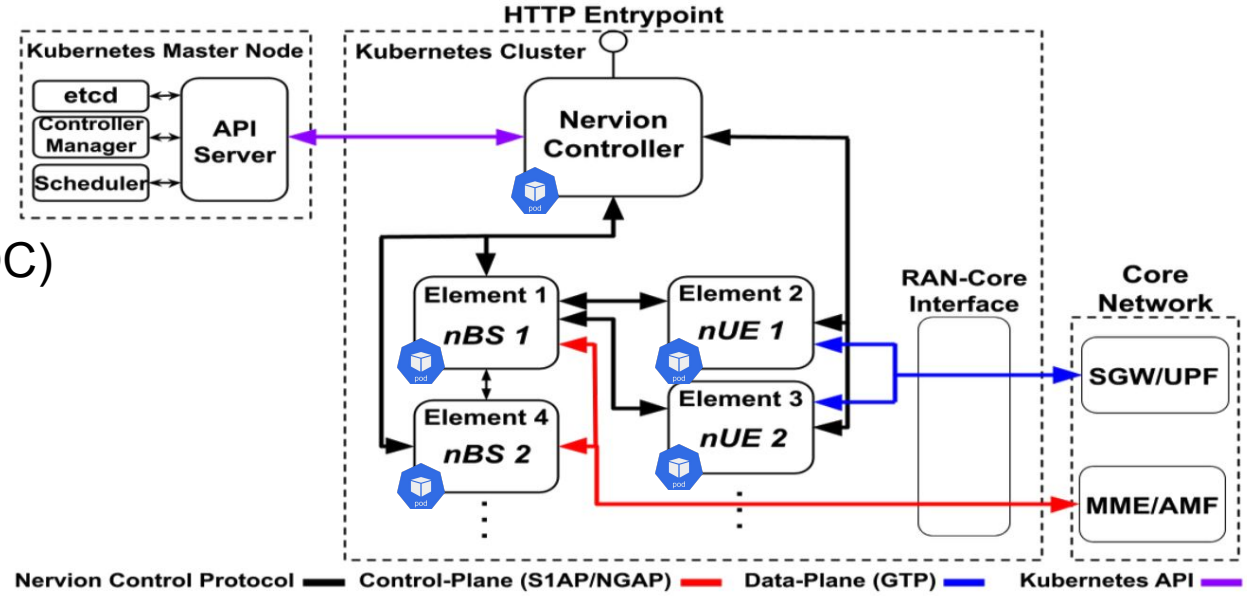
VS.

Nervion Architecture



Nervion Implementation

- Python and C (15K LOC)
- Integrated in K8s
- 4G and 5G support



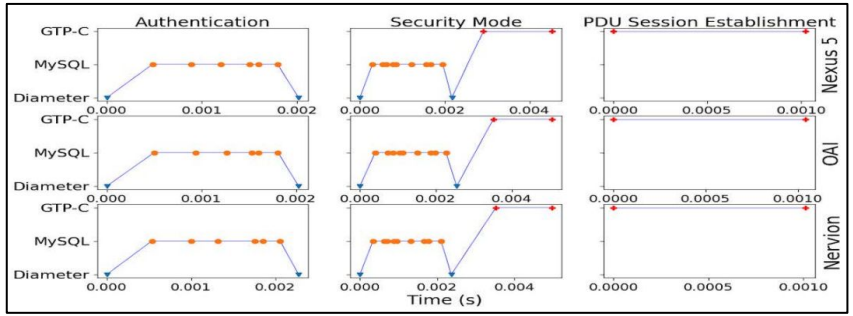
Nervion Scenario

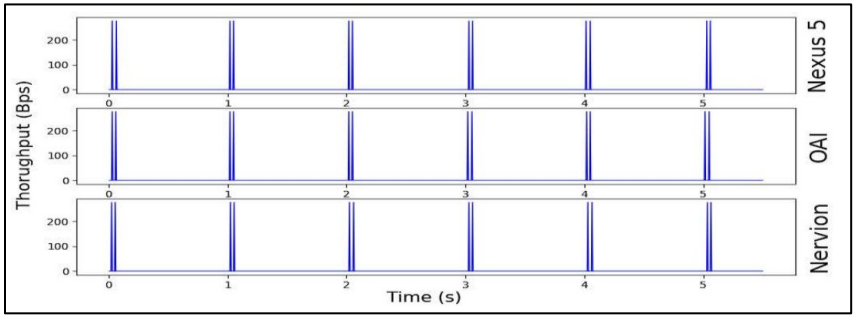
```
<nBS List>:
    -   <nBS 1>:
      -   nbs_id: 1
      -   nbs_mnc: mnc
      -   nbs_mcc: mcc

<nUE List>:
    -   <nUE 1>:
      -   ue_mnc:  mnc
      -   ue_mcc:  mcc
      -   ue_msin:  msin1
      -   ue_key:  key
      -   ue_op_key:  op_key
      -   control_plane:  init-10-detach-5-attach-25
      -   traffic_command:  ping -I {TUN} 8.8.8.8
      -   nBS:  1
```

- Programmability
- Automation
- Repeatability
- Flexibility

NERVION EVALUATION

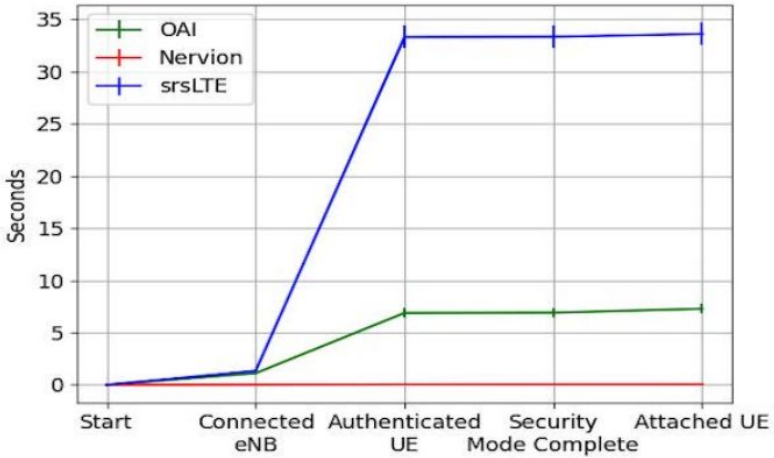
Nervion Evaluation: Correctness



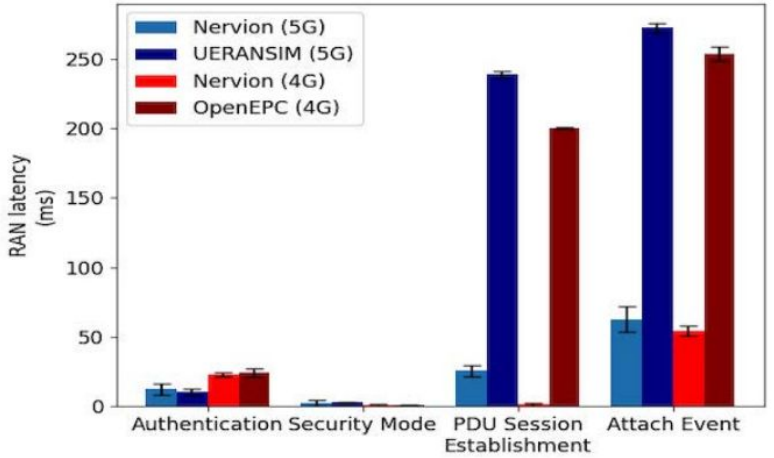


- "The effects inside the core network are the same"
- We monitored the messages exchanged within different core Networks (4G and 5G)
- Nervion vs. Open Source emulators / Comercial emulator / COTS UE

Nervion Evaluation: Efficiency

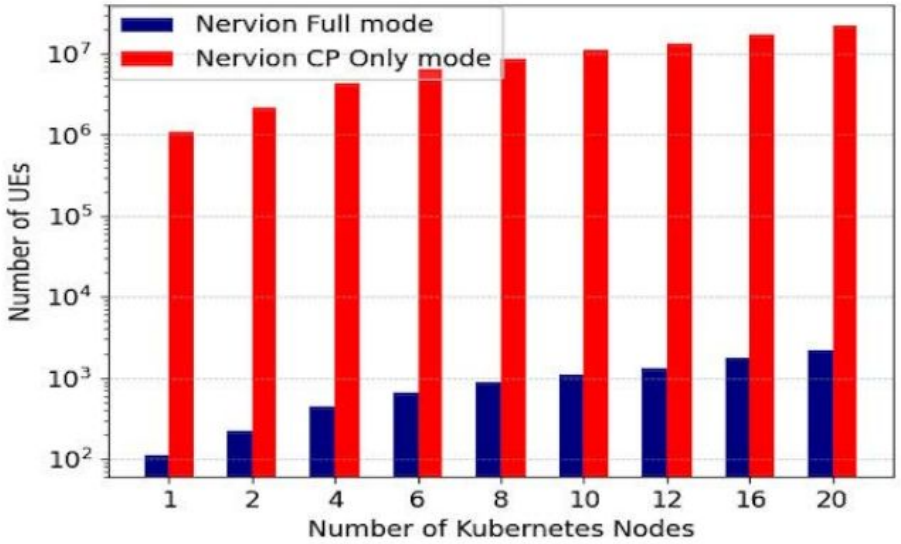


Nervion vs. OAI srsRAN



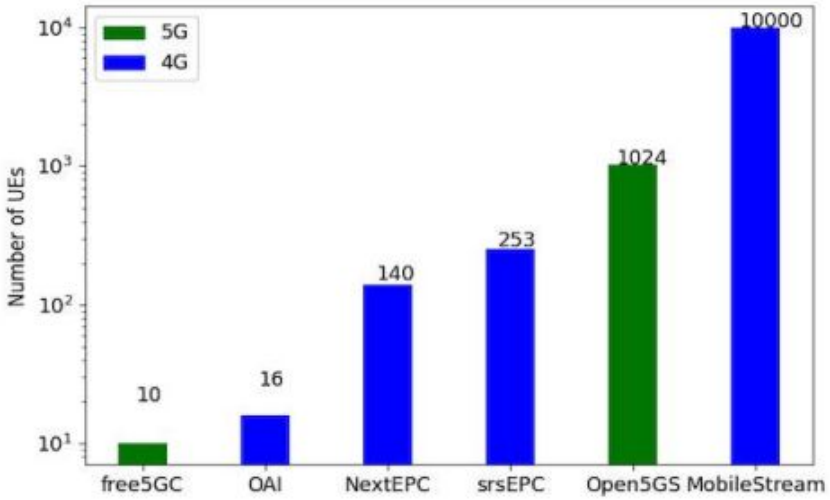
Nervion vs. UERANSIM OpenEPC

Nervion Evaluation: Scalability



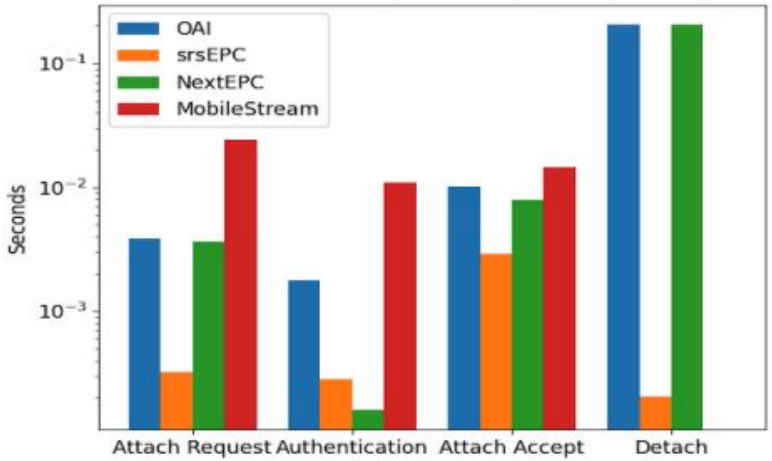
- Nervion Full mode (Data plane)
- Nervion Control Plane Only mode

Nervion Use Cases: Scalability comparison



Which core supports more UEs attached simultaneously?

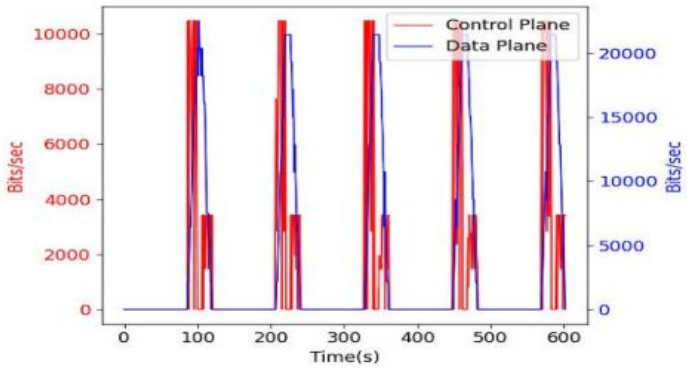
Nervion Use Cases: Latency comparison



Which core supports has less response time (latency)?

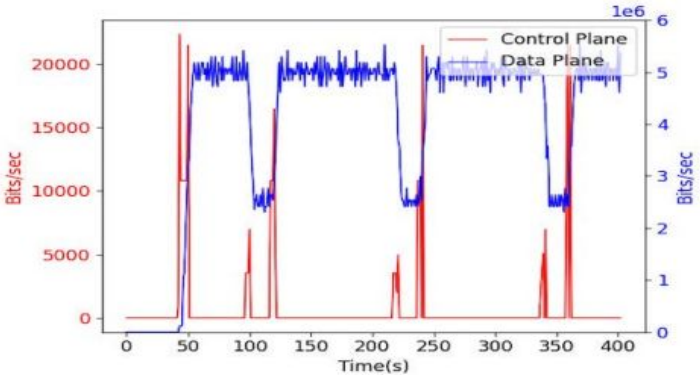
Nervion Use Cases: Network patterns

IoT



vs.

Mobile Broadband



Different control and data plane traffic behaviour (type of UE)

Accessing and using Nervion

Full paper

Documentation