Assessing the Energetical Cost of 5G Softwarization

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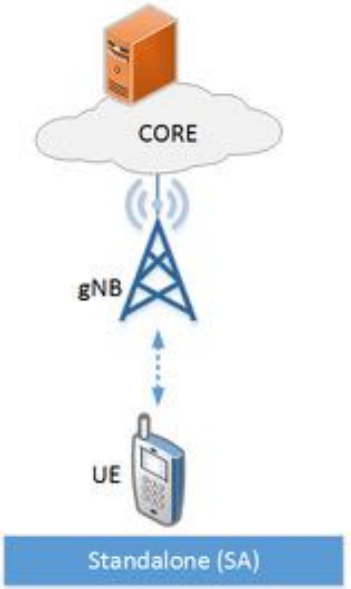
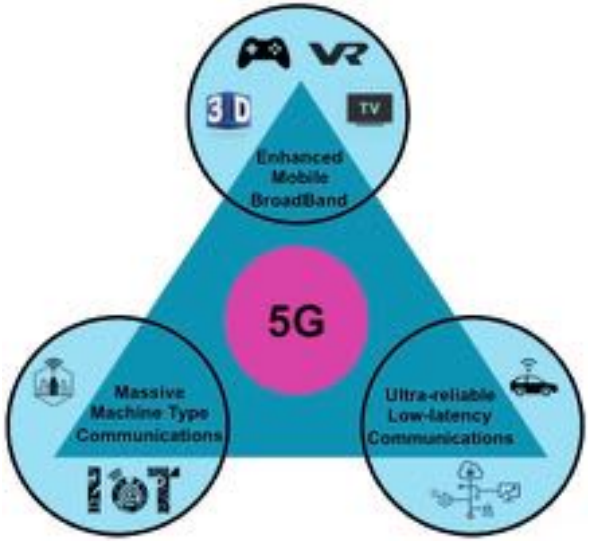
5G: A difficult rise

- 5G has many opponents
- One argument against 5G is its supposed impact on the environment and the society
  - Electromagnetic radiation
  - Energy consumption
  - Ultra-connected society
  - …



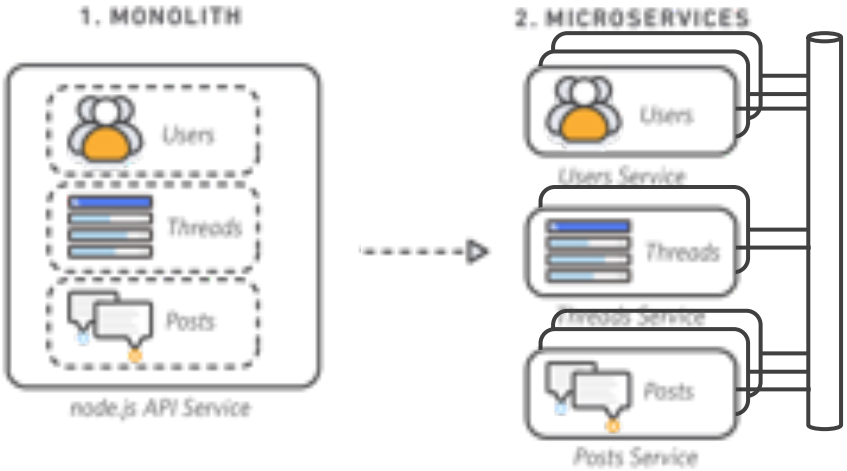
5G services

- Increase throughput and decrease latency whatever the service is
- Provide different classes of services
  - *eMBB : Enhanced mobile broadband*, for a larger bandwitdth.
  - *uRLLC : Ultra Reliable low latence communications*, for ultra reliable and low latency communications.
  - *mMTC : Massive machine type communications*, for M2M massive communications.



- Software based for high flexibility and low operation cost

New Application/cloud/network design principle



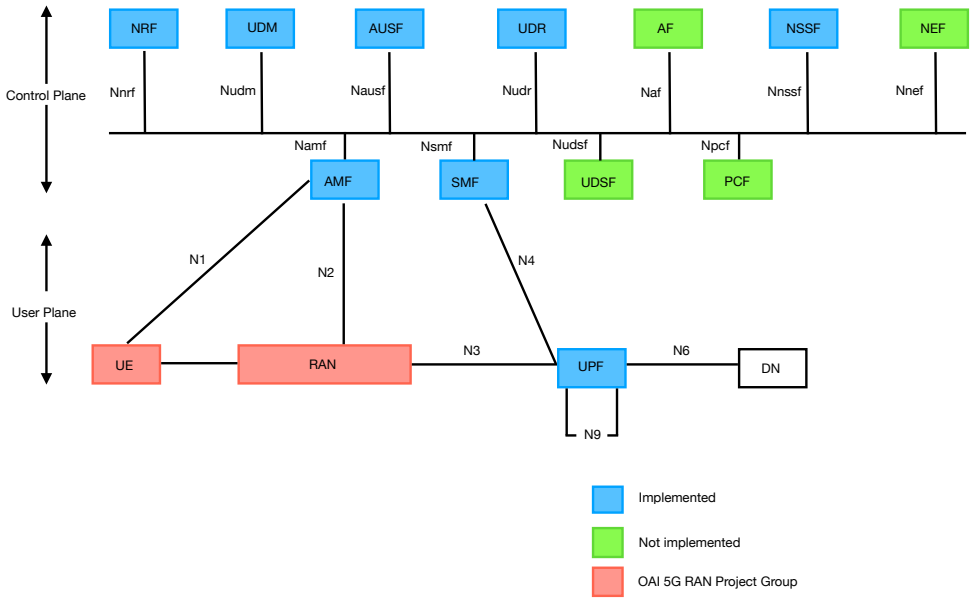
- Separated in several software components: Microservices
- Interconnected
- Geographically distributed
- Automatized management

- Virtualization is a key concept
  - Zones
  - Virtual machines
  - containers

> Software based for high flexibility and low operation cost

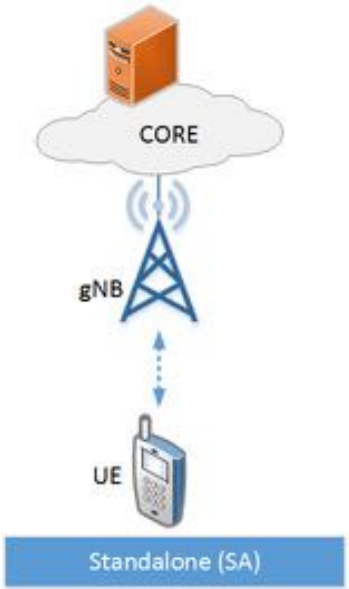
5G Open Air Interface Design

> Generic codes avaiblable on EURECOM Git on the *develop* branch of *OAI 5G standalone* scenario



OpenAirInterface

- Open Source: designed and developed by EURECOM
  - Now OAI Software Alliance
- Accurate and realistic: 3GPP standard and RT Linux OS
- Includes: UE, gNB, Core Network (CN)
- Software Defined Radio: USRP compatible



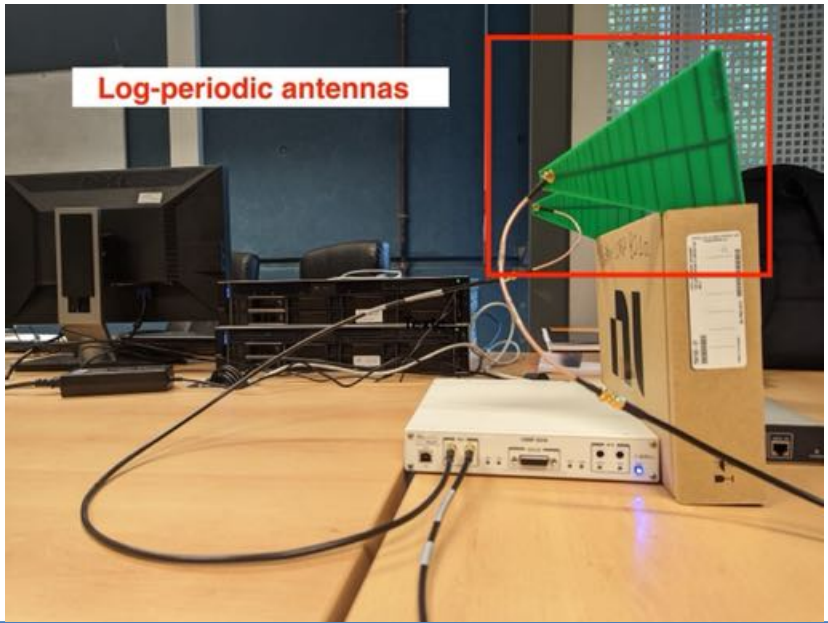
LAAS' 5G experimental platform (1)

> CN + gNB: 18 cores DELL 7920 server + USRP X 310

> UE: 18 cores DELL 7920 server + USRP X 310

LAAS' 5G experimental platform (2)

> Log-periodic antennas
  - Wide band: 850 MHz – 6.5 GHz
  - Directional: around 120°



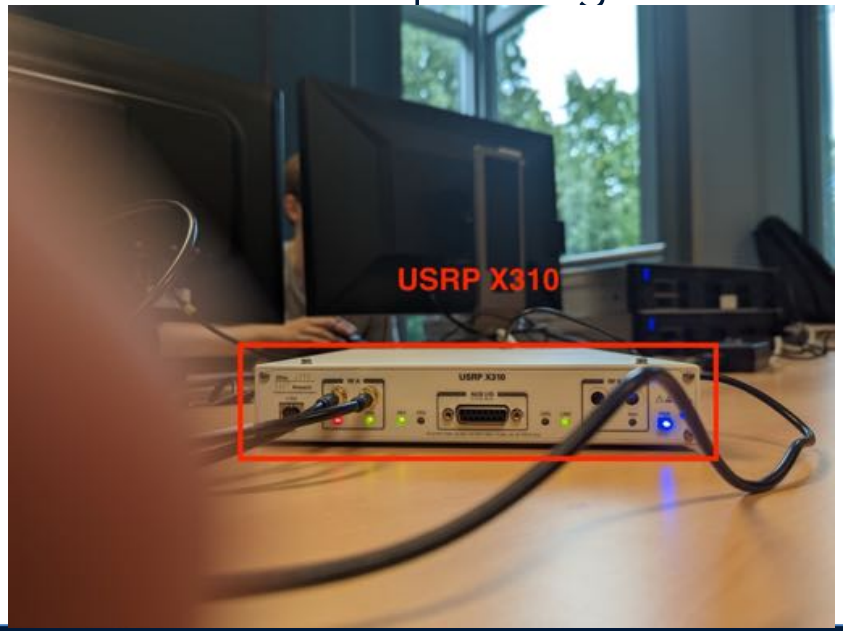
LAAS' 5G experimental platform (3)

> Servers and Operating System

- Servers: 18 cores DELL 7920
- Ubuntu 20.04 with a low latency kernel

LAAS' 5G experimental platform (4)

> Universal Software Radio Peripheral
  - Model: Ettus X310
  - Connection: Ethernet 10 Gbps using an SFP+ module



LAAS' 5G experimental platform (5)

> NORMA 4000 PowerMeter

Objectives

- Measuring the energy consumption of each 5G component
  - Optimizing the most consuming ones
- For that:
  - Classical software energy measurement tools
    - RAPL-based as Scaphandre
  - Hardware powermeter as the ground truth

Big STOP !

> Scenario: UE sends constant traffic at 5 Mbps rate
> gNB energy consumption (Scaphandre): 500 W
> gNB energy consumption (NORMA): 280 W

> The work done just discriminates between USRP and full server energy consumption as measured with the powermeter

Average energy consumption

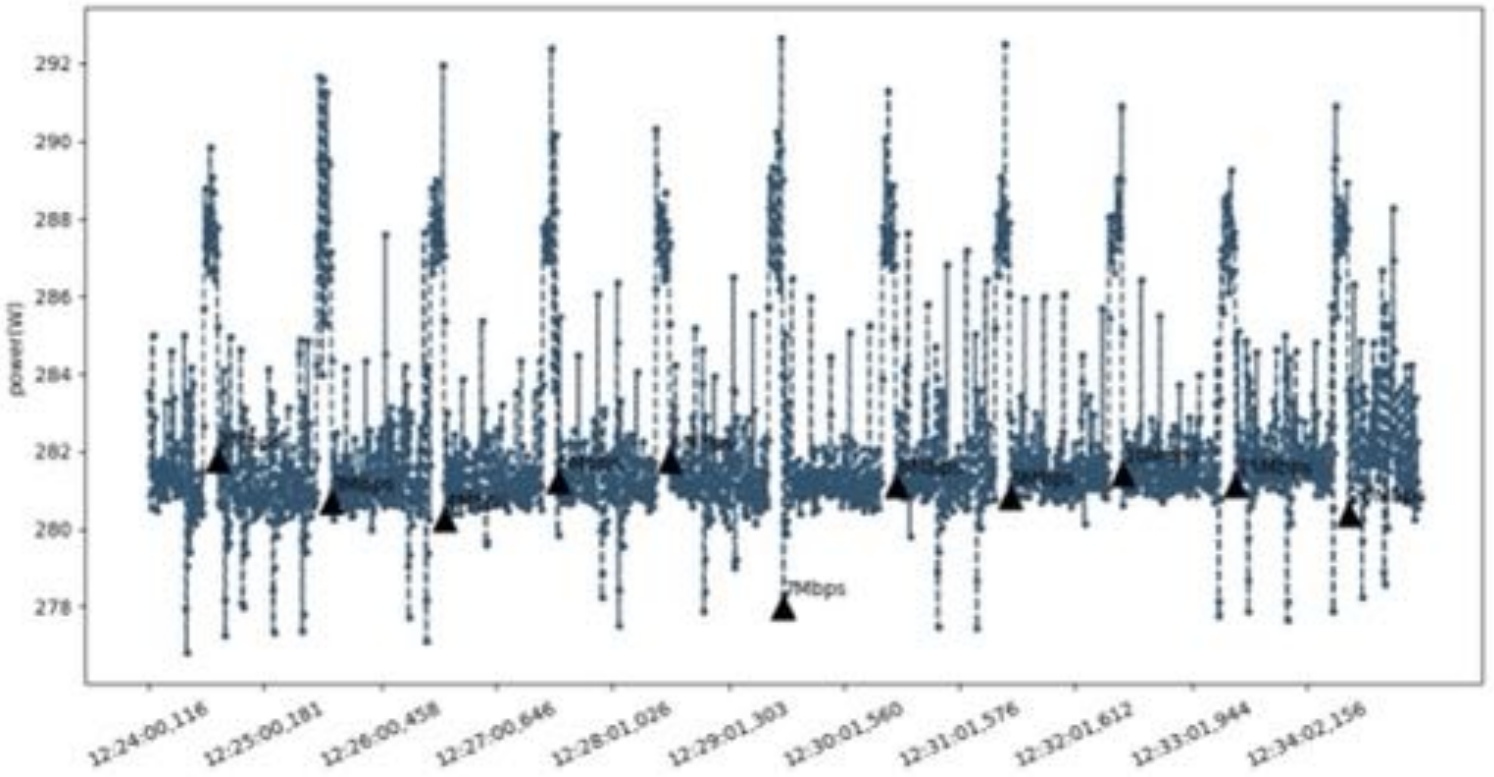
USRP ENERGY CONSUMPTION

Description	Power consumption
USRP without gNB process	25,62 W
USRP with gNB without traffic	37,15 W (+45%)
USRP with 2 Mbps DL traffic	37,25 W
USRP with 20 Mbps DL traffic	37,59 W

SERVER ENERGY CONSUMPTION

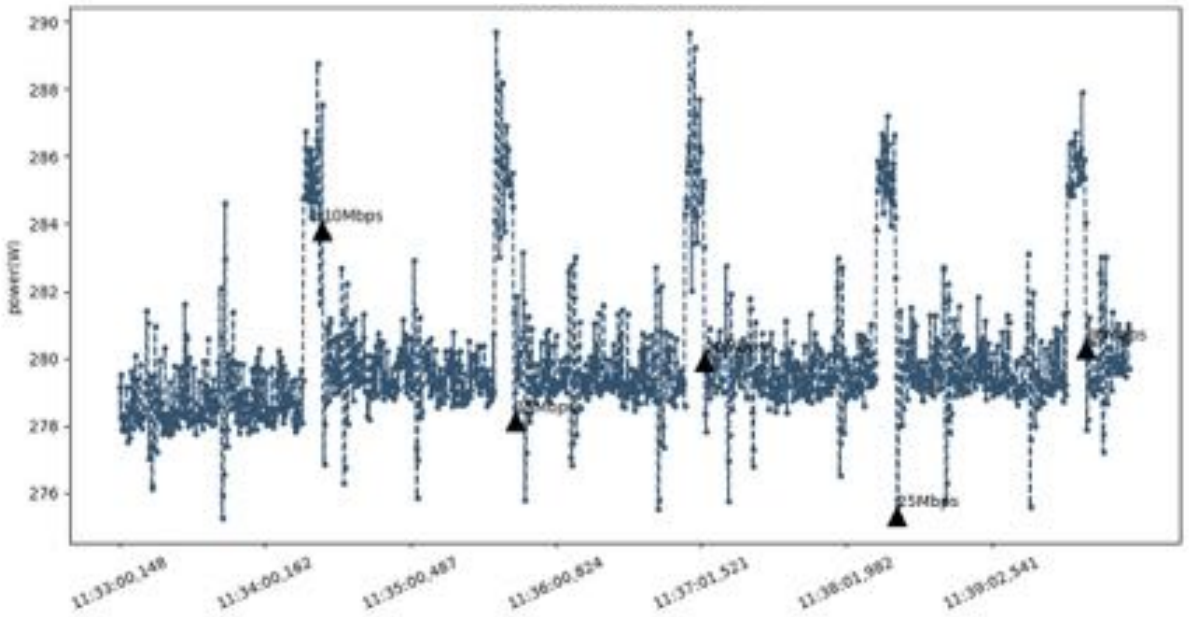
Description	Power consumption
Server without gNB process	274,72 W
Server with gNB without traffic	282,83 W (+2,95%)
Server peak at traffic generation start	289,13 W (+2,23%)

gNB (server) energy consumption - downlink traffic



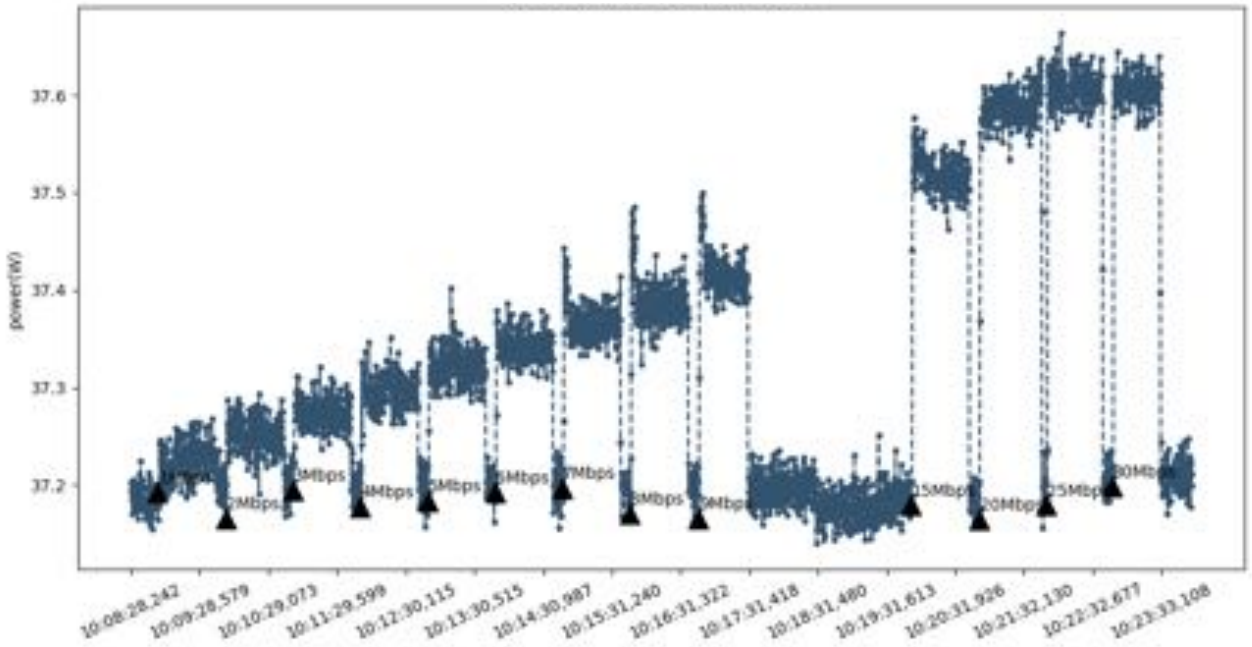
Successive bursts of: 1-2-3-4-5-6-7-8-9-10-15-20 Mbps

gNB (server) energy consumption - uplink traffic



Successive bursts of: 5-10-15-20-25-30 Mbps

gNB (USRP) energy consumption - downlink traffic



Successive bursts of: 1-2-3-4-5-6-7-8-9-10-15-20-25-30 Mbps

Conclusion

- Instrument our 5G experimental platform with trustable energy consumption measurement tools
- Confirm or infirm that:
  - Energy consumption of the server is basically high but does not increase significantly when traffic load increases
  - Energy consumption of the USRP increases significantly with the traffic: scalability issue?