IEEE NETSOFT 2020

Tutorial - A softwarized perspective of the 5G networks - RAN

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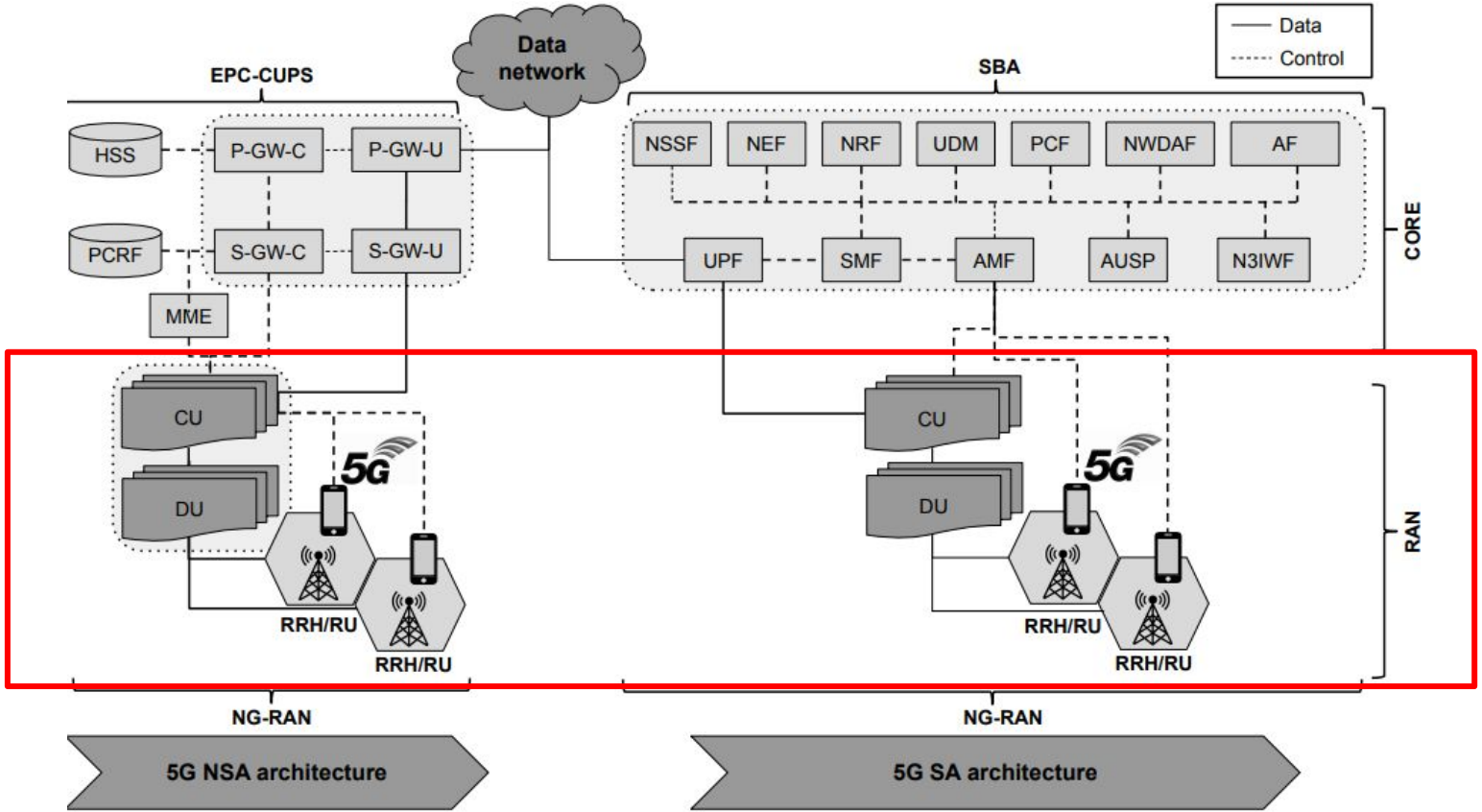
The Radio Access Network - RAN



The Radio Access Network - RAN

A RAN is responsible for managing the air interface to keep a large number of users connected

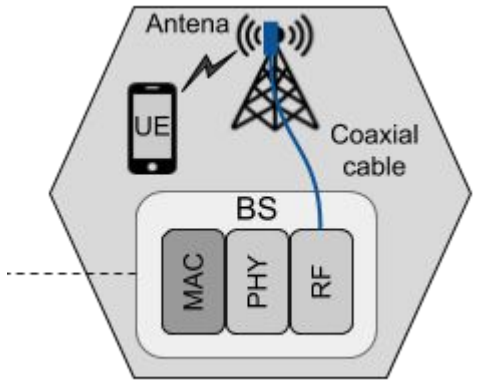
Some RAN tasks:

- Efficiently manage de RF spectrum
- Radio resource management
- Connection mobility control
- Dynamic resource allocation to UEs
- Compression and security (PHY)
- Session management and QoS flow
- ...

The Radio Access Network - RAN

RAN 1G - 2G:

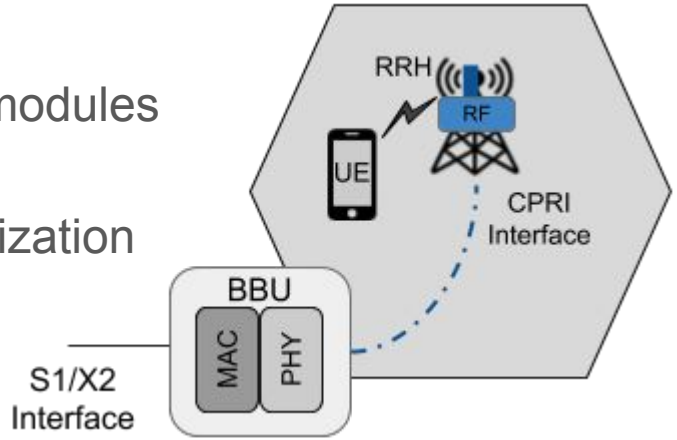
- RF front-end and baseband processing functions were integrated within a BS
- Antenna module located a few meters from the radio module connected with a coaxial cable:
  - High transmission losses
  - Limited bandwidth bus



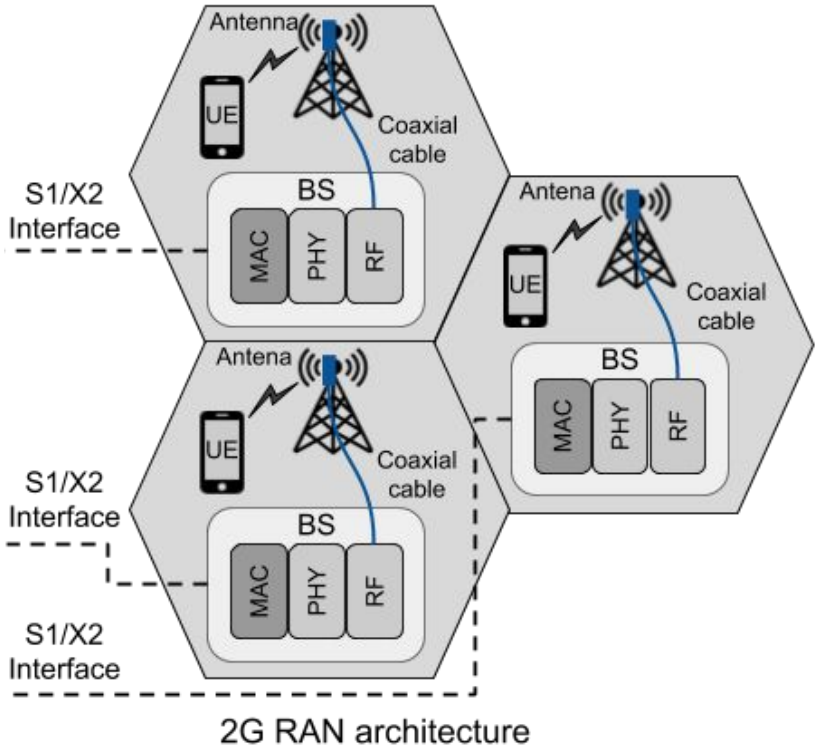
The Radio Access Network - RAN

RAN 3G - 4G:

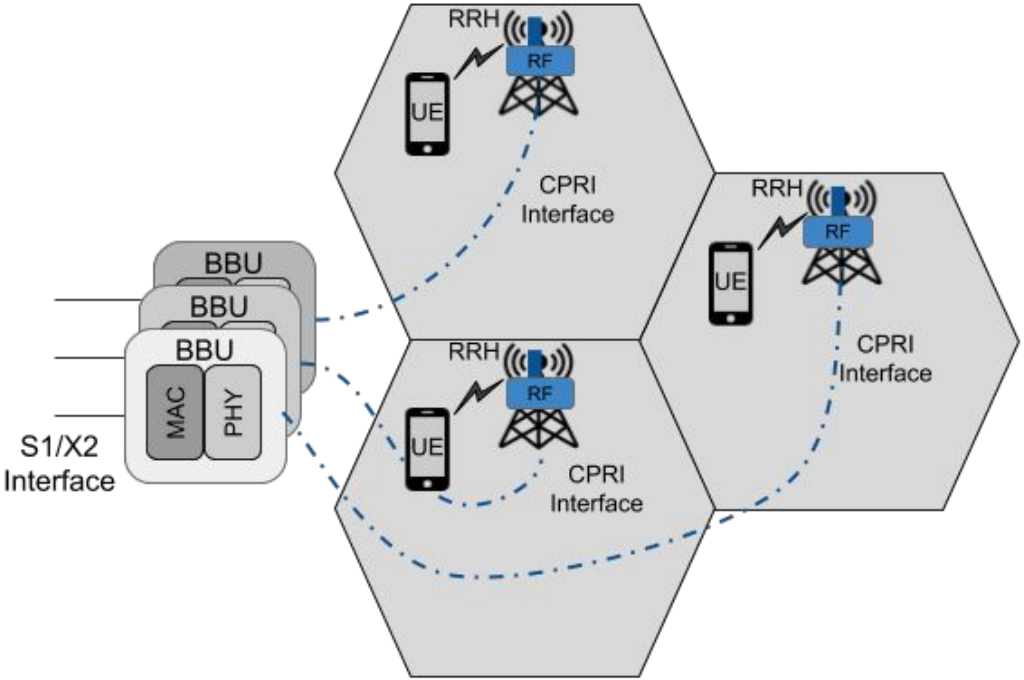
- RF front-end decoupled from the baseband processing module
    - Specialized hardware components -> fiber optics:
        - ➢ reducing data loss and increasing the distance separation
    - Mobile operators has been able to replace modules according to users demands
    - New architectures become possible: centralization and virtualization



RAN centralization



2G RAN architecture



3G/4G RAN architecture

RAN centralization

Since the BBU performs its operation separately from the RU, this architecture is considered decentralized

Optical fibers with high bandwidth -> Cloud Radio Access Network (C-RAN)

- BBUs in data center
- Centralized maintenance: elasticity and cost reduction
- RRHs far from BBUs up to 40 km - delay restrictions:
  - Distance between them
  - Channel conditions
  - Available processing capacity

RAN centralization

The conceps involved C-RAN have been drawn attention to the initial implementation of 5G:

- cost reduction
- better maintenance

BBUs: hardware-based platforms with specialized digital signal processors

vBBUs: general-purpose hadware with BBUs in software

RAN virtualization - vRAN

The vRAN has received prominence in 5G systems:

- Create, manage, and configure RANs dynamically
- Meeting specific requirements of each service

New business models:

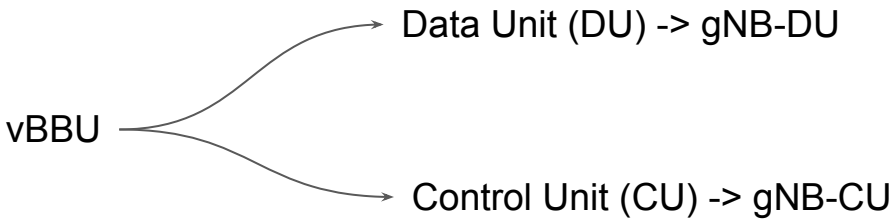
- Service providers can rent vRANs from infrastructure providers

Isolation, programmability, and adaptability:

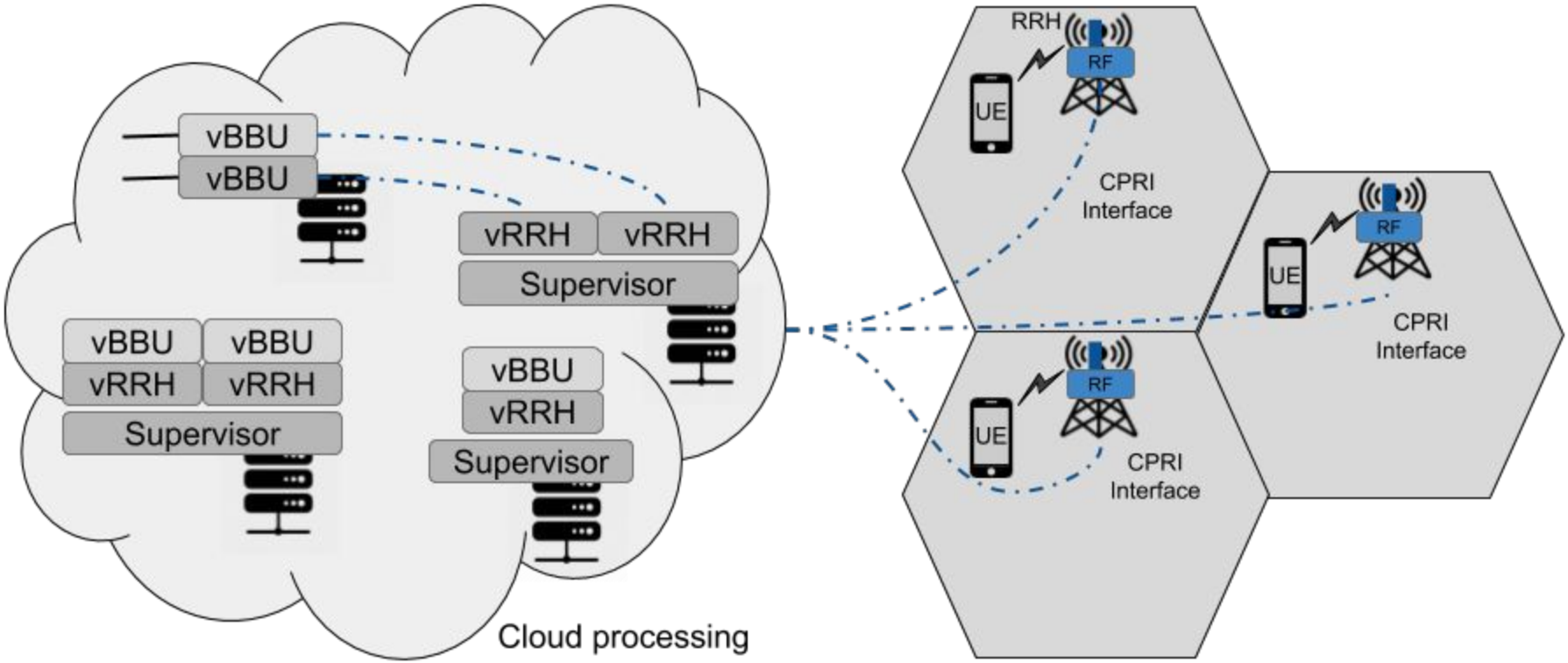
- Network slicing
- Accommodate different services provided for 5G

RAN virtualization - vRAN

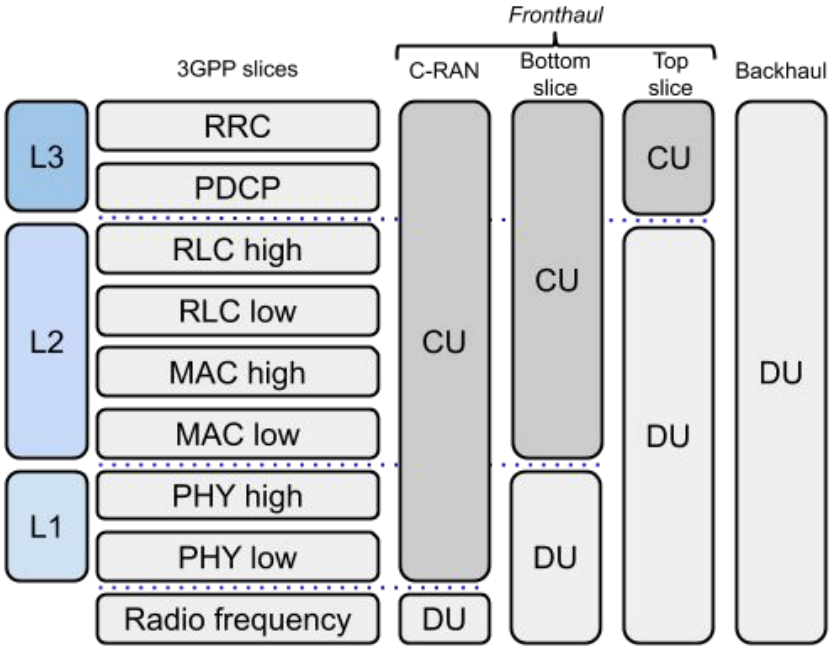
- BBU -> vBBU
- RRH -> vRRH
- A set of vBBUs and vRRHs can run on GPPs:
  - Higly optimized signal processing libraries
  - Ever-increasing evolution of processors
- 3GPP RAN3 working group:



RAN virtualization - vRAN



RAN virtualization - vRAN



S. Gonzalez-Diaz et al., “Integrating fronthaul and backhaul networks: Transport challenges and feasibility results,” IEEE Transactions on Mobile Computing, pp. 1–18, 2019.

RAN virtualization - vRAN

This new flexible architecture of RAN composed of distributed data units (DU/gNB-DU) and control units (CU/gNB-CU) brought changes to the transport network between the access and the core of the 5G system:

- Fronthaul: RRH/vRRH -> DU/gNB-DU
- Midhaul: DU/gNB-DU -> CU/gNB-CU
- Backhaul: CU/gNB-CU -> 5G core