The approach of SoftRAN in 5G ESSENCE: fundamental changes of the radio access layer

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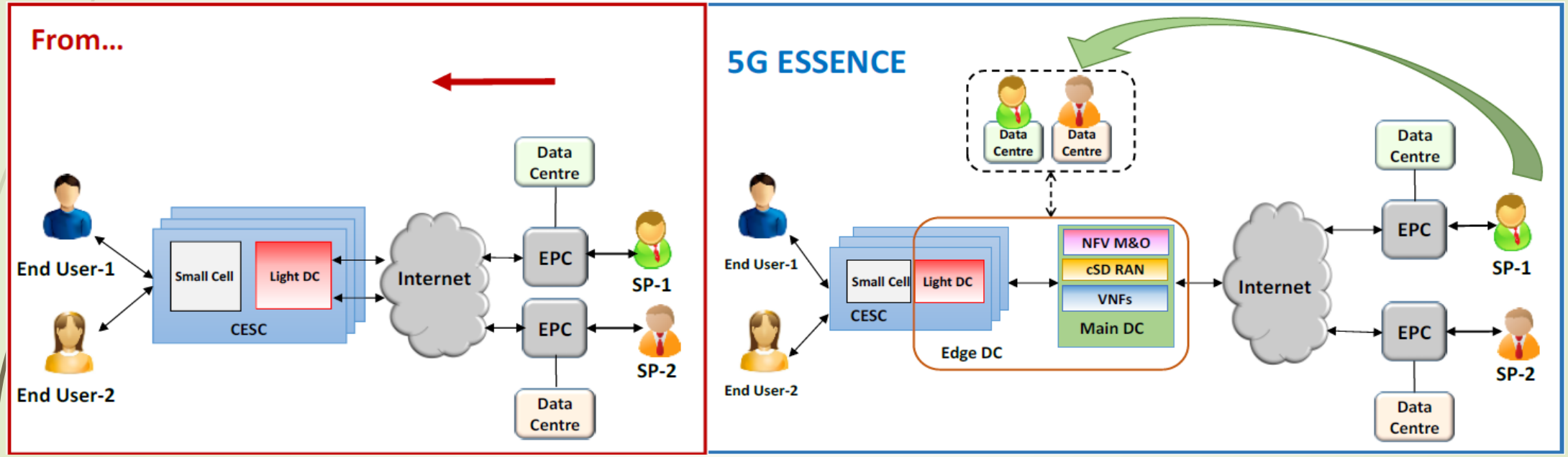
Outline

- The situation today and the needs of 5G ESSENCE
- The problem: Densification / Resource Management becomes challenging
- The approach of C-RAN and its drawbacks
- The Software Defined RAN and its benefits
- Challenges / Future work

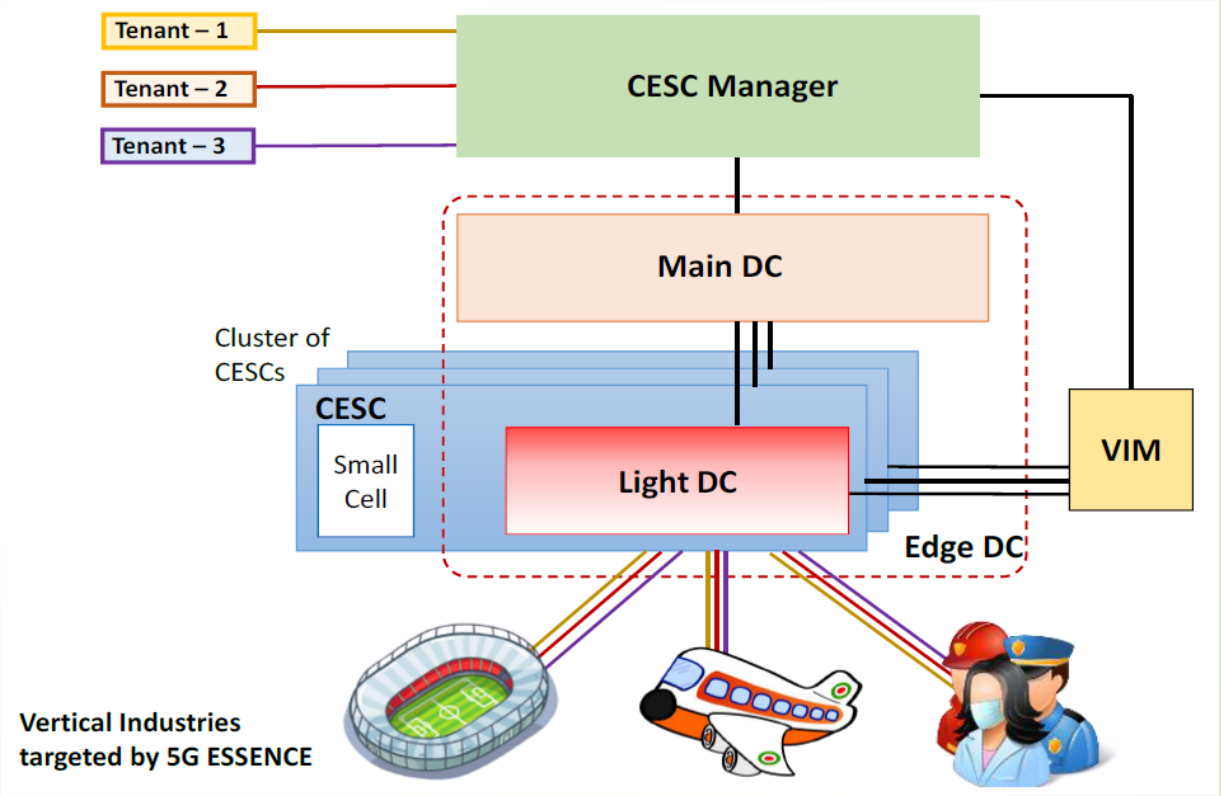
Target: Efficient service deployment

- While the air-interface latency can be minimized independently of the service latency, having service functions close to the users is also necessary to reduce the **end-to-end latency** and also the overall **service creation time**.



Proposed architecture targeting to 5G-PPP verticals

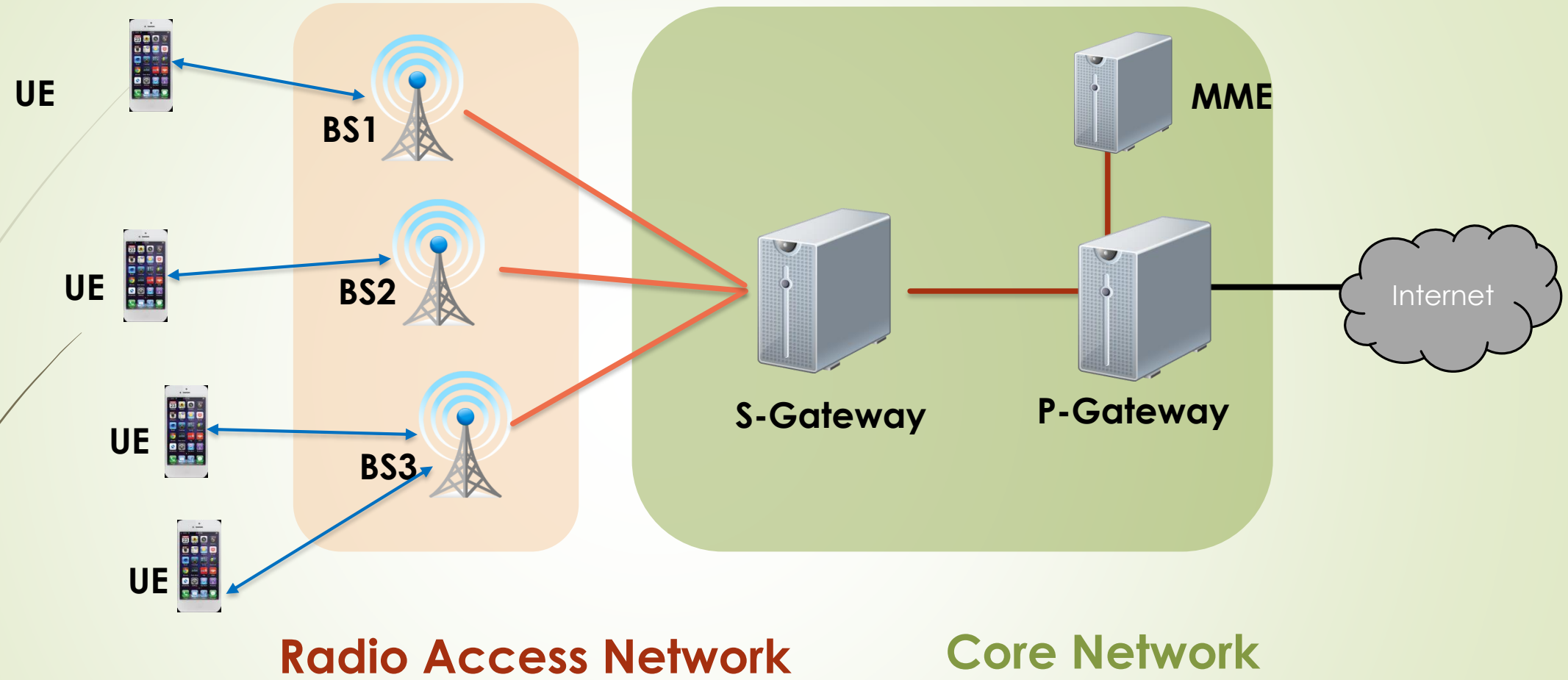
- Based on a two-tier approach
- Each Cloud Enabled Small Cell is able to host one or more service VNFs, directly applying to the users of a specific operator.
- VNFs can be instantiated inside the Main DC and can be parts of a SFC mechanism
- The Light DC can be used to implement different functional splits of the Small Cells as well as to support the mobile edge applications of the end users.



HORIZON 2020

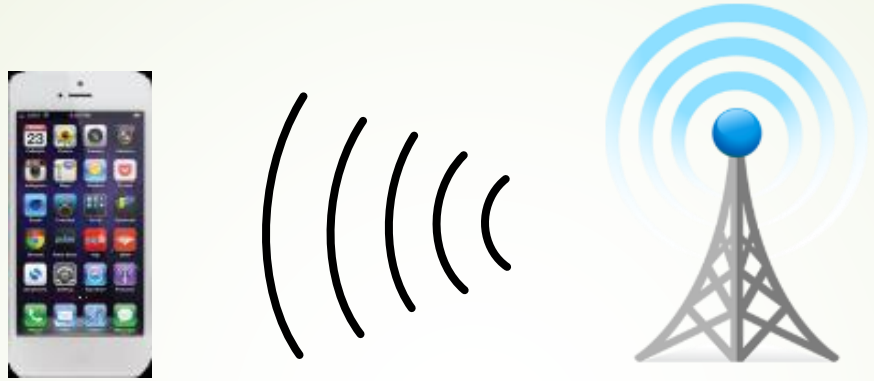
5G PPP
The 5G Infrastructure Public Private Partnership

LTE - Radio Access Network

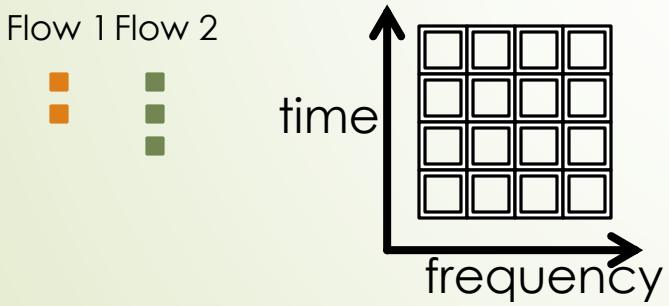


- High Capacity
- Uniform Coverage

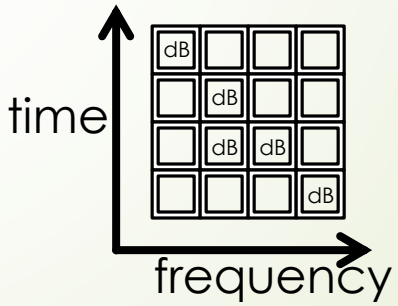
RAN Actions: Radio Resource Management



1. Assign each UE to a base station



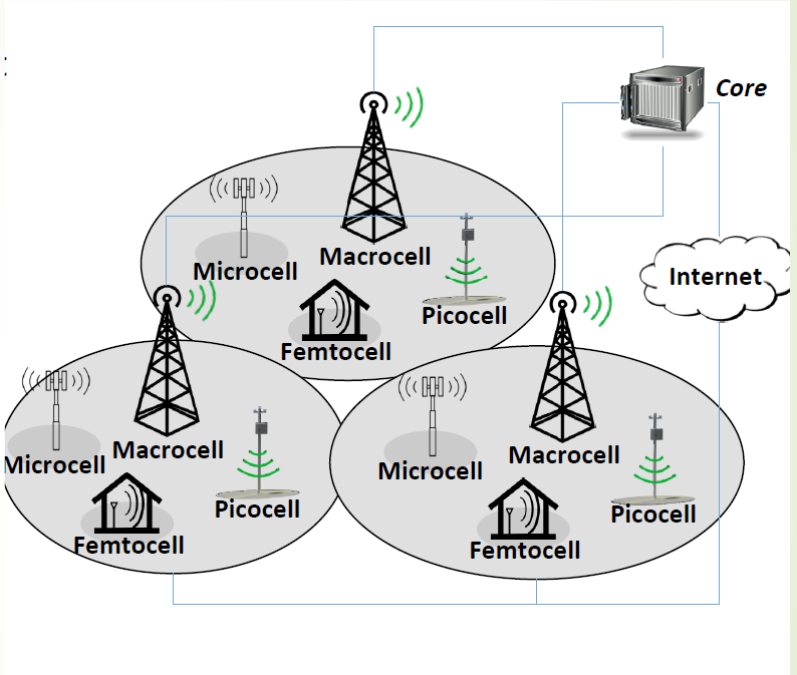
2. Assign resource blocks (time-frequency slots) to each flow



3. Assign transmit powers to be used for each resource block

Densification to scale capacity

- Small cell deployment for spatial reuse and capacity scaling
- Small cells likely on same frequency as macro
- Backhaul through a variety of technologies (cable, public fiber, microwave, etc.)



But… *Network capacity does not scale because small cells interfere with each other and macro in a dense deployment*

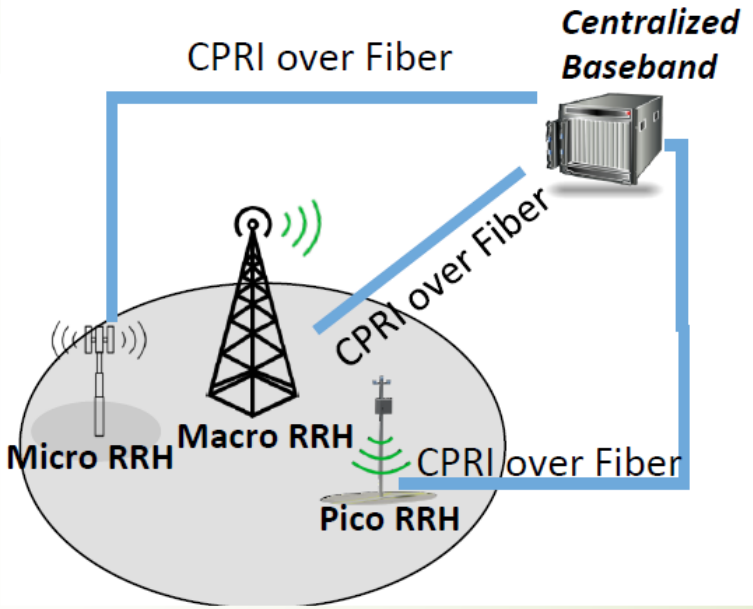
Problem: How to densify the RAN and how to handle interference?

- Coordinate small cell radio resource usage to manage interference and increase capacity. Two approaches:
- Distributed SON
  - Power control, eICIC (enhanced Inter-cell interference coordination - e.g. Qualcomm UltraSON)
- Centralized baseband and control (C-RAN)
  - Implement sophisticated interference coordination by processing all packets and signals centrally

C-RAN

Benefits

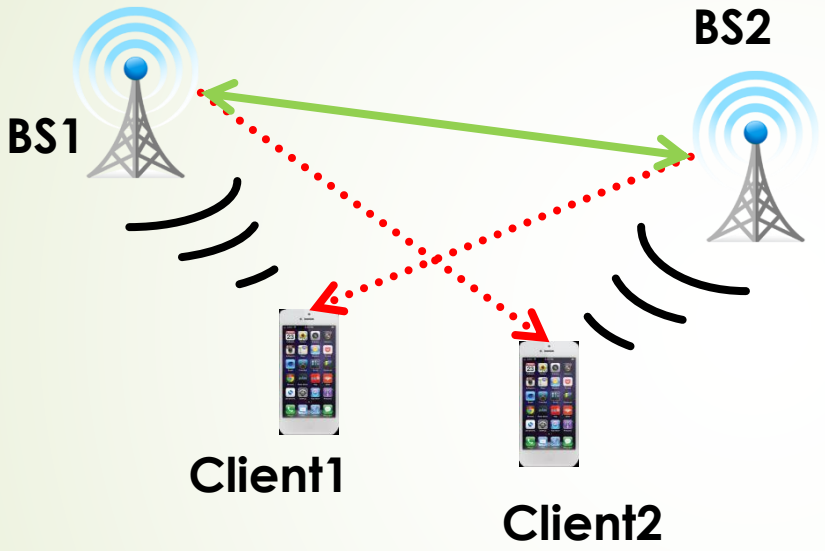
- Each eNB is now only a radiohead (RRH)
- All LTE processing (including L1) is done at a central location
- RRHs backhaul IQ samples from central location via direct fiber
- Can implement sophisticated interference coordination mechanisms
- Statistical multiplexing helps reduce CAPEX of baseband processing



C-RAN Challenges

- Increasing demand on wireless resources
- Expensive and very high performance transport
- Bandwidth: 20Gbps per macro site (16 antennas, 5 bands),
- 6Gbps per small cell site (4 antennas, 3 bands)
- Latency: Less than 1ms RTT

Coupled Radio Resource Management: Interference



- Power used by BS1 affects interference at Client 2
- Interference at Client 2 affects power required at BS2

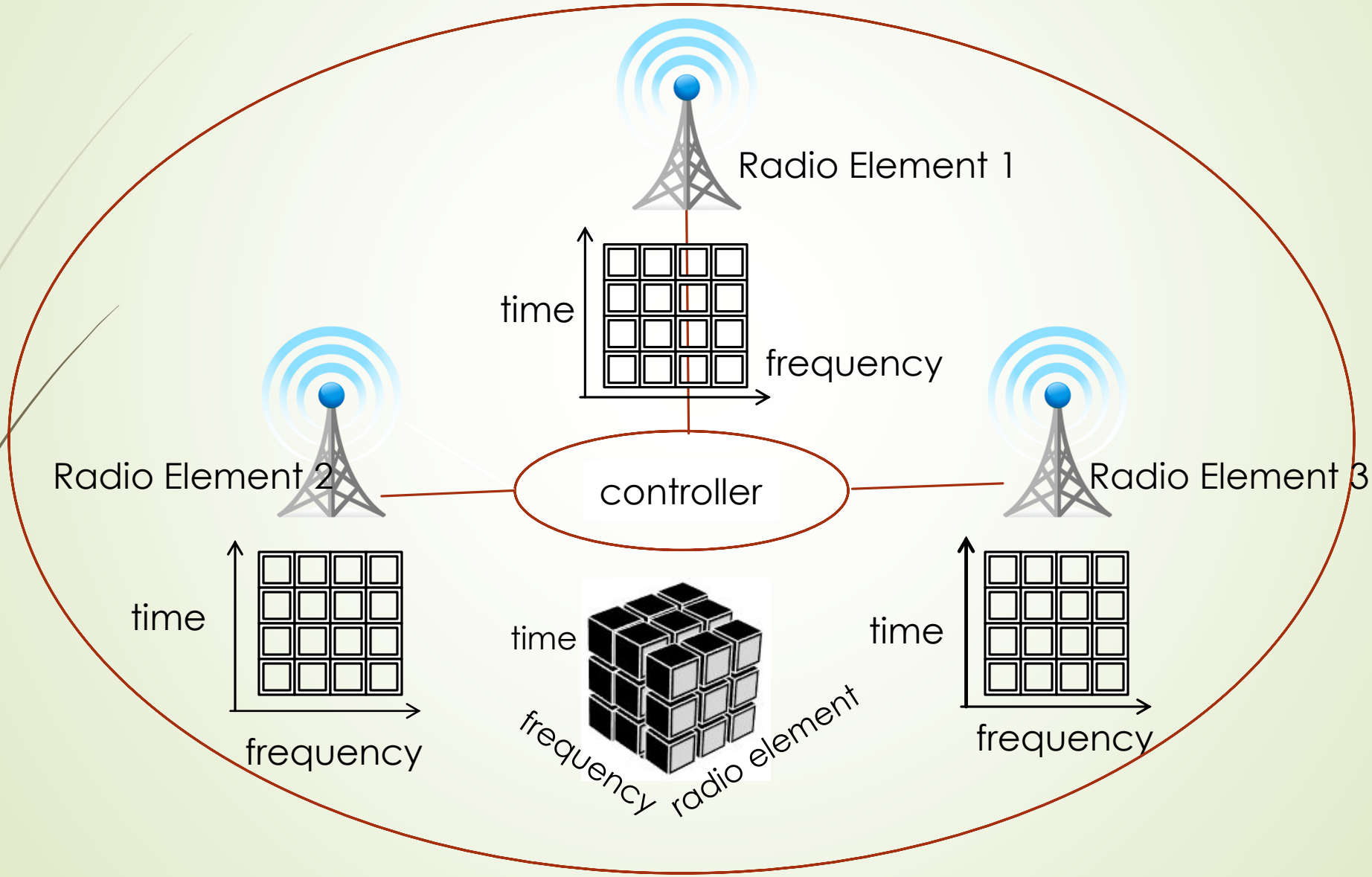
Radio Resource Management gets coupled across base stations

SoftRAN: Bringing (scalable) SDN to the RAN

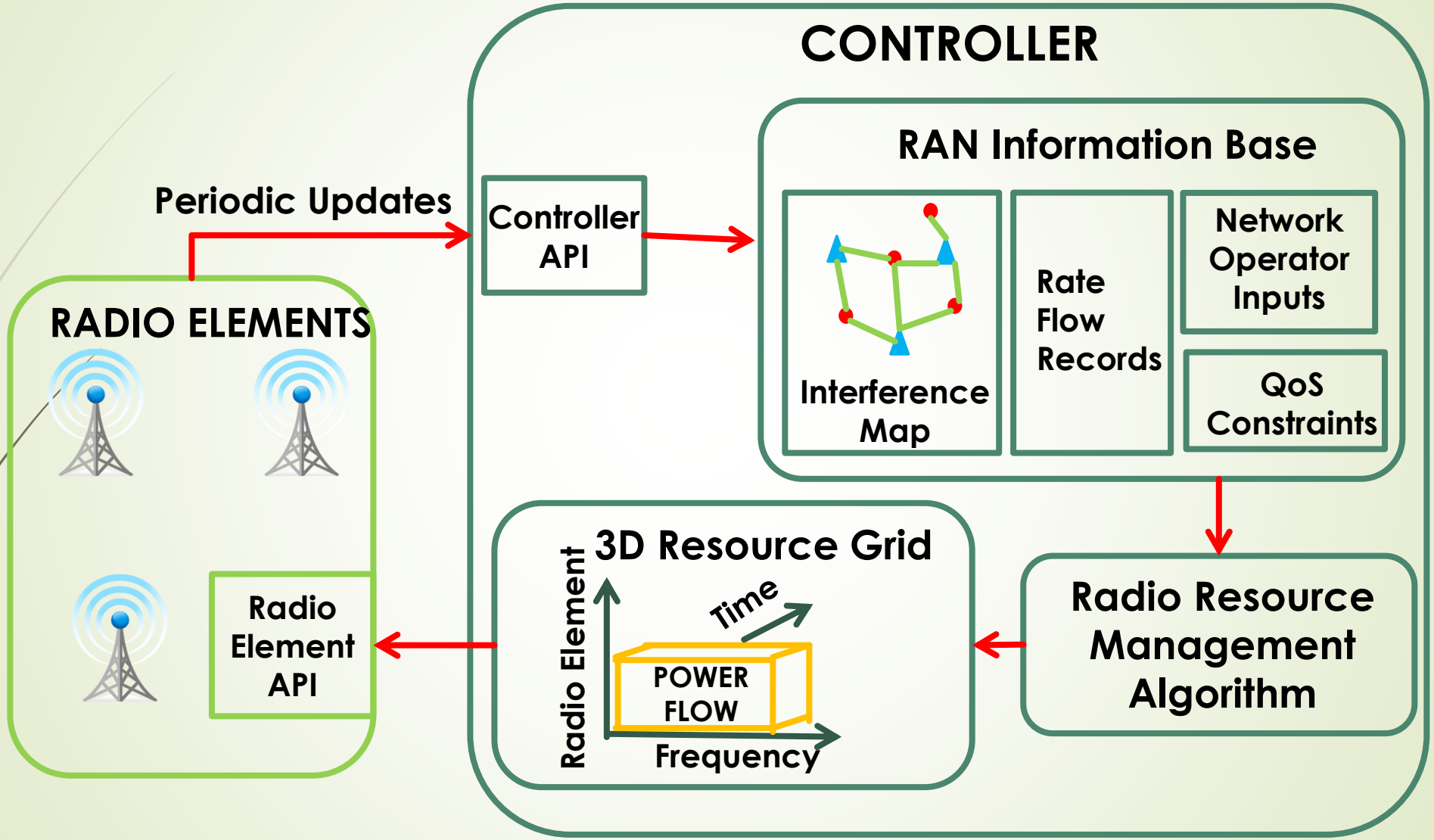
In dense deployments, Radio Resource Management needs to be tightly coordinated

- SoftRAN provides the benefits of CloudRAN without the enormous transport costs
- Decouples the data plane and control plane for the RAN
- Control plane that programs the radio resource usage in a macro sector in a unified fashion
  - Low latency control transport latency still required
- Data plane that leverages low cost transport using whatever medium is available (cable, public, fiber etc)
  - Does not require low latency

SoftRAN: Base Station Abstraction

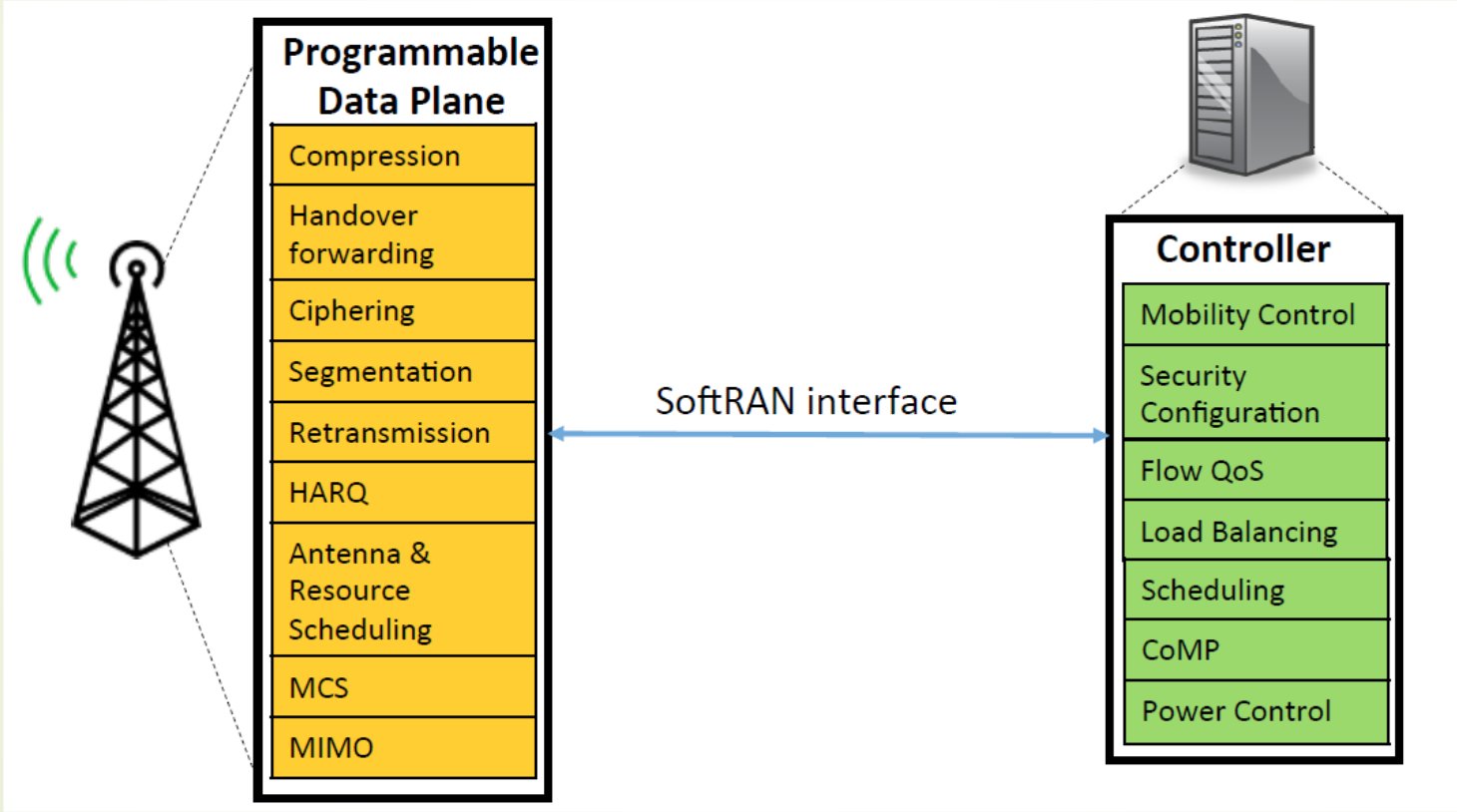


SoftRAN Architecture*



* A. Gudipat et al, SoftRAN : Software Defined RAN, Stanford University, *Bell Labs*

SoftRAN: Decoupling eNB Data & Control Planes



SoftRAN: SDN Approach to RAN (benefits)

- Efficient use of wireless resources
  - Global view on interference and load
- Simplified network management
  - Plug-and-play control algorithms
- Incrementally deployable on current infrastructure
  - No modification to Base Station – Client interface

Thank you

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