



IEEE 1930.1

An SDN based Architecture for beyond 5G networks

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Agenda

- IEEE 1930.1 - Status
- Some Issues with 5GS Architecture
- IEEE 1930.1
 - Software Defined Networking (SDN)
 - Disaggregation of Multi-RAT RAN
 - Unification of Multi-RAT RAN
 - SDN based architecture
 - SDN Middleware
 - Advantages
- IEEE 1930.1/P2061 - Integration with 3GPP 5GS
- Wireless Network Architecture for beyond 5G
- Future Work

IEEE 1930.1

- IEEE Standard (Recommended Practice) for beyond 5G
- Defines an
 - SDN based architecture for Multi-RAT wireless access network
 - SDN middleware to facilitate unified control and management of multi-RAT wireless access network
- Approved as a new standard by IEEE SA on 16 June 2022
- Published on 2nd September 2022



Issues with existing mobile network architecture

Existing Mobile Network Architecture (5GS)

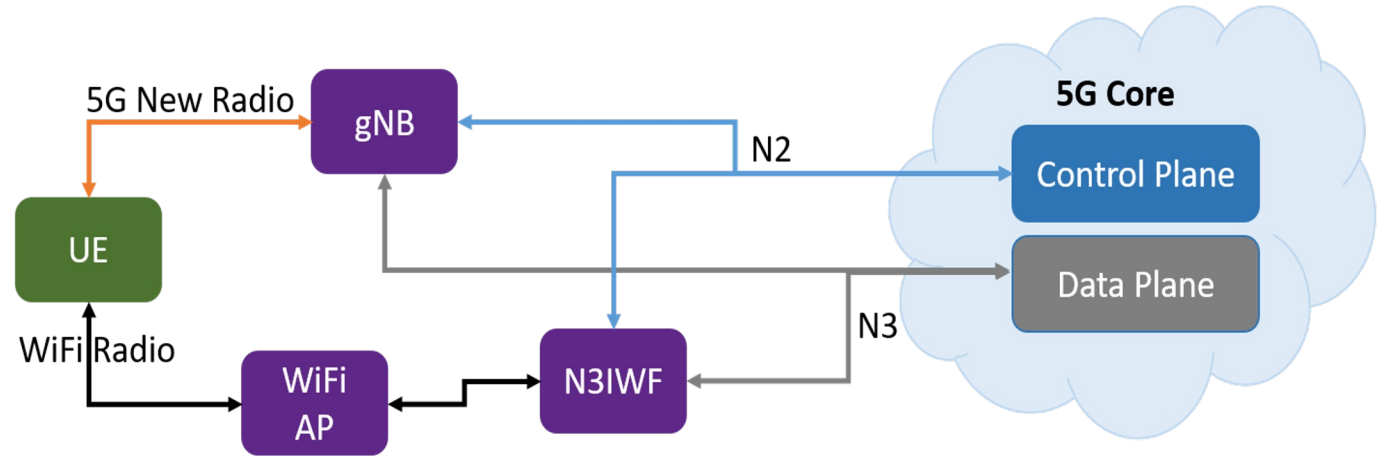
Increased Network
Densification

Multi-RAT Networks -
Presence of 3GPP & Non-3GPP
Access (e.g. Wi-Fi)

Converged 5G Core

Common Interface towards
Core for Access Networks

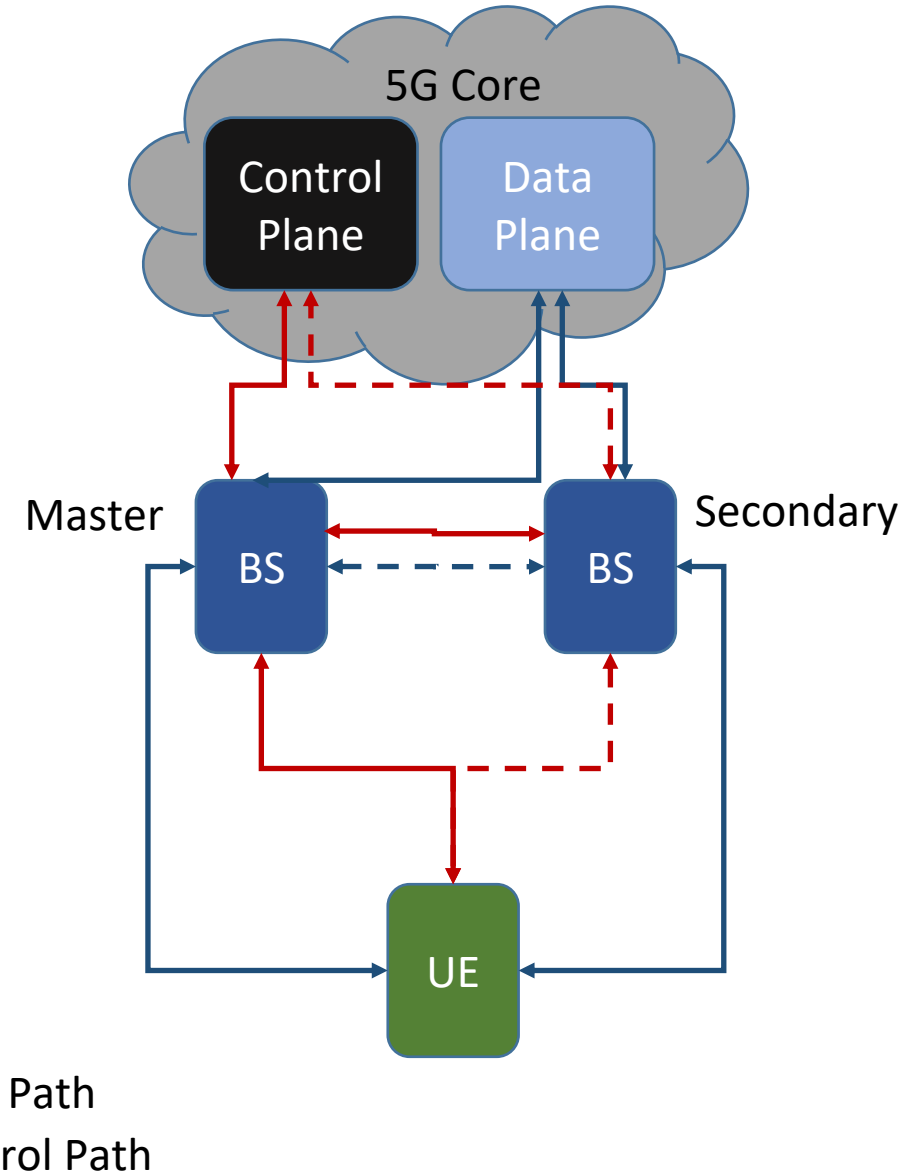
Wi-Fi an Important Access
Technology for 5G



- Fragmented Multi-RAT RAN
 - Limited synergy between RATs despite usage of common functionality
 - No coordination between 3GPP and non-3GPP access
 - Complex Implementation & Poor Performance
- Limited virtualization support
 - Not easy to support features like Network Slicing

Fragmented Multi-RAT RAN - Increased Complexity

- Dual Connectivity
 - Concurrent connection to two BSs (eNB/gNB/AP)
 - An important feature
- UE's primary signalling connection with a single eNB/gNB
- Resources in an individual BS under control of that BS
 - Extensive coordination between BSs (eNBs/gNBs)
 - Coordination missing in some cases
 - Wi-Fi and gNB
- Subtle differences in DC mechanism across RATs
 - LTE-LTE DC, MR-DC, LTE-WLAN Aggregation (LWA)
 - Brings higher complexity



Fragmented RAN - Suboptimal Utilization of Resources

- Load Balancing in Access Network
 - Important Requirement
- Distributed scheme across gNBs (eNBs)
 - Load Information shared over Xn/X2
 - No Load Information in the absence of Xn/X2
 - No entity with a unified/global view of RAN resources
 - Load Balancing may not be very effective
- Load balancing across RATs even more difficult
 - Wi-Fi AP and gNB/eNB – No mechanism available



What does 1930.1 Do?

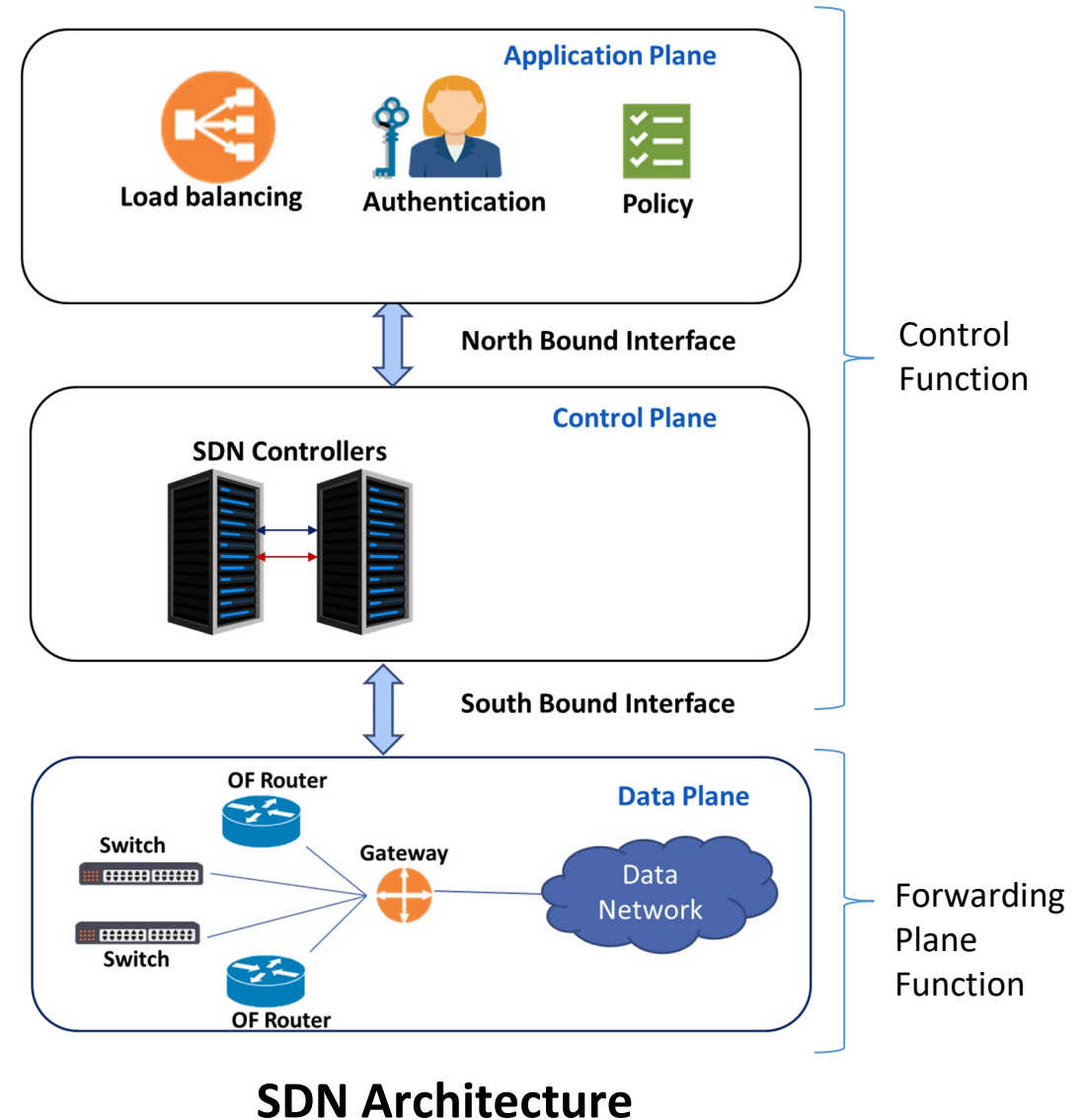
Unifies Multi-RAT RAN

How?

Via Software Defined Networking (SDN) and
Disaggregation

What is SDN?

- Network separated into two sets of functions
 - Forwarding Plane Functions
 - Responsible for data forwarding
 - Also called data/user plane
 - Control Functions
 - Controls forwarding plane functions
 - Separated into Control Plane and Application Plane
- Distributed Forwarding Plane
- Logically Centralized Control Plane
 - Unified Control
- Standardized Interface
 - Between Control & Forwarding Plane
 - To Control the Forwarding Plane



What does SDN enable?

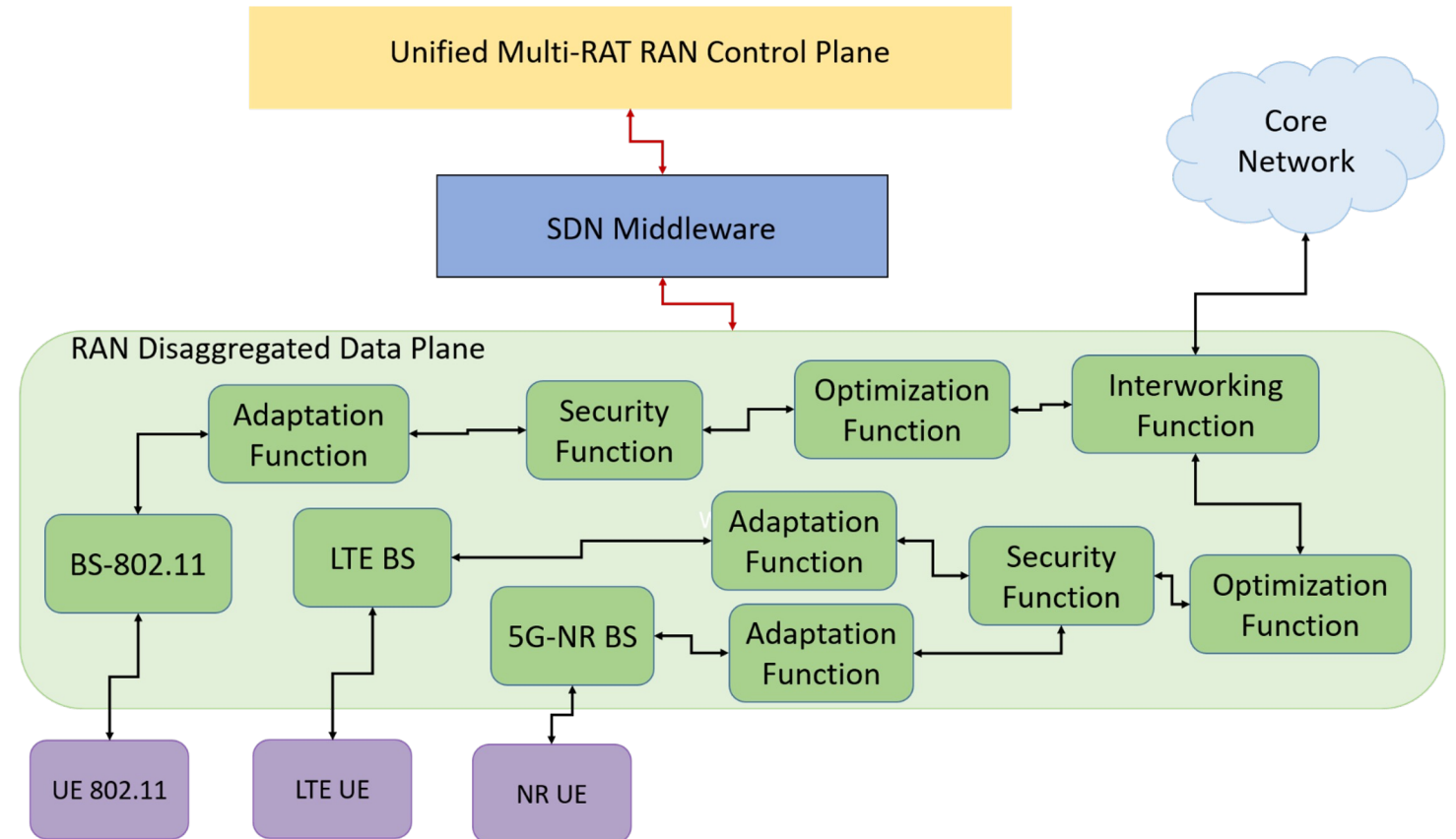
- Programmable network
 - Applications provide policies to the controller
 - Through North bound interface
 - e.g., REST based interface
 - Controller configures forwarding elements
 - Through South bound interface
 - e.g., OpenFlow, NETCONF
- Virtualization of forwarding plane
 - Easy introduction of new services, e.g., network slice
- Improved utilization of network resources
 - Via unified global view of the network
- Independent evolution of all three planes
- Cost effective solution

RAN User(Data) Plane Disaggregation and Unification

- RAN User (Data) Plane of most RATS perform similar functions in 5G
 - Radio Tx/Rx
 - PHY & MAC
 - Security
 - Optimization (Header Compression etc.)
 - Interworking with Core
- Can we Disaggregate RAN along these simpler functions?
- Does it help in unified treatment of RATs?
- Does it help in Load Management, Dual Connectivity?

Disaggregated Data Plane for Multi-RAT RAN

- Modular Data Plane Functions
- Medium Access Control Function - Base Station (BS)
 - Include MAC and lower Layers, e.g., Physical Layer
- Security Function (SF)
 - Encryption and Integrity Protection
- Optimization Function (OptF)
 - IP Header Compression etc.
- RAN Adaptation Function (AdpF)
 - Link Control, ARQ etc.
- Interworking Function (IWF)
 - Interworking with Core
 - In case of 5G - Comprise of N3 Interface Functions
- *An individual Controller may be responsible for controlling a subset of modular functions*



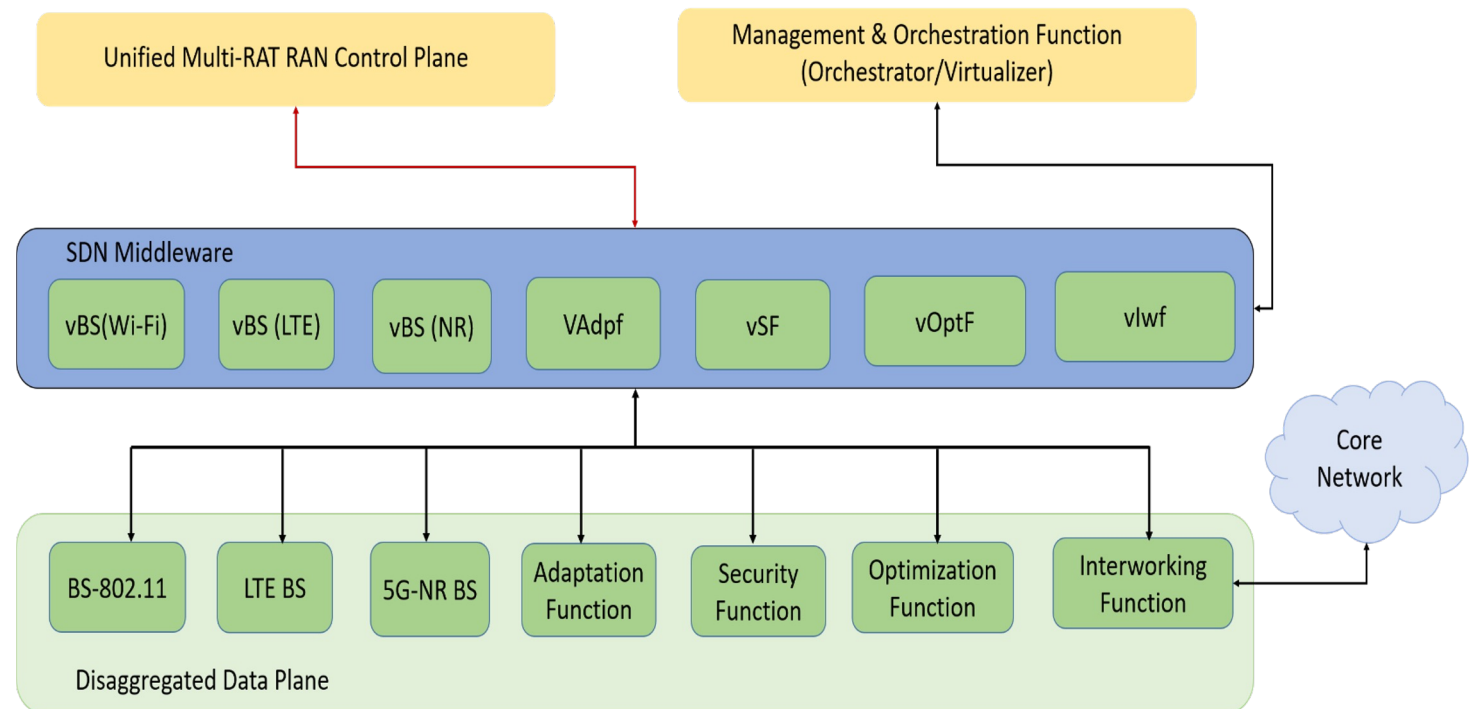
IEEE 1930.1 - Unification of Disaggregated Multi-RAT RAN

■ SDN Middleware

- A Layer between Control & Data Plane
- Abstract Information Model of the Data plane (through virtual entities)
 - *Possible to have different virtual entities from that shown here*
- Virtualize Underlying Data Plane Resources
- Unify Control & Management of Multi-RAT RAN

■ Unified Control Plane

- Controls user plane functions of all RATs
- SDN Middleware Abstraction helps in unified control



IEEE 1930.1 - Unified Multi-RAT RAN

SDN Middleware

- Abstract Information Model of underlying RAN through Virtual Entities

Multi-RAT SDN Controller

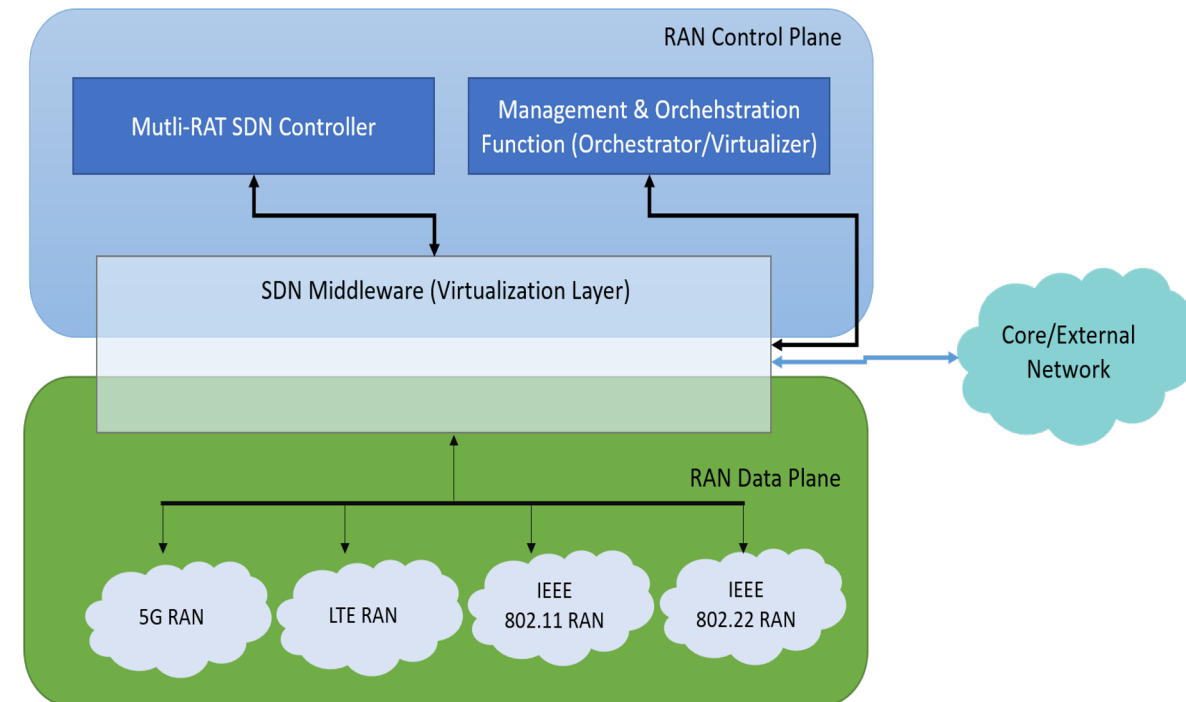
- Control & Management of the Access Network

Management and Orchestration Function

- To Orchestrate & Manage Middleware over RAN Infrastructure

Radio Access Network Infrastructure

- Disaggregated data plane - Access Points, Base Stations, Interworking Functions, ...

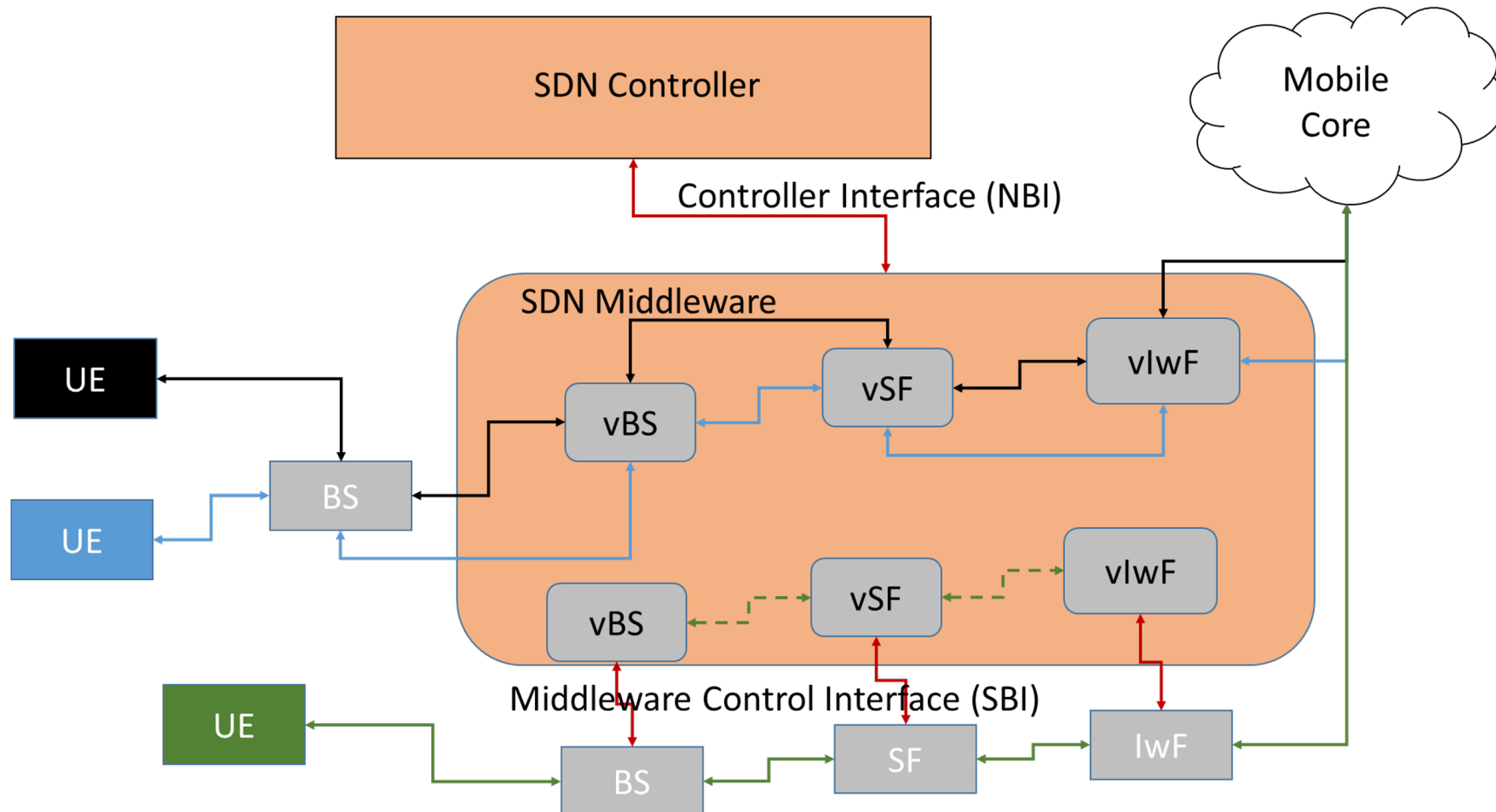


IEEE 1930.1 - SDN Middleware Interfaces

- Northbound Interface of the Middleware
 - Interface towards the Controller
 - e.g., NETCONF for Management (Configuration) and Openflow for Control
 - Not yet decided - neither Protocol nor Information Model
- Southbound Interface of the Middleware
 - Interface between physical infrastructure, e.g., AP/BS and Middleware
 - Can be based on vendor specific or standard protocols
 - Control And Provisioning of Wireless Access Points (CAPWAP)
 - Lightweight Access Point Protocol (LWAPP)
 - SNMP
 - OpenFlow
 - NETCONF
- Middleware maps Southbound Interface with Northbound Interface

IEEE 1930.1 - Distribution of Functionality Across Entities

- Flexible distribution of functionality across SDN Middleware and underlying infrastructure

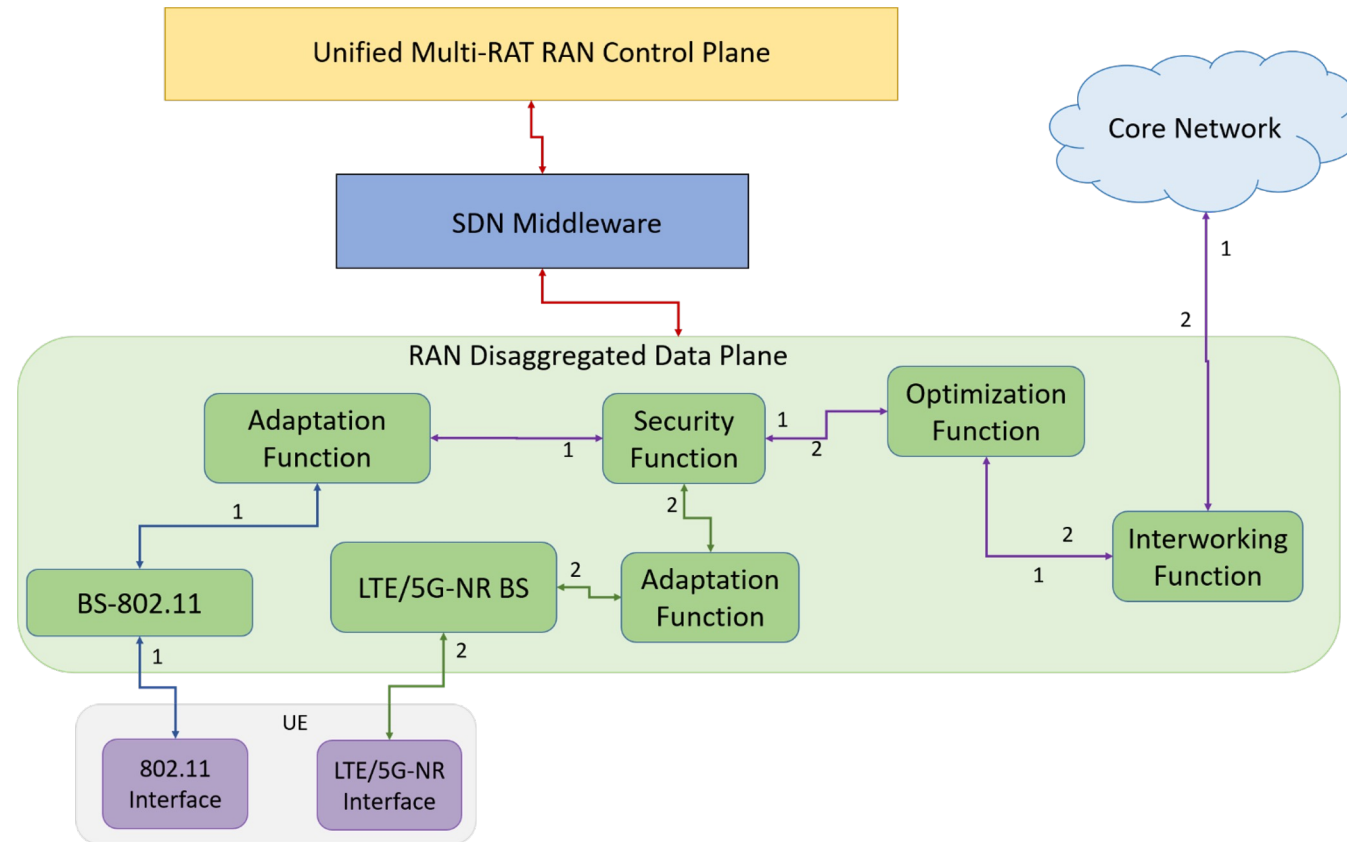




IEEE 1930.1 - Advantages

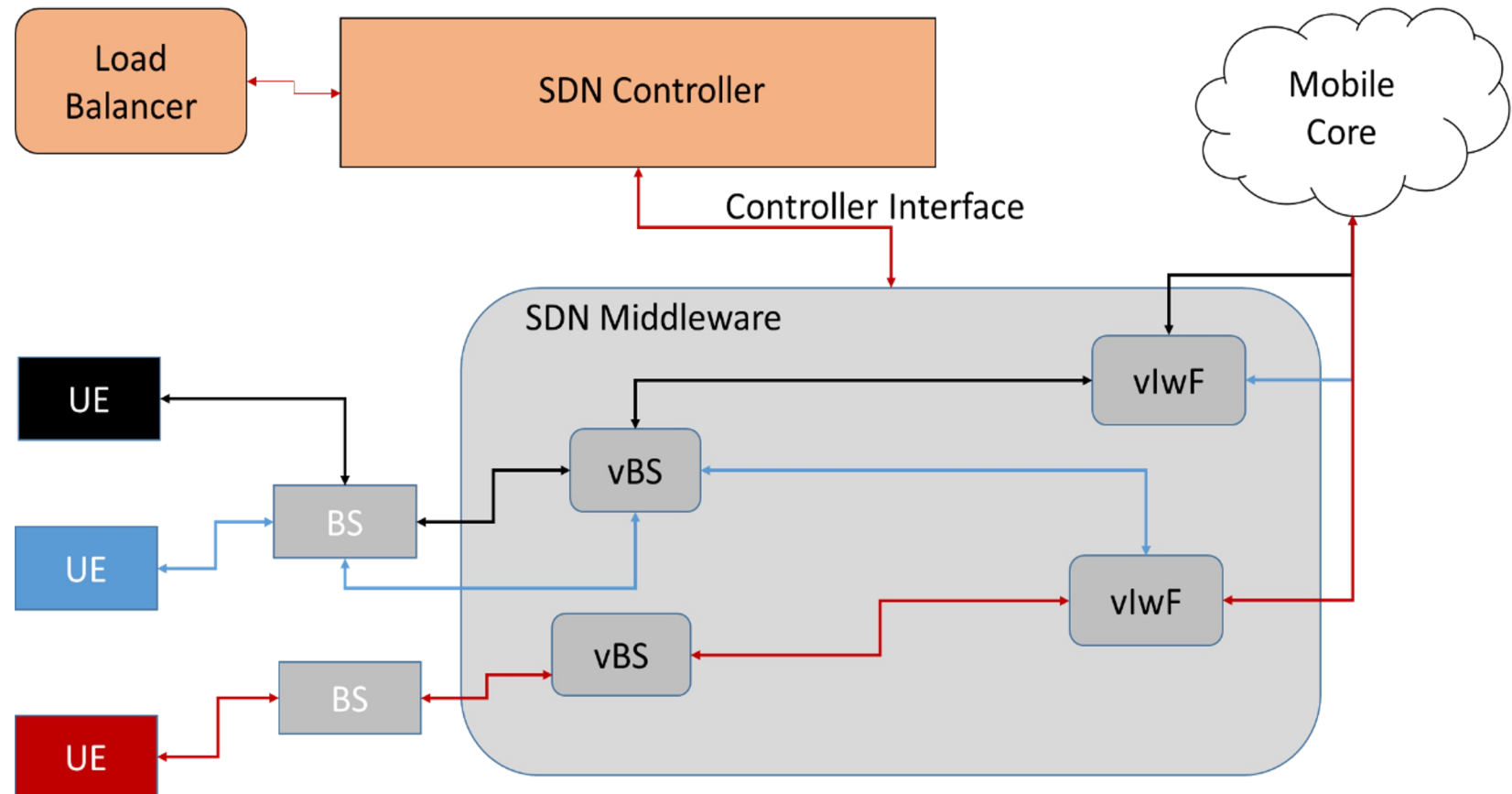
How does it help? IEEE 1930.1 & Dual Connectivity

- A UE connected to two Base Stations
- Traffic From Core - Via the same Interworking, Optimization and Security Functions
- Delivered through different BSs via RAT specific Adaptation (RLC...)
- Control Plane sets up Data path through AN elements
- Dual Connectivity (DC) across RATs supported with ease
 - LWA/LTE DC/MR-DC ...
 - All DC variants



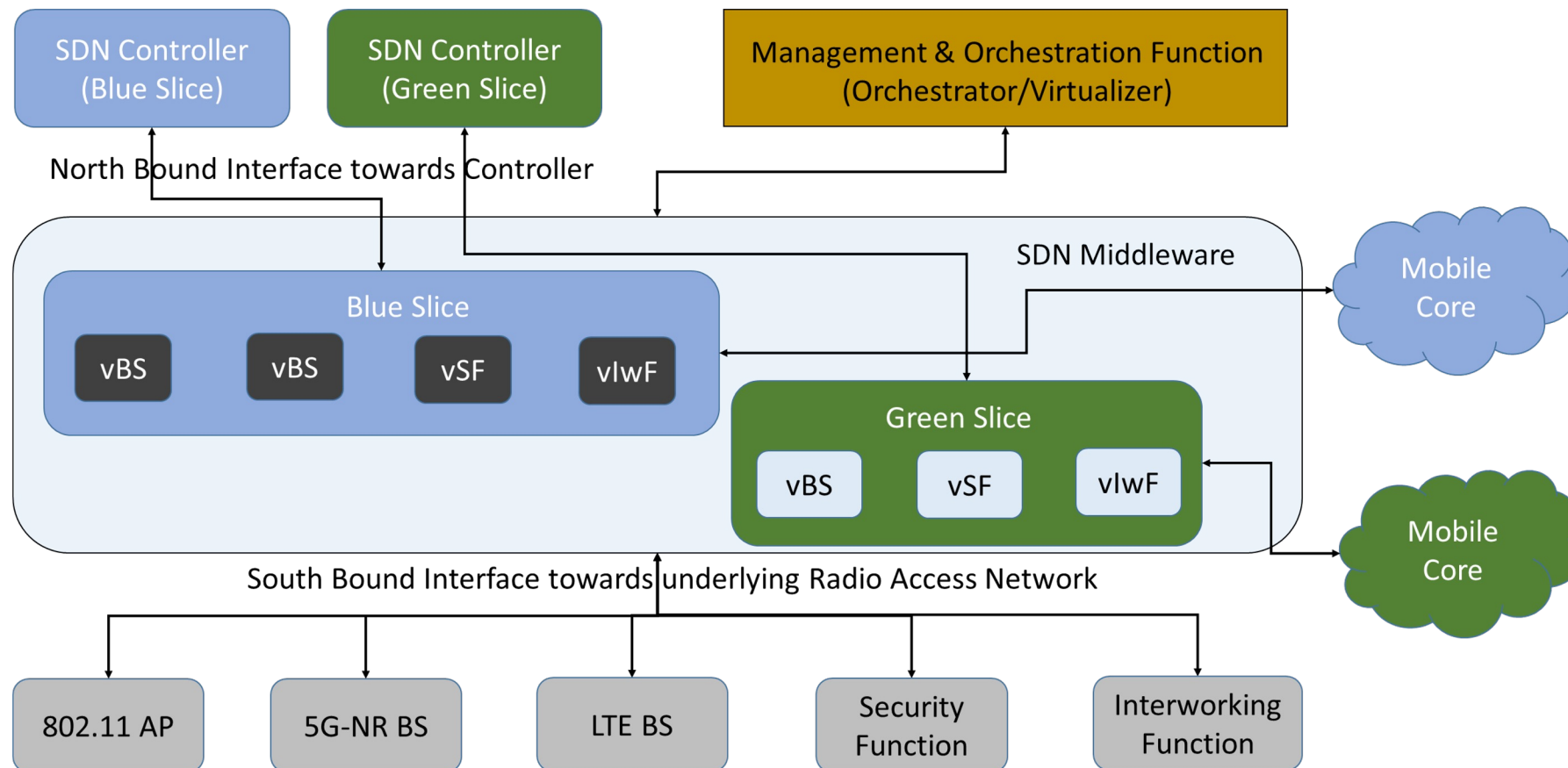
1930.1 - Load Balancing

- Network Function Selection Support through SDN Middleware
- Load Balancing by SDN Controller



1930.1 based Architecture - Network slice support

- Virtual entities distributed across different logical networks (network slices)
- Network slices orchestrated by the Orchestrator
- Possible to have separate Controllers for individual slices

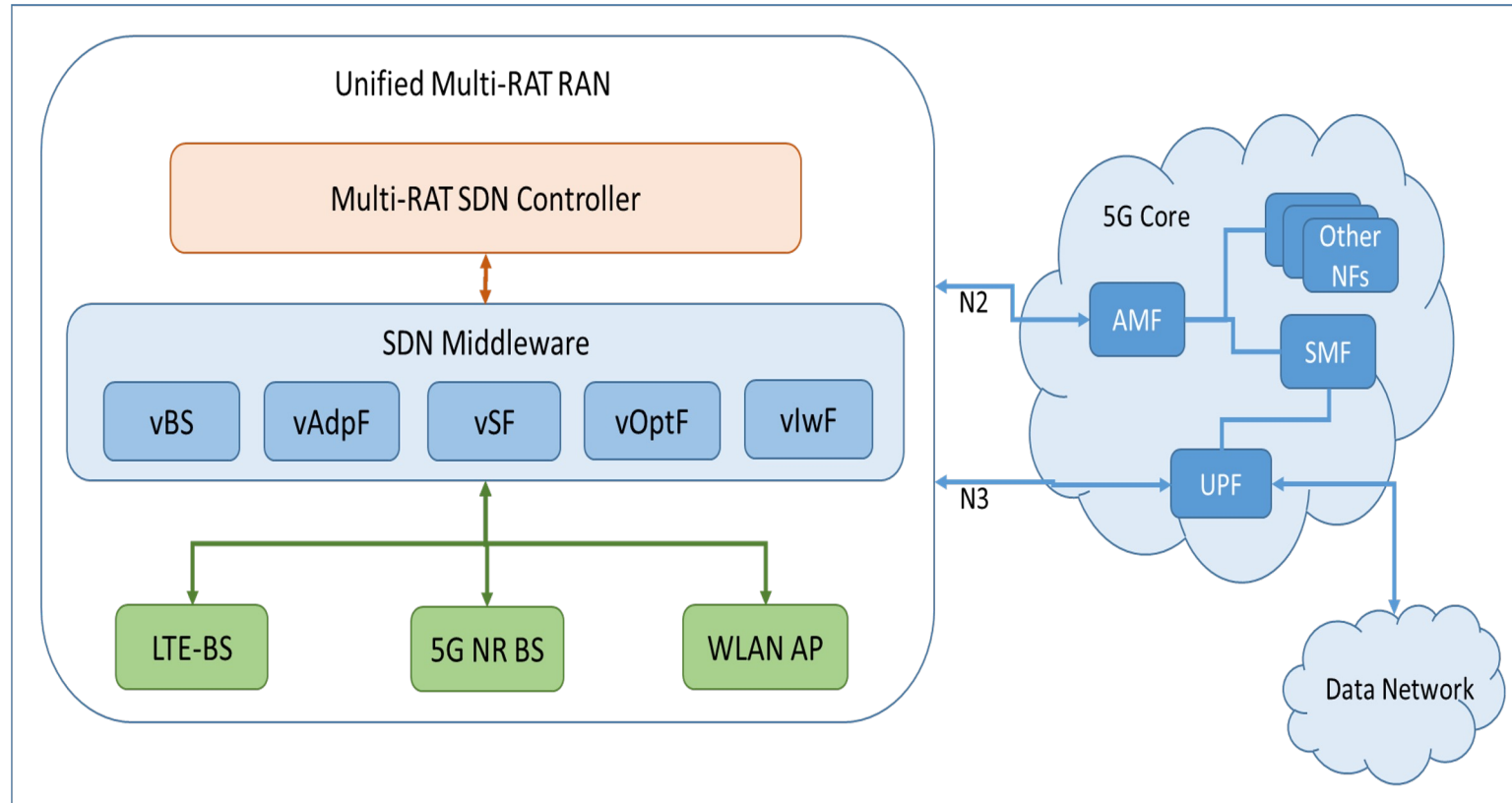




**IEEE 1930.1/2061 Integration with 5GS
&
Future work**

IEEE 1930.1 - Integration with 3GPP 5GS

- 3GPP 5G allows integration of
 - different access technologies
 - 3GPP access technologies
 - LTE, 5G-NR
 - Non-3GPP access technologies
 - WLAN, Wireline access ...
- How to integrate 1930.1 based Multi-RAT RAN with 5GS
 - **As non-3GPP access with 5G Core**
 - Applicable to P2061 also
 - Aspects needed to be studied
 - Mobility

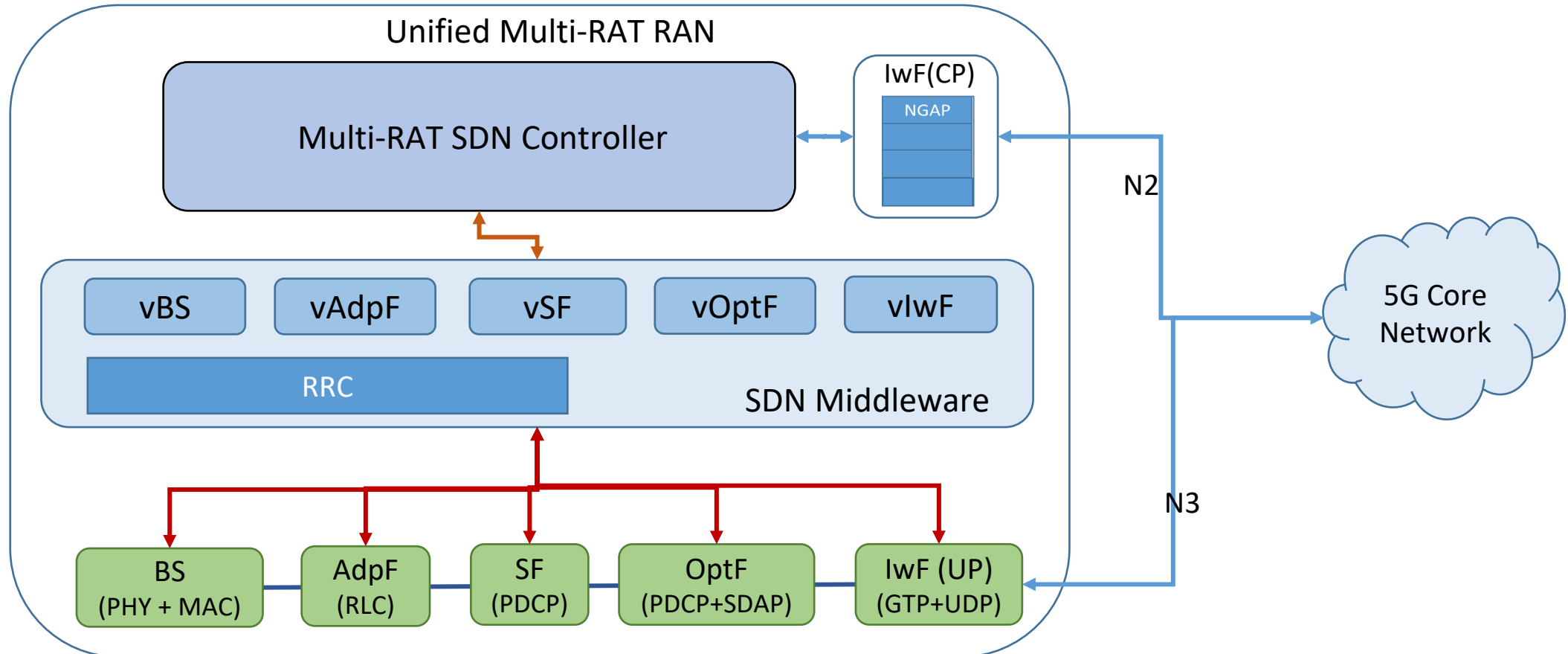


- PDU Session handover between 3GPP and non-3GPP access via 5G Core supported currently
- TS 23.502 – Section 4.9.2/3

IEEE 1930.1/P2061 based 5G NG-RAN

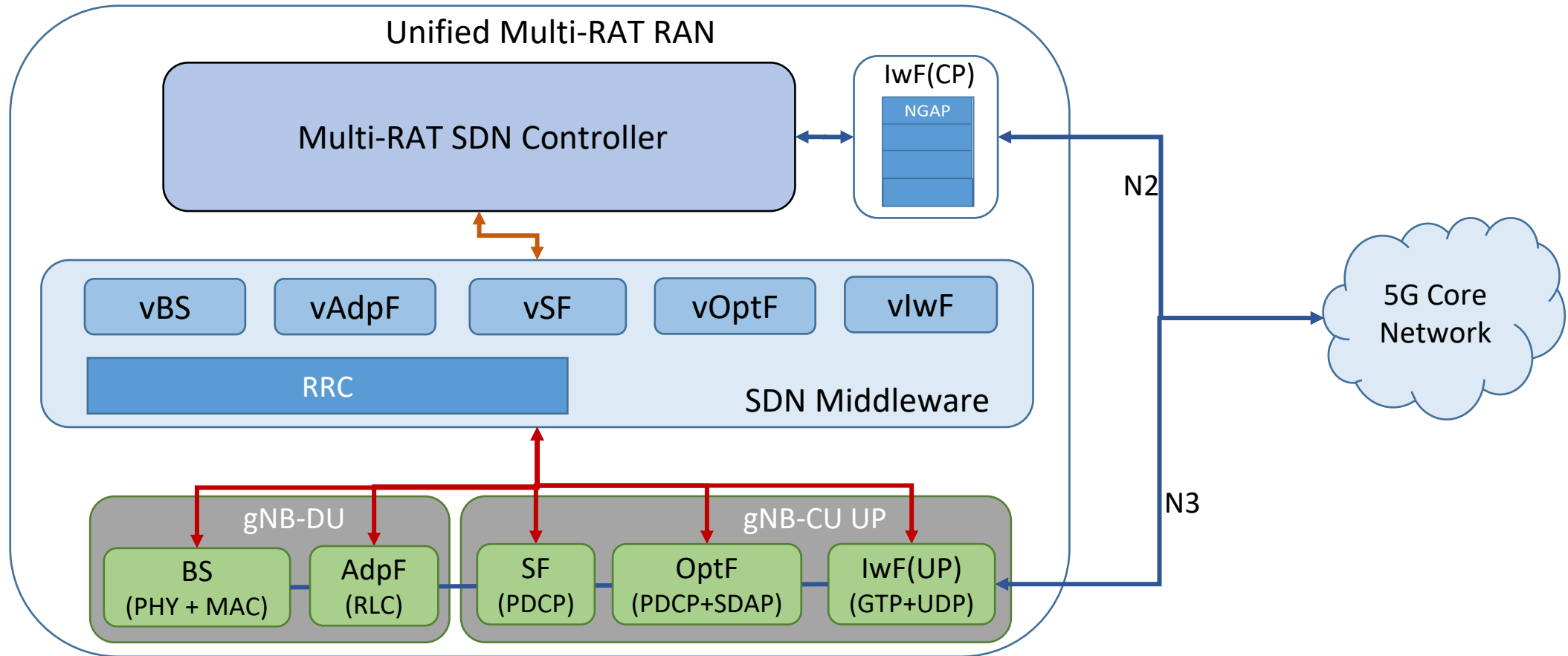
- No/Limited changes in existing protocol layers
- Essentially a different placement of protocols layers

- Disaggregated NF based scheme



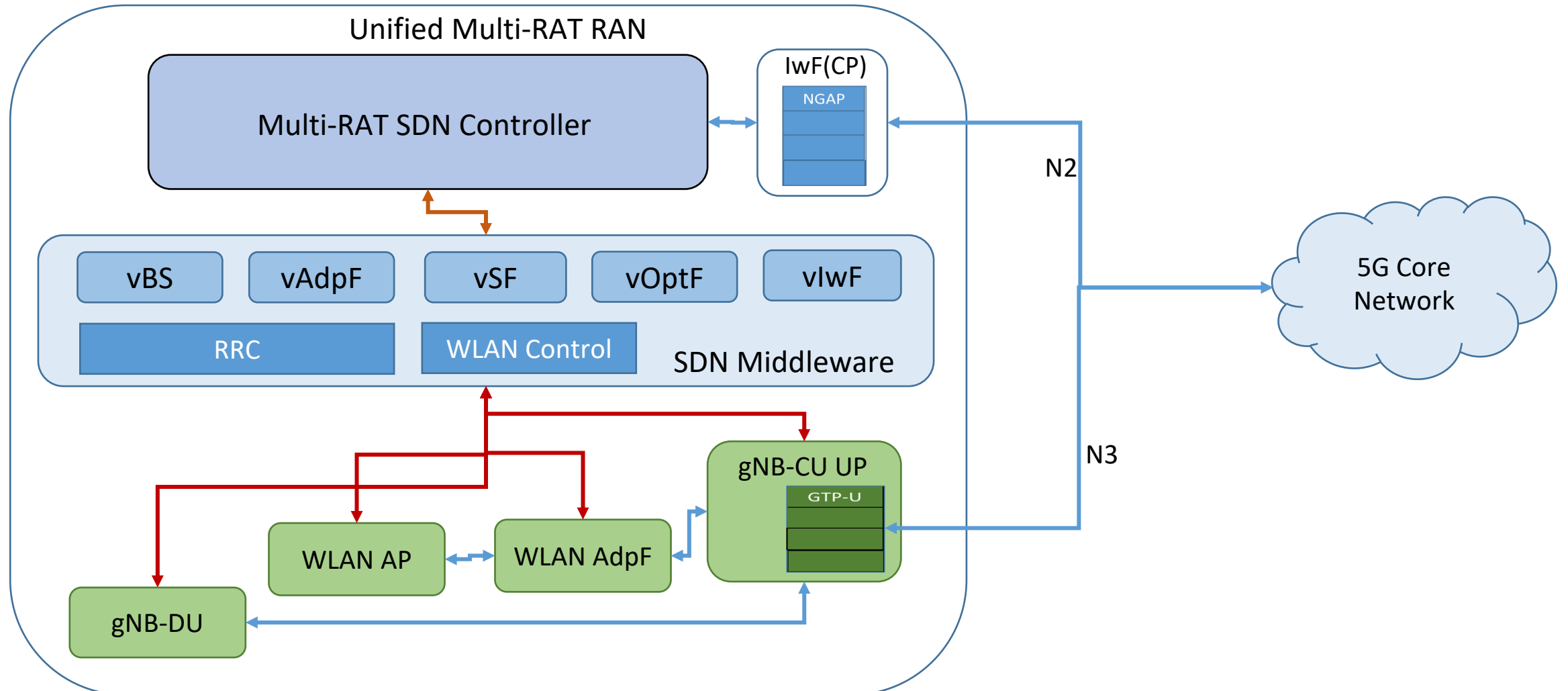
IEEE 1930.1/P2061 based 5G NG-RAN

- Another Scheme - Disaggregated NFs as part of existing nodes



IEEE 1930.1/P2061 - Virtualized Multi-RAT RAN

Integrated WLAN & 5G NR



IEEE 1930 & P2061 - Architecture for beyond 5G

- Disaggregated Multi-RAT RAN
 - Modular and Reusable Network Functions
 - Scalable Architecture
 - Separation of Control and Data Plane
- Virtualization of RAN Resources through SDN Middleware
 - Abstract Information Model of RAN Data Plane
 - Better support for Network Slicing etc.
- Unified Multi-RAT RAN
 - Improved performance
- Decoupled RAN and Core
 - Flexible Architecture – Interworking of any RAN with any Core
 - Direct Connectivity from RAN to Internet (Core bypass)
 - Captive Network

IEEE 1930 - Future work

- SDN Middleware - North Bound Interface Protocol
 - Protocol Definition
 - Information Model – Key aspect
- SDN Middleware - South Bound Interface Protocols
 - Existing protocols can also be used
- Interface between Data Plane Functions
- Controller Functionality
- Orchestrator Functionality and Interfaces
- Integration with 5GS



Thank you

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