3GPP 5G Ph.1
시스템 구조/코어표준(Stage-2)
- TS 23.501, TS 23.502중심-

신명기/ETRI
TTA SPG32의장
TTA STC3-5G포럼 공동워크샵
2018/01/04

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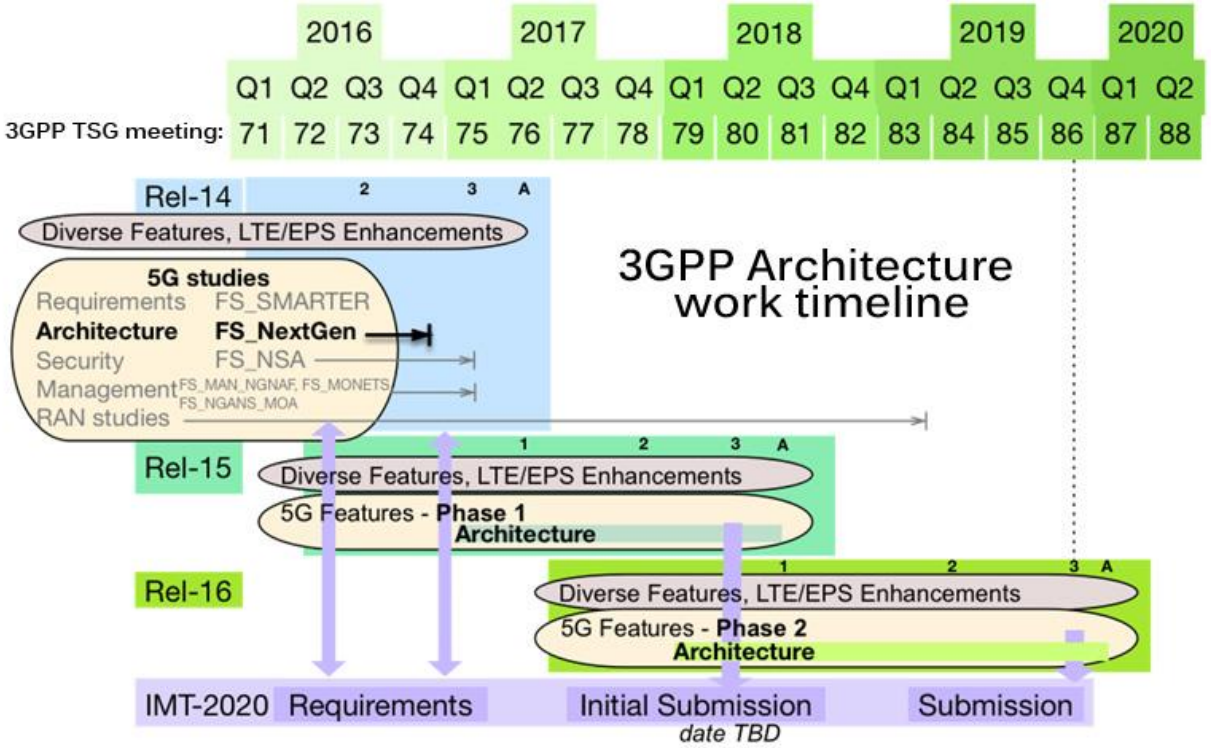
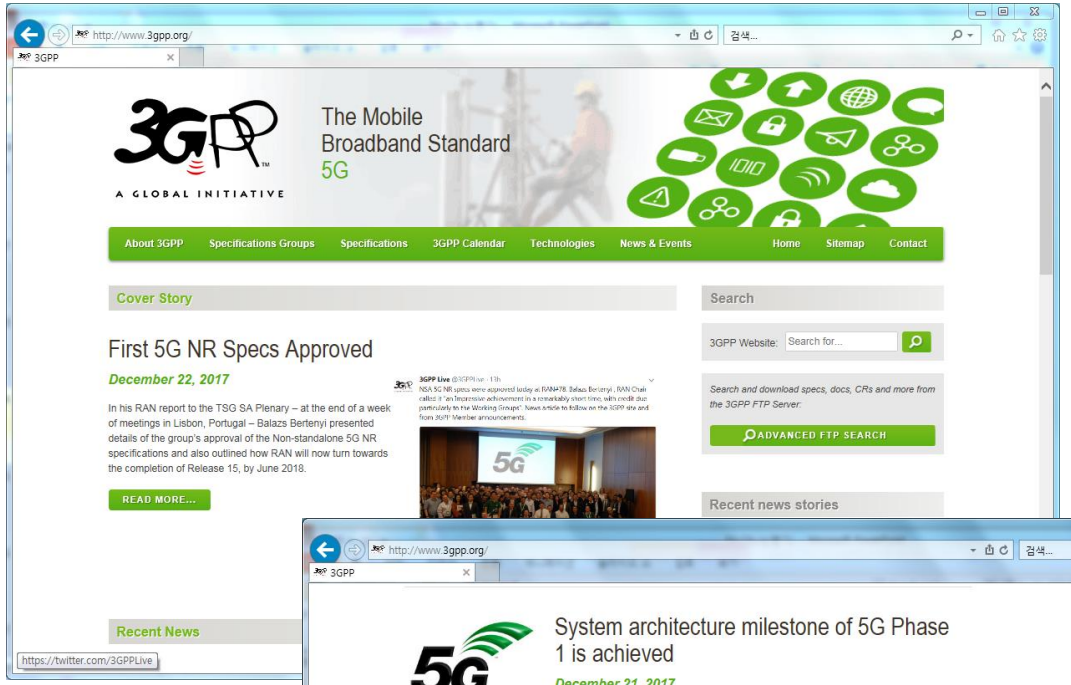
5G 표준화 시사점

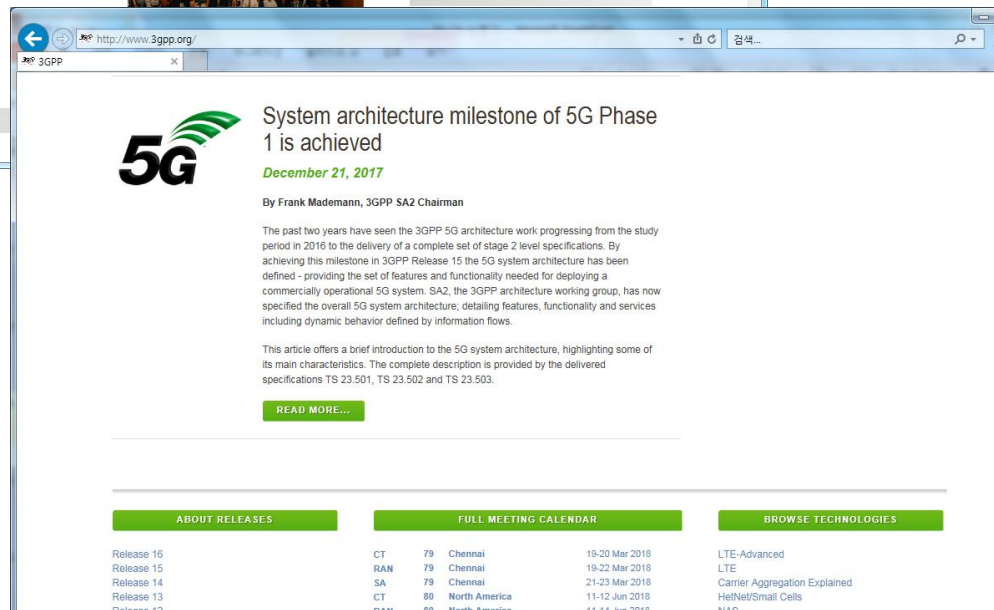
- 5G 요구사항 및 오픈 이슈
  - 4G까지의 기술은 Radio기술의 향상에 초점을 두어 발전되어 왔으나, 5G의 주요 기술적 목표인 신규서비스 수용 용이성, 네트워크 운용 편의성, CAPEX/ OPEX 절감 등을 지원하기 위해서는 코어 네트워크 대한 혁신적인 기술제공 및 표준화의 선행이 병행되어야 함
- 통신사업자 관점의 Network Softwarization의 중요성
  - 5G 코어 네트워크에서의 가상화 (NFV), 개방형 인터페이스 (SDN) 기술은 통신사업자 관점에서는 그동안 특정 하드웨어 종속적인 네트워크장비 시장을 소프트웨어 중심으로 개편할 수 있도록 하는 매우 활용 가능성이 높은 표준 기술임
- 표준 기술의 협업 및 경쟁 심화
  - 3GPP RAN로 단일화된 무선(NR) 표준 기술외에, 3GPP SA – 시스템 및 구조그룹은 ETSI(NFV), IETF (IP)등 여러 표준화기구에서 협업을 통한 표준화 작업을 추진중임
  - ETSI NFV ISG는 5G에서의 NFV적용기술/Use cases 논의중
  - IETF는 네트워크 슬라이싱 (IP-MPLS, Segment Routing, T-SDN적용, E2E 공통네트워크 장비제어/관리를 위한 Yang모델링 논의중, COMS BoF)
  - ITU-T SG13은 IMT-2020 WP 신설하고 다수의 권고안 개발중

3GPP SA and 5G System Works

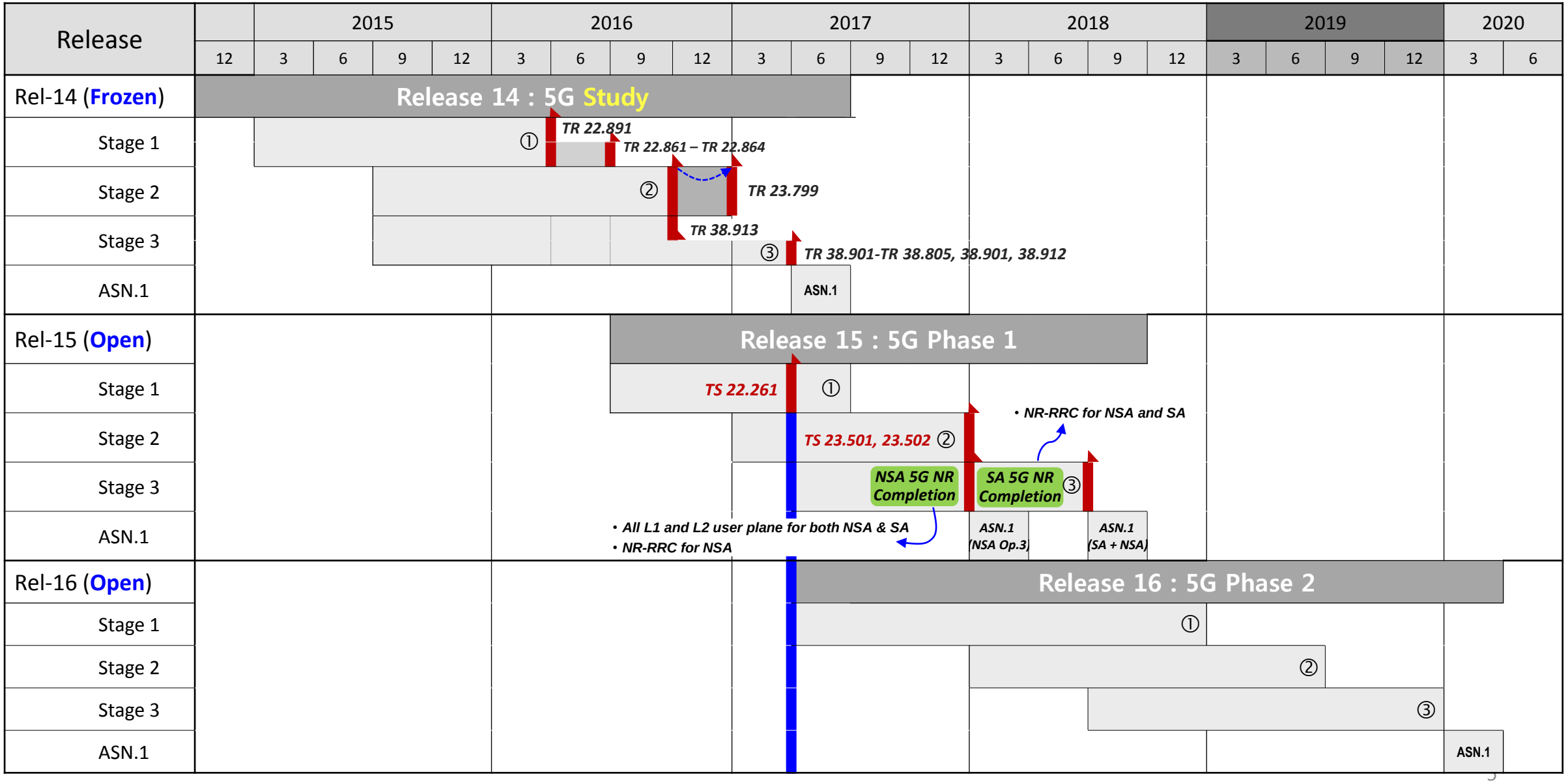
Spec No.	Title	Approved
TS 23.501	System architecture for 5G System	‘17.12
TS 23.502	Procedures for 5G System	‘17.12
TS 23.503	Policy and Charging Control Framework for 5G System	‘17.12







5G Releases



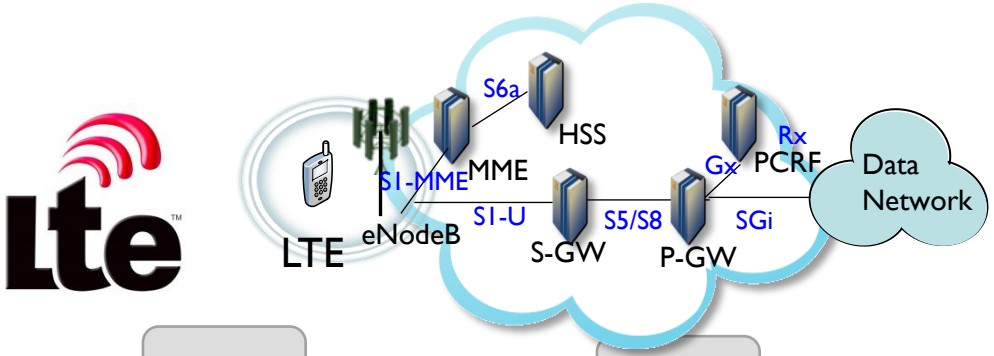
NSA = Non StandAlone = EPC core ("Option 3") & LTE anchor

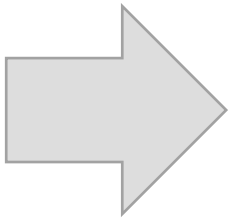
Source- 김은아책임(ETRI)

3GPP – 5G 시스템 설계 원칙

- 소프트웨어-기반(SW-based) 코어 구조
  - SBA (Service-Based Architecture) – The set of interactions between NFs are defined as services, so that their re-use is possible
  - Stateless NFs – the compute resource is decoupled from the storage resource.
  - Service capabilities exposure (like SDN' NBAPIs)
- 유연한(Flexible) 코어 구조
  - Separate UP functions from the CP function (CUPS개념)
  - Modularize the NF design (e.g. to enable flexible and efficient network slicing)
  - Split AMF and SMF
  - Distributed and Flexible location of UP functions (e.g., To support low latency services and access to local data networks, UP functions can be deployed close to the radio network)
- 공통(Common) 코어 구조
  - A common AN – CN interface which integrates different 3GPP and non-3GPP access types
  - A unified authentication framework
  - LTE interworking and migration

3GPP EPC/EPS 구조/기능





MME

- NAS signaling and signaling security
- Authentication and authorization
- P-GW / S-GW selection
- Inter CN node signaling for mobility bw/ 3GPP AN
- MME selection for handovers w/ MME change
- SGSN selection
- UE reachability in idle mode
- Tracking areas list management
- Roaming connection
- Bearer management and establishment
- Lawful interception
- Warning message transfer
- LTE relay nodes support

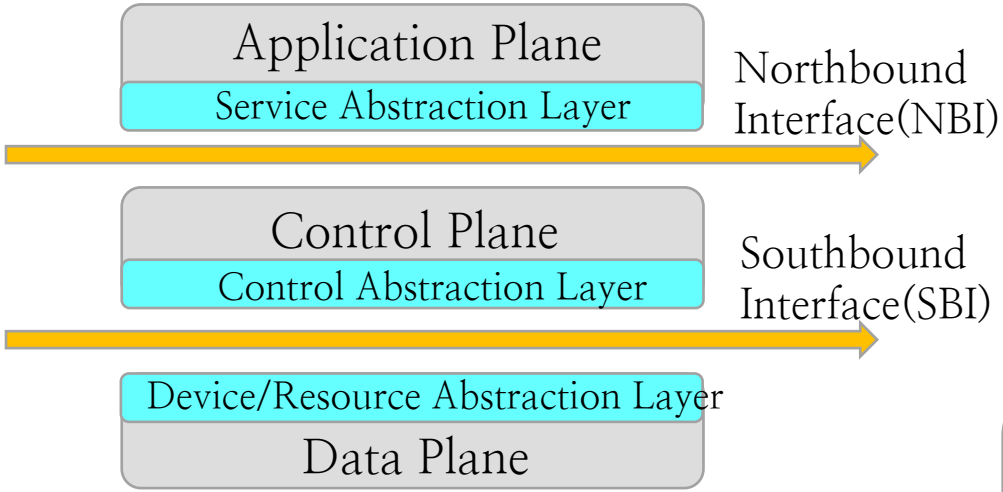
S-GW

- Local mobility anchor for inter-eNB handover
- Mobility anchoring for inter-3GPP mobility
- Inserting end-marker packets into traffic stream during handover path switch events
- GTP tunnel and TEID management
- Packet routing and forwarding
- Idle mode downlink packet buffering
- Transport level DiffServ packet marking
- Charging
- Lawful interception

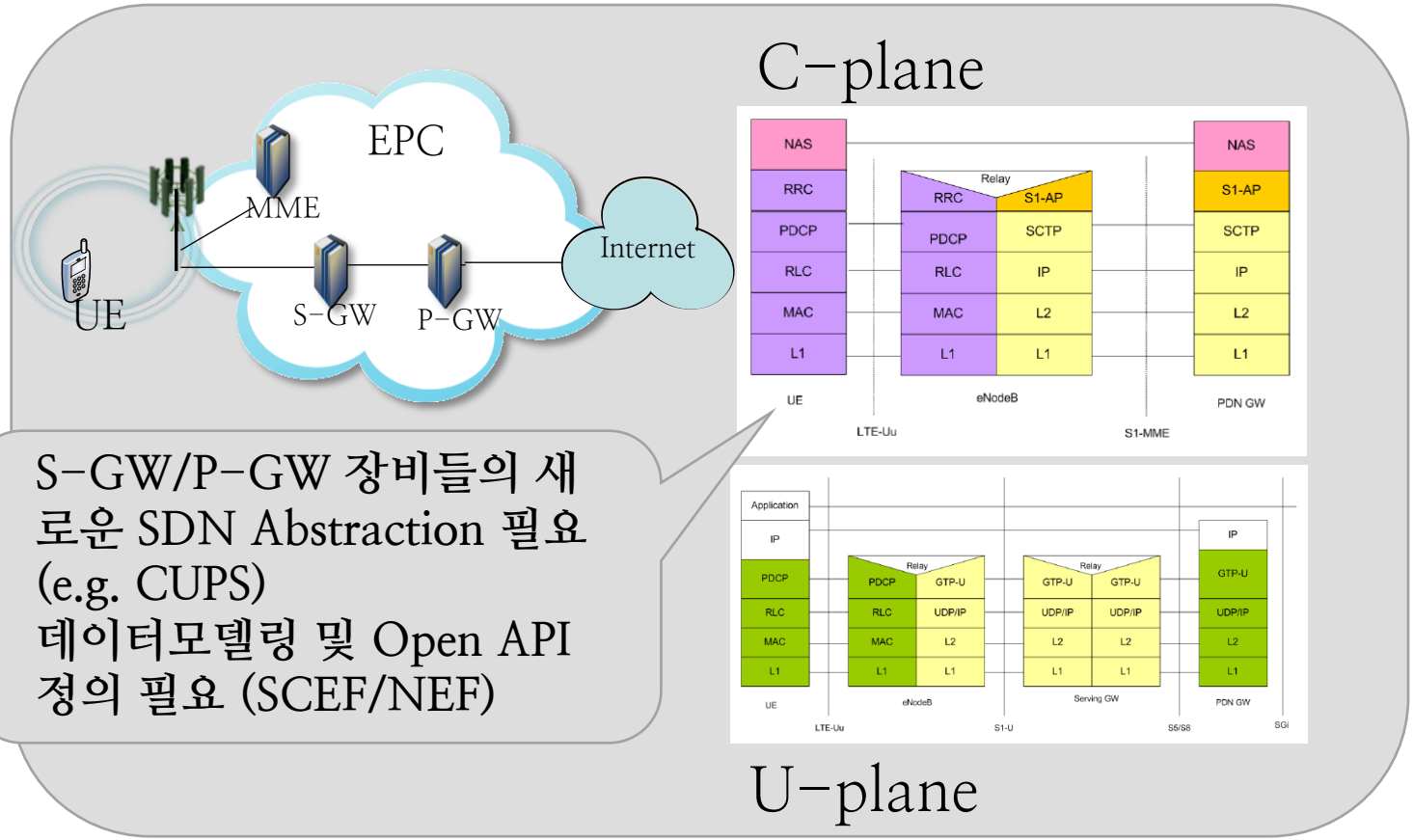
P-GW

- Contain APN (Access Point Name)
- UE IP addr alloction
- DHCPv4 & v6 functions
- GTP tunnel and TEID management
- Creates and maintains TFT (Traffic Flow Templates) for packet routing discrimination
- Static PCC if no PCRF available
- Per-user-based packet filtering
- SDF level charging
- SDF gating control and data enforcement
- DiffServ packet marking
- Lawful interception

SDN Impact on EPC/EPS



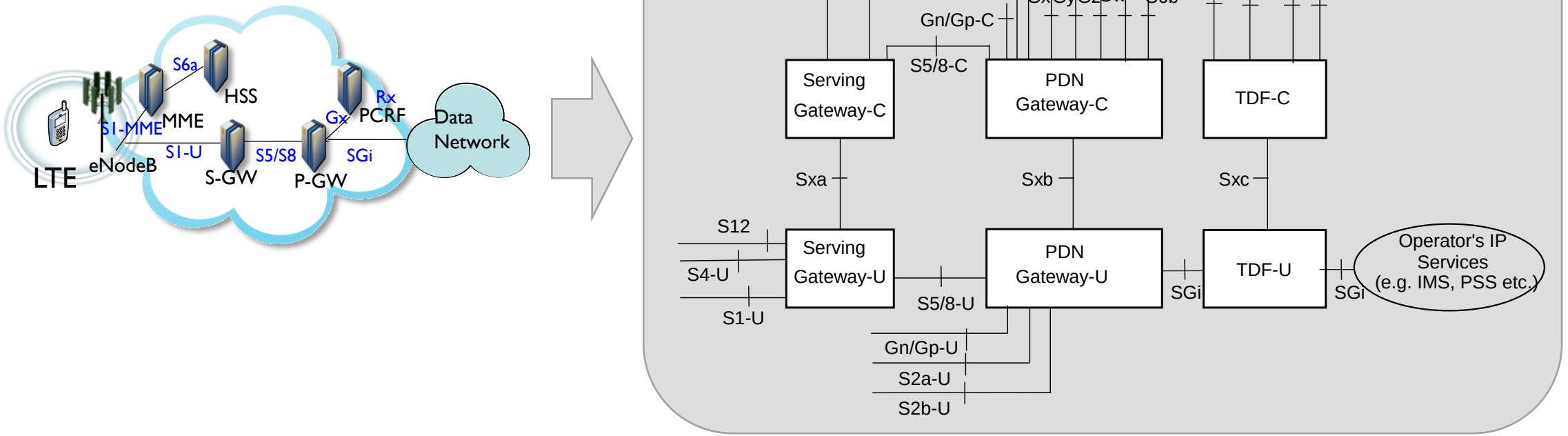
Standardized "Interfaces + entity/resource modeling" (제어/관리할 NF 엔터티(기능)의 abstraction – (CP/UP 분리) 설계 필요



- S-GW/P-GW 장비들의 새로운 SDN Abstraction 필요 (e.g. CUPS)
- 데이터모델링 및 Open API 정의 필요 (SCEF/NEF)

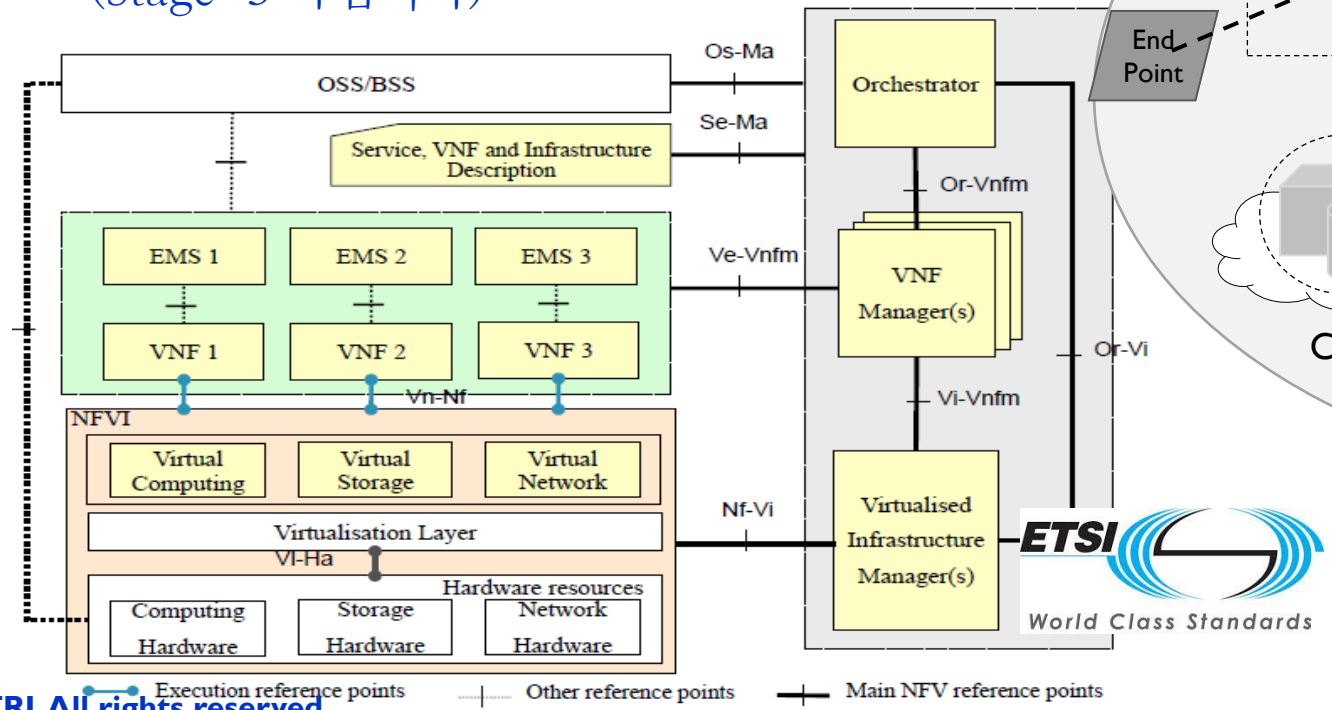
SDN개념적용 CUPS (TS 23.214)

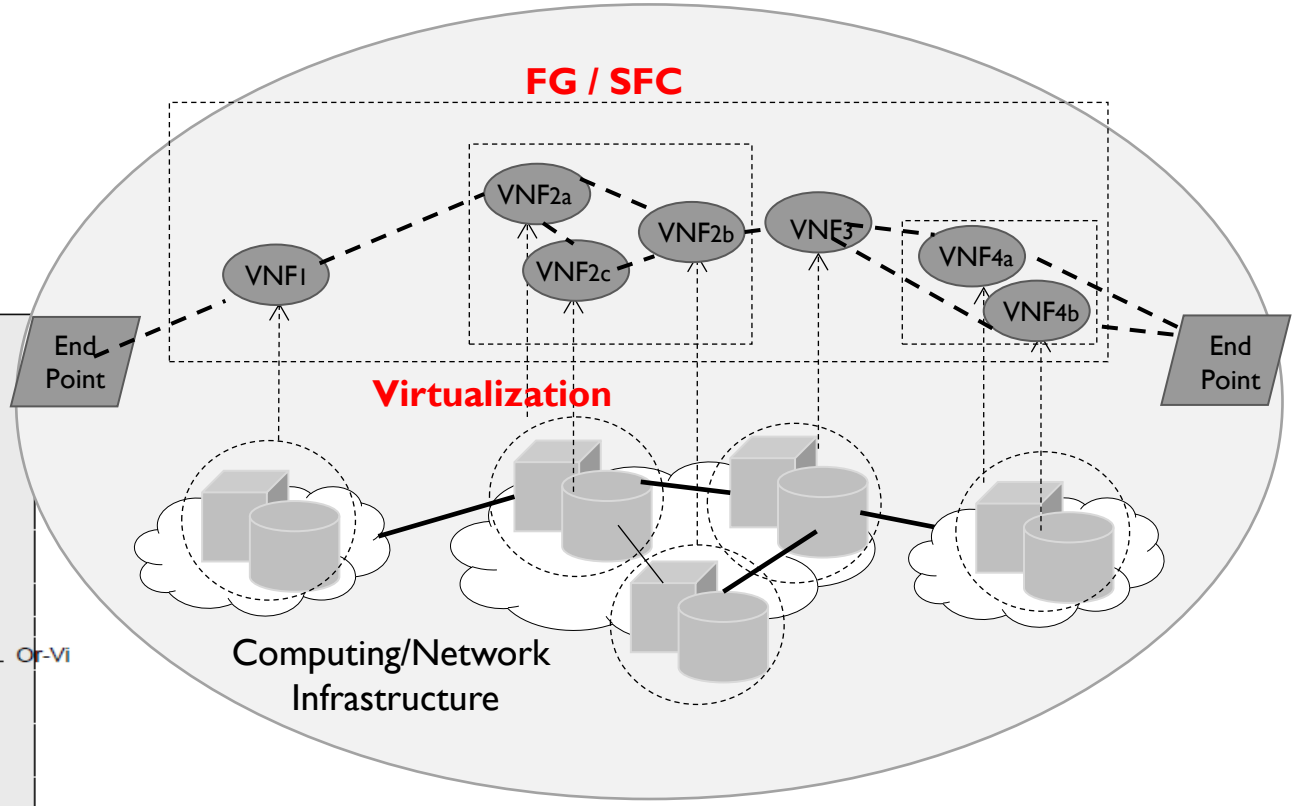
Architecture enhancements for control and user plane separation of EPC nodes



NFV Impact on EPC/EPS

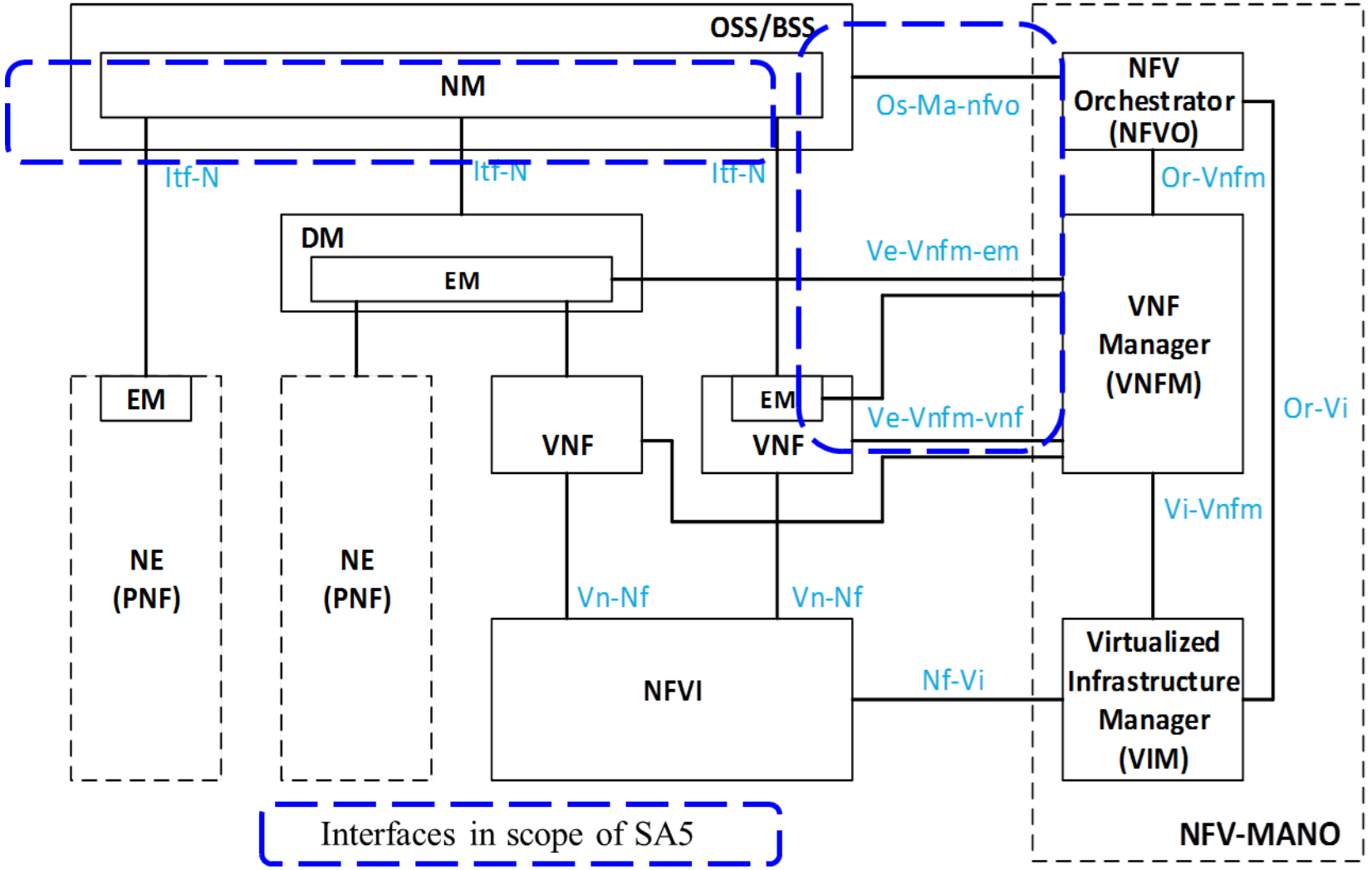
- Network Functions Virtualization
- To relocate network functions from dedicated HW appliances to generic servers (e.g., S-GW, P-GW등)
- ETSI NFV ISG – Rel-2 (Stage-2), Rel-3이후 (Stage-3 작업시작)





ETSI World Class Standards

NFV개념적용 (SA5에서 작업)



3GPP SA2 5G시스템구조 규격

3GPP 5G 구조 Ph-1 신규 WID승인
('16.11, SA2 #118차회의)

CMCC
노키아
....

에릭슨
(ZTE)
....

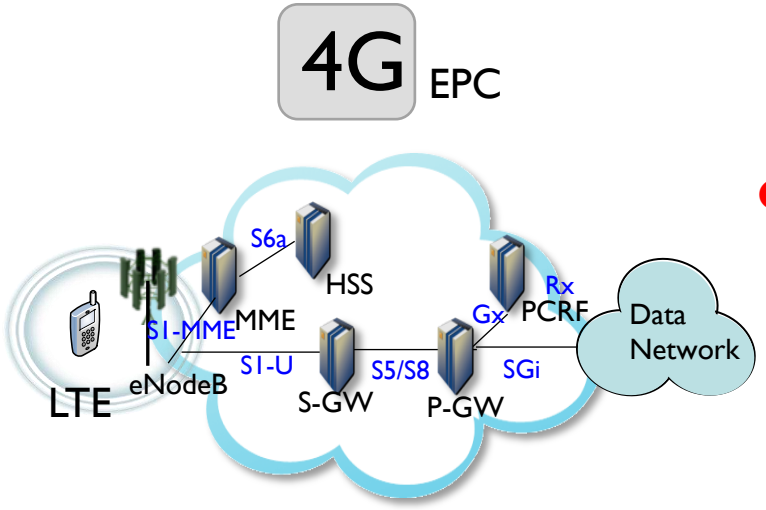
5G 시스템 WID 래포처 - CMCC

Spec	Title	완료	Editors
TS 23.501	System architecture for 5G System	'17.9	노키아
TS 23.502	Procedures for 5G System	'17.12	에릭슨

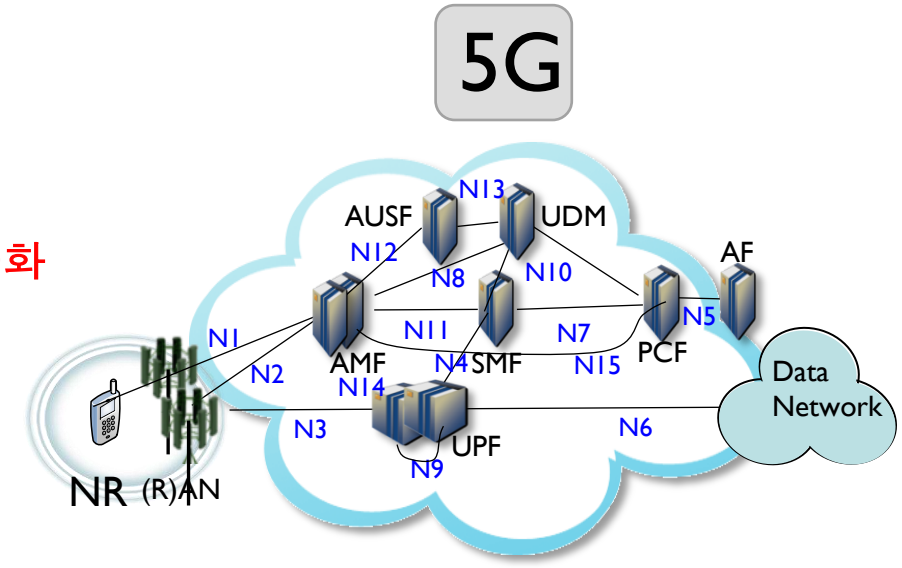
5G Ph-1 Features

- network slicing,
- use of virtual environments,
- service-based architecture,
- network capability exposure,
- support for edge computing,
- access and mobility management,
- session management separate from mobility management,
- (re)selection of efficient user plane path,
- session and service continuity,
- QoS,
- policy framework,
- network discovery and selection,
- network sharing,
- untrusted non-3GPP accesses,
- roaming with EPS,
- interworking with and migration from EPS,
- IMS services (including support for emergency calls),
- Public Warning System (PWS),
- location services as per related service requirements and in alignment with NG RAN,
- SMS over NAS.

5G 코어 시스템 구조 (P2P Arch)



CUPS + NF모듈화



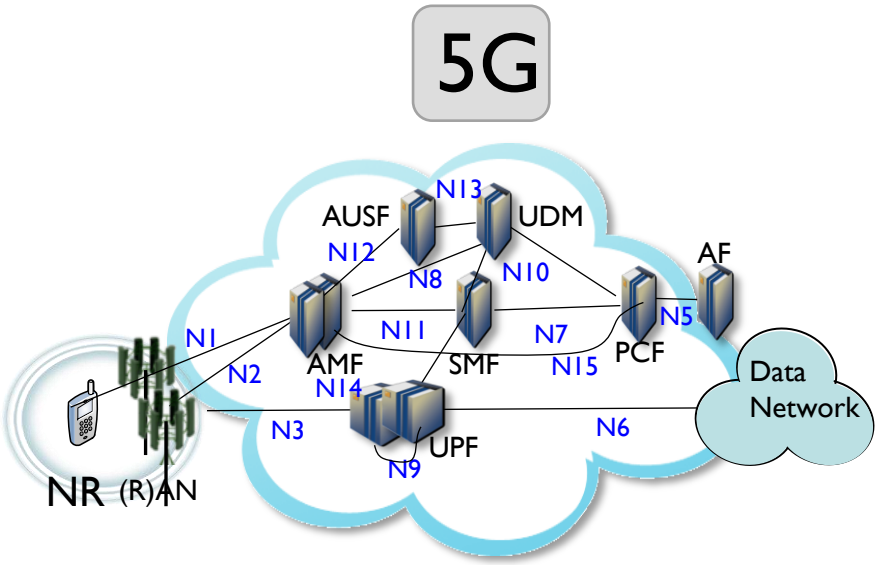
MME : Mobility Management Entity
S-GW : Serving Gateway
P-GW :PDN Gateway
PCRF : Policy and Charging Enforcement Functions
HSS :Home Subscriber Server

AUSF : Authentication Server Function
UDM :Unified Data Management
AMF Access and Mobility Management Function
SMF :Session Management Function
PCF :Policy Control Function
UPF : User Plane Function
AF : Application Function

New Interface N10, N11, N12, N15…

A NF can be implemented either as a network element on a dedicated hardware, as a software instance running on a dedicated hardware, or as a VNF instantiated on an appropriate platform, e.g. on a cloud infrastructure.

5G 코어 시스템 구조 (P2P Arch)



AMF

-Termination of RAN CP interface (N2).
-Termination of NAS (N1), NAS ciphering and integrity protection.
-Registration management.
-Connection management.
-Reachability management.
-Mobility Management.
-Lawful intercept.
-Transparent proxy for routing SM messages.
-Access Authentication.
-Access Authorization.
-Security Anchor Function (SEA).
-Security Context Management (SCM).

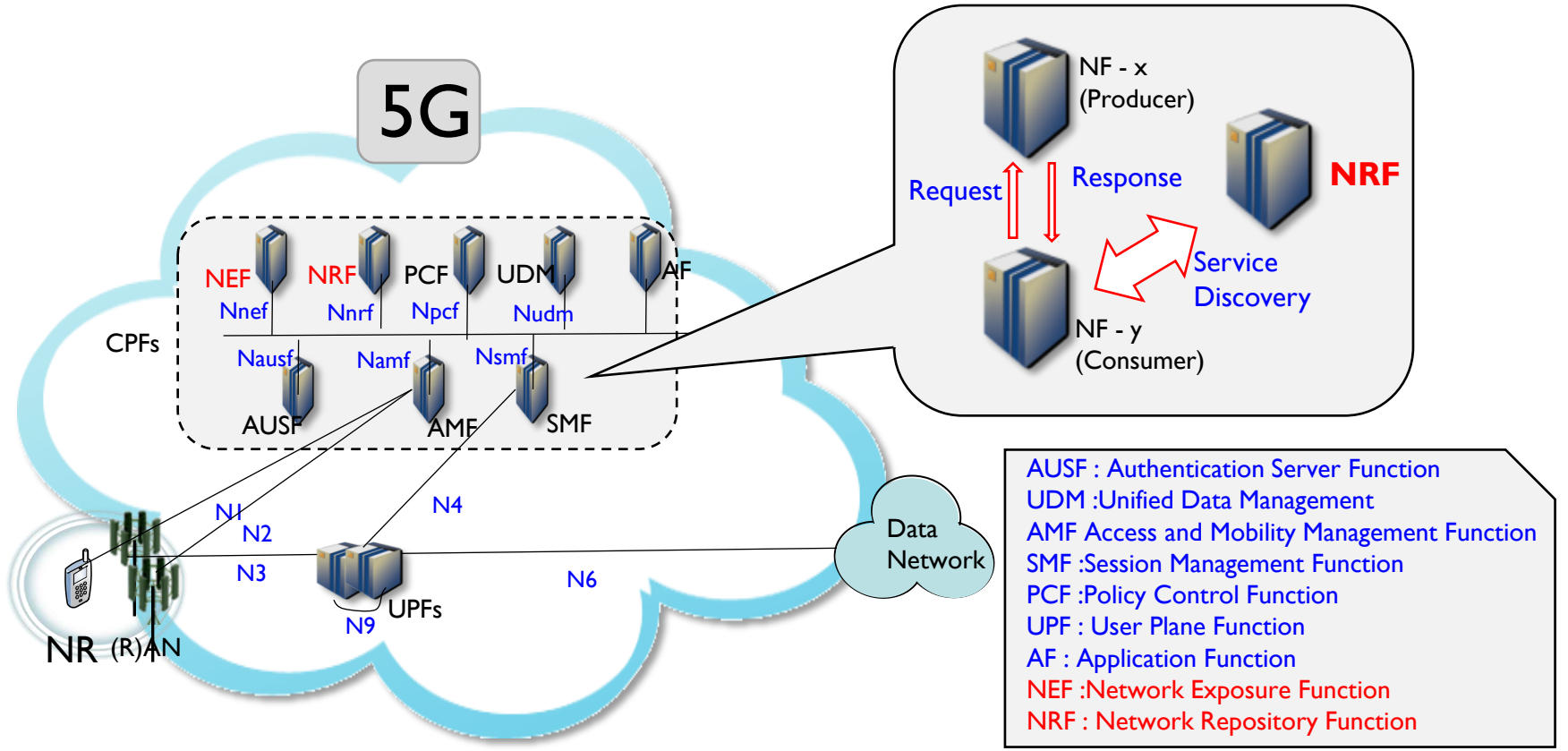
SMF

-Session Management.
-UE IP address allocation & management.
-Selection and control of UP function.
-Configures traffic steering at UPF to route traffic to proper destination.
-Termination of interfaces towards Policy control functions.
-Control part of policy enforcement and QoS.
-Lawful intercept.
-Termination of SM parts of NAS messages.
-Downlink Data Notification.
-Initiator of AN specific SM information, sent via AMF over N2 to AN.
-Determine SSC mode of a session
-Roaming functionality

UPF

-Anchor point for Intra-/Inter-RAT mobility
-External PDU session point of interconnect to Data Network.
-Packet routing & forwarding.
-Packet inspection and User plane part of Policy rule enforcement.
-Lawful intercept
-Traffic usage reporting.
-Uplink classifier to support routing traffic flows to a data network.
-Branching point to support multi-homed PDU session.
-QoS handling for user plane
-Uplink Traffic verification
-Transport level packet marking in the uplink and downlink.
-Downlink packet buffering and downlink data

5G 코어 시스템 구조 (Service Arch)



AUSF : Authentication Server Function
UDM :Unified Data Management
AMF Access and Mobility Management Function
SMF :Session Management Function
PCF :Policy Control Function
UPF : User Plane Function
AF : Application Function
NEF :Network Exposure Function
NRF : Network Repository Function

5G 코어시스템 – NFs

- Access and Mobility Management Function (AMF)
- Session Management Function (SMF)
- User Plane Function (UPF)
- Policy Control Function (PCF)
- Authentication Server Function (AUSF)
- NF Repository Function (NRF)
- Network Exposure Function (NEF)
- Network Slice Selection Function (NSSF)
- Unstructured Data Storage Function (UDSF)
- Unified Data Management (UDM)
- Unified Data Repository (UDR)
- 5G-Equipment Identity Register (5G-EIR)
- Application Function (AF)

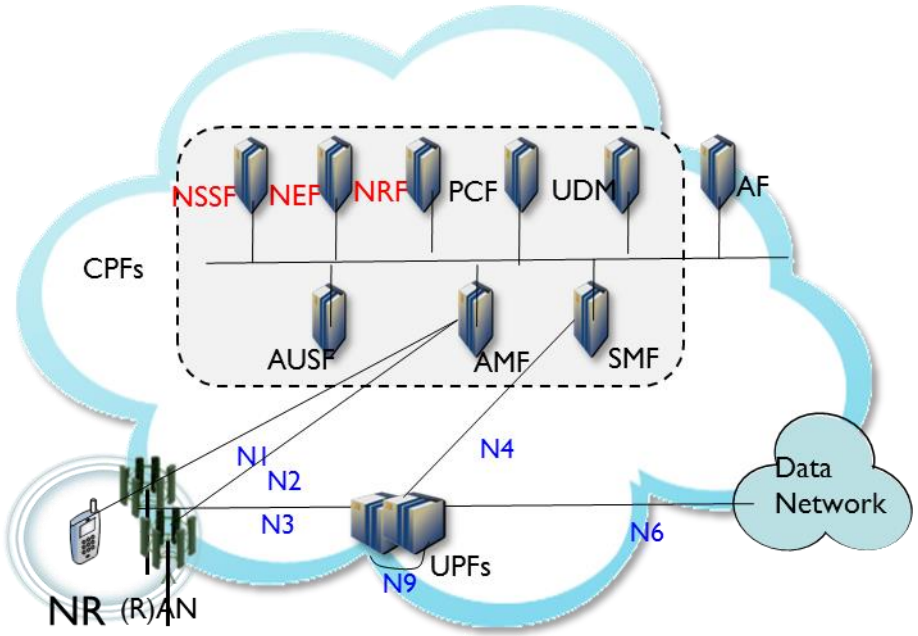
시사점 – SBA구조에 따라
새로운 NF의 추가, 확장이 용이

5G 시스템 (Ph.1)주요 feature

- Service based architecture (SBA) with service-based interfaces within 5GC CP; Definition for NF services
- E2E Network slicing,
- Data Storage architecture enabling Compute and Storage separation, Unified data repository.
- Architectural enablers for virtualized deployment.
- Common N1/N2 for 3GPP and non-3GPP access.
- Support for edge computing, URLLC services architectural enablers
- Application influence on traffic routing.
- Improved Session model including different Session and Service Continuity modes. Support for concurrent (e.g. local and central) access to a data network.
- Interworking with EPC, basic procedures on single & dual registration mode
- Policy framework for Access and mobility control, QoS and charging enforcement, policy provisioning in the UE; introducing NWDA for data analytics support.
- Support of services: SMS over NAS (including over Non 3GPP), support of IMS services
- QoS flow based framework, including reflective QoS.
- Support for RRC inactive
- Support for AMF resiliency, ability to handle AMF planned maintenance, AMF failure with no service disruption and/or adverse impact for the UE.

SBA (Service-Based Architecture)

소프트웨어-기반 인터페이스(The set of interactions between NFs are defined as services, so that their re-use is possible)

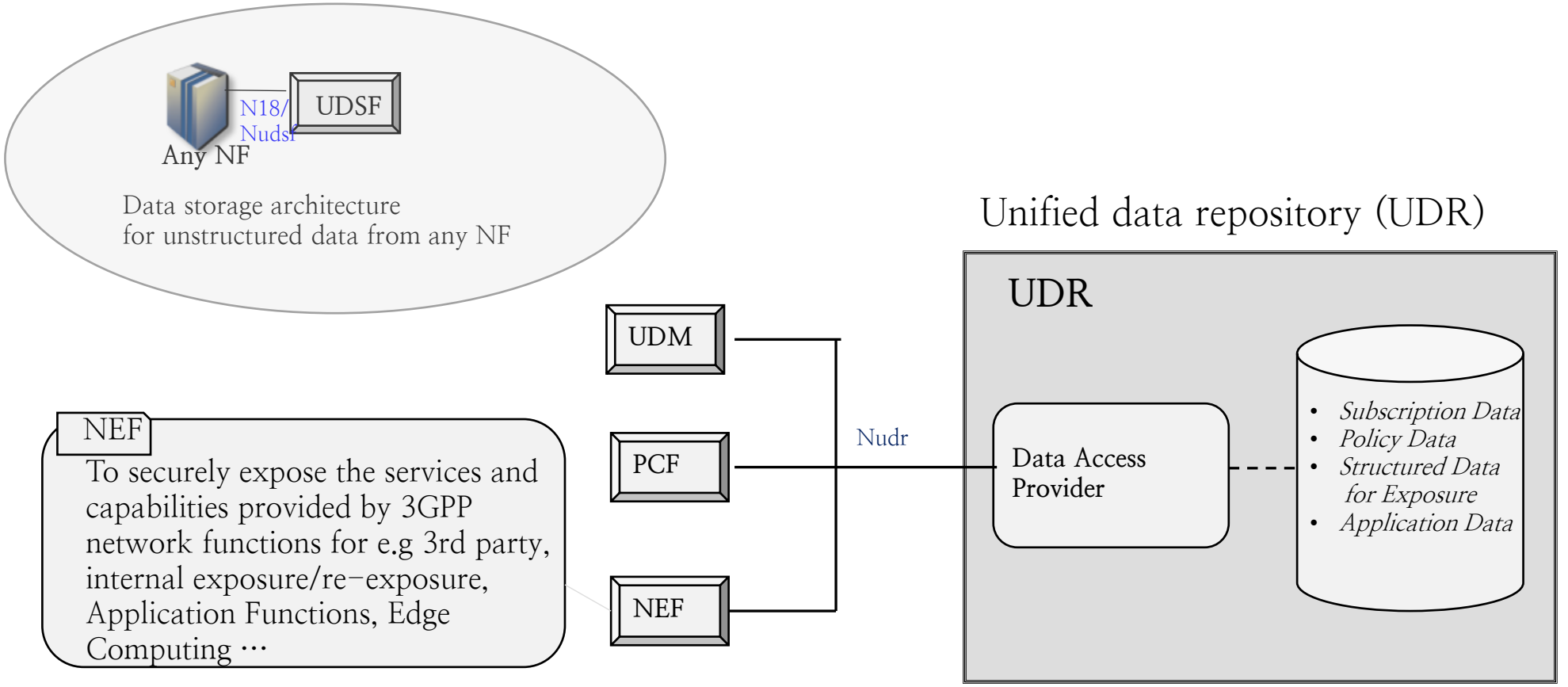


3GPP CT – SBA Interface : protocol selection

- Protocol: HTTP/2
- Transport: TCP
- Serialization protocol: JSON
- API design style: RESTful whenever possible. Custom API methods otherwise
- Support of notification with two HTTP client/server pairs
- IDL: OpenAPI v3.0.0

시사점 – Adopts principles like modularity, reusability and self-containment of network functions, is chosen to enable deployments to take advantage of the latest virtualization and software technologies.

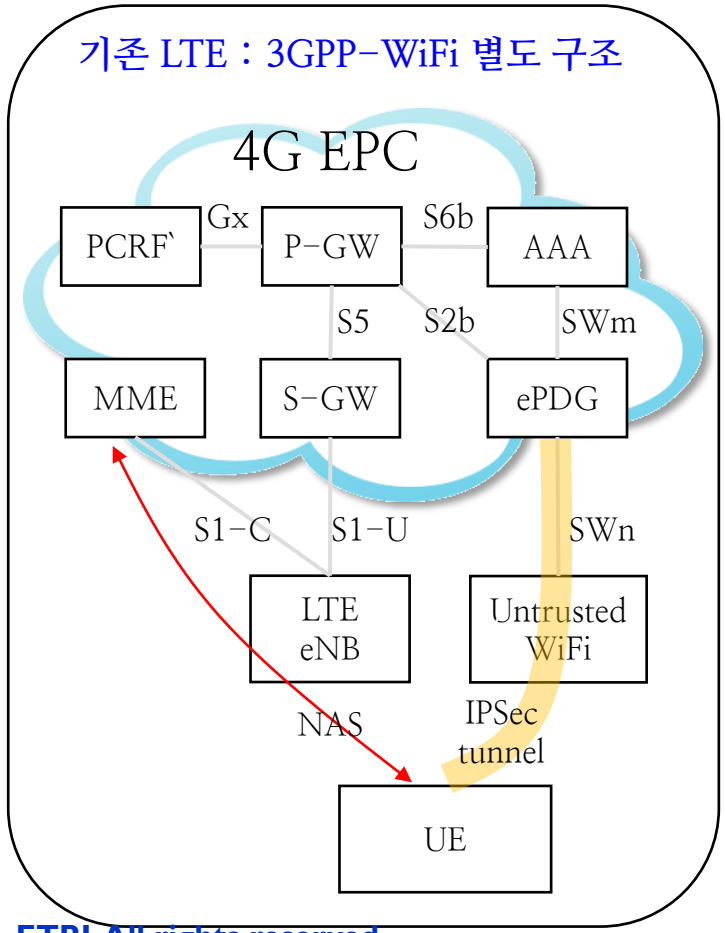
Stateless NFs / Data Storage

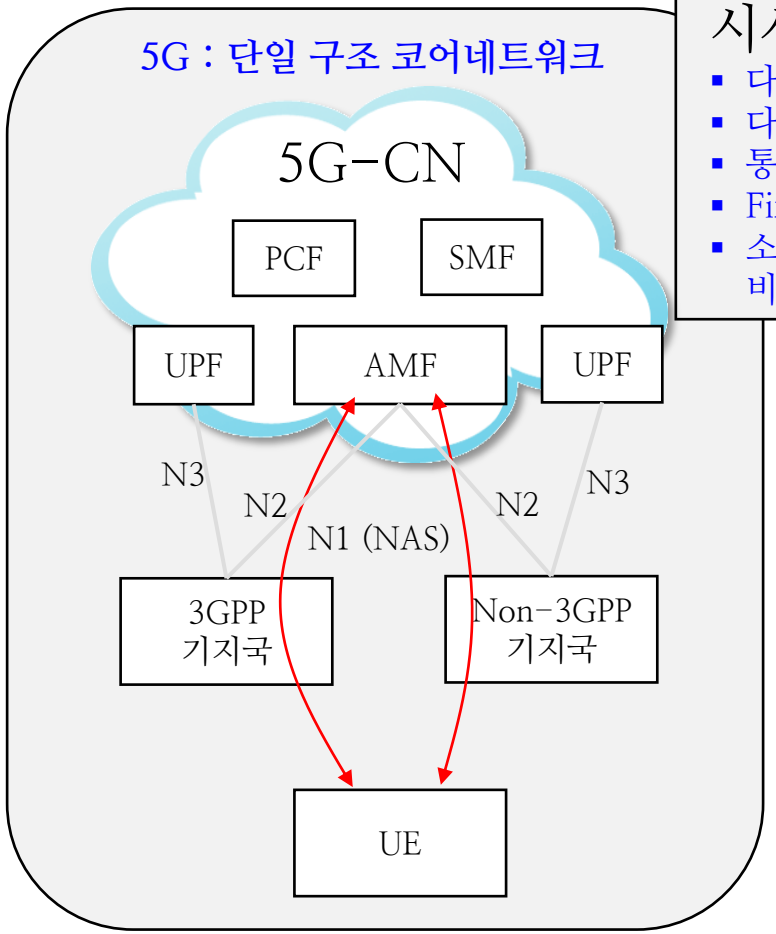


Data Storage architecture enabling Compute and Storage separation

Common Core Network

- Non-3GPP access도 Common CN Interface (N1/2/3) 제어
- Non-3GPP UE 에도 NAS 시그널링 지원
- 단일 종류 NF 에 의한 3GPP/Non-3GPP 공통 제어 (AMF, SMF, PCF 등)

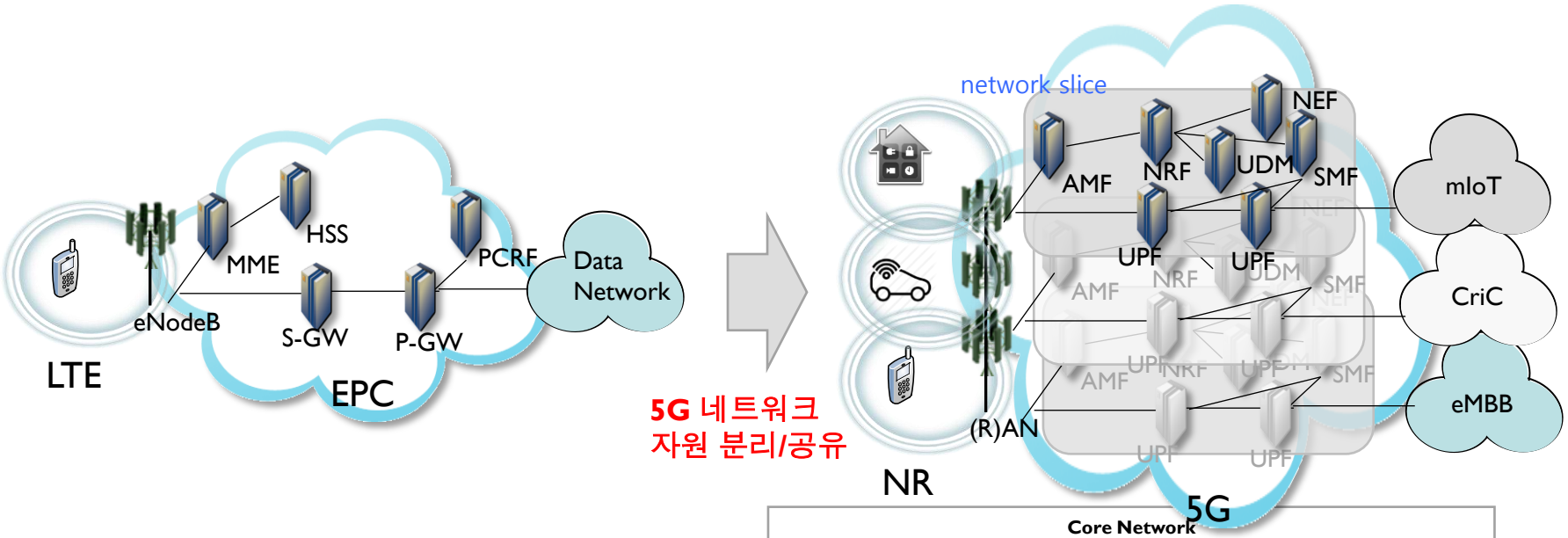


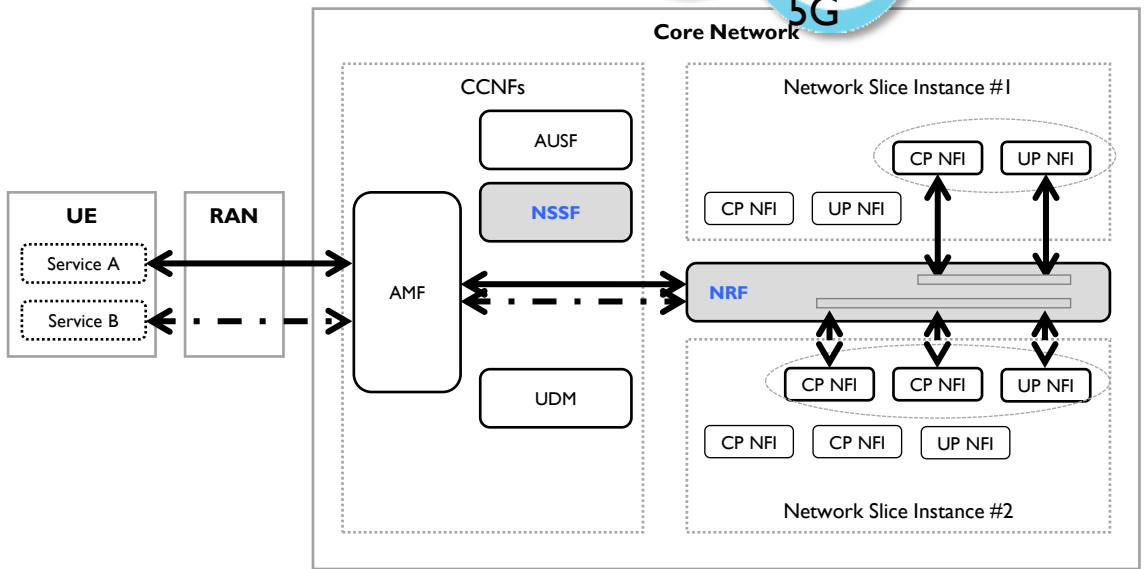


시사점

- 다양한 액세스 기술의 통합 서비스 제공
- 다양한 액세스 이용 UE에 대한 통합 관리
- 통합 QoS framework 개발
- Fixed broadband 등 3GPP 서비스 영역 확대
- 소규모 사업자 특화 non-3GPP 액세스 기반 비즈니스의 5G 코어 수용 및 관리 가능

Network Slicing





Network resources
- isolation
- customization
- elasticity
- composition

5G applications
- dedicated network
- network sharing
- tenant network
- private network

Network Slicing Works in SA2

- Define the concepts/terminologies used for supporting network slicing, e.g. Network slice, Network slice instance.
- Define identifiers relevant to network slice, e.g. SST (Slice/Service Type), NSSAI (Network Slice Selection Assistance Information), S-NSSAI etc.
- Define 3 standardized SST values: eMBB, mIoT, URLLC.
- Define network slice selection procedures for UE (User Equipment) accessing network in non-roaming and roaming scenarios.
- Introduce standalone NSSF for network slice selection
- To support the case that UE accessing to multiple network slices simultaneously, some NFs, e.g. AMF can be shared by multiple network slices, while other NFs shall be network slice specific.
- UE traffics of a specific session are transferred within one specific network slice to ensure the handling of traffics can be customized and isolated from other network slices.

Network Exposure Function

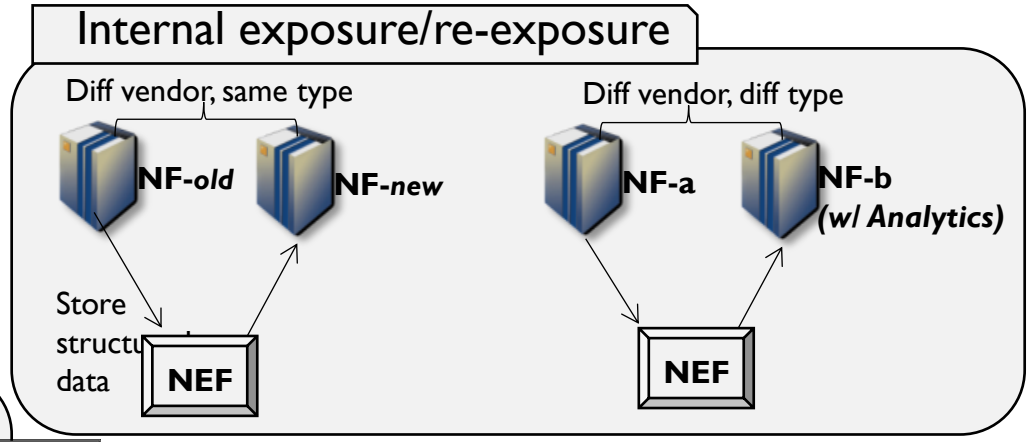
NEF

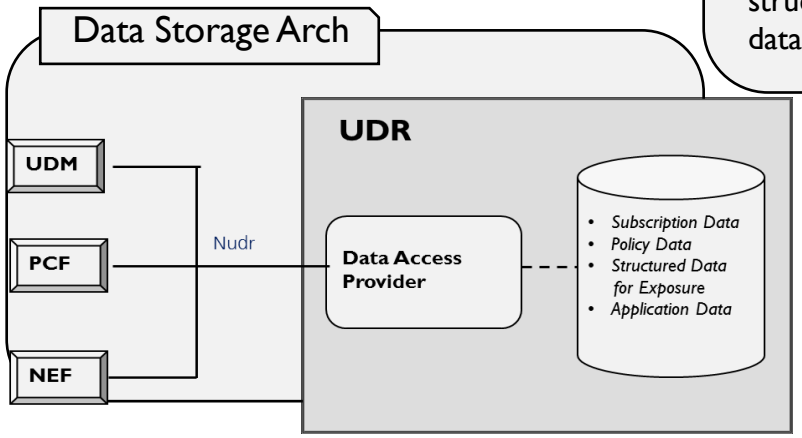
To securely expose the services and capabilities provided by 3GPP network functions for e.g 3rd party, internal exposure/re-exposure, Application Functions, Edge Computing …

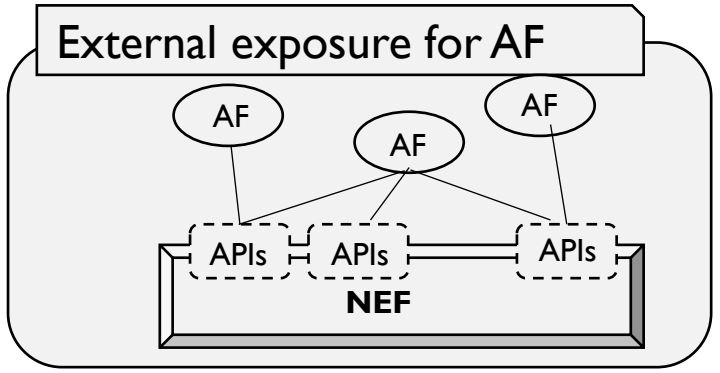
① Internal exposure/re-exposure
- NF relocation/resilience / Data exposure to other NFs

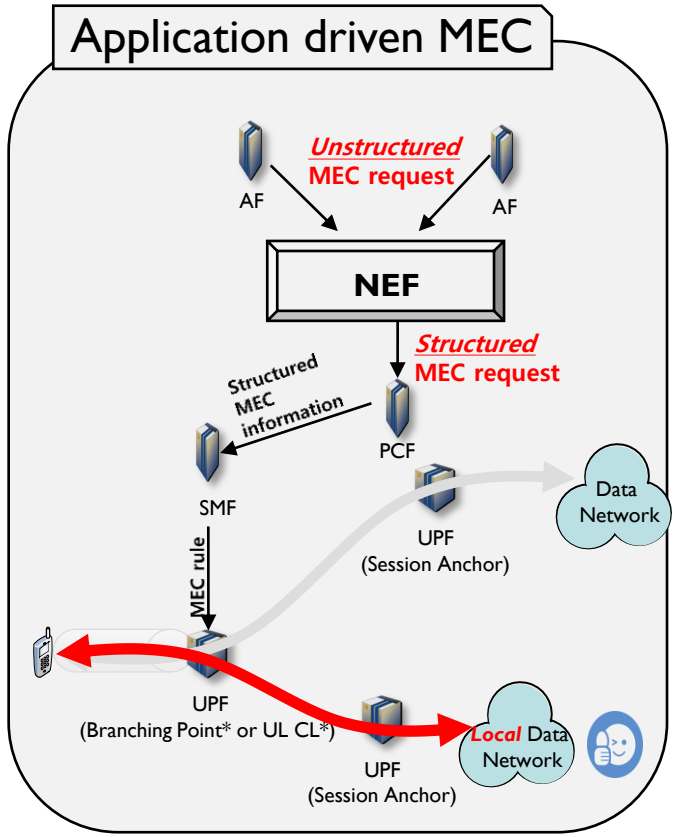
② External exposure - AF (e.g., NBAPIs for 3rd parties (LTE- SCEF))

③ Edge Computing (MEC)





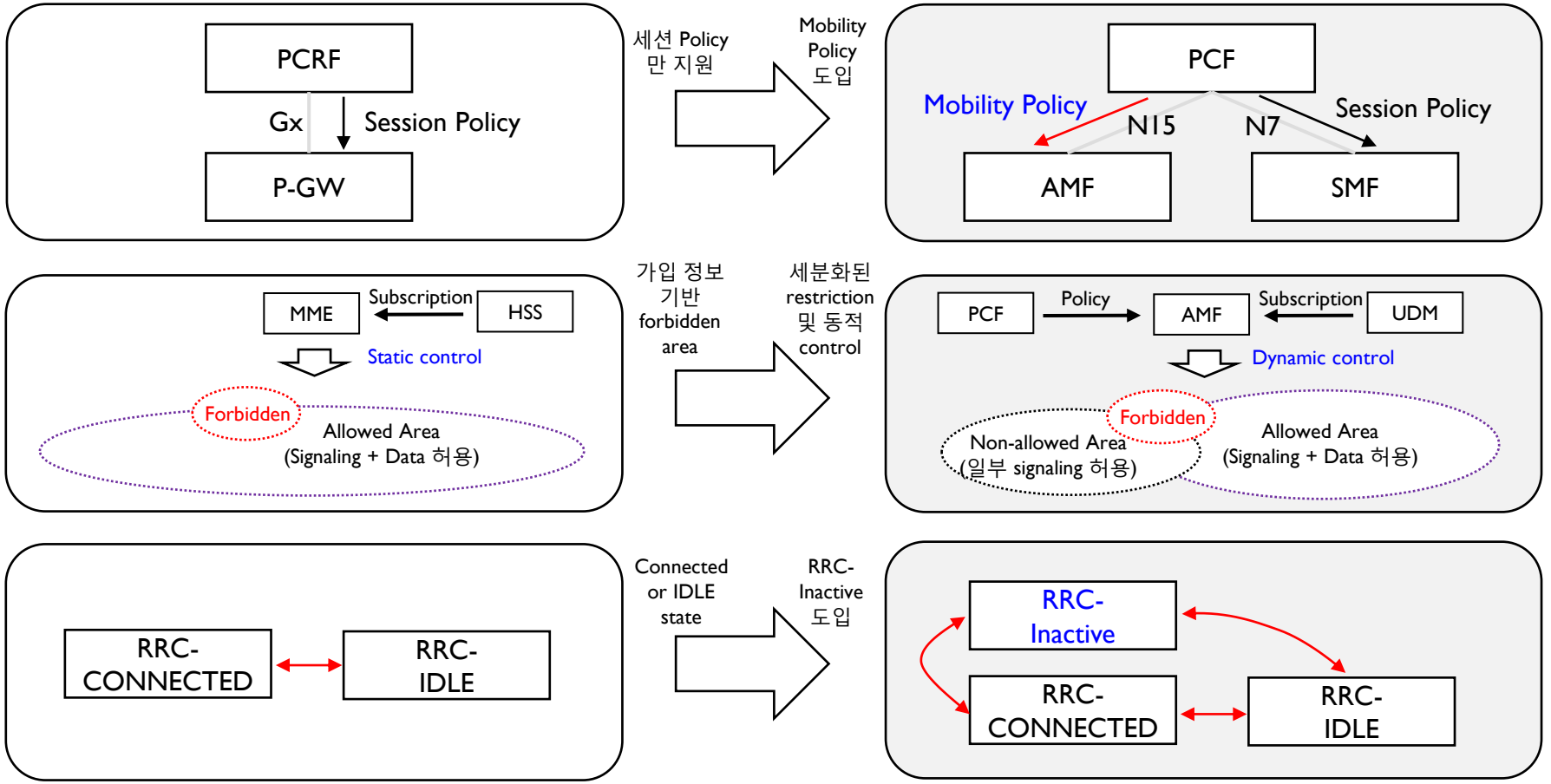




액세스 제어, MM/CM 기능

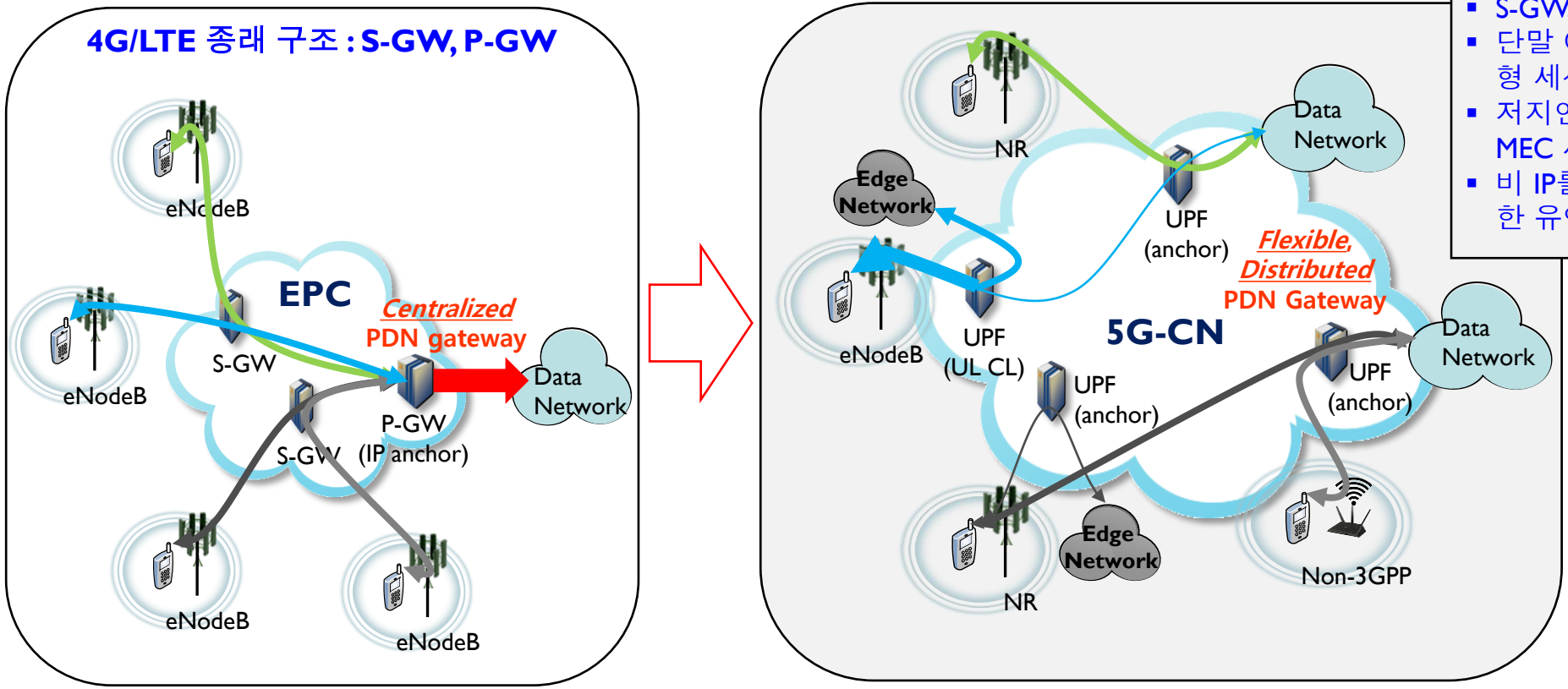
- Mobility Policy 및 Mobility Pattern 을 이용한 단말 이동성 관리 최적화
- 동적인 Mobility Restriction Area 관리 기능 도입
- 단말 에너지 절약을 위한 RRC Inactive 상태 및 MICO 모드 도입

(*) MICO : Mobile Initiated Communication Only



세션 관리 및 연결지속기능

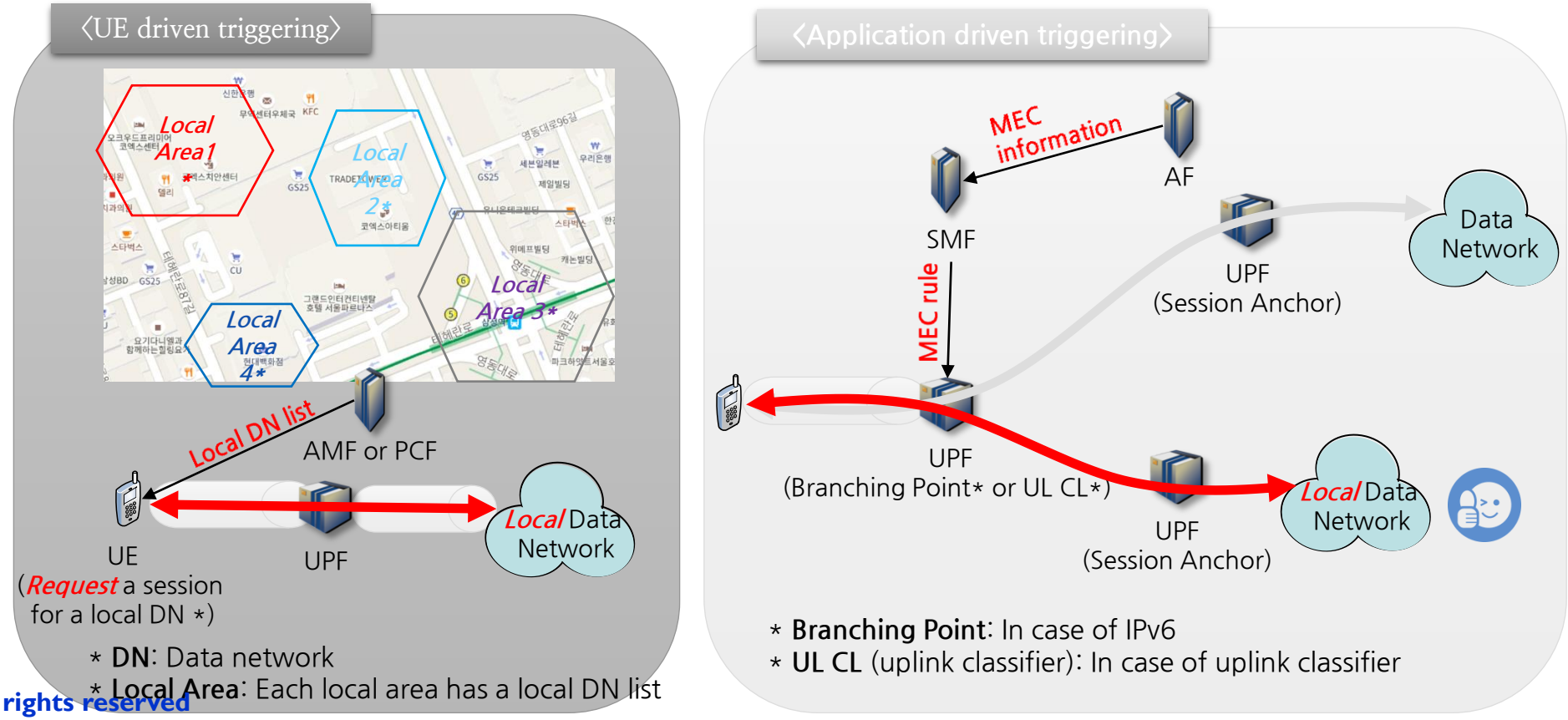
- Flexible gateway: S-GW, P-GW를 통합한 UPF 기반 flexible gateway
- Service and session continuity: 이동성에 따른 UPF 변경 지원
- Multiple and efficient path: 응용 및 사용자 요청에 따른 MEC 지원



- S-GW, P-GW가 통합된 UPF 기능 개발
- 단말 이동성을 지원하는 유연한 분산형 세션 게이트웨이 개발
- 저지연 및 데이터 오프로딩을 위한 MEC 서비스 제공
- 비 IP를 포함한 다양한 세션 타입에 대한 유연한 세션 관리 기능 제공

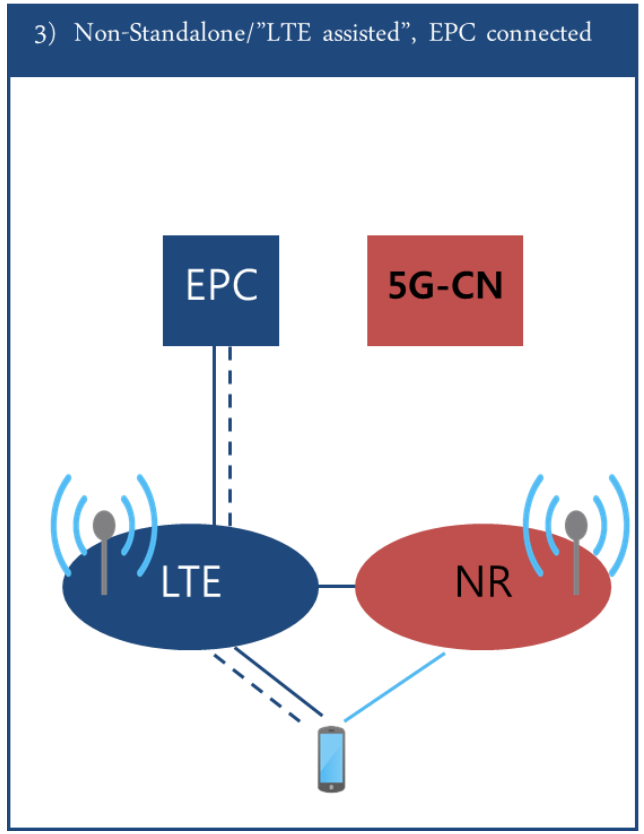
Edge Computing Works in SA2

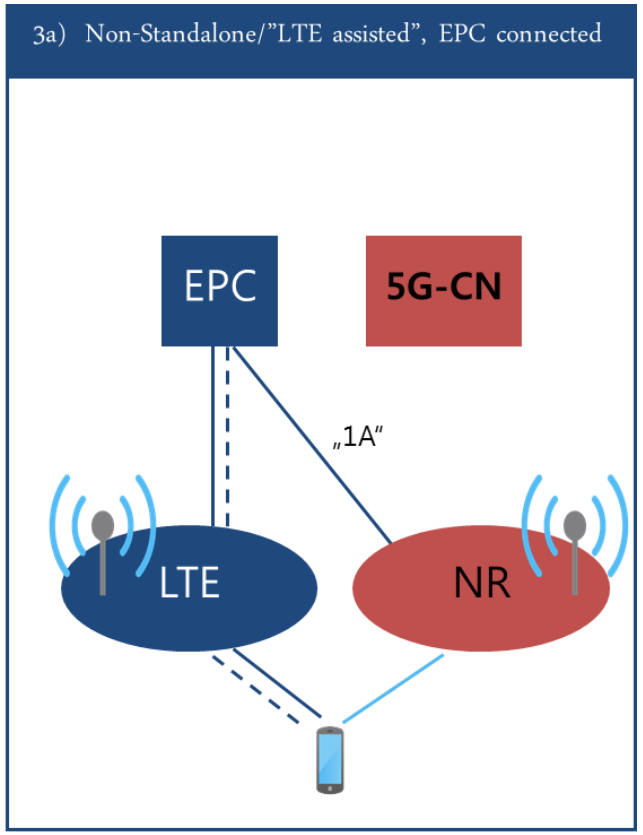
- Edge Computing
  - For ultra low latency and load balancing
- Triggering Method: UE Driven & Application Driven

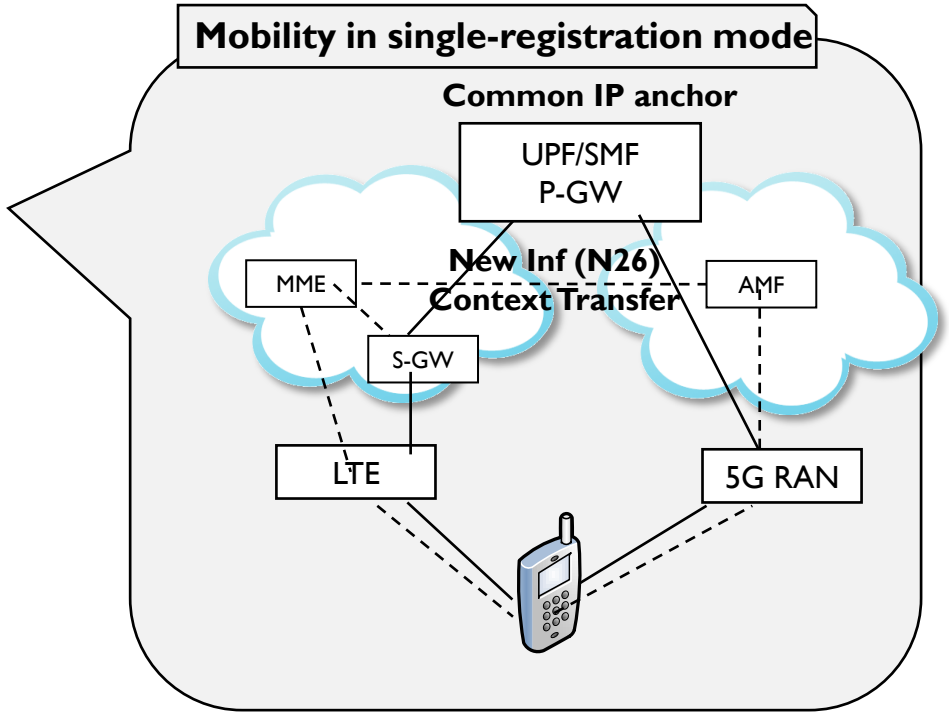


LTE/EPC 연동 및 마이그레이션

5G scenarios in 3GPP NR & 5G-CN Option 3

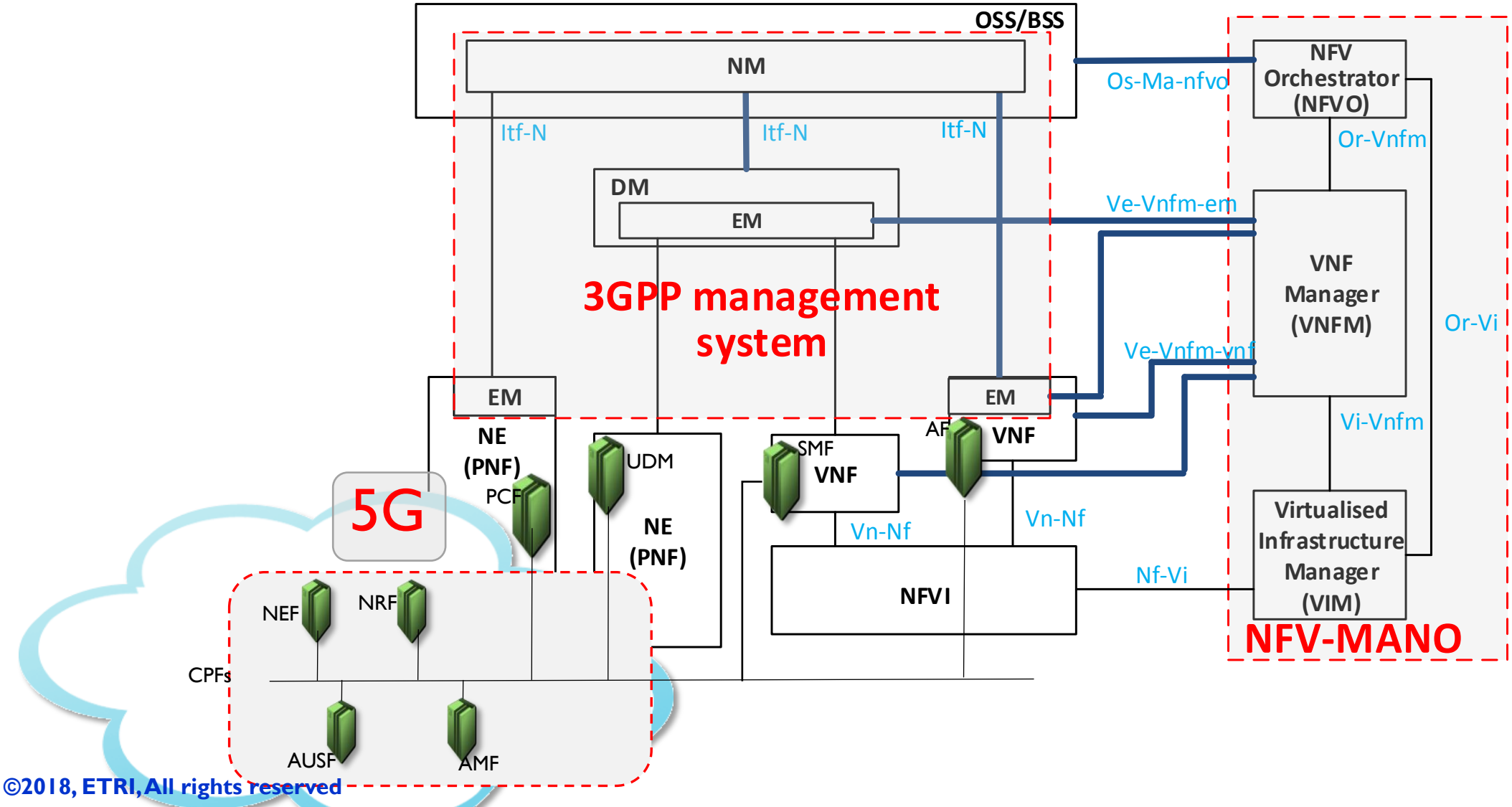






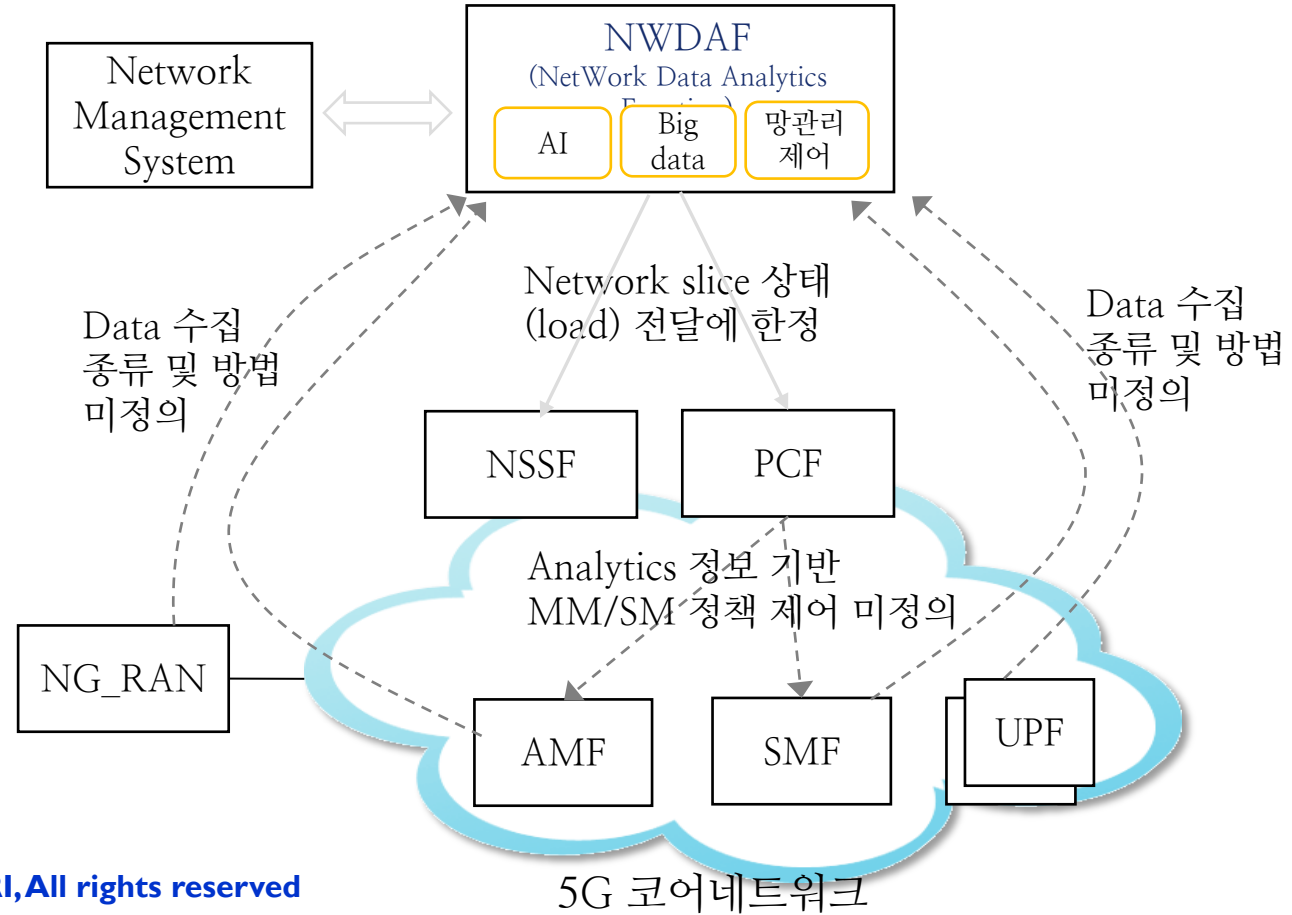
기존 EPC의 새로운 인터페이스 확장 필요

Management w/ MANO



Network Automation

- Network 정보 Big Data 서버를 3GPP entity로 신규 정의 (NWDAF)
- 인공지능/Big Data 기반 이동통신 네트워크 자동화를 위한 표준 구조
- 추가 표준화 및 표준 구조를 밀접히 반영한 연구 개발 필요



5G Ph.2 추가 표준화

- ✓ Collected data 종류 및 인터페이스 표준화
- ✓ Big data, 인공지능 기반 자동관리 정책 종류 및 최적화 동작 추가 표준화

↕ 밀접 연동 필요

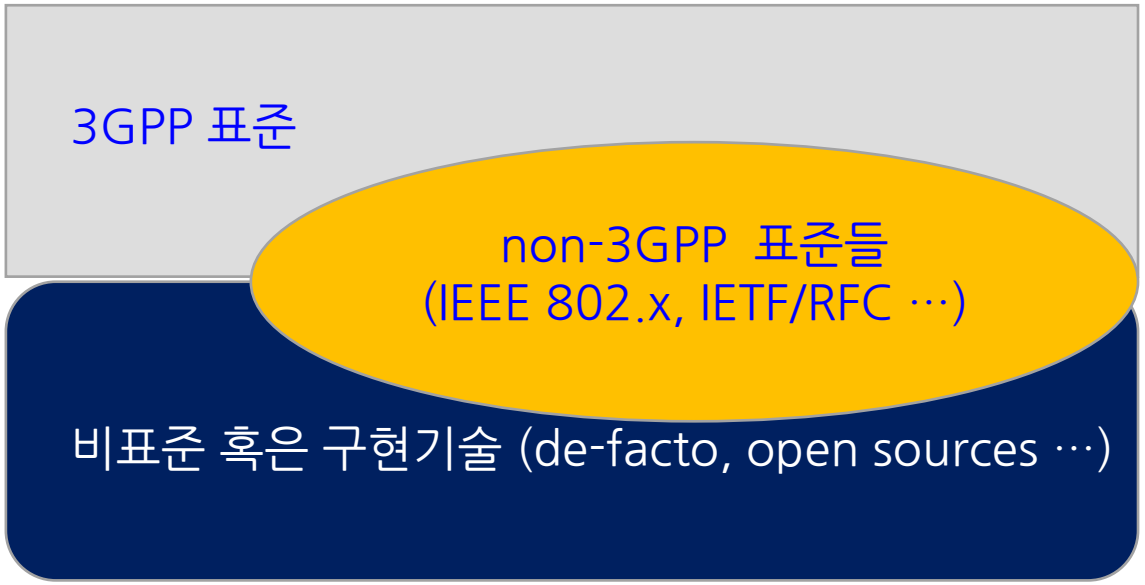
자동관리 구현 기술 연구개발

- ✓ NWDA data 기반 네트워크 인공지능 관리 알고리즘
- ✓ NWDA 빅데이터 저장, 처리, 분석 구조

Approved 5G Ph.2 Study Items

	Acronym	Title
1	FS_ATSSS	Study on Access Traffic Steering, Switch and Splitting support in the 5G system architecture
2	FS_5WWC	Study on the Wireless and Wireline Convergence for the 5G system architecture
3	FS_CIoT_5G	Study on Cellular IoT support and evolution for the 5G System
4	FS_eNA	Study of enablers for Network Automation for 5G
5	FS_eV2XARC	Study on architecture enhancements for 3GPP support of advanced V2X services
6	FS_ETSUN	Enhancing Topology of SMF and UPF in 5G Networks
7	FS_eIMS5G	Study on Enhanced IMS to 5GC Integration
8	FS_eLCS	Study on Enhancement to the 5GC LoCation Services

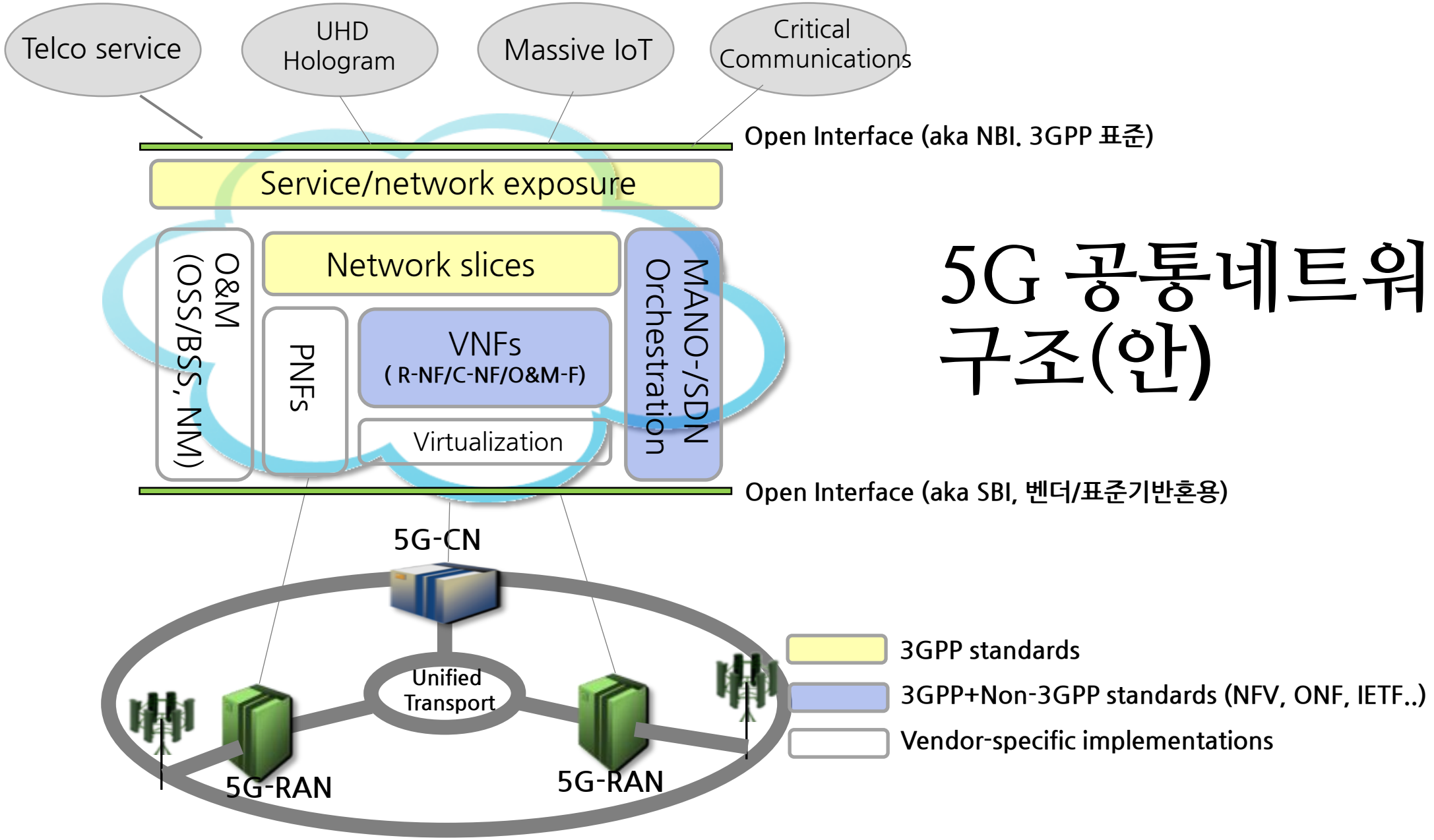
5G도입/구축 관점의 주요이슈들
(네트워크 관점)



① Network slicing (3GPP/IP-MPLS/T-SDN …)
② Multi-site NFV and MANO (C-NFs, R-NFs. ..)
③ MEC / TSN
④ C-RAN and Open Fronthaul Interface (HLS/LLS)
⑤ E2E SDN Multi-site Controller / Orchestration
⑥ NB Interface for Network Capability Exposure (e.g.NEF)
⑦ Big data/AI and analytics on 5G networks (e.g. NWDAF)

E2E / Radio + Access + Core Networks / Rapid deployment

5G 공통네트워크 구조(안)



논의점

- (공공) 5G는 우리나라의 네트워크 산업의 기회
  - 4G까지가 관현악의 앙상블 수준이라면, 5G는 교향곡의 오케스트레이션 !!
  - 표준기반의 기술확보 및 경쟁 심화
  - 무선과 유선 community들이 협업하여 시너지를 내야할때 !!
- (5G/vEPC 제조사) 표준기반의 코어 NF 소프트웨어를 선제적으로 개발
  - 국내 5G 산업활성화 및 국산장비의 국제시장 진입 도모
  - 표준기반 국내 이동통신/네트워크 장비시장 확대개편 기대
- (통신사업자) 고가의 특정 하드웨어 기반의 장비 대신 표준기반의 SW기반 국산 장비 우선도입 추진가능
- (SW업체) 통신사업자의 다양한 요구에 따른 소프트웨어 기반의 맞춤형 5G 서비스SW의 개발 (새로운 3rd party SW 업체의 시장진입 및 신규 서비스창출)

  => 4차 산업혁명을 위한 버티컬 산업의 공통인프라로서의 5G