for the non aficionados

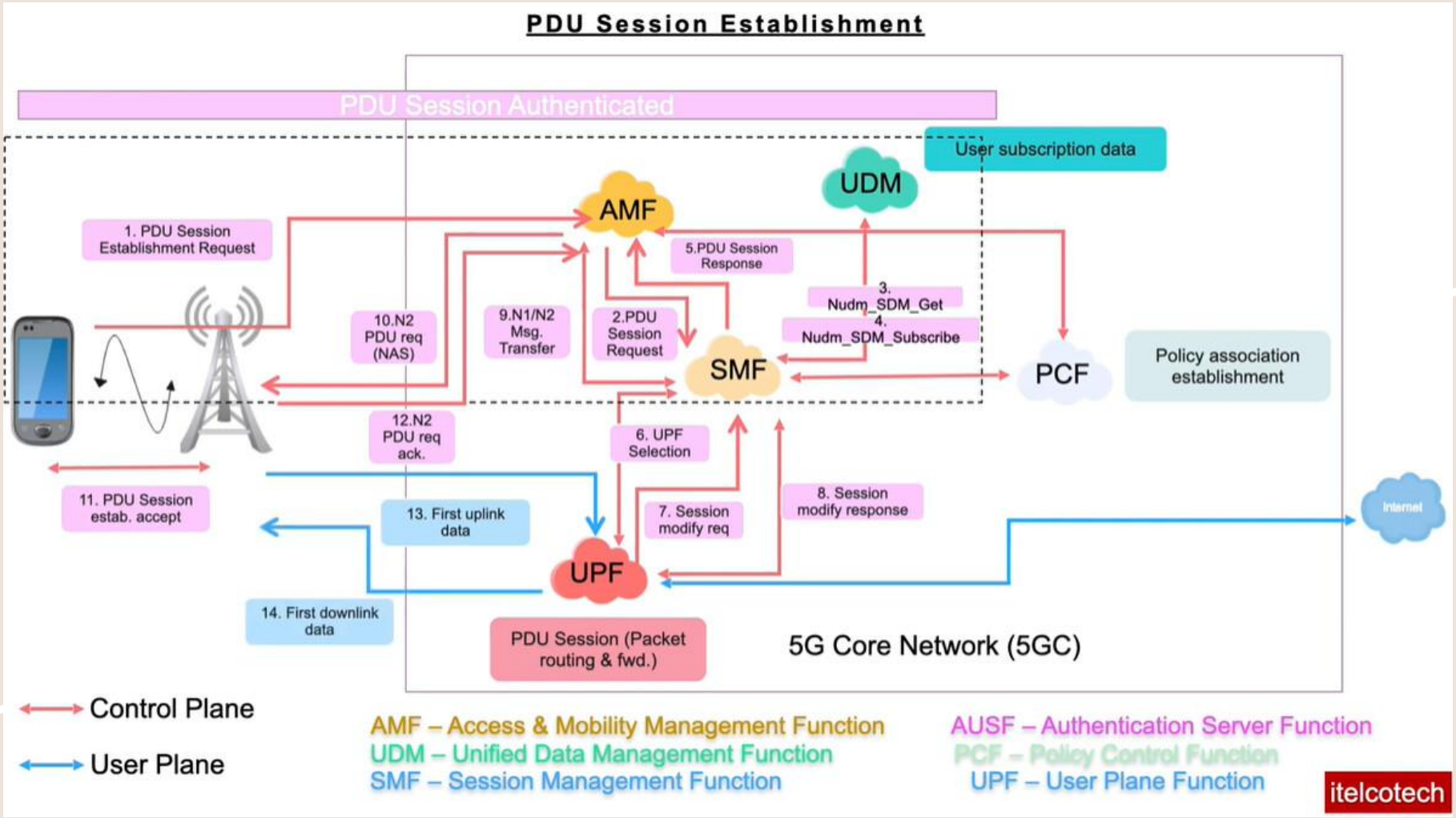
A 5GS core network demystification

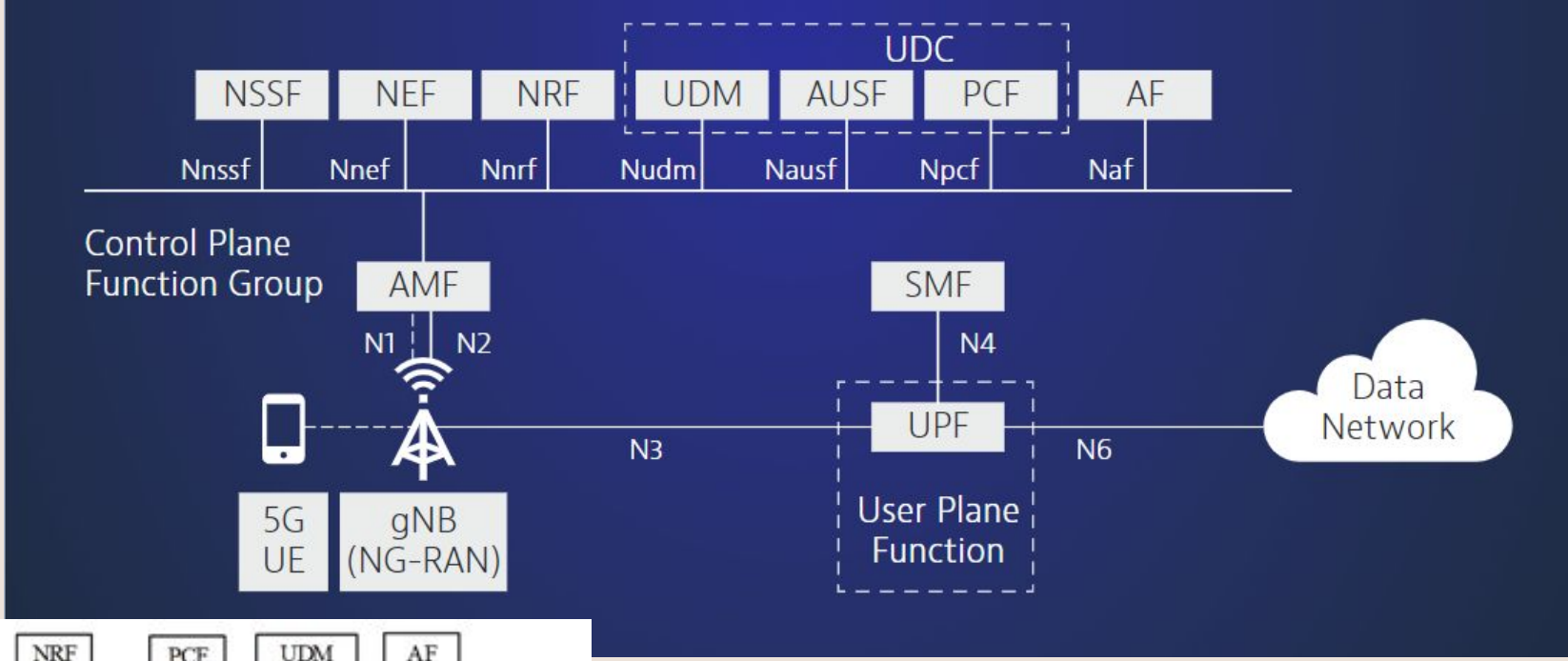
By Patrick Louis

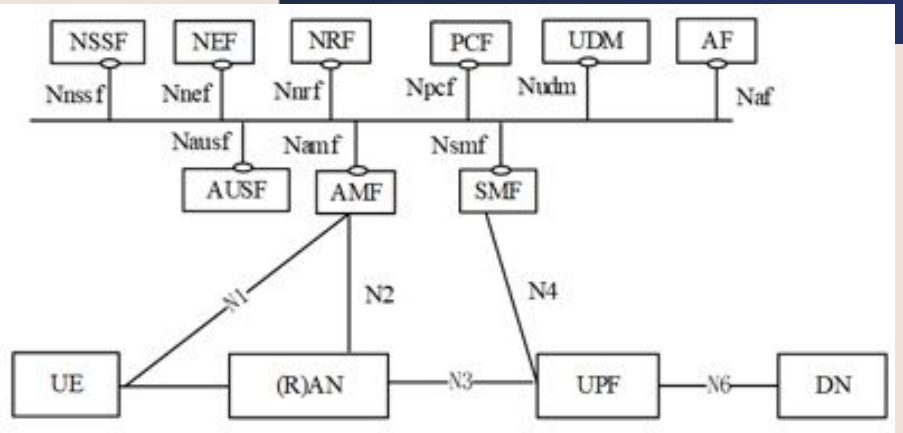
Aims of the Presentation

- Understand the common acronyms
- Grasp the general architecture
- Not be confused by online diagrams anymore

PDU Session Establishment




UDC
NSSF
NEF
NRF
UDM
AUSF
PCF
AF
Nnssf
Nnef
Nnrf
Nudm
Nausf
Npcf
Naf
Control Plane
Function Group
AMF
SMF
N1
N2
N4
Data
Network
UPF
N3
N6
5G
UE
gNB
(NG-RAN)
User Plane
Function


NSSF
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N4
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(R)AN
N3
UPF
N6
DN

What's 5G?

❌ Change in radio spectrum

❌ Change in security

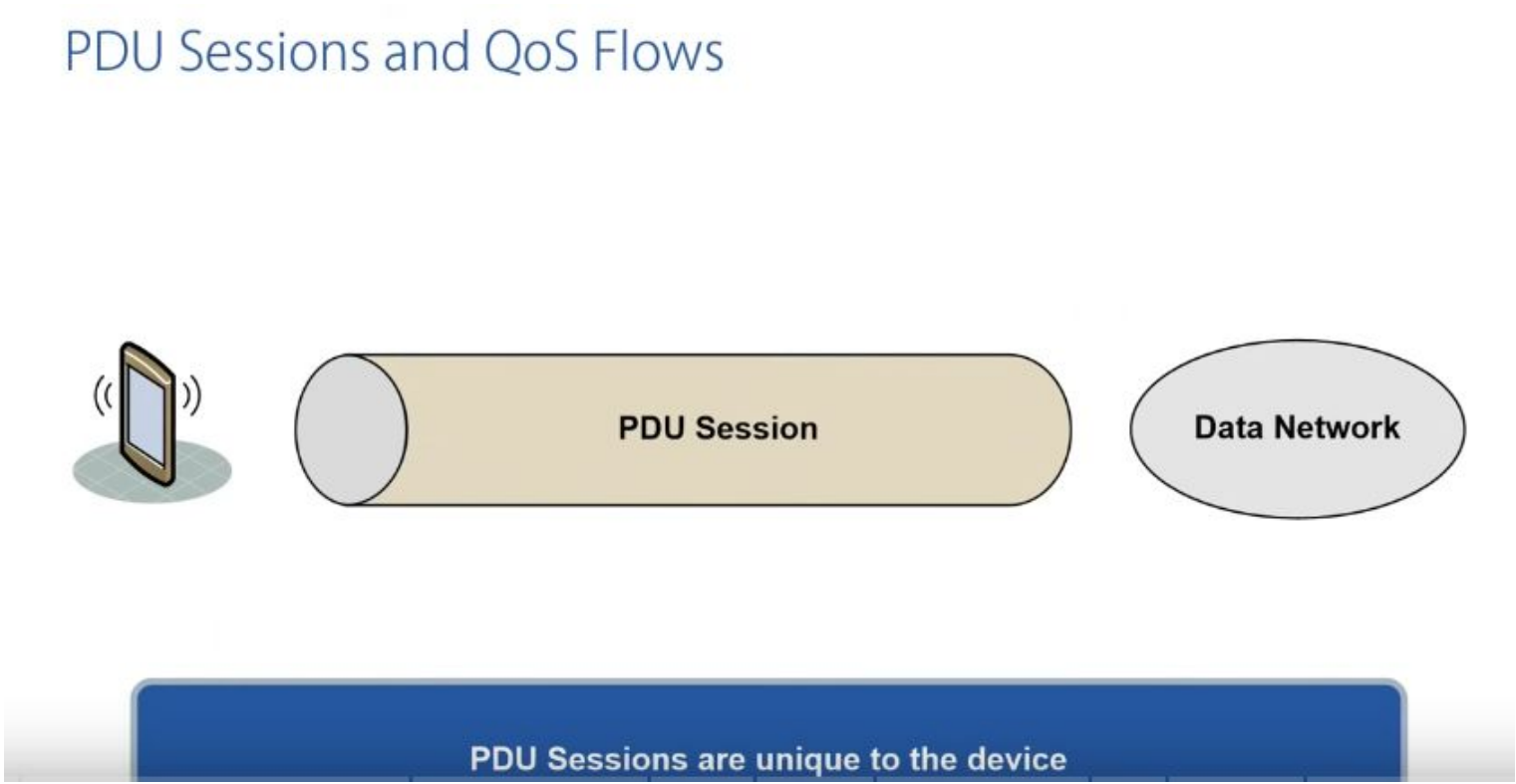
✅ Change in core network architecture

What's 5G?

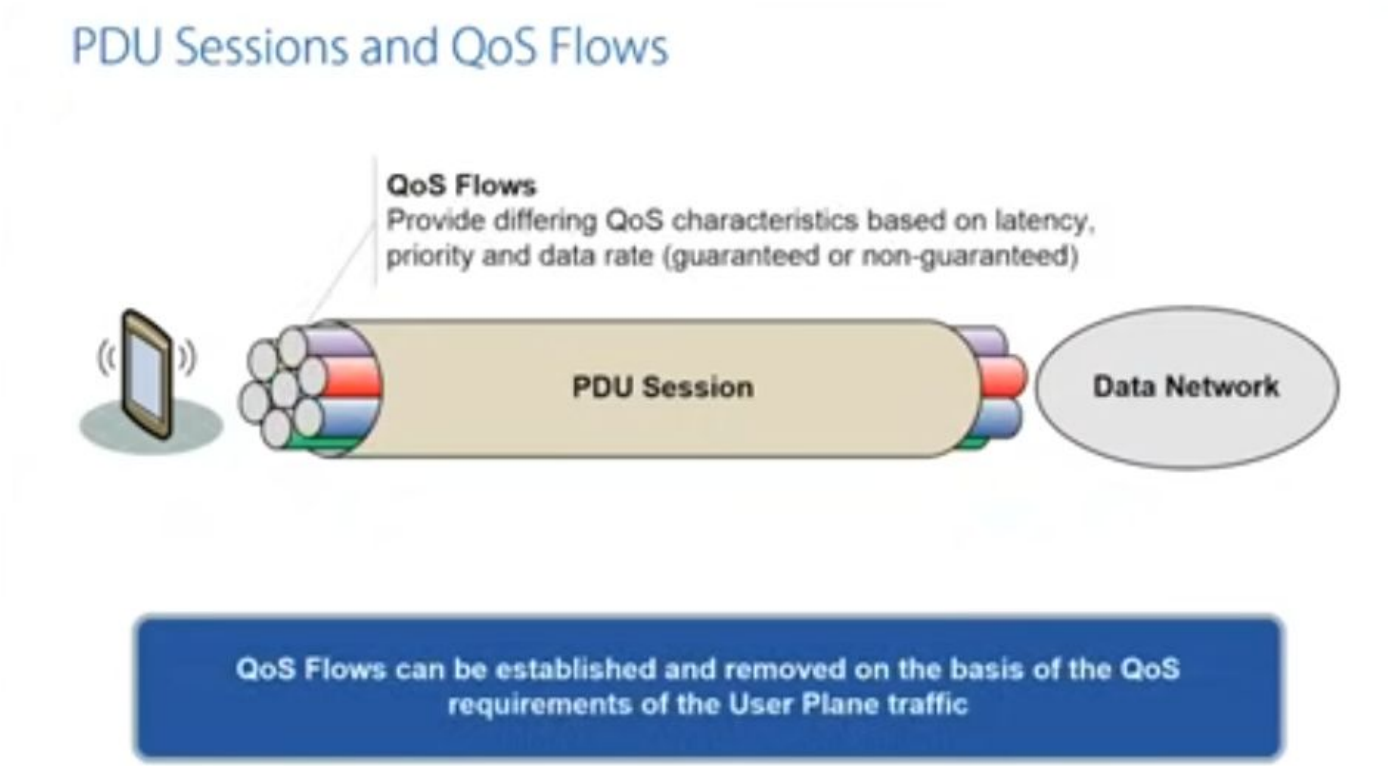
ETSI specs

- System architecture for the 5G System (5GS) in *TS 23.501* to *599*
- NG-RAN architecture in *TS 38.300* and *TS 38.401* along with 3gpp specs for radio equipment
- Security architecture in *TS 33.501* and *TS 33.535*
- Charging architecture in *TS 32.240*
- 5G Media streaming architecture in *TS 26.501*

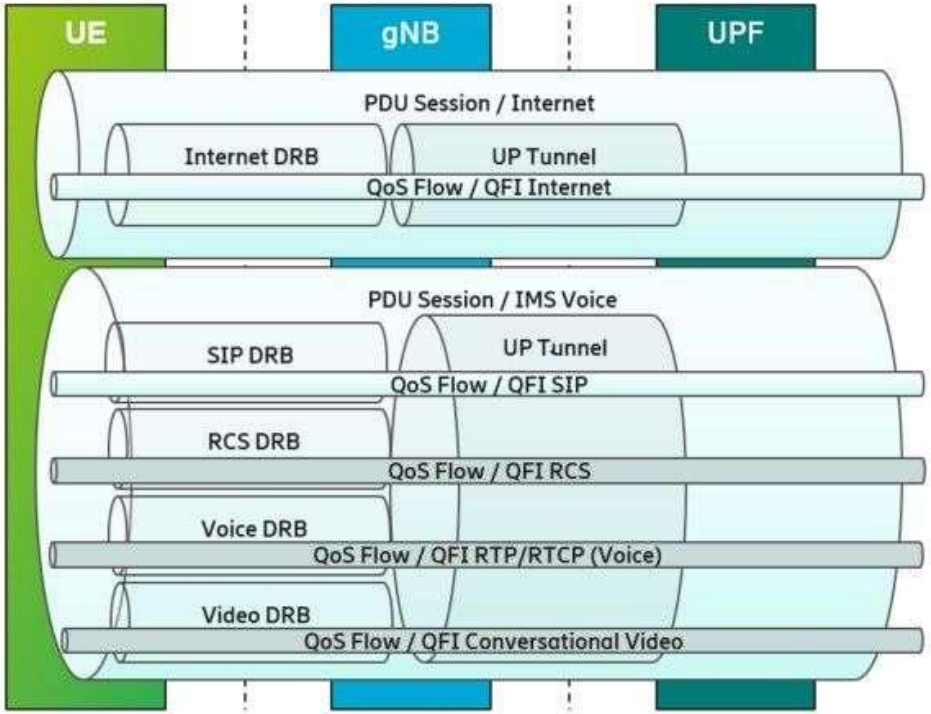
PDU Session and QoS flows



PDU Session and QoS flows



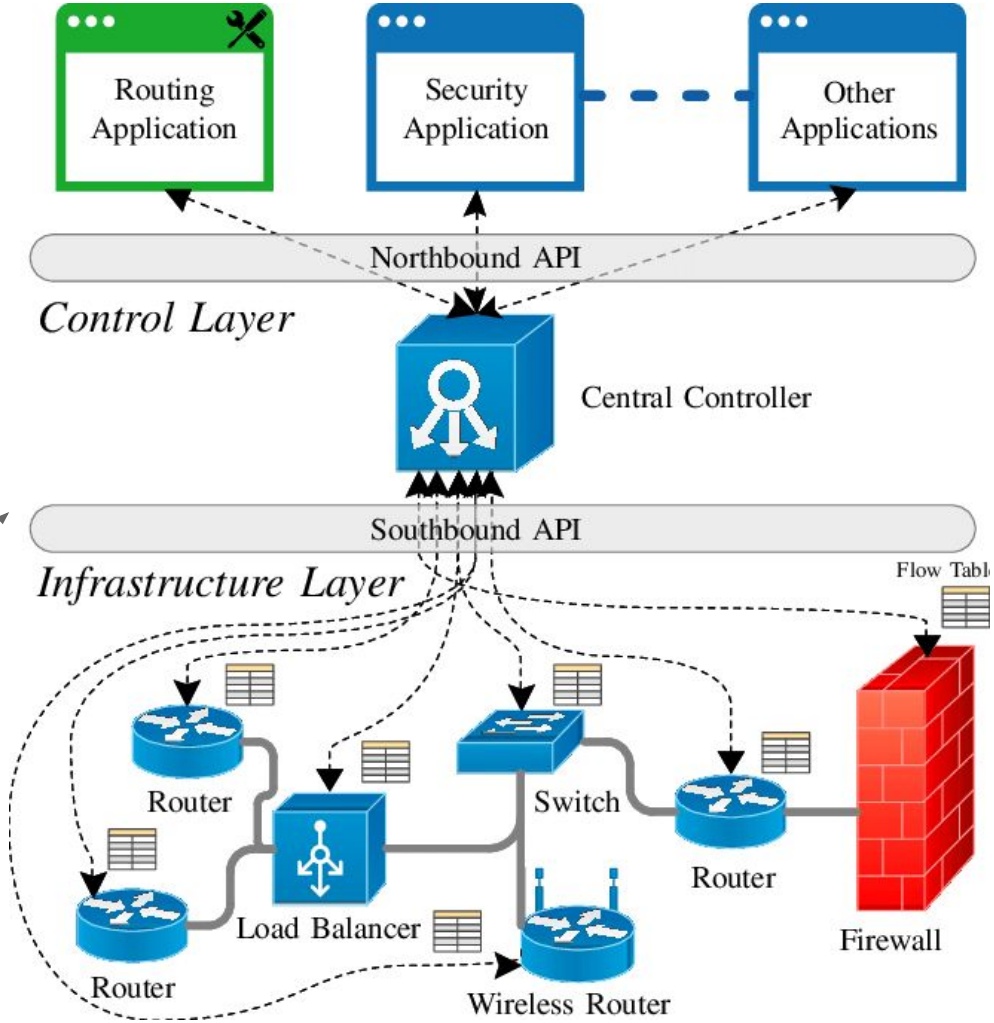
PDU Session and QoS flows



User Plane, Control Plane, and Data Layer

Inspired by Software Defined Networking aka **SDN**

This diagram is SDN



User Plane, Control Plane, and Data Layer

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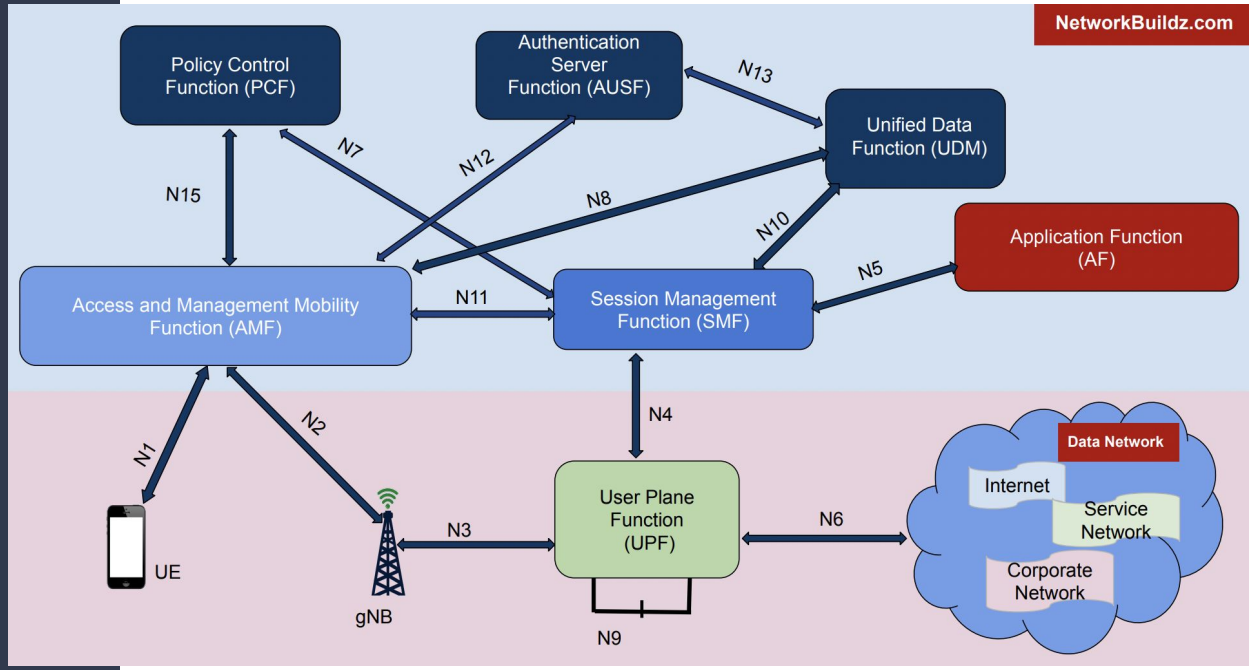


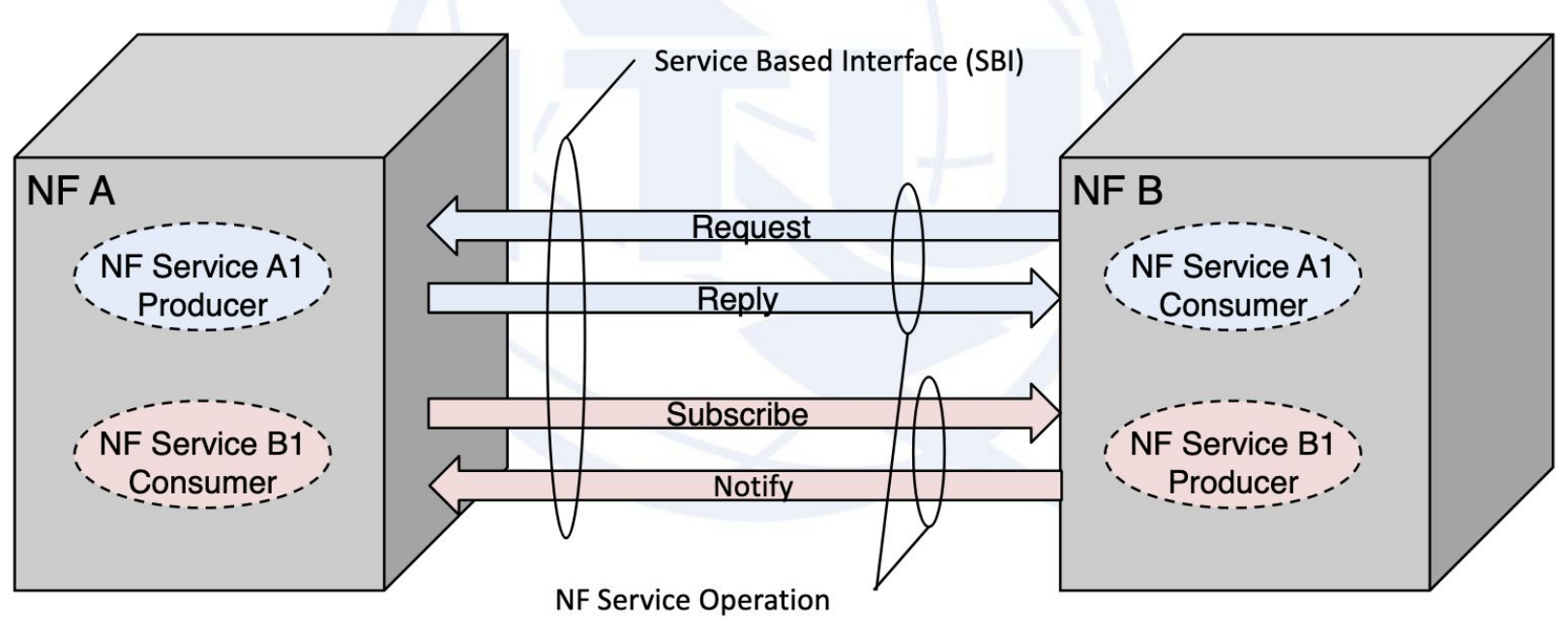
Network Functions (NF)

A service-based architecture for flexibility

- NF are blocks fulfilling a function in the core network
- NF offer a fixed set of services
- Services over well-defined REST interfaces
- Swagger file definitions (*Demo*)

Example
Nausf interface of the AUSF NF

Network Functions (NF)



Network Functions (NF)

```
Namf: Service-based interface exhibited by AMF.
Nsmf: Service-based interface exhibited by SMF.
Nnef: Service-based interface exhibited by NEF.
Npcf: Service-based interface exhibited by PCF.
Nudm: Service-based interface exhibited by UDM.
Naf: Service-based interface exhibited by AF.
Nnrf: Service-based interface exhibited by NRF.
Nnsacf: Service-based interface exhibited by NSACF.
Nnssaaf: Service-based interface exhibited by NSSAAF.
Nnssf: Service-based interface exhibited by NSSF
Nausf: Service-based interface exhibited by AUSF.
Nudr: Service-based interface exhibited by UDR.
Nudsf: Service-based interface exhibited by UDSF.
N5g-eir: Service-based interface exhibited by 5G-EIR.
Nnwdaf: Service-based interface exhibited by NWDAF.
Nchf: Service-based interface exhibited by CHF.
Nucmf: Service-based interface exhibited by UCMF.
Ndccf: Service based interface exhibited by DCCF.
Nmfaf: Service based interface exhibited by MFAF.
Nadrf: Service based interface exhibited by ADRF.
Naanf: Service-based interface exhibited by AANF
etc..
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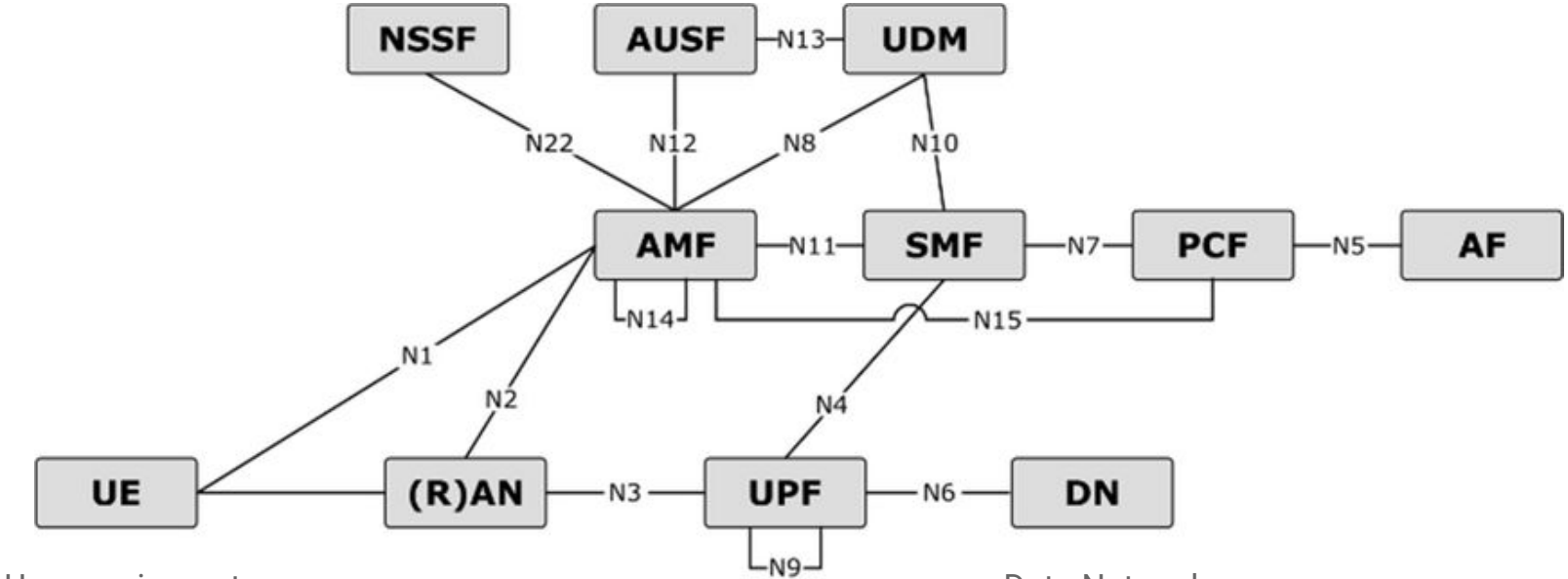
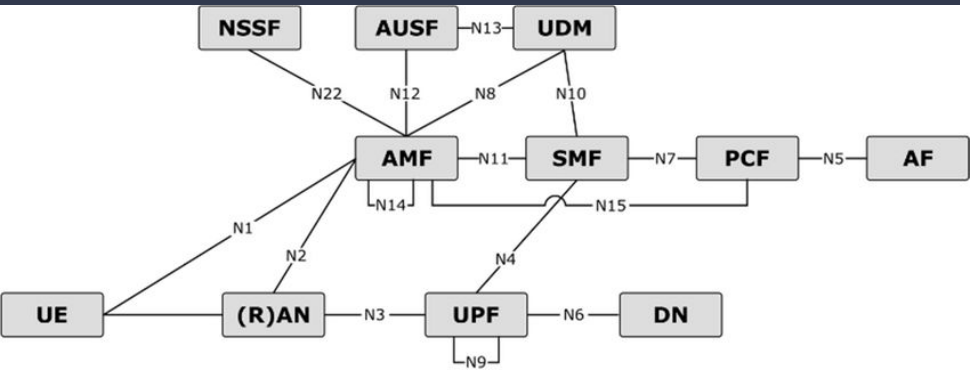
Reference Points of NFs

Confusing names for NF inter-connections/interactions

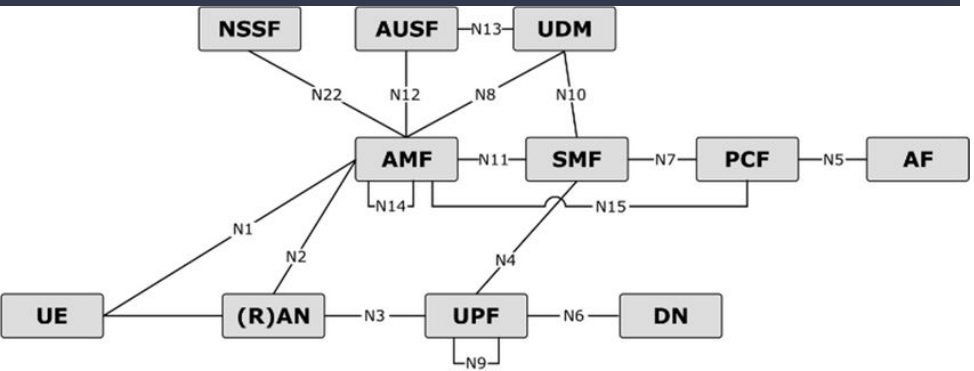


Some Notable NFs



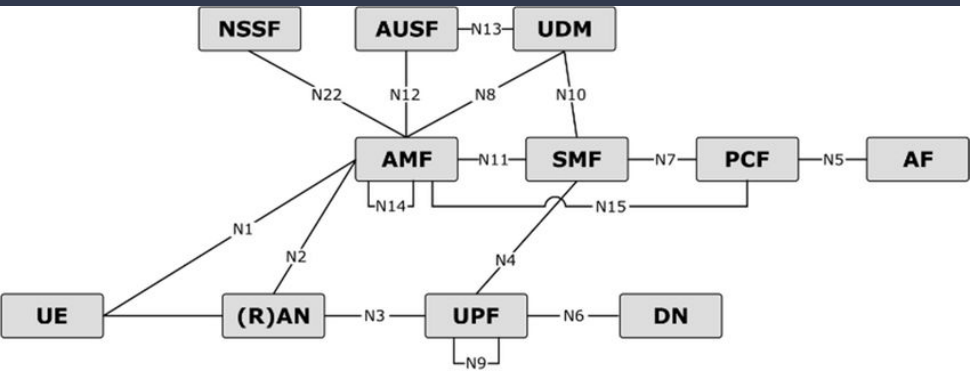
AMF
Access and mobility management function

- Responsible for subscriber mobility, registration, and security
- Similar role to MME in 4GS
- Tracks the subscriber's location across the cells
- Linked to other NF for authentication and finding the user
- Provides temporary identity to subscribers

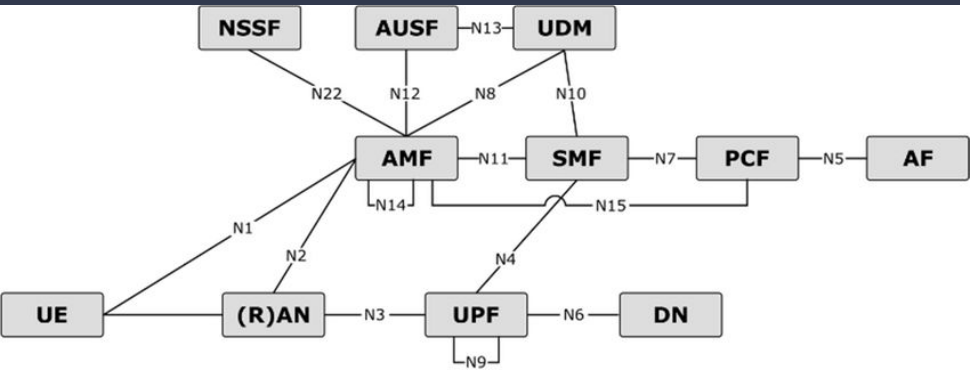


SMF
Session Management Function

- Management and tear down of PDU sessions
- Creation of PDU connectivity
- Allocates IPv4/v6 address to the session (to be given to UPF)
- Linked with policy control (PCF) to determine what to do to the session
- Picks UPF that the PDU will go through



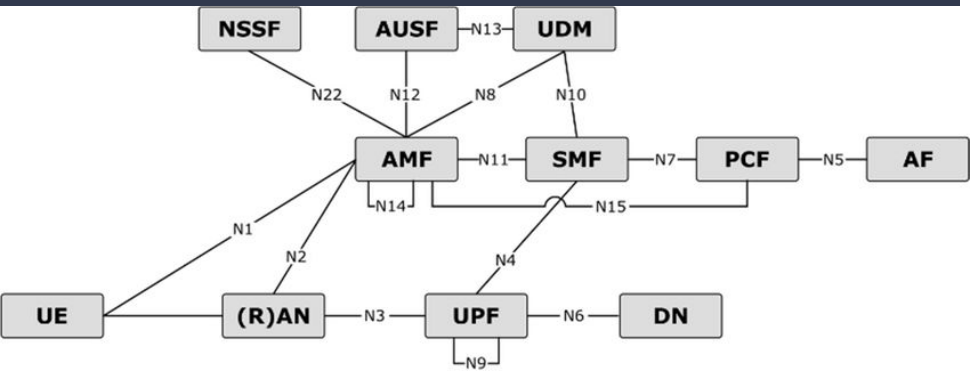
PCF
Policy Control Function



- Provides a unified policy framework to govern network behavior (data rates, latency, priority, and reliability)
- It is questioned dynamically so that other functions make decisions
- Ability to alter both mobility and session related aspects
- Linked to the network so can have conditions based on network events
- Before the SMF sets a session it checks with the PCF to determine the network conditions that influence the subscriber

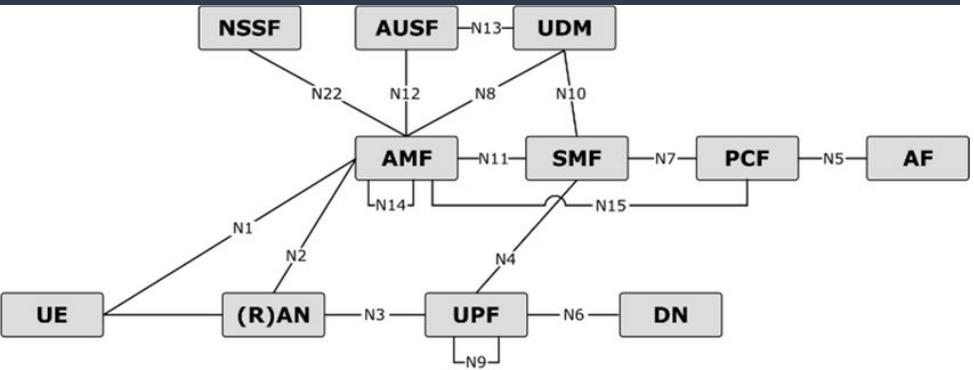
AUSF
Authentication Server Function

- Responsible for all security-related procedure with the SIM
- Authentication (5G-AKA and others)
- Routing based on SUCI and SUPI
- Manages auth timeout
- Re-sync
- Has a centralized database for auth session on the network



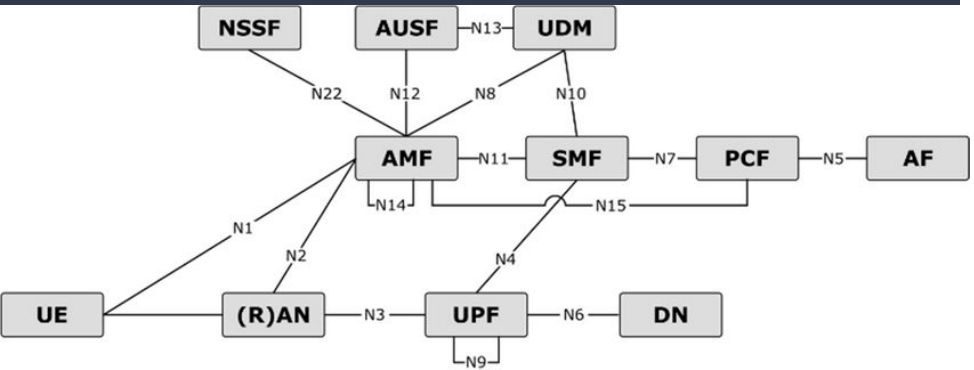
UDM
Unified Data Management

- Responsible for storing access authorization information
- Storage of data network profiles
- Central repository similar to HLR/HSS in 3GS/4GS
- Directly linked to other functions so that secure keys are provide (ex: AUSF)
- Supports SUCI de-concealing
- Stores current context of UE (which AMF is serving it and which SMF is managing its session)



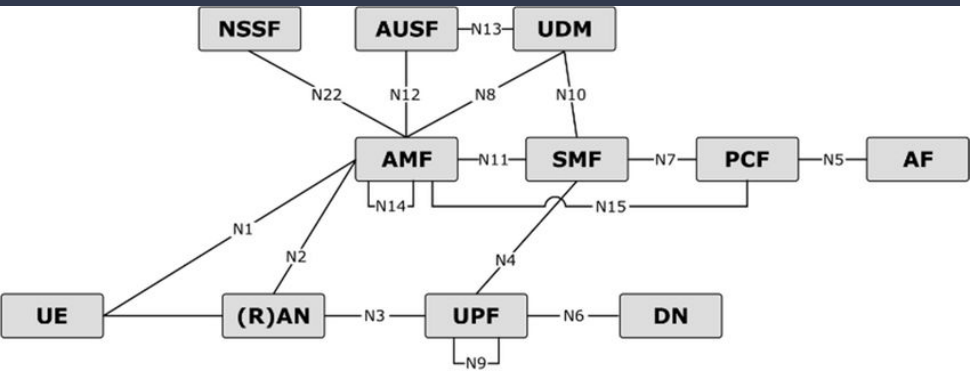
UDR
Unified Data Repository

- Similar to UDM but more generic
- Used to store customer profiles
- It is an in-memory database to store subscription and policy data



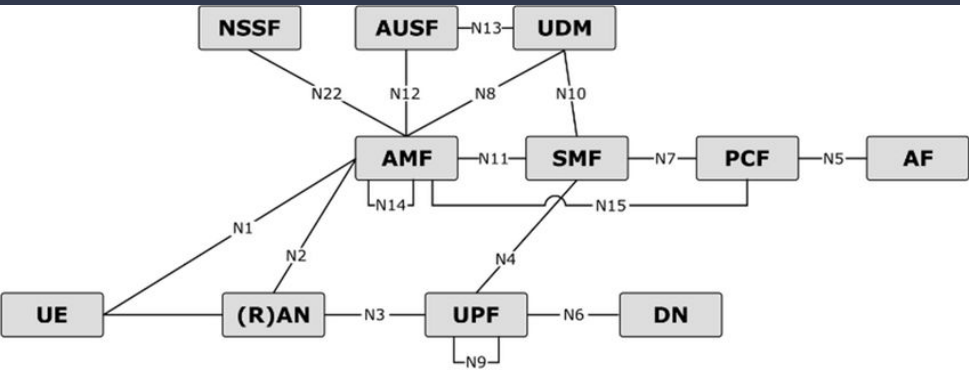
UPF
User Plane Function

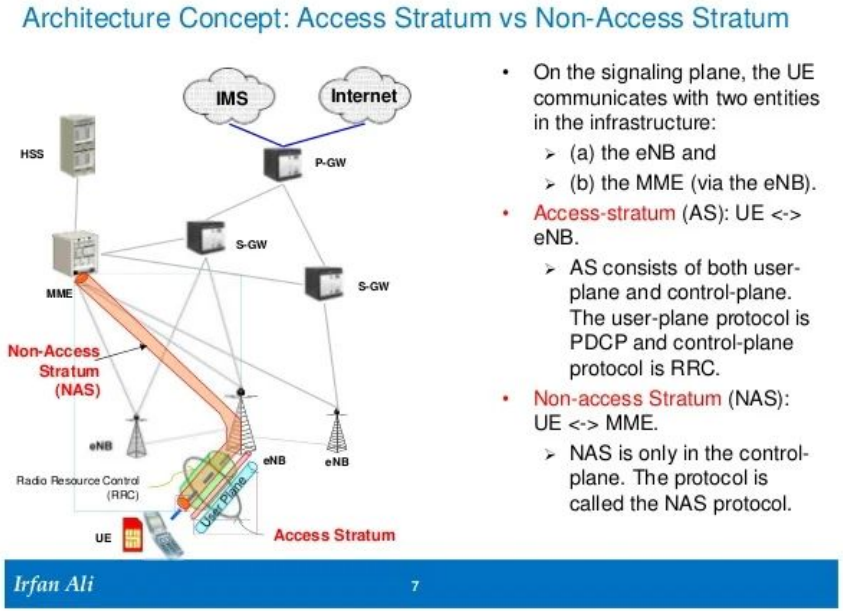
- The actual anchor point of the Ng-ran (radio access) mobility
- This is where everything actually happens, the connection flows through it
- The QoS flow and policy enforcement (read from the PCF)
- Does the packet forwarding and routing, the path of the PDU (again based on decision of the control plane such as SMF)



SMSF and 5G-EIR

- For SMS over 5G network (NAS), connected to AMF
- For EIR aka Check the status of PEI (Permanent Equipment Identifier), connected to AMF





Extra NFs for extensibility

Network Exposure Function (NEF)

- Exposing internal NF to 3rd parties
- Includes UDR (user data repository)

Application Function (AF)

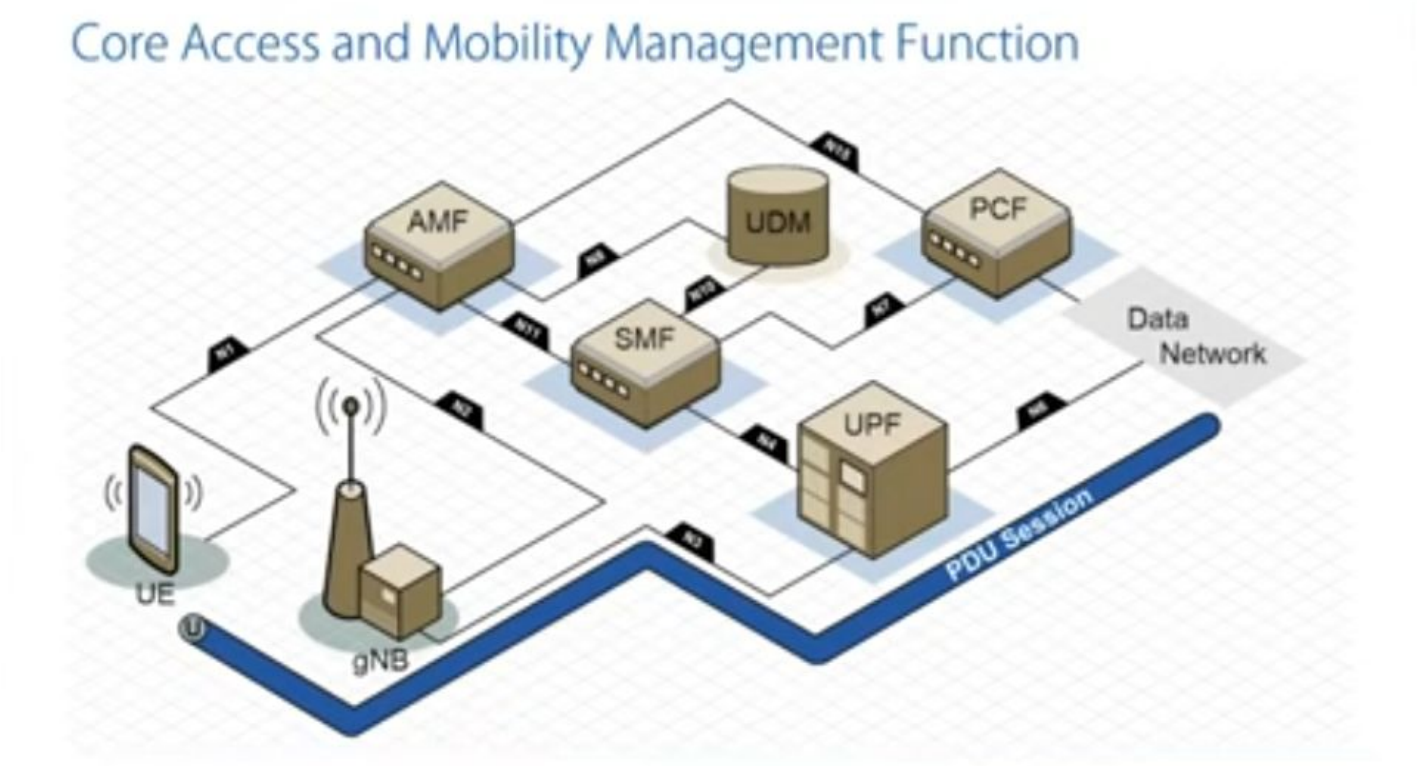
- Can interact with other nodes to affect traffic flow (PCF and UPF)
- Can be used to serve media (like a local CDN)
- Could allow media streaming aka 5GMS (useful with edge computing)

There are many more NFs, see the TS 23.501 for the full list

Discovery Service NRF

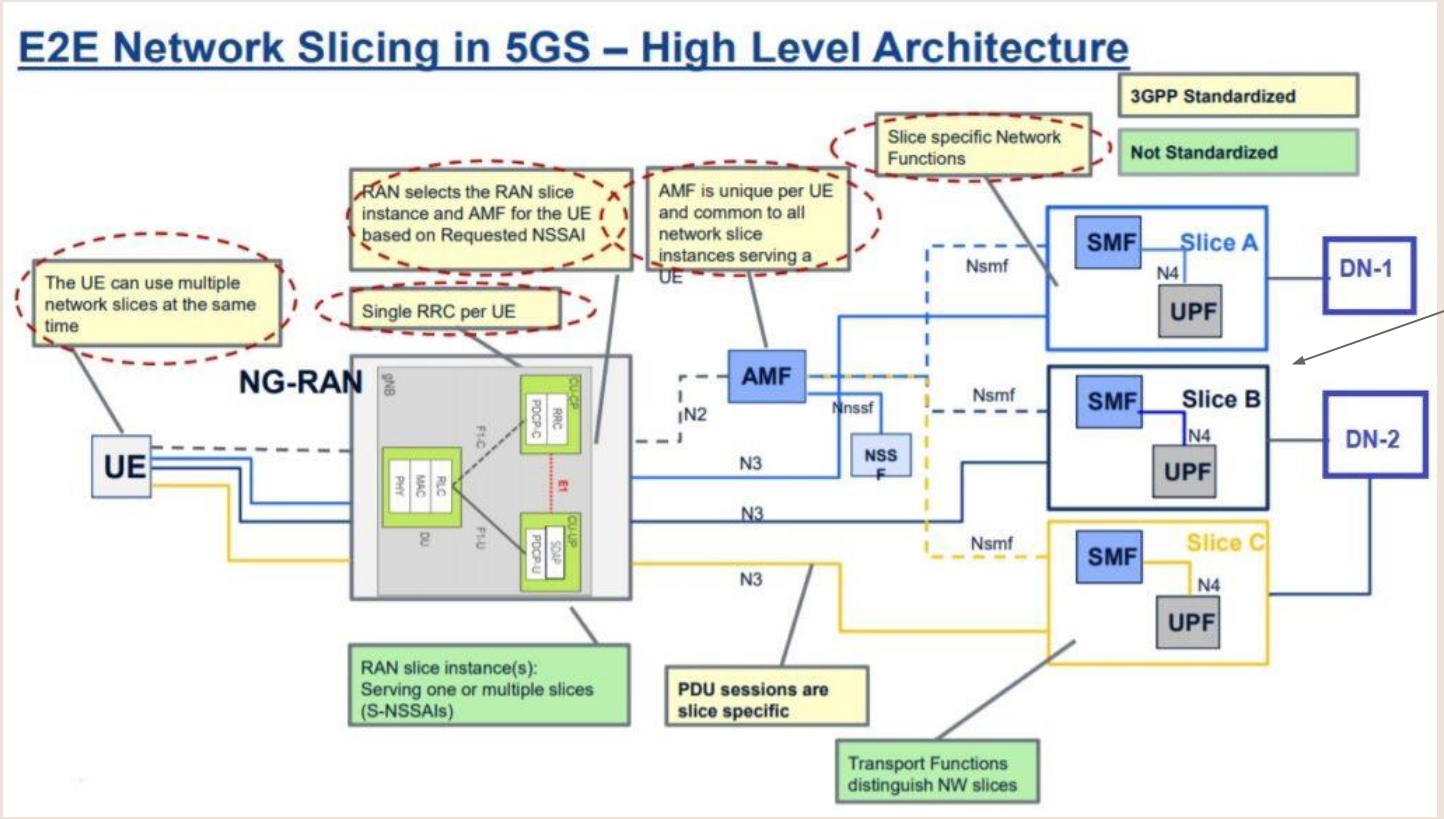
- Network Repository Function
- Maintain NF profiles of available instances along with which services they provide
- Support discovery and registration
- Network Function Service Authorization (optional: OAuth2 basically)

Flow Example



Network Slicing

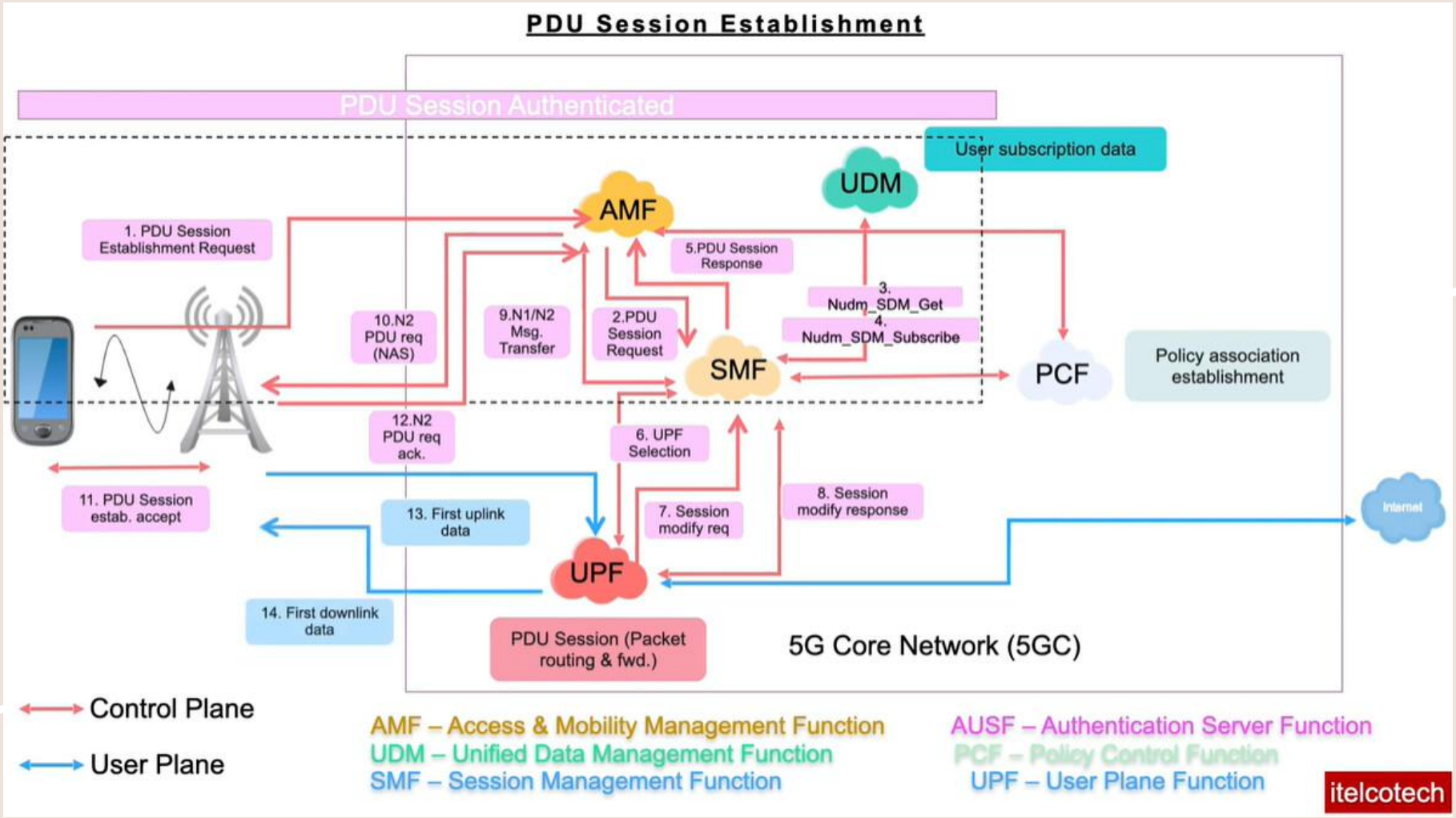
Network Slice Selection Function (NSSF)

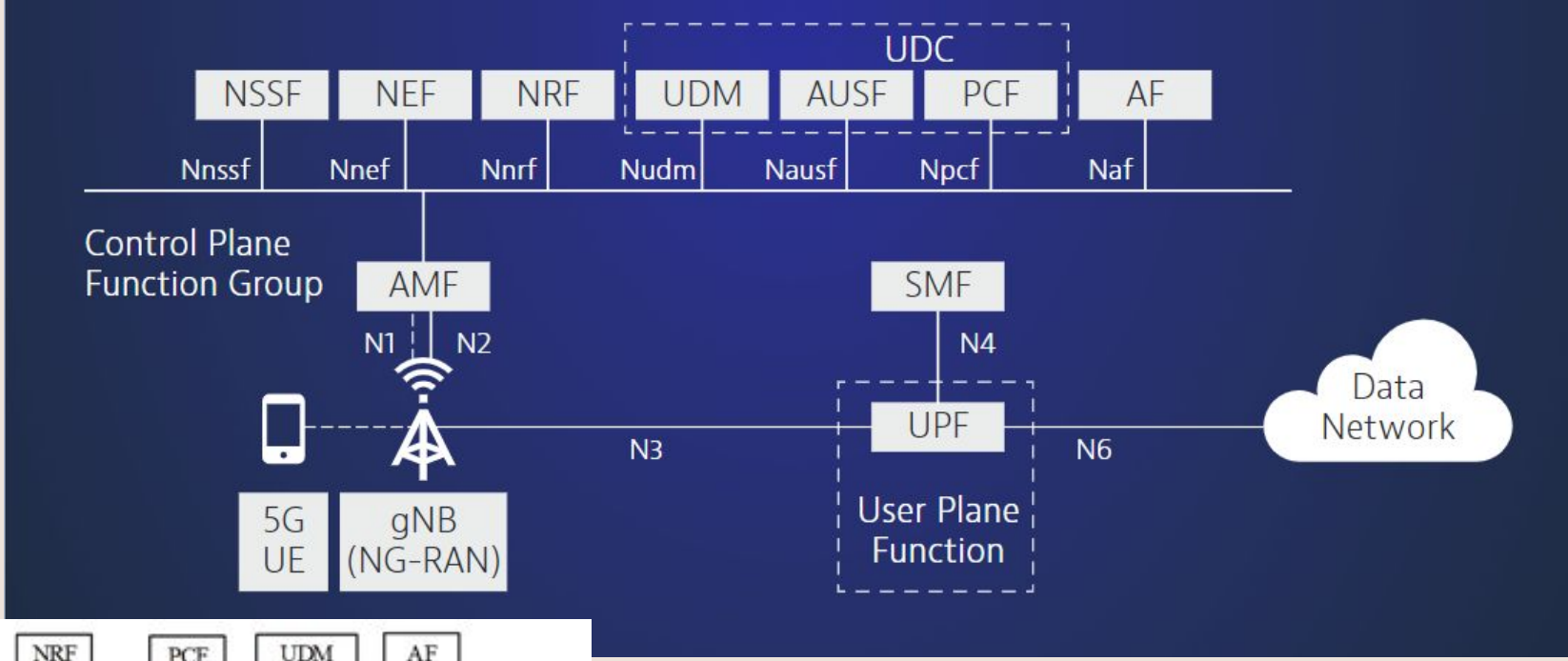


Reviewing the previous examples

- And crossing our fingers

PDU Session Establishment

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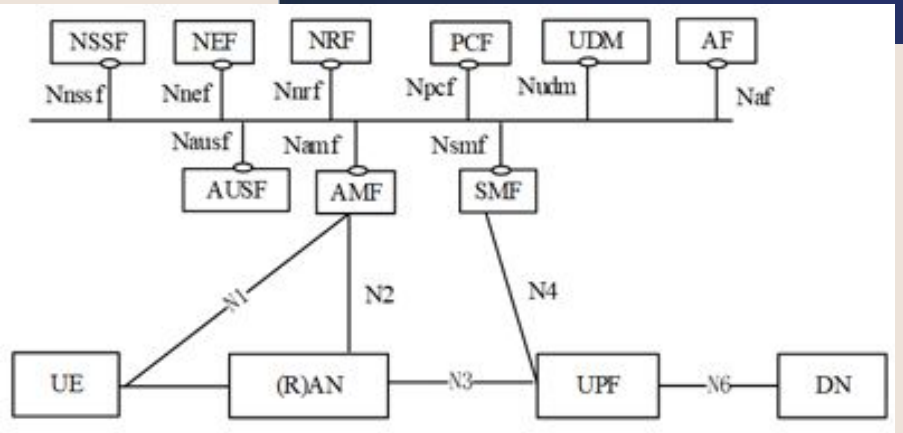
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AUSF
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Open Source Implementation

https://open5gs.org/
https://github.com/open5gs/open5gs

Thanks!

Questions?