Introduction of Release 16
FS_eNA (Study of Enablers for Network Automation for 5G) in 3GPP SA2

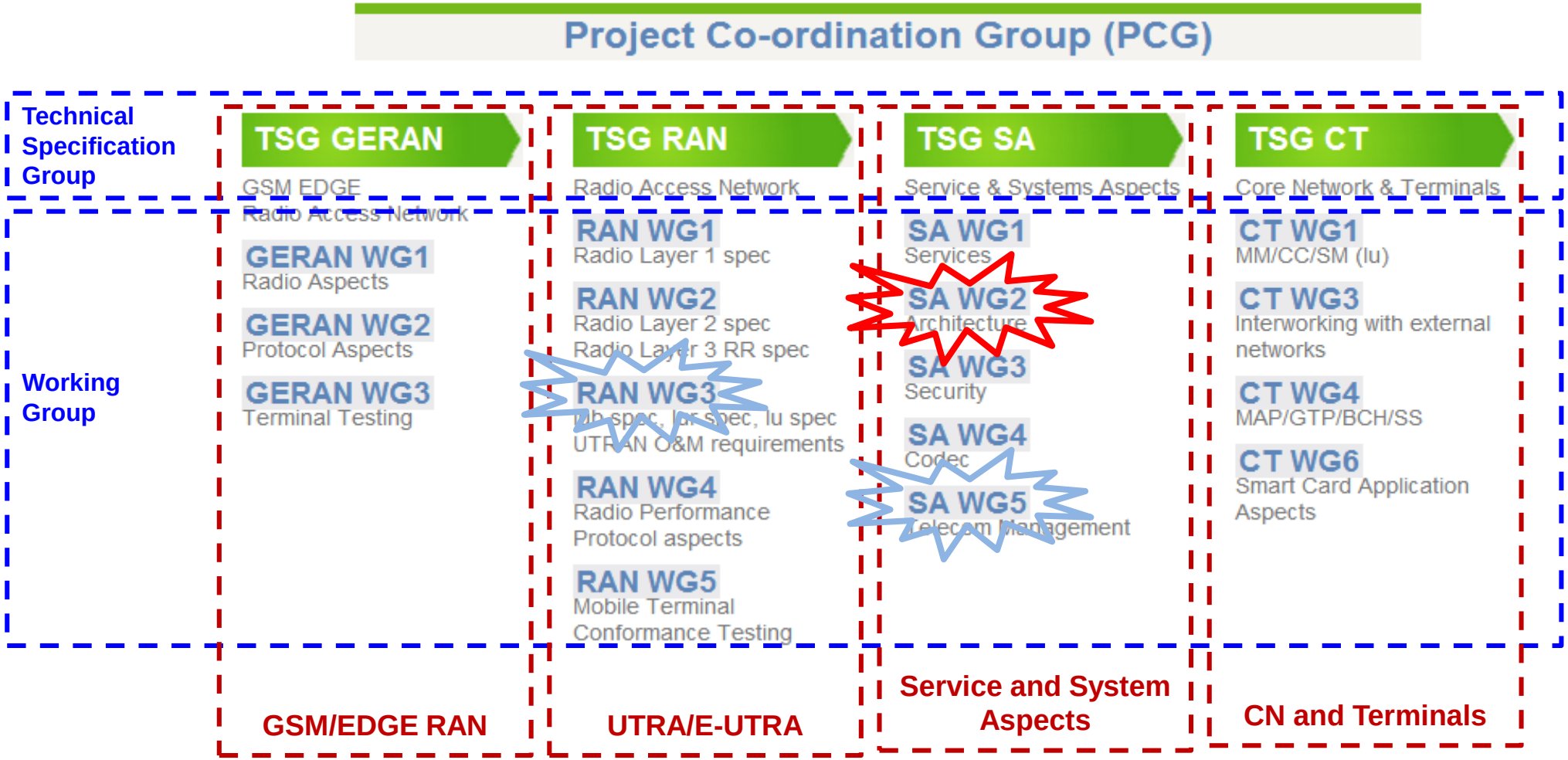
Xiaobo Wu (wuxiaobo@huawei.com)

Rapporteur of FS_eNA

HUAWEI TECHNOLOGIES CO., LTD.

Content

1. 3GPP Structure



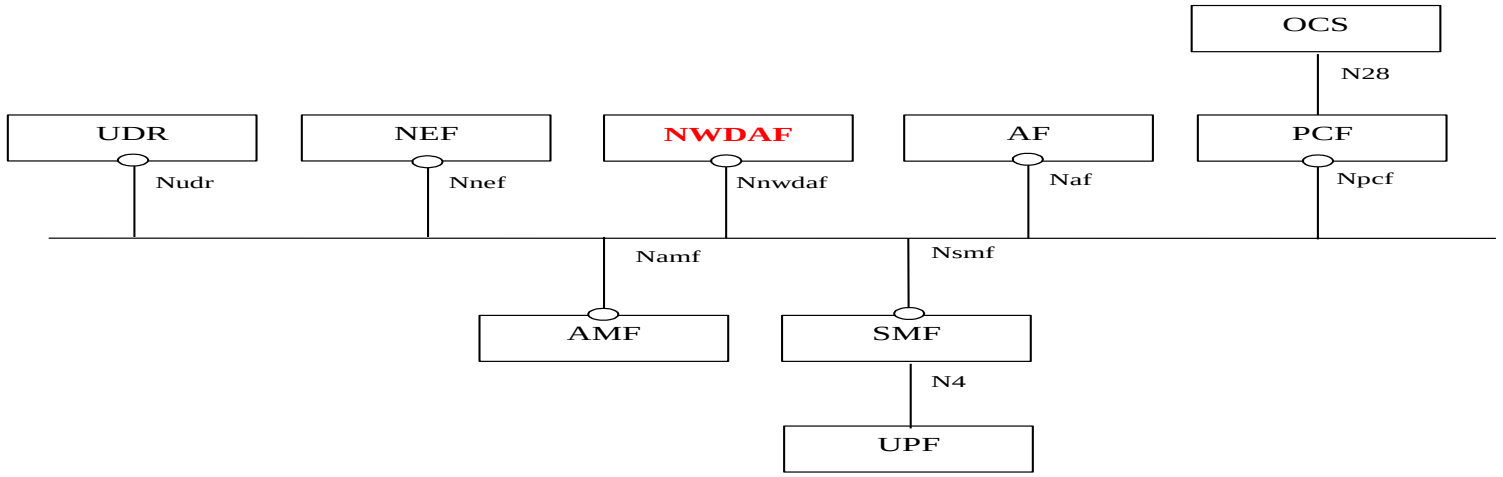
3GPP SA WG2 kicked off data analytics, which could involve 3GPP RAN WG3/SA WG5

Content

1. 3GPP Structure
2. **Status of Data Analytics in 5G in Release 15**
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

2. Status of Data Analytics in 5G in Release 15

- Network Data Analytics Function (NWDAF) has been introduced in the 5G System Architecture in 3GPP SA2#119 meeting, FEB. 2017.



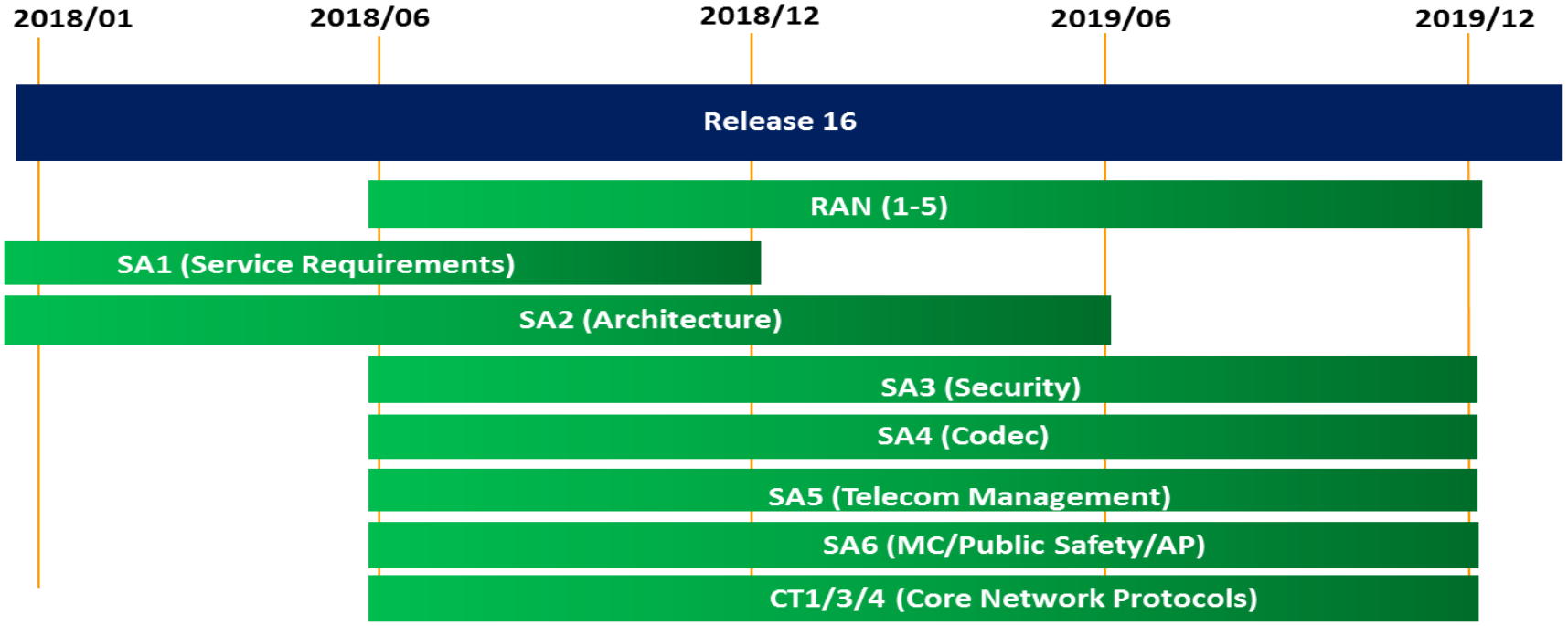
- The functional description for the NWDAF is as follows,
  - NWDAF could provide network slice level data analytics (e.g., load level information) to PCF and NSSF.
  - PCF uses that data in its policy decisions.
  - NSSF may use the load level information provided by NWDAF for slice selection.

Content

1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. **Current Status of Release 16 FS_eNA**
    1) How to better guarantee end user service experience
    2) How to accurately configure/adjust slice resource
    3) Performance Improvement and Supervision of mIoT Terminals
    4) Customizing Mobility Management
4. Challenge in 3GPP SA2
    1) General-purpose 5G architecture
    2) Comparison of Data Analytics between 5G System and IT System
5. Summary

Current Status of Release 16 FS_eNA

- In May, 2017, FS_eNA (**Study of enablers for Network Automation for 5G**) was approved.
- The study (Technical Report 23.791) is expected to be concluded in Dec, 2018 in stage 2.

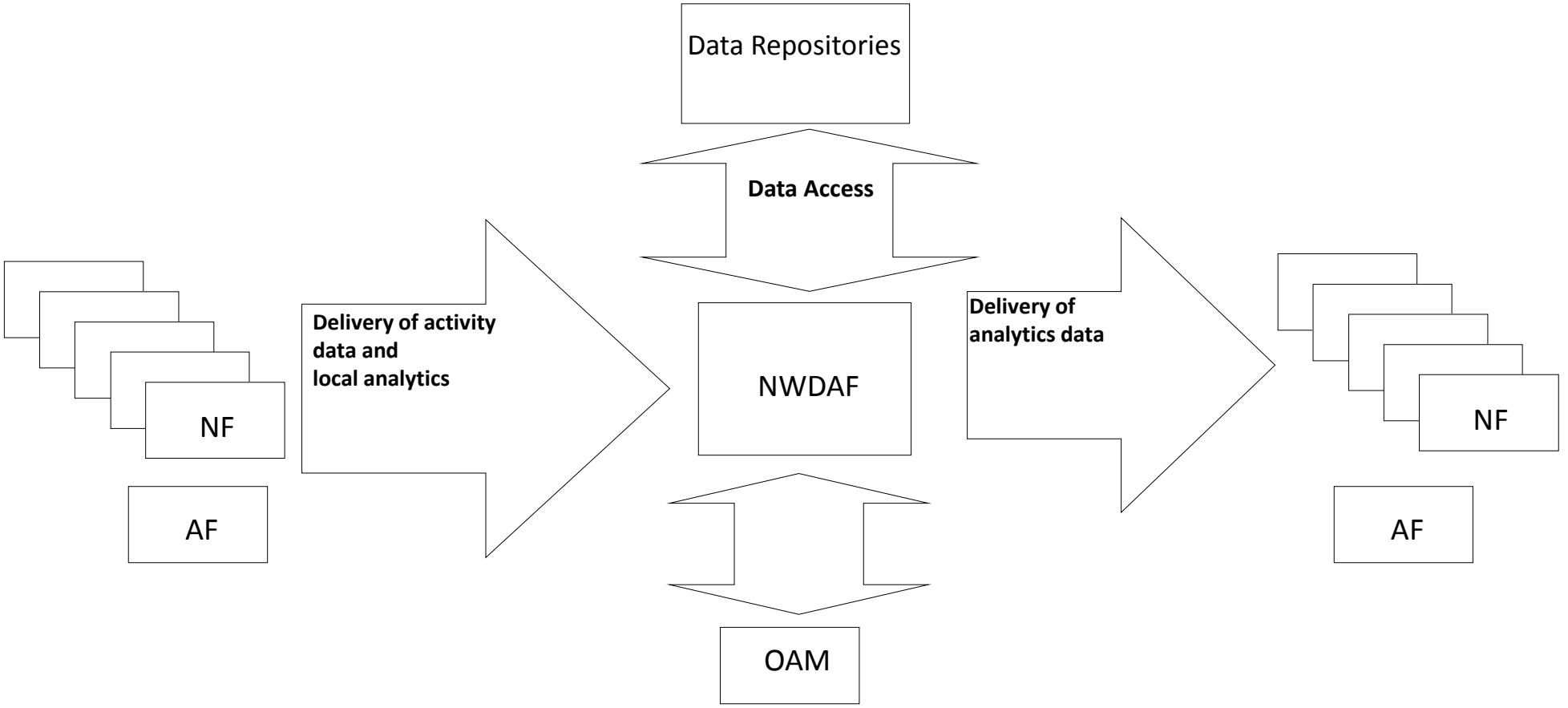


- Target date Stage 1: December 2018
- Target date Stage 2: June 2019
- Target date Stage 3: December 2019
- Target date ASN.1 freeze: March 2020

Supporting IM Name
Huawei
China Telecom
China Mobile
China Unicom
AT&T
CATT
Telecom Italia
KDDI
CATR
NEC
British Telecom
Telenor
Alibaba
InterDigital Inc
Lenovo
ZTE
Verizon UK Ltd
Oracle
Intel
Deutsche Telekom
Openet
Convida Wireless
ATR
Motorola Mobility
TeliaSonera
Ericsson
Orange
Sprint
NTT DoCoMo
ETRI

Current Status of Release 16 FS_eNA (Cont.)

- At the moment, the general framework is depicted as follows:



Key Issues in FS_eNA Until SA2#128

Number	*Title*	*Description*
1	Analytic Information Exposure to 5GS NF	Framework + Architecture
2	Analytic Information Exposure to AF	Framework + Architecture
3	Interactions with 5GS NFs/AFs for Data Collection	Framework + Architecture
4	Interactions with OAM for Data Collection and Data Analytics Exposure	Framework + Architecture (resource adjustment)
5	NWDAF-Assisted QoS Profile Provisioning	user service experience
6	NWDAF assisting traffic routing	UP selection, MEC related
7	NWDAF assisting Future Background Data Transfer	Vertical requirement from Japan
8	Performance improvement and supervision of mIoT terminals	mIoT terminals monitoring
9	Customizing mobility management based on NWDAF output	mobility management
10	NWDAF service support to select NF instances	NF instance selection
11	NWDAF-Assisted predictable network performance	Network Performance prediction
12	Support of Northbound Network Status Exposure	Network status exposure
13	UE driven analytics	UE data collection and analysis

Content

1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) **How to better guarantee end user service experience**
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

Service MOS Model Training

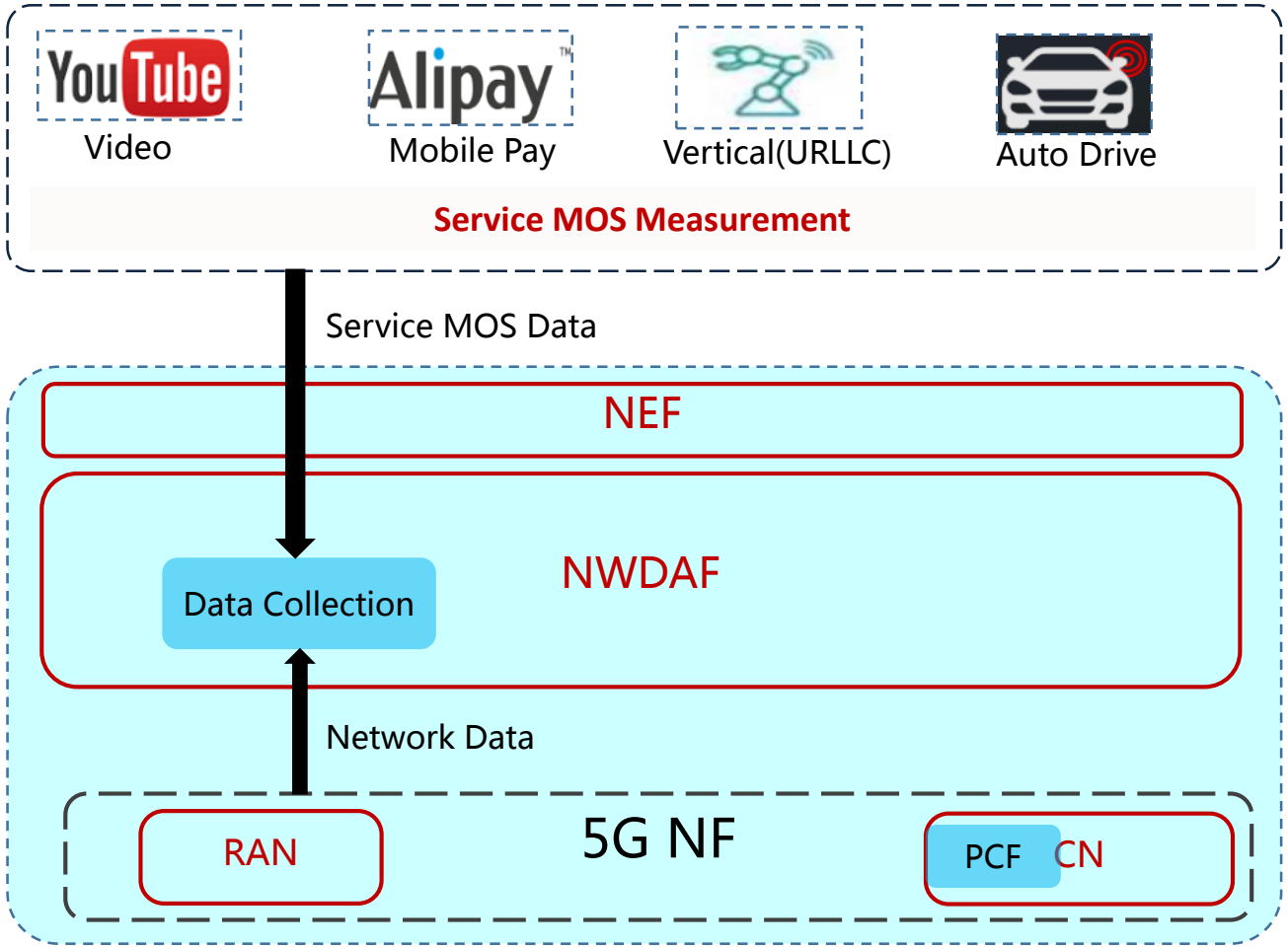


Table 1: Service Data from Tenant i.e. Service MOS Data

Information	Presence	Source	Description
Correlation ID	M	AF	To correlate the service data from AF and the network data from 5GC NF for the service
Application ID	M	AF	To identify the service and support analytics per type of service (the desired level of service)
Service MOS	M	AF	E.g. Service MOS, MOS, to characterize the experience for the service.

Table 2: Network data from 5GS

Information	Description
Correlation ID	To correlate the service data and the network data for the service
Application ID	To identify the application service provider for the QoS flow
QFI	To identify the QoS flow
QoS flow Bit Rate	To determine the QoS parameter: GFBR
QoS flow Packet Delay	To determine the QoS parameter: PDB
……	……
……	……
QoS flow Packet Error Rate	To determine the QoS parameter: PER

Service MOS Model Training

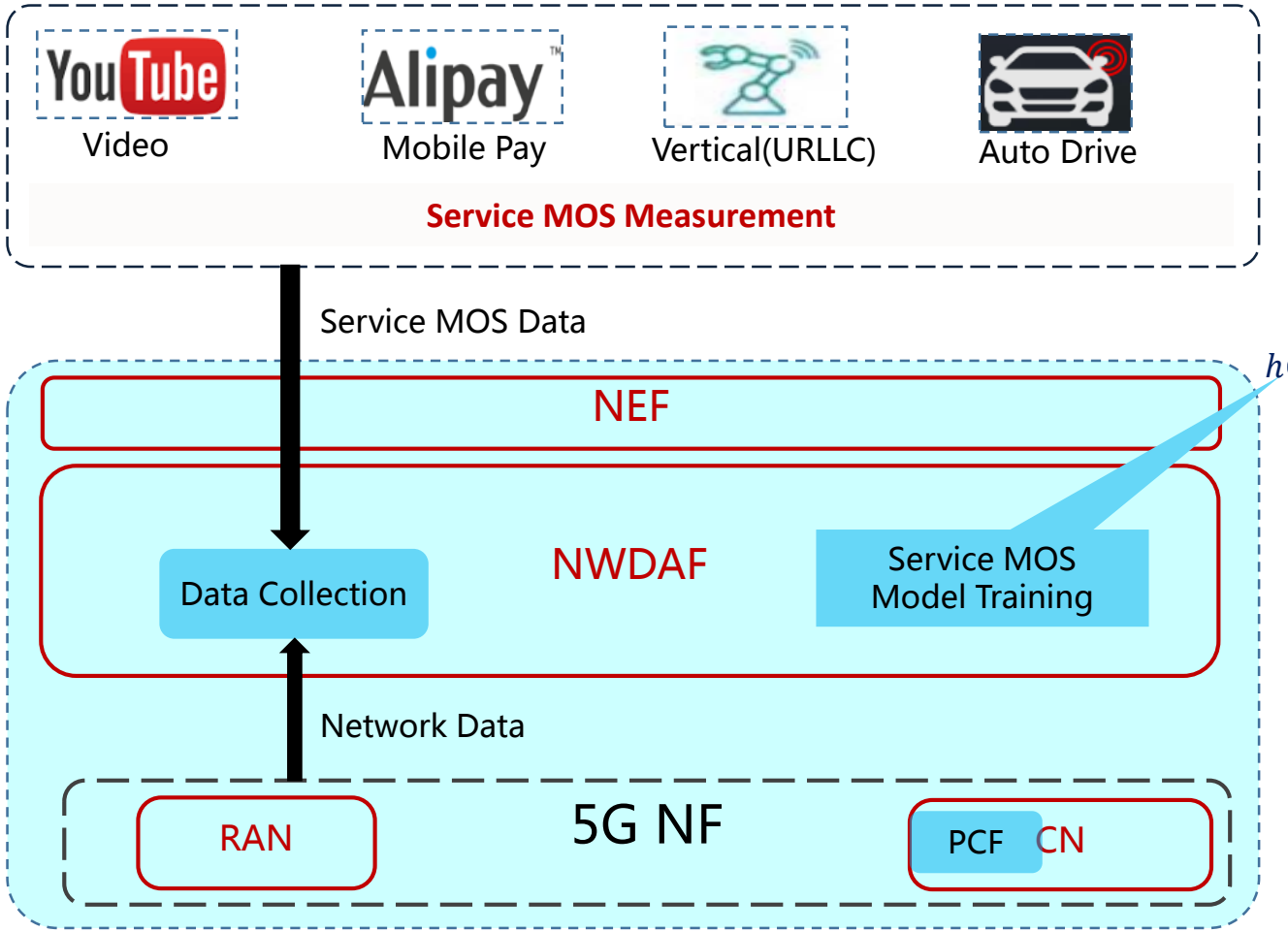


Table 1: Service Data from Tenant i.e. Service MOS Data

Information	Presence	Source	Description
Correlation ID	M	AF	To correlate the service data from AF and the network data from 5GC NF for the service
Application ID	M	AF	To identify the service and support analytics per type of service (the desired level of service)
Service MOS	M	AF	E.g. Service MOS, MOS, to characterize the experience for the service.

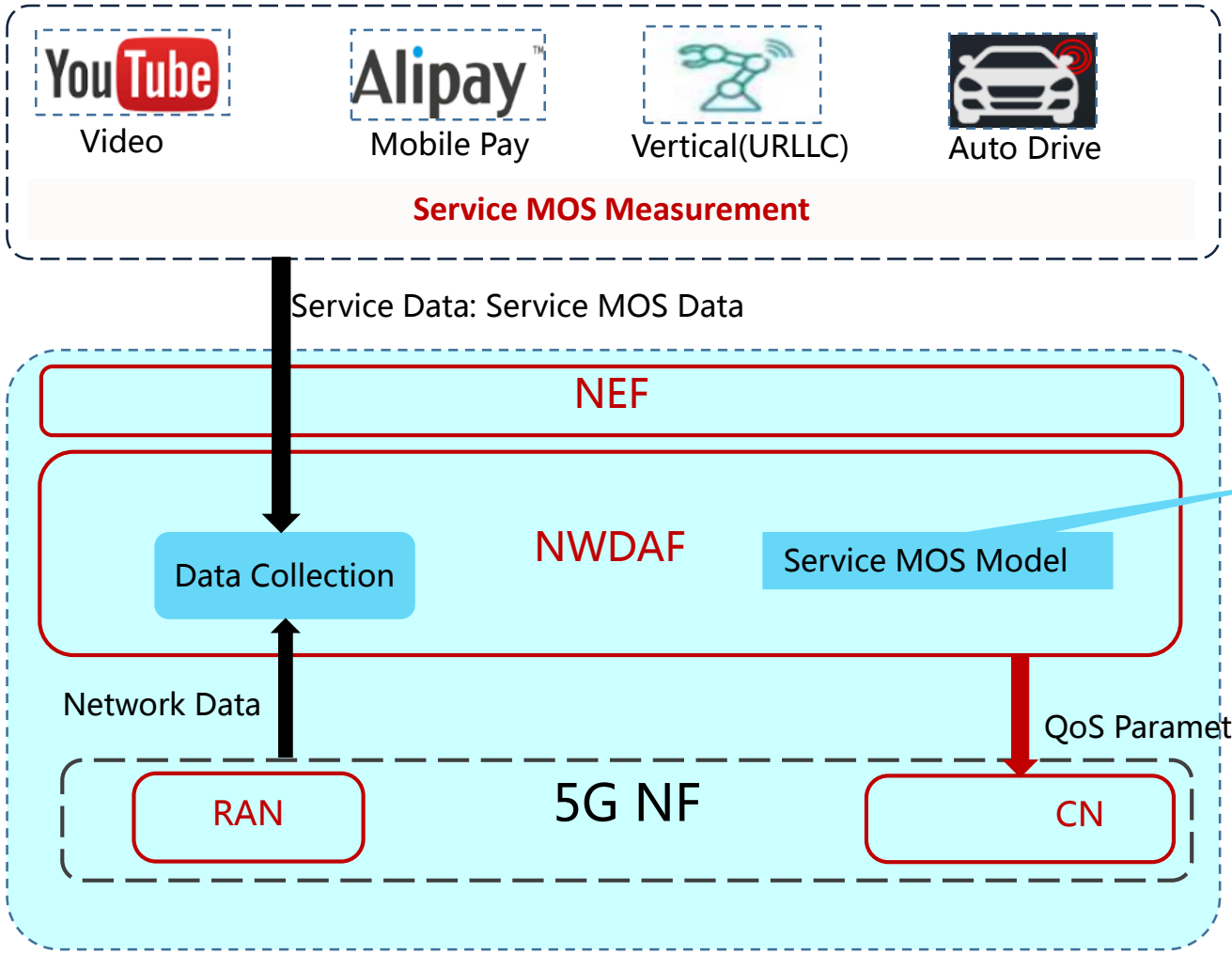
$$h(x) = w_0x_0 + w_1x_1 + w_2x_2 + w_3x_3 + w_4x_4 + w_5x_5 \ldots + w_Dx_D \quad (1)$$

Table 2: Network data from 5GS

Information	Description
Correlation ID	To correlate the service data and the network data for the service
Application ID	To identify the application service provider for the QoS flow
QFI	To identify the QoS flow
QoS flow Bit Rate	To determine the QoS parameter: GFBR
QoS flow Packet Delay	To determine the QoS parameter: PDB
……	……
……	……
QoS flow Packet Error Rate	To determine the QoS parameter: PER

Standardize how to collect service data and network data from Tenant and 5G respectively

QoS Profile Derivation



- Based on the trained Service MOS Model and the tenant service experience requirement (e.g. service MOS ≥ 3.0), a set of QoS parameters combination(s) could be found so that 5GS (e.g. PCF) can determine a suitable QoS parameters combination.

$$h(\mathrm{x}) = w_0 x_0 + w_1 x_1 + w_2 x_2 + w_3 x_3 + \cdots + w_D x_D \quad (1)$$

$$h(\mathrm{x}) \geq 3.0, \quad (2)$$

GFBR_1	PDB_1	PER_1	…
GFBR_2	PDB_2	PER_2	…
…	…	…	…
GFBR_P	PDB_P	PER_P	…

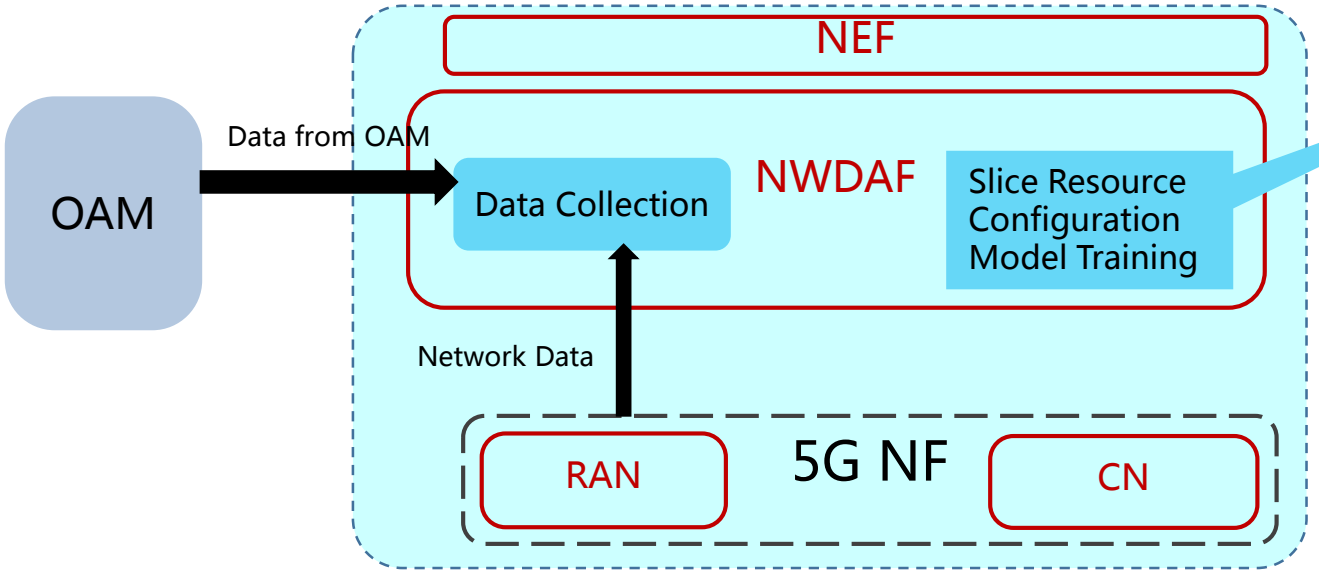
Content

1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

Network Slice Resource Model Training (to be discussed in SA2)

Table 3: Network Slice KPIs as defined in SA5

Information	Source	Description
Mean or Maximum number of Registered Subscribers for AMF	AMF	TS 28.553
Mean or Maximum number of PDU Sessions for SMF	SMF	TS 28.553
Registered Subscribers of network and network Slice Instance	5GS	TS 28.554
Registration success rate of one single network slice instance	5GS	TS 28.554
Upstream or Downstream Throughput for Network and Network Slice	5GS	TS 28.554

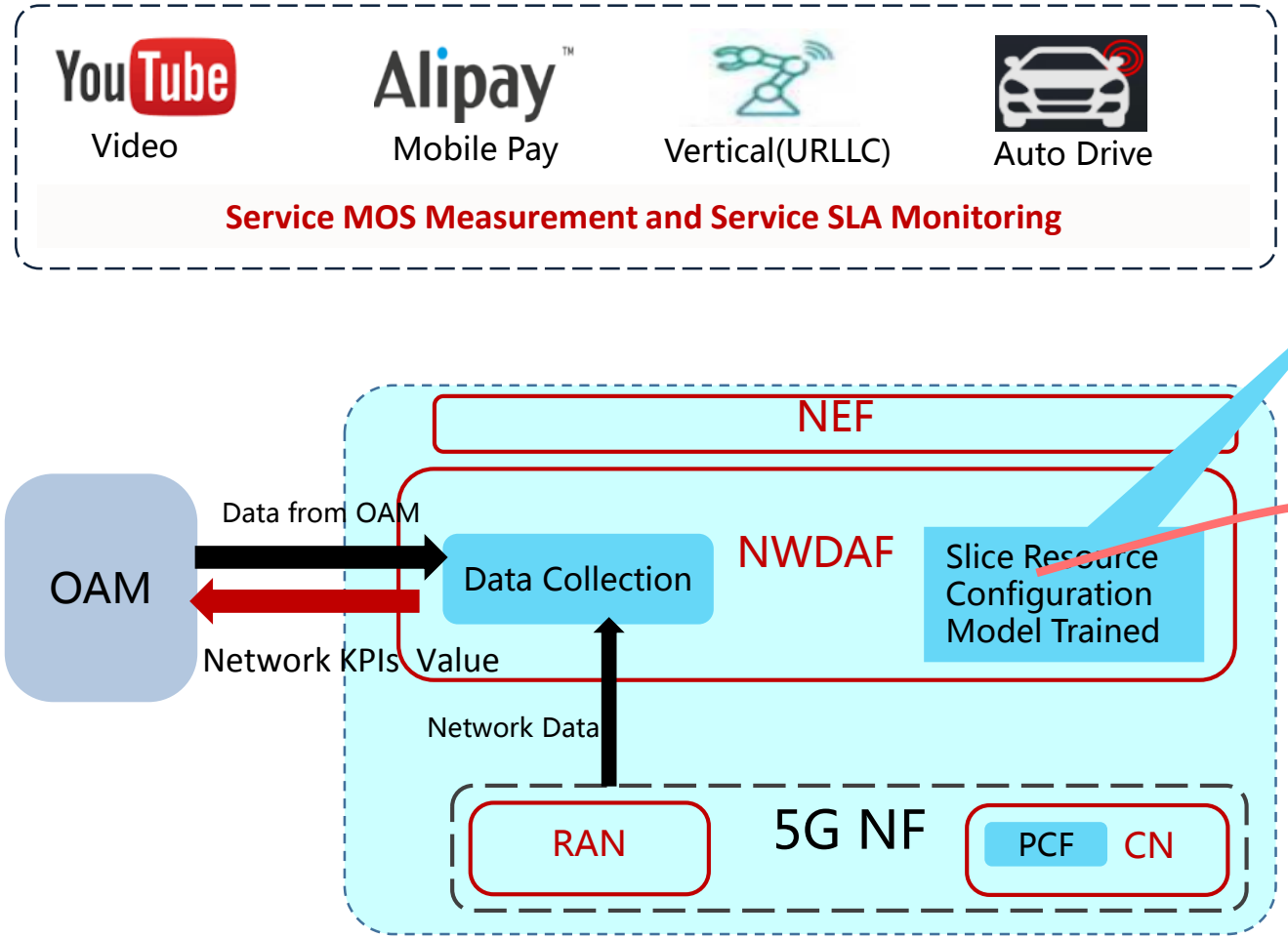


$$h_i(x) = w_{i0}x_0 + w_{i1}x_1 + w_{i2}x_2 + w_{i3}x_3 + \cdots + w_{iD}x_D$$

Table 4: How many percent UEs' service experience satisfy by NWDAF

Information	Presence	Source	Description
S-NSSAI	M	AMF	To identify the slice instance and support analytics per slice instance
Application ID	M	AF/PCF	To identify the service and support analytics per type of service e.g. voice or video
How many percent UEs' service experience satisfy	M	NWDAF	To indicate how many percent UEs' service experience is satisfied (**observed/measured by NWDAF**) , e.g. 60% UE's service experience is satisfied for voice service

Network Slice Resource Adjustment



- Based on the trained Slice Resource Configuration Model and the Tenant service experience requirement (e.g. $h(x) \geq 95\%$), NWDAF derives a set of Network Slice KPIs combination, which are provided to OAM.

$h_1(x) = w_{10}x_0 + w_{11}x_1 + w_{12}x_2 + w_{13}x_3 + \cdots + w_{1D}x_D$ *(1)*

$h_2(x) = w_{20}x_0 + w_{21}x_1 + w_{22}x_2 + w_{23}x_3 + \cdots + w_{2D}x_D$ *(2)*

Slice A

$h_3(x) = w_{30}x_0 + w_{31}x_1 + w_{32}x_2 + w_{33}x_3 + \cdots + w_{3D}x_D$ *(3)*

$h_4(x) = w_{40}x_0 + w_{41}x_1 + w_{42}x_2 + w_{43}x_3 + \cdots + w_{4D}x_D$ *(4)*

Slice B

$h_1(x) \geq 85\%$ *(1)*

$h_2(x) \geq 92\%$ *(2)*

Tenant Requirement for Slice A

$h_3(x) \geq 87\%$ *(3)*

$h_4(x) \geq 80\%$ *(4)*

Tenant Requirement for Slice B

x1_1	x2_1	x3_1	...	xD_1
x1_2	x2_2	x3_2	...	xD_2
...	...	...	...	...
x1_P	x2_P	x3_P	...	xD_P

Content

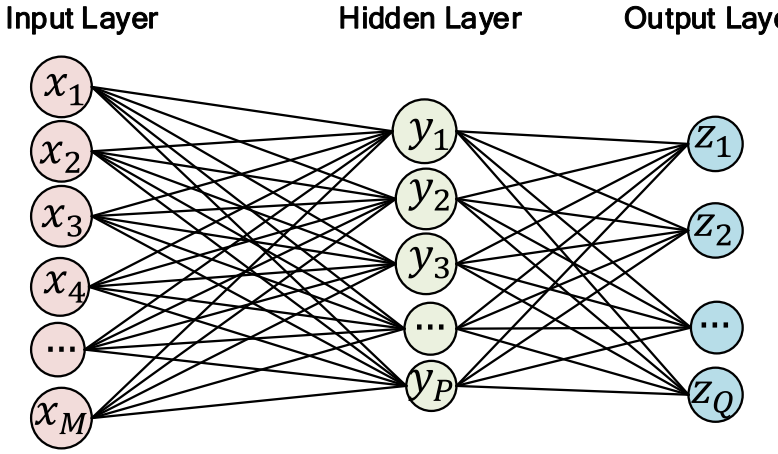
1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) **Performance Improvement and Supervision of mIoT Terminals**
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

Performance Improvement and Supervision of mIoT Terminals

- In some vertical industries, for a specific group, the service behaviors, data traffic (frequency, size) and moving areas probably have obvious regularity.
  - The business models for 5G mIoT are diversified, and the behaviors of mIoT terminals may vary a lot for different use cases, thus requirements for quality of service and power saving are different.

- The IOT terminals with massive number of users may be misused or hijacked, which may result in security issue and may need special mechanisms for monitoring and supervision.

Performance Improvement and Supervision of mIoT Terminals (Cont.)



- With information in Table 1, NWDAF perform data analysis e.g. using a 3-layer Deep Neural Network to cluster the heterogeneous UEs into multiple UE group(s), where each UE group has the same expected UE behavioral information as defined in Table 2.
- 3-layer Deep Neural Network
  - **Input Layer:** UE behavioral information per UE
  - **Output Layer:** expected UE behavioral information per UE group
- The NWDAF provides the expected UE behavioral information to UDM (Unified Data Management) to help supervision of mIoT terminals.

Table 1: UE behavioral information collected from 5GC NF(s)

Information	*Presence*	*Source*	*Description*
UE ID	M	AMF/SMF	Could be e.g. SUPI, which is used by NWDAF to correlate the UE behavioural information from different 5GC NFs.
Location info			
>Timestamp	O	AMF	The timing for the UE
>Location	O	AMF	The location info for the UE e.g. Cell ID or TA ID
Communication Pattern Info			
>Communication start time	O	SMF	Start time when the UE is available for communication
>Communication end time	O	SMF	End time when the UE is unavailable for communication
Network Configuration Info			
>UL or DL Packet Latency	O	SMF	Indicating the delay for uplink or downlink packets transfers for the UE

Table 2: Expected UE behavioural information for a UE group

Information	*Presence*	*Description*
Stationary indication	O	Identifies whether the UE is stationary or mobile, e.g. only on demand. [TS 23.682, clause 5.10.1]
UE Moving Trajectory	O	Identifies the UE's expected geographical movement [TS 23.502, clause 4.15.6], Example: A planned path of movement
Periodic communication indicator	O	Identifies whether the UE communicates periodically or not, e.g. only on demand. [TS 23.682, clause 5.10.1]
Communication duration time	O	Duration interval time of periodic communication [may be used together with 1)] [TS 23.682, clause 5.10.1], Example: 5 minutes
Periodic time	O	Interval Time of periodic communication [may be used together with 1)] [TS 23.682, clause 5.10.1], Example: every hour
Scheduled communication time	O	Time zone and Day of the week when the UE is available for communication [TS 23.682, clause 5.10.1], Example: Time: 13:00-20:00, Day: Monday
Maximum Latency	O	Indicating maximum delay acceptable for downlink data transfers [TS 23.682, clause 4.5.21]
Maximum Response Time	O	Indicating the time for which the UE stays reachable to allow the AF to reliably deliver the required downlink data [TS 23.682, clause 4.5.21]
Suggested Number of Downlink Packets	O	Indicating the number of packets that the UPF shall buffer in case the UE is not reachable [TS 23.682, clause 4.5.21]

Content

1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

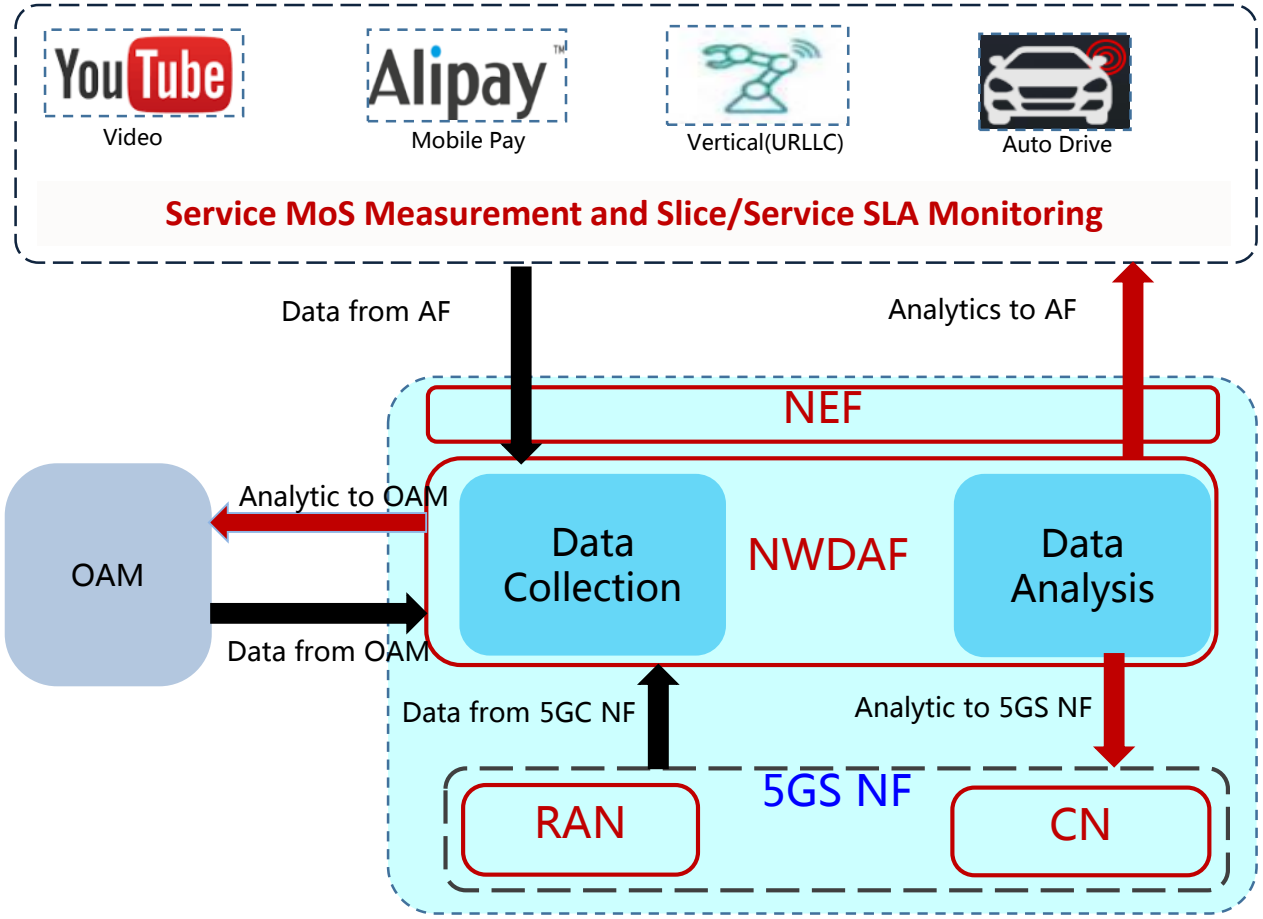
Customizing Mobility Management

- 5G registration area will be similar to 4G tracking area. The registration area list is maintained in both UE and AMF, and 5G RAN still needs to broadcast registration area code to UE.
- As indicated in clause 5.3.4.2, TS 23.501, Mobility Pattern is a concept that may be used by the AMF to characterise and optimise the UE mobility.
- Without NWDAF, it will be very difficult to track and categorize UE's mobility pattern. Based on the agreed MM framework and NWDAF framework in 5GS-Ph1, it looks beneficial leverage NWDA to:
  - Mine the collected network information to precisely predict UE's mobility pattern and the associated UE track e.g. gNB list or cell list per time of day.
  - and then feedback the above data analytics to network, allowing AMF to page the UE via e.g. gNB list or cell list and therefore bring down the paging load in gNB and saving corresponding processing resource in gNB.

Content

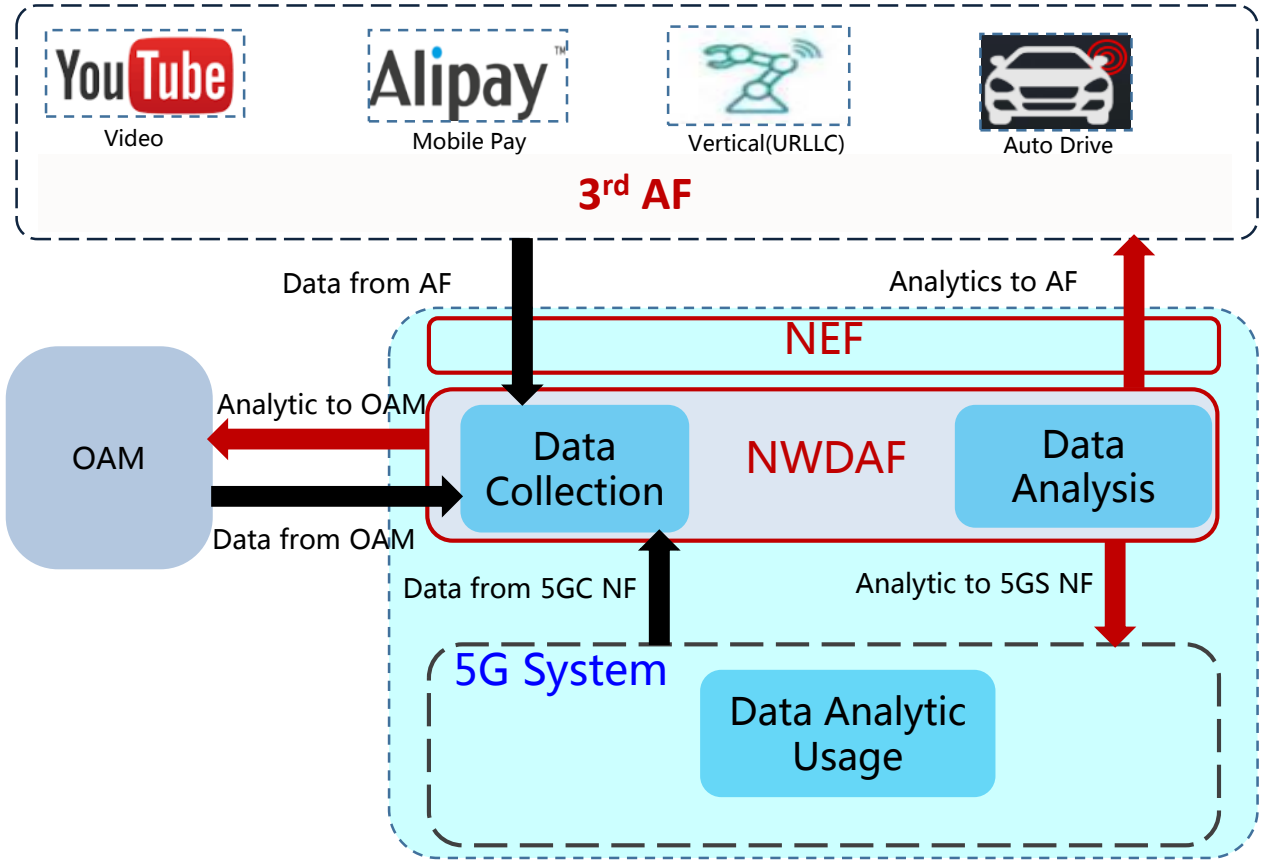
1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. **Challenge in 3GPP SA2**
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. Summary

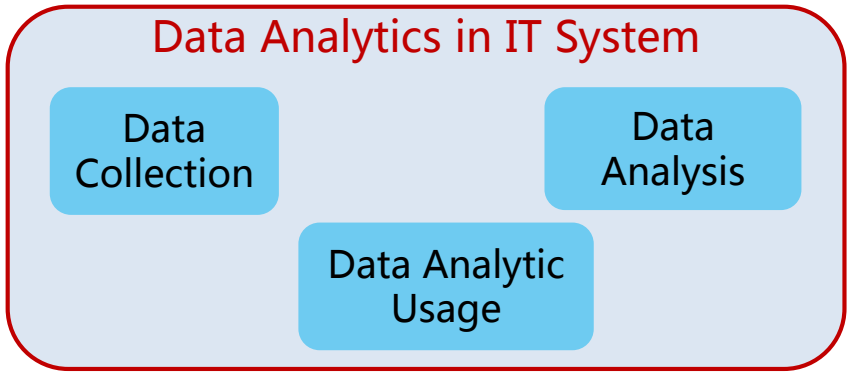
4.1 General-purpose 5G architecture



- As specified in TR 23.791, the NWDAF is to serve multiple use cases e.g. QoS profile provisioning, traffic steering, mIoT security.
- It is important to study how to define a general-purpose data driven architecture
  - ❑ Data Collection
  - ❑ Data Analytics Feedback

4.2 Comparison of Data Analytics between 5G System and IT System





- Data Analytics in 5G System: **Distributed**
  - standardize how to collect data, which is use case driven
  - Standardize how to provide data analytics to e.g. 5GS and OAM
- Data Analytics in IT system: **Centralized**
  - Data Collection, Data Analysis and Analytics Usage are probably performed within one logical system.

Content

1. 3GPP Structure
2. Status of Data Analytics in 5G in Release 15
3. Current Status of Release 16 FS_eNA
   1) How to better guarantee end user service experience
   2) How to accurately configure/adjust slice resource
   3) Performance Improvement and Supervision of mIoT Terminals
   4) Customizing Mobility Management
4. Challenge in 3GPP SA2
   1) General-purpose 5G architecture
   2) Comparison of Data Analytics between 5G System and IT System
5. **Summary**

Summary

- Network Data Analytics Function (NWDAF) has been introduced in 5G phase1, which is mainly for network slice level data analytics
- Further study in 5G phase2 (i.e. R16) kicked off in 3GPP SA2 and is expected to be concluded in Dec, 2018 , which could involve 3GPP RAN3/SA5
- Close cooperation with 3rd party/vertical and other SDOs/Organizations is needed, especially in terms of use cases and general-purpose data driven architecture.

Thank You!

Use Cases in FS_eNA Until SA2#128

Number	*Title*
1	How to get service data from AF
2	QoS profile provisioning
3	Traffic handling e.g. UPF path selection
4	Mobility enhancement
5	Background data transfer
6	QoS profile adjustment
7	MEC enhancement via big data
8	Performance improvement and supervision of mIoT
9	Determination of areas with oscillation of network conditions
10	Predictable network performance
11	Load balancing/rebalancing of network functions
12	Prevention of various security attacks
13	UE driven analytics sharing