

The Discussion on AI/ML enhancements

China Mobile

Motivation

- The convergence of communication networks and AI technology already made some progress. Up to now, the SA2 has studied and/or specified the AI-enabled network architecture and leveraged Artificial Intelligence (AI)/Machine Learning (ML) to enable 5GC in terms of data collection, ML model training, analytics inference, and closed-loop procedures by consuming data analytics, etc.
- Based on the above, the work of AI/ML for 5GS in Rel-19 is proposed to expand the scope of network AI services to leverage AI/ML technologies to enable 5GC by providing network automation and improving the efficiency of 5G network architecture.
- In order to leverage AIML technologies to enable 5GC this study item is to focus on architecture enhancement to support 5G Core intelligence.

Leveraging AI Technologies example---

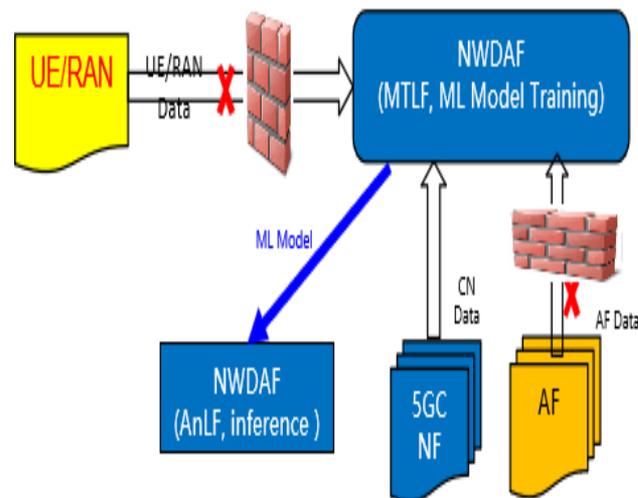
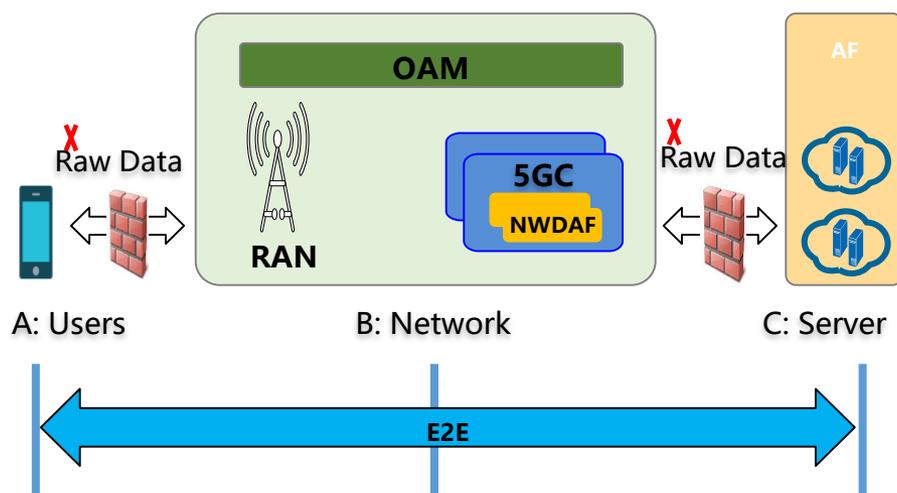
Vertical Federal Learning

Issues and requirement:

- Data analytics in 5G network usually needs data collection from different domains, but each domains (e.g. CN/AF) may be isolated.
- Each domain have many private implementations and is not willing to report their data related to the private implementations.

Potential enhancement:

- Network architecture enhancement to support vertical federated learning, allowing different domains to exchange necessary intermediate information to assist E2E data analysis without exposing RAW data.



AI enabled Use Cases example---

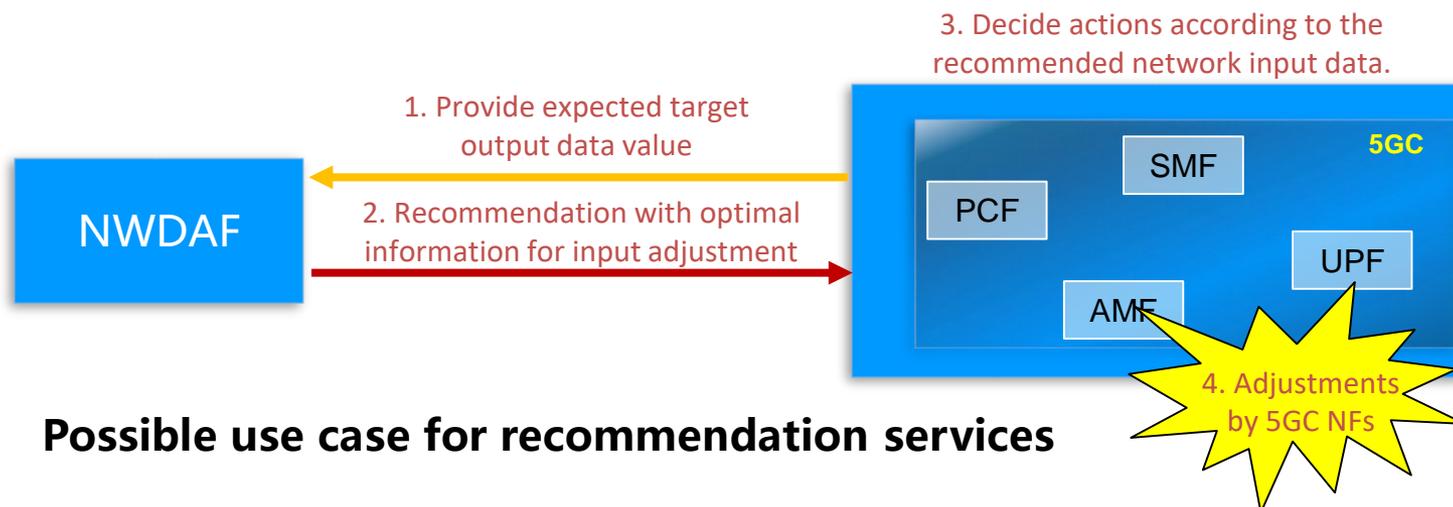
NWDAF assisted policy recommendation

□ Issues and requirement:

- PCF uses static configuration for QoS decisions, which cannot adapt to the diversity of multi-services and personalized policies.
- The network needs to be aware of resource status in time and adjust QoS policies dynamically.

□ Potential enhancement:

- Study whether and how to provide global optimal recommendation to 5GC NFs. For example, based on the analysis of network status, service experience requirements, etc, NWDAF could make policy decisions and adjusts user QoS parameters in time.



Possible use case for recommendation services

AI enabled Use Cases example---

Detection/prevention/mitigation of signaling storm

□ Issues and requirement:

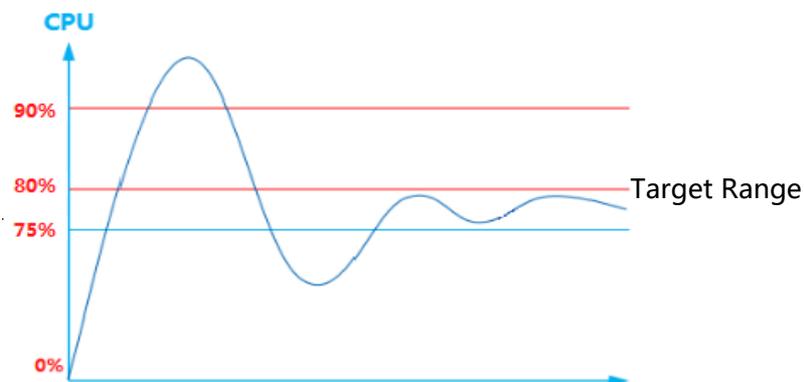
- The system needs to be more intelligent, proactively, dynamically and globally to prevent and mitigate from signalling storm or network abnormal behavior, such as adjust flow control parameters or back-off timer for NFs based on NF loads and failure rates of different interfaces.

□ Potential enhancement:

- Study whether and how to detect or measure signalling storm with the assistance of NWDAF.
- Study the mechanisms of prevention/mitigation for the signaling storm to guarantee the 5GS system stability with the assistance of NWDAF.
- Study whether and how NWDAF provides network level digital twin services to verify candidate actions provided by the 5GC NFs to avoid unexpected impacts on the network.

Signalling Storm Possible Reason

- **Terminals:** e.g., Large amount of UEs attach or connect at once or at a small area, when Holidays or Large-Scale Activities.
- **Public Network Attack or abnormal operation:** e.g., ToB application paging to all Business UEs.
- **CN failure:** e.g., NF restarts triggered UE reattach.



Signalling Storm Mitigation

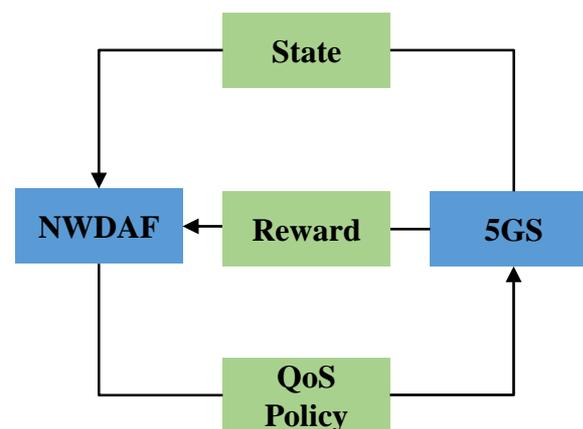
Leveraging AI Technologies example--- Reinforcement Learning

□ Issues and requirement:

- The network can not perceive whether NWDAF analytics data are gaining or losing to the network.
- Based on interactive environment, the optimal model could be generated.

□ Potential enhancement:

- Network architecture enhancement to support the mechanism of reinforcement learning.



AI enabled Use Cases example---

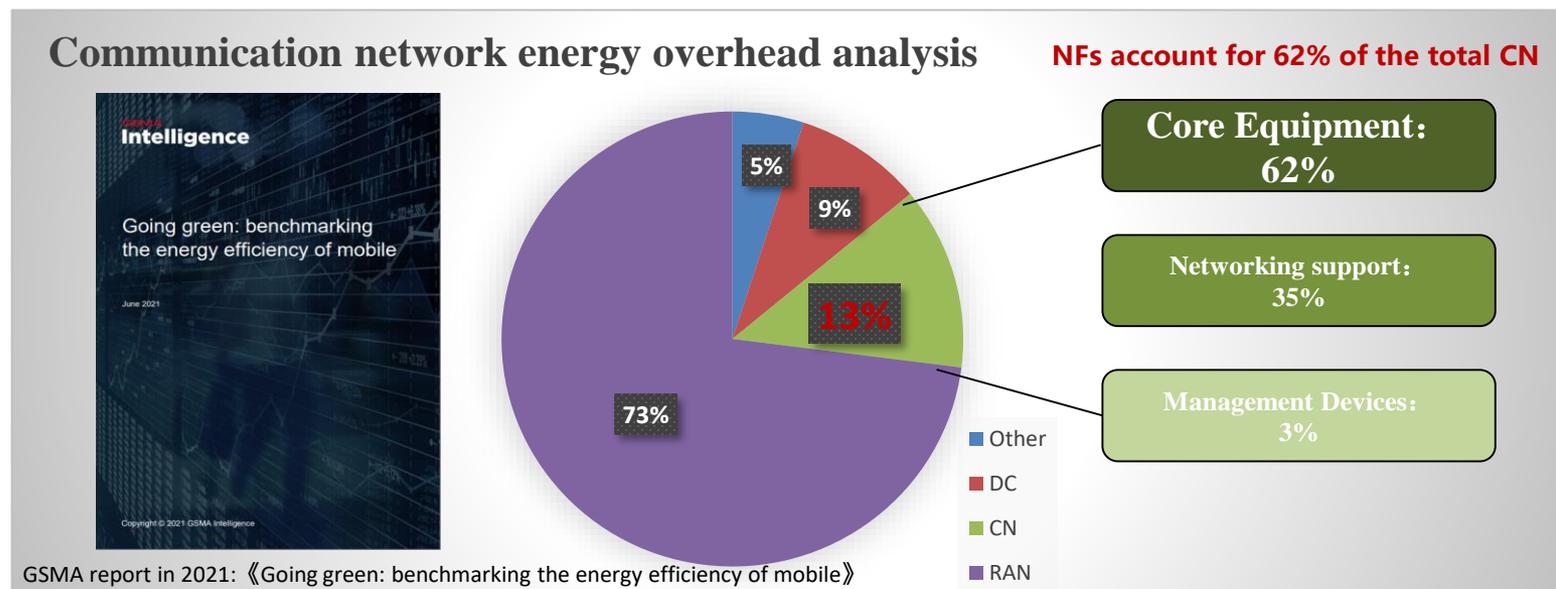
NWDAF assisted energy saving

□ Issues and requirement:

- Based on GSMA research and analysis on 31 operators, wireless network consumes the most energy (73%) followed by core network(13%).
- Energy saving solutions should be studied to reduce carbon emissions of core network, based on analytics data of user plane volume, PDU sessions(user) number, UE access control, etc.

□ Potential enhancement:

- Study whether and how to predict the capacity and load trend of NF(s) with the assistance of NWDAF.
- Study the NWDAF assisted solution for energy saving, e.g., load balancing or redistribution among multiple NF instances.



Leveraging AI Technologies example---

Online Learning

Issues and requirement:

- NWDAF based data collection and AI/ML training are offline. AI/ML models need to adapt to rapidly changing data in some use cases.
- E.g., NWDAF trains application detection ML model with UE/AF when the characteristics of the packet flows has changed frequently due to application update.

Potential enhancement:

- Network architecture enhancement to support online learning, able to quickly adjust the model in real-time based on online feedback data, enabling the model to reflect changes in a timely manner and improve the accuracy of prediction.

**Offline Learning
(Current)**

D features

	x_1	x_2	x_3	...	x_d	y
N samples	x_1	x_2	x_3	...	x_d	y
	x_1	x_2	x_3	...	x_d	y
	x_1	x_2	x_3	...	x_d	y
	x_1	x_2	x_3	...	x_d	y
	x_1	x_2	x_3	...	x_d	y

Batch training




**Online Learning
(Future)**

Time increases

Input data at time t

x_1	x_2	x_3	...	x_d	y
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Online update




Input data at time $t+1$

x_1	x_2	x_3	...	x_d	y
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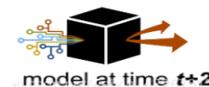
Online update




Input data at time $t+2$

x_1	x_2	x_3	...	x_d	y
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Online update

Proposed consolidated WTs in SA2

The proposed WTs are as follows:

- **WT#3.1:** Study how to provide global optimal recommendation to 5GC NFs.
- **WT#3.2:** Study the mechanisms of prevention/mitigation for the signaling storm to guarantee the 5GS system stability with the assistance of NWDAF.
- **WT#2:** Study the potential architecture enhancements to enable 5G system to assist Vertical Federated Learning (VFL) between 5GC/NWDAF and AF.

The additional proposed WTs are as follows:

- Study network architecture enhancement to support online learning.
- Study network architecture enhancement to support reinforcement learning.
- Study the NWDAF-assisted solution for energy saving, e.g., load balancing or redistribution among multiple NF instances.

Thanks!