Thoughts on potential IMT-2030 network architecture and key technologies

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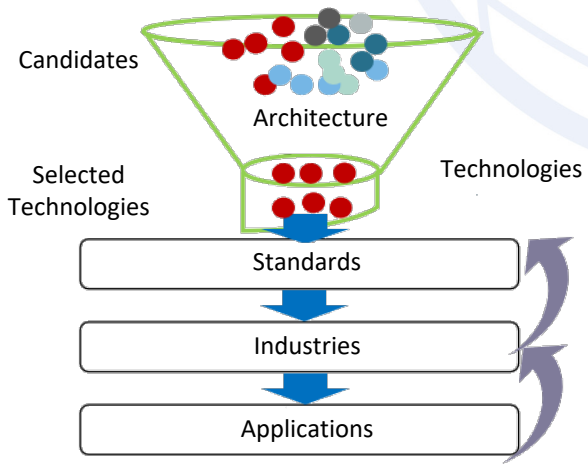
Architecture shapes the IMT-2030 network - Why architecture?

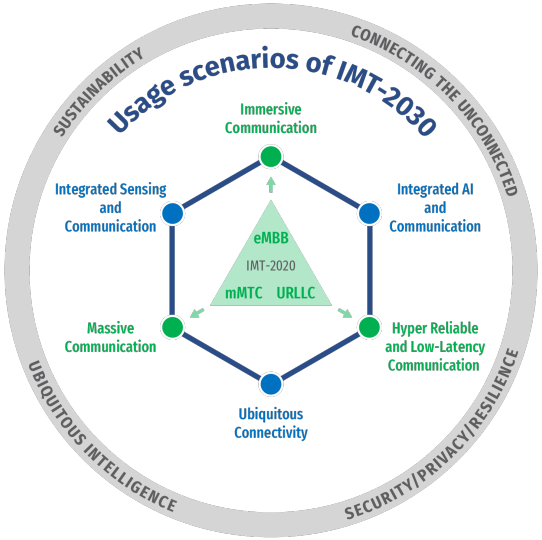
- Network architecture is vital for the inter-generational development of mobile communication networks. The foresight, feasibility, and compatibility of the architecture design significantly affect the evolution route map and application performance of the network, and therefore, must be considered in advance.



- The 6G capabilities will be systematic rather than isolated. The architecture design of the 6G network should consider new scenarios and demands, as well as the development trend and integration potential of new technologies.
- It should also draw from the experience of the 5G network and the direction of 5G-A technology evolution to enhance the existing capabilities and introduce new ones, enabling immersive communication, hRLLC, ubiquitous connectivity, integrated sensing and AI, and more.

Architecture shapes the IMT-2030 network - Drives

- **Scenarios and Demands**
- Business demands are the first drive for the development of each network generation. In the IMT-2030 framework recommendation, 6 usage scenarios have been named.



- **New Technologies**
- DOICT (Data, Operation, Information, and Communication Technology), including but not limited to AI-native networks, CNC, FMSC, and energy-saving technologies.
- Facing 2030, it is necessary to promote the development and integration of DOICT and 6G network architecture.

- **Experience of 5G/5G-A**
- The 5G architecture has proven its success and the need for innovative changes. However, there are still problems left for 6G.
- The evolution of networks in the past shows that features introduced in the later stages of a generation usually become important components of the next. 5G-A will pave the way for the 6G architecture.

Architecture shapes the IMT-2030 network - Design Considerations

- **Inheritance.** Rather than a thorough renovation, 6G architecture should be a smooth innovation inheriting features such as Cloud/SBA/open protocol from 5G.
- **Decommissioning.** The decommissioning of 2/3G provides an opportunity for 6G to address the issues left over from 5G.
- **Change.** To support new technologies such as FMSC, the 6G network requires specific local architectural changes and cross-domain, cross-layer management.
- **Integration.** 6G architecture should consider not only communication but also the integration of new capabilities, such as sensing and AI.
- **Extensibility.** 6G architecture should be more elastic to entensions to accommodate the rapid growth of network scale.
- **Security.** The highly distributed and open network raises trust issues. The security system of 6G should set zero trust as the baseline.
- **Simplicity.** To tackle the problem of network complexity, minimalist design principles should be adopted in the design of 6G architecture.
- **Easy-deployment.** 6G architecture should allow for more efficient and economical deployment.

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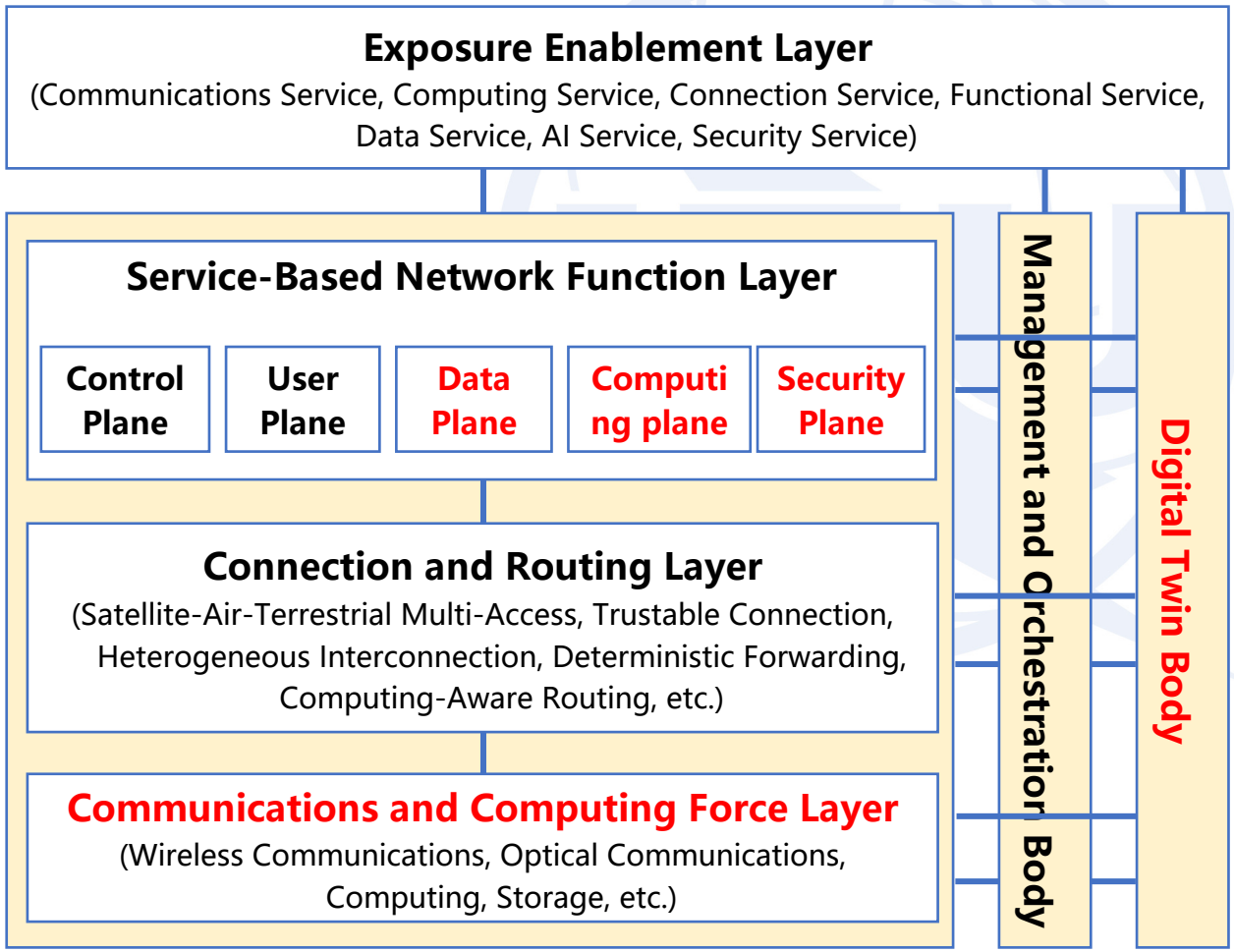
Overall design - 3 bodies, 4 layers, 5 planes

All-field and end-to-end **"3-Body, 4-Layer, 5-Plane"** IMT-2030 overall architecture design for implementing **platform and service-based networks**.



3 Bodies (Space View)

- ✓ Adding Digital Twin body to carry out the integration of virtuality and reality
- ✓ Reorganizing the management and orchestration body to fulfill intelligent network autonomy

4 Layers (Logic View)

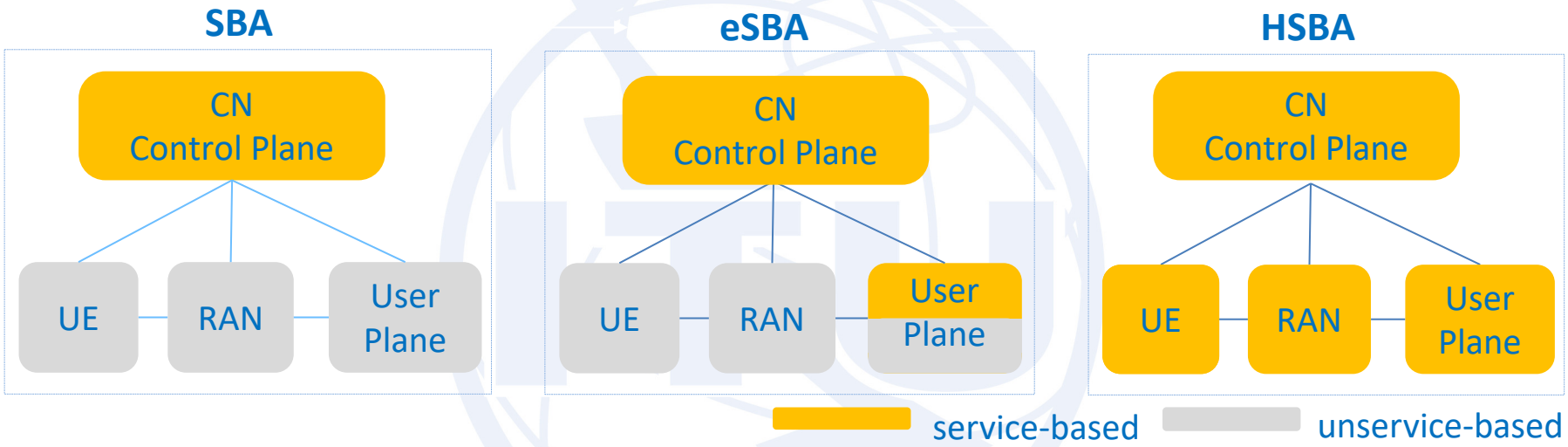
- ✓ Collaborative deployment of centralized and distributed network entities for the service-based network function layer
- ✓ Layered network functions for connecting all network fields

5 Planes (Function View)

- ✓ Enhancing traditional control and user planes
- ✓ Adding independent data plane, computing plane, and security plane

Logical function design - Holistic Service-based Architecture (HSBA)

HSBA is the further **deepening of service-based architecture** that can adapt to network distributed organization, service intelligent scheduling, and flexible deployment of vertical industry by enhancing service framework, service interface, atomic service, and other aspects.



Expand service area

- **RAN**：Cloud-based function decoupling
- **User Plane**：Faster and more direct data processing open
- **Management Orchestration**：Unified service management mechanism
- **Digital Twin**：Initial function decoupling

Optimize service mechanism

- **Explore further decoupling mechanism**

Service Mesh/Mecha is studied to achieve deeper loose coupling

- **Improve API call efficiency**

Introduct GraphQL technology to query the data stored in graph more efficiently

Add Service Element

- **Service-based computing plane and data plane**

Basic elements of intelligent services

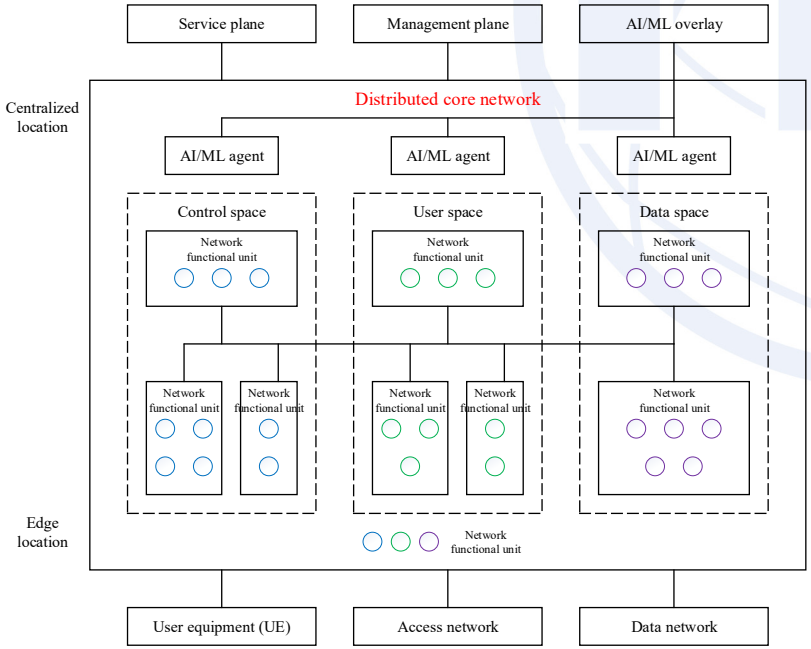
- **Architectural foundation of intelligent services**

Networking design - Distributed Autonomous Network (DAN)

To enable the IMT-2030 usage scenario "**Hyper Reliable and Low-Latency Communication**", the IMT-2030 network is required to support latency of 0.1-1 ms, high density connections, and various types of traffic, which require a **distributed and autonomous architecture**.

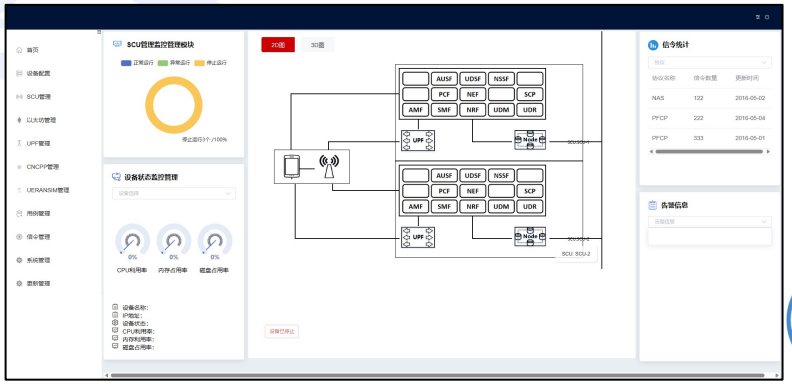
The DAN is the **networking design** of 6G network architecture, building on network functional units collaborating in a distributed manner to provide the network functions of control plane, user plane, and data plane.

ITU-T SG13 has established a set of **standards of distributed core network**. In IMT-2030, the topic needs to be further studied to align with the networking design of 6G architecture.



Distributed core network [Y.IMT2020-DCN]

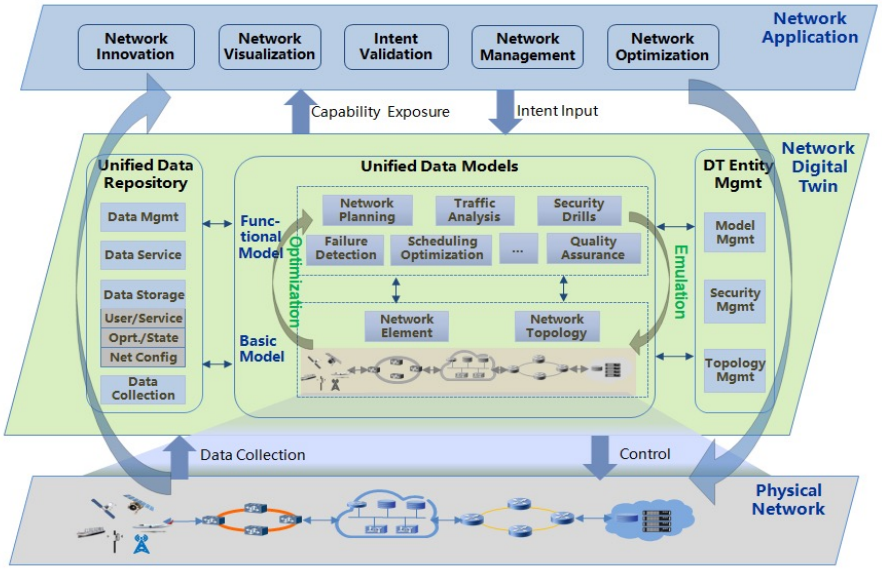
China Mobile has developed **Small Cloud Unit (SCU)** to constitute DAN, ensuring flexible deployment, plug-and-play, low latency, and high energy efficiency.



Twin design - Digital Twin Network (DTN)

One of the use cases for IMT-2030 is expected to replicate the physical world into a digital virtual world as precise real-time representations or digital twins. It's benefit for realizing **low-cost trial and error**, **intelligent decision making** and **efficient innovation of network**.

Digital twins have the potential to provide ubiquitous tools and knowledge platforms for the modelling, monitoring, managing, analysing and simulating of physical assets, resources, environments and situations.



Functional Requirements

- Efficient Data Collection
- Efficient and Unified Data Repository
- Unified Data Models for Network Applications
- Open and Standard Southbound and Northbound Interfaces
- Management

A reference Architecture and Requirements of DTN [Y.3090]

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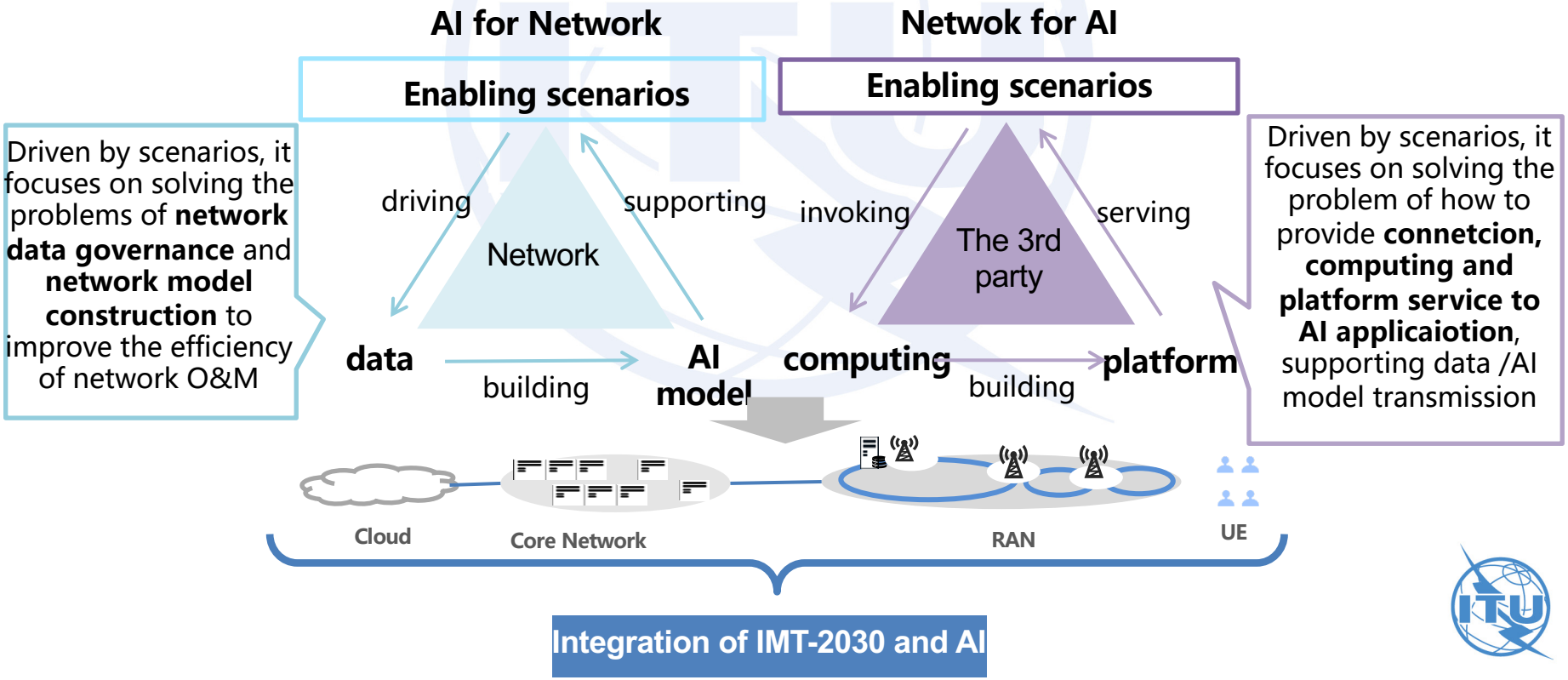
AI-native network

With the steady progress and fast spread of technologies in AI and particularly machine learning (ML), it is expected that intelligence would be present in every part of the communication system to support the building of smart cities and communities.

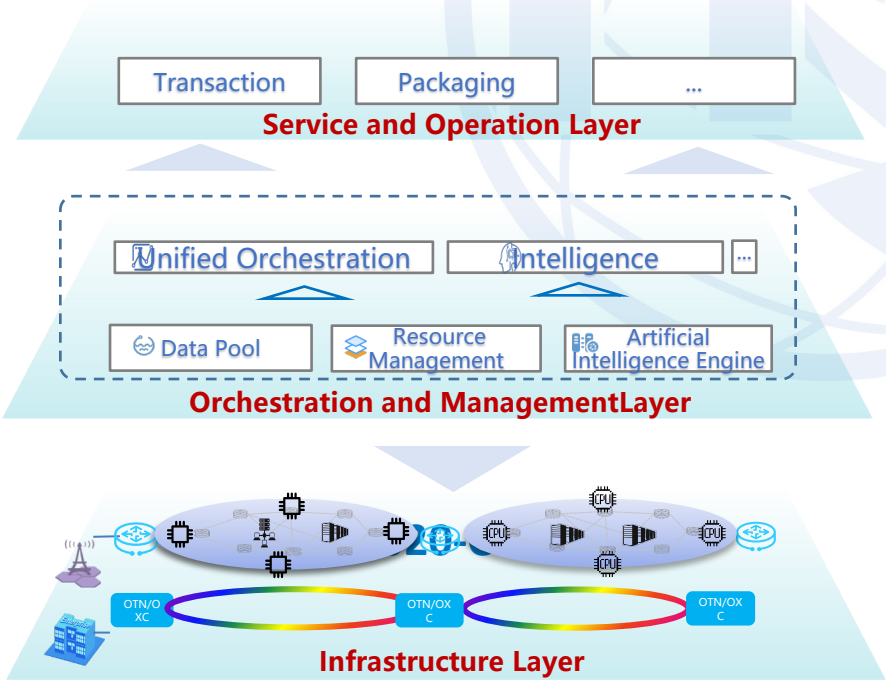
ITU-T SG13 has established a set of **standards of intelligent network** in the context of IMT-2020 and beyond. In IMT-2030, two closed loops need to be further studied, aiming to build a unified AI-native architecture, and enable the IMT-2030 usage scenario "**Integrated AI and Communication**".



Coordination of computing and networking (CNC)

By the application of the coordination of utilization, control and management of computing, storage, and networking resources for the purpose of provisioning and optimization, satisfaction of requirements of resources' users and improvement of resource utilization may be achieved. CNC is a promising technology to support the IMT-2030 user and appliction trend "**Ubiquitous Computing**" in the non-radio part.

ITU-T SG13 has stated **standardization work of CNC** in the context of IMT-2020 and beyond, focusing on requirements, framework, QoS, management. In IMT-2030, the topic needs to be further studied.



Key requirements of CNC

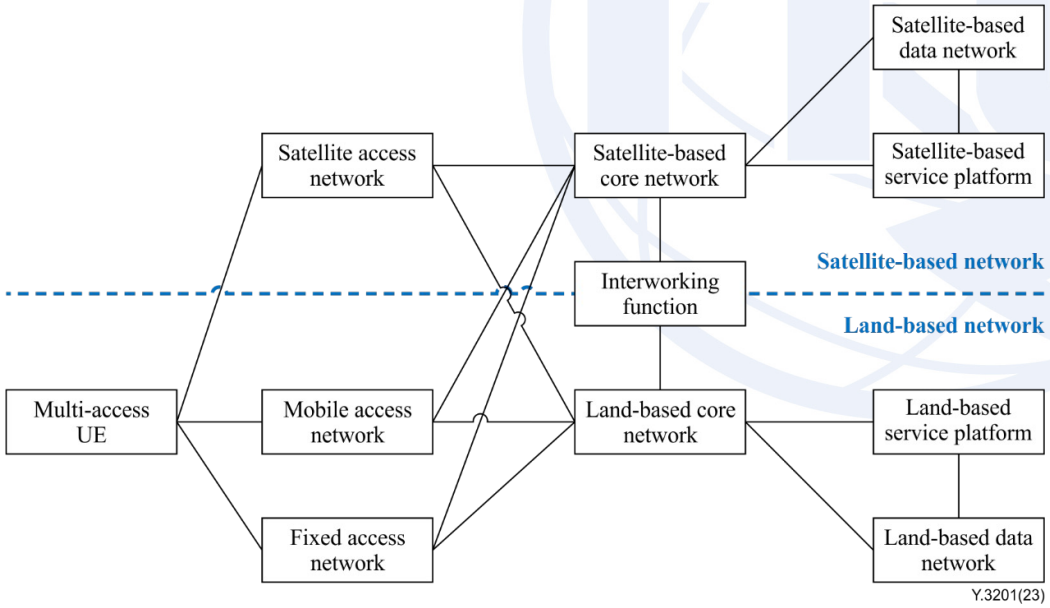
- ✓ Identification of resources
- ✓ Measurement of resources
- ✓ Awareness of resources
- ✓ Joint scheduling of resources
- ✓ Unified management and orchestration
- ✓ AI/ML integration
- ✓ Resource transaction
- ✓ Energy saving
- ✓ Qos assurance
- ✓ Fixed, mobile and satellite convergence
- ✓ Security and privacy

[Y.IMT2020-CNC-req]

Fixed, mobile and satellite convergence (FMSC)

The FMSC is the capability that provides services and applications to end users regardless of the fixed, mobile or satellite access technologies. FMSC is a promising technology to support the IMT-2030 usage scenario "**Ubiquitous Connectivity**" in the non-radio part.

ITU-T SG13 has established a set of **standards of FMSC** in the context of IMT-2020 and beyond, focusing on requirements, framework, network capabilities, enabling technologies, network function enhancements, and service enhancements. The topic needs to be further studied in IMT-2030.



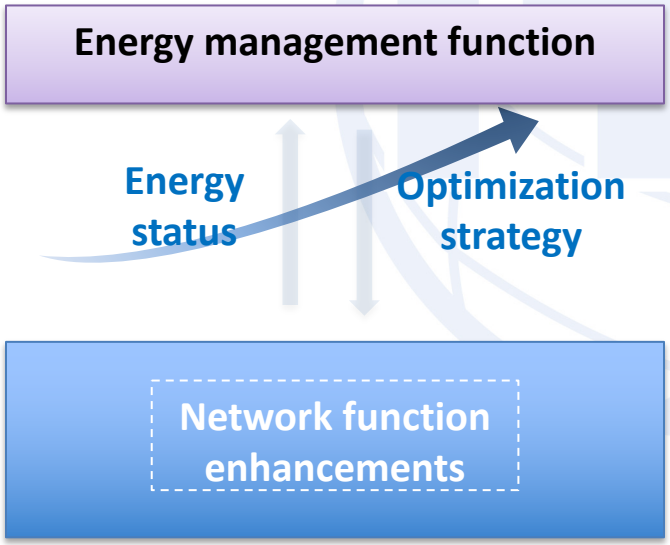
Overall framework of FMSC [Y.3201]

9 Key capabilities of FMSC

- ✓ Multi-access convergence
- ✓ Distributed networking
- ✓ Multi-connection management
- ✓ Converged mobility management
- ✓ Converged session management
- ✓ Converged policy control
- ✓ Converged capability exposure
- ✓ Service Continuity
- ✓ Network sharing

Energy-saving network

Climate change and globally energy shortage have made energy efficiency a strategic priority for telecoms operators. Energy-saving network supports to reduce energy use and improve energy efficieny while guaranting the network service quality. Energy-saving network is a promising technology to support the IMT-2030 capability "**Sustainability**" in the non-radio part.



Key aspects of Energy-saving network

- ✓ Network energy status collection
- ✓ Energy-aware network optimization and scheduling
- ✓ Energy-aware network management
- ✓ Network function enhancements
  - ✓ NACF, SMF, PCF, UPF, CEF, NFR, USM, NSSF, ASF, and AF
- ✓ Security and privacy

Looking forward to further cooperation on IMT-2030 network with all of you!