Problem Statement and Gap Analysis for Agent-enabled 6G Network

The Impact of AI Agent on Network Infrastructure

2025-07-24

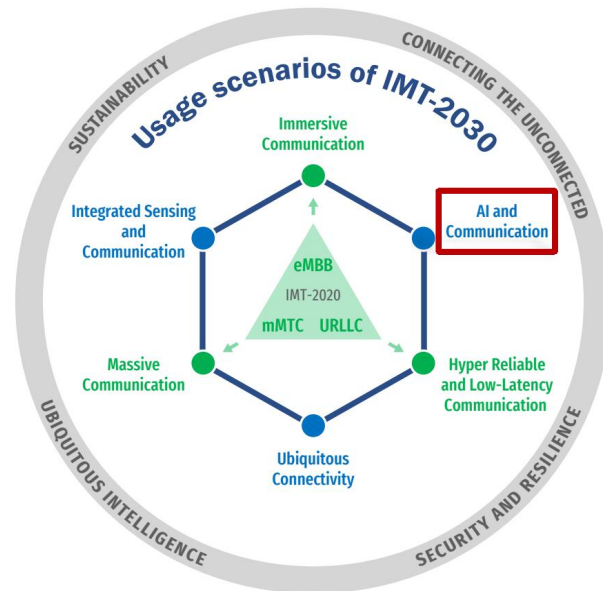ZHANG YAOMIN, ZHANG XUEBEI, YUE YI (CHINA UNICOM)

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What 6G Network Cares About

- What AI Agent is and potential relationship to 6G network

- Impact of AI Agent on 6G network

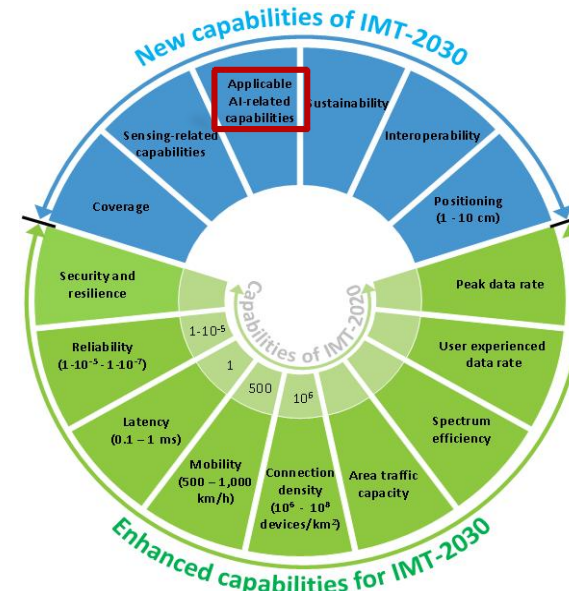- GAP analysis for AI Agent-enabled 6G network

AI & 6G

- The ITU published the proposal for 6G framework and overall objectives, clarifying that integrated AI and Communication to support distributed computing and AI-powered applications.
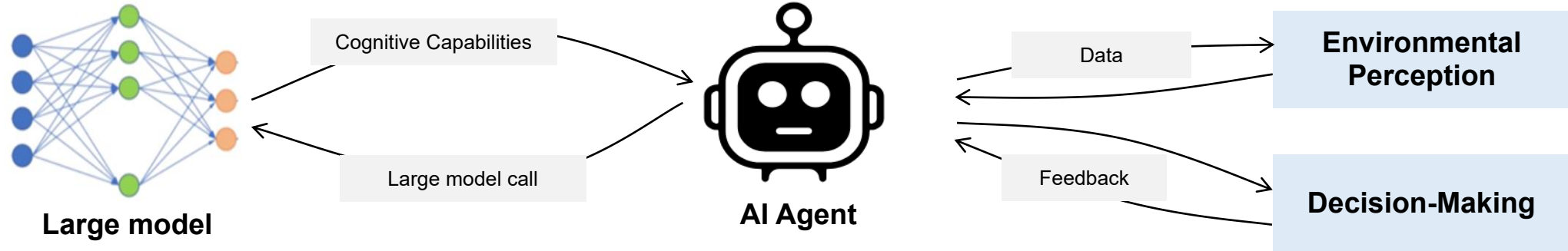

Ubiquitous Intelligence and Computing

Introduce Intelligence related Technologies

New AI-related Capability Definitions

Source: Framework and overall objectives of the future development of IMT for 2030 and beyond.

AI Agent & 6G

- Traditional AI (such as ChatGPT) mainly relies on user input commands. The AI Agent can independently think, make decisions, and perform complex tasks, just like an AI assistant, capable of independently completing multi-step operations.
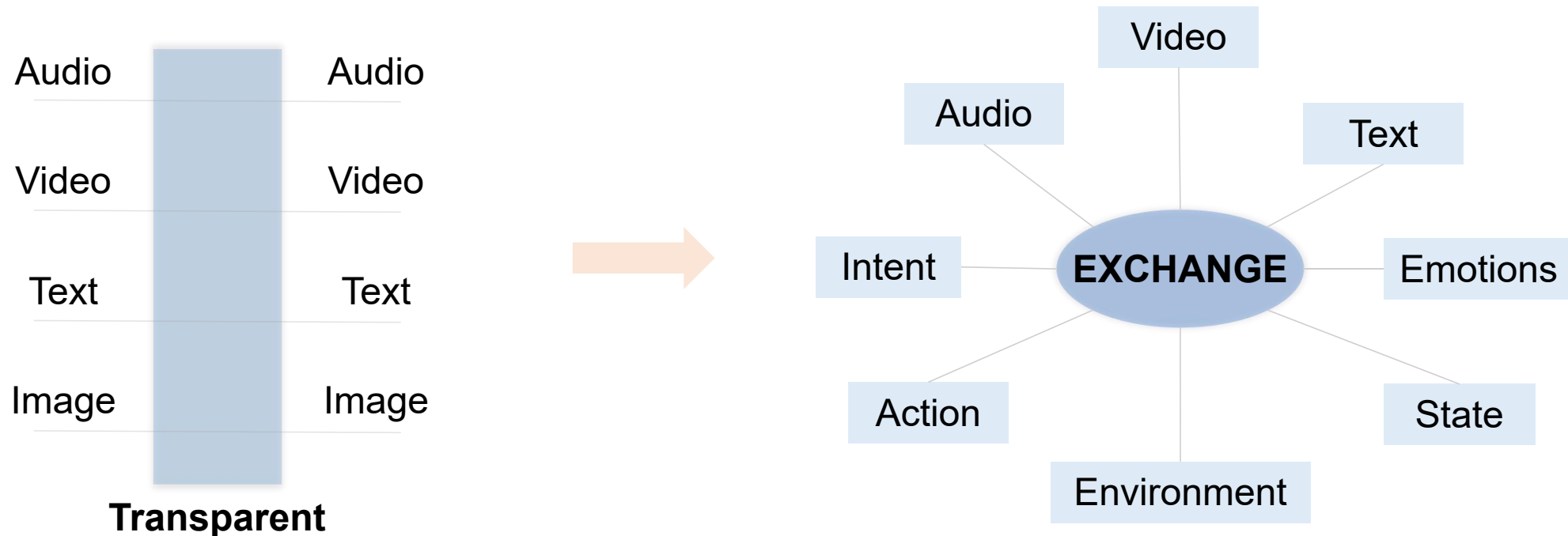

- **AI Agent:** an **automated intelligent entity** capable of e.g. interacting with its environment, acquiring contextual information, reasoning, self-learning, decision-making, executing tasks (autonomously or in collaboration with other AI Agents) to achieve a specific goal. (*Source: 3GPP Technical Report (TR) 22.870 [TR22.870]*)

- Use Cases focus on **Network for AI Agent** and **AI Agent for Network:**

  Network for AI Agent: AI Agent group/OTT AI Agent/AI Agent within network/IMS AI Agent, etc.

  AI Agent for Network: Intelligent intermediary

  (*Source: 3GPP Technical Report (TR) 22.870 [TR22.870]*)

Impact of the AI Agent on 6G Network
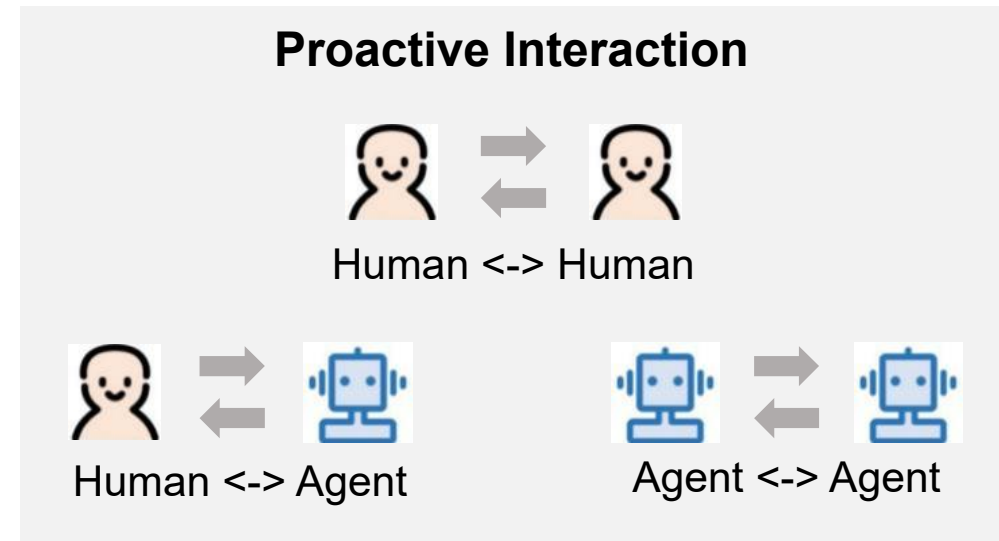
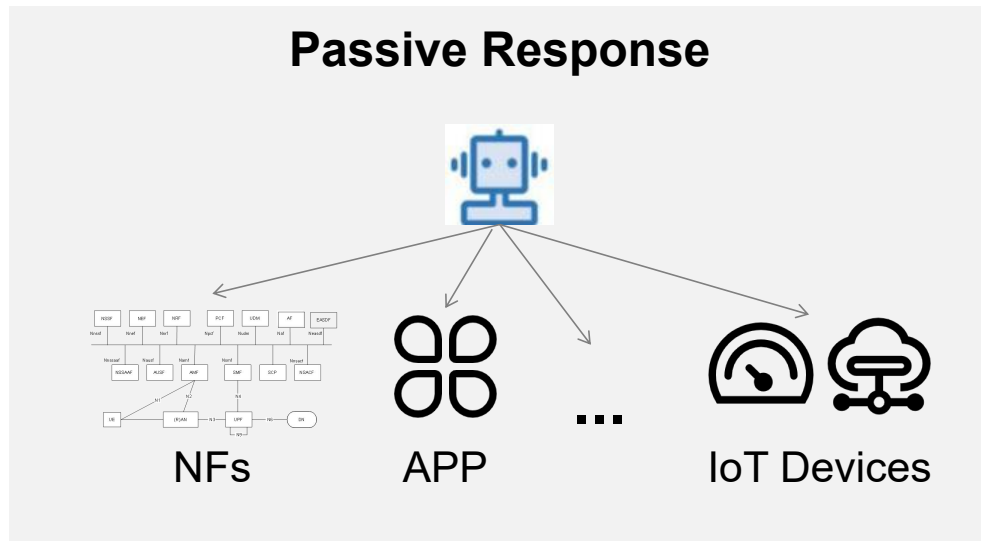- **What ? ----> Interaction Content**

The traditional communication concentrates on **text, video/image, and voice** for the transmission of transparent media. The AI Agent integrate physical and virtual world, driving the evolution of communication interaction content to **multimodal data**, such as the perception and transmission of multimodality data of actions, states/emotions, intent and environment.

Impact of the AI Agent on 6G Network
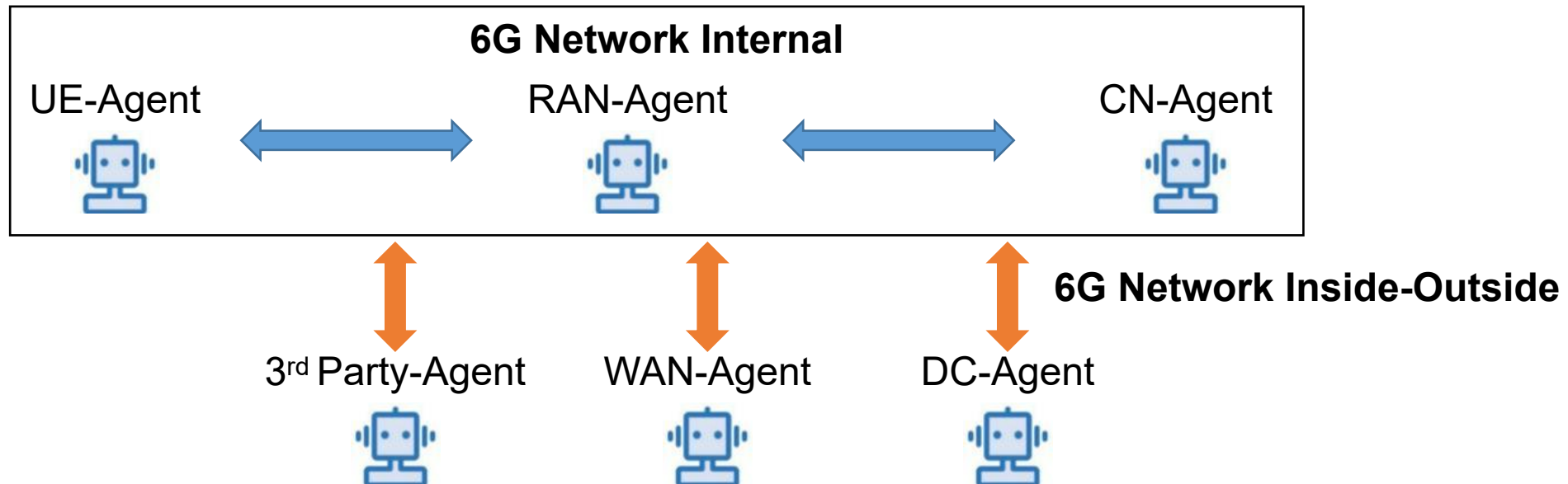
- **Who ? ----> Interaction Entity**

AI Agent extend the scope of traditional interaction entities, which are no longer limited to simple dialogs between humans, machines, and objects or constrained by fixed processes. Instead, it extends to multi-entity interactions **between AI Agents**, **within an AI Agent (such as with tools)**, and **between AI Agents and current network entities(such as IoT devices, network functions, and replication systems)**. The expansion of interacting entities not only enhances autonomous collaboration capabilities but also facilitates more complex and intelligent modes of task collaboration and decision-making.

Passive Response

NFs APP ... IoT Devices

Proactive Interaction

Human <-> Human

Human <-> Agent

Agent <-> Agent

Impact of the AI Agent on 6G Network

- **How ? ----> Interaction Protocol**

Changes in interaction content and entities have correspondingly brought about changes in interation protocols. The traditional protocol paradigm based on **fixed syntax and static layering** can no longer support the new requirements and characteristics brought by agent communication, such as **semantic comprehension, dynamic negotiation, and autonomous collaboration capabilities**, as well as more natural and flexible interactions with users. The interaction protocols both **within the 6G network** and between the **inside and outside of the 6G network** will undergo changes.

GAP Analysis -- Service Capability

- **Service Mechanism**

The current communication network primarily operates on **a user-driven service model**, where users initiate communication requests, and the **network passively responds** by establishing connections to provide communication services. For AI Agent communication, it involves not only simple data/instruction transmission but also interactive behaviors aimed at **completing specific tasks**. The network needs to analyze and understand these tasks and behaviors, perceive the contextual state of the tasks, and thereby optimize resource allocation to better meet user needs.

- **Network Role**

The traditional mobile network, as a **dumb pipeline**, provides basic data packet transmission, which primarily focuses on guaranteeing communication metrics such as bandwidth and latency, and **does not perceive different traffic characteristics**. In AI Agent communication, traffic often exhibits characteristics like multimodality, upstream-downstream peer-to-peer interaction, and short bursts. The network requires the capability to support **dynamic, semantic, and multimodal communication traffic demands** brought by AI Agent communication.

GAP Analysis -- Foundational Capability

- **Network Proceduralization**

The current mobile core network is characterized by **precise definitions, serial processing, and linkage effects**. Specifically, events trigger serial processing across multiple NFs. Both NFs and their associated processes are generally fixed. As a result, both the increase or decrease of NFs and changes in their functions will produce a linkage effect.

- **Network Intelligence**

Although intelligent technologies have been introduced into 5G networks, they remain a form of **plug-in intelligence**, capable only of providing single-point intelligence or local enhancement capabilities. For example, while the 5GC NWDAF has intelligent sensing and analysis capabilities, it cannot perform autonomous decision-making and scheduling based on analysis results. For AI Agent communication, 6G network should incorporate endogenous intelligence from the early design stage and build **AI-native network capabilities**.

- **Network Openness**

AI agents can augment their capabilities using various tools, particularly by invoking external APIs to expand their functionalities. With the integration of agents, **a more flexible open mechanism** must be considered—one that includes **the ability to flexibly open capabilities such as network functions, resources and tools to external entities**, while also supporting the ability to acquire tools, knowledge bases, and resources from external system.

Thanks!