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AI Agent Use Cases and Requirements in 6G Network
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Abstract

This draft introduces use cases related to AI Agents in 6G networks, primarily referencing the technical report of 3GPP SA1 R20 Study on 6G Use Cases and Service Requirements (TR 22.870). It also elaborates on some of the requirements for introducing AI Agents into 6G networks from the perspective of operators.

Status of This Memo

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1. Introduction

Currently, with breakthroughs in large language models and multi-modal technologies, AI Agent has emerged as a major research focus in the industry. Equipped with capabilities such as intent understanding, action planning, decision-making, task execution, and self-awareness, AI Agents can integrate environmental perception, memory, tool invocation, and multi-agent collaboration to accomplish complex tasks. They have already demonstrated significant value in key fields like autonomous driving, intelligent customer service, and smart home systems. In the 6G era, the introduction of AI Agent technology will enable operators to fully leverage the potential of mobile communication networks, significantly improving network operational efficiency and user experience. As a result, AI Agents are expected to become a key research focus in future 6G networks, leading to deep integration between 6G and AI Agent technologies.

In the 3GPP R20 standardization research for 6G, AI Agent has been one of the most discussed and debated topics, whether in SA1's study on 6G scenarios and requirements or SA2's research on network architecture. In the SA1#109 meeting, 19 contributions related to AI Agents were submitted, which include 16 new use cases, with 4 use cases ultimately agreed. And a preliminary definition of AI Agent from a capability perspective was adopted: "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 Al Agents) to achieve a specific goal." In the SA1#110 meeting, more than 30 contributions related to AI Agents were submitted, which include 22 new use cases, with 7 ultimately agreed. In the SA2#172 meeting, how to achieve deep integration of 6G network with AI technology (e.g. AI agent) has been explicitly included in the scope of 6G architecture study.

This draft summarizes and categorizes the AI Agent-related use cases in 6G networks, with a brief introduction provided in Section 2. In Section 3, from an operator's perspective, we elaborate on the potential requirements for introducing AI Agents into 6G networks, which should be considered when designing the agent communication related protocol in mobile communication network. In Section 4, we conclude this draft.

2. Use Cases

AI Agents can be deployed at various locations within the 6G system. Depending on their deployment positions, AI Agents in 6G can be classified into On-device AI Agents, application AI Agents, network AI Agents, operation management AI Agents, etc. For instance, on-device AI Agents refer to those implemented on end-user devices, while network AI Agents are those embedded within the 6G network.

This section summarizes and categorizes AI Agent-related use cases in 6G networks. Unlike AI Agents in the Internet domain, use cases involving AI Agents in mobile communication networks place greater emphasis on how network AI Agents can deliver 6G services to users, as well as how different AI Agents within the 6G system coordinate with each other.

2.1. Intent-based 6G Services Enabled by Network AI Agents

By deploying AI Agents within 6G network, the 6G network can provide users with intent-based services. These intelligent services may represent combinations of multiple network capabilities, such as communication, sensing, AI/ML, computing, data and more. Users only need to express their intent to the 6G network, without requiring specialized technical knowledge to decompose the intent into technical requirements. In this context, 3GPP SA1 has formally defined network intent as: Expectations including requirements, goals and constraints without specifying how to achieve them.

Use Case A: Network-Wide Intent Fulfilment

The 6G system interprets high-level service intents and translate such intent into concrete actions, including resource selection, configuration, and coordination across communication, sensing, computing, AI, and data capabilities utilizing network AI Agents.

Use Case B: Dynamic Service Customization and Optimization

The 6G network AI Agents dynamically adapt and optimize service behavior based on real-time context information, user requirements, and operational conditions in order to maintain desired service objectives.

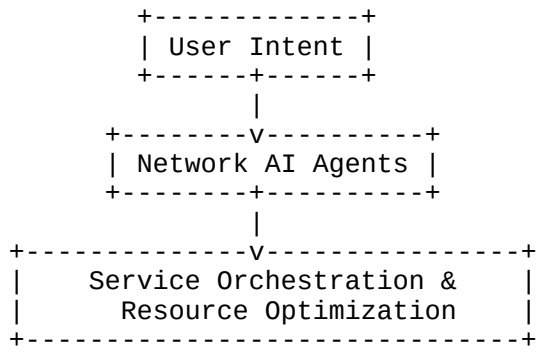

Figure 2.1 Intent-Based Network Control

2.2. Device-Network Collaboration

With the rapid advancement of technologies like smart phones and lightweight large-scale AI models, capabilities of user devices have significantly expanded, enabling autonomous execution of certain AI tasks and independent decision-making. However, due to inherent device limitations - including constrained computational resources and battery capacity - deploying complex AI agents or performing sophisticated AI tasks locally on devices remains challenging. Consequently, investigating optimal collaboration mechanisms between UE-based AI agents and network-based AI agents to accomplish complex tasks represents a critical research direction for 6G networks.

Use Case A: Enhanced UE Intelligence via Network Support

The 6G system enables collaboration between on-device AI Agents and Network AI Agents such that devices can leverage network-provided context, analytics, and capabilities to improve local decision-making and task execution.

Use Case B: Joint Device and Network Coordination Services

On-device AI Agents and Network AI Agents jointly support coordination services in which adaptation decisions are distributed across device-side and network-side components.

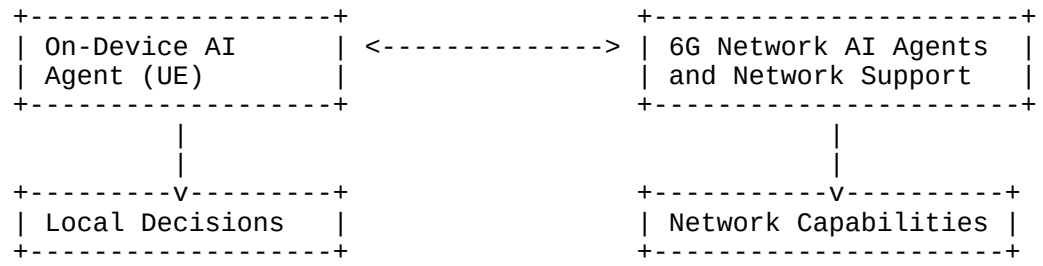

Figure 2.2 Device-Network AI Collaboration

2.3. Multiple Devices Collaboration

Under the powerful communication capabilities of 6G network, multiple on-device AI Agents can collaborate with each other to accomplish complex AI tasks. These AI Agents may from either the same application or different applications.

Use Case A: Cross-Device Intelligent Coordination

The 6G system securely exchanges information among multiple on-device AI Agents to enable coordinated task execution across devices.

Use Case B: Group AI Agent Collaboration Domains

The 6G system dynamically establishes the collaboration domains that allow authorized AI Agents to participate in group-based task execution under defined security and policy constraints.

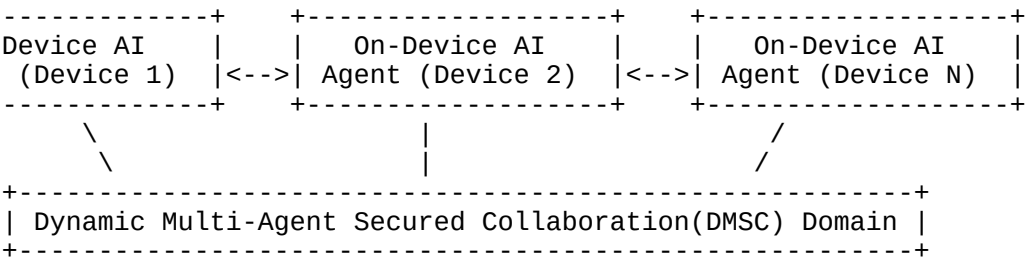

Figure 2.3 Multiple On-device AI Agents Collaboration

2.4. Network-Application Collaboration

The 6G network AI Agents and application AI Agents can fully collaborate to accomplish network tasks. On one hand, AI agents within the 6G network can invoke appropriate application AI Agents based on service characteristics. On the other hand, the network AI Agents can share network data and domain expertise with application AI Agents, providing crucial data support for application AI Agents.

Use Case A: Integrated Service Orchestration

The 6G system enables cooperation between Network AI Agents and application-layer AI Agents to support end-to-end service orchestration through context sharing and coordinated control actions.

Use Case B: Knowledge-Driven AI Enhancements

The 6G system provides mechanisms for exposing network-generated knowledge, such as sensing data and telemetry, to authorized AI Agents in support of advanced reasoning and service optimization.

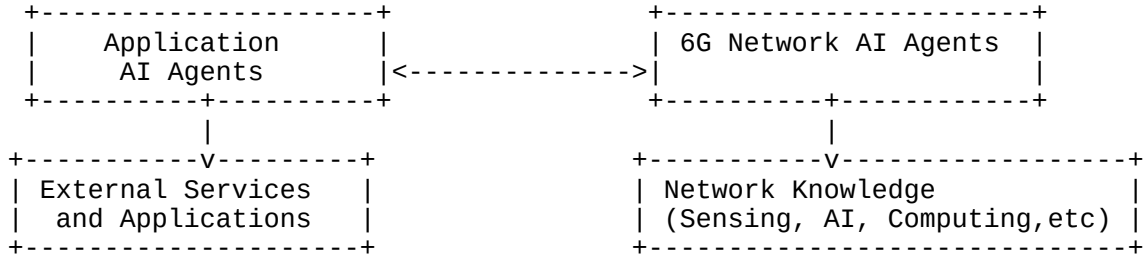

Figure 2.4 Network-Application AI Collaboration

3. Potential Requirements for 6G Network

In this section, we present potential requirements to 6G network that may arise from the introduction of AI Agents in 6G mobile communication network from an operator's perspective. Some of these potential requirements have already been agreed by 3GPP, while others have not yet been adopted by 3GPP.

3.1. The Identity of AI Agents

The 6G network shall support secure authentication, authorization, and management mechanisms for AI Agents' digital identities. These AI Agents include on-device AI Agents, 3rd party AI Agents, Network AI Agents, etc. A robust identity management mechanism is the prerequisite for interactions between users and AI Agents, as well as between different AI Agents.

3.2. Efficient Collaboration

The 6G network shall support efficient collaboration between different AI Agents and between AI Agents and the tools. This include: developing agent communication protocols better suited for 6G network characteristics, supporting multi-modal data (such as text, audio, video, etc.) interactions, enabling rapid transmission of massive data volumes, etc.

3.3. Cross-Domain Collaboration

Future AI agents will be ubiquitous, forming a device-network-industry end-to-end ecosystem. 6G network shall support the cross-domain collaboration of AI agents, including the device domain, RAN domain, core network domain, operation and management domain, application domain, etc.

3.4. Registration and Discovery

The 6G network shall support mechanisms for on-device AI Agents, 3rd party AI Agent, Network AI Agents and tools to register their attributes to 6G network, which enables efficient, cross-platforms and cross-domain AI Agents and tools discovery. This may different from the discovery mechanism in existing agent communication related protocol (e.g. NRF discovery mechanism).

3.5. Service and Data Exposure

The 6G network shall support secure mechanisms to expose the 6G services (e.g. sensing service, computing service, AI/ML service, etc.) and network data (e.g. sensing data, positioning data, etc.) to 3rd party AI Agents.

3.6. Reliability Assurance

The 6G network shall be able to provide mechanisms (e.g. network digital twin) to ensure the reliability and the validity of the decisions made by the AI Agents. The decisions made by the AI Agents in 6G network may directly change the network status, parameters, configurations. Only decisions that have been verified for reliability can be executed to change the network environment.

3.7. High-performance Communication

The 6G network shall enable high-performance communication, which may include low latency, high band-width, ultra-high data rate, etc. This is crucial for numerous scenarios such as device-network collaboration, network-application collaboration.

3.8. Security

The security of AI Agents communication in 6G includes the data protection and user consent. Data privacy means the 6G network shall support end-to-end encryption for the interactions between AI Agents to ensure robust data protection and privacy security for sensitive information. Besides, 6G network shall be able to provide mechanisms to collect the user consent for the local data collection.

3.9. Energy Efficiency

The 6G network shall be able to provide mechanisms to optimize the communication between AI Agents (especially for the on-device AI Agents) to reduce energy consumption.

4. Conclusion

AI Agents are expected to represent a critical innovation vector for 6G. This draft explores the transformative potential of AI Agents in 6G network, outlining key use cases and operational requirements from an operator's perspective. When designing agent communication related protocols for 6G network, the aforementioned requirements should be thoroughly considered and incorporated into the protocol architecture.

5. Informative References

[TR_22.870]
"3GPP TR 22.870, "Study on 6G Use Cases and Service Requirements", 2025.".

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