GTI
5G-AxAI Intelligence Capability Test Specification

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5G-AxAI Intelligence Capability

Test Specification

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Contents

1.Scope

This document defines the 5G-AxAI intelligence capability test cases for network elements, terminals and systems. This version covered a part of the use cases in the white paper "GTI 5G-AxAI New Technology, New Case, New Model White Paper"[1], and the future version will cover all innovative use cases in the white paper. The content of this test specification will be optimized continuously.

2.References

[1] GTI White Paper: "GTI 5G-AxAI New Technology, New Case, New Model White Paper".
[2] CMCC White Paper: "Technical Solutions for Typical Scenarios of 5G Network AI Applications White Paper".
[3] GTI White Paper: "GTI 5G-A Wireless Network Intelligence Evaluation System White Paper".
[4] GTI White Paper: "GTI Metrics and Test Methods Towards AI Device White Paper".

3.Definitions, symbols and abbreviations

Abbreviation	Definitions
5GC	5G Core Network
BBU	Baseband Unit
RF Unit	RadioFrequencyUnit
OMC	Operation and Maintenance Center
CPE	Customer Premises Equipment
RRU	Remote Radio Unit
5QI	5G QoS Identifier
GBR	Guaranteed Bit Rate
NWDAF	Network Data Analysis Function
SMF	Session Management Function
UPF	User Plane Function
PCF	Policy Control Function
RAN	Radio Access Network
AMF	Access Management Function
NRF	Network Repository Function
DN	Data Network

4.Test Environment

4.1 Test Environment

The wireless access network intelligent evaluation system is divided into three types:

The first type consists of network interface protocol tester, terminal simulator, 5GC, RRU, BBU, OMC, etc. The basic network structure is shown in the following figure:

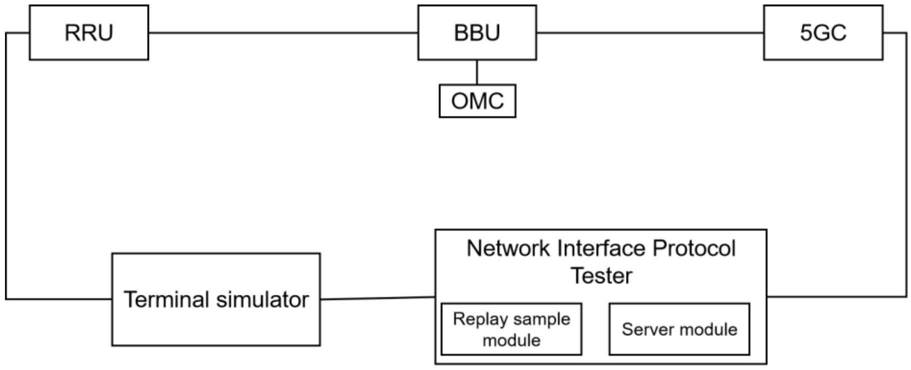

Figure 4-1 Basic architecture of wireless access network intelligent evaluation system based on network interface protocol tester

The second type consists of 5GC, BBU, RF unit, test terminal, OMC, etc. The basic network structure is shown in the following figure:

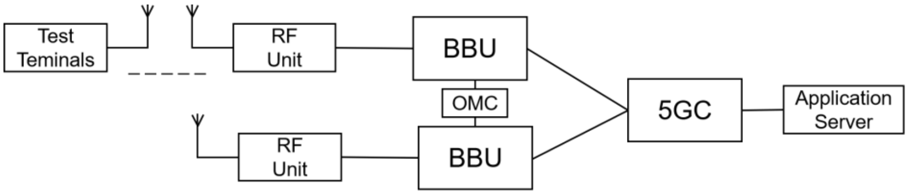

Figure 4-2 Basic architecture of wireless access network intelligent evaluation system based on gNodeB and 5GC

The third type consists of BBU, RF unit, test terminal, industrial service simulator, OMC, 5GC(optional), etc. The basic network structure is shown in the following figure:

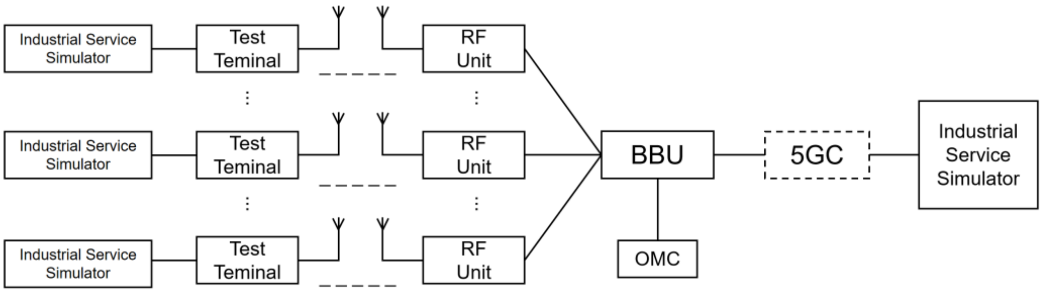

Figure 4-3 Basic architecture of wireless access network intelligent evaluation system oriented to industrial service performance

The core network intelligent evaluation system is divided into two types:

The first type consists of NWDAF, PCF, SMF, UPF, AMF, NRF, BOSS (Simulator), data sharing platform (Simulator), etc. The basic network structure is shown in the following figure:

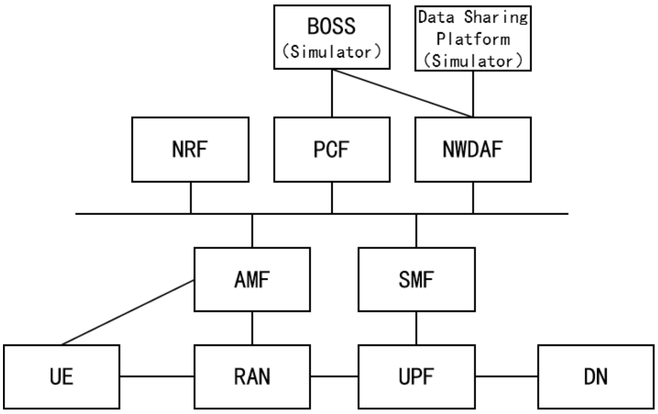

Figure 4-4 Basic architecture of core network intelligent evaluation system

The second type consists of VoLTE AS, SBC, CSCF, VoNR+ capability network element, VoNR+ media equipment, application servers, operation management platform, etc. The basic network structure is shown in the following figure:

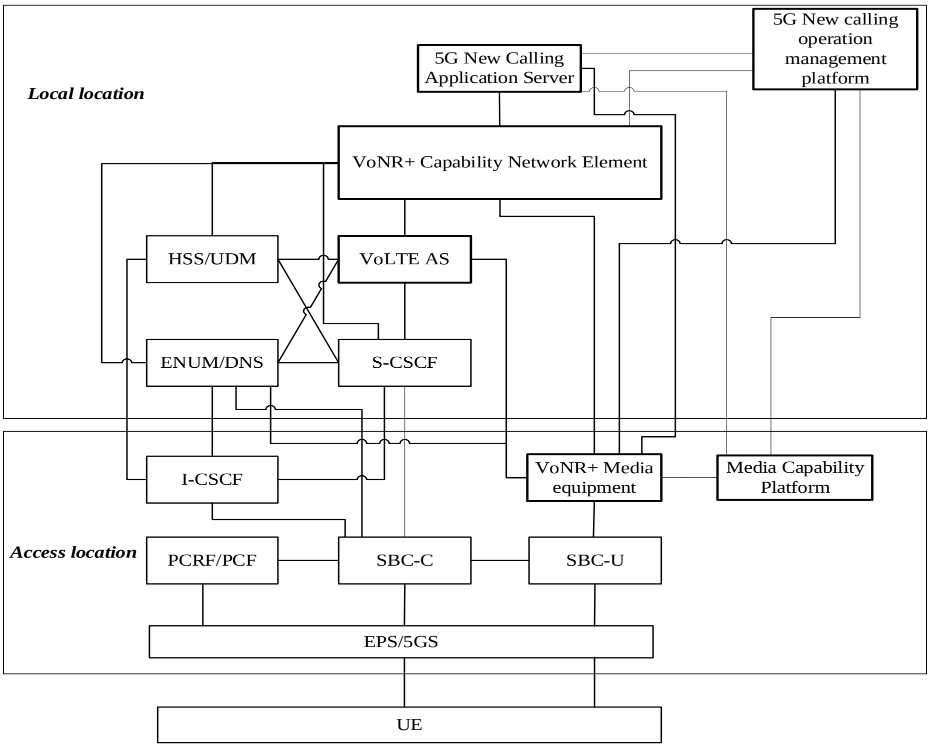

Figure 4-5 Basic architecture of 5G new calling evaluation system based on VoNR+network

The terminal intelligent evaluation system is divided into two types:

The first type consists of gNodeB, 5GC, test terminal, channel simulator, application server etc. The basic network structure is shown in the following figure:

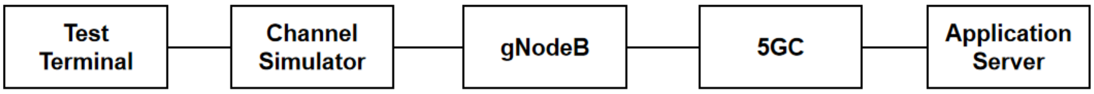

Figure 4-6 Basic architecture of terminal intelligent evaluation system based on gNodeB and 5GC

The second type consists of network simulator, channel simulator, test terminal, application server etc. The basic network structure is shown in the following figure:

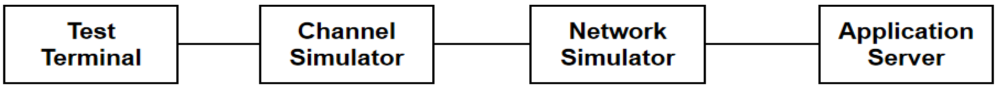

Figure 4-7 Basic architecture of terminal intelligent evaluation system based on network simulator

4.2 Test Equipment

Table 4-1 Equipment list for wireless access network intelligent evaluation system

Equipment	Quantity (Set)
System Equipment and Software of gNodeB	1
Equipment and Software of 5GC	1
Network Packet Capture Tool	1
Gigabit Switch	1
Application Server	1

Table 4-2 Equipment list for core network intelligent evaluation system

Equipment	Quantity (Set)
UPF	2
PCF	1
SMF	1
AMF	1
NWDAF	2
NRF	1
BOSS (Simulator)	1
Data Sharing Platform (Simulator)	1
IMS	1
VoNR+ Capability Network Element	1
VoNR+ Media equipment	1

Table 4-3 Equipment list for terminal intelligent evaluation system

Equipment	Quantity (Set)
Network Simulator	1
Channel Simulator	1
System Automation Testing Tool	1
Evaluation Result Analysis Software	1
Application Server	1

5.Test Use Cases

5.1 Personal Differentiation Experience Assurance

Experience assurance is provided for key users, services, and scenarios. Intelligent technologies enable differentiated experience assurance, facilitating operations. **Service profiling** is a basic capability that involves learning service characteristics and accurately identifying service flows to ensure normal execution of subsequent functions. **Service experience assurance** is measured by the ability of NEs to guarantee specific service metrics, such as the air interface RTT delay metric in short video services. **Service experience guarantee and reporting function** for specific users analyzes and predicts network resource data, makes intelligent decisions to generate QoS guarantee policy suggestions for the PCF, and realizes accurate and dynamic service guarantee for specific users. **The terminal weak signal prediction function** can predict the time when the terminal will enter the weak signal area in the future, preload the video or select a better signal cell before the video interruption, etc., to ensure the smooth experience of video services. The test indicators are the accuracy of terminal weak signal prediction and the quality of video services. **The terminal data stall prediction function** can predict the time when data stall will occur in the future, and preload or reduce the resolution of the video in advance before a video lag occurs to ensure a smooth experience of video services. The test indicators are the accuracy of the terminal data stall prediction and the quality of video services.

5.1.1 Service Profiling Capability

TC NO.	5.1.1
Test Case	Service profiling capability
Test Purpose	Verifies the service profiling capability for both encrypted and non-encrypted traffic, including but not limited to short video, QR code payment, web page browsing, instant messaging, long video, uplink live streaming, mobile gaming, cloud gaming, and video conferencing. The service profiling accuracy must be greater than or equal to 95%.
Reference Networking	Figure 4-1
Initial configuration	1. The cell is successfully activated. 2. The interface protocol tester has imported service samples, including delay-sensitive services like short videos and QR code payments, and rate-sensitive services such as uplink live streaming and long videos. For details, see Sample Library 1 in Remarks of this table. 3. The UE simulator is connected to the interface protocol tester and can simulate a UE to perform different services. Specifically, the UE simulator imports the service samples (each containing only one IP 5-tuple) to the tester. The tester replays the sample on the connected UE. IP adaptation has been completed for the test environment and test sample data.
Test procedure	1. Use the UE simulator to simulate the scenario where multiple users access the network, ensuring that 100 users remain in a connected state. 2. Use the tester to import specified service samples and replay 29 types of samples from the sample library in serial mode. For details about the samples, see item 2 in Prerequisites. 3. Wait until the sample data replay is finished. 4. The OMC collects statistics on the service profiling results, compares them with the service playback status of the protocol interface tester, and calculates the service profiling accuracy. 4. Gradually increase the number of access users in two stages (200 users and 400 users) and repeat steps 2 to 4.
Check Point	1. In step 4, the service profiling results collected on the base station side must be consistent with the replay services. Both the single-service profiling accuracy and the total service profiling accuracy are not lower than 95%. 2. Collect statistics on the single-service profiling accuracy and the total

	profiling accuracy. The calculation method is as follows: 1) Single-service profiling accuracy = Number of times that a single service is correctly perceived/Total number of replays for a single service on the instrument. 2) Total service profiling accuracy $=\sum_{k=1}^{n} P_k * m_k$, where n indicates the total number of service types, k indicates a specific service, p indicates the profiling accuracy of the single service k, and m indicates the ratio of the number of test times of service k to the total number of services.
Remarks	Sample Library 1.xlsx

5.1.2 Service Experience Assurance

TC NO.	5.1.2
Test Case	Service experience assurance
Test Purpose	Verifies that the service experience assurance function based on the service profiling capability can identify and guarantee the required delay for short video users, thereby improving the experience.
Reference Networking	Figure 4-1
Initial configuration	1. The interface protocol tester has imported the real service samples. For details, see Sample Library 2 in Remarks of this table. The samples include 29 types of encrypted and non-encrypted services, including delay-sensitive services like short video and QR code payment, and rate-sensitive services such as uplink live streaming and long video. 2. The UE simulator is connected to the interface protocol tester and can simulate a UE to perform different services. Specifically, the UE simulator imports the service samples to the tester. The tester returns the sample to the connected UE. 3. IP adaptation has been completed for the test environment and test sample data.
Test procedure	1. Turn off the service assurance switch. 2. Use the UE simulator to simulate the scenario where ten users access the cell at a medium distance from the cell center (RSRP < –95 dBm). Then, have five groups of users, each with the same number of users, replay different services. Group A1: Replays short video samples (delay-sensitive services). Group A2: Replays uplink live streaming samples (rate-sensitive services). Group A3: Replays mixed service samples, including QR code payment and instant messaging, with each sample lasting 1 minute and playing cyclically. Group A4: Replays mixed service samples, including long video and web browsing, with each sample lasting 1 minute and playing cyclically. Group A5: Replays mixed service samples, including voice calls and video calls, with each sample lasting 1 minute and playing cyclically. 3. Use a UE simulator to simulate the scenario where five more users access the cell and start service packet injection to construct a light-load cell (uplink and downlink PRB usage = 20%). 4. Have all users maintain their services for 10 minutes. 5. Check whether the service type measured on the base station is consistent with that replayed by the instrument. 6. Measure and record the average air interface RTT delay for users in group

	A1 and group A3. 7. Measure and record the average rates of users in groups A2, A4, and A5. 8. Enable the UE to exit the network. 9. Turn on the short video service assurance switch. 10. Enable the UE to re-access the network. 11. Repeat step 2 and ensure that the services remain unchanged. 12. Measure and record the average air interface RTT delay for users in group A1 and group A3. 13. Measure and record the average rates of users in groups A2, A4, and A5. 14. Compare and record the air interface RTT delay differences between group A1 and group A3 in steps 6 and 12. 15. Compare the rate differences between groups A2, A4, and A5 in steps 7 and 13. 16. Enable all UEs exit the network and clear the buffer. 17. Enable short video service assurance and uplink live streaming assurance. 18. Repeat steps 10 to 16 to compare the RTT delay before and after the assurance for groups A1 and A3, as well as the rate differences for groups A2, A4, and A5. 19. Repeat steps 1 and 2 using the UE simulator to add five more users accessing the cell. Start service packet injection to create a medium-load scenario with uplink/downlink PRB usage at 40%. 20. Repeat steps 4 to 18. 21. Repeat steps 1 and 2 using the UE simulator to add five more users accessing the cell and start service packet injection to create a heavy-load scenario with uplink/downlink PRB usage at 70%. 22. Repeat steps 4 to 18.
Check Point	1. After the assurance is applied, the air interface RTT delay decreases and the rate increases for short video users, while the metrics for other users remain stable. 2. After the assurance is applied, the rate for uplink live streaming users improves, while the metrics for other users remain stable.
Remarks	Sample Library 2.xlsx

5.1.3 Service Experience Guarantee and Reporting for Specific Users

TC NO.	5.1.3
Test Case	Service experience guarantee and reporting for specific users
Test Purpose	Verify the service experience guarantee and reporting performance for specific users, including providing differentiated network guarantee capabilities, achieving accurate experience guarantee for specific users (groups) and specific services. At the same time, it is also necessary to meet the visualization of the service experience indicators for specific users (groups).
Reference Networking	Figure 4-4

Initial configuration	1. Each Network Function system and the operation and maintenance console are running normally, and each Network Function is registered with the NRF normally. 2. The connection between the terminal and the network is normal. 3. The user subscribes to the guarantee package in the BOSS (Business Operation Support System) (Simulator), and the PCF subscribes the user to the specific service guarantee package. 4. The user successfully establishes a PDU session and successfully subscribes to the event of service quality degradation experience analysis. 5. The QoS configuration of the PCF is the same as that of the NWDAF, including 5QI, GBR , MBR, etc.
Test procedure	1. Analysis subscription: When a subscribed user goes online, the PCF subscribes to the intelligent QoS analysis from the NWDAF. 2. Customized data collection: Based on the analysis requirements, the NWDAF triggers the customized collection of service quality degradation data and network resource data from the data sources, namely the UPF and the network management system. 3. Service awareness: When VIP users use services, the service applications are identified (based on DPI). 4. Service experience data / degradation quality awareness: The UPF locally collects the service experience indicator data (such as rate, bandwidth, and delay) of VIP users and executes an experience evaluation. If degradation quality is determined, the UPF reports to the NWDAF. 5. AI-based congestion prediction: The NWDAF executes network congestion prediction based on the network load information. 6. Intelligent QoS decision-making: The NWDAF combines information such as the degradation quality results, experience requirements, network congestion prediction results, and network resources to generate QoS strategy suggestions (QoS parameters: 5QI, GBR, MBR, etc.) and sends them to the PCF. 7. Dedicated GBR guarantee: The PCF generates QoS rules according to the NWDAF's QoS suggestions and sends them to the SMF to establish or update the dedicated GBR. 8. Service guarantee data awareness and reporting: The UPF reports the guaranteed service experience data to the NWDAF on a per-user basis, and the NWDAF reports the guaranteed service experience awareness data to the BOSS.
Check Point	1. The UPF identifies the service flows of the specific users and executes an analysis of degradation service quality. 2. When the service experience of the specific users is of degradation quality, the UPF reports the degradation quality quality situation to the NWDAF. 3. The NWDAF predicts the network resource congestion situation: 1) Both the Mean Absolute Error (MAE) and the Root Mean Squared Error (RMSE) of the average prediction are controlled within 8%. 2) The overall average prediction accuracy (the proportion of time when the deviation between the predicted value and the actual value is less than 10%) reaches over 90%. 4. Based on the network resource congestion situation (sufficient GBR resources and no congestion), the NWDAF sends a user guarantee recommendation message to the PCF. 5. The PCF initiates the establishment of a dedicated GBR bearer to the SMF. 6. The NWDAF reports the user service experience vouchers to the BOSS.
Remarks	The above checkpoints require packet capture tools to check whether the signaling and fields meet the requirements.

5.1.4 Terminal Weak Signal Prediction

TC NO.	5.1.4
Test Case	Terminal weak signal prediction function
Test Purpose	Reproduce models of medium to high-speed mobile outdoor environments (such as highways, subways, and high-speed trains) in the laboratory using a standard sample library. Based on reports from testing terminals, test the accuracy of weak signal prediction for the tested terminals and assess whether the video service experience has been improved.
Reference Networking	Figures 4-6 and 4-7
Initial configuration	1. Establish a typical weak signal environment sample library for medium and high-speed mobile outdoor environments (such as highways, subways, high-speed trains/railways) through field collection, to characterize the current cell signal of the user changing from strong to weak in typical weak signal scenarios, and finally switching to adjacent cell scenarios. 2. The channel simulator imports the environment model from the sample library. 3. Configure 2 cells for the gNodeB or network simulator, set up CQI and SSB RSRP reporting, and support dynamic scheduling. 4. Configure a gNodeB or network simulator to connect to a video service server, which can support the requirement of real-time video playback for terminals. 5. The terminal is connected to the network normally and supports weak signal prediction function. 6. Pre-install video service APP on the terminal. 7. Pre-install a screen recording analysis app on the terminal that can evaluate the quality of video services. The evaluation method can be to take snapshot screenshots of multiple frames per second to assess image quality, and evaluate video lag time by comparing the changes in frame images before and after.
Test procedure	1. Enable weak signal prediction function on the terminal. 2. The terminal is connected to community 1, starts video services, and starts screen recording. 3. Run channel model, terminal reports CQI and SSB RSRP. 4. After the channel model is completed, stop the video service, close the screen recording, and obtain the weak signal prediction results of the terminal, including the prediction timestamp and RSRP. 5. Compare the weak signal prediction result of the terminal with the RSRP reported by the terminal after the prediction time to obtain the accuracy of weak signal prediction. 6. Turn off the weak signal prediction function on the terminal and repeat steps 2-5. 7. Compare the screen recording results of enabling and disabling weak signal prediction and analyze whether the video service quality has improved.
Check Point	1. Check the accuracy of weak signal prediction reported by the terminal. 2. Check if the quality of video services has improved, including snapshot image quality, video card length, etc.
Remarks	

5.1.5 Terminal Data Stall Prediction

TC NO.	5.1.5
Test Case	Terminal data stall prediction

Test Purpose	Reproduce models of medium to high-speed mobile outdoor environments (such as highways, subways, and high-speed trains) in the laboratory using a standard sample library. Based on reports from testing terminals, test the accuracy of data stall prediction for the tested terminals and assess whether the video service experience has been improved.
Reference Networking	Figures 4-6 and 4-7
Initial configuration	1. Establish a typical data stall environment sample library for medium and high-speed mobile outdoor environments (such as highways, subways, high-speed trains/railways) through field collection, to characterize typical data stall scenarios with strong interference or network congestion. 2. The channel simulator imports the environment model from the sample library. 3. Configure two cells for the gNodeB or network simulator, with cell 1 being the serving cell and cell 2 being the strong interfering cell. The network is configured with CQI and SSB RSRP reporting and supports dynamic scheduling. 4. Configure a gNodeB or network simulator to connect to a video service server, which can support the requirement of real-time video playback for terminals. 5. The terminal is connected to the network normally and supports data stall prediction function. 6. Pre install video service APP on the terminal. 7. Pre install a screen recording analysis app on the terminal that can evaluate the quality of video services. The evaluation method can be to take snapshot screenshots of multiple frames per second to assess image quality, and evaluate video lag time by comparing the changes in frame images before and after.
Test procedure	1. Terminal enables data stall prediction function. 2. The terminal is connected to community 1, starts video services, and starts screen recording. 3. Run channel model. 4. The channel model has finished running, stop the video service, and turn off screen recording. 5. Obtain the data stall prediction results of the terminal, including prediction timestamps, and generate a video quality report using screen recording analysis software. 6. Turn off the data stall prediction function of the terminal and repeat steps 2-5. 7. Compare the data stall prediction result reported by the terminal when the data stall prediction function is turned on with the video quality report of the screen recording analysis software after the prediction time when the terminal turns off the data stall prediction function, and obtain the accuracy of the data stall prediction. 8. Compare the video quality report of the screen recording analysis software for predicting data stall when the terminal is turned on and off, and analyze whether the video service quality has improved.
Check Point	1. Check the accuracy of data stall prediction reported by the terminal. 2. Check if the quality of video services has improved, including snapshot image quality, video card length, etc.
Remarks	

5.2 Industrial Deterministic Service Guarantee

In response to the extreme requirements of industrial services for network determinacy, network intelligence means are adopted to achieve intelligent service feature perception and air interface scheduling enhancement functions. It can improve the guarantee capability for the stable operation of industrial services. In this specification, the main tests are the accuracy rate of the base station in identifying industrial service features and the service indicator guarantee effect based on service features.

5.2.1 Industrial Service Feature Perception Capability

TC NO.	5.2.1
Test Case	Industrial Service Feature Perception Capability
Test Purpose	To verify the accuracy of the network in perceiving industrial service features
Reference Networking	Figure4-3
Initial configuration	1. The cell is normally activated. 2. 2 5G terminals and 2 service simulators which is capable of simulating industrial control services. 3. Configure address adaptation according to the test environment and test terminals.
Test procedure	1. The 5G terminals access the 5G cell. 2. The service simulator simulates the industrial control protocol to send data packets. Record the service packet feature information configured by the service simulator. 3. The 5G terminal is in a good signal area (RSRP ≤ - 75dBm, 15dB ≤ SINR ≤ 20dB). The service simulator sends 300,000 packets. 4. Record the service packet feature information perceived by the base station, including the service flow direction, protocol type, service packet size, and packet - sending period.
Check Point	Check the percentage of the service feature information perceived on the base - station side that is consistent with the information configured by the service simulator. And the feature information of the service flow perceived on the base - station side is completely consistent with the information configured by the service simulator.
Note	

5.2.2 Deterministic Guarantee Enhancement Based on Industrial Service Features

TC NO.	5.2.2
Test Case	Deterministic Guarantee Enhancement Based on Industrial Service Features
Test Purpose	To verify the scheduling enhancement guarantee effect after perceiving industrial service features, including RTT delay and delay jitter that meet 99.99% reliability.
Reference Networking	Figure 4-3
Initial configuration	1. The cell is normally activated. 2. 2 5G terminals and 2 service simulators which is capable of simulating industrial control services. 3. Configure address adaptation according to the test environment and test terminals.

Test procedure	1. The 5G terminal accesses the 5G cell. 2. The base station enables the intelligent service feature perception and scheduling enhancement guarantee function. 3. The service simulator simulates the industrial control protocol to send data packets, with the packet-sending period configured as 8ms and the packet-sending size as 200 bytes. 4. The 5G terminal is in an excellent-signal area (SINR > 25dB), and the service simulator sends 300,000 packets. 5. The 5G terminal is in a good-signal area (RSRP ≤ - 75dBm, 15dB < SINR < 20dB), a medium-signal area (-75dBm ≤ RSRP ≤ - 85dBm, 5dB ≤ SINR ≤ 10dB), and a poor-signal area (-85dBm ≤ RSRP ≤ - 95dBm, SINR ≤ 0dB). Repeat step 4. 6. The base station disables the intelligent service feature perception and scheduling enhancement guarantee function. And repeat steps 4-5.
Check Point	1. Count the total number of data packet-sending times, the number of successful times, and the success rate at each point. 2. Count the RSRP, SINR, resource (PRB) utilization rate, CCE usage rate, average delay, maximum delay, and minimum delay of data packet-sending at each point. 3. Count the CDF curve of data packet - sending delay and the delay corresponding to 99.99% reliability. 4. Count the delay jitter range, the maximum and minimum values of jitter, and the delay jitter value corresponding to 99.99% reliability. 5. Count the number of alarms that occur in the service simulator. 6. After enabling the intelligent service feature perception and scheduling enhancement guarantee function, the RTT delay, delay jitter are significantly improved compared with those when it is not enabled.
Remarks	Delay jitter = receiving packet time - previous receiving packet time - sending packet period.

5.3 Precise Network Energy Savings

Intelligent service profiling enables differentiated packet accumulation scheduling for delay-sensitive and non-delay-sensitive services, achieving precise energy savings.

TC NO.	5.3
Test Case	Precise network energy savings
Test Purpose	Verifies that the base station supports service-specific packet accumulation scheduling by observing the **EE.RruMeanPower** parameter and the changes in the buffer delay of the first packets of downlink DRB services at the RLC layer.
Reference Networking	Figure 4-1
Initial configuration	1. The cell is properly activated, and all energy-saving functions are disabled. 2. Two test UEs are properly connected to the tester and can simulate users engaging in short video services. 3. Test samples of short video services, captured from real services on the live network, are ready. 4. IP adaptation has been performed for the test environment and sample data. 5. The base station is connected to the OSS.

Test procedure	1. Change the OMC reporting period to 5 minutes. 2. UE 1 accesses the cell and performs UDP small-packet services. UE 2 accesses the cell and simulates short video services replayed by the tester. The ratio of UDP traffic to short video traffic should be 1:1. 3. Adjust UE services to maintain a 10% PRB usage for 15 minutes. 4. Observe the first packet buffer delay of downlink DRB services at the RLC layer and AAU/RRU power consumption in the cell, and record the UE PDCP throughput and subframe silence duration. 5. Enable the subframe silence function on the base station while keeping the centralized scheduling function (packet accumulation function) disabled. 6. Keep the UE services unchanged for 15 minutes. During this process, observe the buffer delay of the first packet of downlink DRB services at the RLC layer and the power consumption of the AAU/RRU, and record the UE PDCP throughput and subframe silence duration. 7. Enable the centralized scheduling function (packet accumulation function) on the base station. 8. Keep the UE services unchanged for 15 minutes. During this process, observe the buffer delay of the first packet of downlink DRB services at the RLC layer and the power consumption of the AAU/RRU, and record the UE PDCP throughput and subframe silence duration. 9. Enable the precise network energy-saving function on the base station. 10. Keep the UE services unchanged for 15 minutes. During this process, observe the buffer delay of the first packet of downlink DRB services at the RLC layer and the power consumption of the AAU/RRU, and record the UE PDCP throughput and subframe silence duration. 11. Disable all power saving functions and adjust UE services to maintain a 30% PRB usage for 15 minutes. 12. Repeat steps 4 to 10.
Check Point	Observe the first packet buffer delay of downlink DRB services at the RLC layer in the cell, AAU/RRU power consumption, UE PDCP throughput, and subframe silence duration during the test. Power consumption: centralized scheduling (packet accumulation) < precise network energy savings < subframe silence. Delay: subframe silence < precise network energy savings < centralized scheduling (packet accumulation).
Remarks	

5.4 Network Stability Assurance

Intelligent technologies enable quick issue location for smart network O&M, automate service quality data merging, and identify root causes for poor service quality, thus reducing manual judgment and avoiding drive tests.

TC NO.	5.4
Test Case	Network stability assurance

Test Purpose	Verifies that auxiliary analysis of poor-Quality of Experience (QoE) users is supported. Specifically, it simulates the call service quality, radio environment, and key signaling process of a specific user in both temporal and spatial dimensions on the upper-layer platform. The time difference between the poor-QoE event restored through the solution and the poor-QoE event received by the base station is within 30 seconds.
Reference Networking	Figure 4-2
Initial configuration	1. Two test UEs are ready and have been installed with the short video application of the same version. The videos of a social media influencer have been played at a place with good signal quality in the cell and the logs have been saved for analysis. It is determined that the videos are basically HD videos. At least 280 groups of videos have been chosen, and a video is automatically played at an interval of 3s. 2. UE test behavior regulations: 1) Service type and behavior requirements: Short videos are continuously watched during the test, and a new video is automatically played every 3 seconds. 2) Service process: The UE accesses the test cell and gradually moves from a location with good signal quality (RSRP > –85 dBm) to a location with poor signal quality (RSRP < –110 dBm) while short video services are continuously performed. 3. A network with at least 5 sites and 15 intra-frequency cells is available.
Test procedure	1. Enable the two test UEs to access the cell at a location with good signal quality. Open the short video application to watch short videos by referring to prerequisite 1 for details. 2. Ensure that the UEs move at a low speed (see prerequisite 2 for details) and stay at a location with poor signal quality for more than 2 minutes. 3. In the networking, set the following five poor-QoE scenarios so that the test UEs experience poor service quality in the following order, cycling five times. 1) Weak coverage scenario: UEs experience handovers at the cell edge. 2) Handover failure scenario: UEs experience a handover failure at the cell edge. 3) High-capacity scenario: The rates of the test UEs decrease by 50%. 4) Public network intrusion scenario: Add a dedicated-network cell to enable the test UEs to hand over to the dedicated-network cell. The UEs fail to hand over back to the public network because the dedicated-network cell is not configured with a neighboring public-network cell. 5) Intra-frequency interference scenario: Add interference configurations to the cell, making the test UEs hand over to other cells. 4. When each poor-QoE event occurs, record the following information: UE indicators such as RSRP and SINR, and network indicators such as user-level short video service experience, RSRP/SINR, abnormal events, user movement tracks, and signaling processes. Recreate the poor service quality event experienced by a specific user on the upper-level platform, including the causes and occurrence time. 5. Enable the UEs to exit the network.
Check Point	1. Based on the network-side user-level short video service experience indicators, RSRP/SINR indicator data, abnormal events, user movement tracks, and signaling processes, recreate the causes of poor quality experienced by a specific user on the upper-layer platform. 2. Collect statistics on the accuracy of accumulated poor-QoE identification. A single poor-QoE identification is considered correct if the poor-QoE

	type identified through the solution is the same as the actual one, and the occurrence time difference is within 30 seconds.
Remarks	

5.5 Upgrade of Personal New Calling Experience

5G New Calling background replacement is a significant indicator of core network intelligence. When the media stream is transmitted to the IMS media plane, the VoNR+ media plane utilizes portrait recognition capabilities to replace the original background with a virtual one.

TC NO.	5.5
Test Case	The calling VoNR+ user initiates background replacement.
Test Purpose	Verify the process of 5G network supporting VoNR users' fun call background replacement.
Reference Networking	Figure 4-5.
Initial configuration	1. All network element systems and the operation and maintenance console within the network are functioning normally. 2. Both UE A and UE B are 5G subscribers, with UE A subscribed to the fun call service, which has background replacement enabled by default.
Test procedure	1. Use a signaling tracker to track relevant interfaces. 2. UE A initiates a video call to UE B, and UE B answers the video call. 3. UE B observes the video stream of UE A on its screen.
Check Point	The signaling process and service invocation comply with standard definitions, where: 1. Check if the audio and video are successfully anchored to VoNR+ media plane. 1) When VoLTE AS receives a 200 OK response message, it reports a call response event to the VoNR+ capability network element, carrying the call status event (callEvent) parameter, and checks the call event reporting interface to include the calling and called numbers, call status events (ANSWER), etc; 2) The VoNR+ capability network element carries the Audio Video Media Anchoring (ANCHOR) parameter to send call control to the VoLTE AS. Upon receiving it, the VoLTE AS sends a Reinvite to the called side. After receiving a 200 OK SDP from the called side, it creates media resources on the VoNR+ media plane. The VoNR+ media plane returns the context resource ID (contextId) and audio/video endpoint information (terminations); 3) After receiving a 200 OK (Update) SDP Answer, VoLTE AS sends an update audio and video endpoint resource request to VoNR+ media plane, which returns the updated endpoint and stream resource information; 4) VoLTE AS sets the association between audio and video stream resources and VoNR+ media plane, carrying streamIn and streamOut, and VoNR+ media plane returns success; 5) VoLTE AS reports the call control result notification to VoNR+ capability network element, and VoNR+ capability network element returns success. 2. Check the successful replacement of the startup background. 1) The VoNR+ capability network element instructs the VoNR+ media plane to perform background replacement, carrying material information mediaId. After obtaining the background material, the VoNR+ media plane replaces the video background of UE A with the specified virtual background, and checks that the background has been replaced in the

	video stream of UE A displayed on the screen of UE B. 3. Check tip: The user is using background replacement. 1) The VoNR+ capability network element sends a media element synthesis request to the VoNR+ media plane, requesting to include the subtitle prompt templateId. The VoNR+ media plane overlays the 'background replaced' prompt subtitles onto the video stream of UE A, checking if UE A can see the subtitle prompt. 4. Check if DTMF reception has been successfully initiated. 1) The VoNR+ capability network element sends a request to receive the number to the VoNR+ media plane, carrying a fun call data graph and the callback address for receiving the number. The VoNR+ media plane starts continuous number checking. The screen of UE B shows that the background in UE A's video stream has been replaced.
Remarks	

5.6 Personal AI Assistant

AI Agent is a software entity or system that is capable of autonomously perceiving, making decisions, and executing actions in order to achieve specific goals. The personal AI assistant business is a typical application of AI Agent technology, which can complete tasks such as e-commerce shopping, ordering takeout, booking train tickets, social circle interaction, and instant message sending through voice commands. Taking ordering coffee as an example, users only need to give instructions to automatically complete a series of operations such as coffee type selection, payment, and delivery.

TC NO.	5.6
Test Case	Personal AI Assistant Business Support
Test Purpose	Simulate an outdoor environment in the laboratory to test the speed of up/down data transmission and the latency of completing tasks for personal AI assistants.
Reference Networking	Figures 4-6 and 4-7
Initial configuration	1. The channel simulator imports the external environment model from the sample library. 2. Configure one cell with a gNodeB or network simulator, connect to a service server, and support personal AI assistant services. 3. The terminal is connected to the network normally.
Test procedure	1. Terminal access to the community. 2. The server, gNodeB, or network simulator starts executing packet capture commands. 3. Users issue voice commands (human-computer interaction), such as recognizing item services - pointing the terminal camera at the room and saying 'what items are in the room', or online shopping services - saying 'buy a cup of coffee', etc. 4. Personal AI assistants begin to understand scenarios, user intentions, decompose instructions, complete multi-step decomposition tasks, and upload data (images/videos/instructions) to the server. 5. The personal AI assistant provides feedback to the user, such as introducing what items are in the room or indicating that the coffee order is ready.
Check Point	1. Upstream: Perform statistics on upstream data (images/videos/instructions) to obtain the upstream transmission rate and air interface latency.

	2. Downward: Conduct statistics on downstream data to obtain downstream transmission rate and air interface latency. 3. Obtain the AI assistant business response latency (task completion latency) by measuring the time interval between user audio cutoff and personal AI assistant feedback results.
Remarks	

5.7 Embodied Intelligence with Cloud Collaboration Support

Embodied intelligence refers to an intelligent system that interacts with the environment through physical entities, can perceive the environment, recognize information, make autonomous decisions, and take actions, and can achieve intelligent growth and adaptive action from experiential feedback. Based on the characteristics of 5G network such as high bandwidth and low latency, integrating AI capabilities can enhance the high-precision positioning, low latency, real-time control, data acquisition, incremental training and other capabilities of embodied intelligence through cloud collaboration, reducing the computing power requirements and power consumption of embodied intelligence itself.

TC NO.	5.7
Test Case	Embodied Intelligence with Cloud Collaboration Support
Test Purpose	Simulate the outdoor environment in the laboratory to test the speed of up/down data transmission and human-machine interaction response delay of embodied intelligence (humanoid robots, robotic dogs, intelligent robotic arms, or other forms of machines).
Reference Networking	Figures 4-6 and 4-7
Initial configuration	1. The channel simulator imports the external environment model from the sample library. 2. Configure one cell with a gNodeB or network simulator, connect to a service server, and support personalized intelligent services. 3. The embodied intelligence (humanoid robots or robotic dogs or intelligent robotic arms or other forms of machines) is connected to the network normally. 4. Embodied intelligence deployment of embodied action models, equipped with visual, auditory and other sensors. 5. Deploy multimodal large models on business servers.
Test procedure	1. Embodied intelligence access to residential areas. 2. The server, gNodeB, or network simulator starts executing packet capture commands. 3. Users can use the joystick for remote control operations, such as moving forward/backward/left/right, etc., and perform specific actions with intelligent capabilities. 4. Users initiate simple conversations, such as asking an encyclopedia question and answering it with embodied intelligence. 5. Users initiate intelligent conversations, such as holding an item in their hand and asking what they are holding, with embodied intelligence answering. 6. Embodied intelligence understands the scene, user intent, and begins to decompose instructions. 7. Embodied intelligence completes multi-step decomposition tasks. 8. Waiting for the task to be completed. 9. Stop packet capture. 10. Statistically draw message data.

Check Point	1. Obtain the remote control interaction delay through the time interval between user remote control cutoff and embodied intelligent response. 2. For simple conversations, the time interval between user audio cutoff and embodied intelligent response is used to obtain the human-machine interaction latency of simple conversations. 3. For intelligent dialogue, the time interval between user audio cutoff and embodied intelligent response is used to obtain the human-machine interaction delay of intelligent dialogue. 4. Obtain the transmission rate and air interface latency of instructions/audio/images through packet capture analysis.
Remarks	

6.Document Change Record

Version	Date	Record of changes made to previous released version
1.0.0	2025-02-25	Initial Version