Subjective Analysis of WBBA WG4 Cloud-Network Convergence Proof-of-Concept Project Test Report

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EXECUTIVE SUMMARY

Demand is moving toward 5G, gigabit fiber networks, cloud, and Internet of Things (IoT) applications: millions of enterprises have chartered to move their IT resources to the cloud, and at-home consumers desperately need cloud-based video applications. Deepening cloud-network synergy, including extensive AI-enabled network intelligence, big-data integration, security automation, large storage, and supercomputing powers at the edge and data center, will strengthen the digital transformation infrastructure.

The benefits of cloud-network convergence are significant for service providers and enterprises. It offers superior network performance, ensuring a deterministic experience for both business and home users. Service agility is crucial in the intelligent digital era, and cloud-network convergence is the key to achieving this.

The cloud-network convergence landscape, as explained in detail in the WBBA WG4 white paper "Driving the future: Understanding the landscape of cloud-network convergence," is all set to drive the digital economy and will facilitate the connectivity of an intelligent world, just as the power grid accelerated the second industrial revolution. This cloud-network convergence helps to explain the need and key architectural framework for constructing and ensuring IP and optical transport bearer network architecture with five constructs:

- Elasticity on demand
- Guaranteed levels of service
- Cross-domain orchestration
- All-scenarios production
- Tenant-level service operations

The WBBA WG4 members committee proposed a collaborative proof-of-concept (POC) project in response to the increasing demand for advanced telecommunications solutions. This project, the first of its kind under the POC Program track, is designed to complement and assess the viability of the concepts and frameworks specified by WG4 through published white papers and guidebooks, thereby driving the adoption of cloud-network convergence.

The main purpose of the POC is to address and benchmark service performance against traditionally siloed network deployments and verify the viability of various aspects of modern network infrastructure enabled by cloud-network convergence.

In total, 14 test cases, sorted into the three performance metrics categories, were tested and verified in China Telecom labs and in operation/commercial platforms:

- Round-trip time (RTT) – four RTT test cases of 8K video (two Beijing, two Shanghai)
- Transmission control protocol (TCP) – four TCP test cases of 8K video (two Beijing, two Shanghai)
- Lag – six lag test cases:
    - Four lag test cases of 8K video (two Beijing, two Shanghai)
    - One lag test case of 4K video (Beijing)
    - One lag test case at low bit rate (Beijing)

SUBJECTIVE ANALYSIS OF POC AND LESSONS LEARNED

Service providers can only unveil intelligent network connectivity with the deep convergence of digital and service-oriented communication technologies through cloud-network convergence. Cloud-network convergence, not telco cloud or simple cloud-network connection, should be adopted as a key vision in a service provider's cloud-based digital transformation charter.

This POC project test report analyzes and understands the need for cloud-network convergence, which drives the digital economy and will facilitate the connectivity of the digital world. The results of the POC project test will guide the enduring landscape of cloud-network convergence and help service providers expand and modernize key architectural requirements of IP and optical-networking architecture for cloud-network convergence.

A high degree of cloud-network convergence is desirable for service providers' unified transport bearer networks, where best-of-breed IP switching and routing capabilities are essential, and optical systems must be massively scalable for cloud networks.

Intelligent cloud-network-converged infrastructure breaks the boundaries between cloud and network, seamlessly connecting the network and enabling multiple clouds, edge points, and terminal devices.

Intelligent cloud-network convergence for transport bearer networks inspires new growth for service providers, keeps them competitive, and ensures new revenue streams.

IP transport network transformation in the form of metro, IP backbone, and cloud network is imperative for the future digitalization landscape of at-home consumers and enterprises. Cloud-network convergence with intelligent IP metro and cloud backbone will ensure scalability, agility, adaptability, large capacity, and superior network performance, as we observed in the report on the POC project test of cloud XR/8K video on demand (VOD).

Therefore, future IP and optical bearer transport networks must support the following key attributes or capabilities:

- Greater network scalability
- Enhanced network intelligence
- Always-on with enhanced network robustness
- Simplified, delayered, and integrated
- Congestion-free, deterministic performance
- Ultra-high reliability, anti-multiple-fiber cuts
- Multilevel latency circle, meeting cold, warm, and hot data requirements

The key notable benefits of building cloud-network convergence are as follows:

- Intelligent, reliable, and ubiquitous high availability and always-on network connectivity
- Service agility, scalability, and flexibility to help optimize business processes and revenue
- Faster time to market for new services with multicloud interoperations and interactions for quick data sharing and analysis
- Complete network visibility and deterministic service experience
- All-around, one-stop integrated network and service security protections
- Enhanced data protection, privacy, data sovereignty, and more trusted services
- AI-enabled ultra-automated intelligent network automation
- Increased service and business competitiveness for service providers in comparison with cloud providers

TEST SUMMARIES AND TAKEAWAYS

TABLE 1: OVERVIEW OF TEST RESULTS

TEST CASE NUMBER	TEST CASE NAME	TAKEAWAYS EMERGING AND LESSONS LEARNED
TEST CASE #1	Lag test of low-bit-rate VOD access to Beijing cloud platform	This test case proved that cloud-network convergence is a way forward. Remote users in Shanghai can access low-bit-rate video resources of the Beijing cloud platform without video delays or deadlocks. This test aims to reflect the local cloud architecture in cloud-network convergence and guarantee the quality of future ultra-high-definition VOD.
TEST CASE #2	Lag test of 4K high-bit-rate VOD access to Beijing cloud platform	Close cooperation between the central and local edge clouds for different video quality is an important capability requirement of future cloud-network convergence. The quality of videos above 4K cannot be guaranteed simply by improving the network quality but by deploying in the local cloud to realize local-area forwarding. Hence, the importance and necessity of edge cloud development in the evolution of cloud-network convergence are confirmed.
TEST CASE #3	Lag test of 8K video source 1 on-demand access to Beijing platform	From this testing, it is easy to conclude that 8K video demands high resolution and a large bandwidth to access on demand from a remote source. Hence, the importance and necessity of edge cloud development in the evolution of cloud-network convergence are confirmed.
TEST CASE #4	Lag test of 8K video source 2 on-demand access to Beijing platform	This testing proved that cloud-network integration and full convergence are required between the central and edge cloud for videos above 4K, otherwise, large-bandwidth and high-traffic services will challenge the deterministic user experience.
TEST CASE #5	Lag test of 8K video source 1 on-demand access to Shanghai platform	This testing shows the importance of edge cloud development in evolving cloud-network convergence. No video lag is observed in 8K resolution, and overall, it was a good and smooth viewing experience.
TEST CASE #6	Lag test of 8K video source 2 on-demand access to Shanghai platform	This testing shows the importance of edge cloud development in evolving cloud-network convergence. No video lag is observed in 8K resolution, and overall, it was a good and smooth viewing experience from video source 2 accessing the Shanghai cloud platform.
TEST CASE #7	RTT test of 8K video source 1 on-demand access to Beijing cloud platform	This test proved that there was no significant deviation, and the results were roughly in line with the expected results regarding RTT of 8K video source 1 on demand when accessing a remote cloud platform (Beijing).
TEST CASE #8	RTT test of 8K video source 2 on-demand access to Beijing cloud platform	This test proved that there was no significant deviation, and the results roughly agreed with the expected results regarding RTT of 8K VOD source 2 when accessing a remote cloud platform (Beijing).
TEST CASE #9	RTT test of 8K video source 1 on-demand access to Shanghai cloud platform	This test proved that the RTT of 8K VOD source 1 when accessing the local cloud platform (Shanghai) showed no significant deviation, and the results were roughly in line with the expected results. The 10ms RTT difference between remote VOD and local VOD proves the development of cloud-network convergence and the vital importance and necessity of edge cloud development in the evolution of cloud-network convergence.
TEST CASE #10	RTT test of 8K video source 2 on-demand access to Shanghai cloud platform	This test proved that the RTT of 8K VOD source 2 when accessing the local cloud platform (Shanghai) showed no significant deviation, and the results were roughly in agreement with the expected results. The 10ms RTT difference between remote VOD and local VOD proves the development of cloud-network convergence and the vital importance and necessity of edge cloud development in the evolution of cloud-network convergence.
TEST CASE #11	TCP resend rate test of 8K video source 2 on-demand access to Beijing cloud platform	This test proved that the TCP resends rate test of 8K video source 1 accessing the Beijing platform showed no significant deviation, and the results roughly agreed with the expected results. The test proved the importance of cloud-network convergence, where video resources must be deployed in the local cloud to realize nearby forwarding. This cooperative scheduling between the central and edge cloud for different video quality is an important capability for future cloud-network convergence.

TEST CASE #12	TCP resend rate test of 8K video source 2 on-demand access to Beijing cloud platform	This test proved that the TCP resends rate test of 8K VOD source 2 accessing the Beijing platform showed no significant deviation, and the results roughly agreed with the expected results. The test proved the importance of cloud-network convergence, where video resources must be deployed in the local cloud to realize nearby forwarding. This cooperative scheduling between the central and edge cloud for different video quality is an important capability for future cloud-network convergence.
TEST CASE #13	TCP resend rate test of 8K video source 1 on-demand access to Shanghai cloud platform	This test proved that the TCP resend rate difference between remote and local VOD is at least two orders of magnitude for 8K VOD source 1 access to the Shanghai platform. Long-distance transmission causes great damage to network performance, including delay and packet loss. Hence, the value of building cloud-network convergence for service agility and efficiency is well proven here.
TEST CASE #14	TCP resend rate test of 8K VOD source 2 on-demand access to Shanghai cloud platform	This test proved that the TCP resend rate difference between remote and local VOD is at least two orders of magnitude for 8K VOD source 2 access to the Shanghai platform. Long-distance transmission brings great damage to network performance, including but not limited to delay and packet loss. Hence, the value of building cloud-network convergence with edge cloud development for service agility and efficiency is well proven here.

SOURCE: WBBA

CONCLUSION

This collaborative POC project was completed with the clear lesson that digitalization brings excellent opportunities and challenges to service providers' businesses. The robust IP and optical transport network architecture with robust cloud-network convergence is an inevitable and imperative choice in moving forward. Gluing cloud-network convergence is key to meeting users' demands for real-time network connectivity, service agility, and multicloud collaborations.

The four POC scenarios tested proved that cloud-network convergence is a way to modernize service providers' existing IP and optical bearer network infrastructure and leverage one-click access to multicloud interconnections.

Service providers should adopt cloud-network convergence as a key vision rather than simply use cloud-network connections. Modernizing traditional networks to cloud-network convergence will help them meet the complex demands of network agility, network efficiency, and service scalability.

In the WBBA WG4 consultative view, this extensive POC testing exercise sets performance and benchmark checkers for service providers' network service offerings. It also provides the way forward for the whole telco industry to work cohesively to tap the true essence of the cloud network in modernizing traditional IP and optical transport networks to achieve the following:

- One-hop simplified access to multicloud
- End-to-end deterministic networking capabilities
- The enabling of secure cloud-edge-device collaboration
- Heterogeneous IoT access
- An intelligently connected industrial and VOD consumer metaverse

Appendix

POC Program Framework

EXECUTIVE SUMMARY

With the development of new applications such as smart home, XR/ VR/AR, Metaverse and industrial internet, as well as Enterprise Cloudification and Industry Digitalization, new network technologies and associated capabilities and features are proposed. For smart home, private cloud is required. For VR/AR applications, high traffic and low latency are required. For industrial applications, determinacy is required.

WG#4 focus is on these new requirements to be placed on the network (IP Transport Network and to explore and assess the new architectures and networking technology that support the needed capabilities to meet these diversity and variety of requirements.

W#4 developed a holistic “topics map” depicted in Figure 1 to tell a holistic story in the WBBA space from input Policies and Intent expressing the desired service by requesters / consumers and its journey on how it can be handled, executed, delivered, and assured in agile, flexible, scalable, robust, secure, programmable, slice-able and cost-effective manner. This can be achieved by evolving IP Trasport Network to “E2E Converged Cloud – Network” with its associated AI-Enabled Intelligent Integrated Support System through the concept of Net 5.5 G as the key Technology and Architecture Framework developed by WG#4 and delivered to the Industry as Whitepaper series. To assess, test and validate the viability of the concept developed in the Net 5.5G Whitepaper, WG#4 put in place a POC Program as dedicated Track in its ToR. This is the aim of this document. It defines the POC Governance, process and Test Framework (various Templates) developed to help and assist WG# members in their POC Projects journey. This POC Program Governance and Process has been instantiated and operationalized in a 12-month POC Project on “Cloud XR / 8K Video on-Demand” as a case study. This POC project has been completed in June 2024 and will be showcased in MWC Shanghai 2024 and in other events in different regions.

ABBREVIATIONS AND ACRONYMS

4K / 8K: 3840 x 2160 resolution
8K: 7680 x 4320 resolution
B2B / C /G: Business-to-Business / Customer / Government
CDN: Content Distributed Network
CityVerse: Metaverse in the City context
CN -aaS: Cloud Network as a Service
CN-IISS: Cloud Network-Integrated Intelligent Support System
DC: Data Centre
DCI: Data Centre Infrastructure
FTT- M / H / B: Fiber To the Mobile/Home/ Business
HD: High Definition
IEEE: Institute of Electrical and Electronics Engineers
KPI: Key Performance Indicator
KVI: Key Value Indicator
MPLS: Multi-Protocol Label Switching
MWC: Mobile World Congress
OTN: Optical Transport Network

POC: Proof-of-Concept
RTT: Round Trip Time
SDGs: Sustainable Development Goals
Self X Function: Self Organizing, Healing, Optimization, Configuration....
SME: Small Enterprises
SRv6: Segment Routing version 6
SUT / DUT / CUT: System / Device / Component Under Test
TCP: Transmission Control Protocol
VR/AR / XR: Virtual: Augmented / Extended Reality
WBB: World Broadband
WBBA: World Broadband Association
UN: United Nations

SCOPE OF WG#4

The main areas covered by the scope are the following:

- WBB Requirements -Network Technology Capabilities mapping

  Through the analysis of WG2 use cases and deployment scenarios, and understanding the real demands and consistent requirements to well identify tailored capabilities to be supported by network technology is the basic work of this WG#4.

- Cloud-based Applications

  Because clouded application is a main development direction. How the network responds to it is worth studying. Related topics include DCI network, public cloud and private cloud accessing for enterprise or home subscribers, and web cache or CDN network.

- Metro network

  Following topics, but not limited to, are investigated:

  a) Edge DC-based Network Architecture
  Because flow model is changing in today's network. Different from traditional network, future network will support edge DC. Cloud to cloud traffic (east-west traffic) between edge DC will increase sharply. So, there is a need for a new network architecture to solve the problem of flow rotation, because in traditional network architecture, all traffic will be forwarded by the core layer.

  b) DC-Metro Integration design
  Explore new integrated design which include Software and Hardware to meet the requirements of resource constraints in the edge DC (e.g. integrated gateway of network and application, collaboration device of IP and optical.

  c) Industrial applications
  Deterministic network technology the new direction for exploration and assessment in terms of low latency, near zero packet loss, controllable jitter, etc

  d) Cloud-Network Integration
  Assess the benefit of integration, which leads to realize the intensive management of infrastructure resources, provide a consistent experience of cloud and network for users.

WG#4 TRACKS UNDER THE TOR

WG#4 is structured into two separate Tracks while collaborating.

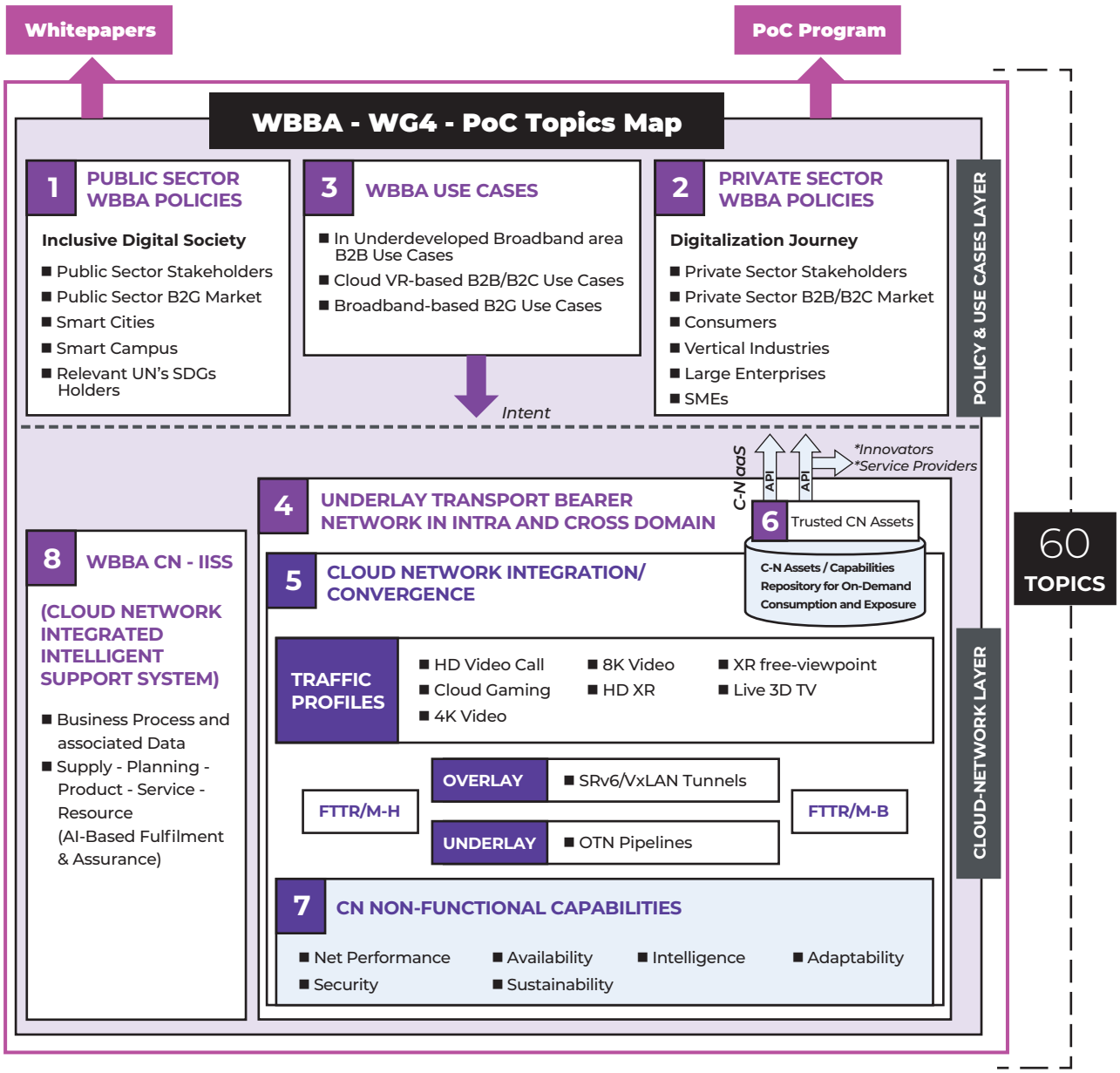
WORK ITEMS TRACK AND WG#4 TOPICS MAP

Approved through ToRs (Term of Reference) WI is mandated to deliver White papers series. To help and assist members in their process of proposing WIs that must be aligned with WG#4 ToR, we developed the concept of WG#4 Topics Map, under a layering model with 2 levels:

- Policy and Use Cases Layer
- Cloud-Network Layer

These two layers are articulated around 8 Building Blocks (Categories) broken down into over 60 Topics as depicted in Figure 1. From this Map, we can derive Whitepaper Topics to be scoped in a proposed new WIs ToRs for approval. Th same goes for POC Project Topics under the governance of the POC Program which is the name of the second Track of WG#4 (section 3.2).

FIGURE 1: WG#4 TOPICS MAP



SOURCE: WBBA

WG#4 POC PROGRAM TRACK AND POC TOPIC MAP

We introduced the concept of POC Topics Map as a visual to tell a holistic story in the WBBA space from input Policies and Intent expressing the desired service by requesters / consumers and its journey on how it can be handled, executed, delivered, and assured in agile, flexible and cost-effective manner by Cloud - Network capabilities / resources and Intelligent Integrated Support System.

WBBA / WG #4 Topic Map gathers specific areas, linked to Working Groups objectives, deliverables, white papers. It can also be instantiated onto WG# POC Topics Map to help WG#4 members to focus POC Projects on the most relevant topics for the WBBA, and to increase the relevance of their contributions and to be aligned with the POC Program Governance when they submit POC Project proposals. The Test Results once the POC project completed will be contributed as input or feedback from the WBBA / WG#4 Proofs of Concept (POCs) is needed.

From process perspective, a POC Team proposal shall address at least one goal relevant to WBBA i.e. related with a Public Sector WBBA Policy, a Private Sector WBBA Policy, a WBBA Use Case, a WBBA Requirement or the suitability of WBBA Network Architecture and Technology aspect as described in WG4 and other WGs. The output of the POC should provide feedback to the related WBBA WG(s) that should support the improvement of the output of the existing WBBA WGs or the creation of new WG(s) to address identified gaps or new topics deemed of high interest to the Industry. Figure1 depicts the proposed POC Topics Map.

The WBBA POC Topics Map is broken down into 8 categories grouped in two layers:

POLICY & USE CASES LAYER
Il contains the three following categories:

- **Category 1**
  It groups the POC Topics pertaining to **“Public Sector WBBA Policies”**

- **Category 2**
  It groups the POC Topics pertaining to **“Private Sector WBBA Policies”**

- **Category 3**
  It groups the POC Topics pertaining to **“WBBA Use Cases”**

CLOUD-NETWORK LAYER
Il contains the two following categories:

- **Category 4**
  It groups the POC Topics pertaining to **“WBBA underlay Transport bearer Network”**

- **Category 5**
  It groups the POC Topics pertaining to **“Cloud- Network Convergence / Integration”**

- **Category 6**
  It groups the POC Topics pertaining to **“Trusted Cloud- Network Assets”** stored in Repository to be exposed to be consumed by Implementers on Demand or offered as Cloud-Network as a Service (CNaaS).

- **Category 7**
  It groups the POC Topics pertaining to **“Cloud- Network Non-Functional Capabilities”**

- **Category 8**
  It groups the POC Topics pertaining to what we named **“C-N IISS” (Cloud-Network Integrated Intelligent Support System).** It is somehow the evolution of the traditional OSS

/ BSS in the context of Cloud -Network Integration / Convergence to handle the WBB era. It cannot be seen as an independent "out-off band" silo from the "in-band" O&M capabilities associated with "Category 4". From design principle, there may be complementarity between the two in terms of time scaling of some analytical and operational processes and Control-Loop automation for Self-X functions (intelligence), for instance. It also encompasses Innovative Business models to be explored in the context of WBBA Business Scenarios of high interest to the Broadband Industry as well as the transition towards Digital Operating Models within the implementation of Digital Strategies where Digital Natives are becoming dominant Players / Competitors.

Note: This POC Program Framework draws its inspiration from various experiences as the author has been POC Program Chair in ETSI TC NTECH, ETSI TC INT, ETSI ISG IPE, NGMN 5G TTI, TM Forum, IPv6 Forum.

WBBA POTENTIAL POCS TOPICS CANDIDATES

Table 1 gives another perspective of the POCs Topics map as depicted in Figure 1. It is broken down into 3 levels:

- **Level 1:** the highest level that reflects the Strategic / Holistic / aggregated view of the POC Topics. It contains **5 components** which corresponds to the 5 categories.
- **Level 2:** It is the disaggregation of Level 1 **(8 components).** To be noted, that category 4 is broken down into 2 nested sub-levels
- **Level 3**: the low level. It is fine grain disaggregation of Level 2. It lists the potential POCs Topics candidates **(58).** This level-based structure allows easily check the alignment of a given POC Topic with the parent category by concatenating the 3 levels. These listed POC Topics candidates are aligned with use cases described in the published WBBA white papers. Other pools of potential POCs Topics candidates that complement the one listed in Table 1 could be extracted from the WBBA white papers by POC Topics Teams. We encourage each POC Topics Team to consider the two families of POC Topics candidates pools and select the POC Topic that is aligned with their POC proposal they intend to submit to the POCs approval process.

TABLE 1: POTENTIAL POCS TOPICS CANDIDATES LIST

LEVEL 1	LEVEL 2	LEVEL 3
PUBLIC SECTOR. WBBA POLICIES	Inclusive Digital Society Policy	· Public Sector Stakeholders (Policymakers) · Public Sector B2G Market · Smart Cities · Smart Campus · CityVerse · Relevant UN's SDGs Holder · Citizens · Group of Citizens · Associations
PRIVATE SECTOR WBBA POLICIES	Digitalization Journey Policy in a Digitalized competitor's landscape	· Private Sector Stakeholders (Policymakers) · Private Sector B2B Market · Private Sector B2C Market · Consumers · Vertical Industries · Large Enterprises · SMEs · Metaverse
WBBA USE CASES	Broadband use case categories	· In Underdeveloped Broadband areas B2C Use Cases · Cloud VR-based B2B Use Cases · Cloud VR-based B2C Use Cases · Broadband-based B2G Use Cases

LEVEL 1	LEVEL 2		LEVEL 3
WBBA UNDERLAY TRANSPORT BEARER NETWORK IN INTRA AND CROSS DOMAIN	Cloud-Network Integration / Convergence	Traffic Profiles categories	• Basic Broadband • HD Video Call • Cloud Gaming • 4K Video • 8K Video • HD XR • XR free-viewpoint • Live 3D TV
		Overlay / Underlay Network	• Overlay « SRv6 / VxLAN Tunnel » • Underlay "OTN Pipelines »
		Optical Access Network segment	• FTTR-M/H • FTTR-M/B
		Trusted C-N Assets / Capabilities Repository (Catalog)	• Trusted C-N Assets / Capabilities for On-Demand Consumption to build desired services • APIs for Trusted C-N Assets / Capabilities exposure and discovery • CN aaS (Cloud - Network as a Service)
		Cross Domain model	• Federated Repository (Catalog) of Trusted C-N Assets / Capabilities • Trusted C-N Assets / Capabilities • Repository (Catalog) exposure & discovery in the context of Partnership & Alliances through APIs • Dynamic Orchestration within digitalized competition landscape
		Intra Domain model	• Federated C-N Assets / Capabilities Repository / Catalog • Dynamic Orchestration within Digital-Native DSPs
		CN Non-Functional Capabilities	• Network Performance • Availability • Intelligence • Adaptability • Security • Trust
		Intent-based Cloud-Network (intra and Cross Domain)	• Intent Owner / Creator (Customer) • Intent Description / Specification (Requirements, Goals, and Constraints) given to the WBBA Underlay Transport Bearer Network in Intra and Cross Domain model to achieve what the Intent Owner / Sender is expecting • Intent Handler (Cloud-Network) • Intent Executer (Cloud-Network) • Intent Report Generator (Cloud-Network)
WBBA CN - IISS (CLOUD -NETWORK INTELLIGENT INTEGRATED SUPPORT SYSTEM	Key Business Processes for a Service-focused BB Provider		• Broadband Service Alignment / Conceptualization, Ordering, Billing • Customer Care • Resource Management & Operations • AI-based Fulfilment & Assurance
	Broadband Business Models		Exploring and assessing innovative Business Models in some WBBA Scenarios
	(Digital) Operating Model		Assessing some known Digital Operating Models in the WBBA context in a Hybrid Digital-Natives and Non-Digital Natives Business environment

Note: Other POCs Topics candidates can be extracted from the published WBBA White papers and submitted by POC Project Teams following the submission process described in Figure 4.

SOURCE: WBBA

ADDRESSING A POC TOPIC IN A POC PROJECT

POC Teams specify the targeted POC Topic(s) among the ones listed in Table 1 or extracted from WBBA published white papers in their POC Proposal and commit to provide the expected input or feedback in the requested format (template).

FEEDING BACK THE POC RESULTS

As soon as experimental results relevant for a given WG#4 POC Topic are available (no need to wait for the POC Project to be completed), the POC Project Team creates a contribution and informs the WBBA WG#4 / POC Governance Team. POC Project Teams are also encouraged to contribute additional results and lessons learned, outcome, and best practices during the POC Project to the WBBA WG4 / POC Governance Team.

POC PROGRAM FRAMEWORK AND ITS BUILDING BLOCKS

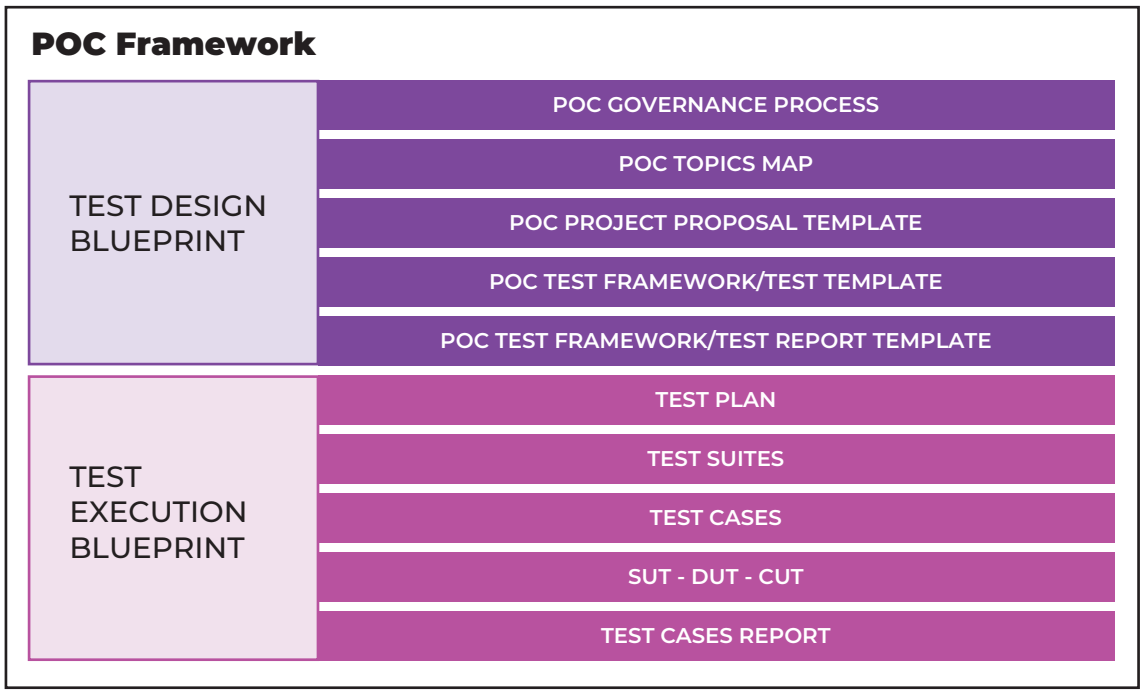
The POC Program Framework is composed of two Blueprints 1) Design Blueprint, 2) Execution Blueprint.

DESIGN BLUEPRINT

It contains the following Templates as depicted in Figure 2:

- POC Governance Process
- POC Topics Map
- POC Project Proposal Template
- POC Test Framework / Test Template
- POC Test Framework / Test Report Template

FIGURE 2: POC PROGRAM FRAMEWORK



SOURCE: WBBA

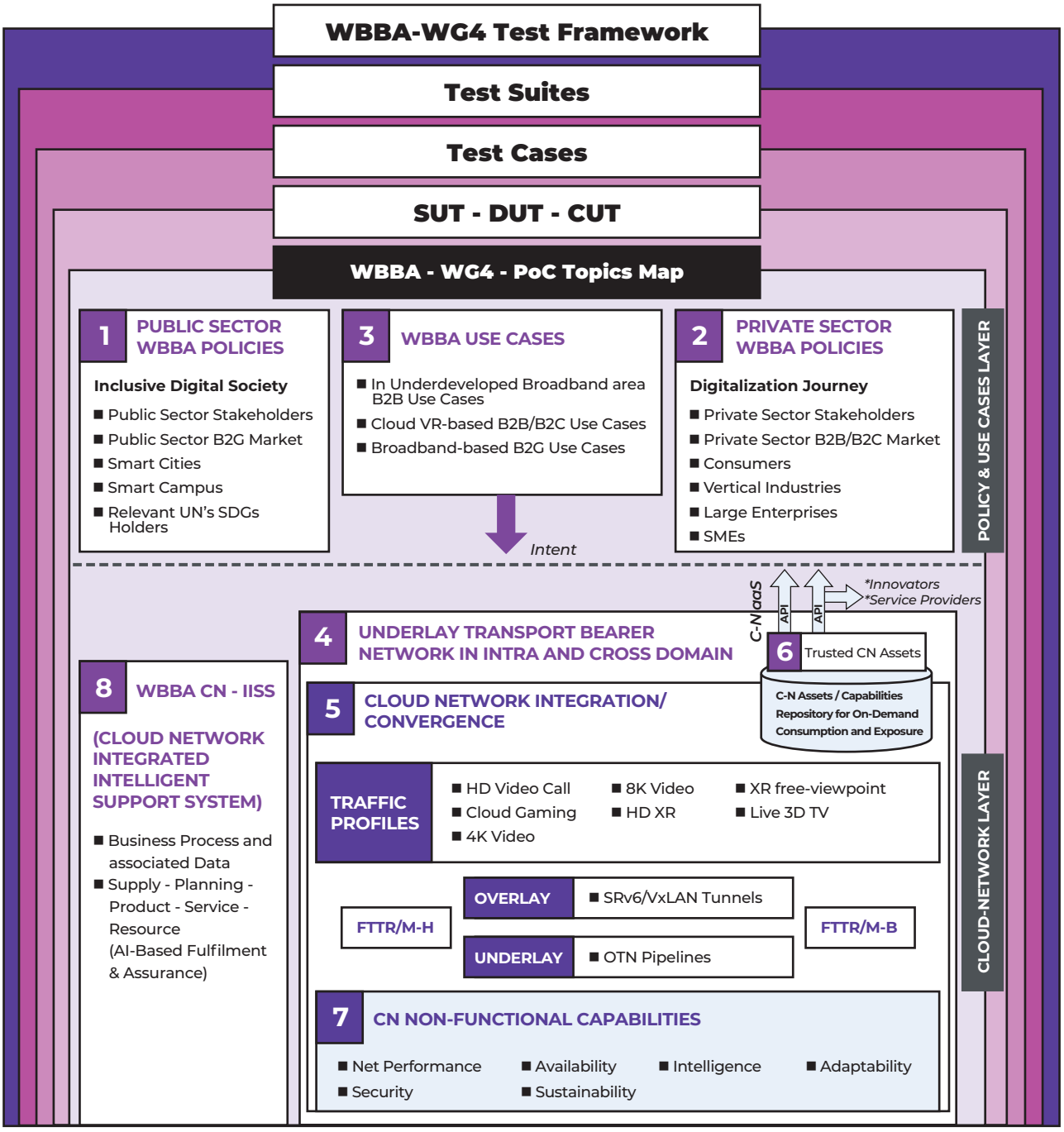
EXECUTION BLUEPRINT

It contains the following Templates as depicted in Figure 2:

- Test Plan
- Test Suites
- Test Cases
- System / Device / Component Under Test (SUT-DUT-CUT)
- Test Case Report

Besides, Figure 3 depicts this WBBA-WG#4 Test Framework / Execution Blueprint nested model where SUT-DUT-CUT points to the WG#4 POC Topic Map.

FIGURE 3: WBBA-WG#4 TEST FRAMEWORK / EXECUTION BLUEPRINT NESTED MODEL



SOURCE: WBBA

POC PROGRAM GOVERNANCE ACTORS, ROLES AND RESPONSIBILITIES DEMARCATION

Figure 4 depicts the 4-phase process of the WG#4 POC Program Governance the involved Actors, their Roles and Responsibilities demarcation.

POC PROGRAM MANAGEMENT RESPONSIBILITY

ROLE

It is the POC Projects Requester and POC Project Report Consumer
The POC Program Management is responsible for the following tasks:

- Call for POC Projects
- Identifying relevant expected contributions and its timelines for POC Topics
- Processing the contributions made by the POC Project teams on those topics
- Interested in the outcome of the POC Projects Results, and takeaways as interface with the WG#4 Track 1 dealing with Whitepaper series development.

It is charge of administering the POC activity process.

- Maintaining and making available the Topics Map
- Providing guidance and support during the creation of POC Project proposals
- Reviewing POC proposals (at submission phase) against the acceptance criteria and POC Reports (at the end of the POC Project)
- Notifying Acceptance/Rejection of each POC Project Proposal to the POC Project Team
- Monitoring the POC projects execution progress.

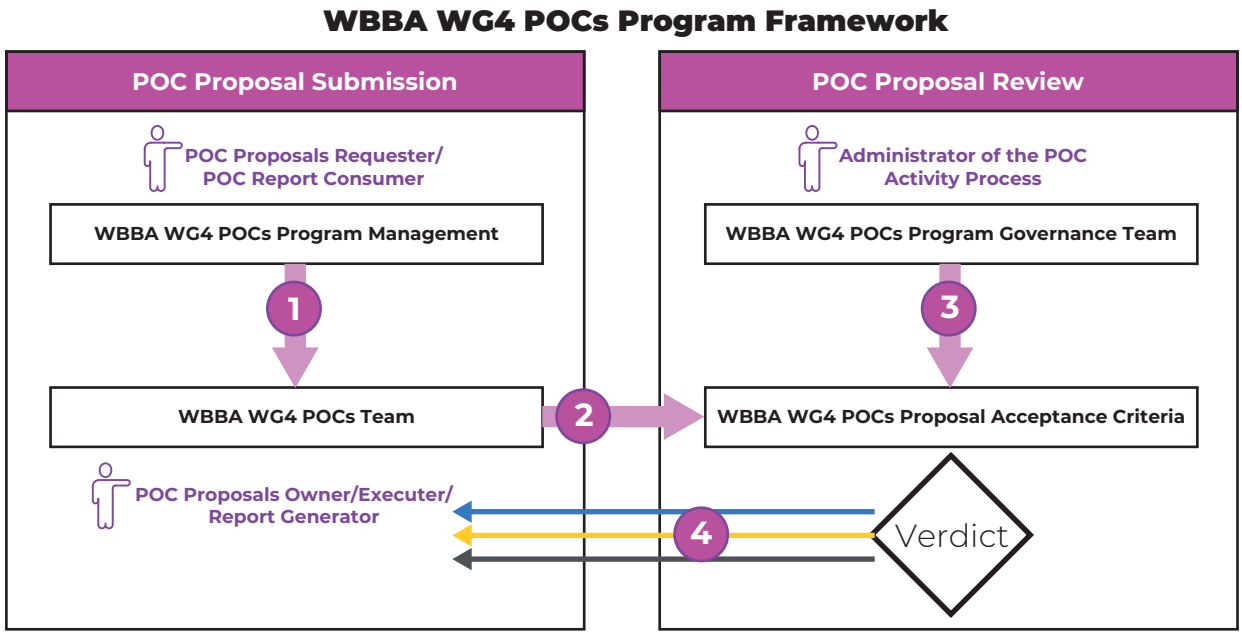
POC PROJECT TEAM RESPONSIBILITY

ROLE

The POC Project Team is a Group of organizations participating in one POC project. The POC Team Is in charge of:

- Writing the POC proposal
- Submitting the POC Project proposal to the POC Program Management
- Executing the POC Project and collecting the relevant data
- Writing the POC Test Report (as aggregation of the Test Case Reports)
- Submitting the expected contributions to the WG#4 POC Program Governance Team.

FIGURE 4: 4-PHASE PROCESS OF THE WG#4 POC PROGRAM GOVERNANCE



SOURCE: WBBA

POC PROJECT ACCEPTANCE

The acceptance criteria are listed below:

1) The POC Governance Team will check the POC proposal contains the information requested in the format of the WBBA WG#4 POCs Program Template.

2) The organizations participating in a POC Project Team include at least two (2) Manufacturers and at least one (1) Cloud / Service Providers / Network Operator. The POC Project Team is encouraged to include members from the categories of Universities and Research Bodies besides the stakeholders mentioned in the WBBA WG #4 POCs Topics Map.

3) The POC Project proposal addresses at least one (1) goal relevant to a WBBA use case or scenario as described in the WBBA WG #4 POCs Topics Map but also others described in WBBA published white papers.

4) The output of the POC Project Team provides feedback to the WBBA WG#4 POCs Program in order to:

a) Support the improvement of the output of the existing WBBA Work Groups
b) Alignment with existing activities and Work Groups is recommended.

5) The POC Project proposal indicates the date/venue where the POC Project will be demonstrated (e.g. POC Project Team member lab, industry trade show, major events such as MWC, MPLS Congress, IEEE and other Platforms).

6) A POC Project timeline should be provided.

7) Description of testing methodologies and concrete measurement processes should be indicated as described in the POC Framework Test Template.

WG#4 POC PROGRAM SUPPORT DELIVERABES

To support and assist POC Project Teams in the whole POC Project process, we developed and made available the following deliverables listed in Figure 5.

FIGURE 5: WG4 POC PROGRAM SUPPORT DELIVERABLES

POC Governance Process, V01	July 26th, 2023
POC Topics Map, V01	July 26th, 2023
POC Project Proposal Template, V01	November 9th, 2023
POC Test Framework: Test Template, v01	November 10th, 2023
POC Test Framework: Test Report Template, v01	November 10th, 2023

SOURCE: WBBA

INSTANTIATION OF THE POC PROGRAM FRAMEWORK ONTO A REAL POC PROJECT AS CASE STUDY

Within the WG#4 Track dedicated to the POC Program as part of the WG#4 ToR, we instantiated and operationalized the WG#4 POC Program Framework onto a 12-month POC Project on “Cloud XR / 8K Video on Demand” as a case study. The POC Topic addressed is in the category 3 of the POC Topic Map (Figure 3). This POC Project is completed and will be showcased, and test Report will be published during MWC Shanghai (June 2024). Besides, WG#4 plans to promote this POC Project Test Report and showcase it in other events in different regions.

In table 2 we summarize the 14 Test Cases of this POC project led by China Telecom.

TABLE 2: SUMMARY OF THE WG#4 POC PROJECT ON “CLOUD XR / 8K VIDEO ON DEMAND” AS A CASE STUDY

WBBA WG#4 POC PROGRAM
POC PROJECT: CLOUD XR/8K VIDEO ON DEMAND
TEST RESULTS AND TEST CASES REPORTS

POC Program Leader: Tayeb BEN MEREM (IPv6 Forum, Vice-Chair)
POC Project Leader and Tester: Luying ShangGuan (China Telecom)
14 Test Cases and Test Case Reports grouped into 3 Test Categories

- Lag Test (6)
- RTT Test (4)
- TCP Test (4)

TEST CASE ID AND TITLE	TEST CAMPAIGN PROGRESS	NEXT STEP
TEST CASE 1 **LAG TEST OF LOW BIT RATE VIDEO ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 1 Report (MWC, Shanghai, June 2024)
TEST CASE 2 **LAG TEST OF 4K (HIGH BIT RATE) VIDEO ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 2 Report (MWC, Shanghai, June 2024)
TEST CASE 3 **LAG TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 3 Report (MWC, Shanghai, June 2024)
TEST CASE 4 **LAG TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 4 Report (MWC, Shanghai, June 2024)
TEST CASE 5 **LAG TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 5 Report (MWC, Shanghai, June 2024)
TEST CASE 6 **LAG TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 6 Report (MWC, Shanghai, June 2024)
TEST CASE 7 **RTT TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 7 Report (MWC, Shanghai, June 2024)

TEST CASE ID AND TITLE	TEST CAMPAIGN PROGRESS	NEXT STEP
TEST CASE 8 **RTT TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 8 Report (MWC, Shanghai, June 2024)
TEST CASE 9 **RTT TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 9 Report (MWC, Shanghai, June 2024)
TEST CASE 10 **RTT TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 10 Report (MWC, Shanghai, June 2024)
TEST CASE 11 **TCP RESEND RATE TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 11 Report (MWC, Shanghai, June 2024)
TEST CASE 12 **TCP RESEND RATE TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 12 Report (MWC, Shanghai, June 2024)
TEST CASE 13 **TCP RESEND RATE TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 13 Report (MWC, Shanghai, June 2024)
TEST CASE 14 **TCP RESEND RATE TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM**	*Test Campaign Completed *Test Case Report Available	Consolidation and Publication of the Test Case 14 Report (MWC, Shanghai, June 2024)

SOURCE: WBBA

OUTCOME AND TAKEAWAYS

Two documents have been developed as outcome of this POC Project:

- POC Project Test Report “Cloud XR/8K Video on Demand “(by China Telecom, June 2024)
- Subjective Analysis of WBBA WG#4 (Cloud Network Convergence) POC Project Test Result Report (by Omdia, June 2024)

POC Test Report

POC PROJECT: CLOUD XR/ 8K VIDEO-ON-DEMAND

ABSTRACT

To assess, test and validate the viability of the Concepts, Architectures, Technologies and the relevance of Business Scenarios and Use cases developed in the NET5.5G Whitepaper, WBBA WG#4 put in place a POC Program as dedicated Track in its ToR. The POC Program developed Governance and Process, Test Frameworks and Test Templates to assist WBBA WG#4 members in their POC Project journey. These Test Templates have been instantiated and operationalized in this current 12-month POC Project on “Cloud XR / 8K Video on-Demand” as a case study. This POC Test Report is composed of 14 Test Cases broken down into 3 Categories (6 Lag Tests), (4 RTT Tests), (4 TCP Tests).

In table 1, we present an overview of these 14 Test Cases, followed by 2 tables for each individual Test Case, 1) Test Case Report Template (26 Clauses), 2) Test Case Report (Data & Results) to help readers navigating this document.

This POC project has been completed in June 2024 and will be showcased in MWC Shanghai 2024 and in other events in different regions.

Targeted audience: Technical Experts

POC PROJECT DESCRIPTION

In 2025, Broadband networks will be expanded from connecting individuals and homes to connecting everything from everyday objects to anything we wear and interact with. This evolution in home Broadband connectivity opens new Business horizons, such as Cloud XR, which demands high Bandwidth, Ultra-Low Latency, and high-performance networks.

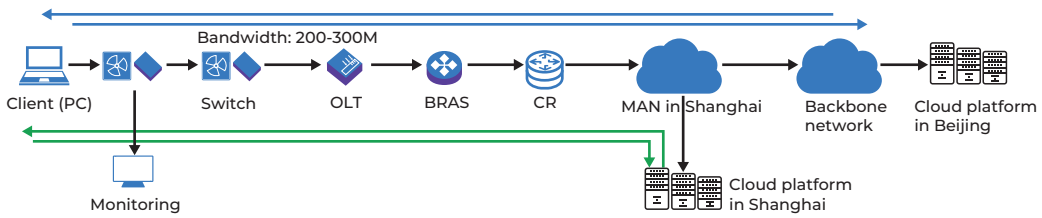
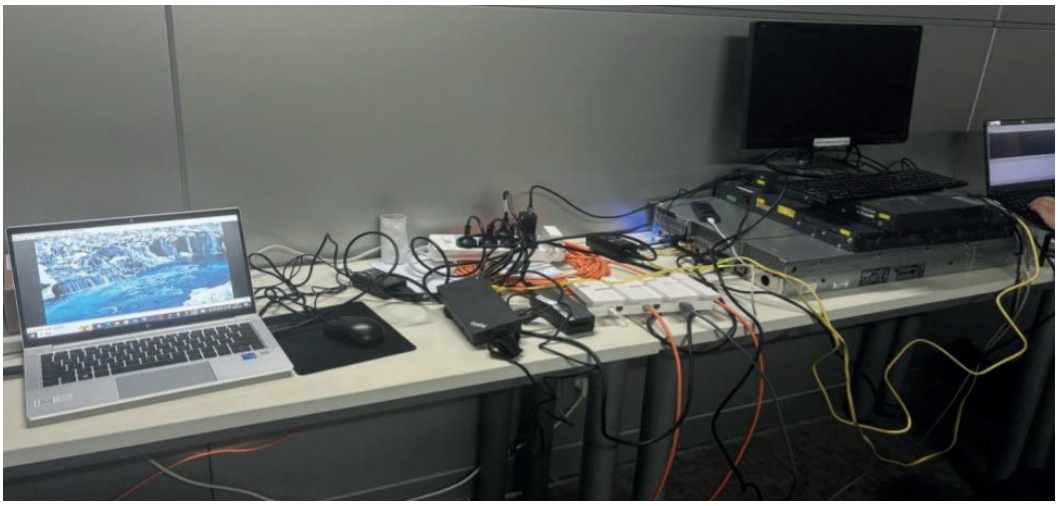
The gap between the physical and digital worlds will narrow using XR immersive experiences—social aspects of life, such as healthcare. Online Shopping and Cloud Gaming are all set to evolve, not only in how people interact with healthcare professionals, do shopping or play on-demand Cloud Games. Cloud VR includes family-oriented Entertainment, Live Gaming, Education, Shopping capabilities etc., in the form of Scenarios, including VR IMAX, VR Panoramic Videos, and Live Broadcasts for an Interactive and Immersive Experience. Numerous intelligent connected devices are used, including Mirrors, Weighing Scales, Cameras, Headsets, Wearables, etc., for real-time experiences. However, high network bandwidth is still a showstopper for the immersive experience because a tiny glitch can severely deteriorate individual service experiences.

TABLE 1: SUMMARY OF THE POC PROJECT 14 TEST CASES

Test Case Categories (3) ■ Lag Test (6) ■ RTT Test (4) ■ TCP Test (4)	
TEST CASE ID AND TITLE	**TEST CASE SCOPE**
Test Case 1	***Lag Test*** of ***low bit rate*** Video-on-Demand accessing to ***Beijing*** cloud platform
Test Case 2	***Lag Test*** of ***4K*** (high bit rate) Video-on-Demand accessing to ***Beijing*** cloud platform
Test Case 3	***Lag Test*** of ***8K*** video ***Source1*** on demand accessing to ***Beijing*** cloud platform
Test Case 4	***Lag Test***of ***8K*** video ***Source2*** on demand accessing to ***Beijing*** cloud platform
Test Case 5	***Lag Test*** of ***8K*** video ***Source1*** on demand accessing to ***Shanghai*** cloud platform
Test Case 6	***Lag Test***of ***8K*** video ***Source2*** on demand accessing to ***Shanghai*** cloud platform
Test Case 7	***RTT Test*** of ***8K*** video ***Source1*** on demand accessing to ***Beijing*** cloud platform
Test Case 8	***RTT Test*** of ***8K*** video ***Source2*** on demand accessing to ***Beijing*** cloud platform
Test Case 9	***RTT Test*** of ***8K*** video ***Source1*** on demand accessing to ***Shanghai*** cloud platform
Test Case 10	***RTT Test*** of ***8K*** video ***Source2*** on demand accessing to ***Shanghai*** cloud platform
Test Case 11	***TCP*** resend rate Test of ***8K*** video ***Source1*** on demand accessing to ***Beijing*** cloud platform
Test Case 12	***TCP*** resend rate Test of ***8K*** video ***Source2*** on demand accessing to ***Beijing*** cloud platform
Test Case 13	***TCP*** resend rate Test of ***8K*** video ***Source1*** on demand accessing to ***Shanghai*** cloud platform
Test Case 14	***TCP*** resend rate Test of ***8K*** video ***Source2*** on demand accessing to ***Shanghai*** cloud platform

TEST CASE #1

LAG TEST OF LOW BIT RATE VIDEO ON-DEMAND ACCESS TO THE BEIJING CLOUD PLATFORM

Executive Summary	Users in Shanghai simulate cloud broadband services, namely video-on-demand services. First, the network environment verification work is carried out to monitor the integrity and robustness of the network link between the user terminal and the Beijing Cloud Service platform. Users in Shanghai successfully access the Beijing Cloud Platform through the Shanghai Metropolitan area MAN and backbone network. Beijing Cloud Platform pushes different types of low-bit-rate videos 240P/480P/720P in real-time, and user terminals perform playback tests to check the playback effect. The test results show that when Shanghai users accessed the Beijing cloud platform and visited low bit rate video resources (240P/480P/720P), with the improvement of resolution, video clarity improved, video playback can maintain almost no deadlock, video lag, and other exceptions, the playback effect is good. The next step will be to detect the "tipping point" of service quality deterioration.
POC Project Name	Cloud XR/8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	The comparison tests of 8K Video-on-Demand in the Beijing and Shanghai platforms confirmed the importance and necessity of developing an edge cloud in the evolution of cloud network convergence. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central and edge cloud for different video quality is an important capability for future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

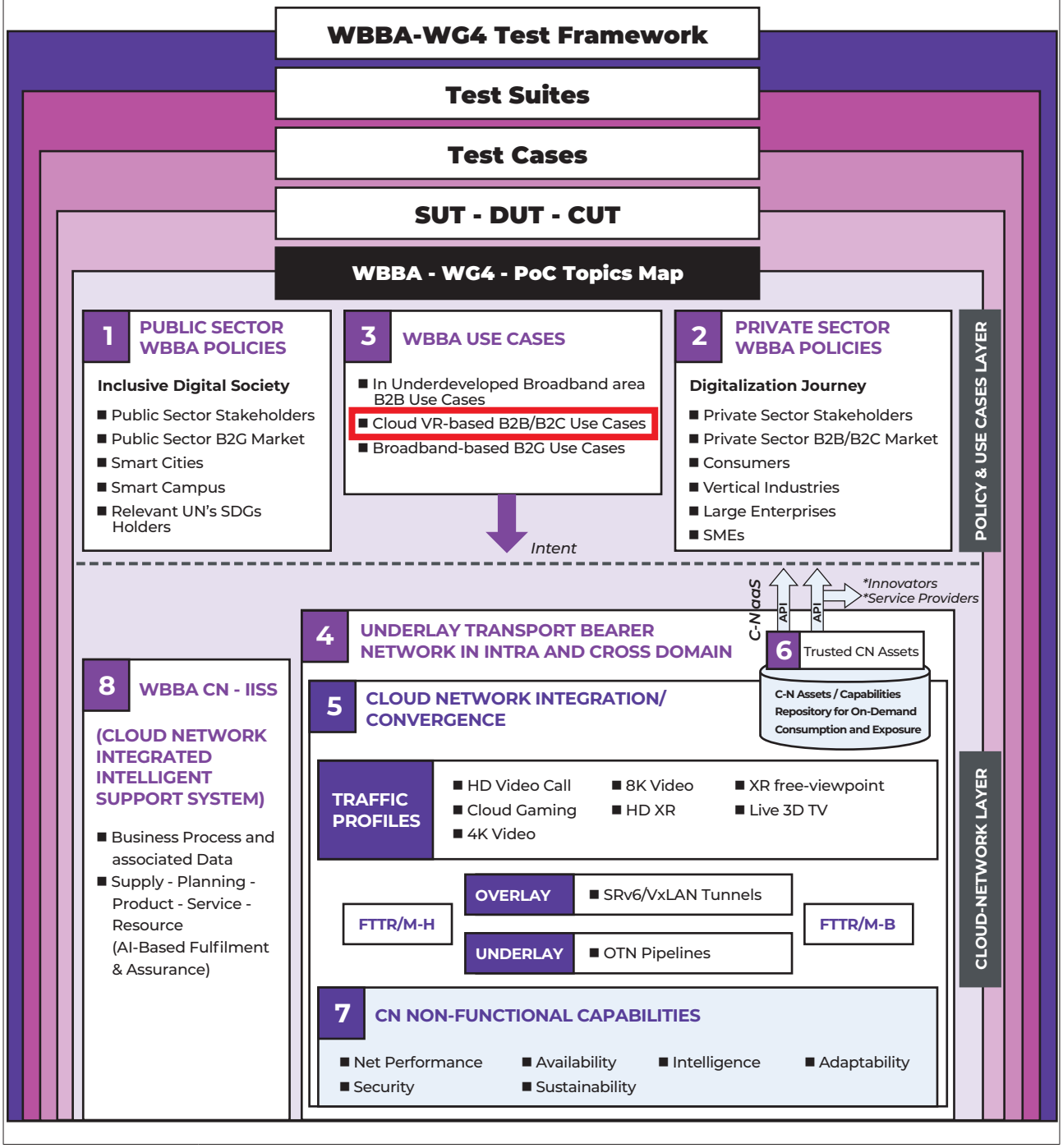
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #1 Lag Test of Low Bit Rate Video-On-Demand Access to Beijing Cloud Platform				
Test Case Owner	China Telecom				
Tester	Luying Shangguan				
Test Date	04/16/2024				
Test Case Purpose / Objective	Please verify that the Beijing Cloud platform network environment supports video-on-demand services, and at the same time, it is in contrast with the deterioration of high bit rate video and even 8K video playback quality				
What Business Challenges the Test Case is addressing?	Construct 8K cloud platform and push real-time stream.				
What makes this a significant problem to be solved?	The construction of the platform involves the acquisition of cloud resources in Beijing				
Test Case Description	Verify the robustness of low bit rate Video-on-Demand (240P /480P/720P) accessing the Beijing Cloud Platform.				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass**				
	2) Fail X				
	3) Inconclusive X				
	Pass / Fail Ratio: 100%				
	4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results				
	5) Unexpected issues happened: No				

Output and Data	1. Platform: Beijing/ Player: VLC /Video: 240P Result: Play smoothly, no video lags 
	2. Platform: Beijing/ Player: VLC /Video: 480P Result: Play smoothly, no video lags 
	3. Platform: Beijing/ Player: VLC /Video: 720P Result: Play smoothly, no video lags 

Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream-pushing
Potential innovation impact	Push stream in real-time.
Recommended Improvements	Describe any recommendation that emerged during the Test Campaign that could improve the SUT/ DUT / CUT and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	This test case proved that clod network convergence is a way forward. Remote users in Shanghai can access low-bit-rate video resources of the Beijing cloud platform video resources without video delays or deadlocks. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand.
Feedback to WBBA WGs	This test proved the viability of the WBBA WG4 whitepaper, Driving the future of understanding the landscape of network convergence.

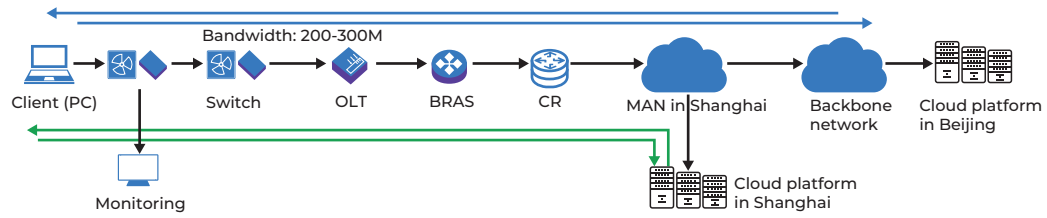
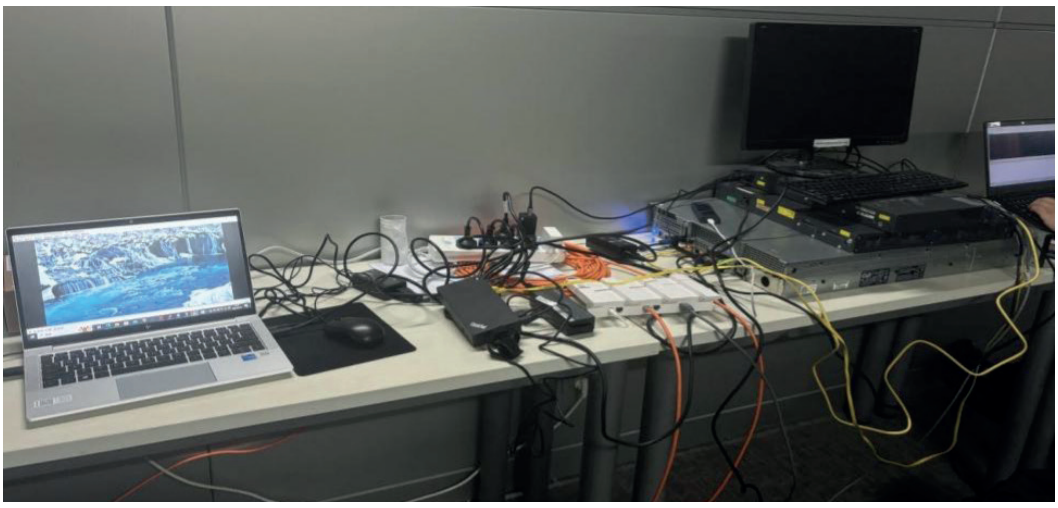
POC Topic Map Test Framework

The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #2

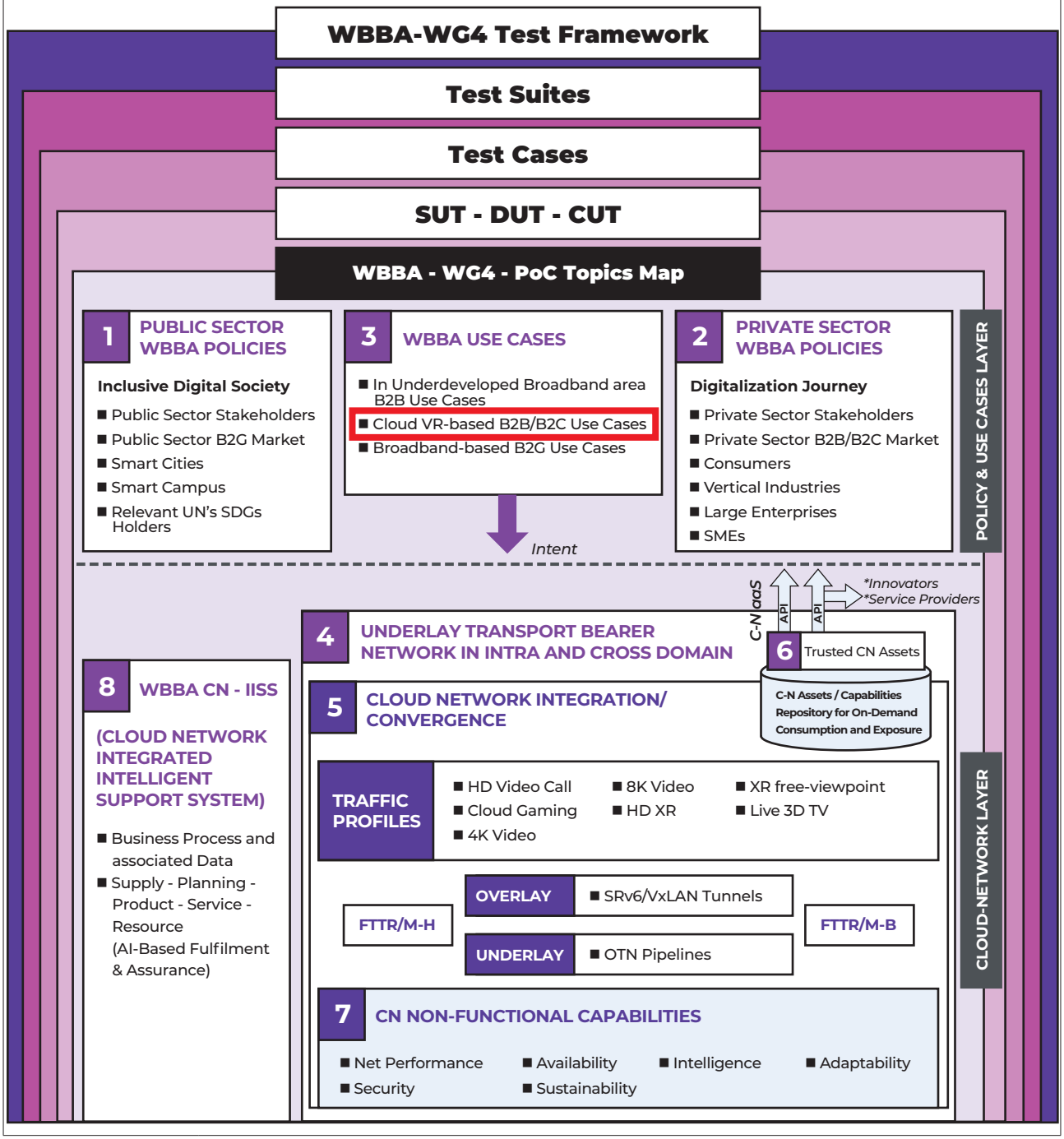
LAG TEST OF 4K (HIGH BIT RATE) VIDEO ON-DEMAND ACCESSING TO BEIJING CLOUD PLATFORM

Executive Summary	The higher the video resolution, the higher the bit rate is required for transmission, and the network overhead must be increased. Compared with accessing the Shanghai cloud platform and visiting local video resources, users in Shanghai accessing the Beijing cloud platform is a long-distance transmission. That will cause more serious network damage. This test case aimed to explore the degradation threshold of video-on-demand service accessing the Beijing platform. It has also proved that short-distance transmission suits large traffic services, such as 8K Video-on-Demand, cloud games, etc. At the same time, new ideas for optimizing Shanghai cloud bandwidth service have been put forward, such as introducing edge cloud to large traffic services.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #2 Lag Test of 4K(High Bit Rate) Video-On-Demand access to Beijing Cloud Platform				
Test Case Owner	China Telecom				
Tester	Luying Shangguan				
Test Date	04/16/2024				
Test Case Purpose / Objective	This test case aimed to explore the degradation threshold of video-on-demand service accessing the Beijing platform.				
What Business Challenges the Test Case is addressing?	Construct 8K cloud platform and push real-time stream.				
What makes this a significant problem to be solved?	The construction of the platform involves the acquisition of cloud resources in Beijing.				
Test Case Description	Explore and verify that the video-on-demand service began to deteriorate when accessing 4K video on the Beijing cloud platform.				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

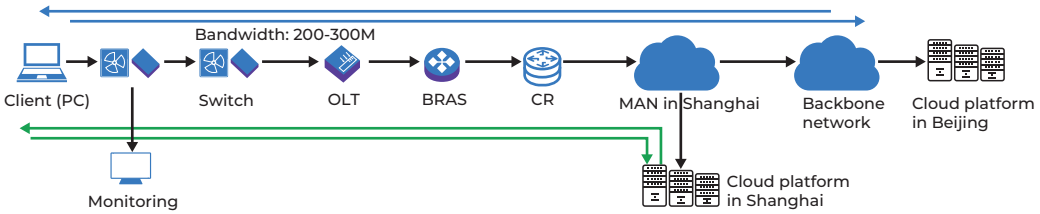
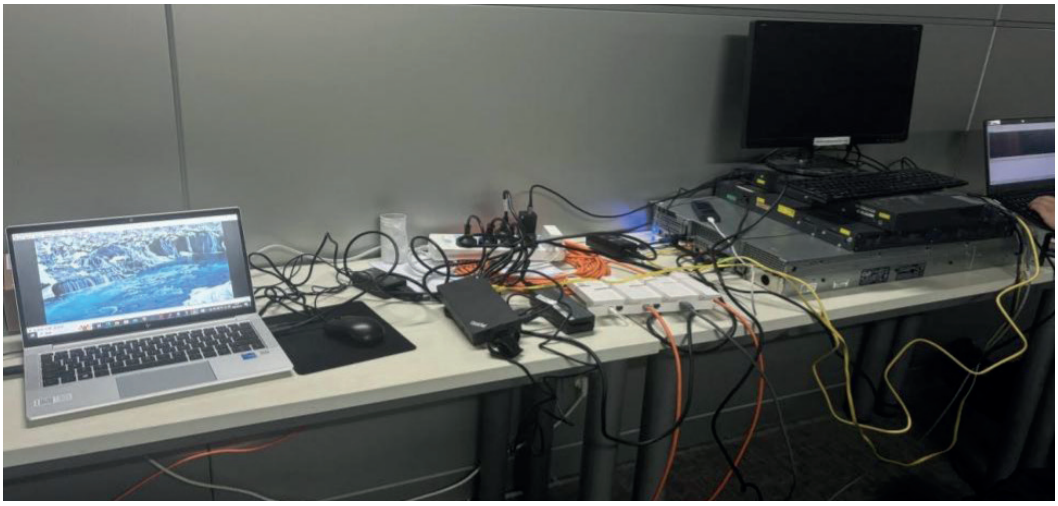
Output and Data	Platform: Beijing/ Player: VLC /Video: 4K Result: Higher resolution, obvious video lag, and the screen becomes blurred and indistinct lightly  
Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing.
Potential innovation impact	Push stream in real-time.
Recommended Improvements	Describe any recommendation that emerged during the Test Campaign that could improve the SUT/ DUT / CUT and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	Close cooperation between the central and local edge clouds for different video quality is an important capability requirement of future cloud network convergence. The quality of videos above 4K cannot be guaranteed simply by improving the network quality but by deploying in the local cloud to realize local area forwarding. Hence, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed.
Feedback to WBBA WGs	Please, Tayeb to advise

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #3

LAG TEST OF 8K VIDEO SOURCE1 ON-DEMAND ACCESS TO THE BEIJING CLOUD PLATFORM

Executive Summary	Test cases 3 and 4 represent the test cases of 8K video source1 and source2 on-demand accessing to a remote cloud platform(Beijing). Compared with ordinary video (240P/480P/720P/4K), whether 8K source1 or source2, there are obvious delay phenomena during playback, including but not limited to the first screen response lag, deterioration of picture quality, black screen, even playback interruption. Therefore, concluding that on-demand remote video will greatly challenge large bandwidth and large traffic services is not difficult.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		

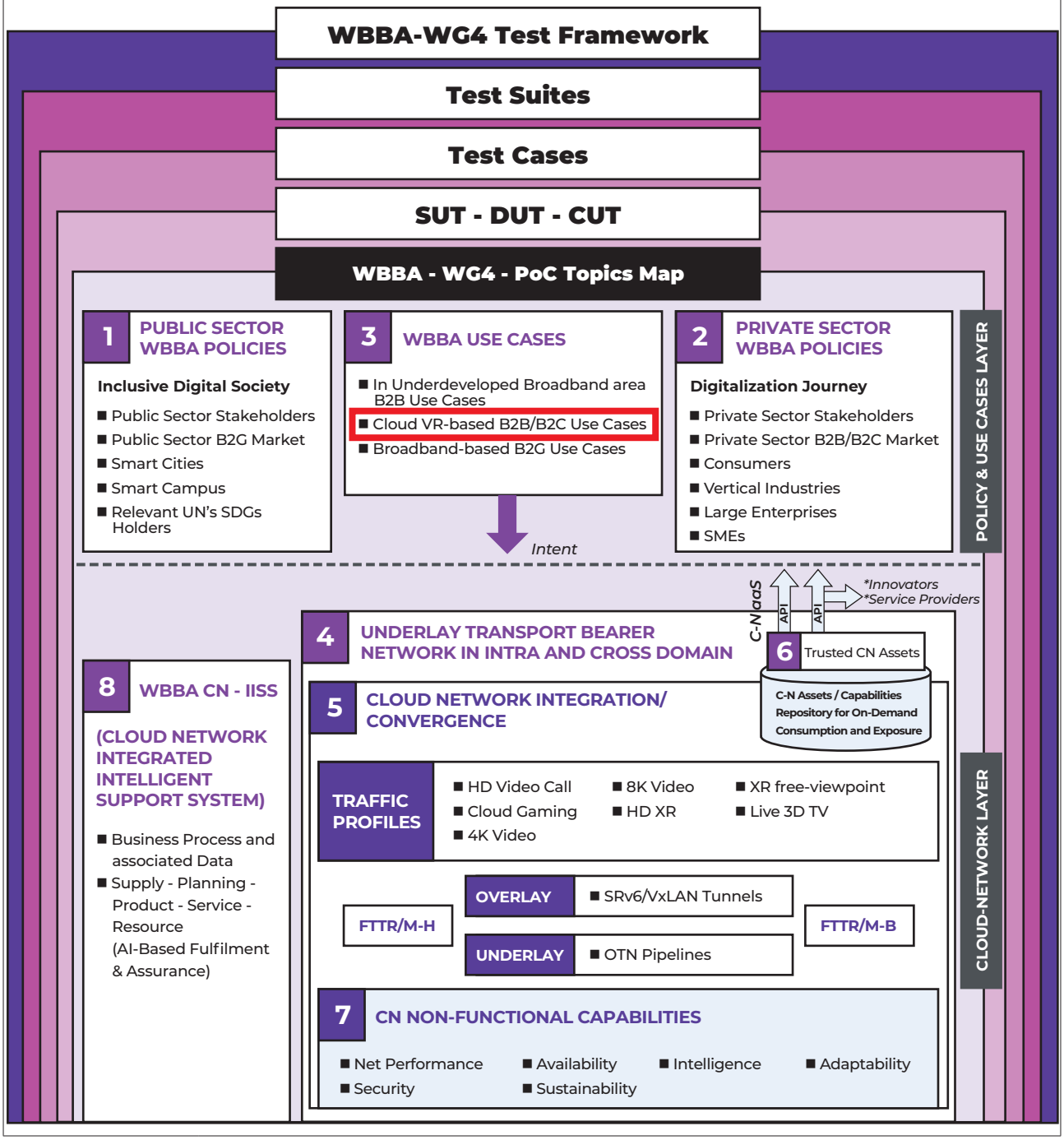
Test Case (TC) Name and ID (TC#1)	Test Case #3 Lag Test of 8K Video Source1 On-Demand access to Beijing Cloud Platform
Test Case Owner	China Telecom
Tester	Luying Shangguan
Test Date	04/16/2024
Test Case Purpose / Objective	Verify that the Beijing Cloud platform network environment supports video-on-demand services, and at the same time, it is in contrast with the deterioration of high bit rate video and even 8K video playback quality.
What Business Challenges the Test Case is addressing?	Construct 8K cloud platform and push real-time stream
What makes this a significant problem to be solved?	The construction of the platform involves the acquisition of cloud resources in Beijing.
Test Case Description	Test the fluency of 8K video source1on-demand on the Beijing cloud platform and observe the remote playback effect.
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases
Test Suite(s)	
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No

Output and Data	Platform: Beijing/ Player: VLC /Video: 8K Video1 Result: Obvious video lag and unable to play later   

Output and Data	 
Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	From this Testing, it is easy to conclude that 8K video demands high resolution and a large bandwidth to access on-demand from a remote source. Hence, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed.
Feedback to WBBA WGs	Please, Tayeb to comment.

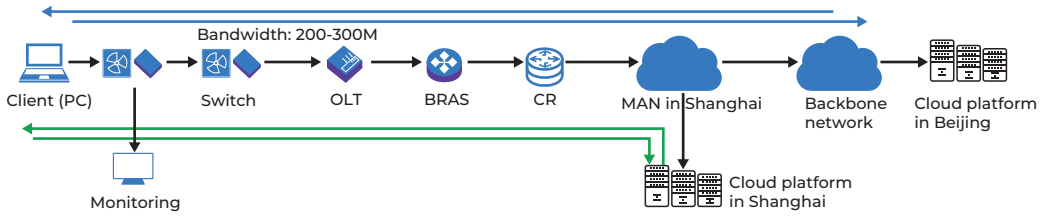
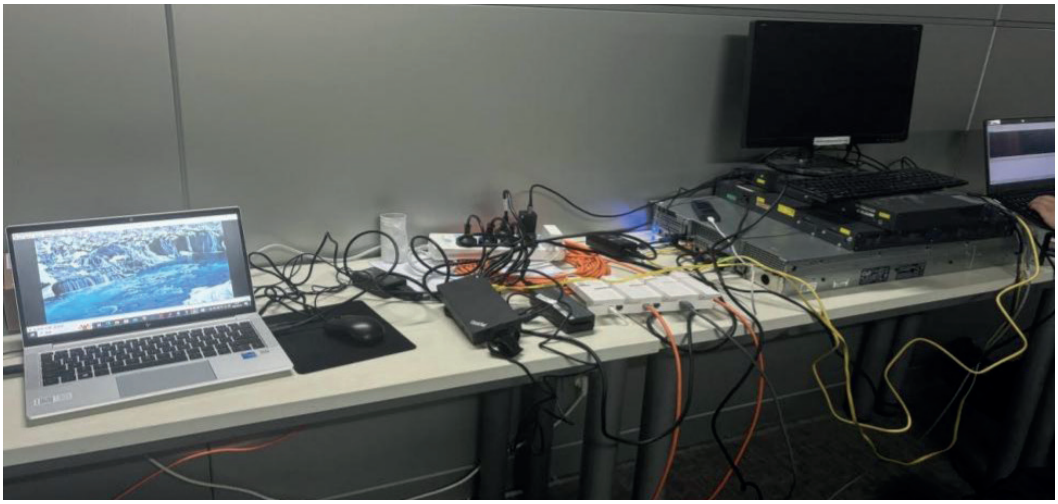
POC Topic Map Test Framework

The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #4

LAG TEST OF 8K VIDEO SOURCE2 ON-DEMAND ACCESS TO THE BEIJING CLOUD PLATFORM

Executive Summary	Test cases 3 and 4 represent the test cases of 8K video source1 and source2 on-demand accessing to a remote cloud platform(Beijing). Compared with ordinary video (240P/480P/720P/4K), whether 8K source1 or source2, there are obvious delay phenomena during playback, including but not limited to the first screen response lag, deterioration of picture quality, black screen, even playback interruption. Therefore, concluding that on-demand remote video will greatly challenge large bandwidth and large traffic services is not difficult.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

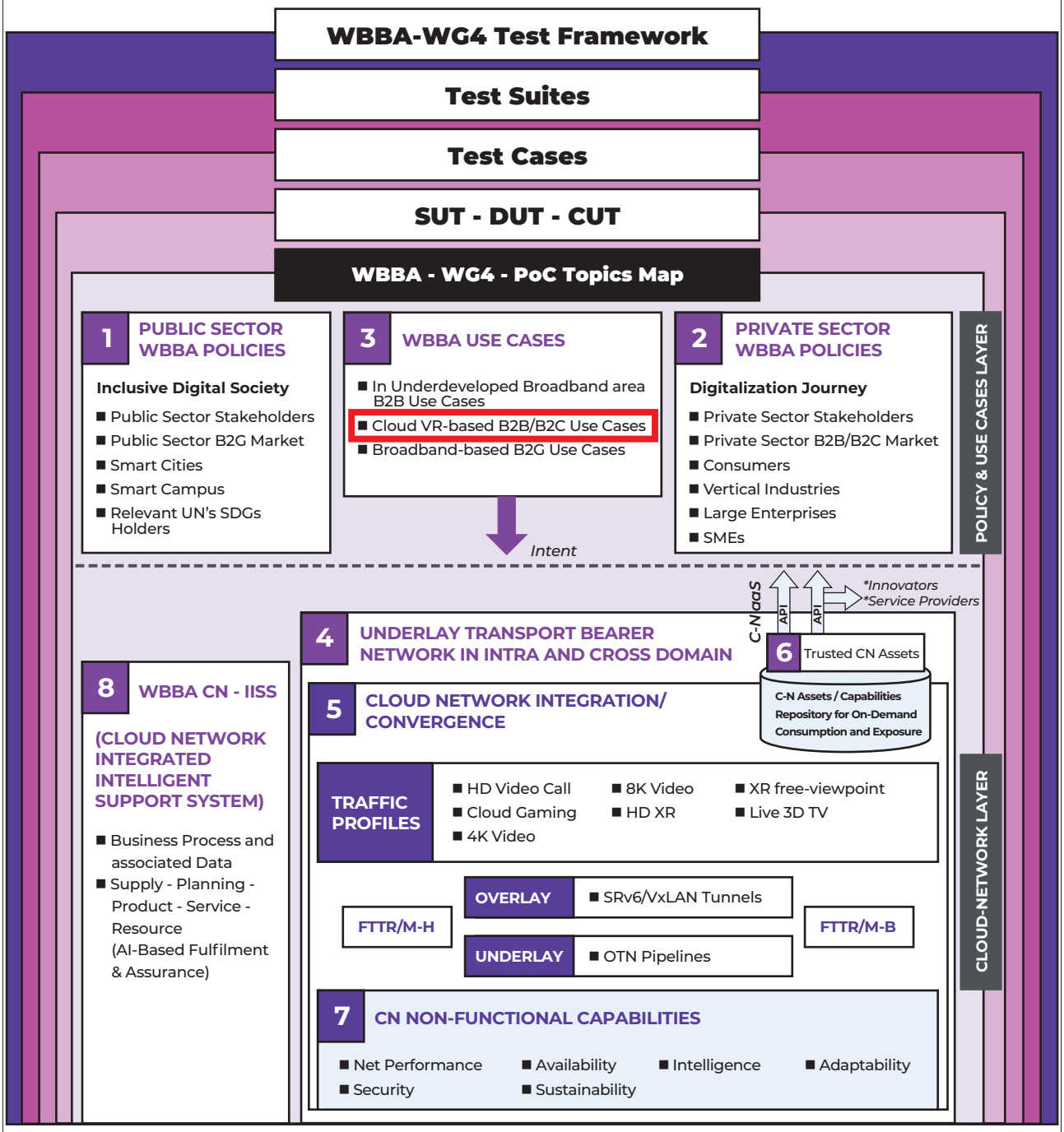
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #4 Lag Test of 8K Video Source2 On-Demand access to Beijing Cloud Platform				
Test Case Owner	China Telecom				
Tester	Luying Shangguan				
Test Date	04/16/2024				
Test Case Purpose / Objective	Verify that the Beijing Cloud platform network environment supports video-on-demand services, and at the same time, it is in contrast with the deterioration of high bit rate video and even 8K video playback quality				
What Business Challenges the Test Case is addressing?	Construct 8K cloud platform and push real-time stream				
What makes this a significant problem to be solved?	The construction of the platform involves the acquisition of cloud resources in Beijing				
Test Case Description	Test the fluency of 8K video source2 on-demand on Beijing cloud platform and observe the remote playback effect				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Platform: Beijing/ Player: VLC /Video: 8K Video2 Result: Obvious video lag and unable to play later  

Output and Data	Platform: Beijing/ Player: VLC /Video: 8K Video2 Result: Obvious video lag and unable to play later   

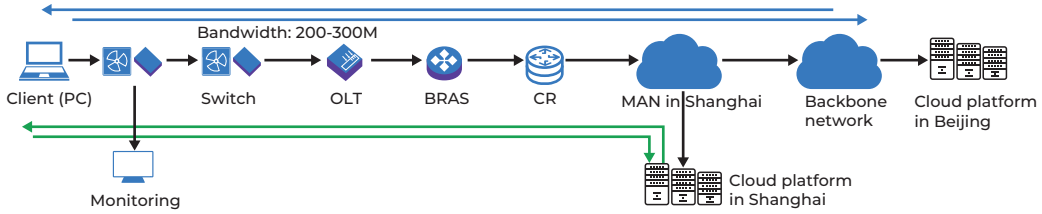
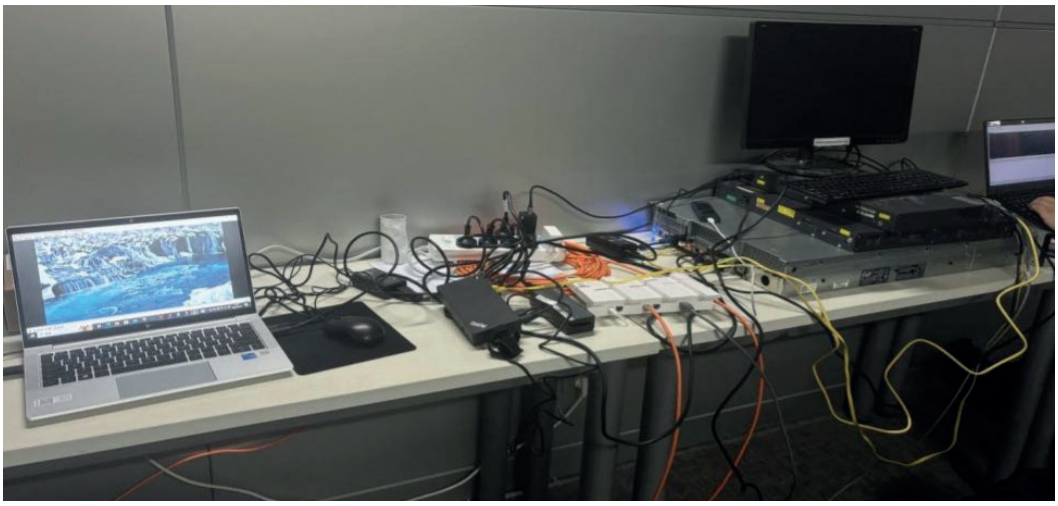
Output and Data	 
Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT/ CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This testing proved that cloud network integration and full convergence are required between the central and edge cloud for videos above 4K; otherwise, large bandwidth and large traffic services will challenge deterministic user experience.
Feedback to WBBA WGs	Tayeb to advise.

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #5

LAG TEST OF 8K VIDEO SOURCE2 ON-DEMAND ACCESS TO THE SHANGHAI CLOUD PLATFORM

Executive Summary	Test case 5 and test case 6 select 8K video source1 and 8K video source2, respectively, to carry out the Video-on-Demand on the local cloud platform(Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and check whether a playback exception(video lag) occurs.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #5 Lag Test of 8K Video Source1 On-Demand access to Shanghai Cloud Platform				
Test Case Owner	China Telecom				
Tester	Luying Shangguan				
Test Date	04/16/2024				
Test Case Purpose / Objective	Observe the deterioration of the playback effect when accessing 8K video source1 on the Shanghai cloud platform and compare it when accessing Beijing platform.				
What Business Challenges the Test Case is addressing?	Get access to the Shanghai Cloud Platform				
What makes this a significant problem to be solved?	Acquisition of cloud resources on the Shanghai platform				
Test Case Description	Observe the network performance of 8K video source1 on demand accessing to the Shanghai Cloud Platform.				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% **4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results** 5) Unexpected issues happened: No				

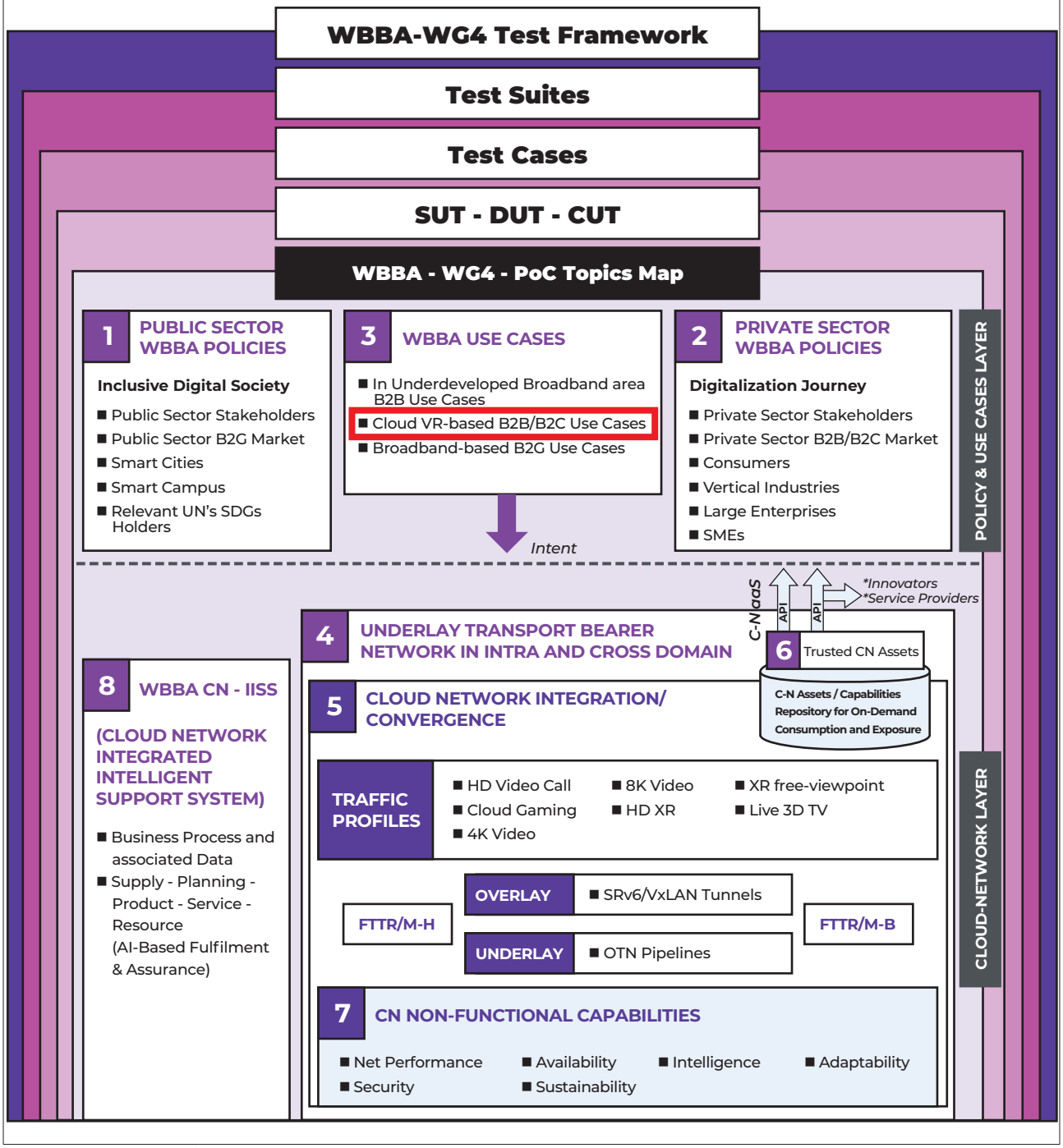
Output and Data	Platform: Shanghai/ Player: VLC /Video: 8K Video1 Result: Play smoothly, no video lags, 8K resolution, good viewing experience   

Output and Data	  

Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	This testing shows the importance of edge cloud development in evolving cloud network convergence. No video lag in 8K resolution is observed, and overall, it was a good and smooth viewing experience.
Feedback to WBBA WGs	Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

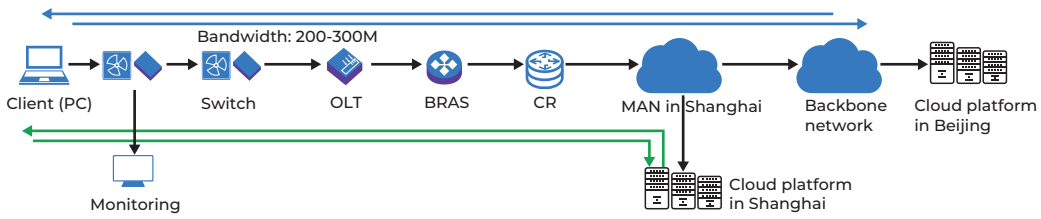
POC Topic Map Test Framework

The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #6

LAG TEST OF 8K VIDEO SOURCE2 ON-DEMAND ACCESS TO THE SHANGHAI CLOUD PLATFORM

Executive Summary	Test case 5 and test case 6 select 8K video source1 and 8K video source2, respectively, to carry out the Video-on-Demand on the local cloud platform (Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and check whether a playback exception(video lag) occurs.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	China Telecom
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources need to be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #6 Lag Test of 8K Video Source2 On-Demand access to Shanghai Cloud Platform				
Test Case Owner	China Telecom				
Tester	Luying Shangguan				
Test Date	04/16/2024				
Test Case Purpose / Objective	Observe the deterioration of the playback effect when accessing 8K video source2 on the Shanghai cloud platform and compare it when accessing Beijing platform.				
What Business Challenges the Test Case is addressing?	Get access to Shanghai Cloud Platform				
What makes this a significant problem to be solved?	Acquisition of cloud resources on the Shanghai platform				
Test Case Description	Observe the network performance of 8K video source2 on demand accessing to the Shanghai Cloud Platform.				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% **4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results** 5) Unexpected issues happened: No				

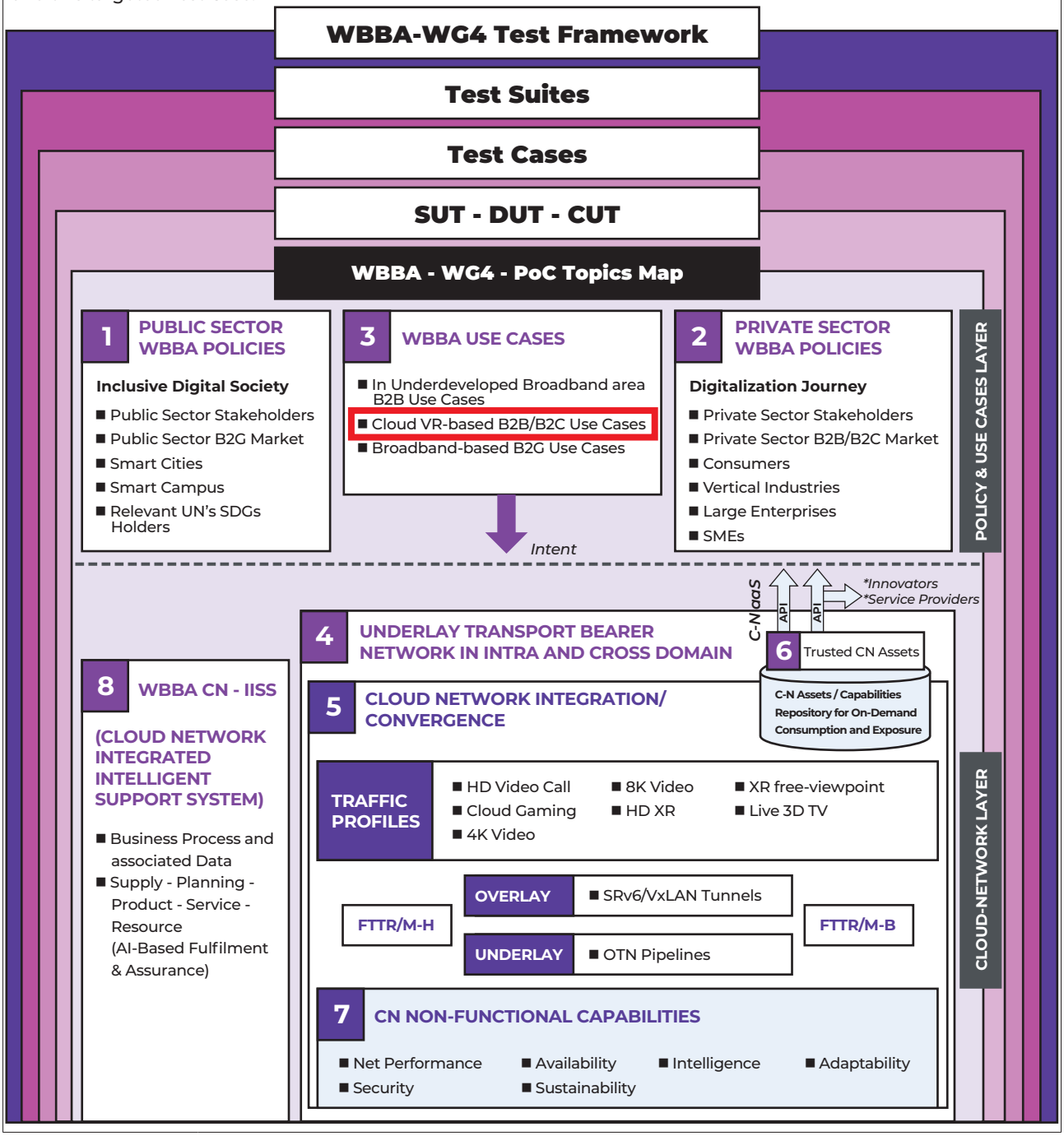
Output and Data	Platform: Shanghai/ Player: VLC /Video: 8K Video2 Result: Play smoothly, no video lags, 8k resolution, good viewing experience   

Output and Data	  

Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	This Testing shows the importance of edge cloud development in evolving cloud network convergence. No video lag in 8K resolution is observed, and overall, it was a good and smooth viewing experience from video source 2 accessing the Shanghai cloud platform.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

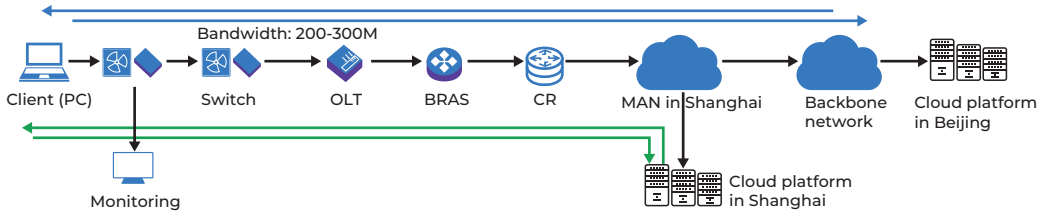
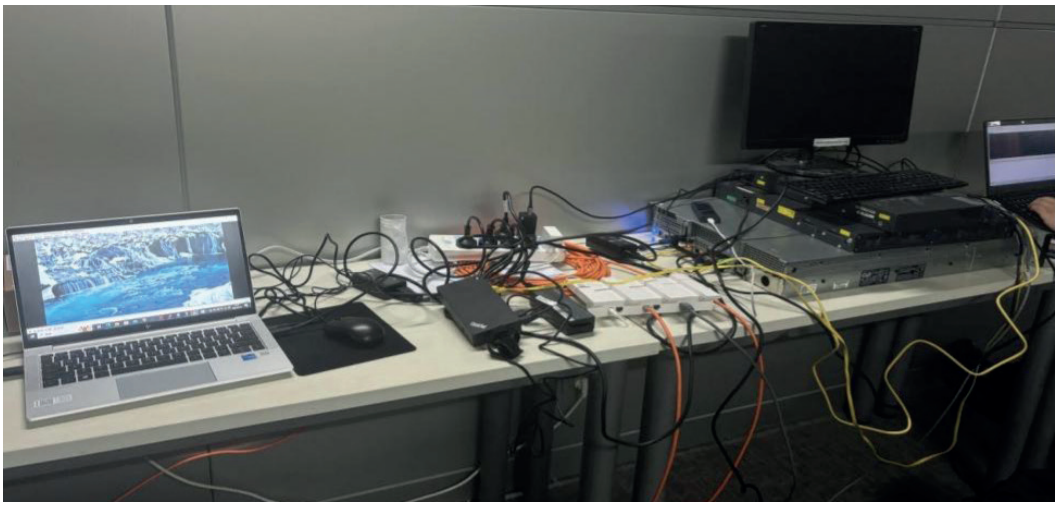
POC Topic Map Test Framework

The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #7

RTT TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM

Executive Summary	Test case7 and test case8 select 8K video source1 and 8K video source2, respectively, to carry out the Video-on-Demand on a remote cloud platform(Beijing) to make a comparison with that on a local cloud platform(Shanghai) and test the round trip time(RTT) when accessing to the remote platform(Beijing). The comparative tests on the local platform (Shanghai) will be carried out by test case9 and test case10.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

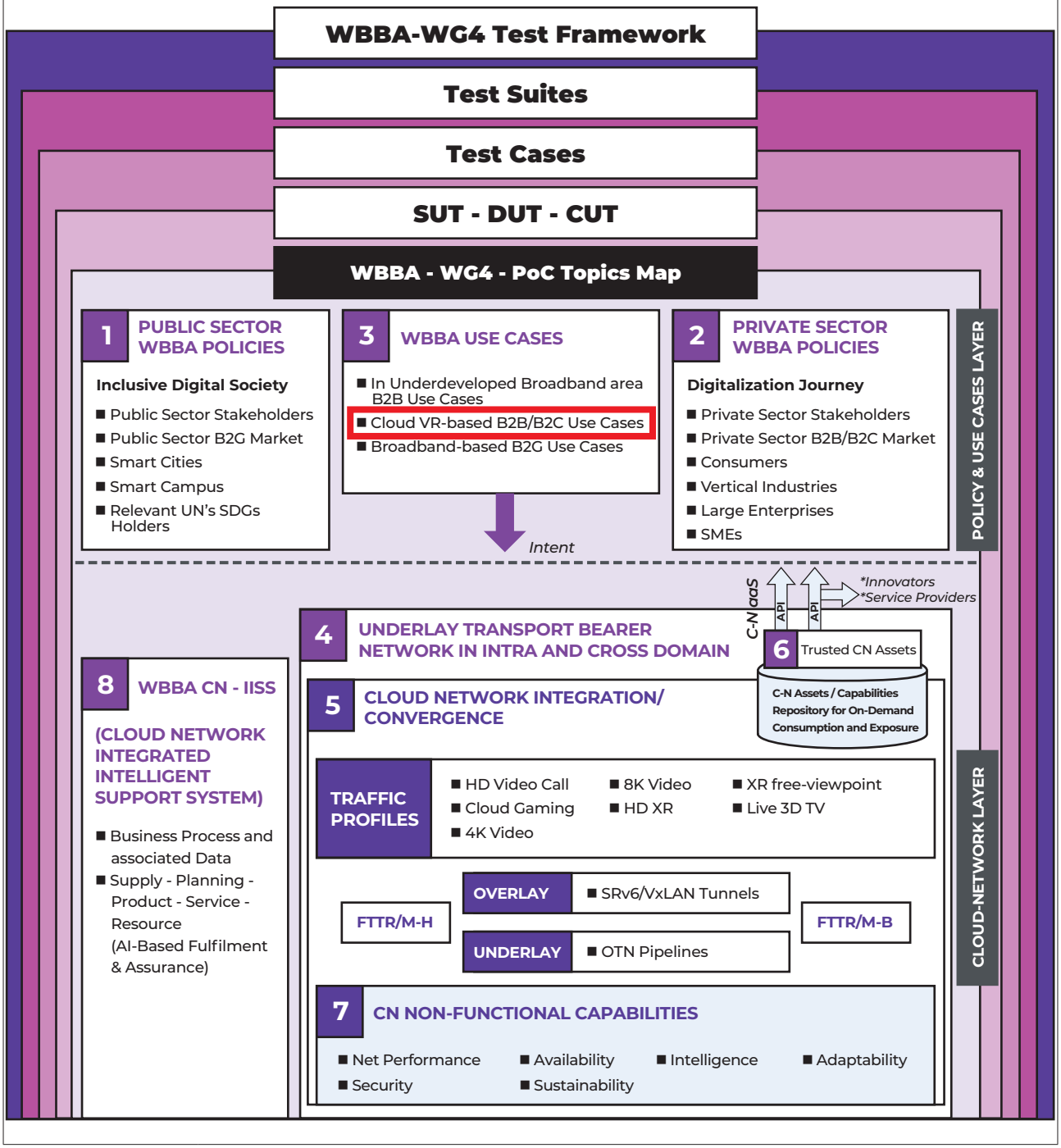
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #7 RTT test of 8K video Source1 on demand accessing to Beijing cloud platform				
Test Case Owner	Eversec /CTCC				
Tester	Pengchao Li/Shangguan Luying				
Test Date	04/29/2024				
Test Case Purpose / Objective	Test the round trip time(RTT) of 8K video source1 on demand when accessing a remote cloud platform (Beijing)				
What Business Challenges the Test Case is addressing?	Accessing through a VPN tunnel				
What makes this a significant problem to be solved?	Control the packet capture time. Filter packet capture conditions. Limit the flow window.				
Test Case Description	RTT test of Video-on-Demand when accessing the Beijing platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% **4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results** 5) Unexpected issues happened: No				

Output and Data	Location: Beijing Video: 8K Source1 Perception: Broken Frame RTT upload(ms): 6.591 RTT download(ms): 7.231 RTT(ms): 13.822

	开始时间	结束时间	上行流量(bytes)(UL_TRAFF)	下行流量(bytes)（bytes)	总流量bytes	上行持续时长-UL_DURATION 单位ms	下行持续时长DL_DURATION 单位ms	上行包数	下行包数	源地址	目标地址	上行TCP重传包数	下行TCP重传包数	RTT上行总时延单位 ms	RTT上行次数	RTT下行总时延单位 ms	RTT下行次数	上行平均rtt结果单位ms	下行平均rtt结果单位ms	重传次数
1	上午 11:25:51	上午 11:25:51	1144	128	1272	28	28	4	3	10.0.160.214	180.163.228.94	0	0	6	2	0	0	3	0	
1	上午 11:26:04	上午 11:26:04	1216	128	1344	7	6	4	3	10.0.160.214	180.163.228.94	0	0	5	2	0	0	2.5	0	
1	上午 11:26:03	上午 11:26:03	1216	128	1344	7	6	4	3	10.0.160.214	180.163.228.94	0	0	5	2	0	0	2.5	0	
1	上午 11:26:04	上午 11:26:04	1216	128	1344	6	5	4	3	10.0.160.214	180.163.228.94	0	0	5	2	0	0	2.5	0	
2	上午 11:27:59	上午 11:27:59	649	92	741	3	2	3	2	10.0.160.214	172.217.160.74	0	0	0	0	0	0	0	0	
2	上午 11:28:54	上午 11:29:09	1050	5928	6978	15216	15188	12	11	10.0.160.214	222.249.233.13	0	0	85	3	1	5	28.33333	0.2	
1	上午 11:26:03	上午 11:26:03	1216	128	1344	9	8	4	3	10.0.160.214	180.163.228.94	0	0	8	2	0	0	4	0	
2	上午 11:28:54	上午 11:29:09	1351	15892	17243	15162	15132	13	14	10.0.160.214	222.249.233.13	0	2	89	3	1	4	29.66667	0.25	
1	上午 11:30:50	上午 11:30:50	1144	128	1272	8	8	4	3	10.0.160.214	180.163.228.94	0	0	7	2	0	0	3.5	0	
1	上午 11:34:03	上午 11:34:03	709	88	797	18	18	3	2	10.0.160.214	36.99.172.91	0	0	18	1	0	0	18	0	
1	上午 11:34:03	上午 11:34:03	677	88	765	21	21	3	2	10.0.160.214	36.99.172.91	0	0	21	1	0	0	21	0	
2	上午 11:26:38	上午 11:30:38	2788	4515	7303	240111	240107	17	20	10.0.160.214	180.163.150.16	0	0	15	5	19	6	3	3.166667	
1	上午 11:34:02	上午 11:34:02	637	88	725	45	45	3	2	10.0.160.214	36.99.172.91	0	0	21	1	0	0	21	0	
1	上午 11:34:03	上午 11:34:03	661	88	749	20	20	3	2	10.0.160.214	36.99.172.91	0	0	15	1	0	0	15	0	
1	上午 11:34:03	上午 11:34:03	693	88	781	19	18	3	2	10.0.160.214	36.99.172.91	0	0	18	1	0	0	18	0	
2	上午 11:33:59	上午 11:33:59	1367	17353	18720	314	215	14	16	10.0.160.214	222.249.233.13	0	0	153	3	46	9	51	5.111111	
2	上午 11:33:59	上午 11:33:59	890	5777	6667	209	160	8	8	10.0.160.214	222.249.233.13	0	0	142	3	0	3	47.33333	0	
4	上午 11:24:59	上午 11:25:03	4058	4008	370	304	674	6	6	10.0.160.214	58.220.67.212	0	0	29	4	94	2	7.25	47	
4	上午 11:24:59	上午 11:24:59	79	0	133	125	258	2	1	10.0.160.214	222.249.233.13	0	0	25	1	54	1	25	54	
4	上午 11:25:02	上午 11:25:02	0	0	69	40	109	1	1	10.0.160.214	42.192.27.184	0	0	4	1	0	0	4	0	
4	上午 11:24:59	上午 11:25:02	3022	0	156	0	156	3	0	10.0.160.214	142.251.42.234	0	0	0	0	0	0	0	0	
4	上午 11:24:59	上午 11:25:03	4000	4012	1041	400	1441	10	10	10.0.160.214	10.0.160.30	0	0	497	10	0	0	49.7	0	
4	上午 11:25:14	上午 11:25:14	0	0	52	0	52	1	0	10.0.160.214	142.251.42.234	0	0	0	0	0	0	0	0	
4	上午 11:25:20	上午 11:25:35	15034	0	260	0	260	5	0	10.0.160.214	172.217.163.42	0	0	0	0	0	0	0	0	
4	上午 11:25:44	上午 11:25:44	0	0	80	0	80	2	0	10.0.160.214	222.249.233.13	0	0	0	0	0	0	0	0	
4	上午 11:27:09	上午 11:27:12	3038	0	804	0	804	4	0	10.0.160.214	239.255.255.250							0	0	
4	上午 11:27:21	上午 11:27:21	0	0	52	52	104	1	1	10.0.160.214	47.97.156.111							0	0	
4	上午 11:27:59	上午 11:28:14	15025	0	260	0	260	5	0	10.0.160.214	142.251.43.10	0	0	0	0	0	0	0	0	

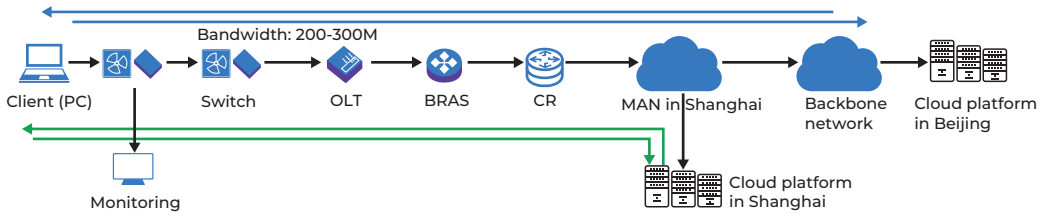
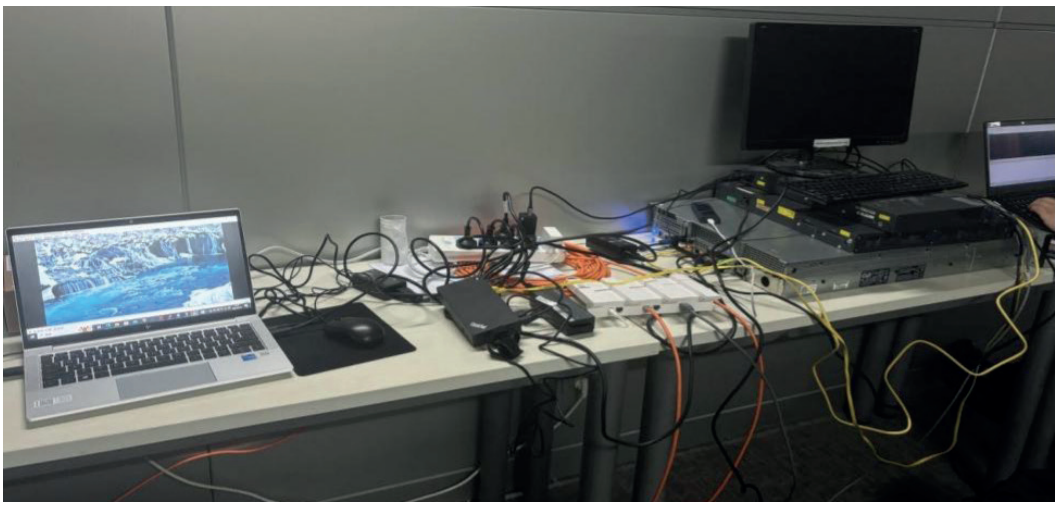
Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing.
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proves that there was no significant deviation, and the results were roughly in agreement with the expected results regarding Round Trip Time(RTT) of 8K video source1 on demand when accessing a remote cloud platform(Beijing).
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #8

RTT TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM

Executive Summary	Test case7 and test case8 select 8K video source1 and 8K video source2, respectively to carry out the Video-on-Demand on a remote cloud platform (Beijing) to make a comparison with that on local cloud platform(Shanghai), and test the round trip time(RTT) when accessing to remote platform(Beijing). The comparative tests on local platform(Shanghai) will be carried out by test case9 and test case10.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality, but the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources need to be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

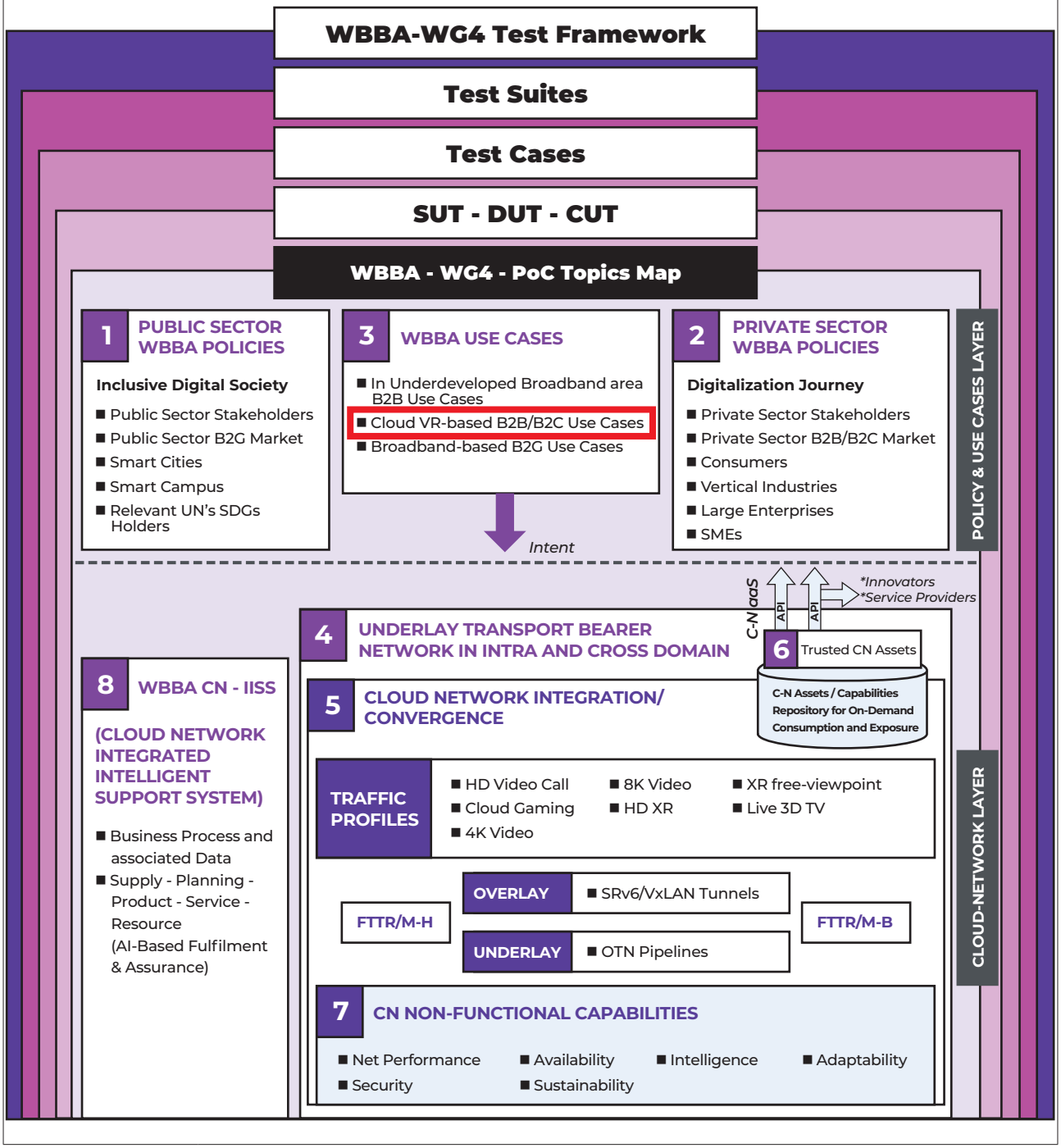
<table>
<tr><td rowspan="7">POC Resource Requirements</td><td>No.</td><td>Software/Hardware resource</td><td>Count</td><td>Characteristic</td><td>Provider</td></tr>
<tr><td>1</td><td>PC</td><td>1</td><td>Install 8K video player (VLC and Pot-player)</td><td rowspan="5">CTCC</td></tr>
<tr><td>2</td><td>IPTV cloud platform in Shanghai</td><td>1</td><td>Afford 8K video resource</td></tr>
<tr><td>3</td><td>Cloud platform in Beijing</td><td>1</td><td>Afford 8K video resources and low-bit-rate videos</td></tr>
<tr><td>4</td><td>Video Server</td><td>2</td><td>vCPU: 8cores;
DDR: 64GB; HD: 2TB;
OS: Ubuntu, SRS-8K
Public IPs: 1~2</td></tr>
<tr><td>5</td><td>Router</td><td>1</td><td>Three-tier switch</td></tr>
<tr><td>6</td><td>Monitoring</td><td>1</td><td></td><td></td></tr>
<tr><td>Test Case (TC) Name and ID (TC#1)</td><td colspan="5">Test Case #8 RTT test of 8K video Source2 on demand accessing to Beijing cloud platform</td></tr>
<tr><td>Test Case Owner</td><td colspan="5">Eversec/CTCC</td></tr>
<tr><td>Tester</td><td colspan="5">Pengchao Li/Shangguan Luying</td></tr>
<tr><td>Test Date</td><td colspan="5">04/29/2024</td></tr>
<tr><td>Test Case Purpose / Objective</td><td colspan="5">Test the round trip time(RTT) of 8K video source2 on demand when accessing to remote cloud platform (Beijing)</td></tr>
<tr><td>What Business Challenges the Test Case is addressing?</td><td colspan="5">Accessing through VPN tunnel</td></tr>
<tr><td>What makes this a significant problem to be solved?</td><td colspan="5">Control the packet capture time
Filter packet capture conditions
Limit the flow window</td></tr>
<tr><td>Test Case Description</td><td colspan="5">RTT test of video source2 on demand when accessing to Beijing platform</td></tr>
<tr><td>What is Under Test: (SUT), (DUT), (CUT)</td><td colspan="5">Cloud VR based B2B/B2C Use Cases</td></tr>
<tr><td>Test Suite(s)</td><td colspan="5"></td></tr>
<tr><td>Type of Test your Test Case is considering</td><td colspan="5">Unit X; Functional X; Non-Functional (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.</td></tr>
<tr><td>Test Case Result</td><td colspan="5">1) Pass
2) Fail X
3) Inconclusive X
Pass / Fail Ratio: 100%
4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results
5) Unexpected issues happened: No</td></tr>
</table>

Output and Data	Location: Beijing Video: 8K Source2 Perception: Frame Loss RTT upload(ms): 6.357 RTT download(ms): 6.375 RTT(ms): 12.732

	开始时间	结束时间	上行流量(bytes)(UL_TRAFF)	下行流量(bytes)（bytes)	总流量bytes	上行持续时长-UL_DURATION单位ms	下行持续时长DL_DURATION单位ms	上行包数	下行包数	源地址	目标地址	上行TCP重传包数	下行TCP重传包数	RTT上行总时延单位 ms	RTT上行次数	RTT下行总时延单位 ms	RTT下行次数	上行平均rtt结果单位ms	下行平均rtt结果单位ms	重传次数
1	下午 7:56:36	午 7:56:36	286	356	642	7	7	3	3	10.0.160.214	180.163.2	0	0	3	1	0	0	3	0	
2	下午 7:56:36	午 7:56:37	1212	3429	4641	413	414	8	9	10.0.160.214	223.6.6.6	0	0	16	3	4	2	5.333333	2	
2	下午 7:54:32	午 7:58:32	2063	2589	4652	240258	240254	17	20	10.0.160.214	180.163.1	0	0	21	6	81	5	3.5	16.2	
2	下午 7:58:12	午 7:58:27	1367	13068	14435	15143	15112	14	14	10.0.160.214	222.249.2	0	0	90	3	231	6	30	38.5	
2	下午 7:59:17	午 7:59:17	649	92	741	4	2	3	2	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	
2	下午 8:01:32	午 8:01:32	649	92	741	13	14	3	2	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	
2	下午 7:58:12	午 7:58:27	970	5888	6858	15138	15111	10	10	10.0.160.214	222.249.2	0	0	80	3	0	4	26.66667	0	
2	下午 7:59:16	午 7:59:17	701	92	793	1020	3	4	2	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	
2	下午 7:56:04	午 8:00:04	2746	5291	8037	240096	240093	16	20	10.0.160.214	180.163.1	0	0	13	5	9	3	2.6	3	
1	下午 8:01:35	午 8:01:35	286	356	642	3	4	3	3	10.0.160.214	180.163.2	0	0	3	1	0	0	3	0	
2	下午 8:01:35	午 8:01:36	1344	4597	5941	853	839	11	12	10.0.160.214	223.5.5.5	0	1	54	3	54	2	18	27	
2	下午 8:03:16	午 8:03:31	970	5888	6858	15159	15128	10	10	10.0.160.214	222.249.2	0	0	93	3	1	4	31	0.25	
2	下午 8:03:16	午 8:03:31	1419	13108	14527	15153	15121	15	15	10.0.160.214	222.249.2	0	1	89	3	63	5	29.66667	12.6	
2	下午 8:05:09	午 8:05:09	649	92	741	9	8	3	2	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	
4	下午 7:53:44	午 7:53:44	0	3	53	88	141	1	2	10.0.160.214	180.163.2	0	0	2	1	0	1	2	0	
4	下午 7:55:47	午 7:56:02	15024	0	260	0	260	5	0	10.0.160.214	142.251.4	0	0	0	0	0	0	0	0	
4	下午 7:56:32	午 7:56:35	3076	0	804	0	804	4	0	10.0.160.214	239.255.255.250							0	0	
4	下午 7:56:38	午 7:56:38	0	0	52	52	104	1	1	10.0.160.214	47.97.156.111							0	0	
4	下午 7:58:34	午 7:58:49	15021	0	260	0	260	5	0	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	
4	下午 7:58:38	午 7:58:38	0	0	52	52	104	1	1	10.0.160.214	47.97.156.111							0	0	
4	下午 7:58:55	午 7:59:10	15040	0	260	0	260	5	0	10.0.160.214	142.251.4	0	0	0	0	0	0	0	0	
4	下午 7:50:00	午 8:00:00	599987	599651	4941718	1097995	6039713	9001	8809	10.0.160.214	10.0.160.3	129	1	48859	2039	13336	3053	23.96224	4.368162	
4	下午 7:50:00	午 7:59:55	595448	595447	4512677	92374457	96887134	106283	171434	10.0.160.214	222.249.2	0	62	0	0	206770	48639	0	4.251115	
4	下午 7:50:03	午 7:59:57	593365	593252	7980	7500	15480	120	60	10.0.160.214	222.249.2	0	0	1978	60	3285	60	32.96667	54.75	
4	下午 7:59:38	午 7:59:38	0	0	52	52	104	1	1	10.0.160.214	47.97.156.111							0	0	
4	下午 7:59:44	午 7:59:44	0	0	229	0	229	1	0	10.0.160.214	10.0.160.255							0	0	
4	下午 7:55:38	午 7:55:38	0	0	72	0	72	1	0	10.0.160.214	1.192.136.133							0	0	
4	下午 7:56:08	午 7:56:23	15020	0	260	0	260	5	0	10.0.160.214	172.217.1	0	0	0	0	0	0	0	0	

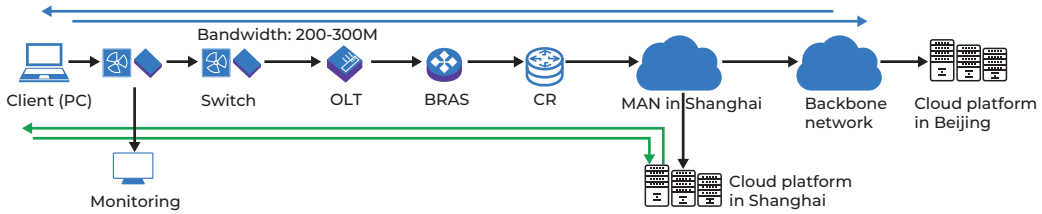
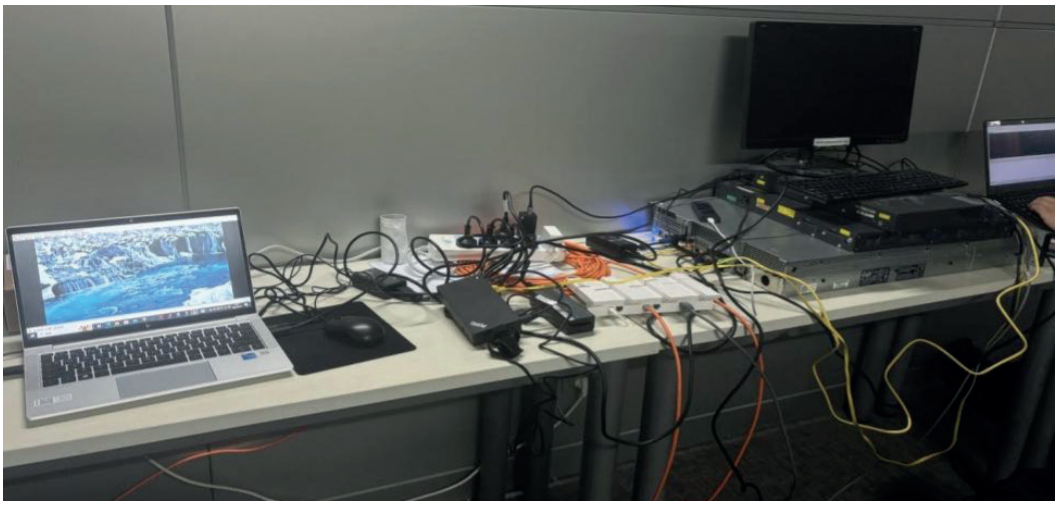
Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proves that there was no significant deviation, and the results were roughly in agreement with the expected results regarding Round Trip Time(RTT) of 8K video source 2 on demand when accessing a remote cloud platform (Beijing).
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #9

RTT TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM

Executive Summary	Test case 9 and test case 10 select 8K video source1 and 8K video source2, respectively to carry out Video-on-Demand on the local cloud platform(Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and test the round trip time(RTT) when accessing to local platform (Shanghai). The test results show that the RTT is about 10-20ms when accessing Beijing platform and less than 10ms when accessing the Shanghai platform, and the RTT difference between remote Video-on-Demand and local Video-on-Demand is at least 10ms.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality, but the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources need to be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

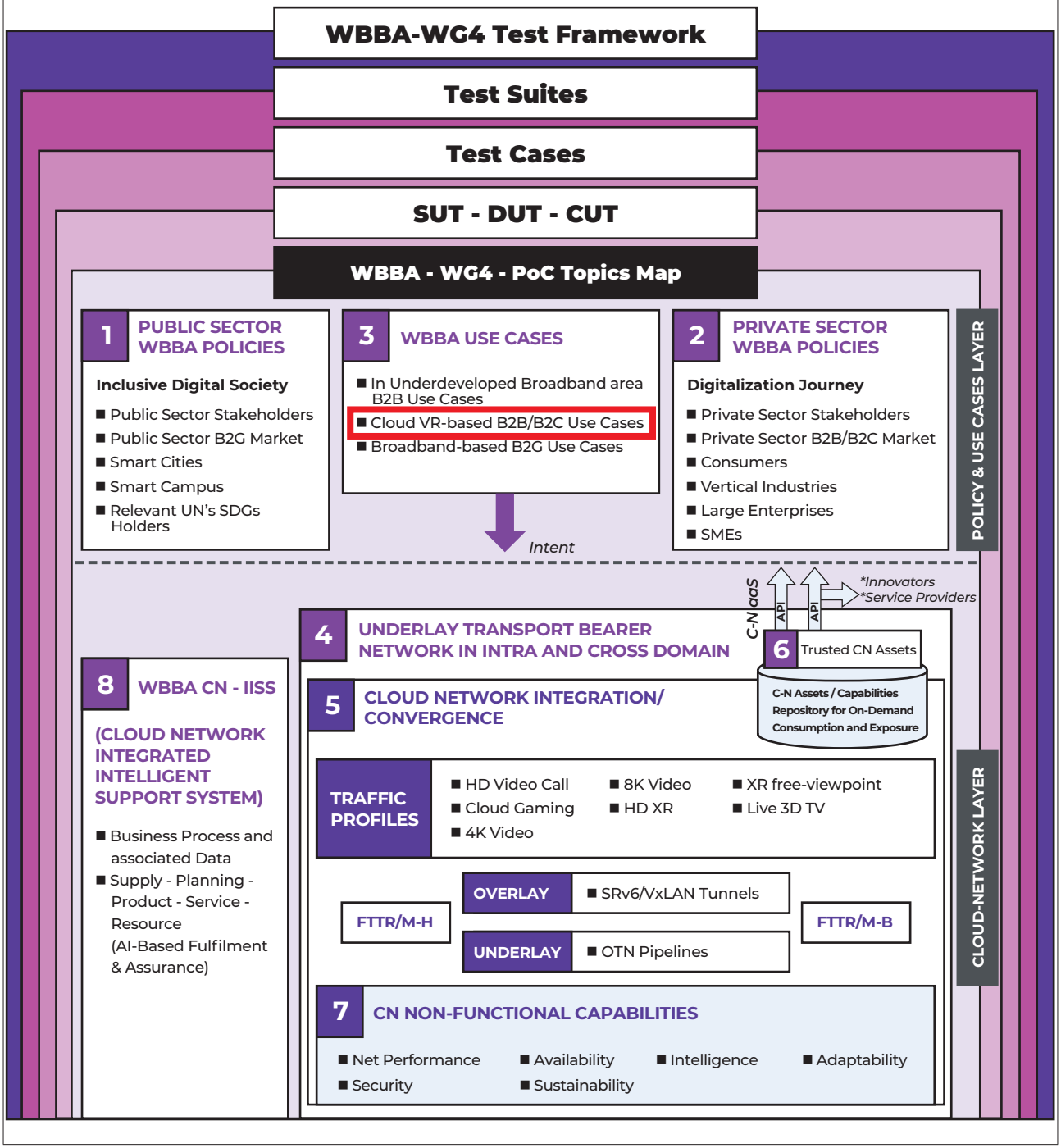
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #9 RTT test of 8K video Source1 on demand accessing to Shanghai cloud platform				
Test Case Owner	Eversec /CTCC				
Tester	Pengchao Li/Shangguan Luying				
Test Date	04/29/2024				
Test Case Purpose / Objective	Test the round trip time(RTT) of 8K video source1 on demand when accessing the local cloud platform (Shanghai)				
What Business Challenges the Test Case is addressing?	Get access to the Shanghai platform				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	RTT test of video source1 on demand when accessing the Shanghai platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% **4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results** 5) Unexpected issues happened: No				

Output and Data	Location: Shanghai Video: 8K Source1 Perception: Smooth RTT upload(ms): 2.308 RTT download(ms): 0.157 RTT(ms): 2.465

开始时间	结束时间	上行流量(bytes)(UL_TRAFF)	下行流量(bytes)(bytes)	总流量 bytes	上行持续时长 UL_DURATION 单位ms	下行持续时长 DL_DURATION 单位ms	RTT上行总时延 单位 ms	RTT上行次数	RTT下行总时延 单位 ms	RTT下行次数	上行下载速率 单位Mb/s	下行下载速率 单位Mb/s	上行平均rtt结果 单位ms	下行平均rtt结果 单位ms
2024/4/17 15:35	2024/4/17 15:35	521	3334	3855	12	68	3	1	0	0	0.331243	0.374066	3	0
2024/4/17 15:35	2024/4/17 15:35	23902	1683582	1707484	243	241	2	1	167	574	0.750444	53.29756	2	0.290941
2024/4/17 15:35	2024/4/17 15:35	24978	1632254	1657232	161	158	3	1	150	514	1.183646	78.81715	3	0.291829
2024/4/17 15:35	2024/4/17 15:35	42834	3065642	3108476	318	315	3	1	186	1029	1.027665	74.25077	3	0.180758
2024/4/17 15:36	2024/4/17 15:36	36674	2623026	2659700	247	245	2	1	122	682	1.132795	81.68204	2	0.138322
2024/4/17 15:36	2024/4/17 15:36	23930	1687978	1711908	170	167	2	1	81	574	1.073949	77.11527	2	0.141115
2024/4/17 15:36	2024/4/17 15:36	32046	2273094	2305140	219	218	2	1	108	769	1.1164	80.28857	2	0.140442
2024/4/17 15:36	2024/4/17 15:36	43446	3122506	3165952	339	337	2	1	201	1037	0.977778	70.69089	2	0.193828
2024/4/17 15:35	2024/4/17 15:35	385	650	1035	20	20	2	1	0	0	0.146866	0.247955	2	0
2024/4/17 15:35	2024/4/17 15:35	24114	1702498	1726612	166	164	2	1	91	577	1.108284	79.2014	2	0.157712
2024/4/17 15:36	2024/4/17 15:36	40782	2920686	2961468	279	277	2	1	175	669	1.115204	80.44428	2	0.179946
2024/4/17 15:37	2024/4/17 15:37	41954	3009258	3051212	323	321	2	1	187	1000	0.990971	71.52279	2	0.187
2024/4/17 15:37	2024/4/17 15:37	43693	3109443	3153036	315	311	3	1	149	1045	1.055836	75.28028	3	0.142584

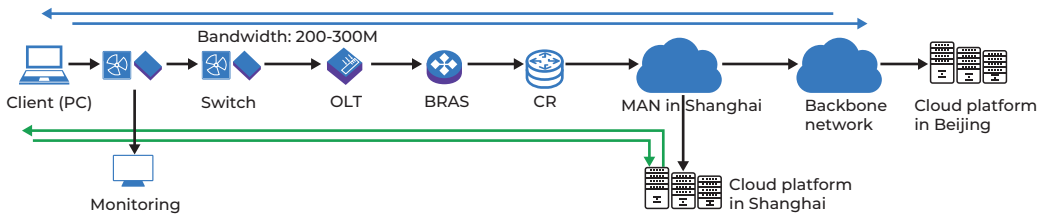
Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proves that the result of Round Trip Time(RTT) of 8K video source1 on demand when accessing the local cloud platform (Shanghai) showed no significant deviation, and the results were roughly in agreement with the expected results. The 10ms RTT difference between remote Video-on-Demand and local Video-on-Demand proves the development of cloud network convergence and the vital importance and necessity of edge cloud development in the evolution of cloud network convergence.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #10

RTT TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM

Executive Summary	Test case9 and test case10 select 8K video source1 and 8K video source2, respectively, to carry out the Video-on-Demand on the local cloud platform(Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and test the round trip time(RTT) when accessing to local platform(Shanghai). The test results show that the RTT is about 10-20ms when accessing the Beijing platform and less than 10ms when accessing Shanghai platform, and the RTT difference between remote Video-on-Demand and local Video-on-Demand is at least 10ms.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

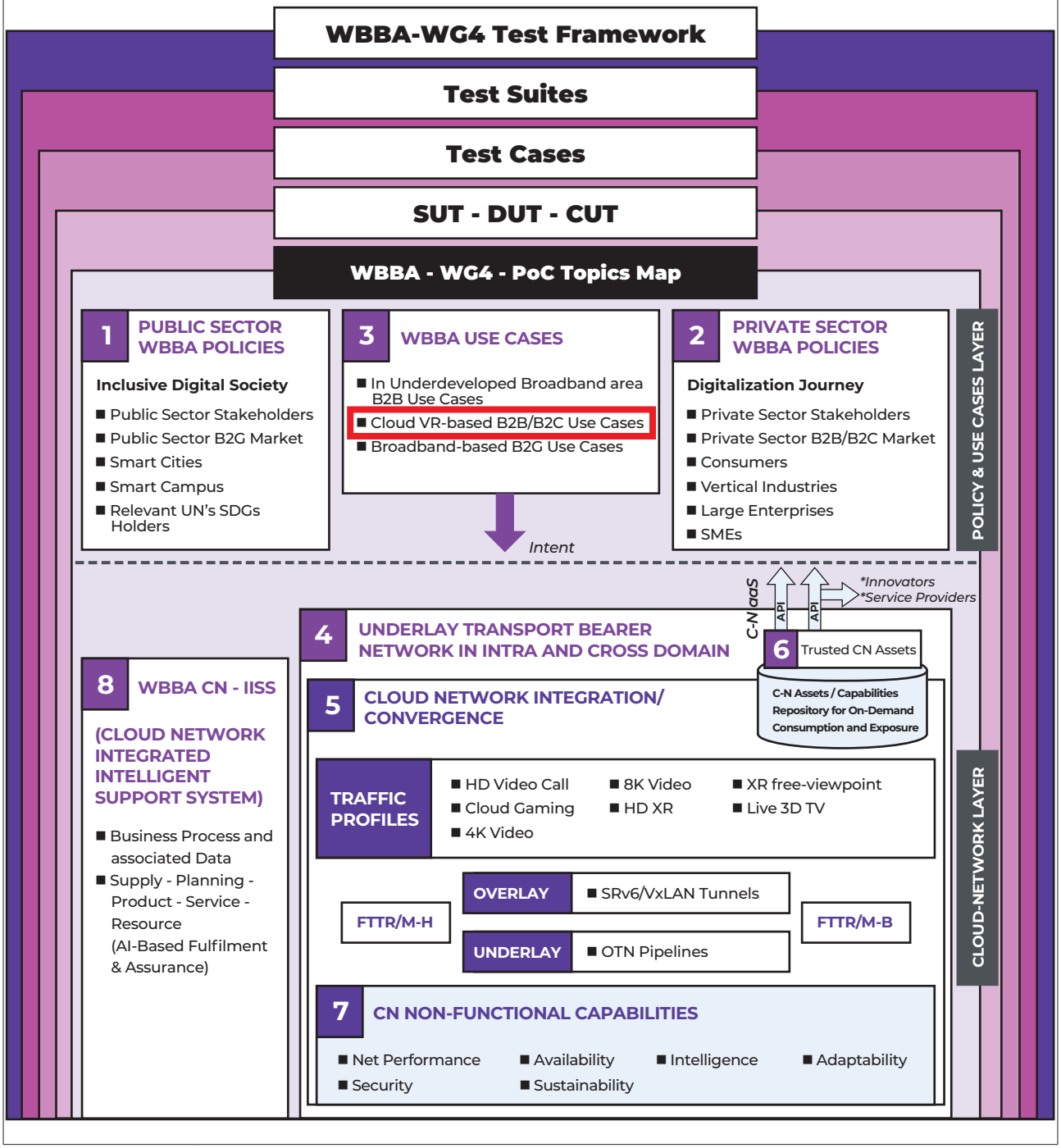
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #10 RTT test of 8K video Source2 on demand accessing to Shanghai cloud platform				
Test Case Owner	Eversec /CTCC				
Tester	Pengchao Li/Shangguan Luying				
Test Date	04/29/2024				
Test Case Purpose / Objective	Test the round trip time(RTT) of 8K video source2 on demand when accessing to local cloud platform (Shanghai)				
What Business Challenges the Test Case is addressing?	Get access to Shanghai platform				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	RTT test of video source2 on demand when accessing to Shanghai platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Location: Shanghai Video: 8K Source2 Perception: Smooth RTT upload (ms): 2.231 RTT download (ms): 0.15 RTT (ms): 2.381

开始时间	结束时间	上行流量(bytes)(UL_TRAFF)	下行流量(bytes)(bytes)	总流量 bytes	上行持续时长 UL_DURATION 单位ms	下行持续时长 DL_DURATION 单位ms	RTT上行丢包值 单位 ms	RTT上行次数	RTT下行丢包值 单位 ms	RTT下行次数	上行下载速率 单位Mb/s	下行下载速率 单位Mb/s	上行平均rtt结果 单位ms	下行平均rtt结果 单位ms
2024/4/17 15:46	2024/4/17 15:46	621	3334	3855	13	48	2	1	0	0	0.305763	0.529925	2	0
2024/4/17 15:46	2024/4/17 15:46	32766	2321010	2353776	249	246	3	1	161	799	1.003955	71.98334	3	0.201502
2024/4/17 15:46	2024/4/17 15:46	21838	1542738	1564576	153	151	2	1	100	520	1.088959	77.94808	2	0.192308
2024/4/17 15:46	2024/4/17 15:46	385	650	1035	19	19	2	1	0	0	0.154596	0.261006	2	0
2024/4/17 15:47	2024/4/17 15:47	44554	3193682	3238216	317	314	3	1	189	1006	1.072303	77.59779	3	0.177290
2024/4/17 15:47	2024/4/17 15:47	22986	1571778	1594144	153	151	2	1	104	534	1.115288	79.41533	2	0.184757
2024/4/17 15:48	2024/4/17 15:48	72190	5190162	5262352	493	490	2	1	296	1830	1.189559	86.08216	2	0.181595
2024/4/17 15:48	2024/4/17 15:48	24474	1725690	1750164	197	195	2	1	88	585	0.947826	67.51779	2	0.150427
2024/4/17 15:48	2024/4/17 15:48	22657	1597911	1620568	168	165	3	1	104	530	1.028924	73.88541	3	0.196226
2024/4/17 15:47	2024/4/17 15:47	27338	1931874	1959212	192	191	2	1	101	652	1.086315	77.16789	2	0.154908
2024/4/17 15:48	2024/4/17 15:48	22530	1591170	1613700	162	159	2	1	105	539	1.061051	76.35009	2	0.194805
2024/4/17 15:48	2024/4/17 15:48	22266	1569462	1591728	149	147	2	1	79	533	1.140108	81.45609	2	0.148218
2024/4/17 15:47	2024/4/17 15:47	34674	2472018	2506692	240	238	2	1	137	838	1.102257	79.2437	2	0.163484

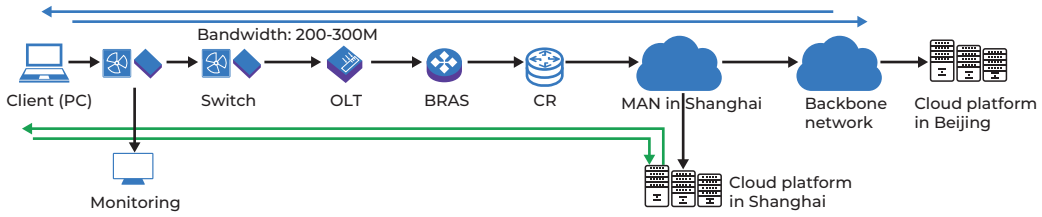
Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proves that the result of Round Trip Time(RTT) of 8K video source 2 on demand when accessing the local cloud platform(Shanghai) showed no significant deviation, and the results were roughly in agreement with the expected results. The 10ms RTT difference between remote Video-on-Demand and local Video-on-Demand proves the development of cloud network convergence and the vital importance and necessity of edge cloud development in the evolution of cloud network convergence.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

POC Topic Map Test Framework
The highlighted block (red rectangle) shows which parts of the POC Topics Map are addressed in this POC project and this targeted Test Case.



TEST CASE #11

TCP RESEND RATE TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM

Executive Summary	Test case 11 and test case 12 select 8K video source1 and 8K video source2, respectively, to carry out Video-on-Demand on a remote cloud platform(Beijing) to make a comparison with that on a local cloud platform(Shanghai), and test the TCP resend rate when accessing to remote platform (Beijing). The comparative tests on the local platform(Shanghai) will be carried out by test case 13 and test case 14.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality, but the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources need to be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

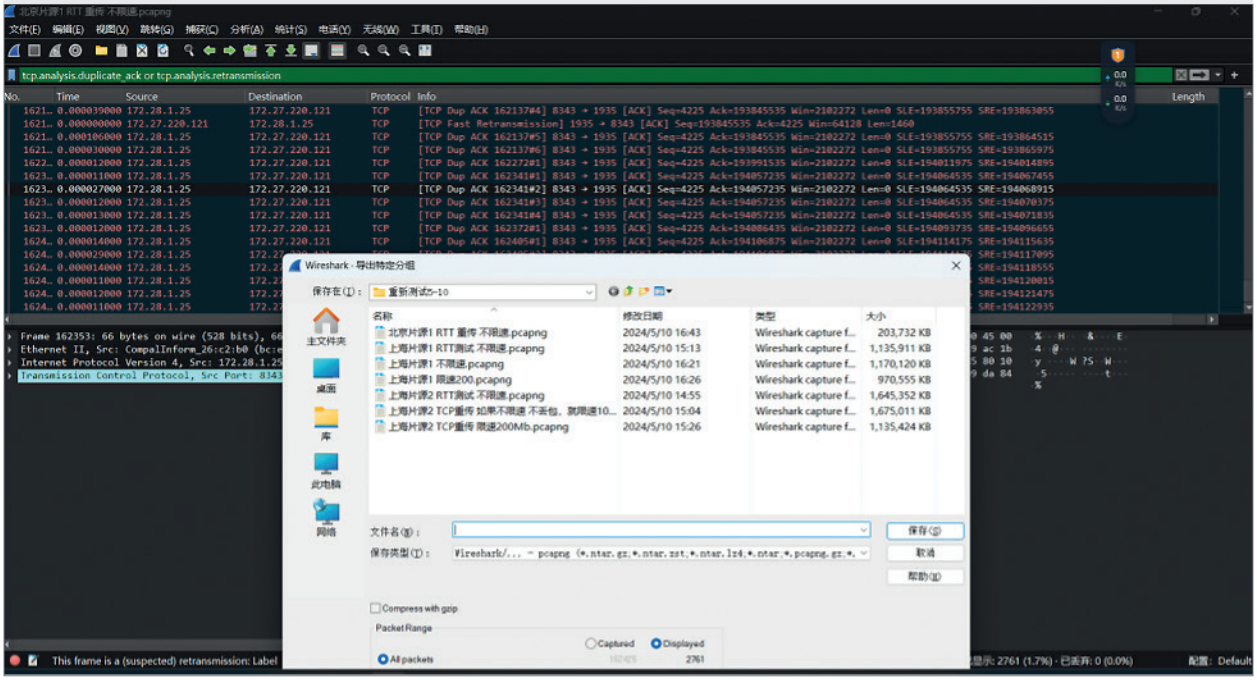
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #11 TCP resends rate test of 8K video Source1 on demand accessing to Beijing cloud platform				
Test Case Owner	CTCC				
Tester	Luying Shangguan				
Test Date	05/10/2024				
Test Case Purpose / Objective	TCP resend rate of 8K video source1 on demand when accessing a remote cloud platform (Beijing)				
What Business Challenges the Test Case is addressing?	Accessing through VPN tunnel				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	TCP resend rate test of Video-on-Demand when accessing to Beijing platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Retransmission rate: 0.01699861474

SQL

tcp.analysis.duplicate_ack or tcp.analysis.retransmission -->> 2761

2761/162425= 0.01699861474



Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing.
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	This test proves that the TCP resends rate test of 8K video source 1 on-demand accessing the Beijing platform showed no significant deviation, and the results roughly agreed with the expected results. The test proved the importance of cloud network convergence, where Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central and edge cloud for different video quality is an important capability for future cloud network convergence.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

POC Topic Map Test Framework
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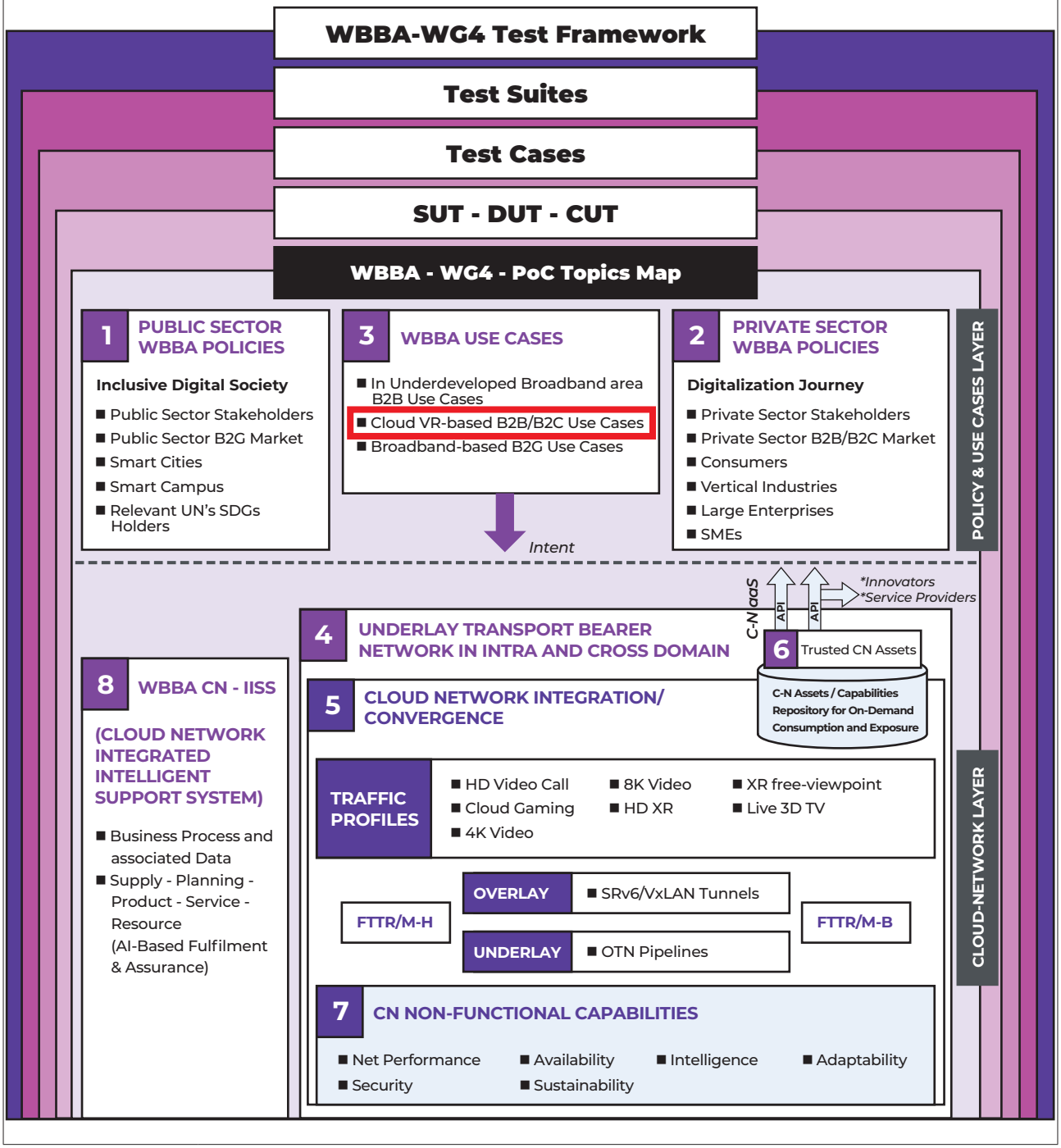
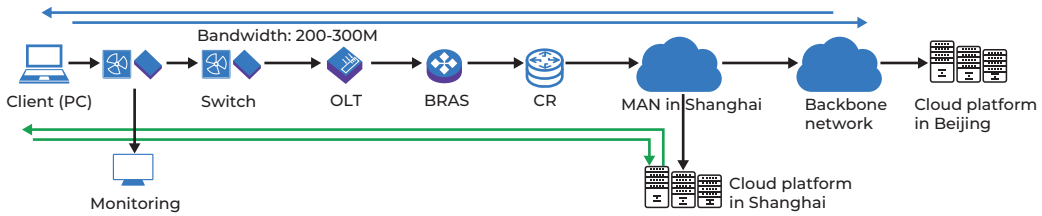


TEST CASE #12

TCP RESEND RATE TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO BEIJING CLOUD PLATFORM

Executive Summary	Test case11 and test case12 select 8K video source1 and 8K video source2, respectively, to carry out Video-on-Demand on a remote cloud platform(Beijing) to make a comparison with that on local cloud platform(Shanghai), and test the TCP resend rate when accessing to remote platform(Beijing). The comparative tests on local platform(Shanghai) will be carried out by test case13 and test case 14.
POC Project Name	Cloud XR/ 8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality. Still, the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

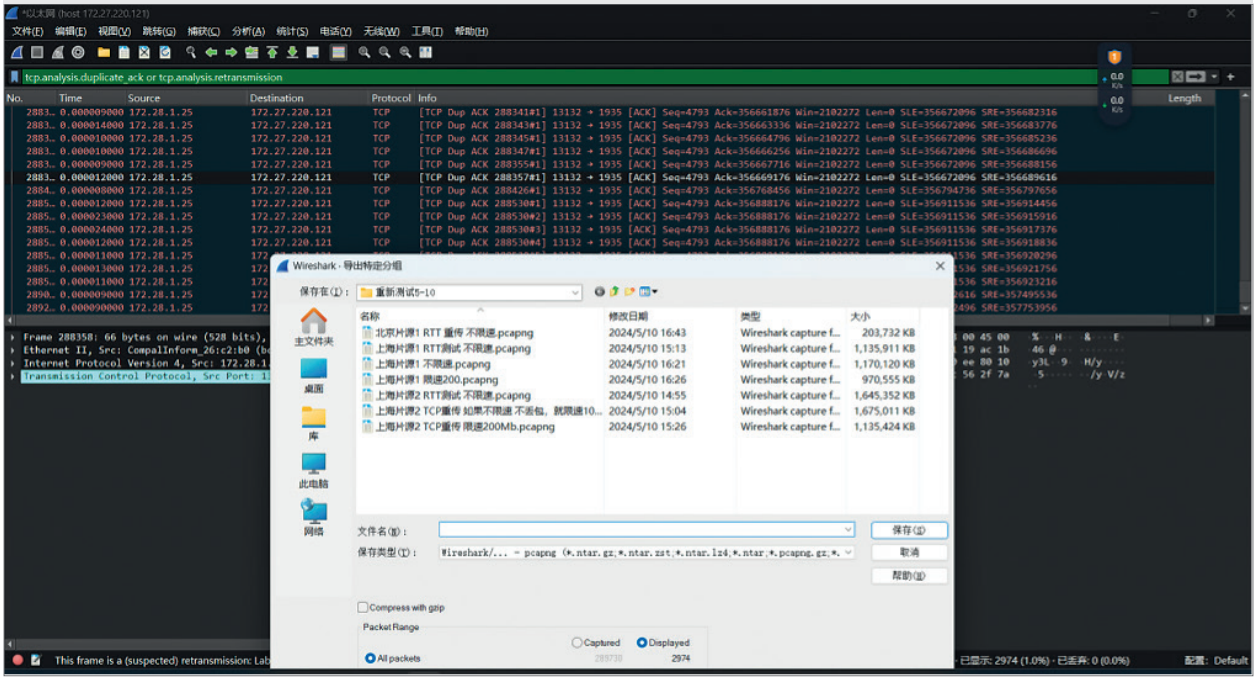
POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #12 TCP resends rate test of 8K video Source2 on demand accessing to Beijing cloud platform				
Test Case Owner	CTCC				
Tester	Luying Shangguan				
Test Date	05/10/2024				
Test Case Purpose / Objective	TCP resend rate of 8K video source2 on demand when accessing to remote cloud platform (Beijing)				
What Business Challenges the Test Case is addressing?	Accessing through VPN tunnel				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	TCP resend rate test of Video-on-Demand when accessing to Beijing platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Retransmission rate: 0.01026472923

SQL

tcp.analysis.duplicate_ack or tcp.analysis.retransmission -->>2974

2974/289730= 0.01026472923



Business Impact / Business Value	Access the Beijing Cloud Platform through the VPN tunnel for real-time stream pushing
Potential innovation impact	Push stream in real-time
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures.
Takeaways emerged, and Lessons learned throughout Testing	This test proves that the TCP resends rate test of 8K video source 2 on-demand accessing the Beijing platform showed no significant deviation, and the results roughly agreed with the expected results. The test proved the importance of cloud network convergence, where Video resources must be deployed in the local cloud to realize nearby forwarding. This cooperative scheduling between the central and edge cloud for different video quality is an important capability for future cloud network convergence.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

POC Topic Map Test Framework
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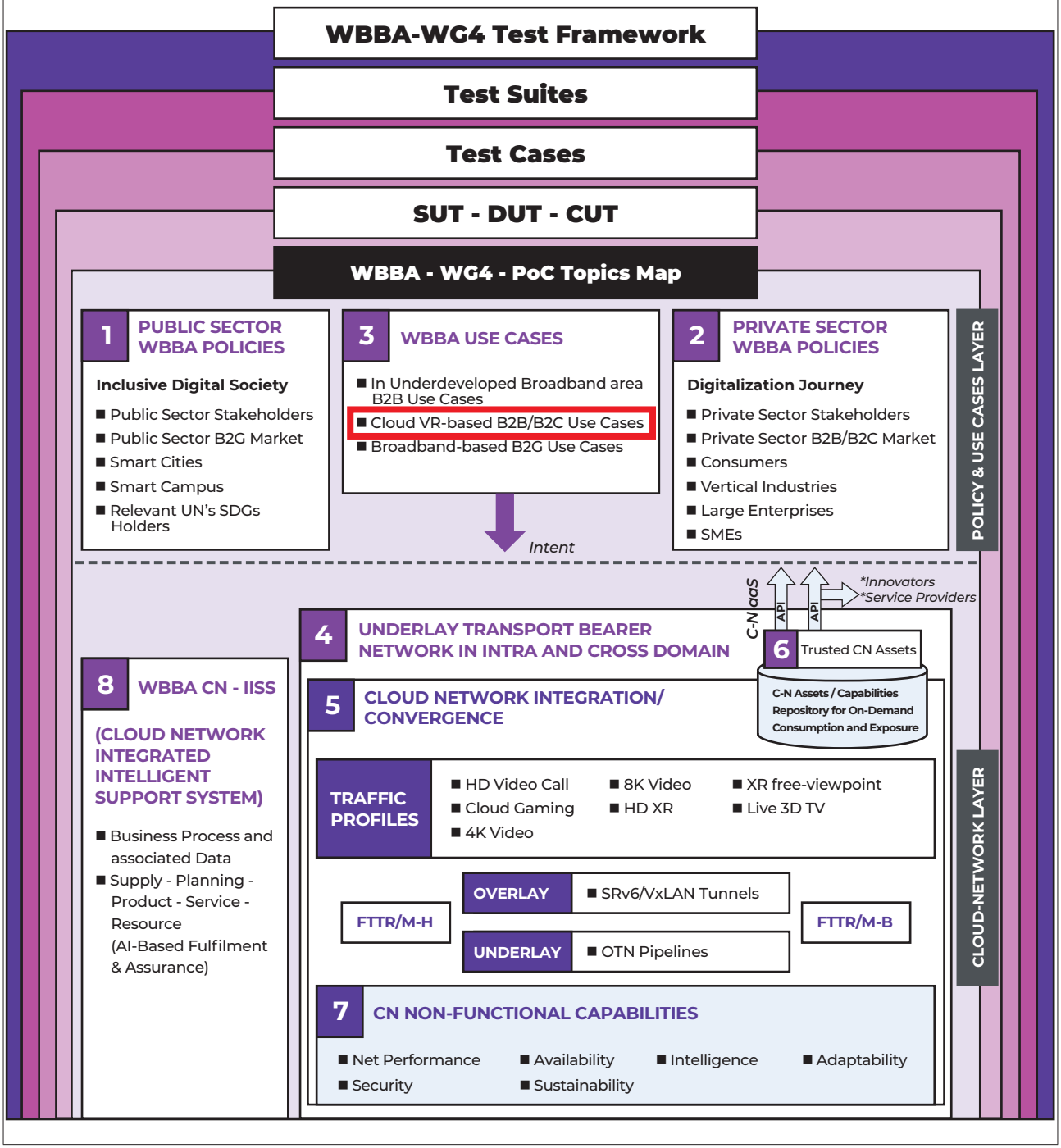
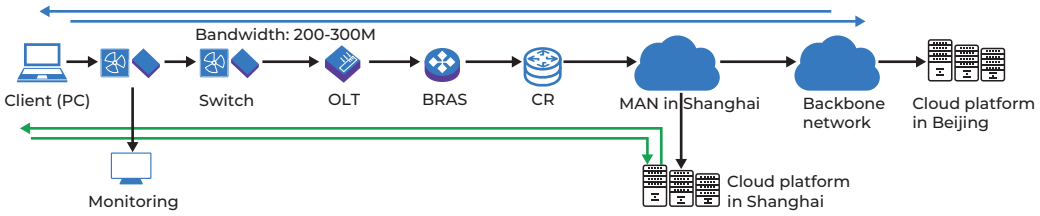
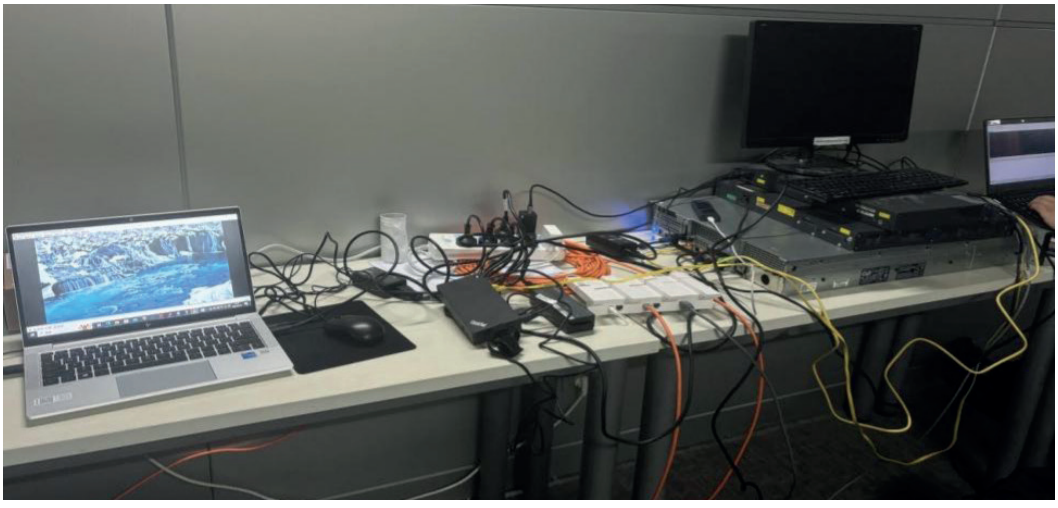


TEST CASE #13

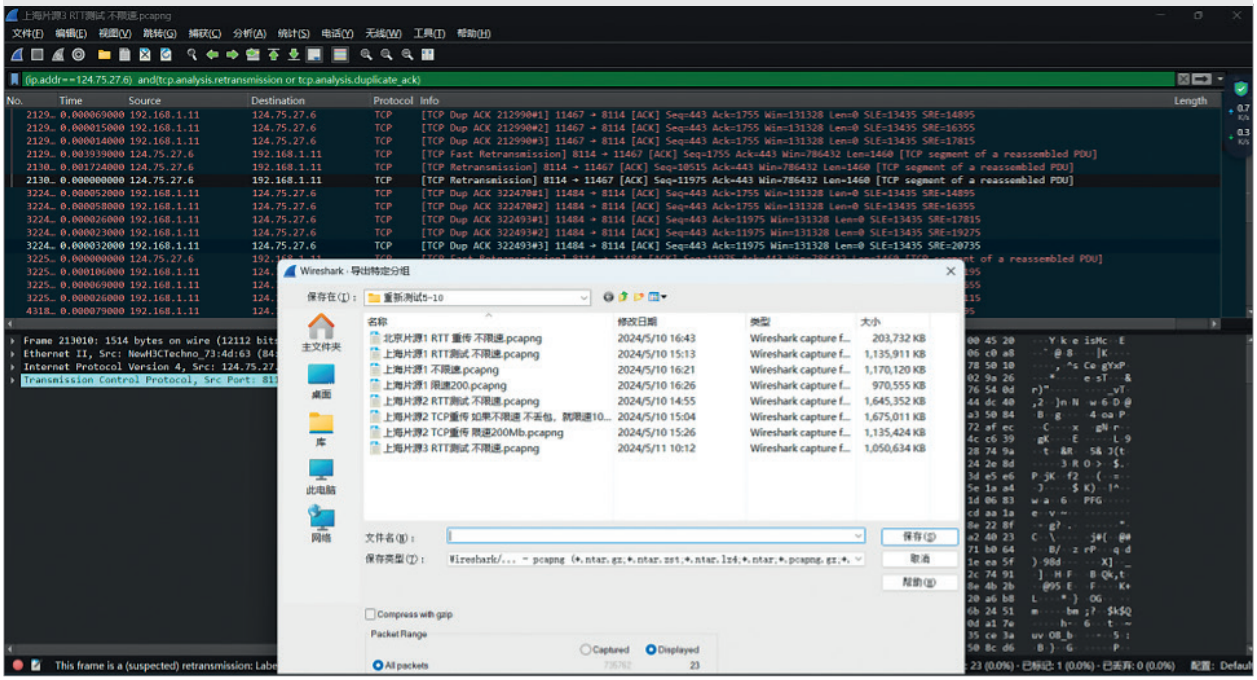
TCP RESEND RATE TEST OF 8K VIDEO SOURCE1 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM

Executive Summary	Test case13 and test case14 select 8K video source1 and 8K video source2, respectively, to carry out Video-on-Demand on the local cloud platform(Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and test the TCP resend rate when accessing to the local platform(Shanghai). The test results show that the TCP resend rate is about 1%~2% when accessing the Beijing platform, the TCP resend rate is about 0.003%~0.004% when accessing the Shanghai platform, and the TCP resend rate difference between remote video-on-demand and local Video-on-Demand is at least two orders of magnitude. It can be seen that long-distance transmission brings great damage to network performance, including but not limited to delay and packet loss.
POC Project Name	Cloud XR/8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality, but the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between central cloud and edge cloud for different video quality is an important capability of future cloud network convergence
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #13 TCP resends rate test of 8K video Source1 on demand accessing to Shanghai cloud platform				
Test Case Owner	CTCC				
Tester	Luying Shangguan				
Test Date	05/10/2024				
Test Case Purpose / Objective	TCP resend rate of 8K video source1 on demand when accessing the local cloud platform (Shanghai)				
What Business Challenges the Test Case is addressing?	Get access to the Shanghai Platform				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	TCP resend rate test of Video-on-Demand when accessing the Shanghai platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Retransmission rate: 0.000031260109

SQL
tcp.analysis.duplicate_ack or tcp.analysis.retransmission -->> 23
23/735762 = 0.000031260109



Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proved that the TCP resend rate difference between remote and local video-on-demand is at least two orders of magnitude for 8K video source 1 on-demand access to the Shanghai platform. Long-distance transmission brings great damage to network performance, including but not limited to delay and packet loss. Hence, the value of building cloud network convergence for service agility and efficiency is well proved here.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

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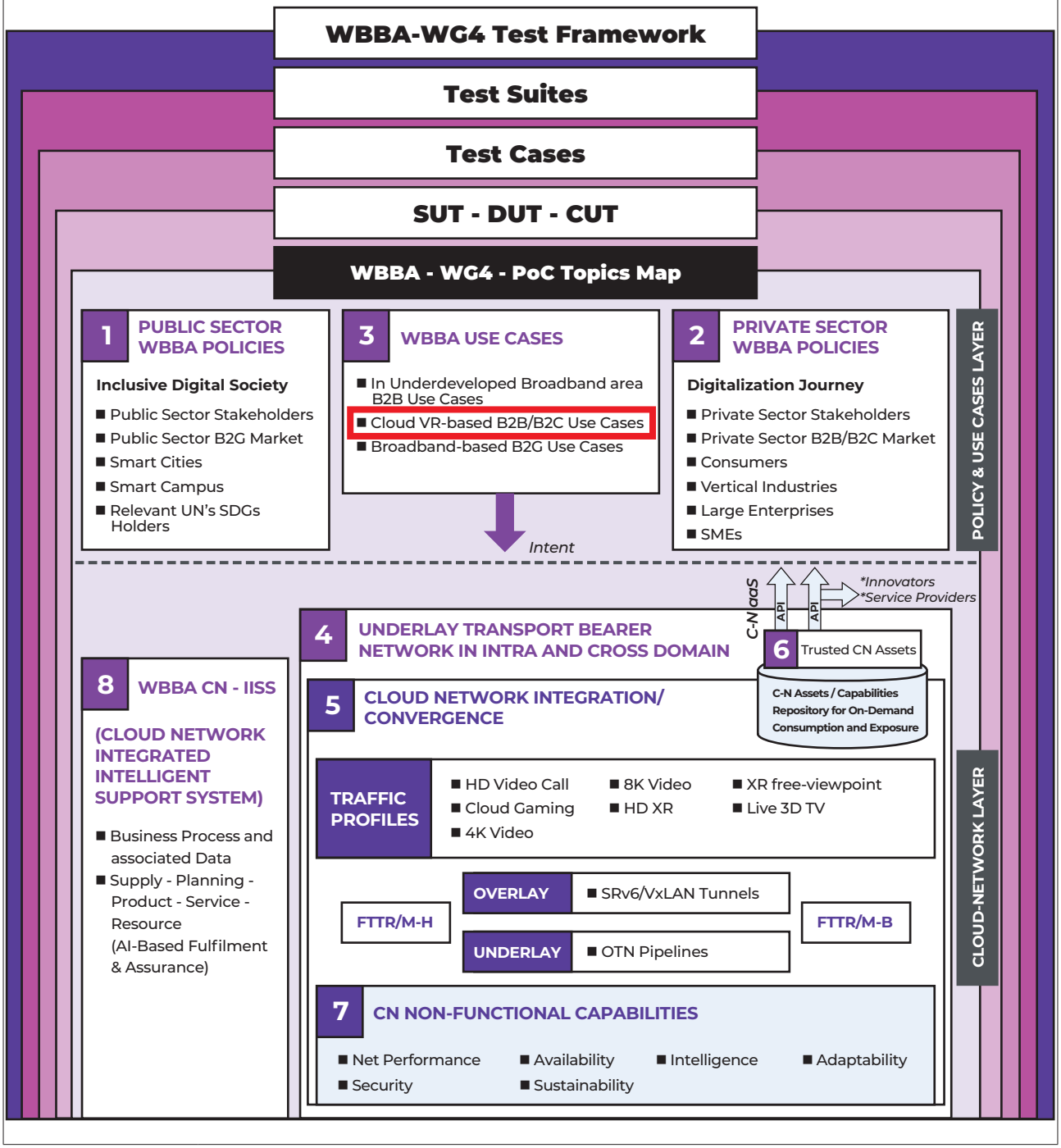
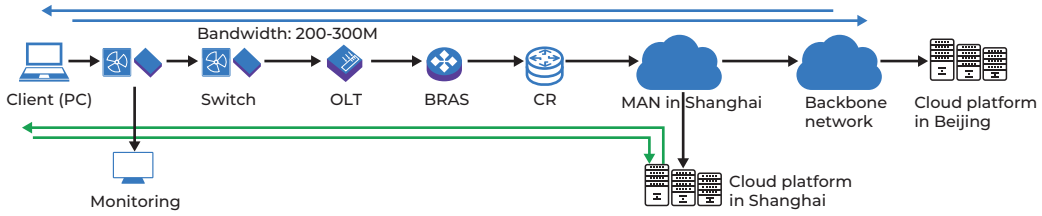
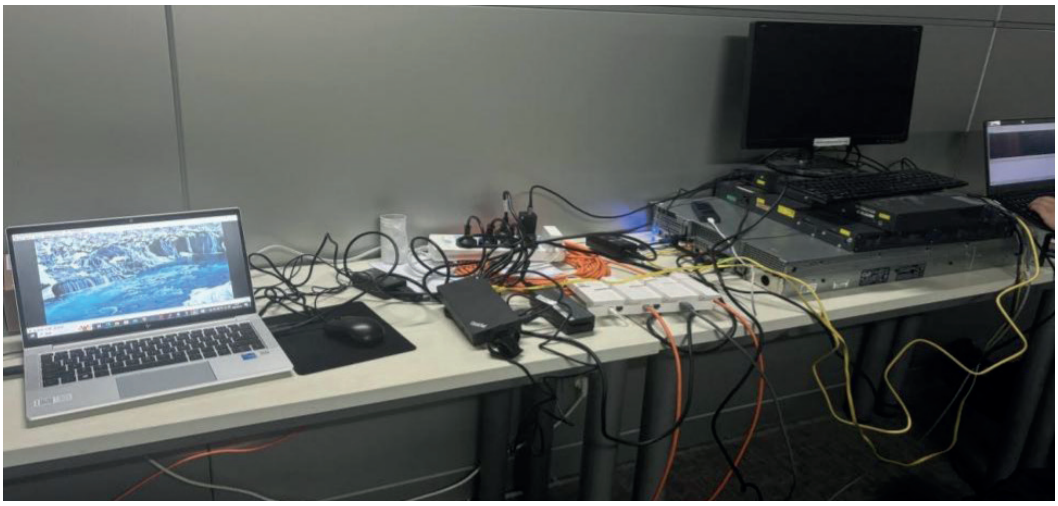


TEST CASE #14

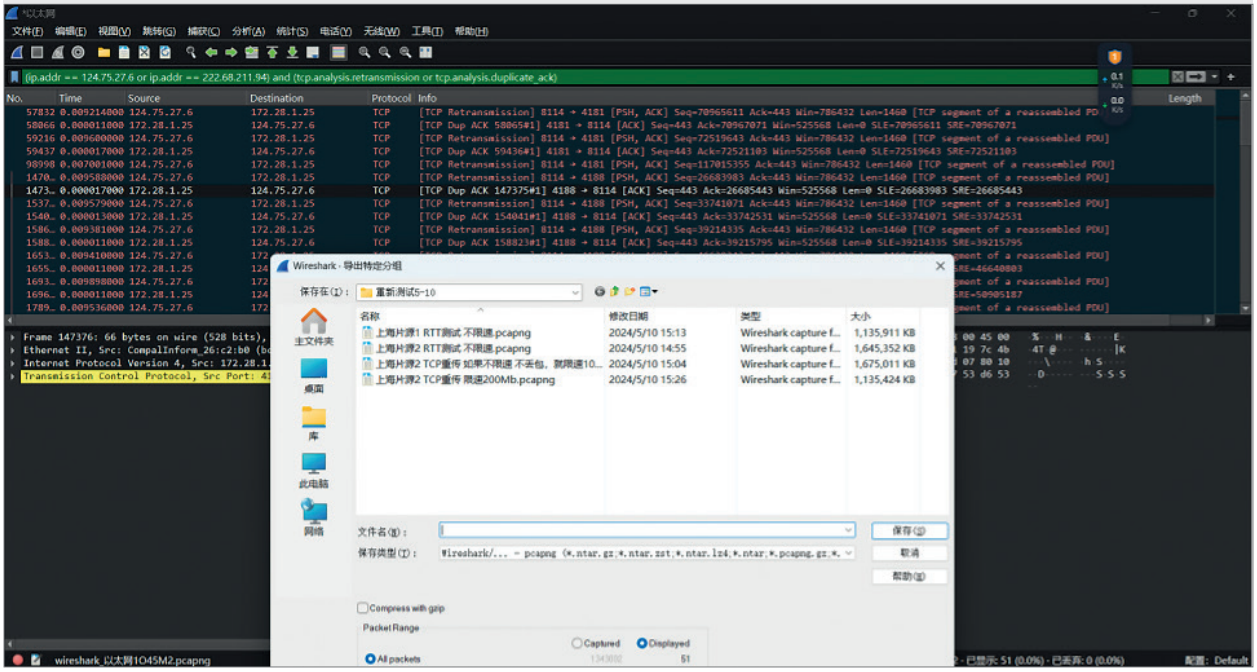
TCP RESEND RATE TEST OF 8K VIDEO SOURCE2 ON DEMAND ACCESSING TO SHANGHAI CLOUD PLATFORM

Executive Summary	Test case13 and test case14 select 8K video source1 and 8K video source2, respectively to carry out the Video-on-Demand on local cloud platform(Shanghai) to make a comparison with that on the remote cloud platform(Beijing), and test the TCP resend rate when accessing to local platform (Shanghai). The test results show that the TCP resend rate is about 1%~2% when accessing the Beijing platform, the TCP resend rate is about 0.003%~0.004% when accessing the Shanghai platform, and the TCP resend rate difference between remote video-on-demand and local video-on-demand is at least two orders of magnitude. It can be seen that long-distance transmission brings great damage to network performance, including but not limited to delay and packet loss.
POC Project Name	Cloud XR/8K Video-on-Demand
POC Project Leader	Luying Shangguan
POC Project Host	CTCC
POC Project Description	With the comparison tests of 8K Video-on-Demand in Beijing and Shanghai platforms, the importance and necessity of edge cloud development in the evolution of cloud network convergence are confirmed. This test aims to reflect the local cloud architecture in cloud network convergence and guarantee the quality of future ultra-high-definition Video-on-Demand. It can be seen from the test results that the current ordinary video(240P/480P/720P) can be centralized and remote cloud deployment under the premise of excellent network quality, but the quality of videos above 4K cannot be guaranteed simply by improving the network quality. Video resources must be deployed in the local cloud to realize nearby forwarding. This kind of cooperative scheduling between the central cloud and edge cloud for different video quality is an important capability of future cloud network convergence.
POC Test Topology	Figure: Network Topology  Figure: Test environment 

POC Resource Requirements	No.	Software/Hardware resource	Count	Characteristic	Provider
	1	PC	1	Install 8K video player (VLC and Pot-player)	CTCC
	2	IPTV cloud platform in Shanghai	1	Afford 8K video resource	
	3	Cloud platform in Beijing	1	Afford 8K video resources and low-bit-rate videos	
	4	Video Server	2	vCPU: 8cores; DDR: 64GB; HD: 2TB; OS: Ubuntu, SRS-8K Public IPs: 1~2	
	5	Router	1	Three-tier switch	
	6	Monitoring	1		
Test Case (TC) Name and ID (TC#1)	Test Case #14 TCP resend rate test of 8K video Source2 on demand accessing to Shanghai cloud platform				
Test Case Owner	CTCC				
Tester	Luying Shangguan				
Test Date	05/10/2024				
Test Case Purpose / Objective	TCP resend rate of 8K video source2 on demand when accessing to local cloud platform (Shanghai)				
What Business Challenges the Test Case is addressing?	Get access to Shanghai Platform				
What makes this a significant problem to be solved?	Control the packet capture time Filter packet capture conditions Limit the flow window				
Test Case Description	TCP resend rate test of Video-on-Demand when accessing to the Shanghai platform				
What is Under Test: (SUT), (DUT), (CUT)	Cloud VR based B2B/B2C Use Cases				
Test Suite(s)					
Type of Test your Test Case is considering	Unit X; Functional X; **Non-Functional** (Performance, Security) X; Regression X; Integration X; Interoperability, Conformance X; Acceptance X.				
Test Case Result	**1) Pass** 2) Fail X 3) Inconclusive X Pass / Fail Ratio: 100% 4) Deviation X: There was no significant deviation, and the results were roughly in agreement with the expected results 5) Unexpected issues happened: No				

Output and Data	Retransmission rate: 0.00003797462

SQL
tcp.analysis.duplicate_ack and tcp.analysis.retransmission 51
(ip.addr == 124.75.27.6 or ip.addr == 222.68.211.94)
51/1343002= 0.00003797462



Business Impact / Business Value	
Potential innovation impact	
Recommended Improvements	Describe any recommendation emerged during the Test Campaign that could improve the SUT/ DUT / CUT, and its related procedures
Takeaways emerged, and Lessons learned throughout Testing	This test proved that the TCP resend rate difference between remote and local video-on-demand is at least two orders of magnitude for 8K video source 2 on-demand access to the Shanghai platform. Long-distance transmission brings great damage to network performance, including but not limited to delay and packet loss. Hence, the value of building cloud network convergence with edge cloud development for service agility and efficiency is well proved here.
Feedback to WBBA WGs	Identify the impact on assessment of the viability of which published WBBA documents / assets and any gaps discovered. Suggestion if there is a need to create dedicated WIs to fill identified gaps and shape the scope of WI.

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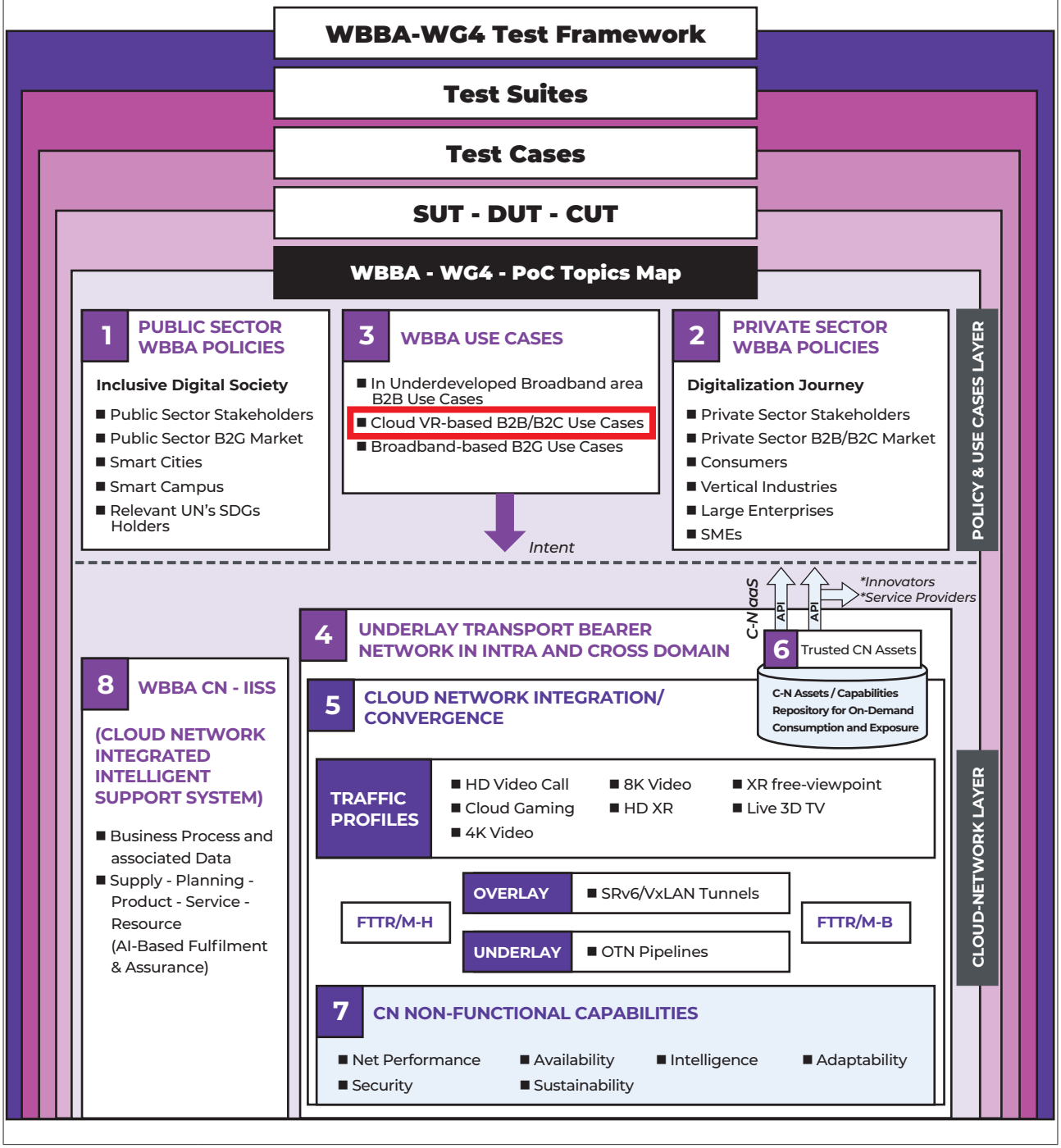

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