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GROUP REPORT

Fifth Generation Fixed Network (F5G); F5G Use Cases Release #1

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Reference

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Fifth Generation Fixed Network (F5G).

Modal verbs terminology

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1 Scope

The present document describes a first set of use cases to be enabled by the Fifth Generation Fixed Network (F5G). These use cases include services to consumers and enterprises as well as functionalities to optimize the management of the Fifth Generation Fixed Network. The use cases will be used as input to a gap analysis and a technology landscape study, aiming to extract technical requirements needed for their implementations. Fourteen use cases are selected based on their impact. The context and description of each use case are presented in the present document.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GR F5G 001: "Fifth Generation Fixed Network (F5G); F5G Generation Definition Release #1".

[i.2] 3GPPP TR 38.801: "3rd Generation Partnership Project;Technical Specification Group Radio Access Network;Study on new radio access technology: Radio access architecture and interfaces (Release 14)".

[i.3] Recommendation ITU-T G.987: "10-Gigabit-capable passive optical network (XG-PON) systems: Definitions, abbreviations and acronyms".

[i.4] ETSI GS F5G 003: "F5G Technology Landscape F5G Technology Landscape".

[i.5] ETSI GS F5G 004: "F5G Network Architecture Specification F5G Network Architecture Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

rendering: process of generating a photorealistic or non-photorealistic image from a 2D or 3D model by means of a computer program

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Artificial Intelligence
AP	Access Point
API	Application Programming Interface
AR	Augmented Reality
ATM	Automatic Teller Machine
B2B	Business to Business
B2C	Business to Customer
BBU	Base Band Unit
BNG	Broadband Network Gateway
CAPEX	CAPital EXpenditure
CCTV	Closed Circuit TeleVision
CDN	Content Delivery Network
CE	Customer Edge
CO	Central Office
CPE	Customer Premise Equipment
CR	Core Router
CT	Communication Technology
CU	Central Unit
DBA	Dynamic Bandwidth Allocation
DC	Data Centre
DIM	Dynamic Integrity Measurement
DSLAM	Digital Subscriber Line Access Multiplexer
DU	Distributed Unit
E2E	End to End
EMI	Electro-Magnetic Interference
EPC	Evolved Packet Core
F5G	Fifth Generation Fixed Network
FAT	Fibre Access Terminal
FFC	Full-Fibre Connection
FGW	Fibre GateWay
FPS	First Person Shooter
FTTB	Fibre To The Building
FTTB/C	Fibre To The Building/Curb
FTTH	Fibre To The Home
FTTR	Fibre To The Room
GE	Gigabit Ethernet
GPON	Gigabit-capable Passive Optical Network
GRE	Guaranteed Reliable Experience
HD	High Definition
HDTV	High Definition TeleVision
HIS	Hospital Information System
HQ	HeadQuter
HSI	High Speed Internet
HW	HardWare
IIoT	Industrial Internet of Things
IP	Internet Protocol
IPTV	Internet Protocol TeleVision
IT	Information Technology
LAN	Local Area Network
MAC	Media Access Control
MAN	Metro Area Network
MDU	Multiple Dwelling Unit
MOBA	Multiplayer Online Battle Arena
MOOC	Massive Open Online Course
NFV	Network Functions Virtualisation
NMS	Network Management System
OA	Office Automation

OAM	Operation And Maintenance
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONT	Optical Network Terminal
ONU	Optical Network Unit
OPEX	OPerational EXpenses
OSS	Operation Support System
OT	Operational Technology
OTN	Optical Transport Network
P2P	Point to Point
PACS	Picture Archiving and Communication Systems
PC	Personal Computer
PLC	Programmable Logical Controller
PoE	Power over Ethernet
POL	Passive Optical LAN
PON	Passive Optical Network
PoP	Point of Presence
RA	Remote Attestation
RAN	Radio Access Network
RRH	Radio Remote Head
RTT	Round Trip Time
RTU	Remote Teminal Unit
RU	Radio Unit
SDN	Software-Defined Network
SD-WAN	Software-Defined Wide Area Network
SFP	Small Form Pluggable
SLA	Service-Level Agreement
SME	Small and Medium Enterprises
STP	Shielded Twisted Pair
TCP	Transmission Control Protocol
TPM	Trusted Platform Module
TSN	Time-Sensitive Networking
TV	TeleVision
UAC	User Application Client
UAS	User Application Server
UHD	Ultra-High Definition
URLLC	Ultra-Reliable and Low Latency Communications
UTP	Unshielded Twisted Pair
VLAN	Virtual Local Area Network
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
VR	Virtual Reality
VR/AR	Virtual Reality/Augmented Reality
VTM	Video Teller Machine
WAP	Wireless Access Points
WIFI	Wireless Fidelity
WLAN	Wireless Local Area Network
XG-PON	10-Gigabit-capable Passive Optical Network
XGS-PON	10-Gigabit-capable Symmetric Passive Optical Network

4 Overview

As described in ETSI GR F5G 001 [i.1], the main business requirements identified by F5G are outlined in Figure 1. They include improved speed, capacity, coverage, responsivity, density, reliability, availability, security, operational efficiency, energy efficiency and spectral efficiency over previous generations of fixed networks.

Networks	Services	Operations
a) Speed and Capacity (Bandwidth) b) Coverage (Connectivity) c) Responsivity (Latency) d) Density (Connection)	e) Reliability f) Availability g) Security	h) Operational Efficiency i) Energy Efficiency j) Spectral Efficiency

Figure 1: Business requirements for F5G in the categories of Network, Service, and Operation

In the present document, fourteen use cases are described. Each use case may demand a different subset of the 10 requirements depicted in Figure 1. With further research, subsequent use cases may be specified in future releases of the present document.

5 Categorization of use cases

5.1 Driving the characteristics of F5G

The use cases as described in the present document are driving the three dimensions of characteristics that are specified in the document on generation definitions [i.1], namely eFBB (enhanced Fixed BroadBand), FFC (Full-Fibre Connection), and GRE (Guaranteed Reliable Experience). Figure 2 shows that:

- depending on the use case, one or more dimensions are particularly important, and
- all dimensions of the F5G system architecture are needed to implement the use cases.

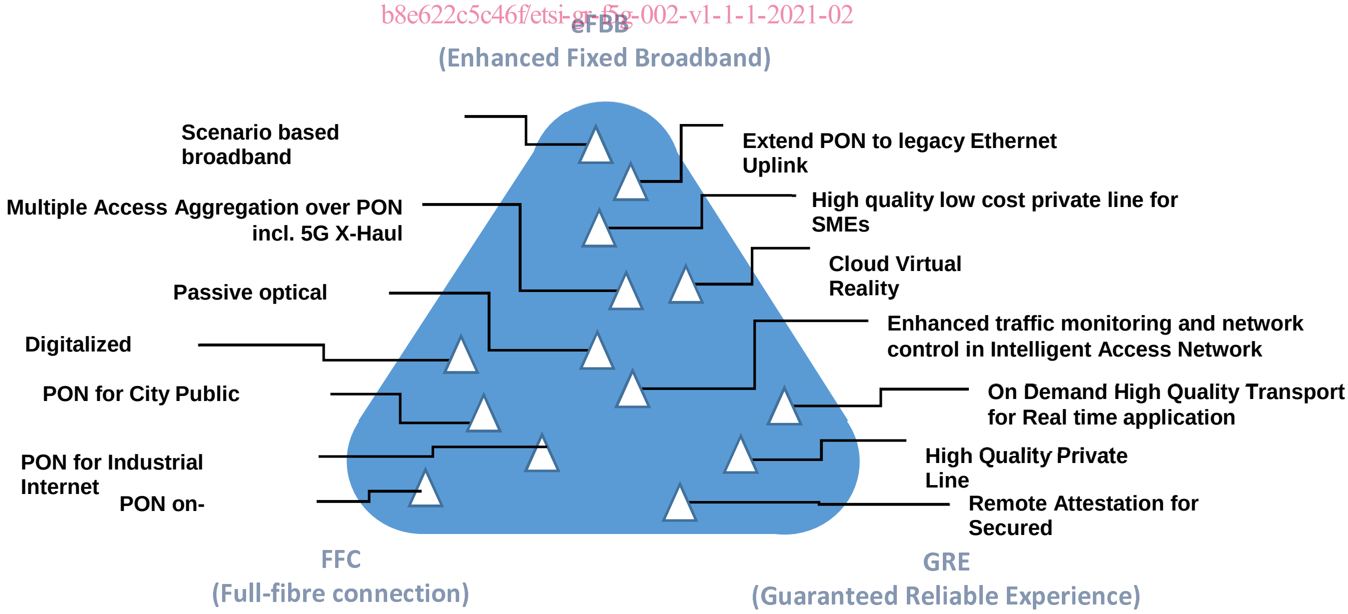

Figure 2: F5G use cases driving the three dimensions of F5G, the enhanced Fixed BroadBand (eFBB), Full-Fibre Connection (FFC), and Guaranteed Reliable Experience (GRE)

5.2 Application Area Perspective

A key motivation for F5G is leveraging technologies of current fibre optical networks to benefit more application areas namely extending the business to cover new fields, including numerous applications in the vertical industries.

The use cases described in the present document cover the major anticipated areas including residential applications, business applications, network internal topics such as network optimizations and the use of F5G for mobile front, midhaul, and backhaul, and finally vertical applications oriented use cases. Many use cases will address topics that may be applicable in different application areas, therefore features and solutions needed by one use case may benefit other areas as well.

Use cases may be classified from the application and business area perspective. For each of the three main technical drivers eFBB (speed), GRE (latency), and FFC (density), additional subcategories on the application and business area are introduced. Based on the strongest existing affinities, each of the use cases is then mapped into one or more of the application categories, as shown in Table 1.

Table 1: Mapping use cases into application categories

Technical driver	Application category	Corresponding use cases
eFBB (speed)	Broadband networking	6.3 Use case #3: High quality low cost private line for small and medium enterprises (6.8 Use case #8: Multiple Access Aggregation over PON) (6.9 Use case #9: Extend PON to legacy Ethernet Uplink) (6.10 Use case #10: Scenario based broadband)
	Customer premises networking	6.4 Use case #4: PON on-premises) (6.5 Use case #5: Passive optical LAN)
	Physical networking	6.14 Use case #14: Digitalized ODN/FTTX
GRE (latency)	Immersive experiences	6.1 Use case #1: Cloud Virtual Reality
	Time-sensitive applications	6.12 Use case #12: On Demand High Quality Transport for Real time applications
	Reliable communications	6.2 Use case #2: High Quality Private Line 6.13 Use case #13: Remote Attestation for Secured Network Elements
FFC (density)	High-density endpoints	(6.4 Use case #4: PON on-premises) (6.5 Use case #5: Passive optical LAN) 6.7 Use case #7: Using PON for City Public Service (6.8 Use case #8: Multiple Access Aggregation over PON) (6.9 Use case #9: Extend PON to legacy Ethernet Uplink)
	Industrial ecosystems	6.6 Use case #6: PON for Industrial Manufacturing
	Autonomous networks	(6.10 Use case #10: Scenario based broadband) 6.11 Use case #11: Enhanced traffic monitoring and network control in Intelligent Access Network
NOTE: The use cases mapped into more than one category are identified by brackets.		

The application area subcategories are defined based on the following characteristics:

- Broadband networking is typified by using gigabit connectivity broadband services in areas such as online education, smart home, enterprise cloudification, collaborative work and social networking.

- Customer premises networking are mostly defined by the needs of using gigabit connectivity on the customer premises. Service areas include wireless and wired access, enhanced broadband services and smart home/enterprise.
- Physical networking are mostly defined by the needs of using physical layer services in areas such as very-high point-to-point transport capacities and low-level transport capacities for legacy systems.
- Immersive experiences are mostly defined by the needs of using VR/AR user experiences in human/machine interactive communication environments such as healthcare, cloud gaming and social networking.
- Time-sensitive applications are mostly defined by the needs of ensuring time-critical, low-latency and data processing capacity requirements in areas such as audio and video streaming/processing, industrial automation and healthcare.
- Reliable communications are mostly defined by the needs of stringent quality of service requirements, such as high-availability and data-integrity, in public services areas, healthcare, real-time banking and mission-critical applications.
- High-density endpoints are mostly defined by the needs of increasing PON density in areas such as public venues, data centres, enterprise and residential buildings and outside plant fibre densification.
- Industrial ecosystems are mostly defined by the needs of using analytics and intelligent devices in areas such as smart manufacturing in vertical sectors and industries.
- Autonomous networks are mostly defined by the needs of using artificial intelligence and automation techniques in areas such as networking, IoT, edge computing and smart city applications.

6 Description of use cases

6.0 Introduction

The present release of F5G use cases includes a set of services and functionalities enabled by the new generation of fixed network, leveraged on its eFBB (enhanced Fixed BroadBand, FFC (Full-Fibre Connection) and GRE (Guaranteed Reliable Experience) characteristics. Future releases will enhance existing use cases and add more use cases.

In the present document each use case includes the context of the use case and a detailed description.

The use case context introduces the background of each use case, providing a quick overview of the covered application and associated challenges.

The description of the use case provides more detailed information. It includes the overview (what is the use case), motivation (the benefits the use case provides), actors/roles (who will be involved in the use case and what they will do in the use case) and precondition (what should be ready before the use case is running).

All the use cases in the present document are identified in Table 2, grouped into 3 use case types - new/enhanced services to users, expanded fibre infrastructure and services, management and optimization.

Table 2: List of Use cases

New/Enhanced Services to Users
6.1 Use case #1: Cloud Virtual Reality
6.2 Use case #2: High Quality Private Line
6.3 Use case #3: High quality low cost private line for small and medium enterprises
Expanded Fibre Infrastructure and Services
6.4 Use case #4: PON on-premises
6.5 Use case #5: Passive optical LAN
6.6 Use case #6: PON for Industrial Manufacturing
6.7 Use case #7: Using PON for City Public Service
6.8 Use case #8: Multiple Access Aggregation over PON
6.9 Use case #9: Extend PON to legacy Ethernet Uplink
Management and Optimization
6.10 Use case #10: Scenario based broadband
6.11 Use case #11: Enhanced traffic monitoring and network control in Intelligent Access Network
6.12 Use case #12: On Demand High Quality Transport for Real time applications
6.13 Use case #13: Remote Attestation for Secured Network Elements
6.14 Use case #14: Digitalized ODN/FTTX

These use cases will contribute to the definition of the requirements for a new architecture, new devices with new interfaces, new network topologies and a set of advanced management and optimization capabilities that will enhance the fields of applicability and the quality of experience of next generation fibre networks.

The order of use cases in the subsequent clauses follows the order in Table 2.

6.1 Use case #1: Cloud Virtual Reality

6.1.1 Use case context

Based on cloud computing and rendering technologies, Cloud Virtual Reality (VR) applications introduce vast amount of data exchange between the terminal and the cloud server. It will place stringent requirements on the bearer network (e.g. bandwidth, latency, jitter, and packet loss), which will require upgrading of the bearer network technology and architecture. The current network may be able to support early versions of Cloud VR (e.g. 4K VR) with limited user experience, but will not meet the requirements for large scale deployment of Cloud VR with enhanced experience (e.g. Interactive VR applications, cloud games). To support more applications and ensure a high-quality experience, much higher available and guaranteed bandwidth (e.g. > 1 Gbps), lower latency (e.g. < 10 ms) and lower jitter (e.g. < 5 ms) are required.

This use case gives a brief introduction of Cloud VR applications and the required capabilities on fixed bearing network.

6.1.2 Description of the use case

6.1.2.1 Overview

Cloud VR offloads computing and cloud rendering in VR services from local dedicated hardware to a shared cloud infrastructure. Cloud rendered video and audio outputs are encoded, compressed, and transmitted to user terminals through fast and stable networks. In contrast to current VR services, where good user experience primarily relies on the end user purchasing expensive high-end PCs for local rendering, cloud VR promotes the popularization of VR services by allowing users to enjoy various VR services where rendering is carried out in the cloud.

Cloud VR service experience is impacted by several factors that influence the achieved sense of reality, interaction, and pleasure, which are related to the network properties (e.g. bandwidth, latency and packet loss).

- The sense of reality requires the network to provide sufficiently high bandwidth.

The sense of reality depends on the audio and video quality. High-quality video transmission needs high network bandwidth.

- The sense of interaction requires the network to provide sufficiently low latency and low jitter.

Cloud VR implements computing and rendering in the cloud. Any latency from remote processing compromise the sense of interaction, including latency in loading, switchover, and joystick operations. The most important effect of high latency in VR is the user becoming sea-sick or dizzy. Note that high jitter will cause VR play-out to not being smooth and frames might be distorted or lost.

- The sense of pleasantness requires high bandwidth, low latency, low jitter, and low packet loss.

The sense of pleasantness depends on the smoothness of the VR service. It is strongly related to factors such as frame freezing and artefacts. The network performance indicators, such as bandwidth, latency, and packet loss rate, need to meet the requirements to realize pleasurable experience.

Figure 3 shows an overview of Cloud VR network architecture.

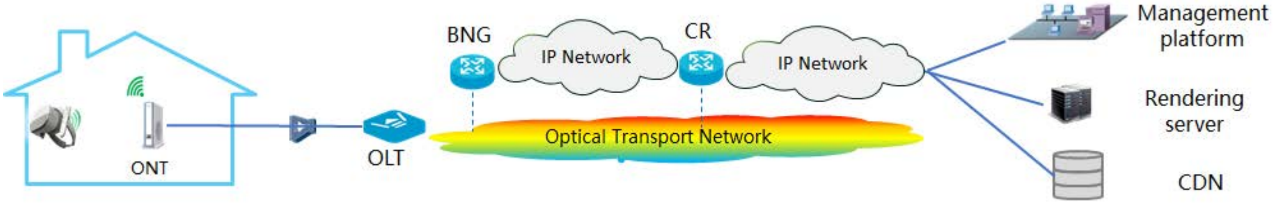

Figure 3: Cloud VR network architecture

As depicted in Figure 3, the Cloud VR bearer network includes the home network, access network, metro IP network, and an Optical Transport network as infrastructure:

- The home network provides Wi-Fi® access and authentication capabilities for Cloud VR headsets.
- The access network provides optical fibre infrastructure (ODN), aggregates and processes packets from home networks through OLT.
- The metro network provides the IP bearer function, and it is connected to the Cloud VR management platform, rendering server and CDN through backbone network.

Cloud VR places stringent requirements on the network. It can be transported with current Internet services, however they will-affect each other's performance. The VR service experience would be difficult to guarantee due to current IP forwarding limitations. To ensure an excellent VR experience, VR traffic is transported via an independent channel that assures the desired performance and thereby isolated from existing internet services. To implement this, an ONU identifies Cloud VR traffic and directs it to the independent channel provided by an optical transport network. From the server side, Cloud VR traffic is transported via the same independent channel. A general view is shown in Figure 4.

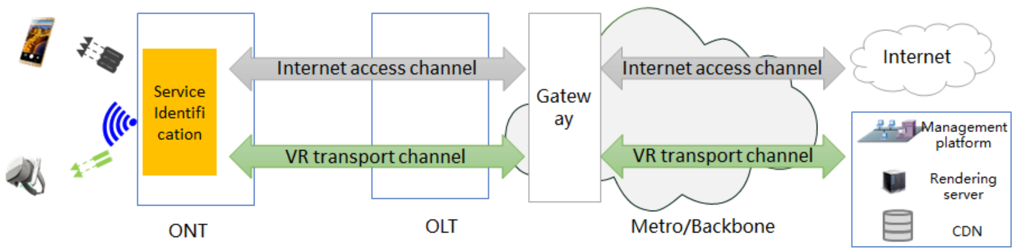

Figure 4: Cloud VR transport in independent channel

6.1.2.2 Motivation

The key features of Cloud VR are cloud-based rendering and delivery of VR content. Powerful cloud computing capabilities can improve the user experience and reduce the cost and energy consumption of terminals, promoting the evolution of VR to Cloud VR, as well as the fast popularization of VR services.

Main advantages and driving forces of Cloud VR development includes:

- Reduction in VR costs for users. Cloud VR requires terminal devices to have only basic functions.

- Protection for VR content copyrights. Precise content management and provisioning can be implemented on the cloud.
- Improvement in user experience. Cloud VR can improve logical computing and image processing capabilities.
- Acceleration of VR commercial take-up. Currently, the high cost per-user, lack of content, impaired mass adoption of VR results from a poor ecosystem. After VR service is moved to the cloud, user costs are greatly reduced, popularizing VR in more households and enriching people's VR experience. High-quality VR content and VR commercial scenarios will continue to develop.
- Cloud VR could be a new value-added service and business for operators beyond triple play.

6.1.2.3 Pre-conditions

The operational flow of actions in this use case will show the process with Cloud VR service bearer in an independent channel, with pre-conditions as follows:

- VR services are deployed on the Cloud.
- The bearer network has created independent transport channels for Cloud VR services.
- The subscriber has subscribed to the Cloud VR service and service identification rules have been configured on the ONU.

6.1.2.4 Operational flow of actions

This clause shows an example of the operational flow of actions for enabling high quality VR games. See Figure 5.

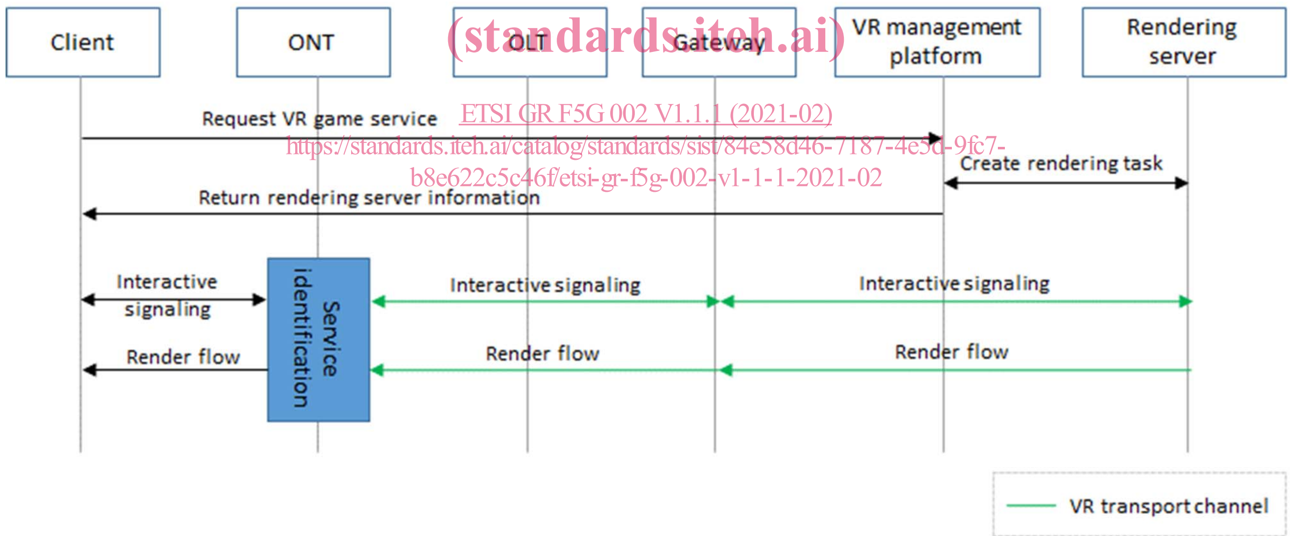

Figure 5: Operational flow of Cloud VR game service

1) When a user starts the game, the client sends a request to VR management platform for gaming service. VR management platform returns the rendering server information after the rendering task was created. Because these are initial signals between client and VR management platform, they can be transported through the best-effort network.

2) With the rendering server information obtained, the client will set up a dedicated connection with the rendering server for interactive signalling. During the interaction, traffic from the client will be identified by ONT, and be directed to the VR transport channel for transmission. The access transport channel is terminated on the Gateway functional module. Depending on an operator's network architecture, the Gateway function module can be located in a BNG (Broadband Network Gateway) or inside the OLT.

3) The traffic then will be further directed to the Cloud VR transport channel in Metro/Backbone network. After receiving these messages, the rendering server gives feedback to the client.