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Fifth Generation Fixed Network (F5G); F5G Advanced Use Cases; Release 3

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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 the use cases to be enabled by the F5G Advanced network. The use cases in the present document include services and applications for residential users, enterprises, vertical industries, network operation optimizations, and evolved fixed end-to-end infrastructure, which were not supported by the F5G network. Use cases will aim to introduce new technical requirements for the F5G Advance network along various characteristic dimensions. The use cases will be used as input to F5G Advanced Technology Requirements and Gap Analyses activities to extract technical requirements.

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 021: "Fifth Generation Fixed Network (F5G); F5G Advanced Generation Definition".

[i.2] ETSI GR F5G 008: "Fifth Generation Fixed Network (F5G); F5G Use Cases Release #2".

[i.3] ETSI GS F5G 015: "Fifth Generation Fixed Network (F5G); F5G Residential Services Quality Evaluation and Classification".

[i.4] IEEE 802.11be™: "Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Extremely High Throughput (EHT)".

[i.5] Nokia Lab report: "Focusing on latency, not throughput, to provide a better internet experience and network quality".

[i.6] ITU-T GSTP-FTTR: "Use cases and requirements of fibre-to-the-room (FTTR)".

[i.7] IEEE 802.11k™: "Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC)and Physical Layer (PHY) Specifications Amendment 1: Radio Resource Measurement of Wireless LANs".

[i.8] IEEE 802.11v™: "Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications Amendment 8: IEEE 802.11 Wireless Network Management".

[i.9] IEEE 802.11r™: "Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Fast Basic Service Set (BSS) Transition".

[i.10] China Unicom: "China Unicom Computing Power Network White Paper, 2019".

[i.11] China Mobile: "Computing Force Network White Paper, 2021".

[i.12] Recommendation ITU-T G.9940: "High speed fibre-based in-premises transceivers - system architecture".

[i.13] Recommendation ITU-T G.652: "Characteristics of a single-mode optical fibre cable".

[i.14] Nanomaterials 2022, 12(3), 429: "Investigation of Autostereoscopic Displays Based on Various Display Technologies".

[i.15] ETSI GS F5G 014 (V1.1.1): "Fifth Generation Fixed Network (F5G); F5G Network Architecture Release 2".

[i.16] Recommendation ITU-T G.984.3 (2014): "Gigabit-capable passive optical networks (G-PON): Transmission convergence layer specification".

[i.17] Recommendation ITU-T G.988 (2022): "ONU management and control interface (OMCI) specification". .

[i.18] WFA, 2019: "Wi-Fi Data Elements Specification 2.0".

[i.19] ETSI TR 103 775 (V1.1.1): "Access, Terminals, Transmission and Multiplexing (ATTM); Optical Distribution Network (ODN) Quick Construction and Digitalization" .

[i.20] IEEE 802.11ad™-2012: "IEEE Standard for Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band".

[i.21] IEEE 802.11ay™-2021: "IEEE Standard for Information Technology -- Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks -- Specific Requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Enhanced Throughput for Operation in License-exempt Bands above 45 GHz".

[i.22] IEEE 802.11aj™-2018: "IEEE Standard for Information Technology -- Telecommunications and information exchange between systems Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput to Support Chinese Millimeter Wave Frequency Bands (60 GHz and 45 GHz)".

[i.23] Recommendation ITU-T G.672 (10/2020): "Characteristics of multi-degree reconfigurable optical add/drop multiplexers".

[i.24] Robot Operating System.

[i.25] Linux® Foundation Project CAMARA website.

NOTE: Linux® is the registered trademark of Linus Torvalds in the U.S. and other countries.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

binocular parallax: disparity between the two retinal images of a three-dimensional object or scene arising from the slightly different vantage points of the two eyes, such binocular disparity functioning as one of the binocular cues of visual depth perception and providing the basis for stereopsis

NOTE: As defined in https://www.oxfordreference.com/.

motion parallax/moving parallax: monocular depth cue arising from the relative velocities of objects moving across the retinae of a moving person

NOTE: The term parallax refers to a change in position. Thus, motion parallax is a change in position caused by the movement of the viewer. Motion parallax arises from the motion of the observer in the environment.

3.2 Symbols

Void.

3.3 Abbreviations

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

3D	three-dimensional
6DoF	six Degrees of Freedom
AGGN	AGGregation Network
AI	Artificial Intelligence
AOA	Angle Of Arrival
AP	Access Point
API	Application Programming Interface
APP	APPlication
AR	Augmented Reality
B2B	Business to Business
BC	Business Continuity
BNG	Broadband Network Gateway
BoD	Bandwidth on Demand
BSS	Basic Service Set
BYOD	Bring Your Own Device
CAPEX	CAPital EXpenditure
CO	Central Office
CPE	Customer Premise Equipment
CPN	Customer Premise Network
CPU	Central Processing Unit
CSMA	Carrier Sense Multiple Access
DBA	Dynamic Bandwidth Allocation
DC	Data Centre
DCN	Data Communication Network
DCSW	Dada Centre Switch
DDS	Data Distribution Service
DR	Disaster Recovery
DTU	Distribution Terminal Unit
E2E	End to End
EMS	Element Management System
E-ONU	Edge ONU
F5G	Fifth Generation Fixed Network
F5G-A	Fifth Generation Fixed Network Advanced
FDT	Fibre Distribution Terminal
FIN	Fibre-based In-premises network
FOADM	Fixed Optical Add/Drop Multiplexer
FTTR	Fibre-To-The-Room
FTU	Feeder Terminal Unit
GIS	Geographic Information System
GPU	Graphics Processing Unit
GUI	Graphical User Interface
ICT	Information Communication Technology
IoT	Internet of Things
IoV	Internet of Vehicles
IP	Internet Protocol
IPTV	Internet Protocol TeleVision

IT	Information Technology
JSON	JavaScript Object Notation
KPI	Key Performance Indicators
KQI	Key Quality Indicators
LAN	Local Area Network
LCD	Liquid Crystal Display
LOS	Loss of Signal
MAN	Metropolitan Area Network
MCM	Multi-Carrier Modulation
MFU	Main FTTR Unit
MQTT	Message Queuing Telemetry Transport
MSE	Multi-service Edge
NAS	Network Attached Storage
NE	Network Element
NMS	Network Management System
NOC	Network Operations Centre
NP	Network Processor
OAI	Optical Artificial Intelligent
OAM	Operation And Maintenance
OCh	Optical Channel
ODN	Optical Distribution Network
ODSP	Optical Digital Signal Processing
ODU	Optical Data Unit
OFDMA	Orthogonal Frequency Division Multiple Access
OLT	Optical Line Termination
OMCI	ONU Management and Control Interface
ONU	Optical Network Unit
OPEX	OPerational EXpenditure
OPGW	OPtical Ground Wire
OSU	Optical Switch Unit
OTDR	Optical Time Domain Reflectometer
OTN	Optical Transport Network
OTT	Over The Top
OXC	Optical Cross-Connect
P2P	Point to Point
PC	Personal Computer
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PDH	Plesiochronous Digital Hierarchy
PON	Passive Optical Network
P-ONU	Primary ONU
PPPoE	Point-to-Point Protocol over Ethernet
QoD	Quality on Demand
QoE	Quality of Experience
QoS	Quality of Service
QR	Quick Response
RaaS	Robotics as a Service
RGB	Red Green Blue
ROADM	Reconfigurable Optical Add-Drop Multiplexer
ROS	Robotic Operating System
RTT	Round Trip Time
SDH	Synchronous Digital Hierarchy
SFU	Sub FTTR Unit
SLA	Service-Level Agreement
SLAM	Simultaneous Localization And Mapping
SME	Small and Medium-size Enterprises
SNCP	Sub-Network Connection Protections
SOP	State Of Polarization
STA	Station
TCP	Transmission Control Protocol
TDMA	Time Division Multiple Address
TPU	Tensor Processing Units

TTM	Time-To-Market
TTU	Transformer supervisory Terminal Unit
UDP	User Datagram Protocol
UHV	Ultra High Voltage
VLAN	Virtual Local Area Network
VoD	Video on Demand
VoIP	Voice over Internet Protocol
VR	Virtual Reality
WDM	Wavelength Division Multiplexing
WLAN	Wireless Local Area Network
WMM	Wi-Fi® Multimedia
WSS	Wavelength Selective Switch
XR	eXtended Reality

4 Categorization of use cases

4.1 F5G Advanced Key Focus

As described in ETSI GR F5G 021 [i.1], the main business needs identified by F5G Advanced are outlined in Figure 1. They improve various dimensions over previous generations of fixed networks.

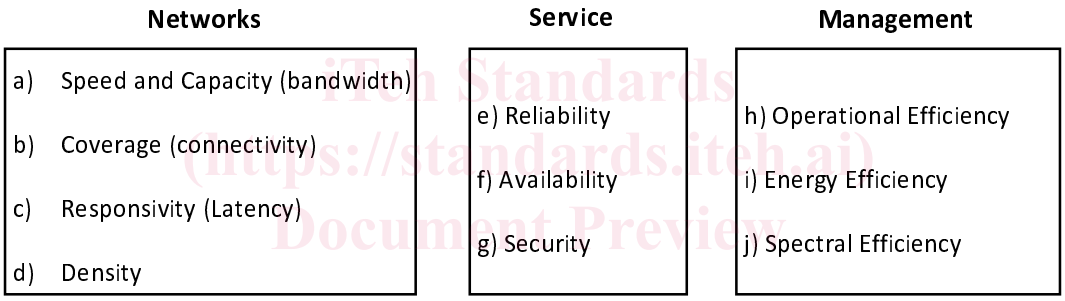

Figure 1: Key Focus for F5G Advanced in the categories of Network, Service, and Management

In the present document, there are seventeen use cases described, which take advantage of the key technical characteristics defined for the F5G-A network. Each use case may demand a different subset of the 10 high level categories depicted in Figure 1. With further research, subsequent use cases may be specified.

4.2 Driving the characteristics of F5G Advanced

The use cases as described in the present document are driving the six characteristic dimensions that are specified in the document on generation definitions ETSI GR F5G 021 [i.1], namely enhanced Fixed Broadband (eFBB), Real time Resilience Link (RRL), Guaranteed Reliable Experience (GRE), Optical Sensing and Visualization (OSV), Full-Fibre Connection (FFC), and Green Agile Optical network (GAO).

Figure 2 shows that:

- Depending on the use case, one or more dimensions are particularly important.
- All dimensions of the F5G-A system architecture are implemented by the following use cases.

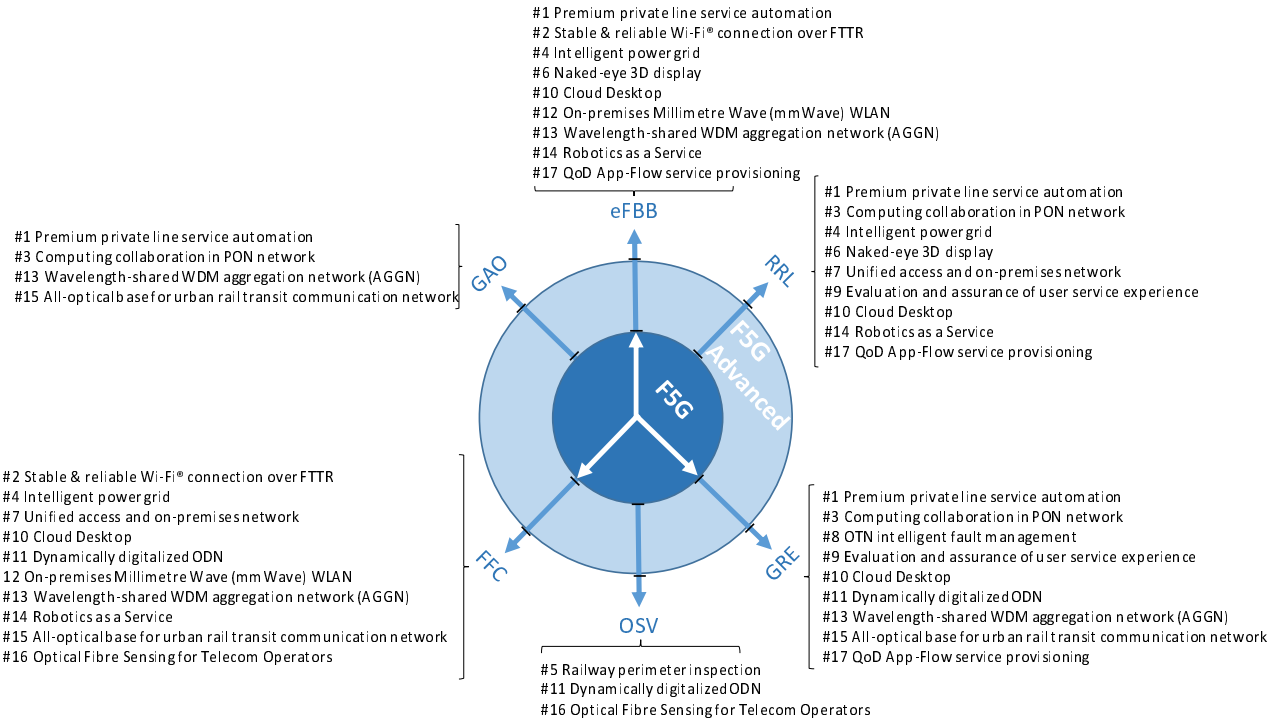

Figure 2: F5G-A use cases (illustrative)

4.3 Paving the Way for Fibre to Everywhere and Everything

F5G-A is leveraging technologies of fibre optical networks to benefit multiple segments including residential applications, enterprise applications, network internal topics such as network optimizations plus the use of F5G-A for the mobile infrastructure and service convergence, and finally vertical industries-oriented use cases.

Figure 3 shows the different high-level segments where fibre to everywhere is applicable. The larger circle named network features focus on optimization of the networking technologies.

In the present document, the aspects of mobile have a limited number of use cases assigned to it. Future use cases might add more mobile oriented aspects.

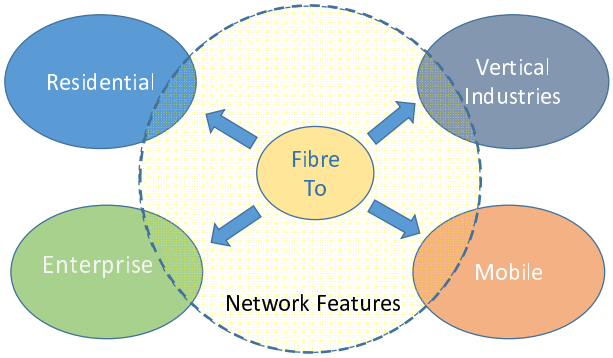

Figure 3: High-level Segment Perspective

As a quick reference, Table 1 summarizes the different use cases from three different perspectives:

a) Key F5G-A dimensions. This column is filled in alphabetical order per use case.

b) Key segment and business area addressed.

c) Key focus of the use case - new or enhanced services, network infrastructure and service features or in network management and optimization.

Table 1: Use cases with key dimensions, segments and focus

F5G-A Use Cases	Key F5G-A Dimensions	Key Segments					Key Focus			Clauses
		Residetial	Enterprise	Mobile	Vertical Industry	Network Features	Services	Network	Management	
F5G-A Use case #1: Premium private line service automation	eFBB, GAO, GRE, RRL	x	x					x		5.1
F5G-A Use case #2: Stable & reliable Wi-Fi® connection over FTTR	eFBB, FFC	x						x		5.2
F5G-A Use case #3: Computing collaboration in PON network	GAO, GRE, RRL					x			x	5.3
F5G-A Use case #4: Intelligent power grid	eFBB, FFC, RRL				x			x		5.4
F5G-A Use case #5: Railway perimeter inspection	OSV				x	x		x		5.5
F5G-A Use case #6: Naked-eye 3D display	eFBB, RRL	x	x		x		x			5.6
F5G-A Use case #7: Unified access and on-premises network	FFC, RRL	x						x	x	5.7
F5G-A Use case #8: OTN intelligent fault management	GRE					x			x	5.8
F5G-A Use case #9: Evaluation and assurance of user service experience	GRE, RRL	x					x		x	5.9
F5G-A Use case #10: Cloud Desktop	eFBB, FFC, GRE, RRL		x				x			5.10
F5G-A Use case #11: Dynamically digitalized ODN	FFC, GRE, OSV					x			x	5.11
F5G-A Use case #12: On-premises MillimetreWave (mmWave) WLAN	eFBB, FFC	x						x		5.12
F5G-A Use case #13: Wavelength-shared WDM aggregation network (AGGN)	eFBB, FFC, GAO, GRE					x		x		5.13
F5G-A Use case #14: Robotics as a Service	eFBB,FFC, RRL		x		x		x			5.14
F5G-A Use case #15: All-optical base for urban rail transit communication network	FFC, GAO, GRE				x	x		x		5.15
F5G-A Use case #16: Optical Fibre Sensing for Telecom Operators	FFC, OSV					x		x	x	5.16
F5G-A Use case #17: QoD App-Flow service provisioning	eFBB, GRE, RRL					x	x		x	5.17

5 Use cases

5.1 F5G-A Use case #1: Premium private line service automation

5.1.1 Use case context

Traditional OTN-based premium private line services have the characteristics of high bandwidth, ultra-low and deterministic latency, availability and security, and are widely used in many scenarios such as government institutions, financial organizations, medical organizations and large enterprises (see Use Case #2 and #16 in ETSI GR F5G 008 [i.2]).

As F5G evolves to F5G-A, new applications such as Business to Business (B2B) high-speed transport, 5G, Virtual Reality (VR) and Cloud Data Centre are rapidly developing, which leads to the emergence of a variety of new application scenarios. These new applications will need different and higher network performance from the operators' premium private line services.

To keep up with the changing application needs and take advantage of the business opportunities, the network operators need to enable fast rollout and provisioning of premium private line services. To achieve these improvements, the premium private line service has to provide a higher degree of automation, with the improvement of self-service, on-demand provisioning, high agility and flexibility.

5.1.2 Description of the use case

5.1.2.1 Overview

In the current premium private line services, many manual processes are involved. For example, during the CPE installation, the private line bandwidth provisioning and bandwidth modification, needs manual service handling at the Service Centre and manual configuration of the network.

As a result, the entire processes of premium private line service provisioning and modification becomes very complex, and takes a long time to achieve. This significantly reduce the users' service experience and the network operators' operation experience.

Additionally, once the premium private line services are provisioned, the users do not know what is the actual qualities of the premium private line services they purchased, such as the latency, availability, and bit error rate of the service.

For F5G-A, the automation capabilities of the premium private line services need to be improved, to enable the evolution towards a higher-level of autonomous optical networking. This includes but not limit to:

- CPE plug-and-play, to enable fast deployment and installation of a large number of CPEs.
- Automatic provisioning of premium private line services and flexible online adjustment of the service bandwidth, operating in an e-commerce environment.
- Visualization of private line SLA information after provisioning.

Figure 4 shows an overview of the premium private line service automation.

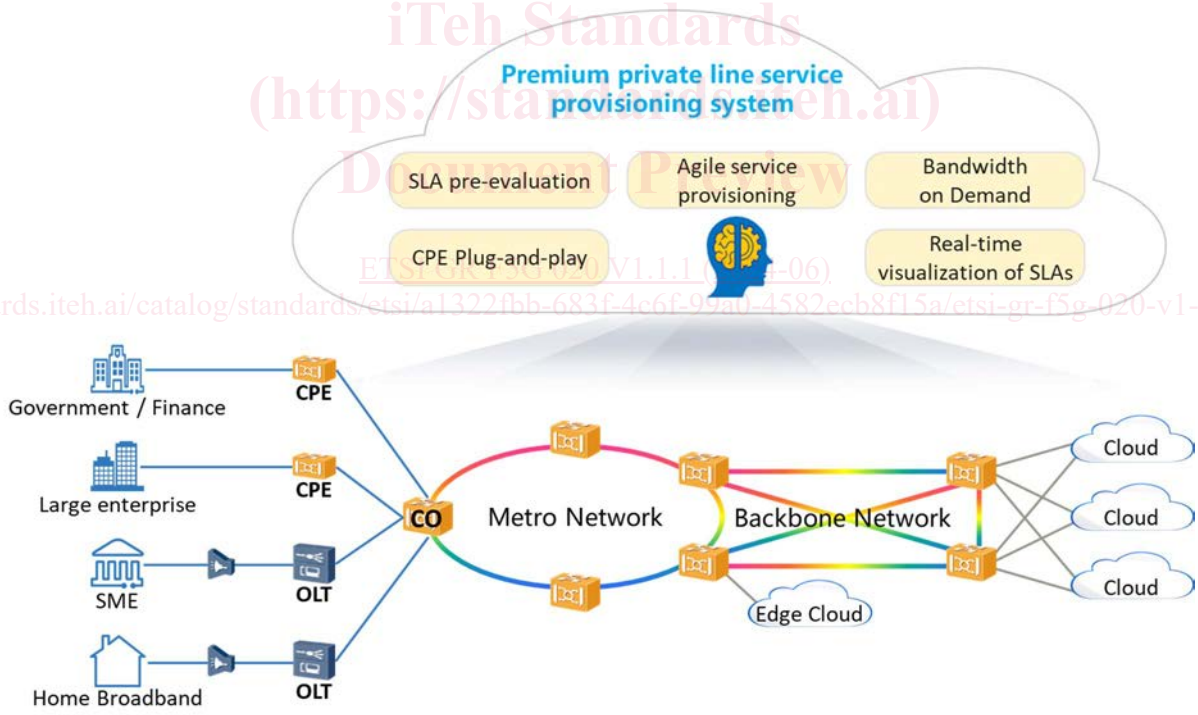

Figure 4: Overview of premium private line service automation

5.1.2.2 Motivation

The main motivation for premium private line service automation include:

- Accelerating the deployment of premium private line services: The customers that desire to accelerate the deployment of their private network infrastructure (including the deployment of premium private line services purchased from the network operators), to help them deploy new applications and seize new business opportunities. This becomes even more important for cloud application evolution.