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ITU-T F.746.15 (12/2022)

SERIES F: Non-telephone telecommunication services

Multimedia services

Requirements for smart broadband network gateway in multimedia content transmission

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Recommendation ITU-T F.746.15

Requirements for smart broadband network gateway in multimedia content transmission

Summary

Recommendation ITU-T F.746.15 specifies requirements for smart broadband network gateway (BNG) in multimedia content transmission, and specifically describes the functional requirements and architecture, security requirements, typical application scenarios and use cases.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.746.15	2022-12-14	16	11.1002/1000/15189

Keywords

Interactive experience, network, smart BNG, timeliness.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Requirements for smart broadband network gateway in multimedia content transmission

1 Scope

This Recommendation specifies requirements for smart broadband network gateway (BNG) in multimedia content transmission, and specifically describes the functional requirements and architecture, security requirements, typical application scenarios and use cases.

The scope of this Recommendation includes:

– Functional requirements and architecture of smart BNG;

– Security requirements of smart BNG.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T M.3080] Recommendation ITU-T M.3080 (2021), *Framework of artificial intelligence enhanced telecom operation and management (AITOM)*.

[ITU-T M.3400] Recommendation ITU-T M.3400 (2000), *TMN management functions*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 broadband network gateway (BNG) [b-ITU-T Q.3315]: The access point to the provider's IP network for wireline broadband services.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

4G 4th-Generation Mobile Communication

5G 5th-Generation Mobile Communication

AGV Automated Guided Vehicle

AI Artificial Intelligence

AR Augmented Reality

ARP	Address Resolution Protocol
BNG	Broadband Network Gateway
CPU	Central Processing Unit
DI	Digital Input
DO	Digital Output
DSL	Digital Subscriber Line
EPON	Ethernet Passive Optical Network
FCAPS	Fault, Configuration, Accounting, Performance, and Security
FE	Fast Ethernet
GE	Gigabit Ethernet
GPON	Gigabit Passive Optical Network
GRE	Generic Routing Encapsulation
IP	Internet Protocol
IPSec	Internet Protocol Security
IPTV	Internet Protocol Television
IS-IS	Intermediate System-to-Intermediate System
ITMS	Integrated Terminal Management System
LoRa	Long Range
NAT	Network Address Translation
OSPF	Open Shortest Path First
PON	Passive Optical Network
RIP	Routing Information Protocol
USB	Universal Serial Bus
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
VR	Virtual Reality
VxLAN	Visual extensible Local Area Network
WAN	Wide Area Network

5 Conventions

In this Recommendation:

– The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

– The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement needs not be present to claim conformance.

6 Introduction of smart BNG based on artificial intelligence

Smart BNG is designed to improve the speed of multimedia resources transmission and enhance the interaction experience of users. The smart BNG, based on artificial intelligence and advanced hardware equipment, can analyse user preferences and store user data to provide better service for smart family, enterprise and industry scenarios.

Traditional BNG mainly provides network access functions for users. Compared to traditional BNG, smart BNG with an artificial intelligence (AI) computing chip supports the AI model inference function and enhances transmission capability for multimedia content. In addition, smart BNG can support intelligent scenarios, including but not limited to smart education, family and industry scenarios. Smart BNG can install related AI platforms or applications for different scenarios to support intelligent functions.

From a functional perspective traditional BNG can be divided into a data gateway, multimedia gateway and collective control gateway. The data gateway is mainly used for data throughput and for providing delivery support for network protocols. The multimedia gateway supports audio and video content transmission. The collective control gateway supports home control and security service management on the network. Smart BNG has the basic functions of these three gateways, and also enhances these functions based on AI technology for different scenarios.

7 Functional requirements and architecture of smart BNG

Clause 7.1 provides an overview of the smart BNG for multimedia application scenarios, and clause 7.2 describes the layered functional architecture of smart BNG.

7.1 Overview of smart BNG for multimedia application scenarios

As is shown in Figure 1, the smart BNG is required to support different multimedia application scenarios, including smart industry, smart family, smart class and other scenarios. Therefore, the smart BNG is required to support the access of multiple multimedia devices and multiple ways to access the cloud, which stores multimedia content.

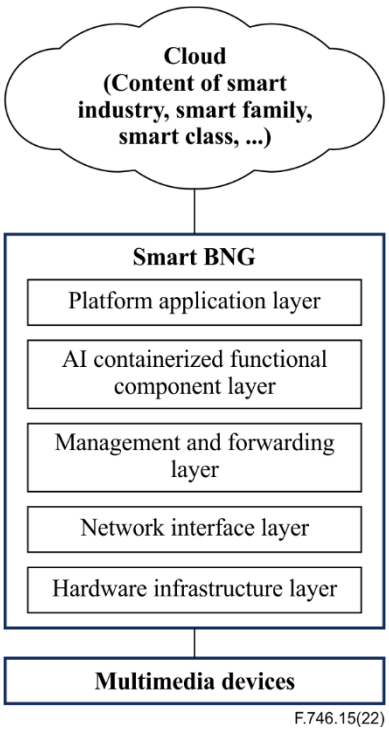


Figure 1 – Overview of smart BNG

7.2 Sub-functions in the layered functional architecture of smart BNG

Figure 2 outlines the sub-functions in the layered functional architecture of the smart BNG.

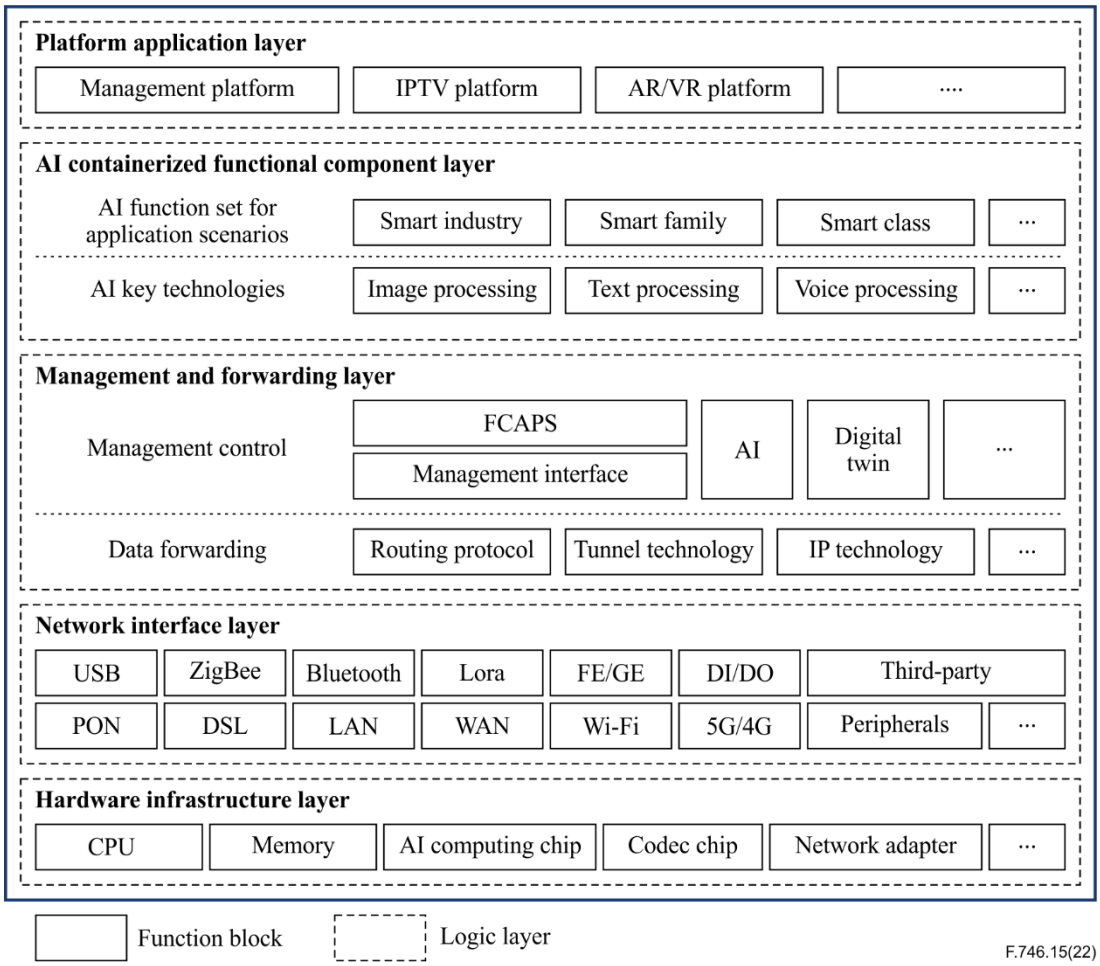


Figure 2 – Sub-functional architecture of smart BNG

7.2.1 Hardware infrastructure layer

The hardware infrastructure layer is aimed at supporting the basic environment for smart BNG. These hardware infrastructures add AI capabilities on the basis of the universal broadband network gateway. This layer includes the following hardware requirements:

1) **Central processing unit** (**CPU)**: The CPU is required to be capable of FP32 floating-point operations at least, so that the CPU can read the model data with higher precision into the memory without losing precision.

2) **Memory**: It is required that the memory is sufficient to support the loading of large model files, the loading of inference data, and support high-speed reading and loading of large model files.

3) **AI computing chip**: In order to ensure the AI model has a low inference delay, the smart BNG is required to use a dedicated chip to support the inference acceleration calculation function of the deep learning model based on the neural network.

4) **Codec chip**: To reduce the load and occupancy of the CPU, the smart BNG is required to support a hardware codec chip to process multimedia data stored in smart BNG.

5) **Network adapter**: The smart BNG is required to support high-bandwidth network cards to satisfy the transmission of large multimedia data.

7.2.2 Network interface layer

The network interface layer is aimed at providing multiple interfaces of the smart BNG to support multiple access methods for the network and users. This layer includes the following requirements:

1) **Wired access**: The smart BNG is required to support wired access to the network and provide wired access for users. Common wired access methods include passive optical network (PON) i.e., Ethernet passive optical network (EPON)/gigabit passive optical network (GPON), digital subscriber line (DSL), wide area network (WAN), local area network (LAN) and other methods.

2) **Wireless access**: The smart BNG is required to support wireless access to the network and provide wireless access for users. Common wireless access methods include 5G/4G, WiFi, ZigBee, Lora, Bluetooth and other methods.

3) **Third-party interface**: The smart BNG is required to support specific interfaces for special scenarios or applications to access some peripherals, such as voice interface, video interface and so on.

7.2.3 Management and forwarding layer

As the BNG is required to be managed by a network management system and forward multimedia data from cloud to users, the BNG is required to support management control function and data forwarding function.

The management control function mainly includes fault management, configuration management, accounting management, performance management, security management and interfaces between different management systems. For requirements of fault management, configuration management, accounting management, performance management, and security management refer to clauses 5, 6, 7, 8, and 9 of [ITU-T M.3400].

The data forwarding function mainly includes routing protocols such as open shortest path first (OSPF), routing information protocol (RIP), intermediate system-to-intermediate system (IS-IS), etc., tunnel technology such as visual extensible local area network (VxLAN), Internet protocol security (IPSec), generic routing encapsulation (GRE), etc., IP technology such as network address translation (NAT), etc., and other network communication technologies.

The smart BNG is also required to support the above functions. In addition, it can use AI, digital twin, and other new technologies to enhance management functions. For requirements of AI enhanced telecom, operation and management, refer to [ITU-T M.3080].

7.2.4 AI containerized functional component layer

The smart BNG is required to provide AI containerized functional components for different application scenarios. There are two types of components; AI functional components for application scenarios, and AI key technologies functional components.

7.2.4.1 AI function set for application scenarios

These scenario functional components are composed of multiple AI functions based on different scenarios. AI application scenarios mainly include the following scenario functional components:

1 **Smart industry scenario components:** This functional component is aimed at providing an AI function set related to the smart industry scenario. This scenario mainly includes machine vision, automated guided vehicle (AGV), augmented reality (AR) of equipment and other AI technologies.

2 **Smart family scenario components:** This functional component is aimed at providing an AI function set related to the smart family scenario. This scenario mainly includes voice recognition for controlling furniture, face recognition for security, virtual reality (VR) for immersive movie viewing and other AI technologies.

3 **Smart class scenario components:** This functional component is aimed at providing an AI function set related to the smart class scenario. This scenario mainly includes holographic projection for distance education, motion analysis for students, AR for auxiliary teaching and other AI technologies.

Different application scenarios are based on different AI technologies and AI models. The smart BNG is required to support general AI functions for these scenarios, and these AI functions can be re-developed for special applications.

7.2.4.2 AI key technologies

The AI key technology functional components are composed of general AI functions. These components mainly include the following AI functions:

1) **Image processing:** This functional component is aimed at providing AI technologies for image processing. It mainly includes image recognition, object detection, behaviour analysis and other AI technologies.
2) **Text processing:** This functional component is aimed at providing natural language processing for text processing. It mainly includes semantic analysis, keyword extraction and other AI technologies.
3) **Voice processing:** This functional component is aimed at providing AI technologies for voice processing. It mainly includes voice recognition, automatic interaction, voice synthesis and other AI technologies.

Different applications are based on different AI technologies and AI models. The smart BNG is required to support multiple AI key technologies, and these technologies can be used in combination according to different requirements. These AI technologies can be used to train different AI models.

7.2.5 Platform application layer

The platform application layer is aimed at supporting multimedia applications through smart BNG. The following platforms are recommended to be supported:

1) **Network management platform***:* The smart BNG is required to be managed by upstream equipment or by a system such as integrated terminal management system (ITMS).
2) **IPTV platform:** The smart BNG is required to support Internet protocol television (IPTV) business for smart family scenario.
3) **AR/VR platform:** The smart BNG is required to support AR/VR business for smart family and smart industrial scenarios.

The smart BNG is required to support general multimedia platforms, and the platform can be re-developed for special applications.

8 Security requirements of smart BNG

The smart BNG is recommended to support following security functions:

1) **Basic firewall function:** The smart BNG is recommended to support the opening and closing of protocol ports, and the protocols corresponding to pre-set common ports (such as 80, 8080, 21, 23, etc.).
2) **Access control function:** The smart BNG is recommended to support the implementation of corresponding access control policies based on parameters such as source/destination MAC address, IP quintuple, and time period.
3) **Content filtering function:** The smart BNG is recommended to filter content based on URL and keyword. It is also required to support setting black and white lists and implementing import and export operations.

4) **Preventing ARP attack function:** The smart BNG is recommended to support MAC address and static binding with IP addresses and address resolution protocol (ARP) broadcast storm suppression function.

5) **Content encryption and decryption function:** The smart BNG is recommended to support encryption and decryption of transmission content as requirements of users.

Appendix I

Scenarios for smart broadband network gateway

(This appendix does not form an integral part of this Recommendation.)

This appendix describes the typical scenarios of smart BNG. The typical scenarios include but are not limited to class, family and industry.

I.1 Smart class scenario of smart BNG

Smart BNG can assist in many types of interactive classrooms, and help teachers better understand students. The smart BNG is recommended to support following interactive classrooms:

1) **Physical interactive classroom:** It means that teachers and students carry out teaching activities in a physical classroom. The smart BNG can support various forms of interactions, including video system, voice system and other multimedia systems.

2) **Online interactive classroom:** This teaching mode is not limited by time and space. Through the smart BNG, video, voice, image and other multimedia content can be transmitted between two or more different classrooms.

3) **Cloud classroom:** This teaching mode can carry both physical classroom and online classroom, and support teaching cross-regional in real-time. The education system is deployed in the cloud, and delivers the education resources to the classroom through the smart BNG.

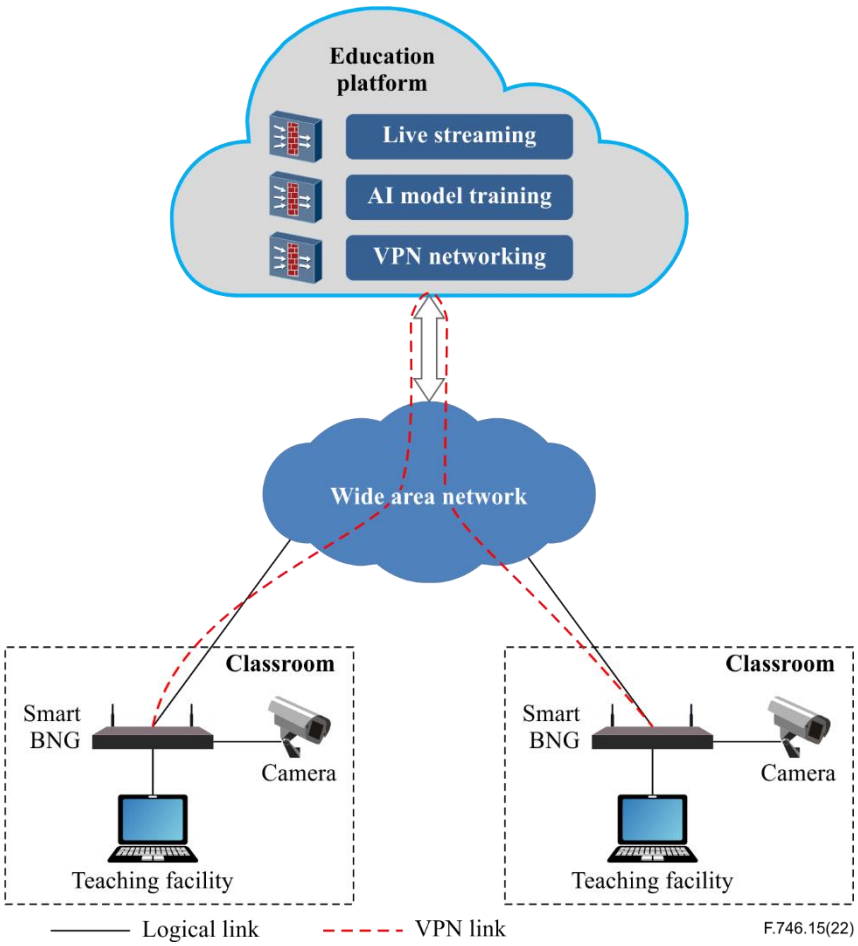


Figure I.1 – The deployment situation of smart BNG in smart class scenario

Figure I.1 shows the deployment situation of smart BNG in a smart class scenario. There are many smart terminals in the class, including tablets, screen projection equipment, electronic whiteboard and others. These teaching facilities and cameras in a classroom are connected with smart BNG. The AI model training is deployed on the education cloud platform. This module gets data through the smart BNG and trains related AI models, and includes handwriting recognition, and behaviour analysis to help teachers correct homework and understand students. The AI models are sent to smart BNG to do edge inference for smart terminal applications. Different classrooms connect with each other through smart BNG to build a virtual private network (VPN) link. Since the IP addresses of the smart BNG for school are private network addresses, they are allocated by the VPN networking module deployed on the education cloud platform. Through VPN links, the education application on cloud can send to multiple classrooms located in different regions.

I.2 Smart family scenario of smart BNG

Multimedia applications are provided to the family through smart BNG. The smart BNG is recommended to support following applications for smart family:

1) **Smart home:** The furniture has WI-FI modules which can be connected with smart BNG, and they can be controlled by a unified control panel or an application on mobile terminal. The furniture includes television, stereo, air conditioner, light and others. Users can control the furniture through a control panel, application or voice messages, and control messages are sent to furniture through smart BNG.

2) **Family entertainment:** With the development of network and IT technology, people can experience cloud games and VR/AR games in the home. These games are rendered in the smart family cloud platform, and smart BNG unzips these videos. People play VR/AR, cloud games without any high-performance processor and graphics card, they just need gaming equipment to experience these games.

3) **Health and security:** A camera in the home can monitor the elderly at home. If something unexpected happens, the security system will notify the family as soon as possible. If a stranger breaks into the house, it also can send out a warning alarm to protect personal and property safety.

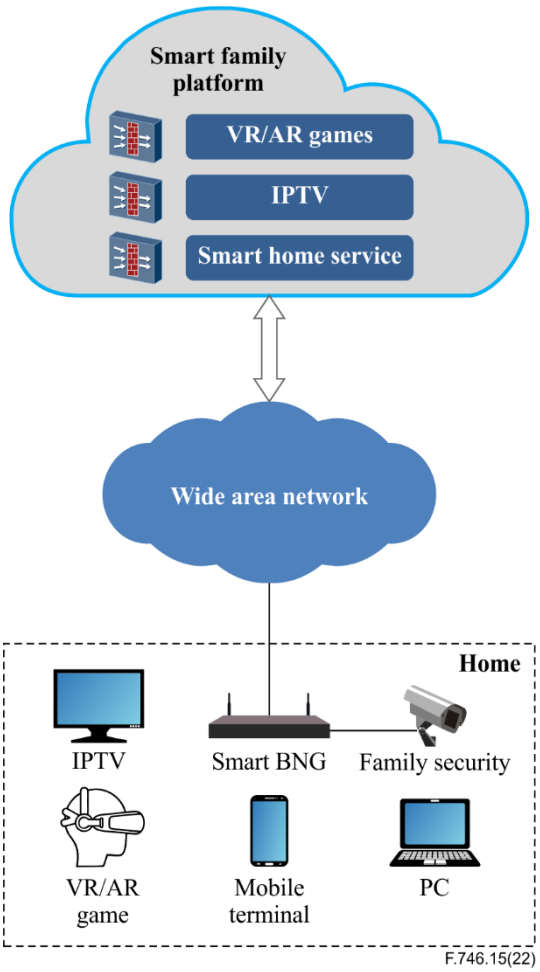


Figure I.2 – The deployment situation of smart BNG in a smart family scenario

Figure I.2 shows the deployment situation of a smart BNG in a smart family scenario. There are many smart terminals in the home, including IPTV, screen projection equipment, VR/AR equipment and others. These smart terminals and cameras in the home are connected with smart BNG. The VR/AR games and IPTV are deployed on the smart family cloud platform. This module renders VR/AR games, and sends them to game terminals through smart BNG. The content of IPTV is sent to smart BNG to provide service. The smart family cloud platform can provide other services, including health monitoring, security, and so on.

I.3 Smart industry scenario of smart BNG

Multimedia applications are provided to industry through smart BNG. The smart BNG is recommended to support following applications for smart industry:

1) **Machine vision:** The camera in industry can collect image data and upload data to a smart industry cloud platform to train AI models through smart BNG. After training, these AI models are sent to corresponding equipment. The AI models can be used in object sorting, quality inspection, object measurement and other industry applications. The smart BNG do inference based on AI trained models for these applications.

2) **Smart office service:** The smart office services are deployed in the smart industry cloud platform. And the branches can use these services through smart BNG. These services can be used directly on the cloud, or can be downloaded locally.

3) **Security:** Cameras in industry can monitor staff working. If something dangerous happens, the security system will notify the whole industry as soon as possible, and it also can send out a warning alarm to protect personal and property safety.

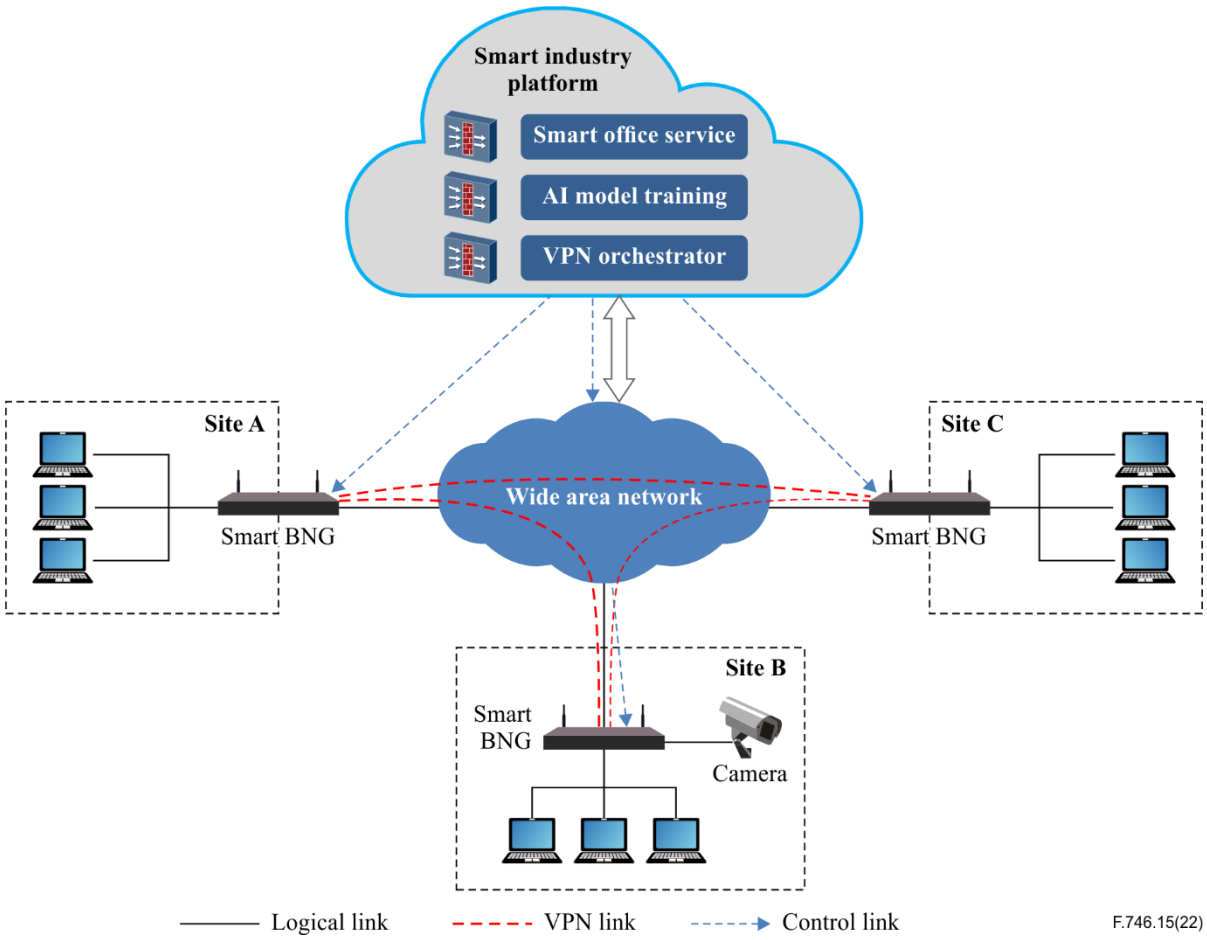


Figure I.3 – The deployment situation of smart BNG in smart industry scenario

Figure I.3 shows the deployment situation of smart BNG in a smart industry scenario. The terminals used in industry include cameras, computers, AGVs, and other equipment. These terminals are connected with the smart BNG. The AI model training is deployed on the industry cloud platform. This module gets data through smart BNG and trains related AI models for various applications to improve production. The AI models are sent to smart BNG to do edge inference for image identification applications. Different branches connect with each other through smart BNG to build VPN links. If the IP addresses of the company are public network addresses, they can build VPN links directly. Otherwise, VPN links can be built by cloud as in the smart class scenario. The VPN orchestrator deployed on the industry cloud platform can manage VPN links based on control links.

Appendix II

Use cases for smart broadband network gateway

(This appendix does not form an integral part of this Recommendation.)

Appendix II describes use cases for smart broadband network gateway.

Table II.1 describes live streaming in a smart education scenario.

Table II.1 – Live streaming in education scenario

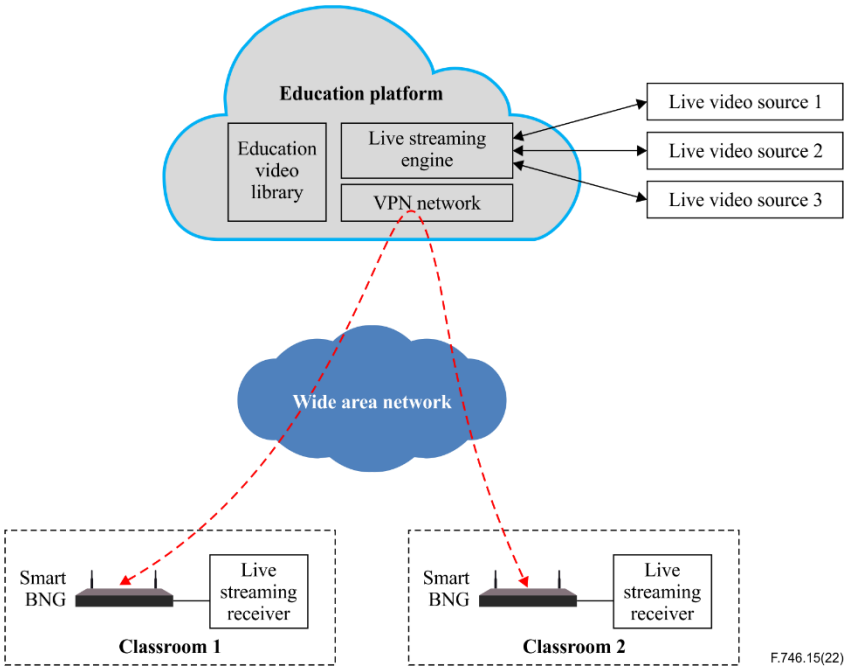
Title	Live streaming in a smart education scenario
Description	Live video is a kind of teaching method in a smart education scenario. The education platform forwards live streaming from different sources through VPN tunnels among the smart BNGs. With VPN tunnels the platform sends living streaming by multicast instead of unicast. The process consists of the following three steps: 1) The education platform gets live video streaming from different sources by unicast; 2) It builds VPN tunnels among multiple smart BNGs; 3) The platform sends the living streaming through tunnels with multicast and the smart BNGs receive streaming from VPN tunnels.
Roles	Network service provider, live video sources, classes
Figure (optional)	
Pre-conditions (optional)	The VPN among the smart BNGs and the education platform should be built.
Post-conditions (optional)	

Table II.2 describes a family VR/AR games use case in a smart family scenario.

Table II.2 – Family VR/AR games in smart family scenario

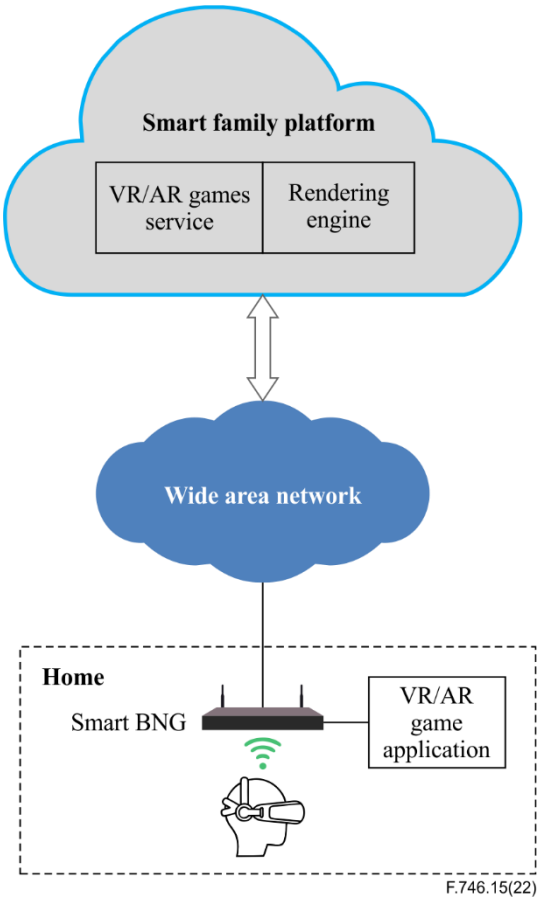
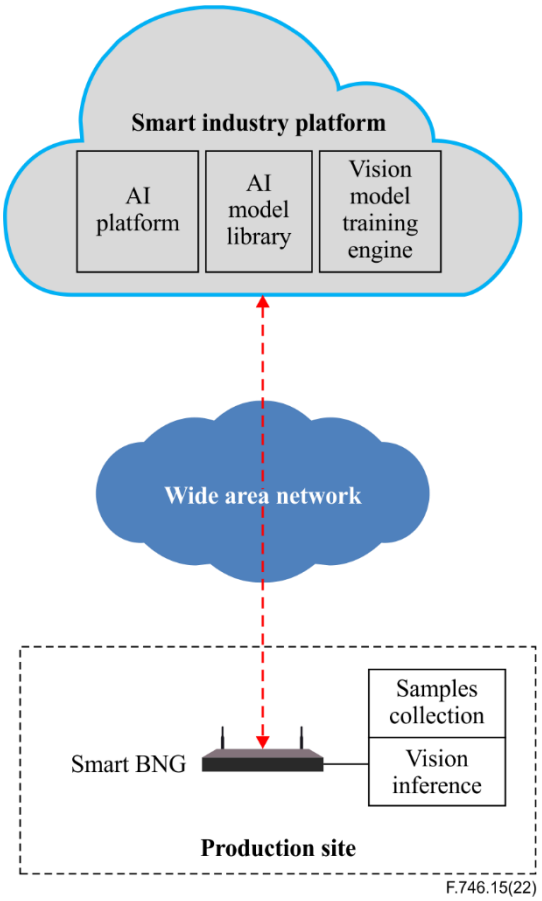
Title	Family VR/AR games in smart family scenario
Description	The smart BNG has an intelligent and open system to run various kinds of applications and it also supports VR/AR games in a family scenario. The smart family platform provides the VR/AR game service and rendering service. The smart BNG runs VR/AR game applications and provides computing resources to support VR/AR streaming handling. The process consists of the following two steps: 1) The smart BNG installs the VR/AR game application and it links VR/AR terminals via Wi-Fi. 2) The smart family platform sends VR/AR game rendered video streaming to the smart BNG and the VR/AR application installed in the BNG handles the streaming and sends to the terminal according to the related command.
Roles	Network service provider, family VR/AR games provider, player
Figure (optional)	
Pre-conditions (optional)	The VR/AR game applications can be installed in the smart BNG.
Post-conditions (optional)	

Table II.3 describes AI model training for machine vision in an industry scenario.

Table II.3 – AI model training for machine vision in industry scenario

Title	AI model training for machine vision in industry scenario
Description	In machine vision use case (such as industrial quality inspection, intelligent picking, etc.), the machine vision AI model needs to be trained when new samples appear. The smart industry platform has different components including AI platform environment, AI model library and vision model training engine, etc. The smart industry platform provides computing resources for machine vision AI model training. The process consists of the following three steps: 1) The samples are produced for machine vision AI model training at the production site. The smart BNG collects all samples and sends them to the smart industry platform through a VPN between smart BNG and the platform. 2) The smart industry platform trains the machine vision AI model after receiving the production samples. 3) The platform sends the trained vision inference model to the smart BNG, and the smart BNG uses the AI model to do inference for productions.
Roles	Network service provider, smart industry platform vendor, industry manufacturer.
Figure (optional)	
Pre-conditions (optional)	The VPN between the smart BNG and the smart industry platform should be built.
Post-conditions (optional)	

Bibliography

[b-ITU-T Q.3315] Recommendation ITU-T Q.3315 (2015), *Signalling requirements for flexible network service combination on broadband network gateway*.

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