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# Introduction

This document contains the clean text of the Questions agreed by Study Group 9 to be submitted to WTSA, which were endorsed at the virtual TSAG meeting, 11-18 January 2021. This set of Questions became effective on 18 January 2021, for the remainder of the study period.

Table 1 lists the Questions endorsed and their relationships to the previously in-force set of Questions.

Table 1 – Map of in-force SG9 Questions (endorsed, left) to the previous ones (right)

| New number | Current Question title | Status | Previous number | Previous Question title |
| --- | --- | --- | --- | --- |
| 1/9 | Transmission and delivery control of television and sound programme signal for contribution, primary distribution and secondary distribution | Continuation of Question 1/9 | 1/9 | Transmission and delivery control of television and sound programme signal for contribution, primary distribution and secondary distribution |
| 2/9 | Methods and practices for conditional access and content protection | Continuation of Question 2/9 | 2/9 | Methods and practices for conditional access, protection against unauthorized copying and against unauthorized redistribution ("redistribution control" for digital cable television distribution to the home) |
| 4/9 | Guidelines for implementations and deployment of transmission of multichannel digital television signals over optical access networks and Hybrid Fibre-Coaxial (HFC) | Continuation of Question 4/9 | 4/9 | Guidelines for implementations and deployment of transmission of multichannel digital television signals over optical access networks and Hybrid Fibre-Coaxial (HFC) |
| 5/9 | Software components application programming interfaces (APIs), frameworks and overall software architecture for advanced content distribution services within the scope of Study Group 9 | Continuation of Question 5/9 | 5/9 | Software components application programming interfaces (APIs), frameworks and overall software architecture for advanced content distribution services within the scope of Study Group 9 |
| 6/9 | Functional requirements for terminal devices of the integrated broadband cable network | Continuation of Question 6/9 | 6/9 | Functional requirements for residential gateway and set-top box for the reception of advanced content distribution services |
| 7/9 | Transmission control and interfaces (MAC layer) for IP and/or packet-based data over integrated broadband cable networks | Continuation of Question 7/9 | 7/9 | Cable television delivery of digital services and applications that use Internet protocol (IP) and/or packet-based data over cable networks |
| 8/9 | The Internet protocol (IP) enabled multimedia applications and services for cable television networks enabled by converged platforms | Continuation of Question 8/9 | 8/9 | The Internet protocol (IP) enabled multimedia applications and services for cable television networks enabled by converged platforms |
| 9/9 | Requirements, methods, and interfaces of the advanced service platforms to enhance the delivery of audiovisual content, and other multimedia interactive services over integrated broadband cable networks | Continuation of Question 9/9 | 9/9 | Requirements, methods, and interfaces of the advanced service platforms to enhance the delivery of sound, television, and other multimedia interactive services over integrated broadband cable networks |
| 10/9 | Work programme, coordination and planning | Continuation of Question 10/9 | 10/9 | Work programme, coordination and planning |
| 11/9 | Accessibility to cable systems and services | Continuation of Question 11/9 | 11/9 | Accessibility to cable systems and services |
| 12/9 | AI-enabled enhanced functions over integrated broadband cable network | New | – | – |

# Wording of Questions

## Question 1/9 – Transmission and delivery control of television and sound programme signal for contribution, primary distribution and secondary distribution

(Continuation of Question 1/9)

### Motivation

ITU‑T and ITU‑R are studying the standards to be used for digital television and sound programme signals transmission.

Television distribution operators such as cable television operators, video distributors and broadcasters normally receive several programme signals from different local or remote sources, and they switch the appropriate signal at the specified time to accommodate local advertisements, local programming, emergency messages, etc.

Bit-rate reduction processing of such digital signals is widely used both in studio installations and for direct broadcasting from terrestrial or satellite transmitters as well as for transmission, including transmission for contribution and for primary and secondary distribution, defined as:

– Contribution – Carriage of signals to production centres where post-production processing may take place;

– Primary distribution – Use of a transmission channel for transferring audio and/or video information to one or several destination points without a view to further post-processing on reception (e.g. from a continuity studio to a transmitter network);

– Secondary distribution – Use of a transmission channel for distribution of programmes to viewers at large (by over-the-air broadcasting or by cable television, including retransmission, such as by broadcast repeaters, by satellite master antenna television (SMATV) and by community based-network, e.g., community antenna television (CATV).

NOTE 1 – Both "community antenna television" and "cable television" are commonly identified by CATV.

It is also important to study the operating requirements for programme delivery controls such as multiplexing, switching and insertion of compressed programme bit streams into different programme streams at content distribution functions such as cable television head-ends. Cost effective and operationally efficient solutions should be found to meet those requirements.

To facilitate the international exchange of programmes and to rationalize the design of equipment, it is desirable to continue to study the methods used for digital source coding of such signals, as defined by other standardization bodies such as Study Group 16.

Indeed, the challenge is to find a balanced compromise among the various factors that interplay in the specification of the transmission method to be preferred for each application. For instance, a compromise must be found among:

– required availability of the service;

– required quality of the picture and sound delivered to the user;

– total latency of the signal in the transmission chain;

– recommended bit-rate reduction method and profile;

– bit rate needed in the channel to deliver the service.

Delivery controls such as multiplexing, switching and/or insertion should satisfy the following requirements:

– would not cause disruptive disturbances to home decoders;

In addition, these solutions would satisfy the above requirements even when the various bit streams:

– are not synchronized to each other;

– use different bit rates and resolutions;

– conform to different picture formats and profiles;

– conform to different compression standards;

– are encapsulated in TS, MMT or other stream format;

– are conveyed over various types of networks after multiplexing (only applies to MMT).

The studies cover not only television and sound programme signals but also the service delivery of emerging advanced video systems such as UHDTV, HDR, 3D, multi-view and free-viewpoint video over a variety of transport means, including IP-based ones.

NOTE 2 – Measurement and control of quality of service is covered by SG12.

### Question

Study items to be considered include, but are not limited to:

– Which source coding methods and which interfaces can be recommended for the transmission of digital television and sound programme signals for purposes of contribution over digital transmission circuits and chains?

– Which solutions, from those studied by ITU‑R Study Group 6, should be recommended for point-to-point contribution transmission of UHDTV and HDR programme material over physical connections?

– What are the appropriate multiplexing arrangements (component, service, higher level protocols) for the applications above?

– What are the service availability requirements and how do they translate into methods of protection against digital transmission errors for those applications?

– Which requirements must be imposed on the various parameters that interplay to determine the performance of the transmission service, such as QoS, picture and sound quality, signal latency, etc., in order to ensure that the transmission service provides adequate performance for those applications using a reasonable amount of resources, such as a reasonable amount of bit-rate?

– What are the requirements and interfaces to interconnect with the outside entities providing content and/or services to the video and sound transmission networks?

– What are the requirements and interfaces for the video and sound transmission networks to interconnect with other outside networks for video and sound distribution not under the responsibility of ITU-T SG9, e.g., vehicle multimedia networks?

– What are the functional and operational requirements of the various applications that must be met for delivery control of different compressed programme bit streams and/or packet streams, i.e., TS or MMT, on the output channel of television distribution systems such as multiplexing, switching, and insertion?

– Which technical solutions can be recommended to allow the delivery control, such as multiplexing, switching and insertion, of different compressed programme bit streams and/or packet streams, i.e., TS or MMT, on the output channel of television distribution systems?

– What are the appropriate system model, requirements and transmission methods for UHDTV, HDR, 3D (stereoscopic/autostereoscopic/hologram), multi-view and free-viewpoint video signals using different transport means?

– What enhancements to existing Recommendations are required to provide energy savings directly or indirectly in information and communication technologies (ICTs) or in other industries? What enhancements to developing or new Recommendations are required to provide such energy savings?

– What is an appropriate way to convey large volume UHDTV and HDR signal from field to broadcaster station?

– What mechanism is required for physical layer to enable IP-multicast for large volume data such as UHDTV and HDR signal?

### Tasks

Tasks include, but are not limited to:

– Preparation of a number of new draft Recommendations by the year 2020, which will specify the methods to be used for the transmission and delivery controls of advanced video programmes for purposes of contribution and of primary distribution, and over the digital cable television infrastructure including community based-network, depending on the contributions received, and on progress in the work of the appointed Rapporteur(s);

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=1/9>).

### Relationships

Recommendations

– ITU-T H.261, H.262, H.263, H.264, H.265

– ITU-T H.222.0

– ITU-T J-series (e.g. J.83, J.181, J.183, J.189, J.195-196, J.216, J.224, J.280, J.288, J.380-series, J.382, J.383)

– ITU-R BT.1769, BT.1121-1, BT.1548-2

Questions

– Q4, 7 and 9/9

Study groups

– ITU-T SG12 (especially Q19/12)

– ITU-T SG16 (especially Q6/16)

– ITU-R SGs 4, 5 and 6

Standardization bodies

– AES

– CableLabs

– DVB

– ETSI TC Cable

– IEC TC100

– IEEE

– ISO/IEC JTC1/SC29/WG11

– Japan Cable Laboratories

– JCTEA

– SCTE

– SMPTE

## Question 2/9 – Methods and practices for conditional access and content protection

(Continuation of Question 2/9)

### Motivation

Studies are currently under way in several countries, on ways to improve the security of conditional access systems used for television subscription, pay-per-view and similar services distributed to the home by cable television. The need for such studies immediately emerges when the security and viability of conditional access systems, currently used in Europe, the United States and elsewhere, is assessed.

Such an assessment shows the evident need to develop enhanced, better performing, piracy-resistant systems that would enable a cable television system to implement programme distribution to the home (be it a subscription or a pay-per-view service) with a security level adequate to make it commercially viable. Indeed, conditional access systems that were considered to be totally secure when they were developed only a few years ago for television distribution to the home, have been invariably "compromised" by pirates, who extract the conditional access enabling information and sell it at a fraction of the regular subscription fee.

Any conditional access system may eventually be compromised, irrespective of its sophistication, if the compromised enabling information can be sold to a sufficiently large base of customers.

It seems that a conditional access system will be more secure if the conditions below are met:

– the scrambling process is highly secure;

– the cryptographic algorithm is highly secure;

– the key and the entitlement information are changed at sufficiently frequent intervals;

– subscribers are divided into small sub-entities, each with its own key and entitlement.

The concurrence of these conditions makes it expensive to compromise the system, and it reduces the pirate's customer base, to the point where piracy is no longer economically viable.

Another very important aspect dealing with digital rights management that is related to conditional access is the provision of measures to prevent a distributed programme from being copied or redistributed, unless the owner of its intellectual property rights authorizes such copying or redistribution. Several approaches, which are not mutually exclusive, are being investigated to achieve this goal:

– The conditional access system could be designed in such a way as to separate viewing authorization from copying authorization. In other words it would provide a viewable output to those users that are authorized to view the programme, but it would provide a recordable output only to those users that are separately authorized to copy it. The issue is further complicated by the need of intellectual property holders to have various degrees of authorization, namely: no copy, one copy or any number of copies;

– The conditional access system could be designed to signal redistribution authorization with respect to the local environment (e.g. the home) in which the content was received;

– The conditional access system could be designed to signal redistribution authorization with respect to the personal authorized domain of the device that originally received the content (e.g. the devices belonging to a single individual or household);

– The conditional access system could be designed to selectively provide an output to a particular device that meets certain characteristics such as resolution or format of the reconstructed signal through a secure negotiation;

– The programme could be "watermarked" with a hidden coded information, which can neither be removed nor altered, and would identify the holder to the programme intellectual property rights, thus allowing to trace the history of unauthorized copies and take appropriate legal action against pirates;

– The programme could be "watermarked" with a hidden coded information, which can neither be removed nor altered, and would signal the usage rights associated with content.

The study should thus focus on:

– Specification of a highly secure scrambling system;

– Specification of a highly secure cryptographic system that can be implemented at a viable cost for programme distribution by cable television to the home, namely, in a mass-produced consumer premises equipment environment;

– Specification and generation of keys and an enabling information distribution system that has adequate protection, capacity and flexibility to serve the diversified requirements of various cable television systems and their various subscribers;

– Development of a set of guidelines on the optimal time interval at which the key and the enabling information should be updated, and on the optimal size of the subscriber population to which the same enabling information is assigned;

– Specifications for an application of the cryptographic system appropriate to implement protection against unauthorized copying at various levels of authorization (no copy, one copy only, any number of copies);

– Specifications for an application of the cryptographic system appropriate to implement "redistribution control" with respect to the local environment (e.g. the home) in which the content was received;

– Specifications for an application of the cryptographic system appropriate to implement "redistribution control" with respect to the personal authorized domain of the device that originally received the content (e.g. the devices belonging to a single individual or household);

– Specifications for an application of the cryptographic system to negotiate authorized transfer of content between devices within the authorized domain meeting signal format or resolution constraints;

– Specifications for a highly secure watermarking system that would not affect the perceptual quality of the distributed programme;

– Specifications for new advanced types of conditional access system that are applicable to emerging services (e.g. online content access service over HTTP, media protection service in HTML5, content protection service in DASH or MMT, hybrid broadcasting service, ultra high definition television service, 3DTV service, etc.) when they are serviced over cable television networks.

### Question

Study items to be considered include, but are not limited to:

– What scrambling approaches can be recommended for digital cable television distribution to the home?

– What is the capacity required of a conditional access system for cable television distribution to the home, in terms of number of individually addressable subscribers or subscriber groups, etc.?

– What are the specifications for a (preferably unique) cryptographic approach appropriate to such conditional access system?

– What are the specifications for an application of the cryptographic system, appropriate to implement protection against unauthorized copying at various levels of authorization (no copy, one copy only, any number of copies)?

– What are the specifications for an application of the cryptographic system, appropriate to implement "redistribution control" with respect to the local environment (e.g. home) in which the content was received?

– What are the specifications for an application of the cryptographic system, appropriate to implement "redistribution control" with respect to the personal authorized domain of the device that originally received the content (e.g. the devices belonging to a single individual or household)?

– What are the specifications for an application of the cryptographic system, appropriate to implement "redistribution control" with respect to the signal output characteristics of the device that originally received the content (e.g. the devices supporting multiple output formats and resolutions)?

– What are the specifications for the (preferably unique) removable (e.g. ISO 7816, PCMCIA, USB2.0/3.0, USIM, Nano-SIM, etc.) or renewable (e.g. programmable secure microprocessor based) cryptographic device, if one is used in such a conditional access system?

– How often should the conditional access keys be updated?

– Which criteria should be used to time the replacement of the (removable or renewable) cryptographic device or of the enabling information in it?

– What is the optimal size of the subscriber population to which the same key and enabling information may be safely assigned?

– Can conditional access solutions developed for terrestrial and satellite broadcasting be used for cable television also?

– What are the specifications for a highly secure watermarking system that would not affect the perceptual quality of the distributed programme?

– What are the specifications for downloadable conditional access systems?

– What are the specifications for downloadable multi-CA/DRM systems?

– What are the specifications for software-only or software-friendly conditional access solutions?

– What are the specifications for exchangeable embedded CA/DRM solutions?

– What are the specifications for DRM/multi-DRM for cable television multiscreen services?

– What are the specifications for new advanced types of broadcasting content protection system that is applicable to emerging services (e.g. online content access service over HTTP, media protection service in hypertext mark-up language 5 (HTML5), content protection service in dynamic adaptive streaming over HTTP (DASH) or modern media transport (MMT), hybrid broadcasting service, ultra high definition television service, 3DTV service, internet of things (IoT), etc.) when they are serviced over cable television networks?

– What enhancements to existing Recommendations are required to provide energy savings directly or indirectly in information and communication technologies (ICTs) or in other industries? What enhancements to developing or new Recommendations are required to provide such energy savings?

### Tasks

Tasks include, but are not limited to:

– Preparation of new Recommendation(s) regarding the above study items as well as maintenance of existing Recommendations.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=2/9>).

### Relationships

Recommendations

– Copy Protection: ITU-T J.95

– DRM: ITU-T J.197

– Conditional Access: ITU-T J.93, J.290, J.291, J.295, J.296

– DOCSIS Security: ITU-T J.222.3

 – DRM for cable television multiscreen service: ITU-T J.1005

– Renewable conditional access system: ITU-T J.1001, J.1002, J.1003, J.1004

– Downloadable Conditional Access System: ITU-T J.1020, J.1026, J.1027, J.1028

– Embedded Common Interface (ECI) for exchangeable CA/DRM solutions: ITU-T J.1012, J.1013, J.1014, J.1015, J.1015.1

Questions

– All Questions of SG9

Study groups

– ITU‑T SG17

– ITU‑R SG6

– ITU‑T SG20

Standardization bodies

– DVB-CM (CI-Plus, CP, SEG, SSC)

– DVB-TM (CI-Plus, CPT, CSA)

– ETSI ISG ECI

## Question 4/9 – Guidelines for implementations and deployment of transmission of multichannel digital television signals over optical access networks and Hybrid Fibre-Coaxial (HFC)

(Continuation of Question 4/9)

### Motivation

Recent fibre optical transmission technology allows extending fibre networks to the curb, the building or the home.

Fibre networks can be brought closer to users' premises than hybrid fibre-coaxial (HFC) networks, although HFC is still widely used in developed countries and expected to be used in some developing countries as the primary cable access infrastructure.

Fibre technology enables transmission of multichannel digital television signals in the form of RF as in the HFC networks. It can also provide high capacity (10Gbps or more) in the forward and return channel in the form of high-speed digital signals such as IP, which is required for the provision of typical cable television services, including interactive ones.

Although several Recommendations on optical access networks have been developed to transmit high quality television signals, further study on the interworking and interfaces between digital video systems and fibre networks is needed.

### Question

Study items to be considered include, but are not limited to:

– Which mechanisms can be used to transport multichannel digital television signals over fibre networks and hybrid fibre–coaxial (HFC), in view of the high loss of optical splitters used for PON (passive optical networks)?

– Which mechanisms can be used to ensure the low composite distortion and high carrier-to-noise ratio (CNR) that are required for frequency division multiplex (FDM) transport of digital television signals over fibre networks?

– Which mechanism can be used to transport multichannel digital television signals over fibre networks in the form of a high-speed digital communication link or IP packets?

– Which mechanism can be used to compensate the jitter arising from transporting over asynchronous communication links over fibre networks?

– Which mechanism can be used to compensate the packet loss arising from transporting over best effort communication links over fibre networks?

– Which mechanism or interface can be used between content providers, core networks and optical access networks/HFC?

– Which mechanism can be used to control access to the traffic in term of traffic management and security?

– How ITU-T SG9 can support developing countries to deploy digital television services on optical fibres and HFC, taking into account their limited resources as well as other specific needs?

### Tasks

Tasks include, but are not limited to:

– Preparation of new Recommendation(s) regarding the above study items listed under "questions" as well as maintenance of existing Recommendations such as ITU-T J.185 and J.186;

– Publish useful information (e.g. Reports, Surveys, Supplements, Guidelines or Handbooks) to support the deployment of digital television services on optical fibres and HFC in developing countries.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=4/9>).

### Relationships

Recommendations

– ITU-T J.83, J.185, J.186 and other relevant J-series Recommendations;

– ITU-T G.984-series, G.987-series, G.9807-series and other G-series Recommendations addressing optical fibre networks, systems and interfaces.

Questions

– All Questions of SG9

Study groups

– ITU‑T SG15 (optical network architectures, particularly those related to PON systems, and optical interfaces)

– ITU-D SG1 and SG2

Standardization bodies

– IEEE 802.3

– IEC TC 100

## Question 5/9 – Software components application programming interfaces (APIs), frameworks and overall software architecture for advanced content distribution services within the scope of Study Group 9

(Continuation of Question 5/9)

### Motivation

The design of the next generation set-top boxes and/or digital receivers for advanced content1 distribution services for consumer use will require the smooth integration of many hardware and software components.

NOTE – The ITU Terminology database defines "content" as "program material and related information of any variety".

Particularly, these software components will have to be built following proven architectural practices, will have to communicate with each other through clearly defined application programming interfaces (APIs) and will have to be integrated as much as possible in a reusable form. A set of portable, interoperable, and properly abstracted functional components for a specific scope, which is sometimes called "framework", is a useful tool to develop an advanced system. Integrated APIs play an important role in frameworks to facilitate faster development of products, solutions or projects within the specified scope. These frameworks should also follow precise rules and definitions that would enable their reusability and hence reduce the overall cost of such advanced systems.

Today, software components usage is not limited only to content distribution services. There are many types of services such as integrated broadcast-broadband services, multiple device presentation and synchronization services, user-generated content services, social TV, etc. These services will enable better interactivity, accessibility and usability. This in turn leads to the same need for well-defined and well-organized software architecture.

The software architecture described above stands on the fact that a detailed knowledge and ability to control each API is of great importance; indeed, since some APIs can grow to take control of and supersede other APIs, and since even only one of such closed APIs in an otherwise open set-top box and/or digital receiver makes the entire box a closed environment, the control of practically all of the key APIs is of paramount importance. It is of course also highly desirable that the specified APIs should conform to accessible published standards, e.g. ITU-T Recommendations, rather than to proprietary standards, and that they should incorporate well-defined mechanisms for adding extensions.

A further purpose of defining these software architectures, frameworks and APIs is to enable service operators to deploy advanced set-top boxes and/or digital receivers, while ensuring their ability to keep costs low, choose among flexible architectures, maintain a multi-vendor modular environment, and obviate the need to compromise on features and functionality.

It is thus important and urgent that APIs, frameworks and the overall software architecture used in the advanced content distribution services and next generation set-top boxes and/or digital receivers, be studied and specified to conform to the operating requirements delineated above.

### Question

Study items to be considered include, but are not limited to:

– What are the relevant requirements for the APIs (e.g. APIs for the set-top-boxes or digital receivers) to support the required advanced content distribution and functionalities?

– What are the specifications of the APIs that can be recommended for use in applications, paying attention to their desirable interoperability with other APIs used in other services and next generation set-top boxes for the reception of advanced content distribution services via interactive systems?

– What are the specification of APIs that can be recommended for use in multiple devices, such as multiple STBs or mobile devices, to provide a service, paying attention to the desirable interoperability with other APIs used in each device, to enable advanced content distribution services via interactive systems?

– What are the appropriate Operating Systems architectures and frameworks that can be recommended to enable advanced content distribution services via interactive systems?

– What are the specifications of the APIs that can be recommended to provide the mechanisms to allow its future extension to further functionalities?

– What are the specifications of APIs to support accessibility requirements?

### Tasks

Tasks include, but are not limited to:

– The preparation of new Recommendation(s) to address the study items under "Question" above, that will eventually fully specify all the APIs, frameworks and overall software architecture recommended for use in the advanced content distribution services via interactive access networks.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=5/9>).

### Relationships

Recommendations

– APIs: J.200-series

– TVOS: J.1200-series

– IBB: ITU‑R BT.1699, BT.1722, BT.1889, BT.2037, BT.2053 and BT.2075

Questions

– Q6, 7, 8 9, 11 and 12/9

Study groups

– ITUT SG16 (especially Q13/16)

– ITU‑R SG6

– ITU IRG-IBB (Intersector Rapporteur Group on Integrated Broadcast Broadband)

Standardization bodies

– ISO/IEC JTC 1

– DVB

– ETSI

– W3C

## Question 6/9 – Functional requirements for terminal devices of the integrated broadband cable network

(Continuation of Question 6/9)

### Motivation

As the technologies advance, the services are evolving towards more and more interactive, intelligent, user friendly and with ever-increasing new functions and services, thus a variety of functions will be required by devices in the home. Due to considerations on consumer cost and convenience, it is desirable that all those functions be integrated into a single device. In order to provide this wide variety of services in a manner that is acceptable to service providers, consumers, and content providers, it is important to standardize a number of critical areas for the terminals. These include hardware configuration, interfaces, security, conditional access, content protection, device provisioning and management, user interface, application program interface (API), etc.

Furthermore, the various services that home users will be able to access over the digital television infrastructure, may be based on various service platforms that support a variety of applications. A flexible architecture would be necessary to bundle these service platforms and to make dynamic changes of functions easy and convenient.

Considering the rapid development of new services such as high dynamic range (HDR), 4K and 8K ultra high definition television (UHDTV), and the deployment of new technologies within cable industry such as VR/AR, multi-screen, internet of things (IoT), artificial intelligence (AI) and Smart Home, the terminal devices need to support related applications and services on demand with enhanced functionalities and APIs embedded.

### Question

Study items to be considered include, but are not limited to:

– What architecture will be required for the future terminal devices of the integrated broadband cable network?

– How will broadcast and IP-based service reception, via connection to the access network, be integrated into the future terminal devices of the integrated broadband cable network?

– What gateway functions should be included in terminal devices of the integrated broadband cable network to interconnect with smart home devices.

– What operating system, middleware and related user interfaces are required for terminal devices of the integrated broadband cable network?

– What implementation of security mechanisms, conditional access and content protection is required for terminal devices of the integrated broadband cable network?

– What provisioning and terminal devices management tools will be required for terminal devices of the integrated broadband cable network?

– What types of content management capabilities will be required for terminal devices of the integrated broadband cable network?

– What mechanism will be required for terminal devices of the integrated broadband cable network to satisfy various quality of services?

– What protocols will be required to enable terminal devices of the integrated broadband cable network to interoperate with other devices in the home, including both IP and non-IP devices?

– What requirements are needed to present services (including HDR, 4K and 8K UHDTV, VR/AR, multi-screen) making use of new technologies (e.g. AI, IoT etc.) to consumers in terminal devices of the integrated broadband cable network?

### Tasks

Tasks include, but are not limited to:

– Preparation of new Recommendation(s) regarding the above study items under the paragraph "Question" as well as maintenance of existing Recommendations.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=6/9>).

### Relationships

Recommendations

– Application platform: ITU-T J.200, J.201, J.202

– Set-top box: ITU-T J.290, J.291, J.292, J.293, J.295, J.296, J.297, J.298

– Gateway: ITU-T J.294

– Home networking: J.190, J.192

Questions

– Q2, 5, 7, 8, 9, 11 and 12/9

Study groups

– ITU‑T SGs 13, 15, 16, 17 and 20

– ITU‑R SG6

– ITU IRG-AVA (Inter-sector Rapporteur Group on Audio-visual Accessibility)

Standardization bodies

– DVB

– ETSI

– ISO/IEC JTC 1

– IETF

– OCF

– SCTE

– W3C

Other bodies

– Bluetooth SIG

– Zigbee Alliance

## Question 7/9 – Transmission control and interfaces (MAC layer) for IP and/or packet-based data over integrated broadband cable networks

(Continuation of Question 7/9)

### Motivation

Digital cable television systems in most countries are also provisioning very high-speed bidirectional data facilities intended to support, among other payloads, those utilizing Internet protocol (IP). These facilities can also be used to supply other digital services to the home, based on packet-data, exploiting the broadband capacity provided by hybrid fibre/coaxial (HFC) based on advanced smart digital cable television systems, and interconnecting local, geographically distinct digital cable television systems through direct connections or managed backbones.

The envisaged range of packet-based data services to be provided encompasses those services and applications that are based on the use of IP. It also encompasses among others, digital bidirectional (interactive) television and sound-programme cablecasting, advanced interactive television, sound-programme and multimedia services, video conference and video telephony and so on.

The technology considered for the transmission and delivery of those packet-based data services over the advanced smart cable television infrastructure utilizes the relevant transmission protocols, including IP and enhancements thereof.

The peculiarities common to the range of services to be provided are:

– the use of modern and future hybrid bidirectional integrated broadband cable network;

– the use of the transmission methods specified for integrated broadband cable network;

– the architecture for the transmission protocol for integrated broadband cable network;

– the service architecture for the transmission on integrated broadband cable network (managed and unmanaged services);

– the use of the architecture and modems specified for those integrated broadband cable network;

– the architecture of the integrated broadband cable network and its interoperability with mobile networks, including 5G;

– the transmission control and management of the integrated broadband cable network;

– compliance with the specifications and QoE peculiar to integrated broadband cable network;

– capability for real time (low latency) operation for advanced smart interactive services that require it;

– interoperability with relevant transmission protocols for packet-based data, notably IP.

### Question

Study items to be considered include, but are not limited to:

– What are the transmission protocols to support services that need to be provided over integrated broadband cable network?

– What are the specifications to convey IP-based data over quadrature amplitude modulation (QAM)?

– Which open protocols can be used or enhanced for the delivery of services?

– Which protocol should be recommended to provide each considered service, in order to facilitate future service upgrades?

– Which protocol requirements should apply to provide and operate digital services utilizing IP over integrated broadband cable network?

– Which interfaces (MAC layer) are needed to support applications utilizing IP over integrated broadband cable network?

### Tasks

Tasks include, but are not limited to:

– Preparation of draft new Recommendations to address the study items under the above paragraph "Question".

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=7/9>).

### Relationships

Recommendations

– ITU-T J-series

Questions

– Q1, 5, 6, 8 and 9/9

Study groups

– ITU T SG11

– ITU T SG13

– ITU T SG15

Standardization bodies

– Cablelabs

– ETSI

– IEEE

– IETF

– SCTE

## Question 8/9 – The Internet protocol (IP) enabled multimedia applications and services for cable television networks enabled by converged platforms

(Continuation of Question 8/9)

### Motivation

In addition to the distribution of television programming, the IP enabled cable television infrastructure can provide a means by which a myriad of advanced services (e.g., over the top and multi-screen services) are realized for the subscriber/consumer, including cloud computing services, big data services, artificial intelligence and interactivity services, etc. Such services include cloud DVR, time-shift TV (catchup, restart, pause/resume), video on demand and linear TV in the data plane as well as advanced search, recommendations, targeted advertisements, personalized UI, advanced fraud detection and much better business analytics in the control plane.

Rapid development of IP technologies enables cable television networks to be a versatile infrastructure for various interactive multimedia services, and their enabling platforms. Future IP‑based cable television networks, at a very high level, will connect with at least four entities:

– hybrid fibre/coaxial (HFC) access network;

– IP network;

– public switched telephone network (PSTN);

– third party entities.

Additionally, the convergence of these entities (their delivery mechanisms as well as their services/applications) will catalyse the hybridization of new services and applications.

The system architecture for future IP-enabled cable networks should include the specifications of the functional components and define the interfaces between the above mentioned entities, including their delivery mechanisms, and IP-based cable television networks as well as definition of how the various services and related subsystems (also called micro-services) are deployed in the cloud, on premises, and/or at the edge of the network.

IP-enabled advanced multimedia applications and services will require strict latency and packet-loss control. While it may not be necessary to develop new codecs for these applications and services, it is required to specify which codecs should be mandatory to guarantee the quality of service (QoS) of these advanced multimedia applications and services over IP-enabled cable television networks. The new Recommendations will describe the mandatory and optional requirements for IP-enabled multimedia applications and services in accordance with the specified QoS and security.

### Question

Study items to be considered include, but are not limited to:

– What are the mechanics required of the subscriber's environment, to enable the trusted/secure access of multimedia services/applications?

– What high level services and micro-services application interfaces and event messages are necessary for the fulfilment of IP enabled multimedia applications and services?

– What are the mechanisms that need to be implemented in order to accommodate the various services and micro-services that will extend the reach of the cable network?

– What are the technologies necessary for the provisioning multimedia interactive services, including primary cable services, third party services (e.g., over the top service), multi-screen service, cloud computing services, big data services and AI services?

– What application configuration methods in every TV viewing device should be appropriate for these services and micro-services?

– What multimedia encoding packaging and transport methods should be employed to fully leverage historic HFC network capabilities, as well as future IP-enabled services and applications? For these applications:

 What type of audio and video codecs including trans-coding technology should be specified?

 What adaptive bit-rate (ABR) formats should be supported? How the corresponding encryption technologies should be applied?

 What parameters should be specified for latency and packet-loss control?

 What class of QoS should be used?

– What IP broadband and broadcast services and micro-services need to be supported by the next generation IP/HFC networks?

– How will these services be deployed – public cloud or private cloud including the edge?

– Can we create a standard architecture for these services, including what set of micro-services need to be included in each service?

– What appropriate big data architecture should be utilized for data driven applications?

### Tasks

Tasks include, but are not limited to:

– The preparation of updated or new Recommendations, as required.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=8/9>).

### Relationships

Recommendations

– Reference architecture: ITU-T J.700

– Application platform: ITU-T J.200-J.202; J.205-207; J.1200-series

– Set-top box and other TV viewing devices: ITU-T J.290, J.291, J.293; J.295-J.297

– Home network: ITU-T J.190, J.192

Questions

– Q2, 5, 6, 7, 9 and 12/9

Study groups

– ITU‑T SG11

– ITU‑T SG13

– ITU‑T SG16

– ITU‑T SG20

Standardization bodies

– DVB

– ETSI

– IETF

– SCTE

– 3GPP 5GNR

## Question 9/9 – Requirements, methods, and interfaces of the advanced service platforms to enhance the delivery of audiovisual content, and other multimedia interactive services over integrated broadband cable networks

(Continuation of Question 9/9)

### Motivation

The use of the service platform, including cloud computing platform, for the end-to-end (E2E) delivery of audiovisual content, e.g., television programs, over-the-top (OTT) services, is spreading at an impressive pace. Existing cable television platform is based on conventional functions including user management, accounting, terminal management, content management, content delivery, and so on. These functions are still useful and will be used continuously in the future for not only cable television but also general audiovisual content (including the new emerging interactive and immersive videos) delivery systems. On the other hand, a lot of advanced server-side technologies for service enhancement (e.g. target specific content distribution system, artificial intelligence assisted operation and maintenance system, multi-device content distribution, content recommendation system, and cloud-based content storage) become viable. To adopt these server-side technologies to the existing cable television and other audiovisual content delivery services efficiently and quickly, the common interfaces between those systems and other advanced platforms are indispensable. Therefore, it is quite important and urgent to study the requirements, architectures, methods, and interfaces to leverage the platform side technology to enhance the existing cable television systems. This study will include, but is not limited to, advanced service platforms which include:

– advanced content management including cloud-based content storage to realize the cable contents TV everywhere;

– user's account/terminal management for TV everywhere services;

– platform side technologies and interfaces to realize the harmonization between existing cable television services and OTT services;

– management functions of the user/service statistics and analyses to enhance the personalization services, with the necessary collaboration with other Questions (e.g., Q12).

The work area includes the interface between cable television systems and advanced platforms. In some cases, not only cable television systems but also the advanced platforms are operated by the cable operator (e.g. TV everywhere service system, target specific content distribution system, application market). In other cases, multiple cable systems work together through interfaces with the outside systems such as (but not limited to) machine-to-machine (M2M) system, Internet of things (IoT) system, and cloud-based system.

### Question

Study items to be considered include, but are not limited to:

– What are the service requirements applicable to the service platform to enhance the existing cable television and OTT services?

– What are the requirements and technologies applicable to the service platform for enabling interactive or immersive audiovisual content delivery

– What is the appropriate platform architecture to provide enhanced service with the satisfaction of the above-described service requirements?

– What interfaces and compatibility are required between existing cable television platform and the advanced service platform?

– What user account/terminal management method can be used for the TV everywhere service and how should it harmonize with existing user account/terminal management system? More specifically, when the cable operator provides the TV everywhere service, the content distribution to second devices (such as the mobile phone, tablet, etc.) will be controlled based on the subscriber information of cable television systems. Therefore, the communication between the subscriber management function of cable TV system and the TV everywhere service platform is necessary.

– What interface can be used to realize the harmonization between OTT video services and existing cable TV content management system?

– What interface can be used to adopt device-independent content recommendation system to the existing cable television system?

– What are management functions requirements for enabling the enhancement of personalization services, with the necessary collaboration with other Questions (e.g., Q12)?

– What management method and interface can be used to utilize the social media information to the content recommendation?

### Tasks

Tasks include, but are not limited to:

– The preparation of revised or new Recommendations as required.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (https://www.itu.int/ITU-T/workprog/wp\_search.aspx?sp=16&q=9/9).

### Relationships

Recommendations

– API of terminal platform: ITU-T J.200, J.201, J.202

– Set-top box: ITU-T J.295, J.296

– Server platform: ITU-T J.287, J.301, J.302, J.380-series, J.704, J.706, J.707

Questions

– Q1, 2, 5, 6, 7, 8 and 12/9

Study groups

– ITU‑T SG12

– ITU-T SG13

– ITU-T SG15

– ITU‑T SG16

– ITU‑T SG20

Standardization bodies

– Broadband forum

– ETSI

## Question 10/9 – Work programme, coordination and planning

(Continuation of Question 10/9)

### Motivation

A home is needed to handle contributions and liaison statements when they are not directly related to Questions already under study. This Question is also intended to provide cross-ITU coordination for the many aspects for which Study Group 9 is responsible and to foster consistency among ITU‑T, ITU‑R and ITU-D study groups as well as with other related bodies. Additionally, this Question provides a focal point for Study Group 9 matters such as terminology, co-existence of wired and wireless telecommunications, ICT and climate change, conformance and interoperability testing, standardization roadmaps etc.

### Question

Study items to be considered include, but are not limited to:

– When considering new topics for Study Group 9, which actions are needed to address contributions not related to existing Study Group 9 Questions?

– What are the new or updated Questions that need to be worked on in Study Group 9?

– What are the results of workshops, TSB initiatives, and actions of other SGs or SDOs that need to be considered under Study Group 9 work programme?

– What kind of promotional materials (including workshops) can be prepared to assist in the dissemination of Study Group 9 work?

– What kind of materials (reference implementations, tutorial etc.) could be made available on the study group website?

– What guides would be needed to help the users to implement the new Recommendations?

– What terms and definitions should be collected and made available to the Study Group 9 Rapporteurs for vocabulary?

– What coordination needs to take place in Study Group 9 based upon activities of various joint coordination activities (JCAs)?

### Tasks

Tasks include, but are not limited to:

– Identify the needs of the rapidly changing telecommunication marketplace best addressed by the work programme of Study Group 9, and propose new Questions or updates to existing Questions;

– Nominate, in collaboration with other study groups or standardization bodies, representatives in the steering committees of workshops;

– Ensure coordination among various standards activities mandated to Study Group 9 and collaboration with other standards bodies;

– Serve as a focal point in Study Group 9 for conformance and interoperability testing based on WTSA Resolution 76;

– Serve as a focal point in Study Group 9 for terms and definitions, and maintaining related Recommendations;

– Maintain Recommendations that are not under the responsibility of other existing Study Group 9 Questions.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=10/9>).

### Relationships

Recommendations

ITU-T J.1

Questions

– All Questions of SG9

Study groups

– All ITU‑T, ITU‑R and ITU‑D Study Groups with activities related to SG9

Standardization bodies

– ARIB

– ATIS

– CableLabs

– ETSI

– IEC

– IEEE

– IETF

– ISO

– ISO/IEC JTC 1

– Japan Cable Laboratories

– JCTEA

– OMA

– SCTE

– SMPTE

## Question 11/9 – Accessibility to cable systems and services

(Continuation of Question 11/9)

### Motivation

Among different audio-visual media, television is the oldest and by so far the most popular one. With advent of electronic technologies, it is changing its role from an one-to-many broadcasting media to an interactive system. Using systems like WebTV or Hybrid TV, users can interact with both broadcasting program and webpages using TV. This interactive role also enhances TV's role to offer accessibility not only to people with different range of abilities but also to foreign language speakers, elderly people and users in situation impairment like inside moving vehicle.

This question plans to investigate accessibility of existing cable TV systems and propose recommendations for enhancing accessibility in line of the United Nations Convention on the Rights of Persons with Disabilities (UN CRPD), European Union Accessibility Directive and other national legislation of Member States. ITU-T SG9 would also like to take forward the work earlier initiated at the ITU-T Focus Group on Smart Cable TV and liaison with ITU-T Q26/16 and ITU IRG-AVA.

### Question

Study items to be considered include, but are not limited to:

– In collaboration with the IRG-AVA, investigating a common framework to offer accessibility across various media and TV networks such as Cable TV, Direct-to-Home (DTH), Satellite TV, IPTV and so on.

– Propose a common taxonomy of use cases for accessible audio-visual media in cable TV systems.

– Propose a common user profile format addressing the needs of persons with accessibility restrictions, that could be utilized by different media and platforms.

– Investigating accessibility of emerging input technologies applicable to the delivery of cable television services, such as second screen and gesture recognition.

– Investigate accessibility of audiovisual content delivery issues for cable networks.

– Investigate challenges of providing accessibility services for cable TVs in developing countries.

### Tasks

Tasks include, but are not limited to:

– Coordinating with ITU-T Q26/16, ITU IRG AVA and ISO/IEC JTC1 SC35

– Developing participation taxonomy of use cases for accessible audio-visual media in cable TV systems

– Developing common user profile format addressing the needs of persons with accessibility restrictions, that could be utilized by different media and platforms

– Optimizing positioning of visual accessibility features (like signing, closed captioning) in cable TV systems and related advanced services (e.g. AR/VR)

– Developing audiovisual content delivery accessibility roadmap for cable networks in both developed and developing countries

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=11/9>).

### Relationships

Recommendations

ITU-T F-, H-, J- and Y-series Recommendations addressing accessibility and human factors

Questions

– All Questions of SG9

Study groups

– ITU-T SG16 (in particular Q26/16 on accessibility and Q8/16 on AR, VR and ILE)

– ITU-R SG6

– ITU‑D SG1 and SG2

Standardization bodies

– ITU IRG-AVA

– ISO/IEC JTC1 SC35

– W3C

– G3ict

– WHO

## Question 12/9 – AI-enabled enhanced functions over integrated broadband cable network

(New Question)

### Motivation

Artificial intelligence (AI) is becoming very popular in the framework of end-to-end transmission and displaying of advanced video and TV content, thus the implementation of AI-enabled functions is changing the customer behaviour and experience. Through these intelligent functions, the final users can benefit from personalized proposals selection and filtering of video content as well as a more effective video delivering and harmonization of the video displaying. Service providers can also benefit by learning the user behaviours which facilitate the migration and upgrade of networks, systems and devices.

In addition to the conventional transmission and display functions, various other intelligent functions, including gathering and analysing statistics to suggest personalized content, optimizing systems and devices, etc. can be installed into the integrated broadband networks to enable an immersive video experience and zero-touch service satisfaction of the customer. Those AI functions can be conceived and implemented in various parts of the entire network, e.g. the cloud platform, the edge computing entity, the operating system, the gateway, the set-top-box, and the management and optimization system.

To maximize the use of the intelligent functions, the following aspects need to be studied:

– statistical analysis of the watching behaviour for a better personalized service to the customer;

– video, television and data transmission optimization from both source and channel coding aspects over the integrated broadband network;

– multi-quality-of-service (multi-QoS) optimization and dynamic self-adaptation and network slicing for harmonizing both video and data transmission;

– key performance indicators (KPI) as well as their monitoring and management for the use of multi-QoS optimization;

– precision marketing over television and other over-the-top (OTT) video terminals;

– fast zero-touch troubleshooting, diagnosing as well as AI-assisted migration plan for the integrated broadband network;

– use of business analytics and anti-fraud techniques.

To facilitate implementation of the above aspects, it is important to study the collaboration, coordination and information exchange among the different intelligent entities. As a consequence, besides intelligent functions, it is also necessary to study the various interactions, which depends on the general or the dedicated AI functions framework, architecture, interfaces and data models.

Furthermore, the intelligent function shall be manageable, customizable and controllable. It can be either forced, preferred or disabled at different parts of the video transmission network and at different time, depending on the combinations of the service package, the network policy of the service providers or the final user configuration.

### Question

Study items to be considered include, but are not limited to:

– What kinds of intelligent functions are applied for video and data transmission over the integrated broadband network?

– What are the requirements and benefits about the use of intelligent functions for the video and data transmission?

– Where and how intelligent functions are logically deployed within the integrated broadband network?

– What and how interfaces and data models can be used for harmonizing the intelligent functions of video and data transmission, also to ensure compatibility with the traditional functions over the integrated broadband network?

– What are the physical and logical entities that enable intelligent functions over the entire video and data transmission network for the use and configuration of the service provider or customers or both?

– Taking advantage of the intelligent functions for video and data transmission optimization over the network, what methods can be utilized to enhance the video experience for the final customer?

### Tasks

Tasks include, but are not limited to:

– Preparation of new Recommendation(s) regarding the above study items listed under "Question";

– Maintenance and enhancements of existing Recommendations in the J.1600-series

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<https://www.itu.int/ITU-T/workprog/wp_search.aspx?sp=16&q=12/9>).

### Relationships

Recommendations

– ITU-T J.1600: Premium cable network platform – Framework

Questions

– Q1, 5, 6, 7, 8, and 9/9

Study groups

– ITU‑T SG12

– ITU‑T SG13

– ITU‑T SG15

– ITU‑T SG16

– ITU‑T SG20

Standardization bodies

– ETSI

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