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| ITU-T Study Group 9 |
| Television and sound transmission and integrated broadband cable networks |
| REPORT of ITU-T SG9 TO THE WORLD TELECOMMUNICATION STANDARDIZATION ASSEMBLY (WTSA-16), Part II: QUESTIONS PROPOSED FOR STUDY DURING THE NEXT STUDY PERIOD (2017-2020) |

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| **Abstract:** | This contribution contains the proposal of ITU-T Study Group 9 of 13 Questions for study during the study period 2017-2020 |

Note by the TSB:

The report of Study Group 9 to the WTSA-16 is presented in the following documents:

Part I: **Document 7** – General

Part II: **Document 8** – Questions proposed for study during the study period 2017-2020

# 1 List of Questions proposed by Study Group 9

| Question number | Question title | Status |
| --- | --- | --- |
| A/9 | Transmission of television and sound programme signal for contribution, primary distribution and secondary distribution | Continuation of Q1/9 |
| B/9 | Measurement and control of the end-to-end quality of service (QoS) for advanced television technologies, from image acquisition to rendering, in contribution, primary distribution and secondary distribution networks | Continuation of Q2/9 |
| C/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) | Continuation of Q3/9 |
| D/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 Q4/9 |
| E/9 | Functional requirements for residential gateway and set-top box for the reception of advanced content distribution services | Continuation of Q5/9 |
| F/9 | Digital programme delivery controls for multiplexing, switching and insertion in compressed bit streams and/or packet streams | Continuation of Q6/9 |
| G/9 | Cable television delivery of digital services and applications that use Internet protocol (IP) and/or packet-based data over cable networks | Continuation of Q7/9 |
| H/9 | The IP enabled multimedia applications and services for cable television networks enabled by converged platforms | Continuation of Q8/9 |
| I/9 | Requirements for advanced service capabilities over broadband cable home networks | Continuation of Q9/9 |
| J/9 | Requirements, methods, and interfaces of the advanced service platforms to enhance the delivery of sound, television, and other multimedia interactive services over cable television network | Continuation of Q10/9 |
| K/9 | Guidelines for implementations and deployment of transmission of multichannel digital television signals over optical access networks | Continuation of Q11/9 |
| L/9 | Objective and subjective methods for evaluating perceptual audiovisual quality in multimedia services within the terms of Study Group 9 | Continuation of Q12/9 |
| M/9 | Work programme, coordination and planning | Continuation of Q13/9 |

# 2 Wording of Questions

Draft Question A/9

Transmission of television and sound programme signal for contribution, primary distribution and secondary distribution

(Continuation of Question Q1/9)

### 1 Motivation

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

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 or by SMATV).

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 for all those applications within the scope of Study Group 9.

It is also necessary to ensure the utmost compatibility among the methods used for the various applications.

The studies include the specification of the availability objectives, and how availability objectives affect the choice of technical solutions for, e.g. digital source coding, multiplexing and error protection.

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;

– differential latency of the audio and video signals (lip-sync) in television transmission;

NOTE 1 – lip-sync is defined as the "operation to provide the feeling that the speaking motion of the displayed person is synchronized with that person's voice. The minimization of the relative delay between the visual display of a person speaking and the audio of the voice of the person speaking. The objective is to achieve a natural relationship between the visual image and the aural message for the viewer/listener".

– recommended bit-rate reduction method and profile;

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

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.

It is therefore urgent to study the following Questions, taking into account Recommendations J.89, as well as the several existing Recommendations on primary and secondary distribution. (Measurement and control of quality of service is covered in Question B/9).

### 2 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?

– Which source coding methods can be recommended for the transmission of digital television and sound programme signals for purposes of primary and secondary distribution over digital transmission circuits and chains?

– 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?

– Which provisions can be made to preserve lip-sync when the audio and video components of a television programme undergo different delays through the transmission chain?

– What are the appropriate transmission methods for uncompressed digital television and sound programme signals when they are used for contribution purposes?

– 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?

– Do the UHDTV and HDR applications and the related quality levels, that will be identified by ITU‑R Study Group 6, adequately cover all the applications of UHDTV and HDR, and the related quality levels identified within Study Group 9, and if they do not, which additional applications should be taken into account?

– 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?

### 3 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 delivery of advanced video programmes for purposes of contribution and of primary distribution, and over the digital cable television infrastructure, depending on the contributions received, and on progress in the work of the appointed Rapporteur(s).

– While studies of UHDTV and HDR may include characteristics in the terms of reference of Study Group 9 that are common to motion pictures, Study Group 9 recognizes that aspects specifically relating to motion pictures should be based on standards developed by motion picture expert groups.

*“*An up-to-date status of work under this Question is contained in the SG 9 work programme ([http://itu.int/ITU-T/workprog/wp\_search.aspx?sg=9](http://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=9))”

### 4 Relationships

Recommendations:

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

– ITU-T H.222.0

– ITU-R BT.1769, BT.1121-1, BT.1548-2

Questions:

– B, F, G, K and L/9

Study Groups:

– ITU‑T SG 16 (Questions 6, 7 and 10/16)

– ITU‑R SGs 4, 5 and 6

Standardization bodies:

– IEC, ISO, ISO/IEC JTC1/SC29/WG11

– AES, DVB, ETSI, IEEE, SMPTE, JCTEA

Draft Question B/9

Measurement and control of the end-to-end quality of service (QoS) for advanced television technologies, from image acquisition to rendering, in contribution, primary distribution and secondary distribution networks

(Continuation of Q2/9)

### 1 Motivation

ITU‑T has adopted several Recommendations for the transmission of digital television signals for contribution, primary distribution and secondary distribution applications. However, a number of issues related to the measurement, monitoring and control of digital and mixed analogue-digital television transmission chains still remain to be solved.

This Question focuses on perceptual impacts of audiovisual quality of the entire video stream, also taking into account perceptual quality impacts of the camera and display. The effect of the source and display is particularly important and necessary for the case of 3DTV and high-dynamic range (HDR) displays, as both these technologies are not mature and still introduce quality problems. Display technologies are evolving from 2D to 3D, high-definition to ultra-high definition, low dynamic range to wide-gamut and high-dynamic range displays. In particular, HDR images are currently typically displayed on low-dynamic range (LDR) displays because of the limited availability of HDR displays. In order to visualize HDR images on LDR displays, tone mapping is necessary and this creates information loss that can deteriorate the quality and details of the HDR image. Recently, HDR displays have appeared on the market but they use internal processing that can affect the video quality. 3DTVs exhibit crosstalk to various degrees and can impact negatively the viewing experience. For these new technologies, the quality impact of the display and transmission (or camera, production and transmission) cannot always be separated. Although bandwidths available in cable transmission are well suited for ultra-high definition television (UHDTV), maintaining adequate video quality still represents a challenge.

– ITU‑R has recommended methods for the subjective assessment of picture quality (e.g. BT.500-13, BT.1788, BT.2021). There is a need to confirm that those subjective assessment methods and set-up requirements (including selection of the display, settings/calibration of the display, viewing distance, angle, luminance levels etc.) are equally applicable to the case of next-generation visual media, such as television transmission on digital or mixed analogue-digital chains, 3D, HDR and UHDTV images. In particular, current 3DTVs exhibit crosstalk to various degrees and can affect more or less the viewing experience even though the intrinsic 3D signal quality is very high. Subjective testing requires (objective) measurement or characterization means to adequately select display equipment to conduct such subjective testing in a reliable and repeatable manner.

– In the digital domain, ITU‑R Study Group 6 and ITU‑T Study Groups 9 and 12 have been also studying together, in a video quality experts group (VQEG), the identification of appropriate parameters and algorithms that are representative of digital picture quality, as well as the correlation of the objective measurement of those parameters to the subjective picture quality. This work has resulted in Recommendations J.143, J.144, J.242, J.244, J.246, J.247, J.249, J.340, J.341, J.342, and J.343-series.

– Concerning the measurement of the overall quality of experience (QoE), it includes not only a single impairment of each mono-media but also inter-media relation and response time of user operation. There is a need to identify the group of parameters that can provide objective measurement of the overall QoE and continuous in-service monitoring and control of it along the transmission chain.

– For some objective video quality models to operate effectively, the source and processed video sequences need to be aligned in the spatial and temporal dimensions. (In some cases such video registration can be treated separately from objective perceptual video quality assessment). Furthermore, in order to test processed video sequences to see if they meet validation test requirements (e.g. maximum spatial and temporal shifts), reliable methods to measure video registration are required. Therefore, it would be helpful and necessary to develop methods for video registration.

– Sometimes there is also a need for calibration methods in order to identify any modifications introduced into the video signals (e.g. gain and offset).

### 2 Question

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

– What are the quality requirements for transmission of UHDTV?

– Are the current methods recommended for subjective assessment of digital picture quality also applicable to scenarios where the display is not transparent, such as in 3DTV or HDR images? Are the current quality assessment methods applicable to ultra-high definition television?

– If they are not, should any different or additional methods for picture quality assessment be recommended by Study Group 9?

– How should the impairment introduced by the display be taken into account in evaluation of the viewing experience?

– How should the impairments introduced by the transmission chain be taken into account, such as those introduced by digital or mixed analogue-digital television transmission chains?

– How should the impairment introduced by the (stereo-) camera be taken into account in evaluation of the viewing experience?

– What objective methodology can be used to jointly analyse the perceptual quality of the entire stream, including the quality of both the camera and the display?

– Which parameters and algorithms are representative of digital picture quality and how does the objective measurement of them correlate to subjective picture quality? (This work is to be carried out in cooperation with the VQEG.)

– How should the objective measurement of impairments introduced by digital or mixed analogue-digital transmission networks be carried out?

– Which network parameters should be used to provide objective measurement of the overall QoE and should be the basis for continuous in-service monitoring along the transmission chain both for digital and for mixed analogue-digital television transmission?

– Which network parameters can be dynamically adjusted for the supervision and control of the overall QoE in digital television transmission networks and how can such supervision and control be implemented in operation?

– What methods can be used for video registration of source and processed sequences for use in objective video quality assessment?

– What methods can be used for video calibration?

– What are the necessary test materials and test signals required for video registration and calibration?

– What trade-offs are inherent in different registration and calibration methods with respect to such factors as speed, accuracy and complexity and what are the effects on accuracy when limited information is available for video registration and calibration?

– What perceptual image/video quality assessment methods can be used to determine which tone-mapping operator maintains best the visual information of an HDR image or produces the highest-quality LDR image? What perceptual image/video quality assessment methods can be used to assess the quality of HDR content?

– What methods can be used to measure the visual fatigue in 3D video from the video capture, rendering and display?

– 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?

### 3 Tasks

Tasks include, but are not limited to:

– Maintenance and enhancement of J-series and P.900-series Recommendations.

– It is anticipated that new Recommendations will address:

• methods to characterize and select appropriately 3D displays for subjective evaluation of 3D picture quality;

• methods for HDR and UHDTV quality evaluation;

• methods to assess/characterize the impact of non-transparent displays on viewing experience.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=2/9>).

### 4 Relationships

Recommendations

– ITU-T J- and P-series, ITU‑R BT-series

Questions

– L/9

Study groups

– ITU‑T SGs 12 and 16

– ITU‑R SG 6

– ITU IRG-AVQA (Intersector Rapporteur Group among ITU-T SG9, SG12 and ITU‑R SG6)

Standardization bodies

– ISO/IEC, IEEE P3333

Other groups

– VQEG

Draft Question C/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)

(Continuation of Q3/9)

### 1 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.

### 2 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?

### 3 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 (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=3/9>).

### 4 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

Questions

– All/9

Study groups

– ITU‑T SG 17

– ITU‑R SG 6

– ITU‑T SG 20

Standardization bodies

– DVB-CM (CI-Plus, CP, SEG, SSC)

– DVB-TM (CI-Plus, CPT, CSA)

– ETSI ISG ECI

Draft Question D/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 Q4/9)

### 1 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 1 – 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. Such new generation of services make delivery of new interactive services possible via this mechanism. These services will enable better interactivity, accessibility and usability. This in turn leads to the same need for well-defined and well organized software components structure.

The software component structure 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.

A further purpose of defining these 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 of course also highly desirable that the specified APIs should conform to "open", published standards rather than to proprietary standards, and that they should incorporate well-defined mechanisms for adding extensions. However, adding extensions in an uncontrolled manner will lead to development confusion and incompatibility, to illegal superseding of other APIs and to the risk of addition of proprietary extensions.

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

### 2 Question

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

– What are the relevant advanced content distribution applications and the functionality that each API should be able to provide in order to meet the requirements? (APIs are required for the support of applications but are also required for downloading purposes, display purposes, for network control and for security).

– What specification of open API or APIs can be recommended for use in each application, paying attention to their desirable interoperability with other APIs recommended for use in other services and their use in next generation set-top boxes for the reception of advanced content distribution services via interactive systems?

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

– What is an appropriate architecture for the APIs and the frameworks dealt within this Question?

– What specifications can be recommended for the mechanisms to be provided in each recommended API, to allow its future extension to further functionalities?

– What are the appropriate frameworks, with a specified scope, that integrate sets of APIs in order to provide reusable functionalities, extensibility and interoperability?

– What specification of open API or APIs and underlying mechanisms can be recommended to support or to improve accessibility?

– What is required in developed or new Recommendations to provide energy savings directly or indirectly in information and communication technologies (ICTs) or in other industries?

### 3 Tasks

Tasks include, but are not limited to:

– The preparation of new Recommendation(s) that will eventually fully specify all the open 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 (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=4/9>).

### 4 Relationships

Recommendations

– J.200-series,

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

Questions

– E, G and J/9

Study groups

– ITU‑T SGs 11, 12, 13, 15 16 (Question 13/16), and 20

– ITU‑R SGs 4 and 6

– ITU IRG-IBB (Intersector Rapporteur Group among ITU-T SG9, SG16 and ITU-R SG6)

Standardization bodies

– ISO/IEC

– ETSI, DVB, and regional standardization bodies

Draft Question E/9

Functional requirements for residential gateway and set-top box for the reception of advanced content distribution services

(Continuation of Q5/9)

### 1 Motivation

Continued studies on residential gateway and set-top box for the reception of advanced content1 distribution services include all aspects of residential gateway and set-top box with connectivity to the home network, including service definition, architecture, and specifications.

NOTE 1 – The ITU Terminology database defines "content" as "program material and related information of any variety".

The future service environment will be both IP- and broadcast-based. It will be highly interactive, and standardized technology will be critical in creating a convenient and interoperable solution for the consumer.

Because there are many broadcast and IP services available, a variety of functions will be required by devices in the home. Due to considerations of consumer cost and convenience, it is desirable that these 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. These include security, conditional access, protection against unauthorized copying, protection against unauthorized redistribution ("redistribution control"), device provisioning and management, quality of service, user interface, application program interface (API), etc.

Furthermore, it can be foreseen that the various services within the scope of Study Group 9, that home users will be able to access over the digital television infrastructure, may be based on various service platforms (middle-wares) that support proprietary applications. An architecture would be necessary to bundle these middle-wares and to assure cross-platform2 and multi-platform3 operation among them. It would be very convenient to users if the residential gateway and set-top box would be designed to exchange middleware dynamically and to navigate among applications that users can access, or at least among the most widely employed ones.

NOTE 2 – The term cross-platform refers to communications between different platforms within the home network environment, which have different applications residing within them. These communications are controlled by systems which primarily reside within one or more of the platforms.

NOTE 3 – The term multi-platform refers to communications between different platforms, which have the same or similar applications. These communications are primarily controlled by systems within the cable operator's network.

Considering the rapid development of HDR (High Dynamic Range), UHDTV (ultra high definition television), multi-screen, cloud computing, big data, IoT (internet of things)/M2M(machine to machine) and SmartHome related technologies and their emerging applications and deployment within cable industry, residential gateway and set-top box will provide support for such kinds of applications and services on demand with enhanced functionalities and APIs embedded.

This Question also plans to discuss requirements and include considerations on accessibility, so that residential gateways and set-top boxes will provide support for such kinds of capabilities.

### 2 Question

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

– What architecture will be required for the future residential gateway and set top box (STB)?

– How will broadcast and IP-based service reception, via connection to the access network, be integrated into the future residential gateway and STB?

– What technologies will be required to accommodate service delivery over the home network?

– What gateway functions should be included in the future residential gateway and STB?

– What user interface is required for the future residential gateway and STB?

– What are the appropriate features and functionalities of the interfaces and middleware for the future residential gateway and STB?

– What security, conditional access, protection against unauthorized copying or redistribution is required for the future residential gateway and STB?

– What provisioning and management tools will be required for the future residential gateway and STB?

– What type of quality of service will be required for the future residential gateway and STB?

– What protocols will be required to enable the future residential gateway and STB to interoperate with other devices in the home, including both IP and non-IP devices?

– What technologies will be required to present services (including HDR, UHDTV, multi-screen, cloud computing, big data, IoT/M2M and SmartHome) to consumers in the future residential gateway and STB?

– What types of content management capabilities will be required for the future residential gateway and STB?

– What provisions can be made in order that the residential gateway and STB may contain a facility to exchange middleware dynamically and to navigate within an application and among applications? This would allow the residential gateway and STB to properly operate with received services that reside in a variety of platforms and applications, thus providing maximum operating convenience to the home user.

– 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 developed or new Recommendations are required to provide such energy savings?

– What requirements, capabilities and technologies to address accessibility will be required for the future residential gateway and STB?

### 3 Tasks

Tasks include, but are not limited to:

– Creation by 2017 of an architecture document describing interoperation among multiple applications and platforms by means of converged mechanisms, and of one or more specification documents by 2020.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=5/9>).

### 4 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

– Gateway: ITU-T J.294

– Home networking: J.190, J.192

Questions

– C, D, G, H, I and J/9

Study groups

– ITU‑T SGs 13, 15, 16, 17 and 20

– ITU‑R SG 6

– ITU IRG-AVA (Inter-sector Rapporteur Group among ITU-T SG9, SG16 and ITU-R SG6)

Standardization bodies

– ISO/IEC, IETF, W3C, OneM2M and regional standardization bodies (e.g. SCTE, ETSI)

Draft Question F/9

Digital programme delivery controls for multiplexing, switching and insertion in compressed bit streams and/or packet streams

(Continuation of Q6/9)

### 1 Motivation

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 appointed time, on each output channel of their television transmission system to accommodate local advertisements, local programming, emergency messages, etc.

Several programme signals are often multiplexed with each other for broadcast and/or multicast distribution purposes, which utilize distribution network resources effectively based on statistical characteristics of the programme signals. And the multiplexing may dynamically vary due to a condition of programme requests from viewers namely in such services as VOD (video on demand), SDV (switched digital video), etc. A targeted service such as a programme promotion and an advertisement, which provides different content1 to each viewer based on, for example, the viewer’s programme preference, also needs a delivery control based on this dynamic multiplexing.

NOTE 1 – The ITU Terminology database defines "content" as "program material and related information of any variety".

With the advent of digital television transmission systems, programme signals take the form of compressed audio-video signals such as H.262 (MPEG-2), H.264 (MPEG-4 AVC) and H.265 (HEVC) bit streams, and they would be delivered with a multiplexing mechanism, i.e. MPEG transport stream defined in H.222.0 (MPEG-TS) and MPEG media transport defined in ISO/IEC 23008-1 (MMT). Television distribution operators such as cable television operators will be confronted with the task to switch or multiplexing among the bit streams without causing disruptive disturbances to home decoders, and preferably without incurring the artefacts attendant to multiple cascaded encoding and decoding.

The problem is compounded by the fact that the various programme bit streams at the input of a digital programme delivery function will likely be out of synchronization with each other; they may use different bit rates, different resolutions different picture formats and different types of packet and possibly conform to various different profiles or levels of each compression coding standard.

The problem is further compounded by the fact that programme distributers may wish to edit among compressed bit streams using some simple visual transitions, such as cross-fades, wipes, etc.

Television distribution systems have been moved to digital operation. It is important and urgent 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, and they should be reflected in any international standardization that may be required in order that those solutions may be readily and uniformly implemented.

Another important consideration is the replication or reuse of existing analogue functionality in the digital programme insertion system. All the attendant monitoring, auditing and control functions in widespread use today should be accommodated in any digital system that supports equivalent applications such as local advertising, local programme insertions, or emergency message insertion in the analogue domain.

### 2 Question

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

– 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?

– Also, this Question will study 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. These solutions would satisfy the following requirements:

• would not cause disruptive disturbances to home decoders;

• would not incur in programme quality losses attendant to repeated compression encoding and decoding, while at the same time meeting the specified operating requirements, for example:

– allowing simple visual transitions between switched programmes;

– allowing independent switching of the video, audio and data present in the compressed bit stream;

– allowing bundling of multiple programmes on the bit stream domain and encapsulated packet domain with taking advantage of statistical characteristics of each programme.

 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)

– 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 developed or new Recommendations are required to provide such energy savings?

### 3 Tasks

Tasks include, but are not limited to:

– The preparation of a number of draft new Recommendations by the end of the study period.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=6/9>).

### 4 Relationships

Recommendations

– ITU-T H.222.0, H.262, H.264, H.265, J-series

Questions

– A/9, G/9 and J/9

Study groups

– ITU‑T SG 16

– ITU‑R SG 6

Standardization bodies

– ISO/IEC JTC1/SC29/WG11

– SCTE

Draft Question G/9

Cable television delivery of digital services and applications that use Internet protocol (IP) and/or packet-based data over cable networks

(Continuation of Q7/9)

### 1 Motivation

In their conversion to digital television, cable television systems in many 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.

The technology considered for the 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: In their conversion to digital television, cable television systems in many 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.

The technology considered for the 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 fibre/coax television cable networks;

– the use of the transmission methods specified for those networks;

– the use of the architecture and modems specified for those networks;

– compliance with the specifications and QoS peculiar to those networks;

– 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.

### 2 Question

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

– What are the services that could desirably be provided over the advanced smart digital cable television infrastructure, by means of packet-based data transmission?

– What are the functionalities that each service should be able to provide in order to meet its service requirements?

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

– Which open protocols can be used for the envisaged services, preferably choosing them among those already recommended for packet-based data by other bodies, or identifying the need for appropriate enhancements to them, paying attention to their desirable interoperability with IP?

– Which specification should be recommended for the mechanisms to be provided for each considered service, in order to allow its future extension to further functionalities?

– In particular, for those services and applications that utilize IP, the following specific questions should be studied:

– Which user requirements apply to the provision of digital services that support applications utilizing IP and operate over advanced bidirectional smart cable television systems?

– Which digital interfaces are needed to support applications utilizing IP over advanced smart cable television systems?

– Which systems implications for cable television systems derive from the requirement that they should be able to support advanced smart digital services and applications that utilize IP?

– 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 developed or new Recommendations are required to provide such energy savings?

### 3 Tasks

Tasks include, but are not limited to:

– Preparation of draft new Recommendations providing specifications and recommended operating practices. Depending on the contributions received, and on progress in the preparatory activity of the rapporteur, the studies should be completed by 2020.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=7/9>).

### 4 Relationships

Recommendations

* ITU-T J-Series

Questions

* All/9

Study groups

* ITU T SGs 13, and 15

Standardization bodies

* SCTE, ETSI

Draft Question H/9

The IP enabled multimedia applications and services for cable television networks enabled by converged platforms

(Continuation of Q8/9)

### 1 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 those that are based on internet of things (IoT)/machine-to-machine (M2M) services, cloud computing services, big data services and interactivity.

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.

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 in accordance with the specified QoS and security.

### 2 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 are the subscriber environment interfaces necessary for the fulfilment of IP enabled multimedia and multi-sensory applications/services?

– What are the mechanisms that need to be implemented in order to accommodate the various 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, internet of things (IoT)/machine-to-machine (M2M) services, cloud computing services and big data services, etc?

– What type of call signalling protocol should be used for these applications?

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

– What device provisioning method should be appropriate for these services and applications?

– What type of event messaging should be required for these applications?

– What class of security and privacy should be required for these applications?

– What type of audio and video codecs including trans-coding technology should be specified for these applications?

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

– What class of QoS should be used for these applications?

– What class of QoS should be specified for these applications in relationship with each codec parameter?

### 3 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 (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=8/9>).

### 4 Relationships

Recommendations

– Reference architecture: ITU-T J.700

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

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

– Gateway device: ITU-T J.294

– Home network: ITU-T J.190, J.192

Questions

– C/9, D/9, E/9, I/9 and J/9

Study groups

– ITU‑T SGs 11, 13, 16 and 20

Standardization bodies

– ETSI, DVB, IETF, SCTE, OneM2M

Draft Question I/9

Requirements for advanced service capabilities over broadband cable home networks

(Continuation of Q9/9)

### 1 Motivation

The increasing integration and convergence of traditional cable television technologies and emerging information/communication technologies (e.g. cloud computing, software defined networking, network functions virtualisation) are enabling advanced capabilities for supporting new advanced services on cable television networks. Question I/9 will focus on requirements for advanced service capabilities over broadband cable home networks.

In the future, driven by the ever increasing demand of customer for a better lifestyle through smart home, the broadband cable home networks will not only deliver traditional broadband services and multimedia content to subscribers, but also enable advanced smart cable television services (e.g. multi-screen services, multi-device services, etc.) and enable additional smart home services (e.g. home automation, home energy management, home-monitoring, home healthcare and education, etc.). This will benefit consumers, multi-service operators (MSOs) and third application providers by providing advanced services over broadband cable networks.

To meet the customer’s increasing demand on any-screen and anywhere, certain functional requirements such as multi-screen play, mobile-device apply and remote access are needed. Interconnecting and interworking between wired and wireless broadband cable home networks should be supported.

To ensure appropriate quality of experience (QoE), certain functional, application/service creation and application programming interface (API) requirements need to be incorporated into the requirements for service enablement. Increasing high bandwidth and content delivery services need to be supported.

The resulting software stack will be capable of providing high bandwidth services, content delivery services and lifestyle services. It will include support for technologies such as cloud computing, software defined networking/network functions virtualisation (SDN/NFV), IPv6 and machine-to-machine/Internet of things (M2M/IoT). Consideration should be given to support of legacy installed base along with IP network services.

### 2 Question

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

– What performance characteristics should broadband cable home networks possess in order to satisfactorily transport data streams associated with specific services as these streams are passed between access network and the home network and across the home network to the terminal device?

– What mechanisms should be employed in order to maintain the QoE on data streams associated with specific services as these streams are passed between the access network and the broadband cable home networks?

– What mechanisms should be employed in order to improve the user experience by functionality such as remote content access, multi-screen play and mobile device support over broadband cable home networks?

– What network management mechanisms should be employed to provision new network-based advanced services to devices connected to the broadband cable home networks?

– What application management mechanisms should be employed to provision advanced applications to devices connected to the broadband cable home networks?

– What security mechanisms should be employed to provide protection of the broadband cable home networks?

– What content protection mechanisms should be employed to provide safeguards for content stored and distributed on the broadband cable home networks?

– What mechanisms should be employed to realize seamless interconnection between multiple devices for advanced services in broadband cable home networks?

– What type of protocol conversions should be used for the purpose of seamlessly interconnecting IP to non-IP domains in broadband cable home networks?

– What mechanisms should be employed to support low cost, less cumbersome and low maintenance on broadband cable home 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 developed or new Recommendations are required to provide such energy savings?

### 3 Tasks

Tasks include, but are not limited to:

– maintenance of ITU-T J.190-J.192;

– requirements document for distributing video over broadband cable home networks, including consideration of management and provisioning, QoE, content protection, and user interface;

– requirements document for bridging of IP to non-IP domains;

– requirements document for supporting multi-screen/device services and smart home services over broadband cable home networks;

– one or more Recommendations to address the issues identified in the requirements documents listed above.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=9/9>).

### 4 Relationships

Recommendations

– Reference architecture: ITU-T J.700

– 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

– Gateway device: ITU-T J.294

– Home network: ITU-T J.190, J.192

Questions

– A/9, C/9, D/9, E/9, F/9, G/9, H/9 and J/9 (on non-redundant issues from an end-to-end perspective)

Study groups

– ITU‑T SGs 13, 15, 16 and 20

Standardization bodies

– ISO, IEC, ISO/IEC JTC 1, ARIB, ATIS, ETSI, IEEE, IETF, MoCA, NIST, OMA, SCTE, SMPTE

Draft Question J/9

Requirements, methods, and interfaces of the advanced service platforms to enhance the delivery of sound, television, and other multimedia interactive services over cable television network

(Continuation of Q10/9)

### 1 Motivation

The use of the service platform, including cloud computing platform, for the delivery of sound and television signals as multimedia content, 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 cable television systems. On the other hand, a lot of advanced server side technologies for service enhancement (e.g. target specific content distribution 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 service efficiently and quickly, the common interfaces between existing cable 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 over-the-top (OTT) services.

– management functions of the user/service statistics to enhance the personalization services.

The work area is the interface between cable television systems and advanced platforms. In some cases, not only cable TV 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) but it is also possible that the cable system work together with the outside systems such as (but not limited to) machine-to-machine (M2M) system, Internet of things (IoT) system, and cloud-based system.

### 2 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 services?

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

– What interfaces are required between existing cable 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 management functions can be used for the aggregation of user/service statistics, enabling the enhancement of personalization services?

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

### 3 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 (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=10/9>).

### 4 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.380-series, J.704, J.706, J.707

Questions

– D, E, H and I/9

Study groups

– ITU‑T SG13,16 and 20

Standardization bodies

– SCTE, ETSI TC Cable

Draft Question K/9

Guidelines for implementations and deployment of transmission of multichannel digital television signals over optical access networks

(Continuation of Q11/9)

### 1 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 networks.

Fibre technology can provide the higher capacity in the forward and return channel, which is required for the provision of typical cable television services, including interactive ones.

Fibre technology provides the fat bandwidth (100 Mbps or more) on its communication links and is being deployed as the Internet access network. Although fibre networks have the potential to transmit high quality television signals and several Recommendations on optical access networks such as G.983 and G.984-series have been developed, further study on the interworking and interfaces between digital video systems and fibre networks is needed.

### 2 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, 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 term of a high-speed digital communication link?

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

– Which mechanism or interface can be used to coordinate digital video systems with optical access and core 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 developed or new Recommendations are required to provide such energy savings?

### 3 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 such as ITU-T J.185 and J.186.

– Publish useful information (e.g. Reports or Handbooks) to deploy digital television services on optical fibres in developing countries.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=11/9>).

### 4 Relationships

Recommendations

– ITU-T G.983-series, G.984-series and other G-series Recommendations addressing optical fibre networks, systems and interfaces

Questions

– A/9 and F/9

Study groups

– ITU‑T SG 15 (optical network architectures, particularly those related to PON systems, and optical interfaces)

– ITU-D SG1 and SG2

Standardization bodies

– IEEE and IEC

Draft Question L/9

Objective and subjective methods for evaluating perceptual audiovisual quality in multimedia services within the terms of Study Group 9

(Continuation of Q12/9)

### 1 Motivation

In digital transmission systems, the perceptual quality of the audiovisual signal is influenced by a number of interacting factors, such as source coding and compression, bit rate (fixed or variable), delay, bandwidth, synchronization between the media, transmission impairments, and many others. New services that use IP, wireless, mobile, NGN, etc. are providing ubiquitous access for multimedia services. Audiovisual multimedia cover multichannel audio, television, and 3D video applications including interactive ones, in addition to other applications such as videoconferencing, personal computer desktop conferencing, interactive educational and training services, groupware, interactive gaming, and videotelephony. This Question focuses on perceptual impacts of compression, transmission, and decompression on audiovisual quality of these multimedia services and applications.

In order to develop the two-way measurement techniques required for conversational applications, a basis in one-way audio and video quality evaluation must first be defined and validated. Considering the spread of broadband connections to business and the home, the bandwidths will support both low resolution, e.g. quarter video graphics array (QVGA), and standard, high and ultra-high definition imagery. As an example, audio multimedia applications currently range from audio for narrow-band applications, e.g. video telephony, to the enhanced audio contained in 7.1 surround sound systems for interactive gaming. In the future, HDR, 3D programmes and 3D games are expected to become more widely available. Objective and subjective methods for assessing the perceptual quality of these media services are needed, particularly those relating to transmission.

– Objective methods: Current objective quality measuring techniques for audiovisual applications do not correlate to the user opinion on the perceived audiovisual quality with the desirable accuracy. It is therefore necessary to identify objective techniques for measuring the various individual and combined effects of factors such as digital compression, transmission, storage, and others on the perceived quality of audiovisual systems. It is also important to verify that these techniques are meaningful by correlating proposed objective tests with corresponding subjective test data.

– Subjective methods: There is a need to continue to develop new subjective methods to address new audiovisual services. The perceived quality depends on the kind of application and on the tasks the applications are used for. For example, in a free conversation through a videophone or videoconferencing application, the perceived quality may primarily depend on delay, lip-synchronization and audio quality, while in a mainly one-way application like remote-teaching the perceived quality could be primarily related to the quality of graph and low motion picture sequences.

These studies include the maintenance of and enhancements to existing Recommendations, and the development of new Recommendations as needed.

Much of the work on this Question (and its predecessors) was and will be done in cooperation with the video quality experts group (VQEG).

### 2 Question

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

– Interaction of media: What subjective and objective measurement methods should be used to evaluate end-to-end quality of each medium (e.g. video, audio, television, 3D video) and the interactions between the media, with particular attention to the audiovisual quality assessment of systems used for videoconferencing/videotelephony and other interactive multimedia services? What are the quality levels that can be defined by objective or subjective methods in different applications (or tasks) taking into account the interactions between media?

– Transmission errors: What objective methods could be used for in-service measurement and monitoring of transmission systems for such multimedia services in the presence of transmission errors? What new subjective measurement methods should be used for the evaluation of transmission quality of real time audiovisual services by expert observers resulting in the identification of specific flaws in the transmission equipment or environment? What procedures should be used, and which dimensions, transforms, and partial or differential signals should be viewed by experts to evaluate specific impairments of real time audiovisual services? What objective and subjective methods can be used to evaluate audiovisual signals with time-varying quality?

– Impairment characterizations: Among the most significant factors (e.g. spatial resolution, temporal resolution, colour fidelity, audio and visual artefacts, media synchronization, delay, cross-talk etc.) affecting the overall quality of multimedia services, what objective and subjective methods assess the extent of or can differentiate between these factors? How can the mutual interaction between these factors be objectively and subjectively measured with respect to their influence on overall audiovisual quality? For what applications can the assessment methods be shown to be useful and robust over a range of conditions? What kind of artificial impairment generator would be useful for subjective or objective methods?

– Evaluation of specific services: What assessment methods (objective and subjective) can be used to characterize the quality effects of multipoint distribution for interactive communication and other new audiovisual services such as remote monitoring, interactive gaming, and mobile audiovisual communication?

– Test methodologies: What subjective methods and assessment tools are required to fully describe perceived visual or audiovisual impairments in terms of measurable system parameters? What kind of references should be used in subjective tests? What methods can be used to measure the video quality of 3D video? What new subjective methods are needed when analysing new applications and usage scenarios? What kind of service or application design is needed to minimize visual fatigue in 3D video applications? What methods can be used to measure the visual fatigue level introduced into a 3D video signal by the source content (e.g. amount of motion, depth of field), compression and transmission?

– Combination of test results: In some cases it may be useful to combine objective measures (e.g. video measures, audio measures, media synchronization) to provide a single figure of merit. In this regard, which objective measures and/or techniques should be combined, and in what manner, so that the figure of merit correlates satisfactorily with subjective test results?

– Test sequences: While the library of test sequences has increased greatly during the last study period (e.g. www.cdvl.org), there is still a need for more test sequences, especially those with audio included and 3D. Which audiovisual test material (e.g. audiovisual test sequences, 3D video) can be standardized for subjective and objective evaluations? In addition to the definitions of SI and TI in P.910, which criteria (objective and/or subjective) should be used to characterize and classify multimedia test material?

– Validation and applicability of objective methods: There are three basic methodologies of objective picture quality measurement. Full-reference (FR) uses the full bandwidth video input. Reduced-reference (RR) uses lower bandwidth features extracted from the video input. No reference (NR) has no information about the video input. What objective methodology should be used for different multimedia applications? What subjective methods should be used to validate each of the three basic objective methodologies? How can hybrid perceptual/bitstream (hybrid) methodologies use information about the encoded bit‑stream to supplement FR, RR or NR methodologies?

– 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 developed or new Recommendations are required to provide such energy savings?

### 3 Tasks

Tasks include, but are not limited to:

– Quality assessment in multimedia services requires on the one hand the continuous updating of Recommendations under the responsibility of Study Group 9 and also the definition of new task oriented/application-dependent evaluation and subjective methods for the combined evaluation of audio and video signals.

– A new Recommendation utilizing expert viewers is expected in this study period. Three Recommendations defining objective methods for assessing audiovisual quality in multimedia services are expected to be approved in the study period.

– Initial work on quality assessment of interactive gaming applications will result in a new Recommendation in the study period.

– Maintenance and revision of Recommendations on 3D subjective methods.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=12/9>).

### 4 Relationships

Recommendations

– ITU-T P- and J-series

Questions

– B, H and J/9

Study groups

– ITU‑T SGs 12, 13, 15 and 16

– ITU‑R SG 6

– ITU IRG-AVQA (Intersector Rapporteur Group among ITU-T SG9, SG12 and ITU-R SG6)

Standardization bodies

– IETF and regional standardization bodies (e.g. ATIS)

Other

– Video Quality Experts Group (VQEG)

Draft Question M/9

Work programme, coordination and planning

(Continuation of Q13/9)

### 1 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, accessibility, conformance and interoperability testing, implementation of WTSA-12 Resolution 80, etc.

### 2 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)?

### 3 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 [acknowledging the active involvement of the membership in the development of ITU-T deliverables](http://www.itu.int/pub/publications.aspx?lang=en&parent=T-RES-T.80-2012) based on WTSA-12 Resolution 80.

– Serve as a focal point in Study Group 9 for terms and definitions.

– Ensure accessibility is addressed in appropriate Study Group 9 Recommendations.

– Maintain Recommendations that are not under the responsibility of other existing Study Group 9 Questions. No new Recommendation will be developed under this Question.

An up-to-date status of work under this Question is contained in the Study Group 9 work programme (<http://itu.int/ITU-T/workprog/wp_search.aspx?sp=15&q=13/9>).

### 4 Relationships

Resolutions

* ITU-T Res. 80

Recommendations

– All Recommendations related to Study Group 9 activities.

Questions

– All/9

Study groups

– All ITU‑T, ITU‑R and ITU‑D SGs with Study Group 9 related activities

Standardization bodies

– ISO, IEC, ISO/IEC JTC 1, ARIB, ATIS, ETSI, IEEE, IETF, OMA, CableLabs, Japan Cable Labs, SCTE, SMPTE

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