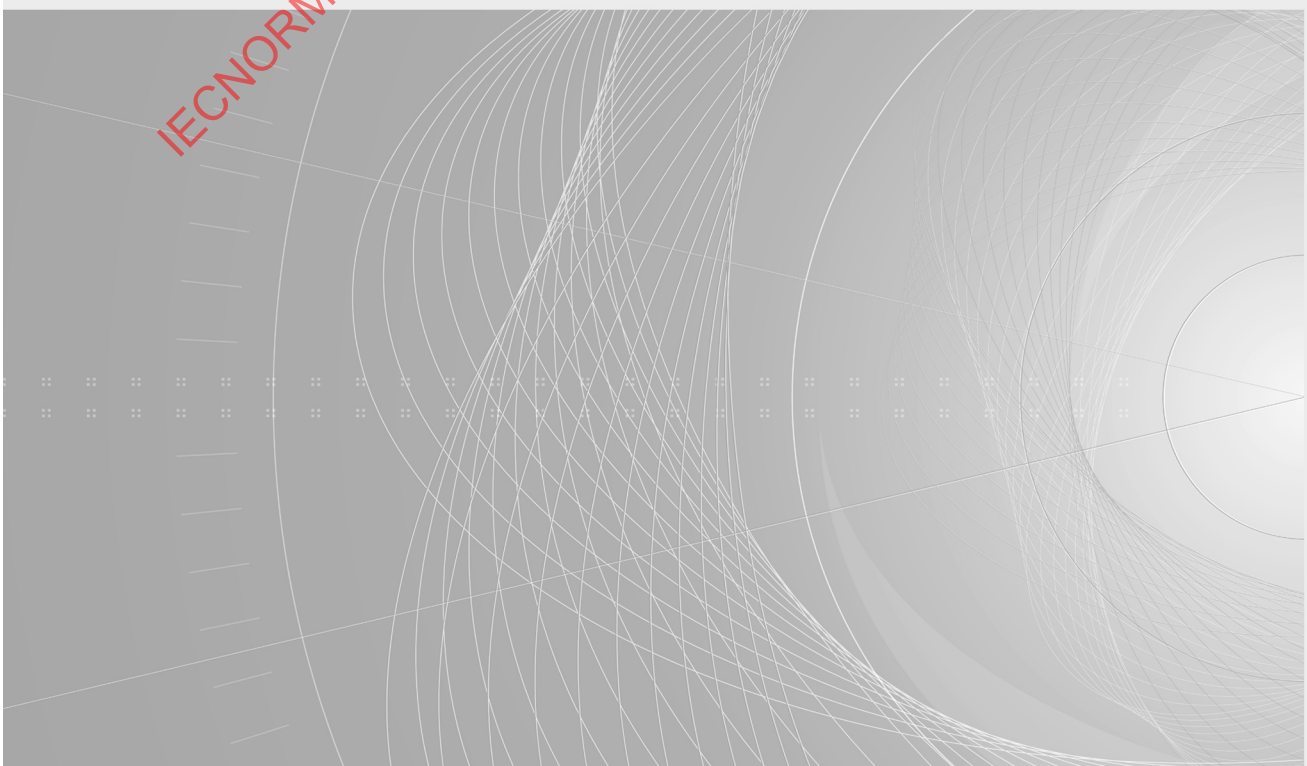
IEC TR 63289

Edition 1.0 2020-09

TECHNICAL REPORT

colour inside

Conceptual model for TC 100 standardization on multimedia cyber technology



IEC TR 63289:2020-09 (en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC TR 63289

Edition 1.0 2020-09

TECHNICAL REPORT

colour inside

Conceptual model for TC 100 standardization on multimedia cyber technology

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.160.60

ISBN 978-2-8322-8914-3

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

CONCEPTUAL MODEL FOR TC 100 STANDARDIZATION ON MULTIMEDIA CYBER TECHNOLOGY

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 63289, which is a Technical Report, has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
100/3442/DTR	100/3468/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC TR 61998:2015, *Model and framework for standardization in multimedia equipment and systems*, has already described cyber world applications and at the present time, some CE products with Internet service are starting to use these cyber world applications. TC 100 has only a few standards regarding this cyber world application up to now; however, now and in the future, TC 100 standardization must shift into cyber-physical systems.

"Study Session 10 – Multimedia cyber technology" was established to consider the cases of the multimedia cyber technology, including IoT or CPS, within the scope of TC 100, and proposes study items. This Technical Report explains these SS 10 studies and shows the possible future works of CPS within the scope of TC 100.

CONCEPTUAL MODEL FOR TC 100 STANDARDIZATION ON MULTIMEDIA CYBER TECHNOLOGY

1 Scope

This Technical Report describes the cases of the multimedia cyber technology, including IoT or CPS, within the scope of TC 100, and possible standardization items.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
CPS
cyber-physical system
system processing physical or real world entities as a cyber world or information entities, and vice versa

3.2
SaaS
Software as a Service
software provided by cloud and server via Internet

3.3
PaaS
Platform as a Service
platform provided by cloud and server via Internet

3.4
IaaS
Infrastructure as a Service
infrastructure provided by cloud and server via Internet

4 Cyber-physical system in TC 100

The CPS model in this document is illustrated in Figure 1. A provider manages contents or services in the physical world. A provider distributes data for contents or services with cyber-physical technology. The data reaches users via a network with information technologies. The user receives contents or services with cyber-physical technologies.

The meaning of CPS, IT and IoT are generally thought of as follows:

- CPS is a system to improve efficiency of all systems, create new services and improve productivity by collecting data obtained from the physical world into cyber world, by processing and utilizing the data.
- IT is a technology related to computers and data communications.
- IoT is a mechanism of mutual control, not only through information and communications equipment, such as computers, but also through various objects existing in the physical world have a communication function, connect to the Internet and communicate with each other.

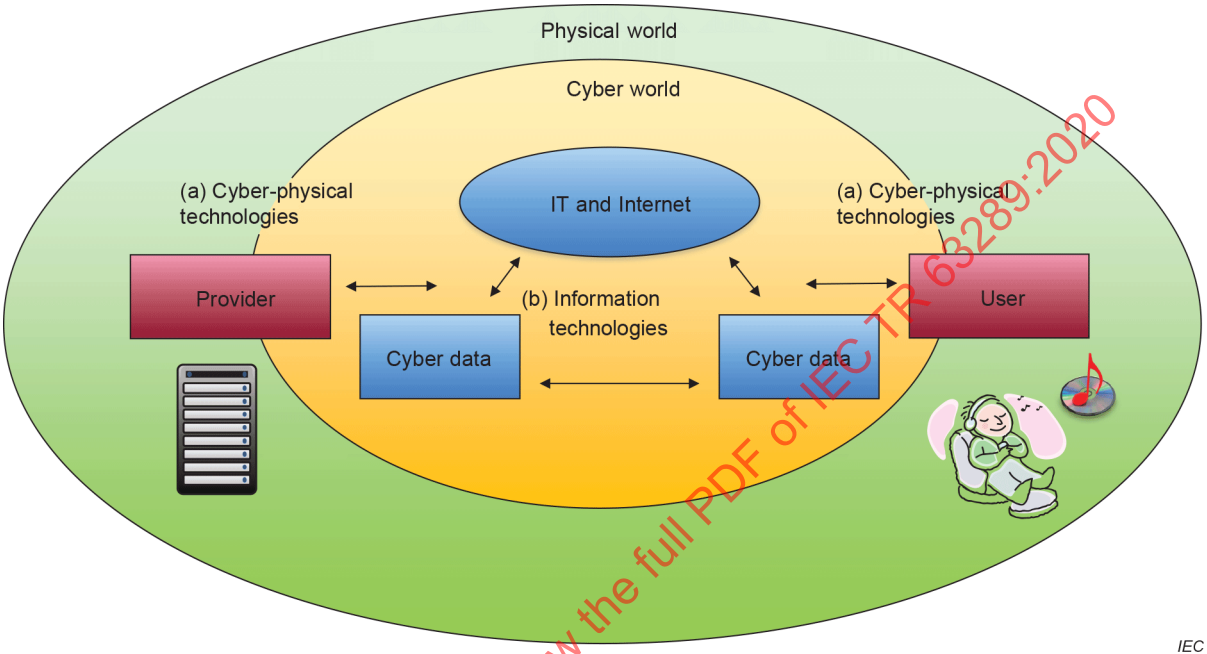


Figure 1 – Cyber-physical system model

The model from IEC 61998:2015 describes the entire system and includes CPS as shown in Figure 2. Equipment and systems in the TC 100 model exchange data through the network with the data source. The TC 100 model also shows a variety of domains such as home, car and mobile.

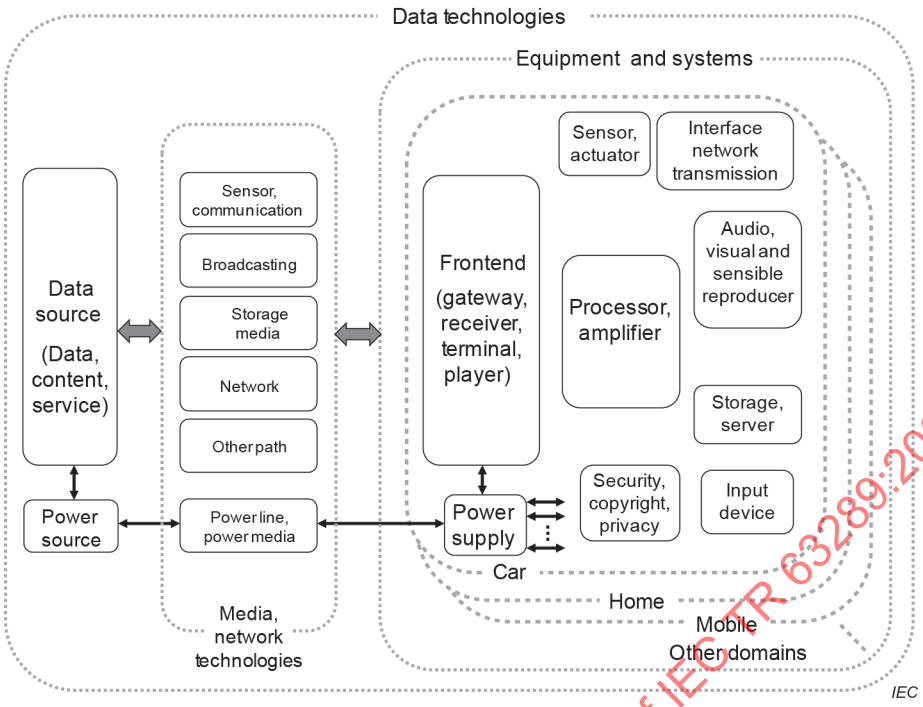


Figure 2 – TC 100 model from IEC 61998:2015

Figure 3 shows the relation between the TC 100 model and the user. This explains what causes a communication between the TC 100 model and the user; this communication is established by human senses. Audio and visual communication are the primal human senses, and other senses can communicate with the TC 100 model also.

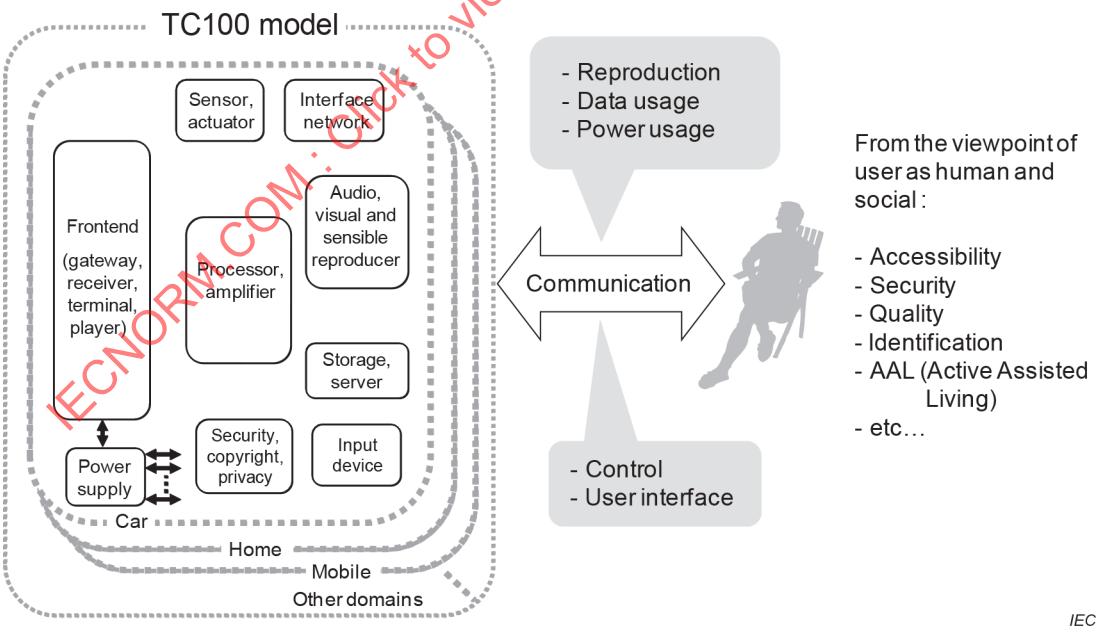


Figure 3 – TC 100 model and user communication from IEC 61998:2015

From all these models, the important essence of the TC 100 model is communication with a user resulting in a physical phenomenon. Equipment, a device or means that communicates with the physical world is a physical world entity because the user and the physical phenomenon exist in the physical world. All other equipment, devices or means can be cyber world entities.

This is the most important situation for TC 100: the legacy standardization items, such as devices and equipment that are physical entities, are replaced with cyber entities.

Current status of activities related to CPS in TC 100 is illustrated in Figure 4. The application area is not standardized yet. The platform and wide area network are standardized in other standard developing organizations. IEC TC 100 TA 18 has standardized some local area network area items, such as Network configuration. Each TA has standardized many devices.

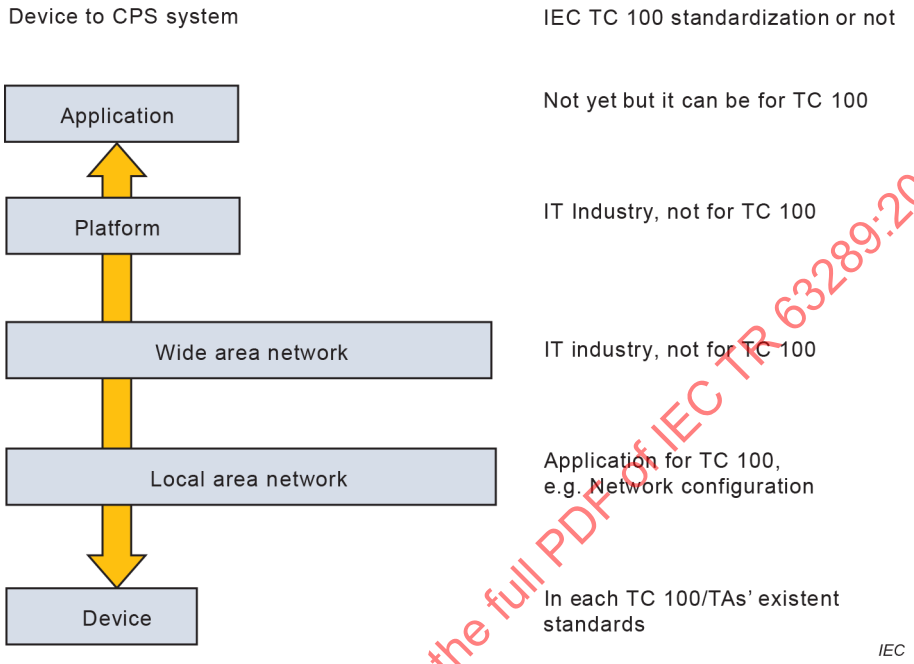


Figure 4 – Current status of activities related with cyber-physical system

In this scheme, the provider can provide not only data but also cyber equipment and cyber systems of TC 100. For instance, raw audio data can be processed to be amplified, tone controlled, filtered and edited in cyber world by cloud computing. Therefore, the only physical device that user needed is receiving data and reproducing it; any other function can be done in the cyber world. This cyber world functionality will be done by cloud services such as SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). For instance, services for audio and video are described in Clause 5.

5 Cases of audio and video services

5.1 General

Audio and video services are provided with IoT/CPS technologies, such as video/audio streaming, video/audio on demand, download, cloud storage and others. Firstly, home music service is studied as a typical TC 100 system case. Home video services and CPS are also studied to investigate the standardization area of multimedia cyber technology in TC 100.

5.2 Home music service

A typical music listening scene with CPS is shown in Figure 5. A music service provider offers its music through the network. Users can buy or subscribe to the music service and listen to it on several audio devices. Users may also upload the user's music content to the server and unify the management of the contents. Furthermore, content editing or modification will be done in the cyber system.

Currently, the service is providing audio content only; other information of the service is quite limited. For instance, the jacket picture is provided but no liner notes and related information. There could be more information services that link to other services.

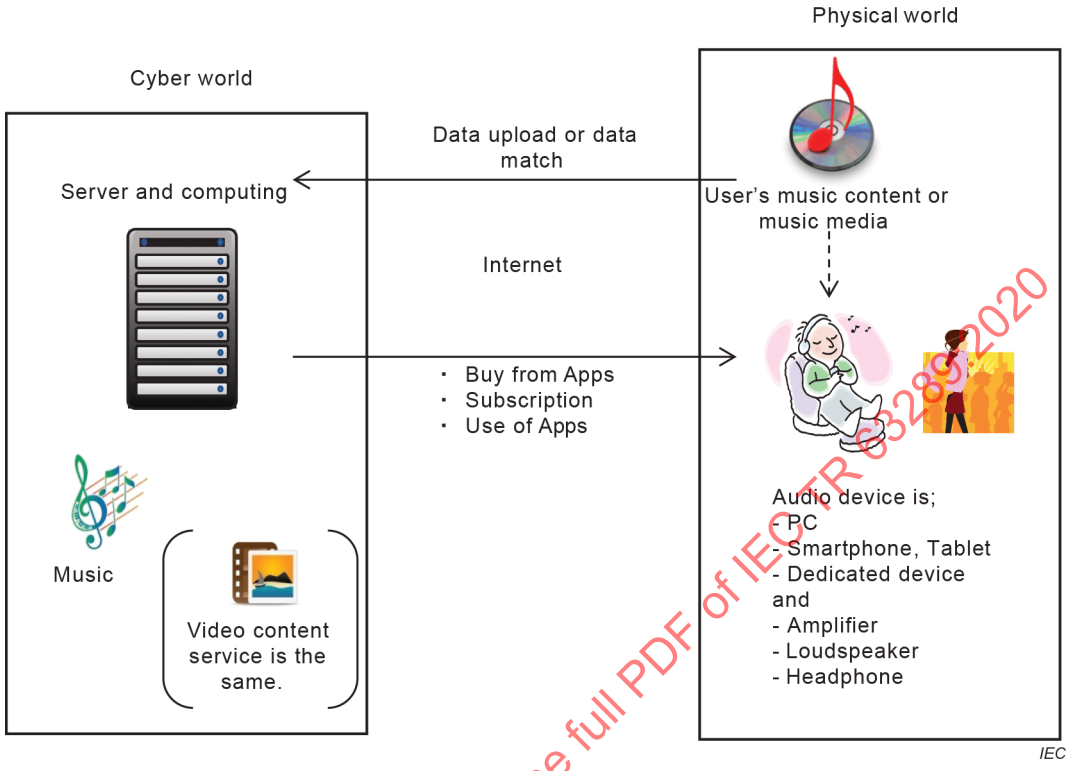


Figure 5 – Typical music-listening scene

The primary clients of user devices in the past and now are the following components: the player, the STB (Set Top Box) and the AV amplifier, loudspeaker or headphone, monitor device, microphone, camera and other interface devices as shown in Figure 6. The data of the content came from disc media.

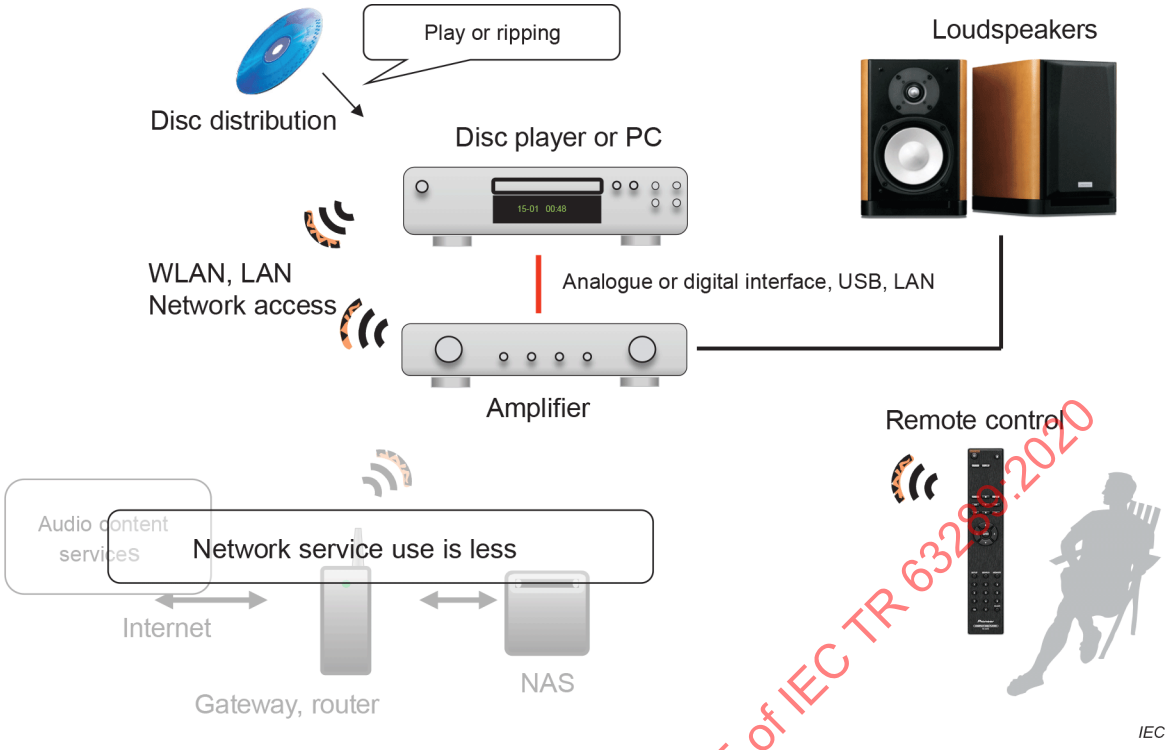


Figure 6 – The primary client in the past and now

Figure 6 shows an example of audio systems and equipment for consumer, and each element is related to the activities in TC 100. These are that DRM of contents is specified by TA 18, the specifications related with speakers are managed in TA 20, the technologies of digital interface of audio devices are specified by TA 4 and TA 20, the technologies related to energy efficiency are specified in TA 19, the technologies related to PC are specified by TA 18.

When a music service of CPS becomes widely used, the primary client will consist only of the following components: smart phone, smart watch, PC and amplifier, loudspeaker or headphone, monitor device, microphone, camera and other interface devices. There will be no player, receiver, STB as shown in the prediction or latest reality in Figure 7.

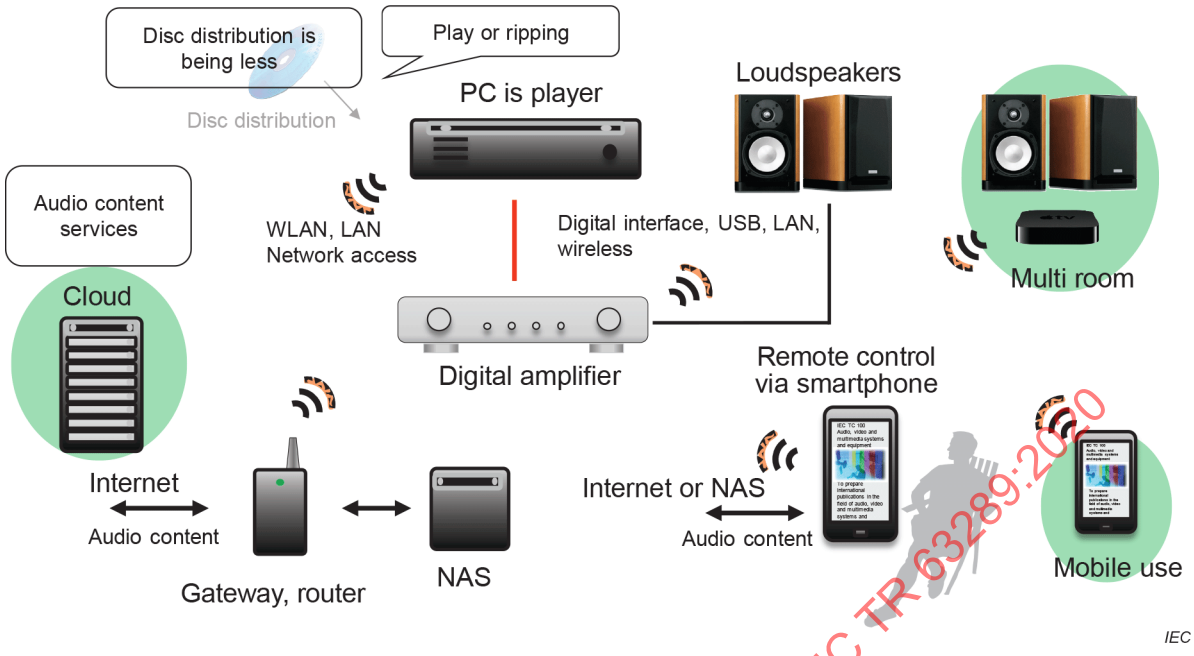


Figure 7 – The primary client now and the future

The user's client device will be such devices as PC/tablets and smartphones, or devices based on PC and smartphone architecture. Players and STBs will be not used, but the key reproduction devices such as DACs, digital amplifiers, monitors, and loudspeakers will continue to be used.

The electronic distribution of music via cloud services spreads instead of physical media distribution such as CDs. Furthermore, high-resolution audio more than CD is distributed through the network to maximize user experience. In a multi-room use case, when the user listens to music and moves to another room, the configuration of speakers is deferent with each room. Therefore, rendering of audio is required for each room. In a mobile use case, a user can listen to audio everywhere and regardless of location, for example with a mobile device or mobile phone to play content from cloud server or home server system.

Digital processing of audio data is required to fit the user environment more efficiently for such a speaker layout or listening position, and for compensation of the reproduction capability of the device. To gather each device's information for the data processing, a unified method and data structure is helpful.

Currently, there is also no universal scheme for all kinds of such cyber domain services. If users want to access the information regarding audio content, such as liner notes or content information, there is no such universal method for accessing these services.

The entity of content and service in cyber system is such as SaaS, PaaS and IaaS, they base on software and IT technologies. On the other hand, a physical system has disadvantages in that it requires physical manufacturing and maintenance, which requires physical work and cost. Therefore, only a small part of high-end audio systems will exist in a physical system. This cyber system will make consumer disc media and player disappear, and also, the user may not need to keep physical media of music in home, most of content will exist in the cyber system.

5.3 Home video service

Video service in CPS has also spread quickly. Electronic sell through or streaming video service has become popular instead of media distribution, such as video tape or DVD. Video service has different requirements than music service.

There are many types of video devices, video browsers and video formats. It is very hard to develop home video systems to support all of these formats. Owing to the difference of display resolution or type of network, it is required to transform video data to fit the user's environment.

Video data is bigger than music data, generally. Faster and wideband network is required for better quality. When the user downloads video data, it takes a long time and the device needs a large local memory to store or cache it.

To establish a high-quality home video service, the following needs to be considered:

– Quality of network: when packets in the network are lost often, the playback of video is interrupted.
– Bandwidth of network: high-resolution video requires high bit encoding and transfer rate.
– Latency of network: if latency of network is not small, it needs a longer time to respond when the user makes an interaction as a user operation.
– Efficient video compression and coding method: for quality, function, and data reduction.

Copyright management is one of key issues for video service. Video content, especially movies, requires a highly copyright-protected system, so that should be considered. Currently several methods, such as contract basis or technical encryption, are used for copyright management. On the other hand, existing video content on video tape or DVD that the user obtained cannot be transformed to cyber-domain data because of copyright; it may need to be solved. IEC 62919, *Content management – Monitoring and management of personal digital content*, could be one solution; such a standard to use cyber content is required.

And, cyber security is another key issue, a standard for which, from the viewpoint of TC 100's scope, is needed.

5.4 Car audio and video system

The different aspect is that the car system is movable on road and land, and autonomous. The characteristics of a car system are as follows:

- movable and autonomous, with its own energy supply,
- a car has various working and functional modes, car AV and multimedia system works depending on the condition of the car such as drive, cruise, stop, park and refuel or charge,
- users are drivers, passengers, pedestrians in and around the car, and remote users of the car's AV and multimedia system.

These aspects affect AV and multimedia systems; however, networked AV and multimedia systems can take advantage of CPS to correspond to these aspects.

The CPS of car AV systems has been introduced with mobile networks; therefore, there is a limitation of network ability. Audio content in the cyber world can be played back with good quality. Video content stored in a mobile phone can be played on a display with which the car is equipped. The current typical CPS car audio system consists of a car main AV device and smartphone as shown in Figure 8. This system may provide not only AV, but also navigation and many Internet services.

Figure 8 – Car audio systems consist of car main AV device and smartphone

Currently, this system depends on smartphones, therefore its function and specification also depend on a smartphone. To obtain a more integrated system with car and other AV and multimedia systems, for example, IEC 63246, Multimedia systems and equipment for cars – Configurable Car Infotainment Services (CCIS), is under development. CCIS provides an integrated car AV and multimedia system with other AV and multimedia systems and car systems, and controls the whole system including CPS. Figure 9 shows CCIS.

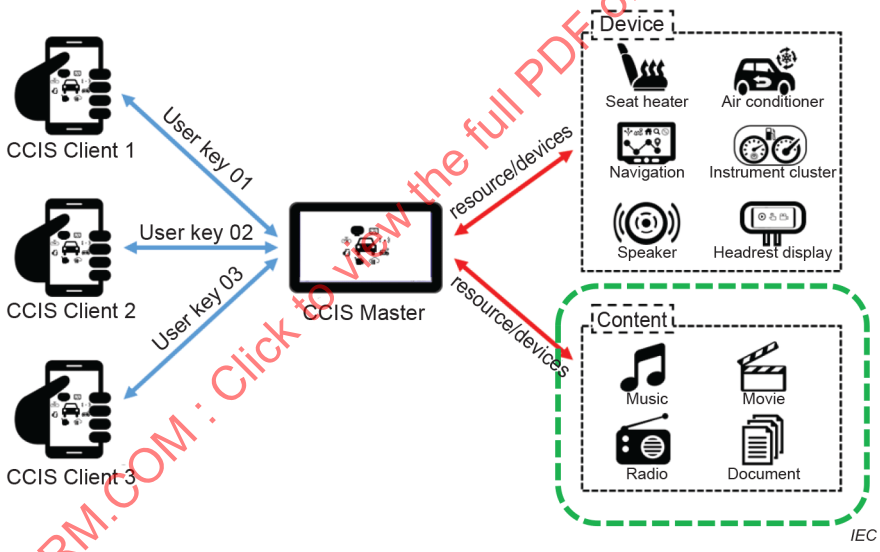


Figure 9 – CCIS

Furthermore, many CPS services for cars are on the way. For example:

– HUD+AR will be popular soon;
– digital signage service is launched but still a limited market;
– surround view monitor will be more popular, it adds more valuable services;
– drive monitor with CPS application will start existing.

5.5 Cable and network video system

STB has been the key terminal device of cable and network video systems. The next generation STB functionality will be implemented in the provider's server as a virtual STB functionality by SaaS, PaaS and IaaS. Figure 10 shows this change.

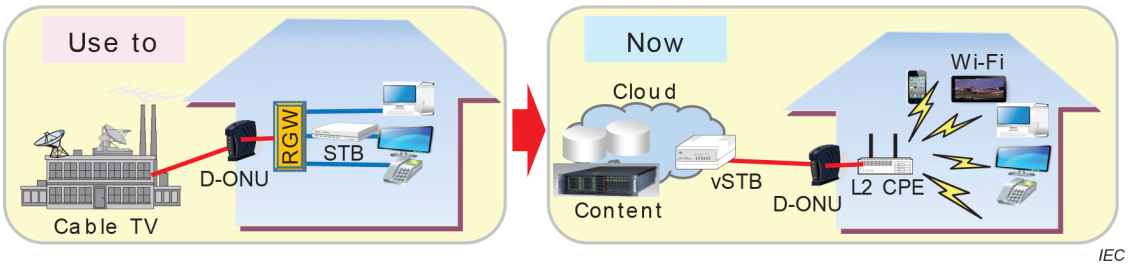


Figure 10 – Virtual STB

Virtual STB provides the following services to replace the conventional services, Figure 11 shows this change.

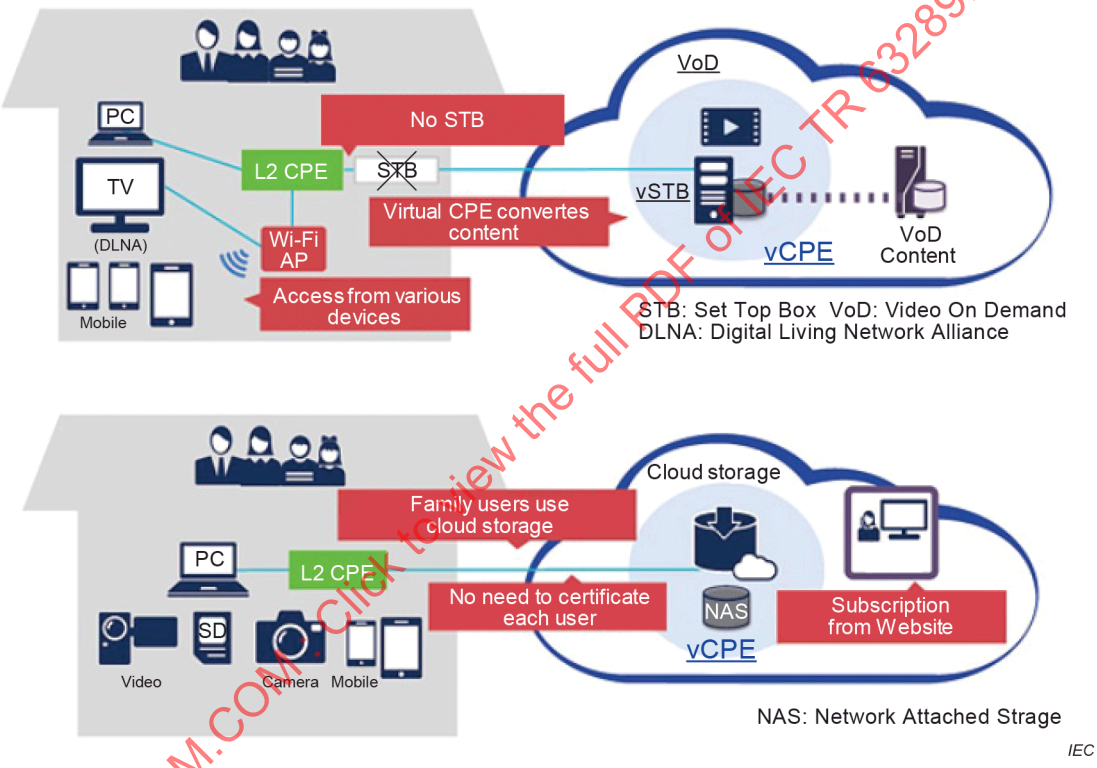


Figure 11 – Virtual CPE and cloud storage

6 Cases of other services

6.1 General

Some other services in cloud applications, big data applications and Internet data services other than audio/video service are studied to investigate the standardization area of multimedia cyber technology within the scope of TC100.

6.2 Service with distributed system

The cloud can exist anywhere and can compose a distributed system. The user's physical and cyber location can be obtained from IoT with IPv6, wireless LAN base station and GNSS. From these, a service depending on user's location and distributed cloud can be provided.

An example of a smartphone application provides various CPS services with location based as shown in Figure 12. Smartphone application with GNSS detects user location. Content provider can provide content to the user's smartphone, then content arrangement service provider gets user information such as location and any other information from network and the user's preference, etc. The content arrangement service provider may use other user's preferences on the same location from its big data information. The content arrangement service provider chooses contents that the user probably likes or suitable for the user using AI technology. The recommended content is shown or pushed to the user's smartphone.

There are many types of smartphone applications, content arrangement services, and content providers. To get information of what device is connected and any other information about user's device and user behaviour, a unified management method is desired. For that, there are several necessary elements:

- Content semantics analysis and data structure

  To understand the user's content, some analysis is required; it is also preferable for data structure to be standardized.

- Metadata

  To indicate content attribution, common metadata is required to identify content type, codec type, permission code, etc.

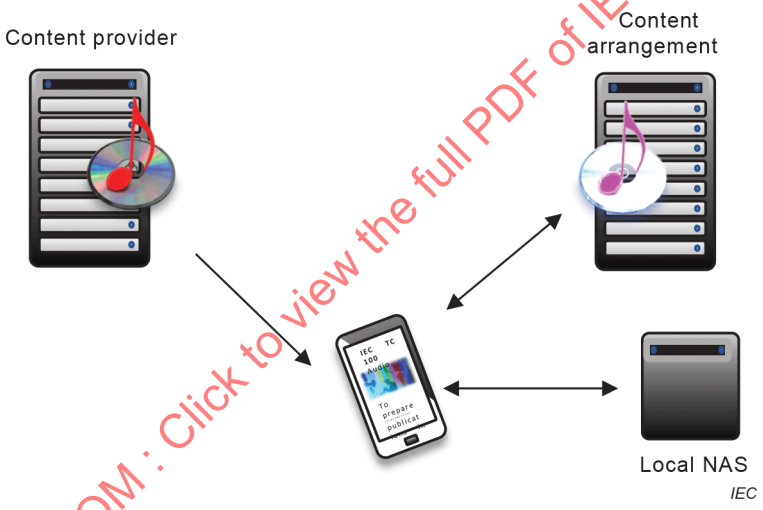


Figure 12 – An example of distribution system with IoT

6.3 AI assisted Information services

Voice input – voice output or functional action is becoming popular. Two services are shown in Figure 13 as examples. This requires hardware comprising a microphone-earphone (or loudspeaker) and smartphone or its like devices. For example, the user asks the weather at some place, the user's voice is sent to a service server through an application on the smartphone. Then the service server analyses user requests then sends the answer to the user. A kind of knowledge database is used to provide this service. To make and utilize the knowledge database, content/data recognition or categorization are important technologies. Categorizing, searching and recognizing are improved with AI technology. These applications are suitable for wearable smart devices, it is so-called concierge service or personal assistance.

Figure 13 – Examples of AI assisted information services

Another example of an AI assisted information service is travel or event route guidance depending on where the event venue is based, personal preferences or overall trends collected from visitor's devices automatically at the event. To recognize a trend, a lot of personal information is handled as big data that is analysed with AI technologies to get better results. Big data processing with AI is an important technology to provide improved CPS service.

AI assisted information service and control with audio (voice and talk) is popular now; AI will be incorporated into CPS in any aspects. To provide better services, AI technology is required; example of services are processing data for services such as recommended music selection, arrangement of user's audio visual content, or analysis of user's behaviour for better user experience.

6.4 AI speaker

AI speakers that are powered loudspeakers with AI are provided by several companies. The AI speaker also provides AI-assisted information services such as a concierge service. The AI speaker also can control functionality of networked home devices, such as an AV receiver, a TV and room lights; these are controlled by the user's voice. In this service, speech recognition is one of the key technologies.

AI speakers are also used for listening to music. An AI speaker can work with other speakers in the same room as a multi-channel audio speaker. In this work, an AI speaker may make speaker configuration for the room by itself or by communication with other control systems. When the user listens to music and moves to another room, the AI speaker itself or other sensor detects user movements and activates other speakers so that the user listens to the music continuously.

6.5 AR/VR/MR/SR and XR

6.5.1 General

Augmented reality, virtual reality, mixed reality, substitutional reality, and X (summarize all) reality are technologies to provide user-immersive experiences and extended human senses and ability. Various input/output methods are used such as hand gesture, eye/head-move tracking, haptics, etc.

6.5.2 Consumer usage

XR technologies are used for consumer usage like video games; especially AR and VR can be used for that. A variety of VR headsets have been introduced in the market, that headset also has a capability to provide 3D audio. That VR headset will provide, for example, a visual avatar with 3D audio as an entity in a virtual world as shown in Figure 14.

Figure 14 – An example of VR for consumer usage

There are many kinds of devices that affect human's senses such as head-mount displays, multi-channel speakers/headphones, force feedback joysticks, haptics devices, olfactory devices, etc. Each device may support different formats of information such as display resolution, refresh rate, number of speakers, video codec, audio codec, computer graphics platform, etc. Therefore, required capability of each interface and data format are different with each device. The management method for such deferent devices and systems is important to keep a good interoperability.

6.5.3 Industrial usage

XR technology is widely noticed not only for consumer usage like video game software, but also for industry. XR works in combination with hardware, software, and network as a system, that helps people to do correct operations or to get appropriate real-time instructions.

The requirements may be different with those of consumer usage. Figure 15 shows an example: a worker fixes broken points of pipeline and that worker is instructed by overlaying digital information on a view of the real world. When the worker looks around for the broken point of pipeline, the view of the real world is slightly moved. If overlaid digital information is not re-rendered with enough speed, the digital information is overlaid on a wrong position of the view of the real world.

Figure 15 – An example of AR for industrial usage

Performance of devices and systems that must be met is a critical element for industrial usage. A measurement method for devices and systems is also required to recognize whether a device or system fits the required performance or not. Figure 16 shows the XR system model. This system model shows the items of TC 100 as applications and hardware, as shown in Figure 4.

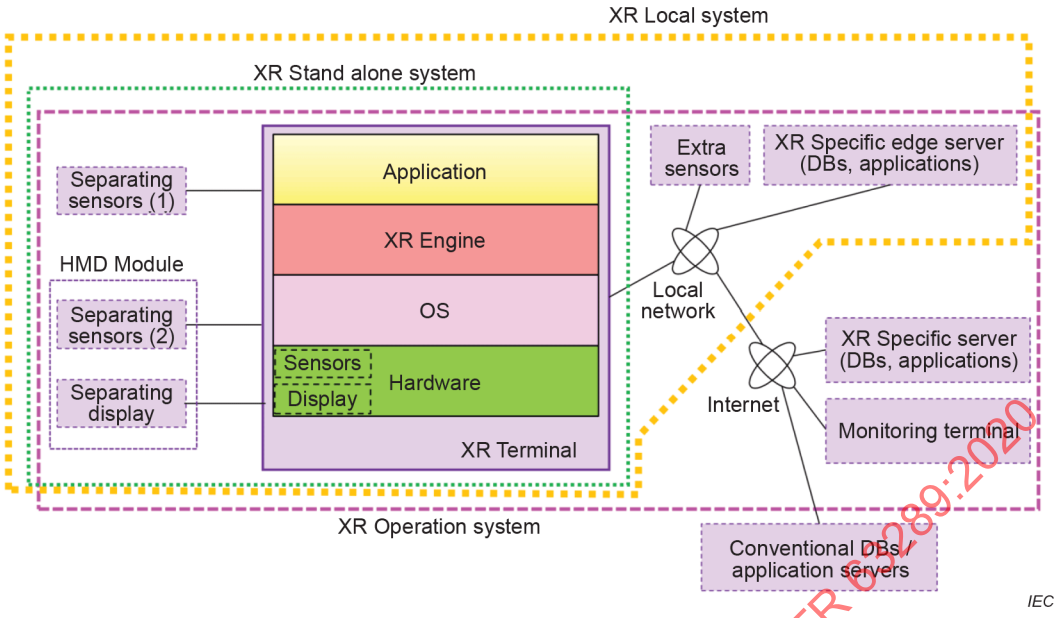


Figure 16 – XR system model

6.5.4 VR/AR/MR/SR and XR contents distribution platform

Each VR/AR/MR/SR and XR manufacturer offers its own content distribution system. For instance, XR applications with 3D video content are dependent on the XR visual device as its resolution of display device, optic system (e.g., image distortion needs to be corrected), FOV (or AOV) and supported OS and software platform. To apply each content to all kind of XR systems, a common platform for content distribution can be defined. Figure 17 shows its outline.

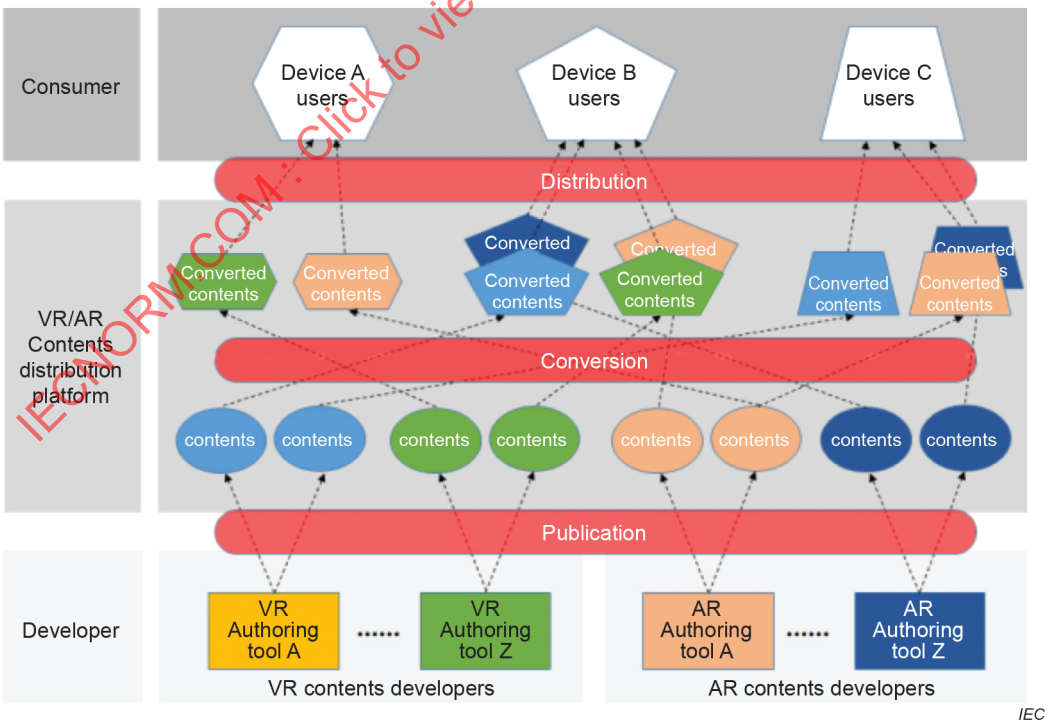


Figure 17 – Contents distribution platform

In this model, an area between conversion and publication is an item of TC 100. This system presents the independence of hardware specifications of VR/AR/MR/SR and XR systems.

6.6 Connected car

IEC TR 63038:2016, *Conceptual model of standardization for multimedia car systems and equipment*, describes a connected car within the scope of TC 100.

As it is described, many sensors such as cameras, acceleration sensors, GPSs are attached to a car. Users also can add a sensor, such as a camera and various devices, after buying the car. To integrate all of them and obtain interoperability, standardization of common interface, control scheme and other is needed. When the user adds a drive recording camera device after buying the car, the data from that camera can be valuable information for driving; to use this information, standardization is required. If all data and information can be integrated, that information can be used in the cyber domain and make a new valuable service for the user.

When cars are connected to a network, a lot of information from sensors is collected as big data and analysed in the cloud with AI technology. This can make new CPS services. For example, information such as expected traffic flow on the road map is provided based on the big data analysis with AI technology.

For autonomous car driving, a car can also communicate with nearby cars without going through central servers. For example, an autonomous car obtains information on objects sensed by sensors of other cars, recognizes objects at the blind spot, such as the oncoming vehicle, pedestrians and obstacles. More sophisticated sensors (camera, radar, etc.) are used to recognize objects, road conditions, etc.

A dynamic map is another CPS service for connected cars. The dynamic map consists of a static high-precision three-dimensional map and dynamic information, such as traffic regulations, road construction, accidents and congestion. Various information, such as the centre line of the roadway, the pedestrian crossing, the stop line, the traffic sign, the signboard is stored in the high-precision three-dimensional map of the dynamic map; connected cars sense all information around the car and information from the cloud to update that information of the dynamic map.

6.7 AAL

AAL (Active Assisted Living) aims to improve the quality of life with technologies. Some users may have difficulties in hearing, listening, viewing, and sensing because of their age, nature, or some other reasons. AAL devices or the system complement the weakness of the users who have some difficulties. Standards for physical devices have been developed, but standards for CPS are needed to assist users to obtain good information.

Assistance services for information, such as AAL, are provided with CPS technology. There are three kinds of information assistance for AAL as follows:

– Audio information assistance area:

  Audio information assistance helps the person hear. In TC 100 activity, IEC 63087 (all parts)[1], will specify requirements for the assistive listening in audio and equipment.

– Visual information assistance area:

  Visual information assistance helps a person recognize video or subtitles. In TC 100's activity, the speaking of teletext is specified. Eyewear devices are expected with AR/VR/MR/SR and XR technology to assist visual information directly.

– Cognitive assistance area:

  Cognitive assistance helps persons understand what is going on around them. To recognize what happens around them, mobile or wearable devices with many sensors are usually used. Cognitive assistance provides new opportunities for social participation to people with disabilities and the elderly.

[1] Under consideration.

Various types of devices are used to handle audio, video, and multimedia data. These devices provide help to users after signal processing sensed data by the device. Assistance by analysis of big data is especially important to help people's judgment for cognitive assistance.

6.8 Personal wellness care

There are many types of activity trackers on the market. Most of them are wearable devices like a wristband. Some of them work with smartphone applications to provide a more intelligent service. For example, a service provider gathers personal activity data, such as walking distance, from a user's wearable device automatically, the service provider analyses the data and gives a recommendation of exercise, foods and body care to the user. The service provider can provide more helpful information, such as generation and regionality, by analysing a lot of personal activity data such as big data.

7 Environmental aspect

CPS shifts any physical properties to the cyber domain; this also means e-waste can be reduced and the electric power used for device and equipment is reduced.

The content in CDs, DVDs, BDs, or tapes, and HDDs can be in the cyber domain. That reduces the amount of physical memory devices. Audio/video players, receivers or processing functions are executed in the cyber domain, which reduces physical equipment. Figure 18 shows this situation.

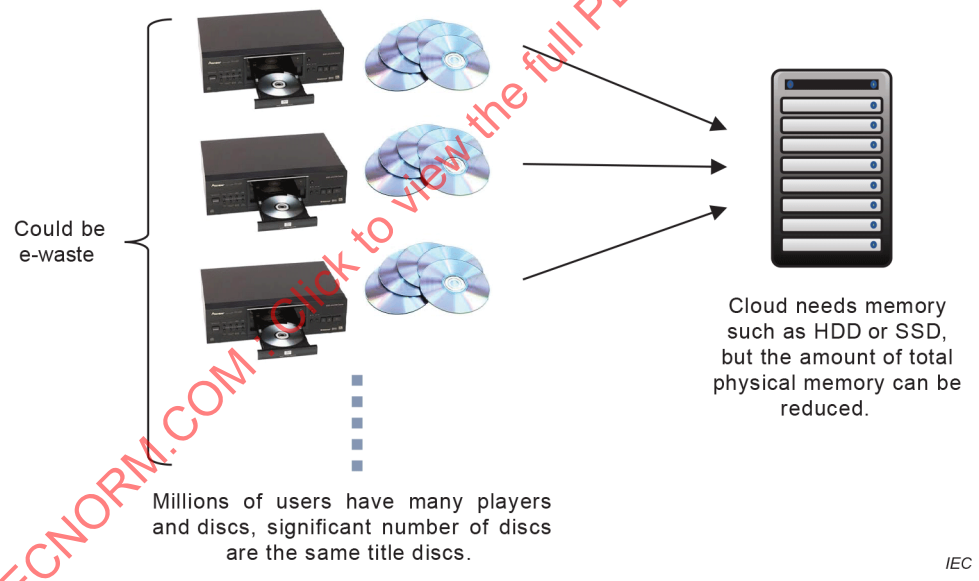


Figure 18 – Reducing e-waste

8 Safety aspects

There are many reports of hacking IoT devices, such as web cameras and network routers. Robustness is important for each element. And firmware update mechanisms are also important to protect against the threat increases.

In addition to that, there is a unique safety requirement for IoTs. A lot of devices are connected in CPS. They will be autonomous and work by interacting with each other. If a device influences the other, the system will not work properly, and it may cause harm to users. For example, if a remote user tries to turn the volume up on an audio player, the sound may be too high for the listener at the site. If a user requests to turn a TV having a capability of motored turning, the TV might hit another person or an object.