INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2022-2024

SG20-TD665-R1

STUDY GROUP 20

Original: English

Question(s): 1/20 Geneva, 30 January-10 February 2023

TD

Source: Editors

Title: Output text of draft Technical Report ITU-T YSTR.ACC-SCC "Guidelines on developing ICT services for accessible smart cities", Q1/20 meeting (Geneva, 30 January - 10 February 2023)

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Abstract: This TD contains an updated draft new Technical Report ITU-T YSTR.ACC-SCC "Guidelines on developing ICT services for accessible smart cities," output of Q1/20 meeting, Geneva, 30 January - 10 February 2023.

This is the updated version of the draft new Technical Report ITU-T YSTR.ACC-SCC "Guidelines on developing ICT services for accessible smart cities."

It is generated based on SG20-TD291 output of the Q1/20 meeting, Geneva, 18-28 July 2022, and the meeting agreements on the following contribution:

No.	Source	Title	Proposal	Discussion and results
C144	Korea (Republic of)	YSTR.ACC-SCC "Guidelines on developing ICT services for accessible smart cities", the proposed modification of Section 7	Add new text on the Section 7	It was agreed with some minor adjustments including: 1. Some changes to wordings (including key terms used) in Section 7 reflecting comments from the meeting, 2. Adding some editor's notes for further consideration.

Draft new Technical Report ITU-T YSTR.ACC-SCC

Guidelines on developing ICT services for accessible smart cities

Summary

Smart city services can have a ripple effect beyond improving physical accessibility for persons with disabilities, those with age-related disabilities and those with specific needs. Persons with disabilities can benefit from more efficient and sophisticated city services through smart city services. Thus, it is an important opportunity to improve the quality of life using city functions equivalent to those without disabilities. However, as seen in many other use cases of ICTs, without consideration for persons with disabilities from the design stage, it is bound to be another barrier for persons with disabilities.

Using a two-layer structure of accessibility consideration principles, this Technical Report provides development guidelines to be considered at each layer to implement accessible smart city services. Also, exemplar accessible smart city services are illustrated in the appendix.

[TBD]

Keywords

Accessibility, accessible smart cities, persons with age-related disabilities, persons with disabilities, persons with specific needs, *[TBA]*.

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Technical Report ITU-T YSTR.ACC-SCC

Guidelines on developing accessible ICT services for smart cities

1 Scope

This Technical Report describes guidelines for developing accessible ICT services for smart cities for everyone, including but not limited to persons with disabilities, persons with age-related disabilities, and those with specific needs. It introduces a two-layer structure of accessibility consideration principles and provides development guidelines to be considered at each layer to implement accessible smart city services.

2 References

Editor's Note: need to check before proposing an agreement to ensure no duplication between the References section and the Bibliography section and proper placement of references.

[ITU-T F.790] Recommendation ITU-F.790 (2007), *Telecommunications accessibility guidelines for older persons and persons with disabilities*.

[ITU-T F.791] Recommendation ITU-T F.791 (2018), *Accessibility terms and definitions*.

[ITU-T Y.4204] Recommendation ITU-T Y.4204 (2019), *Accessibility requirements for Internet of things applications and services.*

[ITU-T Y.4211] Recommendation ITU-T Y.4211 (2020), *Accessibility requirements for smart public transport services.*

[TBA]

3 Definitions

3.1 Terms defined elsewhere

Editor's Note: need to revisit before proposing an agreement to ensure valid terms are defined correctly. Initially, some usual accessibility-related terms were listed without relating them to the text. Also, need to check Section 4, Abbreviations and acronyms.

This Technical Report uses the following terms defined elsewhere:

3.1.1 accessibility [b-ITU-T F.791]: The degree to which a product, device, service or environment (virtual or real) is available to as many people as possible.

3.1.2 accessibility feature [b-ITU-T F.791]: An additional content component that is intended to assist people hindered in their ability to perceive an aspect of the main content.

3.1.3 assistive technology [b-ITU-T F.791]: Piece of equipment, product system, hardware, software or service that is used to enable, maintain or improve functional capabilities of individuals with disabilities.

3.1.4 Internet of things (IoT) [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.5 person with age-related disabilities [b-ITU-T F.791]: A person with cognitive or physical disabilities caused by the aging process. Examples are impaired eyesight, deafness in varying degrees, reduced mobility or cognitive abilities.

3.1.6 person with specific needs [b-ITU-T F.791]: Includes persons with disabilities (PWDs), persons who are not literate, those with learning disabilities, children, indigenous people, older persons with age-related disabilities, and anyone who has a temporary disability.

3.1.7 platform accessibility feature [b-ITU-T F.791]: Accessibility functionality provided as standard on a particular hardware or software platform.

3.1.8 profile setting [b-ITU-T F.791]: The ability for users to store and retrieve multiple profiles containing sets of user interface preference settings without having to reset them each time, including accessibility settings.

3.1.9 screen reader software [b-ITU-T F.791]: Software application used by a person who is blind or cannot easily read print to identify and interpret what is shown on a video display and read aloud using speech synthesis.

3.1.10 sign language [ITU-T F.930]: A natural language that, instead of relying on acoustically conveyed sound patterns, uses signs made by moving the hands combined with facial expressions and postures of the body to convey meaning. It is also called signed language or simply visual signing.

3.1.11 sign language interpretation [ITU-T F.791]: Synchronized showing of an interpreter who uses sign language to convey the main audio content and dialogue to people who use sign language.

3.1.12 specific needs [b-ITU-T F.791]: This replaces the use of the term 'special needs'. This term refers to a wide range of categories including women, children, youth, indigenous people, older persons with age-related disabilities, persons with illiteracy, as well as persons with disabilities (PWDs), see [b-ITU PP Res.175], [b-WTDC Res.58], and [b-WTDC AP] and clause 6.39 (of [b-ITU-T F.791]).

3.1.13 universal design [b-ITU-T Y.4211]: The design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.

NOTE – Paraphrased from [b-UNCRPD].

[TBA]

3.2 Terms defined in this Technical Report

None

[TBD]

4 Abbreviations and acronyms

This Technical Report uses the following abbreviations and acronyms:

AT	Assistive Technology
ICT	Information and Communication Technology
IoT	Internet of Things
PWD	Persons with Disabilities

[TBA]

5 Background

Smart cities can provide various services to residents by converging information and communication technology (ICT) into the city's infrastructure. Smart cities use ICT, including the Internet of Things (IoT), to build various smart city infrastructures.

Smart cities have services that directly help individuals' daily lives and background services that increase efficiency by improving city functions. Smart city services, both directly and indirectly, provide residents with benefits in various fields, such as health and well-being, quality of life, housing, civic engagement, and emergency services.

In particular, it can have a ripple effect beyond improving physical accessibility for persons with disabilities, those with age-related disabilities and those with specific needs. Persons with disabilities can benefit from more efficient and sophisticated city services through smart city services. Thus, it is an important opportunity to improve the quality of life using city functions equivalent to those without disabilities. However, as seen in many other use cases of ICTs, without consideration for persons with disabilities from the design stage, it is bound to be another barrier for persons with disabilities.

6 A two-layer structure of accessibility consideration principles

Accessible smart cities can be understood in multiple dimensions. The most fundamental part is to ensure that all citizens, including persons with disabilities, can use the same level of service without discrimination because of physical and cognitive disabilities with others. This starts with lowering the barriers to smart city services by securing accessibility to ICTs that serves as a user interface. Furthermore, accessibility can be increased by integrating smart city services with assistive devices (e.g., screen readers, hearing aids, braille keyboards, etc.) for persons with disabilities. As identified in Recommendation ITU-T Y.4211 [ITU-T Y.4211] in the context of smart public transport services, the smart city services may be used to create access tools for persons with many types of disabilities and specific needs, including physical, visual, hearing and cognitive disabilities.

Additionally, smart city services play an essential role in increasing the accessibility of city services to persons with disabilities. It means smart city services themselves can function as an assistive means of city services. The accessibility of city services that could not be solved by existing physical city infrastructure alone can be provided through smart city services. For example, remote sign language interpretation services can be integrated into public services. In addition, using Metaverse technology, citizens with visual or physical disabilities can experience educational or administrative services regardless of disabilities in a virtual environment. Smart cities may also provide more advanced services to users with specific needs. For example, smart grid technology can track the stable power supply of a hospital or an individual's life support device that is directly connected to a citizen’s life. Further, it is also possible to provide a safe path for persons with visual disabilities using a location service.

Each mentioned dimension can be mapped into an interface layer and an information layer, as shown in Figure 1. The accessibility principles can be more clearly distinguished using these two layers of structure. In particular, the information and services provided in accessible smart city services must satisfy the needs of all users at an equal level. Therefore, first, accessible smart city services must satisfy accessibility in providing information or services to users. Second, they must be customised so that the information provided can meet users' specific needs. By dividing them into interface and information layers, clearer accessibility considerations for each level can be determined.

Figure 1 a two-layer structure of accessibility consideration principles

The interface layer focuses on ensuring appropriate accessibility of user interfaces so that smart city services can be used independently of visual, auditory, physical, and cognitive disabilities, as well as user's specific needs. The IoT-based smart city service communicates with users using various user interfaces such as users' smart devices, wearable devices, kiosks, and embedded panels. In addition, smart city services should appropriately reflect multiple user needs, such as accessibility assistance devices.

The information layer is related to constructing a service system so that users with specific needs can appropriately address their needs using urban services. This can be implemented through a proper design that reflects factors concerning the user's environment and specific needs.

The following sections provide development guidelines to be considered at each layer to implement accessible smart city services.

7 Interface layer: accessible smart city services as an interface to city services

This section examines the accessibility principles that smart city interfaces must have for users with disabilities to use the service.

The most representative user interface as a way for people, including those with disabilities to use smart city services is maybe a smartphone. When incorporated with mobile data networks, various services may be provided through smart cities using a smartphone. However, users can also use smart city services using other devices such as wearable devices, a tablet PC, and an infotainment system connected to the car. In addition, smart city services may interface with users through various IoT devices. Some of these devices may be dedicated to smart city services, but some devices may include smart city services in their own services to create added value.

Utilizing these diverse interfaces may be challenging for developers as it requires huge implementation work. Still, it could be an opportunity and, at the same time, a challenge for persons with disabilities who have various specific needs. On the one hand, it is suggested to provide appropriate alternatives when persons with disabilities face difficulties in using common interfaces, and IoT-based smart city services with various interfaces could make it easier to use other appropriate alternative interfaces.

On the other hand, there is a problem in that all accessibility requirements (e.g., as in [ITU-T Y.4204]) for all interfaces must be met in an environment where various interfaces are provided. It should not be assumed that there is no need to adhere to the principle of device accessibility just because there is an alternative means for a particular user with specific needs. All devices should not discriminate against users as much as possible and should ensure maximum accessibility as technically possible. When sufficient accessibility is guaranteed, the smart city service will be a helpful service for persons with disabilities.

In this report, we first look at the basic accessibility principles that all user interfaces participating in smart city services should have, regardless of the interface's nature. And then, we also discuss accessibility principles for the two different types of devices.

Various types of devices are participating in smart city services, ranging from personal devices for an individual to public devices for all citizens. If these devices participate in smart cities, there are accessibility principles that must be common to secure accessibility. We consider these general accessibility principles. However, we note that the direction of accessibility principles that each device should pursue may differ depending on whom the device is subordinated. We want to examine the accessibility principles required in each case by dividing the cases of using personal devices and that of using public facilities according to the method of using smart city services. Figure 2 shows the composition of the accessibility principle according to the characteristics of such devices.

Figure 2 Composition of the accessibility principle for smart city services

7.1 General accessibility principles

Editor's note – to replace Y.ACC-UI-req with the proper code number once it has consented.

Before discussing the general accessibility principle, we would like to mention that the general accessibility standards that devices should basically comply with are not covered here. General accessibility standards for the characteristics of each device are addressed in the individual platform accessibility standards. For web-based environments, WCAG standards for W3C can be referenced [b-W3C WCAG 2.2], and for smartphone user interfaces in IoT environments, [b-ITU-T Y.ACC-UI-req] is available. Some other relevant standards for other types of devices may be helpful. Even if no standards exist for a particular device, the two aforementioned standards may be helpful.

This document introduces the accessibility principles to be considered in configuring smart city services, even if they comply with the general accessibility standards that devices should have.

1) The interface of smart city services should be provided to understand the use of the included functions intuitively.

It may sound natural, but it should be noted that the intuition of persons with disabilities may differ from that of those without disabilities. Intuition sometimes depends on human senses such as sight or hearing. Users with visual or hearing disabilities may differ from the intuition of those without disabilities. For example, those without visual disabilities commonly perceive red as a colour that marks a stop, warning, or danger, but colour-blind users may be unable to distinguish red. Likewise, a person with developmental disabilities or a foreigner from another culture are people with different intuitions. To solve this problem, it is necessary to comply with international norms that are not subordinate to culture and use various methods simultaneously.

2) The interface of smart city services must be developed considering as many types of disabilities and environments as possible and considering future scalability.

Accessibility technologies also develop with technological advances. In particular, various auxiliary devices are emerging that can assist or improve the inconvenience of persons with disabilities through the development of artificial intelligence technology and various new emerging technologies. Because smart city services usually aim for a very long lifecycle, they should be designed to accommodate not only the current level of technology but also various accessibility-related technologies to be introduced in the future.

3) When implementing existing accessibility features, it is necessary to ensure maximum compliance with the relevant accessibility standards and to standardise as soon as possible when introducing new accessibility features.

Persons with disabilities and those with age-related disabilities need more time to acquire and understand new skills. When technologies with similar functions operate differently, complexity increases, and the learning cycle becomes longer. As smart city services are generally provided by integrating various unit services, it is very important to simplify them by standardising accessibility features.

4) The interface of smart city services should be designed and developed from the user's point of view.

This principle needs to be understood in two respects. First, development through evaluation of developer-centred validity and development difficulty should be avoided. There is no guarantee that convenient use from the developer's point of view is necessarily convenient from the point of view of users with disabilities. It may not be convenient for all users just because they make it easy and simple. Through understanding the characteristics of the disability, it is necessary to determine what parts the user finds difficult and what functions are helpful.

Second, for this, it is necessary to understand the disability. Many developers easily fall into the error of jumping to conclusions about what persons with disabilities can and cannot do. Surprisingly, many persons with visual disabilities can freely use various functions of their smartphones. Also, many older people with age-related disabilities use smartphones as much as young people.

However, it is necessary to consider various user environments because not all persons with visual disabilities or those with age-related disabilities necessarily use all functions easily.

5) Environmental factors of users should also be considered

At first glance, considering the user's environment may seem to be an issue unrelated to accessibility, but disability is not something that causes difficulty for a person. Factors that hinder persons with disabilities from living equally with those without disabilities are often caused by environments created around persons without disabilities. Voice-oriented contents, public posts that rely entirely on sight and pedestrian paths that do not consider wheelchair movement are typical examples of urban environments centred around persons without disabilities.

In addition, even if it is an environment that is not too much for many users, it may be a barrier for some users. For example, although smart city services utilising smartphones could increase accessibility for many persons with disabilities and those with age-related disabilities, some users who use smart city services over smartphones in a mobile network environment may face the challenges of high data usage costs, slow speed, and insufficient network coverage. To minimise the risk of providing non-affordable services, care should be taken to ensure the service can function without high burdens to users, as many persons with disabilities are often in economic difficulties.

Editor's note – To elaborate more on discussions related to the economic difficulties of persons with disabilities.

7.2 Accessibility principles on the use of personal devices

Personal devices may include smartphones, tablets, wearables, and home IoT devices. Here, the personal device includes home devices shared with a family. This includes cases where users can use the device exclusively at the moment of use, even if they are not necessarily family members, and assistive technologies may be connected and used.

The characteristic of a personal device is that the user can change the accessibility features of the device to suit his or her accessibility needs. Setting these devices to meet the user's specific needs is important. It is also important that the connection with the assistive technologies used by the user, such as hearing aids and braille displays, works smoothly.

The accessibility principles of smart city services using this type of device are as follows.

1) Smart city services should support various devices that correspond to various accessibility needs of users.

Services that support various devices are a matter of choice for persons without disabilities, but for persons with disabilities, there are devices that better meet their specific needs. Persons with visual disabilities may prefer smart speakers that provide information by voice and control devices through voice conversations. Persons with hearing difficulties may prefer a choice of connecting to voice-based information using t-coil or Bluetooth technologies, both commonly used in hearing aids and other hearing technologies. Persons with physical disabilities may want to use computers, smartphones, or tablets that can connect their specific assistive technologies. Of course, it is important to provide accessibility features in all devices with as much enhancement as possible. Still, it should be considered that various devices can be complementary alternatives to each other in terms of accessibility.

Editor's note – To elaborate more on t-coil, for those who are not familiar.

2) The interface of smart city services must provide a feature to customise to meet users' specific needs.

Providing accessibility functions to meet the user's specific needs is a common requirement in general information and communication devices. Smart city services should be able to be used well even if the user's location changes, regardless of whether the user is at home, at work, or on the move. As mentioned in the previous section, the user's accessibility needs may change according to changes in the environment.

In addition, various user devices such as smartphones, smartwatches, and tablets can be connected to use the service by moving the work done on one side to another device. It is also necessary for a user using multiple devices to control the accessibility function of all devices in a single setting.

3) Smart city services must be compatible with users' assistive technologies.

Many general-purpose information and communication devices, including smartphones, provide accessibility functions for persons with disabilities and support the connection of assistive technologies. However, many of these functions depend on the services provided. Ultimately, when designing and developing smart city services, they should be provided considering the use of these functions.

It is necessary to increase the accessibility of users with disabilities by making the most of these assistive technologies when developing smart city services.

Editor's Note: Contributions concerning an additional accessibility principle reflecting the following comments are requested (these comments were raised during the editor's discussion). Need to develop further on these comments. Also need to collect and add similar cases for technologies that persons with visual, physical, and developmental disabilities use, if possible.

"Many people with disabilities prefer older technologies that operate reliably, albeit somewhat less technologically advanced, to newer, not fully stable, and under-developing technologies. New technologies are encouraged, but existing technologies must be maintained for greater scalability.

For example, persons with hearing disabilities who use hearing aids prefer hearing loop technology, which is built into most hearing aids by default, to Bluetooth connections. It was developed long ago, but it is still a widely used technology. Of course, hearing loop technology is not a complete technology. Since it is an analogue connection, the audio quality is large depending on the distance between the hearing loop and the recipient's hearing aids. The sound quality of the hearing loop technology is not as good as that of digital voice transmission technology and is vulnerable to noise. However, although the hearing loop technology has been around for quite a few years, it is installed in most hearing aids and operates stably. Bluetooth connectivity may provide better sound quality than hearing loop technology. Still, many problems must be solved regarding high-power consumption, unstable connection, and one-to-many connection response. In addition, there are barriers to entry for users who have difficulty learning and using new technologies."

7.3 Accessibility principles on the use of public devices

Public devices refer to devices used by multiple people or used by the public at the same time. Such devices may include kiosks and digital signage.

A feature of these devices is that the user cannot change the device's settings to accommodate his or her specific needs. Therefore, it is necessary to incorporate appropriate functions so that more users with specific needs do not feel uncomfortable using such devices.

The accessibility principles necessary to provide smart city services through these devices are as follows.

1) It is necessary to develop a service applied with a universal design to accommodate various specific needs.

Various efforts are needed, such as taking appropriate alternative measures for persons with visual and hearing disabilities or providing sufficient time to understand information for users with cognitive disabilities. See [b-ISO/IEC TR 29138-1] for a list of user needs required to accommodate various specific needs in the information system. In addition, for information system requirements for persons with visual disabilities, see [b-ITU-T F.922].

2) Smart city services must ensure that the needs of as many users as possible are reflected and provide appropriate alternatives.

If possible, it is necessary to provide a function for accessing the information through a personal device or to provide a method for using a user's assistive technologies. For example, the use of the

hearing loop technology that utilizes FM frequencies is of great help when persons with hearing disabilities using hearing aids are exposed to noisy environments.

Not all public devices can incorporate alternative technology. However, by utilizing smartphones that provide IoT technology and location-based functions, it is possible to provide a method of using auxiliary technology through personal devices as an alternative to information services of public devices.

3) Physical accessibility should be considered together with smart city service accessibility.

Public devices should consider accessibility from not only the perspective of information and communication but also physical accessibility. For example, when installing kiosks that require user interaction, appropriate heights should be ensured so that wheelchair users do not feel uncomfortable using them.

8 Information layer: accessible smart city services as a tool for users with specific needs

Editor's Note: This section provides guidelines for implementing accessible smart city services. Since a user's specific needs may vary, designing a service considering the user's environment, disabilities, and functions in developing a smart city service rather than providing guidelines by classifying specific types of user needs will be described.

[TBD]

Appendix I

Exemplar accessible smart city services

Editor's Note – This appendix will illustrate exemplar accessible smart city services based on this guideline.

Editor's Note – To facilitate the discussion, contributions to the appendix prior to the main body are recommended.

[TBA]

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[TBA]