International Telecommunication Union

ITU-T
TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.4206
(06/2019)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet of things and smart cities and communities – Requirements and use cases

Requirements and capabilities of user-centric work space service

Recommendation ITU-T Y.4206

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	Y.2000–Y.2099
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	**Y.4100–Y.4249**
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899
Evaluation and assessment	Y.4900–Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.4206

Requirements and capabilities of user-centric work space service

Summary

Recommendation ITU-T Y.4206 provides the requirements and capabilities of the user-centric work space (UCS) service, based on the use cases of the UCS service addressed by ITU-T Y.Suppl.42. A UCS service is one that is capable of providing a personalized work space to its service users by orchestrating local and/or remote ICT resources as addressed in ITU-T Y.Suppl.42.

The provided requirements and capabilities are necessary to implement various types of UCS services.

History

Edition	Recommendation	Approval	Study Group	Unique ID[*]
1.0	ITU-T Y.4206	2019-06-13	20	11.1002/1000/13919

---

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

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Y.4206

Requirements and capabilities of user-centric work space service

1 Scope

This Recommendation identifies requirements and capabilities of the user-centric work space (UCS) service. A UCS service is one that is capable of providing a personalized work space to its service users by orchestrating local and/or remote ICT resources as described in [b-ITU-T Y.Suppl.42].

In particular, this Recommendation addresses:

– requirements of the UCS service;

– capability framework of the UCS service; and

– essential workflows of the UCS service.

2 References

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

[ITU-T Y.4000]   Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things*.

[ITU-T Y.4100]   Recommendation ITU-T Y.4100/Y.2066 (2014), *Common requirements of the Internet of things*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.2 gateway [b-ITU-T Y.4101]: A unit in the Internet of things which interconnects the devices with the communication networks. It performs the necessary translation between the protocols used in the communication networks and those used by devices.

3.1.3 thing [ITU-T Y.4000]: With regard to the Internet of things, this is an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks.

3.1.4 UCS service [b-ITU-T Y.Suppl.42]: A service providing UCS to service users.

3.1.5 user-centric work space (UCS) [b-ITU-T Y.Suppl.42]: A personalized work environment configured by orchestrating local and/or remote ICT resources.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 device resource: ICT resource associated with a device.

3.2.2 user-centric work space device agent (UCS DA): The device-side component of the UCS system, which manages one or more device resources.

3.2.3 user-centric work space manager (UCS manager): The component of the UCS system mediating between UCS UA and UCS DA.

3.2.4 user-centric work space system (UCS system): The set of UCS components necessary to realize a UCS service.

3.2.5 user-centric work space user agent (UCS UA): The user-side component of the UCS system, which enables a user to configure their own UCS.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DA   Device Agent

FE   Functional Entity

ICT   Information and Communication Technology

IoT   Internet of things

UA   User Agent

UCS   User-Centric work Space

5 Conventions

In this Recommendation:

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

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

The keywords "**can optionally**" and "**may**" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Overview

The user-centric work space (UCS) is a personal work environment configured by orchestrating one or more device resources provided by devices. A device may have one or more device resources; device resources are equivalent to functions provided by a device, for example, a multifunction printer represents scanning, printing and copying functions.

With one or more device resources, regardless of their physical location, a UCS is configured by orchestrating them. As an example of a UCS configuration, a UCS service user borrows both keyboard and display functions from available nearby office devices and then associates them with a smart device to have an experience similar to that of a desktop personal computer (PC).

NOTE 1 – Examples of smart devices include smart phones and smart tablets.

Figure 1 depicts the concept of a UCS, which can be used as a personalized work environment [b-ITU-T Y.Suppl.42]. In terms of the Internet of things (IoT) reference model [ITU-T Y.4000], device resources are represented by virtual things and devices are represented by physical things.
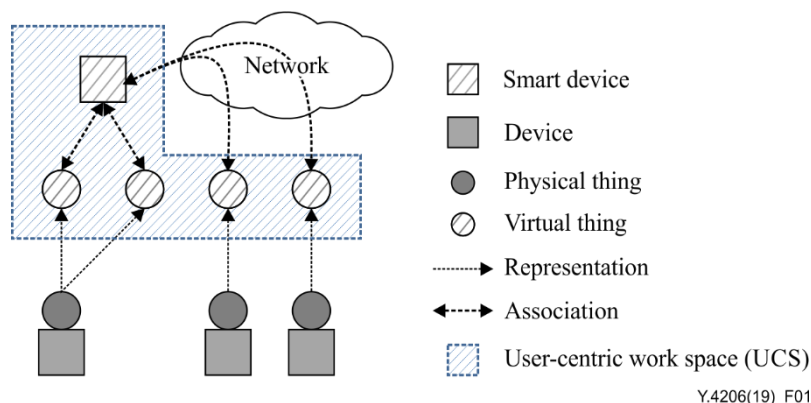

Figure 1 – The UCS concept

By associating device resources with a UCS service user's smart device, a UCS service provides a user-centric work space to the UCS service user [b-ITU-T Y.Suppl.42].

In terms of a UCS service, the service capabilities offered by a device are regarded as device resources. As a device may have one or more service capabilities (for instance, a multifunction printer has printing, scanning and other service capabilities), a device may have one or more device resources, i.e., each service capability offered by a device is mapped into a device resource.

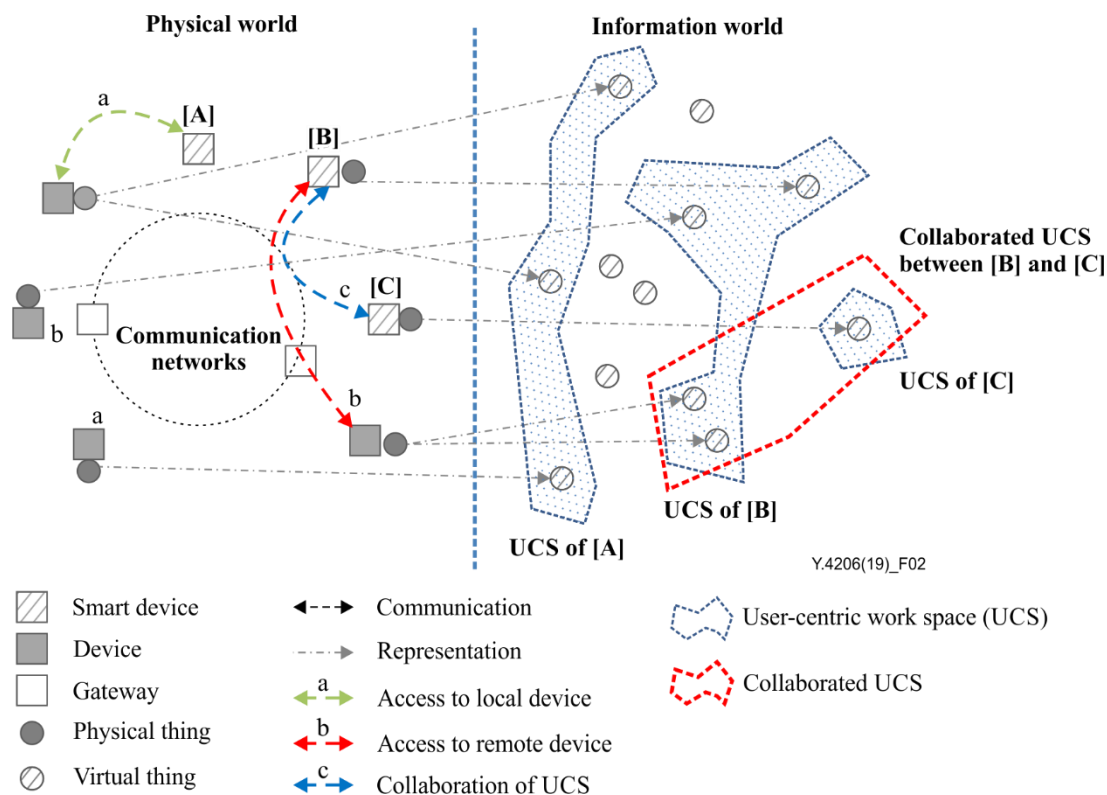Figure 2 presents three ways of configuring the UCS, based on [b-ITU-T Y.Suppl.42].

Figure 2 – Three ways of configuring a UCS

NOTE 2 – Figure 2 of [b-ITU-T Y.Suppl.42] shows that a device is associated with a physical thing and the physical thing is projected into one or more virtual things. In terms of this Recommendation, a physical thing corresponds to a UCS device (see Figure 3), and a virtual thing corresponds to a device resource (see Figure 3).

The three ways of configuring UCS are:

1) UCS with local device resource: When a UCS service user wants to configure their UCS with local device resources UCS of (user) [A], the user communicates with UCS devices in the physical world in order to orchestrate virtual things (device resources) in the information world as shown in Figure 2;

2) UCS with remote device resources: When a UCS service user wants to configure their UCS with remote device resources UCS of (user) [B], the user communicates with UCS devices in the physical world via a gateway in order to orchestrate virtual things (device resources) in the information world as shown in Figure 2;

3) UCS by collaboration: When a UCS service user wants to configure UCS with device resources which are already involved in another UCS which is a collaboration UCS between (user) [B] and (user) [C], the user communicates with the the other UCS service user's smart device (capable of UCS user agent (UA)) in the physical world in order to share virtual things (device resources) in the information world between the two UCSs as shown in Figure 2.

A UCS service can be realized by a UCS system which consists of a UCS UA, UCS device agent (DA) and UCS manager as shown in Figure 3.
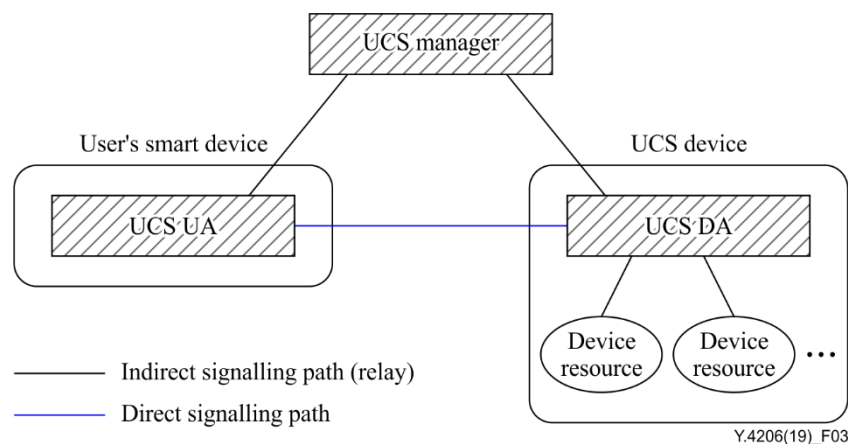

Figure 3 – Overview of the UCS system

The UCS UA, which is located at the UCS service user's smart device, discovers available device resources through the UCS manager. On behalf of a UCS service user, it orchestrates the discovered device resources to configure UCS.

The UCS DA, which is located at the UCS device, advertises device resources' information and status through the UCS manager. Upon appropriate request from the UCS UA, it offers its associated device resources to the UCS UA.

NOTE 3 – The device resources' information may include device resources' location, capabilities and identification. The status of device resources indicates their occupancy status.

The UCS manager, which is an intermediate component, handles one or more UCSs. It manages device resources' information collected from the UCS DA, and then it provides device resources' information to the UCS UA according to the UCS service user's profile.

NOTE 4 – Appendix I describes examples with different potential locations of the UCS manager.

7 Requirements of the user-centric work space service

This clause addresses the requirements of a UCS service with respect to aspects of the UCS UA, UCS manager and UCS DA, respectively.

7.1 User-centric work space service UA requirements

The followings are UCS UA's requirements for UCS service.

1) Requirements of UCS service control:
– UCS UA is required to be capable of communicating directly with the UCS service user's smart device;
– UCS UA is required to have an interface to collaborate with other UCS system components;
– UCS UA is required to be capable of managing information related to the UCS service user and smart device associated with itself.

2) Requirements of resource advertisement and discovery:
– UCS UA is required to be capable of discovering the UCS manager;
– UCS UA is required to be capable of getting information related to available device resources from the UCS manager.

   NOTE – Examples of information provided by the UCS manager include ownership, capabilities and occupancy status of device resources.

3) Requirements of device resource access control:
– UCS UA is required to be capable of requesting access permission for the device resource which is occupied and/or owned by others;
– UCS UA is required to be capable of granting the access permission request for the device resource which is occupied and/or owned by itself;
– UCS UA is required to use information security management best practices.

7.2 User-centric work space service manager requirements

The followings are the UCS manager's requirements for UCS service.

1) Requirements of UCS service control:
– UCS manager is required to be capable of managing one or more UCSs;
– UCS manager is required to have an interface for collaborating with other UCS system components;
– UCS manager is required to be capable of managing the connection between the UCS UA and device resources;
– UCS manager is required to be capable of relaying connection control messages between the UCS UA and UCS DA. In some cases direct communication between the UCS UA and UCS DA may be possible and management of connection by the UCS manager is not required;
– UCS manager is required to use information security management best practices to protect information of the UCS UA and UCS DA.

2) Requirements of resource advertisement and discovery:
– UCS manager is required to be capable of managing device resource information provided by the UCS DA;
– UCS manager is required to be capable of managing information of the UCS UA and UCS DA;

– UCS manager is required to be capable of providing selected device resources information to the UCS UA based on the UCS service user's profile and/or on the location of the UCS UA.

3) Requirements of device resource access control:

– UCS manager is required to be capable of access control for device resources;

– UCS manager is required to be capable of granting UCS UA's access to the device resources which are owned by other UCS service users;

– UCS manager is required to be capable of granting UCS UA's access for the shared resources which are occupied by other UCS service users.

NOTE – UCS manager can relay access control messages to the UCS UAs or UCS DAs involved in the UCS service.

7.3 User-centric work space service device agent requirements

The followings are the UCS DA requirements for UCS service.

1) Requirements of UCS service control:

– UCS DA is required to be capable of accessing the device resources;

– UCS DA is required to have interfaces to collaborate with the other UCS system components as well as the device resources associated with the UCS DA itself.

2) Requirements of resource advertisement and discovery:

– UCS DA is required to be capable of managing information of associated device resources.

   NOTE – Examples of information include ownership, capabilities access profile and occupancy status of device resources;

– UCS DA is required to have an interface to notify the status of device resources;

– UCS DA is required to be capable of advertising the associated device resources through collaboration with UCS manager;

– UCS DA is required to be capable of sharing device resources among multiple UCS UAs.

3) Requirements of device resource access control:

– UCS DA is required to be capable of handling associated device resources based on UCS service user's access rights;

– UCS DA is required to use information security management best practice to protect device resources' owner.

NOTE – UCS DA can assign different levels of access rights for each device resource.

8 Capability framework for user-centric work space service

The UCS service can be realized by a UCS system which consists of a UCS UA, UCS manager and a UCS DA. This clause addresses the functional entities (FEs) of the UCS system and interfaces between them.

8.1 Functional entities of the user-centric work space system

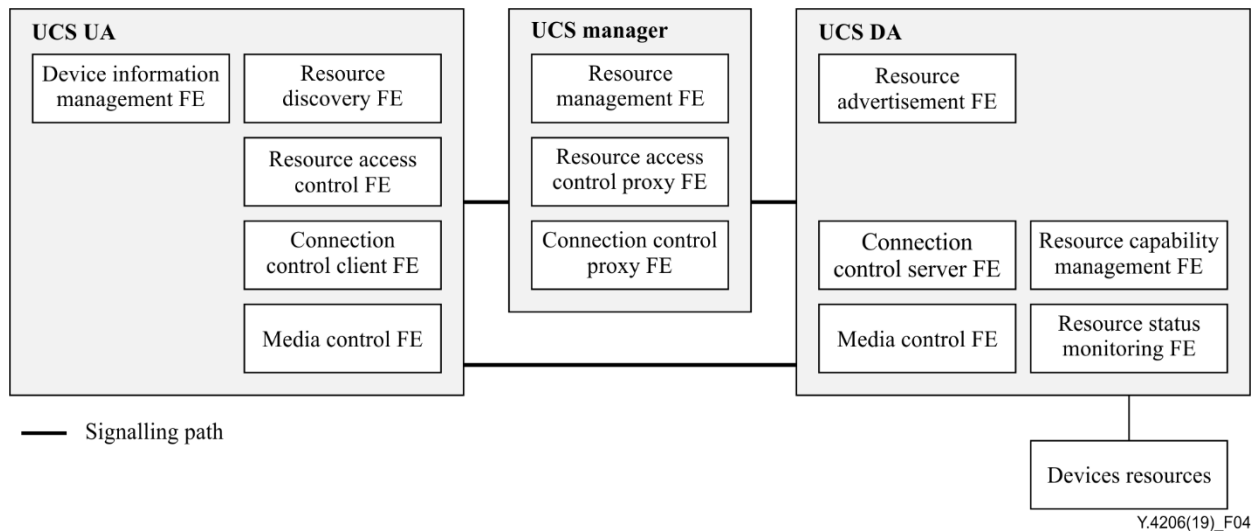Figure 4 shows the FEs of the UCS system.

Figure 4 – Functional entities of the UCS system

Functional entities of the UCS UA are as follows:

– **Device information management FE** manages information related to the UCS service user and associated smart device itself.

  NOTE 1 – Examples of the managed information include user identification and user location.

– **Resource discovery FE** discovers device resources advertised by the UCS DA in consultation with the UCS manager. The discovered device resources are used to configure a specific UCS;

– **Connection control client FE** manages the device resource control path enabling the UCS service user to utilize the device resources provided by the UCS DA;

– **Resource access control FE** enables UCS service user to obtain the access right for device resources;

– **Media control FE** establishes a control path for device resources between the UCS UA and UCS DA.

Functional entities of UCS manager are as follows:

– **Resource management FE** collects device resource information associated with the UCS DA and then provides this information to the UCS UA;

– **Connection control proxy FE** relays the control messages used for device resource control path management between the UCS UA and UCS DA;

  NOTE 2 – Example cases of this FE's involvement are when the direct exchange of control messages used for control device resource control path between the UA and DA is not possible and when a service provider is involved in the interaction between the UCS UA and UCS DA for billing purposes.

– **Resource access control proxy FE** relays resource access control messages between the UCS UA and UCS DA.

Functional entities of the UCS DA are as follows:

– **Resource advertisement FE** advertises device resource information associated with corresponding UCS DA;

– **Resource capability management FE** collects and manages device resource information managed by corresponding UCS DA. Examples of managed device resource information include location, control profile and media type of device resources;

– **Resource status monitoring FE** monitors the availability of the device resources associated with the UCS DA;

– **Connection control server FE** manages the device resource control path associated with the UCS DA;

– **Media control FE** establishes a control path for device resources between the UCS UA and UCS DA.

8.2   Interfaces of the user-centric work space system
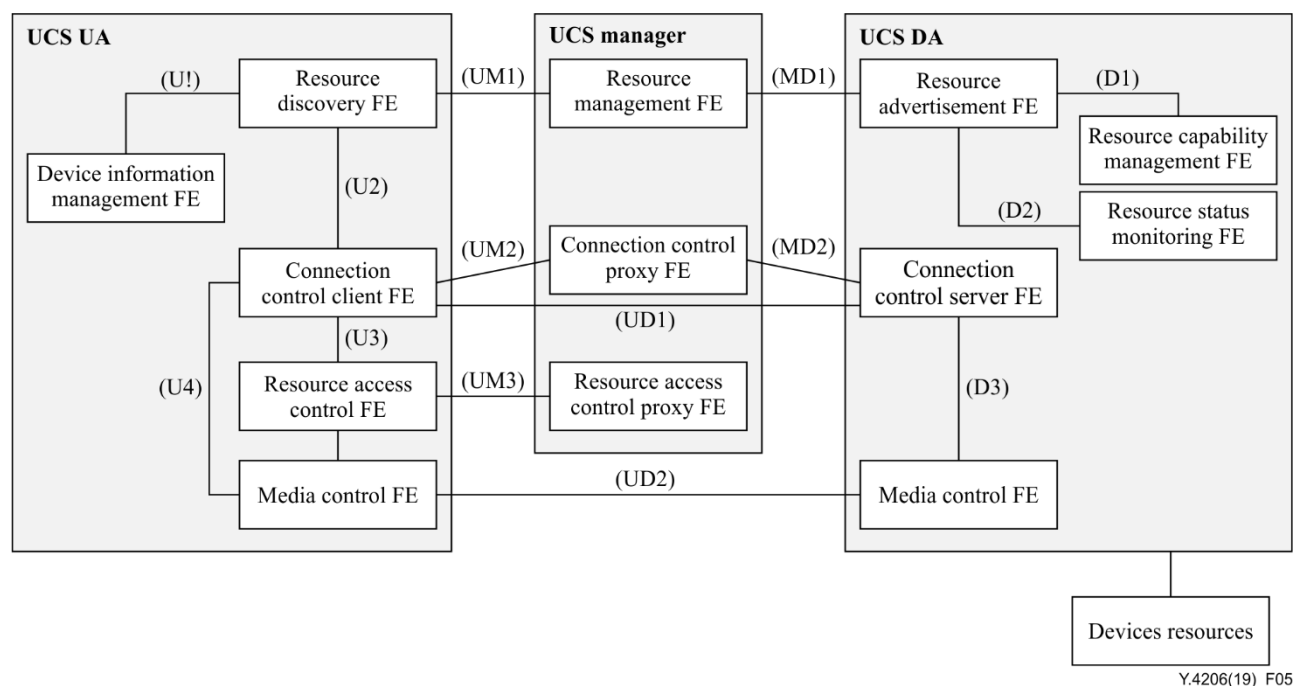
Figure 5 shows the interfaces of the UCS system.

Figure 5 – Interfaces of the UCS system

1)   Interfaces between the UCS UA and UCS manager:

– **(UM1) resource discovery FE – resource management FE**: this interface is used by the UCS UA to discover the UCS manager and to receive device resource information;

– **(UM2) connection control client FE – connection control proxy FE**: this interface is used by the UCS UA and UCS manager to manage the connection for device resource delivery between the UCS UA and UCS DA;

  NOTE 1 – Example cases of when this interface is required include when the direct path between the UCS UA and UCS DA is not possible and when a service provider is involved for billing purposes.

– **(UM3) resource access control FE – resource access control proxy FE**: this interface is used by the UCS UA and the UCS manager to control access rights for device resources. Upon successful UCS UA's access request for a certain device resource, the owner of the device resource grants access through this interface.

2)   Interfaces between UCS manager and UCS DA:

– **(MD1) resource management FE – resource advertisement FE**: this interface is used by the UCS manager and the UCS DA to advertise the information and status of device resources;

–   **(MD2) connection control proxy FE – connection control server FE**: this interface is used by the UCS manager and the UCS DA to manage the connection used for the device resource association between the UCS UA and UCS DA.

　　NOTE 2 – Example cases of when this interface is required include when the direct path between the UCS UA and UCS DA is not possible and when a service provider is involved for billing purposes.

3)   Interfaces between UCS UA and UCS DA:

–   **(UD1) connection control client FE – connection control server FE**: this interface is used by the UCS UA and the UCS DA to manage the direct connection to associate device resources (without intermediation of the UCS manager);

–   **(UD2) media control FE – media control FE**: this interface is used by the UCS UA and UCS DA to deliver device resources.

4)   Interfaces within UCS UA:

–   **(U1) resource discovery FE – device information management FE**: this interface is an internal interface of the UCS UA. To initiate the UCS configuration, the resource discovery FE uses this interface to get the necessary information of the UCS service user's smart device from the device information management FE;

　　NOTE 3 – The information of the UCS service user's smart device includes device profile, device capability and its location.

–   **(U2) resource discovery FE – connection control client FE**: this interface is an internal interface of the UCS UA and is used to discover device resource information from the resource discovery FE;

–   **(U3) connection control client FE – resource access control FE**: this interface is an internal interface of the UCS UA and is used to discover resource access rights from the resource access control FE;

–   **(U4) connection control client FE – media control FE**: this interface is an internal interface of the UCS UA and is used to manage connection for delivering device resources.

5)   Interfaces within the UCS DA:

–   **(D1) resource advertisement FE – resource capability management FE**: this interface is an internal interface of the UCS DA and is used by the resource advertisement FE to obtain the device resource capability information from the resource capability management FE;

–   **(D2) resource advertisement FE – resource status monitoring FE**: this interface is an internal interface of the UCS DA and is used to obtain the status of device resources from the resource status monitoring FE;

–   **(D3) UCS connection control server FE – media control FE**: this interface is an internal interface of the UCS DA and is used to manage connections for device resource delivery.

9   User-centric work space service workflows

This clause addresses four workflows to realize the UCS service.
The first workflow addresses advertisement and discovery of device resources.
The second workflow addresses UCS service with device resources requiring additional access control.

The third and fourth workflows address UCS collaboration.

9.1   Device resource advertisement and discovery

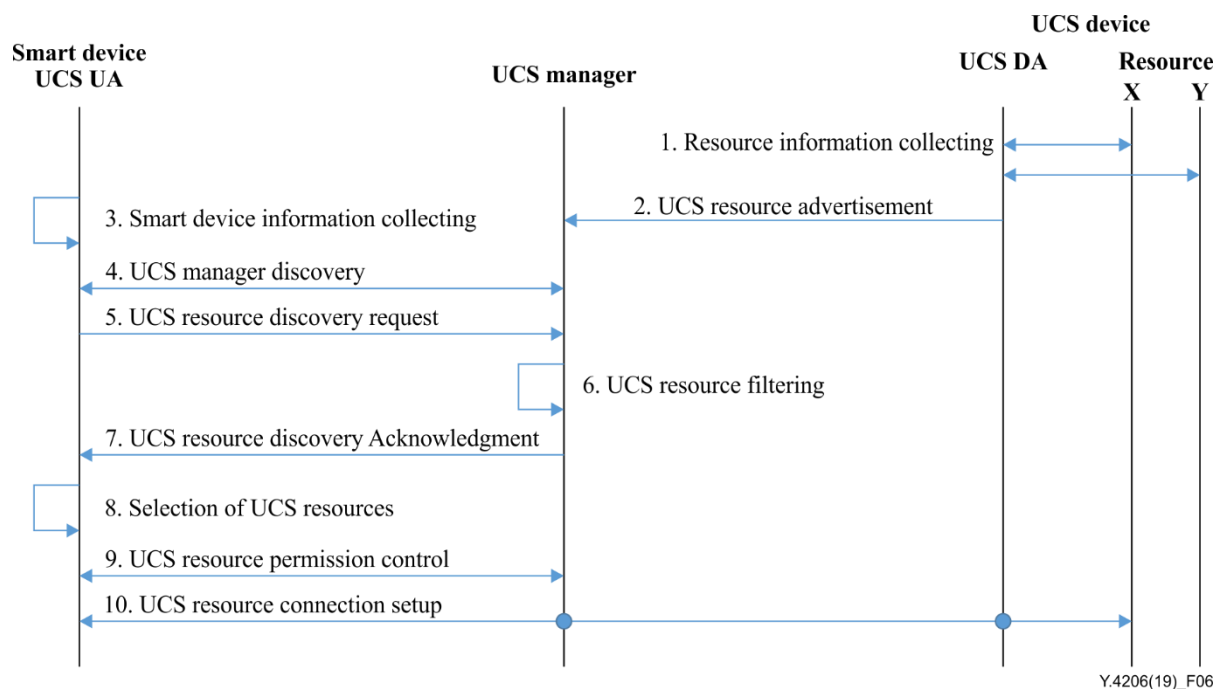Figure 6 shows the workflow for device resource advertisement and discovery.

Figure 6 – Device resource advertisement and discovery

(Step 1) **resource information collecting**: the UCS DA's resource capability management FE stores and manages device resource capability information, and then the UCS DA's resource status monitoring FE collects the availability status of each device resource.

(Step 2) **UCS resource advertisement**: the UCS DA's resource advertisement FE sends the collected resource capability information and status to the specified UCS manager. The UCS manager's resource management FE stores and manages the resource capability information and status.

(Step 3) **smart device information collecting**: the UCS UA's device information management FE collects user information and smart device information (such as its current location).

(Step 4) **UCS manager discovery**: the UCS UA discovers the UCS manager. The UCS UA's resource discovery FE sends a request to discover the UCS manager, and then the UCS manager's resource management FE which receives the UCS manager discovery request acknowledges the discovery request.

(Step 5, 6, 7) **UCS resource discovery**: when the UCS UA's resource discovery FE receives the UCS manager's discovery acknowledgement, the UCS UA's resource discovery FE requests the UCS manager for available device resources. When this request is received, the UCS manager's resource management FE configures available device resources information according to smart device information such as location. As a response to the UCS UA's UCS resource discovery request, the UCS manager's resource management FE provides the configured device resource information to the UCS UA's resource discovery FE.

(Step 8) **selection of UCS resources**: based on the received device resource information, the UCS UA decides which device resources are to be involved in the UCS. The UCS UA's resource discovery FE can choose one of two options for the selection: it can select the device resources either automatically or by asking the UCS service user which device resources are required.

(Step 9) **UCS resource access permission control**: the UCS UA's resource access control FE requests access permission for selected device resources from the UCS manager. When access is allowed, the UCS manager sends an acknowledgement to the UCS UA's resource access control FE.

(Step 10) **UCS connection setup and service starting**: the UCS UA's connection control client FE establishes a connection with the UCS DA's connection control server FE via the UCS manager's connection control proxy FE.

9.2 UCS with device resources requiring additional access control

Figure 7 shows the workflow of UCS with device resources requiring additional access control.
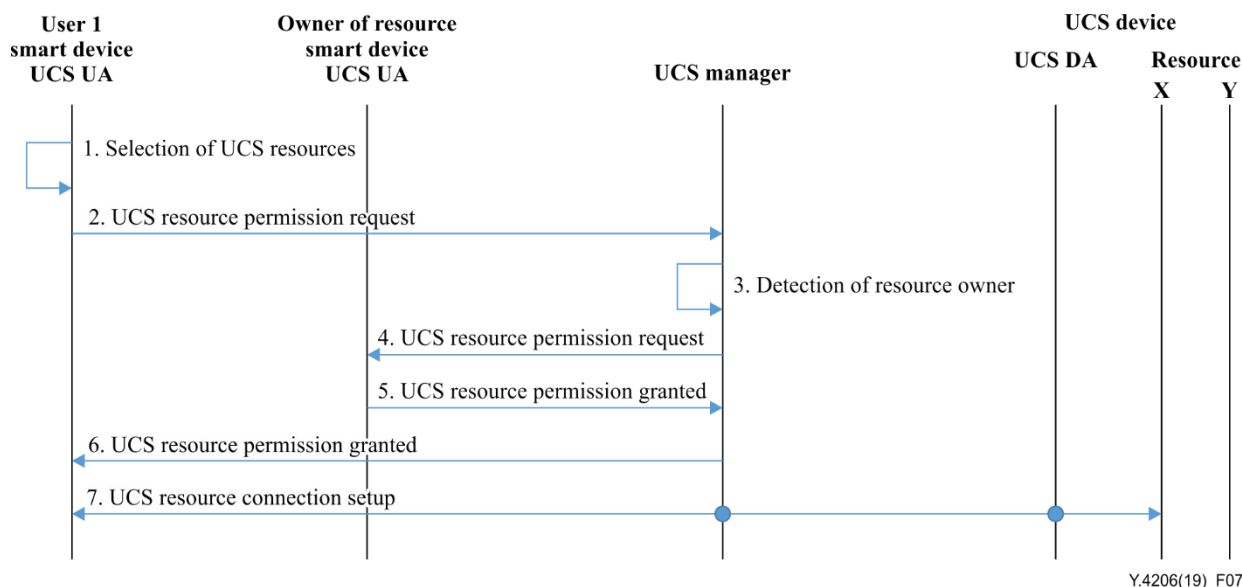

Figure 7 – Device resources requiring additional access control

(Step 1) **selection of UCS resources**: after the UCS resource advertisement and discovery process is completed, the UCS UA's resource discovery FE selects the resources from the discovered device resources to configure UCS.

(Step 2, 3, 4) **UCS resource permission request**: the UCS UA's resource access control FE requests access permission for selected resources. When the UCS manager's resource access control proxy FE receives the access permission request, if additional access control is required for a specific resource, the UCS manager's resource access control proxy FE detects the owner of that resource and forwards the access permission request for the resource.

(Step 5, 6) **UCS resource permission granted**: when the UCS UA of the resource owner receives the permission request message, the UCS UA's resource access control FE decides whether the resource permission is granted or not through interaction with the user of the UCS UA. The UCS UA's resource access control FE of the resource owner sends the UCS resource permission response. When the resource permission granted message is received from the UCS UA of the resource owner, the UCS manager's resource access control proxy FE forwards it to the UCS UA's resource access control FE which requested the resource permission.

(Step 7) **UCS connection setup and service starting**: when the UCS UA's resource access control FE receives the resource permission granted message, the UCS UA's connection control client FE starts connection setup with the UCS DA's connection control server FE via the UCS manager's connection control proxy FE. And the UCS UA starts the UCS service.

9.3 Collaborative UCS with shared resource

Figure 8 shows a workflow of collaborative UCS with shared resource.
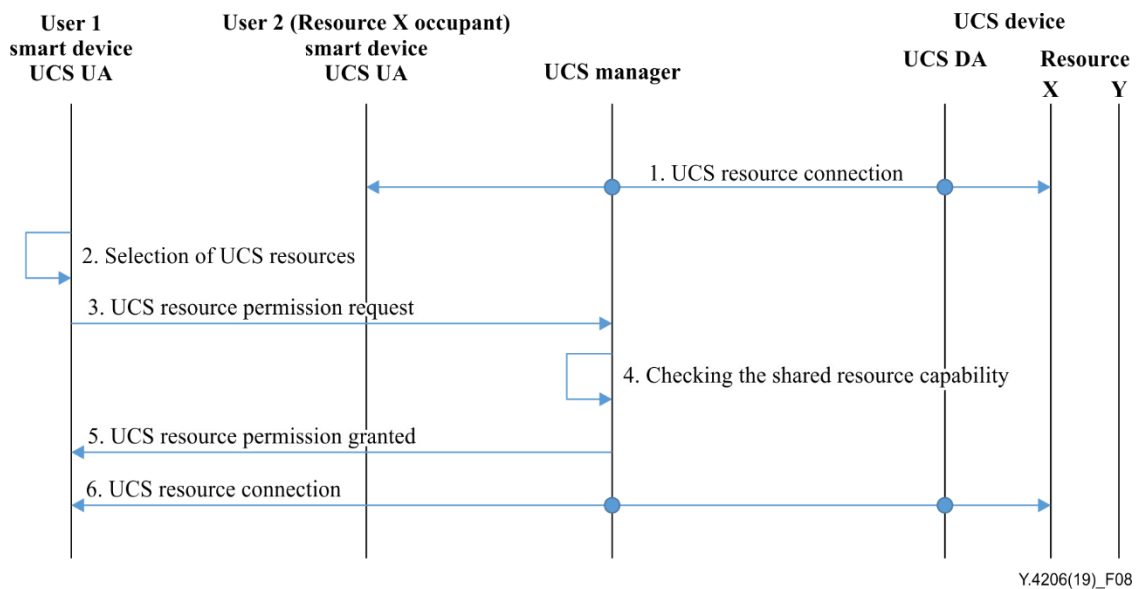
Y.4206(19)_F08

Figure 8 – Collaborative UCS with shared resource

(Step 1) **shared resource condition**: User 1 tries to configure UCS using the device resources occupied by User 2. User 2 has already configured UCS including resource X which is a shared device resource.

(Step 2) **selection of UCS resources**: after the UCS resource advertisement and discovery process is completed, the UCS UA's resource discovery FE selects the resources including the shared device resource X among the discovered device resources.

(Step 3) **UCS resource permission request**: the UCS UA's resource access control FE requests access permission for the shared resource X.

(Step 4, 5) **UCS resource permission granted**: when the UCS manager's resource access control proxy FE receives the access permission request, the UCS manager's resource access control proxy FE checks whether the device resource can be shared or not. If the requested device resource can be shared with User 1, the UCS manager's resource access control proxy FE grants the resource permission to the UCS UA which is associated with User 1.

(Step 6) **UCS connection setup and service starting**: when the UCS UA's resource access control FE receives the resource permission granted message from the UCS manager, the UCS UA's connection control client FE establishes a connection with the UCS DA's connection control server FE via the UCS manager's connection control proxy FE. Finally, the UCS UA provides UCS to User 1.

9.4 Collaborative UCS with shared resource and mitigation of race condition

Figure 9 shows a workflow of collaborative UCS with shared resource and mitigation of race condition.
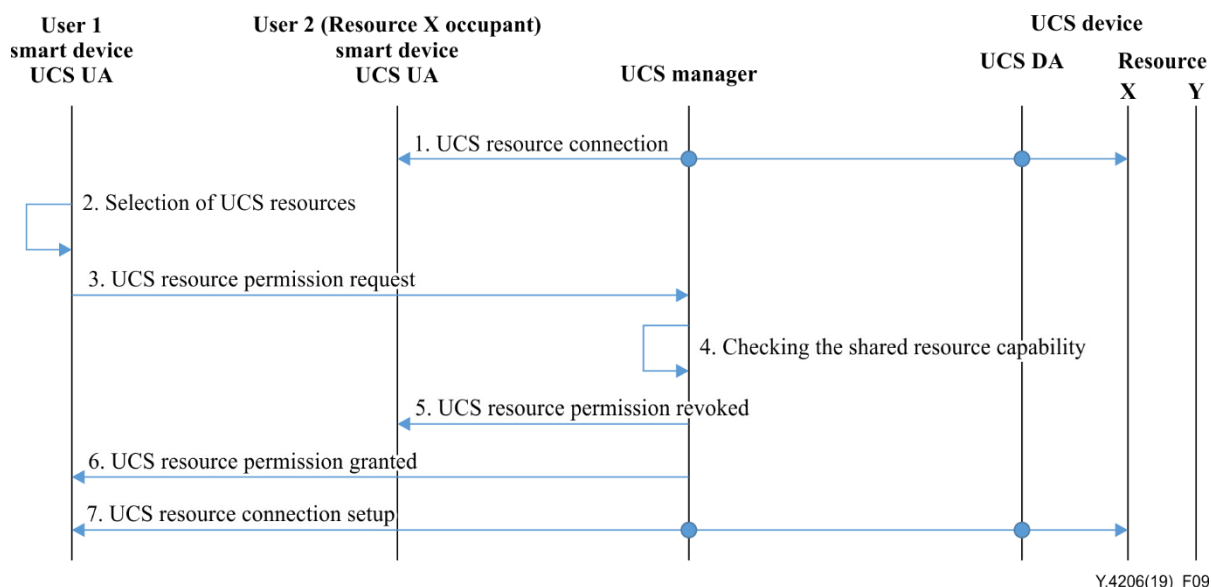
Figure 9 – Collaborative UCS with shared resource and mitigation of race condition

(Step 1) **shared resource condition**: User 1 tries to configure UCS using the device resources occupied by User 2. User 2 has already configured UCS including resource X which is a shared device resource. This can cause a race condition as more than one user attempts to occupy a device resource at the same time.

(Step 2) **selection of UCS resources**: after the UCS resource advertisement and discovery process is completed, the UCS UA's resource discovery FE selects device resources including the shared device resource X among the discovered device resources.

(Step 3) **UCS resource permission request**: the UCS UA's resource access control FE requests the UCS manager access permission for the shared device resource X.

(Step 4) **checking the shared resource capability**: when the UCS manager's resource access control proxy FE receives the access permission request from the UCS UA, the UCS manager's resource access control proxy FE detects the occupant status of the device resource X and whether the device resource can be shared.

(Step 5, 6) **mitigation of race condition**: in order to mitigate the race condition, the UCS manager's resource access control proxy FE requests the device resource's access permission to the UCS UA which occupies the target device resource. The resource access control FE of User 2's UCS UA grants the resource access request from User 1's UCS UA.

(Step 7) **UCS connection setup and service starting**: when the device resource is granted, the UCS UA's connection control client FE establishes a connection with the UCS DA's connection control server FE via the UCS manager's connection control proxy FE. Finally, the UCS UA provides UCS to User 1.

Appendix I

Implementation scenarios for UCS manager's location

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

I.1 UCS manager co-located with UCS UA at user's smart device level

A UCS service user may have a personal UCS manager. In this case, a user can configure their UCS using device resources, which can be located both locally and remotely, with the UCS manager collocated with the UCS UA at the UCS service user's smart device level. The UCS manager's stored information for accessing both local and remote device resources is used only by the associated UCS UA.
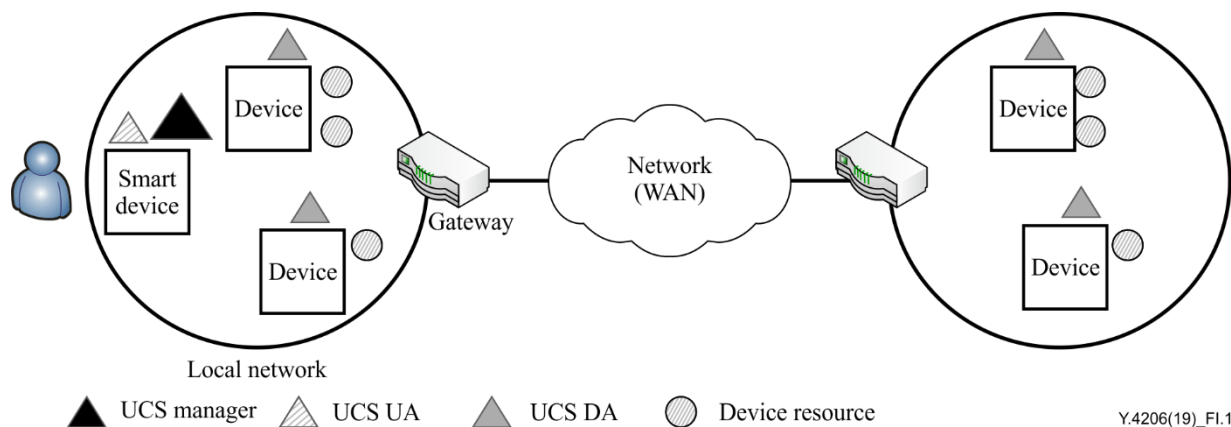

Figure I.1 – UCS manager co-located with UCS UA at user's smart device level

I.2 UCS manager co-located at a gateway level

When a UCS service is open and public in a certain restricted area such as q home, office or café, a UCS manager can be collocated at the gateway level of the area (e.g., in an IoT gateway with edge computing capabilities). In this case, a UCS manager stores the necessary information for accessing the device resources and then offers the stored information to the UCS UA upon appropriate request.
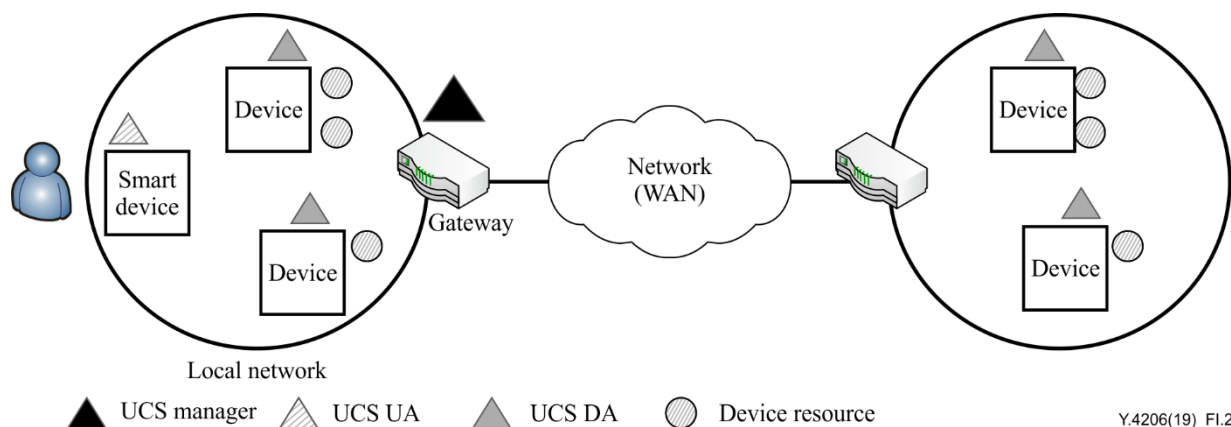

Figure I.2 – UCS manager co-located at a gateway level

I.3 UCS manager located at a dedicated server level

When a service provider wants to offer UCS service to users on a large scale, permanent basis, a UCS manager can be located at a dedicated server level. In this case, the UCS service provider can offer UCS service to its UCS service users with long-term commercial agreements. In addition, this

approach is suitable for UCS collaboration because, in this case, the UCS manager can easily maintain the information of both device resources to be shared for UCS collaboration and their occupants.
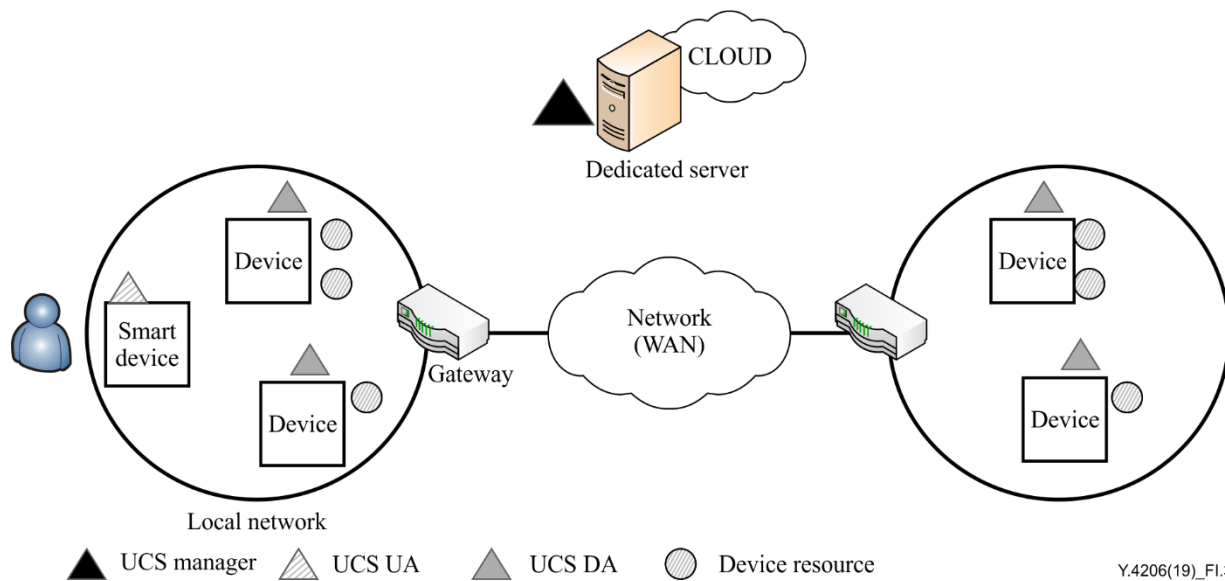
NOTE – Refer to clause 6 for UCS collaboration.

Figure I.3 – UCS manager located at a dedicated server level

Bibliography

[b-ITU-T Y.4101]   Recommendation ITU-T Y.4101/Y.2067 (2017), *Common requirements and capabilities of a gateway for Internet of things applications*.

[b-ITU-T Y.Suppl.42]   Recommendation ITU-T Y.Suppl.42 (2016), *Use cases of user-centric work space service*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities**
Series Z	Languages and general software aspects for telecommunication systems