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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 – Services, applications, computation and data processing

Requirements and functional architecture of smart residential community

Recommendation ITU-T Y.4556

International Telecommunication Union

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Recommendation ITU-T Y.4556

Requirements and functional architecture of smart residential community

Summary

Smart residential community (SRC) is an IoT-based approach for residents to acquire safe, comfortable and convenient living conditions in a residential community. SRC can provide community property management, safety control and other integrated third-party services for residents, public facilities, and enterprises. Recommendation ITU-T Y.4556 presents the key components and specifies requirements and the functional architecture of SRC.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4556	2019-12-06	20	11.1002/1000/13863

Keywords

IoT, integrated information and service platform, SRC.

* 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.

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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/.

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1 Scope

This Recommendation specifies requirements and the functional architecture of smart residential community (SRC). The scope of this Recommendation includes:

– Concept, goals and key components of SRC;

– Requirements of SRC;

– Functional architecture of SRC.

As this Recommendation is intended to collect relevant information for supporting smart residential community, implementers and users of this Recommendation shall comply with all applicable national and regional laws, regulations and policies, as appropriate.

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.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

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

[ISO 37101] ISO 37101:2016, *Sustainable development in communities – Management system for sustainable development – Requirements with guidance for use*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 Internet of things (IoT) [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 safety and privacy requirements are fulfilled.

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

3.1.2 functional entity [ITU-T Y.2012]: An entity that comprises an indivisible set of specific functions. Functional entities are logical concepts, while groupings of functional entities are used to describe practical, physical implementations.

3.1.3 community [ISO 37101]: Group of people with an arrangement of responsibilities, activities and relationships.

NOTE – In many, but not all, contexts, a community has a defined geographical boundary.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 residential community: A community which resides in a specific area, composed mostly of houses, facilities, residents, as well as government departments, enterprises and other organizations.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FE	Functional Entity
GPS	Global Positioning System
ICT	Information Communication Technology
IoT	Internet of Things
PII	Personally Identifiable Information
SCP	Smart City Platform
SRC	Smart Residential Community
SRC-CIC	SRC Community Information Collector
SRC-IISP	SRC Integrated Information and Service Platform
SRC-SM	SRC Safety Monitor
UI	User Interface

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 Recommendation 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.

6 Introduction

6.1 Concept and goals of SRC

SRC is an IoT-based system for residents to acquire safe, comfortable and convenient living conditions in a residential community. SRC uses information and communication technology (ICT, including IoT, mobile Internet and other information technology) to provide community property management, safety control and other third-party services for residents, public facilities and enterprises.

As an important part of the smart city, SRC is mostly concerned with statistics related to residents of a community. It aims at improving residents' safety and living conditions in a residential community. The residential information collected from SRC services may be shared with other systems (e.g., e-government, e-health) of a smart city through smart city platform (SCP). However,

measures to protect the personally identifiable information (PII) are a key requirement to implement this Recommendation. The relationship between SRC and SCP is depicted as Figure 6-1.

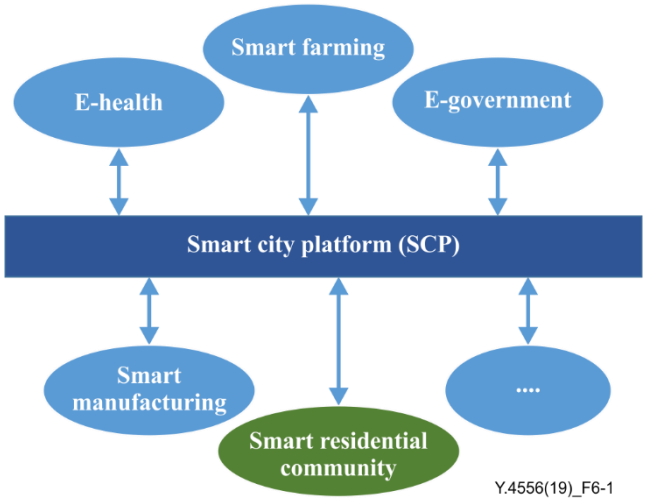

Figure 6-1 – Relationship between SRC and SCP

Goals of SRC are:

1) improving the level of community management by managing houses, public facilities (e.g., garages, sport facilities, garbage cans, drainage system, etc.) for residents;

2) providing overall safety control and environment maintenance for residents to have safe and healthy life;

3) integrating a variety of services (e.g., smart home services, smart building, parking system, e-health, smart retail stores, etc.) for residents to live conveniently and comfortably.

6.2 Key components of SRC

The key components of SRC are depicted as Figure 6-2.

1) **SRC community information collector (SRC-CIC)** is responsible for collecting and recording information about houses, public facilities, organizations, and events happened in a residential community. Information that are collected should not identify a particular person or indicate his behaviour. Protection of PII is critical at this stage and a set of user approved personal attributes may be allowed to be collected subject to relevant laws, regulations and policies where this Recommendation is to be applied. The SRC-CIC reports community information to SRC integrated information and service platform (SRC-IISP) through a communication network, and also receives configuration commands and work plans from SRC-IISP at the same time.

2) **SRC safety monitor (SRC-SM)** is responsible for monitoring public facilities and important public sites in a residential community, and also for detecting exceptions and reporting alarms. It gathers and reports monitoring information to the SRC-IISP through a communication network, and also receives configuration commands from SRC-IISP at the same time.

3) **SRC-IISP** is responsible for:

   – handling requests and information from SRC-CIC or SRC-SM;

   – providing management and services relevant to community;

   – integrating other systems or services deployed inside a residential community;

   NOTE 1 – For example, a smart home service focuses on remote control and safety control for appliances inside the house, a smart parking system focuses on parking lot management and parking guidance, etc.

– integrating external systems or services deployed outside the residential community through the SCP platform.

NOTE 2 – The external systems or services may include e-health services, e-government services, health and old-aged services, etc.

4) **Communication network** is responsible for communications among sensors, SRC-CIC, SRC-SM and SRC-IISP.

5) **Web/APP client** is responsible for community operators and residents to access the SRC-IISP anytime and anywhere.

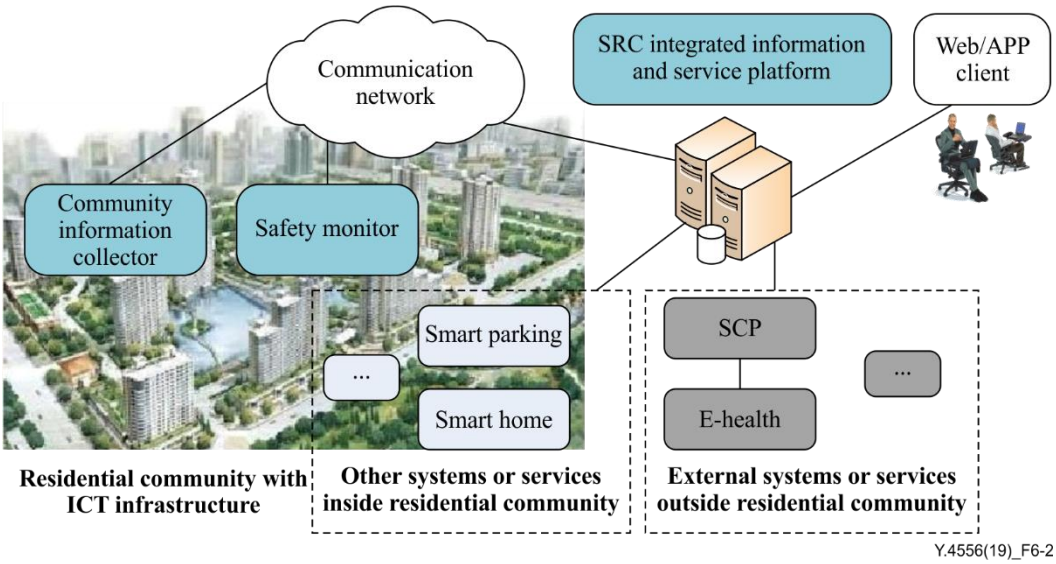

Figure 6-2 – Key components of SRC

7 Requirements of SRC

7.1 Requirements of SRC-CIC

The SRC-CIC requirements are as follows:

SRC-CIC Req1: SRC-CIC is required to collect public facilities information for property management purposes.

NOTE – Public facilities information: type, location, status, etc. of a public facility.

SRC-CIC Req2: SRC-CIC is required to receive commands and work plans from community operators, record and report safety events that happen in the community.

SRC-CIC Req3: SRC-CIC is recommended to collect home owner contact information, house information, organization information, and vehicle information that is strictly necessary for property management purposes.

SRC-CIC Req4: SRC-CIC is required to conform with regulations and policies that protect PII. This includes for example, the right to be forgotten, an expiry date for the saved information, and automatic deletion of the saved and collected data records. Information that are collected is required not to identify a particular person or indicate his behaviour unless a set of user approved attributes is explicitly approved by the user, and under the condition that this is allowed by relevant laws, regulations and policies where this Recommendation is to be applied.

NOTE 1 – Home-owner contact information: name, contact phone number, contact e-mail of a house owner.

NOTE 2 – House information: location, status, etc. of a house. Here, houses may include villas, single family houses, townhouses, buildings and apartments, etc.

NOTE 3 – Organization information: type, contact phone number, contact e-mail, status, etc. of an organization. Here, organizations are registered or located in the community, such as property management companies which are responsible for the management of the residential community, government departments, non-profit organizations and commercial service companies.

NOTE 4 – Vehicle information: license plate number, vehicle model, contact phone number of a vehicle.

SRC-CIC Req5: SRC-CIC is recommended to be portable and precisely located.

SRC-CIC Req6: SRC-CIC is recommended to be configured and managed remotely in order to prevent information leakage in case of being stolen or lost.

7.2 Requirements of SRC-SM

The SRC-SM requirements are as follows:

SRC-SM Req1: SRC-SM is required to be configured and managed remotely.

SRC-SM Req2: SRC-SM is recommended to have the functional capabilities for collecting and reporting real-time videos of physical surroundings to SRC-IISP.

NOTE – Physical surroundings may include surroundings of public facilities, community entrance gates, parking lots, vehicles, houses, etc.

SRC-SM Req3: SRC-SM is required to operate steadily and reliably in 7 x 24 hours.

SRC-SM Req4: SRC-SM is recommended to detect events and report alarms in time.

SRC-SM Req5: SRC-SM is required to implement measures to protect PII.

7.3 Requirements of SRC-IISP

The SRC-IISP requirements are as follows:

SRC-IISP Req1: SRC-IISP is required to have the capabilities for securely pre-processing, storing, and deleting collected information, videos, and event handling records.

SRC-IISP Req2: SRC-IISP is required to manage SRC-CIC and SRC-SM remotely.

SRC-IISP Req3: SRC-IISP is required to manage public facilities information and maintenance procedure of public facilities.

SRC-IISP Req4: SRC-IISP is required to manage home-owner contact information and house information and in accordance with measures to protect PII.

SRC-IISP Req5: SRC-IISP is recommended to manage organization information and vehicle information.

SRC-IISP Req6: SRC-IISP is required to manage safety events and their resolution procedures.

NOTE – Safety events may be triggered by alarm information from SRC-SM, event information collected by SRC-CIC, and alarm information from other systems inside or external systems outside the residential community.

SRC-IISP Req7: SRC-IISP is recommended to provide public services, life services, health and old-aged services by integrating external systems or services deployed outside the residential community.

SRC-IISP Req8: SRC-IISP is required to control access to various management and services for residents, community managers, and service providers.

8 Functional architecture of SRC

8.1 Functional architecture overview

The functional architecture of SRC, shown in Figure 8-1, exhibits functions derived from the SRC requirements. From the requirements in clause 7, it specifies functional entities (FEs) of SRC-CIC, SRC-SM and SRC-IISP. Other components (i.e., communication network, external systems and Web/APP client) are out of the scope of this Recommendation in terms of functional architecture.

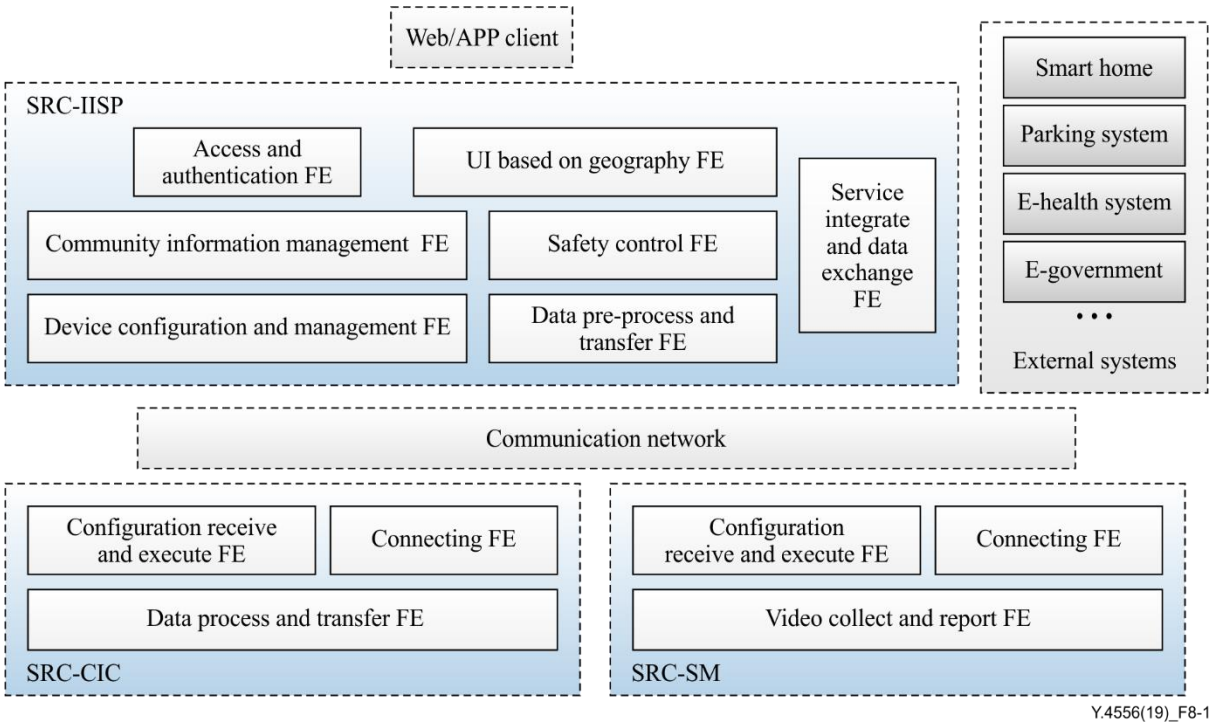

Figure 8-1 – Functional architecture of SRC

8.2 SRC-IISP

SRC-IISP includes a device configuration and management functional entity (FE), data pre-process and transfer FE, community information management FE, safety control FE, service integrate and data exchange FE, access and authentication FE, and a user interface (UI) based on a geography FE. The main roles of these FEs are described below:

Device configuration and management FE

The device configuration and management FE:

- creates configuration policies of SRC-CIC based on mobile device's operating system version and status, mobile apps available, mobile user's authentication, mobile user's authorization and app access permissions, and all relevant consent requirements for collecting user data;
- creates configuration policies of SRC-SM based on monitoring area, environment of surroundings, objects monitored, and accuracy requirements;
- starts/stops specific applications on SRC-CIC or SRC-SM remotely;
- masks/opens, encrypts/decrypts, deletes/restores specific data stored in SRC-CIC or SRC-SM remotely;
- modifies and deletes configuration policies;
- sends configuration policies to SRC-CIC and SRC-SM;

- receives data about operating status, performance, fault report of SRC-CIC or SRC-SM.

Data pre-process and transfer FE

The data pre-process and transfer FE:

- receives community information, videos and processing records from SRC-CIC and SRC-SM;
- deletes any data that is redundant or unnecessary for property management purposes, converts data format, handles exceptional data, and integrates community information data into the data store of SRC-IISP;
- converts video format, decompresses videos, and stores videos in the data store of the SRC-IISP;
- deletes redundant data, handles exceptional data and integrates processing record into the data store of SRC-IISP;
- sends commands and work plans to SRC-CIC.

Community information management FE

The community information management FE:

- manages information about residents, houses and their relationships according to the property rights or location and in accordance with measures, regulations to protect PII where applicable;
- manages information about public facilities and their maintenance process;
- manages the information of safety control events and workflow of emergency case processing;
- manages work plan, work assignment, and the completion of work for company managers;
- searches and displays the physical distribution of all things on the map including houses, public facilities, SRC-SM on demand;
- searches and displays community managers' activity track on the map when using SRC-CIC for event handling;
- protects the confidentiality and integrity of information;
- manages the deletion of information that is outdated and/or no longer relevant to fulfilling the purpose for which it was collected.

Safety control FE

The safety control FE:

- manages monitoring videos of public facilities and important public sites, if video monitoring is implemented;
- displays videos in real-time, searches specific videos with time and position;
- detects exceptions and reports alarms by video stream analysis;
- processes an emergency case by integrating other alarm information from other systems in the residential community (e.g., smart home, smart building, smart parking system, etc.).

Service integrate and data exchange FE

The service integrate and data exchange FE:

- exchanges data by a platform with synchronous data updating and asynchronous data switching;
- provides services based on the interface specification;

- integrates services among multi-systems deployed inside the community according to the specification;
- integrates services and exchanges data with external systems out of the community used by SCP;
- provides an interface for app developers (e.g., development kits, web services);
- provides instant messaging and file transferring;
- provides notification through e-mail, short message service, etc.;
- limits data exchanges to ensure that only data that is consented to be shared with specific external systems is exchanged.

Access and authentication FE

The access and authentication FE:

- identifies and authenticates SRC-CIC and SRC-SM;
- authorizes users to access SRC-CIC based on management roles, management area, management objects for community managers;
- authorizes users to access SRC-IISP based on roles and rights for community managers, service providers and residents.

UI based on geography FE

The UI based on geography FE:

- provides UI of community information management and property management;
- provides UI of safety control services;
- provides UI of integrated third-party services (e.g., public services, life services, health care and old-aged services);
- provides UI of authentication and authorization, device configuration and management, etc.

8.3 SRC-CIC

SRC-CIC includes connecting FE, configuration receive and execute FE, data process and transfer FE. The main roles of these FEs are described below:

Connecting FE

The connecting FE:

- establishes and manages wireless communication (e.g., WiFi, 3G/4G, etc.) between SRC-CIC and SRC-IISP.

Configuration receive and execute FE

The configuration receive and execute FE:

- receives configuration policies from SRC-IISP and executes them;
- reports status and fault information of SRC-CIC to SRC-IISP.

Data process and transfer FE

The data process and transfer FE:

- inputs and updates the information of public facilities, home owners, houses, organizations, and vehicles;
- inputs and edits process information of safety events happened in the community;
- receives work plans and work assignment data from SRC-IISP;

- sends collected data with global positioning system (GPS) data to SRC-IISP;
- supports the recognition of bar codes or two-dimensional codes;
- supports photos, binary files, videos, voice inputs.

8.4 SRC-SM

SRC-SM includes connecting FE, configuration receive and execute FE, video collect and report FE. The main roles of these FEs are described below:

Connecting FE

The connecting FE:

- establishes and manages wired communication (e.g., copper network, optical network, etc.) between SRC-SM and SRC-IISP.

Configuration receive and execute FE

The configuration receive and execute FE:

- receives and executes the configuration policies from SRC-IISP;
- reports the status and fault information of SRC-SM to SRC-IISP.

Video collect and report FE

The video collect and report FE:

- creates and stores videos of cameras for monitoring physical surroundings, if video monitoring is implemented;
- supports infrared and night vision, low power consumption and strong anti-vibration;
- transfers videos with cameras' identification to SRC-IISP;
- detects exceptions and reports alarms on time by on-site video analysis.

Appendix I

Use cases of SRC

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

I.1 Use case: SRC improves management level

For residential community management, there are many different systems of government departments and social service corporations where dataflow and workflow appears peer to peer. It leads to inefficient management, wasting of resources and isolated information. In general, there are three types of residential communities with different users and demands as follows:

- Type 1: A residential community mainly including residents, distributed single family houses, town houses, public facilities, and an owners' committee composed of house owners (i.e., residents). Residents negotiate community public affairs through the owners' committee. City operators are responsible for managing community information and public facilities separately.
- Type 2: A residential community mainly including residents, buildings and apartments which belong to a specific property company, public facilities, and a property management company. Property managers are responsible for assuring safety, providing living services and managing public facilities for residents who live there. City operators are responsible for managing community information and public facilities separately.
- Type 3: A residential community mainly including residents, houses or apartments which certain year property rights belonging to residents, public facilities, owners' community, property management companies, community committees, non-profit organizations and commercial service companies. Members of the owners' community participate in community management and governance on behalf of residents. Community managers from a community committee act as basic-level operators of a city. Property managers and community managers are both responsible for assuring safety, providing living services and managing public facilities for residents.

In a residential community based on IoT, integration functions of SRC are as shown in Figure I.1. SRC-IISP works on data collection normally from IoT devices deployed by community managers, systems inside the residential community, or external systems outside the residential community. The data about persons, objects and activities are categorized and converged into a community database for usage of community management and services by means of data processing, analysis and visualization. The platform provides an integrated closed-loop process according to the business process specification of community management and service sectors to improve community comprehensive management and service efficiency. There are many kinds of services including health care and old-aged services, life services and public services integrated from third-party service providers.

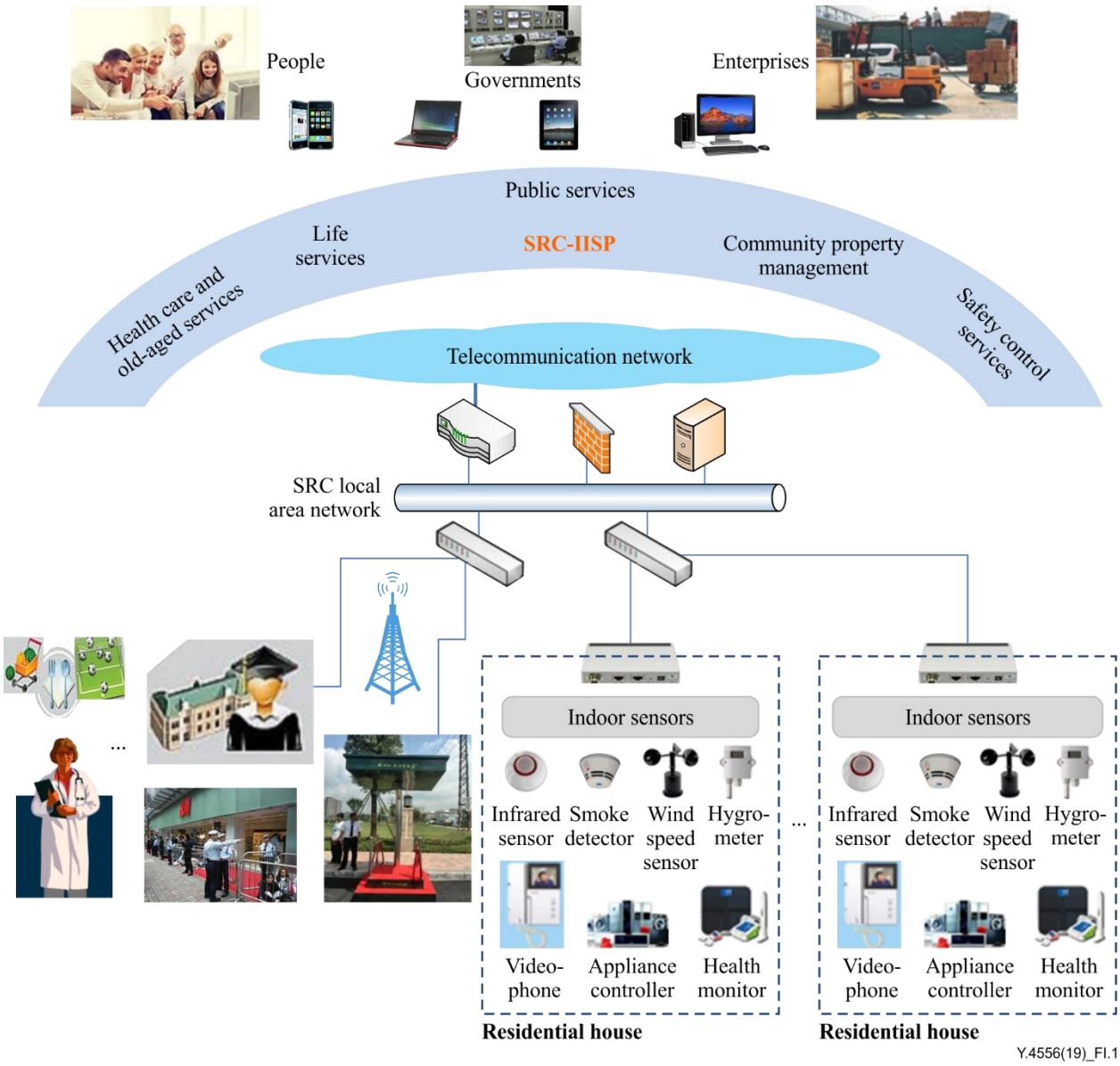

Figure I.1 – Integration functions of SRC

I.2 Use case: safety control service

A community safety control service ensures community safety and refers not only inside the house but also outside the house.

A smart home system is responsible for ensuring safety inside the house and for providing relevant capabilities by integrating with SRC-IISP.

To ensure safety outside the house, community managers or property managers monitor the entrance of the residential community or other important public places on-site and real-time by means of SRC-SM. SRC-SM located on the entrance of the residential community can identify vehicles. SRC-SM located around public facilities can detect moving objects. If e accident events happen, community managers would report information directly by emergency case processing to the other e-government systems through SCP and other city operators (e.g., community mediators, policemen) would quickly arrive and effectively solve the problem in the residential community.

I.3 Use case: access to SRC services

Figure I.2 shows various types of clients which are used to access SRC services. Community managers and property managers use mobile app clients as SRC-CIC to collect information about

houses, facilities, safety events, etc. Managers can also use PC clients to access a system website and carry out business processes, and can also use a large screen display to monitor key performance indicators. Residents can use mobile clients or touch terminals to request information, indicate complaint problems, request repairs, and search for other convenient living services.

Figure I.2 – Various clients access to SRC services

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