International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.4120

(06/2018)

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 of Internet of things applications for smart retail stores

Recommendation ITU-T Y.4120

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Recommendation ITU-T Y.4120

Requirements of Internet of things applications for smart retail stores

Summary

Recommendation ITU-T Y.4120 provides requirements of Internet of things (IoT) applications for smart retail stores. Retail stores are one of the important application fields of the IoT. The usage of the IoT enables "smart retail stores". The IoT can enable a safe and efficient retail store management system for non-stop operation (i.e., 24 hours a day/365 days a year): the collection and monitoring in real-time of information related to the various kinds of equipment in stores may allow early detection of equipment failure and accurate prediction of equipment problems.

For an effective usage of the IoT by retail store operators and store equipment providers, appropriate guidelines for IoT applications for smart retail stores are necessary.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4120	2018-06-29	20	11.1002/1000/13635

Keywords

Internet of things, IoT, IoT applications, retail store, smart retail store.

* 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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Requirements of Internet of things applications for smart retail stores

1 Scope

This Recommendation provides requirements of Internet of things (IoT) applications for smart retail stores. Specifically, this Recommendation addresses concepts, requirements and ecosystem aspects for smart retail stores. Use cases of IoT applications for smart retail stores are provided in Appendix I.

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 Internet of things*.

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

[ITU-T Y.4113] Recommendation ITU-T Y.4113 (2016), *Requirements of the network for the Internet of things*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 in-store equipment: Equipment installed in stores.

NOTE – In this Recommendation, in-store equipment corresponds to equipment installed in retail stores. Examples of in-store equipment installed in retail stores include refrigerators, air-conditioners and coffee brewers.

3.2.2 smart retail store: In this Recommendation, Internet of things (IoT)-enabled retail store.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API Application Programming Interface

GUI Graphical User Interface

IoT Internet of Things

MAC Media Access Control

PHY Physical layer of the Open Systems Interconnection model

POS Point of Sale

Wi-Fi Wireless Fidelity

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.

"IoT application" means "IoT-enabled application".

6 Concept of IoT applications for smart retail stores

Retail stores are one of the important application fields of the IoT. The usage of IoT enables "smart retail stores". The IoT can enable a safe and efficient retail store management system for non-stop operation (24 hours a day/365 days a year): the collection and monitoring in real-time of information related to the various kinds of equipment in stores may allow early detection of equipment failure and accurate prediction of equipment problems.

As shown in Figure 1, a smart retail store ecosystem involves the following roles: (a) IoT application provider(s), (b) network provider(s), (c) retail store operator(s), and (d) in-store equipment provider(s).

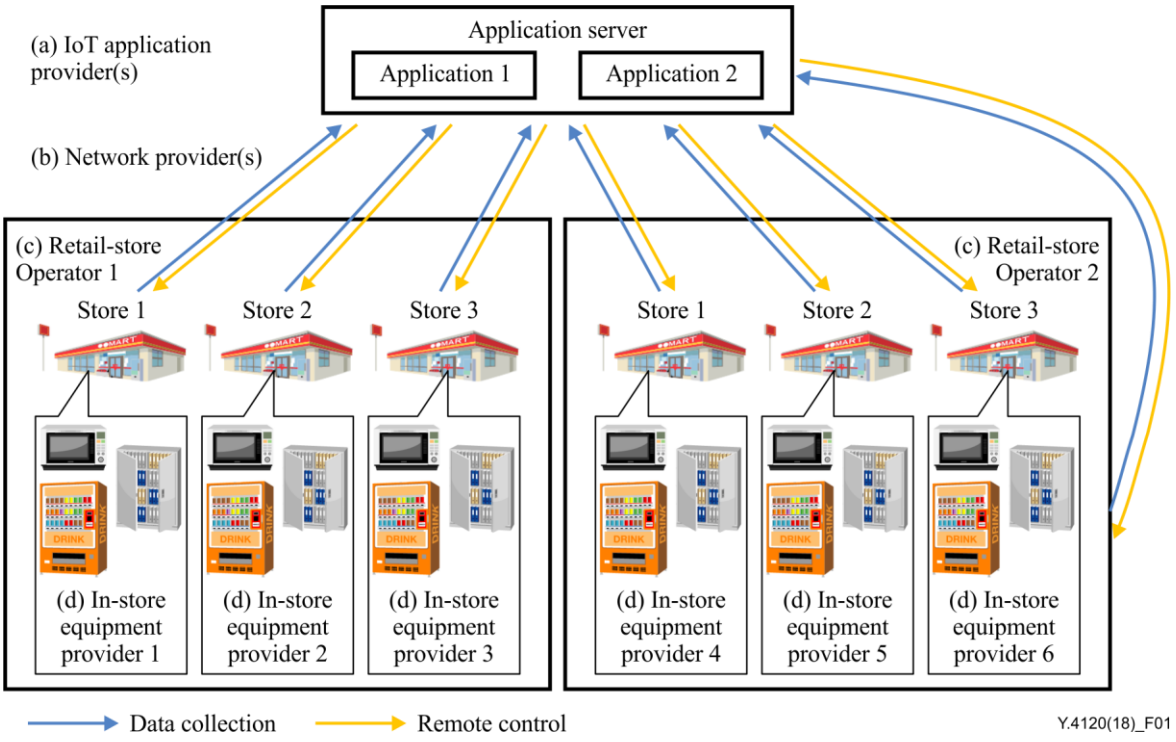

Figure 1 – Smart retail store ecosystem

With respect to the IoT reference model described in [ITU-T Y.4000], the identified smart retail ecosystem roles are associated with the following capabilities:

– the IoT application provider provides IoT applications;

– the network provider provides networking and transport capabilities;

– the retail store operator provides gateway capabilities;

– the in-store equipment provider provides device capabilities.

The IoT application provider operates and manages an IoT-enabled application ("IoT application") in order to support the operations and management of the smart retail store. The same IoT application provider can provide IoT applications for different retail store operators.

A single IoT application can monitor retail stores operated by different retail store operators (e.g., different retail store chains) or can monitor in-store equipment provided by different in-store equipment providers.

NOTE – IoT applications are generally deployed on application servers. An alternative option is to deploy them in a cloud environment.

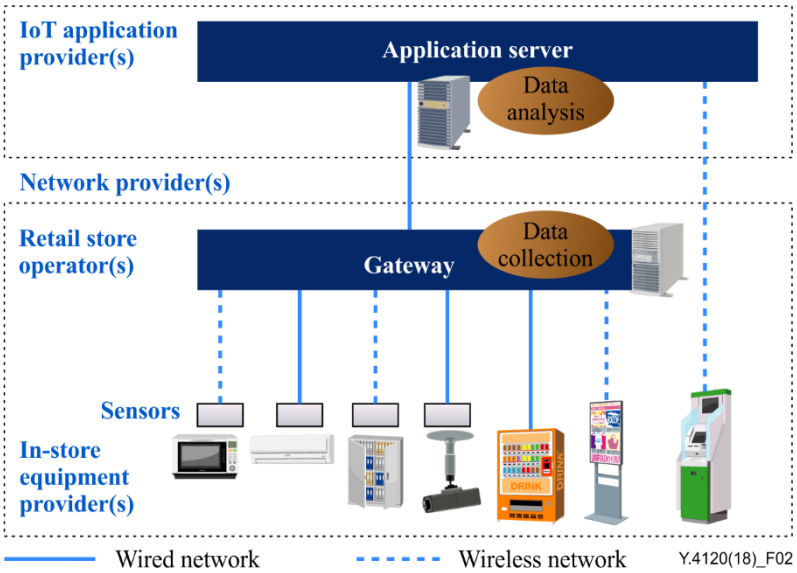

Figure 2 – Data collection and analysis in a smart retail store ecosystem

Figure 2 describes data collection and analysis in a smart retail store ecosystem. As shown in Figure 2, each retail store provides gateway functionalities. It temporally aggregates the sensed data and transmits them to the IoT application. In this case, the gateway must support all communication capabilities required by the in-store equipment and must support appropriate functionalities to receive and process data from the in-store equipment. The in-store equipment can also transmit data to the IoT application server without using the gateway.

7 Requirements of IoT applications for smart retail stores

High-level requirements of IoT are identified in [ITU-T Y.4000]. Common requirements of IoT are identified in [ITU-T Y.4100]. Requirements of the network for the IoT are identified in [ITU-T Y.4113].

In this Recommendation, specific requirements of IoT applications for smart retail stores are identified.

7.1 General requirements

– IoT applications for smart retail stores are required to support non-stop retail store operation, including management of maintenance and operational data received from in-store equipment.

– IoT applications for smart retail stores are required to concurrently support retail stores managed by different retail store providers (including equipment from different equipment providers).

– IoT applications for smart retail stores are required to support real-time monitoring of in-store equipment installed in retail stores.

– IoT applications for smart retail stores are required to support mechanisms for failure prediction of in-store equipment.

– IoT applications for smart retail stores are required to support operation optimization (e.g., energy consumption optimization) of retail stores.

It is required that in-store equipment or sensors installed into in-store equipment generate data (delivered to IoT applications for smart retail stores) containing information enabling the identification of which in-store equipment generates the data.

NOTE – As an example, manufacturer name, product name, and serial number of in-store equipment can be used for that purpose.

7.2 Communication requirements

– IoT applications for smart retail stores are required to support communications with a huge number of gateways installed in retail stores and in-store equipment, including collection of different types of data and provisioning of proper instruction and information for in-store equipment management.

– IoT applications for smart retail stores are required to support connectivity adaptation and a variety of communication protocols for different types of in-store equipment and gateways provided by different providers.

– In-store equipment used by IoT applications for smart retail stores is required to support standardized interfaces and communication methods.

NOTE 1 – Examples of standardized interfaces and communication methods include RS-232C interface, 920 MHz-band wireless communication, wireless fidelity (Wi-Fi), Bluetooth, etc.

– IoT applications for smart retail stores are required to support connection to various types of communication networks according to the appropriate communication technologies.

NOTE 2 – This includes physical (PHY)/media access control (MAC) layer adaptation between the in-store gateway and the access portion of the communication networks.

– IoT applications for smart retail stores are required to support the adequate application delay tolerance and schedule the communication accordingly, or request the underlying network to do it, based on application policy criteria.

7.3 Interoperability requirements

– IoT applications for smart retail stores of a given retail store operator are recommended to provide mechanisms to interact with applications managed by a different retail store operator, subject to permissions as appropriate.

NOTE –An example of the benefit of such interaction is the optimization of product logistics when the retail store operators share a logistic network.

7.4 Scalability requirements

– IoT applications for smart retail stores are required to support monitoring of retail store status (e.g., energy consumption, amount of waste) at different granularity levels (i.e., individual store, group of stores, all stores operated by the same retail operator, and all stores operated by different retail operators).

– IoT applications for smart retail stores are required to support monitoring capabilities without being impacted by dynamic installation changes of store and equipment (i.e., newly opened or closed retail stores and newly installed or removed in-store equipment).

7.5 Location requirements

– IoT applications for smart retail stores are required to identify the location of the gateway of each retail store.

– IoT applications for smart retail stores are required to identify the location of each in-store equipment.

7.6 Security requirements

– IoT applications for smart retail stores are required to support functionality to handle the data collected by each retail store operator in a secure environment including secure communications.

8 Smart retail store ecosystem

8.1 Mapping between smart retail store ecosystem and IoT reference model

As described in clause 6, a smart retail store ecosystem involves the following roles: (a) IoT application provider, (b) network provider, (c) retail store operator and (d) in-store equipment provider.

In line with clause 6, Figure 3 shows a mapping between smart retail stores ecosystem and IoT reference model as described in [ITU-T Y.4000].

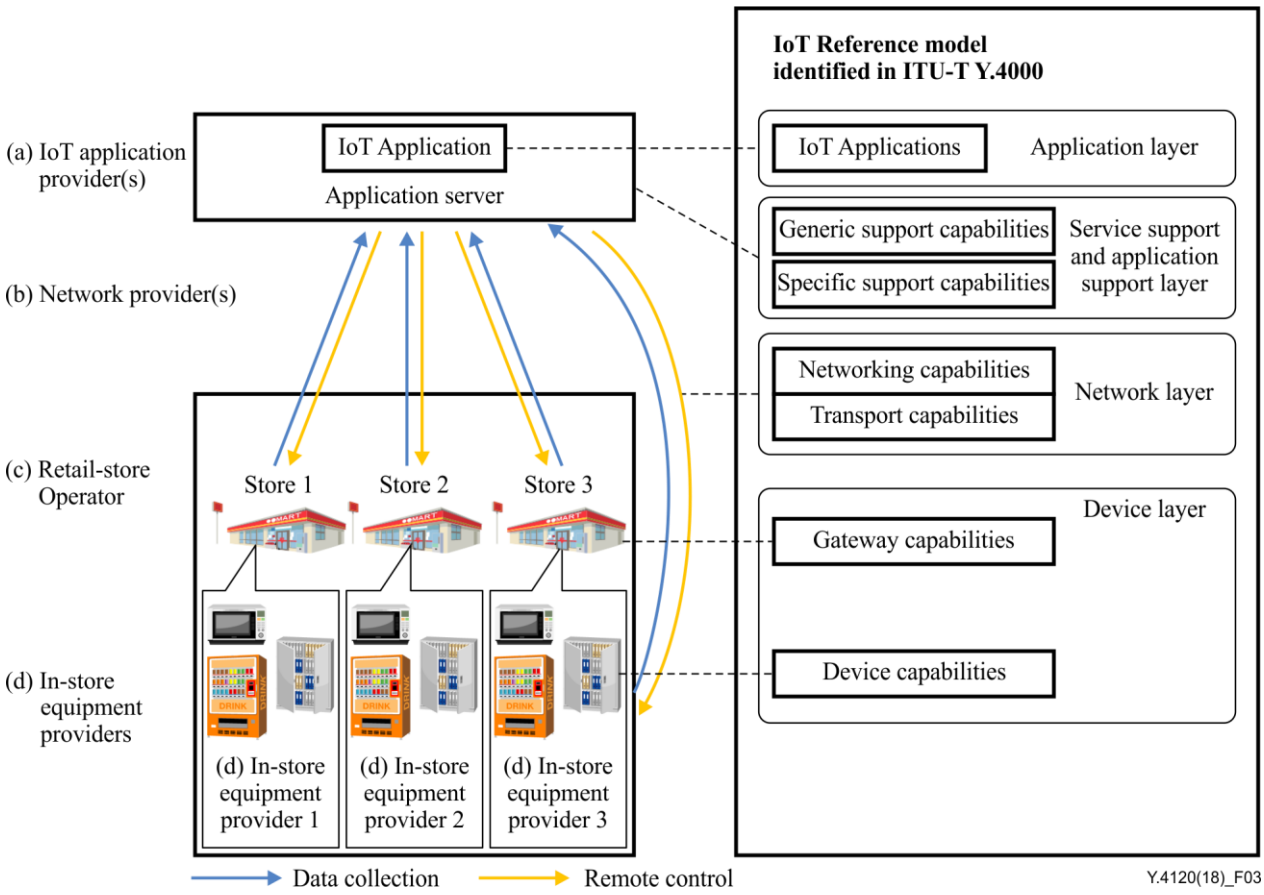

Figure 3 – Mapping between smart retail store ecosystem and IoT reference model

8.2 Variations of smart retail store ecosystem

According to the number of retail store operators and the number of in-store equipment providers, variations of the smart retail store ecosystem are identified as described below.

8.2.1 Single retail store operator and single in-store equipment provider

In this smart retail store ecosystem variation, an actor playing the role of retail store operator or in-store equipment provider may also play the role of IoT application provider. See Figure 4.

When an actor plays both roles of in-store equipment provider and IoT application provider, the sensed data may be transmitted directly to the IoT application (server side) and not via each retail store as a gateway.

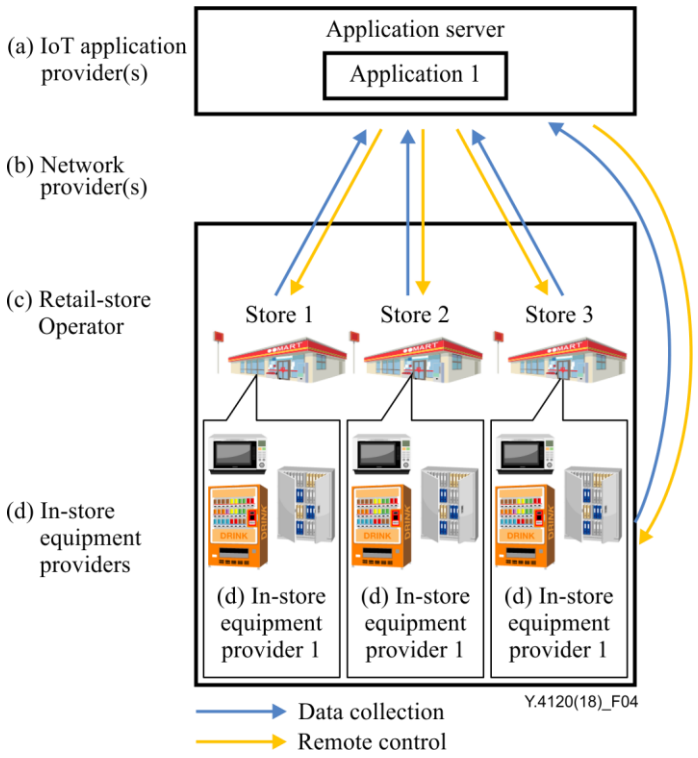

Figure 4 – Smart retail store ecosystem variation for the case of single retail store operator and single in-store equipment provider

8.2.2 Single retail store operator and multiple in-store equipment providers

In this smart retail store ecosystem variation, an actor playing the role of retail store operator adopts and installs in-store equipment provided by different providers; see Figure 5. In such case, the retail store operator actor may also act as the IoT application provider. An IoT application provider or a retail store operator should specify what kinds of data (e.g., temperature of refrigerators, operational status of equipment) of in-store equipment is collected and should inform the in-store equipment providers about it. It is also recommended to support capabilities in order to enable the collection of new kinds of data (e.g., from newly installed equipment) without predetermined specifications related to the data collection.

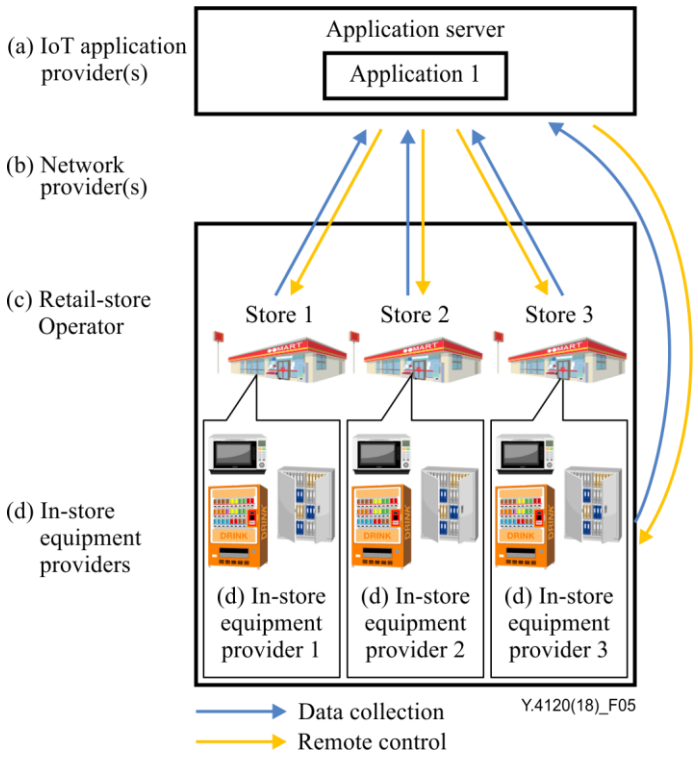

Figure 5 – Smart retail store ecosystem variation for the case of single retail store operator and multiple in-store equipment providers

8.2.3 Multiple retail store operators and single in-store equipment provider

In this smart retail store ecosystem variation, an actor playing the role of in-store equipment provider may also act as the IoT application provider. In such a case, the sensed data may be transmitted directly to the IoT application (server side) and not via each retail store as a gateway. See Figure 6.

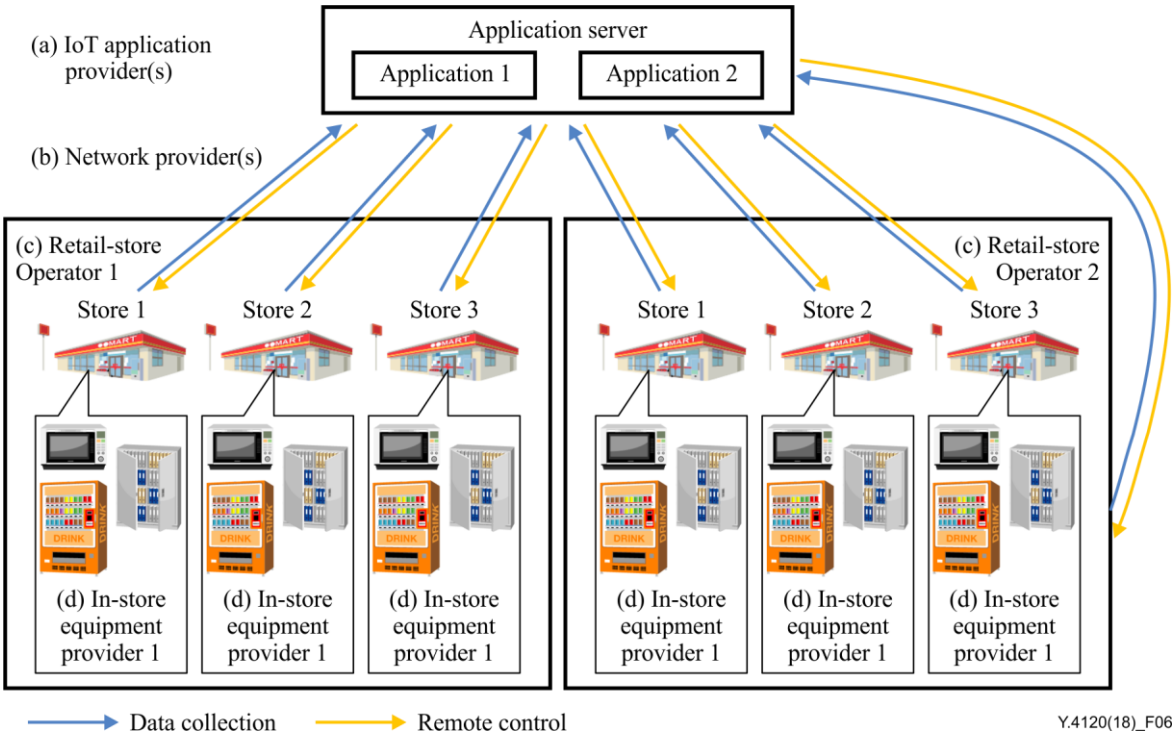

Figure 6 – Smart retail store ecosystem variation for the case of multiple retail store operators and single in-store equipment provider

8.2.4 Multiple retail store operators and multiple in-store equipment providers

In this smart retail store ecosystem variation, the IoT application provider collects information of in-store equipment – provided by different in-store equipment providers – installed in retail stores operated by different retail store operators. See Figure 7. The information is analysed by the IoT application and the analysis results are used by the retail store operators or the in-store equipment providers. The IoT application provider should specify what kinds of data (e.g., temperature of refrigerators, operational status of equipment) from retail stores or in-store equipment are collected and should inform about it the retail store operators and in-store equipment providers. It is also recommended to support capabilities in order to enable the collection of new kinds of data (e.g., from newly installed equipment) without predetermined specifications related to the data collection.

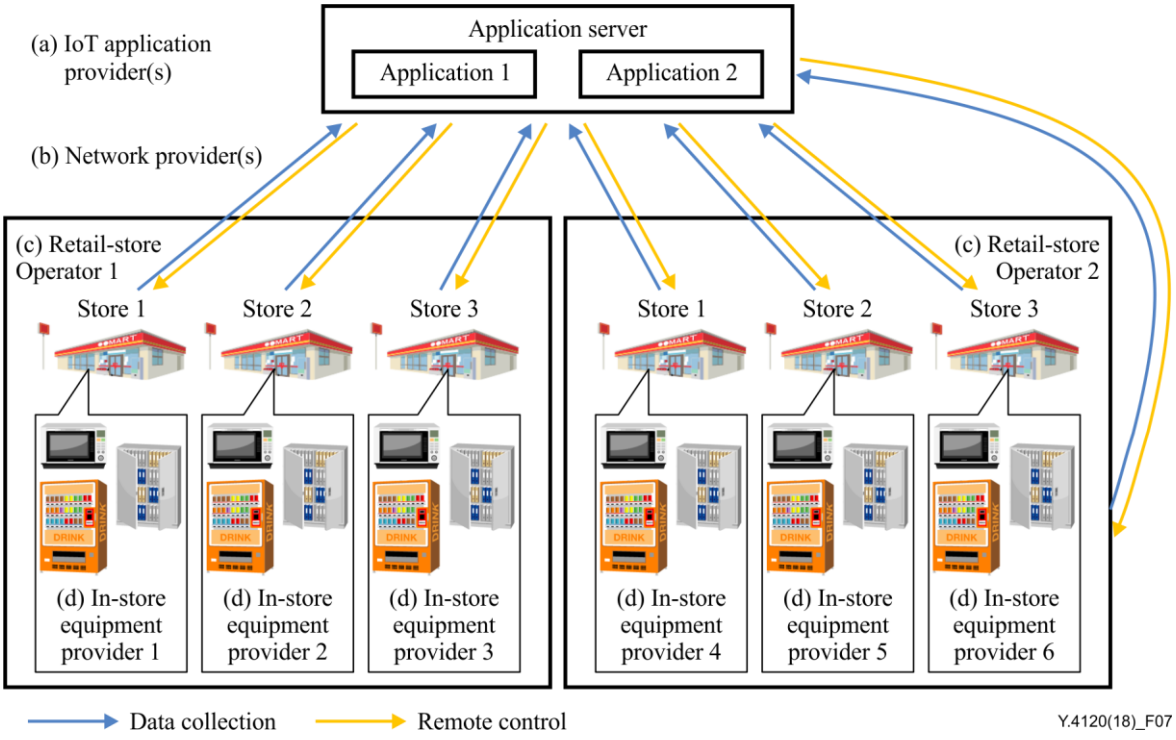

Figure 7 – Smart retail store ecosystem variation for the case of multiple retail store operators and multiple in-store equipment providers

Appendix I

Use cases of IoT applications for smart retail stores

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

I.1 In-store equipment monitoring for retail stores

1. Title of the use case

   a) Name of the use case

      In-store equipment monitoring for retail stores.

2. Objective of the use case

   This use case describes an IoT application for remote and real-time monitoring of equipment in retail stores.

3. Background

   a) Current practice (current process/context which will benefit from the implementation of the use case).

      Since a lot of equipment in retail stores does not have communication capability, remote and real-time monitoring of retail store equipment is not widely conducted.

   b) Need for use case

      Remote and real-time monitoring for such equipment enables early detection of equipment failure, prediction of equipment failure, and remote control and management of the equipment.

   c) Country ecosystem specifics

      Such applications are useful for countries and regions where large-scale retail store operators are present.

4. Description

   a) Ecosystem description in terms of actors and roles

      - IoT application provider(s);
      - network provider(s);
      - retail store operator(s);
      - in-store equipment provider(s).

   b) Contextual illustration (Figure I.1)

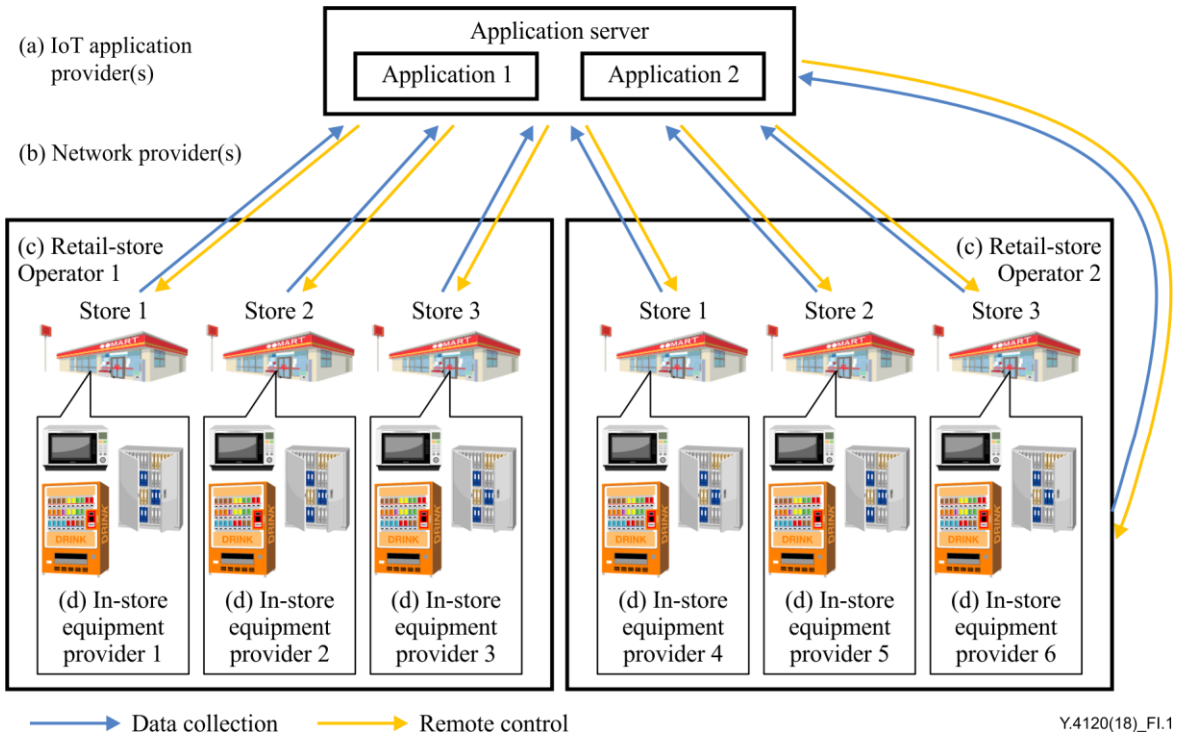

Figure I.1 – Smart retail store ecosystem

- sensors are installed into in-store equipment (e.g., refrigerators, air-conditioners, coffee brewers), operational information or maintenance information of the equipment is sensed;
- the sensed information is transmitted via a gateway in the retail store or directly to the IoT application (server side);
- the transmitted information is analyzed by the IoT application;
- the analysis results are employed for failure diagnosis or equipment control.

c) Pre-requisites

- sensors must be installed into in-store equipment in order to collect information;
- in-store equipment must have communication capabilities or be supplemented by a communication module installed into the in-store equipment itself in order to transmit the sensed data to external entities.

d) Triggers

- by instruction from the IoT application, sensors installed in in-store equipment start sensing data and transmitting them to the IoT application.

5. Architectural considerations

a) Deployment considerations

With respect to the IoT reference model described in [ITU-T Y.4000]:

- the IoT application provider provides IoT applications;
- the network provider provides network capabilities and transport capabilities;
- the retail store operator provides gateway capabilities;
- the in-store equipment provider provides device capabilities.

b) Geographical considerations

- according to countries or regional specificities, retail stores may be located in a wide area;

- retail stores operated by a single retail store operator may be located in multiple countries or regions;
- location of in-store equipment differs from store to store.

c) Communication infrastructure
- the data sensed by the sensors are transmitted via wired or wireless communication to a server. Therefore, the in-store equipment needs communication capabilities. Sensors themselves have communication capabilities, otherwise a communication module is installed into the in-store equipment.

d) Performance criteria
- data collection, data analysis and remote control should be done in real-time or in quasi real-time.

e) Interface requirements
- IoT application, retail store, and in-store equipment need pre-determined interfaces for connectivity.

f) User interface
- the IoT application needs a graphical user interface (GUI) for status monitoring of each in-store equipment;
- sensors installed into the in-store equipment need interface to indicate current status.

g) Application programming interfaces (APIs) to be exposed to the application from platform
- when the data are disclosed to third-party applications, API must be defined for that purpose.

h) Data management
- data must be managed by the IoT application which collects them.

i) Data backup, archiving and recovery
- data backup, archiving, and recovery must be conducted by the IoT application which collects the data.

j) Remote device management
- the IoT application must remotely manage in-store equipment or sensors installed into the in-store equipment.

k) Start-up/shutdown process
- the IoT application should have the ability to remotely start-up or shutdown in-store equipment or sensors installed into the in-store equipment.

l) Security requirements
- the collected data must be stored in secure environment.

6. Potential market growth forecast

a) Market scale of retail store solutions incorporating IoT is expanding. Some reports indicate it will be 1.5 trillion US dollar market over the next decade.

7. Implementation constraints (for the support of the use case)

a) Communication methods and protocols adopted by in-store equipment will not be unique. IoT applications or a gateway in a retail store must support all methods and protocols which the in-store equipment adopts.

I.2 In-store goods out of stock reminding for retail stores

1. Title of the use case

   a) Name of the use case

      In-store goods out of stock reminding for retail stores

2. Objective of the use case

   This use case describes an IoT application for remote and real-time monitoring of the sales information in retail stores and for notification to the retail store operator of out of stock situations.

3. Background

   a) Current practice (current process/context which will benefit from the implementation of the use case).

      Current practice is that the staff holding POS terminals scans each good in order to get the commodity stock information, and then send the information to the management platform for statistical analysis.

   b) Need for use case

      Sensors have been widely used and sensors can be used to collect the stock of goods, which can be efficiently and rapidly realized.

      Compared with the use of point of sale (POS) terminal for inventory management, the use of sensors in this case is more conducive to the automatic detection and location of goods.

4. Description

   a) Ecosystem description in terms of actors and roles

      - IoT application provider(s);
      - network provider(s);
      - retail store operator(s);
      - in-store equipment provider(s).

   b) Contextual illustration (see Figure I.2)

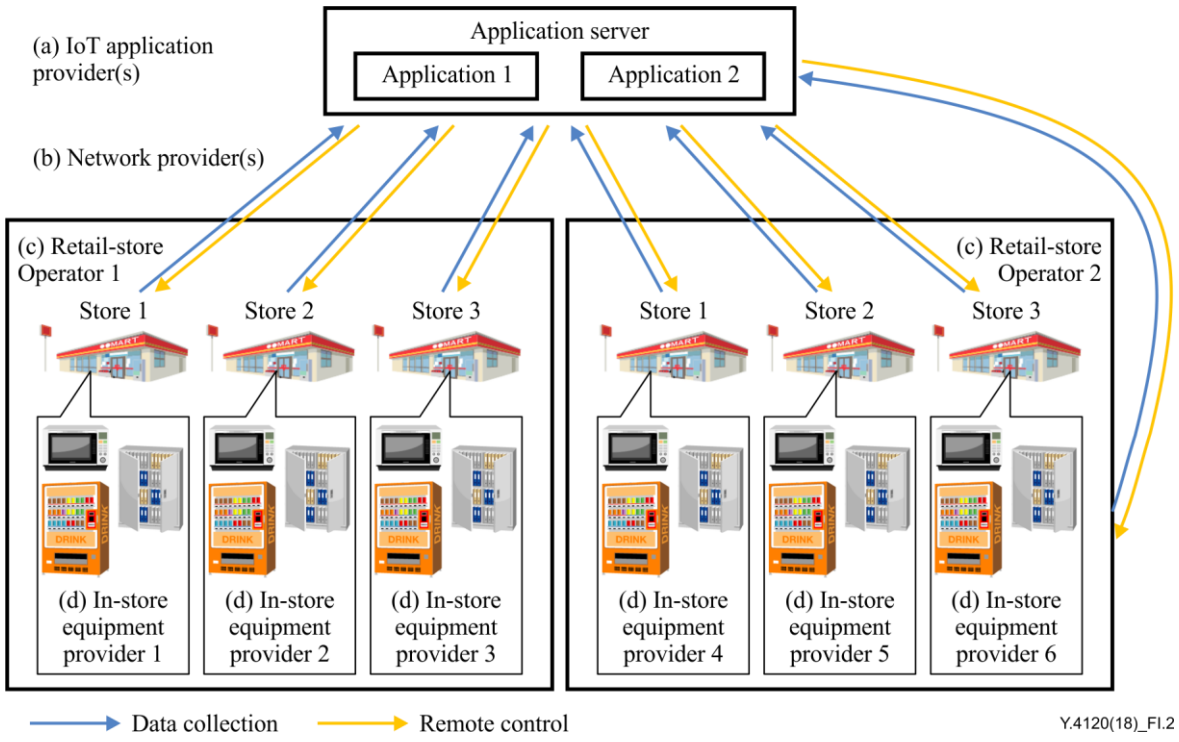

Figure I.2 – Smart retail store ecosystem

- sensors are installed on the shelves of retail stores or into the in-store equipment to monitor and detect the stock of goods;
- the sensed information is transmitted via a gateway in the retail store or directly to the IoT application (server side);
- the transmitted information is analyzed by the IoT application;
- the analysis results are employed for replenishing the inventory.

c) Pre-requisites

- sensors must be installed into in-store equipment or on the shelves in order to collect information;
- in-store equipment must have communication capabilities or be supplemented by a communication module installed into the in-store equipment itself in order to transmit the sensed data to external entities.

d) Triggers

- sensors test goods identifiers at fixed areas and locations of the shelves or the in-store equipment to find out whether or not there are out of stock situations.

5. Architectural considerations

a) Deployment considerations

With respect to the IoT reference model described in [ITU-T Y.4000]:

- the IoT application provider provides IoT applications;
- the network provider provides network capabilities and transport capabilities;
- the retail store operator provides gateway capabilities;
- the In-store equipment provider provides device capabilities.

b) Geographical considerations

- according to countries or regional specificities, chain retail stores may be located in a wide area;

- chain retail stores operated by a single retail store operator may be located in multiple countries or regions;
- location of in-store equipment differs from store to store.

c) Communication infrastructure
- the data sensed by the sensors are transmitted via wired or wireless communication to a server. Therefore, the in-store equipment needs communication capabilities. Sensors themselves may be supplemented by communication capabilities of a device, otherwise a communication module is installed into the in-store equipment.

d) Interface requirements
- IoT application, retail store, and in-store equipment need pre-determined interfaces for connectivity.

e) User interface
- the IoT application needs a GUI for status monitoring of in-store goods;
- sensors installed into the in-store equipment need interface to indicate their current status.

f) APIs to be exposed to the application from platform
- when the data are disclosed to third-party applications, APIs must be defined at appropriate system location for that purpose.

g) Data management
- data must be managed by the IoT application which collects the data.

h) Data backup, archiving and recovery
- data backup, archiving, and recovery must be conducted by the IoT application which collects the data.

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Printed in Switzerland
Geneva, 2018