International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.2238

(06/2015)

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Service aspects: Service capabilities and service architecture

Overview of Smart Farming based on networks

Recommendation ITU-T Y.2238

International Telecommunication Union

ITU-T Y-SERIES RECOMMENDATIONS

GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

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

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

Recommendation ITU-T Y.2238

Overview of Smart Farming based on networks

Summary

Recommendation ITU-T Y.2238 considers the actualized convergence service for agriculture, namely Smart Farming, as a solution to cope with various problems caused by severe conditions or the gap of viewpoints between people engaged in farming and IT engineers. In particular, this Recommendation defines service capabilities for Smart Farming, provides a reference model for Smart Farming, and identifies network capabilities required to produce an infrastructure which supports Smart Farming.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2238	2015-06-13	13	11.1002/1000/12520

Keywords

Convergence service for agriculture, Smart Farming.

---

* 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

Introduction

An actualized convergence service for agriculture is expected to bring more efficiency and quality improvement in production, distribution and consumption of agricultural products with the aid of IT information processing and autonomous control technologies.

However, there exist many difficulties to establish services and systems to actualize the convergence service in the agricultural field to cope with various problems such as time-varying weather changes, growth condition of farm products, and continual diseases or technical problems such as battery life and sensor malfunctions due to severe conditions. In addition, the gap of viewpoints between people engaged in farming and IT engineers may make it difficult to accomplish this mission.

Therefore, it is appropriate to consider an actualized convergence service for agriculture, namely Smart Farming, as a solution to cope with anticipated problems. In addition, the aspect of network capabilities to support this convergence service, where various types of networks, such as NGN, Future Networks and legacy networks, could be applied should be considered. This Recommendation develops a reference model, defines service capabilities and identifies network capabilities required to support such services.

Recommendation ITU-T Y.2238

Overview of Smart Farming based on networks

1 Scope

This Recommendation provides an overview of Smart Farming based on networks.

The scope of this Recommendation includes:

– Smart Farming reference model.

– Service capabilities required by Smart Farming.

– Network capabilities required by Smart Farming.

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.2002] Recommendation ITU-T Y.2002 (2009), *Overview of ubiquitous networking and its support in NGN*.

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

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

[ITU-T Y.3041] Recommendation ITU-T Y.3041 (2013), *Smart ubiquitous networks – Overview*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 context [ITU-T Y.2002]: The information that can be used to characterize the environment of a user.

NOTE – Context information may include where the user is, what resources (devices, access points, noise level, bandwidth, etc.) are near the user, at what time the user is moving, interaction history between person and objects, etc. According to specific applications, context information can be updated.

3.1.2 object [ITU-T Y.2002]: An intrinsic representation of an entity that is described at an appropriate level of abstraction in terms of its attributes and functions.

NOTE 1 – An object is characterized by its behaviour. An object is distinct from any other object. An object interacts with its environment including other objects at its interaction points. An object is informally said to perform functions and offer services (an object which makes a function available is said to offer a service). For modelling purposes, these functions and services are specified in terms of the behaviour of the object and of its interfaces. An object can perform more than one function. A function can be performed by the cooperation of several objects.

NOTE 2 – Objects include terminal devices (e.g., used by a person to access the network such as mobile phones, personal computers, etc.), remote monitoring devices (e.g., cameras, sensors), information devices (e.g., content delivery server), products, contents, and resources.

3.1.3 ubiquitous networking [ITU-T Y.2002]: The ability for persons and/or devices to access services and communicate while minimizing technical restrictions regarding where, when and how these services are accessed, in the context of the service(s) subscribed to.

NOTE – Although technical restrictions to access services and communicate may be minimized, other constraints such as regulatory, national, provider and environmental constraints may impose further restrictions.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 agricultural consumer: The service role that ultimately purchases the final agricultural products from distributors or agricultural producers.

3.2.2 agricultural distributor: The service role that distributes agricultural products supplied from agricultural producers through the distribution channel.

3.2.3 agricultural producer: The service role that actually produces agricultural products to be supplied to distributors or consumers.

3.2.4 Smart Farming based on networks: A service that uses networks to actualize a convergence service in the agricultural field to attain more efficiency and quality improvement and to cope with various problems.

NOTE – Problems may include such items as time-varying weather changes, growth condition of farm products, plant diseases, and technical problems, such as battery life and sensor malfunctions due to severe conditions. The service may overcome such problems with the aid of IT information processing and autonomous control technologies.

3.2.5 Smart Farming service provider: The service role that provides the requested Smart Farming services, such as providing a portal or consulting based on data gathered from agricultural fields, to requesting users.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA Authentication, Authorization and Accounting

API Application Programming Interface

CCTV Closed-Circuit Television

DC Distribution Centre

GC Gathering Centre

IoT Internet of Things

IPv6 Internet Protocol, version 6

ISDN Integrated Services Digital Network

IT Information Technology

NGN Next Generation Network

PSTN Public Switched Telephone Network

QoS Quality of Service

RFID Radio Frequency Identification

5 Conventions

None.

6 Introduction of Smart Farming based on networks

6.1 Concept

Smart Farming is a service that uses networks to actualize a convergence service in the agricultural field to cope with various problems, e.g., time-varying weather changes, growth condition of farm products, and continual diseases or technical problems, such as battery life, sensor malfunctions due to severe conditions, with the aid of information processing and autonomous control technologies of the information technology (IT) area.

Smart Farming, based on networks, needs to be considered on the basis of interactions between the entities that are tightly related to the agricultural field, i.e., agricultural producers, service providers, logistics agents, market distributors, customers and the telecommunications network that interconnects these, as shown in Figure 1.

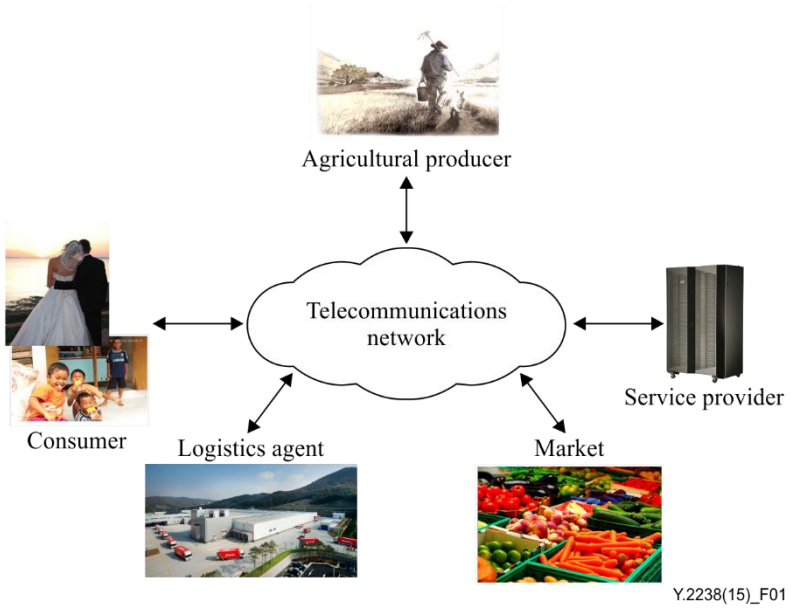

Figure 1 – Conceptual diagram of Smart Farming based on networks

6.2 General overview

Smart Farming can run autonomously without human intervention with the cyclic procedures of Appendix I considering environments as shown in Appendix II when advanced technologies such as sensors, computers or control systems are used. However, Smart Farming must also be capable of coping with unexpected events, such as product theft and reduction in revenues due to excess production. Hence, there is a need for capabilities to address these issues. Services, such as the following, which use networks, could be developed to address such problems in the future environment:

– Farm products protection: a service that prevents the theft of agricultural products in farmlands, greenhouses or warehouses by humans and animals through surveillance, such as closed-circuit television (CCTV), infrared sensors or other sensors that are connected via networks to agricultural producers.

– Farm products traceability: a service that provides traceability information about farm products in the market to customers, including identity information about agricultural producers, food safety certification, etc.
– Remote farm management: a service that enables agricultural producers to monitor and control farm conditions on remote sites through devices such as smartphones or other terminals connected to networks.
– Farm production regulation: a service that provides information to aid agricultural producers in deciding which farm products to sow, when to sow, when to harvest, and applicable farm production regulations.

7 Reference model of Smart Farming based on networks

7.1 Reference architecture

To apply Smart Farming based on networks shown in Figure 1, a reference architecture showing the service roles, consumers, distributors, agricultural producers and service providers, is presented in Figure 2.

Service roles shown in Figure 2 (consumers, agricultural producers, distributors, service providers and network providers) play major roles in Smart Farming based on networks as follows:

– Consumer: the service role that ultimately purchases the final agricultural product from distributors, agricultural producers or direct sellers and also provides a farm product traceability service to the service provider.
– Agricultural producer: the service role that actually produces agricultural products to be supplied to distributors or consumers that is provided with Smart Farming services, such as a farm product protection service or remote farm management service.
– Distributor: the service role that distributes agricultural products supplied from agricultural producers through the distribution network and provides a farm production regulation service, which is required to identify and maintain the break-even point.
– Service provider: the service role that provides the requested Smart Farming services to requesting users such as consumers, agricultural producers and distributors.
– Network provider: the service role that provides the infrastructure that conveys information related to Smart Farming based on networks and interconnects the other service roles.

These service roles play their part according to the stage at which they are positioned, i.e., pre-production stage, production stage or post-production stage. In the pre-production and production stages, the agricultural producer can be advised on what to produce, when to produce, what to seed and other matters by the service provider via plan/production consulting. Distributors and consumers can also be advised by the service provider about market demands, food traceability and prices. The network provider can provide the telecommunication network to support information transfer between the various service roles.

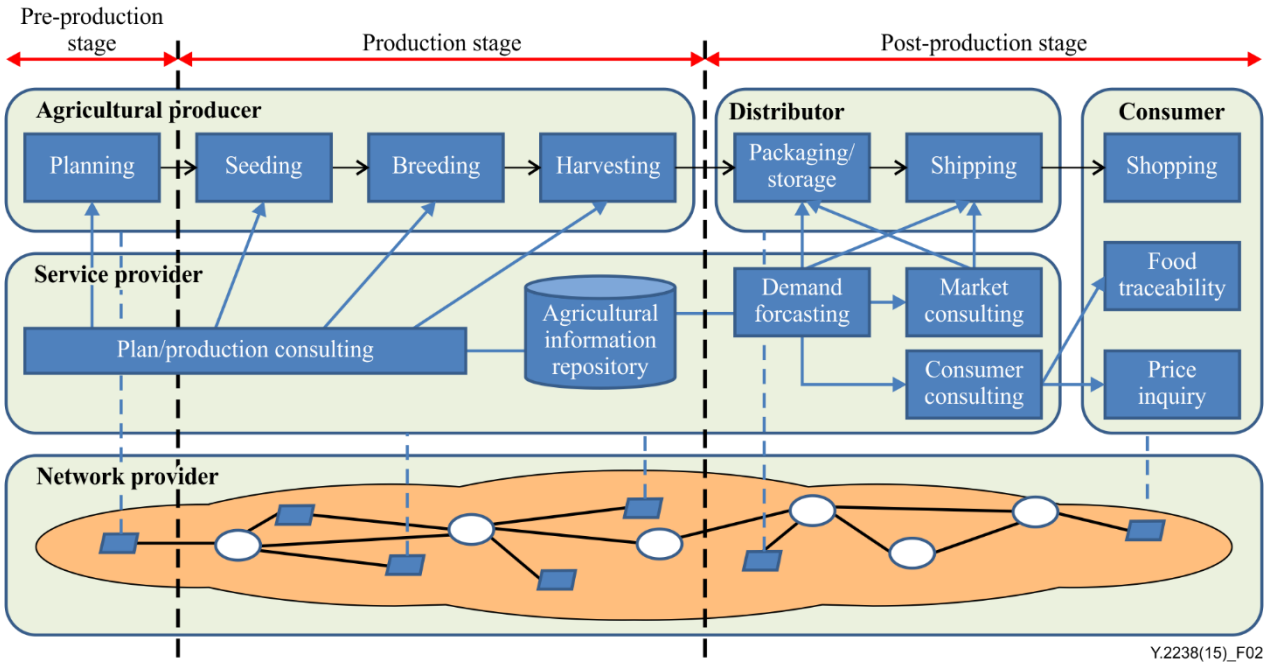

Figure 2 – Reference model of Smart Farming based on networks

7.2 Service roles

There can be various types of service roles, each with differing capabilities. Categorization of each of the identified service roles facilitates identification of appropriate service capabilities in this Recommendation. For this purpose, the service roles in the Smart Farming service are categorized in Table 1.

Table 1 – Service roles

Domain	Actor	Role
Agricultural producer	Outdoors producer	Agricultural producer who grows crops outdoors.
	Greenhouse producer	Agricultural producer who grows crops in greenhouses.
	Plant factory operator	Agricultural producer who operates a plant factory and grows crops in it.
Distributor	Direct seller	Seller who grows and sells crops.
	Wholesale/retail distributor	Business operator who gathers, selects, packages and/or processes agricultural products to sell wholesale/retail.
	On-line seller	Business operator who runs an on-line market site and trades and sells agricultural products to those who access the on-line site.
Service provider	Service business operator	Business operator who makes a profit by providing a portal to consumers through the network.
	Content business operator	Information provider, e.g., agriculture consultant, who makes a profit by providing plant growth aid information based on data, gathered from sensors and videos in greenhouses or plant factories.
Network provider	Network business operator	Business operator who makes a profit by providing networks to other service roles for agricultural products information delivery.

Table 1 – Service roles

Domain	Actor	Role
Consumer	General consumer	Consumer who buys agricultural products for personal use.
	Business consumer	Consumer who buys agricultural products for business purposes, such as restaurants and hotels.
	Group consumer	Consumer who buys agricultural products for inter-group members' purposes.

The service roles could interact for the purpose of conducting business. Actors may assume more than one role and through the use of services may attain profits. It is also possible to access dedicated services through these interactions.

8 Service capabilities required to support Smart Farming

There are a number of tasks that must be accomplished during the various implementation stages associated with Smart Farming in Figure 2. In the pre-production stage, the agricultural producer performs planning based on the service provider's plan/production consulting using connections provided by the network provider. In the production stage, the agricultural producer performs seeding, breeding and harvesting based on the service provider's production consulting through the connections provided by the network provider. The agricultural information repository is required to support these consulting tasks of the service provider. In the post-production stage, the distributor performs packaging/storage and shipping based on the service provider's market consulting and demand forecasting through the connections provided by the network provider. The consumer also performs shopping with food traceability and price inquiry based on consulting through the connections provided by the network provider.

These tasks could be defined in the context of service capabilities. The detailed service capability information is provided in Appendix III. It is recognized that, while Appendix III may not provide an all-inclusive list of the many tasks that must be undertaken during the various stages of implementing Smart Farming, it does allow for sufficient information to be obtained to develop a set of required network capabilities that are identified in clause 9.

9 Network capabilities

The high-level network capabilities for the support of Smart Farming are as follows:

– Connecting to anything capabilities: Theses capabilities refer to the support of the different ubiquitous networking communication types (person-to-person communication, person-to-object communication and object-to-object communication) and include the support of tag-based devices (e.g., radio frequency identification, RFID) and sensor devices. Identification, naming and addressing capabilities are essential for supporting "connecting to anything".

– Open web-based service environment capabilities: Emerging ubiquitous services/applications will be provided based upon an open web-based service environment, as well as on legacy telecommunication and broadcasting services. In particular, application programming interfaces (APIs) and web with dynamics and interactivities will be supported. Such a web-based service environment will allow not only the creation of retail community-type services, but also the building of an open service platform environment which third-party application developers can access to launch their own applications. Using interactive, collaborative and customizable features, the web can provide rich user experiences and new business opportunities for the provision of ubiquitous networking services and applications.

– Context-awareness and seamlessness capabilities: Context-aware means the ability to detect changes in the status of objects. Intelligence systems associated with this capability can help to provide the best service, which meets the situation using user and environmental status recognition. Seamlessness is a key capability for "5 Any" (anytime, anywhere, any-service, any-network and any-object).
– Multi-networking capabilities: A transport stratum needs multi-networking capabilities in order to simultaneously support unicast/multicast, multi-homing and multi-path. Because of high traffic volume and the number of receivers, ubiquitous networking requires multicast transport capability for resource efficiency. Multi-homing enables the device to be always best connected using multiple network interfaces including different fixed/mobile access technologies. These capabilities can improve network reliability and guarantee continuous connectivity with desirable quality of service (QoS) through redundancy and fault tolerance.
– End-to-end connectivity over interconnected networks: For Smart Farming, it is critical to develop a solution to provide end-to-end connectivity to all objects over interconnected heterogeneous networks such as next generation networks (NGNs), other IP-based networks, broadcasting networks, mobile/wireless networks and public switched telephone network/integrated services digital networks (PSTN/ISDNs). Internet Protocol, version 6 (IPv6), with its large address space, can be considered a good candidate for providing globally unique addresses to objects [ITU-T Y.3041].
– Networking capabilities: Provide relevant control functions of network connectivity, such as the Internet of Things (IoT) and transport resource control functions, mobility management or authentication, authorization and accounting (AAA) [b-ITU-T Y Suppl. 3].
– The device capabilities include, but are not limited to: Direct interaction with the communication network: Devices are able to gather and upload information directly (i.e., without using gateway capabilities) to the communication network and can directly receive information (e.g., commands) from the communication network [ITU-T Y.2060].

10 Security considerations

This Recommendation is recognized as an enhancement of IP-based networks. Thus, it is assumed that security considerations in general are based on the security of IP-based networks and thus it is required to follow the security considerations identified by clauses 7 and 8 of [ITU-T Y.2701].

Appendix I

The cyclic procedures of a convergence service for agriculture

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

An actualized convergence service for agriculture is expected to bring more efficiency and quality improvement in the cyclic procedures for production, distribution and consumption of agricultural products with the aid of information processing and autonomous control technologies of the IT area as shown in Figure I.1.

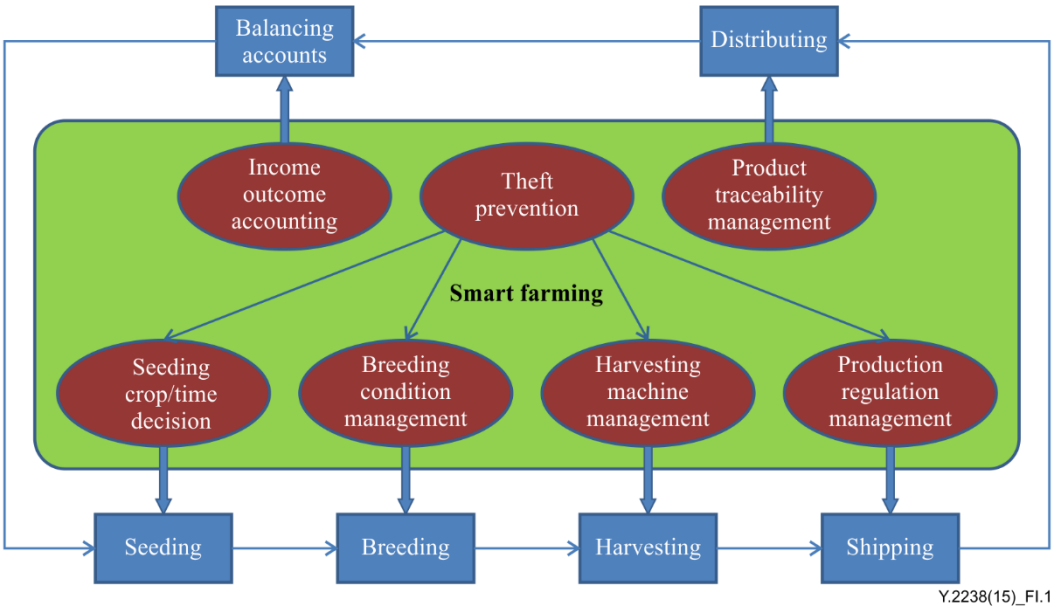

Figure I.1 – The cyclic procedures of a convergence service for agriculture

Appendix II

Environments and deployments of a convergence service for agriculture

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

Considering the deployments of a convergence service for outdoor farming, there could exist two types of environment, i.e., real-time facilities environments and crop growth environments. The former is related to administration networks mainly consisting of indoor actuators connected with telecommunication networks, while the latter is related to monitoring networks mainly consisting of sensors connected with telecommunication networks. Figure II.1 shows the aspect of environments and deployments of the convergence service for outdoor farming.

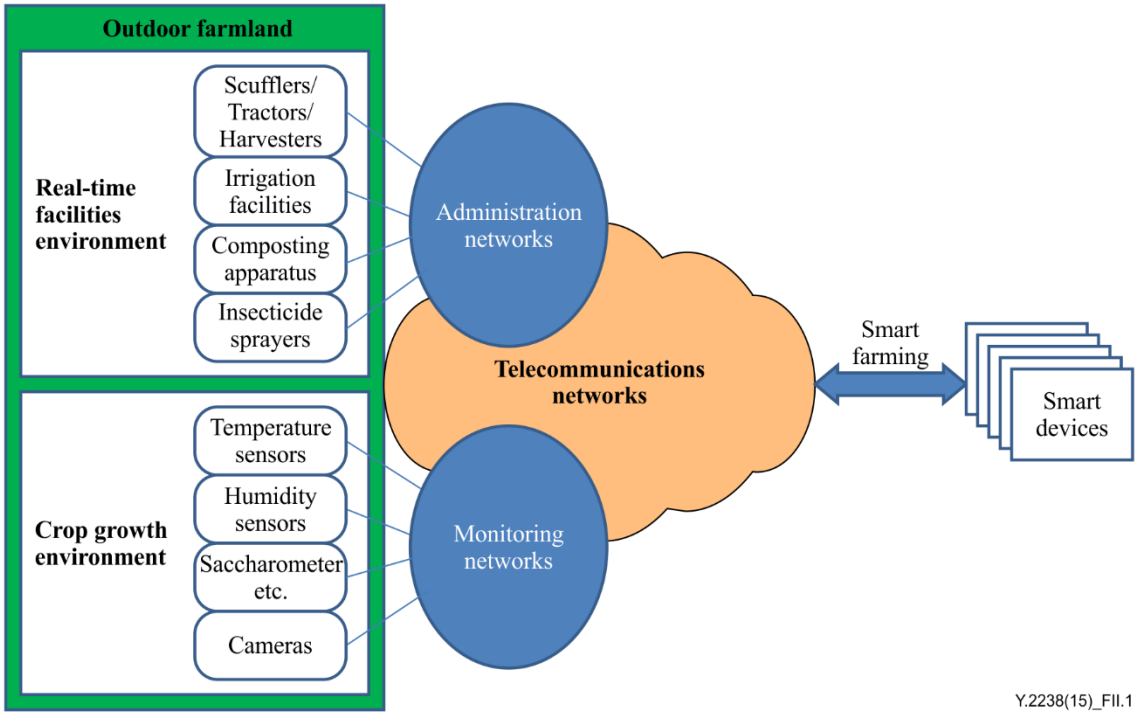

Figure II.1 – Environments and deployments of a convergence service for outdoor farming

Considering the deployments of a convergence service for greenhouse/plant factory farming, there could exist two types of environment, i.e., real-time facilities environments and crop growth environments. The former is related to administration networks mainly consisting of indoor actuators connected with telecommunication networks, while the latter is related to monitoring networks mainly consisting of sensors connected with telecommunication networks. Figure II.2 shows the aspect of environments and deployments of the convergence service for greenhouse/plant factory farming.

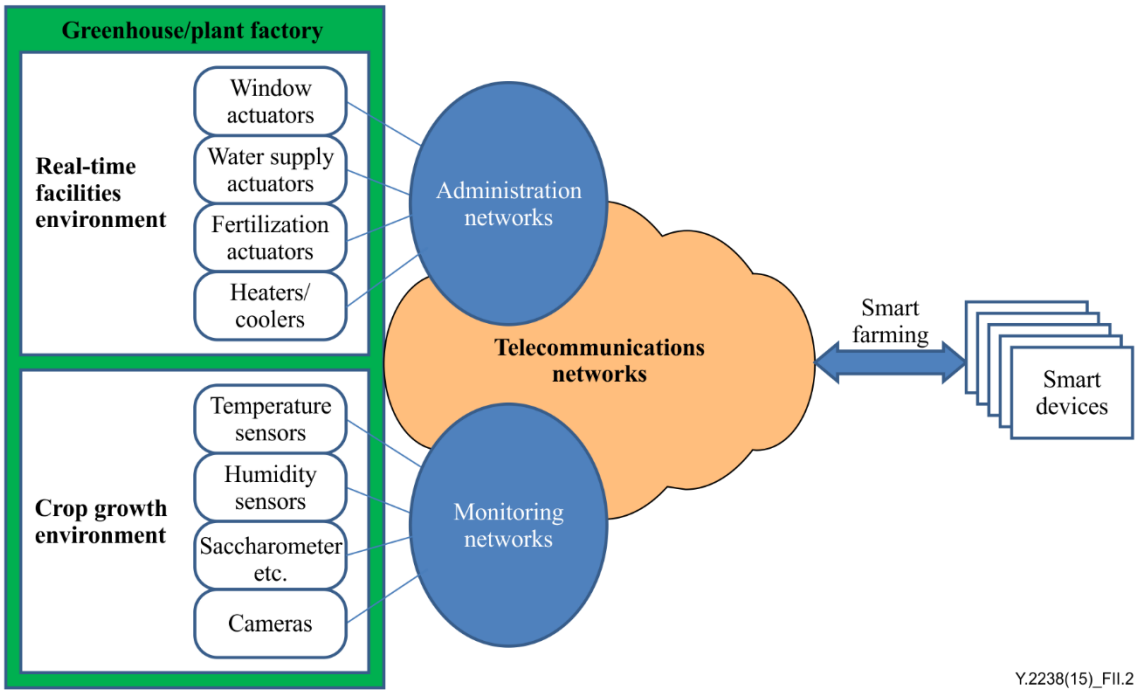

Figure II.2 – Environments and deployments of a convergence service for greenhouse/plant factory farming

Appendix III

Service capabilities

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

In this appendix, attention focuses on tasks that must be accomplished during the various implementation stages associated with Smart Farming. It is recognized that this is not an all-inclusive list of the many tasks which must be undertaken during the various stages of implementing Smart Farming.

III.1 Service capabilities for the pre-production stage

In the pre-production stage, the following service capabilities are required to facilitate a convergence service for agriculture:

– Making a business plan: A business plan should consider sales/production planning, generate profit and loss calculations of the overall business production enterprise, address marketing and management issues, and understand business interactions with personal communication communities;

– Operational review: While an operational review is required to ensure stable revenues, it is also required to provide a global review on licenses, permits, regulations, patents, trademarks, risk management, environmental issues, production quality, timeline, etc.;

– Role of IT in Smart Farming: The role of IT in Smart Farming should be determined, e.g., how to apply IT for such items as sensing and monitoring systems, network infrastructure, controlling systems, information data bases and farming management servers to support Smart Farming;

– Business review: For the stable management of the Smart Farming business, it is appropriate to consider: the size, type and quality of facilities and facility equipment; real estate; farming equipment; ownership structure; etc.

– Financial estimate: For maintaining the Smart Farming business and attaining more profits, it is very important to estimate projected cash flow, income statement and balance sheet. It is also necessary to estimate a projected statement of expenses and profitability;

– Decision making: This is the process used to make decisions on produce and product selection and amounts, development of a rationalized price policy and marketing policy at all levels of marketing, etc.;

– Marketing plan: Before the production phase, it would be appropriate to consider market trends, customer service, marketing contracts, strategic partners, pricing, promotion, distribution, target markets, competitive advantage, etc. in a marketing plan to produce a better decision;

– Understanding customers: For better understanding, it is required to identify customer class for primary products and anticipating customer's changing characteristics.

III.2 Service capabilities for the production stage

Service capabilities for the production stage need to be described for Smart Farming to attain effective crop production. For this purpose, optimal environmental control methods that take into consideration energy use and automation efficiency are required for more effective crop production. The optimal growth condition is different as it depends on crop species, types and varieties of plants that are grown in greenhouses and plant factories.

The control system at the production stage could define the major components in applying IT technologies in Smart Farming and specify the requirements and the architecture for technological

issues. The system could collect information for the growth management of crops and control the facilities promoting optimal growth environments in greenhouses. Such a system covers the growth environment management, the growth environment controls, etc. This is specified to make an artificial cultural environment for crops with culture fluid, carbon dioxide concentration, temperature, humidity, wind and light. Smart farming enables generation of such a system, which provides an automatic and continuous production of agricultural produce regardless of the place and the season, and control over the greenhouse and plant factory (indoor) or outdoor fields by management of sensor networks.

It is also required to have defined interfaces for Sensor Nodes and Control Gateways as the control system for such operations between the Sensor Nodes. A Smart Farming. Control Gateway needs to interact with inside and outside sensors. The technical requirements for sensor nodes and gateways must allow for operation in appropriate environments, e.g., it must cope with external weather conditions, internal air quality and various soil environments. The following should be defined and characterized:

– Operating environment: Sensors and sensor node configuration, communications, environments and operation management;
– Message passing model: Message passing models between a Smart Farming control gateway and sensor nodes should be developed;
– Message format: General frame structure and configuration of each field;
– Message flow: Initialization for sensor nodes, sensor data monitoring (passive, active and event-based), the sensor node status and reporting of information obtained.

It is also necessary to define the relationship among environmental variables, e.g., temperature, relative humidity, controlling actuators and application technologies for Smart Farming. It should contribute to stability and high efficiency of plant production in plant factories and greenhouses by providing indicators for environmental control. The convergence service for greenhouse and plant factory farming can be divided into several phases as follows:

– Monitoring changes of facility environments in real-time;
– Offering the most suitable information on the quality of crops by analysing synthetically the observation of crop status, growth conditions and environmental information;
– Organic controlling facility environments according to the growth level of crops and any changes of environments.

Considering these phases, Smart Farming can be provided to users based on environments related to real-time facilities and crop growth monitoring.

Required features in greenhouses and plant factories, which consist of devices related to energy, harvesting devices, light sources, environmental controls for a greenhouse and a plant factory interior, and a wide area of interfaces for the related control information are as follows:

– Interface among sensors, controllers and energy components;
– Information and communication interfaces among plant factories and greenhouses;
– Component monitoring specification for sensing in plant factories and greenhouses;
– Control and monitoring specification for actuators in plant factories and greenhouses;
– Energy monitoring and control specification in plant factories and greenhouses;
– Service structure and service specification standards in plant factories and greenhouses.

III.3 Service capabilities for the post-production stage

Service at the post-production stage is required for product distribution flow from producers to consumers. In the product flow, farmers, vendors/agents, wholesalers, rural retailers and suppliers,

and logistics are involved. At all levels, information flow and produce management is essential to maintain the product's quality throughout the product distribution flow as shown in Figure III.1. The flow of input products from producers to consumers should be described in detail and the constraints in each sub-process should be identified to develop appropriate solutions for the post-production stage.

Figure III.1 – Product flow between producers and consumers

It is important to note that lack of packaging facilities may be one of the constraints in the product flow control of small-scale farmers during the transition from subsistence to commercial farming. Significant post-harvest losses occur when especially vulnerable crops and fruits are subjected to mechanical damage. Therefore, management of packaging and distribution should be taken into consideration in the development of product flow control systems during the post-production stage.

III.3.1 Product distribution flow at the post-production stage

Integrated post-production networks can be developed by forming clusters of producers and determining the optimum gathering centres (GCs) linking goods producers, distributors, and consumers/retailers enabling coordinated distribution of local goods products and facilitating the integration of food distribution in the local products supply systems into large scale product distribution channels as shown in Figure III.1. Detailed gathering and distribution routes can be analysed using product flow control functions. It can be noted that coordinating and integrating the product flow control activities of local product delivery systems may reduce the number of routes, transport distances and transport times. Such post-production network integration can produce positive improvements towards potential markets, product flow efficiency, environmental issues and traceability of product quality and product origins.

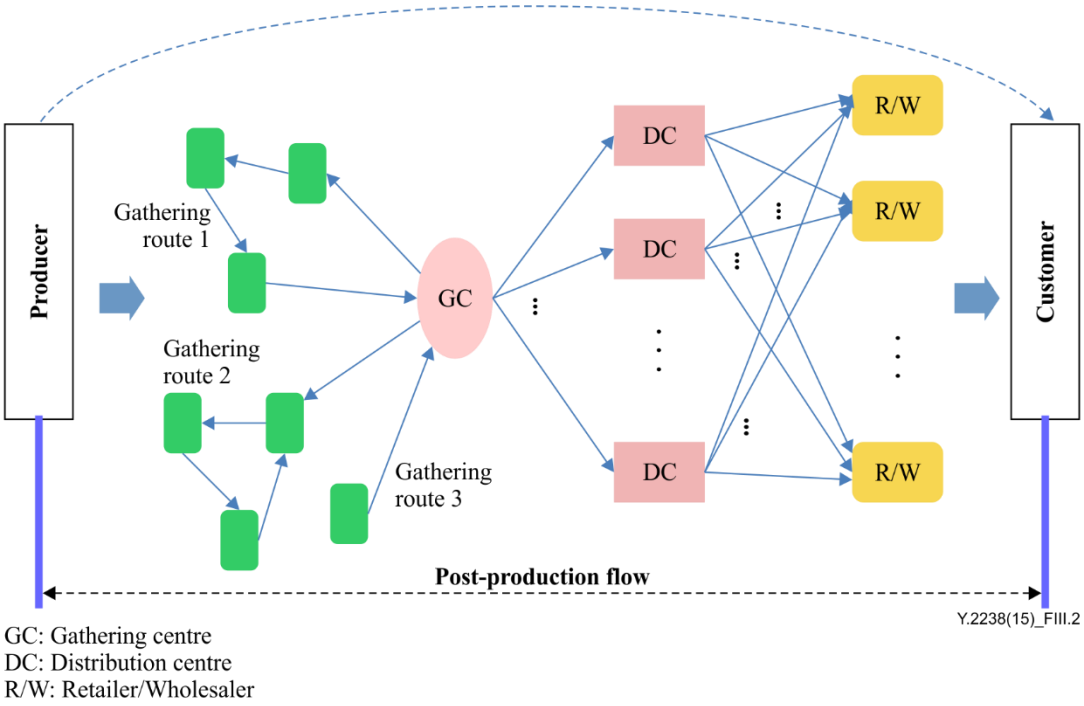

Figure III.2 – Product distribution flow at the post-production stage

The dotted line in Figure III.2 indicates the case of direct delivery from producer to customers. Coordination and network integration in the local product supply chain increases distribution efficiency, potential markets and access to information while reducing environmental impact. Forming the best gathering and distribution centres (DCs) for locally produced product can be very important. Such location decisions can be supported technically, since the location decisions may have dynamic results over time. Therefore, in the process of developing improved product flow control in the local product supply chain, it can prove essential to try detailed location analysis to map and cluster producers, to determine the optimum location of gathering and distribution centres, to analyse routes to optimize them for product gathering and distribution, and to simulate route distance and delivery time.

III.3.2 Product flow control at the post-production stage

Generally, product flow control at the post-production stage consists of the components shown in Figure III.3, to work collaboratively to meet the consumers' demand. The utilization of product flow control at the post-production stage can provide a meeting point among availability, facilitate factors which can be realized through products. In setting up product flow control, all factors involved in the supply chain process of a farming business can be used as a reference. In other words, a product flow control system can translate a simple object to a very complex system in the operational decisions. Policies on product flow control system utilization at the post-production stage are expected to provide benefits in the farming management commodity supply chain, from production, storage and distribution, to the wholesaler and finally consumer level.

In principle, the structure of a product flow control system can accommodate two important decisions from both the producer's and the consumer's point of view. From the producer's side, it is important to consider how products can be made available and well distributed, and from the consumer's side, how, where and when they can obtain a good quality product.

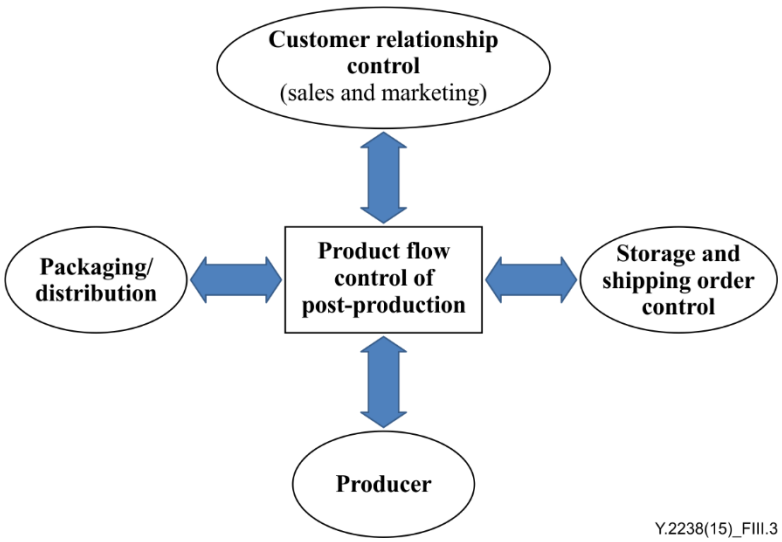

Figure III.3 – Conceptual product flow control for post-production stage

Conceptual product flows in Figure III.3 describe interaction at the post-production stage and how it works. Efficient management of the product flow is required for production planning, physical gathering of primary products from fields, processing and storage at various levels, handling, packaging and distribution of final products. In the product distribution flow, various types of customers such as farmers, vendor/agents, wholesalers, rural retailers and suppliers and transporters are involved.

The activities required for product flow control function can consist of four parts: producers' activity for production quality, markets' activity for sales and marketing, customers' activity for purchasing and product flow control for coordination. The physical infrastructure can consist of a series of IT network infrastructures to connect each location, i.e., producers, wholesalers, retailers, markets and consumers. Communication networks connect central offices with geographically separated branch offices of customers or markets. From the perspective of effective product flow control, an integrated approach for farming is required for the effective control of product hazards that is a shared responsibility of producers, packers, processors, distributors, retailers, food service operators and consumers. Therefore, tracking products from seed sowing to harvesting and shipment is becoming an area of focus.

In the product distribution flow, there is potential for control related to improvements in terms of reducing transport routes, distances and times; reducing emissions from vehicles; improving the packaging of food products; and improving transport services for deliveries from wholesalers/retailers to consumers.

Bibliography

[b-ITU-T Y Suppl. 3] ITU-T Y-series Recommendations – Supplement 3 (2008), *ITU-T Y.2000 series – Supplement on service scenarios for convergence services in a multiple network and application service provider environment*.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
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	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
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 and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2015