International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Y.2244

(12/2019)

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

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

Service model for a cultivation plan service at the pre-production stage

Recommendation ITU-T Y.2244

ITU-T Y-SERIES RECOMMENDATIONS

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

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

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

Recommendation ITU-T Y.2244

Service model for a cultivation plan service at the pre-production stage

Summary

A cultivation plan service at the pre-production stage is critical in that it supports decision making of agricultural producers by providing relevant information such as predicted crop production or expected profits for consulting or other agricultural information. A service model is required to derive necessary service features that support these aims. Therefore, Recommendation ITU-T Y.2244 describes the service model for a cultivation plan service including reference architecture, service requirements, and related capabilities..

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2244	2019-12-14	13	11.1002/1000/14126

Keywords

Cultivation plan service, pre-production stage.

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

FOREWORD

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

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

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

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

NOTE

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

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

INTELLECTUAL PROPERTY RIGHTS

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

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

Table of Contents

Recommendation ITU-T Y.2244

Service model for a cultivation plan service at the pre-production stage

1 Scope

This Recommendation covers, for a cultivation plan service at the pre-production stage, the following:

– service requirements;

– reference architecture;

– service scenarios.

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

[ITU-T Y.4401] ITU-T Recommendation Y.4401/Y.2068 (2015), *Functional framework and capabilities of the Internet of things*.

[ITU-T Y.4806] ITU-T Recommendation Y.4806 (2017), *Security capabilities supporting safety of the Internet of things.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 agricultural producer [b-ITU-T Y.4450]: The service role that actually produces agricultural products to be supplied to distributors or consumers.

3.1.2 big data [b-ITU-T Y.3600]: A paradigm for enabling the collection, storage, management, analysis and visualization, potentially under real-time constraints, of extensive datasets with heterogeneous characteristics.

NOTE – Examples of datasets characteristics include high-volume, high-velocity, high-variety, etc.

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

3.1.4 machine learning (ML) [b-ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

3.1.5 service user [b-ITU-T T.135]: A person, an organization or any intermediate entity using the services provided by a service provider.

3.1.6 smart farming service provider [b-ITU-T Y.4450]: 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.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 agricultural information: All information regarding agricultural processes, such as raw data from farm fields, markets, yearly log data and expertise information.

3.2.2 agricultural information repository: An information repository that holds all information including measured data from farm fields and markets, log data, and expertise data, predicted or calculated information relevant to smart farming to support cultivation plan consultation for service users.

3.2.3 big data analysis: Scrutiny performed on massive volume of data with the purpose of obtaining meaningful results, such as trends or preferences.

3.2.4 cultivation plan: A scheme of service users' decisions on every aspects of agricultural production, such as selected crops, seeding time and seeding amount, before cultivation starts.

3.2.5 data accumulation functional entity: A functional entity that collects log data from an environment monitoring function and a knowhow base management function to provide cultivation plan consultation and related information to service users.

3.2.6 data analysis function: A function that analyses collected data by analytical means such as big data analysis or machine learning, and produces meaningful results to help the consultation process.

3.2.7 data collection function: A function that collects measured data, log data, expertise data through functional entities inside itself.

3.2.8 environment monitoring functional entity: A functional entity that collects cultivation data (e.g., temperature, humidity and pH), market status data (stock amount, price of crops and market demand), and production cost data (e.g., water usage, power usage and payroll information) for data analysis to be used for cultivation plan consultation.

3.2.9 expertise data: Values gathered from skilled service users, experts, service user communities that will help cultivation.

3.2.10 knowhow base management functional entity: A functional entity that gathers expertise data from experts, skilled service users or service user communities to provide cultivation plan consultation and related information to service users.

3.2.11 log data: Values tracked from past consultation, past cultivation records, final profits per variety of crop, etc.

3.2.12 measured data: Values recorded from sensors or measurement facilities, or gathered from agricultural product markets or distribution networks, or government agencies or statistic offices including cultivation data, market status data, production cost data.

3.2.13 plan consulting function: A function that interacts with service users, farmers or enterprises to help service users to make decisions by providing relevant information or analysed results to resolve their concerns.

3.2.14 service provider: An organization owning or controlling one or more systems and using them to provide services.

NOTE – Based on [b-ITU-T T.135].

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

5G Fifth Generation

AAA	Authentication, Authorization and Accounting
DRM	Digital Rights Management
IoT	Internet of Things
IP	Internet Protocol
LoRa	Long Range
ML	machine learning
NB-IoT	Narrowband IoT
NGN	Next Generation Network

5 Conventions

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

In the body of this document, the words shall, shall not, should, and may sometimes appear, in which case they are to be interpreted, respectively, as is required to, is prohibited from, is recommended, and can optionally. The appearance of such phrases or keywords in an appendix or in material explicitly marked as informative are to be interpreted as having no normative intent.

6 Concept of cultivation plan service at the pre-production stage

Smart farming at the pre-production stage is critical, because it aims to increase the final profit to the agricultural producer. An agricultural producer’s plan at the pre-production stage on crop type, seeding time and seeding area can result in success or failure after cultivation. These decisions on a cultivation plan can be based on agricultural information or cultivation plan consultation provided by service providers. Therefore, a cultivation plan service can help agricultural producers with cultivation plans by providing agricultural information or cultivation plan consultation, as appropriate. Agricultural information is provided to service users when agricultural producers decide the cultivation plan. Alternatively, cultivation plan consultation is provided to service users when service providers decide the cultivation plan. These aspects of a cultivation plan service are shown in Figure 1.

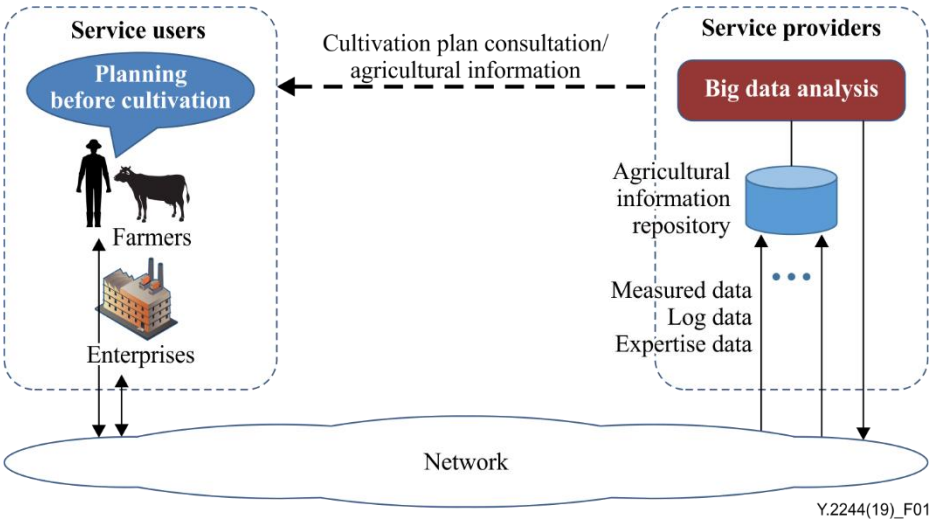

Figure 1 – Conceptual diagram for a cultivation plan service at the pre-production stage

Cultivation plan consultation can be provided based on big data analysis by collecting measured data, log data and expertise data via a network. Big data in the agricultural information repository are analysed by applying available analysis methods. The analysed results then need to be provided to the service users. The following information from the agricultural information repository can be provided to help service users to make decisions:

– current status of the cultivation for the intended types of the crops;
– expected monthly and yearly weather;
– market status of the intended types of the crops;

In addition, service providers could provide cultivation plan consultation to service users on the following items:

– Suggested types of the crop for seeding;
– Suggested time for seeding;
– Suggested area for seeding;
– Expected amount of production from the minimum to the maximum;
– Expected profits from the minimum to the maximum;

The big data analysis in Figure 1 utilizes various types of data such as production cost, market status and cultivation to provide the expected profit or other information for cultivation plan consultation. This analysis requires a model, such as machine learning (ML) or regression process, for prediction and calculation that inputs the production cost, market status and cultivation data. The output of the analysis is used as input for cultivation plans.

Clause 7 describes service requirements for cultivation plan service at the pre-production stage that take these aspects into account.

7 Service requirements for cultivation plan service

Various types of data are required to support the cultivation plan service. Three types of such data are shown in Figure 1: measured data; log data; and expertise data. These data types must be classified more in detail to cope with various consulting demands and necessity of various agricultural information. Considering these various data types, it is required to have service requirements as follows:

7.1 Requirements for measured data

Cultivation Plan Service demands the following requirements for gathering measured data:

– cultivation data from various sensors or measurement facilities located at the farms or measuring fields are required to be delivered to the agricultural information repository of service provider via any means in the network side;

– market status data from various sources related with agricultural product markets or distribution networks are required to be delivered to the agricultural information repository of service provider via any means in the network side;

– production cost data from various sources related with government agencies or statistic offices are required to be delivered to the agricultural information repository of service provider via any means in the network side;

– the means to deliver all types of data to the agricultural information repository of service provider are recommended to support capabilities described in clause 9.

7.2 Requirements for log data

Cultivation plan service demands the following requirements for manoeuvring log data:

– log data of consultation, past cultivation records, final profits per variety of crop, etc. from the agricultural information repository can optionally be updated when any changes occur at or any input are delivered to the agricultural information repository;

– log data from the agricultural information repository can optionally be applied to data analysis function for feedback from the previous consultation cases via any means in the network side.

7.3 Requirements for expertise data

Cultivation plan service demands the following requirements for managing expertise data:

– expertise data from various sources such as skilled service users, experts, service user communities, etc. are required to be delivered to the agricultural information repository of service provider via any means in the network side;

– expertise data can optionally be delivered to the agricultural information repository for establishing agricultural information base via any means in the network side.

7.4 Requirements for data analysis

Big data analysis demands the following requirements for dealing with various data types:

– cultivation data stored in the agricultural information repository are required to be provided for predicting production results such as crop production amount;

– production cost and market status data in the agricultural information repository are required to be provided for calculating required target values;

– calculated or predicted results are required to be provided for cultivation plan consultation.

7.5 Requirements for cultivation plan consultation

Cultivation plan service demands the following requirements for delivering consultation contents including analysed results:

– analysed results such as crop production, profit per agricultural producer, etc. are required to be delivered to the service users;

– any data or contents requested by service users are required to be delivered to the service users.

Classification and types of the data for cultivation plan service are listed in Table 1.

Table 1 – Classification and types of data for a cultivation plan service

Types		Attributes	Usages
Measured data	Cultivation data	– Cultivating area – Growth cycle – Status of growth (colour, size, No. of leaves, etc.) – Predicted climate data (temperature, humidity, etc.) – Soil data (soil nitrogen concentration, vapour concentration, pH, etc.) – Cultivation methods (hydroponics, soil cultivation, transplantation, direct planting, etc.) – etc.	– Grasping the current status of the crop cultivation
	Market status data	– Stock amount – Price of crops – Market demand – etc.	– Aligning with the market trends
	Production cost data	– Power usage – Water usage – Fertilizer usage – Worker salary – etc.	– Grasping the total production cost
Log data		– Past consultation – Past cultivation records – Yearly final profits per variety of crop, – etc.	– Grasping the total Feedback from the previous consulting cases, etc.
Expertise data		– Expected production per cultivation area – Expected profit per cultivation area – Necessities for biennial cultivation – etc.	– Establishing agricultural information base, etc.

An example of data usage for big data analysis is given in Appendix I.

8 Reference architecture for Cultivation Plan Service

Considering the service requirements in the previous clause, the required functions, i.e., data collection function, data analysis function, and plan consulting function, for cultivation plan service are defined as shown in Figure 2.

The data collection function consists of environment functional entity, data accumulation functional entity, and knowhow base management functional entity. The environment monitoring functional entity gathers and delivers measured data including cultivation data such as temperature, humidity and pH. The measured data also include market status and production cost. The data accumulation functional entity gathers all information related to past service processes, such as the past cultivation records and final profits per variety of crop, to form log data. The knowhow base management

functional entity gathers and delivers expertise data from experts, skilled service users or service user communities. All gathered information is stored in the agricultural information repository, then transferred to the data analysis function, which analyses the gathered data and produces meaningful results that will help the service process. The agricultural information repository and related surrounding functions are required to have their security ensured, especially for data transferred and processed in these functions. Analysed results are transferred to the plan consulting function that interacts with service users or agricultural producers, who enquire about agricultural information or request cultivation plan consultation via a network owned by a network provider to help them to make decisions.

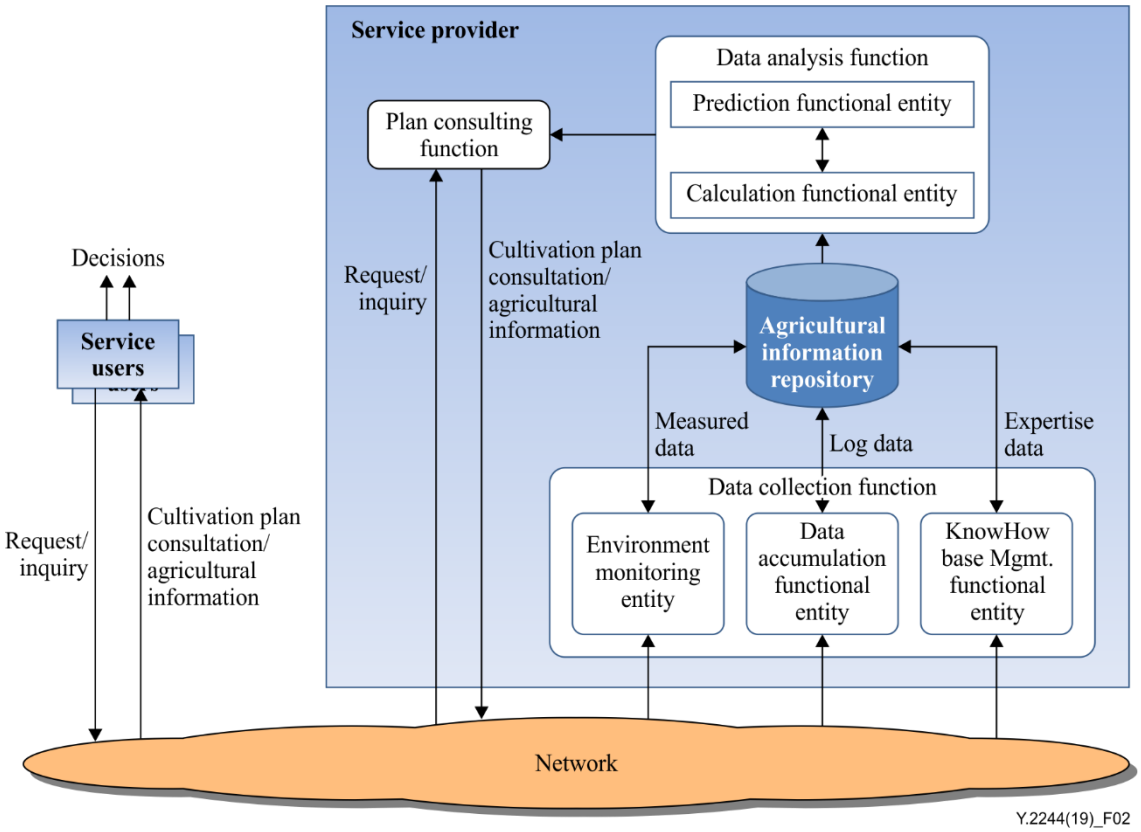

Figure 2 – Reference architecture for a cultivation plan service at the pre-production stage

The functions shown in the Figure 2 are explained in the clauses 8.1 to 8.3.

8.1 Data collection function

The data collection function collects all types of data listed in Table 1. These collected data will be transferred to an agricultural information repository and used for big data analysis. The data collection function consists of the functional entities specified in clauses 8.1.1 to 8.1.3.

8.1.1 Environment monitoring functional entity

The environment monitoring functional entity carries out the following functionalities:

– gathering data like cultivation data measured from agricultural fields (e.g., climate data, soil data and production cost data (water usage, power usage));

– gathering statistical data like market status data from the corresponding agencies (e.g., stock amount and price of crops);

– updating measured data in the agricultural information repository.

8.1.2 Data accumulation functional entity

The data accumulation functional entity carries out the following functionalities:

– capturing log data from previous consultation cases;

– collecting and maintaining log data, such as past cultivation records and final profits per variety of crop.

8.1.3 Knowhow base management functional entity

The knowhow base management functional entity carries out the following functionalities:

– gathering expertise data from experts, skilled service users or service user communities;

– updating expertise data in the agricultural information repository.

8.2 Data analysis function

The data analysis function receives all relevant data from an agricultural information repository and applies big data to analyse them. Analysing the data collected requires a clear description to provide meaningful results, such as expected profit or expected production, to agricultural producers at the pre-production stage. Hence, the data analysis function consists of a calculation functional entity and a prediction functional entity as shown in Figure 2. The prediction functional entity and calculation functional entity can interact or intercommunicate to produce final results. An example of data analysis for profit prediction is given in Appendix I.

8.2.1 Prediction functional entity

The prediction functional entity carries out the following functionalities:

– potential delivery of cultivation data (cultivating area, climate data, soil data, cultivation method, etc.) stored in the agricultural information repository to this functional entity for the prediction of production results, such as crop production amount;

– optional application of any means to predict production results, i.e., ML and statistical regressions, to this functional entity;

– delivery of predicted results to a plan consulting function or calculation functional entity.

8.2.2 Calculation functional entity

The calculation functional entity carries out the following functionalities:

– potential delivery of production cost data (power usage, water usage, fertilizer usage, worker salary, etc.) and market status data (stock amount, market demand, price of crops, etc.) in the agricultural information repository to this functional entity for the calculation of the required target values;

– production of required results, calculated by any means according to the corresponding formulas, from input from the agricultural information repository or prediction functional entity;

– delivery of calculated results to the plan consulting function or prediction functional entity.

8.3 Plan consulting function

The plan consulting function carries out the following functionalities:

– receiving enquiries from service users such as agricultural producers or distributors;

– composing and delivering cultivation plan consultation contents after processing the analysed results;

– inclusion of cultivation plan consultation contents potentially including:

  – recommended types of crop for seeding;

– recommended time for seeding;
– recommended area for seeding;
– current status of cultivation of intended types of the crop;
– expected monthly and yearly weather;
– expected amount of production from minimum to maximum;
– expected profits from minimum to maximum.

The plan consulting function can estimate crop production or profit from the data analysis function, as shown in the example given in Appendix I.

9 Network capabilities

The high-level network capabilities for the support of a cultivation plan service are as follows.

– *End-to-end connectivity over interconnected networks*: It is critical to develop a solution to provide end-to-end connectivity between relevant users or terminals over interconnected heterogeneous networks such as next generation networks (NGNs), other networks based on the Internet protocol (IP), broadcasting networks, mobile or wireless networks (fifth generation (5G) [b-ETSI TS 137], narrowband IoT (NB-IoT), long range (LoRa) [b-ETSI TR 103]) and public switched telephone network or integrated services digital networks.

– *Networking capabilities*: Provision of relevant control functions of network connectivity and transport resource control functions, mobility management or authentication, authorization and accounting (AAA) [b-ITU-T Y-Sup.3].

– *IoT service providers offer products and services to end users with wide area embedded connectivity*. To ensure quality and reliability of services, they also need to ensure quality and reliability of embedded network connectivity of each IoT device. With 10s or 100s of 1 000s of deployed devices, it is difficult to monitor and manage network connectivity manually by enterprise customers and IoT service providers through traditional customer care services provided by network operators. An IoT transport network is recommended to have a solution for efficient and scalable operation and maintenance.

– *Big data*: A large amount of data will be transferred from those sensors and cameras to the IoT platform. All data will undergo collection, transfer, pre-processing, storage and analysis. ML finds insights hidden in IoT data without explicitly being told where to look or what to conclude, resulting in better, faster discoveries and action.

10 Service scenarios

A cultivation plan service can be provided in various ways. Appendix II provides examples of detailed information flows associated with the following service scenarios.

– *Agricultural information enquiry*: To support agricultural producers who want to grasp the exact status of the agricultural field at the pre-production stage by providing agricultural information for a plan to cultivate.

– *Cultivation plan consultation*: To support agricultural producers to make a decision on a cultivation plan at the pre-production stage.

– *Agricultural information update*: To update the agricultural information repository to the latest version for a more effective cultivation plan with benefits to service users who contribute to this update.

11 Security considerations

This Recommendation is recognized as an enhancement to IP-based networks. Thus, it is assumed that security considerations are in general based on the security of IP-based networks and thus conformity to the security considerations identified in clauses 7 and 8 of [ITU-T Y.2701] is required. The data in an agricultural information repository should be treated as public information to be secured. In addition, it is also required to consider the security of agricultural data collected and processed with the capabilities of [ITU-T Y.4401] and [ITU-T Y.4806].

Appendix I

An example of big data analysis for profit prediction

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

In this example, the data analysis function includes a profit calculation functional entity and a production prediction functional entity, which can have ML and regression processes internally for predicting crop production. The production prediction functional entity demands cultivation data, including:

– cultivated area;
– climate data;
– soil data;
– cultivation method.

Profit calculation functional entity demands market status data, including:

– stock amount;
– market demand;
– price of crops.

The profit calculation functional entity also demands production cost data, including:

– power usage;
– water usage;
– fertilizer usage;
– worker salary.

Figure I.1 shows the architecture of big data analysis from the aspect of providing expected profit and predicted production of crop values.

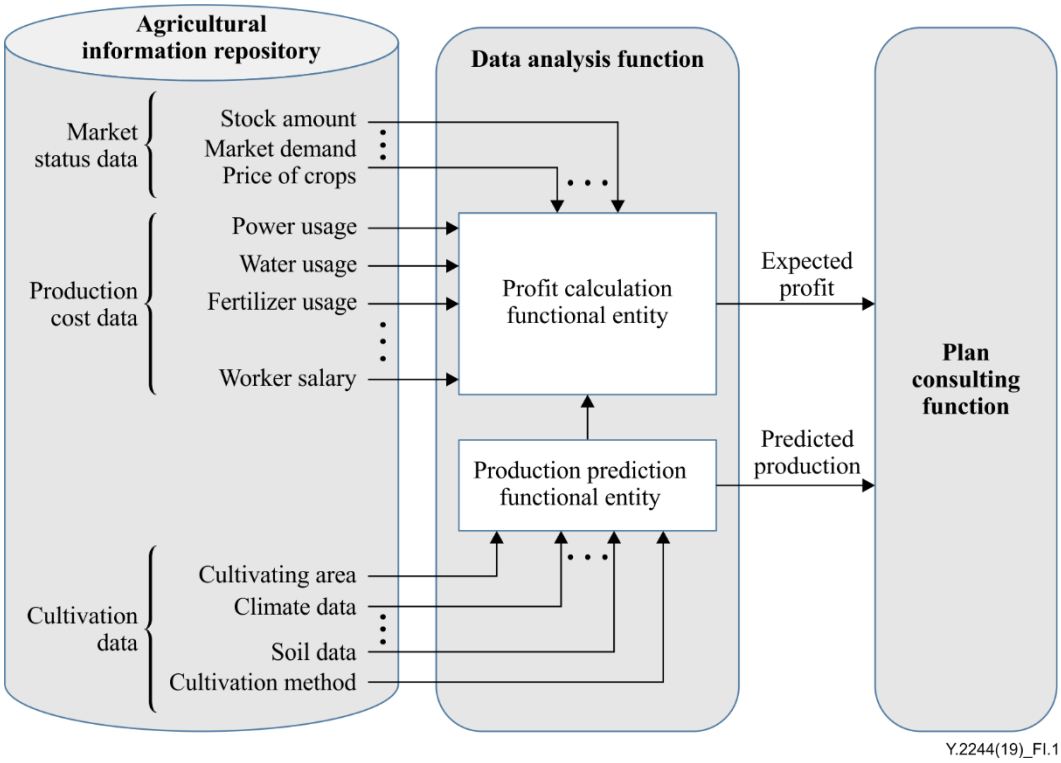

Figure I.1 – An architecture of big data analysis for profit prediction values

Appendix II

Examples of detailed information flows for service scenarios

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

II.1 Service scenario for agricultural information enquiry

Agricultural producers may wish to estimate the status of an agricultural field at the pre-production stage using agricultural information that will be used to plan the crop. It is therefore possible that agricultural information enquiries would be the most frequently required service at the pre-production stage. Figure II.1 shows the information enquiry workflow.

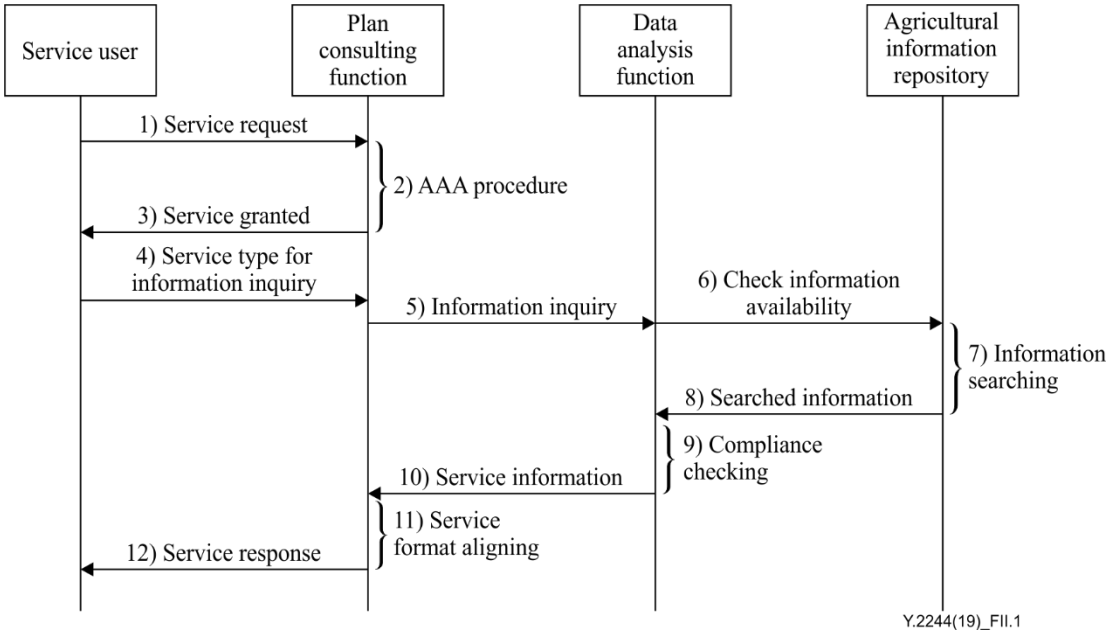

Figure II.1 – Information flow for an agricultural information enquiry

The following assumptions are made:

1) the service user is subscribed to a smart farming service provider and will be charged on a usage basis by each service provider;
2) digital rights management (DRM) processing for licence transaction between service providers is hidden;
3) the flows shown in Figure II.1 are at high level and not meant to show actual protocol procedures.

Descriptions of flow follow:

1) the service user requests agricultural information by service user activity for service activation;
2) the plan consulting function then carries out the AAA procedure for the requesting service user;
3) if the AAA result is OK, the plan consulting function then sends to the service user a service granted message – otherwise, it sends a service rejected message;
4) after receiving a service granted message, the service user sends a service type for information enquiry including the service type that the service user wants;
5) the plan consulting function forwards the information enquiry to the data analysis function;

6) the data analysis function then checks data availability in the agricultural information repository;

7) the agricultural information repository queries the appropriate data for the requested check;

8) the agricultural information repository returns data retrieved to the data analysis function;

9) the data analysis function checks compliance of the information returned;

10) the data analysis function delivers the compliance-checked information to the plan consulting function;

11) the plan consulting function aligns the format of the information received to prepare the response;

12) the plan consulting function sends a service response message with the service contents including the information requested.

II.2 Service scenario for cultivation plan consultation

The cultivation plan might be the most important to the people involved in the farming fields at the pre-production stage. Therefore, the cultivation plan consultation will be very helpful for them to make a decision at the pre-production stage regarding the following issues:

– types of crop for seeding;

– time for seeding;

– area for seeding;

– expected amount of production from minimum to maximum;

– expected profits from minimum to maximum.

In the process of service provision, service users can get additional information to inform their decisions as follows:

– expected monthly and yearly weather;

– expected amount of production from minimum to maximum;

– expected profits from minimum to maximum.

The information flow for this service scenario is shown in Figure II.2.

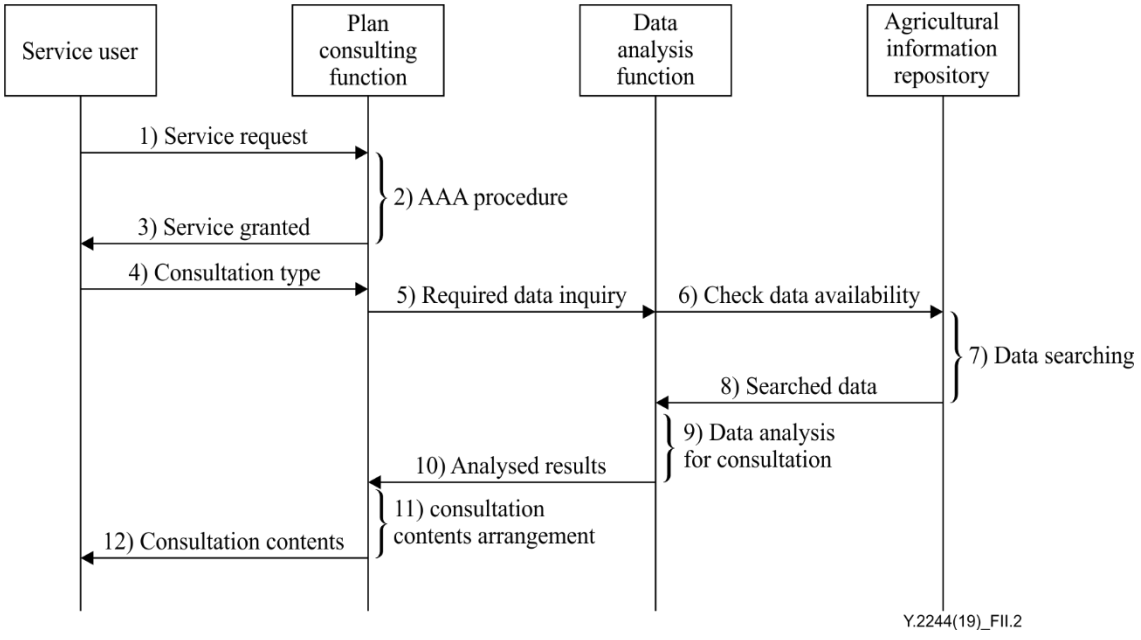

Figure II.2 – Information flow for cultivation plan consultation

The following assumptions are made:

1) the service user is subscribed to a smart farming service provider and will be charged on a usage basis by each service provider;
2) DRM processing for licence transaction between service providers is hidden;
3) the flows shown in Figure II.2 are at high level and not meant to show actual protocol procedures.

Descriptions of flow follow:

1) the service user requests cultivation plan consultation by service user activity for service activation;
2) the plan consulting function then carries out the AAA procedure for the requesting service user;
3) if the AAA result is OK, the plan consulting function then sends to the service user a service granted message – otherwise, it sends a service rejected message;
4) after receiving a service granted message, the service user sends a consultation type for data enquiry including the service type that the service user wants (consultation type is chosen by the service user, and can include a recommendation for crop type, seeding time, area or profit prediction);
5) the plan consulting function forwards the required data enquiry to the data analysis function;
6) the data analysis function then checks data availability in the agricultural information repository;
7) the agricultural information repository queries the appropriate data for the requested check;
8) the agricultural information repository returns data retrieved to the data analysis function;
9) the data analysis function analyses the searched data by various means;
10) the data analysis function delivers the analysed results to the plan consulting function;
11) the plan consulting function formats the analysed results to produce the consultation contents;
12) the plan consulting function sends the consultation contents to the service user.

II.3 Service scenario for agricultural information update

Agricultural information must be updated to the latest version for more effective cultivation plan service. Service users with expertise data can contribute to this update in exchange for the benefit of service use.

The information flow for this service scenario is shown in Figure II.3.

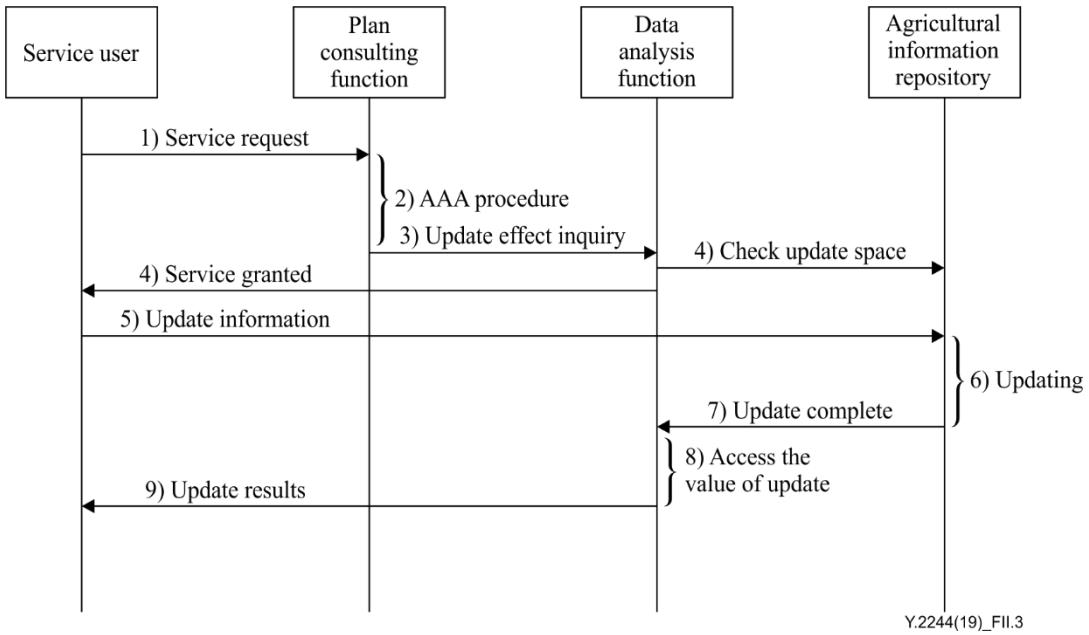

Figure II.3 – Information flow for an agricultural information update

The following assumptions are made:

1) the service user is subscribed to a smart farming service provider and will be rewarded on the update after assessing its value;
2) DRM processing for licence transaction between service providers is hidden;
3) the flows shown in Figure II.3 are at high level and not meant to show actual protocol procedures.

Descriptions of flow follow:

1) the service user requests agricultural information update by service user activity for service activation – this request includes summary of information update that the service user will submit (the update can be one of agricultural knowhow, such as procedures, timing or amounts for fertilization and pesticides.);
2) the plan consulting function then carries out the AAA procedure for the requesting service user;
3) if the AAA result is OK, the plan consulting function then enquires about the effect of the update on the data analysis function and if the result is under the predefined level, goes to step 9 – if the AAA result is not OK, it sends a service rejected message to the service user;
4) the data analysis function then checks the storage space in the agricultural information repository – if there is space available for the update, a service granted message is transferred to the service user;
5) after receiving the service granted message, the service user sends update information including summary of information update that the service user will submit (update information can be one of agricultural knowhow, such as procedures, timing or amounts for fertilization and pesticides.);
6) the agricultural information repository updates the data entries with the received update information;
7) the agricultural information repository returns an update complete message to the data analysis function;
8) the data analysis function assesses the value of the update and decides the level of reward;
9) the data analysis function delivers the update results including the rewards to the service user.

Bibliography

[b-ITU-T T.135] ITU-T Recommendation T.135 (2007), *User-to-reservation system transactions within T.120 conferences.*

[ITU-T Y.3172] ITU-T Recommendation Y.3172 (2019), *Architectural framework for machine learning in future networks including IMT-2020.*[b-ITU-T Y.3600] ITU-T Recommendation Y.3600 (2015), *Big data – Cloud computing based requirements and capabilities.*

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

[b-ITU-T Y.4450] ITU-T Recommendation ITU-T Y.4450/Y.2238 (2015), *Overview of Smart Farming based on networks*.

[b-ITU-T Y-Sup.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.*

[b-ETSI TR 103] ETSI TR 103 526, V1.1.1 (2018), *System reference document (SRdoc); Technical characteristics for low power wide area networks chirp spread spectrum (LPWAN-CSS) operating in the UHF spectrum below 1 GHz.*

[b-ETSI TS 137] ETSI TS 137 141, V15.8.0 (2019), *Digital cellular telecommunications system (Phase 2+) (GSM); Universal mobile telecommunications system (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-standard radio (MSR) base station (BS) conformance testing*.

SERIES OF ITU-T RECOMMENDATIONS

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

Printed in Switzerland
Geneva, 2020