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SERIES M: TELECOMMUNICATION MANAGEMENT, INCLUDING TMN AND NETWORK MAINTENANCE

Telecommunications management network

Requirements for on-site telecommunication smart maintenance management function

Recommendation ITU-T M.3364

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Recommendation ITU-T M.3364

Requirements for on-site telecommunication smart maintenance management function

Summary

Recommendation ITU-T M.3364 introduces requirements for on-site telecommunication smart maintenance management function. In this Recommendation, the requirements for telecommunication smart maintenance function are provided, which include on-site patrol, on-site overhaul, on-site troubleshooting, evaluation of maintenance work, management of maintenance knowledge base, management of service activation function, management of network resource, and management of smart maintenance assistant toolkit (SMAT). This Recommendation also provides use cases of SMAT in telecommunication smart maintenance system (TSMS).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T M.3364	2020-02-13	2	11.1002/1000/14183

Keywords

Function requirements, telecommunication smart maintenance.

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1 Scope

This Recommendation proposes requirements for on-site telecommunication smart maintenance management function, which include on-site patrol, on-site overhaul, on-site troubleshooting, evaluation of maintenance work, management of maintenance knowledge base, management of service activation function, management of network resource, management of smart maintenance assistant toolkit (SMAT). This Recommendation also applies to the design and development of on-site telecommunications smart maintenance system.

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 M.3040] Recommendation ITU-T M.3040 (2019), *Principles for on-site telecommunication smart maintenance.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 telecommunication smart maintenance [ITU-T M.3040]: The maintenance carried out with advanced technology-based (IoT, AR, wearable technology, etc.) toolkit and system, which can provide strong human-computer interaction capabilities and online guidance to personnels, to achieve higher efficiency and precision of actions.

3.1.2 on-site overhaul [ITU-T M.3040]: A kind of on-demand preventive maintenance performed at a facility site in the condition of natural disasters or major events.

3.1.3 on-site patrol [ITU-T M.3040]: A kind of routine preventive maintenance periodically performed at a facility site.

3.1.4 on-site troubleshooting [ITU-T M.3040]: A kind of corrective maintenance performed at a facility site when the quality of equipment degrades.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 maintenance executor: A drone, or an intelligent maintenance robot, or a maintenance personnel equipped with a wearable device, to carry out maintenance tasks.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI Artificial Intelligence

AR Augmented Reality

IoT Internet of Things

NEF Network Element Function

OSF Operations Systems Function

RFID Radio Frequency Identification

SMAT Smart Maintenance Assistant Toolkit

SMATF Smart Maintenance Assistant Toolkit Function

TMN Telecommunication Management Network

TSMS Telecommunication Smart Maintenance System

TSMSF Telecommunication Smart Maintenance System Function

5 Convention

None.

6 Overview

The telecommunication smart maintenance system (TSMS) shall realize intelligent monitoring of the maintenance site, support the general flow of intelligent maintenance of the telecommunication network and elements, and improve the operational level of on-site maintenance executors.

This Recommendation presents management function requirements for on-site telecommunication smart maintenance. The purpose is to apply smart wearable device, drone or intelligent maintenance robot, which is a combination of Internet of things (IoT) and augmented reality (AR), in the maintenance of communication network equipment and lines.

The functional architecture of telecommunication smart maintenance is defined in [ITU-T M.3040] as shown in Figure 1.

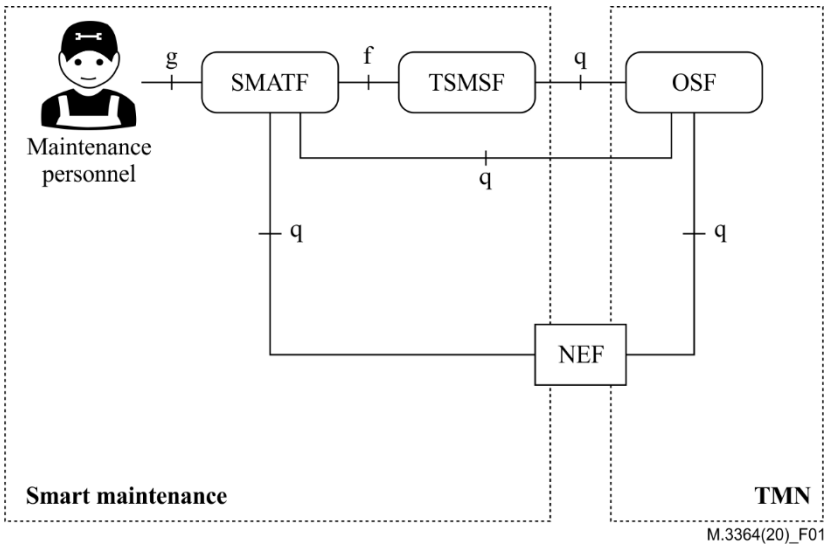

Figure 1 – Functional architecture of on-site telecommunication smart maintenance [ITU-T M.3040]

This Recommendation gives a detailed description of the specific functional requirements of telecommunication smart maintenance system function (TSMSF) in Figure 1.

7 Requirements for telecommunication smart maintenance function

The telecommunication smart maintenance function consists of two parts: the application part and the resource data part.

The application part includes on-site patrol, on-site overhaul, on-site troubleshooting, maintenance work evaluation, management of maintenance knowledge base and service activation.

The resource data part collects and stores the information about communication network resource and maintenance assistant toolkit resource, and provides data support for the application part.

7.1 Requirements for on-site patrol

7.1.1 Requirements for patrol task management

TSMS is recommended to support the addition, deletion, modification, investigation, and graphic presentation of combined spatial coordinates information. Information related to the patrol work task can be retrieved and combined with the resource list. The chronologically reversed sequence list shows the current day's patrol work tasks in the system, as well as details of these work tasks, including real-time status, completion status, and data list to be collected.

Before performing the patrol work task, it is necessary to ensure the safety of the patrol environment, the relevant qualifications of the operators, and the integrity of the patrol device.

7.1.2 Requirements for patrol route design

The patrol route consists of several patrol points in series. Based on the selected spatial coordinates and order of the patrol points, TSMS is recommended to generate patrol routes intelligently by using satellite navigation positioning and satellite navigation technology. For example, during a patrol process based on a wearable device, TSMS sends graphical patrol routes, directions and patrol points to the wearable device in conjunction with the patrol site plan.Also, TSMS could monitor the patrol route of the drone or the intelligent maintenance robot in real time during a patrol process based on a drone or an intelligent maintenance robot.

7.1.3 Requirements for generation of smart identification data related to patrol object

According to the patrol route and the designed checkpoints, smart identification data related to patrol object, such as a virtual resource view and an operation panel map that can present the maintained resource in the wearable device, is generated and downloaded in advance to SMAT. In this way, during the patrol process, the smart identification data in SMAT can increase the recognition efficiency as long as there is pre-stored smart identification data related to the object to be patrolled.

7.1.4 Requirements for report of patrol record

TSMS is recommended to provide the function of returning the scene image and video data to support on-site abnormal situation reporting and trouble reporting.

7.1.5 Requirements for supervision of patrol

TSMS is recommended to provide surveillance functions based on satellite navigation, radio frequency identification (RFID), two-dimensional code that gives the location of the SMAT and the maintained resource object. It can supervise whether the SMAT carries out patrol work according to the planned patrol procedures and patrol object or not.

7.2 Requirements for on-site overhaul

7.2.1 Requirements for management of maintenance job

TSMS is recommended to support the addition, deletion, modification, and search of the maintenance job. During an overhaul process based on a wearable device, TSMS sends the resource object to be overhauled to SMAT with the panel image. TSMS present the details of the maintenance job combined with the resource list, including real-time status and maintenance record.

7.2.2 Requirements for push of guidance information

TSMS is recommended to push the guidance to SMAT according to the information returned from the overhaul site. For example, during a overhaul process based on a wearable device, according to the actual execution situation of the on-site maintenance executor at the overhaul site, the steps to be performed and the objects to be overhauled, TSMS obtains the maintenance data and steps information related to the work task list and pushes them to the SMAT. The AR-based information enhancement technology is integrated with the actual scene to provide real-time operational training guidance in the wearable device through animation, voice and text.

7.2.3 Requirements for record of overhaul process

SMAT is recommended to support detailed record of the overhaul operation process and return the overhaul record to TSMS. TSMS is recommended to provide standardized operation comparison technology, complete the determination of whether the maintenance job content is correct, and notify the on-site maintenance executor of the judgment result in order to undertake smart maintenance.

7.2.4 Requirements for remote assistance

TSMS is recommended to provide a video conference channel between SMAT and experts. Experts can remotely view the overhaul objects through video and provide overhaul guidance.

7.3 Requirements for on-site troubleshooting

7.3.1 Requirements for trouble management

TSMS is recommended to support trouble management functions. Trouble management includes trouble information collection, trouble information display, trouble confirmation and clearing, and trouble query and statistics.

TSMS is recommended to support real-time monitoring of the operational status of resources such as telecommunication infrastructure, applications and SMAT. The trouble information is presented in

the form of a list, a view, a color, etc., and the relevant maintenance executors are notified in time by means of mail, short message and banner.

TSMS is recommended to provide the function of trouble confirmation and clearing.

TSMS is recommended to provide trouble query function. Users can specify the query conditions to query the trouble information. The query conditions include the trouble object, the time range, the trouble cause, the trouble severity, the alarm type, whether the trouble is acknowledged, and whether the trouble is cleared.

TSMS is recommended to support trouble statistics. It can classify and compare trouble according to the trouble object, type, level, time, and cause in the form of reports, graphs, and so on.

7.3.2 Requirements for trouble analysis

TSMS is recommended to support the analysis of the trouble based on the information such as network resource object, location, time, service, trouble type, content, etc. For example, during a maintenance process based on a wearable device, TSMS is recommended to simultaneously display the trouble location in the wearable device panel with the virtual resource view. A list of possible trouble causes will be given.

7.3.3 Operational guidance push combined with trouble phenomenon

TSMS is recommended to push operation guidance in conjunction with the trouble phenomenon. Combined with the maintenance knowledge base, TSMS is recommended to automatically identify troubles, obtain corresponding knowledge and provide a trouble solution, process flow or play the troubleshooting operation instruction video.

7.3.4 Requirements for remote assistance

TSMS is recommended to match experts according to the type of trouble. On-site maintenance executors can use dial-up video conferencing with remote experts to communicate through text, pictures and video, and return the on-site information to remote experts in the form of text, pictures, video, etc. A number of experts can be accessed at the same time for failure consultation.

7.3.5 Requirements for update maintenance knowledge base

If a trouble is solved according to the existing knowledge information, TSMS is recommended to submit the trouble-related information to update the maintenance knowledge base and establish a reference relationship between the knowledge and the trouble.

7.4 Requirements for evaluation of maintenance work

7.4.1 Requirements for management of evaluation criteria

According to the evaluation requirements, TSMS is recommended to establish a dynamic assessment baseline for the intelligent maintenance work quality of telecommunication. TSMS is recommended to provide management functions for the evaluation criteria of intelligent maintenance work, including the addition, deletion, modification and research of evaluation criteria.

7.4.2 Requirements for collection of record

TSMS is recommended to use SMAT for intelligent acquisition of on-site maintenance operation data. SMAT automatically takes photos and record data according to the progress of the work, and upload them to TSMS.

7.4.3 Requirements for management of evaluation report

TSMS is recommended to evaluate the quality of telecommunication smart maintenance work according to the evaluation criteria. The evaluation includes star rating and explanation information.

TSMS is recommended to generate evaluation reports based on the quality evaluation results of the maintenance work. TSMS is recommended to support the addition, deletion, modification, query and batch operation of evaluation reports.

7.5 Requirements for management of maintenance knowledge base

7.5.1 Requirements for collection of maintenance record

TSMS is recommended to collect the maintenance records submitted by SMAT. The content includes text, pictures, videos, and voice information. TSMS provides a variety of maintenance record collection methods such as collection from external files, web pages, automatic generation and manual entry, and then stores them in the database according to a predefined classification.

7.5.2 Requirements for evaluation and generation of maintenance knowledge

TSMS is recommended to combine data mining, machine learning and other big data processing techniques to analyze and evaluate maintenance work records, form useful maintenance knowledge, and use it for subsequent maintenance jobs, such as smart matching of maintenance instruction videos and smart push of maintenance jobs, etc.

7.5.3 Requirements for updating maintenance knowledge base

TSMS is recommended to support the update of maintenance knowledge base. TSMS performs routine maintenance of maintenance knowledge records in the knowledge base, and evaluates maintenance knowledge by counting usage. TSMS updates the knowledge in the knowledge base according to the evaluation results.

7.5.4 Requirements for use of maintenance knowledge base

TSMS is recommended to automatically select the appropriate knowledge based on certain reasoning principles. During work task execution process, if on-site training function is performed, TSMS automatically performs knowledge search and query pre-processing and provides applicable knowledge for training.

7.6 Requirements for management of service activation function

7.6.1 Download of new service activation job

TSMS is recommended to provide the function of downloading an order related to service activation work task. On-site maintenance executors obtain the service activation work task list from the TSMS, and receive the service activation work task according to their own service duty and scope of responsibility.

7.6.2 Service activation

The on-site maintenance executors are recommended to perform service activation tasks sent by TSMS, such as gateway installation and configuration, take photos automatically according to the work schedule.

7.6.3 Upload service activation record

TSMS is recommended to provide the function of service activation. During and after the execution of service activation work task, on-site maintenance executors feedback the execution of the on-site work tasks and upload information, such as the photos of the on-site resource tables to be constructed, through SMAT to provide a record of the execution of the on-site service activation work tasks to TSMS.

7.7 Requirements for network resource management

The objects of network resource management include resources that can be maintained with the aid of intelligent means in various types of communication networks such as transport networks, mobile networks, and data networks. For example, the resource can be racks, boards, pipes, optical fibers and so on. Network resource management should provide the following functions that are outlined in clauses 7.7.1 to 7.8.2.

7.7.1 Requirements for basic resource management

TSMS is recommended to support the addition, deletion, modification, search and batch of network resources information. For example, during the smart maintenance of communication networks based on wearable devices, TSMS is recommended to support AR modeling of resource objects, that is, the virtual resource view presented in the AR operation panel. It can be used to generate a virtual operation panel view corresponding to the real resource after the wearable device identifies the resource object.

7.7.2 Requirements for position guidance

TSMS is recommended to assist SMAT to locate construction locations related to resources in the maintenance work task by the location information and spatial information, and prompt the best routes from the current positions to the construction locations.

7.7.3 Requirements for resource smart identification

TSMS is recommended to support SMAT load the resource smart identification data, and obtain the detailed information of the resource by invoking the resource information interface provided by the system, including but not limited to the vendor information, history trouble, beared service, etc.

7.7.4 Requirements for resource synchronization

TSMS is recommended to compare the image recognition results of the on-site network resource with the data stored in the system, and modify the system data according to the real on-site information to complete the whole lifetime management of the network resources in a smart way.

7.8 Requirements for management of SMAT

7.8.1 Requirements for management of toolkit information

TSMS is recommended to support the addition, deletion, modification, query and batch information of SMAT.

7.8.2 Requirements for management of toolkit status

TSMS is recommended to provide the function of managing the status of SMAT, which can show the list of displayed toolkits, current usage status and whether or not it is lost. TSMS can also provide information about requisition record, return record and upgrade record of SMAT.

Appendix I

Use cases of SMAT in TSMS

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

With the TMN management architecture as a guide, network management technology, products and applications have been rapidly developed, and a complete industrial chain has been established. However, due to insufficient development of technologies such as Internet of things (IoT) and artificial intelligence (AI), on-site maintenance work concerning non-intelligent parts (such as racks, boards, pipes, optical fibers, lines and other dummy resources) that constitute the network have required a large amount of manpower for a long period of time. It is hard to reach a closed-loop maintenance, and the low degree of intelligence level, resulting in the difficult to ensure the consistency and completeness of dummy resource informationseriously affects the quality of network management. Therefore, using SMAT in telecommunication smart maintenance can complete on-site patrol, on-site overhaul, on-site troubleshooting effectively, and save time and manpower. At present, SMAT mainly includes wearable devices, drones and intelligent maintenance robots. The use cases of SMAT are shown below.

Wearable devices can help telecommunication smart maintenance in on-site patrol, on-site overhaul, on-site troubleshooting. For example, in the process of on-site patrol, TSMS will visually display the patrol route, direction and patrol points in the wearable device in a graphical way, so that the staff can conduct quick and efficient patrol. In the process of on-site overhaul, TSMS obtains the relevant maintenance data and operation steps according to the actual situation and operation objects, and send them to wearable devices. Based on AR technology, integrated with the actual scene, wearable devices can provide real-time operation training guidance through animation, voice, text and other forms.

Drone is mainly used for on-site patrol in telecommunication smart maintenance, especially for communication tower and line network quality. As shown in Figure I.1, during the patrol of communication tower, the drone can carry a variety of sensors (including but not limited to visible light sensor, infrared sensor, laser rangefinder and laser radar). After receiving the patrol task, the drone will hover to inspect the corresponding communication tower, detect whether the temperature, light and other indicators around the tower are normal or not, and upload the data to TSMS. Besides, in the line network quality patrol, the drone carries the mobile communication network test instrument (including but not limited to spectrum instrument, DT test instrument, etc.), the drone will hover to detect the line network quality, check whether there is any problem in the line, and upload the patrol information to TSMS.

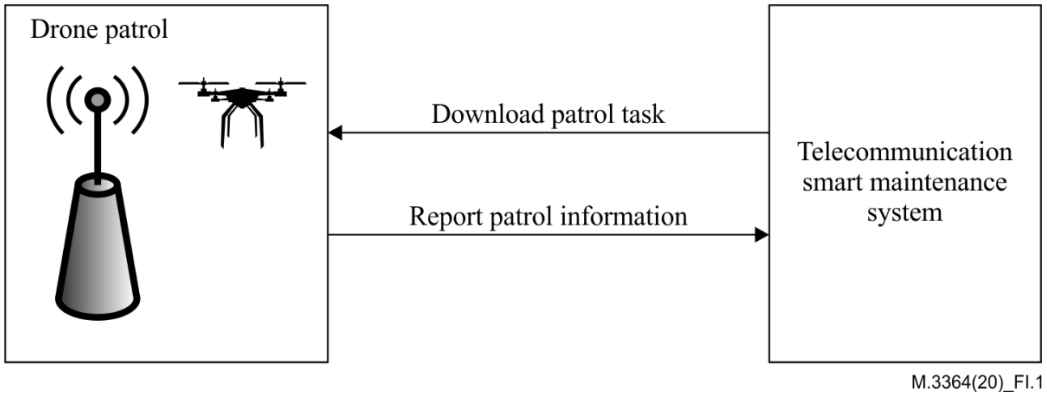

Figure I.1 – Drone patrol

The intelligent maintenance robot is also mainly used for on-site patrol in telecommunication smart maintenance, mainly for the patrol of indoor communication equipment, power environment and outdoor communication infrastructure. As shown in Figure I.2, during the patrol, the intelligent maintenance robot downloads the patrol task from TSMS. The intelligent maintenance robot can integrate infrared, visual, sound and other multi-functional sensors, use the autonomous navigation and positioning function to follow the patrol route, and use visible image analysis, infrared temperature measurement and other technologies to carry out the intelligent identification of resource defects and temperature measurement of infrared area. Then, the intelligent maintenance robot reports the patrol information to the smart maintenance system.

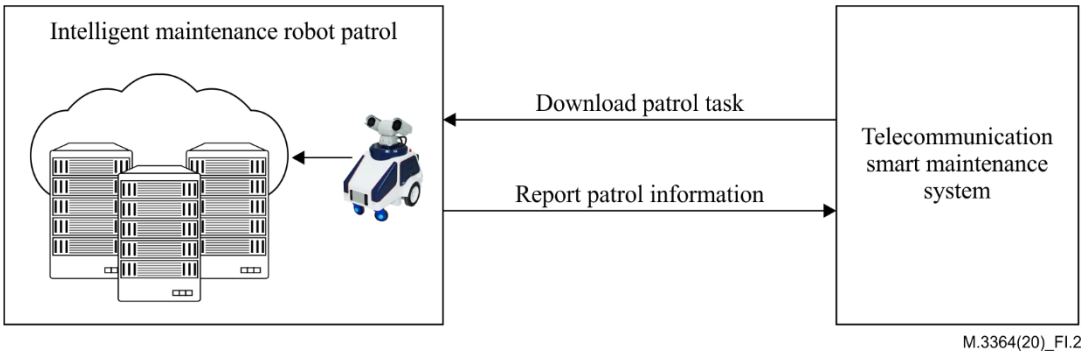

Figure I.2 – Intelligent maintenance robot patrol

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