ISO/IEC 30144

Edition 1.0 2020-10

INTERNATIONAL STANDARD

colour inside

Internet of things (IOT) – Wireless sensor network system supporting electrical power substation

ISO/IEC 30144:2020-10(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

ISO/IEC 30144

Edition 1.0 2020-10

INTERNATIONAL STANDARD

colour inside

Internet of things (IOT) – Wireless sensor network system supporting electrical power substation

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.10; 35.110

ISBN 978-2-8322-8941-9

CONTENTS

INTERNET OF THINGS (IOT) – WIRELESS SENSOR NETWORK SYSTEM SUPPORTING ELECTRICAL POWER SUBSTATION

FOREWORD

1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.
2) The formal decisions or agreements of IEC and ISO on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC and ISO National bodies.
3) IEC and ISO documents have the form of recommendations for international use and are accepted by IEC and ISO National bodies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC and ISO documents is accurate, IEC and ISO cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC and ISO National bodies undertake to apply IEC and ISO documents transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC and ISO document and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC and ISO do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC and ISO marks of conformity. IEC and ISO are not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this document.
7) No liability shall attach to IEC and ISO or their directors, employees, servants or agents including individual experts and members of its technical committees and IEC and ISO National bodies for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this ISO/IEC document or any other IEC and ISO documents.
8) Attention is drawn to the Normative references cited in this document. Use of the referenced publications is indispensable for the correct application of this document.
9) Attention is drawn to the possibility that some of the elements of this ISO/IEC document may be the subject of patent rights. IEC and ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 30144 has been prepared by subcommittee 41: Internet of Things and related technologies, of ISO/IEC joint technical committee 1: Information technology.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
JTC1-SC41/163/FDIS	JTC1-SC41/176/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The data collected from various types of electrical equipment is sparsely located, and on-line transmission of the data helps to collaboratively aggregate and analyse them in real-time. Transitioning to the smart electrical power substation using wireless communication among the sensor nodes – i.e. wireless sensor network (WSN) – requires systems architecture provisioning automated data collection from the electrical equipment, which allows collaborative data processing, sends automatic alerts, provides preventive actions, and potentially takes corrective actions for certain situations.

Electrical power substation communications should be designed to support scalability, interoperability, autonomous fault correction, and other key attributes. The intelligent wireless sensor network (iWSN) is inherently flexible and scalable in its capabilities and in operations including in the size of its converge areas; however, depending on the geographical (e.g. urban, suburban, remote location) and structural (both natural and man-made) situations, the installation architecture should ensure the fidelity of all sensor nodes' wireless connectivity. Furthermore, the WSNs can support either distributed or decentralized network architecture. The wired substation network typically uses high-availability seamless ring (HSR) and parallel redundancy protocol (PRP) protocols (see IEC 62439-3, IEC 61850-8-1 and IEC 61850-9-2) to provide seamless failover against failure of any network component. For the iWSN, it is also important to have the key iWSN network components (e.g. sensor nodes) from data communication failure. Therefore it is important to select wireless sensor network architecture for a substation which overcomes the potential issue of a single point of failure in the wireless sensor network, for example, by installation architecture, the use of PRP to improve packet loss and timing behaviour in wireless network, or a combination of these.

This document introduces iWSN as a system which helps to make the power substation smarter, which is compatible with IEC 61850. In the past, wireless communication was thought to be unreliable and ineffective over long distances. With the advancements in communication technologies in the last decade, the wireless communications have given rise not only to wireless meshed systems, multi-hop and self-healing networks, but also to various low-power protocols having high network/communication security standards. Additionally, different network topologies with effective wireless signal routing algorithms have improved range and reduced power consumption while minimizing frequency of communication channel error. These improvements can be leveraged to form a highly reliable communication network for the electrical power substation.

The existing applications of the WSNs in smart grid include, but are not limited to, automatic meter reading, remote system monitoring and control, equipment fault diagnostics, distribution automation, outage detection, line fault and electronic fault detection, underground cable system monitoring, towers and poles monitoring, conductor temperature and dynamic thermal rating. However, the realization of these existing and envisioned WSN-based smart grid applications is hindered by not having uniform sensing data formats, data interfaces, etc. Although some sensor communication systems are not compatible with the devices from different equipment manufacturers, most intelligent electronic devices used in electrical power substations are interoperable, through the use of standard protocols, for example, IEC 61850 GOOSE, TCP, UDP, etc., and standards related to the common information model (CIM) defined by IEC 61970 and IEC 61968. For cases where new types of sensors (either existing or newly developed) have not adopted IEC 61850, they may be used with an intelligent wireless sensor network (iWSN) system[1] [2] because the iWSN system interfaces can act as an adaptor for the sensors and the rest of the systems.

---

[1] Wireless technology in general is not suitable for the transmission of mission critical data such as sampled measured values according to IEC 61850-9-2 or trip signals for circuit breakers due to the possible interference of electromagnetic radiation caused by arc-flashes (e.g. in case of an internal fault or switching operations inside a substation) with the radio signals of wireless sensors.

[2] Any data commonly sent over layer 2 broadcast (e.g. GOOSE) are not suitable for transmission over wireless networks due to the unavailability of corresponding broadcast features.

The main purpose of wireless sensor network applications for electrical power substations is to improve the capability of acquiring, monitoring, processing, and maintaining the data and information from the power equipment. A wireless sensor network (WSN) is characterized by flexible deployment, device collaboration and low-cost implementation, and WSN realizes efficient monitoring of the smart grid systems and subsystems. By enabling the monitoring and controlling capabilities by installing wireless sensor nodes on critical power grid equipment, reliable and real-time online management of this equipment can be accomplished.

Electrical power substation is one of the most important building blocks of the smart grid. The monitoring and control systems in electrical power substations acquire current, voltage, status and other parameters from their primary equipment, and also data from their environment. The information from the measurement systems provides the basis for integrated applications, enabling the transformation of a conventional electrical power substation to a smart electrical power substation, especially when considering the use of the IEC 61850 series, iWSN and other information technologies. In addition to the substation equipment's (wired) connectivity, which is likely based on the IEC 61850 series, the iWSN system will provide additional benefits to collect, process, and transmit data/information about power substation equipment and its environment. An effective and efficient sensing system can be achieved by an iWSN system which takes the role of a data/information measurement and collection system. The concept of the iWSN system provides functions, such as automatic data collection and aggregation, collaborative information processing (e.g. data/information fusion), data analysis, and alarming, and other functional applications that enable the intelligence or smartness of the system that the iWSN system is monitoring.

The information collected in an electrical power substation about the equipment state and the flow of electricity provides the electricity providers with a clearer view and better control over the electrical power substation. Among the many add-values that the iWSN brings compared to the wired installation, one of them is the migration to the no-wire installation as all the sensor nodes are powered by batteries and the data is transmitted via the wireless communication links of the iWSN. A wireless sensor network, that is able to communicate with the utility provider's control system by sharing the collected information with the existing networks becomes an attractive technology to deploy in an electrical power substation in order to collect required and critical information.

This document is built upon ISO/IEC 29182 (Sensor Network Reference Architecture) and ISO/IEC 30101 (sensor network and its interfaces for smart grid systems), IEC 61850 (communication networks and systems for power utility automation), and ETSI's and NIST's work in smart grid, and extends ISO/IEC 29182 and ISO/IEC 30101 to the application standard of the sensor network that supports the electrical power substations.

The iWSN system uses wireless sensor networks for power substations including substation, equipment, facility, environment, etc. The existing communication protocols specified in IEC 61850-8-1 and IEC 61850-9-2 can be used within power substation, or IEC 61850-8-2 can be used over public network. This document provides the iWSN system's infrastructure from System and Communications Views and also specifies the iWSN system's technical requirements to realize and support the smart electrical power substation. Electrical power substations with sensor networks use advanced information and communication technologies in order to improve the efficiency, reliability, and security of their components and services.

INTERNET OF THINGS (IOT) – WIRELESS SENSOR NETWORK SYSTEM SUPPORTING ELECTRICAL POWER SUBSTATION

1 Scope

This document specifies

– intelligent wireless sensor network (iWSN) from the perspectives of iWSN's system infrastructure and communications internal and external to the infrastructure, and

– technical requirements for iWSN to realize smart electrical power substations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61000-4-39, *Electromagnetic compatibility (EMC) – Part 4-39: Testing and measurement techniques – Radiated fields in close proximity – Immunity test*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61850-3, *Communication networks and systems for power utility automation – Part 3: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
control subsystem for sensor network
CSSN
platform together with all the sensor nodes communicated to it with networks, including the rules for control, for communication and for management among application processes of sensor network

[SOURCE: IEC 60050-732:2014, 732-10-02, modified – In the definition, "home network", "devices" and "attached to it" have been replaced by "platform", "sensor nodes" and "communicated to it with networks", respectively, and "of sensor network" has been added at the end.]