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Internet of things (IoT) – Integration of IoT trustworthiness activities in ISO/IEC/IEEE 15288 system engineering processes

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FOREWORD

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ISO/IEC 30147 has been prepared by subcommittee 41: Internet of Things and related technologies, of ISO/IEC joint technical committee 1: Information technology. It is an International Standard.

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

FDIS	Report on voting
JTC1-SC41/210/FDIS	JTC1-SC41/221/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1, available at www.iec.ch/members_experts/refdocs and www.iso.org/directives.

INTRODUCTION

In the Internet of Things (IoT), all IoT devices are mutually connected to each other and this is expected to bring new advantages to daily life. On the other hand, traditional system management devices (thermostats, lighting systems, traffic lights, etc.) which were not previously connected to the Internet are now being connected without regard to the level of IoT trustworthiness required by the system-of-interest. Many of these devices are being connected without the benefit of security controls and processes in place for servers, PCs, and smartphones. Flaws or failures in these devices caused by lack of IoT trustworthiness can have a deep impact on the users and system operation. This implies that there are conditions and characteristics specific to IoT systems and services which are different from those of other existing IT systems and services. Examples are as follows.

– The extent and the degree of impacts of threats are very wide and big.
– The life time of IoT systems and services, especially in operation and maintenance, is sometimes very long.
– It can be very difficult to monitor and manage some types of IoT devices.
– It can be difficult for communication entities including IoT devices to sufficiently know the environments of each other.
– The functions and performances of some IoT devices might be restricted technologically.
– In IoT systems and services, connections between entities can be made which the developers of the entities did not anticipate.

The purpose of this document is to provide guidance to realize IoT trustworthiness. This is because existing documents are targeted to each application area and do not necessarily cover all the challenges faced by the IoT system and service according to the above conditions and characteristics specific to IoT systems and services. This document provides system life cycle processes to realize IoT trustworthiness by applying and supplementing ISO/IEC/IEEE 15288:2015.

INTERNET OF THINGS (IoT) – INTEGRATION OF IoT TRUSTWORTHINESS ACTIVITIES IN ISO/IEC/IEEE 15288 SYSTEM ENGINEERING PROCESSES

1 Scope

This document provides system life cycle processes to implement and maintain trustworthiness in an IoT system or service by applying and supplementing ISO/IEC/IEEE 15288:2015. The system life cycle processes are applicable to IoT systems and services common to a wide range of application areas.

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 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

ISO/IEC Guide 51:2014, *Safety aspects – Guidelines for their inclusion in standards*

ISO/IEC 27005:2018, *Information technology – Security techniques – Information security risk management*

ISO/IEC 27031:2011, *Information technology – Security techniques – Guidelines for information and communication technology readiness for business continuity*

ISO/IEC 29134:2017, *Information technology – Security techniques – Guidelines for privacy impact assessment*

ISO/IEC/IEEE 15288:2015, *Systems and software engineering – System life cycle processes*

ISO 31000, *Risk management – Guidelines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC/IEEE 15288:2015, and the following apply.

NOTE The following terms are defined in ISO/IEC/IEEE 15288:2015:

acquirer, acquisition, activity, agreement, architecture, architecture viewpoint, asset, baseline, concept of operation, concern, customer, design (verb), design (noun), enabling system, environment, incident, information item, interface, life cycle, life cycle model, operational concept, operator, organization, party, problem, process, product, project, quality assurance, quality characteristic, quality management, requirement, resource, risk, stage, stakeholder, supplier, system, system element, system-of-interest, task, user, validation, verification.

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
asset
entity (3.6) that has value and is either owned by or under the custody of an individual, an organization, a government, or other groups

[SOURCE: ISO/IEC 20924:2021[1], 3.1.4]

3.2
availability
property of being accessible and usable on demand by an authorized entity (3.6)

Note 1 to entry: IoT systems can include both human users and service components as "authorized entities".

[SOURCE: ISO/IEC 27000:2018[2], 3.7]

3.3
characteristic
abstraction of a property of an entity (3.6) or of a set of entities

[SOURCE: ISO 18104:2014[3], 3.1.4]

3.4
component
modular, deployable, and replaceable part of a system that encapsulates implementation and exposes a set of interfaces

[SOURCE: ISO 14813-5:2010[4], B.1.31]

3.5
confidentiality
property that information is not made available or disclosed to unauthorized individuals, entities (3.6), or processes

[SOURCE: ISO/IEC 27000:2018[2], 3.10]

3.6
entity
thing (physical or non-physical) having a distinct existence

[SOURCE: ISO/IEC 15459-3:2014[5], 3.1, modified – In the definition, "anything" has been replaced by "thing".]

3.7
integrity
property of accuracy and completeness

[SOURCE: ISO/IEC 27000:2018[2], 3.36]

3.8
Internet of Things
IoT
infrastructure of interconnected entities (3.6), people, systems and information resources together with services which processes and reacts to information from the physical world and virtual world

[SOURCE: ISO/IEC 20924:2021[1], 3.2.4]

3.9
IoT device
entity (3.6) of an IoT system that interacts and communicates with the physical world through sensing or actuating

[SOURCE: ISO/IEC 20924:2021[1], 3.2.6]

3.10
IoT system
system providing functionalities of IoT

Note 1 to entry: An IoT system can include, but not be limited to, IoT devices, IoT gateways, sensors, and actuators.

[SOURCE: ISO/IEC 20924:2021[1], 3.2.9]

3.11
IoT trustworthiness
trustworthiness of an IoT system with characteristics including security, privacy, safety, reliability and resilience

Note 1 to entry: The term "trustworthiness" is defined at 3.1.34 in ISO/IEC 20924:2021 as the ability to meet stakeholder expectations in a demonstrable, verifiable and measurable way

Note 2 to entry: The relative importance of characteristics of IoT trustworthiness, including security, privacy, safety, reliability and resilience, depends on the nature and the context of the IoT system or service.

[SOURCE: ISO/IEC 20924:2021[1], 3.2.10, modified – Note 1 to entry and Note 2 to entry have been added.]

3.12
network
infrastructure that connects a set of endpoints, enabling communication of data between the digital entities (3.6) reachable through them

[SOURCE: ISO/IEC 20924:2021[1], 3.1.26]

3.13
reliability
ability of an item to perform as required, without failure, for a given time interval, under given conditions

Note 1 to entry: The time interval duration may be expressed in units appropriate to the item concerned, e.g. calendar time, operating cycles, distance run, etc., and the units should always be clearly stated.

Note 2 to entry: Given conditions include aspects that affect reliability, such as: mode of operation, stress levels, environmental conditions, and maintenance.

[SOURCE: IEC 60050-192:2015, 192-01-24]

3.14
resilience
tolerance of a system to malfunctions or capacity to recover functionality after stress

[SOURCE: ISO 18457:2016[6], 3.9]

3.15
security
protection against intentional subversion or forced failure, achieved by a composite of five attributes – confidentiality, integrity, availability, non-repudiation, and accountability – plus aspects of a sixth, usability, all of which have the related issue of their assurance

[SOURCE: ISO/IEC/IEEE 15288:2015, 4.1.41, modified – In the definition, the attribute "non-repudiation" has been added.]

3.16
service
distinct functionality that is provided by an entity (3.6) through interfaces

[SOURCE: ISO/IEC 20924:2021[1], 3.1.30]

4 Abbreviated terms

ATM	automated teller machine
ICT	information and communication technology
IIoT	industrial IoT
OS	operating system
OT	operational technology
PC	personal computer
SoS	system of systems

5 IoT systems/services and IoT trustworthiness

5.1 Characteristics specific to IoT systems and services

An IoT service is a service provided by an IoT system which may be a system of systems (SoS), characterized as operationally and managerially independent of constituent systems (see 4.1 in ISO/IEC/IEEE 21839:2019[7][1], see also Figure 1). Note that there may be a case where no one is responsible for an IoT system which is an SoS. In such a case, it is a distinguishing feature of an IoT system that cooperation with other organizations, which operate and manage constituent systems of the IoT system, is necessary to achieve IoT trustworthiness. IoT trustworthiness is considered to be achieved if all the requirements of IoT trustworthiness are satisfied because IoT trustworthiness depends on each system. For details of IoT systems, a lot of examples are provided in ISO/IEC TR 22417:2017[8].

This document is targeted at users who are responsible for implementation and maintenance of IoT trustworthiness. When there is no entity responsible for the whole IoT system or service, this document applies to each constituent system or service for which there is an entity responsible regardless of whether it consists of multiple subsystems, part(s) of which may be operated and managed by another entity or entities.

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1 Numbers in square brackets refer to the Bibliography.

Activities and tasks in each process to realize IoT trustworthiness are included in those for the IoT system by which the IoT service is provided. Descriptions of activities and tasks are represented by those for an IoT system, unless otherwise specified. When applied to an IoT service, choose activities and tasks that are applicable.

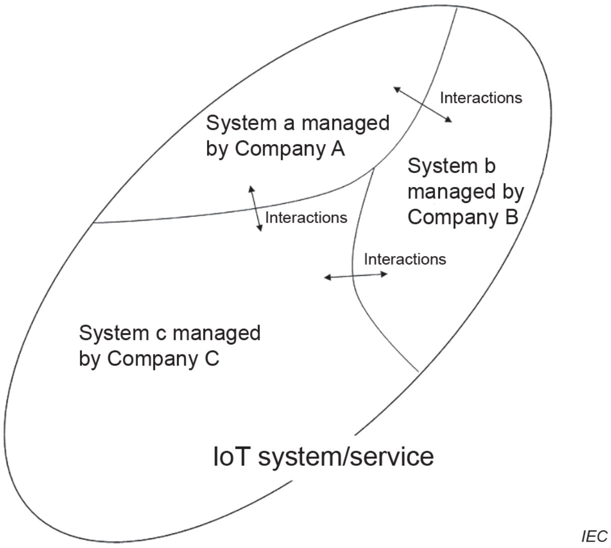

Figure 1 – An IoT system, a system of systems

A Thing in an IoT system might be the following status or might have the following issues.

1) Compromised Thing

An intruder could have taken control of the Thing-of-interest and provided data, command and controls with the intent of disrupting the entire IoT setup resulting in the loss of trust of the Thing. This results in hacking of flights or automobiles, for example.

2) Incorrectly configured Thing

Because of some fault in command and control, the configuration of the Thing-of-interest could have exhibited a state that is neither expected nor detected, resulting in loss of IoT trustworthiness of the Thing. An example of this issue is CO_2 and SO sensors incorrectly configured in a gas turbine.

3) Damaged Thing

Because of some operational conditions, the Thing-of-interest could have become damaged, resulting in a situation or state that the Thing-of-interest is not trustworthy. This can cause a disaster if it is an altitude, speed, or flap sensor in an airplane.

4) Incorrect interactions because of poor interfaces

The interfaces between the Thing-of-interest and other Things could have lost the compatibility because of various factors (upgrades, incorrect patches, wrong configuration and so on), resulting in the Thing-of-interest ceasing to be trustworthy. For example, patches not or incorrectly installed in medical devices can cause a serious healthcare problem.

5) Incompatibility because of incorrect configuration

The Thing-of-interest could be configured incorrectly (for example, units of measurement, size of data exchange, nature of data, and so on), resulting in a situation that the information received from the Thing-of-interest is not useful, which results in the Thing-of-interest ceasing to be trustworthy. An example is incorrect baud rate used for configuring the IoT devices.