

TR IEC/TS 62443-1-1:2018(2024)
IEC/TS 62443-1-1:2009, IDT
(ICS 25.040.40; 33.040.40; 35.040)

TECHNICAL REFERENCE

Industrial communication networks – Network and system security

– Part 1-1 : Terminology, concepts and models

Confirmed 2024

TR IEC/TS 62443-1-1:2018(2024)

IEC/TS 62443-1-1:2009, IDT
(ICS 25.040.40; 33.040.40; 35.040)

TECHNICAL REFERENCE

Industrial communication networks – Network and system security

– Part 1-1 : Terminology, concepts and models

Published by Enterprise Singapore

**Enterprise
Singapore**



**THIS PUBLICATION IS COPYRIGHT
PROTECTED**
Copyright © 2018 Enterprise Singapore
Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilised in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from Enterprise Singapore, representing the IEC National Committee of Singapore, or the IEC. If you have any questions about the copyrights of Enterprise Singapore or the IEC or have an enquiry about obtaining additional rights to this publication, please contact Enterprise Singapore at: standards@enterprisesg.gov.sg for further information.

ISBN 978-981-48-3522-0

National Foreword

This Technical Reference (TR) was prepared by the Working Group on Cyber Security for Industrial Automation set up by the Technical Committee on Smart Manufacturing under the purview of the Manufacturing Standards Committee.

This TR is an identical adoption of IEC/TS 62443-1-1:2009, “Industrial communication networks – Network and system security – Part 1-1 : Terminology, concepts and models”, published by the International Electrotechnical Commission.

Attention is drawn to the possibility that some of the elements of this TR may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

NOTE

- 1. Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions. Where SSs are deemed to be stable, i.e. no foreseeable changes in them, they will be classified as “mature standards”. Mature standards will not be subject to further review, unless there are requests to review such standards.*
- 2. An SS or TR is voluntary in nature except when it is made mandatory by a regulatory authority. It can also be cited in contracts making its application a business necessity. Users are advised to assess and determine whether the SS or TR is suitable for their intended use or purpose. If required, they should refer to the relevant professionals or experts for advice on the use of the document. Enterprise Singapore and the Singapore Standards Council shall not be liable for any damages whether directly or indirectly suffered by anyone or any organisation as a result of the use of any SS or TR. Although care has been taken to draft this standard, users are also advised to ensure that they apply the information after due diligence.*
- 3. Compliance with a SS or TR does not exempt users from any legal obligations.*



TECHNICAL SPECIFICATION



Industrial communication networks – Network and system security – Part 1-1: Terminology, concepts and models





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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 corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00



TECHNICAL SPECIFICATION



**Industrial communication networks – Network and system security –
Part 1-1: Terminology, concepts and models**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XC**

ICS 25.040.40; 33.040.040; 35.040

ISBN 978-2-88910-710-0

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
1.1 General.....	8
1.2 Included functionality.....	8
1.3 Systems and interfaces.....	8
1.4 Activity-based criteria.....	9
1.5 Asset-based criteria.....	9
2 Normative references.....	10
3 Terms, definitions and abbreviations.....	10
3.1 General.....	10
3.2 Terms and definitions.....	10
3.3 Abbreviations.....	26
4 The situation.....	26
4.1 General.....	26
4.2 Current systems.....	27
4.3 Current trends.....	28
4.4 Potential impact.....	28
5 Concepts.....	29
5.1 General.....	29
5.2 Security objectives.....	29
5.3 Foundational requirements.....	30
5.4 Defence in depth.....	30
5.5 Security context.....	30
5.6 Threat-risk assessment.....	32
5.6.1 General.....	32
5.6.2 Assets.....	32
5.6.3 Vulnerabilities.....	34
5.6.4 Risk.....	34
5.6.5 Threats.....	36
5.6.6 Countermeasures.....	39
5.7 Security program maturity.....	39
5.7.1 Overview.....	39
5.7.2 Maturity phases.....	42
5.8 Policies.....	45
5.8.1 Overview.....	45
5.8.2 Enterprise level policy.....	46
5.8.3 Operational policies and procedures.....	47
5.8.4 Topics covered by policies and procedures.....	47
5.9 Security zones.....	50
5.9.1 General.....	50
5.9.2 Determining requirements.....	50
5.10 Conduits.....	51
5.10.1 General.....	51
5.10.2 Channels.....	52
5.11 Security levels.....	53

5.11.1	General	53
5.11.2	Types of security levels	53
5.11.3	Factors influencing SL(achieved) of a zone or conduit	55
5.11.4	Impact of countermeasures and inherent security properties of devices and systems	57
5.12	Security level lifecycle	57
5.12.1	General	57
5.12.2	Assess phase	58
5.12.3	Develop and implement phase	59
5.12.4	Maintain phase	60
6	Models	61
6.1	General	61
6.2	Reference models	62
6.2.1	Overview	62
6.2.2	Reference model levels	63
6.3	Asset models.....	65
6.3.1	Overview	65
6.3.2	Enterprise.....	68
6.3.3	Geographic sites	68
6.3.4	Area	68
6.3.5	Lines, units, cells, vehicles	68
6.3.6	Supervisory control equipment.....	68
6.3.7	Control equipment	69
6.3.8	Field I/O network	69
6.3.9	Sensors and actuators.....	69
6.3.10	Equipment under control.....	69
6.4	Reference architecture	69
6.5	Zone and conduit model	70
6.5.1	General	70
6.5.2	Defining security zones	70
6.5.3	Zone identification	70
6.5.4	Zone characteristics	74
6.5.5	Defining conduits.....	76
6.5.6	Conduit characteristics	77
6.6	Model relationships	79
	Bibliography.....	81
	Figure 1 – Comparison of objectives between IACS and general IT systems	29
	Figure 2 – Context element relationships	31
	Figure 3 – Context model.....	31
	Figure 4 – Integration of business and IACS cybersecurity.....	40
	Figure 5 – Cybersecurity level over time	40
	Figure 6 – Integration of resources to develop the CSMS.....	42
	Figure 7 – Conduit example	52
	Figure 8 – Security level lifecycle.....	58
	Figure 9 – Security level lifecycle – Assess phase	59
	Figure 10 – Security level lifecycle – Implement phase	60

Figure 11 – Security level lifecycle – Maintain phase	61
Figure 12 – Reference model for IEC 62443 standards	62
Figure 13 – SCADA reference model	63
Figure 14 – Process manufacturing asset model example	66
Figure 15 – SCADA system asset model example	67
Figure 16 – Reference architecture example	69
Figure 17 – Multiplant zone example	71
Figure 18 – Separate zones example	72
Figure 19 – SCADA zone example	73
Figure 20 – SCADA separate zones example	74
Figure 21 – Enterprise conduit	77
Figure 22 – SCADA conduit example	78
Figure 23 – Model relationships	80
Table 1 – Types of loss by asset type	33
Table 2 – Security maturity phases	43
Table 3 – Concept phase	43
Table 4 – Functional analysis phase	43
Table 5 – Implementation phase	44
Table 6 – Operations phase	44
Table 7 – Recycle and disposal phase	45
Table 8 – Security levels	53

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
NETWORK AND SYSTEM SECURITY –****Part 1-1: Terminology, concepts and models**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC 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 National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC 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 National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees 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 IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62443-1-1, which is a technical specification, has been prepared by IEC technical committee 65: Industrial-process measurement, control and automation.

This technical specification is derived from the corresponding US ANSI/S99.01.01 standard.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
65/423/DTS	65/432A/RVC

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

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

A list of all parts of the IEC 62433 series, published under the general title *Industrial communication networks – Network and system security*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

NOTE The revision of this technical specification will be synchronized with the other parts of the IEC 62443 series.

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 publication using a colour printer.

INTRODUCTION

The subject of this technical specification is security for industrial automation and control systems. In order to address a range of applications (i.e., industry types), each of the terms in this description have been interpreted very broadly.

The term “Industrial Automation and Control Systems” (IACS), includes control systems used in manufacturing and processing plants and facilities, building environmental control systems, geographically dispersed operations such as utilities (i.e., electricity, gas, and water), pipelines and petroleum production and distribution facilities, and other industries and applications such as transportation networks, that use automated or remotely controlled or monitored assets.

The term “security” is considered here to mean the prevention of illegal or unwanted penetration, intentional or unintentional interference with the proper and intended operation, or inappropriate access to confidential information in IACS. Cybersecurity which is the particular focus of this technical specification, includes computers, networks, operating systems, applications and other programmable configurable components of the system.

The audience for this technical specification includes all users of IACS (including facility operations, maintenance, engineering, and corporate components of user organizations), manufacturers, suppliers, government organizations involved with, or affected by, control system cybersecurity, control system practitioners, and security practitioners. Because mutual understanding and cooperation between information technology (IT) and operations, engineering, and manufacturing organizations is important for the overall success of any security initiative, this technical specification is also a reference for those responsible for the integration of IACS and enterprise networks.

Typical questions addressed by this technical specification include:

- a) What is the general scope of application for IACS security?
- b) How can the needs and requirements of a security system be defined using consistent terminology?
- c) What are the basic concepts that form the foundation for further analysis of the activities, system attributes, and actions that are important to provide electronically secure control systems?
- d) How can the components of an IACS be grouped or classified for the purpose of defining and managing security?
- e) What are the different cybersecurity objectives for control system applications?
- f) How can these objectives be established and codified?

Each of these questions is addressed in detail in subsequent clauses of this technical specification.

INDUSTRIAL COMMUNICATION NETWORKS – NETWORK AND SYSTEM SECURITY –

Part 1-1: Terminology, concepts and models

1 Scope

1.1 General

This part of the IEC 62443 series is a technical specification which defines the terminology, concepts and models for Industrial Automation and Control Systems (IACS) security. It establishes the basis for the remaining standards in the IEC 62443 series.

To fully articulate the systems and components the IEC 62443 series address, the range of coverage may be defined and understood from several perspectives, including the following:

- a) range of included functionality;
- b) specific systems and interfaces;
- c) criteria for selecting included activities;
- d) criteria for selecting included assets.

Each of these is described in the following subclauses:

1.2 Included functionality

The scope of this technical specification can be described in terms of the range of functionality within an organization's information and automation systems. This functionality is typically described in terms of one or more models.

This technical specification focuses primarily on industrial automation and control, as described in a reference model (see Clause 6). Business planning and logistics systems are not explicitly addressed within the scope of this technical specification, although the integrity of data exchanged between business and industrial systems is considered.

Industrial automation and control includes the supervisory control components typically found in process industries. It also includes SCADA (Supervisory Control and Data Acquisition) systems that are commonly used by organizations that operate in critical infrastructure industries. These include the following:

- a) electricity transmission and distribution;
- b) gas and water distribution networks;
- c) oil and gas production operations;
- d) gas and liquid transmission pipelines.

This is not an exclusive list. SCADA systems may also be found in other critical and non-critical infrastructure industries.

1.3 Systems and interfaces

In encompassing all IACS, this technical specification covers systems that can affect or influence the safe, secure, and reliable operation of industrial processes. They include, but are not limited to: