IEC 62657-3

Edition 1.0 2022-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Industrial networks – Coexistence of wireless systems – Part 3: Formal description of the automated coexistence management and application guidance

Réseaux industriels – Coexistence des systèmes sans fil – Partie 3: Description formelle de la gestion automatisée de la coexistence et recommandations d'application

IEC 62657-3:2022-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL NETWORKS – COEXISTENCE OF WIRELESS SYSTEMS –

Part 3: Formal description of the automated coexistence management and application guidance

FOREWORD

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

Draft	Report on voting
65C/1165/FDIS	65C/1171/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 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62657 series, published under the general title *Industrial networks – Coexistence of wireless systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The intended audience for the IEC 62657 series is shown in Table 1.

Table 1 – Audience of the IEC 62657 series

Audience	Part 1 Wireless requirements	Part 2 Coexistence management	Part 3 Architecture and use	Part 4 Central coordination
1. Regulator	✓	—	—	—
2. IA expert	✓	—	—	—
3. Plant owner	—	✓	✓	—
4. Device manufacture	—	✓	✓	✓
5. System integrator	✓	✓	✓	✓
Key: ✓ = applies especially to the audience #; — = should be read by everybody				

This document is aimed at plant owners that are operating industrial wireless solutions, manufacturers of industrial wireless devices, as well as wireless system integrators and operators.

Plant owners need to understand the nature of the coexistence state with respect to wireless automation systems. Also, they need to make sure that all impacts to the industrial wireless application systems represented by parameters are taken into account. This document provides them the information needed to understand coexistence management parameters and each relationship for a reliable plant operation.

Device manufacturers should provide quantitative parameters on their wireless device and system to manage the coexistence of the wireless industrial application based on IEC 62657-2. This document defines related parameters and interfaces of devices for automatic coexistence management.

System integrators should, in collaboration with the plant owner and device manufacturers, design, implement, and manage the wireless industrial automation systems throughout the plant lifecycle. This document provides essential parameters and interfaces for coexistence management for system integrators.

A consideration of this document is to outline the features of automated collaborative coexistence management to develop solutions with, for example, a central coordination point (CCP), with a software-defined networking approach for flexible use of frequency spectrum or using a global navigation satellite system (GNSS) for location-based use of frequency spectrum.

Figure 1 shows the relation between the parts of the IEC 62657 series.

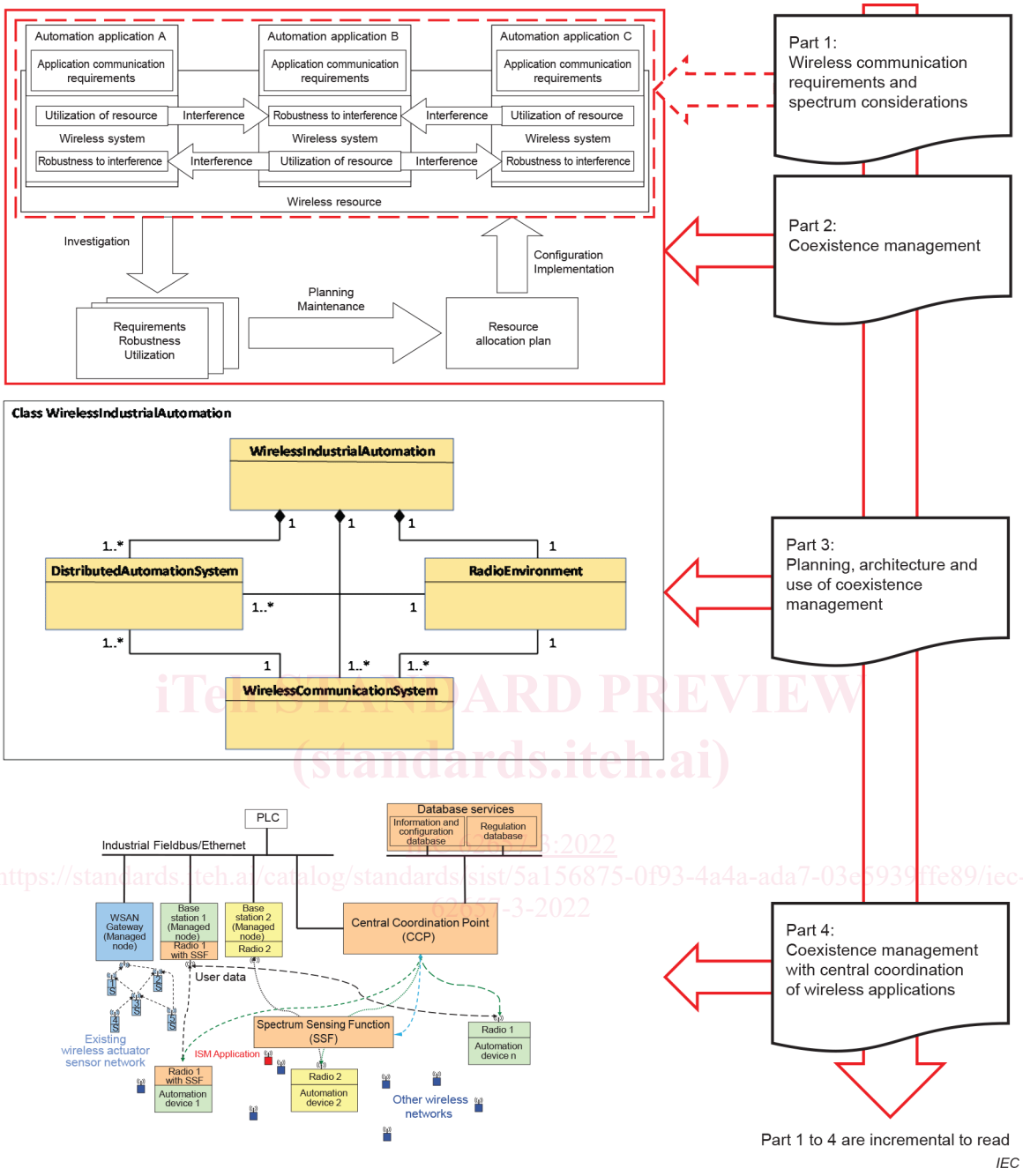

Figure 1 – Relation between the parts of the IEC 62657 series

INDUSTRIAL NETWORKS – COEXISTENCE OF WIRELESS SYSTEMS –

Part 3: Formal description of the automated coexistence management and application guidance

1 Scope

This part of IEC 62657 specifies a general model approach for automated coexistence management and provides application guidance. This document provides the usage of related parameters and interfaces to establish and to maintain functions for automatic coexistence management. This document specifies an abstract description of the system elements, properties, interfaces and relationships between influencing parameters and characteristic parameters specified in IEC 62657-1 and IEC 62657-2.

NOTE IEC 62657-4 specifies the central coordination point approach as one example of the usage of the formal description of this document.

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 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 62657-1, *Industrial communication networks – Wireless communication networks – Part 1: Wireless communication requirements and spectrum considerations*

IEC 62657-2:—[1], *Industrial networks – Coexistence of wireless systems – Part 2: Coexistence management*

IEC 62657-4:—[2], *Industrial networks – Coexistence of wireless systems – Part 4: Coexistence management with central coordination of wireless applications*

3 Terms, definitions and abbreviated terms

3.1 General

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

[1] Under preparation. Stage at the time of publication: IEC FDIS 62657-2:2022.

[2] Under preparation. Stage at the time of publication: IEC FDIS 62657-4:2022.

3.2 Terms and definitions specific for this document

3.2.1
dependability
ability to perform as and when required

Note 1 to entry: Dependability includes availability, reliability, recoverability, maintainability, and maintenance support performance, and, in some cases, other characteristics such as durability, safety and security.

Note 2 to entry: Dependability is used as a collective term for the time-related quality characteristics of an item.

[SOURCE: IEC 60050-192:2015, 192-01-22]

3.2.2
industrial automation system
set of interrelated industrial automation applications

3.2.3
logical link
relationship between logical endpoints of local automation functions of a distributed automation system

3.2.4
message
information which is transmitted in one or several packets from a sender to one or more receivers

[SOURCE: IEC 60050-821:2017, 821-11-29]

3.2.5
message loss ratio
ratio, expressed as a percentage, of the number of messages not delivered divided by the total number of messages during a time interval T, where the number of messages not delivered is the difference between the number of messages arriving at the ingress flow point and the number of messages delivered at the egress flow point in a point-to-point connection

3.2.6
reliability
reliability of an item
ability of an item to perform a required function under stated conditions for a specified period of time

[SOURCE: IEC 60050-603:1986, 603-05-01]

3.3 Terms and definitions given in IEC 62657-2

For ease of understanding, the most important terms from IEC 62657-2 used within this document are listed but the definitions are not repeated in the list.

– active environmental influence
– application communication requirements
– area of operation
– automated collaborative coexistence management
– automation application
– channel number
– coexistence
– coexistence management

– coexistence manager
– collaborative coexistence management
– communication availability
– communication load
– cut-off frequency
– device
– distance between wireless devices
– distributed automation system
– duty cycle
– electromagnetic interference
– frequency band
– frequency bandwidth
– frequency channel
– industrial automation application, see automation application
– industrial communication network
– industrial, scientific and medical application
– infrastructure device
– interference
– intervisibility
– life-cycle
– line of sight (LOS)
– lower cut-off frequency
– modulation
– natural environmental condition
– network
– network topology
– non-line of sight (NLOS)
– observation time
– obstructed line of sight (OLOS)
– packet
– passive environmental influence
– performance requirements
– physical link
– plant
– power spectral density
– radio channel
– radio environment
– reference interface
– regional radio regulation
– relative movement
– transfer interval
– transmitter sequence
– update time

– upper cut-off frequency
– wireless application
– wireless communication
– wireless communication application
– wireless communication solution
– wireless communication system
– wireless device
– wireless solution
– wireless technology or standard

3.4 Abbreviated terms

BNC	Bayonet Neill–Concelman
CCP	Central coordination point
DAA	Detect and avoid
EMI	Electromagnetic interference
GNSS	Global navigation satellite system
I/O	Input and output
IA	Industrial automation
ISM	industrial, scientific and medical application
LBT	listen before talk
LOS	Line of sight
M	Motor
NLOS	Non-line of sight
OLOS	Obstructed line of sight
P95	Percentile
PCB	printed circuit board
PLC	programmable logic controller
PSD	Power spectral density
RED	Radio equipment directive
RF	Radio frequency
SIL	Safety integrity level
XML	Exchangeable mark-up language

4 Automated collaborative coexistence management

4.1 Motivation

Wireless communication systems for industrial automation applications should adopt a coexistence management process that can be maintained along the life cycle of the automation application. Coexistence management parameters are formally specified in order to enable formal description of the coexistence management process. This formal description is the fundament for a dependable use of wireless communication systems during the life cycle of the automation application especially if a collaborative coexistence management is to be used. According to IEC 62657-2, automated collaborative coexistence management is a form of coexistence management that is supported by software tools with defined interfaces between the tool and the wireless communication systems. The term collaborative indicates that all wireless systems involved provide the necessary information and can be influenced with regard to the overall objective of the automation applications.

This document specifies the system elements, properties, interfaces and relationships between influencing parameters and characteristic parameters specified in IEC 62657-1 and IEC 62657-2. It describes the relevant parameters to be used for profile specification. Since a profile specification is the abstraction of many different individual use cases, the parameters used for this purpose are abstracted as well.

This document can be used to contribute to national and regional regulations. It does not exempt devices from conforming to all requirements of national and regional regulations.

4.2 Application scenarios

4.2.1 General

Automated collaborative coexistence management is intended to provide an analysis of the coexistence state that fluctuates in real time and autonomously implements the solution to stabilize the operation of wireless applications. It has the following functions:

– discovering solutions to coexistence problems;
– optimizing coexistence management plan;
– supporting robust and flexible wireless applications even in dynamic fluctuation in the radio environment;
– supporting rapid implementation for new industrial wireless applications;
– optimizing a solution by identifying the cause of trouble from a large combination of coexistence management parameters.

It makes possible to provide efficient work process for maintaining the wireless system. Automated coexistence management offers the following various benefits:

- reduction or elimination of interferences leading to unplanned downtimes;
- reduction or avoidance of laborious, cost-intensive and time-consuming fault elimination;
- reduction of efforts and time for introduce new wireless applications.

Subclause 4.2 describes typical application scenarios in the automated collaborative coexistence management in the entire plant life-cycle.

4.2.2 Establishing wireless industrial automation

4.2.2.1 General

There are two types of projects being conducted for building an industrial automation application. One is a green field project, another one is a brown field project. From the coexistence management perspective, application scenarios applied with automated collaborative coexistence management for those two types of projects are described in 4.2.2.

4.2.2.2 Green field projects

Green field projects are newly construct plants from scratch.

Wireless communication solutions are planned and engineered according to the application communication requirements. The wireless system and device related influencing parameters are stored for the use in the automated coexistence management. For the assessment of propagation conditions, of relevant interferences, and of the effects of these interferences, the radio environment is investigated using for example network analyzers or spectrum sensing tools. The environment related influencing parameters, for example radio signals, frequencies, duty cycles and their fluctuations are recorded and stored into the database of the collaborative coexistence manager. This information can also be used to configure new wireless applications appropriately.

Investigations using collaborative coexistence management under laboratory conditions can also be useful to prepare the implementation of a wireless solution in cases where the target environment is not yet available (for example during the construction of a new production hall).

4.2.2.3 Brown field projects

Brownfield projects are carried out on land that has previously been developed and used for a manufacturing or processing operation. The new wireless solution shall be integrated into the available implementation.

During the planning, engineering and implementation of a new wireless solution in brown field projects, the collision risks and already allocated spectrum are to be analyzed. Depending on the application communication requirements, it is possible that existing solutions are to be reconfigured. The values of the influencing parameters shall be included into the implementations for collaborative coexistence management.

4.2.3 Operation and maintenance of wireless industrial automation

4.2.3.1 General

In the plant operation of wireless automation applications, collaborative coexistence manager monitors to assess the condition of coexistence continuously. The maintenance works of wireless industrial automation specified in 4.2.3 could be conducted effectively utilizing the collaborative coexistence management.

4.2.3.2 Degradation of existence state

When the coexistence state function is getting down to an unaccepted level (see IEC 62657-4:—, Figure 3), the maintenance phase of coexistence management is initiated to reestablish the coexistence state. Collaborative coexistence management should compute and reallocate spectrum resources based on the level of related performance parameters to achieve again the coexistence state.

4.2.3.3 Reconfiguration of wireless communication system

A reconfiguration of a wireless communication system will be launched depending on the needs of the automation application. Application requirements change, then for example wireless devices could be added or removed, devices could move or data traffic volume could change. Reconfiguration is also valuable when the coexistence state is influenced and fluctuates due to the changing of radio propagation environment. In these cases, collaborative coexistence management will contribute to minimize risks and work processes to maintain the wireless industrial automation.

If there are wireless applications already active containing wireless solutions of critical application classes (for example classes of functional safety or mission critical control applications), then the collaborative coexistence management should not modify spectrum resources for the wireless solutions of critical application classes to minimize risks in the operation of a plant.

4.2.3.4 Troubleshooting

Collaborative coexistence management is recording performance parameters and characterized parameters of wireless industrial automation continuously. It contributes to analyze cause and mechanism of fault. Then collaborative coexistence management reconfigures spectrum resources such as frequency, channels, transmitting time, network topology based on the cause of fault.