

TECHNICAL REPORT



**OPC unified architecture –
Part 1: Overview and concepts**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPC UNIFIED ARCHITECTURE –

Part 1: Overview and concepts

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62541-1, which is a Technical Report, has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition of IEC TR 62541-1, published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) added Subclauses 6.5 and 6.6 and other text throughout to include PubSub introduction;
- b) added new transports and encodings to existing overview sections;
- c) removed WS-SecureConversation example since this mapping has been deprecated;
- d) improved the definition of Certificate.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
65E/678/DTR	65E/702/RVDTR

Full information on the voting for the approval of this technical report 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.

Throughout this document and the referenced other Parts of the series, certain document conventions are used:

Italics are used to denote a defined term or definition that appears in the "Terms and definition" clause in one of the parts of the series.

Italics are also used to denote the name of a service input or output parameter or the name of a structure or element of a structure that are usually defined in tables.

The *italicized terms* and names are also often written in camel-case (the practice of writing compound words or phrases in which the elements are joined without spaces, with each element's initial letter capitalized within the compound). For example, the defined term is *AddressSpace* instead of Address Space. This makes it easier to understand that there is a single definition for AddressSpace, not separate definitions for Address and Space.

A list of all parts of the IEC 62541 series, published under the general title OPC Unified Architecture, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability 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

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

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OPC UNIFIED ARCHITECTURE –

Part 1: Overview and concepts

1 Scope

This part of IEC 62541 presents the concepts and overview of the OPC Unified Architecture (OPC UA). Reading this document is helpful to understand the remaining parts of this multi-part document set. Each of the other parts of IEC 62541 is briefly explained along with a suggested reading order.

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 TR 62541-2, *OPC unified architecture – Part 2: Security Model*

IEC 62541-3, *OPC unified architecture – Part 3: Address Space Model*

IEC 62541-4, *OPC unified architecture – Part 4: Services*

IEC 62541-5, *OPC unified architecture – Part 5: Information Model*

IEC 62541-6, *OPC unified architecture – Part 6: Mappings*

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IEC 62541-7, *OPC unified architecture – Part 7: Profiles*

IEC 62541-8, *OPC unified architecture – Part 8: Data access*

IEC 62541-9, *OPC unified architecture – Part 9: Alarms and Conditions*

IEC 62541-10, *OPC unified architecture – Part 10: Programs*

IEC 62541-11, *OPC unified architecture – Part 11: Historical Access*

IEC 62541-12, *OPC unified architecture – Part 12: Discovery and global services*

IEC 62541-13, *OPC Unified Architecture – Part 13: Aggregates*

IEC 62541-14, *OPC unified architecture – Part 14: PubSub*

ITU X.509, *Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks*
<https://www.itu.int/rec/T-REC-X.509>

3 Terms, definitions, and abbreviated terms

3.1 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>

3.1.1

AddressSpace

collection of information that ~~an OPC UA~~ a *Server* makes visible to its *Clients*

Note 1 to entry: See IEC 62541-3 for a description of the contents and structure of the *Server AddressSpace*.

3.1.2

Aggregate

function that calculates derived values from *Raw data*

Note 1 to entry: Raw data may be from a historian or buffered real time data. Common *Aggregates* include averages over a given time range, minimum over a time range and maximum over a time range.

3.1.3

Alarm

type of *Event* associated with a state condition that typically requires acknowledgement

Note 1 to entry: See IEC 62541-9 for a description of *Alarms*.

3.1.4

Attribute

primitive characteristic of a Node

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<https://standards.iteh.ai/catalog/standards/iec/def3e8ea-d1c0-46db-becb-ed07aa2e6c64/iec-tr-62541-1-2020>

Note 1 to entry: All *Attributes* are defined by OPC UA, and may not be defined by *Clients* or *Servers*. *Attributes* are the only elements in the *AddressSpace* permitted to have data values.

3.1.5

Broker

intermediary program module that routes *NetworkMessages* from *Publishers* to *Subscribers*

Note 1 to entry: Brokers are building blocks of *Message Oriented Middleware*.

3.1.6

Certificate

digitally signed data structure that ~~describes capabilities~~ contains a public key and the identity of a *Client* or *Server*

3.1.7

Client

software application that sends *Messages* to OPC UA *Servers* conforming to the *Services* specified in this set of specifications

3.1.8

Condition

generic term that is an extension to an *Event*

Note 1 to entry: A *Condition* represents the conditions of a system or one of its components and always exists in some state.

3.1.9**Communication Stack**

layered set of software modules between the application and the hardware that provides various functions to encode, encrypt and format a *Message* for sending, and to decode, decrypt and unpack a *Message* that was received

~~**3.1.9**~~~~**Complex Data**~~

~~data that is composed of elements of more than one primitive data type, such as a structure~~

3.1.10**DataSet**

list of named data values

Note 1 to entry: A *DataSet* typically consists of *Event* fields or *Variable* values.

3.1.11**DataSetMessage**

payload of a *NetworkMessage* created from a *DataSet*

Note 1 to entry: The *DataSetMessage* is an immutable payload of the *NetworkMessage* handed off to the *Message Oriented Middleware* (transport layer) for delivery by the *Publisher*. The *Subscriber* receives the *DataSetMessage* as the payload of a *NetworkMessage* from the *Publisher* with additional headers that may be supplied by the *Message Oriented Middleware* along the way.

3.1.12**Discovery**

process by which ~~OPC UA~~ *Client* obtains information about ~~OPC UA~~ *Servers*, including endpoint and security information

3.1.13**Event**

generic term used to describe an occurrence of some significance within a system or system component

3.1.14**EventNotifier**

special *Attribute* of a *Node* that signifies that a *Client* may subscribe to that particular *Node* to receive *Notifications* of *Event* occurrences

3.1.15**Information Model**

organizational framework that defines, characterizes and relates information resources of a given system or set of systems

Note 1 to entry: The core ~~address space~~ *AddressSpace* model supports the representation of *Information Models* in the *AddressSpace*. See IEC 62541-5 for a description of the base OPC UA Information Model.

3.1.16**Message**

data unit conveyed between *Client* and *Server* that represents a specific *Service* request or response

3.1.17**Message Oriented Middleware**

infrastructure supporting sending and receiving *NetworkMessages* between distributed systems

Note 1 to entry: An OPC UA *Application* may support different types of *Message Oriented Middleware* infrastructures and protocols like AMQP, MQTT, or UDP with IP multicast. Other types like DDS or XMPP can also be integrated into the OPC UA *PubSub* model.

3.1.18

Method

callable software function that is a component of an *Object*

3.1.19

MonitoredItem

Client-defined entity in the *Server* used to monitor *Attributes* or *EventNotifiers* for new values or *Event* occurrences and that generates *Notifications* for them

3.1.20

NetworkMessage

DataSetMessages and header to facilitate delivery, routing, security and filtering

Note 1 to entry: The *Publisher* hands off the *NetworkMessage* to the *Message Oriented Middleware* (transport layer) to deliver *DataSetMessages* to the *Subscribers*.

Note 2 to entry: The term message is used with various connotations in the messaging world. The *Publisher* might like to think of the message as an immutable payload handed off to the *Message Oriented Middleware* for delivery. The *Subscriber* often thinks of the message as not only that immutable payload from the sender, but also various annotations supplied by the *Message Oriented Middleware* along the way. To avoid confusion, the term *DataSetMessage* is used to mean the message as supplied by the *Publisher* for a *DataSet* and the term *NetworkMessage* is used to mean the *DataSetMessage* plus sections for annotation at the head and tail of the *DataSetMessage*.

3.1.21

Node

fundamental component of an *AddressSpace*

3.1.22

NodeClass

class of a *Node* in an *AddressSpace*

Note 1 to entry: *NodeClasses* define the metadata for the components of the OPC UA object model. They also define constructs, such as *Views*, that are used to organize the *AddressSpace*.

3.1.23

Notification

generic term for data that announces the detection of an *Event* or of a changed *Attribute* value; *Notifications* are sent in *NotificationMessages*.

~~Note 1 to entry: Notifications are sent in NotificationMessages.~~

3.1.24

NotificationMessage

Message published from a *Subscription* that contains one or more *Notifications*

3.1.25

Object

Object Instance

Node that represents a physical or abstract element of a system

Note 1 to entry: *Objects* are modelled using the OPC UA Object Model. Systems, subsystems and devices are examples of *Objects*. An *Object* may be defined as an instance of an *ObjectType*.

3.1.22

Object Instance

~~synonym for Object~~

~~Note 1 to entry: Not all Objects are defined by ObjectTypes.~~

3.1.26

ObjectType

Node that represents the type definition for an *Object*

3.1.27

OPC UA Application

Client, which calls OPC UA *Services*, or a *Server*, which performs those *Services*, or an OPC UA *Publisher* or an OPC UA *Subscriber*

3.1.28

Publisher

entity sending *NetworkMessages* to a *Message Oriented Middleware*

Note 1 to entry: A *Publisher* can be a native OPC UA *Application* or an application that only has knowledge about the *Message Oriented Middleware* and the rules for encoding the *NetworkMessages* and *DataSetMessages*.

3.1.29

PubSub

OPC UA variant of the publish subscribe messaging pattern

3.1.30

Profile

specific set of capabilities to which a *Server* may claim conformance

Note 1 to entry: Each *Server* may claim conformance to more than one *Profile*.

Note 2 to entry: The set of capabilities are defined in IEC 62541-7.

3.1.31

Program

executable *Object* that, when invoked, immediately returns a response to indicate that execution has started, and then returns intermediate and final results through *Subscriptions* identified by the *Client* during invocation

3.1.32

Reference

explicit relationship (a named pointer) from one *Node* to another

Note 1 to entry: The *Node* that contains the *Reference* is the source *Node*, and the referenced *Node* is the target *Node*. All *References* are defined by *ReferenceTypes*.

3.1.33

ReferenceType

Node that represents the type definition of a *Reference*

Note 1 to entry: The *ReferenceType* specifies the semantics of a *Reference*. The name of a *ReferenceType* identifies how source *Nodes* are related to target *Nodes* and generally reflects an operation between the two, such as "A contains B".

3.1.28

RootNode

beginning or top *Node* of a *hierarchy*

Note 1 to entry: The *RootNode* of the OPC UA *AddressSpace* is defined in IEC 62541-5.

3.1.34

Server

software application that implements and exposes the *Services* specified in ~~the IEC 62541 series of standards~~ this set of specifications

3.1.35

Service

Client-callable operation in ~~an OPC UA~~ a *Server*

Note 1 to entry: *Services* are defined in IEC 62541-4. A *Service* is similar to a method call in a programming language or an operation in a Web services WSDL contract.

3.1.36

Service Set

group of related *Services*

3.1.37

Session

logical long-running connection between a *Client* and a *Server*

Note 1 to entry: A *Session* maintains state information between *Service* calls from the *Client* to the *Server*.

3.1.38

Subscriber

entity receiving *DataSetMessages* from a *Message Oriented Middleware*

Note 1 to entry: A *Subscriber* can be a native OPC UA *Application* or an application that has just knowledge about the *Message Oriented Middleware* and the rules for decoding the *NetworkMessages* and *DataSetMessages*. A *Subscription* in the OPC UA *Client Server* model has a different meaning than the *Subscriber* in the *PubSub* model.

3.1.39

Subscription

Client-defined endpoint in the *Server*, used to return *Notifications* to the *Client*

Note 1 to entry: "Subscription" is a generic term that describes a set of *Nodes* selected by the *Client* (1) that the *Server* periodically monitors for the existence of some condition, and (2) for which the *Server* sends *Notifications* to the *Client* when the condition is detected.

3.1.40

Underlying System

hardware or software platforms that exist as an independent entity

Note 1 to entry: *UA Applications* are dependent on an entity's existence in order to perform UA services. However, the entity is not dependent on *UA Applications*.

Note 2 to entry: : Hardware and software platforms include physical hardware, firmware, operating system, networking, non-UA applications, as well as other *UA Applications*. A Distributed Control System, PLC/Device, and UA Server are examples of an *Underlying System*.

3.1.41

Variable

Node that contains a value

3.1.42

View

specific subset of the *AddressSpace* that is of interest to the *Client*

3.2 Abbreviated terms

A&E	Alarms and Events
AMQP	Advanced Message Queuing Protocol
API	Application Programming Interface
COM	Component Object Model
DA	Data Access
DCS	Distributed Control System
DX	Data Exchange
DDS	Data Distribution Service
HDA	Historical Data Access
HMI	Human-Machine Interface
JSON	JavaScript Object Notation