

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



OPC unified architecture –  
Part 6: Mappings

Architecture unifiée OPC –  
Partie 6: Correspondances

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## OPC UNIFIED ARCHITECTURE –

## Part 6: Mappings

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International Standard IEC 62541-6 has been prepared by subcommittee 65E: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

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

- a) Some applications need to operation in environments with no access to cryptography libraries. To support this a new HTTPS transport has been defined in 7.3;
- b) The padding byte is not long enough to handle asymmetric key sizes larger than 2048 bits. Added an additional padding byte to 6.7.2 to handle this case.
- c) Fixed errors in SOAP action URIs defined in 7.2.2;

- d) Needed a standard way to serialize nodes in an address space. Added the UANodeSet schema defined in Annex F;

The text of this standard is based on the following documents:

CDV	Report on voting
65E/377/CDV	65E/405/RVC

Full information on the voting for the approval of this standard 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 62541 series, published under the general title *OPC Unified Architecture*, can be found on the IEC website.

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## OPC UNIFIED ARCHITECTURE –

### Part 6: Mappings

#### 1 Scope

This part of IEC 62541 specifies the OPC Unified Architecture (OPC UA) mapping between the security model described in IEC TR 62541-2, the abstract service definitions, described in IEC 62541-4, the data structures defined in IEC 62541-5 and the physical network protocols that can be used to implement the OPC UA specification.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TR 62541-1, *OPC Unified Architecture – Part 1: Overview and Concepts*

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 62541-7, *OPC Unified Architecture – Part 7: Profiles*

XML Schema Part 1: XML Schema Part 1: Structures

<http://www.w3.org/TR/xmlschema-1/>

XML Schema Part 2: XML Schema Part 2: Datatypes

<http://www.w3.org/TR/xmlschema-2/>

SOAP Part 1: SOAP Version 1.2 Part 1: Messaging Framework

<http://www.w3.org/TR/soap12-part1/>

SOAP Part 2: SOAP Version 1.2 Part 2: Adjuncts

<http://www.w3.org/TR/soap12-part2/>

XML Encryption: XML Encryption Syntax and Processing

<http://www.w3.org/TR/xmlenc-core/>

XML Signature: XML-Signature Syntax and Processing

<http://www.w3.org/TR/xmldsig-core/>

WS Security: SOAP Message Security 1.1

<http://www.oasis-open.org/committees/download.php/16790/wss-v1.1-spec-os-SOAPMessageSecurity.pdf>

WS Addressing: Web Services Addressing (WS-Addressing)

<http://www.w3.org/Submission/ws-addressing/>

WS Trust: WS Trust 1.3

<http://docs.oasis-open.org/ws-sx/ws-trust/v1.3/ws-trust.html>

WS Secure Conversation: WS Secure Conversation 1.3

<http://docs.oasis-open.org/ws-sx/ws-secureconversation/v1.3/ws-secureconversation.html>

WS Security Policy: WS Security Policy 1.2

<http://docs.oasis-open.org/ws-sx/ws-securitypolicy/200702/ws-securitypolicy-1.2-spec-os.html>

SSL/TLS: RFC 5246 – The TLS Protocol Version 1.2

<http://tools.ietf.org/html/rfc5246.txt>

X509: X.509 Public Key Certificate Infrastructure

<http://www.itu.int/rec/T-REC-X.509-200003-I/e>

WS-I Basic Profile 1.1: WS-I Basic Profile Version 1.1

<http://www.ws-i.org/Profiles/BasicProfile-1.1.html>

WS-I Basic Security Profile 1.1: WS-I Basic Security Profile Version 1.1

<http://www.ws-i.org/Profiles/BasicSecurityProfile-1.1.html>

HTTP: RFC 2616 – Hypertext Transfer Protocol – HTTP/1.1

<http://www.ietf.org/rfc/rfc2616.txt>

Base64: RFC 3548 – The Base16, Base32, and Base64 Data Encodings

<http://www.ietf.org/rfc/rfc3548.txt>

X690: ITU-T X.690 – Basic (BER), Canonical (CER) and Distinguished (DER) Encoding Rules

<http://www.itu.int/ITU-T/studygroups/com17/languages/X.690-0207.pdf>

IEEE-754: Standard for Binary Floating-Point Arithmetic

<http://grouper.ieee.org/groups/754/>

HMAC: HMAC – Keyed-Hashing for Message Authentication

<http://www.ietf.org/rfc/rfc2104.txt>

PKCS #1: PKCS #1 – RSA Cryptography Specifications Version 2.0

<http://www.ietf.org/rfc/rfc2437.txt>

FIPS 180-2: Secure Hash Standard (SHA)

<http://csrc.nist.gov/publications/fips/fips180-2/fips180-2.pdf>

FIPS 197: Advanced Encryption Standard (AES)

<http://www.csrc.nist.gov/publications/fips/fips197/fips-197.pdf>

UTF8: UTF-8, a transformation format of ISO 10646

<http://tools.ietf.org/html/rfc3629>

RFC 3280: RFC 3280 – X.509 Public Key Infrastructure Certificate and CRL Profile

<http://www.ietf.org/rfc/rfc3280.txt>

RFC 4514: RFC 4514 – LDAP: String Representation of Distinguished Names

<http://www.ietf.org/rfc/rfc4514.txt>

NTP: RFC 1305 – Network Time Protocol (Version 3)

<http://www.ietf.org/rfc/rfc1305.txt>

Kerberos: WS Security Kerberos Token Profile 1.1

<http://docs.oasis-open.org/wss/v1.1/wss-v1.1-spec-os-KerberosTokenProfile.pdf>

### 3 Terms, definitions, abbreviations and symbols

#### 3.1 Terms and definitions

For the purposes of this document the terms and definitions given in IEC TR 62541-1, IEC TR 62541-2 and IEC 62541-3 as well as the following apply.

##### 3.1.1

##### **DataEncoding**

a way to serialize OPC UA *Messages* and data structures

##### 3.1.2

##### **Mapping**

specifies how to implement an OPC UA feature with a specific technology

Note 1 to entry: For example, the OPC UA Binary Encoding is a *Mapping* that specifies how to serialize OPC UA data structures as sequences of bytes.

##### 3.1.3

##### **Security Protocol**

ensures the integrity and privacy of OPC UA *Messages* that are exchanged between OPC UA applications

##### 3.1.4

##### **Stack Profile**

a combination of *DataEncodings*, *SecurityProtocol* and *TransportProtocol Mappings*

Note 1 to entry: OPC UA applications implement one or more *StackProfiles* and can only communicate with OPC UA applications that support a *StackProfile* that they support.

##### 3.1.5

##### **Transport Protocol**

a way to exchange serialized OPC UA *Messages* between OPC UA applications

#### 3.2 Abbreviations and symbols

API	Application Programming Interface
ASN.1	Abstract Syntax Notation #1 (used in X690)
BP	WS-I Basic Profile Version
BSP	WS-I Basic Security Profile
CSV	Comma Separated Value (File Format)
HTTP	Hypertext Transfer Protocol
HTTPS	Secure Hypertext Transfer Protocol
IPSec	Internet Protocol Security
RST	Request Security Token
OID	Object Identifier (used with ASN.1)
RSTR	Request Security Token Response

SCT	Security Context Token
SHA1	Secure Hash Algorithm
SOAP	Simple Object Access Protocol
SSL	Secure Sockets Layer (Defined in SSL/TLS)
TCP	Transmission Control Protocol
TLS	Transport Layer Security (Defined in SSL/TLS)
UTF8	Unicode Transformation Format (8-bit) (Defined in UTF8)
UA	Unified Architecture
UASC	OPC UA Secure Conversation
WS-*	XML Web Services Specifications
WSS	WS Security
WS-SC	WS Secure Conversation
XML	Extensible Markup Language

#### 4 Overview

Other parts of this series of standards are written to be independent of the technology used for implementation. This approach means OPC UA is a flexible specification that will continue to be applicable as technology evolves. On the other hand, this approach means that it is not possible to build an OPC UA *Application* with the information contained in IEC TR 62541-1 through to IEC 62541-5 because important implementation details have been left out.

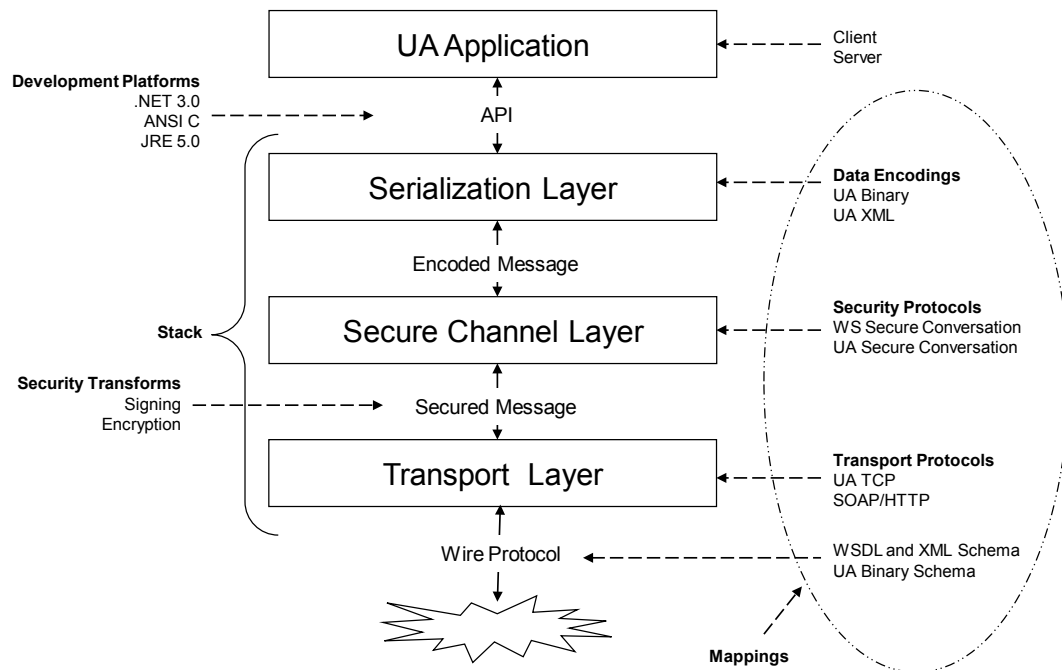
This standard defines *Mappings* between the abstract specifications and technologies that can be used to implement them. The *Mappings* are organized into three groups: *DataEncodings*, *SecurityProtocols* and *TransportProtocols*. Different *Mappings* are combined together to create *StackProfiles*. All OPC UA *Applications* shall implement at least one *StackProfile* and can only communicate with other OPC UA *Applications* that implement the same *StackProfile*.

This standard defines the *DataEncodings* in Clause 5, the *SecurityProtocols* in Clause 6 and the *TransportProtocols* in 6.7.6. The *StackProfiles* are defined in IEC 62541-7.

All communication between OPC UA *Applications* is based on the exchange of *Messages*. The parameters contained in the *Messages* are defined in IEC 62541-4; however, their format is specified by the *DataEncoding* and *TransportProtocol*. For this reason, each *Message* defined in IEC 62541-4 shall have a normative description which specifies exactly what shall be put on the wire. The normative descriptions are defined in the appendices.

A *Stack* is a collection of software libraries that implement one or more *StackProfiles*. The interface between an OPC UA *Application* and the *Stack* is a non-normative API which hides the details of the *Stack* implementation. An API depends on a specific *DevelopmentPlatform*. Note that the datatypes exposed in the API for a *DevelopmentPlatform* may not match the datatypes defined by the specification because of limitations of the *DevelopmentPlatform*. For example, Java does not support an unsigned integer which means that any Java API will need to map unsigned integers onto a signed integer type.

Figure 1 illustrates the relationships between the different concepts defined in this standard.



**iTeh STANDARD PREVIEW**  
**Figure 1 – The OPC UA Stack Overview**  
**(standards.iteh.ai)**

IEC

The layers described in this specification do not correspond to layers in the OSI 7 layer model [X200]. Each OPC UA *StackProfile* should be treated as a single Layer 7 (Application) protocol that is built on an existing Layer 5, 6 or 7 protocol such as TCP/IP, TLS or HTTP. The *SecureChannel* layer is always present even if the *SecurityMode* is *None*. In this situation, no security is applied but the *SecurityProtocol* implementation shall maintain a logical channel with a unique identifier. Users and administrators are expected to understand that a *SecureChannel* with *SecurityMode* set to *None* cannot be trusted unless the *Application* is operating on a physically secure network or a low level protocol such as IPsec is being used.

## 5 Data encoding

### 5.1 General

#### 5.1.1 Overview

This standard defines two data encodings: OPC UA Binary and OPC UA XML. It describes how to construct *Messages* using each of these encodings.

#### 5.1.2 Built-in Types

All OPC UA *DataEncodings* are based on rules that are defined for a standard set of built-in types. These built-in types are then used to construct structures, arrays and *Messages*. The built-in types are described in Table 1.