



Standards
Certification
Education & Training
Publishing
Conferences & Exhibits

Setting the Standard for Automation™

AMERICAN NATIONAL STANDARD

ANSI/ISA-95.00.05-2007

Enterprise-Control System Integration Part 5: Business-to-Manufacturing Transactions

Approved 10 January 2007

NOTICE OF COPYRIGHT

This is a copyright document and may not be copied or distributed in any form or manner without the permission of ISA. This copy of the document was made for the sole use of the person to whom ISA provided it and is subject to the restrictions stated in ISA's license to that person.

It may not be provided to any other person in print, electronic, or any other form. Violations of ISA's copyright will be prosecuted to the fullest extent of the law and may result in substantial civil and criminal penalties.



Documents
Document Sharing Hub

ANSI/ISA-95.00.05-2007
Enterprise-Control System Integration Part 5: Business-to-Manufacturing Transactions

ISBN 13: 978-0-9792343-5-4
ISBN 10: 0-9792343-5-2

Copyright © 2007 by ISA. All rights reserved. Not for resale. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise), without the prior written permission of the Publisher.

ISA
67 Alexander Drive
P. O. Box 12277
Research Triangle Park, North Carolina 27709
USA

NOTE — Some of the work in this document is based on the work of the Open Applications Group, Inc. (OAGi). All references to the Open Applications Group, OAGi, OAGIS, and BODs remain the property of the Open Applications Group and its members. The Open Applications Group's OAGIS is a royalty-free standard and the license grants any user to build products and base derivative works on OAGIS, as long as the intellectual property is acknowledged to belong to OAGi and its members. For more information on the Open Applications Group and OAGIS, visit www.openapplications.org.

Preface

This preface, as well as all footnotes and annexes, is included for information purposes and is not part of ANSI/ISA-95.00.05-2007.

The standards referenced within this document may contain provisions which, through reference in this text, constitute requirements of this document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards indicated within this document. Members of IEC and ISO maintain registers of currently valid International Standards. ANSI maintains registers of currently valid U.S. National Standards.

This document has been prepared as part of the service of ISA toward a goal of uniformity in the field of industrial automation. To be of real value, this document should not be static but should be subject to periodic review. Toward this end, the Society welcomes all comments and criticisms and asks that they be addressed to the Secretary, Standards and Practices Board; ISA; 67 Alexander Drive; P. O. Box 12277; Research Triangle Park, NC 27709; Telephone (919) 549-8411; Fax (919) 549-8288; E-mail: standards@isa.org.

It is the policy of ISA to encourage and welcome the participation of all concerned individuals and interests in the development of ISA standards, recommended practices, and technical reports. Participation in the ISA standards-making process by an individual in no way constitutes endorsement by the employer of that individual, of ISA, or of any of the standards, recommended practices, and technical reports that ISA develops.

CAUTION:

ISA ADHERES TO THE POLICY OF THE AMERICAN NATIONAL STANDARDS INSTITUTE WITH REGARD TO PATENTS. IF ISA IS INFORMED OF AN EXISTING PATENT THAT IS REQUIRED FOR USE OF THE STANDARD, IT WILL REQUIRE THE OWNER OF THE PATENT TO EITHER GRANT A ROYALTY-FREE LICENSE FOR USE OF THE PATENT BY USERS COMPLYING WITH THE STANDARD OR A LICENSE ON REASONABLE TERMS AND CONDITIONS THAT ARE FREE FROM UNFAIR DISCRIMINATION.

EVEN IF ISA IS UNAWARE OF ANY PATENT COVERING THIS STANDARD, THE USER IS CAUTIONED THAT IMPLEMENTATION OF THE STANDARD MAY REQUIRE USE OF TECHNIQUES, PROCESSES, OR MATERIALS COVERED BY PATENT RIGHTS. ISA TAKES NO POSITION ON THE EXISTENCE OR VALIDITY OF ANY PATENT RIGHTS THAT MAY BE INVOLVED IN IMPLEMENTING THE STANDARD. ISA IS NOT RESPONSIBLE FOR IDENTIFYING ALL PATENTS THAT MAY REQUIRE A LICENSE BEFORE IMPLEMENTATION OF THE STANDARD OR FOR INVESTIGATING THE VALIDITY OR SCOPE OF ANY PATENTS BROUGHT TO ITS ATTENTION. THE USER SHOULD CAREFULLY INVESTIGATE RELEVANT PATENTS BEFORE USING THE STANDARD FOR THE USER'S INTENDED APPLICATION.

HOWEVER, ISA ASKS THAT ANYONE REVIEWING THIS STANDARD WHO IS AWARE OF ANY PATENTS THAT MAY IMPACT IMPLEMENTATION OF THE STANDARD NOTIFY THE ISA STANDARDS AND PRACTICES DEPARTMENT OF THE PATENT AND ITS OWNER.

ADDITIONALLY, THE USE OF THIS STANDARD MAY INVOLVE HAZARDOUS MATERIALS, OPERATIONS OR EQUIPMENT. THE STANDARD CANNOT ANTICIPATE ALL POSSIBLE APPLICATIONS OR ADDRESS ALL POSSIBLE SAFETY ISSUES ASSOCIATED WITH USE IN HAZARDOUS CONDITIONS. THE USER OF THIS STANDARD MUST EXERCISE SOUND PROFESSIONAL JUDGMENT CONCERNING ITS USE AND APPLICABILITY UNDER THE USER'S PARTICULAR CIRCUMSTANCES. THE USER MUST ALSO CONSIDER THE APPLICABILITY OF

ANY GOVERNMENTAL REGULATORY LIMITATIONS AND ESTABLISHED SAFETY AND HEALTH PRACTICES BEFORE IMPLEMENTING THIS STANDARD.

THE USER OF THIS DOCUMENT SHOULD BE AWARE THAT THIS DOCUMENT MAY BE IMPACTED BY ELECTRONIC SECURITY ISSUES. THE COMMITTEE HAS NOT YET ADDRESSED THE POTENTIAL ISSUES IN THIS VERSION.

The following individuals served as voting members of ISA-SP95 during the development of ANSI/ISA-95.00.05-2007.

NAME**COMPANY**

Keith Unger [*]	Stone Technologies Inc.
William H. Bosler ^{**}	Texas Consultants Inc.
Donald Clark ^{**}	Invensys Process Systems
Dennis Brandl ^{***}	BR&L Consulting Inc.
Chris Monchinski ^{****}	Automated Control Concepts Inc.
Gary Addison	Lyondell – Equistar Chemicals LP
David Adler	Eli Lilly & Co.
Michael Bachelor	Bachelor Controls Inc.
Lynn Craig	MAA Inc.
Eric Cosman	Dow Chemical
Paresh Dalwalla	OpteBiz
Em delaHostria	Rockwell Automation
Stefano Dighero	Siemens
David Emerson	Yokogawa
Charlie Gifford	GE Fanuc America
Les Hastings	ProsCon Ltd.
Gavan Hood~	Rockwell Automation
Jay Jeffreys~	Invensys Wonderware
Charlotta Johnsson	Lund Institute of Technology
Alan Johnston	MIMOSA
Eugene Lambert	Wunderlich-Malec
Marc Leroux	ABB Inc.
Richard Martin	Aspen Technology
Tracy Miller	Deere & Co.
Yasuyuki Nishioka	Hosei University
Saroj Patnaik	Emerson Process Management
Costantino Pipero	Beeond Inc.
Anne Poorman~	ABB Inc.
Leif Poulsen	NNE A/S
Swarandeep Singh~	ABB A/S
Leon Steinocher	Fluor Enterprises Inc.
Jean Vieille	Psynapses
Ray Walker	DuPont Engineering
Theodore Williams	Purdue University

* Chairman

** Vice Chairman

*** Editor

**** Secretary

~ Alternate

The following individuals also served as active members of ISA-SP95 during the preparation of this standard:

NAME	COMPANY
Ken Bever	Assetricity LLC
David Connelly	Open Applications Group Inc.
Baha Korkmaz	Automation Vision Inc.
David Cornel	Procter & Gamble
Dennis Delaney	Accenture
Russ Dickinson	Dow Chemical
Llorenç Domingo	Aspen Technology
Steve Downs	Applied Creative Technologies
Yves Dufort	Wonderware
Daniel Dziadiw	Schering-Plough Corp.
Joe Faccenda	Aspen Technology
Christine Hermetet-Filez	AFNOR
Kevin Fitzgerald	Invensys
Tony Gallo	Real Time Software Solutions
Alistar Gillanders	DynoChem Inc.
Stephen Graham	Dow Chemical
Graeme Hall	Aspen Technology
William Hawkins	HLQ Ltd.
Girish Joglekar	Purdue University
Hansil Kim	University of Ulsan
Jim Luth	OPC Foundation
Kishen Manjunath	Honeywell Process Solutions
Jean-Jacques Michel	IDPI Conseil
Thorsten Ruehl	Camstar
Nathan Schallert	Eli Lilly & Co
Paul Schiller	BP America
Bianca Scholten	Ordina Technical Automation
David Shorter	IT Focus
Bryan Singer	Rockwell Automation
Arne Svendsen	Arla Foods
Jason Toschlog	Flexware Innovation
Gregory Winchester	NEMA
Chunhua Zhao	Purdue University



The following served on the ISA Standards & Practices Board and approved this standard on 9 November 2006.

NAME	AFFILIATION
I. Verhappen, Chair	Synchrude Canada, Ltd.
F. Amir	E I Du Pont Co.
D. Bishop	Consultant
M. Coppler	Ametek Inc.
B. Dumortier	Schneider Electric
W. Holland	Consultant
E. Iccayan	ACES Inc.
A. Iverson	Ivy Optiks
R. Jones	Consultant
K. P. Lindner	Endress + Hauser Process Solutions
V. Maggioli	Feltronics Corp.
T. McAviney	Jacobs Engineering Group
A. McCauley	Chagrin Valley Controls Inc.
G. McFarland	Emerson Process Management
R. Reimer	Rockwell Automation
J. Rennie	Consultant
N. Sands	E I Du Pont Co.
H. Sasajima	Yamatake Corp.
T. Schnaare	Rosemount Inc.
J. Tatera	Tatera & Associates
R. Webb	Consultant
W. Weidman	Parsons Energy and Chemicals
J. Weiss	KEMA Inc.
M. Widmeyer	Stanford Linear Accelerator Center
C. Williams	Eastman Kodak Co.
M. Zielinski	Emerson Process Management

Contents

1	Scope	17
2	Normative references	17
3	Definitions	17
4	Transaction messages and verbs	18
4.1	Introduction	18
4.2	Message structure	18
5	Message verbs	23
5.1	Verbs and transaction models	23
5.2	GET verb	26
5.3	SHOW verb	27
5.4	PROCESS verb	27
5.5	ACKNOWLEDGE verb	28
5.6	CHANGE verb	29
5.7	CANCEL verb	30
5.8	CONFIRM verb	30
5.9	RESPOND verb	32
5.10	SYNC verb	32
5.11	SYNC ADD verb	33
5.12	SYNC CHANGE verb	33
5.13	SYNC DELETE verb	34
6	Message nouns	34
6.1	Introduction	34
6.2	Defined message nouns	34
6.3	Personnel model	38
6.4	Equipment model	49

6.5	Maintenance model	60
6.6	Material model	66
6.7	Process segment model	83
6.8	Production capability model	86
6.9	Product definition model	90
6.10	Production schedule model	93
6.11	Production performance model	96
6.12	Transaction Profile	99
7	Completeness, compliance and conformance	101
7.1	Completeness	101
7.2	Compliance	101
7.3	Conformance	101
	Annex A (Informative) – Transaction models and business scenario examples	107
	Annex B (Informative) – Questions on the use of transactions	119
	Annex C (Informative) – Bibliography and References	121

Figures

Figure 1 - Typical exchanged data set	19
Figure 2 - Typical layout of an application identification area	20
Figure 3 - Typical exchanged messages in a transaction	22
Figure 4- GET with wildcard and SHOW response	23
Figure 5 – GET and SHOW transaction	26
Figure 6 - GET and SHOW transaction with a CONFIRM always	27
Figure 7 – PROCESS/ACKNOWLEDGE transaction	28
Figure 8 - Example of acknowledge to a process message	29
Figure 9 – CHANGE/RESPOND transaction	29
Figure 10 - CANCEL message	30
Figure 11 - Example of a GET message with Confirm OnError	31
Figure 12 - Confirm Message	32
Figure 13 - SYNC ADD transaction with confirmation	33
Figure 14 - SYNC DELETE transaction with no confirmation	34
Figure 15 - Object grouping for the personnel model	39
Figure 16 - Object grouping for the equipment model	50
Figure 17 - Object grouping for the maintenance model	60
Figure 18 - Object grouping for the material model	66
Figure 19 - Object grouping for the process segment model	84
Figure 20 - Object grouping for the production capability model	87
Figure 21 - Object grouping for the product definition model	91
Figure 22 - Object grouping for the production schedule model	94
Figure 23 - Object grouping for the production performance model	97
Figure 24 - Transaction profile model	100
Figure 25 – Coordinating planning and operations processes	107
Figure 26 - Push model; production schedule and production performance	108

Figure 27 – Pull model; production schedule and production performance	109
Figure 28 - Publish Model; production schedule and production performance	109
Figure 29 - Push Model; Production schedule changes	110
Figure 30 - Publish model: production schedule changes	111
Figure 31 - Push model; production schedule canceled	111
Figure 32 - Push and pull model; schedule canceled	112
Figure 33 - Push model; daily production performance	112
Figure 34 - Pull model; daily production performance	113
Figure 35 - Publish model; daily production schedule	113
Figure 36 – Pull and push model; production capability and production schedule	114
Figure 37 - Publish and push model; production capability and production schedule	115
Figure 38 - Push and pull model; schedule changes	116
Figure 39 – Publish model; schedule changes after capability changes	116
Figure 40 – Push model; material lot added, material lot quantity changed	117
Figure 41 - Publish and push model; material quantity changes	117
Figure 42 - Push and pull model; material quantity changes	118

Tables

Table 1 - Defined verbs	24
Table 2 – Acknowledge request options	27
Table 3 – Acknowledge element	28
Table 4 – Respond options	30
Table 5 – Confirmation request options	31
Table 6 – Respond element	32
Table 7 - Personnel class verb actions	40
Table 8 - Person verb actions	45
Table 9 - Qualification test specification verb actions	48
Table 10 – Equipment class verb actions	51
Table 11 - Equipment verb actions	56
Table 12 - Equipment capability test specification verb actions	59
Table 13 - Maintenance request verb actions	61
Table 14 - Maintenance response verb actions	63
Table 15 - Maintenance work order verb actions	64
Table 16 - Material Class verb actions	67
Table 17 - Material definition verb actions	71
Table 18 - Material lot verb actions	76
Table 19 - Material subplot verb actions	79
Table 20 - QA test verb actions	82
Table 21 – Process segment verb actions	85
Table 22 - Production Capability verb actions	88
Table 23 – Production capability element definitions for GET verb	89
Table 24 – Product definition verb actions	92
Table 25 - Production schedule verb actions	95
Table 26 – Production Schedule element definitions for GET verb	96
Table 27 - Production Performance verb actions	98

Table 28 – Production Performance definitions for GET verb	99
Table 29 – Supported action attributes	100
Table 30 - Transaction Profile verb actions	101
Table 31 – Supported verb-noun actions	102
Table 32- Vendor conformance example	104

Enterprise-Control System Integration

Part 5: Business-to-Manufacturing Transactions

FOREWORD

This standard is Part 5 of a multi-part series of standards that defines enterprise-to-control system integration. This Part 5 standard defines the transactions to interface business and manufacturing activities.

Clause 4 of this standard is normative. It describes the transaction models and messages used.

Clause 5 is normative. It describes the verbs used in the messages.

Clause 6 is normative. It defines the message nouns, the structure of the nouns, the verbs used with the nouns, and the rules for the verbs.

Clause 7 is normative. It describes the requirements for declarations about completeness, compliance, and conformance to the standard.

Annex A of this standard is informative. It contains examples of sequences of transactions used to coordinate selected business activities.

Annex B is informative. It contains a series of questions and answers regarding the use of the standard.

Annex C is informative. It contains references to documents used in the generation of this standard.

As currently envisioned, the ANSI/ISA-95 series consists of the following parts under the general title, Enterprise-Control System Integration:

- Part 1: Models and terminology (published 2000)
- Part 2: Object model attributes (published 2001)
- Part 3: Models of manufacturing operations management (published 2005)
- Part 4: Object models and attributes of manufacturing operations management (in development at the time of publication of this Part 5 standard)
- Part 5: Business to manufacturing transactions (published 2007)
- Part 6: Manufacturing operations management transactions (in development at the time of publication of this Part 5 standard)



This page intentionally left blank.



INTRODUCTION

This Part 5 standard is based on the use of ISA-95 abstract models previously defined in the ISA-95 Part 1 and Part 2 standards, combined with OAGi verbs to define transaction models for information exchange. It is recognized that other, non-ISA-95 Part 5 transaction protocols are possible and are not deemed invalid as a result of this standard. Transactions occur at all levels within the enterprise and between enterprise partners, and are related to both required and actual activities, but the focus of this standard is the interface between enterprise/business systems and manufacturing systems. This standard defines business-to-manufacturing transactions and manufacturing-to-business transactions that may be used in relation to the objects that are exchanged between Level 4 and Level 3, as defined in the object models of the Part 1 and Part 2 standards. Models are introduced that provide descriptions of the transactions and explanations of the required transaction processing behavior. Technology-specific implementations to provide this behavior are not defined in this standard. This standard has the intent of providing insight into the level of work required to construct information messages in business-to-manufacturing transactions.



This page intentionally left blank.

1 Scope

This ISA-95 Part 5 standard defines transactions in terms of information exchanges between applications performing business and manufacturing activities associated with Levels 3 and 4. The exchanges are intended to enable information collection, retrieval, transfer and storage in support of enterprise-control system integration. This Part 5 standard is consistent with the Part 1 models and terminology and Part 2 object model attributes. This standard defines transactions that specify how to exchange the objects defined in Part 1 Clause 7 and Part 2.

The models covered in this standard are: Personnel Model, Equipment Model, Maintenance Model, Material Model, Process Segment Model, Production Capability Model, Product Definition Model, Production Schedule Model, and Production Performance Model.

2 Normative references

The following normative documents contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid normative documents.

- ANSI/ISA 95.00.01-2000, Enterprise-Control System Integration Part 1: Models and Terminology (referred to as “Part 1” in this standard)
- ANSI/ISA 95.00.02-2001, Enterprise-Control System Integration Part 2: Object Model Attributes (referred to as “Part 2” in this standard)
- ANSI/ISA 95.00.03-2005, Enterprise-Control System Integration Part 3: Activity Models of Manufacturing Operations Management (referred to as “Part 3” in this standard)
- ISO/IEC 19501-1:2005, Information Technology – Open Distributed Processing – Unified Modeling Language (UML) Version 1.4.2
- IEC 62264-1:2003, Enterprise-Control System Integration – Part 1: Models and Terminology
- IEC 62264-2: 2004, Enterprise-Control Systems Integration – Part 2: Object Model Attributes

3 Definitions

3.1 message:

a structured information unit conveyed in a one-way transfer of data from one sending application to one or more receiving applications.

3.2 noun:

one of two parts in the content of a message, a noun represents one or more objects, as defined in the Part 1 and Part 2 object models

3.3 transaction:

a sequence of related messages that are exchanged among applications performing Level 3 or Level 4 activities

3.4 verb:

one of two parts in the content of a message, a verb defines the action to be performed, or the response to a request

4 Transaction messages and verbs

4.1 Introduction

This clause defines a common set of transactions, messages, and verbs that should be used between Level 4 and Level 3 applications to exchange the data defined in the object models of Part 1, Clause 7 and Part 2.

A transaction shall consist of a sequence of messages, where each message shall have a structure as defined in Clause 4.2.

Messages shall contain both a noun and a verb area. The information conveyed in a message shall be contained in the noun area of a message, while the actions associated with the information shall be contained in the verb area.

The role of an application initiating a transaction shall determine the set of verbs to be used in conducting the transaction. These transaction models are described in Clause 4.2.5.

Three different transaction models are defined:

1. A PUBLISH model, where the owner of data publishes it to users (subscribers) of the data.
2. A PULL model, where a user of data requests the data from a provider of the data.
3. A PUSH model, where a provider of data requests an action (processing, changing, or canceling) on the data by another user.

The phrase “owner of data” is used to identify the application that has responsibility for enforcing the consistency of data.

NOTE — This standard does not address the case where there may be multiple systems that can act as the owner of data. In these situations, configuration should be set up so that one master owner of the data should be designated, with other systems performing the role of data users.

4.2 Message structure

4.2.1 General Structure

Every message shall contain the information required to identify the source of the message and the type of the message. There shall be two main areas in a message, as shown in Figure 1, an *application identification area* and a *data area*. Within the *data area* there shall be a *verb area* and a *noun area*.

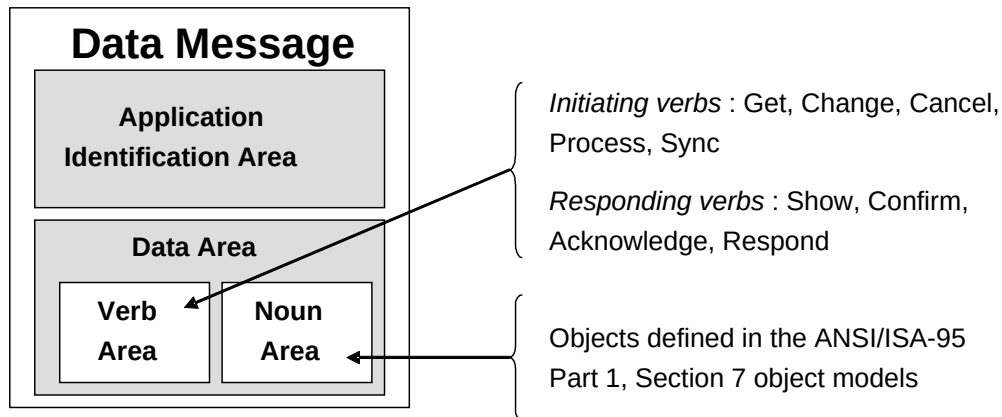


Figure 1 - Typical exchanged data set

4.2.2 Application identification area

The application identification area shall carry information that a receiving application uses to handle a message. The application identification area is used for the application layer of communication, such as indicating a required confirmation of message processing. This information typically includes the electronic address of the sender, an indication of the confirmation requirement, and the date and time the message was created. The application identification area may also include other information required for identification and authentication of the messages. Figure 2 illustrates a typical layout for an application identification area.

NOTE — See the OAGIS (Open Applications Group Integration Specification) 9.0 specification for a format for the application identification area. The data exchange model defined in this document is consistent with the OAGIS specification; such that an implementation of OAGIS, using the objects defined in the Part 1 and Part 2 standards, can conform to this Part 5 standard.

Dates and times shall include time zone information in order to unambiguously identify times, such as coordinated universal time or ISO 8601 CE (Common Era) calendar extended format.

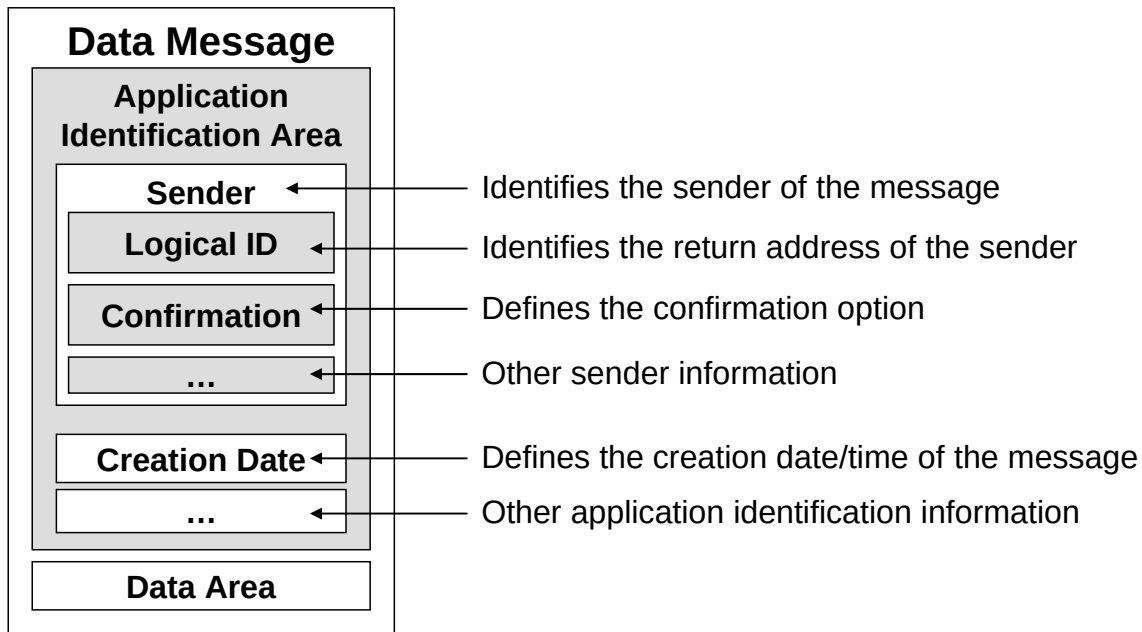


Figure 2 - Typical layout of an application identification area

4.2.3 Data Area

The data area in a message shall contain a verb area and a noun area.

The verb area shall contain verbs and associated elements that represent the actions to be performed by the receiving application, or the response to a request by the sending application. The verbs defined in this Part 5 standard are listed in Clause 5.

The noun area shall contain nouns and associated elements that represent one or more objects defined in the ISA-95 Parts 1 and 2 object models. The nouns defined in this Part 5 standard are listed in Clause 6.

The verb-noun combinations define messages that are intended to have a unique and unambiguous meaning.

4.2.4 Message nouns

Nouns represent one or more objects from the object models defined in the Parts 1 and 2 standards that have been grouped together for use with messages.

Example: The Equipment Class noun includes an equipment class object and equipment class property objects.

4.2.5 Transaction models

There are three classes of actions provided by the verb set: data synchronization, transaction processing, and query/reporting. These are defined through three different transaction models:

1. A PUBLISH model, where the provider of data publishes it to users (subscribers) of the data. This model is used for data synchronization.

Applications that support the PUBLISH model as a subscriber should be listening for SYNC messages.

Applications that support the PUBLISH model as a publisher should send SYNC messages as their information changes.

- a. The publisher sends SYNC messages containing new, changed, or deleted information to subscribers.
 - b. A subscriber receives SYNC messages containing new, changed, or deleted information.
2. A PUSH model, where a sender of information sends new or changed information to the receiver to process requests. This model is used for transaction processing.

Applications that support the PUSH model as a receiver should be listening for PROCESS, CHANGE, or CANCEL messages and should be prepared to receive the new information and respond in a timely manner.

Applications that support the PUSH model as a sender should be able to send PROCESS, CHANGE, and CANCEL messages when their information changes.

- a. New information is pushed to the receiver through a PROCESS message. Responses may be returned to the sender through an ACKNOWLEDGE message.
 - b. Changes to information are pushed to the receiver through a CHANGE message. Responses may be returned to the sender through a RESPOND message.
 - c. Information to be removed is pushed to the receiver through a CANCEL message.
3. A PULL model, where a user of data requests information from an information provider. This model is used for query/reporting.

Applications that support the PULL model as an information provider should be listening for GET messages and should be prepared to respond with a SHOW message in a timely manner.

Applications that support the PULL model as an information user should be able to send GET messages when new information is needed.

- a. Requests for information are sent through GET messages.
- b. A GET message describes the scope of the requested information.
- c. A SHOW message returns the information.

A single application may support one or more transaction models and the application may take on multiple roles (sender, receiver, provider, and user).

NOTE — The transactions are based on the assumption that the exchanged information (noun) is contained in a message of some form. The exact form of the messages is undefined in this specification; for example, the messages could be tab delimited files, XML files, electronic mail messages, or data in a named pipe. The exact form of the transport mechanism for the sending, receiving, listening, and publishing of messages is not defined in this standard.

The transactions assume the ability to send an empty or nearly empty message that identifies either a specific object (typically by ID), a list of specific objects (by a list of IDs), or a class of objects (by wildcard or property value definition). Figure 3 illustrates the exchange of messages in a typical transaction, where a message is sent from the user of information with an identification of an object (GET Equipment), and a message is returned from the information provider with the object's information (SHOW Equipment).

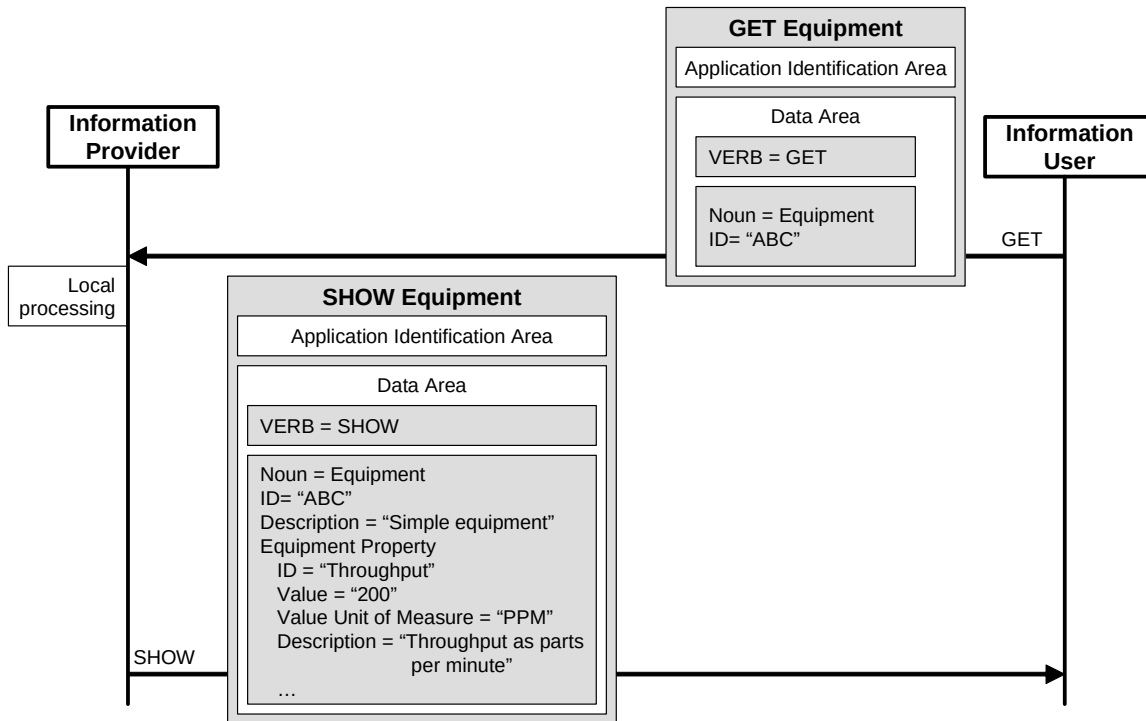


Figure 3 - Typical exchanged messages in a transaction

4.2.6 Wildcard

The noun may contain wildcard values to identify multiple objects.

NOTE — Wildcards apply to the ID of a property, not to the value of the properties.

NOTE — Wildcards should be used with care if combined with lists of object IDs or property IDs. In the case of errors, a confirmation message may not have sufficient information to determine the exact error.

A wildcard value can have the following special characters:

- "*"** – Indicates zero or more characters, any character is acceptable
Example 1: The wildcard "ABC*" would match "ABC", "ABCD", "ABCDEF", "ABC@4!*", but not "ABDDEF"
- "%"** – Indicates one or more characters, any character is acceptable
Example 2: The wildcard "ABC%" would match "ABCD", "ABCDEF", "ABC^4^*", but not "ABC"
- "?"** – Indicates zero or one characters at the specified position, any character is acceptable
Example 3: The wildcard "ABC?" would match "ABCX", "ABCD", "ABC!", "ABC", but not "ABCDE" or "ABDC"
- The character following a **"\"** is considered a literal character, not a wildcard character.
Example 4: An object ID of "ABC\"*" defines the object ID as "ABC*".

Example 5: A property ID of "\\USM 123" defines the property ID "\\USM 123".

NOTE — Two consecutive backslash characters, i.e. **"\"** are interpreted to be a single backslash character **"\"**.

Figure 4 illustrates a GET/SHOW transaction with a wildcard specified. The provider of the information returns a list of objects matching the wildcard specification.

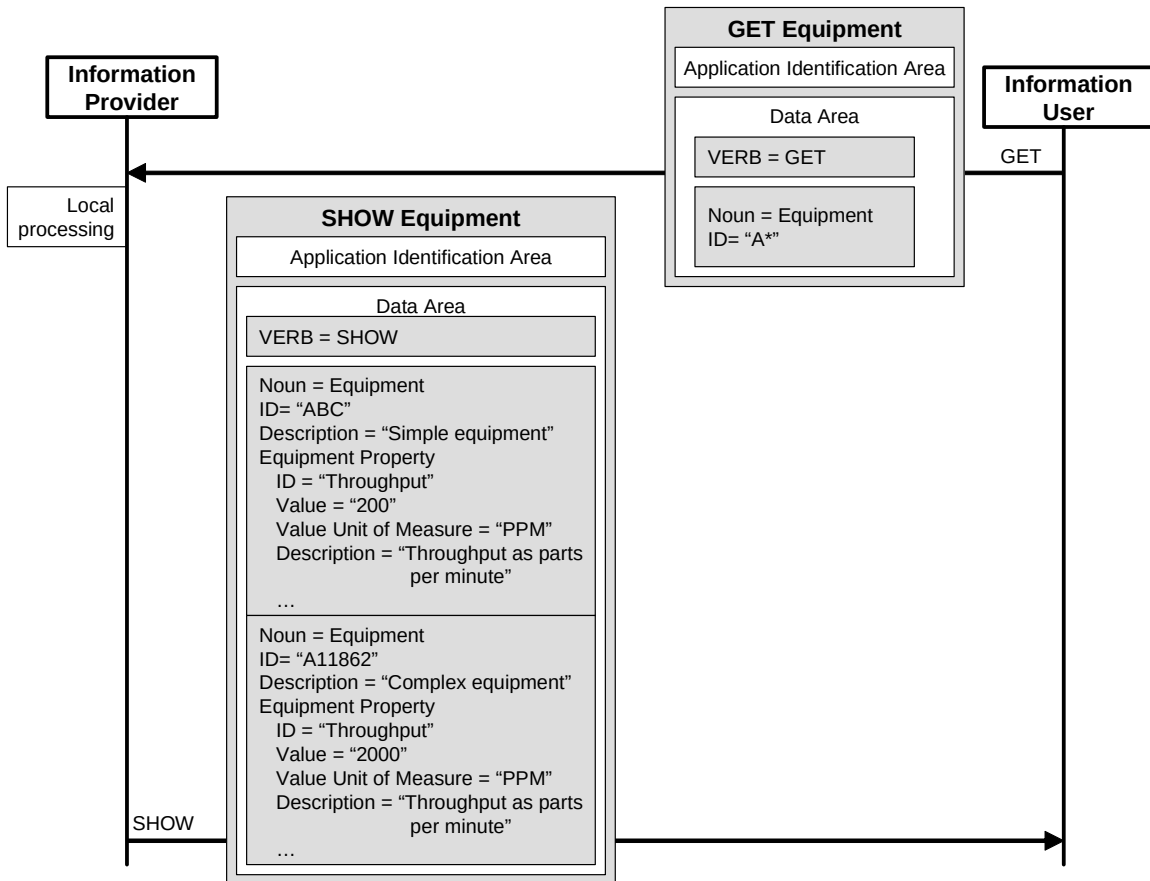


Figure 4- GET with wildcard and SHOW response

5 Message verbs

5.1 Verbs and transaction models

The verb area of a message shall contain a verb, defined in this clause and listed in Table 1.

Table 1 - Defined verbs

Verb	Description	Transaction Model
ACKNOWLEDGE	Acknowledgement of a PROCESS request. The noun may contain assigned IDs and other information to inform the sender of the PROCESS message the IDs of any created objects. Example: A PROCESS message sent with a Material Lot may return the ID assigned to the lot by the receiving system.	PUSH
CANCEL	Request to a receiver to remove information. The specified noun shall be canceled. If contained elements IDs are specified, then only the specified contained elements for the specified noun shall be canceled, not the noun. NOTE — Not all objects have contained elements. Examples of contained elements are properties, specifications, actuals, etc.	PUSH
CHANGE	Request to a receiver to change information. The specified attributes and contained elements of the noun shall be changed. If no IDs of contained elements are specified, only the specified attributes shall be changed.	PUSH
CONFIRM	Confirmation response to a request.	PUSH, PULL, PUBLISH
GET	Request to a receiver for information on one or more objects. The receiver shall return a SHOW message containing all the specified attributes and all the specified contained elements of the specified nouns. If no attribute or contained element is specified in the noun area, then all attributes and/or contained elements shall be returned. When wildcards are applied to the noun and property IDs, it shall be possible to further filter the information to be returned by specifying a value for one or more attributes of the noun. Only objects whose attributes match the specified value (out of the list of objects matching the wildcards applied to noun and property IDs) shall be returned. Example: To get all the Material Lots with <i>Status</i> = "New", the wildcard "*" would be specified for the Material Lot ID and the "New" value would be specified for the <i>Status</i> attribute.	PULL



PROCESS	Request to a receiver to process new information. A new noun shall be added. If the specified noun already exists, only the specified contained elements shall be added.	PUSH
RESPOND	Response to a CHANGE message request. The noun may contain proposed or alternate information that was used in place of the CHANGE noun information. Example: A CHANGE message sent with an updated Material Lot status of "OK" may return a RESPOND with a different status of "OUT OF SPEC" because of business rules in the receiver of the CHANGE message.	PUSH
SHOW	Response to a GET message.	PULL
SYNC ADD	Request from the owner of the object to add information. A new noun shall be added. If the specified noun already exists, only the specified contained elements shall be added.	PUBLISH
SYNC CHANGE	Request from the owner of the object to change information. The specified attributes and contained elements of the noun shall be changed. If no IDs of contained elements are specified, only the specified attributes shall be changed.	PUBLISH
SYNC DELETE	Request from the owner of the object to delete information. The specified noun shall be canceled. If contained elements IDs are specified, then only the specified contained elements for the specified noun shall be canceled.	PUBLISH

NOTE 1 — The processes on either side of the messages are not defined in this technical specification.

NOTE 2 — The mechanism to set up the one-to-one association of the PUSH model is not included in this standard. Configuration and set up are implementation specific and would be defined in conforming specifications.

NOTE 3 — The mechanism to set up the one-to-one association of the PULL model is not included in this standard. Configuration and set up are implementation specific and would be defined in conforming specifications.

NOTE 4 — The mechanism used for subscribing in the PUBLISH model is not included in this standard. Subscribing mechanisms are implementation specific and would be defined in conforming specifications.

NOTE 5 — Contained elements are object properties or other contained elements as described in Clause 6.2.

NOTE 6 — Different methods are possible to specify objects. Such methods depend on the specific noun as well as on the specific verb used, and are specified in the sections for each object type.

NOTE 7 — The entity receiving the PROCESS message may perform further processing of the added information.

NOTE 8 — There is no ability defined in this Part 5 standard to add or remove object attributes; the Part 2 standard defines the object attributes.

NOTE 9 — Additional information returned in a SHOW message (as a response to a GET message) (e.g., IDs of referenced objects) is specified in the sections for each object type.

NOTE 10 — Additional information changed by the CHANGE and SYNC CHANGE messages (e.g., IDs of referenced objects) is specified in the sections for each object type.

NOTE 11 — Objects can be specified by specific values of their ID or by using wildcards.

5.2 GET verb

The GET verb shall be used to communicate a request for information on an object or list of objects.

The response to the GET message is a SHOW message; see Figure 5.

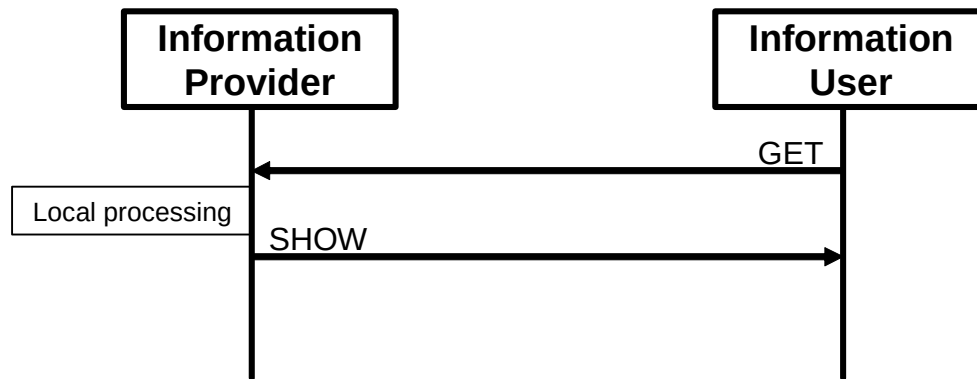


Figure 5 – GET and SHOW transaction

The GET is designed to retrieve one or more objects and any contained objects by using the ID attribute.

Within a GET message, the ID of the requested object is passed to the provider of the information. Where a single ID is not sufficient identification, such as when a property of an object is needed, then the ID of the encapsulating object and the ID or value of the encapsulated object (the property) are passed to the provider of the data. The identifying IDs are specified in the sections for each object type.

When a wildcard definition is used in the ID, then the GET returns a list of objects matching the wildcard specification.

Example: The GET may retrieve multiple objects such as all of the personnel classes.

NOTE — A GET with a wildcard provides a very limited query capability. The transactions are not intended to provide a complete query/reporting capability as normally seen in a database system. If additional query capability is needed, then the GET/SHOW transaction can be used to create copies of all data, and then that copy can be queried locally.

5.3 SHOW verb

The SHOW verb shall be used when responding to a GET message.

Figure 6 illustrates a transaction with a GET message followed by a SHOW message and a CONFIRM message (because of the CONFIRM always option specified with the GET message).

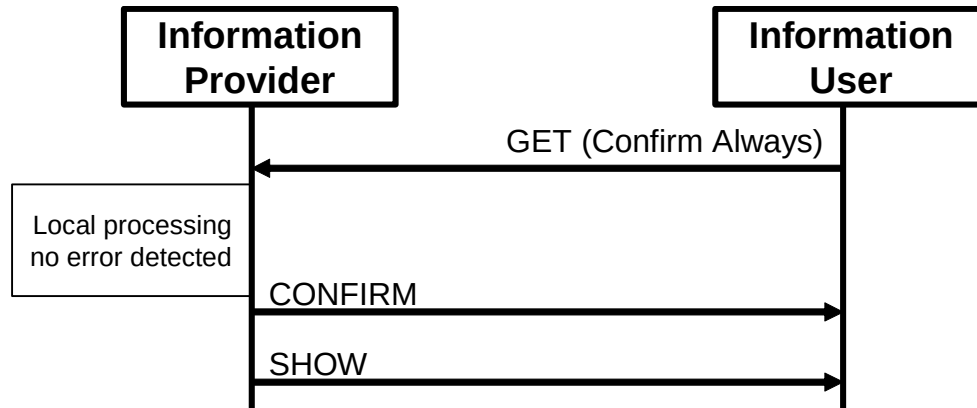


Figure 6 - GET and SHOW transaction with a CONFIRM always

NOTE — The order of arrival of the CONFIRM message, SHOW message, and any other response message is not defined in this standard.

5.4 PROCESS verb

The PROCESS verb shall be used to request processing of the associated noun by the receiving application. A PROCESS message is sent to an entity that can process the object. In a typical exchange scenario a PROCESS message is considered to be the equivalent of a formal command.

NOTE — A PROCESS verb is often the equivalent of a command to add an object, but usually the receiving entity does further processing of the information.

Example: The sending of a *PROCESS Production Schedule* message to a site indicates that the schedule is to be executed.

Example: The sending of a *PROCESS Equipment* message indicates that a new equipment item is to be added.

A PROCESS verb area contains an optional element with one of the following additional definitions: Never or Always (see Table 2). If the optional element is not specified, then it defaults to Never.

Table 2 – Acknowledge request options

Name	Description
Never	No ACKNOWLEDGE message requested.
Always	Always send an ACKNOWLEDGE message.

5.5 ACKNOWLEDGE verb

The ACKNOWLEDGE verb shall be used to indicate an application's receipt of a PROCESS request. The response to a PROCESS message is an ACKNOWLEDGE message. The ACKNOWLEDGE message may return the original or modified data. Figure 7 illustrates a PROCESS message with a response ACKNOWLEDGE message.

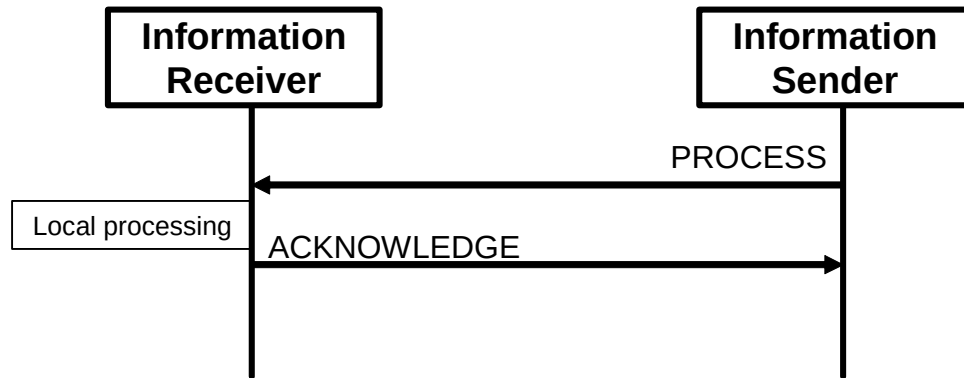


Figure 7 – PROCESS/ACKNOWLEDGE transaction

Example: Sending of an *ACKNOWLEDGE Production Schedule* message, where a *PROCESS Production Schedule* message has been received and the corresponding business application acknowledges the receipt of the Production Schedule and responds with an acceptance.

An ACKNOWLEDGE verb area contains an element with one of the following additional definitions: Accepted, Rejected, or Modified (see Table 3).

Table 3 – Acknowledge element

ACKNOWLEDGE ELEMENT	DEFINITION
ACCEPTED	The information was accepted by the receiver of the information and was processed according to the business rules of the receiver.
REJECTED	The information was rejected by the receiver of the information and was not processed by the receiver. The message data area shall contain an identification of the reason for rejection.
MODIFIED	The information was accepted by the receiver of the information but was modified for correct processing; the modified data shall be returned with the ACKNOWLEDGE. The message data area shall contain an identification of the type of modification.

Example: Figure 8 shows a message sequence from a scheduling system to an execution system. The initial PROCESS message with a production schedule is received and an ACKNOWLEDGE message with a MODIFIED flag was returned with a new proposed schedule. The scheduling system re-generates a schedule and resends to the execution system. The execution system accepts the production schedule and returns an ACKNOWLEDGE message with an ACCEPTED flag.

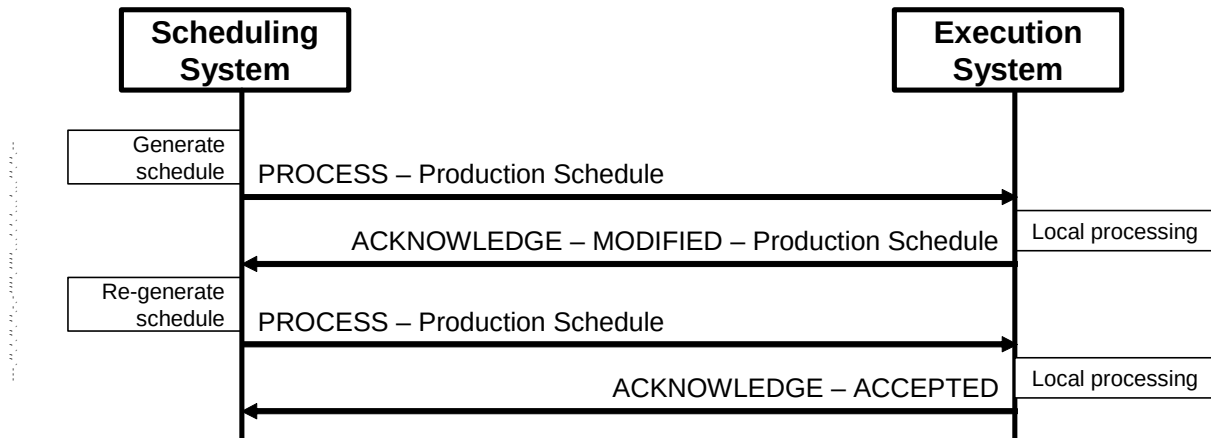


Figure 8 - Example of acknowledge to a process message

5.6 CHANGE verb

The CHANGE verb shall be used when the sender of the message is sending a request for the data to be changed. The noun area contains the new data. Figure 9 illustrates a CHANGE message with a RESPOND message.

Example: Sending of a *CHANGE Person* message, where the personnel information, such as a qualification test, is changed by a system that is not the owner of the personnel model data.

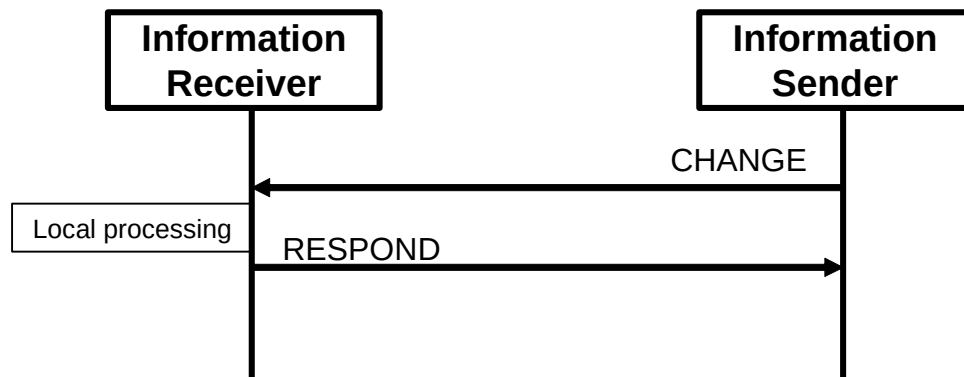


Figure 9 – CHANGE/RESPOND transaction

A CHANGE verb area contains an optional element with one of the following additional definitions: Never or Always. (see Table 4.) If the optional element is not specified, then it defaults to Never.

Table 4 – Respond options

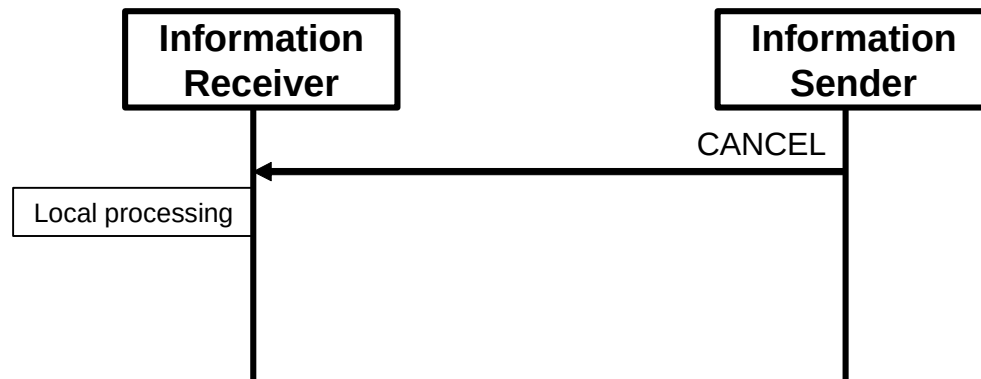
Name	Description
Never	No RESPOND message requested.
Always	Always send a RESPOND message.

5.7 CANCEL verb

The CANCEL verb shall be used when the sender of the CANCEL message is sending a request for the data to be canceled.

Example: Sending of a *CANCEL MaterialLot* message, where an application indicates that a material lot is no longer valid (or available), but the application that is sending the CANCEL message is not the owner of the material model data.

NOTE — Because the CANCEL is not sent by the owner of the data, the data are not necessarily deleted. The sender is indicating that the sender no longer needs the data.

**Figure 10 - CANCEL message**

5.8 CONFIRM verb

A CONFIRM verb shall be used in a CONFIRM message for confirmation of receipt and processing of any message other than the CONFIRM, RESPOND, or ACKNOWLEDGE messages. See Figure 11 for an example of confirmation with detected errors.

Confirmation is an option controlled by the sending business application. It is a request to the receiving application to send back a confirmation message to the sender of the initiating message.

The CONFIRM message shall indicate an identification of the initiating message being confirmed.

The CONFIRM message indicates the successful processing of the initiating message or returns error conditions if the initiating message could not be processed. The error condition should include a description of the error.

If an error occurs in the processing of the initiating message by the receiving application and the sender set the confirmation element to either *OnError* or *Always*, then the receiving application shall provide a CONFIRM message. If no confirmation option was specified, then the default value is *Confirm Never*.

Error handling at the application layer is through the confirmation element in the application identification area.

The application error handling is in addition to any communication layer error handling that may be provided by the infrastructure framework, web service, or middleware.

A confirmation request has the values defined in Table 5.

Table 5 – Confirmation request options

Name	Description
Never	No confirmation requested.
OnError	Send back a confirmation only if an error has occurred.
Always	Always send a confirmation regardless of the local processing.

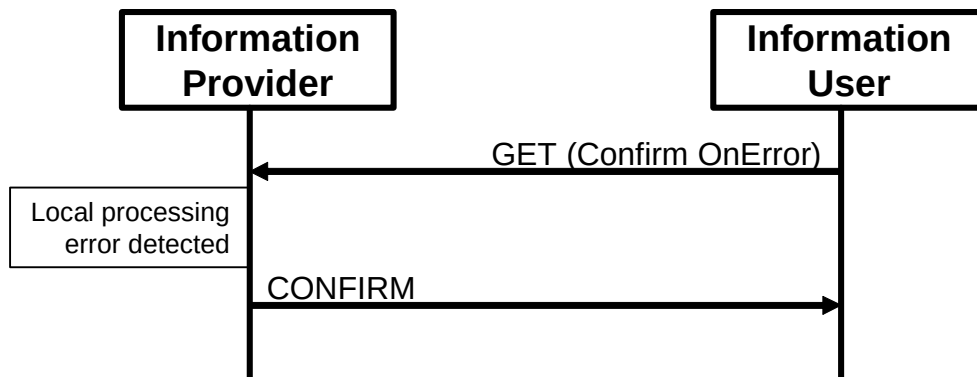


Figure 11 - Example of a GET message with Confirm OnError

(The order of arrival of the CONFIRM message and any other response message is not defined in this standard. In 5.3 this is depicted as a note.)

The error description, code, or text associated with a CONFIRM message is contained in the noun area, as shown in Figure 12.

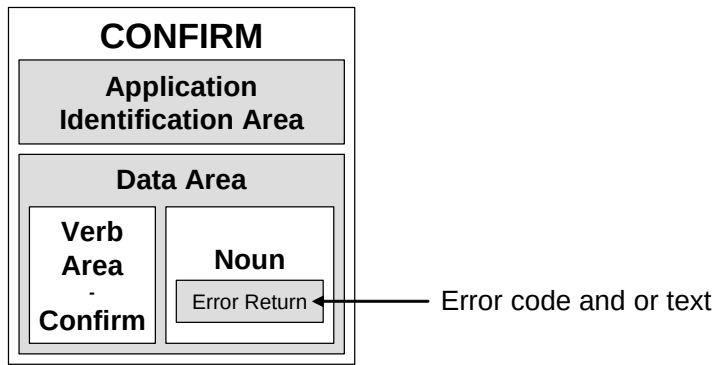


Figure 12 - Confirm Message

Specific error codes or error text are not defined in this standard and are implementation specific.

5.9 RESPOND verb

The RESPOND verb shall be used to signify the application receipt and processing of a CHANGE message. The RESPOND message is used when responding to a CHANGE message. The RESPOND message may return the original or modified data.

A RESPOND verb area contains an element with one of the following additional definitions: Accepted, Rejected, or Modified (see6).

Table 6 – Respond element

RESPOND ELEMENT	DEFINITION
ACCEPTED	The information was accepted by the receiver of the information and was changed according to the business rules of the receiver.
REJECTED	The information was rejected by the receiver of the information and was not changed by the receiver. The message data area shall contain an identification of the reason for rejection.
MODIFIED	The information was accepted by the receiver of the information but was modified for correct processing and the modified data were returned with the RESPOND. The message data area shall contain an identification of the type of modification.

5.10 SYNC verb

The SYNC verb shall be used when the owner of the data is publishing the information or change in information to subscribers.

NOTE 1 — SYNC is short for synchronize, and implies synchronized or aligned data; it does not mean synchronous communications.

There should only be one application that sends SYNC messages for any specific element of information.

NOTE 2 — Other applications may send SYNC messages for elements of information that they own.

Example 1: A human resources system may provide personnel capability information; however, a training system may provide the Qualification Test Specification information pertaining to the personnel capability object.

The owner of the information sends the SYNC message.

The SYNC message shall contain one of the following modifiers in the verb area: ADD, CHANGE, or DELETE.

The timing of the publication and scope of the published information is not defined in a message. It is determined by an out-of-band agreement between the publisher and subscriber.

Example 2: This verb is commonly used when mass changes are necessary, such as when an ERP publishes item master to multiple MES systems, or when a publish and subscribe mechanism is used as a company's integration architecture.

5.11 SYNC ADD verb

A SYNC ADD verb shall be sent by the owner of the information and indicates that the owner of the information has added new information. The SYNC ADD message shall include the object instances added and the values of all attributes of these objects. The specific elements to be added are defined in Clause 6. See Figure 13.

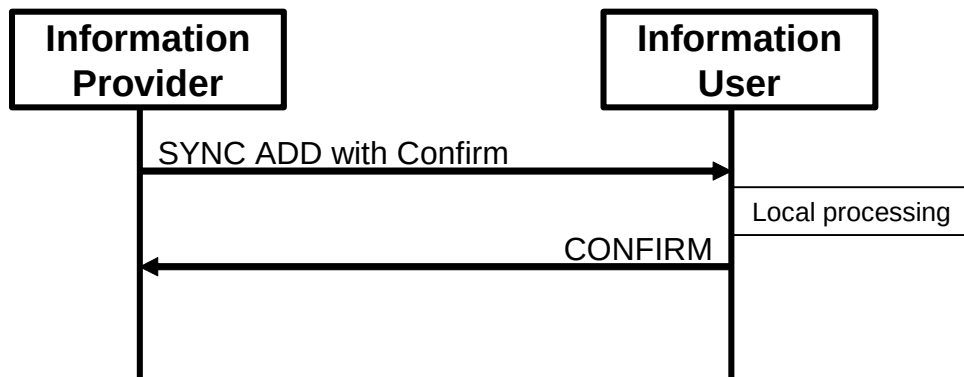


Figure 13 - SYNC ADD transaction with confirmation

Example: A SYNC ADD on a *QA TEST SPECIFICATION* object indicates the definition of a new QA Test Specification.

5.12 SYNC CHANGE verb

A SYNC CHANGE verb is sent by the owner of the information and is used to disseminate information on changed objects to subscribed users. The SYNC CHANGE message shall include the object instances changed with the values of the attributes changed. The specific elements to be changed are defined in Clause 6.

Example: A SYNC CHANGE message with a *MATERIAL CLASS* object indicates a change in the material class or a property of the material class and the new value.

5.13 SYNC DELETE verb

A SYNC DELETE verb is sent by the owner of the information and indicates that the provider of the information has deleted the information. The SYNC DELETE message shall include the object instances deleted. The specific elements to be deleted are defined in Clause 6. See Figure 14.

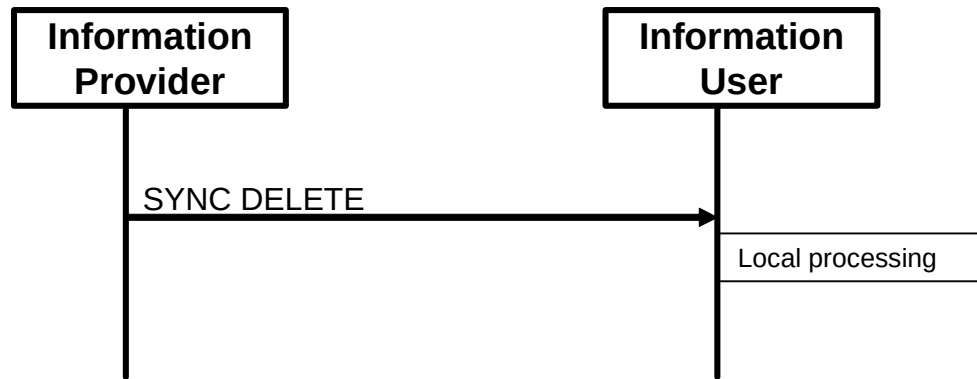


Figure 14 - SYNC DELETE transaction with no confirmation

NOTE — A SYNC DELETE message only indicates that the provider has deleted the information from publication. The information may still be archived or retained in accordance with business policies, but just not available for further publishing. The information user has the responsibility to determine the correct action, such as retaining or archiving their information.

6 Message nouns

6.1 Introduction

This clause defines the set of message nouns that shall be used by verbs to identify information exchanged between Level 4 and Level 3 systems as defined in the object models of Part 1 Clause 7 and Part 2.

6.2 Defined message nouns

6.2.1 Transaction service profile

A transaction service profile noun returns all supported verb/noun combinations, if the combination is supported as a receiver, if it is supported as a sender, and if wildcards are supported. See Clause 6.12 and Clause 7 for the definition of the object and compliance information.

NOTE — The transaction service profile is a method to interactively determine what verbs and nouns are supported by an application.

6.2.2 Personnel class

The Personnel Class noun contains the following objects as defined in the Part 2 standard:

- Personnel Class
- Personnel Class Property

6.2.3 Person

The Person noun contains the following objects as defined in the Part 2 standard:

- Person
- Person Property
- Qualification Test Result

6.2.4 Qualification test specification

The Qualification Test Specification noun contains the following object as defined in the Part 2 standard:

- Qualification Test Specification

6.2.5 Equipment class

The Equipment Class noun contains the following objects as defined in the Part 2 standard:

- Equipment Class
- Equipment Class Property

6.2.6 Equipment

The Equipment noun contains the following objects as defined in the Part 2 standard:

- Equipment
- Equipment Property
- Equipment Capability Test Result

6.2.7 Equipment capability test specification

The Equipment Capability Test Specification noun contains the following object as defined in the Part 2 standard:

- Equipment Capability Test Specification

6.2.8 Maintenance request

The Maintenance Request noun contains the following object as defined in the Part 2 standard:

- Maintenance Request

6.2.9 Maintenance work order

The Maintenance Work Order noun contains the following object as defined in the Part 2 standard:

- Maintenance Work Order

6.2.10 Maintenance response

The Maintenance Response noun contains the following object as defined in the Part 2 standard:

- Maintenance Response

6.2.11 Material class

The Material Class noun contains the following objects as defined in the Part 2 standard:

- Material Class
- Material Class Property

6.2.12 Material definition

The Material Definition noun contains the following objects as defined in the Part 2 standard:

- Material Definition
- Material Definition Property

6.2.13 Material lot

The Material Lot noun contains the following objects as defined in the Part 2 standard:

- Material Lot
- Material Lot Property
- QA Test Result

6.2.14 Material subplot

The Material Sublot noun contains the following objects as defined in the Part 2 standard:

- Material Sublot
- Material Sublot Property
- QA Test Result

NOTE — In the Part 1 and Part 2 standards, material sublots do not have unique properties or quality test results. Implementation of this model should allow material sublots to have unique properties and quality test results.

Example: Sublot-specific properties may be unique RFIDs (Radio Frequency ID) for each subplot or maximum temperature indicators for each subplot.

6.2.15 QA test specification

The QA Test Specification noun contains the following object as defined in the Part 2 standard:

- QA Test Specification

6.2.16 Process segment

The Process Segment noun contains the following objects as defined in the Part 2 standard:

- Process Segment
- Process Segment Parameter
- Personnel Segment Specification
- Equipment Segment Specification
- Material Segment Specification
- Process Segment Dependency



- Personnel Segment Specification Property
- Equipment Segment Specification Property
- Material Segment Specification Property

6.2.17 Production capability

The Production Capability noun contains the following objects as defined in the Part 2 standard:

- Production Capability
- Personnel Capability
- Equipment Capability
- Material Capability
- Process Segment Capability
- Personnel Capability Property
- Equipment Capability Property
- Material Capability Property

6.2.18 Product definition

The Product Definition noun contains the following objects as defined in the Part 2 standard:

- Product Definition
- Product Segment
- Product Segment Dependency
- Manufacturing Bill
- Product Parameter
- Personnel Specification
- Equipment Specification
- Material Specification
- Personnel Specification Property
- Equipment Specification Property
- Material Specification Property

6.2.19 Production schedule

The Production Schedule noun contains the following objects as defined in the Part 2 standard:

- Production Schedule
- Production Request
- Product Production Rules
- Segment Requirement
- Requested Segment Response
- Production Parameter



- Personnel Requirement
- Equipment Requirement
- Material Produced Requirement
- Material Consumed Requirement
- Consumable Expected
- Personnel Requirement Property
- Equipment Requirement Property
- Material Produced Requirement Property
- Material Consumed Requirement Property
- Consumable Expected Property
- Product Parameter
- Process Parameter

6.2.20 Production performance

The Production Performance noun contains the following objects as defined in the Part 2 standard:

- Production Performance
- Production Response
- Segment Response
- Production Data
- Personnel Actual
- Equipment Actual
- Material Produced Actual
- Material Consumed Actual
- Consumable Actual
- Personnel Actual Property
- Equipment Actual Property
- Material Produced Actual Property
- Material Consumed Actual Property
- Consumable Actual Property

6.3 Personnel model

6.3.1 Personnel model elements

The message definitions assume that information may be accessed from any of three starting points: personnel class, person, or qualification test, as identified by the dotted collections in Figure 15.