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IPC-2501

Definition for Web-Based Exchange of XML Data (Message Broker)

IPC-2501

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A standard developed by IPC

2215 Sanders Road, Northbrook, IL 60062-6135

Tel. 847.509.9700 Fax 847.509.9701

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IPC-2501

Message Broker

– GENERIC

Definition for Web-Based Exchange of XML Data

A standard developed by the CAMX Frameworks Communication Committee (2-50).

The IPC-2501 standard specifies the governing semantics and an XML based syntax for shop floor communication between electronic assembly equipment and associated software applications. Wherever possible, existing and widely accepted protocols have been utilized. Certain guaranteed behaviours have been defined to ensure that mission-critical data is reliably communicated among Clients. The purpose of the standard is to outline the communication architecture, supporting XML messages, and to define the choreography between sender and receiver.

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798



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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the CAMX Frameworks Communication Committee (2-50) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

CAMX Frameworks Communication Committee

Chair

Andrew D. Dugenske
Georgia Institute of Technology

Technical Liaisons of the IPC Board of Directors

Nilesh S. Naik
Eagle Circuits Inc.

Sammy Yi
Flextronics International

CAMX Frameworks Communication Committee

Robert E. Neal, Agilent Technologies
Kay Lannen, Agilent Technologies
Jeremy Nuanes, Agilent Technologies
Jason Schnitzer, Agilent Technologies
John Minchella, Celestica
Robert Voitus, Celestica
Jorge Camargo, Cookson Electronics Equipment Group
Richard Johnson, DEK Printing Machines Ltd.
Andrew Oughton, DEK Printing Machines Ltd.
Mike Rogers, DEK Printing Machines Ltd.
Richard Coblenz, Fuji America Corporation
Monte Cramer, Fuji America Corporation
Michael Kimpton, Fuji America Corporation
Kevin Kroplewski, Fuji America Corporation
Tony Picciola, Fuji America Corporation
Andrew D. Dugenske, Georgia Institute of Technology
Douglas A. Furbush, Georgia Institute of Technology

Andrew Scholand, Georgia Institute of Technology
Jeffrey Gerth, Georgia Tech Research Institute
John Cartwright, Intel Corporation
Douglas Jackson, Intel Corporation
David Martin, Intel Corporation
Hannu Ronkainen, Jot Automation
Mark Doyle, Mapics, Inc.
Brian Nigro, Mapics, Inc.
Brent Bohmont, Motorola Inc.
Mark Williams, Motorola
Dan Pattyn, Motorola, Inc.
Jim Brazelton, NACOM Corporation
Louis Watson, NACOM Corporation
Kevin Brady, NIST Nat'l. Institute of Stds & Technology
Barbara Goldstein, NIST Nat'l. Institute of Stds & Technology
Michael McLay, NIST Nat'l. Institute of Stds & Technology
John Messina, NIST Nat'l. Institute of Stds & Technology
Rick Lloyd, Nortel Networks
Dave J. Morris, Nortel Networks
Tony Wong, Nortel Networks
Hitoshi Nakamura, Panasonic

Tom Baggio, Panasonic Factory Automation
Hiro Kurata, Panasonic Factory Automation
Tak Yokoi, Panasonic Factory Automation
Moustafa Nouredine, Router Solutions Inc.
Robert Schwanke, Siemens
Dilip Soni, Siemens
Cord Burmeister, Siemens Dematic Corporation
Tuan M. Nguyen, Siemens Dematic Elect. Asmbly. Systems
Art Sedighi, Talarian Corporation
Grace Yee, Talarian Corporation
Niko Siltala, Tampere University of Technology Institute of Production Engineering
Carey Price, TechCenter
Rudi Streif, Teradyne Inc.
Allan Fraser, Teradyne Inc.
Rob Bryla, Universal Instruments Corporation
Tom J. Dinnel, Universal Instruments Corporation
Jerry Lowery, Visiprise, Inc.



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Definition for Web-Based Exchange of XML Data

Introduction

Information flow is essential to efficient electronics manufacturing and standards are essential to information flow. One area of commerce that has lacked its own communication standards is the electronics manufacturing factory floor. Information exchange between a system of electronic assembly equipment and higher-level applications has, in the past, used proprietary or borrowed standards. The IPC-254X and IPC-255X series of standards address this issue by defining the messages needed for this information exchange.

Just as “snail mail” and e-mail information exchanging requires standards for the envelope and transportation mechanisms – or messaging interface – so also do factory floor communications. This standard describes a messaging interface that is based upon an architecture whereby a single logical middleware server (the Message Broker) exchanges messages among Clients in a Domain.

Clients may be electronics manufacturing equipment or software applications present in the domain. The Message Broker acts as an intelligent message router between these Clients, accomplishing both Point-to-Point and Publish/Subscribe communications. Figure 1 shows a computer-aided manufacturing XML (CAMX) Domain consisting of the Message Broker, Application Clients, and Equipment Clients.

Although the scope of this document is that of electronics manufacturing, the broader applicability of the message transport mechanisms defined by this standard must be noted. Any application that uses XML-based messages can use the IPC-2501 web-based exchange mechanism. Specifically, this standard can support the exchange of XML-based messages both within an enterprise, be it manufacturing or service based -- and externally -- between multiple enterprises having the need for efficient, reliable web-based communications. Broad adoption of this standard is strongly encouraged.

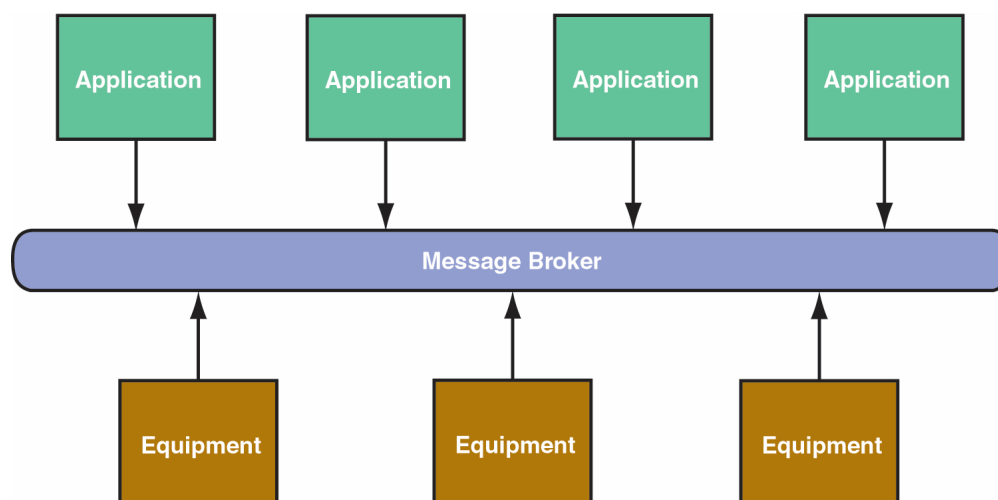


Figure 1 Example IPC-2501 Domain consisting of the Message Broker, Application Clients, and Equipment Clients

1 Scope

The intent of this standard is to establish the governing semantics and an XML based syntax for shop floor communication between electronic assembly equipment and associated software applications. Wherever possible, existing and widely accepted protocols have been utilized. Certain guaranteed behaviors have been defined to ensure that mission-critical data is reliably communicated among Clients.

The purpose of this specification is to outline the communication architecture and supporting XML messages. The required programmatic actions that define the choreography between sender and receiver have also been defined.

The domain of this standard is that of an electronics assembly manufacturing shop, consisting of up to several hundred machines, each of which is capable of producing tens of messages per second. Most of these messages are relatively small in size (under 20 kilobytes); however some application-specific files of several megabytes will occasionally need to be transferred. The number of consumers of this information is assumed to be a relatively small number, typically less than 20, and this number does not directly increase in proportion to the number of machines. Provisions have also been made to accommodate network interruptions.

1.1 General Design Principals

Many different levels of system complexity are possible in addressing the intent outlined above. The industry participants guiding the development of this standard set forth the following design principles:

- Low Cost
- Low Complexity
- Stable
- Deterministic
- Centrally Configured
- Scalable

1.2 Intended Audience

This document is intended for an audience of manufacturing system software developers, computer aided manufacturing application programmers and Information Technology professionals as well as an end user community that includes process engineers and manufacturing specialists.

2 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance with the XML syntax and semantics **shall** be followed without ambiguity, or the insertion of superfluous information. The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions. "Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in boldface characters.

3 General Requirements

The XML schemas contained in this document describe the structures for a CAMX data exchange. The document specifies data elements specifically designed to establish the information exchange capabilities as related to the electronics manufacturing factory floor. The XML schemas define the configuration of mandatory and optional elements, as well as mandatory and optional attributes.

3.1 Terms and Definitions

The definitions of all terms used herein **shall** be as specified in IPC-1050, and by the following:

Client – A generic term for any of the various machines, applications, or devices that may connect to a Message Broker in a Domain.

Domain - The set of all Clients interested in communicating with each other. It contains a single logical Message Broker and a configurable number of Clients.

Domain Configuration - The Domain Configuration defines publishing capabilities, subscription interests, point-to-point communication privileges, quality of service parameters and general information about the Domain.

Message Broker - The Message Broker is the messaging middleware. It is responsible for intelligently routing messages among Clients.

3.2 Communication Architecture

In accordance with the intent of using broadly accepted standards where possible, this system makes use of TCP/IP, HTTP, XML, and SOAP as illustrated in Figure 2.

Message Exchange	(IPC 2501)
Message Semantics	(IPC 251X - 258X)
Message Syntax	(XML)
Packaging	(SOAP w/ Attachments) (IPC 2501 Extensions)
Transport	(HTTP)
Network	(TCP/IP)

Figure 2 IPC-2501 Layered Communications Architecture

There are two chief advantages of this standards-based approach. First, re-invention and re-implementation of basic commodity functionality is minimized. Second, the use of widely accepted Internet standards will make the IPC-2501 more attractive to potential implementers.

The way in which SOAP with attachments and the HTTP protocol are used together to represent IPC-2501 messages is illustrated in Figure 3.

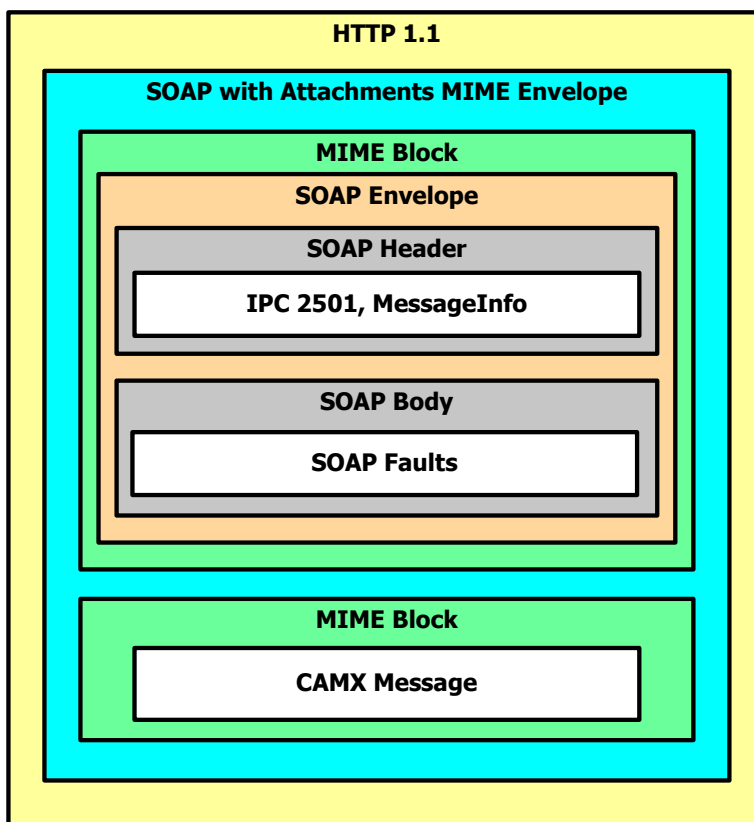


Figure 3 The IPC-2501 transmission structure

3.2.1 TCP/IP Usage

TCP/IP is used by this standard because it is absolutely standardized and offers the highest assurance that all types of systems from all vendors can communicate effectively.

3.2.2 HTTP Usage

All transfers of messages in an IPC-2501 Domain are accomplished via the HTTP 1.1 protocol through the Message Broker. The Message Broker acts as an HTTP Server and the Clients act as HTTP Clients.

A transaction consists of two HTTP transmissions. The first transmission is an HTTP Client Request and **shall** be initiated by a Client. The second transmission is an HTTP Server Response, and **shall** be accomplished by the Message Broker (see Figure 4).

The HTTP Client Request **shall** use the HTTP POST method. The HTTP Server **shall** Respond with either an HTTP 200 or an HTTP 500 status code. An HTTP 200 status code **shall** indicate that the HTTP request has succeeded. An HTTP 500 status code **shall** indicate the Message Broker encountered an unexpected HTTP condition that prevented it from fulfilling the request.

For further information about HTTP 1.1, see:

<http://www.w3.org/Protocols/rfc2616/rfc2616.html>.

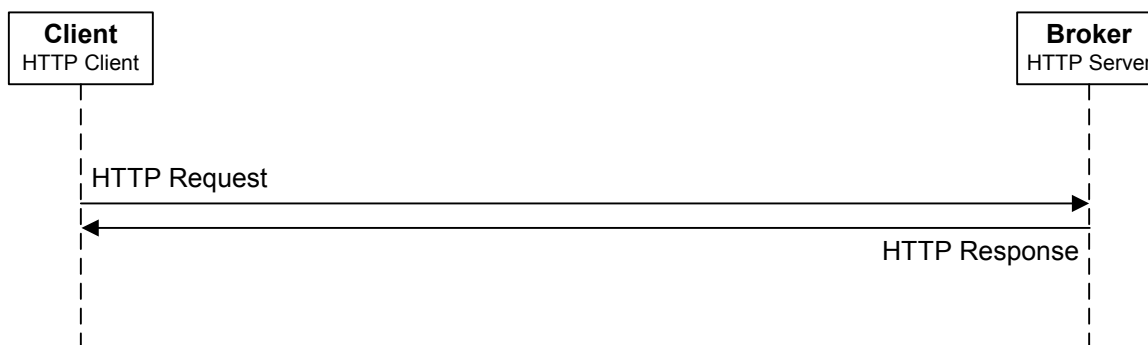


Figure 4 An HTTP Request/Response Transaction between a Client and the Message Broker. All communication in an IPC-2501 Domain follows this pattern.

3.2.3 SOAP with Attachments Usage

In addition to HTTP, SOAP with Attachments **shall** be used to transfer messages. Each HTTP transmission as defined in the previous section **shall** contain two MIME blocks. The first MIME block **shall** contain a SOAP Envelope. The second MIME block **shall** contain the message that is being transferred. (note: Future versions of this standard may use multiple MIME blocks to transfer additional data.)

The SOAP Envelope contains a SOAP Header element and a SOAP Body element. The SOAP Header element **shall** contain an IPC-2501 MessageInfo as a child element. If a SOAP fault has been generated, the SOAP Body **shall** contain the SOAP fault (see Figure 5).



Figure 5 Location of MessageInfo element within the SOAP Envelope

For more information about SOAP Version 1.1, see:

<http://www.w3.org/TR/SOAP/>

For more information about SOAP with Attachments, see:

<http://www.w3.org/TR/2000/NOTE-SOAP-attachments-20001211.html>

The SOAP 1.1 envelope schema can be found at:

<http://schemas.xmlsoap.org/soap/envelope/>

3.2.3.1 MessageInfo Element

The MessageInfo element contains meta-level information about the message that is contained in the second MIME block of each HTTP transmission. Attributes of the MessageInfo element provide origination and destination context to the message so that it can be routed appropriately. Attributes are also included that indicate the schema of the message, a unique identifier, and the date and time of the message.

ATTRIBUTE NAME	ATTRIBUTE TYPE	DESCRIPTION	occ ¹
sender	anyURI	The unique, predefined name of the entity in the Domain sending this message.	1
destination	anyURI	The unique, predefined name of the entity in the Domain where this message is to be sent.	1
dateTime	dateTime	The date and time of the message.	1
messageSchema	anyURI	The location of the schema of the attached message represented by this element.	1
messageld	string	An attribute representing the unique identifier of the message.	1

URI: <http://webstds.ipc.org/2501/MessageInfo.xsd>

Graphic Representation:

Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema"
  elementFormDefault = "qualified">
  <xsd:element name = "MessageInfo">
    <xsd:complexType>
      <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
      <xsd:attribute name = "sender" use = "required" type = "xsd:anyURI"/>
      <xsd:attribute name = "destination" use = "required" type = "xsd:anyURI"/>
      <xsd:attribute name = "messageld" use = "required" type = "xsd:string"/>
      <xsd:attribute name = "messageSchema" use = "required" type = "xsd:anyURI"/>
    </xsd:complexType>
  </xsd:element>
</xsd:schema>
```

3.2.3.1.1 Unique ID Generation

Each message **shall** be uniquely identified for the purpose of acknowledgement, logging, response correlation and other purposes. Identifier strings must be printable characters and may be generated in any fashion that will produce an identifier with a name space collision possibility of zero.