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Generic Computer Aided Manufacturing (CAMX) Standard Shop-Floor Communication Messages Definitions for Inspection and Test

Introduction

Factory Information Systems (FIS) form the nervous system of an enterprise, analyzing data and delivering information to the machines and people who need to make information-based decisions. These systems provide a bi-directional flow of information between the factory floor and the rest of the enterprise and beyond.

The CAMX standards (IPC 254X) are designed to foster application integration and shop floor equipment communications based on XML. It assumes that application programs (including equipment interfaces) are distinct entities, and application integration takes place using a loosely coupled, message-passing approach. There is no need for a common object model, programming language, network protocol, persistent storage mechanism or operating system for two applications to exchange XML messages formatted using the CAMX standards. The two applications simply need to be able to format, transmit, receive and consume a standardized XML message.

1 Scope

This document describes event message content and an XML encoding scheme, that enables a detailed definition of messages in the domain of electronics inspection, test and repair/rework (i.e. product and process quality). These messages are to be encoded at a level appropriate to facilitate interoperability in the factory shop floor equipment and information system integration process.

1.1 Interpretation

"Shall", the emphatic form of the verb, is used throughout this standard whenever a requirement 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 bold characters.

2 Applicable documents

The following documents contain provisions that, through reference in this text, constitute provisions of this standard. All documents are subject to revision. Parties who make agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below.

IPC-T-50   Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC 2500   Virtual Factory Information Interchange Framework definitions

IPC 2511   Generic Computer Aided Manufacturing (GenCAM) descriptions for Printed Circuit Boards and Printed Board Assembly

IPC 2541   Generic Requirements for Electronics Manufacturing Shop Floor Equipment Communication

W3C   Date-time format standard

3 General Requirements

The requirements of IPC-2541 are a mandatory part of this standard. That document describes the generic requirements for the CAMX format.

3.1 Terms and Definitions

The definition of all terms used herein **shall** be as specified in IPC-T-50, and the following:

Assembly
An electronic product consisting of a printed circuit board or boards, attached electronic and mechanical components with associated connectors and cabling.

Base-64
A method of encoding binary data into a restricted, printable ASCII characters subset. This method is used by the inspection systems for encoding their binary image format, such as .tif, .jpg, and .bmp.

Board
A single instance of a printed circuit. One circuit image of a fabrication panel. The foundation of an electronic printed circuit assembly.

Component
A single instance of a part package. Identified by an alpha-numeric designator, each of these will have a unique location on a circuit assembly.

Defect
An unacceptable deviation from a norm.

Event
A process action or trigger of significance. Also a term used in this standard as synonymous with message records generated upon the event occurrence.

Fault
The detected manifestation of a defect.

Frame
An instance of a captured optical, x-ray, or infra-red picture, image or other artifact facsimile of a circuit board or assembly. A Frame may be of a relatively small geometry or it may represent an entire assembly.

Image
A single board or assembly circuit instance typically used to identify one member of a homogeneous or heterogeneous panel, but not limited to that.

Item
An identifiable and traceable product or product component instance.

Indictment
A defect condemnation identified during human or automated inspection or test.

Octet
A measured or expected value expressed as an 8-bit byte. Measured and expected values that are not necessarily numeric in nature (e.g. character strings) are expressed and compared as octets.

Panel
An electronic assembly consisting of multiple circuit images. Homogeneous panels are defined as having multiple of the same circuit image revision and assembly (Bill of Materials) revision. Heterogeneous panels are defined a having more than one circuit image and/or more than one assembly revision.

Inspection
A process relating to one or more regions-of-interest of a board or an assembly.

Region Of Interest (ROI)
An area of focus in or on an electronic assembly pertinent to inspection.
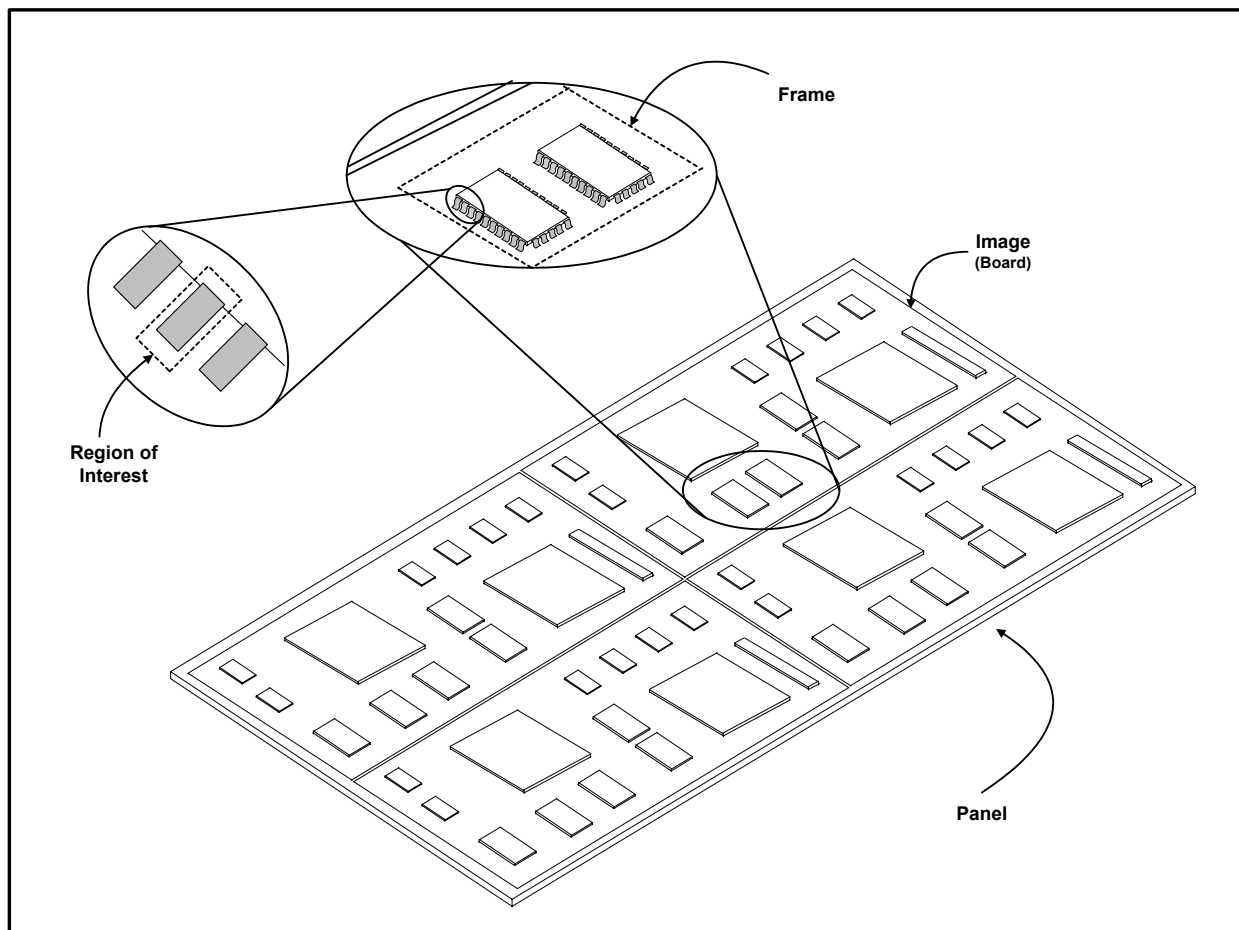
Figure 1 - Inspection Frame and Inspection Region of Interest

Signal
An electrically-common logical net or physical conductor or connection.

Station
A uniquely identifiable, task-specific work area of a manufacturing environment.

Stage
A uniquely identifiable task within the sequence of manufacturing steps for electronic assemblies.

Symptom
Description of an element of evidence of a fault or defect.

Termination
A lead, pin, ball, leg or other conductive connection between a component package and the circuit board.

3.2 Date and Time Notation

All 2540 standards **shall** use the World Wide Web consortium (W3C) date time standard. This standard **shall** use the Complete Date plus Hours, Minutes, Seconds, and a decimal fraction of a second and Time Zone Designator. Two decimal places will be used in order to represent time down to a hundredth of a second. For additional information on date and time, see web page:

http://www.w3.org/TR/1998/NOTE-datetime-19980827

3.3 CAMX Compliance

The IPC-2501 document defines a message packet structure. The IPC-2541 document defines a set of Equipment, Recipe, Item, and Operator events and related message formats. All test, inspection and repair stations that comply with the IPC-2547 standards **shall** also comply with the event messages contained in the IPC-2541 standard as well as those events that are described in this document. All event messages **shall** be formatted in compliance with the IPC-2501 message packet structure.

4 Test and Inspection Specific Event Messages

The figure below illustrates the relationships and cardinality of the key event elements.

ProcessSessionStart

sessionId

ItemProcessStatus

itemProcessId

One or more
ProcessStepStatus
events can be
associated with a
single
ItemProcessStatus

ProcessStepStatus

processStepId

One or more Signals,
and/or Components,
may be analyzed for
one ProcessStepStatus

Signal

signalId

Component

designator

Zero or more
Signals, and/or
Components
may be
associated with
a single
RepairAction

A process
step may
result in zero
or more
Indictments
or Symptoms

Indictment

indictmentId

RepairAction

repairKey

A single ItemRepair
can be associated
with one or more
Indictment or
Symptom

Symptom

symptomId

ItemRepair

repairId

One or more
RepairActions may
be associated with a
single ItemRepair

Zero or more
inspection
regions may
be used to
determine the
result for a
single
ItemProcess
Step

Zero or more
Measurements
may be used to
determine a single
ProcessStepStatus

RegionOfInterest

regionId

Measurement

measurementId

Zero or more
measurements may be
used to analyze a
single RegionOfInterest

A single
InspectionFrame
can be associated
with multiple
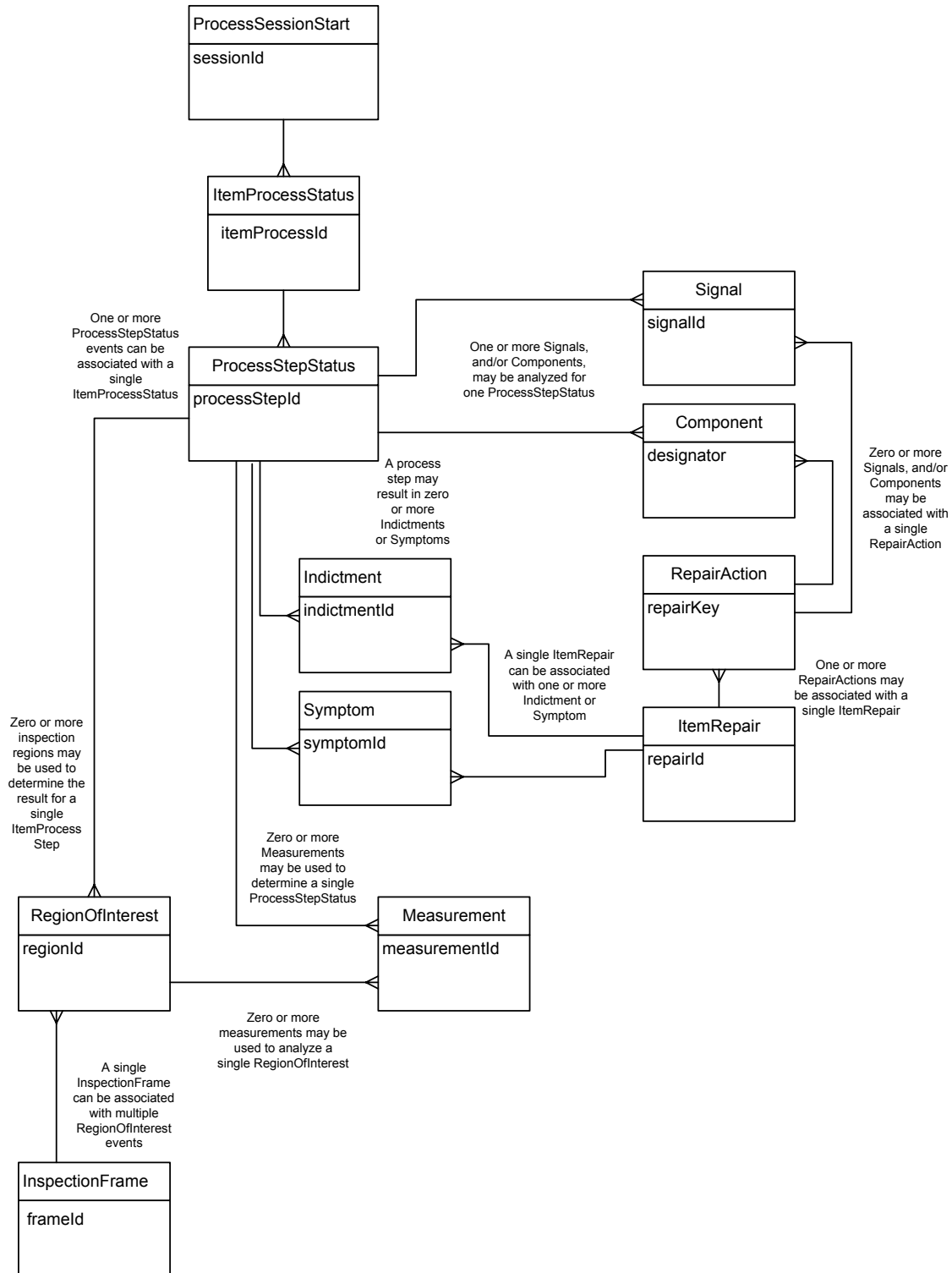RegionOfInterest
events

InspectionFrame

frameId

Figure 2. Key Event Object Relationships

Though the events are asynchronous, the relationships are linked using identifiers and identifier references for grouping the event records. Each session has an identifier that **shall** be unique across at least the reporting domain. The recommendation is to use a date-time in conjunction with a MAC or IP address, *GUID* or Java-style organization package path. For example:
- Network address and date-time (`"15.11.9.54-2000-08-05T10:04:31.20+0800"`)
- Enterprise Id and date-time (`"com.ourco.mch2-2000-08-05T10:04:31.20+0800"`)

This identifier is then referenced in each ItemProcessStatus There is one ItemProcessStatus for one execution of the test or inspection program. In turn, each ItemProcessStatus has an indentifier unique within the reporting domain that is referenced in the ProcessStepStatus event for each step of the test or inspection program. Similarly each supporting inspection or test step has an identifier that is unambiguous within the test or inspection program's sequencing. Indictments or symptoms of failing test steps are also unabiguously identified, enabling association with repair events and repair actions.

The tables in this section define the event message attributes that are appropriate for test, inspection, and repair/rework functions. These events are necessary for tracking product and process quality as well as enabling identification and intelligent correlation of fault signatures to effective repair actions. The right-most column (labeled Occ) indicates the expected number of occurrences (cardinality) of each attribute or element. 0-1 indicates an optional field. 1-1 indicates a single mandatory field. 0-n indicates any number, including zero. 1-n indicates at least one.

4.1 Management Event - ProcessSessionStart

In recognition that there is a need for information to be shared between factory equipment and processes this event message has been defined to meet this need. There are typically many items processed during one session. Consider this message as an event separator that can be triggered by the equipment itself or by a change in its environment, including a new operator, a shift change, a change in the product or in the program/recipe.

Event: ProcessSessionStart

Description: The ProcessSessionStart record provides information regarding the product, process, location and environment.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
sessionId	string	Domain unique identifier of this process session	1-1
Product	Element	Identifies the type, lot, batch etc. of the product	1-1
Entity	Element	Identifies the location and enterprise	1-1
shift	string	Identify the work interval.	0-1
Recipe	Element	Identifies the process program, model, best practices or algorithms	0-n
Operator	Element	Equipment operator identifier	0-n
FixtureTooling	Element	Identifies the test fixture(s) if applicable	0-n

4.1.2 Element: Product

Description: The Product element uniquely describes the item and its groupings.

Attribute Name	Attribute Type	Description	Occ
itemType	string	Product type id	1-1
itemClass	string	Identify the product classification such as system, assembly, board,	0-1
boardRevision	string	Identify the board layout revision	0-1
assemblyRevision	string	Identify the assembly version (i.e. bill of materials)	0-1
workOrder	string	Identify the product work order	0-1
batch	string	Identify the product batch	0-1
lot	string	Identify the product lot	0-1
count	positiveInteger	The number of product in the lot or batch	0-1

4.1.3 Element: Operator

Description: The Operator element **shall** contain a unique identifier for the operator such as their employee number or social security number, and may also contain a personal identifier such as the person's name, nickname or logon name.

Attribute Name	Attribute Type	Description	Occ
employeeId	string	Employee number, login name or internal identifier	1-1
givenName	string	Employee's first name	0-1
familyName	string	Employee's last name	0-1

4.1.4 Element: Entity

Description: The Entity element uniquely describes the equipment or process station.

Attribute Name	Attribute Type	Description	Occ
stationId	string	Process station identifier unique to the domain	1-1
stage	string (enumerated)	Process step. One of: MVI | ALI | AOI | MXI | AXI | AXL | MDA | FPT | ICT | FNT | INT | SYS | OLT	1-1
stationRevision	string	Identify the station's hardware revision if applicable	0-1
subStage	string	Additional information regarding the stage, station or processing.	0-1
line	string	Identifier for this manufacturing line or cluster	0-1
building	string	Identify the building	0-1
site	string	Identify the site or location	0-1
enterprise	string	Identify the company	0-1

4.1.5 Element: Recipe

Description: The Recipe element uniquely identifies the recipe, program, algorithms or best practices being executed at the station or specified station zones and/or lanes. The attributes zoneList and laneList are defined using the XML string list syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups.

Attribute Name	Attribute Type	Description	Occ
recipeId	string	Identifies the name of the program	1-1
revision	string	Identifies the revision of the program	1-1
zoneList	string (list)	Identifies the zone(s) executing this recipe	0-1
laneList	string (list)	Identifies the lane(s) executing this recipe	0-1
RecipeModule	Element	Identifies the files or individual parts of a multiple part recipe	0-n

4.1.6 Element: RecipeModule

Description: The RecipeModule element uniquely identifies a single component of the recipe, program, algorithms or best practices being executed at the station and identifies its type.

Attribute Name	Attribute Type	Description	Occ
moduleId	string	Identifies the name of the recipe part	1-1
revision	string	Identifies the revision of the recipe part if applicable	0-1
type	string (enumerated)	Identifies the entry type as one of ALGORITHM | CONFIGURATION | DOCUMENTATION | EXECUTIVE | FIRMWARE | LIMITS | SEQUENCE | SETUP	0-1

4.1.7 Element: FixtureTooling

Description: The FixtureTooling element uniquely describes the test fixture and can be used to track its actuation count for probing accuracy and maintenance purposes.

Attribute Name	Attribute Type	Description	Occ
fixtureId	string	Identify the test fixture	1-1
revision	string	Identify the revision of the fixture	1-1
serialNumber	string	Identify the particular fixture instance	0-1
type	string	Identify the fixture type or function	0-1

```
<ProcessSessionStart
    dateTime="2000-08-05T10:04:31.20+0800"
    sessionId="NewCo3070-2-2000-08-05T10:04:31.20+0800"
    shift="FIRST">
    <Operator
        employeeId="0024335"
        givenName="Jane"
        familyName="Wilson"/>
    <Entity
        stationId="NewCo3070-2"
        stage="ICT"
        line="3"
        building="B6"
        site="Hillsboro"
        enterprise="CPUCo"/>
    <Recipe
        recipeId="11356-66540"
        revision="3"
        zoneList="3 4 5"
        laneList="1 2"/>
    <FixtureTooling
        fixtureId="11356-66540\2"
        revision="A"/>
    <Product
        itemType="11356-66540"
        boardRevision="B-20000512"
        assemblyRevision="4"
        workOrder="Cpq4592-002"
        batch="12"
        count="144"/>
</ProcessSessionStart>
```

4.2 .**Event: ProcessSessionEnd**

Description: The ProcessSessionEnd record is optional, and can be used as the companion to the ProcessSessionStart record and serve to close the process session.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
sessionId	string	Globally unique identifier of this process session	1-1

```
<ProcessSessionEnd
    dateTime="2000-08-05T10:04:31.20+0800"
    sessionId="NewCo3070-2-2000-08-05T10:04:31.20+0800"
/>
```

4.3 **Event: InspectionFrame**

Description: An image frame captured for analysis.

The InspectionFrame message describes an inspection frame, uniquely identifying it and providing its size and location in relationship to the board origin. The data payload may include the base-64 encoded image file (e.g., gif, tif, jpg, png) binary. There are typically many InspectionFrame events per item (board, panel or assembly).

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	References the session in which this event occurred	1-1
itemProcessRef	string	References the process that captured the frame	1-1
frameId	string	Unique identifier for this frame for later reference	1-1
Region	Region Element	Identify the frame region and orientation with respect to the board origin.	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
frameStatus	string (enumerated)	PASSED | FAILED Frame either contains zero failing regions-of-interest (PASSED) or contains one or more failing regions (FAILED).	0-1
layer	string	Identify board surface or layer of the frame if applicable. This can be the slice of an x-ray inspection or absent for multiple-frame x-ray image synthesis.	0-1
Base64Encoding	Base64 Element	Encoded frame element	0-1

4.3.1 Element: Region

Description: A rectangular or circular area definition. Point1X and point1Y attributes are always required. If the point2X and point2Y attributes are present then the region is analyzed as rectangular. If point2X and point2Y are not present then the diameter attribute **shall** be present and the region is analyzed as circular.

Attribute Name	Attribute Type	Description	Occ
units	String (enumerated)	Coordinate units (INCH | MM | PIXEL)	1-1
point1X	double	The region origin X value	1-1
point1Y	double	The region origin Y value	1-1
point2X	double	The opposite corner X value if rectangular	0-1
point2Y	double	The opposite corner Y value if rectangular	0-1
diameter	double	The diameter if a circular region	0-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1
Orientation	Element	Rotation of the region vs. the board.	0-1

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4.3.2   Element: Orientation

Description: The Orientation element describes the rotation (theta) of an InspectionFrame region with respect to its parent board or the rotation of a RegionOfInterest with respect to its InspectionFrame.

Attribute Name	Attribute Type	Description	Occ
value	double	Rotation value	1-1
units	string (enumerated)	Rotation units (DEGREES|RADIANS)	1-1

4.3.3 Element: Base64Encoding

Description: The Base64Encoding element identifies the MIME type of the binary and its encoding. If the binary is decoded at its destination and written to the file system it is given the name and the suffix associated with the type.

Attribute Name	Attribute Type	Description	Occ
name	string	File name	1-1
mimeType	string	Frame MIME type (suffix)	1-1
encoding	string	Base-64 encoded frame	1-1

```
<InspectionFrame
    dateTime="2000-08-05T10:04:31.20+0800"
    itemInstanceId="66540A00343"
     sessionRef=="NewCo3070-2-2000-08-05T10:04:31.20+0800"
    itemProcessRef="20111954-2000080510043120+08"
    imageId="3"
    frameId="382"
    frameStatus="FAILED"
    layer="2">
    <Region
       point1X="2000"
       point1Y="3000"
       point2X="2750"
       point2Y="3750"
       units="INCH"
       decade="-3">
       <Orientation value="90" units="DEGREES"/>
    </Region>
    <Base64Encoding
       name="382"
       mimeType="JPG"
       encoding="XXXXXXXXX- Base 64 Encoded Binary Image -XXXX"
    />
</InspectionFrame>
```

4.4 Event: ItemProcessStatus

Description: Processing of an item has completed, and the process task issues an overall status for the processed item.

This message reports the overall status of a complete test or inspection of a product item. This message is intended to satisfy those applications that analyze product quality using such measures as first pass yield. If the item arrived at the equipment but was passed through and not processed then a status of NOTEST is reported. If the equipment's test or inspection process was interrupted then a status of ABORTED is reported. If an equipment hardware or software error occurs that precludes a successful completion of the process then a status of ERROR is reported. If any of the individual test or inspection steps produced a failing status then the overall status **shall** be FAILED. Otherwise the overall status **shall** be PASSED. The exception to this is when a known-good item is being processed for the purpose of equipment calibration or program verification. To identify these process step executions and prevent the skewing of the statistical analysis of the process, the status should be set to KNOWNGOOD.

ItemEventCount element should be included within the ItemProcessStatus event and is generated for purposes of data integrity. Due to the nature of network transport of IPC-2547 event messages, this record is provided to assure that the client has received all of the messages that were sent regarding the processing of an item at a test or inspection stage. This message is for information purposes only. There is no recommendation of appropriate action to be taken when the number of event messages received does not match the count in the ItemEventCount.

Attribute Name	Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	A reference to the unique process session identifier	1-1
itemProcessId	string	An identifier for a single process execution that is unique within the physical and temporal domains of the session.	1-1
status	String (enumerated)	NOTEST | PASSED | FAILED | ABORTED | ERROR | KNOWNGOOD	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
itemParentId	string	Identify parent of instance if panelized	0-1
ItemEventCount	Element	Provides a count of published events associated with the processing of this item.	0-n
comment	string	Any additional information at the whole process level.	0-1

4.4.1 Element: ItemEventCount

Description: The count of IPC-2547 events associated with this item and process.

Attribute Name	Attribute Type	Description	Occ
eventType	string (enumerated)	INSPECTIONFRAME | PROCESSSTEPSTATUS	1-1
count	nonNegativeInteger	The number of event records sent	1-1

```
<ItemProcessStatus
     dateTime="2000-08-05T10:04:31.20+0800"
     itemInstanceId="66540A00343"
     sessionRef="NewCo3070-2-2000-08-05T10:04:31.20+0800"
     itemProcessId="20111954-2000080510043120+08"
     status="PASSED"
     imageId="4">
  <ItemEventCount eventType="INSPECTIONFRAME" count="347"/>
  <ItemEventCount eventType="PROCESSSTEPSTATUS" count="6492"/>
</ItemProcessStatus>
```

4.5 Event: ProcessStepStatus

Description: An inspection or measurement step has been executed and a resulting status for the individual step has been determined.

Execution of a Measurement or Inspection process step triggers the issuing of a ProcessStepStatus event. This step status event **shall** be unambiguously identified within the test or inspection program execution (e.g. processStepId or processStepId + sequence) and **shall** provide a reference to the overall process event and to the session event.

If the process step is incomplete due to temporal or equipment limit conditions then the ProcessStepStatus **shall** be NOTEST. If an equipment error (e.g. fiducial, barcode) occurs that precludes a successful completion of the step then a status of ERROR **shall** be reported. Otherwise the ProcessStepStatus **shall** be PASSED or FAILED. If the status is FAILED then one or more Indictment or Symptom elements may be included in the event. Each ProcessStepStatus event may reference one or more RegionOfInterest or Measurement events that contributed to the status, and may also contain one or more Symptom and/or Indictment elements as well as associated Component or Signal elements.

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Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
sessionRef	string	References the session for this event	1-1
itemProcessRef	string	References the overall process issuing the status	1-1
processStepId	string	Identify the process step leading to the status.	1-1
status	string (enumerated)	PASSED | FAILED | NOTEST | ERROR	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
sequence	positiveInteger	Execution/presentation order or disambiguation	0-1
comment	string	Additional free-format information	0-1
Error	Element	Additional information supporting a status of ERROR	0-n
Symptom	Element	Identify an observed anomaly if applicable	0-n
Indictment	Element	Identify the defect type if applicable	0-n
RegionOfInterest	Element	Inspection region(s) associated with this step	0-n
Measurement	Element	Measurement(s) associated with this step	0-n
Component	Element	Associated component(s)	0-n
Signal	Element	Associated signal network(s)	0-n

4.5.1 Element: Error

Description: This element is sent by a piece of equipment when it cannot process an item to produce a meaningful PASS/FAIL status. This event differs from the IPC-2541 EquipmentError in that it does not halt the equipment and does not require operator or host intervention.

Attribute Name	Attribute Type	Description	Occ
errorId	string	Error identifier	1-1
description	string	The error symptom or other diagnostic information.	0-1
recipeRef	string	Reference the recipe being executed	0-1
moduleRef	string	Reference the recipe module if applicable	0-1
recipeStep	string	Identify the recipe step or command	0-1
lane	string	Identify the lane	0-1
zone	string	Identify the zone	0-1

4.5.2 Element: Symptom

Description: This element provides detailed information on a measured or observed fault. The symptomKey attribute should be specific. (See Appendix-B for a suggested list of symptom keys.) The confidence attribute value expresses a low (0) confidence to high (100) confidence in the observation or measurement to identify a defect. The category attribute can provide a keyword to be used for such functions as diagnostics, routing, closed loop quality.

Attribute Name	Attribute Type	Description	Occ
symptomId	string	Identifier for this symptom record with which to associate one or more repair actions.	1-1
symptomKey	string	Identifies product or process faults (See Appendix B)	1-1
category	string	Additional key, if known (See Appendix E)	0-1
description	string	Additional free format information (comment)	0-1
confidence	nonNegativeInteger (100-0)	Relative confidence in the symptomKey accuracy	0-1
MeasurementRef	Element	Reference to the Measurement Id(s) associated with this event	0-n
RegionRef	Element	Reference to the RegionOfInterest Id(s) associated with this event	0-n

4.5.3   Element: Indictment

Description: This element provides specific information supporting a failing ProcessStepStatus. The indictmentKey attribute should be specific. (See Appendix-C for a suggested list of indictment keys.) The priority attribute is expressed in a value from high (1) priority to an open-ended low priority (n) of the indictment. The confidence attribute value expresses a low (0) confidence to high (100) confidence in the indictment. The category attribute can provide a keyword to be used for such functions as diagnostics, routing, closed loop quality.

Attribute Name	Attribute Type	Description	Occ
indictmentId	string	Identifier for this indictment record with which to associate one or more repair actions.	1-1
indictmentKey	string	Identifies product or process faults (See Appendix C)	1-1
category	string	Additional key, if known. (See Appendix E)	0-1
description	string	Additional free format information (comment)	0-1
priority	positiveInteger	Presentation of an unbounded priority of the indictment where 1 = highest priority.	0-1
confidence	nonNegativeInteger (100-0)	Relative confidence in the indictmentKey accuracy	0-1
MeasurementRef	Element	Reference to the Measurement Id(s) that lead to this indictment	0-n
RegionRef	Element	Reference to the RegionOfInterest Id(s) that lead to this indictment.	0-n

4.5.4 Element: RegionOfInterest

Description: A sub-region of an item or an inspection frame.

Manual inspection can be of an item component, region or point. With automated inspection technologies the imaging device (e.g. camera) captures a frame. One or more regions of interest (ROI) of the frame(s), scan(s) or field(s)-of-view is analyzed. The RegionOfInterest element is uniquely identified and describes one inspection region and the analysis that combines to justify the ProcessStepStatus.   The X and Y points describing the inspected region or location are themselves elements containing a value in one of three units: millimeter (MM), inch (INCH) or pixel (PIXEL). If an InspectionFrame is referenced then the location of the RegionOfInterest **shall** be with relation to the InspectionFrame origin.

Attribute Name	Attribute Type	Description	Occ
regionId	string	Unique identifier for the inspection region	1-1
frameRef	string	Reference to the unique frame element	0-1
layer	string	Identify board surface or layer of the region.	0-1
status	string (enumerated)	Option to report (PASSED | FAILED) status of the inspection of the point, region or component.	0-1
Region	Region Element	Identify the region of interest (ROI) dimensions and orientation.	0-1
Point	Point Element	Identify an exact (X,Y) point of interest	0-1
Component	Component Element	Identify associated component or feature inspected	0-1

4.5.5 Element: Point

Description: Provides an XY ordered pair with units and decade (order of magnitude).

Attribute Name	Attribute Type	Description	Occ
pointX	double	X Parameter value	1-1
pointY	double	Y Parameter value	1-1
units	string (enumerated)	Parameter units (MM | INCH)	1-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1

4.5.6 Element: Measurement

Description: When the test or inspection of an item results in measured values, those measurements are described using the Measurement event. This is true whether the measurement is a numeric value, a string value, or a bit sequence or an array of any of these. Measured values **shall** be one of MeasuredNumeric or MeasuredOctet so that the values can be reported and correctly parsed. Similarly, expected values **shall** be one of ExpectedNumeric or ExpectedOctet.

Attribute Name	Attribute Type	Description	Occ
measurementId	string	Identify the measurement by a name unique within this item process. (test program)	1-1
mode	string	Additional information about the measurement result	0-1
type	string	Identify the type of measurement	0-1
sequence	positiveInteger	Identify the sequence number if applicable	0-1
status	string (enumerated)	Option to report (PASSED | FAILED) status.	0-1
MeasuredNumeric	Element	A numeric value measured	0-n
MeasuredOctet	Element	A string, byte or bit sequence value measured	0-n
ExpectedNumeric	Element	A numeric value and range expected.	0-n
ExpectedOctet	Element	A string, byte or bit sequence value expected	0-n
Component	Element	Identify associated component(s)	0-n
Signal	Element	Identify associated signal network(s)	0-n

4.5.7 Element: MeasuredNumeric

Description: Provides a numeric value.

Attribute Name	Attribute Type	Description	Occ
value	double	Parameter value	1-1
units	string	Units of measure	0-1
decade	double	Unit multiplier in powers of 10 (default is 0).	0-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1

4.5.8 Element: MeasuredOctet

Description: A measured string, byte or bit sequence value.

Attribute Name	Attribute Type	Description	Occ
value	string	Measured sequence	1-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1

4.5.9 Element: ExpectedNumeric

Description: An expected numeric value, units and decade with minimum and maximum values that define the measurement tolerance *window*. Minimum and maximum limits **shall** be in the same units and decade as the nominal. When nominal, minimum and/or maximum attributes are present the minimum **shall** be the least, maximum **shall** be the greatest and the nominal **shall** fall between these values.

Comparator Semantics

- EQ **shall** mean equal to the nominal value. The nominal is a required attribute.

- NE **shall** mean not equal to the nominal value. The nominal is a required attribute.

- GT **shall** mean greater than the minimum. The minimum is a required attribute.

- LT **shall** mean less than the maximum. The maximum is a required attribute.

- GE **shall** mean greater than or equal to the minimum. The minimum is a required attribute.

- LE **shall** mean less than or equal to the maximum. The maximum is a required attribute.

- GTLT **shall** mean greater than the minimum and less than the maximum. Both limits are required attributes.

- GELE **shall** mean greater than or equal to the minimum and less than or equal to the maximum. Both limits are required attributes.

- GTLE **shall** mean greater than the minimum and less than or equal to the maximum. Both limits are required attributes.

- GELT **shall** mean greater than or equal to the minimum and less than the maximum. Both limits are required attributes.

- LTGT **shall** mean less than the minimum or greater than the maximum. Both limits are required attributes.

- LEGE **shall** mean less than or equal to the minimum or greater than or equal to the maximum. Both limits are required attributes.

- LTGE **shall** mean less than the minimum or greater than or equal to the upper limit. Both limits are required attributes.

- LEGT **shall** mean less than or equal to the lower limit or greater than the upper limit. Both limits are required attributes.

- If no comparator is expressed the following **shall** apply:

- If both limits are present then the default **shall** be GELE. (the nominal is optional).

- If only the upper limit is present then the default **shall** be LE.

- If only the lower limit is present then the default **shall** be GE.

- If only the nominal is present then the default **shall** be EQ.

Attribute Name	Attribute Type	Description	Occ
nominal	double	Expected value in the described units and decade	0-1
units	string	Units of measure	0-1
decade	double	Unit multiplier in powers of 10.(default is 0) (Not applicable to non-numeric measures)	0-1
minimum	double	Actual lower limit bound in the described units and decade	0-1
maximum	double	Actual upper limit bound in the described units and decade	0-1
comparator	string (enumerated)	EQ | NE | GT | LT | GE | LE | GTLT | GELE | GTLE | GELT | LTGT | LEGE | LTGE | LEGT	0-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1

4.5.10 Element: ExpectedOctet

Description: An expected string, byte or bit sequence value. The position attribute is defined using the XML string list syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups.

Attribute Name	Attribute Type	Description	Occ
value	string	Expected sequence	1-1
position	string (list)	Describe the positional location if the expression is for a multidimensional array of values	0-1
caseSensitive	boolean	TRUE | FALSE (only applies to character string values)	0-1

4.5.11 Element: Signal

Description: A measurement or process step has been associated with one or more signal networks. Each signal element is reported within the scope of the event. These elements **shall** uniquely identify the signal net in question by providing the signal name, and when the product is panelized also providing the identifier for the circuit image instance. Signals are most often reported in pairs; for example, electrical shorts.

Attribute Name	Attribute Type	Description	Occ
signalId	string	Identify the signal instance	1-1
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1

4.5.12 Element: Component

Description: A measurement, inspection region or status has an associated component.

Each component is reported within the scope of the event. These elements **shall** describe the component and uniquely identify the component in question by providing the component designator. When the product is panelized the element also provides the identifier for the board image instance. Note that the termination identification is a string that must be parsed to determine the number and range of terminations. A dash (-) character denotes an inclusive sequence while a comma (,) is used to separate sequences or individual terminations.

Attribute Name	Attribute Type	Description	Occ
designator	string	Identify the component instance	1-1
imageId	string	Identify the board image if panelized	0-1
subassembly	string	Identify the subassembly or module	0-1
type	string	See Appendix F for suggested component types	0-1
layer	string (enumerated)	TOP | BOTTOM | INTERNAL	0-1
subcomponent	string	Identify package element	0-1
termination	string format (1..n, 1-m)*	Identify the lead, pin, ball number(s) e.g. "1, 4-6" identifies 1, 4, 5, 6	0-1
partId	string	Identify the device part number from the BOM	0-1
package	string	See Appendix-G for suggested package types	0-1
jointType	string	See Appendix-H for suggested lead joint types	0-1
jointSubtype	string	User defined algorithm identifier	0-1

```
<ProcessStepStatus
    dateTime="2000-08-05T10:04:31.20+0800"
    itemInstanceId="66540A00343"
    sessionRef=="NewCo3070-2-2000-08-05T10:04:31.20+0800"
    itemProcessRef="20111954-2000080510043120+08"
    processStepId="analog_q1"
    status="FAILED">
    <Indictment
      indictmentId="analog_q1-1"
      indictmentKey="COMPONENT VALUE OUT OF TOLERANCE"
      priority="2"
      categoy="MATERIALS"
      confidence = "87"/>
      <MeasurementRef>
        11356-66540-analog/q1/base-collector
      </MeasurementRef>
    </Indictment>
    <RegionOfInterest
      regionId="A2-382-01-Left"
      layer="PRIMARY" frameRef="382">
      <Region
        point1X="0"
        point1Y="2"
```

```
       point2X="1"
       point2Y="4"
       units="MM">
        <Orientation value="90" units="DEGREES"/>
     </Region>
     <Component
         designator="q1"
         type="PNP"
         layer="PRIMARY"
         partId="54-35-6664"
         package="SOT"/>
     <MeasurementRef>
        11356-66540/q1-SolderVolume
     </MeasurementRef>
   </RegionOfInterest>
   <Measurement
       measurementId="11356-66540-analog/q1/base-collector"
       mode="UNPOWERED"
       type="ANALOG"
         <MeasuredNumeric
            value="0.7"
            units="VOLT"
            decade="0"/>
         <ExpectedNumeric
            nominal="0.7"
            units="VOLT"
            decade="0"
            minimum="0.4"
            maximum="1.5"/>
         <Component designator="q1" type="PNP" layer="PRIMARY"
           partId="54-35-6664" package="SOT"/>
   </Measurement>
   <Measurement
       measurementId="11356-66540-analog/q1/emitter-base"
       mode="UNPOWERED"
       type="ANALOG">
       <MeasuredNumeric
          value="3.0"
          units="VOLT"
          decade="0"/>
       <ExpectedNumeric
          nominal="0.7"
          units="VOLT"
          decade="0"
          minimum="0.4"
          maximum="1.5"/>
       <Component designator="q1" type="PNP" layer="PRIMARY"
          partId="54-35-6664" package="SOT"/>
   </Measurement>
   <Measurement
       measurementId="11356-66540/q1-SolderVolume"
       <MeasuredNumeric
          value="30"/>
   </Measurement>
   <Component designator="q1"/>

</ProcessStepStatus>
```

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4.6 Event: ItemRepair

Description: An item has been repaired, reworked or scrapped.

The ItemRepair event is generated at the repair/rework/debug station based on the action taken by the operator or technician. Each ItemRepair references one or more indictment or symptom events. Multiple RepairAction elements may be included in a single ItemRepair event. Within each repair action is a repairKey that may be user defined. (See Appendix D for a suggested list of repair keys.) Since the operator or technician can often provide more specific information regarding the actual defect, an optional DefectDetail element is available to capture this information for more accurate reporting.

Attribute Name	Attribute Type	Description	Occ
dateTime	dateTime	Date and time of the event	1-1
itemInstanceId	string	Item instance identifier	1-1
itemProcessRef	string	References the process that issued the defect call	1-1
repairId	string	Identifier for this repair event	1-1
RepairAction	Element	Identifies repair action taken	1-n
imageId	string	Identify the board image if panelized or a single item of a multiple item test grouping.	0-1
stationId	string	Identify the repair station	0-1
SymptomRef	Element	Reference the test/inspection symptom(s) addressed	0-n
IndictmentRef	Element	Reference the test/inspection indictment(s) addressed	0-n
DefectDetail	Element	Detailed or additional defect data	0-n
Operator	Operator Element	Identifies the repair technician	0-1

4.6.1 Element: DefectDetail

Description: More specific information regarding the indictment(s) or symptom(s) has been observed, measured or otherwise obtained.

Attribute Name	Attribute Type	Description	Occ
detailKey	string	Specific, additional or corrective defect detail (See recommended indictments in Appendix C)	1-1
category	string	Additional or overriding causal Information	0-1
comment	String	Additional free format information	0-1

4.6.2 Element: RepairAction

Description: A specific repair action has been taken. This action may involve one or more components, subcomponents or signals.

Attribute Name	Attribute Type	Description	Occ
repairKey	string	Identifies repair action taken (See Appendix D)	1-1
comment	string	Additional Information	0-1
Component	Component Element	Associated Component(s)	0-n
Signal	Signal Element	Associated Signal(s)	0-n
Location	Point Element	The repair (x,y) location	0-1

```
<ItemRepair
     dateTime="2000-08-05T10:04:31.20+0800"
     itemInstanceId="66540A00343"
     imageId="3"
     itemProcessRef="20111954-2000080510043120+08"
     repairId="20111966-20000805110944"
     <RepairAction
        repairKey="COMPONENT REPLACED"
        <Component
              designator="q1"
              type="PNP"
              layer="PRIMARY"
              partId="54-35-6664"
              package="SOT"
        />
     </RepairAction>
     <IndictmentRef>analog_q1</IndictmentRef>
     stationId="NewCo-Bldg2-SolderPot-2">
     <DefectDetail
        detailKey="COMPONENT ROTATED"
        category="PLACEMENT"/>
     <Operator
        employeeId="0024335"
        givenName="Jane"
        familyName="Wilson"/>
</ItemRepair>
```

5   Event Extensions

All IPC-2547 events can be extended. An element called Extensions may be included in each event. See the IPC-2547 XML Schema section for a complete listing of the XML schema used in the IPC-2547 standard.

6 Event Sequences

Due to the nature of test and inspection, judgements regarding the status of processes and process steps are dependent on the analysis done by the algorithms being executed on the equipment. Recognizing this, liberties are given in the order in which events are reported vs. when they actually happened. The following are examples of measurement and analysis reporting sequences utilizing IPC-2541 and IPC-2547. Others are also valid.

6.1 Test Sequences

```
ItemLabelRead                           ItemLabelRead
ItemTransferIn                            ItemTransferIn
   ItemTransferZone                          ItemTransferZone
     ItemWorkStart                             ItemWorkStart
         Measurement                             ItemProcessStatus
         Measurement                               ProcessStepStatus
          ProcessStepStatus                        Measurement
                                                   Measurement

         Measurement
          ProcessStepStatus                        ProcessStepStatus
           …                                       Measurement
         ItemProcessStatus                         …
     ItemWorkComplete                          ItemWorkComplete
   ItemTransferZone                          ItemTransferZone
ItemTransferOut                           ItemTransferOut
```

6.2 Inspection Sequences

```
ItemLabelRead                           ItemLabelRead
 ItemTransferIn                           ItemTransferIn
   ItemTransferZone                          ItemTransferZone
    ItemWorkStart                             ItemWorkStart
        RegionOfInterest                        ItemProcessStatus
        Measurement                               ProcessStepStatus
        Measurement                               InspectionFrame
        InspectionFrame                            RegionOfInterest
        ProcessStepStatus                          Measurement
                                                   Measurement
         …
        RegionOfInterest                          …
        Measurement                             ProcessStepStatus
        InspectionFrame                          InspectionFrame
        ProcessStepStatus                         RegionOfInterest
                                                  InspectionFrame
         …                                       …
       ItemProcessStatus
    ItemWorkComplete                          ItemWorkComplete
   ItemTransferZone                          ItemTransferZone
ItemTransferOut                           ItemTransferOut
```

7   IPC-2547 XML Schema Definition

7.1 ProcessSessionStart

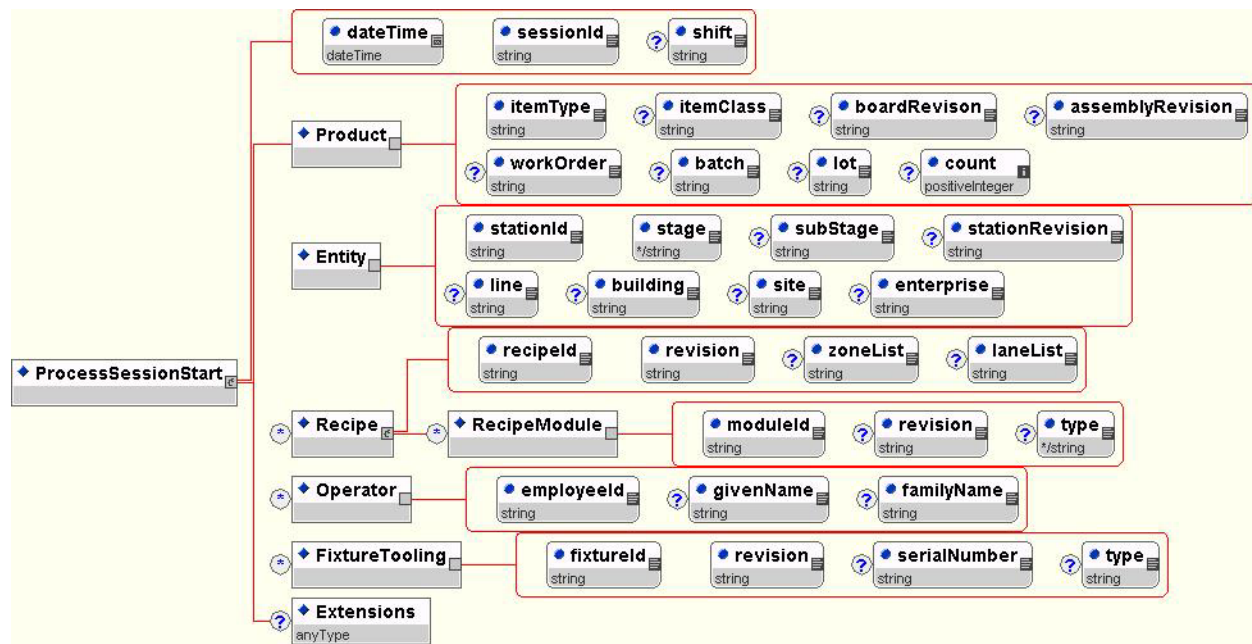| |
|---|
| **URL:** http://webstds.ipc.org/2547/ProcessSessionStart.xsd |
| **Extends:** http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements) |

7.1.1 Graphical Representation

7.1.2 Schema

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessSessionStart">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Product"/>
                <xsd:element ref = "Operator" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Entity"/>
                <xsd:element ref = "Recipe" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "FixtureTooling" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "sessionId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "shift" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Product">
        <xsd:complexType>
            <xsd:attribute name = "itemType" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemClass" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "boardRevison" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "assemblyRevision" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "workOrder" use = "optional" type = "xsd:string"/>
```

```
            <xsd:attribute name = "batch" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "lot" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "count" use = "optional" type = "xsd:positiveInteger"/>
        </xsd:complexType>
</xsd:element>
<xsd:element name = "Entity">
    <xsd:complexType>
        <xsd:attribute name = "stationId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "stage" use = "required">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "MVI"/>
                    <xsd:enumeration value = "ALI"/>
                    <xsd:enumeration value = "AOI"/>
                    <xsd:enumeration value = "MXI"/>
                    <xsd:enumeration value = "AXI"/>
                    <xsd:enumeration value = "AXL"/>
                    <xsd:enumeration value = "MDA"/>
                    <xsd:enumeration value = "FPT"/>
                    <xsd:enumeration value = "ICT"/>
                    <xsd:enumeration value = "FNT"/>
                    <xsd:enumeration value = "INT"/>
                    <xsd:enumeration value = "SYS"/>
                    <xsd:enumeration value = "OLT"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
        <xsd:attribute name = "subStage" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "stationRevision" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "line" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "building" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "site" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "enterprise" use = "optional" type = "xsd:string"/>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "Recipe">
    <xsd:complexType>
        <xsd:sequence>
            <xsd:element ref = "RecipeModule" minOccurs = "0" maxOccurs = "unbounded"/>
        </xsd:sequence>
        <xsd:attribute name = "recipeId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "revision" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "zoneList" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "laneList" use = "optional" type = "xsd:string"/>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "RecipeModule">
    <xsd:complexType>
        <xsd:attribute name = "moduleId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "revision" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "type" use = "optional">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "ALGORITHM"/>
                    <xsd:enumeration value = "CONFIGURATION"/>
                    <xsd:enumeration value = "DOCUMENTATION"/>
                    <xsd:enumeration value = "EXECUTIVE"/>
                    <xsd:enumeration value = "FIRMWARE"/>
                    <xsd:enumeration value = "LIMITS"/>
                    <xsd:enumeration value = "SEQUENCE"/>
                    <xsd:enumeration value = "SETUP"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "Operator">
    <xsd:complexType>
        <xsd:attribute name = "employeeId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "givenName" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "familyName" use = "optional" type = "xsd:string"/>
```

```
            </xsd:complexType>
      </xsd:element>
    <xsd:element name = "FixtureTooling">
        <xsd:complexType>
            <xsd:attribute name = "fixtureId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "revision" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "serialNumber" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "type" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```
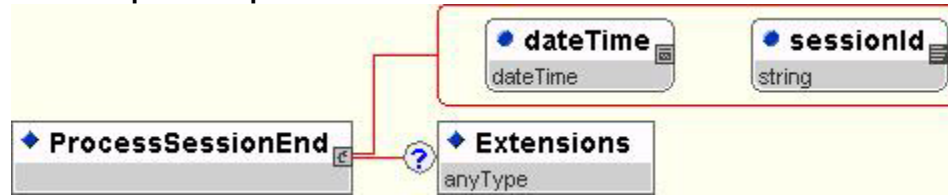
7.2 ProcessSessionEnd

URL: http://webstds.ipc.org/2547/ProcessSessionEnd.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

7.2.1 Graphical Representation

7.2.2 Schema

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessSessionEnd">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "sessionId" use = "required" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.3 ItemProcessStatus

URL: http://webstds.ipc.org/2547/ItemProcessStatus.xsd
Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

7.3.1 Graphical Representation

7.3.2 Schema

```
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ItemProcessStatus">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "ItemEventCount" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "sessionRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "status" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "NOTEST"/>
                        <xsd:enumeration value = "PASSED"/>
                        <xsd:enumeration value = "FAILED"/>
                        <xsd:enumeration value = "ABORTED"/>
                        <xsd:enumeration value = "ERROR"/>
                        <xsd:enumeration value = "KNOWNGOOD"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "itemParentId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "comment" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ItemEventCount">
        <xsd:complexType>
            <xsd:attribute name = "eventType" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "PROCESSSTEPSTATUS"/>
                        <xsd:enumeration value = "INSPECTIONFRAME"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "count" use = "required" type = "xsd:nonNegativeInteger"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```
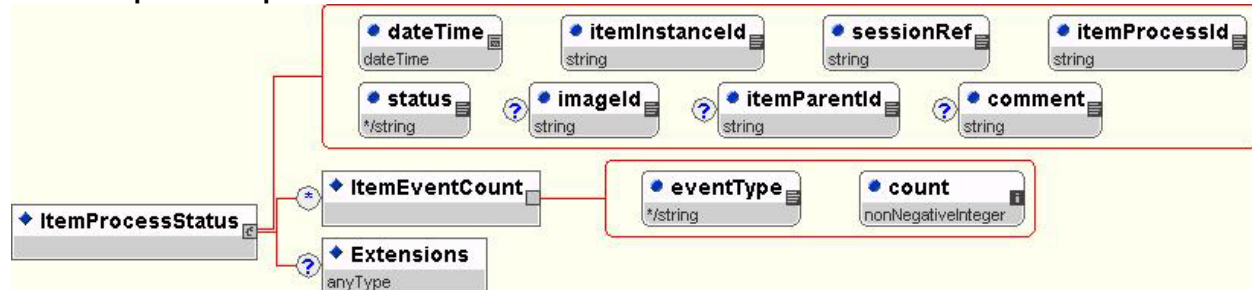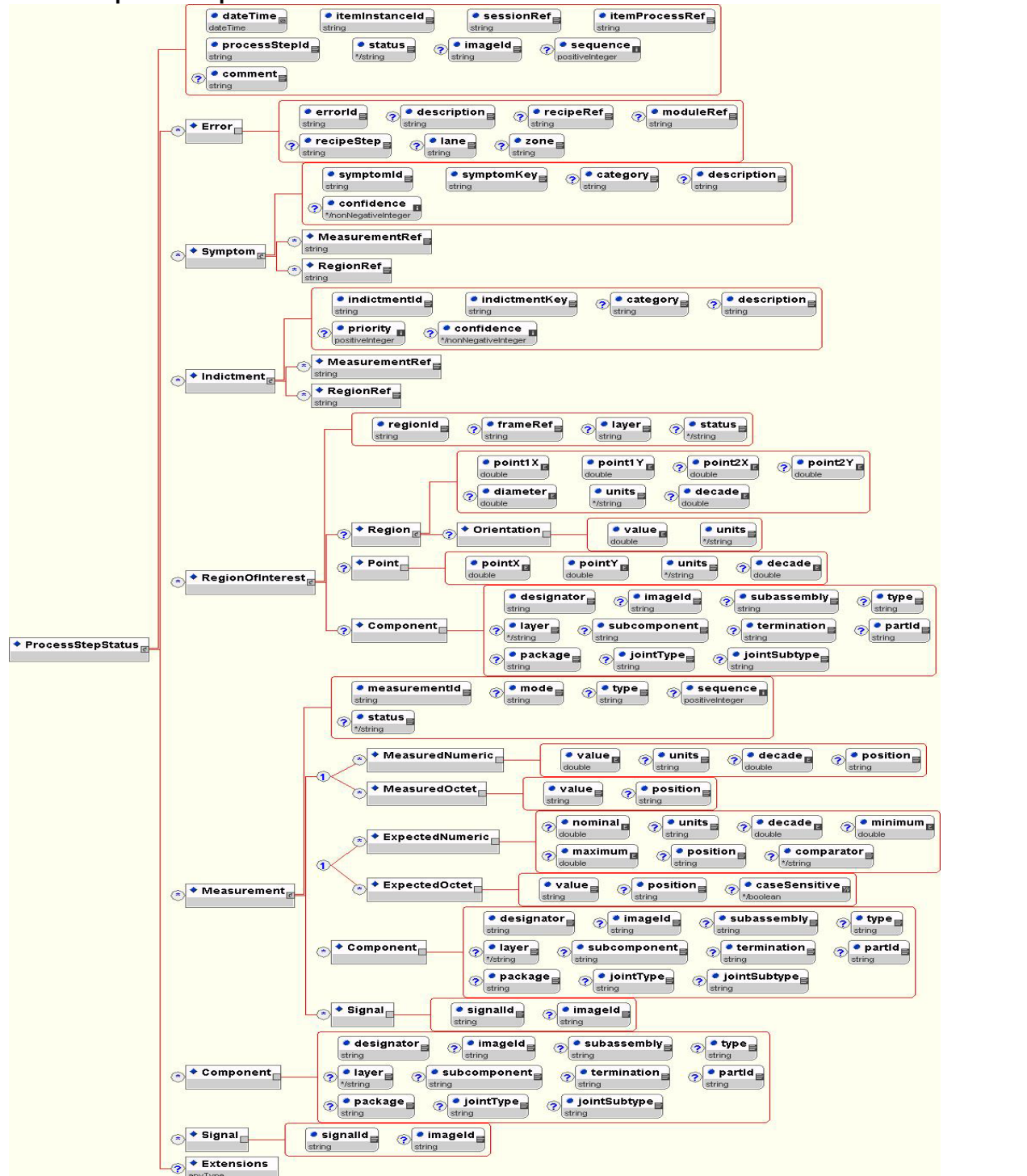
7.4 ProcessStepStatus

URL: http://webstds.ipc.org/2547/ProcessStepStatus.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

7.4.1 Graphical Representation

7.4.2 Schema

```xml
<?xml version = "1.0" encoding = "UTF-8"?>
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
    <xsd:element name = "ProcessStepStatus">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Error" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Symptom" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Indictment" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "RegionOfInterest" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Measurement" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "sessionRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "processStepId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "status" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "ERROR"/>
                        <xsd:enumeration value = "FAILED"/>
                        <xsd:enumeration value = "NOTEST"/>
                        <xsd:enumeration value = "PASSED"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "sequence" use = "optional" type = "xsd:positiveInteger"/>
            <xsd:attribute name = "comment" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Error">
        <xsd:complexType>
            <xsd:attribute name = "errorId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "recipeRef" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "moduleRef" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "recipeStep" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "lane" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "zone" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Symptom">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "MeasurementRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "RegionRef" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:sequence>
            <xsd:attribute name = "symptomId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "symptomKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "confidence" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:nonNegativeInteger">
                        <xsd:maxInclusive value = "100"/>
                        <xsd:minInclusive value = "0"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Indictment">
```

```
    <xsd:complexType>
        <xsd:sequence>
            <xsd:element ref = "MeasurementRef" minOccurs = "0" maxOccurs = "unbounded"/>
            <xsd:element ref = "RegionRef" minOccurs = "0" maxOccurs = "unbounded"/>
        </xsd:sequence>
        <xsd:attribute name = "indictmentId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "indictmentKey" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "category" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "description" use = "optional" type = "xsd:string"/>
        <xsd:attribute name = "priority" use = "optional" type = "xsd:positiveInteger"/>
        <xsd:attribute name = "confidence" use = "optional">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:nonNegativeInteger">
                    <xsd:maxInclusive value = "100"/>
                    <xsd:minInclusive value = "0"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "RegionOfInterest">
    <xsd:complexType>
        <xsd:sequence>
            <xsd:element ref = "Region" minOccurs = "0"/>
            <xsd:element ref = "Point" minOccurs = "0"/>
            <xsd:element ref = "Component" minOccurs = "0"/>
        </xsd:sequence>
        <xsd:attribute name = "regionId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "frameRef" type = "xsd:string"/>
        <xsd:attribute name = "layer" type = "xsd:string"/>
        <xsd:attribute name = "status">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "PASSED"/>
                    <xsd:enumeration value = "FAILED"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "Measurement">
    <xsd:complexType>
        <xsd:sequence>
            <xsd:choice>
                <xsd:element ref = "MeasuredNumeric" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "MeasuredOctet" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:choice>
            <xsd:choice>
                <xsd:element ref = "ExpectedNumeric" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "ExpectedOctet" minOccurs = "0" maxOccurs = "unbounded"/>
            </xsd:choice>
            <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
            <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
        </xsd:sequence>
        <xsd:attribute name = "measurementId" use = "required" type = "xsd:string"/>
        <xsd:attribute name = "mode" type = "xsd:string"/>
        <xsd:attribute name = "type" type = "xsd:string"/>
        <xsd:attribute name = "sequence" type = "xsd:positiveInteger"/>
        <xsd:attribute name = "status">
            <xsd:simpleType>
                <xsd:restriction base = "xsd:string">
                    <xsd:enumeration value = "PASSED"/>
                    <xsd:enumeration value = "FAILED"/>
                </xsd:restriction>
            </xsd:simpleType>
        </xsd:attribute>
    </xsd:complexType>
</xsd:element>
<xsd:element name = "MeasuredNumeric">
    <xsd:complexType>
        <xsd:attribute name = "value" use = "required" type = "xsd:double"/>
```

```
                <xsd:attribute name = "units" type = "xsd:string"/>
                <xsd:attribute name = "decade" use = "optional" type = "xsd:double"/>
                <xsd:attribute name = "position" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "MeasuredOctet">
        <xsd:complexType>
                <xsd:attribute name = "value" use = "required" type = "xsd:string"/>
                <xsd:attribute name = "position" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ExpectedNumeric">
        <xsd:complexType>
                <xsd:attribute name = "nominal" type = "xsd:double"/>
                <xsd:attribute name = "units" type = "xsd:string"/>
                <xsd:attribute name = "decade" type = "xsd:double"/>
                <xsd:attribute name = "minimum" type = "xsd:double"/>
                <xsd:attribute name = "maximum" type = "xsd:double"/>
                <xsd:attribute name = "position" type = "xsd:string"/>
                <xsd:attribute name = "comparator">
                    <xsd:simpleType>
                        <xsd:restriction base = "xsd:string">
                            <xsd:enumeration value = "EQ"/>
                            <xsd:enumeration value = "NE"/>
                            <xsd:enumeration value = "GT"/>
                            <xsd:enumeration value = "LT"/>
                            <xsd:enumeration value = "GE"/>
                            <xsd:enumeration value = "LE"/>
                            <xsd:enumeration value = "GTLT"/>
                            <xsd:enumeration value = "GELE"/>
                            <xsd:enumeration value = "GTLE"/>
                            <xsd:enumeration value = "GELT"/>
                            <xsd:enumeration value = "LTGT"/>
                            <xsd:enumeration value = "LEGE"/>
                            <xsd:enumeration value = "LTGE"/>
                            <xsd:enumeration value = "LEGT"/>
                        </xsd:restriction>
                    </xsd:simpleType>
                </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "ExpectedOctet">
        <xsd:complexType>
                <xsd:attribute name = "value" use = "required" type = "xsd:string"/>
                <xsd:attribute name = "position" type = "xsd:string"/>
                <xsd:attribute name = "caseSensitive">
                    <xsd:simpleType>
                        <xsd:restriction base = "xsd:boolean">
                            <xsd:enumeration value = "TRUE"/>
                            <xsd:enumeration value = "FALSE"/>
                        </xsd:restriction>
                    </xsd:simpleType>
                </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Region">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Orientation" minOccurs = "0"/>
            </xsd:sequence>
                <xsd:attribute name = "point1X" use = "required" type = "xsd:double"/>
                <xsd:attribute name = "point1Y" use = "required" type = "xsd:double"/>
                <xsd:attribute name = "point2X" type = "xsd:double"/>
                <xsd:attribute name = "point2Y" type = "xsd:double"/>
                <xsd:attribute name = "diameter" type = "xsd:double"/>
                <xsd:attribute name = "units" use = "required">
                    <xsd:simpleType>
                        <xsd:restriction base = "xsd:string">
                            <xsd:enumeration value = "MM"/>
                            <xsd:enumeration value = "INCH"/>
                            <xsd:enumeration value = "PIXEL"/>
```

```
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Orientation">
        <xsd:complexType>
            <xsd:attribute name = "value" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "DEGREES"/>
                        <xsd:enumeration value = "RADIANS"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Point">
        <xsd:complexType>
            <xsd:attribute name = "pointX" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "pointY" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MM"/>
                        <xsd:enumeration value = "INCH"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Component">
        <xsd:complexType>
            <xsd:attribute name = "designator" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "subassembly" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "type" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "layer" use = "optional">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "TOP"/>
                        <xsd:enumeration value = "BOTTOM"/>
                        <xsd:enumeration value = "INTERNAL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "subcomponent" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "termination" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "partId" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "package" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "jointType" use = "optional" type = "xsd:string"/>
            <xsd:attribute name = "jointSubtype" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Signal">
        <xsd:complexType>
            <xsd:attribute name = "signalId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" use = "optional" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "RegionRef" type = "xsd:string"/>
    <xsd:element name = "MeasurementRef" type = "xsd:string"/>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

7.5 ItemRepair

URL: http://webstds.ipc.org/2547/ItemRepair.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd (Publish and Send Elements)

7.5.1 Graphical Representation

7.5.2 Schema

```
<?xml version = "1.0" encoding = "UTF-8"?>
<xsd:schema xmlns:xsd = "http://www.w3.org/2001/XMLSchema">
<!--Conforms to w3c http://www.w3.org/2001/XMLSchema-->
    <xsd:element name = "ItemRepair">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "RepairAction" maxOccurs = "unbounded"/>
                <xsd:element ref = "SymptomRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "IndictmentRef" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "DefectDetail" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Operator" minOccurs = "0"/>
                <xsd:element ref = "Extensions" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "dateTime" use = "required" type = "xsd:dateTime"/>
            <xsd:attribute name = "itemInstanceId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "itemProcessRef" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "repairId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
            <xsd:attribute name = "stationId" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "RepairAction">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref = "Signal" minOccurs = "0" maxOccurs = "unbounded"/>
```
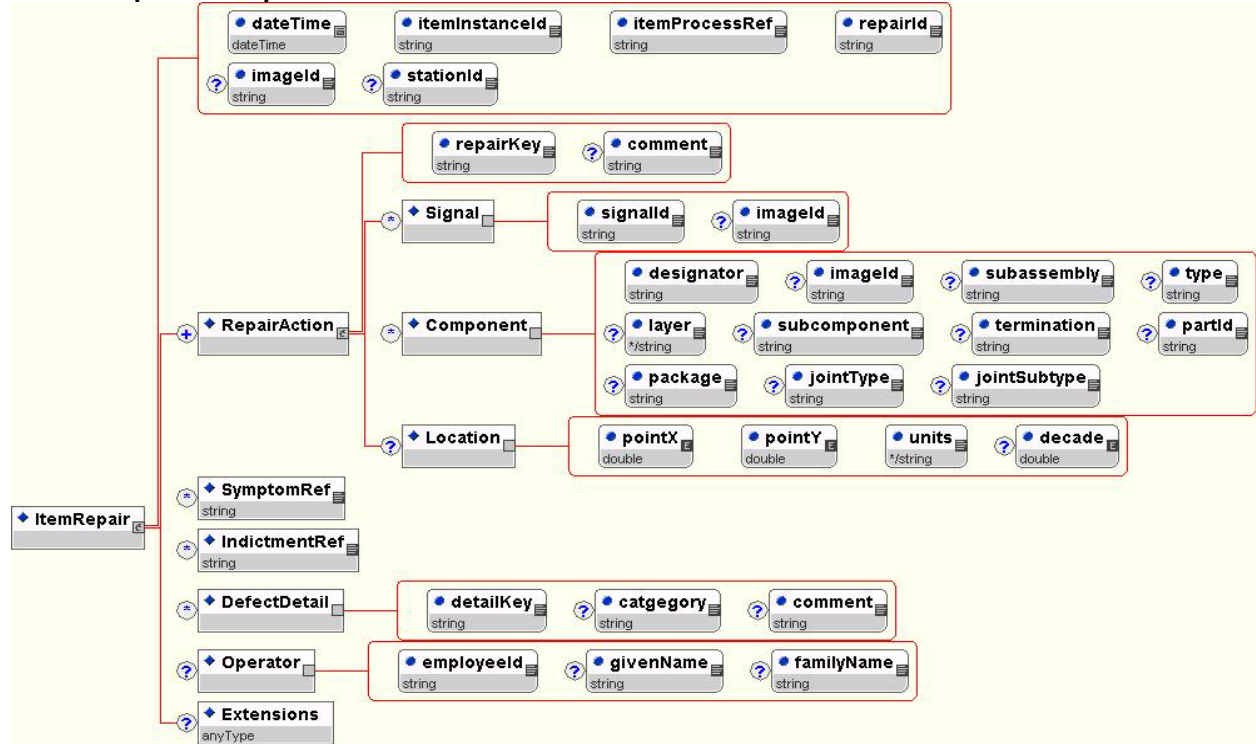
```
                <xsd:element ref = "Component" minOccurs = "0" maxOccurs = "unbounded"/>
                <xsd:element ref = "Location" minOccurs = "0"/>
            </xsd:sequence>
            <xsd:attribute name = "repairKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "comment" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Signal">
        <xsd:complexType>
            <xsd:attribute name = "signalId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Component">
        <xsd:complexType>
            <xsd:attribute name = "designator" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "imageId" type = "xsd:string"/>
            <xsd:attribute name = "subassembly" type = "xsd:string"/>
            <xsd:attribute name = "type" type = "xsd:string"/>
            <xsd:attribute name = "layer">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "TOP"/>
                        <xsd:enumeration value = "BOTTOM"/>
                        <xsd:enumeration value = "INTERNAL"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "subcomponent" type = "xsd:string"/>
            <xsd:attribute name = "termination" type = "xsd:string"/>
            <xsd:attribute name = "partId" type = "xsd:string"/>
            <xsd:attribute name = "package" type = "xsd:string"/>
            <xsd:attribute name = "jointType" type = "xsd:string"/>
            <xsd:attribute name = "jointSubtype" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Location">
        <xsd:complexType>
            <xsd:attribute name = "pointX" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "pointY" use = "required" type = "xsd:double"/>
            <xsd:attribute name = "units" use = "required">
                <xsd:simpleType>
                    <xsd:restriction base = "xsd:string">
                        <xsd:enumeration value = "MM"/>
                        <xsd:enumeration value = "INCH"/>
                    </xsd:restriction>
                </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name = "decade" default = "0" type = "xsd:double"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "IndictmentRef" type = "xsd:string"/>
    <xsd:element name = "SymptomRef" type = "xsd:string"/>
    <xsd:element name = "DefectDetail">
        <xsd:complexType>
            <xsd:attribute name = "detailKey" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "catgegory" type = "xsd:string"/>
            <xsd:attribute name = "comment" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "Operator">
        <xsd:complexType>
            <xsd:attribute name = "employeeId" use = "required" type = "xsd:string"/>
            <xsd:attribute name = "givenName" type = "xsd:string"/>
            <xsd:attribute name = "familyName" type = "xsd:string"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name = "MeasurementRef" type = "xsd:string"/>
    <xsd:element name = "RegionRef" type = "xsd:string"/>
    <xsd:element name = "Extensions" type = "xsd:anyType"/>
</xsd:schema>
```

Appendix A – Acronym Definitions

AOI   Automated Optical Inspection

ALI   Automated Laser Inspection

AXI   Automated X-ray Inspection

AXL   Automated X-ray Laminography

EQ   Comparator *Equal To*

FNT   Functional Test

FOV   Field Of View

FPT   Flying Probe Test

GE   Comparator *Greater Than or Equal To*

GELE   Comparator *Greater Than or Equal To or Less Than or Equal To*

GELT   Comparator *Greater Than or Equal To or Less Than*

GT   Comparator *Greater Than*

GTLE   Comparator *Greater Than or Less Than or Equal To*

GTLT   Comparator *Greater Than or Less Than*

ICT   In-Circuit Test

INT   System Integration Test

LE   Comparator *Less Than or Equal To*

LEGE   Comparator *Less Than or Equal To or Greater Than or Equal To*

LEGT   Comparator *Less Than or Equal To or Greater Than*

LT   Comparator *Less Than*

LTGE   Comparator *Less Than or Greater Than or Equal To*

LTGT   Comparator *Less Than or Greater Than*

MDA   Manufacturing Defect Analyzer

MVI   Manual Visual Inspection

MXI   Manual X-ray Inspection

NE   Comparator *Not Equal To*

OLT   Off-Line Test (Sampling)

ROI   Region Of Interest

SYS   Full System Test

Appendix B – Example Symptoms

The following is a listing of recommended non-conformances for possible use in the Symptom record.

SYSTEM CLOCK FAILURE
SYSTEM TIMEOUT FAILURE
CLOCK SYNCHRONIZATION FAILURE
CLOCK REFERENCE FAILURE
TRANSMISSION FAILURE
RECEPTION FAILURE
SIGNAL INTERMITTENT FAILURE
SIGNAL DEGRADATION FAILURE
SYSTEM OVERVOLTAGE FAILURE
SYSTEM UNDERVOLTAGE FAILURE
SYSTEM OVERCURRENT FAILURE
SYSTEM UNDERCURRENT FAILURE
VOLTAGE OFFSET FAILURE
VOLTAGE REFERENCE FAILURE

Appendix C – Example Indictments

The following is a listing of recommended non-conformances for use in the Indictment record.

OPEN
SHORT
SOLDER BAD
SOLDER BALL
SOLDER BRIDGE
SOLDER COLD
SOLDER CONTAMINATED
SOLDER EXCESSIVE
SOLDER FRACTURED
SOLDER INSUFFICIENT
SOLDER MISSING
SOLDER POOR WETTING
SOLDER SMEAR
SOLDER SPLASH
SOLDER VOID
COMPONENT BAD
COMPONENT COPLANARITY BAD
COMPONENT DAMAGED
COMPONENT EXTRA
COMPONENT INCORRECT MOUNTING
COMPONENT LEAD BENT
COMPONENT LEAD LIFTED
COMPONENT LEAD MISSING
COMPONENT MARKING UNREADABLE
COMPONENT MARKING WRONG
COMPONENT MISSALIGNED
COMPONENT MISSING
COMPONENT POLARITY REVERSED
COMPONENT ROTATED
COMPONENT SKEWED
COMPONENT TOMBSTONED
COMPONENT BILLBOARDED
COMPONENT VALUE OUT OF TOLERANCE
COMPONENT WILL NOT PROGRAM
COMPONENT WRONG PART
BOARD CONTAMINATED
BOARD DIRTY
BOARD FEATURE BAD
BOARD MARK MISSING
BOARD SERIAL UNREADABLE
BOARD WARPED
FIXTURE CONTACT PROBLEM

Appendix D – Example Repair Actions

The following is a listing of recommended repair actions for use in the ItemRepair event record.

NO DEFECT FOUND
SOLDER RETOUCHED
SOLDER ADDED
SOLDER REMOVED
COMPONENT ADDED
COMPONENT REALIGNED
COMPONENT REMOVED
COMPONENT REMOUNTED
COMPONENT REPAIRED
COMPONENT REPLACED
COMPONENT REPROGRAMMED
BOARD RESERIALIZED
BOARD REWASHED
BOARD SCRAPPED
NOT REPAIRED

Appendix E – Example Indictment/Symptom Categories

ASSEMBLY
BUILDUP
CONNECTION
DOCUMENTATION
COMPONENT
CONTAMINATION
DESIGN
DISPENSING
ETCH
ENVIRONMENTAL
FABRICATION
GLUE
HANDLING
LABELING
MANUAL
MACHINE
MATERIALS
MECHANICAL
PASTE
PRINTING
REGISTRATION
THERMAL
TOOLING

Appendix F – Suggested Component Types
(Reference IPC-2511)

RES
VRES
RPCK
CAP
PCAP
VCAP
CPCK
IND
VIND
XFMR
DIODE
DIAC
ZENER
BRIDGE
PNP
NPN
NFET
PFET
LED
LEDPCK
OSCIL
OPTO
VREG
SCR
RELAY
SWITCH
JUMPER
FUSE
CONN
SOCKET
OPAMP
LOGIC
ANALOG
HYBRID
ANTENNA
CARD
BACKPLANE
CAGE
POWERSUPPLY
CABLE
CABLEEND
HARNESS
MOTHERBOARD
DAUGHTERBOARD

Appendix G – Suggested Component Package Types
(Reference IPC-2511)

CHIP
MELF
EMBEDDED
SOC
SOJ
SOT23
SOT52
SOT89
SOT143
SOD123
SOIC
SOPIC
SSOIC
TSOP
CERAMIC_FLATPACEK
CERAMIC_QUAD_FLATPACK
PGA
PLASTIC_CHIP_CARRIER
LEADLESS_CERAMIC_CHIP_CARRIER
CERAMIC_DIP
PLASTIC_DIP
CERAMIC_SIP
PLASTIC_SIP
SQUARE_QUAD_FLATPACK
RECTANGULAR_QUAD_FLATPACK
PLASTIC_BCA
CERAMIC_BGA
INI_BGA
CHIP_SCALE
BARE_DIE
FLIPCHIP
AXIAL_LEADED
RADIAL_LEADED
TO_TYPE
MOLDED
POWER_TRANSISTOR
RELAY_SM
RELAY_TH
TRIMPOT_TH
TRIMPOT_SM
TRANSFORMER
CONNECTOR_SM
CONNECTOR_TH
COIL_CHOKE
SWITCH
HERMETIC_HYBRID
MCM
NETWORK

Appendix H – Example Package Lead Types
(Reference IPC-2511)

TH_ROUND
TH_RIBBON
TH_V
TERMINATION
GULLWING
BUTTLEAD
JLEAD
SLEAD
WRAPAROUND
CASTELLATION
BALL
BUMP
COLUMN
LAND

Appendix I - IPC Web-based Standards (IPC25XX)

The web-based standards (IPC 25XX) are designed to foster application integration and electronic commerce through data and information interchange standards based on XML. It assumes that application programs (including equipment interfaces) are distinct entities, and application integration takes place using a loosely coupled, message-passing approach. There is no need for a common object model, programming language, network protocol, persistent storage mechanism or operating system for two applications to exchange XML messages formatted using the web-based standards. The two applications simply need to be able to format, transmit, receive and consume a standardized XML message.

The web-based standards series have been identified for each of the value-added activities occurring throughout the product life cycle of an electronics product. The web-based standards are:

IPC-2500 – Framework Standard

IPC-2510 – Product Data Representation

IPC-2520 – Product Data Quality

IPC-2530 – Surface Mount Equipment Standard Recipe File Format

IPC-2540 – Shop Floor Equipment Communications

IPC-2550 – Manufacturing Execution Systems Communications

IPC-2560 – Enterprise Resource Planning Systems Communications

IPC-2570 – Supply Chain Communications

Table H-1 shows the correlation of the different standards in each of the series. Although not every standard has been started, the figure represents a coordinated opportunity to maintain consistency throughout the standard development cycle.

Table I-1   CAD/CAM Standardization

IPC Number/ Function	-xxx1 Generic	-xxx2 Administ	-xxx3 Documnt	-xxx4 Board Fabricat	-xxx5 Bare Bd Test	-xxx6 Assy Manufac	-xxx7 Assy/ Test/ Insp.	-xxx8 Comp. & Material	-xxx9 Informa. Modeling
IPC-2500 CAMX Framework	IPC-2501 PINS								
IPC-2510 GenCAM Product Data	IPC-2511A (Pub)	IPC-2512A (Pub)	IPC-2513A (Pub)	IPC-2514A (Pub)	IPC-2515A (Pub)	IPC-2516A (Pub)	IPC-2517A (Pub)	IPC-2518A (Pub)	IPC-2519A (Pub)
IPC-2520 Quality Product Data				IPC-2524 (Pub)					
IPC-2530 SRFF Process Data Recipe file	IPC-2531 ANSI Draft								
IPC-2540 Shop Floor Communicate	IPC-2541 2nd IF					IPC-2546 Interim final	IPC-2547 Interim final		
IPC-2550 Execution Communicate	IPC-2551 PINS			IPC-2554 Working draft		IPC-2556 PINS			
IPC-2560 Enterprise Communicate									
IPC-2570 Supply Chain Communicate	IPC-2571 Proposal					IPC-2576 Proposal	IPC-2577 Working draft	IPC-2678 Proposal	

Messages are the basis of the web-based standards. Messages are the means to integrate applications at the business-process level by defining a loosely coupled, request-based communication process. Since many business processes involve one party performing a service at the request of another party, the mapping of messages to requests is natural. An XML-based messaging system with open, extensible formats captures the essential elements of an electronics business communication message while allowing flexible implementations.