

1 **P1849™/D03**  
2 **Draft Standard for XES - eXtensible**  
3 **Event Stream - for achieving**  
4 **interoperability in event logs and event**  
5 **streams**

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37

1 **Abstract:** The XES standard defines a grammar for a tag-based language whose aim is to  
2 provide designers of information systems with a unified and extensible methodology for capturing  
3 systems' behaviors by means of event logs and event streams. This standard includes a "XML  
4 Schema" describing the structure of an XES event log/stream and a "XML Schema" describing  
5 the structure of an extension of such a log/stream. Moreover, the standard includes a basic  
6 collection of so-called "XES extension" prototypes that provide semantics to certain attributes as  
7 recorded in the event log/stream.  
8  
9 **Keywords:** event log, event stream, system behavior, extensions, XML.  
10  
11

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# 1 Introduction

2 This introduction is not part of P1849/D03, Draft Standard for XES - eXtensible Event Stream - for achieving  
3 interoperability in event logs and event streams .

4 Event logs contain information on how processes have evolved in running systems. As more and more  
5 systems capture such information, there is a need to be able to transfer this information from these running  
6 systems to a site where the information can be analyzed, either automatically by software from the  
7 computational intelligence field, or manually (at least in part) using such software.

8 This Standard addresses this need by defining an eXtensible Event Stream (XES) structure for such event  
9 logs.

10 Furthermore, this Standard defines the World Wide Web Consortium (W3C) Extensible Markup Language  
11 (XML) structure and constraints on the contents of XML 1.1 documents that can be used to represent XES  
12 instances, and a likewise structure (called XESEXT) that can be used to represent so-called extensions to  
13 this structure.

14 The purpose of this Standard is to allow the generation and analysis of event logs using XML. This  
15 Standard uses the W3C XML Schema definition language as the encoding, which allows for  
16 interoperability and the exchange of XES XML instances between various systems.

17



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12 R.2 June 1<sup>st</sup>, 2015: Created annex for tool, data, and publication support.....46

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15 R.5 June 29<sup>th</sup>, 2015: Comments of Lijie Wen.....46

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18 R.8 October 2<sup>nd</sup>, 2015: Comments of Josep Carmona. ....47

19 R.9 October 6<sup>th</sup>, 2015: Comments of Michal Rosik.....47

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21 R.11 December 2<sup>nd</sup>, 2015: First draft for balloting .....47

22 R.12 January 5<sup>th</sup>, 2016: Pre-ballot MEC.....47

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## 15 1. Overview

16 The scope and purpose of this Standard are discussed in 1.1 and 1.2.

### 17 1.1 Scope

18 This Standard defines World Wide Web Consortium (W3C) Extensible Markup Language (XML) structure  
19 and constraints on the contents of XML 1.1 documents that can be used to represent extensible event  
20 stream (XES) instances. A XES instance corresponds to a file-based event log or a formatted event stream  
21 that can be used to transfer event-driven data in a unified and extensible manner from a first site to a second  
22 site. Typically, the first site will be the site generating this event-driven data (for example, workflow  
23 systems, case handling systems, procurement systems, devices like wafer steppers and X-ray machines, and  
24 hospitals) while the second site will be the site analyzing this data (for example, by data scientists and/or  
25 advanced software systems).

26 To transfer event-driven data in a unified manner, this Standard includes a W3C XML Schema describing  
27 the structure of a XES instance. To transfer this data in an extensible manner, this Standard also includes a  
28 W3C XML Schema describing the structure of an extension to such a XES instance. Basically, such an  
29 extension provides semantics to the structure as prescribed by the XES instance. Finally, this Standard  
30 includes a basic collection of such extensions.

## 1 1.2 Purpose

2 The purpose of this Standard is to provide a generally-acknowledged Extensible Markup Language (XML)  
 3 format for the interchange of event data between information systems in many applications domains on the  
 4 one hand and analysis tools for such data on the other hand. As such, this Standard aims to fix the syntax  
 5 and the semantics of the event data which, for example, is being transferred from the site generating this  
 6 data to the site analyzing this data. As a result of this Standard, if the event data is transferred using the  
 7 syntax as described by this Standard, its semantics will be well-understood and clear at both sites.

## 8 2. Normative references

9 The following referenced documents are indispensable for the application of this document (i.e., they must  
 10 be understood and used, so each referenced document is cited in text and its relationship to this document is  
 11 explained). For dated references, only the edition cited applies. For undated references, the latest edition of  
 12 the referenced document (including any amendments or corrigenda) applies.

- 13 — ISO 639-1, Code for the Representation of Names of Languages—Part 1: Alpha-2 code.
- 14 — ISO 639-2, Codes for the Representation of Names of Languages—Part 2: Alpha-3 code.
- 15 — ISO 4217:2008, Codes for the Representation of Currencies and Funds.
- 16 — ISO 8601, Data elements and interchange formats – Information interchange – Representation of  
 17 dates and times.
- 18 — W3C Recommendation (28 October 2004), XML Schema Part 1: Structures, Second Edition.
- 19 — W3C Recommendation (28 October 2004), XML Schema Part 2: Datatypes, Second Edition.

## 20 3. Definitions

21 For the purposes of this document, the following terms and definitions apply. The *IEEE Standards*  
 22 *Dictionary Online* should be consulted for terms not defined in this clause.<sup>1</sup>

23 **component:** A XES element that may contain XES attributes, that is, a log, a trace, an event, or an  
 24 attribute.

## 25 4. XES metadata structure

### 26 4.1 Hierarchical components

#### 27 4.1.1 Log component

28 A *log component* represents information that is related to a specific process. Examples for processes are  
 29 handling insurance claims, using a complex X-ray machine, and browsing a website. A log shall contain a

---

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1 (possibly empty) collection of traces followed by a (possibly empty) list of events. The order of the events  
2 in this list shall be important, as it signifies the order in which the events have been observed.

3 If the log contains only events and no traces, then the log is also called a *stream*.

#### 4 **4.1.2 Trace component**

5 A *trace component* represents the execution of a single case, that is, of a single execution (or enactment) of  
6 the specific process. A trace shall contain a (possible empty) list of events that are related to a single case.  
7 The order of the events in this list shall be important, as it signifies the order in which the events have been  
8 observed.

#### 9 **4.1.3 Event component**

10 An *event component* represents an atomic granule of activity that has been observed. If the event occurs in  
11 some trace, then it is clear to which case the event belongs. If the event does not occur in some trace, that  
12 is, if it occurs in the log, then we need ways to relate events to cases. For this, we will use the combination  
13 of a trace classifier and an event classifier, see 4.4.

### 14 **4.2 Attribute component**

15 Information on any component (log, trace, or event) is stored in *attribute components*. Attributes describe  
16 the enclosing component, which may contain an arbitrary number of attributes. However, no two attributes  
17 of the same component may share the same key, that is, every key shall occur only once in a single  
18 component.

19 For providing maximum flexibility, this Standard allows for *nested* attributes, that is, attributes that  
20 themselves have child attributes. While this feature is necessary for efficient encoding of certain  
21 information types, it is *optional for tools to implement nested attributes*, that is, the feature is not strictly  
22 required in order to be compliant to this Standard. Nevertheless, a tool that does not support nested  
23 attributes shall be able to read documents which feature nested attributes. These tools shall transparently  
24 ignore and discard any nested attributes, and, where feasible, alert the user to the fact that some information  
25 may not be available.

26 An attribute shall be either *elementary* or *composite*.

#### 27 **4.2.1 Elementary attributes**

28 An *elementary attribute* is an attribute that shall contain an elementary (single, basic) value. In this  
29 Standard, an elementary attribute shall be a *string attribute*, a *date and time attribute*, an *integer number*  
30 *attribute*, a *real number attribute*, a *Boolean attribute*, or an *ID attribute*.

##### 31 **4.2.1.1 String attributes**

32 Valid values for a string attribute are values that conform to the `xs:string` datatype.

#### 1 4.2.1.2 Date and time attributes

2 Values for a date and time attribute should be specified in UTC time (cf. the ISO 8601 Standard), also  
3 known as zulu time, and represented as xs:dateTime datatype. ~~Valid values for a date and time attribute~~  
4 ~~are values that conform to the xs:dateTime datatype.~~

#### 5 4.2.1.3 Integer number attributes

6 Valid values for an integer number attribute are values that conform to the xs:long datatype.

#### 7 4.2.1.4 Real number attributes

8 Valid values for a real number attribute are values that conform to the xs:double datatype.

#### 9 4.2.1.5 Boolean attributes

10 Valid values for a Boolean attribute are values that conform to the xs:boolean datatype.

#### 11 4.2.1.6 ID attributes

12 Valid values for an ID attribute are values that conform to the ID datatype, that is, all string representations  
13 of UUIDs.

#### 14 4.2.2 Composite attributes

15 A *composite attribute* is an attribute that may contain multiple values. In this Standard, a composite  
16 attribute shall be a *list attribute*.

#### 17 4.2.2.1 List attribute

18 Valid values for the list datatype are all lists (series) of attribute values. The order between the child  
19 attributes in this list shall be important. In contrast to attributes enclosed in a component, attributes  
20 enclosed in such an attribute value list may share the same key. Note that the attribute value list is not the  
21 same as the list attribute: The former is contained in the latter, and the latter is a component but the former  
22 is not.

#### 23 4.3 Global attributes

24 A log shall hold a (possibly empty) list of global attribute declarations. A global attribute declaration shall  
25 have a valid *key*, a valid *datatype*, and a valid *value* for the datatype. A global attribute declaration shall  
26 either be a global event attribute or a global trace attribute.

27 Global attributes are a required feature for compliance to this Standard. Nevertheless, a defensive approach  
28 is recommended with respect to global attributes, as there is no way to undo a global declaration.

### 1 4.3.1 Global event attributes

2 Global event attributes are event attributes that are understood to be *available* and *properly defined* for each  
3 event in the log (be it in a trace or not). As a result, every event in the log shall contain an attribute with the  
4 given key and the given datatype, but possibly with a different valid value. The value provided for a global  
5 event attribute declaration is *only significant* in case an event *needs to be created* (for some reason) for  
6 which *no value is provided* for that attribute. In that case, the value of the declaration shall be used as the  
7 value for the attribute. In all other cases, the value of the declaration is insignificant, and shall not be used.

### 8 4.3.2 Global trace attributes

9 Global trace attributes are trace attributes that are understood to be *available* and *properly defined* for each  
10 trace in the log. As a result, every trace shall contain an attribute with the given key and the given datatype,  
11 but possibly with a different valid value. The value provided for a global attribute declaration is *only*  
12 *significant* in case a trace *needs to be created* (for some reason) for which *no value is provided* for that  
13 attribute. In that case, the value of the declaration shall be used as the value for the attribute. In all other  
14 cases, the value of the declaration is insignificant, and shall not be used.

## 15 4.4 Classifiers

16 In this Standard, there are per se no predefined attributes with any well-understood meaning. Instead, a log  
17 shall hold a (possibly empty) list of classifiers. *These classifiers are a mandatory feature of this Standard.*

18 A classifier assigns to each event an *identity*, which makes it comparable to others (via their assigned  
19 identity). Examples of such identities include the descriptive name of the event, the descriptive name of the  
20 case the event relates to, the descriptive name of the cause of the event, and the descriptive name of the  
21 case related to the event.

22 A classifier shall either be an *event classifier* or a *trace classifier*.

23 In case the log contains events that do not occur in a trace, then it is necessary to be able to relate these  
24 events to cases. For this reason, we assume that one of the existing event classifiers provides the descriptive  
25 name of its case. Two events for which this classifier result in the same identity, belong to the same case.  
26 Furthermore, we assume that one of the trace classifiers provides the descriptive name for the case. If this  
27 classifier and the event classifier mentioned earlier return the same identity, then the corresponding events  
28 belong to the same case as the corresponding trace. As such, the event shall be appended to this trace in the  
29 same order as they appear in the log. If no matching trace exists, a new trace shall be constructed from  
30 these events again in the same order as they appear in the log.

### 31 4.4.1 Event classifiers

32 An event classifier shall be defined via an ordered list of attribute keys. The identity of the event shall be  
33 derived from the actual values of the attributes with these keys. An attribute whose key appears in an event  
34 classifier list shall be declared as a global event attribute before the event classifier is defined, as the actual  
35 value for the attribute is required by the event classifier.

#### 1 4.4.2 Trace classifiers

2 A trace classifier shall be defined via an ordered list of attribute keys. The identity of the trace shall be  
 3 derived from the actual values of the attributes with these keys. An attribute whose key appears in a trace  
 4 classifier list shall be declared as a global trace attribute before the trace classifier is defined, as the actual  
 5 value for the attribute is required by the trace classifier.

#### 6 4.4.3 Event ordering

7 Within the context of a single trace, the ordering of events shall be important: An event that occurs in a log  
 8 (be it in a trace or in the log itself) before another event that is related to the same trace, shall be assumed to  
 9 have occurred before that other event. However, the notion of a trace also depends on the trace and event  
 10 classifiers selected by the user. As such, the notion of a trace is not necessarily predefined for a log. As a  
 11 result, the notion of the event ordering may be affected by the choice of classifiers.

12 Whatever classifier is selected by the user, the ordering in the log shall be maintained: The first event that  
 13 belongs to some trace shall be the first event encountered in the log (be it in a trace or in the log itself), etc.  
 14 As an example, consider the event log that contains (1) a trace containing events  $e_{11}$  and  $e_{12}$ , (2) a trace  
 15 containing an event  $e_{21}$ , (3) a trace containing events  $e_{31}$ ,  $e_{32}$ , and  $e_{33}$ , and (4) an event  $e_4$ . Now, assume that  
 16 the user has selected an event classifier and a trace classifier that causes the events  $e_{11}$ ,  $e_{31}$ ,  $e_{33}$ , and  $e_4$  to  
 17 belong to the same trace. Then the ordering in this (classified) trace shall be  $e_{11}$ ,  $e_{31}$ ,  $e_{33}$ , and  $e_4$ .

#### 18 4.5 Extensions

19 This Standard does not define a specific set of attributes per component. As such, the semantics of the data  
 20 attributes these elements do contain may necessarily be ambiguous, hampering the interpretation of that  
 21 data.

22 This ambiguity is resolved by the concept of *extensions* in this Standard. An extension defines for every  
 23 type of component a (possibly empty) set of attributes. The extension provides points of reference for  
 24 interpreting these attributes, and, thus, their components. Extensions therefore are *primarily a vehicle for*  
 25 *attaching semantics to a set of defined attributes per component.*

26 Extensions have many possible uses. One important use is to introduce a set of commonly understood  
 27 attributes which are vital for a specific perspective or dimension of event log analysis (and which may even  
 28 not have been foreseen at the time of developing this Standard). See Clause 7 for the current set of standard  
 29 extensions.

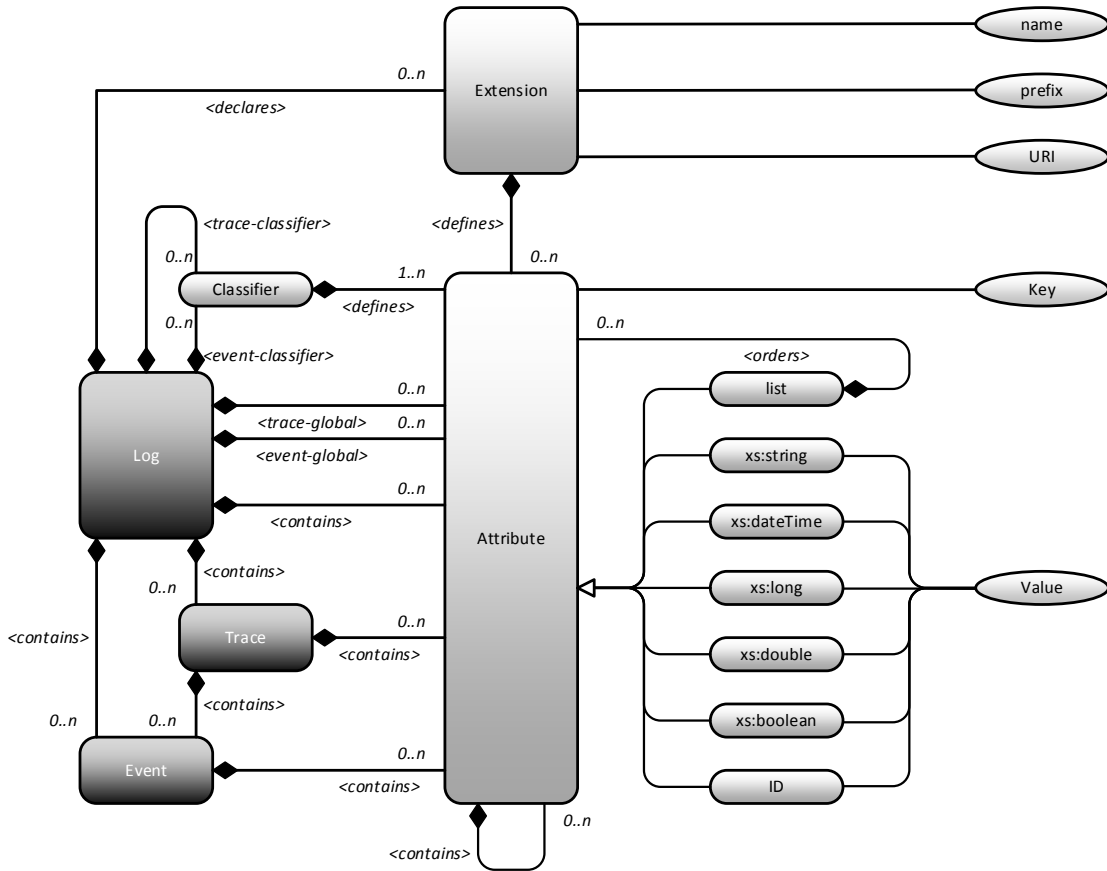
30 Other uses include the definition of generally-understood attributes for a specific application domain (for  
 31 example, medical attributes for hospital processes), or for supporting special features or requirements of a  
 32 specific application.

33 An extension shall have a descriptive *name*, a *prefix*, and a *URI*. The prefix is the prefix of all attributes  
 34 defined by the extension. This means, the keys of all attributes defined by the extension shall be prepended  
 35 with this prefix and colon separation character (like a namespace in XML). The URI is a unique URI which  
 36 points to the definition of the extension.

37 The definition of the extension shall contain for every component a (possibly empty) list of attribute  
 38 declarations. An attribute declaration shall contain the *key* of the attribute, the *datatype* of the attribute, and  
 39 a (possible empty) list of *aliases*. An alias shall contain the *descriptive text* for the attribute (that is, the



1 commonly understood semantics for the attribute) and the *language code* of the language of this descriptive  
 2 text.



3  
 4 **Figure 1 Overview of the XES metadata structure**

5 **5. XES XML serialization**

6 **5.1 Log element**

7 Captures the log component from the XES metadata structure.

8 — XML name: log.

9 **5.1.1 Elements**

10 The following (sub) elements shall appear in the specified order.

XML name	XES element	Min	Max	Description
extension	Extension, see 5.5.	0	∞	An extension declaration for the log.

global	Global, see 5.6.	0	∞	A list of global (event or trace) attributes for the log.
classifier	Classifier, see 5.7.	0	∞	A classifier (even tor trace) definition for the log.
attribute	Attribute, see 5.4.	0	∞	An attribute for the log. Shall be elementary or composite.
trace	Trace, see 5.2.	0	∞	A trace for the log.
event	Event, see 5.3.	0	∞	An event for the log.

1 **5.1.2 Attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
xes.version	xs:decimal	Required	The version of the XES standard the document conforms to (e.g., 2.0).
xes.features	xs:token	Required	A whitespace-separated list of optional XES features this document makes use of (e.g., nested-attributes). If no optional features are used, this attribute shall have an empty value.

2 **5.2 Trace element**

3 Captures the trace component from the XES metadata structure.

4 — XML name: trace.

5 **5.2.1 Elements**

6 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XES element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 5.4.	0	∞	An attribute for the trace. Shall be elementary or composite.
event	Event, see 5.3.	0	∞	An event for the trace.

7 **5.2.2 Attributes**

8 N/A.

1 **5.3 Event element**

2 Captures the event component from the XES metadata structure.

3 — XML name: event.

4 **5.3.1 Elements**

5 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XES element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 5.4.	0	∞	An attribute for the event. Shall be elementary or composite.

6 **5.3.2 Attributes**

7 N/A.

8 **5.4 Attribute element**

9 Captures the attribute component from the XES metadata structure. Shall be any of the following:

<i>XML name</i>	<i>Datatype</i>	<i>Value</i>	<i>Description</i>
string	xs:string	Elementary	A string value.
date	xs:dateTime	Elementary	<del>A data and time value.</del> <u>A UTC time value.</u>
int	xs:long	Elementary	An integer number value.
float	xs:double	Elementary	A real number value.
boolean	xs:boolean	Elementary	A Boolean value.
id	ID	Elementary	A UUID value.
list	Attribute list	Composite	A sorted list of attributes.

10 **5.4.1 Elements for elementary attributes**

11 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XES element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 5.4.	0	∞	An attribute for the attribute, that is, a meta-attribute. Shall be elementary or

	composite.
--	------------

1 **5.4.2 Elements for composite attributes**

2 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XES element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 5.4.	0	$\infty$	An attribute for the attribute, that is, a meta-attribute. Shall be elementary or composite.
values	Attribute list	1	1	The ordered list of attributes that constitute the composite value of the attribute. Attributes in this list shall be elementary or composite, and attributes in this list may share the same key.

3 **5.4.3 Attributes for elementary attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
key	xs:string	Required	The key of the attribute.
value	xs:string	Required	The value (as a string) of the elementary attribute.

4 **5.4.4 Attributes for composite attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
key	xs:string	Required	The key of the attribute.

5 **5.5 Extension element**

6 Captures the extension declaration from the XES metadata structure.

7 — XML name: extension.

8 **5.5.1 Elements**

9 N/A.

## 1 5.5.2 Attributes

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
name	xs:NCName	Required	The name of the extension.
prefix	xs:NCName	Required	The prefix of the extension.
uri	xs:anyURI	Required	The URI from where the definition of this extension (shall be a file that conforms to the XESEXT format) can be retrieved.

## 2 5.6 Global element

3 Captures the global attribute declaration from the XES metadata structure.

4 — XML name: global.

### 5 5.6.1 Elements

<i>XML name</i>	<i>XES element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 5.4.	0	$\infty$	A global attribute declaration for the log. Depending on whether the attribute is declared global for events or traces, every event or trace in the log shall have this attribute as sub element.

6 The attribute value provided with this global declaration shall only be used if a new event or trace needs to  
 7 be inserted in the log for which no other valid value for this attribute can be obtained. In that case, and only  
 8 in that case, may the value of this attribute be used.

### 9 5.6.2 Attributes

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
scope	xs:NCName	Optional	Shall be either event or trace, to denote whether this attribute is declared global for events or traces. The default is event .

## 10 5.7 Classifier element

11 Captures the classifier definition from the XES metadata structure.

12 — XML name: classifier.

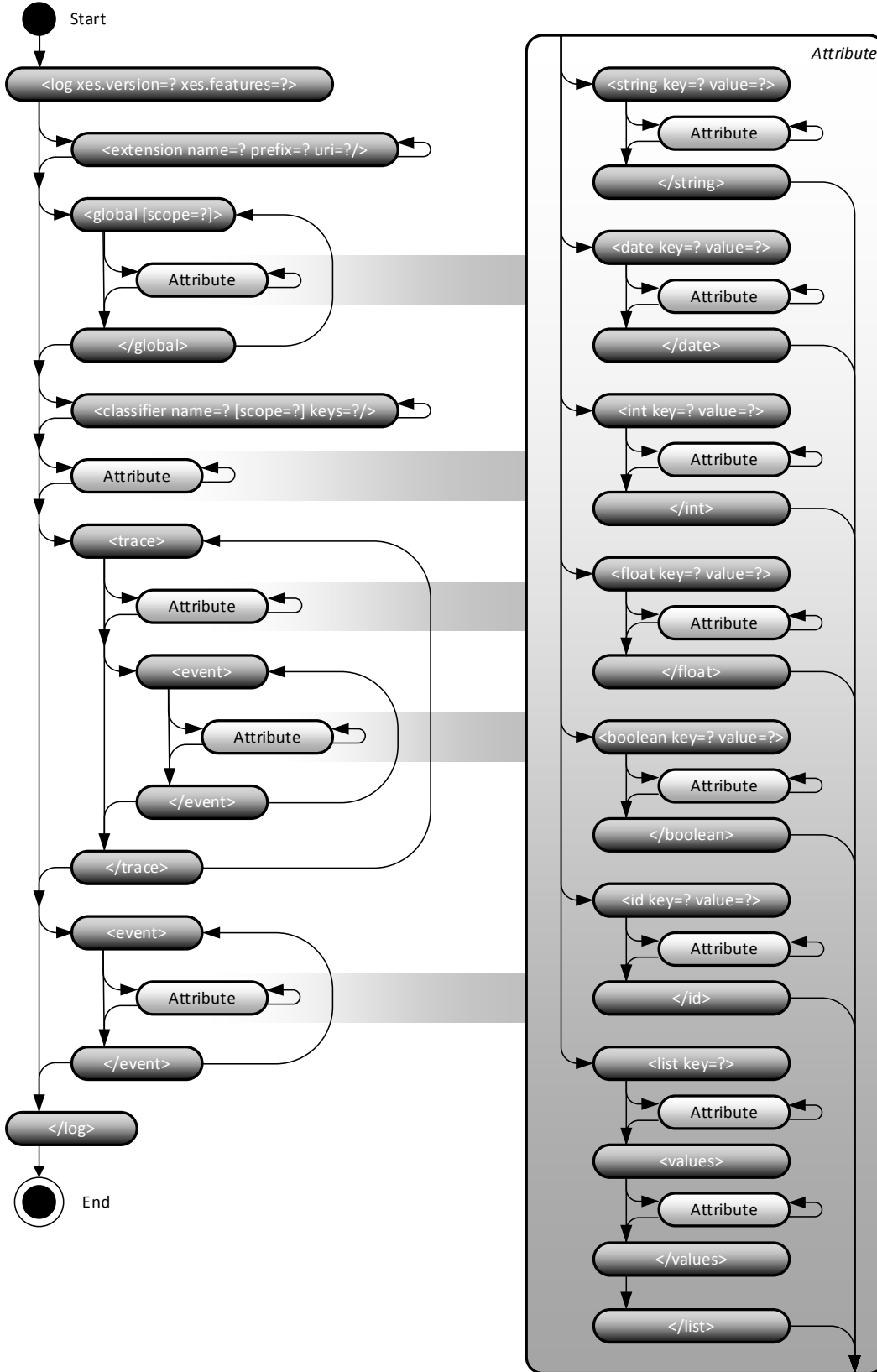
1 **5.7.1 Elements**

2 N/A.

3 **5.7.2 Attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
name	xs:NCName	Required	The name of the classifier.
scope	xs:NCName	Optional	Shall be either <code>event</code> or <code>trace</code> , to denote whether this classifier shall be used to classify events or traces. The default is <code>event</code> .
keys	xs:token	Required	The white-space-separated list of attribute keys that constitute this classifier. These attributes shall be declared global at the proper (either <code>event</code> or <code>trace</code> ) level.

4



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Figure 2 State machine flow diagram for XES XML serialization

1 **6. XESEXT XML Serialization**

2 **6.1 XESExtension element**

3 Captures the extension definition from the XES metadata structure.

4 — XML name: `xesextension`.

5 **6.1.1 Elements**

6 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
log	Log, see 6.2.	0	1	Attribute definitions for logs.
trace	Trace, see 6.3.	0	1	Attribute definitions for traces.
event	Event, see 6.4	0	1	Attribute definitions for events.
meta	Meta, see 6.5	0	1	Attribute definitions for attributes.

7 **6.1.2 Attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
name	<code>xs:NCName</code>	Required	The name of the extension.
prefix	<code>xs:NCName</code>	Required	The prefix to be used for this extension.
uri	<code>xs:anyURI</code>	Required	The URI where this extension can be retrieved from.

8 **6.2 Log element**

9 Captures the log extension definition from the XES metadata structure.

10 — XML name: `log`.

11 **6.2.1 Elements**

12 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
-----------------	-----------------------	------------	------------	--------------------



attribute	Attribute, see 6.6.	0	∞	Attribute definition for logs.
-----------	---------------------	---	---	--------------------------------

1    **6.2.2 Attributes**

2    N/A.

3    **6.3 Trace element**

4    Captures the trace extension definition from the XES metadata structure.

5    — XML name: `trace`.

6    **6.3.1 Elements**

7    The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 6.6.	0	∞	Attribute definition for traces.

8    **6.3.2 Attributes**

9    N/A.

10   **6.4 Event element**

11   Captures the event definition from the XES metadata structure.

12   — XML name: `event`.

13   **6.4.1 Elements**

14   The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 6.6.	0	∞	Attribute definition for events.

15   **6.4.2 Attributes**

16   N/A.

1 **6.5 Meta element**

2 Captures the meta (attribute) extension definition from the XES metadata structure.

3 — XML name: meta.

4 **6.5.1 Elements**

5 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
attribute	Attribute, see 6.6.	0	∞	Attribute definition for attributes.

6 **6.5.2 Attributes**

7 N/A.

8 **6.6 Attribute element**

9 Captures the attribute extension element from the XES metadata structure. Shall be any of the following:

<i>XML name</i>	<i>Description</i>
string	A string valued attribute.
date	<del>A date and time valued attribute.</del> <u>A UTC time valued attribute.</u>
int	An integer number valued attribute.
float	A real number valued attribute.
boolean	A Boolean valued attribute.
id	A UUID valued attribute.
list	A list valued attribute.

10 **6.6.1 Elements**

11 The following (sub) elements shall appear in the specified order.

<i>XML name</i>	<i>XESEXT element</i>	<i>Min</i>	<i>Max</i>	<i>Description</i>
alias	Attribute, see 6.7.	0	∞	Aliases for this attribute.

1 **6.6.2 Attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
key	xs:string	Required	The key of the attribute.

2 **6.7 Alias**

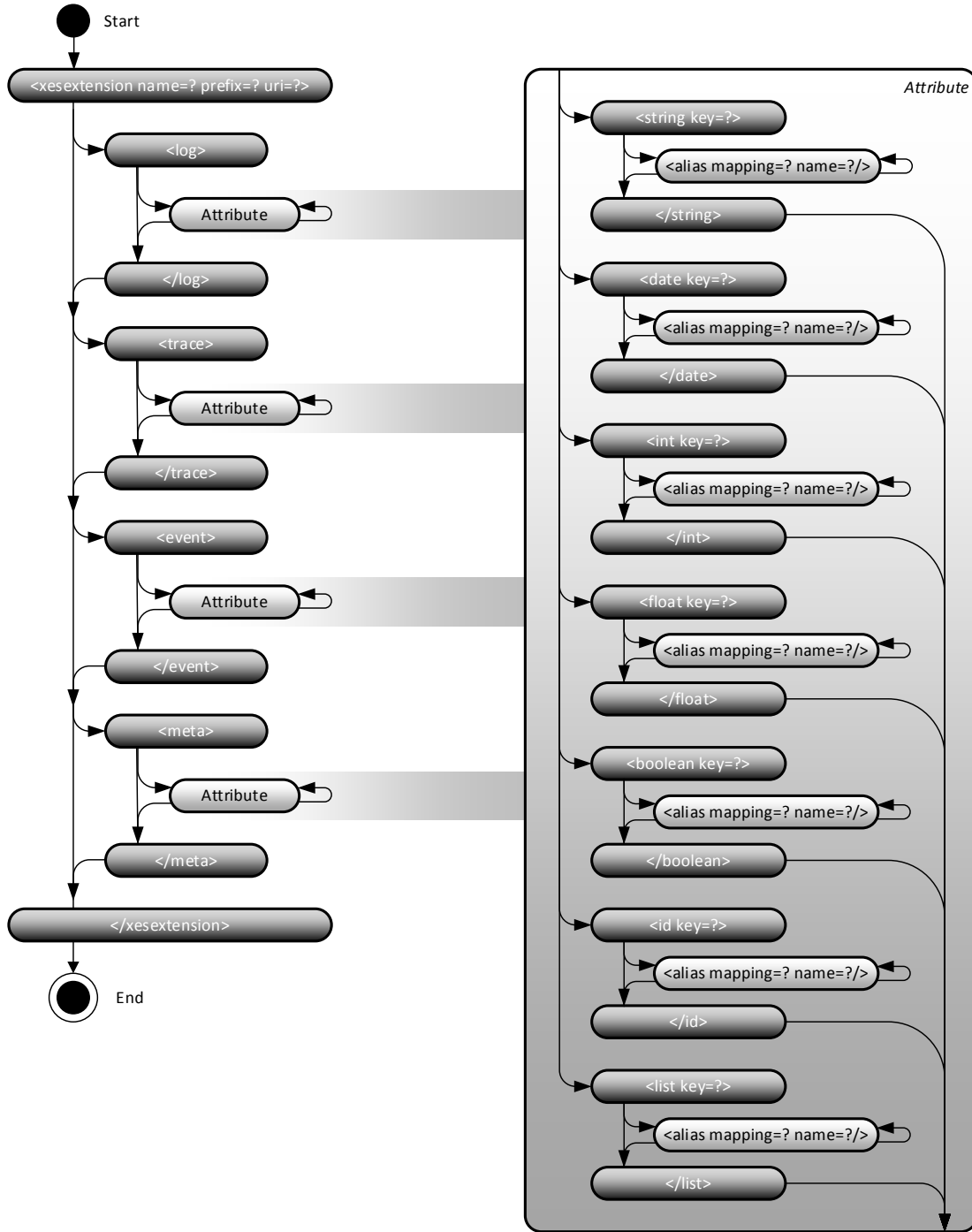
3 Captures the alias extension element from the XES metadata structure.

4 **6.7.1 Elements**

5 N/A.

6 **6.7.2 Attributes**

<i>Attribute key</i>	<i>Attribute type</i>	<i>Status</i>	<i>Description</i>
mapping	xs:NCName	Required	The language code (using the ISO 639-1 and 639-2 Standards) for this alias.
name	xs:string	Required	The semantics of this attribute described using the language with the given code.



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Figure 3 State machine diagram for XESEXT XML serialization

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### 7. XES standard extensions

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XES shall recognize and treat all extensions as equal, independent from their source. This allows users of the format to extend it, in order to fit any purpose or domain setting. However, there are recurring requirements for information stored in event logs, which demand a fixed and universally understood semantics. For this purpose, a number of extensions have been standardized. When creating logs for a

1 specific domain, or also when designing log-analyzing techniques, one should consider using these  
 2 standardized extensions, since they allow for a wider level of understanding of the contents of event logs.

3 In the following, the currently standardized extensions to the XES formats are introduced.

4 **7.1 Concept extension**

5 The Concept extension defines, for all levels of the XES type hierarchy, an attribute which stores the  
 6 generally understood name of type hierarchy elements.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Concept	concept	<a href="http://www.xes-standard.org/concept.xesext">http://www.xes-standard.org/concept.xesext</a>

7 **7.1.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Name	name	Log Trace Event	xs:string	Stores a generally understood name for any component type. For streams and logs, the name attribute may store the name of the process having been executed. For traces, the name attribute usually stores the case ID. For events, the name attribute represents the name of the event, e.g. the name of the executed activity represented by the event.
Instance	instance	Event	xs:string	This represents an identifier of the activity instance whose execution has generated the event. This way, multiple instances (occurrences) of the same activity can be told apart.

8 **7.2 Lifecycle extension**

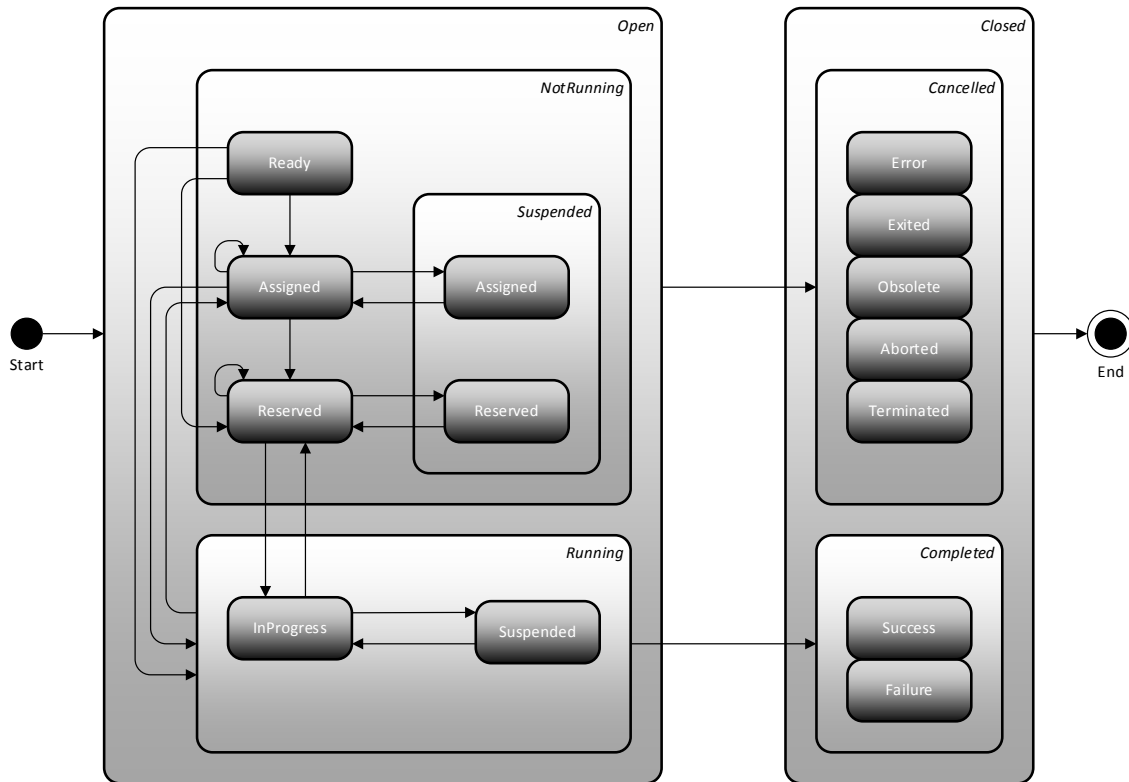
9 The Lifecycle extension specifies for events the lifecycle transition they represent in a transactional model  
 10 of their generating activity. This transactional model can be arbitrary. However, the Lifecycle extension  
 11 also specifies two standard transactional models for activities, see the figures that follow. The use of this  
 12 extension is appropriate in any setting where events denote lifecycle transitions of higher-level activities.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Lifecycle	lifecycle	<a href="http://www.xes-standard.org/lifecycle.xesext">http://www.xes-standard.org/lifecycle.xesext</a>

1 **7.2.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Model	model	Log	xs:string	This attribute refers to the lifecycle transactional model used for all events in the log. If this attribute has a value of standard, the standard lifecycle transactional model of this extension is assumed. If it has a value of bpaF, the BPAF lifecycle transactional model is assumed.
Transition	transition	Event	xs:string	The transition attribute is defined for events, and specifies the lifecycle transition of each event.
State	state	Event	xs:string	The state attribute is defined for events, and specifies the lifecycle state of each event.

2 **7.2.2 BPAF lifecycle transactional model**



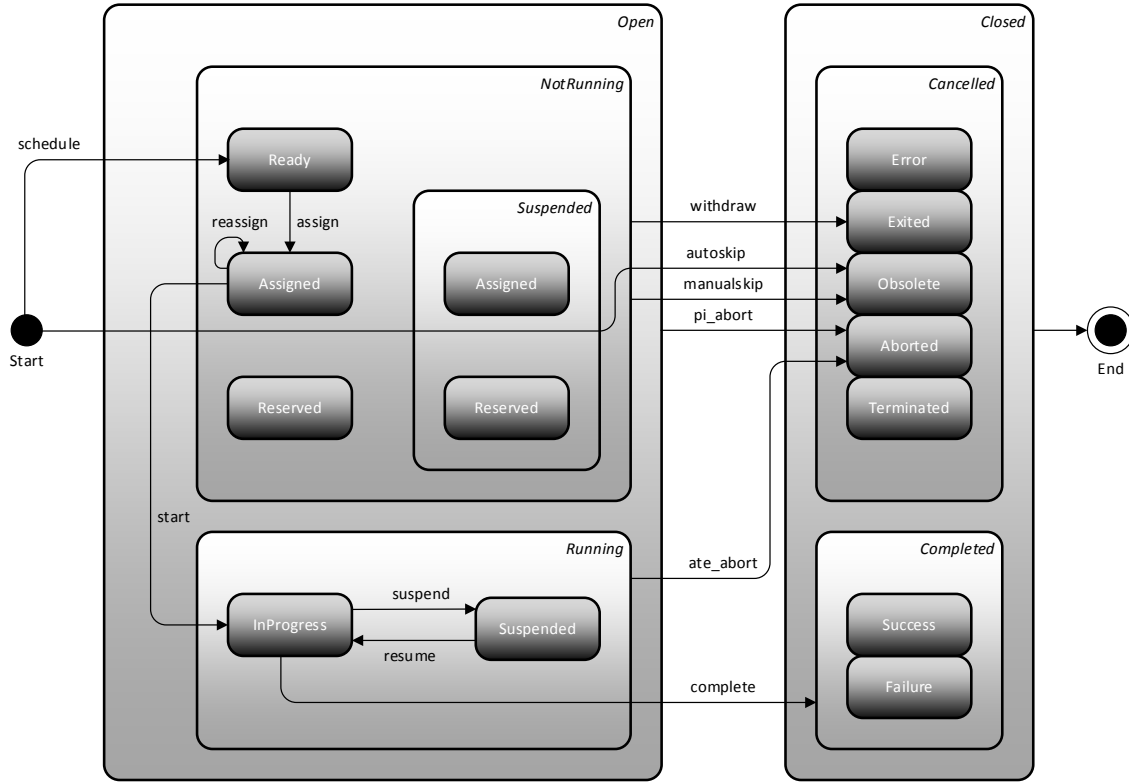
3

4 **Figure 4 State machine for the BPAF transactional model**

5 Note that the transitions shown in this figure are the most typical transitions, but manual interventions and  
 6 different system implementations may lead to additional transitions not depicted in the model.

<i>State</i>	<i>Description</i>
Closed	The activity is closed for execution.
Closed.Cancelled	The execution of the activity is cancelled.
Closed.Cancelled.Aborted	The execution of the activity is aborted.
Closed.Cancelled.Error	The execution of the activity is in error.
Closed.Cancelled.Exited	The execution of the activity is exited manually.
Closed.Cancelled.Obsolete	The execution of the activity is obsolete (e.g. in case of a timeout).
Closed.Cancelled.Terminated	The execution of the activity is forcibly terminated.
Completed	The execution of the activity is completed, i.e., it has ended naturally.
Completed.Failed	The execution of the activity is completed, but the result is unsuccessful (from a business perspective).
Completed.Success	The execution of the activity is completed, and the result is successful (from a business perspective).
Open	The activity is open for execution.
Open.NotRunning	The execution of the activity is not on-going.
Open.NotRunning.Assigned	The activity is on the worklists of resources.
Open.NotRunning.Reserved	The activity has been selected by a resource to work on.
Open.NotRunning.Suspended.Assigned	The activity is on the worklists of resources, but is barred from execution.
Open.NotRunning.Suspended.Reserved	The activity has been selected by a resource, but is barred from execution.
Open.Running	The execution of the activity is on-going.
Open.Running.InProgress	The execution of the activity is in progress.
Open.Running.Suspended	The execution of the activity is on-going, but not in progress.

1 **7.2.3 Standard lifecycle transition model**



2

3 **Figure 5 State machine for the standard transactional model**

4 In contrast with the BPAF transactional model, the standard lifecycle model uses the transitions instead of  
 5 the states to denote the new state of an activity.

<i>Transition</i>	<i>From State</i>	<i>To State</i>	<i>Description</i>
assign	Open. NotRunning. Ready	Open. NotRunning. Assigned	The activity is assigned for execution to a resource.
ate_abort	Open. Running	Closed. Cancelled. Aborted	The execution of the activity is aborted, the execution of the corresponding case is not aborted. As a result, execution of the activity has failed.
autoskip	Start	Closed. Cancelled. Obsolete	The execution of the activity is skipped by the system. As a result, execution of the activity has succeeded.
complete	Open. Running. InProgress	Closed. Completed	The execution of the activity is completed. As a result, execution of the activity has succeeded.
manualskip	Open.	Closed. Cancelled.	The execution of the activity is skipped by the user. As a



	NotRunning	Obsolete	result, execution of the activity has succeeded.
pi_abort	Open	Closed. Cancelled. Aborted	The execution of the activity is aborted, the execution of the corresponding case is also aborted. As a result, execution of the activity has failed.
reassign	Open. NotRunning. Assigned	Open. NotRunning. Assigned	The activity has been reassigned for execution to another resource
resume	Open. Running. Suspended	Open. Running. InProgress	The execution of the activity is resumed.
schedule	Start	Open. NotRunning. Ready	The activity is scheduled for execution.
start	Open. NotRunning. Assigned	Open. Running. InProgress	The execution of the activity is started.
suspend	Open. Running. InProgress	Open. Running. Suspended	The execution of the activity is suspended.
unknown	Any	Any	Any lifecycle transition not captured by any of the other transitions.
withdraw	Open. NotRunning	Closed. Cancelled. Exited	The assignment of the activity is revoked. As a result, execution of the activity has failed.

1 **7.3 Organizational extension**

2 The organizational extension is useful for domains, where events can be caused by human actors, who are  
3 somewhat part of an organizational structure. This extension specifies three attributes for events, which  
4 identify the actor having caused the event, and his position in the organizational structure.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Organizational	org	<a href="http://www.xes-standard.org/org.xesext">http://www.xes-standard.org/org.xesext</a>

5 **7.3.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Resource	resource	Event	xs:string	The name, or identifier, of the resource that triggered the event.

Role	role	Event	xs:string	The role of the resource that triggered the event, within the organizational structure.
Group	Group	Event	xs:string	The group within the organizational structure, of which the resource that triggered the event is a member.

1 **7.4 Time extension**

2 In almost all applications, the exact date and time at which events occur can be precisely recorded. Storing  
 3 this information is the purpose of the time extension. Recording a ~~timestamp~~-UTC time for events is  
 4 important, since this constitutes crucial information for many event log analysis techniques.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Time	time	http://www.xes-standard.org/time.xesext

5 **7.4.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Time	timestamp	Event	xs:dateTime	The <del>date and time</del> <u>UTC time</u> at which the event occurred.

6 **7.5 Semantic extension**

7 Depending on the view on a process, type hierarchy artifacts may correspond to different concepts. For  
 8 example, the name of an event (as specified by the Concept extension) may refer to the activity whose  
 9 execution has triggered this event. However, this activity may be situated on a low level in the process  
 10 meta-model, and be a part of higher-level, aggregate activities itself.

11 Besides events, also other elements of the XES type hierarchy may refer to a number of concepts at the  
 12 same time (e.g., a log may refer to different process definitions, on different levels of abstractions). To  
 13 express the fact, that one type artifact may represent a number of concepts in a process meta-model, the  
 14 semantic extension has been defined.

15 It is assumed that there exists an ontology for the process meta-model, where every concept can be  
 16 identified by a unique URI. The semantic extension defines an attribute, which allows to store a number of  
 17 model references, as URIs, in any element of the XES type hierarchy.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Semantic	semantic	http://www.xes-standard.org/semantic.xesext

1 **7.5.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Model reference	modelReference	Log Trace Event Meta	xs:string	References to model concepts in an ontology. Model References are stored in a literal string, as comma-separated URIs identifying the ontology concepts.

2 **7.6 ID extension**

3 The ID extension provides unique identifiers (UUIDs) for elements.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Identity	identity	<a href="http://www.xes-standard.org/identity.xesext">http://www.xes-standard.org/identity.xesext</a>

4 **7.6.1 Attributes**

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Id	id	Log Trace Event Meta	ID	Unique identifier (UUID) for an element.

5 **7.7 Cost extension**

6 The cost extension defines a nested element to store information about the cost associated with activities  
 7 within a log. The objective of this extension is to provide semantics to cost aspects that can be associated  
 8 with events in a log. The definition associates three data elements with a particular cost element: the  
 9 amount associated with the cost element as well as the cost driver that is responsible for incurring that cost  
 10 and the cost type. As it is possible for more than one cost element to be associated with an event, the cost  
 11 incurred per event is summarized using the `total` attribute. The `currency` element is also recorded  
 12 once per event. Cost information can be recorded at the trace level (for instance, to be able to say that it  
 13 costs \$20 when a case is started). Cost information can also be recorded at the event level (for instance, for  
 14 certain event types such as complete or canceled events) to capture the cost incurred in undertaking the  
 15 activity by a resource.

<i>Name</i>	<i>Prefix</i>	<i>URI</i>
Cost	cost	<a href="http://www.xes-standard.org/cost.xesext">http://www.xes-standard.org/cost.xesext</a>

## 1 7.7.1 Attributes

<i>Name</i>	<i>Key</i>	<i>Components</i>	<i>Datatype</i>	<i>Description</i>
Total	total	Trace Event	xs:double	Total cost incurred for a trace or an event. The value represents the sum of all the cost amounts within the element.
Currency	currency	Trace Event	xs:string	The currency (using the ISO 4217:2008 Standard) of all costs of this element.
Drivers	drivers	Trace Event	List	A detailed list containing cost driver details.
Amount	amount	Meta	xs:double	The value contains the cost amount for a cost driver.
Driver	driver	Meta	xs:string	The value contains the id for the cost driver.
Type	type	Meta	xs:string	The value contains the cost type (e.g., Fixed, Overhead, Materials).

2 The `drivers` attribute shall contain any number of `driver` attributes, and every `driver` attribute shall  
3 contain the `amount` and `type` attribute, like follows:

```

4 <event>
5   <string key="cost:currency" value="AUD" />
6   <string key="cost:total" value="123.50" />
7   <list key="cost:drivers">
8     <values>
9       <string key="driver" value="d2f4ee27">
10        <float key="amount" value="21.40" />
11        <string key="type" value="Labour" />
12      </string>
13      <string key="driver" value="abc124">
14        <float key="amount" value="102.10" />
15        <string key="type" value="Variable Overhead" />
16      </string>
17    </values>
18  </list>
19 </event>

```

## 20 8. XES Conformance

21 Conformance to the XES part of this Standard is discussed in 8.1 and 8.2. In 8.1 and 8.2, *strictly*  
22 *conforming XES XML instance* and *conforming XES XML instance* refer to the metadata represented in the  
23 XES XML instance before any processing of the XES XML instance.

## 1 **8.1 Strictly conforming XES instances**

2 A strictly conforming XES instance shall consist solely of XES data elements as defined in Clause 4, and  
3 shall conform to the requirements of Clause 4. A strictly conforming XES XML instance

- 4 • Shall be a strictly conforming XES instance as defined before
- 5 • Shall conform to the requirements of Clause 5
- 6 • May not include XML elements or attributes that are not defined in Clause 5
- 7 • May not include mixed content

## 8 **8.2 Conforming XES instances**

9 A conforming XES instance may contain XES data elements as defined in Clause 4, and shall conform to  
10 the requirements of Clause 4. A conforming XES XML instance

- 11 • Shall be a conforming XES instance as defined before
- 12 • Shall conform to the requirements of Clause 5
- 13 • May include XML elements or attributes that are not defined in Clause 5
- 14 • May include mixed content

## 15 **9. XESEXT Conformance**

16 Conformance to the XESEXT part of this Standard is discussed in 9.1 and 9.2. In 9.1 and 9.2, *strictly*  
17 *conforming XESEXT XML instance* and *conforming XESEXT XML instance* refer to the metadata  
18 represented in the XESEXT XML instance before any processing of the XESEXT XML instance.

### 19 **9.1 Strictly conforming XESEXT instances**

20 A strictly conforming XESEXT instance shall consist solely of XESEXT data elements as defined in  
21 Clause 4.5, and shall conform to the requirements of Clause 4.5. A strictly conforming XESEXT XML  
22 instance

- 23 • Shall be a strictly conforming XES instance as defined before
- 24 • Shall conform to the requirements of Clause 6
- 25 • May not include XML elements or attributes that are not defined in Clause 6
- 26 • May not include mixed content

## 1 **9.2 Conforming XESEXT instances**

2 A conforming XESEXT instance may contain XESEXT data elements as defined in Clause 4.5, and shall  
3 conform to the requirements of Clause 4.5. A conforming XES XML instance

- 4     • Shall be a conforming XES instance as defined before
- 5     • Shall conform to the requirements of Clause 6
- 6     • May include XML elements or attributes that are not defined in Clause 6
- 7     • May include mixed content

## 1 **Annex A**

2 (informative)

### 3 **History of XES**

4 Unlike classical process analysis tools which are purely model-based (like simulation models), process  
5 mining requires event logs. Fortunately, today's systems provide detailed event logs. Process mining has  
6 emerged as a way to analyze systems (and their actual use) based on the event logs they produce [B1],  
7 [B2], [B3], [B4], [B6], [B25]. Note that, unlike classical data mining, the focus of process mining is on  
8 concurrent processes and not on static or mainly sequential structures. Also note that commercial Business  
9 Intelligence (BI for short) tools are not doing any process mining. They typically look at aggregate data  
10 seen from an external perspective (including frequencies, averages, utilization levels, and service levels).  
11 Unlike BI tools, process mining looks "inside the process" and allows for insights at a much more refined  
12 level.

13 The omnipresence of event logs is an important enabler of process mining, as analysis of run-time behavior  
14 is only possible if events are recorded. Fortunately, all kinds of information systems provide such logs,  
15 which include classical workflow management systems like FileNet and Staffware, ERP systems like SAP,  
16 case handling systems like BPM[one], PDM systems like Windchill, CRM systems like Microsoft Dynamics  
17 CRM, and hospital information systems like Chipsoft. These systems provide very detailed information  
18 about the activities that have been executed.

19 However, also all kinds of embedded systems increasingly log events. An embedded system is a special-  
20 purpose system in which the computer is completely encapsulated by or dedicated to the device or system it  
21 controls. Examples include medical systems like X-ray machines, mobile phones, car entertainment  
22 systems, production systems like wafer steppers, copiers, and sensor networks. Software plays an  
23 increasingly important role in such systems and, already today, many of these systems log events. An  
24 example is the "CUSTOMerCARE Remote Services Network" of Philips Medical Systems (PMS for  
25 short), which is a worldwide internet-based private network that links PMS equipment to remote service  
26 centers. Any event that occurs within an X-ray machine (like moving the table or setting the deflector) is  
27 recorded and can be analyzed remotely by PMS. The logging capabilities of the machines of PMS illustrate  
28 the way in which embedded systems produce event logs.

29 The MXML format [B10] has proven its use as a standard event log format in process mining. However,  
30 based on practical experiences with applying MXML in about one hundred organizations, several problems  
31 and limitations related to the MXML format have been discovered. One of the main problems is the  
32 semantics of additional attributes stored in the event log. In MXML, these are all treated as string values  
33 with a key and have no generally understood meaning. Another problem is the nomenclature used for  
34 different concepts. This is caused by MXML's assumption that strictly structured process would be stored  
35 in this format [B11].

36 To solve the problems encountered with MXML and to create a standard that could also be used to store  
37 event logs from many different information systems directly, a new event log format was developed. This  
38 new event log format is named XES, which stands for eXtensible Event Stream [B31]. This XES standard  
39 has been adopted for standardization by the IEEE Task Force Process Mining [B11].

## 1 **Annex B**

2 (informative)

### 3 **Current status of XES**

4 At the moment, there already exists a XES standard [B15] (which has not been endorsed by the IEEE),  
5 which comes with a reference implementation called OpenXES [B12]. The IEEE XES Standard differs  
6 from the XES 2.0 standard in the following respects (see also [B29]):

- 7       • Events in logs. In the XES 2.0 standard, every event had to be contained in some trace. In the  
8       IEEE XES Standard, events may also be contained by the log itself.
- 9       • Classifiers use ordered attribute keys. In the XES 2.0 standard, a classifier corresponds to a set of  
10       attribute keys. In the IEEE XES Standard, a classifier corresponds to a list of attribute keys.
- 11       • Trace classifier. In the XES 2.0 standard, only event classifiers were defined. In the IEEE XES  
12       Standard, also a trace classifier is defined, which allows to classify an entire trace. This can be  
13       useful in case the events in that trace lack the attributes for a corresponding event classifier.
- 14       • List attribute values. In the XES 2.0 standard, a list could not have any metadata as all attributes of  
15       the list were considered to be values of this list. In the IEEE XES Standard, there is a new element  
16       called `values` to hold the list values, which allows for the list metadata.
- 17       • Container attributes. In the XES 2.0 standard, a container attribute was defined. In the IEEE XES  
18       Standard, this attribute has been dropped. The list attribute suffices.
- 19       • Lifecycle extension. In the XES 2.0 standard, only the transition labels were defined. In the IEEE  
20       XES Standard, also the state labels (as introduced by [B21]) are used.
- 21       • Timestamps. In the XES 2.0 standard, timestamps could be local timestamps, that is, they were  
22       allowed to lack relevant time zone information. In the IEEE XES Standard, timestamps are  
23       required to in UTC time, which enforces either using the UTC time zone or using a time offset to  
24       the UTC time zone.



## 1 **Annex C**

2 (informative)

### 3 **XES support**

#### 4 **C.1 Tool support**

5 The latest version of the XES standard, 2.0, is supported by many tools including the following tools:

- 6 • AProMore [B29], an advanced process model repository.
- 7 • Celonis Process Mining [B5], a process mining tool that retrieves and visualizes all of the process  
8 data saved in your IT systems.
- 9 • CoBeFra [B23], a comprehensive benchmarking framework for conformance checking.
- 10 • CoPrA Tool [B33], a tool for communication analysis and process mining of team processes.
- 11 • Disco [B11], a process mining tool that helps you to discover your processes.
- 12 • Flipflop [B22], a test and Flip net synthesis tool for the automated synthesis of surgical procedure  
13 models.
- 14 • JIRAVIEW [B18], a tool to extract data from JIRA through REST and create charts.
- 15 • Lean Document Production [B26] toolkit, a Xerox toolkit [B34] to model and analyze complex  
16 print operations.
- 17 • minit [B19], a modern process mining tool for complex process discovery, visualization and  
18 analysis.
- 19 • OpenXES [B12], The XES reference implementation, an Open Source Java library for reading,  
20 storing, and writing XES logs.
- 21 • PMLAB [B32], a scripting environment for Process Mining in Python, which allows to perform  
22 exploratory process-oriented computing and/or research in a process-oriented language.
- 23 • ProM 6 [B13], an extensible Process Mining framework, which is basically the breeding ground  
24 for many new process mining related techniques.
- 25 • RapidProM [B14], a ProM 6 Framework extension to RapidMiner 5.3.
- 26 • Rialto PI (Process Intelligence). The Rialto suite [B16] from Exeura covers Data Mining, Text  
27 Mining, Reasoning and Process Mining in one single environment.
- 28 • ruby-xes [B30], a Ruby library for generating XES event log.
- 29 • XES Python Tool [B25], a simple Python tool for generating XES files for Process Mining.
- 30 • XESame, a tool for extracting XES logs from databased, distributed with ProM 6.

- 1       • YAWL [B35], a BPM/Workflow system, based on a concise and powerful modelling language,  
2       that handles complex data transformations, and full integration with organizational resources and  
3       external Web Services.

## 4       **C.2 Data support**

5       A number of datasets have been published that use the XES standard:

- 6       • A real-life log from 5 Dutch Municipalities containing all building permit applications over a  
7       period of approximately five years [B8].
- 8       • A real-life log from a Dutch Financial Institute which contains some 262.200 events in 13.087  
9       cases [B7].
- 10      • A real-life log from a Dutch Academic Hospital which contains some 150.000 events in over 1100  
11      cases [B9].
- 12      • A real-life log from Volvo IT Belgium [B28]. The log contains events from an incident and  
13      problem management system called VINST.

14      These datasets are publicly available and can be used as benchmark datasets for many Computational  
15      Intelligence techniques. The use of the DOIs makes it easy to refer to the datasets.

## 16      **C.3 Publication support**

17      The XES standard has appeared in a number of publications:

- 18      • Aalst, W.M.P. van der, *Process Mining: Discovery, Conformance and Enhancement*. Heidelberg:  
19      Springer, 2011.
- 20      • Aalst, W.M.P. van der et al., “Process Mining Manifesto.” In *BPM 2011 Workshops*, LNBIP 99,  
21      edited by F. Daniel, et al., 169–194. Heidelberg: Springer, 2012.
- 22      • Aalst, W.M.P. van der and Dongen, B.F. van, “Discovering Petri Nets from Event Logs.” In  
23      *ToPNoC VII*, LNCS 7480, edited by K. Jensen et al., 372–422. Heidelberg: Springer, 2013.
- 24      • Accorsi, R., Wonnemann, C., and Dochow, S., “SWAT: A Security Analysis Toolkit for Reliably  
25      Process-aware Information Systems.” In *Workshop on Security Aspects of Process-aware*  
26      *Information*, 692–697. IEEE Computer Society, 2011.
- 27      • Accorsi, R., Stocker, T., and Müller, G., “On the Exploitation of Process Mining for Security  
28      Audits: The Process Discovery Case.” In *SAC 2012*, 1709–1716. ACM, 2012.
- 29      • Aruna Devi. C and Sudhamani, “Application Of Business Process Mining Using Control Flow  
30      Perspective In Manufacturing Unit,” *International Journal of Emerging Trends & Technology in*  
31      *Computer Science*, vol. 2, no. 5, pp. 130–133, 2013.
- 32      • Baumgrass, A., “Deriving Current-State RBAC Models from Event Logs.” In *International*  
33      *Workshop on Security Aspects of Process-aware Information Systems (SAPAIS), Proc. of the 6th*  
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- 13 • Bui, D.B., Dazic, F., and Hecker, M., “Application of Tree-structured Data Mining for Analysis of  
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- 16 • Burattin, A., *Process Mining Techniques in Business Environments: Theoretical Aspects,*  
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- 19 • Burattin, A., Maggi, F.M., and Sperduti, A., “Conformance Checking Based on Multi-Perspective  
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- 36 • Singh, L. and Chetty, G., “A Comparative Study of MRI Data Using Various Machine Learning  
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- 1 • Suriadi, S. et al., “Root Cause Analysis with Enriched Process Logs.” In *BPM 2012 Workshops*,  
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## 1 Annex D

2 (informative)

### 3 XESEXT Example

4 We have chosen the Semantic Extension (see 7.5) to exemplify the XESEXT format for XES extensions.  
 5 This extension defines, on each level of abstraction (log, trace, event, and meta), the same string-based  
 6 attribute modelReference. Attributes can be defined on all four levels of abstraction, similar to attribute  
 7 declarations in XES (while omitting the value attribute). For every defined attribute, the XESEXT  
 8 document may feature an arbitrary number of alias mappings as child elements. These mappings define a  
 9 human-readable alias for the attribute within a given namespace (typically a country code, used for  
 10 localization).

```

11 <?xml version="1.0" encoding="UTF-8" ?>
12 <xesextension name="Semantic"
13     prefix="semantic"
14     uri="http://www.xes-standard.org/semantic.xesext">
15
16     <log>
17         <string key="modelReference">
18             <alias mapping="EN" name="Ontology Model Reference" >
19             <alias mapping="DE" name="Ontologie-Modellreferenz" />
20             <alias mapping="FR" name="Référence au Modèle Ontologique" />
21             <alias mapping="ES" name="Referencia de Modelo Ontológico" />
22             <alias mapping="PT" name="Referência de Modelo Ontológico" />
23         </string>
24     </log>
25
26     <trace>
27         <string key="modelReference">
28             <alias mapping="EN" name="Ontology Model Reference" />
29             <alias mapping="DE" name="Ontologie-Modellreferenz" />
30             <alias mapping="FR" name="Référence au Modèle Ontologique" />
31             <alias mapping="ES" name="Referencia de Modelo Ontológico" />
32             <alias mapping="PT" name="Referência de Modelo Ontológico" />
33         </string>
34     </trace>
35
36     <event>
37         <string key="modelReference">
38             <alias mapping="EN" name="Ontology Model Reference" />
39             <alias mapping="DE" name="Ontologie-Modellreferenz" />
40             <alias mapping="FR" name="Référence au Modèle Ontologique" />
41             <alias mapping="ES" name="Referencia de Modelo Ontológico" />
42             <alias mapping="PT" name="Referência de Modelo Ontológico" />
43         </string>
44     </event>
45
46     <meta>
47         <string key="modelReference">
48             <alias mapping="EN" name="Ontology Model Reference" />
49             <alias mapping="DE" name="Ontologie-Modellreferenz" />
50             <alias mapping="FR" name="Référence au Modèle Ontologique" />

```

```
1         <alias mapping="ES" name="Referencia de Modelo Ontológico" />
2         <alias mapping="PT" name="Referência de Modelo Ontológico" />
3     </string>
4 </meta>
5
6 </xesextension>
```

1 **Annex E**

2 (normative)

3 **XES Schema definition (XSD)**

4 This XESEXT XML Schema definition is based on the types defined in XML Schema Part 2: Datatypes,  
 5 Second Edition and the structure types defined in XML Schema Part 1: Structures, Second Edition.

```

6 <?xml version="1.0" encoding="UTF-8"?>
7 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
8     elementFormDefault="qualified">
9
10 <xs:element name="log" type="LogType"/>
11
12 <!-- Attributables -->
13 <xs:complexType name="AttributableType">
14 <xs:choice minOccurs="0" maxOccurs="unbounded">
15 <xs:element name="string" minOccurs="0" maxOccurs="unbounded"
16     type="AttributeStringType" />
17 <xs:element name="date" minOccurs="0" maxOccurs="unbounded"
18     type="AttributeDateType" />
19 <xs:element name="int" minOccurs="0" maxOccurs="unbounded"
20     type="AttributeIntType" />
21 <xs:element name="float" minOccurs="0" maxOccurs="unbounded"
22     type="AttributeFloatType" />
23 <xs:element name="boolean" minOccurs="0" maxOccurs="unbounded"
24     type="AttributeBooleanType" />
25 <xs:element name="id" minOccurs="0" maxOccurs="unbounded"
26     type="AttributeIDType" />
27 <xs:element name="list" minOccurs="0" maxOccurs="unbounded"
28     type="AttributeListType" />
29 </xs:choice>
30 </xs:complexType>
31
32 <!-- String attribute -->
33 <xs:complexType name="AttributeStringType">
34 <xs:complexContent>
35 <xs:extension base="AttributeType">
36 <xs:attribute name="value" use="required" type="xs:string" />
37 </xs:extension>
38 </xs:complexContent>
39 </xs:complexType>
40
41 <!-- Date attribute -->
42 <xs:complexType name="AttributeDateType">
43 <xs:complexContent>
44 <xs:extension base="AttributeType">
45 <xs:attribute name="value" use="required" type="xs:dateTime" />
46 </xs:extension>
47 </xs:complexContent>
48 </xs:complexType>
49
50 <!-- Integer attribute -->
```



```

1 <xs:complexType name="AttributeIntType">
2   <xs:complexContent>
3     <xs:extension base="AttributeType">
4       <xs:attribute name="value" use="required" type="xs:long" />
5     </xs:extension>
6   </xs:complexContent>
7 </xs:complexType>
8
9 <!-- Floating-point attribute -->
10 <xs:complexType name="AttributeFloatType">
11   <xs:complexContent>
12     <xs:extension base="AttributeType">
13       <xs:attribute name="value" use="required" type="xs:double" />
14     </xs:extension>
15   </xs:complexContent>
16 </xs:complexType>
17
18 <!-- Boolean attribute -->
19 <xs:complexType name="AttributeBooleanType">
20   <xs:complexContent>
21     <xs:extension base="AttributeType">
22       <xs:attribute name="value" use="required" type="xs:boolean" />
23     </xs:extension>
24   </xs:complexContent>
25 </xs:complexType>
26
27 <!-- ID attribute -->
28 <xs:complexType name="AttributeIDType">
29   <xs:complexContent>
30     <xs:extension base="AttributeType">
31       <xs:attribute name="value" use="required" type="xs:string" />
32     </xs:extension>
33   </xs:complexContent>
34 </xs:complexType>
35
36 <!-- List attribute -->
37 <xs:complexType name="AttributeListType">
38   <xs:complexContent>
39     <xs:extension base="AttributeType">
40       <xs:sequence>
41         <xs:element name="values" minOccurs="1" maxOccurs="1"
42           type="AttributeType" />
43       </xs:sequence>
44     </xs:extension>
45   </xs:complexContent>
46 </xs:complexType>
47
48 <!-- Extension definition -->
49 <xs:complexType name="ExtensionType">
50   <xs:attribute name="name" use="required" type="xs:NCName" />
51   <xs:attribute name="prefix" use="required" type="xs:NCName" />
52   <xs:attribute name="uri" use="required" type="xs:anyURI" />
53 </xs:complexType>
54
55 <!-- Globals definition -->
56 <xs:complexType name="GlobalsType">
57   <xs:complexContent>

```

```

1      <xs:extension base="AttributableType">
2          <xs:attribute name="scope" type="xs:NCName" use="required" />
3      </xs:extension>
4  </xs:complexContent>
5 </xs:complexType>
6
7 <!-- Classifier definition -->
8 <xs:complexType name="ClassifierType">
9     <xs:attribute name="name" type="xs:NCName" use="required" />
10    <xs:attribute name="scope" type="xs:NCName" use="required" />
11    <xs:attribute name="keys" type="xs:token" use="required" />
12 </xs:complexType>
13
14 <!-- Attribute -->
15 <xs:complexType name="AttributeType">
16     <xs:complexContent>
17         <xs:extension base="AttributableType">
18             <xs:attribute name="key" use="required" type="xs:Name" />
19         </xs:extension>
20     </xs:complexContent>
21 </xs:complexType>
22
23 <!-- Elements may contain attributes -->
24 <xs:complexType name="ComponentType">
25     <xs:complexContent>
26         <xs:extension base="AttributableType" />
27     </xs:complexContent>
28 </xs:complexType>
29
30 <!-- Logs are elements that may contain traces -->
31 <xs:complexType name="LogType">
32     <xs:complexContent>
33         <xs:extension base="ComponentType">
34             <xs:sequence>
35                 <xs:element name="extension" minOccurs="0"
36                     maxOccurs="unbounded" type="ExtensionType" />
37                 <xs:element name="global" minOccurs="0"
38                     maxOccurs="unbounded" type="GlobalsType" />
39                 <xs:element name="classifier" minOccurs="0"
40                     maxOccurs="unbounded" type="ClassifierType" />
41                 <xs:element name="trace" minOccurs="0" maxOccurs="unbounded"
42                     type="TraceType" />
43                 <xs:element name="event" minOccurs="0" maxOccurs="unbounded"
44                     type="EventType" />
45             </xs:sequence>
46             <xs:attribute name="xes.version" type="xs:decimal"
47                 use="required" />
48             <xs:attribute name="xes.features" type="xs:token" />
49         </xs:extension>
50     </xs:complexContent>
51 </xs:complexType>
52
53 <!-- Traces are elements that may contain events -->
54 <xs:complexType name="TraceType">
55     <xs:complexContent>
56         <xs:extension base="ComponentType">
57             <xs:sequence>

```

```
1         <xs:element name="event" minOccurs="0" maxOccurs="unbounded"
2             type="EventType" />
3     </xs:sequence>
4 </xs:extension>
5 </xs:complexContent>
6 </xs:complexType>
7
8 <!-- Events are elements -->
9 <xs:complexType name="EventType">
10     <xs:complexContent>
11         <xs:extension base="ComponentType">
12             </xs:extension>
13         </xs:complexContent>
14     </xs:complexType>
15
16 </xs:schema>
```

1 **Annex F**

2 (normative)

3 **XESEXT Schema definition (XSD)**

4 This XESEXT XML Schema definition is based on the types defined in XML Schema Part 2: Datatypes,  
 5 Second Edition and the structure types defined in XML Schema Part 1: Structures, Second Edition.

```

6 <?xml version="1.0" encoding="UTF-8"?>
7 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
8     elementFormDefault="qualified">
9
10     <xs:element name="xesextension">
11         <xs:complexType>
12             <xs:sequence>
13                 <xs:element name="log" type="AttributableType" minOccurs="0" />
14                 <xs:element name="trace" type="AttributableType"
15                     minOccurs="0" />
16                 <xs:element name="event" type="AttributableType"
17                     minOccurs="0" />
18                 <xs:element name="meta" type="AttributableType"
19                     minOccurs="0" />
20             </xs:sequence>
21             <xs:attribute name="name" type="xs:NCName" use="required" />
22             <xs:attribute name="prefix" type="xs:NCName" use="required" />
23             <xs:attribute name="uri" type="xs:anyURI" use="required" />
24         </xs:complexType>
25     </xs:element>
26
27     <!-- Attributes -->
28     <xs:complexType name="AttributableType">
29         <xs:choice minOccurs="0" maxOccurs="unbounded">
30             <xs:element name="string" type="AttributeType" />
31             <xs:element name="date" type="AttributeType" />
32             <xs:element name="int" type="AttributeType" />
33             <xs:element name="float" type="AttributeType" />
34             <xs:element name="boolean" type="AttributeType" />
35             <xs:element name="id" type="AttributeType" />
36             <xs:element name="list" type="AttributeType" />
37         </xs:choice>
38     </xs:complexType>
39
40     <!-- Attribute -->
41     <xs:complexType name="AttributeType">
42         <xs:sequence>
43             <xs:element name="alias" type="AliasType"
44                 minOccurs="0" maxOccurs="unbounded" />
45         </xs:sequence>
46         <xs:attribute name="key" type="xs:Name" use="required" />
47     </xs:complexType>
48
49     <!-- Alias definition, defining a mapping alias for an attribute -->
50     <xs:complexType name="AliasType">

```

```
1     <xs:attribute name="mapping" type="xs:NCName" use="required" />
2     <xs:attribute name="name" type="xs:string" use="required" />
3 </xs:complexType>
4
5 </xs:schema>
```

## 1 Annex G

2 (informative)

### 3 Bibliography

4 Bibliographical references are resources that provide additional or helpful material but do not need to be  
5 understood or used to implement this standard. Reference to these resources is made for informational use  
6 only.

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## 1 **Annex R**

2 (informative)

### 3 **Revision history**

4 This annex contains the revision history of this Standards proposal, and is to be omitted from the final  
5 Standard proposal.

#### 6 **R.1 May 21<sup>st</sup>, 2015: Initial revision**

#### 7 **R.2 June 1<sup>st</sup>, 2015: Created annex for tool, data, and publication support**

- 8
- Fixed some typos.

#### 9 **R.3 June 2<sup>nd</sup>, 2015: Fixed citation style to Chicago.**

- 10
- Resorted citations accordingly.
- 11
- Fixed references to citations.

#### 12 **R.4 June 26<sup>th</sup>, 2015: Comments of Moe Wynn, fixed some other glitches.**

- 13
- Textual changes based on comments of Moe.
- 14
- Fixed event notation in Clause 4.4.3.
- 15
- Fixed undefined references in Clause 8 and Clause 9.

#### 16 **R.5 June 29<sup>th</sup>, 2015: Comments of Lijie Wen.**

- 17
- Textual changes based on comments of Lijie.

#### 18 **R.6 June 30<sup>th</sup>, 2015: Comments of JC Bose and Walter van Herle.**

- 19
- Added Xerox Lean Document Production toolkit, as suggested by JC Bose, together with two
- 20
- Added Rialto PI, as suggested by Walter van Herle, together with a reference.
- 21

#### 22 **R.7 July 10<sup>th</sup>, 2015: Comments of Alexander Rinke.**

- 23
- Added Celonis Process Mining tool, as suggested by Alexander Rinke.



- 1       • Updated all fields.

2       **R.8 October 2<sup>nd</sup>, 2015: Comments of Josep Carmona.**

- 3       • Added PMLAB as tool that supports XES, with a reference.  
4       • Added all members to the WG.  
5       • Updated month in header.

6       **R.9 October 6<sup>th</sup>, 2015: Comments of Michal Rosik.**

- 7       • Added minit as tool that supports XES, with reference.  
8       • Added Michal as WG participant.

9       **R.10 November 4<sup>th</sup>, 2015: Comments of Zbigniew Paszkiewicz.**

- 10      • Minor textual changes.

11      **R.11 December 2<sup>nd</sup>, 2015: First draft for balloting**

- 12      • Updated header.

13      **R.12 January 5<sup>th</sup>, 2016: Pre-ballot MEC**

- 14      • Updated Scope and Purpose.  
15      • Inserted Notice to Users.  
16      • Reviewed use of shall/should/may/can/will/must.  
17      • Removed references to UUID and namespaces.  
18      • Changed Annex E and Annex F (containing the XML Schemas) to normative.  
19      • Resolved inconsistency with global declarations.  
20      • Updated header, changed D01 into D02.

21      **R.13 June 21<sup>st</sup>, 2016: Revision due to ballot comments**

- 22      • Added texts in Annex E and Annex F to explain that both annexes use an XML Schema as defined  
23      by the last two normative references as mentioned in Clause 2.  
24      • Changed wording in Annex C.1 as suggested by the IEEE editor.

- 1 • Clauses 4.2.12, 5.4, 7.4, and 7.4.1: Required timestamps to be in UTC time.
- 2 • Annex B: Added item to emphasize the required use of UTC times in timestamps.
- 3 • Changed D02 into D03.