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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 7, *Software and systems engineering*.

A list of all parts in the ISO/IEC 19770 series can be found on the ISO website.

Guidelines for mapping of industry Software Asset Management (SAM) practices with the ISO/IEC 19770 series of standards and guidelines for the application of ISO/IEC 19770-1 for small organizations will form the subjects of future ISO/IEC 19770-8 and ISO/IEC 19770-11, respectively.

Introduction

0.1 Overview

International Standards in the ISO/IEC 19770 series of standards for IT asset management (ITAM) address both the processes and technology for managing IT assets. Because IT is an essential enabler for almost all activity in today's world, these standards should integrate tightly into all of IT. For example, from a process perspective, ITAM standards should be able to be used with all management system standards, because hardware and software, and management of hardware and software management are essential components of any modern management system. From a technology perspective, ITAM standards for information structures provide not only for the interoperability of IT management data, but also provide the basis for many additional benefits such as more effective security in the use of software. ITAM standards for information structures also facilitate significant automation of IT functionality, such as improved authentication of software and easier and more consistent collection of data relating to the use of that software.

0.2 Purpose of this document

This document provides an International Standard for Resource Utilization Measurement (RUM). A RUM is a standardized structure containing usage information about the resources that are related to the use of an IT asset. A RUM will often be provided in an XML data file, but the same information may be accessible through other means depending on the platform and the IT asset/product.

This document contains information structures that are designed to align with the identification information defined in ISO/IEC 19770-2, and with the entitlement information defined in ISO/IEC 19770-3. When used together, these three types of information have the capability to significantly enhance and automate the processes of IT asset management.

This document supports the IT asset management processes defined in ISO/IEC 19770-1. This document also supports the other parts of the ISO/IEC 19770 series of standards that define information structures.

The RUM is specifically designed to be general-purpose and usable in a wide variety of situations. Like other information structures defined in the ISO/IEC 19770 series of standards, the consumer of a RUM may be an organization and/or a tool or other consumers. In contrast to the other information structures in the ISO/IEC 19770 series, the entity creating a RUM data on a periodic basis will likely be an IT asset or an automation tool monitoring an IT asset.

The definition of a RUM will benefit all stakeholders involved in the creation, licensing, distribution, releasing, installation, and on-going management of IT assets. Key benefits associated with a RUM for three specific groups of stakeholders include:

— IT asset users

  — RUM data will typically be generated and processed by IT assets and automation tools, within the consumers enterprise boundary, for purpose of IT asset compliance and optimization;

  — RUM data is human readable and can provide improved visibility into resource utilization within IT assets independent of vendor or third-party supplied tools;

  — the ability to combine identification, entitlement, and resource utilization information together to perform quantitative and authoritative IT asset management, for example, to meet compliance requirements;

  - a much-improved ability to perform IT asset management in support of green data center strategies such as optimization of the use of power and air conditioning;

- IT asset manufacturers
  - the ability to consistently and authoritatively generate resource utilization information for consumption by a central facility that is maintained by the creator, or one or more third-party tools, or by the IT asset users;
  - the ability to support multiple instances and types of third-party tools with a single set of functionality within the IT asset;
  - the ability to offer a service to track real-time IT asset usage in the field and, when combined with identification and entitlement information, the ability to give advance warning as resource limits are approached;
  - the ability to offer an alternative approach to asset utilization measurement to traditional techniques that employ key-based, or platform-restricted licenses;
- Tool vendors
  - the ability to support multiple IT assets, and types of IT asset, without having to create and maintain unique instrumentation that is associated with each asset;
  - the ability to more easily aggregate usage information across multiple instances of an asset;
  - a much-improved ability to track resource utilization and IT assets in near real-time.

This document is divided into the following clauses and annexes:

- Clause 1 is the scope;
- Clause 2 describes the normative references;
- Clause 3 describes the terms, definitions, symbols, and abbreviations used in this document;
- Clause 4 defines conformance;
- Clause 5 describes key concepts;
- Clause 6 defines implementation requirements and gives guidance;
- Clause 7 defines tool requirements;
- Clause 8 defines the elements of the RUM;
- Annex A contains the XML schema document (XSD) for the RUM;
- Annex B gives examples of RUMs; and
- Annex C gives methods of linking a RUM to a specific software asset.

This document is not intended to conflict either with any organization's policies, procedures, or standards. Any such conflict should be resolved before using this document.

Information technology — IT asset management —

Part 4:
Resource utilization measurement

1 Scope

1.1 Purpose

This document establishes specifications for an information structure to contain Resource Utilization Measurement information to facilitate IT asset management (ITAM).

This document is applicable to all types of organization (for example, commercial enterprises, government agencies, and non-profit organizations).

1.2 Field of application

This document applies to the following.

a) IT asset manufacturers: These are the entities that create IT assets for distribution or installation.

b) Tool providers: These are the entities that may provide any number of tools that use the information contained in a Resource Utilization Measurement (RUM). These tools will include aggregation facilities capable of producing consolidated reports of the utilization of resources throughout an organization, and threshold reporting facilities capable of generating an alarm when utilization reaches a predetermined level.

c) IT asset users: These are the entities that purchase, use IT assets, and who are intended as one of the major beneficiaries of the visibility made possible by the information that is contained within the RUM.

1.3 Limitations

This document does not detail ITAM processes required for the reconciliation of resource utilization information with other types of information such as identification and entitlement information.

This document only defines an information structure, and does not define how that information is communicated between systems, or how resource measurement information from different systems is reconciled or consolidated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19770-5, *Information Technology — Software asset management — Overview and vocabulary*

ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

RFC 3986, *Uniform Resource Identifier (URI): Generic Syntax, January 2005, http://tools.ietf.org/html/rfc3986*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19770-5 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

NOTE In these definitions, the generic term *{info struct} that* is used in ISO/IEC 19770-5 to reference an ISO/IEC 19770 information structure, is replaced by the term RUM. Unlike ISO/IEC 19770-2, the term "tag" is not used because the information structure defined in this document may not always be realized as an XML file, and thus the term "tag" is not always appropriate.

3.1
asset
item, thing, or entity that has potential or actual value to an organization

Note 1 to entry: Value can be tangible or intangible, financial, or non-financial, and includes consideration of risks and liabilities. It can be positive or negative at different stages of the asset's life.

Note 2 to entry: For most organizations, physical assets usually refer to equipment, inventory, and properties owned by the organization. Physical assets are the opposite of intangible assets, which are non-physical assets such as leases, brands, digital assets, use rights, licenses, intellectual property rights, reputation or agreements.

Note 3 to entry: A grouping of assets referred to as an asset system could also be considered as an asset.

Note 4 to entry: ISO/IEC 19770-5 incorporated a slightly different definition of asset, taken from a development version of ISO 55000. This definition is sourced from the latest published version ISO/IEC 19770-5, which is in turn aligned with ISO 55000.

[SOURCE: ISO/IEC 19770-5:2015, 3.2]

3.2
element
component of an *info struct* that provides information related to the entity represented by the *info struct*

[SOURCE: ISO/IEC 19770-5:2015, 3.12]

3.3
extensible markup language
XML
license-free and platform-independent markup language that carries rules for generating text formats that contain structured data

[SOURCE: W3C Recommendation Extensible Markup Language (XML) 1.1 (Second Edition), 1.2]

3.4
globally unique identifier
GUID
16-byte string of characters that is generated in a manner that gives a high probability that the string is unique in any context

Note 1 to entry: Other globally unique identifier algorithms can be used in some situations. In general, alternative algorithms use uniform resource identifier (URI) based structures, so the id owner's *registration identifier (regid)* is included in the identifier.

Note 2 to entry: In this document, GUID as an all capitalized term refers specifically to the 16-byte version. If the term is in lowercase (guid), it refers to a general algorithm that can use either a URI, or a 16-byte-based identifier.

[SOURCE: ISO/IEC 19770-5:2015, 3.16]

3.6
registration identifier
regid
unique identifier for an entity

Note 1 to entry: ISO/IEC 19770-5 incorporated a different definition of regid that defined a specific format.

[SOURCE: ISO/IEC 19770-5:2015, 3.27]

3.7
software identification tag
SWID tag
information structure (3.13) containing identification information about a software *configuration item*, which may be authoritative if provided by a *software creator*

[SOURCE: ISO/IEC 19770-5:2015, 3.40]

3.8
Resource Utilization Measurement
RUM
structure that provides information about resources associated with an IT *asset* (3.1) in order to facilitate its management

Note 1 to entry: In the case of a RUM, the structure specifically contains information about the consumption of resources in relation to an IT asset.

[SOURCE: ISO/IEC 19770-5:2015, 3.18, modified – Note 1 to entry has been added.]

3.9
RUM creator
entity that initially creates a RUM

Note 1 to entry: This entity can be part of the organization that created the IT asset, in which case the RUM creator and IT asset manufacturer will be the same. The RUM creator can also be a third-party organization unrelated to the IT asset manufacturer (such as in the case where tags are created for legacy software by third-party organizations). The RUM creator can also be a separate software tool that is used to measure usage of an IT asset.

[SOURCE: ISO/IEC 19770-5:2015, 3.19, modified – Note 1 to entry has been added.]

3.10
uniform resource identifier
URI
compact sequence of characters that identifies an abstract or physical resource available on the Internet

Note 1 to entry: The syntax that is used for URIs is defined in IETF RFC 3986.

[SOURCE: IETF RFC 3986, 1]

3.11
valid
status of a RUM that follows the specified *XML Schema document* and is valid from an XML perspective

[SOURCE: ISO/IEC 19770-5:2015, 3.52]

3.12
version
unique string of number and letter values indicating a unique revision of an item

Note 1 to entry: Versions are often referred to in software to identify revisions of software that provide unique functionality or fixes. A version typically has multiple parts with at least a major version indicating large changes in functionality or user interface changes and a minor version indicating smaller changes in functionality or user interface changes.

[SOURCE: ISO/IEC 19770-5:2015, 3.54]

3.13
information structure
structure that provides information about an IT *asset* (3.1) in order to facilitate its management

4 Conformance

4.1 RUM conformance

A Resource Utilization Measurement (RUM) is in conformance as specified in this document when the RUM obeys all normative requirements that are specified in this document.

4.2 Application conformance

Application conformance incorporates both syntax and semantics and are defined for producers of RUM and entities that are designed to process RUMs, as follows.

A conforming application (i.e. an IT asset, automation tool, etc.) that is designed to produce RUMs

— shall be able to produce RUMs conforming to this document.

An entity that is designed to process RUMs:

a) shall not reject any RUM conforming to this document which is in XML format and which conforms to the schema provided in Annex A;

b) shall treat the information in the RUM in a manner consistent with the semantic definitions given in this document. Such an application may choose not to process all of the information in the RUM, but any information that it does process shall be processed in a manner that is consistent with the semantic definitions given in this document;

c) shall, when necessary, be able to identify the version of the XML schema document (XSD) that is to be used for the RUM, and thus be able to process information in a manner that is consistent with that XSD. This is important because in the future, RUMs that conform to several different versions of this document may exist in the field concurrently, and it will thus be important that each version is processed with the correct XSD.

5 Key concepts

5.1 General

A Resource Utilization Measurement (RUM) is an information structure containing authoritative information about the consumption of resources in relation to an IT asset. The structure contains information to identify a particular instance of an IT asset (see 5.2), and one or more sets of resource utilization information that are contained within an element that is called a measurement (see 5.3). This subclause also contains a description of the relationship between the RUM and other information structure definitions within the ISO/IEC 19770 series of standards.

Consumers of RUMs shall be aware that some IT assets will append new measurement information to an existing file for a period in preference to creating a new file for each time. This is how software generally interacts with logs, and RUMs are sufficiently similar to logs that the same mechanism may also be used in this case.

5.2 Software asset and IT asset identification

Where a RUM contains resource utilization elements that are related to an IT asset that is referenced by a SWID tag, the RUM shall contain a Link element that references that SWID, and the unique identifier that is used in that SWID shall be employed in the creation of constructs within the RUM.

Where a RUM contains resource utilization elements that are related to an IT asset for which there is no SWID tag, the RUM shall incorporate an Asset element containing a unique identifier for that asset. Where both a Link element and an Asset element containing a unique identifier are included in a RUM, the Link element shall take precedence.

5.3 Measurements

A single RUM shall contain one or more elements that define a measurement. This is to support a situation where multiple measurement types may be available with a single IT asset. Specifically, the knowledge of which of those measurement types may be of interest in a particular instantiation may not be available within the IT asset itself, and therefore some assets will always report the measurement data of all of the resources of which they are aware.

Each measurement element shall contain:

a) the time at which the information was captured,

b) the start time of the period over which the utilization was measured,

c) the end time of the period over which the utilization was measured (which shall be equal to the start time for a point in time value),

d) the measurement type, which is defined by a text string, and

e) one or more values, each with an identified type.

Optional information and meta-information may also be associated with each measurement, or each value.

Note that the measurement in a RUM is only defined by a textual description of a metric, a type and a value. No mathematical description for a measurement is included, and no standard set of types are defined. It is expected that IT asset manufacturers will report already existing measurements in a RUM, and thus the textual description of the type will be defined by pre-existing practice.

5.4 Relationship to other ISO/IEC 19770 family information structures

This document is intended to complement the information structures that are defined by the other parts of ISO/IEC 19770 series of standards, but also to be usable independently. For instance, while it is preferred that a software asset to which a RUM relates be identified by a link to a SWID as defined by ISO/IEC 19770-2, the RUM also incorporates an optional structure which can contain a string that uniquely identifies an IT asset.

If the measurements that are defined in a RUM have a relationship to the entitlements defined in the ISO/IEC 19770-3, they shall have the same value of metricName (see 8.4.3). The details of that relationship between the measurements and the entitlement are outside of the scope of this document.

6 Implementation requirements and guidance

6.1 Usage scenario

The RUM is specifically designed to be general-purpose and usable in a wide variety of situations. The entity creating a RUM will be an IT asset or an automation tool monitoring an IT asset, and the information structure will generally be encapsulated within the entity, or within the file system of the

system upon which the entity is executing. In addition, while the RUM information may be deposited in a platform-specific repository, or communicated to a remote system or central facility, the details of both of these mechanisms are outside of the scope of this document.

6.2 Unique registration ID (regid)

6.2.1 Overview

RUMs may be created by IT assets produced by different organizations and do not strictly require a centralized registration authority. To accommodate these requirements, this document uses a regid. The regid provides a unique naming authority identifier.

6.2.2 Structure of regid

A regid shall use a URI reference in accordance with RFC 3986. Once an organization specifies a regid for their organization's IT asset, that regid shall be used consistently for all IT asset from the organization.

To ensure interoperability, allow for open source project support and third-party tag consistency, the following recommendations should be applied when creating a regid.

— Unless otherwise required, the URI should utilize the http scheme.

— If the http scheme is used, the "http://" may be left off the regid string (a string without a URI scheme specified is defined to use the "http://" scheme).

— Unless otherwise required, the URI should use an absolute-URI that includes an authority part, such as a domain name.

— To ensure consistency, the absolute-URI should use the minimum string required (for example, example.com should be used instead of www.example.com).

6.2.3 Examples of regid

A regid for a company that creates and sells software is expected to be the HTTP reference to that company. So a regid for the Fabrikam Company is:

"fabrikam.com"

A regid for an open source project called SampleProject that is hosted on sourceMyProject.net may be one of the following:

— sampleproject.sourcemyproject.net;

— sourcemyproject.net/sampleproject;

— sourcemyproject.net/?projectname=sampleproject.

The appropriate regid to choose for the project is dependent on the default reference used by the hosting site for the particular project.

6.3 XML and XSD

The RUM shall be defined as an XML data structure. The XML schema definition (XSD) to be used shall be that defined in Annex A, and that schema may be downloaded from:

http://standards.iso.org/iso-iec/19770/-4/ed-1

6.4 Time formats

All time information in this document shall be encoded in a date and time of day representation for a point in time as specified in ISO 8601. The use of UTC-based times is recommended. Use of the limited formats in the W3C note entitled "date and time formats" is also recommended. The ISO 8601 representations for a time interval, or a recurring time interval, shall not be used.

6.5 Frequency of generation

The frequency at which RUMs are generated is a function of both the IT asset and the specific measurement being reported and is not specified in this document. Some measurements may require a RUM to be generated at intervals as short as minutes, while others may require only to be reported at daily or weekly intervals.

Both measurements that relate to an instantaneous point in time, and a period of time, shall be supported. The period shall be defined by different start and end times, while for a point in time measurement the start and end times shall be identical.

Some measurements will also require information to be generated when a particular set of conditions are met (for example, a threshold is reached), while other measurements will require that information be generated at fixed or varying intervals. In this latter case, the intervals shall be contiguous and non-overlapping, that is the end time reported in one set of information will be identical to the start time of the next set of information. The start time of the first interval reported after an IT asset is installed shall be the installation or activation time, and where an asset is gracefully terminated or uninstalled the end time of the final interval shall be the termination time.

Automation tools shall be able to read the content of a RUM at any time, even during the process of generating or updating it. Tools shall ignore incomplete XML elements.

6.6 Filename

One of the form RUM can be represented is the file on the file system. When a RUM is contained within a file, the following rules and recommendations for the filename shall be used.

Where there is an SWID tag linked to the RUM, the filename shall be:

<SWIDtagfilename>.<logname>.integer

Where there is no SWID tag linked to the RUM, the filename shall be structured to be globally unique for the RUM creator and product.

RUM creators may use different approaches to defining the base portion of the filename of the file containing the RUM; however, if the filename aligns with the following structure, the filename will be globally unique for the product and recognizable by a system administrator:

<name of the RUM creator> + <product name>.<instanceidentifier>.<logname>.integer

Filenames should be restricted to use only the characters listed in the Portable Filename Character Set defined in IEEE std 1003.1, section 3.278 to maximize interoperability between platforms. If this limitation is too restrictive, the RUM creator shall ensure that the characters used in the filename are valid characters for all platforms where their RUMs may be stored in files(s) in a file system.

6.7 File extension

The extension of a file containing RUM data shall be .rum.

Where there is an SWID tag linked to the RUM, the filename shall be:

<SWIDtagfilename>.<logname>.integer.rum

6.8 File location

The location of a RUM is a function of the RUM creator and/or a data storage location defined and managed by the platform provider for the IT asset and is not specified in this document. It is allowed for a single directory to contain multiple RUMs, generated for example by different IT assets, or by some form of automation tool monitoring external IT assets.

6.9 Managing file sizes and file numbers

RUMs are similar in many ways to existing application log files, and are expected to be generated in a similar manner. Many IT assets set a maximum size for a log file, and define how many separate log files are to be retained for a period, and those assets may take the same approach with files containing RUMs. Thus, if a file containing RUMs exceeds the maximum size set, its content shall be saved in a file with a numbered suffix appended to its filename, and a new file shall be created to hold further RUM information. See B.1 for an example of the handling of multiple files.

The maximum file size value and the maximum number of files is a function of the implementation of the IT asset, and is not specified in this document. However, it is recommended that values be chosen that allow at least one month of usage history to be maintained on a device.

6.10 Uninstallation and upgrade

RUMs shall not be deleted when an IT asset is uninstalled or upgraded. This behaviour is consistent with the handling of log files in many applications. Where the linkage of the RUM and an IT asset identified by a SWID tag needs to be preserved across software upgrades, the linkage to the SWID tag shall not be specified by the SWID tagId attribute, but by another SWID tag attribute that will provide better traceability. One example of such linkage is by using the SWID software name attribute, but other mechanisms might also work for such a use case.

6.11 Digital signatures

The use of digital signatures with RUMs is optional. Where signatures are used, careful consideration should be given to situations where RUMs are generated frequently, or on a fixed schedule. It may be appropriate to only sign RUMs when they are communicated from the system on which they are generated to a remote system such as a central repository.

6.12 Nesting XML documents

IT asset instances may use an XML nesting mechanism to simplify the process of generating a RUM. This mechanism employs a root XML document containing header information and a measurement document that stores only measurement elements. Subsequent measurements can then easily be appended to the end of the measurement file. See B.3 for an example of nesting XML documents.

7 Tool considerations

It shall be possible to manually extract information from RUMs and to store and manipulate the extracted information in a simple spreadsheet. Users wishing to perform such a manual extraction should employ the same techniques that have traditionally been used to extract information from log files that are in active use (see 6.10).

8 Schema elements

8.1 Overview

An overview of the elements of the schema of a RUM is shown in Figure 1.

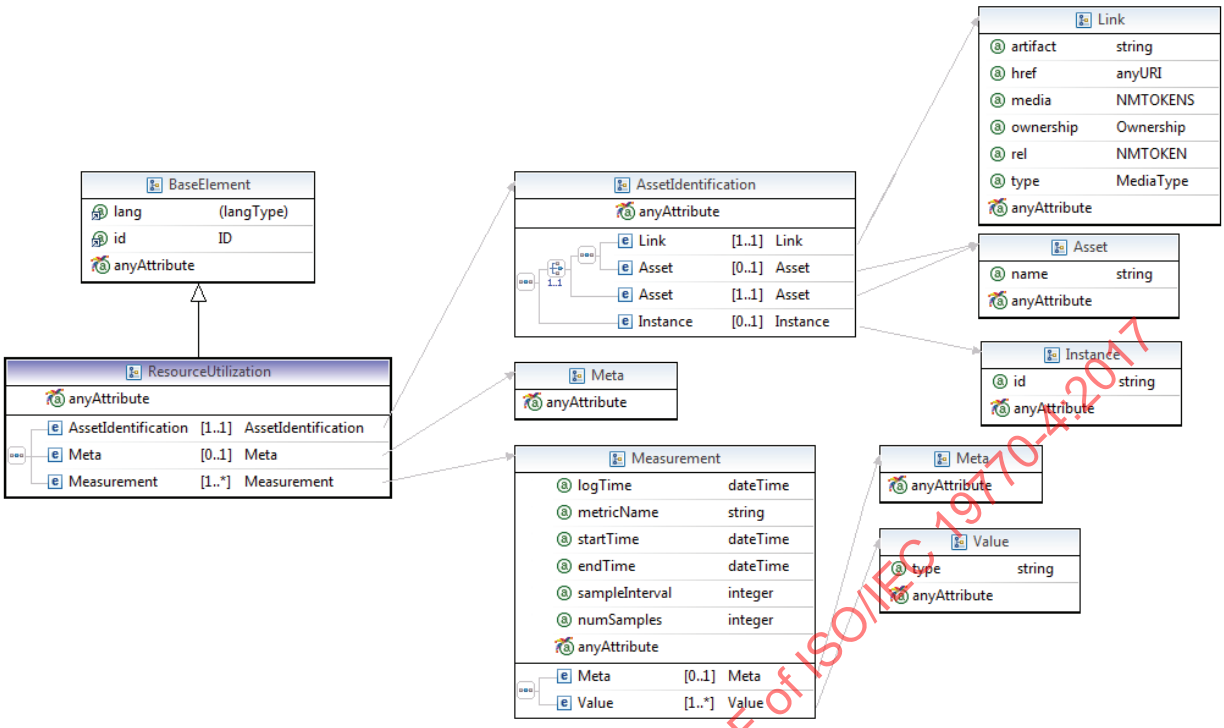

Figure 1 — RUM Schema

8.2 Minimum RUM data required

Due to the multiple use cases identified for RUM creation, the minimum data requirements for a RUM are relatively sparse. The only values that are required for a RUM to be considered valid to meet the requirements of the XML schema shall be:

— ResourceUtilization (see 8.4.1)

— AssetIdentification (see 8.4.2) at least one of:

  — Link – in case the SWID tag exists for the software asset

  — Asset – in case SWID tag does not exist, to identify the IT asset

— Measurement (see 8.4.3)

  — logTime

  — metricName

  — startTime

  — endTime

— Value (8.4.4)

See examples in Annex C.

8.3 XML element and attribute names

RUM content shall be identified in accordance with the XML element and attribute names specified below. This naming requirement ensures consistent interoperability with SWID tag content, regardless of the creator or consumer of the tag data.

NOTE Data values in the RUM can be structured as XML elements (which contain XML attributes) or XML attributes (which contain the actual data values). These types can be differentiated using the following structures:

— elements are Pascal cased (ThisIsAnExample);

— attributes are Camel cased (anotherExampleIsLikeThis).

8.4 Data values

8.4.1 Resource Utilization

Element name	ResourceUtilization		
Description	Represents the root element containing a collection of measurements		
Attribute or element	Type	Required/ default	Definition
AssetIdentification	AssetIdentification (see 8.4.2)	required (1)	Reference to IT asset instance that generates the Resource Utilization Measurements.
Meta	Meta (see 8.4.6)	optional	An open-ended collection of elements that can be arbitrary metadata describing this collection of measurements.
Measurement	Measurement (see 8.4.3)	required (1+)	Sequence of measurements that are related to a software asset instance referenced by the RUM.

Example:

```
<ResourceUtilization
  xmlns="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xsi:schemaLocation="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd rum.xsd">
  <AssetIdentification>
<Link
  rel="asset"
    href="file:///opt/productX/swidtag/acme.com_ACME_Product_X-Applicaton-1.1.0.swidtag" />
  </AssetIdentification>
<Meta
  productName="ProductX"
  productId="12345e3b-ec42-4b08-a4ac-22a076c31a5a" />
<Measurement
  logTime="2012-05-30T09:31:10+06:00"
  startTime="2012-05-29T09:30:10+06:00"
    endTime="2012-05-30T09:30:10+06:00"
    metricName="AUTHORIZED_USER">
    <Meta subtype="EMPLOYEE" />
    <Value type="number">12</Value>
  </Measurement>
<Measurement
  logTime="2012-05-31T09:31:10+06:00"
  startTime="2012-05-30T09:30:10+06:00"
    endTime="2012-05-31T09:30:10+06:00"
    metricName="AUTHORIZED_USER">
    <Meta subtype="EMPLOYEE" />
    <Value type="number">11</Value>
  </Measurement>
</ResourceUtilization>
```

8.4.2 AssetIdentification

Element name	AssetIdentification		
Description	Represents the element, whose child elements are the identification of the IT asset providing the usage measurement data. One or both of link or asset child elements shall be provided.		
Attribute or element	Type	Required/ default	Definition
Link	Link (see 8.4.5)	Optional (one of link or asset element is required)	Reference to software asset instance that generates the Resource Utilization Measurements.
Asset	Asset (see 8.4.7)	Optional (one of link or asset element is required)	In the absence of the SWID tag, this element contains a unique identifier of the measured IT asset.
Instance	Instance (see 8.4.8)	Optional	Unique identifier of the asset instance.

Example:

```
<ResourceUtilization
  xmlns="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xsi:schemaLocation="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd rum.xsd">
<AssetIdentification>
  <Link
  rel="asset"
    href="file:///opt/productX/swidtag/acme.com_ACME_Product_X-Applicaton-1.1.0.swidtag" />
</AssetIdentification>
<Measurement
  logTime="2012-05-30T09:31:10+06:00"
  startTime="2012-05-29T09:30:10+06:00"
    endTime="2012-05-30T09:30:10+06:00"
    metricName="AUTHORIZED_USER">
    <Meta subtype="EMPLOYEE" />
    <Value type="number">12</Value>
  </Measurement>
<Measurement
  logTime="2012-05-31T09:31:10+06:00"
  startTime="2012-05-30T09:30:10+06:00"
    endTime="2012-05-31T09:30:10+06:00"
    metricName="AUTHORIZED_USER">
    <Meta subtype="EMPLOYEE" />
    <Value type="number">11</Value>
  </Measurement>
</ResourceUtilization>
```

8.4.3 Measurement

Element name	Measurement		
Description	Represents the measurement that is related to a software asset instance referenced by the RUM		
Attribute or element	Type	Required/ default	Definition
logTime	dateTime	required	Time when the measurement was logged
metricName	string	required	Name of the metric (for example, AUTHORIZED_ USER). Metric names may or may not be consistent across multiple product families in an organization.
startTime	dateTime	required	Start of period when the measurement consumption value applies.
endTime	dateTime	required	End of period when the measurement consumption value applies
sampleInterval	integer	Optional (0,1)	Number of seconds between samples
numSamples	integer	Optional (0,1)	Number of samples used to measure value
Value	Value (see 8.4.4)	Required (1+)	Value of the measurement. Usually, this is the numeric peak value between startTime and endTime
Meta	Meta (see 8.4.6)	Optional (0+)	An open-ended collection of elements that can be arbitrary metadata describing this measurement
Example:			

```
<Measurement
logTime="2012-05-30T09:31:10+06:00"
startTime="2012-05-29T09:30:10+06:00"
  endTime="2012-05-30T09:30:10+06:00"
  metricName="AUTHORIZED_USER">
    <Meta subtype="EMPLOYEE" />
    <Value type="number">12</Value>
</Measurement>
```

8.4.4 Value

Element Name	Value		
Description	Value (typically quantity) of the measurement consumed. This element has the mixed content value.		
Attribute or element	Type	Required/ default	Definition
type	string	Optional (string)	Type of value – which defines the data type of the actual value – e.g. "number", "string"
Meta	Meta (see 8.4.6)	Optional (0+)	An open-ended collection of elements that can be arbitrary metadata describing this value
Example:			

```
<Value type="number">12</Value>
```

8.4.5 Link

Element name	Link		
Description	A reference to another item (the most common use in a RUM is to link to the SWID tag of the related software asset, which shall use a “"swid:..." URI.) NOTE This is modeled directly to match the HTML [LINK] element.		
Attribute or element	Type	Required/ default	Definition
artifact	string	optional	An optional identifier Items with the same artifact name shall be considered mirrors of each other
href	anyURI	required	The link to the item. Notes: The href can point to several different things, and can use any of the following: — a relative URI (no scheme) - which is interpreted depending on the context (for example, “./folder/supplemental.swidtag"); — a "swid:..." URI, which refers to another swid by its tagId; — a "swidpath:..." URI, which contains an XPATH to filter or select a particular SWID ; — a physical file location with any system-acceptable scheme (for example, file:// http:// https:// ftp:// ... etc). Only one href attribute is allowed per link element, however multiple link elements can be included to reference multiple URI’s.
media	NMTOKENS	optional	Used as an optimization hint to notify a system that it can ignore something when it's not likely to be used. The format of this string is modelled upon the MediaQuery definition at http://www.w3.org/TR/css3-mediaqueries/.
ownership	Ownership (see 8.5.1)	optional	Determines the relative strength of ownership of the target of the link
rel	NMTOKEN (see 8.5.3)	required	The relationship between this RUM and the target of the link Relationships can be identified by referencing the IANA registration library, see section 2.5 Internet Assigned Numbers Authority (IANA).
type	String (MediaType)	optional	The IANA MediaType for the target href. This provides RUM consumer an indicator of the resource type being referenced. See section 2.5 Internet Assigned Numbers Authority (IANA) for more details on link type.
Example:			

```
<Link
  rel=”asset”
        href="swid:iso-sid-cmp-acme-endpoint-protection-manager-v12-1-mp1"
        ownership="private"/>
```

8.4.6 Meta

Element name	Meta		
Description	An open-ended collection of key/value data related to this RUM The meta type allows any attributes to be included regardless if the attribute is defined in the XSD, or not. This gives a flexibility to the RUM-Creator to include additional metadata as required. No specific attributes or elements are defined for Meta. An example of the information that may be encapsulated in the meta element is a link to an entry in a product log file. NOTE The processContents declaration for additional Meta attributes is defined as lax.		
Attribute or element	Type	Required/ default	Definition
<anyAttribute>	per definition	optional	Additional attributes that have been defined in their own namespace. This allows the meta values that can be defined to be extended by the tag creator.

8.4.7 Asset

Element name	Asset		
Description	In the absence of the SWID tag, this element contains the unique identifier of the IT asset under measurement.		
Attribute or element	Type	Required/ default	Definition
name	string	required	The unique identifier of the IT asset

8.4.8 Instance

Element name	Instance		
Description	An identifier of the asset instance, to optionally distinguish between multiple instances of the asset deployed within the same environment		
Attribute or element	Type	Required/ default	Definition
id	string	required	Identifier of the particular software or IT asset instance providing measurement data.

8.5 Type definitions

8.5.1 Ownership

Name	Ownership (enumerated value)
Data type	NMTOKEN (see 8.5.3)
Definition	Specifies how an entity relates to this RUM.

Defined values	Value	Meaning
	abandon	If the item referenced by this RUM is uninstalled, then leave the file containing the RUMs in place.
	private	If the item referenced by this RUM is uninstalled, then the file containing the RUMs should also be removed after the current reporting period concludes.
	shared	If the item referenced by this RUM is uninstalled, then the file containing the RUMs should be removed if no other software asset is using it.

8.5.2 rel

Name	rel (enumerated values)	
Data type	NMTOKEN (see 8.5.3)	
Definition	Specifies how the target of a [Link] relates to this RUM.	
Defined values	Value	Meaning
	asset	Refers to a SWID tag that identifies the software asset associated with the measurements contained in this RUM
	metric	Refers to a further definition of a metric referenced in this RUM
	supplemental	Additional information associated with this RUM. This may be used to provide additional information related to measurement techniques, etc.
	<any>	Any other value specified is allowed, but the use of it is not specified and optional

8.5.3 NMTOKEN

NMTOKEN and NMTOKENS are XML types as defined in W3C Recommendation, *XML Schema Part 2: Datatypes (Second Edition).* NMTOKEN is a string value or "token" made up of a limited set of specified ASCII characters and NMTOKENS is a set of values or "tokens" separated by the ASCII space (#0x20) character. See the W3C Recommendation for further details.

Annex A
(normative)

XML Schema Definition

```
<?xml version="1.0"?>
<xs:schema xmlns="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
  xmlns:rum="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
   xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:ds="http://www.
w3.org/2000/09/xmldsig#"
  targetNamespace="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
  elementFormDefault="qualified">
  <xs:import namespace="http://www.w3.org/2000/09/xmldsig#"
      schemaLocation="http://www.w3.org/TR/xmldsig-core/xmldsig-core-
schema.xsd" />
  <xs:import namespace="http://www.w3.org/XML/1998/namespace"
    schemaLocation="http://www.w3.org/2001/xml.xsd" />

  <xs:annotation>
    <xs:documentation>
     Schema for ISO-IEC 19770-4 Resource Utilization
     Measurement
        http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd
        Copyright 2015 ISO/IEC, all rights reserved
        Copyright notice: ISO and
        IEC grant the users of this Standard
        the right to use this XSD file
        free of charge for the purpose
        of implementing the present Standard.

        Disclaimer: In no event shall ISO and/or IEC be liable for any
        damages whatsoever (including, but not limited to, damages for
        loss of
        profits, business interruption, loss of information,
```

```
        or any other
        pecuniary loss) arising out of or related to the
        use of or inability
        to use the XSD file. ISO and IEC disclaim
        all warranties, express or
        implied, including but not limited
        to warranties of merchantability
        and fitness for a particular
        purpose.
    </xs:documentation>
    <xs:appinfo>1.0</xs:appinfo>
  </xs:annotation>
  <xs:element name="ResourceUtilization" type="ResourceUtilization">
     <xs:annotation>
        <xs:documentation>Represents the root element specifying data
          resource utilization
        </xs:documentation>
    </xs:annotation>
   </xs:element>

  <xs:simpleType name="MediaType">
  <xs:annotation>
    <xs:documentation>
      The IANA MediaType for the target href; this provides the SWID tag
      consumer with intelligence of what to expect.
      See http://www.iana.org/assignments/media-types/media-types.xhtml
      for more details on Link type.
    </xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:string" />
</xs:simpleType>
```

```
<xs:simpleType name="Ownership">
  <xs:restriction base="xs:NMTOKEN">
    <xs:enumeration value="abandon">
      <xs:annotation>
        <xs:documentation>
          Determines the relative strength of ownership of
          the target
          piece of software.
        </xs:documentation>
      </xs:annotation>
    </xs:enumeration>
    <xs:enumeration value="private">
      <xs:annotation>
        <xs:documentation>
          If this is uninstalled, then the [Link]'d
          software should be removed
          too.
        </xs:documentation>
      </xs:annotation>
    </xs:enumeration>
    <xs:enumeration value="shared">
      <xs:annotation>
       <xs:documentation>
          If this is uninstalled, then the [Link]'d
          software should be removed
          if nobody else is sharing it
       </xs:documentation>
      </xs:annotation>
    </xs:enumeration>
  </xs:restriction>
</xs:simpleType>
<xs:complexType name="AssetIdentification">
  <xs:complexContent>
    <xs:extension base="BaseElement">
      <xs:annotation>
      <xs:documentation>Represents the element, whose child elements the
```

```
            identification of the software or IT Asset providing the usage
            measurement data. One of Link or Asset child elements are
            required.
          </xs:documentation>
        </xs:annotation>
        <xs:sequence>
          <xs:choice minOccurs="1" maxOccurs="1">
            <xs:sequence>
              <xs:element name="Link" type="Link" minOccurs="1"
                maxOccurs="1" />
                <xs:element name="Asset" type="Asset" minOccurs="0"
                maxOccurs="1" />
                </xs:sequence>
                <xs:element name="Asset" type="Asset" minOccurs="1"
                maxOccurs="1" />
           </xs:choice>
          <xs:element name="Instance" type="Instance" minOccurs="0"
            maxOccurs="1" />
          </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>

  <xs:complexType name="Asset">
    <xs:complexContent>
      <xs:extension base="BaseElement">
       <xs:annotation>
         <xs:documentation>The unique identifier of the IT Asset
         </xs:documentation>
       </xs:annotation>
       <xs:attribute name="name" type="xs:string" use="required">
         <xs:annotation>
           <xs:documentation></xs:documentation>
         </xs:annotation>
       </xs:attribute>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
```

```
<xs:complexType name="Instance">
  <xs:complexContent>
    <xs:extension base="BaseElement">
      <xs:annotation>
       <xs:documentation>Identifier of the particular software or IT Asset
           instance providing measurement data
             </xs:documentation>
           </xs:annotation>
      <xs:attribute name="id" type="xs:string" use="required">
        <xs:annotation>
          <xs:documentation></xs:documentation>
        </xs:annotation>
       </xs:attribute>
      </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="Link">
  <xs:complexContent>
    <xs:extension base="BaseElement">
      <xs:annotation>
        <xs:documentation>
           A reference to any another item (can include
           details that are
           related to the RUM tag such as details on where
           software
           downloads can be found, vulnerability database
           associations,
           use rights, etc).
           This is modeled directly to match
           the HTML [LINK] element; it is
           critical for streamlining software
           discovery scenarios that
           these are kept consistent.
        </xs:documentation>
```

```
        </xs:annotation>
        <xs:attribute name="artifact" type="xs:string" use="optional">
          <xs:annotation>
            <xs:documentation>
               For installation media (rel="installationmedia")
               - dictates the
               canonical name for the file.
               Items with the same
               artifact name should be considered mirrors
               of each other (so
               download from wherever works).
             </xs:documentation>
           </xs:annotation>
           </xs:attribute>
           <xs:attribute name="href" type="xs:anyURI" use="required">
             <xs:annotation>
                <xs:documentation>
                  The Link to the item being referenced.
                  The href
                  can point to several different things, and can be any
                  of the
                  following:

                  - a RELATIVE URI (no scheme) - which is interpreted
                  depending on
                  context (ie, "./folder/supplemental.swidtag" )

                  - a
                  physical file location with any system-acceptable
                  URI scheme (ie,
                  file:// http:// https:// ftp:// ... etc )
                  - an URI with "swid:" as
                  the scheme, which refers to another
                  swid by tagId. This URI would
                  need to be resolved in the
                  context of the system by software that
                  can lookup other
                  swidtags.( ie,
                  "swid:2df9de35-0aff-4a86-ace6-f7dddd1ade4c" )
```

```
                - an URI with
                "swidpath:" as the scheme, which refers to another
                swid by an
                XPATH query. This URI would need to be resolved in
                the context of
                the system by software that can lookup other
                swidtags, and select
                the appropriate one based on an XPATH
                query. Examples:
               swidpath://SoftwareIdentity[Entity/@regid='contoso.com']
                would
                retrieve all swidtags that had an entity where the
                regid was
                Contoso
              swidpath://SoftwareIdentity[Meta/@persistentId='b0c55172-
38e9-4e36-be86-92206ad8eddb']
             would retrieve swidtags that matched a specific persistentId

                See
                XPATH query standard : http://www.w3.org/TR/xpath20/
              </xs:documentation>
            </xs:annotation>
          </xs:attribute>
        <xs:attribute name="media" type="xs:NMTOKENS" use="optional">
          <xs:annotation>
            <xs:documentation>
                An attribute defined by the W3C Media Queries
                Recommendation
                (see http://www.w3.org/TR/css3-mediaqueries/).

                A
             hint to the consumer of the Link to what the target item is
```

```
                    applicable for.
                  </xs:documentation>
                </xs:annotation>
              </xs:attribute>
             <xs:attribute name="ownership" type="Ownership" use="optional">
              <xs:annotation>
                  <xs:documentation>
                     Determines the relative strength of ownership of
                     the target
                     piece of software.
                  </xs:documentation>
                  </xs:annotation>
                </xs:attribute>
               <xs:attribute name="rel" type="xs:NMTOKEN" use="required">
                 <xs:annotation>
                   <xs:documentation>
                     The relationship between this RUM and the
                     target
                     file.
                     Relationships can be identified by referencing the
                     IANA
                     registration library -
                        https://www.iana.org/assignments/link-relations/link-
relations.xhtml.
                  </xs:documentation>
                </xs:annotation>
             </xs:attribute>
             <xs:attribute name="type" type="MediaType" use="optional">
                <xs:annotation>
                  <xs:documentation>
                     The IANA MediaType for the target file; this
                     provides the consumer
                     with intelligence of what to expect.
```

```
                See
            http://www.iana.org/assignments/media-types/media-types.xhtml
                for
                more details on Link type.
             </xs:documentation>
           </xs:annotation>
         </xs:attribute>
       </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:complexType name="BaseElement">
 <xs:annotation>
    <xs:documentation>
      Attributes common to all Elements in this schema
    </xs:documentation>
  </xs:annotation>
  <xs:attribute ref="xml:lang">
    <xs:annotation>
      <xs:documentation>
        Allow xml:lang attribute on any element.
      </xs:documentation>
    </xs:annotation>
  </xs:attribute>
  <xs:anyAttribute namespace="##other" processContents="lax">
    <xs:annotation>
      <xs:documentation>
         Allows any undeclared attributes on any element as
         long as the
         attribute is placed in a different namespace.
      </xs:documentation>
    </xs:annotation>
  </xs:anyAttribute>
</xs:complexType>
```

```
<xs:complexType name="Meta">
  <xs:complexContent>
    <xs:extension base="BaseElement">
      <xs:annotation>
         <xs:documentation>
           An open-ended collection of key/value data
           related to this RUM.
         </xs:documentation>
       </xs:annotation>
       <xs:anyAttribute processContents="lax">
       <xs:annotation>
        <xs:documentation>
          Permits any user-defined attributes in Meta tags
        </xs:documentation>
       </xs:annotation>
      </xs:anyAttribute>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
<xs:complexType name="Value" mixed="true">
    <xs:complexContent>
      <xs:extension base="BaseElement">
          <xs:annotation>
            <xs:documentation>
                Value of the measurement. Usually this is the
                numeric peak value
                between startTime and endTime of the parent
                measurement.
            </xs:documentation>
          </xs:annotation>
          <xs:attribute name="type" type="xs:string" use="optional">
          <xs:annotation>
           <xs:documentation>
            Type of value.
           </xs:documentation>
          </xs:annotation>
       </xs:attribute>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```

```
<xs:complexType name="Measurement">
     <xs:complexContent>
        <xs:extension base="BaseElement">
         <xs:annotation>
           <xs:documentation>
               Sequence of measurements that are related to a
               software Asset referenced
               by the RUM.
            </xs:documentation>
          </xs:annotation>
           <xs:sequence>
            <xs:element name="Meta" type="Meta" minOccurs="0"
              maxOccurs=" unbounded " />
            <xs:element name="Value" type="Value" minOccurs="1"
            maxOccurs="unbounded" />
          </xs:sequence>
        <xs:attribute name="logTime" type="xs:dateTime" use="required">
           <xs:annotation>
             <xs:documentation>Time when the measurement was logged.
            </xs:documentation>
          </xs:annotation>
         </xs:attribute>
       <xs:attribute name="metricName" type="xs:string" use="required">
          <xs:annotation>
            <xs:documentation>Name of the metric (for example,
               AUTHORIZED_USER).
               Metric names may or may not be consistent across
               multiple product
               families in an organization.
```

```
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
        <xs:attribute name="startTime" type="xs:dateTime" use="required">
          <xs:annotation>
            <xs:documentation>
              Start of period when the metric measurement
              con-sumption value
              applies.
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
        <xs:attribute name="endTime" type="xs:dateTime" use="required">
          <xs:annotation>
            <xs:documentation>
              End of period when the measurement consumption
              value applies.
            </xs:documentation>
            </xs:annotation>
        </xs:attribute>
        <xs:attribute name="sampleInterval" type="xs:integer"
          use="optional">
           <xs:annotation>
            <xs:documentation>
               Number of seconds between samples
```

```
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
        <xs:attribute name="numSamples" type="xs:integer" use="optional">
          <xs:annotation>
            <xs:documentation>
              Number of samples used to measure value.
            </xs:documentation>
          </xs:annotation>
        </xs:attribute>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
  <xs:complexType name="ResourceUtilization">
    <xs:annotation>
      <xs:documentation>
        Root element type.
      </xs:documentation>
    </xs:annotation>
    <xs:complexContent>
      <xs:extension base="BaseElement">
        <xs:sequence>
          <xs:element name="AssetIdentification" type="AssetIdentification"
            minOccurs="1" maxOccurs="1" />
          <xs:element name="Meta" type="Meta" minOccurs="0"
            maxOccurs="1" />
          <xs:element name="Measurement" type="Measurement"
          minOccurs="1" maxOccurs="unbounded" />
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>



</xs:schema>
```

Annex B
(informative)

Examples of multiple file RUM and nesting XML documents

B.1 Fabrikam webserver example

The Fabrikam webserver software is providing RUM for its measured metric identifying authorized users of employee subtype.

```
<?xml version="1.0" encoding="UTF-8"?>
<ResourceUtilization
      xmlns="http://standards.iso.org/iso-iec/19770/-4/ed-1/schema.xsd"
      xmlns:xml="http://www.w3.org/XML/1998/namespace" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://standards.iso.org/iso-iec/19770/-4/ed-1/
schema.xsd rum.xsd ">
      <AssetIdentification>
      <Link
            href="swid:FabrikamWebserver-2.2"
            rel="asset" />
      </AssetIdentification>
      <Measurement logTime="2014-11-25T09:31:10+06:00"
            startTime="2014-11-24T09:30:10+06:00"
            endTime="2014-11-25T09:30:10+06:00"
            metricName="AUTHORIZED_USER">
            <Meta subtype="EMPLOYEE" />
            <Value type="number">12</Value>
      </Measurement>
      <Measurement logTime="2014-11-26T09:31:10+06:00"
            startTime="2014-11-25T09:30:10+06:00"
            endTime="2014-11-26T09:30:10+06:00"
            metricName="AUTHORIZED_USER">
            <Meta subtype="EMPLOYEE" />
            <Value type="number">11</Value>
      </Measurement>
</ResourceUtilization>
```

B.2 Multiple file RUM example

This is an example of the division of a RUM into separate files as described in 6.9.