MTConnect Specification and Materials

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1 Purpose of This Document

This document, *MTConnect Standard: Part 4.3 - Raw Material Asset Information Model* of the MTConnect Standard, establishes the rules and terminology to be used by designers to describe the function and operation of raw material used within manufacturing and to define the data that is provided by an Agent from a piece of equipment.

The data associated with these raw material will be retrieved from multiple sources that are responsible for providing their knowledge of an *MTConnect Asset*. 
2 Terminology and Conventions

Refer to Section 2 of *MTConnect Standard Part 1.0 - Overview and Fundamentals* for a dictionary of terms, reserved language, and document conventions used in the MTConnect Standard.

2.1 Glossary

**Agent**

Refers to an MTConnect Agent. Software that collects data published from one or more piece(s) of equipment, organizes that data in a structured manner, and responds to requests for data from client software systems by providing a structured response in the form of a *Response Document* that is constructed using the *semantic data models* defined in the Standard. Appears in the documents in the following form: Agent.

**Asset**

An item, thing or entity that has potential or actual value to an organization *Ref:ISO 55000:2014(en)*

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 life.

Note 2 to entry: 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, licences, 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.

**Child Element**

A portion of a data modeling structure that illustrates the relationship between an element and the higher-level *Parent Element* within which it is contained. Appears in the documents in the following form: Child Element.
Component

General meaning:
A **Structural Element** that represents a physical or logical part or subpart of a piece of equipment.

Appears in the documents in the following form: **Component**

**Used in Information Models:**
A data modeling element used to organize the data being retrieved from a piece of equipment.

- When used as an XML container to organize **Lower Level** Component elements.
  
  Appears in the documents in the following form: **Components**.
- When used as an abstract XML element. **Component** is replaced in a data model by a type of **Component** element. **Component** is also an XML container used to organize **Lower Level** Component elements, **Data Entities** or both.
  
  Appears in the documents in the following form: **Component**.

Current Request

A **Current Request** is a **Request** to an **Agent** to produce an **MTConnectStreams Response Document** containing the **Observations Information Model** for a snapshot of the latest observations at the moment of the **Request** or at a given **sequence number**.

Data Entity

A primary data modeling element that represents all elements that either describe data items that may be reported by an **Agent** or the data items that contain the actual data published by an **Agent**.

Appears in the documents in the following form: **Data Entity**

Devices Information Model

A set of rules and terms that describes the physical and logical configuration for a piece of equipment and the data that may be reported by that equipment.

Appears in the documents in the following form: **Devices Information Model**

Equipment Metadata

See **Metadata**
**Information Model**

The rules, relationships, and terminology that are used to define how information is structured.

For example, an information model is used to define the structure for each MTConnect Response Document; the definition of each piece of information within those documents and the relationship between pieces of information.

Appears in the documents in the following form: Information Model.

**Lower Level**

A nested element that is below a higher level element.

**Metadata**

Data that provides information about other data.

For example, Equipment Metadata defines both the Structural Elements that represent the physical and logical parts and sub-parts of each piece of equipment, the relationships between those parts and sub-parts, and the definitions of the Data Entities associated with that piece of equipment.

Appears in the documents in the following form: Metadata or Equipment Metadata.

**MTConnect Agent**

See definition for Agent.

**MTConnect Asset**

An MTConnect Asset is an Asset used by the manufacturing process to perform tasks.

Note 1 to entry: An MTConnect Asset relies upon an MTConnect Device to provide observations and information about itself and the MTConnect Device revises the information to reflect changes to the MTConnect Asset during their interaction. Examples of MTConnect Assets are Cutting Tools, Part Information, Manufacturing Processes, Fixtures, and Files.

Note 2 to entry: A singular assetId uniquely identifies an MTConnect Asset throughout its lifecycle and is used to track and relate the MTConnect Asset to other MTConnect Devices and entities.

Note 3 to entry: MTConnect Assets are temporally associated with a device and can be removed from the device without damage or alteration to its primary functions.
MTConnect Device

An MTConnect Device is a piece of equipment or a manufacturing system that produces observations about itself and/or publishes data using the MTConnect Information Model.

MTConnect Information Model

See Information Model

MTConnectDevices Response Document

A Response Document published by an MTConnect Agent in response to a Probe Request.

MTConnectStreams Response Document

A Response Document published by an MTConnect Agent in response to a Current Request or a Sample Request.

observation

The observed value of a property at a point in time.

Observations Information Model

An Information Model that describes the Streaming Data reported by a piece of equipment.

Parent Element

An XML element used to organize Lower Level child elements that share a common relationship to the Parent Element. Appears in the documents in the following form: Parent Element.

Probe Request

A Probe Request is a Request to an Agent to produce an MTConnectDevices Response Document containing the Devices Information Model.

raw material

Crude or processed material that can be converted by manufacture, processing, or combination into a new and useful product.

Request

A communications method where a client software application transmits a message to an Agent. That message instructs the Agent to respond with specific information. Appears in the documents in the following form: Request.
Response Document

An electronic document published by an MTConnect Agent in response to a Probe Request, Current Request, Sample Request or Asset Request.

Sample Request

A Sample Request is a Request to an Agent to produce an MTConnectStreams Response Document containing the Observations Information Model for a set of timestamped observations made by Components.

Semantic Data Model

A methodology for defining the structure and meaning for data in a specific logical way.

It provides the rules for encoding electronic information such that it can be interpreted by a software system.

Appears in the documents in the following form: semantic data model.

Sequence Number

The primary key identifier used to manage and locate a specific piece of Streaming Data in an Agent.

sequence number is a monotonically increasing number within an instance of an Agent.

Appears in the documents in the following form: sequence number.

Streaming Data

The values published by a piece of equipment for the Data Entities defined by the Equipment Metadata.

Appears in the documents in the following form: Streaming Data.

Structural Element

General meaning:

An XML element that organizes information that represents the physical and logical parts and sub-parts of a piece of equipment.

Appears in the documents in the following form: Structural Element

Used to indicate hierarchy of Components:

When used to describe a primary physical or logical construct within a piece of equipment.

Appears in the documents in the following form: Top Level Structural Element.
When used to indicate a Child Element which provides additional detail describing the physical or logical structure of a Top Level Structural Element. Appears in the documents in the following form: Lower Level Structural Element.

Top Level Structural Elements that represent the most significant physical or logical functions of a piece of equipment.

2.2 Acronyms

AMT
The Association for Manufacturing Technology

ASTM
American Society for Testing and Materials

2.3 MTConnect References


3 Raw Material Information Model

Raw material represents the source of material for immediate use and sources of material that may or may not be used during the manufacturing process.

The RawMaterial Asset holds the references to the content stored in the actual RawMaterial container or derived about the RawMaterial by the system during operation.

3.1 RawMaterial

RawMaterial is an Asset that represents raw material.
Figure 1: RawMaterial Diagram
### 3.1.1 Attributes for RawMaterial

*Table 1* lists the attributes for a RawMaterial element in addition to attributes inherited from Asset element.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>The <em>raw material</em> name. Examples: Container1 and AcrylicContainer. The value of name <strong>MUST</strong> be a string.</td>
<td>0..1</td>
</tr>
<tr>
<td>containerType</td>
<td>The type of container holding the <em>raw material</em>. Examples: Pallet, Canister, Cartridge, Tank, Bin, Roll and Spool. The value of type <strong>MUST</strong> be a string.</td>
<td>0..1</td>
</tr>
<tr>
<td>processKind</td>
<td>The ISO process type supported by this <em>raw material</em>. Examples include: VAT_POLYMERIZATION, BINDER_JETTING, MATERIAL_EXTRUSION, MATERIAL_JETTING, SHEET_LAMINATION, POWDER_BED_FUSION, or DIRECTED_ENERGY_DEPOSITION. Ref: ASTM F2792-12a The value of processId <strong>MUST</strong> be a string.</td>
<td>0..1</td>
</tr>
<tr>
<td>serialNumber</td>
<td>The serial number of the <em>raw material</em>. The value of serialNumber <strong>MUST</strong> be a string.</td>
<td>0..1</td>
</tr>
</tbody>
</table>

### 3.1.2 Elements for RawMaterial

*Table 2* lists the elements for a RawMaterial element.
Table 2: Elements for RawMaterial

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>The form of the raw material. The value MUST be BAR, SHEET, BLOCK, CASTING, POWDER, LIQUID, GEL, FILAMENT, or GAS.</td>
<td>1</td>
</tr>
<tr>
<td>HasMaterial</td>
<td>Material has existing usable volume. The value of HasMaterial MUST be boolean.</td>
<td>0..1</td>
</tr>
<tr>
<td>ManufacturingDate</td>
<td>The date the raw material was created. The value of ManufacturingDate MUST be reported in ISO 8601 format.</td>
<td>0..1</td>
</tr>
<tr>
<td>FirstUseDate</td>
<td>The date raw material was first used. The value of FirstUseDate MUST be reported in ISO 8601 format.</td>
<td>0..1</td>
</tr>
<tr>
<td>LastUseDate</td>
<td>The date raw material was last used. The value of LastUseDate MUST be reported in ISO 8601 format.</td>
<td>0..1</td>
</tr>
<tr>
<td>InitialVolume</td>
<td>The amount of material initially placed in raw material when manufactured. The value of InitialVolume MUST be reported in CUBIC_MILLIMETER.</td>
<td>0..1</td>
</tr>
<tr>
<td>InitialDimension</td>
<td>The dimension of material initially placed in raw material when manufactured. The value of InitialDimension MUST be reported in MILLIMETER_3D.</td>
<td>0..1</td>
</tr>
<tr>
<td>InitialQuantity</td>
<td>The quantity of material initially placed in raw material when manufactured. The value MUST be an integer.</td>
<td>0..1</td>
</tr>
<tr>
<td>Element</td>
<td>Description</td>
<td>Occurrence</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>CurrentVolume</td>
<td>The amount of material currently in raw material.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value of <code>CurrentVolume</code> MUST be reported in CUBIC_MILLIMETER.</td>
<td></td>
</tr>
<tr>
<td>CurrentDimension</td>
<td>The dimension of material currently in raw material.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value of <code>CurrentDimension</code> MUST be reported in MILLIMETER_3D.</td>
<td></td>
</tr>
<tr>
<td>CurrentQuantity</td>
<td>The quantity of material currently in raw material.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value MUST be an integer.</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Material used as the raw material.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>See Section 3.2 - Material for details.</td>
<td></td>
</tr>
</tbody>
</table>
3.2 Material

Material used as the raw material.

Figure 2: Material Diagram

3.2.1 Attributes for Material

Table 3 lists the attributes for a Material element.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>The unique identifier for the material. The value for id MUST be a string.</td>
<td>0..1</td>
</tr>
<tr>
<td>name</td>
<td>The name of the material. Examples: ULTM9085, ABS, 4140. The value for name MUST be a string.</td>
<td>0..1</td>
</tr>
</tbody>
</table>
### 3.2.2 Elements for Material

*Table 4* lists the elements for a Material element.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot</td>
<td>The manufacturer’s lot code of the material.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value for Lot <strong>MUST</strong> be a string.</td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td>The name of the material manufacturer.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value for Manufacturer <strong>MUST</strong> be a string.</td>
<td></td>
</tr>
<tr>
<td>ManufacturingDate</td>
<td>The manufacturing date of the material from the material manufacturer.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value for ManufacturingDate <strong>MUST</strong> be reported in ISO 8601 format.</td>
<td></td>
</tr>
<tr>
<td>ManufacturingCode</td>
<td>The lot code of the raw feed stock for the material, from the feed stock manufacturer.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value for ManufacturingCode <strong>MUST</strong> be a string.</td>
<td></td>
</tr>
<tr>
<td>MaterialCode</td>
<td>The <strong>ASTM</strong> standard code that the material complies with.</td>
<td>0..1</td>
</tr>
<tr>
<td></td>
<td>The value for MaterialCode <strong>MUST</strong> be a string.</td>
<td></td>
</tr>
</tbody>
</table>
Appendices

A Bibliography


