

MTConnect® Standard

Part 3 – Streams, Events, Samples, and Condition

Version 1.2.0 – Draft Final A

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MTConnect® Specification and Materials

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# Overview

MTConnect® is a standard based on an open protocol for data integration. MTConnect® is not intended to replace the functionality of existing products, but it strives to enhance the data acquisition capabilities of devices and applications and move toward a plug-and-play environment to reduce the cost of integration.

MTConnect® is built upon the most prevalent standards in the manufacturing and software industries, maximizing the number of tools available for its implementation and providing the highest level of interoperability with other standards and tools in these industries.

To facilitate this level of interoperability, a number of objectives are being met. Foremost is the ability to transfer data via a standard protocol which includes:

* + A device identity (i.e. model number, serial number, calibration data, etc.).
  + The identity of all the independent components of the device.
  + Possibly a device’s design characteristics (i.e. axis length, maximum speeds, device thresholds, etc.).
  + Most importantly, data captured in real or near-real-time (i.e. current speed, position data, temperature data, program block, etc.) by a device that can be utilized by other devices or applications (e.g. utilized by maintenance diagnostic systems, management production information systems, CAM products, etc.).

The types of data that may need to be addressed in MTConnect® could include:

* + Physical and actual device design data
  + Measurement or calibration data
  + Near-real-time data from the device

To accommodate the vast amount of different types of devices and information that may come into play, MTConnect® will provide a common high-level vocabulary and structure.

The first version of MTConnect® focused on a limited set of the characteristics mentioned above that were selected based on the fact that they can have an immediate effect on the efficiency of operations. Subsequent versions of the standard have and will continue to add additional functionality to more completely define the manufacturing environment.

## MTConnect® Document Structure

The MTConnect® specification is subdivided using the following scheme:

Part 1: Overview and Protocol – Version 1.2.0

Part 2: Components and Data Items – Version 1.2.0

Part 3: Streams, Events, Samples, and Condition – Version 1.2.0

Part 4: Assets – Version 1.2.0

All information applicable to all basic machines and devices will be included in the basic standard defined within these four parts. Additional parts will be added to provide information and extensions to the standard focused on specific devices, components, or technologies. All information specific to the topic of each additional part **SHALL** be included within that document.

Extensions to the standard will be made according to this scheme and new sections will be added as new areas are addressed. Documents will be named as follows:

MTC\_Part\_<Number>\_<Description>.doc.

All documents will be developed in Microsoft® Word format and released in Adobe® PDF format.

For example, this document is MTC\_Part\_3\_Streams.doc.

# Purpose of This Document

The four base MTConnect® documents are intended to:

* define the MTConnect® standard;
* specify the requirements for compliance with the MTConnect® standard;
* provide engineers with sufficient information to implement Agents for their devices;
* provide developers with the necessary guidelines to use the standard to develop applications.

Part 3 of the MTConnect standard focuses on the data returned from a current or sample request (for more information on these requests, see Part 1). This section covers the data representing the state of the machine. To reduce the amount of redundant information being transmitted and the resulting impact on the communications network, the descriptive information about a data item and its actual value are separated into different communication requests.

The information being transmitted is broken into three types – Events, Samples, and Condition. An Event represents the state of a data item or a message. Samples represent the value of a data item at a specific point in time for continuously changing data items like axis position. Condition represents the health of a device or component. This section also covers the vocabulary and format for each piece of data that can be retrieved from a machine.

## Terminology

**Adapter** An optional software component that connects the Agent to the Device.

**Agent** A process that implements the MTConnect® HTTP protocol, XML generation, and MTConnect protocol.

**Alarm** An alarm indicates an event that requires attention and indicates a deviation from normal operation.

**Application** A process or set of processes that access the MTConnect® Agent to perform some task.

**Attribute** A part of an element that provides additional information about that element. For example, the name element of the Device is given as <Device **name=“mill-1”**>...</Device>

**CDATA** The text in a simple content element. For example, *This is some text*, in <Message ...>This is some text</Message>.

**Component** A part of a device that can have sub-components and data items. A component is a basic building block of a device.

**Controlled Vocabulary** The value of an element or attribute is limited to a restricted set of possibilities. Examples of controlled vocabularies are country codes: US, JP, CA, FR, DE, etc…

**Current** A snapshot request to the Agent to retrieve the current values of all the data items specified in the path parameter. If no path parameter is given, then the values for all components are provided.

**Data Item** A data item provides the descriptive information regarding something that can be collected by the Agent.

**Device** A piece of equipment capable of performing an operation. A device may be composed of a set of components that provide data to the application. The device is a separate entity with at least one component or data item providing information about the device.

**Discovery** Discovery is a service that allows the application to locate Agents for devices in the manufacturing environment. The discovery service is also referred to as the *Name Service.*

**Element** An XML element is the central building block of any XML Document. For example, in MTConnect® the Device element is specified as <**Device** >...</**Device**>

**Event** An event represents a change in state that occurs at a point in time. Note: An event does not occur at predefined frequencies.

**HTTP** Hyper-Text Transport Protocol. The protocol used by all web browsers and web applications.

**Instance** When used in software engineering, the word *instance* is used to define a single physical example of that type. In object-oriented models, there is the class that describes the thing and the instance that is an example of that thing.

**LDAP** Lightweight Directory Access Protocol, better known as Active Directory in Microsoft Windows. This protocol provides resource location and contact information in a hierarchal structure.

**MIME** Multipurpose Internet Mail Extensions. A format used for encoding multipart mail and http content with separate sections separated by a fixed boundary.

**Probe** A request to determine the configuration and reporting capabilities of the device.

**REST** REpresentational State Transfer. A software architecture where the client and server move through a series of state transitions based solely on the request from the client and the response from the server.

**Results** A general term for the Samples, Events, and Condition contained in a ComponentStream as a response from a sample or current request.

**Sample** A sample is a data point from within a continuous series of data points. An example of a Sample is the position of an axis.

**Socket** When used concerning interprocess communication, it refers to a connection between two end-points (usually processes). Socket communication most often uses TCP/IP as the underlying protocol.

**Stream** A collection of Events, Samples, and Condition organized by devices and components.

**Service** An application that provides necessary functionality.

**Tag** Used to reference an instance of an XML element.

**TCP/IP** TCP/IP is the most prevalent stream-based protocol for interprocess communication. It is based on the IP stack (Internet Protocol) and provides the flow-control and reliable transmission layer on top of the IP routing infrastructure.

**URI** Universal Resource Identifier. This is the official name for a web address as seen in the address bar of a browser.

**UUID** Universally unique identifier.

**XPath** XPath is a language for addressing parts of an XML Document. See the XPath specification for more information. <http://www.w3.org/TR/xpath>

**XML** Extensible Markup Language. <http://www.w3.org/XML/>

**XML Schema** The definition of the XML structure and vocabularies used in the XML Document.

**XML Document** An instance of an XML Schema which has a single root element and conforms to the XML specification and schema.

**XML NMTOKEN** The data type for XML identifiers. It **SHALL** start with a letter, an underscore “\_” or a colon “:” and then it **SHALL** be followed by a letter, a number, or one of the following “.”, ”-“, ”\_”, “:”. An NMTOKEN cannot have any spaces or special characters.

## Terminology and Conventions

Please refer to Part 1 “Overview and Protocol” Section 2 for XML Terminology and Documentation conventions.

# Streams, Samples, Events, and Condition

The MTConnect Agent collects data from various sources and delivers it to applications in response to sample or current requests. (See *Protocol* section in *Part 1*.) All the data is collected into streams and organized by device and then by component. A component stream has three parts: Samples, Events, and Condition. For an example, refer to the Device in Figure 2 below.

Samples are point-in-time readings from a component reporting what the value is at that instant.

An Event changes state to a limited set of values or represents a message. It is assumed that an event remains at a state until the next event occurs; it cannot have any intermediate values between the reported values. The following are examples of Events: Block, Execution, Message etc.

A Condition communicates the device’s health and ability to function. It can be one of Unavailable, Normal, Warning, or Fault and there can be multiple active conditions at one time; whereas a sample or event can only have a single value at one point in time.

## Streams Response Header

Every MTConnect® response **SHALL** contain a header as the first element below the root element of any MTConnect® XML Document sent back to an application. (See *Header* in *Part 1, Section 4.5* for details on the Header structure)



Figure : Header Schema Diagram for MTConnectStreams

## Streams Structure

A Streams element is the high level container for all device streams. Its function is to contain DeviceStream sub-elements. There **SHALL** be no attributes or other type elements within the Streams element.



Figure : Streams Schema Diagram

| **Elements** | **Description** | **Occurrence** |
| --- | --- | --- |
| DeviceStream | The stream of samples, events, and condition for each device. | 1..INF |

A Stream **SHALL** have at least one DeviceStream and the DeviceStream **MAY** have one or more ComponentStream elements, depending on whether there are events or samples available for the component. If there are no ComponentStream elements, then no data will be delivered for this request.

The following diagram illustrates the structure of the streams with some samples, events, and condition at the lowest level:

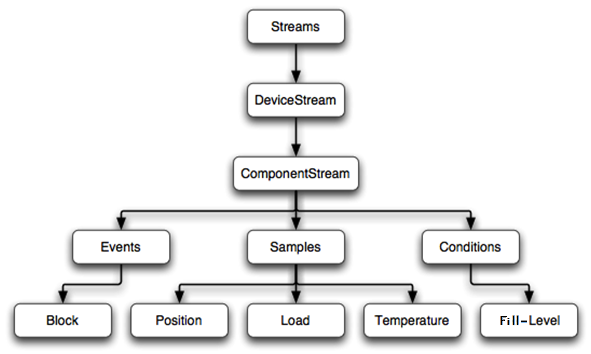


Figure 3: Streams Example Structure

Below is an example XML Document response for an Agent with two devices, mill-1 and mill-2. The data is reported in two separate device streams.

<MTConnectStreams …>

<Header … />

<Streams>

<DeviceStream name="mill-1" uuid="1">

<ComponentStream component="Device" name="mill-1" componentId="d1">

<Events>

<Availability dataItemId="avail1" name=="avail" sequence="5"

timestamp="2010-04-06T06:19:35.153141">AVAILABLE</Availability>

</Events>

</ComponentStream>

</DeviceStream>

<DeviceStream name="mill-2" uuid="2">

<ComponentStream component="Device" name="mill-2" componentId="d2">

<Events>

<Availability dataItemId="avail2" name="avail" sequence="15"

timestamp="2010-04-06T06:19:35.153141">AVAILABLE</Availability>

</Events>

</ComponentStream>

</DeviceStream>

</Streams>

</MTConnectStreams>

The sequence numbers are unique across the two devices in the example above. The applications **SHALL NOT** assume that the event and sample sequence numbers are strictly in sequence. All sequence numbers **MAY** **NOT** be included. An example of this case would occur when a path argument is provided and all the Samples, Events, and Condition are not selected or when the *Agent* is supporting more than one device and data from only one device is requested. Refer to *MTConnect® Part 1, Overview and Protocol, Section 5: Protocol* for more information.

## DeviceStream

A DeviceStream is created to hold the device-specific information so it does not need to be repeated for every event and sample. This is done to reduce the size of each event and sample so they only carry the information that is being reported. A DeviceStream **MAY** contain one or more ComponentStream elements. If the request is valid and there are no events or samples that match the criteria, an empty DeviceStream element **SHALL** be created to indicate that the device exists, but there was no data available.

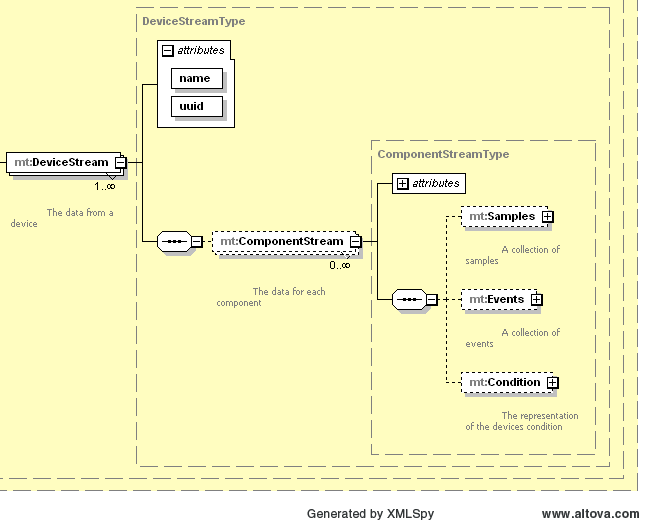


Figure : DeviceStream Schema

### DeviceStream Attributes

| **Attributes** | **Description** | **Occurrence** |
| --- | --- | --- |
| name | The device’s name. An NMTOKEN XML type. | 1 |
| uuid | The device’s unique identifier | 1 |

### DeviceStream Elements

| **Element** | **Description** | **Occurrence** |
| --- | --- | --- |
| ComponentStream | One component’s stream for each component with data | 0..INF |

## ComponentStream

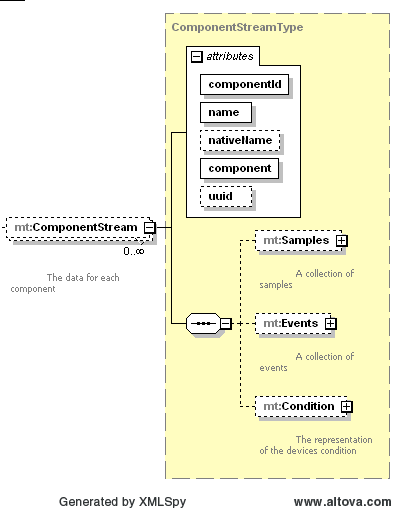


Figure : ComponentStream Schema

A ComponentStream is similar to the DeviceStream. It contains the information specific to the component within the Device. The uuid only needs to be specified if the Component has a uuid assigned.

### ComponentStream Attributes

| **Attribute** | **Description** | **Occurrence** |
| --- | --- | --- |
| name | This component’s name within the device. An NMTOKEN XML type. | 1 |
| nativeName | The name the device manufacturer assigned to the component. If the native name is not provided it **SHALL** be the name. | 0..1 |
| component | The element name for the component | 1 |
| uuid | The component’s unique identifier | 0..1 |
| componentId | Corresponds to the id attribute of the component in the probe request (Refer to Probe in Part 1). | 1 |

The Elements of the ComponentStream classify the data into Events, Samples, and Condition. *(The classification is discussed below)*. The ComponentStream **SHALL NOT** be empty. It **SHALL** include an Events and/or a Samples element.

### ComponentStream Elements

| **Element** | **Description** | **Occurrence** |
| --- | --- | --- |
| Events | The events for this component stream | 0..1 |
| Samples | The samples for this component | 0..1 |
| Condition | The condition of the device. | 0..1 |

## Types and Subtypes of Data Items

What follows is the association between the various types and subtypes of data items. Each data item type **SHALL** be translated into a Sample, Event, or Condition with the following rules:

* The type name will be all in capitals with an underscore (\_) between words.
* The element of the event or sample will be the transformation of the data item type by capitalizing the first character of each word and then removing the underscore. For example, the data item type DOOR\_STATE is DoorState, POSITION is Position, and ROTARY\_VELOCITY is RotaryVelocity.

The following example shows the transformation between the DataItem name as returned in a Probe Request and the corresponding structured data returned in a Stream element returned from a Current or Sample request. In the Probe request, each DataItem defines its data item type, category, and (if applicable) the sub-category.

The probe request will return the response below.

<Path name="path" id="p1">

<DataItems>

<DataItem type="**LINE**" category="EVENT" id="p2" subType="**ACTUAL**" name="line" />

<DataItem type="**CONTROLLER\_MODE**" category="EVENT" id="p3" name="mode" />

<DataItem type="PROGRAM" category="EVENT" id="p4" name="program" />

<DataItem type="EXECUTION" category="EVENT" id="p5" name="execution" />

<DataItem type="BLOCK" category="EVENT" id="p6" name="block" />

</DataItems>

</Path>

The transformation from the probe *(as defined in Part 1 of the standard)* to the current or sample will occur per the example below. This example also illustrates how the subType is placed in the ComponentStream. In the Current and Sample request, data items will be returned in the ComponentStream grouped into their respective categories. Also note how the CONTROLLER\_MODE was changed to ControllerMode in the current request below.

<ComponentStream componentId="p1" component="Path" name="path">

<Events>

<**Line** dataItemId="p2" timestamp="2009-03-04T19:45:50.458305" subType="**ACTUAL**" name="line" sequence="150651130">702</Line>

<Block dataItemId="p6" timestamp="2009-03-04T19:45:50.458305" name="block" sequence="150651134">x0.371524 y-0.483808</Block>

<**ControllerMode** dataItemId="p3" timestamp="2009-02-26T02:02:35.716224" name="mode" sequence="182">AUTOMATIC</ControllerMode>

</Events>

</ComponentStream>

## Samples and Events

All sample and event values **SHALL** be able to provide UNAVAILABLE as a valid value when the data source is not connected or the data source is unable to retrieve information. The UNAVAILABLE value will persist until the connection is restored and a new value can be retrieved. This state does not imply the device is no longer operational, it only implies that the state cannot be determined.

## Samples

The Samples element **SHALL** contain at least one Sample element. The Samples element acts only as a container for all the Sample elements to provide a logical structure to the XML Document.

| **Element** | **Description** | **Occurrence** |
| --- | --- | --- |
| Sample | The subtype of Sample for this component stream | 1..INF |

## Sample

A Sample is an abstract type. This means there will never be an actual element called Sample, but any element that is a sub-type of Sample can be used as a sub-element of Samples. Examples of sample sub-types are Position, Load, and Angle. Sample types **SHALL** have numeric values.

If two adjacent samples for the same component and data item have the same value, the second sample **SHALL NOT** be sent to the client application and does not need to be retained by the MTConnect Agent. This will greatly reduce the amount of information sent to the application. The application can always assume that if the sample is not present, it has the previous value. For data items containing an *attribute* for Duration, the application **SHALL** assume that the value has not changed until another sample is sent to the client application. The application **SHALL** assume that Duration is the total time of the duration specified in the last sample plus the time elapsed since the last sample was provided. If the application needs the present value, it can always ask for the current values (see *Protocol).*

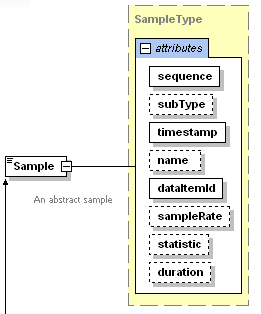


Figure : Sample Schema

### Sample attributes:

| **Attribute** | **Description** | **Occurrence** |
| --- | --- | --- |
| name | The name **SHALL** match the name of the DataItem this sample is associated with. It **SHALL** be an NMTOKEN XML type. | 0..1 |
| sequence | The sequence number of this event. The value **SHALL** be represented as a unsigned 64 bit with valid values from 1 to 2^64-1. | 1 |
| timestamp | The timestamp of the sample. The most accurate time available to the device **SHALL** be used for the timestamp | 1 |
| dataItemID | The id attribute of the corresponding data retrieved in the probe request. | 1 |
| subType | The sub-type of the dataItem | 0..1 |
| sampleRate | The rate at which successive samples of a dataItem are recorded. Sample rate is expressed in terms of samples per second. If the sample rate is smaller than one, the number can be represented as a floating point number. For example, a rate 1 per 10 seconds would be 0.1 The sampleRate attribute **SHALL** be included in the *TimeSeries* streams element if it is not constant OR if it is not in the DataItem. If the sampleRate is constant it **MAY** be placed in the DataItem and does not need to be repeated in the streams element. | 0..1 |
| statistic | The type of statistical calculation specified for the dataItem | 0..1 |
| duration | The time elapsed since the statistic calculation was last reset | 0..1 |

A sample **SHALL** contain CDATA as the content between the element tags. A position is formatted like this:

1. <Position sequence=”112” timestamp=”2007-08-09T12:32:45.1232” name=”Xabs” dataItemId=”10”>123.3333</Position>

In this example the 123.3333 is the CDATA for the position. All the CDATA in a sample is typed, meaning that it can be validated using an XML parser. This restricts the format of the values to a specific pattern.

### Time Series

A Time Series is a SAMPLE which includes multiple readings of a dataItem taken at a specified sample rate. A time series can be used for collecting high frequency samples of a dataItem and then providing the series of samples to an application as a single dataItem. A time series contains the same *Attributes* as a SAMPLE, plus one additional attribute sampleCount. For a Time Series, sampleRate defines the time period (frequency) for the collection of each reading of the dataItem and sampleCount defines the total number of readings being transmitted. The CDATA **SHALL** be a series of floating point numbers. The number of readings **SHALL** match the sampleCount. The units for a Time Series SHALL be the same as specified for the dataItem.

The element of the sample for a dataItem with an *Attribute* of representation will be the transformation of the data item type by capitalizing the first character of each word and then removing the underscore and adding the representation type. For example, ANGULAR\_VELOCITY with representation defined as TimeSeries SHALL be AngularVelocityTimeSeries. If representation is not defined or it is VALUE, then the transformation **SHALL** be AngularVelocity.

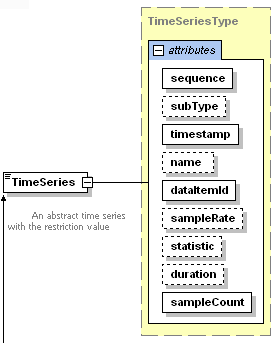


Figure : Time Series Schema

### Time Series attributes:

| **Attribute** | **Description** | **Occurrence** |
| --- | --- | --- |
| sampleCount | The number of readings of a data item provided in a Time Series. | 0..1 |

### Sample Element Tag Names

The following is a list of all the elements that can be placed in the Samples section of the ComponentStream. All samples have a numeric value as the CDATA or UNAVAILABLE if the data is in an indeterminate state.

**Acceleration** The acceleration of a linear component **SHALL** always be reported in MILLIMETER/SECOND^2. An acceleration **SHALL** have a numeric value.

**AccumulatedTime** The accumulated time associated with a component or a function of a component. The time **SHALL** have a numeric value and **SHALL** be reported in SECOND.

**Amperage** The current in an electrical circuit. The amperage **SHALL** have a numeric value and **SHALL** be reported in AMPERE.

**Angle** An angle **SHALL** always be reported in DEGREE and **SHALL** always have a numeric CDATA value as a floating point number.

**AngularAcceleration** The angular acceleration of the component as measured in DEGREE/SECOND^2. An acceleration **SHALL** have a numeric value.

**AngularVelocity** An angular velocity represents the rate of change in angle. An angular velocity **SHALL** always be reported in DEGREE/SECOND and **SHALL** always have a numeric CDATA value as a floating point number.

**AxisFeedrate** Axis Feedrate is defined as the rate of motion of the linear axis of the tool relative to the workpiece[[1]](#footnote-1). An axis feedrate **SHALL** always be reported in MILLIMETER/SECOND or PERCENT for override and **SHALL** always have a numeric CDATA value as a floating point number.

**ClockTime** The reading of a timing device at a specific point in time. The time **SHALL** have a value reported in W3C ISO 8601 format of YYYY-MM-DDThh:mm:ss.ffff

**Concentration** Percentage of one component within a mixture of components. The concentration **SHALL** have a value reported in PERCENT.

**Conductivity** The ability of a material to conduct electricity. The conductivity **SHALL** have a value reported in SIEMENS/METER.

**Displacement** The displacement measured as the change in position of an object. The displacement **SHALL** have a value reported in MILLIMETER.

**ElectricalEnergy** The measurement of electrical energy consumed by a component. Electrical Energy **SHALL** have a value reported in WATT\_SECOND.

**Flow** The rate of flow of a fluid. The flow **SHALL** have a value reported in LITER/SECOND.

**Frequency** The rate measurement of the number of occurrences of a repeating event per unit time. The frequency **SHALL** have a numeric value and **SHALL** be reported in HERTZ.

**FillLevel** The measurement of the amount of a substance remaining compared to the planned maximum amount of that substance. The fill level **SHALL** be reported in PERCENT.

**LinearForce** The measurement of the amount of push or pull introduced by an actuator or exerted on an object. The linear force **SHALL** be reported in NEWTON.

**Load** The measurement of the percent of the standard rating of a device. The load **SHALL** always be reported in PERCENT and **SHALL** always have a numeric CDATA value as a floating point number.

**Mass** The measurement of the mass of an object(s) or an amount of material. The mass **SHALL** be reported in KILOGRAM.

**PathFeedrate** Path Feedrate is defined as the rate of motion of the feed path of the tool relative to the workpiece[[2]](#footnote-2). A path feedrate **SHALL** always be reported in MILLIMETER/SECOND or PERCENT for override and **SHALL** always have a numeric CDATA value as a floating point number.

**PathPosition** The program position as given in 3 dimensional space. This position **SHALL** default to WORK coordinates, if the WORK coordinates are defined, and **SHALL** be given as a space delimited vector of floating point numbers given in MILLIMETER\_3D units. The PathPosition will be given in the following format and **SHALL** be listed in order X, Y, and Z:  
<PathPosition …>10.123 55.232 100.981</PathPosition>  
Where X = 10.123, Y = 55.232, and Z=100.981.

**PH** The measure of acidity or akalinity. The PH **SHALL** be a numeric value and **SHALL** be provided in PH.

**~~GlobalPosition~~** ~~The global position is the three space coordinate of the tool. A global position~~ **~~SHALL~~** ~~always be reported in MILLIMETER and~~ **~~SHALL~~** ~~always have a numeric CDATA value as three floating point numbers (x, y, and z). Position~~ **~~SHALL~~** ~~always be given in absolute coordinates.~~ DEPRECATED in Release 1.1

**Position** A position represents the location along a linear axis. A position **SHALL** always be reported in MILLIMETER and **SHALL** always have a numeric CDATA value as a floating point number. The default coordinate system for Position **SHALL** be MACHINE\_COORDINATES.

**PowerFactor** The measurement of the ratio of real power flowing to a load to the apparent power in that AC circuit. The power factor **SHALL** be a numeric value and **SHALL** be provided in PERCENT.

**Pressure** The force per unit area exerted by a gas or liquid. The pressure **SHALL** be a numeric value and **SHALL** be provided in PASCAL.

**Resistance** The measure of the degree to which an object opposes an electrical current through it. The resistance **SHALL** be a numeric value and **SHALL** be provided in OHM.

**RotaryVelocity** The rate of rotation of a rotary axis. A rotary velocity speed **SHALL** always be reported in REVOLUTION/MINUTE or PERCENT for Override.

**SoundLevel** The measure of acoustic sound level or sound pressure level. The sound level **SHALL** be provided in DECIBEL.

**~~SpindleSpeed~~** ~~The rate of rotation of a machine spindle~~ ~~[[3]](#footnote-3)~~~~. A spindle speed~~ **~~SHALL~~** ~~always be reported in REVOLUTION/MINUTE and~~ **~~SHALL~~** ~~always have a numeric CDATA value as a floating point number.~~ DEPRICATED in Release 1.2. See RotaryVelocity.

**Strain** The measured amount of deformation per unit length of an object. Strain **SHALL** be reported as PERCENT.

**Temperature** Temperature **SHALL** always be reported in degrees CELSIUS and **SHALL** always have a numeric CDATA value as a floating point number.

**Tilt** The measured amount of angular displacement of an object. Tilt **SHALL** be reported as MICRO\_RADIAN.

**Torque** The turning force exerted on an object of by an object **SHALL** be reported in units of NEWTON\_METER and **SHALL** have a numeric CDATA value as a floating point number.

**Velocity** A velocity represents the rate of change in position along one or more linear axis. When given as a Sample for the Axes component, it represents the magnitude of the velocity vector for all given axis, similar to a path feedrate. A velocity **SHALL** always be reported in MILLIMETER/SECOND and **SHALL** always have a numeric CDATA value as a floating point number.

**Viscosity** The measurement of a fluid’s resistance to flow. Viscosity **SHALL** be reported as PASCAL\_SECOND.

**Voltage** The measurement of electrical potential between two points. The voltage **SHALL** have a numeric value and **SHALL** be reported in VOLT.

**VoltAmpere** The measurement of apparent power in an electrical circuit, equal to the product of the RMS voltage and RMS current. The voltage ampere **SHALL** have a numeric value and **SHALL** be reported in VOLT\_AMPERE.

**VoltAmpereReactive** The measurement of reactive power in an AC electrical circuit. The voltage ampere reactive **SHALL** have a numeric value and **SHALL** be reported in VOLT\_AMPERE\_REACTIVE.

**Wattage** The electrical power (volt-amps) consumed or dissipated by an electrical circuit or device. The watts **SHALL** have a numeric value and **SHALL** be reported in WATT.

### Extensibility

Additional sample types can be added by extending the Sample type in the XML schema. The samples presented here are the official sample types that will be supported by all MTConnect *Agents*. Any non-sanctioned extensions will not be guaranteed to have consistency across implementations.

## Events

The Events element **SHALL** contain at least one Event element. The Events element acts only as a container for all the Event elements to provide a logical structure to the XML Document.

| **Element** | **Description** | **Occurrence** |
| --- | --- | --- |
| Event | The subtype of Event for this component stream | 1..INF |

## Event

An Event is an abstract type. This means there will never be an actual element called Event, but any element that is a sub-type of Event can be used in place of Event. Examples of event sub-types are Block, Execution, and Line. Events types have values in any format.

An event is similar to a sample, but its values are going to be changing with unpredictable frequency. Events do not have intermediate values. When an Availability transitions from UNAVAILABLE to AVAILABLE, there is no intermediate state that can be inferred. Therefore, most events have a controlled vocabulary as their content.

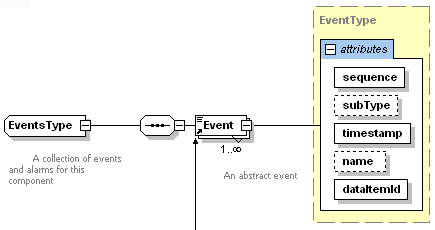


Figure : Event Schema

### Event attributes:

| **Attribute** | **Description** | **Occurrence** |
| --- | --- | --- |
| name | The name **SHALL** match the name of the DataItem this sample is associated with. It **SHALL** be an NMTOKEN XML type. | 0..1 |
| sequence | The sequence number of this event. Values from 1 to 2^63-1 SHALL be supported. | 1 |
| timestamp | The timestamp of the sample. The most accurate time available to the device **SHALL** be used for the timestamp | 1 |
| dataItemID | The id attribute of the corresponding data retrieved in the probe request. | 1 |
| subType | The sub-type of the dataItem | 0..1 |

### Event Element Tag Names

The Event elements represent the state of various device attributes. The following is a list of all the event elements that may be placed within the Events section of the ComponentStream.

**ActiveAxes** The set of axes being controlled by a Path. The value **SHALL** be a space delimited set of axes names. For example:  
<ActiveAxes …>X Y Z C</ActiveAxes>  
If this is not provided, it **SHALL** assumed the Path is controlling all the axes.

**ActuatorState** An actuator state represents a device for moving or controlling a mechanism or system. The CDATA **SHALL** be as follows:

| **Value** | **Description** |
| --- | --- |
| ACTIVE | The actuator is operating or active |
| INACTIVE | The actuator is not operating or inactive |

**Availabilty** Represents the component’s ability to communicate its availability. This **SHALL** be provided for the device and **MAY** be provided for all other components.

| **Value** | **Description** |
| --- | --- |
| AVAILABLE | The component is available. |
| UNAVAILABLE | The component is not available. |

**AxisCoupling** Describes the way the axes will be associated to each other. This is used in conjunction with COUPLED\_AXES to indicate the way they are interacting**.**

| **Value** | **Description** |
| --- | --- |
| TANDEM | The axes are physically connected to each other and SHALL operate as a single unit. |
| SYNCHRONOUS | The axes are coupled and are operating together in lockstep. |
| MASTER | The axis is the master of the CoupledAxes |
| SLAVE | The axis is a slave of the CoupledAxes |

**Block** A Block of code is a command being executed by the Controller. The Block **SHALL** include the entire command with all the parameters.

**~~Code~~** ~~The code is just the G, M, or NC code being executed. The Code~~ **~~SHALL~~** ~~only contain the simplest form of the executing command.~~ **DEPRECATED in Rel. 1.1.**  Duplicates Block.

**ControllerMode** The Mode of the Controller. The CDATA **SHALL** be one of the following:

| **Value** | **Description** |
| --- | --- |
| AUTOMATIC | The controller is configured to automatically execute a program. |
| SEMI\_AUTOMATIC | The controller is operating in a single cycle, single block, or single step mode. |
| MANUAL | The controller is under manual control by the operator. |
| MANUAL\_DATA\_INPUT | The operator can enter operations for the controller to perform. There is no current program being executed. |
| FEED\_HOLD | The axis of the device are commanded to stop, but the spindle continues to function. |

**CoupledAxes** As a Linear or Rotary axis data item, refers to the set of associated axes to be used in conjunction with AxisCoupling. The value will be a space delimited set of axes names. For example:  
 <CoupledAxes …>Y2</ CoupledAxes >

**Direction** A Direction indicates the direction of rotation. The CDATA SHALL be as follows:

| **Value** | **Description** |
| --- | --- |
| CLOCKWISE | The rotary component is rotating in a clockwise fashion using the right hand rule. |
| COUNTER\_CLOCKWISE | The rotary component is rotating in a counter clockwise fashion using the right hand rule. |
| POSITIVE | A linear component moving in the direction of increasing position value |
| NEGATIVE | A linear component moving in the direction of decreasing position value |

**DoorState** A door state represents an opening that can be opened or closed. The CDATA **SHALL** be as follows:

| **Value** | **Description** |
| --- | --- |
| OPEN | The door is open to the point of a positive confirmation |
| CLOSED | The door is closed to the point of a positive confirmation |
| UNLATCHED | The door is not closed to the point of a positive confirmation and not open to the point of a positive confirmation |

**Execution** The Execution state of the Controller. The CDATA **SHALL** be one of the following:

| **Value** | **Description** |
| --- | --- |
| READY | The controller is ready to execute. It is currently idle. |
| ACTIVE | The controller is actively executing an instruction. |
| INTERRUPTED | The operator or the program has paused execution and is waiting to be continued. |
| STOPPED | The controller has been stopped. |

**mergencyStop** The emergency stop state of the machine, device, or controller path. The CDATA **SHALL** be one of the following:

| **Value** | **Description** |
| --- | --- |
| ARMED | The circuit is complete and the device is operating. |
| TRIGGERED | The circuit is open and the device SHALL cease operation. |

**Line** This event refers to the optional program line number. For example in RS274/NGC the line number begins with an N and is followed by 1 to 5 digits (0 – 99999). If there is not an assigned line number in the programming systems as in RS274, the line number will refer to the position in the executing program. The line number **SHALL** be any positive integer from 0 to 232-1.

**Message** A text notification. Format **MAY** be any valid text string.

**PartCount** The number of parts produced. This will not be counted by the agent and **SHALL** only be supplied if the controller provides the count.

**PartId** This is a reference to an identifier for the current part being machined. It is a placeholder for now and can be used at the discretion of the implementation.

**PathMode** The Path mode is provided for devices that are controlling multiple sets of axes using one program. When PathMode is not provided it **SHALL** be assumed to be INDEPENDENT.

| **Value** | **Description** |
| --- | --- |
| INDEPENDENT | A set of axes are operating independently and without the influence of another set of axes. |
| SYNCHRONOUS | The sets of axes are operating synchronously. |
| MIRROR | The sets of axes are mirroring each other. |

**~~PowerStatus~~** ~~Power status~~ **~~SHALL~~** ~~be either ON or OFF.~~  DEPRECATED in Rel. 1.1

| **~~Value~~** | **~~Description~~** |
| --- | --- |
| ~~ON~~ | ~~The power to the component is ON.~~ |
| ~~OFF~~ | ~~The power to the component is OFF.~~ |

**PowerState** Power state **SHALL** be either ON or OFF. DEPRECATION WARNING: **MAY** be deprecated in the future.

| **Value** | **Description** |
| --- | --- |
| ON | The power to the component is ON. |
| OFF | The power to the component is OFF. |

**Program** The name of the program executing in the controller. This is usually the name of the file containing the program instructions.

**RotaryMode** The mode the rotary axis is currently operating. The CDATA **SHALL** be one of the following:

| **Value** | **Description** |
| --- | --- |
| SPINDLE | The axis is operating like a spindle and spinning. |
| INDEX | The axis is indexing to a position. |
| CONTOUR | The axis is interpolating its position as part of the path position defined by the controller. |

**~~ToolId~~ Deprecated in Rel. 1.2. See ToolAssetID.** ~~This is a reference to an identifier for the current tool in use by the Path. It is a placeholder for now and can be used at the discretion of the implementation. Once mobile assets have been defined, this will refer to the corresponding asset.~~

**ToolAssetId** This is a reference to an identifier for the current tool in use by the Path.

**WorkholdingId** This is a reference to an identifier for the current workholding. It is a placeholder for now and can be used at the discretion of the implementation. Once mobile assets have been defined, this will refer to the corresponding asset.

## Condition

Condition items provide a method by which the machine can communicate its health and ability to function. A condition can be one of Normal, Warning, Fault, or Unavailable. A Component **MAY** have multiple active conditions at one time whereas a Sample or Event can only have a single value at a point in time.

### Types of Condition

* **Normal**The item being monitored is operating normally and no action is required. Normal also indicates a Fault or Warning has been cleared if the item was previously identified with Fault or Warning.
* **Warning**The item being monitored is moving into the abnormal range and should be observed. No action is required at this time. Transition to a normal condition indicates that the Warning has been cleared.
* **Fault**The item has failed and intervention is required to return to a normal condition. Transition to a normal condition indicates that the Fault has been cleared. A fault is something that always needs to be acknowledged before operation can continue. Faults are sometimes noted as an alarm.
* **Unavailable**The condition is in an indeterminate state since the data source is no longer providing data. This will also be the initial state of the condition before a connection is established with the data source. The condition **SHALL** be Unavailable when the value is unknown.

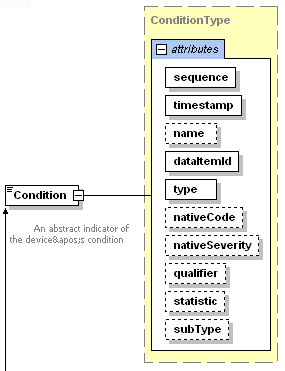


Figure : Condition Schema

### Condition Attributes

| **Attribute** | **Description** | **Occurrence** |
| --- | --- | --- |
| sequence | The sequence number of this event. Values from 1 to 2^63-1 SHALL be supported. | 1 |
| timestamp | The timestamp of the sample. The most accurate time available to the device **SHALL** be used for the timestamp | 1 |
| dataItemID | The id attribute of the corresponding data retrieved in the probe request. | 1 |
| name | The name **SHALL** match the name of the event's associated DataItem. An NMTOKEN XML type. | 0..1 |
| type | The data item type this condition refers to. | 1 |
| sub-type | The sub-type of the dataItem | 0..1 |
| qualifier | Qualifies the condition and adds context or additional clarification. This optional attribute can be used to convey information like HIGH, LOW, … | 0..1 |
| nativeCode | The native code for the piece of equipment. This is the way the alarm is represented on the component. | 0..1 |
| nativeSeverity | The pass thru severity from the device manufacturer. | 0..1 |
| statistic | The type of statistical calculation specified for the dataItem | 0..1 |
| xs:lang | An optional attribute that specifies language of the alarm text. Refer to IETF RFC 4646 (http://www.ietf.org/rfc/rfc4646.txt) or successor for a full definition of the values for this attribute. Does not appear in the Header schema diagrams | 0..1 |

### Condition Contents - CDATA

The contents are the optional text from the data source in the un-interpreted form. The text is provided for informational purpose only for interpretation by the application or other client software.

### Condition Types

All existing Data Item types **MAY** be used as types for the Condition types. There are some additional types that have been added that represent logical parts of the device architecture and allow for better association and representation of the devices health. The following are the types specifically added for the Condition.

| **Data Item type/ qualifier** | **Description** |
| --- | --- |
| **ACTUATOR** | A condition with the motion drive, servo, or actuator. |
| **COMMUNICATIONS** | A communications failure indicator. |
| **HARDWARE** | The operational condition of the hardware subsystem of the component. |
| **LOGIC\_PROGRAM** | An error occurred in the logic program or PLC (programmable logic controller). |
| **MOTION\_PROGRAM** | An error occurred in the motion program. |
| **SYSTEM** | A condition representing something that is not the operator, program, or hardware. This is often used for operating system issues. |

### Condition Examples

The following are abbreviated examples of the use of the Condition elements in XML. The condition has additional restrictions which are different form the Event and Sample. The following will demonstrate the differences and usage of the Condition.

...

<Linear id="y" name="Y">

<DataItems>

<DataItem type="POSITION" subType="ACTUAL" id="yp" category="SAMPLE"

name="Yact" units="MILLIMETER" nativeUnits="MILLIMETER"

coordinateSystem="MACHINE"/>

**<DataItem type="POSITION" id="ylc" category="CONDITION" />**

**<DataItem type="LOAD" id="ylc" category="CONDITION" />**

**<DataItem type="TEMPERATURE" id="ytc" category="CONDITION" />**

</DataItems>

</Linear>

...

<Controller id="cont" name="controller">

<DataItems>

<DataItem type="PROGRAM" id="pgm" category="EVENT" name="program"/>

<DataItem type="BLOCK" id="blk" category="EVENT" name="block"/>

<DataItem type="LINE" id="ln" category="EVENT" name="line"/>

<DataItem type="PATH\_FEEDRATE" id="pf" category="SAMPLE" name="Fact"

units="MILLIMETER/SECOND" nativeUnits="FOOT/MINUTE" subType="ACTUAL"

coordinateSystem="WORK"/>

<DataItem type="PATH\_FEEDRATE" id="pfo" category="SAMPLE" name="Fovr"

units="PERCENT" nativeUnits="PERCENT" subType="OVERRIDE"/>

<DataItem type="PATH\_POSITION" id="pp" category="SAMPLE" name="Ppos"

units="MILLIMETER" nativeUnits="MILLIMETER" coordinateSystem="WORK"/>

<DataItem type="TOOL\_ASSET\_ID" id="tid" category="EVENT" name="Tid"/>

<DataItem type="PART\_ID" id="pid" category="EVENT" name="Pid"/>

<DataItem type="EXECUTION" id="exec" category="EVENT" name="execution"/>

<DataItem type="CONTROLLER\_MODE" id="cm" category="EVENT" name="mode"/>

**<DataItem type="COMMUNICATIONS" id="cc1" category="CONDITION" />**

**<DataItem type="MOTION\_PROGRAM" id="cc2" category="CONDITION" />**

**<DataItem type="LOGIC\_PROGRAM" id="cc3" category="CONDITION" />**

</DataItems>

</Controller >

In the previous example we have focused on two components, a Linear Y axis and a controller. They both have condition associated with them. The axis has a temperature sensor and a load sensor that will alert when the temperature or load goes out of range. The controller also has a few condition data items associated with the program and communications.

When everything is working properly, a current request will deliver the following XML:

<DeviceStream uuid="HM1" name="HMC\_3Axis">

<ComponentStream component="Linear" name="Y" componentId="y">

<Samples>

<Position dataItemId="yp" name="Yact" subType="ACTUAL" sequence="23"

timestamp="2009-11-13T08:00:00">213.1232</Position>

</Samples>

**<Condition>**

**<Normal type="TEMPERATURE" id="ytmp" sequence="25" timestamp="..."/>**

**<Normal type="LOAD" id="ylc" sequence="26" timestamp="..."/>**

**<Normal type="POSITION" id="ypc" sequence="26" timestamp="..."/>**

**</Condition>**

</ComponentStream>

</DeviceStream>

<ComponentStream component="Controller" name="cont" componentId="cont">

<Events>

...

</Events>

**<Condition>**

**<Normal type="MOTION\_PROGRAM" id="cc2" sequence="25" timestamp="..."/>**

**<Normal type="COMMUNICATIONS" id="cc1" sequence="26" timestamp="..."/>**

**<Normal type="LOGIC\_PROGRAM" id="cc3" sequence="26" timestamp="..."/>**

**</Condition>**

</ComponentStream>

</DeviceStream>

The example below shows all of the condition items reporting that everything is normal for the linear axis Y and that the Controller has two conditions that are normal, but there is a communications fault on the device.

<DeviceStream uuid="HM1" name="HMC\_3Axis">

<ComponentStream component="Linear" name="Y" componentId="y">

<Samples>

<Position dataItemId="yp" name="Yact" subType="ACTUAL" sequence="23"

timestamp="2009-11-13T08:00:00">213.1232</Position>

</Samples>

<Condition>

<Normal type="TEMPERATURE" id="ytmp" sequence="25" timestamp="..."/>

<Normal type="LOAD" id="ylc" sequence="26" timestamp="..."/>

<Normal type="POSITION" id="ypc" sequence="26" timestamp="..."/>

</Condition>

</ComponentStream>

</DeviceStream>

<ComponentStream component="Controller" name="cont" componentId="cont">

<Events>

...

</Events>

<Condition>

<Normal type="MOTION\_PROGRAM" id="cc2" sequence="25" timestamp="..."/>

**<Fault type="COMMUNICATIONS" id="cc1" sequence="26" nativeCode="IO1231"**

**timestamp="...">Communications error</Fault>**

<Normal type="LOGIC\_PROGRAM" id="cc3" sequence="26" timestamp="..."/>

</Condition>

</ComponentStream>

</DeviceStream>

When a failure occurs the item **SHALL** be reported as a Fault. This indicates that intervention is required to fix the problem and reset the state of the machine. In the following example, we show how multiple Faults on the same condition can exist.

</DeviceStream>

<ComponentStream component="Controller" name="cont" componentId="cont">

<Events>

...

</Events>

**<Condition>**

**<Fault type="MOTION\_PROGRAM" id="cc2" sequence="25" nativeCode="PR1123"**

**timestamp="...">Syntax error on line 107</Fault>**

**<Fault type="MOTION\_PROGRAM" id="cc2" sequence="28" nativeCode="PR1123"**

**timestamp="...">Syntax error on line 112</Fault>**

**<Fault type="MOTION\_PROGRAM" id="cc2" sequence="30" nativeCode="PR1123"**

**timestamp="...">Syntax error on line 122</Fault>**

<Normal type="COMMUNICATIONS" id="cc1" sequence="26" timestamp="..."/>

<Normal type="LOGIC\_PROGRAM" id="cc3" sequence="26" timestamp="..."/>

**</Condition>**

</ComponentStream>

</DeviceStream>

In this case a bad motion program was loaded and multiple errors were reported. When this occurs all errors **SHALL** be provided and classified accordingly. The only exception to having multiple values per condition is Normal. If the condition is Normal, there **SHALL** only be one condition with that type present. There **SHALL** **NOT** be more than one Normal and a Normal **SHALL NOT** occur with a Fault or Warning of the same type.

A sample **SHALL** treat condition items the same way it does Events, Samples, and Condition and only return those that are in the current select window.

## ~~Alarms~~ DEPRECATED: See Condition

~~The Alarm event adds some additional fields to the standard Event schema. The following additional attributes are used for the alarm:~~

| **~~Attribute~~** | **~~Description~~** | **~~Occurrence~~** |
| --- | --- | --- |
| ~~code~~ | ~~The type of alarm. This is a high level classification for all codes.~~ | ~~1~~ |
| ~~severity~~ | ~~The severity of the alarm, currently we have CRITICAL, ERROR, WARNING, or INFORMATION.~~ | ~~1~~ |
| ~~nativeCode~~ | ~~The native code for the piece of equipment. This is the way the alarm is represented on the component.~~ | ~~1~~ |
| ~~state~~ | ~~Either INSTANT, ACTIVE or CLEARED. When the Alarm occurs, it will be created with an ACTIVE state. Once it has been addressed, the state will be changed to CLEARED. An INSTANT alarm does not need to be cleared.~~ | ~~1~~ |
| ~~lang~~ | ~~An optional attribute that specifies language of the alarm text. Refer to IETF RFC 4646 (http://www.ietf.org/rfc/rfc4646.txt) or successor for a full definition of the values for this attribute.~~ | ~~0..1~~ |

~~The code can have one of the following values:~~

| **~~Enumeration~~** | **~~Description~~** |
| --- | --- |
| ~~CRASH~~ | ~~A spindle crashed~~ |
| ~~JAM~~ | ~~A component jammed.~~ |
| ~~FAILURE~~ | ~~The component failed.~~ |
| ~~FAULT~~ | ~~A fault occurred on the component.~~ |
| ~~STALLED~~ | ~~The component has stalled and cannot move.~~ |
| ~~OVERLOAD~~ | ~~The component is overloaded.~~ |
| ~~ESTOP~~ | ~~The ESTOP button was pressed.~~ |
| ~~MATERIAL~~ | ~~There is a problem with the material.~~ |
| ~~MESSAGE~~ | ~~A system message.~~ |
| ~~OTHER~~ | ~~The alarm is not in any of the above categories.~~ |

~~The CDATA of the Alarm is the human-readable text from the component that raised the alarm. The device should specify this text so it can be logged.~~

Appendices

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17. IEEE STD 1451.4-1994*, Standard for a Smart Transducer Interface for Sensors and Actuators – Mixed-Mode Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats, IEEE Instrumentation and Measurement Society, TC-9, The Institute of Electrical and Electronics Engineers, Inc., New York, N.Y. 10016, SH95225, December 15, 2004.*
18. Annotated XML Examples
    1. Example of a current Request

<?xml version="1.0" encoding="UTF-8"?>

<MTConnectStreams xmlns:m="urn:mtconnect.org:MTConnectStreams:1.1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:mtconnect.org:MTConnectStreams:1.1" xsi:schemaLocation="urn:mtconnect.org:MTConnectStreams:1.1 http://www.mtconnect.org/schemas/MTConnectStreams\_1.1.xsd">

<Header creationTime="2010-04-16T21:19:35+00:00" sender="localhost"

instanceId="1267747762" bufferSize="131072" version="1.1"

nextSequence="739103692" firstSequence="738972620"

lastSequence="739103691" />

The above is a standard header. The buffer size is 131072 entries. The first sequence number is 738972620 and the last sequence number is 739103691, if you subtract and add one, gives 131072 entries; this means the buffer is full. For the next streaming request, you would request with *from* set to 739103692.

<Streams>

<DeviceStream name="VMC-3Axis" uuid="000">

<ComponentStream component="Path" name="path" componentId="pth">

<Samples>

<PathFeedrate dataItemId="Fovr" sequence="738968517"

timestamp=

"2010-04-16T21:09:58.356100">100.0000000000</PathFeedrate>

<PathFeedrate dataItemId="Frt" sequence="739103685"

timestamp="2010-04-16T21:19:07.019367">0</PathFeedrate>

</Samples>

<Events>

<Block dataItemId="cn2" name="block" sequence="739103493"

timestamp="2010-04-16T21:19:05.751294">G0Z1</Block>

<ControllerMode dataItemId="cn3" name="mode" sequence="738968515"

timestamp=

"2010-04-16T21:09:58.356100">AUTOMATIC</ControllerMode>

<Line dataItemId="cn4" name="line" sequence="739103687"

timestamp="2010-04-16T21:19:07.051368">0</Line>

<Program dataItemId="cn5" name="program" sequence="738968514"

timestamp="2010-04-16T21:09:58.356100">FLANGE\_CAM.NGC</Program>

<Execution dataItemId="cn6" name="execution" sequence="739103689"

timestamp="2010-04-16T21:19:07.063369">READY</Execution>

</Events>

</ComponentStream>

The Path component has both Samples and Events. The information regarding the path feedrate and feedrate override are considered sampled information in the Path. The events are related to the execution of the program for this Path.

<ComponentStream component="Rotary" name="C" componentId="c1">

<Samples>

<SpindleSpeed dataItemId="c2" name="Sspeed" sequence="739103691"

subType="ACTUAL" timestamp=

"2010-04-16T21:19:07.063369">0.0000000000</SpindleSpeed>

<SpindleSpeed dataItemId="c3" name="Sovr" sequence="738968518"

subType="OVERRIDE" timestamp=

"2010-04-16T21:09:58.356100">100.0000000000</SpindleSpeed>

</Samples>

<Events>

<RotaryMode dataItemId="cm" name="Cmode" sequence="2"

timestamp="2010-03-05T00:09:22.457383">SPINDLE</RotaryMode>

</Events>

<Condition>

<Normal dataItemId="Cload" sequence="738968524" timestamp=

"2010-04-16T21:09:58.356100" type="LOAD" />

</Condition>

</ComponentStream>

The rotary C axis is the spindle and can be seen by checking the RotaryMode. In this case it is constrained to the value SPINDLE and will probably have a native name of “S”. There is also a condition which is monitoring the spindle load and is currently Normal.

<ComponentStream component="Linear" name="X" componentId="x1">

<Samples>

<Position dataItemId="x2" name="Xact" sequence="739103504"

subType="ACTUAL" timestamp=

"2010-04-16T21:19:05.795297">0.0019900000</Position>

<Position dataItemId="x3" name="Xcom" sequence="739103489"

subType="COMMANDED" timestamp=

"2010-04-16T21:19:05.751294">0.0019900000</Position>

</Samples>

<Condition>

<Normal dataItemId="Xload" sequence="738968525" timestamp=

"2010-04-16T21:09:58.356100" type="LOAD" />

</Condition>

</ComponentStream>

Each of the linear axes has an actual and commanded position that is represented as samples as well as a condition monitoring the load. This is the same pattern for all the linear axes.

<ComponentStream component="Linear" name="Y" componentId="y1">

<Samples>

<Position dataItemId="y2" name="Yact" sequence="739103500"

subType="ACTUAL" timestamp=

"2010-04-16T21:19:05.783296">0.0002004431</Position>

<Position dataItemId="y3" name="Ycom" sequence="739103490"

subType="COMMANDED" timestamp=

"2010-04-16T21:19:05.751294">0.0002000000</Position>

</Samples>

<Condition>

<Normal dataItemId="Yload" sequence="738968526" timestamp=

"2010-04-16T21:09:58.356100" type="LOAD" />

</Condition>

</ComponentStream>

<ComponentStream component="Linear" name="Z" componentId="z1">

<Samples>

<Position dataItemId="z2" name="Zact" sequence="739103690"

subType="ACTUAL" timestamp=

"2010-04-16T21:19:07.063369">1.0000000000</Position>

<Position dataItemId="z3" name="Zcom" sequence="739103684"

subType="COMMANDED" timestamp=

"2010-04-16T21:19:07.019367">1.0000000000</Position>

</Samples>

<Condition>

<Normal dataItemId="Zload" sequence="738968527" timestamp=

"2010-04-16T21:09:58.356100" type="LOAD" />

</Condition>

</ComponentStream>

<ComponentStream component="Controller" name="controller"

componentId="cn1">

<Events>

<EmergencyStop dataItemId="estop" sequence="738968519"

timestamp="2010-04-16T21:09:58.356100">RESET</EmergencyStop>

</Events>

<Condition>

<Normal dataItemId="clp" sequence="738968528" timestamp=

"2010-04-16T21:09:58.356100" type="LOGIC\_PROGRAM" />

</Condition>

</ComponentStream>

Since the Path has subsumed the execution and program state, the Controller now contains mainly conditions about the hardware and the state of the device.

<ComponentStream component="Device" name="VMC-3Axis" componentId="dev">

<Events>

<Availability dataItemId="avail" sequence="9" timestamp=

"2010-03-05T00:09:22.457383">AVAILABLE</Message>

<Message dataItemId="msg" sequence="29" timestamp=

"2010-03-05T00:09:22.457383">UNAVAILABLE</Message>

</Events>

</ComponentStream>

Availability is the one required event for the device and it is currently available. If the machine is powered off then this will become UNAVAILABLE. There have been no messages on this machine, so the message state is currently UNAVAILABLE.

<ComponentStream component="Coolant" name="coolant" componentId="cool">

<Condition>

<Normal dataItemId="clow" sequence="738968520" timestamp=

"2010-04-16T21:09:58.356100" type="LEVEL" />

</Condition>

</ComponentStream>

<ComponentStream component="Hydraulic" name="hydraulic"

componentId="hsys">

<Condition>

<Normal dataItemId="hlow" sequence="738968521" timestamp=

"2010-04-16T21:09:58.356100" type="LEVEL" />

<Normal dataItemId="hpres" sequence="738968522" timestamp=

"2010-04-16T21:09:58.356100" type="PRESSURE" />

<Normal dataItemId="htemp" nativeCode="HTEMP" qualifier="HIGH"

sequence="739051314" timestamp="2010-04-16T21:15:42.835731"

type="TEMPERATURE" />

</Condition>

</ComponentStream>

The previous two components are systems. Systems will usually report on the condition of the components, as can be seen here it is reporting on the temperature and the pressure in the Hydraulic and the coolant level. If the level can’t be read, it will report on just the coolant related alarms.

</DeviceStream>

</Streams>

</MTConnectStreams>

1. From ASME B5.54 - 2005 [↑](#footnote-ref-1)
2. From ASME B5.54 - 2005 [↑](#footnote-ref-2)
3. From ASME B5.54 - 2005 [↑](#footnote-ref-3)