MTConnect Application Development

Leveraging Web Technologies

Conference · Workshop · Expo

Background

- Benjamin Kiefer
  - University of Waterloo B. Asc – Mechatronics
  - Pratt & Whitney – Controls Software
- Jared Evans
  - University of Waterloo B. Asc
  - Apple Inc – HW Engineering Manager
- MAJiK Systems
  - Dynamic Real-Time Web Applications for Manufacturers

Why Use Web Applications in Manufacturing

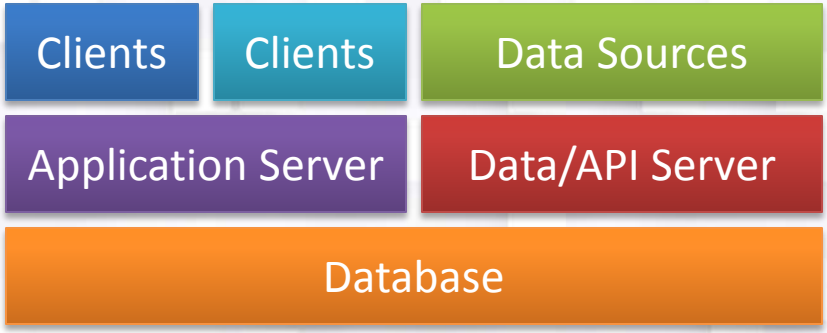
- Available to everyone within your organization
- Operating System Independent
- Reliable, real-time information

Why MTConnect is a Good Fit

- Based off of HTTP Protocol
- RESTful Interface
- XML document schema to represent data

Structure of a Web Application

- Clients
- Application Server
- Data/API Server
- Database
- Other Data Sources



Data Sources

- Traditional Web Applications:
  - People are the source of all data
- Emerging Trends:
  - Web-Enabled Devices, Servers, and ‘Agents’ provide data as well as people
  - API Design becomes a huge factor for anyone creating a scalable web app

HTTP Protocol

- Foundation of the World Wide Web
- Application Level Protocol
- Uses TCP for its transport layer protocol
- Request-Response Based Protocol
- Uses a Client-Server Model

RESTful Interface

Representational **S**tate **T**ransfer

- Stateless – Client's responsibility to track its own state
- Uniform Interface – Resources and Information always accessed the same way
- Scalability and Performance – Separation of data and User Interface

HTTP REST Example

https://www.facebook.com/search/bwkiefer/friends

https://www.google.ca/search?q=mtconnect+institute

MTConnect Example

http://agent.mtconnect.org/current?path=//Controller

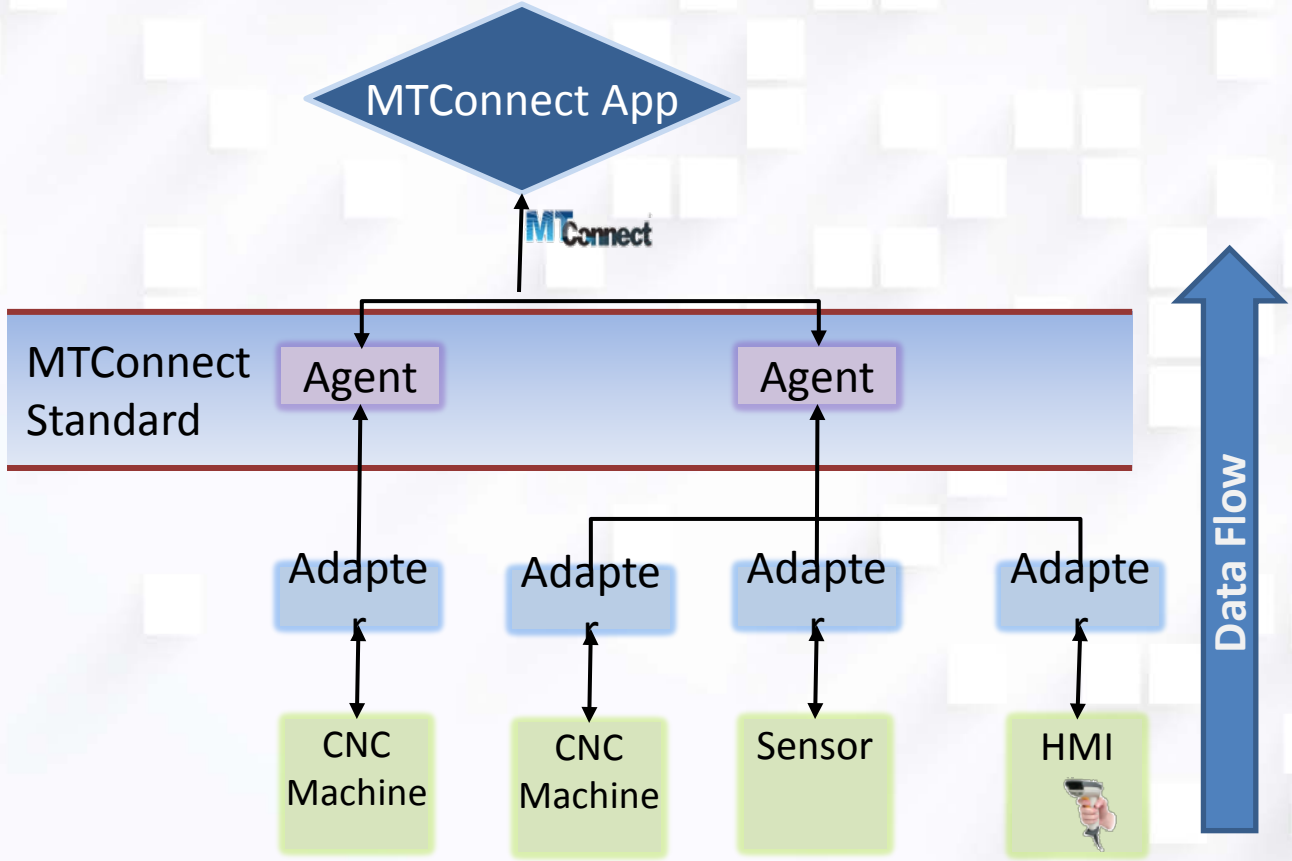
Developing with REST

- Language Independent
- Distributes Computing Load
- Standardizes API and Data Representation for faster development

Developing Using MTConnect

- Your application is the ‘Client’, the MTConnect Agent is the ‘Server’
- Your Application requests data from the MTConnect Agent based on your needs
- Agent responds with requested data
- Your application parses data and completes necessary actions

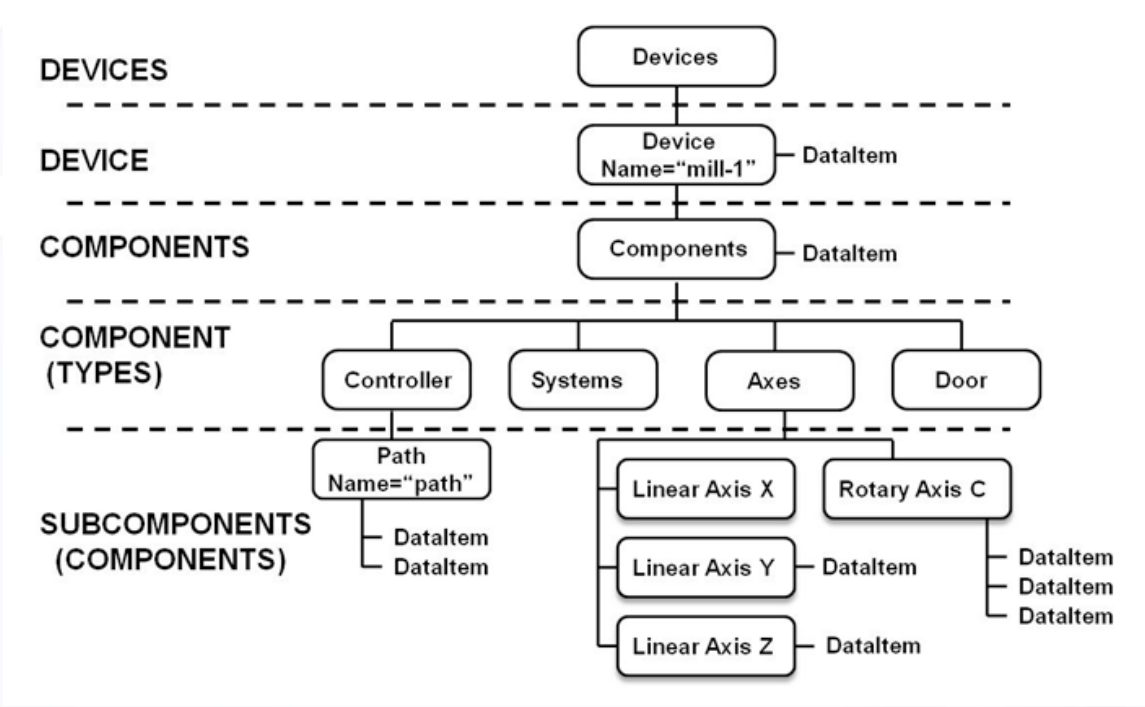
MTConnect Overview



MTConnect Basics

- Probe – Describes Agent's Devices, Components, and Data Items
- Assets – Things associated with a device that are not a component
- Sample – Retrieves values for components' Data Items
- Current – Retrieves *current* values for components' Data Items

Data Hierarchy within the Agent



http://mtcup.org/wiki/Data_Items

Configuring an Agent

- Source Code - https://github.com/mtconnect/cppagent
- Agent.cfg – Boost C++ File Format that tells the agent where the adapters it is connecting to should be located
- Devices.xml – Same format as an MTConnectDevices document. Data served by adapter should match a DataItem tag in Devices.xml

Components and Data Items

Adapter Data Output:

2013-05-13T16:00:05.0000Z|mode|AUTOMATIC

Agent DataItem:

```
<DataItem type="CONTROLLER_MODE" category="EVENT" id="p2" name="mode"/>
```

Agent tries to map Adapter data to a DataItem that has an **ID, Name,** or **Source** that matches Adapter Key

Running an Agent from your Command Line

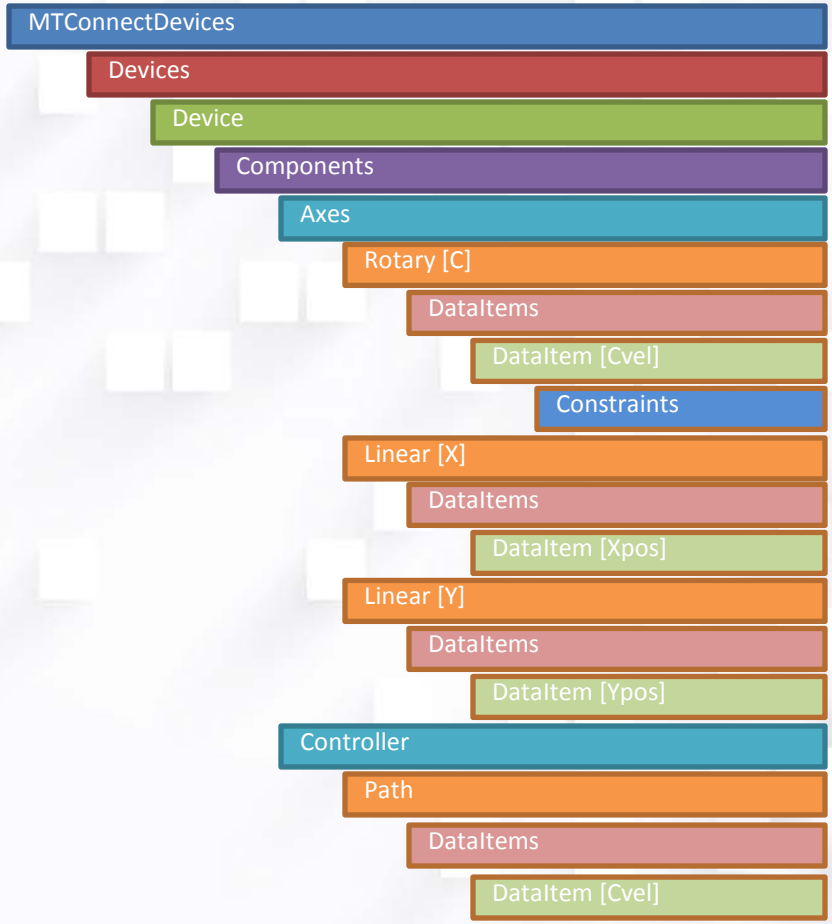
- Build MTConnect Agent
- Agent.cfg
- Devices.xml
- Run Mtconnect Agent
- Try http://127.0.0.1:5000/probe

What Data Are You Interested In?

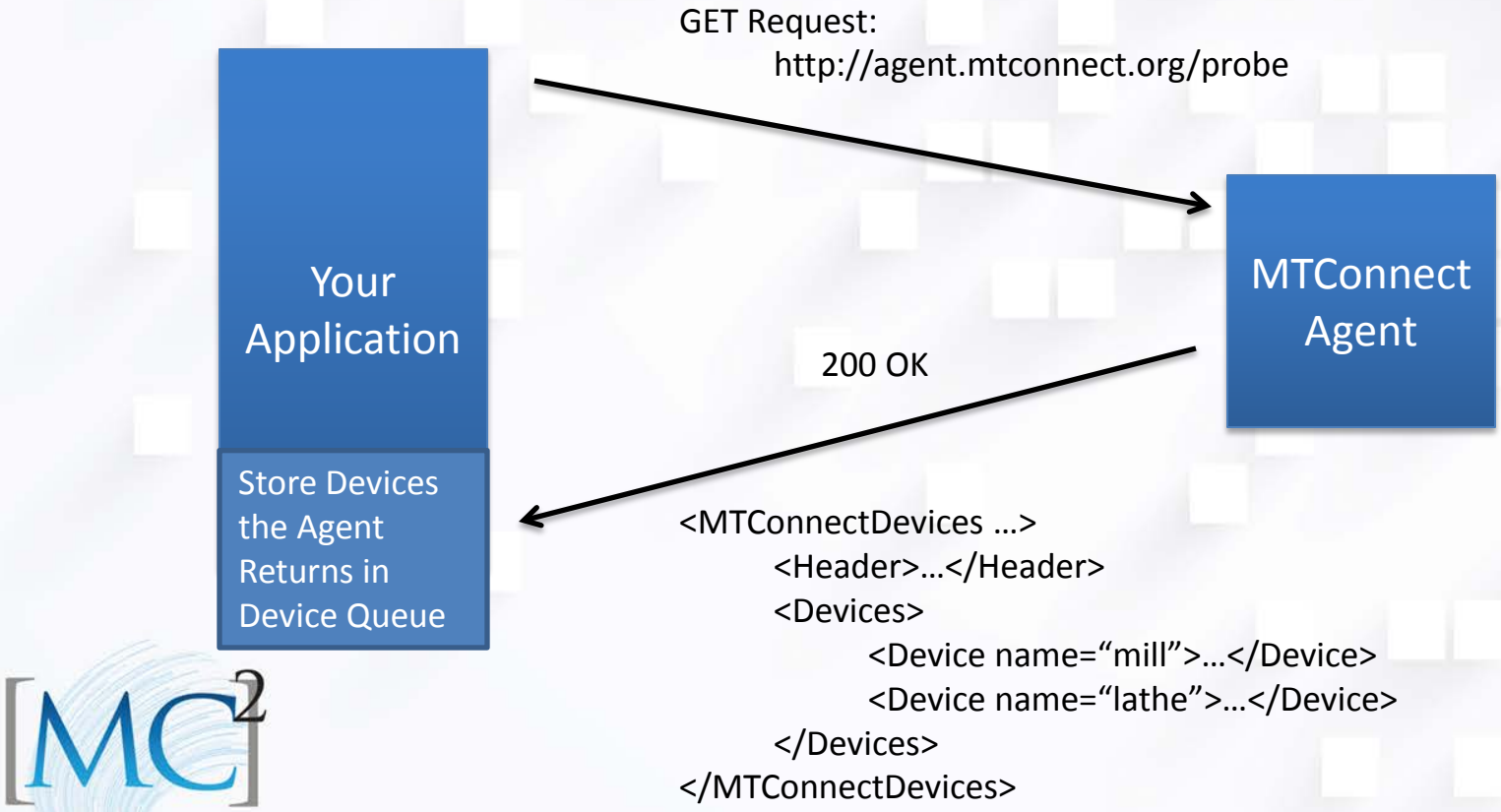
- Sample – Values read from the Device at a certain time
- Event – State or Message from the Device
- Condition – Device's Health/Ability to Function

MTConnect XML Format

```
<MTConnectDevices>
        <Header></Header>
        <Devices>
                <Device>
                        <Axes>
                                <Rotary>...</Rotary>
                                <Linear>...</Linear>
                        </Axes>
                </Device>
        </Devices>
</MTConnectDevices>
```

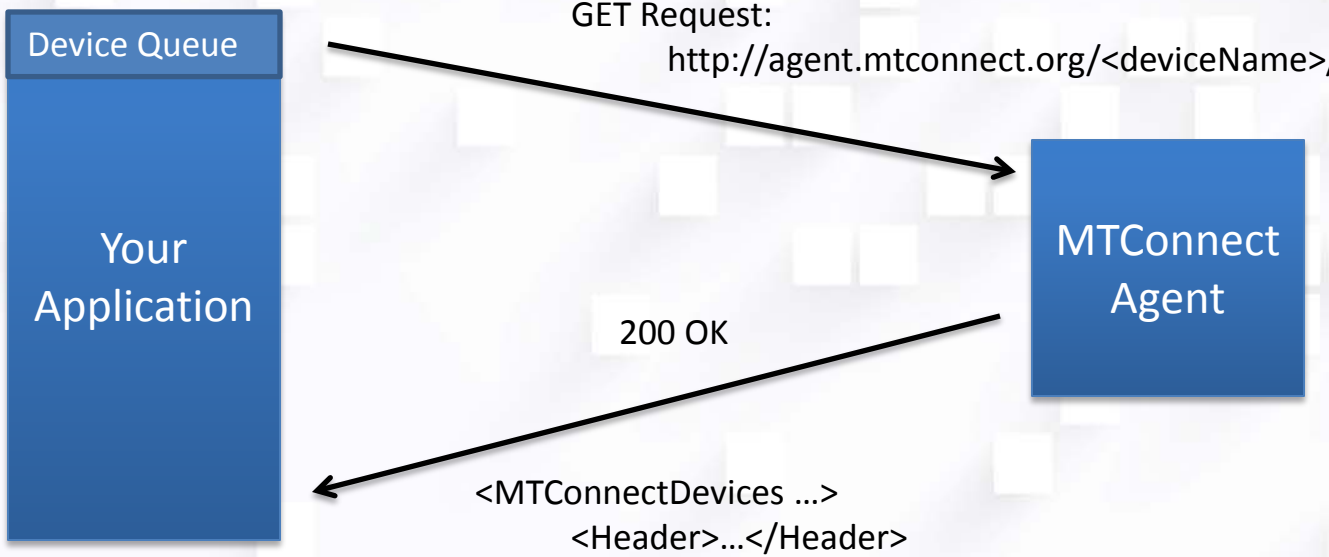


Probing The Agent



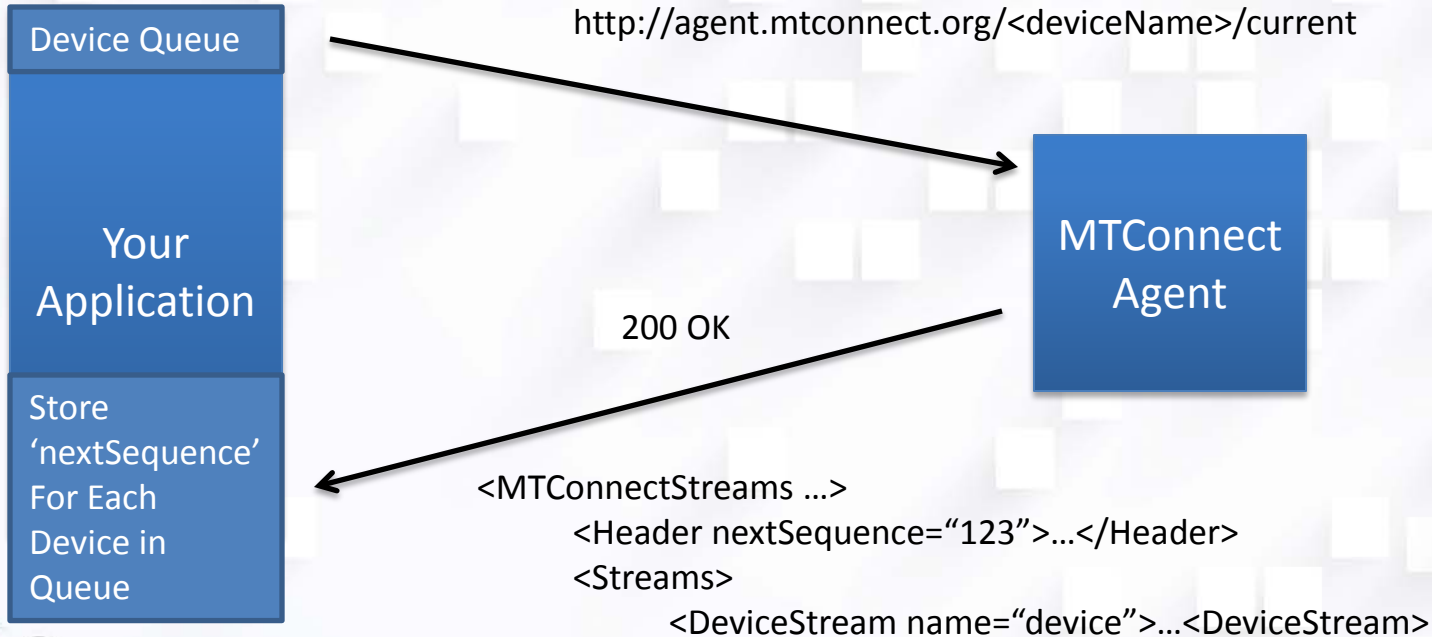
Probing Individual Devices

For Each Device in Device Queue:
GET Request:
http://agent.mtconnect.org/<deviceName>/probe

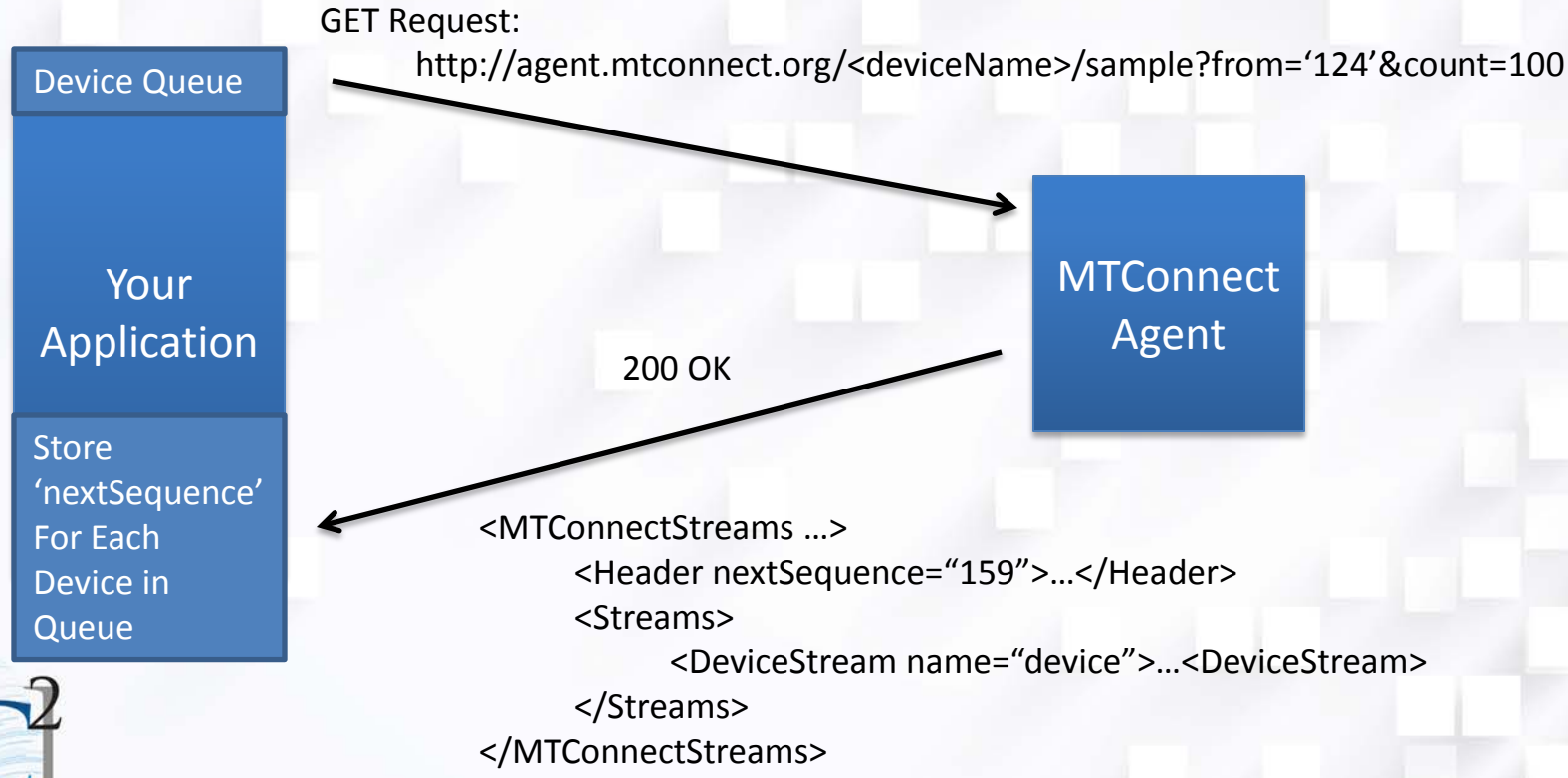



```
<MTConnectDevices …>
    <Header>…</Header>
    <Devices>
        <Device name="deviceName">…<Device>
    </Devices>
</MTConnectDevices>
```

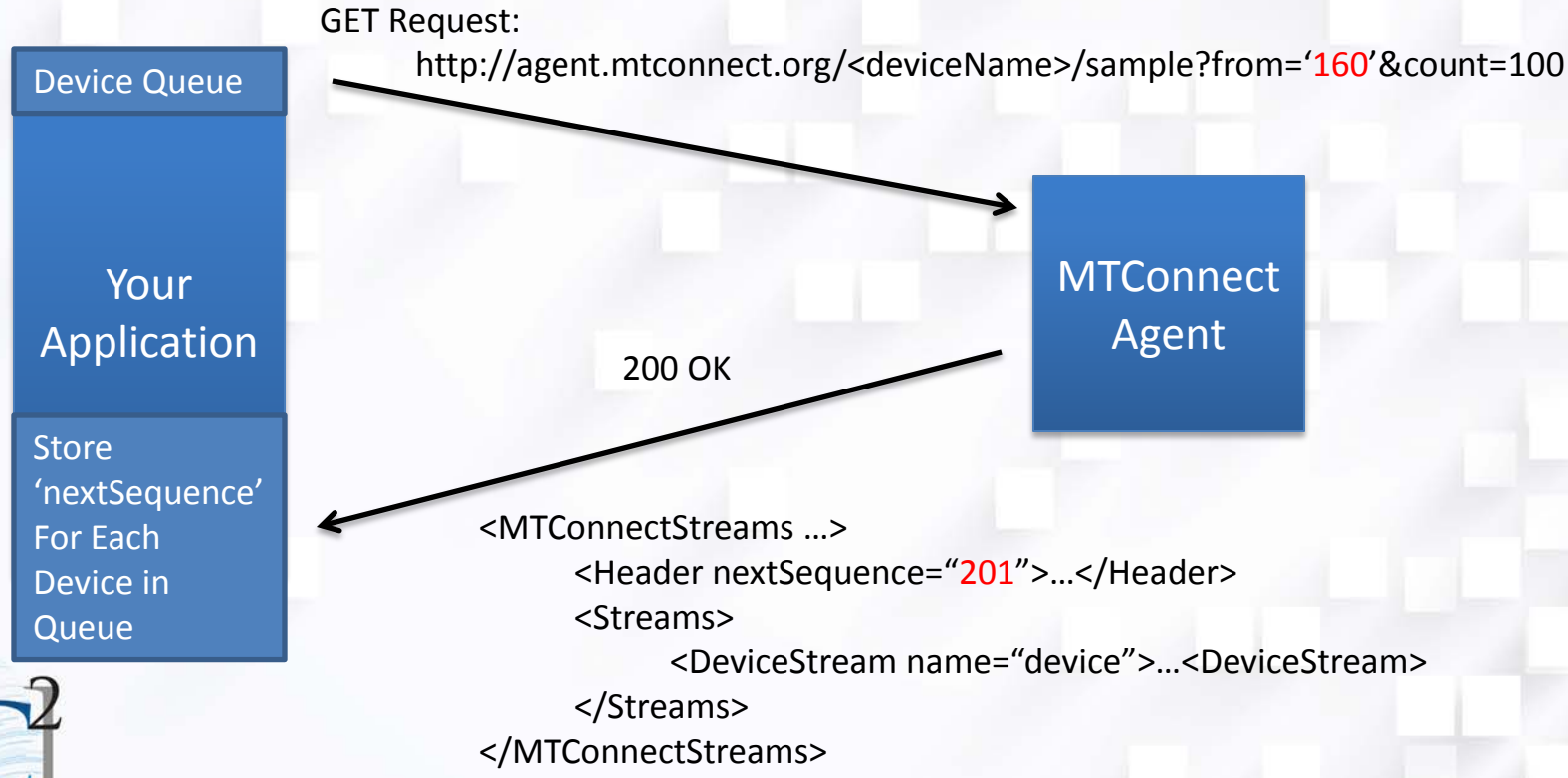
Current


GET Request:
http://agent.mtconnect.org/<deviceName>/current
Device Queue
Your Application
Store 'nextSequence' For Each Device in Queue
MTConnect Agent
200 OK
<MTConnectStreams …>
<Header nextSequence="123">…</Header>
<Streams>
<DeviceStream name="device">…<DeviceStream>
</Streams>
</MTConnectStreams>

Sample


GET Request:
http://agent.mtconnect.org/<deviceName>/sample?from='124'&count=100
Device Queue
Your Application
Store 'nextSequence' For Each Device in Queue
MTConnect Agent
200 OK
<MTConnectStreams …>
<Header nextSequence="159">…</Header>
<Streams>
<DeviceStream name="device">…<DeviceStream>
</Streams>
</MTConnectStreams>

Sample


GET Request:
http://agent.mtconnect.org/<deviceName>/sample?from='160'&count=100
Device Queue
Your Application
Store 'nextSequence' For Each Device in Queue
MTConnect Agent
200 OK
<MTConnectStreams …>
<Header nextSequence="201">…</Header>
<Streams>
<DeviceStream name="device">…<DeviceStream>
</Streams>
</MTConnectStreams>

Streaming ‘Real-Time’ with MTConnect

http://agent.mtconnect.org/sample?interval=0&heartbeat=1000

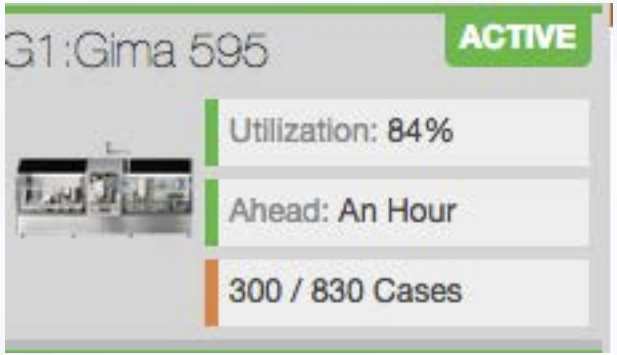
- Interval – Send data every **0 ms** (if data is available)
- Heartbeat – If there is no data available, the agent must send out a heartbeat to maintain contact with the client every **1000 ms** (10 seconds is default)

Fault Tolerance

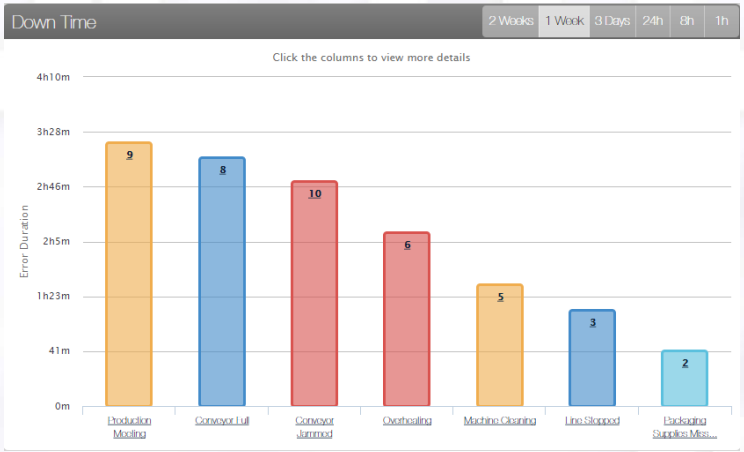
- Applications can be made fault tolerant by persisting ‘nextSequence’ number
- If application is disconnected from Agent, it can pick up from where it left off after re-establishing connection
- Agent’s Buffer has finite memory. Like other application level protocols, if Agent’s Buffer is exceeded during period that application is disconnected, information is permanently lost

Where to Send Data

Real Time Data can be sent directly to Clients through Web Sockets or other technology.



Historical Data can be archived to your database to be retrieved and rendered when requested by clients.



Node-Red Demo