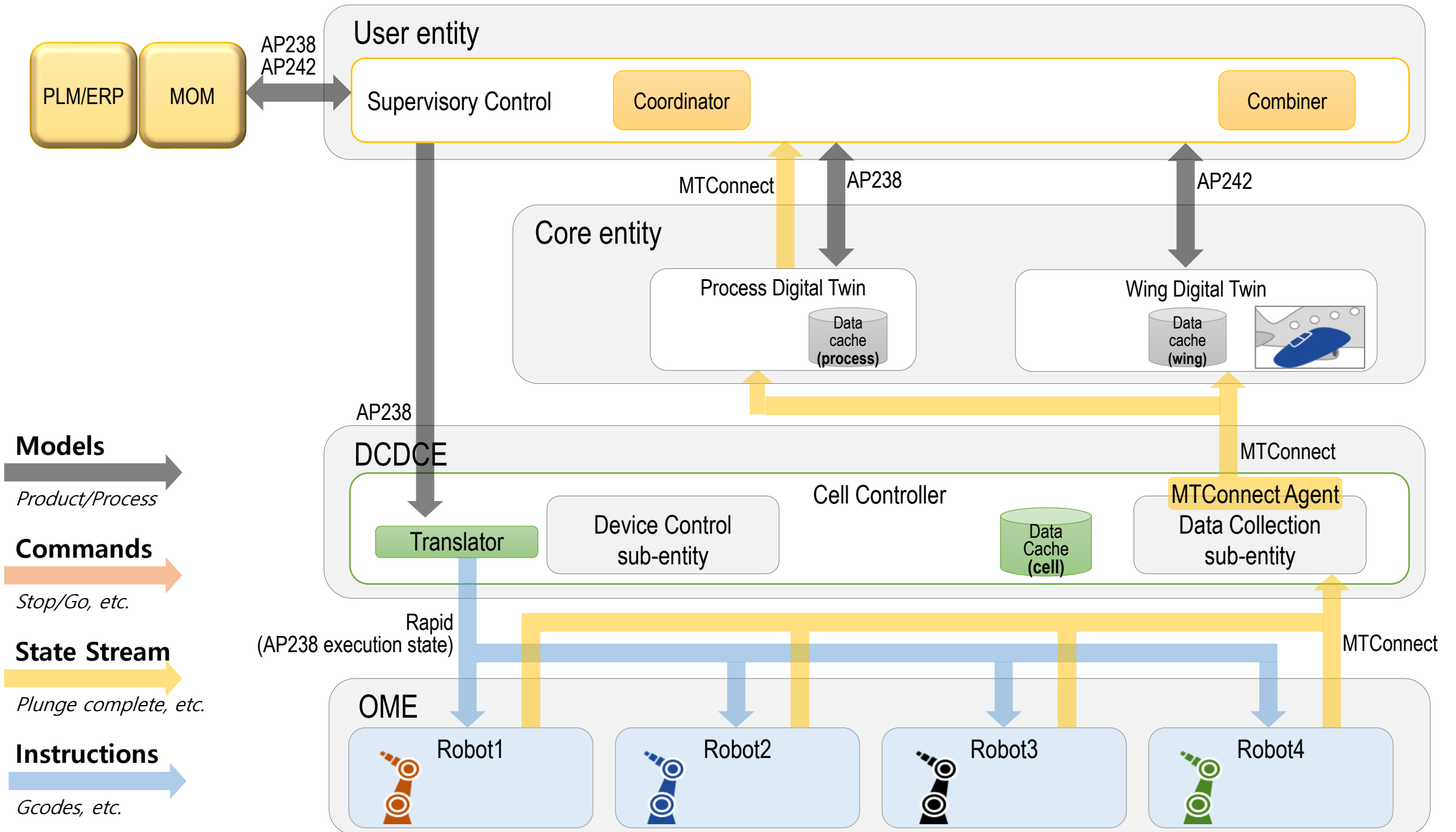


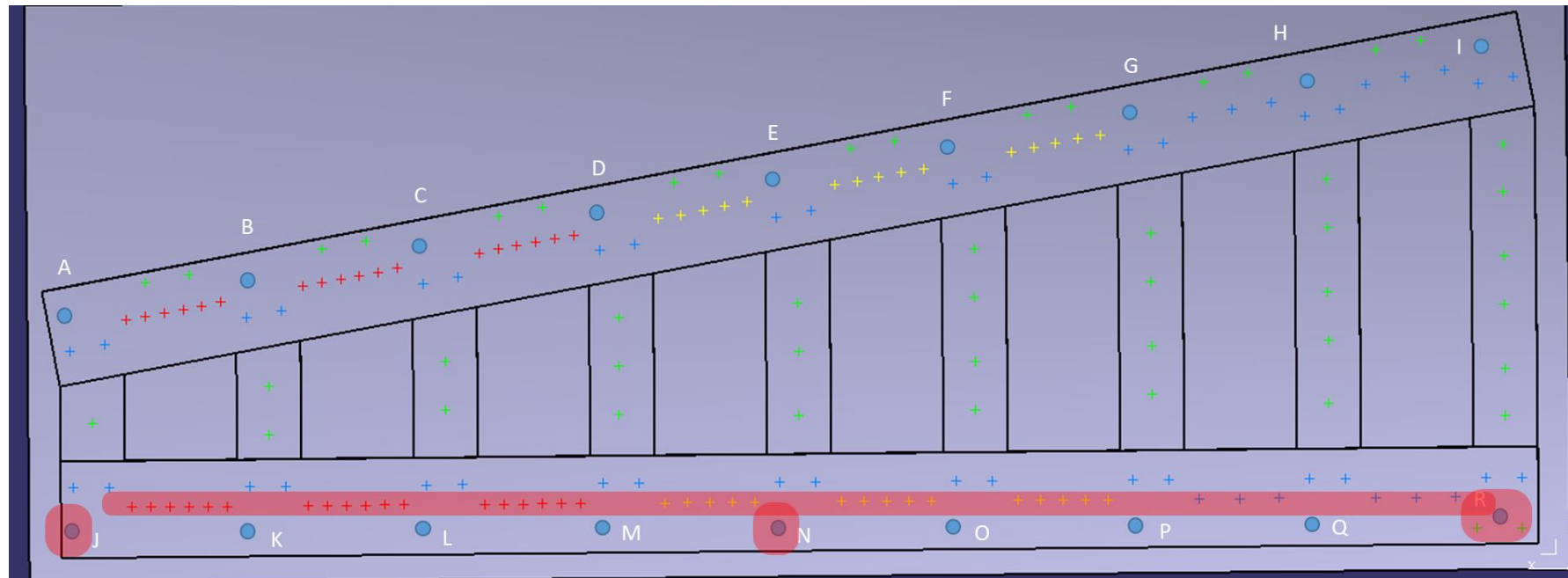
Agenda

- About ISO 23247
- About the Use Case
- Present State
- Desired Future State
- Data Flow
- Demo
- Discussion



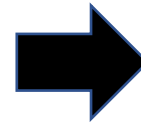
Large Aerospace Structures

- 1000s of holes and fasteners
 - "Condition of Assembly (COA)" can vary
 - Holes drilled already (prior work)
 - Holes not to be drilled (missing bracket)
- "One-Up-Assembly (OUA)" requirements mean the process sequence has constraints
- Any variations/exceptions must be tracked for validation and subsequent work (becomes new COA)



Desired Transition

- Manual -> Automatic
- Massive monolithic machines -> Robot cells
- Static processes -> dynamic processes
- Non-Optimized -> Optimized



Information Requirements (Digital Twin)

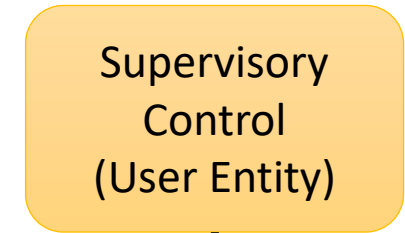
- Incoming
 - Assembly state (Condition Of Assembly) -> Assembly Digital Twin
 - Nominal process requirements -> Process Digital Twin
 - Adjusted process requirements -> Process Digital Twin
- In process
 - Completion -> Process Digital Twin
 - Exceptions -> Process Digital Twin
- Outgoing
 - Assembly state (Condition Of Assembly) -> Assembly Digital Twin
 - Process executed -> Process Digital Twin
 - Exceptions -> Assembly Digital Twin

Demonstration Part 1

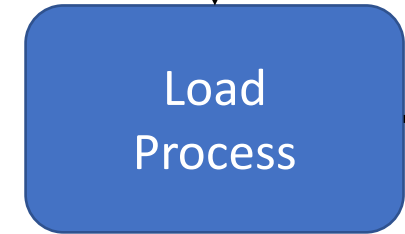
Data Preparation

Data Preparation

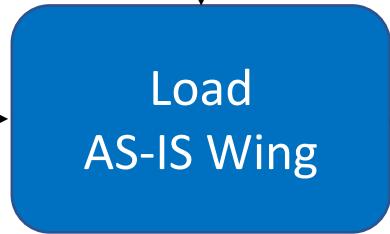
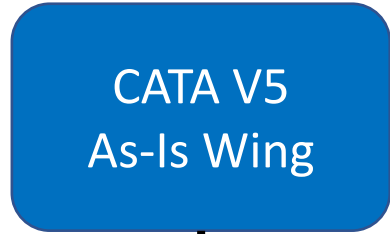
(Previous slide)



AP238

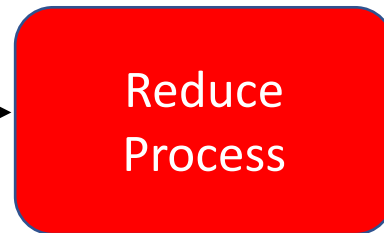


Base machining process for this cell

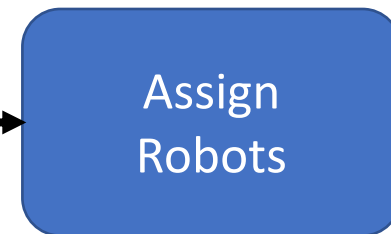


AP242 with current state of the wing

Technology Sources

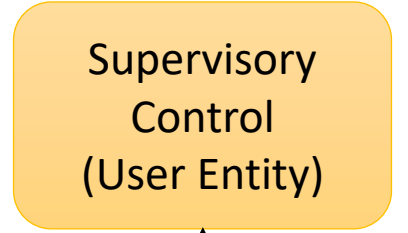


Use Hole detection to test if hole already exists

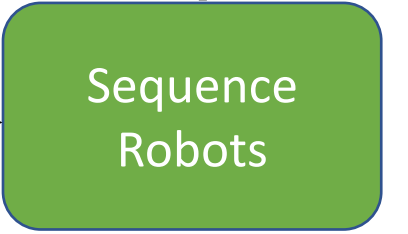


Choose robots for remaining operations

(Previous slide)

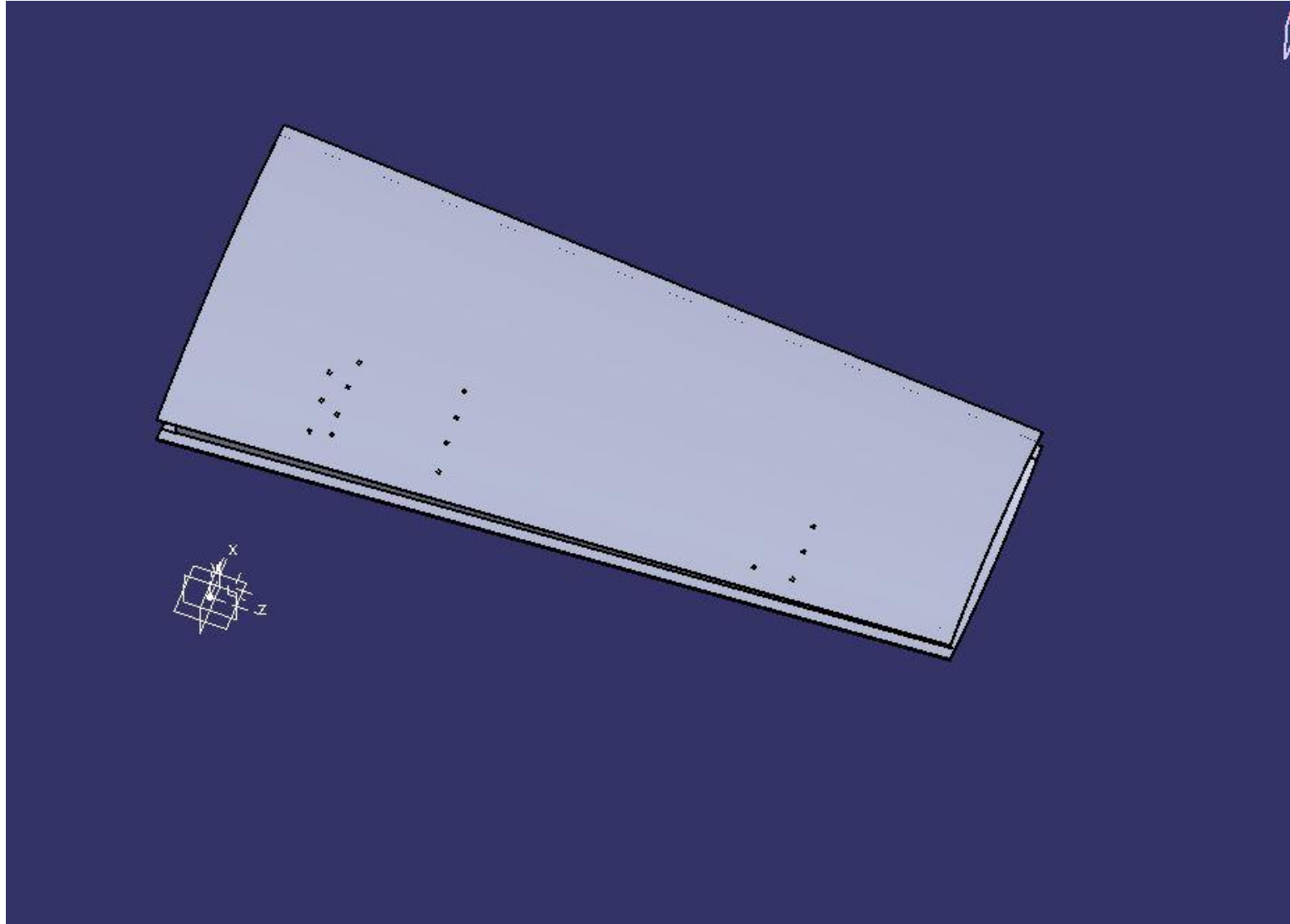


AP238



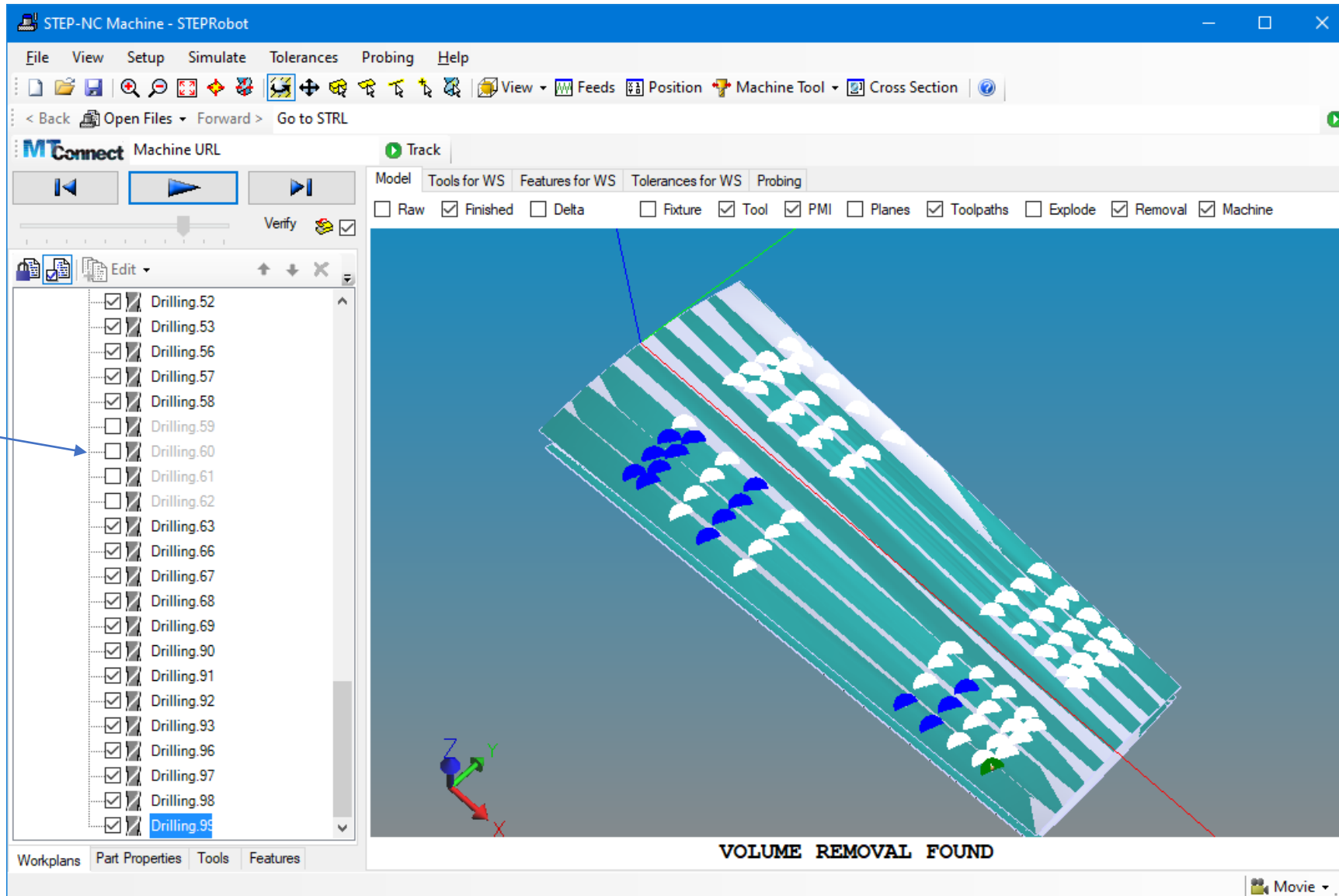
Traveling salesman optimization

Wing COA



Reduced Process

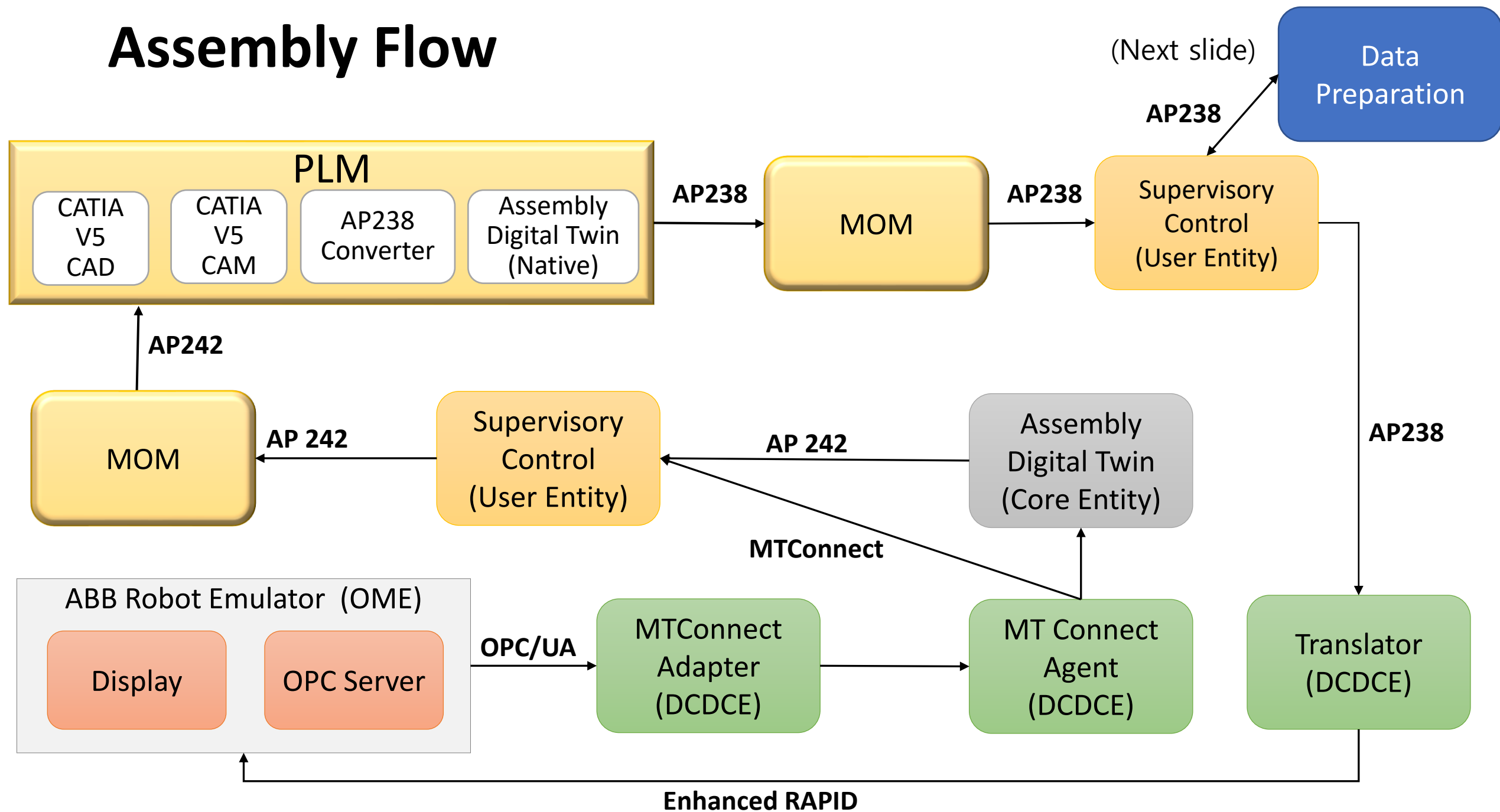
Disabled



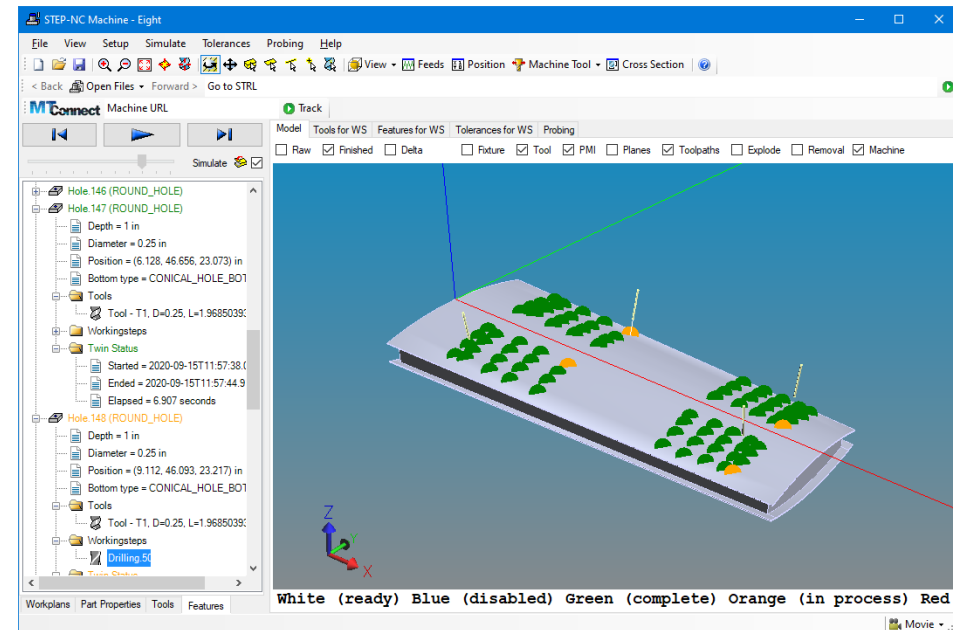
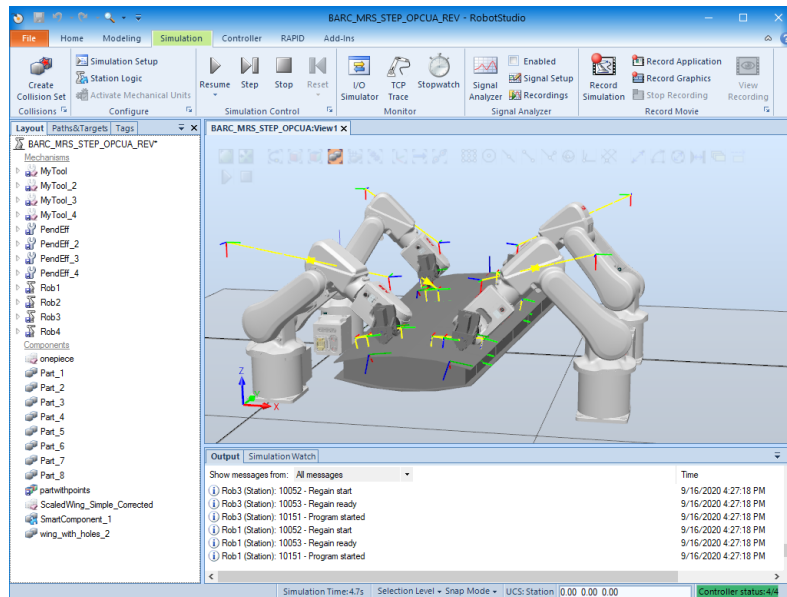
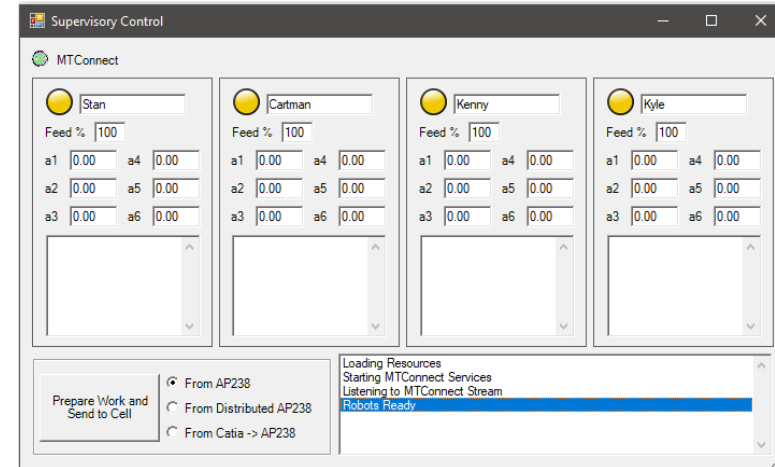
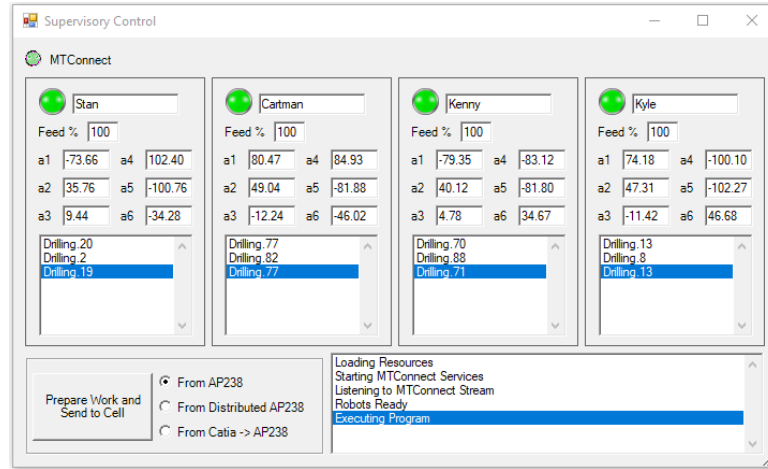
Demonstration Part 2

Assembly Flow

Assembly Flow



Digital Twins of product and process



Backup Slides

MTConnect

<Events>

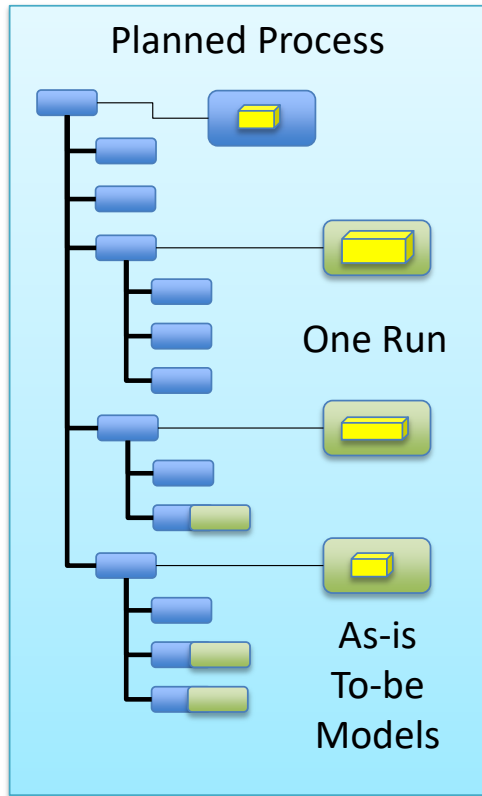
```
<WorkingStepDataSet dataItemId="I22a766e4465"  
    timestamp="2020-07-28T20:27:06.147161Z"  
    name="WorkingStep" sequence="179" count="2">  
    <Entry key="NAME">Drilling.2</Entry>  
    <Entry key="UUID">b062b09d-c75e-4509-b058-f533fc3121cb</Entry>  
</WorkingStepDataSet>  
<FeatureDataSet dataItemId="I95ded582189"  
    timestamp="2020-07-28T20:27:06.147161Z"  
    name="Feature" sequence="180" count="2">  
    <Entry key="NAME">Hole.101</Entry>  
    <Entry key="UUID">7ba2387a-5122-471d-9e62-f4dd978dd916</Entry>  
</FeatureDataSet>
```

</Events>

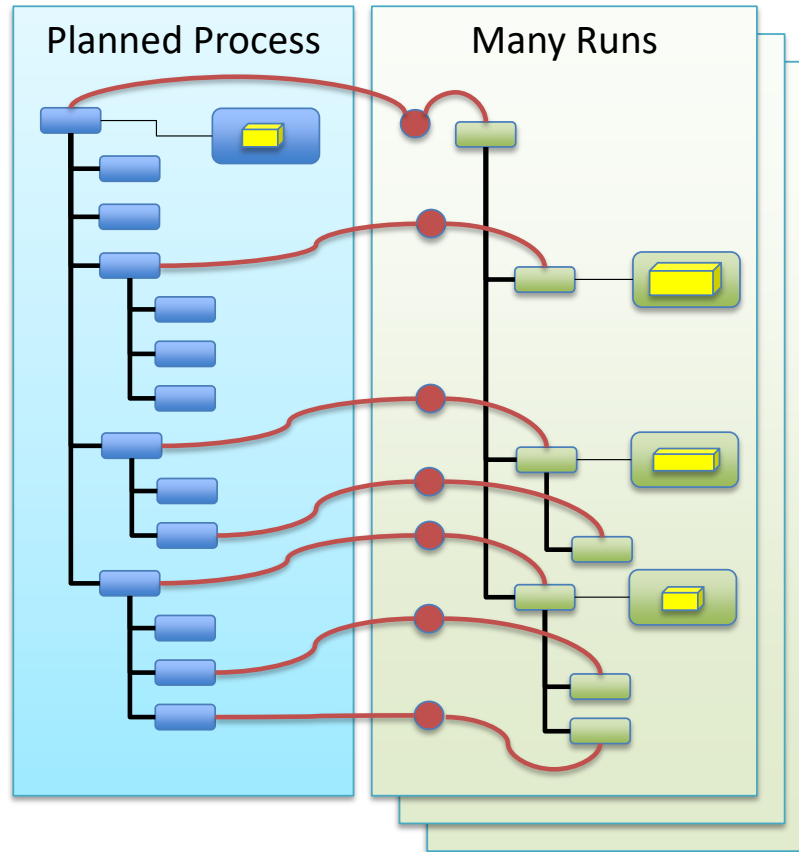
https://github.com/mtconnect/iso_digital_twin_adapter

Digital Twin process model

<https://stepmfg.github.io/ap238e2/data/clause5.htm#fig-twinmodel>



Model process state using new attributes



Link runs using Part 21 Edition 3

ENTITY executable

```
[ ... other attributes omitted ... ]  
twin_source: OPTIONAL twin_source_enum;  
twin_plan: OPTIONAL executable;  
twinning_start : OPTIONAL Date_time;  
twinning_end :   OPTIONAL Date_time;  
twinning_log : LIST [0:?] log_record;  
in_cut_time : OPTIONAL Duration;  
END_ENTITY;
```

```
TYPE twin_state_enum = ENUMERATION OF (simulat  
ed, machined); END_TYPE;
```

ENTITY log_record

```
description : STRING;  
date_time : Date_time;  
END_ENTITY;
```

Executable is supertype of all processes.

Definition above shows new attributes for Edition 2

Demo Environment

- Boeing/University of Washington BARC lab
- On campus at UW
- 4 ABB robots
- Previously used for WG15 demos
- "South Park" themed configuration
 - Kenny
 - Kyle
 - Cartman
 - Stan

- This demo is using ABB Emulators due to access issues

