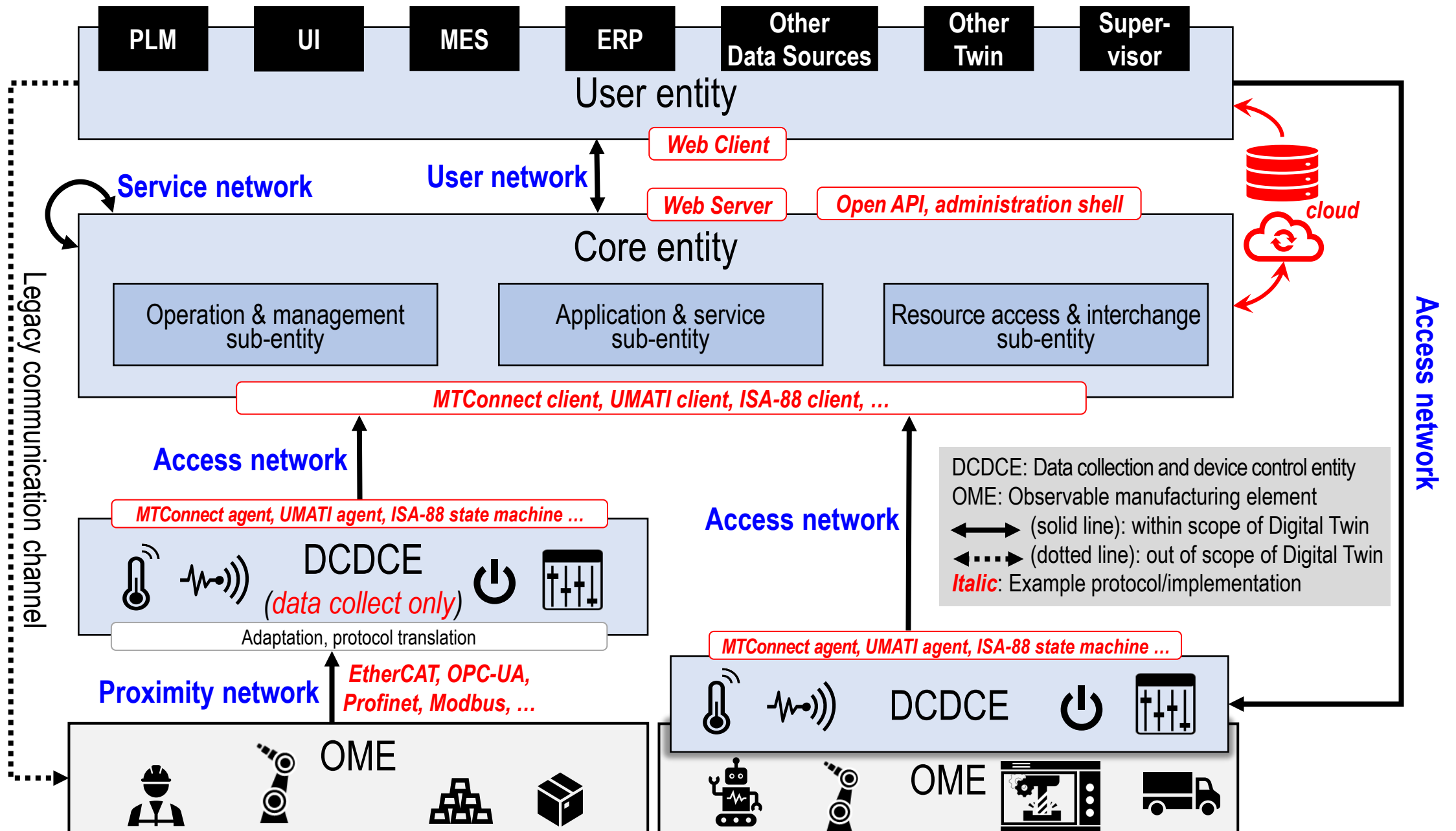
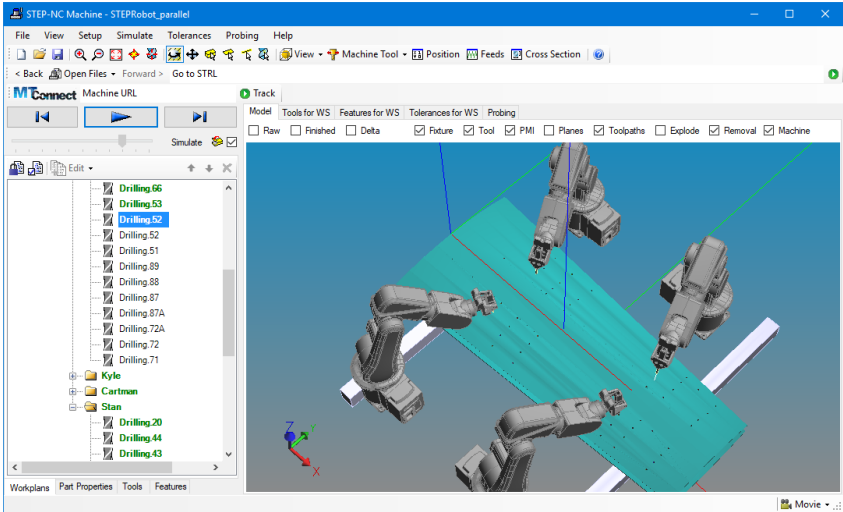
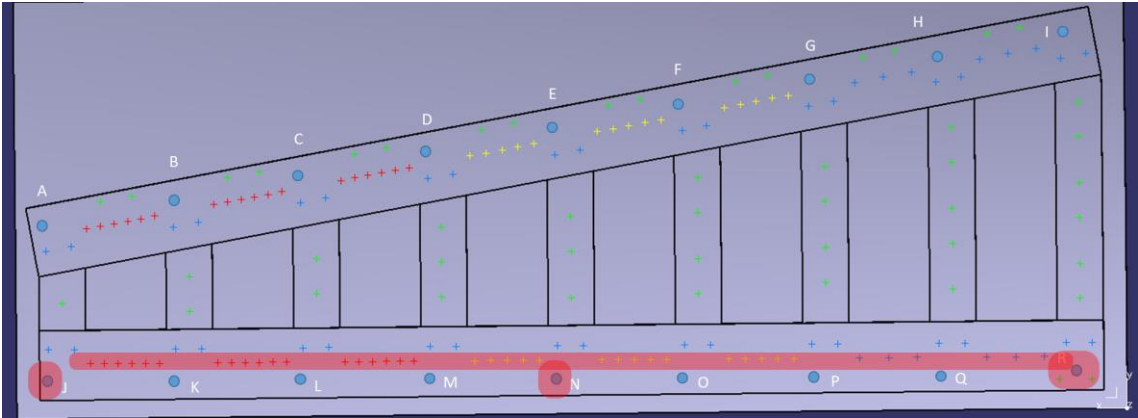
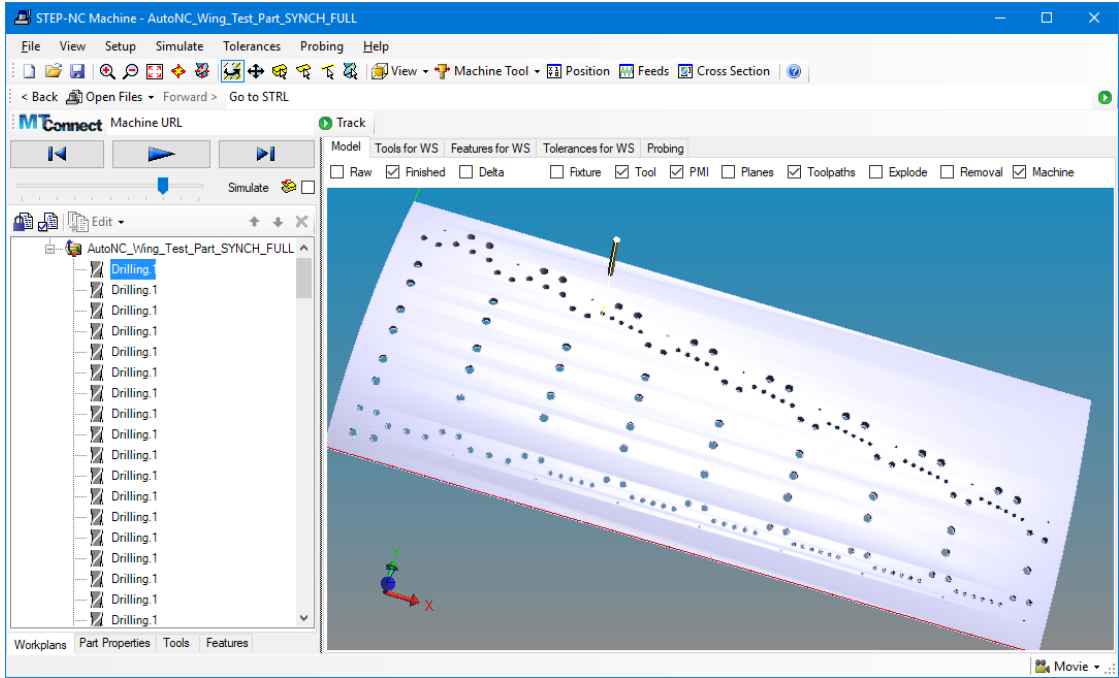


# ISO 23247 Digital Twin Use case Testing

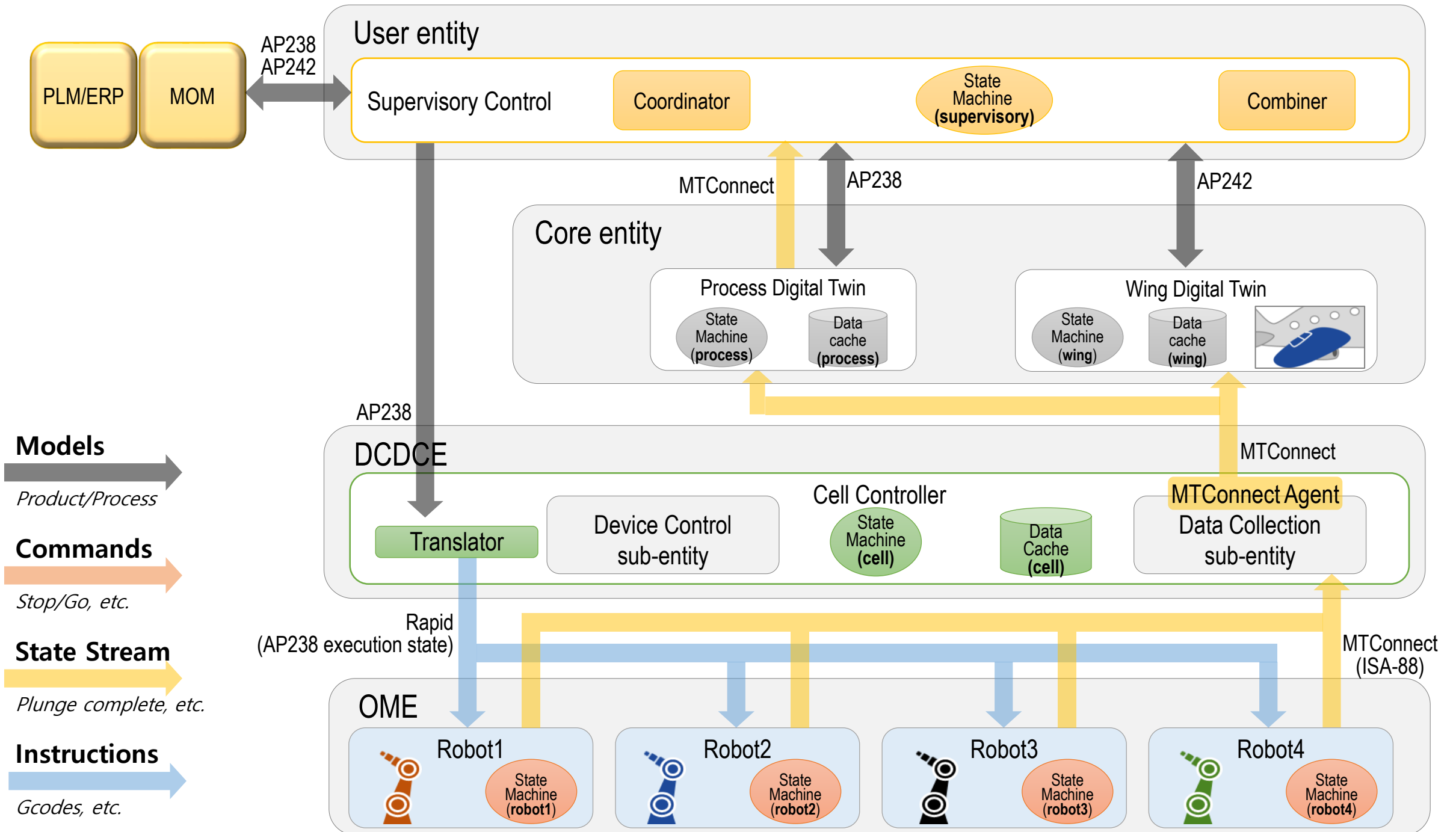
August 4 Conference call



# Use Case 1 – flexible schedule for robot drill & fill

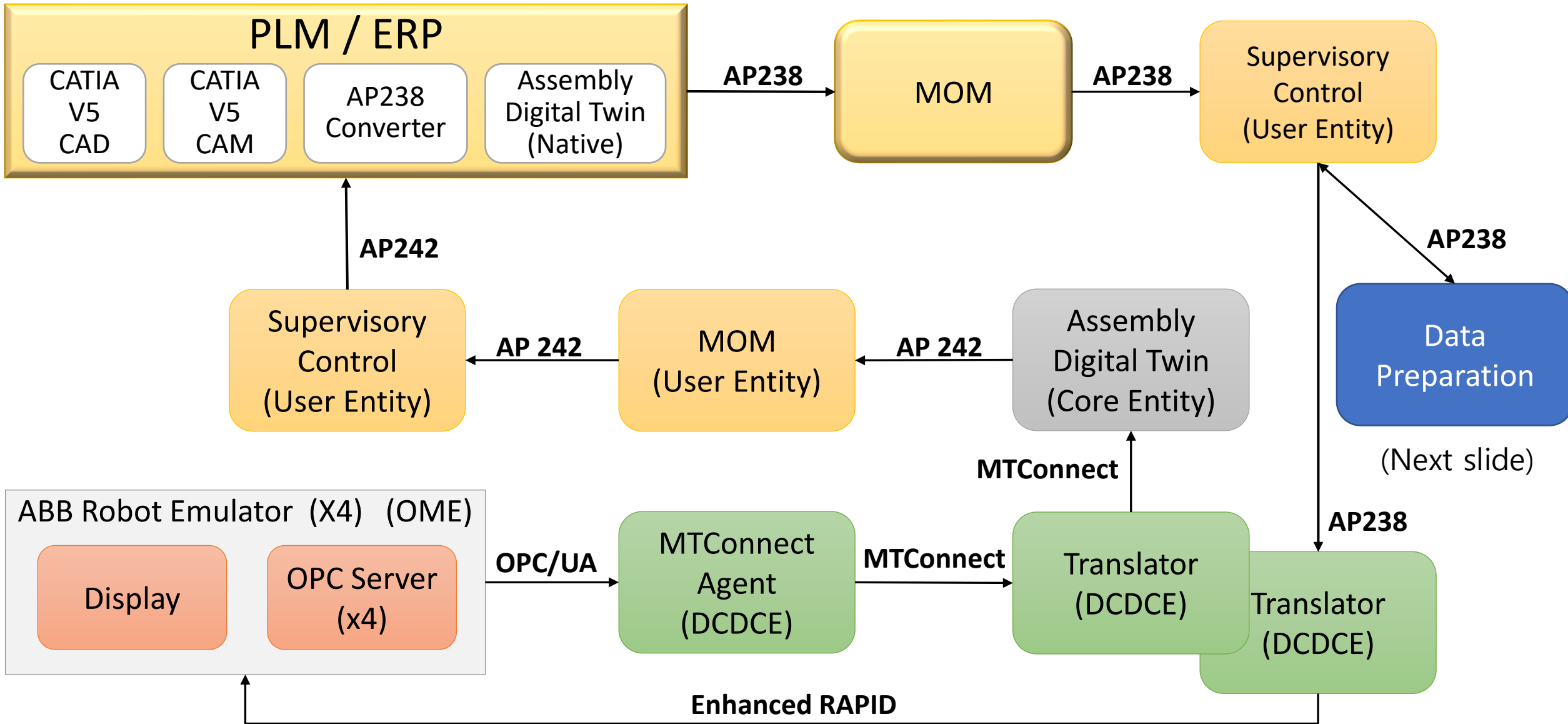


On-shoring can increase by 50%



- Models** *Product/Process*
- Commands** *Stop/Go, etc.*
- State Stream** *Plunge complete, etc.*
- Instructions** *Gcodes, etc.*

# Assembly/Process Flow



# MTConnect

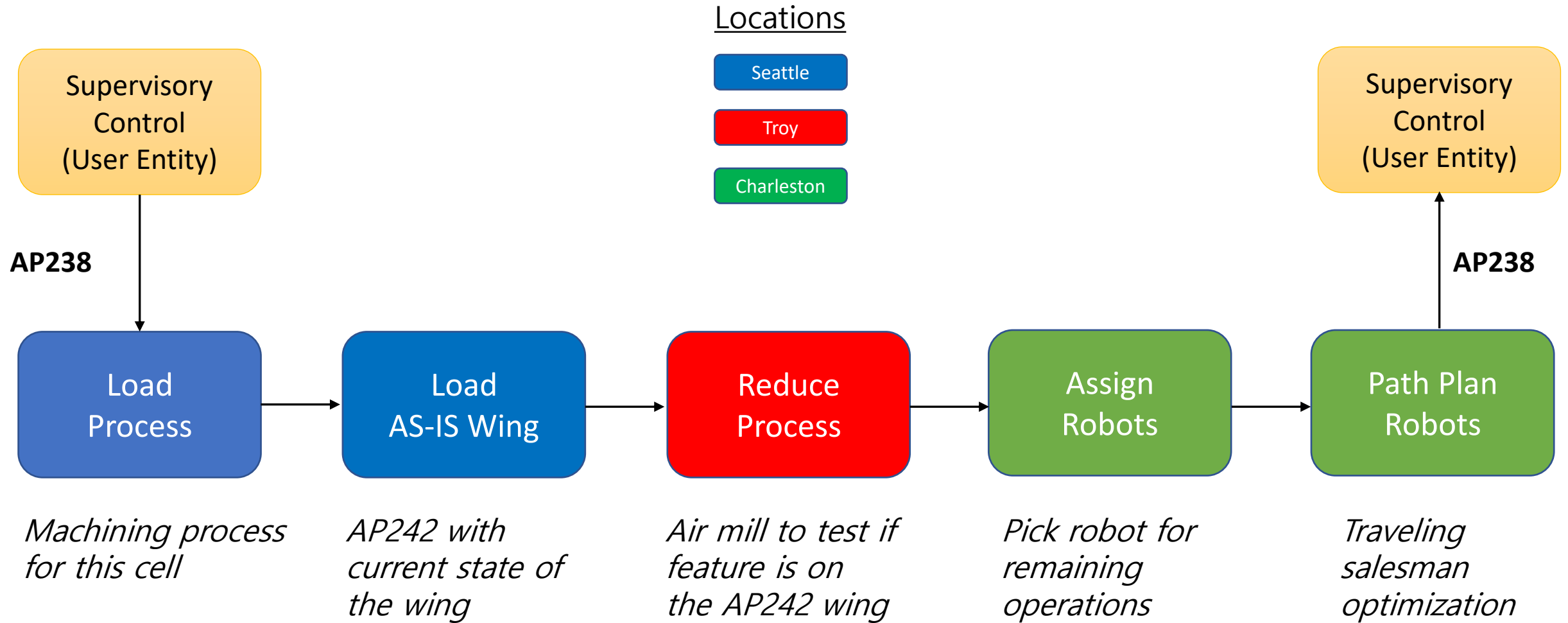
<Events>

```
<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>
```

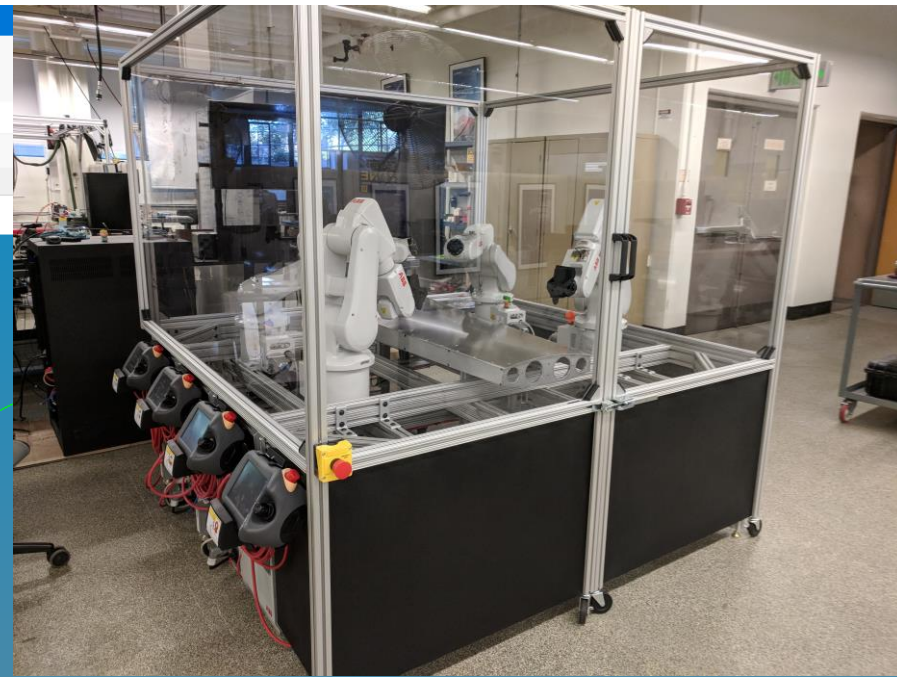
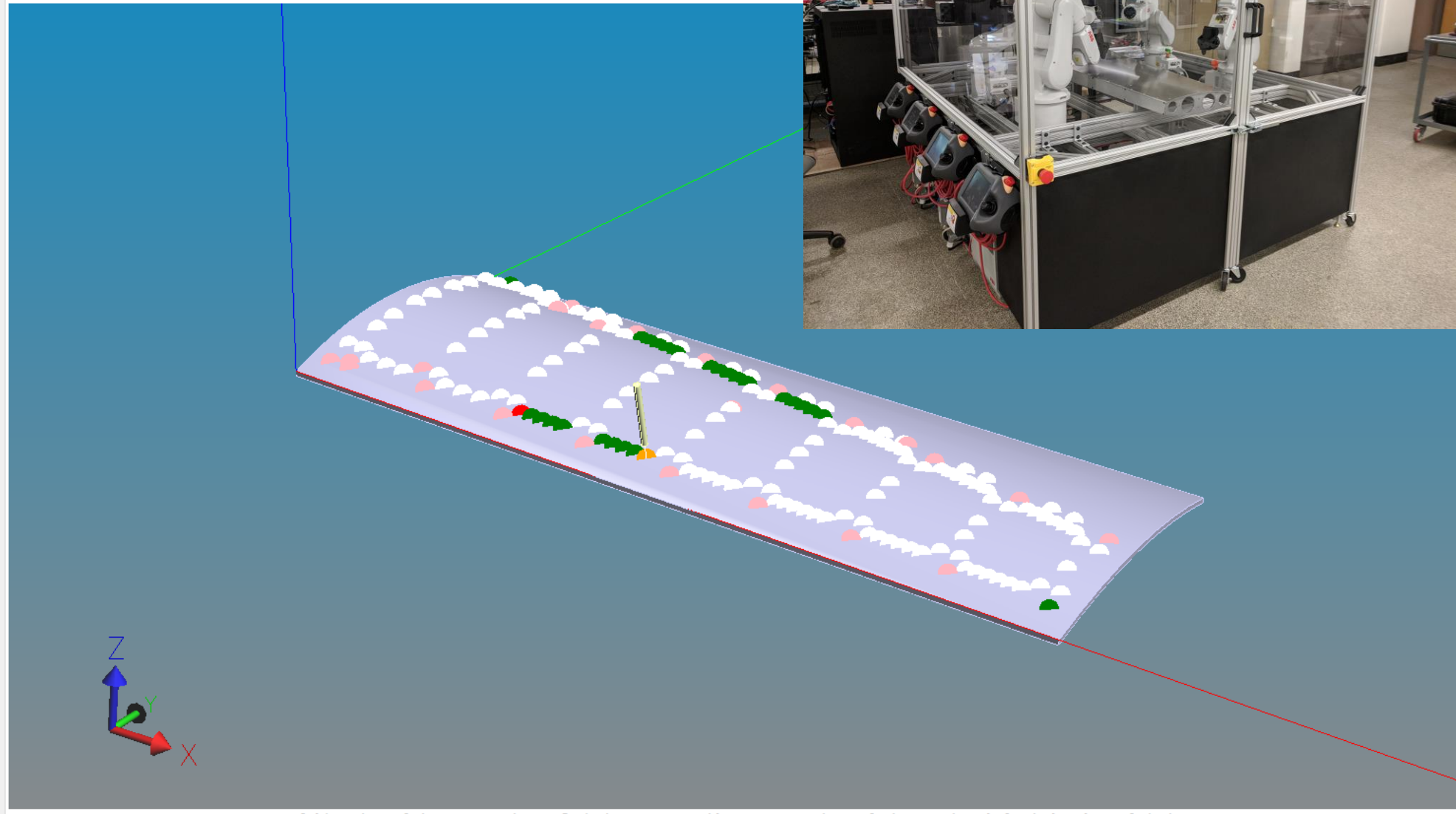
</Events>

[https://github.com/mtconnect/iso\\_digital\\_twin\\_adapter](https://github.com/mtconnect/iso_digital_twin_adapter)

# Data Preparation



- Hole.1 (ROUND\_HOLE)
- Hole.2 (ROUND\_HOLE)
- Hole.3 (ROUND\_HOLE)
- Hole.4 (ROUND\_HOLE)
- Hole.5 (ROUND\_HOLE)
- Hole.6 (ROUND\_HOLE)**
  - Depth = 0.39 in
  - Diameter = 0.19 in
  - Position = (11.354, 1.149, 0.34) in
  - Bottom type = CONICAL\_HOLE\_BOTTOM
  - Tools
    - Tool - T6, D=0.19, L=1.96850393700787
  - Workingsteps
    - Drilling.6
    - Entity = 17463 Started = 2020-07-21T09:16:29.701-04:00
    - Ended =
    - Elapsed time =
- Hole.7 (ROUND\_HOLE)
- Hole.8 (ROUND\_HOLE)
- Hole.9 (ROUND\_HOLE)
- Hole.10 (ROUND\_HOLE)
- Hole.11 (ROUND\_HOLE)
- Hole.12 (ROUND\_HOLE)
- Hole.13 (ROUND\_HOLE)
- Hole.14 (ROUND\_HOLE)
  - Depth = 0.387 in
  - Diameter = 0.19 in
  - Position = (7.554, 1.139, 0.372) in
  - Bottom type = CONICAL\_HOLE\_BOTTOM
  - Tools
    - Tool - T6, D=0.19, L=1.96850393700787
  - Workingsteps
    - Drilling.14
    - Entity = 17391 Started = 2020-07-21T09:16:01.341-04:00
    - Ended = 2020-07-21T09:16:25.616-04:00
    - Elapsed = 24 seconds, 275 milliseconds
- Hole.15 (ROUND\_HOLE)
- Hole.16 (ROUND\_HOLE)
- Hole.17 (ROUND\_HOLE)
- Hole.18 (ROUND\_HOLE)

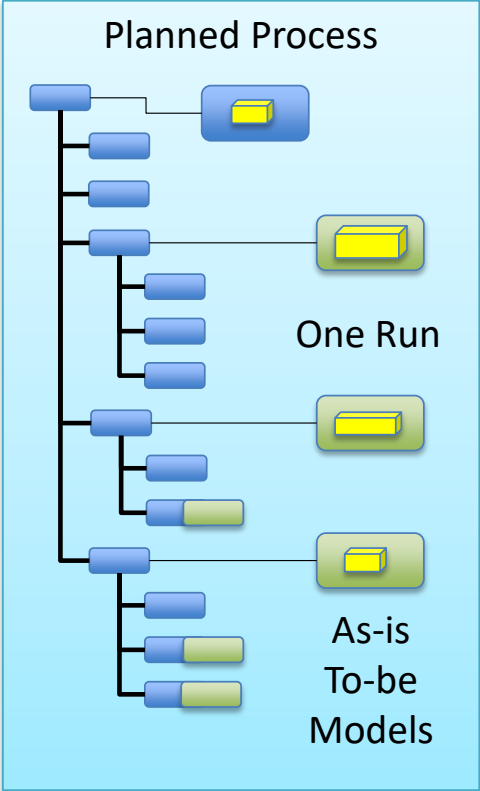


White (ready) Green (complete) Orange (in process) Red (error) Pink (missing data)

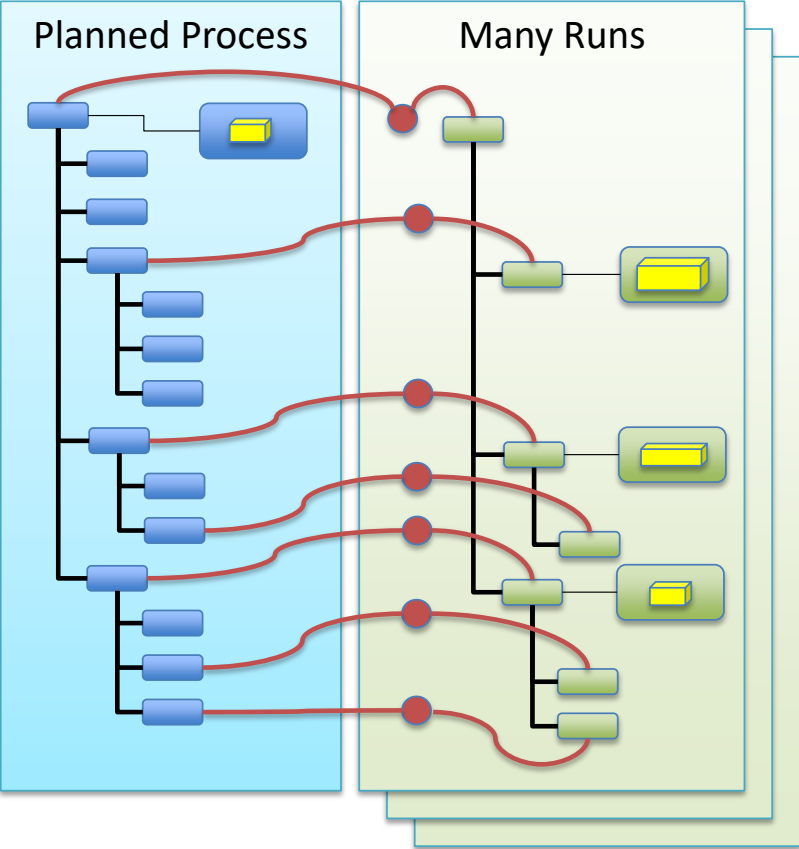


# Digital Twin process model

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



*Model process state using new attributes*



*Link runs using Part 21 Edition 3*

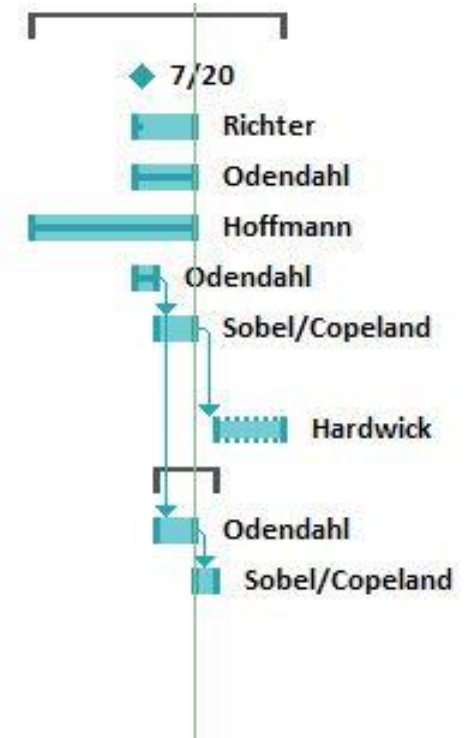
```
ENTITY executable
[ ... other attributes omitted ... ]
twin_source: OPTIONAL twin_source_enum;
twin_plan: OPTIONAL executable;
twinning_start : OPTIONAL Date_time;
twinning_end :   OPTIONAL Date_time;
twinning_exception : OPTIONAL explanation;
END_ENTITY;
```

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

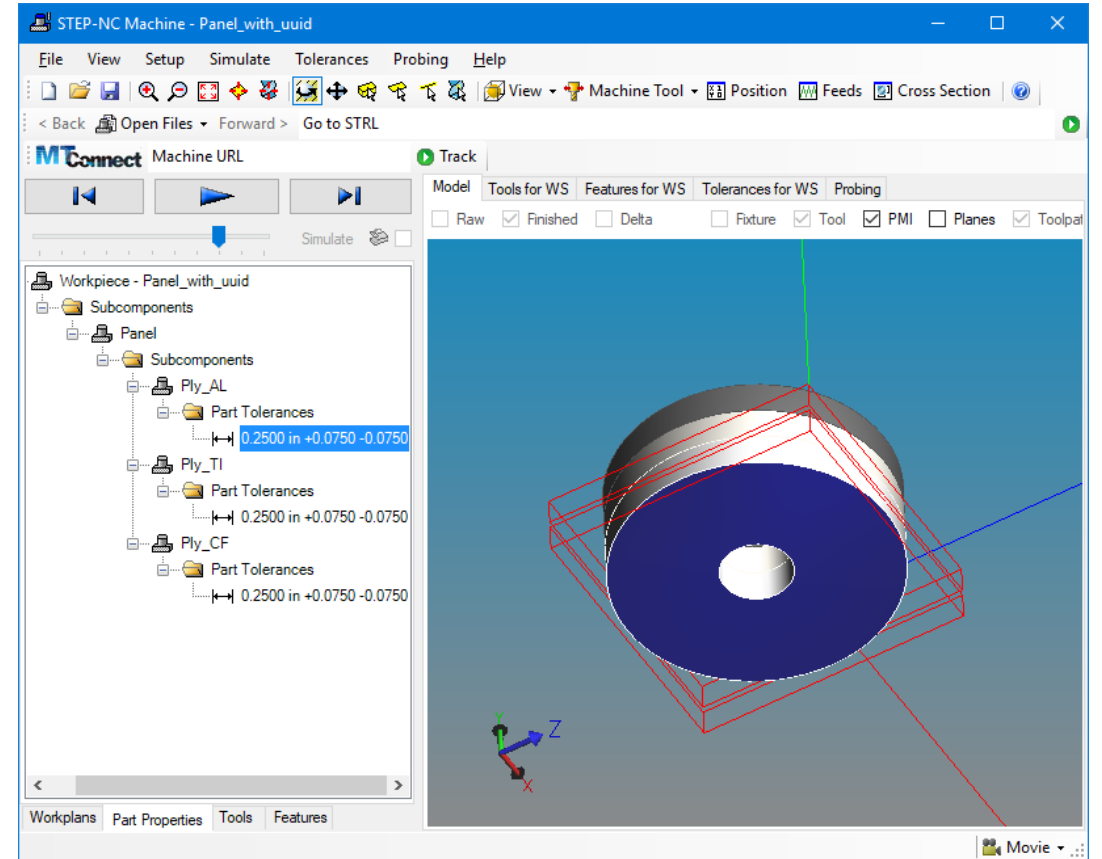
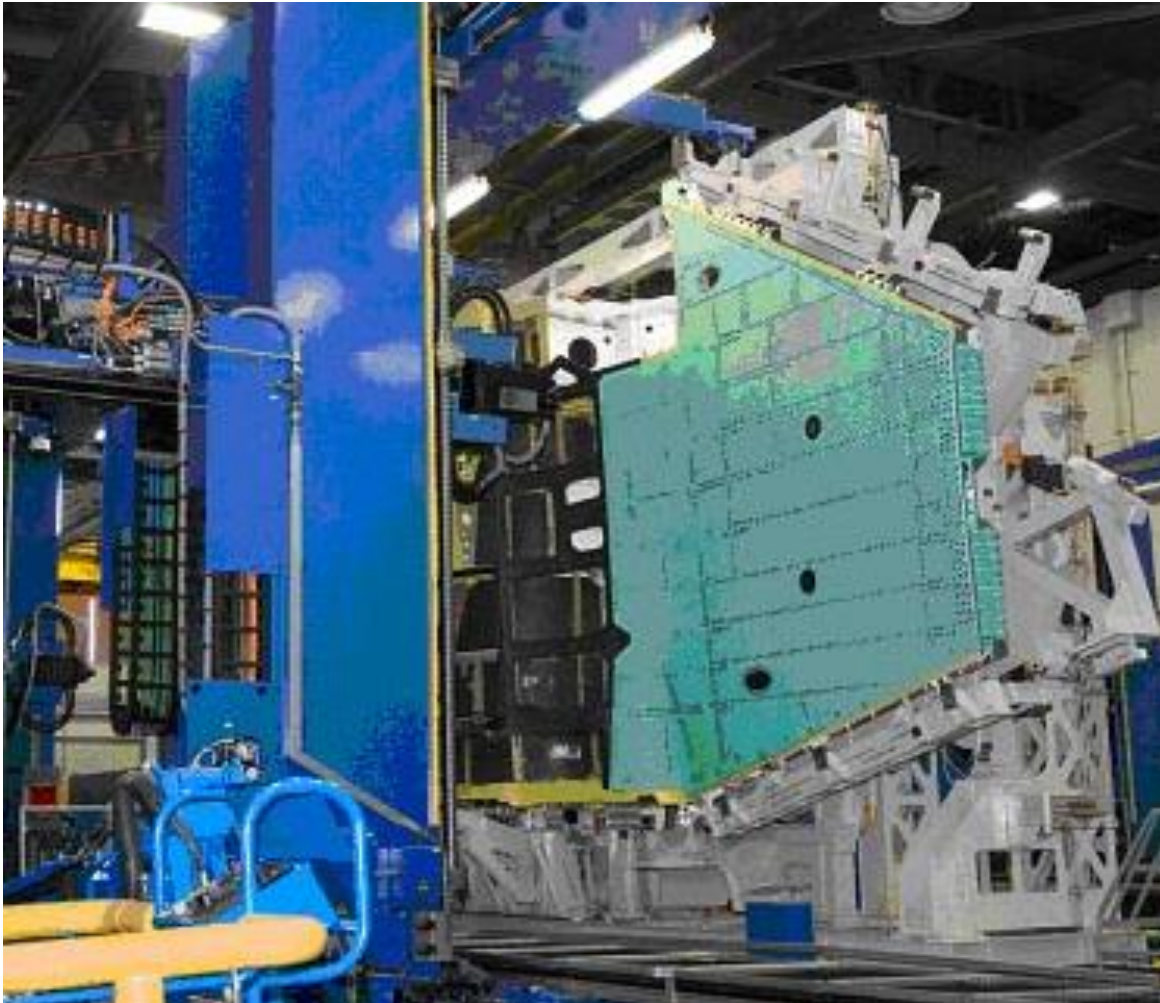
*Executable is supertype of all processes.  
Definition above shows new attributes for Edition 2*

# Schedule

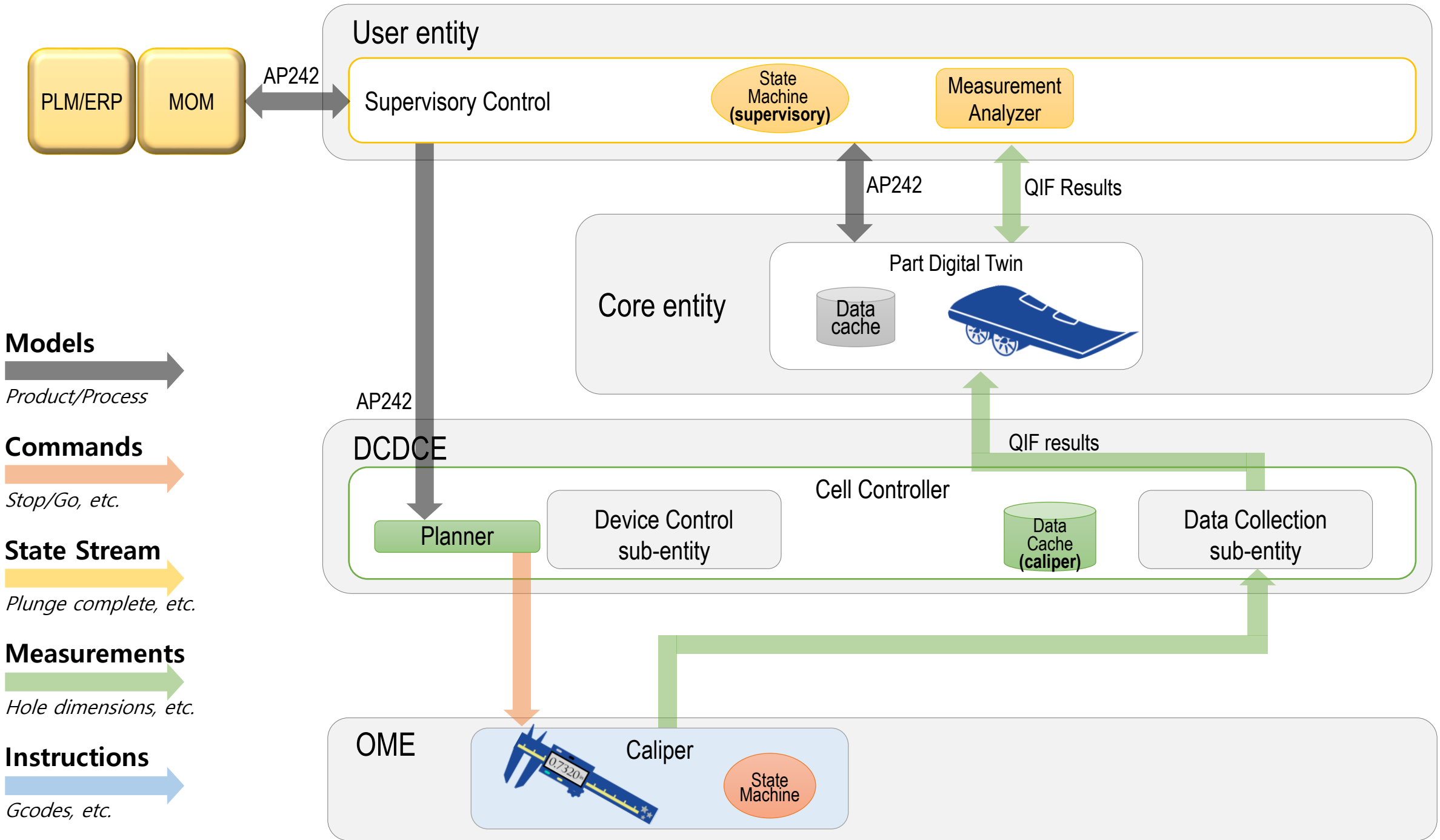
<b>CAD /CAM</b>	<b>25 days</b>	<b>Mon 7/6/20</b>	<b>Sat 8/8/20</b>	
CATIA V5 -> AP238	0 days	Mon 7/20/20	Mon 7/20/20	
Supervisory Control	6 days	Mon 7/20/20	Mon 7/27/20	
AP238 -> Rapid	6 days	Mon 7/20/20	Mon 7/27/20	
Setup OPC/UA Server	16 days	Mon 7/6/20	Mon 7/27/20	
Define OPC/UA Tags	3 days	Mon 7/20/20	Wed 7/22/20	
Define MTConnect Tags	3 days	Thu 7/23/20	Mon 7/27/20	30
Setup MTConnect Adapter/Agent				
MTConnect -> Digital Twin	7 days	Fri 7/31/20	Sat 8/8/20	31
<b>State Machine</b>	<b>6 days?</b>	<b>Thu 7/23/20</b>	<b>Thu 7/30/20</b>	
Define OPC/UA Tags	3 days	Thu 7/23/20	Mon 7/27/20	30
Define MTConnect Tags	3 days	Tue 7/28/20	Thu 7/30/20	35
Map MTConnect to PackML				
PackML Client				



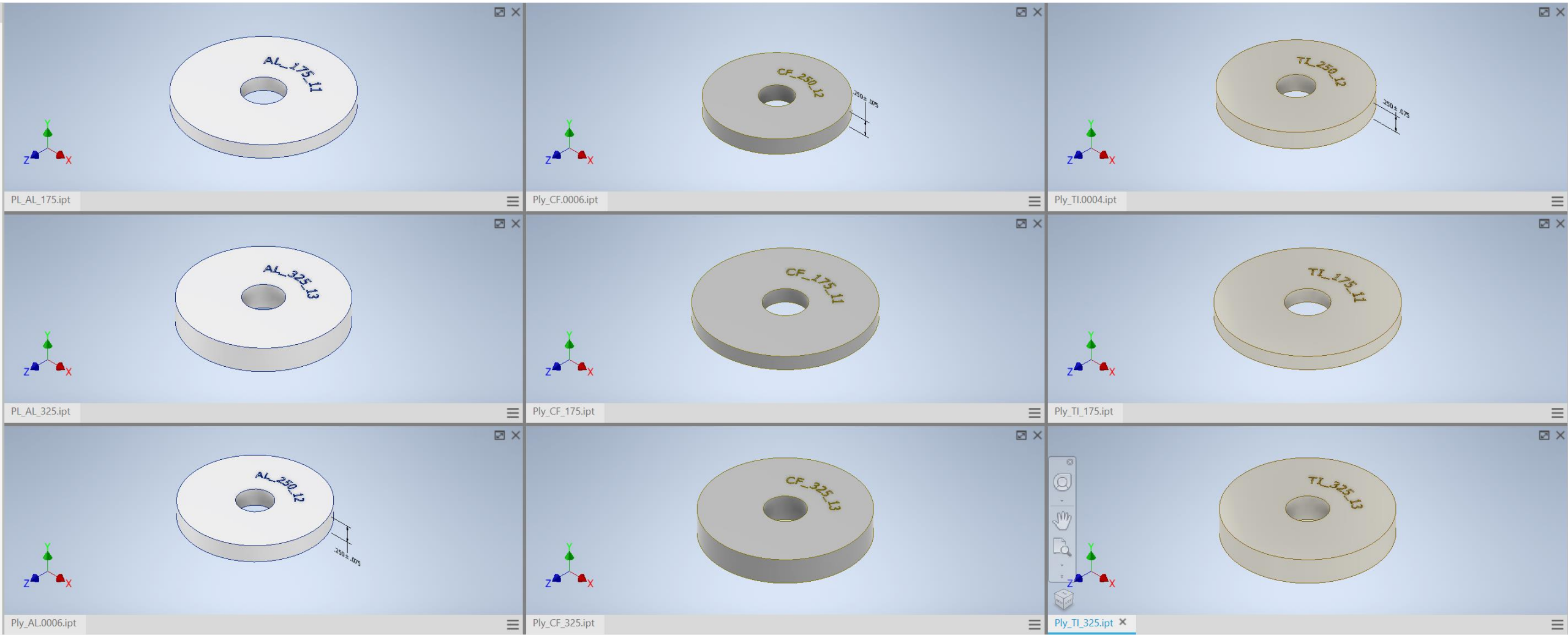
# Use Case 2 – weight reduction



Exact match of fastener to hole depth  
can reduce weight by 500lb

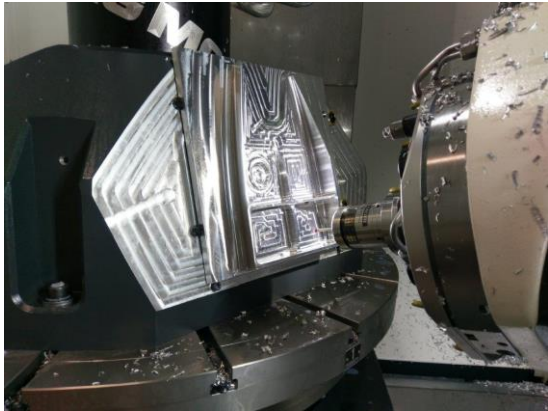


# Measurement samples

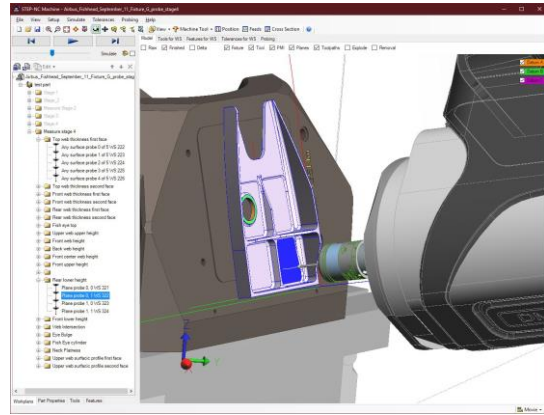


<b>Task</b>	<b>23247 Use Case Reference</b>	<b>Completion Date</b>	<b>Completion %</b>	<b>Status</b>
Define Use Case		16-Mar-20	100%	Complete
Document Use Case		22-Apr-20	100%	Complete
Author MBDs	PLM/ERP	14-May-20	100%	Complete
Export AP242 Nominals	User Entity	14-May-20	100%	Complete
Export QIF Plan	DCDCE	14-May-20	100%	Complete
Measure Parts (key-in)	OME	14-May-20	100%	Complete
Export QIF Measured Results	DCDCE	15-May-20	100%	Complete
Import QIF Measured Results	Core Entity	20-May-20	100%	Complete
Assemble AP242 Digital Twin	User Entity	20-May-20	100%	Complete
Revise Use Case	OME	30-Jun-20	100%	Complete
Receive Fabricated Parts		5-Aug-20		
Measure Parts (as-built)	OME	5-Aug-20		
Internal Rehearsal	OME	7-Aug-20		
Export QIF Measured Results	DCDCE	7-Aug-20		
Import QIF Measured Results	Core Entity	10-Aug-20		
Assemble AP242 Digital Twin	User Entity	14-Aug-20		
Evaluate As-built Digital Twin	PLM/ERP	28-Aug-20		Rehearsal

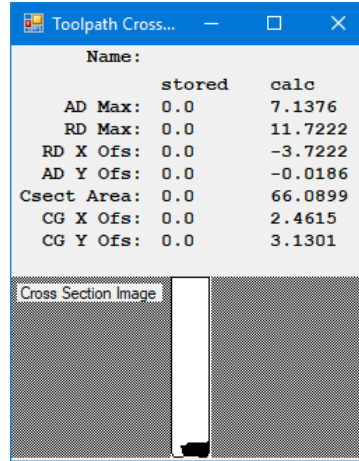
# Use Case 3 – tool life optimization



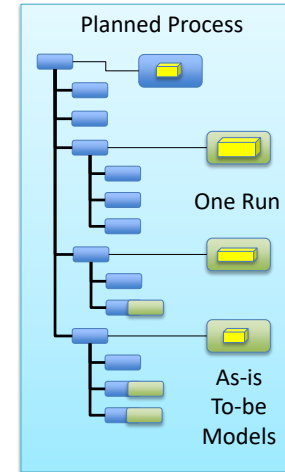
Machine parts



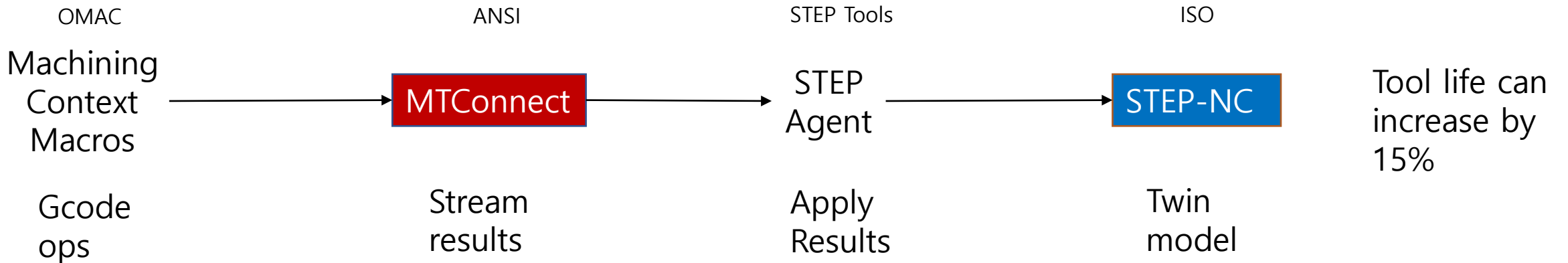
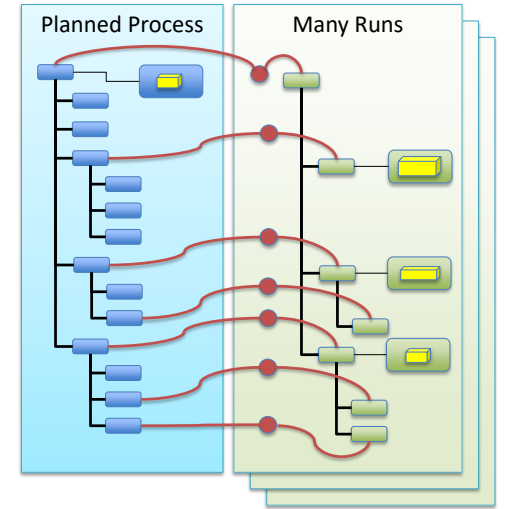
Monitor tool diameter



Compute tool engagement



Store linked data



ISO 23247-4 Figure A.3

