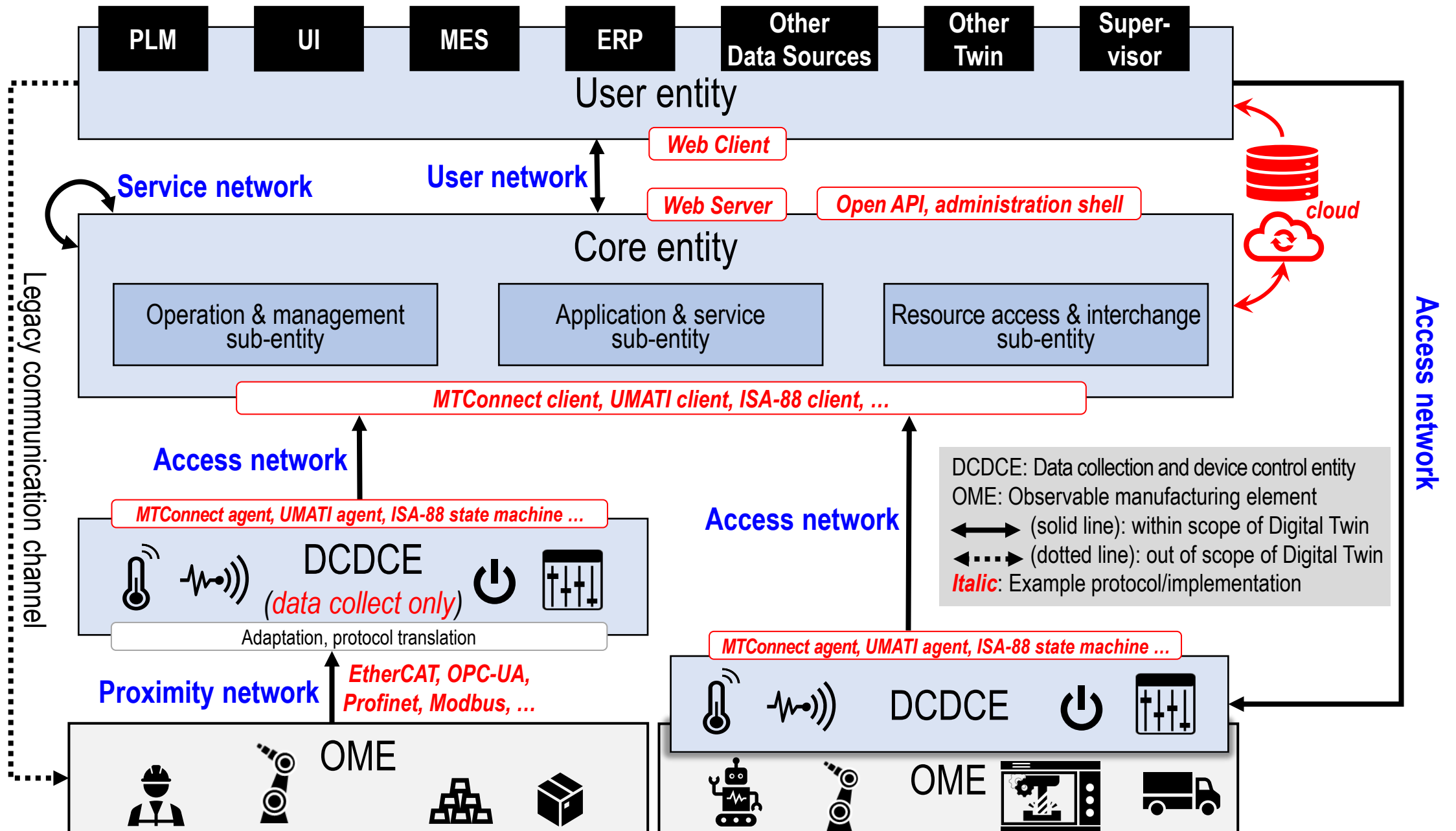
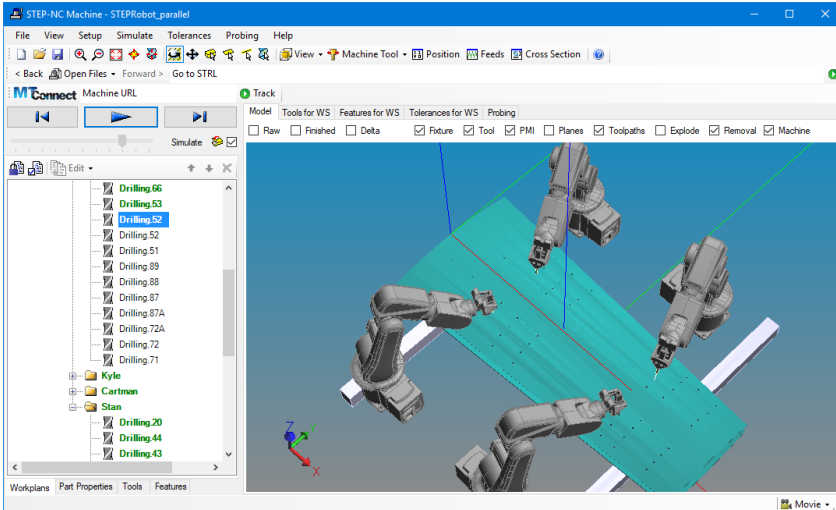
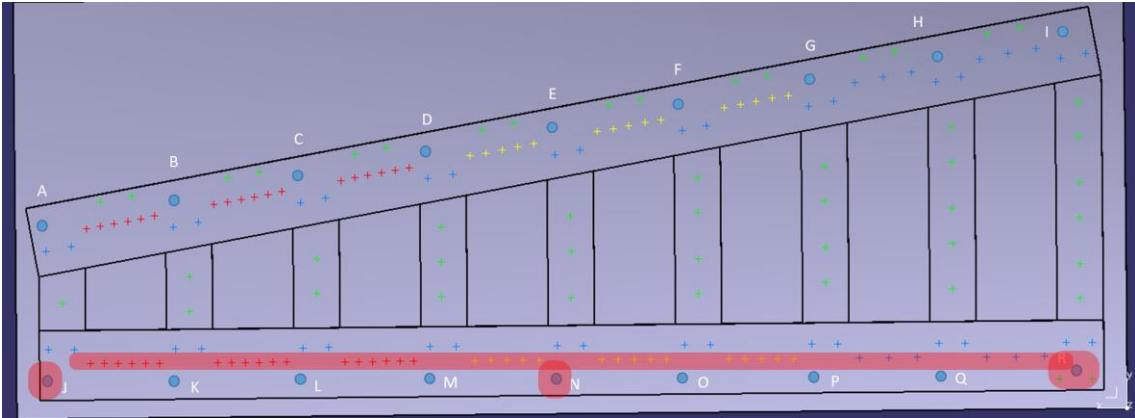
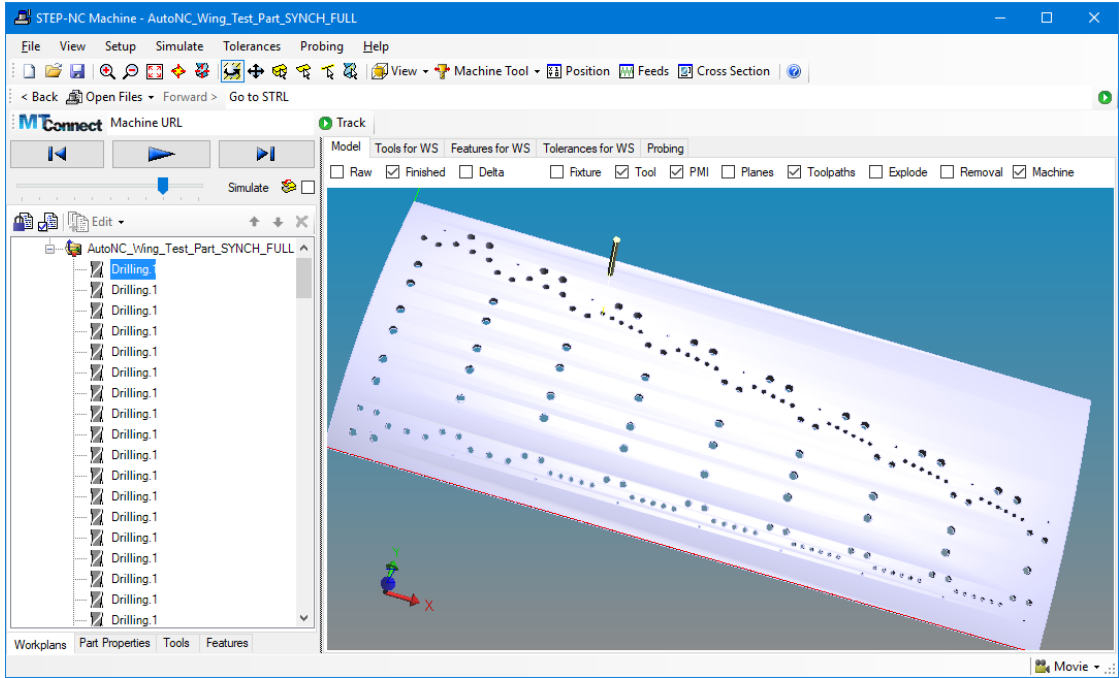


ISO 23247 Digital Twin Use case Testing

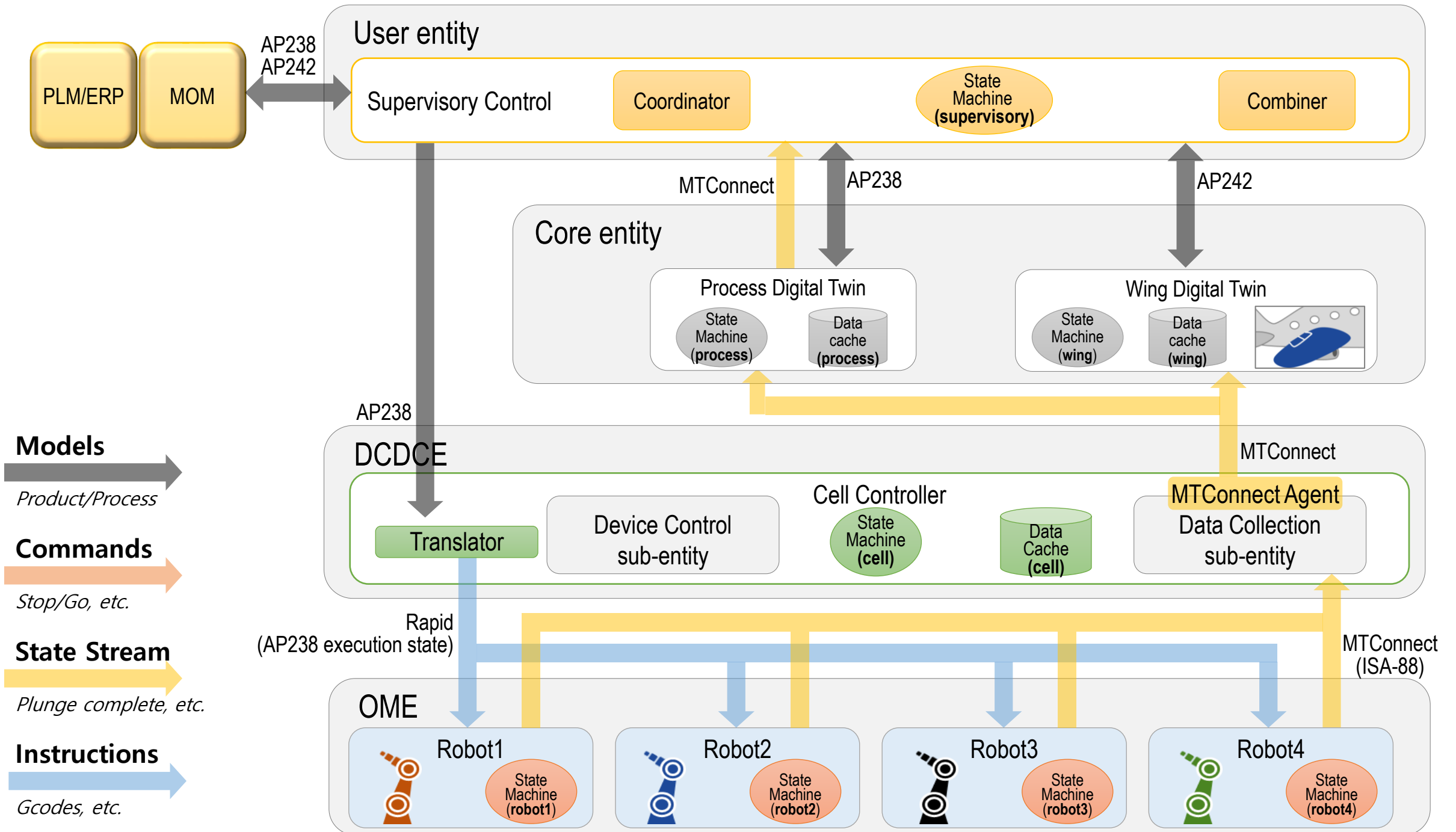
Results of July 21 Conference call



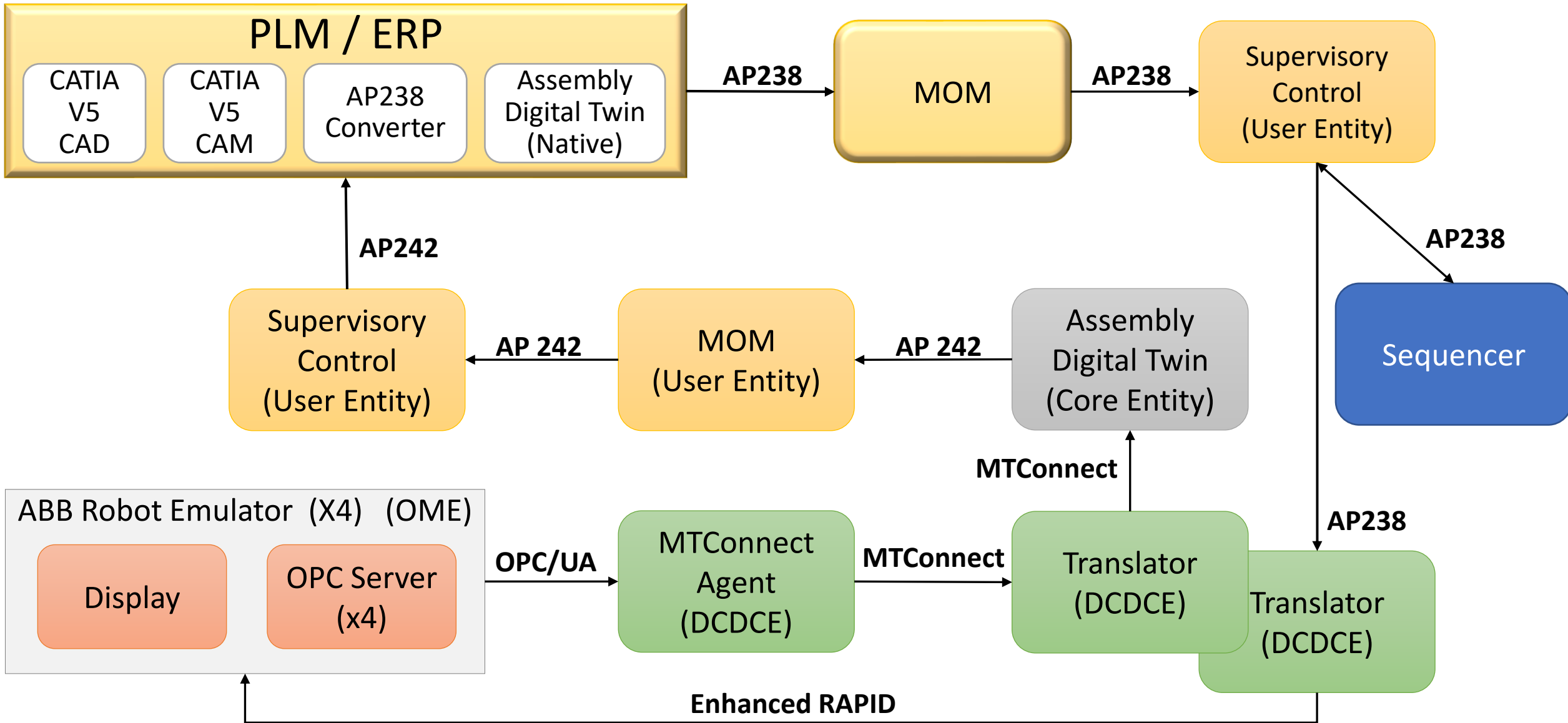
Use Case 1 – flexible schedule for robot drill & fill



On-shoring can increase by 50%

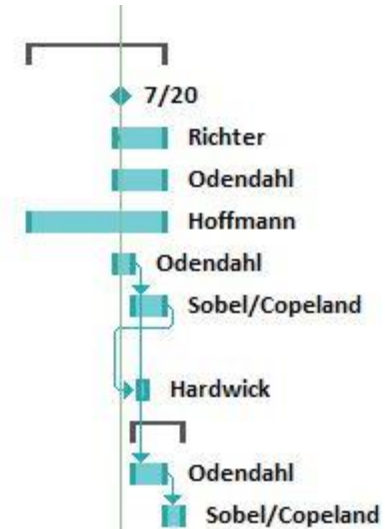


Assembly/Process Flow



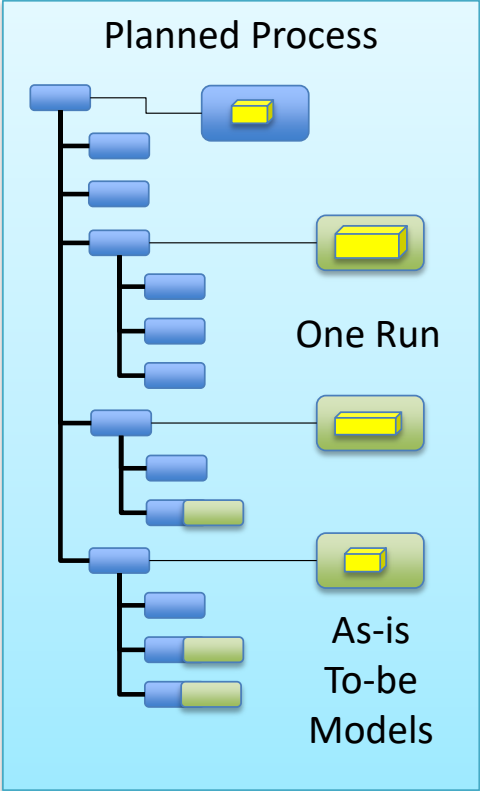
Schedule

4 CAD /CAM	16 days	Mon 7/6/20	Mon 7/27/20		
CATIA V5 -> AP238	0 days	Mon 7/20/20	Mon 7/20/20		Odendahl
Supervisory Control	6 days	Mon 7/20/20	Mon 7/27/20		Richter
AP238 -> Rapid	6 days	Mon 7/20/20	Mon 7/27/20		Odendahl
Setup OPC/UA Server	16 days	Mon 7/6/20	Mon 7/27/20		Hoffmann
Define OPC/UA Tags	3 days	Mon 7/20/20	Wed 7/22/20		Odendahl
Define MTConnect Tags	3 days	Thu 7/23/20	Mon 7/27/20	30	Sobel/Copeland
Setup MTConnect Adapter/Agent					
MTConnect -> Digital Twin	1 day	Fri 7/24/20	<u>Fri 7/24/20</u>	31	Hardwick
4 State Machine	6 days?	Thu 7/23/20	Thu 7/30/20		
Define OPC/UA Tags	3 days	Thu 7/23/20	Mon 7/27/20	30	Odendahl
Define MTConnect Tags	3 days	Tue 7/28/20	Thu 7/30/20	35	Sobel/Copeland
Map MTConnect to PackML					
PackML Client					

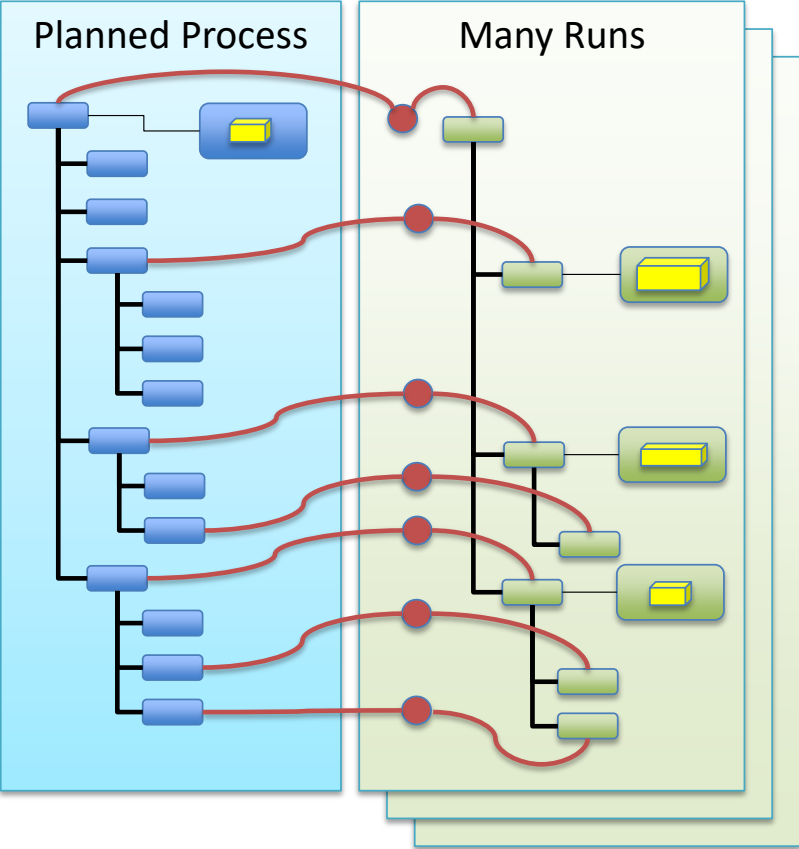


Digital Twin process model

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



Model process state using new attributes



Link runs using Part 21 Edition 3

```

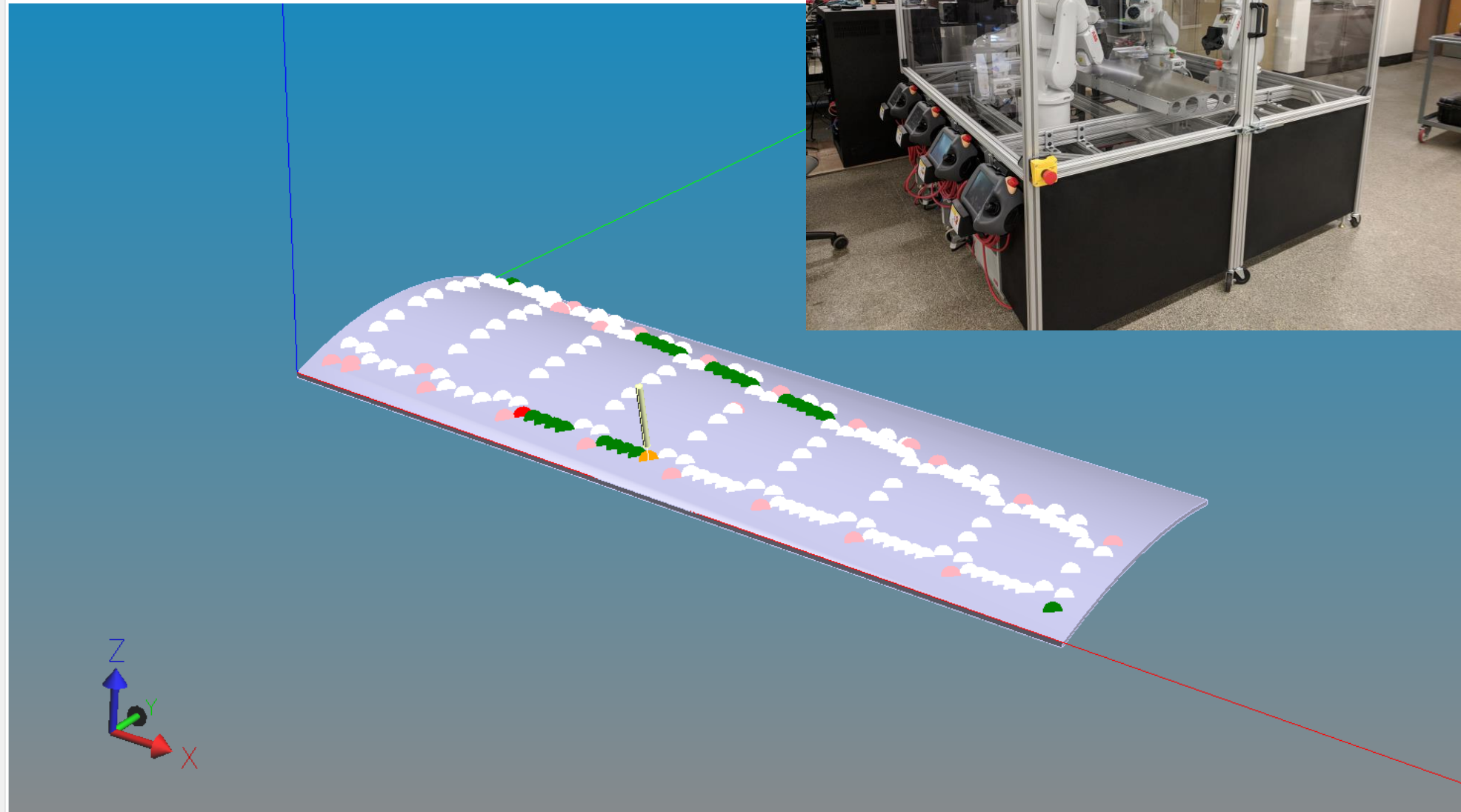
ENTITY executable
  [ ... other attributes omitted ... ]
  twin_source: OPTIONAL twin_source_enum;
  twin_plan: OPTIONAL executable;
  twinning_start : OPTIONAL Date_time;
  twinning_end :   OPTIONAL Date_time;
  twinning_exception : OPTIONAL explanation;
END_ENTITY;
  
```

```

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

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

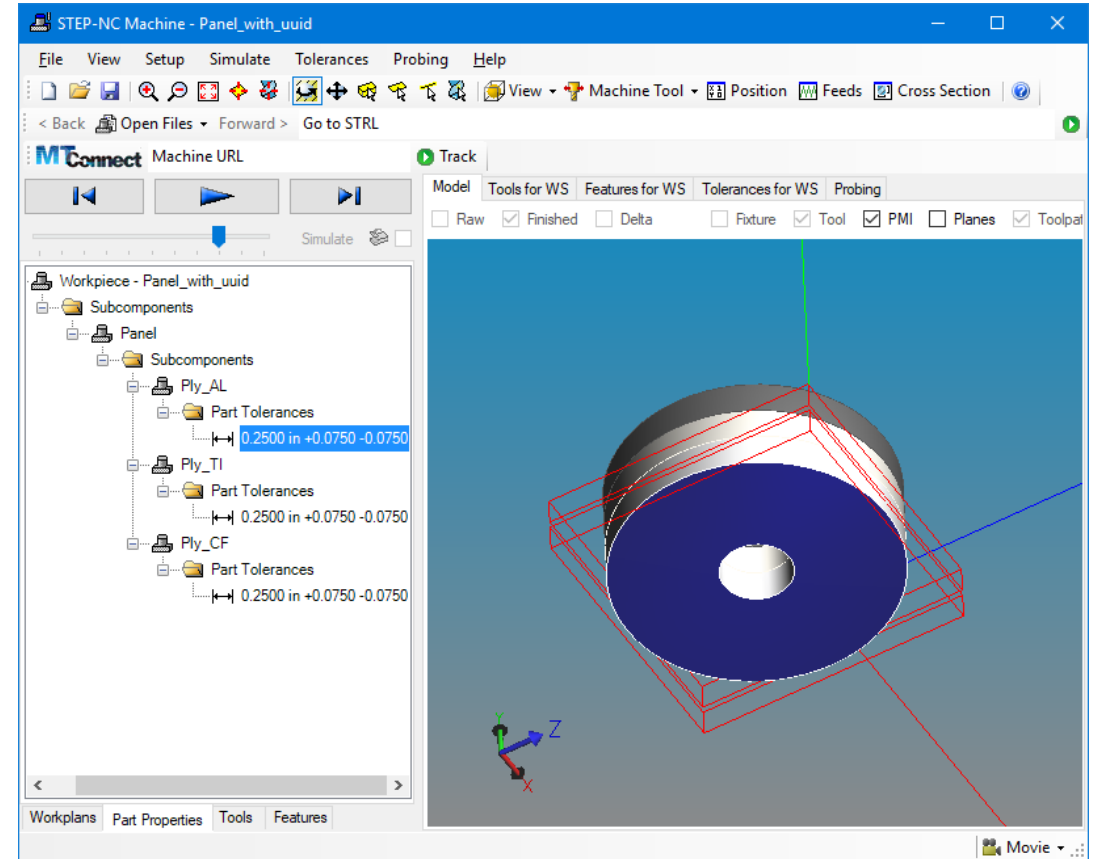
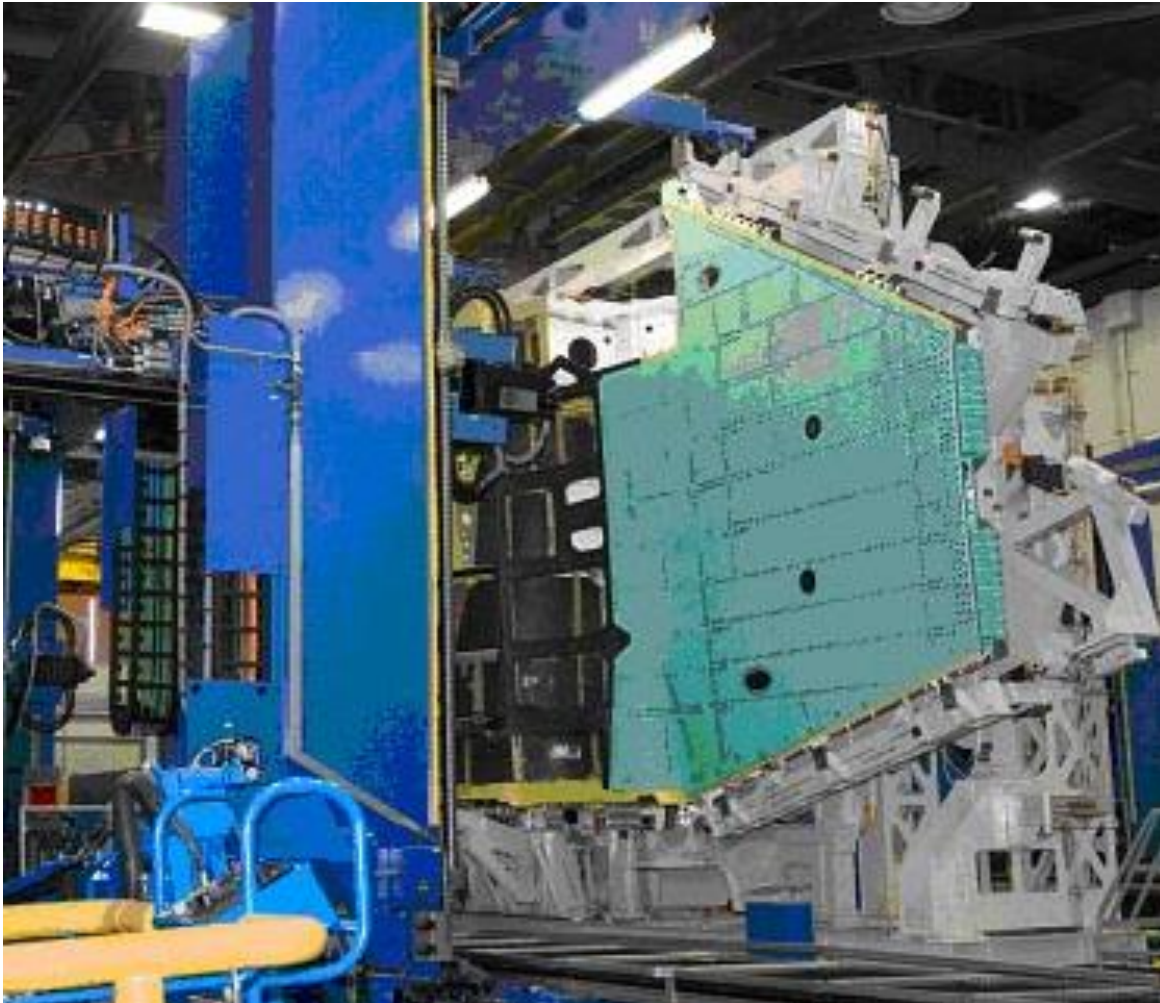
- Hole.1 (ROUND_HOLE)
- Hole.2 (ROUND_HOLE)
- Hole.3 (ROUND_HOLE)
- Hole.4 (ROUND_HOLE)
- Hole.5 (ROUND_HOLE)
- Hole.6 (ROUND_HOLE)**
 - Depth = 0.39 in
 - Diameter = 0.19 in
 - Position = (11.354, 1.149, 0.34) in
 - Bottom type = CONICAL_HOLE_BOTTOM
 - Tools
 - Tool - T6, D=0.19, L=1.96850393700787
 - 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)



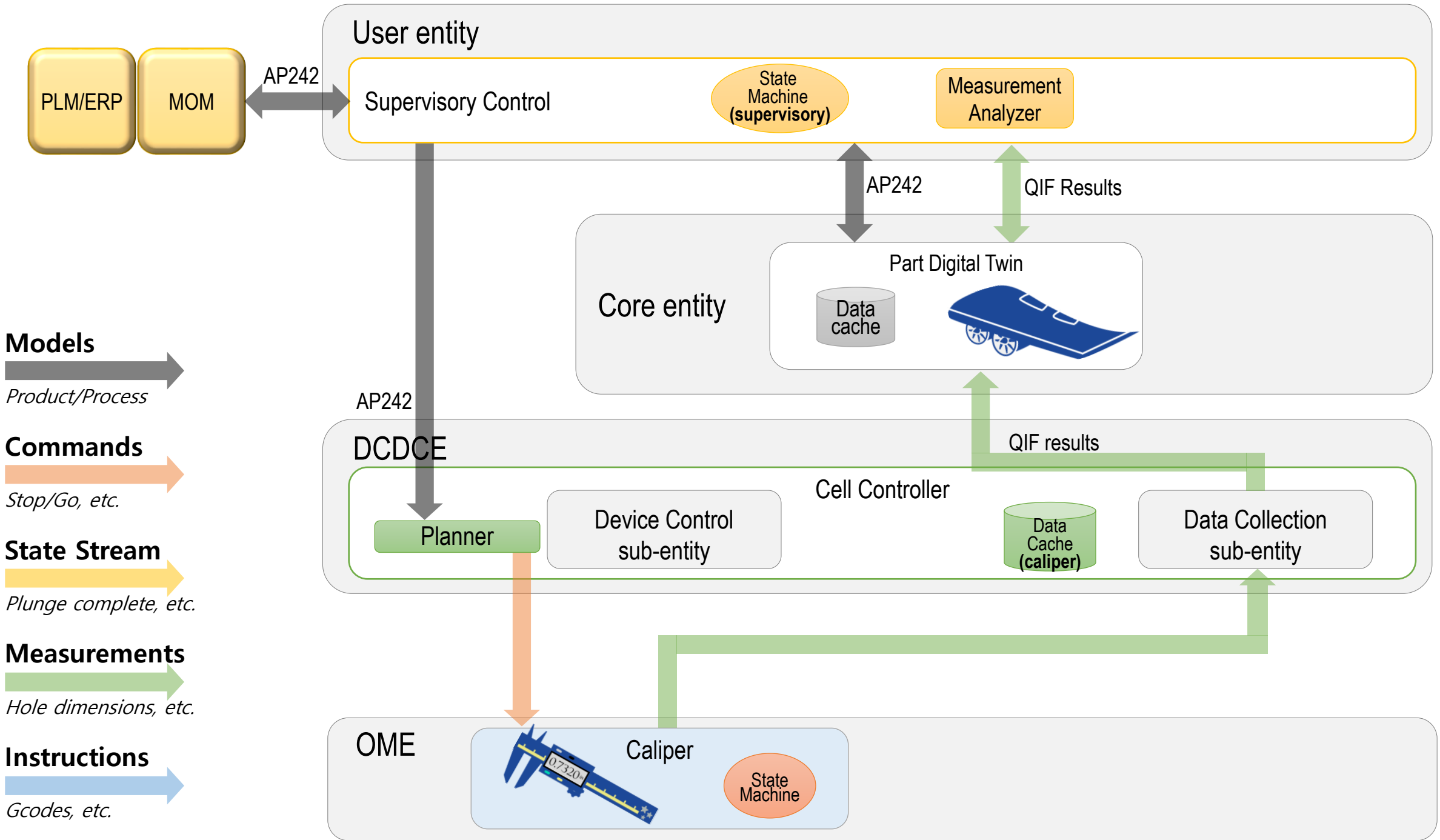
White (ready) Green (complete) Orange (in process) Red (error) Pink (missing data)

Group/Name	Task	23247 Use Case Reference	Completion Percentage	Completion Date	Status
Vice Commodore	Generate AP238 from CATProcess	External	100	6/22/2020	Complete
Fred Richter	Fake MOM	External	0		Asking
Fred Richter	Fake Supervisory Control	User Entity	0		Asking
AutoNC	Sequencer	User Entity/External Modules	0		Refused
Vice Commodore	RAPID Translator	DCDCE	50%		In Work
MicaH	ABB Emulator	OME/Robot 1-4	10%		in Work
BiTech	Loader Emulator	OME/Loader	0%		Asking
Will Sobel	MT Connect Adapter	OME/Robot 1-4	0%		Asking
Will Sobel	MT Connect Agent	OME/Loader	0%		Asking
Vice Commodore	Assembly Digital Twin	Core Entity	0%		Agreed
Vice Commodore	Generate CATPart from AP242	External	0%		Agreed
	Pack-ML State Machine	OME/Robot 1-4	0%		
	Pack-ML State Machine	OME/Loader	0%		
	Pack-ML State Machine	User Entity	0%		
	Pack-ML State Machine	Assembly Digital Twin	0%		
	Pack-ML State Machine	DCDCE	0%		
	Pack-ML State Machine	Supervisor Control	0%		

Use Case 2 – weight reduction

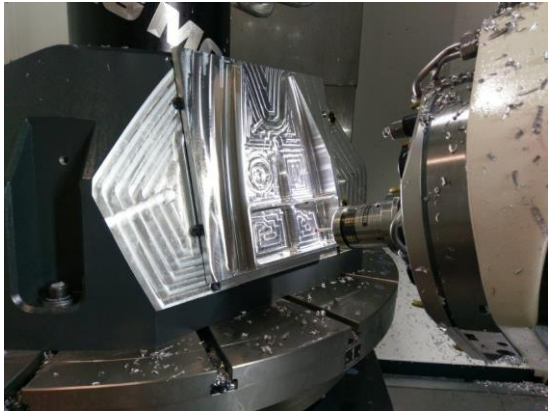


Exact match of fastener to hole depth
can reduce weight by 500lb

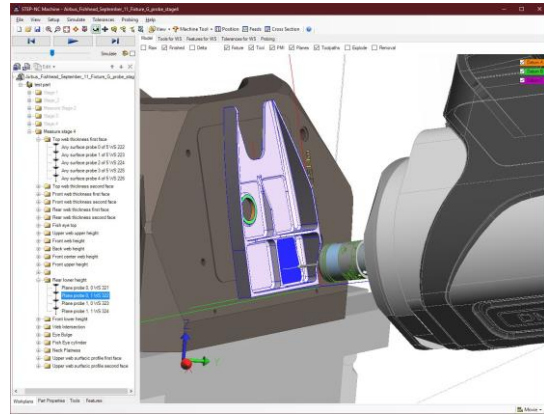


Group/Name	Task	23247 Use Case Reference	Completion Date	Completion %	Status
Jan De Nijs	Define Use Case		16-Mar-20	100%	Complete
Martin Hardwick	Document Use Case		22-Apr-20	100%	Complete
Jan De Nijs/L Maggiano	Author MBDs	PLM/ERP	14-May-20	100%	Complete
L Maggiano	Export AP242 Nominals	User Entity	14-May-20	100%	Complete
L Maggiano	Export QIF Plan	DCDCE	14-May-20	100%	Complete
Hany Abdel-Motaleb	Measure Parts (key-in)	OME	14-May-20	100%	Complete
Hany Abdel-Motaleb	Export QIF Measured Results	DCDCE	15-May-20	100%	Complete
Martin Hardwick	Import QIF Measured Results	Core Entity	20-May-20	100%	Complete
Martin Hardwick	Assemble AP242 Digital Twin	User Entity	20-May-20	100%	Complete
Sung Hei Kim	Revise Use Case		30-Jun-20	100%	Complete
Xometry	Fabricate Parts		17-Jul-20		Approved
Hany Abdel-Motaleb	Measure Parts (as-built)	OME	24-Jul-20		
Hany Abdel-Motaleb	Export QIF Measured Results	DCDCE	24-Jul-20		
Martin Hardwick	Import QIF Measured Results	Core Entity	31-Jul-20		
Martin Hardwick	Assemble AP242 Digital Twin	User Entity	14-Aug-20		
Jan De Nijs	Evaluate Assembled Digital Twin	PLM/ERP	28-Aug-20		

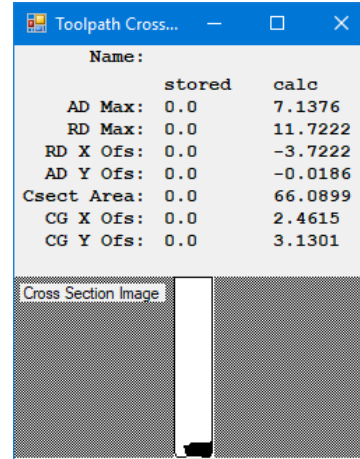
Use Case 3 – tool life optimization



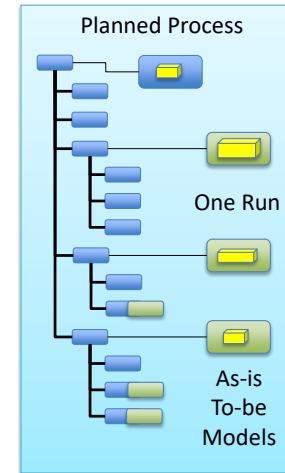
Machine parts



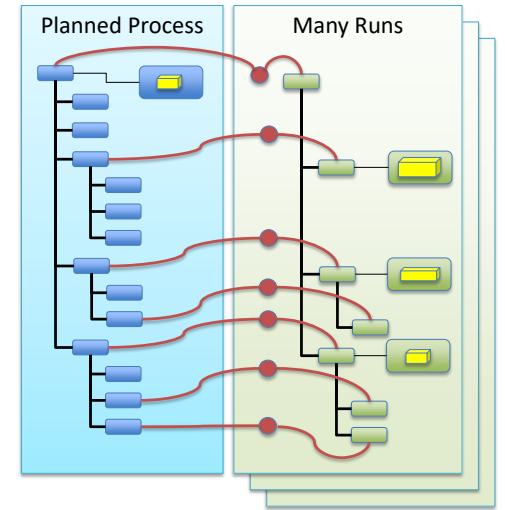
Monitor tool diameter



Compute tool engagement



Store linked data



OMAC
Machining
Context
Macros

ANSI
MTConnect

STEP Tools
STEP
Agent

ISO
STEP-NC

Tool life can
increase by
15%

Gcode
ops

Stream
results

Apply
Results

Twin
model

ISO 23247-4 Figure A.3

