

# Requirements for a digital twin manufacturing framework

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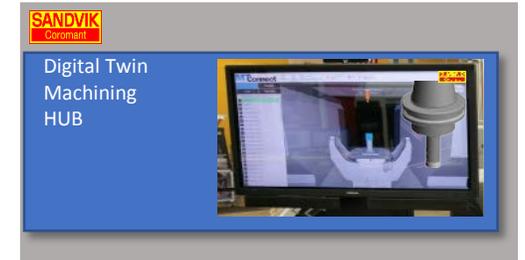
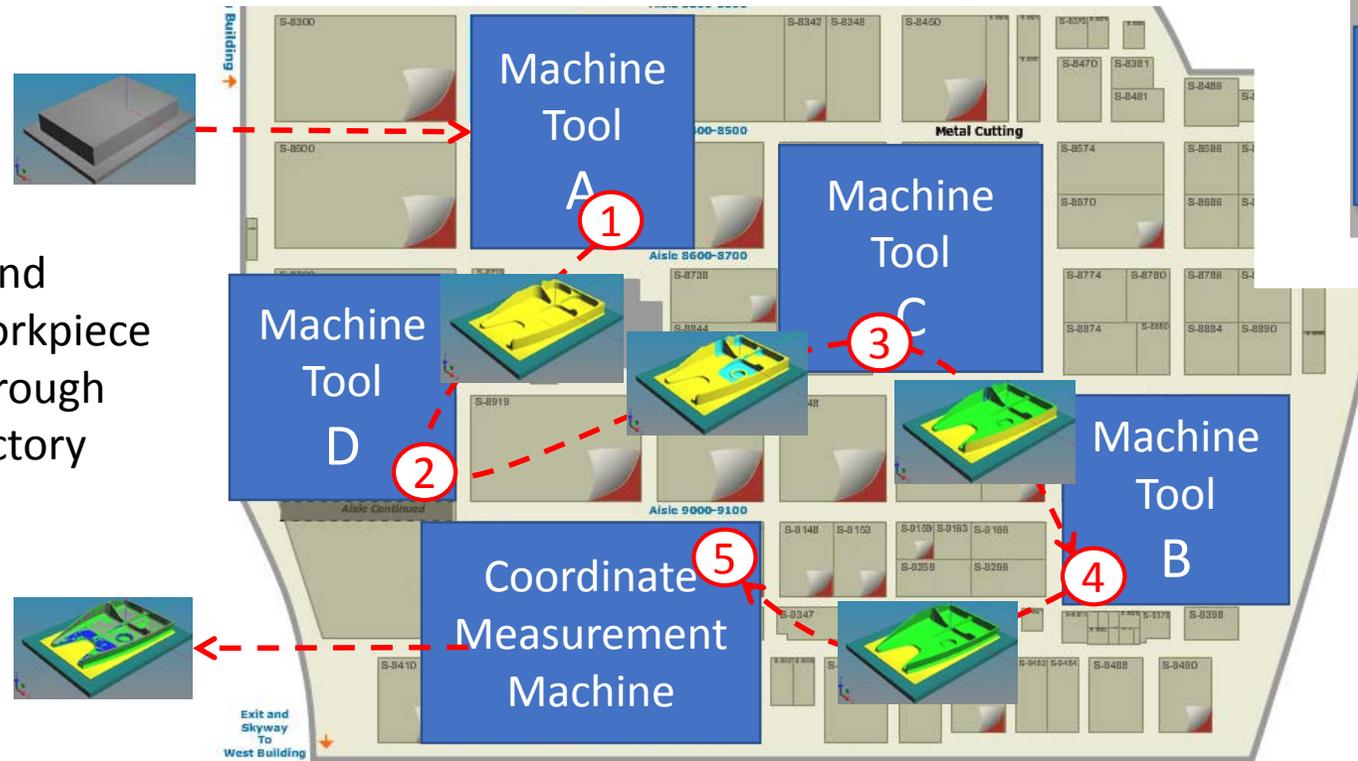
# Digital Twin machining at IMTS 2018

- ✓ Plan process

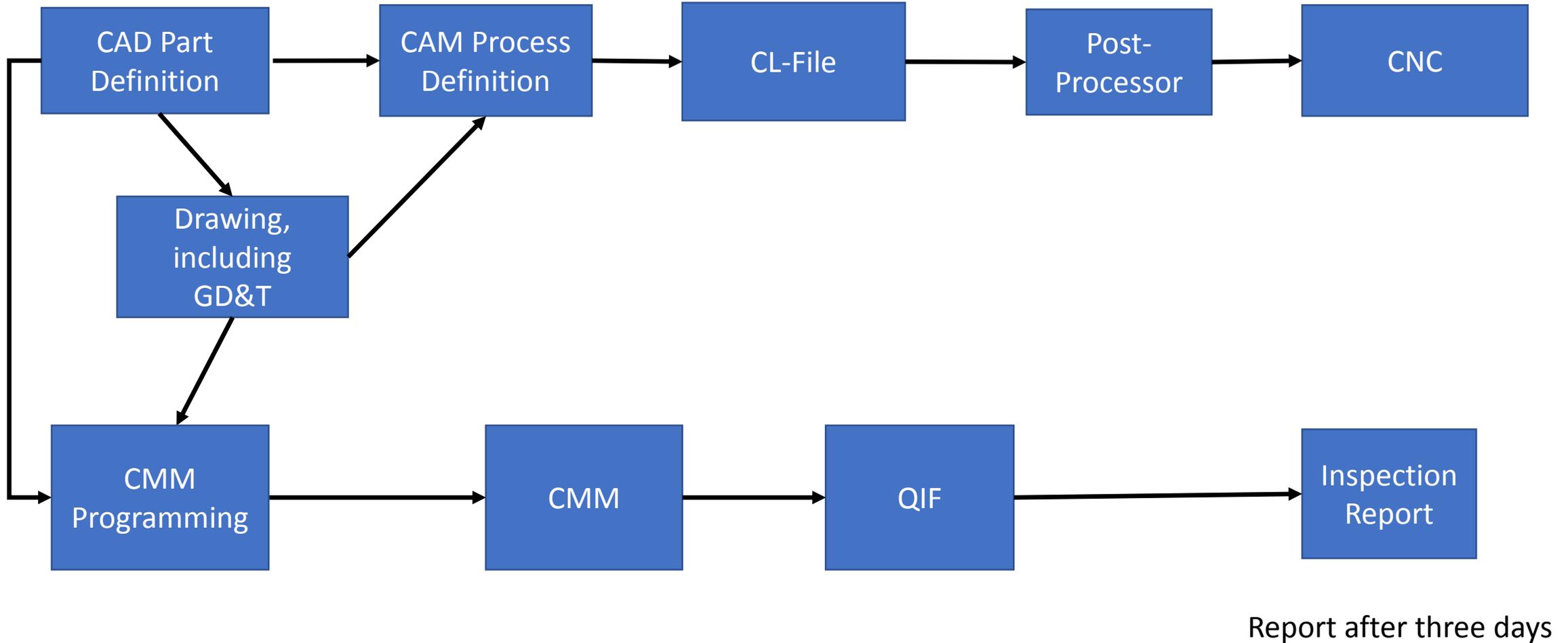
*"Factory floor plan" at machine tool show*

- ✓ Send workpiece through factory

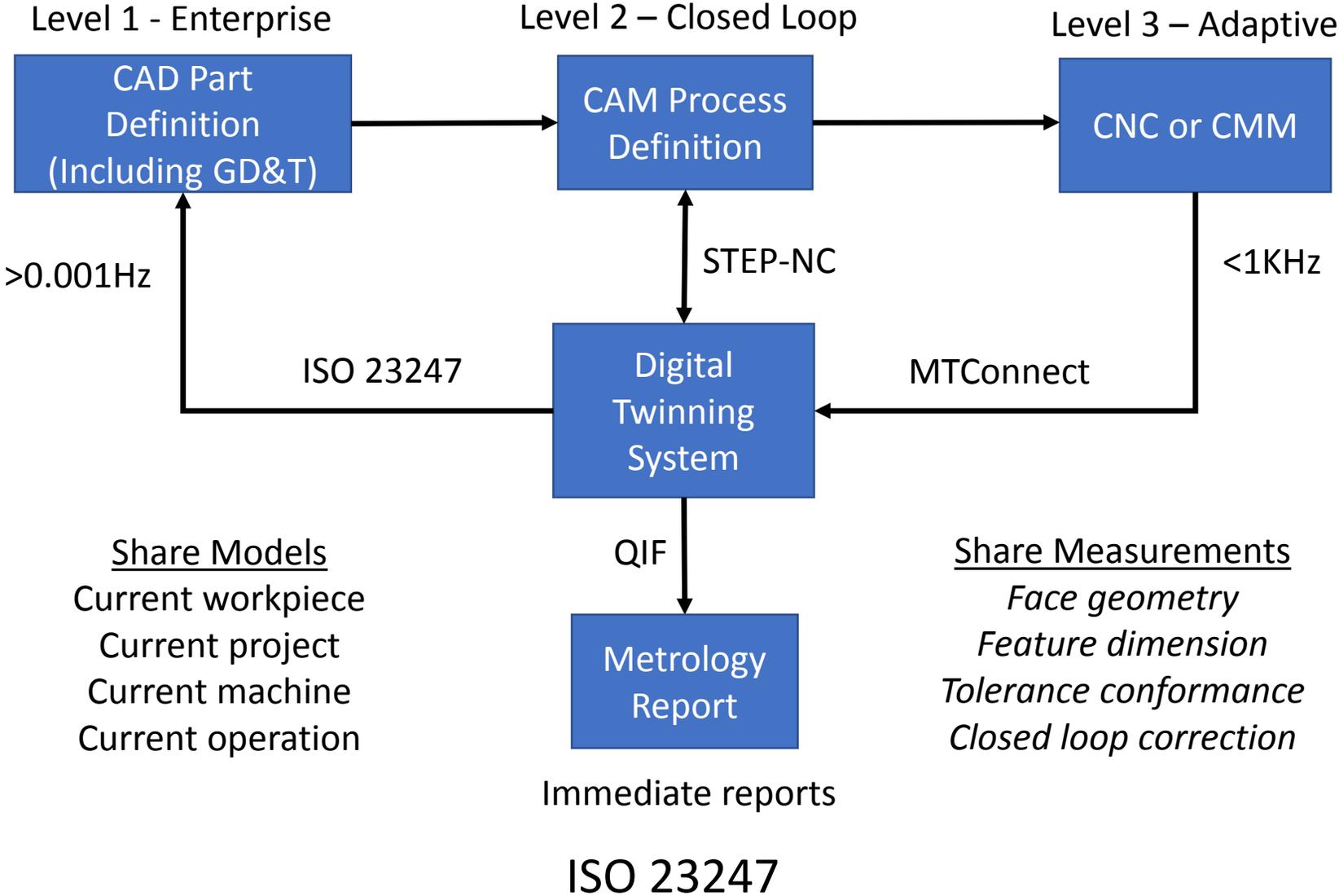
- ✓ Receive finished part



# Traditional CNC and CMM Data Flow



# Digital Thread Data Flow



# Digital Twin machining



“Mind the Gap” 14-02-02

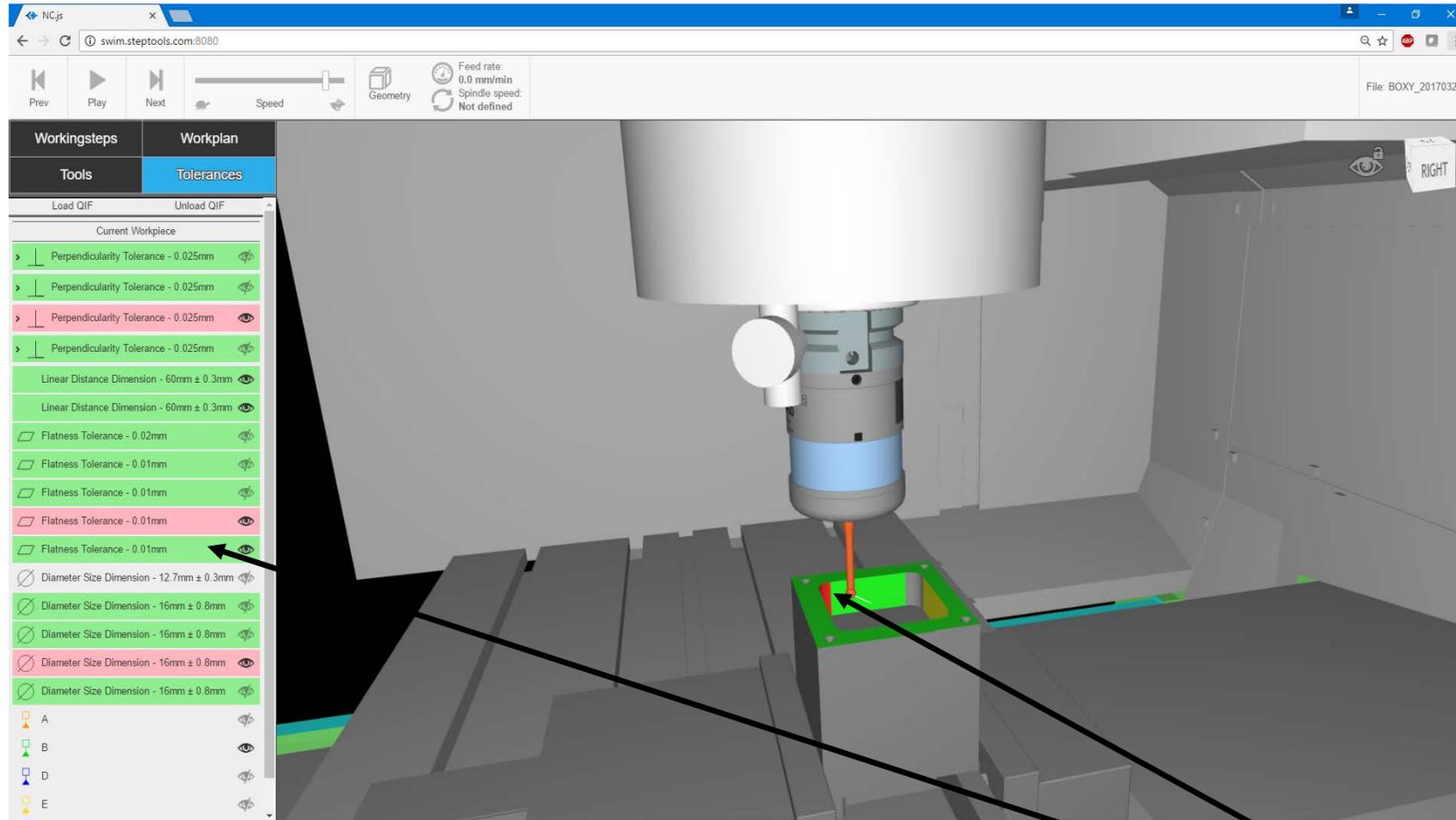


<http://fishhead.steptools.com:8080/>

- Real time twinning from MTConnect
  - 1Hz trace the planning data
  - 10Hz+ model the machining data
- Phone and large screen TV display
  - STEP in Node.js
  - View in Three.js
  - UI in React.js

[https://youtu.be/n\\_syXtpyxgM](https://youtu.be/n_syXtpyxgM)

# Digital Twin measurement



- Green good
- Red bad
- Yellow good and bad

Tablet,  
Phone or  
Large Screen TV

Touch  
Probe

MTConnect

STEP  
Model

QIF

Feature or face  
requiring corrections

# Digital Twin manufacturing framework

## STEP Data

## QIF Data

```
STEP File Browser - BOXY_20170306.stp [page 1/1]
File View Navigate Help
<img alt="STEP File Browser toolbar" data-bbox="10 330 480 370"/>
FILE_SCHEMA (('AP242_MANAGED_MODEL_BASED_3D_ENGINEERING_MIM_LF { 1 0 1 0 }
ENDSEC;

ANCHOR;
<4210ed32-a599-43d1-9e84-96120d5ece42>=#983; /* perpendicularity_toler
<767be10a-4d9a-49d8-9fd5-205adcd7ad82>=#987; /* perpendicularity_toler
<459f7ee4-fced-4c3d-be7d-ca20f28e1855>=#991; /* perpendicularity_toler
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```
BOXY_20170306_Results.xml - Notepad
File Edit Format View Help
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</FlatnessCharacteristicItem>
<PerpendicularityCharacteristicItem id="23">
  <Attributes n="1">
    <AttributeQPid name="QPid">
      <Value>4210ed32-a599-43d1-9e84-96120d5ece42</Value>
    </AttributeQPid>
  </Attributes>
  <Description>BOXY_20170306.PERPENDICULARITY_3</Description>
  <Name>PERPENDICULARITY_3</Name>
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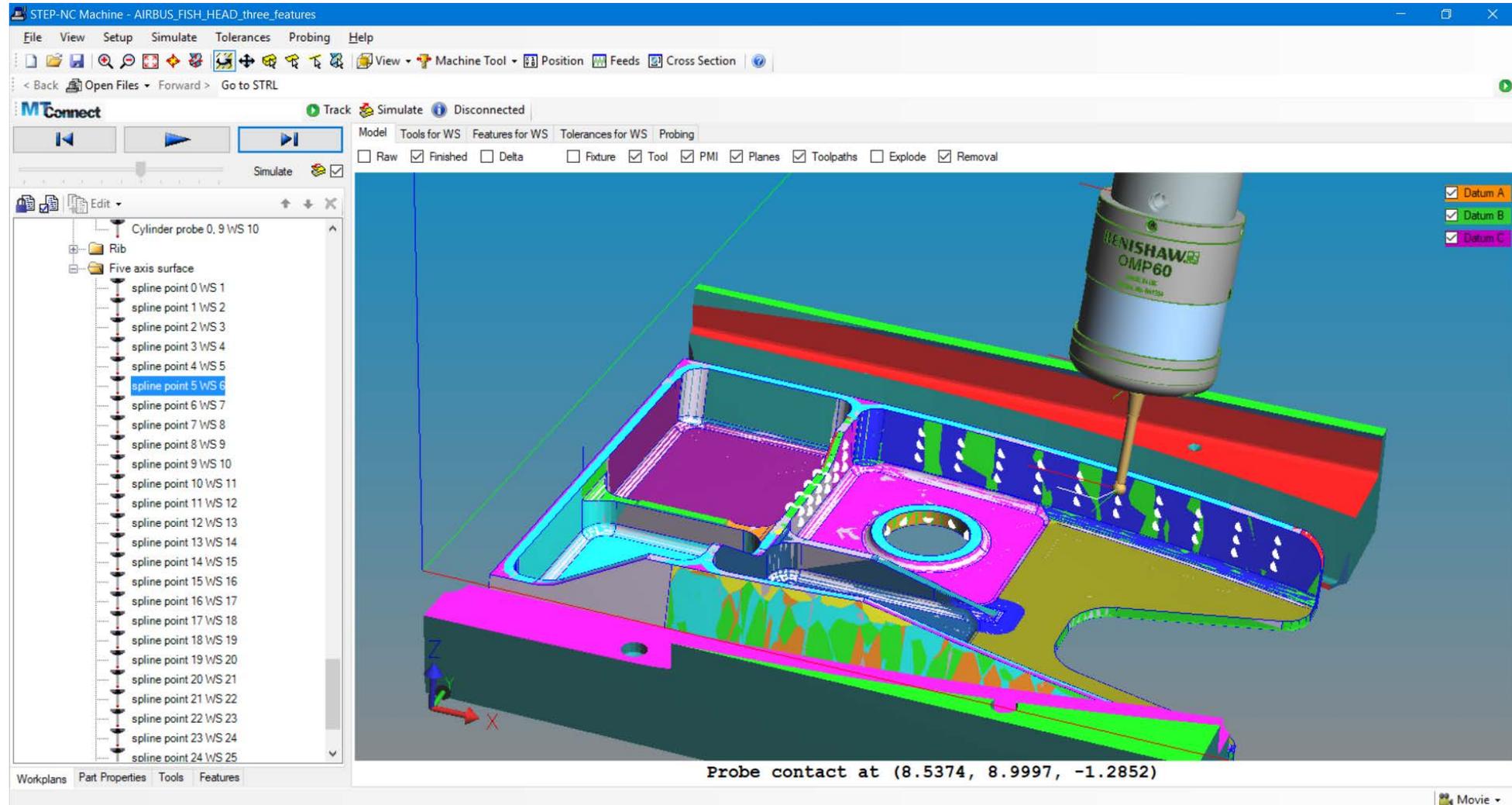
UUID's

UUID's

## MTConnect Adapter Data

```
BOXY_20170306.log.txt - Notepad
File Edit Format View Help
2017-03-02T18:53:41.080Z|pprogram|BOXY_20170306
2017-03-02T13:53:49.104-05:00|measure|feature:"dc13594f-b8d5-4b23-bb38-ca86d96552e1" order:1 count:8 id:"FACE32373" characteristic:"3DLocation" x:-14.166667 y:-40.000000 z:9.166667
2017-03-02T13:53:50.306-05:00|measure|feature:"dc13594f-b8d5-4b23-bb38-ca86d96552e1" order:2 count:8 id:"FACE32373" characteristic:"3DLocation" x:-4.722222 y:-40.000000 z:9.166667
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```

# Five axis example part



# Results

- 3-axis Boxy – July 2017
  - Hyundai WIA XF6300 Siemens 840D – Aluminum – Renishaw Probing
  - 130Hz MTConnect, 100Hz Simulation, QIF results
  - Part coordinate simulation
- 5-axis Fishhead – February 2017
  - Northwood Fanuc 31i – Foam
  - 10Hz MTConnect, 10Hz Simulation
  - Machine coordinate simulation
- 5-axis Fishhead – March 2017
  - DMU Siemens 840D – Aluminum – Renishaw Probing
  - 230Hz MTConnect, 50Hz Simulation, QIF results
  - Machine coordinate simulation

# Participants

- Participants / Supporters/ Invitees (\* = not confirmed)

- Organizations

- ISO TC184/SC4/WG15
- OMAC
- NIST
- AMT/MTConnect
- DMSC/QIF

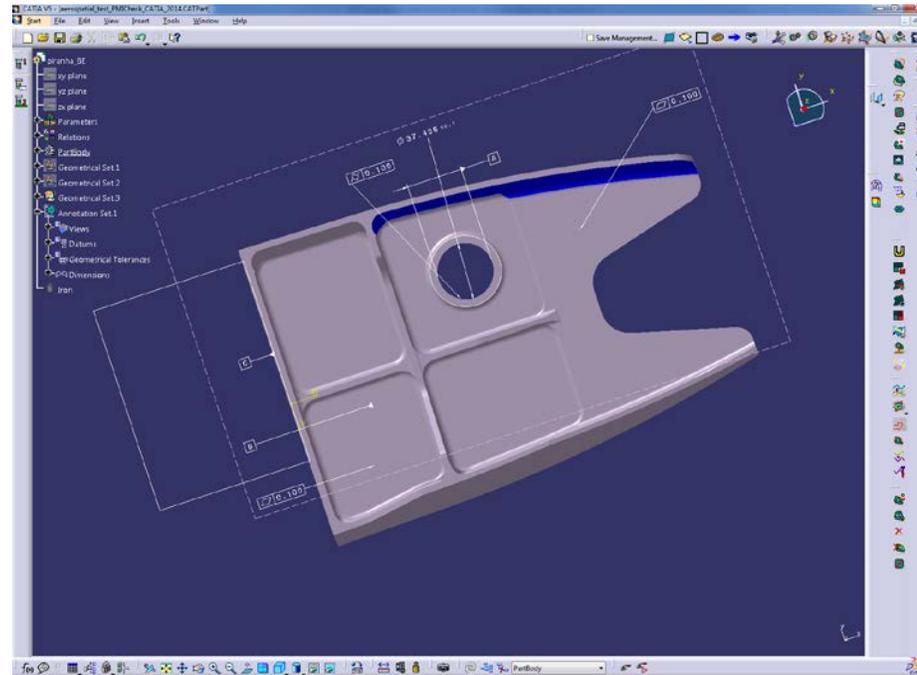
- Technology Providers

- STEP-Tools, Inc.
- Dassault \*
- Autodesk \*

- Cutters/ HOLDERS

- Sandvik Cormorant

CATIA



- Machine Tool Suppliers

- DMG Mori
- Hyundai
- Makino
- Okuma \*

- Metrology

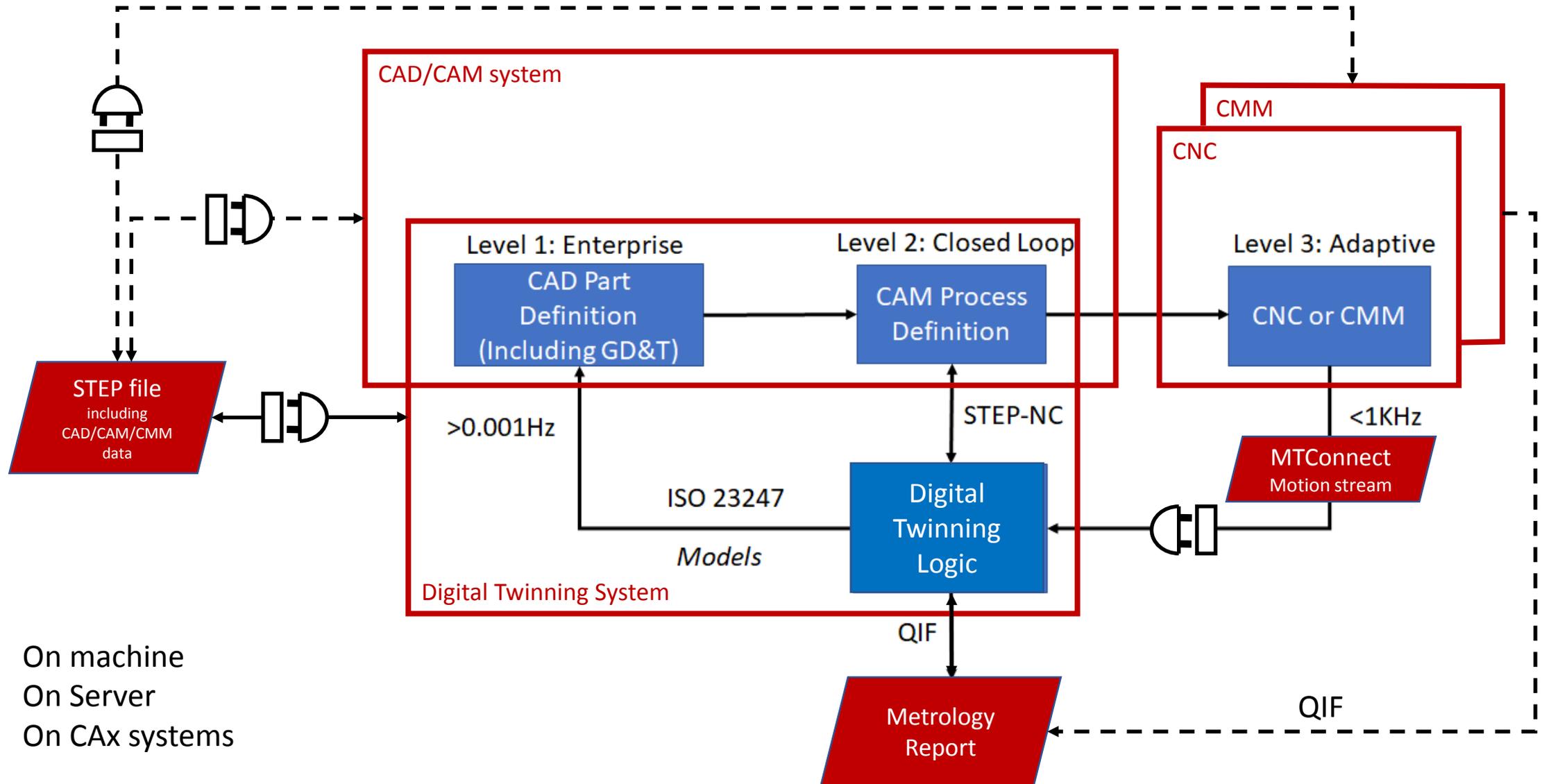
- Mitutoyo
- Renishaw

- End Users

- Boeing
- Airbus

**Participate by adding value to MTConnect, QIF or STEP  
in the framework**

# System configurations



# Requirements

- Large screen TV with HDMI connection to
- High speed desktop e.g <https://www.cyberpowerpc.com/system/VR-Ready-Deal-Radeon-RX-580> (this is the base - add options for cooling and 5G+ speed)
- Basic connection to network
  - Enable real time, but perhaps sporadic, display at the digital twin hub
  - Enable reliable previously recorded display at the digital twin hub
- On machine probe with Inspection Plus or similar
- Interfaces in CAD and CAM
  - STEP for design requirements (hardest)
  - QIF for quality results (easier)
  - MTConnect for machine monitoring (easiest)

