Reliable process checking for better quality control

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Reliable process checking

- Reliable – Multiple systems cross check each other
- Process – A sequence of defined actions
- Checking – Every action is completed or given an excuse

Defined action means planned or allowed

UUIDs for actions

- Someone or something authorizes construction of a wing
  - UUID when the task is authorized
  - UUID when the hole is authorized
  - UUID when the pilot hole is machined
  - UUID when the full hole is started
  - UUID when each layer is completed
  - UUID when the full hole is finished
  - UUID when the pin is placed
  - UUID when a washer is added
  - UUID when the collar is tightened
  - UUID when the sealant is added
  - UUID for location, size and form

Most of these are planned but some are allowed

What is a UUID for an action

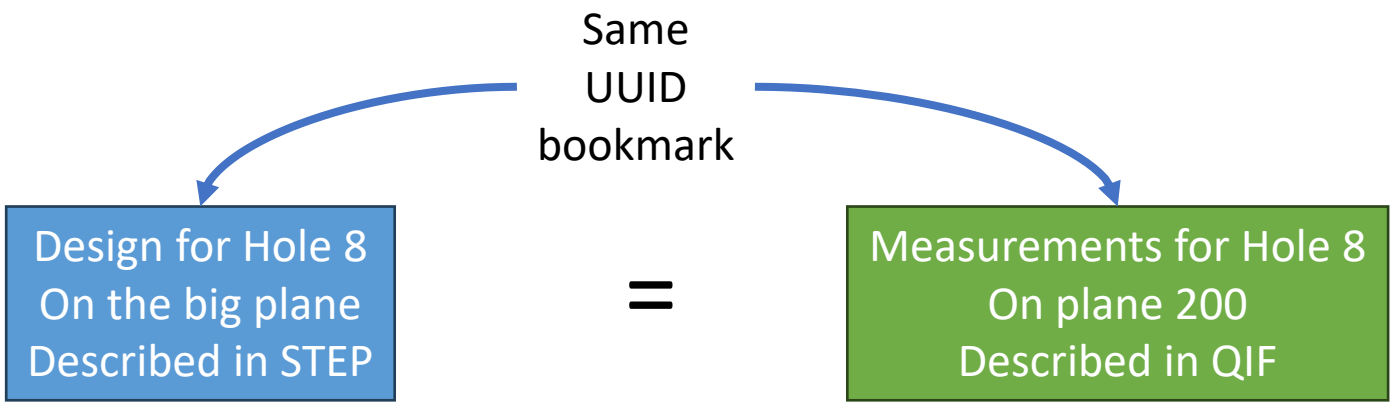
- A way to find something without knowing its context
- When you find the UUID, a system gives you a context
  - You may find a product
  - You may find a feature
  - You may find a tolerance
  - You may find an action
  - You may find a machine
  - You may find a tool
- In most cases if you know the context then there are better ways to find the something

What is a UUID in a STEP file

- A bookmark or anchor for the description of a digital twin in the data
  - A design digital twin describes a property or requirement
  - A planning digital twin describes an action
  - A manufacturing digital twin describes a feature
  - An inspection digital twin describes a dimension

Two digital twins describe the same thing

- If they have the same UUID they describe the same thing
  - They could be identical descriptions in the same encoding (value equal)
  - They could be identical descriptions in different encodings (translation equal)
  - They could be different descriptions in the same encoding (similar equal)
  - They could be different descriptions in different encodings (twin equal)



Complexity

- A design is used to plan many processes
- A process is reused in many places and machines
- A physical part contains many dimensions to be measured
- A organization makes many copies of the same product

How to use a design UUID to find a measurement UUID?

Proposal - Four Grades of UUID

- A UUID for each type of event
- A UUID for each planned event
- A UUID for each event instance
- A UUID for each actual event

Less in UUID **Action: "Add a second washer to hole 8 in plane 200"** *More in UUID*

Grade IV – ticket color	Grade III – ticket number	Grade II – ticket repeat	Grade I – ticket unique
UUID = Add a washer	UUID = Add a second washer	UUID = Add a second washer to hole 8	UUID = Add a second washer to hole 8 on plane 200
Listener needs to know this is the 2nd washer	Listener needs to know this is hole 8	Listener needs to know this is plane 200	Listener needs to know nothing

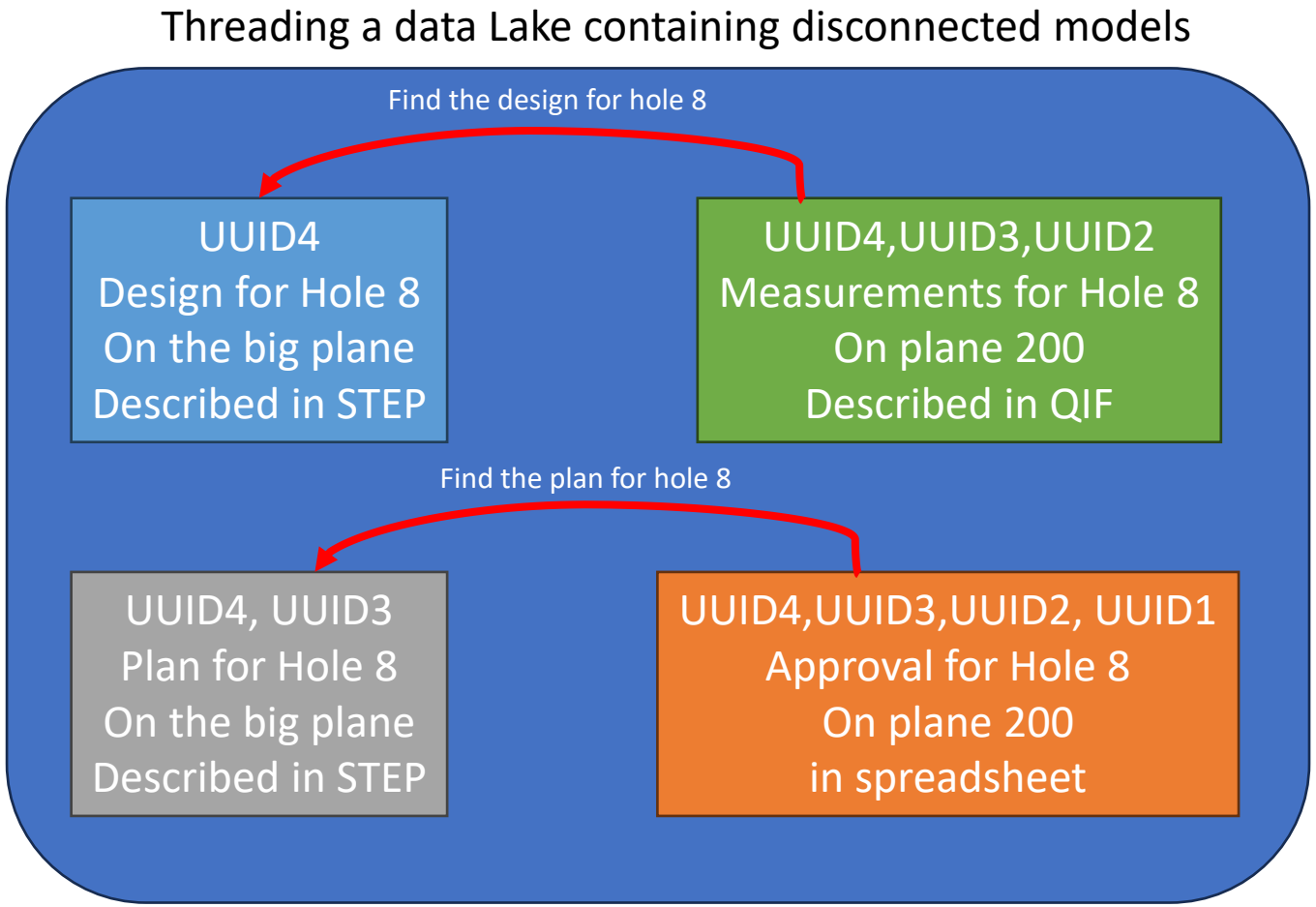
Representation (UUID4 is a Grade IV UUID)

- Compound method – UUID4,UUID3,UUID2,UUID1 (512 bytes)
  - Example - design(4), planning(3), manufacturing(2), inspection(1)
  - Example- property(4), workingstep(3), feature(2), product(1)
- Computed method – UIID4+UUID3+UUID2+UUID1 (128 bytes)
    - UUID3 = Class 5_hash (UUID4 + instance number)
    - UUID2 = Class 5_hash (UUID3 + feature number)
    - UUID1 = Class 5_hash (UUID2 + serial number)
    - Computed method is not good – number of UUID1 is largest, but number space is smallest
- Database method – find (UUID(x)) yields UUID(x+1) + index
  - Find (UUID1) = UUID2 + serial number (e.g. plane 200)
  - Find (UUID2) = UUID3 + feature number (e.g. hole 6)
  - Find (UUID3) = UUID4 + instance number (e.g. washer 2)

Database method is efficient but compound method enables distribution, consistency checking & composition

Example Graded UUID's in the data lake

- Ideal is no UUID's are necessary
- Whole lake is modeled using AP239 or similar
- Until then sections of lake are modeled using AP203, AP214, AP242, AP238, MTC, QIF, etc.
- And data is connected using Graded UUID's which lead to context



Example three washers on a pin

- Three washers are added to the pin in hole 6 on plane 200
- You are a listener and you only receive two add washer messages
  - You know there is an error if the UIID's are Grade I
  - You know there is an error if you are following the process
  - You know there is an error if the design includes three washers in hole 6
  - Otherwise you have to assume this hole only needs two washers

For plane 200 in hole 8, I have only received messages for add washer 3 and add washer 2

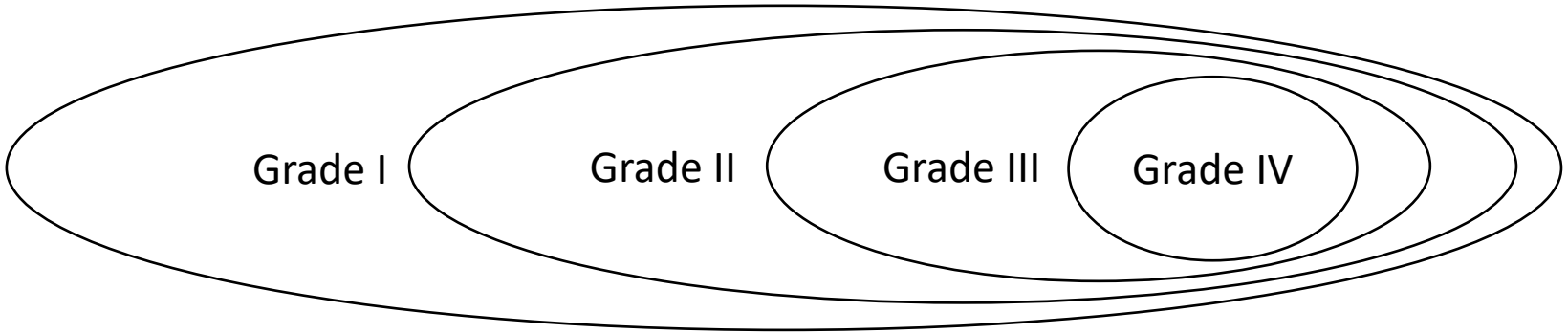
Example different life cycle stages

- If the Grade IV is the same then they are for the same design
- If the Grade III is the same then they have the same properties
- If the Grade II is the same then they are the same usage
- If the Grade I is the same then they are the same thing

AP239 will give the full context for all the grades

Example – manufacturing data standards

- Grade IV is the STEP perspective
- Grade III is the MTConnect perspective
- Grade II is the QIF perspective
- Grade I is the reliable process checking perspective



STEP is master design data, MTConnect records actions,
QIF measures requirements, RPC finds missing events

Proposal

- In the 2020 demo we used
  - Grade IV UUID’s for AP242 (we made an MBOM)
  - Grade III UUID’s for AP238 (we made working steps)
- For the next demonstration we should target Grade I
  - with digital twin composition
  - and detection of missing actions