



# STEP Technical Definitions for: Digital Twin Instance, Digital Twin Prototype, Digital Twin Aggregate and Digital Thread

Wednesday August 10<sup>th</sup>, 2022

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# Digital Twin Instance (DTI)

“This type of Digital Twin describes a specific corresponding physical product that an individual Digital Twin remains linked to throughout the life of that physical product. Depending on the use cases required for it, this type of Digital Twin may contain, but again is not limited to, the following information sets: A fully annotated 3D model with General Dimensioning and Tolerances (GD&T) that describes the geometry of the physical instance and its components, a Bill of Materials that lists current components and all past components, a Bill of Process that lists the operations that were performed in creating this physical instance, along with the results of any measurements and tests on the instance, a Service Record that describes past services performed and components replaced, and Operational States captured from actual sensor data, current, past actual, and future predicted.” - Grieves

- *The as-built data for a digital twin*
- A model tracking an observable manufacturing item with units of functionality for the required properties.
  - *stp\_product\_definition in AP242, stp\_process\_operation in AP238*

# Digital Twin Prototype (DTP)

“This type of Digital Twin describes the prototypical physical artifact. It contains the informational sets necessary to describe and produce a physical version that duplicates or twins the virtual version. These informational sets include, but are not limited to, Requirements, Fully annotated 3D model, Bill of Materials (with material specifications), Bill of Processes, Bill of Services, and Bill of Disposal.” - Grieves

- *The as-designed information for a digital twin*
- Nominal product and nominal process models with identified key characteristics
  - Geometric dimensions and tolerances
    - Stp\_geometric\_tolerance, stp\_dimensional\_location and stp\_dimensional\_size
  - Feature templates, definitions and instances
    - Stp\_feature\_definition, stp\_feature\_component\_definition
  - Material properties, Process properties and others
    - Stp\_material\_property, stp\_process\_property,

# Digital Twin Aggregate (DTA)

“This type of Digital Twin is the aggregation of all the DTIs. Unlike the DTI, the DTA may not be an independent data structure. It may be a computing construct that has access to all DTIs and queries them either ad-hoc or proactively. On an ad hoc basis, the computing construct might ask, “What is the Mean Time Between Failure (MTBF) of component X.” Proactively, the DTA might continually examine sensor readings and correlate those sensor readings with failures to enable prognostics.” - Grieves

- 1<sup>st</sup> degree DTA for DTIs with the same design
  - The set of stp\_product\_definition that share the same stp\_formation
- 2<sup>nd</sup> degree DTA for DTIs with the same purpose
  - The set of stp\_product\_definition that share the same stp\_product
- 3<sup>rd</sup> degree DTA for DTIs with common functionality
  - The set of stp\_product\_definition that share the same identified characteristic

# Digital Thread

“The sequence of digital twin prototypes used by a digital twin instance” - Hardwick

- If two DTIs have the same digital thread then they belong to the same 1<sup>st</sup> degree DTA
- If the thread of one DTI is a subset of the thread of another DTI then they belong to the same 2<sup>nd</sup> degree DTA
- If the threads of two DTIs have a DTP in common then they belong to the same 3<sup>rd</sup> degree DTA



# Digital Twin Certification

- The DTI met the characteristics identified by the DTP's of its Digital Thread.