BAMM Aspect Meta Model

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Digital Twins – digital representations of physical as well as abstract assets, e.g., a drilling machine or a production process – are the foundation of digitalization efforts in production and logistics as they aim to achieve consistent data homogeneity and interoperability. We conceive Digital Twins as a collection of Aspects, where the Digital Twin establishes identity by representing a specified asset and the Aspects provide a domain-specific view on this asset. Technically an Aspect is a software service that offers functionality and data related to the represented asset. Each Aspect references a concrete Aspect Model, which formally describes the data that is provided by the Aspect. An Aspect Model contains both information about the runtime data structure (e.g., that there is a property in the data called "temperature", and that it has a numeric value) and information that is not part of the runtime data (e.g., the physical unit and the value range). It does not, however, contain actual runtime data (e.g., a numeric value representing the current temperature), as this will be delivered by an Aspect conforming to this Aspect Model. The combination of raw runtime data and its corresponding Aspect Model yields information.

The Open Manufacturing Platform specifies the BAMM Aspect Meta Model (BAMM, [1]) and develops accompanying tooling to create, manage, and leverage such Aspect Models. This helps to support manufacturing organizations in setting up an environment to make data-driven decisions that can help manage risk, optimize production, and adopt and explore new revenue streams or business models.

Known standards such as IEC 61360 and international data dictionaries like ECLASS [2] and IEC CDD [3] do not solve the problem to determine information from data in a specific context. A meta model is required allowing to express both schema information to perform data validation and domain semantics to make implicit information explicit.

BAMM addresses both: Aspect Models express a schema with a defined RDF [4] vocabulary and are validated by a comprehensive set of rules in the Shapes Constraint Language (SHACL, [5]). Domain semantics are captured by a combination of structural elements, relations, namespaces and reified named concepts. RDF is ideally suited to express a graph-shaped model that is organized in multiple namespaces. In comparison to OWL [6], BAMM favors aggregation over inheritance in modeling, thus enabling domain experts without background in ontology engineering to create and maintain Aspect Models.

With the discussed challenges touching domains ranging from automotive [7] to environmental policy making [8] BAMM has a broad field to unfold its potential. We demonstrated this potential in internal applications, where over 15M product instances spanning over 0.5M product types are represented with Digital Twins, that each have about 5 to 10 Aspects. Large scale product lifecycle management solutions exploit the corresponding Aspect Models in processing and display of the data pertaining to these products.

The talk will discuss BAMM as a case study for applying semantic technology in the manufacturing domain and will focus on rationales for its design and draws lines to adjacent Semantic Technologies. The presentation will conclude with examples from and a discussion of the anticipated impact on manufacturing industry.

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