Use Cases of the Industrial Knowledge Graph at Siemens

Thomas Hubauer[1], Steffen Lamparter[1], Peter Haase[2], and Daniel Herzig[2]

[1] Siemens AG, Munich, Germany
thomas.hubauer,steffen.lamparter@siemens.com
[2] metaphacts GmbH, Walldorf, Germany
ph,dh@metaphacts.com

Abstract. The Industrial Knowledge Graph has become an integral elements in Siemens' digitalization strategy towards integlligent engineering and manufacturing. In the presentation, we will share details on how semantic technologies are used in Industrial Knowledge Graph use cases and generate business value in real-world applications.

Siemens is building an intelligent knowledge hub that can support knowledge-driven applications across the company, and serve as a smart knowledge factory generating new knowledge. Towards this end, we are creating an industrial knowledge graph as an intelligible domain model to support the easy integration of multiple data sources and to provide a formal semantic representation to enable inference and machine processing. The path towards this goal involves four major steps: First, we extend single data silos with domain-specific models - for many use cases, knowledge graphs can already generate value on this level, for instance by facilitating information access for domain users. Next, we connect the different islands by integrating their individual models, thereby enabling for information flow between silos. Our third step is the formation of an integrated Siemens Data Space from those linked islands. Here, our focus lies on a tighter and more consistent integration, together with a more sophisticated framework of higher-level models mediating between domains and use cases. This integrated data space then serves as the basis for our fourth stage, where the integration of graph-specific machine learning capabilities transforms the passive data space into an active knowledge factory building on the vast amount of knowledge available within Siemens.

Siemens' industrial knowledge graph applications are implemented on a general knowledge graph infrastructure developed by Siemens together with metaphacts including the metaphactory platform[3], graph databases such as Amazon Neptune[4], and others, with the following main components:

- a scalable graph database backend for query processing and analytics,
- a data integration layer for both phyiscal as well as virtualized integration and federation across heterogeneous and distributed data sources,

[3] http://www.metaphacts.com/product/
[4] https://de.slideshare.net/AmazonWebServices/new-launch-amazon-neptune-overview-and-customer-use-cases-dat319-reinvent-2017

- end-user oriented interaction components for semantic search, visualization, exploration of data,
- expert-user oriented components for knowledge graph management, including components for authoring and maintenance of knowledge assets such as ontologies, vocabularies, instance data, and queries,
- a knowlegde graph middleware comprising components and services for rapid application development for specific knowledge graph solutions as well as interfaces to third party applications.

In the presentation, we will showcase several of the industrial knolwedge graph use cases involving various user groups and application areas:

Building Digital Twin: The knowledge graph is used to integrate and represent knowledge about a building in order to create a full virtual copy (Digital Twin) of the real building. This virtual representation comprises a model of the building, which describes the whole structure and physical shape of the building, as well as dynamic sensor data about the current state of the building, such temperatures, humidity and other parameters. Based on this integrated information space run several applications for building management and services.

Risk Management: Industry projects need careful planning and constant monitoring of all potential risks. On the financial side, the relations between all stakeholders, investors and partners, as well as their investments and information about them, such as official legal location, currencies and similar parameters are integrated in one knowledge graph. The internal data is augmented with external data from third-parties to cover additional areas. This integrated knowledge graph allows to discover risks unable to be seen before, to assess potential conflicts of interest as well as to monitor portfolios and keep KPIs on track.

Process Monitoring: Production processes involve many steps, which are highly automated using Siemens' technology. Each valve and control unit produces data, which is integrated to the model describing each physical component and device in one knowledge graph allowing a comprehensive process supervision.

Machine Service Operations: Large industry machine, such as turbines, transformers or generators, are valuable assets and are kept in maintenance program. All events are documented in high detail. Having all maintenance events, model of the machines, information about location, usage and connected components in one knowledge graphs allows for better maintenance cycles in terms of prediction and error detection, which yields higher availability and lower costs.

Factory Monitoring: Having machines and processes modeled, the obvious next step is to have the entire factory integrated in a knowledge graph. Already in the planning phase of a production plant, but also during construction and operation, the knowledge graph is the basis for getting faster insights into dependencies and relations and allows comprehensive supervision and monitoring.

For each of the use cases, we will emphasize challenges, demonstrate how knowledge graph technology is used to address these challenges, provide technical solutions, and explain the generated business value. We will share our practical experiences and lessons learned on aspects of technology maturity, scalability and performance and end user experience. Further, we will discuss open research challenges and future work in the areas of data virtualization and federation, integration of knowledge graphs and machine learning techniques, as well as end-user oriented interfaces for knowledge modelling and data transformation.