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Information flow in LEVEL-UP project

The LEVEL-UP Project aims to offer a scalable platform covering the overall lifecycle, ranging from the digital twins setup, predictive maintenance, modernization actions to diagnose and predict the operation of physical assets, to the refurbishment and remanufacturing activities towards the end of life. One cornerstone of the LEVEL-UP scalable platform is the achievement of interoperability for sensors and legacy system related data, enabling the information to flow the field, to the cloud modules in charge of intelligent prognostic and diagnostic actions.

According to the LEVEL-UP Overall Architecture, three main clusters are involved in the management of the information flow: a) the edge services, b) the data-sharing infrastructure and c) the cloud services and enterprise resources (Figure 1). With the term “edge devices” we identify all the industrial assets such as sensorized machines, IIoT devices, industrial sensors, gateways etc. which operate equipped with a layer of sensorization and IoT interfaces, allowing field-to-cloud communication through the use of specific technologies and protocols, e.g. MQTT. These devices send information to the LEVEL-UP system, which manages the data flow leveraging its data-sharing infrastructure. The second cluster consists of many modules managing real-time data streaming with a custom use of Kafka technology, data persistency/retrieval with a Knowledge Based System (KBS) exposing REST interface and metadata/semantics with specific applications, i.e. Middleware Registry and Sematic Mediator. The so-called cloud services consist of the IT modules (such as DSS - Decision Support System, Fusion, Machine learning for predictive maintenance) aiming at performing data analysis, simulations etc. and generating feedback towards machines/users and prognostics actions.

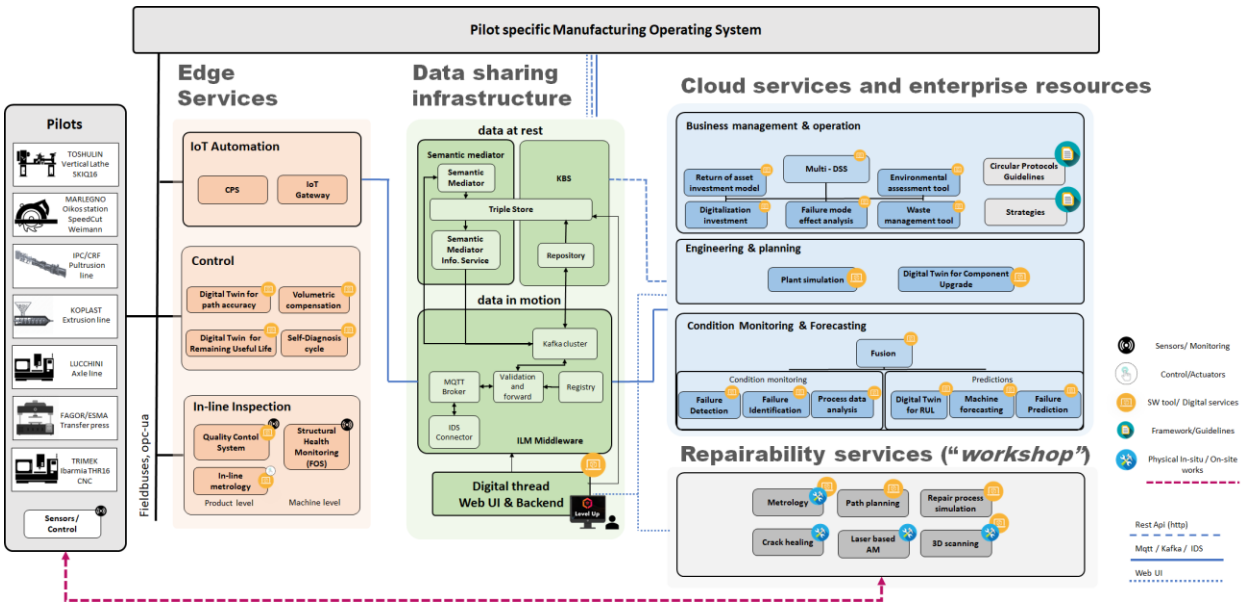

Figure 1: LEVEL-UP Overall Architecture

Taking into consideration the ESMA Pilot Line (Press for automotive parts, Automotive) - whose goal is to have analysis and monitoring of cracks, identifying their appearance and subsequent evolution in situ, and to monitor and control their operation through the strategies for optimizing their performance against their known conditions – the information flow is managed as follows. The I-Like Machines (ILM) Middleware manages several types of objects and enables data collection from connected devices. A device type is declared, mapping ESMA transfer presses, and instances of the type are created to collect data from different devices. Several data series are declared to manage the different type of data of the use case. Each data series can be configured with several options to handle correctly the large amounts of data, while the dependencies define the structure of the data exchange through a schema definition in other formats.

According to the object definition, data are processed by dedicated services. Data received from connected devices are validated and pushed to the streaming platform, so that they can be made available for further processing or recorded on long-term storage. The KBS exposes a layer of REST APIs and several endpoints are available for different types of queries: the avatar endpoint provides a quick representation of the last state of a device, while the history endpoint provides efficient access to large amount of data, processing and filtering them by specific data series or devices. The Semantic Mediator, responsible for a universal cross-pilot data transformation, transforms the json files into the LEVEL-UP json schema to achieve interoperability. The transformation results in similar json files independent from the data source format and provides the same data structure for data analytics. Condition monitoring and forecasting block for data analysis are used to address the elaborations made by the cloud services. A first tentative application of machine forecasting can take into account a period of one week. During this time, a die product change is demonstrated, showing the changes in acceleration data flow occurring after the die change. Considering anomaly detection

and prediction, the web interface contains a data consumer page to configure the communication with the ILM Middleware. In the fault detection tab, the detection techniques are configured as the fault prediction tasks in the time series prediction page. All required parametrizations can be provided in batches, deploying automatically all the needed tasks. Data analysis results and machine functionality can be monitored through integrated Grafana dashboards as well as the KPIs interface, so the user can focus on specific aspects, e.g. exploring the evolution of the measurements as the ESMA press is working.

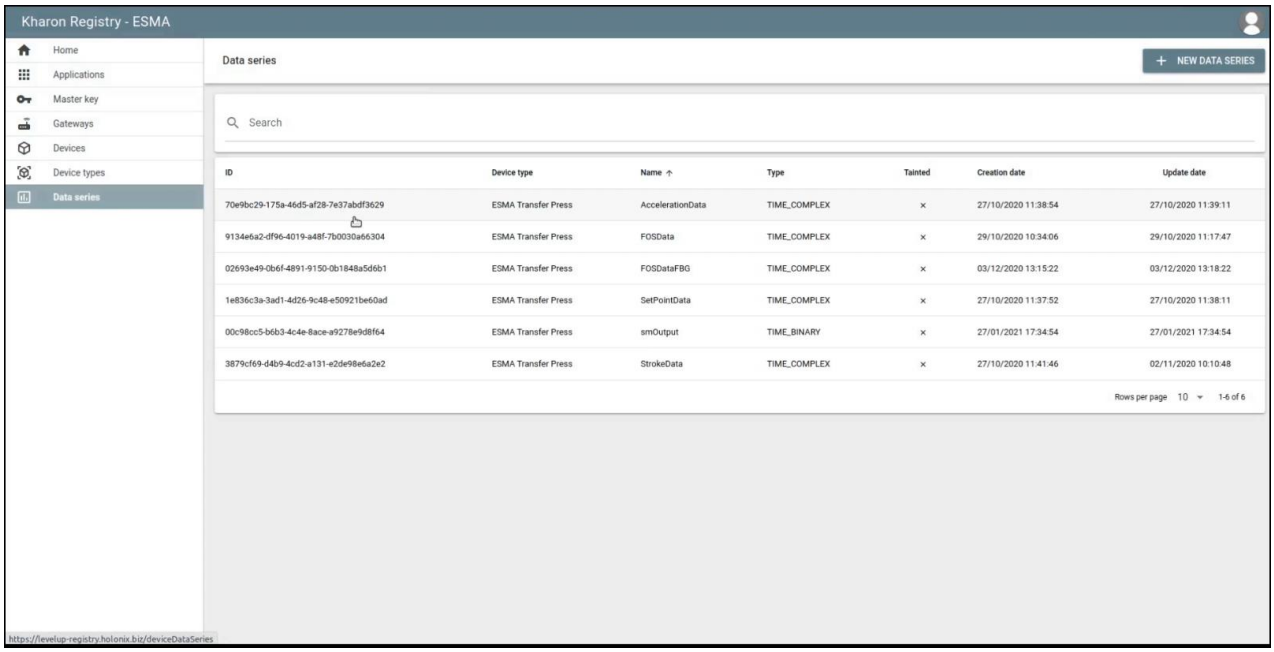

Figure 2: ILM Middleware Registry UI, form for data series declaration and setting

About the project

LEVEL-UP will offer a scalable platform covering the overall lifecycle, ranging from the digital twins' setup, modernisation actions to diagnose and predict the operation of physical assets, to the refurbishment and remanufacturing activities towards end of life. In-situ repair technologies and the redesign for new upgraded components will be facilitated through virtual simulations for increased performance and lifetime. LEVEL-UP will therefore comprise new hardware and software components interfaced with the current facilities through IoT and data-management platforms, while being orchestrated through eight (8) scalable strategies at component, workstation and shopfloor level. The actions for modernising, upgrading, refurbishing, remanufacturing, and recycling will be structured and formalised into ten (10) special Protocols, linked with an Industrial Digital Thread weaving a seamless digital integration with all actors in the value chain for improved future iterations. LEVEL-UP will be demonstrated in 7 demo sites from different sectors.

Details

Project title: Protocols and Strategies for extending the useful Life of major capital investments and Large Industrial Equipment

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Project Consortium:

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