Spotlight on the

Industrial IoT Analytics Framework

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INTRODUCTION

The Industrial Internet Consortium (IIC) recently published the Industrial IoT Analytics Framework (IIAF). The release of this IIC technical report marks a milestone in addressing the concerns surrounding industrial analytics and its importance in the Industrial Internet of Things (IIoT) applications and services. Industrial analytics is a key means of achieving the objectives of IIoT applications. Industrial analytics may be broadly defined as a discipline transforming data into information and the creation of business value and insights in the context of industrial operations. Without creating value or insights, there is little purpose in collecting data.

THE IMPORTANCE OF INDUSTRIAL ANALYTICS

Business leaders have increasingly recognized the importance of industrial analytics. A recent survey (see Figure 1) carried out by IoT Analytics GmbH[1] found that 69% of the surveyed business leaders or industry analysts consider industrial analytics crucial for their businesses within 5 years and want to apply analytics to strengthen their businesses. The same survey found that analytics on physical objects and machines rank high in importance. Predictive and prescriptive maintenance of machines (at 79% of surveyed considering it extreme or very important) ranks at the top, slightly surpassing consumer and market related analytics (at 77%).

Industrial analytics enables a better understanding of an industrial system's operational states, performance and environment. It identifies and analyzes emerging information patterns to enable industrial system assessments under varied conditions. There has been a great deal of development on analytics in other domains,

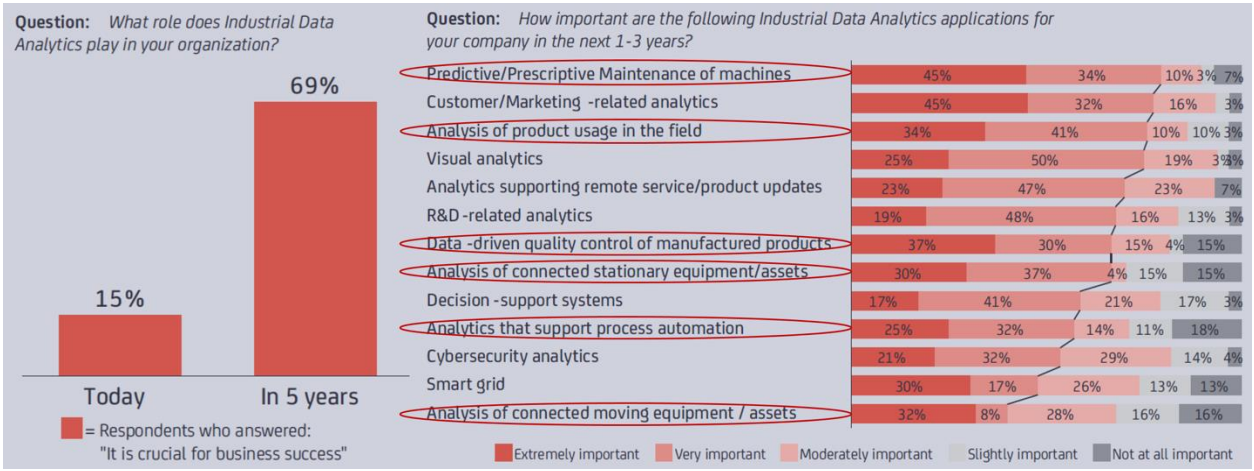

Figure 1: Importance of industrial analytics considered by business leaders and industry analysts

[1] Knud Lasse Lueth, Christina Patsioura, Zana Diaz Williams and Zahra Zahedi Kermani, "INDUSTRIAL ANALYTICS 2016/2017", IoT Analytics GmbH, December, 2016

media, finance and retail to name a few, but less has been done in determining the special requirements of the industrial domain. Historically, the majority of industrial applications have been narrowly defined around a singular purpose or piece of equipment with few keeping pace with the latest technology innovations.

PUBLICATION OF THE FRAMEWORK

The Industrial IoT Analytics Framework is the first document to survey the requirements for implementing IIoT applications enabled by industrial analytics, such as those with predictive and prescriptive capabilities that will have a major impact on the industries.

As a fledgling discipline combining advances in mathematics, computer science and engineering in the context of Information Technologies (IT) and Operational Technologies (OT) convergence, industrial analytics plays a crucial rule in the success of any IIoT system. Industrial analytics has unique requirements, characteristics and challenges compared to the traditional business analytics and so requires special considerations in its design and implementation. Since industrial analytics is in its early stage of development, much needs to be explored. The Industrial IoT Analytics Framework is intended to encourage discussions and research, and speed up the development and maturity of this indispensable technology.

Industrial analytics has unique challenges because the results can alter the operation and introduce vulnerability to things in the physical world. These effects may be undesirable or harmful, inadvertently affecting the safety of people or damaging property and the environment. Moreover, because industrial analytics often interpret data from different sensors and machines that may conflict with one another, we need to understand and synthesize the diverse information streams to reach a correct conclusion. Table 1 identifies the requirements to consider when planning for industrial analytics.

Topic	Description
Correctness	Industrial analytics must satisfy a higher level of accuracy in its analytic results. Any system that interprets and acts on the results must have safeguards against undesirable and unintended physical consequence.
Timing	Industrial analytics must satisfy certain hard deadline and synchronization requirements. Near instantaneous analytic results delivered within a deterministic time window are required for reliable and high quality actions in industrial operations.
Safety	When applying industrial analytics, and interpreting and acting on the result, strong safety requirements must be in place safeguarding the wellbeing of the workers, users and the environment.
Contextualized	The analysis of data within an industrial system is never done without the context in which the activity and observations occur. One cannot construct meaning unless a full understanding of the process that is being executed and the states of all the equipment and its peripherals are considered to derive the true meaning of the data and create actionable information.
Causal-oriented	Industrial operations deal with the physical world and industrial analytics needs to be validated with domain-specific subject matter expertise to model the complex and causal relationships in the data. The combination of first principles, e.g. physical modeling, along with other data science statistical and machine learning capabilities, is required in many industrial use cases in order to provide accurate analytics results.
Distributed	Many complex industrial systems have hierarchical tiers distributed across geographic areas. Each of these subsystems may have unique analytic requirements to support their operations. Therefore, industrial analytics must be tailored to meet the local requirements of the subsystems it supports. The requirements on timing (avoiding long latency) and resilience (avoiding widespread outage of service because of faults in the network or in a centralized system) require a distributed pattern of industrial analytics in that the analytic will be implemented close to the source of data it analyzes and to the target where its analytic outcome is needed.
Streaming	Industrial analytics can be continuous or batch processes. Because of continuous execution in industrial systems, a large proportion of industrial analytics will be streaming in nature, performing analysis of live data and providing continuous flow of analytics results in support of the operations. Traditional batch-oriented analytics will still be performed either for building or improving analytic models, or for human decision-making.
Automatic	For the industrial analytics to support continuous operations, the analysis of streaming data and the application of analytic outcomes must be automatic, dynamic and continuous. As the technologies in industrial analytics advance, improvements in analytic modeling e.g. through learning may also be automatic.
Semantics	Analytical systems require data that has meaning and context. Unstructured data, when reported without attribution to the source and the component or system it represents, makes deriving value complex since it requires the analytics to guess or infer the meaning. Inference unnecessary adds significant uncertainty into the system. Most data can be properly attributed at the source, and if this information is communicated, it can significantly increase the success and accuracy of the analytical systems.

Table 1: Industrial Analytics Requirements

Industrial analytics functionality is deployable throughout the IIoT architecture that is covered in the Industrial Internet Reference Architecture (IIRA). The IIRA addresses the need for a common architecture framework to develop interoperable IIoT systems for diverse applications across a broad spectrum of industrial verticals. The capabilities needed for successful industrial analytics solutions

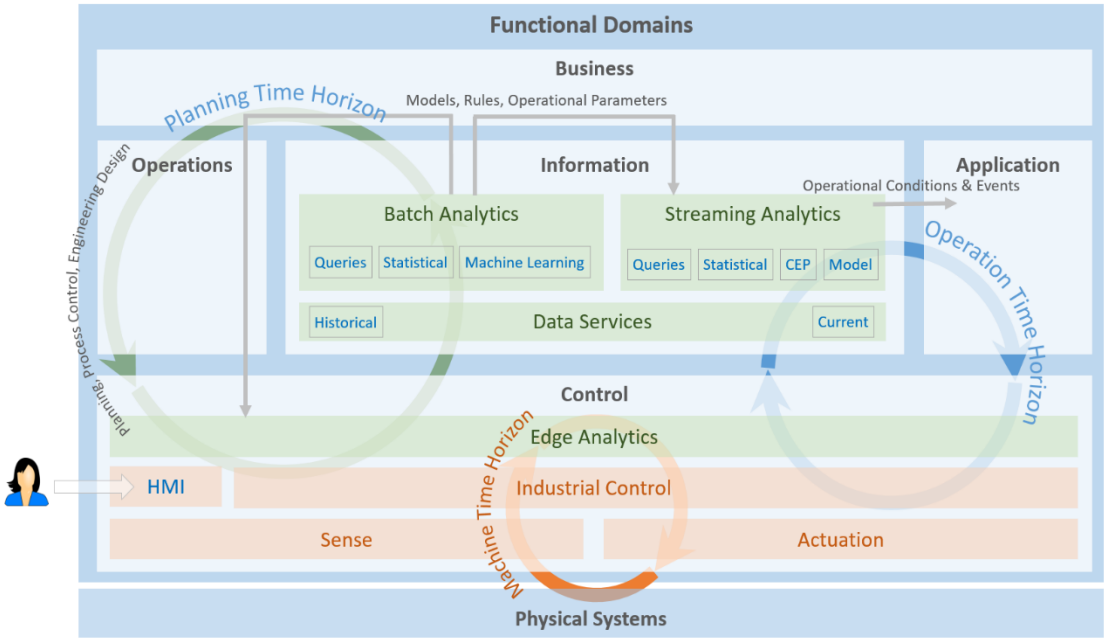

Figure 2. Analytics Mapping to the Industrial Internet Reference Architecture

are shown in Figure 2 with respect to the other concerns in the IIRA. Each capability is realized by a set of functions defined by use cases that meet the stakeholders' expectations, especially with regard to non-functional requirements.

The fundamental prerequisite for industrial analytics is availability and access to data from the industrial process and related assets. Data is collected close to the process through connections and stored, at least temporarily, where the readings can be scanned and evaluated depending on the type of analytics. The stored values may be discarded or archived for further calculations. Data scientists can explore the archived data using statistics to compute correlations, and apply algorithms to classify and cluster the evidence over time. Industry subject matter experts have a good understanding of the context and condition of the process and assets, and can interpret and validate the readings and recommend cleansing filters. It is this combination of data science and subject matter expertise that produces the best result

In Conclusion

This release of the Industrial IoT Analytics Framework is only the beginning of a journey to create a comprehensive study of all aspects of how analytics can be used in the Industrial Internet; there is still a lot of work

to be done. The IIC is committed to furthering the knowledge sharing and state-of-the-art in the industrial internet and promulgating this knowledge to increase the rate at which new applications and advances in the industrial sector can be achieved. The Industrial IoT Analytics Framework is publicly available and the IIC welcomes anyone who finds it valuable to contribute to the further development of the Industrial IoT Analytics Framework.

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