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Next generation energy data management platforms: the MORE project

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Abstract

Electricity production from renewable energy sources (RES) is characterized by its distributed nature, massiveness, and vast divergence of the production facilities. Such facilities require close monitoring for fault management, yield tuning, maintenance scheduling and production reporting. Renewable energy data management platforms have evolved, from simple data repositories, into complex, IoT-based, asset management and online analytics platforms. This evolution continues, as new assets -such as distributed storage- are integrated in the grid, and is accompanied by an explosion in the data size and sampling rate of the data recorded in the field.

In this paper, we present INACCESS's state-of-art UNITY RES asset management and performance assessment platform and we discuss next generation platform evolutions, as proposed by the MORE H2020 research project. We focus on the challenges presented by the need for massive ingestion of data, from thousands of dispersed production facilities, encompassing hundreds of thousands of assets, generating tens of millions of data points per second! We propose data compression at the edge as a potential solution for the efficient data transmission and ingestion of RES data in the cloud.

Keywords: renewable energy sources analytics; MORE project; data analytics; pattern extraction; data compression; RES platforms

1. Technology Background

Established in 2000, with a focus on digital infrastructure management, Inaccess specializes in monitoring and control solutions.

The company is well established worldwide and constantly develops and delivers state-of-the-art products and solutions for the centralized management, control, and optimization of geographically distributed, large-scale critical assets (Solar, Wind, Batteries, Microgrids, and Telecoms). Unity, Inaccess' indigenous platform solution, provides its users with invaluable access to data and information, enabling them to maximize the viability and effectiveness of their investments, by offering real-time secure collection and recording of statistical data as well as smart controls and smooth grid integration, customization of SCADA systems, remote plant supervision, control room services, system migration, and retrofits.

Today, Inaccess systems manage more than 32 GW of renewable generation across more than 2,500 assets in 60 countries worldwide. With headquarters in UK, R&D center in Greece and regional offices in the US, Europe, Middle East & Oceania, is one of the leading vendors of converged infrastructure monitoring platforms worldwide.

1.1. Unity Platform

Unity is a state-of-the-art Hybrid SCADA and real-time big data platform for RES power plants, integrating modern technologies and concepts to maximize capacity and speed, minimize latency and optimize the operation of all controllable assets. The platform provides monitoring, control, grid, and market integration for solar, wind, battery, microgrid, and hybrid assets, allowing capabilities and services that unlock new revenue streams and value.

Deployed locally and centrally, Unity offers unparalleled flexibility and a uniform approach for the operation of RES power plants. The local suite includes the field and plant SCADA, the Power Plant Controller (PPC), and the Grid Integration RTU, effectively implementing extensive controls for seamless grid integration and efficient market participation, and offering all the necessary tools for the asset's operation, performance evaluation and optimization. Centralized in the cloud or on-premise, Unity offers remote access to multiple asset classes, integrating events, alarms, and operations control center HMIs into a single platform for ease of operations and real-time responsiveness.

Currently, the total production dataset of Inaccess sums up to 60 TB. Of course, this figure is continuously increasing by around 12 TB per year, as more sites are added and new data points continue to be added for all sites (>2 billion data points are added on a daily basis).

Nomenclature

BESS	Battery Energy Storage System
HMI	Human-Machine Interface
KPI	Key Performance Indicator
ML	Machine Learning
PPC	Power plant Controller
RES	Renewable Energy Sources
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition

1.2. Challenges to the current architecture

New applications for hybrid plats, which incorporate RES and battery energy storage systems (BESS), are continuously emerging in a constantly changing energy market landscape. New data driven services, such as synchronous inertia response and power oscillation damping, are being added to the existing large service portfolio, creating the need for real time coordination. This poses a major technical challenge for the energy management system of the plant that is expected to handle extremely big volumes of data while enabling real-time monitoring and regulation with no latency and maximum reliability.

Currently, the existing systems cannot satisfy the requirement for extremely high sampling rates making the real time trend analysis impossible. In fact, UNITY provides a wealth of analytics and real time reports resulting in more than 100K queries on a daily basis, of which more than 2000 are unscheduled real time reports, applied to a sub-set of total production dataset.

Table 1. Current state and emerging challenges

Current State	Emerging requirements
Locally managed servers	Distributed servers and edge computing nodes
Batch analytics on a few billion tuples	Streaming analytics on thousands of billions of tuples
Aggregated values for 5-, 10- or 15-minutes intervals	Values for at least every 100 msec will be required for analytics
Calculation of simple analytics	Real-time patterns extraction algorithms will be applied to sub-second samples for thousands of streams

2. The MORE Platform

In the context of the MORE H2020 research project [1], INACCESS participates with partners (ATHENA RC; Aalborg Univerity; IBM; Perception Dynamics; ENGIE Laborelec; ModelarData) for the definition, development, and evaluation of next generation massive RES data platforms. Such platforms are expected to ingest and process massive real time data, providing for the possibility of streaming analytics on thousands of billions of tuples, using many distributed servers and edge computing nodes.

2.1. Edge node and Ingestion engine

Focusing on the challenges presented by the need for massive ingestion of data, a new scalable and efficient model-based edge data ingestion component is currently being developed within MORE, for converting streaming data points into optimized models, within an error bound, that are inserted in the central data store. The model will enable data compression at the edge for the efficient data transmission and ingestion of RES data in the cloud.

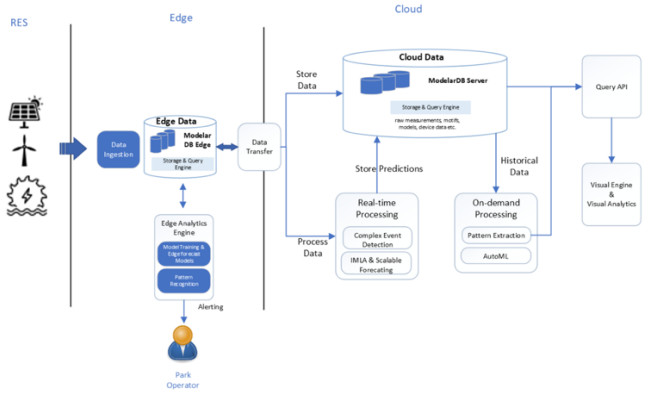

Fig. 1. The architecture of the MORE platform

The data ingestion component will be fast enough to keep up with enormous amounts of data, i.e., billions of values per day. Ingestion of data happens first on the edge nodes and later the models are transferred to (and ingested into) the data center nodes. While the ingestion is done, the data can still be queried.

When the data is migrated to the center nodes, further compression and optimization occur as models from several edge nodes are combined into the same model (coefficients) if possible, within the error bound, e.g., when wind speed from nearby turbines are very similar [2, 3]

Given that cloud hosting costs correspond to a significant portion of operational expenses and increase rapidly, the impact of MORE could be very significant. Further, the prospect of reducing system response time, through optimised data queries, is essential for the overall user experience.

In this direction, the MORE data compression and re-construction possibilities, are anticipated to reduce the long-term data retention costs and improve significantly the overall performance and functionality of the system.

2.2. Real-time ML analytics engine

The new platform enables the possibility for sophisticated analytics by incorporating Pattern Recognition and Machine Learning model both on the edge and at the cloud [4, 5, 6].

Models on the edge are trained utilizing only a subset of the most important features, while the central models can explore a broader feature set. The communication between the edge node and the central server is only performed for exchanging the model parameters during the training phase.

The MORE platform provides beyond the state-of-art performance and accuracy, allowing the application of ML inference models on incoming streams, real-time pattern extraction and complex event detection. As a result, Inaccess will be able to offer sophisticated real-time alarms, complex KPIs and analytics that require cross corelation of data and consequently the possibility of detecting in real-time any potential power degradation than could be attributed to specific causes.

3. Conclusion

Inaccess is at the forefront of RES data market challenges, continuously working towards implementing novel services while fostering the data re-use and the IT resource optimization. Against this background, the MORE platform is anticipated to provide a compelling solution for scalability and advanced processing framework.

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