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Leveraging High-Speed Data, Analytics and AI at Plant Scale to Deliver Business Value in Steel Production

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ABSTRACT

This paper presents ways to leverage various data types acquired during steel manufacturing to enable fully data-driven decisions on the production floor. By combining a robust data acquisition system (iba) with an automated AI system (Falkonry), manufacturers can instantly gain operational visibility and insights without any data science/data engineering/IT/MLOPS resources, that enable proactive decisions. This enables operational users to proactively diagnose the root causes of operational issues and take timely corrective actions. Both secure and scalable, this integrated approach can expand to cover the entire plant. We showcase the benefits achieved by leading steel manufacturers in improving productivity and quality.

Keywords: IIoT, Industry 4.0, OT (Operational Technology), Digitalization, Process Data Acquisition, Time Series AI, AI Cloud, Data connectivity, Cold Mill Productivity

INTRODUCTION

A significant hurdle in the adoption of smart manufacturing in steel plants arises from the complex IT groundwork required to establish seamless data connectivity between physical systems and analytics and AI solutions. The data itself may be abundant, reflecting the exponential growth of time series data, now among the fastest-growing data types globally. Yet, leveraging this data for performing tasks such as high-speed trace analysis depends heavily on its availability and accessibility. To harness valuable insights from the time series data, data integration is crucial for establishing seamless northbound connectivity. Effectively managing and reliably establishing connectivity for the data at scale, without extensive IT efforts, emerges as a pivotal factor in predicting the success of AI deployments. This crucial step of easy data integration paves the way for accelerated AI activation in various steel manufacturing processes. It is a key enabler in harnessing valuable insights, streamlining processes, and enhancing decision-making through AI.

To do more with the available data, iba and Falkonry have combined their robust data management and advanced analytics capabilities, allowing steel manufacturers to seamlessly implement AI within their existing infrastructure without requiring additional data science/data engineering/AI/algorithm/MLOPS resources. The iba system is an autonomous, modular, and scalable data acquisition system for machines, production lines, and plants. It can acquire, record, and make the operational data from PLCs readily available to cloud-based AI applications. The modular design and simple configuration make the iba system easy to deploy and use in the steel manufacturing setup. The Falkonry's Time Series AI Cloud compatibility with the iba system ensures smooth and trouble-free integration, eliminating tedious efforts from the IT and OT teams. In this discussion, we focus on the need for a high-speed data platform and a self-serving automated AI that enables steel manufacturers to do more with data without changing the existing infrastructure.

CHARACTERISTICS OF DATA

Data is the lifeblood of businesses and modern organizations. Akin to the significance of blood in sustaining the functions of the human body, data serves as the lifeblood necessary for survival, growth, and competitiveness amidst the dynamic and fast-paced landscape. Much like blood's multifaceted functions within the body, data serves a multitude of purposes in businesses, including facilitating decision-making, fostering innovation, enhancing processes, and problem-solving [1].

In the context of manufacturing and other business processes, understanding the unique characteristics of data is paramount for stakeholders. Four essential data characteristics are highlighted: type, source, velocity, and volume:

- Type: Data generated, processed, and utilized within a facility or business encompasses various types, including operating data, material data, process data, machine data, energy data, vibration data, and video data (Figure 1).
- Source: In a manufacturing facility, each type of data originates from diverse sources, such as Programmable Logic Controllers (PLCs), sensors, fieldbuses, analog/digital terminals, cameras, and databases. These sources may differ in manufacturers, protocols, and methods used in acquiring data.
- Velocity: The rate at which data is generated and processed varies significantly depending on its type and source. Data velocity spans a wide range, from microseconds to days or even longer durations, reflecting the diverse operational contexts and requirements.
- Volume: Data volume, like velocity, exhibits considerable variability influenced by data type, source characteristics, and operational needs. Factors such as storage costs and infrastructure further impact data volume considerations, prompting businesses to assess storage capabilities and associated expenses.

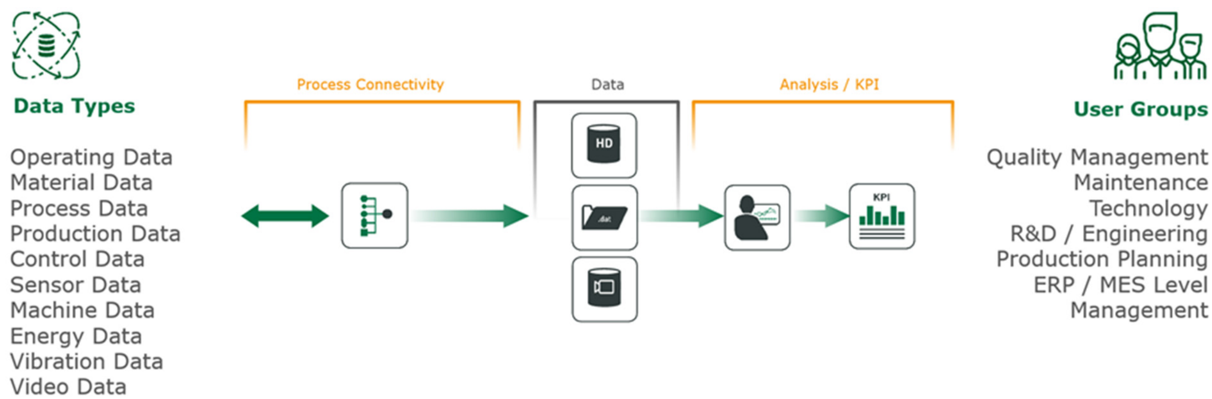

Figure 1: Holistic Data Flow in Modern Steel Manufacturing

CENTRALIZATION OF DATA

Understanding and effectively managing these unique data characteristics are crucial for diverse user groups and stakeholders within organizations, including Maintenance, Quality, R&D, Production Planning ERP, MES, and Expert Systems, among others. These stakeholders aim to get the most out of their data assets to drive operational excellence and strategic decision-making. Centralizing data onto a single platform (Figure 2) is also crucial for organizations aiming to maximize the potential of their data assets and enhance operational efficiency. By consolidating data onto a unified platform, businesses can unlock significant benefits, including:

- Reduction/Elimination of Data Silos: Data silos hinder comprehensive insights by fragmenting data across different systems or departments. For instance, in steel production, disparate data sets pose challenges for data teams in the finishing areas as they need to extract and consolidate data from other upstream processes to get a holistic picture of the final product.
- Reduction of Duplication: Dispersed data across multiple platforms often leads to inaccurate or duplicated data, complicating the identification of inefficiencies, defects, and waste in processes. Centralization minimizes duplication and ensures data accuracy, facilitating more accurate analysis and insights.
- Improved Data Governance: Managing and protecting data scattered across various locations and platforms poses challenges to overall data governance. Centralization enables organizations to enhance data governance capabilities by establishing standardized processes, security measures, and compliance protocols.
- Increased Transparency and Stakeholder Awareness: Establishing a single source of truth accessible to all stakeholders enhances transparency and eliminates surprises. With centralized data, stakeholders can access reliable information in real-time, enabling proactive decision-making and adjustments.

- Decreased Maintenance: Managing data spread across multiple platforms diverts resources from extracting value from data to reconciling disparate data sets and managing the various platforms. Centralization streamlines data management processes, reducing maintenance efforts and allowing teams to focus on value-added activities such as improving data pipelines and fine-tuning analytics software.
- Improved Data Accessibility: A single platform for data storage and sharing facilitates seamless data exchange within the organization and with external partners. Eliminating separate systems reduces the complexity of data access and sharing, enhancing efficiency and collaboration.

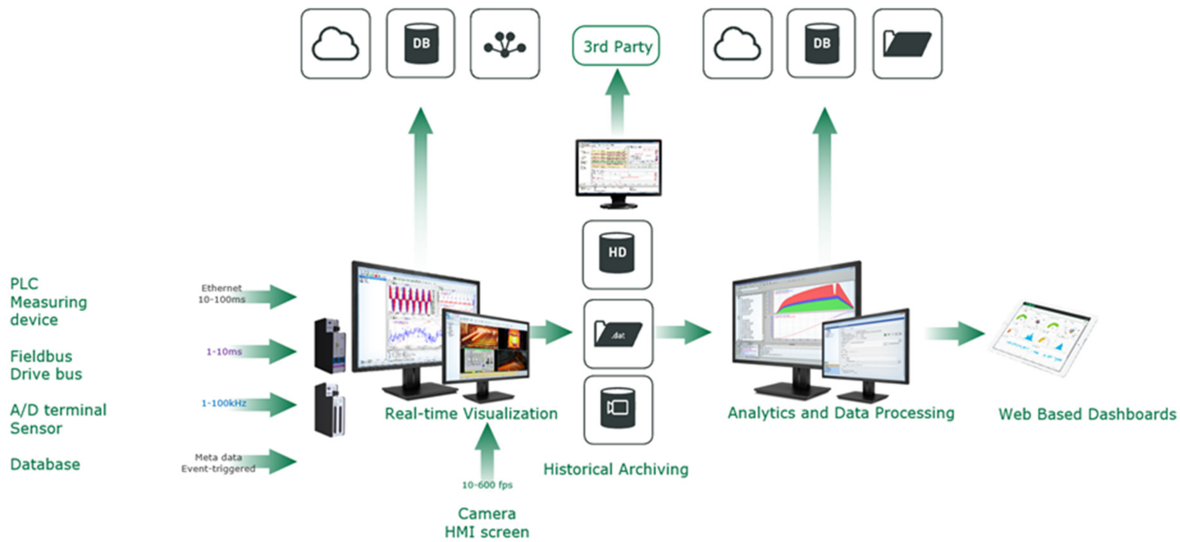

Figure 2: Example of Accessible Centralized Data Platform

ACCESSIBILITY OF DATA

Data accessibility is a critical aspect of utilizing a centralized data platform effectively. Without ease of access to high-quality data, the potential benefits of centralization will not be fully realized. Just like the famous line, 'water, water everywhere and not a drop to drink', in Samuel Taylor Coleridge's poem, 'The Rime of the Ancient Mariner', having a rich concentration of data does little good if you cannot access it. Here are some aspects of data accessibility that should be addressed:

- Flexible Data Handling: The centralized data platform should be capable of handling diverse data formats and sources seamlessly. This includes accommodating raw high-speed time series data from the southbound operational technology systems (OT) and facilitating its transfer to the northbound information technology (IT) systems. Flexibility in data handling ensures that data can be efficiently processed and analyzed regardless of its origin or format.
- Robust Data Management: Robust data management capabilities are essential for ensuring data accessibility. This involves implementing efficient data storage, retrieval, and processing mechanisms to support rapid access to data by stakeholders and external partners. Moreover, robust data management encompasses functionality such as data indexing and search capabilities, enhancing the accessibility and usability of data. Additionally, implementing backup and recovery solutions is vital to prevent data loss and maintain data integrity.
- Data Pre-processing and Cleaning: Pre-processing and cleaning of raw data are often necessary steps before data can be analyzed or used for decision-making. The centralized data platform should provide tools and capabilities for pre-processing and cleaning raw data to ensure its quality and usability. This may include data normalization, outlier detection, and data transformation techniques to prepare data for further analysis.
- User-Friendly Interfaces: User-friendly interfaces are pivotal for enhancing data accessibility without the need for specialized software development expertise. Intuitive dashboards, visualization tools, and query interfaces simplify the process of accessing and interfacing with data. This accessibility enables users to derive insights and make well-informed decisions effectively, without relying on technical assistance.
- Security and Governance: While ensuring accessibility, it's also important to maintain robust security and governance measures to protect sensitive data and ensure compliance with regulatory requirements. Access controls, encryption, and auditing mechanisms help safeguard data integrity and confidentiality while enabling authorized access to data for relevant stakeholders.

One such centralized platform that distinguishes itself by offering several facets of data accessibility is the iba system. Specifically designed for process data acquisition and analysis, the iba system utilizes hardware and software components capable of seamlessly acquiring, recording, analyzing, visualizing, and processing measurement data. With its modular design and straightforward configuration, the iba system can be tailored to various tasks and scaled up as needed, ensuring adaptability and flexibility.

Key Components of the iba System:

- ibaPDA: As the central core of the iba system, ibaPDA has proven itself as one of the most versatile data acquisition systems for maintenance and production for many years. Among the many powerful features of ibaPDA are asset-agnostic acquisition, high-speed synchronous archiving, and real-time streaming analytics.
- ibaCapture: In conjunction with ibaPDA, records video and HMI images synchronously with measurement data. Recording can be done continuously or triggered by events. Important events can be automatically stored as still images. For historical analytics, ibaAnalyzer can be used to automatically retrieve, align, and display recorded video and HMI images with archived measurement data.
- ibaHD-Server: Empowers users with the ability to perform long-term analytics while rapidly visualizing trends and events from months to milliseconds. Easily archive large time-synchronized data sets, even from multiple ibaPDA systems. Querying events provides immediate access to failure-mode and root-cause discovery.
- ibaAnalyzer: Is characterized by its broad capability for analyzing and evaluating data. The application is intuitive and offers an advanced set of functions. The license for analyzing measurement files, which have been generated with the iba system, is free of charge.
- ibaDatCoordinator: Is a powerful tool for processing and managing measurement data automatically. Typical fields of application are automatic data management, creating reports or the extraction of product-related characteristic values in databases or other systems. In synergy with ibaAnalyzer, various tasks can be done automatically, and routine procedures can be simplified.

LEVERAGING OF DATA

By prioritizing these aspects of data accessibility, organizations can effectively leverage their centralized data platform to help drive operational excellence, foster innovation, and maintain a competitive advantage in today's data-driven environments. Here are some strategies that businesses can employ to leverage their data [2]:

- Automation: Implementing automated processes powered by data insights can streamline operations, reduce manual effort, and enhance efficiency across various functions.
- Ad hoc Monitoring: Real-time monitoring of data allows organizations to promptly identify and address emerging issues, enabling proactive decision-making, and ensuring continuous improvement.
- Forensic Analysis and Process Optimization: Analyzing historical data can uncover insights into past performance and process inefficiencies, guiding optimization efforts to enhance productivity and resource utilization.
- Artificial Intelligence/Machine Learning (AI/ML): Deploying AI and ML algorithms on data sets can unlock predictive analytics capabilities, enabling organizations to anticipate future trends, mitigate risks, and capitalize on opportunities more effectively.

AI/ML EXAMPLE WITH IBA SYSTEM AND FALKONRY AI CLOUD

Now, our focus shifts to the synergistic combination of a robust centralized data platform (iba) with a purpose-built Falkonry Time Series AI Cloud to accelerate AI implementation across diverse steel manufacturing processes. This integration swiftly furnishes users with crucial insights, streamlining operations and augmenting decision-making capabilities through AI.

ARCHITECTURE

For this example, the following components (Figure 3) were utilized:

- ibaPDA: Serves as the central acquisition system to connect and gather high-speed data (in milliseconds) from numerous assets within the facilities. This data is compressed and stored in iba's .dat file format. The system is configured to store files continuously at user-defined intervals (e.g., every 10 minutes, 30 minutes, 1 hour, etc....). While real-time visualization and streaming of the data to databases, cloud stores, and other third-party systems are available options, they are not utilized in this example.
- ibaAnalyzer: Functions as a comprehensive and central component for analysis within the iba ecosystem. It offers capabilities for interactive analysis, advanced calculations, reporting, data conversion, extraction, and long-term trending. For this example, data conversion was used to convert iba's .dat files to Apache Parquet file format in preparation for data ingestion by the AI Cloud.

- ibaDatCoordinator: In conjunction with ibaAnalyzer, ibaDatCoordinator provides a powerful tool for automatic processing and managing iba data. It can simultaneously monitor multiple data sources (iba's .dat directories and ibaHD stores) and execute various tasks based on triggers. These tasks range from basic operations like copying or moving data to more complex tasks such as transforming and uploading, as well as generating reports and triggering alarms. In this example, ibaDatCoordinator was used to automate the conversion of iba .dat files into Apache Parquet files and subsequently upload them to the AI Cloud.
- Falkonry Time Series AI Cloud: By ingesting, storing, and organizing the time series data from iba system and other OT data sources, Falkonry's Time Series AI Cloud discovers hidden insights and delivers timely, actionable intelligence. It enables the engineers on the plant floor to be more effective in making informed decisions and improving operational performance across a broad swath of use cases such as maintenance, reliability, emissions, quality, and many more. The detailed description of each component of the AI Cloud is explained in the upcoming sections of this paper.

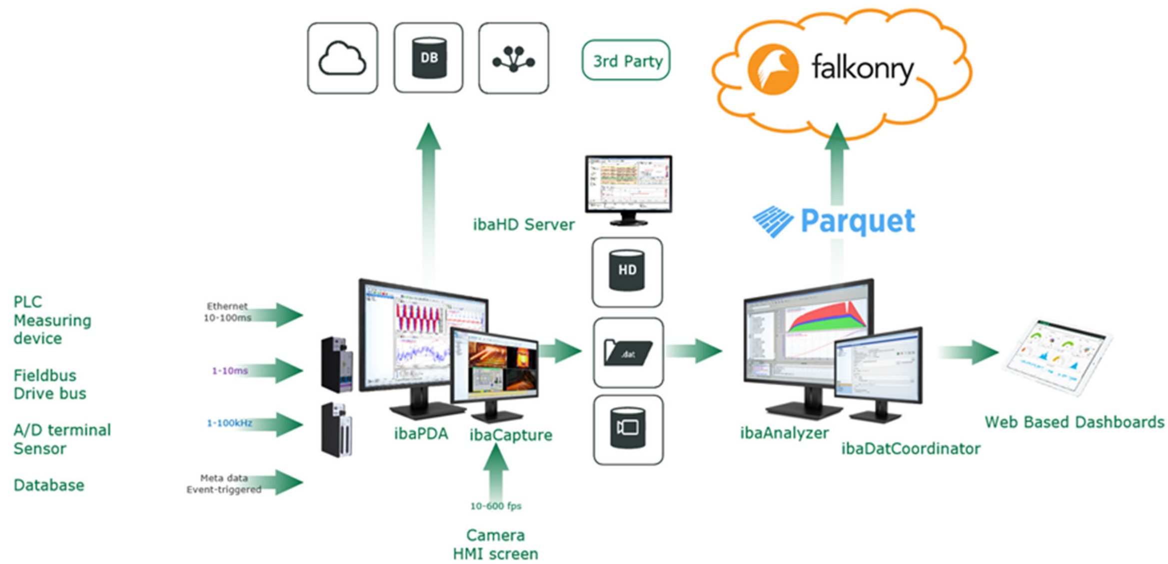

Figure 3: Sample Architecture

DATA INGESTION TO AI CLOUD

Parquet is an open-source, column-oriented data file format for efficient data storage and retrieval. It provides efficient data compression and encoding schemes with enhanced performance to handle complex data in bulk [3]

time	signal1	signal2	…	signalN
1700001001000	1.2	Yes		1
1700001001010	1.0	None		*NULL*
1700001001020	NaN	Yes		*NULL*
1700001001030	123	No		34.2
…	…	…	…	…
1700331681080	12.3	Yes		28.2

Table A: Illustration of a column-oriented Parquet data file

Table A above illustrates how the data is organized and read from a Parquet file. Using Parquet files users can pack 1000s of columns, which represent signals, and millions of rows of data. Falkonry can read and process an entire column of data at once and repeat the process for each column in the file. This provides for higher performance, storage efficiency, and scalability to transfer and process several GB of data with ease. Therefore, Parquet formatted files are most preferred in the industry for transferring operational data to a cloud infrastructure for further processing. When processing the data file. Falkonry automatically identifies any errors in data and removes them from the processing. For example, the **signal1** illustrated in Table A is automatically recognized as a numeric signal and any data values that are not numeric (e.g. NaN) will be dropped during processing.

Without the iba system, it is common for manufacturers to utilize row-oriented CSV files. CSV files are widely known for storing structured data in columns using a comma as a column separator. CSV files apply zero compression and therefore tend to be bulky and require greater network bandwidth and time to be uploaded to the cloud store. Table B below shows how the data is organized and read from a CSV file one row at a time.

From our experience, we have found that processing CSV files to be inefficient and slow, mainly because each row of data needs to be read individually and numeric data is converted to character strings instead of their compressed numeric data types (e.g., INT, DINT, REAL, etc.). These inefficiencies are amplified with large files containing thousands of signals. Therefore, CSV files are not suitable for high-volume real-time data analytics.

time	**signal1**	**signal2**	**…**	**signalN**
1700001001000	1.2	Yes		1
1700001001010	1.0	None		*NULL*
1700001001020	NaN	Yes		*NULL*
1700001001030	123	No		34.2
…	…	…	…	…
1700331681080	12.3	Yes		28.2

Table B: Illustration of a row-oriented CSV data file

For generating timely alerts on anomalies and failures, it is important to minimize the latency during data extraction and packing as well as ingestion, analysis, and alert. The connectivity recipe between the iba system and Falkonry AI Cloud involves a simple one-click configuration step that enables the ibaDatCoordinator to send the data to Falkonry.

ibaDatCoordinator establishes a secure data pipeline to the AI Cloud for immediate processing of the Parquet files in order of their arrival. ibaDatCoordinator is configured to convert ibaPDA file recordings into the Parquet file format and transfer these Parquet formatted files to the Falkonry-hosted or customer-hosted cloud storage as illustrated in Figure 4.

Subsequently, the iba system connection in the AI Cloud automatically discovers and processes the Parquet files as they arrive in the configured cloud storage. The iba system connection keeps track of all the files in the order of their arrival with relevant stats and processing status. Any delays in the data transfer, connectivity issues, or data processing discrepancies can also be audited via Falkonry connection UI. Such a file-based data transfer offers the following advantages:

- It is not required for the iba system to be always connected for continuous data streaming. Instead, the file collection and ingestion can be performed periodically depending on the nature of the continuous process operations being monitored.
- It is not required for the steel plant to have a high-bandwidth network connection.
- It is simple to configure, meter, and use, enabling the reliability and maintenance teams to continue to focus on AI insights for process optimization without worrying about the data infrastructure.

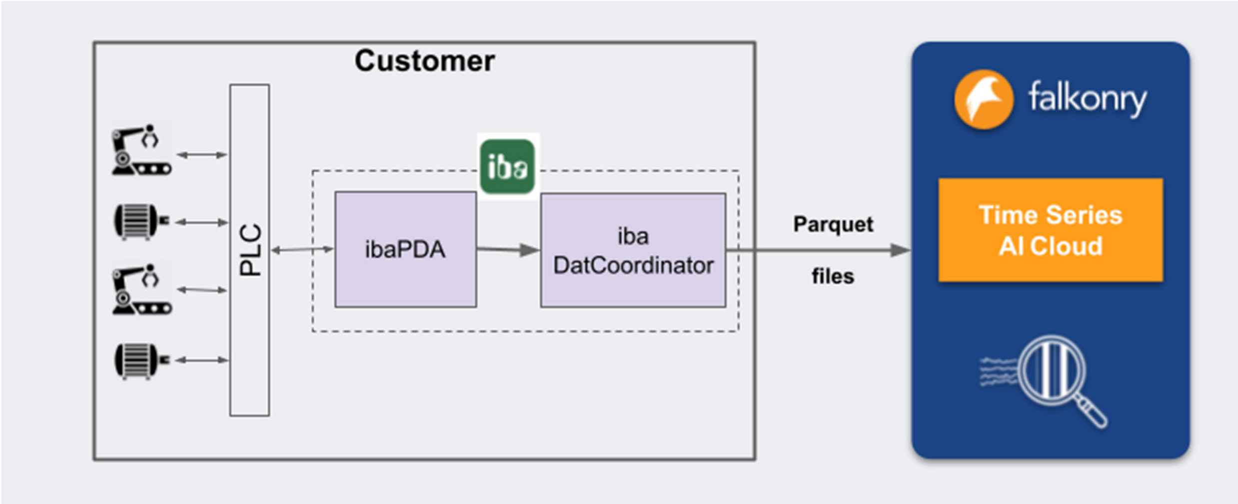

Figure 4. Architecture for data collection and analysis with AI Cloud

We now present the efficacy of the parquet ingestion in terms of speed, scale, and reliability of the connectivity and ingestion to the AI Cloud.

Speed of data processing:
Once the AI Cloud receives the data file, the processing of large Parquet files with 180,000 rows of data for ~200 signals takes place instantly and is completed in about 2 minutes. The timestamps of received times and processed times are displayed in Figure 5. The speed of file processing is mainly attributed to the file format - column-oriented Parquet files that are efficient for the AI Cloud to process compared to row-based CSV format. For reference, a smaller CSV data file with just 15 signals and over a million rows of data took an hour to process (Figure 6).

Received Time ↓	Processed Time	File Path	Status	Total Rows	Total Bad Points	Actions
2024-02-06 08:46:49	2024-02-06 08:48:28	/falkonry-customer-uploads/[redacted]/Time_pda_2024-02-06_08.16.04.parquet view less	PROCESSED	180,000	0	⋮
2024-02-06 08:16:43	2024-02-06 08:18:03	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 07:46:42	2024-02-06 07:49:10	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 07:16:41	2024-02-06 07:18:12	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 06:46:41	2024-02-06 06:48:20	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 06:16:33	2024-02-06 06:18:01	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 05:46:33	2024-02-06 05:48:50	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
2024-02-06 05:16:33	2024-02-06 05:18:50	/falkonry-customer-uploads/[redacted]/Time_p... view more	PROCESSED	180,000	0	⋮
[illegible]	[illegible]	/falkonry-customer- [illegible]	[illegible]	[illegible]	[illegible]	

Total Items: 7771

Figure 5: Data transferred to Falkonry in Parquet files from ibaDatCoordinator

Received Time ↓	Processed Time	File Path	Status	Total Rows	Total Bad Points	Actions
2023-12-20 12:49:46	2023-12-20 13:49:15	/falkonry-customer-uploads[redacted]iuploads/1187134602696978432-CompressorMonitoring-Wide.csv view less	UNAVAILABLE	1,052,519	0	⋮

Figure 6: Data transferred to Falkonry in CSV files

Scalability:
To scale the AI applications to an entire line or site across multiple use cases, the data system and AI Cloud need to handle large volumes of data without any data loss and delays. For continuous live monitoring of a typical steel mill, over 40,000 signals at an average sampling rate of 1 Hz need to be ingested and analyzed. The volume of potential data points in this case is simply beyond human scale. At the same time, any computing system capable of handling such a large scale should be cost-effective when used for limited data and use cases. The AI Cloud offers flexibility to scale the data ingestion and compute as required. Table C below shows an example of data scale for different user groups. The iba system and Falkonry AI Cloud can handle both small and large-scale data for real-time analysis.

Customer	Frequency Bins	Signals	Live Data (Million-Measurements/Month)	Historical Data (Million-Measurements/Month)
Customer A	10 Hz	16	12.41	0.00
Customer A	100 Hz	145	38,924.34	0.00
Customer A	1 kHz	16	4,368.89	0.00
Customer B	100 Hz	40,391	10,911,295.91	251,097.05

Table C: Amount of high-speed data transferred in a month to Falkonry via ibaDatCoordinator

Reliability
As seen in Figure 4 above, the AI Cloud received about 8,000 Parquet files and all of them were processed successfully without any failures. This high reliability is available irrespective of the file format used for transferring data from iba server to the AI Cloud.

As new systems are added to the line or when an existing line is upgraded with more components, it is observed that signal names and tags change, making the signal mapping between different data systems a challenge. iba system eliminates the challenge as the signal names are constructs that do not change for life and these are encoded into:

- Module - are either physical components or software modules for data acquisition, and
- Channel - is a slot dedicated to the sensor.

Every signal is assigned a notation [MM:NN] or [MM.NN], where MM = module number, NN= Channel number, ":" = analog signals, and "." = digital signals. The Parquet file from iba contains the module and channel number, allowing the AI Cloud system to leverage this information to keep the signal identification intact. However, This doesn't prevent the user from reassigning the channel to some other data stream. For example, if [0:1] was Mill Speed and is reassigned to send Rolling Load, all the calculations and reports will reflect the newly assigned signal 'Rolling Load'. Mapping new signal names is quick without requiring coordination across multiple teams.

HIGH-SPEED AI ANALYSIS
With seamless connectivity to various operational data types from the iba system, the Time Series AI Cloud performs automated analysis of the data and provides a real-time view of the operating conditions in the plant. By directly interacting with the AI dashboard, maintenance and reliability engineers can quickly diagnose, prioritize, and resolve critical issues in the plant. The key components of the AI Cloud are illustrated in Figure 7 -

- Insights, a self-supervised AI application, automatically discovers anomalies in individual signals and groups of signals by systematically identifying deviations from normal operating behavior without requiring any setup or supervision. It allows users to explore and understand prioritized anomalies while it continuously updates its understanding of normal signal behavior. Insights is well suited for the discovery of known and unknown issues and enables rapid diagnosis through explanations and comparative analysis.
- Patterns, an unsupervised and semi-supervised AI application, discovers meaningful patterns such as early warning or stages of deterioration in complex assets using multivariate data streams. This is a no-code application that does not require an understanding of machine learning algorithms or software code. Aimed at process engineers and data analysts, Patterns allows the studying of and continuous monitoring for specific events and known conditions, or for performing root cause analysis toward finding permanent fixes.
- Rules, a post-AI filtering application, enables operational users to establish custom rules on time series data or AI outputs to trigger actions and workstreams. Rules can be created on one or more signals and works with both numerical

and categorical data. Rules also allow users to adjust the alert sensitivity and frequency based on the criticality and the nature of downstream actions.

We have presented the detailed workings and practical application of these Time Series AI components (Figure 7) in our previous papers [4,5,7]. It is worth mentioning that the AI Cloud can seamlessly ingest data not only from the iba system but also from other plant automation systems such as PLC, SCADA, IIoT sensors, and various other systems as mentioned in Figure 7. The no-code AI analysis on a variety of OT data enables manufacturers to become data-driven in a wide range of use cases such as condition-based maintenance (CBM), monitoring quality and emissions, reliability-centered maintenance, and many more. The accessibility of different data sources and computational resources in the cloud enables various aspects of data analysis, interpretation, and decision-making across numerous use cases listed above.

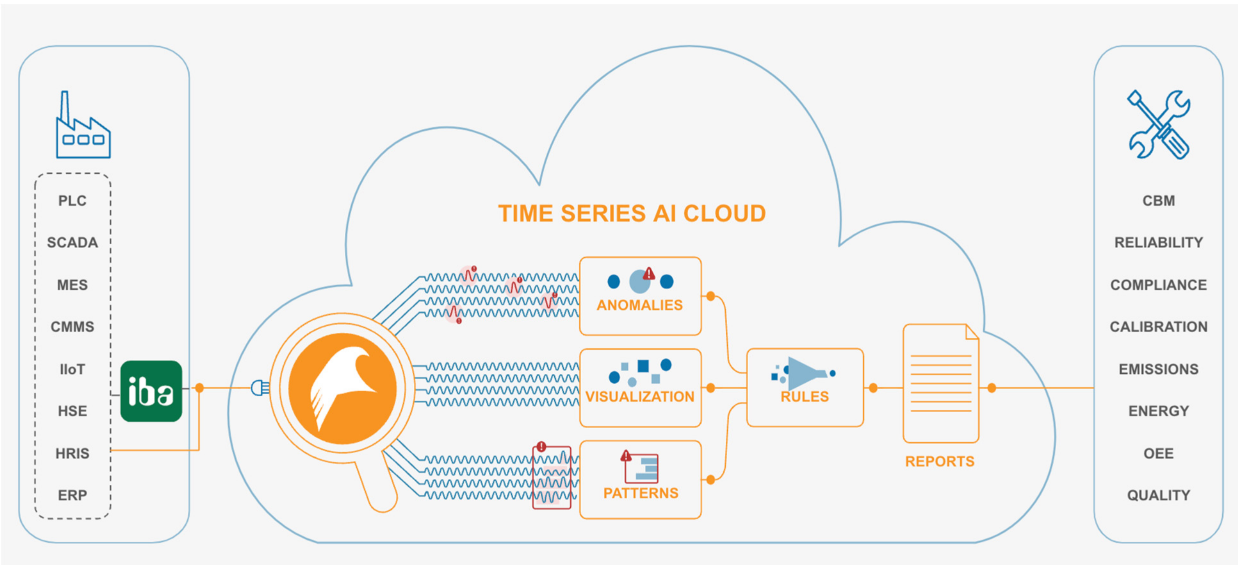

Figure 7: Time Series AI Cloud Components and Applications

The Time Series AI Cloud is built to scale [4] and is capable of handling 100,000s of signals and monitoring them. Falkonry simultaneously evaluates the incoming data on all of these signals and surfaces relevant excursions and faults for human review and action [6].

APPLICATION CASE AND RESULTS

Automated strip-break classification in tandem cold-rolling mills [7]

A global steel manufacturer witnessed dozens of strip breaks every month in the cold rolling process of a North American plant. The challenge here is that when a strip break occurs, it is immensely difficult to diagnose the root cause and address it on time. Root cause analysis and classification require manually extracting collected mill data on tension, current, torque, and other parameters leading up to the break, and then applying human interpretation to these signal traces from multiple systems. The steel manufacturer aimed to improve the productivity of the cold mill by automating the strip break diagnosis using AI analysis of the time series data. The automated analysis of various breaks provided instant insights to the plant team to adjust the mill parameters or perform preventive maintenance to improve the mill uptime. Figure 8 below illustrates the workflow for the high-speed automated data analysis using iba and AI Cloud.

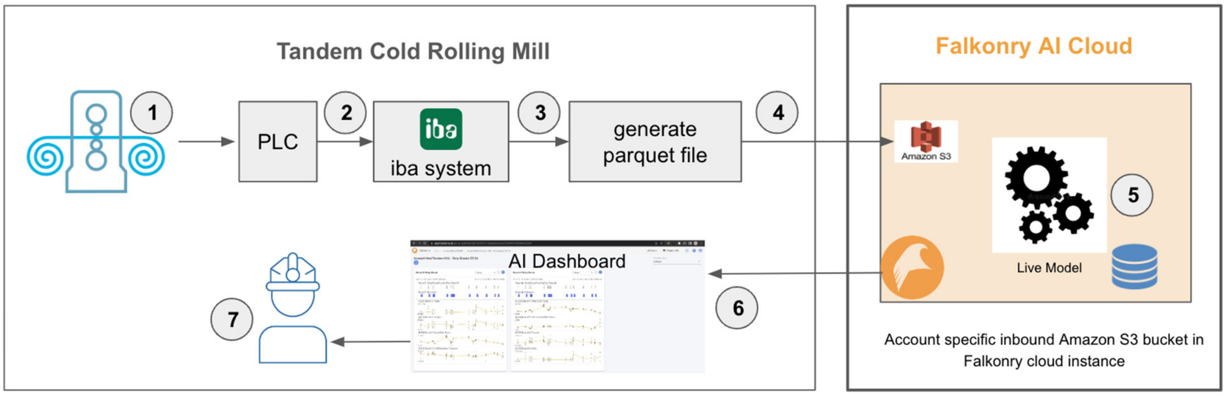

Fig 8. Automated strip break classification workflow using Time Series AI

1. Mill Stand data is collected by PLC at the sampling rate of 1 Hz. Typical signals include current, rolling speed, differential rolling force, torque, tension feedback, and so on.
2. The data is collected by iba data server
3. When a strip break occurs, sensor data 10 seconds before the break and 5 seconds after the break are packaged and exported as a Parquet file automatically
4. The Parquet file is copied to Falkonry Cloud instance
5. Falkonry Patterns receives, processes the data, and produces break classification.
6. The classification is rendered in the Falkonry Dashboard, along with insights on signals that caused the break (Figure 9).
7. The Production Engineer validates the root cause analysis and plans action to avoid the recurrence of the break.

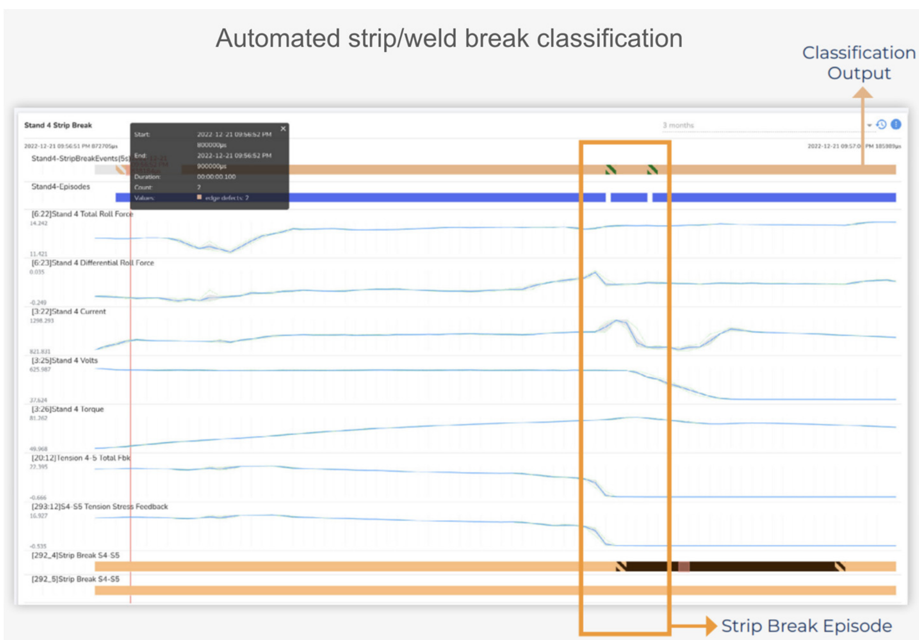

Figure 9. Automated strip-break classification with contributing signals

RESULTS MATRIX		
KPI Type	Original Target	Actual Value
Use case Coverage	50%	78%
Classification Accuracy	80%	85.6%
Routine weekly process engineering effort	4 hours	< 30 minutes

Table D. Aggregated results for the strip break classification

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This automated workflow allows low-latency classification of strip breaks for use by operations teams to understand underlying causal factors and implement corrective actions. By drastically reducing the delay between the occurrence of a strip break and its classification (Table D), the subject matter experts were instantly able to mitigate upstream causes. For example, if it was consistently noticed that surface defects were responsible for most of the strip breaks, an input parameter in say an upstream pickling process can be changed, or greater quality control can be implemented upstream to reduce further occurrence. This drastically reduces downtime and results in indirect energy savings as the amount of scrap produced during strip breaks also gets reduced. The automated classification also improved the accuracy of classification results, leading to higher confidence in expanding the coverage of this workflow to 78% of the use cases in the cold mill. This application led to significant productivity improvement for the steel manufacturer - 1% production improvement and 20% human productivity improvement (of the full-time subject matter expert).

CONCLUSION

The integration of a robust centralized data platform like the iba system with the Falkonry Time Series AI Cloud accelerates AI implementation in steel manufacturing. This synergy offers swift insights, streamlines operations, and enhances decision-making capabilities through AI. The centralization of data onto a single platform and understanding data characteristics, while prioritizing accessibility, are crucial for driving operational excellence in a business or organization. The practical application of this integration, as seen in the automated strip-break classification case study, demonstrates how seamless connectivity between the iba system and Falkonry AI Cloud can lead to tangible improvements in real-time analysis and rapid decision-making. Overall, by harnessing the power of data and AI, steel manufacturers can unlock new opportunities for optimization, innovation, and sustainable growth.

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