WHITE PAPER

BUILDING NEXT-GENERATION DATA FOUNDATION AND FRAMEWORK FOR MINING INDUSTRY

Abstract

With the emergence of data democratization and value chain integrations, organizations are making data-driven insights available to their key users. However, many are facing hurdles with managing their vast amounts of data to extract planned outcomes. According to industry trends[1], data management is one of the three key issues that affect manufacturers of all sizes and types. The key to success is to have a strong data management and governance framework. The objective of this whitepaper is to layout a foundation for managing data and a framework to achieve operational insights for augmented productivity.

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Managing data is complex and critical for the mining industry

The mining industry is sitting atop vast data, collected from various business functions. This data such as geological, geo-chem, geophysical, drill log, ore grade, imagery, structural, time series, machine sensor and operational is diverse, complex, and voluminous. It needs to be structured and processed to be insightful.

Exploration & development	Mine Operations	Mineral Processing	Outbound Logistics	Health, Safety and Environment
Survey and Drilling; Planning Development & Infrastructure	Mine planning; Drilling and Blasting and Hauling	Plant Processing; Stockyard/Tailing Management	Railroad Transportation; Port Operations	Asset Safety; Process and People Safety
• Use of emerging and digital technology to explore new resource • Real time drill information and visualization • Leveraging algorithms and artificial intelligence to process data from sources within and beyond the traditional explorations and methods	• Optimized Ore management and better demand/supply forecasting • Develop new ways of process optimization with improved properties to meet customer demand • Effective fleet management for timely production & order with GIS/GPS/GNSS systems	• Ensure high yield and productivity of crusher, screener and smelters • Energy monitoring systems • Prediction of energy consumption based on production schedules • Seamless integration with mine functions and minimal intervention for complex decisions	• Efficient asset and capacity management, improved efficiency to increase operating margins. • Improved asset utilization and equipment lifespan by improving • Increase conditioned based maintenance life by use of advance analytics	• Decrease human exposure to health and safety hazards by improving plant automation and process control • Using connected mobility, virtual and augmented reality to empower field, remote and centralized workers in real time

Emerging Trends illustrated with Mining Value Chain

Challenges in Data management

Data management is an ongoing challenge for mining companies due to various factors:

- **Variety of sources** – Mining companies like others, have many different systems for various business functions. This data needs to be integrated into a structured, standardized format.
- **Data Quality** – Duplicate data records take up storage space and bogs down computational capabilities. This may also produce incorrect insights when not identified and corrected.
- **Multiple database formats** – With different systems having different databases, data has to be first converted, cleanse and sorted out for integration with other systems. Data conversion should ensure that the data is transferred correctly. For example, data migration for drill and blast hole is required to go through advance analysis from historical values.
- **Merging of data among business systems** – Be it consolidating the ERP within the company or streamlining data center operations, an important requirement is to merge data among business systems. One of the challenges is to ensure the integrity of business processes before and after the merger. Restructuring of data and business processes has to be sequential - with business rules and logic.
- **Privacy** – With the amount of data in the systems, companies risk data breach because of weak security practices. The large volume of data should ensure the implementation of a robust governance framework.

Best practice for data structuring

Structured data is generally stored in tables like a relational database. It can be either machine generated or manually entered. This data can be rationalized, searched, and analyzed for actionable insights. Unstructured data, on the other hand, cannot be readily searched or analyzed. It is not structured in a predefined data model where it can be related to other data. Some examples of unstructured data are word files, spreadsheets, image files, videos, etc.

The first step in processing unstructured data is to eliminate noisy data. This reduces storage space. The data then needs to be reviewed for processing - whether any tags can be associated with the inputs received. For images and videos, software can be adopted to extract data. For example, the output from the dump yard camera can give the time at which a certain dump truck has dumped ore. The identification number of the truck processed from the image can be stored in a structured format.

The company can increase its collection of structured data by using IoT devices. Instead of manual entries at data collection points for assets, workforce, etc. Next, a data setup can be created to link, process, analyze, rationalize and derive patterns derived.

How to progress towards a 'One Sourced Data' framework

When different departments in a mining company use different data for their day-to-day work, integration becomes difficult. One of the major issues with having multiple sources of data is that when sourced data is fed into business systems from different entry points it moves between systems and exits through other systems, in the end, there is plenty of different information floating around in silos with the same base data that was fed.

Even little pieces of data such as a supplier's details when used and updated in different siloed systems end up becoming unreliable. Sometimes data takes time to synchronize within the system and users may be unaware that they are accessing outdated information. Thus, some of this data needs to be maintained and managed in a central repository - One Sourced Data. This concept indicates that certain data in the company has just one source from where all users access it. Having a single source where the data is available for analysis helps the company get the right insights.

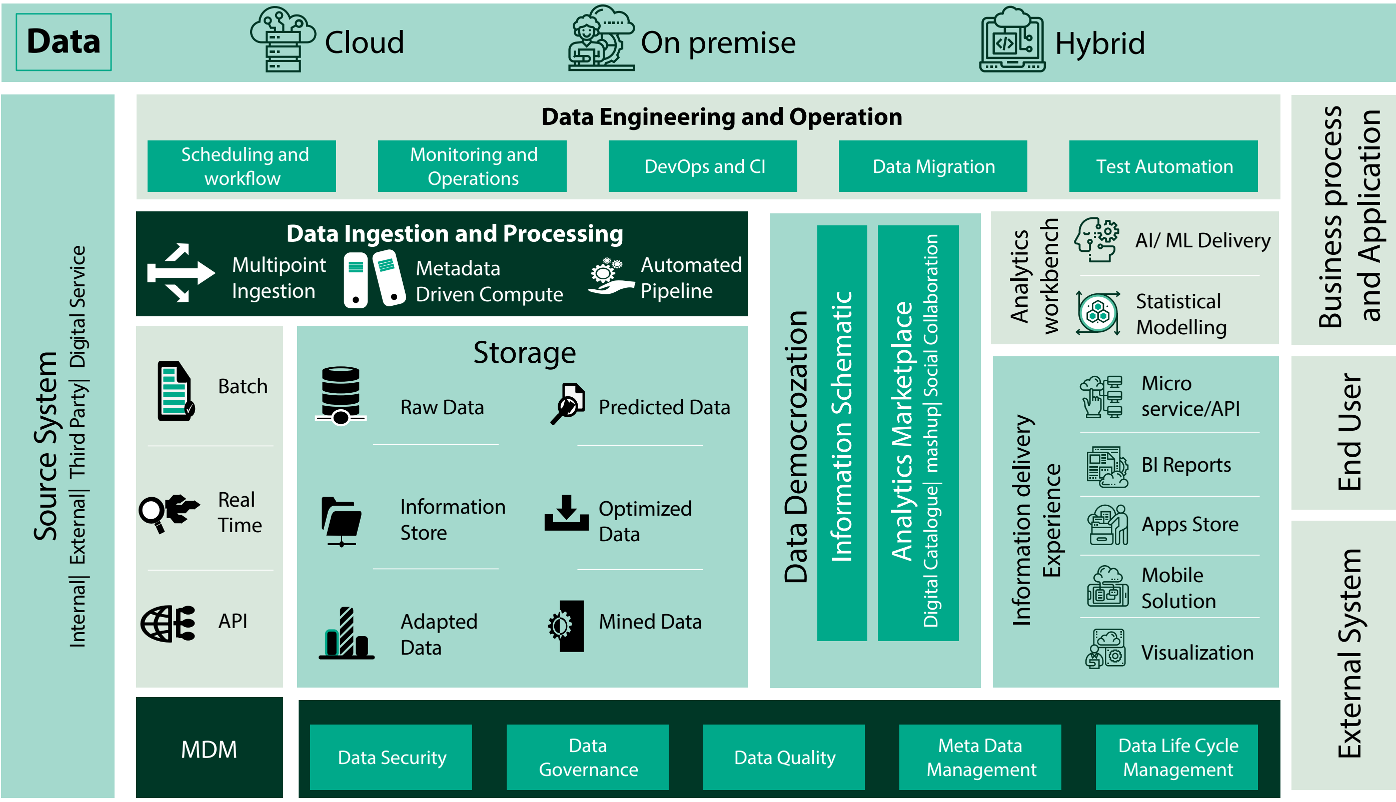
Big Data Management (BDM)[2] can help access one sourced data. When a user enters data into the BDM platform it is not on their system. This increases confidence among users that the data is the latest.

Once data integrity is addressed, mining companies need to adopt the right method of analysis. If business users can slice the data and get insights without the help of programmers they can do more with data. To benefit from structured data, companies will have to adopt technologies that can analyze the raw data and convert them into actionable insights[3].

The building blocks of a Big Data Management solution include:

- **Data Lake:** Stores archived and active systems of data
- **Data Grid:** Removes boundaries between various source systems and provides seamless metadata-driven integration
- **Data Governance:** Provides quality, curated and secure data for analytics
- **Data Consumption:** Self-service tools to aid reporting across archived and active systems
- **Data Science:** Advanced analytical insights to predict and prevent risks and further business growth

A sample solution framework is as

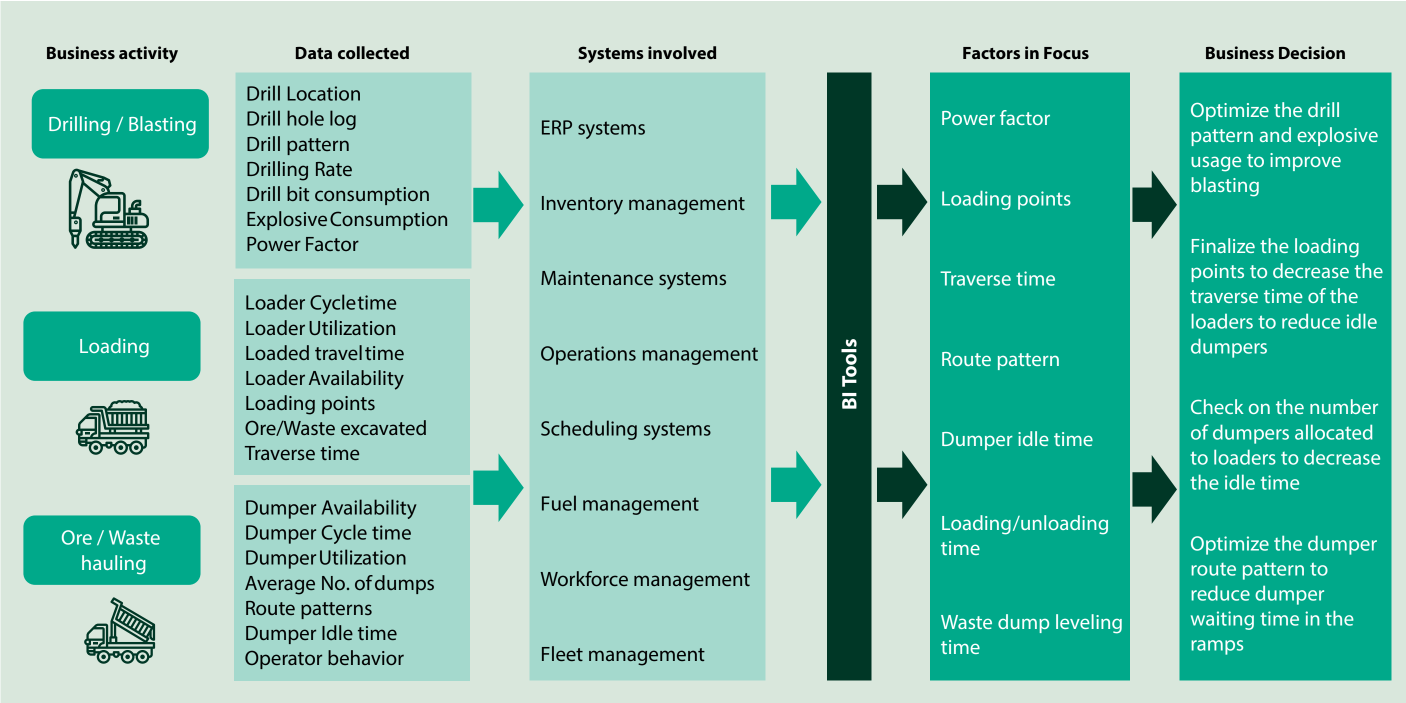


Business Intelligence and Data Analytics

How does Business Intelligence enable quicker decisions?

Business intelligence and analytics tools are commonly used across industries including mining. The BI tool should have access to well-structured one sourced data to derive the right predictions.

With data being generated in petabytes, it is not easy for users to derive insights from the data. An example of how business decisions are made based on data in drilling and hauling operations is below.



BI is key to identifying factors causing problems in operations. For instance, we have set up a system for one of the leading diversified mining company to optimize the performance of semi-autogenous grinding (SAG) of a plant. The system analyzes real-time data captured at the crusher, which communicates with conveyors and lets them know when material is required. The system regulates TPH through the SAG feeder belt speed, rpm, and water addition.

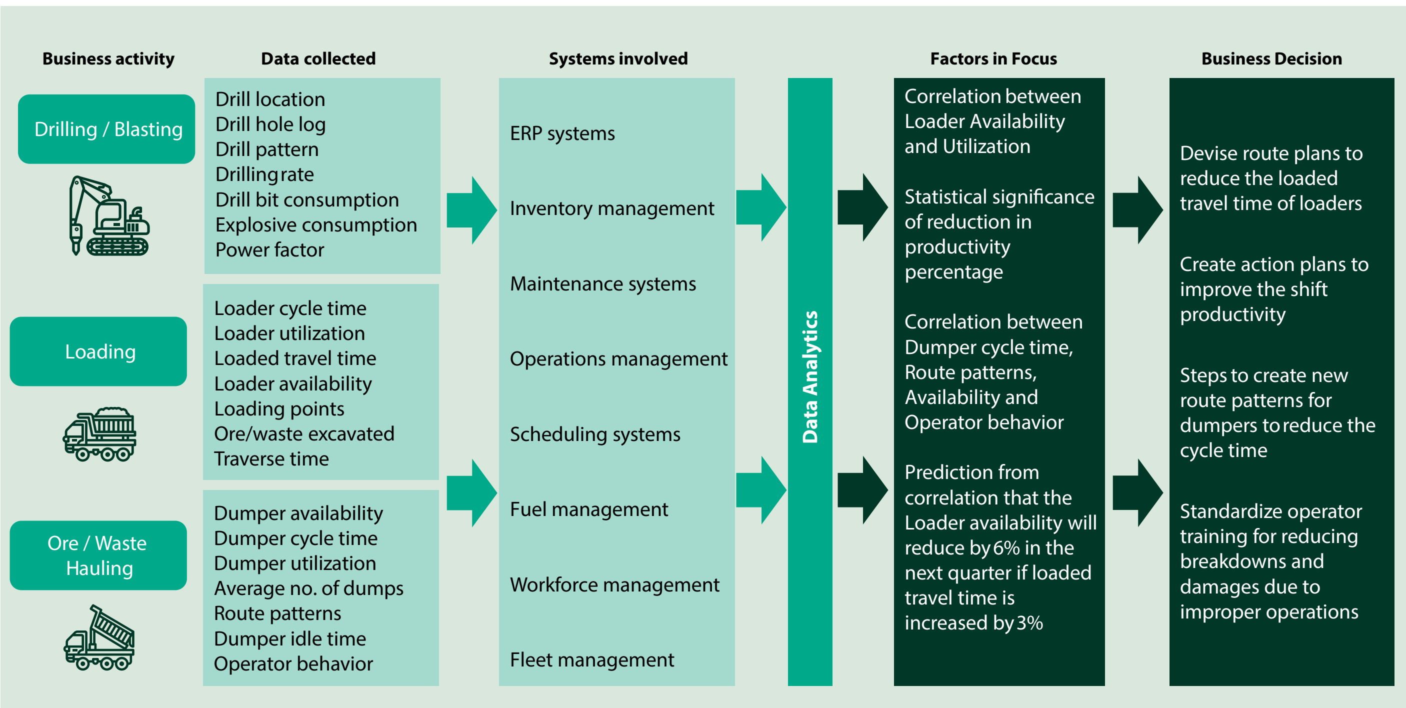
How does Data Analytics foster informed decisions?

BI is all about reporting, arranging data and deriving insights from it. This helps the business in understanding where they are by deploying historical data. Data analytics is a wider concept where we analyze data to understand why something happened and predict what will happen in the future. With an integrated data culture fostered within the company, the output from an analytics model can be meaningful.

With different types of analytics[4], mining companies can choose how to assess their position and predict outcomes. With descriptive analytics, companies can peg their current position. With diagnostic analytics, the company can identify the root cause of the current issues and derive different action plans. With prescriptive analytics, companies can analyze different options and finalize the action plan which will help in achieving optimized output for the given options and variables. Predictive analytics help companies to foresee outcome of the operations if they continue in the current pattern.

There are various types of predictive analytics. For instance, with historical data, a company can build new data models and with the aid of intelligence and analytics new drilling targets can be predicted and defined. For operations and maintenance, a company can analyze data to predict unplanned breakdowns and ensure higher availability of equipment.

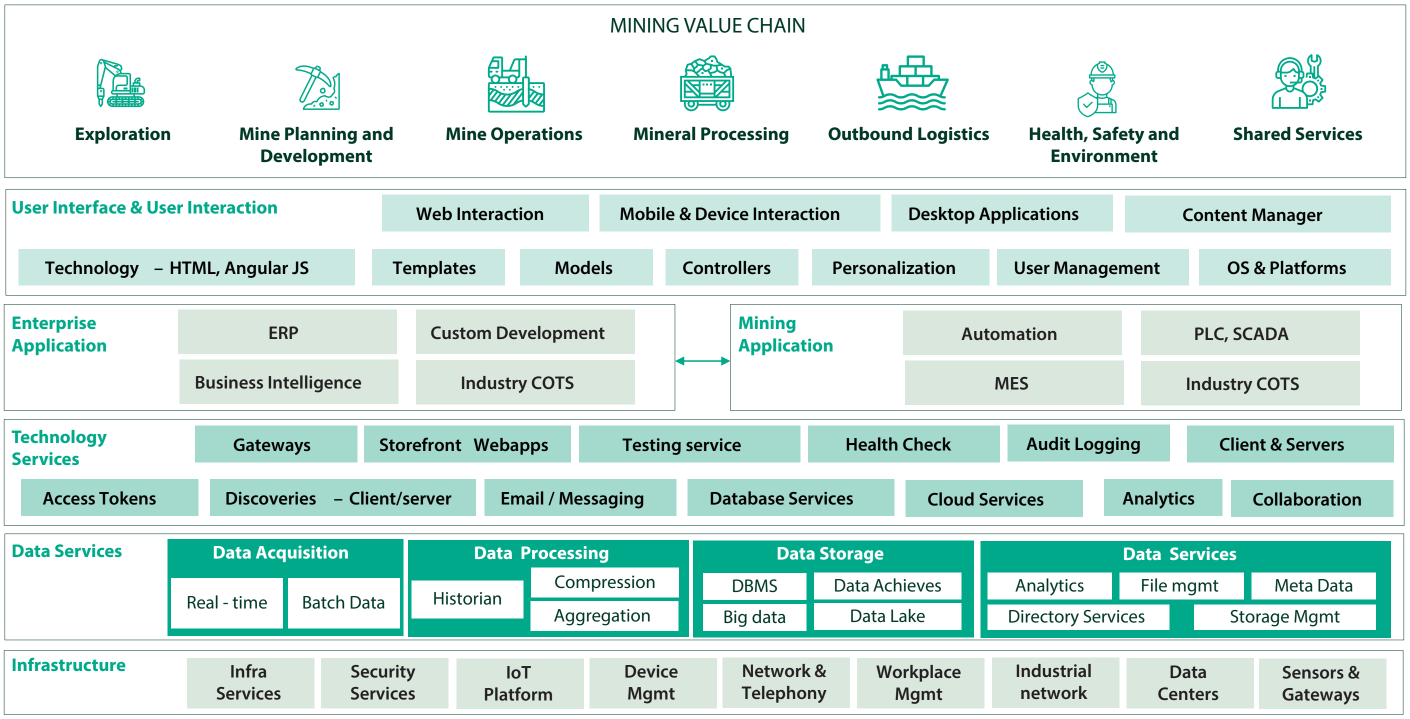
An example of how data analytics used in drilling and hauling operations is below:



Conclusion

The mining industry is growing at a rapid pace with extensive digital intervention. This is generating large quantities of data. There are multiple touchpoints of applications and devices for synthesizing, storing, governing and producing actionable insights that are powered by data.

Our architecture elaborated below connects processes to infrastructure, devices to systems, information to operational technology, that is infused by one sourced data, BI and data analytics to build Next Generation Data Foundation and Framework for Mining Industry.



Digital Architecture for Mining

This digital architecture could help mining companies be agile and digital at scale, and generate roadmaps and solutions for future-readiness. It could help them collect real-time data from smart sensors, as well as, access data from legacy PLC, SCADA, MES systems and make it available in on-premises data warehouses on the cloud. Any future changes to the architecture across the value chain for production and structure of components can evolve in response to emerging new technology-based research[5] to build on the top of digital reference architecture. This architecture will also act as a bridge between business data, create data assets[6] transparency from shaft floor to CXO level, create leading-edge inventory control for business needs, secure and scale operations for data generation and analytics and introduce a high level of operational efficiency.

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