MongoDB and Connectivity for Industry 4.0

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What is Industry 4.0?

Industry 4.0 (I4.0)

symbolizes the beginning of the Fourth Industrial Revolution. It represents the current trend of automation technologies in the manufacturing industry and includes the enabling disruptive technologies and concepts such as Cyber-Physical Systems (CPS), Industrial Internet of Things (IIoT), cloud computing, and immersive visualization.

What can be achieved through Industry 4.0?

IIoT and CPS technologies are integrating the virtual space with the physical world. This is resulting in a new generation of industrial systems, such as smart factories, to deal with the complexity of fast-paced and hyper-personalized production in current macro environments.

IIoT is expected to transform existing industrial systems, enable digital transformation and unlock tomorrow's smart enterprise. The technology has been finding its way into products and sensors all while revolutionizing existing manufacturing systems; thus, it is considered to be a key enabler for the next generation of advanced manufacturing.

What does Industry 4.0 consist of?

Industry 4.0 generally comprises many complex components and has broad applications in all manufacturing sectors. The very first challenge faced by manufacturing companies when embarking on the I4.0 journey is to sensor and connect their manufacturing equipment in order to collect, store and analyze data for information and insights.

This is where MongoDB Developer Data Platform shines by making it easy to collect, store and analyze information all the while presenting the results to stakeholders in a single view.

MongoDB.

Digital Transformation and Connectivity Platform

How can a connectivity platform drive digital transformation?

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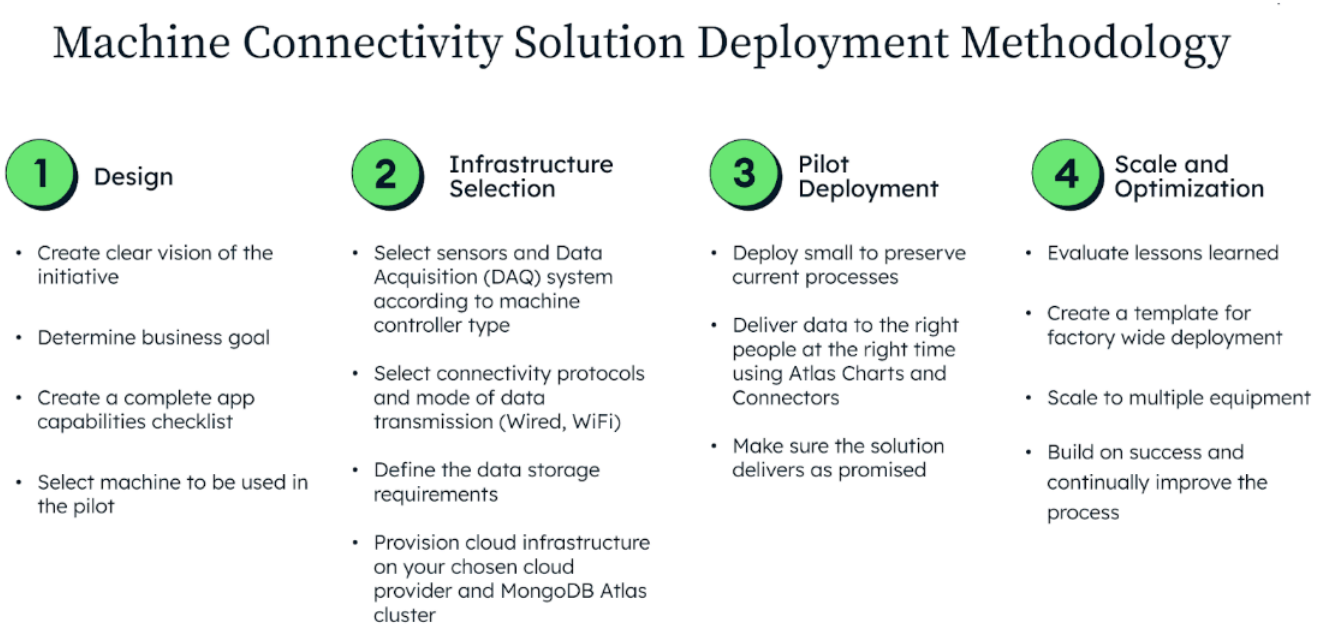
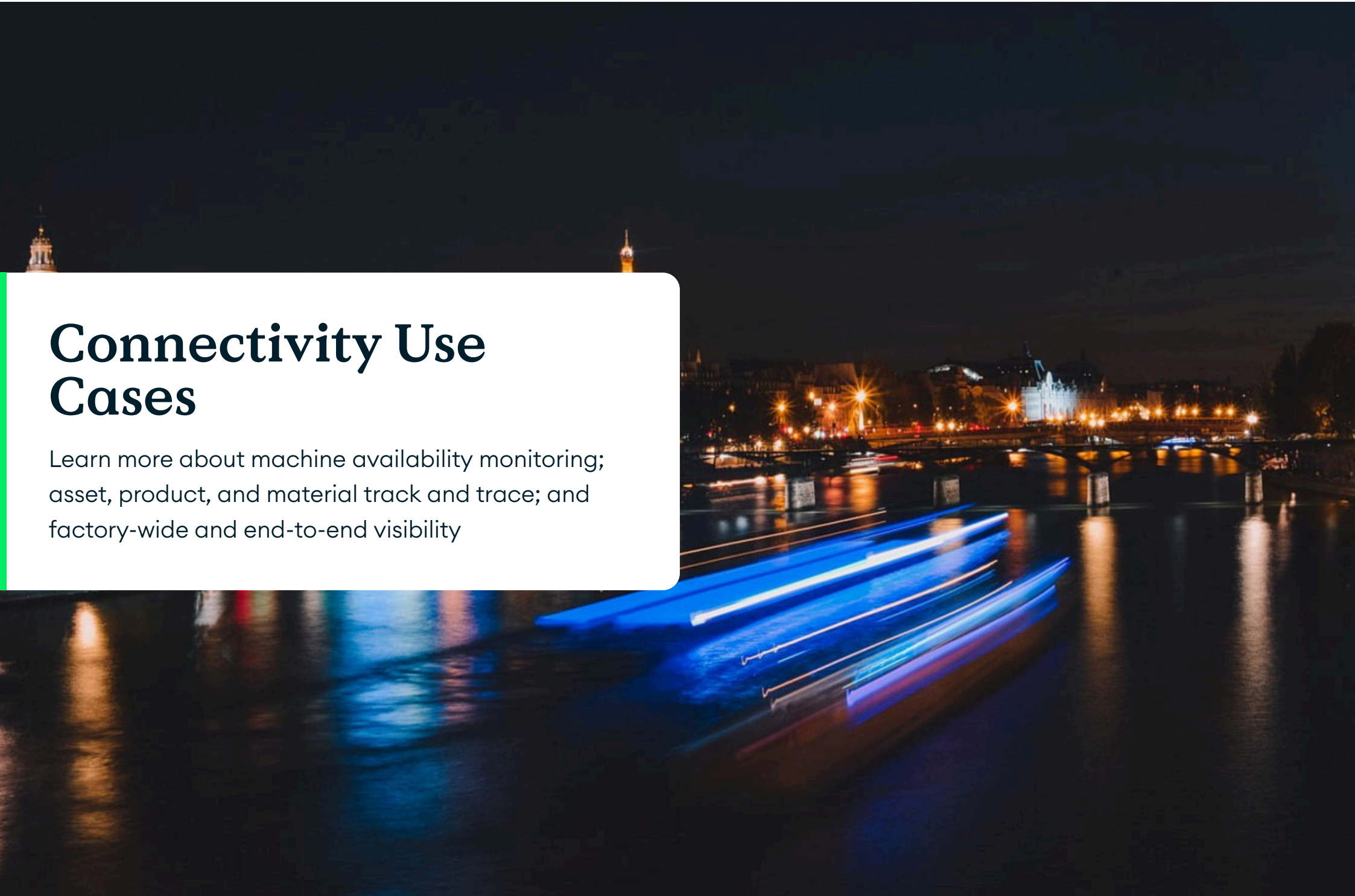
IIoT data from equipment, products, and services can now be used in novel ways to identify unique business opportunities and enable digital ways of working. Through the use of data-driven decision making, operational efficiency can be gained for production and supply chain management. Gone are the days when manufacturing companies were only relying on two or three sources of production data to improve their Overall Equipment Effectiveness (OEE). The traditional method of manually calculating OEE using spreadsheets seems outdated in the digitalization age.

These days, machines are being produced with embedded sensors and the cost of external sensorization is dropping. This presents a unique opportunity and a challenge for manufacturers around the world. The challenge is not just to work with multiple data sources but to also simplify the data aggregation process in a way that it can be deployed easily for the company, thus improving developer efficiency along the way. Distributed data sets sitting in silo data stores are difficult to access and keep in sync.

MongoDB Atlas is well positioned to solve such challenges because it is built around the most intuitive way to model data - the document data model. It provides a unified query interface for a broad range of workload types (time series, operational, real-time analytical, etc.) and supports a wide range of modern IIoT application types as they grow and evolve.





Connectivity Use Cases

Learn more about machine availability monitoring; asset, product, and material track and trace; and factory-wide and end-to-end visibility

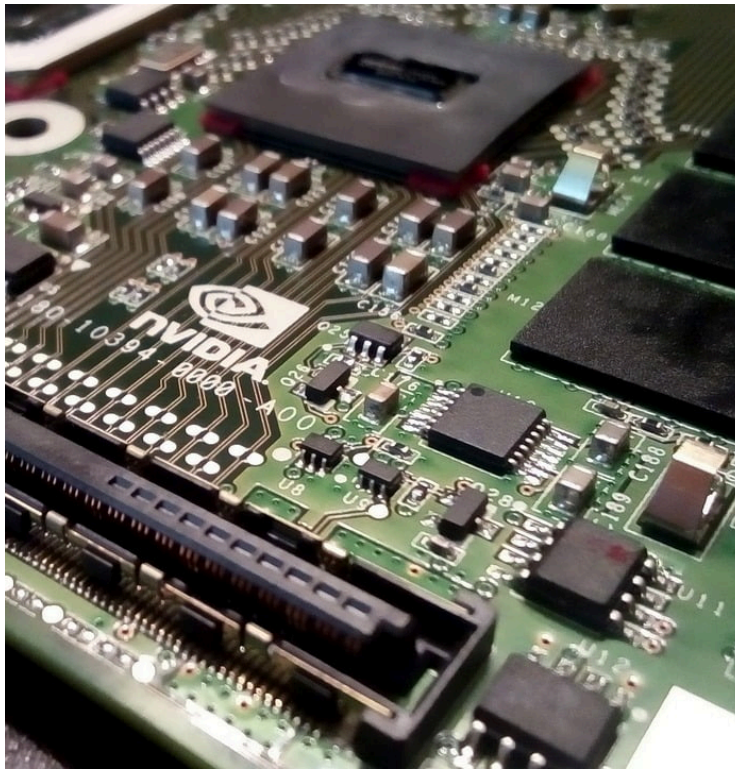
Machine availability monitoring

Machine availability is defined as the total amount of time a machine actually runs versus the scheduled run time. Monitoring machine availability provides insight into production efficiency. It also helps ensure sufficient production run time in order to generate profit.

Machine availability monitoring is becoming increasingly important as the costs associated with its absence are ever-present . Examples include but are not limited to the following. Detection costs are incurred to investigate the root cause of equipment downtime. Recovery costs are spent on restoring baseline operations after downtime, such as locating and installing backup systems for data recovery. The cost of labor when employees are unable to perform their duties due to downtime leads to overtime compensation. Companies must also consider third-party costs for asset specialists and contractors to resolve availability issues.

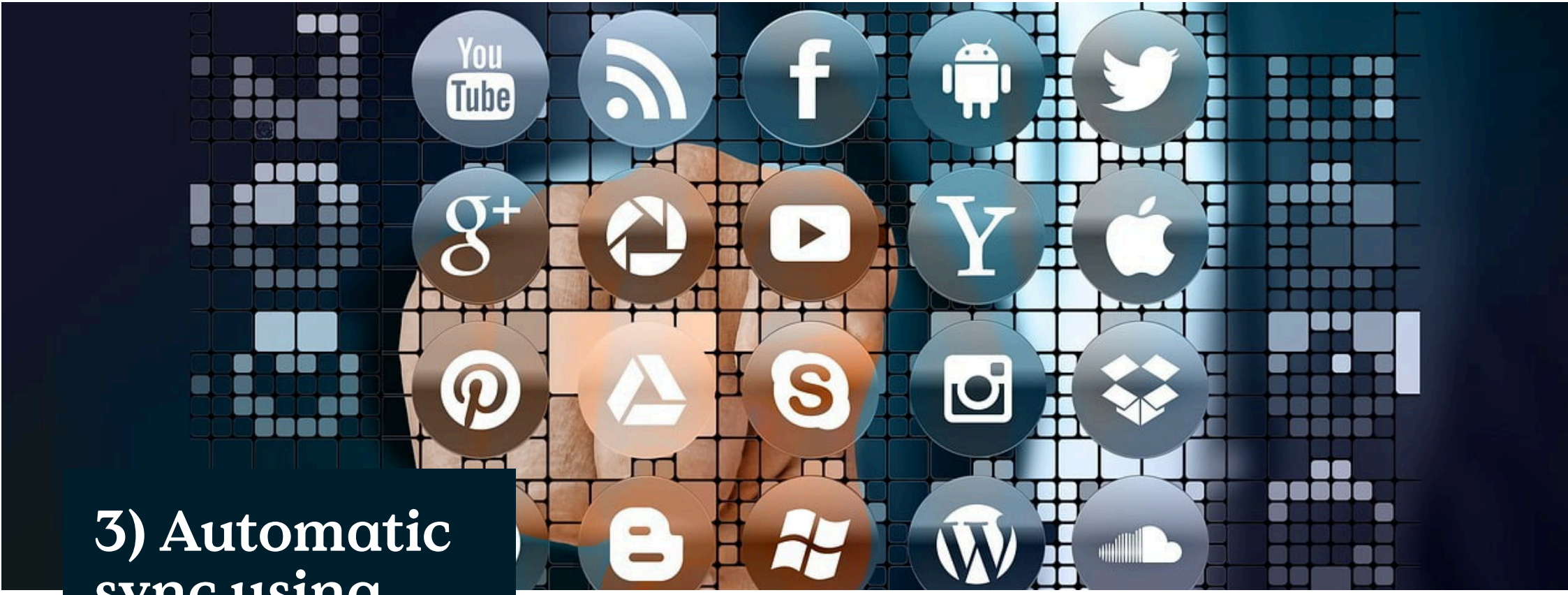
1) Flexible modeling using Native Time-Series Platform

MongoDB supports native time series collections with hands-free optimization supporting high storage efficiency and low latency queries. This helps in collecting time series data from machine sensors and controllers and storing them in a highly optimized manner on the edge.



2) Faster app development using Realm SDK

Realm SDKs are an easy, object-oriented, and idiomatic way of persisting data locally on the device and integrating with the MongoDB Atlas backend. The core of the Realm SDK is a lightweight, embedded, and object-oriented database comparable to SQLite. Classes are literally the data schema and thus building machine monitoring applications on the edge becomes much easier and straightforward.



3) Automatic sync using App Services

Using App Services Device Sync, the data from Realm databases can be automatically synced to Atlas ensuring that the data coming from the machine is kept up to date at all times. In addition to Device Sync, users can define and execute server-side database logic for machine monitoring applications with serverless functions. Even when network connectivity is unstable, the data is persisted in Realm DB and then automatically synchronized with Atlas without incurring any data loss.

4) Quick data ingestion using MongoDB Kafka Connector

The MongoDB Kafka connector is a Confluent-verified connector that persists data from Kafka topics as a data sink into MongoDB as well as publishes changes from MongoDB into Kafka topics as a data source. Machine sensor data can be streamed to MongoDB using the Kafka Sink connector. This provides an easy way to push machine availability events data into MongoDB.

Asset, Product, and Material Track and Trace

Learn how to gain valuable insights from real-time tracking

Asset Tracking

Asset tracking in manufacturing is no longer a mere location tracking tool. When combined with other disruptive technologies such as cloud computing, advanced analytics, and NB-IoT (Narrowband IoT), businesses can extract valuable insights from the data to optimize operational efficiencies.

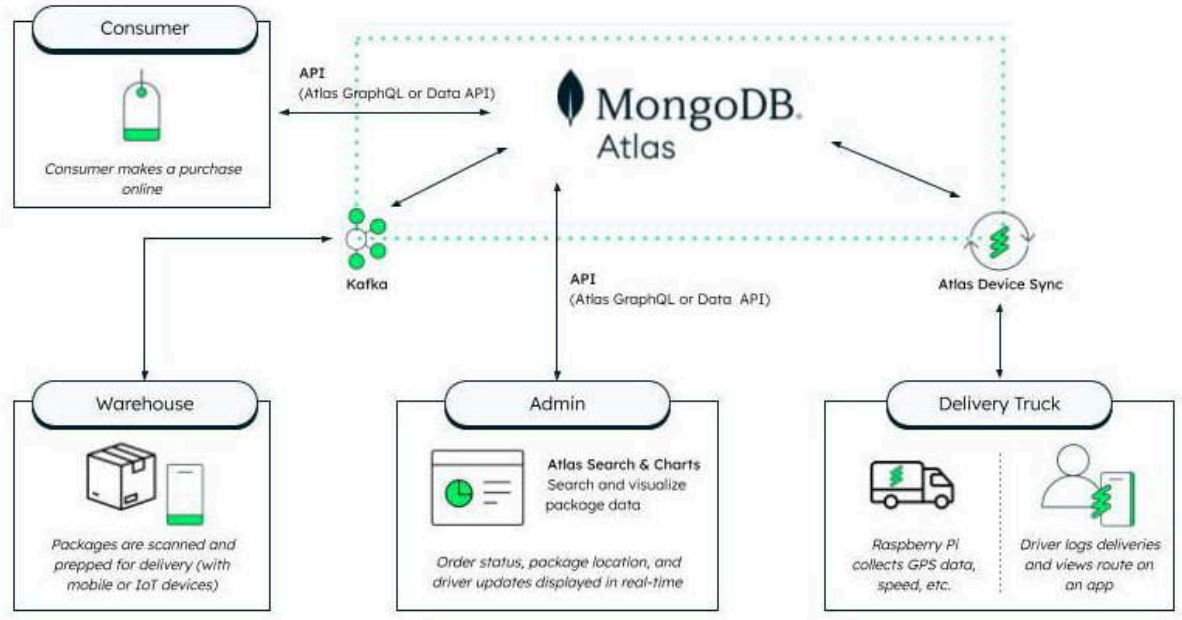
With the evolution of technologies such as BLE (Bluetooth Low Energy), LoRaWAN (Long Range Wide Area Network), and NB-IoT (Narrowband IoT), the reliability and performance of asset tracking solutions have greatly enhanced. Low power tags connected with a positioning engine allow one to automatically and precisely track assets across the manufacturing shop floor. Such tags are mobile with long battery life and can be attached to any movable equipment. Examples include forklifts, trolleys, and dollies.

Currently, real-time location systems (RTLS) for asset tracking generally consist of three major components: mobile tags, positioning engines, and stationary reference nodes. Mobile tags typically carry identification information and communicate with the reference nodes. The positioning engine estimates the location of the tag based on the information derived from the signals received.

MongoDB enables Asset and Material Track and Trace through a wide variety of features. MongoDB Atlas sits in the middle as a central operational data hub collecting data from various sources including the localization sensors and the inventory data from the warehouse. All this data can be modeled effectively with the **Document Data Model** and stored in an optimized manner such as time series collections. MongoDB documents are inherently flexible while allowing data governance when required.

In the factory, the Kafka Connector can be used to stream sensor data to Atlas whereas real-time data changes in other data stores can be pushed to MongoDB through Change Data Capture (CDC) technique. MongoDB change streams can be used to write data back to other enterprise software systems such as Order and Inventory Management. As the product goes into the truck, the location data can be stored on a mobile device using **Realm SDK** and then synced to Atlas through the use of **App Services and Device Sync**.

MongoDB as the central data store for track and trace use case



Factory-wide, End-to-end Visibility and OEE Monitoring

Gain visibility from conception to distribution

Manufacturing organizations have data sitting in various data stores which makes it difficult to correlate and find actionable information when needed. Standardizing data collection through a data model makes it easy to understand the correct picture of manufacturing operations. This also helps improve machine uptime, which has a direct impact on factory efficiency and quality.

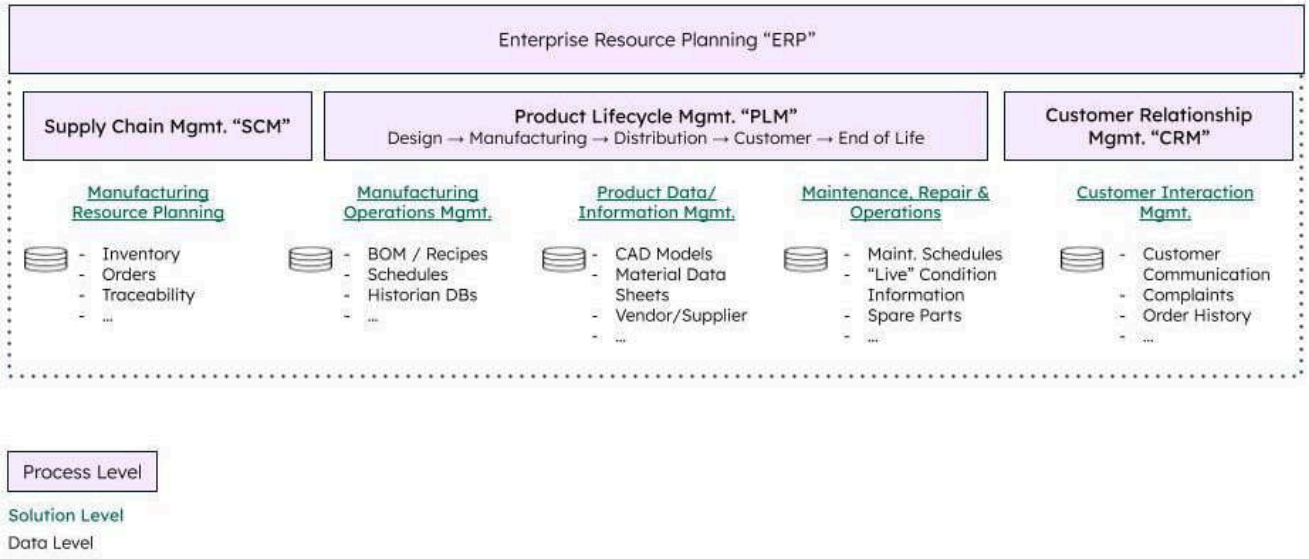
Factory-wide end-to-end visibility and OEE monitoring provide manufacturers with the ability to see different assets, tools, and material availability using a single-view data platform. IIoT at the edge combines data from various sources in a standardized I4.0 document data model. Once the data is collected, it can be used to perform real-time analytics to support decision-making on the shop floor.

MongoDB Atlas Developer Data Platform makes it possible to achieve factory wide end-to-end visibility and OEE monitoring for manufacturers:

1. Document data model

MongoDB documents are inherently flexible while allowing data governance when required. The key to enabling a factory-wide monitoring use case is to combine and model data from different sources.

MongoDB document model is a perfect fit for this use case because multiple data structures can be stored in the same database and collections. It also allows easy combination, aka join, of different data structures and enrichment of data. Finally, it gives the ability to integrate with any programming language and with analytical platforms.



2. Data API

Companies can use Atlas Data API to integrate Atlas into any apps and services that support HTTPS requests. Leveraging this feature, the shop floor and worker apps can request raw data or analytical results from Atlas and consume the results with ease.

3. Change streams

MongoDB change streams allow applications to access real-time data changes in the database without any complexity or risk. IIoT connectivity applications can use change streams to subscribe to all data changes in either a single collection, a database, or an entire deployment and immediately react to them. This enables quick response time and fast decision-making.

4. Data tiering and data federation

Online archive

With Atlas Online Archive, manufacturers can tier off cold data or infrequently accessed data from a MongoDB cluster to an object store. This can lower costs via archival cloud storage for old data, while active data that is more often accessed and queried remains in the primary database. The archived data can be used for audit queries or for historical data analysis.

Data lake

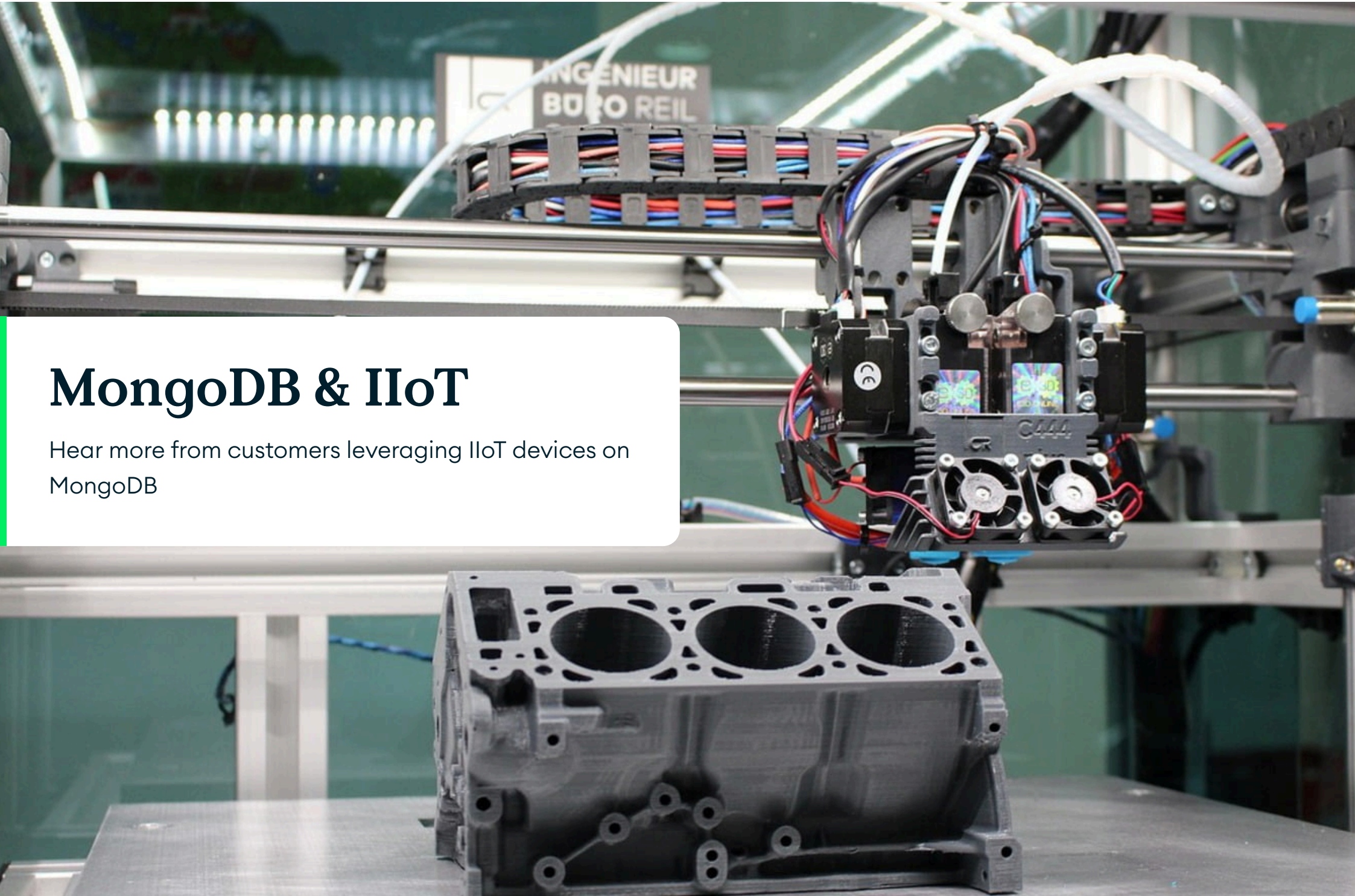
With Data Lake functionality enabled, as data is ingested, Atlas Data Lake automatically optimizes and partitions the data in columnar format which allows for fast point queries and fast aggregate queries.

Data federation

Atlas Data Federation provides the capability to federate queries across data stored in various supported storage formats, including Atlas Clusters, Data Lake Datasets, AWS S3 Buckets, and HTTP endpoints. This feature reduces the complexity of bringing data together for visualization and analytical purposes.

5. Atlas Charts

With Charts, a single-view dashboard can be created that provides visibility into factory performance and OEE. Charts is the best way to visualize MongoDB data. Built specifically for the document model, no ETL, and no time loss due to data manipulation or duplication are required to visualize rich JSON data. Using Charts, powerful and engaging data experiences can be created for stakeholders. For factories that rely on relational BI tools such as Power BI and Tableau for KPI visualization and analysis, Atlas SQL Connectors and Drivers allow them to easily connect their SQL-based business intelligence and analytics tools to Atlas.



MongoDB & IIoT

Hear more from customers leveraging IIoT devices on MongoDB

Toyota

Toyota is one of the world's most renowned automotive manufacturers, and has been progressively modernizing its organization and processes to keep up with global and client demands. Inspired by the acceleration of Industry 4.0 as the default, Toyota is making a shift in their manufacturing processes through their machines and data platforms. MongoDB Atlas is at the core of this shift, with its fully-managed, global cloud database service. This switch moved them from a monolithic codebase to a microservices approach, allowing more productivity from developer teams and an improved user experience for customers.

Learn more about Toyota and MongoDB

Vaillant

With over 30 million customers in 60 countries, Vaillant is a global leader in heating, ventilation, and air conditioning. They have long been using IoT for building, installing and maintaining complex machines. As a result, reaping the benefits of IoT has created new revenue streams for them, from remote condition monitoring to better product design.

However they faced a challenge of being able to handle the large volumes of data they were producing and being able to analyze it quickly for actual real time feedback.

Learn how Vaillant migrated from Azure CosmosDB to MongoDB Atlas for automated scalability, real-time analytics, data security, and a faster development experience.

"When we implemented MongoDB Atlas, there was no downtime at all, and our customers immediately noticed the performance improvements. The whole experience was fantastic."

Jürgen Stauvermann, Senior Java Software Engineer, Vaillant

Bosch

Bosch is an engineering group with a vast array of connected products for virtually every industry today, and IoT has unfolded as a major opportunity to increase efficiency and the development of new business models. However the massive volume and unstructured nature of IoT data presents unprecedented challenges for design, development, and operations.

This required Bosch to rethink their entire underlying data infrastructure, where rigid tabular relational models were simply not meeting the needs anymore for modern applications. With that, MongoDB is now a technology provider and partner of Bosch. With MongoDB, flexibility, scalability, and the real time analytics needed to handle IoT data intelligently is essential, providing powerful operational insights, business agility, and unified views of arrayed information.

"Prior to MongoDB 5.0, the Bosch IoT Insights cloud service relied on a custom solution with its own bespoke data model for time series data. This approach added complexity and friction to both our own developers and to our customers."

Erwin Segerer, Bosch.IO

BOSCH

Read More about MongoDB and Manufacturing

- Manufacturing at Scale: MongoDB & IIoT Blog Post
- MongoDB & IIoT: A 4-Step Data Integration - Connect Blog Post
- MongoDB & IIoT: Data Streaming with Kafka - Collect Blog Post
- MongoDB & Manufacturing: From Shop Floor to Cloud with MongoDB and Kafka Webinar