Unleash Telco Transformation with an Operational Data Layer

Modernizing Telecom Infrastructures Through MongoDB

Oct. 2024

MongoDB.

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Executive summary

The telecom industry is undergoing a profound transformation. The advent of 5G networks, the proliferation of Internet of Things (IoT) devices, and the increasing integration of AI into business support systems and operational support systems are creating unprecedented demands. These include ultra low latency, high throughput, and exceptional resilience. Leading telcos are under immense pressure to modernize their infrastructures to meet these evolving requirements. They must do so while remaining competitive in a market characterized by rapid innovation, compressed margins, and ever-increasing customer expectations.

Traditional relational databases, once the backbone of telecom operations, are proving inadequate in this new landscape. They struggle with scalability, incur high operational costs, and lack the flexibility needed for rapid innovation. Moreover, the existence of data silos across on-premises systems, cloud services, 5G edge environments, and hybrid setups complicates data sovereignty, compliance, and real-time access. These challenges hinder telcos from delivering the seamless, high-quality experiences that modern consumers demand.

This white paper explores how building an operational data layer (ODL) using MongoDB provides a strategic pathway for telcos to modernize their infrastructures. By decoupling companies from the limitations of legacy systems, an ODL offers a flexible abstraction layer that enhances resilience and scalability. It enables rapid innovation and facilitates the integration of data from multiple sources. This approach not only addresses immediate challenges but also future-proofs telecom infrastructures for sustained growth and innovation.

Understanding the limitations of legacy systems

Telcos have historically relied on monolithic relational database systems to manage vast amounts of data. These systems were designed in an era when technological capabilities and customer expectations were different. Today, they present several significant challenges:

First, scalability has become a pressing issue. Traditional databases were not built to handle the exponential data growth associated with modern telecom services. The surge in data generated by 5G networks and IoT devices necessitates databases that can scale horizontally across multiple nodes and geographies. Legacy systems, with their vertical scaling limitations, cannot meet these demands effectively.

Second, operational costs associated with maintaining and licensing legacy systems are prohibitively high. These costs are compounded by the need for specialized hardware and expertise to manage and troubleshoot these outdated systems. In an industry with compressed margins, these expenses significantly impact profitability.

Third, the inflexibility of rigid schemas in traditional relational databases makes it difficult to adapt to new data types and evolving business requirements. Any changes often require extensive downtime and significant effort to restructure the database, hindering the agility needed in today's fast-paced market.

Performance bottlenecks also become more pronounced as data volumes grow. Complex queries take longer to execute, affecting the responsiveness of applications and services. This degradation in performance directly impacts customer satisfaction and can lead to churn.

Data silos and integration complexity

The issue of data silos is another critical challenge. Data is often isolated within separate business units, each holding only a portion of the overall information. For example, billing systems for landline, mobile, and additional value-added services are often managed

independently in different silos. This fragmentation makes it difficult to create a unified bill for customers who subscribe to multiple services.

Integrating these disparate data sources is complex. It involves multiple data formats, storage technologies, and access protocols. The lack of a unified data strategy leads to delayed insights, increased complexity, and hindered decision-making. For instance, a customer service representative may not have real-time access to network performance data, limiting their ability to resolve customer issues promptly.

Compliance and data sovereignty

With data spread across multiple jurisdictions and systems, ensuring compliance with regulations such as the General Data Protection Regulation (GDPR) becomes increasingly complex. Data sovereignty issues arise when data crosses borders or resides in third-party cloud services. Maintaining control over data to meet legal requirements is challenging, especially when legacy systems do not provide the necessary tools for data governance and auditing.

Noncompliance can result in significant financial penalties and damage to brand reputation. Therefore, telcos need solutions that provide robust data governance capabilities, enabling them to control where data is stored and how it is accessed.

Demand for real-time access and low latency

Modern telecom services demand real-time data access with minimal latency. Capabilities such as fraud detection, network optimization, and personalized customer experiences rely on instantaneous data processing. Legacy systems, with their monolithic architectures and centralized databases, are ill equipped to provide the low-latency responses required.

For example, in fraud detection, the ability to analyze and act upon data in real time can prevent losses and protect customers. Legacy systems may introduce delays that render these protective measures ineffective. Similarly, personalized services that recommend

products or adjust network resources spontaneously require immediate data processing capabilities.

Introducing the operational data layer

An ODL serves as an architectural paradigm that centrally integrates and organizes siloed enterprise data, making it readily available to consuming applications. It acts as an intermediary between existing data sources and the applications that need to access that data, providing a unified, consistent, and real-time view of enterprise data across various domains.

By implementing an ODL using MongoDB, telcos can address the limitations of their legacy systems. The ODL decouples applications from underlying data sources, facilitating greater flexibility in data access and manipulation. This decoupling is crucial for modern applications that require rapid development cycles and adaptability to changing business needs.

The ODL enhances scalability and resilience by leveraging MongoDB's distributed architecture. Data can be sharded across multiple nodes and geographies, ensuring high availability and performance. The system can handle large volumes of data and high-throughput demands, essential for processing real-time data generated by 5G networks and IoT devices.

Moreover, the ODL accelerates innovation by providing developers with flexible data structures. MongoDB's document-oriented model supports the storage of complex, semistructured data without the constraints of rigid schemas. Developers can rapidly prototype and deploy new applications, incorporating diverse data types and accommodating evolving requirements.

The ODL also plays a critical role in maintaining compliance. It offers robust data governance features, enabling telcos to control data distribution, enforce access controls, and ensure data sovereignty. By centralizing data management, companies can more easily comply with regulations like the GDPR.

Building an ODL with MongoDB

Reasons for choosing MongoDB

MongoDB is a document-oriented database that stores data in flexible, JSON-like documents. This model aligns closely with the data structures used in modern applications and offers several advantages over traditional relational databases.

First, the flexible schema of MongoDB accommodates changes in data structures without downtime or complex migrations. This flexibility is essential for telcos, which need to adapt quickly to new services, technologies, and customer demands.

Second, MongoDB offers both vertical and horizontal scalability, with the capability to distribute data across multiple data centers and geographic locations. This is crucial for handling growing workloads and ensuring that applications remain responsive as data volumes increase.

Third, MongoDB offers rich query capabilities, supporting complex queries, indexes, and aggregations. These features enable efficient data retrieval and manipulation, essential for applications that require real-time analytics and insights.

Furthermore, MongoDB supports multi-cloud and on-premises deployments, offering flexibility in infrastructure choices. Telcos can deploy MongoDB on any infrastructure, including private data centers, public clouds, or hybrid environments. This enables them to optimize for cost, performance, and regulatory compliance.

Architectural overview

An ODL built on MongoDB involves several key components:

Data ingestion

Data from various sources—including legacy systems, edge devices, and cloud applications—is ingested into MongoDB. This process may involve batch processing for

historical data and real-time streaming for current data. Change data capture mechanisms and data pipelines that leverage MongoDB Atlas Stream Processing capabilities can be established to ensure that the ODL remains synchronized with source systems.

Data access layer

Applications interact with the ODL through a data access layer, which provides APIs and services that abstract the underlying data sources. This layer enforces security policies, manages connections, and translates application requests into database operations. This ensures that applications have a consistent and efficient means of accessing data.

Data federation

The ODL can federate queries across multiple databases, providing a unified view without data duplication. Data federation techniques enable the ODL to query data residing in external systems or across different clusters as if it were in a single database. This approach reduces the need for extensive data migrations and enables more-flexible data management strategies.

Event streams

Integration with event buses like Apache Kafka enables the ODL to support real-time data streams to consumers. Event-driven architectures enable applications to react to changes in data promptly. MongoDB's change streams feature can be used to monitor data changes and trigger events, facilitating responsive and scalable application designs.

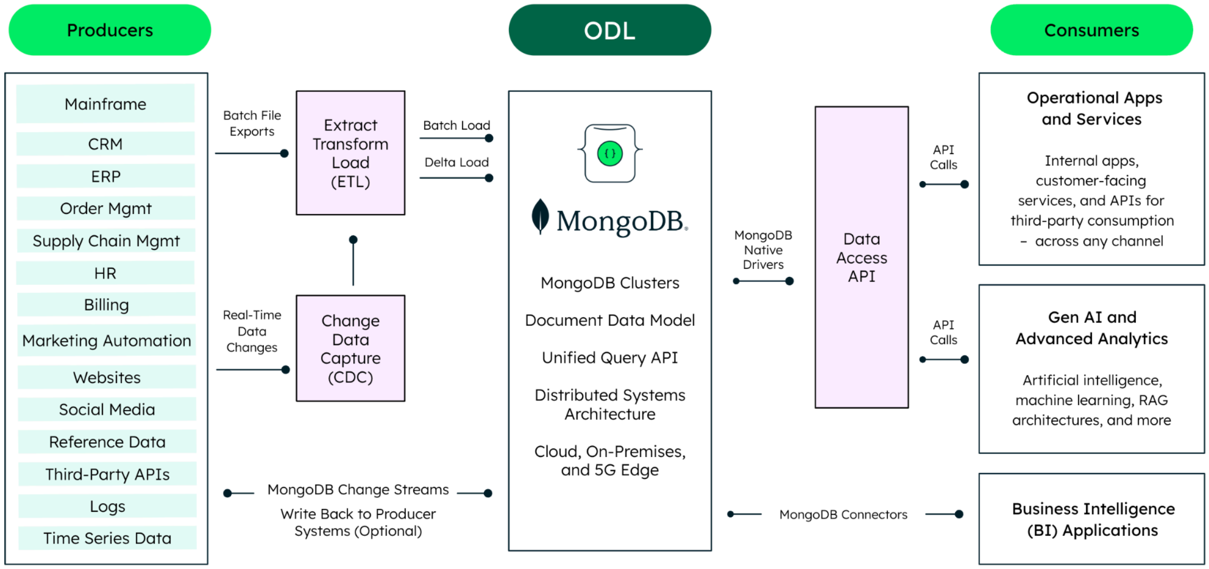

Figure 1. ODL architecture with MongoDB.

Phased implementation approach

Implementing an ODL is a strategic initiative that can be approached in phases. This phased approach enables telcos to mitigate risks, manage resource allocation, and realize benefits incrementally.

Phase 1: Offloading reads from legacy systems

The initial phase focuses on addressing immediate limitations by offloading read operations from legacy systems to the ODL. This step reduces the load on legacy databases, resulting in faster response times and improved performance. It also decreases maintenance and operational costs by reducing the strain on outdated infrastructure.

By directing read requests to the ODL, companies can enhance customer experiences through real-time access to billing history, central data repositories, and account information. Existing applications can be modified to read from the ODL without significant changes to their core logic.

Phase 2: Enriching data and enabling new use cases

As the ODL matures, it can be enriched with additional data sources and metadata, providing a more comprehensive view of enterprise data. This enrichment facilitates new use cases, such as advanced analytics, AI model training, and machine learning applications.

Breaking down data silos enables applications to access a holistic view of enterprise data. For instance, customer service applications can access network performance data alongside customer profiles, facilitating more-effective issue resolution and personalized services.

Phase 3: Offloading writes and enabling bidirectional data flow

In this phase, the ODL begins to accept write operations, updating data in real time. Bidirectional synchronization mechanisms are established so that changes in the ODL can be propagated back to legacy systems if necessary. This step reduces dependency on legacy systems and gradually shifts workloads to the ODL.

Applications can be modified to write to the ODL, with synchronization services ensuring data consistency across systems. This phase requires careful planning to handle potential conflicts and maintain data integrity.

Phase 4: Setting the ODL as the primary data store

In the final phase, the ODL becomes the primary data store and legacy systems can be decommissioned. This transition simplifies the overall data architecture, reducing complexity and operational overhead. The ODL provides a future-proof infrastructure capable of adapting to evolving technological demands.

At this stage, applications fully rely on the ODL for both read and write operations. Legacy systems can be archived or maintained in a minimal capacity for compliance purposes.

Telco Transformation with an Operational Data Layer (ODL)

Recommended adoption phases

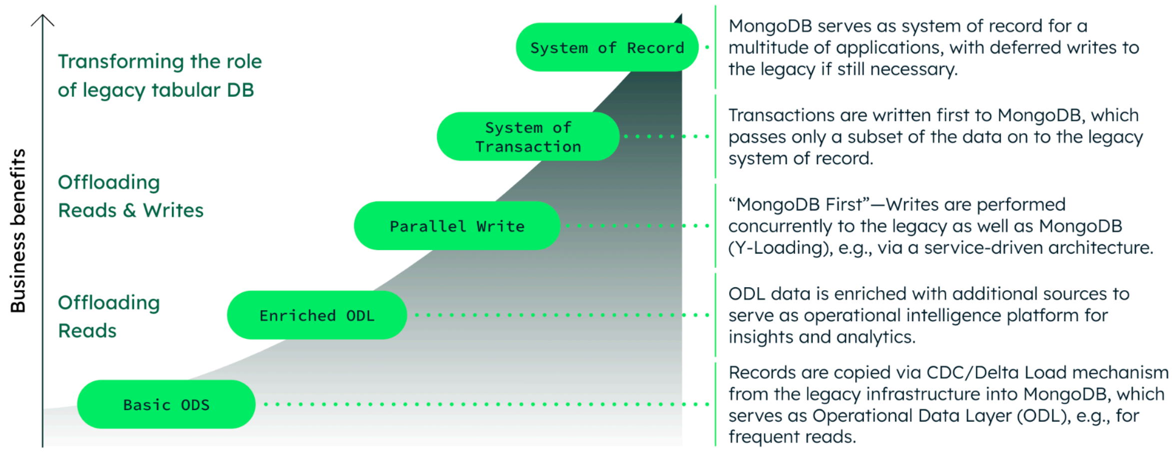

Figure 2. ODL adoption phases.

Unlocking innovation with the ODL

Facilitating data federation and desiloing

The ODL enables data federation, creating a unified data layer that provides seamless access across different environments without the need to move or replicate data extensively. For example, customer data from customer relationship management systems, billing platforms, and support tickets can be combined to create a comprehensive customer view.

This unified approach facilitates real-time analytics by integrating network performance metrics, usage statistics, and customer data. Decision-makers can gain immediate insights, enhancing operational efficiency and strategic planning.

Enabling event-driven architectures

By serving up events from domain-based datastores into an event bus, the ODL facilitates event-driven architectures. Applications can react to data changes in real time, supporting agile development and responsive systems. This also promotes loose coupling between components, making systems more modular and easier to maintain.

Supporting advanced use cases

The ODL facilitates several advanced use cases:

AI-powered customer support

By leveraging real-time data through an ODL built on MongoDB, telcos can harness the power of AI to revolutionize their customer support services. Through this integration, they can generate intelligent, responsive, and personalized customer interactions that enhance the overall experience.

AI models, including machine learning algorithms and natural language processing systems, rely on access to comprehensive, up-to-date data to function effectively. The ODL provides a unified platform where customer profiles, interaction histories, and contextual data are readily available: Customer profiles may include demographic information, service usage patterns, billing history, and personal preferences. Interaction histories encompass previous communications across various channels, such as phone calls, emails, chat sessions, and social media interactions. Contextual data involves real-time network performance metrics, service outages, and maintenance schedules relevant to each customer.

With this wealth of data, AI can enhance the support process. By analyzing the nature of the inquiry, the AI can predict the required expertise and connect the customer with the agent best suited to address their problem. This intelligent routing reduces wait times, minimizes the need for transfers between departments, and improves the likelihood of first-contact resolution.

AI-powered customer support also enables personalized recommendations and upselling opportunities. By analyzing customer data in real time, AI models can identify patterns and preferences that suggest certain products or services may be of interest. For instance, a customer who consistently reaches their data limit might be offered an upgrade to a higher-tier data plan. These tailored promotions not only enhance the customer experience but also drive additional revenue streams.

As AI evolves, its potential in customer support continues to expand. Voice assistants can offer hands-free customer service options, catering to customers who prefer voice interactions over text-based communication. Multilingual support through AI translation services can serve a diverse customer base without the need for extensive human language resources. Predictive support capabilities can anticipate customer issues before they occur by analyzing usage patterns and proactively offering solutions or notifications.

Network optimization

As networks become more complex with the integration of 5G, IoT devices, and increased data traffic, the task of optimizing network operations has become both more challenging and more essential. An ODL provides telcos with the tools necessary to monitor network performance in real time, enabling proactive issue resolution and optimized resource allocation.

Real-time monitoring of network performance enables telcos to detect and address issues before they can escalate into significant problems that would affect a large number of customers. By aggregating data from various sources—such as network equipment logs, performance metrics, customer usage patterns, and environmental sensors—the ODL creates a holistic view of network health. This comprehensive perspective is crucial for understanding the intricate interplay between network components and for identifying subtle anomalies that may indicate underlying issues.

The flexible data model of MongoDB is particularly well suited for handling the diverse and voluminous data that modern networks generate. Network data often includes structured information (like device configurations and performance statistics), as well as unstructured or semistructured data (such as log files and error messages). MongoDB's ability to store and query this heterogeneous data without the constraints of a rigid schema enables telcos to adapt quickly to new types of data and evolving network technologies.

Furthermore, the ODL facilitates capacity planning and long-term network evolution strategies. By analyzing trends in data consumption, device types, and service adoption, telcos can make informed decisions about where to invest in network expansions or technology upgrades. For example, a growing number of IoT devices in a particular industry sector may indicate a need for enhanced network capabilities tailored for machine-to-machine communication.

Collaboration between different departments is enhanced by the centralized data provided by the ODL. Network operations teams, customer service representatives, and business analysts can all access the same source of truth, reducing miscommunication

and enabling coordinated efforts. For example, marketing campaigns promoting new services can be aligned with network capacity planning to ensure that the infrastructure can support increased demand.

Future-proofing telecom infrastructure

Scalability for next-generation services

An ODL built on MongoDB ensures scalability to meet the demands of next-generation services:

- 5G networks: Handle the exponential data growth and low-latency requirements associated with 5G technologies. The ODL can process vast amounts of data generated by high-speed networks and support real-time applications.
- IoT devices: Manage the influx of data from billions of connected devices. The flexible schema of MongoDB supports the storage and processing of diverse data types generated by various sensors and devices.
- Edge computing: Process and analyze data at the network edge for immediate insights. The ODL can be deployed in distributed architectures, bringing data processing closer to the source and reducing latency.

Adaptability to evolving technologies

The telecom landscape is rapidly evolving with emerging technologies:

- AI and machine learning: Integrate AI seamlessly to enhance services and operations. The ODL provides the data foundation needed for training models and deploying AI-driven applications.
- Augmented and virtual reality: Support data-intensive applications that enhance customer experiences. The high throughput and low latency of the ODL support immersive experiences that require real-time data processing.

Enhanced security and compliance

MongoDB provides robust security features essential for telcos:

- Encryption: Secure data at rest and in transit using advanced encryption standards, including MongoDB Queryable Encryption. This level of protection is currently unique in the industry, and it is vital for safeguarding sensitive customer information.
- Access controls: Implement fine-grained permissions and role-based access to control who can access specific data. These controls help prevent unauthorized access and data breaches.
- Audit logging: Maintain detailed logs for compliance and monitoring. Audit trails are essential for demonstrating compliance with regulations and for investigating incidents.

By adopting MongoDB's security features, telcos can enhance their security posture and ensure compliance with regulatory requirements.

Conclusion

Telcos are at a critical juncture, where modernization is not just beneficial but essential. Implementing an operational data layer built on MongoDB provides a strategic solution to the challenges posed by legacy systems. By adopting this architectural pattern, telcos can transition from rigid, costly systems to a flexible, scalable platform that supports current and future needs, effectively modernizing their infrastructure. This shift enables rapid development and deployment of new services, enabling companies to accelerate innovation and stay ahead in a competitive market.

Moreover, by providing real-time, personalized services that meet modern expectations, telcos can enhance customer experiences, increasing customer satisfaction and loyalty. Embracing technological advancements and leveraging data as a strategic asset enables them to maintain a competitive edge over rivals.

In choosing MongoDB for their ODL, telecom providers invest in a future-proof foundation that addresses current challenges and positions them for long-term success. The combination of flexible data models, scalability, robust security, and a comprehensive support ecosystem makes MongoDB an ideal partner for this transformation.

About MongoDB

MongoDB, the leading modern general-purpose database platform, empowers innovators to unleash the power of software and data. Organizations across industries, including telecom, use MongoDB for a variety of applications, such as billing system modernization, customer data platforms, network optimization tools, and more.

At the core of our offering is MongoDB Atlas, the most advanced cloud database service on the market. Atlas can run on any cloud and across multiple clouds, enabling organizations to get the best from each provider without lock-in. MongoDB Atlas simplifies deployment, management, and scaling of databases, enabling companies to focus on building applications that drive their business forward.

To learn more about MongoDB, visit mongodb.com.

About the author

Benjamin Lorenz started his career with MongoDB back in 2016, managing the Central European presales team. He has been instrumental in growing the sales region and has been involved in a large number of strategic customer projects. Working as head of telco, media, and content in the industry solutions team since 2023, Benjamin loves to listen to decision-makers from these industries, understand their needs, and shape solutions that are based on a solid and powerful foundation—the data platform of MongoDB.

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