Designing High-Performance Data Structures for Couchbase, Cassandra and MongoDB

The NoSQL Data Modeling Imperative

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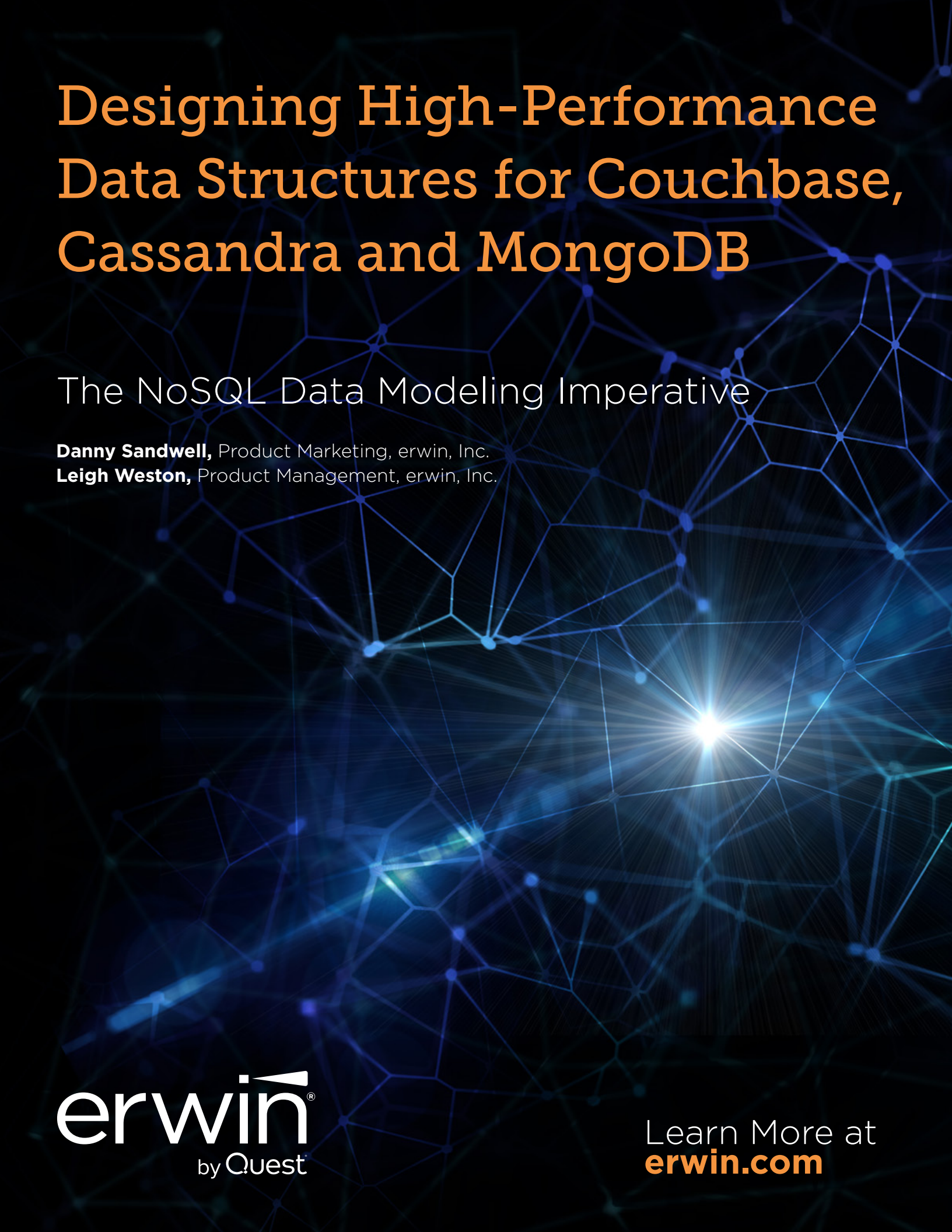

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When Not "If" NoSQL

We've heard the business case and accepted the modern technology justifications for adopting NoSQL database management system (DBMS) solutions to support data-driven business transformation.

DBMS products based on rigid schema requirements impede our ability to fully realize business opportunities that can expand the depth and breadth of relevant data streams for conversion into actionable information. New, business-transforming use cases often involve variable data feeds, real-time or near-time processing and analytics requirements, and the scale to process large volumes of data. NoSQL databases, such as Couchbase and MongoDB, are purpose-built to handle the variety, velocity and volume of these new data use cases. Schema-less or dynamic schema capabilities, combined with increased processing speed and built-in scalability, make NoSQL the ideal platform.

Now the hard part. Once we've agreed to make the move to NoSQL, the next step is to identify the architectural and technological implications facing the folks tasked with building and maintaining these new mission-critical data sources and the applications they feed. As the data modeling industry leader, erwin has identified a critical success factor for the majority of organizations adopting a NoSQL platform like Couchbase, Cassandra and MongoDB.

Successfully leveraging this solution requires a significant paradigm shift in how we design NoSQL data structures and deploy the databases that manage them. But as with most technology requirements, we need to shield the business from the complexity and risk associated with this new approach. The business cares little for the technical distinctions of the underlying data management "black box." Business data is business data, with the main concerns being its veracity and value. Accountability, transparency, quality and reusability are required, regardless. Data needs to be trusted, so decisions can be made with confidence, based on facts. We need to embrace this paradigm shift, while ensuring it fits seamlessly into our existing data management practices as well as interactions with our partners within the business.

Therefore, the challenge of adopting NoSQL in an organization is two-fold: 1) mastering and managing this new technology and 2) integrating it into an expansive and complex infrastructure.

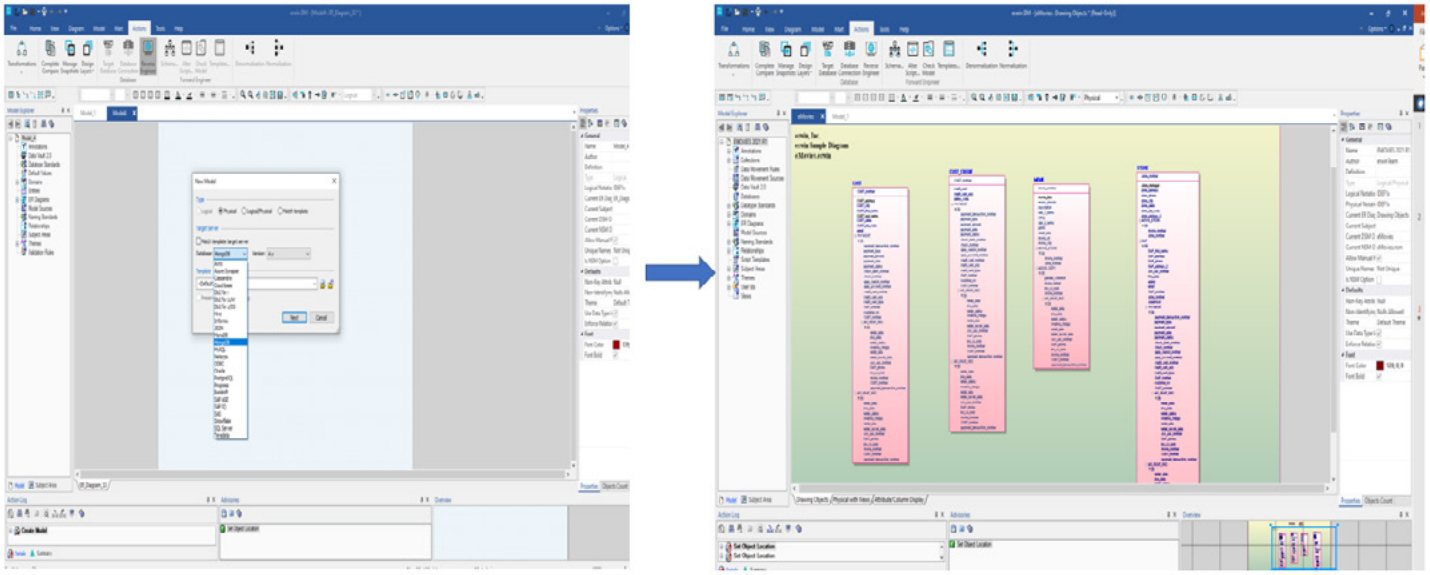
A Historical Perspective of Database Design

SQL (Structured Query Language) is a traditional programming language used to manage data in a relational database.

It has been widely adopted because it helps to maintain the referential integrity, constraints, normalization and structured access for data across disparate systems.

Traditional database design, focused on normalization and storage optimization, has been driven by the technological playing field of the day and the belief that normalization and the resulting referential integrity it provided was paramount. Relational database platforms thrived on this model that provides in-depth capabilities and mechanisms to manage data with integrity. The upside of this design is the reduction in complex application code to maintain the data. The downside is the loss of flexibility in data structures due to rigid schema requirements. Querying is also very complex, requiring lots of joins that results in less than stellar performance.

For the majority of historical data use cases, these were trade-offs we were willing to make because we could allocate more resources when query performance was paramount but real- and near-time performance requirements were not the norm. But when we look at new data use cases, development technologies and techniques, and the DBMS capabilities and behaviors they demand, the database design deck has been shuffled. The needs for real-time access and analysis drive demand for real-time performance. Therefore, query performance is now king from a design perspective. We have the new platforms, technologies and application developers to manage the risk of de-normalization, and we can now embrace it in pursuit of simplified querying and high-performance response.



Import erwin Data Modeler model, reverse-engineer NoSQL instances, create new NoSQL models.

Query-Optimized Database Design

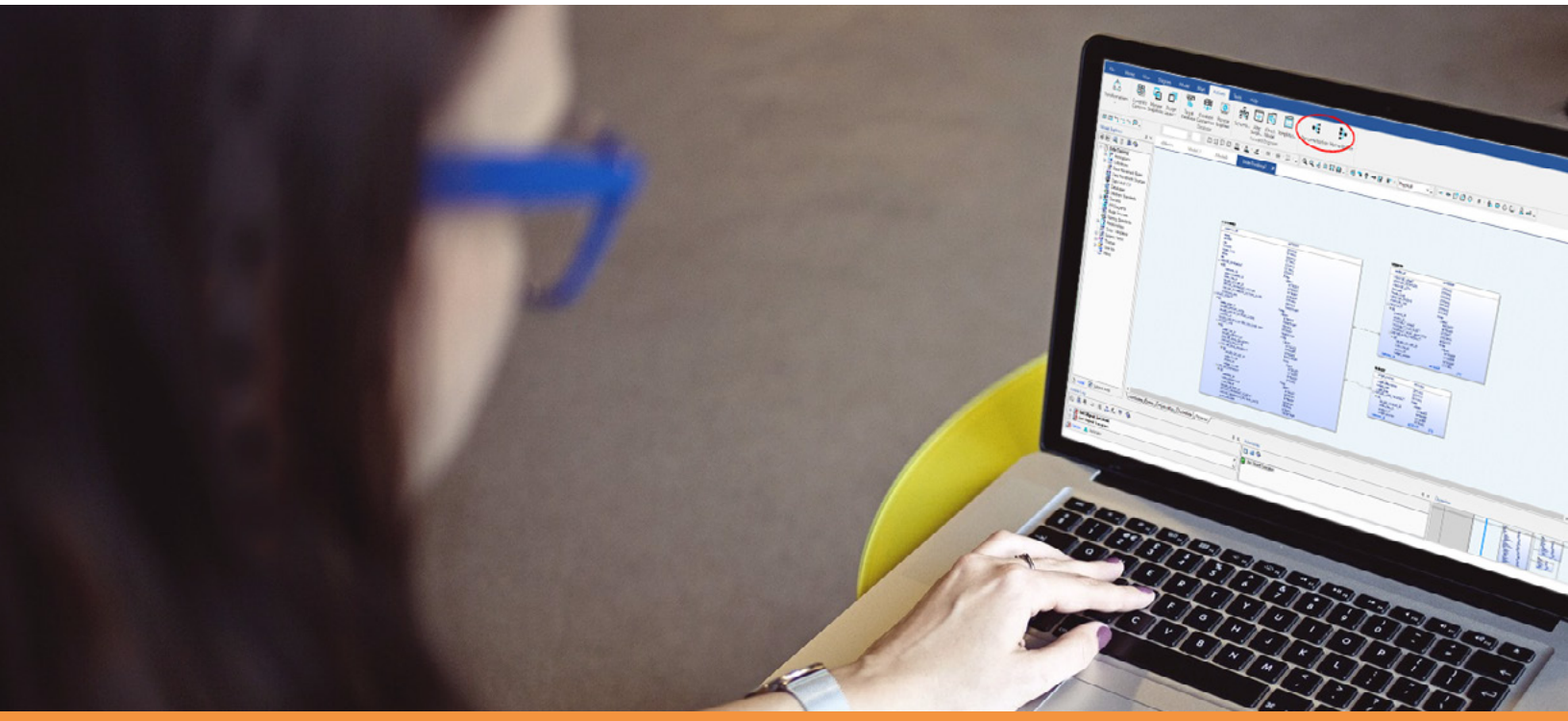
Couchbase, Cassandra and MongoDB are fast NoSQL databases, providing high performance with high availability.

They scale easily and offer rich query language in addition to flexible storage that does not require pre-defined tables with keys and relationships. Couchbase, Cassandra and MongoDB allow you to index attributes for performance with multiple, simultaneous database connections to increase throughput with asynchronous queueing. Unfortunately, NoSQL is not a cure for all your performance woes. A single complex query can bring your code to a grinding halt, and the design of the JSON-like documents and collections has a major impact on the performance of applications accessing Couchbase and MongoDB and their associated queries.

NoSQL design considerations and structures are radically different, even counterintuitive, and not what traditional database administrators and data modelers are used to. In the NoSQL world, there are no data normalization or storage rules. In fact, denormalization and duplications often are encouraged to make queries faster, making business operations more efficient. In addition, joins are rarely supported. They are instead the responsibility of the application code, so you need to consider this before structuring your data because application joins are expensive and will impact query times.

The net-net is that we used to design database schema based on what needs to be stored. The storage-optimized model ensured efficiency and integrity in data storage. With NoSQL, we now design data structures based on the questions we want the data to answer: What do I want to achieve with this information? What queries typically need to be run? How frequently do I need to create, read update and/or delete data? New development technologies allow us to manage the risk to data integrity, so now we can structure data with the emphasis on simple queries and response speed.

Data modeling can guide you through this paradigm shift, enabling you to successfully incorporate modern database design into your data management practices and take the pain out of adopting NoSQL.



Tried-and-True Data Modeling

Data modeling is a rigorous discipline with numerous benefits:

Using a visual method of collecting data requirements, specifying and organizing them with proven notations, and collaborating around the model to ensure the data aligns to the business need. It allows data requirements analysis and design to be done in a rigorous, efficient and effective way by breaking down complexity, incorporating multiple perspectives, and documenting the details in a centralized and malleable fashion. Data modeling tools automate many time-consuming tasks, accelerating the delivery of value to the enterprise. With NoSQL, the motivations and resulting structures might be different, but the method and benefits of data modeling are largely the same.

VISUALIZATION AND DOCUMENTATION OF CONTENT AND STRUCTURE

Using a rigorous approach with a graphically rich visualization of business data requirements enables team members to understand, contribute and optimize business data sources. Specification, verification and organization of data elements is efficient and effective, ensuring completeness, connectivity and alignment with organizational standards.

With erwin Data Modeler, you can use proven logical entity relationship diagrams (things, details about things, and relationships between things) to capture and organize business data requirements and then transform these requirements in a native document format for deployment as NoSQL databases or JSON or AVRO files.

GUIDED DESIGN TRANSFORMATION

Leveraging data modeling to guide and execute structural transformation helps database designers to deploy and analyze multiple scenarios in a low-cost, low-risk, easy-to-consume fashion. Abstracting the design allows architects to try different structures, employ normalization and de-normalization rules, and better understand the costs and benefits of these optimization strategies long before any technology goes into production. This capability ensures that the application is ready for prime time.

At erwin, we provide three conversion options: 1) normalized that reflects a traditional SQL approach, 2) de-normalized with tables embedded as much as possible, and 3) custom that allows you to choose what to embed and what to make a reference. In all three cases, erwin guides you through the process and manages the mapping and construction of the resulting structural changes.

Tried-and-True Data Modeling

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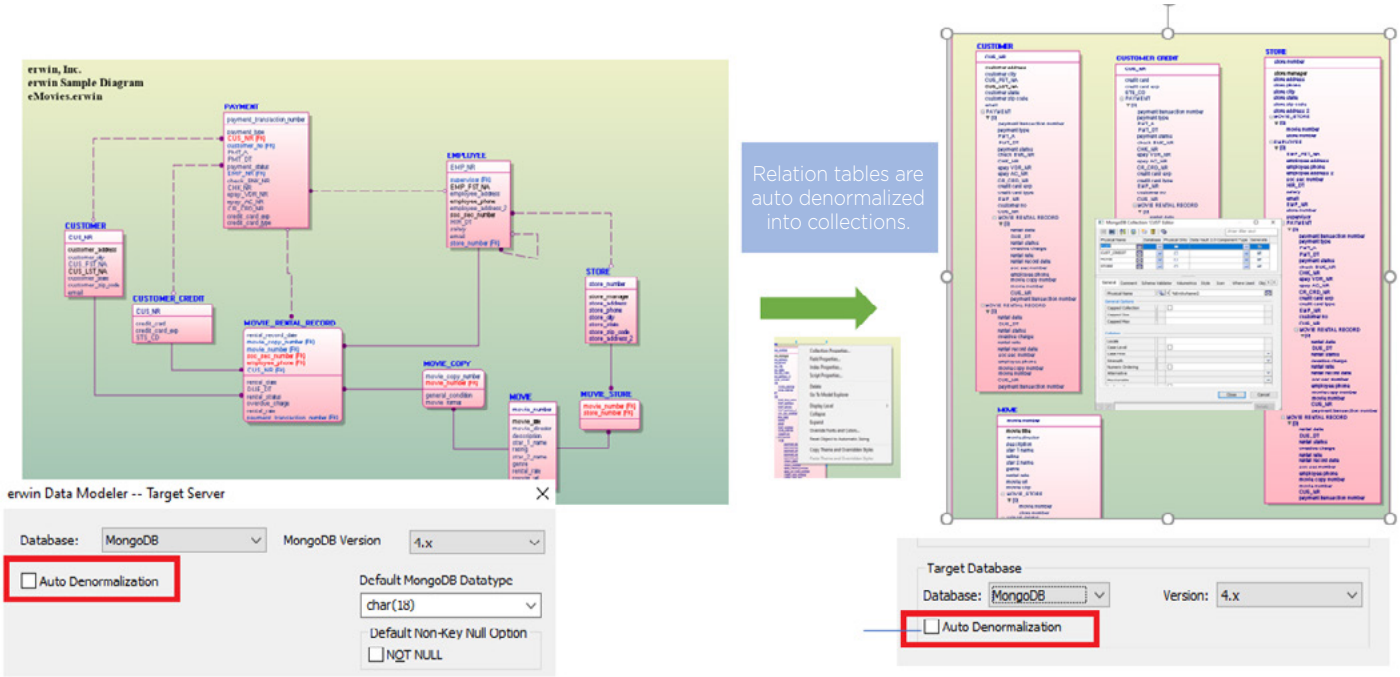
TASK AUTOMATION FOR DATA DEFINITION AND DATABASE DEPLOYMENT

History has shown that a model-driven approach will not work unless there's sufficient automation for designing patterns and accelerating deployment tasks once the model is finished. The abilities to create models automatically by reading the DBMS catalog (reverse-engineering) and generate the structures from the model (forward engineering) are critical. Both model development and database deployment are then accelerated, saving countless hours of manual analysis, construction and coding. At erwin, we provide round-trip engineering for legacy databases, as well as Couchbase, Cassandra and MongoDB in the NoSQL world.

STAKEHOLDER COLLABORATION

These two proverbs continue to ring true: "It takes a village to raise a child," and "a picture is worth a thousand words." To ensure your application and the data it serves is ready for prime time, you need to incorporate feedback from a variety of technical and non-technical partners from within the business. A visual model is the best way to promote understanding and garner feedback in the development process. It's tough to grasp complex concepts from code or even pseudo-code, so having the ability to visualize a structure from inception through finish with multiple iterations in between is invaluable. erwin Data Modeler WorkGroup Edition enables teams to collaborate on model development and governs the process with granular versioning and lifecycle management. Business stakeholders on the frontend and developers on the backend of the process can visualize the models using PDFs that can be exported from erwin Data Modeler. Or they can use erwin Data Modeler Navigator Edition to browse, visualize and analyze the models to increase their understanding of and effectiveness in using the data or building applications that utilize the database.



Create NoSQL models using auto denormalization with collections and fields, arrays and definitions.

erwin Data Modeler NoSQL Workflow

Organizations are transitioning to NoSQL and need data modeling capabilities to help them successfully adopt this modern database technology.

That's why we integrated NoSQL data modeling into erwin Data Modeler. We want to help our customers take advantage of NoSQL, while maintaining the integrity, quality and governance of their underlying business-critical information.

erwin Data Modeler takes the pain out of designing high-performance NoSQL structures. Our model-driven approach enables you to master and manage this new technology, seamlessly integrating it into existing processes and data management infrastructures.

Following are three use cases for erwin Data Modeler NoSQL with Query-Optimized Modeling. The solution supports data modeling for Couchbase, Cassandra and MongoDB.

MIGRATING LEGACY DATABASES

- If you're migrating a legacy database that you have previously remodeled, re-target your erwin Data Modeler to the NoSQL DBMS target of your choice. If no data model exists, use erwin Data Modeler to reverse-engineer a model and then re-target the DBMS.
- Utilize our automated naming standard's glossary to ensure semantic consistency of your NoSQL data sources.
- Utilize the physical model editors to manage the structure and physical DBMS parameters.
- If you are using erwin Data Modeler WorkGroup Edition, save the model to your desired library, which will maintain versions of the model for ongoing development. If you are using the Standard Edition, save your model to your file system.
- Forward-engineer the DDL and deploy to NoSQL target selected.
- Publish the model in a PDF or to erwin Data Intelligence for wider visibility and consumption.

DOCUMENTING AND OPTIMIZING PREVIOUSLY DEPLOYED DOCUMENTS AND COLLECTIONS

- Use erwin Data Modeler to reverse-engineer from the NoSQL target of your choice, whether on premises and in the cloud.
- Utilize the physical model editors to manage the structure and physical DBMS parameters.
- If you are using erwin Data Modeler WorkGroup Edition, save the model to your desired library, which will maintain versions of the model for ongoing development. If you are using the Standard Edition, save your model to your file system.
- Utilize our automated naming standard's glossary to ensure semantic consistency of your NoSQL data sources.
- Forward-engineer the DDL and deploy to the NoSQL target selected.
- Publish the model in a PDF or to erwin Data Intelligence for wider visibility and consumption.

erwin Data Modeler NoSQL Workflow

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DEVELOPING NET-NEW DESIGNS FOR DEPLOYMENT

- If you're developing a net-new application, collaborate with business stakeholders and subject-matter experts, and then use erwin Data Modeler to create a logical model identifying, specifying and organizing your business data requirements. Focus on entities, attributes, keys, business names, business rules and meaningful definitions.
- Switch to the physical model and select one of our NoSQL DBMS targets to create a document model complete with de-normalization and embedded collections.
- Utilize our automated naming standard's glossary to ensure semantic consistency of your NoSQL data sources.
- Utilize the physical model editors to manage the structure and physical DBMS parameters
- If you are using erwin Data Modeler WorkGroup Edition, save the model to your desired library, which will maintain versions of the model for ongoing development. If you are using the Standard Edition, save your model to your file system.
- Forward-engineer the DDL and deploy to the NoSQL target selected.
- Publish the model in a PDF or to erwin Data Intelligence for wider visibility and consumption.

About erwin by Quest

erwin is a leader in enterprise modeling and data intelligence software. The erwin EDGE platform creates an enterprise data governance experience for IT and business collaboration, driving meaningful insights, agile innovation, risk management and business transformation. Integrated data modeling, data governance, enterprise architecture and business process modeling capabilities help guide smart decisions. With erwin, organizations of all types across the globe can maximize the security, quality and value of their assets to control data chaos and prepare for the next IT challenge.

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