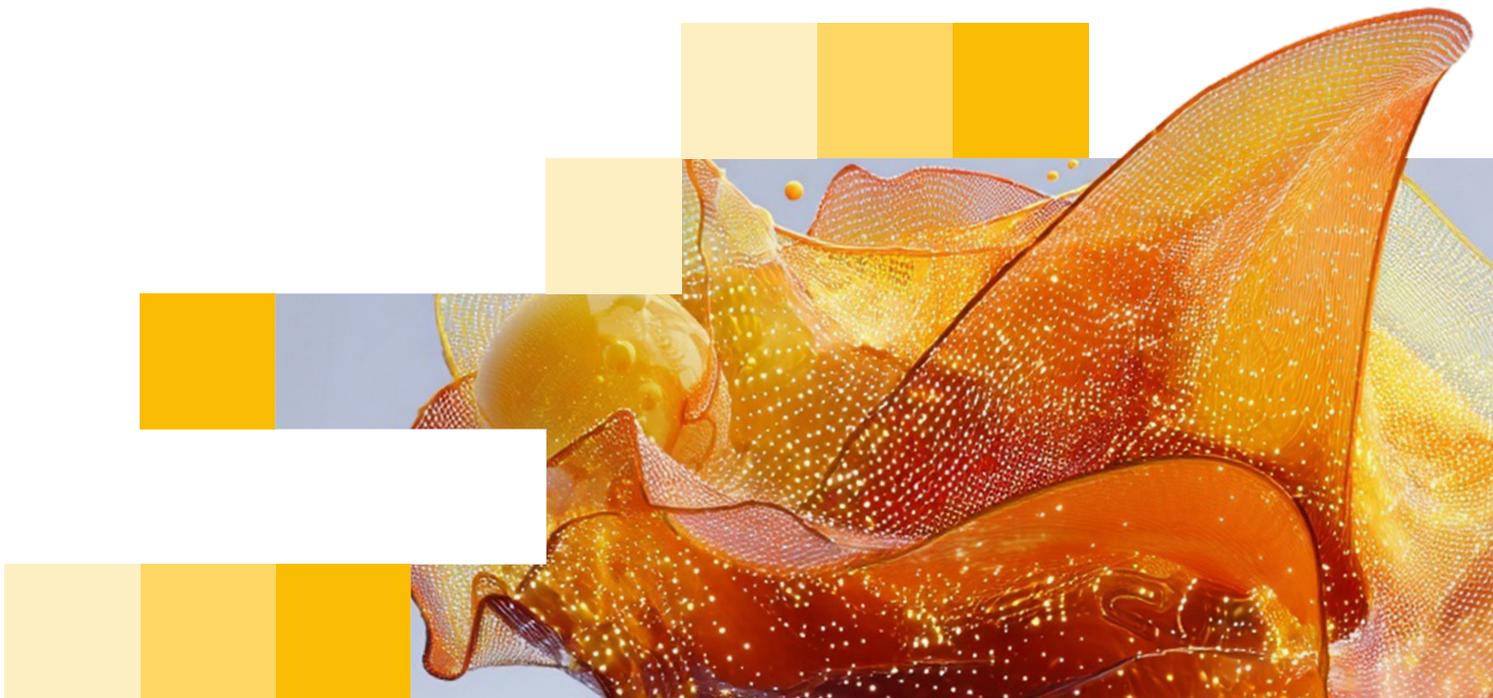


Accelerate database modernization with AI

How AI is driving faster database migration
and smarter operations



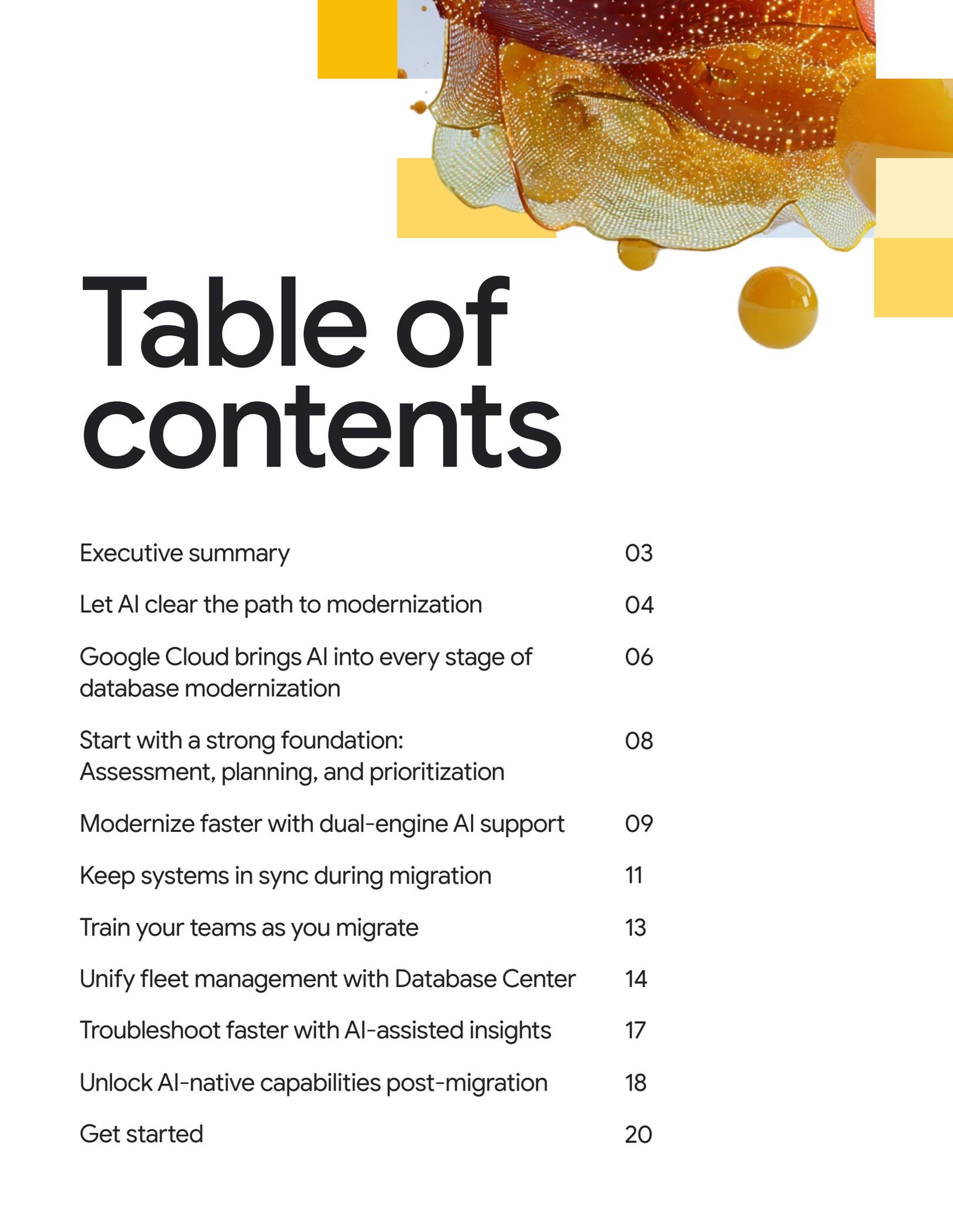


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Executive summary

Legacy databases are holding organizations back. With high licensing costs, operational complexity, and limited support for modern, AI-driven workloads, the need to modernize is clear. However, the path forward has historically been slow due to the complexity involved and risks for business continuity. Google Cloud is changing that.

This whitepaper explores how Google Cloud is rethinking every stage of database modernization and management with AI built in from day one. Whether you're moving off legacy platforms like SQL Server or planning a full portfolio modernization, Google Cloud provides the tools to move faster, reduce risk, and unlock new value from your data.

Google Cloud's Database Migration Service (DMS) streamlines the move to PostgreSQL with a dual-engine approach. A deterministic engine handles standard schema and code conversion, while Gemini auto-conversion uses built-in generative AI to translate complex procedural logic, explain changes, and help build repeatable migration patterns. AI guidance is embedded in the workflow, so teams not only convert code but get trained in PostgreSQL dialect and features in the process.

Once in the cloud, Database Center provides a single console to monitor and manage your entire database fleet, including Cloud SQL, AlloyDB, Spanner, Bigtable, Firestore, and more. Gemini Cloud Assist powers intelligent diagnostics, natural-language insights, and actionable recommendations across performance, security, compliance, data protection, availability, and cost. Even teams without much database administrator (DBA) experience can operate database landscapes with confidence.

Google Cloud databases also come AI-ready out of the box. Developers can use natural language to write SQL, run vector searches, generate embeddings through Vertex AI integration, and embed reasoning directly in queries. These capabilities make it easier to build intelligent applications and real-time analytics workflows without managing infrastructure or stitching together third-party tools.

Across the lifecycle, from code conversion to long-term optimization, Google Cloud enables faster migrations, smarter operations, and better outcomes with AI at the core. If you're ready to move beyond legacy systems and build what's next, this whitepaper offers a roadmap for how to get there.

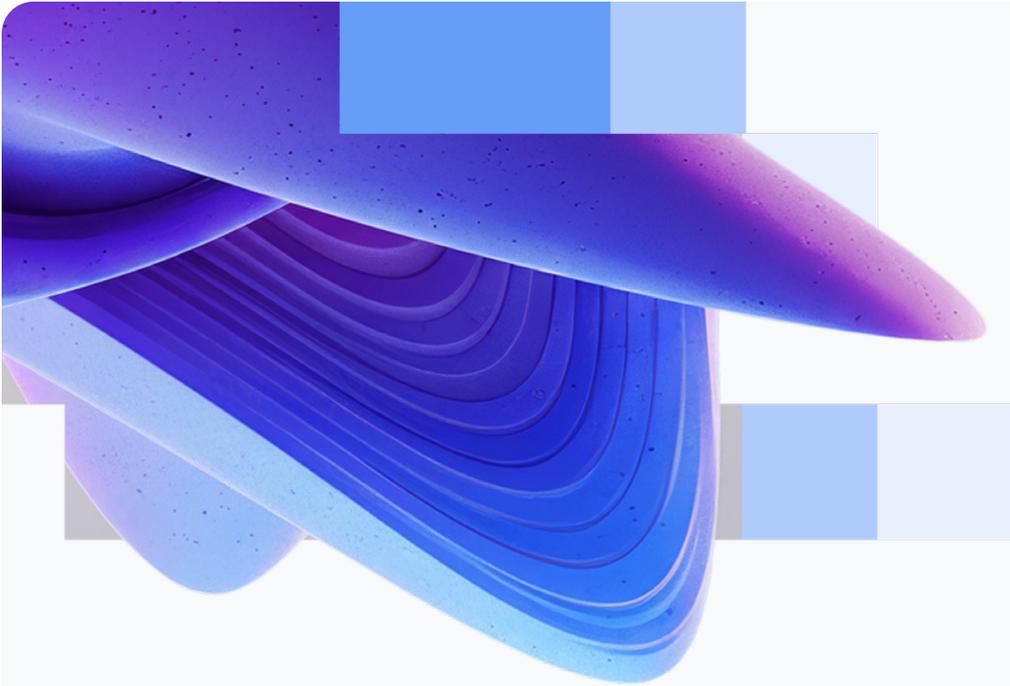
Let AI clear the path to modernization

Moving off legacy databases is hard. Managing what comes after can be even harder.

The reasons to modernize your databases are clear: legacy systems like SQL Server are expensive to maintain, locked behind rigid licensing, and often incompatible with cloud-first goals. But getting there is rarely simple.

Some straightforward workloads may still require code translation and architectural changes. Most tools only cover the basics, leaving teams to untangle edge cases and rewrite logic by hand, often in code no one's touched in years. With critical systems on the line, there's little room for trial and error.





57%

of organizations cite skill set gaps and training as their biggest challenge in managing diverse database technologies, up from just 38% a year earlier.¹

What comes after: complexity at scale

Once in the cloud, database operations can still be complex. Different databases often mean different monitoring tools, different teams, and disconnected workflows. This slows down troubleshooting and limits visibility.

DBAs and site reliability engineers (SREs) are spread thin, while developers, often lacking formal database training, are expected to take on more responsibilities. The demand for database expertise continues to outpace available skills in the market. And as generative AI raises expectations, even experienced teams struggle to keep up without unified tools.

AI-first modernization is redefining what's possible

These challenges aren't new, but the way organizations address them is changing fast. Across Google Cloud's database portfolio, AI is making it easier to tackle long-standing pain points, from code conversion and fleet monitoring to performance tuning and security hardening.

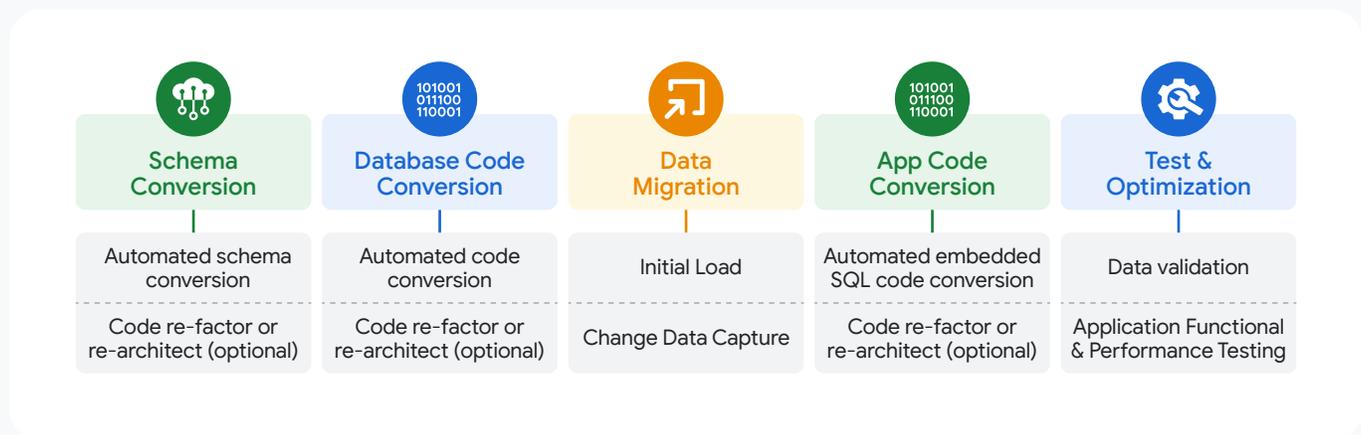
Today, teams can migrate off legacy systems with speed and confidence. Once in the cloud, they can manage fleets across Cloud SQL, AlloyDB, Spanner, Bigtable Memorystore, and Firestore with smarter tools that surface insights, flag risks, and automate routine tasks.

1. [2025 State of the Database Landscape](#), Redgate. Survey of ~2,500 IT professionals worldwide.

Google Cloud brings AI into every stage of database modernization

Google Cloud is rethinking the entire migration and management journey by infusing AI into the process. Whether you're modernizing a single database or planning a fleet-wide migration, AI now plays an active role in accelerating progress and reducing risk. Teams can move faster and with fewer surprises along the way.

AI support across the migration lifecycle



More specifically, AI assists your teams in the following modernization phases:

- **Schema and code conversion:** Gemini translates procedural logic and explains changes.
- **Team enablement:** AI-powered insights help teams learn and validate as they migrate.
- **Fleet operations:** Post-migration, Gemini supports diagnostics, performance tuning, and fleet-wide observability.
- **AI-native innovation:** Cloud databases support natural language queries, vector search, and semantic ranking out of the box.

Along the way, AI helps teams build knowledge they can reuse on future workloads. By embedding insight and guidance directly into familiar tools, Gemini turns day-to-day tasks into opportunities to learn and improve.

For example, once you're in the cloud, tools like [Database Center](#) and system insights make it easier to monitor and manage your database fleet—even if your team isn't made up of lifelong DBAs. Gemini surfaces performance bottlenecks, explains slow queries in plain language, and recommends fixes inside tools like [AlloyDB Studio](#) and [Cloud SQL Studio](#).

A smarter database from day one

Google Cloud offers a full portfolio of fully managed, AI-enabled databases. Cloud SQL, AlloyDB, Spanner, Bigtable, and Firestore each support modern workloads and scale across regions. But what sets them apart is intelligence:

- **Natural language in SQL** supports writing queries in plain English.
- **Vector search and semantic operators** power multimodal and AI application use cases.
- **AI-enabled databases** integrate smoothly with the Google Cloud AI ecosystem, including Vertex AI and open-source frameworks like LangChain and LlamaIndex.
- **Gemini diagnostics** help teams find and fix issues faster.

As you can see, there are many benefits of having AI work alongside your teams during the modernization journey. Now let's explore what this looks like in practice.

“

This is the kind of AI-powered solution that can truly transform how we operate.”

Kristofer Sikora,
Executive Director, Cloud Data Engineering, CME Group

 CME Group



Start with a strong foundation

Assessment, planning, and prioritization

Before migration and modernization, teams need a clear picture of what they're working with. What data exists and where? How do applications interact with it? How much code needs converting, and which systems carry the most risk?

To answer those questions, organizations can start with discovery and assessment tools like [Database Migration Assessment \(DMA\)](#) and [Migration Center](#). These tools scan your environment, inventory schema structures, flag procedural logic, and estimate migration complexity.

Assess the landscape before you move

With DMA, teams can evaluate schema structure, understand dependencies, and uncover procedural code that might slow down conversion. For legacy platforms like SQL Server, this is especially important because custom logic and embedded code often require careful evaluation.

By identifying high- and low-complexity workloads early, teams can validate compatibility, improve confidence, and plan for migration in structured waves. They can start small and scale up with repeatable patterns.

What DMA enables before migration:

- Inventory schema structure and flag procedural logic
- Estimate code complexity and potential blockers
- Validate compatibility before moving data
- Surface metadata to inform migration planning
- Prioritize low-risk workloads for early wins
- Train teams incrementally using real assessment data

Plan in waves, not in isolation

No two migrations are alike, but that doesn't mean each one should be treated as a one-off. With insights from DMA and Migration Center, teams can sequence migrations based on complexity, readiness, and business impact. Starting with lower-risk databases helps teams build confidence, establish repeatable patterns, and reduce disruption to the business.

Just as important, this early planning helps set the stage for AI-assisted execution later on—when tools like Gemini can streamline conversion, validation, and performance tuning. A structured approach today leads to smarter systems tomorrow.

Modernize faster with dual-engine AI support

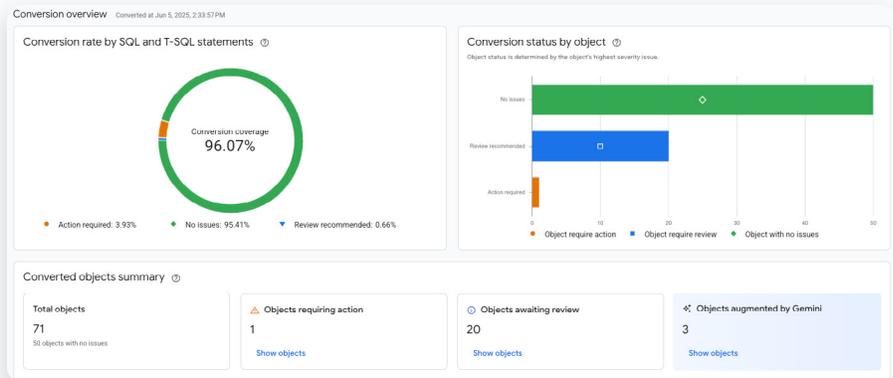
Legacy systems often contain decades of custom business rules, stored procedures, and embedded SQL. Rarely do they cleanly map to open-source databases like PostgreSQL. Manual conversion is time-consuming and error-prone. But [Database Migration Service](#) (DMS) simplifies this process with a dual-engine approach to modernization.

Two engines. One streamlined path forward.

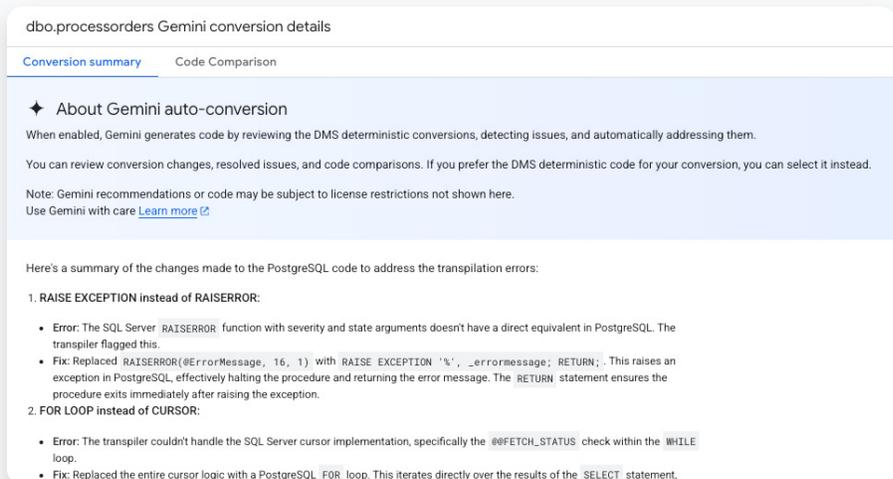
DMS uses a two-part system to automate and explain code conversion: First, a deterministic engine converts standard schemas, stored procedures, and SQL commands. Then, Gemini steps in to translate complex or custom code and provide a comprehensive report to explain the conversion logic and facilitate an informed review.

How it works:

- DMS converts schema and procedural code using algorithmic logic.
- Gemini analyzes the remaining unconverted logic.
- Gemini applies AI-generated translations.
- A conversion report explains what changed, why, and how.



Database Conversion Dashboard



Gemini Conversion Report

```
SQL Server (read-only)
1
2 CREATE PROCEDURE ProcessOrders
3   @BatchId INT,
4   @Success BIT OUTPUT,
5   @ErrorMessage VARCHAR(MAX) OUTPUT
6 AS
7 BEGIN
8   SET @Success = 1;
9   SET @ErrorMessage = '';
10
11  DECLARE @OrderId INT;
12  DECLARE @CustomerId INT;
13  DECLARE @OrderDate DATETIME;
14  DECLARE @TotalAmount DECIMAL(18, 2);
15
16  BEGIN TRY
17    BEGIN TRANSACTION;
18
19    IF NOT EXISTS (SELECT 1 FROM Batches WHERE BatchId = @BatchId)
20    BEGIN
21      SET @Success = 0;
22      SET @ErrorMessage = 'Invalid batch ID.';
23      RAISERROR(@ErrorMessage, 16, 1);
24    END;
25
26
27    DECLARE order_cursor CURSOR FOR
28    SELECT OrderId, CustomerId, OrderDate, TotalAmount
29    FROM Orders
30    WHERE BatchId = @BatchId;
31
32    OPEN order_cursor;
33
34    FETCH NEXT FROM order_cursor INTO @OrderId, @CustomerId, @OrderDate, @TotalAmount;
35
36    WHILE @@FETCH_STATUS = 0
37    BEGIN
38
39      UPDATE Products
40      SET Quantity = Quantity - (SELECT Quantity FROM OrderItems WHERE OrderId = @OrderId AND
41      ProductId = Products.ProductId)
42      WHERE ProductId IN (SELECT ProductId FROM OrderItems WHERE OrderId = @OrderId);
43
44
AlloyDB for PostgreSQL augmented by Gemini
1 CREATE OR REPLACE PROCEDURE dbo.processorders(_batchid INTEGER, INOUT _success BOOLEAN, INOUT
2 _errorMessage VARCHAR)
3 LANGUAGE plpgsql
4 AS $$
5 DECLARE
6   _orderid INTEGER;
7   _customerid INTEGER;
8   _orderdate TIMESTAMPTZ;
9   _totalamount DECIMAL(18, 2);
10  _discount DECIMAL(18, 2);
11 BEGIN
12   _success := TRUE;
13   _errorMessage := '';
14
15   IF NOT EXISTS (SELECT 1 FROM dbo.batches WHERE batchid = _batchid) THEN
16     _success := FALSE;
17     _errorMessage := 'Invalid batch ID.';
18     RAISE EXCEPTION '%', _errorMessage;
19     RETURN;
20   END IF;
21
22   FOR _orderid, _customerid, _orderdate, _totalamount IN
23   SELECT OrderId, CustomerId, OrderDate, TotalAmount
24   FROM dbo.orders
25   WHERE BatchId = _batchid
26   LOOP
27     UPDATE dbo.products
28     SET quantity = quantity - (SELECT quantity FROM dbo.orderitems WHERE orderid = _orderid AND
29     productid = products.productid)
30     WHERE productid IN (SELECT productid FROM dbo.orderitems WHERE orderid = _orderid);
31
32     _discount := CASE
33                   WHEN _totalamount > 1000 THEN 0.10
34                   WHEN _totalamount > 500 THEN 0.05
35                   ELSE 0
36                 END;
37
38     INSERT INTO dbo.invoices (orderid, invoicedate, amount, discount)
39     VALUES (_orderid, CURRENT_TIMESTAMP, _totalamount, _discount);
40
41     INSERT INTO dbo.orderlogs (orderid, logmessage)
42     VALUES (_orderid, 'Order processed successfully.');
```

Converted Code

Enhance code post-conversion

With schema and code converted, the Gemini conversion assistant takes the next step. It refines the code for better performance and adds embedded comments to improve readability and maintainability. These enhancements help fully modernize the code, moving it beyond simple translation.

This refinement reduces manual effort and frees teams to focus on validating business logic. Even complex migrations move faster and maintain full control. With the code ready, teams can transition to production data transfer with consistency, speed, and no surprises for end users.



Keep systems in sync during migration

Migrating data is often the most sensitive phase of modernization. But DMS is designed for this moment. It handles bulk data transfer, real-time sync, and low-downtime cutovers, all from a single interface.

Designed for speed, built for control

DMS starts with a high-throughput initial load, optimized to move large volumes of data efficiently. It partitions the source data and processes multiple threads in parallel, dramatically reducing time-to-sync – even for multi-terabyte or multi-tenant environments.

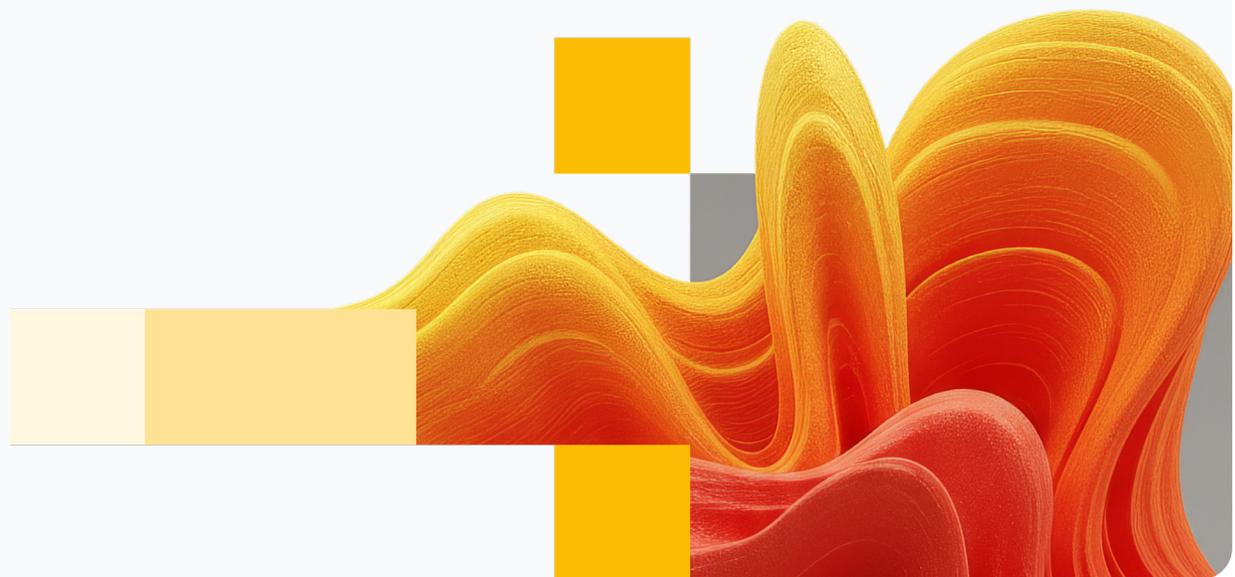
Once the bulk load completes, DMS seamlessly transitions into change data capture (CDC) mode. Ongoing transactions from the source are continuously replicated to the destination, so production systems can stay online while the migration finishes in the background.

From the user's perspective, nothing changes. From the engineering team's perspective, the destination stays seconds behind the source. They get full control over when and how to cut over.

“

This makes the migration process less manual and time-consuming, allowing teams to spend more time on development and less on infrastructure.”

Shashank Srivastava,
Software Engineering Manager,
Wayfair



One interface from start to finish

All this happens in the same DMS interface, no bolt-on tools or handoffs required. Teams configure the migration, watch progress, monitor sync, and execute cutover all in one place.

- **Configure source and destination**
Select your existing database and your PostgreSQL target.
- **Perform initial load**
DMS bulk loads data from source to destination using parallel threads for speed and scale.
- **Enable CDC (Change Data Capture)**
Real-time replication starts, syncing ongoing transactions to keep both systems aligned.
- **Monitor sync status**
Watch for lag, throughput, or anomalies – all from the same UI.
- **Execute cutover**
Pick a low-traffic window to make the switch and promote the destination database.

For critical systems like ERP, logistics, e-commerce, downtime isn't an option. DMS helps teams complete high-volume, high-stakes migrations with minimal business impact. Everything is designed to reduce rework, preserve data integrity, and keep operations running smoothly.



Train your teams as you migrate

Modernization is a learning curve. Moving from systems like SQL Server to PostgreSQL introduces unfamiliar concepts, from procedural language differences to new performance patterns. But with Gemini embedded in DMS, training doesn't have to happen before or after migration. It happens during.

The Gemini conversion assistant acts like a personal tutor, guiding DBAs and developers through PostgreSQL dialect, features, and conversion patterns. It covers everything from the basics of function creation and variable declaration to advanced topics like dynamic SQL and cursor optimization.

By embedding this guidance in the workflow, developers save time they'd otherwise spend researching syntax or features. They can validate and test converted code with confidence, while teams build best practices they can carry into future projects.

Faster onboarding and growing velocity

What once took months could now be achieved in days. Not because corners are being cut, but because teams are learning as they go.

For organizations modernizing at scale, this creates a powerful feedback loop. Lower-risk workloads become live-fire training grounds. Teams gain experience, refine their process, and reduce friction before moving on to complex, business-critical systems.

Key questions Gemini helps answer during migration:

- What does this stored procedure do?
- Why did you use this PostgreSQL function?
- Will this run as fast as it did before?
- What's the performance impact of this rewrite?
- How should I test this logic in PostgreSQL?



Unify fleet management with Database Center

Migrating to a modern database platform is just the beginning. Now teams must manage a growing fleet of cloud databases across multiple engines, environments, and teams. Without a centralized approach, operational work becomes fragmented and reactive, especially at scale.

Database Center brings cohesion to fleet-wide management. It provides a single interface for overseeing your entire Google Cloud database estate, including Cloud SQL, AlloyDB, Spanner, Bigtable, Firestore, and Memorystore. Instead of siloed dashboards and ad hoc scripts, observability, diagnostics, and optimization tools are unified in one place.

Included with your fully managed database service

Database Center is available at no additional cost for all Google Cloud managed databases. Advanced AI and security capabilities are available through Gemini Cloud Assist and Security Command Center.



What Database Center enables

With real-time visibility into the health, performance, and configuration of your fleet, teams can troubleshoot issues, strengthen security posture, and reduce operational overhead.

Capabilities include:

- Comprehensive fleet visibility with custom views and weekly snapshots
- Proactive performance, security, and compliance insights, including index recommendations, hotspot detection, and security alerts
- Assistive troubleshooting with natural-language diagnostics and optimization suggestions

By consolidating signals across services and surfacing actionable insights, Database Center helps teams move from reactive to proactive. As Gemini capabilities evolve, Database Center is offering even more assistance. It helps teams generate diagnostics in natural language and manage increasingly complex environments with less effort.

The screenshot displays the Google Cloud Database Center interface. The main dashboard shows a 'Fleet inventory' section with a donut chart indicating 557 database groups. Below the chart is a table with columns for Product & version, Groups, Resources, and 7-day increase. The table lists MySQL 8.0, MySQL 5.7, Spanner, AlloyDB, and PostgreSQL 11. To the right, there are several issue categories: Availability (5 issues), Data protection (5 issues), Security (15 issues), Performance & capacity (18 issues), Other (3 issues), Cost (3 issues), and Industry compliance (3 issues). Each category includes a list of specific issues with links to 'Show affected resources'. Overlaid on the right is the 'Cloud Assist' chat window, which provides a natural language response to the question 'Are all my production databases highly available?'. The response states that 3 of the production databases are not highly available and provides a table of the affected resources. The table has columns for 'Issue' and 'Resource #' and lists 'Resource not failover protected' with a count of 3. Below the table, the chat window shows the query used to obtain the results: 'Filtering by: labels.key'environment' AND labels.value'production'' and 'Finding signals: Availability configuration'. There are also options to rate the answer and a prompt input field.

Product & version	Groups	Resources	7-day increase
MySQL 8.0	37	76	3 ↓
MySQL 5.7	12	26	1 ↑
Spanner	7	7	3 ↓
AlloyDB	4	21	18 ↑
PostgreSQL 11	2	5	3 ↑
Total	62	135	16 ↑

Issue	Resource #
Resource not failover protected	3

Database Center automatically surfaces fleet health issues and recommendations. With Cloud Assist, you can ask ad-hoc questions about database health and get tailored responses immediately.

What customers are saying

Organizations managing hundreds or thousands of databases are already seeing value.



“Database Center has given us unparalleled insight into our database landscape. The robust monitoring and observability tools have allowed us to proactively identify and address potential issues before they impact our users.”

Bogdan Capatina, Technical Expert in Database Technologies, Ford Motor Company



“Database Center perfectly aligns with our vision of database observability — delivering a single, unified view just like we monitor our on-prem databases. It simplifies management, strengthens security compliance, and sets the standard for how database oversight should be: seamless and comprehensive.”

Sangeeth Talluri, Senior Principal Architect, Home Depot



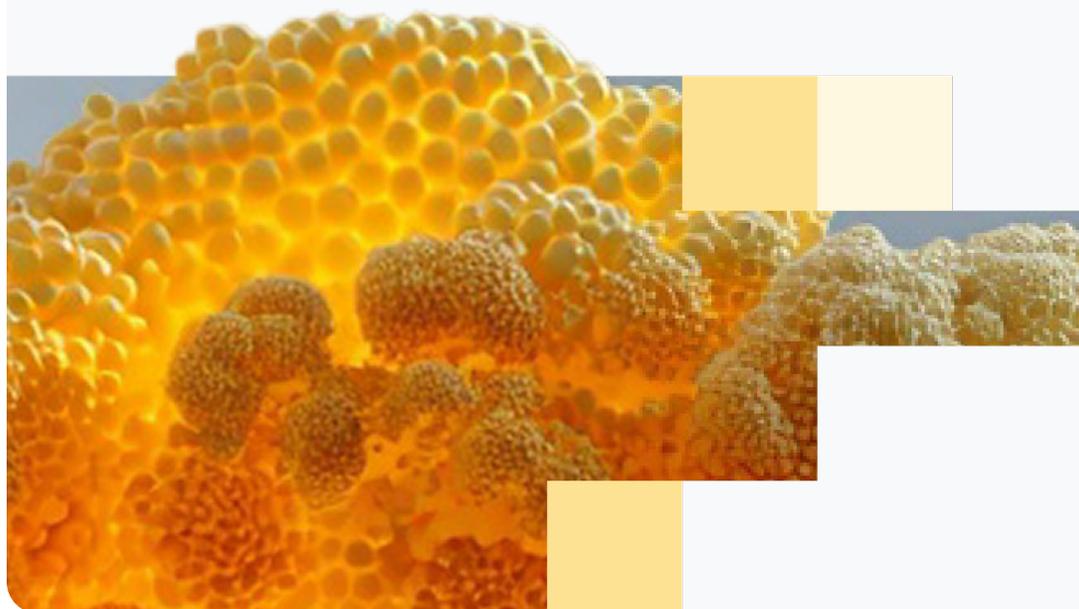
“Database Center offers a comprehensive overview of the entire database landscape and serves as a central hub for navigating and taking action on any database within TELUS.”

Kurt Harsft, Manager Information Services, Telus



“The ability to effortlessly access comprehensive infrastructure health, security, compliance, alerts, and data protection across the entire fleet through the Database Center is truly a game-changer, providing exceptional value and peace of mind.”

Rahul Jain, Engineering Manager, UKG



Troubleshoot faster with AI-assisted insights

Database performance issues are rarely straightforward. Spikes in latency, slow queries, or resource saturation may show up in dashboards, but diagnosing the root cause still takes time and expertise. As developers and application teams take on more operational responsibility, many lack the background to dig into query plans or system metrics.

That's where AI-assisted troubleshooting helps. With Gemini enabled, Google Cloud integrates AI assistance into tools like [query insights](#) and [system insights](#) to detect, explain, and resolve performance problems without requiring deep DBA expertise.

Gemini continuously monitors your fleet for early signs of degradation. It flags more than just slow queries, including high CPU or memory usage, excessive connections, lock contention, hotspots in index usage, and sudden drops in throughput. Instead of spending hours digging through metrics, teams get a clear diagnosis and next steps before problems turn into incidents.

Fix problems faster with prescriptive guidance

When something's wrong, Gemini explains why it's happening and how to fix it. Recommendations appear directly inside query insights and system insights, where developers can act quickly.

- Suggesting new indexes to improve scan performance
- Recommending query rewrites to reduce sort operations
- Identifying which queries are causing resource spikes

System insights takes it further by correlating CPU, memory, IOPS, and storage to highlight broader performance constraints.

Built for developers, DBAs, and platform teams

AI-assisted troubleshooting helps developers take more ownership of performance earlier in the process. Developers get the guidance they need to fix issues independently. Application teams can monitor performance without deep database expertise. And DBAs and SREs can focus on higher-value optimization instead of triaging routine escalations.

- **Developers:** Optimize queries with clear, in-context recommendations
- **Application teams:** Troubleshoot without needing to dig into query plans
- **DBAs/SREs:** Reduce escalations and focus on long-term performance strategy

Whether you're resolving a bottleneck in Cloud SQL or scaling AlloyDB for peak performance, Gemini helps every team to act faster.

Unlock AI-native capabilities post-migration

Your modernization journey sets the stage for something even more powerful. When your databases are AI-ready from day one, they stop being backend systems and start becoming strategic enablers for your business.

Across Cloud SQL, AlloyDB, Spanner, Bigtable, Memorystore, and Firestore, AI is woven into the fabric of each database. When you're launching a new app, scaling global infrastructure, or building intelligent agents, your databases can now speak natural language, run vector searches, and surface insights in real time.



AlloyDB AI: A launchpad for intelligent apps

For teams building next-gen applications and agentic experiences, AlloyDB offers the richest set of AI-native capabilities.

Developers can:

- Query structured data using plain English
- Combine real-time structured and unstructured data for semantic search
- Use AI operators like AI.RANK() to embed reasoning directly into SQL
- Generate embeddings from text, images, and video using built-in integrations with Vertex AI and DeepMind

Because of these features, AlloyDB AI is ideal for building chat interfaces, recommendation systems, and apps that learn and adapt as they go.

Smarter tools, broader access

With Gemini integrated into tools like system insights and query insights, developers can ask natural-language questions, resolve slow queries, and optimize performance without digging through logs or query plans.

For advanced teams, new AI capabilities expand what's possible:

- Spanner now supports vector search and graph visualization, which is perfect for knowledge graphs and memory in AI agents
- Bigtable adds support for real-time materialized views and Iceberg integration
- Firestore introduces MongoDB compatibility, making it easier to support AI-powered document processing

Built-in intelligence for what's next

Google Cloud databases are ready to support AI-enabled applications the moment you provision an instance. With AI-powered indexing, natural language interfaces, and fleet-wide observability through Database Center, you can build systems that respond in real time, learn from usage, and grow with your business.

“

We used the ability to combine our structured and unstructured data to enhance the accuracy of natural language search queries by 20%.”

Visagan Subburayalu, VP of Infrastructure & Cybersecurity, Target





Get started

AI-ready applications start with AI-ready databases. Whether you're tackling one migration or planning for a full portfolio shift, these steps can help you move with speed – and set the stage for what's next.

- 01 Identify legacy workloads ready for assessment.
- 02 Use tools like DMA to assess schema complexity and migration effort.
- 03 Prioritize low-risk workloads to build repeatable migration patterns.
- 04 Use Database Center to monitor and manage your Google Cloud database fleet in one place.
- 05 Turn on Gemini Cloud Assist to enable AI-powered diagnostics and recommendations.
- 06 Boost developer productivity with natural language capabilities built into SQL queries.

[Learn more and start your free trial](#)