

## IT@INTEL

# Optimizing Intel's Supply Chain with an In-Memory Data Platform

Our new in-memory data platform will transform Intel's supply chain by providing real-time predictive business analytics to enable better, faster decision making.

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### Executive Overview

In today's fast-paced business world, rapid, data-driven decisions are crucial to maintaining a competitive edge. This is especially important for Intel's supply chain, which spans order-taking, resource procurement, manufacturing, testing, and final delivery of product.

We are deploying a new in-memory data platform that has the potential to transform Intel's entire enterprise application and business intelligence (BI) environment. Our first implementation of the in-memory data platform will transform Intel's supply chain by providing real-time predictive business analytics. The platform benefits both the business and IT in the following ways:

- Improves system performance.
- Collapses reporting and transaction layers.
- Consolidates database, data processing, and application capabilities onto a common platform, which eliminates multiple points of failure.
- Uses real-time data, which means fewer data hops between online transaction processing applications and analytic applications. This reduces data latency and time-to-decision, which helps Intel maintain optimal inventory levels.
- Supports self-service analysis, which enables the business to make faster, better decisions without waiting for IT to build reports and new databases.
- Improves data quality by eliminating the need to reconcile data across systems.
- Improves supply chain workflow through a common user interface for multiple applications, which also reduces the amount of training and support that IT teams need to provide to Intel's business units.

The real-time nature of the in-memory data platform supports Intel IT's goal of a dynamic supply chain that can instantly respond to changes. More importantly, we'll be able to build on what we learn with the supply chain implementation, applying real-time data in innovative ways in many other areas of the enterprise.

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## Acronym

**BI** business intelligence

## Sample of Intel Supply Chain Management Applications

### Most Commonly Used

- Allocation management
- Demand planning
- Supply network planning
- Capacity assessment
- Availability assessment
- Event management
- Transportation management

### Other Applications

- Enterprise sales, procurement, inventory management, and financial management
- Warehouse management
- Factory and business unit division planning
- Subcontractor management
- Business-to-business management
- Inventory optimization

# Business Challenge

In 2014, Intel IT's supply chain management applications (see Sample of Intel Supply Chain Management Applications sidebar) supported several major product lines that account for a significant portion of Intel's revenue. Intel's business depends heavily on these applications 24/7. If these applications fail, Intel's business would be affected almost immediately. As Intel enters new markets, supply chain management becomes more volatile and requires more agility powered by real-time business intelligence (BI). Our legacy supply chain management applications were not capable of supporting that need.

Some of the limitations of our legacy supply chain management applications included the following:

- **Data latency.** Our legacy supply chain management process is batch-oriented. We run 200 supply chain management batch jobs per hour. These jobs have dependencies and run on multiple platforms, which caused data latency. The latency hampered Intel's ability to perform real-time supply-and-demand planning. Changes in demand without real-time visibility into the supply chain resulted in delayed decisions or adjustments.
- **Data fragmentation and quality.** The legacy system collected data over multiple hops, which lengthened the time for data collection and required data reconciliation. With the legacy system, the data provided only hindsight information. As a result, Intel's supply chain management teams received limited or historical alerts, analytics, and decision support; the BI came after the fact, with no way to prioritize risks. Decision support was based on expert judgment not on real-time data. Data from one supply chain management application was not necessarily available to the other supply chain management applications.
- **Lack of scalability.** The legacy system consisted of multiple platforms to support diverse groups of users (division and factory planners, outsource buyers, finance, business units, and so on). The data latency, availability, data transformation, and batch process limitations resulted in the creation of multiple BI solutions. Supply chain management applications and their dependencies constantly evolve, averaging one new release per day, making it difficult to easily manage the supply chain. These drawbacks not only impede decision making, but also make it difficult to scale the supply chain planning processes.

Our new in-memory data platform eliminates most of these limitations, providing us with an opportunity to converge toward a single end-to-end supply chain management solution.

# Intel IT's Vision For Real-Time Supply Chain Data

Our vision for 2017 is to have a simplified, transformational, real-time, end-to-end system of supply chain management applications. We plan to fulfill this vision over several years. The first step is to transform the business using BI solutions that allow for visibility and risk management of business events. Next, we will embed integrated analytics and decision support. Finally, we will transform the business with end-to-end integrated business planning.

A single integrated supply chain management platform will provide real-time end-to-end inventory visibility. This will enable us to integrate risk management with business planning, predictive analytics, and scenario analysis. To accomplish this, we need a high-performance in-memory data platform. A real-time supply chain management platform can create a "sense-and-respond" BI solution that will recommend action and influence decisions for increased efficiency. This just-in-time visibility can provide measurable positive business impact through inventory optimization and maximum order fill rates. We anticipate using real-time analytics to focus on decisions that provide the biggest business impact.

Our goals for the in-memory data platform are summarized in Table 1.

## Roadmap for Real-Time Data Implementation

Finished goods inventory analysis is one of the first consolidated transactional and analytical supply chain management applications we are deploying. This application will allow an analyst to quickly analyze and manage Intel's worldwide warehouse inventory positions.

- In the first phase, we are using the in-memory data platform for near-real-time visibility into global finished goods inventory including in-transit data.
- Next, we will identify where Intel was at risk. We are incorporating multiple demand signals in the in-memory platform to compare weeks of inventory against various targets. We will then be able to highlight and monetize risk areas across different planning horizons: real-time, daily, weekly, monthly, and quarterly, helping us build a next-generation solution for Material Master weeks of inventory.
- Finally, we will be able to compare planned and actual inventory and run cycle-on-cycle analytics to identify root cause and explain when and how risk situations happened. In addition, we will enable what-if analysis to evaluate migration scenarios to resolve risk areas. This will include a simple supply/demand analysis tool to evaluate sensitivity between weeks of inventory and changes in demand, supply, SKU mix, and so on.

Figure 1 shows our legacy supply chain landscape, while Figure 2 shows the planned landscape.

Table 1. Intel IT's In-Memory Data Platform Goals for Supply Chain Optimization

Efficiency Category	Specific Goals
Finance analytics efficiencies	<ul style="list-style-type: none"> <li>• Generate global logistic audit and pay reporting 72% faster</li> <li>• Generate business warehouse reporting 60% faster</li> <li>• Reduce finance database access by more than 35%</li> </ul>
Supply chain planning efficiencies	<ul style="list-style-type: none"> <li>• Perform allocation management 25% faster</li> <li>• Complete key transactions 23-50% faster</li> <li>• Increase headroom for supply chain batch processing and product mix planning runs</li> </ul>
Business warehouse data processing	<ul style="list-style-type: none"> <li>• Increase processing velocity by 38%</li> <li>• Decrease error rates</li> <li>• Resolve issues before they become a major incident</li> <li>• Encrypt supply chain and business warehouse databases</li> </ul>

## Legacy Application Landscape, 2014

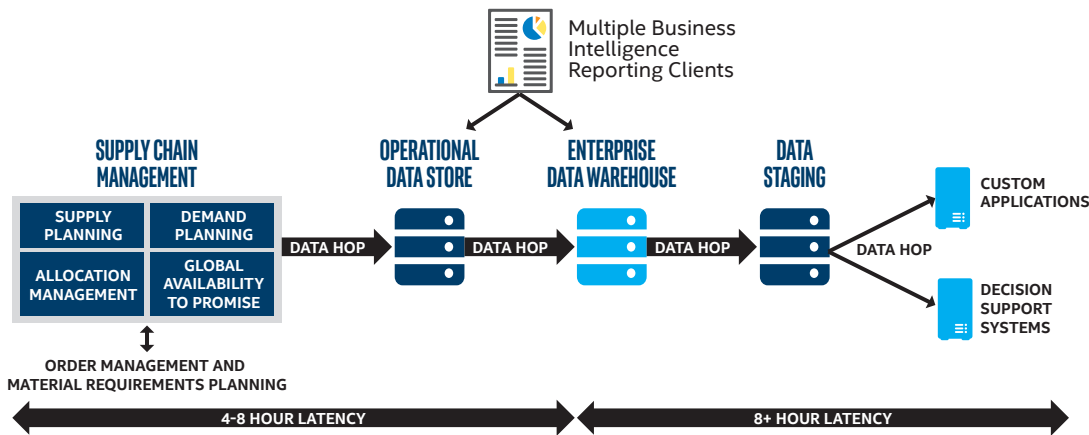


Figure 1. Intel's legacy supply chain landscape. The limitations of our legacy supply chain management applications include latency, data fragmentation, lack of scalability, and excessive data hops.

## Planned Application Landscape, 2017

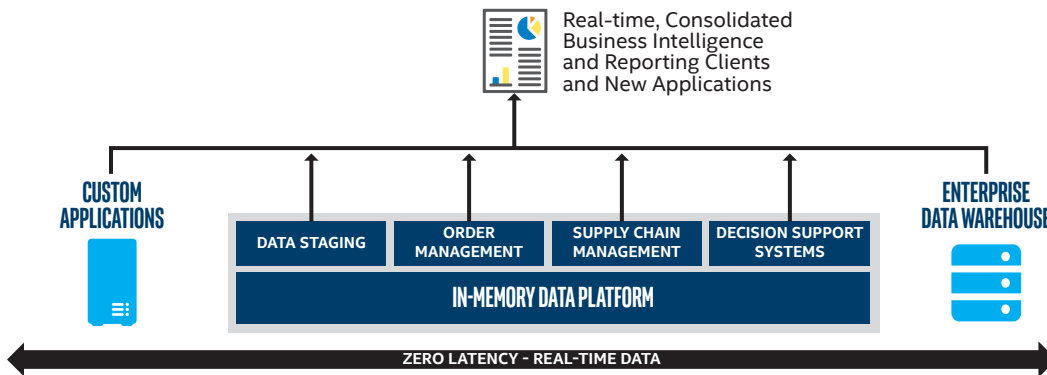


Figure 2. Intel's planned supply chain landscape. The new in-memory data platform will feature real-time business intelligence and well-connected applications.

## Supply Chain Management Success Stories

The in-memory data platform has simplified the supply chain management landscape. Intel's supply chain management teams use the new in-memory data platform to improve supply chain planner efficiency, enable real-time planning in downstream systems, reduce cycle time of planning runs, and optimize inventory. An in-memory database that powers near-real-time reporting has enabled supply chain planner efficiencies that improve our responsiveness to customers, eliminate risk of delays and lost opportunities, and reduce time-to-decision and time-to-market.

The solution provides Intel's business users with instant access to reports, dashboards, and ad-hoc queries with less involvement from IT teams. Our supply chain management has become much more efficient because planners can access live data for making decisions. Real-time aggregation eliminates the need for expensive tuning tasks such as indexes and materialized views. Pre-built analytics libraries deliver deeper analysis of current and historical data.

The supply chain management teams can now mine unstructured data, which improves decision making. The in-memory data platform helps Intel IT to transform unstructured data into structured information for analytics and correlation with structured datasets. Text analysis constantly classifies relationships among entities for sentiment analysis. The teams can perform simulations to help better understand risks with inventory predictions, thus improving supply chain management efficiency and improving Intel's bottom line.

The following are some specific examples of how the in-memory data platform is transforming supply chain management at Intel.

### Runtime Improvements

We have seen runtime improvements for all supply chain management applications.

- **Daily applications.** We optimized warehouse delivery note generation for all outbound product movement. We can now check immediately for inventory availability. A deployment optimizer re-plans stock movements between locations worldwide, based on updated factory outputs, current demand, inventories, and planned receipts. All stock transfer requests are automatically generated, including stock transfer orders. Automated back-order promising provides the best delivery dates for customer commits based on changing supply availability. We can perform on-demand late-stage product configuration at assembly-test-manufacturing facilities, and can initiate manufacturing escalation management.
- **Weekly applications.** We can run deployment optimizers and capability to match to re-plan demand across the network of subcontract manufacturers for multiple product lines, including silicon, modules, interconnects, boards, and systems. Supply/demand plans and commits are reset with daily refresh of customer forecasts, supply forecasts, geographical region, and customer allocation changes.
- **Continuously connected applications.** Intel runs 200 batch job dependencies per hour, around the clock, every day. The in-memory data platform improved these continuously connected applications' runtimes as well.

### Real-Time Planning

Improved real-time planning has resulted in faster response to customers. Cycle-time planning has been reduced by up to 40 percent. In addition to the reduced cycle planning, fewer batch jobs now run during the weekend. Supply chain management planning is scaling to new lines of businesses; merger and acquisitions are being integrated without additional IT investments. Finally, inventory has been optimized by reducing carrying costs and the number of days products remain in inventory.

### Other Results

We have already achieved many of our goals (see [Table 1](#)) by implementing the in-memory data platform. For online transaction processing, we reduced data hops and eliminated multiple points of failure. With reduced data latency and improved time-to-decision, we are maintaining optimal inventory levels and making real-time decisions based on the latest data. We have also eliminated data reconciliations across systems. The in-memory data platform has enabled Intel's supply chain management teams to realize planner efficiencies, increased planning accuracy, and inventory reduction. Other improvements include the following:

- Database size has been reduced by 63 percent
- Processing chains run 40 percent faster

- Advanced business application programming runtime has been reduced by 24 percent
- Runtime of batch jobs has been reduced by an average of 24 percent
- Overall business warehouse queries run 62 percent faster
- Top ten transactions' average response time has been reduced by 47 percent

## Key Learnings For Migrating Supply Chain Management To An In-Memory Data Platform

As we worked through the various phases of migrating Intel's supply chain management to an in-memory data platform, we learned what worked and what didn't. The top four key learnings are as follows:

- **Plan for scalability.** To enable the system to dynamically scale, we reserve 20 to 50 percent of server memory capacity as working memory.
- **Engage with the business.** We engaged with the business groups early in the migration process. This enabled us to define new opportunities for using the in-memory data platform to transform Intel's business. We proved the platform's value with small projects, building on each success.
- **Implement in steps.** We first migrated our data to the in-memory database to confirm functional equivalency with existing databases. Next, we optimized custom code for the in-memory system to enable enhanced analysis performance. Finally, we re-engineered the business processes to work with real-time data and analysis.
- **Perform data quality checks.** We performed data quality checks before, during, and after the migration, including row counts, checksums, and verification of data consistency.

## Next Steps

We plan to continue growing the business value from real-time analytics in the areas of spare parts inventory management; supply chain pioneer efficiencies; pipeline inventory reporting; real-time response to supply/demand changes; end-to-end reporting for capital, platforms, boards, and systems materials; and finance close efficiencies. We have also determined several areas besides supply chain management where the in-memory data platform is applicable. We can build on the foundation we have laid with supply chain management to deliver increasing Intel business value in these areas.

### A Deeper Look at In-Memory Processing

Our new in-memory data platform is designed to support real-time analytic and transactional processing. It combines database software with pre-tuned Intel® Xeon® processor E7 v2 family-based servers, storage, and networking hardware. Analytics, spatial processing, and stream processing run in a single environment. The platform can help accelerate business intelligence (BI), anticipate future opportunities and risks, and swiftly react to business change.

The platform operates completely in memory, compared to traditional databases which store data on disk. Data can therefore be accessed more quickly since it does not have to be reloaded or rewritten. The memory capacity of the 15-core Intel Xeon processor E7 v2 family-based servers can support 1.5 TB of memory per socket. Using Intel Xeon processor E7 v2 family-based servers and the in-memory data platform, we found transaction processing and data could be analyzed nearly as fast as the users and devices generated that data.

## Conclusion

Implementing an in-memory data platform has allowed us to make our supply chain management BI real-time and scalable. We can now process large volumes of data quickly because of the in-memory computing. Data that is captured in real time can now be added during analysis. Our analytics are more comprehensive by running in-database predictive, text, and spatial algorithms and libraries. In particular, the platform's dynamic inventory management has provided a solid return on investment to Intel.

We have consolidated and simplified the supply chain management landscape at Intel and have delivered significant efficiencies across the enterprise application and BI landscapes. With a common platform in place, we can focus on innovation, expanding the business value of the in-memory data platform and real-time data.

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