SingleStore for Supply Chain Analytics

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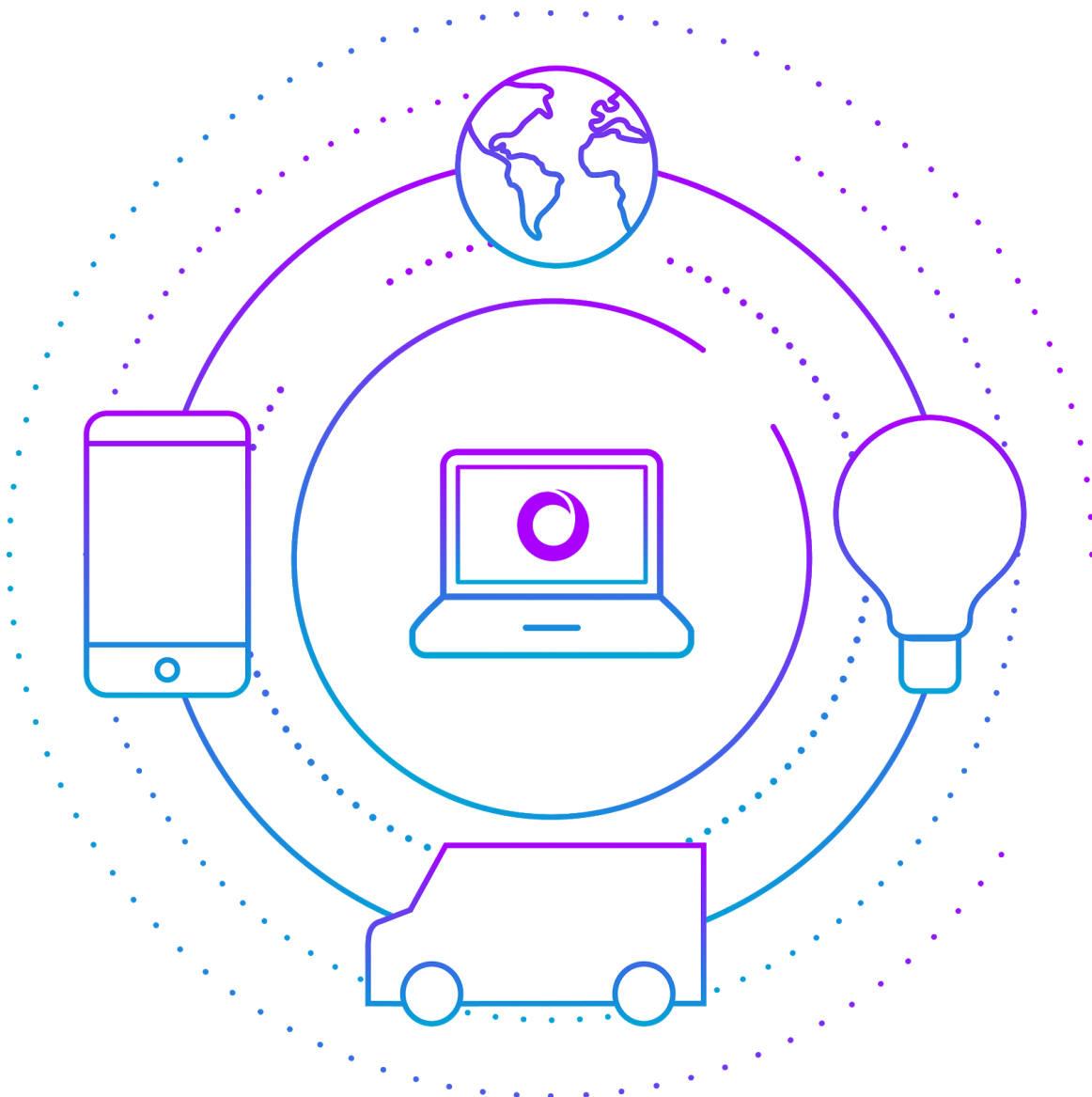
1. Introduction

Global companies have heavily invested in technologies that can empower their supply chain management to maximize their operational efficiency. This helps in managing their flow of goods and services, which includes all processes that transform raw materials into final products. Streamlining of supply chain activities also helps the businesses to maximize customer value and achieve a competitive position in the marketplace. Different steps involved in supply chain management include controlling and overseeing purchases from suppliers and customers, maintaining the storage of stock, controlling the amount of product for sale and order fulfillment, and managing customer returns.

Data analytics in supply chain management (aka 'supply chain analytics') can deliver tremendous value as it enables businesses to operate with greater efficiency, based on better informed decisions. Modern businesses leverage supply chain analytics to make the right predictions on future risk, analyze customer trends, and improve the demand forecasting capabilities. The insights derived from real-time data have gained a lot of attention in recent years. The ability to gain insights from the real-time data always helps the decision makers to make the best judgement. As supply chain companies generate massive amounts of data on a daily basis, managing such data platforms has turned out to be significantly challenging for larger companies.

2. Biggest Supply Chain Challenges in the World

This section discusses some of the biggest supply chain problems and challenges in today's world.

2.1 Distributing COVID-19 Vaccines Across the Globe

COVID-19 pandemic has had a significant impact on supply chain businesses globally. Over a short period of time, businesses were forced to adapt the new normal way and operate with greater efficiency to respond to evolving demand and supply requirements.

According to a recent article, the requirement of cold-chain transportation and storage are the key challenges in distributing vaccines across the globe. For example, vaccines currently going through the trial phase have to be stored and transported anywhere between -20 deg C and -70 deg C.

During the initial phase of distribution, some of the mandatory requirements such as deep freezing, immediate use, and storage packaging protocol may potentially restrict the availability of the vaccines only to the urban centres that can be reached quickly. Another major challenge is about managing and coordinating the supply chain logistics, to ensure that vaccines are made available to every person in the country. In order to efficiently manage the whole distribution process, these pharmaceutical companies need to rely on a data driven platform that can enable them with better logistics and supply chain planning based on the real-time insights. Data scientists believe that an efficient design and implementation of data driven models and plans derived from near real-time data could help overcome these challenges at a global level.

2.2 FedEx Supply Chain Management

FedEx is a global leader in non-asset-based transportation, warehousing and distribution, and value-added services. The company also works with reverse logistics processes, including returns, recommerce and recycling. Some of the key challenges faced by FedEx include: (i) rapidly increasing volume of orders and inventory, (ii) lack of visibility to the inventory across every channel, (iii) latent inefficiencies, (iv) labor shortages, (v) meeting service level agreement during peak seasons etc. Despite these challenges, FedEx consistently meets today's demand and in the future by better planning and execution.

FedEx believes that, if you have the right solution to empower your supply chain platform then the challenges won't be a burden for the execution. They have optimized their supply chain in order to make better-informed decisions with real-time business intelligence. As an example, FedEx provides real-time package tracking for each shipment and uses one of the world's largest computer and telecommunications networks. The company's couriers operate SuperTracker® hand-held computers, to record the transit of shipments through the FedEx integrated network.

2.3 Manufacturing and Distributing iPhones

Apple's supply chain has been a leader and led the Gartner's Supply Chain Top 25 list since 2013. In order to manufacture and distribute Iphones, Apple has to coordinate and manage the materials from global suppliers, assemble them in their China plant, and get them ready for shipment (via

UPS/FedEx) for the consumers who bought through Apple's online store. Some of the key challenges include: (i) ability to obtain components in sufficient quantities, (ii) dependency on logistics services provided by outsourcing partner, (iii) inventory management based on demand, (iv) unexpected changes in the global economy, (v) any natural or man-made supply chain disruptions, (vi) logistics management etc.

Efficient execution of supply chain planning at Apple Inc is a classic example for the industry. Apple has integrated R&D, marketing, and various other functions under supply chain management. This integration has become a part of their new product development process and helps in accelerating the manufacturing and distribution process. Apple has built digitized solutions powered by modern big data platforms to manage their supply chain function with utmost efficiency. Apple strongly believes the fact that, the modern data platforms built with real-time capabilities enable the decision makers to make the best judgement, based on the supply chain insights derived from live data.

3. Market Trends for Supply Chain

3.1 Recent Changes in Supply Chain Management

Digitization. Includes efforts to integrate corporate systems into a unified platform with focus on implementing new digital technologies. The goal of digitization, as described by PwC, is a smart, efficient supply chain ecosystem that demolishes silos, creates transparency and enhances responsiveness. This also eliminates manual processes and provides a single view of the organization.

Move to the Cloud. While many enterprises still rely on legacy on-premise supply chain software, the future is in the cloud. Supply chain cloud computing offerings have proved to greatly increase the scalability and flexibility as compared to the traditional legacy systems. According to McKinsey, cloud-specific spending in 2020 will grow six-times faster than other IT expenditures. Cloud computing can enable supply chain applications with better user experience with minimal hassle on infrastructure management.

Event Stream Processing (ESP). Growth of raw data in the supply chain sector has been enormous in recent times. ESP software platforms are widely used in supply chain management. It can stream raw data from various sources and perform real-time or near real-time calculations on data in motion. This platform is smart enough to process the input data as it arrives, before storing it in any persistent store for performing any complex or advanced analytics.

3.2 Leading Technology Trends

3.2.1 Digital Supply Chain Twin

Digital supply chain twin is the detailed simulation model of an actual supply chain which uses real-time data and snapshots to forecast supply chain dynamics. From this analysis, analysts can understand a supply chain's behavior, predict abnormal situations, and work out a proactive action plan. For example, a leading oil and gas company based in the US, maintains an extremely complex and expensive equipment, using predictive analytics to do preventive equipment maintenance, and manages the supply chain with utmost efficiency. They have named their oil supply chain as "Supply Chain of Data".

3.2.2 Internet of Things (IoT)

Research shows that the number of businesses using IoT devices grew from 13% in 2014 to 25% in 2019. The IDC forecasts 13.6% annual growth through to 2022. IoT enables organizations to monitor inventory, automate inventory management and reordering, and keep track of deliveries, all in real-time. Sensors in the IoT network can help with predictive maintenance applications and also enhances the overall supply chain transparency.

3.2.3 Artificial Intelligence (AI) and Machine Learning (ML)

With the big data revolution, more enterprises are turning to AI and machine learning to simplify complex operations through automation. Gartner reports that in the four years to 2019, there was a 270% increase in the number of organizations using artificial intelligence. The predictive analytics and machine learning algorithms can help automating warehouse management,

determine the purchase patterns and trends, and minimize manual tasks involved in inventory management.

3.3.3 Advanced Analytics

Prescriptive analytics and predictive analytics are the most common advanced analytics techniques followed by modern organizations. Prescriptive analytics makes use of machine learning to help businesses decide a course of action based on a computer program's predictions. Predictive analytics helps in analyzing data, identifying patterns, and predicting the future. In other words, predictive analytics predicts what is most likely to happen in the future and prescriptive analytics recommends actions you can take to affect those outcomes.

3.3.4 Immersive Experience

Organizations in the supply chain sector are leveraging capabilities of augmented reality (AR) and virtual reality (VR) to achieve immersive experiences for the end user. This is another emerging trend followed by leading companies to achieve enhanced customer experience and improve the overall speed of service.

4. Business Problem

Lack of end-to-end visibility is a major business problem in supply chain management. A 2018 survey found that the biggest challenge for global supply chain executives was visibility, with 21.8 percent of respondents selecting this response. The nature of the challenges generated by visibility slightly differs depending on whether a company is a producer or a supplier of goods. Producers were most concerned with having oversight on how materials were provisioned to their production facilities, while suppliers were concerned with visibility over the quality and availability of the products they intend to sell. Both producers and suppliers though were concerned with being able to trace the flow of materials and/or goods through their supply chain process.

The key challenge with lack of visibility is that businesses risk the integrity of their products as they travel from suppliers to distributors, up until they reach the customer. Some goods are fragile or perishable so maintaining environmental conditions at optimal levels is paramount to reducing costs or waste, as well as possibly risking public health in the case of shipping pharmaceuticals. Industries like healthcare have regulatory compliances that companies need to follow to guarantee the safety of their products throughout the shipping process. The challenges in distributing COVID-19 vaccine is a classic example for this scenario. Hence the ability to monitor and control the supply chain at all times is obviously key for pharmaceutical businesses. A study by Supply Chain Media, involving 67 pharmaceutical supply chain executives found that - supply chain visibility was a significant challenge facing the industry, with loss of control and deteriorating service levels also being major concerns. Hence a data-driven approach could give businesses the information they need to make better-informed decisions in supply chain management.

Many companies have focused on single-sourcing strategies, possibly because this was considered as one of the low cost scenarios. But such companies are under higher risk if suppliers face any challenges like shortages or production failures. Single sourcing strategy is highly risky and could sometimes potentially lead to loss of sales, when any sort of disruption occurs in the supply chain workflow. These companies should rather focus on risk mitigation strategies to anticipate and minimize supply chain challenges and risks.

Another common problem facing the executive leadership in supply chain management, is the lack of actionable data and insights from real-time or near real-time data. Hence companies have to focus on building data platforms that's capable of running business analytics to provide insights, which is capable of identifying current trends and making predictions for the future. For example, advanced machine learning based modeling techniques allows businesses to build a customized model, allowing them to automate various tasks and manage analytics against large volumes of data. This approach would help data driven companies to identify the trends, patterns and tradeoffs to overcome the key problems in the supply chain management.

5. SingleStore Solution

As supply chain data grows at a tremendous rate, the need to have a reliable, modern database platform has become a crucial requirement to improve the operational efficiency and derive real-time insights for informed decision making. Legacy database platforms can neither be able to deliver high performance for large volumes of data, nor be able to operate at higher user concurrency. Such platforms also limit the capability of unlocking the value proposition from streaming data in real-time. Hence the underlying database solution powering the supply chain operations should be capable of integrating huge volumes of data sets in real time, processing events as they stream, and providing a solid converged platform for performing low-latency analytics at high user concurrency, against petabytes of data. Without real-time visibility, businesses can't convert rich and invaluable insights into consumer behavior, buying patterns and other key metrics.

Our mission at SingleStore is to deliver The Database of Now™ which provides the speed, scale, and SQL in a cloud-native solution. SingleStore solution simplifies your data infrastructure by providing a converged data platform, optimized for real-time applications in hybrid and multi-cloud environments.

SingleStore DB is a distributed, relational, SQL database management system (RDBMS) that features ANSI SQL support and is known for exceptional speed in both query processing and data ingestion with unlimited scaling capability. The database-as-a-service version of SingleStore is known as SingleStore Managed Service. SingleStore solution is an operational database built for speed and scale, and can be an excellent solution to empower supply chain systems with real-time analytical capabilities. Some of the leading supply chain companies leverage SingleStore to ingest, query, and serve data to tens of thousands of simultaneous users, with unlimited scalability.

SingleStore's key capabilities, such as unlimited scalability and support for fast, SQL-based analytics with high concurrency, and ultra-fast query performance while streaming data, makes it very well-suited to serve as the underlying database platform to empower the supply chain sector. The following key capabilities of SingleStore are instrumental for this solution:

- **Scalable analytics concurrency.** Scale-out for growing analytics concurrency for ad hoc queries, business intelligence tools, and apps, with industry-standard hardware
- **Low latency queries.** Interactive query response time through scale-out and query compilation
- **Stream ingestion.** Discover insights on fast-changing data with real-time ingestion, including scalable integration with Kafka
- **Scale-out architecture.** Deliver performance as ingest, processing, and query requirements grow, on industry-standard hardware or on the cloud
- **Fast SQL.** Vectorized and compiled query performance deliver reliable sub-second response
- **Interoperable architecture.** Drop-in compatibility using standard SQL, hardware, and interfaces provides seamless integration

SingleStore can empower digital supply chain platforms by delivering demanding needs for near real-time data such as faster ad-hoc based complex analytics, real-time dashboards (aka 'fastboards'), reporting, and support for modern applications, so as to provide quick insights from real-time or near real-time data.

5.1 Benefits

SingleStore enables ultra-fast operational analytics and real-time insights to achieve faster, more informed decisions, improved customer experiences, and operations.
Some of the key benefits are as follows:

- **Latency-Free Analytics:** SingleStore lets you achieve ultra fast query response with high concurrency across both live and historical data using familiar ANSI SQL
- **Ultra-fast Event-to-Insight Performance:** Deliver against the toughest service level agreements using parallel, distributed lock-free ingestion and real-time query processing
- **Scale Limitlessly:** Elastic scale-out architecture with distributed massively parallel data processing delivers consistent, predictable response under high ingest and user concurrency
- **Ease of Use and Flexibility:** SingleStore brings simplicity and ease to your data

architecture by allowing OLTP and OLAP workloads to be processed on operational data using a single table type

- **Drop-in Compatibility:** Plug-in directly with existing technologies and skills with support for standard SQL, BI and distributed technologies like Amazon S3, Spark, Kafka and Hadoop
- **Powerful Programmability:** Supports simple, fast, and powerful in-database programming via MPSQL and an extensive set of built-in data types and functions

6. Customer Success Stories

6.1 Kellogg's

About Kellogg's

Kellogg's is the world's leading cereal company. They are the second largest producer of cookies, crackers, and savory snacks, and a leading frozen foods company in the supply chain sector. With annual sales revenue greater than $13 billion, Kellogg's produces more than 1,600 foods across 21 countries and markets its many brands in 180 countries.

Business Problem

Scenario Before SingleStore

Kellogg's relies heavily on customer logistics data, and they were unable to get this data quickly enough to make relevant business decisions. The logistics data was 24 hours to reach the point of analysis due to slow performance of SAP Business Objects Data Services and Hadoop. In the preceding 5 years, cereal demand had dropped by 10%, forcing Kellogg's to start becoming more innovative in their product offering, logistics, and customer retention strategies.

Consequences of Before Scenario

Key consequences faced by their business unit as follows:

- Accuracy and speed of logistics data is directly proportional to the profitability of Kellogg's business
- Due to the length of time these workloads took in SAP/Hadoop, they could only run them

over the weekend meaning business decisions were one week behind

- Unable to track shipment SLAs leading to poor metrics with their customers
- Re-order rate decreased and product movement rate stagnated due to lack of agility in business decision making
- Kellogg's had begun divestitures of major business units because its inability to be an agile business led to decreasing revenues
- Quarter over quarter growth metrics ranged from -5% to -10%

SingleStore Solution

SingleStore solution supported the scale Kellogg's required for new user concurrency and data volumes. Additionally, SingleStore provided Kellogg's the ability to leverage AWS S3 and Kafka through the SingleStore data ingestion pipelines. Kellogg's can now continuously ingest data from AWS S3 buckets and Apache Kafka for up-to-date analysis with exactly-once semantics for more accurate reporting. As a result, SingleStore enabled Kellogg's to reduce the 24-hour ETL to minutes and accelerated the BI speed by 20x.
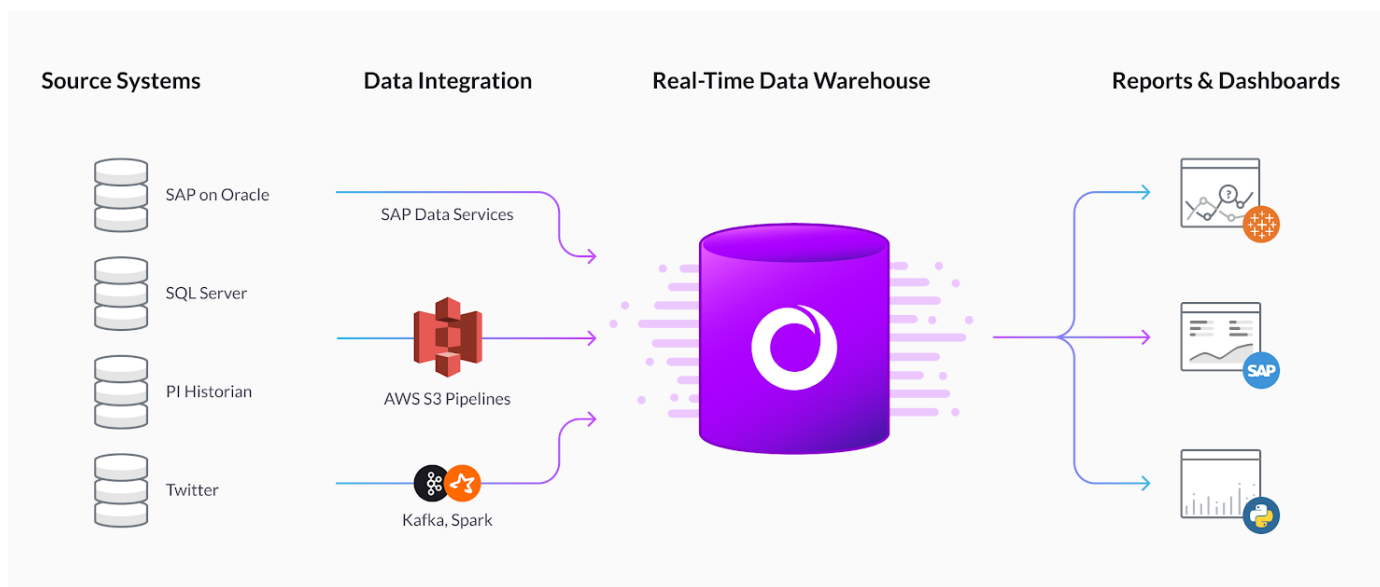

Fig 1. Kellogg's Reference Architecture

Positive Business Outcomes

- Kellogg's is now able to move at an iterative, intra-day pace in their business decision making, specifically around supply chain and product lifecycle
- Total cost of ownership is much improved now that they have been able to offload data from SAP
- Improved reorder rate due to faster strategic decisions
- Product movement rate from retailers like Wal-Mart has increased
- Further optimized boxes per case per crate per truck, one of the key metrics in customer logistics for Kellogg's

6.2 Top Technology Company: Digital Supply Chain Platform

About Company

A leading technology company that develops and sells computer hardware and software to the consumer and enterprise market across the globe. This company is one of the largest technology corporations in the world, employing more than 165,000 people in the U.S. and around the world. It is one of the biggest personal computer (PC) product companies in the world.

Business Problem

The company processes millions of orders every year. Keeping track of orders, shipments, manufacturing, warehouses, partners and related became an extremely challenging task in today's fast moving world. They were not able to make the right commitment (as to when the order will ship) or to keep the customer informed as to the status of the order in a timely manner. This resulted in poor customer experience which in today's world translates to customers who will not return.

Consequences of Business Problem

Key consequences faced by their digital supply chain follows:

- Existing legacy platform powered by Oracle was performing poorly
- Old legacy architecture was not able to handle the workload as they scale

- Inability to run real-time analytics

SingleStore Solution

As a part of Digital Transformation, the company decided to modernize and streamline the entire supply chain process. As part of this initiative, they needed to keep track of all the warehouses, parts, factory status and partner suppliers in near real-time.

This technology company chose SingleStore as the solution to provide operational analytics for the entire supply chain framework. SingleStore has native capabilities to ingest JSON from Kakfa, and provide both transactional and analytical capabilities in a single system. With SingleStore, they were able to converge their workloads in a single database platform to provide real-time answers to sales, manufacturing, inventory, and operational staff.

Positive Business Outcomes

Key positive business outcomes after SingleStore implementation include:
- Improved customer experience
- Significant performance gains over Oracle
- Significant cost savings over Oracle
- Flexibility to scale on demand
- Improved customer retention rate
- Ability to cross-sell and upsell based on availability of other products, by integrating in real-time with marketing analytics

6.3 Global Top 3 Consumer Tech Company

A global top 3 consumer tech company uses SingleStore to power their real-time C-suite executive dashboard. They leverage the SingleStore platform for strategic sales decision making, based on the insights derived from the most up-to-date data in retail and supply chain systems. SingleStore is used as an acceleration layer for their legacy data warehouse solution.

SingleStore architecture provides the following capabilities to empower the real-time dashboard requirements, set by the company:

- 500+ queries per second against columnstore on disk
- Query latency ~ 100 ms (~87%)
- Ingest of millions of rows per second

Positive Business Outcomes

Some of the key business outcomes after implementing SingleStore solution:

- Empower critical C-level executives with real-time dashboards (aka 'fastboards')
- Meet and exceed the data growth and scalability requirements of the company
- Support launch of new products without degradation in performance