

Transforming Intel's Supply Chain to Meet Market Challenges

Intel IT has helped to increase supply chain responsiveness and productivity while reducing process cycle time and inventory levels.

Executive Overview

To support an efficient and responsive supply chain, Intel IT works closely with many teams throughout Intel to formulate a strategy that integrates IT solutions across all levels. While manufacturing technology and operations are at the center of Intel's business, Intel recognizes that supply chain capabilities are critical to meeting market demands.

These demands include the following:

- Increased product mixes and volume
- Shorter delivery times
- Increased responsiveness to change requests
- More efficient and cost-effective performance
- Increased competition as new products are introduced
- Increased environmental sustainability
- Changing government regulations

Intel IT helps Intel's supply chain meet these demands by partnering with the internal business teams to re-engineer business processes and deliver more efficient information systems. These systems are associated with multiple aspects of supply chain management, including planning, demand forecasting, production planning, order fulfillment, warehousing, and logistics.

Through several initiatives in the last few years, including standardizing Intel's enterprise resource planning platform, developing automation and business intelligence solutions, and simplifying supply chain

planning processes, Intel IT has helped to increase supply chain responsiveness and productivity while reducing process cycle time and inventory levels.

- Greater than a 50-percent reduction in the time it takes to ramp up a new manufacturing process
- 65-percent reduction in order-fulfillment lead time
- 50-percent reduction in order-to-delivery time
- 3x increase in responsiveness to customers
- 32-percent reduction in inventory
- 21-percent increase in the number of central processing units (CPUs) produced per headcount and a 16-percent increase in CPUs produced per capital dollar spent

Intel's accomplishments in supply chain management have been recognized across the supply chain industry, as our rise on the Gartner Supply Chain Top 25 rankings demonstrates. Intel IT will continue to implement IT-enabled supply chain solutions to transform Intel's business, helping to increase Intel's competitiveness and market position.

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BACKGROUND

Manufacturing technology and operations are at the center of Intel's business. Intel factories turn raw silicon wafers into complex and advanced integrated circuits. The manufacturing process produces integrated circuits that are delivered to customers as finished goods or subsequently used in the assembly of products such as central processing units (CPUs), graphics processing units (GPUs), memory units, communication controllers, motherboards, wireless devices, and solid-state drives (SSDs).

Intel recognizes that its supply chain—the combination of people, technology, processes, information, and resources required to turn materials and components into finished goods and move goods and services to customers—is critical to Intel's success. The importance of the supply chain in Intel's continued manufacturing leadership and business growth has steadily increased over the last decade.

Intel's primary supply chain for wafer manufacturing is complex, as each integrated circuit or die goes through hundreds of steps as the product and materials move from the planning stage through production, packaging, warehousing, and delivery to customers. In addition, Intel is currently manufacturing multiple generations of process technology in high volume in its manufacturing network of 16 factories—11 fabrication facilities and five assembly/test factories spread across seven countries, as shown in Figure 1. Approximately 30 global warehouses handle the warehousing and delivery to customers of these products, shipping about 1 million PC units per day and fulfilling over 750,000 orders per year.

In addition to integrated circuits, Intel also maintains a diverse set of products, such as wireless controllers, software products, and SSDs, serving many different markets. The resulting complexity drives multiple supply chain requirements and capabilities that differ from the core wafer manufacturing supply chain. Each of these additional supply chains requires planning, forecasting, inventory management, packaging, and shipping.

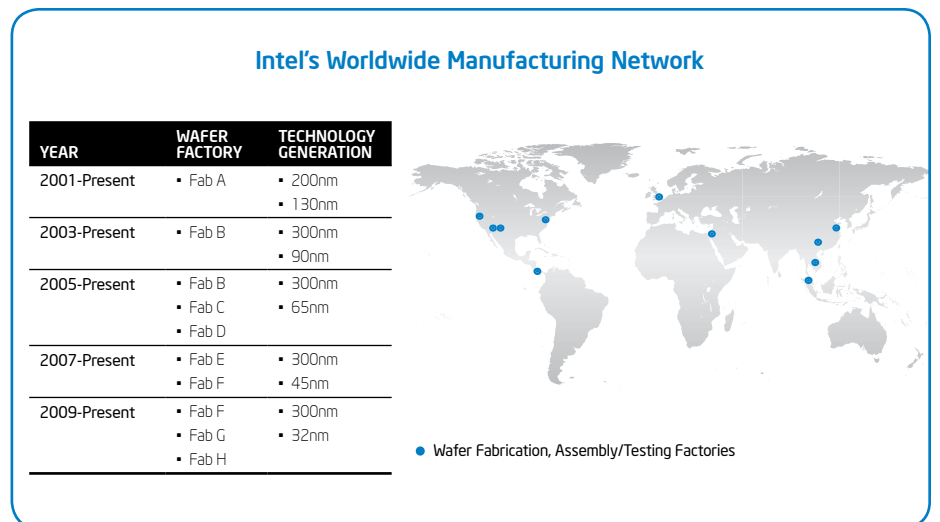


Figure 1. Multiple generations of process technology in high-volume manufacturing and the global nature of Intel's manufacturing business add complexity to the supply chain.

As shown in Figure 2, there are also many industry- and market-driven supply chain challenges. Expanding product offerings and shrinking product life cycles, new and shifting market conditions, emerging regulations, and more demanding customer expectations require that Intel continue to improve on existing supply chain processes while being able to quickly adapt to new supply chain business requirements and create solutions to support them.

Intel IT plays a key role in maintaining and transforming Intel's supply chain to meet these challenges. Intel IT helps redesign business processes and deliver more efficient information systems associated with many aspects of the supply chain management. These efforts include the following:

- Re-engineering the overall planning and other processes: mid-range and tactical demand forecasting, production planning, master production schedule, order fulfillment, and warehouse logistics
- Consolidating many legacy systems across all business functional areas into a more efficient enterprise resource planning (ERP) system
- Re-engineering large amounts of data and data flows
- Consolidating our master data relating to customers, suppliers, locations, and products into centrally managed master data systems
- Developing a centralized workflow data-staging system to manage our CPU and chipset product planning data with much improved data-quality monitoring capability

This work has reduced the number of manual processes, and data errors and associated correction efforts; increased our supply chain efficiency and responsiveness; and helped Intel better meet supply chain challenges. The improvement in data handling and related business intelligence (BI) analytics can also help identify problems early on and influence the business to change behaviors.

Just Say Yes Program: 2005 to 2007

In 2005, Intel executives visited several customers to get direct feedback and discuss how Intel could better serve them. The goal was to improve business processes based on real customer needs.

During these visits, customers indicated dissatisfaction with the order fulfillment process: A typical response to changing an order could take up to 1.5 weeks; during that time period, the customer didn't know if Intel could promise to deliver the product when requested. The delay in response was due to the need for multiple levels of approval; additional delays stemmed from multiple order changes.

In response to this feedback, Intel launched the Just Say Yes program, which led to sweeping changes to the microprocessor fulfillment process and an intense focus on customer responsiveness.

In the beginning of the program, IT data analytics were used to develop a better awareness of the steps involved in the current processes and create a baseline understanding of the situation. The data points included the number of times a given order changed—an average of six times—and what percentage of orders shipped without changes—only 1 percent.

Combining the knowledge from the data analytics with customer feedback, the supply chain organization defined the program goals. The program would initially focus on four elements.

- Improve Intel's ability to respond quickly and positively to change order requests
- Respond to customers within 24 hours with a committed dock date (CDD), which entailed committing to a date for product availability and having products available in the warehouse within three days
- Reduce inventory levels
- Reduce errors in demand forecasting

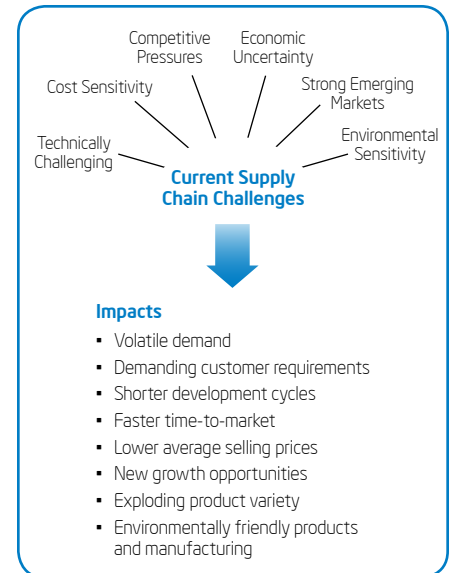


Figure 2. Market pressures require an efficient and agile supply chain.

Early Supply Chain Improvement Efforts

In the early 2000s, Intel implemented a Customer Excellence Program (CEP)—a structured process for obtaining and prioritizing independent customer feedback on the quality of Intel® products and services. The CEP uses an annual customer survey to generate top-level customer improvements. Feedback obtained from the CEP survey is analyzed and compared with other Intel customer feedback to identify issues that have a high impact on customer commitment and retention. The CEP sets the stage for future supply chain improvement efforts.

Just Say Yes Program: 2008 to 2010

The success of the Just Say Yes program from 2005 to 2007 led to a continued focus on improving customer responsiveness through several new initiatives.

- Implementing new supply chain performance metrics
- Replacing manual processes with automated processes
- Reducing the time between when a customer places an order and when the product is received, known as the “order horizon”
- Improving internal efficiency

In addition to increasing responsiveness, these efforts continued to increase productivity and reduce process cycle time and inventory levels.

TRANSITION TO STANDARD METRICS

Replacing the original program metrics were industry-standard metrics that enable comparisons across supply chains. The new metrics, also known as key performance indicators (KPIs), are:

Order fulfillment lead time (OFLT). This KPI is the average time it takes to fulfill customer orders, calculated from order creation to delivery. OFLT measures responsiveness.

Perfect order. This KPI is the percentage of orders that are delivered with items and quantities in-full and on-time, per the customer request, with complete and accurate documentation and no damage. Perfect order measures reliability from a customer perspective.

Intel IT BI solutions help to enable dashboards that provide visibility to these new KPIs and identify early trends.

INCREASE RESPONSIVENESS THROUGH AUTOMATION

Vendor-managed inventory (VMI) hubs, located near large customers, provide better inventory management and faster product shipment. Dynamic VMI increases

responsiveness and the reliability of order fulfillment, and also reduces the inventory.

A pilot conducted during 2007 and 2008 at two European distributor locations provided proof that the VMI strategy was suitable for Intel. Intel positioned two weeks of inventory at warehouses close to the customers—instead of at a regional or worldwide warehouse location—and allowed the distributors to book orders at their discretion instead of using the existing tightly controlled process.

The new approach virtually eliminated the cycle by which customers order a product in advance to hold the supply, then change the order multiple times as product requirements become better defined. In 2010 VMI hubs helped reduce order-fulfillment lead times by 23 days and contributed to a 26-percent improvement in responsiveness.

During the pilot, the lead time between customers placing an order and receiving the product decreased from three months to one week. Also the product was available at the customer location to be consumed as they required, without having to wait for shipment. Customer feedback was exceedingly positive, citing both a reduction in onsite inventory levels and lower overhead.

These improvements were enabled by Intel IT-built automated solutions that include real-time order promising, daily hub replenishment, and supply optimization. These solutions help support supply chain responsiveness in several ways.

- Supply targets are maintained, while enabling a low-touch, automated response to customer forecast changes.
- Supply planners can respond more precisely to support business goals when problems arise or supply or demand varies.
- Supply planners can recommend the use of inventory or earlier planned builds to support current or near-term customer forecast needs, while not using up inventory or builds that are already committed.

REDUCE ORDER HORIZON

Intel IT BI analytics helped to identify that three-quarters of all customer change requests occur in the last four weeks prior to shipment. Asking customers to book orders several months prior to need and then managing these orders through the multiple change requests had little or no value to either party.

This new data served as the basis for a pilot project in 2007 and 2008, which shortened the order horizon significantly for a few customers. The results achieved high responsiveness to initial orders, and change order requests were reduced by 40 percent. Based on the pilot success, Intel has shortened the order horizon to less than a month for all non-VMI customers.

The Just Say Yes program also drove significant changes to our business-to-business capabilities and adoption of those capabilities. Prior to the program less than a quarter of Intel customer orders were automated—most were manually entered. Given the new, short lead time from when the order is entered to when the product arrives on the customer's dock, manually entered data was no longer viable for most orders. Intel IT implemented automated processes that eliminated the delays and errors associated with manual order entry, for over three-quarters of our current customer orders.

IMPROVE DEMAND SIGNAL AND SIMPLIFY THE PLANNING PROCESS

A key part of our supply chain re-engineering efforts was to increase responsiveness by improving internal efficiency. We re-aligned legacy planning processes to use actual orders in the system, combined with demand forecasts, as the primary signal to build product. In addition, we redefined the supply planning process, eliminating or redesigning 15 of the 21 steps. Our build planning process now consists of three tiers: production planning, master product scheduling, and production scheduling. During re-engineering, we examined and streamlined the decision making process, the cycle time, and ownership.

To support these efforts, we developed key infrastructural enablers, including analytical algorithms, standardized reporting, and alerts-based planning. Intel IT and business process owners also developed new processes and tools to enable efficient collaboration among supply chain partners. These innovations eliminated an estimated 95 percent of the 2,000-plus spreadsheets that previously had been manually managed.

SPECIFIC INTEL IT-ENABLED SUPPLY CHAIN SOLUTIONS: 2011 AND BEYOND

Intel IT is working closely with Intel supply chain business teams to develop a supply chain strategy that integrates IT solutions across all levels. One of the key elements of supply chain improvements has been adopting a standard ERP system.

Through a multi-year effort, we have transitioned from several instances of highly customized ERP applications to a single ERP platform with a significant reduction in customized processes. An ERP customization is used when there is a gap between standard ERP processes and the required business processes. However, customizations significantly increase overall support cost for the ERP system and make it more difficult to keep the system current with the latest software versions.

Re-platforming our ERP system has resulted in a single, integrated system for forecasting, planning, and procurement, and has added BI capabilities for increased data visibility and budget controls. This has led to a 92-percent reduction in ERP software customizations, a 90-percent cost reduction for implementing maintenance releases, a 40-percent reduction in the number of servers, and a 260-percent increase in capacity by consolidating applications on servers based on the latest Intel® Xeon®

processors. In total, we expect a return on investment of approximately USD 124 million.

This new platform also enables increased standardization of business processes across various business segments and increased use of more advanced ERP capabilities in the supply chain process—from forecast to order fulfillment to warehouse. The new ERP system has provided the foundation for improvements in several business process areas, including the following:

- A more efficient supply chain that is cross-organizational and automated
- Better inventory management using simulation and modeling
- A more dynamic and automated order management system
- Optimized transportation
- Automated invoicing and customs
- Improved capital supplier payment processes through automated event management

These areas of improvement illustrate how IT can help transform a fragmented, manual supply chain into one that supports business agility and productivity.

Efficient, Cross-organizational, and Automated Supply Chain

We are moving away from supply chain capabilities that are specific to divisions and functions—a narrow approach that duplicates accountabilities and is overly dependent on manual processes. Instead, our goal is a cross-organizational, automated supply chain that reduces inefficiencies and the costs associated with managing the overall supply network.

One example is Intel IT's support of tactical sales and operations planning with a foundation of high-quality data and master data management that links the shop floor to the planning process. This data foundation is based on an enterprise data warehouse, operational data store, advanced reporting solutions, and links to upstream and downstream infrastructure to provide BI capabilities.

Better Inventory Management

Simulation and modeling capabilities help planners predict inventory needs and helps decrease the likelihood of excess inventory. Intel IT solutions enable multi-echelon inventory optimization to right-size safety stock buffers across the entire supply chain, taking into account complex interdependencies, long lead times, demand uncertainty, and supply volatility. The result is a reduction in excess inventory and an improvement in customer-service levels.

SUPPLY NETWORK REPLENISHMENT

Intel has continued to focus on improving the VMI hub capabilities implemented through the Just Say Yes program. Instead of relying entirely on forecasting demand, Intel is implementing systems that are sensitive to consumption and replenishment signals. Using our integrated ERP system, VMI hubs provide better inventory management and faster product shipment. We expect to continue extending VMI hubs to more customers and include a wider selection of Intel's expanding product line.

Dynamic and Automated Order Management System

The significant changes in the management and customer operational paradigm over the past few years have driven a continued evolution of IT solutions, including automated tools that guide order commits by applying business rules for allocation management and booking. These solutions have also enabled the automation of back-office order management transactions. We have replaced static order-to-cash spreadsheets with a system that enables us to dynamically shrink and grow availability-to-promise horizons, as necessary. And we are now able to segment demand signals.

Transportation Optimization

Intel IT has enabled automation and BI solutions to help optimize transportation routing and management of carrier performance and payment. With the IT transportation cost-optimization solution, we can use robust shipping strategies, such as ocean shipment, which is less expensive than shipping by air.

The trade-offs between these transportation modes is cost (higher for air) and lead time (significantly longer transport times on the ocean). The IT solution allows the business to identify when and where lead time is not an issue. As a result, we have been able to increase ocean shipping by 30 percent.

We have also increased our customer responsiveness through better management of third-party carriers transporting our products. Tracking and providing visibility to the carriers' performance help us better manage vendors. Also, our automated shipment and payment tracking system has increased on-time payments by more than 90 percent.

Automated Invoicing and Customs

Implementing a web-based invoicing system, which enables suppliers to bill electronically, has reduced invoicing issues by 75 percent. Our eCustoms system is a completely automated process that doesn't require a signature. It also provides a single location for documents and data, improving our reporting ability.

Automated Event Management: Improved Capital Supplier Payment Processes

Some of the equipment Intel buys to support the production of new generations of processors costs millions of dollars and could be antiquated within four years. Factories therefore must get capital equipment up and running as soon as possible, while taking advantage of any supplier discounts. Some

suppliers offer one- to two-percent discount terms for payment within 10 to 15 days of shipping. For a tool that costs USD 3.5 million, such a discount could amount to USD 70,000 in savings per transaction.

Until recently, the capital supplier payment processes were hindering Intel's ability to procure and pay for equipment quickly and to take advantage of the prompt payment discounts available—the business was capturing only about 50 percent of the available discounts.

To address this, we designed an automated process that pays suppliers early enough to capture those discounts. We modified ERP-based processes for invoices and purchase orders so that receipt is registered when a freight carrier receives the equipment, rather than when the shipment arrives at Intel's dock, enabling the supplier to be paid sooner.

Automating the process required coordinating systems data from Intel, suppliers, and freight carriers. The new automated process uses a supply chain event-management application, which tracks and monitors milestones (events) within a business process, providing real-time visibility to process status and alerts to relevant stakeholders.

With the new system, the discount capture rate for capital purchases has increased from about 50 percent to more than 95 percent, exceeding the corporate goal and resulting in tens of millions in cost savings each year. Payment based on ship date instead of receipt date provides the incentive for suppliers to prioritize production to ship tools as soon as possible. Several suppliers consistently ship equipment sooner than the contracted lead time, which accelerates the supply chain while reducing costs.

In the future, we hope to apply this same event-management capability to monitor and accelerate other supply chain activities.

RESULTS

Since 2008, our supply chain transformation efforts have resulted in significant savings and improvements in business velocity, responsiveness, and efficiency, as summarized in Table 1.

As an indicator of the effectiveness of our supply chain transformation, Intel entered the Gartner Supply Chain Top 25 ranking in 2009¹ at number 25. In 2010,² we rose to number 18, the biggest jump of any ranked company. In 2011, Intel ranked number 16.³ We were the highest ranked "ingredient company" (defined as a company that does not sell directly to end-customers). Also, Intel received the 2009 Supply Chain Innovation award from the Council of Supply Chain Management Professionals (CSCMP) for the Just Say Yes program.

¹ The Gartner Supply Chain Top 25 for 2009. www.rankingthebrands.com/The-Brand-Rankings.aspx?rankingID=94&year=120

² The Gartner Supply Chain Top 25 for 2010. www.gartner.com/id=1379613

³ The Gartner Supply Chain Top 25 for 2011. www.gartner.com/DisplayDocument?doc_cd=213740

Table 1. Results of IT-enabled supply chain transformation

AREA	RESULTS
BUSINESS VELOCITY	
<ul style="list-style-type: none"> 50% faster ramp up 65% shorter lead times 	<ul style="list-style-type: none"> Improved by more than 50-percent the time it takes to ramp up a new manufacturing process, including a 25-percent reduction in supplier build times and a 95-percent reduction in request-to-order time 65-percent shorter order-fulfillment lead times through automated allocation management and booking
BUSINESS RESPONSIVENESS	
<ul style="list-style-type: none"> 50% faster order-to-delivery 300% faster response to customers 	<ul style="list-style-type: none"> 50-percent faster order-to-delivery time through the use of vendor-managed inventory (VMI) hubs, the IT solutions supporting the hub business processes, and information visibility enabled through IT business intelligence solutions 3x faster response to customers' orders and change requests through an integrated enterprise resource planning system and the automation of many steps in the order management and planning business process
BUSINESS EFFICIENCY	
<ul style="list-style-type: none"> 32% inventory reduction 16-21% productivity increase 	<ul style="list-style-type: none"> 32-percent reduction in inventory through automation and VMI hubs 21-percent increase in the number of central processing units (CPUs) produced per head count and a 16-percent increase in CPUs produced per capital dollar spent

SUPPLY CHAIN EVOLUTION

While we're much closer to the corporate supply chain vision illustrated in Figure 3, the transformation will continue as we implement additional IT-enabled solutions to support changes in market conditions and new markets Intel's product will serve in the future.

Emerging supply chain challenges include the following:

- A continually increasing portfolio of products and services, such as Ultrabook™ devices, tablets, smart phones, and embedded technologies
- Issues related to the global supply chain, including government regulations, available infrastructure, worker location, environmental sustainability, and social media
- Emerging markets and expanding customer reach

To address these challenges, we are looking to implement agile and adaptable IT solutions that can be used across multiple supply chains. Clear identification and definition of business requirements for the various supply chains, including service levels and supply chain models, will allow Intel IT to more effectively deliver robust solutions that can be quickly changed to support market conditions and customer requirements.

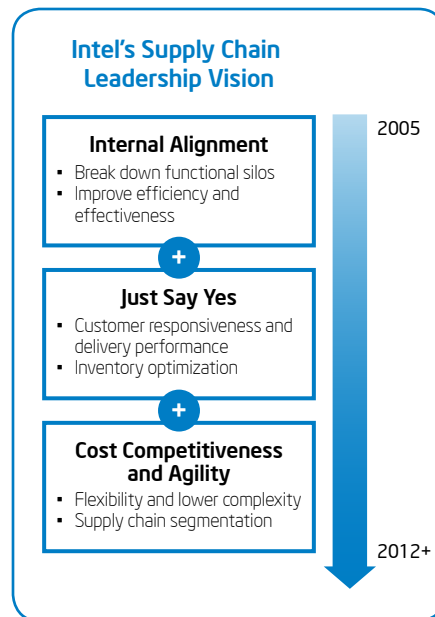


Figure 3. Intel's supply chain vision builds on early improvements to processes and responsiveness.

For example, while continuing the make-to-stock (push) model for Intel's traditional CPU product, we are implementing pull and hybrid models to support some new product market segments.

- In a push model, the supply chain is run based on the demand forecast for finished goods, and inventory is managed to support the forecasted demand. Intel forecasts and pushes the inventory to the warehouse and hub locations that seem best positioned to support customers.
- In a pull model, products are finished once the customer actually places the order.
- In a hybrid model, certain portions of the supply chain use a push model to stage inventory (either finished goods or components) and then the final products are created based on the pull model.

Pull models offer several primary potential benefits:

- Increased responsiveness
- Reduced inventory and product obsolescence in new and changing markets that require higher stock-keeping unit counts
- Varying levels of customer responsiveness.

In the future, the goal is for Intel's supply chain to have the ability to dynamically select the right push, pull, or hybrid model based on product type and product life cycle.

CONCLUSION

Working closely with many supply chain business teams, Intel IT plays a key role in maintaining and transforming Intel's supply chain to meet market challenges. We help re-engineer business processes and deliver more efficient information systems associated with many aspects of supply chain management, including planning, demand forecasting, production planning, order fulfillment, and warehouse logistics.

Some of the measurable effects of Intel IT's contribution to supply chain transformation include decreasing the time it takes to ramp up a new manufacturing process by half, a 3x-increase in responsiveness to customers, a 32-percent reduction in inventory, and a 65-percent reduction in order-fulfillment lead times.

As the market continues to change and Intel's business evolves and accelerates, we will continue to implement flexible, adaptable, and expandable IT-enabled solutions that will further transform Intel's supply chain and increase Intel's competitiveness.

ACRONYMS

BI	business intelligence
CDD	committed dock date
CEP	Customer Excellence Program
CPU	central processing unit
ERP	enterprise resource planning
GPU	graphics processing unit
KPI	key performance indicator
OFLT	order fulfillment lead time
SSD	solid-state drive
VMI	vendor-managed inventory

For more information on Intel IT best practices, visit www.intel.com/it.


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