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Intel IT

IT Best Practices

Enterprise Resource Planning and IT Business Transformation

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Creating Business Value through ERP Transformation

The transformation of our ERP system greatly reduced its complexity—providing increased business value through improved agility and velocity, increased reliability and support, and enhanced cost efficiency.

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Executive Overview

Intel IT has transformed Intel's enterprise resource planning (ERP) system into an agile, cost-effective tool that supports high-velocity business growth and ever-changing business needs.

During the transformation process, we addressed critical concerns about our existing ERP environment. To effect the transformation, we systematically implemented a detailed plan over five years, including adopting new enterprise architecture strategies, acquiring new skill sets, and installing a new technical platform support based on Intel® processors.

The success of our ERP transformation depended on several key components, including governance and regular review of the plan to keep it aligned with changing business needs. Our ERP transformation has resulted in an enterprise platform that can adapt to the speed of today's business.

- We can implement patches and enhancements from the supplier in five weeks, across our entire ERP landscape with minimal production downtime. Prior to the transformation, it took six months to apply an ERP system patch.
- We can better integrate new out-of-the-box capabilities, including business intelligence capabilities, which help us analyze business data, react quickly to changing business needs, and perform better predictive analytics.
- We now have a system that supports agile development processes, providing an optimal user experience across multiple devices.
- We have lowered our operational costs significantly with reusable horizontal services, minimal customizations, and fewer suppliers.

The transformation of our ERP system greatly reduced its complexity—providing increased business value through improved agility and velocity, increased reliability and support, and enhanced cost efficiency.

We intend to further transform our ERP system to maximize our return on investment and minimize our total cost of ownership. We plan to streamline our agility so that we can deploy new services in as little as six days, deliver services through the cloud and on small form factor devices, and improve our real-time business intelligence capabilities.

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BUSINESS CHALLENGE

In 2004, Intel's enterprise resource planning (ERP) system was very large and complex, supporting 15,000 daily users who accessed more than 250 databases and 450 servers. Although state-of-the-art when it was installed, we realized that the system could not efficiently scale to meet future business needs—it was too slow to adapt to changing business requirements, and it was too expensive to maintain. Clearly, we needed to transform both our business processes and the technical platform to enable greater velocity in providing business value, greater agility to take advantage of supplier-provided capabilities, and greater cost efficiency in operations.

At the heart of the problem was the complex nature of our ERP system used by numerous business groups. The ERP system consisted of four modules:

- Order management
- Finance
- Direct procurement (used for purchasing components for manufacturing our silicon products)
- Indirect procurement (used for all other purchases)

As shown in Figure 1, these modules were highly vertical in nature—that is, a single business process involved multiple, disparate systems. For example, the order-taking process started in the ERP system, but there was no direct, real-time connection to the supply chain system to determine if we had enough inventory to meet the order. Similarly, no direct connection existed to the systems that analyzed whether certain products could be shipped to certain countries, calculated taxes, or confirmed the order with the customer.

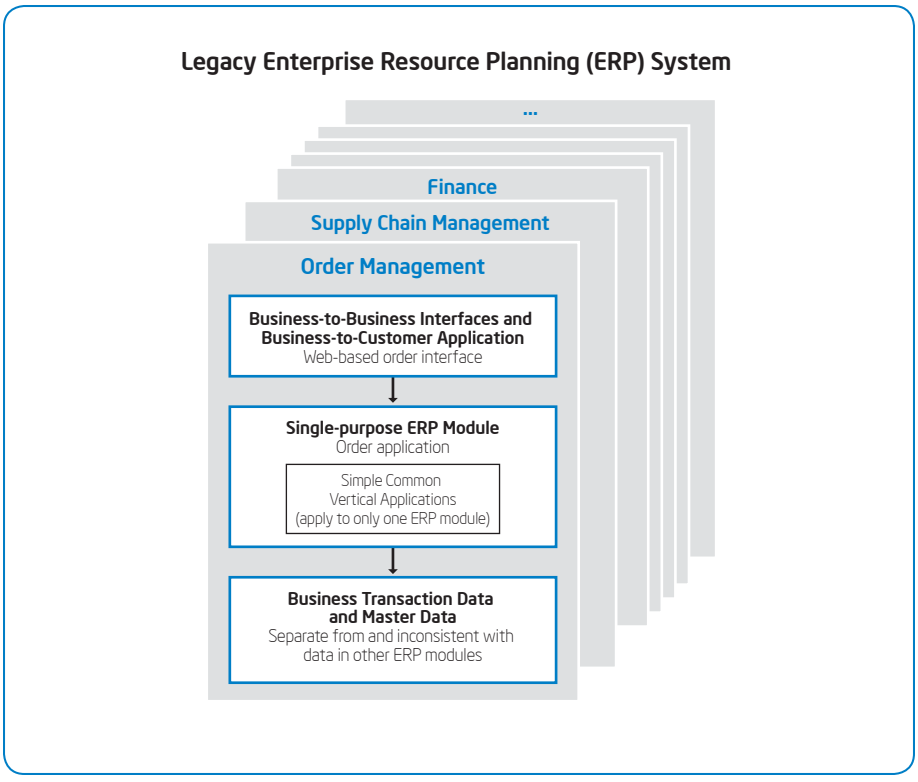

Figure 1. In our legacy ERP system, each business group, such as order management, had its own separate ERP module and its own supporting applications and master data.

The vertical nature of the system led to a complex network of interconnections and dependencies. This complexity made it difficult to change business processes, extract and correlate data, and develop new capabilities.

Although we chose a major software supplier in the early 1990s when we first established our ERP system, Intel needed more complex business processes than the supplier could support. Therefore, to meet the needs of the business, we made more than 100,000 modifications and customizations to the system.

Although these modifications were necessary (see Figure 2), they hampered business velocity, agility, and cost efficiency by preventing us from taking advantage of supplier-provided improvements. These same improvements, had we been able to deploy them, would have made the customizations unnecessary. Also, upgrading to a new version of the OS was impossible, because it required a base code change which would have been enormously expensive and time-consuming.

Slow to Respond to Business Needs

Due to the complexity of our ERP system, our ERP business processes were unable to respond to changing business needs quickly and efficiently. Business velocity was particularly relevant in the mid-2000s because Intel was experiencing dramatic growth worldwide. The rate of growth and geographic dispersion of data underscored the need to update our business processes. Driven by the Internet and global commerce, as the pace of Intel's business continued to increase, we experienced tremendous customer demand for new business-to-business, business-to-consumer, and online store services.

Slow to Adapt to New Technologies

The legacy ERP system lacked the agility to adapt to new technologies and business trends, including the following:

- Increasing demand for better and more rapid business intelligence (BI) capabilities. Separate vertical ERP modules made it difficult to combine and exchange data, because each module had its own definitions and data. So, the data was inconsistent across multiple business groups. It was becoming critical that we be able to deliver an accurate and consolidated picture of the business, to guide the right business decisions.
- A shift in the application development environment toward service-oriented architecture (SOA). We expected assemble-to-order web services to change the application landscape, by providing reusable system components.
- An evolution of form factors, where users were increasingly dissatisfied with access to enterprise applications only from a desktop or laptop PC. Smaller form factor devices, such as netbooks, then later tablets and smart phones, were becoming common productivity tools in the enterprise environment.

Expensive to Maintain

The high level of customization of our ERP system made it increasingly expensive to maintain. Growing ERP operating costs prevented us from allocating a sufficient budget toward new business development, such as providing new capabilities, increasing quality of services, pursuing innovation, and differentiating business processes.

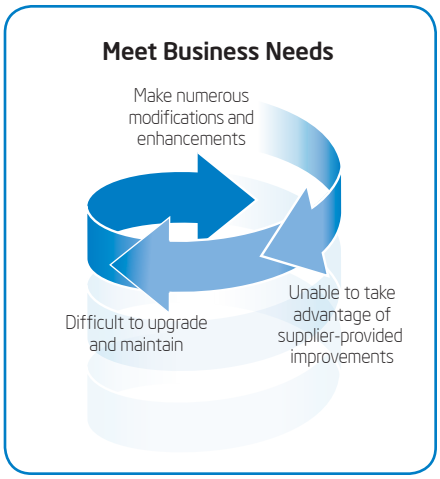

Figure 2. Large numbers of modifications and customizations to the legacy enterprise resource planning system led to maintenance difficulties and an inability to take advantage of the supplier's improvements to the application.

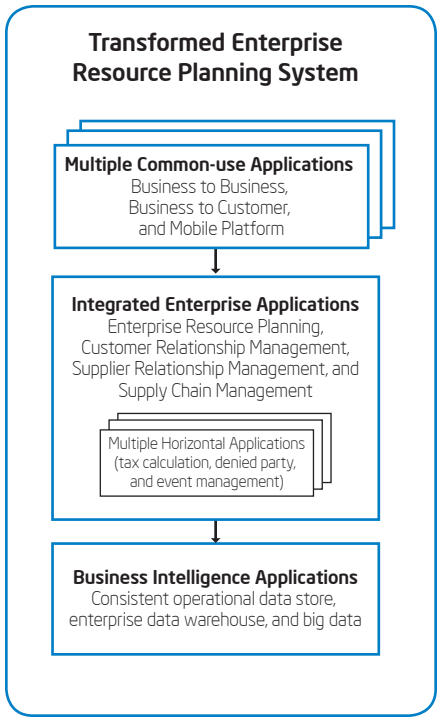

Figure 3. The transformed ERP system features components that can be used by multiple business processes and a consistent base of master data that supports business intelligence applications.

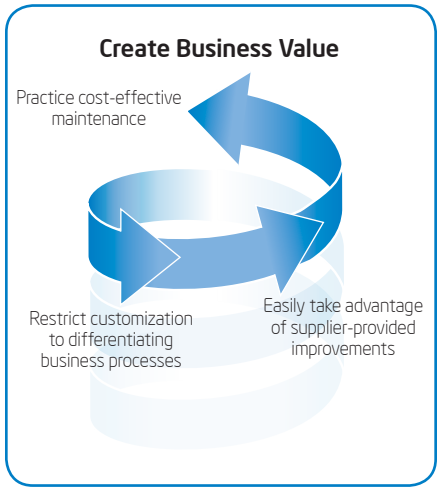

Figure 4. Investing in customization only when it provides a competitive advantage provides more business value and keeps maintenance costs low.

ERP TRANSFORMATION PROCESS

By transforming the technical ERP platform along with our business processes, we had the opportunity to create a more agile and more cost-efficient ERP environment that could support a high-velocity business.

To achieve the transformation, we first performed external benchmarking to develop an idea of the end state we wanted for our ERP system. During the process, we talked to customers, engaged external research companies, and consulted with our ERP suppliers. We developed a vision of a horizontal, distributed system, illustrated in Figure 3, where components are reusable across business processes. Each component, such as tax calculation, denied-party evaluation, and middleware applications are hosted separately. Multiple business processes, such as order-taking and procurement can use exactly the same tools in different ways and in a different order.

After we had a clear vision of what we wanted, we systematically accomplished that vision, as follows:

- Implemented several new enterprise architecture strategies that would help guide the transformation
- Detailed a five-year plan for how we would transition the legacy system to the new system
- Installed a new supporting hardware platform based on Intel® processors
- Developed new skill sets required to support the new horizontal components of the ERP system, effectively used new development methodologies, and developed new system components such as Java*, middleware, and BI applications

Each of these aspects of the transformation is described in detail in the following sections.

Enterprise Architecture Strategies

To maximize the value of our transformation efforts, we developed four foundational enterprise architecture strategies that guided our decisions and implementation of the new ERP system.

- **Maximize the value proposition of enterprise contracts.** Reducing the number of ERP, OS, and database suppliers lowers our operating costs by reducing both the size and number of required support organizations and the number of development and technical skills required for IT staff.
- **Create an assemble-to-order environment.** The horizontal, distributed organization of the new system enables us to quickly upgrade to the latest version of a particular ERP application. This lets us maximize our use of new horizontal capabilities provided by the ERP supplier, increasing agility at minimal cost to the business. It also lets business processes change quickly and adapt to new technological advances. For example, if the supplier adds a radio-frequency identification capability, we can plug it into the system and all the business processes can access the new feature.
- **Minimize customizations.** As shown in Figure 4, we perform customizations only when they support processes that maximize the business value of those customizations. For example, Intel requires a general ledger application to conduct business, but additional investment in modifications to improve the functionality of this application would provide little, if any, additional business value. In contrast, a low-cost supply chain can provide significant business value. We established a governance process to review the total cost of ownership (TCO) of a given modification and determine if a particular modification provides a competitive advantage.

- **Minimally impact the customer.** We minimized system downtime by carefully mapping process dependencies. Using this approach avoids scenarios where one change inadvertently affects other processes negatively—and, therefore, affects our IT customers downstream. We also avoid wasting budget and effort on developing temporary bridges between the new and old systems.

The Five-Year Plan

As shown in Figure 5, our ERP transformation took about five years, using a phased approach that included discovery, proofs of concept, initial deployment, and scale and ramp. During the first two years, we focused mainly on technology; once the platform was technically mature we were able to shift our focus to business processes.

During the discovery phase, we overcame our first major hurdle—we gained the support of the business groups. Working with them, we determined the scope and priorities of the transformation and established the enterprise architecture strategies discussed earlier. We also established governance policies to help us manage the program as a cohesive unit.

In the proof of concept phase, we continued our focus on governance by creating architecture tool standards. We also validated the transformation sequence to minimize back-patching, completed the integration of suppliers' products into a base platform, and continued the evolution of our organization by expanding our skill set development.

By this time, the technical platform was mature and we could focus more on transforming business processes. In the initial deployment phase, we moved a single business process to the new system to prove that our risk mitigation efforts were sufficient and that we were ready to deploy. We also performed a significant number of business process modeling, so that we didn't copy an inefficient business process. Finally, we validated our support model to

Keys to Success

The success of our ERP transformation depended on several key components:

- **Governance.** We implemented program, architectural, and implementation governance that guided the transformation process. For example, modification and enhancement review enforced our strategy of customizing only in the case of differentiating capabilities.

  IT staff and key program leaders comprising a revitalized Enterprise Architecture Steering committee helped align all business groups on decisions impacting the ERP environment. This steering committee was responsible for making prioritization and funding decisions surrounding the ERP transformation project.

  We also created architecture tool standards and established governance policies to help us manage the program as a cohesive unit.

- **Skill sets.** We discovered that projects could slip based on the lack of a single person's skill set. We needed to have the appropriate organizational and development skill sets in place when and where they were needed. To achieve this, we made a concerted effort in resource management, and worked with business groups to prioritize application development. For a detailed discussion, see "Developing New Skill Sets."

- **Plan review.** We performed quarterly re-evaluation of the transformation plan to support changing business needs. The end plan looked quite different from the original plan, because business needs changed significantly during the five-year transformation period. For example, the business asked us to delay deployment of a key functionality for six months, and we accelerated our deployment of the post-sales support process to improve customer satisfaction.

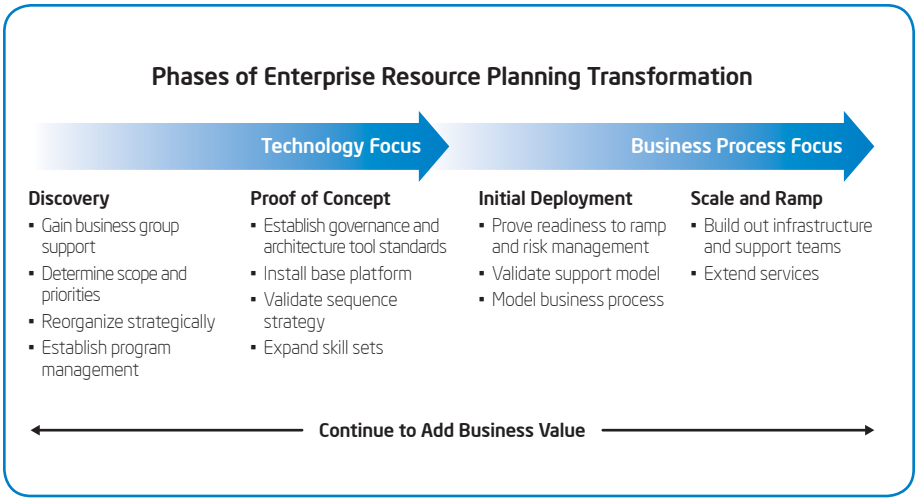

Figure 5. In the beginning, our focus was on technology and organization transformation; later, we focused more on business process transformation and business value delivery.

verify that our support teams were ready to maintain the new business processes.

In the final phase—scale and ramp, we continued to build out the infrastructure and support teams as the transformation completed.

It is important to note that we evaluated and adjusted our plan as we went along. The business did not remain static during the five years of ERP transformation—we continued to adapt to business needs and add business capabilities during this time, such as adding middleware, global trade services, and BI. More importantly, we ended with significantly more capability than we started with.

Sometimes, we had to adjust the transformation plan to reflect business reality. For example, we were scheduled to finish the transformation in 2010. However, we extended the schedule a full year because the business couldn't accept so much change so fast.

SERVICE-ORIENTED ARCHITECTURE

The key to transforming our ERP system from the legacy vertical approach to a more distributed, horizontal approach lies in implementing SOA. By developing common pieces of business logic that can be used by several different business processes, SOA promotes business velocity and maximizes business value through reuse.

During the transformation, we installed new horizontal—that is, reusable—enterprise capabilities, such as tax calculation, global trade, web portal, middleware, and BI applications. These common horizontal services support automation and consistent master data for BI, and we can quickly and easily upgrade them to take advantage of new supplier-provided capabilities.

We used a just-in-time development methodology when implementing new horizontal services. When a customer requested a service, such as single sign-on or Java development, an IT forward engineering team designed a use case and demonstrated it to the customer. This prescriptive guidance, which is even more detailed than general governance, promotes a factory-type application development environment based on assemble-to-order and reuse. As each service was developed, we stored it in an enterprise service registry, so that future projects and other business processes can take advantage of the newly developed service. We also developed an enterprise service bus, which is a software infrastructure that facilitates application integration.

One key benefit of implementing SOA is cost containment. Throughout the enterprise, self-contained, isolated repositories of redundant application functionality and data can consolidate. Consolidation reduces software life cycle costs and the number of software licenses and servers required. SOA also increases IT agility, improves time-to-market, results in better IT utilization and return on investment (ROI), and simplifies our enterprise architecture and computing model.

Hardware Platform Refresh

From a platform perspective, we have always chosen the best platform available for our ERP system. Originally, Intel's ERP system ran on mainframes using proprietary processor architecture. Over the period from 1992 to 1996 we migrated our ERP environment off the mainframes onto a proprietary OS running on servers based on Intel® Pentium® processors. Then, in 2004, we were faced with a two-fold dilemma:

- The supplier of our servers had been acquired by another company, and the new company was discontinuing that line of servers. This threatened the business continuity of our mission-critical ERP environment because there would soon be no upgrades or support available.
- Our supply chain in-memory database applications required more memory than was available on the platform we were using.

We decided to upgrade the OS, database, and software solution stack simultaneously when we migrated to a newer Intel® architecture. Each horizontal component of the ERP system, such as customer relationship management (CRM), middleware, web portal, and BI services, is hosted on its own set of servers. This approach contributes to business velocity because we can upgrade one system component without affecting the rest. For example, we can upgrade CRM or middleware services without taking down the entire ERP system.

We continue to adhere to a three-and-a-half to four-year hardware refresh cycle, which mirrors the hardware warranty schedule in our ERP environment. This refresh cycle lets us take advantage of compute performance and technology improvements such as multi-threading and multi-core processors. Figure 6 shows performance increases in workloads for the most frequently used batch application employed in the simulation of Intel® chip designs. Because a hardware upgrade represents a certain amount of disruption to the business, we work the hardware upgrade into a test cycle that the business is already performing.

We have created an agile, scalable, and cost-effective technical platform that facilitates agile service development methods. Our distributed server and application landscape supports a Plug and Play methodology for adopting new technology, such as in-memory database technology and the virtualization of our ERP system.

New Skill Sets

Our IT staff needed to acquire new skill sets to support the new horizontal components of the ERP system, to effectively use new development methodologies such as SOA, and to develop new system components such as Java, web servers, middleware, and BI applications. They also needed foundational skills that could support advanced networking concepts, information security, and performance challenges such as content delivery acceleration.

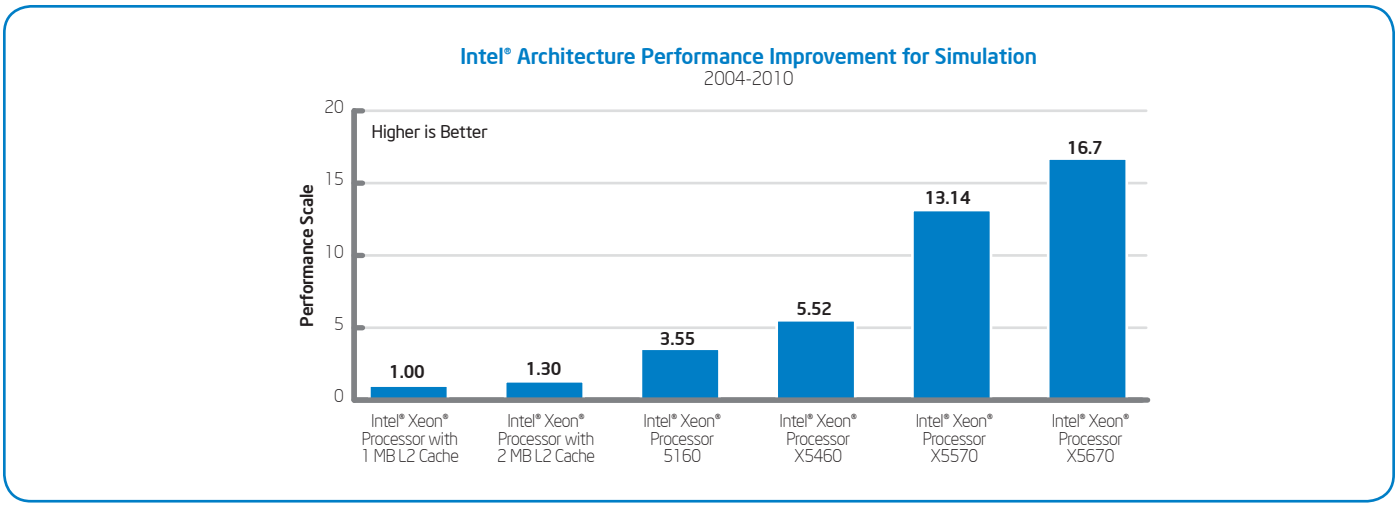

Figure 6. Each new generation of Intel® processor increases performance. Between 2004 and 2010, the performance of Intel® Xeon® processors increased almost 16x when running our most intensive design simulation application. Intel internal measurements May 2007, November 2007, February 2009, and March 2010.

Our forward engineering teams were responsible for determining the exact capabilities required at both the application development and system levels. To prepare them for these tasks we quadrupled our training budget and accelerated the training time frame for those groups first, so they could master the new technologies. By prototyping and creating prescriptive guidance in advance of demand by the customer, IT staff refined their skills and methods.

We also spent a significant amount of time providing business process modeling training to our forward engineering teams. Business process modeling at multiple layers of the system helped us understand what the business process did, how it mapped to the underlying technology, and how the business processes worked together.

Another change we made to support the ERP transformation process was to add project managers to the engineering teams. These employees took project management courses, and, if desired, could become certified in project management.

Initially, we used third-party training resources, but found that the value we got from those training sessions did not match what we could get from training provided by our ERP supplier. The supplier offered a more attractive training environment that supported online, on-site training instead of off-site training sessions.

We have created an internal web site where we store our training materials. Examples include prescriptive guidance documents, training documents, specifications around user experience development, reference architectures, FAQs, and how-to presentations for specific engineering activities. The web site also includes access to code management processes and customer engagement processes.

In addition to investing heavily in IT staff training, we also train customer organizations to use the new business processes and applications. We made the new applications intuitive and embedded how-to information in the application, such as mouse-over tips and F1 help buttons. We also provided online, self-paced training, which avoided the high cost of holding large face-to-face training sessions.

ERP TRANSFORMATION RESULTS

Our ERP transformation has resulted in an enterprise platform that can adapt to the speed of today's business. For example, Intel generated revenue of USD 40 billion in 2010, more than USD 50 billion in 2011, and expects to generate just less than USD 60 billion in 2012. Both our ERP and CRM transaction volumes have doubled in the last year and a half. Transforming our ERP system has helped make this magnitude of business scaling possible.

As shown in Figure 7, the transformation of our ERP system greatly reduced system complexity—it increased business value through increased agility and velocity, improved reliability and support, provided a better user experience, and enhanced cost efficiency.

Figure 7's illustration of Before Transformation is a representation of the legacy system. The rectangles represent disparate business processes executed on different application platforms. They supported an element of the business process, such as order creation, bill

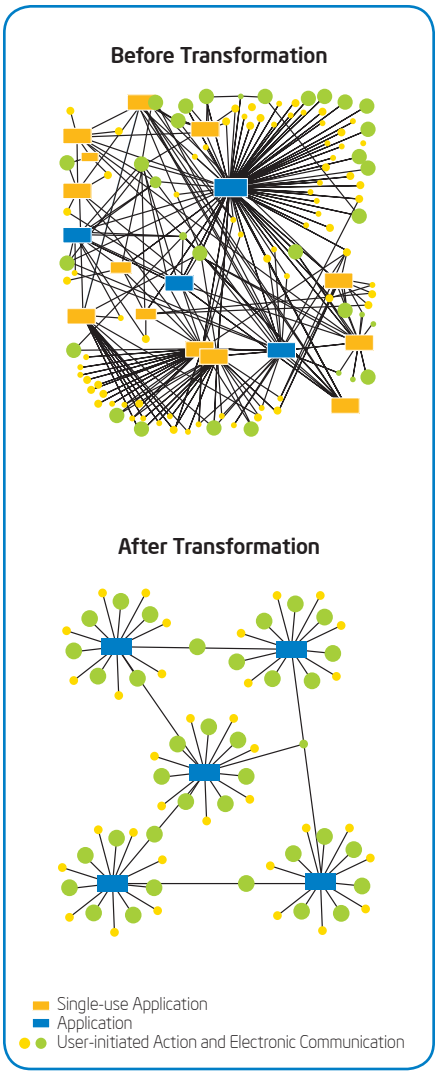

Figure 7. We have greatly reduced the complexity of our ERP system, maximizing the use of applications.

of materials tracking, or supplier payment. The outer ends of each line represent a user-initiated action, such as a customer requesting more CPUs or post-sales support activities. Because there were no real-time connections between the applications, the entire system tended to be batch-driven and was unable to provide real-time data.

In contrast, the figure's illustration of After Transformation represents the transformed ERP system. Note that there are about half as many applications, and each application has a real-time connection to the others. The new streamlined system works by implementing horizontal and reusable components, minimizing customizations, and transforming business processes.

Improved Velocity

It is common for an application supplier to release bug fixes. Before the transformation, it took 60 people six months to apply a patch from the supplier. Although we wanted to deploy such patches, doing so had a negative impact on our development factory.

With the transformed system, we can support rapid growth and change in our enterprise applications environment and can adapt to rapidly changing business needs and processes. We now can implement patches from the supplier twice a year with minimum resources, a mere 10-hour production downtime, and a five-week path to production. Smaller updates to the system, such as new code to support new or changed business processes, have a release window of one to two weeks—we can release these types of projects 150 to 170 times per year.

Enhanced Agility

Our legacy batch-driven ERP system did not support real-time data queries, suffered from inconsistent master data between the vertical modules, and made it difficult to add new capabilities. In addition, users of the system interacted with a single user interface that had to be run on a full desktop PC or on a laptop, with a full connection to the Intel enterprise network and application servers.

In contrast, our out-of-the-box implementation of the transformed ERP system lets us identify and focus on high-value, differentiate business processes, and rapidly deploy supporting capabilities. BI is a good example of such a capability. We can easily plug new BI applications into our horizontal, distributed system. By identifying and standardizing highly shared, integrated data into a master data warehouse, these BI applications can rapidly and reliably use the master data for actionable analytics that support better decision making.

Also, the transformed assemble-to-order system supports agile development processes that can provide an optimal user experience across multiple devices. Currently, we offer CRM on certain mobile devices; in the future, we expect to support some ERP applications, such as expense reporting, on multiple form factors, both connected and non-connected.

Better Cost Efficiency

We have lowered our development costs by supporting a high level of reuse of system components. An integrated ERP system that uses many common components across the enterprise is easier to support, and more reliable. Fewer modifications and customizations mean lower maintenance costs—we have made less than 10,000 modifications to the new system, compared to more than 100,000 for the old one. In addition, having a single supplier also lowers sustaining costs and lets us end of life many legacy applications.

NEXT STEPS

Although the transformation has already resulted in tremendous business value for Intel, we intend to further transform our ERP system to maximize ROI and minimize TCO.

Some of our plans include the following:

- Continue to streamline our ability to adapt to business change by being able to deploy a revised business process in six days
- Use an in-memory database, which provides real-time BI that enables on-the-fly queries to the data warehouse, such as for order management applications
- Make real-time BI part of the standard business practice so that users can get data when they want it, how they want it[1]
- Implement automatic and self-provisioning systems in the ERP environment, to further improve agility and velocity
- Adapt the ERP environment to accommodate changing usages, such as IT consumerization, multiple devices, and mobility
- Deliver ERP through the cloud to provide elastic compute capacity and to satisfy variable user needs from the ERP system

[1] For more information on business intelligence at Intel, see "Roadmap for Transforming Intel's Business with Advanced Analytics," Intel Corp., October 2011.

CONCLUSION

We have transformed Intel's ERP environment into a system that provides increased business value through increased agility and velocity, improved reliability and support, and enhanced cost efficiency. The transformation was necessary for us to support business growth and ever-changing business needs.

Prior to the transformation, our ERP system was highly complex, expensive, and slow to respond to changing customer needs. For example, more than 100,000 modifications and customizations made it financially and technically impossible to upgrade to new capabilities provided by the supplier and contributed to escalating maintenance costs.

Developing a detailed transformation plan, adopting new enterprise architecture strategies, acquiring new skill sets, and installing a new supporting hardware platform based on Intel processors, helped us create a cost-effective enterprise platform that can scale quickly and adapt to the speed of today's business.

Prior to the transformation, it took six months to apply an ERP system patch; today, we can implement patches from the supplier in five weeks. We can better integrate new technologies, such as BI, which enables us to analyze data to make informed decisions and better predict future requirements. The transformed system supports agile development processes and reusable horizontal services with minimal customizations.

Although the transformation has already resulted in tremendous business value for Intel, we intend to further transform our ERP system to maximize ROI and minimize TCO. We plan to streamline our agility so that we can deploy new services in as little as six days, deliver services through the cloud and on small form factor devices, and improve our real-time BI capabilities.

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ACRONYMS

BI	business intelligence
CRM	customer relationship management
ERP	enterprise resource planning
ROI	return on investment
SOA	service-oriented architecture
TCO	total cost of ownership

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