



Smarter products: the building blocks for a smarter planet.

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Executive overview

As a way to differentiate their offerings and optimize business returns, manufacturers across all industries are delivering a new generation of “smarter products.” They are unleashing the creativity and productivity of the individual like never before — whether that’s an individual business or an individual person. These smarter products can better adapt to the unique needs, preferences and characteristics of consumers to get things done. They are helping people tackle many of their biggest challenges, and they better exploit scarce resources such as time, money, skills and energy. As a result, they are sparking innovation for a smarter planet and transforming our world as we know it. We are entering a new era of flexible, realtime customization where the products we rely on are consumed seamlessly within integrated experiences or processes.

How is this all happening? What is new? Product companies are tapping into accelerating innovation using embedded software control—the new “brains” that make products smarter. When software is effectively fused with microelectronic, actuator, sensor and mechanical technologies, products can become increasingly interconnected, intelligent and instrumented. That is, they can respond to changes quickly and accurately and produce better results by anticipating and optimizing for future events. They can measure and sense the relevant conditions and are able to interact with other products, people and IT systems in entirely new ways. This is what makes them “smart”—their ability to adapt to the unique needs of individual businesses and people.

As software becomes a critical ingredient in product innovation, traditional manufacturers are essentially becoming software companies. The success of traditional manufacturing companies across multiple industries is increasingly tied to how well they harness software to deliver a competitive advantage.

Highlights

Software is becoming a critical element in product innovation, playing a significant role in such success factors as customer satisfaction, safety ratings and product reliability.

While this transformation is sparking unprecedented leaps in product value, it also introduces new challenges and implications. Today, 66 percent of products rely on software as a key differentiator.¹ And it's only going to continue to expand. The automotive industry, for example, is expected to experience a 165 percent growth in embedded software through 2015.² Even treadmills are being purchased or dismissed based on their software functionality, not just their mechanical capabilities.

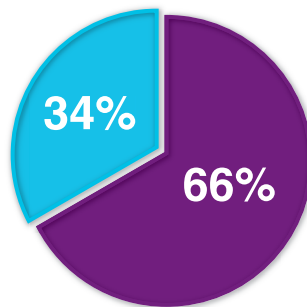


Figure 1: According to a March 2009 Aberdeen Group report on embedded systems development, software is the key differentiator for 66 percent of today's products.

For the world's manufacturers, software is playing an increasingly significant role in key business success factors such as customer satisfaction, safety ratings, product reliability, profitable cost and risk models, and their overall image as innovators. For example, over 30 percent of car warranty costs are now related to electronics and their embedded software.³

The successful businesses of the future will be those that build a strong competency in software, which is where IBM can help. IBM has extensive expertise, technologies, tools and methodologies to help the world's manufacturers and their consumers reap the value of smarter products as we all work toward building a smarter planet.

Highlights

There is growing demand for smart products that can be easily configured to enable highly individualized consumer experiences.

A seismic shift is under way in how we interact with everyday products

There is something profound going on in how we humans run our daily lives. There are nearly 7 billion people on the planet—individuals with unique needs, desires and approaches to getting things done and enjoying life. There are over 100 million businesses, worldwide, all facing a wide variety of challenges based on their unique characteristics and conditions. Yet for so long, the products they rely on have been largely one size fits all. They were not created for the unique needs of individuals but, rather, produced for the masses with limited options for personalization.

Thus the era of one-size-fits-all products is rapidly coming to an end, shifting to a focus on integrated experiences designed to help businesses, institutions and consumers get things done that are uniquely important to them. Manufacturers and consumers are realizing quickly that individuality—the desired experience—is what can differentiate their offerings in a competitive marketplace. As a result, mass production no longer dictates how people use specific products. Instead, businesses and consumers are craving personalization and integration of the products they rely on every day. This demand for smarter products is driving manufacturers and service providers to look for new and innovative ways to differentiate their products and enable them to be easily configurable to highly individualized experiences. In turn, this is driving consumer-focused businesses and individuals to invent new ways to solve big and small challenges—such as smarter cities that educate the young, keep citizens safe, attract and facilitate commerce, and enable the smooth flow of planes, trains, cars and pedestrians; or smarter healthcare that includes personalized workout programs and monitors the individual’s status to improve overall health. Smarter products are enabling innovation, and this worldwide revolution in product design is only just beginning.

Highlights

Consumers want products that can work together to meet individual lifestyle objectives and preferences.

With the era of one-size-fits-all products drawing to a close; the result is a departure from the mass-produced, “cold” commodities that once limited productivity in terms of energy, time, application of skills, and money. Consumers desire products that are better able to work together and help create experiences that are completely unique, molding to the specific preferences of an individual’s objectives and personal characteristics. Businesses and consumers everywhere are looking to unleash the human experience and capability to succeed like never before, and this is best accomplished with smart products that can adapt to the task at hand. Consider that in 2006 there were nearly 203 million licensed drivers the United States,⁴ yet clearly there are not 203 million uniquely manufactured automobiles tailored to the desired experience and particular needs of every driver. Well, not yet.

To be sure, there are many aspects of automobile design regarding safety that require the standardization that highway and automobile regulations have evolved over the decades. But there are many aspects that can be customized.

Highlights

It's not difficult to imagine — and enable — cars with sensors that are integrated into home alarm systems, cell phones, diagnostics, safety features and GPS systems to protect drivers and enable more productive use of commuter time.

Imagine this scenario, which could definitely give those 203 million drivers a different perspective on their daily commutes:

As you exit your driveway, your car automatically senses that you are leaving the residence and activates the home alarm system, thus ensuring that the appropriate lighting is set. Your cell phone capabilities are automatically consumed into the car's dashboard without your lifting a finger, and they're enabled to the car's voice command system. Your iPod has already downloaded the podcasts for your daily business briefings, which you listen to right from your radio. Your car has been using your new GPS to analyze driving patterns and has recommended a new route to lower your fuel costs and help you avoid heavy traffic. Finally, the car informs you that your antilock brakes need servicing and has checked with the dealer and your BlackBerry calendar to present options for Saturday morning appointments, which it knows you prefer from previous appointment patterns and your availability. An e-mail is waiting for you to accept the appropriate time. Overall, you are comforted by knowing that you are in a safe vehicle. It understands its passenger load, assists in lane changes, and can detect and respond to potential threats. In the event of an accident, it would balloon the air bag to the appropriate level based on the body weight that your car seat provided to the sensors, and it would use the GPS and cell phone to target your location and call emergency services. You are encouraged knowing that nearly 2,800 lives have already been saved by such capabilities, according to the National Highway Transportation Safety Administration (NHTSA).

Highlights

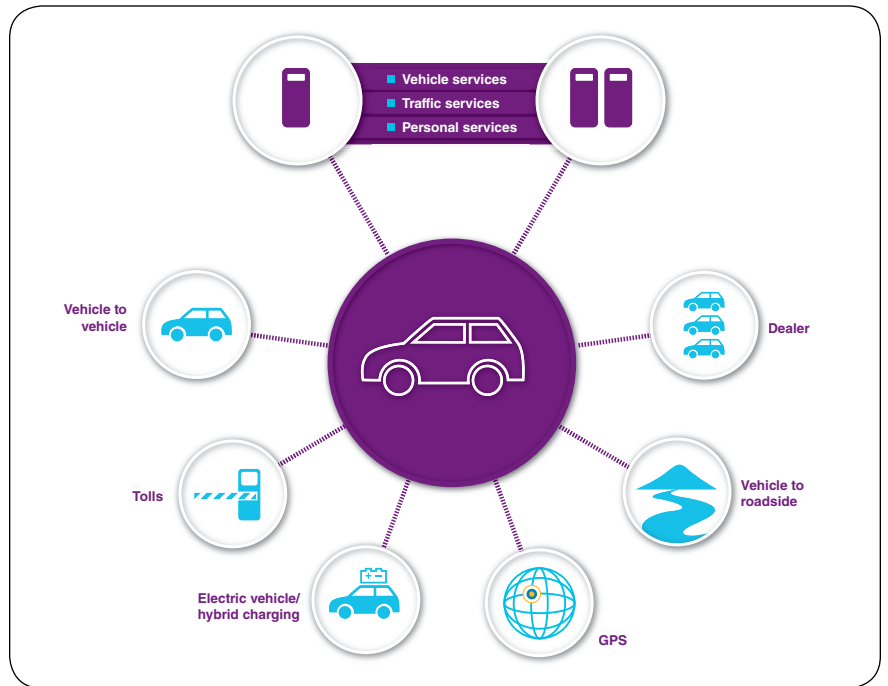


Figure 2: The underlying complexity of interactions involved in vehicle performance and safety remain hidden from the driver.

The smart automotive experience is only one example of how embedded software can revolutionize virtually all types of products and activities.

This example of a smart automotive experience is just the tip of the iceberg. Businesses and consumers around the world are looking to revolutionize all types of industries and daily activities, from the treadmill that helps track weight loss, to the medical device that saves lives, to the airplane that brings passengers safely to their destination.

Highlights



Interconnected

Enable people, systems and other products to communicate and interact with one another in entirely different ways.



Intelligent

Respond to changes quickly and accurately, and get better results by predicting and optimizing for future events.



Instrumented

Measure, sense and see the exact condition of everything.

Yet the question remains, how can these demands and desires be met? How are products becoming smarter?

First, they are becoming more *interconnected* so that people, systems, back-end applications and objects can communicate and interact with one another in entirely new ways. Mass production no longer dictates how people use specific products. For example, as quickly as consumers activate their smartphones, they begin to forge personal relationships with the phones, the applications and the other systems with which they interconnect. When a collection of these smarter products is interconnected into an ecosystem to work together, it creates experiences that are completely unique and can mold to the specific preferences of an individual's daily work and personal life.

Second, they are becoming more *intelligent* and thus able to respond to changes quickly and accurately, and get improved results by anticipating and optimizing for future events. This allows the array of products that a person, or business, is using to deliver an experience, or tackle a task, based on a better understanding of the user or the problem. The technologies that allow manufacturers to build these increasingly intelligent products are completely transparent to the consumer, yet allow them to bring differentiated value to an increasingly commoditized marketplace.

Lastly, they are becoming better *instrumented*. The potential of products is exploding with the incorporation of sensors, actuators, cameras, GPS positioning, etc., all of which provide individualized context and deliver groundbreaking functionality that enables measuring and sensing the exact condition of the device environment. By interconnecting to weather systems, smart home controls can have sprinklers turn on only when it's not raining. Instrumentation makes way for many smarter applications, such as the ceiling heater in the bathroom that automatically turns on in the winter five minutes before the alarm clock goes off. This helps fine-tune energy usage to exact needs.

Highlights

While embedded software can significantly increase product value, it also introduces new levels of complexity that create challenges for product design, development, production and management.

How is all this getting enabled? Manufacturers are tapping into accelerating innovation in embedded software control—the new “brains” that make products smarter. When software is effectively fused with microelectronic, actuator, sensor and mechanical technologies, it accelerates the innovation that’s so essential to delivering smarter products. As software becomes the key ingredient in product innovation, traditional manufacturers are basically becoming software companies! That’s right, the success of automotive companies, cell phone providers, medical device companies and kitchen appliance manufacturers is increasingly tied to how well they are able to harness software to deliver competitive advantage.

While this transformation is sparking unprecedented leaps in product value, it is also introducing new challenges and implications. The drive to infuse these smarter capabilities is resulting in an exponential leap in complexity. Just consider the challenges inherent in designing, building and managing smarter cars:

- *Approximately 90 percent of innovation in today’s cars is based on electronics and embedded software, and the value of these in-vehicle electronics and software will increase by 35 percent by 2010.⁵*
- *Frost and Sullivan estimated that cars will require between 200 and 300 million lines of software code in the near future.⁶*
- *For today’s cars, the cost of software and electronics can reach 40 percent of the cost of a car. The software alone represents about a billion dollars’ worth of investment.⁷*

Highlights

As products become more interconnected, intelligent and instrumented, businesses must find ways to deal effectively with the added complexity, cost and risk of product creation and lifecycle management.

The world has seen only a tiny bit of what is possible. For example, a leading automaker is already prototyping new automotive capabilities that can sense and respond to human thoughts. This would require a significant degree of software control and management in order to make successful.

While most people take these technologies for granted, the design, development and management of the embedded technology (software, sensors, semiconductors, mechanical systems) that make cars more innovative also add a layer of complexity, cost and risk to the products used each day. Embedded systems, sensors and software that differentiate the manufactured products of the world, and the applications that interconnect them to back-end IT systems, must be created to perform specific functions and tasks. Likewise, products themselves must be designed to do what their “brains” tell them to do—for example, automatically deploying an air bag when the driver slams on the brakes, and then dialing emergency services to send help while leveraging a GPS device to identify the vehicle’s location.

As product creation and lifecycle management become more complex due to the increasingly sophisticated degree of interconnectivity, intelligence and instrumentation, it’s becoming an outright business success factor for manufacturers to better manage the risk and cost associated with smarter products.

Highlights

If not managed effectively, the increased complexity of smarter products can drag down profits and threaten the long-term viability of the business.

This jump in complexity, if not well managed, can negatively affect the bottom line for many companies. For the world's automotive manufacturers, software is playing an increasingly significant role in key business success factors such as customer satisfaction, safety ratings, product reliability, profitable cost and risk models, as well as in their overall image as innovators. Again, consider a few examples:

- *An automaker stops sales of its hot-selling truck due to an engine control software flaw that failed to recognize improper levels of heat in the exhaust system.⁸*
- *Another automaker recalls 25,000 automobiles because power train control modules were programmed with software that may allow the engine to stall under certain conditions.⁹*
- *Yet another automaker recalls 16,000 of its SUVs to fix a software program that may cause passenger air bags to fail.¹⁰*
- *Fifty percent of car warranty costs are related to embedded electronics and software, costing automakers in the United States around US\$350 and European automakers €250 per car.¹¹*

Yet this is only the start of the challenge of managing the complexity of a world composed of smarter products. Once the smarter capabilities are created, they become “living things” — evolving, morphing and growing in subsequent releases. Expectations grow, as does the need to be compatible with previous releases of products that make up the ecosystem in a person's life experience or a business's workflow. Products progressively become more interconnected, more intelligent and more instrumented. In turn, they drive greater degrees of the vision for a smarter planet over time by further unleashing the creativity, and thus the expectations, of people and businesses everywhere. Managing their evolution in an increasingly interconnected, realtime and fast-paced world is resulting in unprecedented complexity, which can threaten a business's long-term viability if not well managed.

Highlights

Forward-thinking product manufacturers are learning to become software companies, building the competency required to design, develop, deliver and manage smart products.

Furthermore, as these smarter products become the foundations that run the businesses, institutions and personal properties of the world, they will help transform our world at a speed that perhaps has not yet been experienced.

The successful businesses and institutions of the future must start today to build the competency to design, develop, deliver and manage a new generation of smarter products. The reality is that product manufacturers are now also becoming software companies, infusing the technological capabilities of electrical, mechanical and software components into a new generation of innovation. Further, the businesses and institutions that use these smarter products will be compelled to do the same, as they integrate value around these smarter products, building layers of customized interconnectivity, intelligence and instrumentation.

Challenges of the existing approach

Software is the invisible thread that differentiates so many products used today and makes them seem so smart. While often unseen, software is increasingly the driving force behind the functionality of a device, what animates it and what gives it its purpose. Yet it is precisely the intangible nature of software — especially the development and management of software assets — that presents the challenge that most organizations struggle with every day. For example:

- *Only 34 percent of software products are deemed successful, costing the industry nearly US\$300 billion annually.¹²*
- *Only 37 percent of organizations are satisfied with the current speed of software development, even with current levels of complexity.¹³*

Highlights

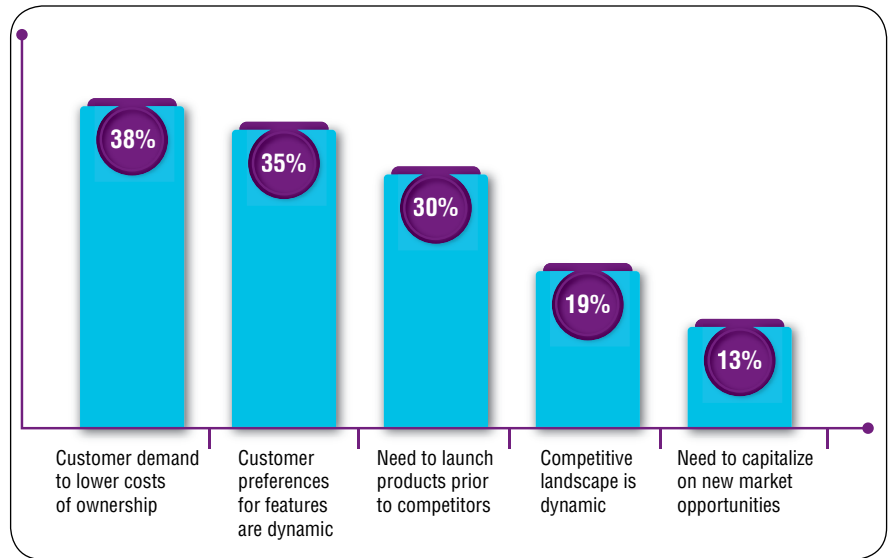


Figure 3: The March 2009 report from Aberdeen shows that customer demand for new features and lower cost are dominate factors in the drive to improve embedded software.

The transformation from product to software manufacturing often requires a new business model, one that can accommodate the speed of software-led innovation.

Product manufacturers must become more adept at software delivery and software-led conceptualization, design and systems integration. Most products are still being developed with ad hoc techniques for software delivery, which are not adapted to the modern challenge. Many of these companies do not have the skill sets, resources or development platforms necessary to build and maintain the software that is needed. In fact, they often have such limited experience in software development that their business model needs to be completely rewritten. One such organization, developing baggage-handling systems, had to go from a purely mechanical belt system that required human interaction to a completely automated, software-based smart system in order to win the new airport and delivery contracts it needed to stay in business. As a result of the speed of software-led innovation, traditional hardware systems design and delivery processes also need to evolve to keep up. Organizations need to rethink the way they have traditionally developed electrical, mechanical and embedded software to ensure that they don't become a bottleneck to innovation.

Highlights

Software and hardware development teams have traditionally operated in silos, and mechanical and electrical product components have evolved much more slowly than software components.

Since smarter products need to be instrumented, they must connect to the hardware components. The challenges here are also increasing as the amount of integration with sensors and actuators grows, needing flawless quality and high responsiveness in what is becoming an increasingly complex system. Historically, software and hardware development teams have been relatively disconnected, with the mechanical and electrical components evolving much more slowly than the newcomers on the software side. As new instrumentation functions appear, these two disciplines need to evolve together to provide a high-quality working component and a lifecycle process that manages newly instrumented products as they evolve over the years. This is easier said than done, as requirements need to be decomposed, assigned and tracked across multiple disciplines. Heterogeneous systems must be simulated up front to validate designs. Changes may impact components across multiple teams, leading to complex project management, testing and change control. One organization designing a smart entertainment system recently discovered just before delivery that change requests that had been implemented in the software hadn't been included in the hardware... leading to two months of delay.

Finally, what helps to create a unique experience is how these components interconnect—to the Internet and to back-end IT systems. Organizations must learn how to develop products that can talk together within their intended ecosystems. Standardized communication protocols are needed so that all these products can interconnect seamlessly. Wireless interaction and radio waves must comply with new health standards, and organizations must be able to demonstrate that compliance. This means going beyond traditional silos between software and hardware development, between IT and systems, between competing companies, and between vendors and governments.

Highlights

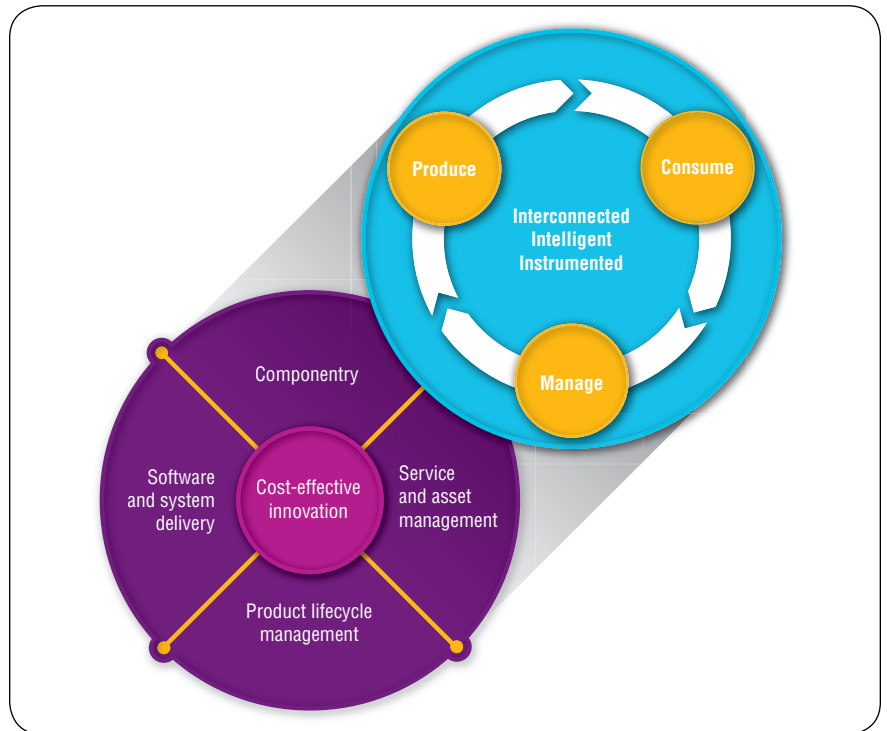


Figure 4: Many systems must come together in order to build a smarter product.

Because product complaints can be publicized in minutes on the worldwide Web, businesses need to work closely with suppliers, customers and partners in the launch or enhancement of all their smart products.

Enterprises and their suppliers, customers and partner communities will also need new ways of working together. They will require capabilities such as consulting, training and collaboration services to help tackle this transformation successfully. They will need to implement best practices and thereby create value quickly, learning from the lessons of others. Not only is this necessary in order to manage cost and improve time to market, it's also necessary in order to maintain the level of quality that customers expect on this smaller, flatter planet—any failure can have cascading effects and be publicized globally in minutes.

Highlights

Unless the right processes, systems and people are put in place, manufacturers of smart products face losses from project delays, cost overruns and product quality issues.

Implications of an inefficient approach

Failure to adapt to the new challenges for building and delivering smarter products can significantly impact a company's bottom line and brand image. If organizations cannot create the products required to build a smarter planet, they risk being left on the sidelines as this infrastructure is deployed within vertical industries. Industries cannot deliver on the promise of a smarter planet without smarter products that are customizable, individualized and efficient. Whether the target industry is energy, automotive, healthcare or transportation, participation in the creation of a smarter planet is essential. Increased cost, higher risk, low customer satisfaction and delayed marketplace entry will threaten businesses, industries and institutions as complexity takes over.

Even today, 49 percent of software-related projects suffer budget overruns, and 50 percent of outsourced projects are expected to underperform.¹⁴ With the levels of integration and interconnection planned between products, systems, companies and countries, the potential cost will increase dramatically... unless the right processes, products and people are put in place.

Examples abound. For instance, poor quality management can be extremely expensive in the automotive industry. Consider a situation where a leading automotive manufacturer had to recall vehicles with improperly working rain-sensing wipers, costing the company millions of dollars. The development of rain-sensing wipers includes mechanical, electronics and software components that are procured by tier-one suppliers. They need to be integrated, instrumented and interconnected to the dealership applications for maintenance.

Highlights

Failing to take steps now can significantly impair future competitiveness – perhaps even survival.

The speed of innovation across a smarter planet means that organizations must evolve now in order to remain competitive tomorrow. The risks of inaction are significant:

- 1. **Loss of marketplace leadership or relevance:** Organizations can quickly lose their current foothold in their marketplace, yielding share to more nimble organizations that have made the transition to building smarter products. This is especially obvious in the consumer electronics and telecommunications domain where consumers are particularly fickle, but equally relevant in other industries such as aerospace and defense or automotive.*
- 2. **Unnecessary risk and profit hits:** The competitive pressures to develop complex, innovative products in shorter cycles are compounded by the challenge of maintaining quality standards and therefore brand equity. More and more products are becoming “user critical”—beyond mission critical. A software flaw in an airplane’s control system, in a medical device or in a fire alarm needs to be prevented before a tragedy occurs. It can also mean dramatic increases in warranty costs, maintenance costs and total costs over the lifetime of the product.*
- 3. **Increased cost of development and customer service:** As the company works on new projects using new technologies, the cost of development needs to be managed. Without being able to leverage best-practice product development processes, companies have to reinvent the wheel and have no predictability into budgets and deadlines. Nor does the company have the assurances that these products meet the requirements of the end user—until they are in the marketplace. Having to prove compliance and pass audits to evolving standards and regulations can be very expensive.*

Highlights

IBM offers expertise and solutions to help organizations create and deliver smart products successfully.

What IBM is doing today to help clients make smarter products

IBM helps its clients deliver products that are increasingly *intelligent* and realtime *instrumented*, enabled through components (software, chips, embedded systems, technology) and capabilities (tools, best practices and deep industry know-how). IBM enables its clients to create and deliver products that are *interconnected* to the Internet and back-end IT systems to radically infuse functionality and value. By leveraging IBM solutions, clients can deliver value through innovation at lower cost and risk through software, embedded systems, best-practice product development and product lifecycle management capabilities.

IBM has the unique blend of experts, knowledge and solutions that is necessary to help bring the promise of accessible, widespread, high-quality smarter products to the planet.

Solutions design, development and evolution of products

IBM Rational® products provide a platform for delivering the software that powers smarter products, helping organizations develop increasingly complex, groundbreaking functionality that can be the intelligence behind innovation, helping to manage the communication between interconnected devices.

Rational software also provides critical systems engineering solutions such as requirements engineering, integrated change management, model-driven systems development, and product portfolio management to help ensure that manufacturers bring the right products to market at the right time.

Highlights

IBM solutions include the components, technology, capabilities, tools, best practices and deep industry know-how that can help businesses address the organizational and operational challenges of manufacturing smart products.

Product lifecycle management solutions

IBM product lifecycle management (PLM) solutions help clients improve time to market and reduce costs through enhanced design, delivery and lifecycle management of manufactured products, while bridging the schism between hardware and software, to help clients ensure that their instrumented products are of high quality, efficient and built to deliver on expectations.

Smarter products development and delivery best practices

IBM Global Business Services provides best practices that organizations need in order to address the challenges of building the smarter products that enable our smarter planet. This can help them transform their businesses to be more competitive at lower risk.

Providing the building blocks of smarter products

IBM Systems and Technology Group delivers microchips that are a key enabler of a smarter planet, providing the billions of transistors embedded in devices big and small that make the world more digitally aware and interconnected. IBM also provides the sensors and actuators that are critical to instrumented products.

Highlights

For 14 consecutive years, IBM has been the United States patent leader, with innovations in business processes, products and technology.

For instance, IBM is teaming with Ramtron for the production of ferroelectric random access memory (F-RAM) chips, used in applications ranging from automobiles to medical devices to electrical metering systems. Ramtron provides chips for advanced metering devices that enable two-way communications via phone, radio frequency or satellite, allowing customers to see and control their energy use in realtime. Ramtron also provides chips that enable intelligent automobile air bags, which use sensors to control the force of how the air bag deploys based on the severity of the accident, the weight of the driver and other factors.

Industry-leading community of subject matter experts

IBM Systems Engineering Community of Practice unites thousands of experts who exchange their experience in building smarter products and in helping organizations succeed in this area. IBM has been the United States patent leader for 14 consecutive years, with innovations in business processes, products and technology.

Service management

IBM service management (IBM Tivoli®) offerings deliver the visibility, control and automation needed to deliver quality service, to manage risk and compliance, to optimize return on investments, and to accelerate business growth. This allows organizations to deliver new, personalized services around smarter products more rapidly and at a lower cost of operation.

Highlights

IBM continues to build a vibrant network of Business Partners to support organizations as they learn how to create and manage customer-tailored, smarter products.

Application integration

IBM can help organizations bring together, in a collaborative, consistent environment, the disparate development tools that teams use to produce smarter products, by providing the Product Development Integration Framework (PDIF) from IBM, consisting of industry extensions built on service-oriented architecture (SOA).

Building a solid Business Partner network

IBM coordinates a network of tens of thousands of Business Partners who provide industry vertical expertise and local know-how to help the world build and manage customer-tailored smarter products.

Summary

It's all about the increasingly complex web of individual relationships with products and technology — an ever-growing concentric circle. People, and the businesses they connect to, are driving the need for smarter products. The potential of the individual, whether an individual business, an individual institution or an individual person, to create customized, personalized experiences that are efficient, productive and transparent is vast. Therefore, many products that are commoditized are increasingly becoming obsolete. But products that are designed to make the most of time, resources, skills and energy, and that are designed, above all, to fit the individual's specific needs, are the way of the future.

Highlights

The payoff of smarter products is their ability to help organizations respond more effectively to the personal needs of users and the communal needs of society.

The challenge is clear: Smarter products must be increasingly *intelligent*, realtime *instrumented* and *interconnected* to the ecosystem of users, customers, IT environments, the Web... in short, the world. Nothing less than this is necessary to achieve the magnitude of pervasive design, production and usage that smarter products can unleash. Smarter products are intelligent and able to respond to changes quickly and accurately, as well as gauge performance and adjust to optimize moving forward. Smarter products are instrumented for measurement and feedback on data, preferences and interactions. And the larger payoff of smarter products is their ability to bring interconnectivity to people, systems, other products and back-end applications. Businesses can now respond more effectively to the personal needs and desired behaviors of the user in unprecedented ways.

As software becomes the most active ingredient in product innovation, traditional manufacturers are essentially becoming software companies. While this transformation is sparking unprecedented leaps in product value, it is also introducing new challenges and implications.

For the world's manufacturers, software is playing an increasingly significant role in key business success factors such as customer satisfaction, safety ratings, product reliability, profitable cost and risk models, and organizations' overall images as innovators.

Highlights

Smarter products will collectively help build a smarter planet.

As software becomes the invisible thread linking this system of smarter products and the key enabler for differentiation, the world's manufacturers will use it to influence everything from customer experience and reliability to brand image and beyond. Smarter products will be the building blocks for new solutions across every industry, and will collectively help build a smarter planet. IBM will be there to help make it all happen.

For more information

To learn more about how IBM Rational software can help you build smarter products for a smarter planet, contact your IBM representative or IBM Business Partner, or visit:

ibm.com/software/rational



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