IBM Smarter Industries Symposium

How GM could develop the “car of the year 2011”: Accelerating Innovation Through Systems Engineering Best Practices

2011/03/03

Meg A Selfe, Rational VP Complex & Embedded Systems, IBM

IBM

We are ushering in a new wave of innovation…

IBM Smarter Industries Symposium

Driven by*

1. New & emerging technologies
2. Genuine market need and economic viability

Innovation

The Industrial Revolution

1st Wave

Age of Steam and Railways

2nd Wave

Age of Steel, Electricity and Heavy Engineering

3rd Wave

Age of Oil, Cars and Mass Production

4th Wave

Age of IT & Telecom

5th Wave

6th Wave

Smarter Products

- Instrumented, interconnected, and intelligent
- Building blocks for a smarter planet
- Sustainability





1770 1830 1875 1920 1970 2010

*Source: "Next Generation Green: Tomorrow's Innovation Green Business Leaders", Business Week, Feb 4, 2008

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The disruption of the digital music industry is an example of the shift in innovation and value in the market

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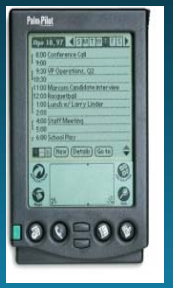
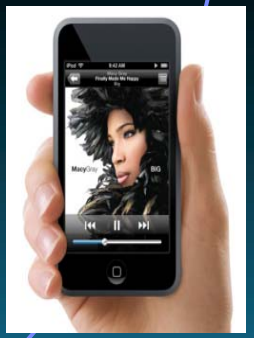
Software Functionality and Amount





- Attract new customers
- Improve customer service
- Create new revenue streams

1970 1980 1990 2000 2010

Uniquely customizable phone, email, music, Web, camera, GPS, games, apps, video recorder... in a single device

Over the last 30 years vehicle content has out paced consumer orientated industries in complexity

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03 Mar 2011

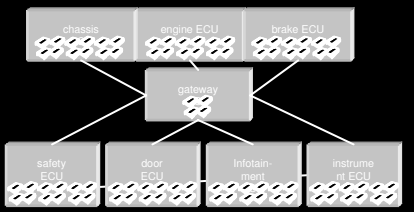
Software Functionality and Amount

10 M LOC
1 M LOC
100 k LOC
10 k LOC

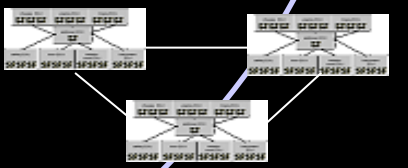
1980
1990
2000
2010
2020

- Ignition
- Engine controls
- Instrumentation

- Engine management
- ABS
- Digital dashboard
- Electronic seats / doors
- Automated climate control
- Safety sensors



- Dynamic Damping Control
- Brake Energy Regeneration
- Integral Active Steering
- Electrically controlled air vents
- Night Vision
- Lane Departure Warning
- Lane Change Warning
- Adaptive Headlights
- Head-Up Display
- Active Cruise Control
- Camera systems
- Driver assistant systems

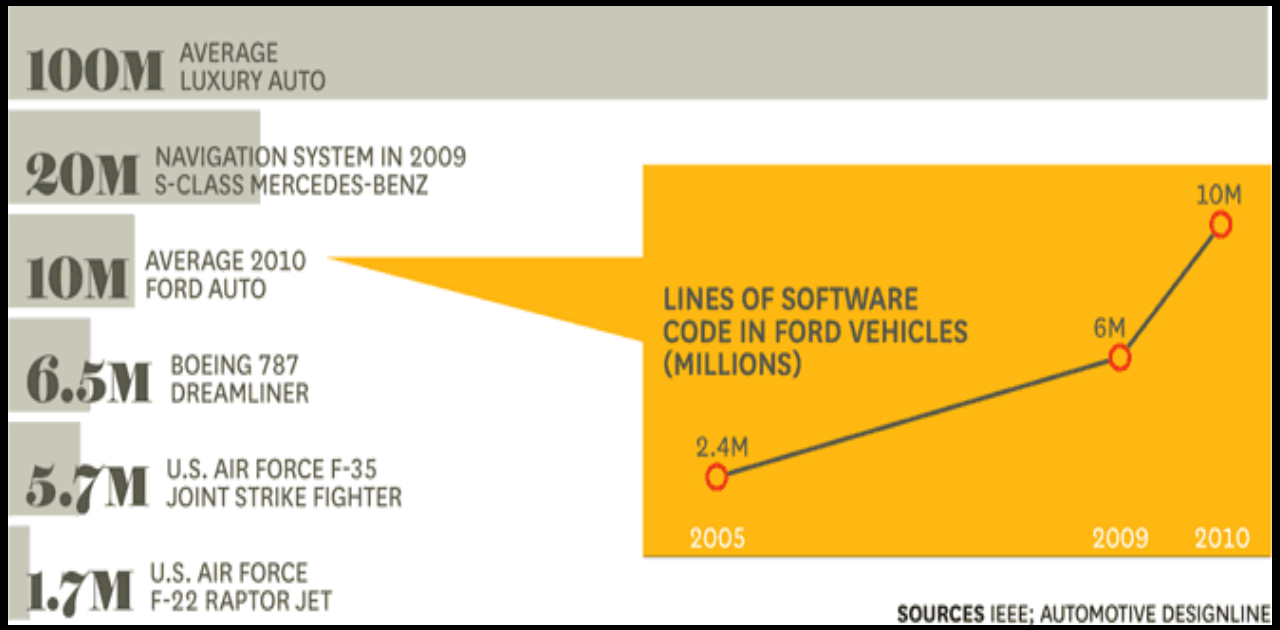


- "Intelligent" Vehicles
- Increasing levels of electrification
- Intersection control violations
- Lane/road departure
- Road surface and pavement conditions
- 360/distance vision
- Active suspension and stability control
- Dynamic route guidance / navigation
- Motorist information
- Data downloads
- Recovery of stolen vehicles
- Electronic payments

The intelligent vehicle of the future will be connected and green, bringing increasing levels of electrification as well as further integration of the vehicle with its surroundings

Software complexity brings inherent risk to product manufacturers

source, HBR, June 2010



More Complex Than a Fighter Jet: Safety regulations and consumer demand for performance and convenience have led to an exponential spike in cars' software complexity.

What hinders innovation? In our customers' words

Customer Speak!

Evolving Business Models

The marketplace is in constant flux - adapting to customer needs, accelerating the speed to enter new markets, adopting new technologies, integrating into new ecosystems.

I need to transform product development to be more collaborative while removing redundant activities

Increasing Product Complexity

Increase in product intelligence enabled by software has led to an exponential leap in product capability, which drives a commensurate increase in risk and complexity.

I need for mechanical, electrical, and software engineering to all be on the same page

Extension of the Enterprise

Disconnected product development applications and processes hinder collaborative product development among an extended design chain of departmental, partner and supplier teams.

I need a way for all my design and supply partners to participate in a unified process for product development

Disconnect with Operations

Operational and support services are becoming an increasingly strategic profitability lever, yet products aren't being designed with support requirements in mind

I need to ensure that the products I build can be profitably supported and maintained over their lifetime

Delivery of smarter products and services will require new investments in software and systems

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Connect multiple products and services into a *"system of systems"* to deliver unique valu



Leverage *systems engineering* to accelerate time to market, improve quality and reduce costs




Develop a core competency in *software delivery* to produce products that are differentiated

Tying it All Together: Smart Products and Services Example

From sophisticated in-vehicle software, to complex "system of systems" ecosystems, cars will continue to get smarter

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System of Systems

Fleet and traffic management systems

Smart grid hybrid / electric vehicle recharging

Emergency services, vehicle diagnostics, and GPS / location services

Collaboration and visibility across diverse teams and disciplines

Integration of mechanical, electronic, software, and electrical engineering

Systems Engineering

Driver assistance safety alarms

360 degree surround vision

Hybrid and electric vehicle control

Software-intensive Subsystems

Adaptive cruise control

Predictive collision avoidance

Intelligent navigation

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Systems & Software Engineering disciplines will need to continue to evolve to keep pace with innovation and move to 'co-creation'

Collaborative Engineering

Silos of Automation

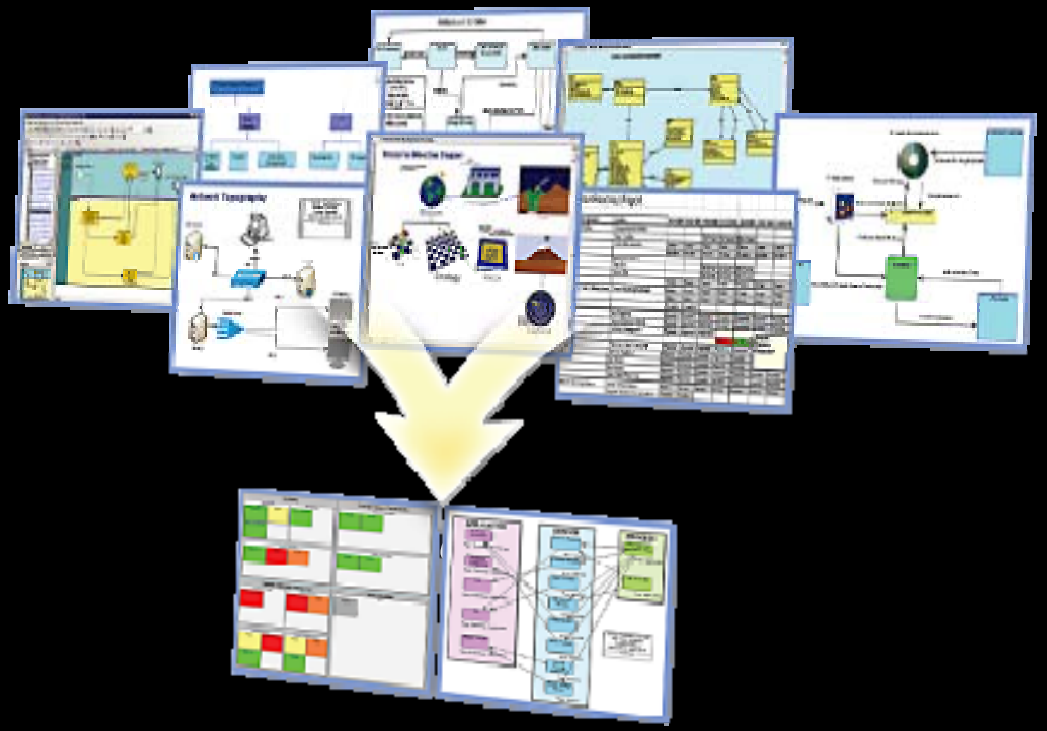
Tool-assisted Design

	1970 – 1980's	1980's - Present	Present & Beyond
Systems & Software Engineering	▪ Ad hoc processes ▪ Support for 100% custom coding ▪ In-house tools ▪ No integration	▪ Repeatable processes, but little flexibility and limited automation ▪ Mix of in-house and proprietary commercial tools. Artifacts managed at the file system level. Little data management support ▪ Core SW disciplines of SE, RE, SCM, and Quality supported with a few point integrations and proprietary API's ▪ Other tools used are best of breed with almost no integrations	▪ Adapt best practices to the complexity of the development project – from rigorous to agile ▪ A collaborative Systems Lifecycle Management (SLM) platform supporting systems / electrical / electronics / software processes, data and artifacts. ▪ Engineering disciplines fully integrated on SLM platform based on open, community developed, standards ▪ COTS E/E Engineering solution tailored specifically for the automotive industry

Best-in-class product & service companies are those that build a strong competency in systems engineering

Best-in-class produce results:

- 19% more likely to meet revenue targets than the industry average
- 4.4x more embedded software than competitors
- 50% fewer defects in embedded software
- 25% decrease in product development time



Source: "Embedded Systems Development", Aberdeen Group, March 2009

IBM Approach: “Engineering Lifecycle Management”

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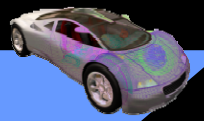

Brand Portfolio
Model Functions
Requirements
Functional Networks
Logical Architecture

Mechanical MCAD
Hardware PCB/IC
Electrical / Harness
Network / COM / BSW
Software

Driver / Field Test
Functional Test
E/E system tests
E/E system integration
Sub-system-tests
Sub-system integrations
ECU tests
SW tests

SW Architecture
SW Design & Implemention
SW Deployment on ECU

Automobile
E/E network
Application SW
Basic SW
ECU

Rational. software
Rational Software Platform for Systems

- Manage lifecycle of all non-mechanical engineering artifacts through engineering process
- Manage product configurations and enable queries and reports across artifact types
- Provide common Electronics and SW engineering project planning and dashboards

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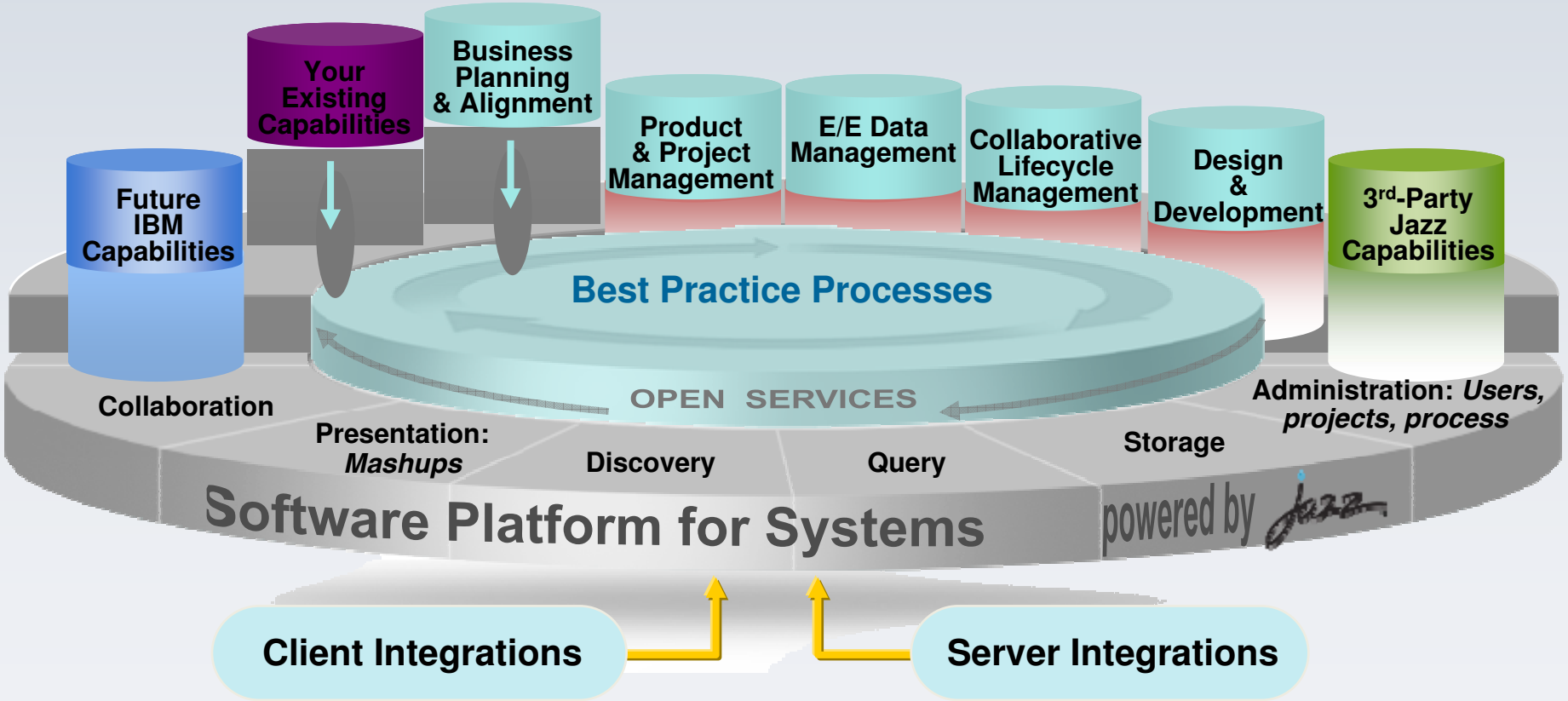
Future E/E engineering capabilities need to integrate seamlessly into the design process to provide

A Common Software and Systems Platform Based on standards and open technologies such as OSLC will provide a vehicle for accelerated product innovation



General Motors leverages Rational tools to develop innovative products

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GM

IBM helps GM develop smarter products like the Chevrolet Volt

What's smart?

- Innovative electric drive system uses software and electronics to control interaction of electric motors and gasoline engine
  - "System of systems" seamlessly integrates electric drive system with powertrain and body controllers
  - >10 million lines of code in car; nearly 100 microprocessors

Smarter business outcomes

- Smarter products delivered in less time
  - Volt was delivered in <5 years, compared to typical 10+ year development cycle for new vehicle technology

How IBM helps GM develop smarter products

- Rational DOORS for requirements management
- Rational Rhapsody for model-driven development
- Rational Team Concert for team collaboration
- Rational Asset Manager for engineering asset management
- Rational Professional Services for technical services
- IBM Global Services for business transformation services

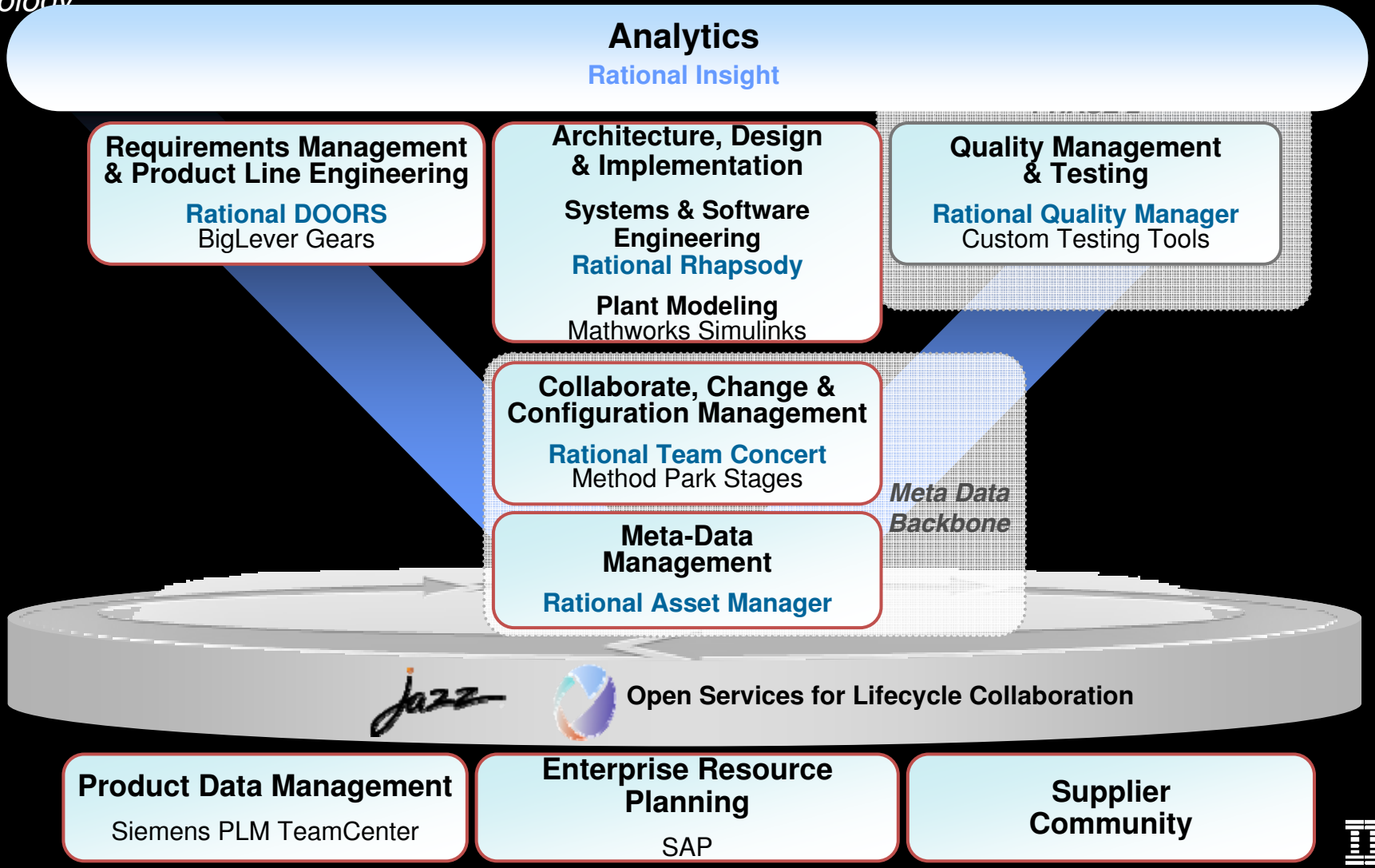
"The IBM Rational platform enables our globally distributed teams to collaborate in real-time to develop innovative software and electronics for our vehicles. GM's use of the Rational platform will deliver business results in efficiency, time-to-market, quality, and overall customer satisfaction."

General Motors

IBM

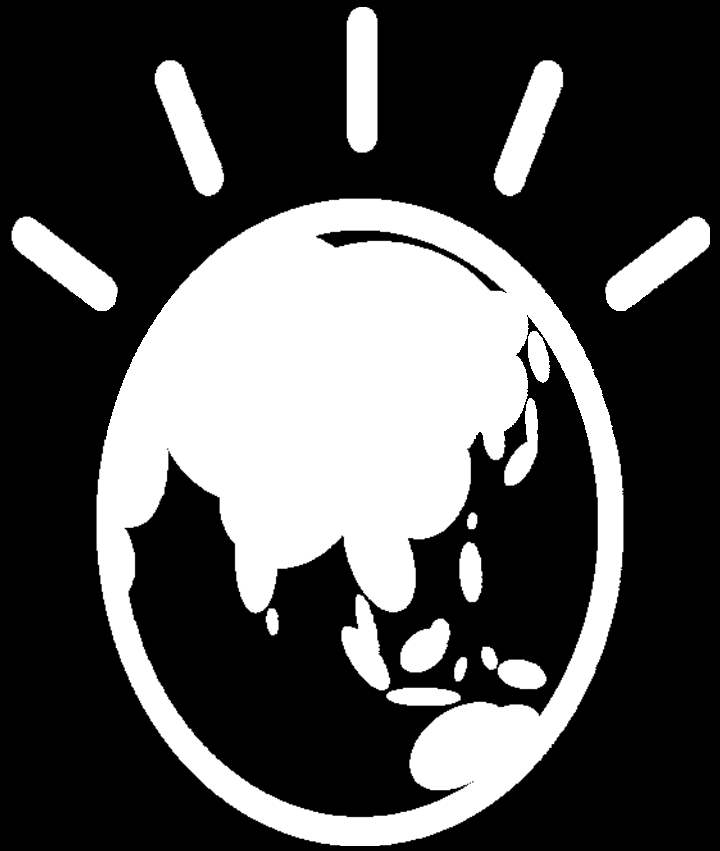
GM and IBM Rational's Engineering Lifecycle Management

Chevy Volt designed and engineered in 29 months vs. typical 5-10 year cycle for new technology



Summary

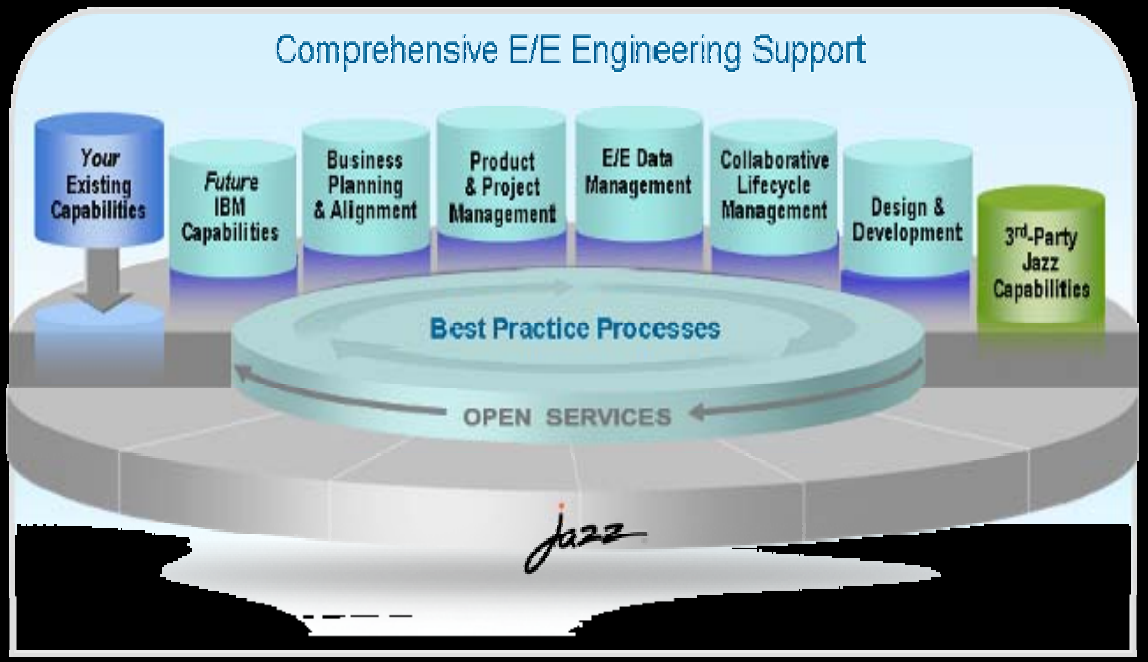
- Value migration in the manufacturing industries is disrupting the current design and delivery life cycle of smarter products and services.
- New approaches are required to manage the complexity – combining the fundamentals of systems engineering disciplines with software delivery principles.
- IBM and its partners are pioneering the next generation of software and systems engineering technologies based on open standards and leveraging out clients existing investments.
- Clients such as GM are already reaping tangible results that are measurable and sustainable.



Let’s build a smarter planet

Back Up

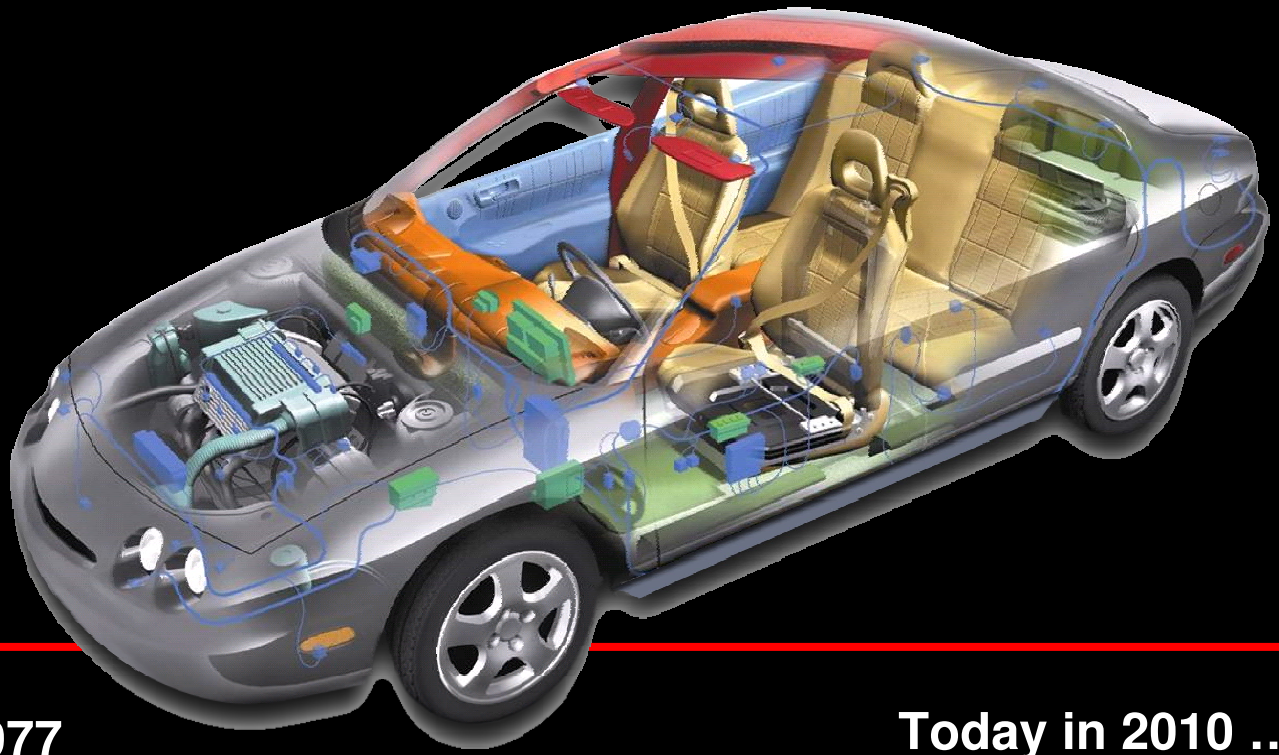
First class Electrical/Electronic lifecycle management for smart products and services



- **A single environment for the creation, access and management of Electrical/Electronic Engineering developed with *your* client input**

- 80-90% commonality with other industry verticals
- Currently working with multiple OEM's on delivery
- Based on our 6 year, $100m+ investment on our Jazz platform
- Project management visibility and reporting
- Design chain collaboration
- E/E artifact management
- Easily extensible
- Full, standards-based, integrated development environment

Automotive Product & Service Innovation – A look back



1977

Oldsmobile Toronado had a single computer unit for spark-plug timing

Today in 2010 …

A modern car is more like 30 computers on wheels with over 100,000,000 lines of code

More software and more complex control units than the NASA Space Shuttle

Software is the invisible thread that unleashes innovation in today's Smarter Products ….

Our cars are highly
INSTRUMENTED

- By 2010, 12% of new cars will ship with embedded telematics.

Our cars get more
INTERCONNECTED

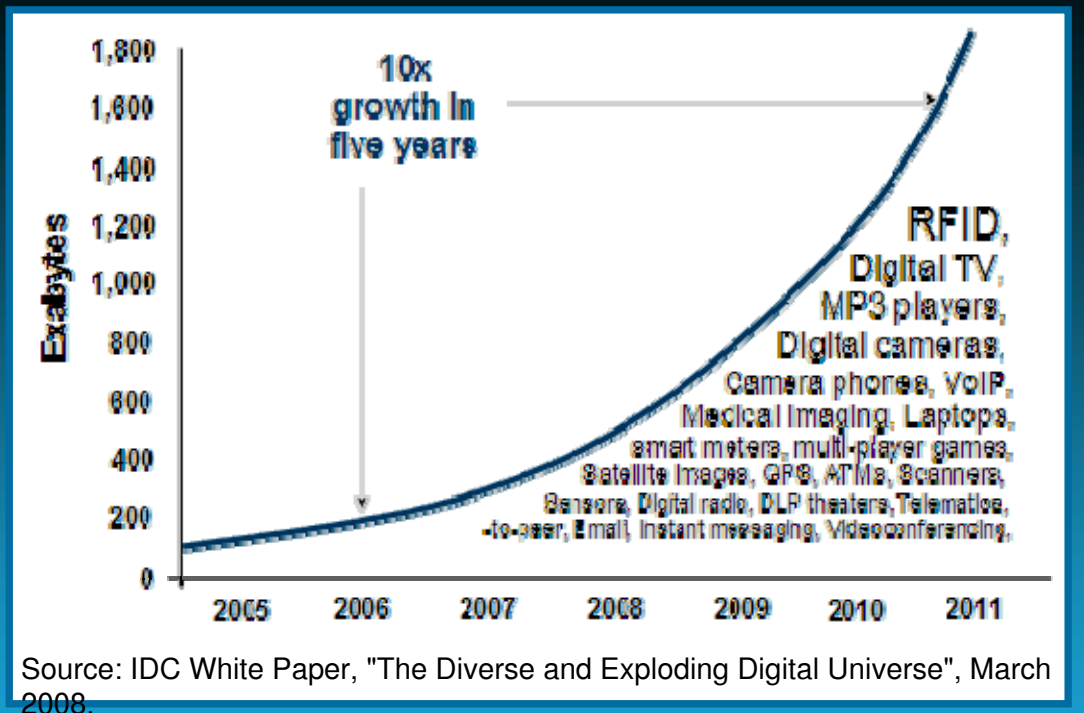
- Over 3 million car navigation devices were sold in China in 2008, more than double the amount in 2007.

Our cars become
INTELLIGENT

- The market for Advanced Driver Assistance Systems is estimated to reach 143 million Euros by 2015

…fueled by the "building blocks" of the connected world

The world is becoming 10x more instrumented with connected devices doubling to over 1 Trillion



Source: IDC White Paper, "The Diverse and Exploding Digital Universe", March 2008.

Software is the *lifeblood* of today's innovation and is changing the orientation of design within the Automotive market

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System of Systems

Fleet and traffic management systems

Smart grid hybrid / electric vehicle recharging

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IBM

Which is further complicated by current automotive business and market drivers impacting design cycles

Green	Product Differentiation	Growing Customer Demands	Competition	Legal Requirements
▪ Hybrid ▪ Electric	▪ Innovation ▪ Brand Image	▪ Infotainment ▪ Telematics	▪ Overcapacity ▪ Price Wars	▪ Safety ▪ Environment

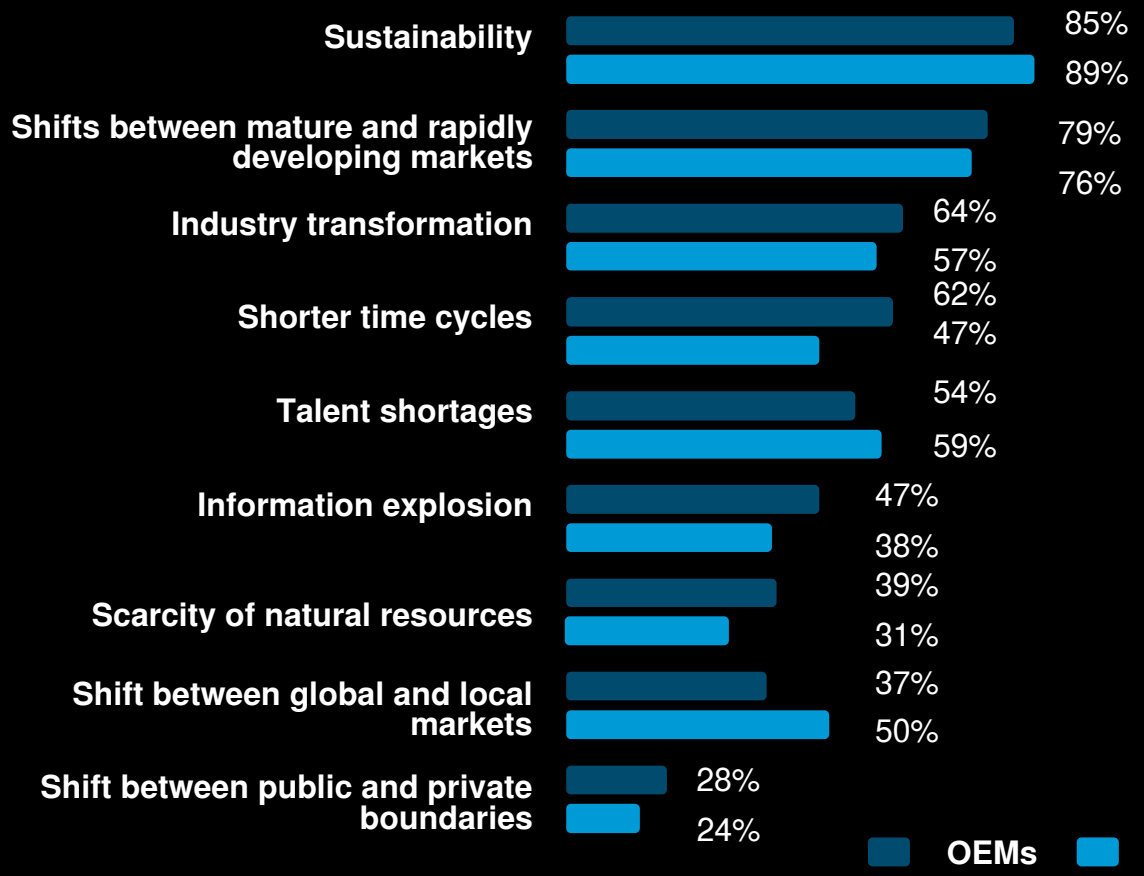
Increased usage of electronics and embedded software;
Highly sophisticated in-vehicle electric/electronic (E/E) systems

INSTRUMENTED **INTERCONNECTED** **INTELLIGENT**

Several factors add to the urgency and shift in landscape

Insights from the IBM Global CEO Study 2010

Factors impacting your organization to a large extent over the next 5 years



The industry is aligned on the most important factors…

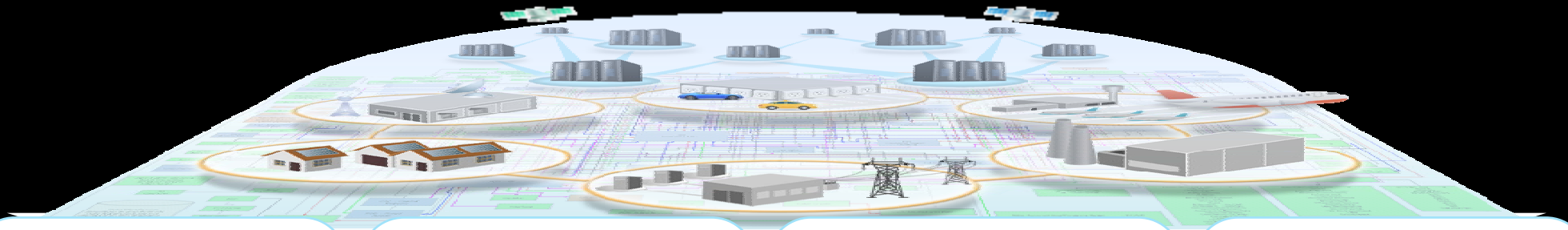
– Sustainability
– Shifts to developing markets
– Industry transformation

… however, there are also discrepancies

– OEMs far more concerned with shorter time cycles for new products
– OEMs are feeling the explosion of information across their farther reaching eco-system
– Suppliers are struggling to catch up to OEMs global presence

Source: Q9 To what extent will the following factors impact your organization over the next 5 years? Automotive transformation n=1515; Information Explosion n=1514; Sustainability n=1507; Shorter time cycles: n=1501; Talent Shortages n=1523; Shifts between mature and rapidly developing markets n=1499; Shift between public/private boundaries n=1513; Shift between global/local markets n=1498; Scarcity of resources n=1490; Automotive n=75

IBM's Integrated Product Management provides a Software and Systems Engineering framework to address key design drivers



BUSINESS PLANNING & TRANSFORMATION

Global optimization of business and development processes and organization

PRODUCT & SYSTEMS DEVELOPMENT

Processes and tools to deliver product value and differentiation

DESIGN CHAIN COLLABORATION

Automating processes across the ecosystem of system contributors

ASSET MANAGEMENT & OPERATIONS

Visibility and control over critical assets to improve development efficiencies and value

DESIGN | **DELIVER** | **MANAGE**

Mechanical, electronic and software processes

IBM's Integrated Product Management initiative provides clients with multiple entry points for maximizing ROI across the product development domains

1. Strategically transform business processes to build new capabilities, save costs, accelerate product introduction, and create new markets

BUSINESS PLANNING & TRANSFORMATION

2. Adopt an advanced systems engineering approach to manage all product interrelationships across engineering disciplines and build a strong competency in software development and delivery

PRODUCT & SYSTEMS DEVELOPMENT

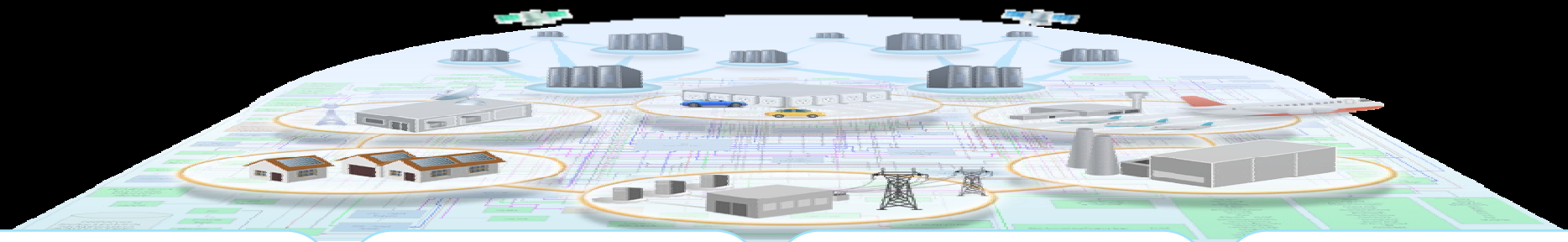
3. Optimize the design and supply chain by automating business processes that leverage existing investments in best-of-breed applications & data

DESIGN CHAIN COLLABORATION

4. Ensure that product and asset maintenance and support is treated as a strategic business process that drives profitability

ASSET MANAGEMENT & OPERATIONS

Tangible results are providing proof points across the industry in key areas



BUSINESS PLANNING & TRANSFORMATION

- Business transformation services
- Product portfolio management
- Enterprise architecture

PRODUCT & SYSTEMS DEVELOPMENT

- Requirements management
- Model-driven development
- Software and systems lifecycle
- Quality, security and compliance management

DESIGN CHAIN COLLABORATION

- Enterprise application integration
- Business process management
- Partner ecosystem management

ASSET MANAGEMENT & OPERATIONS

- Enterprise asset management
- Product information management and re-use
- Application management

Receive up to…

30% reduction in time-to-market

47% reduction in development costs

77% less defects after production

Integrated Systems Engineering Processes and Tools Unify the Mechanical, Electronic and Software domains to pave the way for greater innovation

Integrated Systems Engineering

Business Planning & Alignment | **Product & Project Management** | **Compliance & Security**

Collaborative Lifecycle Management

Design & Development

SOFTWARE

ELECTRONIC

MECHANICAL

Internet & Back-end IT Systems

- Processes and best practices for measured improvement
- Integrated software, electronic and mechanical
- Rich set of modular, easy to adopt tools

The key first step to innovation is to be able to leverage existing investments including linkage to mechanical packages


OEM Chief Engineer


OEM Electronic Engineer


OEM Purchaser


Supplier Project Lead


Supplier E/E Engineer


OEM HW/SW Integrator

Portal Server

IBM Methods and Best Practices for Systems Engineering

Rational.

Rational Software Platform for Systems

DOORS | Rhapsody | Team Concert | Quality Manager

Software Development and Operations Enterprise Asset Management

Service and Asset Management

Master Data Mgmt Information Integration

Information Mgmt and Analytics

Open Services for Lifecycle Collaboration (OSLC)

Enterprise Service Bus

IBM Product Development Integration Framework

SIEMENS

Teamcenter

DASSAULT SYSTEMES

Enovia

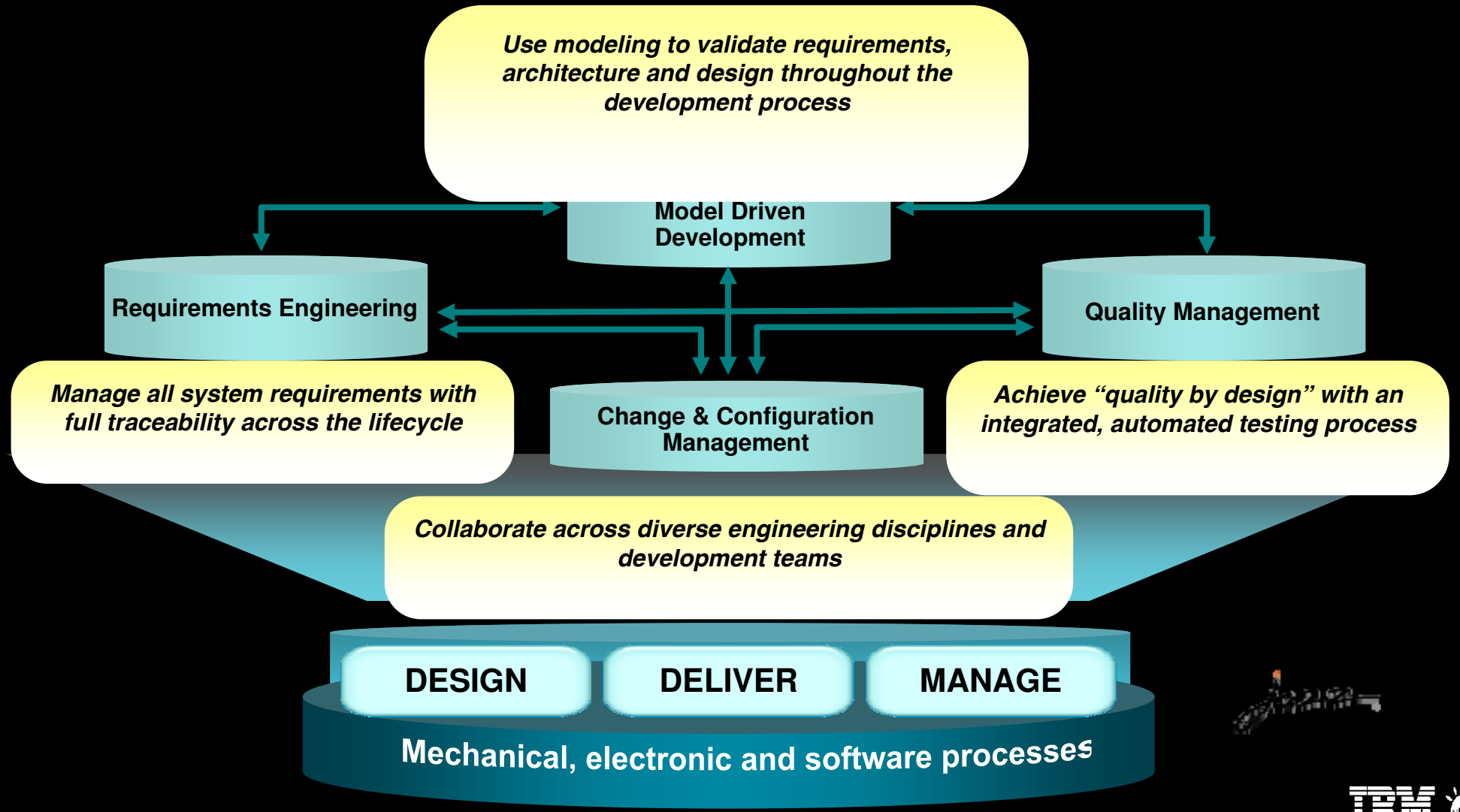
PTC

Windchill

SAP

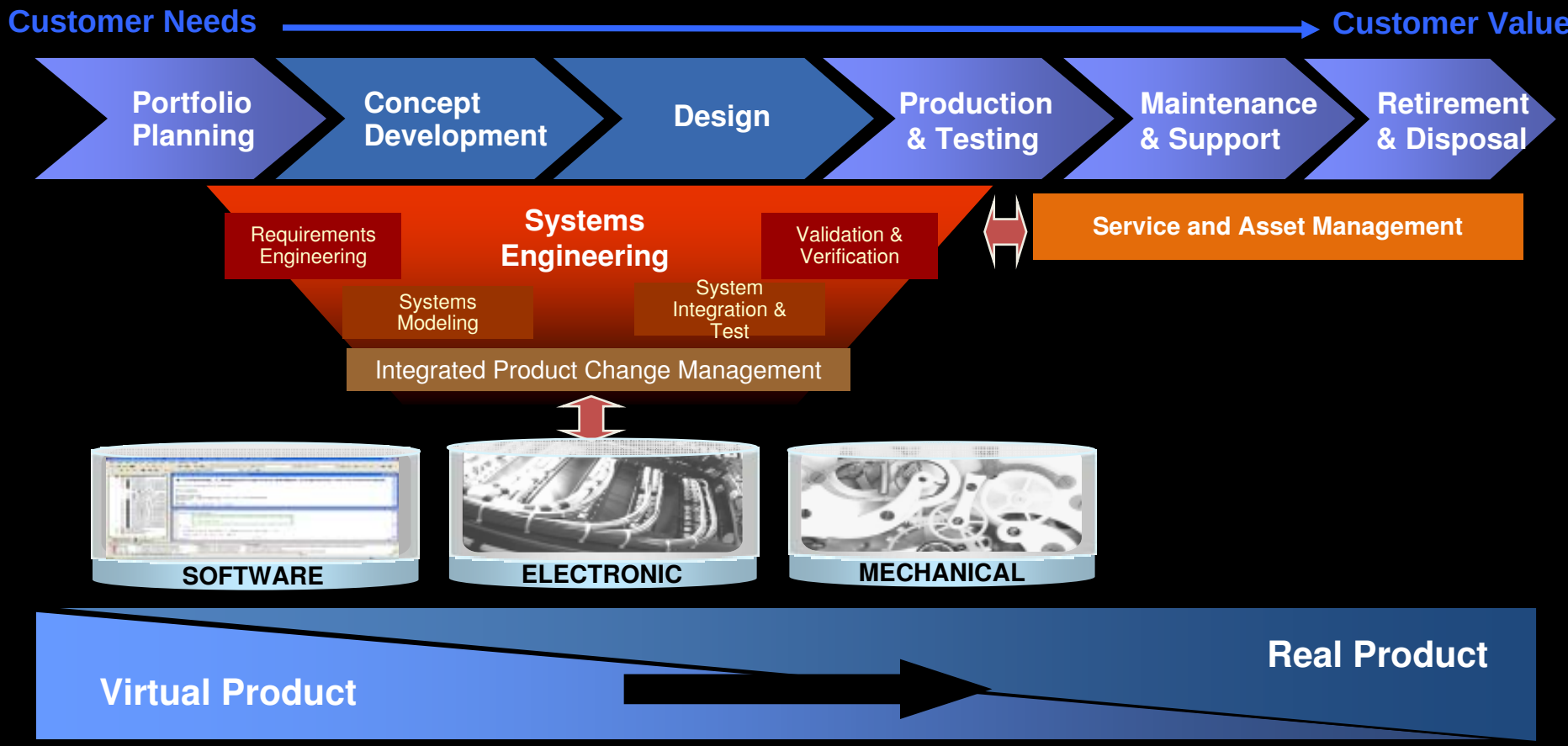
Enterprise Resource Planning

Collaborative systems engineering and software development best practices integrate design at a domain level across the lifecycle



Integrating product and software lifecycle management

Integrates teams, disciplines and workflows



- Industry extensions apply specific patterns & methodology
- Accelerate the acceptance and adoption of a single product or an integrated solution
- Mandated or simply table-stakes for doing business

AUTOSAR

SysML

ISO International Organization for Standardization

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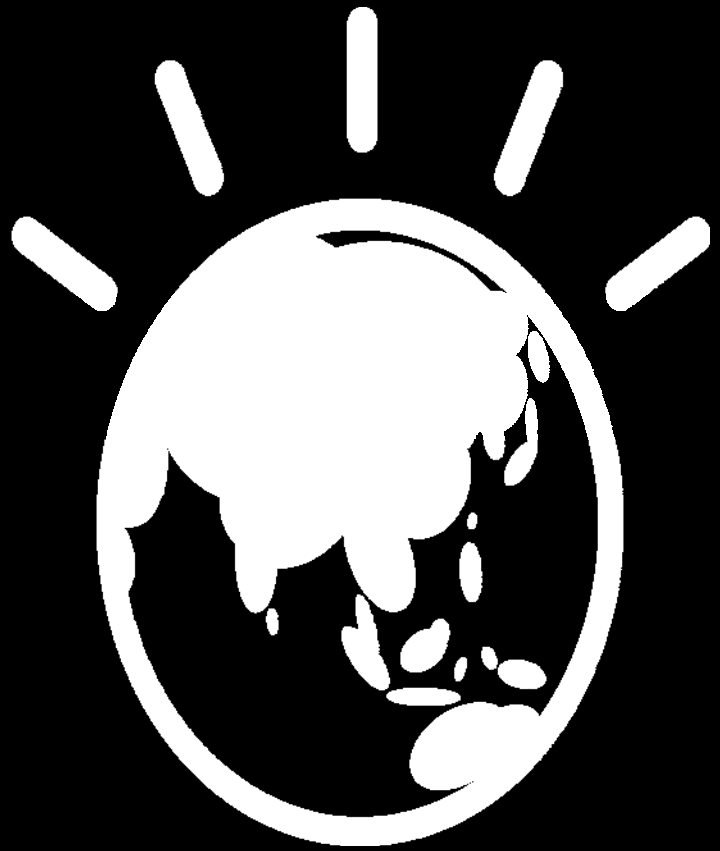

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