IBM Global Industries

PLM - Driving Innovation in Automotive

CAE Symposium 2007
9th May 2007
Troy, MI.

Peter Robison

Director

IBM Automotive Industry

Agenda

1. The increasing focus on Innovation
2. Trends in Product Development
3. Emerging PLM capabilities
4. A flexible and scaleable IT infrastructure
5. Summary

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Global CEO Study 2006: On the Minds of CEOs

IBM Business Consulting Services

Expanding the
Innovation Horizon

Global CEO Study 2006
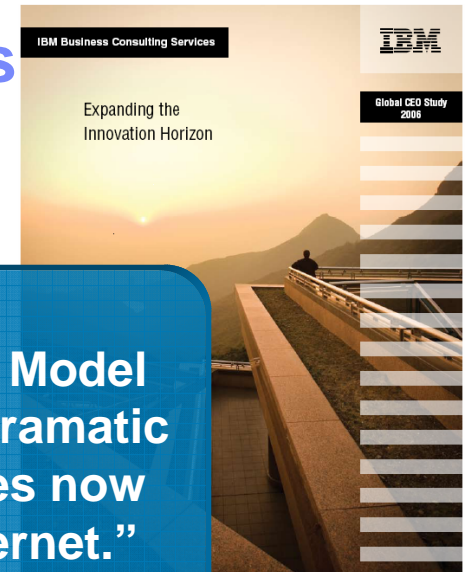
"The market imposes innovation."

"Competitors are emerging from everywhere."

"Business Model change is dramatic …40% sales now on the internet."

"Globalization, commoditization, higher cost structure, increasing specialization…"

"No growth without changing ourselves and the industry itself."

"We must innovate to justify our existence."

"Last year's products are last year's dollars."

The Top Focus for Business

The CEOs' "Innovation Mix"

- Due to competitive and market forces, CEOs plan to radically change their companies in the next 2 years.

- > 80% of CEOs stated their organizations have not been very successful at managing change

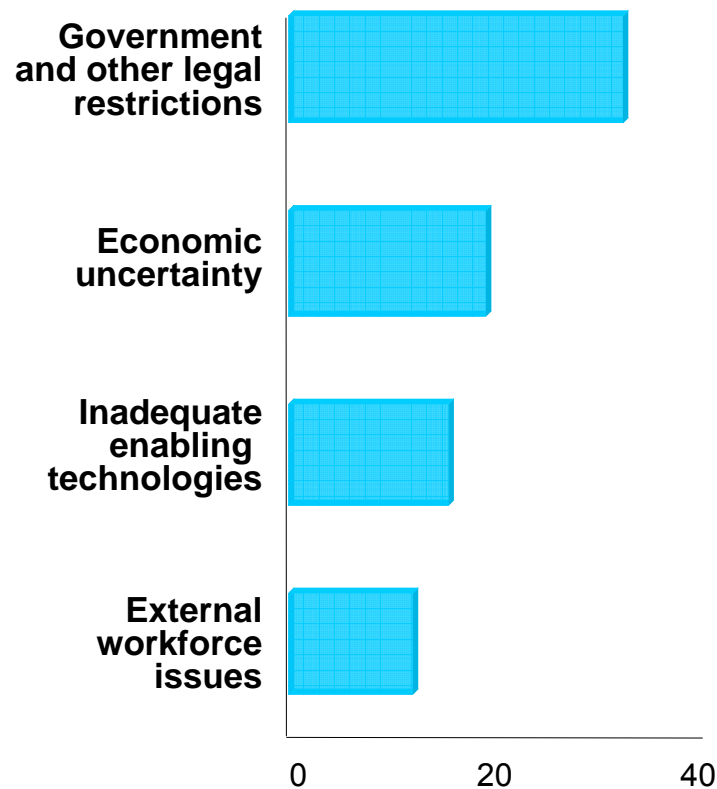- 78% of CEOs believe integrating business and technology is fundamental for innovation

Business Processes

Products/ Services/ Markets

Business Model
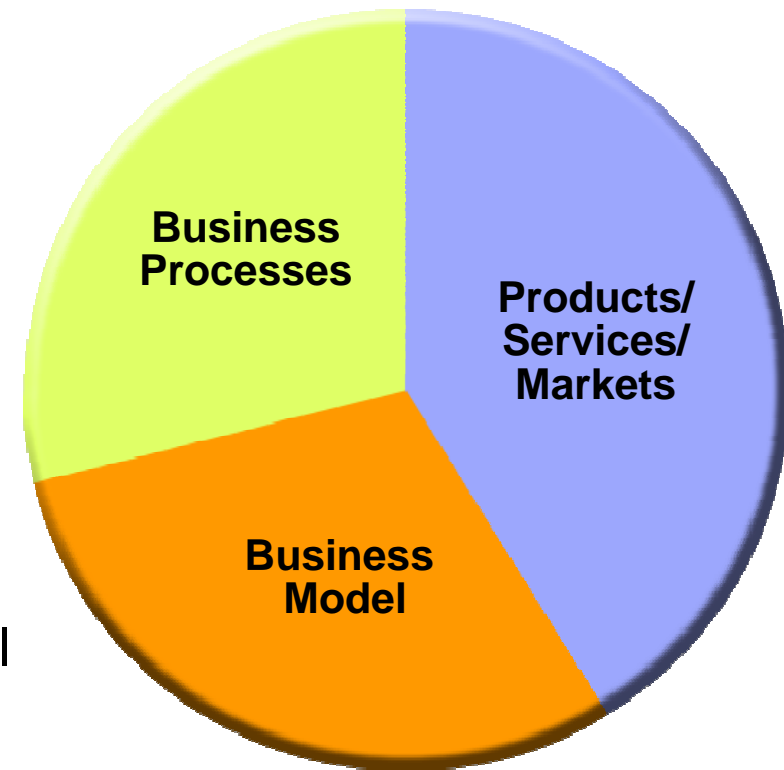
Required to achieve:
- Revenue growth
- Cost reduction
- Asset utilization
- Risk management

IBM Institute for Business Values (IBV) CEO Study 2004, multiple answers permitted
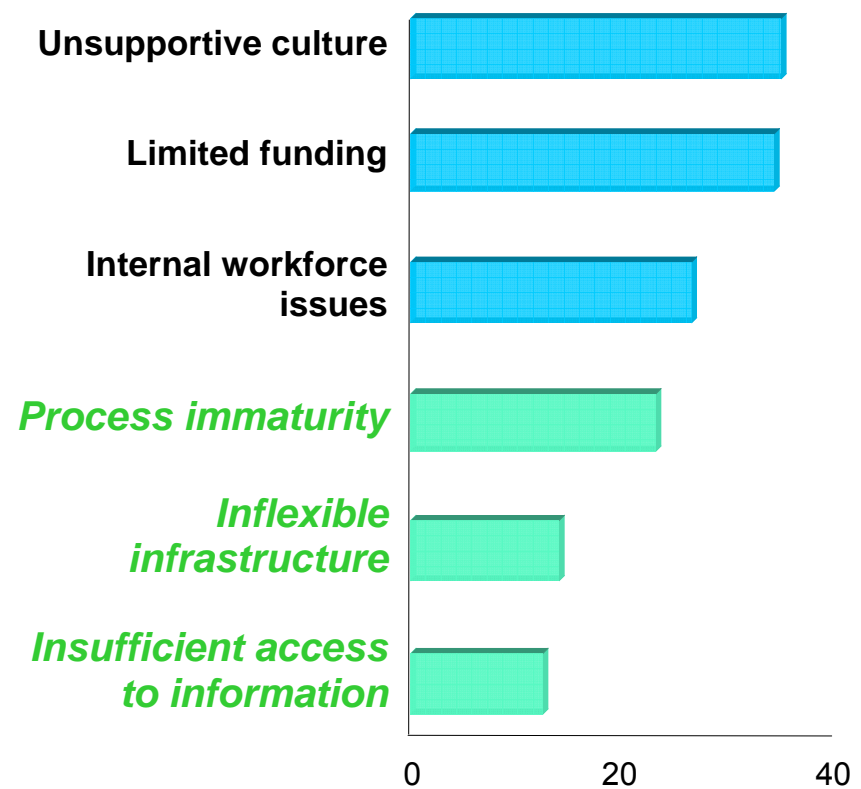IBV CEO Study 2006, top answer shown

Innovation Spurred by Collaboration

Business Partners, Customers and Employees were the Top sources of new ideas and innovation but barriers to collaboration with these groups were identified

External

- Government and other legal restrictions
- Economic uncertainty
- Inadequate enabling technologies
- External workforce issues

Internal

- Unsupportive culture
- Limited funding
- Internal workforce issues
- *Process immaturity*
- *Inflexible infrastructure*
- *Insufficient access to information*

IBM Institute for Business Value, CEO Study 2006

Lack of Collaboration Hinders Innovation

Collaboration Importance vs. Extent

80%

Collaboration Gap

40%

0%

Collaboration of great importance

Collaborate to a large extent
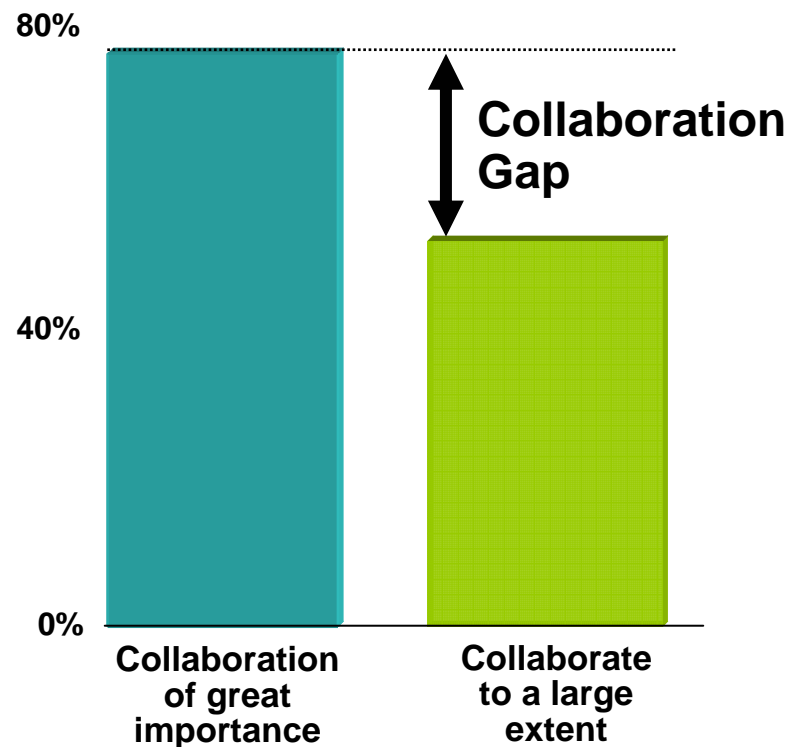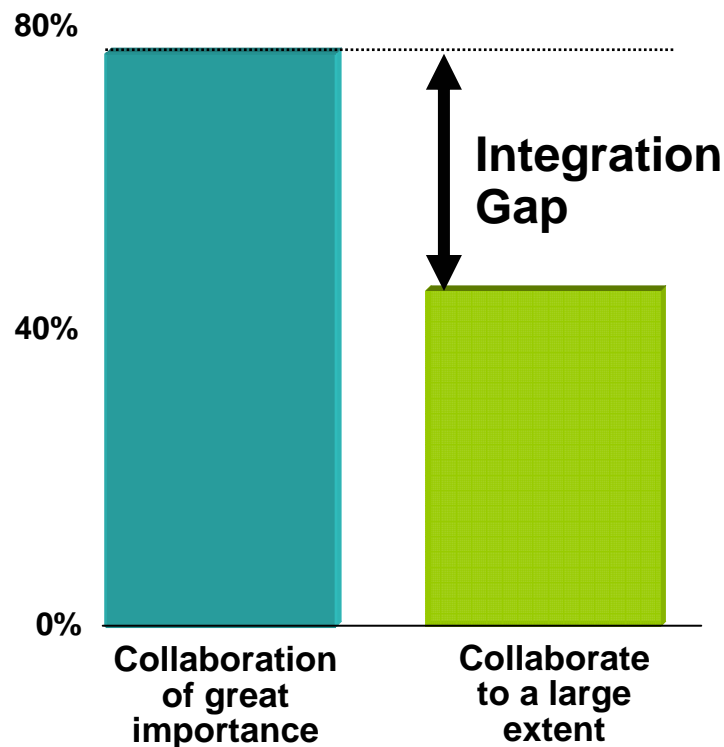
CEOs say:

"Without collaboration innovation would be impossible."

"It would be counterproductive to do everything yourself."

"Partner…extract maximum value and avoid reinventing the wheel."

IBM CEO Study 2006

Need to Integrate Business and Technology

Business and Technology Integration Importance vs. Extent

CEOs say:

"We must use technology to stay ahead of the curve."

"Technology must be integrated early in the stages of business strategy."

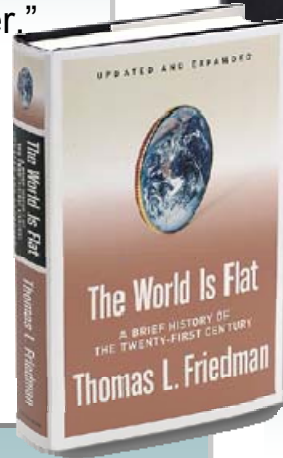*"Technology is the only way to cope with the surge of new work and opportunities."*

IBM CEO Study 2006

Innovation has never been more relevant to the Automotive industry

DAIMLERCHRYSLER

"Innovation – The key to our success

Innovation drives our company and is the key to the worldwide success of DaimlerChrysler."

INNOVATION
is our mission.

First SUV Hybrid
on the road today

250,000 Hybrids
a year by 2010

250,000 ethanol-ready
vehicles next year

Engineers from Ford
and our Volvo Division
working together on
new safety strategies

The guiding compass
of everything we do.

Smarter, safer, more
fuel-efficient vehicles.

Ford

UPDATED AND EXPANDED

The World Is Flat

A BRIEF HISTORY OF
THE TWENTY-FIRST CENTURY

Thomas L. Friedman

BOSCH

"Bosch Innovation

From the beginning engineers and technicians not only built tools but also developed visions and translated them into a reality."

PSA PEUGEOT CITROËN

"Innovation and useful technologies for everyone. The Group is seeking to establish itself as a leader in key areas of automotive technology, particularly those linked to the environment, safety and comfort."

Source: Company websites

Innovate to gain Market share

The ability to identify, integrate and manage innovation, without adding risk, is what differentiates successful companies from the rest

Software offers the means to introduce winning features quickly and inexpensively

Increasing cost pressures
New Asian entrants

Want better equipped but cheaper products

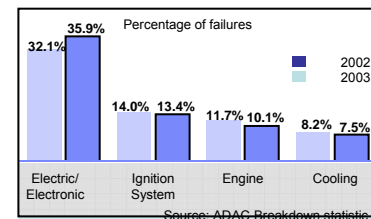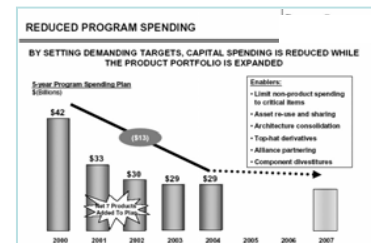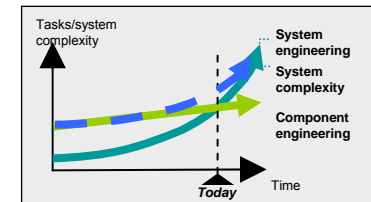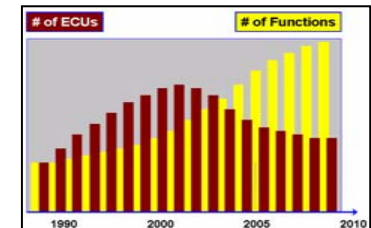Gain market share and improve revenue and profit rather than giving rebates
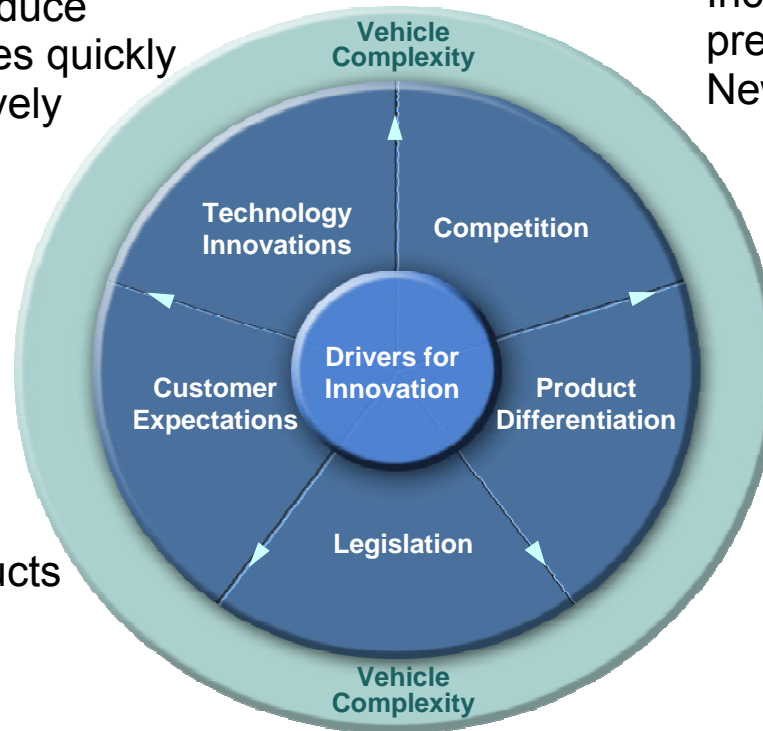
Safety, fuel consumption, exhaust emissions, End-of-life vehicle
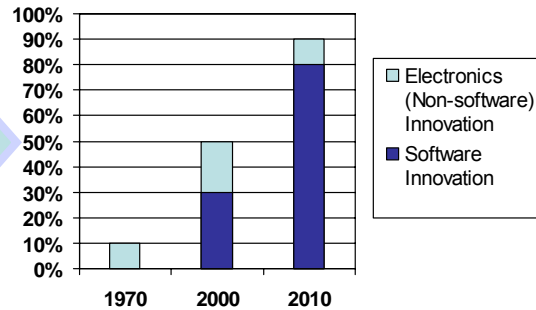
Agenda

Automotive industry issues

- Increasing Innovation and number of new models in order to differentiate the brand

- Drives up the number of features and functions per model

- The complexity of both the vehicle and the processes to manufacture and support it increase

- Greater demands on Product Development capabilities and capacity

- The risk of failures reaching the customer increases

- Reduced margins and negative Brand impact due to higher warranty costs and more product recalls

Automakers are offering more models than ever to target specific customers

New Models
35% increase in 10 years

2000   2003   2008 (est)
Total number of light-vehicle models (cars and trucks) by year
Source: J.D. Powers and Associates Forecasting Division

# of ECUs   # of Functions

1990   2000   2005   2010

Tasks/system complexity

System engineering
System complexity
Component engineering

Today   Time

REDUCED PROGRAM SPENDING

BY SETTING DEMANDING TARGETS, CAPITAL SPENDING IS REDUCED WHILE THE PRODUCT PORTFOLIO IS EXPANDED

Percentage of failures

2002
2003

32.1% 35.9%   14.0% 13.4%   11.7% 10.1%   8.2% 7.5%

Electric/Electronic   Ignition System   Engine   Cooling
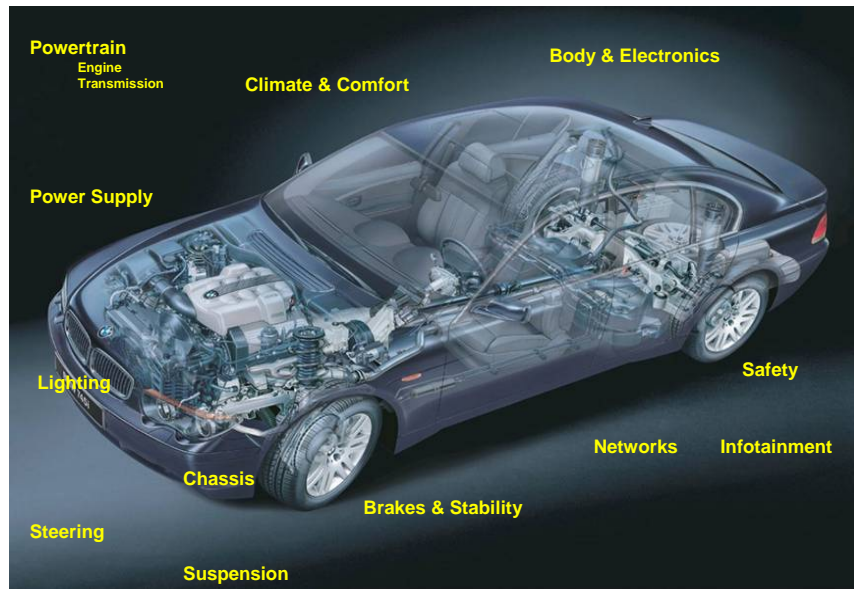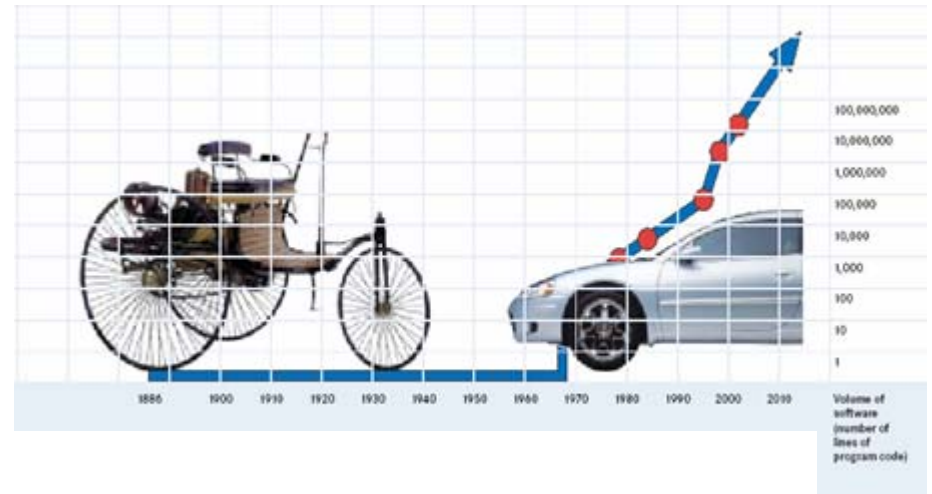Source: ADAC Breakdown statistic 2004
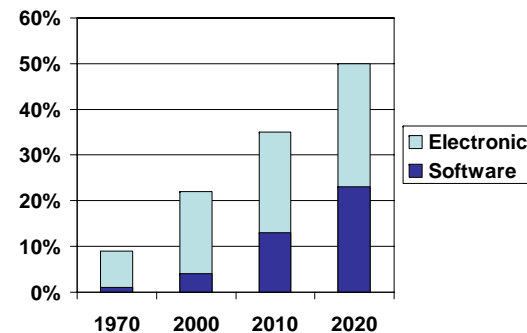
Increasing Electronic and Software Content

It is estimated that 90% of innovation by 2010 will be electronics related, and 80% of that is in the area of software.

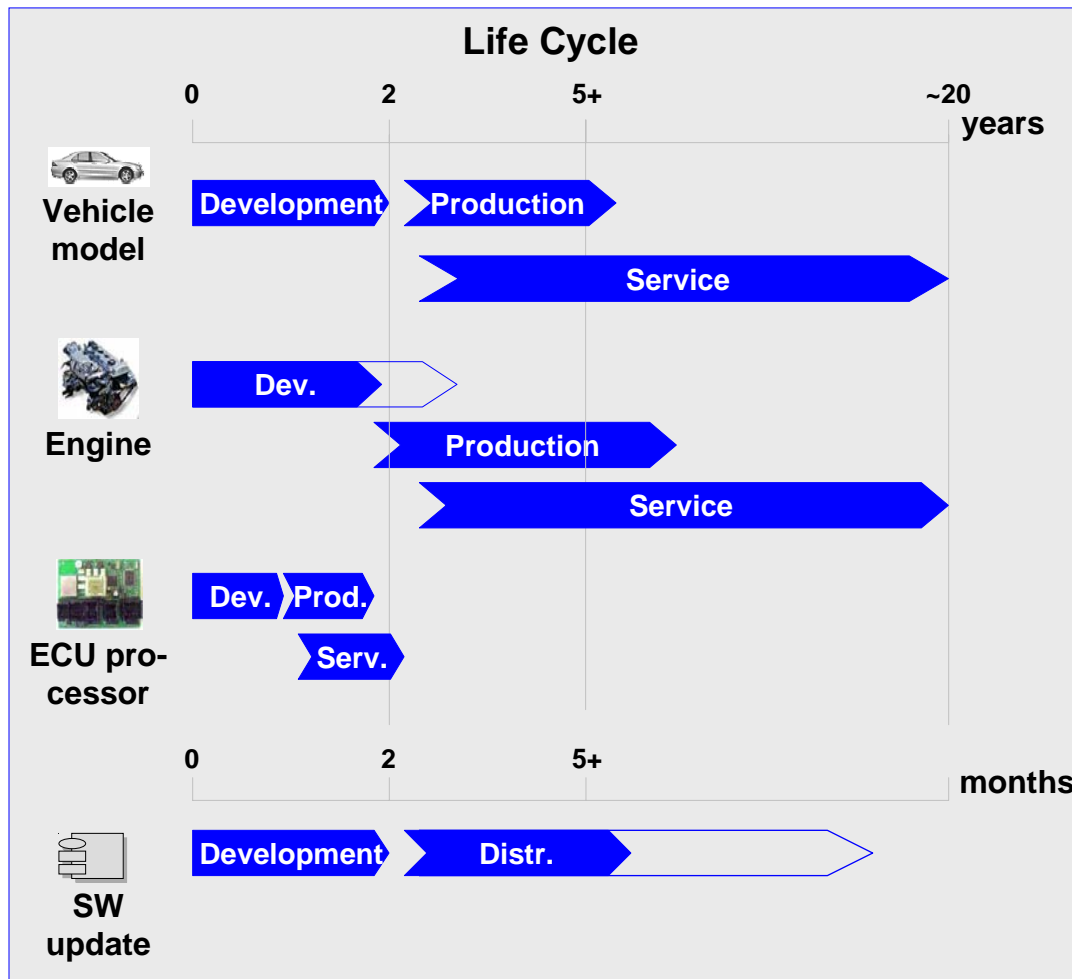**Software and Electronics Innovation**

Legend:
- Electronics (Non-software) Innovation
- Software Innovation

Volume of software (number of lines of program code)

Powertrain — Engine, Transmission
Body & Electronics
Climate & Comfort
Power Supply
Lighting
Safety
Networks   Infotainment
Chassis
Steering
Brakes & Stability
Suspension

Software and Electronics Value

Legend:
- Electronics
- Software

The value of electronics and software is expected to grow to 35-40% of the vehicle value by 2010.

As the shift to fuel cell engines occurs, it is expected to reach 50%

Automotive electronics & software development costs are expected to rise 12% annually for the next 5 years

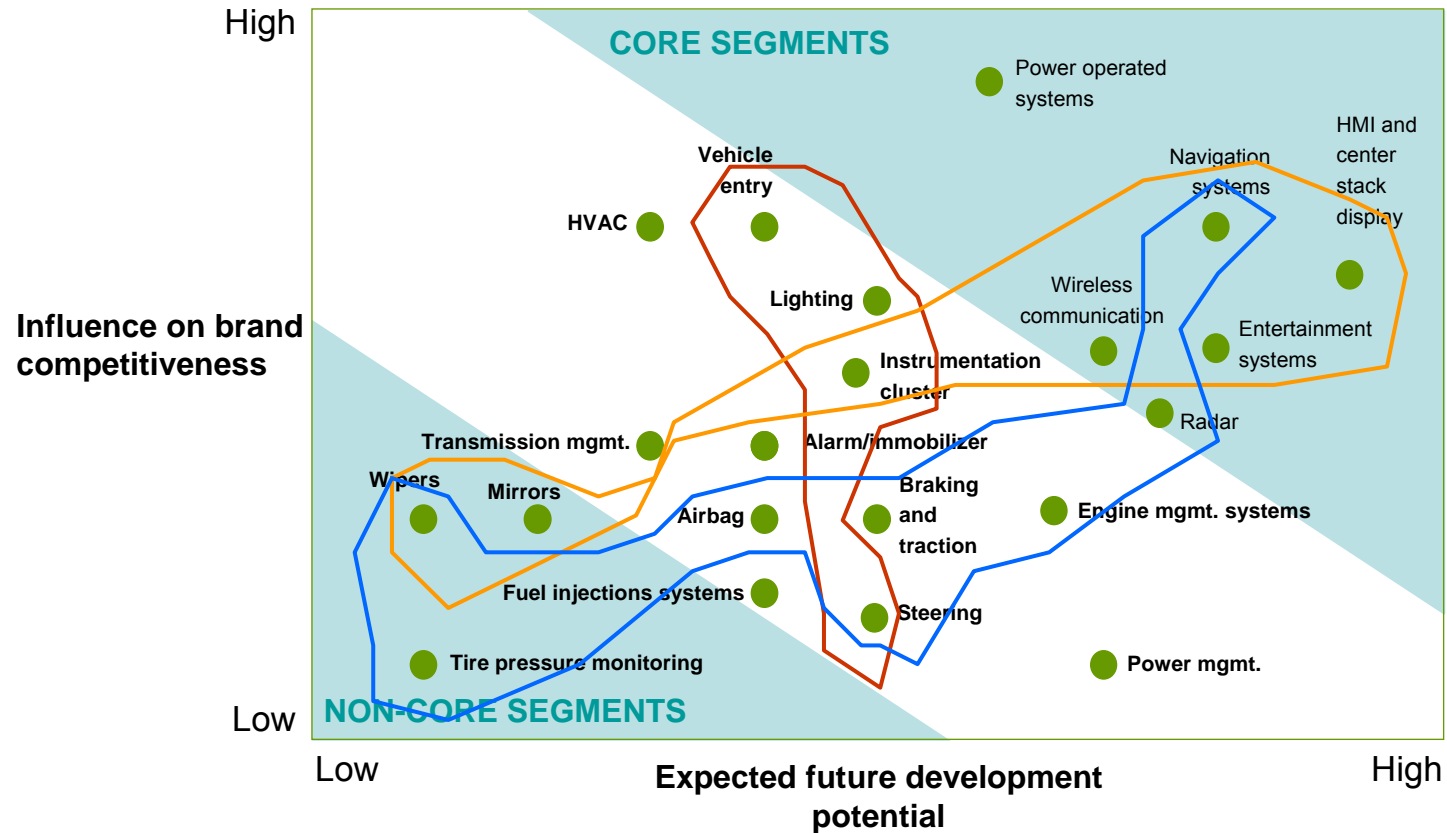# Electronics drives innovation in vehicle – but has extremely short lifecycles compared to other parts in vehicle

Life Cycle

| 0 | 2 | 5+ | ~20 years |

Vehicle model
- Development → Production
- Service

Engine
- Dev.
- Production
- Service

ECU pro-cessor
- Dev. → Prod.
- Serv.

| 0 | 2 | 5+ | months |

SW update
- Development → Distr.

- **Continuous updates of SW during Production and service**
- **Exchange of ECU HW during service period needs new development**
- **High storage volumes for spare and production parts**
- **Example ATLAS: ECU spare parts have a life cycle of 1-2 months**

Standards

- **HW independent SW develop-ment enables exchange of ECU HW without redevelopment**
- **Spare part storage can be decreased**

Combinations of segments to deliver the future brand values

Evaluating the existing and emerging E/E segments, in terms of being Core to both the Brand values and the contribution to the Value Creation, is necessary as an input to setting the capability objectives
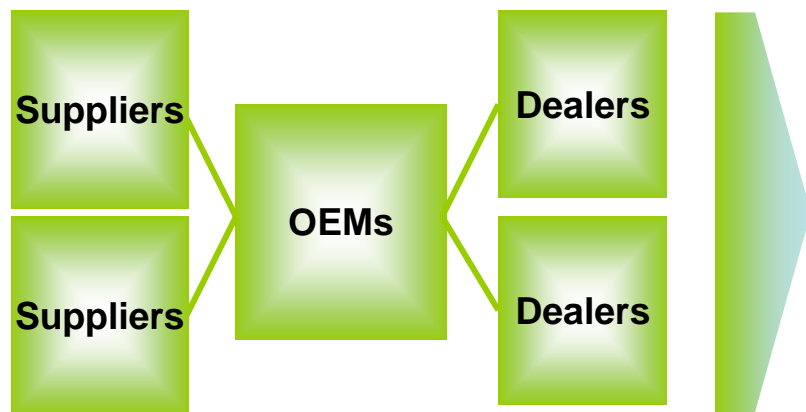

Influence on brand competitiveness

High

Low

CORE SEGMENTS

NON-CORE SEGMENTS

Power operated systems

HMI and center stack display

Vehicle entry

Navigation systems

HVAC

Wireless communication

Lighting

Entertainment systems

Instrumentation cluster

Transmission mgmt.

Alarm/immobilizer

Radar

Wipers

Mirrors

Braking and traction

Engine mgmt. systems

Airbag

Fuel injections systems

Steering

Tire pressure monitoring

Power mgmt.

Low **Expected future development potential** High

Examples of emerging Cross-domain systems functionality:
Driver Assistance
Active / Dynamic Safety
Intelligent Lighting

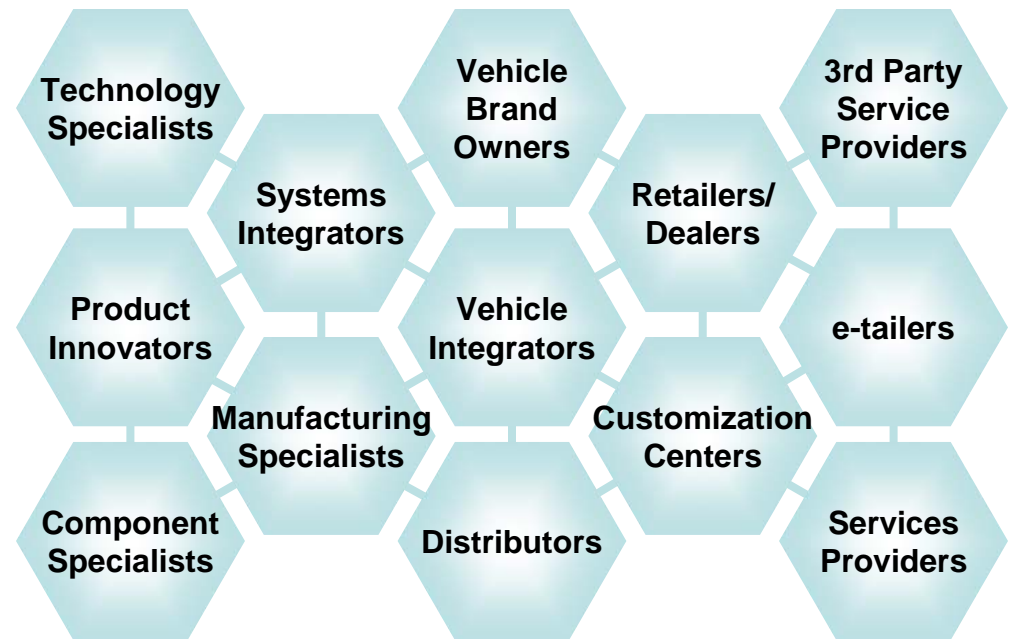New functionality increasingly requires development across domains
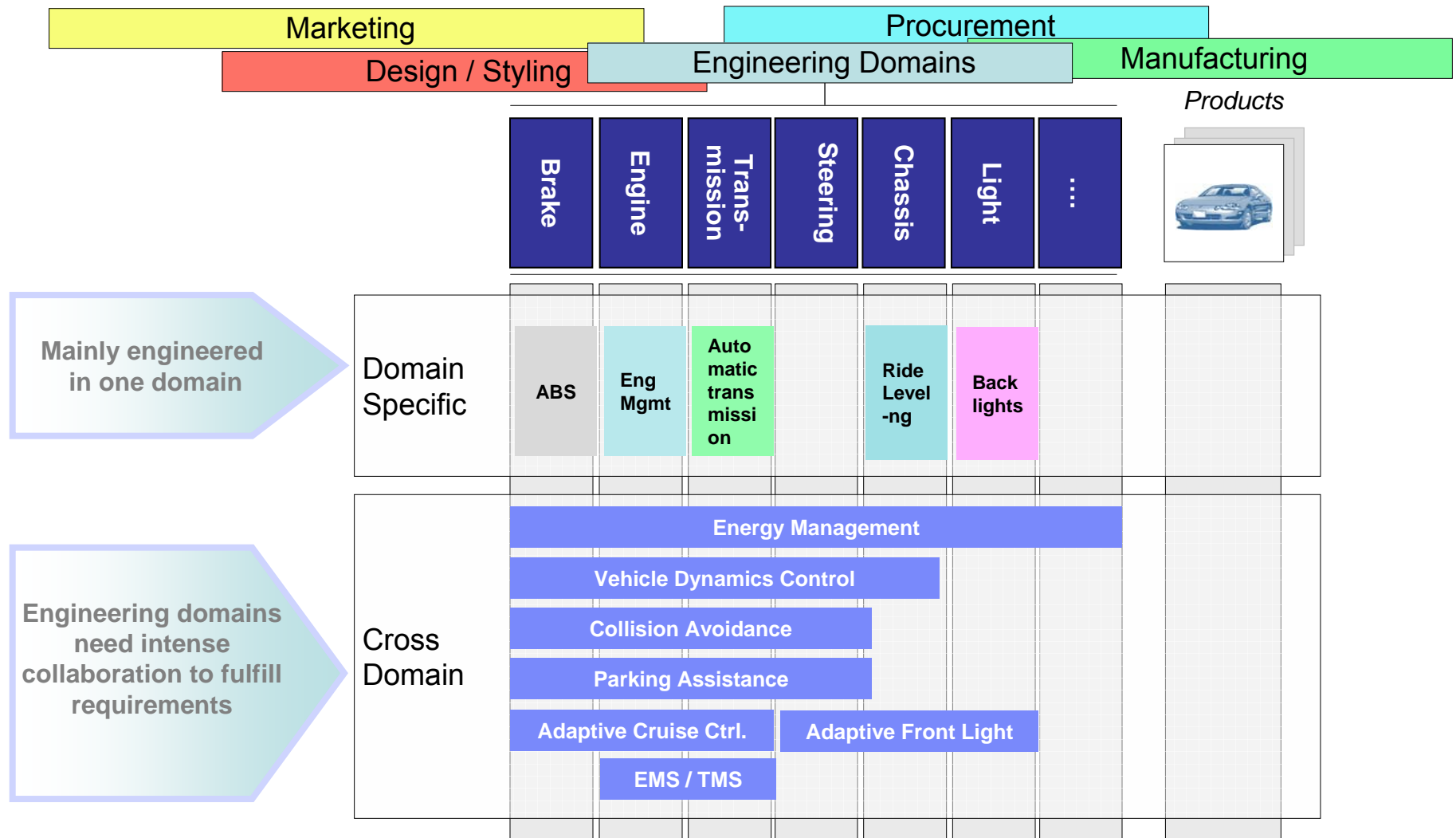
Role-based evolution is transforming the traditional supply chain structure to a virtual value network

Traditional Supply Chain

Virtual Value Network

Suppliers

Suppliers

OEMs

Dealers

Dealers

Technology Specialists

Vehicle Brand Owners

3rd Party Service Providers

Systems Integrators

Retailers/ Dealers

Product Innovators

Vehicle Integrators

e-tailers

Manufacturing Specialists

Customization Centers

Component Specialists

Distributors

Services Providers

Also involves convergence between industries

Shifting more focus on electronics resources – Competitors with same intention but different approaches
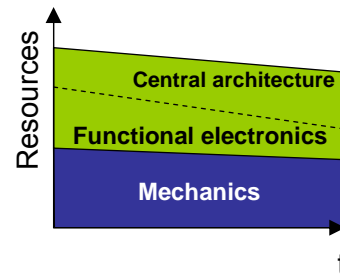
Shift from mechanics to electronics resources – General models
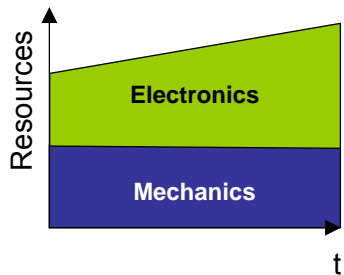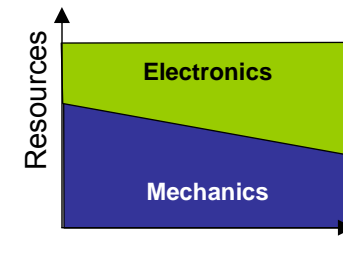

- Investing in electronics resources

- Released mechanics resources are used for managing the increasing number of new models
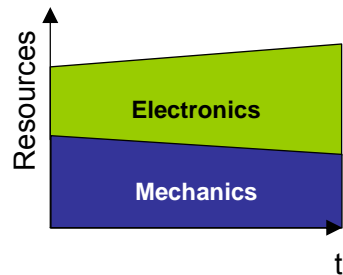
- Substituting mechanics with electronics resources

- Increase of total resources
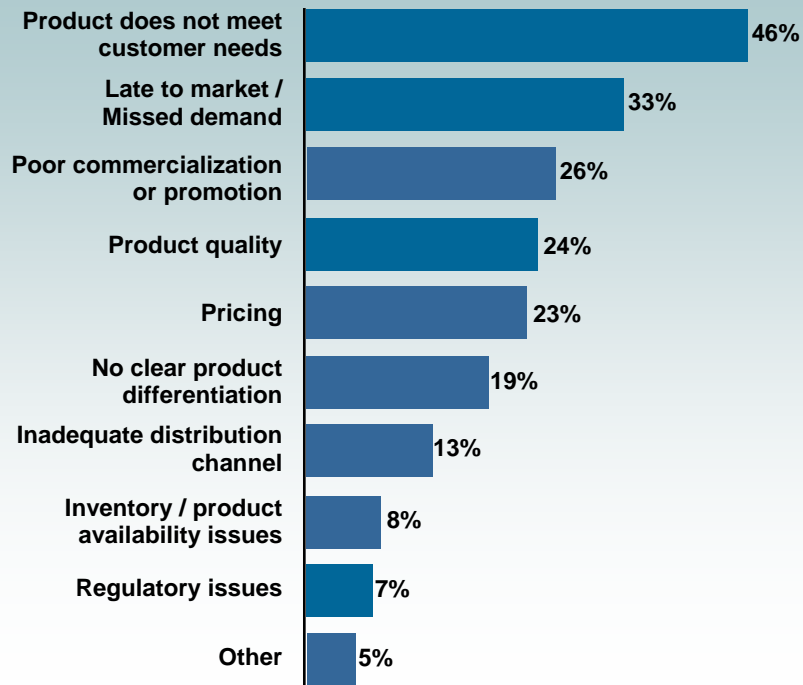
- Shifting resources towards electronics

- Substituting mechanics with electronics resources

- Decrease of total resources

- Strengthening the central architecture competence – reduction of functional competence

- Substituting mechanics with electronics resources

- Constant total resources

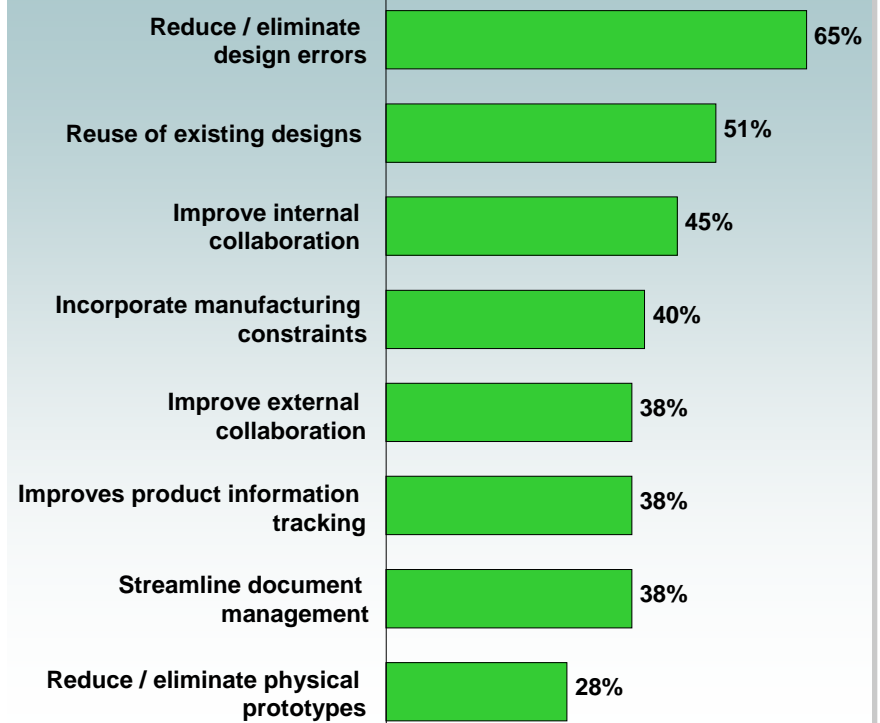- Shifting resources towards electronics

Innovation needs to be managed, or product launches fail.

Why Launches Fail

Category	%
Product does not meet customer needs	46%
Late to market / Missed demand	33%
Poor commercialization or promotion	26%
Product quality	24%
Pricing	23%
No clear product differentiation	19%
Inadequate distribution channel	13%
Inventory / product availability issues	8%
Regulatory issues	7%
Other	5%

Source: AMR Study ,Translating Innovation into Business Benefit', 6/05

Design issues that top Business priorities

Category	%
Reduce / eliminate design errors	65%
Reuse of existing designs	51%
Improve internal collaboration	45%
Incorporate manufacturing constraints	40%
Improve external collaboration	38%
Improves product information tracking	38%
Streamline document management	38%
Reduce / eliminate physical prototypes	28%

Source: IBM Study Q1'05 Global sample n = 527

PLM enables Design Innovation practices

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2. Trends in Product Development
3. **Emerging PLM capabilities**
4. A flexible and scaleable IT infrastructure
5. Summary
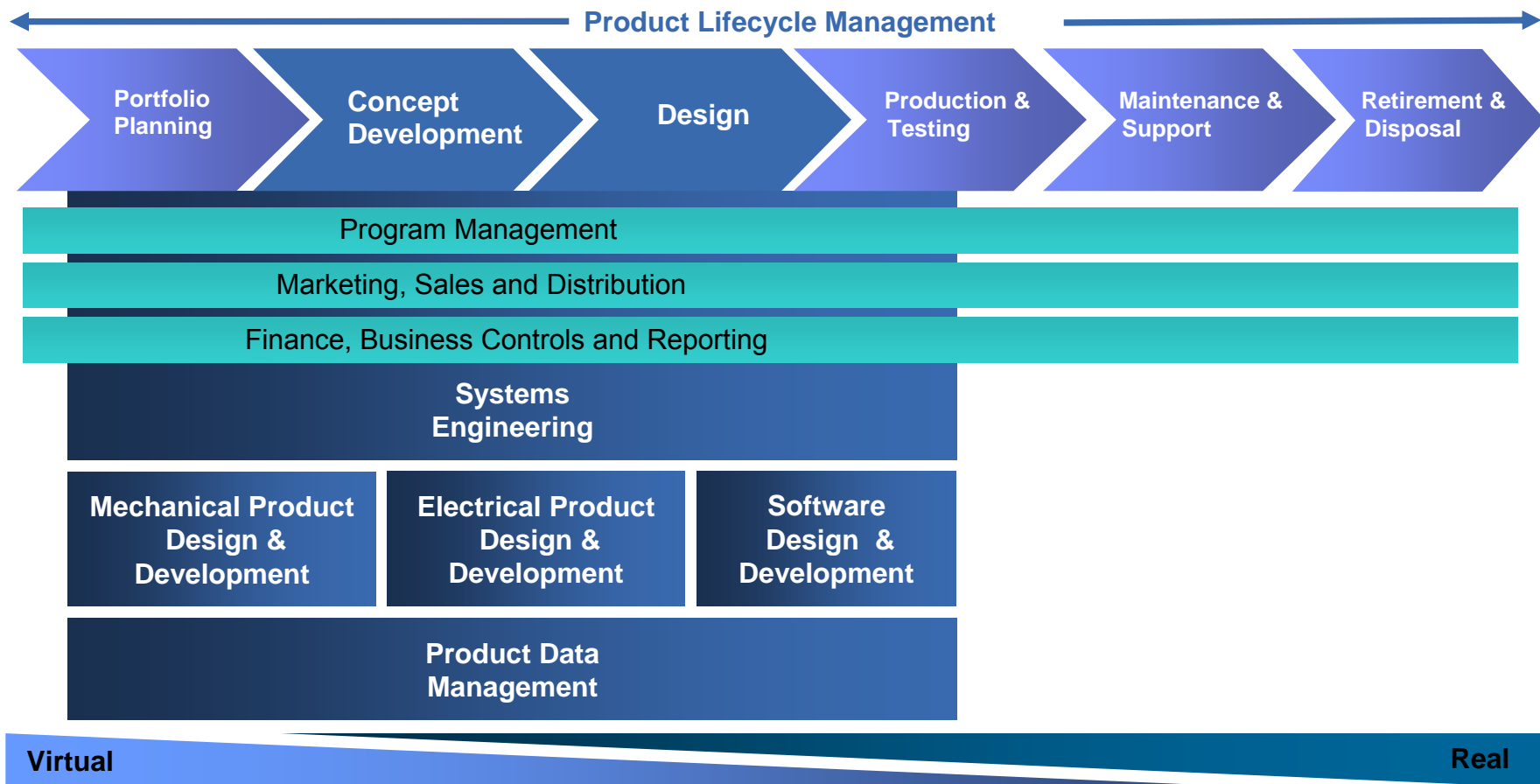
What is within the scope of PLM?

PLM is comprised of the processes and systems that define, develop, manufacture and service products throughout the value chain...
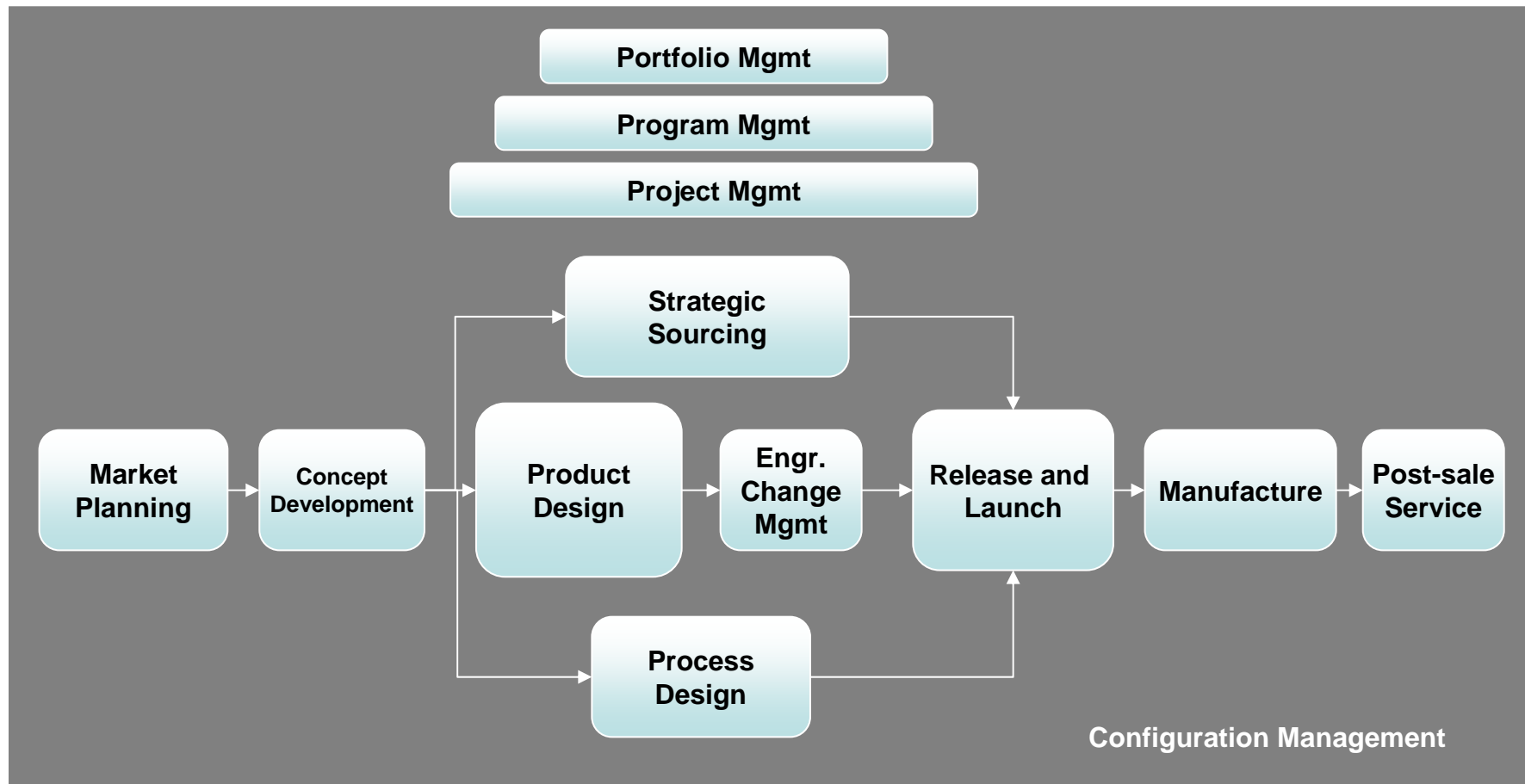
… and is based upon a complete, accurate set of associated data.

Scope and definition of PLM continues to expand and mature

Product Lifecycle Management is a set of capabilities that enables an enterprise to effectively and efficiently innovate and manage its products and related services throughout the entire business lifecycle, from conception through recycling or disposal.

Product Lifecycle Management

| Portfolio Planning | Concept Development | Design | Production & Testing | Maintenance & Support | Retirement & Disposal |

Program Management

Marketing, Sales and Distribution

Finance, Business Controls and Reporting

Systems Engineering

| Mechanical Product Design & Development | Electrical Product Design & Development | Software Design & Development |

Product Data Management

Virtual   Real

Executive viewpoint reveals challenges with information management related to PLM systems

60% *of CEOs want to do a better job capturing and understanding information rapidly for better business decisions*

66% *of CFOs believe that the information is NOT easy to use, tailored, cost effective or integrated*

79% *of companies have 2 or more Repositories &*
25% *have >15*

30% *of people's time is spent searching for relevant information*

85% *of information is unstructured*

40% *of IT budgets may be spent on integration*

Customers
Trx.
Employees
Partners
Orgs.
Products
Financials
e-Mails
Databases
Web Content
Reports
Documents
Media

Source: IBM & Industry Studies, Customer Interviews

The scope of System Engineering

Enable Systems Engineering Best Practices:

– Common language

– Common methodology based on systems engineering principles

– Integration infrastructure: inter- and intra-enterprise collaboration

Program viability	*Concept development*	*Variant optimisation*

Define Needs and Objectives:
- Project metrics
- Design Performance Metrics
- Quality Metrics
- Profitability
- Customer requirements

Determine overall Program
Internal Rate-of-Return
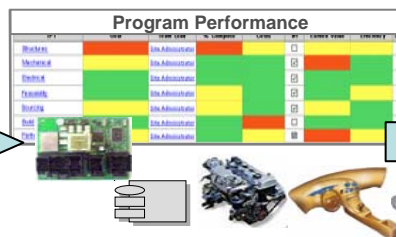
Design & Engineering trade-off:
- Design alternatives
- Evaluation of carryover designs
- Market impact
- Product Development capacity
- Piece & Tooling Costs

Select optimal 'solution'
(vehicle plus services)
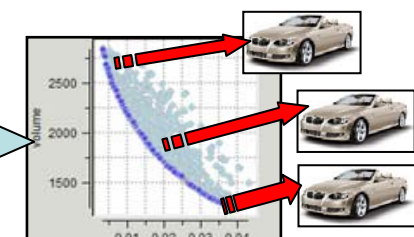
Multiple Solution Options:
- Program Effectiveness
- Design Performance and Quality
- Lifecycle Costs
- Option Trade-offs

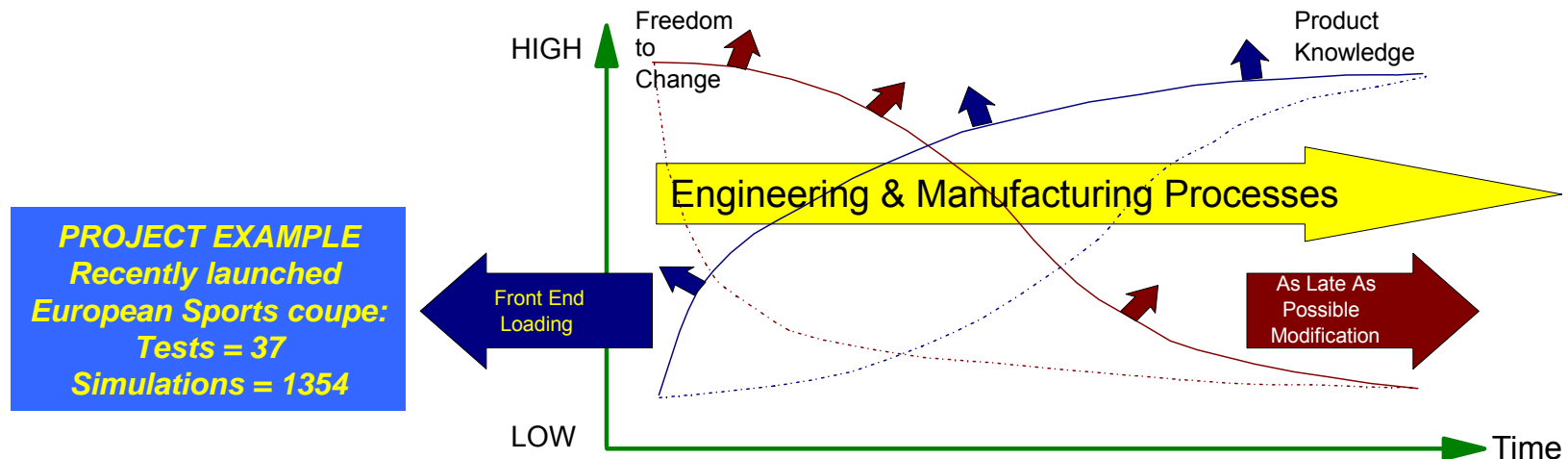Maximise coverage of
segments and markets

Right Data at the Right Time, regardless of location

To manage the increased product and process complexity companies need to transform their Product Creation environment to mitigate risk
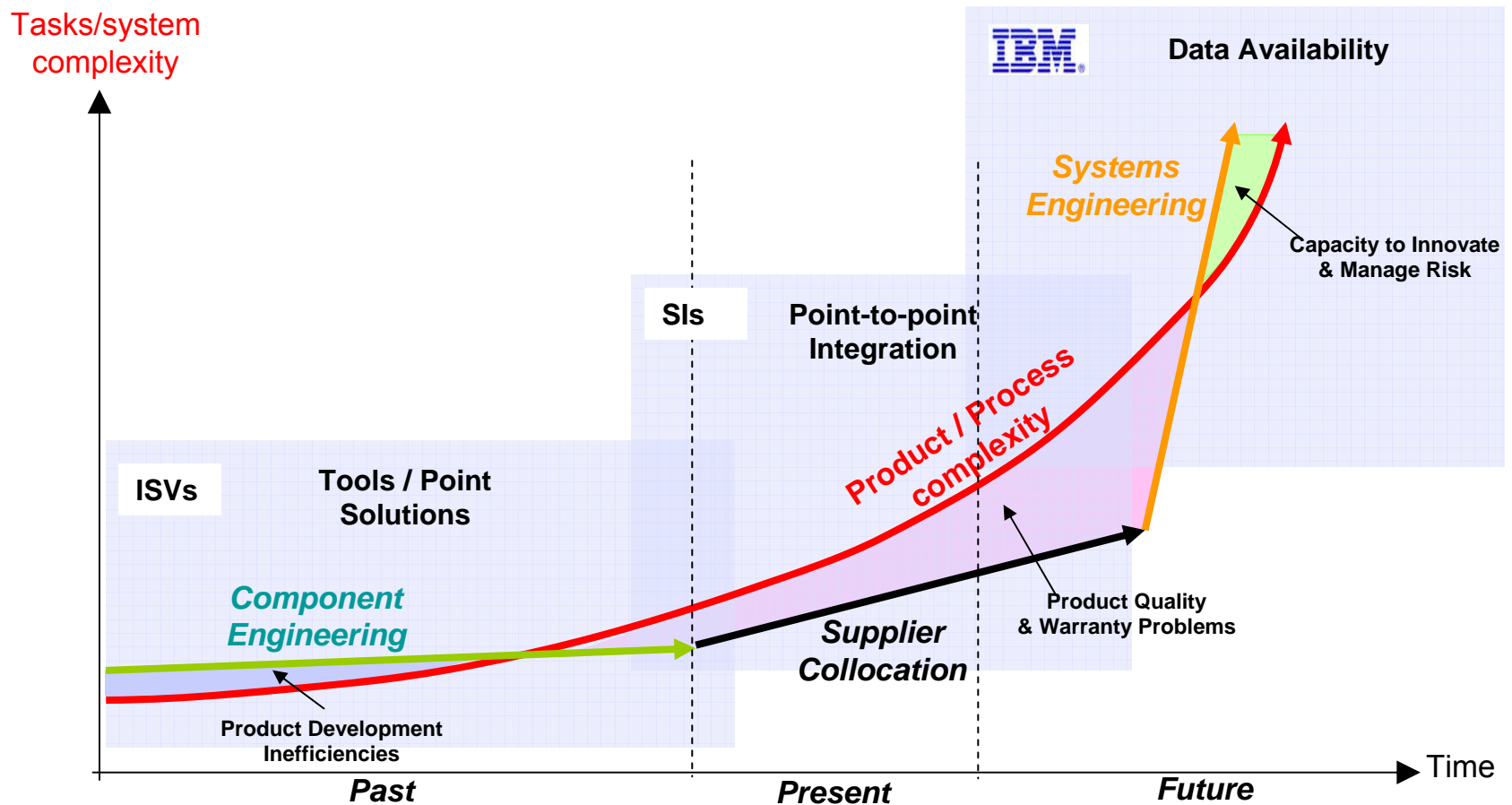
Front-end loading through Systems Engineering

Through knowledge-based, multi-disciplinary capabilities the future
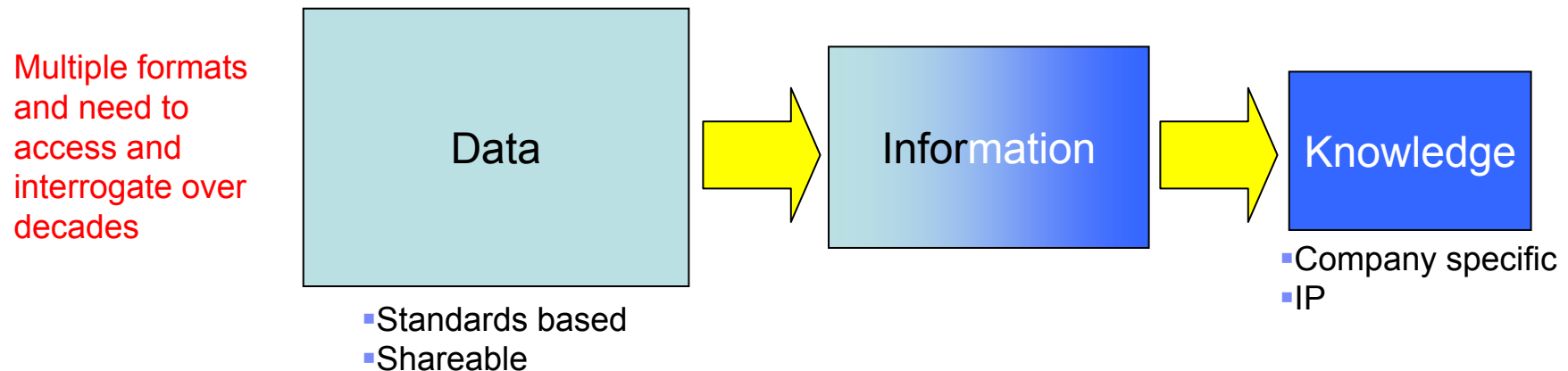New Product Introduction process will deliver 'More' with 'Less'

PROJECT EXAMPLE
Recently launched
European Sports coupe:
Tests = 37
Simulations = 1354

HIGH

Freedom to Change

Product Knowledge

Engineering & Manufacturing Processes

Front End Loading

As Late As Possible Modification

LOW

Time

- Improved Product Development resource efficiencies:
  - Reduced Engineer hours per design
  - Reduced physical prototyping and testing
- Manufacturing process optimisation: cycle time and material flow
- Improve product Serviceability
- Improved product quality and reduced warranty

The Data Challenge

The quantity and format of data is creating a challenge for Automotive companies as they attempt to meet Market and Lifecycle demands

- VW addressed 9 segments in 1985 and in 2005 this had risen to 40

- Whilst this is a factor of about 4 the amount of data has grown by much more

- An IDC Berkeley study suggests that by 2008 the amount of data will exceed the available storage

Multiple formats and need to access and interrogate over decades

Data → Information → Knowledge

- Standards based
- Shareable

- Company specific
- IP

Dr. Hoge, Head of PDM for VW

*Keynote at ProStep iViP Symposium in Wolfsburg 25-26 April 2007

Systems and Storage Virtualization

Improves the utilization of computing, information and human resources.

Pools of virtual resources

Servers	Storage	Distributed	Network

Servers

Partitioning
- Dynamic LPARS
- Virtual machines
- Blades

Clustering
- Parallel Sysplex®
- HACMP
- Linux clusters

Workload Management
- Policy-based
- Heterogeneous

Storage

SAN volumes
- Storage Pools
- Centralized management

TotalStorage Virtualization
- SAN Block Virtualization
- SAN File Aggregation

TotalStorage Virtualization expanded capabilities
- Increase capacity utilization
- Manage non-IBM storage

Distributed

GRID
- Globus Toolkit
- IBM OGSA Toolbox

Server allocation for Web application servers
- Computation heavy, parallel applications
- Manage multiple applications across multiple server clusters

ISV Grid middleware
- Provide services such as data services, scheduling
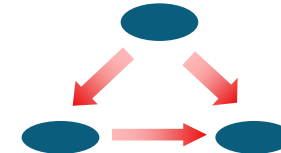
Network

VLANs
- Isolate/prioritize traffic on shared network, 802.1

HiperSockets™/ Virtual ethernet
- Optimized inter-partition communications, virtual network

Differentiated services
- Prioritize network traffic
- Network QOS, IP TOS

Vendor alliances

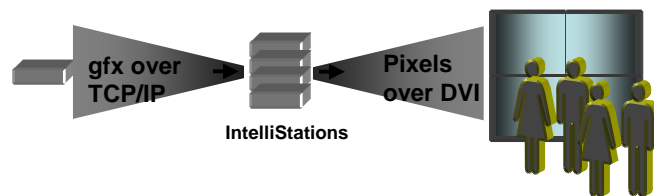# PLM capabilities grown out of IBM Research

Remote application delivery and visualization
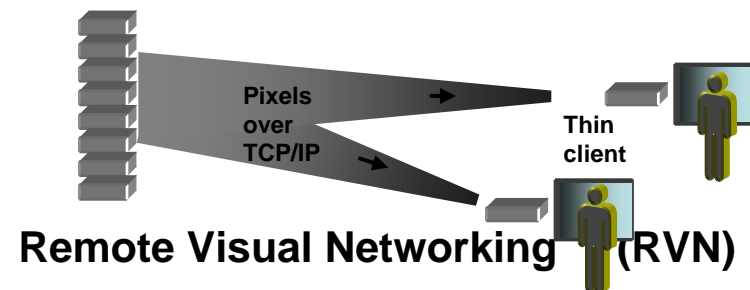
Progressive Deployment System
- ✓ Solution is installed & configured in a "virtual sandbox" by the service provider or IT administrator
- ✓ Entire virtual sandbox is delivered to each end user

Deep Computing Visualization
- ✓ High Performance Cluster-Based Rendering and Media Server For Networked Visualization

gfx over TCP/IP

Pixels over DVI

IntelliStations

Scalable Visual Networking (SVN)

Pixels over TCP/IP

Thin client

Remote Visual Networking (RVN)

PLM capabilities grown out of IBM Research

Remote application delivery and visualization

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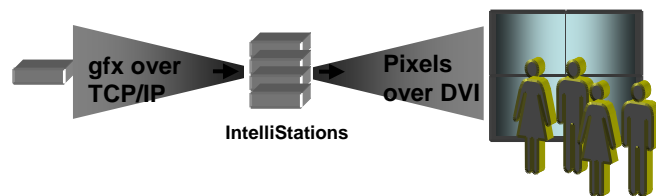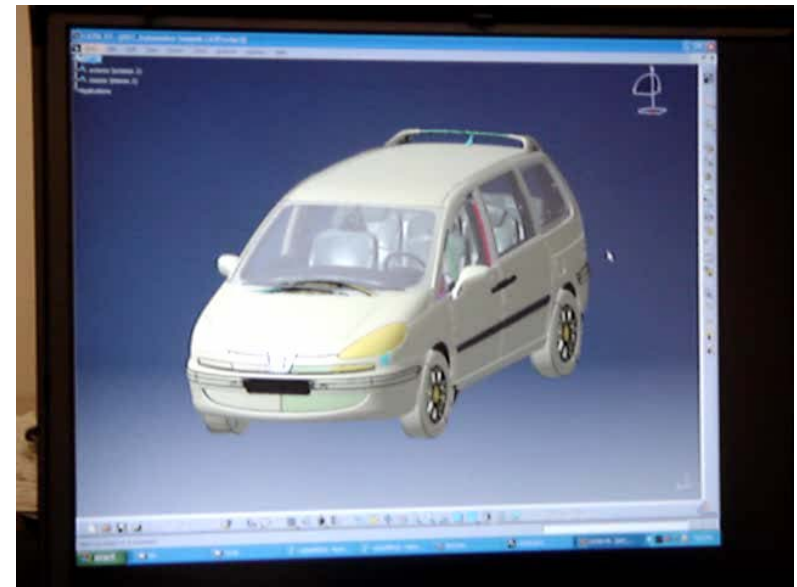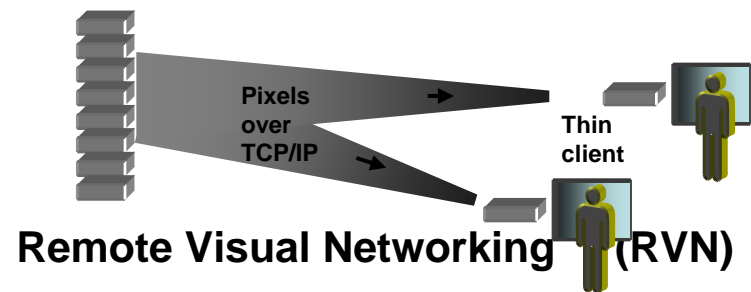
Remote Visual Networking (RVN)

Multi-Core Acceleration Capability: Cell Broadband Engine™

Cell Broadband Engine

- **"Supercomputer & Network on a Chip"**
- 1 PPE + 8 Synergistic Processing Elements (SPE) cores
- Element Interface Bus (EIB) @ 300+GB/s
- 1 Cell BE Blade = 2 Cell BE Chips = 16 SPEs
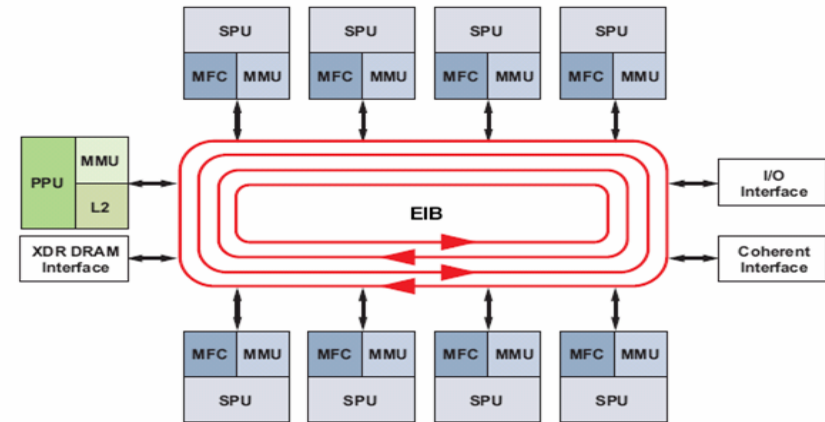
Revolutionary Hybrid Supercomputer at Los Alamos National Laboratory Will Harness Cell BE Chips and AMD Opteron™ Processor Technology

x86 Linux Master Cluster

Cell BE Accelerator Cluster

Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc.
Development collaboration between Sony, Toshiba and IBM.

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Level of Business and Technology integration

Automotive is striving hard but, based on CEO responses, it is lagging in integration compared with other industries


Percentage of respondents with 'significant' to 'large' rating
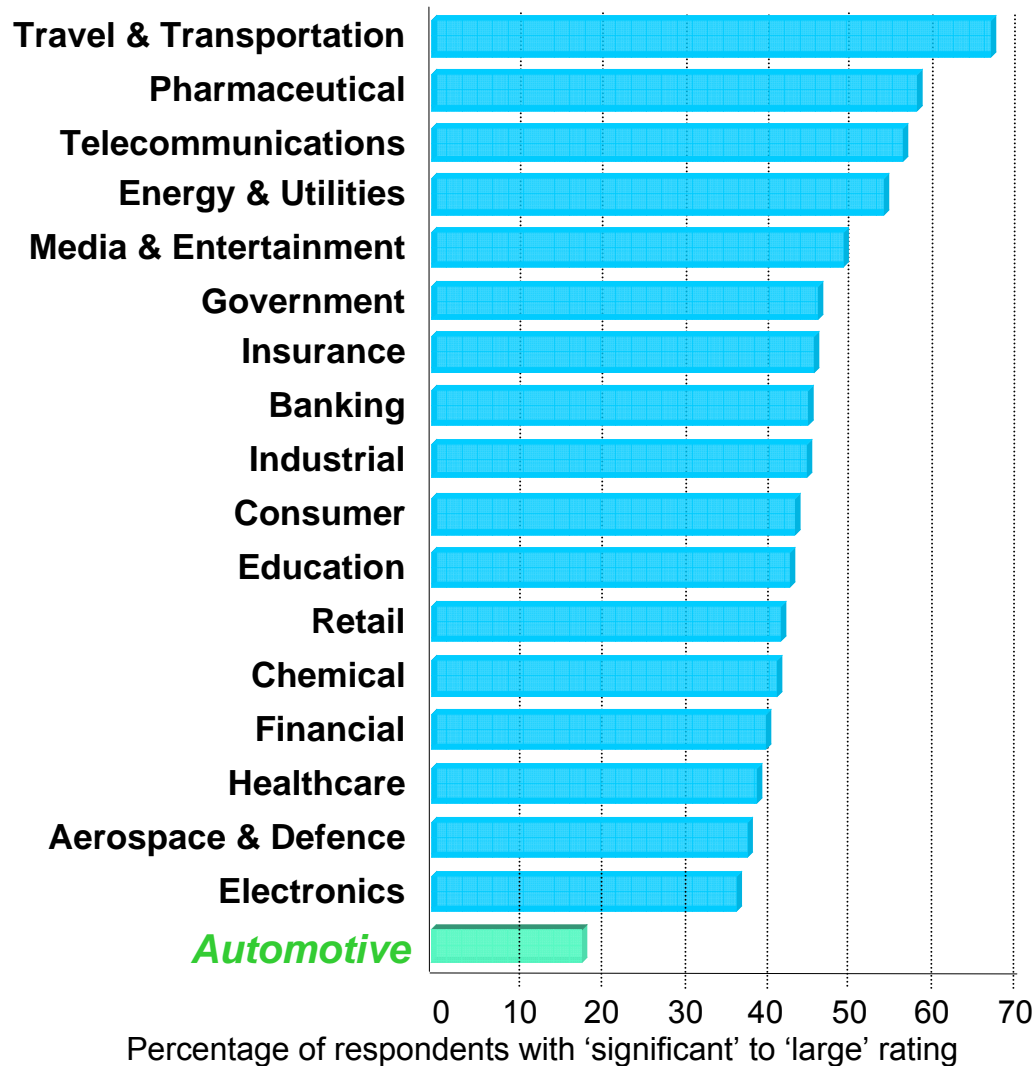
Areas of technology adoption in Automotive:

☑ *Virtual simulation of designs*

☑ *Automation of manufacturing facilities*

☑ *In-vehicle technology*

Possible reasons for position of Automotive:

✖ *Complexity plus speed*

✖ *Acquisition plus global expansion*

✖ *Amount and degree of outsourcing across the lifecycle*

IBM Institute for Business Value, CEO Study 2006

PLM Process Based Integration
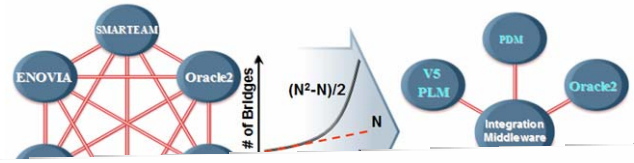
|		
Authoring Applications	Catia V5	Pro/E
VPDM • tightly coupled data management with authoring applications	ENOVIA	Windchill
Enterprise Service Bus (ESB)		
ePDM		
Other Business Systems	ERP	Parts Mgmt

Logistics | Maint. Systems | Legacy ….
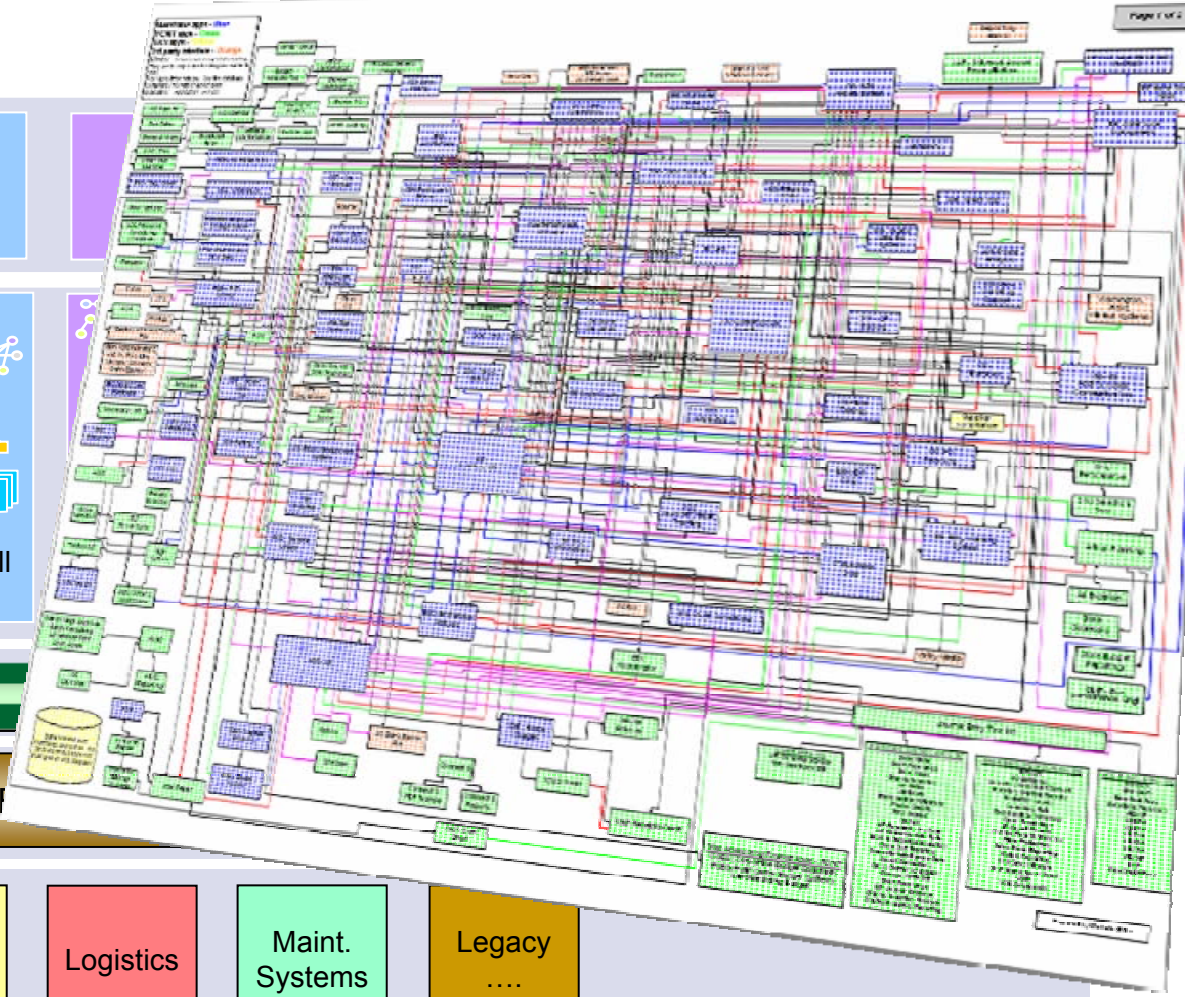
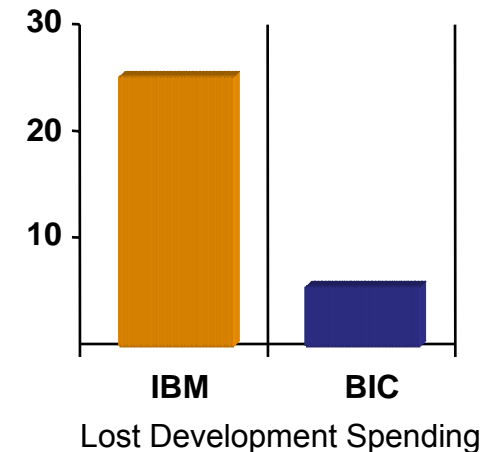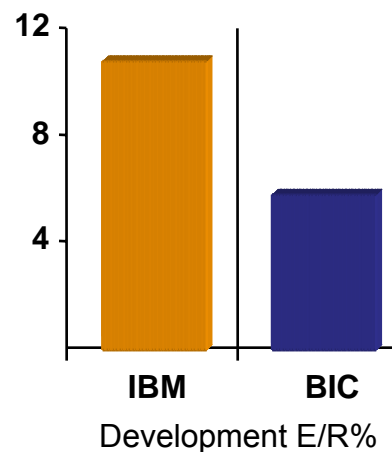# IBM's strategy is based on our reengineering experience

How PLM saved IBM

Hardware Development Challenge:

– Over 35 % of our products took at least 100 percent longer to get to market than best-in-class

– Development expense running at 11% while best-in-class was greater than 50% lower

– Abandoned projects were running at 26%

– Part reuse less than 2% across divisions

– Multiple design, PDM, ERP, CRM systems and component repositories.

Slow Time to Market
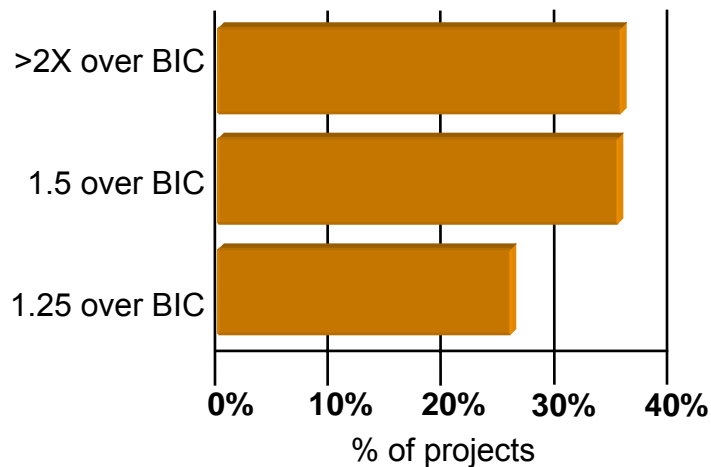
% of projects

High Development Cost

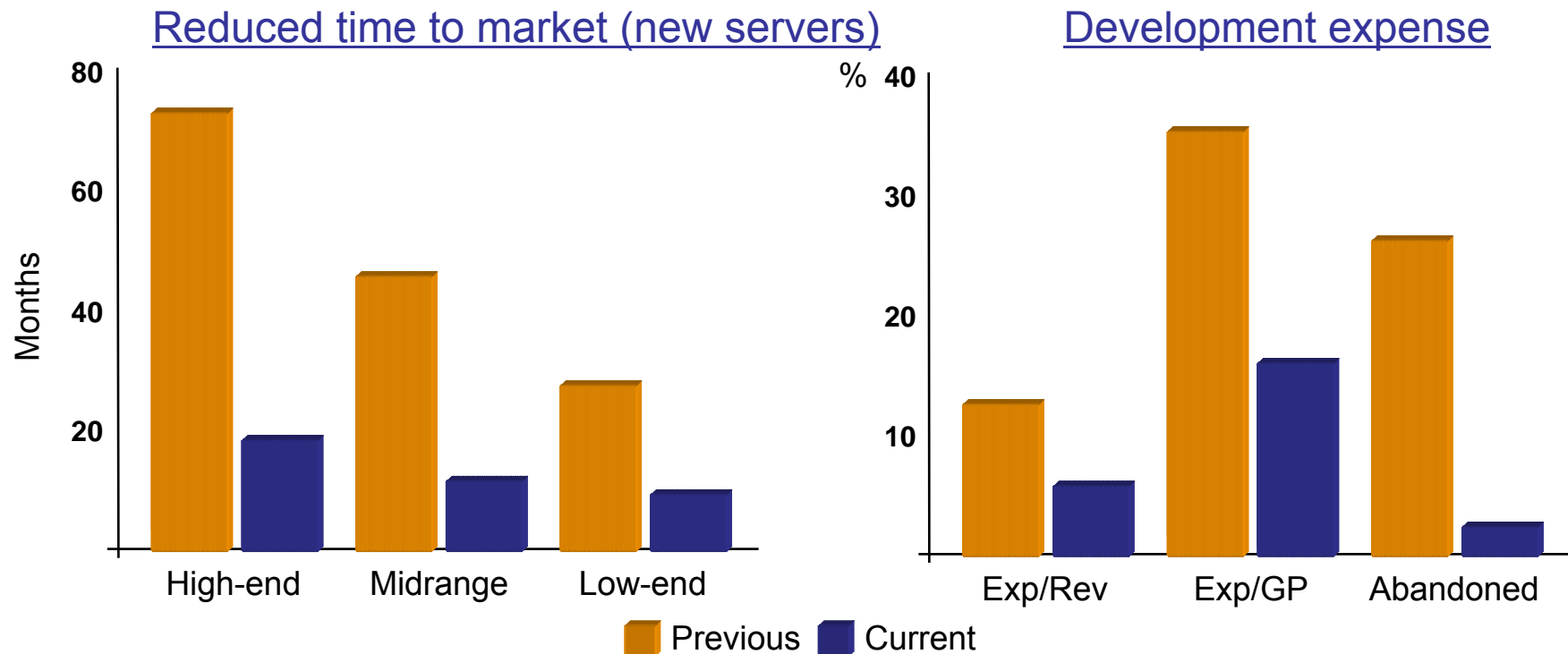Development E/R%

Lost Development Spending

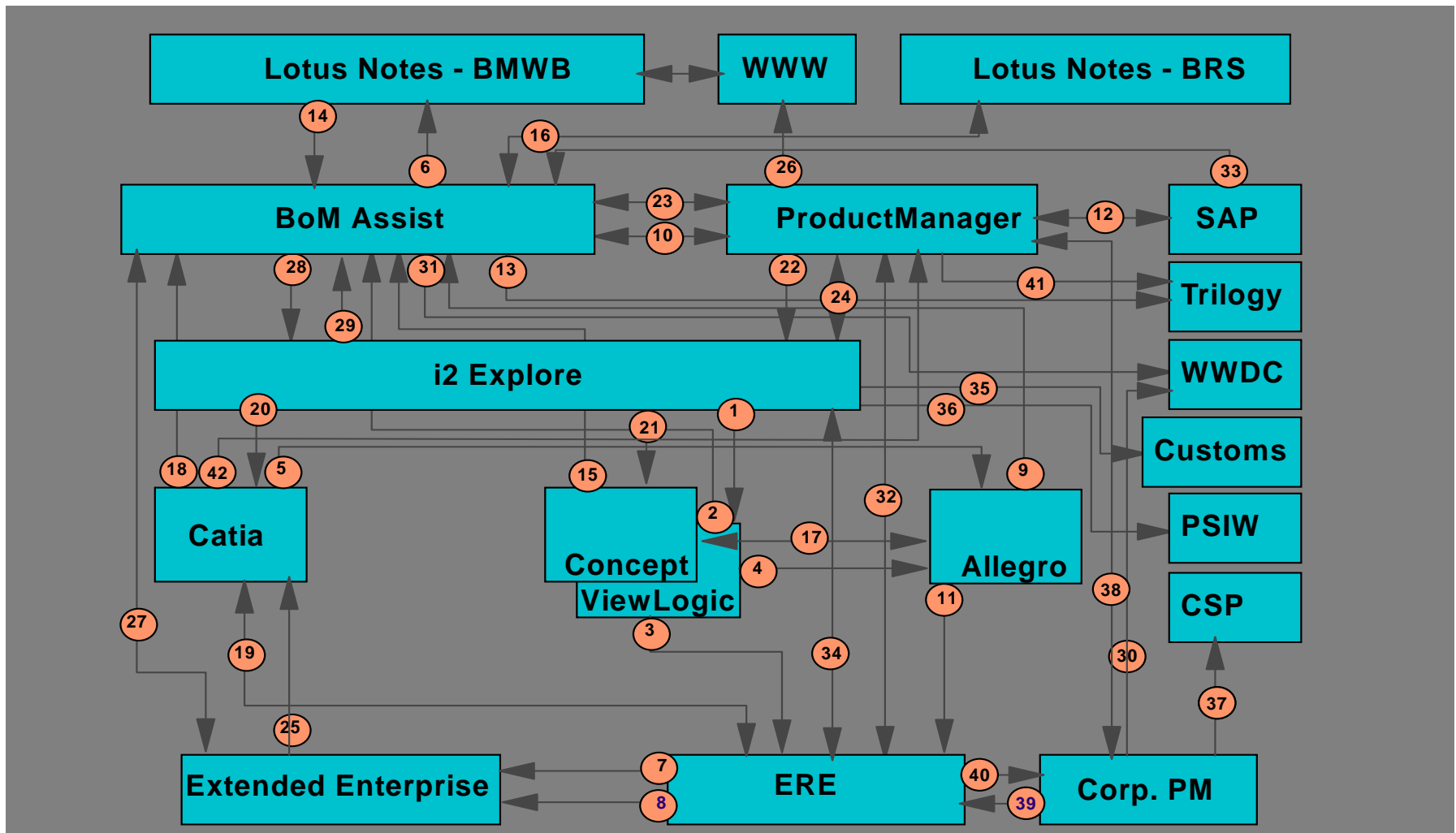# IBM's strategy is based on our reengineering experience
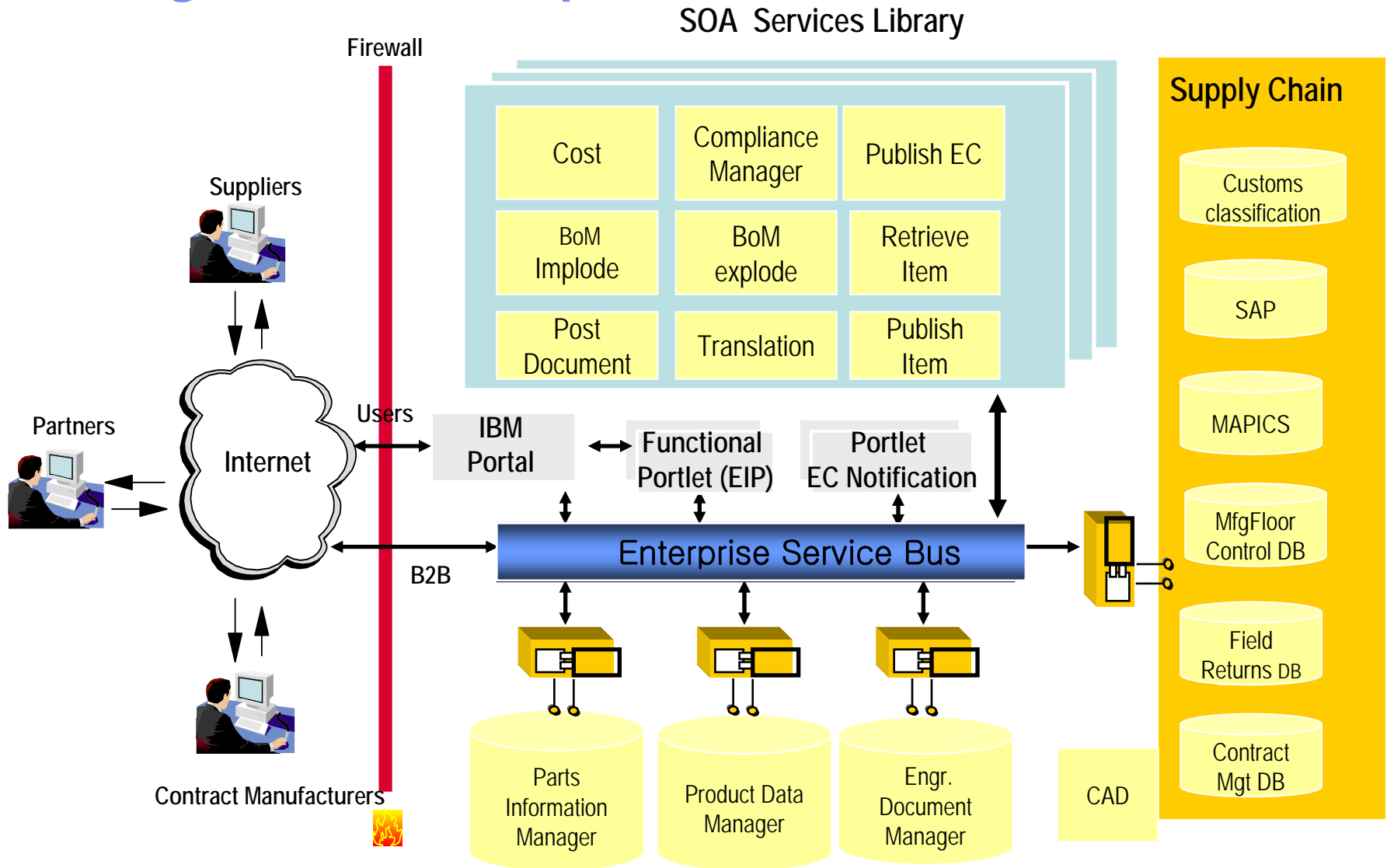
How PLM saved IBM

Solution:

– Structured process: asynchronous development, event driven check points, cross-functional teams
– Organizational alignment to support defined detailed process
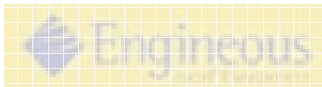– PLM integrated architecture

Reduced time to market (new servers)

Development expense

IBM's strategy is based on our reengineering experience

IBM's Target PLM landscape

SOA Services Library

Cost	Compliance Manager	Publish EC
BoM Implode	BoM explode	Retrieve Item
Post Document	Translation	Publish Item

Firewall

Suppliers

Partners

Internet

Users

Contract Manufacturers

B2B

IBM Portal

Functional Portlet (EIP)

Portlet EC Notification

Enterprise Service Bus

Parts Information Manager

Product Data Manager

Engr. Document Manager

CAD

Supply Chain

- Customs classification
- SAP
- MAPICS
- MfgFloor Control DB
- Field Returns DB
- Contract Mgt DB

Product Development Integration framework (PDIF) Launched December 2006
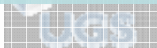

"**Monumental** – very stimulating."
Ann McFarland, Clipper Group

"**Very significant announcement** – high impact on the PLM space"
Dick Slansky, ARCWeb

"This is a **game-changer for the PLM space,** both in terms of the expanded value that it delivers to customers as well as the opportunity it presents software developers and solutions providers."

Richard Harrison, CEO & President, PTC

www.ibm.com/solutions/plm/pdif

What is an Integration Framework?

An integration framework is a <u>flexible and scalable integration architecture for a specific business domain</u>, that addresses both business and technology by organizing the business processes and functions for the specific domain area and identifying the set of offerings and technology from IBM and its business partners to implement the processes.

Some examples of Integration Frameworks From IBM:

- *SPDE – Service Provider Delivery Environment (Telco)*
- *SIF – Store Integration Framework (Retail)*
- *PDIF - Product Development Integration Framework (PLM / Industrial)*
- *EPP - Enterprise Payments Platform (Banking)*
- *HIF – Health Integration Framework (Healthcare)*

Target PLM Environment

PDIF enables PLM development processes using native data and role-based access to cross-application business processes

Project/Business Management

System / Product Development

Manufacturing Operations

Maintenance, Repair, Overhaul

People Collaboration

Role Based PLM Workplaces
Composite applications

Customized User Workplace
Instant Collaboration

PLM Business Processes

Enterprise Change Mgmt
Concept Exploration
System Engineering

Supplier Collaboration
Program & Project Mgmt
Lifecycle Mgmt

PLM Services

BOM Mgmt
Config Mgmt
Traceability

Product Arch Mgmt
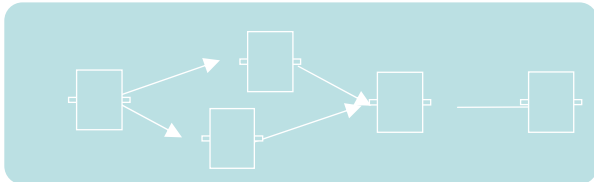Process Arch Mgmt
Artifact Lifecycle Mgmt

Information Integration

PLM system connection
PLM object schema
PLM object transformation

PLM event broker
PLM message transformation
Link Management

Product Development Integration Framework

WebSphere

Lotus

Rational

Tivoli

Information Management

IBM SOA Foundation

PLM Application Systems

Program and Portfolio Management

Requirements Management

Data Management

Mechanical Authoring

Data Management

Electrical Authoring

Data Management

Software Authoring

Data Management

Analysis & Simulation

Enterprise Application Systems

Enterprise PDM

ERP

EAM

Other Enterprise Applications

Servers

Software

Storage

PDIF SOA Assets: Reusable Components

Business Process Logic
• BPEL files, Use Case documents

Application Interfaces
• Adapters & Web Services

Assy_W01
○ Doc_X0A
Part_T01
○ Doc_X0B
Part_T02
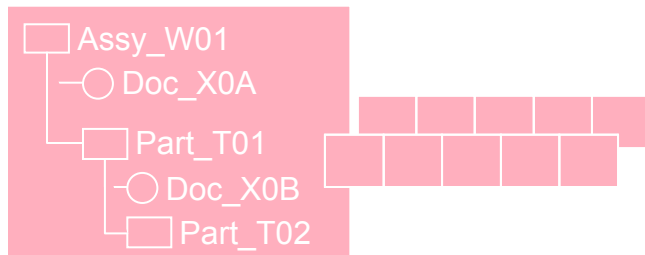
Neutral Object Models
• Standardized info maps such as OMG PLM
Services Information (STEP) Models
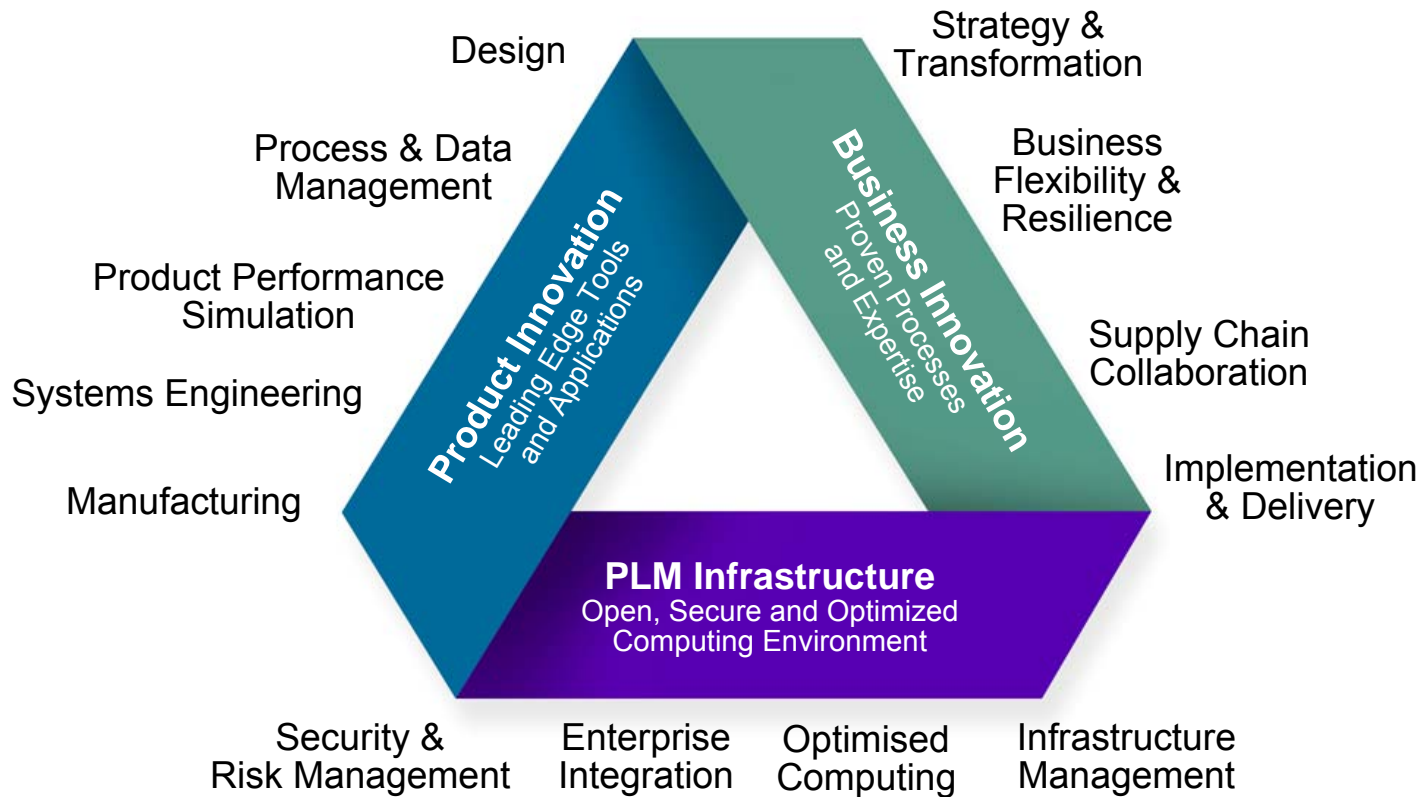
PDIF SOA Industry Content Packs to be published

■ *PDM Connection* Provides orchestrated exchange of PDM objects and attributes between DS, PTC, UGS, and ERP repositories using OMG PLM Services 1.0. Uses ProStep adapters and model mapping.

■ *Engineering Change Management* Based on OMG PLM Services 2.0 (draft) and VDA 4965 Standards; Manages engineering change process across multiple PDM repositories (including supplier's systems), Requires assets from PDM Connection.

■ *Analysis and Simulation* Closed-loop Engineering analysis driving ECM processes; Uses MSC SimManager and Engenious FIPER combined with PDM Connection and ECM Assets

■ *Supplier Collaboration* Based on auto-supplier use cases; Manages exchange of work-packages, issues management and change management across firewalls and varied PDM repositories. Requires PDM Connection and ECM Assets

Agenda

1. The increasing focus on Innovation
2. Trends in Product Development
3. Emerging PLM capabilities
4. A flexible and scaleable IT infrastructure
5. Summary

Innovation is a Discipline

It requires a culture to make it happen, the tools and infrastructure to let it happen, and business processes to do it right.

Design

Process & Data Management

Product Performance Simulation

Systems Engineering

Manufacturing

Product Innovation
Leading Edge Tools and Applications

Business Innovation
Proven Processes and Expertise

Strategy & Transformation

Business Flexibility & Resilience

Supply Chain Collaboration

Implementation & Delivery

PLM Infrastructure
Open, Secure and Optimized Computing Environment

Security & Risk Management *Enterprise Integration* *Optimised Computing* *Infrastructure Management*

Leading Consulting, Products and Services plus the enabling infrastructure

Conclusions

To maximise the benefits of PLM Automotive companies
must better align their Business and IT strategies.

- Developing true Systems Engineering capabilities to manage increasing complexity, considering the tasks at each stage of the lifecycle.

- Increasing Up-front analysis and simulation, across all disciplines and domains, in order to reduce risk.

- Agreeing Business and process standards / semantics, in addition to technical standards, in order to facilitate collaboration with partners.

- Adopting a flexible, standards-based architecture to fully exploit emerging solutions, thus increasing margins and facilitating the necessary industry transformation.
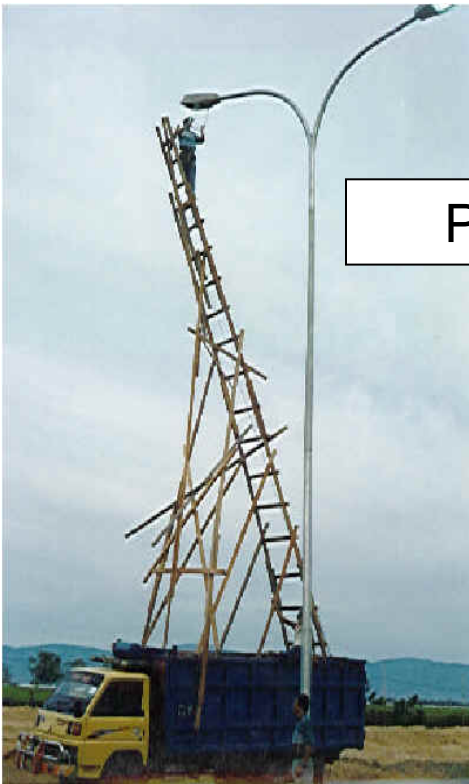
The Vision: A Requirements-driven Product Development process
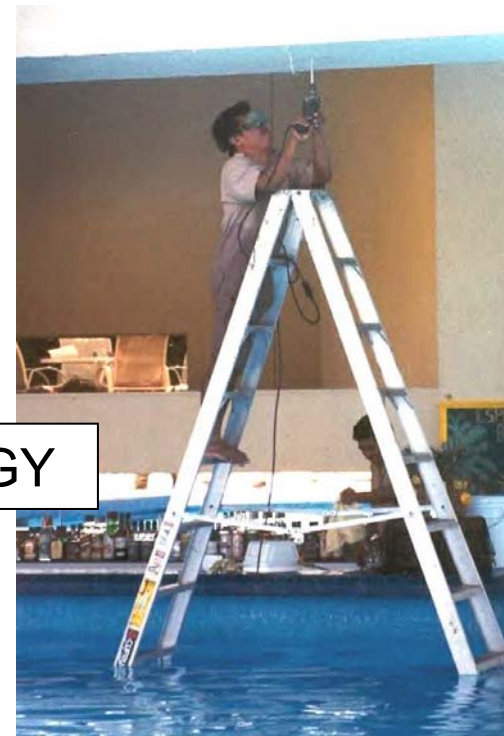
Remember, it requires….

ORGANISATION

PROCESS

TECHNOLOGY

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