

Simulation Data Management in PLM

9th NASA-ESA PDE Workshop – May 2007



Gene Allen Background

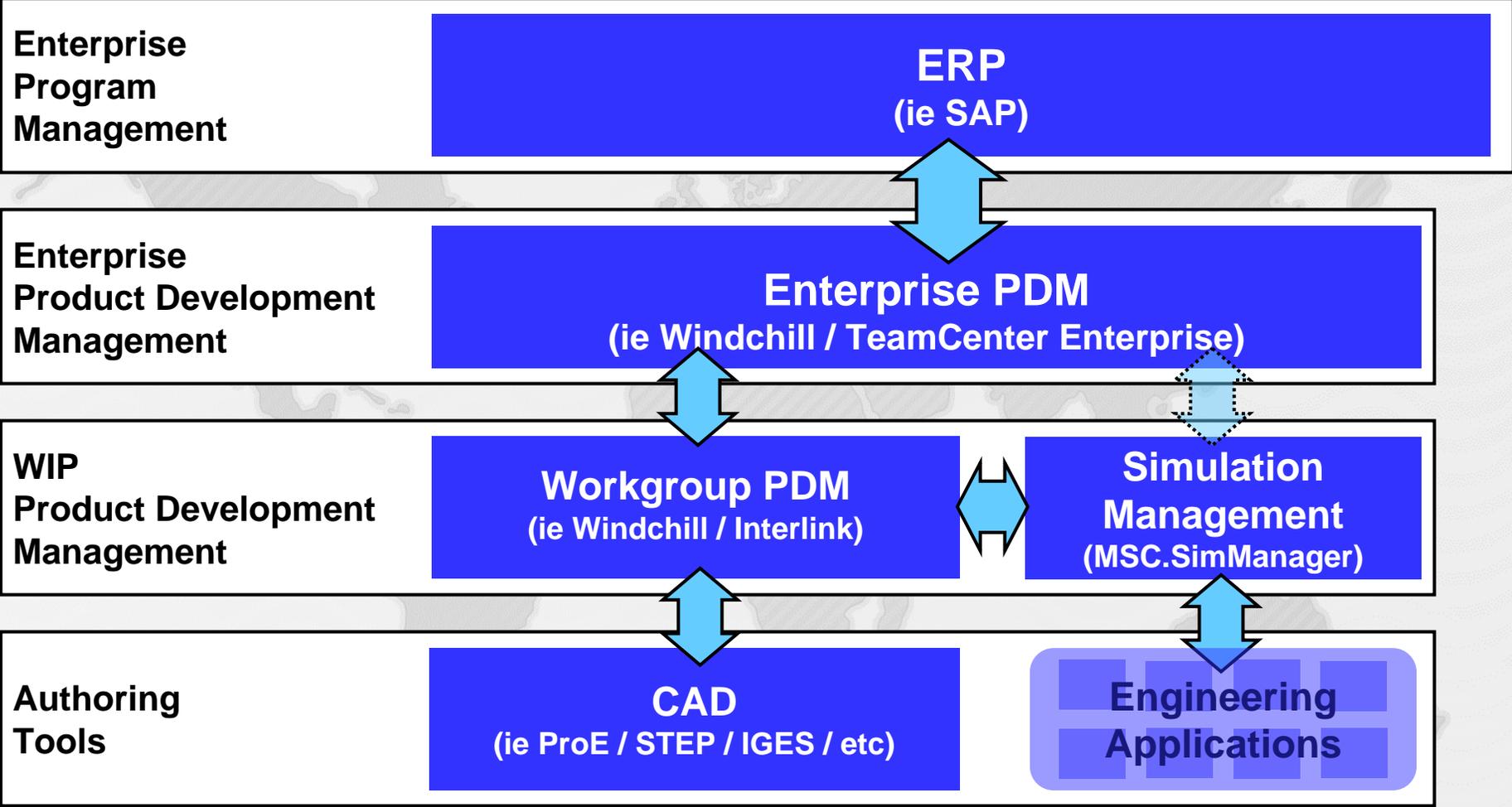


- **Director, Collaborative Development, MSC (13 yrs)**
 - Promoting Simulation for Decision Making
 - Establish & manage CAE research projects with major users
 - Co-Authored “Collaborative R&D: Manufacturing’s New Tool”
 - PDES, Inc Board member
- **Director, Collaborative Development, NCMS (3 yrs)**
- **Economic Development & Defense Procurement Assistant, Senator Robert C. Byrd, (2 yrs)**
- **Associate, Booz, Allen & Hamilton (3 yrs)**
 - SSBN Acquisition
- **U.S. Navy, Officer (5 yrs)**
 - Qualified Nuclear Engineer, CGN Command Duty Officer, Wartime OOD, Nuclear Training Officer
 - Reserve Officer on CNO staff (15 yrs)
- **B.S. Nuclear Engineering, MIT 1978**

Agenda

- **Engineering in the Enterprise**
 - IBM PDIF through SOA
 - Enterprise Simulation Role
- **Simulation Data Management**
 - Data Interoperability
- **MSC.SimManager Capabilities**
- **MSC.SimManager Applications**

Role of Engineering Simulation in the Enterprise



PLM Business Partners Working with IBM

IBM Strategic PLM Partner



Dassault Systemes

**ENOVIA-brand
(vPLM, SMARTEAM & MATRIXONE)**

Enabled on IBM SOA Foundation

PDIF Launch Partners

- **Agile Software Corp.**
 - PDM; Agile-brand
 - Enabled on SOA Foundation Connect Level
- **Centric Software Inc.**
 - Integration Application; Connection Center
 - Enabled on SOA Foundation Connect Level
- **Engineous Software Inc.**
 - Specialized PLM; FiPER-brand
 - Enabled on SOA Foundation Connect Level
- **Geometric Software Solutions Ltd**
 - Integration Application; V5-xPDM Gateway
 - Utilizes IBM middleware stack (WAS)
- **MSC Software Corp.**
 - Specialized PLM; SimManager-brand
 - Enabled on SOA Foundation Connect Level
- **PROSTEP AG**
 - Integration Application; OpenPDM
 - Enabled on SOA Foundation Extend Level
- **PTC**
 - PDM; Windchill-brand
 - Enabled on SOA Foundation Connect Level
- **UGS Corp.**
 - Specialized PLM; Teamcenter SRM
 - Enabled on SOA Foundation Connect Level



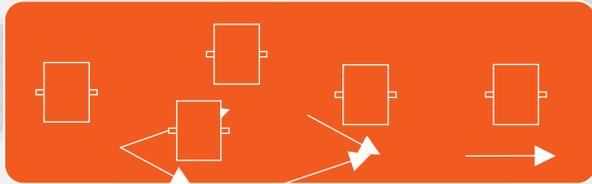
Other Partners (in progress)

Eurostep, Class Technologies, Vector,



PDIF SOA Assets: Reusable Components

PDIF SOA Asset Components



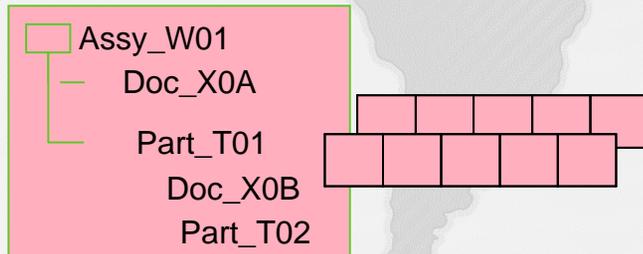
Business Process Logic

- BPEL files, Use Case documents



Application Interfaces

- Adapters & Web Services



Neutral Object Models

- Standardized info maps such as OMG PLM Services Information (STEP) Models

PDIF SOA Asset Packs in Development*

- **PDM Connection**: Provides orchestrated exchange of PDM objects and attributes between DS, PTC, UGS, and SAP 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.
- **Simulation driven Change Management**; Closed-loop Engineering analysis driving ECM processes; Uses MSC SimManager and Ingenious 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

* Development Plan for SOA Assets is Subject-to-Change



IBM Product Data Innovation Framework (PDIF)

- ***Enterprise Infrastructure***

- Deployment & strategic support
- Services Oriented Architecture (SOA) frameworks
- PLM enterprise integration middleware
- Enterprise level IT integration

IBM

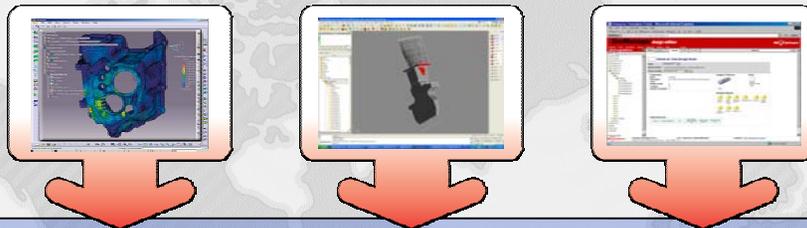
- ***Enterprise Simulation***

- Enterprise Simulation Management Environment
- Extend into detailed 3D simulation, multi-disciplinary, traditional design
- Simulation Process execution
- Automated data capture
- Establish analysis pedigree

MSC

SimManager Enterprise

MSC SimDesigner™ MSC SimXpert™ MSC SimManager™



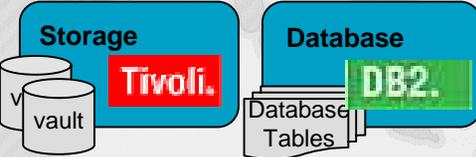
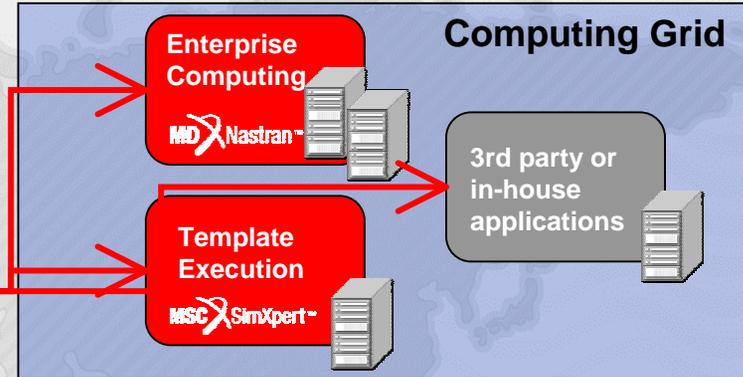
WebSphere



Component Framework



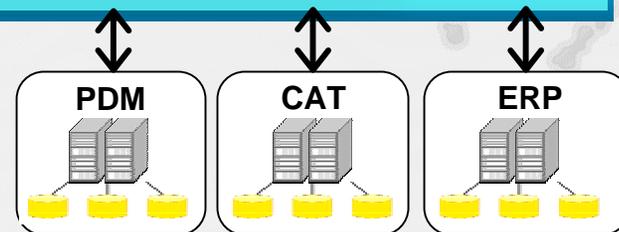
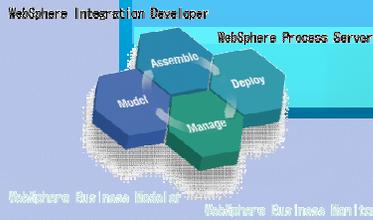
Security Identity Management High Availability Load Balancing



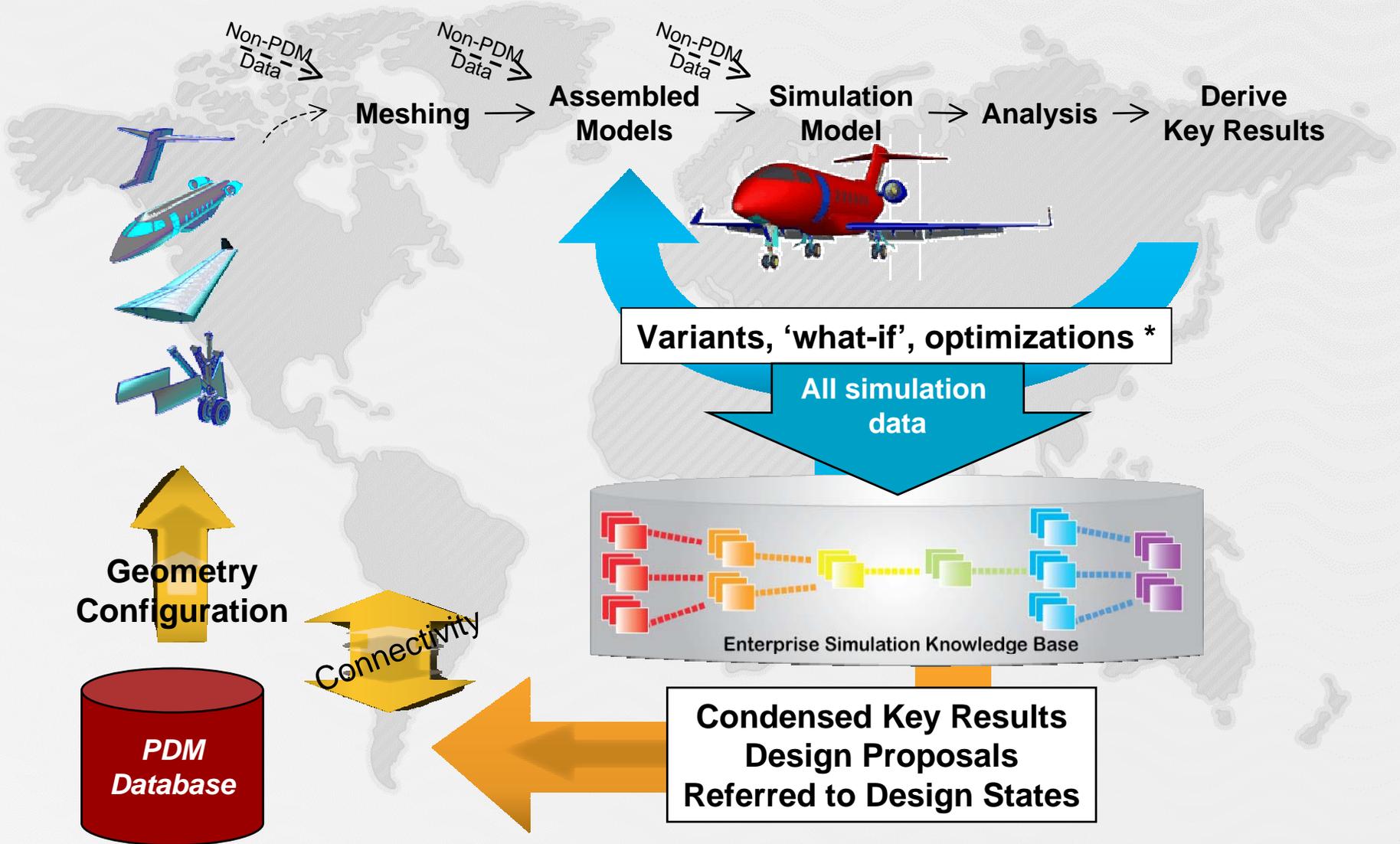
Enterprise Service Bus

Federation / Meta-Model Layer

Enterprise Workflow (BPEL)



Simulation Data Management



* Manages the "work-in-process"

Elements of Engineering Simulation

- **Pre-processing**
 - **Modeling**
 - **Geometry simplification**
 - **Meshing**
 - **Model assembly**
 - **Load cases, materials, etc**
- **Solving**
- **Post processing**
- **Iteration – optimisation / what-if, etc**

STEP AP209

Analysis Discipline Product Definitions

- Finite Element Analysis
 - Model (Nodes, Elements, Properties,...)
 - Controls (Loads, Boundary Constraints,...)
 - Results (Displacements, Stresses,...)
- Analysis Report

Design Discipline Product Definition

- Shape Representations
- Assemblies

Configuration Control, Approvals

- Part, product definitions
- Finite element analysis model, controls, and results

Information Shared Between Analysis & Design

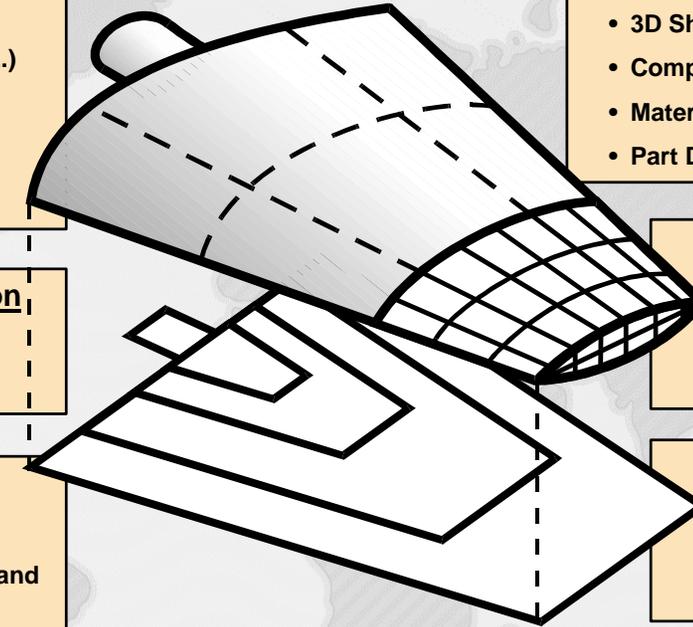
- 3D Shape Representations
- Composite Constituents
- Material Specifications & Properties
- Part Definitions

Composite Constituents

- Ply Boundaries, Surfaces
- Laminate Stacking Tables
- Reinforcement Orientation

Material Specifications & Properties

- Composites
- Homogeneous (metallics)



3D Shape Representation

- AP202/203 Commonality Plus Composite Specific 3D Shapes
 - Advanced B-Representation
 - Faceted B-Representation
 - Manifold Surfaces With Topology
 - Wireframe & Surface without Topology
 - Wireframe Geometry with Topology
 - Composite Constituent Shape Representation

MSC.SimManager Is An Open System

- Will support any & all engineering tools & data
 - MSC Tools
 - 3rd Party Tools
 - Home Grown Tools
- Integration is performed via:
 - Process scripting
 - API for deep integration

Example Applications Integrated In MSC Customer Environments

- Pre-processors
 - Ansa
 - CATIA
 - ESI
 - HyperMesh
 - Medina
 - PATRAN
 - ...
- Solvers
 - ABAQUS
 - ADAMS
 - DYNA
 - DYTRAN
 - FLUENT
 - NASTRAN
 - PamCrash
 - Powerflow
 - ...
- Post-processors
 - Animator
 - FeGraph
 - PamView
 - PATRAN
 - Scripte
 - ...
- PDM
 - Windchill
 - ENOVIA
 - In-house
 - ...
- CAD
 - CATIA
 - PRO-E
 - UG
 - ...
- In-house
 - Various

SimManager is NOT limited to these applications

MSC-ProSTEP Press Release

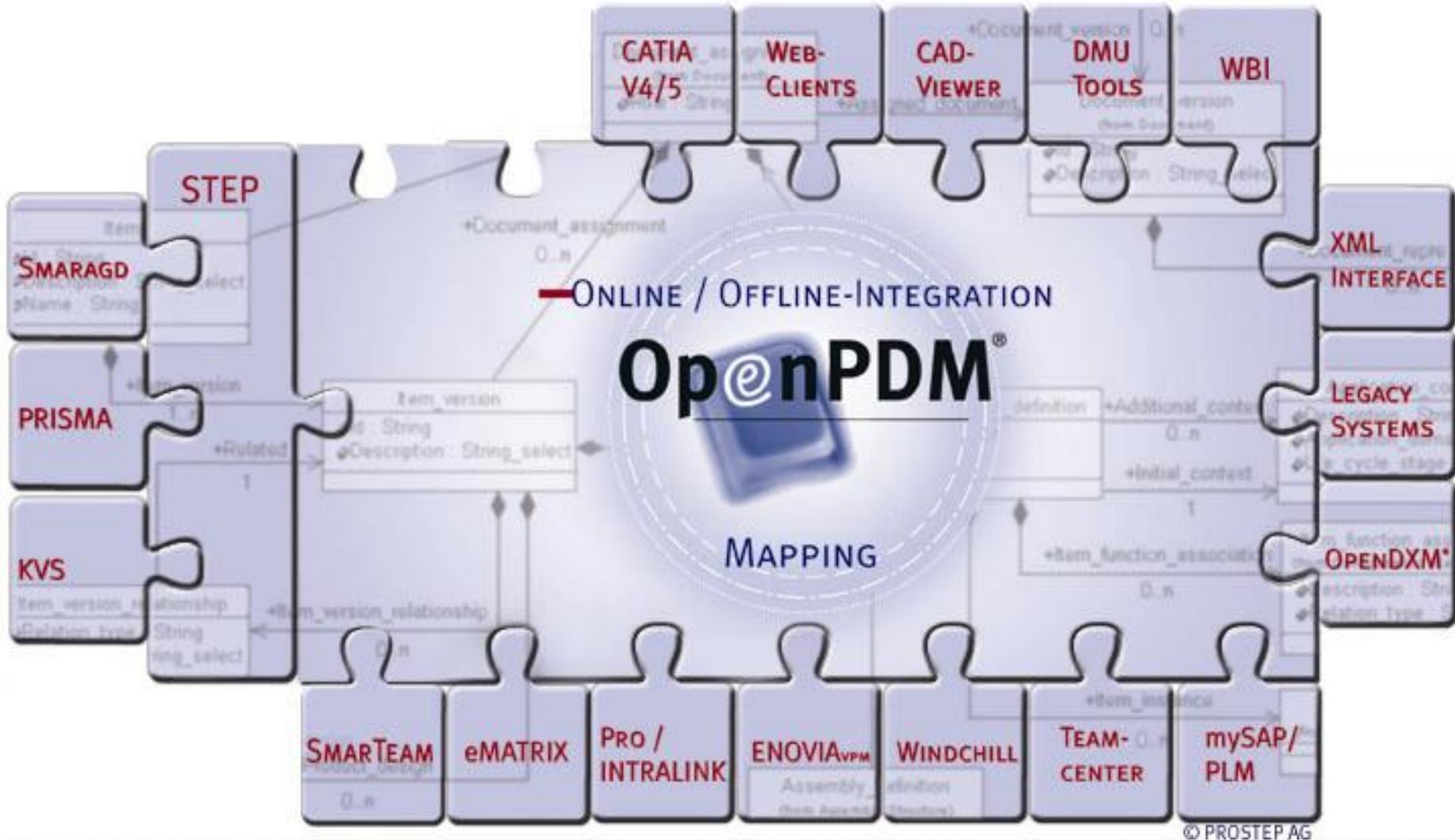
MSC.Software and PROSTEP AG Partner to Accelerate Adoption of Simulation Data Management

Enterprise Simulation Leader to Utilize PROSTEP AG Products for Data Exchange between MSC Software's SimManager Enterprise and PLM Systems

SANTA ANA, Calif. - December 13, 2006

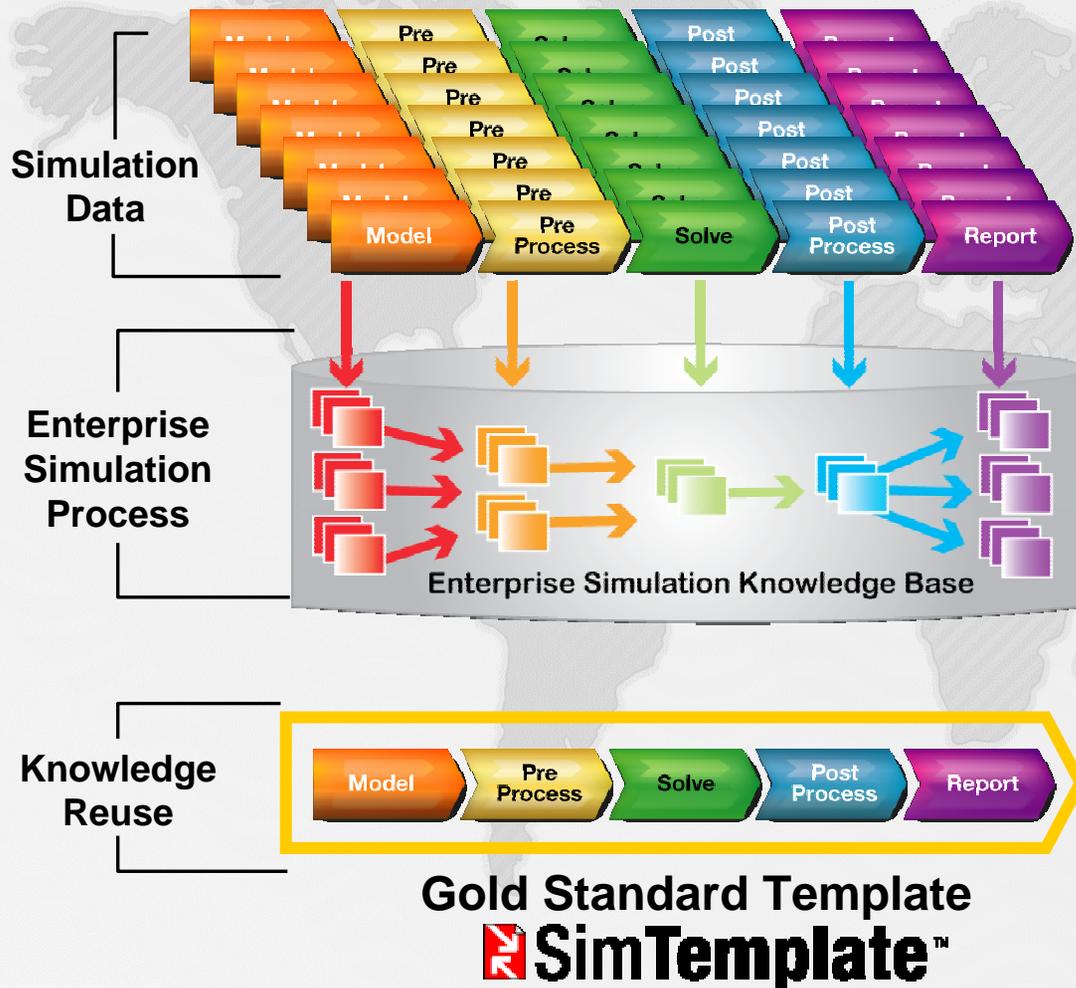
MSC.Software (NASDAQ: MSCS), the leading global provider of enterprise simulation solutions including simulation software and services, today announced that the company has partnered with PROSTEP, the leading PLM product data integration specialist, to enable data exchange between PLM systems and simulation data management systems such as SimManager Enterprise.

OpenPDM® - ONE solution for internal and external integration projects



© PROSTEP AG

Enterprise Simulation Management Summary



- **Enables efficient data management**
 - Automate data capture
 - Reduce errors - improve control
 - Organize simplified data reuse
 - Enables audit-trails
- **Optimizes simulation process**
 - Manage ad-hoc process
 - Make the process
 - Automate time reduction
 - Manage change - audit-trails
- **Automates expert knowledge**
 - Automates expert practices
 - Enable collaboration
 - Increase reuse

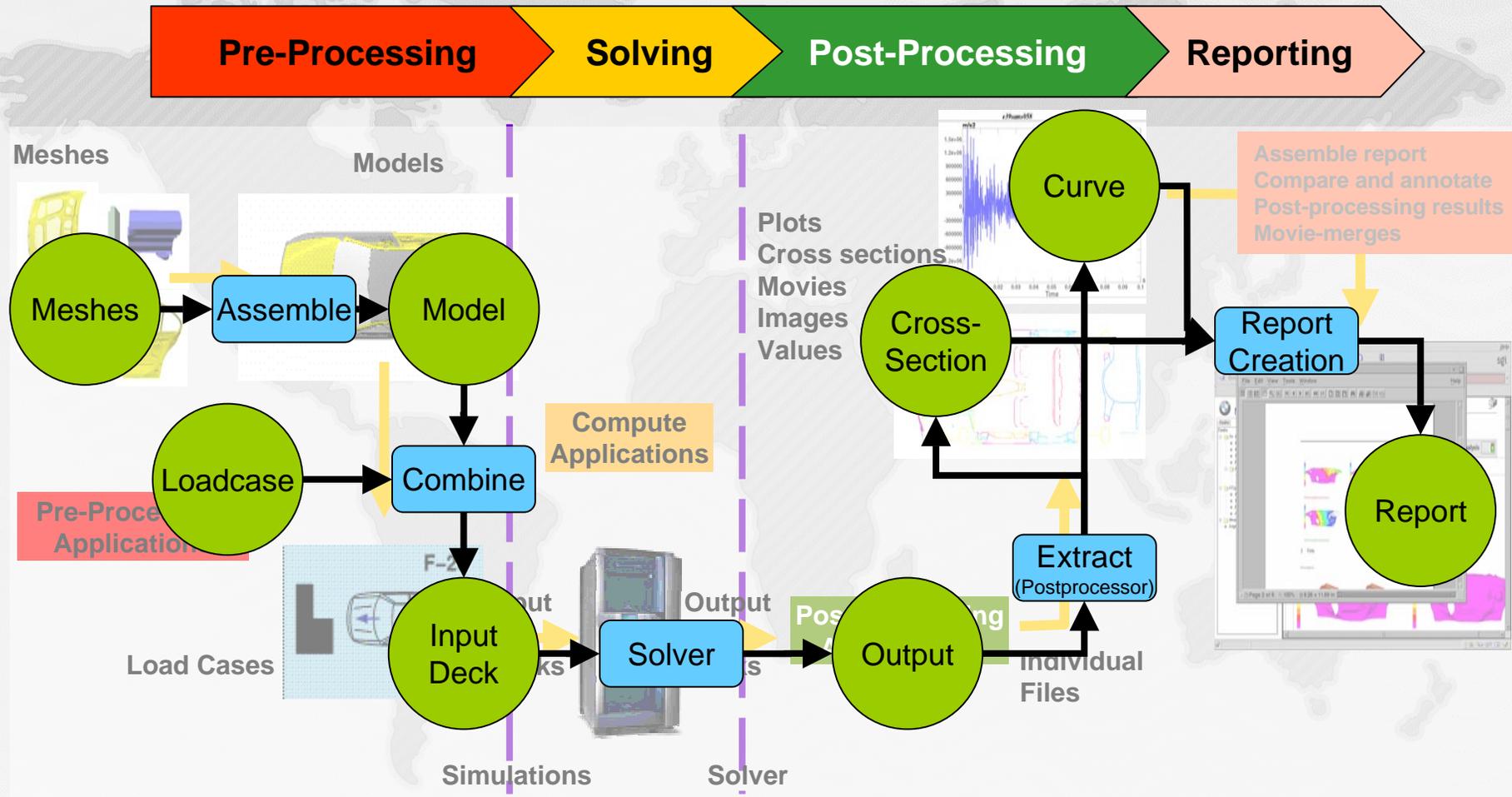
Rigor

Fidelity

Consistency

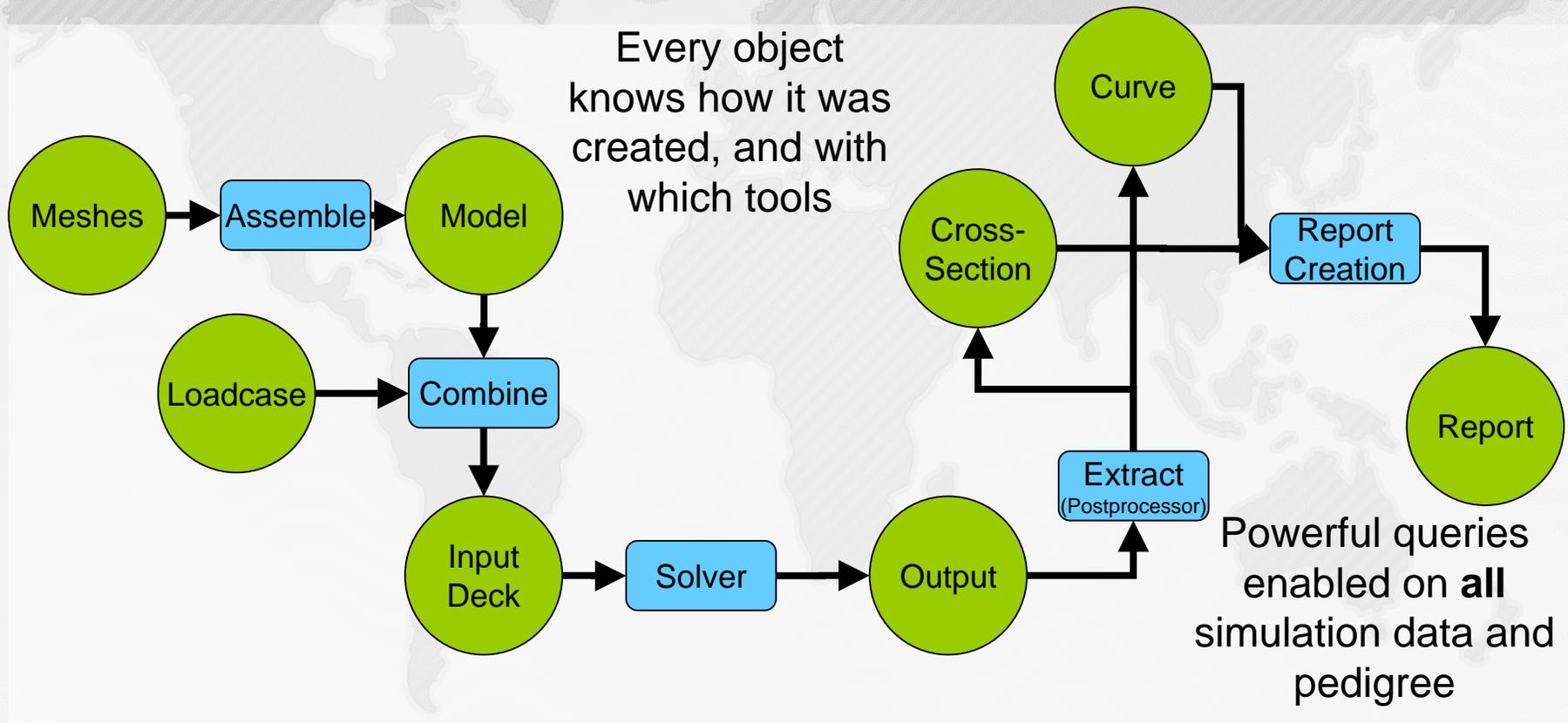
How Processes Are Managed In SimManager

Ex: Typical Simulation Process Map



Pedigree and Context Management

- Guided Analytical Workflow ... **plus...** Pedigree/Audit Trail Context

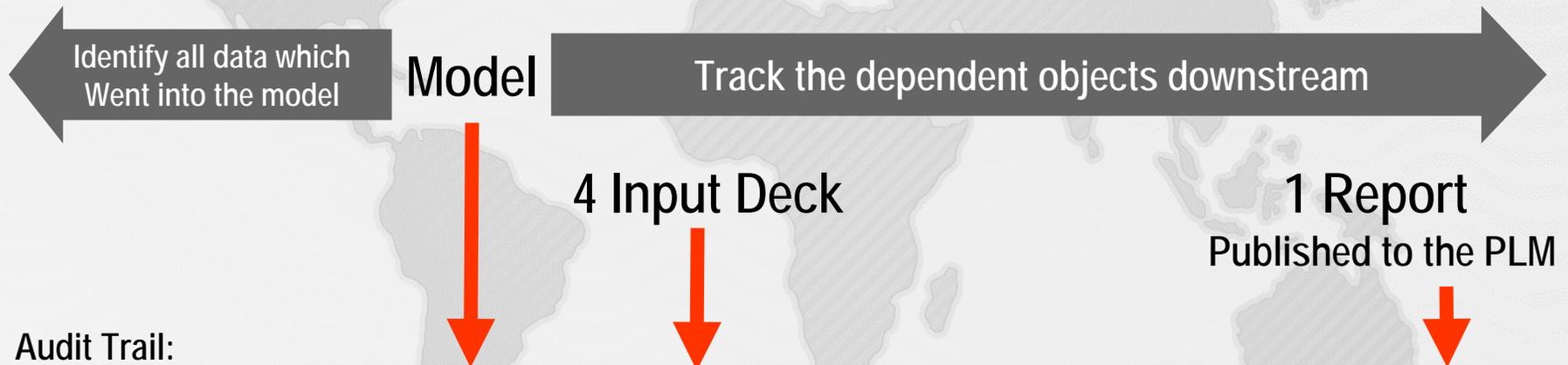


Benefit: Powerful search capabilities and automatic audit trail generation.

MSC.SimManager: Audit Capability

- **Process Management Ensures**

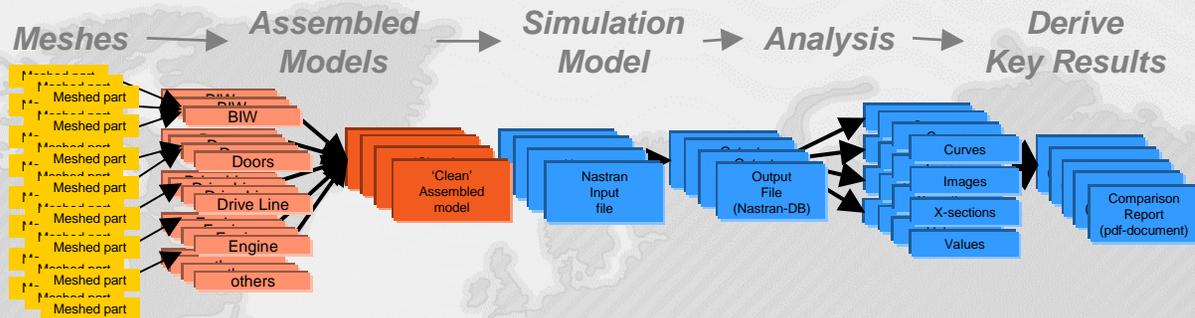
- Consistent Data
- Audit (tracking) of the dependency chain



Audit Trail:

-3	-2	-1	1	2	3	4	
CAD Parts (10)	Submodel (10)	Model (1) Load Case (4)	Input Deck (4)	Result (4) 42	Postprocess (54)	Report (1)	Published Reports (1)
[X] [v]	[X] [v]	[X] [v]	[v]	[X] [v]	[X] [v]	[X] [v]	[X] [v]

Ability to Handle Diverse Data



Inputs:

- **Simulation Model**
 - Geometry and Configuration
 - Connections / Contacts
- **Material Properties**
 - Material Models
 - Connection technologies
- **Virtual Testbed**
 - Dummies, Barriers, External Loads
 - Contact Definitions
 - Pre- and Post-processing procedures
- **Inputs from Previous Simulations**
 - Loads
 - Stamping

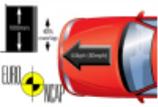
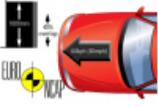
Outputs:

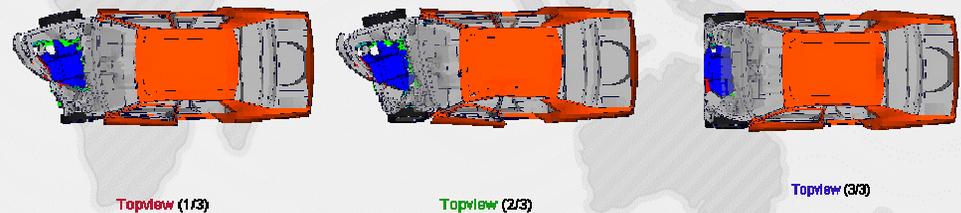
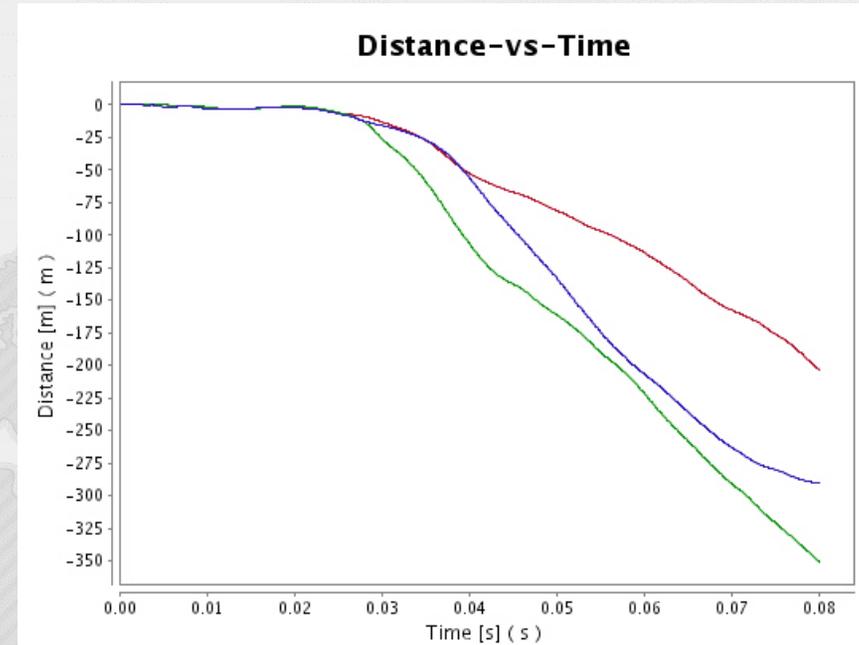
- **Raw solver Output Files**
- **Post-processing Results:**
 - Values, Curves, Images, Movies
- **Results for subsequent Simulations:**
 - Loads
 - Acceleration profiles
- **Reports:**
 - Single Simulation report
 - Comparison and statistical reports
- **Compiled Key results**
 - Meeting Protocol
 - Design Suggestions

Benefit: Handle multiple performance attributes

Simulation Comparisons

- Instantly compare design variants
 - Compare:
 - Simulation/design variants
 - Overlaid response curves
 - Side-by-side images
 - Response tables
 - Model setup parameters

ID	Name	Loadcase	Loadcase	Owner
127	Taurus Input Deck 1	Euro NCAP Front Offset		Boma
142	Taurus Input Deck 2	Euro NCAP Front Offset		Boma
157	Taurus Input Deck 3	Front Crash		Boma



Benefit: System automatically ensures comparisons of equivalent data

Report Generation

- Customized report templates
- Easy comparisons of variants
 - Compare curves
 - Compare images
- Annotate and modify
- High quality PDF output
- Incorporate sim pedigree

The screenshot displays the MSC.SimManager Enterprise Simulation Portal interface. The main content area shows a report titled "Webinar Report 1" with the author "Boma". A "Table Of Contents" is visible, listing sections: 1 Introduction, 2 Firewall Intrusions, 3 Top View, and 4 Mass of Module 1.1. The "Introduction" section is expanded, showing a table of simulation runs. The table has columns for ID, Name, Loadcase, a visual representation of the loadcase, and Owner. Two rows are shown, both for "Euro NCAP Front Offset" loadcases, with IDs 127 and 142, and owner "Boma".

ID	Name	Loadcase	Loadcase	Owner
127	Taurus Input Deck 1	Euro NCAP Front Offset		Boma
142	Taurus Input Deck 2	Euro NCAP Front Offset		Boma

Benefit: Reduce time and effort in reporting

Ensure repeatable and valid comparisons for trending

Solution Implementation – Boeing Simulation Management Projects



- **Propulsion Portal**

- Goal: Significantly Reduce Process Time
- Integrates entire Propulsion Loads and Analysis process
 - Static & Dynamic Loads
 - Fan Blade Out and related transient events
 - Primarily Based on MSC.Patran and MSC.Nastran
- Core Analysis performed by Internal Analysts

- **Structures Portal**

- Goal: Provide global access and collaboration
- Integrates Fuselage Stress Analysis Process
 - Using in-house developed analysis programs
- Provides worldwide web access to these programs to 787 partners in a secure environment
 - Controls Partner Access to programs and data
 - Secures IP
 - Maintains Pedigree information of fuselage stress analysis
- Core Analysis performed by Global Supplier Partners
- PDM Integration

- **Materials Management:**

- Enterprise-wide production system for materials management & security
- Expanding to materials test data management
- Serves 1000's of engineers

SimManager Infrastructure at Major Customers

Company	Pre Proc	Post Proc	Solvers	Others	Hardware	OS	Storage Systems	Database	Vault	Web App Server	PDM System	EAI Mechanism
Auto OEM	ANSA Hypermesh	ANSA	PamCrash Nastran		SGI	IRIX	SGI NAS	Oracle	NAS	Tomcat		
Auto OEM	Medina ANSA	Animator ANSA	PamCrash Abaqus Nastran	Federated Test databases	SGI	IRIX	SGI NAS	Oracle	NAS	Tomcat	Prism	
Aero OEM	Patran	Patran	MSC Nastran		pSeries etc eServer	AIX or Linux	IBM Storage	BD2 UDB	Content Manager	WebSphere	Enovia LCA	Web SphereBI
Heavy Equipment OEM	ProMesh Patran	Patran	MSC Nastran	Excel	IBM eServer xSeries 440	Win2000	Windows Server File Vault	Oracle 8.1.7	Windows Server	Tomcat 5.0.28	WindChill	n/a
Auto OEM	SOFY EasiCrash	HyperView HyperGraph LS-Post	LSDyna3D Madymo	Powerpoint	IBM 671	AIX 5.1	HP NAS on HPUX B11.11	DB2 UDB 8.1	NAS	WebSphere	Enovia LCA	Web Sphere BI
Auto OEM	Hypermesh SOFY	SOFY	Nastran LSDyna	Federated databases	HP Lp2004 x4000	HPUX	HP NAS	Oracle	NAS	Tomcat	TeamCenter Engineering	
Auto Supplier	ProMesh	Nastran	Patran	Excel	Dell PowerEdge Series	Linux RHE 3, Win2003	Dell EMC CX300 SAN	Oracle 9.2 Standard	SAN	Tomcat 5.0.28	Windchill	n/a
Electronics OEM	Patran Hypermesh	LSDyna	Nastran Dytran LSDyna		IBM T42p	Windows	n/a	MS SQL	Local vault	Tomcat	SmartTeam	n/a
Auto Supplier	Moldflow Patran	Moldflow Patran	Moldflow Nastran Dytran		HP Lp2004 x 4000	Linux RHE 3. Win2000	HP NAS8000	MS SQL 2000 SP2	NAS	Tomcat 4.6.0	Windchill	

Major Automotive OEM Production Systems



- 4 years in production
- Manages all Crash and NVH simulations
- Several Million files (TB of Data)
- 1,000 CPU's
- Accessed and used by suppliers (on-site and remote)
- Includes Integration with PDM System (PDM-SDM-PDM)
- CAE/Test Correlation



- 3 years in production
- Attributes managed:
 - Crash & Occupancy Safety
 - NVH
 - CFD
- Expanding CAE/Test Correlation



- Occupancy Safety (Today)
- Future
 - Crash, NVH, Durability

MSC SimManager Summary

Production proven management for *all* simulation processes and data



- **Commercial integration platform**
 - Simulation management foundation
 - Configure to customer specific processes
- **Open architecture**
 - Integrate any data, tool, DB, system
- **Built on industry-standard technologies**
 - Web-based UI, JAVA, XML, ...
 - STEP-based Data Definitions
 - Will support enterprise IT infrastructure
- **Enterprise Scalability**
 - Terabyte scale data volumes
 - Enterprise level transactional throughput

SLCS Pilot to interface AP 209 into AP 239

FALCON STEP-Based Architecture

