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Enterprise SPDM Architecture: Breaking Simulation Silos & Scaling Multi-Disciplinary Digital Twins

Unifying CAD, FEA, CFD & Test Data Through Governed Simulation Lifecycle Management

EXECUTIVE ABSTRACT

Engineering organizations lose up to 32% of simulation engineering hours searching for model variants, reconciling mismatched mesh versions, and manually copying files across unmanaged network drives. This whitepaper details an enterprise SPDM deployment framework that establishes complete pedigree traceability from CAD geometry to HPC results and regulatory compliance sign-offs.

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1. The Simulation Data Crisis in Modern Engineering

As virtual prototyping replaces physical testing, the volume of simulation data generated by product development teams is multiplying exponentially. A single automotive or aerospace development cycle produces terabytes of finite element models, boundary condition decks, and post-processed result animations.

The Engineering Productivity Gap: Independent studies indicate that CAE engineers spend **over 30% of their working hours** searching for input decks, manually translating CAD geometries, or re-running simulations because the provenance of an older result cannot be proven during design review.

Without an integrated Simulation Process and Data Management (SPDM) system, companies suffer from simulation silos, untracked design iterations, and severe intellectual property leakage.

2. SPDM Architectural Blueprint & Core Tenets

An enterprise-grade SPDM architecture must bridge three disparate technological worlds: Product Lifecycle Management (PLM), specialized CAE pre/post-processors, and High-Performance Computing (HPC) schedulers.

LAYER	FUNCTIONALITY	KEY INTEGRATIONS	BUSINESS VALUE
Data Governance	Pedigree tracking, variant comparison, access controls	Teamcenter, 3DEXPERIENCE, Windchill	Guaranteed CAD-to-CAE lineage
Process Automation	Standardized workflows, automated meshing, solver execution	Ansys Minerva, SimManager, dSPACE	70% reduction in manual setup time
HPC Orchestration	Dynamic cluster job dispatch, queue management	Slurm, PBS Pro, AWS ParallelCluster	Optimized cluster utilization & license pooling
Executive Analytics	Cross-variant KPI dashboards, correlation with test data	Zoho Analytics, PowerBI, Tableau	Real-time design decision verification

3. The 5-Stage Simulation Pedigree Chain

eShocan implements an immutable 5-stage simulation lineage protocol that guarantees auditability across complex global engineering teams:

1. **CAD Freeze & Ingestion:** Automated metadata extraction from CAD assemblies (geometry hash, material properties, tolerance stackups).
2. **Governed Mesh & Pre-Processing:** Linking element quality metrics, node sets, and connection definitions directly to CAD part revision IDs.
3. **HPC Job Dispatch & Environmental Capture:** Recording exact solver binaries, license IDs, MPI configurations, and cluster core hours utilized.
4. **Automated Post-Processing & Extraction:** Automated generation of standardized PowerPoint/PDF scorecards, stress contour plots, and KPI CSVs.
5. **Closed-Loop Verification & Sign-off:** Role-based cryptographic approval workflow linking CAE sign-off directly back to the PLM Engineering Change Order (ECO).

4. Case Study: 65% Faster Iteration Cycles for Global OEM

GLOBAL HEAVY MACHINERY MANUFACTURER CASE STUDY

Baseline Challenge: Over 120 structural and hydraulic CAE analysts across 4 continents operated on isolated network shares. Engineers frequently ran overnight runs on obsolete CAD revisions, costing an estimated \$800,000 annually in lost compute and engineering rework.

eShocan Solution: eShocan architected and deployed a multi-site SPDM framework integrated with their existing PLM environment and on-premise Slurm HPC cluster. Automated meshing scripts and standardized reporting templates were created for fatigue and structural stiffness evaluation.

Validated Results:

- Model retrieval and variant comparison time dropped from **4 hours to under 3 minutes**.
- Duplicate simulations and stale-CAD runs eliminated entirely (**100% CAD-CAE alignment**).
- Product design iteration turnaround accelerated by **65%**, shortening total vehicle program delivery by 4.5 months.

5. Implementation Roadmap with eShocan

eShocan provides vendor-neutral SPDM consulting, custom connector development, and legacy simulation data migration services. Our team accelerates digital thread adoption from initial readiness assessment to enterprise rollout within 12 to 16 weeks.

Accelerate Your Engineering Roadmap

Schedule a 30-minute technical evaluation with eShocan's senior practice leads to review your simulation architecture, battery safety models, or embedded lifecycle.

Visit: www.eshocan.com / Contact: info@eshocan.com