



3DEXPERIENCE®

3DEXPERIENCE Twin for Rolling Stock Manufacturers

Executive Overview

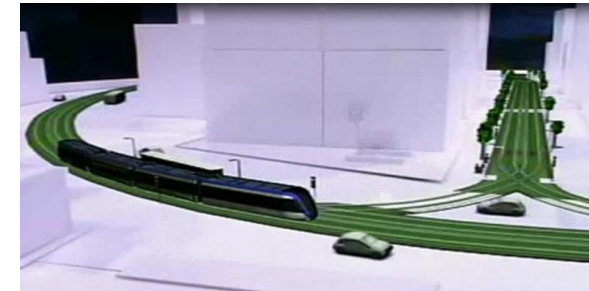
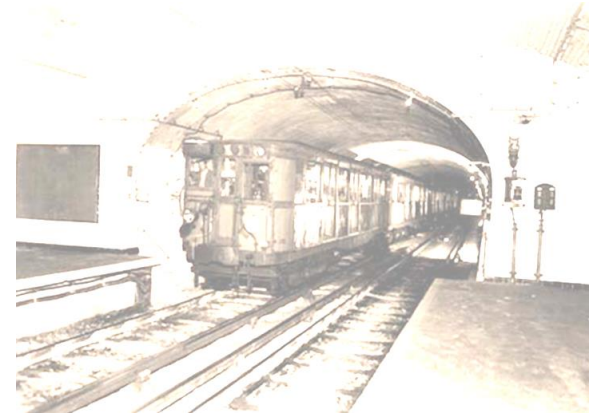
Agenda

- ▶ Railway Industry Challenges (5')
- ▶ Introduction to **3DEXPERIENCE** Platform (10')
- ▶ Value of **3DEXPERIENCE** CATIA (10')
- ▶ 3DS solutions for Railways (20')
- ▶ Q&A (5')

Challenges for train makers that we address

Meeting market growth for rail based transportation

- ▶ Quickly satisfy needs for new products **fitting perfectly each local market**
- ▶ **Increase traffic** on existing lines through **better traffic automation**
- ▶ **Improve services** to passengers
 - ▷ Ensure passengers **safety**
- ▶ **Upgrade legacy control systems** to incorporate new functionality and equipment
 - ▷ Ensure compliance with standards



Key Elements for Railway Transformation



Accelerate business decision through cross discipline collaboration

Maximize re-use & standardization thanks to modularization

Reduce time to market & Optimize operation efficiency

Deploy Systems Engineering Approach

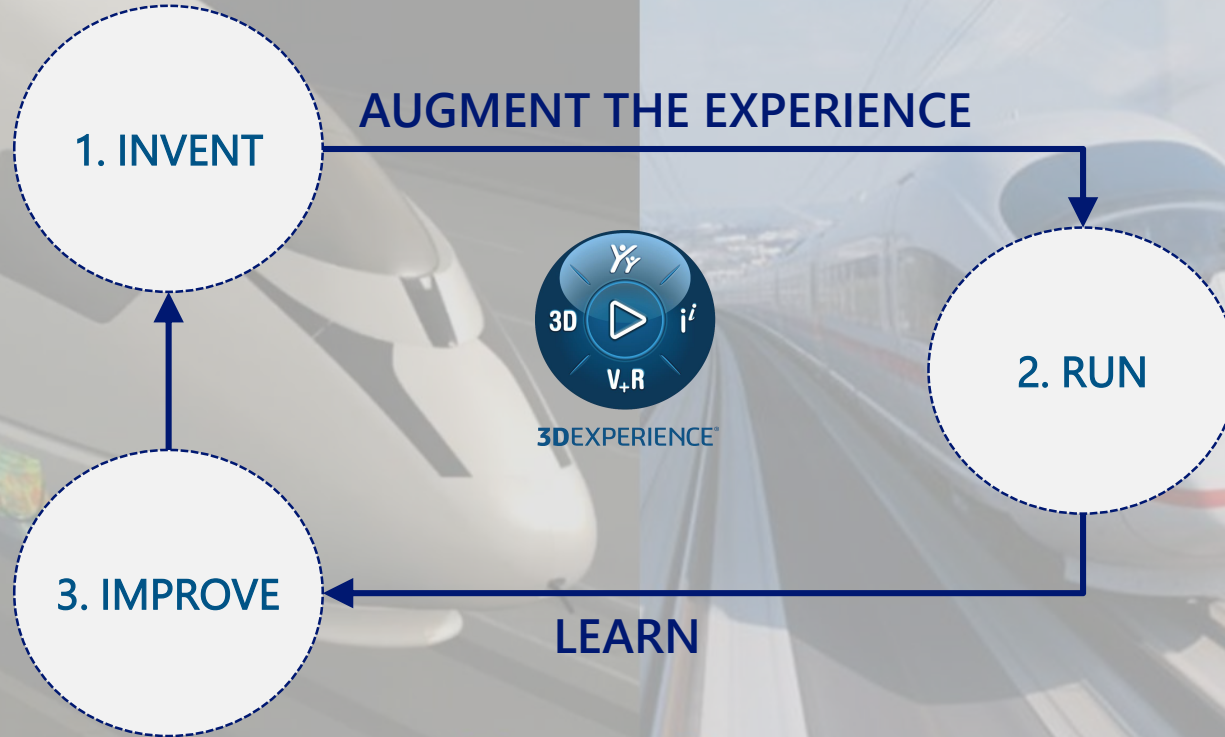
Accelerate certification with virtual tests

Bridging VIRTUAL & REAL worlds



Bridging VIRTUAL & REAL worlds

Continuous Improvement



Sample Rail Manufacturer & Operators references



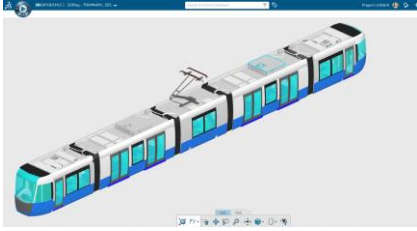
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3DEXPERIENCE for Digitalization of Railways

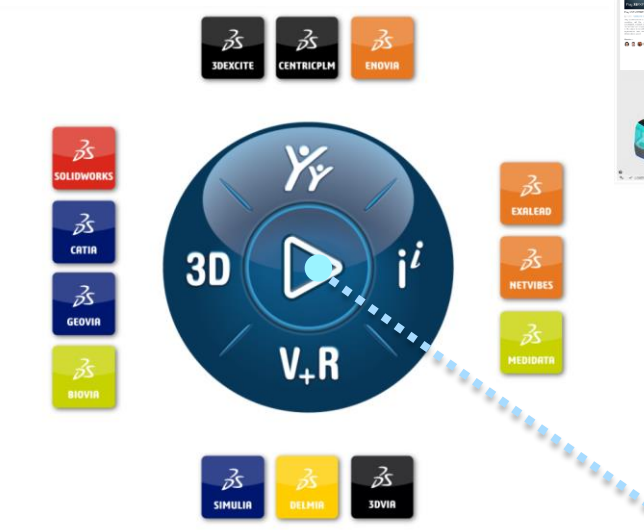
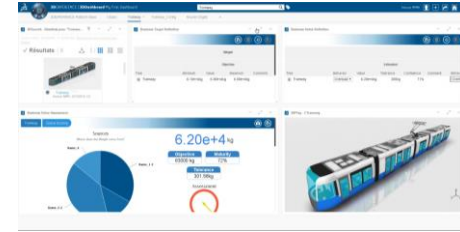
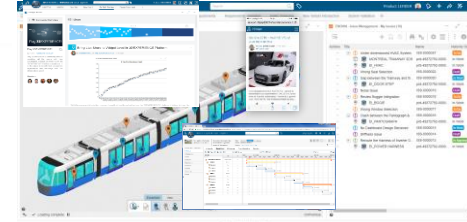
MODEL



SIMULATE



SOCIAL COLLABORATION



VR / PLAY 3DEXPERIENCE



BUILD, MANUFACTURE & OPERATE



Innovation on Track powered by 3DEXPERIENCE Platform

Product Lifecycle Management



Manufacturing



Operational Efficiency



Simulation



Design & Engineering



Ownership

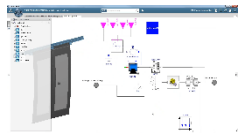
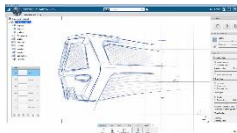
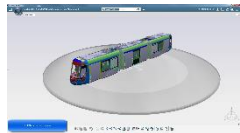


Upstream Experience thinking



3DEXPERIENCE Platform Applications

MODELING 3D & SYSTEM



City and Infrastructure
Industrial Design
Real Time Rendering
Mechanical Design
Systems Engineering
Material Science

SIMULATION

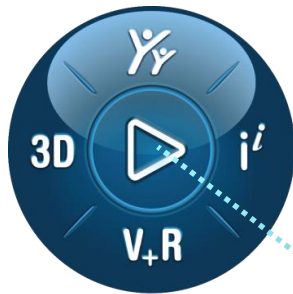


Multiphysics
Electrical, Electro Magnetics
Aerodynamics
Systems and Software



Digital Process Engineering
Factory Twin
Manufacturing Planning & Scheduling Optimization
Manufacturing / Maintenance Operations Management

SOCIAL & COLLABORATION



MANUFACTURING AND OPERATIONS



Fast ideas sharing
Ideas & project Management
Requirement Management
Social Monitoring
Social Network

INFORMATION INTELLIGENCE



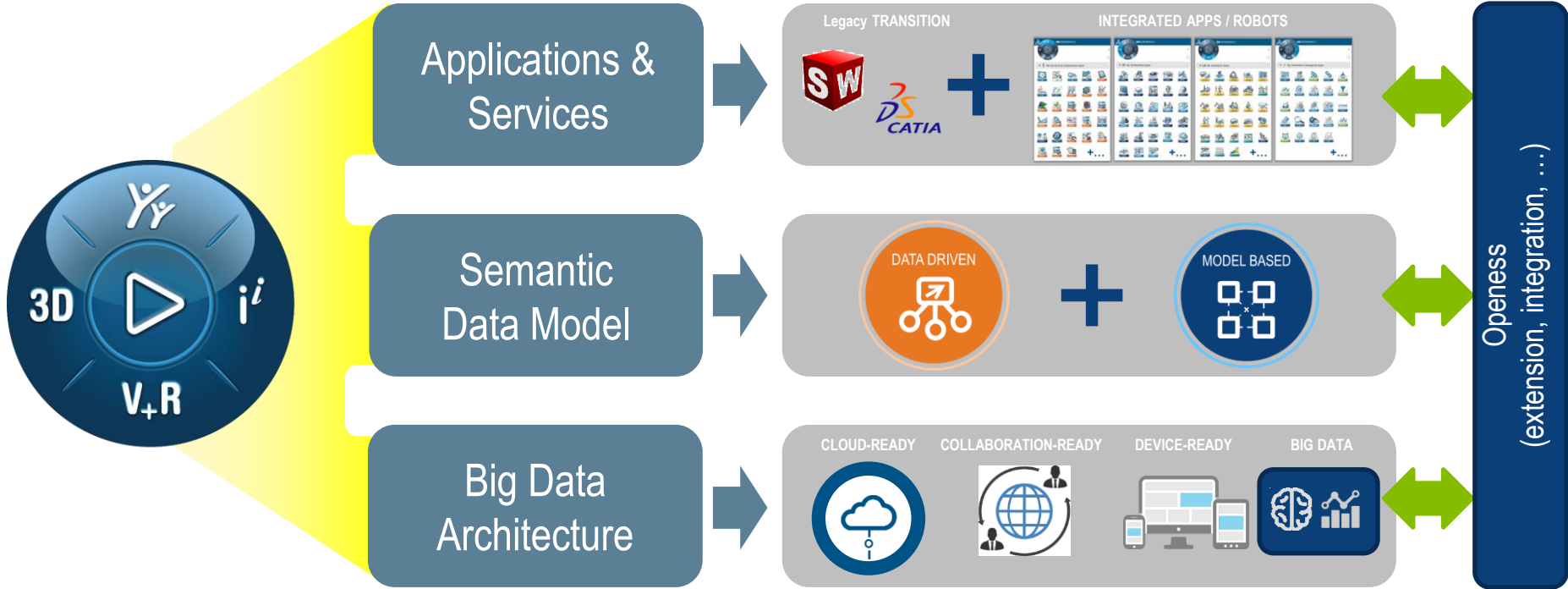
KPI monitoring
Social Intelligence
Customer Knowledge
Customer Trends
Connected Objects & Big Data

PLAY 3DEXPERIENCE



High-End Renderings & Animations
User Experience (+ IHM)
Virtual Clinics V+R
Sales Configurator

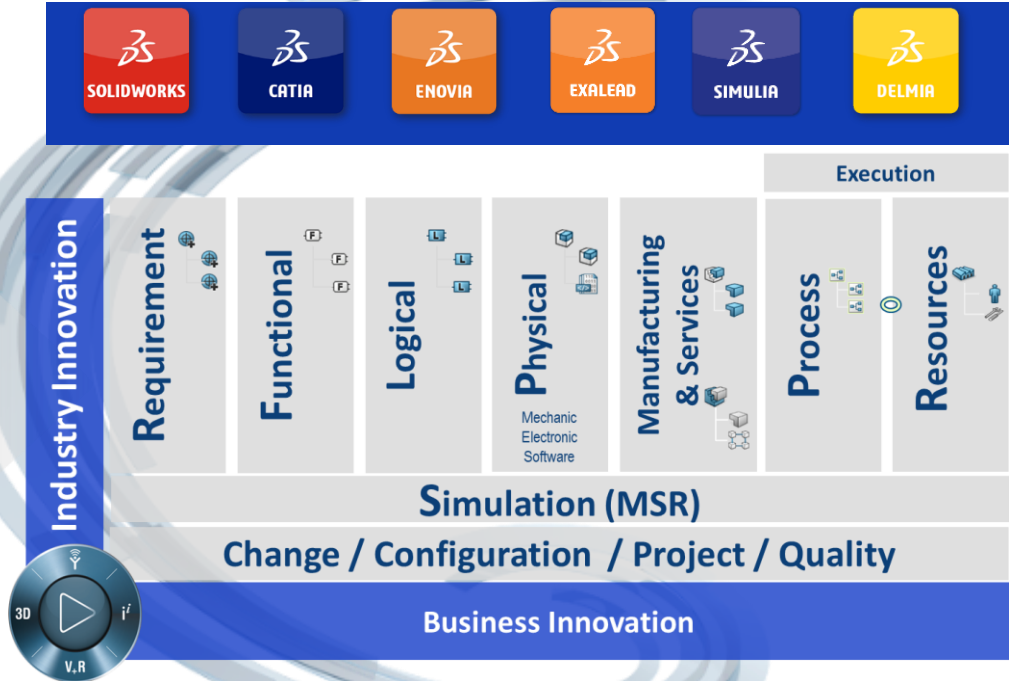
3DEXPERIENCE | Investing for the Future



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3DEXPERIENCE TWIN – Semantic Meta-models

POWER'BY



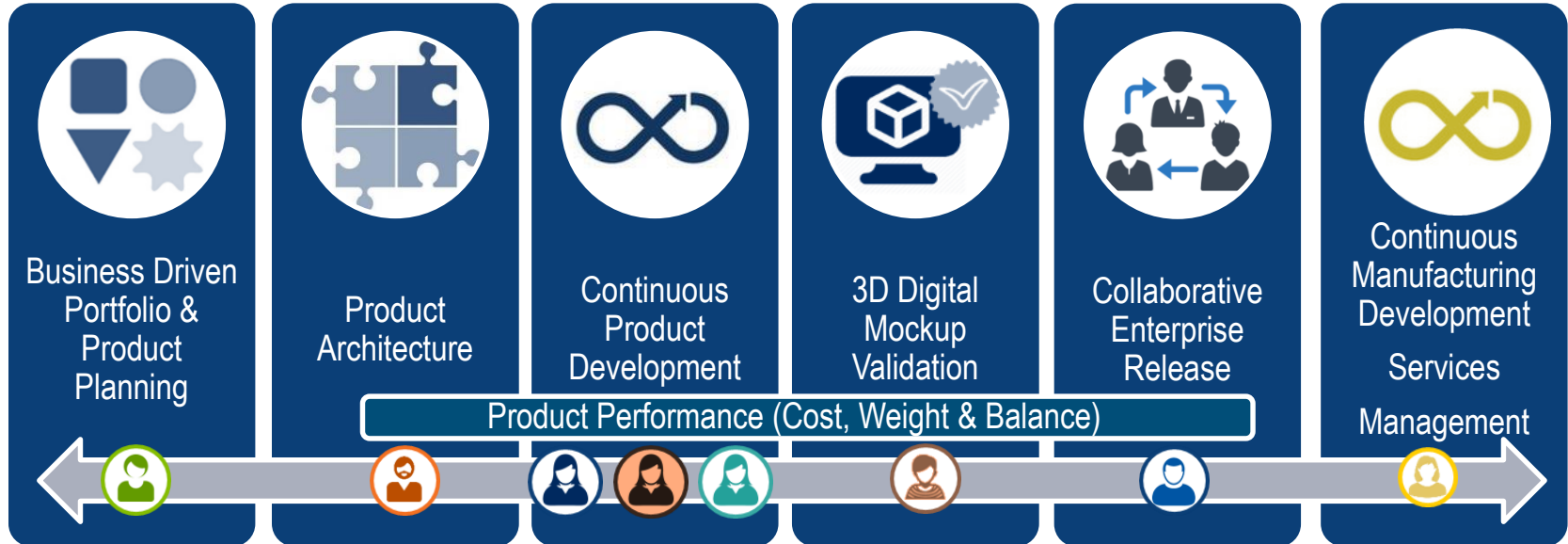
Roles / Apps

PROVEN
RFLP - PPR - MSR
Semantic

Next Generation Product Development

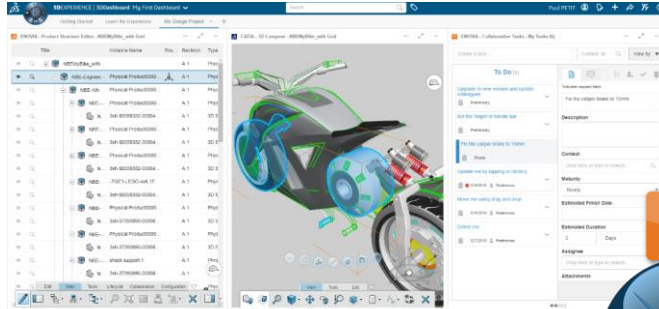
COLLABORATIVE PLANNING, EXECUTION & INSIGHTS, QUALITY, BUSINESS INTELLIGENCE

CHANGE & CONFIGURATION MANAGEMENT

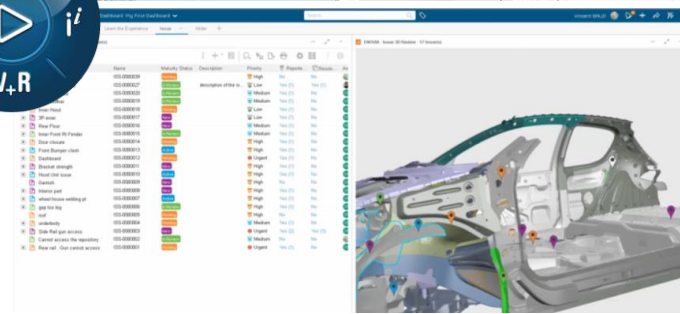
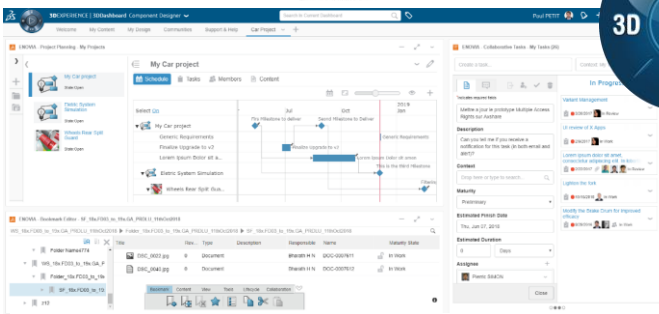
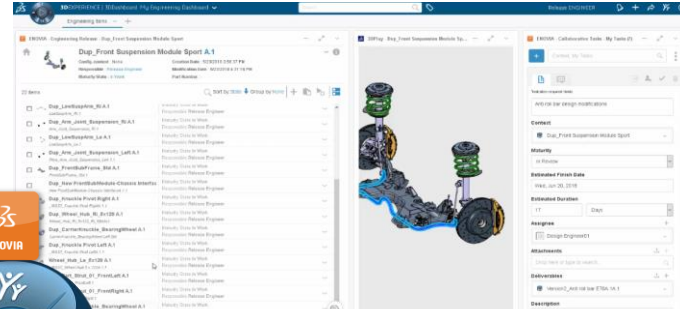


3DEXPERIENCE ENOVIA Business Experience

Designer Dashboard



Engineer Dashboard



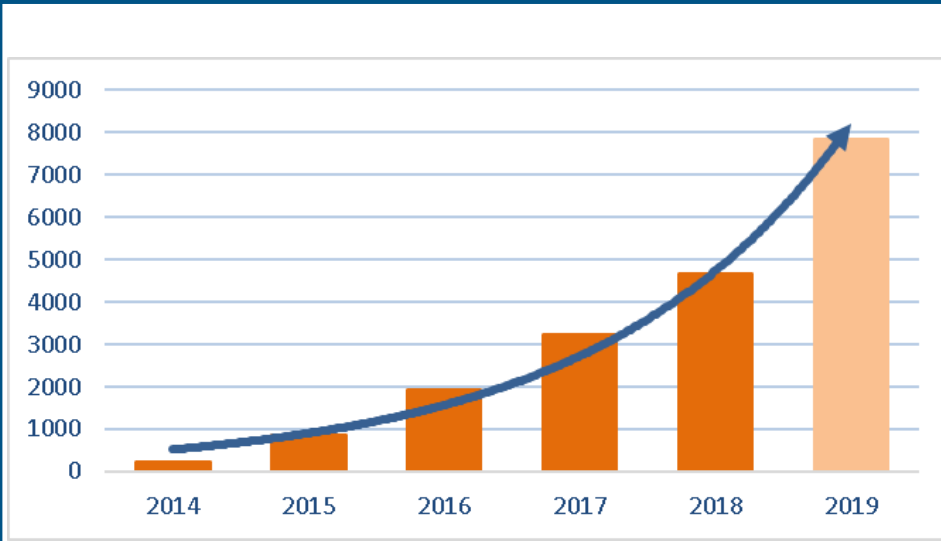
Project Management Dashboard

Reviewer Dashboard

3DEXPERIENCE ENOVIA Adoption Dynamic & Scalability



Strong Customer Adoption Trend of 3DEXPERIENCE



- **7851 Customers**
- **86% mid-market customers**
- **21% Cloud customers / 16,570 users**
- **Vast majority of our customers are SAP customers** (95% of DELMIA Apriso customers are SAP customers)



Net sales by product segment 2016, %



- Trucks 60%
- Buses 10%
- Engines 2%
- Service-related products 20%
- Used vehicles 6%
- Other 2%

- Leader in sustainable transportation services (250 000 connected)
- HQ in Sweden – global business except North America
- Trucks – Buses – Engines – all configured to order
- Part of VW Truck & Bus – 12 Billion Euro / year (10,4% Op. Result)

Business Drivers

“We will continue to broaden our efforts to become the leader in sustainable transport.”

HENRIK HENRIKSSON PRESIDENT AND CEO, SCANIA AB

- ✓ Global Growth
- ✓ Innovation & New business areas
- ✓ Digitalization
- ✓ Sustainable transport system

Solution Offer

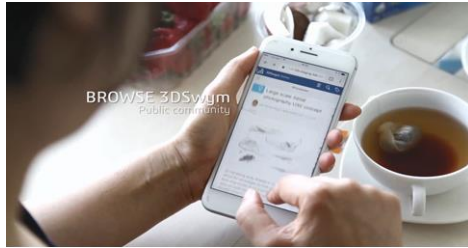
- Partnership for future innovation “all in ”3DEXPERIENCE
- SOLUTIONS - GLOBAL MODULAR ARCHITECTURE
- CATIA, ENOVIA, SIMULIA, DELMIA, 3DEXCITE, APRISO

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3DEXPERIENCE CATIA Values

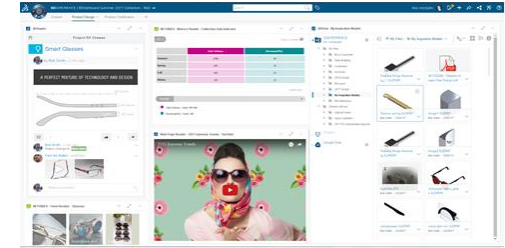
CONNECTED



COLLABORATIVE



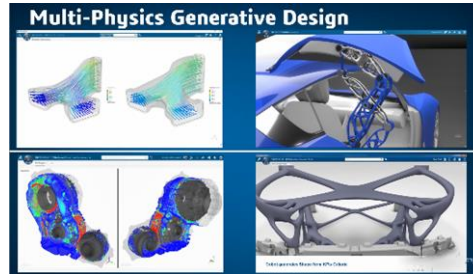
COMPASS BUSINESS



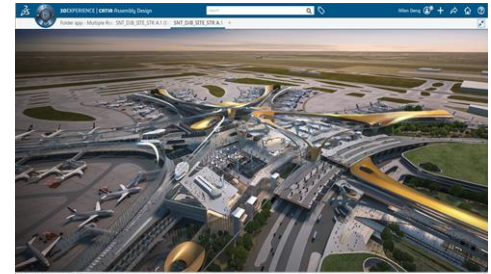
FROM MECHANICAL 3DEXPERIENCE TWINS ...
... TO CYBER 3DEXPERIENCE TWINS

- Mechanical system**
- Mechatronics systems**
Multidisciplinary field
- Cyber Physical systems**
Populations of **software**-intensive distributed **systems** interacting together in an **unpredictable** world

CYBER SYSTEMS



COGNITIVE



CITY (CONSTRUCTION)

CATIA Key Differentiators



High geometry accuracy



Update stability & robustness



General performance on heavy models



Efficiency for feature-based surface design



Strong and reliable rules, checks and templates

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DS Solutions for Railways

“Reduction of warranty cost by 20%”

LEAN PRODUCTION RUN
IMPROVE VISIBILITY, EFFICIENCY AND CONTROL OF MANUFACTURING OPERATIONS, WITHIN AND ACROSS PLANTS

“reduced cost per vehicle, increased market share”

ON-TARGET VEHICLE LAUNCH
RAPIDLY ENGINEER AND INDUSTRIALIZE VEHICLES WITH OPTIMIZED PERFORMANCE, COMFORT AND SAFETY

MOBILITY OPERATIONS
DEFINE, PLAN AND OPTIMIZE EFFICIENT MOBILITY SERVICES

EFFICIENT MULTI-ENERGY PLATFORM
DEVELOP AND INDUSTRIALIZE VERSATILE AND COMPLIANT POWERED UNITS

SMART, SAFE & CONNECTED
DESIGN, VALIDATE, DELIVER THE INTELLIGENT VEHICLE EXPERIENCE

GLOBAL MODULAR ARCHITECTURE
ENHANCE COLLABORATION AND MASTER COMPLEXITY TO DRIVE PROFITABILITY

“Reduction of development cost by 30%”

DRIVE EMOTION
CREATE 3D SKETCHES AND VALIDATE VIRTUAL DESIGNS IN A FULLY-IMMERSIVE ENVIRONMENT

“Lead time reduction by 30%, Reduction of design change request by 40%”

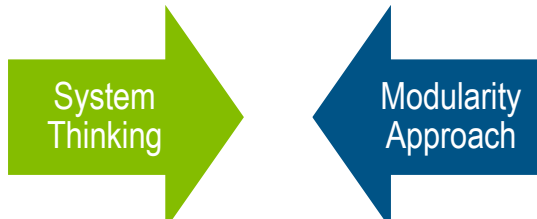




Modular System Thinking

Combine **System Thinking** of New innovative services to end User with **Modularity Approach** to share development cost across several vehicles.

Optimize Product Definition to achieve external performance



Minimize development effort and industrialization



3DEXPERIENCE

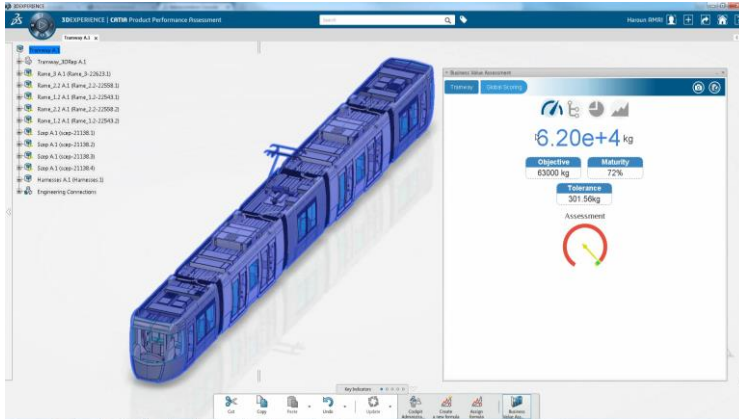
T&M - Train Segments

Vehicle Systems Architecture

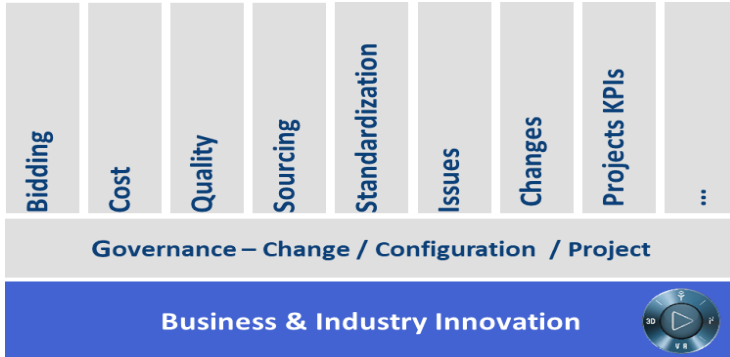


OPTIMUM AND PROFITABLE DEVELOPMENT

How to insure that best targets are reached globally with minimum discrepancies ?

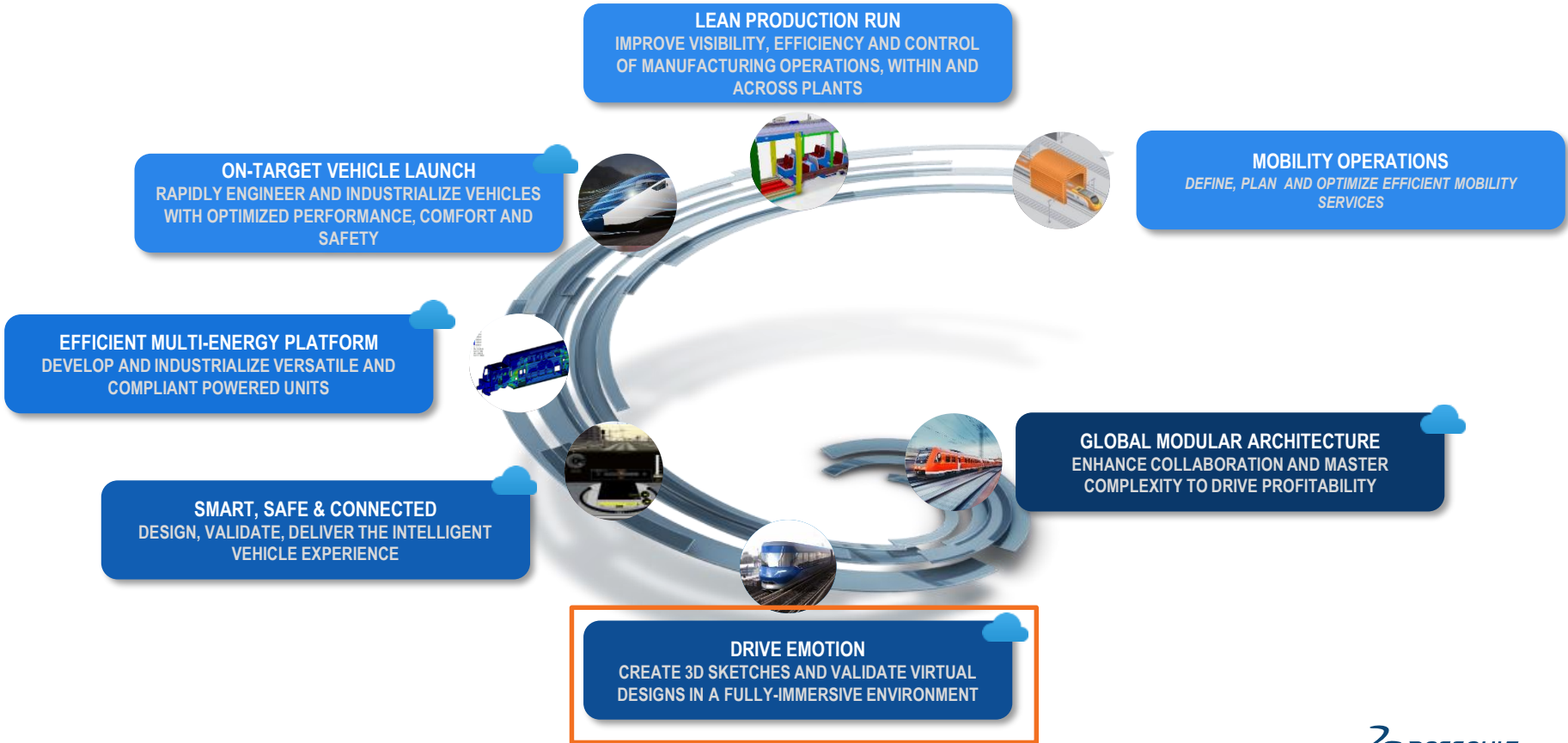


By calculating, rolling-up, publishing, ... information to all stakeholders simultaneously while understanding dependencies



By consolidating all information on same data referential

DS Solutions for Railways



Drive Emotion

Vehicle Aerodynamics

Refinement of detailed body shape to meet aero drag/FE target before design freeze



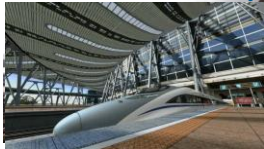
Design Experience & Validation

Explore virtual vehicles and concepts to optimize customer's experience



Perceived Quality

Validate both Design and Engineering with Perceived Quality review



Class A Surfaces

Reach the best level of geometry quality to catch customer's eye



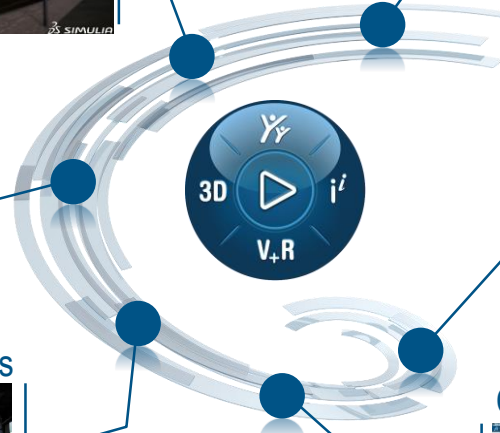
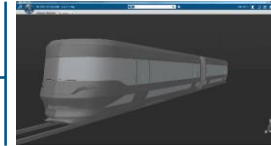
Briefing, Ideation & Market Watch

Be inspired and connected to fulfill customer's desire



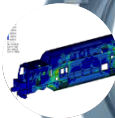
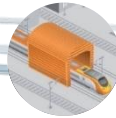
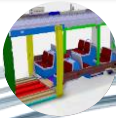
Creative Concept Design & Styling

Be more creative and collaborative to realize customer's dream



DS Solutions for Railways

ON-TARGET VEHICLE LAUNCH
RAPIDLY ENGINEER AND INDUSTRIALIZE VEHICLES
WITH OPTIMIZED PERFORMANCE, COMFORT AND
SAFETY



EFFICIENT MULTI-ENERGY PLATFORM
DEVELOP AND INDUSTRIALIZE VERSATILE AND
COMPLIANT POWERED UNITS

SMART, SAFE & CONNECTED
DESIGN, VALIDATE, DELIVER THE INTELLIGENT
VEHICLE EXPERIENCE

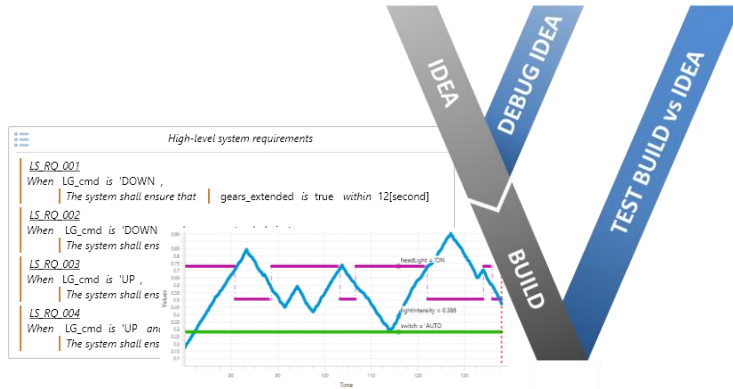
DRIVE EMOTION
CREATE 3D SKETCHES AND VALIDATE VIRTUAL
DESIGNS IN A FULLY-IMMERSIVE ENVIRONMENT

LEAN PRODUCTION RUN
IMPROVE VISIBILITY, EFFICIENCY AND CONTROL
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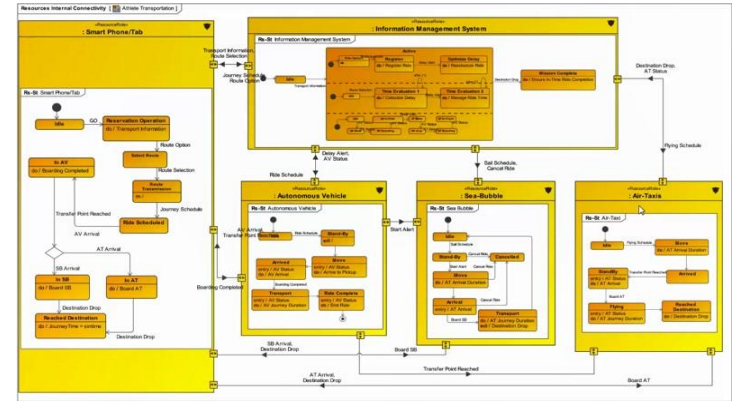
GLOBAL MODULAR ARCHITECTURE
ENHANCE COLLABORATION AND MASTER
COMPLEXITY TO DRIVE PROFITABILITY

MOBILITY OPERATIONS
DEFINE, PLAN AND OPTIMIZE EFFICIENT MOBILITY
SERVICES

Simulation on Requirements & Functions



Simulate requirements to detect incorrect, missing, conflicting requirements before design begins.



Simulate functional models to validate early high level behavior of the intended function (modes, states & interactions)

Debug the requirements and Test against requirements

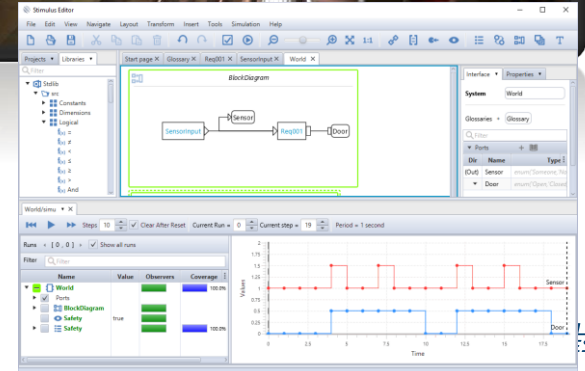
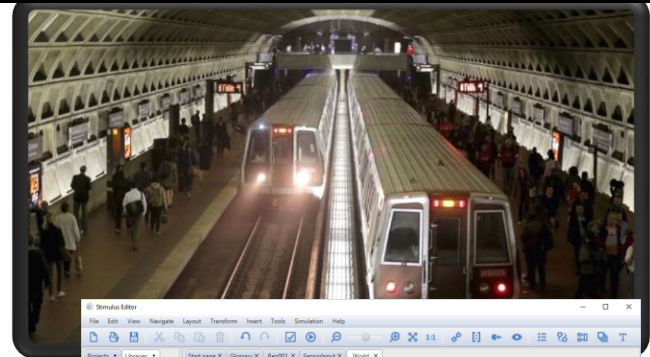
Sample Use cases

- ▶ Communication based train control (CBTC)
 - ▷ Train Reconfiguration System
 - ▶ Context: some coupling configurations prevent the train to initialize and therefore start properly, 3 weeks before the final acceptance of the train.
 - ▷ 1 day to find the conflicting requirements in CATIA STIMULUS
 - ▷ 1 day to rewrite the specification in CATIA STIMULUS
 - ▷ 1 week to redesign from scratch and test in CATIA STIMULUS
 - ▶ Financial penalties: 20M\$ / quarter
- ▶ Automated signalling control:
 - ▷ Signal cancellation on the track.
 - ▷ Track section control lights
- ▶ Tunnel ventilation control coupled to train fleet management
- ▶ Automated door control
- ▶ Insertion/extraction of trains in working fleet
- ▶ Automated train repositioning on arrival at a platform

Do

For 3 [second], Door shall be 'Open afterwards

Door shall be 'Closed

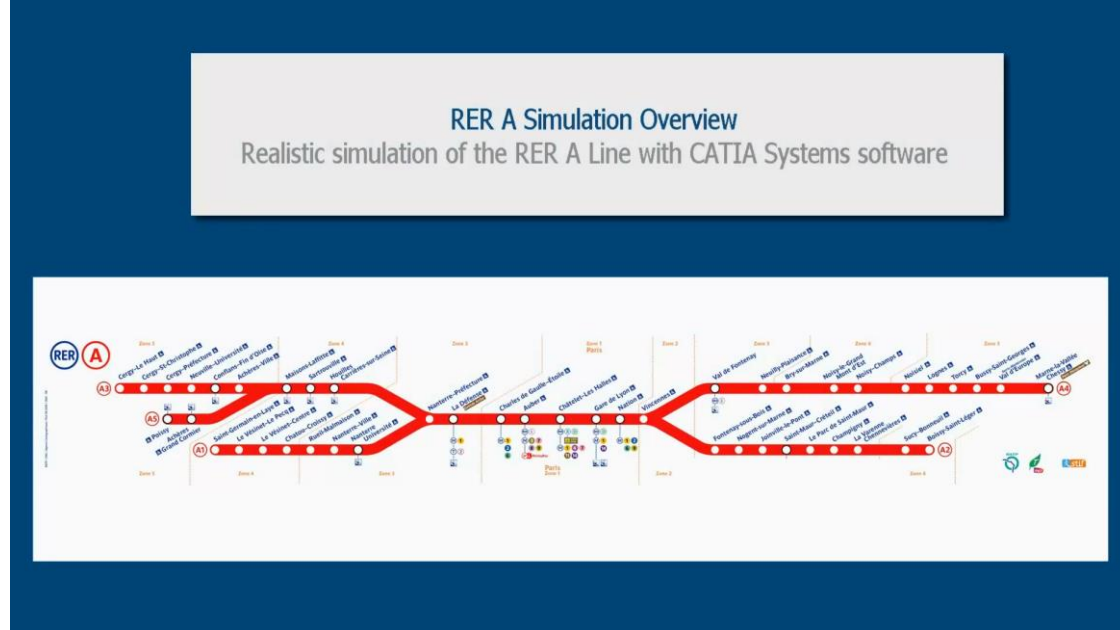




SMART, SAFE & CONNECTED

EMBEDDED SOFTWARE ENGINEERING

- 1 Perform real time simulations with **software in the loop** and **hardware in the loop**
- 2 Remove **Test & Verification** activities for the software
- 3 Decrease drastically **the certification time & costs**



3DEXPERIENCE Twins of Train and Rail Infrastructure

Model

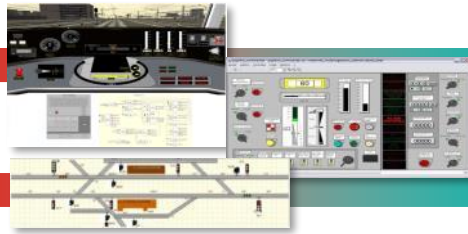
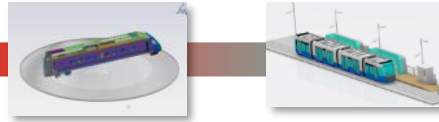
3D virtual model of train, including assembly and components

Behavioral model of assembly and components

Behavioral model of control and software (Control)

Virtual systems and Signaling

3D model of infrastructure, including station, crossway, ...



Simulate

Collaborative digital mock up review and analysis, space allocation

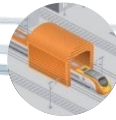
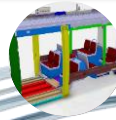
Multi-physics integration, pre-design of the sub-systems and the control laws (Thermal, dynamic, electric, ...)

Model, Software and Hardware In the Loop simulation for Control Systems, including Monitoring and Signals

Infrastructure fatigue, material behavior and maintenance

DS Solutions for Railways

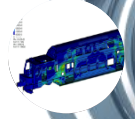
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Generative Design

Explore unimaginable shapes while respecting design specifications

Weight
KG

Stiffness

Durability

Cost
Material | Engineering | Manufacturing

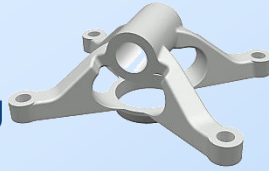
Materials

Business KPIs

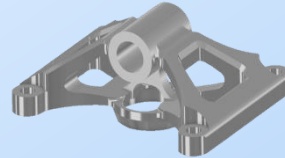


Alternatives

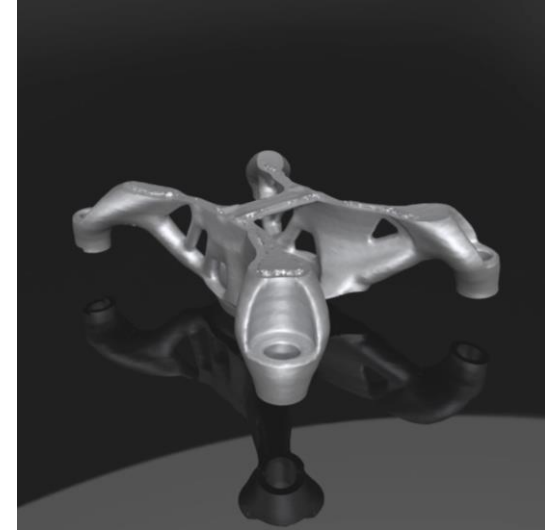
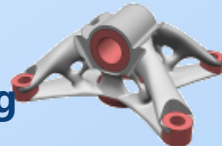
1 Casting & Forging



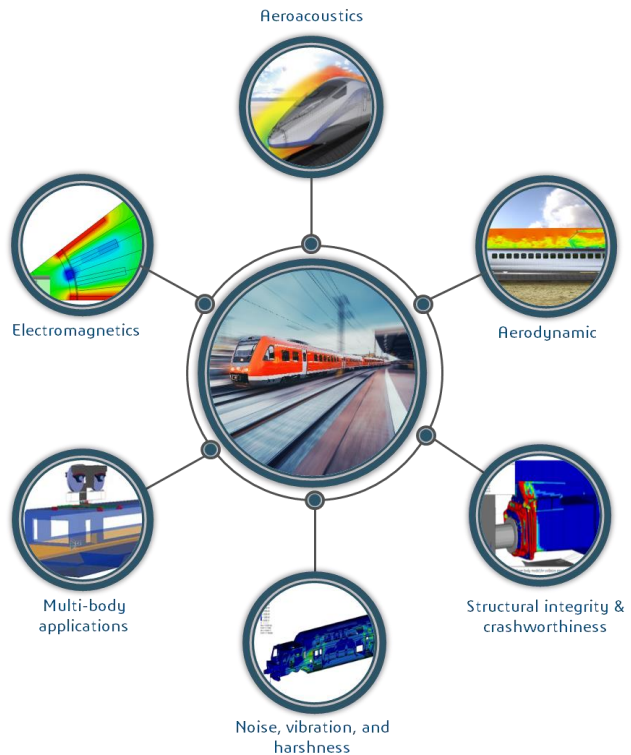
2 Milling



3 Additive Manufacturing



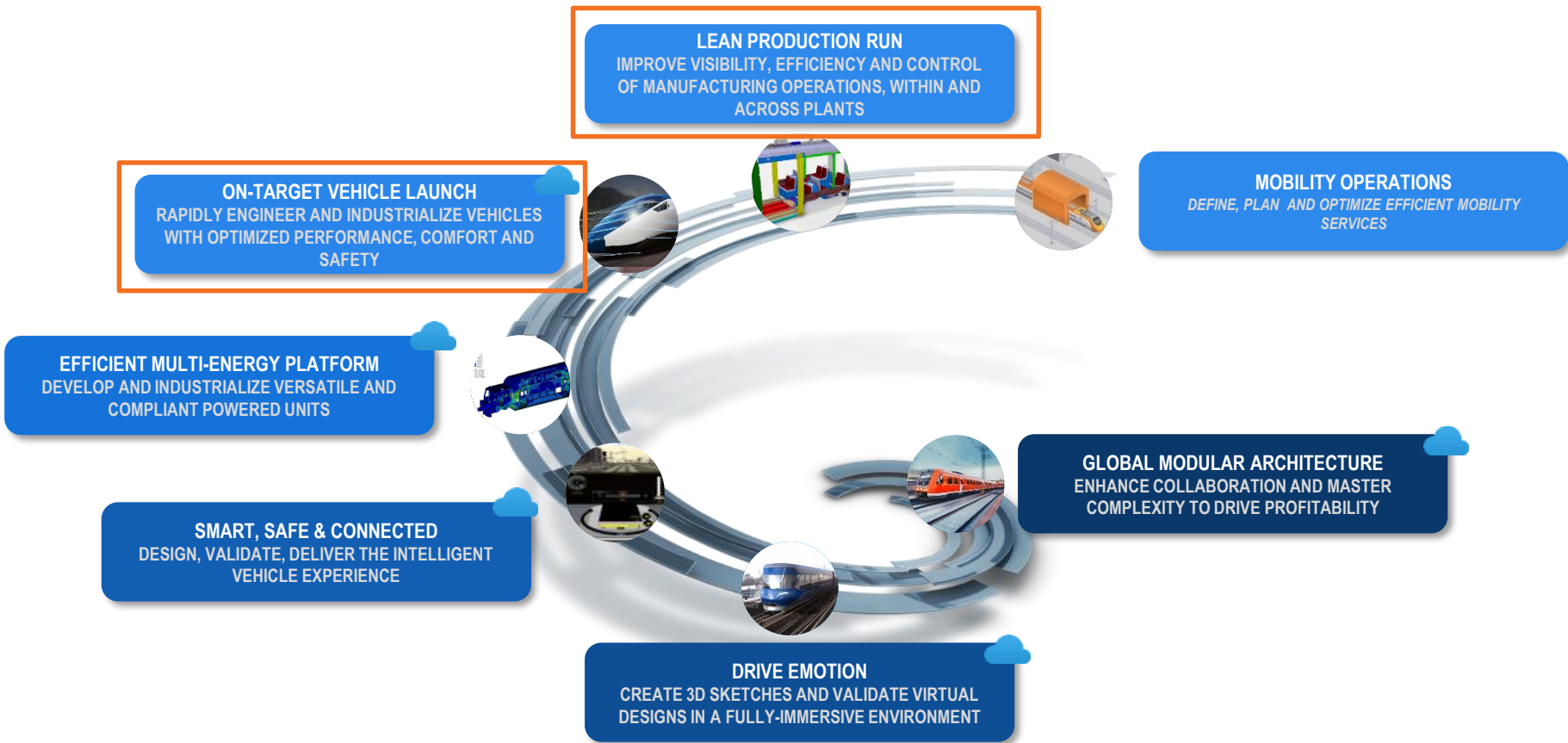
Simulation Portfolio



DS SIMULIA

DS DASSAULT SYSTEMES

DS Solutions for Railways



3DEXPERIENCE | Virtual Rolling Stock Manufacturing

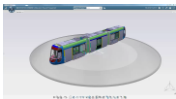
New Product - Renovation – Refurbishment



ALSTOM

Global Industrial Operations

DS DASSAULT SYSTEMES





LEAN PRODUCTION RUN

MASTER PRODUCTION SCHEDULE PRODUCTION SCHEDULING

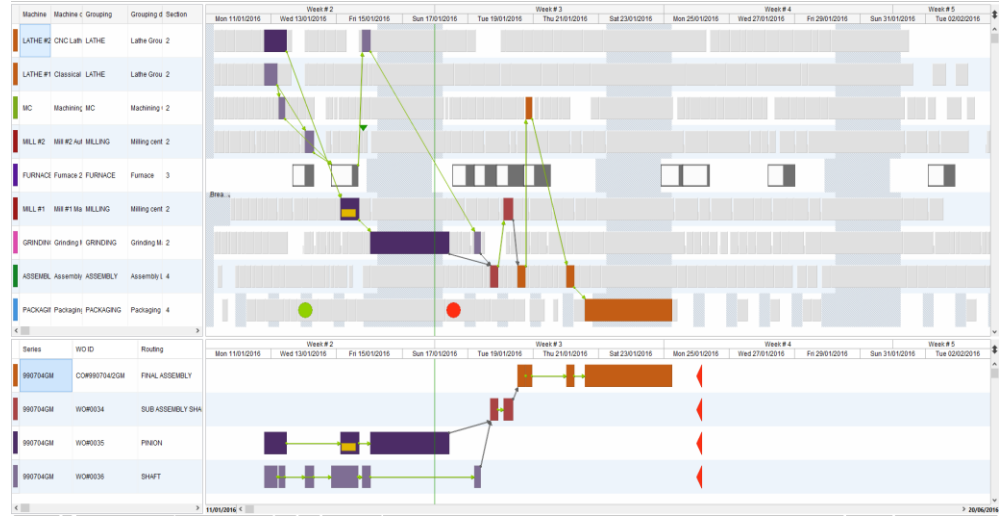
1

Choose **best resource** for each production operation

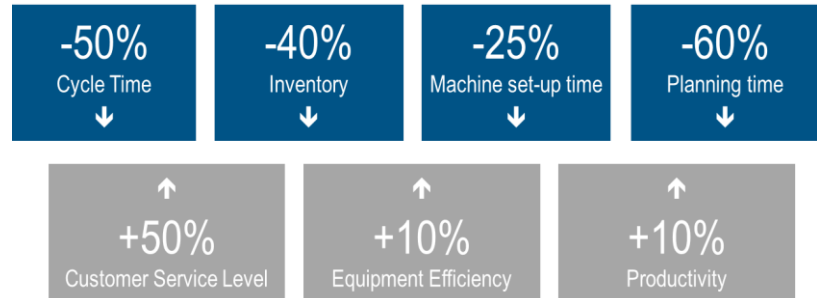
2

Sequence **optimally** production orders on each machine:

- Pull flow for **just in time** delivery and **just in sequence** scheduling
- Synchronize **multi-level Bill of Material**
- Minimize **setup** time
- Minimize **Work in Progress**



Sample Customer benefits

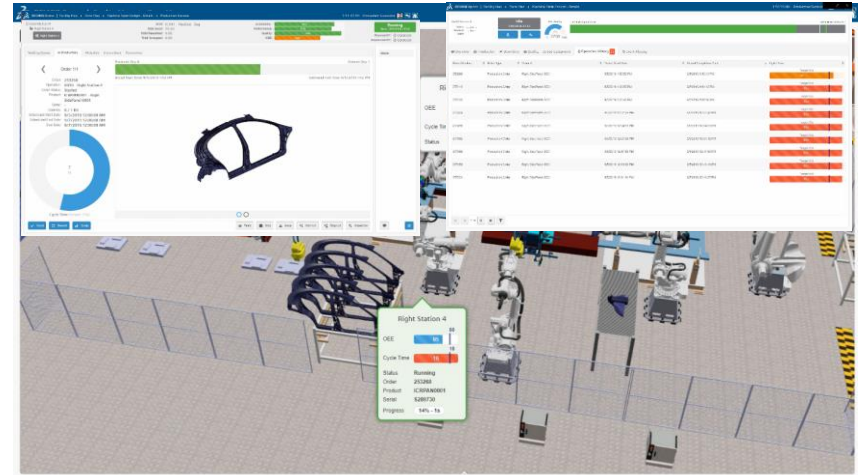




LEAN PRODUCTION RUN

PRODUCTION EXECUTION

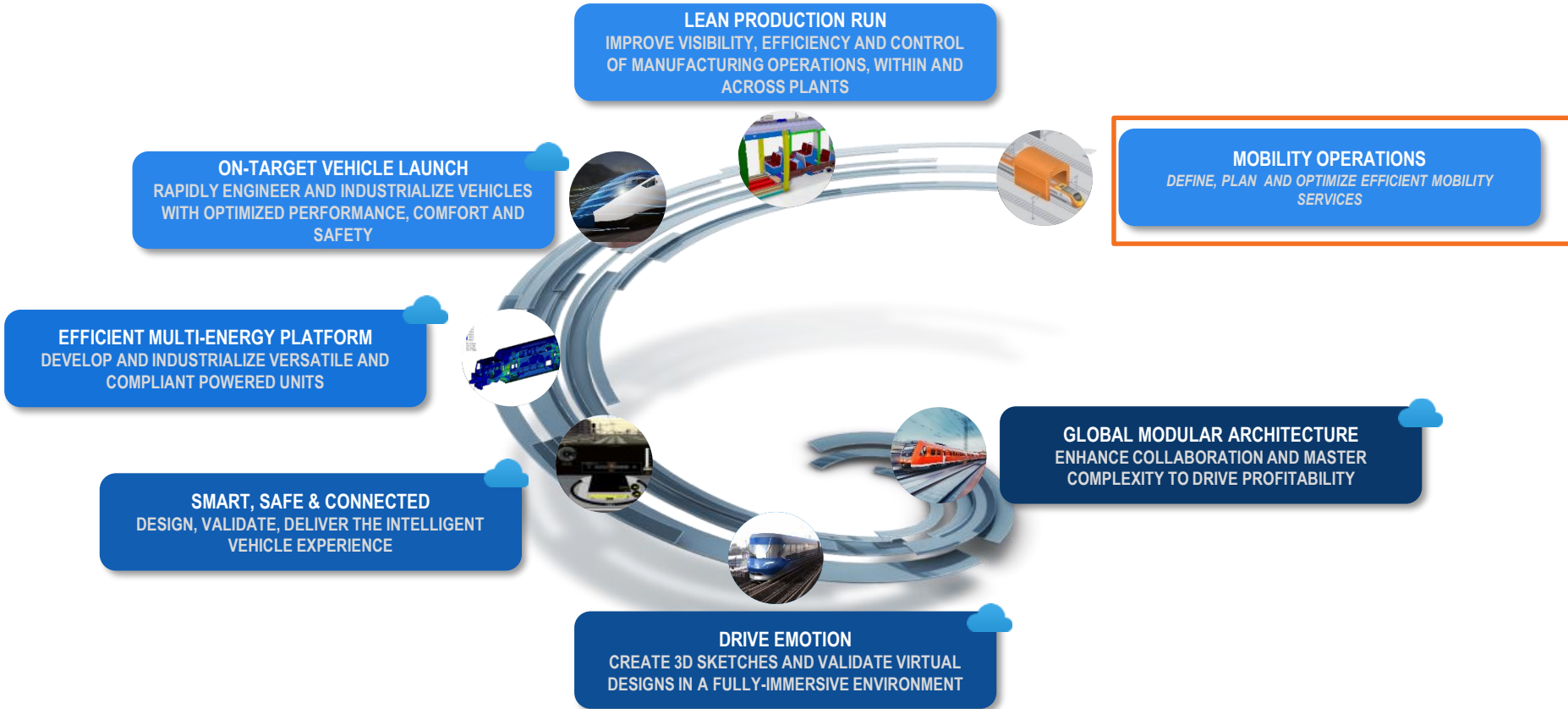
- 1 **Visibility, control & synchronization** of global production
- 2 **Drive paperless manufacturing operations** to eliminate delays, waste and inaccuracy
- 3 **Leverage “Smart Manufacturing”** investments
- 4 **Deploy manufacturing innovation across plants** while supporting site-specific operating requirements



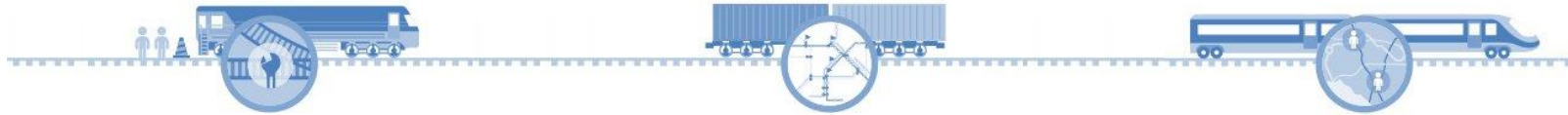
Sample DELMIA Apriso Customer benefits

- +25% Throughput without capital investment
- +10% Throughput while doubling the number of models

DS Solutions for Railways



Rail Operations Planning and Optimization



Strategic

Maintenance Planning and Scheduling

Traffic Planning and Management

Service, Fleet and Crew Planning

Station and Yard Personnel Planning

Tactical

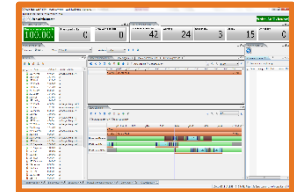
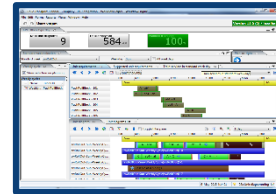
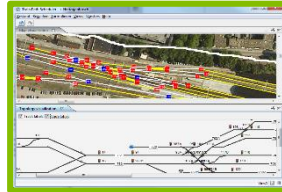
Schedule accesses, skills and equipment to perform maintenance tasks

Optimize network capacity
Offer paths compatible with infrastructure constraints
(Network, Station, Platforms)

Optimize Service offering
Minimize empty kilometers
Minimize idle time

Minimize idle time
Real time working rules management

Pre-operative



Operational



Improve Rolling-Stock Health & Availability

Integrated Maintenance Engineering & Execution



Maintenance

System Engineering

- Requirements
- Functional Breakdown
- Logical Structure



Manufacturer

Contract & Portfolio Management



Operator

Maintenance Execution & Feedback

Multi-Discipline Engineering

- Mechanical
- Electrical
- Electronic
- Software



3DEXPERIENCE

Global Maintenance Dashboard

Maintenance Scheduling

Maintenance Engineering

Service BOM, Service Process,
Maintenance Task Analysis (MTA)
Reliability, Availability.... (RAMS)

Tech Pub Engineering

Maintenance Analytics

Maintenance Planning

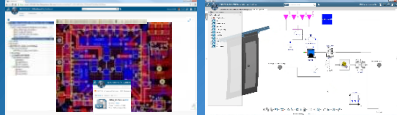
Keep them Running



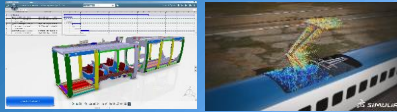
Business-Driven Product Development a Path to Industry Renaissance



3DEXPERIENCE Twin (V+R)



**Model Based System Engineering
Software Management**



**Configured Configured
Manufacturing Simulation**



**Configured
Multi Discipline Engineering**



**Governance, Quality
Change Management**



**xCAD & xBOM
Management**

**From 'Digital Transformation' to
Industry Renaissance**

Start from the Experience

Break Silos - Connect the Dots

Profitability & Sustainability

From Supply Chain to Value Chain

Open & Protected Innovation

Agenda

- ▶ Railway Industry Challenges (5')
- ▶ Introduction to **3DEXPERIENCE** Platform (10')
- ▶ Value of **3DEXPERIENCE** CATIA (10')
- ▶ 3DS solutions for Railways (20')
- ▶ Q&A (5')

