Digital Enterprise

Openness Standards

and Best Practices

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GLOBAL PRODUCT DATA
INTEROPERABILITY
SUMMIT
2016

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Siemens 'Ingenuity for Life'

Global trends

Digital transformation
Networked world of complex and heterogeneous systems

Globalization
Global competition driving productivity and localization

Urbanization
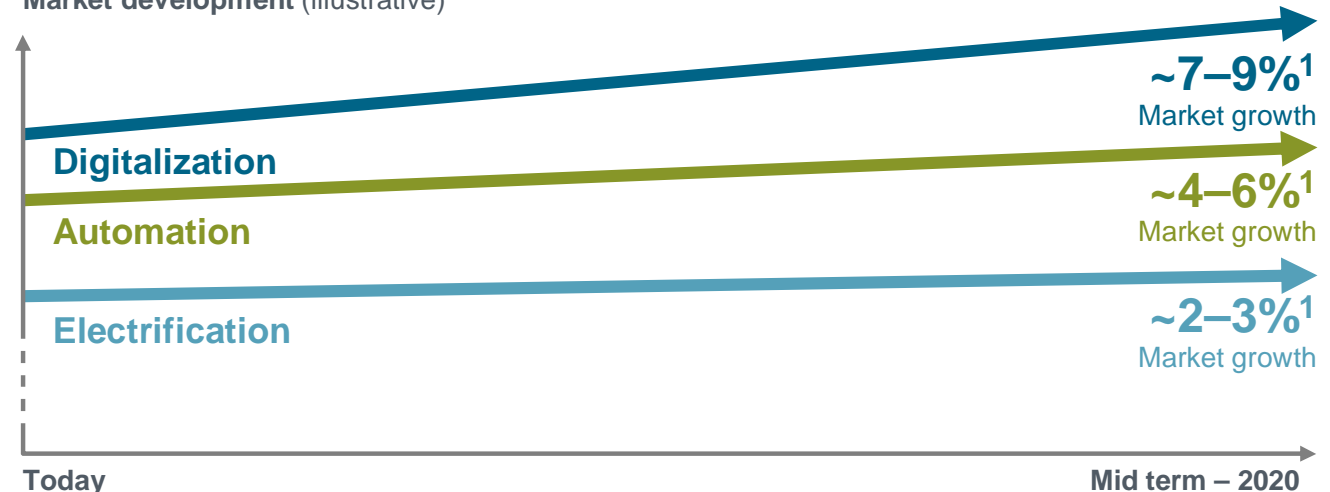Infrastructure investment needs of urban agglomerations

Demographic change
Decentralized demand of a growing and aging population

Climate change
Higher resource efficiency in an all-electric world

Market development (illustrative)

Digitalization

~7–9%[1]
Market growth

Automation

~4–6%[1]
Market growth

Electrification

~2–3%[1]
Market growth

Today

Mid term – 2020

Innovating along the digital value chain

Digital model-based designs	Simulation linking product and production	Digital models of complete lifecycle	Self-optimizing cyber-physical systems

1 Est. market growth (CAGR) **over cycle**

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Leveraging digital technology trends for concrete customer benefits

Siemens Digitalization

Collaboration and mobile

Smart data and analytics

Cloud technologies

Connectivity and Web-of-systems

Cyber-Security

Improved productivity & time-to-market

Higher flexibility & resilience

Increased availability & efficiency

Design & engineering

Automation & operation

Maintenance & services

Combining the virtual & physical world …
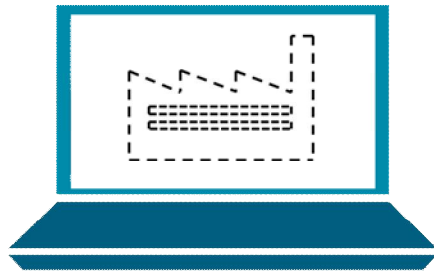
… across entire customer value chains

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Digital Enterprise

Ever expanding scope for standards

Digital Twin

Physical production system

Manufacturing Planning + Manufacturing Engineering + Manufacturing Execution

The reality of establishing a Digital Enterprise

- Many integration points to worry about across PLM, ERP, MES

- Many legacy systems and bespoke interfaces

- Many processes based on manual intervention

- People looking for ways to standardize the definition, execution, and exchange of the 'Digital Twin'
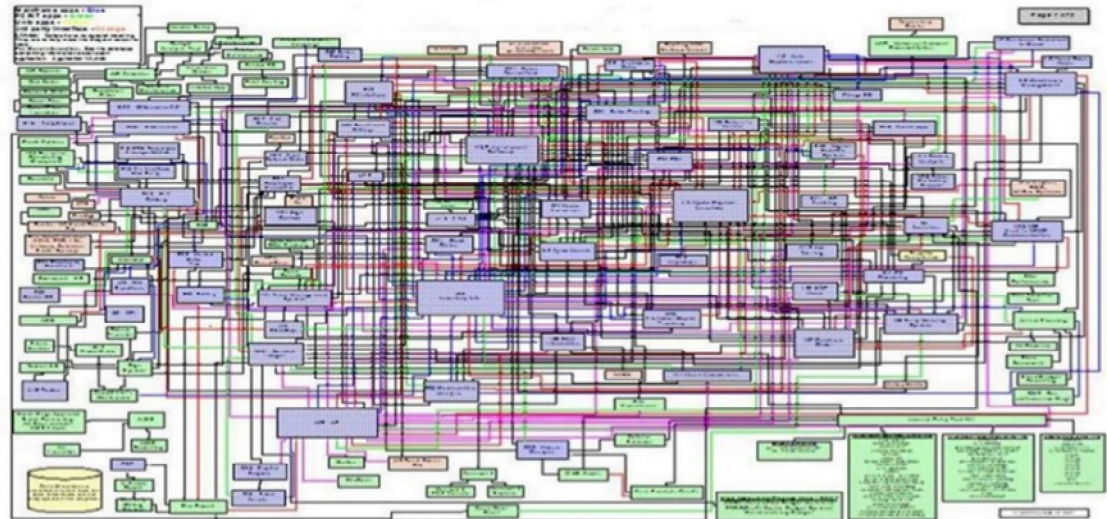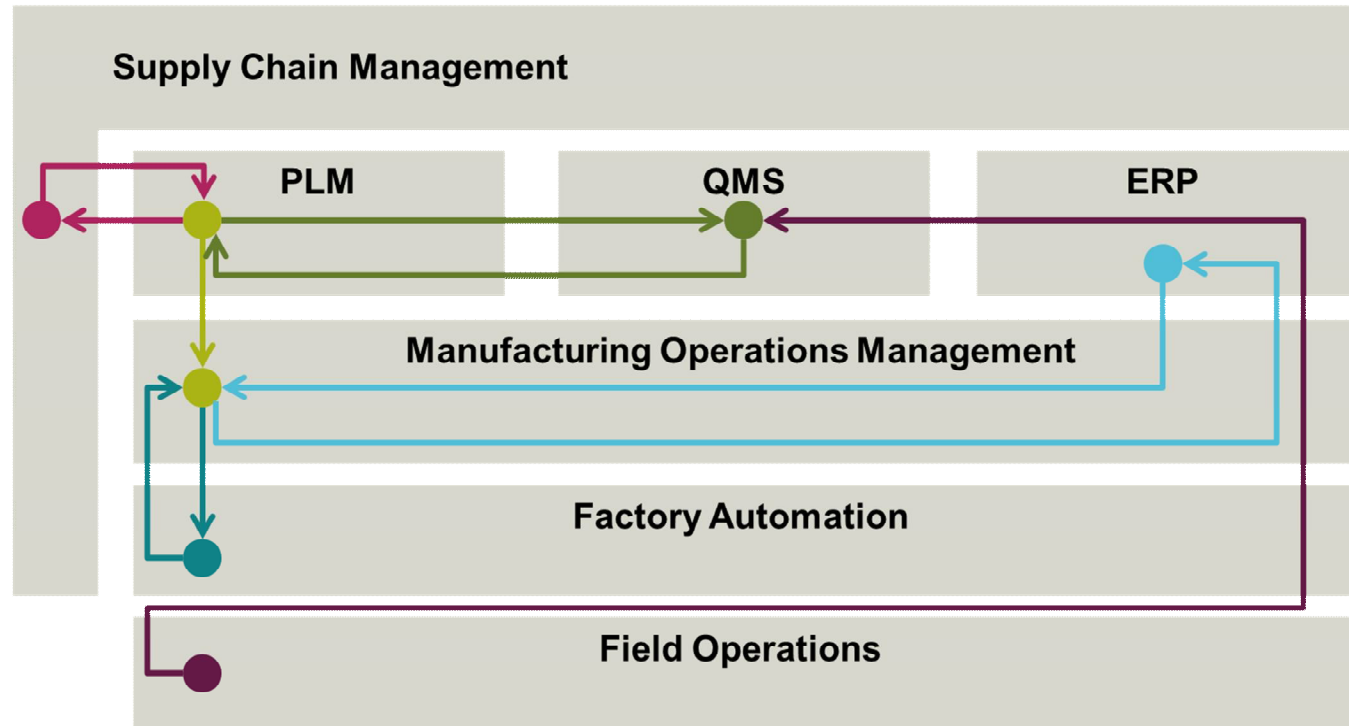

Looks familiar? Complex enterprise IT is a major reason for OEMs to struggle and not being able to adopt the 'Digital Enterprise' to its full extent

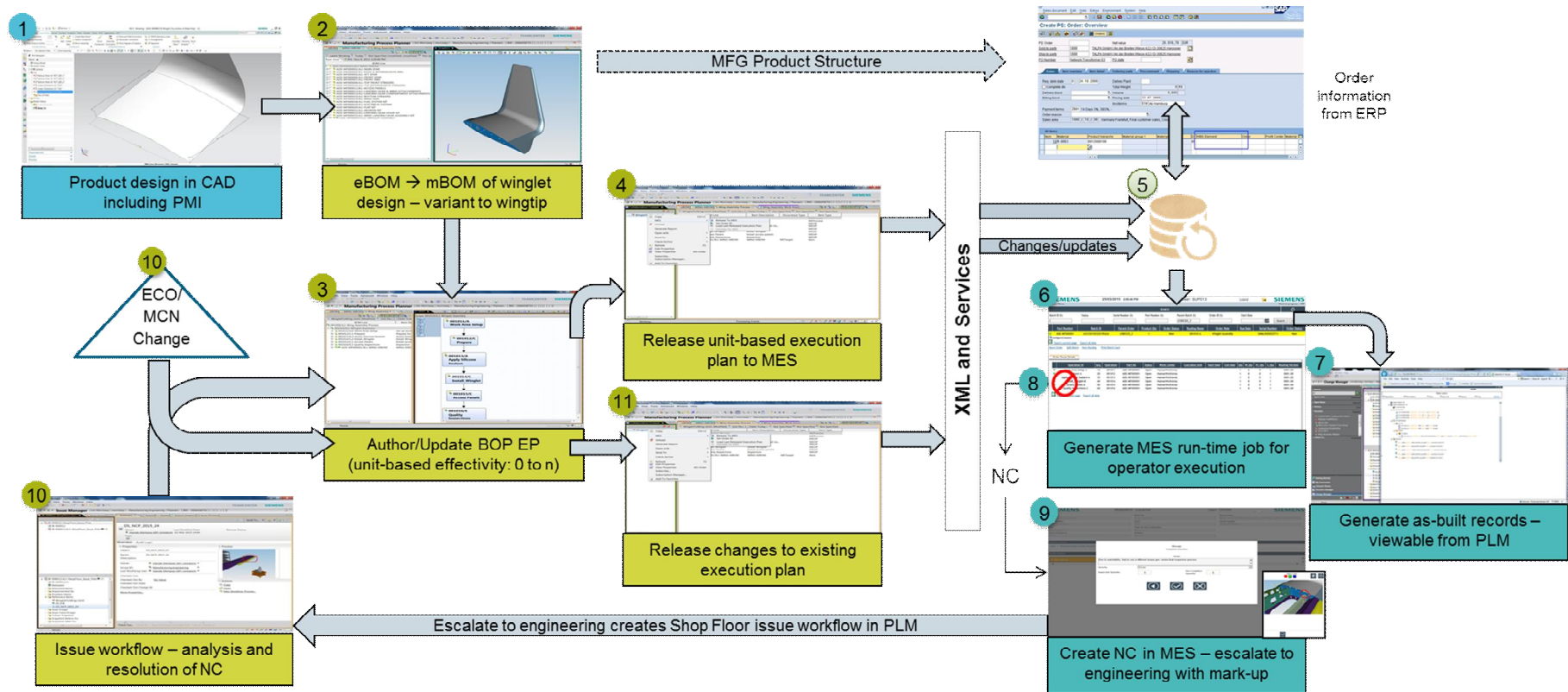# The 'big picture' of Digital Enterprise Integration

- Foundation starts with PLM, MOM, and ERP

- Many loops!

- Don't forget QMS, Factory Automation, and Field Operations

- Many BOMs!

- Include your supply chain

New variant for aircraft wingtip

MFG Product Structure

Order information from ERP

1 — Product design in CAD including PMI

2 — eBOM → mBOM of winglet design – variant to wingtip

3 — Author/Update BOP EP (unit-based effectivity: 0 to n)

4 — Release unit-based execution plan to MES

5

6 — Generate MES run-time job for operator execution

7 — Generate as-built records – viewable from PLM

8

9 — Create NC in MES – escalate to engineering with mark-up

10 — ECO/ MCN Change

10 — Issue workflow – analysis and resolution of NC

11 — Release changes to existing execution plan

Changes/updates

XML and Services

NC

Escalate to engineering creates Shop Floor issue workflow in PLM

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Standards Challenge

Growing interest in implementing processes based on standards supporting multiple disciplines and business needs

- IT / MIS / Operations
- Customer / Program
- Government / Regulation
- Supplier Management

Driving the identification, definition, evaluation of standards and processes across, and throughout, multiple tiers

- Industry
- Business
- Suppliers
- Customers

Standards for

- Interoperability
- Business processes and methods
- Models

https://www.zachman.com/about-the-zachman-framework
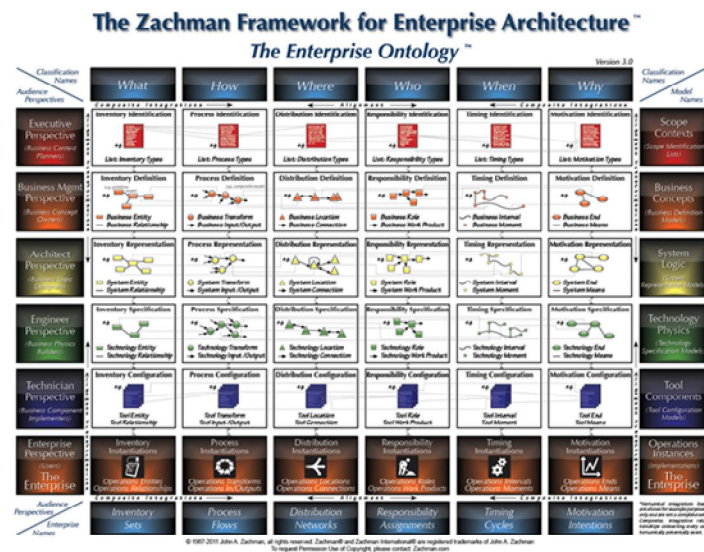
Advantages and Benefits Supporting Standards

Realize a direct return on investment for the products you engineer and sell
* Lowering installation and startup costs
* Reducing need to maintain large inventories
* Enabling interchangeability of components improving design with less "custom" effort
* Increasing safety (e.g. ISO 26262)

Use of standards in industry
* Improves communication
* Provides practical application of expert knowledge
* Represents years of experience and avoids necessity of starting each project from ground up
* Support advancement of new technology / architectures while preserving existing SLAs

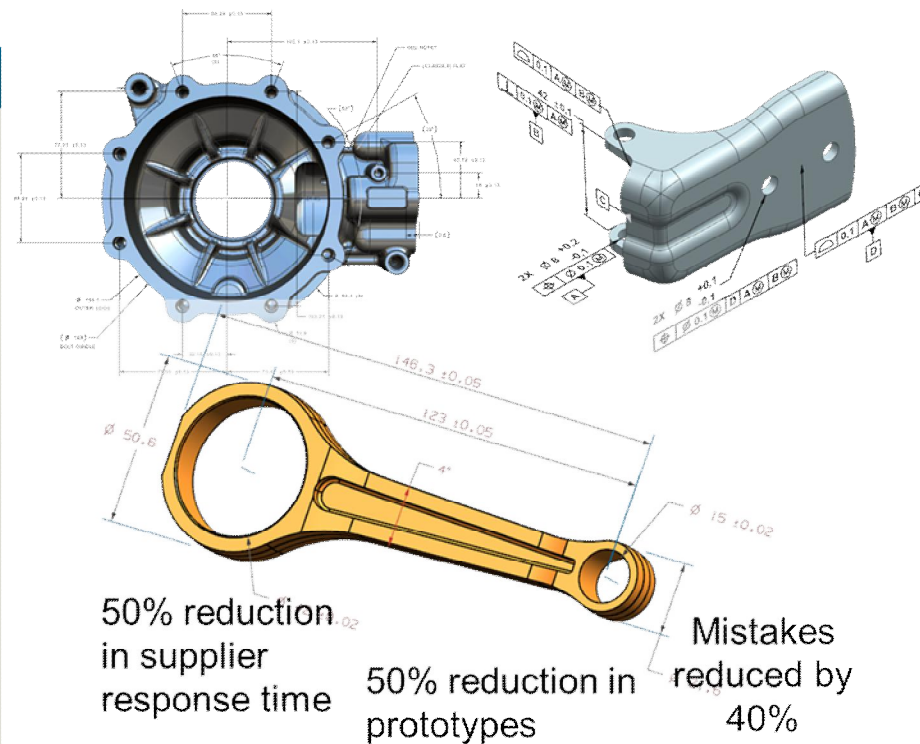In general, standards help you achieve operational excellence by
* Improving performance
* Lowering maintenance costs
* Reducing downtime and enhancing operability

Example – PMI, GD&T ASME Y14.41 and ISO 16792

ASME Y14.41, ISO 16792

- Conveys information such as geometric dimensioning and tolerancing (GD&T), 3D annotation, surface finish and material specifications
- Allows for the manufacture and inspection of the product without need for traditional 2D drawings
- Standards provide the underpinnings for Model Based Definition (MBD), i.e. a complete digital definition of the product within the 3D model.
- Good example of standards influencing commercial CAD software vendors

50% reduction in supplier response time

50% reduction in prototypes

Mistakes reduced by 40%

AP 242

- Focused on all facets of a 'digital Part'
- Siemens PLM Software closely followed the inception and development of AP242
- Currently extending the implementation of AP242 across our product portfolio
- For example, NX CAD extending the integration of AP242 in the following areas:
  - Semantic PMI
  - Tessellated Geometry
  - Import/Export of 242 Compressed Files
  - Import/Export of 242 XML Files
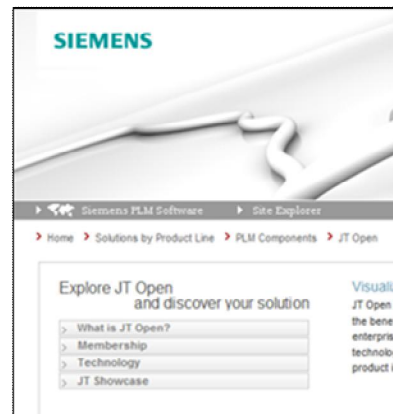 - Import/Export of Compressed 242 XML Files
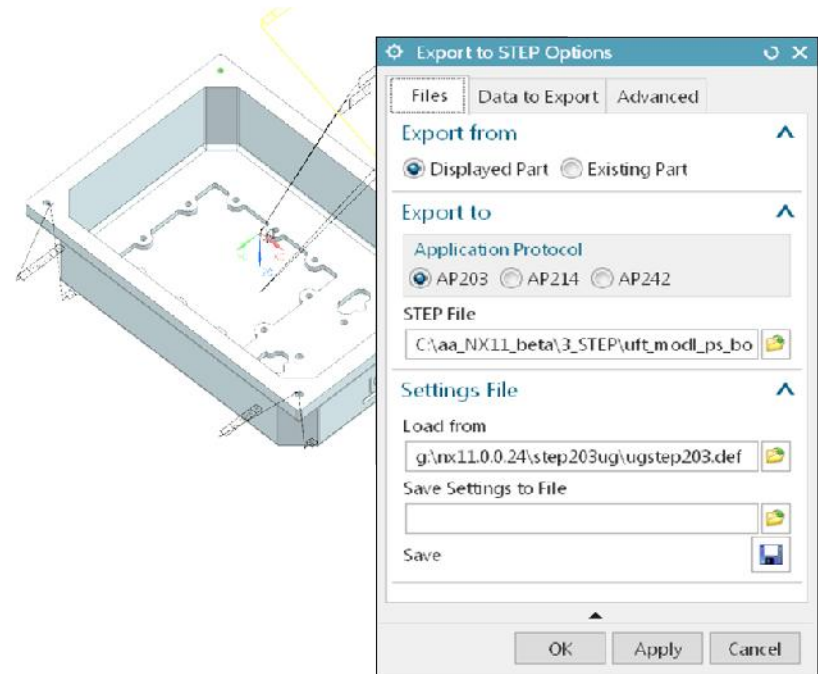
Example – JT (ISO 14306)

ISO JT

- The JT File Format unanimously passed a global ballot on December 11, 2012 and has been accepted by ISO as an International Standard
- JT V9.5 is now ISO/IS 14306:2012 - JT file format specification for 3D product data visualization
- The format specification was published to the ISO purchase/download site December 15, 2012
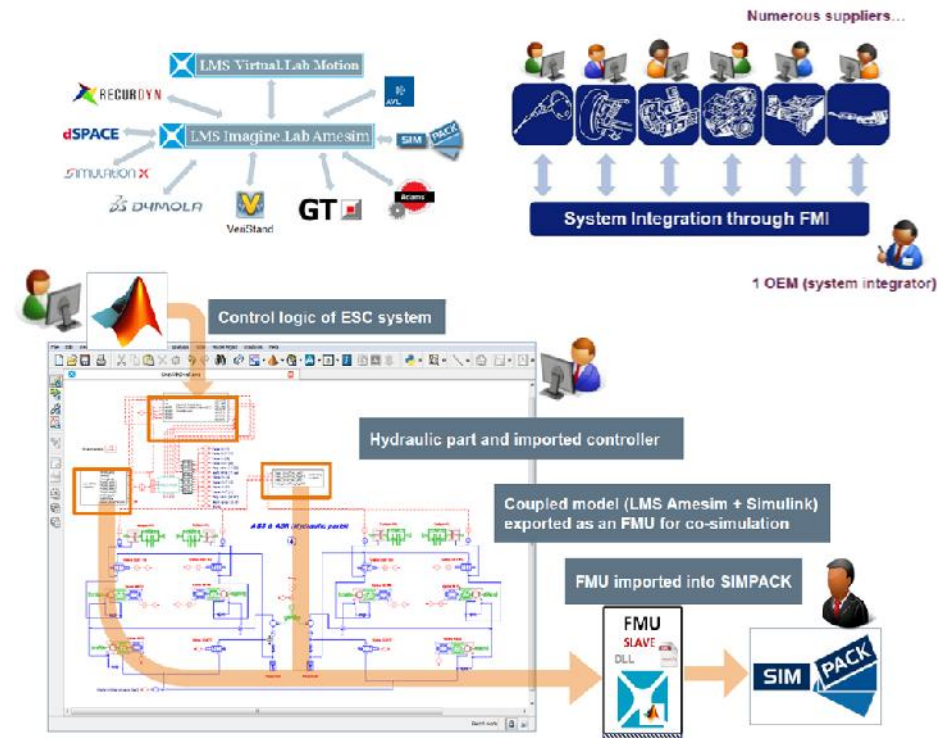- JT Open membership going strong, JT International Conference 2016

Functional Mock-up Interface

- Collaborative MBSE
  - Between OEMs and suppliers
  - Between departments
  - Involving different domains
- Tool neutral software interface for either model exchange, or co-simulation
- Open format, with publicly available specs

- Siemens is an active member of FMI Steering Committee and FMI Design group
- Siemens has highly contributed to the specification of FMI 1.0 and FMI 2.0


Numerous suppliers...

System Integration through FMI

1 OEM (system integrator)

Control logic of ESC system

Hydraulic part and imported controller

Coupled model (LMS Amesim + Simulink) exported as an FMU for co-simulation

FMU imported into SIMPACK

FMU SLAVE DLL

Example – Integrations based on OSLC

OSLC

- Focused on PLM and ALM integration
- Siemens has integrated OSLC principles with Teamcenter Linked Data Framework
- Reference remote resources based on persistent URIs
- Extend SOA to support HTTP REST services
- Delegate user interface where applicable

- Initially focused on CM and RM specifications as provided by OSLC
- OSLC support with service extensibility based on Teamcenter Business Modeler IDE
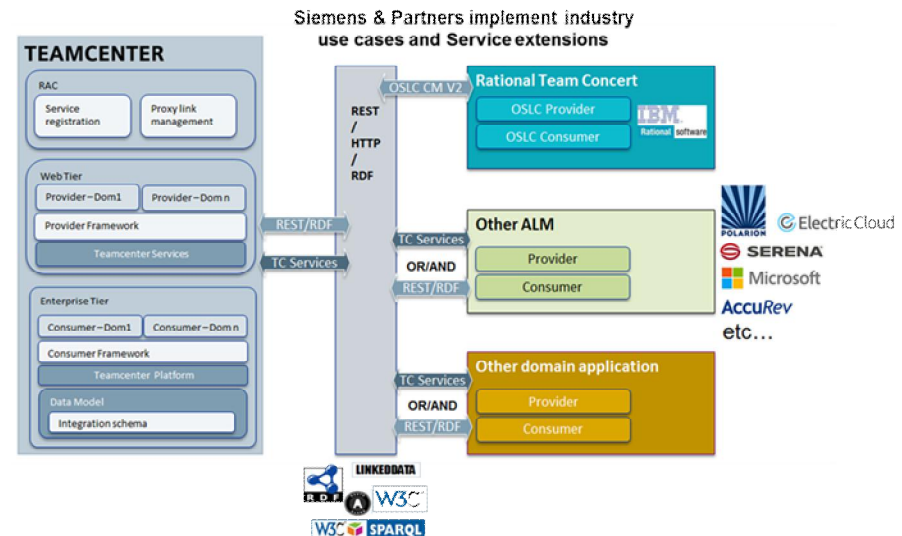
Example – Electronic Disclosures based on JT + PDF

JT + PDF

- Good example of combining industry-driven standards
- Addressing security and translation concerns from major customers
- Combining the strengths of JT with documents published as PDF
- Enabled by attaching JT to PDF for 3D and PMI interrogation and visualization
- Supporting 'paperless' collaboration

- No need for redundant for data translation to support 3D visualization
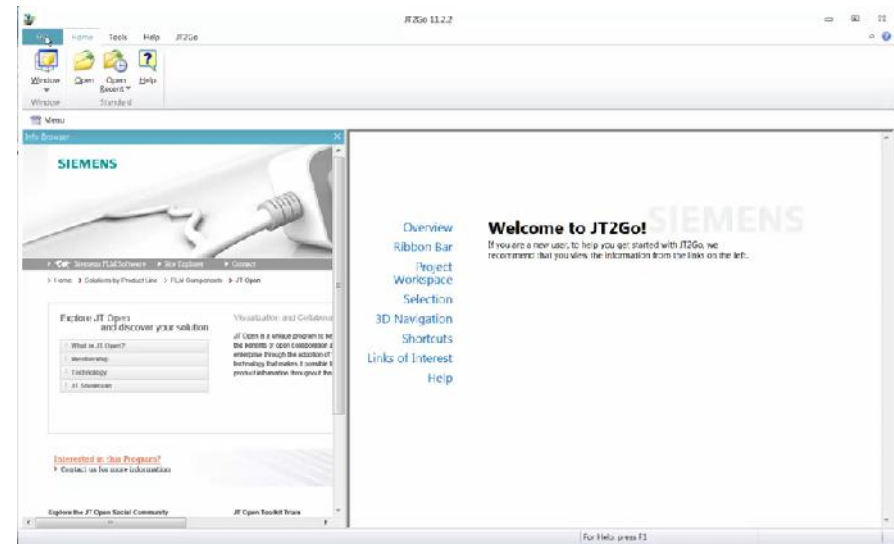
Example – MES integration based on ISA 95

ISA 95

- The ISA 95 standard consists of the following parts:
  - Part 1: Models and Terminology
  - Part 2: Object Model Attributes
  - Part 3: Activity Models of Manufacturing Operations Management
  - Part 4: Object models and attributes for Manufacturing Operations Management
  - Part 5: Business to Manufacturing transactions
- Used as the foundational data model for MES and Enterprise Interoperability
- Foundation for Siemens SIMATIC IT Manufacturing Operations Management
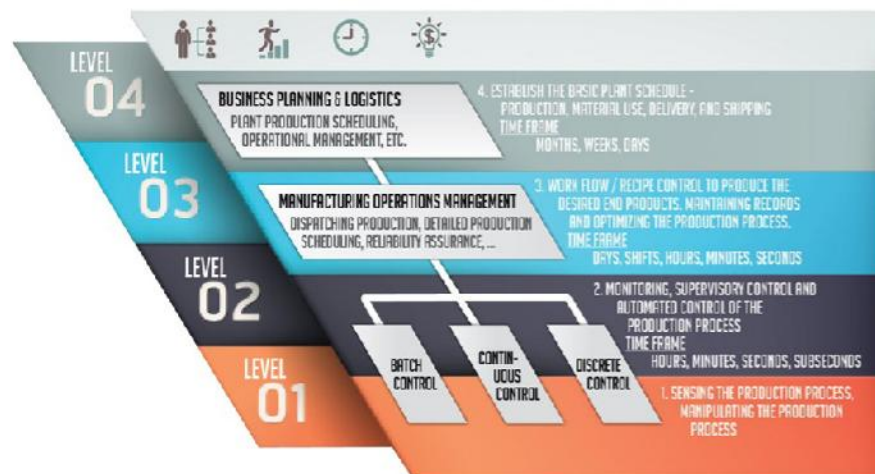
Example – Programming standards, HTML 5

HTML 5

- HTML5 is the latest evolution of the standard that defines HTML
- Zero install content delivery
- Typically referenced along with other programming standards like CSS, JavaScript, and related technologies like WebGL
- For Siemens as technology provider key foundation for delivering product innovation, e.g. Active Workspace
- Allows for ease of configuration, extensibility and embedding as part of your extended enterprise
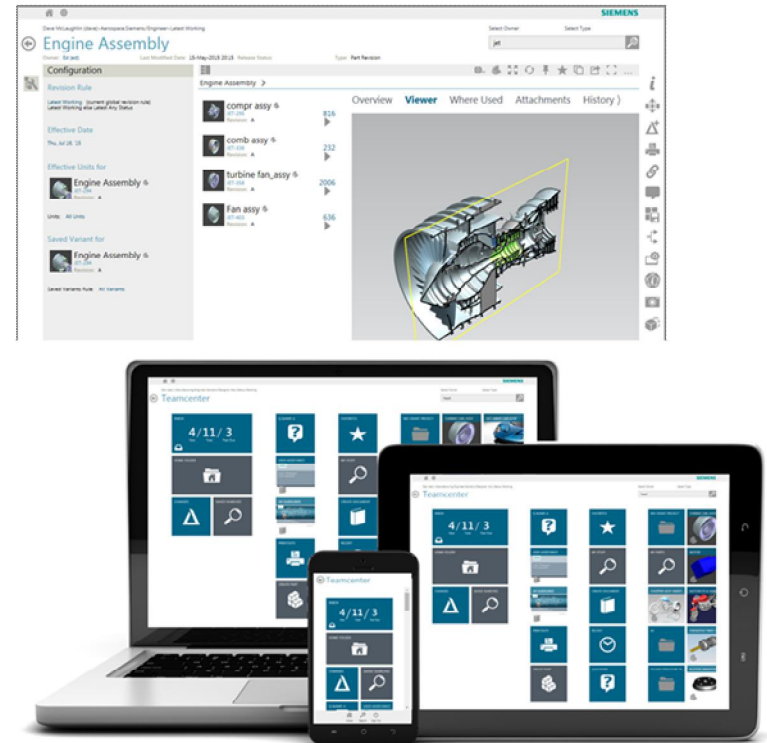
Example – Technology standards, Hadoop

Hadoop

- Open-source software framework for storing data and running applications on clusters of commodity hardware
- Good example of how open source can spark a new wave of innovation, i.e. Big Data
- Allows Siemens to close the loop between 'virtual' and 'physical' by correlating sensor and engineering data

- Hadoop and related technology set at the foundation of new Siemens products like OMNEO
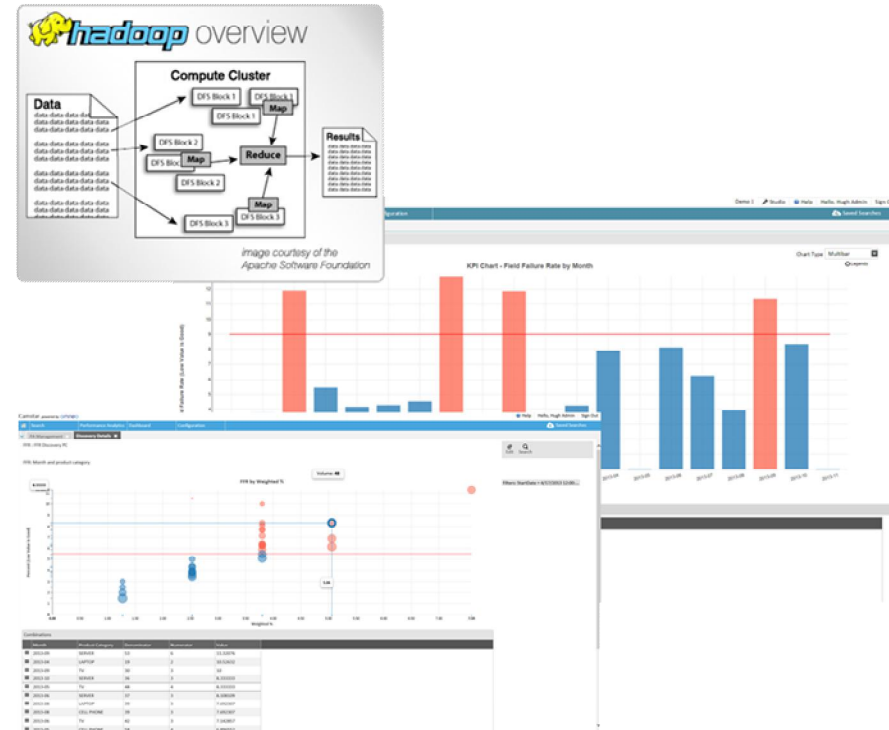
Best Practices to Consider

- Establish a 'Digital Enterprise' office responsible for the governance of tool chain integration, semantics and best practices

- Focus on 'digital threads' with high ROI for your business, e.g. model based engineering, electronic work instructions, etc.

- Use industry 'state of the art' for critical and value-add business processes

- Leverage industry driven standards via consortiums

- Use open standards where semantics are comprehensive, mature and broadly supported and hence 'least common denominator' is not a problem, e.g.

    - PMI and GD&T

    - Model Based Engineering

- Make sure that you consider shared semantics between the virtual, and physical world to accelerate your IoT adoption

- Include your supply chain!

Thank you

www.siemens.com/plm