Managing complexity in engineering processes

Watson IoT

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Software is everywhere

its driving transformation in engineering
Engineers need a living, on-demand system to manage the complexity of product development.

Information cannot be static. It must be ready, available, accessible and actionable both inter and intra-enterprise.

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<tr>
<th>Managing versions/variants</th>
<th>Ensuring compliance</th>
<th>Model-based systems engineering</th>
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<td>Tracking of complex configuration management and managing strategic reuse of engineering assets</td>
<td>Determining compliance to functional safety, regulations and industry standards available at any time</td>
<td>Understanding the effects of changes to requirements and the ability to model interdependencies between sub-systems</td>
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Engineers need to trace and manage strategic reuse of assets in product variants and versioning across sub-assemblies

More customization leads to variants in products and sub-assemblies

More components, interfaces and software lead to configuration complexity

Traceable engineering tools
Open and effective integrations

1 engineering environment configuration
Engineering teams manage complexity bases on sophistication of development processes and software

Teams can reduce errors and increase productivity by managing versions and variants of software-intensive products and systems

- **Baseline**
  - Establish enduring reference points for requirements, designs, tests and implementations

- **Process-driven**
  - **Change Management**
    - Controlled development process in which changes require formal approvals with full audit trail
  - **Parallel Development**
    - Teams work on multiple cascading sprints or releases simultaneously

- **Software-driven**
  - **Product Variants**
    - Engineer products variants that have small differences among them
  - **Product Line Engineering**
    - Engineer as product line for high level of reuse in variants
• As engineering complexity rises, engineering regulatory standards are demanded from manufacturers

• New engineering regulations are being introduced for SW intensive products

• Regulations relate to engineering maturity and functional safety

• With today’s engineering complexity meeting compliance with ad-hoc practices is a major challenge

• Better engineering practices are needed

Meeting engineering compliance demands provide an opportunity to save costs and increase efficiency
Manufacturers are struggling to manage complexity amid increasing regulation.

**Automotive**

- Lines of code in new Ford F-150 Truck 10 speed transmission = 1 million, in 2003 this was 155 K
- QA and testing spend is predicted to increase to 40% of total IT budget by 2019

**Aerospace and defense**

- 5 generation F-35 functionality is 90% Software driven compared to F-16 which has 40% functionality driven by Software
- F-35 testing cost overrun $1 Billion caused by late identification of Software errors in prior versions of the software

**Medical devices**

- The da Vinci S surgical robotic system:
  - 1.4 million lines of code
  - Computing power of 7 laptops
  - 10,000 individual parts

...while the minimum viable product concept works in app development, this is a non-starter for complex safety related products.
Engineering compliance requirements

• Basically demonstrating repeatable and traceable engineering process
  • Details vary across industry

• Carry out systems engineering – not only HW and SW development

• Proper management of requirements, design, and test with complete traceability across

• Carrying out safety assessments and provisions for safety related standards

• Process measurement and improvement by maturity standards
Challenges with meeting engineering compliance

- Little or no visibility into the progression of development of the various engineering artifacts
- Manage traceability across multi-disciplinary engineering artifacts
- Clear specification of the engineering process and how the process relates to the generated artifacts
- Providing evidence for required activities (e.g., verification)
- Standardizing the process across the organization
- Recording artifacts changes and configurations
Complex products need to comply to standards to assure safety, demonstrate engineering maturity, and enable supply chains.

Best practices and services

- Architecture, design and development
- Visualize, analyze and organize
- Planning, change/configuration management
- Requirements
- Quality

Open lifecycle integration

Industry architectural Standards
- ECU Design/Dev via AUTOSAR
- Defense Architectures via DoDAF
- HW-SW Co-design

Compliance Standards: Functional Safety and Maturity
- ASPICE (Maturity)
- Automotive Safety via ISO 26262
- Aerospace Safety via DO-178B/ ARP $754
- Med Device Safety via IEC 62304
- FDA Design Control

Supported industries
- Automotive
- Aerspace and Defense
- Electronics
- Network service providers
- Rail
- Chemicals and petroleum
- Energy and utilities

...status of compliance to standards must be knowable at any time from any place
The migration to model-based systems engineering is an indispensable capability for delivering complex, interconnected systems.

Today’s system engineering is based on disparate and non-verifiable documents across multiple tools...

Documents are static with no way to understand how a change affects other components.

...model-based systems engineering maintains fully traceable and verified system specifications.
IBM CE platform provides the necessary means to facilitate compliance with today’s engineering standards.
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Methods to manage product complexity can improve systems engineering processes

Agile software development can deliver innovation faster

Enable access to all engineering and related information through open standards

<table>
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<tr>
<th>Component</th>
<th>Design</th>
<th>Test</th>
<th>Implementation</th>
<th>Requirements</th>
<th>Analysis</th>
<th>Operations and Maintenance</th>
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<tr>
<td>Electronic Design</td>
<td>Lean Software Engineering</td>
<td>Mechanical Design</td>
<td>Deploy or Release to Mfg</td>
<td>System Test</td>
<td>System V &amp; V</td>
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<tr>
<td>Electrical / Electronics Design</td>
<td>Iterative</td>
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<td>Decomposition and Definition</td>
<td>Customer Requirements</td>
<td>Market Analysis</td>
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How does the CE platform help with compliance

• Properly manage requirements, design, and test
• **Traceability** across all engineering which is essential to support the various compliance standards based on the OSLC open standard
• **Metrics and reporting** – Visualization of progress as to the completion of the various engineering activities and completion of artifacts for all project stakeholders
• **Configuration and Change management processes** – mandated by all safety and maturity standards
• Domain specific templates
  • Aiding users to develop engineering artifacts that comply to the standard
• Process enactment through integration with Stages
  • Standardizing task flows that detail how to develop specific engineering artifacts in specific tools
  • Standardizing processes across the organization
Partner Integration
Bringing you a cohesive ecosystem for continuous engineering

- Define, publish, Tailor process
- Enact process workflow into task management
- Prove compliance

Tap into our other integration partners
MethodPark-IBM Workflow

1. Define Processes
   - Design in Stages
   - Import from RMC, Excel, Visio, Word

2. Map Process Against Regulations
   - Process leader determines which items are critical – engineers relieved of this burden

3. Enact Process in RTC with real-time updates
   - Change Management
   - Safety Critical Work Items Created Automatically in RTC

4. Prove Compliance & Create Executive Dashboard
   - Audit trail
   - Execs can view progress RTC or Dashboards in Stages

Regulations:
- IEC 62304
- DO178B/C
- ISO 26262
- ...
Thank you