Effective ALM Automotive Solutions for ISO 26262

Andy Holton
Systems Engineer
Polarion Software, Inc.
Agenda

- Company Introduction
- ALM for Functional Safety / ISO 26262
- Automotive Trends and Challenges
- Automotive Customer Case Study
  - Quantum Technologies
  - AGI Greentech
- Polarion Technology
- QA
Company Introduction

- 9+ Years in Business
- > 500 Global Customers
- > 3 million Users
- Operating > 22 Countries
- Cloud or On-premise
- >220 Plug-in Extensions
Polarion is recognized by Gartner, Forrester, Ovum, and many other industry analysts as a unique visionary and technology leader in this space.
Polarion introduced the world’s first ALM system in 2005 as defined by Gartner, Ovum, and Forrester.
Polarion launched the world’s first 100% browser-based ALM, Requirements Management, and Test Case Management software.
Polarion created the LiveDoc™ technology for dual presentation of data allowing users to work a UI they find convenient and rewarding.
Polarion created the “Round-Trip” technology that eliminates the conflicts of import/export. Changes made outside of Polarion can be imported seamlessly while keeping the original formatting.

“We took our time to thoroughly investigate the ALM market; and in every analysis, Polarion showed-up as the number one provider in its category.”
Ralf Schnell, CEO of Siemens Venture Capital
Polarion has helped many of our customers achieve Automotive Spice, CMMI, and ISO 26262 compliance. Polarion’s ALM software is validated as a trusted tool by TUV Nord for ISO 26262.
“Functional Safety is the part of the overall safety of a system or piece of equipment that depends on the system or equipment operating correctly in response to its inputs”

Functional safety, by necessity, is comprehensive in scope. Each component, sub-system, and system has to be treated with the same processes as the entire product.

Between 20 and 45 percent of all software defects originate from requirement or design errors.

Defect removal rates are the lowest during requirements review phase.

Most errors are found much, much later in the development process.
According to Gartner:

- Most companies are still using non-structured tools for requirements management instead of purpose-built tools.
- Microsoft Office (Word/Excel) is still the most common “requirements management” tool being used.

What goes wrong with a traditional requirements system?

- Inconsistent process enforcement
- Bulk approval of entire specifications
- Inconsistent or improper requirements definitions
- Manual and inconsistent assignment of IDs and traceability
- Siloing of requirements, test cases, risk management, etc.
- Reuse of existing specifications can be problematic
- Inability to provide efficient impact analysis over a large number of requirements
What does ALM technology provide for Functional Safety?

- Provides process controls end to end process management and enforcement
- Automation of tedious and error prone manual procedures
- Eases reporting of large scale traceability and impact analysis
- Central repository helps collaboration and sharing of information between functional groups
- Reuse of specifications can be traced back to source
- Self-documenting processes help guide users
ALM for ISO 26262

- Qualification of Hardware Components
  - How do you show relationship of component to system?
  - How can you ensure that all verification tests have been completed?

- Qualification of Software Components
  - How can you ensure that all proper development steps were taken?
  - How do you show traceability from spec to code and test?

- “Proven in use”
  - How can you prove that reused component is being used in the same way?
  - How can you show what has changed in the reuse?

Qualification of Hardware components

- Traditional document specifications exist in vacuum
- ALM helps remove silos between:
  - Components and System
  - Specification and Development and Test
  - R&D and Functional Safety
- Artifacts are not constrained to documents, traceability exists throughout repository
- Help provide immediate feedback from testing to development
ALM for ISO 26262

Qualification of Software components

- Traditional systems have no linking between inputs (specification) and outputs (source code, test results)
- Integrated process management eliminates hand-off points, since all teams work in the same environment
- Provides deeper integration between hardware, software, and functional safety
- Integrated defect tracking provides immediate feedback for development groups
- Helps integrated the use of certified software tools
“Proven in use” specifications

- Traditional requirements management can reuse specifications, but with loss of context
- Centralized ALM repositories allow copying of specification, while still retaining all context of use and processes
- Changes to reused specification can easily be found, or portions of specification can be reused “proven in use”
The focus of ALM for functional safety is on Integration

- Tracking integration of components within a system
- Integrating work done by functional groups
- Integration of input and outputs into a common system
- Ensuring that all process steps are completely integrated
- Integrating proven tools (requirements, testing, risk management)
“The typical car contains about 2,000 functional components, 30,000 parts, and 10 million lines of software code.

Why all the intricacy? Automobiles are heavy, fast-moving objects operating in public space.”

Harvard Business Review
http://hbr.org/2010/06/why-dinosaurs-will-keep-ruling-the-auto-industry/ar/1
Automotive Trends and Challenges

- There are estimations that today’s premium-class cars contain close to 100 million lines of software code.

- This software executes about 70-100 microprocessor-based electronic control units (ECUs) which include ABS Brakes, Airbags, electric window regulator, GPS, entertainment, electronic drive, parking distance, and more.

“The radio and navigation system in the current S-class Mercedes-Benz requires over 20 million lines of code alone, and that car contains nearly as many ECUs as the new Airbus A380”

Alfred Katzenbach, director of Information Technology Management at Daimler
Automotive Trends and Challenges

- One car will contain over 30,000 individual parts, each of which have to conform to specifications.

- In 2006 Hyundai launched 35 parts plants in Alabama to support their new Georgia factory, plus local suppliers

"Here at Kia, we want [our suppliers] so close that we can reach out and grab them by the hand… The better we can communicate, the better we can make changes or improvements when we need to."

Randy Jackson, director of Human Resources and Administration, Kia Motors

http://www.toyota.co.jp/en/kids/faq/d/01/04/
http://www.autonews.com/article/20060403/ANA/60331076/kias-new-u.s.-plant-is-no-windfall-for-u.s.-suppliers
http://www.autonews.com/article/20090601/OEM01/306019759/kias-suppliers:-up-close-and-personal
Automotive Trends and Challenges

- Software development, as a whole, is moving towards more agile processes for greater efficiency.

- However, manufactures still must comply with and meet standards (CMMI, Automotive SPICE, ISO26262) which have traditionally been based on Waterfall processes.

- Even Formula 1 teams are using Agile!

“If [IT changes] reduce the amount of manual work engineers have to do, they can focus on the car and driver“

Graeme Hackland, IT Director for Lotus F1

http://www.cio.com/article/705865/Formula_One_Racing_Team_Speeds_to_Agile_Development?page=1&taxonomyId=3038
Automotive Trends and Challenges

- Ford Motor Corporation falls from 5th to 23rd in quality due to software interaction on their dashboards
  - According to J.D. Power Initial Quality Survey and New York Times

- Toyota to recall 1.9 million Prius cars due to software defect that could thermally stress transistors
  - Reported by Reuters

- GM to recall 2014 Buick LaCrosse and Chevy Malibu due to incorrectly installed brakes
  - Recently recalled 2.6 million cars due to ignition switch issues

http://www.reuters.com/article/2014/02/12/us-toyota-recall-idUSBREA11B920140212
Automotive Trends and Challenges

- How do we balance safety and regulations, improved processes, and supplier controls?

**Improved Processes**
- Increased productivity
- Iterative development
- Less focus on process and documentation

**Safety and Regulations**
- Increases safety and reliability
- Requires enforcement of processes
- Traditionally revolves around waterfall processes

**Suppliers**
- Leverages existing expertise
- Must coordinate different processes
Polarion Customer Case Studies

- Quantum Technologies
  - Supplier for OEMs
  - Produces software and hardware

- AGI Greentech
  - Retrofitter of heavy duty vehicles
  - Mostly hardware, some software and calibrations

- Quantum is a supplier to AGI

- Polarion Automotive Template
Quantum Technologies

- Supplier to many OEMs
- Produces a wide range of natural gas storage systems
- Supplies engine mappings and ECUs for customers as well
- Needed a solution that could comply with ISO 26262 and Automotive Spice, while allowing them to retain an agile environment

“Polarion’s ISO 26262 qualification will save us a great deal of effort and cost in our own qualification process. We leverage Polarion’s ALM solution across our complete development lifecycle for requirements tracking, release packaging, test results, and full traceability coverage for vehicle hazards ISO 26262”

Maria Eugenia Zuniga, Quantum Technologies
Quantum Technologies has successfully combined Agile processes with ISO 26262 and Automotive Spice compliance

- Leveraged existing Polarion ISO 26262 template to create custom template for their processes
- Create workflow to guide developers through the required processes, without needing constant oversight
- Workflow engine and historical traceability help create self-documentation
- Because all work is tracked, less need for formal process meetings
AGI Greentech

- Diesel to CNG retrofitter for heavy duty vehicles
- Manufactures both replacement parts and systems as well as provides new ECUs and calibration settings
- Internal process deeply ingrained into culture, both traditional waterfall as well as agile
- Wanted a tool flexible enough to replicate existing processes
- Originally planned to only implement controls group, now rolling out to entire R&D
Collaboration

- AGI choose Polarion because of Quantum’s use
- Quantum supplies CNG systems and controls to AGI
- Collaboration occurred through sharing Polarion repositories, allowed both groups to track progress and items
- Both groups use their own processes, yet collaboration has been seamless so far
Functional Safety Management for Automotive Applications - ISO 26262

ISO 26262 is the adaptation of IEC 61508 to comply with needs specific to the application sector of E/E systems within road vehicles. ISO 26262 covers functional safety aspects of the entire development process (including such activities as requirements specification, design, implementation, integration, verification, validation, and configuration). ISO 26262 is based upon a ‘Y’ model as a reference process model for the different phases of your product development.

The Polarion ISO 26262 Template supports the Hazard Analysis and Risk Assessment as well as the Functional Safety Concept of the Concept Phase - ISO 26262 Part 3: Based on the functional safety requirements specified during the functional safety concept the technical, hardware and software safety requirements can be derived - ISO 26262 Part 4.5.6.

All the details can be found on Polarion ISO 26262 Template How-To.

Hazard Items by Status

<table>
<thead>
<tr>
<th>Status</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft</td>
<td>0</td>
</tr>
<tr>
<td>Analysed</td>
<td>1</td>
</tr>
<tr>
<td>In Progress</td>
<td>0</td>
</tr>
<tr>
<td>Completed</td>
<td>0</td>
</tr>
<tr>
<td>Rejected</td>
<td>0</td>
</tr>
</tbody>
</table>

Hazard Analysis and Risk Assessment Documents

- Item Definition
- Hazard Analysis and Risk Assessment
- Functional Safety Concept

Guidelines
- Polarion ISO 26262 Template How-To

Reports
- Report about Hazards by ASIL
- Report about Hazards Traceability
- Report about Safety Goal ASIL Inheritance
- Report about Safety Goal Coverage
- Report about Functional Safety Requirements ASIL Inheritance

Workflow Schemas

Hazard Workflow

Safety Goal
Safety Goal Items use the same workflow as Business Case Work Items.

Safety Requirement
Safety Requirement Work Items use the same workflow as Requirement Work Items.
Polarion Automotive Template
2.1 Context

Provide a context diagram of the system, with explanations as applicable. The context of a system refers to the connections and relationships between the system and its environment.

2.2 System Features

This template illustrates organizing the functional requirements for the product by system features, the major services provided by the product. You may prefer to organize this section by use case, mode of operation, user class, object class, functional hierarchy, or combinations of these, whatever makes the most logical sense for your product.

Itemize the detailed functional requirements associated with this feature. These are the software capabilities that must be present in order for the user to carry out the services provided by the feature, or to execute the use case. Include how the product should respond to anticipated error conditions or invalid inputs. Requirements should be concise, complete, unambiguous, verifiable, and necessary. Use "Ted" as a placeholder to indicate when necessary information is not yet available.

SAMPLE 1 - Some functional requirement representing a system feature. Itemize the detailed functional requirements associated with this feature as a sub requirements.

SAMPLE 4 - A more detailed functional requirement.
### Requirements, Test Cases, Defects, Traceability

#### Filter Requirements:
- **type**: requirement AND project.Id: andy26262
- **type**: testcase AND project.Id: andy26262
- **type**: defect AND project.Id: andy26262 AND status: open

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLE-1</td>
<td>Sema functional requirement representing a system feature. Itemize the detailed...</td>
</tr>
<tr>
<td>SAMPLE-2</td>
<td>A more detailed functional requirement.</td>
</tr>
<tr>
<td>SAMPLE-3</td>
<td>Test Case verifying related functional requirement</td>
</tr>
<tr>
<td>SAMPLE-4</td>
<td>As a &lt;role&gt;, I want &lt;goal/desire&gt; so that &lt;benefit&gt;</td>
</tr>
<tr>
<td>SAMPLE-5</td>
<td>User acceptance Test for &quot;As a &lt;role&gt; I want &lt;goal/desire&gt; so that &lt;benefit&gt;&quot;</td>
</tr>
<tr>
<td>SAMPLE-6</td>
<td>Failed. Test Case verifying related functional requirement</td>
</tr>
<tr>
<td>SAMPLE-7</td>
<td>Failed. Test Case verifying related functional requirement</td>
</tr>
<tr>
<td>SAMPLE-8</td>
<td>Failed. Test Case verifying related functional requirement</td>
</tr>
<tr>
<td>SAMPLE-9</td>
<td>Failed. Test Case verifying related functional requirement</td>
</tr>
<tr>
<td>SAMPLE-10</td>
<td>Failed. Test Case verifying related functional requirement</td>
</tr>
</tbody>
</table>

---

**Note:**
- The screenshot shows a page from the Polarion Automotive Template with various sections for requirements, test cases, and defects, highlighting the traceability feature.
- The filter options allow for specific type of requirements, test cases, or defects to be displayed.
- The table lists various sample requirements with detailed descriptions and status.
Easily Organize Mechatronics Artifacts into Polarion “Work Items”

Configurable Link Roles between Polarion “Work Items”

Web Search Engine

Integrated Safety Hazard and FMEA Risk Management built in

Full Web 2.0 software

Polarion “LiveDocs” and “RoundTrip” combine artifact and document based process

Fully configurable workflow Engine

Versioning in SVN repository provide Historical Traceability

Templates for standard processes (Agile, ISO26262, etc.)

Open API and integration platform
Polarion Solution for Automotive Customers

“We had ten months to achieve our objective, but actually reached CMMI Level III in just three months. That is a blistering fast pace for anyone in the industry”

Reggie Burgess, Project Configuration Manager

Improved Processes
- Historical Traceability helps self-documentation
- Workflow engine automates processes
- Lessens need on traditional progress tracking

Safety and Regulations
- Workflow enforces processes
- Centralized repository eases documentation
- Reporting helps ensuring all regulations and processes are being followed

Suppliers
- Easily share information with RoundTrip
- Web-based system helps collaboration across locations
Thank You

Andy Holton
Systems Engineer
Polarion Software, Inc.
andy.holton@polarion.com