# Solutions To Automate Collaborative Requirements Management

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# Solutions To Automate Collaborative Requirements Management

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**Abstract**: Years after years, the number of partners involved in a product development increases significantly. As a result and because of tight project schedule and high quality constraints, solution to improve the relationship between stakeholders of the same company, JVs, tier 1 and 2 is becoming mandatory to avoid project deliveries delays and bad quality (misunderstanding, lost requirements...).

Requirement-oriented document definition, with both standardized textual and/or graphical representations like SysML, is one of the best practices that appear for improving the communication and the exchange of specifications. Unfortunately even if requirement definition clarifies what the system shall do and speed up the commitment on system specification, the relationship, especially during specification negotiation and product delivery phases, is still time consuming due to heterogeneous processes and communication channels.

In recent years, some standards have begun to emerge which support the systems engineering process. HIS, a joint standard initiative of the German automotive industry created RIF (Requirement Interchange Format) for component specification exchange between OEM and potential tier suppliers.

This paper demonstrates two different solutions that have already been adopted by major companies of Automotive, Aerospace and Railway industries to automate such relationship with considerable cost-efficiencies, development time savings and quality improvements. It also introduces an innovative peer-to-peer solution upon this newly introduced RIF standard, based on an intelligent client and a light MySQL server allowing all the parties to share requirements from their original Requirement Management tool.

**Keywords**: Requirements management, model based design, Traceability Automation, Impact Analysis, DO178B, DO254, ISO 26262, RIF, Quality Process, workflow.

## 1. Introduction

Requirement management became years after years a recommended activity for addressing new market challenges. Projects complexity is increasing, managing diversity on products and reusability of components is now the only way to stay competitive. Compliance with standards (FAA, FDA, ISO, Sarbanes-Oxley…) and providing evidence of quality is mandatory to address new markets.

At the end, all these new objectives are reinforcing company's motivation to put in place such a new methodology, giving quantifiable benefits on product quality and product development time saving.

The fact that product development is now distributed across organizations from different companies changes requirement management problematic. Specification and traceability evidences have now to be exchanged between different organizations. As a consequence, Requirement Management has to evolve to facilitate collaborative aspects especially for requirement exchange and traceability data consolidation.

This paper presents several approaches based on Reqtify technology that have been chosen by companies from Aerospace, Automotive and Railway industries to succeed implementing collaborative requirement management with their partners.

## 2. Reqtify Technical Overview

Reqtify is a requirement management and traceability technology, originally born and matured in the European Aerospace industry, now also developing fast in other safety critical domains like Automotive, Railway, Energy, Semiconductors and pharmaceutical industries.

The solution has been used on projects under most demanding quality and domains standards constraints:

- Aerospace: DO178B/C, DO254…

- Automotive: ISO26262, Spice, AUTOSAR…

- Railway: EN5012x, IEC6150x…

- Defense: MoDAF, DoDAF.

- Medical Devices: CFR 21part11, GAMP.

- Allow to meet CMMI Objectives.

Reqtify is an innovative technology that allows keeping engineering teams focused on their daily work, synchronized and focused on requirements, implementation and verification.

Typical use cases are System requirements defined using Word[TM,] Requirement Management tools, and refined using model-based approach with Simulink[TM] or Statemate[TM], or a SysML[1] approach. SysML provides an emerging approach leveraging modelled requirements vs. textual requirements. Some advanced SysML tools or verification tools offer requirements traceability features, provided the requirements are created in their environment.
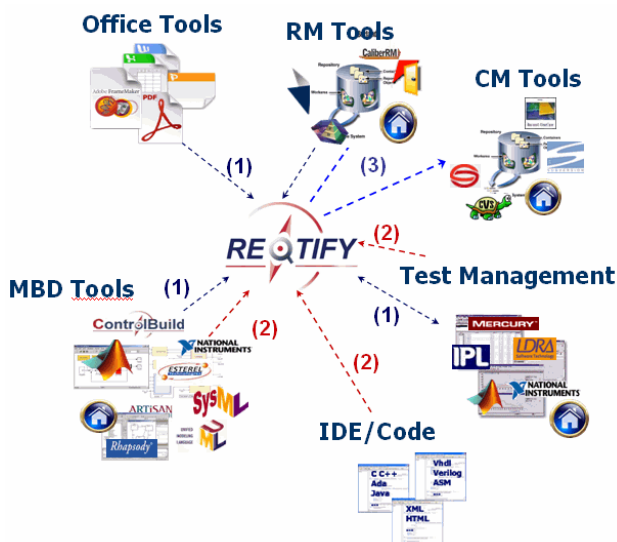


Figure 1: Requirement Traceability everywhere

(1) Requirements are captured from any source. They are made available everywhere for simple traceability

(2) Traceability is easily performed directly in the authoring, testing and coding environments.

(3) Work results and Traceability can be uploaded into repositories.

The Reqtify engine also takes as inputs process information describing expected traceability relations, and Company Standards describing requirements syntax.
Results can be filtered to allow more accurate and oriented analysis and rules check consistency with best practices or company own process rules. Generic and/or specific analysis results are made available for users through the intuitive GUI, for reports generation, and also for 3rd party tools.
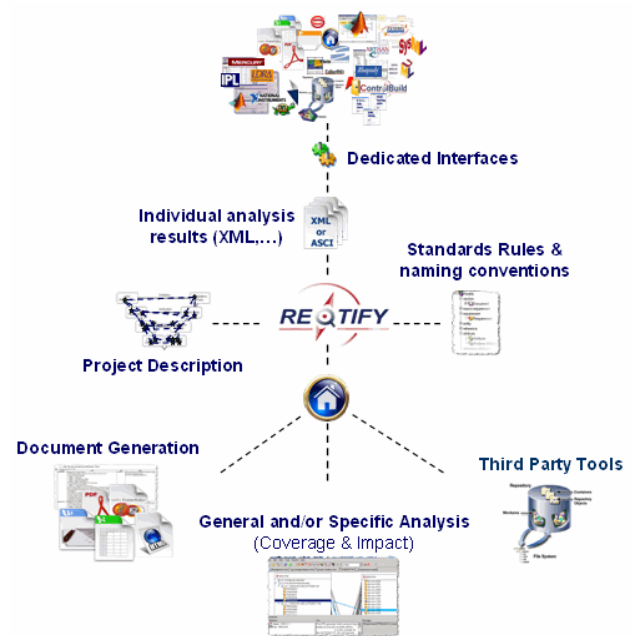


Figure 2: Analysis of Project information

## 3. Reqtify centric approach

Consolidation of partner's data is always time consuming and can be really painful if it has not been managed and fully organized in advance. This use case will demonstrate on a software component development project how to share traceability data between internal and external organization that are all using Reqtify technology.

In most of 90% of the case the OEM lead the relationship and consolidate partner's project files in order to manage requirements globally and to show traceability evidences on the entire development lifecycle. The main benefits of this approach are the lightweight of the exchanged data (attached to an email) and the automatic linkage of partner's artifacts to the original requirements. This mode is fully automatic and allows OEM to measure impact analysis & global requirement coverage on both sides (OEM & Partners).

The figure 3 just below depicts the traceability project hierarchy as it has been specified by the OEM.
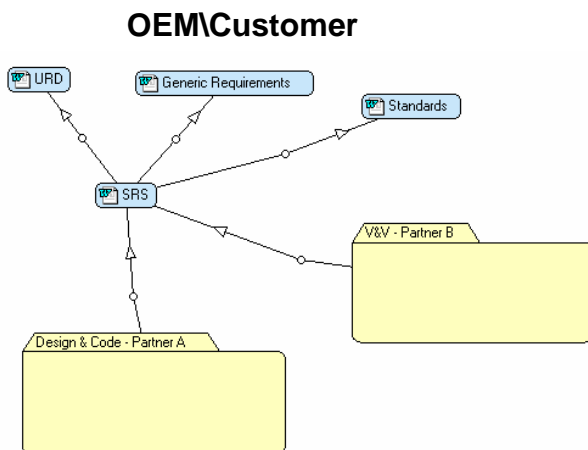
## OEM\Customer



Figure 3: Traceability project on OEM/Customer side

In this case the SRS (Software Requirement Specification) is the "software contract document" between all stakeholders. This is not a pre-requisite. It should be one for each partner but it is mandatory to establish and manage this "contract document" in a point-to-point relationship, to improve understanding and to automate the consolidation within Reqtify.

On the OEM side, the SRS is covering a set of requirements coming from corporate know-how (Technical & Quality requirements) and Marketing requirements (User Requirement Document).

The Software Requirement Specification document will be shared with partners A & B with Reqtify type of analysis that will give the ability to all stakeholders to automatically integrate and capture Requirements within Reqtify.

At this stage each of the partners is fully independent and can manage his own Reqtify project throughout the activities he is in charge of.

Figure 4 just below describes partners traceability projects in Reqtify. Partner A is in charge of Design and Coding activities where verification and validation will be managed by Partner B
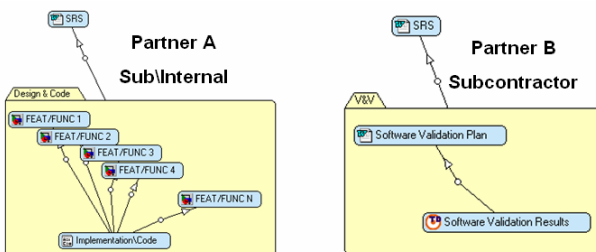


Figure 4: Traceability project on Partners side

Partner A has to fully cover requirements captured from SRS document with Simulink$^{TM}$ designs.

Traceability data as design hierarchies are extracted from each *.mdl file. As soon as traceability data are added by Designers, requirements coverage information is updated in a real time basis in Reqtify. In the same way, a code developer will add formalized comments at the top of each function or directly in the header of each file to manage requirement traceability in his piece of code.

As a consequence, each designer and coder can analyze how well requirements he/she is in charge of get covered and can easily measure the remaining required effort. Project manager and\or quality manager will take care of the full traceability picture as they have information in real time from Software Requirements to design and code. Reqtify gives a global view of the overall project status enabling risk analyses and providing help to prove compliancy with project requirements and constraints.

For each delivery, partners will provide, in addition to product data, a Reqtify file (*.rqtfimage) that is containing all the extracted information from real project data. This file will be used by the OEM in order to merge partner sub-project with the original Reqtify project. As a result the contractor can measure requirement traceability and impact analysis from highest level requirements to partner's artifacts. He can generate automatically traceability matrices on the entire design activities.

As Partner A, Partner B will have to fully cover software requirements with his V&V artifacts. A Software Validation Plan will first depict all the V&V activities that are going to cover all the software requirements. Then the validation plan will be covered by the test cases and the final test results within Quality Center$^{TM}$. Verification engineers can link verification plans and results to both system and technical requirement assessments and can measure the impact of failed test results on higher level requirements. Partner B will generate an *.rqtfimage file in order to provide the entire traceability graph to the OEM. The OEM is now able to see all the verification branch traceability linked to the Technical, Quality and Business related requirements. No need to acquire all the tools that have been used by partners. Even real data are not requested by Reqtify to recreate the entire Traceability graph!
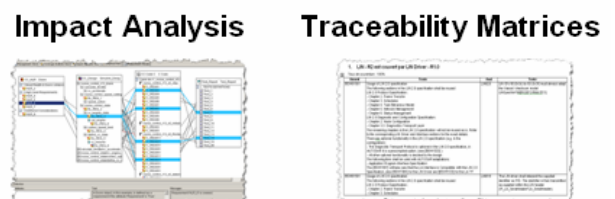


Figure 5: Impact analysis & Traceability matrix on OEM side

As a result, the OEM is now able to generate automatically global traceability matrices on both validation and conception activities (Figure 5). Thanks to Reqtify, measuring risk and impact on project activities at each milestone is now as simple as one click away, even on partners activities.

## 4. Doors centric approach

If we consider the global project lifecycle, trying to get all the information managed in the DOORS database may lead to a huge and non reasonable effort. Project artifacts are generated by a significant number of tools and practices. This situation exists between internal teams but also, at a larger scale, for relationship between a customer specifying the "system" or the "equipment (LRU, ECU)" and subcontractors.

The Reqtify technology is widely used and offers support of several practices that we describe here.

The best solution to apply depends on several criteria:

- The first criteria will be the capability (or not) for the subcontractor to access the Doors requirements database.

- The reference applied to the customer-subcontractor relationship. Frequently the reference to consider is a set of documents.

The Figure 3.1 describes several ways to create requirements-based exchanges between the customer and the subcontractor.
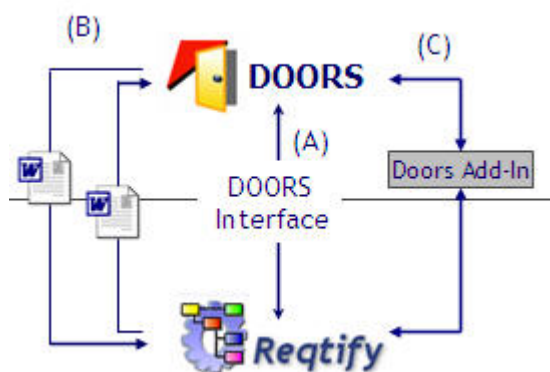
Figure 5: Several collaboration solutions.

Case B is a case very widely used. In a lot of contexts, the reference for the exchanges are documents (Word, PDF,…). Typically, requirements

are discussed and defined using Doors; Specifications documents which are then sent to subcontractors are Word documents generated from Doors. So we see a lot of cases where subcontractors say "our requirements come from Doors", the reality being that requirements are contained in Word documents coming from Doors.

In the same way, what is expected by the customer is a set of traceability matrices, contained in Word documents generated by the subcontractor, typically an appendix to the Design Document,…).

In this case there is no real logic to have a direct interface between tools: The customer uses Doors, then generates Specification documents. Reqtify captures requirements in those documents, and also captures project artifacts with the traceability information, then generates traceability matrices that are sent to the customer.

Hundreds of projects are in this case, since the very first versions of Reqtify in 2001.
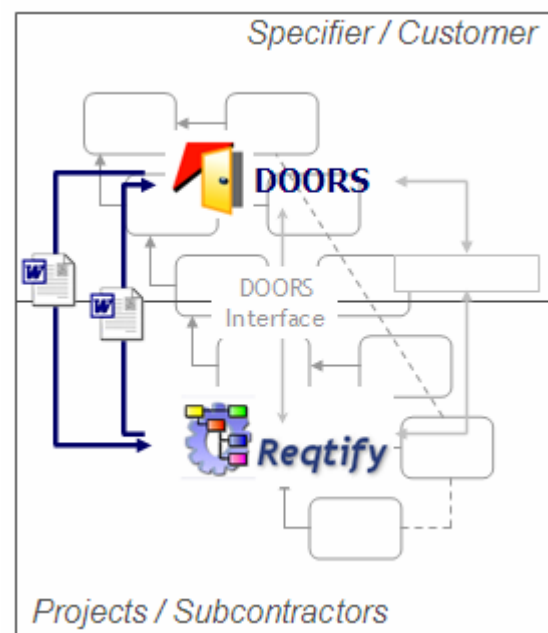
Figure 6: Document-based exchanges

Characteristics of this case are as follows:

- More consistent and synchronized with the contracts that are usually document-based.

- Tool Independent (all the documents could even be written manually…)

- Tool capabilities are not fully used, a gap still exists between the customer and the subcontractor environments and exchanges are timed by document releases.

In the case A, there is a direct, bidirectional exchange between tools:

Doors requirements are captured directly from the database,

Project artifacts and traceability information captured by Reqtify can be directly uploaded in the Doors database, allowing Doors users to navigate in the whole project lifecycle.
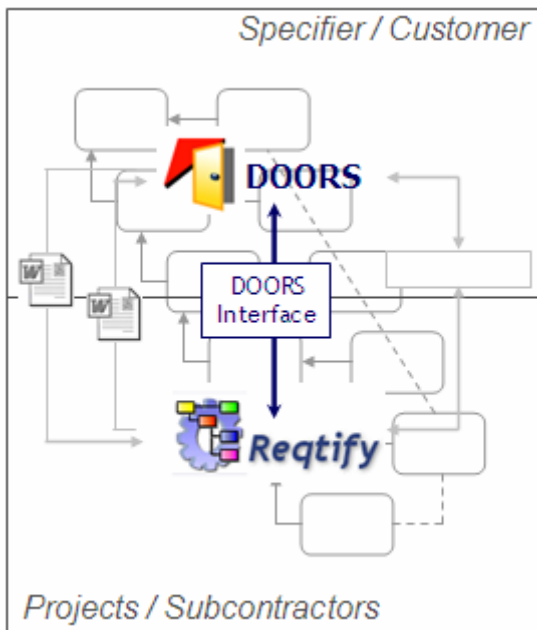


Figure 7: Direct bidirectional collaboration

Frequently used in the "Reqtify" context, this solution is widely used with the Reqtify technology being integrated into development and verification workbenches from several leaders: Telelogic (Rhapsody Gateway), Esterel Technologies (SCADE RM Gateway) LDRA (TBreq),...

In practice, this approach makes it easier or even possible to deploy the requirements management process with traceability of DOORS requirements at all steps of the project lifecycle.

The Reqtify technology creates a universal, bidirectional interface between the requirements database and the software and hardware tools/

Characteristics of this case are:

- Subcontractors, internal or external, need to have access to Reqtify but also to the Doors database,

- Very good acceptance by project teams, tools are used according to their respective positioning

- More cost effective for the projects, because of the very effective deployment cost of Reqtify

All exchanges between customer and subcontractors are fully based on Doors formats (.dma,…)

This solution is fully transparent for Doors users, who get all the artifacts automatically imported into Doors including with the traceability information (*link modules*), which is unique.

Thanks to this engineering tools collaboration, Doors users (System engineers usually) can easily extend their analysis scope if they want.

This difficult point is the introduction of 2 tools related to "requirements" and to explain to non-technical stakeholders the differences and potential synergy.
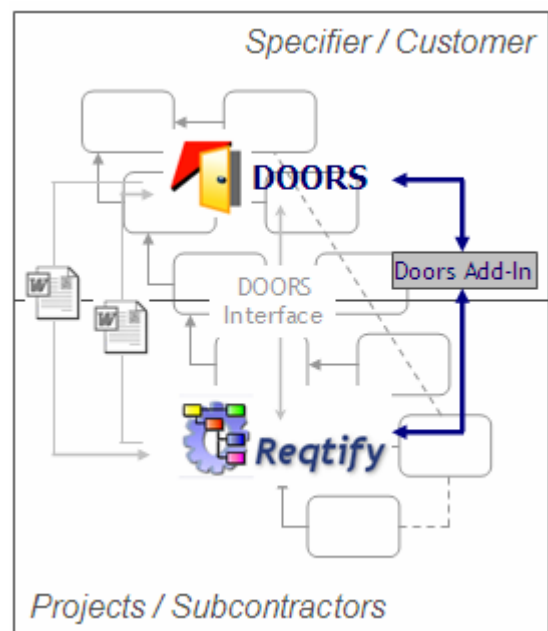


Figure 8: Integration as a Doors Add-In

Case C is the integration of the Reqtify technology as a Doors add-in.

Some menu items are added in Doors allowing using Reqtify in batch mode.

- The add-in is used to export the Doors module in a ready-to-use XML format, which is sent to the subcontractor.

- The subcontractor uses the XML file to extract requirements, works on his project and performs traceability,

- The image of the project artifacts and traceability results are sent in the Reqtify format to the customer.

- From Doors, the customer imports the information into Doors, and the corresponding modules and linked modules are created.

Highlights for this case are:
- Subcontractor needs only Reqtify
- Specifier/customer needs to modify the Doors configuration to include this add-in.

## 5. Specification exchanges between OEMs & Suppliers

Another key aspect of a collaborative requirement management approach is the requirement exchange between OEMs, Suppliers and the different partners involved in the product development process. A wide range of benefits for system engineering and purchasing departments is created by the edition of a central specification that becomes the reference for both sides.

The main difficulty of this approach, as soon as requirement has been specified correctly (i.e. unambiguous, complete, testable, and traceable, with good granularity...), is to manage the arbitration on requirements and to create the good specification configuration according to component variants. VDA [2] provides the prerequisite for raising quality on a standardized component requirement specifications document in the automotive industry.

To address this objective, a primary need is the ability to import and export automatically specifications between different IT/Requirement Engineering tools. Reqtify implements exchange automation between different requirement management and Office tools: it has already been chosen to manage the relationship between major automotive actors. The two others benefits are the capability to keep the history on specification negotiation and to create specific requirement configurations on system variants.

HIS [3] has defined a requirement interchange format RIF [3] to break down the boundaries between RE tools available on the market. Reqtify has integrated this format as a new entry point called RIF Gateway. The picture just below shows a requirement exchange process with change and specification configuration management that has been implemented with this solution:
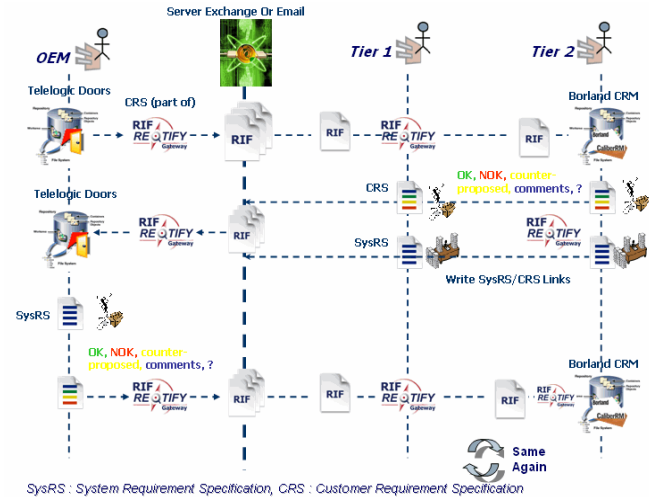


Figure 9: Typical specification exchange between OEM and partners.

## 6. Conclusion

In today's projects which involve distributed teams, a large number of tools, tasks sharing, etc., it is necessary to consider flexible and open solutions in order to successfully manage diversity.

This paper has provided several use cases where requirement management can be shared and kept synchronized between project stakeholders from different organizations.

For the companies that prefer collaboration between tools rather than the difficult objective of deploying the same solution everywhere for everyone, it is now proven that there is a technology that can leverage the respective added values of several tools and environments, for system, software and hardware engineering domains.

Worldwide economy evolution is impacting all process & practices needed to reach quality level objectives requested by market demands. The key success factors for system companies are directly related to their capacity to efficiently reduce time spent between the different stakeholders in the product development chain. Reqtify is a proven technology, which has been widely delivering its value in achieving such goals; in all of its current market sectors - automotive, aerospace, train transportation etc.., Reqtify has confirmed that avoiding revolution with pragmatic evolutions is the safe and cost-effective way to go.

## 7. About the Authors

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Eric holds a Master 2 Pro in Quality and Safety of embedded systems. After some years as an R&D Engineer in Valiosys company - where he worked on software formal verification of safety critical applications, Eric Joined TNI-Software as a Worldwide Field Application Engineer.
Eric is currently Reqtify Products Line Manager for Geensys (ex TNI-Software), in charge of the requirement-based solutions and tools integration for major companies in Aerospace, Automotive, Railway and Semiconductors worldwide.
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Lionel is Aerospace Business Unit Manager for Geensys (formerly TNI-Software).
Before joining Geensys, Lionel worked 11 years for the French Ministry of Defense (DGA, CEAT), and has been involved in Certification for Military and Civil aircrafts, and in RTCA / Eurocae Working Groups.
He acts as a Senior Consultant for requirement management process definition and deployment for major companies in Aerospace, and until 2006 for Automobile and Railway transportation.
Lionel initiated and chairs the DO-254 Users Group.
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**Eliane Fourgeau**

Eliane is Geensys VP Sales & Marketing.
She has a long experience working in the EDA industry on tool based development paradigms with a prime focus on system level design, addressing the needs of large customers in the transportation, telecommunication and consumer industries worldwide.
Before joining Geensys (ex TNI-Software) she was European System Sales Manager at Cadence.
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[2]     VDA "*Automotive standard guideline component requirement specification.*" - VDA/QMC project, May.2006

[3]     "HIS*: Specification - Requirements Interchange Format (RIF)."* - HIS, November.2005

## 9. Glossary

*PDF*:    Portable Document Format
DOORS is a tool from Telelogic
Simulink is a tool from The Mathworks
Quality Center is a tool from HP-Mercury
RIF: Requirement Interchange Format