Requirements Exchange: From Specification Documents to Models

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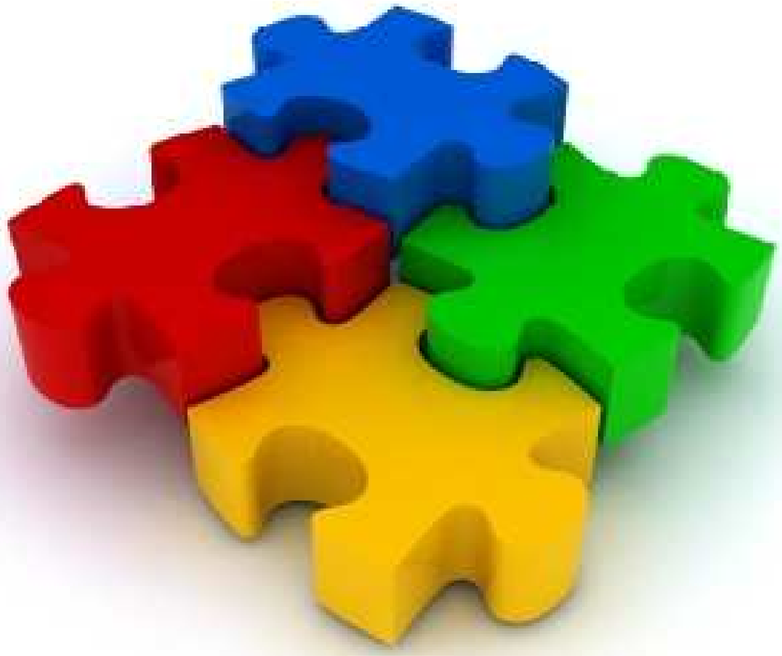
Agenda

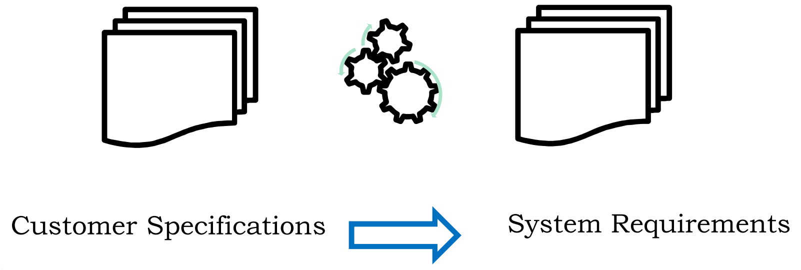
Big picture



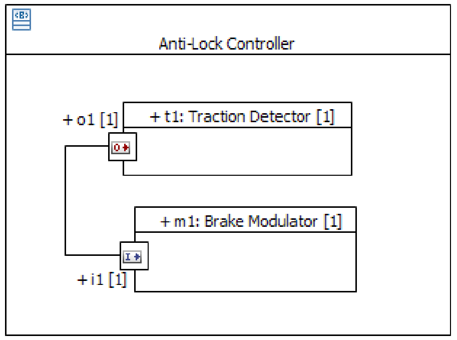
Requirement engineering steps

- Requirements Engineering can be divided into discrete chronological steps:
  - Requirements elicitation,
  - Requirements analysis and negotiation,
  - Requirements specification,
  - System modeling,
  - Requirements validation,
  - Requirements management.

- For elicitation, analysis, negotiation & specification activities, requirements are in text format*



- For system modeling activity, a system architecture is defined in graphical environment*

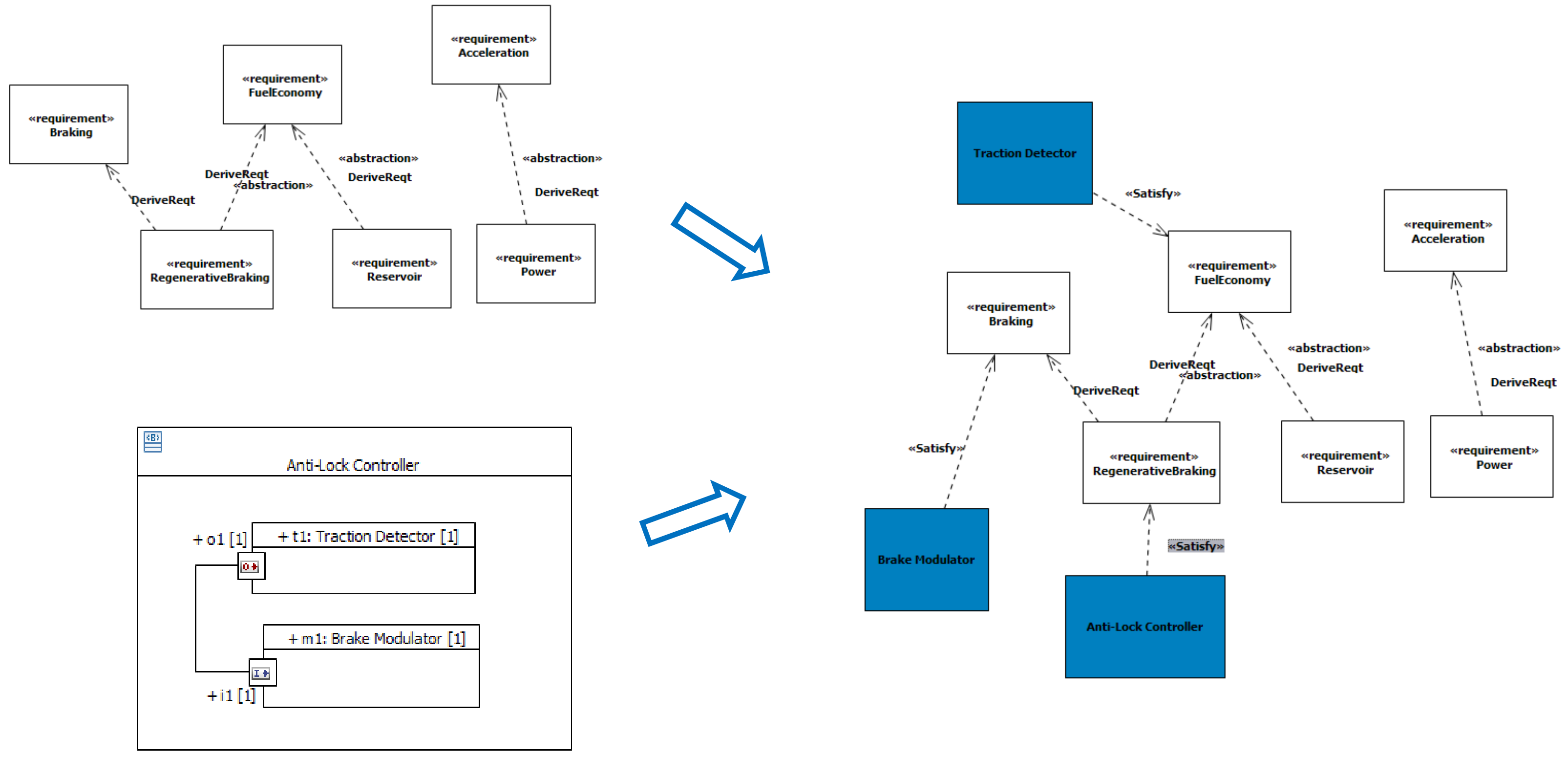


System architecture

* General practices in automotive industry

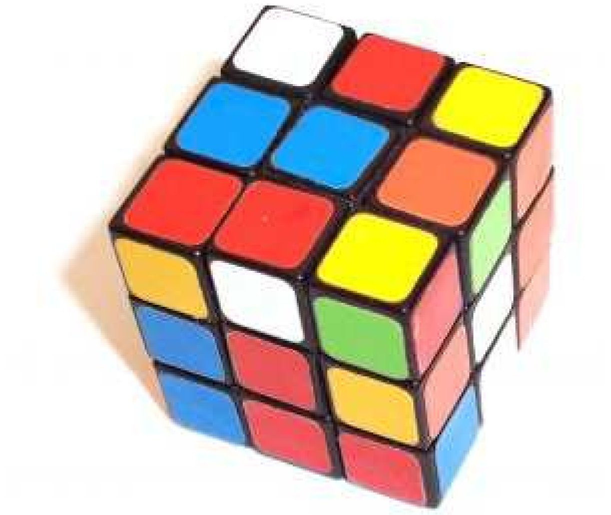
Requirement allocation

- To allocate requirements on system architecture, requirements engineers **manually** define the requirements model from system requirements



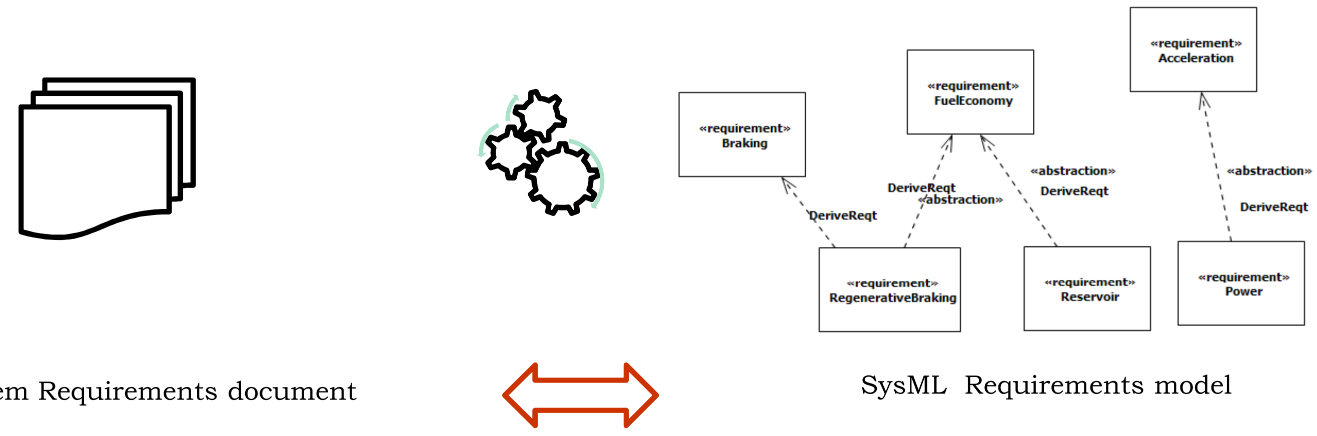
- Problem: Each time the system requirements are changed, the requirements model must be updated

Challenge



Requirements modeling

- Goal
  - Document the customer needs from source specifications in the required environment as well as requirements model



- Preconditions
  - System requirements in MS documents (Excel™, Word™)
  - Requirements model in SysML (UML2 Profile)
  - Requirements in model are identical that requirements in requirements document

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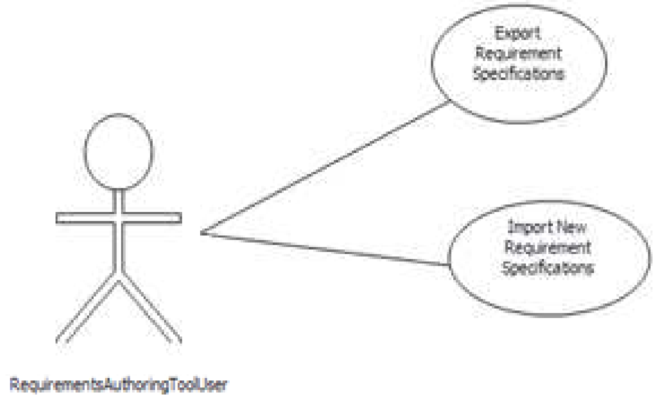
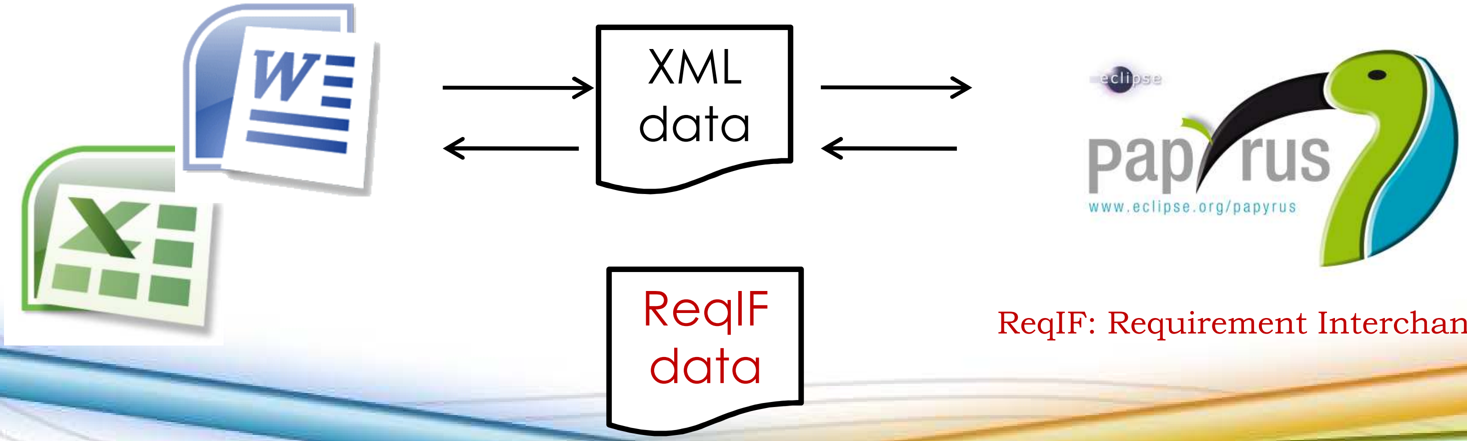
Use Case & Scenario

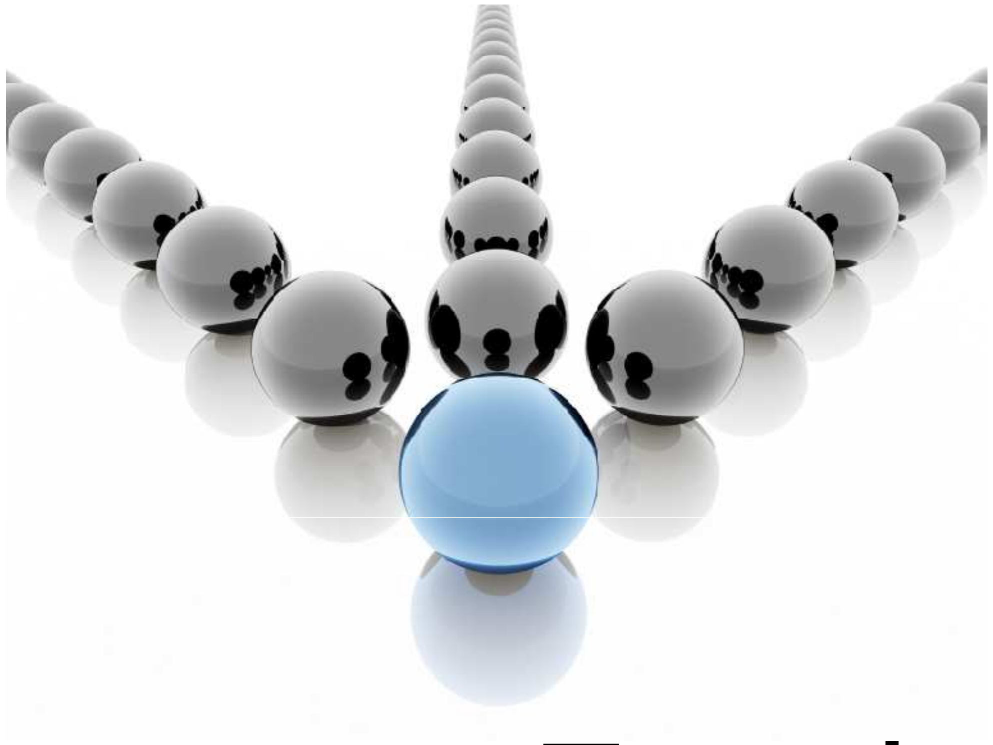
- Use Case :
  - Export requirements from documents
  - Import requirements from modeling tool (with Papyrus MDT tool)


Export Requirement Specifications
Import New Requirement Specifications
RequirementsAuthoringToolUser

- MS documents allow to export (import) data in XML format
- UML2 modeler allow to import (export) data in XML format
  - Scenario: transferring XML documents compliant to a standardized format



ReqIF: Requirement Interchange Format



Technologies

MDT Papyrus

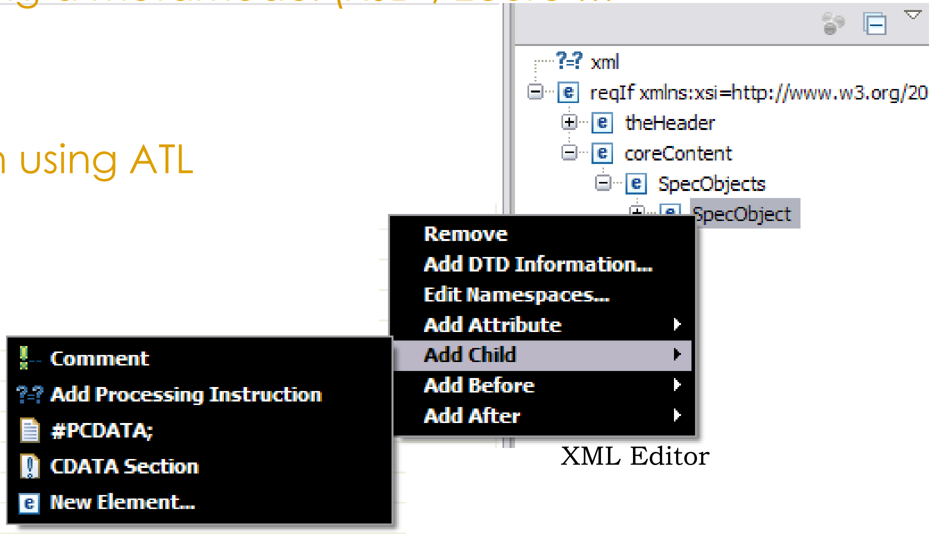
Graphical editor under the Eclipse Model Development Tool (MDT)

Features:

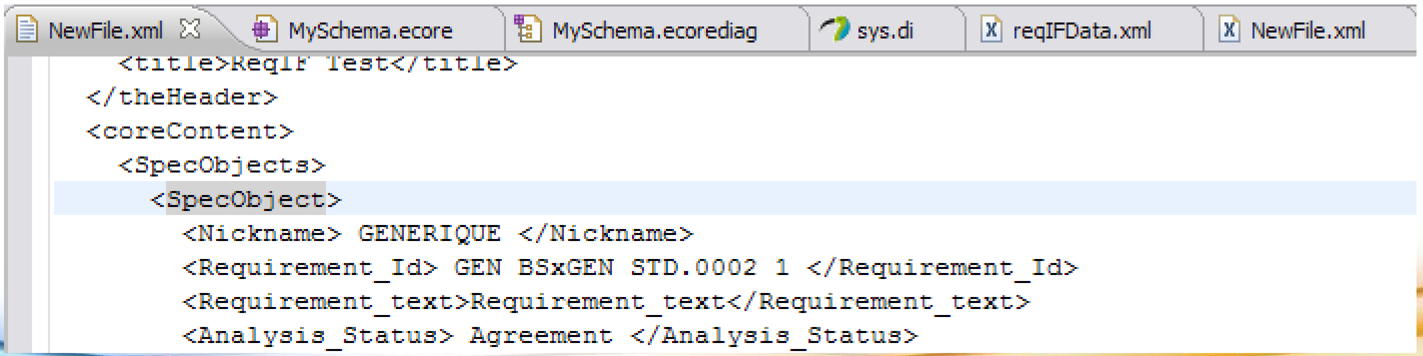
- UML2.2
  - Papyrus targets to implement 100% of the OMG specification
- Domain Specific Language (DSL)
  - Papyrus provides advanced support for UML profiles enabling support for pure DSL: MARTE, EAST-ADL2, CCM…
- SysML
  - Provides complete support to SysML (static profile and graphical editors)
- Text
  - Possible to edit model elements using contextual text editors (syntax highlight, completion, content assist…)
- Code Generation
  - In Java, C/C++, Ada…
- Customization
  - Every part of Papyrus may be customized: model explorer, diagram, property and text editors…
- And more…
  - Glue around valuable UML/SysML diagram editors & others MDE tools

We are mainly interested in:

- XML Editor in Papyrus
  - Manage XML node and data following a metamodel (XSD , Ecore …
- Model transformation and Editor
  - Model 2 model (M2M) transformation using ATL
- Text editor
  - XML data in text format
  - Model in text format (XMI)



XML Editor



```
    <title>ReqIf Test</title>
  </theHeader>
  <coreContent>
    <SpecObjects>
      <SpecObject>
        <Nickname> GENERIQUE </Nickname>
        <Requirement_Id> GEN BSxGEN STD.0002 1 </Requirement_Id>
        <Requirement_text>Requirement_text</Requirement_text>
        <Analysis_Status> Agreement </Analysis_Status>
```

Text Editor

ReqIF

- We choose the Requirement Interchange Format (ReqIF) to link the 2 steps
- ReqIF Properties:
  - Open standardized (Object Management Group)
  - Generic, non-proprietary and tool-independent format
  - Based on XML standard
  - Developed to exchange requirements between authoring requirement management tools
  - Driven by car industry

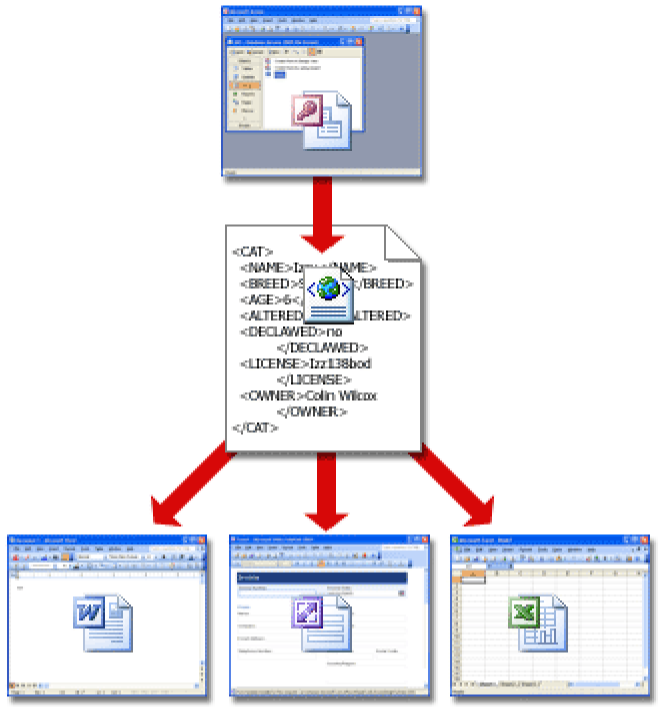
- ReqIF features:
  - Uniquely identify requirements
  - Associate attributes with the requirements, e.g. a requirements text, an attribute value,
  - Establish relations between requirements…
  - Structure specifications hierarchically

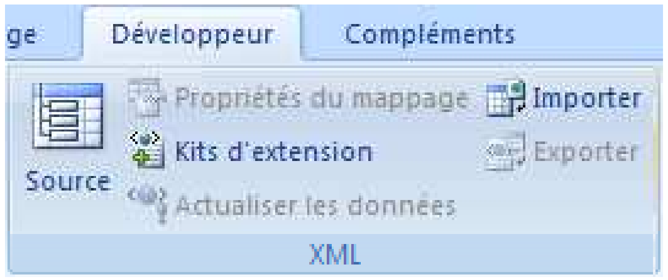
- ReqIF structure (main XML tag):
  - ReqIFheader (comment, creationTime, identifier… Title)
  - ReqIFContent (DataTypeDefinition, SpecType, SpecObject, SpecRelation…)
  - ReqIFToolExtension

MS Documents

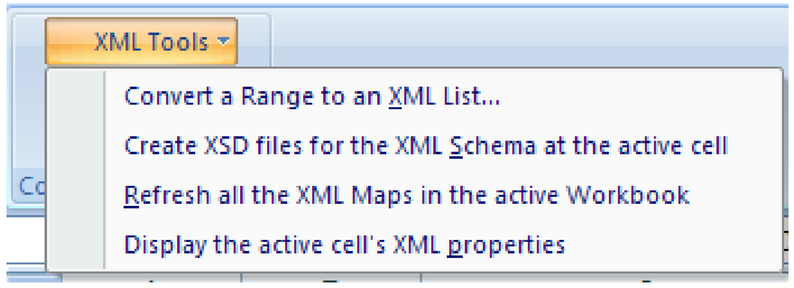
We use Excel™ and Word™

- Microsoft provides an XML tools add-in to build XML-enabled applications
  - Import /Export data in XML (.xml)
  - Manage XML schema(.XSD) from a document
  - Transformation and style (.XSL, .CSS)





Developer tab



XML Tools
Convert a Range to an XML List...
Create XSD files for the XML Schema at the active cell
Refresh all the XML Maps in the active Workbook
Display the active cell's XML properties

Complement tab

Experiment approach

Mapping rules

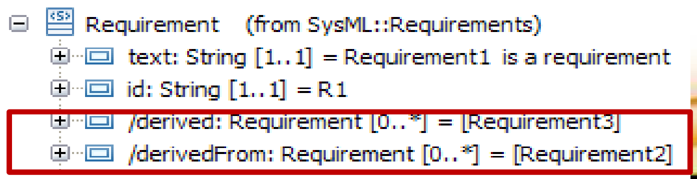
- Mapping Table ReqIF – MS document – UML

ReqIF Term	MS Excel™	MS Word™	UML element
SpecObject	Row	Table Row*	Requirement
Attribute	Cell	Cell	Attribute
Datatype	n/a	n/a	n/a
SpecRelation	Specific Row	Specific Row	Trace links

- **SpecObject**: In MS Word™, a requirement is defined following a table template*

Requirement ID	Description	ID references
The requirement ID	The text requirement	All requirement IDs related to the requirement

- **Attribute**: Attributes element are **id** and **text** in the SysML context
- **Datatype**: In MS document, all data are string. Then, there are no specific datatype defined.
- **SpecRelation**: relation between 2 SpecObject:
  - In MS document
    - source : The current id requirement
    - target : one of ID reference
  - In UML
    - Source : the current id requirement
    - Target: the content of a traceability link


Requirement (from SysML::Requirements)
text: String [1..1] = Requirement1 is a requirement
id: String [1..1] = R1
/derived: Requirement [0..*] = [Requirement3]
/derivedFrom: Requirement [0..*] = [Requirement2]

From MS documents to ReqIF

Steps to export data (requirements) from MS documents to XML file with ReqIF format

1 •Open a requirements specification document (Word ™ or Excel ™)

2 •Import ReqIF metamodel (ReqIF XML Schema from OMG) in Excel ™
  •Integrated plug-in/ feature of MS documents

3 •Map ReqIF element from XML Schema to Cell by drag and drop

4 •Export mapping data in ReqIF XML format

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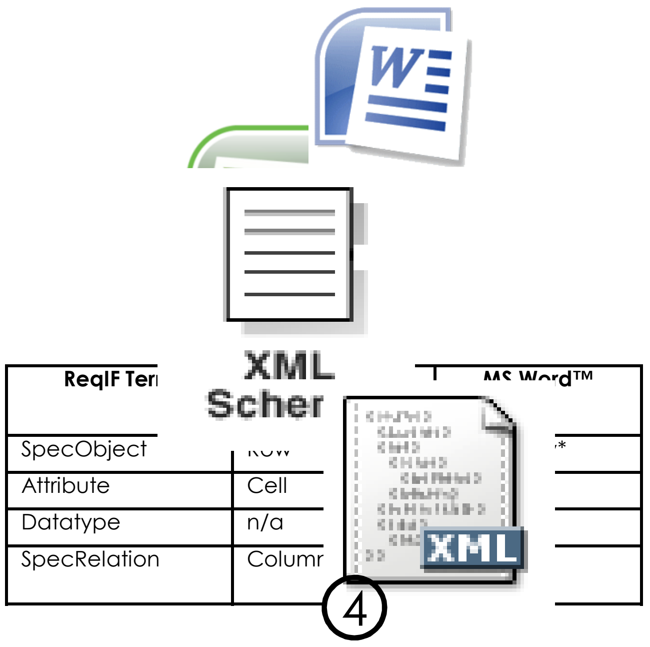


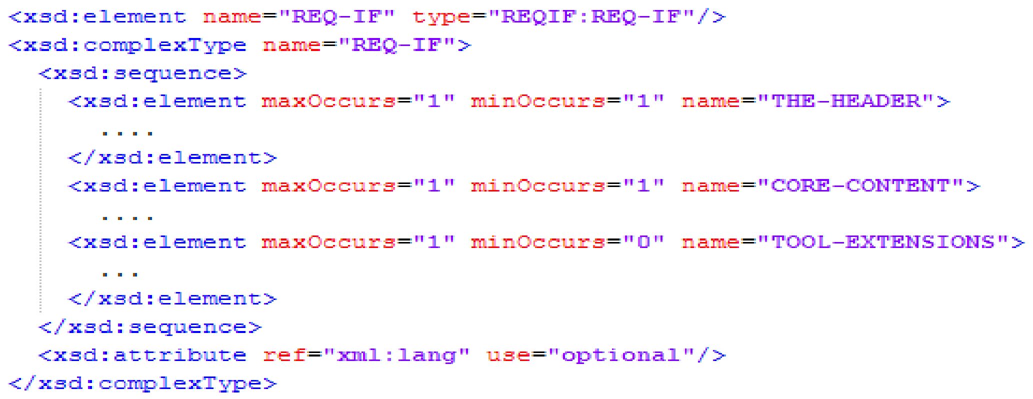
ReqIF Ter		MS Word™
SpecObject	Row	*
Attribute	Cell	
Datatype	n/a	
SpecRelation	Columr	

From MS documents to ReqIF

Steps to export data (requirements) from MS documents to XML file with ReqIF format

1. Open a requirements specification document (Word™ or Excel™)
   1. Install Developper and Complements add-in to access to XML tools features

2. Integrate the ReqIF metamodel in MS document
   1. Use the OMG ReqIF metamodel in XML schema format
   2. Modify the OMG XML schema to have only element which interest us (SpecObject, SpecRelation, Header)

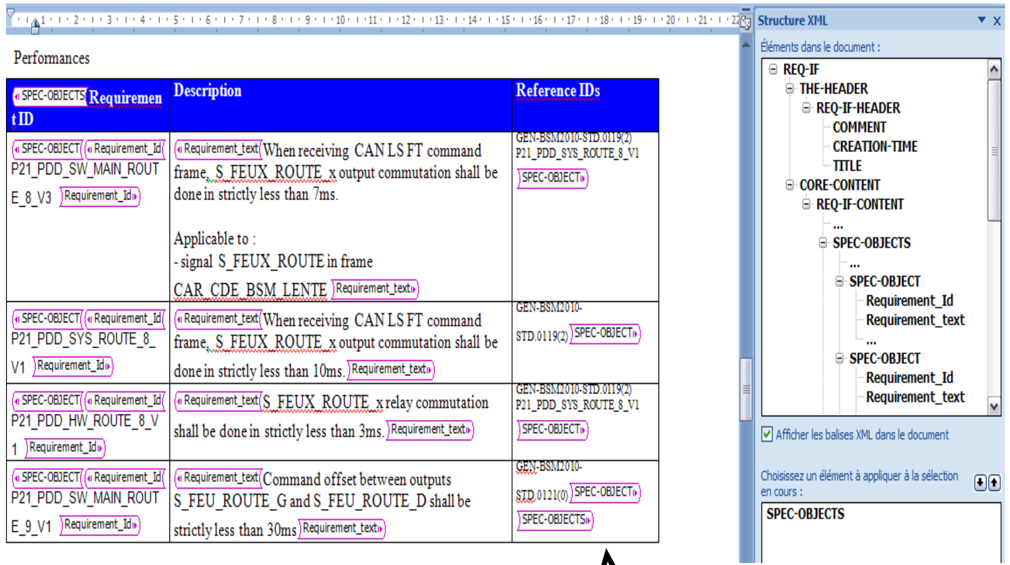


```
<xsd:element name="REQ-IF" type="REQIF:REQ-IF"/>
<xsd:complexType name="REQ-IF">
  <xsd:sequence>
    <xsd:element maxOccurs="1" minOccurs="1" name="THE-HEADER">
      ....
    </xsd:element>
    <xsd:element maxOccurs="1" minOccurs="1" name="CORE-CONTENT">
      ....
    <xsd:element maxOccurs="1" minOccurs="0" name="TOOL-EXTENSIONS">
      ...
    </xsd:element>
  </xsd:sequence>
  <xsd:attribute ref="xml:lang" use="optional"/>
</xsd:complexType>
```

3. Map the XML schema element on data in MS document by drag and drop
   1. Tags appear in the document

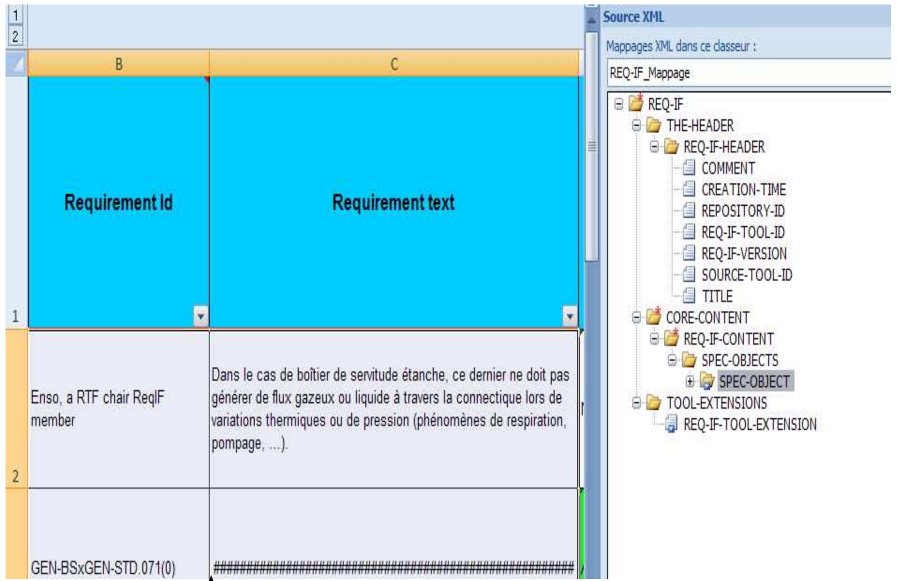
4. Export the data mapped in XML file

From MS documents to ReqIF



Performances

«SPEC-OBJECTS(Requirement ID	Description	Reference IDs
«SPEC-OBJECT(«Requirement_Id(P21_PDD_SW_MAIN_ROUTE_8_V3)Requirement_Id»	«Requirement_text(When receiving CAN LS FT command frame, S_FEUX_ROUTE_x output commutation shall be done in strictly less than 7ms. Applicable to : - signal S_FEUX_ROUTE in frame CAR_CDE_BSM_LENTE)Requirement_text»	GEN-BSM2010-STD.0119(2) P21_PDD_SYS_ROUTE_8_V1)SPEC-OBJECT»
«SPEC-OBJECT(«Requirement_Id(P21_PDD_SYS_ROUTE_8_V1)Requirement_Id»	«Requirement_text(When receiving CAN LS FT command frame, S_FEUX_ROUTE_x output commutation shall be done in strictly less than 10ms.)Requirement_text»	GEN-BSM2010-STD.0119(2))SPEC-OBJECT»
«SPEC-OBJECT(«Requirement_Id(P21_PDD_HW_ROUTE_8_V1)Requirement_Id»	«Requirement_text(S_FEUX_ROUTE_x relay commutation shall be done in strictly less than 3ms.)Requirement_text»	GEN-BSM2010-STD.0119(2) P21_PDD_SYS_ROUTE_8_V1)SPEC-OBJECT»
«SPEC-OBJECT(«Requirement_Id(P21_PDD_SW_MAIN_ROUTE_9_V1)Requirement_Id»	«Requirement_text(Command offset between outputs S_FEU_ROUTE_G and S_FEU_ROUTE_D shall be strictly less than 30ms)Requirement_text»	GEN-BSM2010-STD.0121(0))SPEC-OBJECT»)SPEC-OBJECTS»



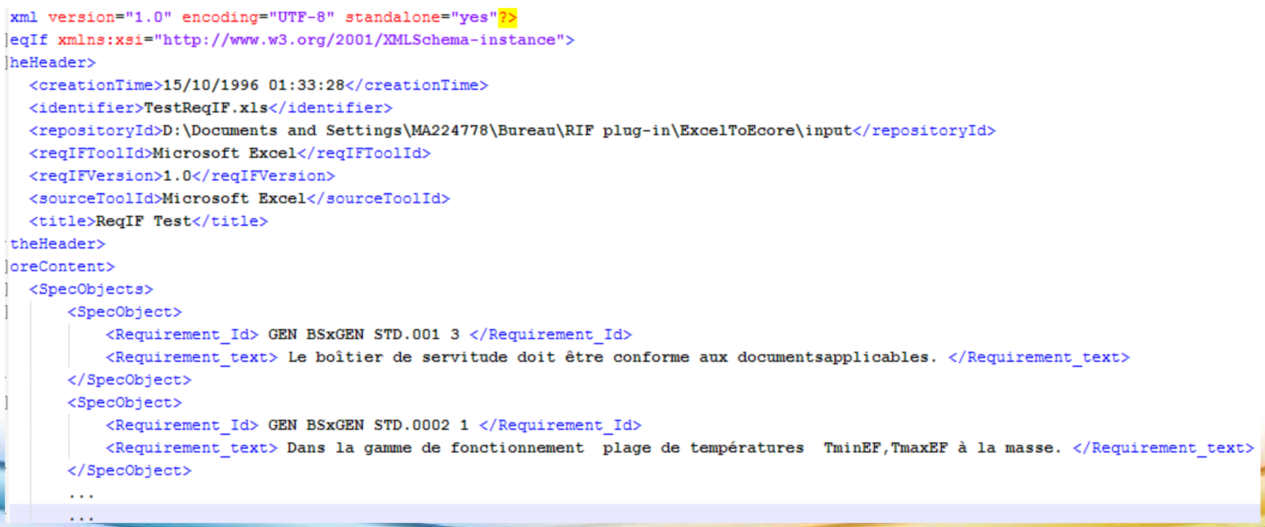
	B	C
1	Requirement Id	Requirement text
2	Enso, a RTF chair ReqIF member	Dans le cas de boîtier de servitude étanche, ce dernier ne doit pas générer de flux gazeux ou liquide à travers la connectique lors de variations thermiques ou de pression (phénomènes de respiration, pompage, ...).
	GEN-BSxGEN-STD.071(0)	##

From Word

From Excel

XML File

(ReqIF Format)



```
xml version="1.0" encoding="UTF-8" standalone="yes"?>
]eqIf xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
]heHeader>
   <creationTime>15/10/1996 01:33:28</creationTime>
   <identifier>TestReqIF.xls</identifier>
   <repositoryId>D:\Documents and Settings\MA224778\Bureau\RIF plug-in\ExcelToEcore\input</repositoryId>
   <reqIFToolId>Microsoft Excel</reqIFToolId>
   <reqIFVersion>1.0</reqIFVersion>
   <sourceToolId>Microsoft Excel</sourceToolId>
   <title>ReqIF Test</title>
theHeader>
]oreContent>
]  <SpecObjects>
]      <SpecObject>
          <Requirement_Id> GEN BSxGEN STD.001 3 </Requirement_Id>
          <Requirement_text> Le boîtier de servitude doit être conforme aux documentsapplicables. </Requirement_text>
       </SpecObject>
]      <SpecObject>
          <Requirement_Id> GEN BSxGEN STD.0002 1 </Requirement_Id>
          <Requirement_text> Dans la gamme de fonctionnement  plage de températures  TminEF,TmaxEF à la masse. </Requirement_text>
       </SpecObject>
       ...
       ...
```

From ReqIF to SysML

Steps to import data (requirements) from XML file with ReqIF format to UML modeler

1
- Import the XML file in ReqIF format in a new SysML project

2
- Import the ReqIF metamodel (ReqIF CMOF file from OMG) and convert it to Ecore metamodel (EMF)
  - Integrated plug-in/ feature of MDT Papyrus

3
- Launch an ATL transformation
  - Tansform data in XML files as UML elements

4
- Generate a requirement diagram
- Integrated feature of MDT Papyrus

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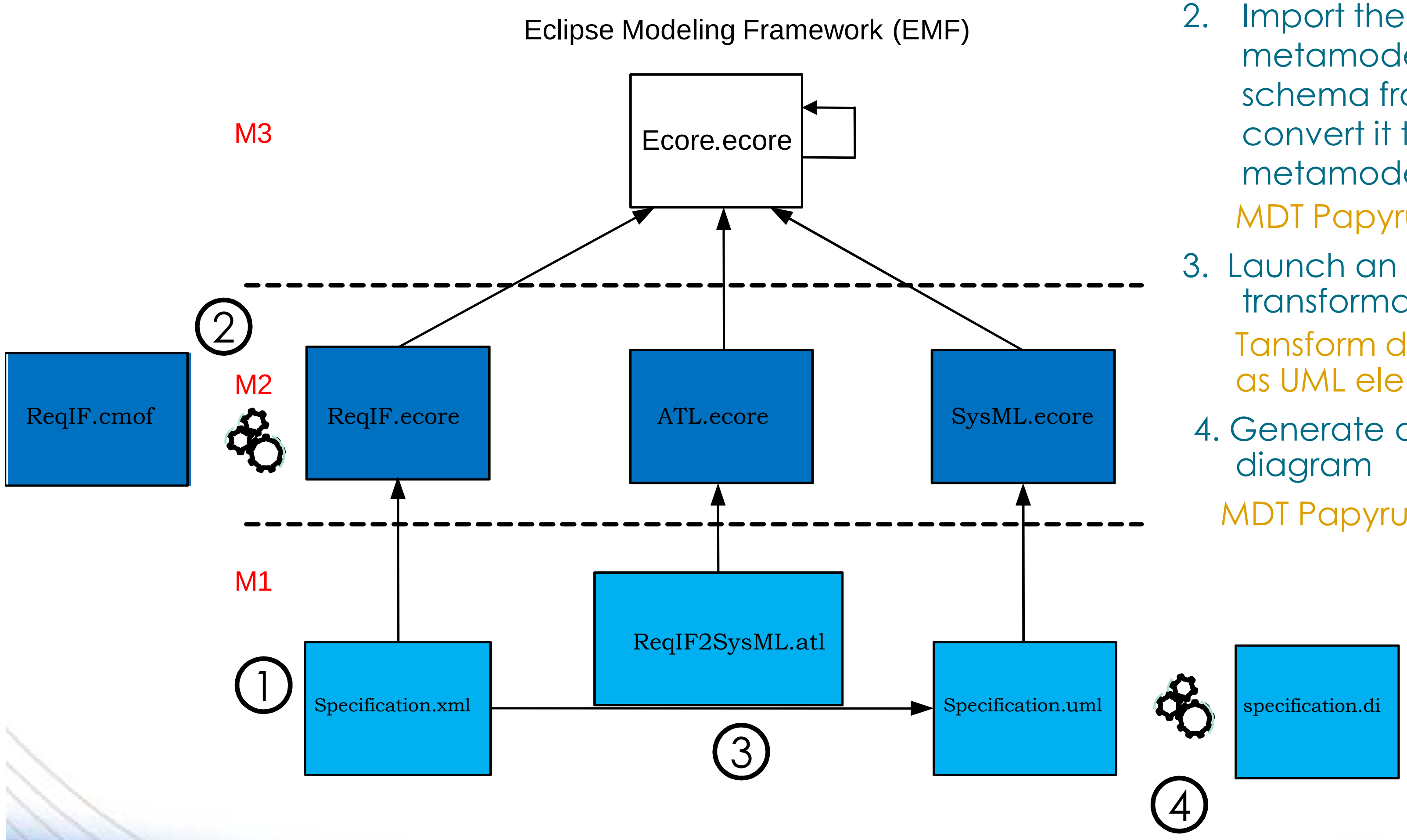
From ReqIF to SysML



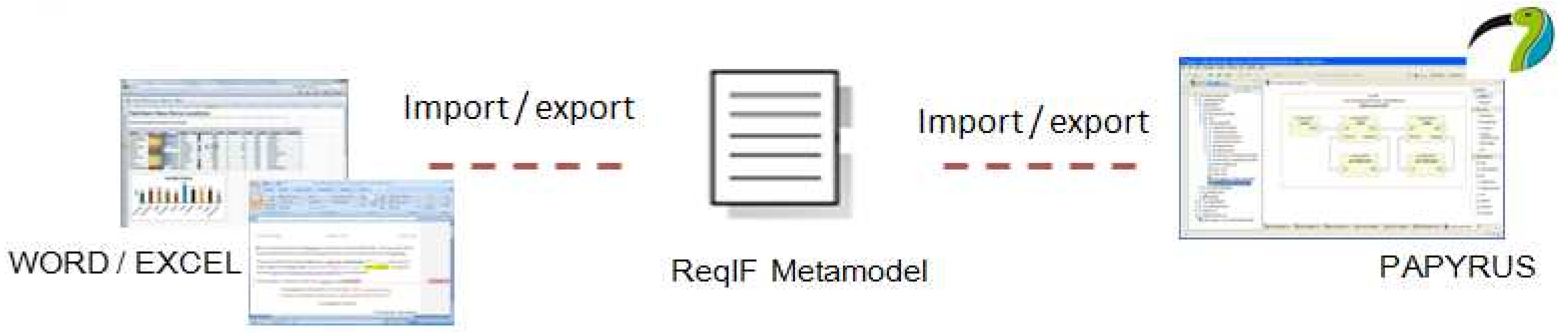
1. Import the XML file in ReqIF format in a new SysML project
2. Import the ReqIF metamodel (ReqIF CMOF schema from OMG) and convert it to Ecore metamodel (EMF)

   MDT Papyrus feature
3. Launch an ATL transformation

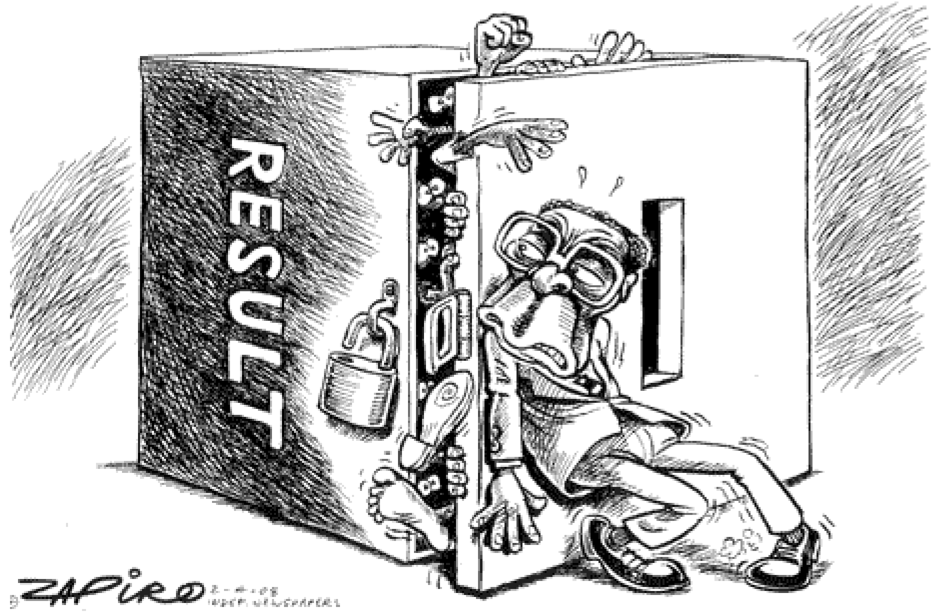
   Tansform data in XML files as UML elements
4. Generate a requirement diagram

   MDT Papyrus feature

Evaluation



- From MS documents to ReqIF, mapping is proceeded tag by tag
  - A generic macro compliant to ReqIF will be easier and faster
- Poor traçability link capture
  - In SpecRelation, attributes are source and target ids requirements, no type (satisfy, derive…)
- Difficult to manage hierarchical structure of requirements
  - IDs reference as a list in MS documents: which is upper or derived?
- Difficult to manage classification of requirements
  - The requirements type (functional, non-functional…) is not set in MS documents
- Datatypes
  - All data are string
  - No distinction between Enumeration, Integer or Boolean attribute value



Future findings

Next steps

- Manage others ReqIF term
    - Handle the requirements types in SpecType term (functional, non-functional…)
    - Improve import/export at Relation level (SpecRelation)
    - Deal with the datatypes (string, integer, enumeration…)
- Requirement have others attributes (risk, status…)
    - Update requirement specification documents (new columns)
    - Extend SysML profile to handle others attributes
- Export from MS documents by macro
- Implement Clause 8 and 9, 10, 11 of the ReqIF standard (OMG specification)
- Implement the roundtrip
    - Export requirements elements from models to XML file (ReqIF format) by the reverse model transformation
    - Generate new MS documents from XML file (ReqIF format) : more interesting than updating to keep the traceability in change management

Related works

- ProR, a Eclipse tool to define requirements in RIF* format
  - Definition of XML file in RIF format. Out of our scope because we want to avoid manual requirement defintion

- Some Requirement Management tools (Reqtify, DOORS) propose a RIF import/export feature
  - Interoperability is established on tool-by-tool basis. Reqtify tool can only import and assess a RIF* file generated with Reqtify and it is the same case for DOORS tool. [Use cases evaluation in CESAR project]

- EAST-ADL2, UML2 profile proposes to import/export requirement using RIF* format
  - Same conclusion about interoperability that with Reqtify and DOORS tools

=> All implement a RIF version and not a ReqIF version (Actual state)

  - RIF is a first proposal by car manufacturers to exchange requirements between stakeholders. The standardized ReqIF is born of RIF.

- Some others entities work on an implementation of the RIF/ReqIF* specification.
  - Tool vendors (ArtiSAN studio, TopCased, MKS integrity…)
  - EU Projects (Verde, Deploy…)
  - Car industry

Conclusion

- Use modeling and text based approaches to specify requirements and integrate them in a standardized way

- Avoiding redundant working for requirement engineers

  ++ Automatic generation of requirement model

- Providing MDT Papyrus with requirement exchange

- Target to implement ReqIF standard

  -- No consideration of all ReqIF features

Thank you !

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