RAMP

Requirements Analysis and Modeling Process for the Development of Complex Systems

INCOSE 2010 Symposium, Chicago

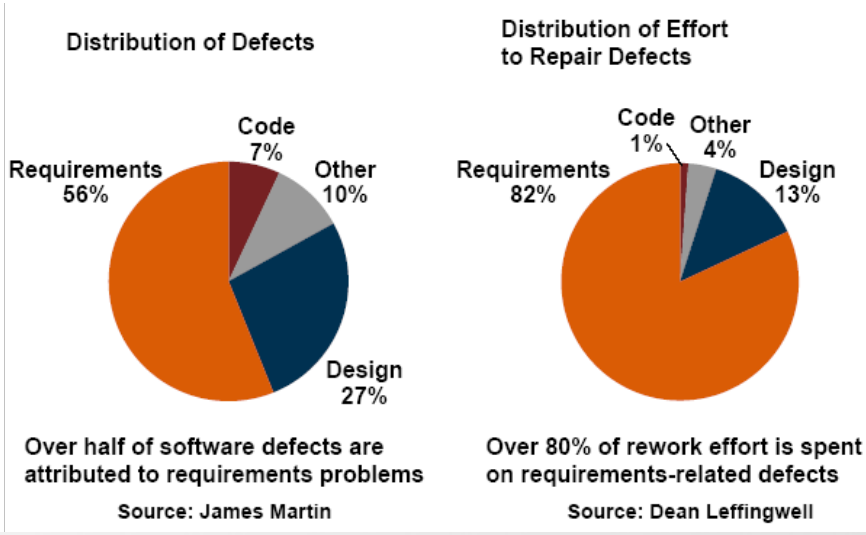
jean-claude.roussel@eads.net
gauthier.fanmuy@adn.fr
hugo.chale-gongora@renault.com
hammami@ensta.fr

RAMP Project Presentation

1. Introduction: Project objectives & partners
2. Industrial needs & initial survey results
3. Research strategy

RAMP Project Context

- Requirements are still most of the time written in natural language which are main sources of defects in the product development process.
- Obtaining consistency and completeness of requirements remains difficult by the only textual review since several thousands of requirements are managed
- Many statistics show importance of Requirements phase for Quality, Costs & Time to market
  - Chaos report,
  - James Martin' s "56%",
  - Dean Leffingwell's « 82% »,
  - …



RAMP Project Rationale

Master complex systems development through the improvement of the quality of Requirements baselines

Quality of requirements is improved via **assistance to the writing and the analysis** of requirements.

The evacuation of requirements form issues allows **the actors to focus on the real substance of requirements.**

RAMP Project Objectives

The starting point of the project is the syntactic analysis of the quality of the requirements written in natural language, taken individually.
This analysis is made via an existing prototype tool LEXIOR, developed by the CORTIM company.

The end point of the project is the quality of a set of requirements within a RAMP research platform :

- The elimination of wording defects of requirements expressed in natural language
- The automatic identification of redundancies or similar textual requirements
- The generation or comparison of specification models to check consistency and completeness of requirements
- The extraction of data allowing the formalization of requirements and their environment via the analysis of scenarios
- The creation, exploitation and re-use of business know-how by the use of ontologies and models.

RAMP Project Partners

- 3 Industrial Companies from different domains :
  - Aerospace (EADS)
  - Automotive (RENAULT)
  - Energy (EDF)

- 2 SME :
  - Service Consulting (ADN)
  - Tool Supplier (CORTIM)

- 3 Academics :

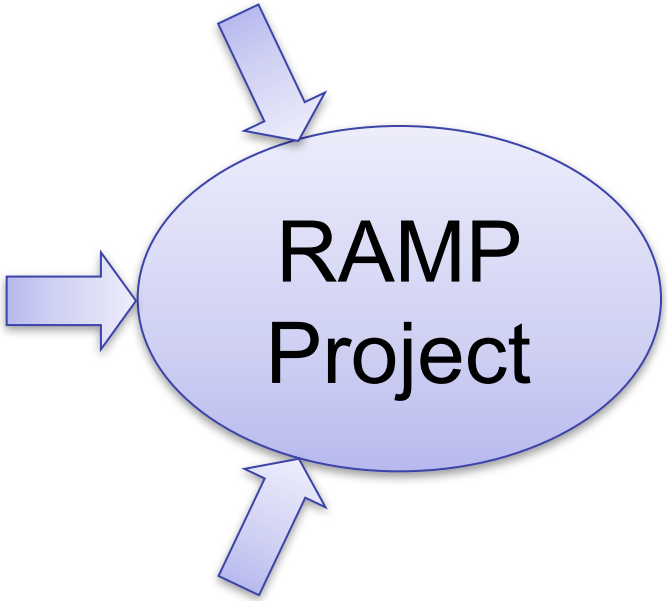
Combining 3 points of view to fulfill the objectives

« Top-down »
to derive needs expressed
by industrials into methods & tools

Industries

Laboratories

« Upstream-downstream »
to deploy & extend
Research
"state of the art"

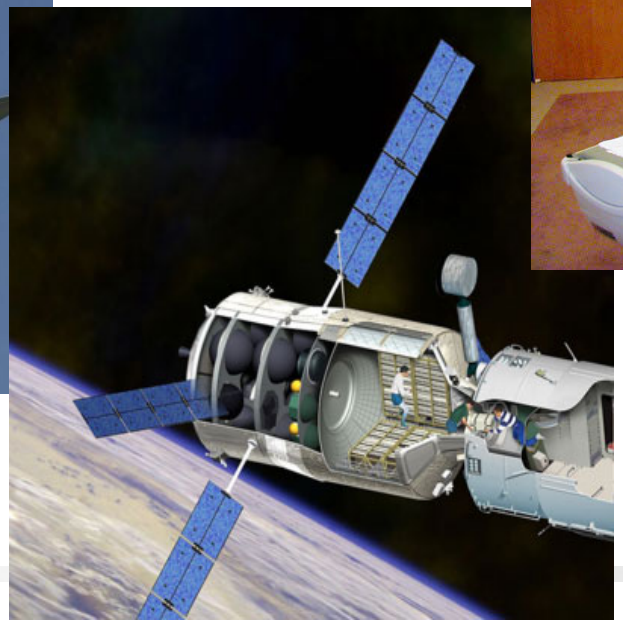


Innovative methods
implemented on a
Research platform
and applied to
industrial pilot cases

« Bottom-up »
to use & extend usage
of some emerging tools

SMEs

Industrial needs & Initial survey results

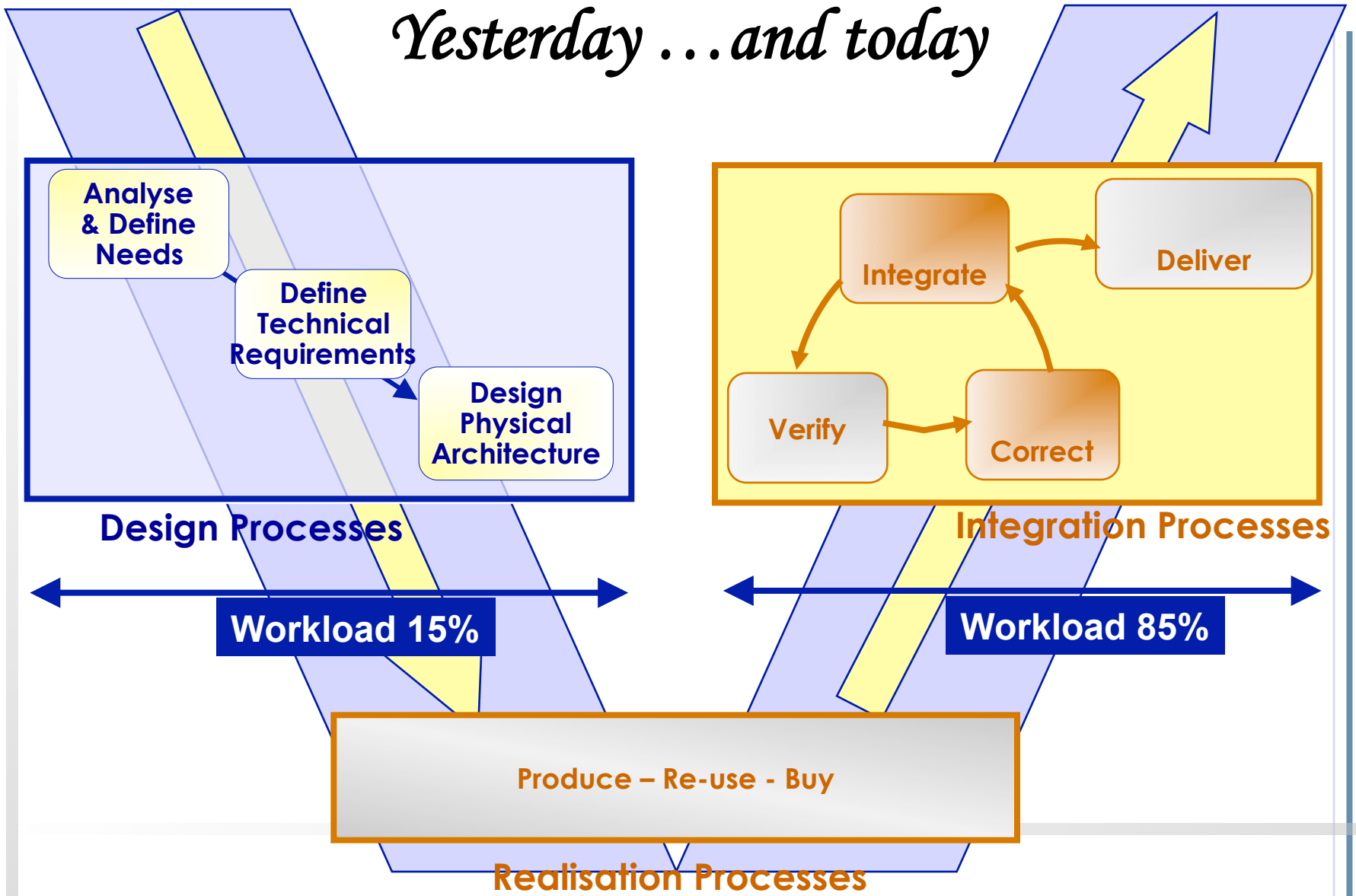


Industrial Needs

- To have the right requirements
  - What the stakeholders really want (value for customer)
  - Only what is needed (kill waste)
- The have the requirements right (SMART*)
- To master the volume of requirements in a context of a great diversity of products (families, ranges, options, versions…)
- To optimize requirement documentation
- To improve requirement verification through
  - Advanced analysis techniques (syntax, semantics…)
  - Modeling techniques
- To ensure the consistency of a set of requirements
- To enable and ease requirements reuse

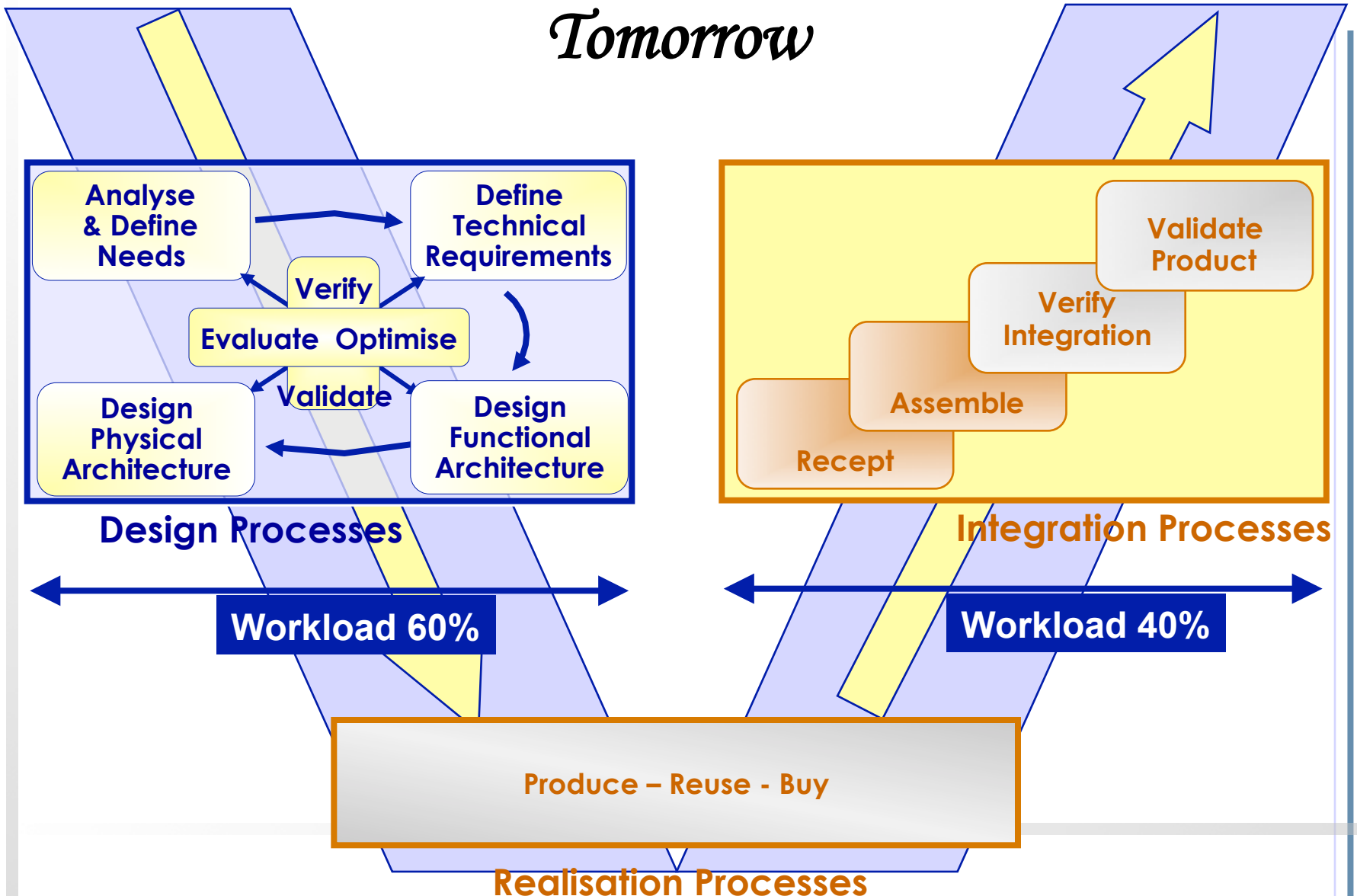
(Specific, Measurable, Acheavable, Realistic,Traceable)*

Industrial Needs



Industrial Needs

Tomorrow



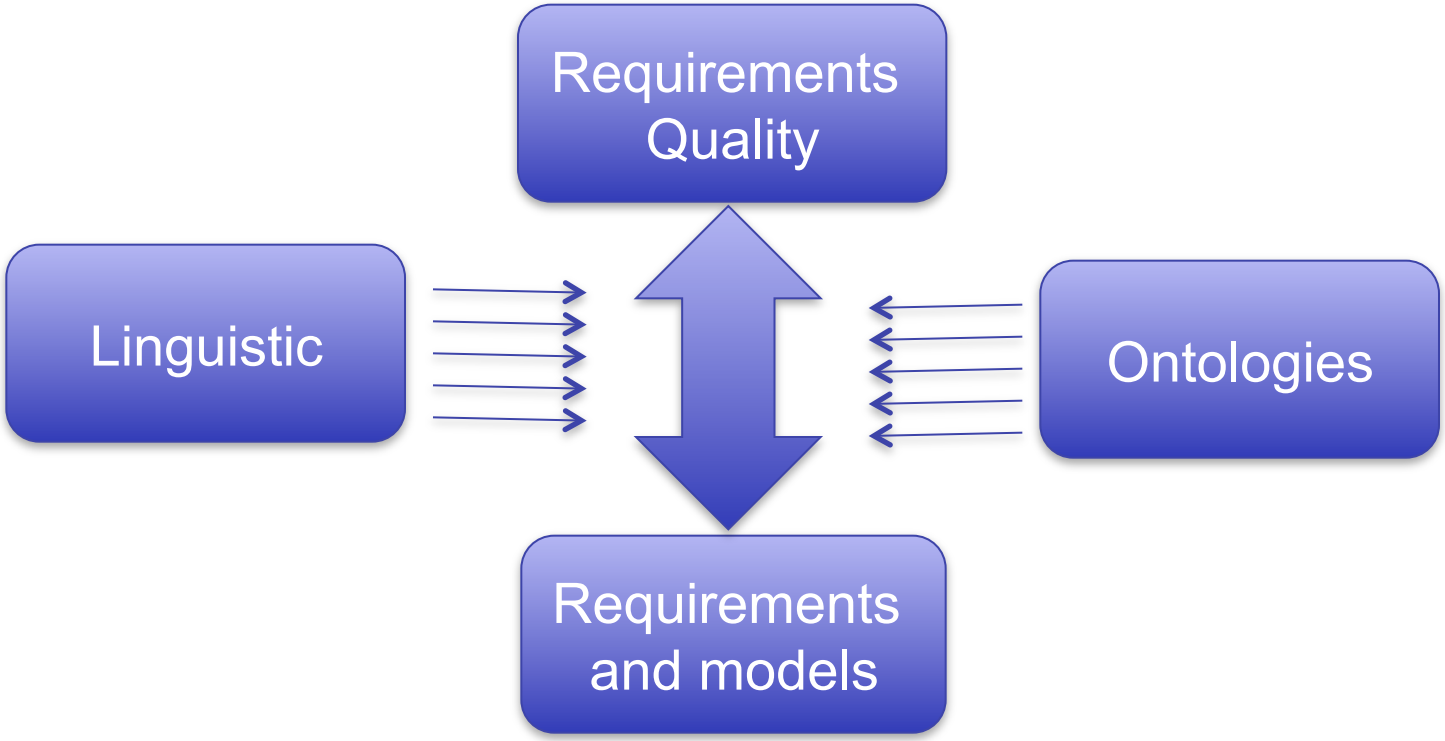
Initial survey of industrial status

- Initial survey on industrial practices in requirements engineering (from May to September)
  - RAMP Project partners: RENAULT, EDF, EADS
  - Other companies: AREVA TA, CNES, SCHNEIDER ELECTRIC, SAGEM D&S, …
- In the coming months, INCOSE survey: (under construction)
  - With RWG & other WG
  - 15 to 20 minutes on INCOSE Connect
  - Contact: gauthier.fanmuy@incose.org

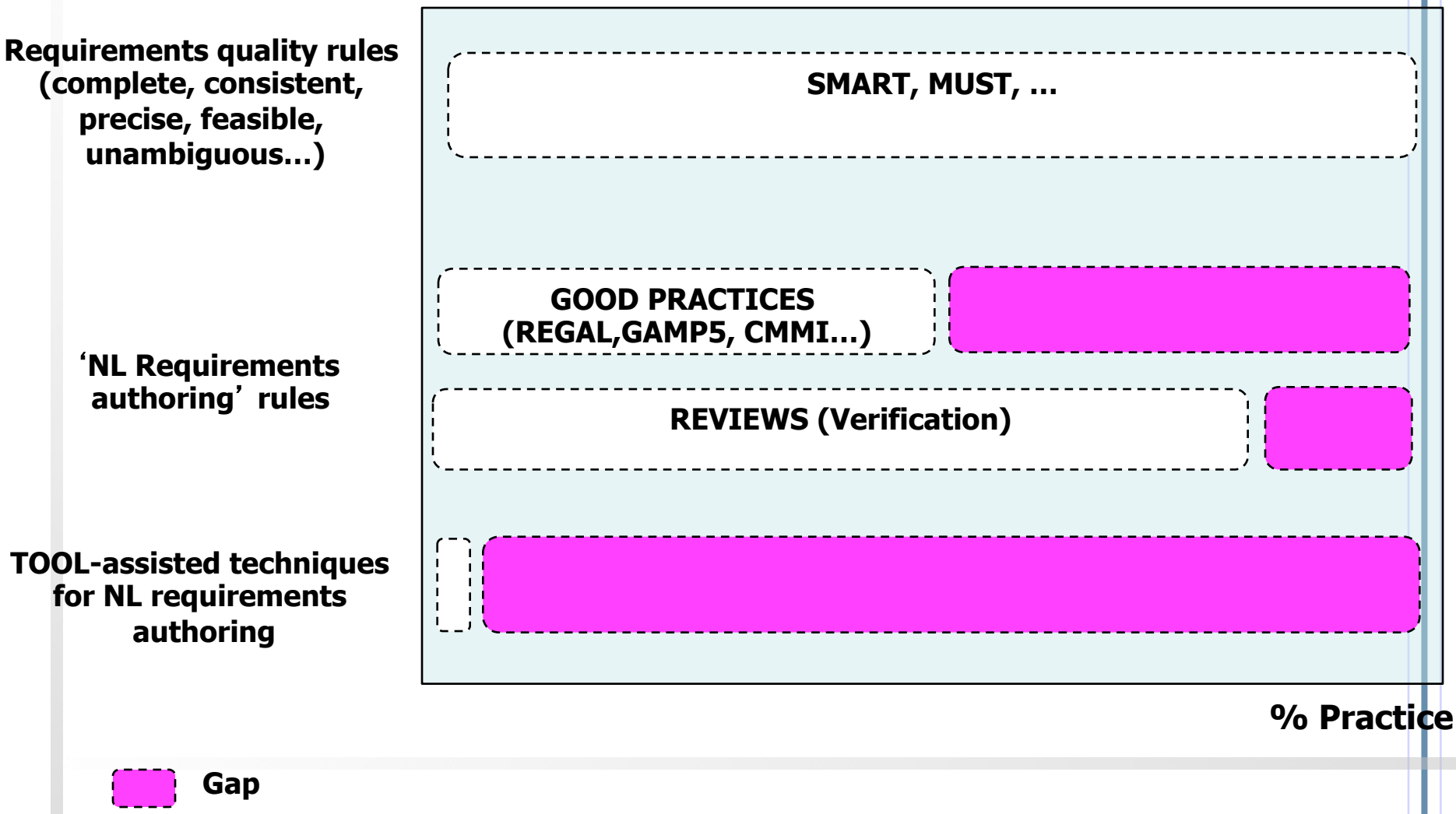
Some results from the initial survey

- Requirements are … numerous
  - Reviews are mandatory, but efficiency improvement also !
- Requirements … about what ?
  - Heterogeneous perimeters in a single document
  - Complex architectures => « non-trivial » allocation
  - Product lines => to master requirements variants
- Poor « toolbox » beyond Natural Language,
  - Use-cases not enough deployed, nor exploited to define requirements
  - Few requirements modeling operational toolsets
- Many teams emitting / receiving requirements
  - Sometimes « silo-effect »
  - Diversity of maturity
  - Most stakeholders do not naturally express themselves in terms of requirements but in solutions

RAMP Research Strategy



Requirements Quality



Tool assisted requirements analysis: LEXIOR

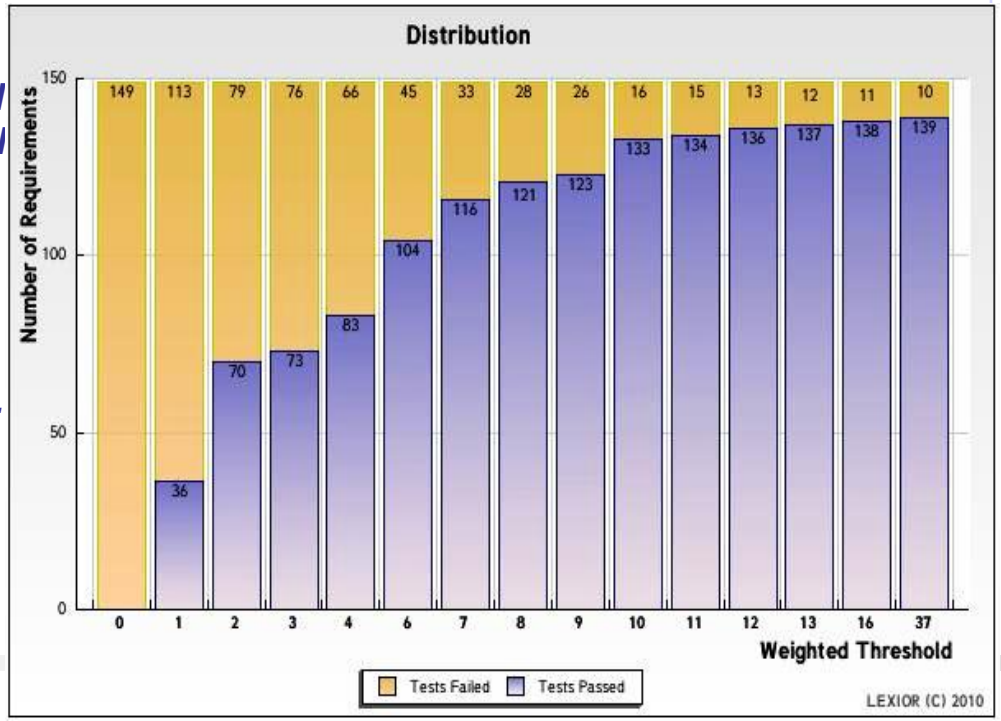
Summary Results			
Parameter	**Count**	**% of Total**	**Weight**
Total Number of Requirements Checked	**149**	**na**	**na**
Rules Checked	**na**	**na**	**na**
Well-formed XML files generated (correclty parsed and XML generated)	149	100%	5
Number of words in requirements < MAX_NUMBER	139	93%	5
RG1.1 : The requireme			
RG1.2 : Negative requi present			
RG1.3 : Sentence conta			
RG1.4 : Sentence is ex			
RG2.1 : More than one cannot).			
RG2.2 : Requirement h			
RG2.3 : Requirement h the same object.			
RG2.4 : Requirement h			
RG3.1 : Requirement d			
RG3.2 : Requirement h			
RG3.3 : The subject of			
RG7 : Requirement con			
RG8.1 : Requirement is			
RG8.2 : Subject of the			

> **RG1.2 Requirements shall avoid using negative expressions with the following « requirements keywords » :**
>
> - ***Shall not, will not, should not , may not***

The system shall disabl during nominal payl

Instead of

Propulsion shall not be payload operations.



Tool assisted requirements analysis: LEXIOR

Weighted Summary	Selected RIDs	Identifier	Requirement Text	Failed Tests	Actions
7	View RID	REQ_00079	Alternatively, a complete software build can be loaded to the alternate FSW location in EEPROM and the DPU commanded to boot the alternate configuration rather than the primary	RG11-RQ=1 RG13-VB>1 RG14-PASSV RG81-GRAM	Edit Comment Edit Req. Analyse Req.
6	View RID	REQ_00051			
6	View RID	REQ_00054			
6	View RID	REQ_00078			
5	View RID	REQ_00081			
4	View RID	REQ_00007 (e)			

http://127.0.0.1 - LEXIOR - Edit comments - Microsoft Internet Explorer

Rules Details : REQ_00079

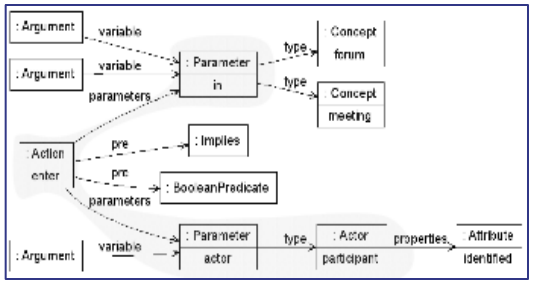
	Comments	Weight
LX01-XML	The XML file is not well-formed XML	45
LX01-LEN	The input sentence is too long	40
RG 1 : A clear distinction shall be made between requirements and statements included only for information or guidance.		
RG11-RQ=1	At least one requirement keyword should exist (shall)	0
RG12-NOT	Negative requirement constructs should be avoided (shall not, will not, should not, may not, can not)	3
RG13-VB>1	This sentence does not contain any verbal form of : should, will, may, can, cannot	3
RG14-PASSV	This sentence is expressed in the passive voice. It is recommended to write in the active voice	3
RG 2 : Requirements relevant to different aspects shall be presented as separate clauses or subclauses.		
RG21-RQ>1	More than one verbal form was found (shall, should, may, can, will, cannot). It is recommended to split this requirement into separate ones, each having a single verbal form	5
RG22-CL>1	Requirement has more than one clause	3
RG23-OB>1	Requirement has more than one object linked to the same verb or more than one verb linked to the same object. It is recommended to separate the sentence into separate requirements	3
RG24-OB<1	Requirement should have at least one object or modifying phrase	3
RG 3 : The subject of the « shall » verb shall be defined in the document.		
RG31-SB<1	This sentence does not contain any subject	3
RG32-SUBJ	The subject of the requirement is not approved	3
RG33-PRSUB	Invalid subject because it is a pronoun	3
RG 7 : Use of recognised forbidden words must be rejected.		
RG7-FORB	Use of recognised forbidden words must be rejected.	3

Terminé

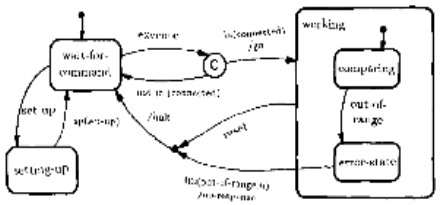
Requirements and Models

NL Requirements

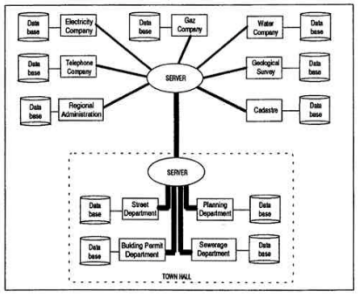
Many work on the use of models starting from constrained natural languages, in particular in the software field

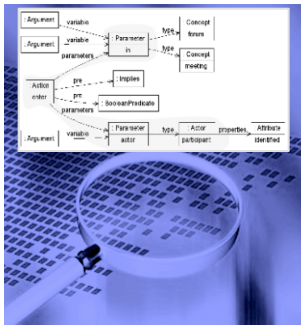


Requirements model



simulation





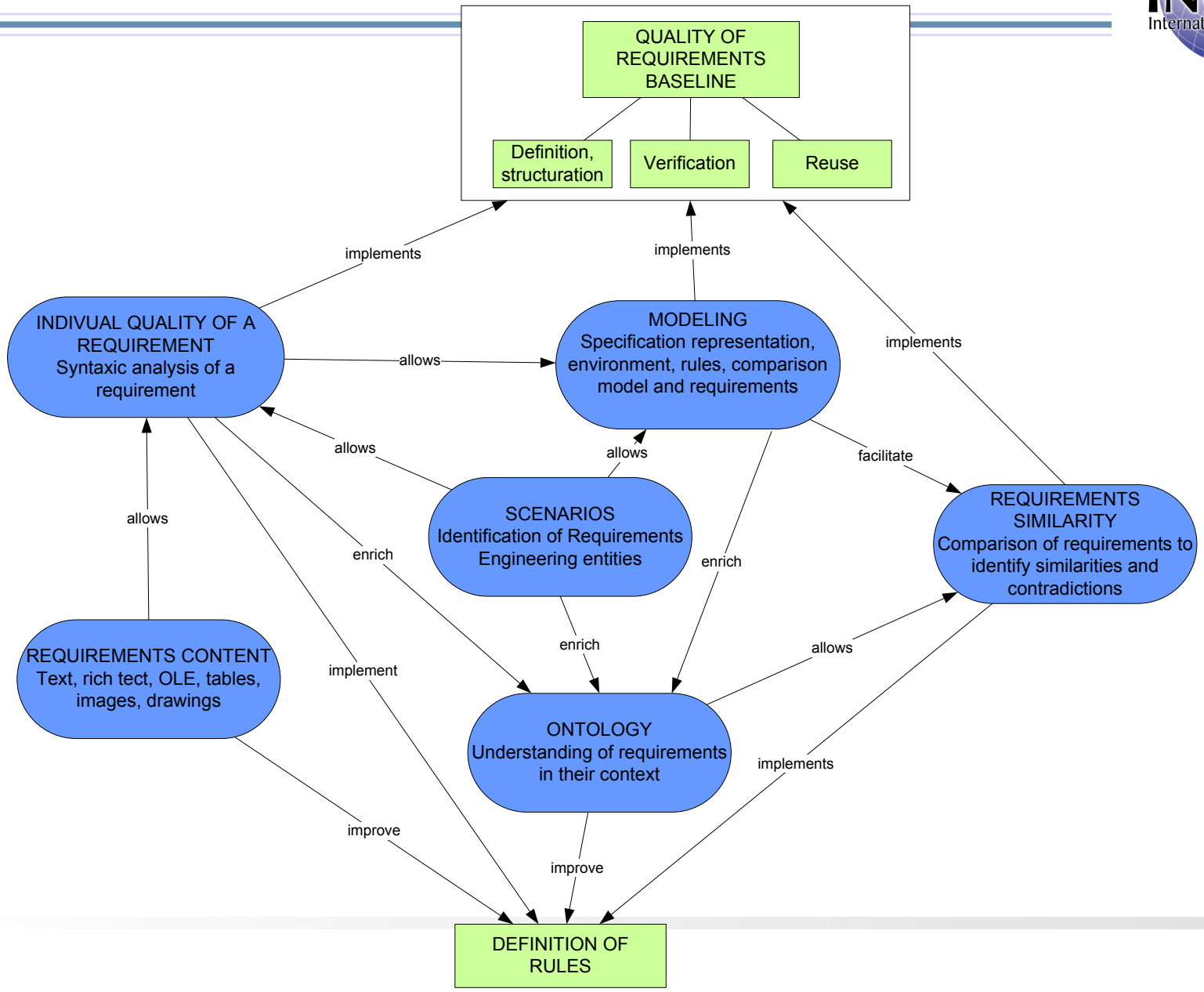
verification

Detection of inconsistencies between requirements / composition of requirements

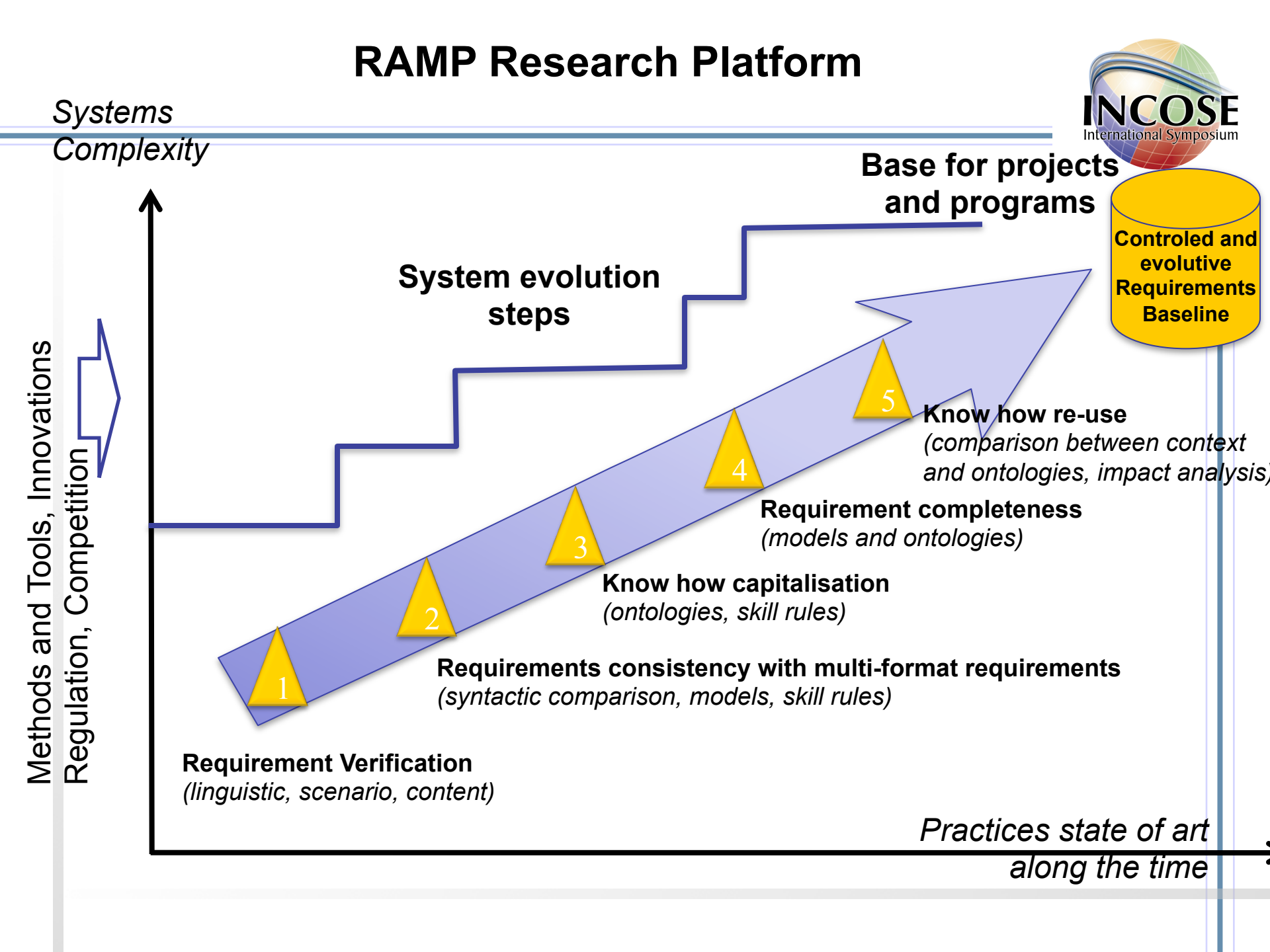
Linguistic and ontologies

- Linguistic
  - Lack of specific linguistic rules for requirements engineering
  - Lack of adequate tooling in a linguistic perspective
  - Few work on similarity analyzes (set of requirements, identification of redundancies and inconsistencies, traceability, organization)
- Ontologies
  - Ontologies for different domains (medical, internet, …)
    - ✓ e.g. OWL: ontology web language
    - ✓ e.g. Use of ontologies for formal methods
  - Very few works done for Requirements Engineering
    - ✓ On requirements level, some approaches on software development and limited only to some phases (e.g. needs elicitation (Saeki), requirements reconciliation (Motoshisaeki)).
    - ✓ OntoREM (Airbus, UWE) first approach on SE integrated the whole process. Principle : develop requirements based on a skill ontology.

RAMP Research Platform



RAMP Research Platform



RAMP Research Platform

Quality of requirements and set of requirements
- SMART
- ...

Enterprise processes
- Elicitation of needs
- Requirements analysis
- …

Gap between the expectations of the organization and the reality of the terrain

Build the RAMP to reduce the gap

Operational practices : variable maturity in requirements engineering

❺ « Management through requirements ? »

❹ « Reuse and traceability ? »

❸ « Consistency and completeness ? »

❷ « Improvement of specification ? »

❶ « Authoring a requirement ? »