



INCOSE Spring 09



Automated Specification Analysis

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Problem Statement

How Can you Create a Clean Useful Specification?

Buzz Words are:

Clear, Complete, Consistent, Testable, etc

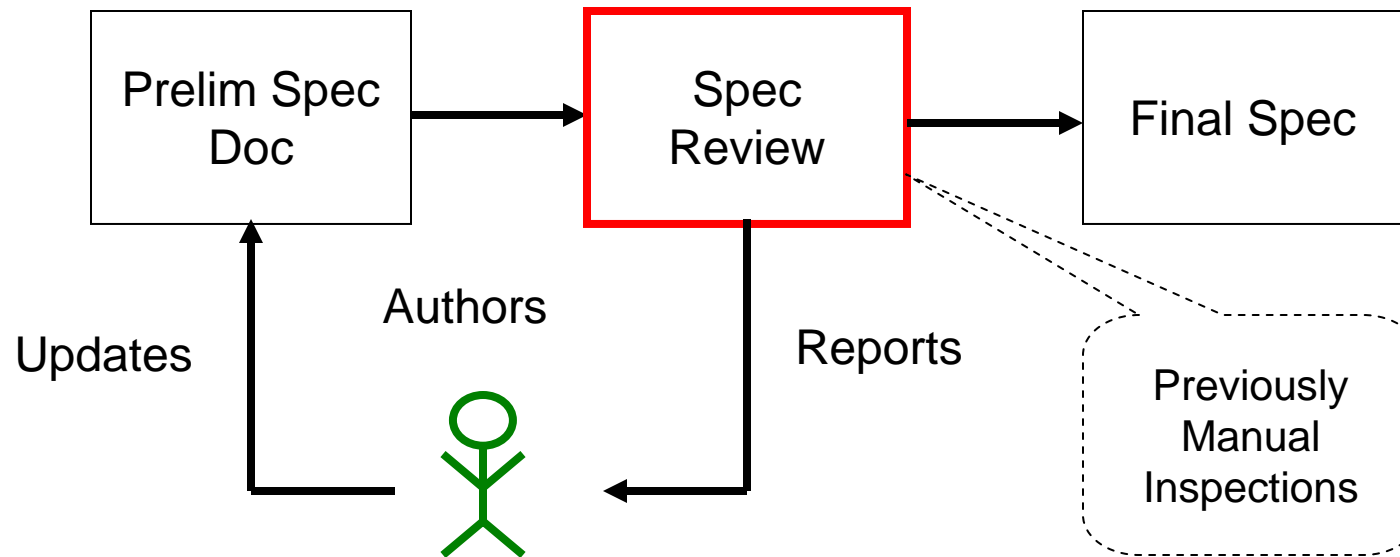


Typical Tools

- Requirement Management
 - Automated database oriented tools
- Modeling and Simulation
 - Automated visualization and calculation tools
- Requirement Text Authoring
 - Manual mentors and check lists



The Idea





Why Do It

- Specifications written in natural language
 - Initial text is rarely perfect
- Everyone relies on specification text
 - Users, designers, testers, vendors, policy makers
- Inspections used for surfacing defects, but
 - Time consuming, costly, only some defects found
- Inspections may not even be performed
 - Fear of findings, not sure how to proceed once surfaced



Why Do It

- Over 50% software defects are reqs problems
 - Source: CMU SEI QuARS Presentation and James Martin, INCOSE 21 June 05
- Over 80% rework spent on reqs related defects
 - Source: CMU SEI QuARS Presentation and Dean Leffingwell, INCOSE 21 June 05
- NASA IVV Entry in 2006
 - Studied the effects of introducing an automated tool into the specification review process



Findings

- Review time not shortened
 - Time usually arbitrarily set
 - People hunt & peck until bored or exhausted
- Tool findings more consistent
 - Humans tend to miss categories
- Tool finds all problems of certain type
 - Humans tend to miss full sets

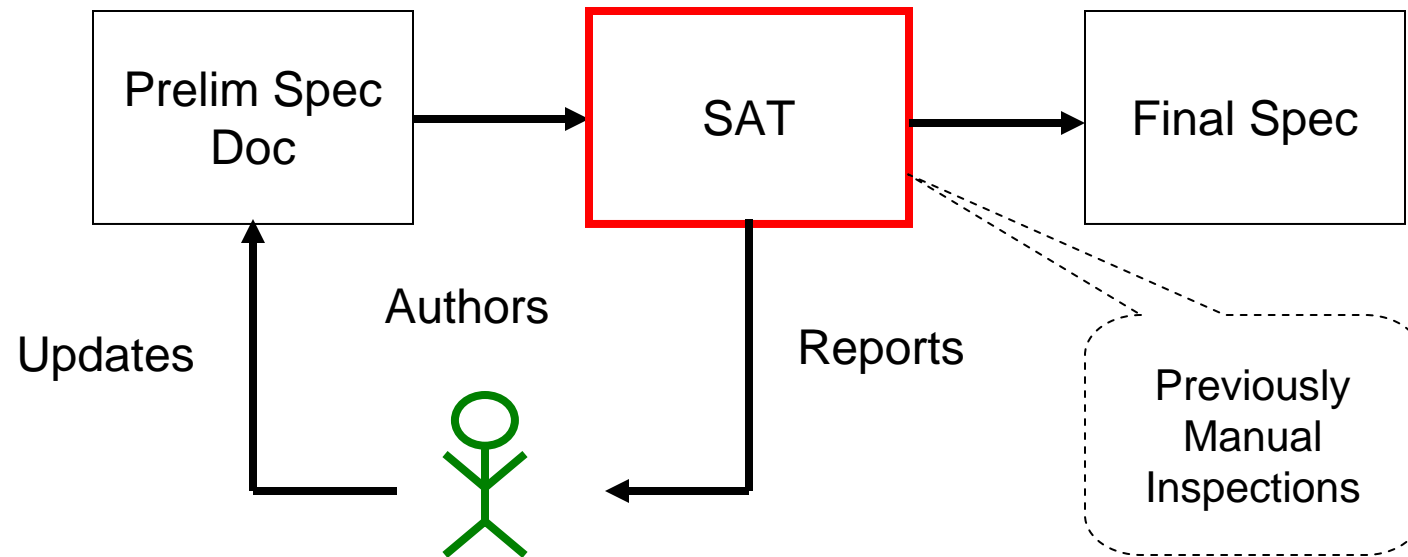


Findings

- Humans better finding domain problems
 - So give humans time to do so
 - And let tool excel in its area
- More findings when tool is used
 - Humans + machines complement each other



The Idea



- Lets machines do what they do well
 - search, count, filter, categorize, profile, visualize
- Lets humans do what they do well
 - creativity, critical thinking, inspiration, intuition



Introduction to Natural Language Analysis

- **Lexical Analysis**
 - Uses dictionary words and phrases
 - Vague, subjective, imply choice or option
- **Syntactical Analysis**
 - Relates to the syntax or grammar of the language
 - Weak phrases, multiplicity, implicit, under-spec
- **Statistical Analysis**
 - Statistical properties of language structure and usage
- **Consistency check**
 - Areas such as units of measure



Examples

- **Lexical examples**
 - Ambiguous words: low, bad, clear, easy, efficient, etc.
- **Syntactical examples**
 - Multiple requirements: use of and / or
 - Under-specification: e.g. 'report', what kind of report
- **Statistical Analysis**
 - Count frequency of words , such as 'strip'
 - If 50 times indicates important concept (domain term)
- **Consistency Check**
 - check units e.g. 5 Hz and 5kHz, 10 ft and 10 meters



SAT Key Requirements

- Open rules visible to everyone
 - Rules for finding bad requirements text should NOT be proprietary
- Rules should be easy to change and coincident with analysis run
 - To allow users to quickly tune tool to their domain and adjust for potential false finding



SAT Key Requirements

- It must be fast, NO overnight runs
- Encourage on-the-fly analysis
- Let users tweak rules, look at results, and press submit button every 30 - 60 seconds



SAT Key Requirements

- Load specs anywhere off network
- Save results anywhere on network
- Duplicate previous analysis runs
- Modify previous runs
- Convert previous analysis into templates



SAT Key Requirements

- Do not discount power of machine to
 - Consistently search, count, organize, and duplicate search-based findings
- It is better than using word processor or requirements database tool
 - To search ad hoc during specification review

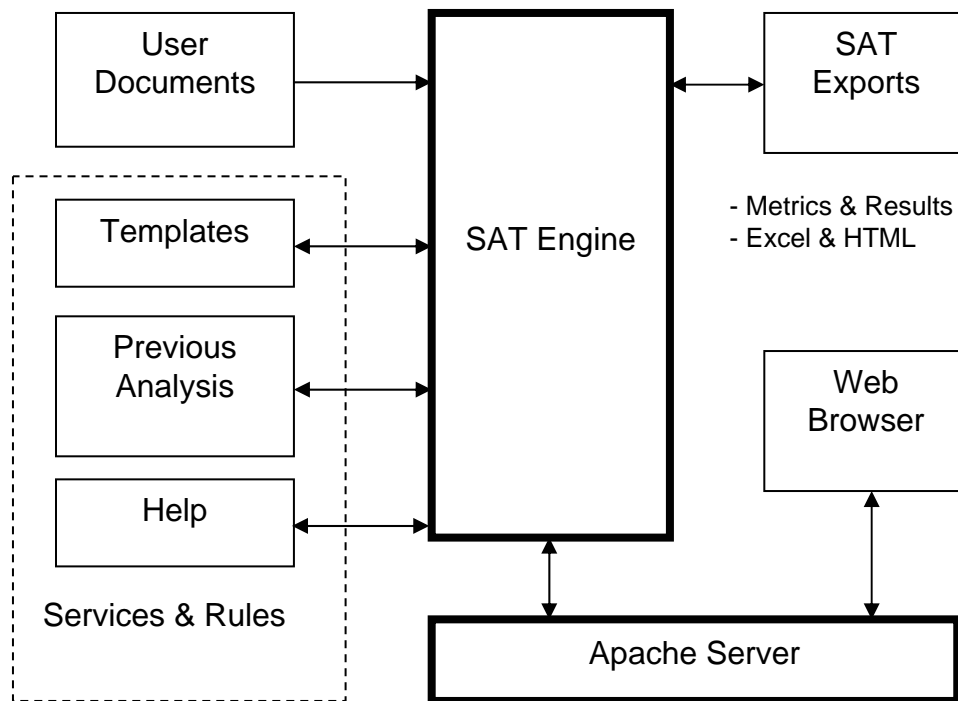


SAT Key Requirements

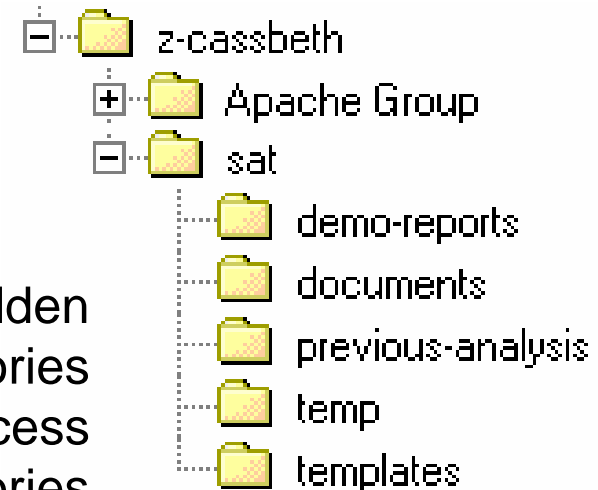
- Let tool reside and run on user computer
- Offer simple install remove mechanism
- Let user peer into where tool is located
- Let user view tool "libraries" using standard operating system services
- Use Internet interface and web search engine experience as stepping off point
 - permeated our collective experience

SAT Architecture

Works Like Internet Search Engine But



Runs on your computer
Returns document text blocks
Search criteria many attributes
Search saved as templates
Grouped by rules & services
Fast 150 pages in 60 seconds



Nothing is hidden
Uses predefined directories
Encourages directory access
Add your own directories



SAT Architecture

- Rules grouped into services
- Services grouped into templates
- Templates grouped into domain
- Domains exist



Services & Rules

[Requirement Text Analysis](#) rta Show Search Show Simple Rules Show Complex Rules

- [Untestable](#)
- [Multiple Imperatives](#)
- [Options](#)
- [Unsure](#)
- [Unbounded](#)
- [Undefined](#)
- [Compound Req](#)
- [Internal Reference](#)
- [Not Standalone](#)
- [Fragment](#)
- [Directive](#)
- [Incomplete](#)
- [Weak Phrases](#)
- [Weak Words](#)
- [Buzz Words](#)

[Find Duplicate Objects](#) rptdup Show Search Show Simple Rules Show Complex Rules

- [Duplicates](#)

[Generic Structure Analysis](#) gsa Show Search Show Simple Rules Show Complex Rules

- [1. Level 1 Req](#)
- [2. Level 2 Req](#)
- [3. Level 3 Req](#)
- [4. Level 4 Req](#)
- [5. Level 5 Req](#)
- [6. Level 6 Req](#)

[Domain Structure Analysis](#) dsa Show Search Show Simple Rules Show Complex Rules

- [3.1 Web Portal](#)
- [3.2 Architecture](#)
- [3.3 General Functions](#)
- [3.4 Req Reporting](#)
- [3.5 Rule Processing](#)
- [3.6 Metrics](#)

[Generic Capabilities Analysis](#) gca Show Search Show Simple Rules Show Complex Rules

- [Shalls](#)
- [Non Shalls](#)

Enable and disable services and rules using these display filters to fit your situation



Services & Rules

Default Template - Netscape

[Generic Capabilities Analysis](#) gca Show Search Show Simple Rules Show Complex Rules
... [Shalls](#) [Non Shalls](#)

[Domain Capabilities Analysis](#) dca Show Search Show Simple Rules Show Complex Rules
... [Security](#) [Mining](#) [User Interface](#)

[Key Reqs Analysis](#) kra Show Search Show Simple Rules Show Complex Rules

<input checked="" type="checkbox"/> 1. Functional	<input checked="" type="checkbox"/> 2. Performance	<input checked="" type="checkbox"/> 3. Systems	<input checked="" type="checkbox"/> 4. Architecture	<input checked="" type="checkbox"/> 5. Safety
<input checked="" type="checkbox"/> 6. Software	<input checked="" type="checkbox"/> 7. Hardware	<input checked="" type="checkbox"/> 8. Environmental	<input checked="" type="checkbox"/> 9. Mechanical	<input checked="" type="checkbox"/> 10. Facilities
... <input checked="" type="checkbox"/> 11. Training	<input checked="" type="checkbox"/> 12. Maintenance	<input checked="" type="checkbox"/> 13. Support	<input checked="" type="checkbox"/> 14. RMA	<input checked="" type="checkbox"/> 15. EMI
<input checked="" type="checkbox"/> 16. Ergonomics	<input checked="" type="checkbox"/> 17. ATC RDP	<input checked="" type="checkbox"/> 18. ATC FDP	<input checked="" type="checkbox"/> 19. ATC Automation	<input checked="" type="checkbox"/> 20. Security
<input checked="" type="checkbox"/> 21. Air Defense				

[Add New Service Name](#) Remove Last Service: *Key Reqs Analysis*

Analysis Results Hide

Modify, Delete, Add services and rules

Reports

NASA IVV Presentation - Netscape

File Edit View Go Bookmarks Tools Window Help

17. [SAT-29](#) 1.2 HDS overview The HDS, ACE GSE, and ACS GSE each consist of components: ??A Pentium PC running Windows NT, with dynamic modeling software and interface software (collectively called "HDS software" or "GSE Software").

... **Compound Req** Requirement Text Analysis Item: and Instance: 3

... **Incomplete** Requirement Text Analysis Item: ?? Instance: 1

18. [SAT-30](#) ??A hardware interface rack that provides electronic interfaces emulating or interfacing to the ACS flight hardware (collectively called the "VXI rack").

... **Compound Req** Requirement Text Analysis Item: or Instance: 1

... **Incomplete** Requirement Text Analysis Item: ?? Instance: 1

19. [SAT-31](#) The HDS software reads the hardware output commands of the A computes the motion of the spacecraft due to the commands, computes the ACS s motion, and writes the sensor readings to the ACS hardware via the VXI rack.

... **Compound Req** Requirement Text Analysis Item: and Instan

20. [SAT-34](#) These commands set up parameters at start the test, and possibly change various values in the events that the ACS must respond to.

... **Unsure** Requirement Text Analysis Item: possibly Instance:

... **Compound Req** Requirement Text Analysis Item: and Instan

Specification Analysis Tool - Netscape

File Edit View Go Bookmarks

Item	Count	Child
1. Level 1 Req gsa	3	
2. Level 2 Req gsa	29	
3. Level 3 Req gsa	24	
4. Level 4 Req gsa	13	
5. Level 5 Req gsa	1	
z Mined Objects	70	

Item	Count	Child
Buzz Words rta	2	
Compound Req rta	129	29.45 75.88 92
Directive rta	20	4.56 11.76 14
Fragment rta		
Incomplete rta	33	7.53 19.41 23
Internal Reference rta	2	0.45 1.17 1
Multiple Imperatives rta	14	3.19 8.23
Not Standalone rta		
Options rta	27	6.16 15.88 15
Unbounded rta	13	2.96 7.64 9
Undefined rta	8	1.82 4.7 4
Unsure rta	3	0.68 1.76 2
Untestable rta		
Weak Phrases rta	14	
Weak Words rta	21	
z Mined Objects	219	

Text Blocks

Specification Analysis Tool - Netscape


File Edit View Go Bookmarks Tools Window Help

Document Shape

Shape

The number of children at a particular level. There are different document shapes and each have implications. The document shapes are: random, rectangle, pyramid, inverted pyramid, trapezoid and diamond.

Item	Count	Percent	Shape
1. Level 1 Req gsa	8	4	
2. Level 2 Req gsa	94	54	
3. Level 3 Req gsa	173	100	
4. Level 4 Req gsa	72	41	
5. Level 5 Req gsa	5	2	
z Mined Objects			



Metrics

Specification Analysis Tool - Netscape

File Edit View Go Bookmarks Tools Window Help

Reading Level

Reading Levels

Disabling the noise filter may reduce the reading level. Re-run the report to capture metrics for both instances.

Accessed Unique Words: 167
 Accessed Unique Syllables: 384
 Words with 3+ Syllables: 64
 Polysyllabic Count: 32
 Reading Level: 9

Default Template - Netscape

Settings

Requirement Text Analysis rta Show Search Show Simple Rules Show Complex Rules

Untestable Multiple Imperatives Options Unsure Unbounded

Undefined Compound Req Internal Reference Not Standalone Fragment

Directive Incomplete Weak Phrases Weak Words Buzz Words

NASA IVV Presentation - Netscape

File Edit View Go Bookmarks Tools Window Help

Number Sort Search None

- 134 HDS
- 70 ACE
- 67 ACS
- 62 GSE
- 16 telemetry
- 15 simulation
- 8 tracker
- 6 Spacecraft

Alpha Sort Search None

- 16 telemetry
- 12 Track
- 12 Tracker
- 8 track
- 20 sensor
- 8 sensors
- 1 Simulation
- 15 simulation
- 36 ASIST
- 62 GSE
- 134 HDS
- 27 SDS

Accessed Patterns Not Found

- space shuttle
- shuttle rover
- lander
- space station robot

All Words Counts

Specification Analysis Tool - Netscape

File Edit View Go Bookmarks Tools Window Help

control 32: optical 32: per

est 22: equipment 22: system

degrees 16: enclosure 16: intensity

est 14: provided 14: paragraph

lead 13: tests 13: used

conducte

percent

its

operation

pitch

ighting

urrent

7: rejection 7: discharge-type 7: lights 7: tested 7: assemblies

7: one 7: plus 7: minimum 7: cause 7: volts

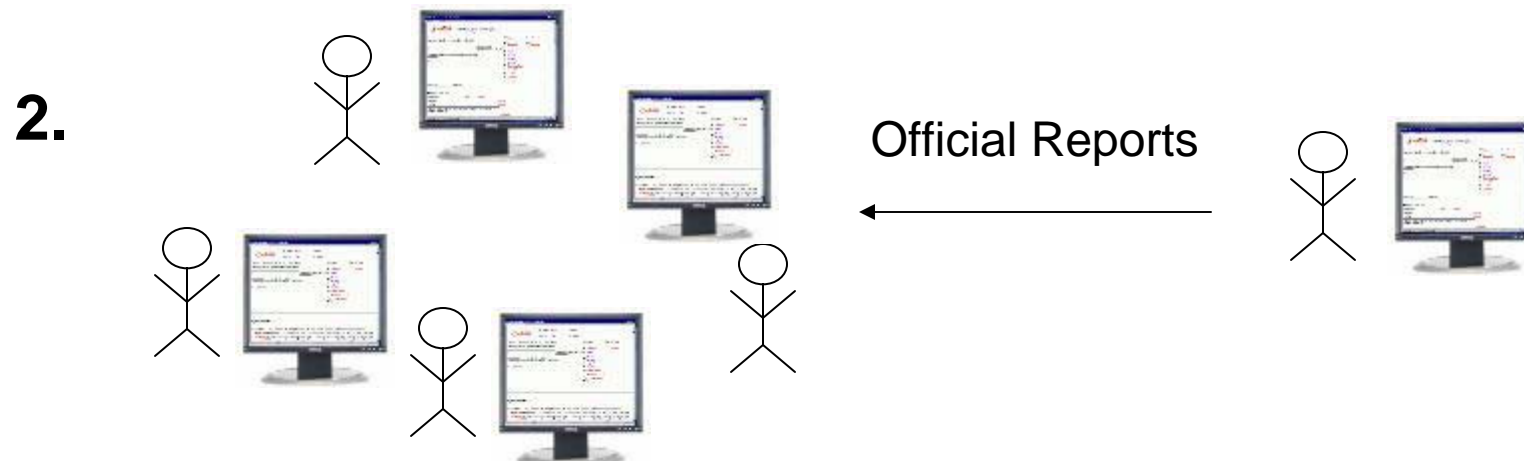
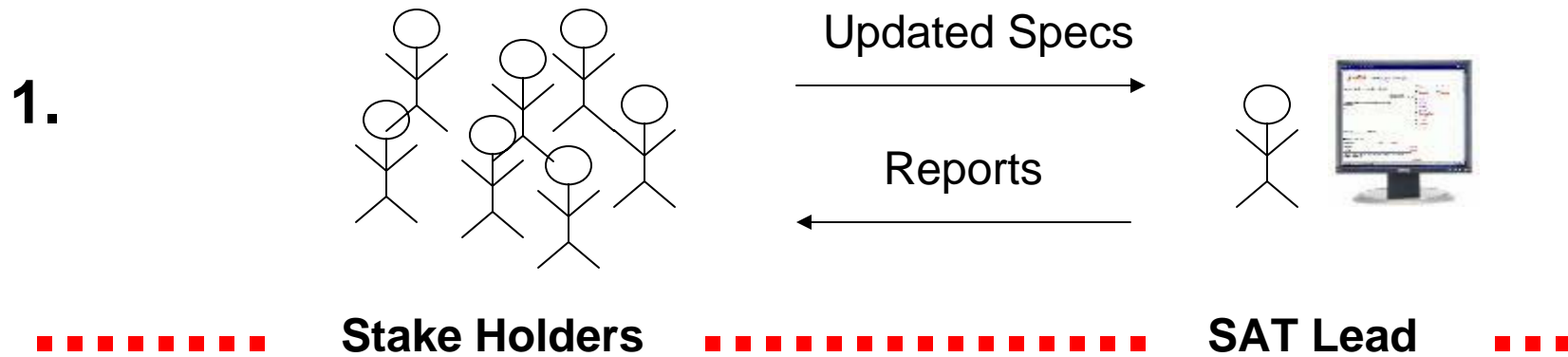
7: Medium 7: volts 7: Requirements 6: Table 6: Type

6: runway 6: withstand 6: temperature 6: DC 6: installed

6: within 6: production 6: per 6: operational 6: through



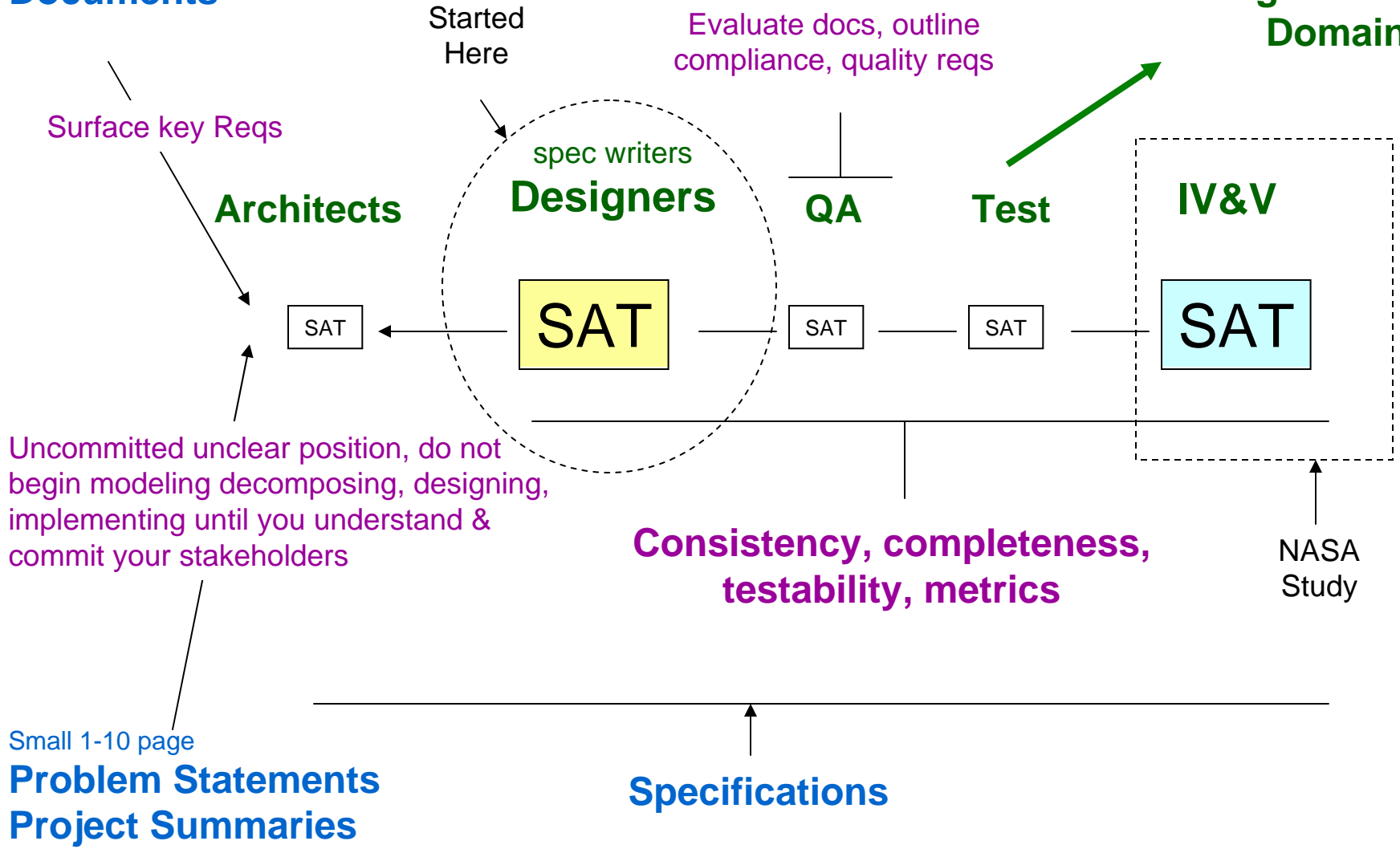
SAT Operations



Evolution

Related Documents

Non Engineering Domains





SAT Application

- While Writing a Specification
- During a Peer Review (original purpose)
- Quality Assurance As Part of Delivery
- Preparing for Test
- Ad Hoc Analysis
 - Analyze and compare previous systems
 - Compare Spec with architecture statements
 - Measure requirement coverage



Questions?



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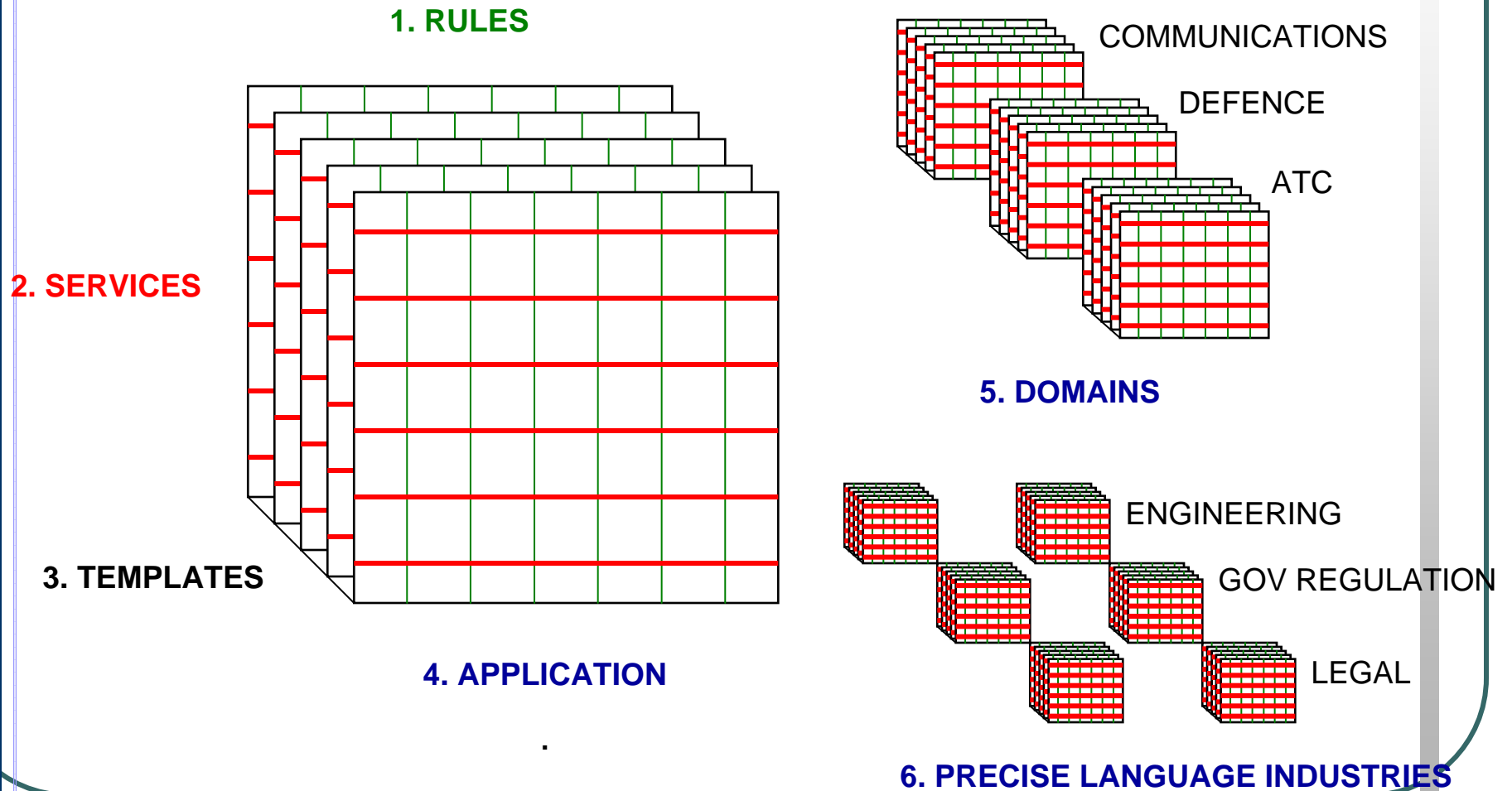


Back Up Slides

If you have the time...



SAT Big Picture





Questions?



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