Requirements Engineering

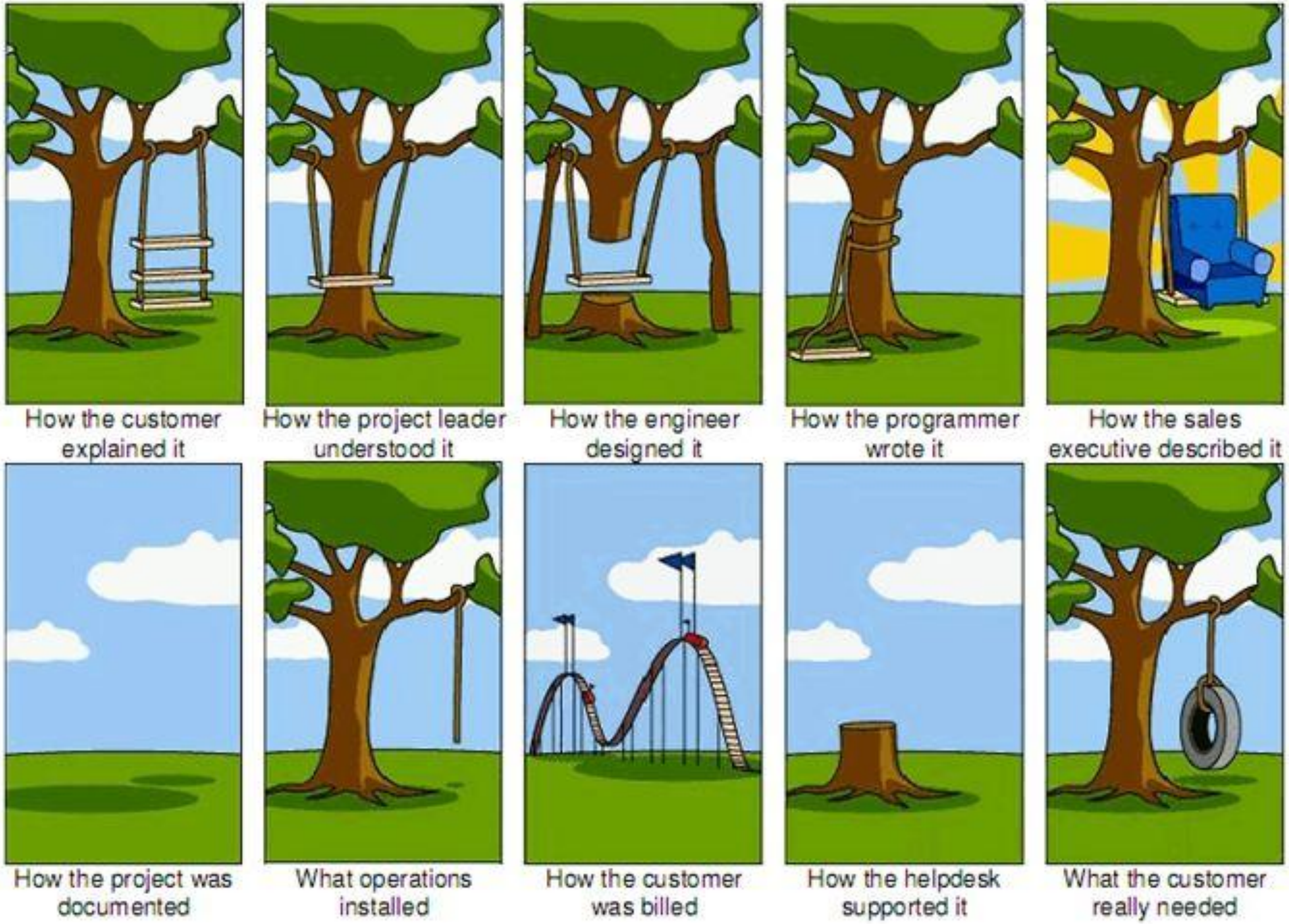
Jun 22th 2015

Definition

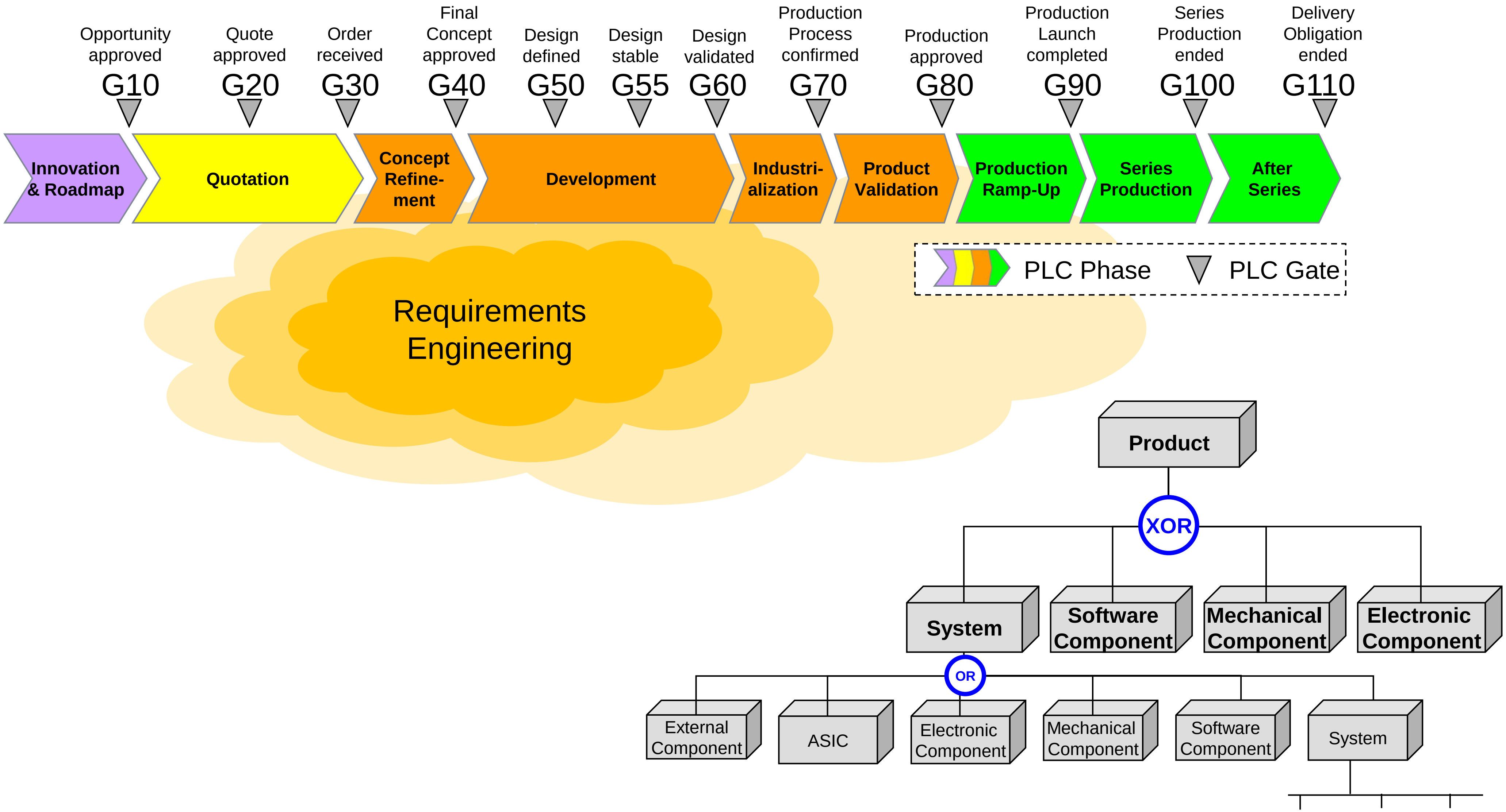
- **What is a requirement?**

- Is a requisite that has to be complete, explicit, consistent, aligned, verifiable, prioritized and traceable

Summary


How the customer explained it
How the project leader understood it
How the engineer designed it
How the programmer wrote it
How the sales executive described it
How the project was documented
What operations installed
How the customer was billed
How the helpdesk supported it
What the customer really needed

Overview – Relation to PLC



G10	G20	G30	G40	G50	G55	G60	G70	G80	G90	G100	G110
Opportunity approved	Quote approved	Order received	Final Concept approved	Design defined	Design stable	Design validated	Production Process confirmed	Production approved	Production Launch completed	Series Production ended	Delivery Obligation ended

Innovation & Roadmap

Quotation

Concept Refine-ment

Development

Industri-alization

Product Validation

Production Ramp-Up

Series Production

After Series

PLC Phase

PLC Gate

Requirements Engineering

Product

XOR

System

Software Component

Mechanical Component

Electronic Component

OR

External Component

ASIC

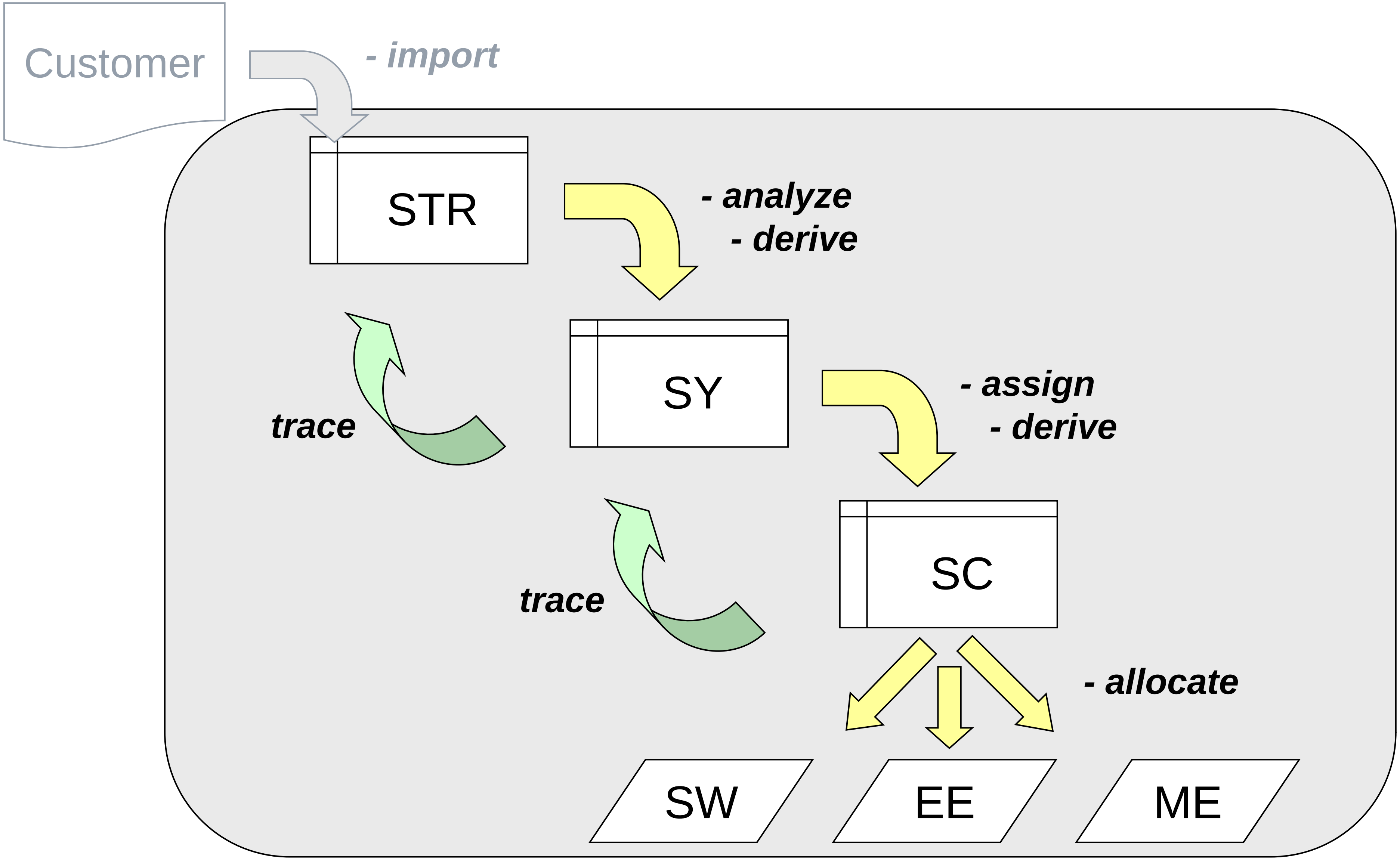
Electronic Component

Mechanical Component

Software Component

System

Overview – Requirements Engineering with DOORS



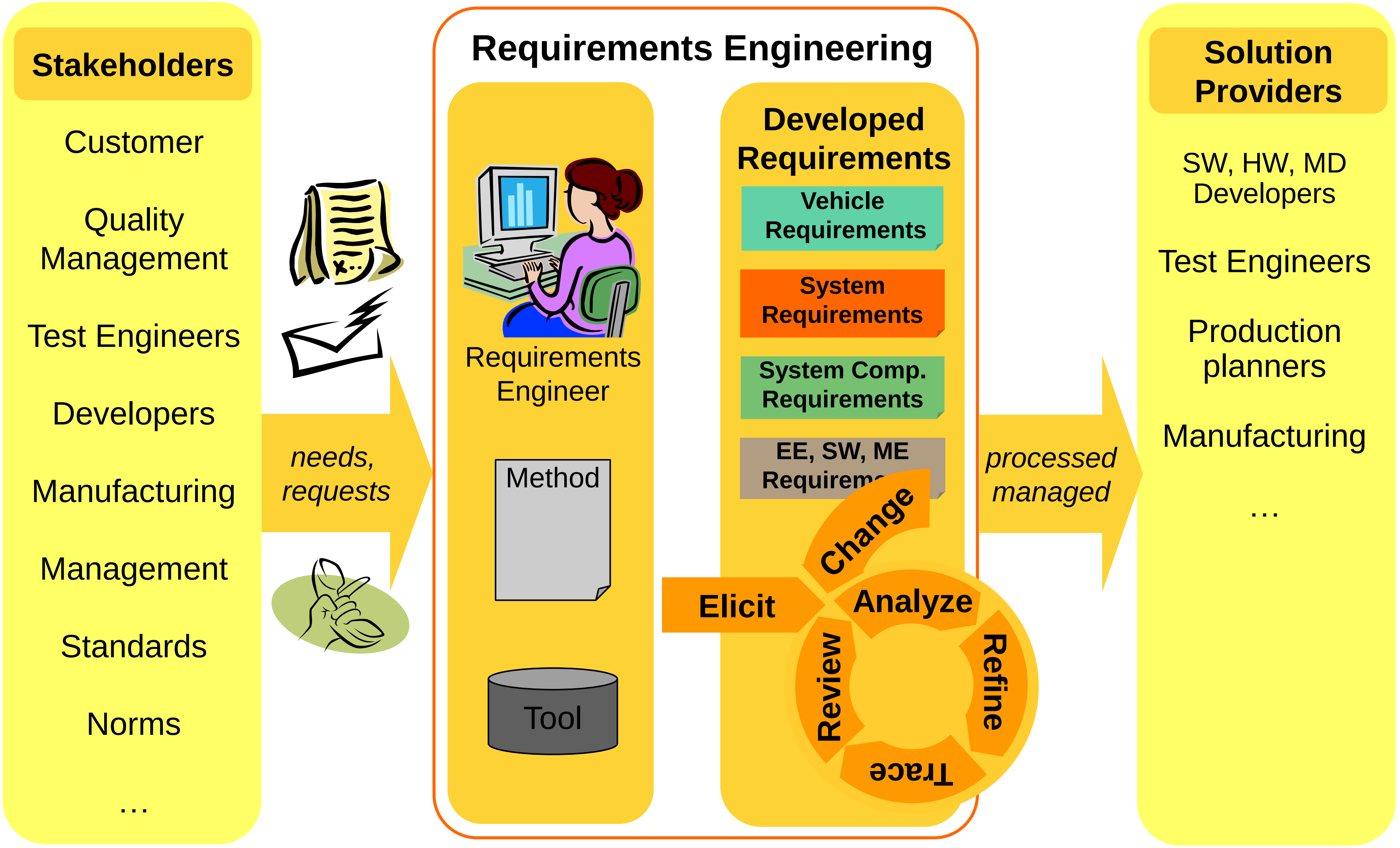
Naming Convention

Domain	*Document Type*	*System Component Identification*	*Function Area*
ST Stakeholder	A Architecture	LF Low Frequency Antennas	FI Flasher
SY System	R Requirements	TG Tire Guard	WI Wiper
SC System Component	T Tests	BCM Body Controller Module	
SW Software	S Specification (Requirements + Architecture)		
	DD Detailed Design		

Examples:

STR	"Stakeholder Requirements"
SYS	"System Specification"
SYT	"System Validation Test"
SCR_LF	"System Component Requirements" for "LF" component
SCR_BCM_WI	"System Component Requirements" for "BCM" for function "Wiper"

RE Process Overview



Stakeholders

Customer

Quality Management

Test Engineers

Developers

Manufacturing

Management

Standards

Norms

…

needs, requests

Requirements Engineering

Requirements Engineer

Method

Tool

Developed Requirements

Vehicle Requirements

System Requirements

System Comp. Requirements

EE, SW, ME Requirem

Elicit

Change

Analyze

Refine

Trace

Review

processed managed

Solution Providers

SW, HW, MD Developers

Test Engineers

Production planners

Manufacturing

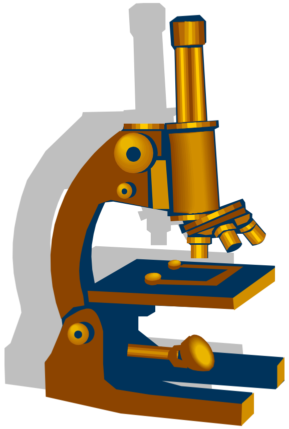
…

Requirements Elicitation

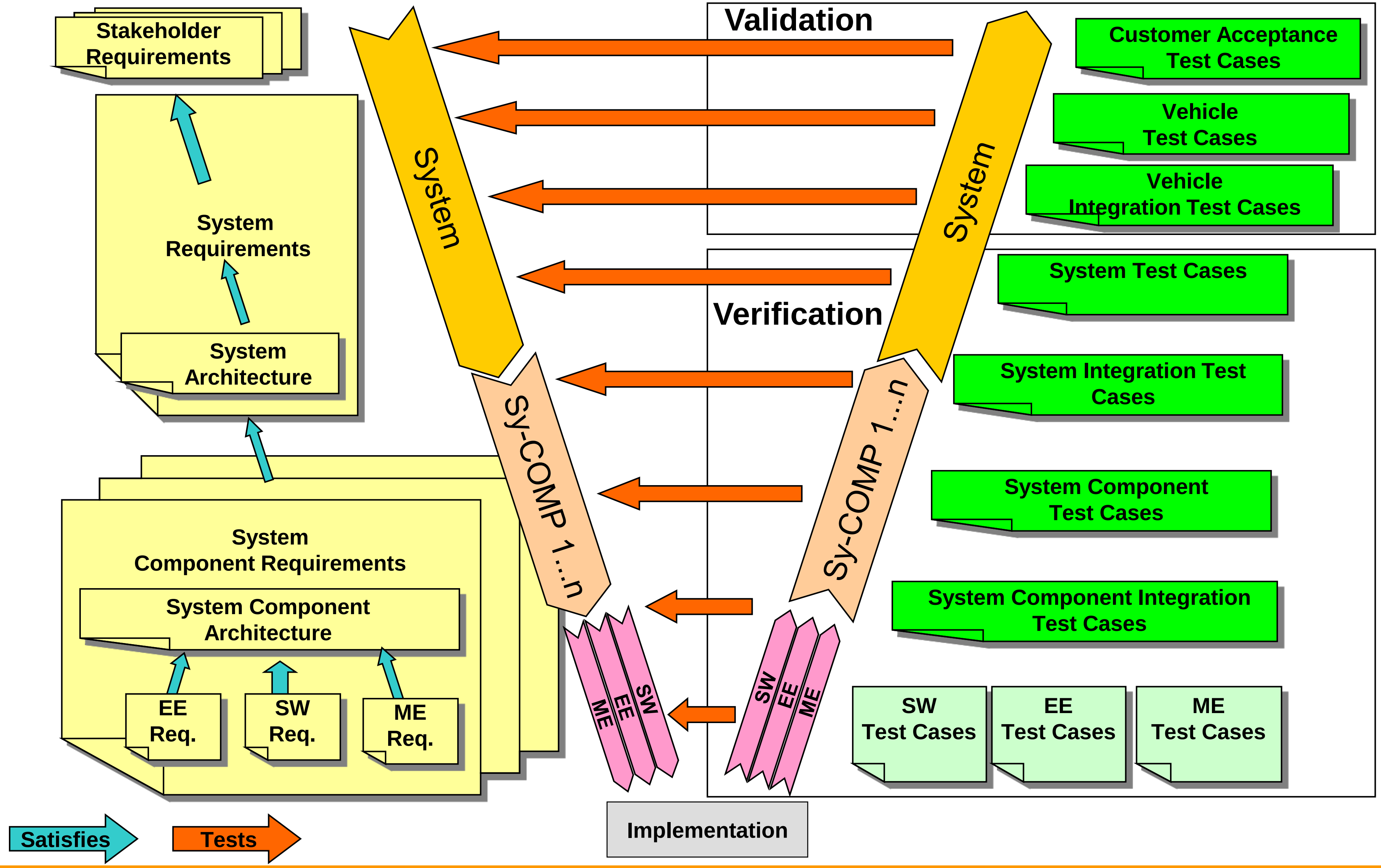
- Active interviewing of all stakeholders

- Gathering and documenting of requirements

- Clarifying of unclear requirements



Requirement Traceability



Quality Criteria for Requirements

- **Complete**
  The requirement is complete, if no information is left unstated, if nothing remains undefined and if no information is missing.

- **Explicit**
  Each specified requirement has (from the author‘s and reader's point of view) exactly one interpretation. This can be achieved in reviews (in case of natural language) or by using formal methods (e.g. UML).

- **Consistent**
  There is no
  - logical or temporal conflict between the actions specified in the requirements,
  - different naming for the same objects.

Quality Criteria for Requirements

- **Aligned**
  Everybody is committing to the specified requirements.

- **Prioritized**
  The requirements are prioritized based on
  - stability (number of the expected changes),
  - importance (e.g. essential, relevant, optional).

- **Verifiable Prioritized Traceable**
  It can be verified, that the requirement is implemented compliant to the definition (no „is working good"), this means
  - concrete time limits,
  - measurable properties.

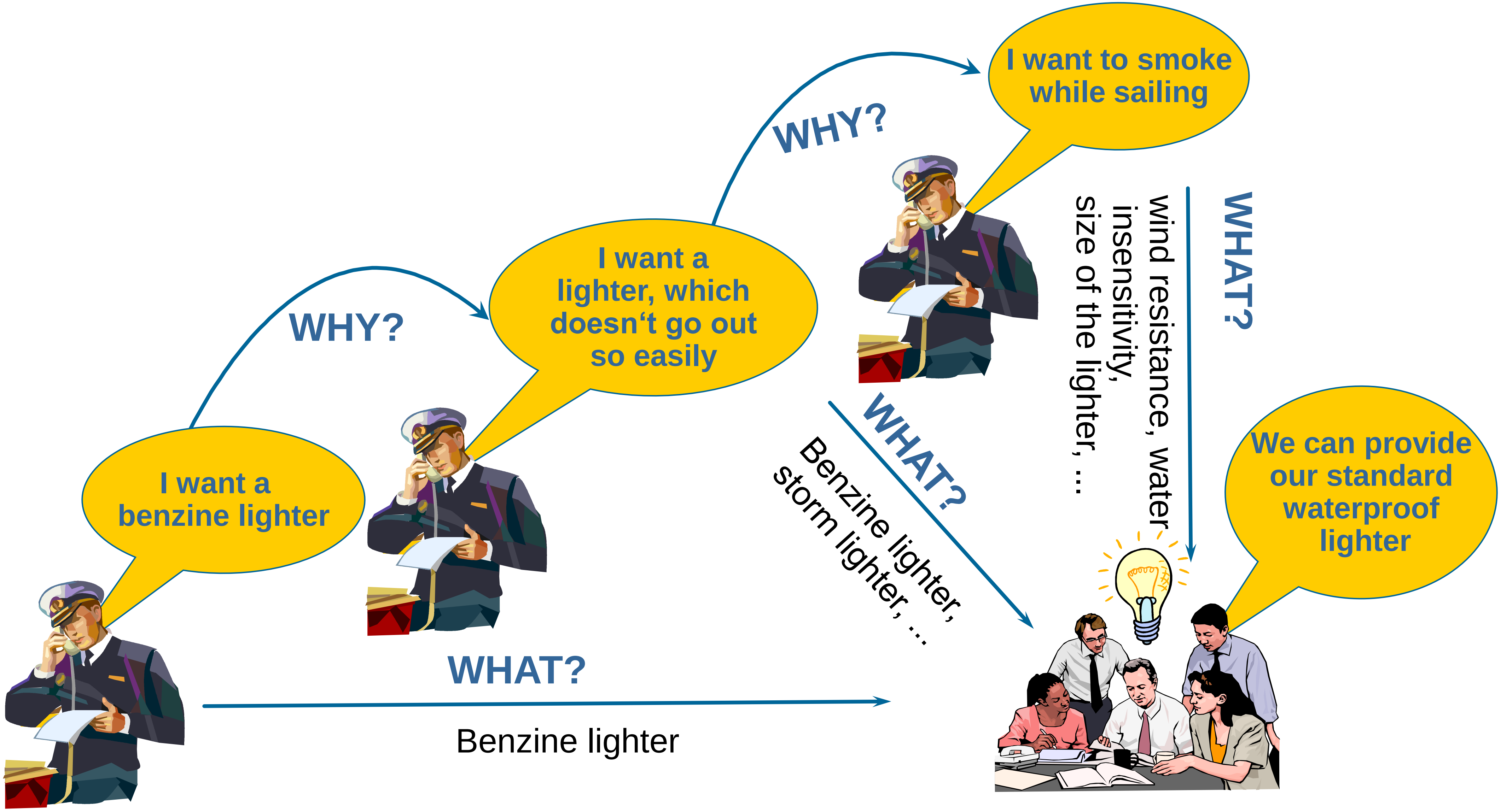
- **Traceable**
  Each requirement can explicitly traced back to its source.

SMART requirements

Requirements need to be made precise and actionable. “**SMART” requirements (Mannion and Keepence, 1995) have the following characteristics:**

Specific: *without ambiguity, using consistent terminology, simple and at the appropriate level of detail.*
Measurable: *it is possible to verify that this requirement has been met. What tests must be performed, or what criteria must be met to verify that the requirement is met?*
Attainable: *technically feasible. What is your professional judgment of the technical “do-ability” of the requirement?*
Realizable: *realistic, given the resources. Do you have the staffing? Do you have the skill? Do you have access to the development infrastructure needed? Do you have access to the run-time infrastructure needed? Do you have enough time?*
Traceable: *linked from its conception through its specification to its subsequent design, implementation and test.*
The first of these (specific and measurable) provide criteria for each quality requirement-it is not well-specified if it is fuzzy or ambiguous or not measurable. The next (attainable and realizable) provide checks you should perform with each requirement-do not include a requirement if it fails to meet either of these criteria. Note that when requirements are neither specific nor measurable, it is difficult to know if they are attainable and realizable. Gilb (1988) makes this point in the following principles:
“Projects without clear goals will not achieve their goals clearly.”
“You can’t hit a bullseye if you don’t know where the target is.”

Requirement vs. Solution



I want a benzine lighter

WHY?

I want a lighter, which doesn‘t go out so easily

WHY?

I want to smoke while sailing

WHAT?

Benzine lighter

WHAT?

Benzine lighter, storm lighter, …

WHAT?

wind resistance, water insensitivity, size of the lighter, …

We can provide our standard waterproof lighter

- **What are Attributes ?**

- Attributes are characteristics of an object
- They are used to hold essential information in a structural way

- **Requirement Classification:**
- **c_this_is_a:**
  - functional requirements
  - non-functional requirements
  - recommendations
  - comments
  - Headings

Requirements Analysis

- c_mature:
  - Proposed
  - Stakeholder accepted
  - Project accepted
  - Rejected
- c_discipline:
  - SW
  - HW
  - ME
  - EE
- c_variant
  - Variant EU
  - Variant JP
- c_SIL
  - QM
  - ASIL_A
  - ASIL_B
  - ASIL_C
  - ASIL_D
- c_verification_method
  - Vehicle test
  - SyIT
  - SyMT
  - SwIT
  - SwMT
  - Review

Example

- Window Module EWCM (Electronic Window Control Module)
  - This module is able to control window movement.
  - EWCM will optimize current consumption in order to avoid energy waste.
  - EWCM allows the user move up, move up window manually or automatically.
  - EWCM can receive commands from buttons or CAN commands.
  - CAN commands are only valid when power mode is equal to RUN or ACC.
  - Anti pinch functionality shall be implemented for all windows.
  - When user press “up” button window will move up.
  - When user press “down” button window will move down.
  - In case of battery disconnection window shall remain in current position.

Example

- EWCM shall have a robust strategy for stuck buttons.
- Window commands are not valid when corresponding door is open.
- Window shall not last more that 2 seconds to open completely.
- Window shall not last more that 2 seconds to close completely.
- EWCM for from driver is able to control lock/unlock and other window modules.
- EWCM for passenger is able to control lock/unlock.
- EWCM for Rear door only have functionality for windows.
- EWCM is a QM module.
- EWCM will be compliant with ISO 26262 for functional safety
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