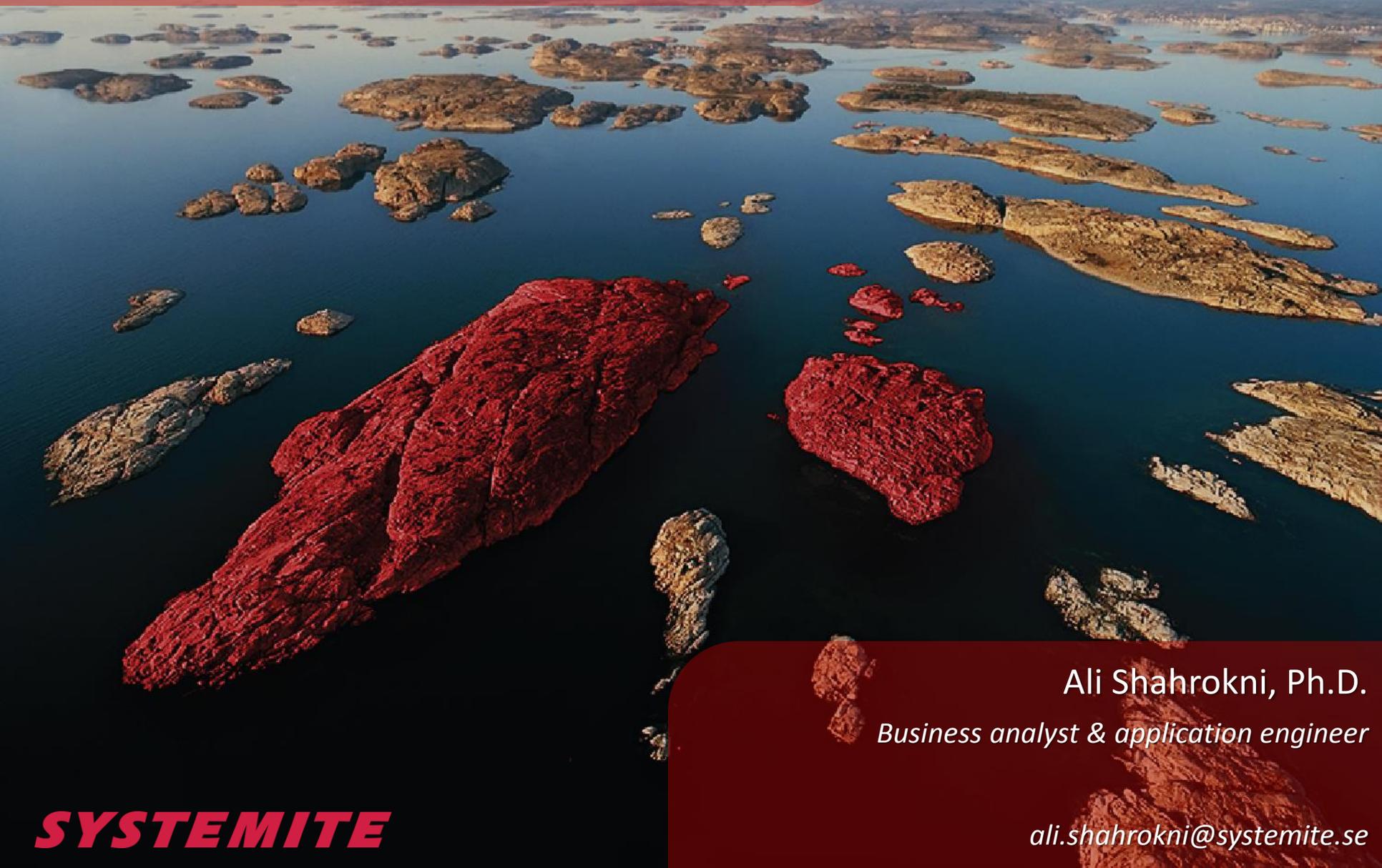


# Requirement Traceability in Practice

How to turn the challenge into an opportunity



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**SYSTEMITE**

# Systemite

Founded 2000 in Gothenburg, Sweden

Large footprint in Swedish automotive industry

## Location

Headquarters in Göteborg/Gothenburg

Branch office in Stockholm

Representation in Republic of Korea: ESG Solutions Ltd

Representation in China: ADG - Auto Development Group

## Concept

Improved information management

Specialized in automotive embedded systems development processes

ALM/ESLM (Embedded Systems Lifecycle Management)

100% focus since day one

Long experience in deploying ALM/ESLM solutions to automotive domain

## Trusted by

Volvo Cars

Volvo Construction Equipment

DongFeng/T-engineering

Delphi Automotive (AUTOSAR)

CEVT/Geely

Volvo Global Truck Technology (incl Renault, Mack, UD)

NEVS / SAAB

KAERI (Korean nuclear research)

dSPACE GmbH

.....

## Research Projects

MAENAD

CRYSTAL

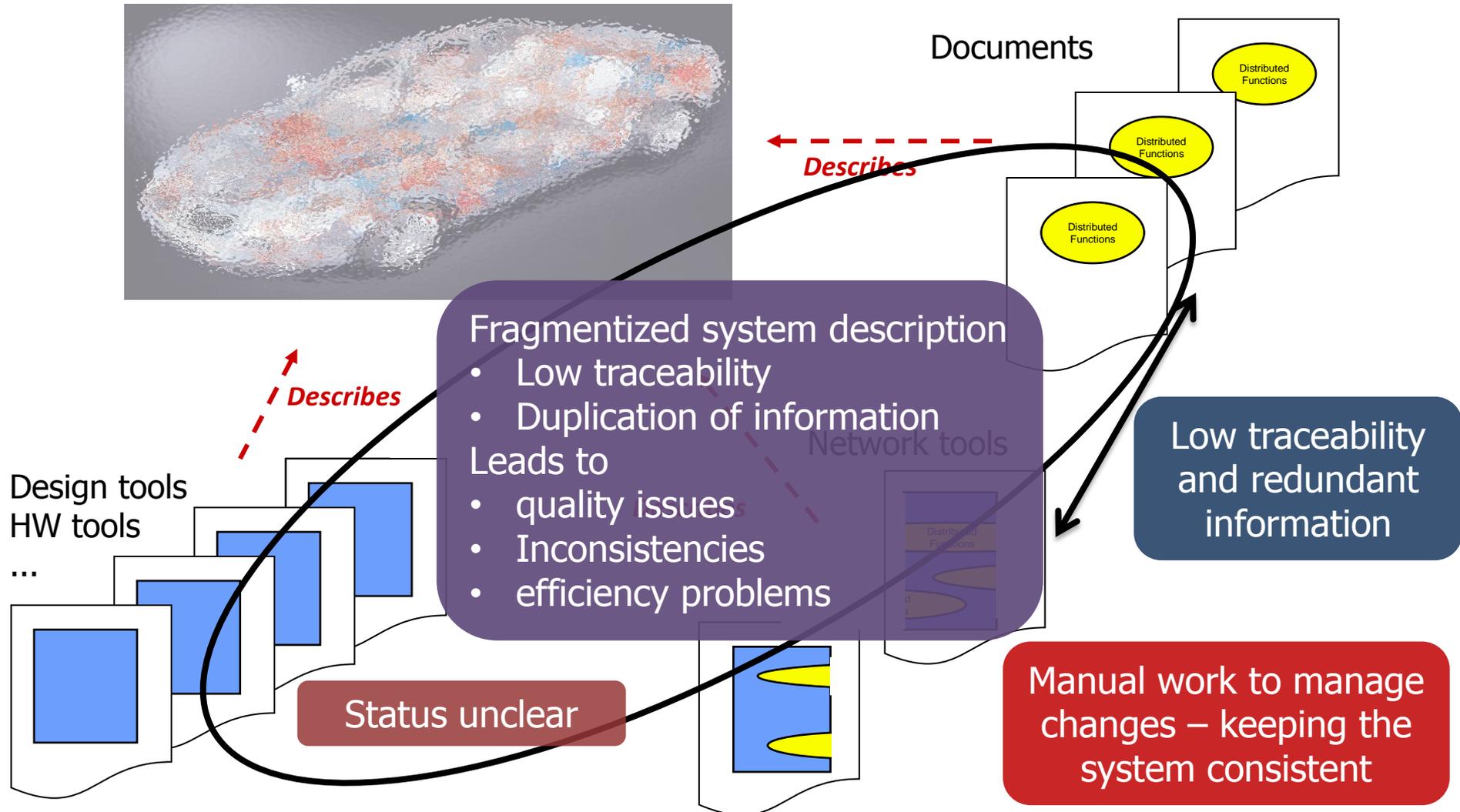
SYNLIGARE

HEAVY ROAD

EMC2

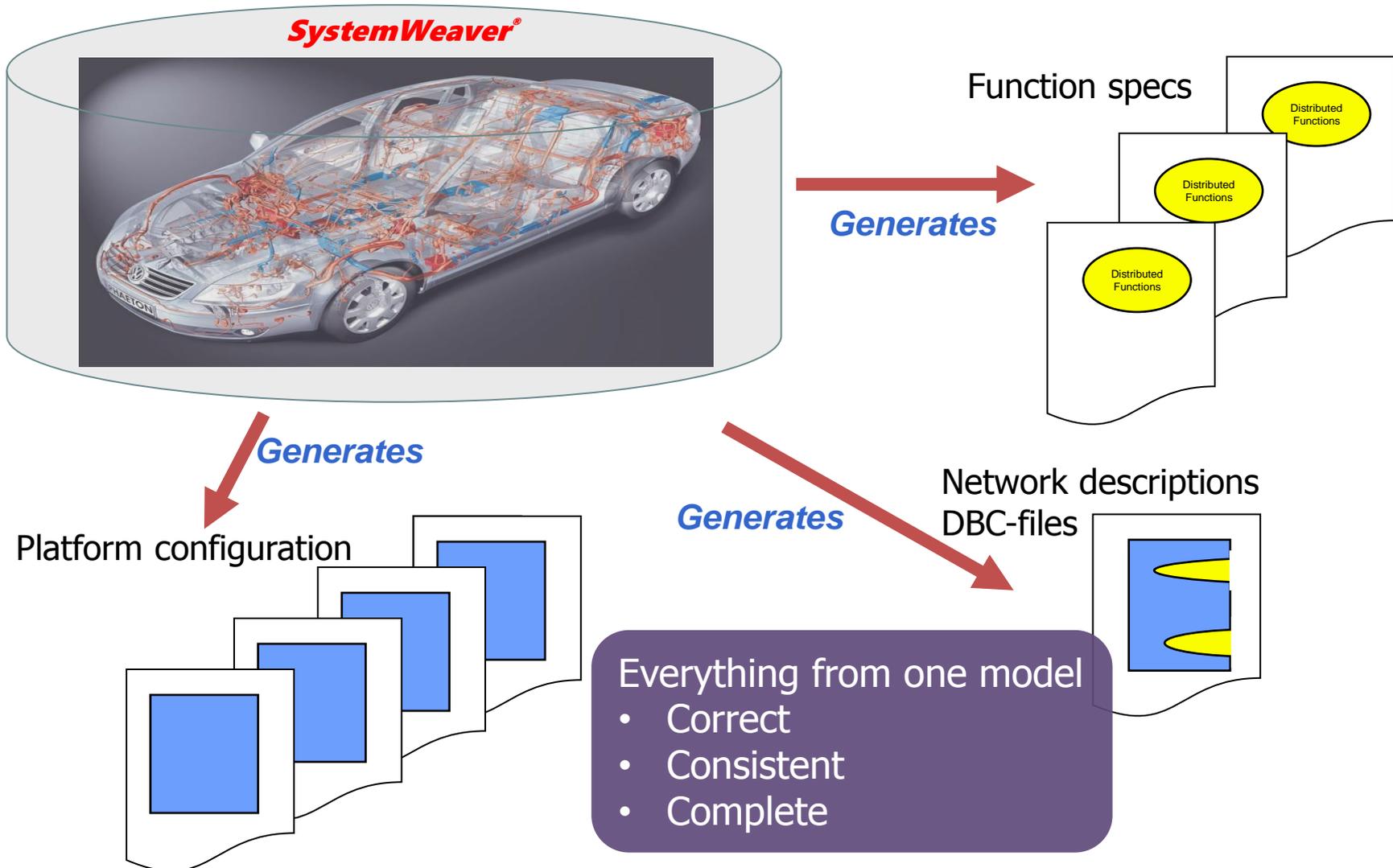


# Traditional approach



# Integrated approach

One unified model – many views



# Integrated data management

- In a complex system such as a modern car
  - Many people **collaborating**
  - **Late integration => high costs** (even with defined interfaces)
  - Information **continuously integrated** in its context => less assumptions, less complexity, more reuse
- Continuous integration benefits from **single source of information**
  - Doesn't mean all the information in one "tool"
  - Means that information is accessible, traceable, reportable, searchable, and analyzable **from one place**.

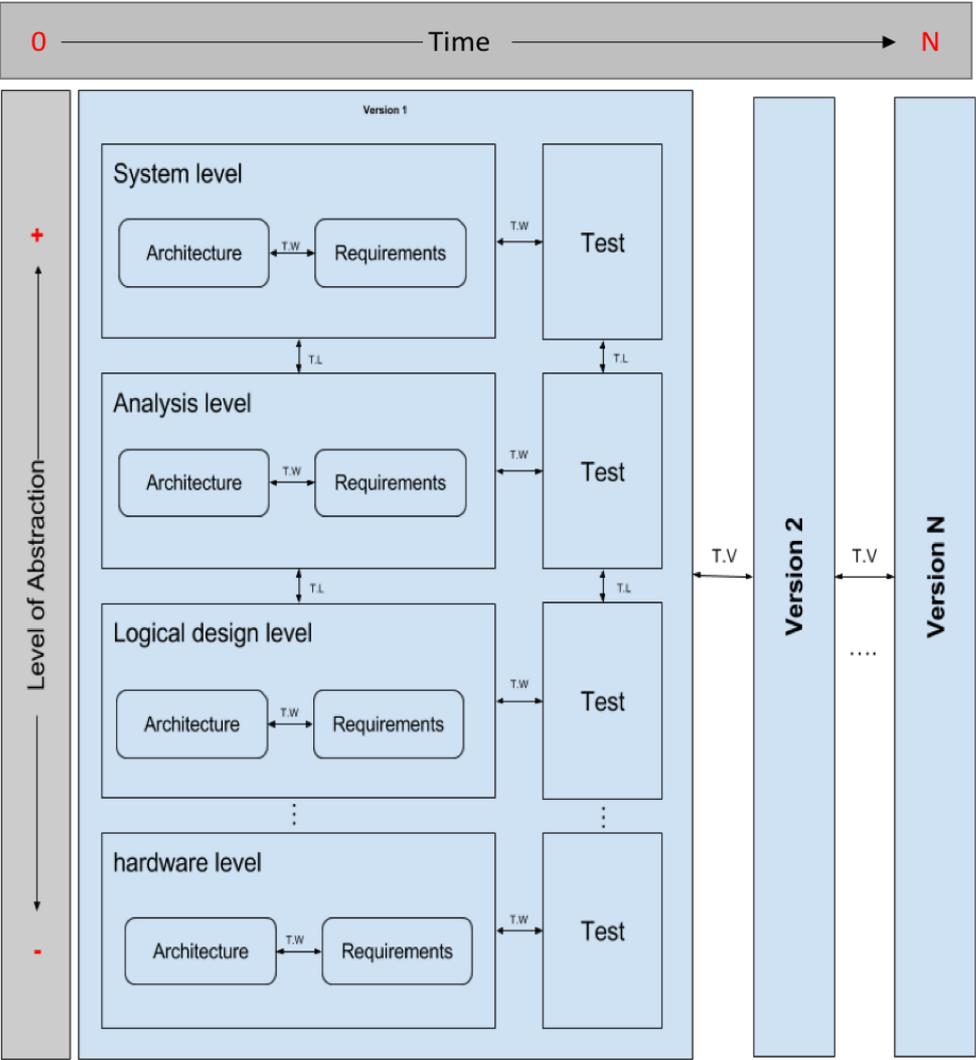


# Automotive OEM

- Requirements for bill of material
  - Safety requirements
  - Requirements for in-house development
  - Design & architecture
  - Simulation models
  - Behavior models
  - ...
- 
- All of these are requirement beyond the notion of requirements as specification



# Traceability on different levels



Traceability between version (T.V)    Traceability between level(T.L)    Traceability within the same level(T.W)

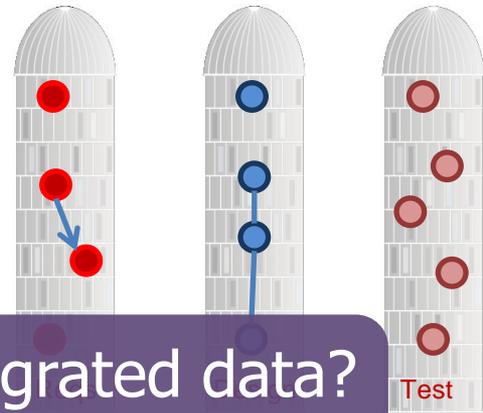


# Four main methods of managing data

File-based  
Example: Word & Excel

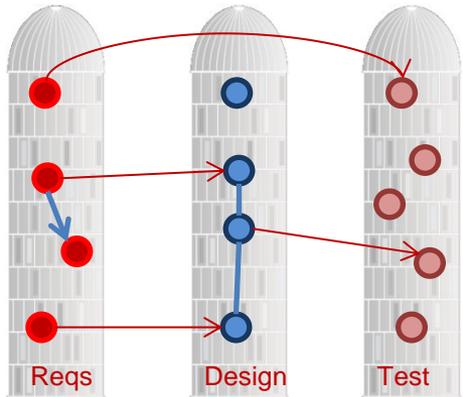


Silos  
Example: Doors & ClearQuest

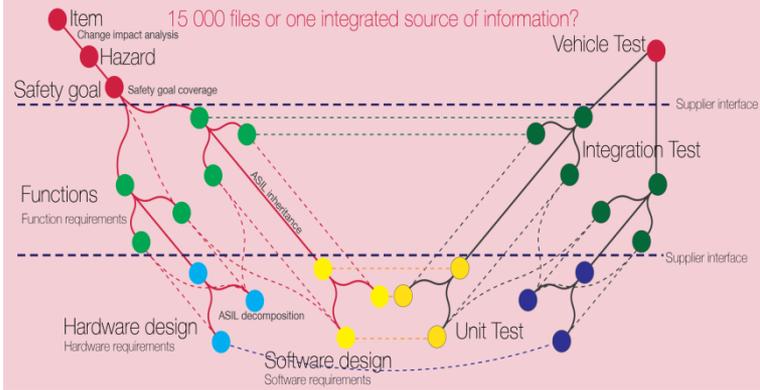


Why the move towards integrated data?  
What are the benefits?

Weakly connected silos  
Example: Jazz (OSLC)



Integrated information management  
Example: SystemWeaver



# Benefits of integrated data

- When you create data in its context you can:
  - Ensure **consistency**
  - **Generate** instead of create
  - **Analyze** (completeness, correctness, progress, process analysis & ...)
  - View from **many perspectives** (change impact, requirements, tests per requirements & ...)
  - **Visualize**
  - **Integrate solutions**
  - Using links to keep data **up-to-date**



# Feature Level Requirements

The screenshot displays the SystemWeaver Collaborative Environment interface. The main window shows a project titled "Vehicle Architecture - Default" with a tree view on the left containing various system components like "Direction Indicators", "Driver Authentication", and "Engine Start". The central pane displays a detailed view of a requirement: "3.1 DI - Turn Signal".

**3.1 DI - Turn Signal**  
 E2E\_DirInd\_Req-7 v6 DI - Function Operation  
 Type: Functional Requirement  
 Verification Method: test  
 This requirement is a prerequisite to all other requirements with the same ID.

The turn signal function is only operational in the following conditions:

E2E\_DirInd\_Req-8 v5 DI - Turn Signal Activation  
 Type: Functional Requirement  
 Verification Method: Test

Logg:  
 Adding Section/ItemNo 27  
 Report Done

An "Overview" window is open on the right, showing details for "Direction Indicator Monitoring". It includes a table of metadata and a description of the requirement.

Last Changed	Last Changed By	Creation Date	Access	Owner	Status	Version
2011-01-11	Morgan Eriksson	2011-01-11	Read Only	Morgan Eriksson	CS_Released	(2)

**Attributes**  
 Unique Id Context: F-DIM  
 SIL: -

**Description**  
 Direction indicators. This was previously done electrically by the use of the telltales but with the new this proved more difficult so instead this function was added.

**Task formulation**  
 Add functionality for monitoring the direction indicators so that the operator is alerted upon a broken indicator light.

**Former system design**  
 In ART-E telltales were used to diagnose a broken indicator light:

Two direction indicator telltales were used. Normally both telltales would be activated simultaneously broken indicator light on the dump body was detected one of the two telltales would be off (the one y

**Issues**

ID	Name	Status
----	------	--------



# Traceability for Single Requirement

The screenshot displays a software interface with three panes. The left pane, titled 'Functional Requirement', shows a single requirement: 'Direction Indicator Relay Fun...'. A red arrow points from this requirement to the right panes. The top right pane, titled 'All References - Direction Indicator Relay Function', lists various documents such as 'E2E Function Report ART-F w1135 PLA document generator' and 'Delivery Report Electronic System Architecture'. The middle right pane, also titled 'All References - Direction Indicator Relay Function', lists products like 'Arbulated Hauler PLA Electronic System Architecture' and 'ART WB Medium PLA'. The bottom right pane, titled 'All References - Direction Indicator Relay Function', lists test suites such as 'Performed Test Activities and report area - Test Suites' and 'Test Run - Prio 3 functions'.

130+ Specifications and Reports

10+ Products

40+ Test Suites



# Traceability to Lower Level Abstractions

**References** | DI - Priority

Referencing Item	Version	Referencing Item Type	Part Type
Direction Indicators	(16)	END-TO-END FUNCTIONAL REQUIREMENT	
Direction Indicators Priority	(5)	Functional Requirement	
Direction Indication Priority	(4)	Functional Requirement	
Direction Indicators Priority	(6)	Functional Requirement	
Direction Indicators Priority	(7)	Functional Requirement	
Direction Indicators Priority	(8)	Functional Requirement	
Direction Indicators Priority	(9)	Functional Requirement	
Direction Indicators Priority	(10)	Functional Requirement	
Direction Indicators Priority	(11)	Functional Requirement	
DI - Priority	(1)	Test Case	
DI - Priority	(1)	Test Case	

**WLO E2E Req Impact** | Direction Indicators | HMI Requirement

Architecture: Articulated Hauler PLA Electronic System Architecture W1105(6a1)

### E2E requirement impact analysis for: Direction Indicators

Unique Id: F-DIM-1 v1

**Description of requirement:**  
 If the direction indicator malfunctions (i.e. a broken lamp) the operator shall be alerted.  
*Note: This is so that the operator is made aware that his direction intentions may not be perceived by the surroundings.*

### Impact analysis

Analysis function	Analysis requirement	Design Component	Design requirement	Real allocation target
Direction Indicator Monitoring	Direction Indicator Diagnostics A-DIM-1 v3			
Direction Indicator Relay	Direction Indicator Diagnostics Reset A-DIM-2 v1			
	Direction Indicator Relay Function A-DIM-4 v1			
	Direction Indicators			

Logg: Creating report... Report Done

**Analysis reqs** | Direction Indicators

If the direction indicator malfunctions (i.e. a broken lamp) the operator shall be alerted.  
*Note: This is so that the operator is made aware that his direction intentions may not be perceived by the surroundings.*

Connected analysis req

Name	Description
Direction Indicator Diagnostics Reset	Upon system startup, <a href="#">Alarm Direction Indicator Malfunction</a> shall be generated. <i>Note: To avoid alarm disappear and reappearing everytime the direction indicator is activated, the alarm shall be generated when the direction indicator is activated.</i>
Direction Indicator Relay Function	When the direction indicators are activated (lit), <a href="#">Direction Indicators</a> shall be set as <a href="#">Direction Indicator</a> .
Direction Indicators Lamp Diagnostics	If one or more direction indicator lamps are detected as broken, <a href="#">Direction Indicators</a> shall be set as <a href="#">Direction Indicator</a> .



# As Used in Test & Verification Planning

## 1 Allocation to Test Specification:

The screenshot shows the 'Requirements' tool interface. On the left, a list of requirements is shown under 'Test Specifications Requirements:'. A red arrow points from 'Direction Indicator Diagnostics' (A-DIM) to the 'Direction Indicator Diagnostics' entry in the 'Test Specifications Requirements:' table on the right. The table has columns for 'Inclusion Status', 'Name', and 'Id'. The entry 'Direction Indicator Diagnostics' (A-DIM-1 v3) is circled in red.

Inclusion Status	Name	Id
Same	Direction Indicator Monitoring	
Same	Direction Indicator Diagnostics	A-DIM-1 v3
Same	Direction Indicator Diagnostics Reset	A-DIM-2 v1
Same	Direction Indicator Diagnostics Lamp	A-DIM-3 v1

## 2 Allocation to Test Case:

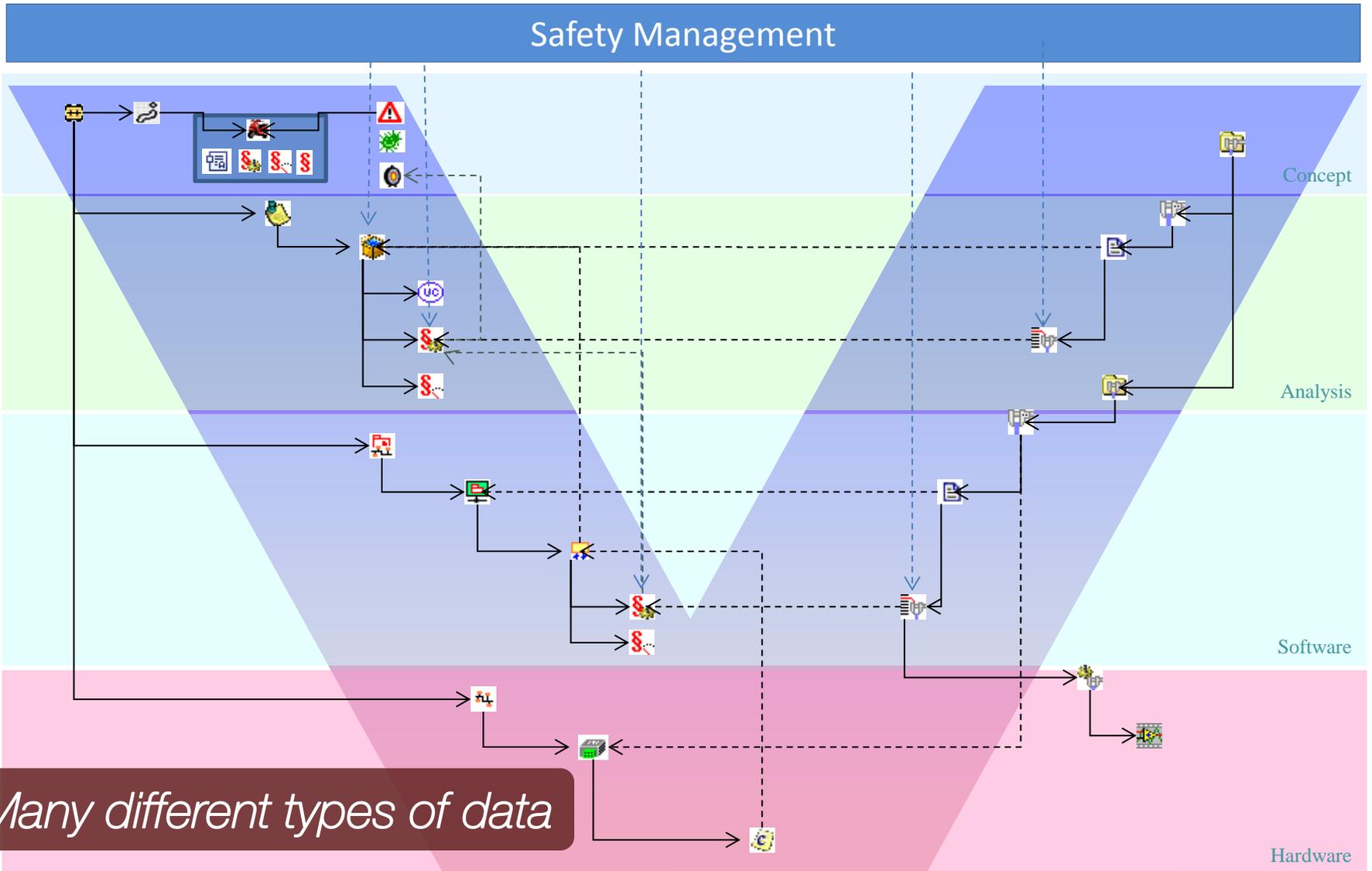
The screenshot shows the 'Test case manager' tool interface. On the left, a tree view of test cases is shown. A red arrow points from 'Direction Indicator Diagnostics' in the tree to the 'Direction Indicator Diagnostics' entry in the 'Test Specifications Requirements:' table on the right. The table has columns for 'Name', 'Id', 'In Test Case', and 'Annotation'. The entry 'Direction Indicator Diagnostics' (A-DIM-1 v3) is circled in red.

Name	Id	In Test Case	Annotation
Direction Indicator Diagnostics	A-DIM-1 v3	NF - Diagnostic Of Director Inx	
Direction Indicator Diagnostics Reset	A-DIM-2 v1	NF - Diagnostic Of Director Inx	
Direction Indicator Diagnostics Lamp	A-DIM-5 v1	NF - Diagnostic Of Director Inx	
Erroneous Input	A-DIM-3 v1	FF - Direction Indicator Errone	

Below the table, the 'Description' field for the selected test case is visible, containing text about the diagnosis check and alarm conditions.



# Example: ISO 26262 – Safety management

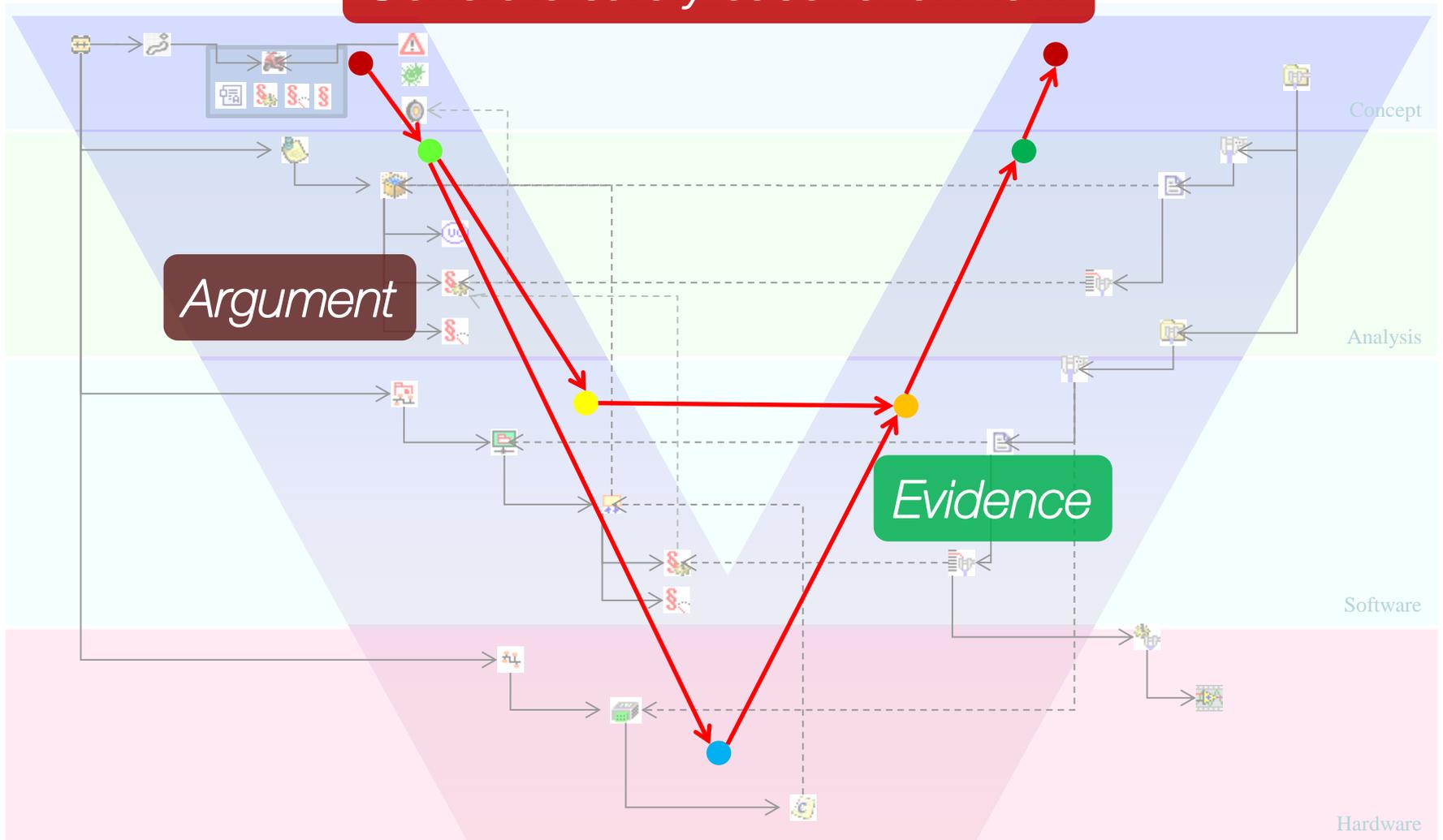


*Many different types of data*

*Organizational changes*

# Integration facilitates...

*Generate safety case for an item*

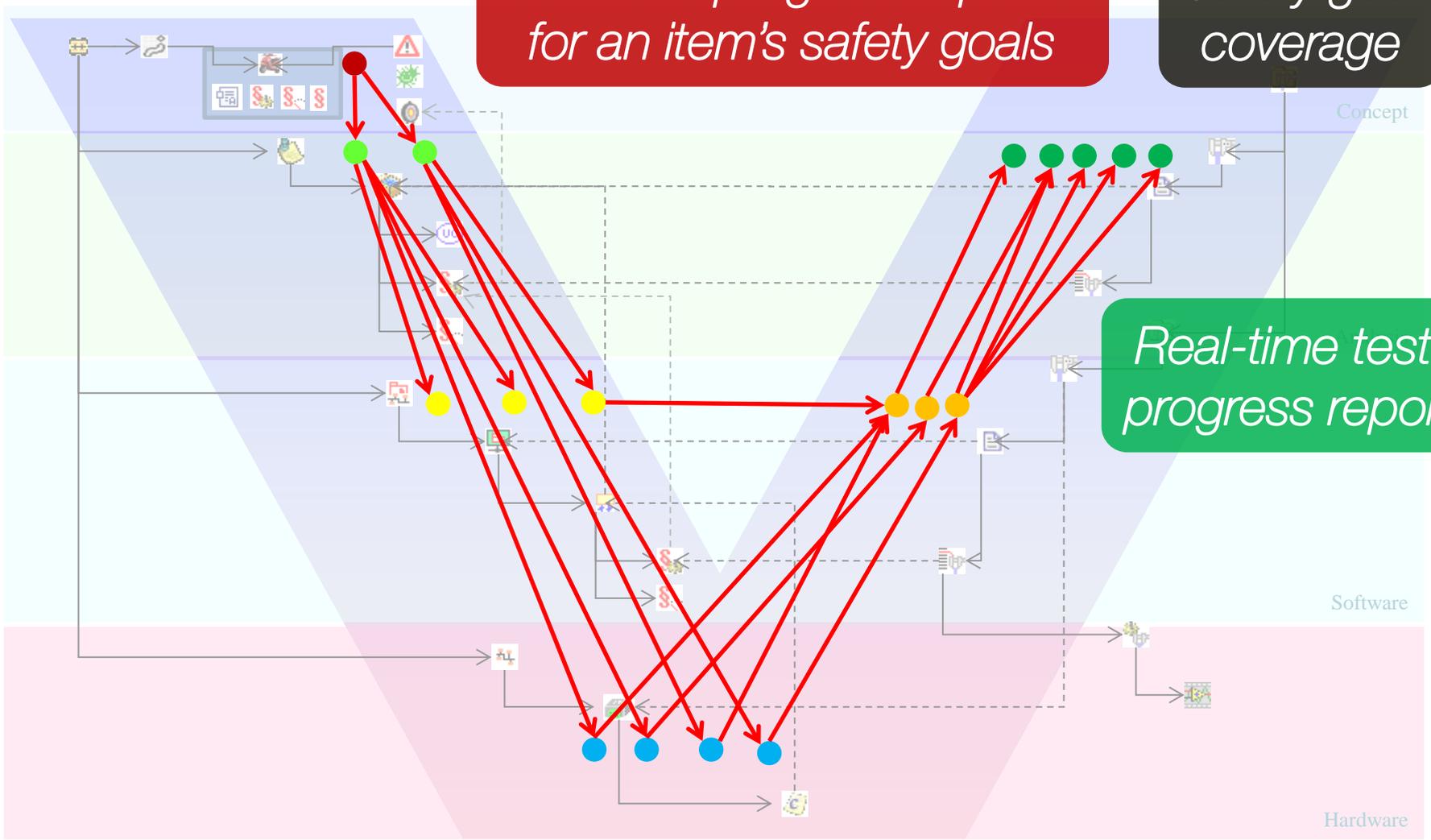


# Integration facilitates ...

*Generate progress reports for an item's safety goals*

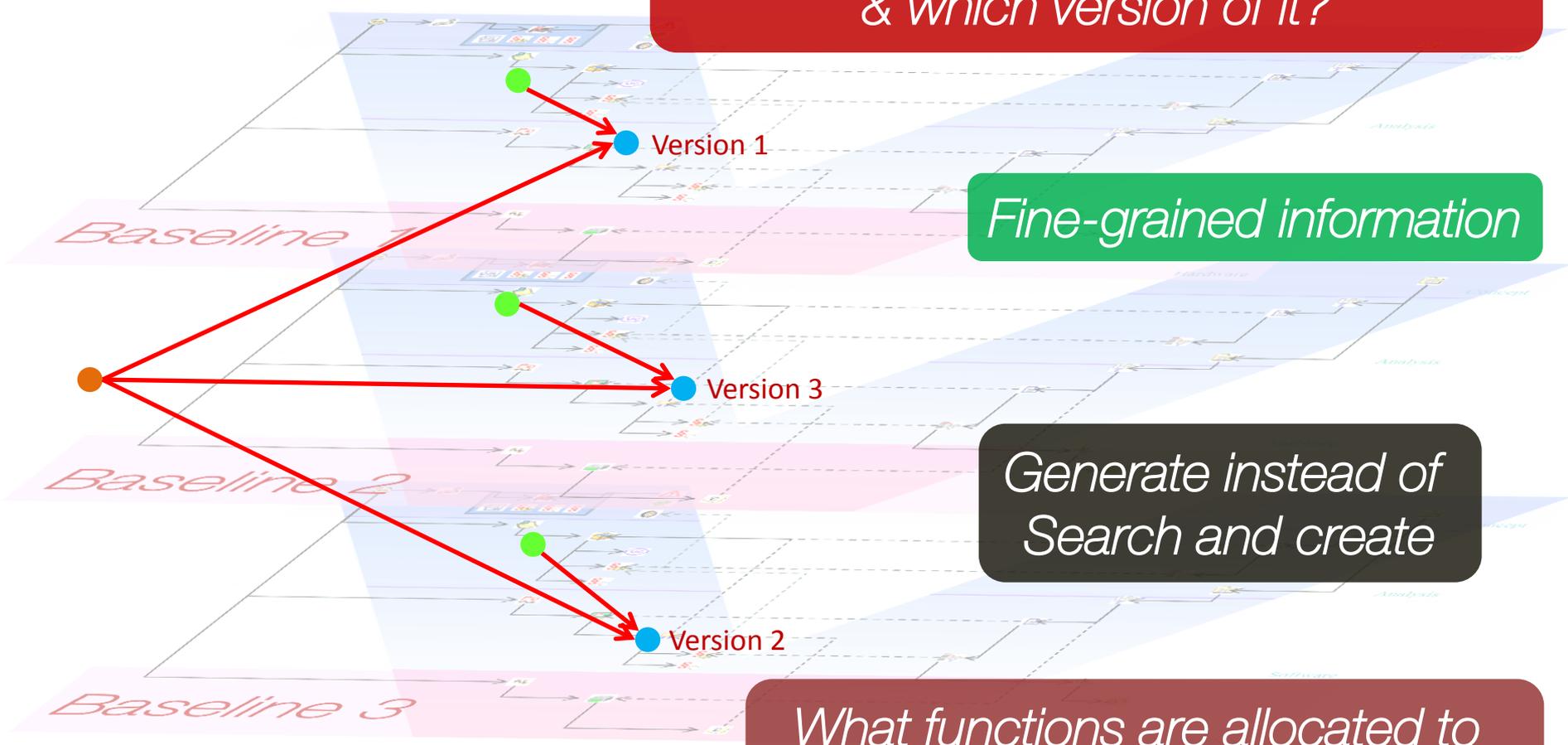
*Safety goal coverage*

*Real-time test progress report*



# Integration facilitates ...

*Which products include component A & which version of it?*



*Fine-grained information*

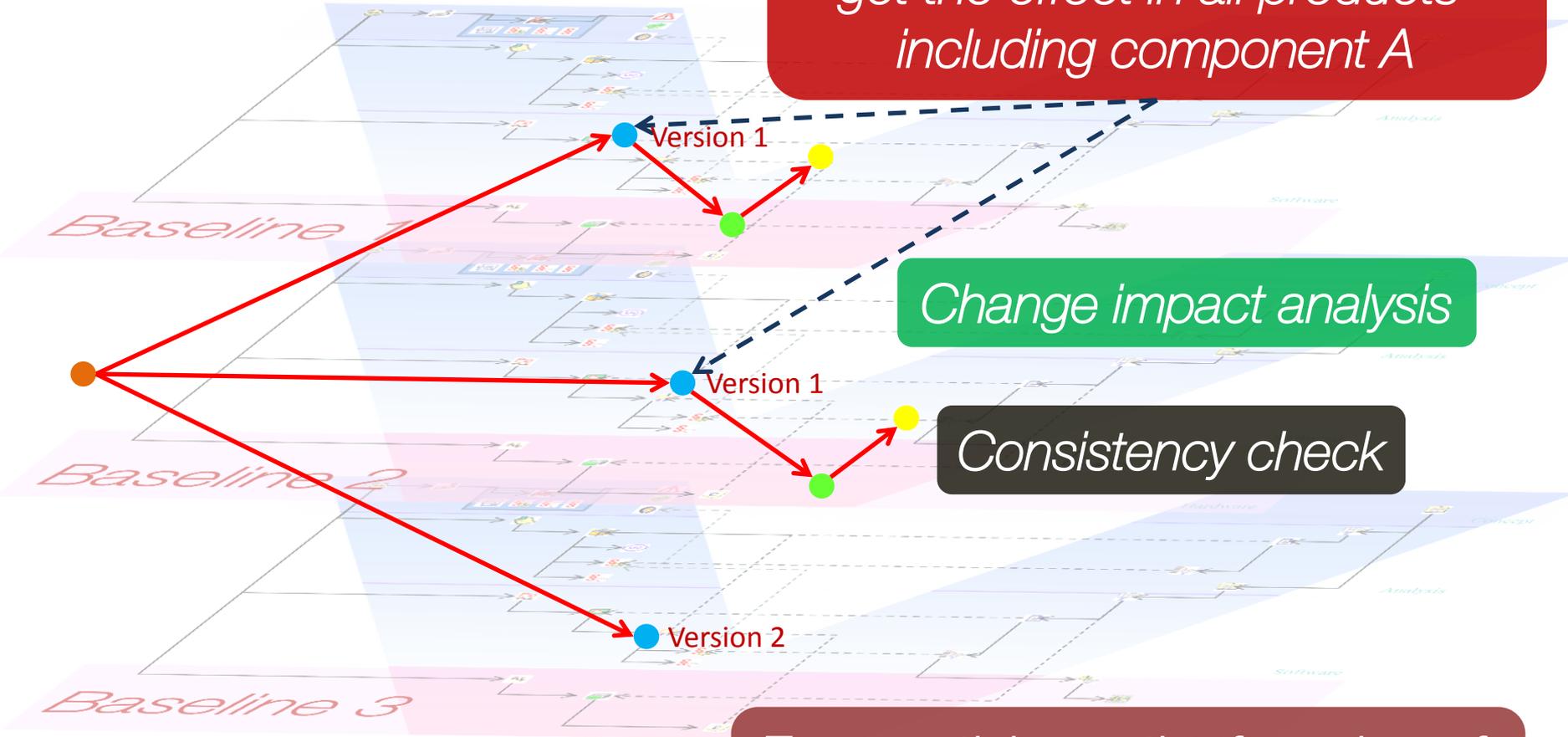
*Generate instead of Search and create*

*What functions are allocated to that component in each product?*



# Integration facilitates ...

*Fix bugs in component A once, get the effect in all products including component A*



*Change impact analysis*

*Consistency check*

*Exponential growth of number of files in file-based approach*



# Reflections

- Academic research: utilizing the opportunities of using integrated data
  - An overemphasis on the mechanisms of storing integrated data and research on special cases but little on studying the benefits
  - There is a gap between purely technical and from-scratch contributions that are hard to apply in industry and observational interview studies.
  - Use the existing platforms to make more actionable research and get closer to studying organizations through their data and maybe guided by interviews



## Reflections 2

- Data analysis on more structured data gives insights not only into the data and the product but also into the organization
- Important to keep data consistent and up-to-date; Not only for efficiency and cost but also for quality and creating new opportunities and raising the complexity to higher levels of abstraction
- Utilize the traceability of data to keep the data updated



Thank you

