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VAILLANT GROUP

Polarion along the mechatronic V-Model to improve function development

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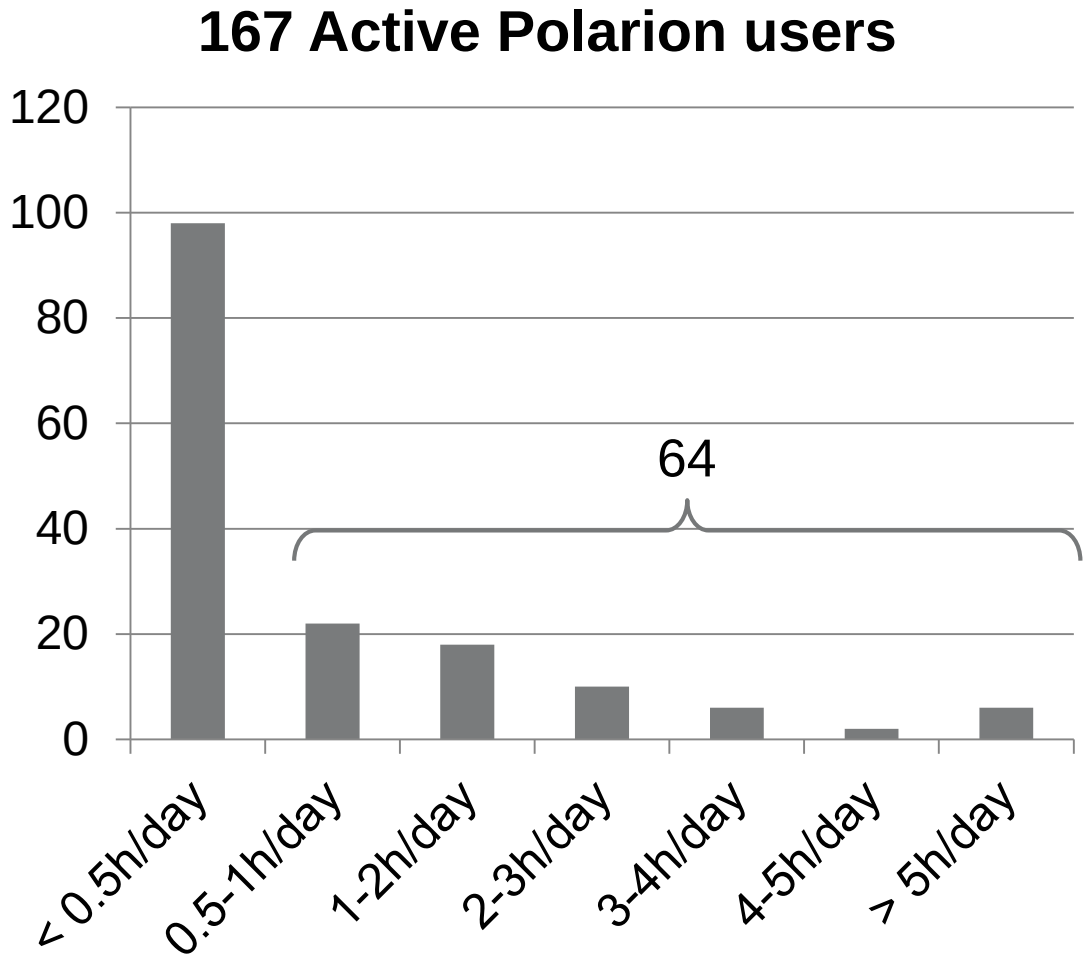
September 2015

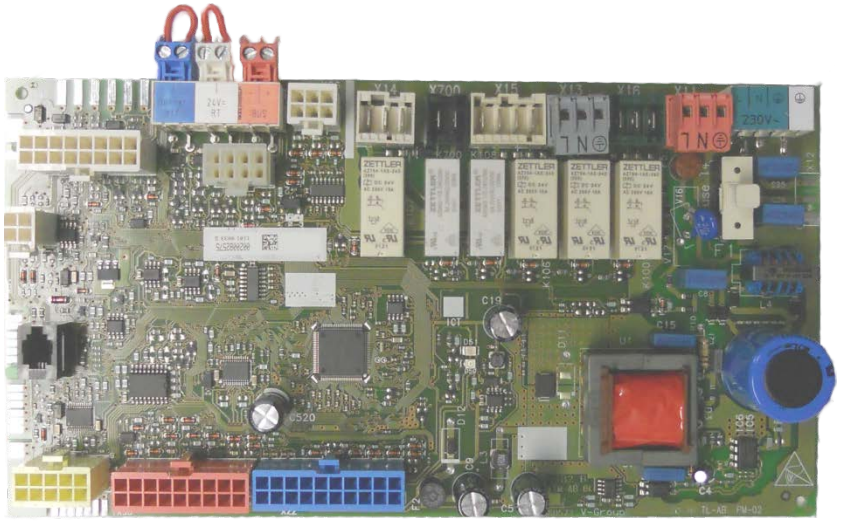
65 projects

69.000 work items

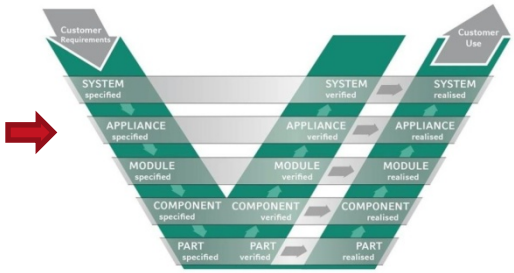


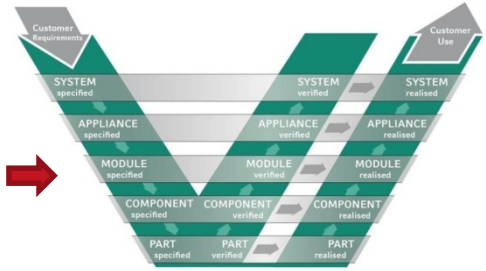
Piloting in 2012 with 2 projects

Heating System Controller



Heat Pump Management Unit





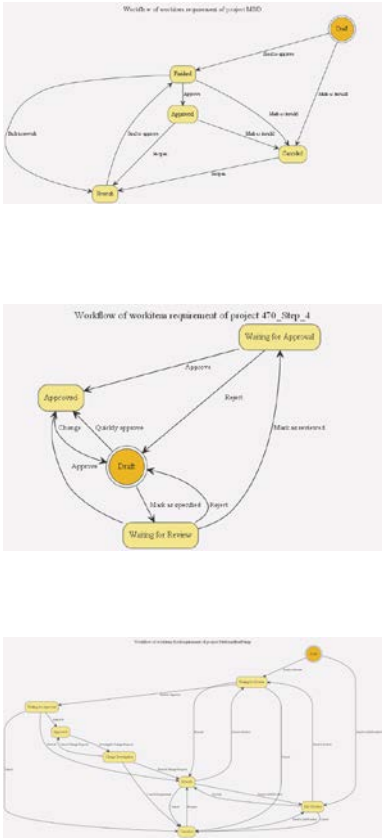
End of 2013: Many projects in Polarion but no efficient work with it

Polarion Templates

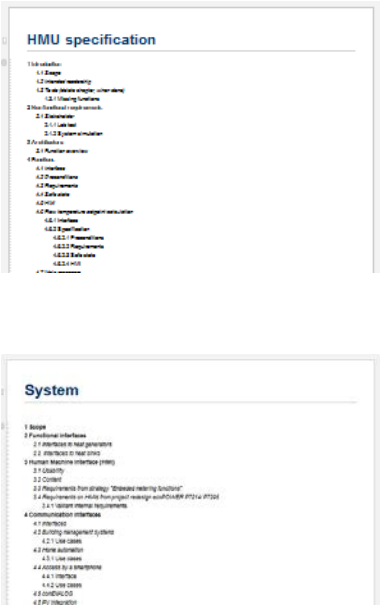
Custom Templates

Different templates

Modified and new work items



Modified or no workflows



Different document structures

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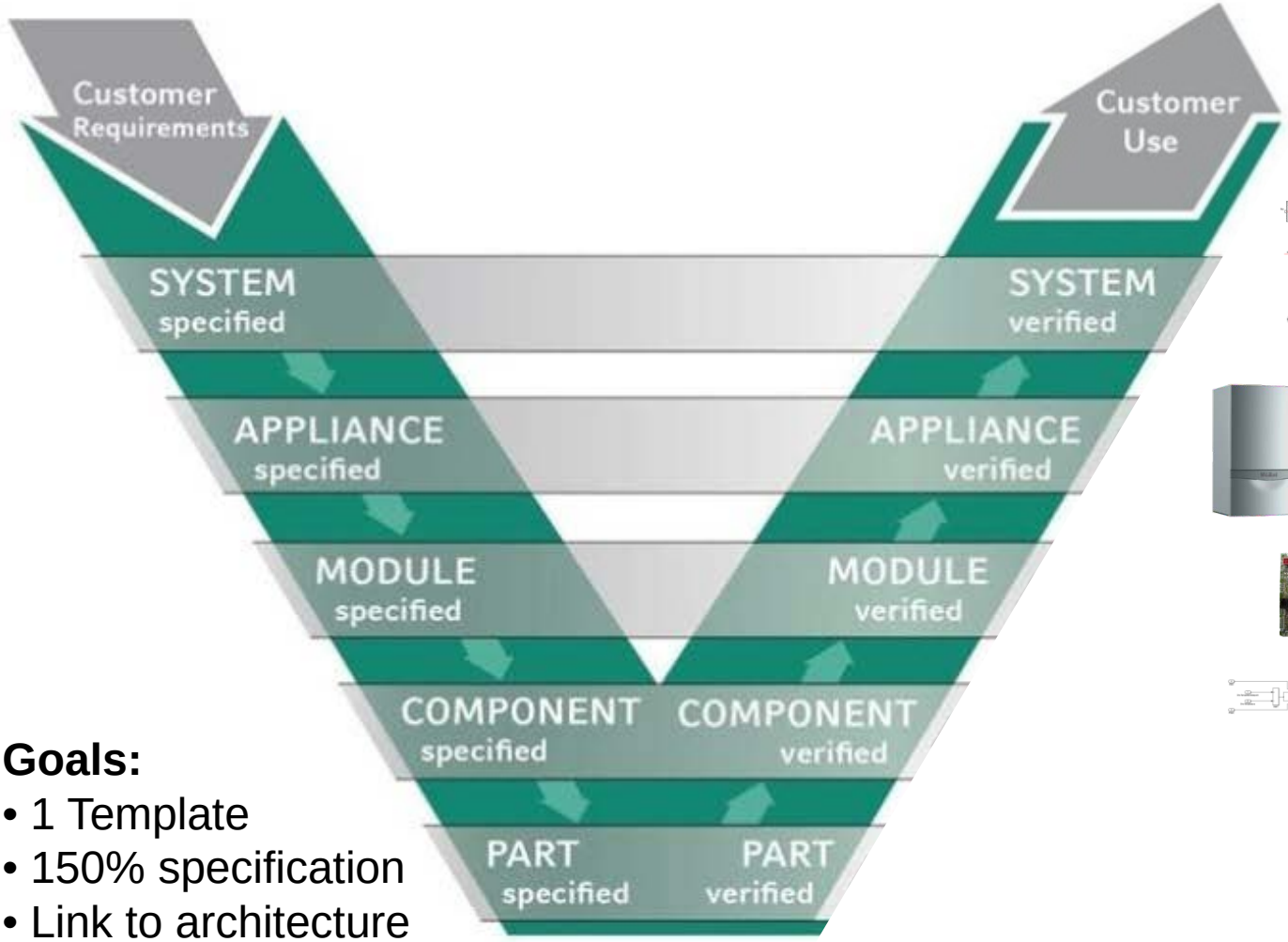
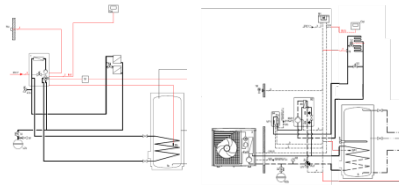
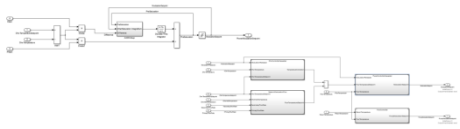
Beginning of 2014: Standardize RE with Polarion along the V-Model



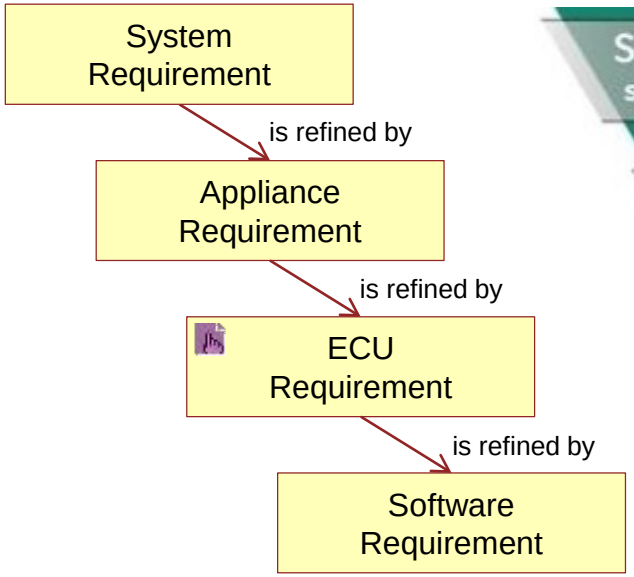


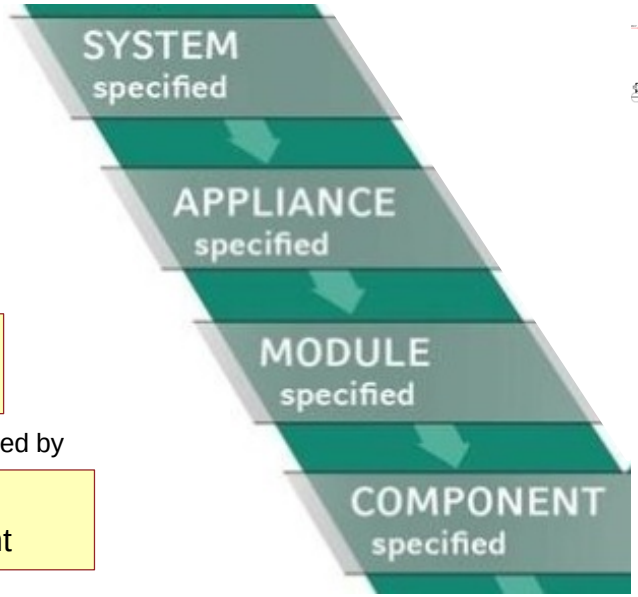


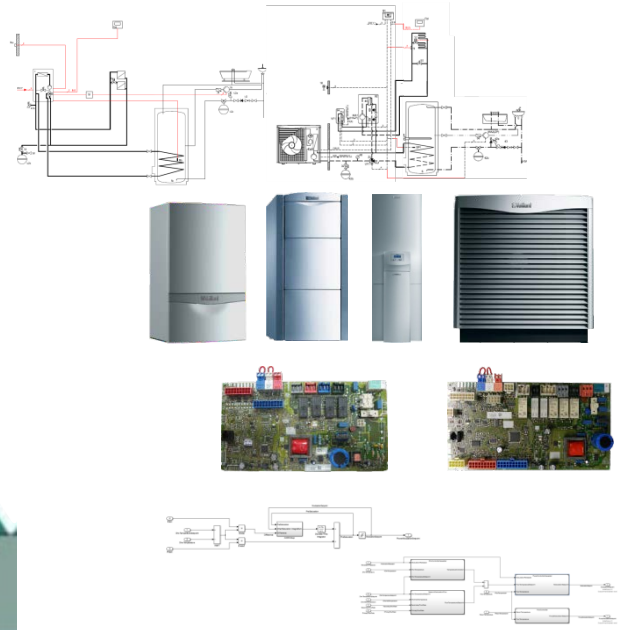
Goals:

- 1 Template
- 150% specification
- Link to architecture

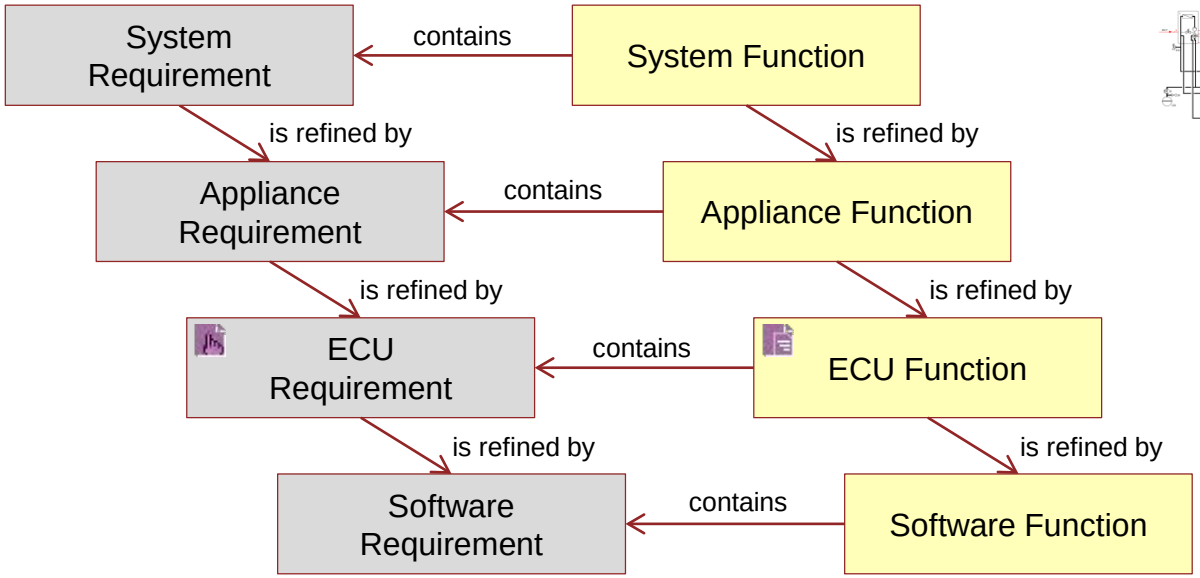
Straight forward approach does not work well

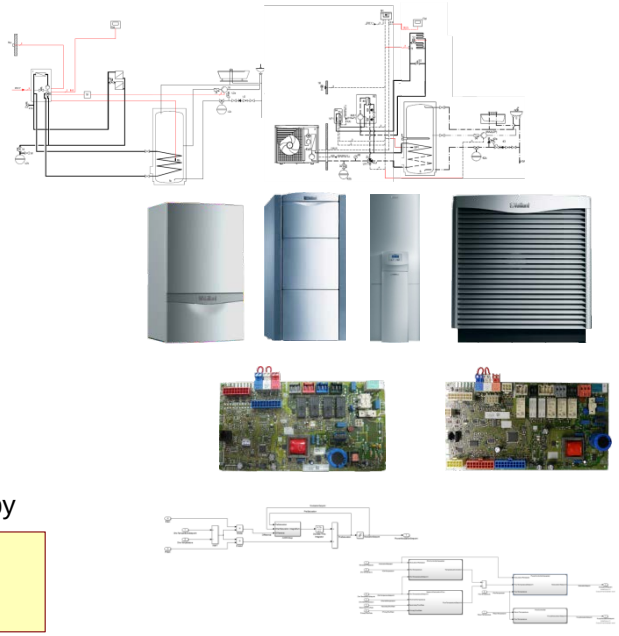


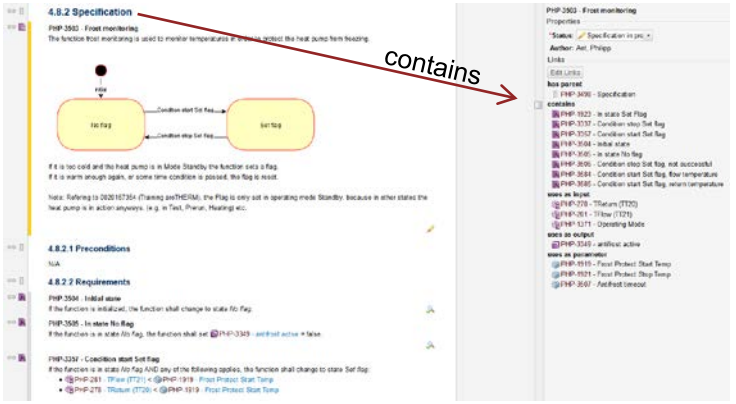




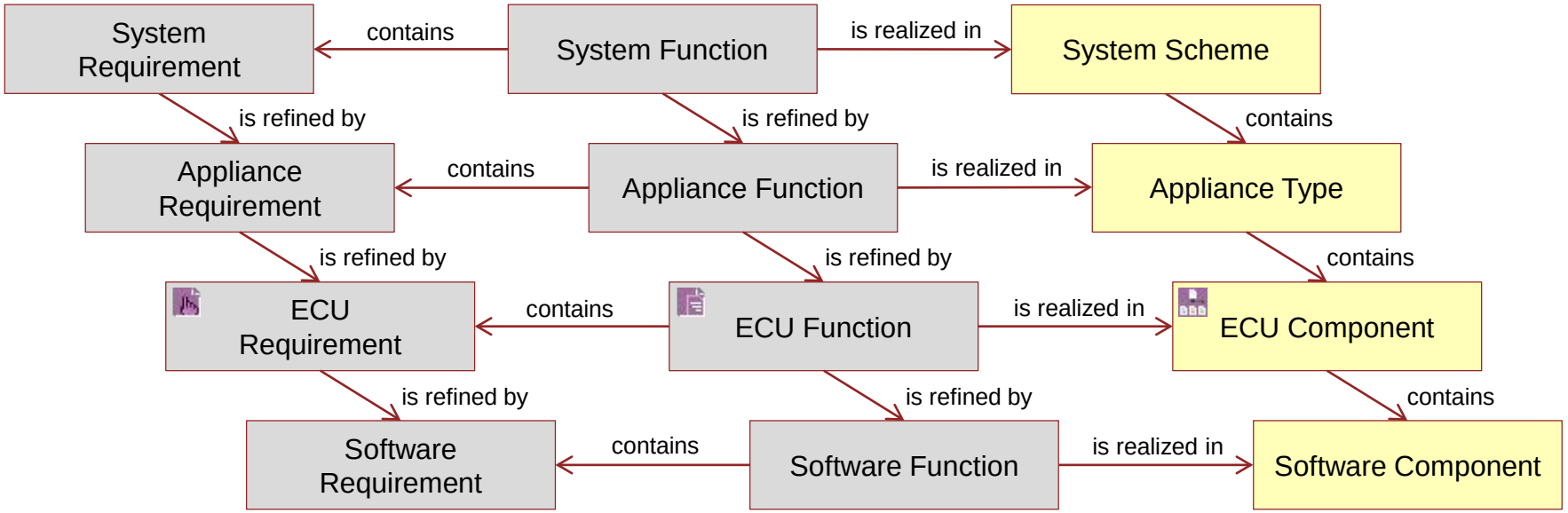
Grouping requirements makes them much more manageable

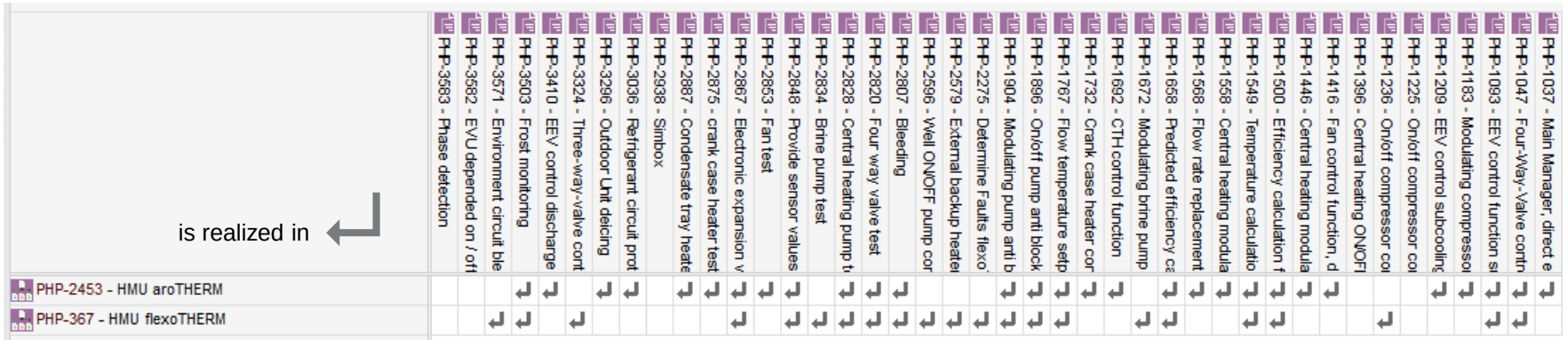






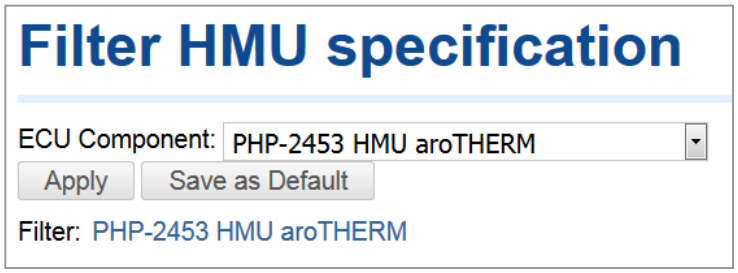
Adding variants and architecture completes the concept





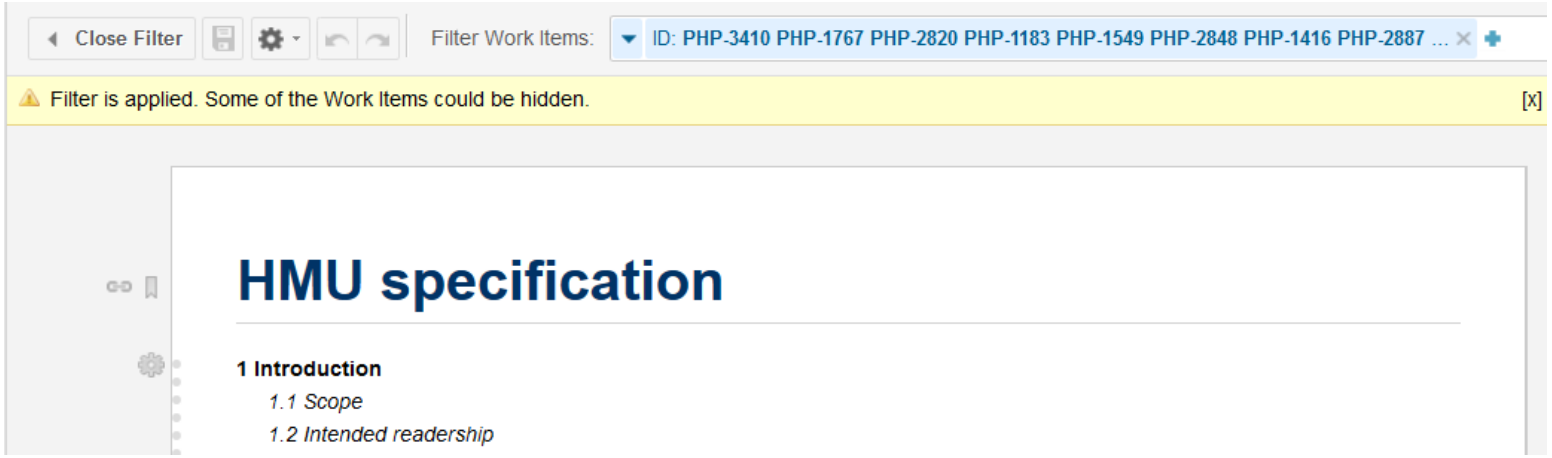
Architecture work items are basis for 150% specification

Wiki page as starting point:

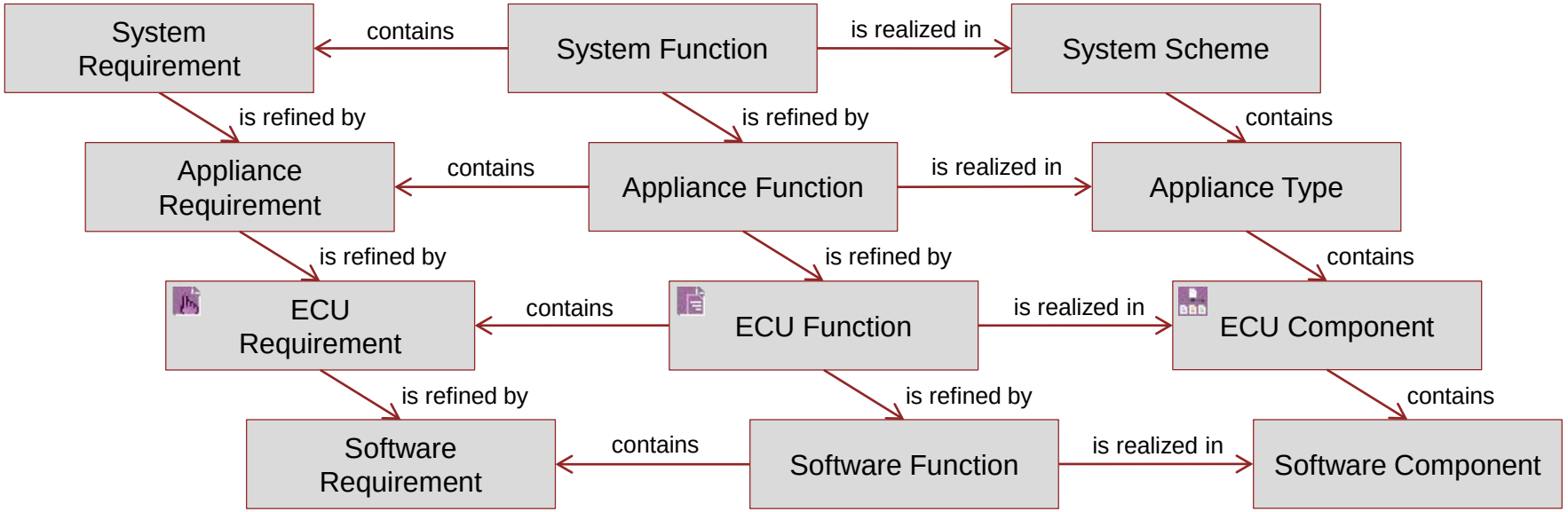


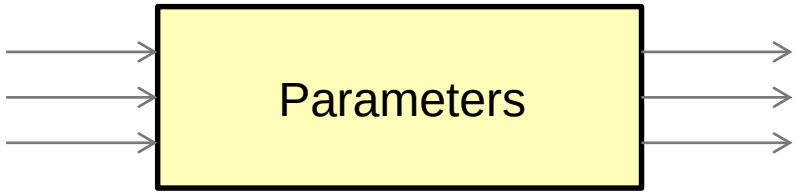
1. Identify selected ECU component
2. Find all functions linked to this component and add to filter
3. Find all requirements linked and add to filter
4. Create link with filter applied

Filtered 150% specification:

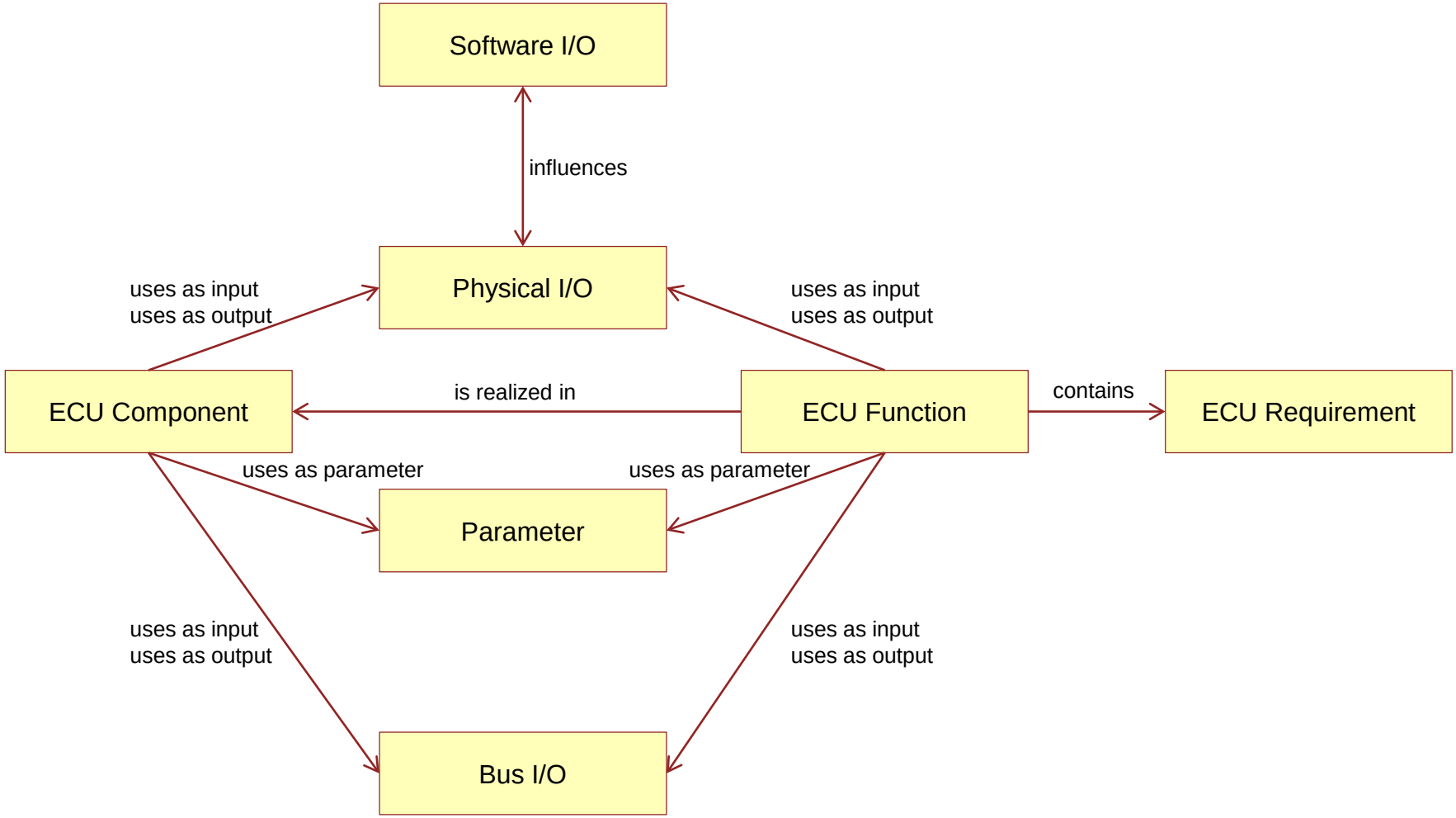


Functions and architecture artifacts are not fully specified yet





Completing the linking scheme



Complete function specification example

4.20 Condensate tray heater function

4.20.1 Interface

Inputs

Title	Unit	Minimum Value	Initial Value	Maximum Value
evaporation temperature	°C	-10	0	10
Operating Mode	enum	N/A	STANDBY	N/A
TAirIn	°C	-35	20	60

3 items found

Outputs

Title	Unit	Minimum Value	Initial Value	Maximum Value
condensate tray heater control	-	false	false	true

1 item found

Parameters

Title	Unit	Minimum Value	Default Value	Maximum Value
CTH Activation Temperature	°C	-5	0	5
condensate tray heater type	-	0	0	1
CTH Deactivation Temperature	°C	-5	2	5
CTH Operation Timeout	s	0	300	600

4 items found

4.20.2 Specification

PHP-1692 - CTH control function
This function controls the activation and deactivation of the condensate tray heater (CTH) to avoid freezing of condensed water on the condensate tray or inside the condensate tube when the outdoor temperature is too low and the appliance is in deicing mode.

The function can only be executed, if the system is equipped with a condensate tray heater.

If the air inlet temperature sinks during deicing below a parameterized value, the function activates the condensate tray heater. The CTH is deactivated after deicing is finished for a parameterized time and the air inlet temperature is higher than a certain value.

If the sensor value of the air inlet temperature is invalid, the function uses the evaporation temperature to switch on the CTH. To switch off the CTH in this case only the time condition is valid.

4.20.2.1 Preconditions

PHP-2933 - Precondition CTH available
If PHP-2929 - condensate tray heater type == 1, the ECU shall execute the function. , N/A

4.20.2.2 Requirements

PHP-1698 - Set CTH ON
If all of the following applies, the function shall set PHP-1531 - condensate tray heater control = true:
- PHP-1371 - Operating Mode == DEICING
- PHP-1861 - TAirIn < PHP-1699 - CTH Activation Temperature

, N/A

PHP-1702 - Set CTH OFF
If all of the following applies, the function shall set PHP-1531 - condensate tray heater control = false:
- time elapsed since PHP-1371 - Operating Mode changed from DEICING to any other mode > PHP-1703 - CTH Operation Timeout
- PHP-1861 - TAirIn > PHP-1701 - CTH Deactivation Temperature

, N/A

4.20.2.3 Safe state

PHP-3417 - Air inlet temperature invalid, activation
If all of the following applies, the function shall set PHP-1531 - condensate tray heater control = true:
- PHP-1371 - Operating Mode == DEICING
- PHP-1128 - evaporation temperature < PHP-1699 - CTH Activation Temperature
- PHP-1861 - TAirIn is invalid

PHP-3418 - Air inlet temperature invalid, deactivation
If all of the following applies, the function shall set PHP-1531 - condensate tray h
- time elapsed since PHP-1371 - Operating Mode changed from DEICING to Operation Timeout
- PHP-1861 - TAirIn is invalid

4.20.2.4 HMI

N/A

has parent
- PHP-1680 - Specification

is contained by
- PHP-2453 - HMU aroTHERM
- PHP-3533 - Refrigerant Split outdoor unit

contains
- PHP-1698 - Set CTH ON
- PHP-1702 - Set CTH OFF
- PHP-2933 - Precondition CTH available
- PHP-3417 - Air inlet temperature invalid, activation
- PHP-3418 - Air inlet temperature invalid, deactivation

uses as input
- PHP-1371 - Operating Mode
- PHP-1861 - TAirIn
- PHP-1128 - evaporation temperature

uses as output
- PHP-1531 - condensate tray heater control

uses as parameter
- PHP-1699 - CTH Activation Temperature
- PHP-1701 - CTH Deactivation Temperature
- PHP-1703 - CTH Operation Timeout
- PHP-2929 - condensate tray heater type

is realized by
- PHP-3059 - Application Software
- PHP-3087 - Protection Functions

Making sure that all function interfaces are referenced in requirements

Link Check for ECU Functions

Link check not ok for:

Main Manager, direct evaporator heat pump PHP-1037	missing in interface: **4** PHP-3346, PHP-3349, PHP-297, PHP-261,
	missing in requirement description: **4** PHP-1919, PHP-1921, PHP-2739, PHP-1920,
	duplicate links: **0**
EEV control function superheating PHP-1093	missing in interface: **1** PHP-1127,
	missing in requirement description: **0**
	duplicate links: **0**
EEV control subcooling PHP-1209	missing in interface: **1** PHP-1283,
	missing in requirement description: **0**
	duplicate links: **0**
On/off compressor control function PHP-1225	missing in interface: **2** PHP-1371, PHP-289,
	missing in requirement description: **4** PHP-1176, PHP-1215, PHP-278, PHP-304,
	duplicate links: **0**
On/off compressor control with EVI PHP-1236	missing in interface: **17** PHP-291, PHP-1255, PHP-292, PHP-330, PHP-1258, PHP-1371, PHP-283, PHP-287, PHP-1248, PHP-1247, PHP-1251, PHP-1252, PHP-1253, PHP-1254, PHP-286, PHP-1249, PHP-289,
	missing in requirement description: **2** PHP-1176, PHP-1215,
	duplicate links: **0**
Central heating ON/OFF pump control function PHP-1396	missing in interface: **0**
	missing in requirement description: **6** PHP-177, PHP-1406, PHP-1405, PHP-1402, PHP-281, PHP-278,
	duplicate links: **1** PHP-1401,

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Formally checking quality of written requirements

Description Checker

Blacklisted words: tbd tbc few many ? fast slow some

Work item type: ECU Requirement

Apply | Save as Default

Work item	tbd	tbc	few	many	?	fast	slow	some	0 words	more than 35 words
Modulating pump control PHP-1471	x									x
Decrease power step PHP-254	x									x
Safety STL monitoring PHP-2684	x									
EVI Control PHP-1160	x									x
High temperature PHP-2573	x									
Precondition system pressure PHP-2582	x									
back to heating mode 2 PHP-3379								x		
Sampling period of controller PHP-1190	x									
Manipulated variable step size PHP-1191	x									
Modulating compressor control PHP-1194	x									x
Condition stop compressor, over-current PHP-3516					x					
In state 4WV reversing PHP-3361	x				x					x
In state PreDeicing PHP-3359	x				x					x
EEV control during cleaning PHP-3822	x									
F.787 PHP-2095					x					

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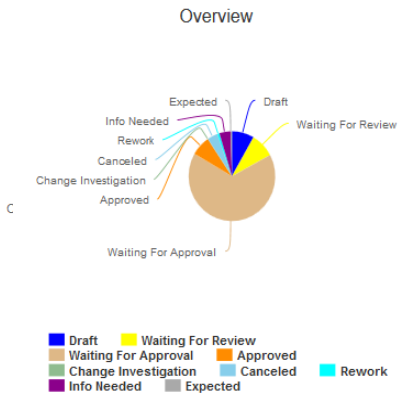
Standardized reporting incl. process KPIs



List of ECU Components in this Project:

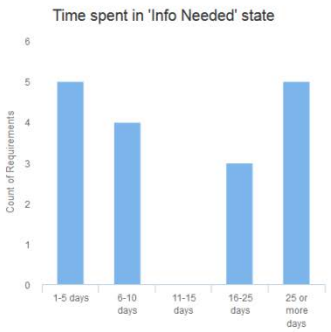
Title	ID
HMU Generic	PHP-937
HMU 3kW	PHP-368
HMU flexoTHERM	PHP-367
HW OMU	PHP-2353
HW AI	PHP-2352
ICL 230V	PHP-2497
ICL 400V	PHP-2498
HMU aroTHERM	PHP-2453
Combined Heatpump Ventilation in one housing	PHP-3535
Monoblock low cost outdoor unit	PHP-3534
Outdoor Air Water Heatpump	PHP-3536
flexoTHERM Inverter+EVI Indoor Unit	PHP-3539
flexoTHERM Inverter Outdoor Unit	PHP-3538
flexoTHERM Inverter Indoor Unit	PHP-3537
Hydraulic Tower step2 monoblock with decoupling	PHP-3568
Hydraulic Tower step2 for ref split	PHP-3567
Hydraulic Tower step2 monoblock	PHP-3569
Refrigerant Split outdoor unit	PHP-3533

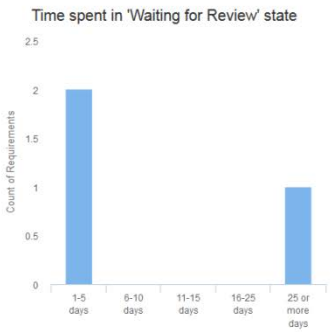
Statistics:

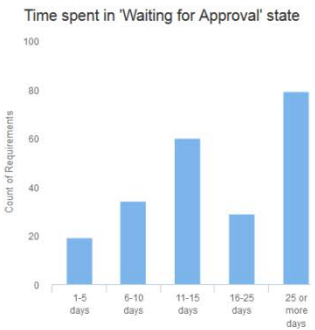
- Total number of requirements: 327
- Further information needed on: 17

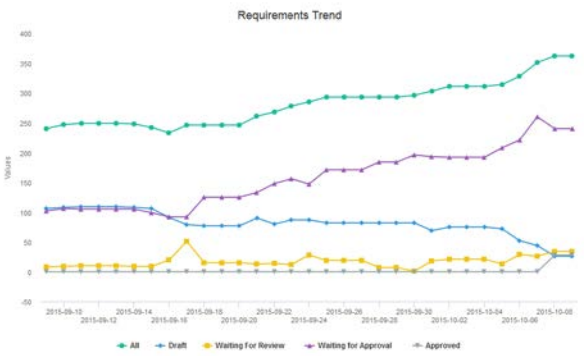
Process KPIs:

- Average number of days spent in:
  - information needed: 18.53
  - waiting for review: 8.67
  - waiting for approval: 21.31









Qualification approach

Every six months
(2 days)

External RE Training

Every two months
(5 days)

External Coaching & Review

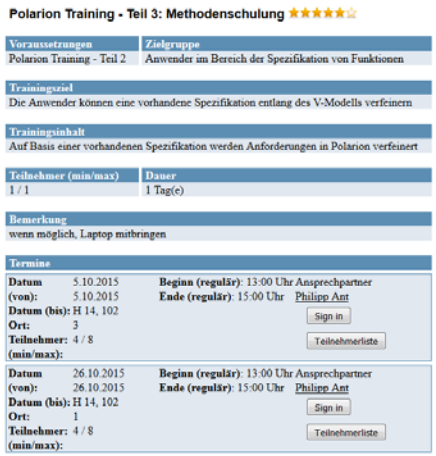
Every month
(2h / module)

Internal Trainings

- Polarion Training
- Method Training
- RE Training
- Expert Training

Sample Project

Polarion Guidelines Project



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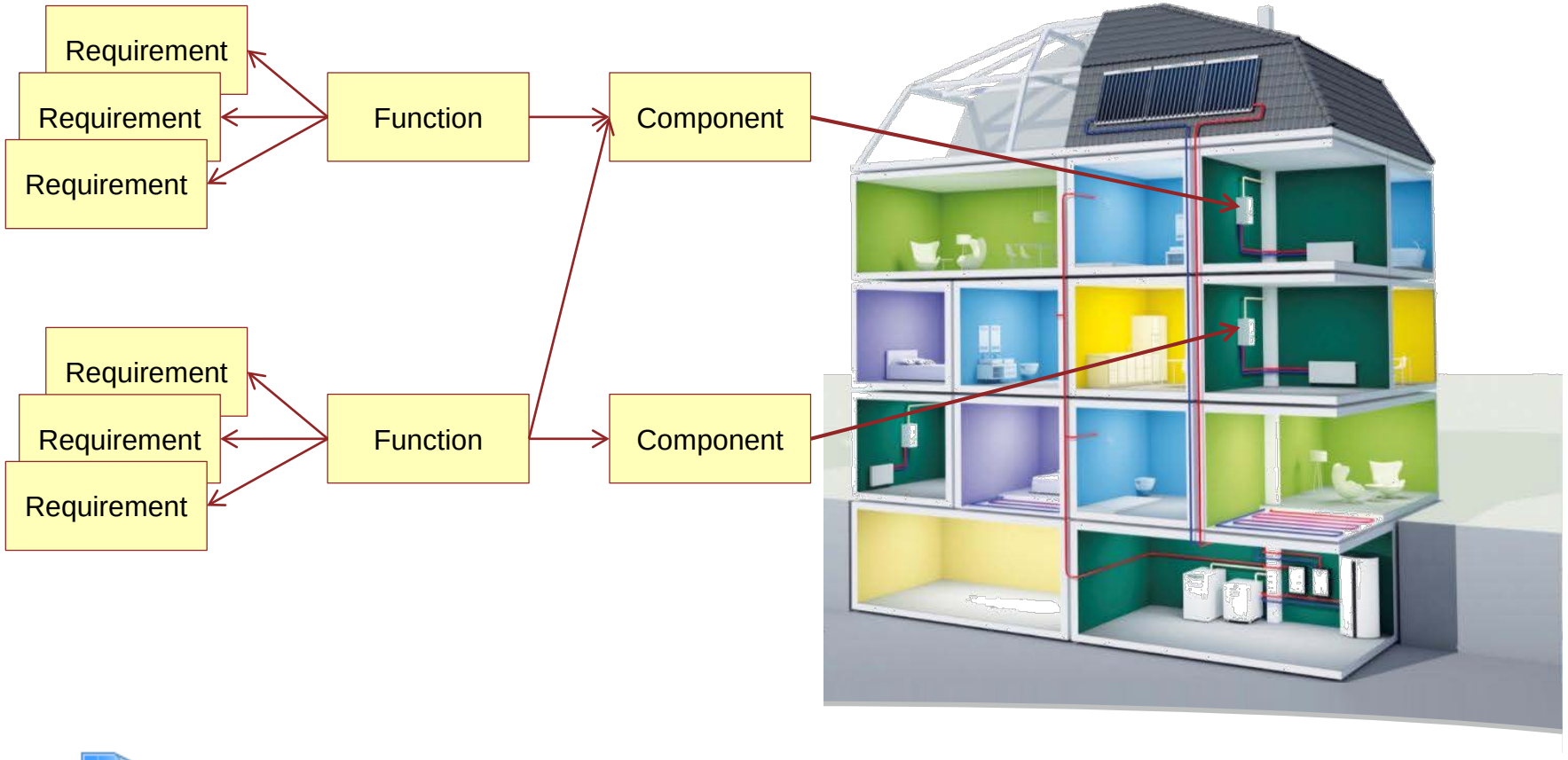
Improvements in function development



1x Vaillant V-Model

150% specification

Link to architecture

Thank you for your attention!