

# EuroAsiaSPI<sup>2</sup> 2017

## EXPERIENCES WITH SQIL

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## What is SQIL

- ▶ Volkswagen certified SW-Quality Improvement Leader (SQIL)
- ▶ SQIL monitors together with the supplier the
  - ▶ Implementation of improvement actions
  - ▶ Quality performance
- ▶ Establishes VW view of software quality at the supplier
- ▶ Prepares a SQIL Report

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## Why SQIL ?

- ▶ Increasing functionality leads to more complexity of components and software → Function Oriented Development
- ▶ Due to the platform concept, components are re-used in several car models
  - ▶ e.g. Volkswagen MQB Platform → Audi A3, Audi TT, Audi Q2, SEAT Ibiza, SEAT León, SEAT Atec, Škoda Octavia, Škoda Superb, Škoda Kodiaq, Volkswagen Arteon, Volkswagen Golf, Volkswagen Golf Sportsvan, Volkswagen Passat, Volkswagen Tiguan, Volkswagen Tiguan, Volkswagen Touran
- ▶ Automotive SPICE “not enough”

**Software quality is not well established at automotive suppliers for software centred systems**

[SQIL training materials, September 2016]

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## SQL Objectives

SQL Report of the software quality as part of the SQL activities should cover:

- a) the fulfilment of the process quality according to Automotive SPICE® and additional Volkswagen requirements [KGAS]
- b) consistency check between requirements, architecture, implementation and tests
- c) metrics (Dashboard) indicating the progress of the product development and test coverage

→ The SQL report should be reported regularly (monthly) to the quality department of Volkswagen.

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## Group Basic Software Requirements [KGAS]

- ▶ Specifying the requirements of the VW Group on the software quality in vehicles
- ▶ Minimum requirements for all types of software products and its development process
- ▶ For safety relevant SW additional requirements apply (Functional Safety Development Guideline)
- ▶ More than 400 requirements related to project management, quality assurance, system and software requirements/architecture/tests, software construction, configuration management...

### ▶ Example:

KGAS\_3193: All requirements must be evaluated in terms of risks and feasibility.

KGAS\_3247: All requirements must be unambiguous.

KGAS\_3248: All requirements must be self-consistent.

KGAS\_3249: All requirements must be understandable.

KGAS\_3250: All requirements must be feasible.

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## BOSCH Automotive Steering and SQL

- ▶ Reporting to VW through Dashboard → first introduced at BOSCH AS in 2014. (developed in the VW MQB project in 2009 to 2013)
- ▶ A large number of the VW Dashboards metrics already existed (BOSCH AS Q – Report)
- ▶ In BOSCH AS first external SQL were used in 2015
- ▶ From 2016 BOSCH AS internal SQLs have been trained. Now there are 6 SQLs at BOSCH AS to support the process and dashboard optimization.
- ▶ SQL Reports established in 2017

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## Process Reviews and KGAS

- ▶ Process review ASPICE 3.0 → SUP.1.BP3 Assure quality of process activities → Checklist
- ▶ BOSCH AS approach: extending the process review checklist with VW KGAS requirements:
  - ▶ Initial Process review question: ***“The project schedule is updated weekly and consistent with the project milestones”***
  - ▶ Relevant KGAS requirements:
    - KGAS\_3173: Each activity planned in the schedule must have a start date, end date, duration, effort, degree of fulfilment, resources and dependencies
    - KGAS\_3182: The schedule must contain the software, hardware, customer, functional safety and quality assurance milestones.
    - KGAS\_3184: The schedule must not contain any activities with a duration longer than a working-week
    - KGAS\_3597: The schedule must not contain any activities with an effort higher than a working-week
  - ▶ Combined process review question: ***“The project schedule is updated weekly and consistent with the project, system and subsystem milestones. All activities are planned with an effort and duration of less than 40h and contain the degree of fulfilment, an assigned resource and dependencies.”***

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## Some of the VW proposed metrics

- ▶ No. of System/SW Features planned
- ▶ No. of System/SW Features implemented
- ▶ No. of System/SW Features positively verified
- ▶ No. of Customer requirements implemented
- ▶ No. of Customer requirements implemented and linked to system requirements
- ▶ No. of Software related System requirements reviewed
- ▶ No. of SW related System requirements linked to system element(s)
- ▶ No. of SW related System requirements linked to SW requirements
- ▶ No. of SW requirements reviewed
- ▶ No. of SW requirements linked to SW elements
- ▶ No. of SW requirements linked to SW units
- ▶ No. of SW components linked to SW detailed design ↓
- ▶ No. of SW component interfaces specified in SW architecture
- ▶ No. of SW units in SW specified in detailed design
- ▶ No. of SW units implemented according to SW detailed design
- ▶ No. of SW units verified
- ▶ No. of SW units positively verified
- ▶ No. of SW units in SW detailed design linked to SW unit test cases
- ▶ No. of SW component interfaces verified
- ▶ No. of SW component interfaces positively verified
- ▶ No. of SW requirements verified
- ▶ No. of SW requirements positively verified
- ▶ No. of SW requirements linked to SW test cases ↓
- ▶ No. of System interfaces verified
- ▶ No. of System interfaces positively verified
- ▶ No. of System interfaces linked to System integration test cases
- ▶ No. of System requirements verified
- ▶ No. of System requirements positively verified
- ▶ No. of System requirements linked to System test cases ↓
- ▶ Number of all customer requirements
- ▶ Impl. Coverage: Customer Requirements
- ▶ Linking Coverage: Cust. Reqs. --> Sys. Reqs.
- ▶ Review Coverage: System Reqs.
- ▶ Linking Coverage: Sys. Reqs. --> Sys. Elements
- ▶ Linking Coverage: Sys Reqs. --> SW Reqs.
- ▶ Review Coverage: SW Reqs.
- ▶ Linking Coverage: SW Reqs. --> SW Arch.
- ▶ Linking Coverage: SW Reqs. --> Units
- ▶ Linking Coverage: SW components --> SW DD
- ▶ SW units impl. Specified in DD
- ▶ Impl. Coverage: SW units acc. DD spec
- ▶ SW Units verified
- ▶ SW Units positively verified
- ▶ SW units in DD linked to test cases
- ▶ SW component interfaces verified
- ▶ SW component interfaces positively verified
- ▶ SW component interfaces linked to SW integration test cases
- ▶ SW Requirements verified
- ▶ SW Requirements positively verified
- ▶ SW Requirements linked to SW Test Cases
- ▶ System interfaces verified
- ▶ System interfaces positively verified
- ▶ System interfaces linked to sys. Integration test cases
- ▶ System Requirements verified
- ▶ System Requirements positively verified
- ▶ System Requirements linked to System Test Cases



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## BOSCH AS Metrics

- ▶ BOSCH AS developed an automated Q-report which was used in VW projects and then rolled out to all projects in the company.
- ▶ The Q-Report contained the traceability and coverage metrics for requirements and test levels
- ▶ Q-report is generated 2- weekly or latest monthly
- ▶ Currently BOSCH central quality is establishing a standard for a dashboard (BBM Metrics) which will be used for all projects concern wide incl. Volkswagen projects
- ▶ Achieving a high level of Coverage by Baukasten / ToolKit:
  - ▶ System functions have been agreed among all steering system variants
  - ▶ System requirements are grouped by system functions
  - ▶ System test catalogues have been created for vehicle verification, test bench and HIL test and re-usable test specifications are linked with the requirements

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## Q - Report

- ▶ Achieving a high Level of Coverage by Baukasten / ToolKit:
  - ▶ SW functions are defined in a SW development Kit (SDK) concept
  - ▶ SW functions related to SW components and SW units
  - ▶ SW requirements have been grouped by SW functions
  - ▶ SW functions has a directory with SW requirements, design requirements, HIL test specification etc. and completely linked.
- ▶ Tracking Safety and Non-Safety separately
  - ▶ Q- Report generates 3 types of trend metrics:
    1. one for the overall coverage
    2. one for safety coverage (classified ASIL- A to ASIL – D)
    3. one for non – safety coverage (QM classification)

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## Example Q - Report



### Q-Bericht Gesamt

Anforderungsmanagement mit  
Anforderungsstatus "released"

Projekt  
VW [redacted]  
Variante VW [redacted]

Schutzklasse:  
Intern

Dokumentenstatus:  
Released

Verantwortung Tool:  
Qualität Prozesse & Entwicklung (AS-ER/QMM1)

Erstellt von:  
[redacted]

V3.6.0 - 2017-09-01 11:10:59

<http://forster.k8801@vw.com/element.do?id=59536&type=Artifact>

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AS-ER/QMM2 | 04/09/2017  
SQL Report

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Q-Bericht Gesamt  
Released

VW [redacted]  
Variante VW [redacted]



### Teil 1: Lastenheft

Lastenhefte Intern		Lastenhefte Kunde	
Anforderungen	0	Anforderungen	6477
davon Sicherheitsanforderungen	0	davon Sicherheitsanforderungen	210
Anforderungen akzeptiert	0 NaN	Anforderungen akzeptiert	3671 (57 %)
Sicherheitsanforderungen akzeptiert	0 NaN	Sicherheitsanforderungen akzeptiert	63 (30 %)
Mitgelende Unterlagen	0	Mitgelende Unterlagen	443
Mitgelende Unterlagen akzeptiert	0 NaN	Mitgelende Unterlagen akzeptiert	134 (30 %)

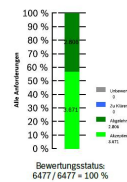
### 1.1 Bewertung der Kundenanforderungen

**Zweck:** Das Diagramm gibt einen Überblick über den Bewertungsstatus der Kundenanforderungen.

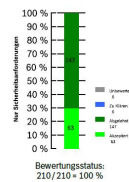
**Dargestellt:** Die Kundenanforderung sind nach ihrem Bewertungsstatus sortiert.

Der Bewertungsstatus zeigt den Anteil der bewerteten Kundenanforderungen bezogen auf die gesamten Kundenanforderungen an.

Bewertungsstatus der Kundenanforderungen



Bewertungsstatus nur Sicherheitsanforderungen

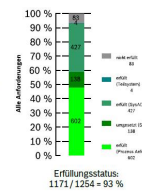


### 3.2 Erfüllung und Umsetzung der Systemanforderungen

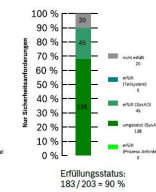
**Zweck:** Das Diagramm gibt einen Überblick, wie viele aktive Systempflichtenheftanforderungen durch das Systemarchitekturdesign umgesetzt oder die Teilsystempflichtenheftanforderungen erfüllt sind (siehe Linkmodule).

**Dargestellt:** Eine Anforderung im Systempflichtenheft ist analysiert und abgedeckt, wenn alle auf sie verlinkten Teilsystempflichtenheftanforderungen oder Systemarchitekturdesignbeiträge korrekt auf diese verlinken. Erfüllen mehrere Teilsystempflichtenheftanforderungen und Architekturdesignbeiträge eine Systempflichtenheftanforderung, wird nur eine Anforderung angezeigt.

Erfüllungstatus aller Systemanforderungen



Erfüllungstatus nur Sicherheitsanforderungen



Q-Bericht Gesamt  
Released

VW [redacted]  
Variante VW [redacted]

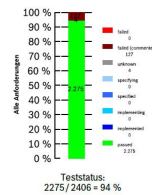


### 7.5 Teststatus der Softwareanforderungen

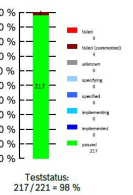
**Zweck:** Das Diagramm zeigt den Teststatus der korrekt verlinkten Softwareanforderungen.

**Dargestellt:** Eine Softwareanforderung gilt als positiv getestet, wenn alle auf sie korrekt verlinkten Testspezifikationen den Teststatus "passed" haben.

Teststatus aller Softwareanforderungen



Teststatus nur Sicherheitsanforderungen



Q-Bericht Gesamt  
Released

VW [redacted]  
Variante VW [redacted]



### Teil 9: Testspezifikation

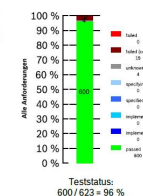
Active Tests	805
Aktive Sicherheitstests	41 (5 %)

### 9.1 Teststatus der mit Testspezifikationen verlinkten Anforderungen

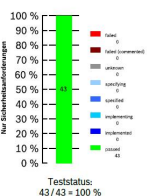
**Zweck:** Das Diagramm zeigt den Teststatus der korrekt verlinkten Anforderungen.

**Dargestellt:** Das Diagramm geht nur auf Anforderungen ein, die mit Testspezifikationen getestet werden. Eine Anforderung gilt als positiv getestet, wenn alle auf sie korrekt verlinkten Testspezifikations Testergebnisse den Teststatus "passed" haben.

Teststatus aller Anforderungen



Teststatus nur Sicherheitsanforderungen



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## SW Q- Metrics @BBM Metrics

### Quality of delivered SW

Ratio of technical customer requirements accepted

Ratio of system interfaces successfully verified

Ratio of system requirements successfully verified

Ratio of software requirements implemented

Ratio of software interfaces successfully verified

Ratio of software requirements successfully verified

Ratio of Number of SSL requirements (system or software) successfully verified

Ratio of defects closed

Ratio of change requests closed

### Preventive Q-Measures

Ratio of technical customer requirements traceable to internal requirements

Ratio of system requirements reviewed

Ratio of system requirements traceable to its source

Ratio of system requirements linked to at least one test case

Ratio of defined system interfaces linked to at least one test case

Ratio of software requirements reviewed

Ratio of software requirements traceable to its source

Ratio of software requirements linked to at least one test case

Ratio of software interfaces linked to at least one test case

Ratio of software components implemented or changed according to current the release plan

Ratio of software components successfully verified

Consumption of processor capacity

Consumption of memory

Sum of unevaluated errors and warnings from static code analysis

Number of software units with a cyclomatic complexity exceeding 20

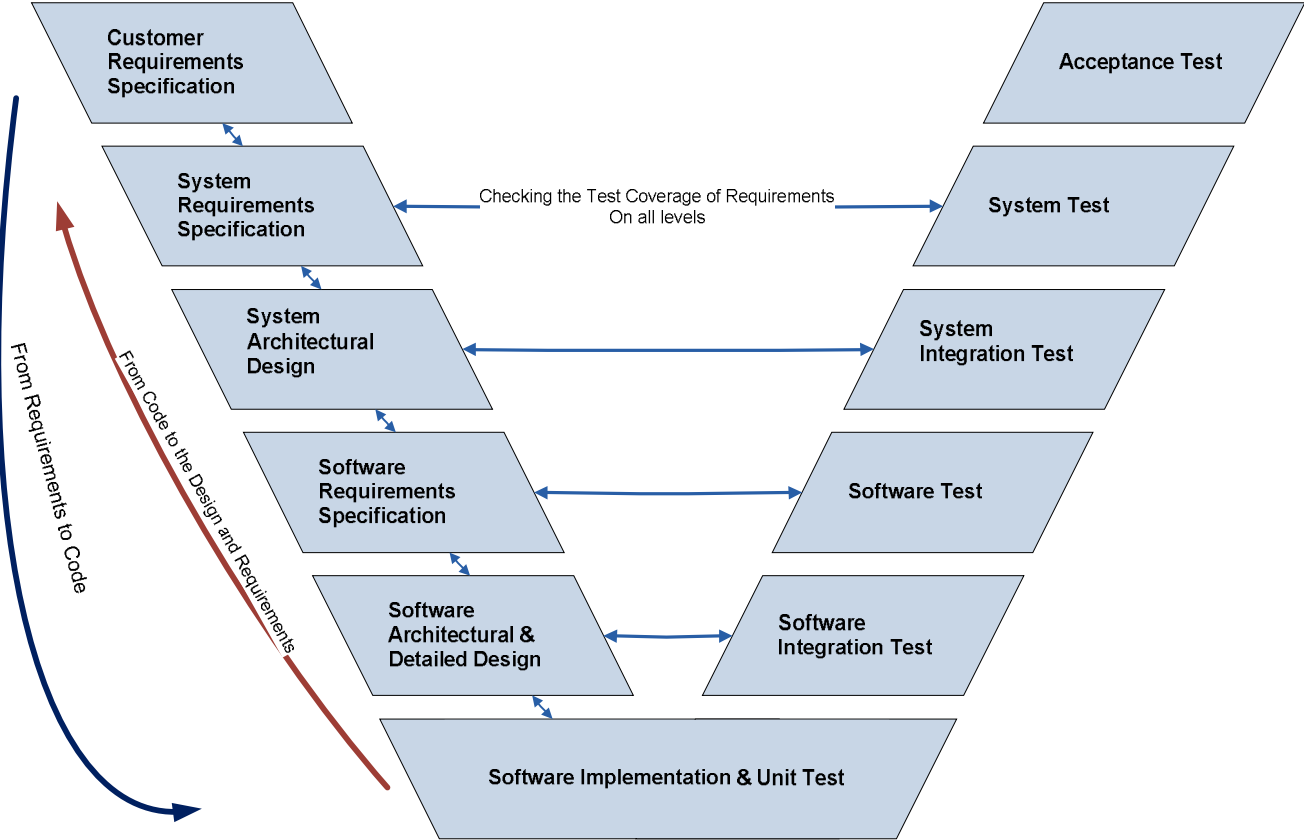
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## Consistency Check

- ▶ Supporting the Automotive SPICE 3.0 approach where consistency and traceability are addressed separately.
- ▶ To check the content of the requirements, design, code and test cases and if they are consistent to each other.
- ▶ BOSCH AS approach:
  - ▶ A customer function/sub-function in the customer requirements specification was selected
  - ▶ Links to the requirements, architecture, and detail design documents till the code section was checked
  - ▶ Link to the test cases were checked (on all levels)
  - ▶ Each check was documented with a screenshot, the path to the work product and the identifier of the objects or work product.
  - ▶ The findings were confirmed by an expert.

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## Consistency Check



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## Conclusion

- ▶ Start early! Don't wait for the VW Assessors! → SQIL activities started approx. 7 months earlier than request by VW.
- ▶ Use your existing (automated) metrics in the beginning → Plan effort and time to refine them
- ▶ Don't start with manual reporting → Seek for a corporate approach (BBM)
- ▶ Incorporate the KGAS requirements to your process reviews
- ▶ Use a Baukasten/Tool kit approach to manage the traceability and coverage