

# The « Functional Verification Manager » to support end to end the satellite verification process.

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## INTRODUCTION

Airbus Defence and Space has developed a data base tool called the “**Functional Verification Manager**” (FVM) aiming at supporting the satellite Verification & Validation process from the early definition of the system verification up to the final VCD closure. **FVM supports particularly the test specifications, the development of test procedures, the supervising of the test execution, and it supports the test reporting.**

This paper presents how the tool is based on the Airbus Defence and Space System Reference Data Base (SRDB), how it is fully digitalized, how it supports the co-engineering for validation and verification, how it is interconnected with all the other functional and verification tools, and how it ensures a full consistency of the test data flow.

## THE FUNCTIONAL VERIFICATION MANAGER: OVERALL

The traditional Verification and Validation work flow of the space systems is “document driven”. It starts by the customer requirements, and then is based on test validation documents like the Verification Control Documents matrixes, the test plans, the test specifications, and at the end of the verification campaign the test reports and the verification control documents. (Refer to Fig.1)

The innovation brought by FVM is **to change this verification work flow into a “test driven” work flow**. Meaning that the main element is now centred on the test itself, and not any more on the test document. The document still exists for formal test configuration, signing and test reviews, but it is not any more the main mean of test development.

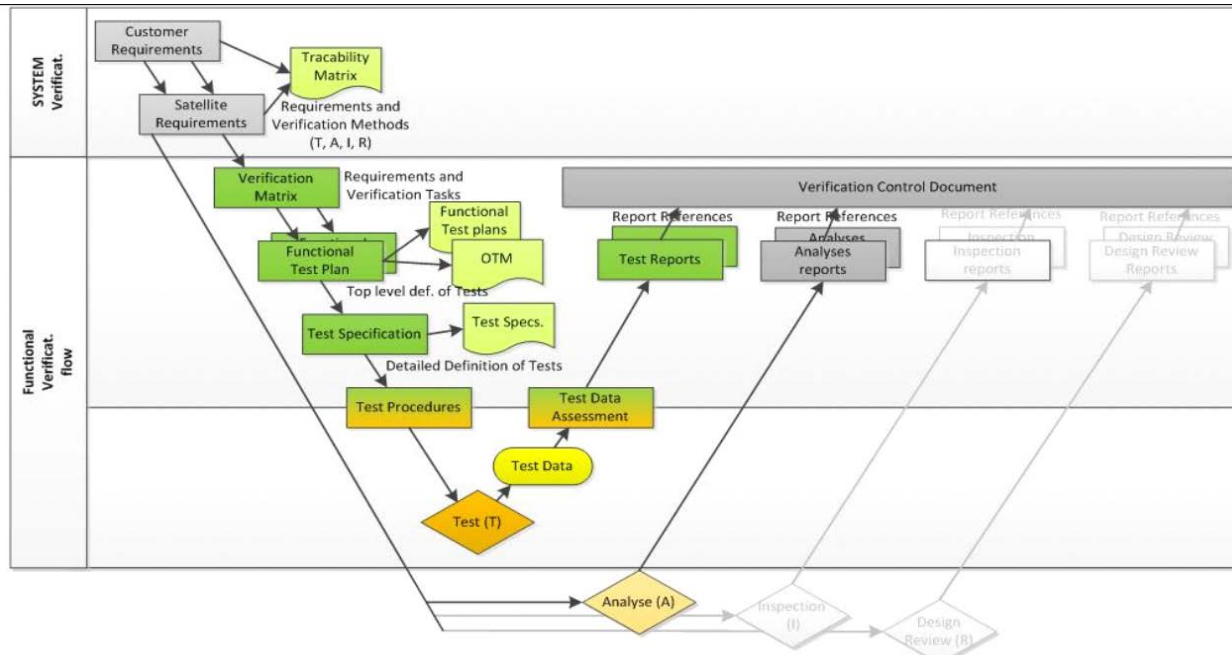


Fig.1: Traditional space system verification work flow

The Functional Verification Manager tool is a data base tool supporting the validation process of the space products, from the early definition of the system verification up to the final VCD closure. (Refer to Fig.2). FVM is also a central cockpit for the interdisciplinary validation team (Engineering, FV and AIT) to control the Functional Test & Verification Process.

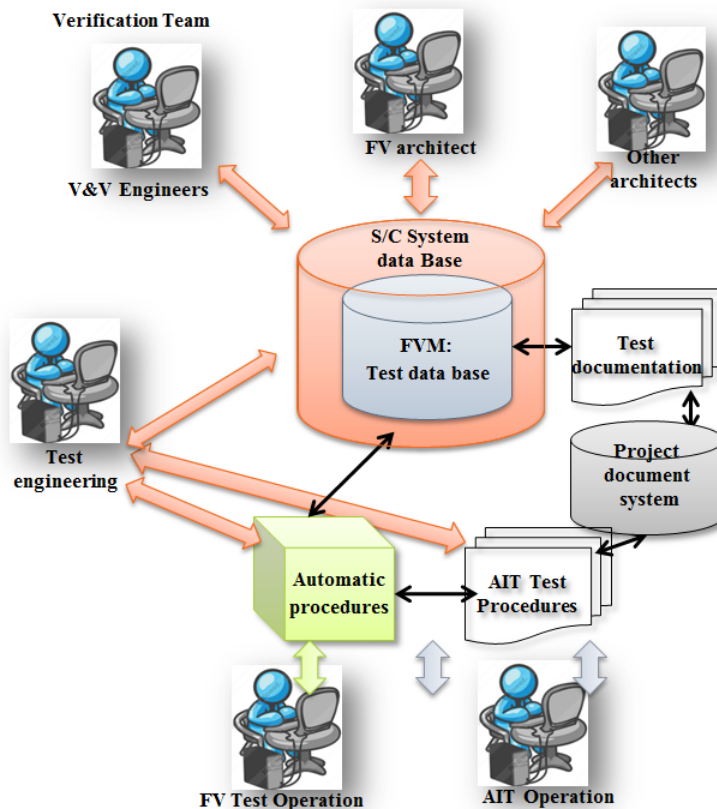


Fig.2: New "Test driven" work flow thanks to the FVM Tool.

## BACKGROUND AND FVM HISTORY

*2004-2014 – FTM: The precursor tool: The Functional Test Manager*

An initial experience started in Airbus DS Germany on the **Cryosat** satellite, and then has been improved on successive ESA programs like **Swarm**, **Grace-Follow**, and **Sentinel-2 & EarthCare**. On these programs a precursor data base FV tool – “Functional Test Manager” (FTM) – has been successfully used. FTM tool was based on Microsoft ACCESS.

*2014 – Emergence of FVM*

The FTM tool was proposed for evaluation to the Airbus DS community on functional validation. The analysis showed a great interest, but also an insufficient level of industrialization of this tool, so far developed in artisanal way. Decision has been taken in 2014 to develop a new industrialized “FVM” tool, based on our “**Range DB**” (Range DB is the new in house Airbus DS System Data Base tool), and relying on transnational FV needs definition.

*2015 - FVM Great principles selected*

At the start of the development, the great principles have been selected for the definition of the FVM tool:

- Full digitalization,
- Maximized automation,
- Centring on the test,
- One data One source,
- Interconnecting to other verification tools.

*2015-2016 – FVM development and ramp-up.*

Finally it appears that the tool can support not only the Functional Verification, but also the full Verification & Validation process, and this whatever the models, for qualification or recurrent.

A first version has been developed, validated and successfully implemented on a pilot program in Germany: **AS400**.

*2016-2017 – FVM in the core of a fully digitalized spacecraft factory 4.0*

Today the development continues in the frame of engineering digitalized factory for spacecrafts from Telecom, Sciences and Earth observation domains. FVM is now expected for all the future Airbus DS validation campaigns like METOP-SG, JUICE, NEOSAT, and all the future Telecom products.

## THE RIGHT VALIDATION TOOL AT THE RIGHT PLACE

One of the main challenges, at the beginning of the development, has been to determine the right validation tool at the right place. After fine clarification of the overall process for verification we have been able to allocate the right tools:

- **DOORS** for upstream satellite design, and for downstream system VCD management,
- **FVM** for the test plans, the test specifications, the test implementation, and the test reporting,
- **Windchill** for the documentation system (PDM),
- **CCS** (Central Checkout System) for automated test procedures, execution and test data assessment,
- **IPS** (Integrated Production System) for manual procedures and as-built constitution,
- **Observation and Problem tracker** by specific tools,
- The test scheduling remains handled by other tools, not in the scope of FVM.

That gave us a clear optimized tools allocation, as drawn in Fig.3 here after.

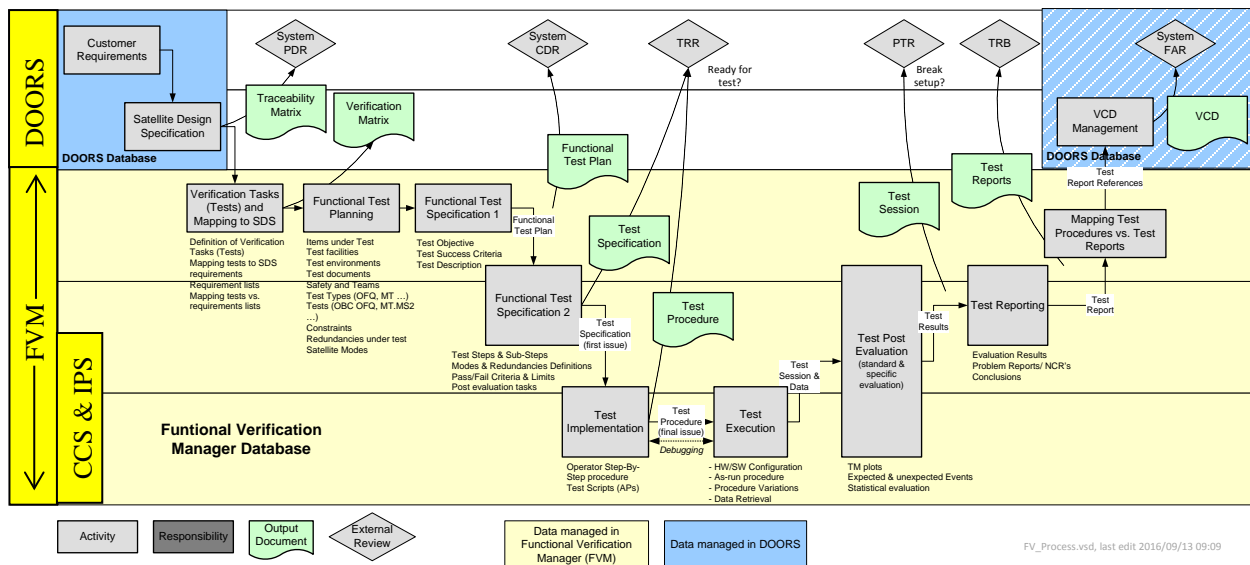


Fig.3: Scope for FVM: The right tool at the right place.

### FUNCTIONALITIES PROVIDED BY FVM:

To support an efficient verification process, the features have been selected and implemented in FVM, aiming at covering end to end the verification flow:

#### Test engineering tasks:

- Test verification needs according to VCD inputs,
- Test plans,
- Test specifications and test configurations,
- Test procedures.

#### Product line test engineering:

- Overall test matrixes with regard to the AIT Phases,
- Generic product test matrixes and applicability matrixes for specific instances.
- Test configuration per functional chain.

#### HW / SW Configuration Manager and Functional Configuration Manager (Supports test configurations tasks)

- HW/SW test configurations,
- Equipment modes and states for the tests,
- Redundancy configurations.

#### Test results engineering:

- Automatic cockpit for test progress supervising,
- Test sessions storage and direct access to test results,
- Test assessments,
- Test results sign-off for AIT and for Engineering, possible also for the customer if required,
- Test execution reports,
- Test engineering reports,
- VCD closure.

### FUNCTIONAL DECOMPOSITION OF THE TEST TOOLS AND CONCEPTUAL ARCHITECTURE:

The functional drawing Fig.4 here after describes how the FVM Tool is connected to the other validation tools. The second drawing Fig.5 provides the conceptual architecture applied on the SRDB. We can see how the principle of one data - one source is respected. Importers and exporters are set-up for every interface possibly by hyperlinks.

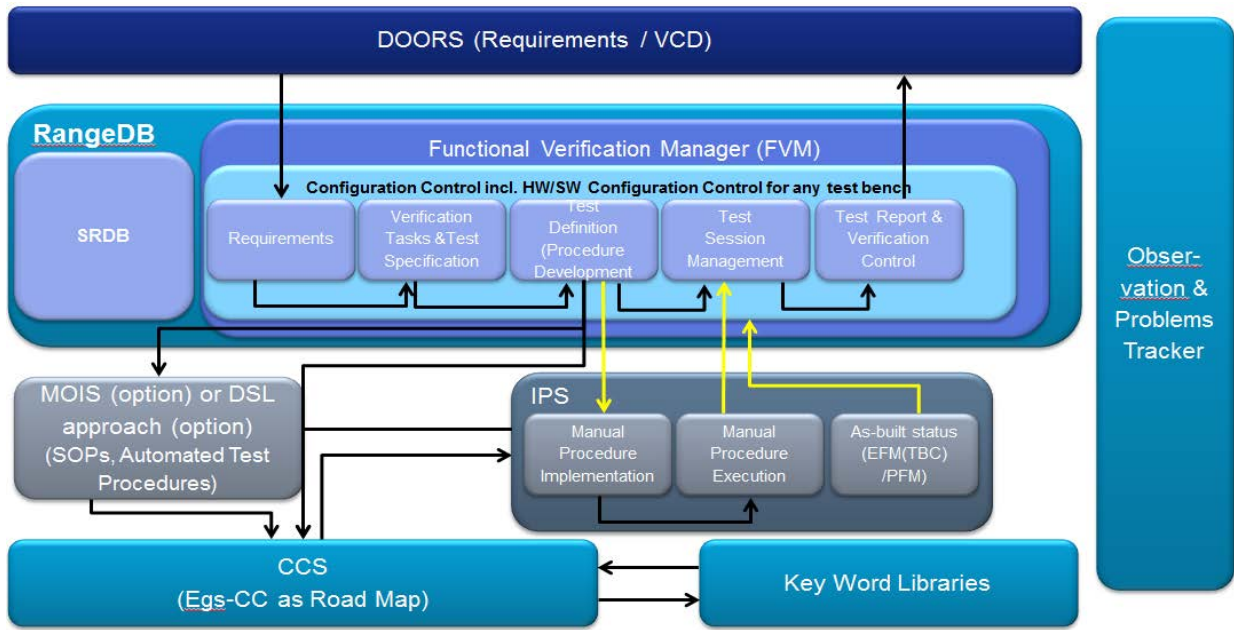


Fig.4: Functional decomposition of the Tool FVM

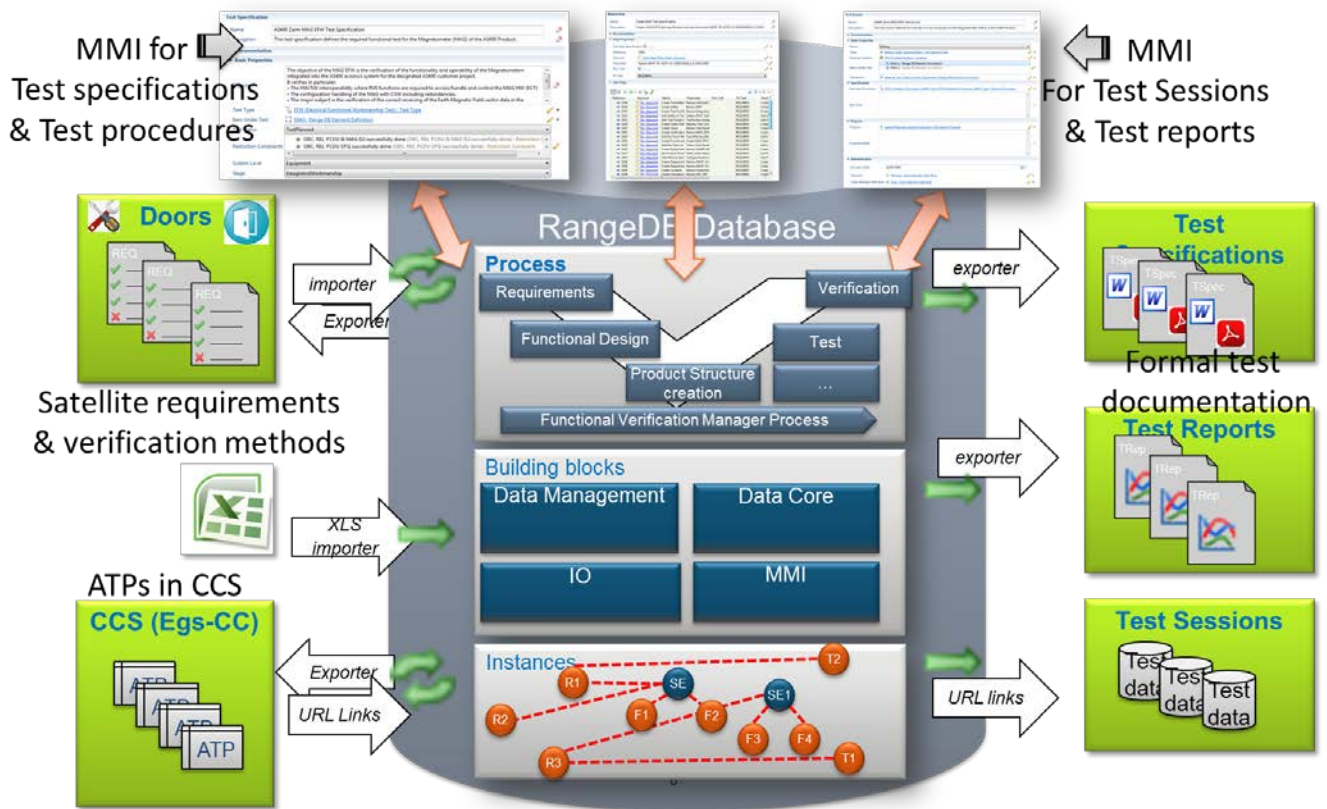
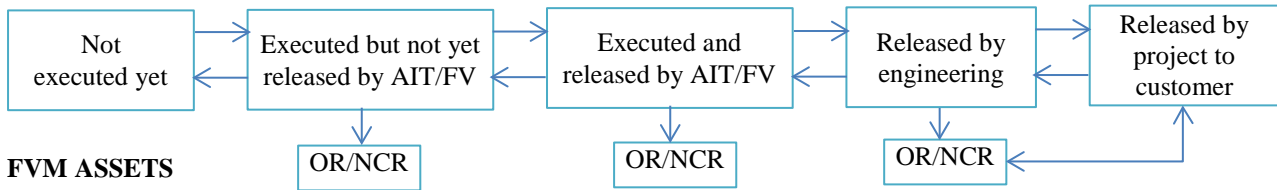


Fig.5: Conceptual architecture solution of FVM

## TEST RESULT ASSESSMENT THANKS TO FVM

A powerful sign-off process is implemented within the tool to support the test assessment by the different stakeholders from AIT/FV up to the customer. The tool embeds also a connection to the Problem tracking / Non-conformance report tool. That will be an efficient support to the post test reviews (PTR):



### FVM ASSETS

#### *Data consistency*

One of the best assets of the tool is the consistency of the data flow; Every main engineering data used for V&V (Verification & Validation) are also embedded within the Range DB tool (TMTCs, EICDs, Simulator data's...).

#### *V&V Co-engineering*

FVM is core to support the co-engineering across V&V communities and in multi-teams projects. Furthermore the access to the test data is controlled, and can even be granted to the customer.

#### *Real-time Cockpit for enhanced supervising of test campaigns*

FVM allows an easy and real time supervising of the test campaigns providing, thanks to visual indicators, the progress of the test and giving easy access to the test results for review.

#### *V&V practices harmonization and Re-use*

FVM allows harmonization of V&V best practices between the V&V actors, implementing common templates of V&V documents like Test specification or the test reports. FVM also re-enforces the re-use between projects and sites. For instance between a product line and its specific Instances, or capability to fully recover from a project to another all the test applications relevant to a same equipment.

#### *Use of a Data Base application*

FVM benefits of the all the features of the Range DB Tool: Enhanced Man-Machine I/F, Configuration management at test data level, Evolution tracking's, Statistic processing, Search & Comparison from projects to other.

## FVM CHALLENGES AND DIFFICULTIES

#### *Buy-in of the V&V actors*

FVM radically changes the V&V working method, moving from a usual word/Excel written documents to a data base application. That might disturb the traditional V&V actors, if not well trained or not enough mind-set to data bases.

#### *Harmonized process*

FVM enforces harmonization of the V&V process & tools. It is an asset only if there is also the overall buy-in of this V&V process. This is not only a new tool but also a new process.

#### *Man-Machine Interfaces*

If the Man Machine Interfaces (MMI) are not enough "user friendly", the V&V actors will be tempted to write first the documents in Word/Excel traditional way, then to import it in FVM, instead of writing it directly in FVM.

A recognized user-friendly MMI I/F is one of the main challenge of this tool.

#### *Use of a data base application*

FVM is based on the Range DB tool, which must be permanently accessible and available all over the satellite project test campaigns.

#### *Connection to other validation tools*

Connecting a data base tool to other industrial validation tools is not evident if not well foreseen from the beginning. Furthermore a difficulty is added if these ones are different from project to another, like the CCS (CCS5, OC, or Egs-CC....).

## **FVM WAY FORWARD**

The first version has been successfully implemented on the pilot test program; **AS400**.

The final version is still currently in development, aiming at providing the full scope of expected features.

In parallel, the implementation is carefully supported on the targeted programs: **Neosat, Metop-SG and Juice**. The formal release and validation is planned by summer 2017.

The tool is still in development, but the implementation of the last expected features is now considered reachable. We are confident that the “go-live” will be reached soon.

Different potential users are assessing the possibility to use it: notably in the domains of on-board instruments and for telecom payloads. That would bring a larger scope to the system validation. Space infrastructure could be also a good candidate for future use.

## **CONCLUSION**

Passing the validation process from a “document driven” to a “data driven” process is considered as a real advantage for the future validation programs. It will streamline the development and the validation of our space products.

Nevertheless implementing FVM on the projects is a significant change that has to be carefully supported, in order to master the transition phase, and to get the expected buy-in of the V&V actors. A lot of intermediate workshops have been required to collect the feed-backs. We are proceeding carefully in this way.

In the future, FVM opens the doors to several interesting enhanced possibilities:

- Enlarge the validation tool to other test domains (Mechanical, Thermal...),
- Possible extension of scope to the flight operations,
- Automatic test definition, according the selected on-board configuration,
- Support to Data base validation...
- Automatic test report,
- Multi-project statistical test analysis,
- Trend analysis on specific technical parameters...

FVM is one of our challenging steps towards a fully digitalized factory for satellite engineering, production and validation.