
THE NEW-GENERATION TOOLSET PROVIDING COMPREHENSIVE SUPPORT FOR MISSION OPERATIONS PREPARATION AND VALIDATION

Steve Pearson, Wolfgang Heinen, Simon Reid

OVERVIEW



1. Test & Operations Challenges
2. Supporting Test & Operations
3. MOIS7 – technology and scope update
4. EGS-CC Integration

TEST & OPERATIONS CHALLENGES

Manufacturers and Operators need to create, exchange, maintain and manage their test and operations data for many years through the spacecraft's lifecycle

TEST & OPERATIONS CHALLENGES



Used to formalise spacecraft operations and system tests by capturing knowledge of test and operations

Can be many 1000s of procedures per mission.

Contain commands and parameters for spacecraft, equipment under test, check-out equipment, ground systems etc.

Linked to spacecraft TM/TC database (and other databases if needed)

Multiple procedure formats (tabular, flow-charts, procedure language for automation)

Commonality between Test and Operations procedures

Configuration control becomes a significant requirement

TEST & OPERATIONS CHALLENGES



Summary

Challenge	Solution
Consistency with Database	A tool that guarantees automatic and consistent updates of procedures when the database changes.
Less Time to Learn	A tool that supports procedure preparation in a generic format, is user friendly and fast to learn.
Procedure Handover & Maintenance	Easy to capture knowledge from spacecraft designers that operations team can take over in order to maintain procedures before & during a mission. Configuration Management is vital. Procedures can be exported in an operations language for automation.
Increasing Operational Workload	Automation of routine activities, increase operations repeatability, handle repeating failure cases, allow operations staff to manage more spacecraft

SUPPORTING TEST & OPERATIONS

SUPPORTING TEST & OPERATIONS

Industry leading suite of integrated tools for Operations & Test

Chosen to support more than 100 different spacecraft – mostly ECSS PUS based

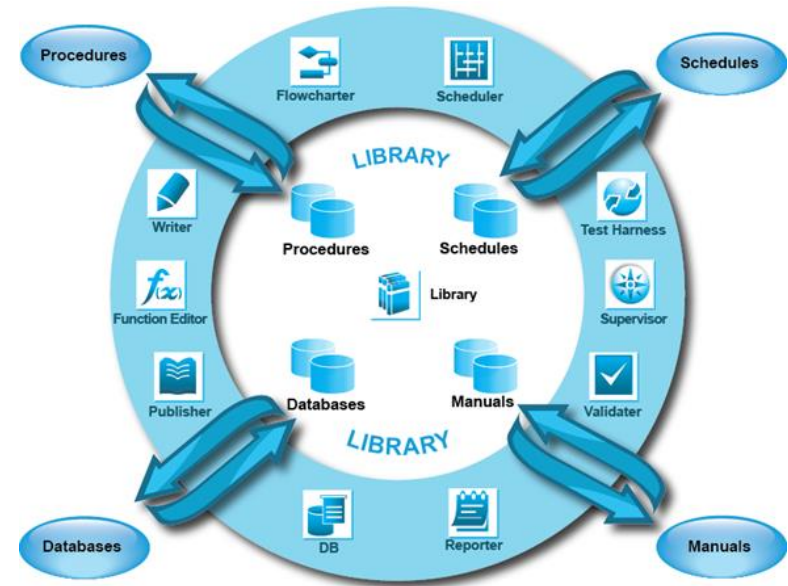
Manages Satellite Test and Operations Data

- Design, Develop, Validate, Execute

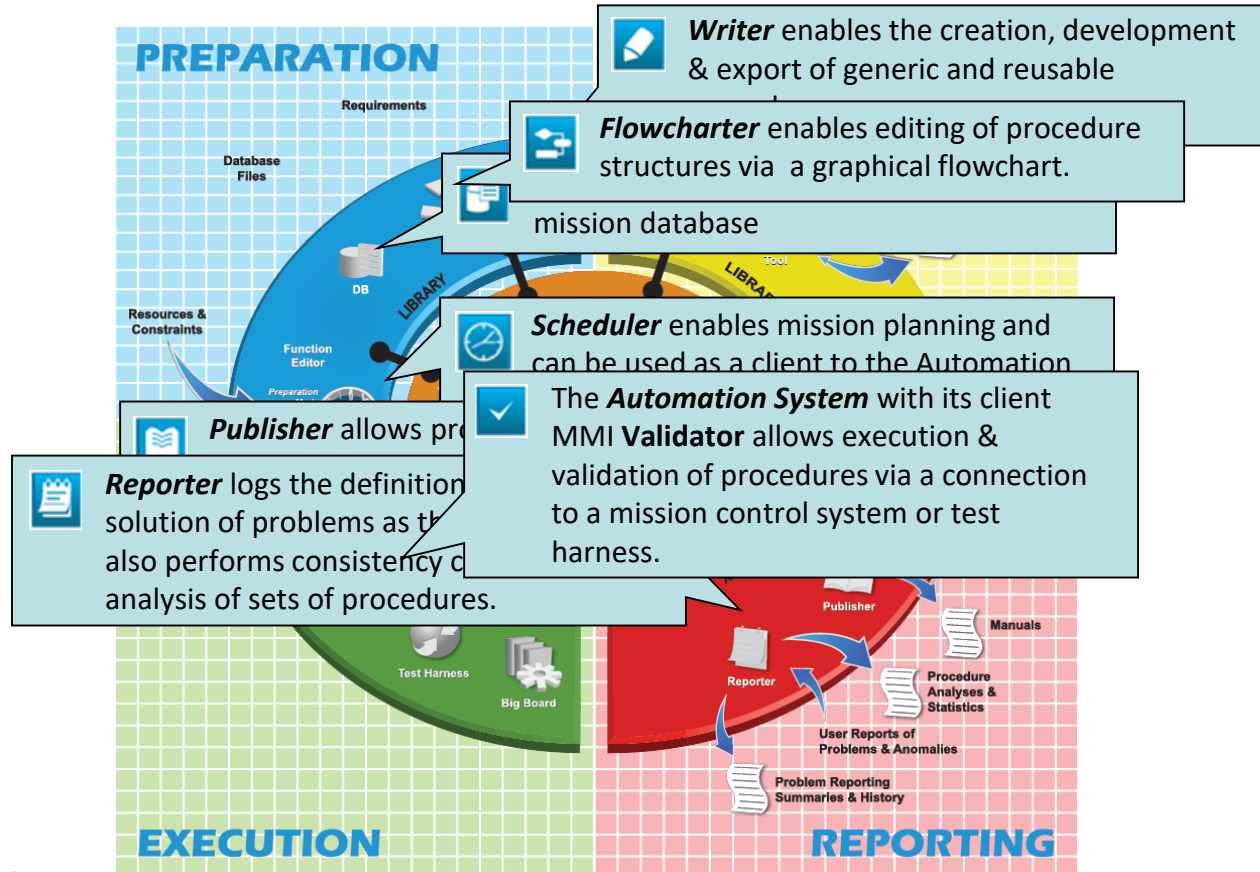
Acts as an information and knowledge bridge between systems & users

Interfaces with many control systems, third party procedures and databases

Provides integrated configuration control, problem reporting, & management reporting



SUPPORTING TEST & OPERATIONS



HISTORY AND ROADMAP



Version	Year	Technology	Comments
MOIS v5	2003	MS Office 2003, VB	Galileo IOV/FOC baseline, extended to support Galileo specific features
MOIS v6	2010	MS Office 2010, VB, .NET, VSS, Visio, Access	Backward compatible with MOIS v5 Galileo MOIS v6 upgraded Office 2016 & SVN
MOIS v7	2017	Eclipse RCP/Java, MS Office 2016, Visio, SVN	Extended support for wide range of operations data types. Consistency checks in the background.
MOIS v8	2019	Eclipse RCP/Java, OPEN, GIT	Integration with EGS-CC - support for Mission Model Editor, requirements verification

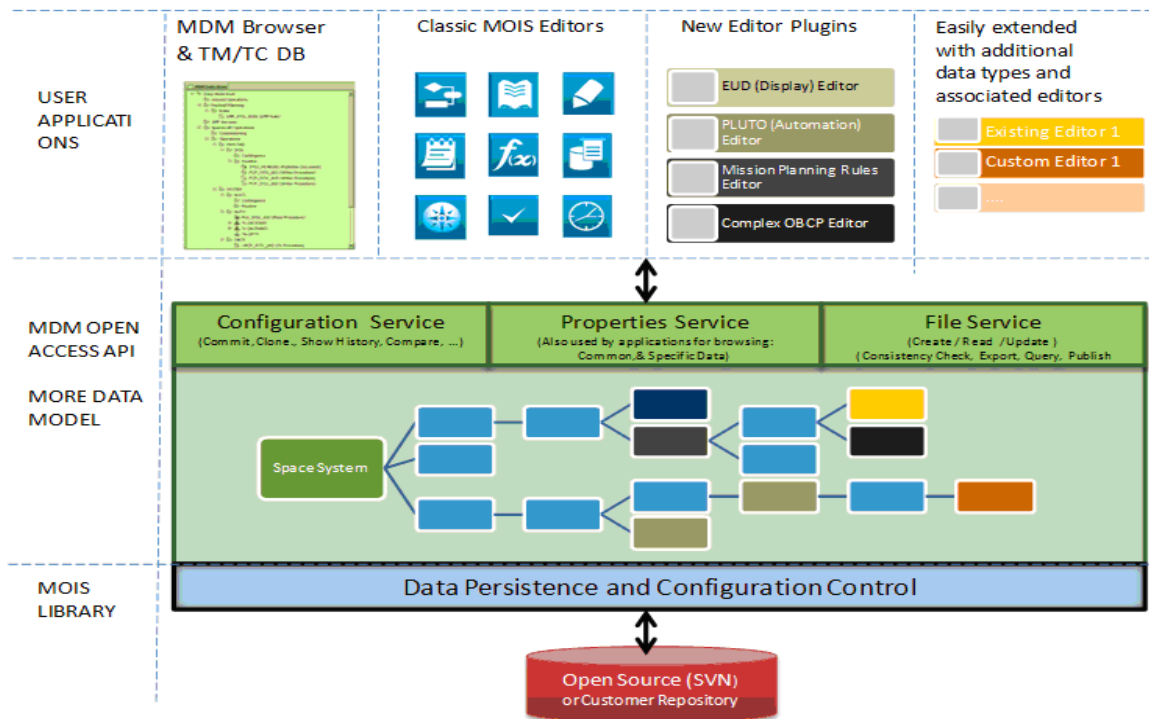
MOIS7

- ✓ Spacecraft Test and Operations is more than writing procedures
- ✓ Increasing number of inter-related systems are involved
- ✓ Derived & duplicated data becomes a concern

The goal

- ✓ Have a unique repository hosting all data items from all systems
- ✓ No duplication of data – single source of information
- ✓ Define relationships and dependencies
- ✓ Ensure overall consistency
- ✓ Have a hierarchical classification of the data
- ✓ Have centralised management of all data (configuration control, publishing, reporting)
- ✓ Have an expandable framework where data types can be added

FUNCTIONAL OVERVIEW



PLUG-IN ARCHITECTURE

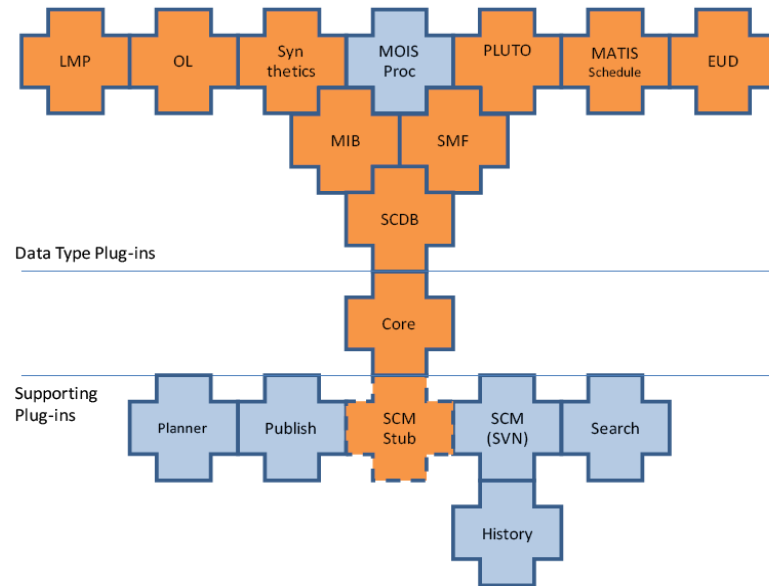
Platform Choice

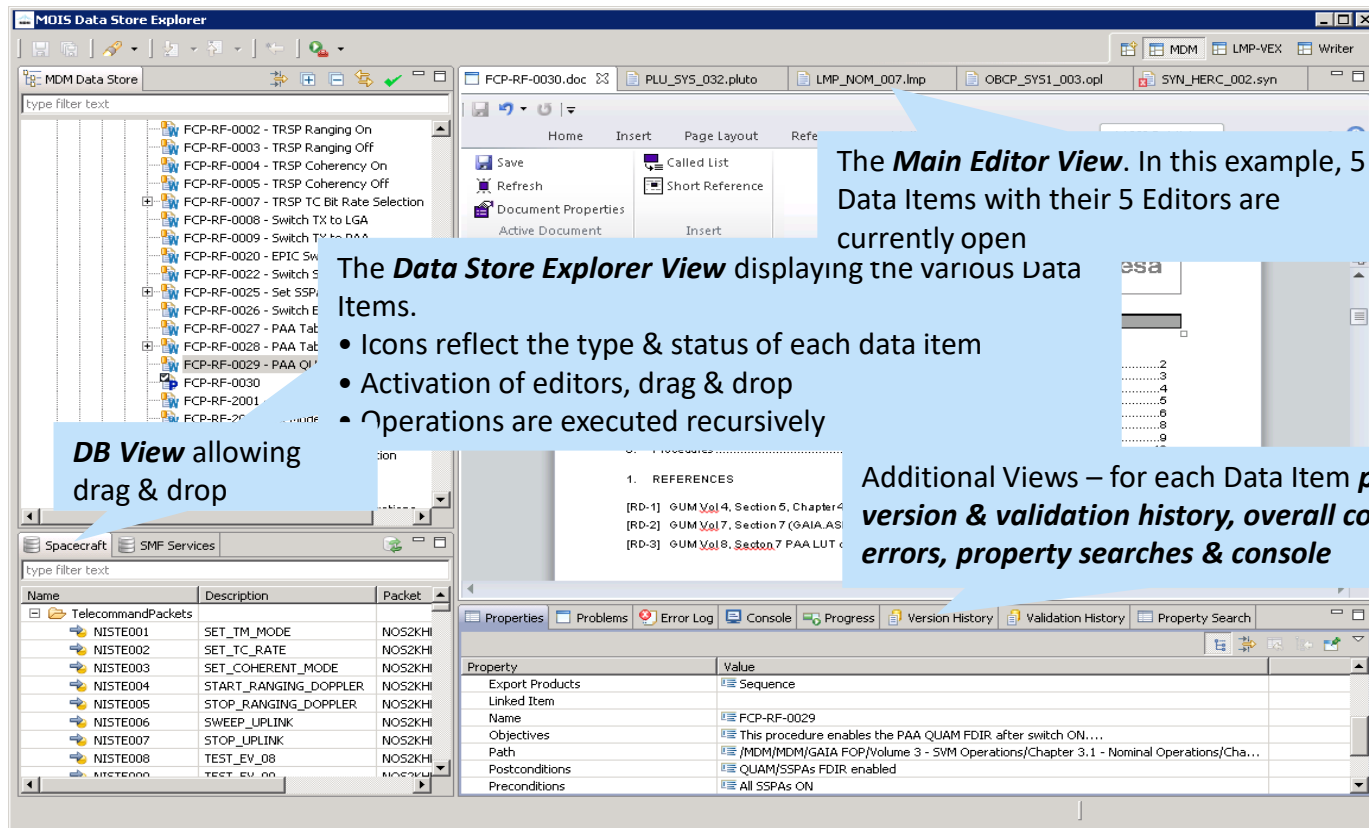
- ✓ Eclipse Application (RCP)
- ✓ Eclipse Modeling Framework (EMF) used for Modelling, data persistence & supporting UIs.
- ✓ Editors: Eclipse & Xtext based

Plug-in Architecture

- ✓ Adapters developed for existing editors
- ✓ MOIS plug-in: Java-.NET bridge
- ✓ ICD for 3rd party plug-ins

Provides the ability to integrate User Interfaces originating from different applications on the framework





MDIS Data Store Explorer

The *Data Store Explorer View* displaying the various Data Items.

- Icons reflect the type & status of each data item
- Activation of editors, drag & drop
- Operations are executed recursively

The *Main Editor View*. In this example, 5 Data Items with their 5 Editors are currently open

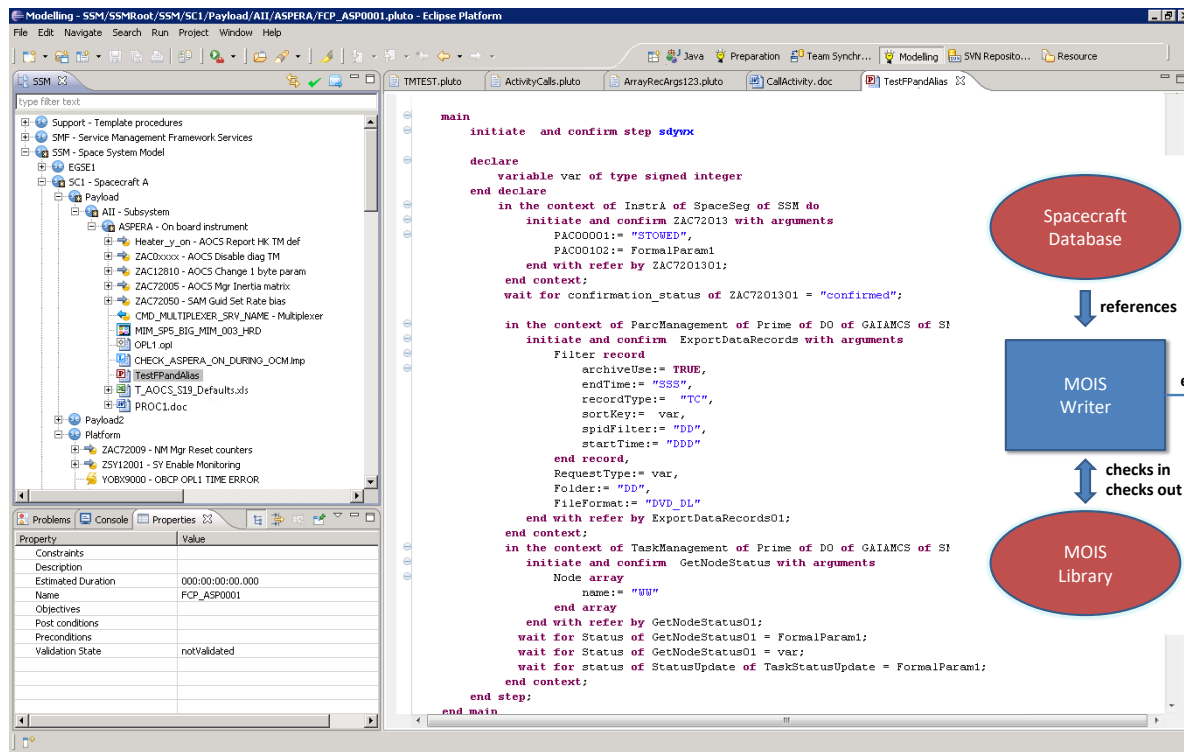
DB View allowing drag & drop

Additional Views – for each Data Item *properties, version & validation history, overall consistency errors, property searches & console*

Name	Description	Packet
TelecommandPackets		
NISTE001	SET_TM_MODE	NOS2KHI
NISTE002	SET_TC_RATE	NOS2KHI
NISTE003	SET_COHERENT_MODE	NOS2KHI
NISTE004	START_RANGING_DOPPLER	NOS2KHI
NISTE005	STOP_RANGING_DOPPLER	NOS2KHI
NISTE006	SWEEP_UPLINK	NOS2KHI
NISTE007	STOP_UPLINK	NOS2KHI
NISTE008	TEST_EV_08	NOS2KHI
NISTE009	TEST_EV_09	NOS2KHI

Property	Value
Export Products	Sequence
Linked Item	
Name	FCP-RF-0029
Objectives	This procedure enables the PAA QUAM FDIR after switch ON...
Path	/MDM/MDM/GAIA FOP/Volume 3 - SVM Operations/Chapter 3.1 - Nominal Operations/Cha...
Postconditions	QUAM/SSPAs FDIR enabled
Preconditions	All SSPAs ON

CUSTOM XTEXT PROCEDURE LANGUAGE EDITORS (PLUTO, OBCPS)



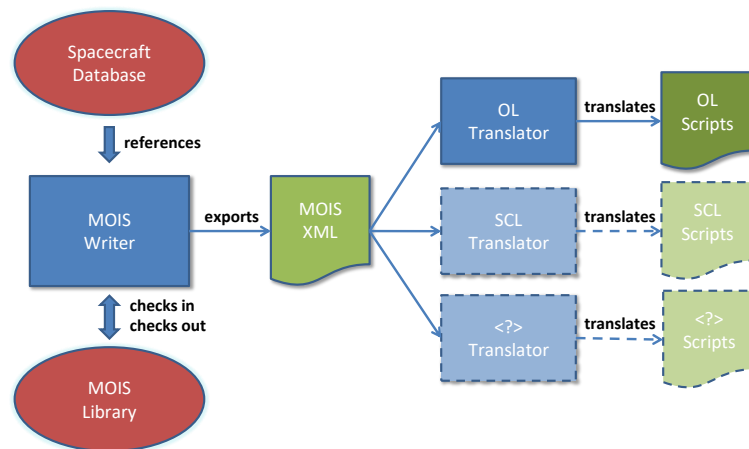
```
main
  initiate and confirm step sdywx

  declare
    variable var of type signed integer
  end declare

  in the context of InstrA of SpaceSeg of SSM do
    initiate and confirm ZAC72013 with arguments
      PAC00001:= "STOWED",
      PAC00102:= FormalParam1
    end with refer by ZAC7201301;
  end context;
  wait for confirmation_status of ZAC7201301 = "confirmed";

  in the context of ParcManagement of Prime of DO of GALMCS of SI
    initiate and confirm ExportDataRecords with arguments
      Filter record
        archiveUse:= TRUE,
        endTime:= "SSS",
        recordType:= "TC",
        sortKey:= var,
        spidFilter:= "DD",
        startTime:= "DDD"
      end record,
      RequestType:= var,
      Folder:= "DD",
      FileFormat:= "DVD_DL"
    end with refer by ExportDataRecords01;
  end context;
  in the context of TaskManagement of Prime of DO of GALMCS of SI
    initiate and confirm GetNodeStatus with arguments
      Node array
        name:= "yuy"
      end array
    end with refer by GetNodeStatus01;
    wait for Status of GetNodeStatus01 = FormalParam1;
    wait for Status of GetNodeStatus01 = var;
    wait for status of StatusUpdate of TaskStatusUpdate = FormalParam1;
  end context;
end step;
end main
```

Property	Value
Constraints	
Description	
Estimated Duration	000:00:00:00:000
Name	FCP_ASP0001
Objectives	
Post conditions	
Preconditions	
Validation State	notValidated



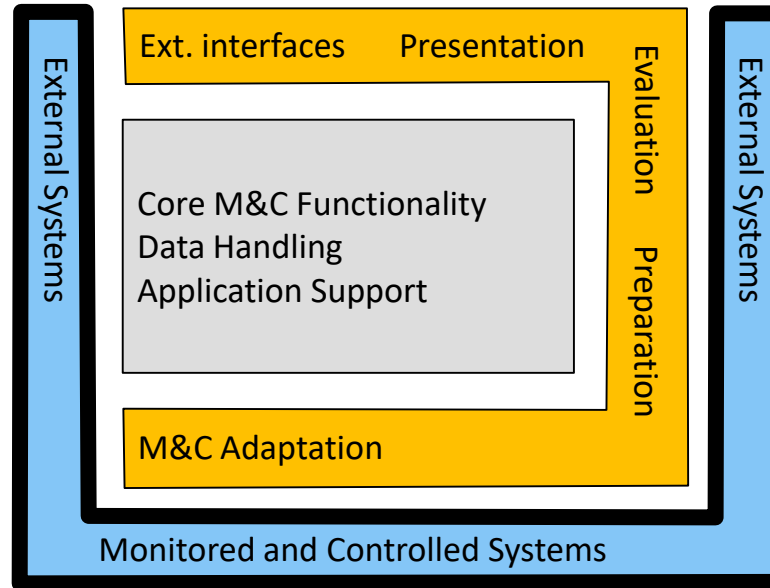
EUROPEAN GROUND SEGMENT COMMON CORE – EGS-CC

A next generation *core* system
for testing & operating
spacecraft

Core for New Ground Systems

- ✓ Collaboration of ESA and ESA Member States
- ✓ European Open Source Licence (Available to ESA member states)
- ✓ Provides the core elements of a test and/or mission control system – PUS support
- ✓ Manufacturers/Operators add their own tools around it to match their test approach/operations concept
- ✓ Java and SUSE Linux
- ✓ OSGi service-oriented architecture (Karaf container-based)
- ✓ Ecore/EMF model-driven; Eclipse RCP UI
- ✓ Incremental releases - IR3 released, IR4 late 2018 (to support telecoms missions), IR5 Feb-19, final delivery planned for June 2019.

EGS-CC REFERENCE TEST FACILITY



Key:

Kernel	Reference Implementations
Reference Test Facility	

MOIS EGS-CC INTEGRATION

Test Requirement Management

CDM data model view

Procedure export to CDM Activity Lists

Test procedure DSL Editor

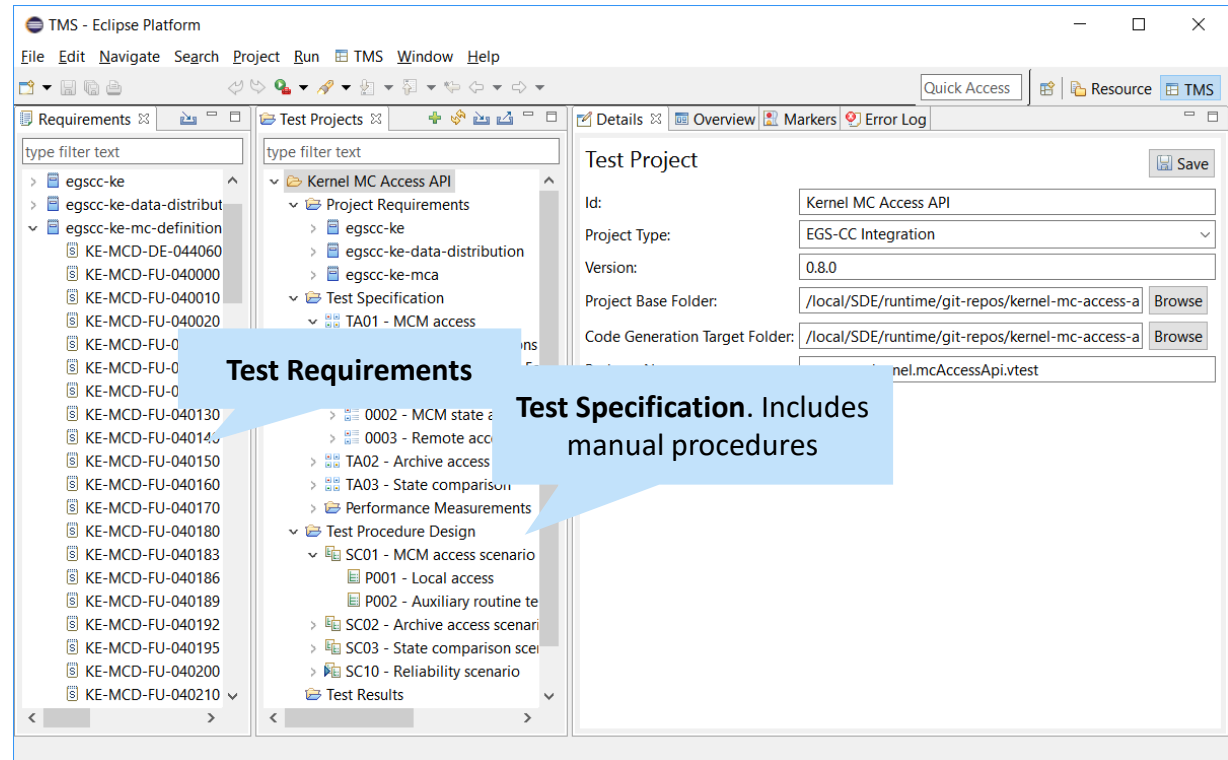
Test execution

Test Requirement Verification - VCD

TEST REQUIREMENT MANAGEMENT

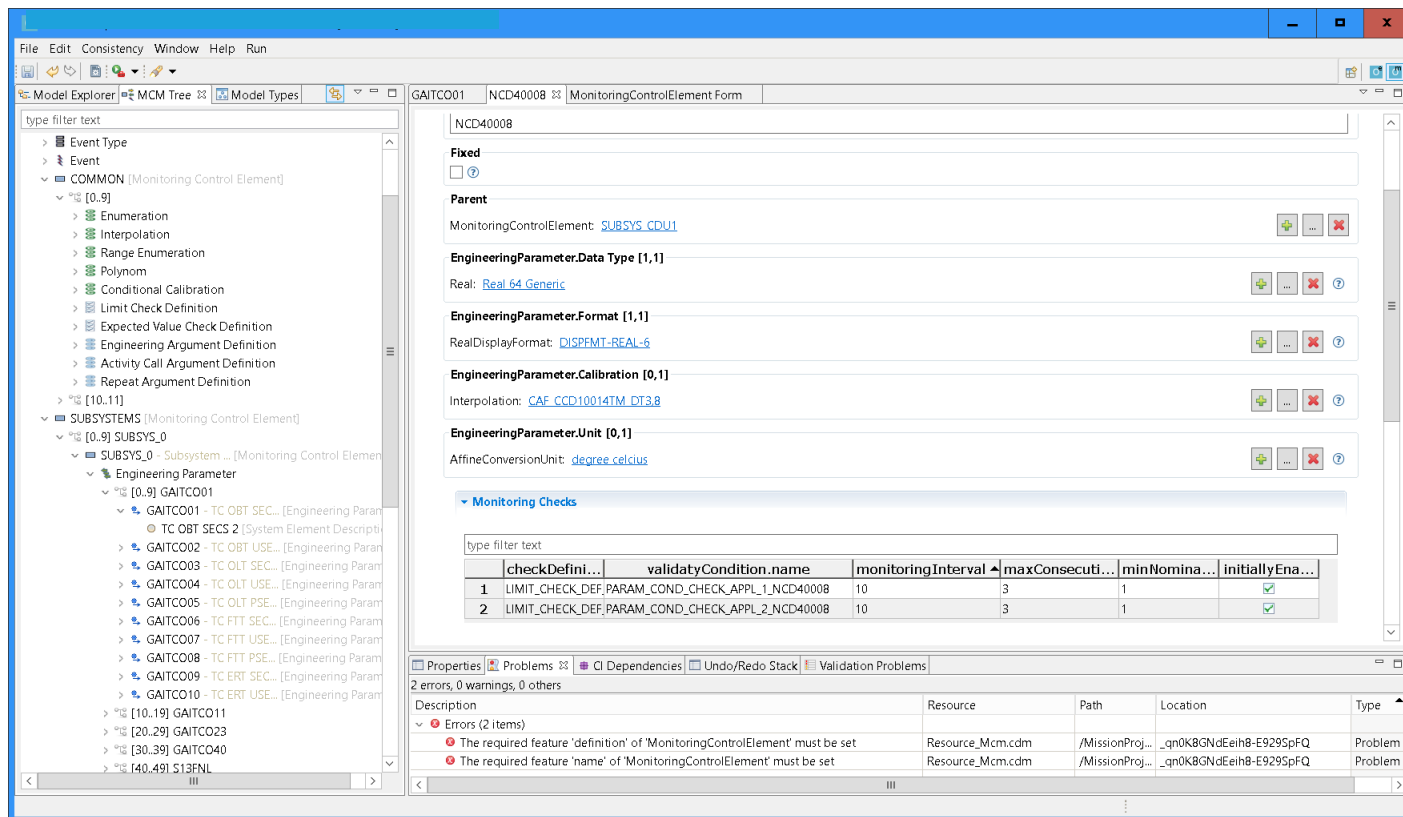
Test requirements
database

With linked test cases



The screenshot displays the TMS - Eclipse Platform interface. The left sidebar shows a tree view of test requirements, including a list of IDs such as KE-MCD-FU-040000, KE-MCD-FU-040010, and KE-MCD-FU-040210. The main area is divided into two panes. The left pane, titled 'Test Requirements', shows a hierarchical view of test specifications, including 'Kernel MC Access API', 'Project Requirements', 'Test Specification', and 'Test Results'. The right pane, titled 'Test Project', displays a form for configuring a test project, with fields for 'Id', 'Project Type', 'Version', 'Project Base Folder', and 'Code Generation Target Folder'. A blue callout box points to the 'Test Specification' section, stating: 'Test Specification. Includes manual procedures'.

EGS-CC CDM-BASED MISSION MODEL EDITOR



The screenshot displays the EGS-CC CDM-Based Mission Model Editor interface. The main window is titled "GAITCO01" and "NCD40008". The left pane shows a "Model Explorer" with a tree structure of monitoring control elements. The right pane shows the "MonitoringControlElement Form" for "NCD40008".

MonitoringControlElement Form:

- Fixed:** ☐
- Parent:** MonitoringControlElement: [SUBSYS_CDUI1](#)
- EngineeringParameter.Data Type [1,1]:** Real: [Real_64_Generic](#)
- EngineeringParameter.Format [1,1]:** RealDisplayFormat: [DISPFMT-REAL-6](#)
- EngineeringParameter.Calibration [0,1]:** Interpolation: [CAF_CCD10014TM_DT3.8](#)
- EngineeringParameter.Unit [0,1]:** AffineConversionUnit: [degree_celsius](#)

Monitoring Checks:

	checkDefini...	validatyCondition.name	monitoringInterval	maxConsecuti...	minNomina...	InitiallyEna...
1	LIMIT_CHECK_DEF_PARAM_COND_CHECK_APPL_1_NCD40008		10	3	1	<input checked="" type="checkbox"/>
2	LIMIT_CHECK_DEF_PARAM_COND_CHECK_APPL_2_NCD40008		10	3	1	<input checked="" type="checkbox"/>

Properties / Problems / CI Dependencies / Undo/Redo Stack / Validation Problems

2 errors, 0 warnings, 0 others

Description	Resource	Path	Location	Type
The required feature 'definition' of 'MonitoringControlElement' must be set	Resource_Mcm.cdm	/MissionProj...	_qn0K8GNdEeih8-E929SpFQ	Problem
The required feature 'name' of 'MonitoringControlElement' must be set	Resource_Mcm.cdm	/MissionProj...	_qn0K8GNdEeih8-E929SpFQ	Problem

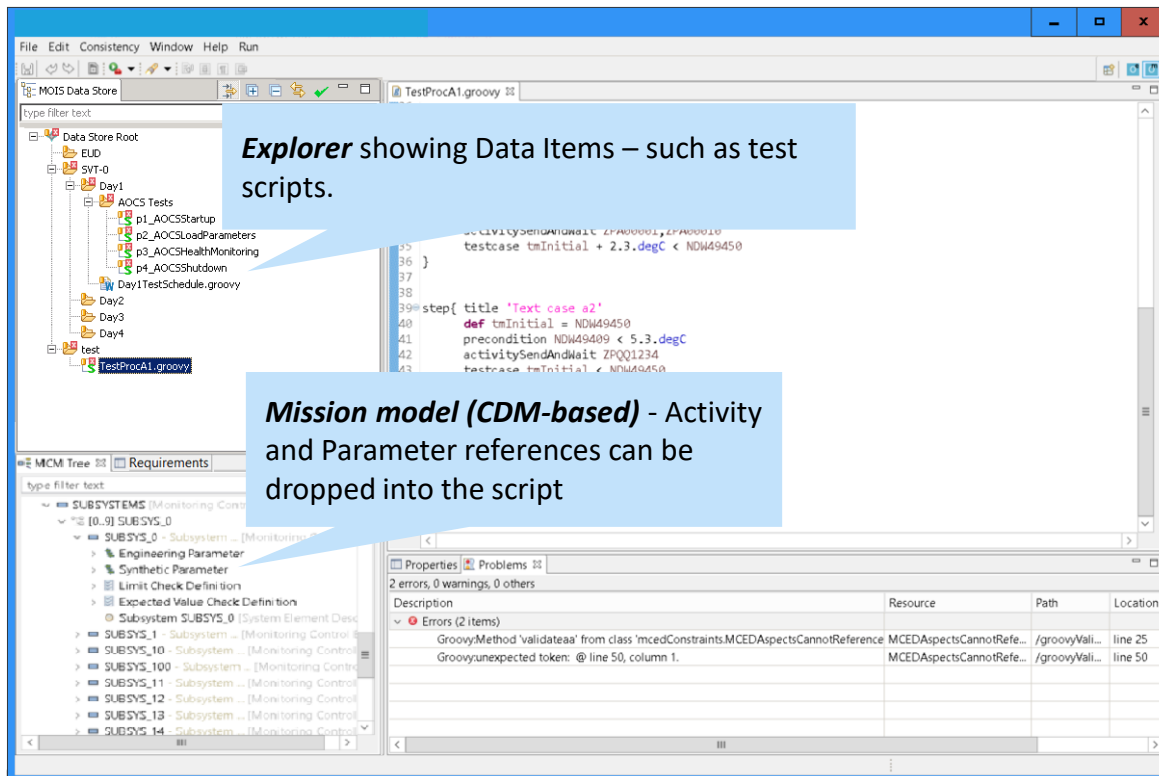
TEST PROCEDURE EDITING AND EXECUTION

Mission model linked
and referenced

Test requirements
linked and referenced

Simple, clear DSL with
editor

Execution results stored



Explorer showing Data Items – such as test scripts.

Mission model (CDM-based) - Activity and Parameter references can be dropped into the script

Properties Problems

2 errors, 0 warnings, 0 others

Description	Resource	Path	Location
Errors (2 items)			
GroovyMethod 'validatedata' from class 'mcedConstraints.MCEDAspectsCannotReference'	MCEDAspectsCannotRefer...	/groovyVali...	line 25
GroovyUnexpected token: @ line 50, column 1.	MCEDAspectsCannotRefer...	/groovyVali...	line 50

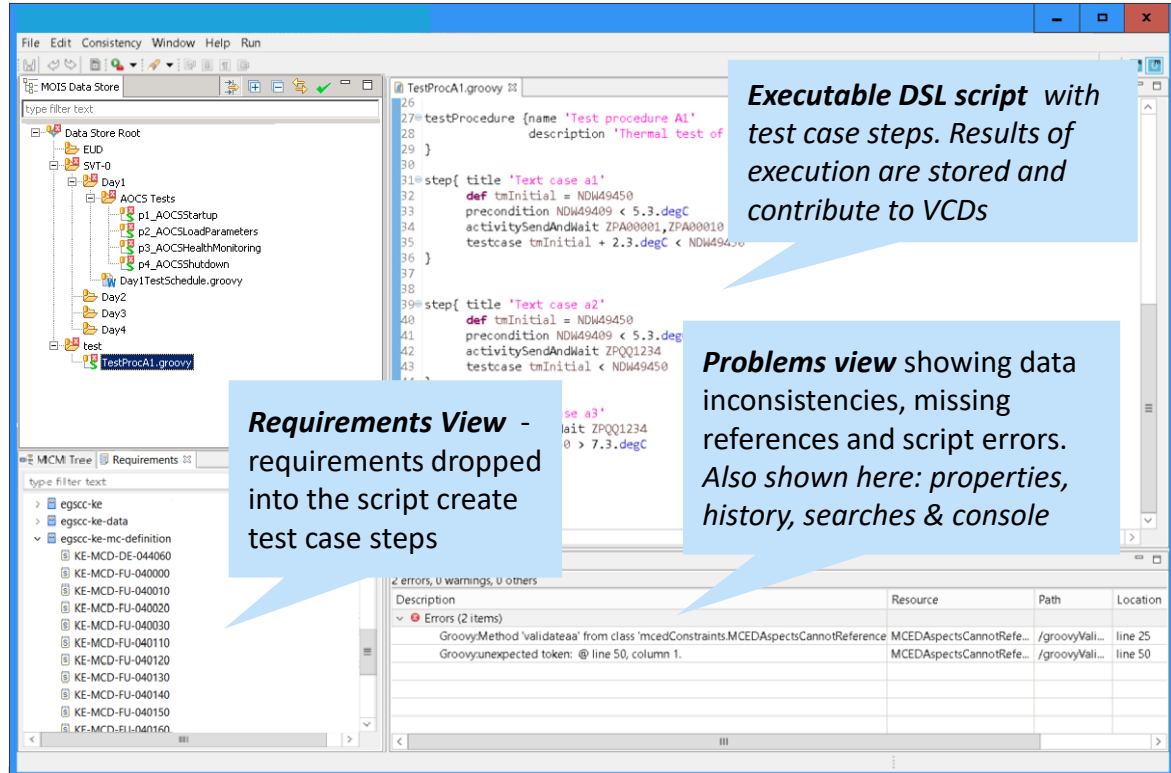
TEST PROCEDURE EDITING AND EXECUTION

Mission model linked
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Simple, clear DSL with
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Execution results stored



Executable DSL script with test case steps. Results of execution are stored and contribute to VCDs

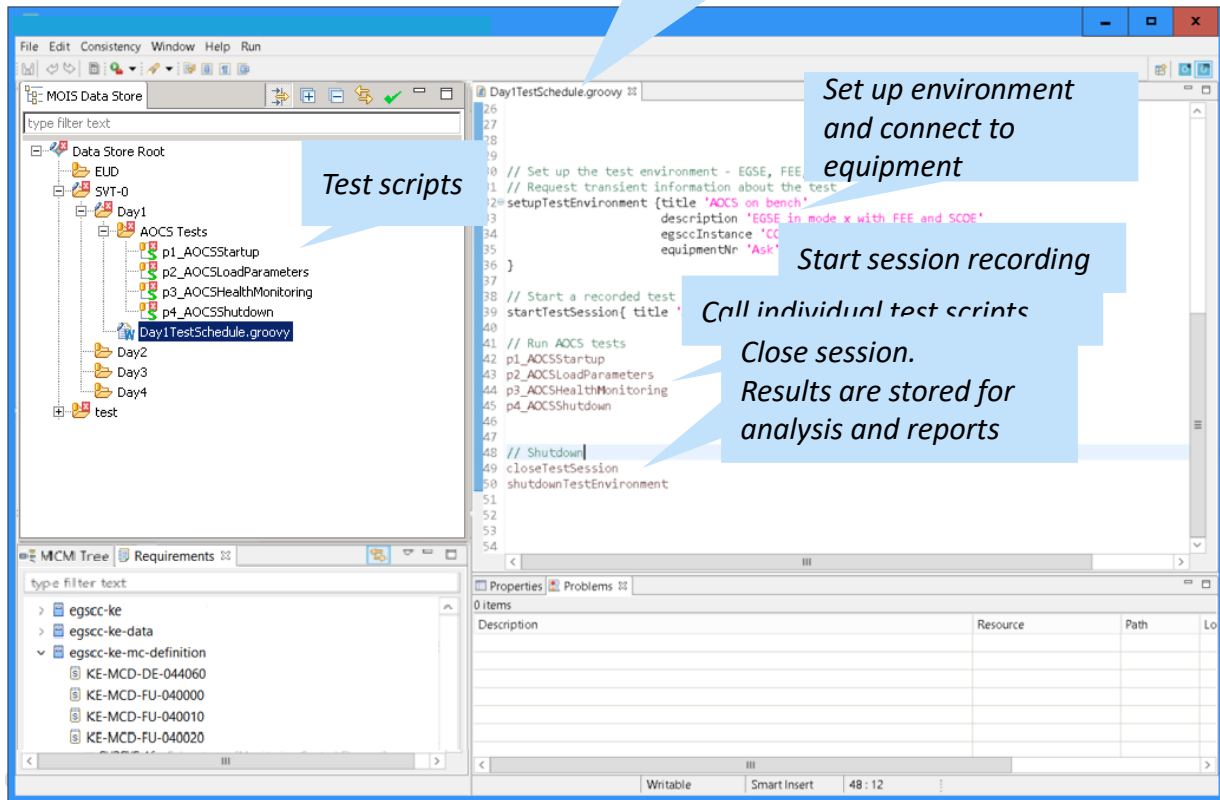
```
26
27 testProcedure {name 'Test procedure A1'
28               description 'Thermal test of
29 }
30
31 step { title 'Text case a1'
32       def tmInitial = NDW49450
33       precondition NDW49409 < 5.3.degC
34       activitySendAndWait ZPA00001, ZPA00010
35       testcase tmInitial + 2.3.degC < NDW49450
36 }
37
38
39 step { title 'Text case a2'
40       def tmInitial = NDW49450
41       precondition NDW49409 < 5.3.degC
42       activitySendAndWait ZPQQ1234
43       testcase tmInitial < NDW49450
44 }
```

Requirements View - requirements dropped into the script create test case steps

Problems view showing data inconsistencies, missing references and script errors. Also shown here: properties, history, searches & console

Description	Resource	Path	Location
GroovyMethod 'validataaaa' from class 'mcedConstraints.MCEDAspectsCannotReference	MCEDAspectsCannotRefer...	/groovy/Vali...	line 25
GroovyUnexpected token: @ line 50, column 1.	MCEDAspectsCannotRefer...	/groovy/Vali...	line 50

TEST SET-UP AND SCHEDULING



Test session top level script

Test scripts

Set up environment and connect to equipment

Start session recording

Call individual test scripts

Close session. Results are stored for analysis and reports

```
Day1TestSchedule.groovy
26
27
28
29
30 // Set up the test environment - EGSE, FEE
31 // Request transient information about the test
32 setupTestEnvironment {title 'AOCS on bench'
33     description 'EGSE in mode x with FEE and SCOE'
34     egscInstance 'CC'
35     equipmentNr 'Ask'
36 }
37
38 // Start a recorded test
39 startTestSession{ title '
40
41 // Run AOCS tests
42 p1_AOCSStartup
43 p2_AOCSLoadParameters
44 p3_AOCSHealthMonitoring
45 p4_AOCSShutdown
46
47
48 // Shutdown
49 closeTestSession
50 shutdownTestEnvironment
51
52
53
54
```

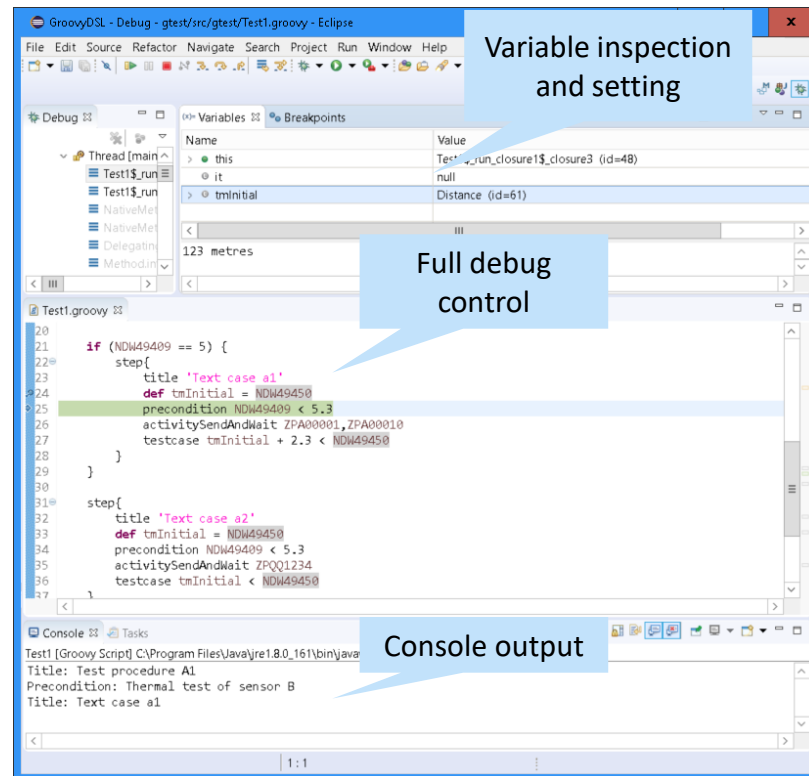
MCM Tree

- egscc-ke
- egscc-ke-data
- egscc-ke-mc-definition
 - KE-MCD-DE-044060
 - KE-MCD-FU-040000
 - KE-MCD-FU-040010
 - KE-MCD-FU-040020

TEST MANUAL EXECUTION AND DEBUG

Tests can be run in debug and values examined.

Scripting makes it is easy to start, stop and restart from anywhere (unlike compiled code)



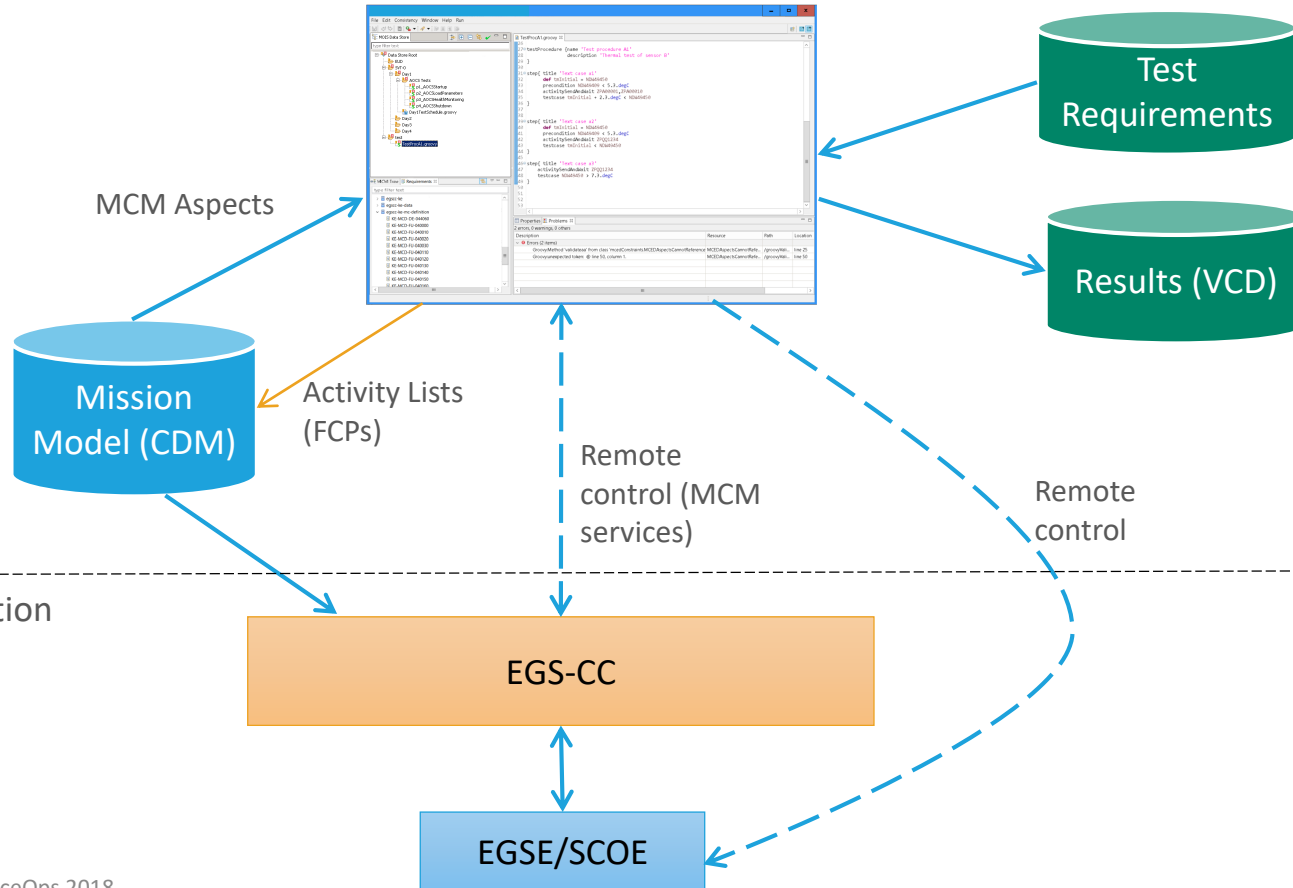
TEST MANAGEMENT - ANALYSIS AND REPORTS



Results recorded during test execution contribute to reports:

- ✓ Test requirement coverage – which requirements have been tested and which have not
- ✓ Requirement validation results against test environment
- ✓ Requirement validation results against equipment / software versions
- ✓ Histories of results
- ✓ Summary of failures
- ✓ Formal VCD generation

EGS-CC INDEPENDENCE



Summary (1/2)

- ✓ Links to CDM mission model for MCM Activity, Parameter and Event references
- ✓ Test scripts developed in line with and checked against mission model.
- ✓ Scripting - flexible and immediate, simple and powerful DSL. Simple, does not look like Java
- ✓ Test requirements linked to executable test case steps. Focused towards verification tasks: send TC, test TM, synchronous calls, packet or parameter change events.
- ✓ All on client - tests executed against remote system. Results correlated for reports and VCD

Summary (2/2)

- ✓ Scripts exportable to Automation AP format for execution inside the EGS-CC kernel
- ✓ Flight Control Procedures exported to back to CDM mission model as Activity Lists
- ✓ Publishing and reporting functions available as before
- ✓ **End to end requirement and test procedure development, publishing, execution and reporting for an EGS-CC based system.**



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Steve Pearson: spearson@rheagroup.com