Telespazio

A Finmeccanica/Thales Company

System Concept Simulation for Concurrent Engineering

Final Presentation

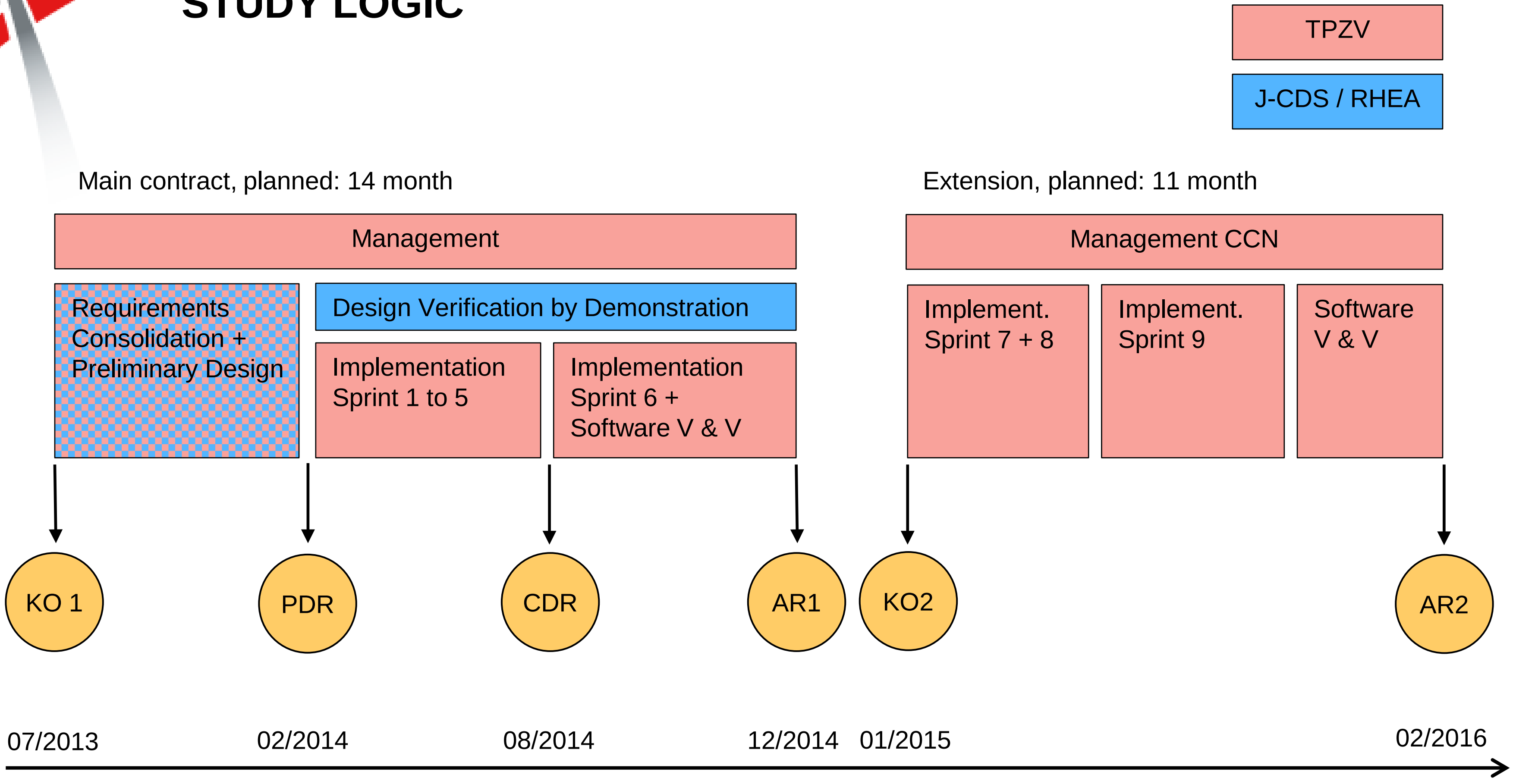
Stephan Kranz

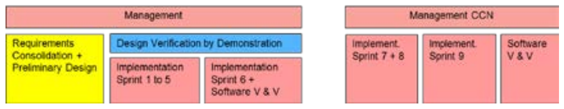
ESTEC, June 9th, 2016

SYSTEM CONCEPT SIMULATOR

- Study Logic
- Use Cases / User Requirements
- Architectural Design
- Workbench Prototype
- Validation & Verification
- Conclusions

STUDY LOGIC


TPZV
J-CDS / RHEA
Main contract, planned: 14 month
Extension, planned: 11 month
Management
Management CCN
Requirements Consolidation + Preliminary Design
Design Verification by Demonstration
Implementation Sprint 1 to 5
Implementation Sprint 6 + Software V & V
Implement. Sprint 7 + 8
Implement. Sprint 9
Software V & V
KO 1
PDR
CDR
AR1
KO2
AR2
07/2013
02/2014
08/2014
12/2014
01/2015
02/2016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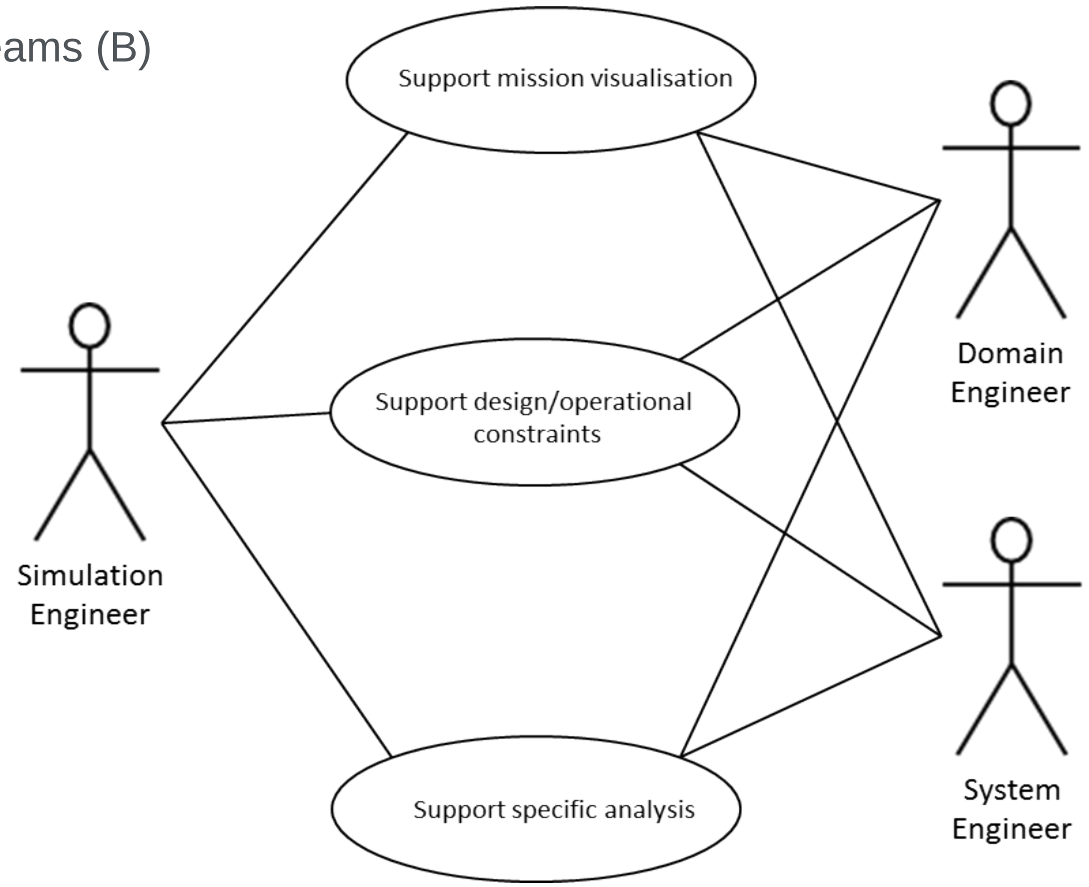
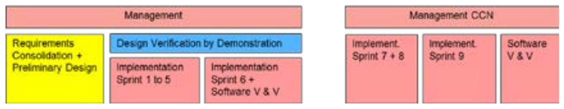
HIGH LEVEL USE CASES

- **CDF Support (0/A) ← time frame!**
- Support to Mission Study Teams (A/B1)
- Support to S/C project teams (B)

- Mission profile presentation at Kick Off
- Online and offline session support
- Reporting and presentation of results (data post-processing and visualisation)


Support mission visualisation
Support design/operational constraints
Support specific analysis
Simulation Engineer
Domain Engineer
System Engineer

User Requirements from Stakeholder Interviews (RHEA)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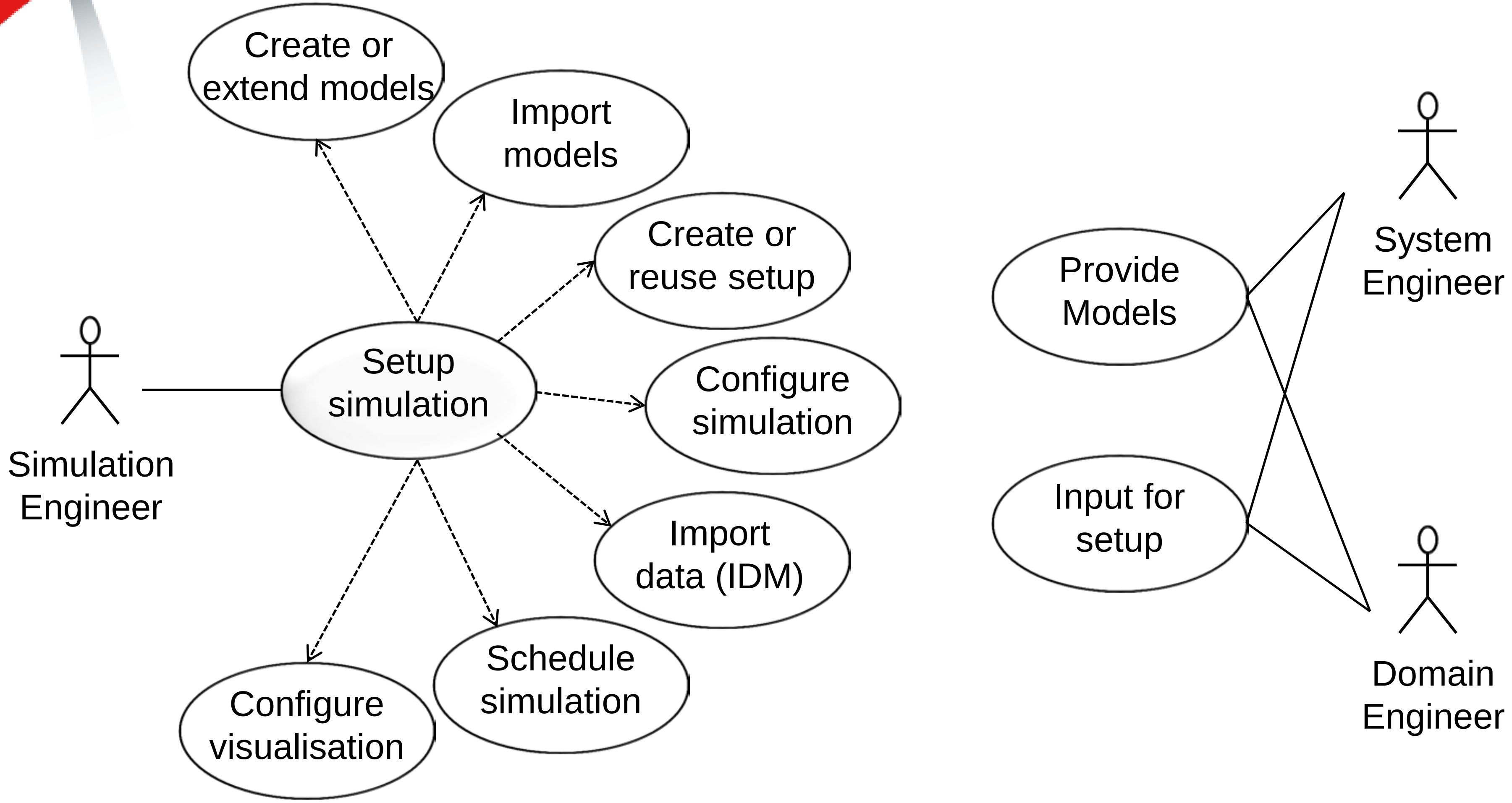
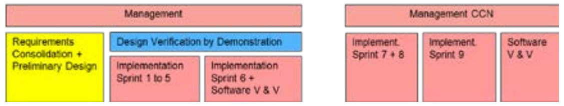
SIMULATION SETUP

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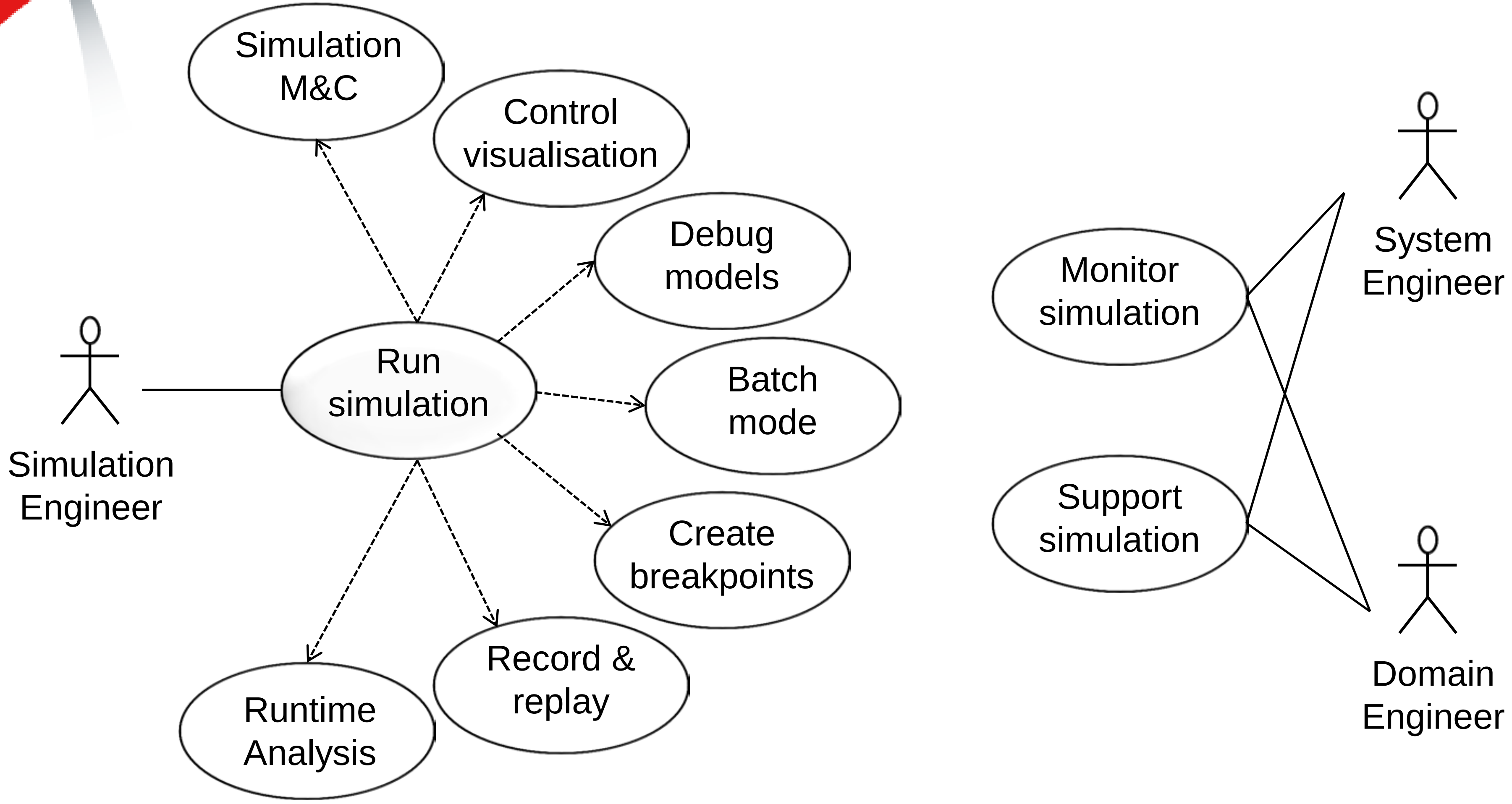
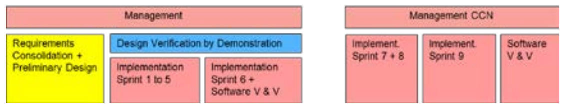
SIMULATION EXECUTION

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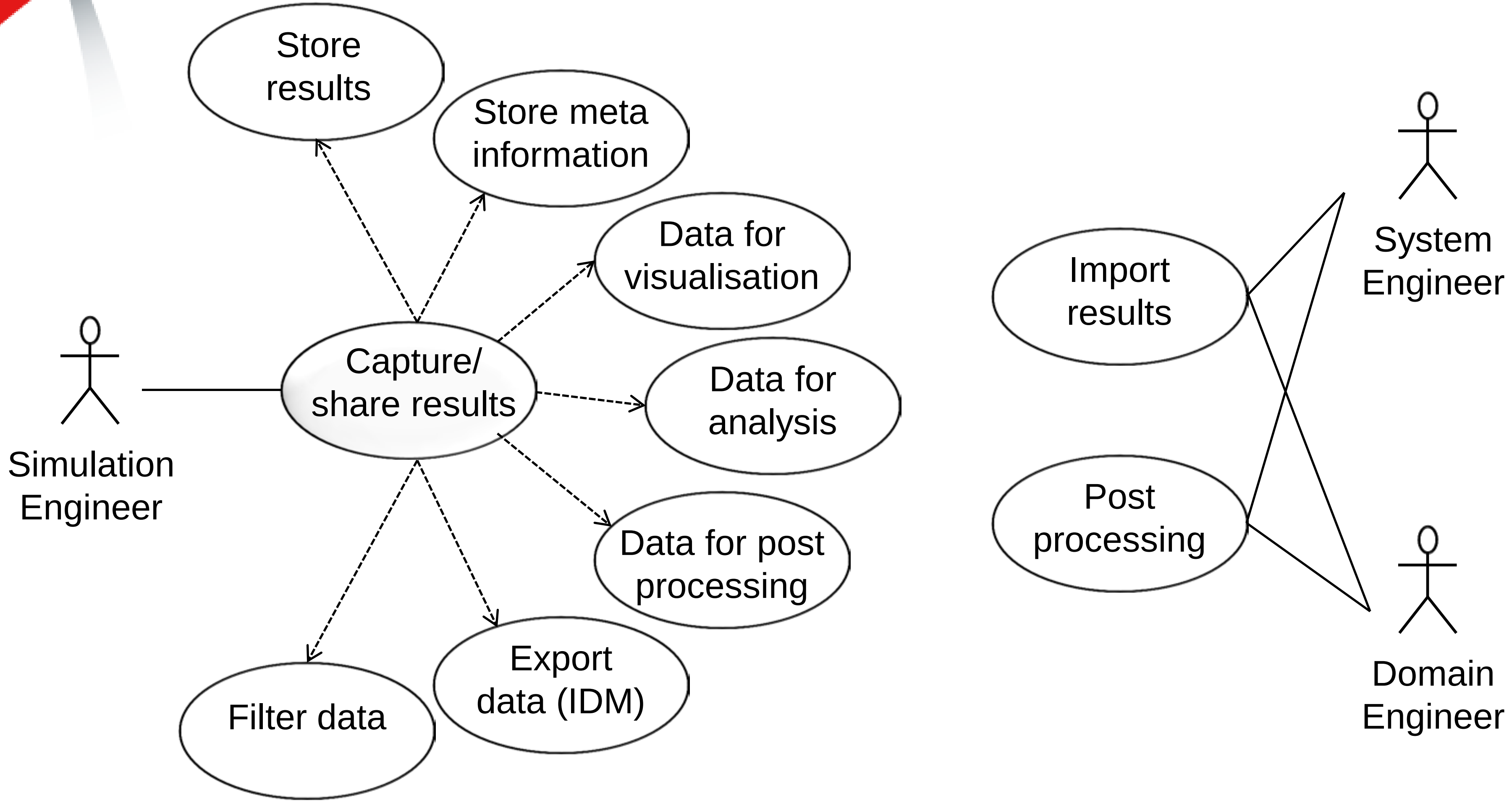
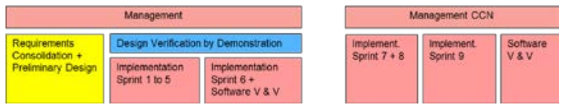
SIMULATION RESULTS CAPTURING

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USER INTERFACE + DATAMODEL

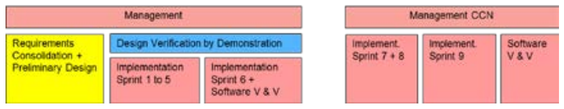
- Project Test Bed (PTB)
  - + Simple datamodel and very easy implementation (C-code)
  - + Very flexible
  - - Lack of model catalogue concept (common vs. mission specific models)
  - - Limited number of verified and validated models for reuse.
  - - Different tools with manual data transfer in-between
- SimVis
  - + Separation of type from instance (SMP2) -> reuse possible
  - + Easy implementation (C++ code with skeleton generator)
  - - (too) complex data model
  - - Confusing integration
  - - Different tools with manual data transfer in-between

➔ SCS: + SMP2 subset only (dataflow)

+ Diagram based Integration (Simulink alike)

+ Integrated into a single tool / UI

+ User (J-CDS) in development loop with Design Verification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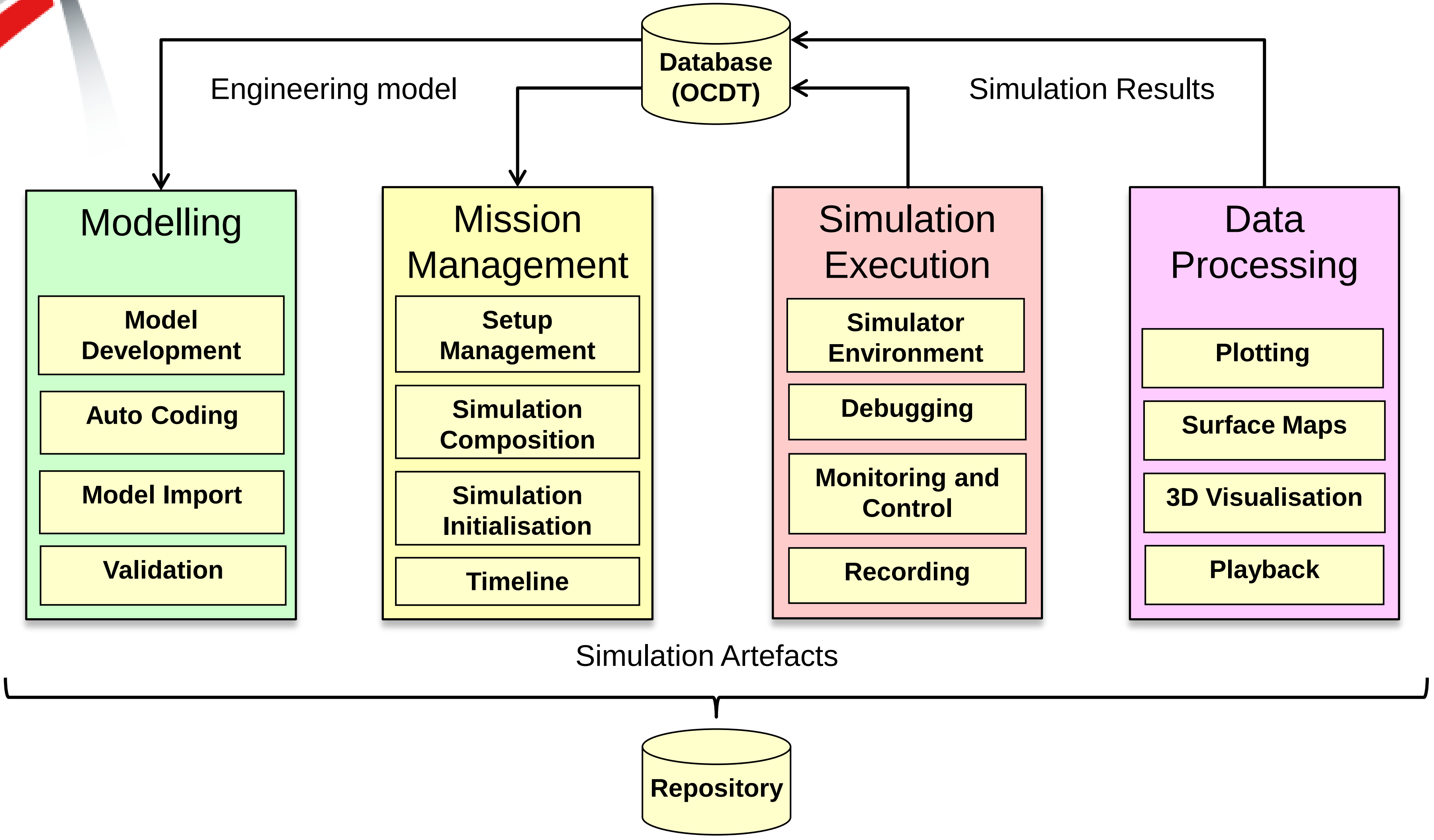
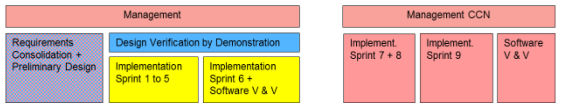
SCS FUNCTIONAL COMPONENTS

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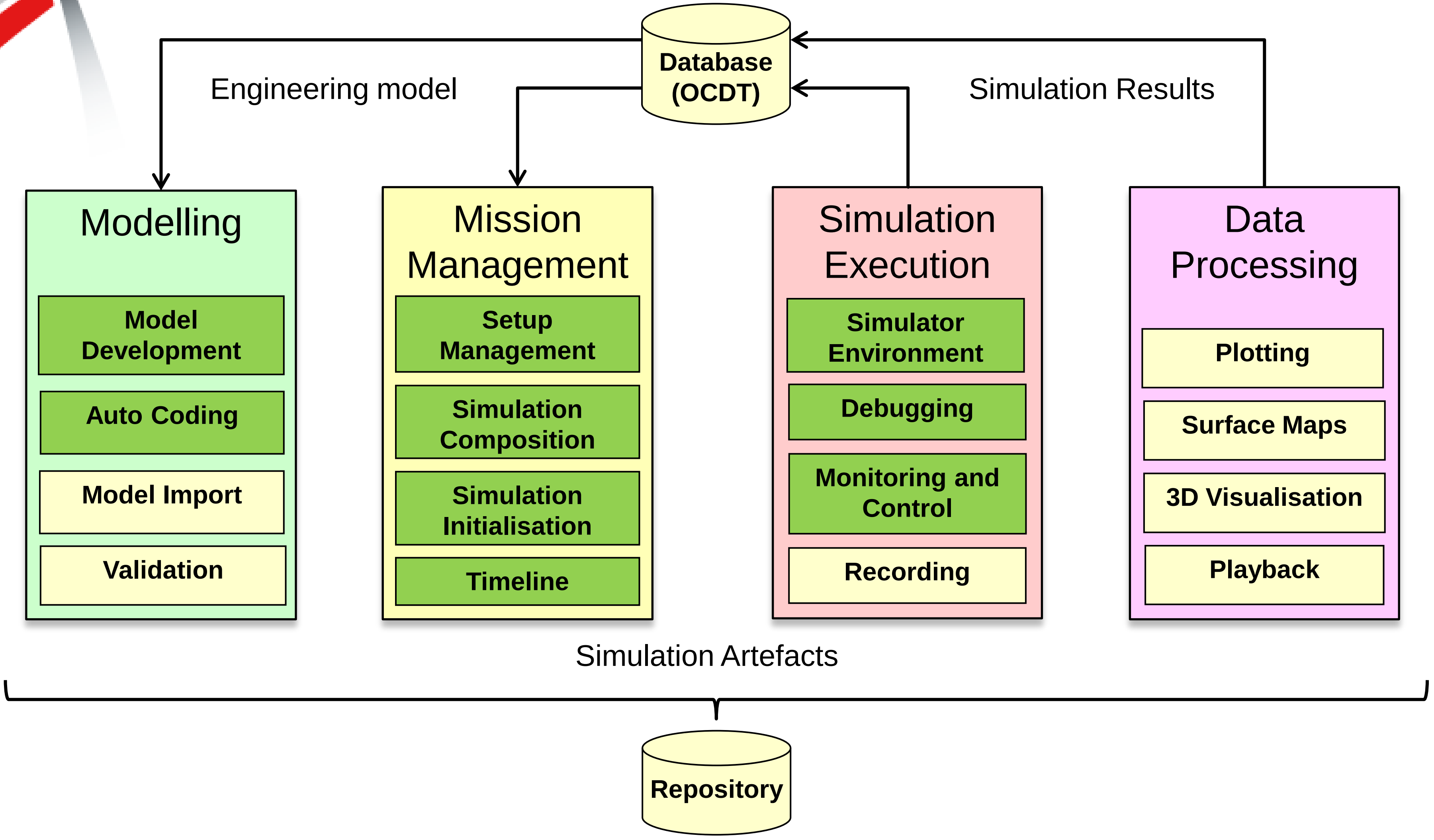
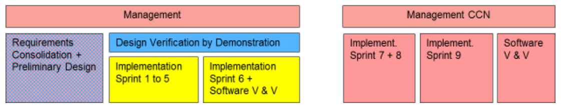
SCS PROTOTYPE COMPONENTS

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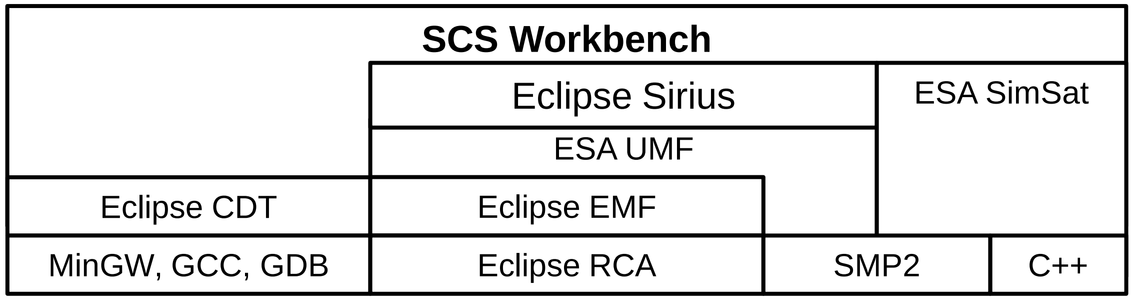
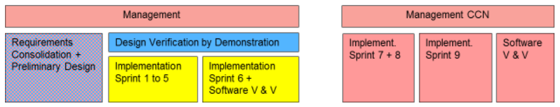
SOFTWARE COMPONENTS

- Java based Eclipse rich client application + EMF
- SMP2 standard (Dataflow flavour only)
- ESA Universal Modelling Framework (UMF)
- Eclipse Sirius based UI
- Eclipse C/C++ Development Tool using GCC Compiler and GDB Debugger
- ESA SimSat Simulation Runtime Environment
- ➔ Eclipse Public Licenses + ESA licenses

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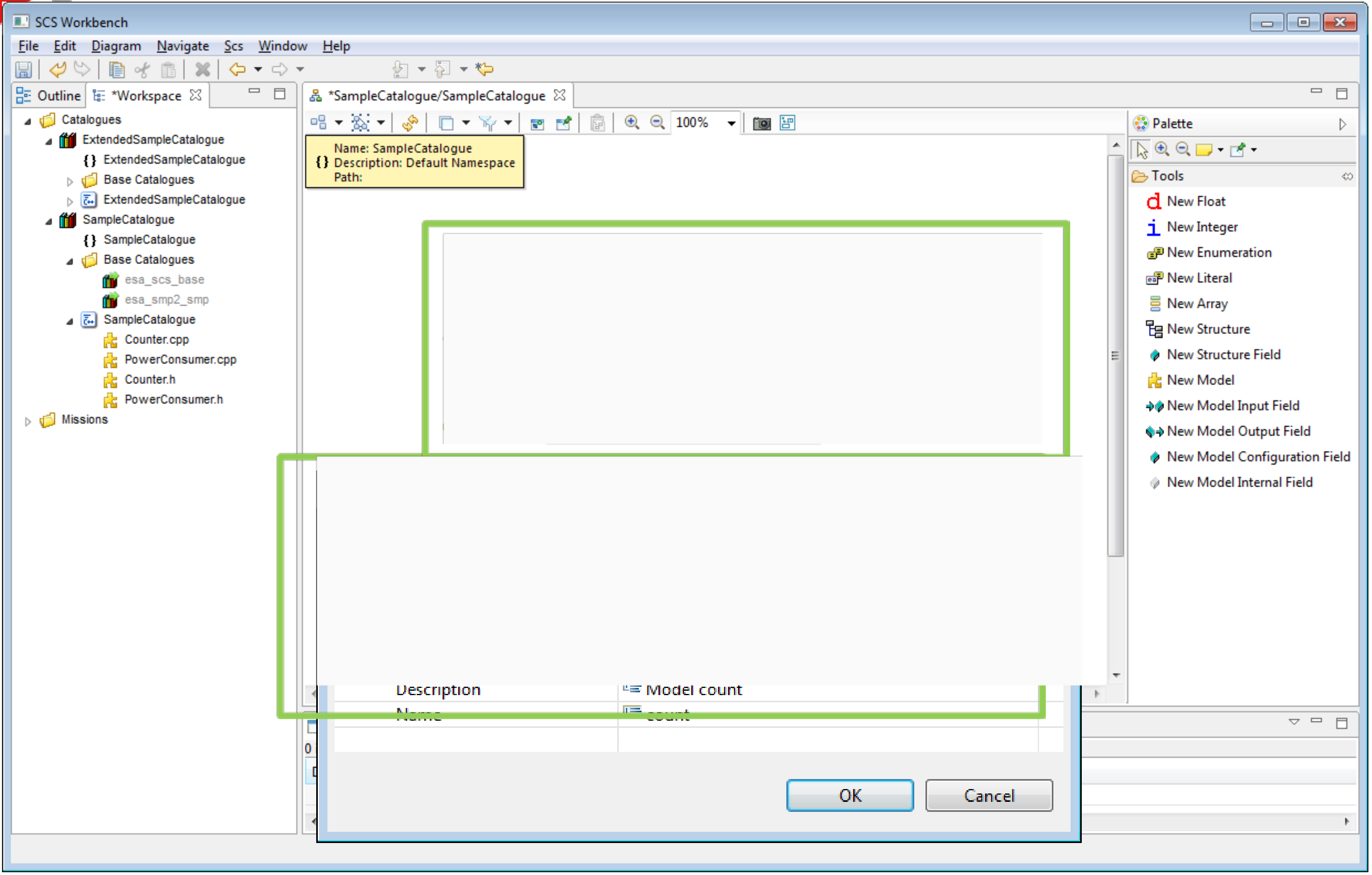
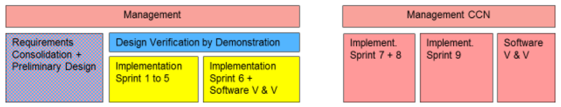
MODEL DEVELOPMENT – CATALOGUES



- Catalogues
  - ExtendedSampleCatalogue
    - ExtendedSampleCatalogue
    - Base Catalogues
    - ExtendedSampleCatalogue
  - SampleCatalogue
    - SampleCatalogue
    - Base Catalogues
      - esa_scs_base
      - esa_smp2_smp
    - SampleCatalogue
      - Counter.cpp
      - PowerConsumer.cpp
      - Counter.h
      - PowerConsumer.h
- Missions

Name: SampleCatalogue
Description: Default Namespace
Path:

Description	Model count
Name	count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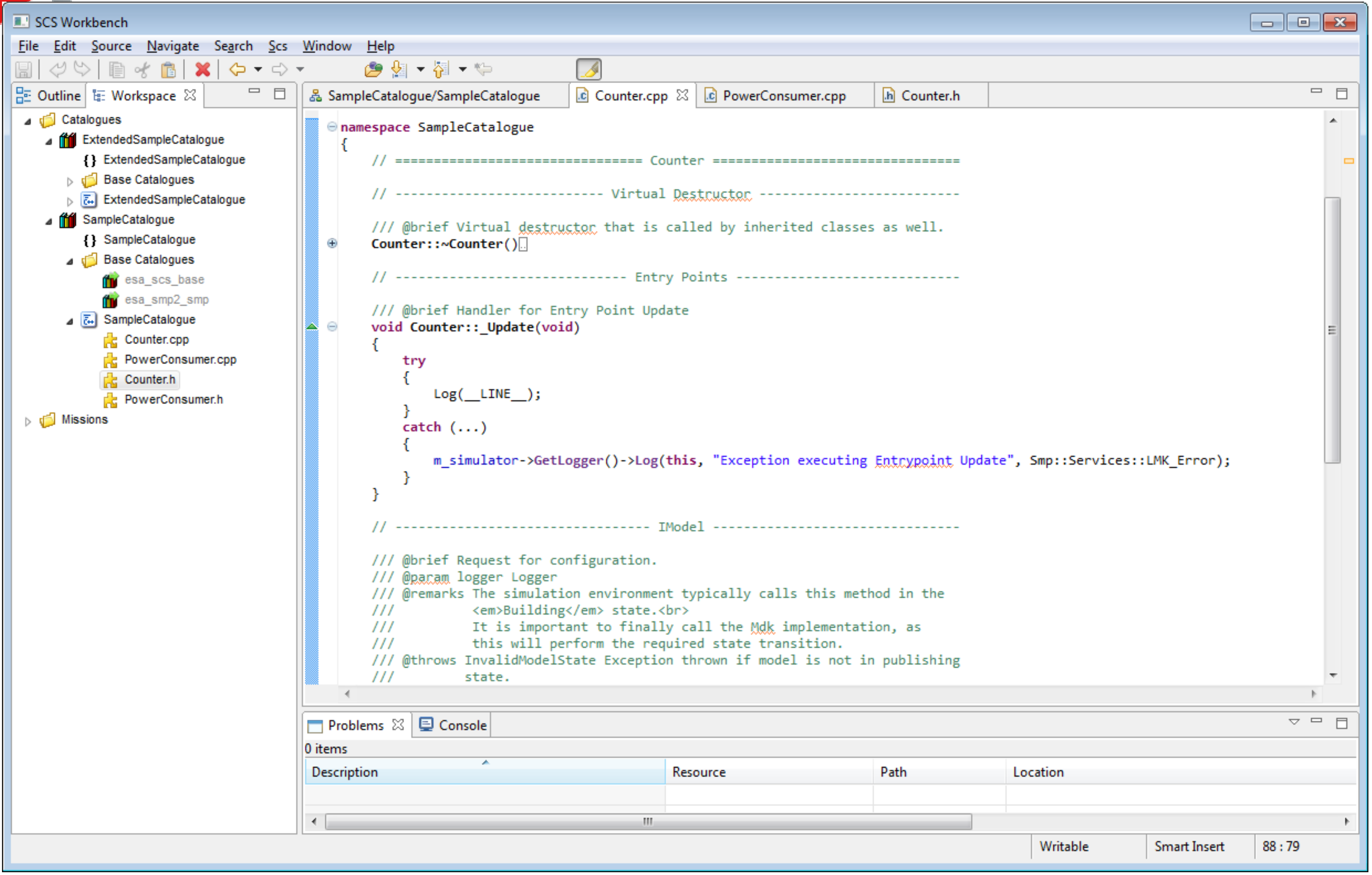
CODE GENERATOR AND EDITOR



```
Catalogues
  ExtendedSampleCatalogue
    ExtendedSampleCatalogue
    Base Catalogues
    ExtendedSampleCatalogue
  SampleCatalogue
    SampleCatalogue
    Base Catalogues
      esa_scs_base
      esa_smp2_smp
    SampleCatalogue
      Counter.cpp
      PowerConsumer.cpp
      Counter.h
      PowerConsumer.h
Missions
```

```
namespace SampleCatalogue
{
    // ============================== Counter ================================

    // --------------------------- Virtual Destructor -------------------------

    /// @brief Virtual destructor that is called by inherited classes as well.
    Counter::~Counter()

    // ------------------------------ Entry Points ----------------------------

    /// @brief Handler for Entry Point Update
    void Counter::_Update(void)
    {
        try
        {
            Log(__LINE__);
        }
        catch (...)
        {
            m_simulator->GetLogger()->Log(this, "Exception executing Entrypoint Update", Smp::Services::LMK_Error);
        }
    }

    // -------------------------------- IModel --------------------------------

    /// @brief Request for configuration.
    /// @param logger Logger
    /// @remarks The simulation environment typically calls this method in the
    ///          <em>Building</em> state.<br>
    ///          It is important to finally call the Mdk implementation, as
    ///          this will perform the required state transition.
    /// @throws InvalidModelState Exception thrown if model is not in publishing
    ///         state.
```

0 items

Description	Resource	Path	Location

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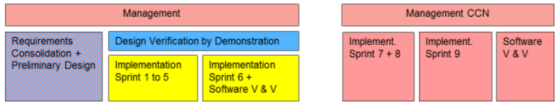
SCS Workbench Prototype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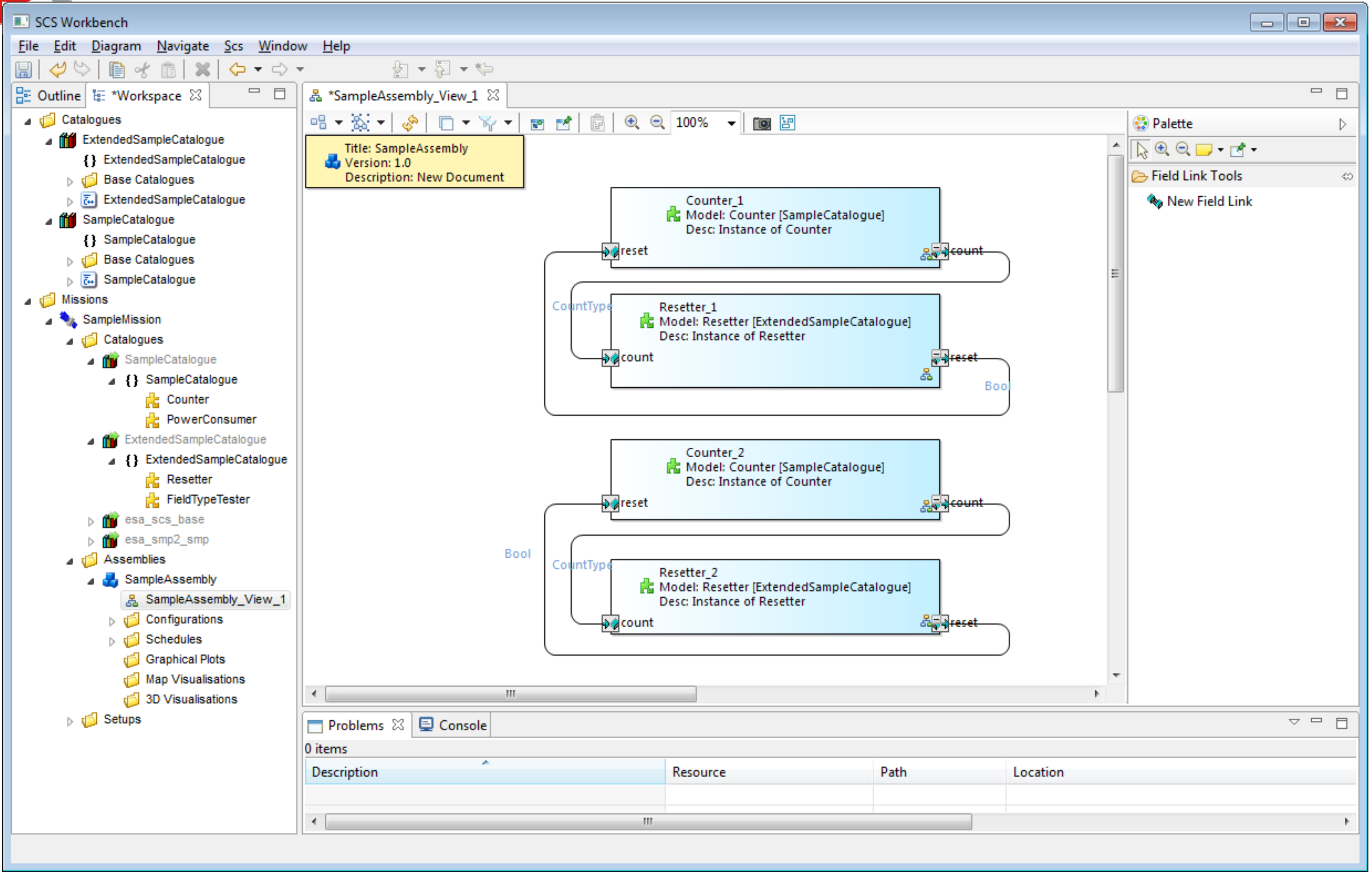
SIMULATION COMPOSITION


SCS Workbench

File Edit Diagram Navigate Scs Window Help

Outline | *Workspace

- Catalogues
  - ExtendedSampleCatalogue
    - {} ExtendedSampleCatalogue
    - Base Catalogues
    - ExtendedSampleCatalogue
  - SampleCatalogue
    - {} SampleCatalogue
    - Base Catalogues
    - SampleCatalogue
- Missions
  - SampleMission
    - Catalogues
      - SampleCatalogue
        - {} SampleCatalogue
          - Counter
          - PowerConsumer
      - ExtendedSampleCatalogue
        - {} ExtendedSampleCatalogue
          - Resetter
          - FieldTypeTester
      - esa_scs_base
      - esa_smp2_smp
    - Assemblies
      - SampleAssembly
        - SampleAssembly_View_1
        - Configurations
        - Schedules
        - Graphical Plots
        - Map Visualisations
        - 3D Visualisations
    - Setups

*SampleAssembly_View_1

100%

Title: SampleAssembly
Version: 1.0
Description: New Document

Counter_1
Model: Counter [SampleCatalogue]
Desc: Instance of Counter
reset | count

Resetter_1
Model: Resetter [ExtendedSampleCatalogue]
Desc: Instance of Resetter
count | reset

CountType | Bool

Counter_2
Model: Counter [SampleCatalogue]
Desc: Instance of Counter
reset | count

Resetter_2
Model: Resetter [ExtendedSampleCatalogue]
Desc: Instance of Resetter
count | reset

Bool | CountType

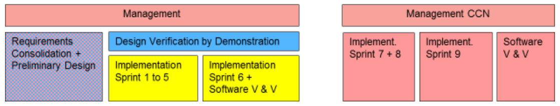
Palette
Field Link Tools
New Field Link

Problems | Console

0 items

Description	Resource	Path	Location

SCS Workbench Prototype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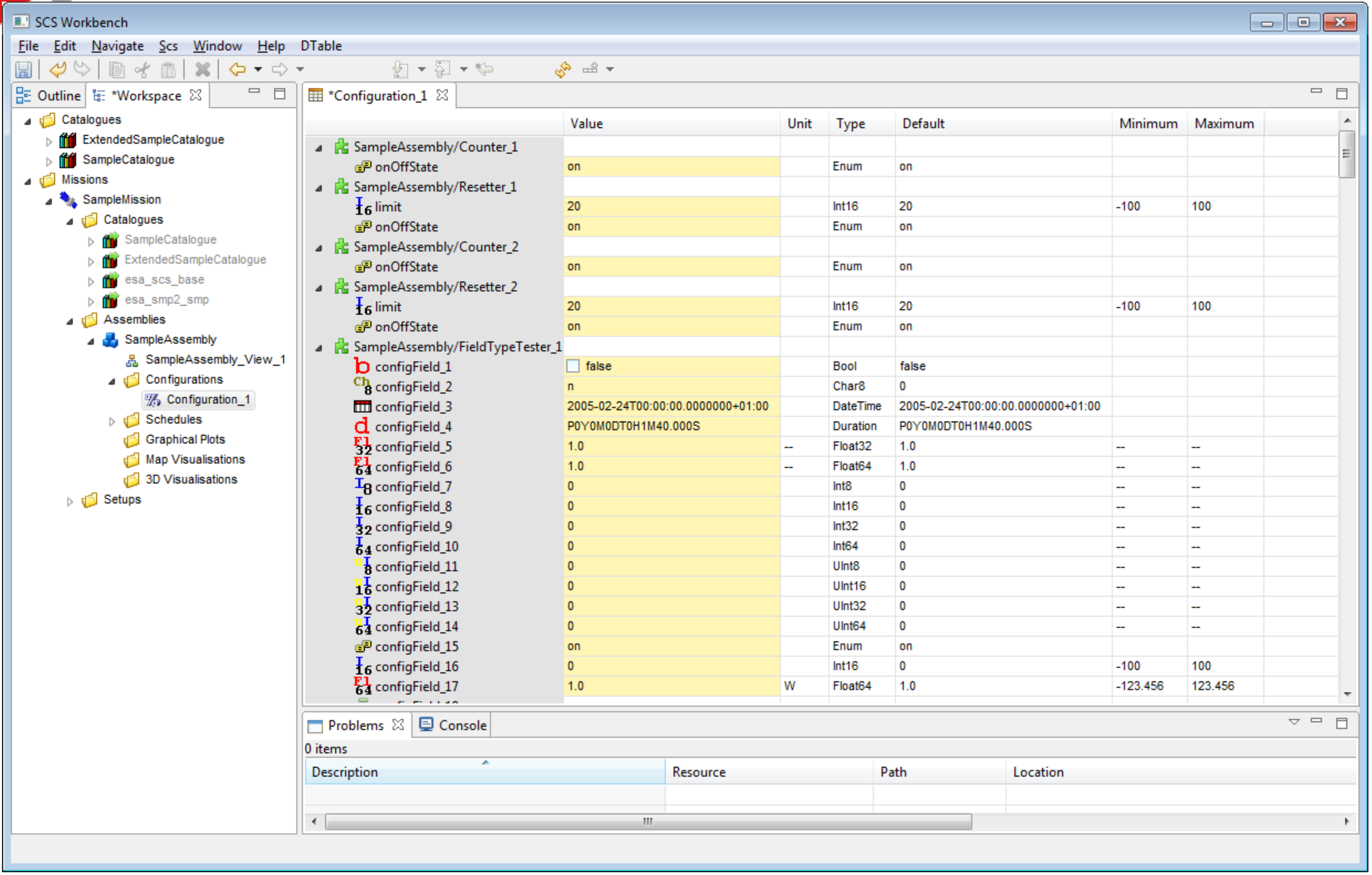
SIMULATION CONFIGURATION

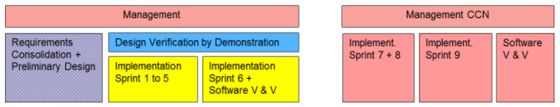


- Catalogues
  - ExtendedSampleCatalogue
  - SampleCatalogue
- Missions
  - SampleMission
    - Catalogues
      - SampleCatalogue
      - ExtendedSampleCatalogue
      - esa_scs_base
      - esa_smp2_smp
    - Assemblies
      - SampleAssembly
        - SampleAssembly_View_1
        - Configurations
          - Configuration_1
        - Schedules
        - Graphical Plots
        - Map Visualisations
        - 3D Visualisations
    - Setups

	Value	Unit	Type	Default	Minimum	Maximum
SampleAssembly/Counter_1						
onOffState	on		Enum	on		
SampleAssembly/Resetter_1						
limit	20		Int16	20	-100	100
onOffState	on		Enum	on		
SampleAssembly/Counter_2						
onOffState	on		Enum	on		
SampleAssembly/Resetter_2						
limit	20		Int16	20	-100	100
onOffState	on		Enum	on		
SampleAssembly/FieldTypeTester_1						
configField_1	☐ false		Bool	false		
configField_2	n		Char8	0		
configField_3	2005-02-24T00:00:00.0000000+01:00		DateTime	2005-02-24T00:00:00.0000000+01:00		
configField_4	P0Y0M0DT0H1M40.000S		Duration	P0Y0M0DT0H1M40.000S		
configField_5	1.0	--	Float32	1.0	--	--
configField_6	1.0	--	Float64	1.0	--	--
configField_7	0		Int8	0	--	--
configField_8	0		Int16	0	--	--
configField_9	0		Int32	0	--	--
configField_10	0		Int64	0	--	--
configField_11	0		UInt8	0	--	--
configField_12	0		UInt16	0	--	--
configField_13	0		UInt32	0	--	--
configField_14	0		UInt64	0	--	--
configField_15	on		Enum	on		
configField_16	0		Int16	0	-100	100
configField_17	1.0	W	Float64	1.0	-123.456	123.456

0 items

Description	Resource	Path	Location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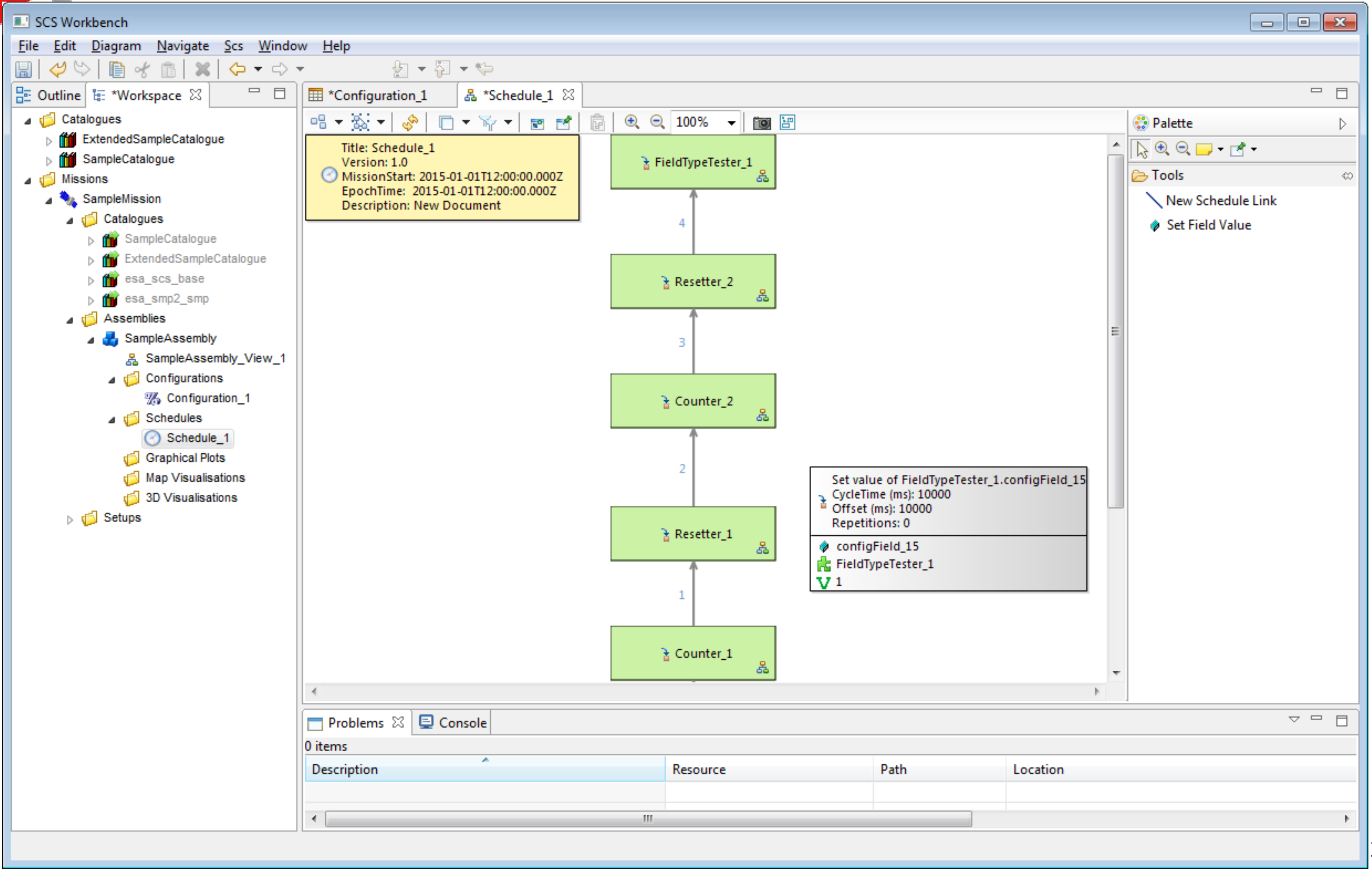
SIMULATION SCHEDULING



- Catalogues
  - ExtendedSampleCatalogue
  - SampleCatalogue
- Missions
  - SampleMission
    - Catalogues
      - SampleCatalogue
      - ExtendedSampleCatalogue
      - esa_scs_base
      - esa_smp2_smp
    - Assemblies
      - SampleAssembly
        - SampleAssembly_View_1
        - Configurations
          - Configuration_1
        - Schedules
          - Schedule_1
        - Graphical Plots
        - Map Visualisations
        - 3D Visualisations
- Setups

Title: Schedule_1
Version: 1.0
MissionStart: 2015-01-01T12:00:00.000Z
EpochTime: 2015-01-01T12:00:00.000Z
Description: New Document

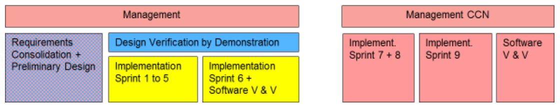
FieldTypeTester_1 ← 4 ← Resetter_2 ← 3 ← Counter_2 ← 2 ← Resetter_1 ← 1 ← Counter_1

Set value of FieldTypeTester_1.configField_15
CycleTime (ms): 10000
Offset (ms): 10000
Repetitions: 0

configField_15
FieldTypeTester_1
1

0 items

Description	Resource	Path	Location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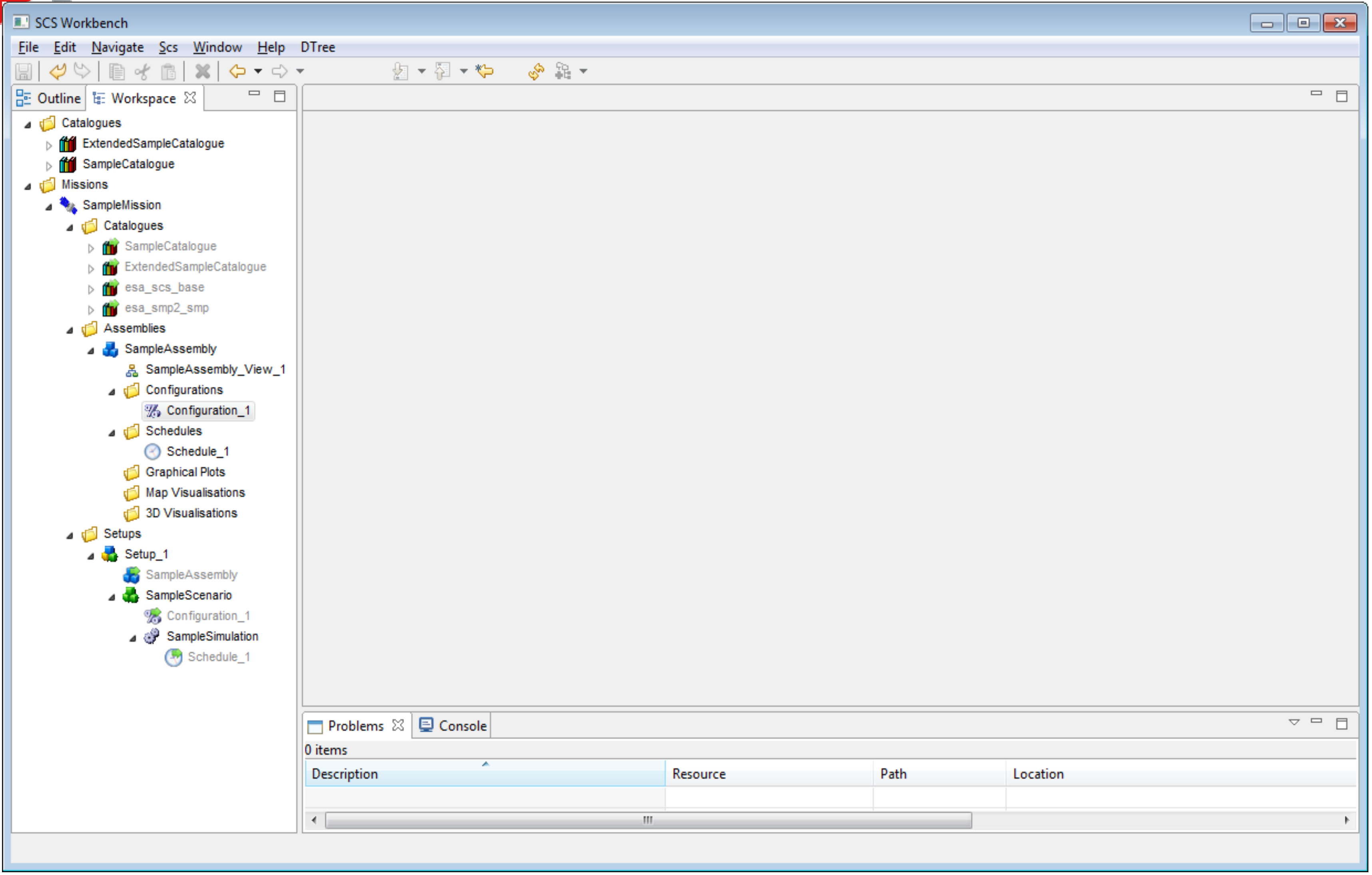
SETUP – SCENARIO – SIMULATION



```
Catalogues
  ExtendedSampleCatalogue
  SampleCatalogue
Missions
  SampleMission
    Catalogues
      SampleCatalogue
      ExtendedSampleCatalogue
      esa_scs_base
      esa_smp2_smp
    Assemblies
      SampleAssembly
        SampleAssembly_View_1
        Configurations
          Configuration_1
        Schedules
          Schedule_1
        Graphical Plots
        Map Visualisations
        3D Visualisations
    Setups
      Setup_1
        SampleAssembly
        SampleScenario
          Configuration_1
          SampleSimulation
            Schedule_1
```

Problems Console

0 items

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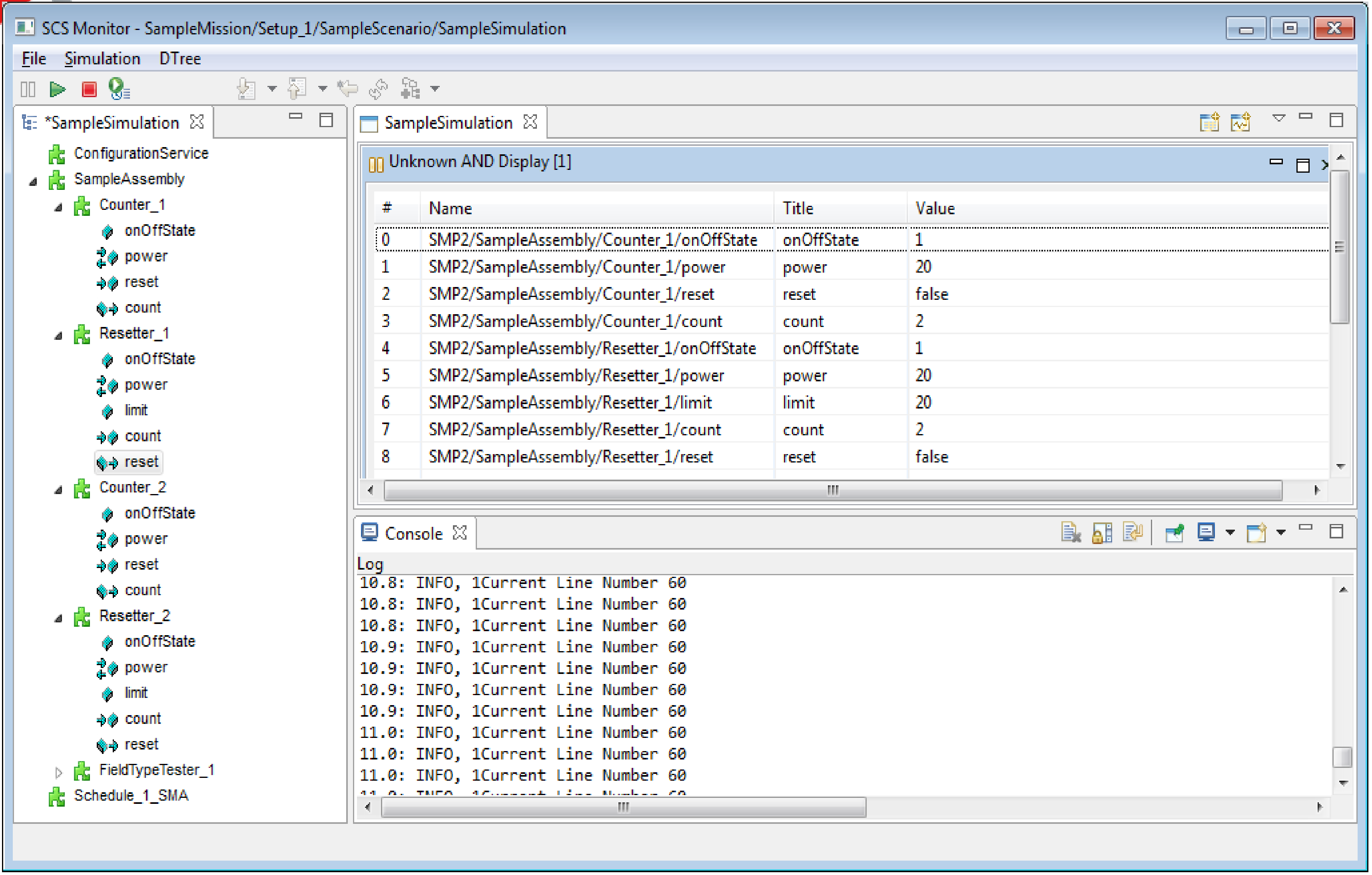
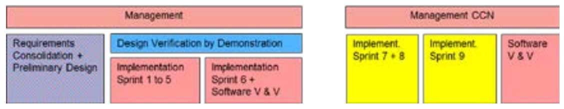
SIMULATION EXECUTION



#	Name	Title	Value
0	SMP2/SampleAssembly/Counter_1/onOffState	onOffState	1
1	SMP2/SampleAssembly/Counter_1/power	power	20
2	SMP2/SampleAssembly/Counter_1/reset	reset	false
3	SMP2/SampleAssembly/Counter_1/count	count	2
4	SMP2/SampleAssembly/Resetter_1/onOffState	onOffState	1
5	SMP2/SampleAssembly/Resetter_1/power	power	20
6	SMP2/SampleAssembly/Resetter_1/limit	limit	20
7	SMP2/SampleAssembly/Resetter_1/count	count	2
8	SMP2/SampleAssembly/Resetter_1/reset	reset	false

```
10.8: INFO, 1Current Line Number 60
10.8: INFO, 1Current Line Number 60
10.8: INFO, 1Current Line Number 60
10.9: INFO, 1Current Line Number 60
10.9: INFO, 1Current Line Number 60
10.9: INFO, 1Current Line Number 60
10.9: INFO, 1Current Line Number 60
11.0: INFO, 1Current Line Number 60
11.0: INFO, 1Current Line Number 60
11.0: INFO, 1Current Line Number 60
```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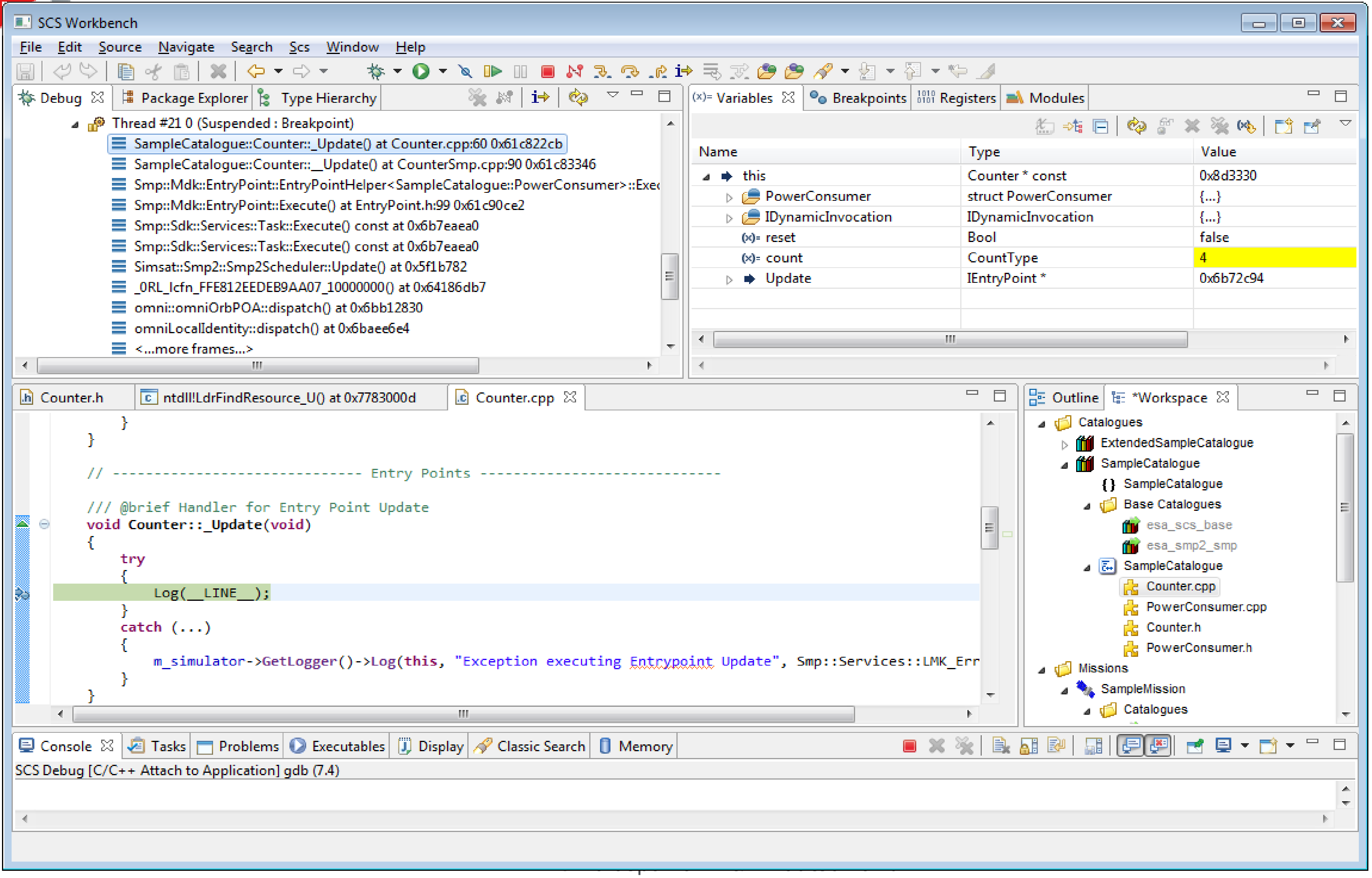
SIMULATION DEBUGGING



```
Thread #21 0 (Suspended : Breakpoint)
    SampleCatalogue::Counter::_Update() at Counter.cpp:60 0x61c822cb
    SampleCatalogue::Counter::__Update() at CounterSmp.cpp:90 0x61c83346
    Smp::Mdk::EntryPoint::EntryPointHelper<SampleCatalogue::PowerConsumer>::Exe
    Smp::Mdk::EntryPoint::Execute() at EntryPoint.h:99 0x61c90ce2
    Smp::Sdk::Services::Task::Execute() const at 0x6b7eaea0
    Smp::Sdk::Services::Task::Execute() const at 0x6b7eaea0
    Simsat::Smp2::Smp2Scheduler::Update() at 0x5f1b782
    _0RL_lcfn_FFE812EEDEB9AA07_10000000() at 0x64186db7
    omni::omniOrbPOA::dispatch() at 0x6bb12830
    omniLocalIdentity::dispatch() at 0x6baee6e4
    <...more frames...>
```

Name	Type	Value
this	Counter * const	0x8d3330
PowerConsumer	struct PowerConsumer	{...}
IDynamicInvocation	IDynamicInvocation	{...}
reset	Bool	false
count	CountType	4
Update	IEntryPoint *	0x6b72c94

```
        }
    }

    // ----------------------------- Entry Points ----------------------------

    /// @brief Handler for Entry Point Update
    void Counter::_Update(void)
    {
        try
        {
            Log(__LINE__);
        }
        catch (...)
        {
            m_simulator->GetLogger()->Log(this, "Exception executing Entrypoint Update", Smp::Services::LMK_Err
        }
    }
```

```
Catalogues
    ExtendedSampleCatalogue
    SampleCatalogue
        {} SampleCatalogue
        Base Catalogues
            esa_scs_base
            esa_smp2_smp
        SampleCatalogue
            Counter.cpp
            PowerConsumer.cpp
            Counter.h
            PowerConsumer.h
Missions
    SampleMission
        Catalogues
```

```
SCS Debug [C/C++ Attach to Application] gdb (7.4)
```

Management
Requirements Consolidation + Preliminary Design
Design Verification by Demonstration
Implementation Sprint 1 to 5
Implementation Sprint 6 + Software V & V
Management CCN
Implement. Sprint 7 + 8
Implement. Sprint 9
Software V & V

VERIFICATION FROM USER PERSPECTIVE

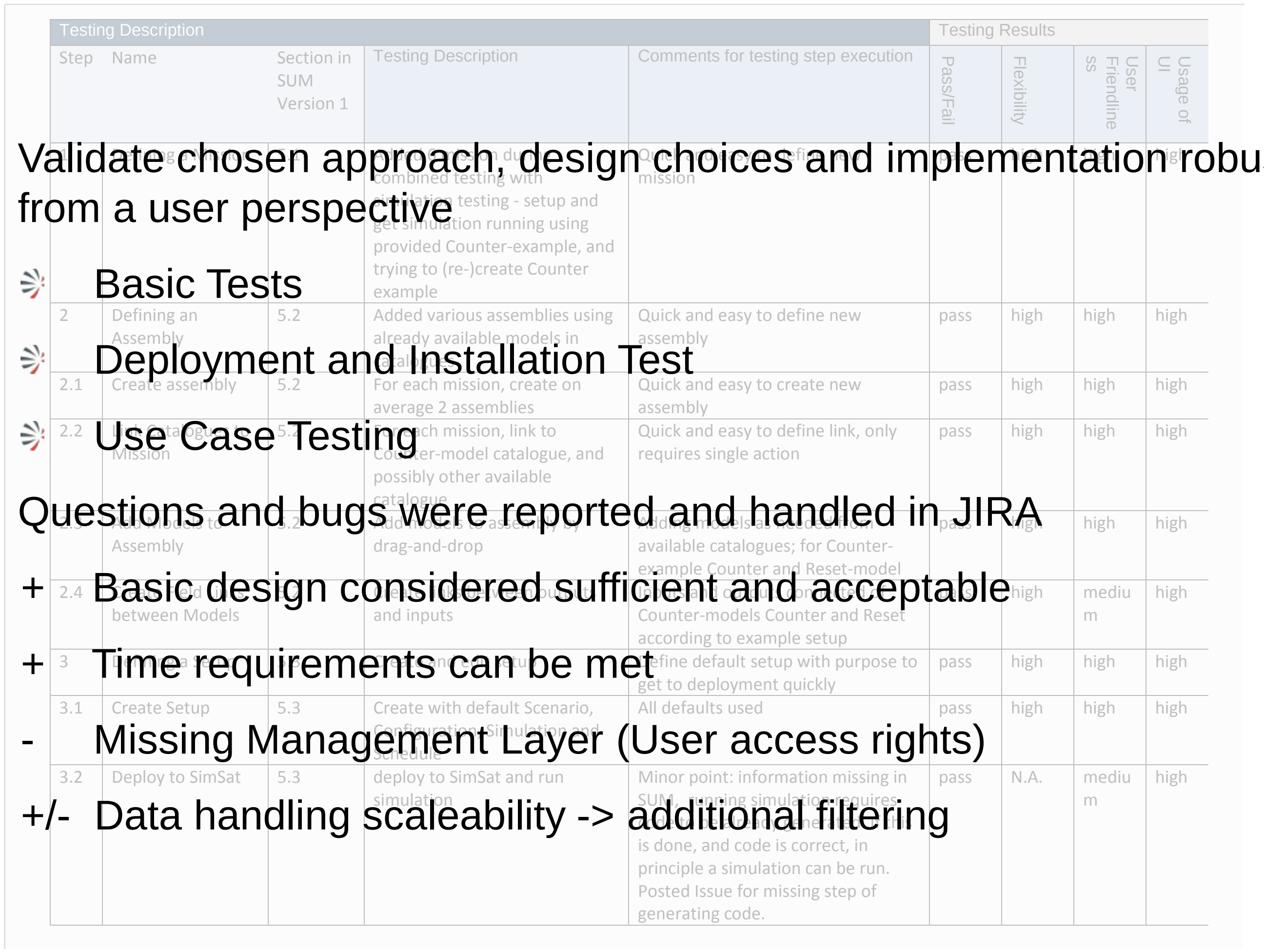
- Validate chosen approach, design choices and implementation robustness from a user perspective
  - Basic Tests
  - Deployment and Installation Test
  - Use Case Testing
- Questions and bugs were reported and handled in JIRA

+ Basic design considered sufficient and acceptable

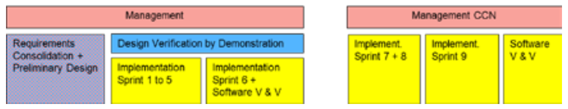
+ Time requirements can be met

- Missing Management Layer (User access rights)

+/- Data handling scaleability -> additional filtering



Testing Description					Testing Results			
Step	Name	Section in SUM Version 1	Testing Description	Comments for testing step execution	Pass/Fail	Flexibility	User Friendliness	Usage of UI
1	Defining a Mission	5.1	Added Mission du[illegible] combined testing with simulation testing - setup and get simulation running using provided Counter-example, and trying to (re-)create Counter example	Quick and easy to define new mission	pass	high	high	high
2	Defining an Assembly	5.2	Added various assemblies using already available models in catalogues	Quick and easy to define new assembly	pass	high	high	high
2.1	Create assembly	5.2	For each mission, create on average 2 assemblies	Quick and easy to create new assembly	pass	high	high	high
2.2	Link Catalogue to Mission	5.2	For each mission, link to Counter-model catalogue, and possibly other available catalogue	Quick and easy to define link, only requires single action	pass	high	high	high
2.3	Add Models to Assembly	5.2	Add models to assembly by drag-and-drop	Adding models as needed from available catalogues; for Counter-example Counter and Reset-model	pass	high	high	high
2.4	[illegible] between Models	5.2	Create links between output and inputs	[illegible] and output connected of Counter-models Counter and Reset according to example setup	pass	high	medium	high
3	Defining a Setup	5.3	Create and edit setup	Define default setup with purpose to get to deployment quickly	pass	high	high	high
3.1	Create Setup	5.3	Create with default Scenario, Configuration, Simulation and Schedule	All defaults used	pass	high	high	high
3.2	Deploy to SimSat	5.3	deploy to SimSat and run simulation	Minor point: information missing in SUM, running simulation requires code to be already generated. If this is done, and code is correct, in principle a simulation can be run. Posted Issue for missing step of generating code.	pass	N.A.	medium	high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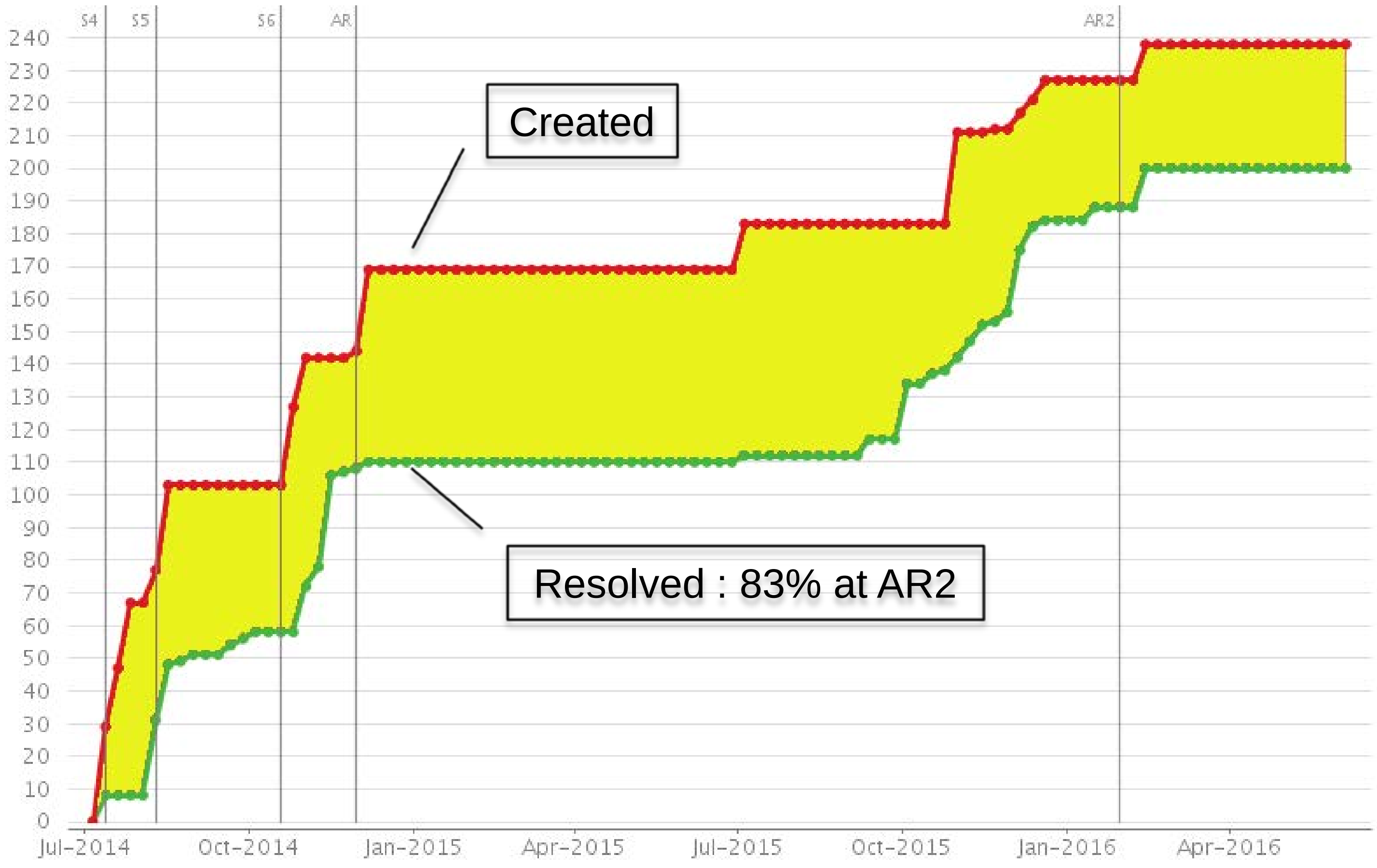
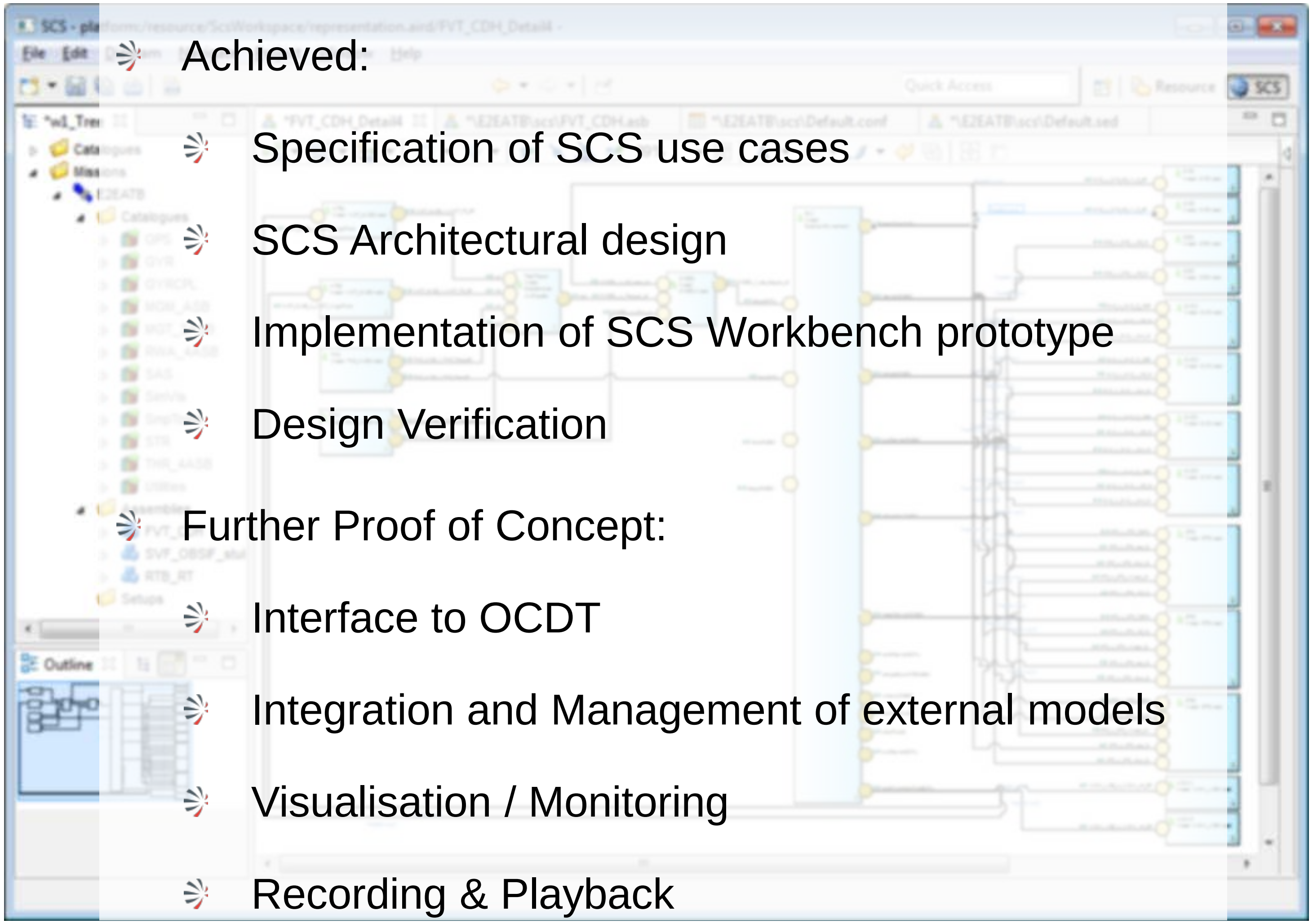
JIRA ISSUE TRACKING



CONCLUSIONS + NEXT STEPS

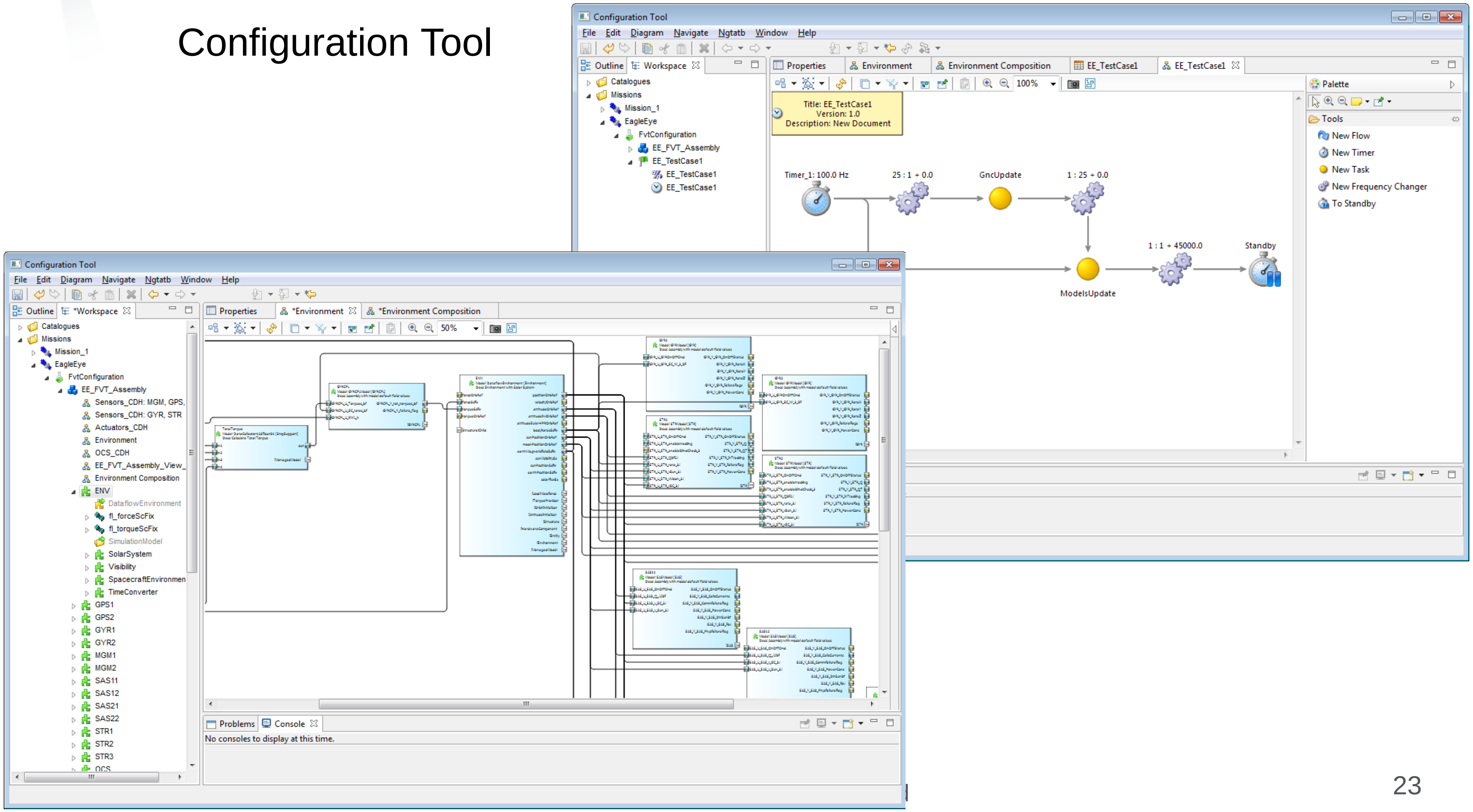


- Achieved:
  - Specification of SCS use cases
  - SCS Architectural design
  - Implementation of SCS Workbench prototype
  - Design Verification
- Further Proof of Concept:
  - Interface to OCDT
  - Integration and Management of external models
  - Visualisation / Monitoring
  - Recording & Playback

REUSE IN OTHER PROJECTS

- NGT-ATB

  Configuration Tool



THANK **YOU** FOR YOUR ATTENTION

Telespazio

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