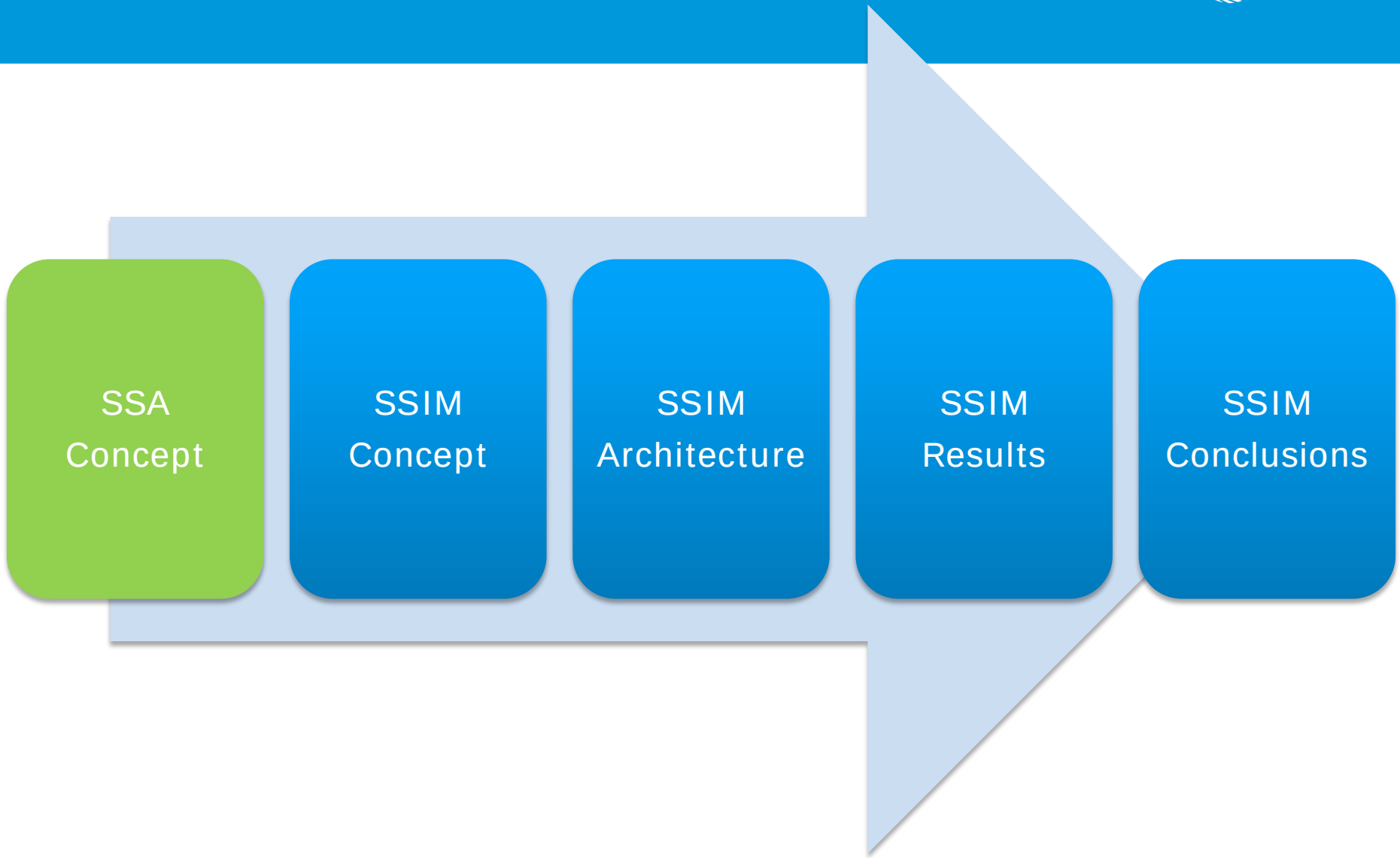
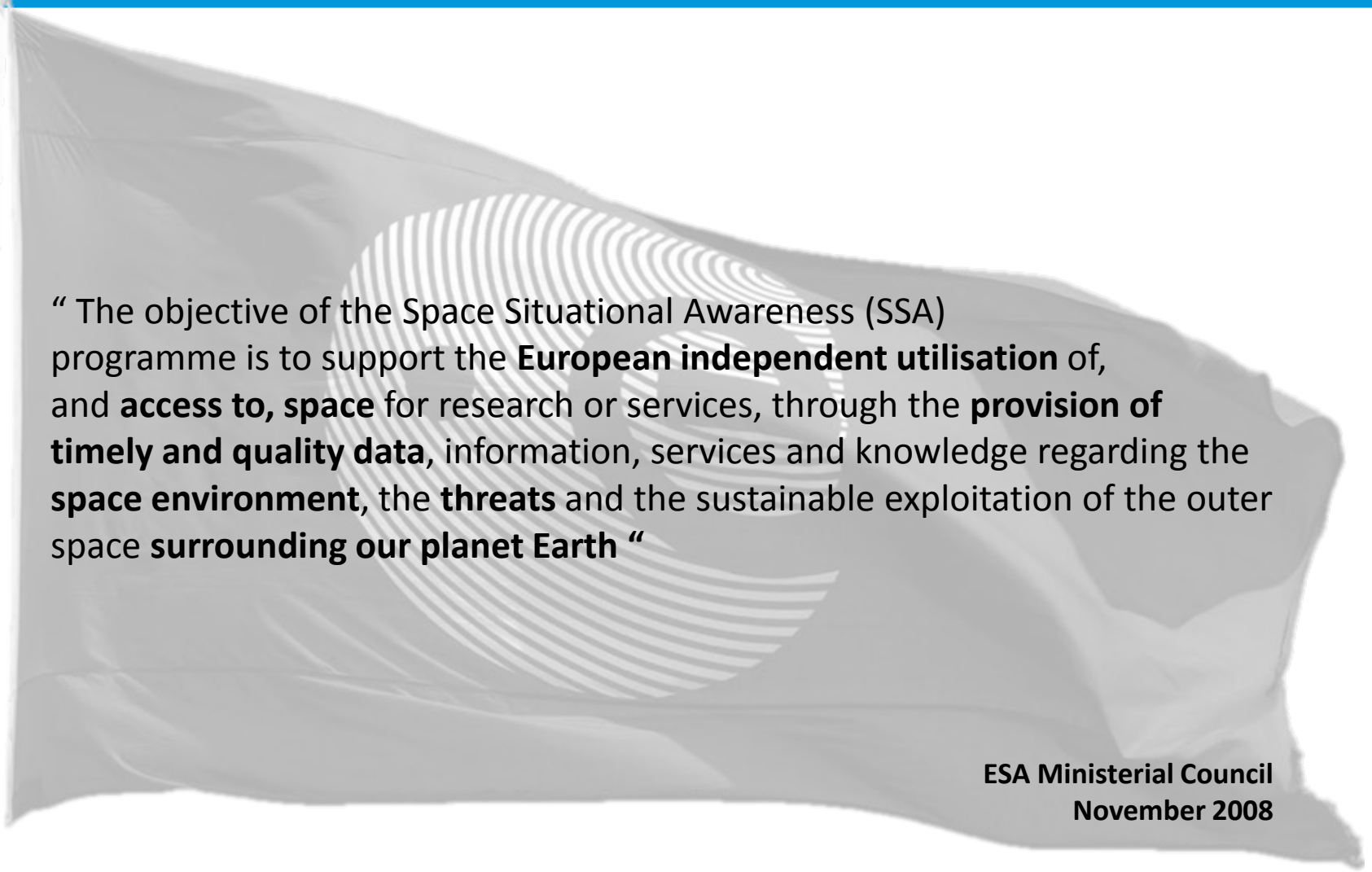
# SSA Sensor Simulator (SSIM) Space object environment simulator and measurements

Vicente Navarro
SESP, ESTEC
27/09/2012

# Agenda


SSA Concept
SSIM Concept
SSIM Architecture
SSIM Results
SSIM Conclusions

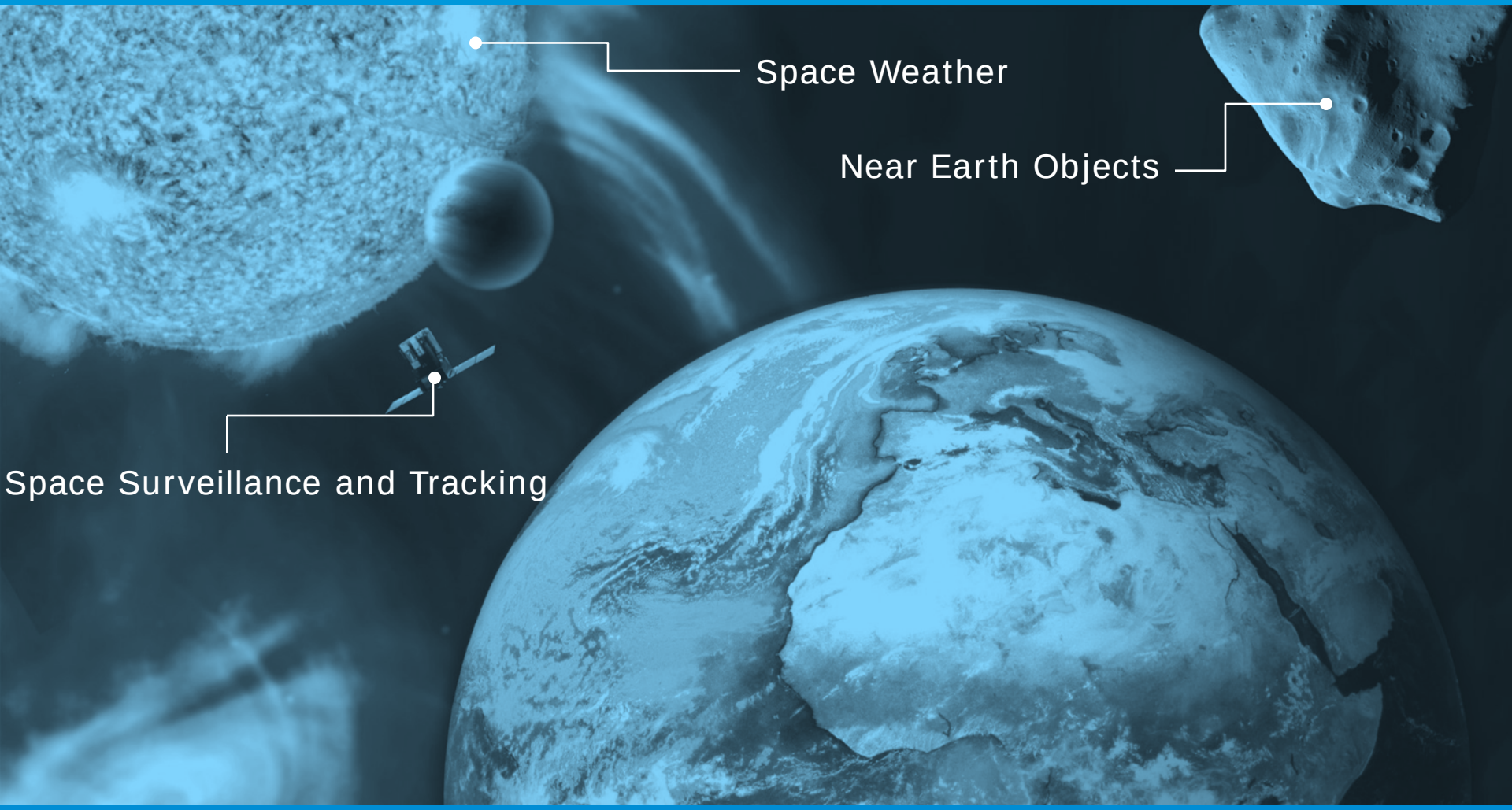
# The Mission



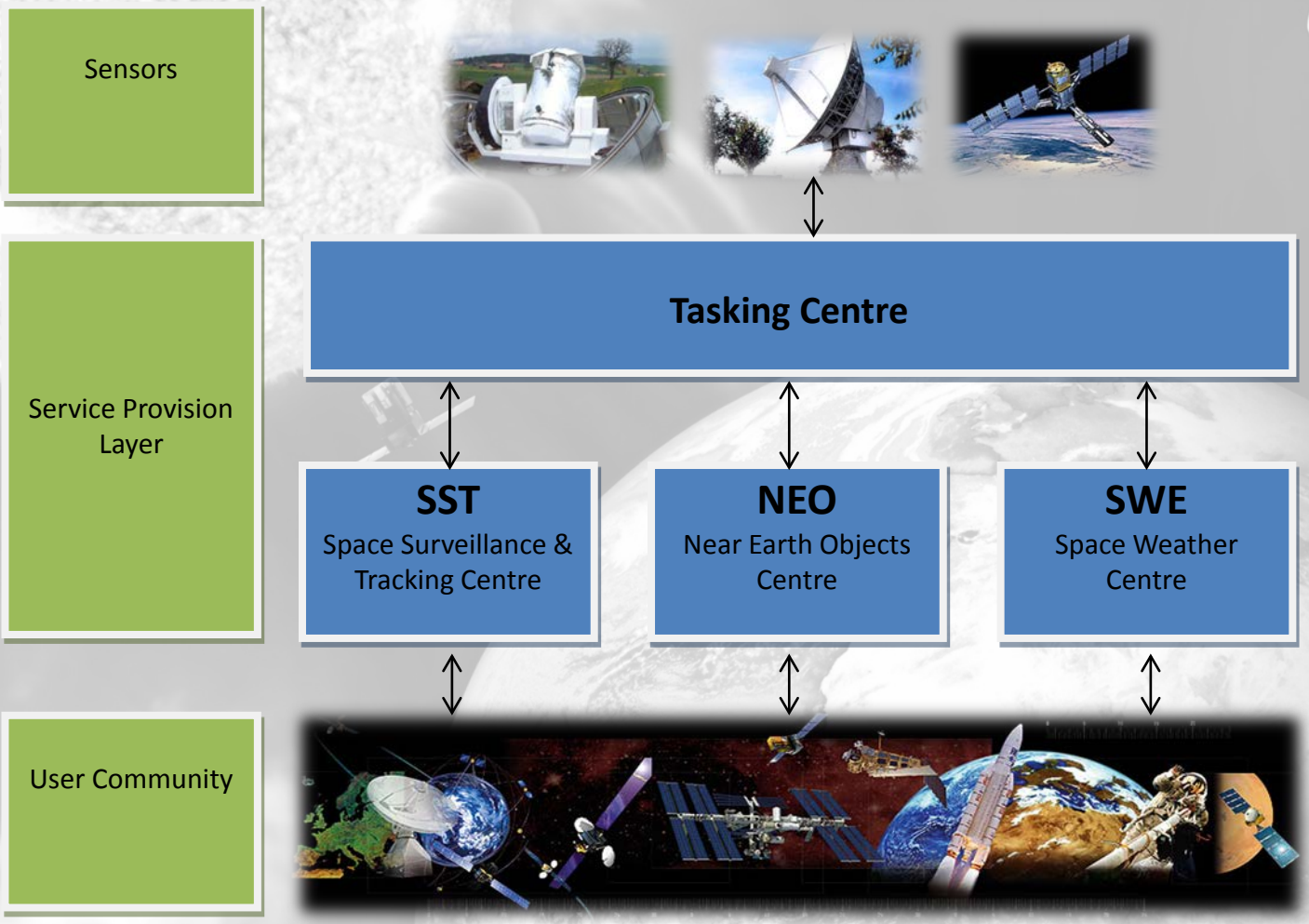
" The objective of the Space Situational Awareness (SSA) programme is to support the **European independent utilisation** of, and **access to, space** for research or services, through the **provision of timely and quality data**, information, services and knowledge regarding the **space environment**, the **threats** and the sustainable exploitation of the outer space **surrounding our planet Earth** "

**ESA Ministerial Council**
**November 2008**

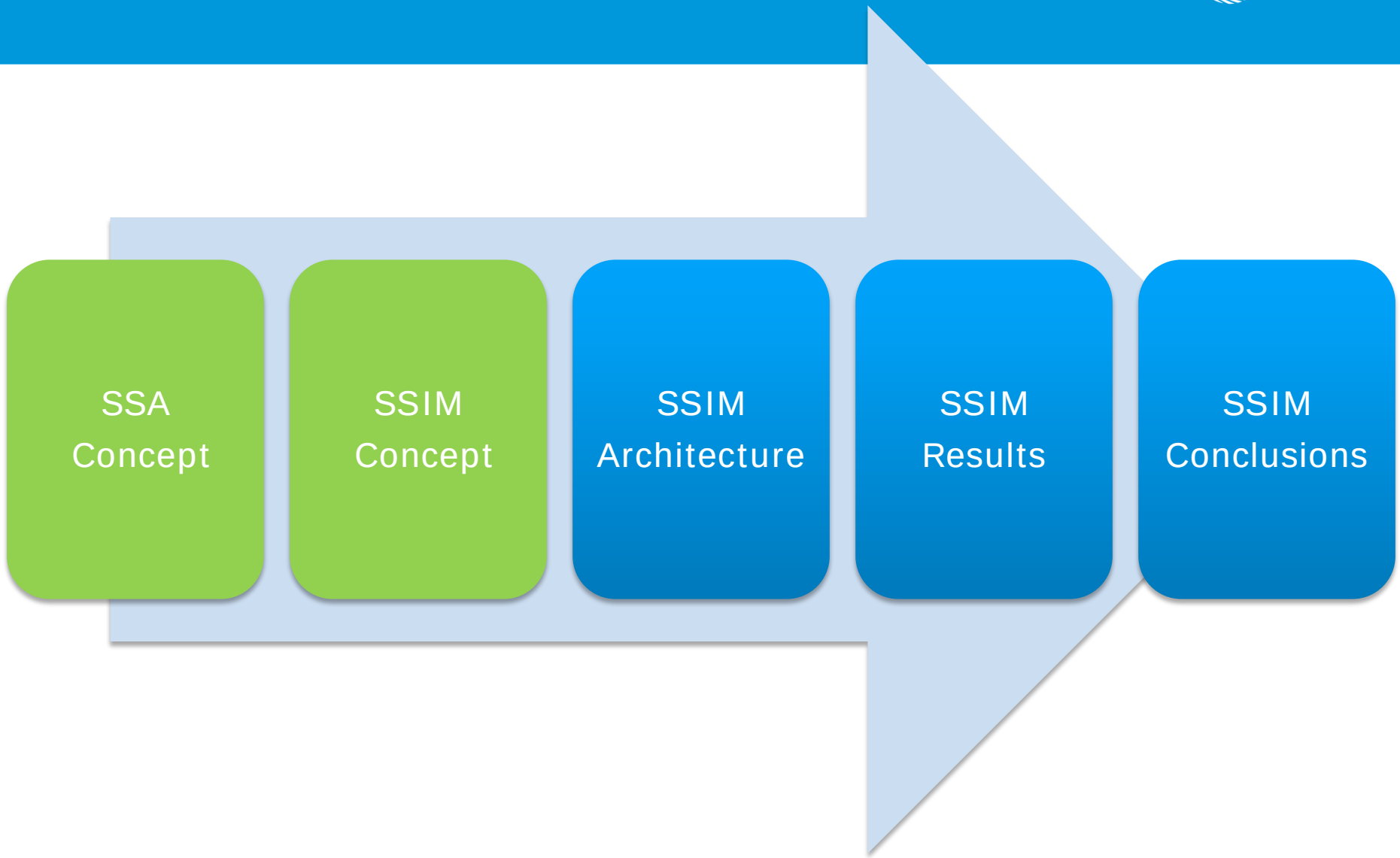
# Space Situational Awareness (SSA)



# SSA System Concept



# Agenda


SSA Concept
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# SSIM Use Case

Sensor Simulator



Sensor Planning System

**Tasking Centre**

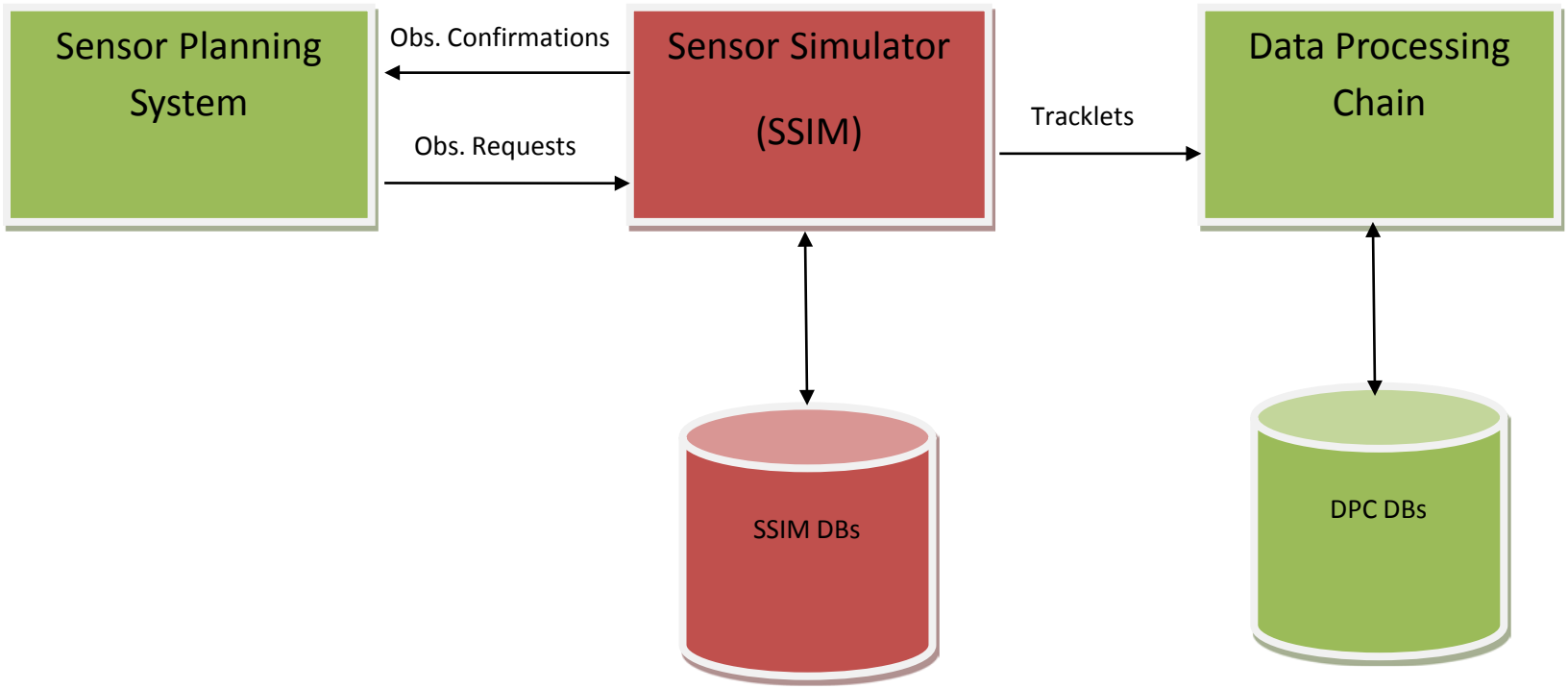
Data Processing Chain

**SST**
Space Surveillance & Tracking Centre

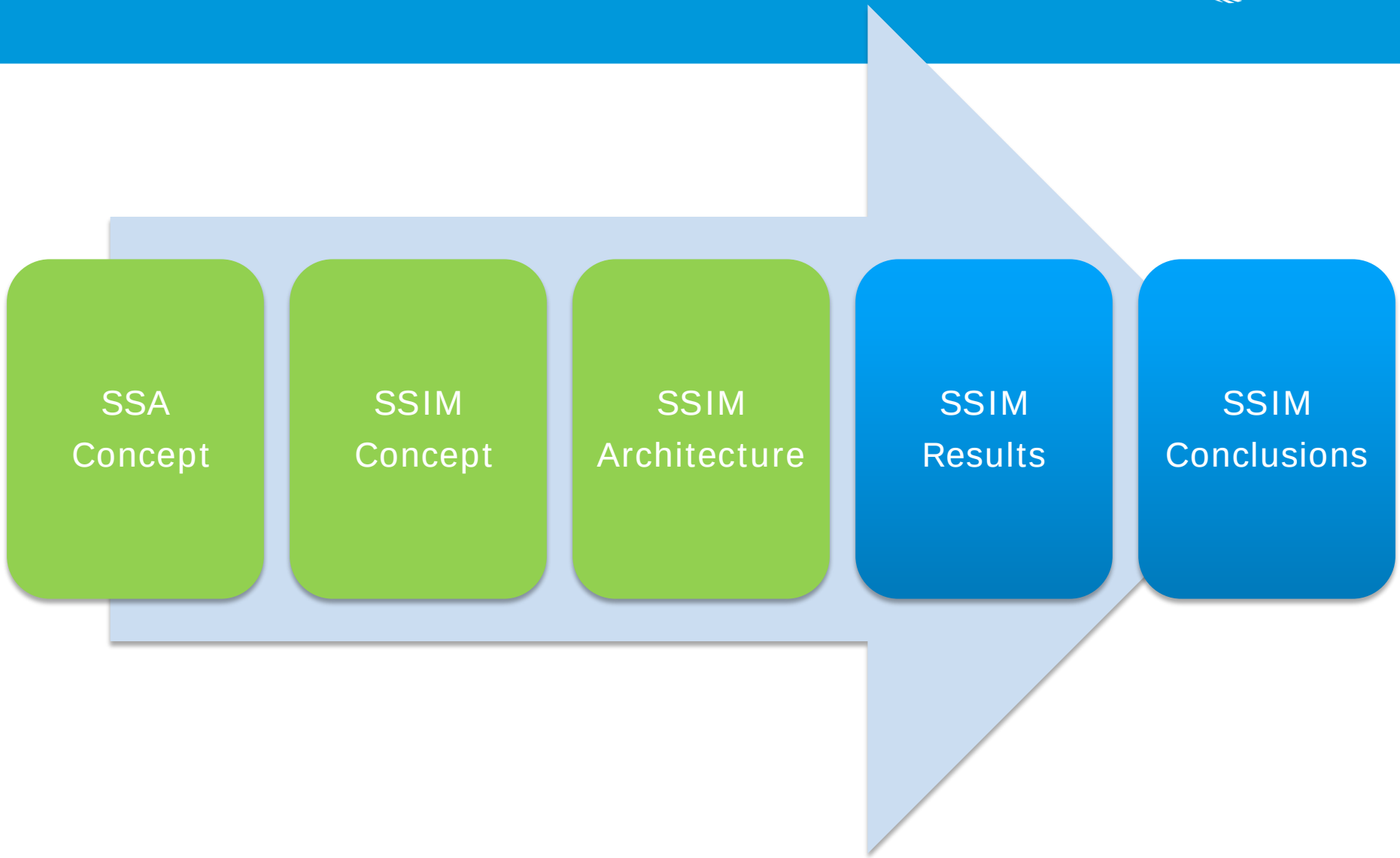
**NEO**
Near Earth Objects Centre

**SWE**
Space Weather Centre

# SSIM System Context



# Agenda


SSA Concept
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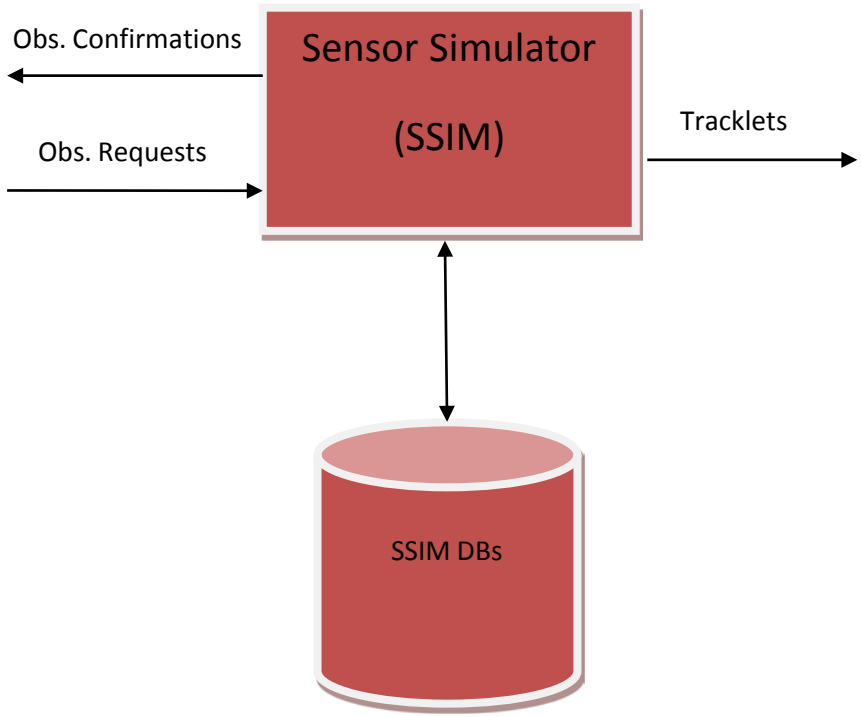
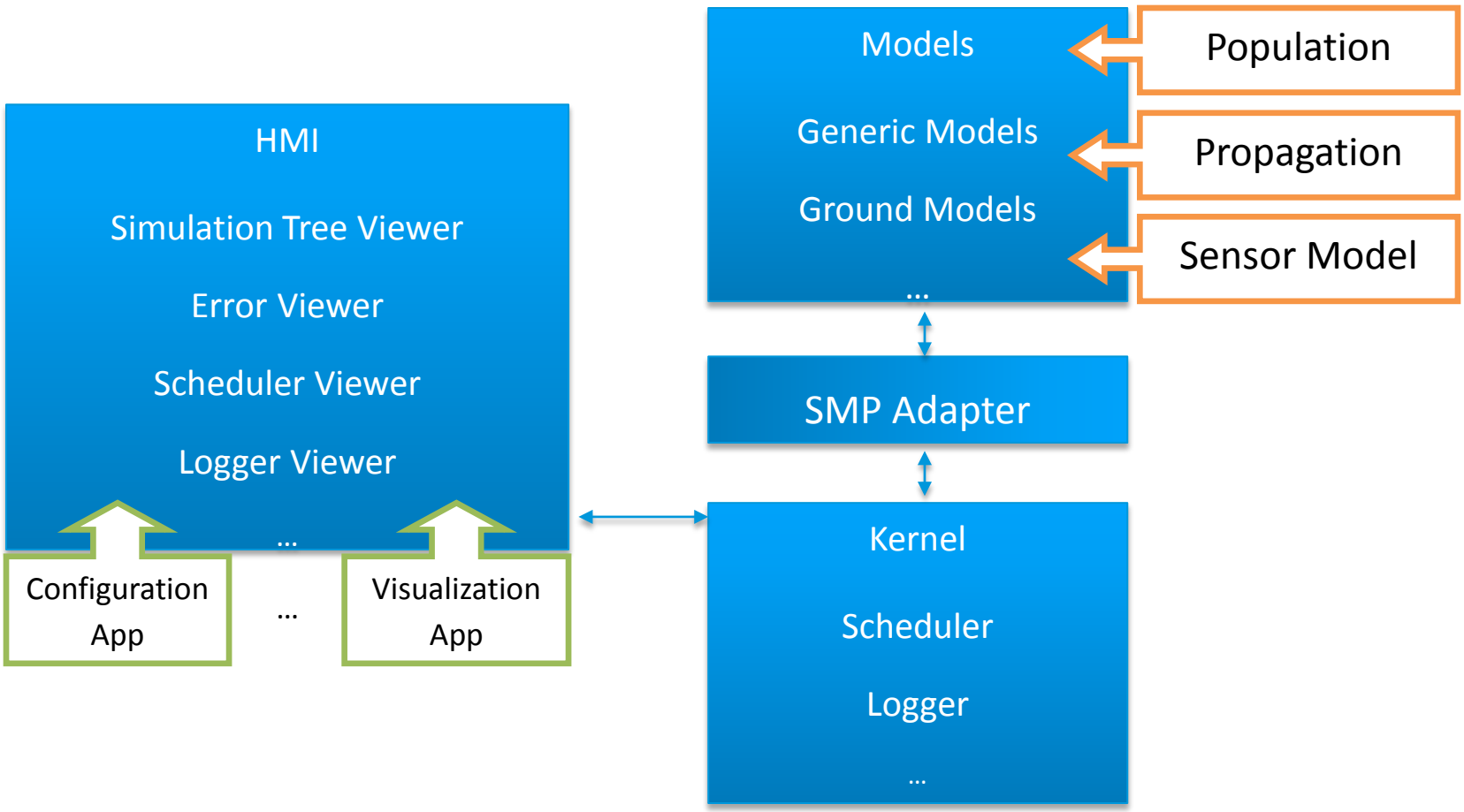
# SSIM System Context



SIMULUS

# SSIM's Conceptual Extension of SIMSAT

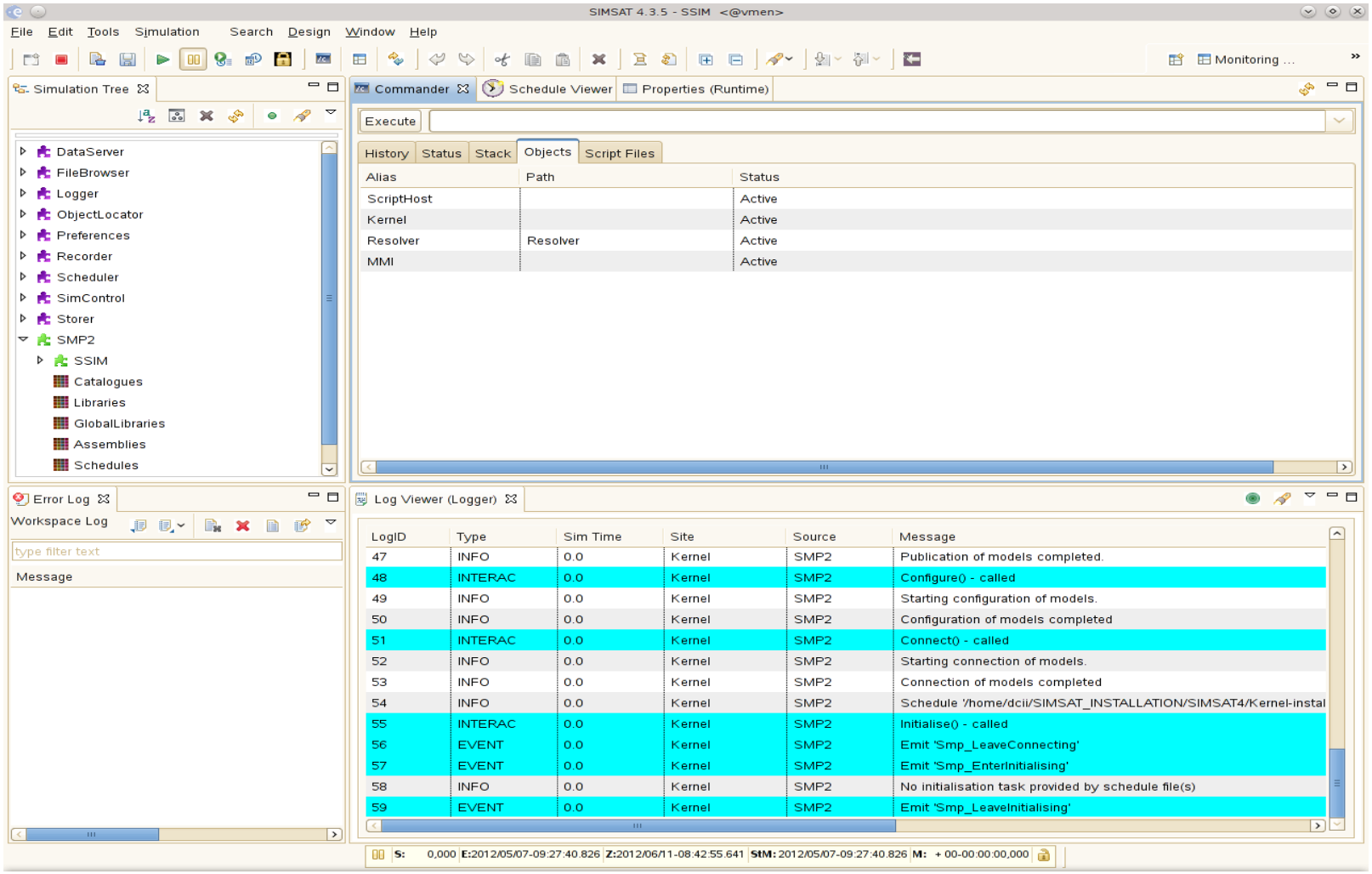


# Models Extension

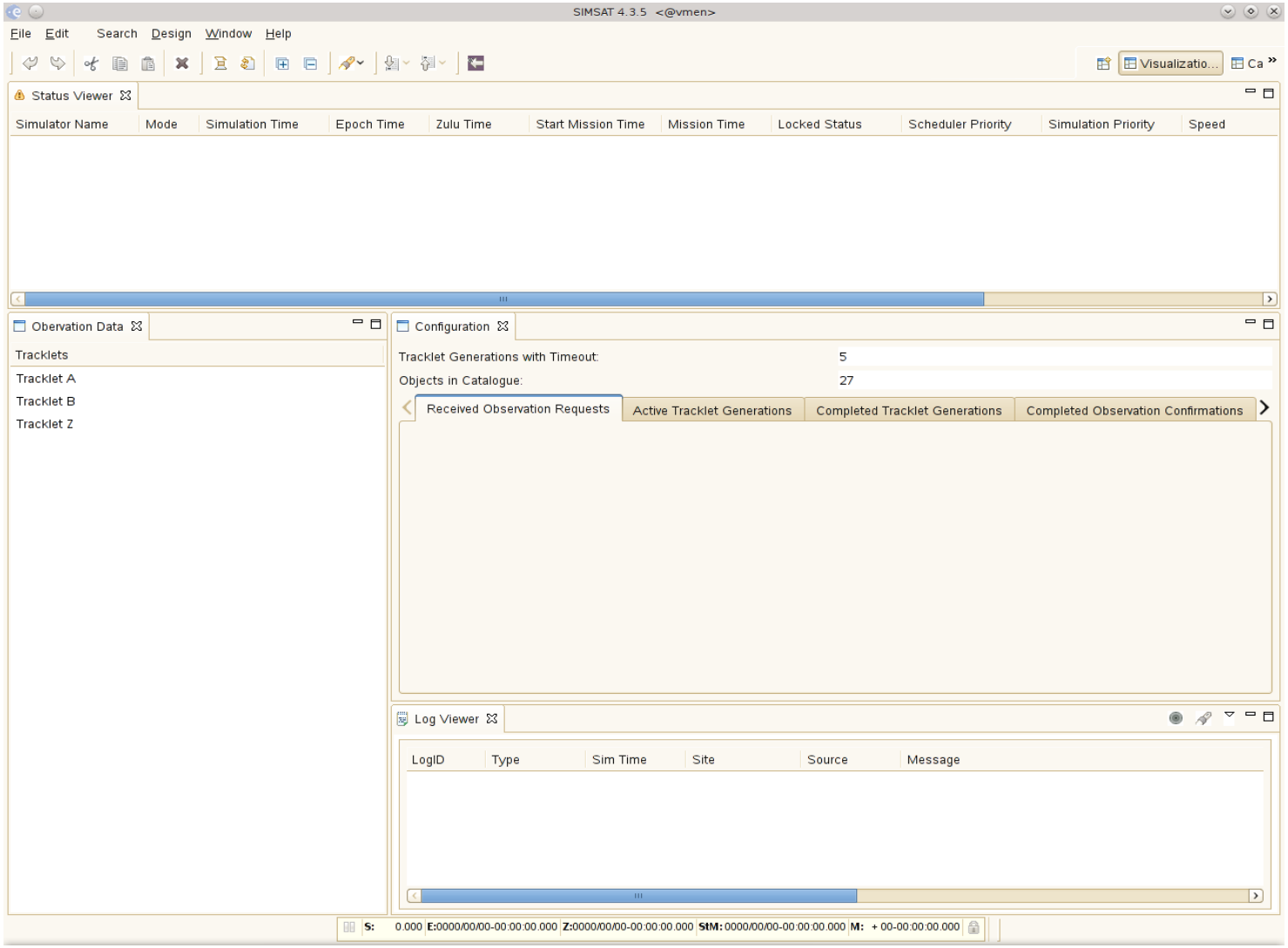
| | |
|---|---|
| **Population model** | This includes all functionalities related to the catalogues: creation of a catalogue, providing an object of the catalogue, and applying an event or a filter on the catalogue. |
| **Propagation orbit model** | This is composed of the functionalities necessary to provide an orbit at requested time. |
| **Sensor model** | This includes all functionalities required to both determine whether or not an object is observed/detected by a sensor, and to generate the corresponding tracklet for the observation. |

# HMI Extension

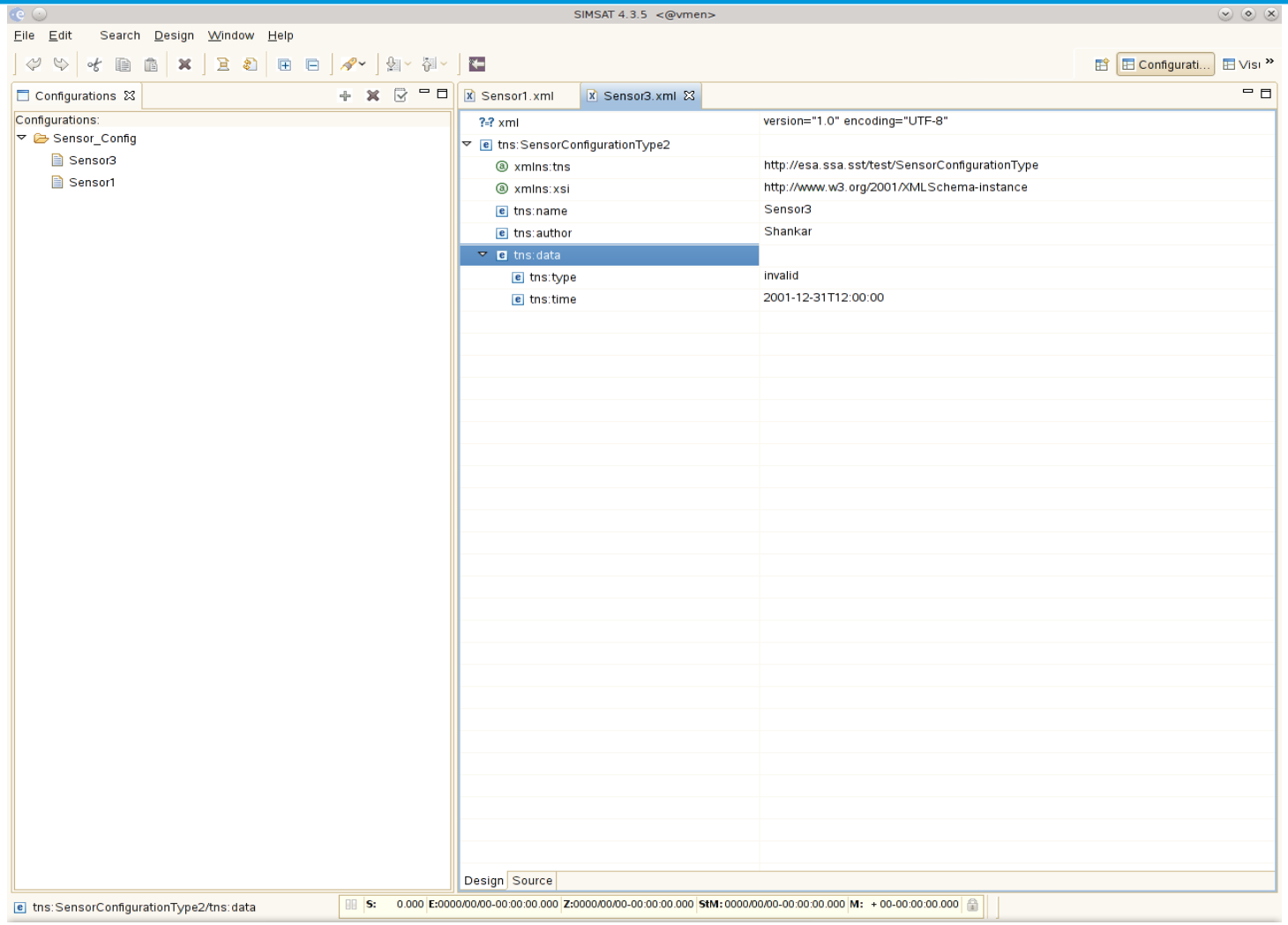
# HMI - Runtime


SIMSAT 4.3.5 - SSIM <@vmen>
File Edit Tools Simulation Search Design Window Help
Monitoring ...
Simulation Tree
DataServer
FileBrowser
Logger
ObjectLocator
Preferences
Recorder
Scheduler
SimControl
Storer
SMP2
SSIM
Catalogues
Libraries
GlobalLibraries
Assemblies
Schedules
Commander
Schedule Viewer
Properties (Runtime)
Execute
History Status Stack Objects Script Files
Alias Path Status
ScriptHost Active
Kernel Active
Resolver Resolver Active
MMI Active
Error Log
Workspace Log
type filter text
Message
Log Viewer (Logger)
LogID Type Sim Time Site Source Message
47 INFO 0.0 Kernel SMP2 Publication of models completed.
48 INTERAC 0.0 Kernel SMP2 Configure() - called
49 INFO 0.0 Kernel SMP2 Starting configuration of models.
50 INFO 0.0 Kernel SMP2 Configuration of models completed
51 INTERAC 0.0 Kernel SMP2 Connect() - called
52 INFO 0.0 Kernel SMP2 Starting connection of models.
53 INFO 0.0 Kernel SMP2 Connection of models completed
54 INFO 0.0 Kernel SMP2 Schedule '/home/dcii/SIMSAT_INSTALLATION/SIMSAT4/Kernel-instal
55 INTERAC 0.0 Kernel SMP2 Initialise() - called
56 EVENT 0.0 Kernel SMP2 Emit 'Smp_LeaveConnecting'
57 EVENT 0.0 Kernel SMP2 Emit 'Smp_EnterInitialising'
58 INFO 0.0 Kernel SMP2 No initialisation task provided by schedule file(s)
59 EVENT 0.0 Kernel SMP2 Emit 'Smp_LeaveInitialising'
S: 0,000 E:2012/05/07-09:27:40.826 Z:2012/06/11-08:42:55.641 StM: 2012/05/07-09:27:40.826 M: + 00-00:00:00,000

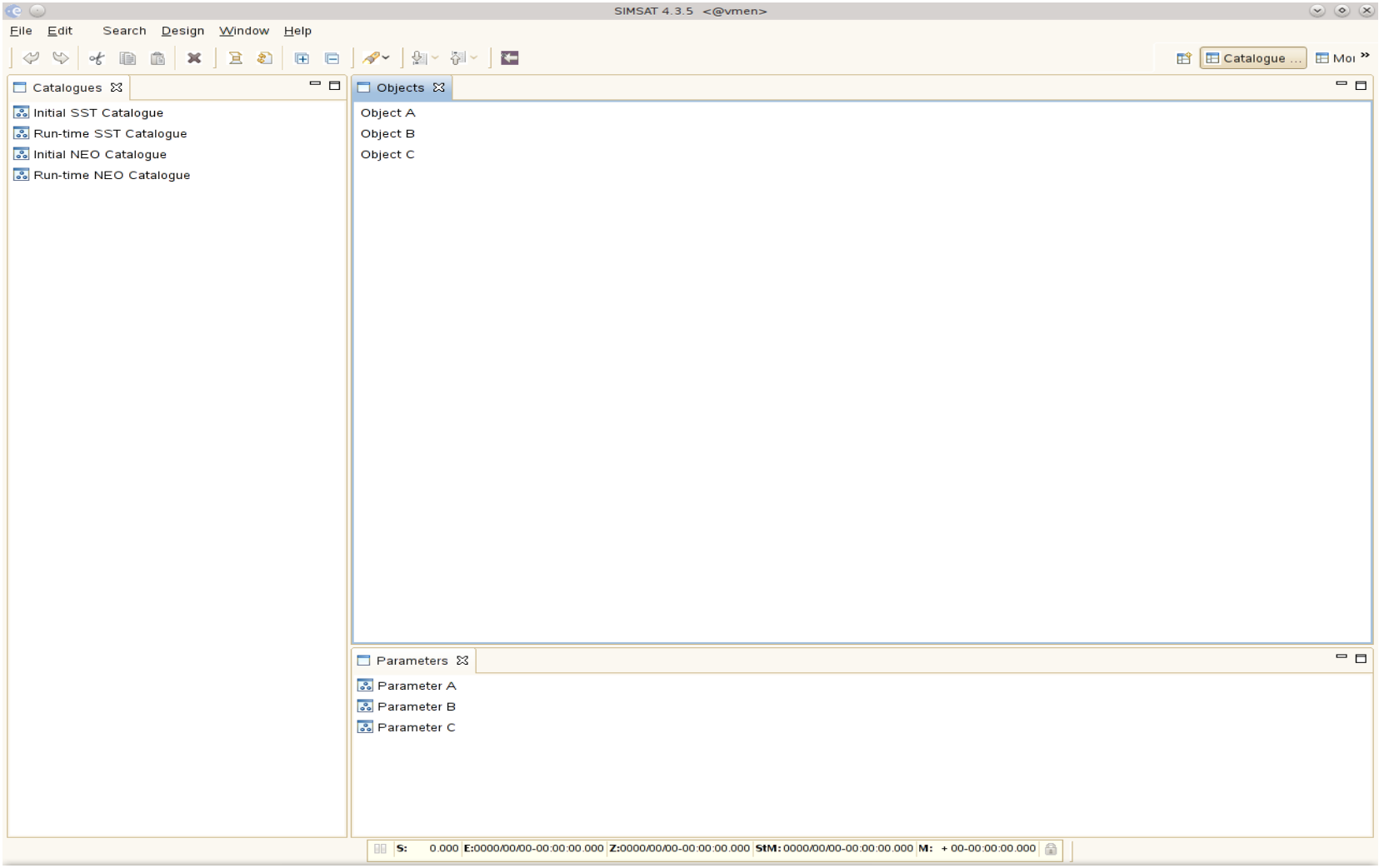
# HMI - Visualization



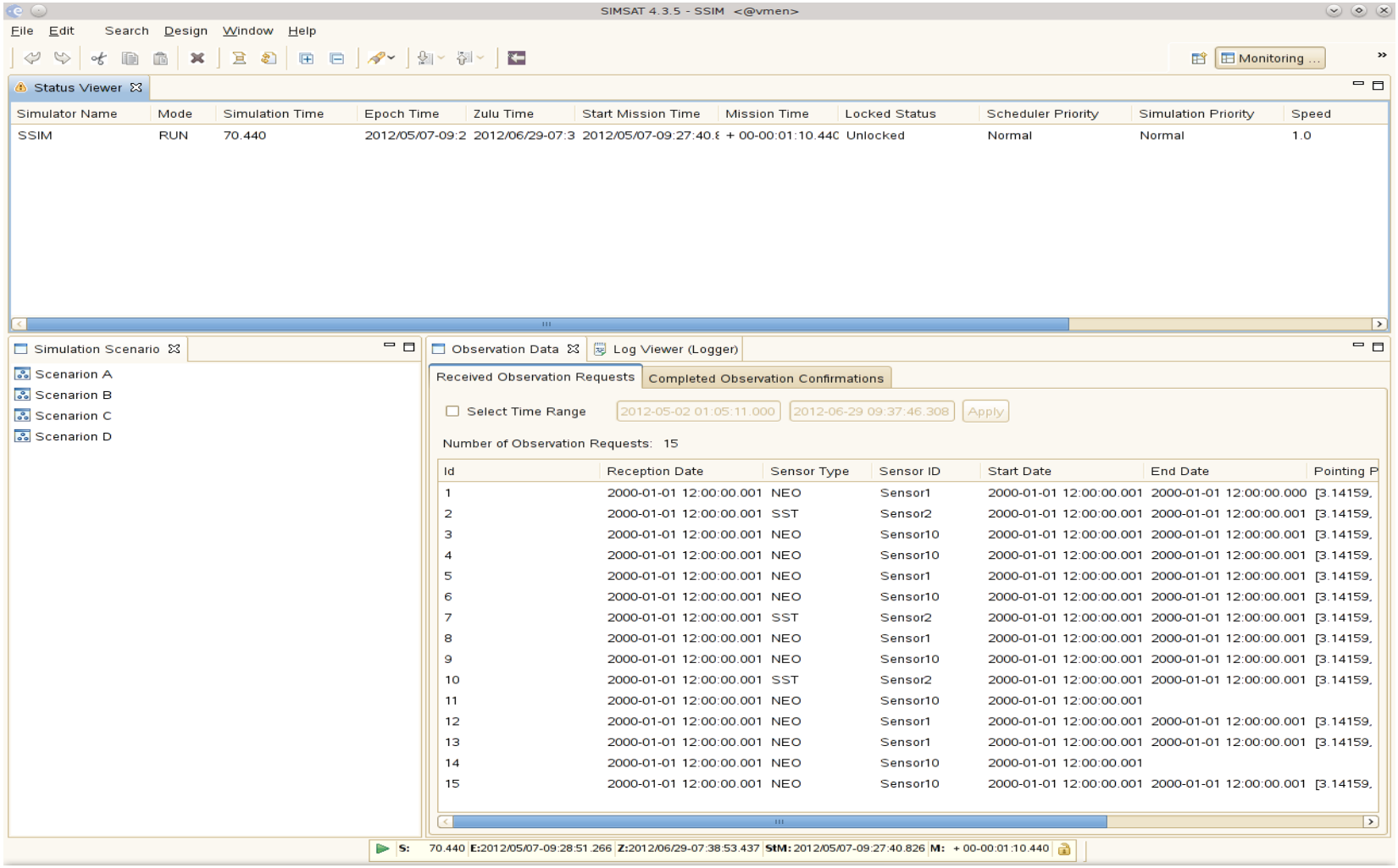
# HMI - Configuration



# HMI - Catalogue



# HMI – M&C


SIMSAT 4.3.5 - SSIM <@vmen>
File Edit Search Design Window Help
Monitoring ...
Status Viewer
Simulator Name | Mode | Simulation Time | Epoch Time | Zulu Time | Start Mission Time | Mission Time | Locked Status | Scheduler Priority | Simulation Priority | Speed
SSIM | RUN | 70.440 | 2012/05/07-09:2 | 2012/06/29-07:3 | 2012/05/07-09:27:40.8 | + 00-00:01:10.440 | Unlocked | Normal | Normal | 1.0
Simulation Scenario
Scenarion A
Scenarion B
Scenarion C
Scenarion D
Observation Data
Log Viewer (Logger)
Received Observation Requests
Completed Observation Confirmations
Select Time Range
2012-05-02 01:05:11.000
2012-06-29 09:37:46.308
Apply
Number of Observation Requests: 15
Id | Reception Date | Sensor Type | Sensor ID | Start Date | End Date | Pointing P
1 | 2000-01-01 12:00:00.001 | NEO | Sensor1 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.000 | [3.14159,
2 | 2000-01-01 12:00:00.001 | SST | Sensor2 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
3 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
4 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
5 | 2000-01-01 12:00:00.001 | NEO | Sensor1 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
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7 | 2000-01-01 12:00:00.001 | SST | Sensor2 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
8 | 2000-01-01 12:00:00.001 | NEO | Sensor1 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
9 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
10 | 2000-01-01 12:00:00.001 | SST | Sensor2 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
11 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001
12 | 2000-01-01 12:00:00.001 | NEO | Sensor1 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
13 | 2000-01-01 12:00:00.001 | NEO | Sensor1 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
14 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001
15 | 2000-01-01 12:00:00.001 | NEO | Sensor10 | 2000-01-01 12:00:00.001 | 2000-01-01 12:00:00.001 | [3.14159,
S: 70.440 E:2012/05/07-09:28:51.266 Z:2012/06/29-07:38:53.437 StM: 2012/05/07-09:27:40.826 M: + 00-00:01:10.440

# Kernel Extension

That’s it!

# SOA Goals / Promises

Interoperability

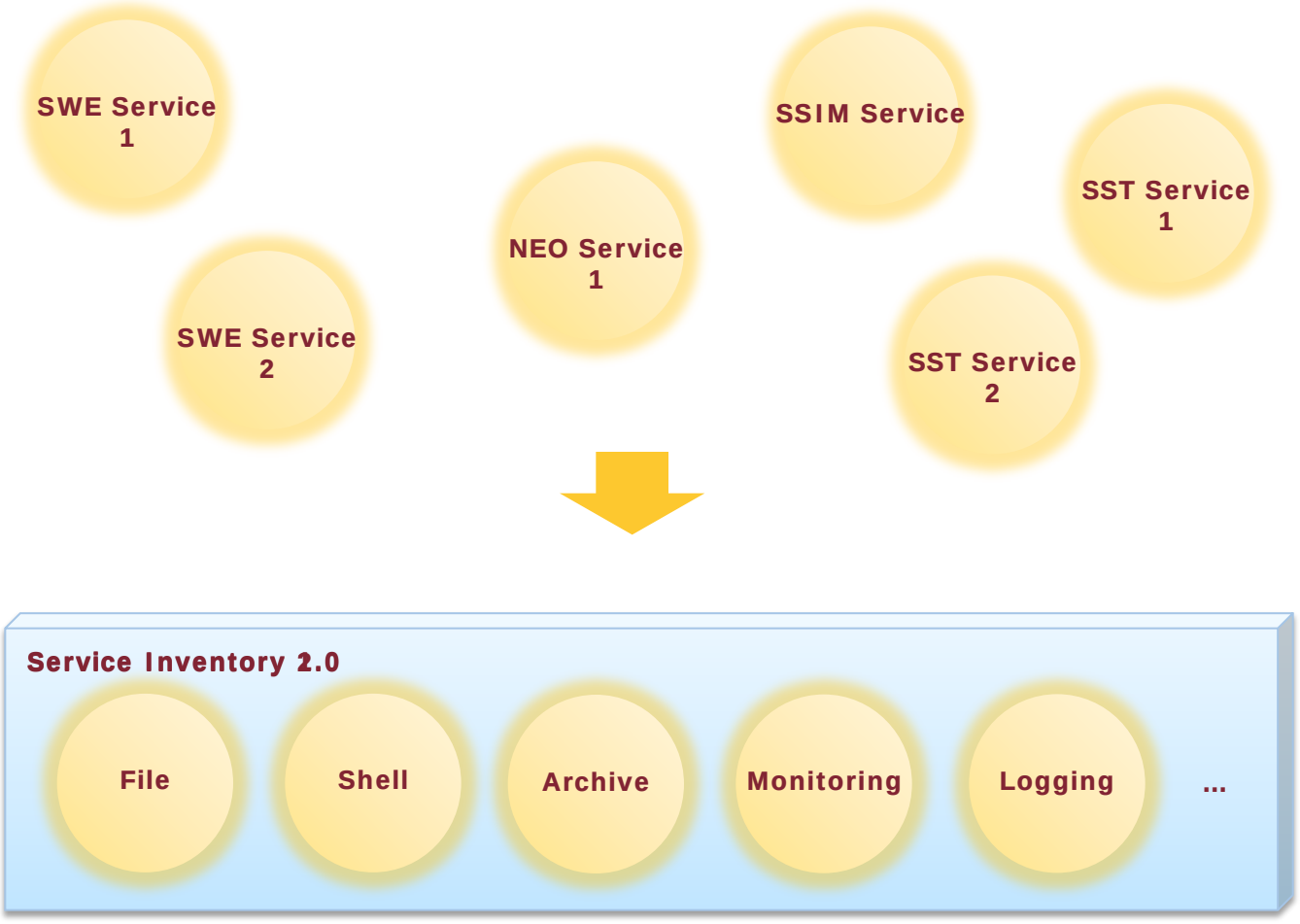
Federation

Business Technology Alignment

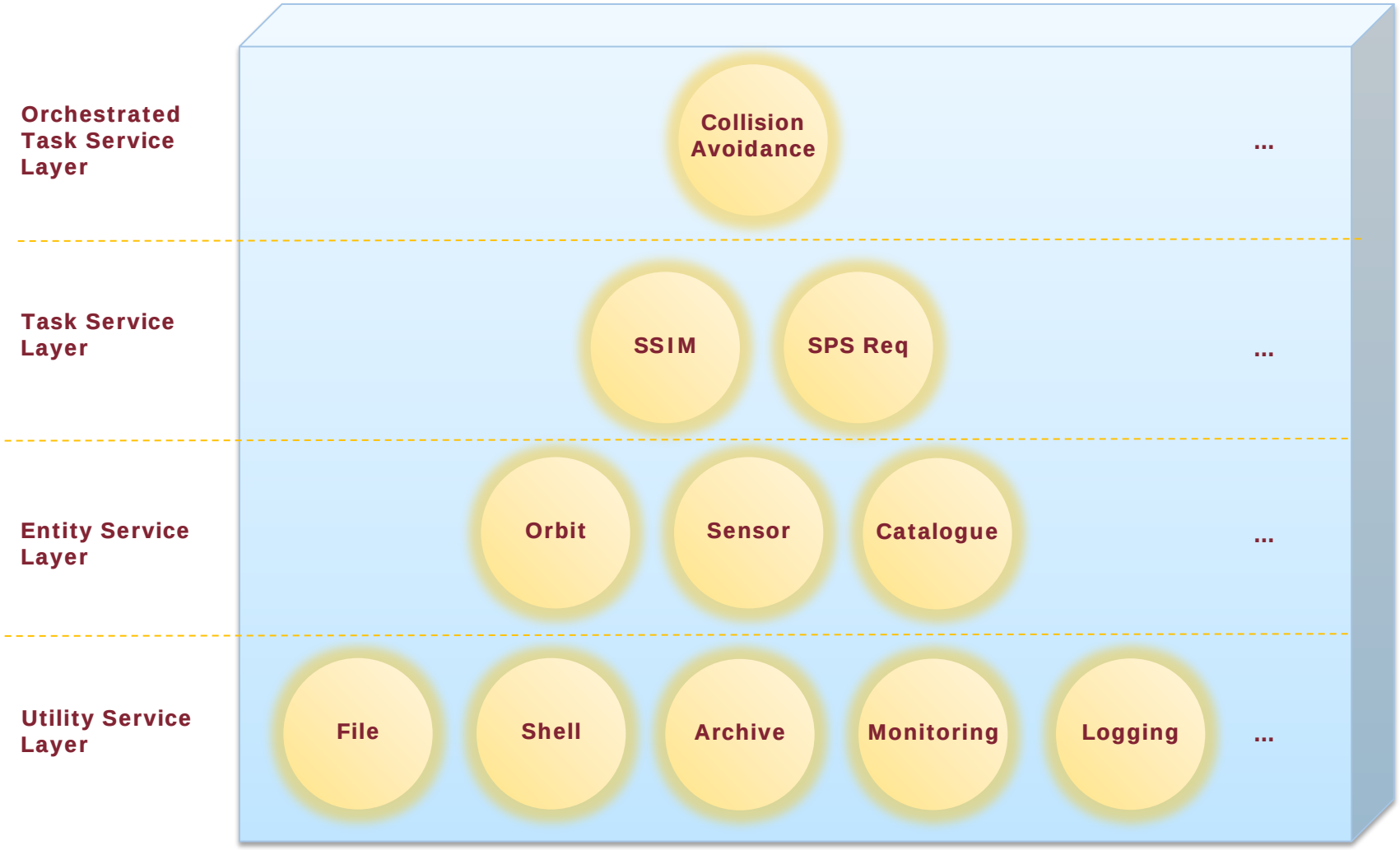
Organisational Agility

and others …

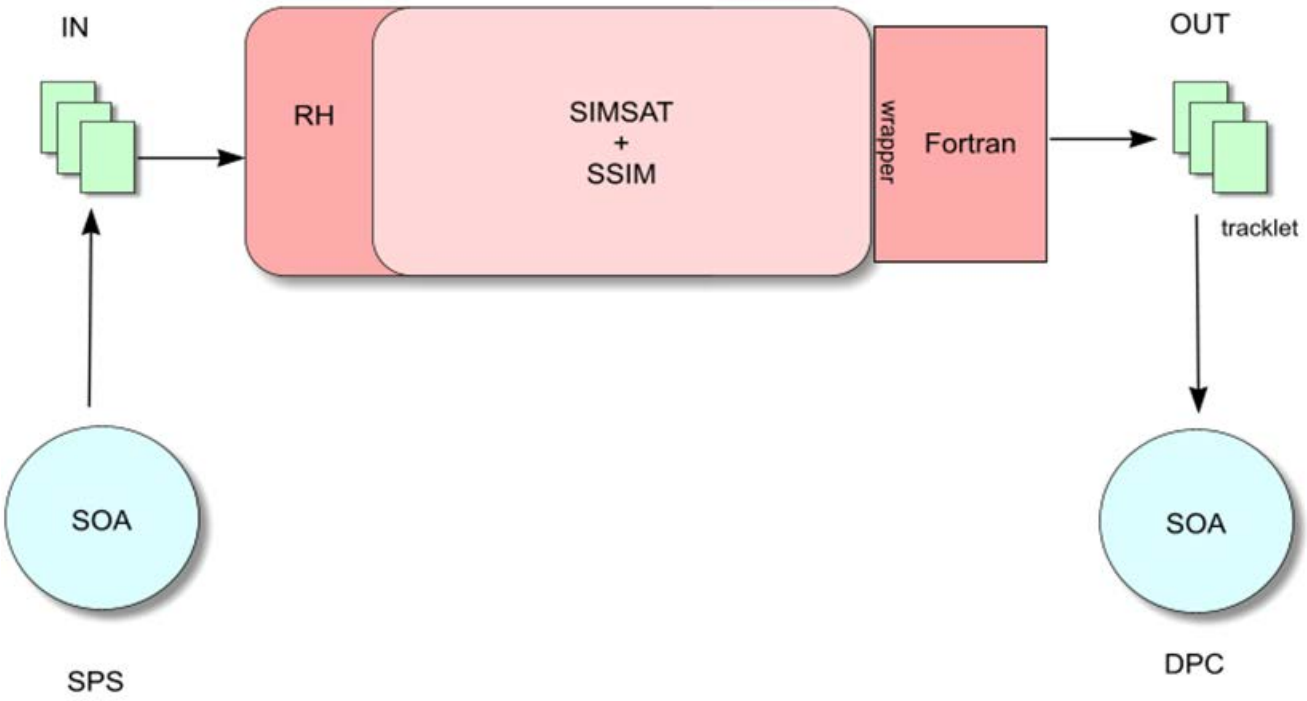
# Our SOA Approach



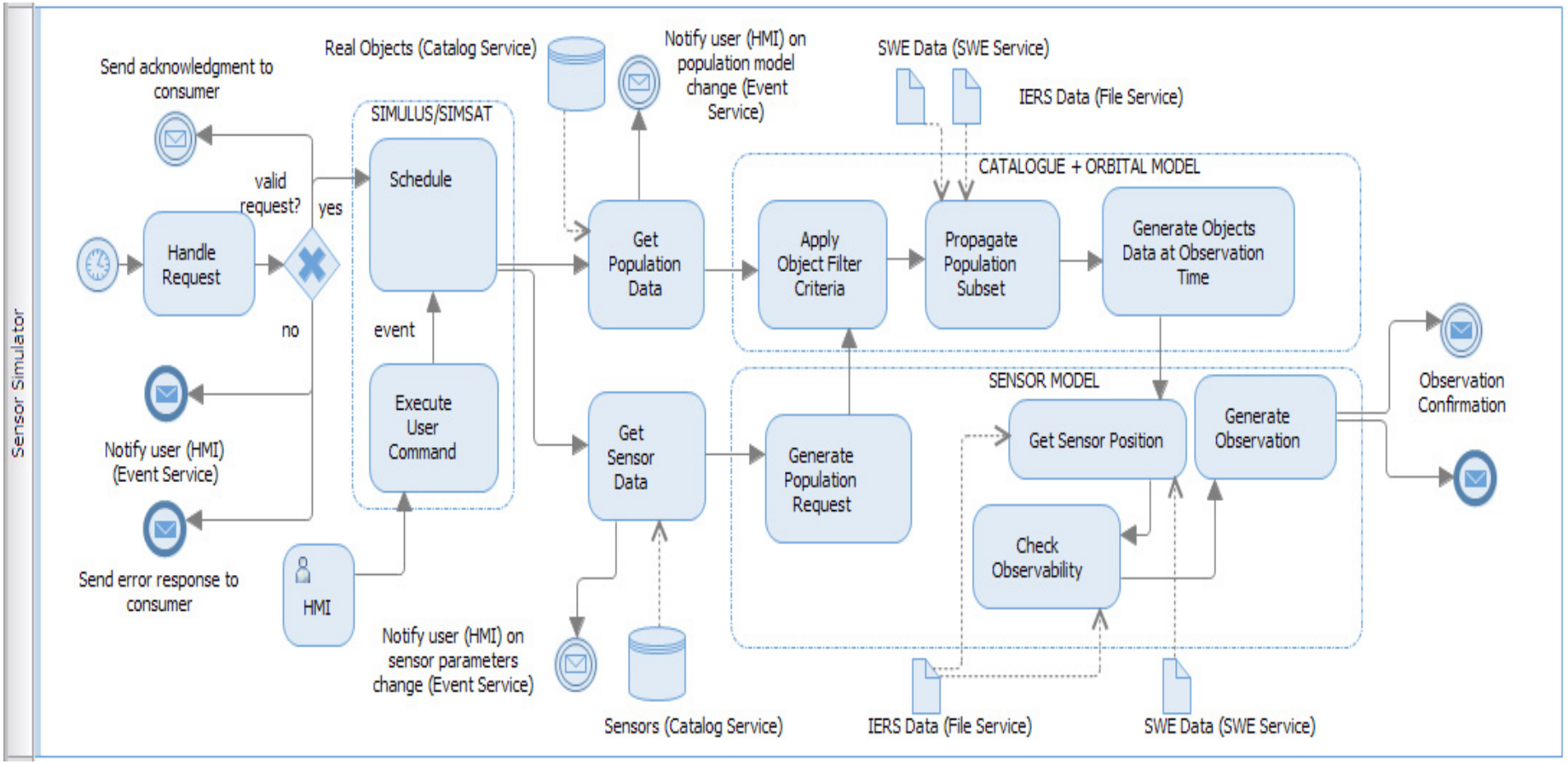
# Target SSA Service Enterprise Model



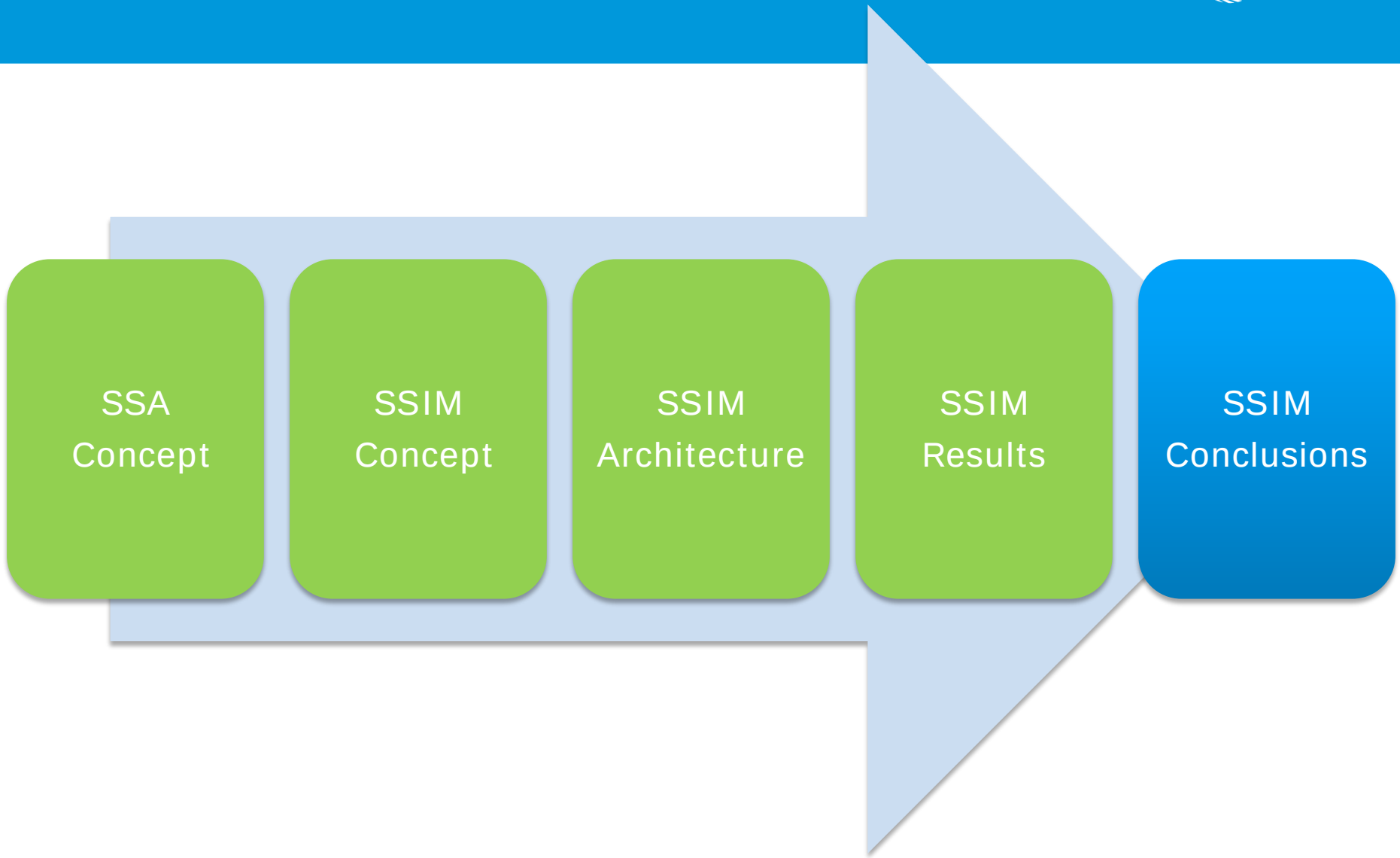
# Integration Design Patterns



# SSIM High Level Business Process



# Agenda


SSA Concept
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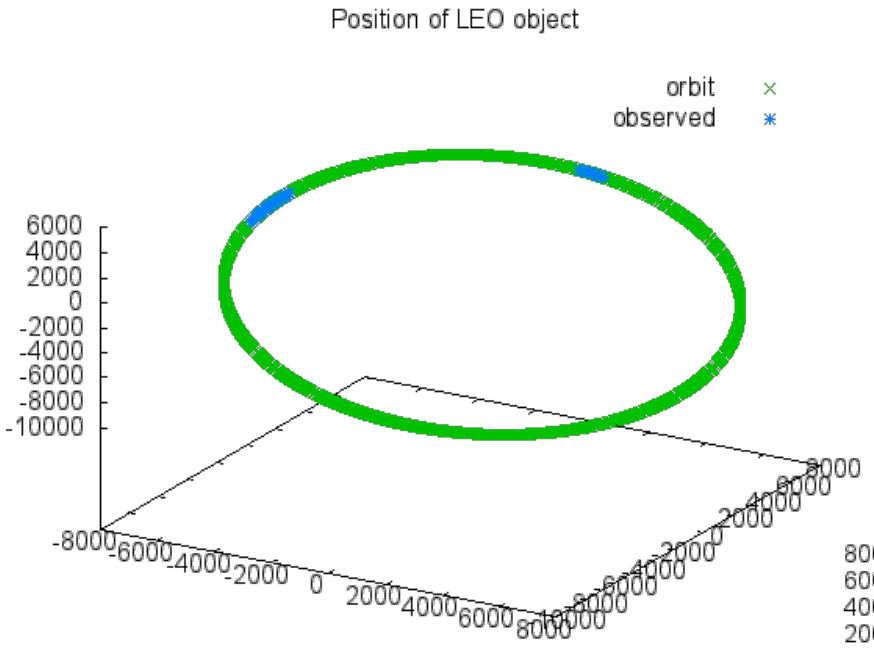
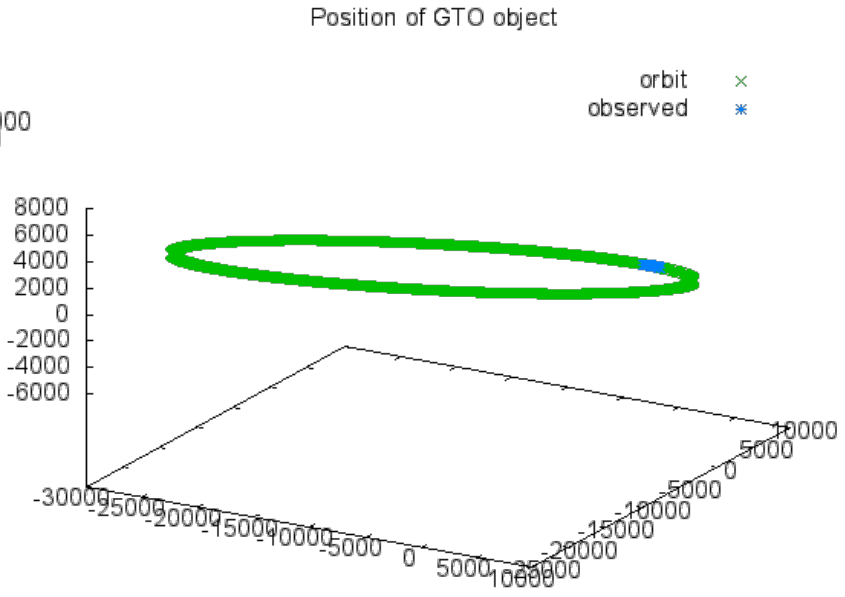
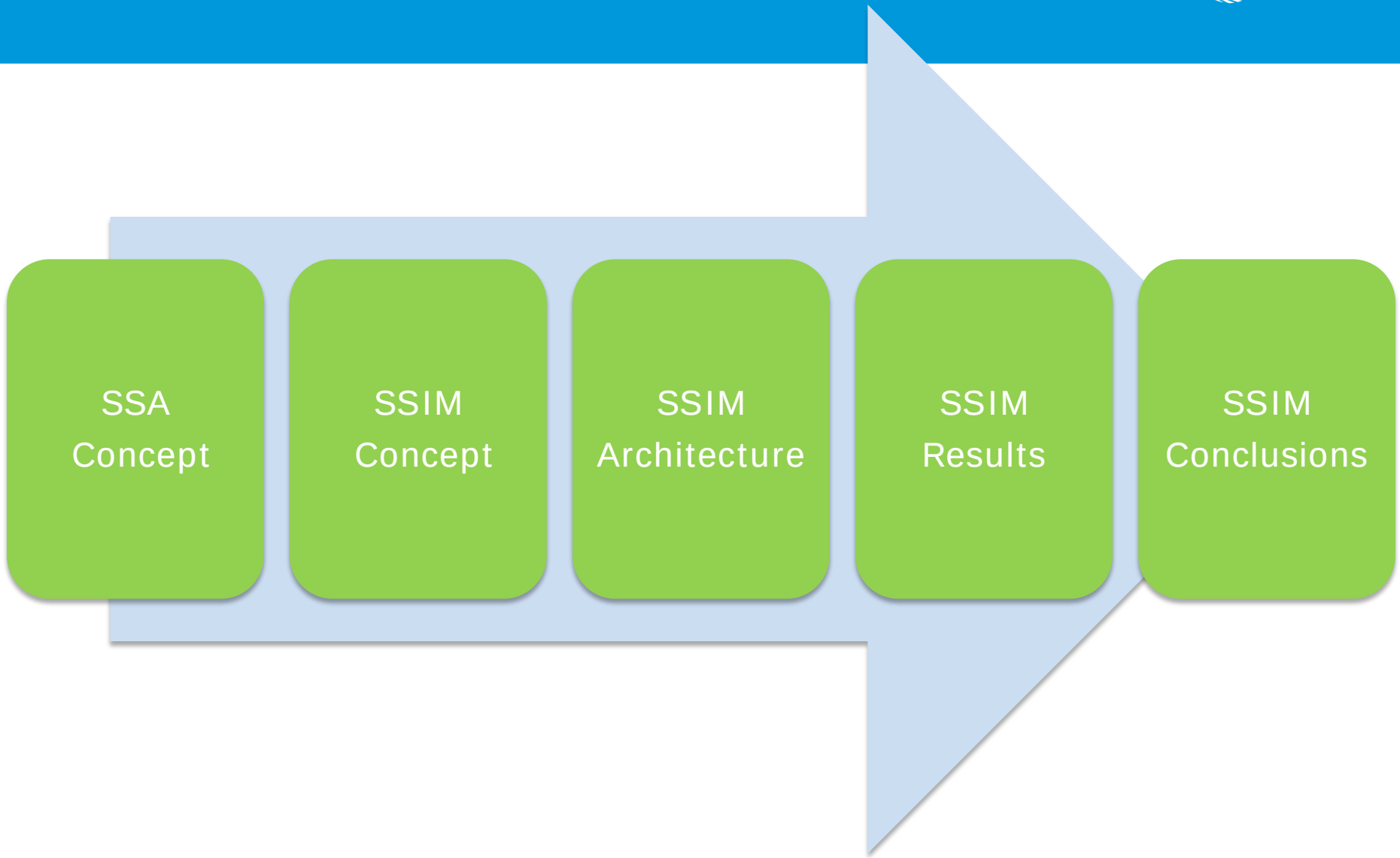
# Preliminary Results:
# SSIM Surveillance Radar Model



# Agenda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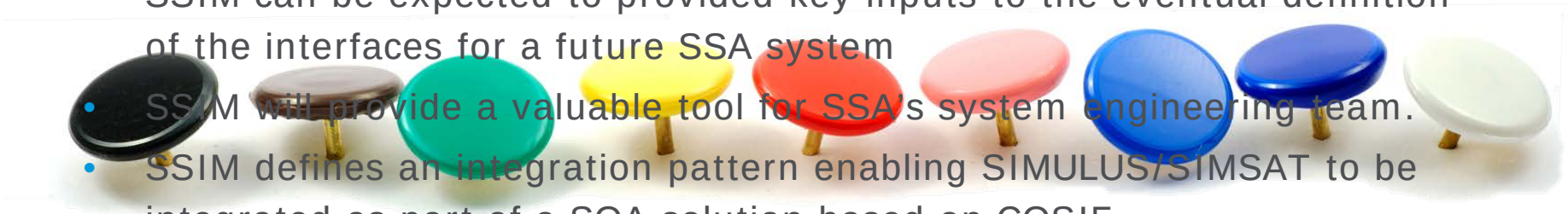
# Coming soon


Autumn 2012
• Integration of SOA
Early 2013
• Overall Performance assessment
Mid 2013
• Maintenance and evolution

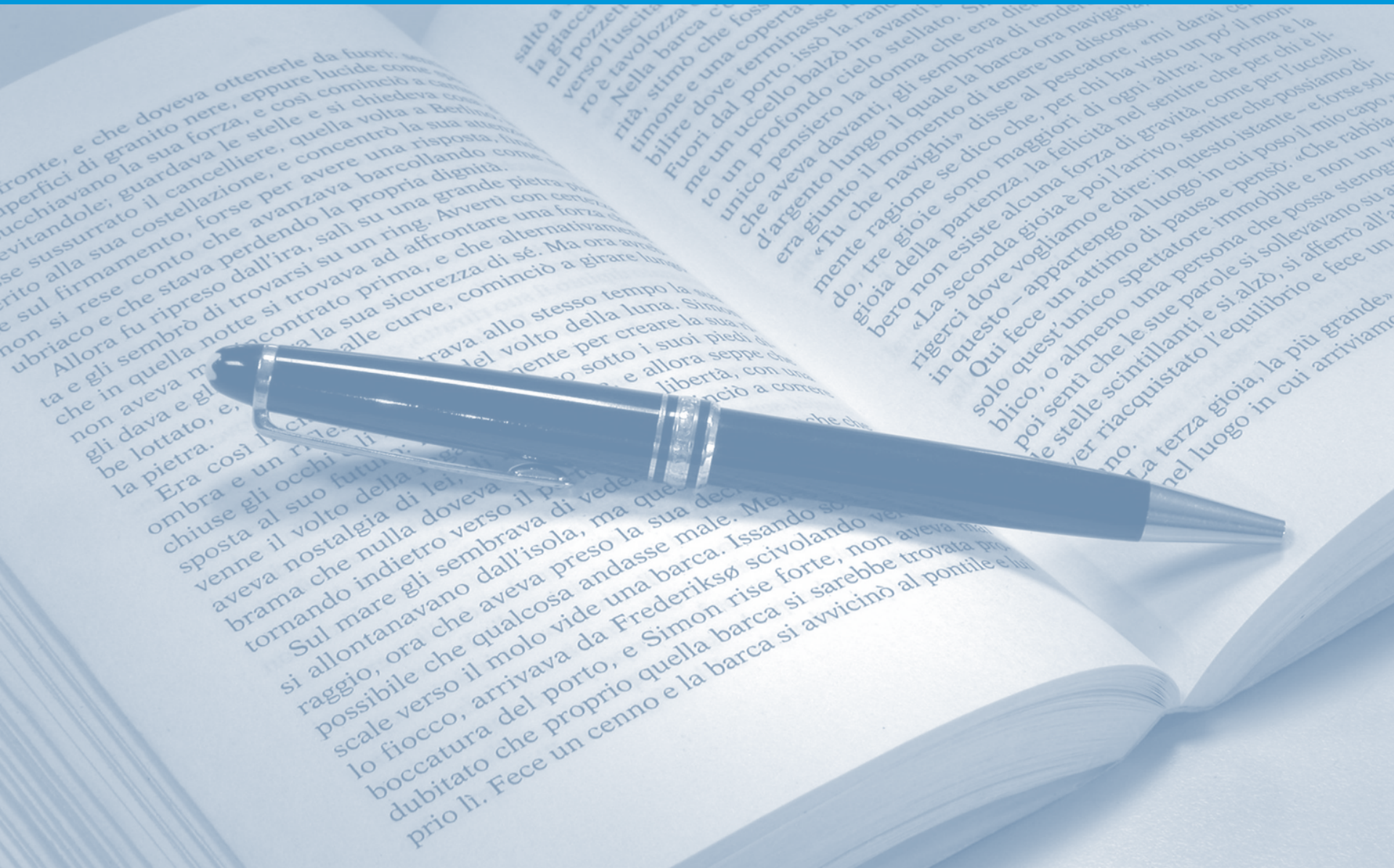
# Conclusions

- SSIM used SIMULUS as starting point, reducing the risk and effort associated to the implementation compared to a development from scratch.
- SSIM can be expected to provided key inputs to the eventual definition of the interfaces for a future SSA system
- SSIM will provide a valuable tool for SSA's system engineering team.
- SSIM defines an integration pattern enabling SIMULUS/SIMSAT to be integrated as part of a SOA solution based on COSIF.
- SSIM has successfully integrated models currently in the form of Fortran libraries in SIMSAT as SMP2 models.




esa
THANK YOU!
sst.ssa.esa.int
neo.ssa.esa.int
swe.ssa.esa.int
www.esa.int/ssa
vicente.navarro@esa.int

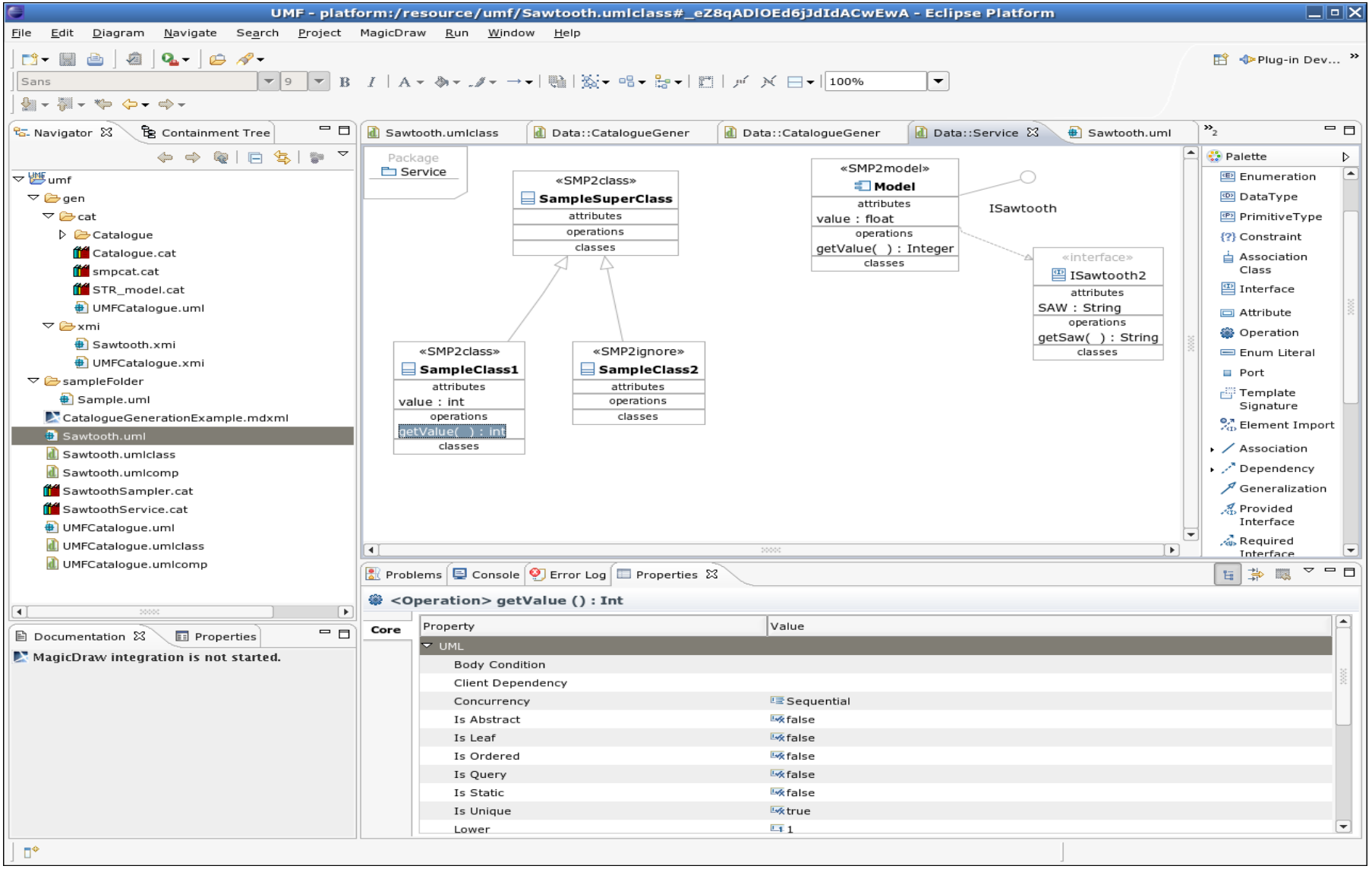
# Backups



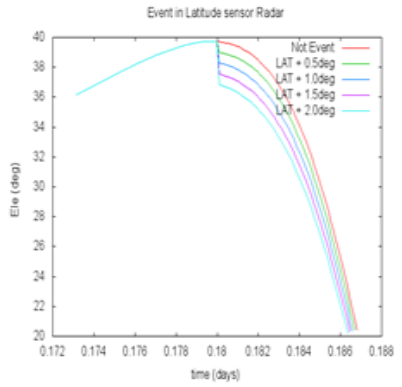
# SMP2 Objectives

- Support model portability
- Promote the reuse of simulation models between:
  - different project phases
  - different projects
  - different simulation platforms
- Improve model integration support – code generation
- Support integration of system engineering data
- Support for modern software technologies
- Support of dynamic simulations
- Make use of open standards
- Decrease sensitivity to platform change

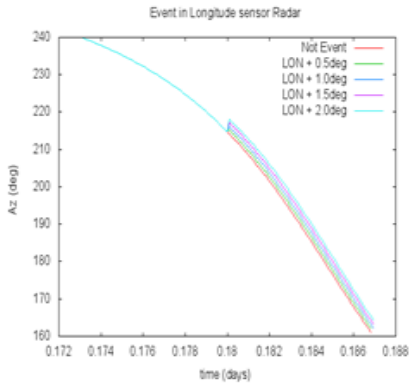
# UMF


UMF - platform:/resource/umf/Sawtooth.umlclass#_eZ8qADlOEd6jJdIdACwEwA - Eclipse Platform
File Edit Diagram Navigate Search Project MagicDraw Run Window Help
Navigator
Containment Tree
umf
gen
cat
Catalogue
Catalogue.cat
smpcat.cat
STR_model.cat
UMFCatalogue.uml
xmi
Sawtooth.xmi
UMFCatalogue.xmi
sampleFolder
Sample.uml
CatalogueGenerationExample.mdxml
Sawtooth.uml
Sawtooth.umlclass
Sawtooth.umlcomp
SawtoothSampler.cat
SawtoothService.cat
UMFCatalogue.uml
UMFCatalogue.umlclass
UMFCatalogue.umlcomp
Documentation
Properties
MagicDraw integration is not started.
Sawtooth.umlclass
Data::CatalogueGener
Data::CatalogueGener
Data::Service
Sawtooth.uml
Package
Service
«SMP2class»
SampleSuperClass
attributes
operations
classes
«SMP2model»
Model
attributes
value : float
operations
getValue( ) : Integer
classes
ISawtooth
«interface»
ISawtooth2
attributes
SAW : String
operations
getSaw( ) : String
classes
«SMP2class»
SampleClass1
attributes
value : int
operations
getValue( ) : int
classes
«SMP2ignore»
SampleClass2
attributes
operations
classes
Palette
Enumeration
DataType
PrimitiveType
Constraint
Association Class
Interface
Attribute
Operation
Enum Literal
Port
Template Signature
Element Import
Association
Dependency
Generalization
Provided Interface
Required Interface
Problems
Console
Error Log
Properties
<Operation> getValue () : Int
Core
Property
Value
UML
Body Condition
Client Dependency
Concurrency
Sequential
Is Abstract
false
Is Leaf
false
Is Ordered
false
Is Query
false
Is Static
false
Is Unique
true
Lower
1

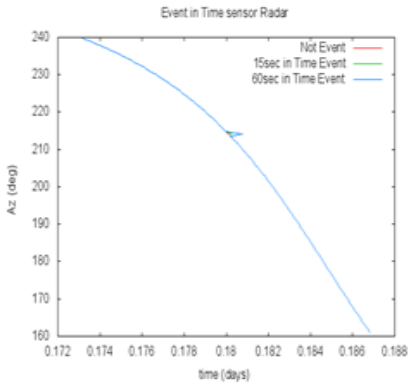
# Surveillance Radar Simulation Events



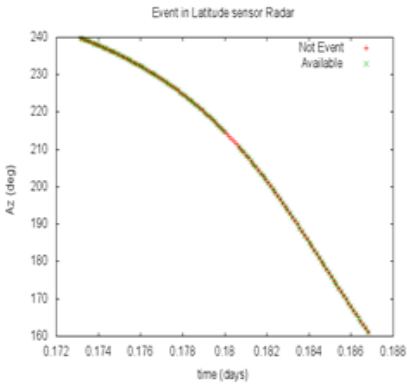

Change of the latitude of the radar.



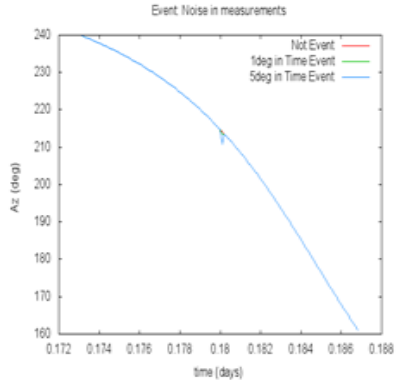

Change of the longitude of the radar.



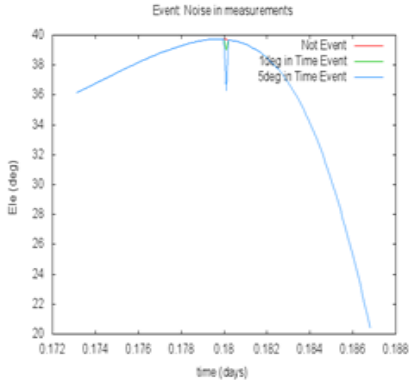

A delay in the time of the observation.



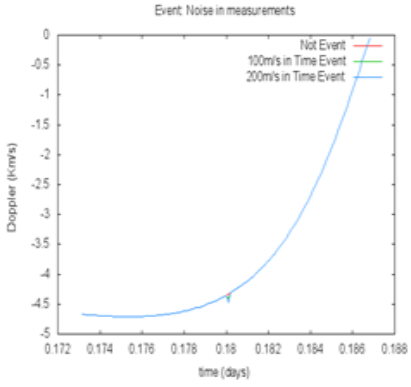

Non-availability of the sensor during a time interval.



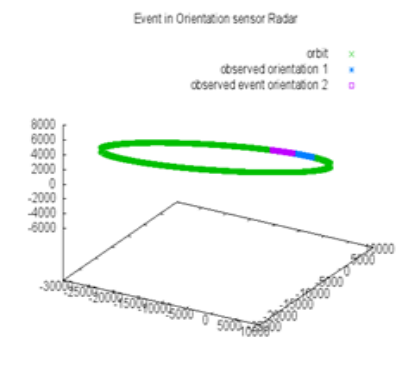

Additional noise in the detected azimuth.




Additional noise in the detected elevation.

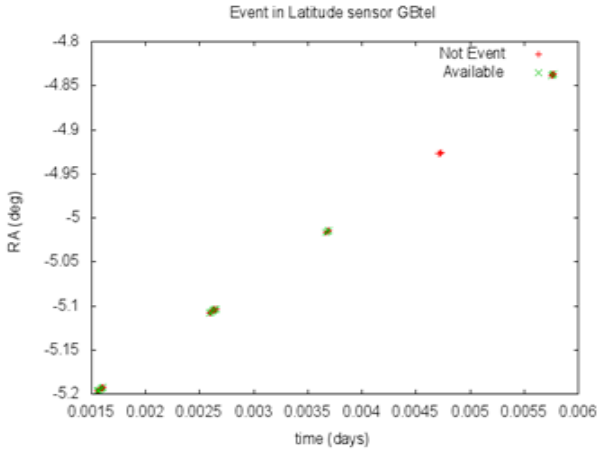



Additional noise in the detected Doppler.

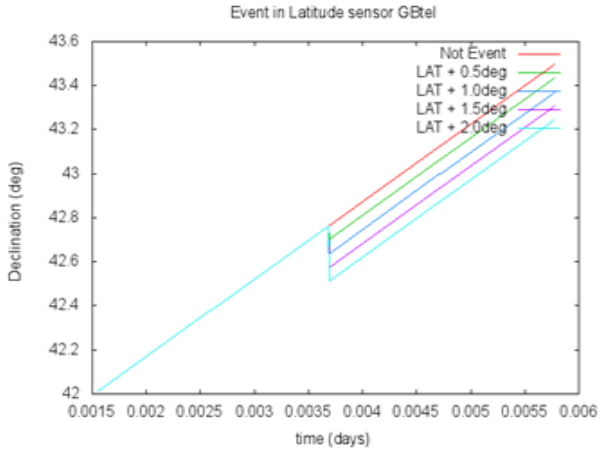



Change in the surveillance radar orientation.

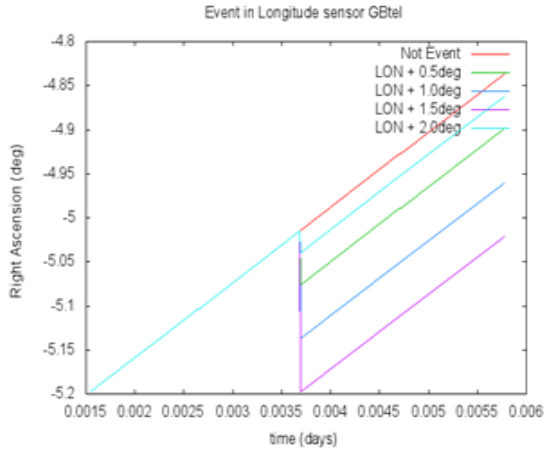
# Surveillance Optical G-B Simulation Events



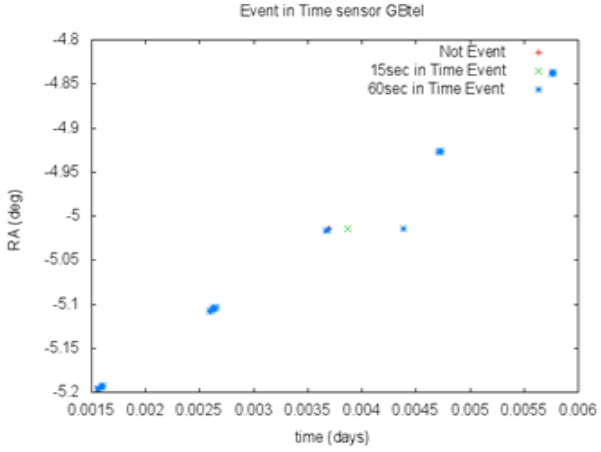

Non-availability of the sensor



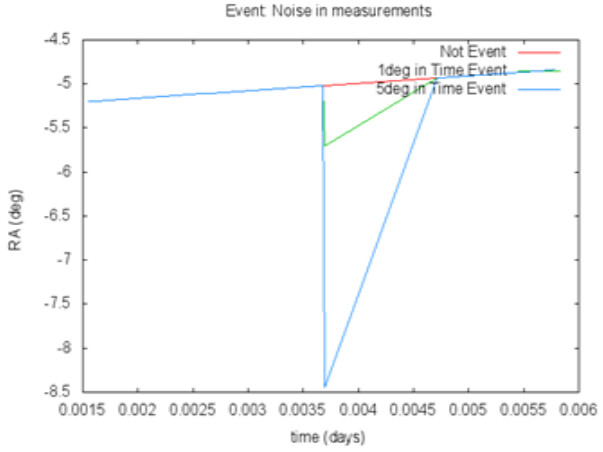

Change in latitude of the sensor



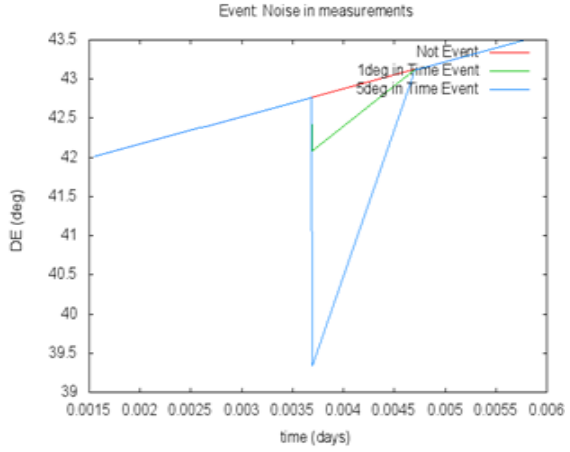

Change in longitude of the sensor




Delay in tracklet generation




Noise in Right ascension




Noise in Declination