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ATENA – Adjusting open Test Exchange staNdard to the spAce domain

Workshop on Simulation and EGSE for Space Programmes
March, 2017
ESA-ESTEC, Noordwijk, The Netherlands

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ITTI - Company information

- Company mission:
  - **development of innovative applications and software solutions**
  - **applied research** in **Information & Communication Technologies**
  - **independent consulting** in the area of telecommunications, IT, and business
- Main facts:
  - **SME – ca. 80 persons** with professional certificates, e.g. **PRINCE2, MSP, ITIL, BS 7799/ISO 27001, TOGAF 8/9, Certificate in Software Testing (SJSI/ISTQB), OCUP2**
  - **"Cristal Brussels Prize" 2006, 2010, and 2013** for the most active and successful Polish SME participating in FP6 and FP7
  - Award for the **high performance in R&D projects for EDA**
  - **Membership in international and national bodies:**
    - Polish Space Industry Association (ZPSK)
    - Public Safety Communications Europe (PSCE)
    - Integrated Mission Group for Security (IMG-S)
    - NetWorld2020 (ETP)
    - National and Regional Smart Specialisations (KIS, RIS)

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ESA projects (1/2)

- **SpaceWire protocol**
  - **SPACEMAN** – A SpaceWire Network Management Tool *(Sub.: TELETEL, Greece)*
  - **SpaceR** – Implementation and Validation of the SpaceWire-R Protocol *(Sub.: TELETEL, Greece)*
- **Space Situational Awareness (SSA)**
  - **Gaia GOSA** – An interactive service for asteroid follow-up observations *(ITTI as subcontractor to OA UAM)*
  - **P2-NEO-VI –** User Support Tools *(Sub.: OA UAM)* – under SSA programme
  - **NEODECS** – NEO Data Exchange and Collaboration Service *(Sub.: OA UAM)*
  - **NOAS** - NEO&SST Observation Assistant Service *(ITTI as subcontractor to OA UAM)*
  - **SSA PL** – Feasibility study to Setup a Polish Component to SSA *(Sub.: OA UAM, CBK Borowiec, CAMK, GMV, PGZ)*

ESA projects (2/2)

- **Ground Segment Support Software**
  - **HMI** – The technology framework for the development of modular, portable and adaptive Human-Machine Interfaces in ground segment software products *(Sub.: VITROCISET, Belgium)*
  - **INSPECTOR** – INtegrated SPacE Components Test platfORm
  - **ATENA –** Adjusting open Test Exchange staNdard to the spAce domain (*Sub.: VITROCISET, Belgium)*
- **Other (e.g. feasibility studies)**
  - **LEX EO** - Law Enforcement eXploitation of Earth Observation – under EOEP programme (*ITTI sub. to e-Geos*)
  - **DART – Direct Air Transport** – under ARTES 20 programme (*Subcontractors: Institute of Avionics, Polish Aeroclub, Mlabs*)
  - **EO SEED –** Support to Enhanced EO Activity in Priority States *(ITTI sub. to OGK)*
  - **PPSLI** – Participation of Poland in the ESA Small Launcher Initiative *(ITTI sub. to Polish Armaments Group)*

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Publications

- **International SpaceWire Conference** (September 2014) – *SPACEMAN: A SpaceWire Network Management Tool, Space-R: Spacewire-R*
- **SESP** (March 2015) – *ESA-HMI Standardized framework for designing Human-Machine Interfaces*
- **DASIA** (May 2016) – *INSPECTOR – Supporting tool for AIT/AIV phase*
- **International SpaceWire Conference** (October 2016) – *SpaceWire Network Management Using Network Discovery and Configuration Protocol*
- **SESP** (March 2017) – *ATENA – adjusting open test exchange standard to the space domain*
- Contributions to **SpaceWire Working Group** (since 2014)
- Several presentations at **national conferences**

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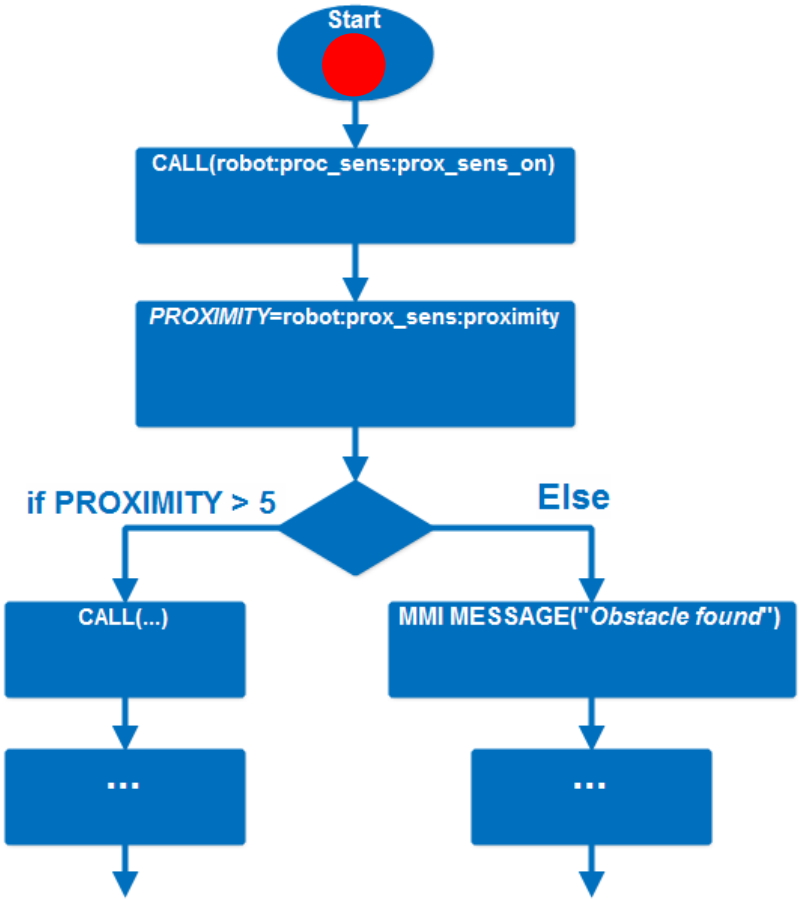
Agenda

- Introduction to diagnostic test sequences
- What is OTX?
- What added value OTX provides?
- ATENA as a fully OTX compliant solution dedicated to ESA

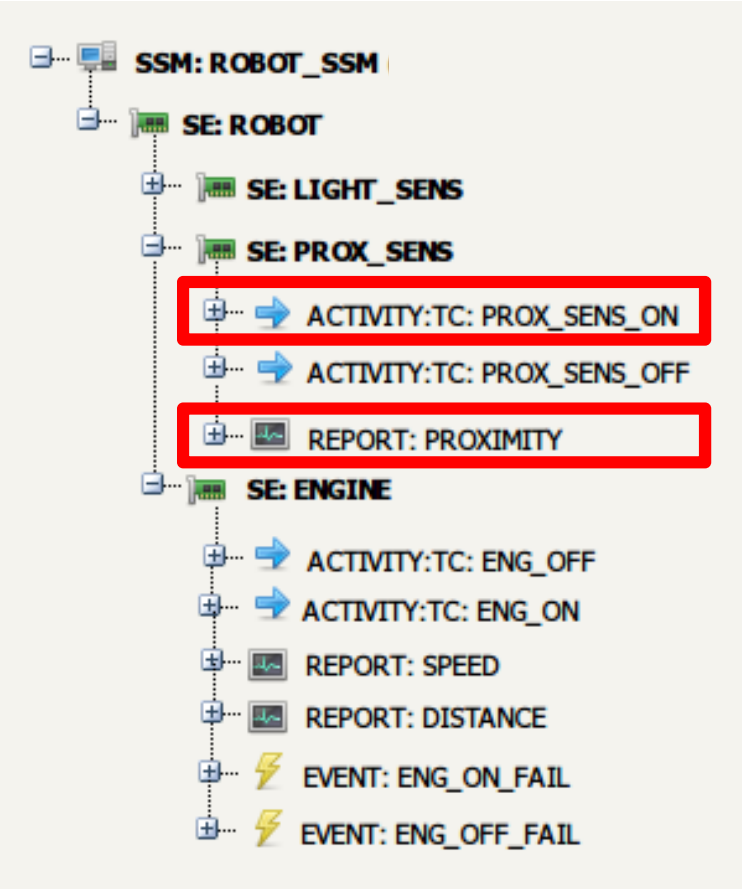
Introduction to diagnostic test sequences

Sample diagnostic test sequence

Sequence



Model



Problematic areas

- Diversity of activities carried out by ESA.
- Multitude of entities collaborating with the Agency exchanging the sequences between collaborating groups and branches.
- Overlapping and inconsistences of work between entities involved in the process of developing new equipment.
- Higher costs and time expenditure than necessary.

- **Necessity of well-designed and uniform standard for the specification and execution of the test sequences.**

Potential solution

- The importance of implementation of a joint and uniform approach to the specification and execution of diagnostic test sequences was recognized in the **automotive domain.**
- A dedicated standard was developed and commonly introduced, i.e. **OTX – Open Test sequence eXchange (ISO 13209).**
- There is a possibiliity to exploit OTX also in other domains thanks to **extension mechanism**.

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What is OTX?

OTX - basic facts

- **OTX – Open Test sequence eXchange (ISO 13209)**
- First edition - 2012
- International standard dedicated to diagnostic test sequences
- Open and standardised
- Tester-independent
- XML-based data exchange format (along with a sequence language) for formal description and documentation of executable sequences
- Three parts: **OTX Overview / OTX Core / OTX Extensions**

Part 1 - The Overview: General information and use cases

- Purpose of the standard on a high level.
- List of use cases which the standard aims to fulfill.
- Use cases defining multiple aspects, i.e. documentation and specification, exchange and reusability, extensibility, localization and runtime execution.
- General considerations regarding integration of OTX with existing standards (ODX – Open diagnostic data exchange, MVCI – Modular vehicle communication interface, UDS – Unified diagnostic services, etc.).

Part 2 – OTX Core: Core data model specification and requirements

- The main requirements and principles of the core OTX data model.
- OTX features and mechanisms that are necessary to build basic test sequences.
- Validation and extension approach.
- OTX Core data model may be extended by following the extension mechanism.
  - **This aspect is crucial for adjusting OTX to the space domain purposes.**

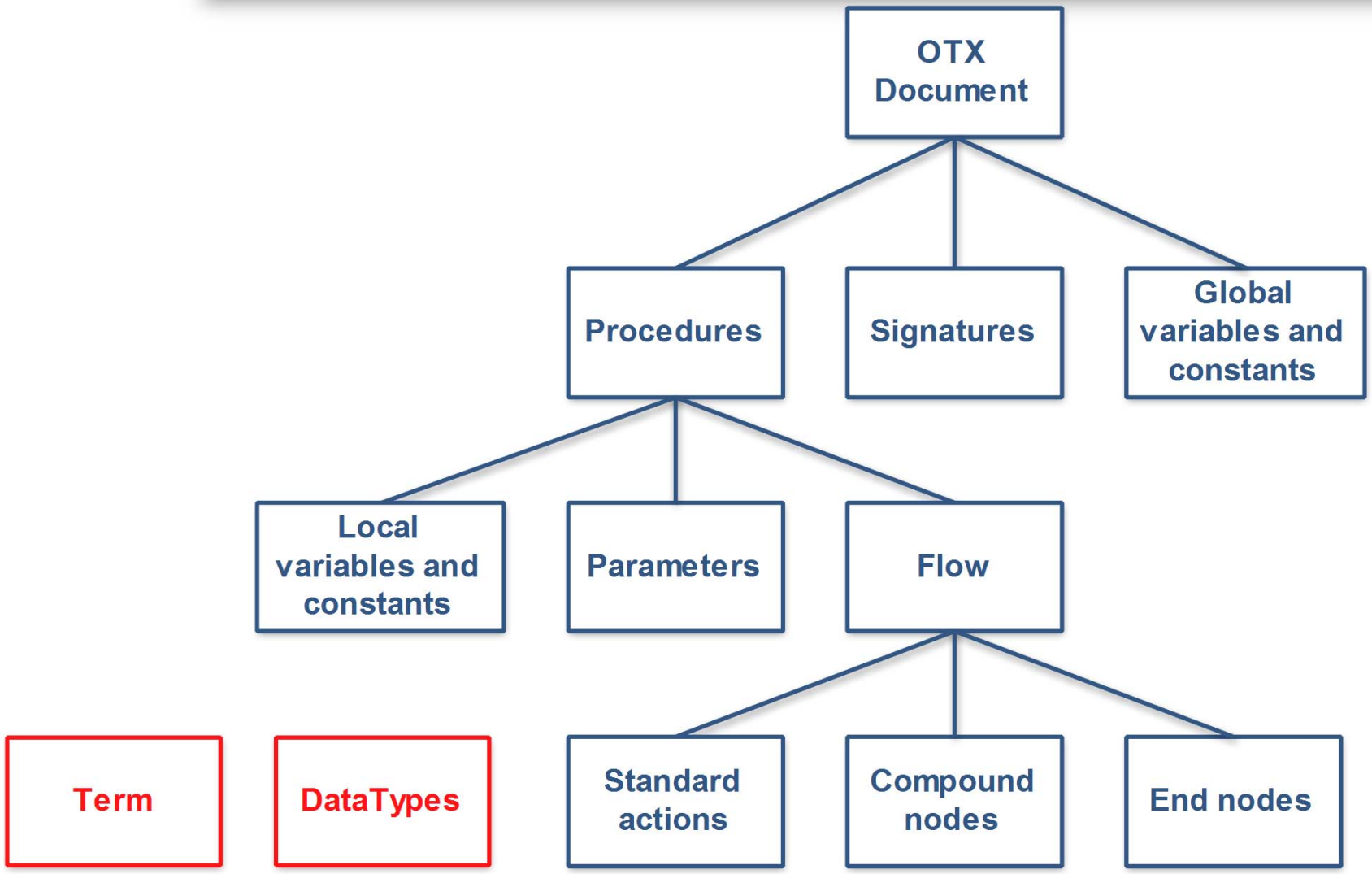
Part 3 – OTX Extensions: Standard extensions and requirements

- Set of additional OTX features, defined in compliance with the extension mechanisms specified in OTX Core.
- OTX features provide additional functionalities to the diagnostic system.
- Automotive industry-specific extensions, like DiagCom, DiagDataBrowsing.
- More general extensions, like DateTime, HMI, Math, Measure.
- **Selected OTX Extensions seem to be useful in a space system use cases as well.**

OTX data model

- A complex structure consisting of a great number of various features.
- Each feature described in a detailed way including syntax, semantics, possible exceptions, validation rules, examples, figures, etc.
- The data model definition provided within UML (Unified Modeling Language) and XSD (XML Schema Definition) that ensure consistency of description.

Overall view of OTX data model



What added value OTX may provide?

Availability of human- and machine-readable levels within OTX test sequence

- People without technical knowledge may understand a purpose of any test sequence (human-readable level),
  - but also build high level test sequences
  - and add implementation data to them.
- The implementation describes technically how test sequence should be performed (machine-readable level).
- Three stages of the test sequence:
  - specification stage,
  - implementation stage,
  - realisation stage.

Action #f1.a3

Specification:

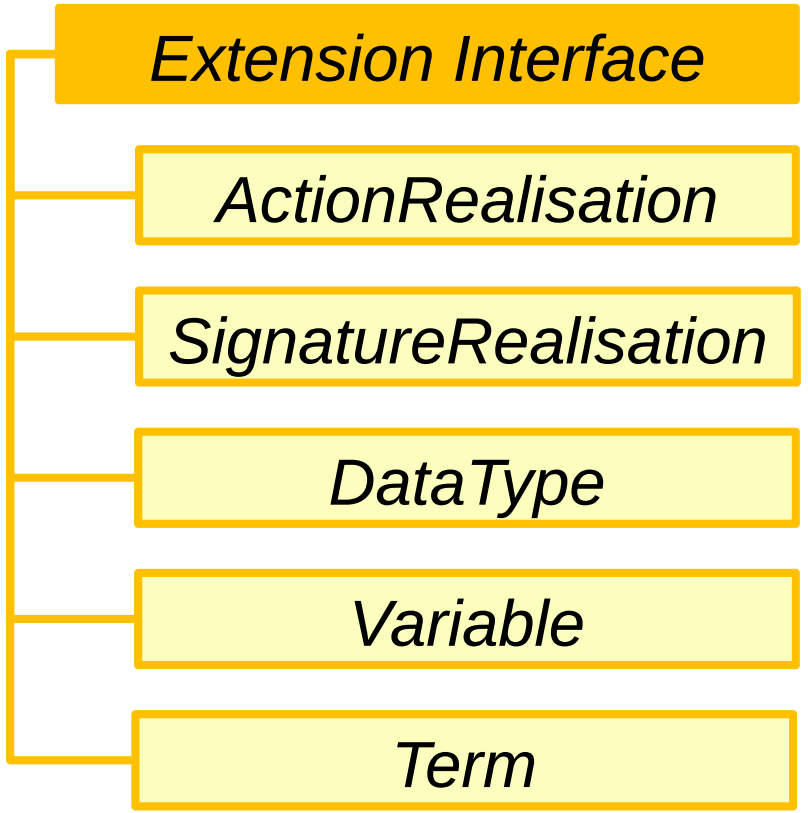
This action adds two Integer values

Realisation:

Result = c
Assign: Add (Int a , Int b)

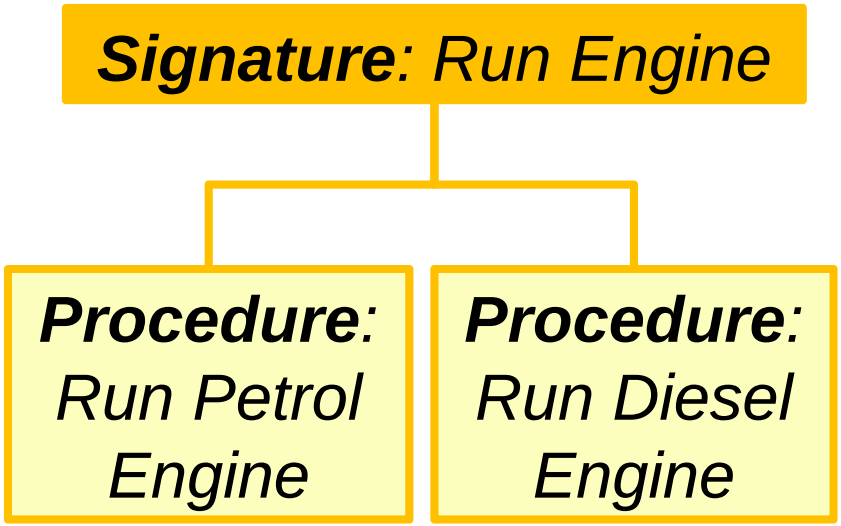
Extensibility of OTX data model

- OTX provides a clear extension mechanism which simplifies adding new data types, terms, variables and actions/signature realisations.
- Any missing OTX features that might be needed in a new area can be developed.
- As long as the OTX principles and requirements are followed, it is not a problem to ensure consistency with the OTX Core or another OTX Extension.



Reusability of OTX test sequences

- Signature is a similar feature to *interface* used in object programming languages (e.g. Java).
- Possibility to define general input and output parameters of a procedure without defining the implementation body.
- It is possible to provide more than one procedure able to realise a given signature within the whole test sequence.
- Selection of a valid procedure for the signature implementation purpose is realised by validity mechanism.



Error detection while creating OTX test sequences

- OTX standard includes a strictly defined set of stand-alone OTX checker applications which ensure OTX document (XML file) correctness at two levels:

- 1st: OTX document correctness **with respect to OTX Schema**
- 2nd: **Semantic issues** that cannot be verified at the XSD level

Error detection

XSD compliance:

e.g. correct nesting of nodes

Semantic correctness:

e.g. correct references between nodes

Focusing on know-how, rather than on programming expertise

- OTX is a XML based standard devoted to test procedures.
- Specific programming expertise is no longer necessary to prepare and understand test sequence flow by various contributors.
- The standard is relatively simple to understand and implement:
  - A test designer is expected to have know-how of the domain of interest when using an OTX tool (e.g. dedicated editor ensuring the syntax and semantics correctness).
- The test sequences creation process supported by OTX is less error-prone than through preparing scripts of the procedural test sequences:
  - Every human-mistake can be automatically detected within preparation and execution stages of the testing process.

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Other advantages

- ***Ensuring manufacturer independence in terms of software tools design***
  - There are multiple competitive tools on the market utilizing OTX standard for car diagnostics.
  - Since OTX is an ISO standard, the only differences between fully OTX compliant tools are on the side of performance and interface.
  - It makes the tools interchangeable and helps to avoid becoming vendor-locked.
  - The same is true also for software tools expandability, e.g. providing a possibility to use new OTX extensions through already built OTX test sequences.
- ***Long-term availability of OTX test sequences***
  - There is no expiration date on the OTX test sequences and therefore they can be reused and shared at any time, that being attributed an ISO specification guarantees long term validity of the standard.
- **…**

ATENA as a fully OTX compliant solution dedicated to ESA

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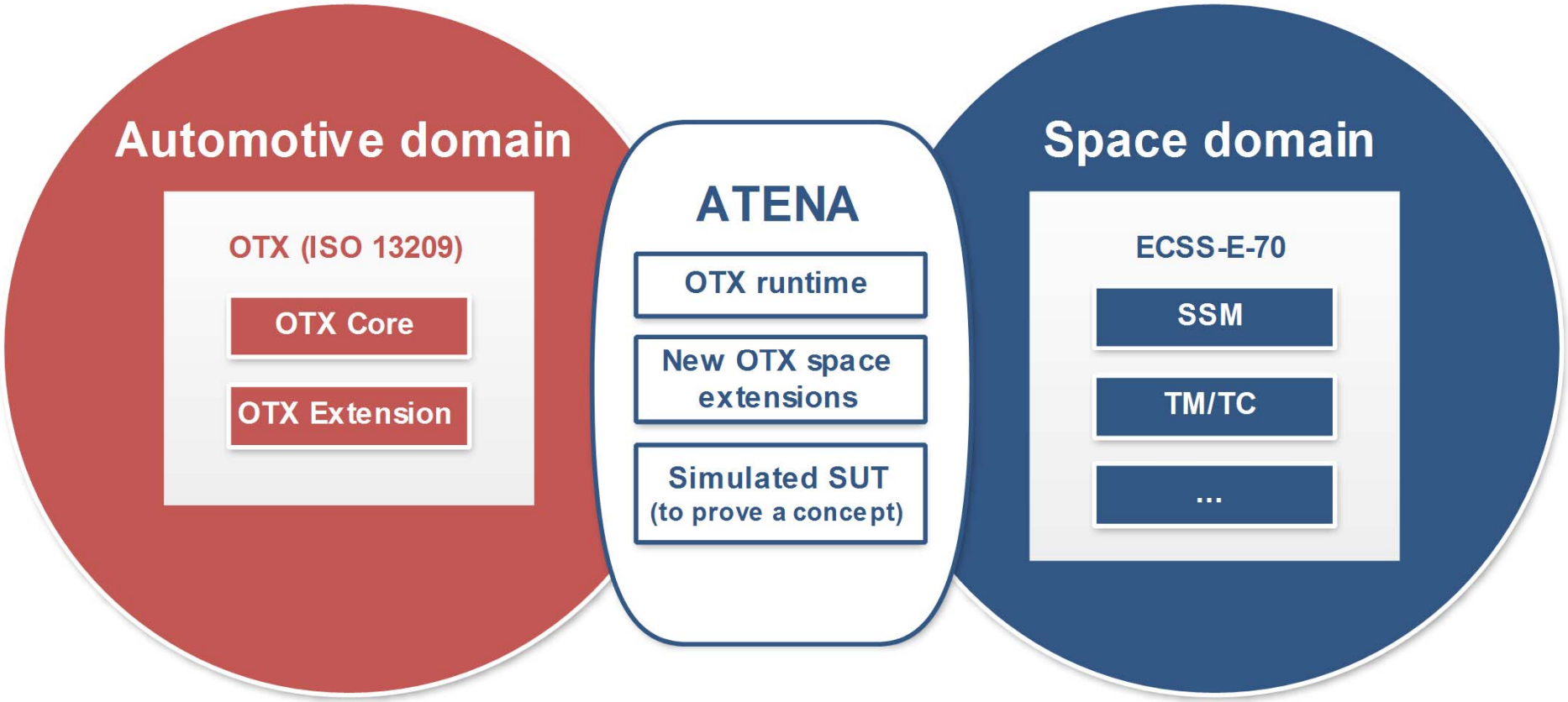
Adjusting OTX to space domain

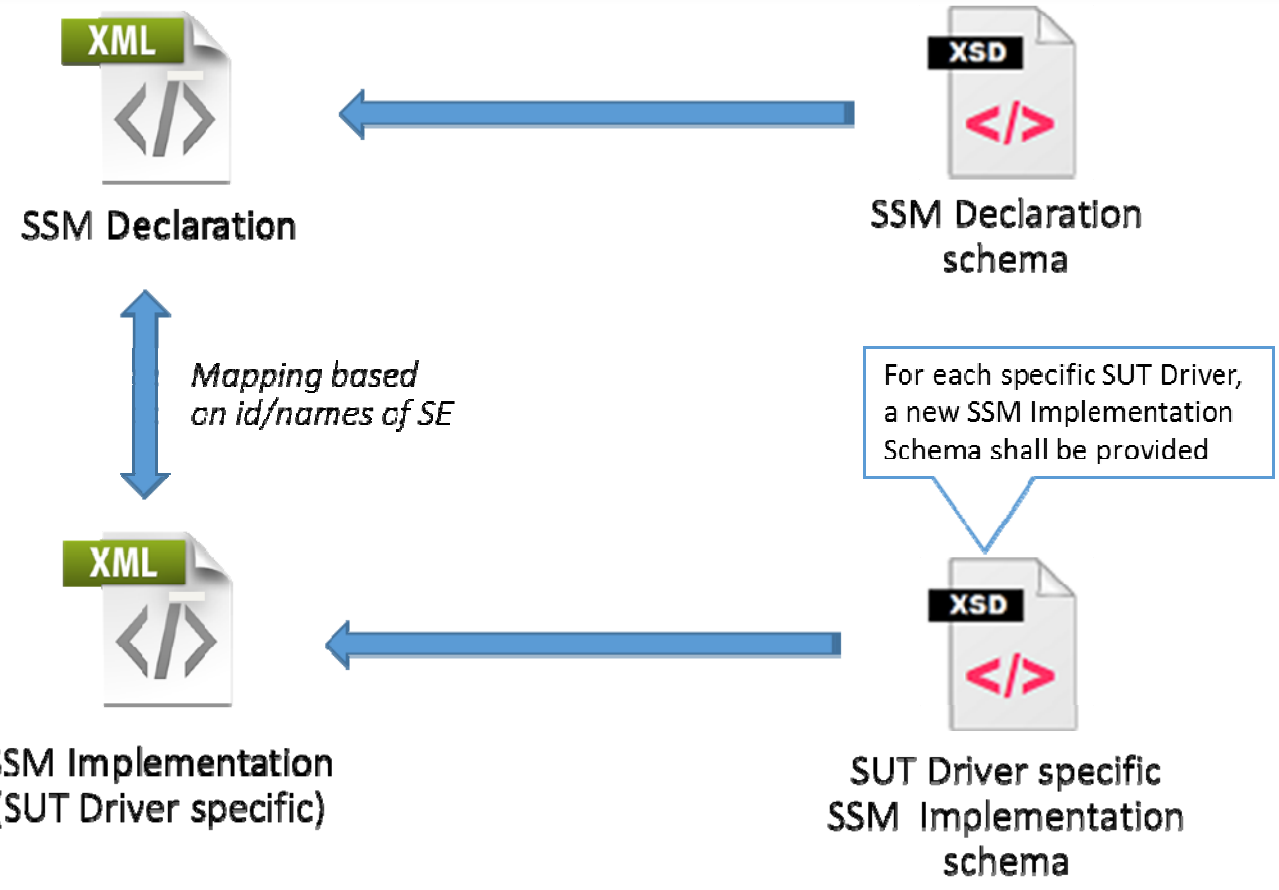


The scope of space domain standardization

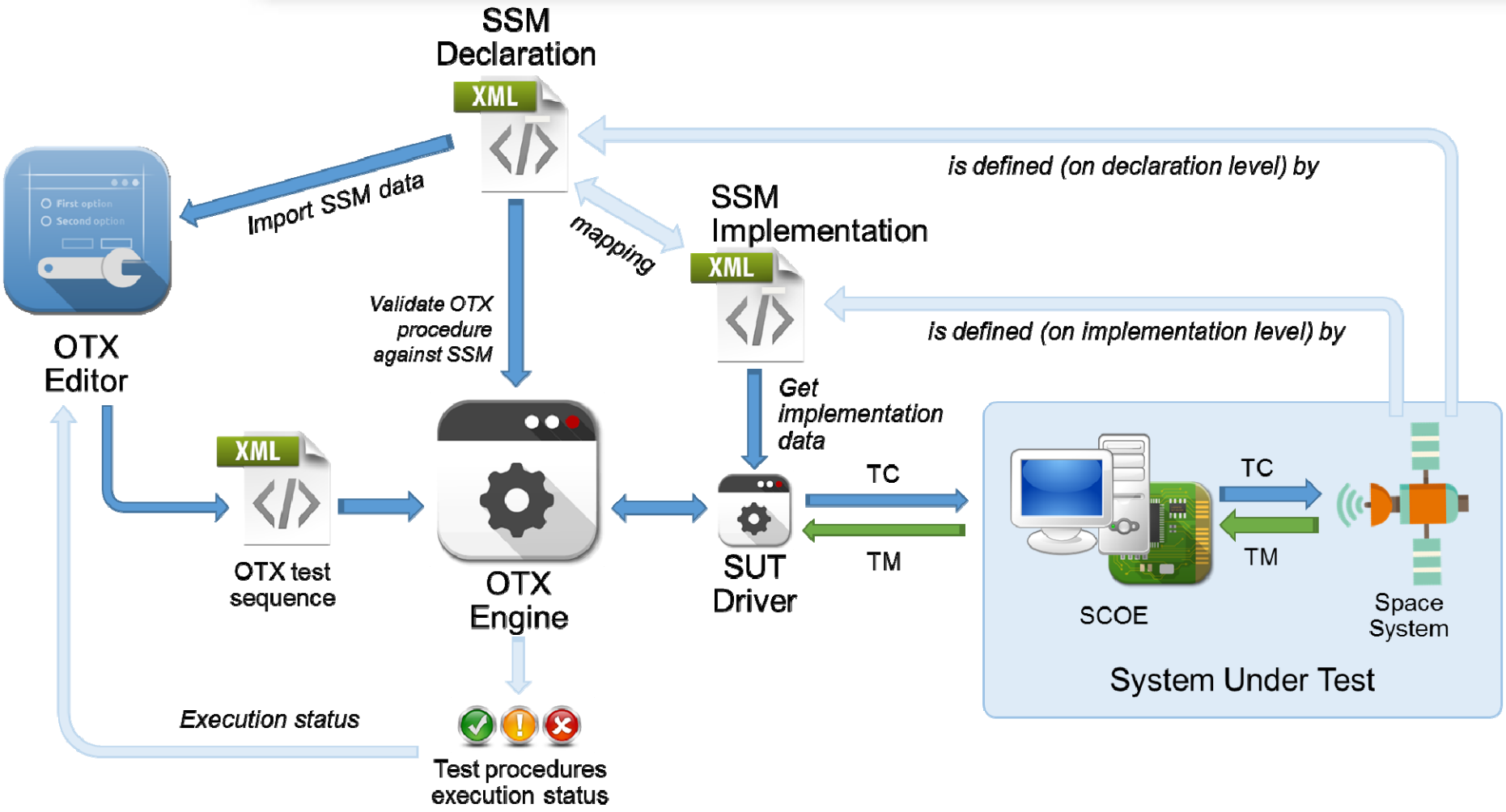
- The main model which the space domain standardization focuses on is **Space System Model (SSM)**, consisting of:
  - **System Elements (SE)** that are results of a functional decomposition of a space system defined in ECSS-E-00 and ECSS-E-70,
  - **Activities (A)** that provide monitoring and control functions. They are associated with SE referring to procedures, telecommands and any function provided by the EMCS (Electrical Monitoring and Control System) implemented within the EGSE (Electrical Ground Support Equipment) or any other mission control system,
  - **Reporting Data (RD)** associated with SE that comprises parameters,
  - **Events (E)** associated with SE and RD representing occurrences of a set of conditions that can arise.

Two levels of Space System Model

- **SSM Declaration**
- **SSM Implementation**



General system design



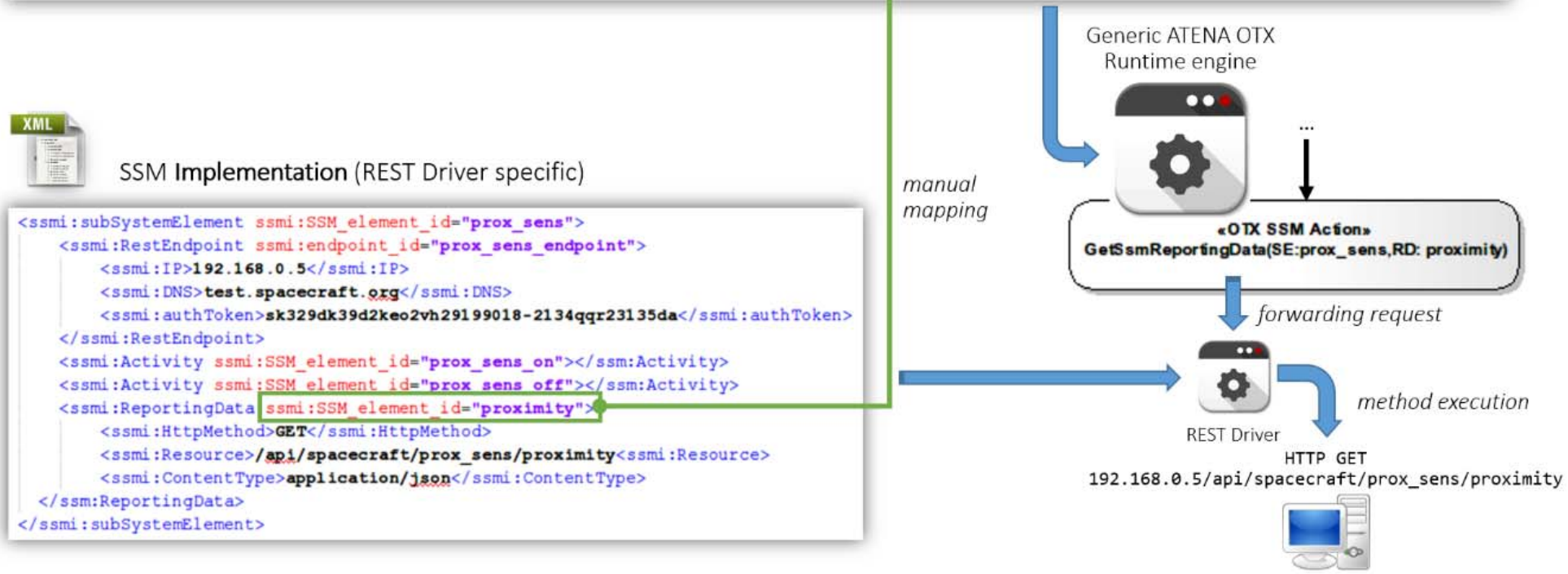
SSM/OTX integration point

SSM Declaration

```
<ssm:subSystemElement ssm:SSM_element_id="prox_sens" ssm:space_sys_obj_name="proximity_sensor">
  <ssm:Activity      xsi:type="ssm:Telecommand"   ssm:SSM_element_id="prox_sens_on"  ssm:space_sys_obj_name="tc_prox_sens_on"></ssm:Activity>
  <ssm:Activity      xsi:type="ssm:Telecommand"   ssm:SSM_element_id="prox_sens_off" ssm:space_sys_obj_name="tc_prox_sens_on"></ssm:Activity>
  <ssm:ReportingData xsi:type="ssm:ReportingData" ssm:SSM_element_id="proximity"     ssm:space_sys_obj_name="proximity"></ssm:ReportingData>
</ssm:subSystemElement>
```

SSM Implementation (REST Driver specific)

```
<ssmi:subSystemElement ssmi:SSM_element_id="prox_sens">
    <ssmi:RestEndpoint ssmi:endpoint_id="prox_sens_endpoint">
        <ssmi:IP>192.168.0.5</ssmi:IP>
        <ssmi:DNS>test.spacecraft.org</ssmi:DNS>
        <ssmi:authToken>sk329dk39d2keo2vh29199018-2134qqr23135da</ssmi:authToken>
    </ssmi:RestEndpoint>
    <ssmi:Activity ssmi:SSM_element_id="prox_sens_on"></ssm:Activity>
    <ssmi:Activity ssmi:SSM_element_id="prox_sens_off"></ssm:Activity>
    <ssmi:ReportingData ssmi:SSM_element_id="proximity">
        <ssmi:HttpMethod>GET</ssmi:HttpMethod>
        <ssmi:Resource>/api/spacecraft/prox_sens/proximity<ssmi:Resource>
        <ssmi:ContentType>application/json</ssmi:ContentType>
  </ssm:ReportingData>
</ssmi:subSystemElement>
```



ATENA – contribution to the space domain

- Standardization is an important factor in space domain activities
- OTX standard can be easily enriched by space-dedicated extensions
- OTX approach brings transparency to what is required from the vendors in terms of testing procedures within the space domain
- Reusability of the existing OTX test sequences shall impact the effectiveness of future testing tasks
- It is possible to work simultaneously on a single OTX test sequence file (or a set of files) at two levels – human-readable and machine-readable

Thank you for your attention

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ATENA toolkit