Streamlining Security Testing and Security Risk Management as part of a Secure System Engineering Framework at ESA

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Ground System Architectures Workshop 2019
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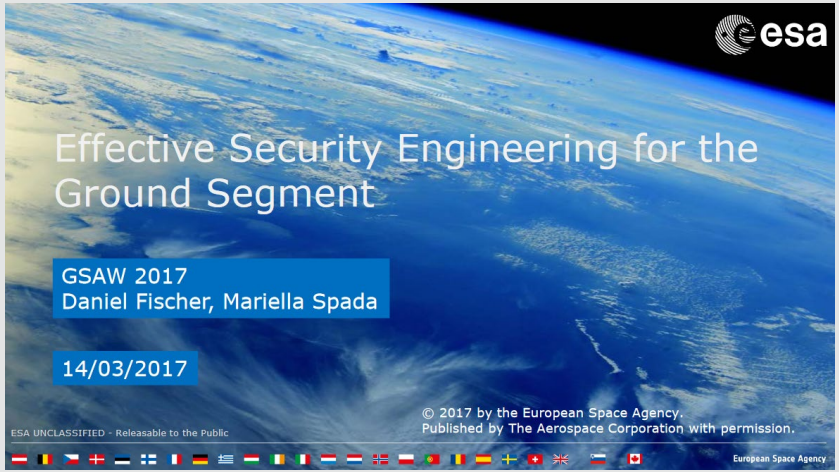
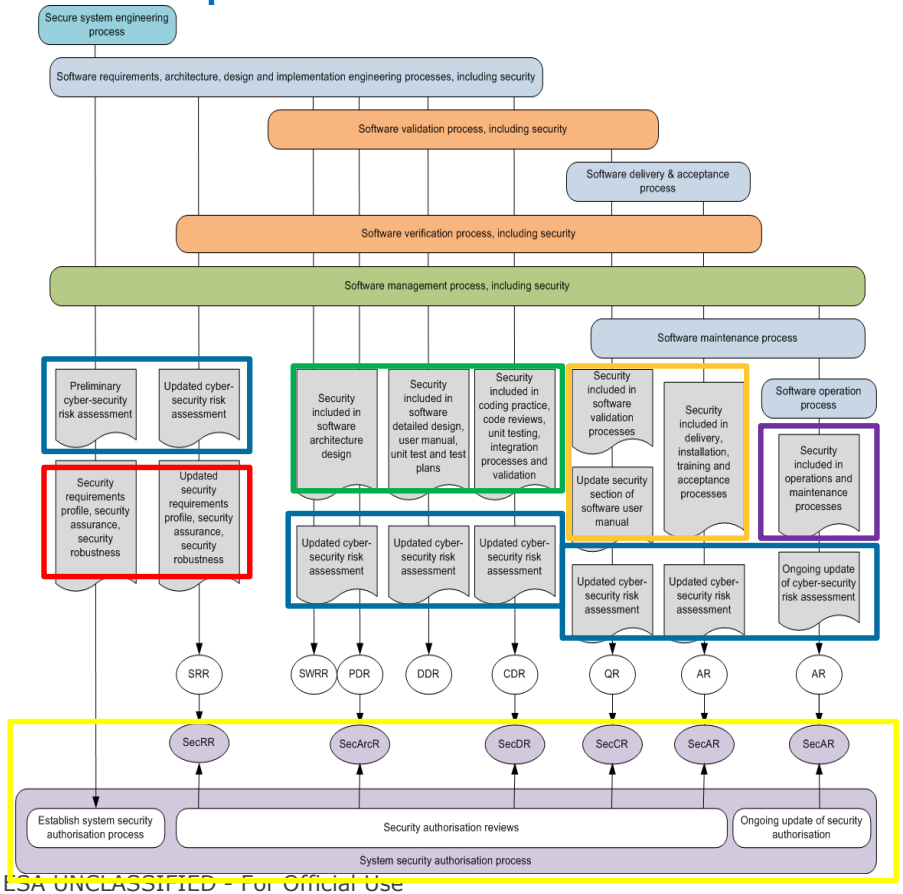
A recap..

- Back in 2017..



- Cyber security emerging as a **strategic objective** for ESA
- Proposed a Framework for **Secure Software and Systems Engineering** for the Ground Segment
- What were we talking about? Where are we now?

A recap..SSE Standard: What are the key processes?



- Risk Assessment
- Requirements Engineering
- Design and implementation
- Verification and validation
- Operations, maintenance, disposal
- Authorisation (including accreditation & certification processes)

A recap.. What are the key support tools?

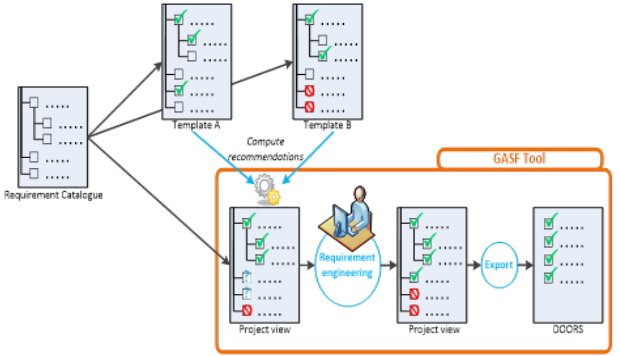
- Supporting methodologies and tools, aimed at **streamlining** implementation:

-> Security requirements engineering (**GASF**)
Status: **Mature, Operational in ESA**

-> Security Verification and Validation - Automated penetration testing (PenBox)
Status: Under Development

-> Security Risk Management (SEST)
Status: Mature, Operational

Generic Application Security Framework



A recap.. What are the key support tools? (2)

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Penetration Testing & Security Awareness Management in a Box

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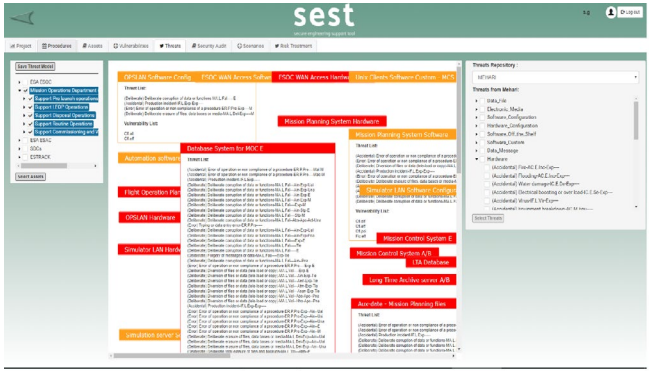
Security Engineering Support Tool



A recap.. What are the key support tools? (4)

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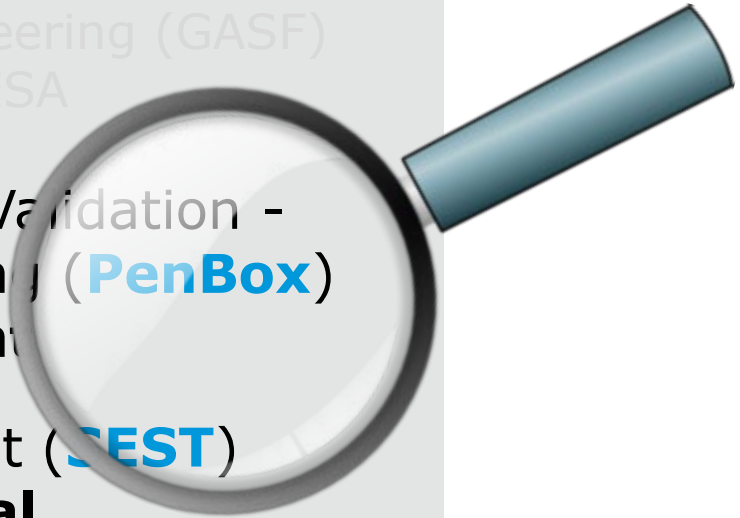

-> Security Verification and Validation - Automated penetration testing (**PenBox**)
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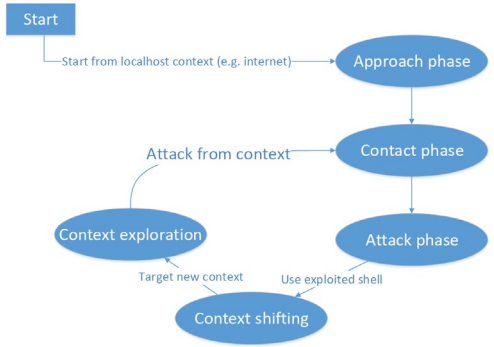
Status: **Mature, Operational**

PenBox: Why automate?

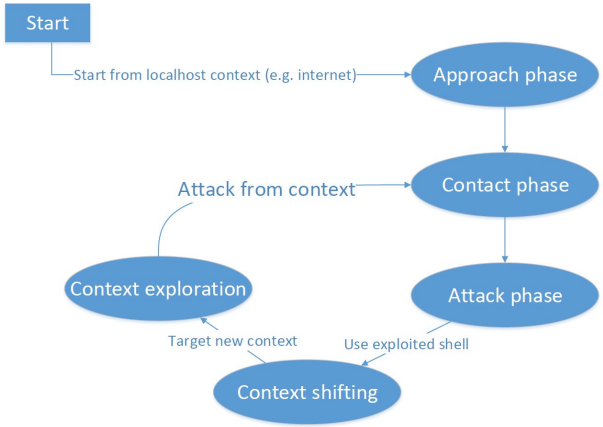
- Comprehensive security testing of software and systems is **complex and expensive**
- Penetration testing in particular is high-cost and **effort-intensive** - not scalable
- Dedicated **experts** and specialised tools
- Broad attack surface at multiple layers, however actions are **repeatable** (cf. IKC)
- Results not easily interpretable for non-experts
- Need to remain aware of **limitations**

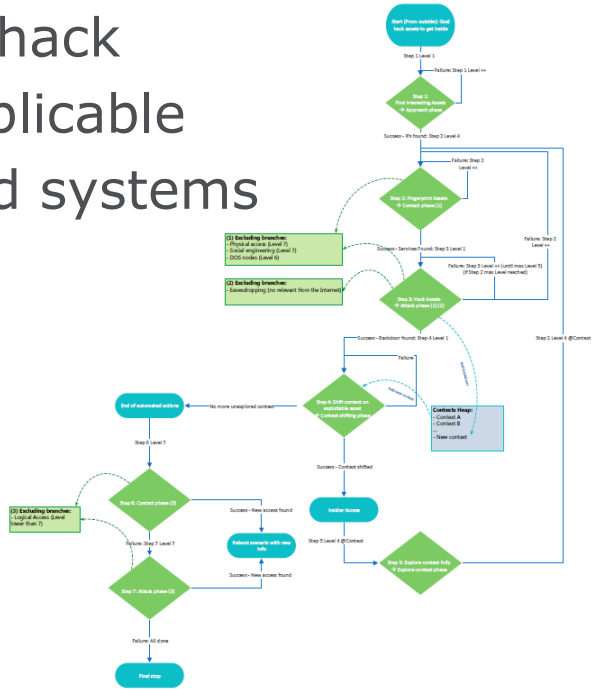


PenBox: Global Approach

1. Define Macro Threat **Scenarios** and **Attack trees**

Generic phases and "hack asset" attack tree applicable for majority of ground systems





Generic tree refined for specific scenarios

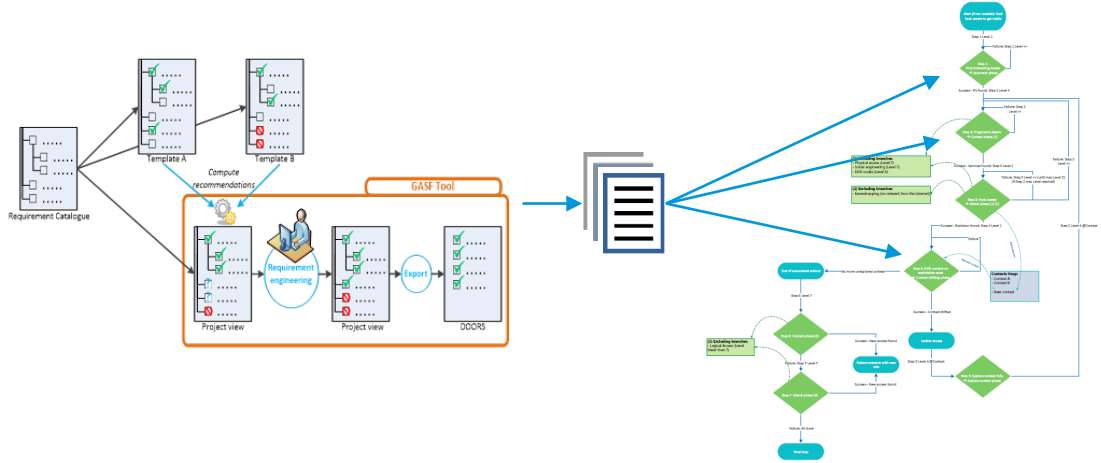
e.g. Send malicious command:

- Hack asset
- Fingerprint asset (MCS)
- Verify commanding capability

PenBox: Global Approach

2. Define security **requirements profile** for ground systems

Assign as security **controls with traceability to attack nodes**



Example attack node:

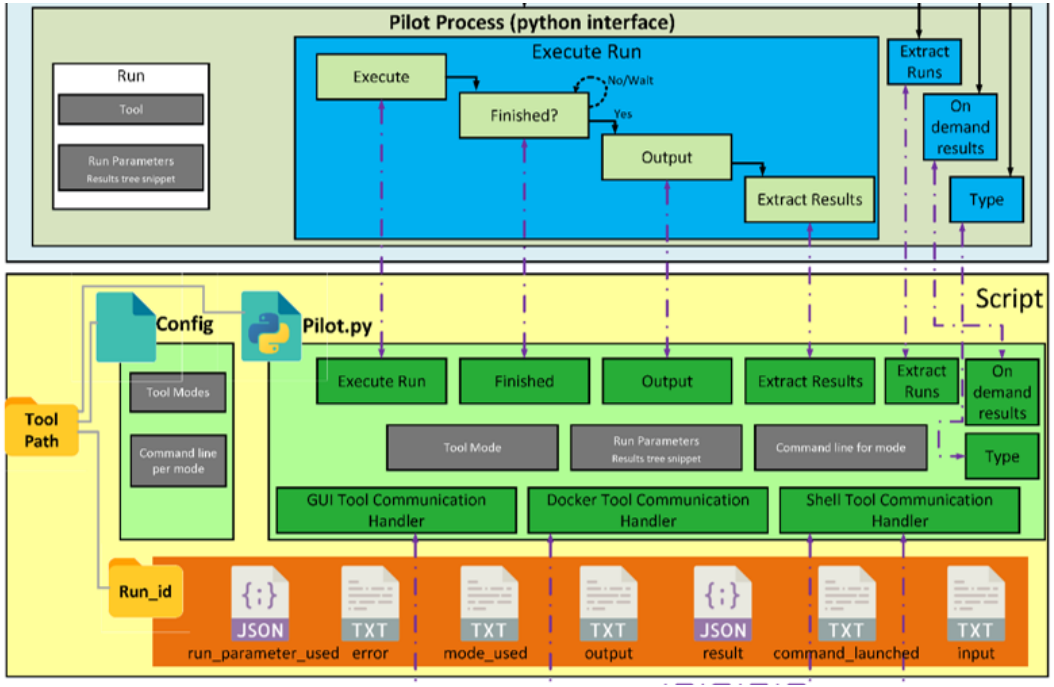
Gain access to application: Brute force

Requirement:

The system shall detect and lock-out repeated unsuccessful authentication attempts

PenBox: Global Approach

3. Define automation architecture for **chaining penetration testing tools** with modes, configuration, execution and logic



- Tools require valid inputs for valid runs – parameter types and execution modes
- Valid runs execute and results are extracted to a results tree
- Pilot.py process computes valid runs for execution from results tree (chaining)

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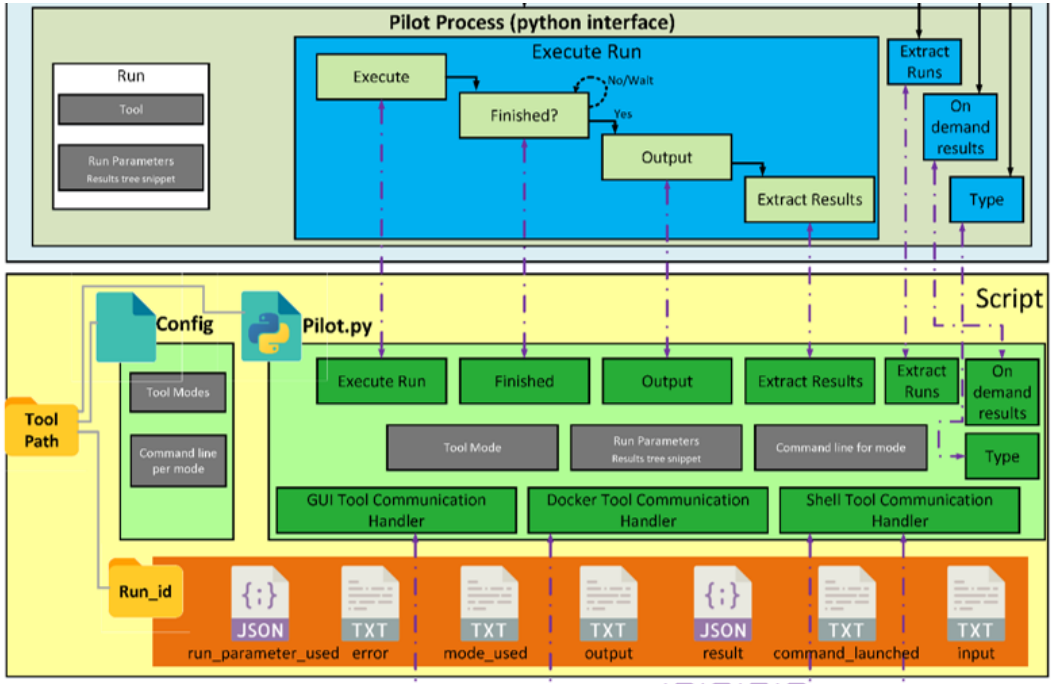


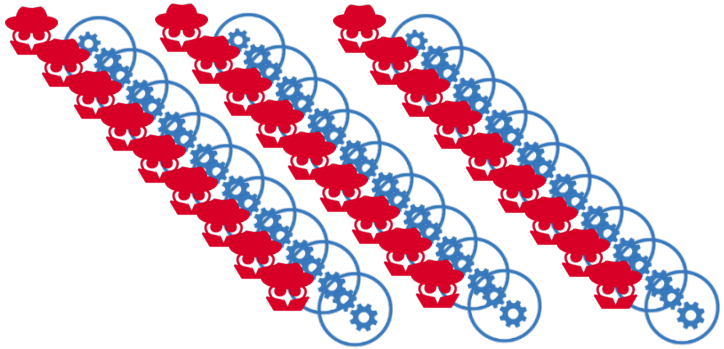
- Tools will not run unless there are new results (no repetition)
- Tools may be “on-demand” or “continuous”
- Tool input handlers:
  - Shell (most common)
  - GUI (Xvfb, PyAutoGUI)
  - Docker (rare)

PenBox: Global Approach

3. Define automation architecture for **chaining penetration testing tools** with modes, configuration, execution and logic

Arpspoof	JohnTheRipper	RIPE
Bluto	LocalSubnetsDetector	SimplyEmail
Burpsuite	metagoofil	slowhttptest
censys.io	Metasploit	smbclient
Crackmapexec	Mimikatz	Sqlmap
CTFR	Net group	SSH-audit
dnsenum	Net user	SSHScan
dnsmap	nikto	sslscan
dnsrecon	nmap	sslyze
dnssearch	nslookup	subfinder
enum4linux	ODIN	sublist3r
Fierce	OpenVAS	theharvester
getprivs	Patator	tshark
getsystem	Pwned	unix_privesc_checker
gobuster	raven	wafw00f
Hot Potato	Responder	waldo
HPING3		whois
Hydra		
InSpy		

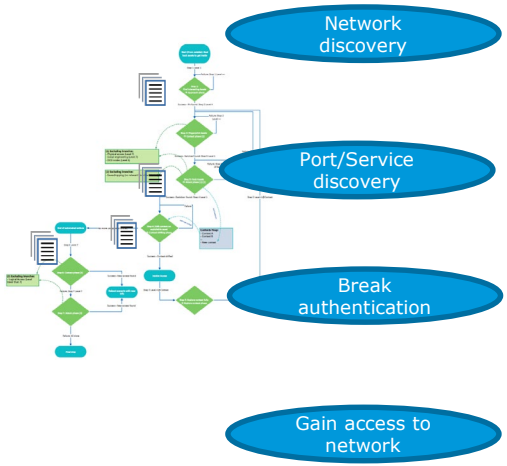
- Over 50 open source penetration testing tools benchmarked and integrated!



PenBox: Global Approach

4. Allocate tools to attack nodes to **execute** a Scenario's attack tree on a System Under Test

Attack tree



Tools

SUT

Results tree

PenBox: Global Approach

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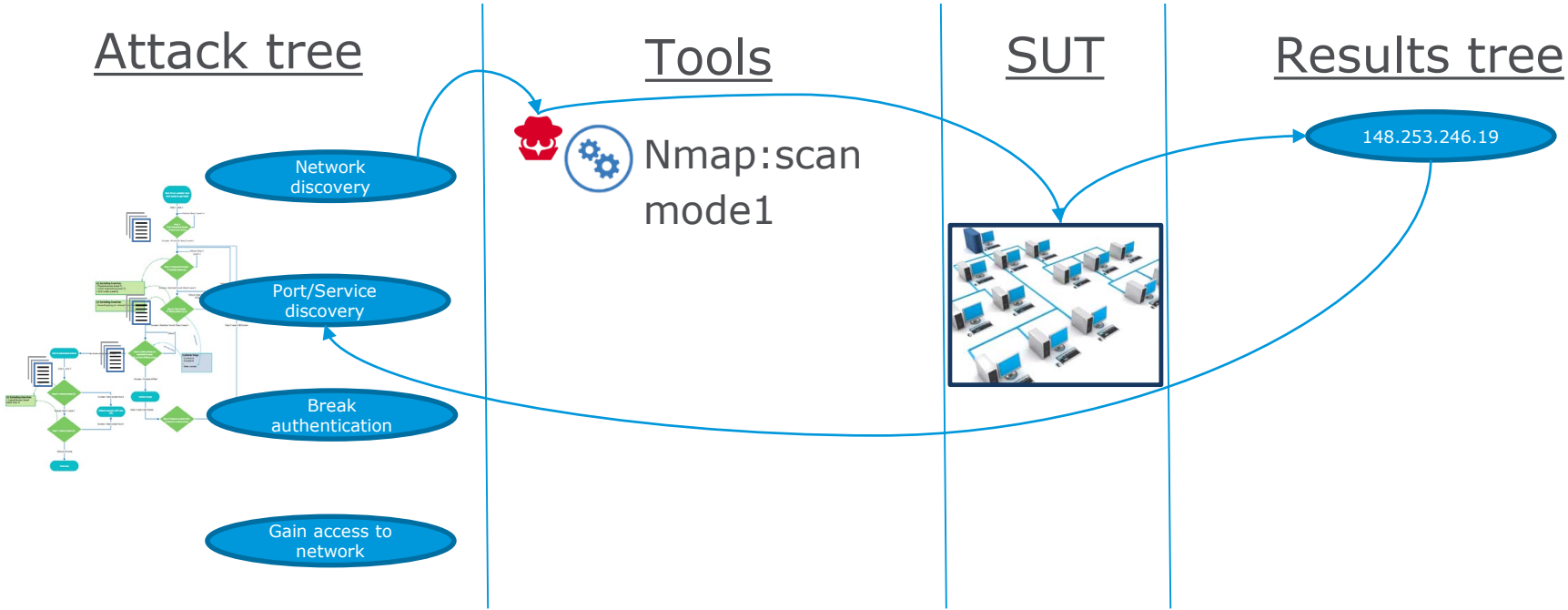

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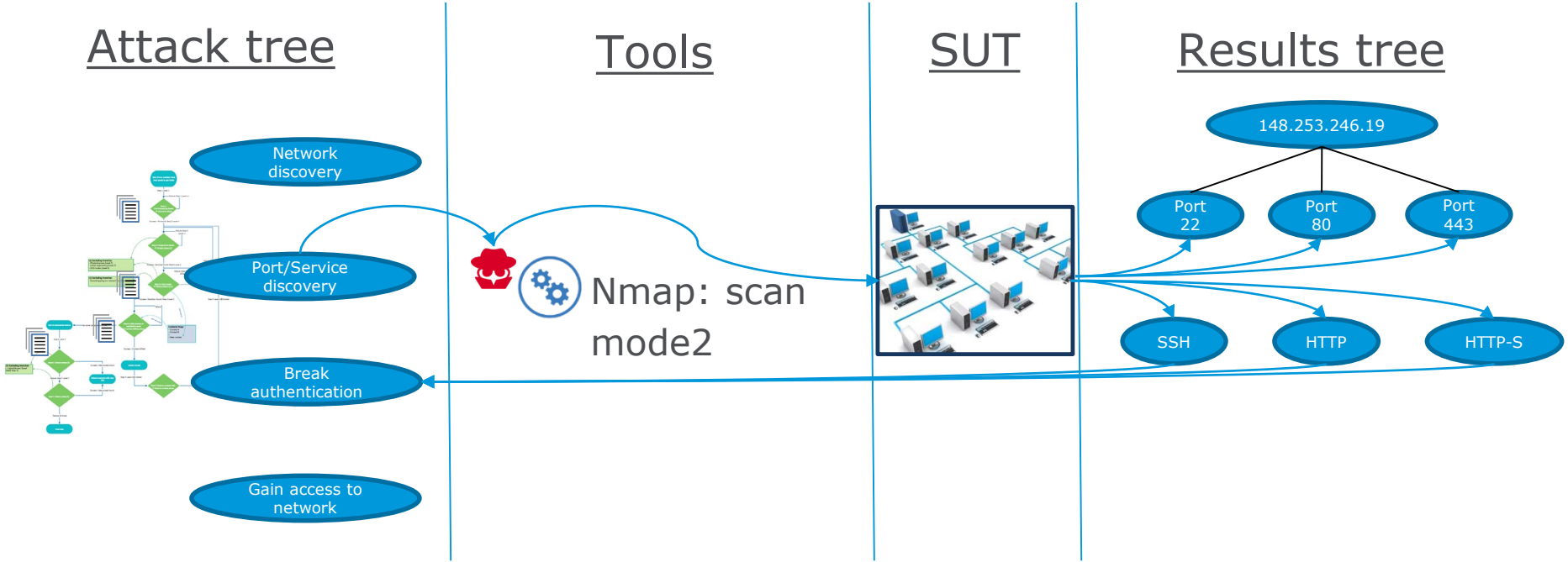

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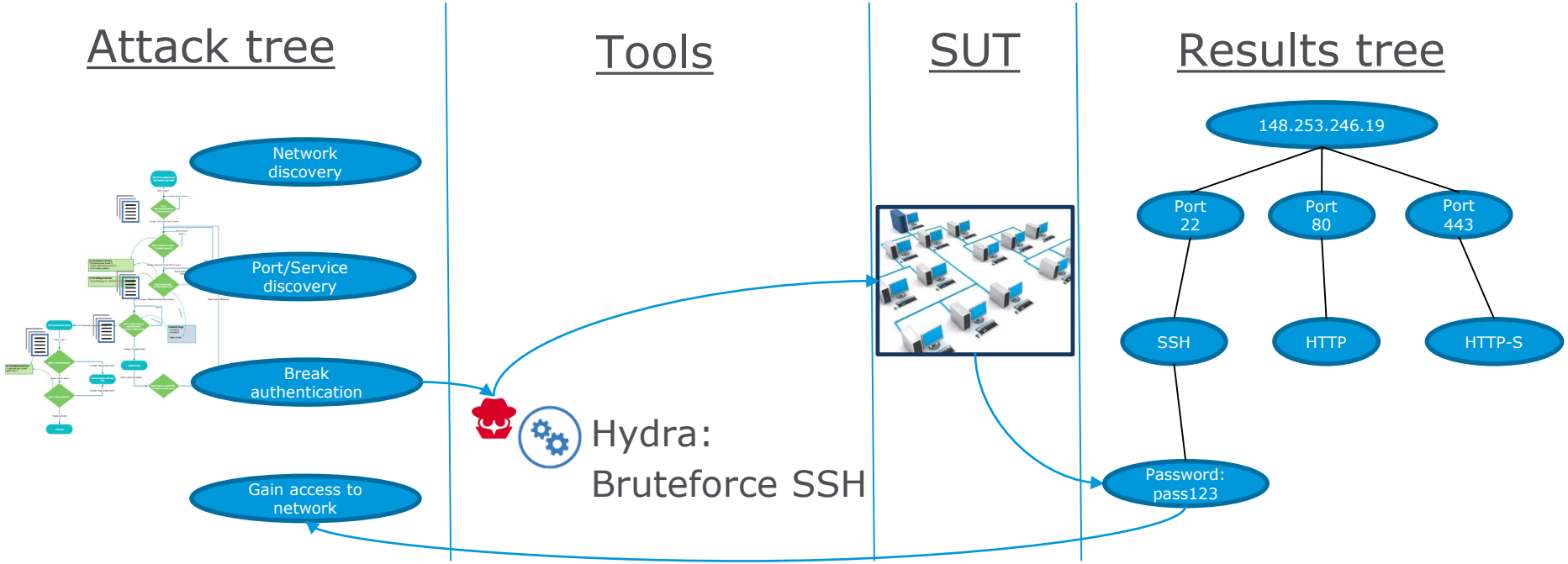
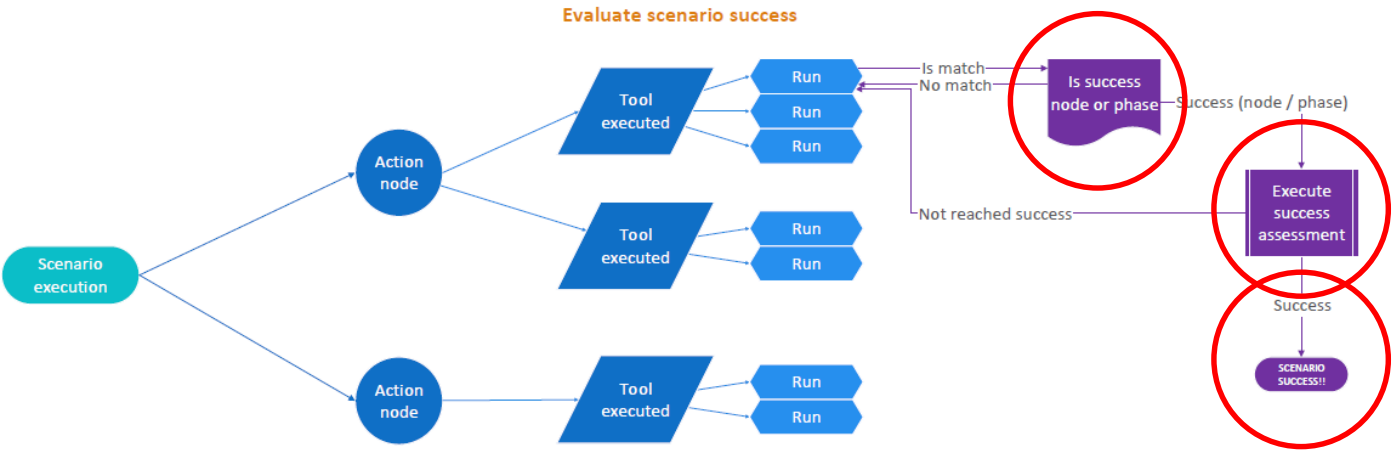


PenBox: Global Approach

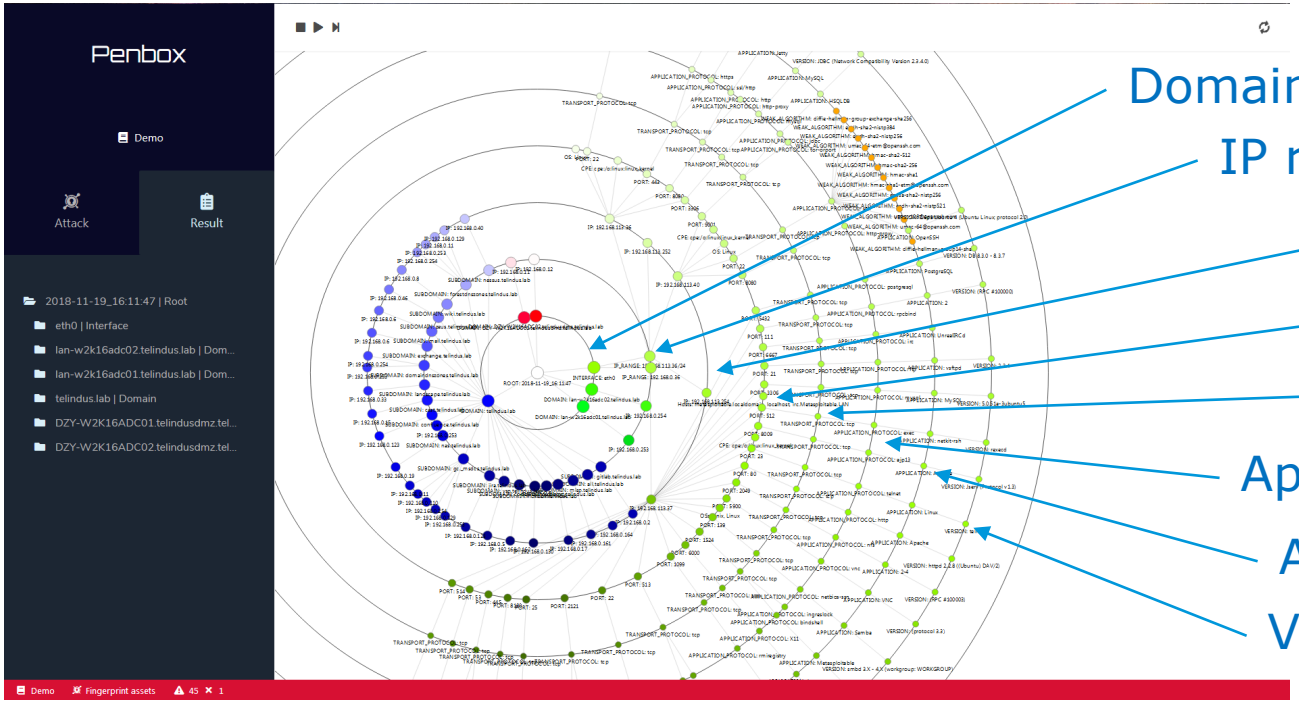
5. Implement logic from results to prove scenario success and test and verify security requirements



- Trigger/success nodes defined per requirement
- Executes requirement assessment logic
- Assessment result pushed to result tree

PenBox: Global Approach

6. Display results and generate reports



PenBox: Global Approach

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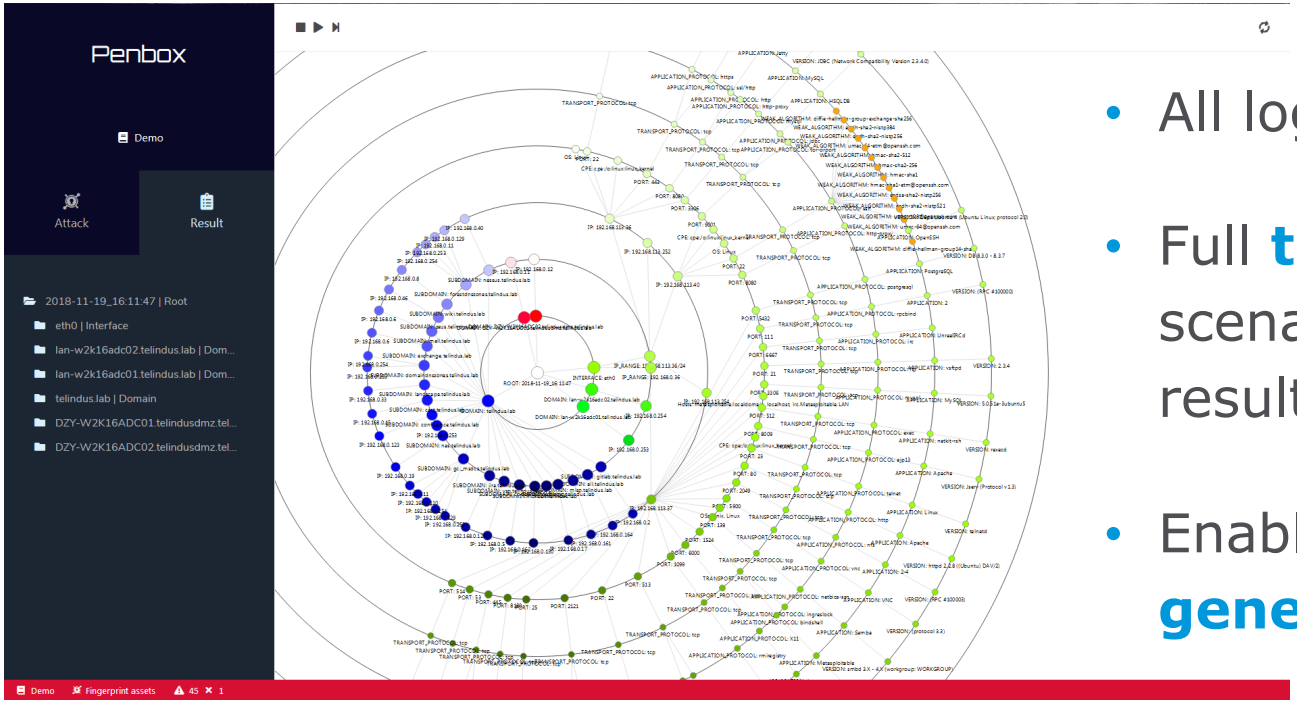
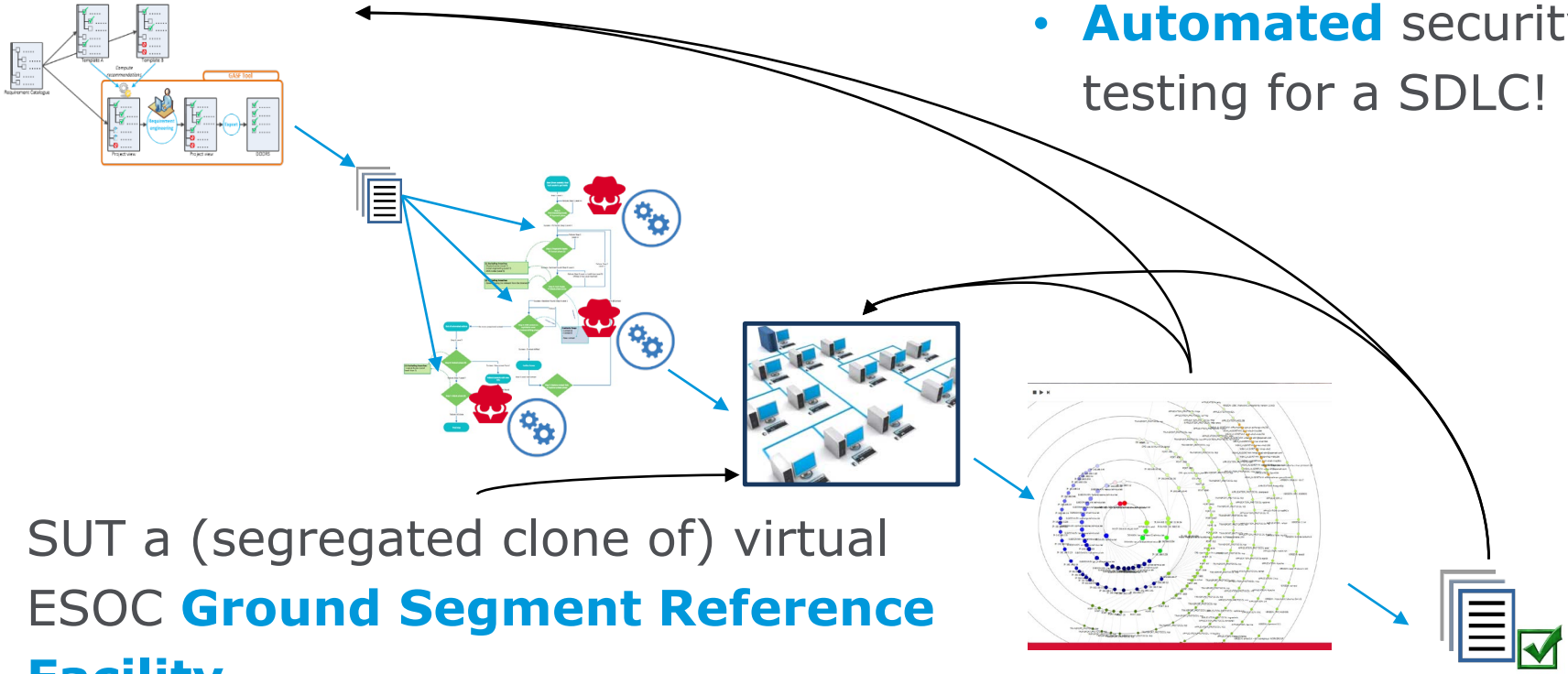


- All log data is recorded
- Full **traceability**: scenario-attack node-tool-result-SUT-requirement
- Enables **detailed report generation**

PenBox: Proof of Concept successful!



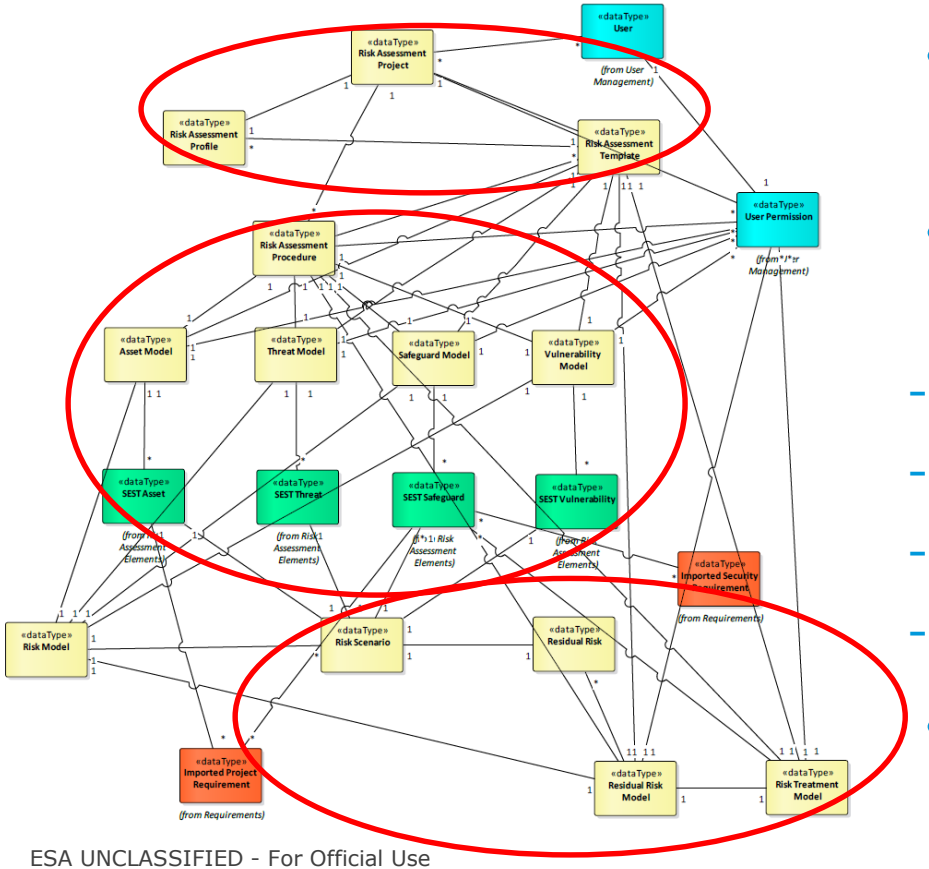
- **Automated** security testing for a SDLC!

- SUT a (segregated clone of) virtual ESOC **Ground Segment Reference Facility**

SEST: Brief Overview

- Security Risk assessment: Another typically **complex and cumbersome process**
- SEST Tool (web-based) enables a **guided and semi-automated implementation** of a risk assessment methodology (MEHARI)
- For use at **earliest phase** of the system engineering lifecycle

SEST: Brief Overview – Data Model

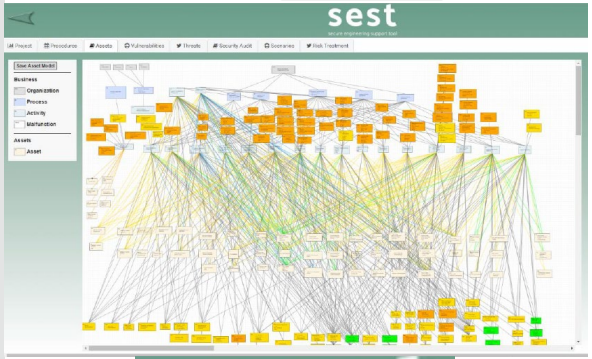


- Multiple Projects and associated profiles for re-use
- Risk Assessment procedure uses various data models:
  - Asset model
  - Threat model
  - Vulnerability model
  - Safeguard model (Requirements)
- Computed risk scenario, residual risk and risk treatment models

SEST: Brief Overview - conclusions

- Guided methodology and **easy UI**
- **Increased efficiency** (with limitations)
- Automatic computations (malfunctions<->business processes, seriousness<->risk scenarios, etc.) for **faster iterations**
- Exportable results and project templates for **re-use**. Support to **Audits**
- Asset model candidate for future **MBSE link**
- **Import/mapping of requirements** (GASF)

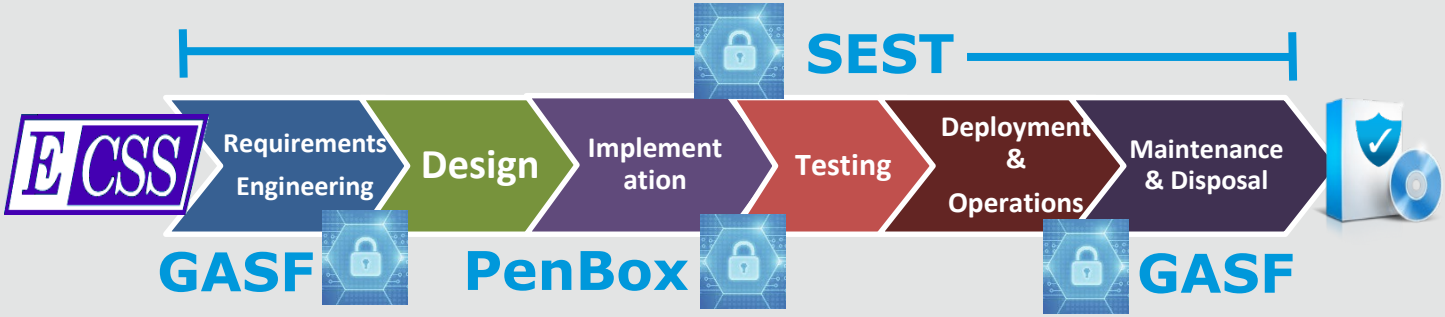
Project | Procedures
Assets | Vulnerabilities
Threats | Risk Treatment
Scenarios | Audit



sest
secure engineering support tool

Secure Systems Engineering for Space: Future

- Follow-up activity “SSE4Space”: consolidate and integrate to form a streamlined **framework for secure systems development**



- Integration with **MBSE** framework
- Space **Data Link** Security
- **Space Segment** Security
- Assurance: Integrated **Certification concept**
- Additional testing tools

Thankyou for your attention!

Questions?

Secure Systems and Software Engineering

- ESOC has lead a gap analysis and subsequent definition of an ESA-internal **Secure Software Engineering (SSE) standard** (released 2016).
  -> Panel and WG composed of representatives from all programmes and directorates

- ESSB-ST-E-008: Secure Software Engineering **Standard** (normative)
  ->Standardizing secure SW engineering processes identified by the gap analysis
- ESSB-ST-E-007: Secure Software Engineering **Handbook** (non-normative)
  -> Complementing the standard: guidelines and recommendations
- ESSB-HB-E-009: **Glossary** of Secure Software Engineering Terms

- Applicable standard for the ESOC ISMS and all in-house SW developments
- Full adoption at ECSS level is planned

GASF: General Application Security Framework

- Security requirements specification and management is a **complex subject**
- The General Application Security Framework tool (GASF) is an **easy-to-use** tool:

- **Simplifies** the application of a complex subject matter for non-experts **whilst not diminishing** the suitability and effectiveness of security controls
- Permits the **efficient** definition of security requirements for a mission, system or software development
- Supports **approval workflows** and informed decision making
- Supports **document generation** (SRS)

The framework consists of 3 pillars:

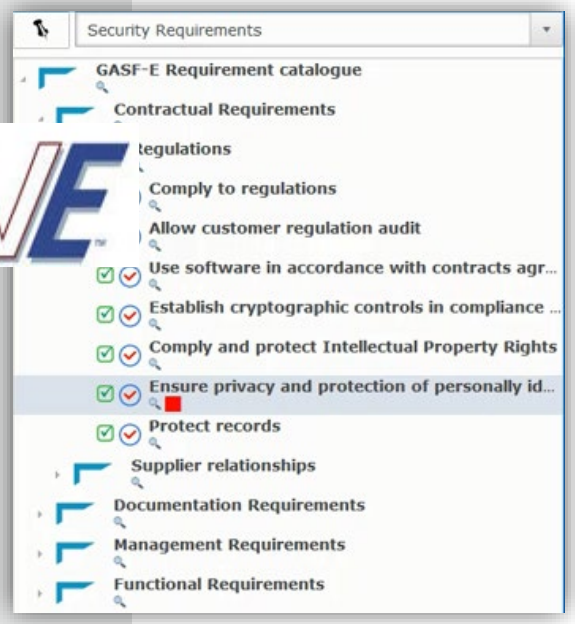
1. Security requirement **catalogues**
2. Context-specific **profiles** which specify **needs**
3. Requirements engineering **tool**

GASF: Security Requirement Catalogues

• **Structured** set of security requirements that may be **used as reference** for composition of a selection / profile

• Derived from **well-known sources**:

esa European Space Agency | ISO International Organization for Standardization | Common Criteria | NIST National Institute of Standards and Technology | CWE

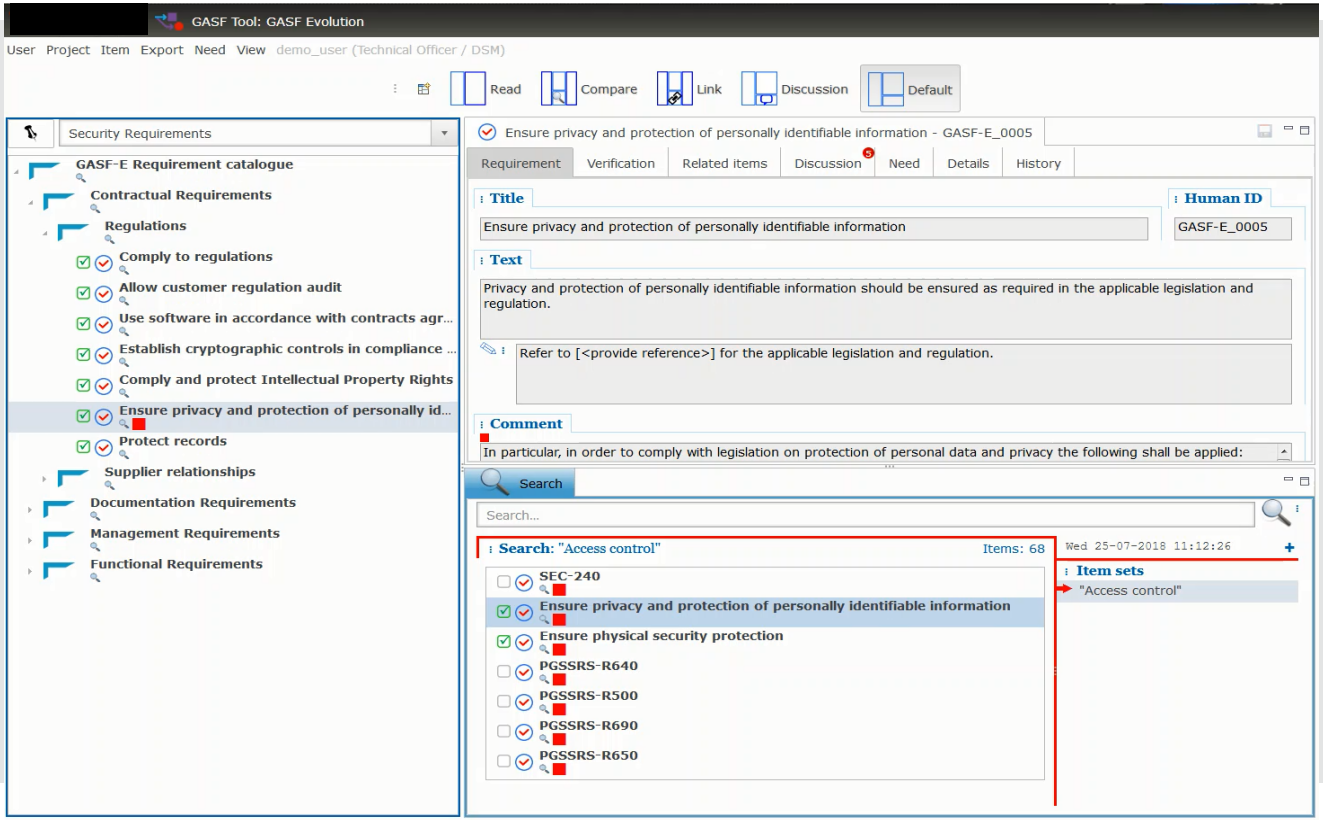


• **GASF Evolution Requirement Catalogue** compiles lessons learned and existing security requirements catalogues from across the agency:
  - ESA SSE
  - ESRIN
  - ESTEC

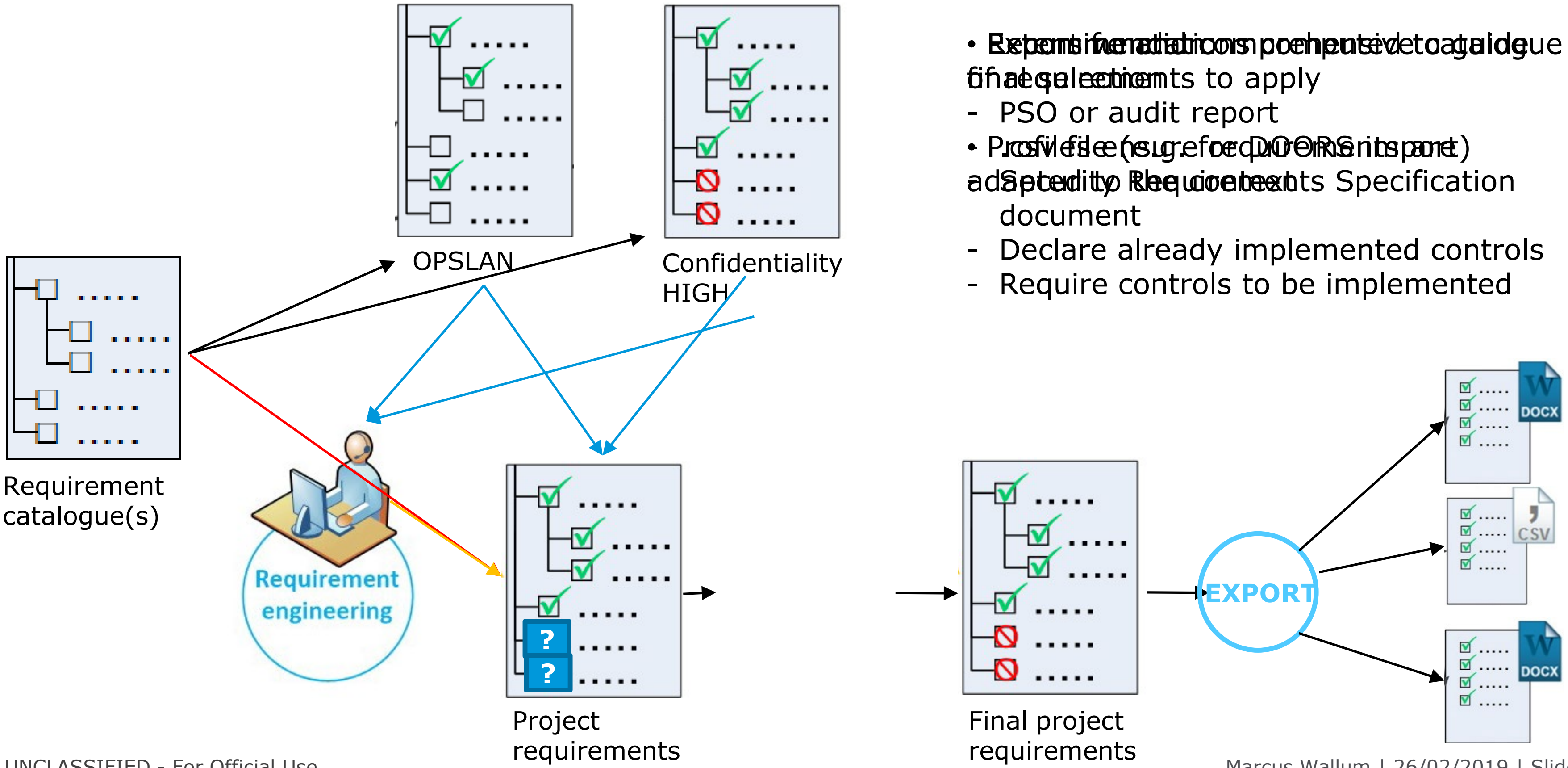
- Merged catalogue is a candidate for use as a **reference throughout the Agency**

GASF: Tool

- **Web Application**
- Requirements can be **amended** or **commented**
- Projects can be **compared**
- Ad-hoc discussions and comments support **collaboration**
- **Search engine**
- Capture of **details and history** (versioning, ID, verification method etc)
- Generation of **reports** (PSO can review deltas verses profile recommendations) and **SRS**



GASF: Workflow



- Recommendations presented to guide final selection
- Profiles ensure requirements are adapted to the context

- Export comprehensive catalogue of requirements to apply
  - PSO or audit report
  - .csv file (e.g. for DOORS import)
  - Security Requirements Specification document
  - Declare already implemented controls
  - Require controls to be implemented