UNIVERSITÀ DEGLI STUDI
DI CAGLIARI

HR EXCELLENCE IN RESEARCH

Direzione per la ricerca e il territorio
Dirigente: Dott. Gaetano Melis

Finanziato dall'Unione europea
NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

Piano Nazionale di Ripresa e Resilienza finanziato dall'Unione Europea – NextGenerationEU -

Missione 4 - Istruzione e Ricerca - Componente 2 - Dalla Ricerca all'Impresa - Linea di investimento 1.3 - Creazione di "Partenariati estesi alle università, ai centri di ricerca, alle aziende per il finanziamento di progetti di ricerca di base"

Partenariato Esteso SERICS (PE00000014)

Avviso Pubblico per la presentazione di Proposte progettuali per la realizzazione di attività di ricerca industriale e sviluppo sperimentale

ALLEGATO 2 – AREA TEMATICA DI RICERCA

Soggetto Esecutore e Spoke Leader: Spoke 3 "Attacks and Defences" – Università degli Studi di Cagliari (UNICA) – CUP F53C22000740007

The "Attack and Defense" Spoke aims to analyze emerging attack methodologies and develop advanced systems for their detection and for the identification of guidelines for the design of computer systems characterized by reduced vulnerabilities with respect to new attack categories. The detailed objectives can be divided into four macro categories: i) Development of advanced tools for malware analysis and software analysis aimed at identifying vulnerabilities that could be exploited by malware; ii) Development of network traffic analysis tools to identify communications related to ongoing attacks; iii) Development of machine learning systems that are robust to attacks and from which it is possible to extract knowledge aimed at creating more advanced tools for the timely analysis of attacks and their early detection; iv) Analysis of the "human factors" involved in an attack with the development of tools for the analysis and correlation of information from OSINT sources and for the defense and prevention of attacks based on social engineering techniques.

This Spoke aims to achieve its objectives within four complementary projects. These projects address core research issues for developing effective defenses against sophisticated attacks. The **CSS** project will address social engineering and human factor issues that account for the preliminary stages of preparation and execution of a cyber attack. In the later stages of an attack, sophisticated techniques are used to evade detection and response mechanisms. The **COVERT** project will develop analysis and detection tools for the early detection of silent software vulnerabilities and obfuscated malware. The detection of sophisticated malicious activities through **network** traffic analysis requires the development of advanced tools addressed within the GERONIMO project. Attack detection techniques increasingly use machine learning methods whose security is essential to consider them reliable. The **SOS AI** project will focus on attacks against machine learning systems and will develop appropriate design techniques for the execution of these algorithms in a hostile environment. The four projects will work synergistically by sharing data, case studies, and results.

This Spoke aims to attain a twofold goal: on the one hand, to increase the capabilities for the independent analysis of sophisticated attacks, that is, attacks designed to evade existing detection techniques: on the other hand, to develop advanced capabilities for the design of information and defense systems that can be resilient to the continuous change and sophistication of cyber-attacks, especially those targeting critical infrastructures.

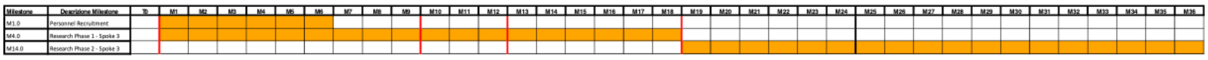
The document is organized as follows. It first outlines the overall plan of the activities and milestones of Spoke 3. Then, it describes the issues that proposals under this call should address and the related expected results and impacts.

Each project proposal should focus on addressing one or more specific project scopes. The activities that can be funded are pilot projects, demonstrators, and/or experiments in line with the proposed actions and/or projects, demonstrators, and experiments with a high degree of complementarity with these actions.

Plan of activities

The project started on 1st Jan 2023 (M1). The duration of the project is 36 months.

The overall plan of the activities and milestones of the Spoke is summarized in the diagram shown in Figure 1. The figure details each type of activity, separated by horizontal bars, to which the partner exposes the costs of the project. The figure also displays the checkpoints at which the Spoke leader and partners must summarize the findings obtained in the corresponding period as vertical red lines.



Milestone	Descrizione Milestone	T0	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
M1.0	Personnel Recruitment		🟧	🟧	🟧	🟧	🟧	🟧																														
M4.0	Research Phase 1 - Spoke 3		🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧																		
M14.0	Research Phase 2 - Spoke 3																				🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧

Figure 1. Gantt diagram

For each project scope (i.e., Ambito Progettuale) included in Spoke 3, the sections below provide a detailed breakdown of the tasks and their corresponding main objectives.

CSS
Cyber Social Security

Abstract

It is a common viewpoint that the combination of data coming from social media, smart-phones and from urban sensors can actually enable the ability to carry out in-depth analyzes and understand complex phenomena based on human behavior, opening new scenarios for the development of numerous innovative services and applications. By following this research line, the recent paradigm of Social Sensing further emphasized this vision, since it proposed an integrated model in which users themselves are turned into sensors, entities that produce simple rough information which is processed and aggregated in order to generate some valuable human-based findings obtained through the combination and merge of individual-based data.

Beyond sensing applications, as those focusing on tracking vehicles to avoid traffic congestions or healthcare tracking and predicting people's lifestyle, a big research effort has been made to analyze text-based signals, such as those coming from social networks like Twitter or Facebook. The reason is twofold: first, methodologies for Natural Language Processing (NLP) rely on very consolidated and effective algorithms, thus it is relatively simpler to process textual data rather than audio, video or especially environmental-based ones. Second, despite its size grows more slowly than video or audio data, textual content represents a very rich, interesting and valuable information source. Furthermore, in a scenario where cyberspace events impact on the real world and influence the political, social and cultural spheres, it is essential to have the cognitive, methodological superstructures as well as the cyber-physical infrastructures necessary to guarantee the resilience of civil society. The purpose of this project is to affect these issues through the proposition of multidisciplinary methods, techniques and tools (IT; psychological, economic, legal, engineering, related to social sciences) capable of operating a Cyber-Social risk management in civil society. To this end, it is necessary to reinterpret the functions of Cyber Security in Cyber Social contexts:

Detection: characterize, identify, understand, and predict significant cyber-mediated events and changes in human, social, cultural, and political behavior as well as the methods for monitoring and protecting "social" end-points, thus being able to operate with devices (IT and IoT) and diversified information sources (OSINT/CLOSINT) taking into account the national and international legal framework (GDPR; NIS; CyberSecurity Act).

Prevention: redefine the processes of census and prevention of "accidents" in the light of new critical assets (individuals, groups, communities, software applications and infrastructures for

the public service, etc.), including elements of physical, organizational and applicative security as well as socio-political, economic, psychological and legal context.
Response: defining intervention and cooperation protocols between the main players in civil society in order to guarantee resilience and social security, including through homeland security technologies and the fight against cyber terrorism and cybercrime.
The review of the Detection-Response-Prevention cycle will also clarify the limits within which it is possible to find and manage information while protecting the citizen's right to privacy and the security of civil society.
Work Breakdown Structure
WP1 - Innovations for Cyber Social Detection
Characterize, identify, understand, and predict significant cyber-mediated events and changes in human, social, cultural, and political behavior, as well as the methods for monitoring and protecting "social" end-points, thus being able to operate with devices (IT and IoT) and diverse information sources (OSINT/CLOSINT) taking into account the national and international legal framework (GDPR; NIS; CyberSecurity Act) and geo-political scenario.

Task 1.1 Methods for extraction of social sensor data
Task 1.2 Methods for extraction of urban sensors data
Task 1.3 Demonstrators - software and Infrastructure for extraction of cyber social data

WP2 - Innovations for Cyber Social Response
Defining intervention and cooperation protocols between the main players in civil society in order to guarantee resilience and social security, including through homeland security technologies and the fight against cyber terrorism and cybercrime.
Task 2.1 Methods for processing of social streams
Task 2.2 Methods for processing of urban stream
Task 2.3 Definition of CSS Response process patterns
Task 2.4 Demonstrators - software and Infrastructure for analyzing and processing urban and social streams

WP3 - Innovations for Cyber Social Prevention
Redefine controls and processes for the prevention of "accidents" in the light of new critical assets (individuals, groups, communities, software applications, and infrastructures for the public service, etc.), including elements of physical, organizational, and applicative security as well as socio-political, economic, psychological and legal context.
Task 3.1 Prevention controls and functions for managing CSS
Task 3.2 Guidelines for preserving rights, privacy, and security in the CSS context

COVERT

In searCh Of eVidence of stEalth cybeR Threats

Abstract

An increasing percentage of cyber attacks are characterized by a chain of different components whose harmful effect is realized only in the presence of specific contexts such as configurations, vulnerabilities of software components, etc. These attacks, known as Advanced Persistent Threats (APT), are characterized by the execution of malware "invisible" to detection systems, and often exploit vulnerabilities that remain silent for a long time, and have an extremely slow activation. The difficulty in identifying attacks is due on the one hand to execution profiles that are similar to those exhibited by legitimate activities, and, on the other hand, to the use of specific components designed to obfuscate the code or evade or mislead the analysis and detection tools. The growing sophistication of attacks makes their detection extremely difficult, requiring the development of new models for the analysis and detection of attacks and new methodologies that provide for the cooperation and integration of several different approaches.

The partners involved in this project will work jointly in producing a Threat Model aimed at relating the techniques and tools used in modern attacks with the malicious goals of the attackers. While in the past it was possible to clearly associate specific code fragments of program behaviour to a clear malicious intent, advanced attacks distribute the code and activities leading to the malicious goal in space and time, so that the analysis and detection tasks need to be reformulated. The complementary expertise of each partner will provide the unique contribution to the definition of an effective threat model. In the following, the specific methodologies that will be developed within this project are detailed.

To this end, we will study and develop advanced software and network traffic analysis methodologies and, in particular, tools for the early detection of vulnerabilities, and the timely detection of harmful components. This goal will be attained through the integration of complementary models and techniques for static and dynamic analysis supported by artificial intelligence and machine learning techniques as well as information obtained through OSINT.

Aspects related to the collection of large amounts of data both at the network level, and from software repositories and execution traces of binaries will also be addressed.

Thanks to the collaboration with companies, tests on different case studies will be carried out and proofs of concepts will be released to make the results available to the research community.

Work Breakdown Structure

WP1 - Analysis and detection of Evasive Malware and Stealth attacks

WP Description: The evolution of techniques for threat analysis and detection forced malware developers to increase the defense mechanisms embedded in their attacks. Those defense mechanisms comes in the form of evasion techniques and stealth behavior. Modern threats can include evasion techniques that are able to detect if they are executed in a sandbox whose goal is to detect potential harmful behavior. For example, when an evasive malware sample detects the execution in a sandbox, then it exhibits a non-malicious behavior, so that so that they are flagged as not harmful, and their execution is allowed in a real environment. Threats can also exhibit an execution profile similar to that of legitimate applications, so that it is difficult to distinguish it without creating a large number of false alarms. The code itself might include different obfuscation techniques that prevent a thorough static analysis of the code.
The goal of this WP is to analyze the evasion and obfuscation techniques employed by modern malware both in traditional execution environments, and in industrial control systems, and deploy novel solutions that allows the analysis and detection of sophisticated malware samples.
Task 1.1 - Static and dynamic analysis frameworks to support evasion-detection techniques
Task 1.2 - Evasive and Stealth attacks in industrial control systems.

WP2 - **Measuring the robustness of detection systems against evasion attacks**
WP Description: Modern threats leverage on a large variety of weaknesses and vulnerabilities in operating systems, execution environments, communication protocols, and applications. Vulnerabilities often affect libraries that are part of applications, and whose correction is far from being straightforward. Tracking the impact of vulnerabilities, and predicting new vulnerabilities is a new challenge that needs to be addressed to be prepared in the deployment of defence in depth approaches. In particular, most recent vulnerabilities allow the development of evasive and stealth malware. Thus, their prediction allows the design and development of advance threat detection mechanisms that can face novel stealth and evasive behavior. Accordingly, this WP aims at developing methodologies and tools for the analysis of known vulnerabilities in order to develop approaches allowing to predict the likelihood of new vulnerabilities and their impact on detection mechanisms. This WP will also develop techniques for the categorization of evasive and stealth techniques with the aim of developing a mutation engine to measure the impact of new evasion and stealth techniques on detection systems. While the above two objectives will be based on the analysis of data from public repositories of weaknesses and vulnerabilities, a third objective of this WP is to develop a formal framework for measuring the impact of evasive and stealth techniques employed by modern threats on detection systems.

Task 2.1 - Large-scale repository mining for vulnerability analysis and impact prediction

Task 2.2 - Definition of a taxonomy of anti-analysis/evasion techniques and design of a mutation engine to generate evasive samples for testing existing analysis environments
Task 2.3 - Development of a formal framework to model and measure the effect of evasion techniques on the precision of static and dynamic analysis.

WP3 - Machine Learning Approaches to Obfuscated and Evasive Attack Analysis and Detection

WP Description: In the past decade Machine learning and deep learning approaches definitely moved from being the topic of a small area in the scientific literature on cybersecurity, to the mainstream of academic and industrial research. Nowadays, all cybersecurity products are based directly or indirectly on machine learning approaches, for their ability to generalize from examples that allows detecting never-before-seen attacks. Attackers are consequently improving their threats to evade detection through stealth and evasive techniques specifically developed to exploit the weaknesses of current machine learning solutions. This WP will focus on the development of machine learning approaches and techniques tailored to face the increased sophistication of threats in terms of their evasion capabilities, and the related need to extract explanations that allows retrieving the knowledge gathered from data. Deep learning and advanced neural network approaches are currently being extensively evaluated as detectors, but they are showing to be extremely vulnerable to easy-to-implement evasion techniques. Thus, their use in cyberthreat detection should include specific training approaches to exploit the generalization capabilities without introducing vulnerabilities that can be exploited by evasion techniques. Malware detection, network intrusion detection and security information and event management systems will be the areas in which these approaches will be developed. Machine learning approaches will also be developed for the analysis of source code repositories for the early detection of vulnerabilities.
Task 3.1 - Development of context-based techniques for static and dynamic evasive threat detection inspired by deep learning approaches
Task 3.2 - Design and development Large Source Code Scanners for Large scale silent Vulnerability detection in Free and Open Source Software
Task 3.3 - Use of OSINT information to improve early detection capabilities of SIEM
Task 3.4 - Development of a Network-IDS based on Self-Organizing Incremental Neural Networks
Task 3.5 - Explainable AI techniques for enhanced malware analysis and improvement of detection techniques

Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA | UNIVERSITÀ DEGLI STUDI DI CAGLIARI

GERONIMO

GEneralized Real-time On-line National Internet MOnitoring Infrastructure

Abstract

The strategic role of network connectivity in many of the vital sectors of society made the Internet one of the critical infrastructures whose availability is crucial for any organization. Thus, there is a need for new Internet monitoring and surveillance solutions. Starting from these premises, the project focuses on a selective Internet surveillance solution, consisting of a distributed monitoring infrastructure operating on a national scale, able to dynamically collect, filter, classify and analyze traffic and trigger real-time alerts based on the detection of specific attack patterns. Selectivity must be provided by traffic analysis engines with advanced inferential capabilities empowered by AI/ML technologies and integrating honeypot capabilities to better detect hostile activities also at the application level. Detection effectiveness relies on the ability to correlate information gathered in distinct observation points. Correlation enabled by federated technologies will be extremely helpful to build new knowledge from the combination of multiple, apparently unrelated events, allowing the development of more sophisticated and reliable models that are able to better understand the deepest dynamics governing the traffic flows or malware activities of interest. This can be useful in developing automatic detection, alerting and filtering mechanisms effective against next-generation APTs characterized by polymorphic and adaptive behaviors and will foster synergies between research, LEAs, technology manufacturers and ISPs, for countering large-scale attacks.

Work Breakdown Structure

WP1 - Developing Selective Traffic Capture and Monitoring Tools

The WP will explore the design of new highly selective Internet surveillance systems, mainly based on Deep Packet Inspection and advanced protocol analysis technologies able to capture and store in a privacy-aware and secure way only the traffic data that may be of interest due to a specific behavior.

Task 1.1 Hierarchical and adaptive traffic capture and analysis, collecting statistical features

Task 1.2 Anonymization techniques for privacy-aware storage of traffic data

Task 1.3 Digital Integrity of Multimedia Contents

WP2 - Traffic Classification and Anomaly Detection Technologies

The detection of threats and anomalies within the huge amount of normal communication flows relies on the ability to correlate local information gathered in multiple network nodes through intelligent detection and/or classification engines relying on dynamic knowledge

bases as well as on traffic models able to recognize the behavior of traffic flows, spot outliers, and hence pick the classic haystack in the needle.
Task 2.1 AI and ML-techniques for Internet traffic modeling
Task 2.2 Developing classification and detection schemes
Task 2.3 Assessing and Validating models and classifiers/detectors

WP3 - Honeypot modules and their coordination
Surveillance engines also integrate honeypot capabilities, complementing traffic sensors to better detect malware activities also at the application level. This WP will be devoted to the exploration of the honeynet architecture and malware analysis activities.
Task 3.1 Honeypot architecture and deployment
Task 3.2 Honeypot Coordination- Results Correlation
Task 3.3 Advanced Malware detection facilities in honeypots

WP4 - Mitigation and Automatic Reaction
Once an attack/menace has been detected, automatic containment technologies available on firewalls or border routers, such as packet and content filtering, can be used to block attack flows or hostile origins. This WP explores the reaction framework in the state-of-the-art Internet scenario.
Task 4.1 Traffic Filtering Distribution Mechanisms
Task 4.2 Automatic Reaction Triggering - Decision Engine

Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA | UNIVERSITÀ DEGLI STUDI DI CAGLIARI

SOS AI
Science and engineering Of Security of Artificial Intelligence
PI: Fabio Roli (fabio.roli@unige.it)

Partners

UNIBA (University of Bari Aldo Moro), UNICA (University of Cagliari), UNIGE (University of Genova), SSSA (Scuola Superiore Sant'Anna of Pisa), UNIVE (Università Ca' Foscari Venezia), TIM (TIM – Telsy)

Abstract

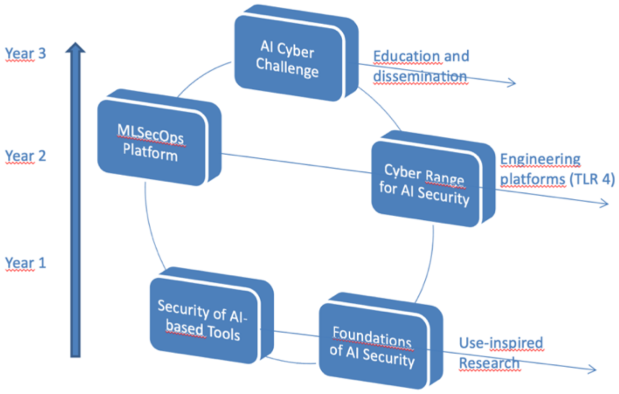
Microsoft reported a dramatic increase of attacks on commercial systems based on Artificial Intelligence (AI) and machine learning (ML) algorithms over the past years. Notably, Microsoft pointed out that companies usually lack the knowledge and tools to secure their ML-powered systems. The Gartner's «2020 Top 10 Strategic Technology Trends» report predicted that 30% of future cyber-attacks might consist of attacks against the AI components of the computerized systems. Over the last ten years, the scientific community proposed many techniques to prevent the execution of attacks against AI/ML, or at least to detect them. However, in most of the cases, these attacks and defenses have been designed to work in laboratory conditions under simplified or unrealistic assumptions that do not consider the requirements of cybersecurity applications (e.g., the practical feasibility of the attacks is often not considered). Given this background situation, the SOS AI project wants to tackle the following 5 open challenges in an integrated way:

1. Foundations of AI security: the theoretical foundations of machine learning have not been originally thought considering intelligent and adaptive attackers who can manipulate input data to purposely subvert the learning process, that is exactly the case of cybersecurity. It's urgent to critically revise the foundations of machine learning focusing on open research questions that arise from practical requirements of cybersecurity applications and require novel, fundamental, understanding of machine learning theory;
2. Security of AI-based Tools and AI-empowered Systems: AI might become the weakest link of the cybersecurity chain, with a large increase of the attack surface. New algorithmic solutions and practical software tools need to be developed for the secure design of AI-based tools and cyber-physical systems made up of AI-based and non-AI-based components;
3. MLSecDevOps: current industrial platforms for developing ML algorithms lack functionalities and modules for evaluating the algorithmic security of machine learning. The SOS AI project will develop a prototype, open-source platform for ML Secure DevOps, for the secure development of software tools containing ML algorithms;

4. AI Cyber Range: there is an alarming scarcity of work that considers realistic environments where ML tools are placed inside a real IT infrastructure. As an example, no previous work considered a real Cyber Range for the security evaluation of AI-based malware detectors. The SOS AI project will develop novel tools for AI security evaluation in next-generation cyber ranges;
5. AI Cyber Challenge: it is urgent to improve the level of university education and the training of industrial workforce on AI Security. The SOS AI project will develop a training program on AI security as part of the SERICS National Cybersecurity Academy.

WP Breakdown Structure

The conceptual organization of the SOS AI project is depicted in the next Figure, which also illustrates the main work packages, their relationships, and the project path from use-inspired basic research to engineering and education.


Year 3
Year 2
Year 1
AI Cyber Challenge
Education and dissemination
MLSecOps Platform
Cyber Range for AI Security
Engineering platforms (TLR 4)
Security of AI-based Tools
Foundations of AI Security
Use-inspired Research

WP1 - Foundations of AI Security

WP1 Description: Machine-learning algorithms are widely used for cybersecurity applications. In these applications, the learning algorithm must face intelligent and adaptive attackers who can carefully manipulate data to purposely subvert the learning process. As theoretical foundations of machine learning have not been originally thought under such premises, learning algorithms have been shown to be vulnerable to well-crafted attacks, including test-time evasion and training-time poisoning attacks (also known as adversarial examples). WP1 is aimed to critically revise the body of knowledge and the state of the art of adversarial machine learning under the lens of the so-called Pasteur's quadrant (https://en.wikipedia.org/wiki/Pasteur's_quadrant) in order to focus on open research questions that arise from practical requirements of cybersecurity applications and require a novel, fundamental, understanding of machine learning theory.

Task 1.1 Foundations of AI security evaluation

Task 1.2 Foundations of attacks against AI and defenses

Task 1.3 Pasteur's quadrant: use-inspired basic research for AI security

WP2 – Security of AI-based Tools and AI-empowered Systems

WP2 Description: this work-package leverages the results of WP1 and delivers novel algorithmic solutions and practical software tools for security evaluation and protection of AI-

based tools and AI-empowered systems. WP2 will contribute to the advancement of the state-of-the-art in three ways: 1) the delivered algorithmic solutions and practical software tools will take explicitly into account the requirements of selected cybersecurity applications, overcoming the unrealistic assumptions of the majority of the solutions proposed so far (e.g., the practical feasibility of the attacks will be taken explicitly into account); 2) challenging and novel application domains will be considered, such as the cyber-physical security of computer vision for driver assistance systems; 3) we will go beyond the state of the art that considered the security of "isolated" machine learning algorithms by analyzing the security of larger, AI-empowered, cyber-physical systems made up of AI-based and non-AI-based components (e.g., malware detection architectures using black listing, machine-learning static analysis, etc.). The activities of this WP2 will be coordinated with the WP4 of the project SANDSTORM of SERICS Spoke 7.
Task 2.1 Methods for security evaluation of AI-based tools and AI-empowered systems
Task 2.2 Defenses of AI-based tools and AI-empowered systems
Task 2.3 Use cases and experiments

WP3 – MLSecOps and AI Cyber Range
WP3 Description: in most of the cases, state-of-art attacks against ML and the related defenses have been designed in laboratory conditions. For instance, adversarial attacks are often executed in the digital domain, paying little or no attention to their practical feasibility in the physical world. This means that the threat of such attacks against AI is often over or underestimated. On the other hand, while basic research is doing a lot of seminal work on AI security, companies are working on automating the development and operations of ML models (MLOps) without focusing too much on ML security-related issues. Current industrial DevOps platforms lack functionalities and modules for evaluating the algorithmic security of machine learning. This work-package aims to bridge these gaps by extending the current MLOps paradigm to also encompass ML security (MLSecOps) and adding functionalities for the security evaluation of AI-based malware detectors in next-generation cyber ranges.
Task 3.1 Development of the SERICS MLSecOps platform
Task 3.2 AI Security Evaluation in Next-Generation Cyber Ranges
Task 3.3 Use cases, best practices and SERICS Guide for Security of AI

WP4 – AI Cyber Challenge
WP4 Description: this work-package aims to develop a training program on AI security as part of the SERICS National Cybersecurity Academy.
Task 4.1 Development of the AI Cyber Challenge platform
Task 4.2 AI Cyber Challenge

Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA | UNIVERSITÀ DEGLI STUDI DI CAGLIARI

Open Innovation Call

FOCUS AREA: CSS

The project aims to develop software components that integrate existing solutions (hardware/software) and custom-developed code to automatically detect and collect data and information for cyber social security. This includes using open information sources to detect and interpret human behavior and social contexts, as well as utilizing sensors (IoT) and infrastructures (audio-video devices) to detect and interpret significant events and behaviors for cyber social security in urban environments (smart cities).

Theme 1: Collection, Analysis, and classification of Cyber-mediated events

The main objective is the development of advanced tools for the automatic collection, analysis, and identification of Cyber-mediated events and changes in behavior from social media platforms, various IT and IoT devices, and other relevant information sources possibly using the new Machine Learning technologies. An important aspect is to clearly define criteria to identify such events.

Theme 2: Intervention and cooperation protocols

One objective is the development of tools to support efficient communication and coordination between stakeholders during various types of incidents.

Another objective is the development of tools to support the management of cyber threats, including threat intelligence sharing, incident response plans, and collaboration with law enforcement.

Theme 3: Redefining Census and Prevention Processes

The main objective is to develop tools to support strategies to mitigate risks in the identified critical assets (individuals, groups, communities, software applications, and infrastructures for the public service, etc.), incorporating best practices and implementing organizational measures and physical security enhancements.

FOCUS AREA: COVERT

The objective of the Innovation Open Calls is to solicit innovative proposals aimed at strengthening and improving the state-of-the-art technologies for vulnerability and threat detection and prevention, focusing on obfuscated and stealth threats, as well as covert channels. Application areas can include any computation environment, including threats against industrial control systems. Techniques can include machine learning and artificial intelligence approaches that are robust against adversarial attacks and with the possibility of extracting explanations.

Specifically, the Innovation Open Call intends to select proposals aimed at incrementing the TRL of the research results attained in this project in the different areas of activity:

- Propose novel tools and techniques aimed at identifying, analyzing, and categorizing advanced evasive, obfuscated, and stealth cyber threats;
- Propose novel tools for simulating different advanced attack scenarios aimed at designing and testing novel detection and prevention approaches; as an example, the tool can focus on generating, organizing, and storing realistic malicious network traffic data.
- Propose novel tools in the area of vulnerability scanning and detection and in the area of vulnerability impact prediction;
- Propose application of recent artificial intelligence developments to enhance threat management and threat intelligence tools;

Theme 1: Identification, Analysis and classification of evasive, obfuscated, and stealth cyber threats

The main objective is the development of advanced tools for the automatic identification of evasion techniques used by cyber threats through Machine Learning approaches. An equally important objective in this area is the creation of mutation engines capable of generating mutated samples that are able to evade threat detection systems, with the aim of testing and improving the latter. The proposed tools should be tested against real or realistic scenarios.

Theme 2: Simulation of attack scenarios

The primary objective is to stimulate proposals that contribute to the development of advanced capabilities to simulate realistic attack scenarios. The system should generate, organize, and store malicious network traffic data generated by devices or systems, such as IoT/OT devices, and provide advanced querying and filtering capabilities to be used for the enrichment of datasets used to design novel threat detection tools. The realism of the generated traffic should be verified through appropriate models.

Theme 3: Source Code Scanner
The main objective is to develop a tool capable of scanning source code repositories to learn to identify vulnerable code and propose the related remediations automatically. The tool can also help manage the SBOM of a complex source code project and check for potentially vulnerable code to improve the quality of the software development process and help produce the related documentation.

Theme 4: Threat Management and intelligence through machine learning approaches
Recent advances in machine learning tools and approaches help in managing structured and unstructured information related to any emerging threats. Deep learning, generative, and language models allow the analyzing and processing of large quantities of data and produce structured, actionable information. Explainability and interpretability techniques will help prioritize the most relevant features of the threat.

FOCUS AREA: GERONIMO

Specifically, the Open Innovation Call intends to select proposals to increment the TRL of the research results attained in this project in the different areas of activity.

Theme 1 - Hierarchical and adaptive traffic capture and analysis, collecting statistical features. The main aim of this activity will be live traffic dynamic clustering and tagging, where per-node and per-flow statistical features have to be collected and analyzed in real-time. Once a suspect behavior has been spotted, the depth of the analysis will be enhanced by adopting a hierarchical model. In addition, efficient representation and compression formats will be developed for short- and long-term storage of traffic data.

Main Objective:

- Design and development of a novel tool for the selective capture facilities and automatic triggering mechanisms associated with the attack models, representation formalisms, and schemes.

Theme 2 - Anonymization techniques for privacy-aware storage of traffic data.

The effort required in this task essentially complements the development of new traffic interception solutions that are fully compliant with current privacy-enforcement regulations and forensics best practices. More precisely, the specific focus of this activity involves the combination of encryption algorithms and anonymization schemes to collect network evidence for use in strategic surveillance as well as prevent and trace any illegal manipulation of the data and ensure their validity as legal proofs with law-enforcement authorities.

Main Objective:

- Design and development of a novel tool for the anonymization/pseudonymization and selective encryption mechanisms for the captured traffic.

Theme 3 - Advanced Malware detection facilities in honeypots

Several research directions in static and dynamic malware analysis, empowered by intelligent, adaptive, and self-learning detection engines, will be explored for coping with polymorphic and metamorphic viruses and ransomware. Also, the effectiveness of compromise indicators, the application of formal methods to malware recognition, and the representation through images of the malware will be studied.

Main Objective:

- Design and Development of an interface/interworking mechanism between existing honeypots and external malware detection facilities.

Theme 4 - Automatic Reaction Triggering - Decision Engine

The automation of the decision-making process related to triggering the proper traffic filtering actions based on specific alerts is the main goal of this task.

The main focus of the activity is the creation of a flexible and effective decision engine able to implement the association between attacks and reaction strategies by identifying the set of defense options and their configurations.

Main Objectives:

- Design and Development of the decision engine and its interface to the traffic filter distribution mechanism (based on BGP Flowspec).
- Functional evaluation of the decision engine. This objective involves conducting rigorous experiments to assess the overall effectiveness of the implemented prototype, determine its limitations, and fix/refine them based on empirical evidence.

FOCUS AREA: SOS AI

Theme 1: Conformity assessment of systems based on artificial intelligence

The primary objective of this topic is to develop a prototype platform for the "conformity assessment of AI systems" that can be used by manufacturers of artificial intelligence systems who will have to produce the documentation required to evaluate the conformity of their systems to the requirements of the European AI Act.

Therefore, this area intends to promote project proposals that present innovative solutions and strategies for the conformity assessment required by the European AI Act by companies, in particular SMEs, producers of systems that use artificial intelligence techniques and are obliged to evaluate compliance based on the European AI Act.

In particular, this thematic area focuses on project proposals capable of:

- propose an innovative solution for the conformity assessment required by the European AI Act of artificial intelligence systems produced by companies, in particular SMEs;
- create a prototype platform for the "conformity assessment of AI systems" that implements this solution;
- validate the developed prototype with adequate testing on a use case of industrial interest that concerns the conformity assessment of one or more artificial intelligence systems.

The project proposals may be based on using the software libraries developed within the SOS AI project (https://secml-torch.readthedocs.io/; https://secml.readthedocs.io). Projects that propose the exploitation of these libraries and/or that plan to make part of the results produced within these open-source software libraries available will be valorized.

Particular emphasis will be placed on projects that, by achieving a good level of TRL, have the aim of allowing companies, in particular SMEs, to carry out the conformity assessment required by the European AI Act and propose an open platform for conformity assessment. to incorporate future developments of the European AI Act and standards for the certification of artificial intelligence.

Theme 2: Protocols for the Industrial Development of Trustworthy AI Systems

The primary objective is to propose a protocol for the development of intelligence-based systems that can be used by companies, in particular SMEs, to ensure compliance with the European requirements on "Trustworthy AI" and facilitate subsequent conformity assessment of the systems developed required by the European AI Act.

This area, therefore, intends to promote project proposals that present innovative solutions and strategies to allow the industrial development of "Trustworthy AI Systems" by companies, in particular SMEs, and facilitate the subsequent conformity assessment required by the European AI Act.

In particular, this thematic area focuses on project proposals capable of:

- propose an innovative protocol to allow the industrial development of Trustworthy AI Systems and facilitate the subsequent conformity assessment required by the European AI Act.;
- create a software prototype that implements this protocol;
- validate the developed prototype with adequate testing on one or more use cases of industrial interest.

The project proposals may be based on the use of the software libraries developed within the SOS AI project (https://secml-torch.readthedocs.io/; https://secml.readthedocs.io). Projects that propose the exploitation of these libraries and/or that plan to make part of the results produced within these open-source software libraries available will be valorized.

Particular emphasis will be placed on projects that, by achieving a good level of TRL, allow companies to develop Trustworthy industrial AI Systems, in particular SMEs, and propose solutions that are open to future developments in European legislation.