
First-Year Status Overview

NGSOTI Project: 101127921
DIGITAL-ECCC-2022-CYBER-03 D1.1 - NGSOTI
Deployment status report #1

Team CIRCL/NGSOTI



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1 First-Year Status Overview

1.1 Disclaimer

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Words displayed in red indicate hyperlinks. These links can be clicked or viewed by hovering over the text.

1.2 Distribution and License

The document is distributed under Creative Common Attribution 4.0 International [CC-BY](#).

The document is distributed as TLP:CLEAR.

1.3 Deliverable definition

The identifier of the deliverable is **D1.1** and it adheres to the definition outlined in the grant agreement written in **bold**. **Interim report with key activities of the NGSOTI infrastructure, including its deployment and usage status.**

1.4 Executive Summary

This report outlines the progress and achievements of the NGSOTI project, aligning with the objectives and scope of the [DIGITAL-2022-CYBER-B-03 — Cybersecurity and Trust call](#). The project aims to support the market uptake and dissemination of innovative cybersecurity solutions, with a particular focus on improving knowledge and auditing cybersecurity preparedness across the EU. The key outcomes and contributions of the project are as follows:

- **Development of Training Infrastructure:** A state-of-the-art training environment leveraging advanced technologies has been deployed to enhance cybersecurity capabilities for SMEs, public organizations, and educational institutions. The following advanced technologies were utilized: [Headscale](#), [LXC](#). The NGSOTI project aims to rely on **open-source technology** to ensure scalability, innovation, and community collaboration. The following stakeholders used in 2024 NGSOTI, SMEs, educational institutions.

- **Innovative Cybersecurity Solutions:** The NGSOTI platform has been instrumental in showcasing and utilizing innovative tools, including incident response solutions and cybersecurity investigation technologies, tailored to address real-world threats.
- **Market Readiness and Adoption:** By integrating cutting-edge tools such as **Flowintel, MISP, Kunai, Tenzir, Vulnerability Lookup** into its framework, NGSOTI provides practical, market-ready solutions. These tools enable organizations to enhance their resilience against cybersecurity threats.
- **Awareness and Education:** Training sessions and materials have been delivered to a diverse audience, including SMEs, students, and professionals.
- **Community Engagement and Open Source:** The project actively supports the open-source ecosystem through blog updates, the adoption of collaborative tools, and dissemination activities. Most of tools in NGSOTI are open source. This aligns with EU goals to improve the security of open-source ICT solutions.
- **Future-Focused Goals:** NGSOTI has contributed to advancing cybersecurity preparedness by fostering the development of scalable, robust solutions that address evolving regulatory and market needs, including compliance with frameworks such as DORA and NIS2.

1.4.1 Advancing the Market-Readiness of Innovative Cybersecurity Tools

As part of our commitment to fostering market-ready innovative cybersecurity solutions, **Kunai** has been successfully adopted by the **Internet Storm Center (ISC)**, a division of the SANS Institute. ISC operates as a global cybersecurity monitoring and analysis center, known for its role in identifying and mitigating emerging threats. By leveraging Kunai, ISC has enhanced its diaries in analyzing and processing malicious software, contributing to more robust threat intelligence and incident response efforts.

Kunai's adoption by ISC underscores its readiness for real-world cybersecurity applications and highlights its value in supporting critical cybersecurity operations. This adoption represents a significant milestone in our efforts to deliver impactful solutions that address complex cybersecurity challenges at a global scale.

2 NGSOTI Project: First-Year Status Overview

This report provides an overview of the deployment status of the NGSOTI project, focusing on the achievements of its key objectives. It highlights the progress made and the impact of the implemented strategies on the project's success. The document also reflects the collaborative efforts and

innovations that have driven the initiative forward, showcasing how the infrastructure and associated goals align with the project's overarching mission.

Additionally, it details the deployment phase of the NGSOTI project, outlining the steps taken to establish the project's infrastructure and ensure its operational readiness. The report provides insights into the technical setup, key components, and methodologies employed to achieve a scalable and robust deployment. Furthermore, it highlights the challenges encountered during this phase and the strategies implemented to address them, ensuring alignment with the project's objectives and timelines.

The tables 1, 2, 3, 4 compare the work package objectives defined in the grant agreement with the achievements accomplished so far. The first column identifies the work package number, prefixed by "WP" followed by the number. The code "O" stands for "Objective," with the number being a consecutive identifier derived from the grant agreement. The next column describes the objective as defined in the grant agreement, followed by a column indicating the state. States are represented as follows: "O" for ongoing, "P" for pending, and "C" for closed. The subsequent column summarizes the achievements, while the final column includes references to chapters in the report for further details.



3 NGSOTI Objectives and Achievements – Work Package 1

Table 1: NGSOTI Objectives and Achievements Work Package 1

Work Package 1				
Number	Description	State	Achievements	Chapter
WP1.01	A first objective is to ensure that the work defined in this project is executed in a timely manner	O	The demand for training has exceeded initial projections, driven in part by upcoming regulations such as DORA and NIS2, set to take effect in 2025. The partial training infrastructure has been successfully utilized in these sessions. While the increased demand for training was successfully managed through the re-allocation of resources, this did result in some delays to project management tasks. We are actively addressing these delays to ensure the project remains on track and aligned with our overall objectives.	
WP1.02	A second objective is that a smooth coordination between the partners is ensured	O	A real-time communication platform was established using Mattermost. Monthly consortium meetings were held subject to availability. A mailing list was set up and is operational.	
WP1.03	A third objective is that the necessary project management data is recorded to ensure reporting towards the funding agency	O	Final documents were transmitted to the consortium in the first month with support from the project officer. Expectations for formal reviews were clarified and regularly discussed during meetings.	

Number	Description	State	Achievements	Chapter
WP1.04	A fourth objective is to set up the agreements to use NGSOTI for teaching and research	O	A formal teaching agreement was signed with one institution. Two additional institutions joined informally. NGSOTI trainings are being delivered and listed in the training section.	

4 NGSOTI Objectives and Achievements – Work Package 2

Table 2: NGSOTI Objectives and Achievements Work Package 2

Work Package 2				
Number	Description	State	Achievements	Chapter
WP2.01	A first objective is to setup the technical infrastructure	O	<p>The NGSOTI project is a training infrastructure designed for security operations training. It comprises three physical servers, datasets, and auxiliary GPU-accelerated workloads. The virtual training environment is built using LXC and Tailscale technologies, enabling container-based environments accessible remotely.</p> <p>The infrastructure includes Headscale for authentication and access control lists. Documentation is provided. Hardware procurement was completed, the equipment was deployed to establish a phishing platform, and dataset processing has been initiated.</p>	2,3
WP2.02	A second objective to maintain the infrastructure agile to easily adapt to new SOC paradigms	O	<p>Two types of adaptations have already been demonstrated:</p> <p>Incremental Design: The training infrastructure was made operational and ready for use, even though it was not yet fully deployed.</p> <p>Adoption of New Tools: Tools such as Flowintel were introduced for case management, replacing RT. Tenzir is the new name of Vast</p>	2





Number	Description	State	Achievements	Chapter
WP2.03	A third objective collect data of the infrastructure	O	During the first year, over 4 TB of network traffic capture data was collected and presented at two conferences. A Linux malware dataset was also compiled and published at https://helga.circl.lu/NGSOTI/malware-dataset .	3
WP2.04	An independent satellite task will be the URL checker for the Restena edu.lu service including a malicious link report option	P		



5 NGSOTI Objectives and Achievements – Work Package 3

Table 3: NGSOTI Objectives and Achievements Work Package 3

Work Package 3				
Number	Description	State	Achievements	Chapter
WP3.01	Evaluate the data of NG-SOTI to create up-to-date training materials	O	Training materials are being updated based on analyzed data.	3
WP3.02	Perform training with NG-SOTI	O	More training sessions than initially expected were successfully delivered using NGSOTI.	3
WP3.03	Collect feedback from existing trainings to improve future ones	O	Feedback has been gathered and is being analyzed for implementation	3



6 NGSOTI Objectives and Achievements – Work Package 4

Table 4: NGSOTI Objectives and Achievements Work Package 4

Work Package 4				
Number	Description	State	Achievements	Chapter
WP4.01	Make NGSOTI attractive for schools and students	O	NGSOTI was utilized for engineering as well as bachelor's and master's students. Additionally, it garnered interest from security professionals and open-source enthusiasts, where it was successfully demonstrated.	4
WP4.02	Enable teachers to use NGSOTI to create training materials	O	The NGSOTI infrastructure was demonstrated during a MISP training session for students, and its functionality was explained to teachers.	4
WP4.03	Maintain blog posts about the components used within NGSOTI	O	Blog posts were published, keeping the community informed about updates.	4

7 Deployment Status

In the NGSOTI project, the consortium closely monitored the behavior and requirements of its user communities, ensuring the development and customization of tools tailored to support efficient Security Operations Center (SOC) operations. These tools are detailed in the following sections.

7.1 Optimized Tools for Streamlined SOC Operations

7.1.1 Tenzir

Tenzir is an open-core data pipeline management (DPM) tool that enables security teams to collect, normalize, enrich, and route security data. NGSOTI relies on Tenzir for automating the exchange of event data between various tools, such as Kunai, MISP, and OpenSearch. In addition to data integration, Tenzir executes detection content in the pipeline with its enrichment framework and built-in operators to execute Sigma and YARA rules. These features are a central reason for using Tenzir within NGSOTI, as they are not available in general-purpose data pipeline tools, such as Fluent Bit.

7.1.1.1 Use Cases

For NGSOTI, Tenzir specifically supports the following use cases:

- **Kunai Log Collection:** Tenzir picks up Kunai log files and ships them to a central location. Kunai writes its logs as JSON to a file, which Tenzir can pick up, parse, and normalize.
- **OCSF Event Normalization:** Tenzir is purpose-built to map security telemetry from disparate sources in various formats to a canonical form for easier correlation. The Open Cybersecurity Schema Framework (OCSF) is the de-factor standard for security teams and has been adopted by Linux Foundation in late 2024. Tenzir makes it easy to transform events to OCSF and also add OCSF-compliant enrichment objects in its pipelines.
- **MISP Content Operationalization:** Tenzir can operationalize MISP events and contained attributes by making the data available in pipelines to flag sightings. The reported sightings do not only serve as corroborating evidence in the subsequent alert processing, but also deliver valuable threat insights when sent back to MISP.

7.1.1.2 Key Activities

In 2024, Tenzir focused on building key capabilities that enable the above mentioned use cases within the NGSOTI project.

- **Tutorial on OCSF Normalization:** To teach SOC operators how to standardize event data for subsequent analytics across multiple data sources, Tenzir published a tutorial that outlines the key steps in great detail.
- **Lookup Table Aggregations:** Tenzir's lookup tables are a building block for several SecOps use cases. In addition to using them for enriching event streams with indicators of compromise that arrive from MISP, they can be used to passively collect observed data for subsequent enrichment.

This is particularly useful for building a passive inventory of assets. A popular example involves computing first/last/times-seen statistics to build passive DNS tables. But also extracting IP-to-MAC, host-to-username, or any other mappings available in telemetry provide valuable context for entity-based reasoning.

Tenzir presented this feature along with various examples at [Suricon in November 2024](#).

- **OpenSearch/ElasticSearch and Splunk Support:** SOC operators often use a SIEM to analyze logs centrally. Since the mission of NGSOTI is to prepare the next generation of SOC operators for real-world settings where they will likely encounter a SIEM, Tenzir built native integrations for the most commonly used SIEMs out there: OpenSearch/ElasticSearch (via the Bulk API) as well as Splunk.
- **String Function Processing:** In order to support flexible dissection of string data that comes—among other tools—from MISP, Tenzir added numerous functions for native string inspection and transformation.

These functions are building block for the MISP integration, which requires receiving data via ZeroMQ, splitting strings at a space, and then parsing the second component as JSON. Tenzir now has all of these building blocks in place to trivially support reading data in real time from MISP in a structured manner.

- **Community ID Computation:** In order to correlate network with endpoint events, Tenzir added a function to compute the Community ID of a network flow.

Kunai also added a feature to support Community ID computation, making it now possible to correlate network data from [Zeek](#) and [Suricata](#) with Kunai in Tenzir.

In summary, Tenzir added essential capabilities for SOC operators that seek to integrate various security tools and their dataflows.

7.1.2 SkillAegis

[SkillAegis](#) is an excellent outcome of the NGSOTI project, aligning seamlessly with its mission to train the next generation of SOC operators. While the project emphasizes creating operational infrastructures and fostering hands-on training environments, SkillAegis addresses the critical human element

by providing a platform for scenario-based training. SkillAegis equips trainees with practical skills to navigate these challenges by simulating real-world incidents in a controlled, dynamic environment. This tool complements the project's vision by enhancing traditional training methods, including academic curricula and industry-led guest lectures, with interactive, real-data-driven cyber range exercises. Hosted by CIRCL and supported by Restena's network interconnectivity, the infrastructure enables SkillAegis to play a pivotal role in preparing SOC operators for future challenges while fostering a collaborative and robust educational ecosystem.

On August 14, 2024, the release of **SkillAegis v1.0.0** was announced on misp-project.org. SkillAegis is an open-source platform developed as part of the NGSOTI project to advance cybersecurity training and capacity building. SkillAegis is designed to enhance cyber threat intelligence training through realistic, scenario-based exercises, enabling participants to simulate and respond to real-world cyber incidents.

7.1.2.1 Key Features of SkillAegis

- **Scenario Creation:** Trainers can design customized exercises with specific learning objectives, simulating various cyber incidents to develop practical skills in threat intelligence and information management.
- **Exercise Execution & Monitoring:** The platform allows trainers to deploy and oversee scenarios in real-time, using a live dashboard to track participant progress and provide immediate feedback.

7.1.2.2 Components of the SkillAegis Platform

- **SkillAegis Main Application:** Serves as the core component, managing scenario execution and integrating ready-to-use training modules.
- **SkillAegis Editor:** Enables trainers to create new exercises, including metadata, injects (tasks), execution order, and evaluation criteria. It also features an Inject Tester to optimize scenarios.
- **SkillAegis Dashboard:** Facilitates training session execution and provides real-time insights into participant progress, including completion status and logs of user actions.

7.1.2.3 Integration with MISP

SkillAegis was specifically developed to integrate with MISP (Threat Sharing Platform), enhancing training quality. Injects can directly interact with data within MISP, querying and monitoring user activity. To enable this, SkillAegis connects to a training MISP instance via a valid site-admin API (Application Programming Interface) Key.

7.1.2.4 Availability and Licensing

SkillAegis is freely available as open-source software under the AGPLv3 license, reflecting its EU project origins and commitment to supporting the cybersecurity community. The platform can be downloaded and utilized at no cost.

7.1.3 MISP Training Infrastructure

MISP is a core element of the NGSOTI infrastructure, and stakeholders often request dedicated MISP training sessions. Since MISP is a fully distributed system, participants should be able to explore and experiment with data flow aspects. To facilitate this, a network of volatile MISP servers was set up for training purposes. These seven servers are publicly accessible, allowing participants to configure synchronization rules as needed. The deployment of the servers was fully automated, including their configuration with default user accounts for participants. After each training session, the servers are reset to provide new trainees with a clean environment. The deployment is managed using LXC technology. LXC (Linux Containers) is a lightweight virtualization technology that enables the creation of isolated environments on a single host by sharing the host's Linux kernel. Unlike traditional virtual machines, LXC containers are more resource-efficient and faster to start, as they don't require a separate operating system. They are ideal for use cases such as development, testing, training, and multi-tenancy, providing secure isolation and flexible resource management through namespaces and cgroups.

7.1.4 Kunai

While Linux workstations may not rival Windows or macOS systems in popularity, Linux systems dominate the server landscape, often hosting critical services such as web servers, databases, and many public systems accessible via the Internet. However, Linux security monitoring for SOCs frequently lacks the detailed visibility available on Windows systems, where free tools like [Sysmon](#) exist. SOC engineers often rely on audit logs or application logs to create detection scenarios, but these sources are not always security-focused and typically lack correlation capabilities necessary for understanding the occurrence of suspicious events.

An attempt to port Microsoft [Sysmon to Linux was made](#). However, the project suffers from several Linux-specific design flaws and has not seen maintenance since its release, making it unappealing for potential users. Other projects, such as [Tracee](#) and [Falco](#), address Linux security visibility issues but lack some key features offered by Sysmon, including threat-hunting capabilities and event correlation for root cause analysis.

From our experience, alert contextualization and root cause analysis are crucial for enabling SOC operators to triage alerts effectively and for incident responders to thoroughly investigate security events. These needs motivated the development of [Kunai](#), with the goal of providing a tailored security visibility tool for Linux systems. Kunai empowers SOC engineers and incident responders to perform their jobs more effectively and efficiently.

As part of the [NGSOTI](#) project, Kunai has undergone significant enhancements to achieve its goals. Integration with [MISP](#) enables Kunai to leverage Indicators of Compromise (IOCs) and threat intelligence shared through the platform. This fosters community-based intelligence sharing and simplifies the detection of known threats. Additionally, a rule engine was developed to facilitate log filtering and the creation of highly customizable detection rules tailored to specific needs and environments. The rule format was designed to be simple to write and share, promoting collaboration and distribution through platforms like [MISP](#). These contributions make data sharing among SOCs seamless, allowing incidents to be detected and addressed more quickly.

Some of the other contributions made under [NGSOTI](#) include:

- Integration of numerous new security events, providing enhanced visibility, analysis, and detection capabilities.
- File scanning using [Yara](#) rules for malicious file detection.
- [Community-ID](#) support, enabling correlation between system logs and network logs from tools like [Suricata](#) and [Zeek](#).

Finally, several production-readiness features have been implemented, such as automated installation and configuration and log rotation. Background tasks such as maintaining an up-to-date [website](#) and documentation, monitoring Linux kernel changes to reflect in the project, and refactoring code have also been undertaken to ensure the project's long-term reliability and relevance.

7.1.5 Vulnerability Lookup

Effective vulnerability management is a critical aspect of SOC operations, requiring the ability to handle and prioritize vulnerabilities efficiently. Historically, only a few vulnerability databases existed, but with the introduction of the NIS2 directive promoting enhanced vulnerability management, the number of databases has grown significantly. This proliferation poses challenges for SOC operators in reconciling and aggregating data across multiple sources. To address this, NGSOTI extended and

integrated the open-source tool Vulnerability Lookup, streamlining the process and improving operational efficiency.

Vulnerability-Lookup is an open-source tool that facilitates the correlation of vulnerabilities from various sources, independent of their IDs, and streamlines Coordinated Vulnerability Disclosure (CVD) management. It serves as a collaborative platform where users can comment on security advisories, create bundles, and add observations. An instance operated by CIRCL is available at <https://vulnerability.circl.lu>.

Key Features: Vulnerability-Lookup provides a comprehensive API for fast vulnerability searches, a modular feeder system for importing vulnerabilities from sources like CISA, NIST, GitHub, and OpenSSF, and supports creating and editing Security Advisories with the vulnogram editor. Users can add sightings (e.g., seen, exploited, patched) to vulnerabilities, share comments, and create bundles of advisories. Integration with EPSS and extensive RSS/Atom feeds are also included.

Sighting Sources: It supports various sighting sources, including Fediverse, MISP, Nuclei, Exploit-DB, CISA KEV, and RSS. Users can also create custom sighting tools using the PyVulnerability-Lookup library.

Installation: Vulnerability-Lookup requires Python 3.10, Poetry, and a Kvrocks database. Detailed installation instructions and architecture are provided in the official documentation.

7.2 NGSOTI Core Infrastructure

Both partners LHC and Restena procured hardware to support the project. Restena's hardware is used for processing activities, such as handling Blackhole data. They set up the equipment in the data center and initiated the first processing of the Blackhole data. Additionally, Restena established a phishing platform to create phishing campaigns as part of the training activities. LHC's hardware was also deployed in a data center and serves as the core infrastructure for NGSOTI, ensuring the project's operational foundation.

As depicted on 1, **ngsot1** holds a headscale LXC container to manage the authentication of users, and Access Control Lists. Within the LXC virtual network, there is a special LXC container that is also part of the **tailscale** VPN (the tailnet) that acts as a router to the virtual training infrastructure.

NGSOTI Core Infrastructure encompasses the software stack that is used for hosting the services and datasets that trainees and trainers have access to within the framework of the action.

- **ngsot1** is a physical server that hosts LXC containers and that host the virtual training network,
- **ngsot2** is a physical server that hosts the datasets used during training (e.g. collections from the blackhole, malware samples, etc.)
- **ngsot3** is a physical server that host auxiliary GPU accelerated workloads (e.g. A.I webservices)

The virtual training environment hosted on **ngsotii1** is built around two main pieces of technology:

- **LXC** is a container runtime for linux. It allows for the creation of containers holding the different services used during trainings, as well as for the creation of a virtual network that users will use to connect to the different services. The LXC infrastructure offers profiles that can be applied on newly created containers to easily create SSH admin access, and mount datasets from **ngsotii2**
- **tailscale** is a VPN (Virtual Private Network) technology that allows us to give access to the virtual network from anywhere where the tailscale client can run. In addition to tailscale, we run **headscale** that is an open source project used to manage tailscale authentication.

The virtual training infrastructure is accessible to trainers, trainees, and administrators through the tailnet. Comprehensive documentation is available to support their use of the platform. The documentation is organized into distinct segments for each component, ensuring clarity and ease of reference.

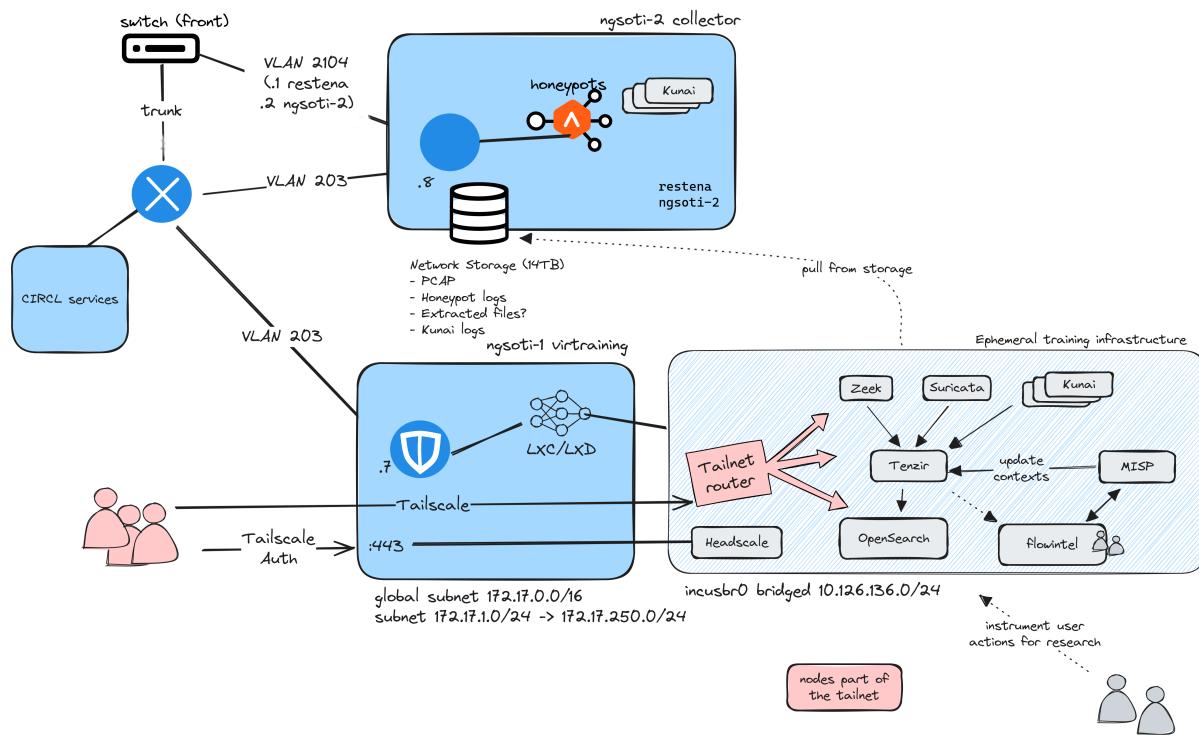


Figure 1: NGSOTI core infrastructure diagram

Overall architecture

Tailscale is a mesh VPN built on WireGuard, enabling secure, private networking within a tailnet. In this setup, a custom coordination server replaces the default Tailscale servers, providing greater control and privacy. Users authenticate using a reusable, non-expiring pre-authentication key and gain

access to a tailnet-router container that routes traffic to LXC containers hosted on the server. After downloading the Tailscale client and connecting with the provided configuration, users can securely access resources within the tailnet, such as SSH into containers, provided their SSH key is authorized. This setup ensures efficient and private access to network resources.

How to create containers

Headscale is a self-hosted implementation of Tailscale's coordination server, responsible for authenticating users, managing access control lists (ACLs), and coordinating connections within a tailnet. It runs as a container and can be managed directly from the host using commands to create users, generate pre-authentication keys, and manage network routes. Configuration files, such as 'config.yaml', specify operational details like server addresses, metrics endpoints, and policy settings for ACLs and DNS. Headscale integrates seamlessly with Tailscale clients, enabling secure network access and advanced management capabilities, including ACL enforcement, MagicDNS, and policy-based connectivity. The deployment includes support for reverse proxying with Apache and options for custom TLS settings.

How to manage headscale

This section of the documentation addresses user authentication and access control lists (ACLs). It describes the setup of a container named headscale running on the ngsoti host. Administration is performed from the host system, enabling the creation of users, reusable pre-authentication keys, and management of network routes. Configuration files, such as config.yaml, define operational settings, including server URLs, metrics endpoints, gRPC configurations, and DNS management.

How to onboard new admin user

The current process for granting and configuring user access involves several manual steps, including granting access to the GitHub organization, creating a new user in the Headscale container, generating and sharing a pre-authentication key, updating the /etc/headscale/policy.hujson file to include the user in the admin list, and restarting the Headscale service. Additionally, the incus ssh-admins profile must be modified to add the user and their SSH key, which currently requires recreating the container to apply changes. Automating this procedure with a script would simplify the workflow, reduce errors, and enhance efficiency.

How to manage the tailnet router

This part of the documentation includes the commands to create a tailnet-router container.

Once the container is running, access the headscale container to authorize the routes advertised by the container. Use headscale nodes list to identify the container's name, then run headscale routes list to find the IDs of the routes that need to be enabled (for both IPv4 and IPv6). Finally, enable the routes using the command headscale routes enable -r <idroute>, ensuring that routing works as expected.

The tailnet-router-profile configures the container to install necessary packages, including

Tailscale and `iptables`, and enables IP forwarding for both IPv4 and IPv6. It applies Linux optimizations for subnet routing, advertises routes, and sets up NAT to forward traffic between `incusbr0` and the Tailscale interface. Additionally, `iptables` rules are configured to allow forwarding and are made persistent across reboots using `netfilter-persistent`. This setup provides a fully functional and secure tailnet-router for the NGSOTI network.

8 Usage Status

8.1 NGSOTI Trainings

Some EU regulations, such as NIS2 and DORA, have created a significant boost in the demand for NGSOTI training sessions. These sessions are designed to ensure organizations are well-prepared to meet the requirements of these regulations, which are often enforced starting in 2025. A key focus of these regulations is the establishment of local SOCs and incident response capacity. The NIS2 Directive mandates that regulated entities implement robust incident response capabilities and maintain effective security operations. Specifically, organizations must establish comprehensive incident handling policies that define roles, responsibilities, and procedures for detecting, analyzing, and responding to security incidents. These policies also cover post-incident activities such as recovery, documentation, and reporting.

Furthermore, the directive emphasizes the importance of continuous monitoring and logging of network and information systems to promptly detect and address potential threats. Entities are expected to:

- Implement automated monitoring where feasible.
- Regularly review logs to identify unusual activities.
- Ensure accurate time synchronization across systems to facilitate effective incident analysis.

By adhering to these requirements, organizations can enhance their resilience against cyber threats and ensure compliance with the NIS2 Directive. Article 21, under point (b), explicitly requires the establishment of incident handling capabilities.

Importantly, NIS2 extends its scope to include entities such as SMEs (Small and Medium Enterprises) involved in the supply chains of Operators of Essential Services (OES) or Digital Service Providers (DSP), which were not regulated under the original NIS Directive. These entities are now required to set up local incident response capabilities.

Given this regulatory landscape, the NGSOTI framework provided an excellent opportunity to conduct targeted incident response training. These efforts were aimed at equipping participants with the skills and knowledge required to comply with these critical regulations. The incident response trainings conducted are detailed in the table 5:

Date	Training	Number of participants	Sector	Target audience
2024-07-05	Kunai	12	Multiple	Open source enthusiasts
2024-09-24	Incident management - part 1	14	Education	Engineering students
2024-09-24	Incident management - part 2	14	Education	Engineering students
2024-10-01	Incident management & crisis exercise	14	Education	Engineering students
2024-11-08	Incident Response	9	Finance	Security professionals
2024-11-10	Incident Response	4	Finance	Security professionals
2024-11-11	Incident Response	4	Finance	Security professionals
2024-11-23	Forensic	4	Finance	Security professionals
2024-11-24	Forensic	4	Finance	Security professionals
2024-12-03	Phishing Lecture	24	Education	Bachelor / Master students
2024-12-10	Phishing Lecture	24	Education	Bachelor / Master students
2024-12-11	Forensic	14	Education	Engineering students
2024-12-16	MISP threat sharing	14	Education	Engineering students

Table 5: NGSOTI training delivered in 2024

The public training sources are listed below. In the ‘Training’ column, publicly available training materials include a link to the repository where the material is hosted. For the other entries, only a description and focus is provided.

Training	Description	Focus
Kunai	This training provides a master-level introduction to Linux endpoint visibility and threat hunting using Kunai. It covers the limitations of traditional antivirus solutions, the importance of context-rich monitoring for effective incident response, and the role of endpoint visibility tools in detecting advanced threats. Through theoretical concepts and practical examples, participants are introduced to Kunai as a Linux monitoring solution for threat hunting and incident response.	This training focuses on the operational use of Kunai by SOC operators, covering its deployment for endpoint telemetry collection and its use in sandbox environments to analyze malicious behavior, enrich alerts, and support threat hunting and incident response activities.

Training	Description	Focus
Incident Management	The incident management course provides an overview of incident management principles, explaining the various processes, roles, and responsibilities involved. It also covers crisis escalation procedures and coordination aspects.	During cyber incidents, SOC operators play a critical role, particularly in the collection of evidence and the implementation of mitigation measures. For this reason, it is essential that SOC operators are familiar with incident and crisis management methodologies, enabling them to operate effectively under pressure and coordinate efficiently during escalated situations.
Incident Response	The incident response training focuses on practical incident response activities in operational environments. It explains how evidence is collected, how CSIRTs analyze and use that evidence, and highlights common pitfalls observed during real-world incidents. The training also provides an overview of the NGSOTI tooling that can be used either online or locally within a SOC.	This training emphasizes the importance of preparatory actions for SOC operators, including ensuring that logging is correctly configured, logs can be effectively correlated, and data acquisition procedures are in place and ready to be executed during an incident.

Training	Description	Focus
Forensic	<p>This training includes slide decks, exercises, and disk images used in forensic analysis trainings such as post-mortem file system forensics—allowing learners to study presentation content and complete practical exercises on their own.</p>	<p>This training focuses on enabling SOC operators to understand what is and is not possible in forensic analysis, including the types of data artifacts and indicators that can be revealed. It also emphasizes how forensic findings can be used to provide feedback to infrastructure teams, particularly by identifying potential weaknesses in system configurations and logging practices.</p>

Training	Description	Focus
MISP	<p>This GitHub repository hosts the official MISP training materials, including slide decks and source content for courses on MISP usage, threat intelligence, OSINT, information sharing, and related topics. All materials are open-source and provided with LaTeX source code to support learning, customization, and contribution.</p>	<p>This training focuses on enabling SOC operators to understand what types of information particularly indicators of compromise (IOCs) are shared by other SOC teams and how to integrate this information into SOC activities such as detection, alerting, and blocking. It also demonstrates how SOC operators can effectively share relevant threat intelligence with other SOCs to support collaborative defense efforts.</p>

Training	Description	Focus
Phishing Lecture	The Phishing Lecture provides an overview of phishing attacks, explaining common techniques used by attackers, how phishing campaigns are conducted, and how they can be detected and mitigated by SOC teams.	This lecture focuses on helping SOC operators recognize phishing techniques, analyze phishing emails and artifacts, and apply appropriate detection and mitigation measures. It emphasizes practical approaches to identifying indicators of phishing and supporting response and awareness activities within the organization.

Table 6: Description and focus of NGSOTI training

Starting in the second semester of the academic year 2024-2025, NGSOTI training activities will also be integrated into the Master in Cybersecurity and Cyber Defence (MCYSD) programme at the University of Luxembourg. These activities, delivered by cybersecurity professionals from the NGSOTI consortium, will complement the existing MCYSD curriculum by offering practical, industry-relevant courses, hands-on exercises, and tailored lectures aligned with the latest regulatory requirements and operational best practices. The specifics regarding credits, teaching modalities, and schedules will be coordinated with the University of Luxembourg's regulations, ensuring a comprehensive and engaging learning experience for MCYSD students.

8.2 NGSOTI Research

In terms of research, now that the infrastructure is in place, the core group has begun using NGOSTI data to shape a focused research agenda.

Key directions include:

- Port Scanning Analysis: Investigate port scanning activities to understand the evolving behavior and interests of attackers over time.
- Malware Propagation: Analyze malware spreading patterns and generate actionable alerts. These alerts will be published and automated through MISP to enhance threat intelligence sharing.
- Correlation with CVE Data: Connect scanning activity with the Common Vulnerabilities and Exposures (CVE) database to identify correlations between observed blackhole activity and newly published vulnerabilities, particularly focusing on services of heightened interest.
- Threat Intelligence Integration: Combine blackhole data with MISP threat intelligence feeds to provide a granular and contextualized view of current threats. This will support the development of machine learning (ML) models to predict potential attacks and threat trends.

8.3 Malware Dataset

One of NGOSTI's objectives is to provide real data to its users, which includes the creation of a **malware dataset**. The malware-dataset repository offers a collection of malware samples, primarily focused on Linux, designed for testing, evaluation, and research purposes. The dataset features a diverse range of samples, accompanied by detailed analyses to support understanding and improve detection methodologies. The process of dataset creation and analysis is documented in the blog post titled **Enhancing Detection Engineering with Automated Malware Sandboxing**. The repository is **open-source** and distributed under the permissive 2-clause BSD license, promoting collaboration and further development.

8.4 NGSOTI Core Working Group Activities

This section describes the activities of the core working group as defined in the grant agreement. The purpose of the core working group is to ensure that the NGSOTI infrastructure and use cases are as closely aligned as possible with real-world requirements. In 2024, a subset of the core working group convened under the framework of CERT.lu, which brings together key SOC operators, ISPs, and CSIRTs/CERTs. The sub group of the coreworking group cert.lu meetings are documented in the table 7.

Date

19/02/2024

29/04/2024

16/07/2024

Date

12/09/2024

15/11/2024

Table 7: CERT.LU meeting dates

9 Dissemination and Endorsement

9.1 Dissemination Activities

Between April and December 2024, several dissemination activities were conducted to promote the NGSOTI project or its components.

9.1.1 Blog Posts

- **April 2024:** A [blog post](#) was published detailing the integration between MISP and Kunai, highlighting how this collaboration enhances threat detection capabilities .
- **July 2024:** An [article](#) was written discussing the outage caused by CrowdStrike earlier this year, using the incident to promote Kunai as a reliable alternative for threat detection.
- **August 2024:** The release of **SkillAegis v1.0.0** was announced on misp-project.org. The blog post includes a description of the features in SkillAegis.
- **October 2024:** A [blog article](#) was released introducing a Kunai-based sandboxing system that can be used to detonate malware samples and collect Kunai traces. The system aims to ease and streamline the process of creating detection rules.

9.1.2 Conferences and Workshops

- **June 10-14, 2024** Preliminary results of Blackhole data processing activities were presented at the TNC'24 [Future Talent Programme](#).
- **July 3-5, 2024:** A talk and workshop were conducted at the [Pass the SALT 2024](#) conference in Lille, France. During the talk, we presented the latest updates to Kunai, and during the workshop, we provided hands-on exercises for attendees to understand the basics of Kunai and start building their own detection scenarios.

- **October 10, 2024:** A presentation titled *Kunai: An Open-Source Threat-Detection Tool for Linux* was delivered at the *LibreOffice Conference 2024* during the Cyber Security track. The session provided a high-level overview of Kunai's development, key features, and practical applications, demonstrating how it enables organizations to better understand and respond to potential threats.
- **October 22-24, 2024:** A lightning talk about Kunai was presented at the *Hack.lu 2024 conference*, a renowned platform for discussions on cybersecurity and related technologies. This talk emphasized Kunai's capabilities and its role in modern security monitoring.
- **December 12-13, 2024:** During the CSAF Community Days conference, a [presentation](#) was delivered on the correlation between CSAF advisories and CVE data. The talk highlighted the practical applications of NGSOTI in automating vulnerability management workflows and improving data interoperability in the field.

A project website on Projects Section on Restena [website](#) was setup in French and English. A rollup was created for the Luxinnovation Day. A picture is shown in the figure below.



Figure 2: NGSOTI Rollup

9.2 Social Media Communication

- **LinkedIn Posts:**

- In September 2024, the integration between NGSOTI and the Vulnerability Lookup tool was showcased, emphasizing how it improves the management and **tracking of vulnerabilities**.
- Another **post** in September 2024 detailed how NGSOTI contributes to open-source cybersecurity and vulnerability management efforts, promoting the project to the cybersecurity community.