SEcure DIstributed IoT ManagemENT (SEDIMENT) for OPS-5G

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SEDIMENT Overview

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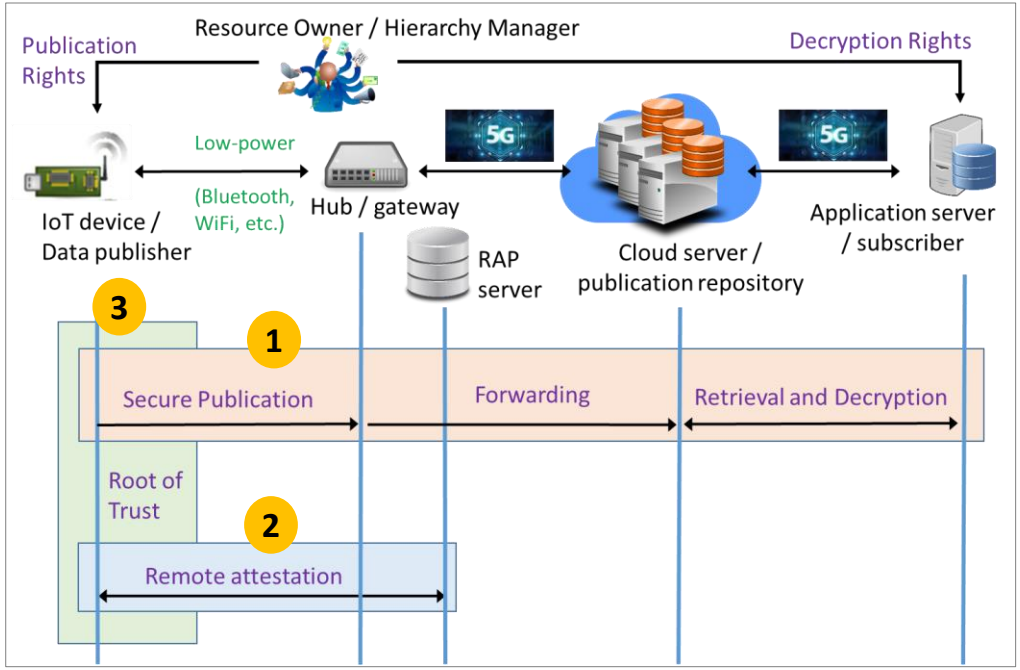
PROBLEM

Resource-constrained devices (IoTs) are a weak link in the 5G security chain. Being easier to compromise, they pose threats to privacy and security of 5G Core, Internet, and critical infrastructure.

SOLUTION

1. **Scalable Cryptography for confidentiality, integrity, and authentication that is end-to-end, one-to-many**
2. **Remote Attestation of device identity, load-time and run-time integrity of software and configuration**
3. **Root-of-Trust, including hybrid options for mid-and low-tier IoT devices**



https://sediment-lfproject.github.io

PROGRAM

DARPA OPS-5G Technical Area 2: Cross-scale 5G node & network security

Phase 1: 10/2020-03/2022
Phase 2: 04/2022-10/2023 ⬅
Phase 3: 11/2023-10/2024

TRANSITION

1. **Open-source project under Linux Foundation**
2. **Exploring alignment with 5G Super Blueprint**
3. **IETF RATS engagement being considered**
4. **Demonstration in Peraton Labs 5G testbed (or other LF testbed) in Phase 3**

SEDIMENT provides a combination of software root of trust, remote attestation, and resource-efficient cryptography to build a zero-trust security system that scales across heterogeneous computing platforms.

SEDIMENT Remote Attestation (RA)

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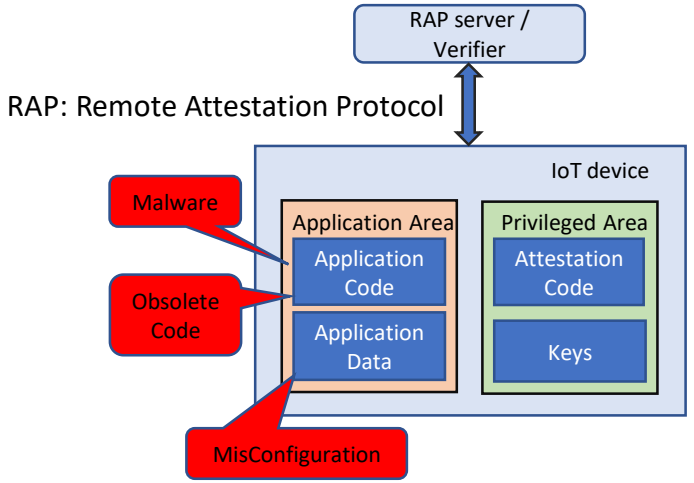
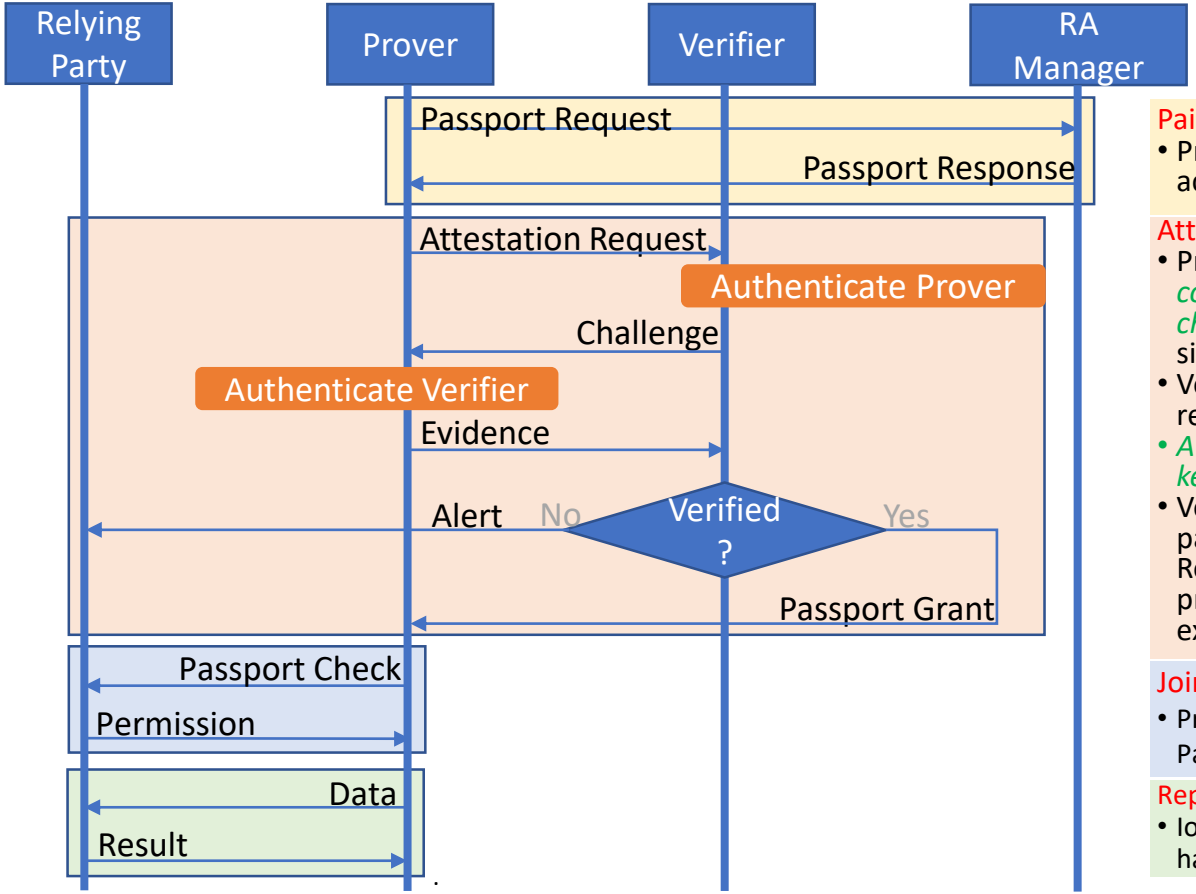
- RA goals
  - Detect presence of malware and software tampering
  - Verify IOT device configuration integrity
  - Authenticate
  - Operate across the entire scale of devices on a 5G network



- Key RA components
  - A protocol (cf. next slide) that supports
    - Authentication and authorization among communicating entities
    - Flexibility in requesting various types of evidences for attestation
      - E.g., firmware fingerprint; software configurations; process status
  - Hardware/software/hybrid Root of Trust (RoT) that ensures the integrity of RA protocol execution [1]
    - Protection of attestation credentials
      - Exclusive access
      - No leaks
    - Safe execution in a protected region
      - Execution atomicity (cannot be interrupted)
      - Immutability (attestation code and everything it depends on cannot be altered after being loaded)
      - Controlled invocation (run attestation code in its entirety)

[1] Karim Eldefrawy, Norrathep Rattanavipanon, and Gene Tsudik. 2017. HYDRA: HYbrid Design for Remote Attestation (Using a Formally Verified Microkernel). *WiSec '17*.

Remote Attestation Protocol Framework



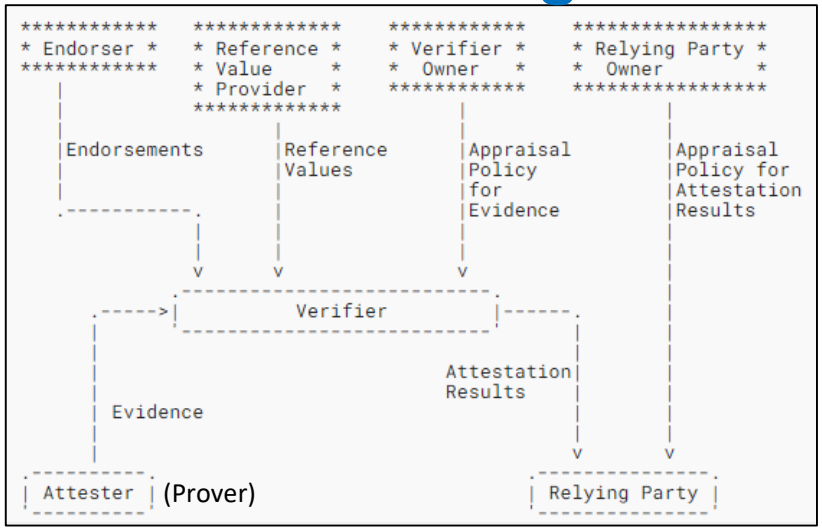
Pairing:
- Prover authenticates itself to RA Manager and acquires Verifier connection information

Attestation:
- Prover initiates attestation, *instead of continuously keeping a communication channel open waiting to be attested,* with significant energy savings.
- Verifier can *issue a variety of challenges* to request Prover to produce evidences.
- *Authentication digests signed with the shared key* enables both parties to authenticate.
- Verifier evaluates evidence. Either grants a passport to Prover or sends an Alert to Relying Party. Prover must restart the procedure after some time if it does not get expected positive response from Verifier.

Join:
- Prover submits granted passport to the Relying Party to gain permission to communicate.

Report:
- IoT device sends application data after Passport has been accepted.

SEDIMENT RA Alignment with IETF RATS Architecture



Conceptual Information Flow https://datatracker.ietf.org/doc/rfc9334/

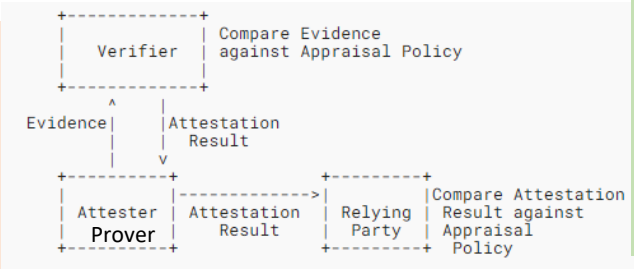
A wide range of evidence types are supported including:

- Full/sparse firmware HMAC
- Application firmware version
- OS/BIOS version
- Boot time; Geolocation
- Software configurations
- User defined functions (UDFs) for run-time integrity checks
  - Running status of specified processes
  - Resource usage
  - Log checks and uptime checks

API features:

- On-demand attestation requests
- IoT device attestation management
  - Access/update of device reference values, appraisal policies

Relying Party: admission;	Network equipment for network access
	Server holding confidential data for release; Entity needing trustworthy remote elements
Evidence:	Claims about the target environment
Reference Values:	Values used in appraising evidences
Endorsements:	Statements that help authenticating device info
Reference models:	Passport; Background-Check



Passport Model

SEDIMENT RA is being aligned with IETF RATS, following the Passport model

SEDIMENT Transition: Linux Foundation Project

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- "SEDIMENT, a Series of LF Projects" is being set up with the following mission statement:
  - "to provide open-source software implementing a distributed and scalable security architecture with remote attestation for networked IoT devices"
- Documents have been adopted/executed by LF and Peraton Labs:
  - Technical Charter, Series Agreement, and Contributor's Agreement (word mark transfer)
- Project supporters including one LF member:
  - NIWC (LF member), DARPA, Peraton Labs, UCI, Kryptowire Labs, Aarno Labs, USC/ISI
- Apache v2.0 License for code and CC-BY-4.0 for documentation chosen
- Code and documentation released by DARPA DISTAR and Peraton
- Repositories for code and webpages: https://github.com/sediment-lfproject
- LF Project public announcement on February 22nd, 2023

Engagement with LF 5G SBP

- Develop use cases for RA in collaboration with Muddasar Ahmed and Ranny Haiby
  - Ensure that IoT devices on a network are authentic and have not been tampered with
  - Ensure that IoT devices can be seamlessly maintained and securely updated
- Develop and integrate SEDIMENT RA onto existing 5G SBP lab infrastructure as proof of concept of ways to realizing 5G SBP use cases

Use Case #1: IoT Device Security and Authentication

- Insure that IoT devices on a network are authentic and have not been tampered with.
  - This is particularly sensitive in remote areas that are not often frequented by people.

- How would remote attestation help?
  - RA Verifier is set to periodically "inspect" remote cameras by checking their firmware fingerprint.
    1. RA Verifier confirms that the firmware fingerprint of Remote Camera A is authentic and permits/allows the camera to stay on the network.
    2. RA Verifier determines that the firmware fingerprint of Remote Camera B is not authentic. RA Verifier then alerts Relying Party (e.g., firewall) to deny Remote Camera B access on the network.

Security Enforcement with KubeArmor

- Visibility into SEDIMENT application behavior
  - Identify the process forking behavior of the application
  - Identify sensitive asset access of SEDIMENT
  - Identify network access required by SEDIMENT

- Protection policies for Gateway deploying SEDIMENT Verifier.
  - Process Whitelisting: Do not allow processes to execute within SEDIMENT container outside of the given spec.
  - Network Access: Only allow SEDIMENT binaries to use the network primitives
  - Check SEDIMENT configuration files and create a security net around SEDIMENT's sensitive assets.
  - Use host hardening policies to protect host.