TRUSTED EXECUTION

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MOTIVATION

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  - **data** (e.g. training data), and/or
  - **code** (e.g., Python code)

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  - publish in top systems conferences (OSDI, EuroSys, …)

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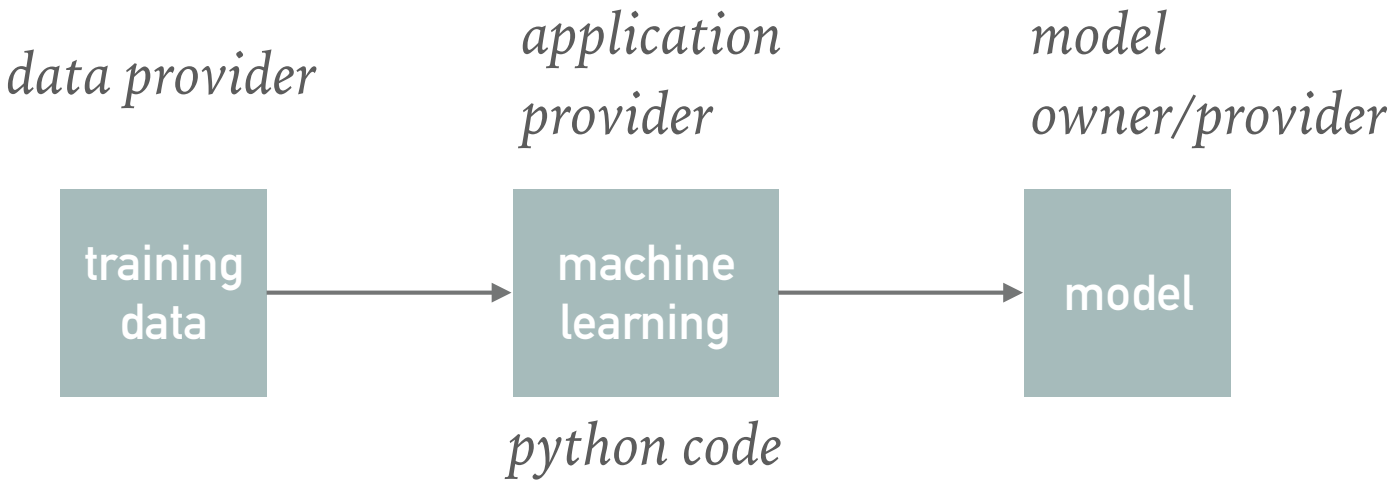
- **Try it out in practice:**
  - spin offs: Cloud&Heat, SIListra Systems, SCONTAIN

PROTECT GOALS

- **Protecting**
  - **Confidentiality** - keeping data / code secret
  - **Integrity** - prevent unauthorized data & code modifications
  - **Freshness** - prevent rollback to old versions of data and code

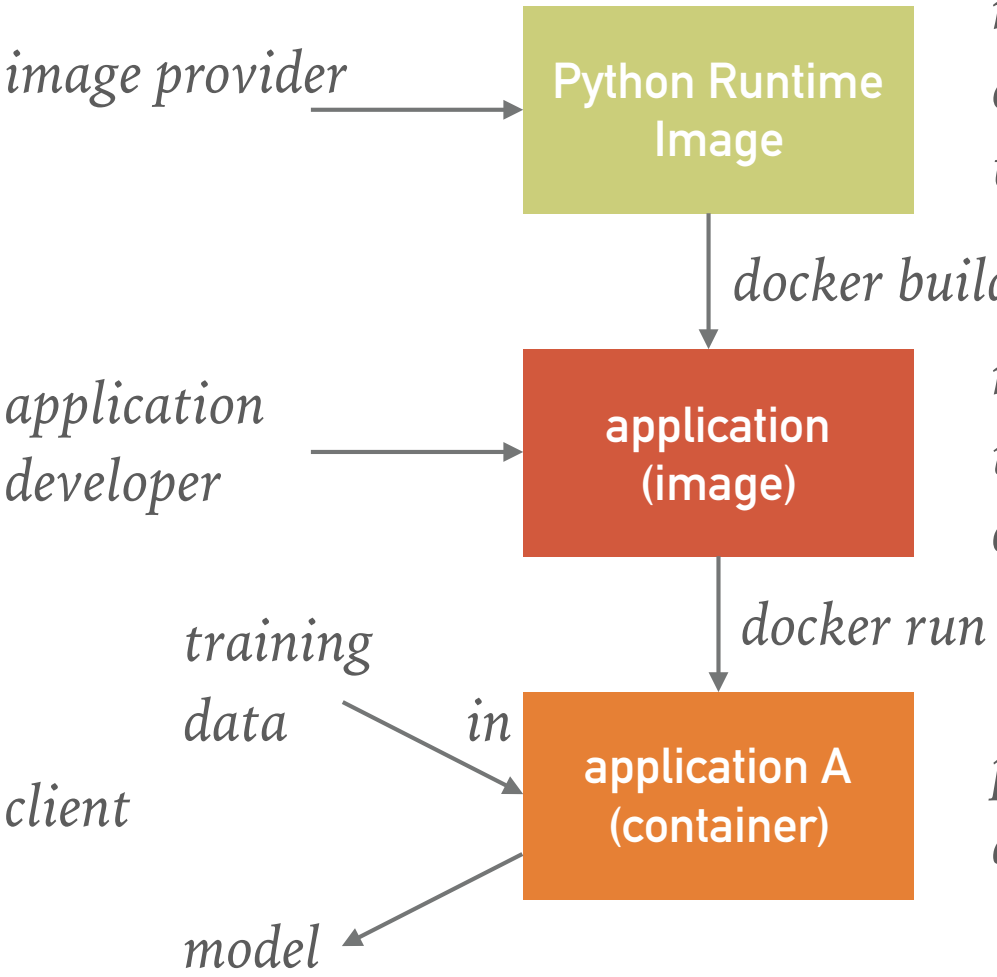
USE CASE: MODEL GENERATION



CONTAINER-BASED APPS

Confidentiality
Integrity
Freshness

protection objectives

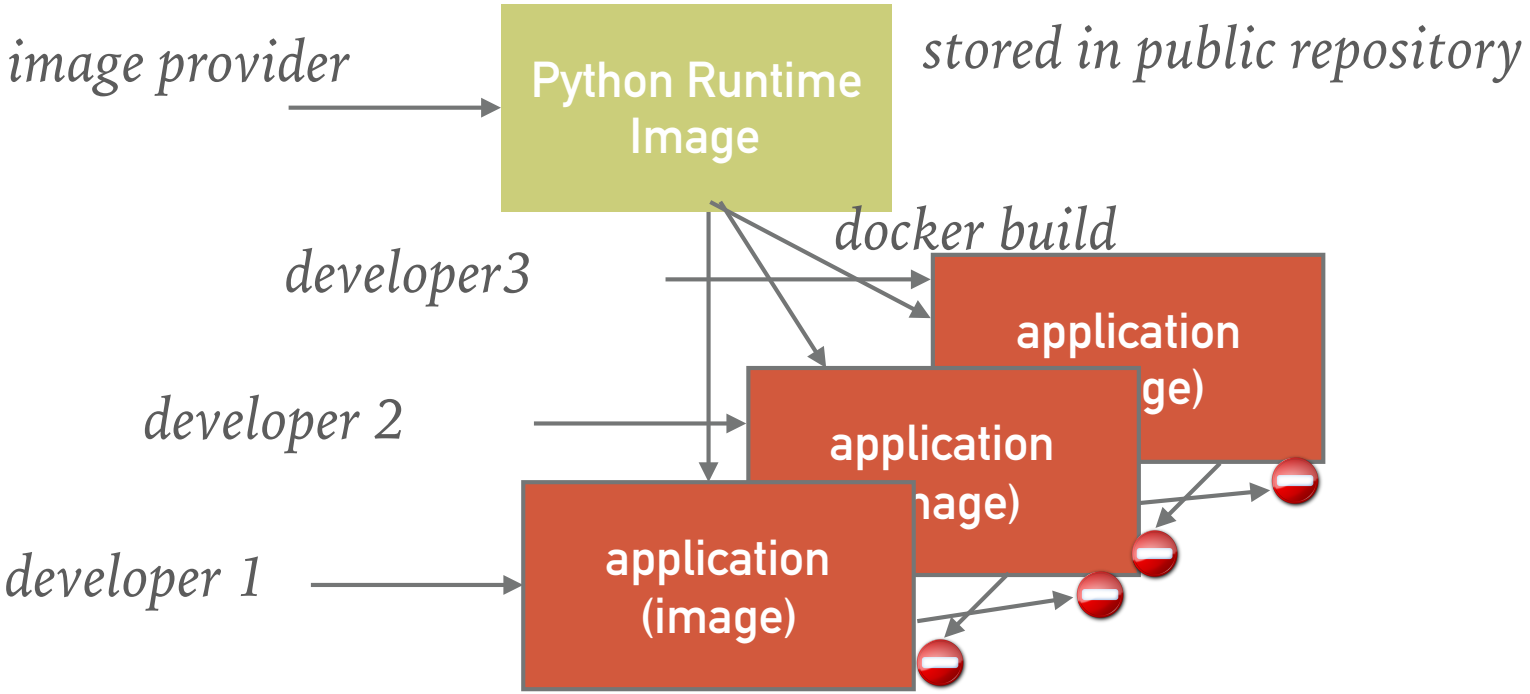


*need to protect the integrity and freshness of the code (**CIF**) and C limits access to the code.*

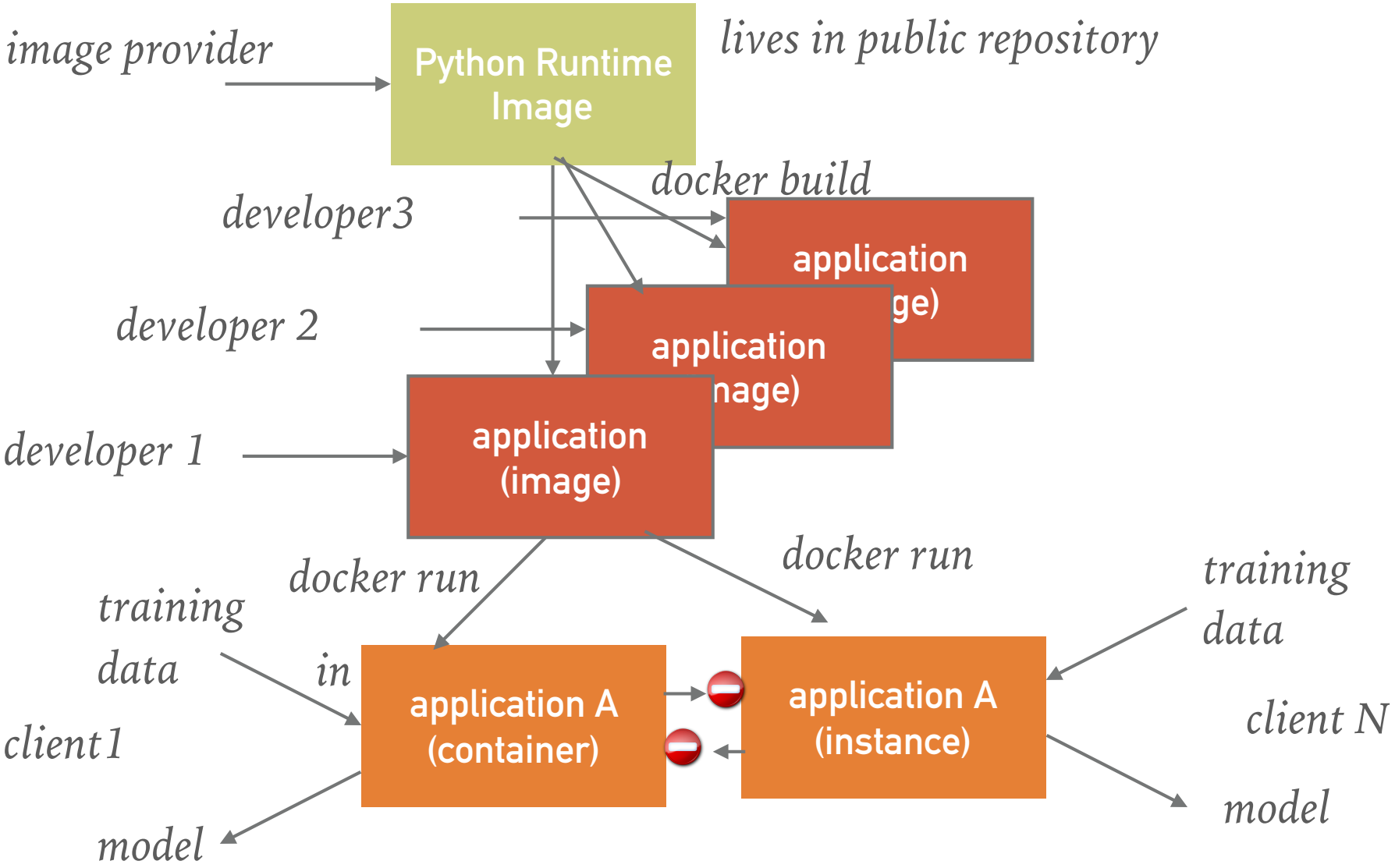
*need to protect the confidentiality, integrity and freshness of application code (**CIF**)*

*protect data (**CIF**), i.e., protect training data as well as generated model*

USE CASE: NEED TO SUPPORT MULTIPLE DEVELOPERS



USE CASE: NEED TO SUPPORT MULTIPLE INSTANCES



THREAT MODEL: BYZANNTINE STAKEHOLDERS

- **We do not trust any individual**, i.e., no trusted person

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- **We do not trust any individual**, i.e., no trusted person

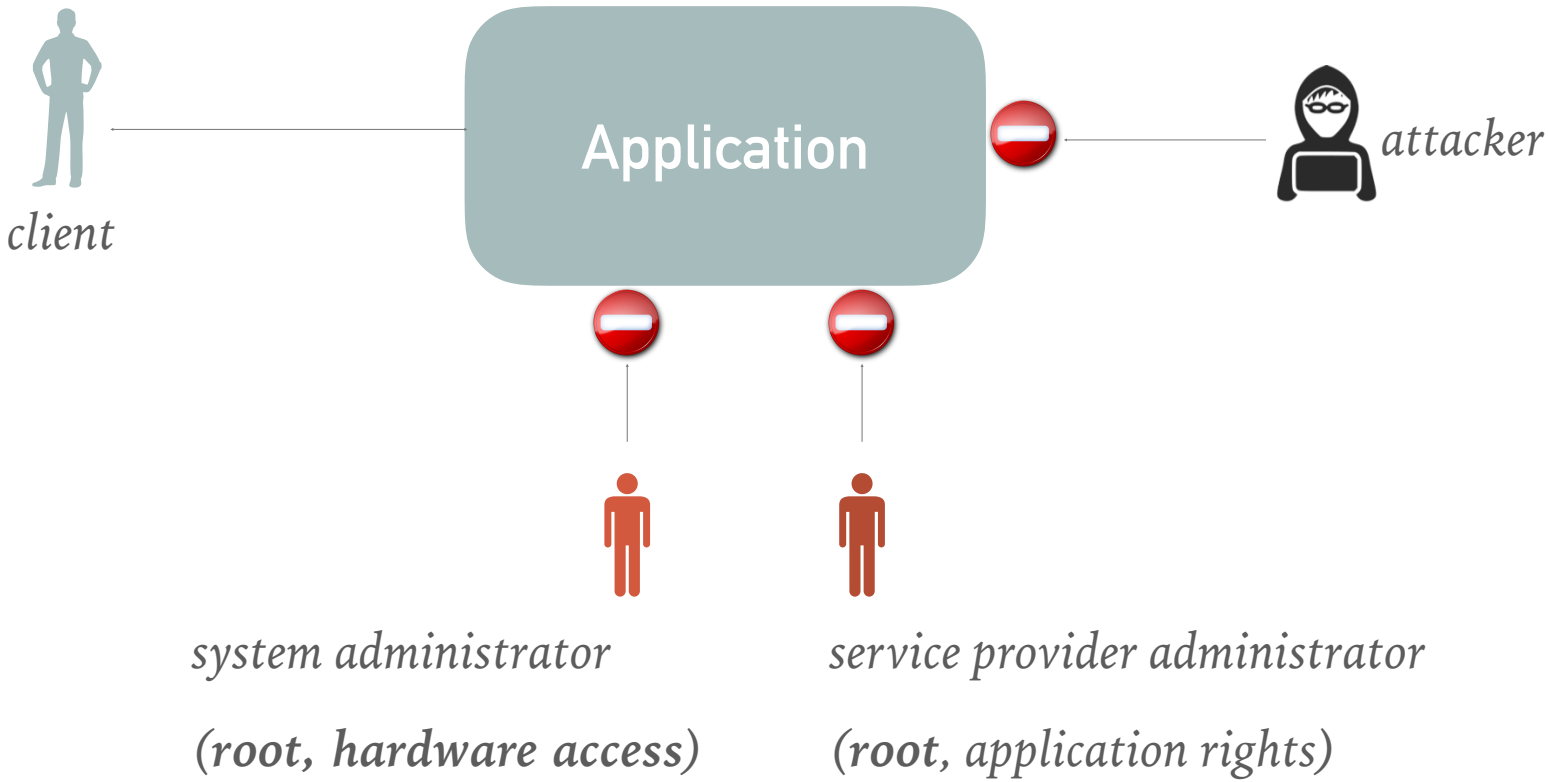
- We believe, however, one can define **N** and **F** ($< N$) and a group of persons PB such that
  - $|PB| = N$
  - at least N-F in PB can be trusted.

We typically do not know who to trust!

THREAT MODEL

https://sconedocs.github.io

THREAT MODEL



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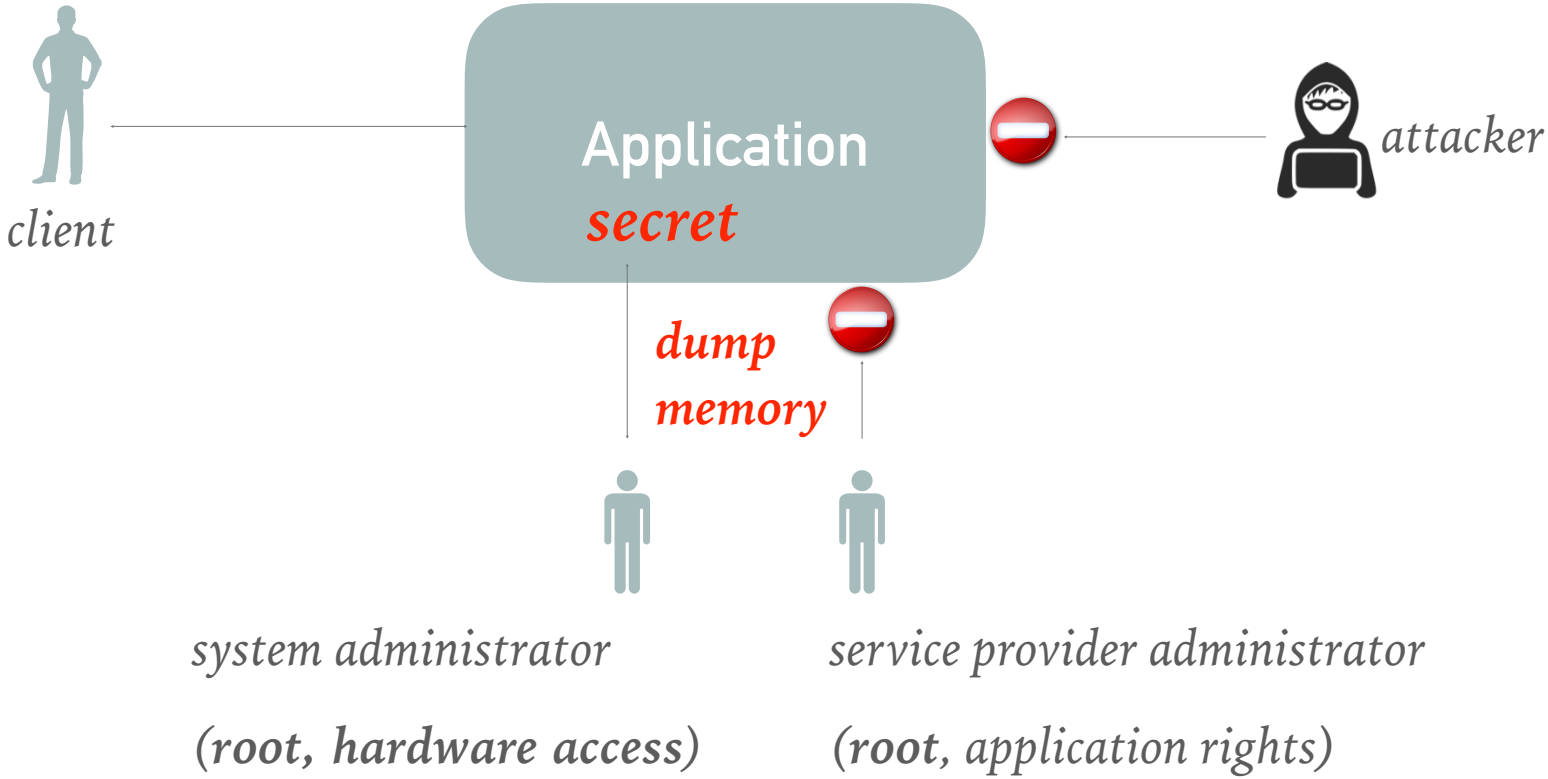
IMPLICATION: OS-BASED ACCESS CONTROL INSUFFICIENT



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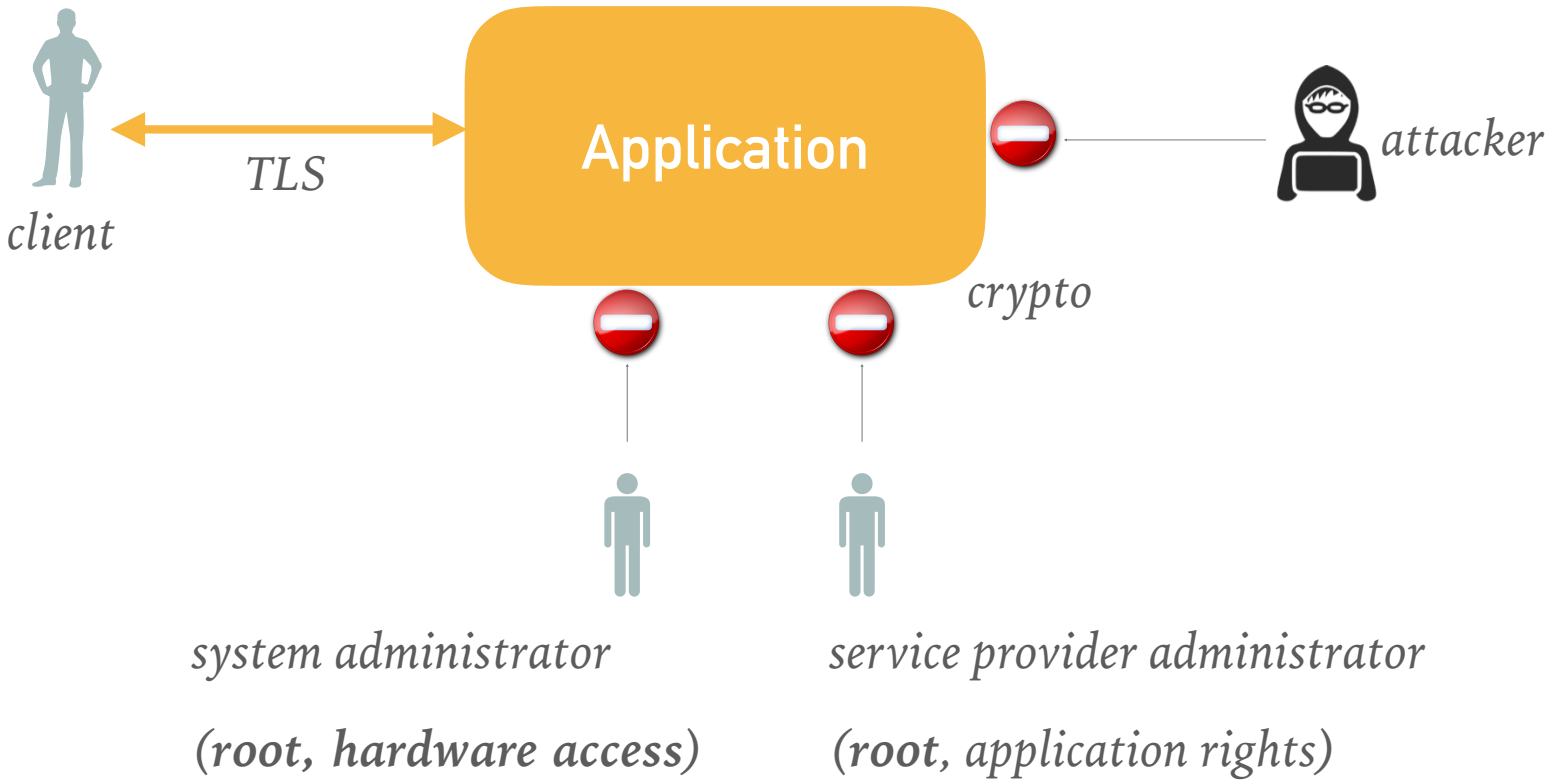
WE NEED A CRYPTOGRAPHIC APPROACH!



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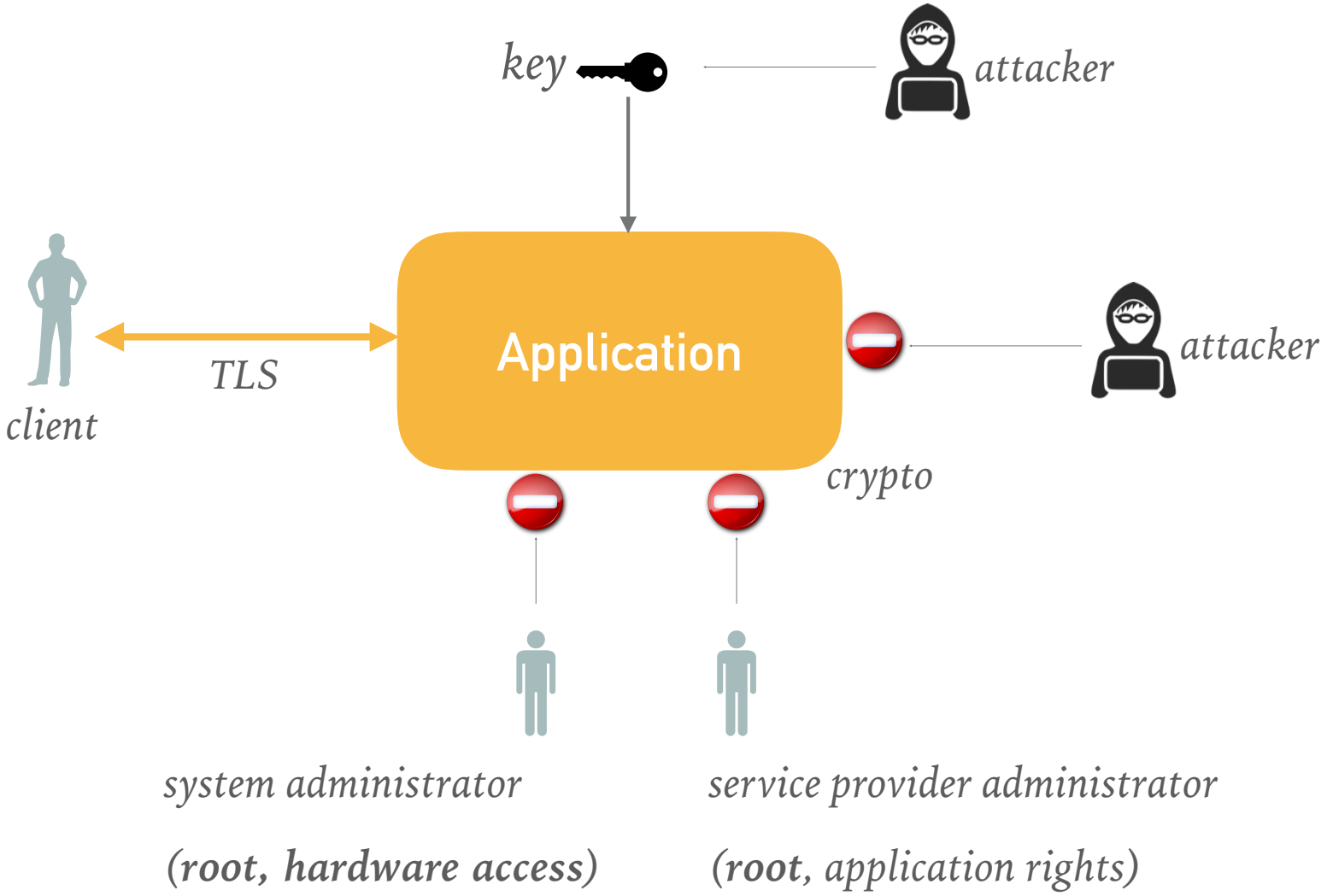
HOW TO PROTECT THE KEYS?



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RESEARCH PROBLEMS ADDRESSED

- How can we *provide applications with secrets* running in an untrusted environment?
- How can we delegate the management of these secrets to untrusted entities?
- How to manage the secrets despite malicious stakeholders?
- How to support secure application updates?
- How can we ensure that no rollbacks happen?
- How to protect against malicious developers, cloud providers and system admins?
- …
- *How can we do all this without changing application source code?*

MORE USE CASES

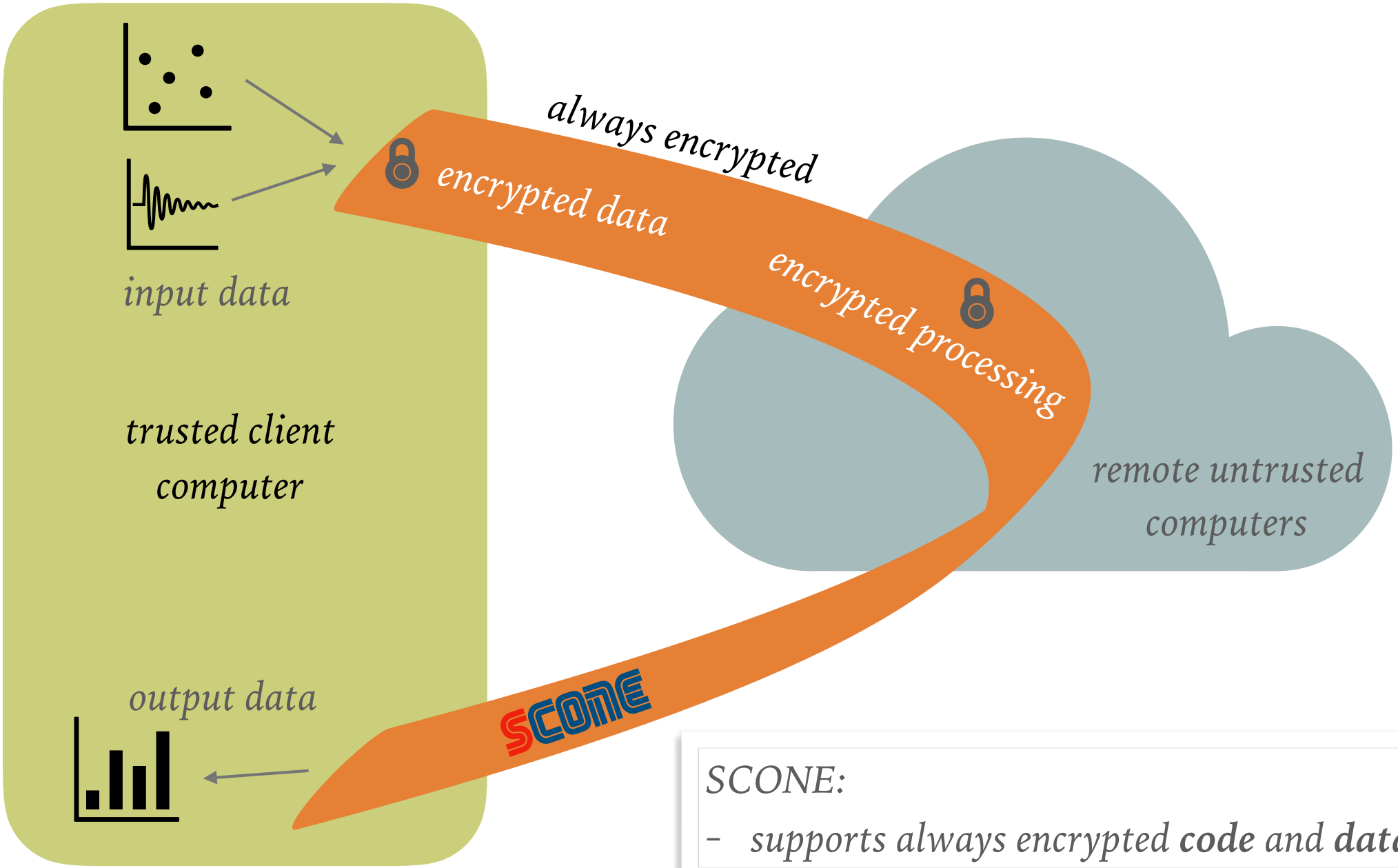
- Electronic Patient Records
- Decentralized Apps (DApps)
- Blockchain related use cases
- Secure Data-as-a-Service
- Health Domain / DNA
- …

- **Approach**:
  - do not start from scratch for each application!

SCONE PLATFORM

sconedocs.github.io

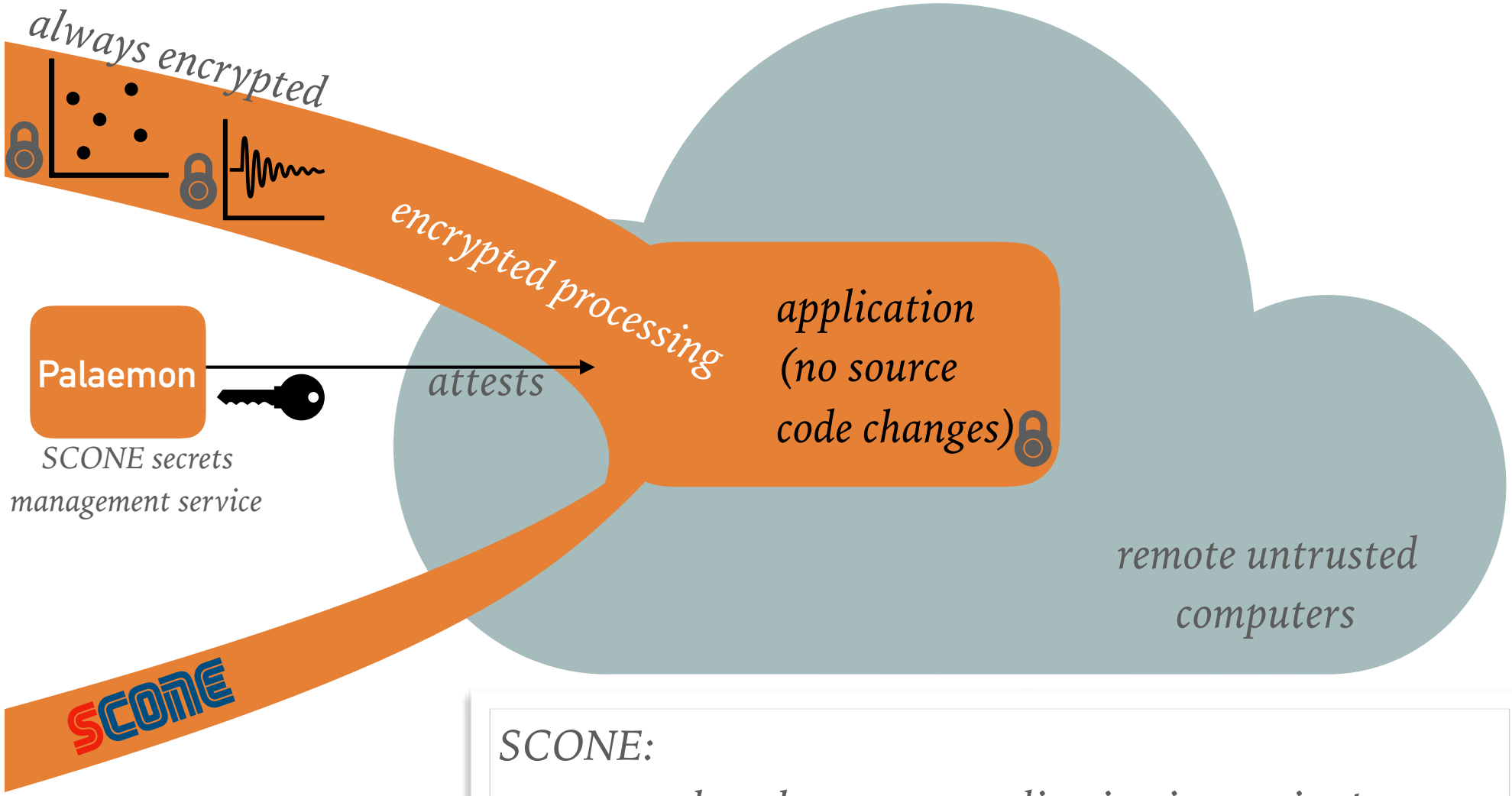
SCONE PLATFORM (HTTPS://SCONEDOCS.GITHUB.IO)



SCONE:

- *supports always encrypted* ***code*** *and* ***data***

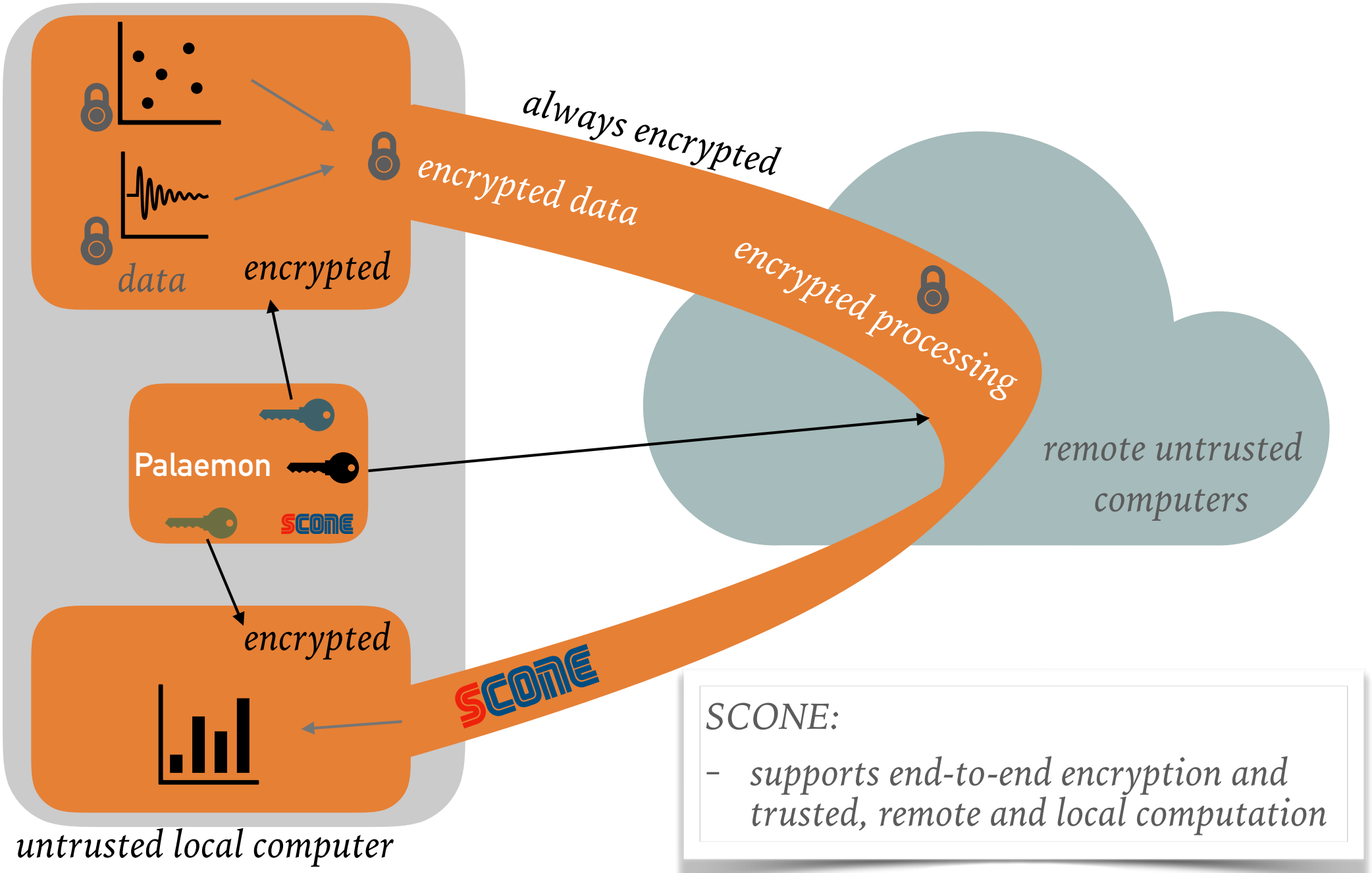
SCONE PLATFORM (HTTPS://SCONEDOCS.GITHUB.IO)



SCONE:

- *attests that the correct application is running!*
- *manages keys & secrets for applications*
- *de/encrypts data and files - transparent to application*

END-TO-END ENCRYPTION



SCONE:

- *supports end-to-end encryption and trusted, remote and local computation*

ADVANTAGES OF USING SCONE

- Attests that the ***correct* code** is running
- Protects **confidentiality, integrity and freshness of data** and **code** even against attackers with root priviledges
- Provides an **integrated secret management**
- Can be used for a more **secure licensing management**

- **Even if attacker would have root access…**

SCONE USE CASES

- **Medical domain:**
  - electronic patient records
- **AI / Machine Learning:**
  - supports TensorFlow
- **Blockchain domain:**
  - decentralized applications
  - Data-as-a-service
  - Supports *Parity Substrate* inside of enclaves
- **General:**
  - Vault, Barbican, PySpark, Blender, …

(EXTENED) THREAT MODEL

- Attacker has **root access** on all machines
- Attacker has **hardware access** on all machines
- Attacker **controls** (credentials of) some but not all **stakeholders**
- Attacker knows sufficient **vulnerabilities in software**
  - note: *about one bug every 2000 lines of source code*
- **Supply chain attacks** on some chips and motherboard

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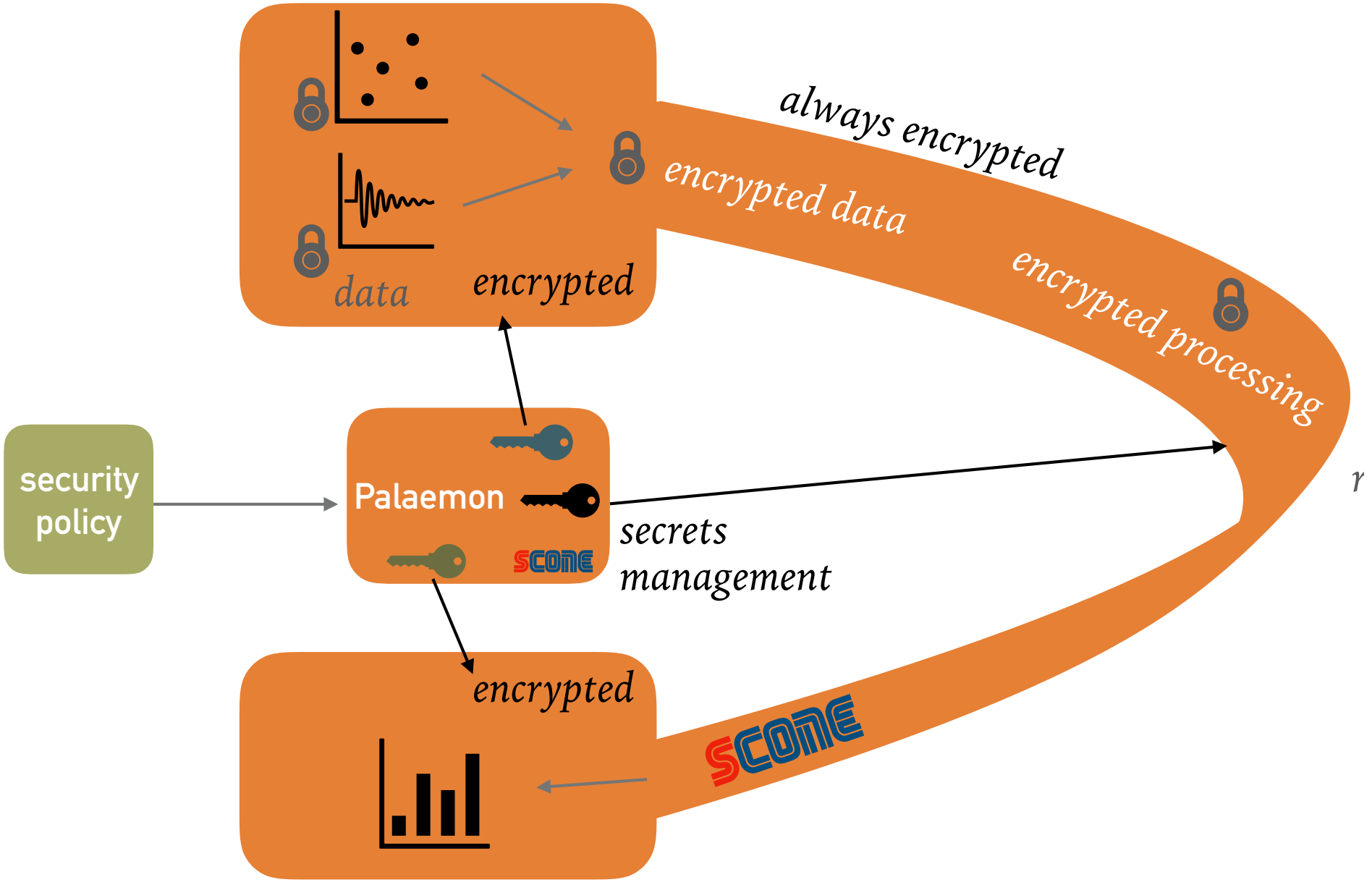
ALL SECRETS ARE PROTECTED BY POLICIES



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NO TRUST IN ANY INDIVIDUAL OPERATORS / USERS / . . .

SCONE:

- *policies are protected by **policy boards***
- *members can be humans and (attested) scripts*
- *changes requires approval from all/majority/.. members*

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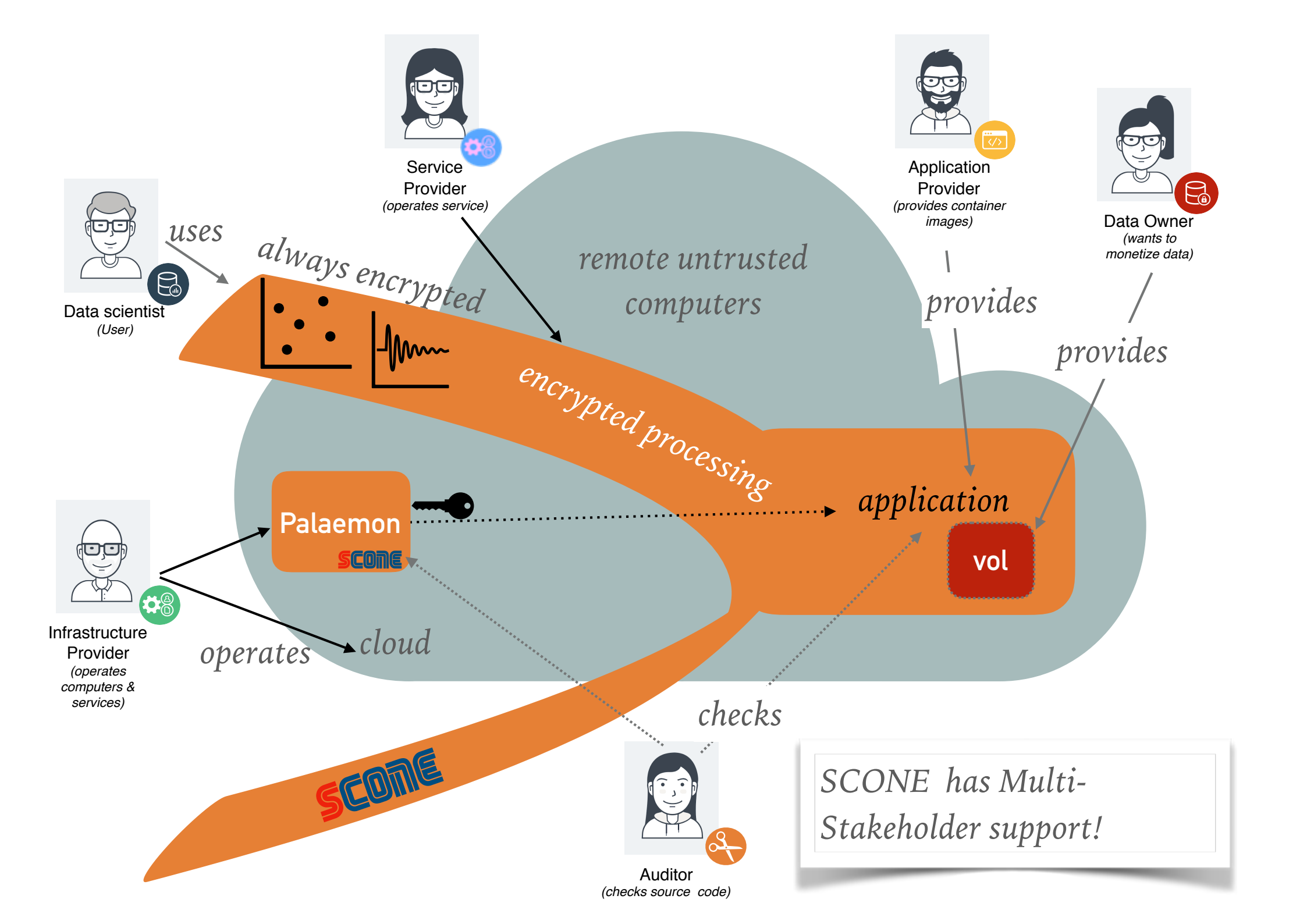
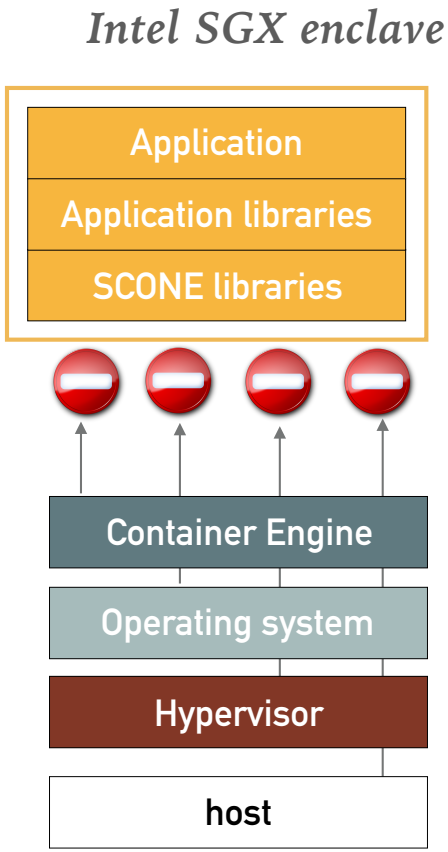

Service Provider
(operates service)
Application Provider
(provides container images)
Data Owner
(wants to monetize data)
Data scientist
(User)
uses
always encrypted
remote untrusted computers
provides
provides
encrypted processing
Palaemon
SCONE
application
vol
Infrastructure Provider
(operates computers & services)
operates
cloud
checks
SCONE
Auditor
(checks source code)
SCONE has Multi-Stakeholder support!

CURRENT IMPLEMENTATION



- Intel SGX protects application's
  - confidentiality
  - integrity
- by preventing accesses to
  - application state in cache and
  - encrypting main memory
- SGX is a TEE (Trusted Execution Environment)

SGX (Software Guard eXtensions) protects application from accesses by other software

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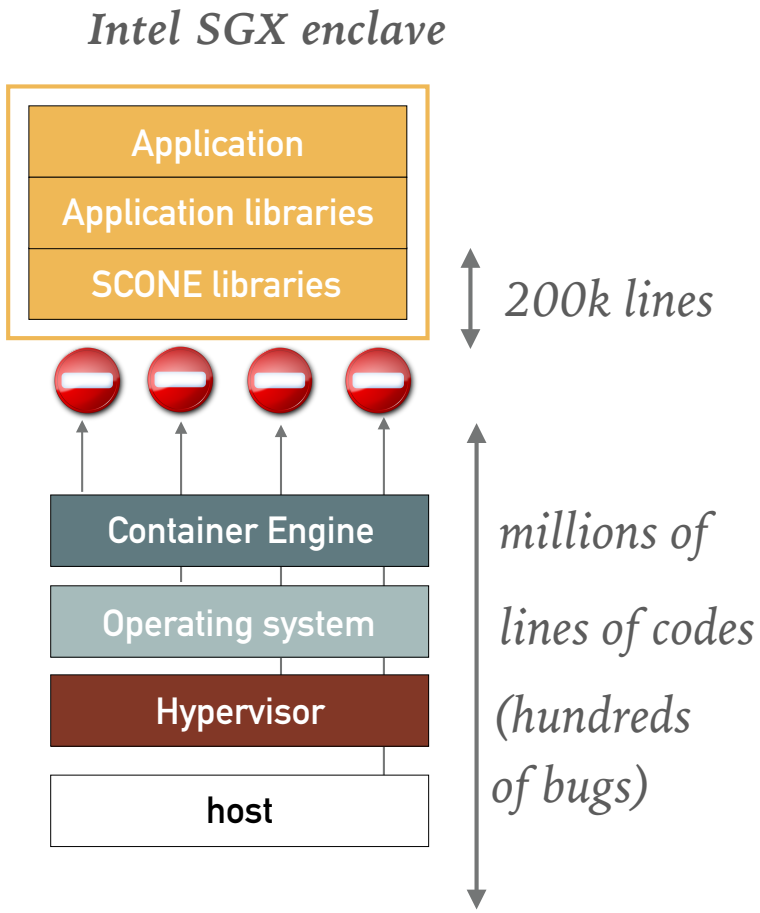
DEFENDER'S DILEMMA



- **Attackers**:
  - success by exploiting a single vulnerability
- Defender:
  - must protect against every vulnerability
    - **system software & application**
  - millions of lines of source code

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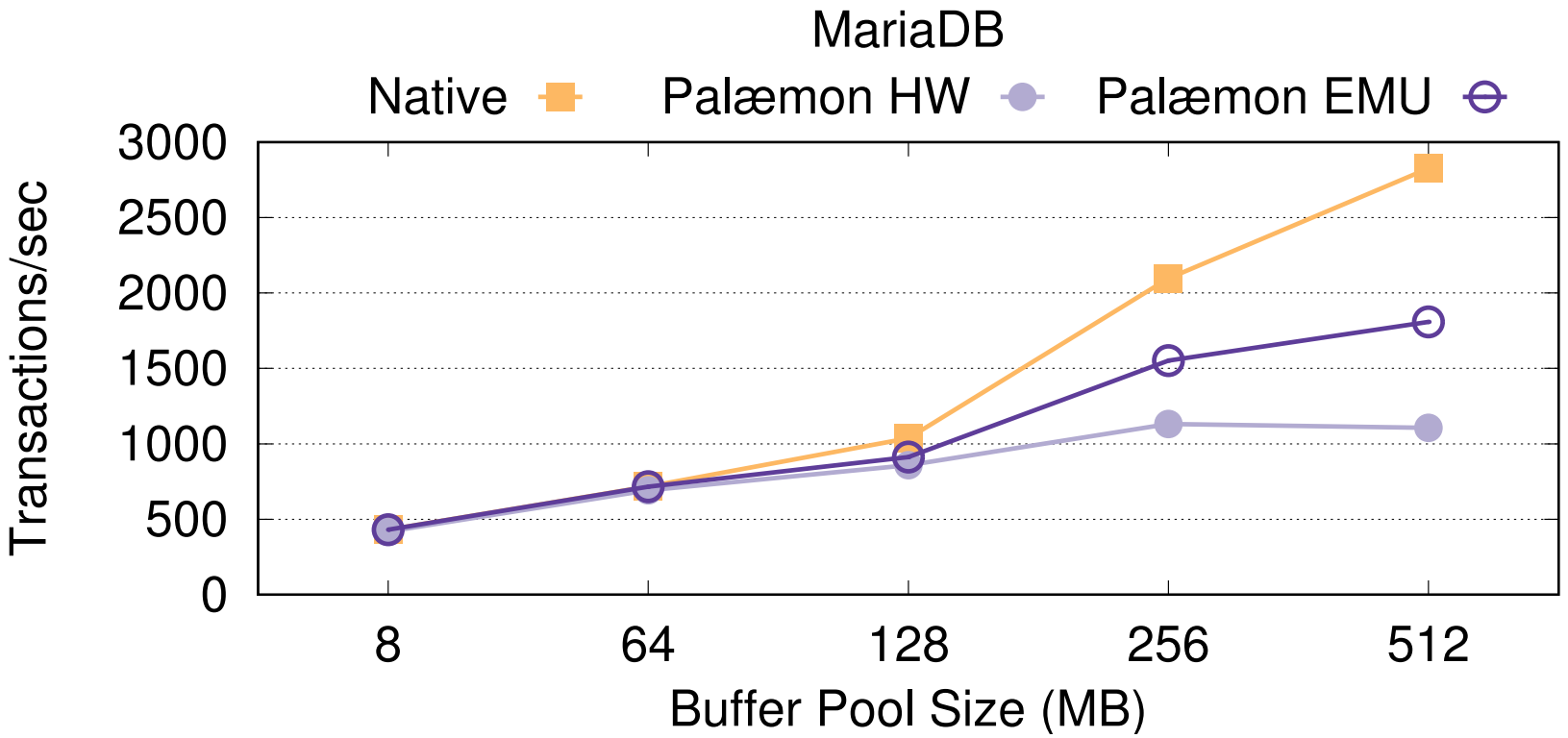
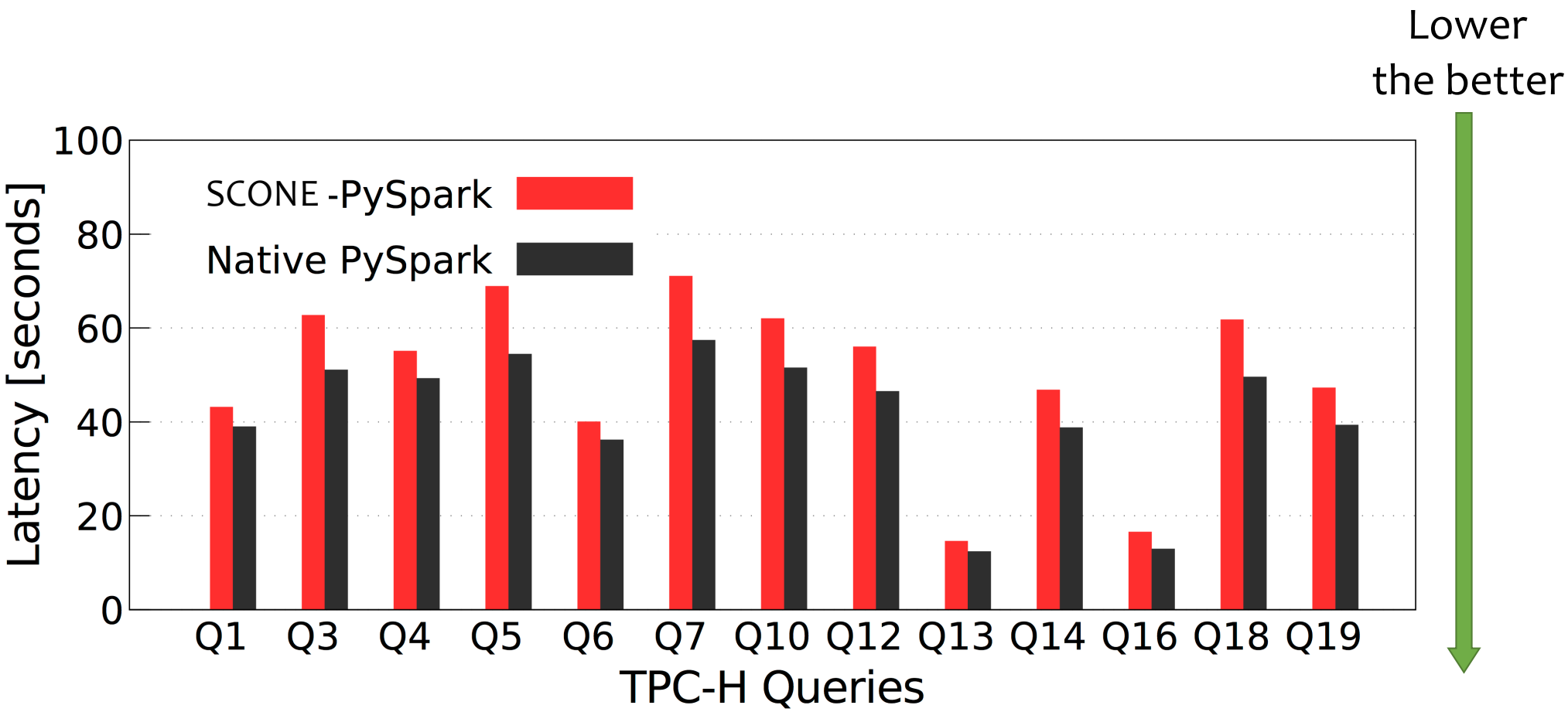
MARIADB PERFORMANCE



TPC-C: increasing buffer pool has little impact on performance

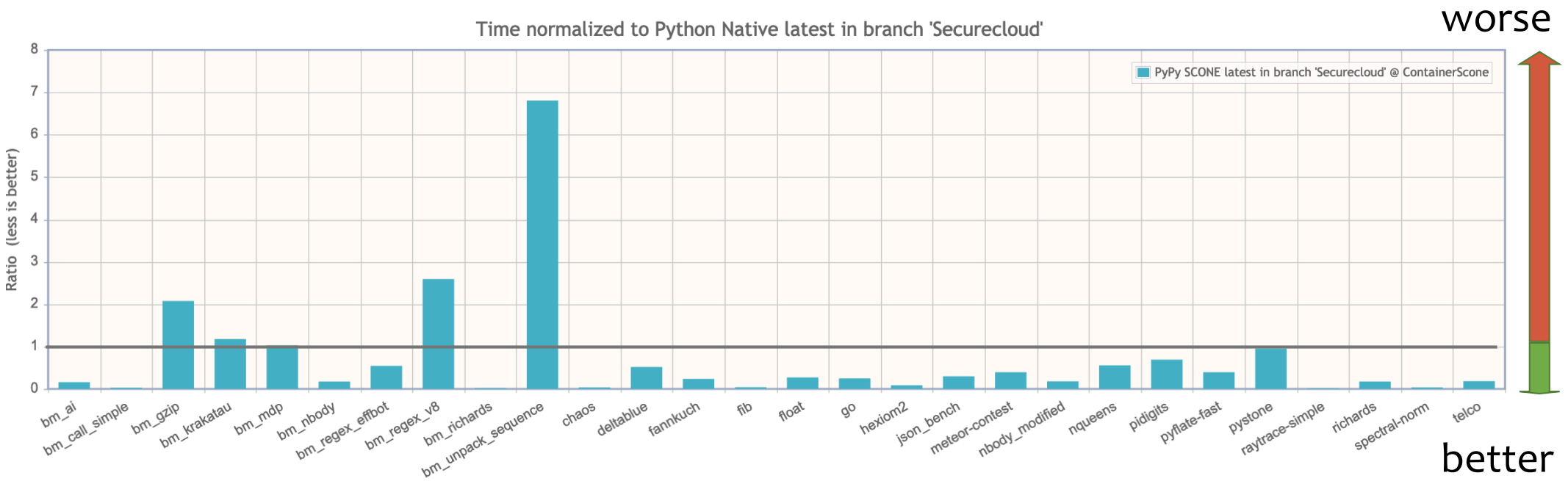
Palaemon = SCONE Secret Management Service

Overheads



< 22 % overhead compared to native execution

PYTHON OVERHEADS



- PyPy SCONE: just in time Python inside enclave
- Python Native: CPython in native mode

SCONE PLATFORM ADVANTAGES

- SCONE supports protection of multiple stakeholders.
- SCONE has an integrated secrets&configuration management
- SCONE scales better (high performance syscall interface)
- SCONE generates smaller executables.
- SCONE comes with a toolchain.
- SCONE protects the OS interface.
- SCONE ensures better Linux compatibility.
- SCONE transparently attests applications.
- SCONE's design is hardware independent.

BA, MSC, DIPLOM THESIS

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- Customized to students
  - talk to me to find an interesting top

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- **Current topics:**
  - Function as a service in DB (with Oracle)
  - Secure GraalVM (with Oracle)
  - Blockchain topics (with vmware)
  - Encrypted binary code
  - …

JOBS

- Always looking for students
  - SHK, WHK
  - PhD students
  - PostDocs

- Talk to me regarding external jobs

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https://sconedocs.github.io/ http://scontain.com