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A Scalable Cyber Security Framework for the Experimentation of DDoS Attacks of Things

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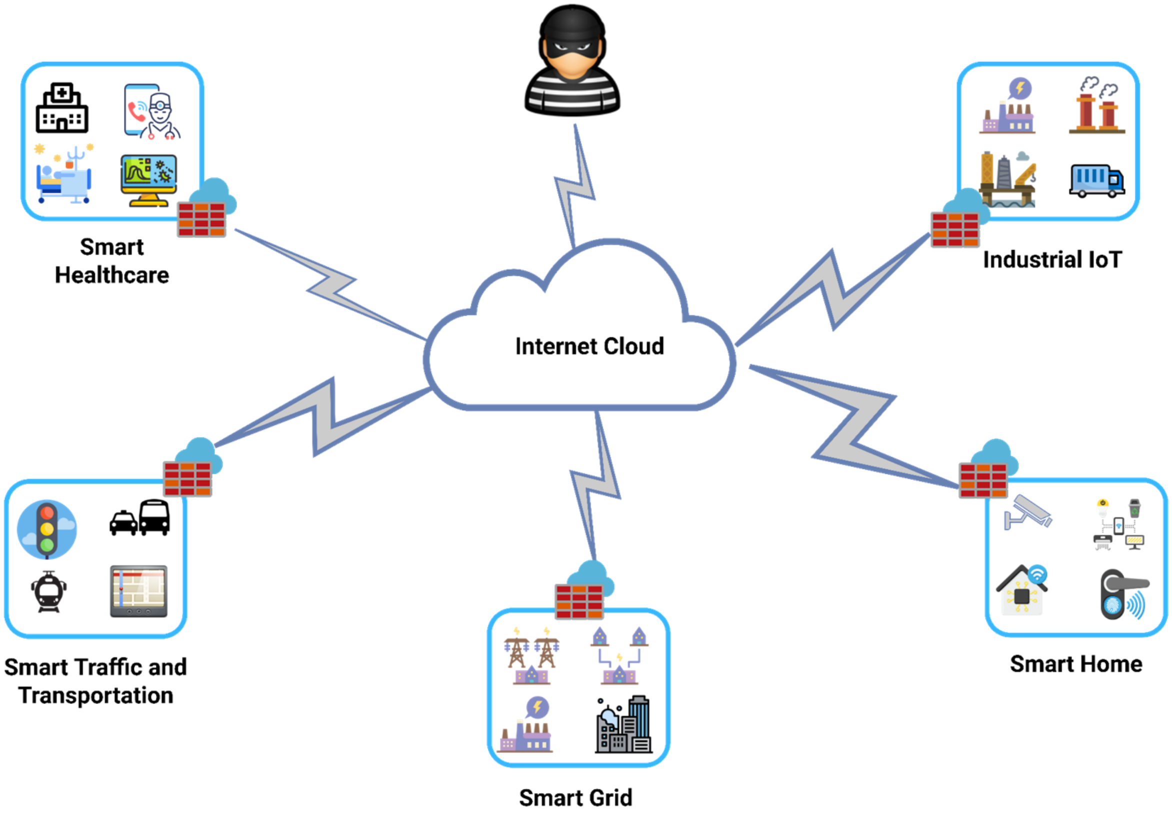
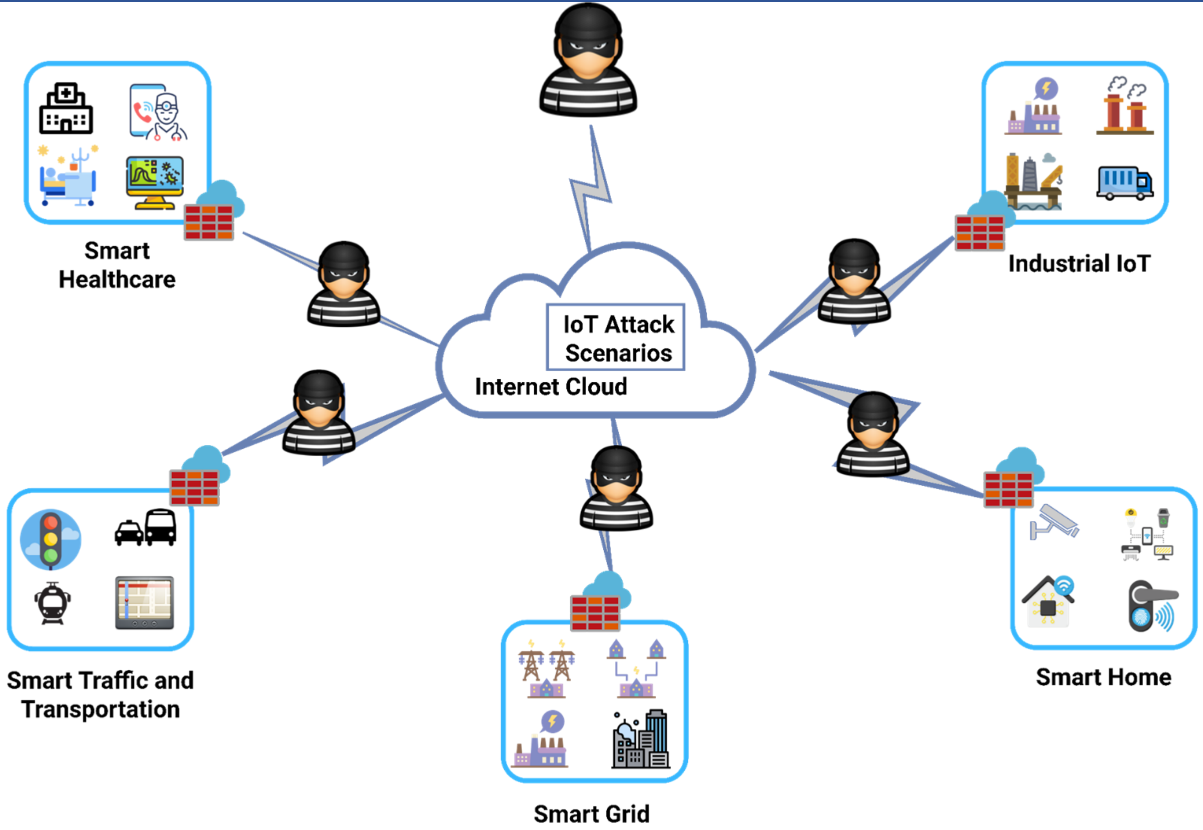
Agenda

- Introduction
- Related Work
- Cyber security framework for DDoS of Things (DoT)
- Mentored testbed
- Case study
- Concluding remarks

IoT has amplified security challhenges



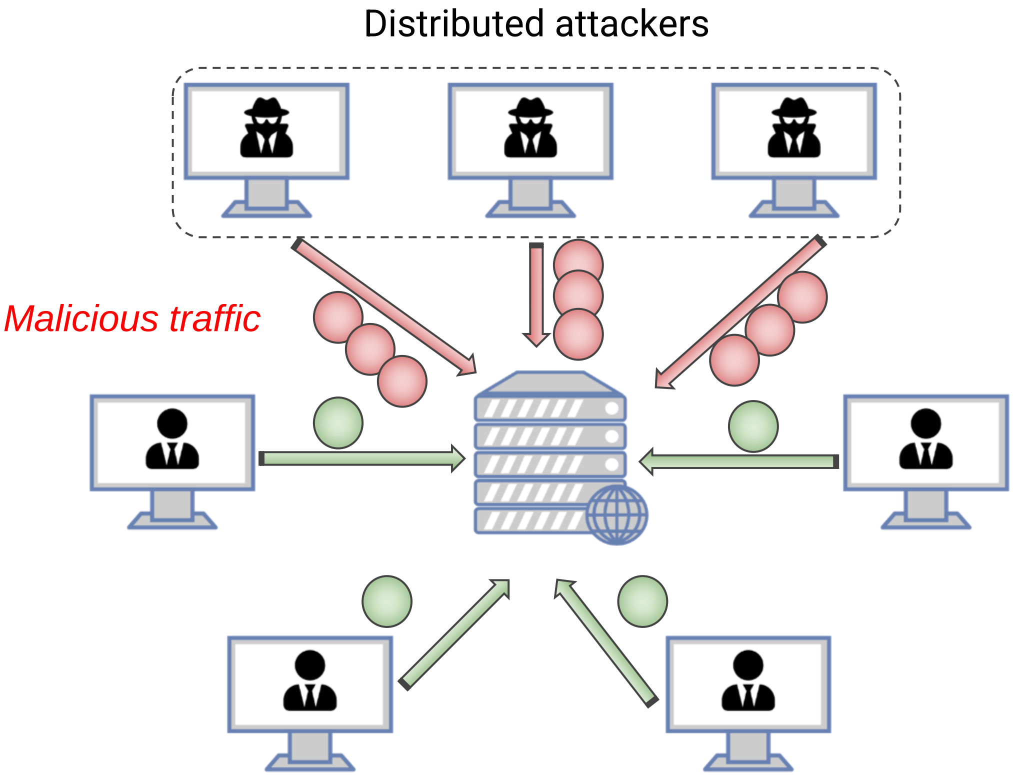
Security of IoT devices



DDoS Attacks

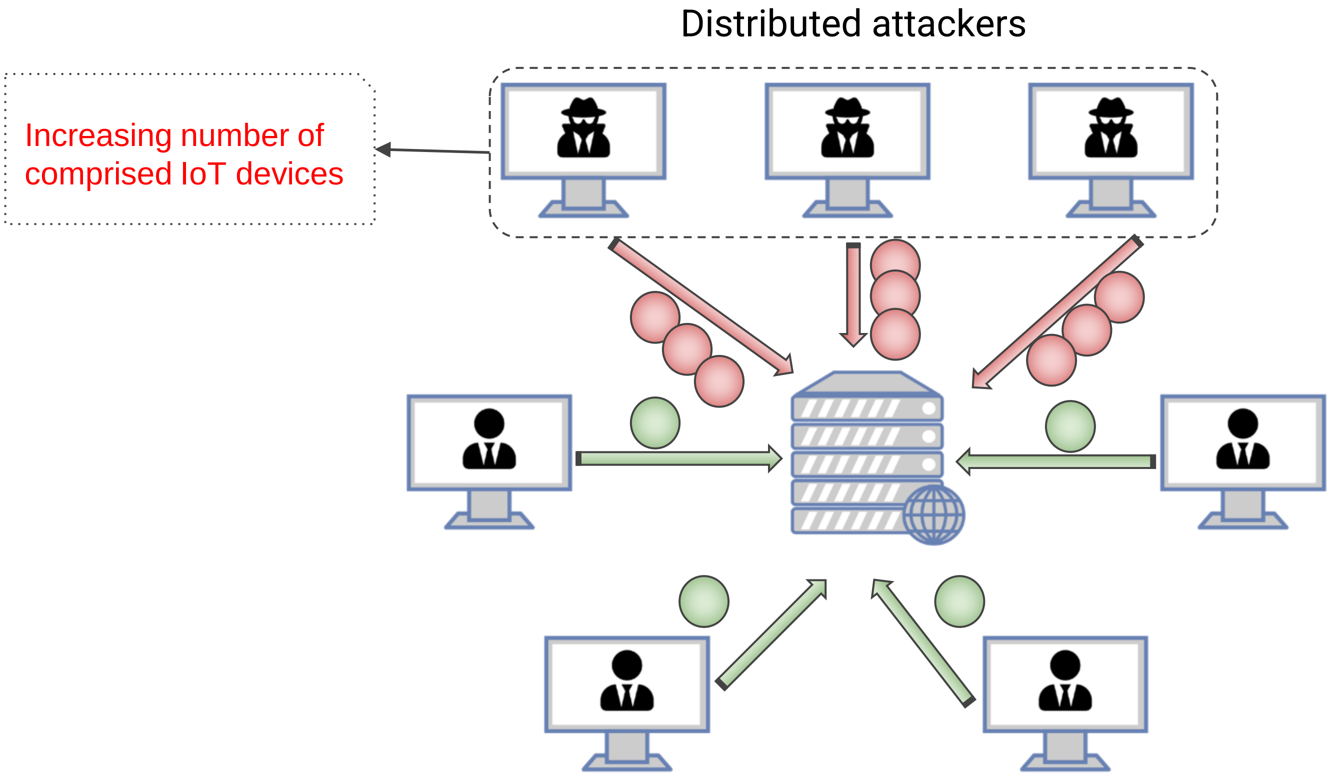
If an attacker has access to several devices

- 🟢 Benign traffic
- 🔴 Malicious traffic
- Clients
- Attackers
- Server (DDoS Target)
- Failed connection



Extended the size of DDoS (DoT Attacks)

- 🟢 Benign traffic
- 🔴 Malicious traffic
- Clients
- Attackers
- Server (DDoS Target)
- Failed connection

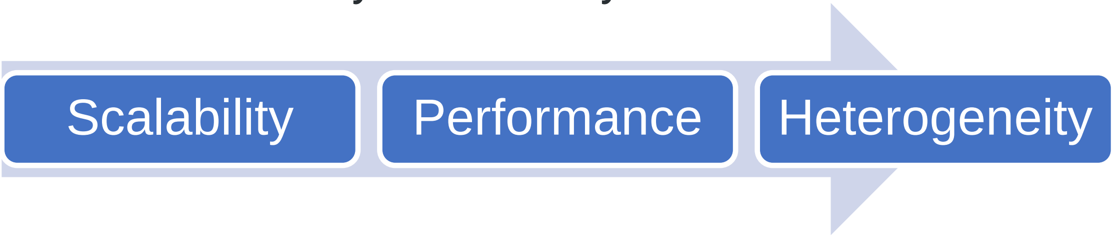


Distributed attackers

Increasing number of comprised IoT devices

Motivation

- Solutions to prevent, detect and mitigate DoT attacks require appropriate tools and methods to **test and validate** them
  - ○ Simulations
  - ○ Lack of realistic experimental environments that meet specific requirements for IoT cyber security



It urges a **framework** to support and guide the development of testbeds

Related Work

Experimental environments

testbeds focusing on cyber security

IoT testbeds

focusing on cyber security and IoT

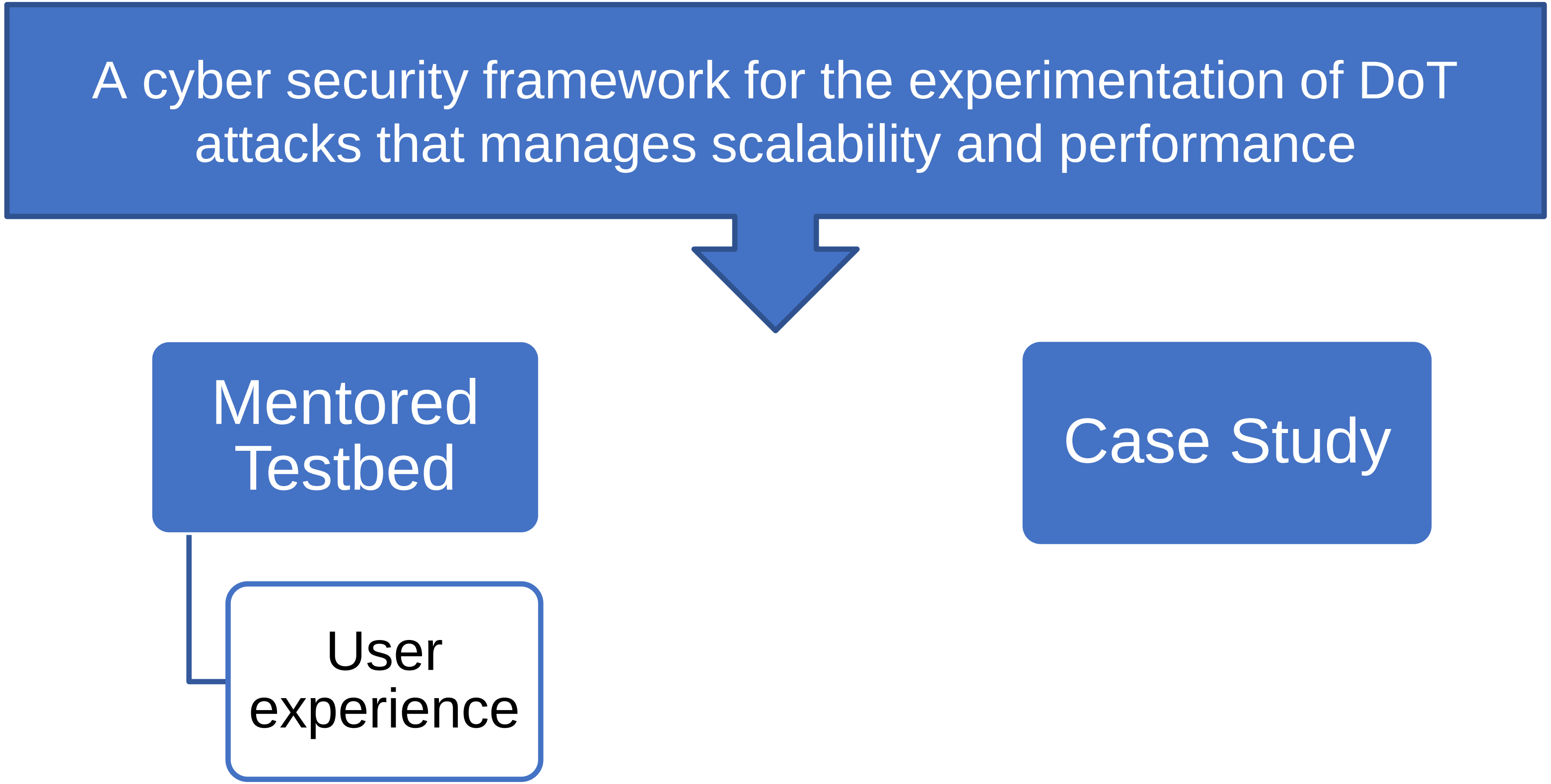
Related Work

- **DETERLab**: designed for large-scale emulation and experimentation; it ignores the context of wireless network
- **FIT IoT-LAB**: offers a platform for researchers to build, evaluate and optimize protocols, applications, and services; it lacks traffic isolation
- **Gotham**: is based on the GNS3 network emulator and provides a set of tools for experimenters to carry out DoS attacks; scalability is still an issue.
- **Takeoglu and Tosun**: low-cost testbed based on off-the-shelf hardware and open-source software (IoT devices); it also does not address scalability.
- **EdgeNet**: comprises virtual machines (VM) interconnected by Kubernetes-based implementation; it does not consider DoT attacks (with heavy network loads)

Problem

- There is still a place for improvement
- A need for well-defined references to assist in designing testbeds for cyber security, concerned with DoT attacks
- A gap defining the requirements to guide the implementation of realistic and geographically distributed environments (scalability and performance)
- Considering IoT devices heterogeneity

Purpose of this paper



A cyber security framework for the experimentation of DoT attacks that manages scalability and performance

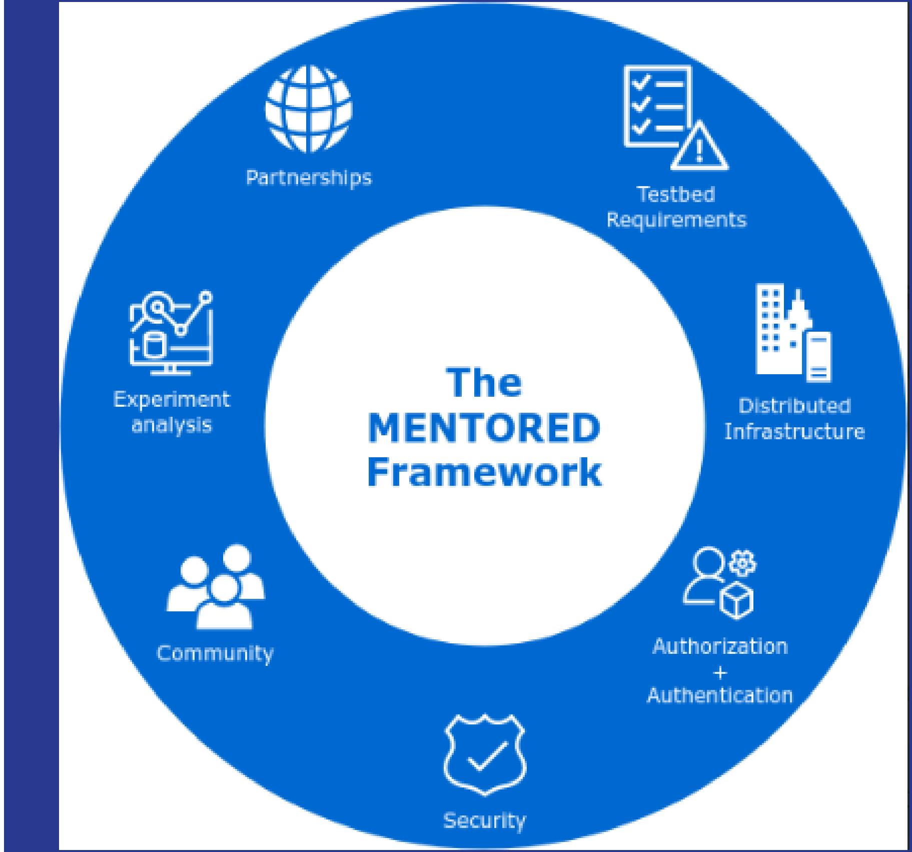
Mentored Testbed

User experience

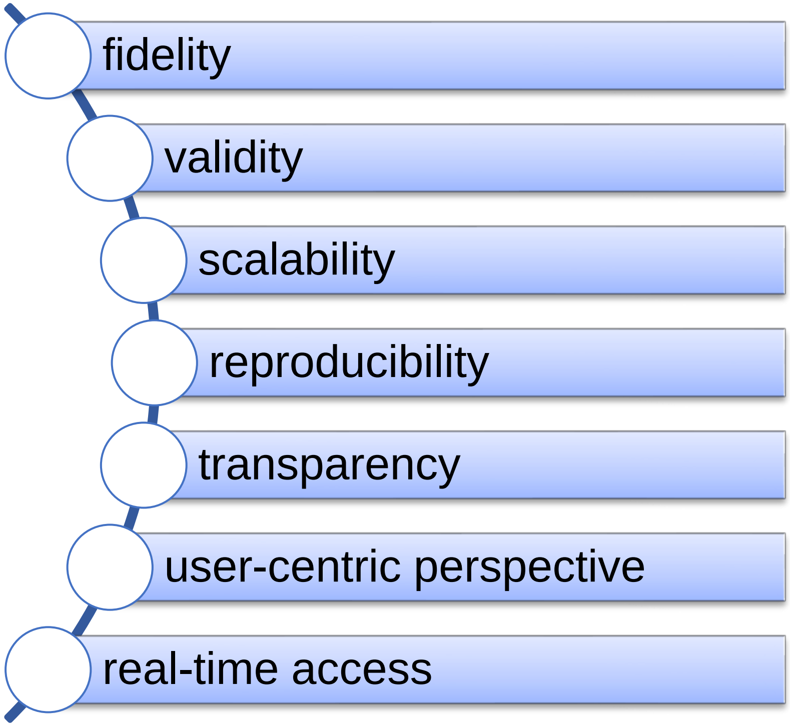
Case Study

Solution

Cyber security framework

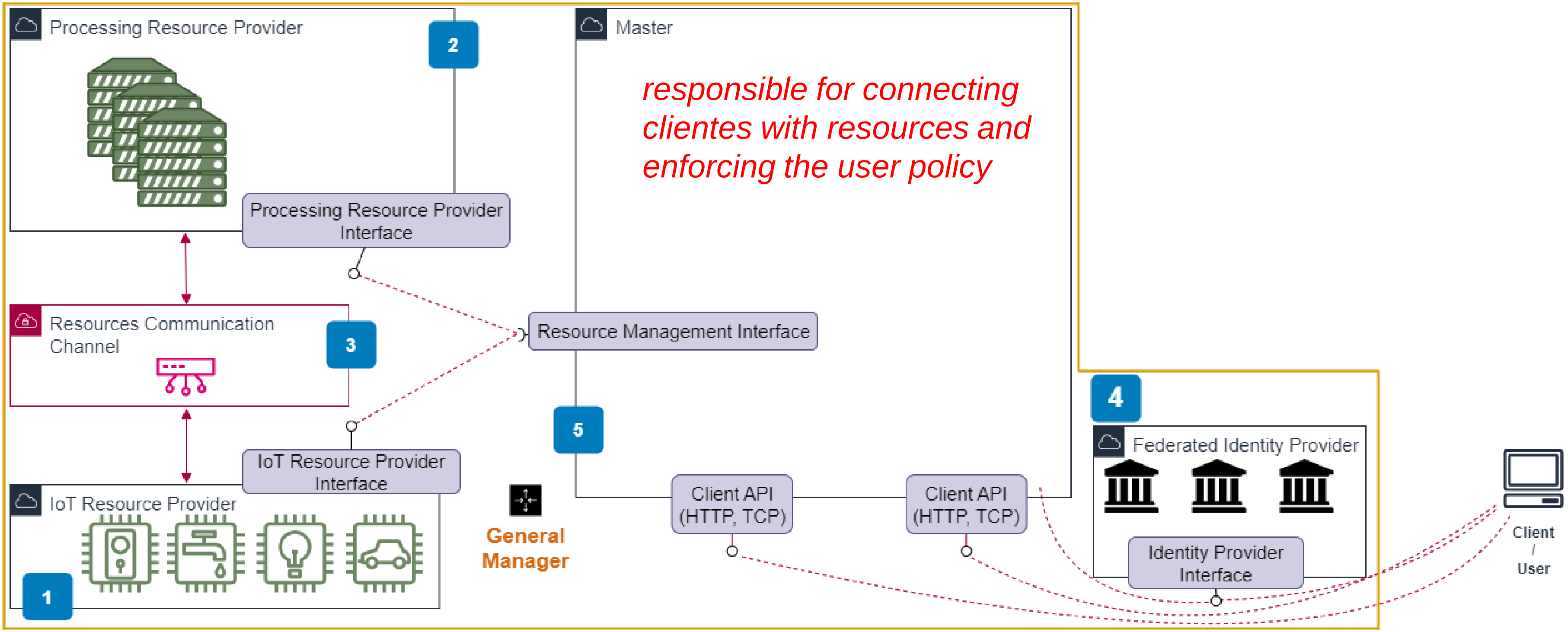


Framework Requirements



- fidelity
- validity
- scalability
- reproducibility
- transparency
- user-centric perspective
- real-time access

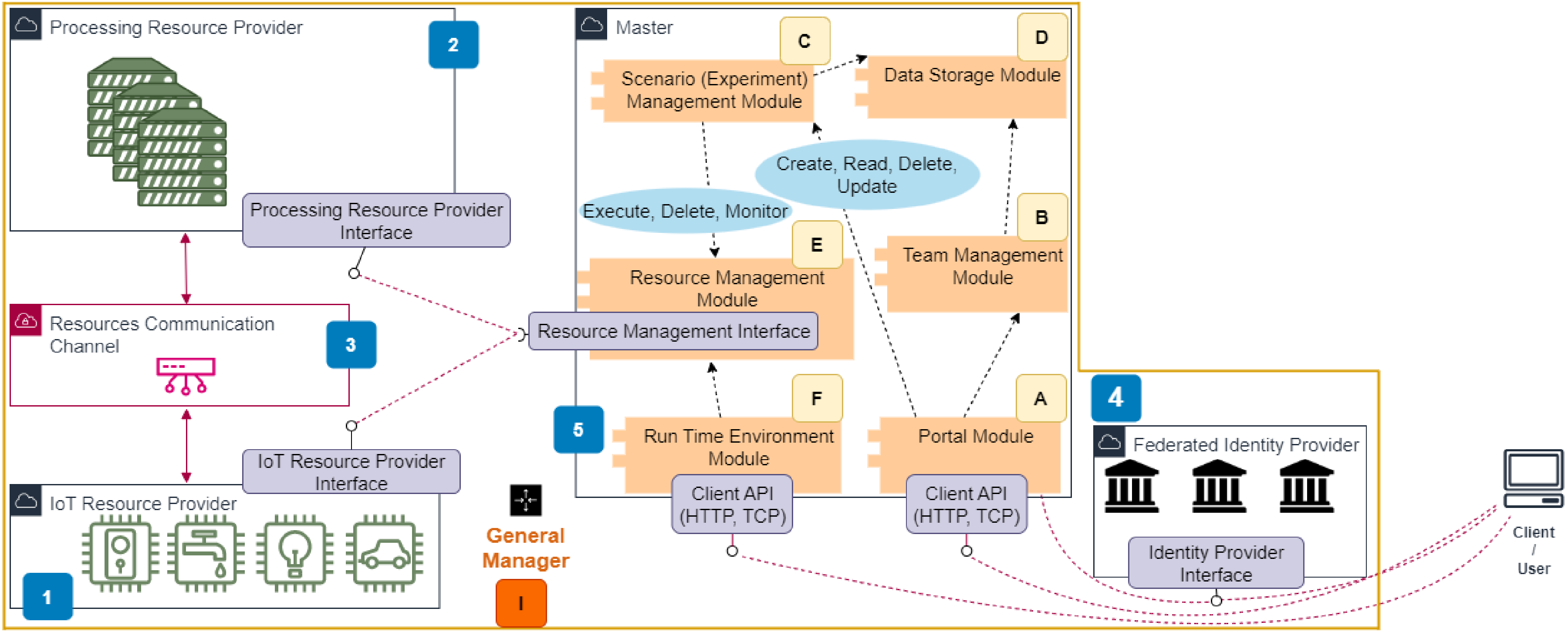
Framework Entities



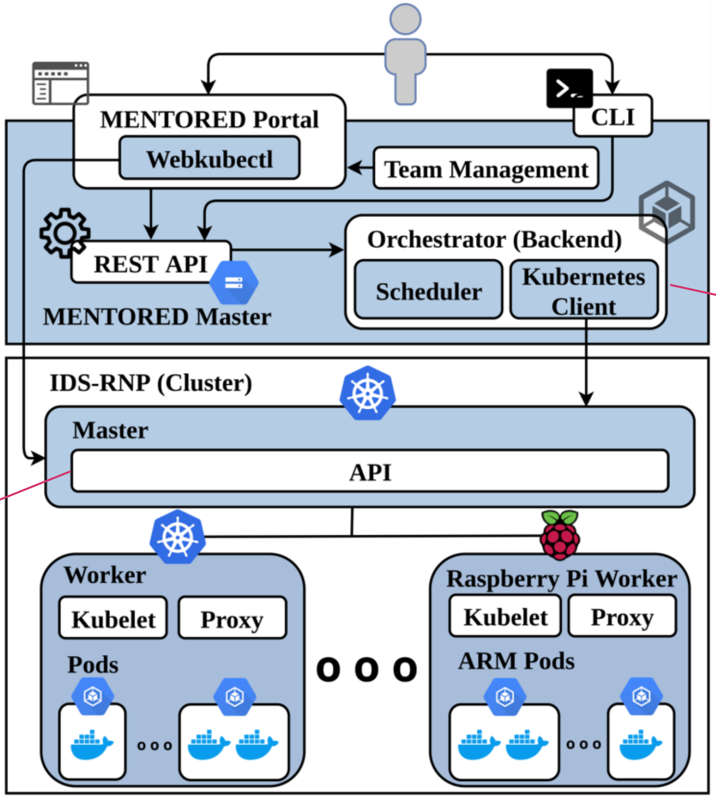
Processing Resource Provider
2
Processing Resource Provider Interface
Master
Resource Management Interface
Resources Communication Channel
3
IoT Resource Provider Interface
IoT Resource Provider
1
5
General Manager
Client API (HTTP, TCP)
Client API (HTTP, TCP)
4
Federated Identity Provider
Identity Provider Interface
Client / User

responsible for connecting clientes with resources and enforcing the user policy

Framework Modules


Processing Resource Provider
2
Processing Resource Provider Interface
Resources Communication Channel
3
IoT Resource Provider Interface
IoT Resource Provider
1
Master
C
Scenario (Experiment) Management Module
D
Data Storage Module
Create, Read, Delete, Update
Execute, Delete, Monitor
B
Team Management Module
E
Resource Management Module
Resource Management Interface
F
Run Time Environment Module
A
Portal Module
5
Client API (HTTP, TCP)
Client API (HTTP, TCP)
General Manager
I
4
Federated Identity Provider
Identity Provider Interface
Client / User

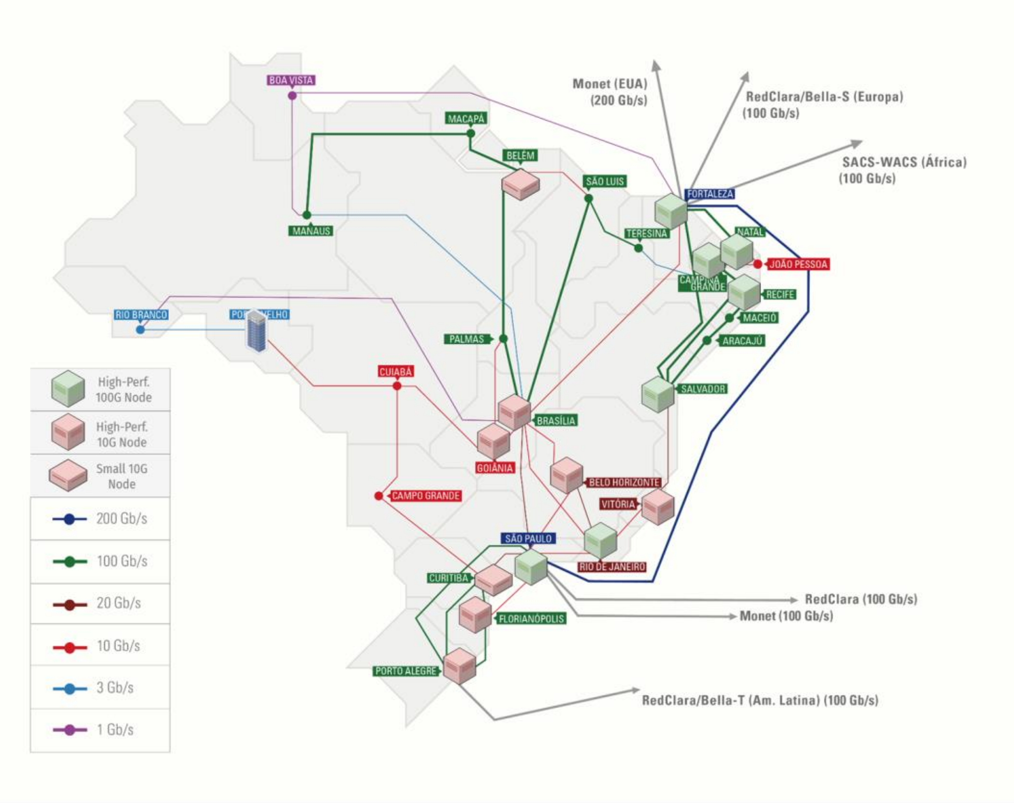
Mentored Testbed



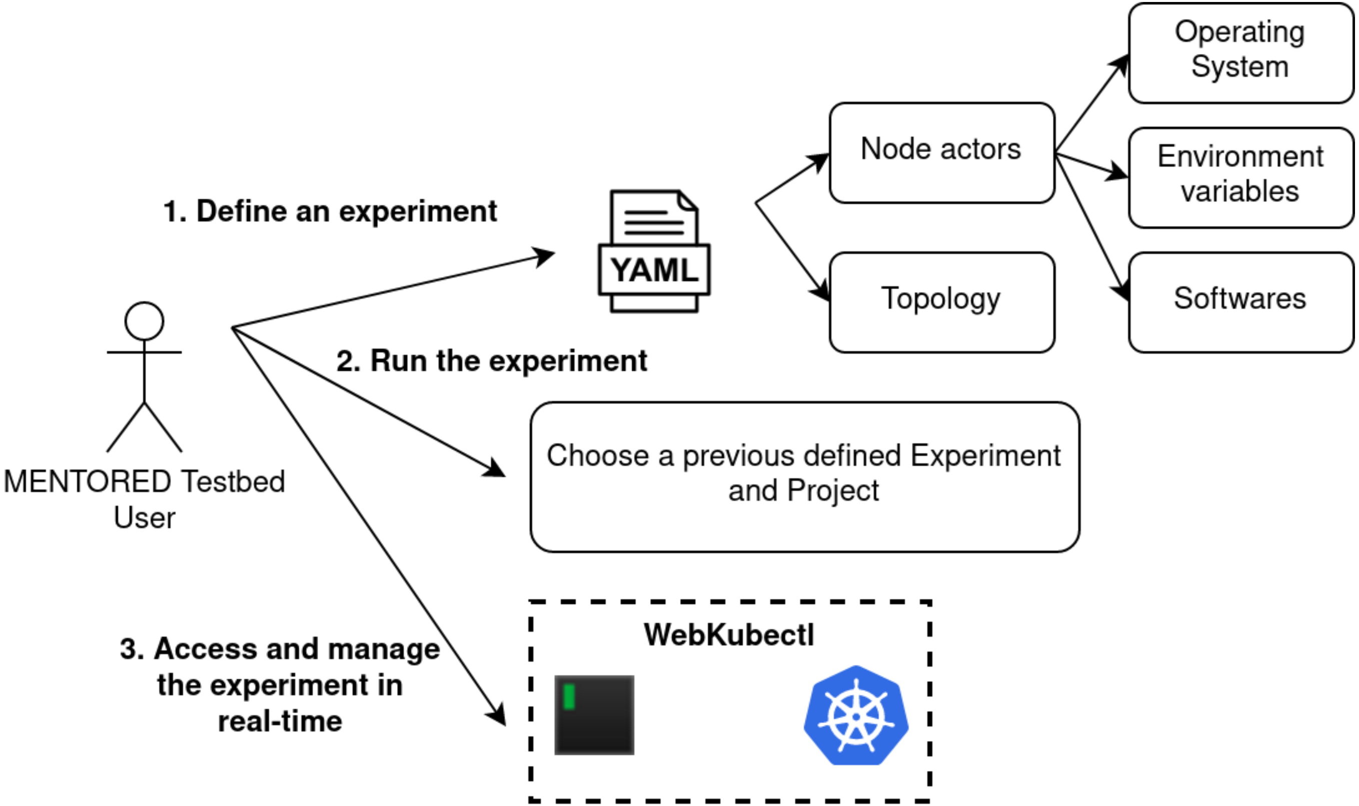
Backend: code executed on the server

KnetLab operations

IT Infrastructure - IDS-RNP



User perspective



MENTORED Testbed User

1. Define an experiment

2. Run the experiment

3. Access and manage the experiment in real-time

Choose a previous defined Experiment and Project

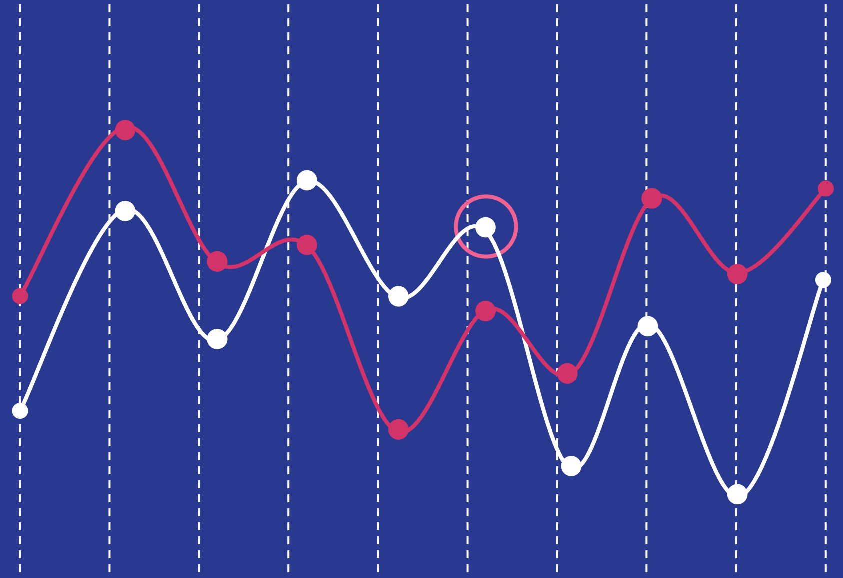
WebKubectl

IT Infrastructure

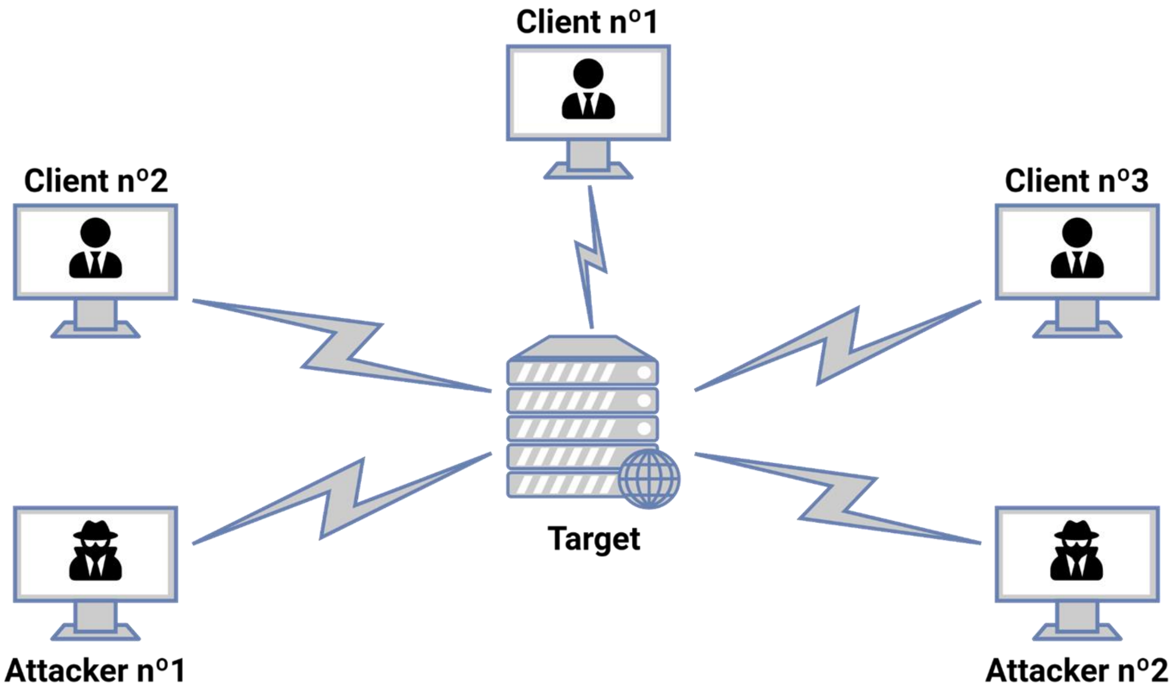
- Frontend
  - React.js

- Backend
  - Kubernetes
  - Python 3
  - Kubernetes Python API
  - Webkubectl
  - Django (Development of a REST API)
  - Knetlab

Case Study



Simple DDoS scenario



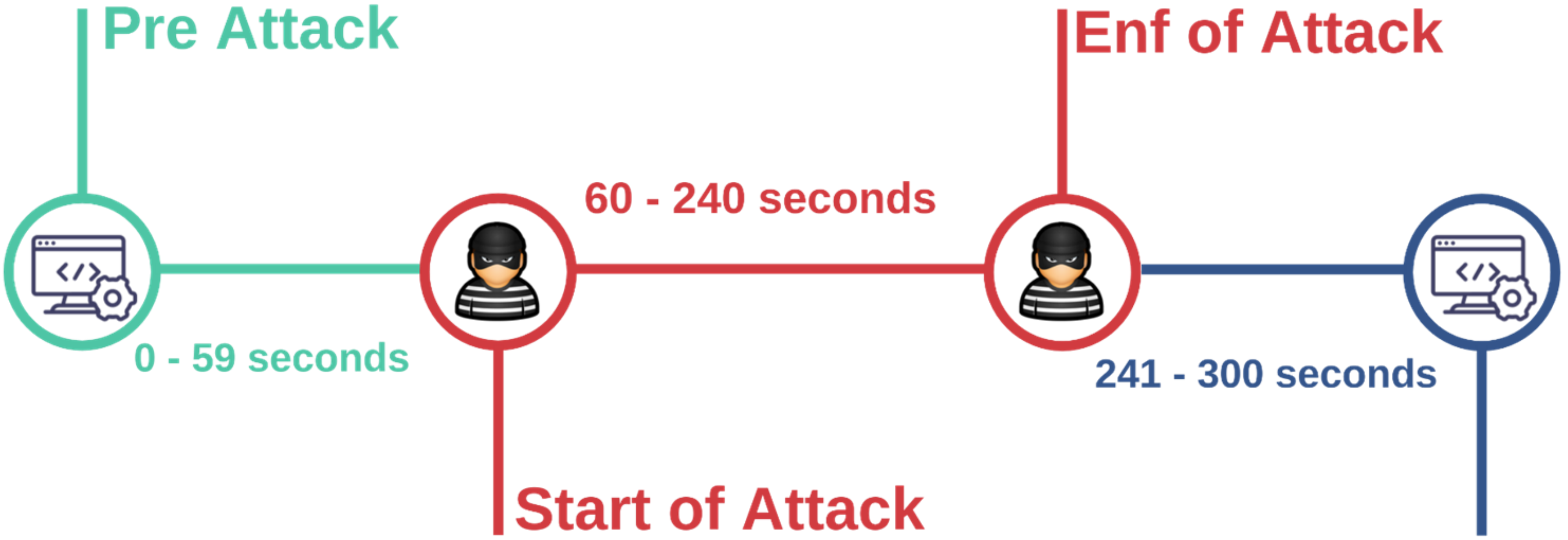
DDoS Target: Web Server NGINX

Client: Resquest at 0.5 second intervals

Attacker: Use hping software for attack, make 100 requests per second

Results

Application example



Pre Attack

0 - 59 seconds

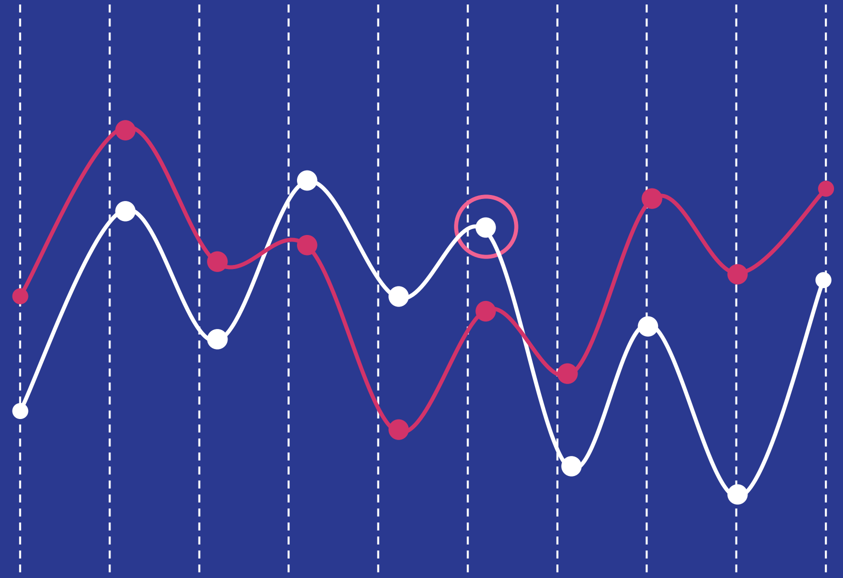
60 - 240 seconds

Start of Attack

Enf of Attack

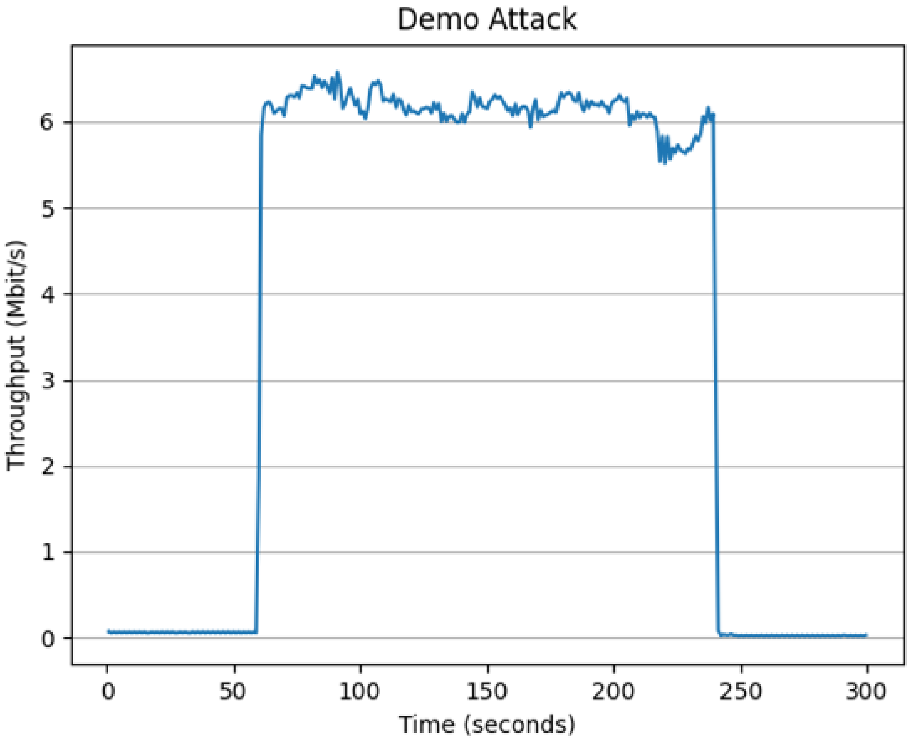
241 - 300 seconds

Results



Results

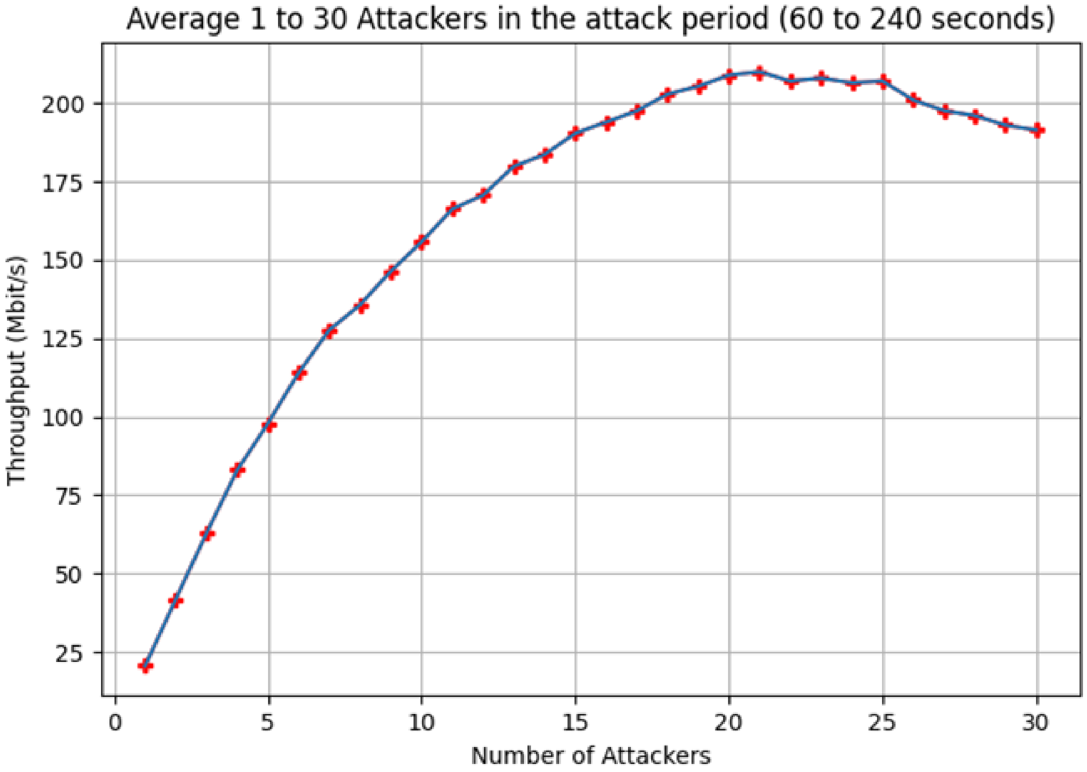
Distributed scenario



Results

Local scenario

- Scalability
- Local scenario: optimal number of attackers per region



Concluding Remarks

- Experimental environments are essential (DoT attacks)
- Framework as a reference to design scable testbed
    - Requiriments, entities and modules
- MENTORED: The Brazilian testbed for IoT cybersecurity
    - Takes advantage of well-known technologies (Kubernetes)
    - Topology modeling through .yaml files
    - REST API in the execution of the experiment
- Preliminary tests – study case

Future Works

- Other scenarios
  - E.g., a higher number of physical and virtual nodes

- Evaluate other technologies for creating virtual networks
- Analyze other attack scenarios (e.g slowloris)

Thank you! Any Questions?

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