Customisable Fault and Performance Monitoring Across Multiple Clouds

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Context

Multiple datacentres in multiple geographical regions

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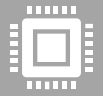

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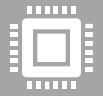

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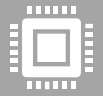

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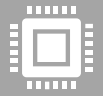

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Cloud Providers require an aggregated single picture of the monitored system's health

Both Cloud infrastructures and Service Level Objectives evolves over time

Our Goal

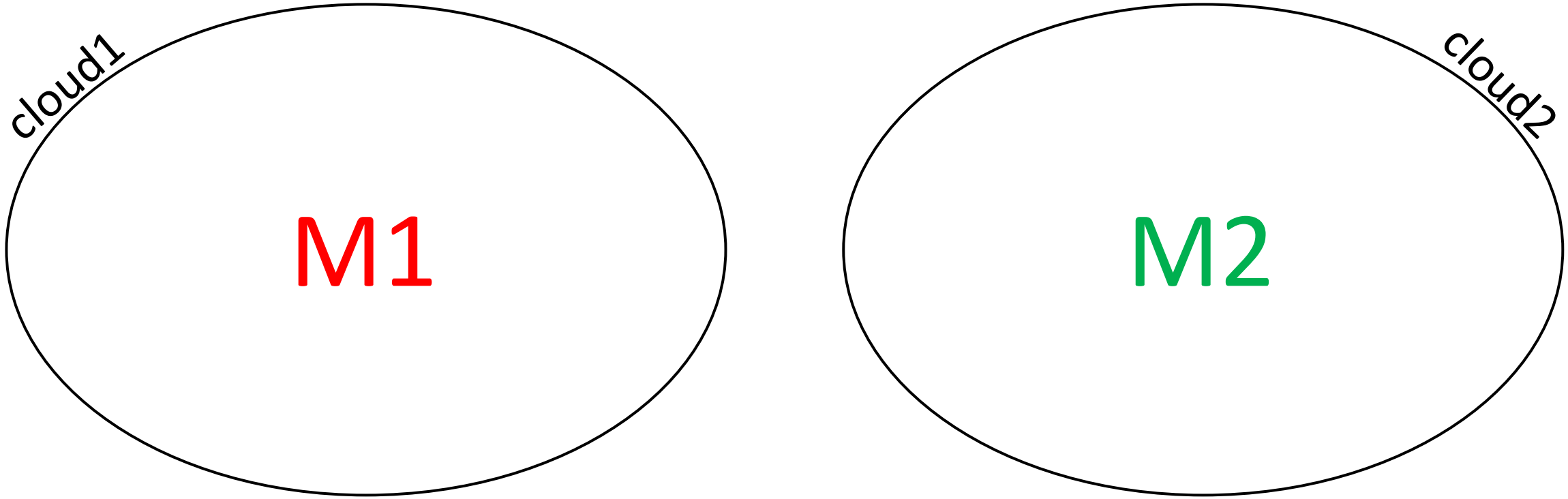

Design a highly customisable fault and performance monitoring tool for multi-Cloud systems

Presenting CLOUDWATCHER

- CLOUDWATCHER aims at **monitoring customised health metrics** of **multi-Cloud** systems.
- It provides **configurable SLO alerts.**
- It is **extensible** to accommodate further metrics.
- It offers a **declarative management**.
- It is freely available at: https://github.com/di-unipi-socc/cloudWatcher

CLOUDWATCHER's Design

- CLOUDWATCHER relies on a set of **Managers**, deployed in each DC to be monitored



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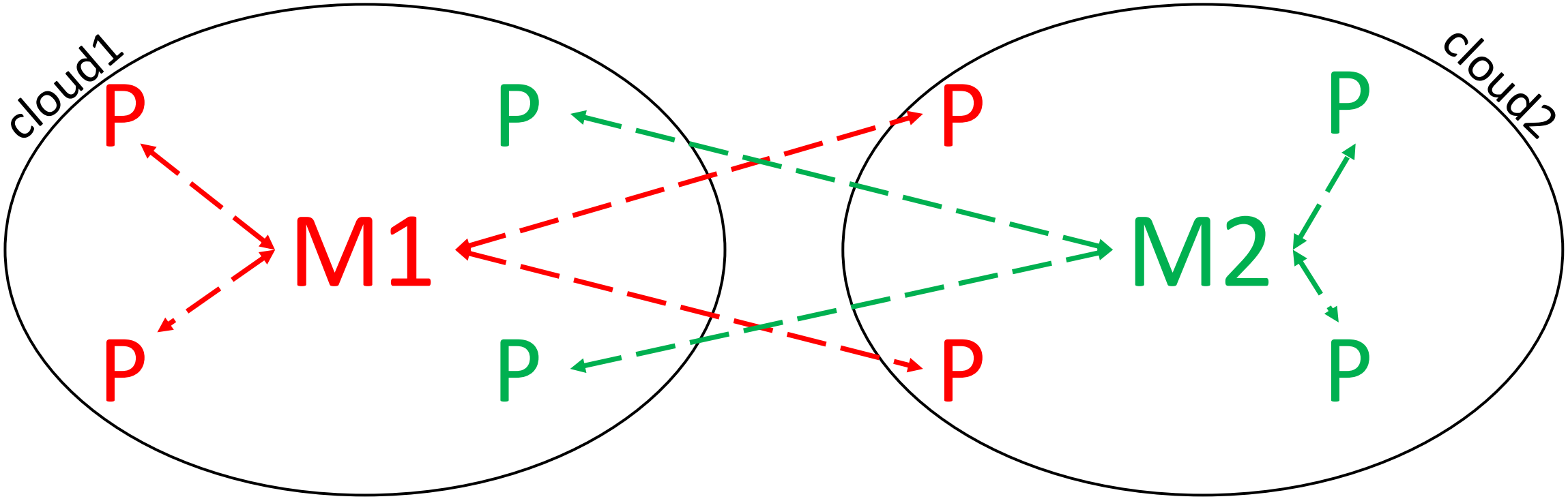
- Managers exploit some **dedicated VMs**, called **Probes**, deployed across all DCs



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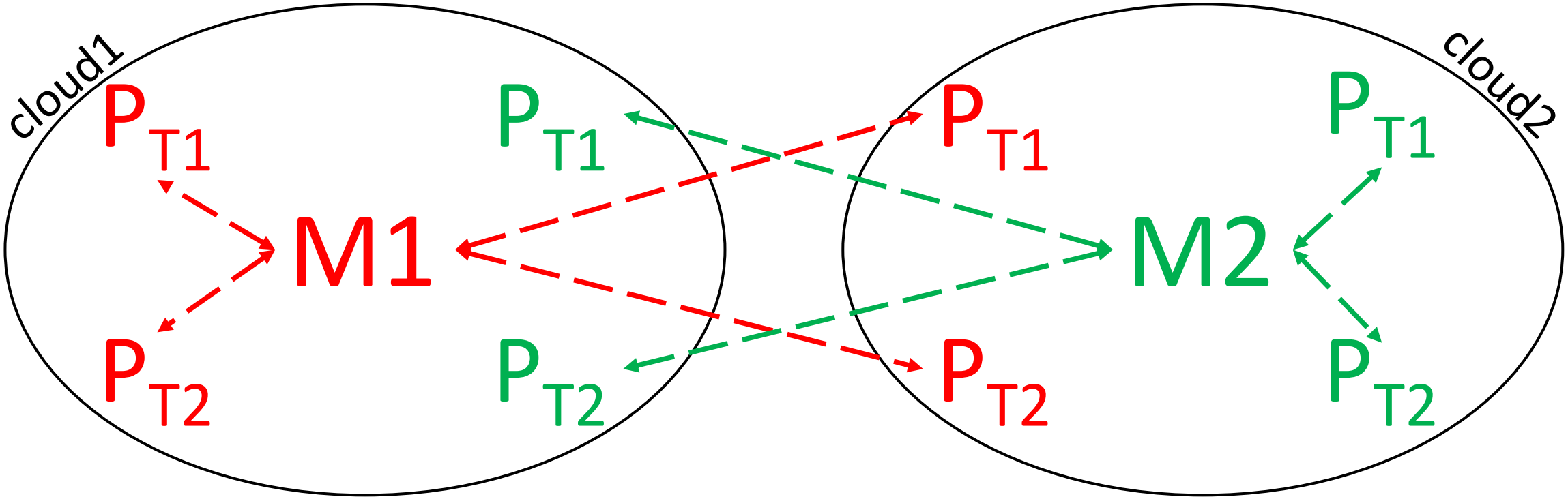
- **Probes** run in **different types**, according to the VM flavour, OS and **purpose**



Managers & Probes

Managers

Each Manager constructs its view of the monitored system by **creating**, **interacting** and **deleting its Probes**.

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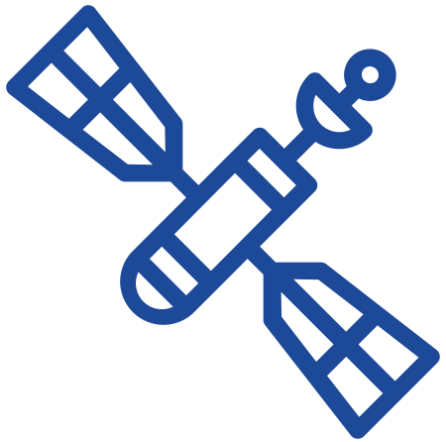
Probes

Probes are **periodically queried** by their **Manager** to **collect** data on **failures** and **performance**, they can also carry out their **own activities.**

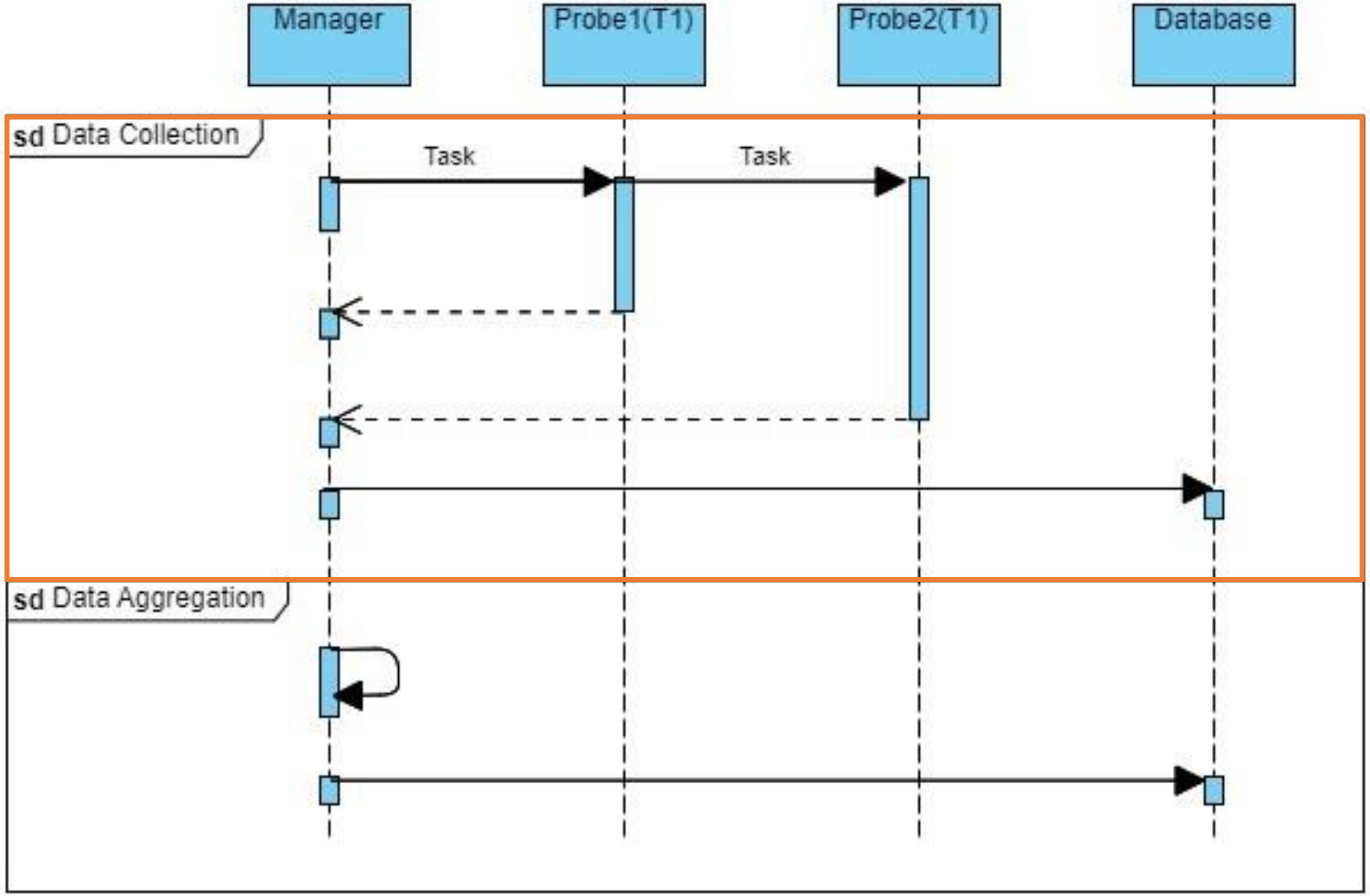


Tasks

- **Interactions** between a **Manager** and a **Probe** occur through **Tasks**.
- A **Task** is a particular **activity initiated** by a **Manager** to **collect monitoring data**.
- The **sequence** of **Tasks** to execute is **determined** by the **Probe type**.
- Each **Manager** works in **parallel** and **independently** from the **others**.

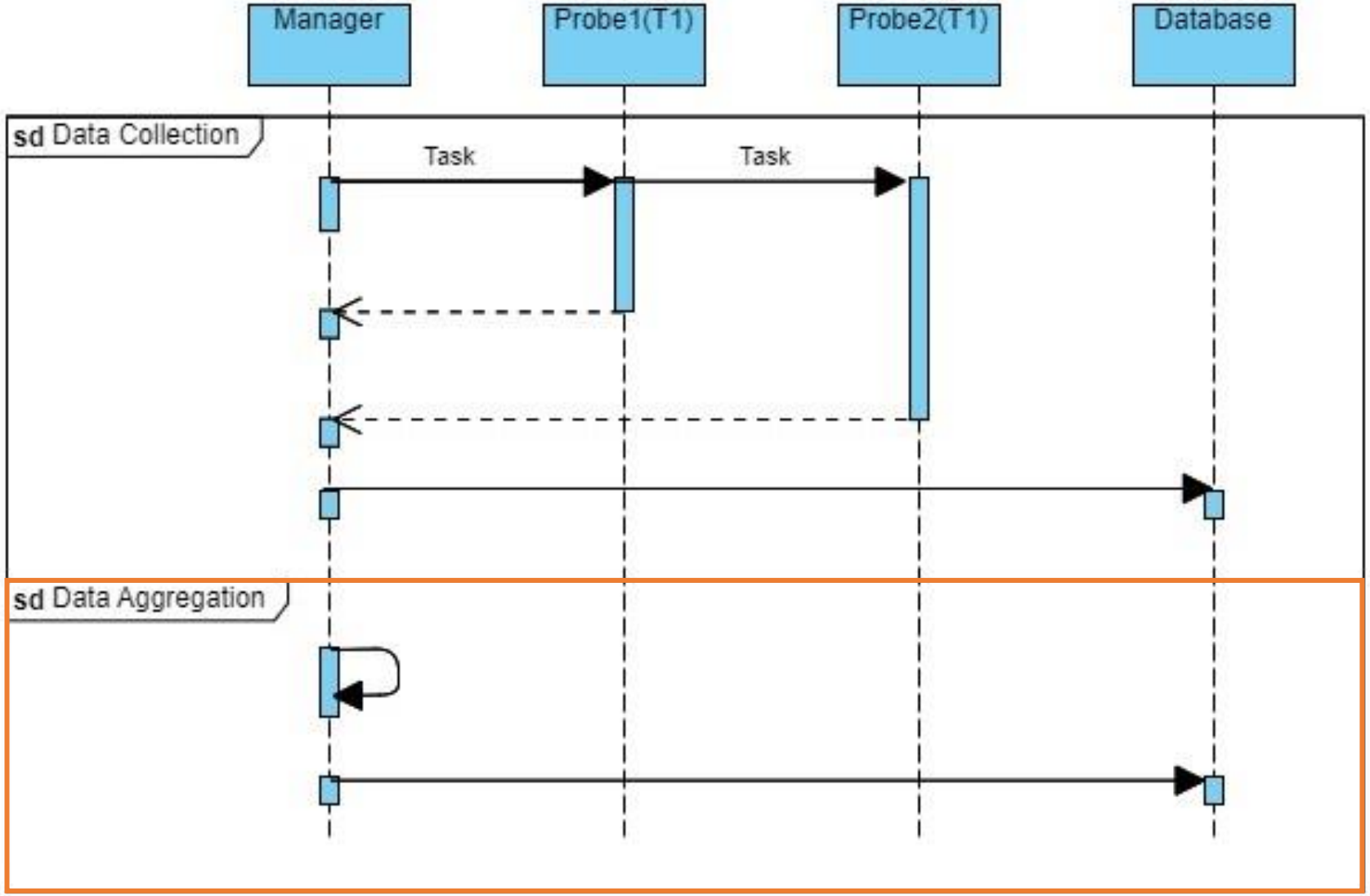
Data Collection Phase

- **Managers** execute the **Task collection activity** gathering the **relevant information**.
- This phase is performed in **parallel** and **independently** for all the controlled **Probes**.



Data Aggregation Phase

The **collected data** are **aggregated** based on a **Task's aggregation policy**.



machines.json

Enables **declarative management** of Probes and Tasks

```
{"keypairs": {"socc": {"public_key": KEY, "key_filename": PATH_TO_PEM_FILE, "user": "ubuntu"}},
"security_groups": {
  "CloudWatcher-sec-group": {
    "description": "CloudWatcher security group",
    "rules": [{
      "protocol": "TCP",
      "port_range_min": 22,
      "port_range_max": 22,
      "remote_ip_prefix": "0.0.0.0/0",
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      "ethertype": "IPv4"}]}},
"tokens":{"<BASEPATH>": "/home/ubuntu/cloudWatcher"},
"machines": {
  "cw-probe-small-20": {
    "image": "Ubuntu 20.04 - GARR",
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    "key_name": "socc",
    "network": "default",
    "security_groups": ["CloudWatcher-sec-group"],
    "scripts": {"setup": ["sudo apt update","sudo apt -f install -y"]},
    "files": [{"source": "./key.pem", "destination": "<BASEPATH>/key.pem"}],
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      "name": "network",
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      "aggregate": {
        "name": "aggregate_network",
        "slo":{
            "latency":{"avg": {"max": 5}},
            "bandwidth":{
              "upload":{"avg": {"min": [[500000000, "WARNING"], [2000000000, "CRITICAL"]]}},
              "download":{"avg": {"max": [[500000000, "WARNING"],  [2000000000, "CRITICAL"]]}}
            }
          }
        },
        args": [],
        "setup": ["sudo apt install -y iperf3","sudo iperf3 -s -D"]}],]},}
```

Keypairs

- For each keypair:
  - Pair identifier
  - Public key
  - Path to .pem file
  - SSH username

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{"keypairs": {"socc": {"public_key": KEY, "key_filename": PATH_TO_PEM_FILE, "user": "ubuntu"}},
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Security Groups

- For security groups:
  - Group identifier
  - Description
  - Rules
    - Protocol
    - Port range
    - Remote IP prefix
    - Direction
    - Ethertype

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Tokens

- Tokens are variables to use inside *machine.json*

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Probe Types

- For each Probe Type:
  - VM flavour and OS
  - Local files to export in the VM
  - Keypair identifier
  - Security Groups
  - List of **named scripts**
  - List of **scenarios**
    - Each **scenario** is a **list of Tasks**

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Tasks

- For each Task:
  - Task identifier
  - **Data collection function**
  - **Aggregation Policy**
  - Optional Input Arguments
  - Further **setup commands**
  - Set of **SLOs**

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SLOs

- A SLO is a **dictionary**. For each **attribute** it is possible to specify:
  - Minimum/maximum value, or
  - Set of **thresholds**, each of them associated with a **severity label**

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```

cloudWatcher

Control Panel

Task: probe->time

Manager: cloudWatcher-manager_garr-ct1_0

Cloud-Probe: garr-pa1->cw-probe-small-20

Start: 24/09/2022

End: 24/09/2022

Last Report

Timestamp

25/9/2022, 12:57:22

Origin

cloudWatcher-manager_garr-ct1_0

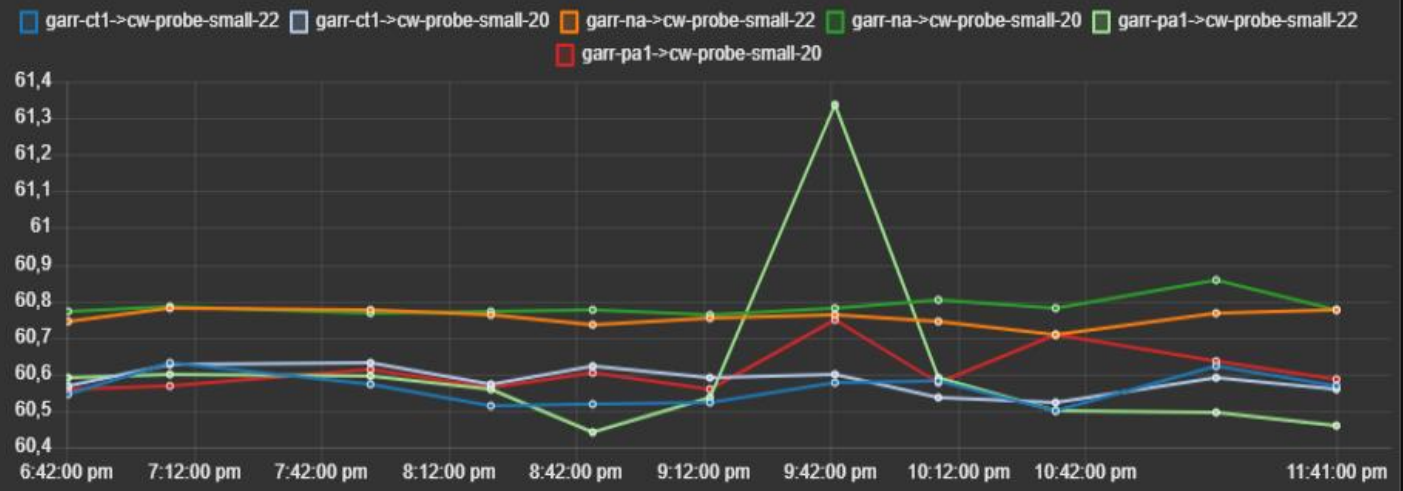
[garr-pa1->cw-probe-small-20] probe->time

60.99969398975372

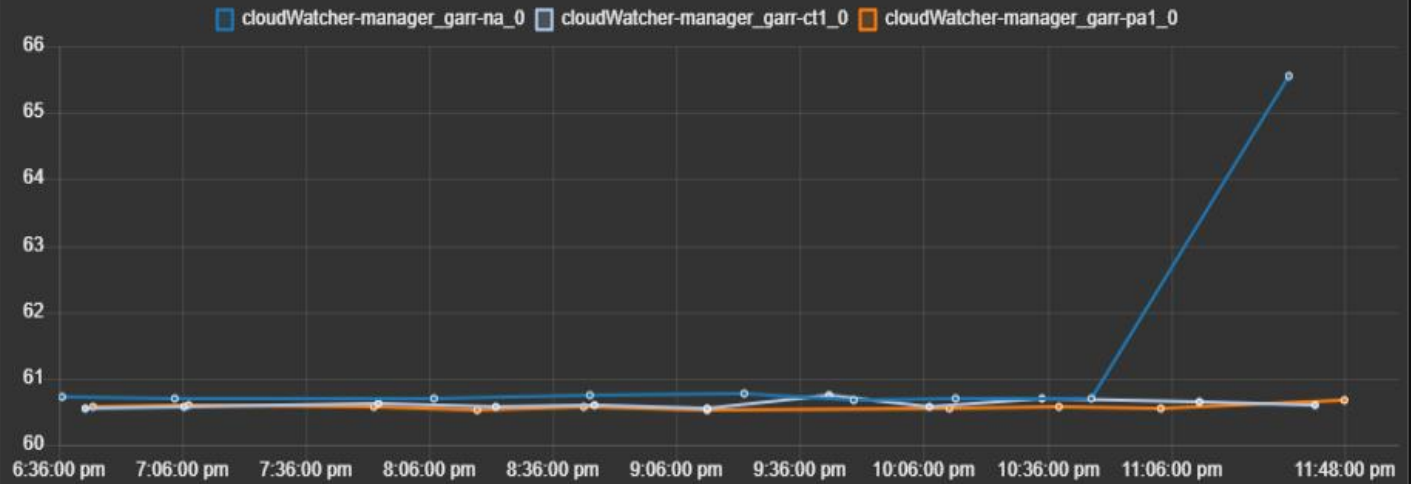
Task History

Task **probe->time** in **garr-pa1->cw-probe-small-20** for **cloudWatcher-manager_garr-ct1_0** [24/9/2022 - 24/9/2022]

by Cloud-Probe



by Manager



SLA Violations

- [garr-pa1->cw-probe-small-20] probe
  - @ 24/9/2022, 21:43:02
    - time->severity: WARNING
    - time->value: 61.1513428688
    - time->max: 61
    - source: cloudWatcher-probe probe-small-20
  - from cloudWatcher-manager_garr

cloudWatcher
SLA Violation @ [garr-na->cw-probe-small-20] network

- bandwidth->upload->severity: WARNING
- bandwidth->upload->value: 951808703.5889693
- bandwidth->upload->min: 1000000000
- bandwidth->download->severity: WARNING
- bandwidth->download->value: 951433518.0614996
- bandwidth->download->min: 1000000000
- source: cloudWatcher-probe_garr-ct1/0_1_garr-na_cw-probe-small-20

Origin: cloudWatcher-manager_garr-ct1_0
Timestamp: 25/9/2022, 12:57:22

2 14:57

cloudWatcher
SLA Violation @ [garr-pa1->cw-probe-small-20] probe

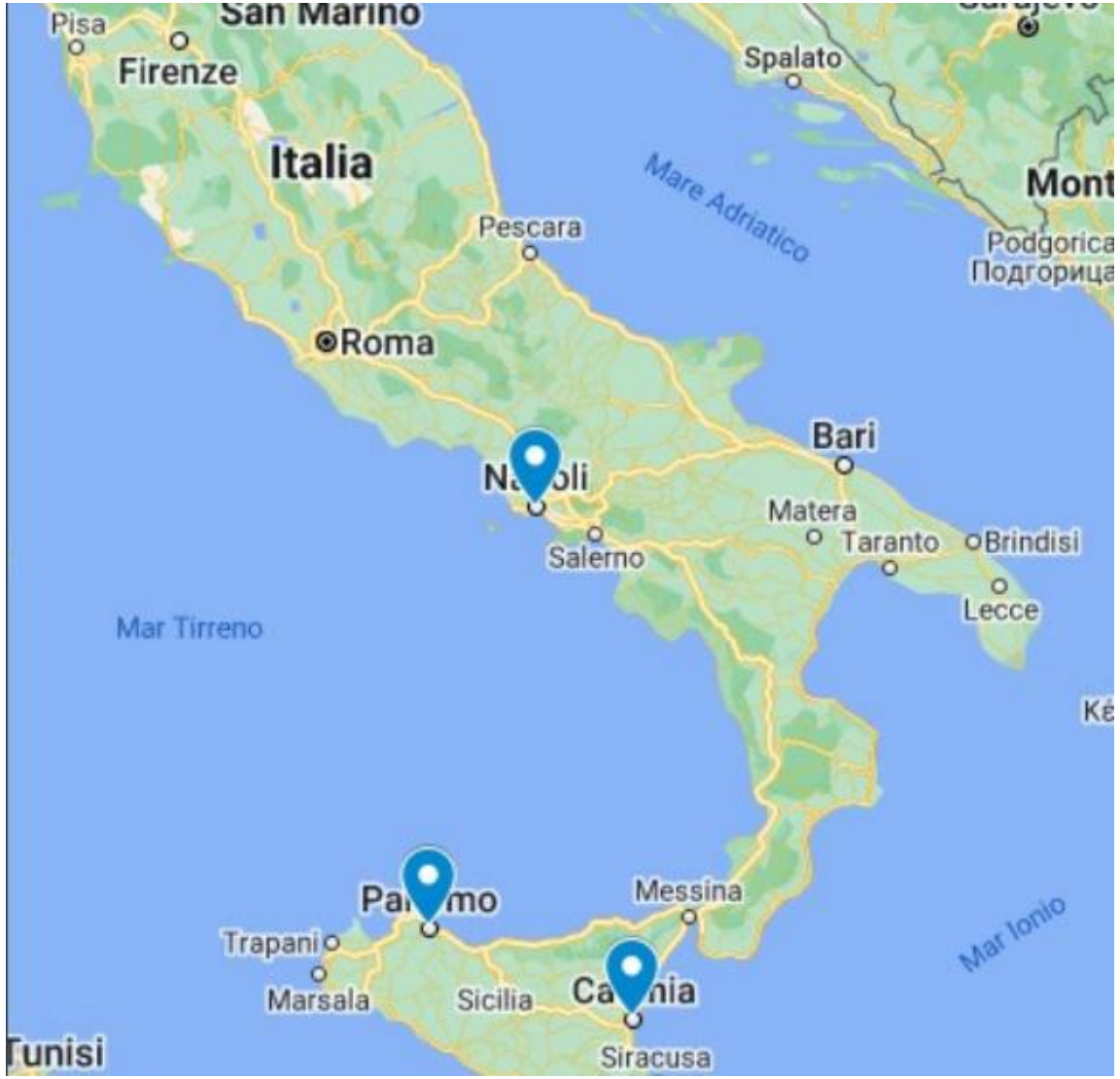
- time->severity: WARNING
- time->value: 61.26642394065857
- time->max: 61
- source: cloudWatcher-probe_garr-ct1/0_2_garr-pa1_cw-probe-small-20

Origin: cloudWatcher-manager_garr-ct1_0
Timestamp: 25/9/2022, 12:57:22

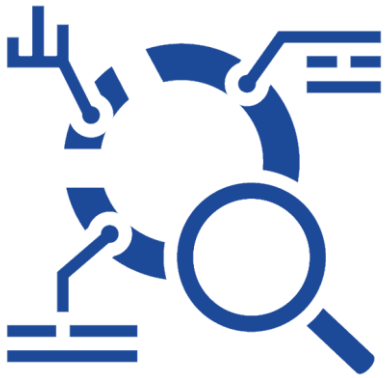
2 14:57

Use Case

- We deployed CLOUDWATCHER on the Cloud of the Italian Research and Education Network Consortium (GARR).
- We employed a total of **3 overlay networks** and **12 probes per Manager**.
- We monitored the:
  - VM **disks I/O performance**;
  - **network latency** and **bandwidth**;
  - **average time** and **success rate** of **SSH requests** to the VMs, and
  - **average time** and **success rate** to **create**, **configure** and **delete VMs**.



Future Work



Data Analysis Pipeline

Future Work

Large Scale Assessment

Data Analysis Pipeline

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Comparison with
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Cloud-Edge Applicability

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