UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

MANAGEMENT OF SERVICES ACROSS MULTIPLE CLOUDS

UPB – Computer Networks Group

Team PG-SCrAMbLE

SCrAMbLE - Introduction

“A software package that bridges different MANO frameworks”

Components:

- Translator
- Splitter
- Adaptor

Translator

SCrAMbLE - Translator

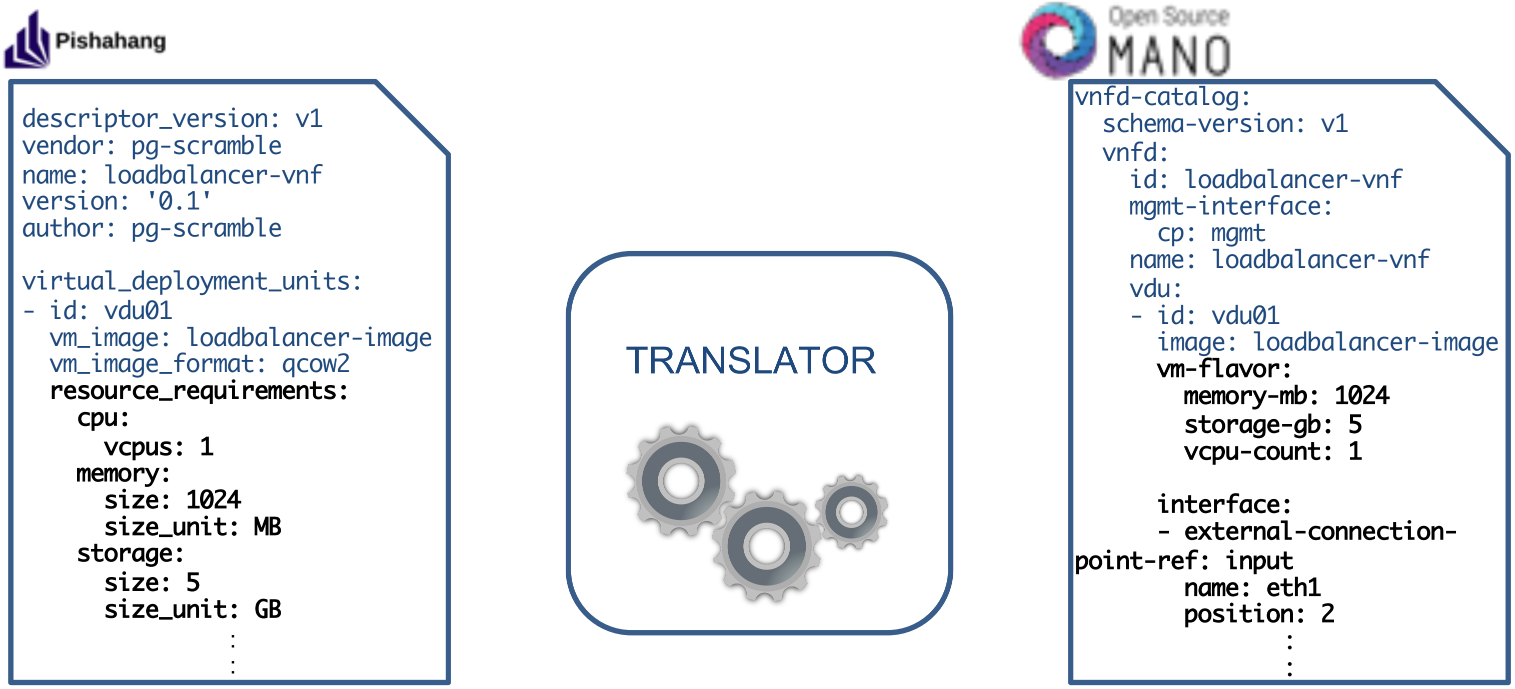
Why?

To overcome schematic differences between service descriptors

How?

- Create key mapping
- Create a dataset with source descriptor and key map
- Extract the keys and values corresponding to destination schema

SCrAMbLE - Translator



```
descriptor_version: v1
vendor: pg-scramble
name: loadbalancer-vnf
version: '0.1'
author: pg-scramble

virtual_deployment_units:
- id: vdu01
  vm_image: loadbalancer-image
  vm_image_format: qcow2
  resource_requirements:
    cpu:
      vcpus: 1
    memory:
      size: 1024
      size_unit: MB
    storage:
      size: 5
      size_unit: GB
                :
                :
```

NSD/VNFD

```
vnfd-catalog:
  schema-version: v1
  vnfd:
    id: loadbalancer-vnf
    mgmt-interface:
      cp: mgmt
    name: loadbalancer-vnf
    vdu:
    - id: vdu01
      image: loadbalancer-image
      vm-flavor:
        memory-mb: 1024
        storage-gb: 5
        vcpu-count: 1

      interface:
      - external-connection-
point-ref: input
        name: eth1
        position: 2
              :
              :
```

NSD/VNFD

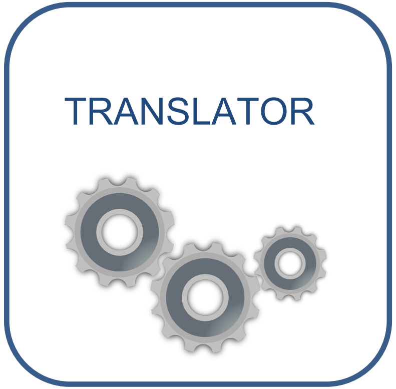
SCrAMbLE - Translator

Pishahang

```
descriptor_version: v1
vendor: pg-scramble
name: loadbalancer-vnf
version: '0.1'
author: pg-scramble

virtual_deployment_units:
- id: vdu01
  vm_image: loadbalancer-image
  vm_image_format: qcow2
  resource_requirements:
    cpu:
      vcpus: 1
    memory:
      size: 1024
      size_unit: MB
    storage:
      size: 5
      size_unit: GB
               :
               :
```

NSD/VNFD



Open Source MANO

```
vnfd-catalog:
  schema-version: v1
  vnfd:
    id: loadbalancer-vnf
    mgmt-interface:
      cp: mgmt
    name: loadbalancer-vnf
    vdu:
    - id: vdu01
      image: loadbalancer-image
      vm-flavor:
        memory-mb: 1024
        storage-gb: 5
        vcpu-count: 1

      interface:
      - external-connection-
point-ref: input
        name: eth1
        position: 2
           :
           :
```

NSD/VNFD

Splitter

SCrAMbLE - Splitter

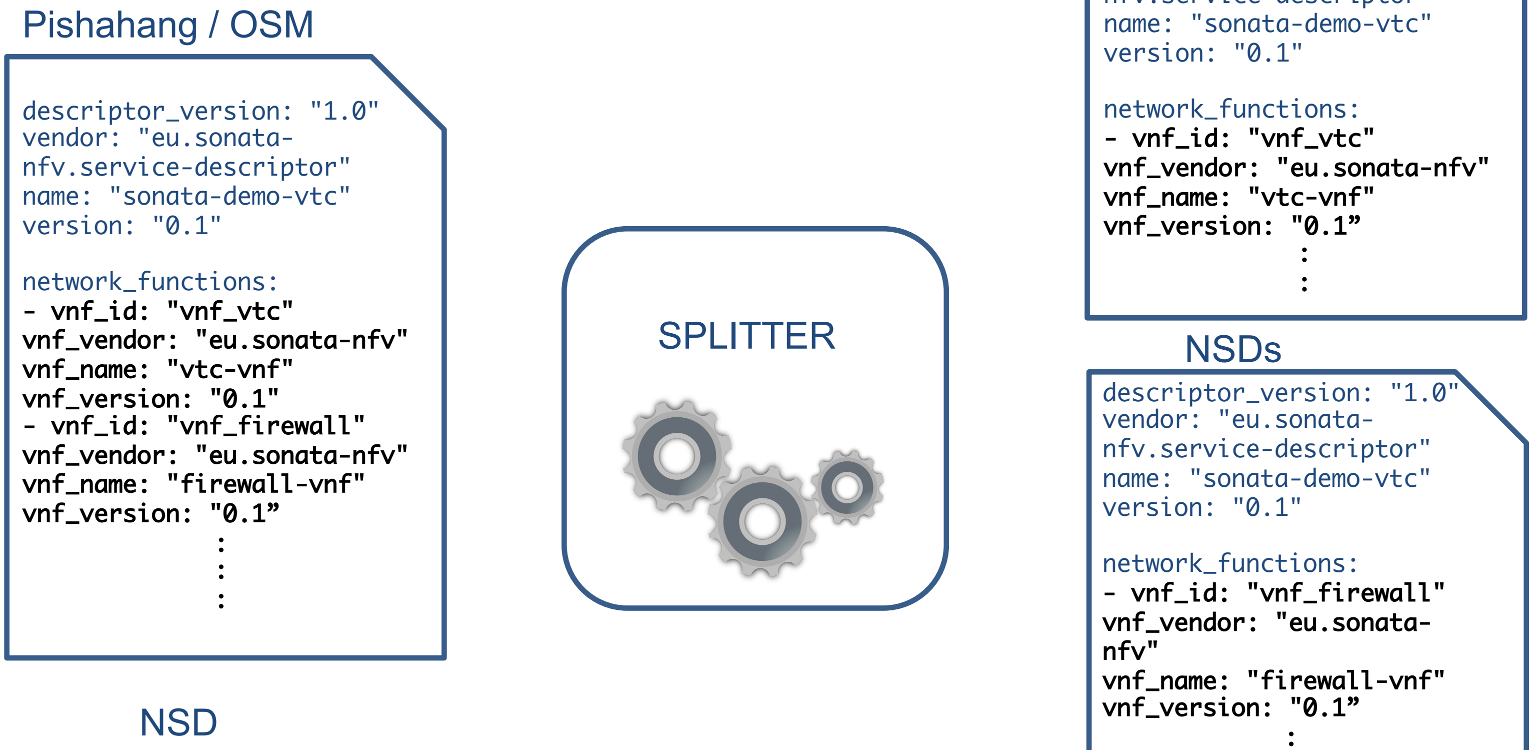
Why?

To deploy network services over different MANO frameworks

How?

- Validation of the request
- Components are stored in python classes objects
- Creates separate sub NSDs
- Creates external points for sub NSDs
- Splits the virtual links
- Splits the forwarding graph (POC)

SCrAMbLE - Splitter



Pishahang / OSM

```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_vtc"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "vtc-vnf"
vnf_version: "0.1"
- vnf_id: "vnf_firewall"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "firewall-vnf"
vnf_version: "0.1”
              :
              :
```

NSD

SPLITTER

```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_vtc"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "vtc-vnf"
vnf_version: "0.1”
              :
              :
```

NSDs

```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_firewall"
vnf_vendor: "eu.sonata-
nfv"
vnf_name: "firewall-vnf"
vnf_version: "0.1”
             :
             :
```

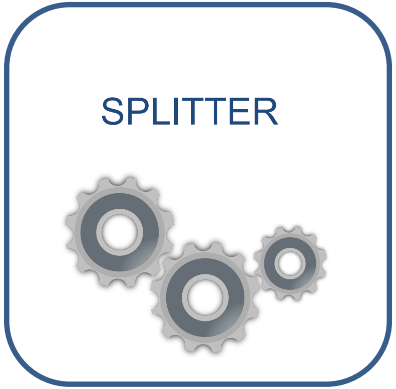
SCrAMbLE - Splitter

Pishahang / OSM

```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_vtc"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "vtc-vnf"
vnf_version: "0.1"
- vnf_id: "vnf_firewall"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "firewall-vnf"
vnf_version: "0.1”
              :
              :
              :
```

NSD



```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_vtc"
vnf_vendor: "eu.sonata-nfv"
vnf_name: "vtc-vnf"
vnf_version: "0.1”
              :
              :
```

NSDs

```
descriptor_version: "1.0"
vendor: "eu.sonata-
nfv.service-descriptor"
name: "sonata-demo-vtc"
version: "0.1"

network_functions:
- vnf_id: "vnf_firewall"
vnf_vendor: "eu.sonata-
nfv"
vnf_name: "firewall-vnf"
vnf_version: "0.1”
             :
             :
```

Adaptor

SCrAMbLE - Adaptor

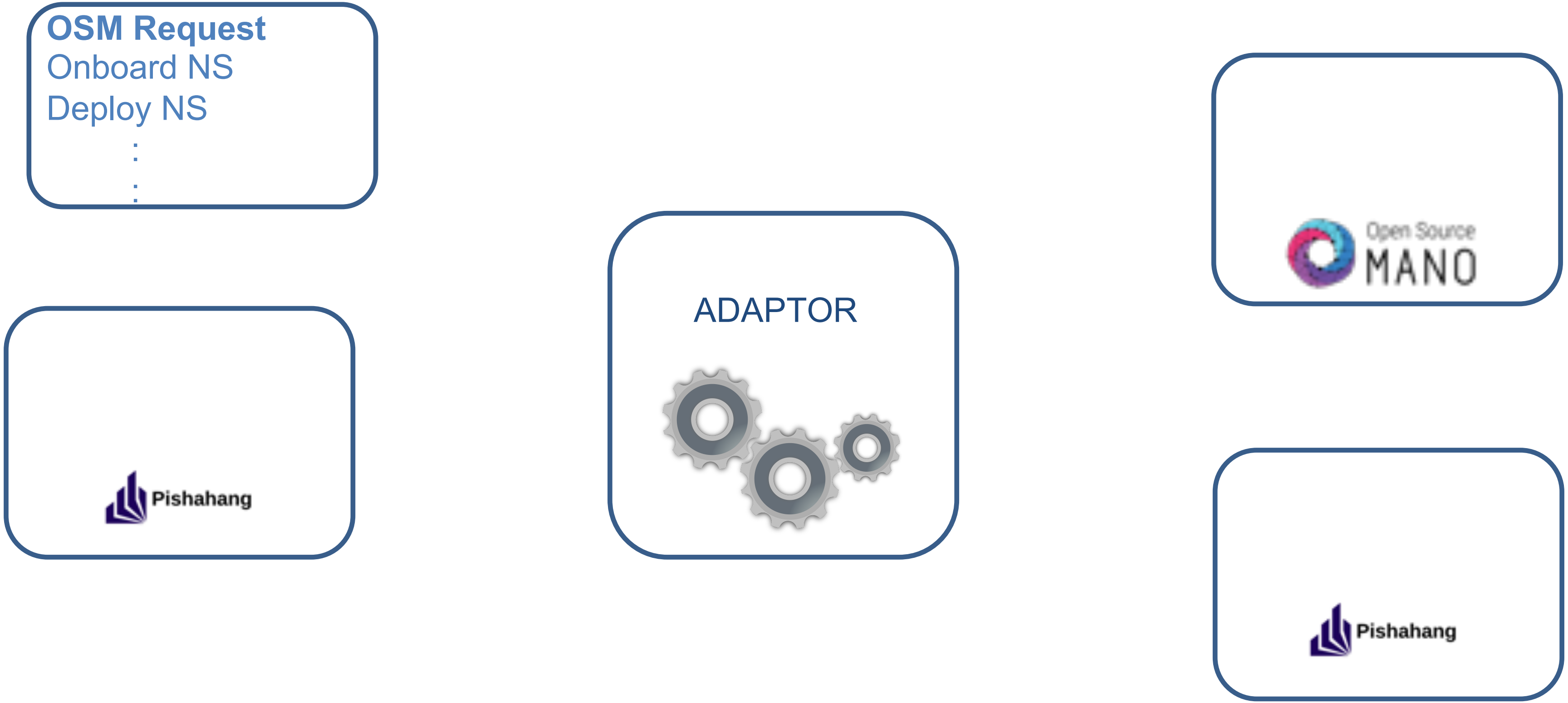
Why?

Provide interaction between MANO instances

How?

- Wrapping REST APIs of OSM and Pishahang
- Semi-automated python base class generation from ETSI document
- Enforce ETSI endpoints for all MANOs

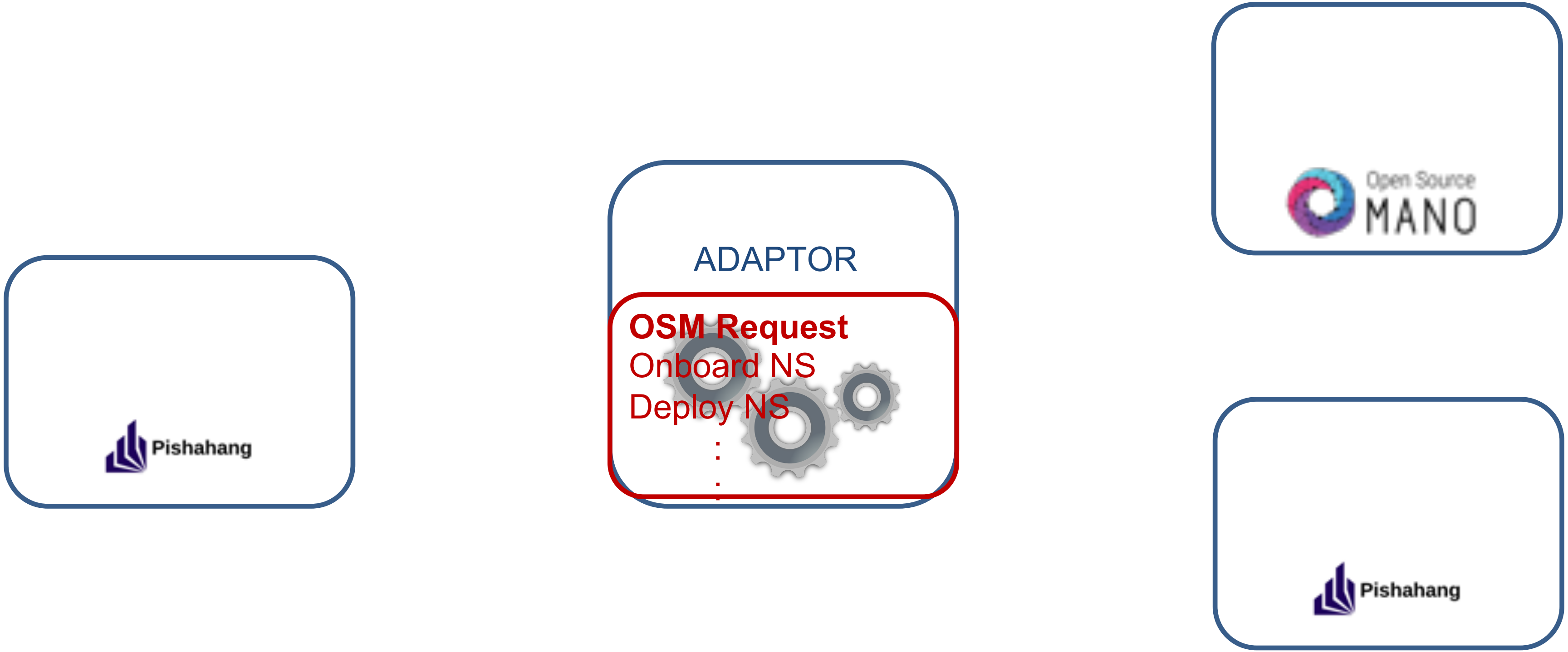
SCrAMbLE - Adaptor



OSM Request
Onboard NS
Deploy NS
:
:

ADAPTOR

SCrAMbLE - Adaptor



ADAPTOR

OSM Request

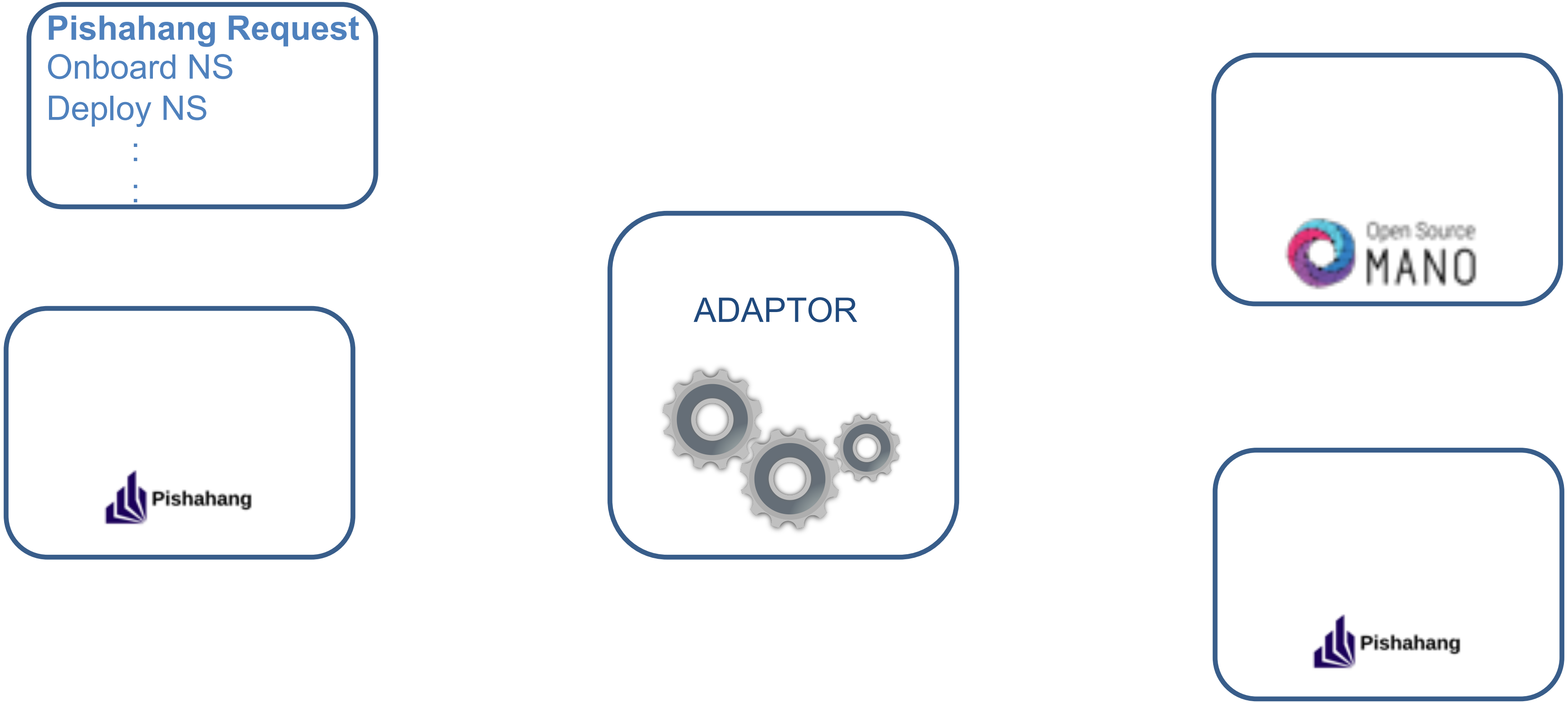
Onboard NS

Deploy NS

:

:

SCrAMbLE - Adaptor



Pishahang Request

Onboard NS

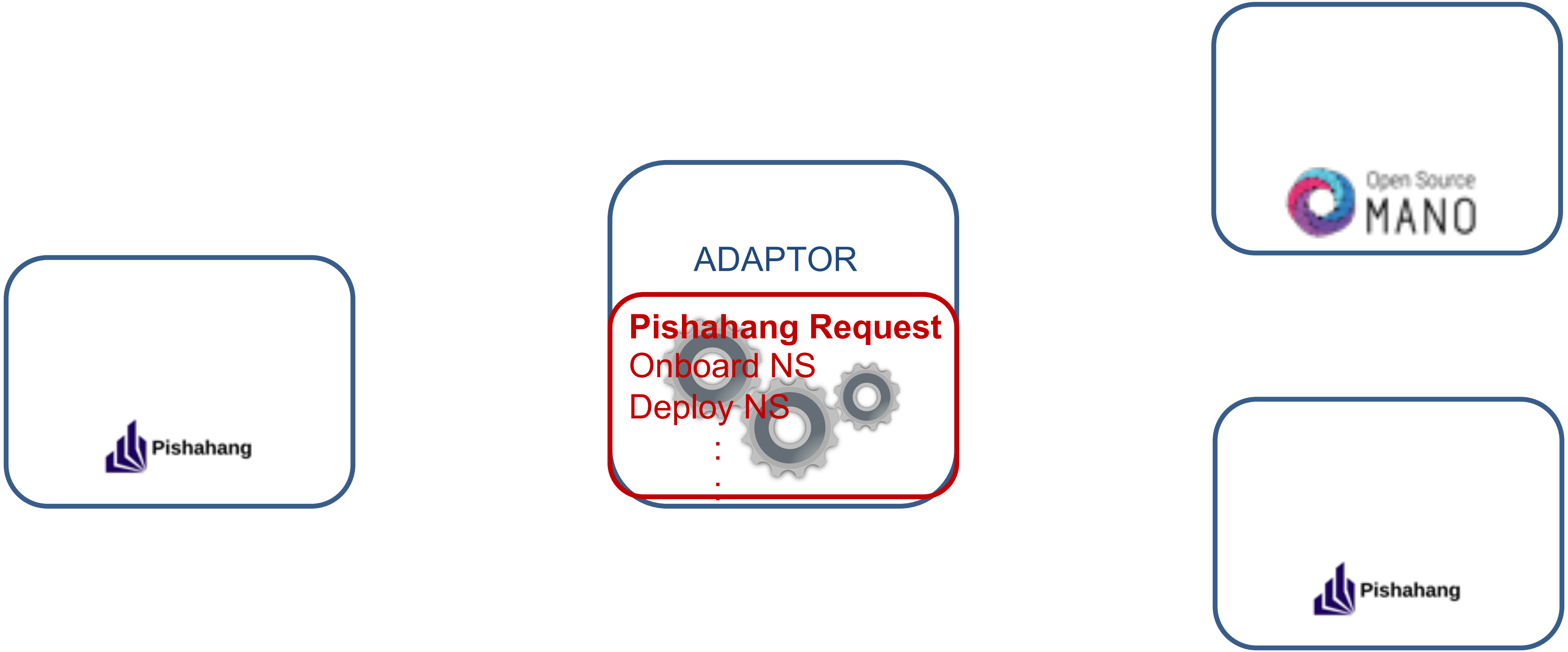
Deploy NS

:

:

ADAPTOR

SCrAMbLE - Adaptor



ADAPTOR

Pishahang Request
Onboard NS
Deploy NS
:
:

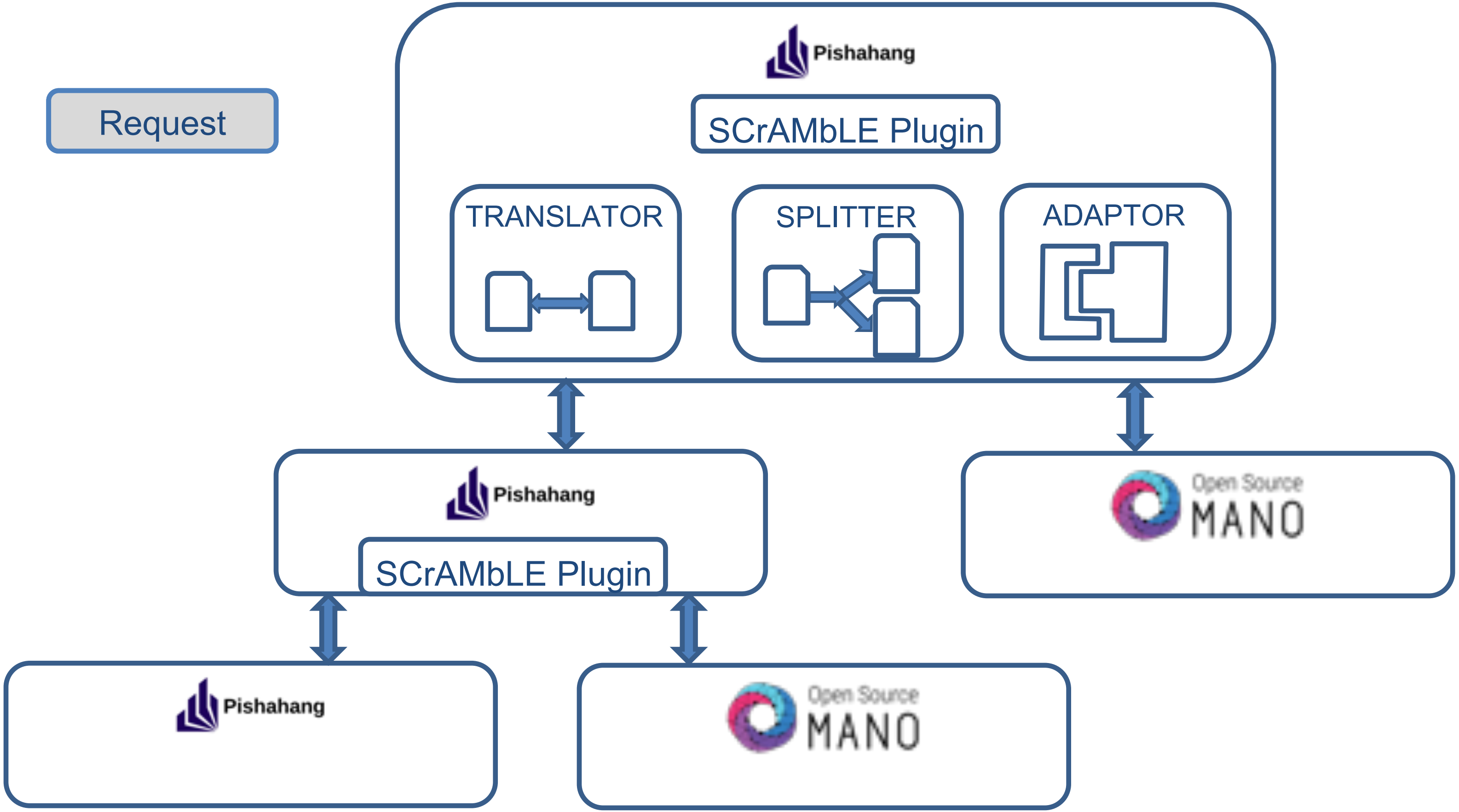
SCrAMbLE - Adaptor

Adaptor Design

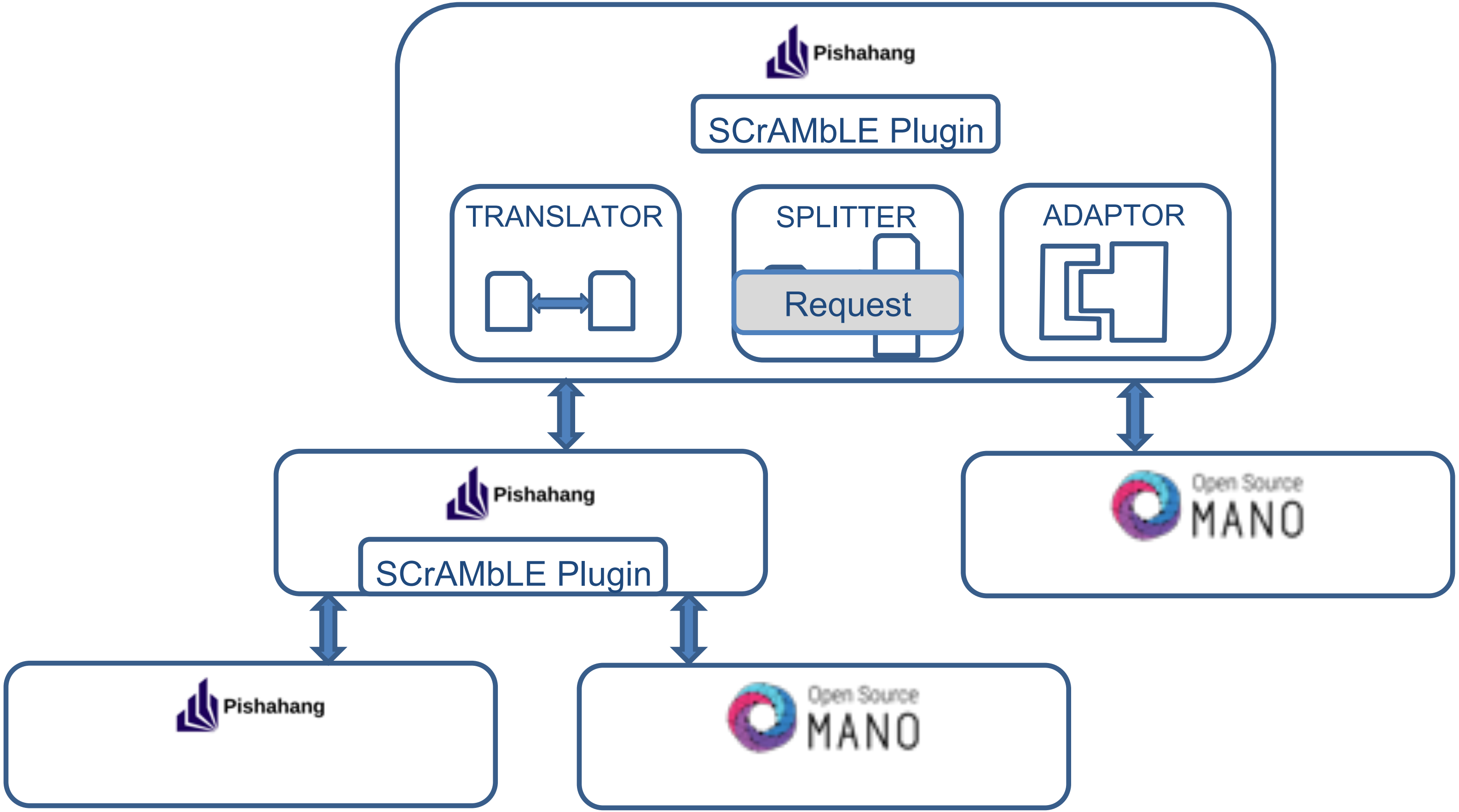
- Automated testing
- Well documented
  - https://python-mano-wrappers.readthedocs.io/en/adaptor/
- Easy to install and use
  - `pip install python-mano-wrappers`

Overview

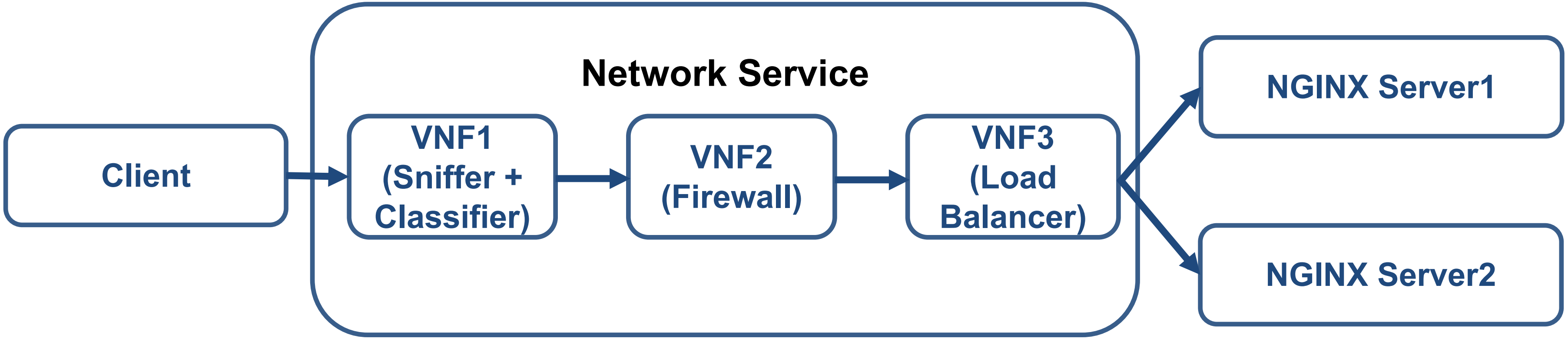
SCrAMbLE - Overview



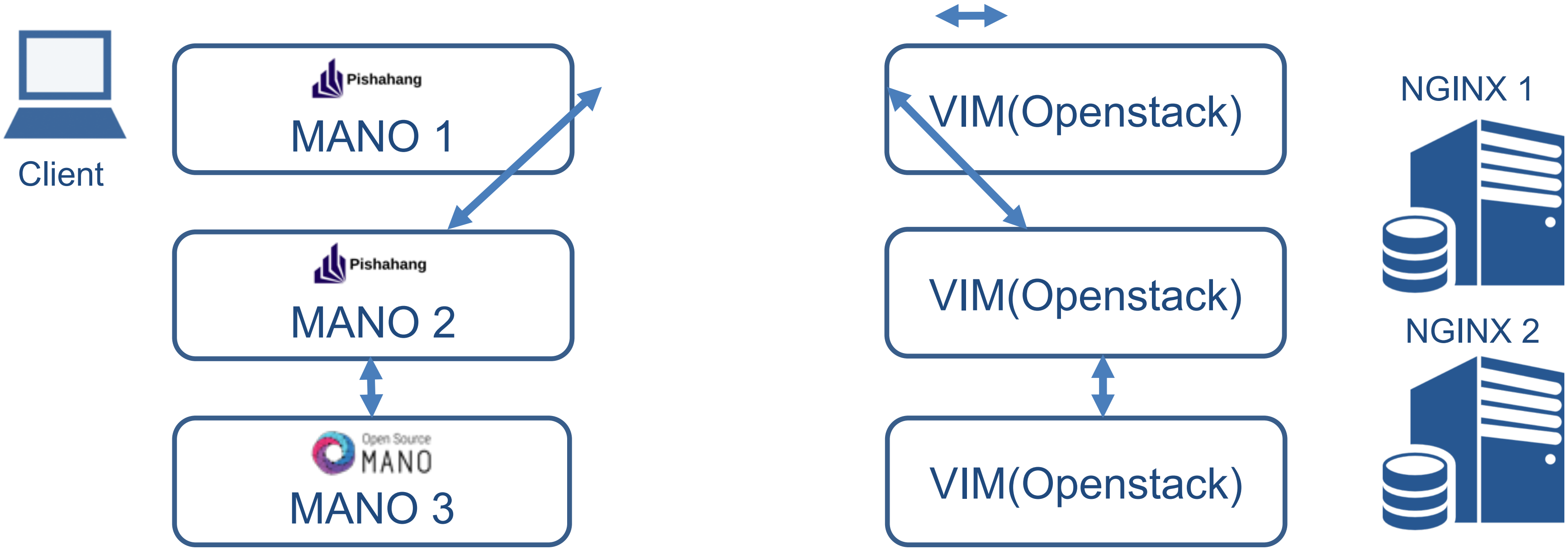
SCrAMbLE - Overview



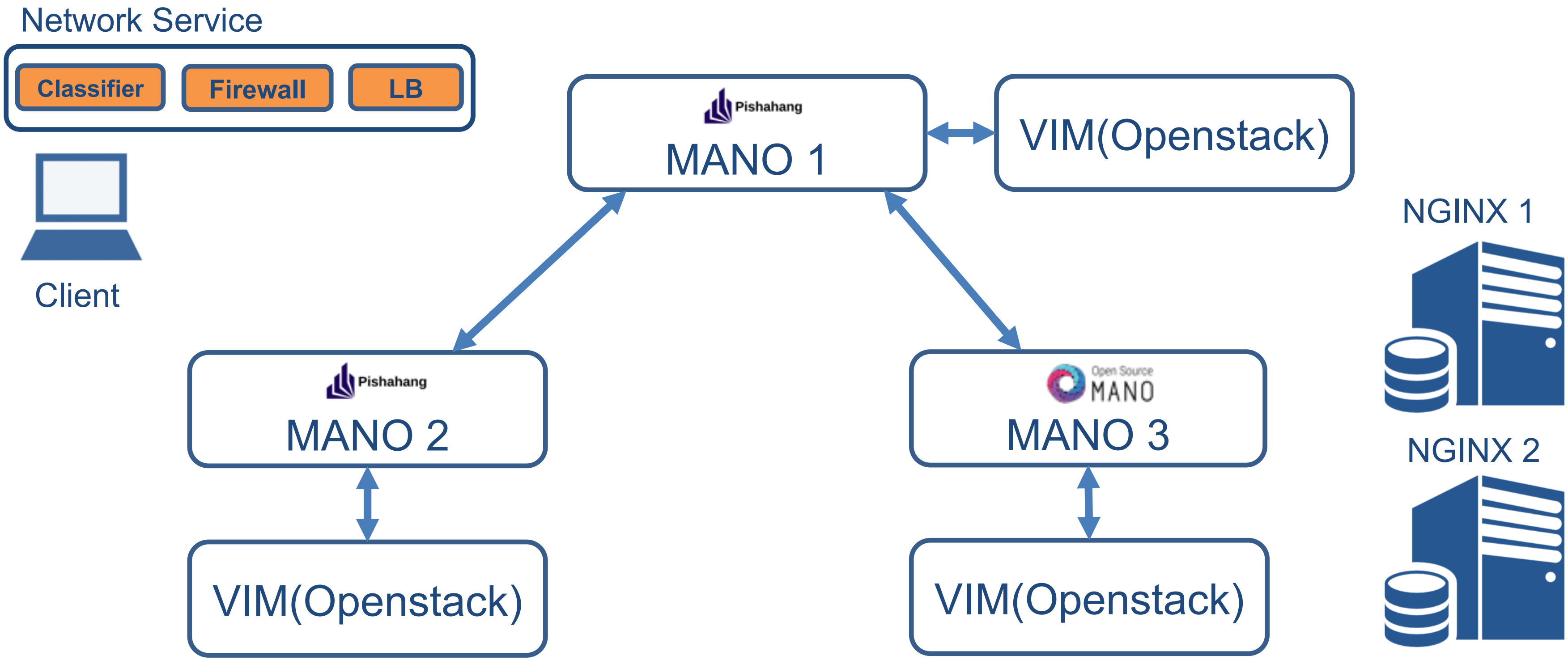
Demo Scenario



Demo Scenario



Demo Scenario


Network Service

Classifier

Firewall

LB

Client

Pishahang

MANO 1

VIM(Openstack)

Pishahang

MANO 2

VIM(Openstack)

Open Source MANO

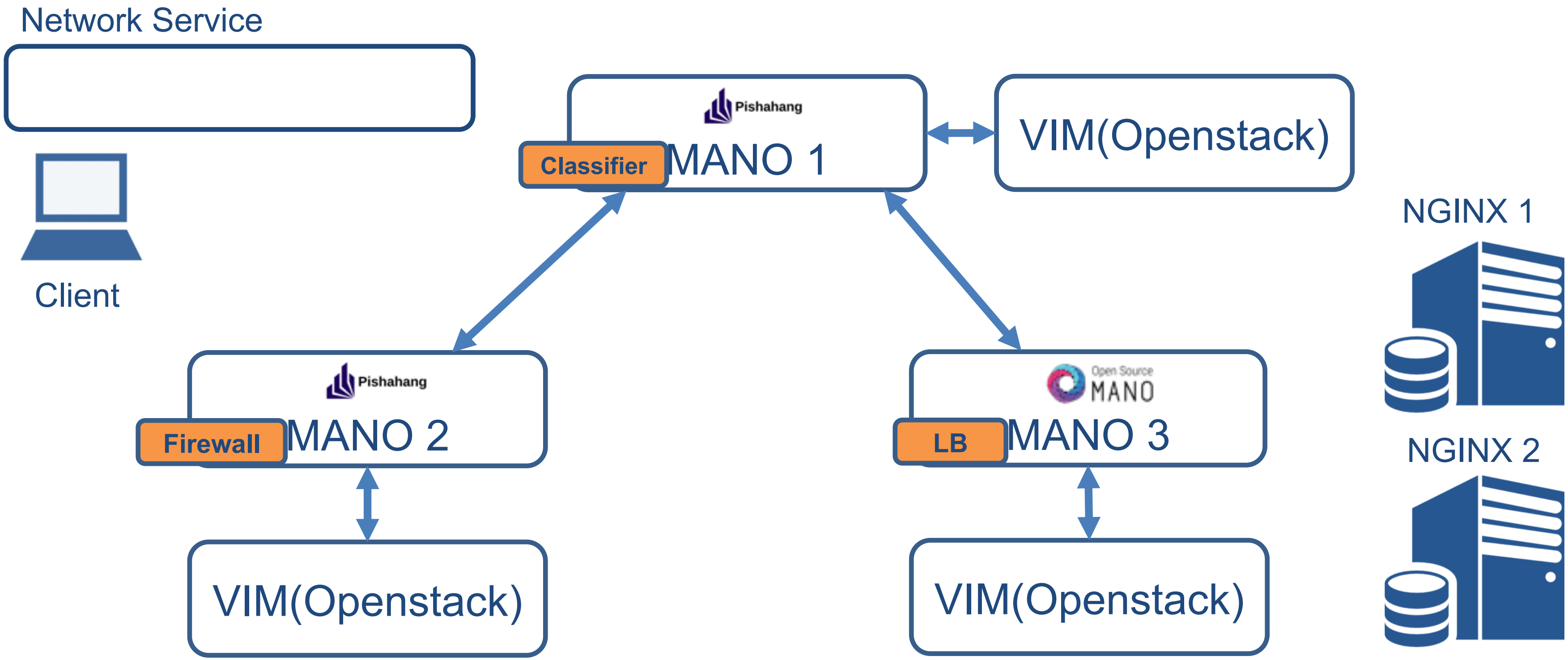
MANO 3

VIM(Openstack)

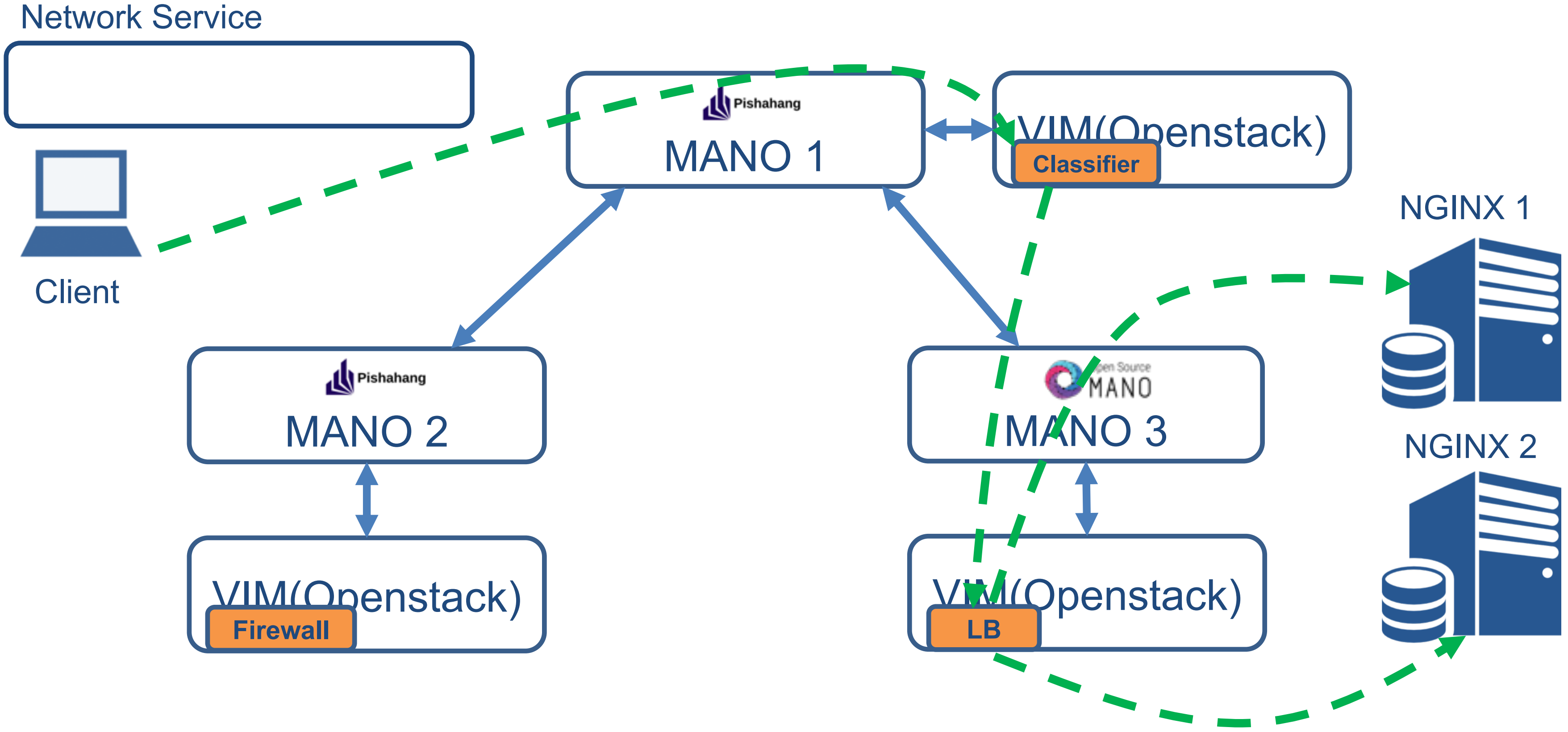
NGINX 1

NGINX 2

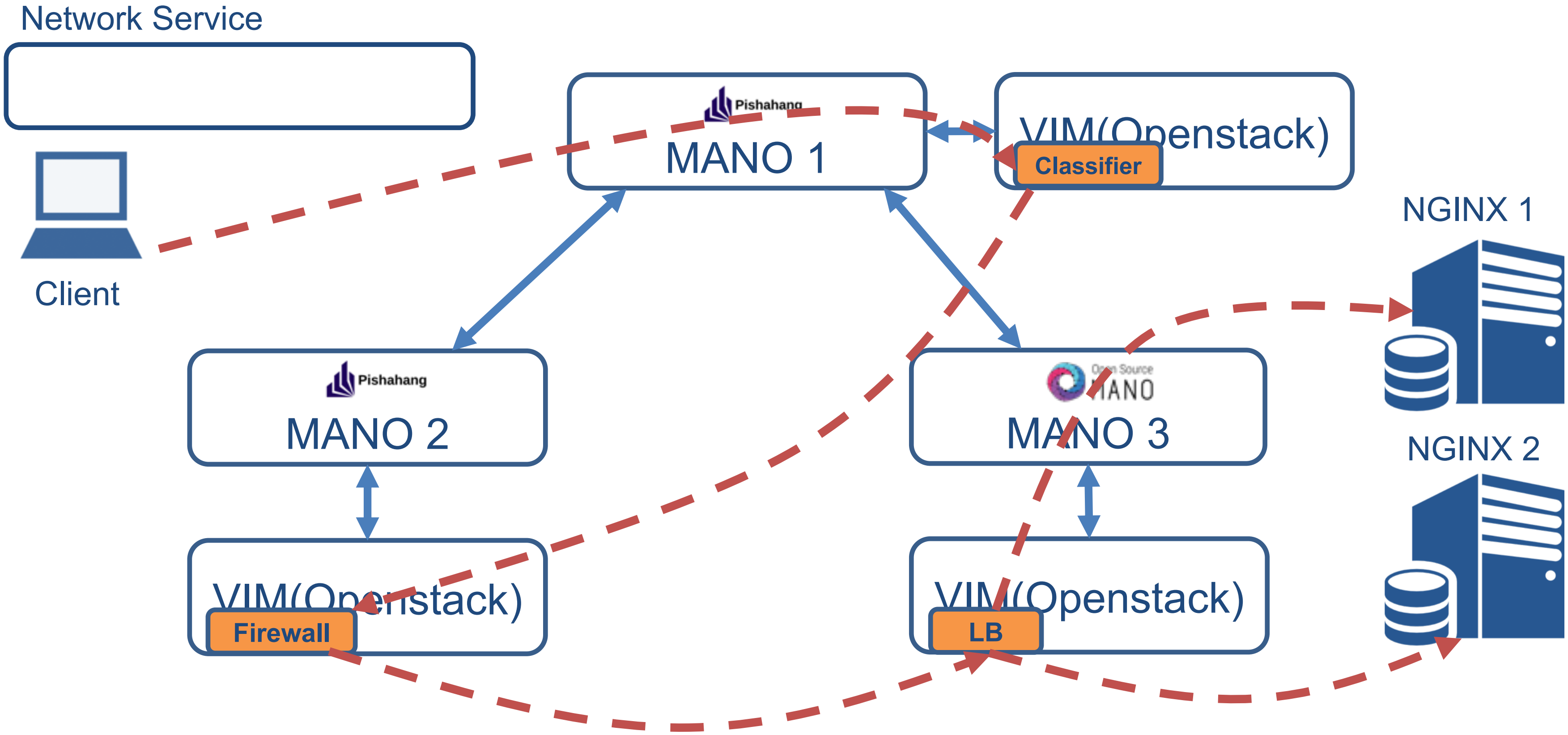
Demo Scenario



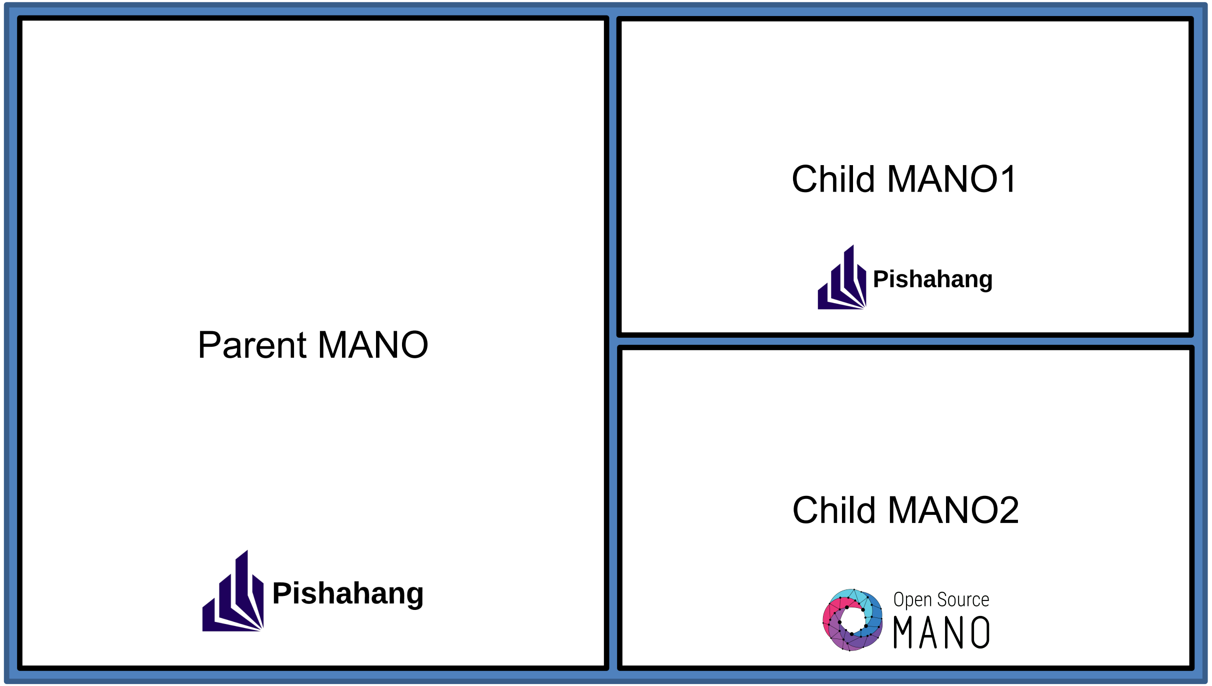
Demo Scenario



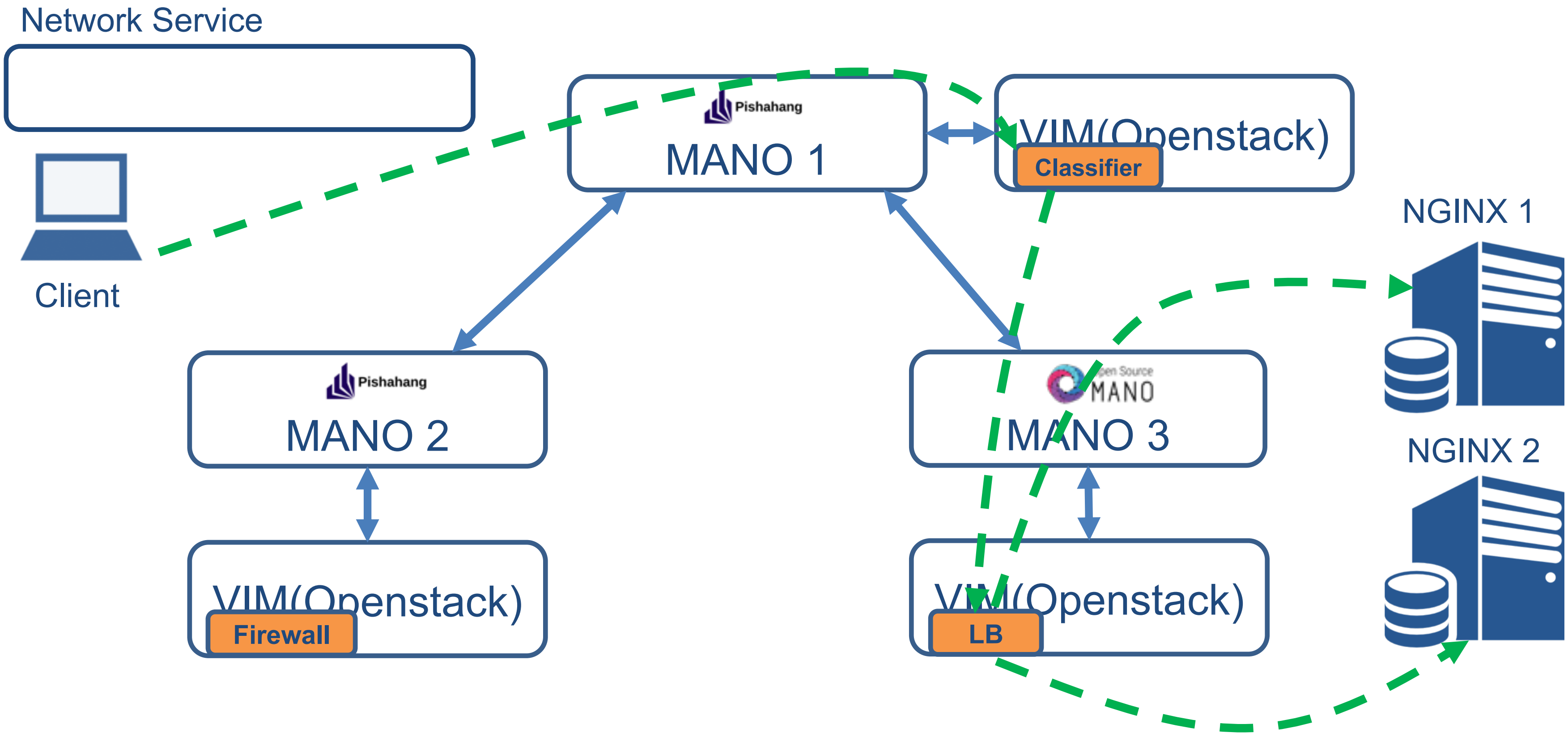
Demo Scenario



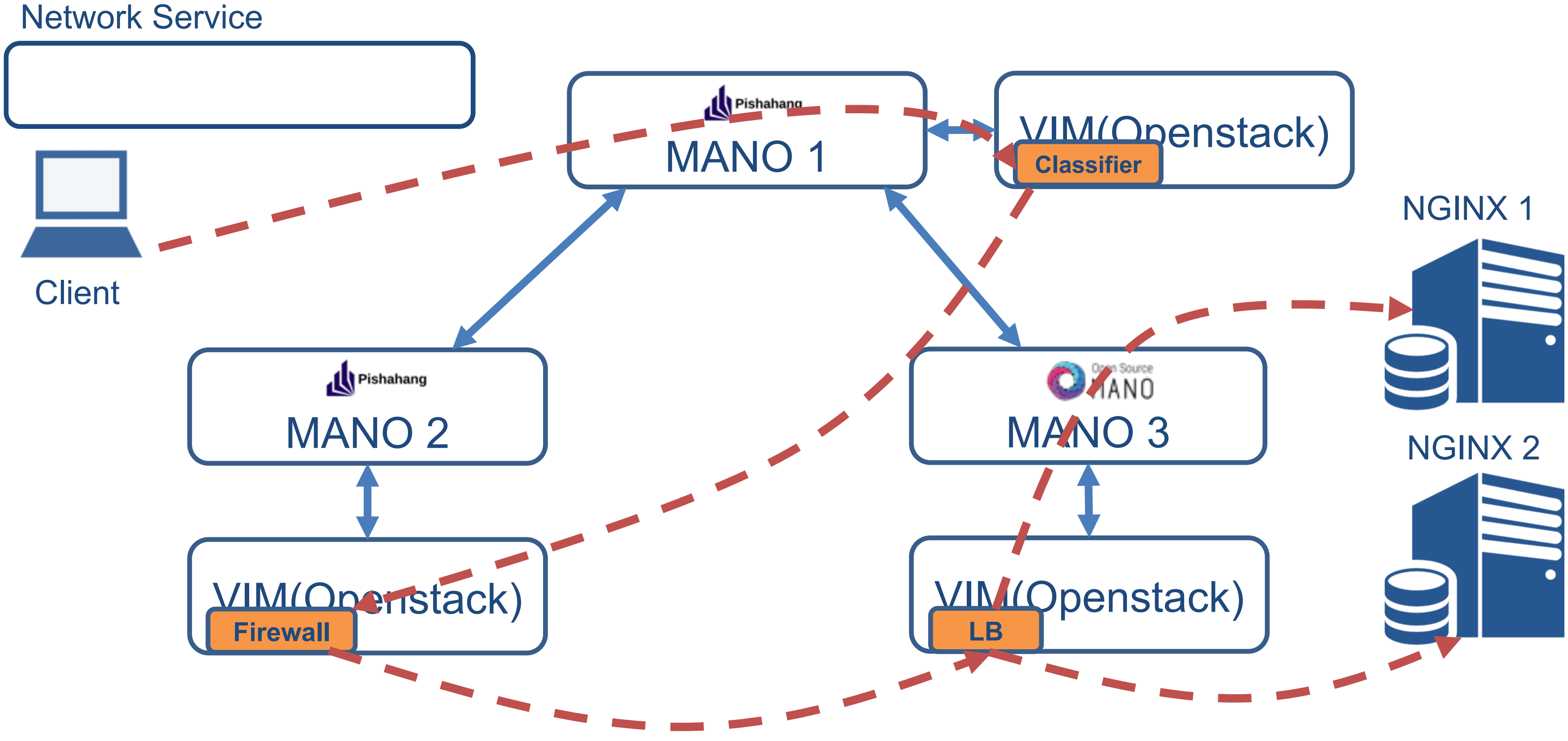
DEMO —>


Parent MANO
Pishahang
Child MANO1
Pishahang
Child MANO2
Open Source
MANO

Demo Scenario



Demo Scenario



MANO Scalability

SCrAMbLE – MANO Scalability

Two Directions

Hierarchical scaling plugin in Pishahang

Experiment on OSM and Pishahang to characterize resource utilization

1. Scalability Plugin

SCrAMbLE - MANO Scalability

Pishahang Scaling Plugin

- Use existing infrastructure to scale-out MANO
- Add ability to Pishahang to scale itself
  - Create and manage child instances
- Act based on **linux system load** average values
  - 1m, **5m, 15m** moving averages

SCrAMbLE - MANO Scalability

- On **warning** threshold reached (5m > 0.7)
  - Instantiate a child MANO instance
  - Add metadata (user, pass, IP) to a list of active child instances
  - Monitor load on child instances

- On **critical** threshold reached (15m > 0.7)
  - Forward incoming requests to child instances

- Load subsides on both MANOs
  - Terminate child instance
  - Store metadata (NSR, VNFR) from child MANO

SCrAMbLE - MANO Scalability

DEMO —>

2. Experiments

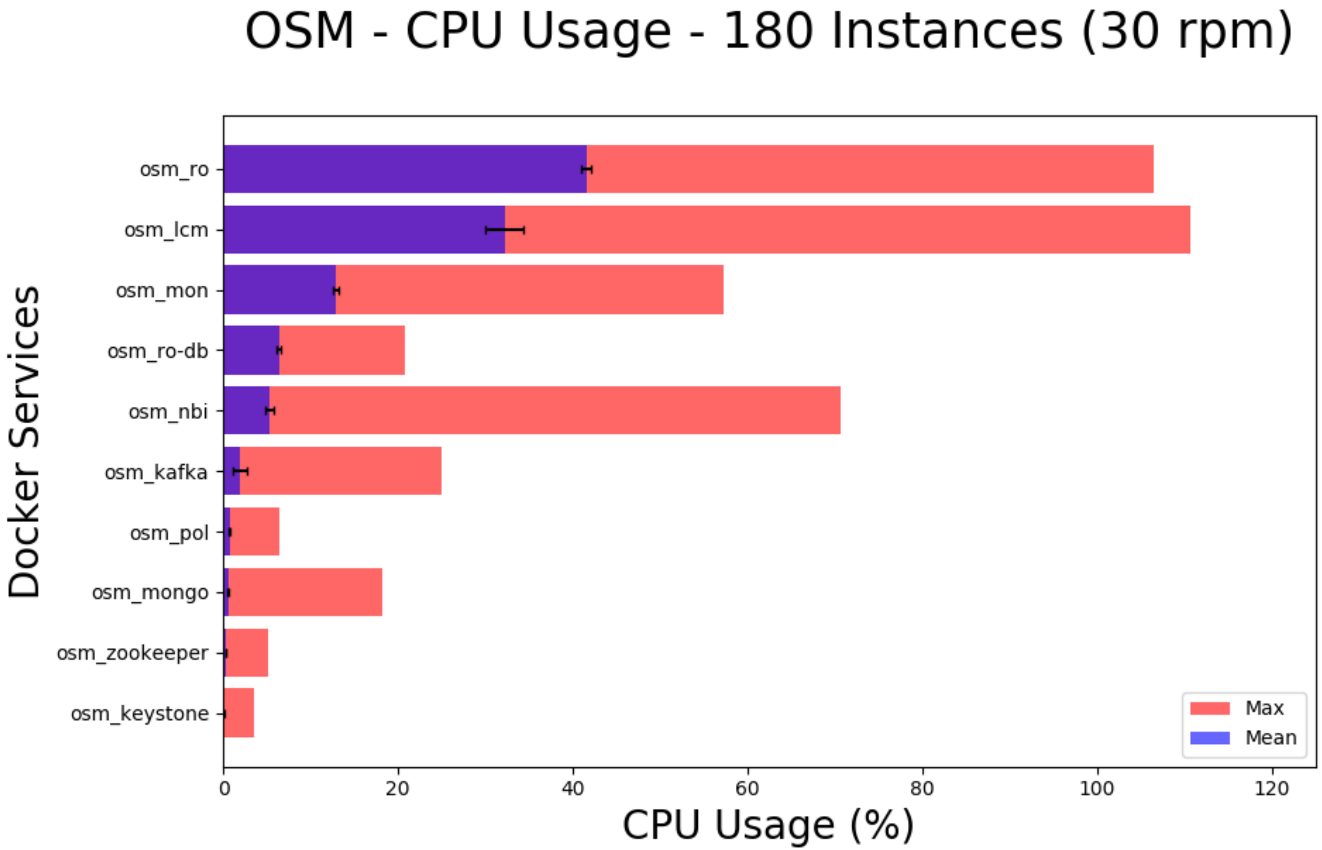
SCrAMbLE - MANO Scalability

Experiments on OSM and Pishahang

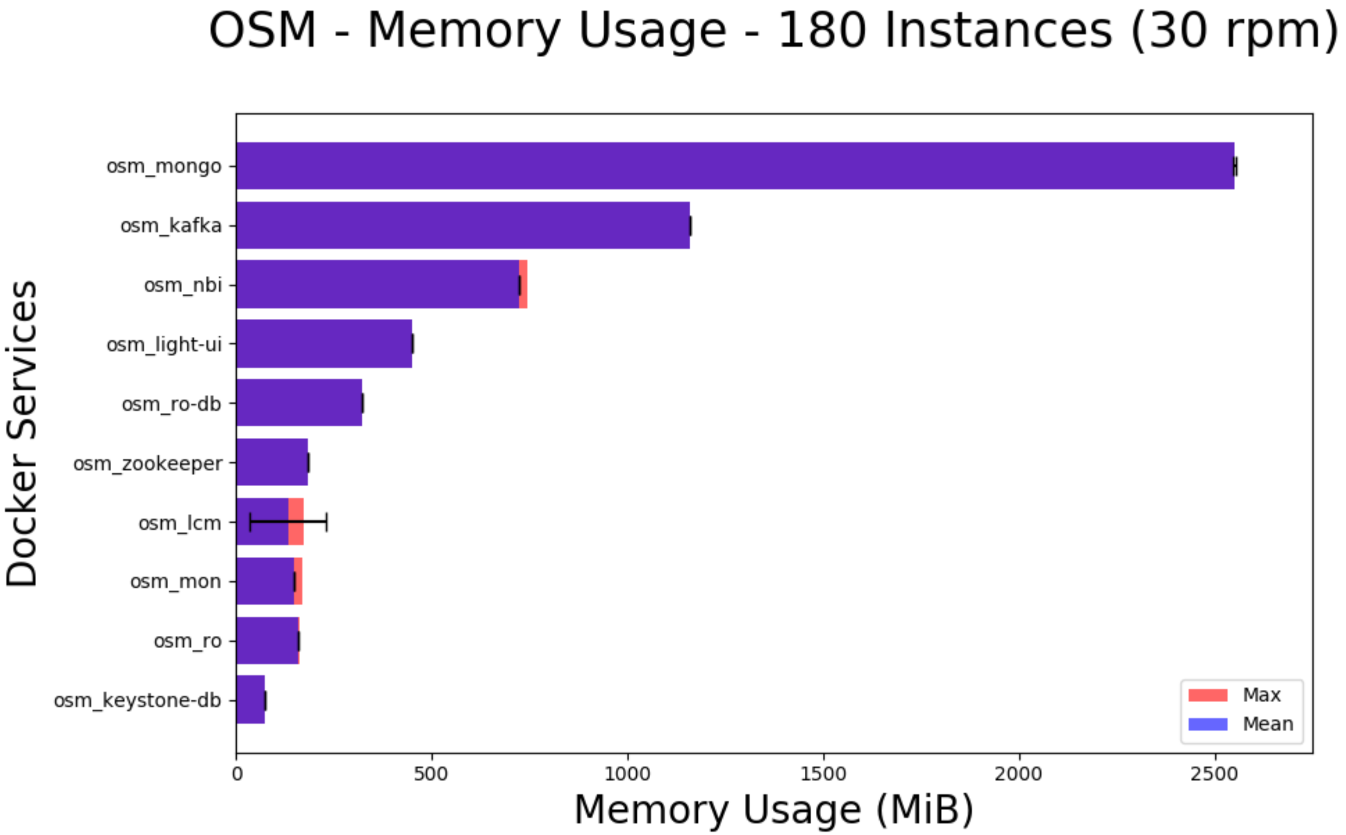
- Record how various microservices behave
  - CPU utilization
  - Linux load averages (1m, 5m, 15m)
  - Memory utilization
- Use **python-mano-wrappers** to continuously send requests to MANOs
- Visualize with graphs

2.1 OSM

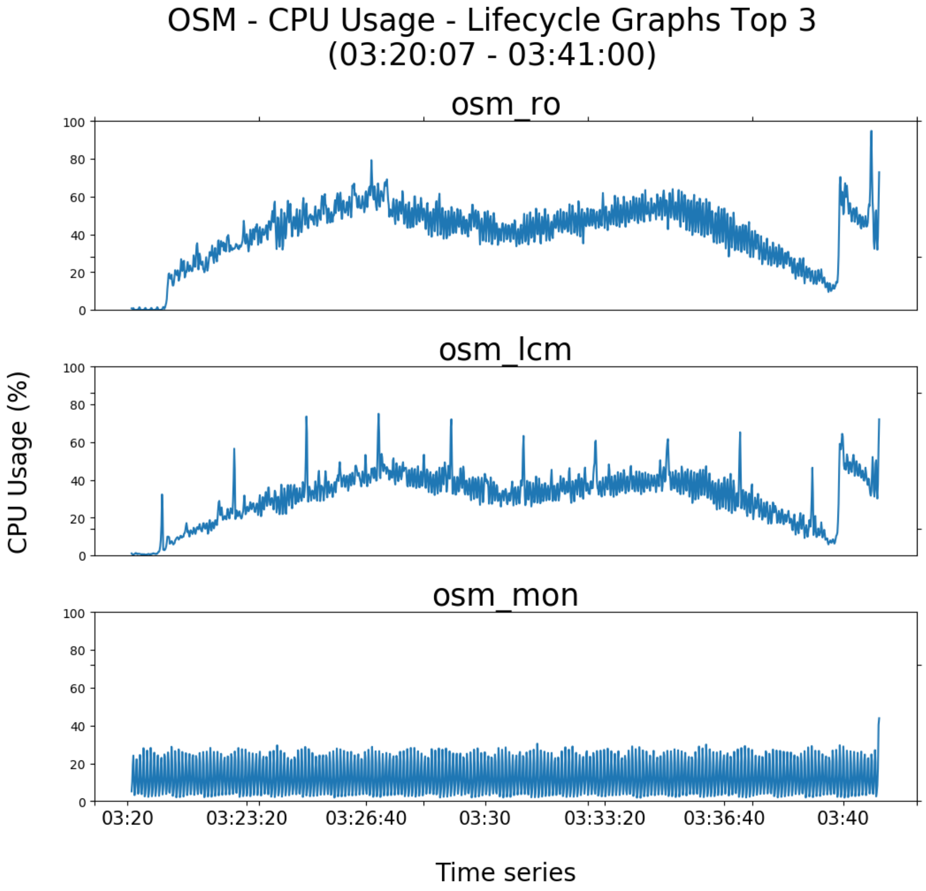
SCrAMbLE - MANO Scalability



SCrAMbLE - MANO Scalability

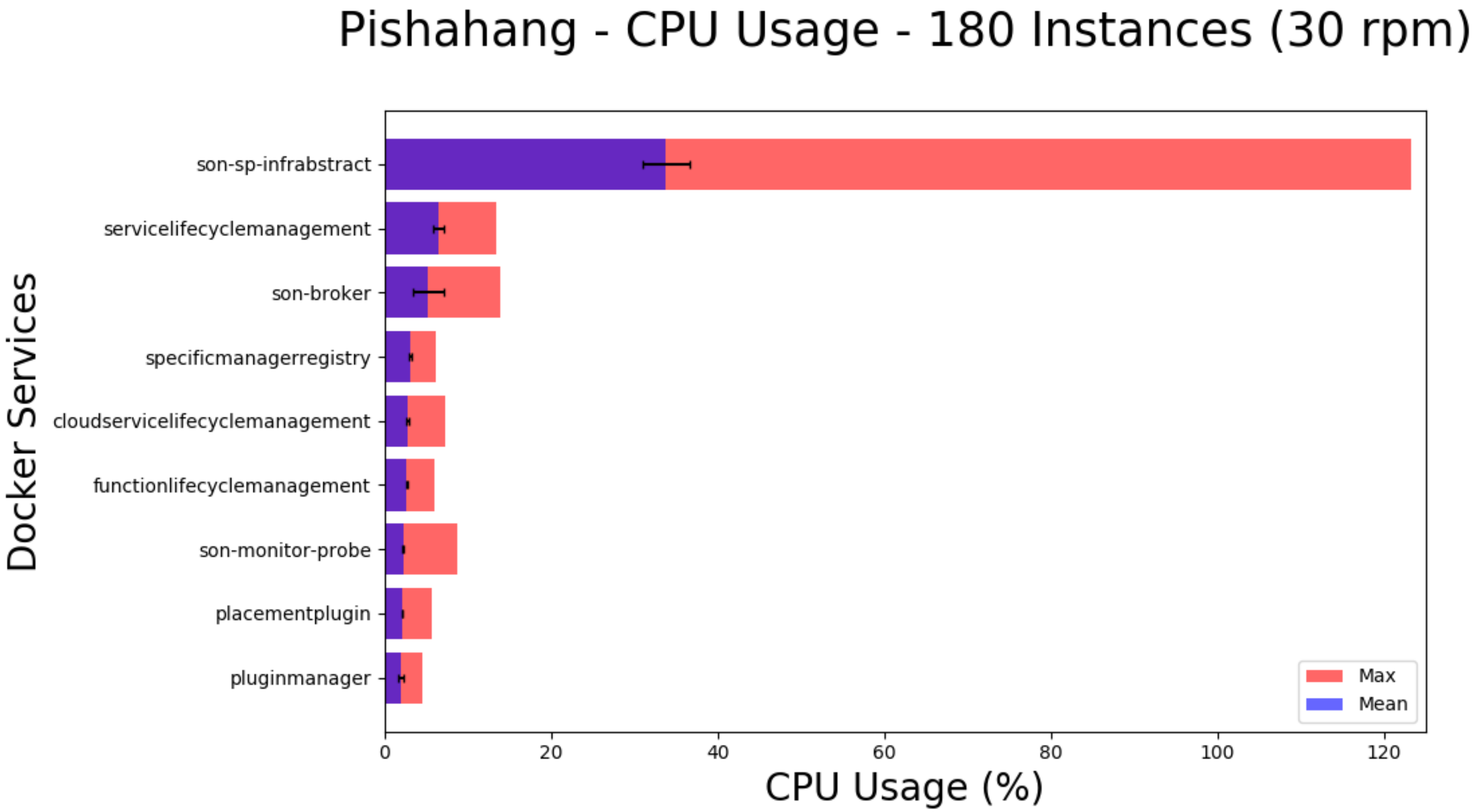


SCrAMbLE - MANO Scalability

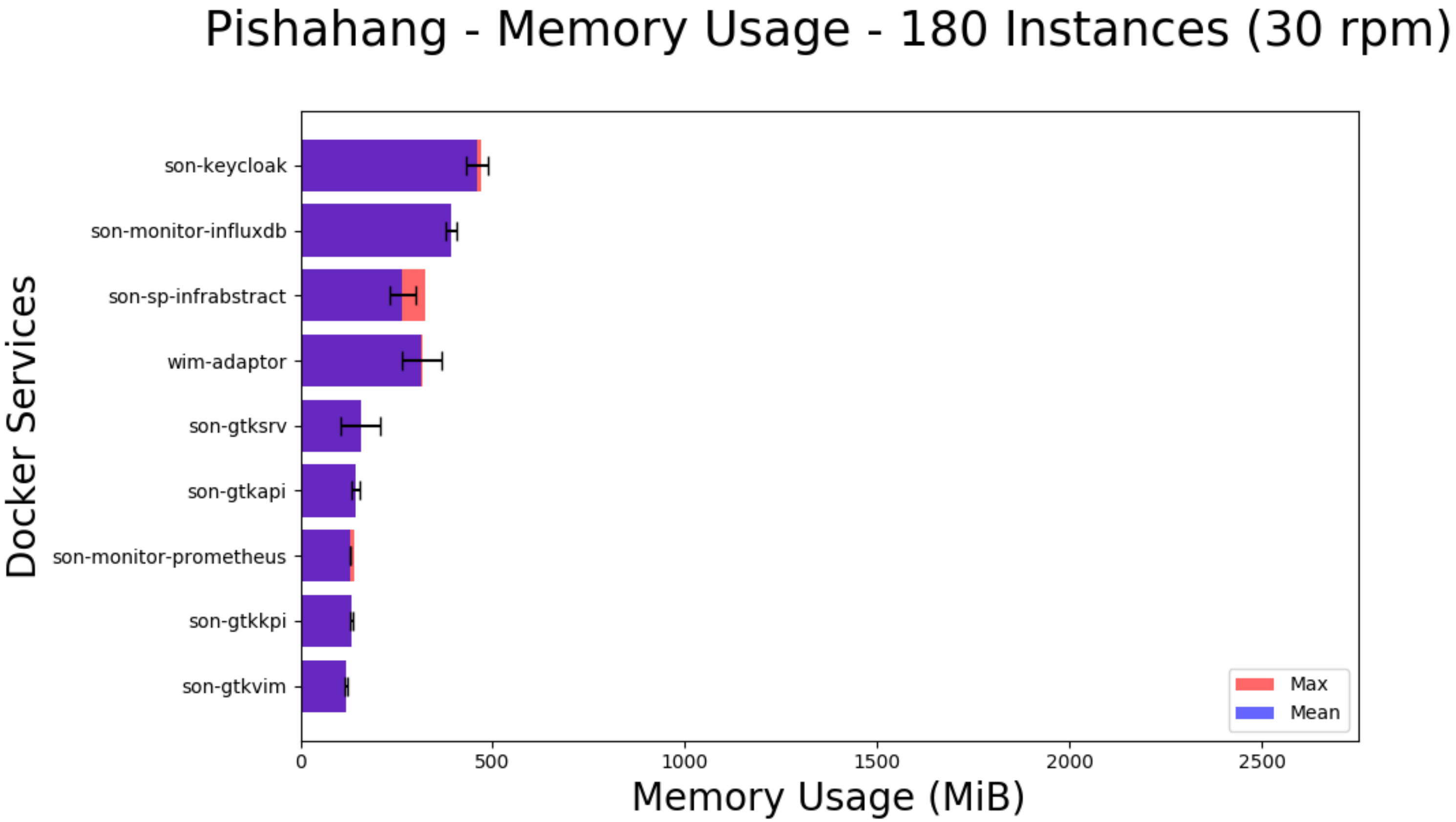


2.2 Pishahang

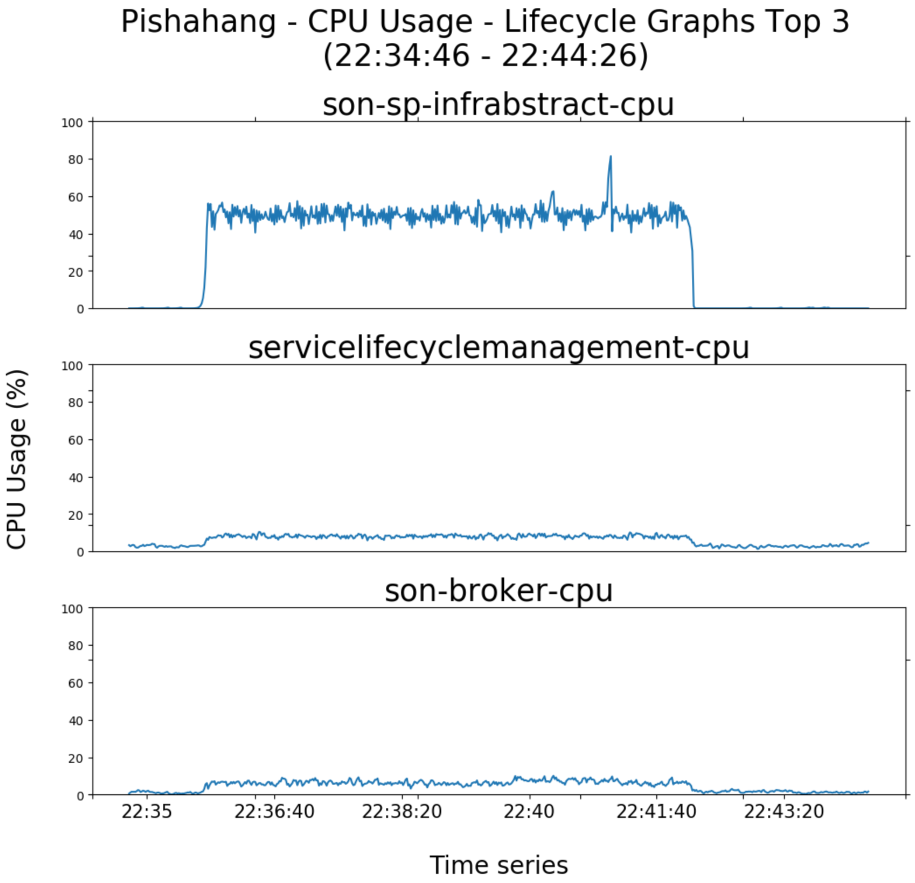
SCrAMbLE - MANO Scalability



SCrAMbLE - MANO Scalability



SCrAMbLE - MANO Scalability



SCrAMbLE - MANO Scalability

What else can we do with this?

- Turn this script into a **MANO Benchmarking Tool**?
- Resource characterization and analytics for MANO developers
- Should be easy to use and test MANOs under different conditions

MANO Benchmarking Framework

MANO Benchmarking Framework

- **Netdata:** Monitoring system, REST API
- **Docker Environment:** Portable, Reproducible
- **Python:** Scripting, Parameters
- **python-mano-wrappers:** Automate the MANO workflow
- ~~**Google Charts:** Easy graphs~~
- **Matplotlib:** Flexible graph generation
- **Flask + JS:** UI for graphs, Sorted tables

SCrAMbLE – MANO Benchmarking

Parameters

- NSDs and VNFDs
- Images: Cirros, Ubuntu
- Requests per minute
- Observation time

KPI

- CPU
- System Load
- Memory
- Success ratio
- End-to-end deployment time
- Individual deployment time
    - NFVO vs VIM

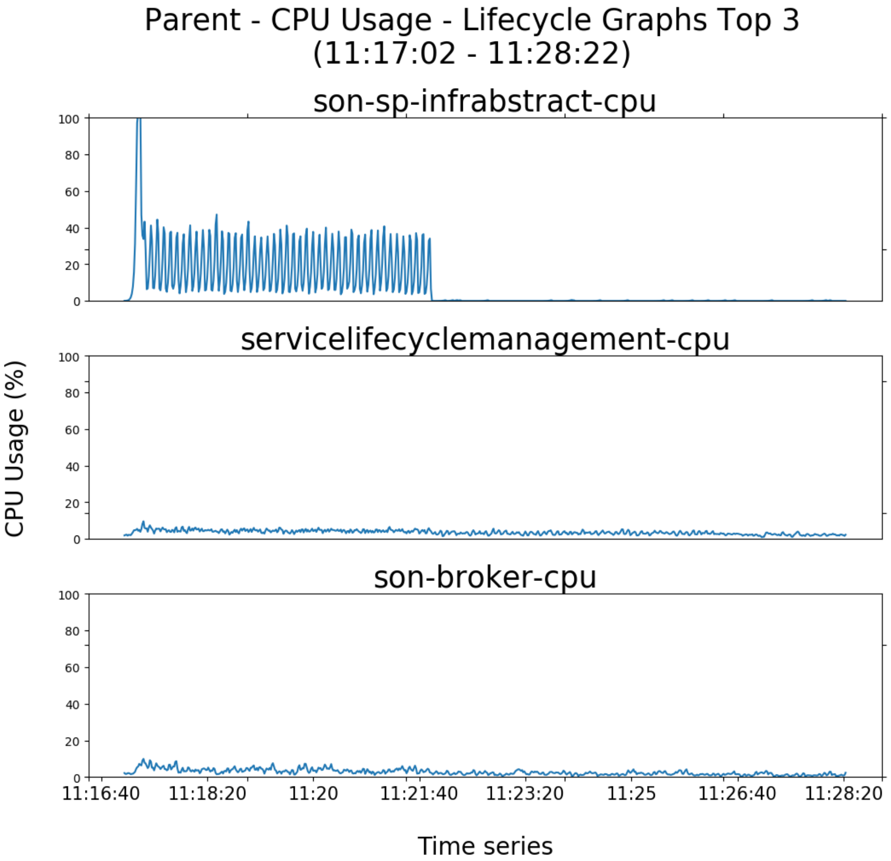
Examples of results

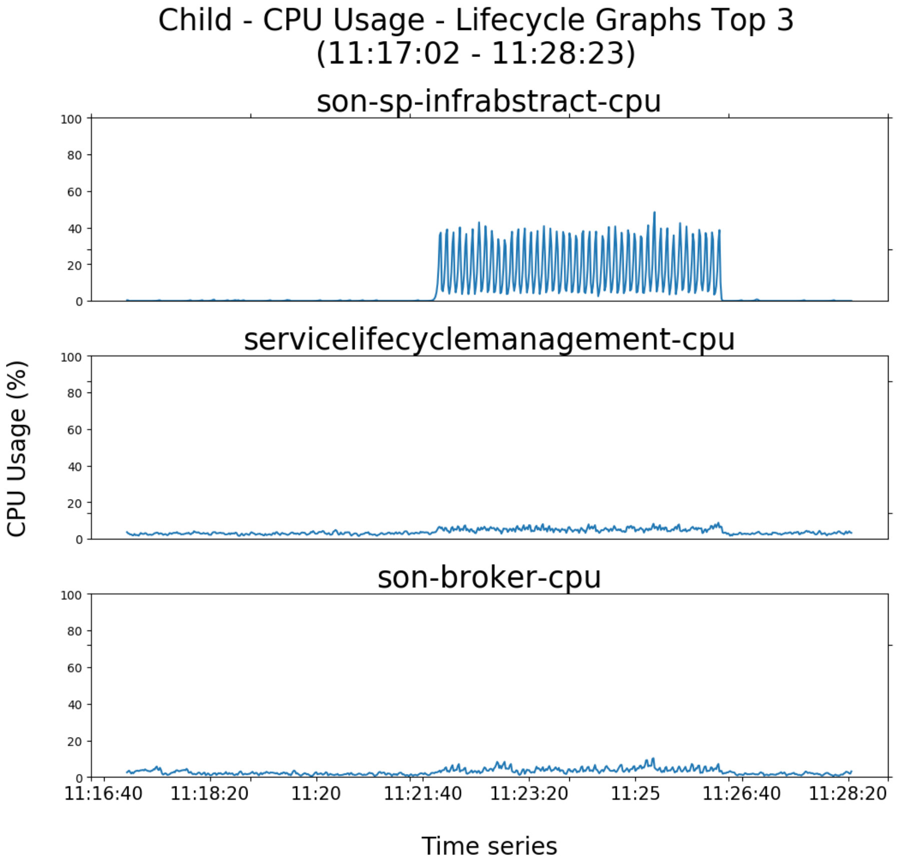
Scalability plugin comparison

Multiple NS comparison

Evaluation of scaling plugin

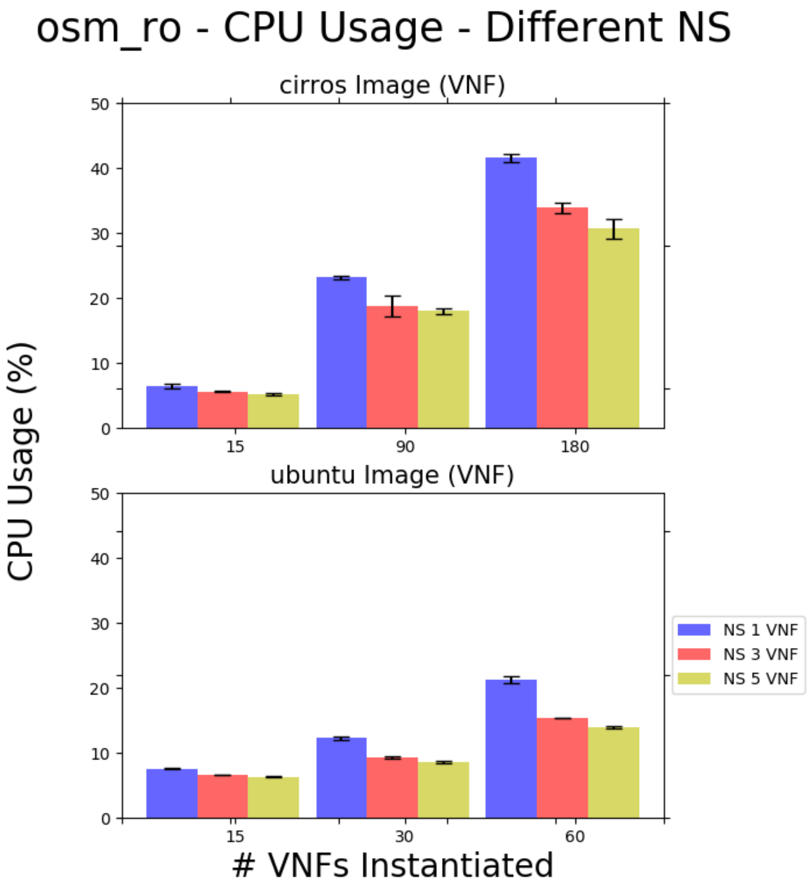
SCrAMbLE – MANO Benchmarking





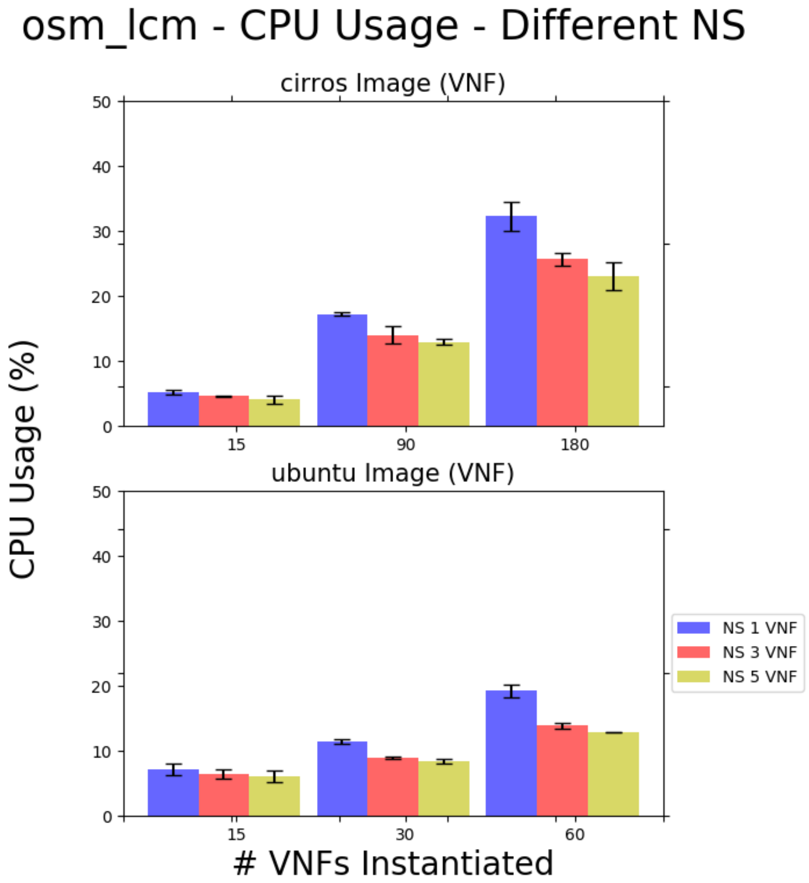
Multiple NS Comparison

SCrAMbLE – MANO Benchmarking

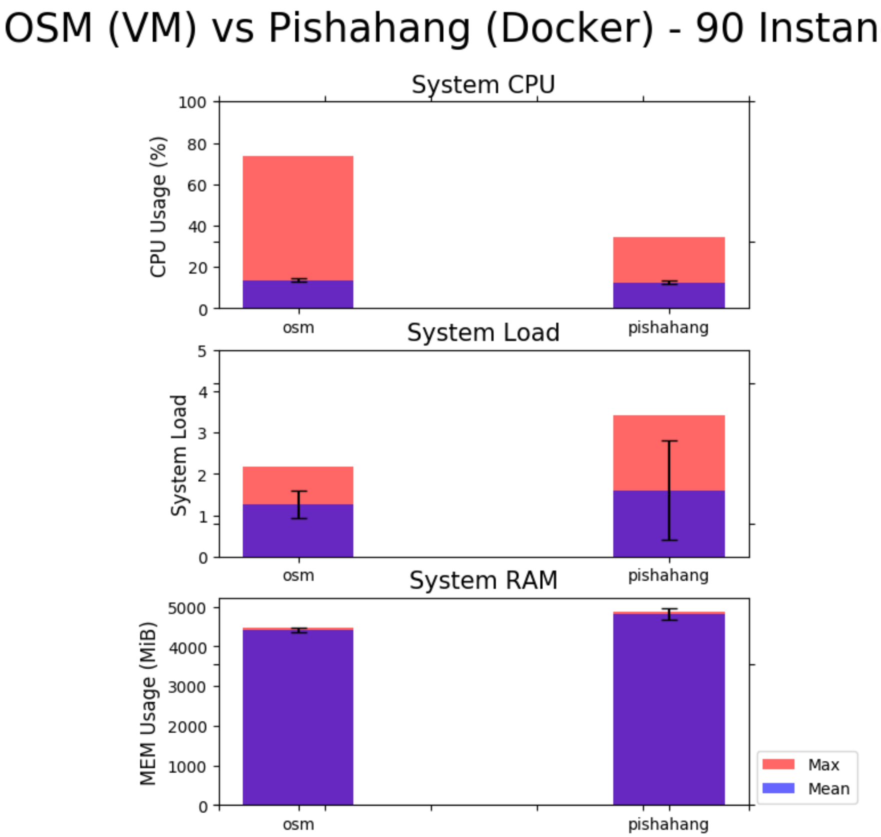


SCrAMbLE – MANO Benchmarking

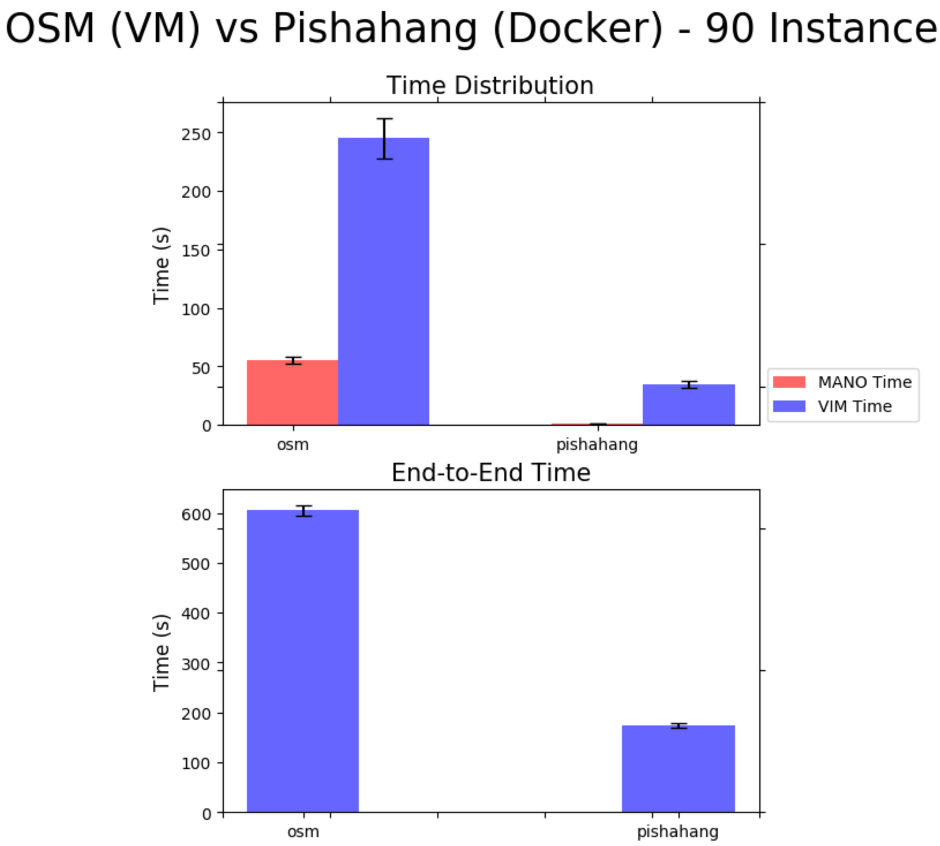
UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft



SCrAMbLE – MANO Benchmarking



SCrAMbLE – MANO Benchmarking



SCrAMbLE – MANO Benchmarking Suite

Blockers

- VIM Infrastructure
  - 16 cores --> ~180 virtual instances
- VM and Container support
  - Pishahang not stable for VM experiments (openstack)
  - OSM doesn't support containers (kubernetes)

Conclusion

SCrAMbLE – Conclusion

Management of services across multiple clouds has been achieved!

- Team PG-SCrAMbLE

SCrAMbLE – Conclusion

There are three states of being. Not knowing, action and completion.

SCrAMbLE – Conclusion

Thank You!