Professorship for Computer Science
Communication Services, Telecommunication Systems and Computer Networks

Cloudless Resource Monitoring in a Fog Computing System Enabled by an SDN/NFV Infrastructure

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Content

Introduction

Major evolutions in computer science

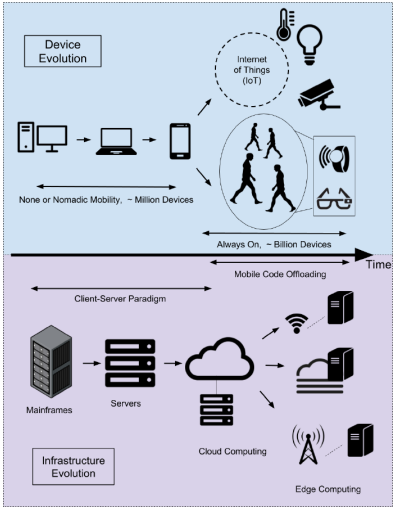


Figure 1: Device & infrastructure evolution [cf. 1]

Characteristics:

- Ubiquitous computing vision a reality now.
- Enormous audio-visual data.
- Dispersed Cloud and resources geographically.

Performance issues [2]:

- High latency.
- Long processing/queueing delay.
- Availability, QoS, resource management.

Introduction

Major evolutions in computer science

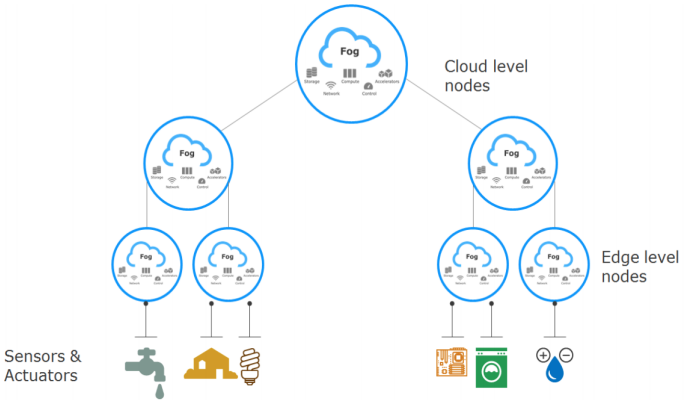


Figure 2: The reference model of multi-tier nodes deployment [cf. 3, p. 4]

Fog computing - a distributed computing paradigm - extending the Cloud computing to support the vision of IoT without restriction[4].
Benefits:

- Low latency
- Mobility support
- Context-awareness
- Real-time analytics
- Efficiency and cost

Traditional network architects increasingly incompetent due to the "vertical" lock between data and control plane inside networking devices[5]. Two approaches to solve that inherent problems:

- Clean-slate: GENI[6], Named Data Networking (NDN) [7, 8]
- **Software-Defined Network (SDN)[5, 9]**

SDN, "In essence, SDN gives network designers freedom to 'refactor' the network control plane..."[9], offers following benefits:

- Programmable network
- Scalability
- Efficiency and cost-effective
- Vendor-agnostic
- Logically centralized
- Proactive and analytical forwarding decisions.

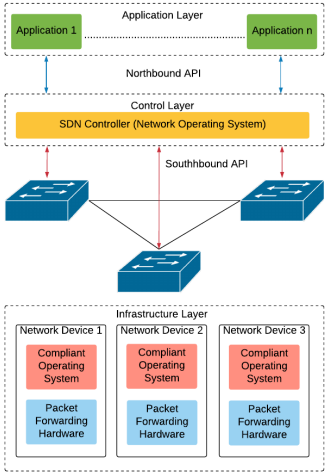


Figure 3: SDN architecture proposal ([cf. 10])

Recent technology advancements also open new possibilities to develop an intelligent & context-aware resource management system:

- Containerization
- Autonomic computing
- Modular monitoring frameworks (Pymon [11], TICK [12], Prometheus [13])

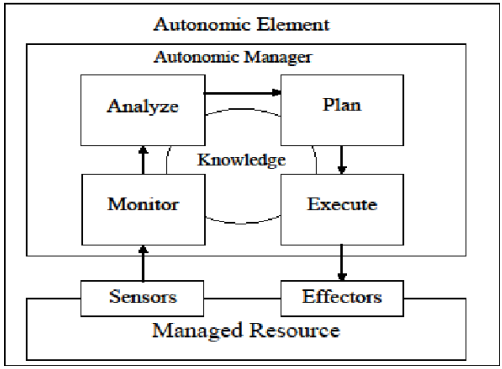


Figure 4: Generic MAPE-K architecture [cf. 14]

Cloudless Resource Monitoring (CRM)

General architecture of the CRM system

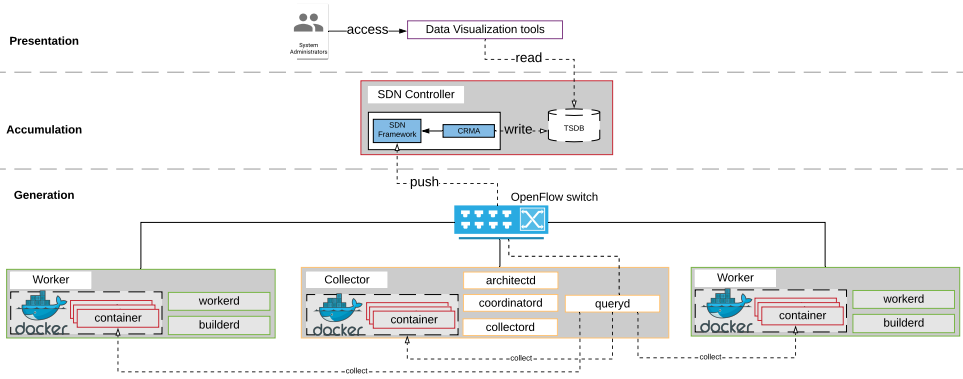
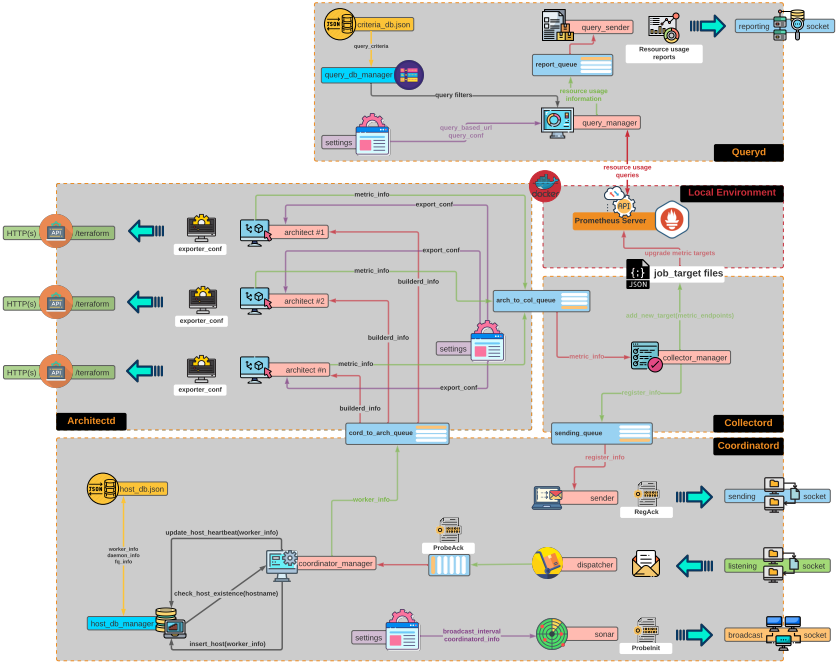


Figure 5: Overview of CRMS system

CRM


criteria_db.json
query_criteria
query_db_manager
query_filters
query_based_url
query_conf
settings
query_manager
resource usage information
report_queue
query_sender
Resource usage reports
reporting
socket
Queryd
resource usage queries
Local Environment
api
Prometheus Server
upgrade metric targets
job_target files
JSON
HTTP(s)
API
/terraform
exporter_conf
architect #1
architect #2
architect #n
metric_info
export_conf
builderd_info
Architectd
arch_to_col_queue
add_new_target(metric_endpoints)
collector_manager
register_info
Collectord
cord_to_arch_queue
sending_queue
Coordinatord
host_db.json
worker_info
update_host_heartbeat(worker_info)
worker_info
daemon_info
hj_info
coordinator_manager
check_host_existence(hostname)
insert_host(worker_info)
host_db_manager
ProbeAck
sender
RegAck
sending
socket
dispatcher
listening
broadcast_interval
coordinatord_info
sonar
ProbeInit
broadcast

Cloudless Resource Monitoring (CRM)

The `Worker` system

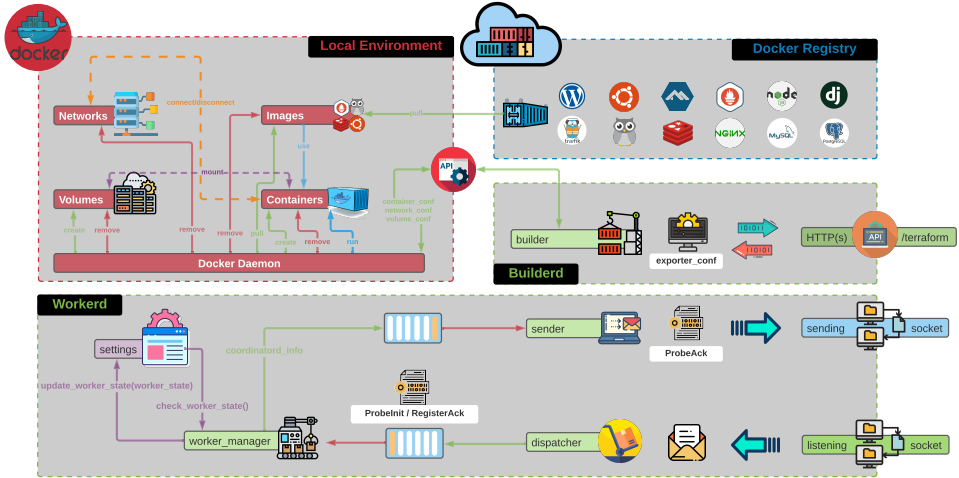


Figure 6: The main components of a Worker system

Cloudless Resource Monitoring (CRM)

Primary phases in the CRM system

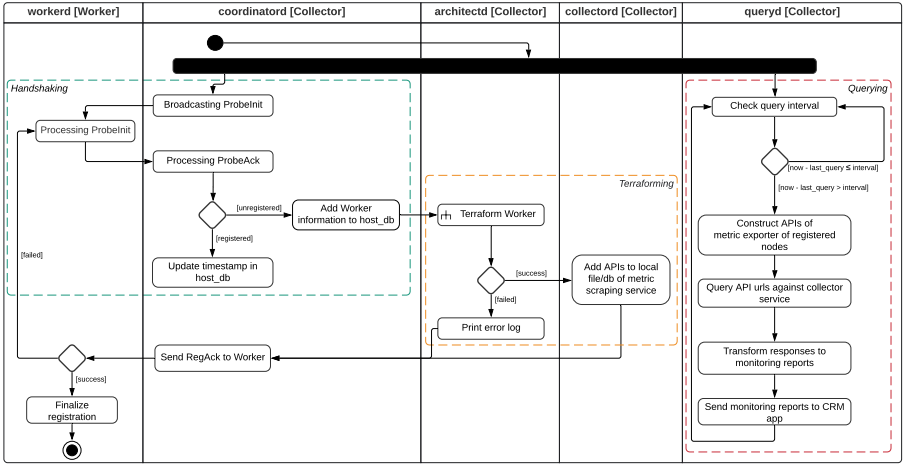


Figure 7: Activities in Generation layer

Cloudless Resource Monitoring (CRM)

Primary phases in the CRM system

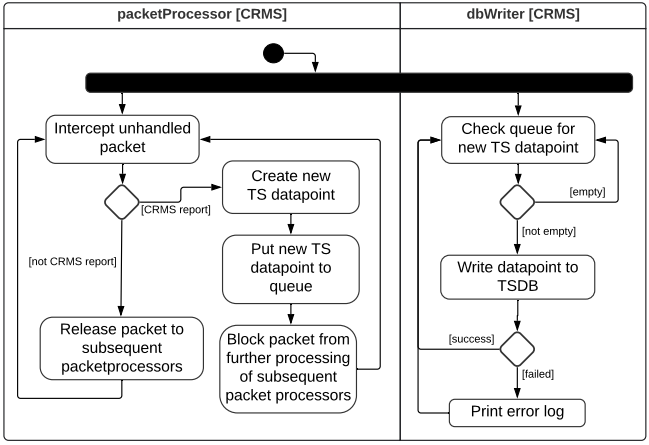


Figure 8: Activities in Accumulation layer

Topology Information	
Name	**mesh**
Device	**4** OVS, **1** Collector; **8** Workers

Hardware specs	
Collector	CPU: 2 cores; RAM: 2GB; Storage Size: 20GB;
Worker	CPU: 2 cores; RAM: 2GB; Storage Size: 20GB; I/O rate: 50MB/s

Name	Version	Architecture
NodeExporter	unibaktr/nodeexporter:0.18.1	linux: amd64;arm64;arm/v6-v7; ...
cAdvisor	unibaktr/cadvisor:v0.36.0	linux: amd64;arm64;/arm/v7; ...
Prometheus	unibaktr/prometheus:2.17.1	linux: amd64;arm64;arm/v6-v7; ...
Influxdb	influxdb:1.8.4	linux: amd64;arm64/v8;arm/v7
Grafana	grafana:latest	linux: amd64;arm64;arm
onos-multiarch	thanhledev/onos-multiarch:0.0.1	linux: amd64;arm64

Table 1: Topology, hardware, container specs

Evaluation of CRM

Test results

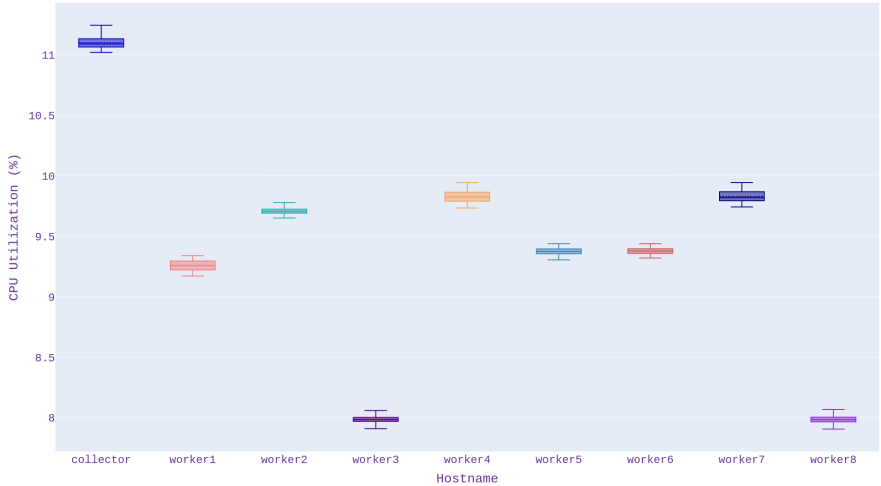


Figure 9: CPU Usage

Evaluation of CRM

Test results

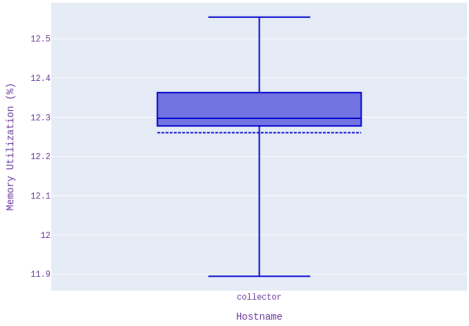


Figure 10: Collector memory usage

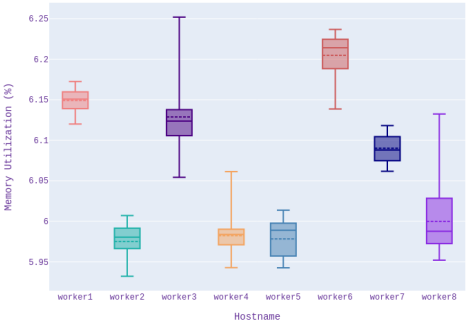


Figure 11: Worker memory usage

Evaluation of CRM

Test results

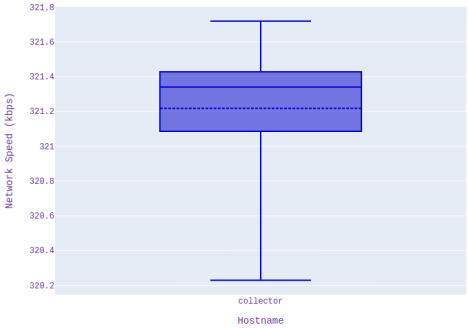


Figure 12: Collector network I/O rate

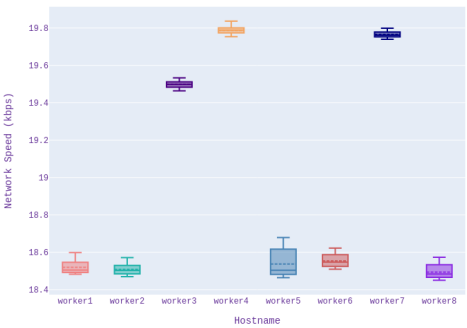


Figure 13: Worker network I/O rates

Conclusions

Achievements of CRM:

- A working prototype of a self-managment container orchestrator
- A working solution of a multi-arch docker image of SND controller ready to be deployed on the egde/fog nodes.

Issues:

- Single point of failure
- Application has not yet supported any GUIs.
- Overall resource utilization is not optimized.

Further developments:

- Implementation of missing elements regarding MAPE-K model.
- Providing utility functions (GUIs, APIs)

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Questions ?

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