A Framework based on SDN and Containers for Dynamic Service Chains on IoT Gateways

Morabito, Roberto, and Nicklas Beijar,
Proceedings of the Workshop on Hot Topics in Container Networking and Networked Systems. ACM, 2017

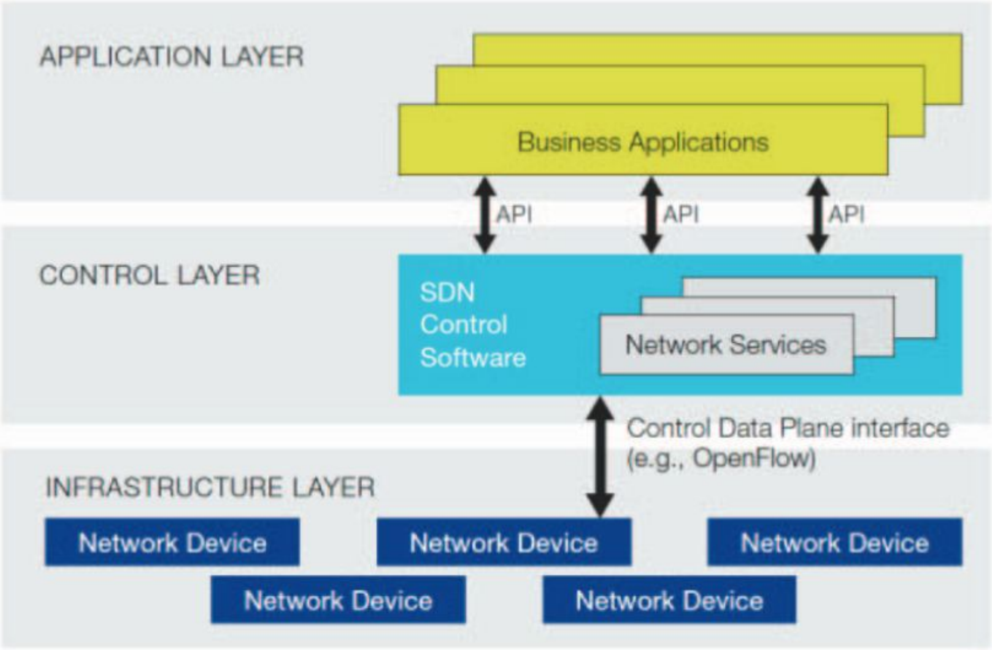
Introduction

- To enable efficient network architectures for the **Internet of Things(IoT)**, They integrate **Software Defined Networking(SDN)** and **Container Virtualization** for coping with the complex requirements in networking.

- This paper proposed a framework aim for application deployment, and scalability in IoT scenarios.

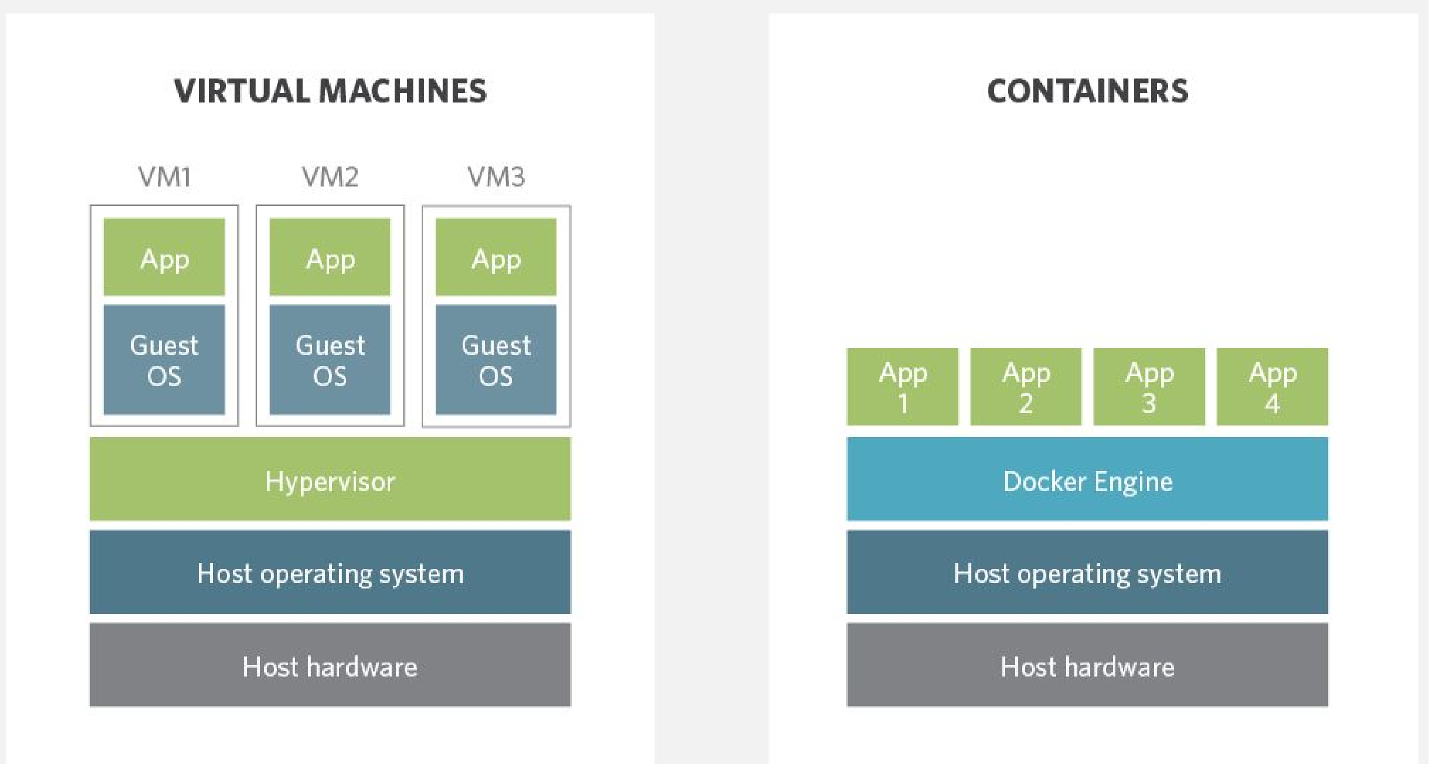
Software-defined networking

- Features of SDN:
  - Decouple control plane and data plane
  - Centralized controller
- SDN enables dynamic reconfiguration of routing.



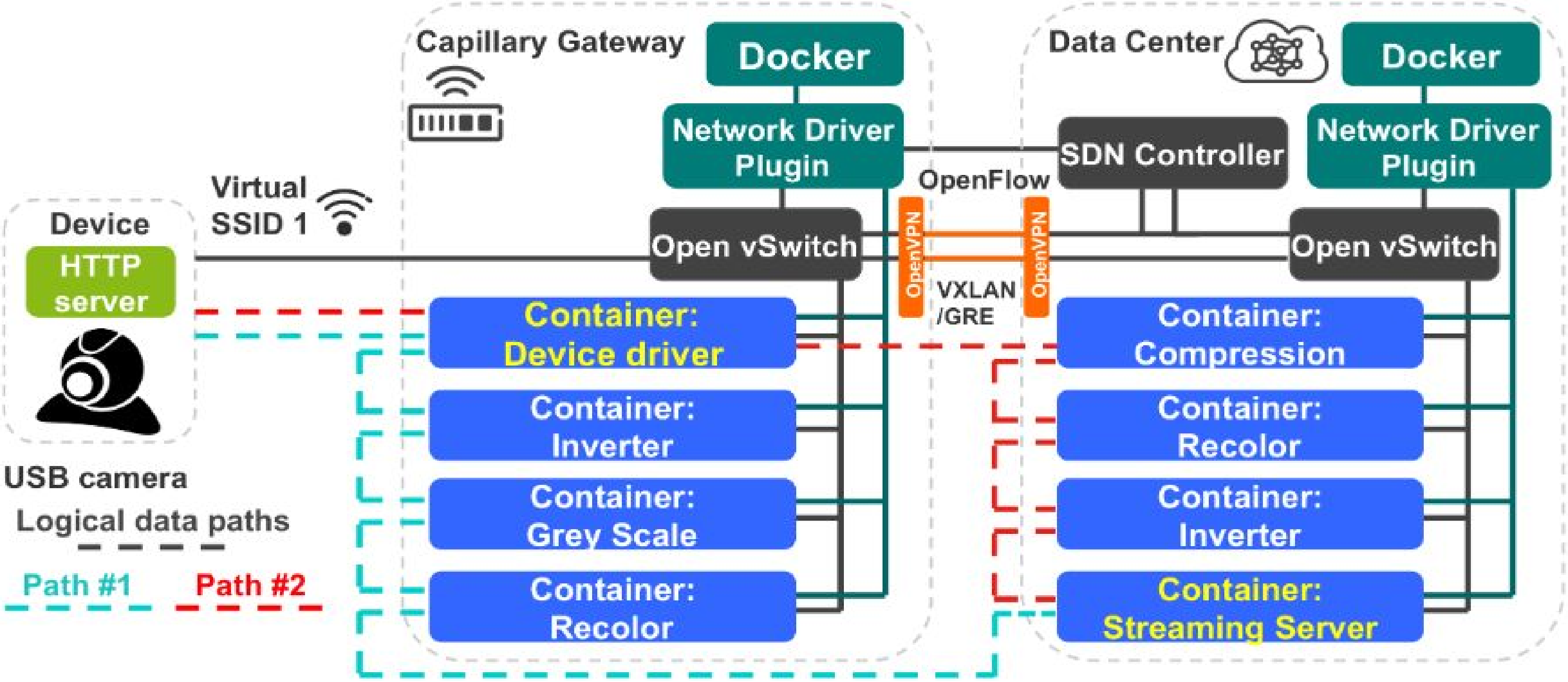
Container Virtualization

- Containers offer application packaging, deployment method, and application isolation with low overhead.
    - can be more efficient than VMs.



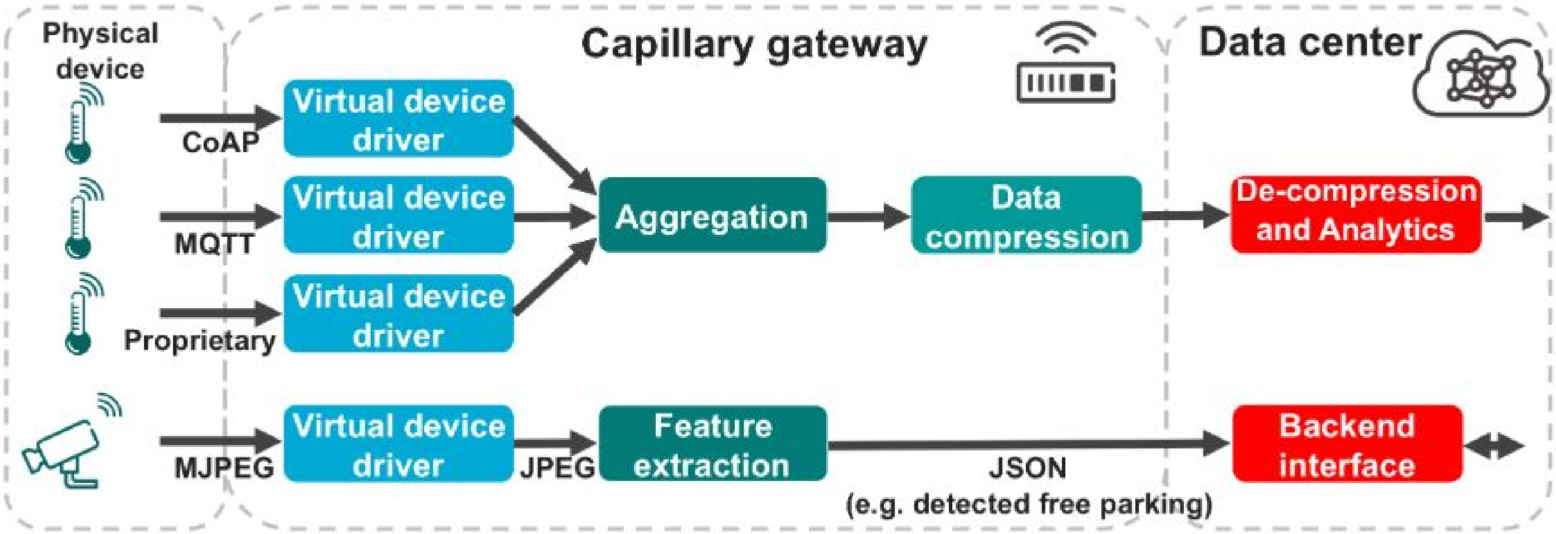
Framework Design

- Architectures: IoT Devices, Capillary Gateway, Data Center
- IoT data process in **Service Function Chain**.



Service Function Chaining

- Services implemented as independent components, interact with each other through specific APIs.
    - In IoT, the software often takes the form of a chain.
- Allow dynamic scaling and reconfiguration.



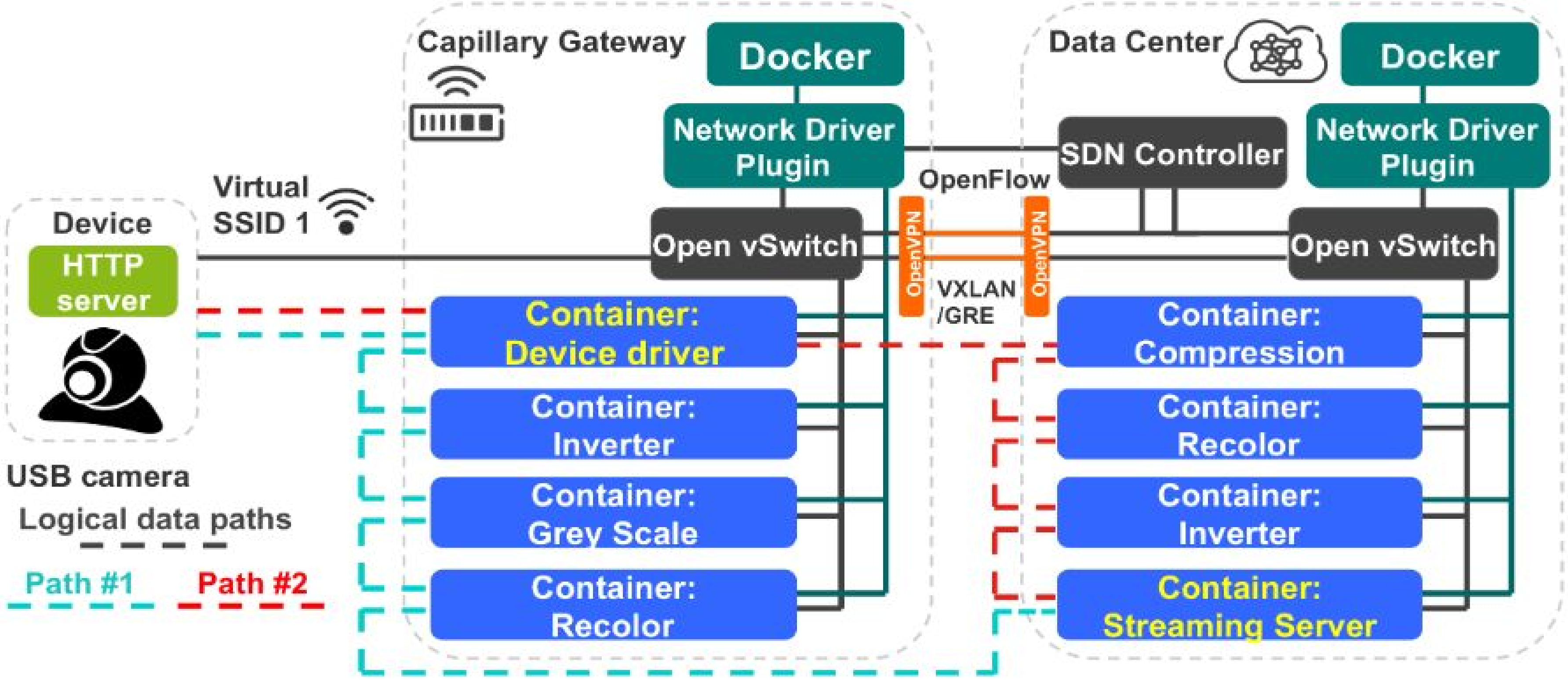
Design Features

- **Chains for IoT data processing**
  - Instantiate a separate chain for each IoT device.
- **Edge computation**
  - Using container virtualization to run seperated services.
- **Seamless network reconfiguration**
  - Using SDN for remaining connection, when re-deploying the chain.
  - Using pseudo addresses to denote the preceding and the succeeding component in the chain.
- **Isolation**
  - Allows gateway to be shared between several tenants.

Implementation

- The data center is in Lund (Sweden), 850 km from the test site(Jorvas,Finland).
- The gateway is a RaspberryPi 3 with 1GB of memory and a 4 core CPU.
  - Running *hostapd* to create 4 SSID for IoT devices.
- Both data center and gateway run a Open vSwitch, which is managed by the SDN controller.
- Service components are running in containers on Docker.
  - Using their own Docker Network Driver Plugin, allow container connecting to the virtual switch.

Implementation (cont.)



Evaluation Goals

- Demonstrate the efficient deployment on low-power devices.
- Understand the capabilities of the gateway scalability.
- Evaluate the impact of the different software components used to build the platform.

Experiments Setting

- The IoT device generates video stream, processed locally on the gateway.
  - Implemented as a RPi connected to an USB camera.
  - Using *VLC* to capture the stream, encode it to MPEG-4, and serve it over HTTP.

- The processing in the data center is omitted, and consists of a simple streaming server to which clients can connect to.

Experiments

- Evaluate the performance, and increase the number of containers.

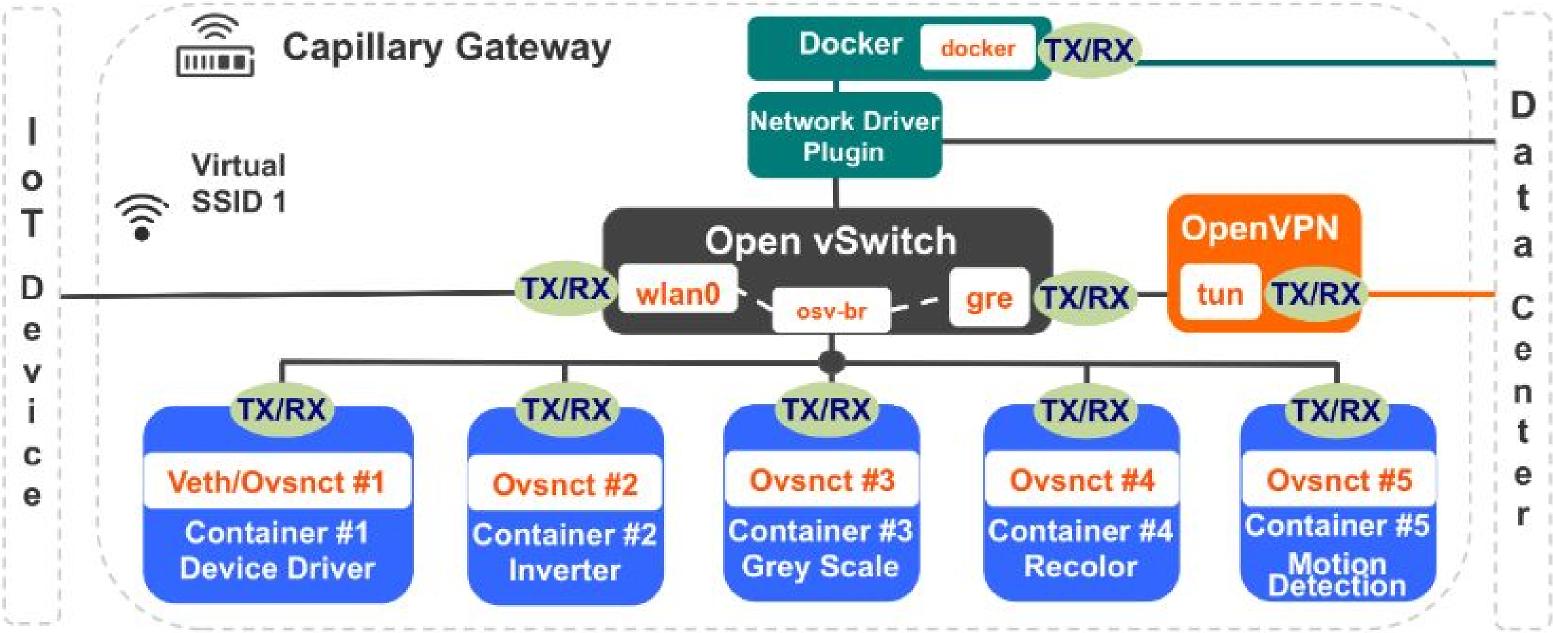
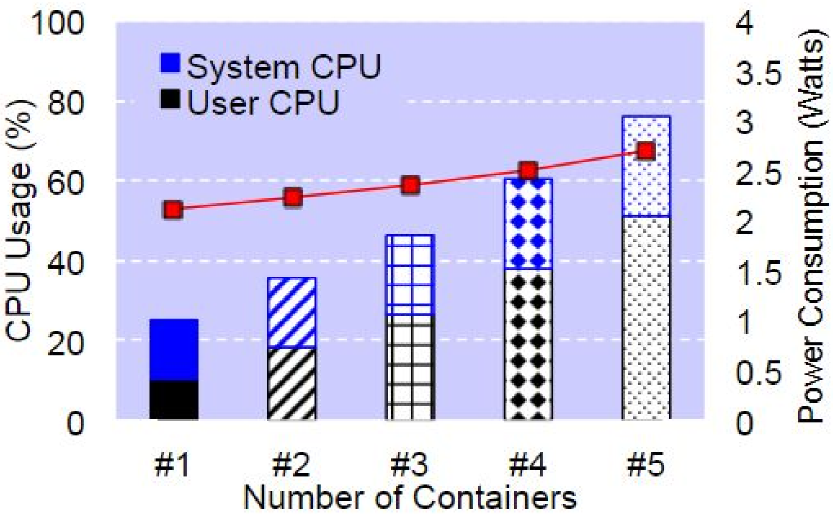
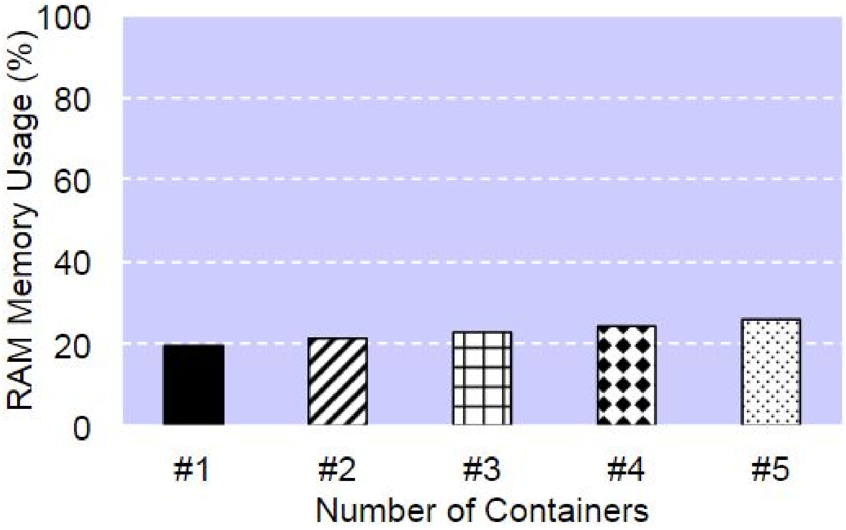


Figure 3: Gateway's network interfaces setup.

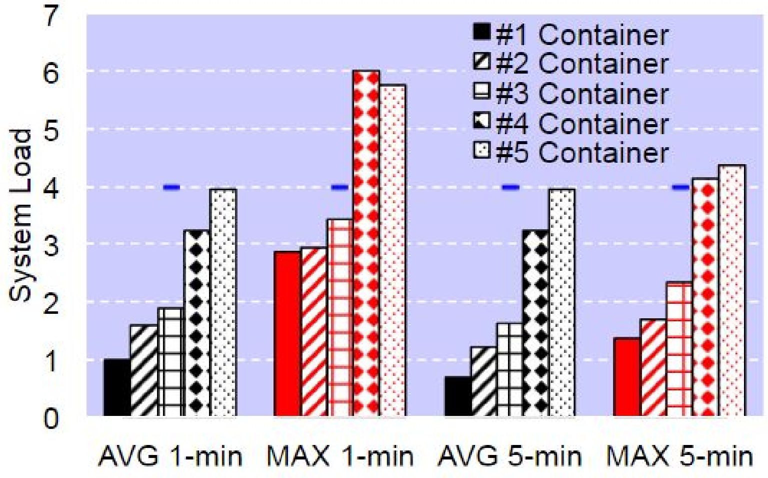
Performance Evaluations



(a)

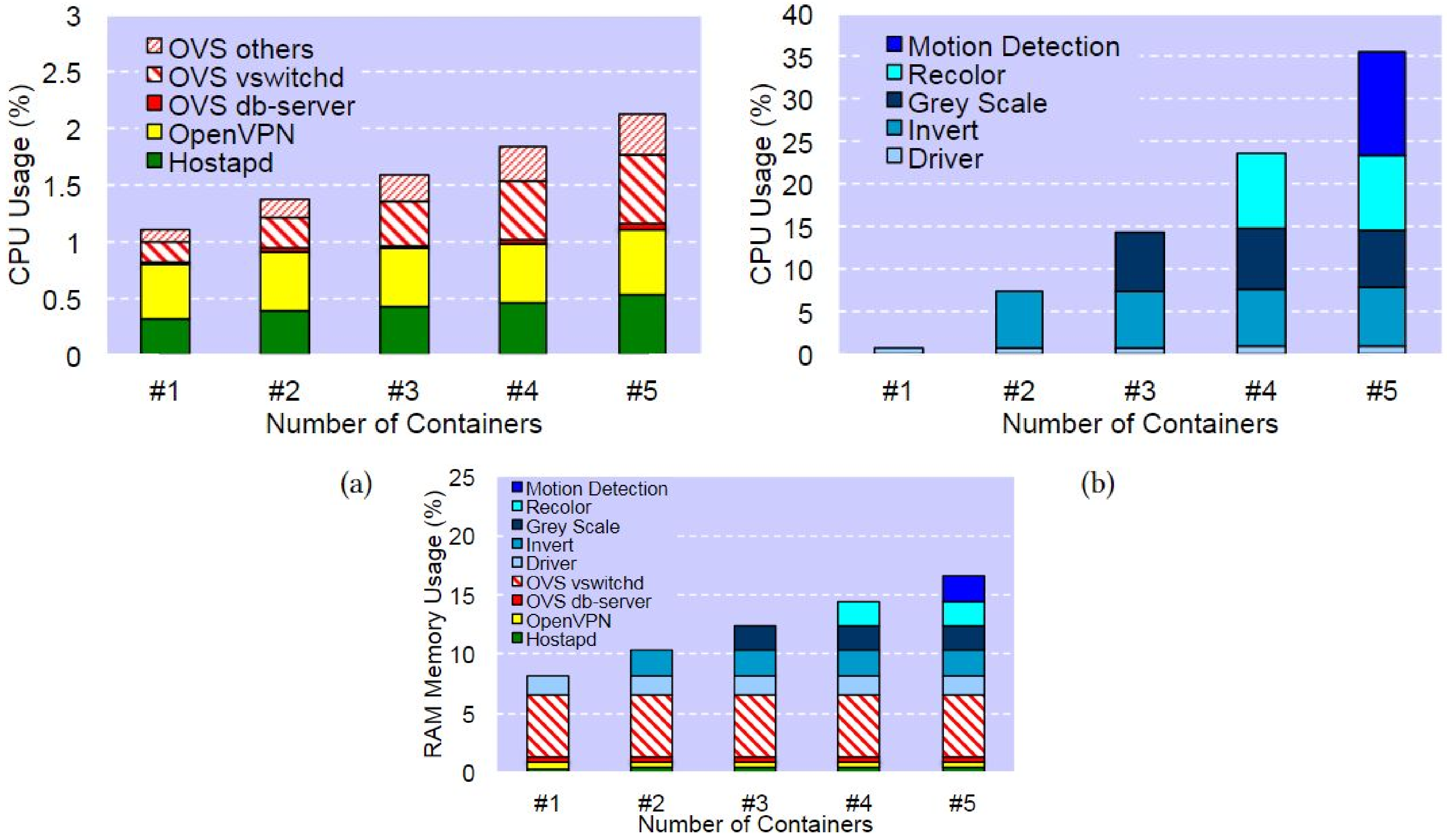


(b)



(c)

Software Components Evaluations



(a)

(b)

(c)

Conclusion

- This paper present a framework that integrate SDN and Docker for constrained IoT scenarios, which can build service function chains in a novel way.
- Experiments show that the approach can deploy efficiently even on low computational resources devices.

- For future work, they intend to explore the framework performance on different devices, and the number of tenants that can share the same gateway.