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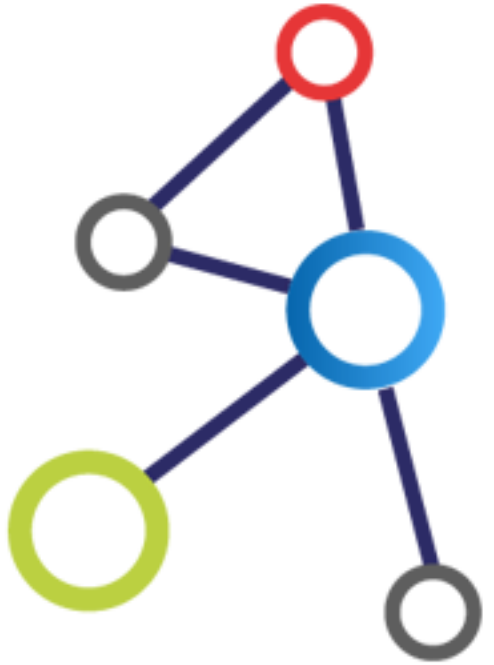
agile service development and orchestration in 5G virtualized networks



# SONATA SDK demo & hands-on

Steven Van Rossem

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HORIZON 2020

5G PPP

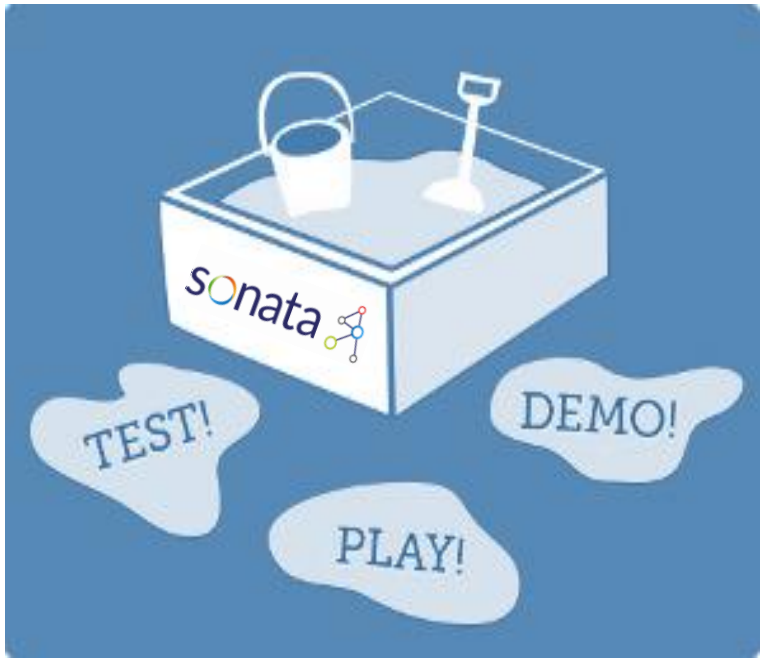
# Agenda

- **SDK architecture**
- Building the Service Descriptor
- Testing the service
- Deploy the service in production

# SONATA SDK : a sandbox for NFV-based services

The SONATA SDK:

- Aim: an easy to use framework to try-out VNF-based service aspects such as: SFC, VNF configuration
- Modular approach
- Sandbox environment to give a service confidence the service will work, before it is deployed in production.

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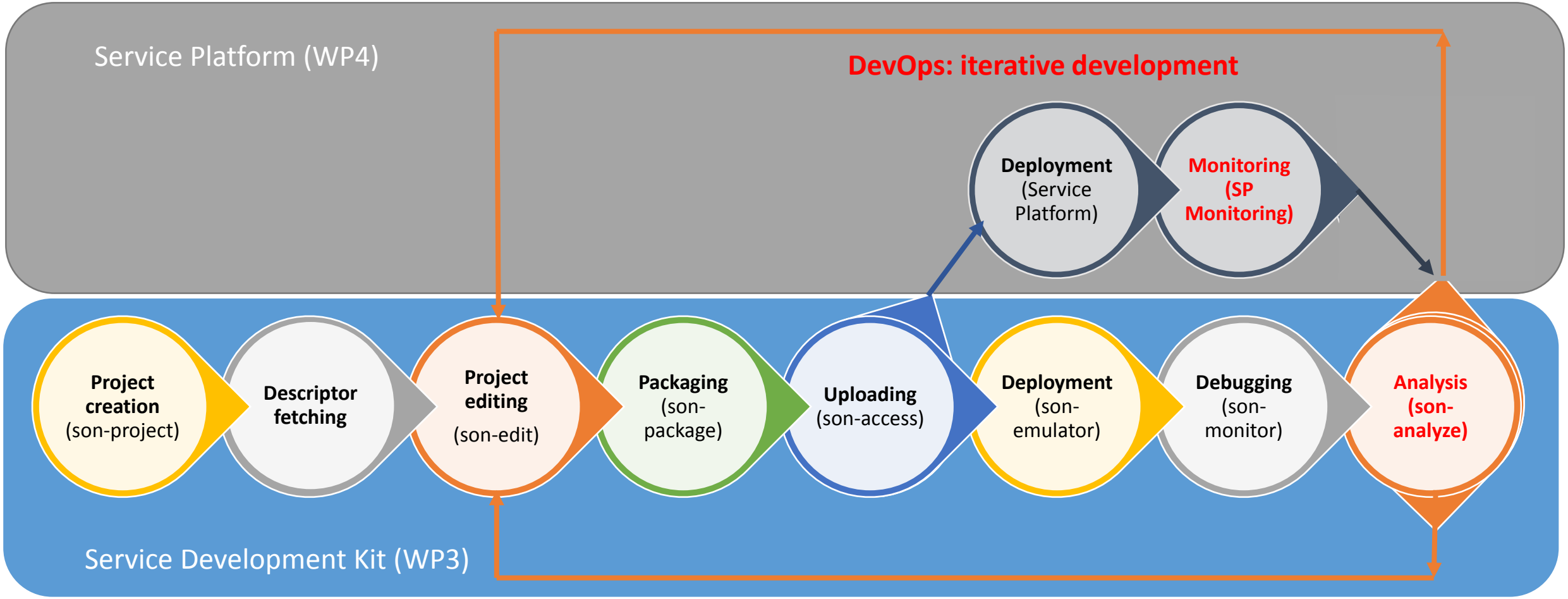
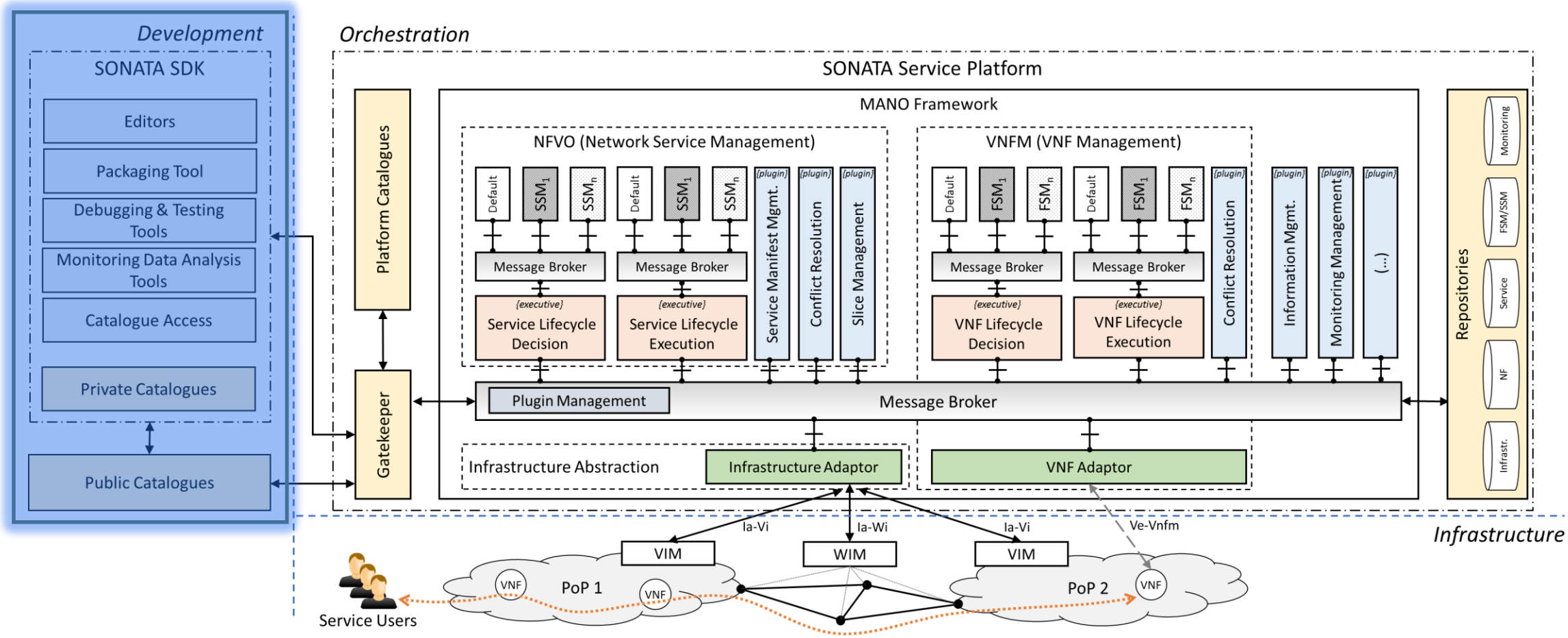
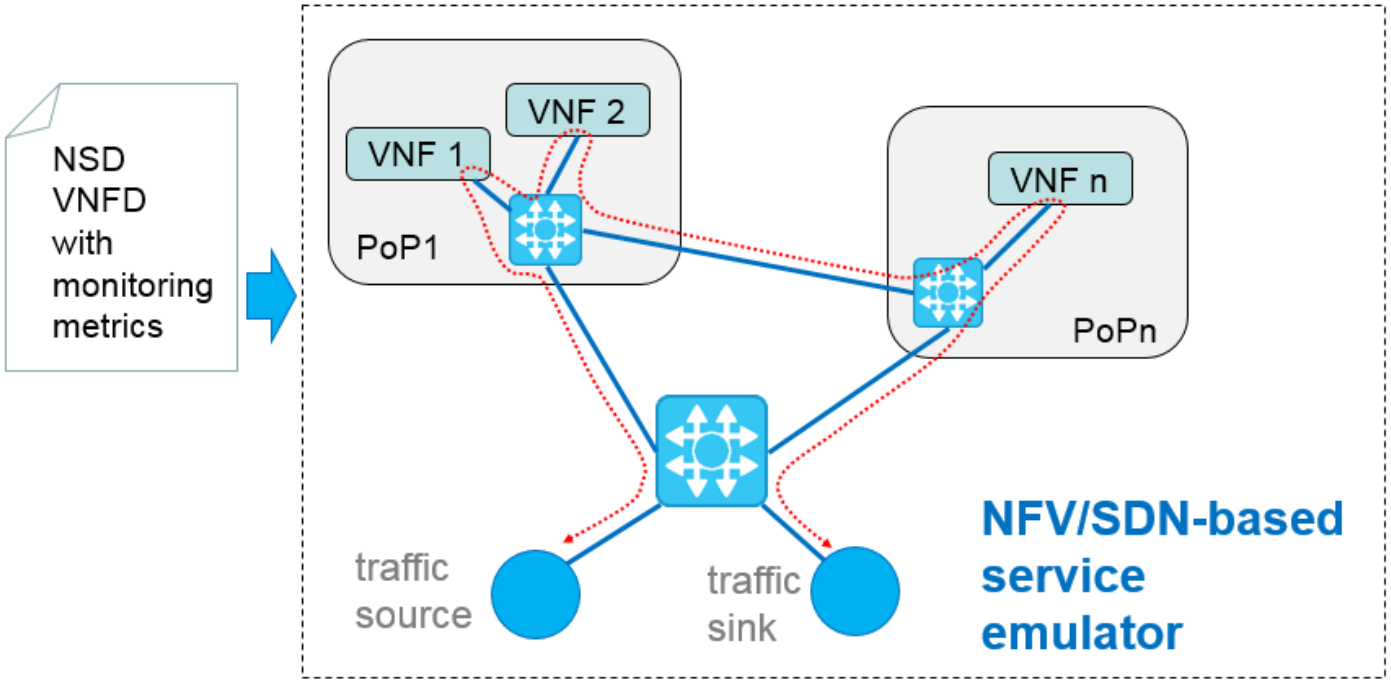
# Service Development Workflow



# SDK in the global SONATA architecture



# SONATA SDK Emulator




**An SDK environment for NFV/SDN based services:**

- Rapid prototyping of network services in a multi-PoP environment
- A descriptor format to define the service
- Custom Service Function Chaining (SFC)
- User-defined monitoring and traffic generation
- Sandbox for fast deployment, configuration and debugging of production-ready network functions

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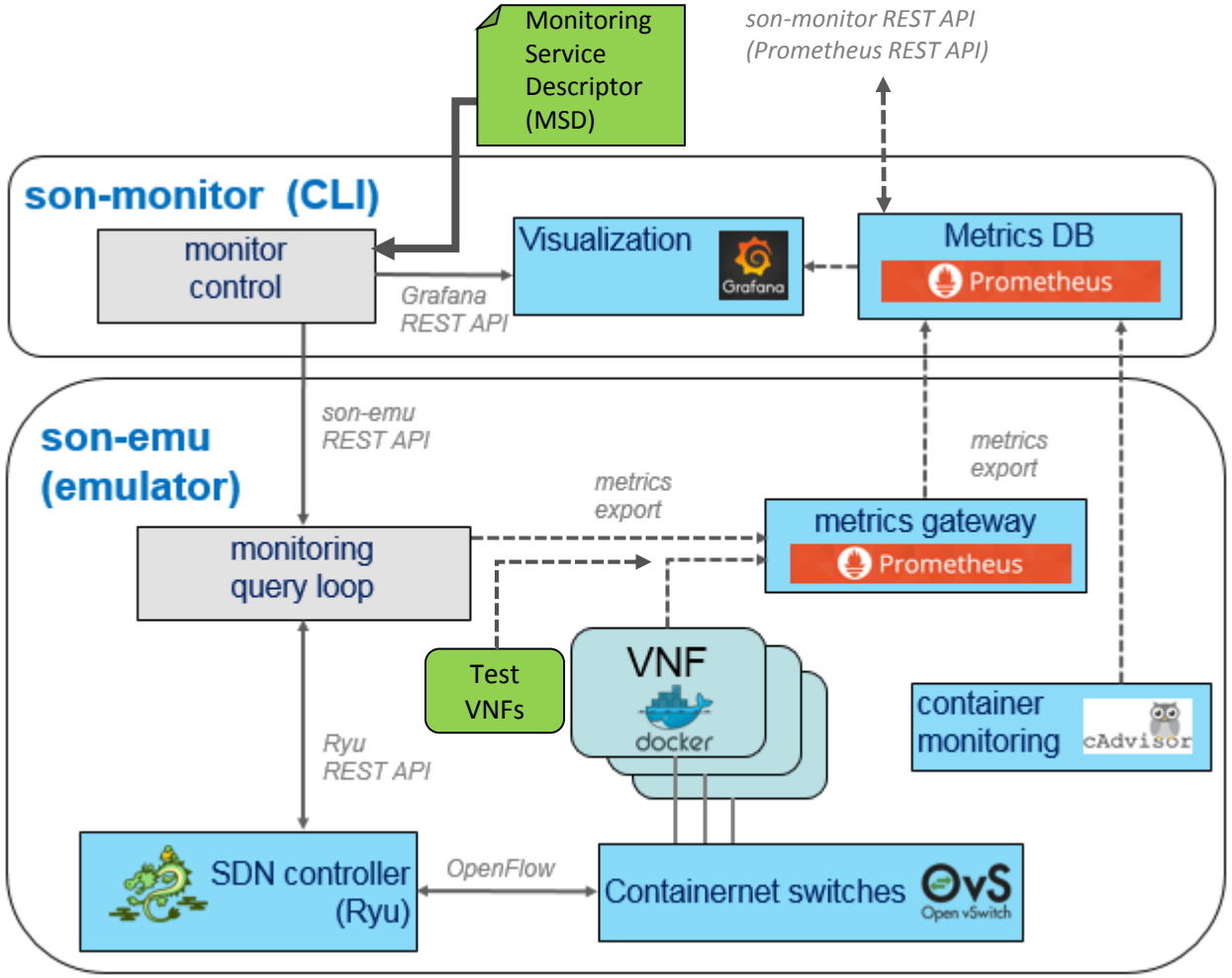
# SONATA SDK architecture




**Implementation based on:**

- Combination of proven NFV/SDN related technologies (Mininet, OvS, Ryu, …)
- Modular architecture with Python-based code that parses YAML-based service descriptors and deploys the chained VNFs.
- Can be deployed as isolated VM, combination of docker containers, debian install packages.

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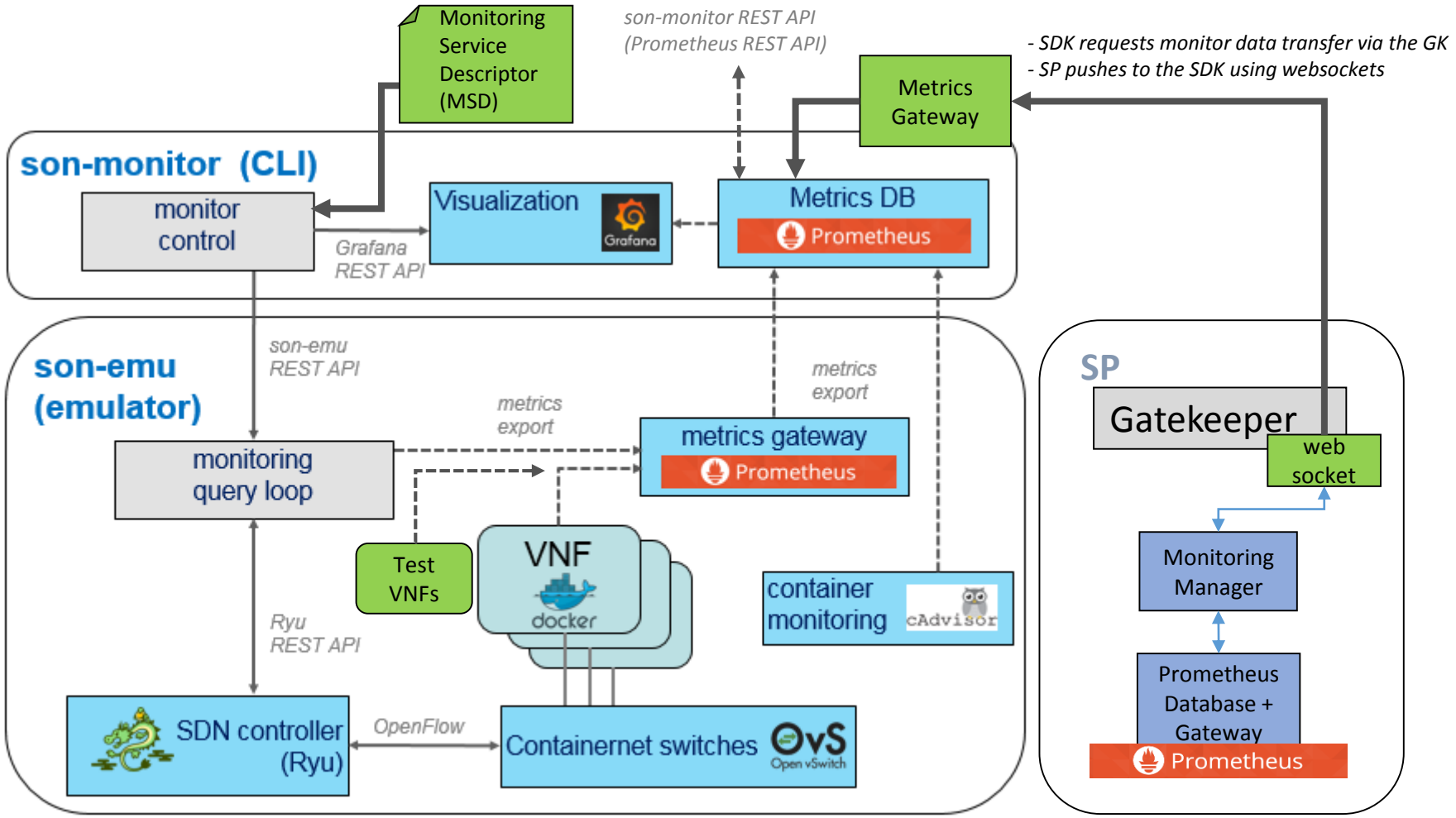
# SONATA SDK architecture

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# SONATA SDK Virtual Machine

- use VirtualBox image to deploy the SONATA SDK VM
- ssh sonata@localhost –p2222
- several interfaces are exposed by the VM:

- This VM was created using Vagrant.
  All related info will be shared via:
  https://github.com/sonata-nfv/son-tutorials

**son-editor (web gui)**

http://localhost:8080

installation instructions on: https://github.com/sonata-nfv/son-emu

**son-emu**

installation instructions on: https://github.com/sonata-nfv/son-emu

| | |
|---|---|
| http://localhost:5001/dashboard/index.html | dashboard |
| http://localhost:5000/restapi | rest api |
| http://localhost:8081 | cAdvisor |
| http://localhost:9091 | Prometheus Pushgateway |

**son-monitor**

installation instructions on: https://github.com/sonata-nfv/son-cli

| | |
|---|---|
| http://localhost:3000 | Grafana |
| http://localhost:9090 | Prometheus |

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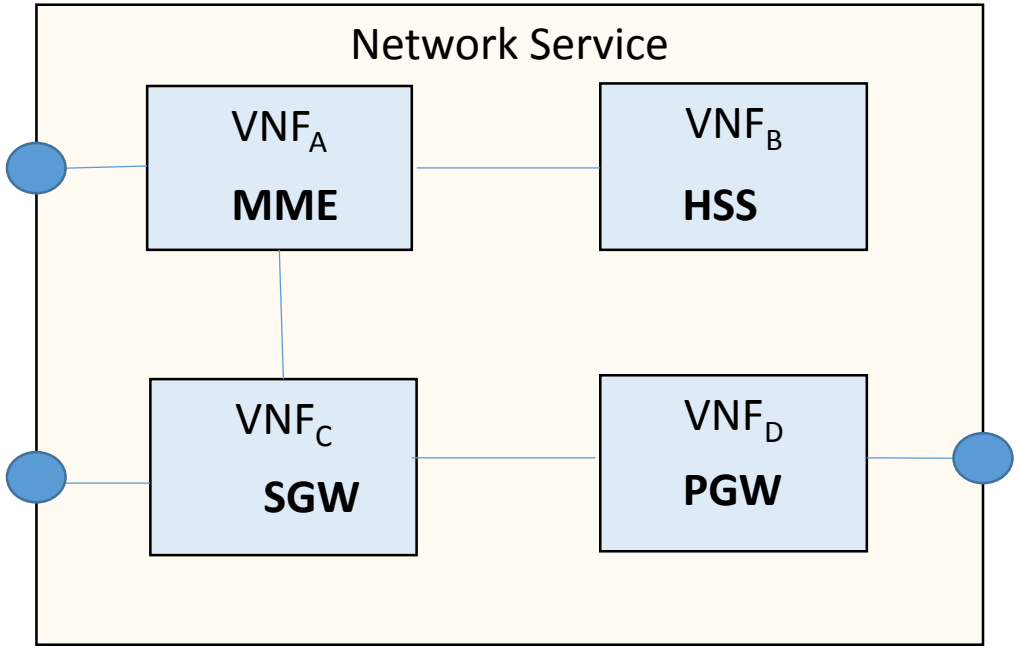
# Agenda

- SDK architecture
- **Building the Service Descriptor**
- Testing the service
- Deploy the service in production

# SONATA Descriptors




- A **Network Service** is specified in the Network Service Descriptor (NSD)

- A **Virtual Network Function** is described in a Virtual Network Service Descriptor (VNFD)

- The VNFD contains one or multiple **Virtual Deploymnent Unit** (VDU) templates that describe the Virtual Machines that run the virtual network function

The JSON format of the SONATA descriptors can be seen in the editor:
http://localhost:8080

The schema and yaml format can be found on our GitHub:
https://github.com/sonata-nfv/son-schema

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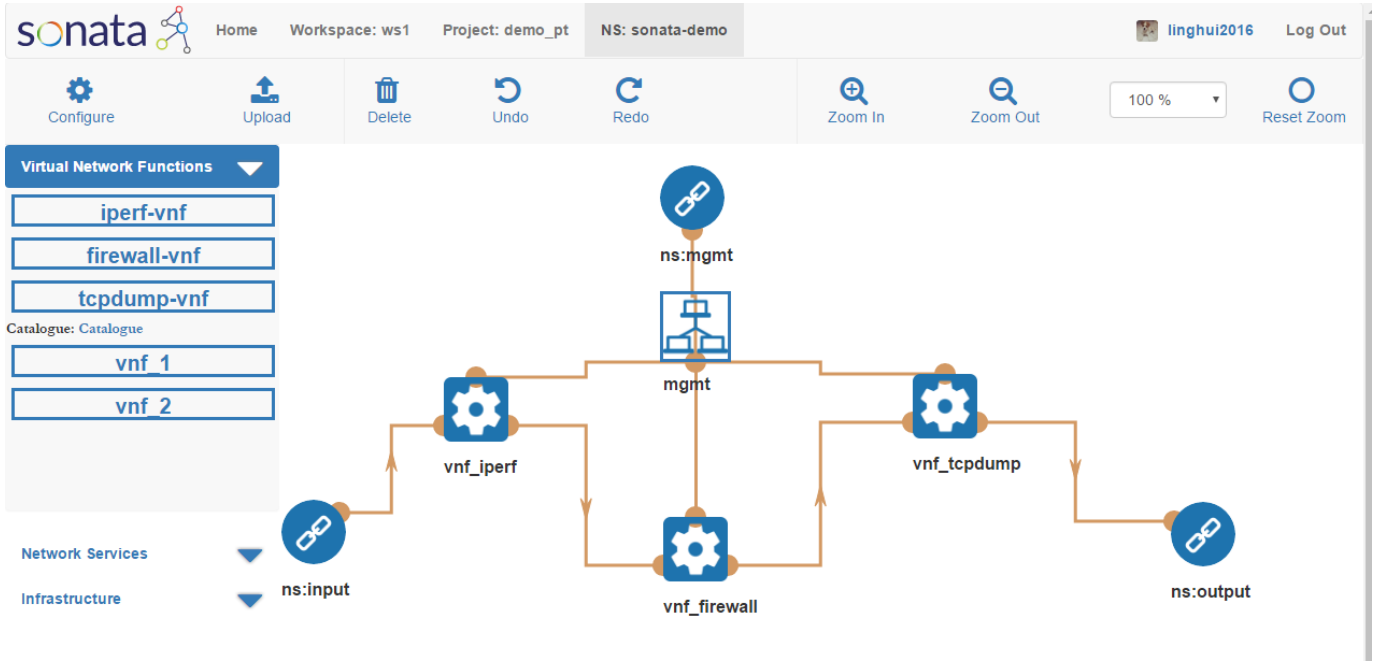
# SONATA Descriptors

Open the editor:
http://localhost:8080

you can login with SONATA demo github user:
*sonatademo*
*s0natademo*




**The editor allows to:**

- **create, edit descriptor files**
- **graphically check the descriptors**
- **upload the created service for deployment**

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# Agenda

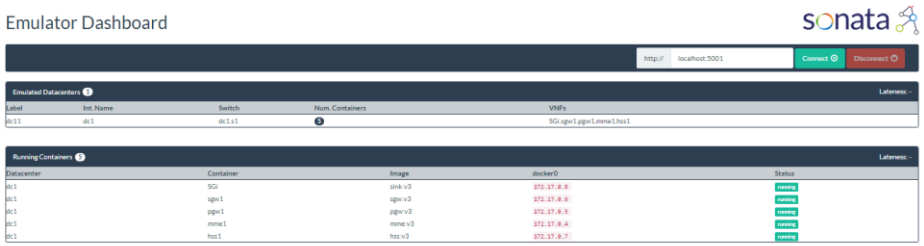
- SDK architecture
- Building the Service Descriptor
- **Testing the service**
- Deploy the service in production

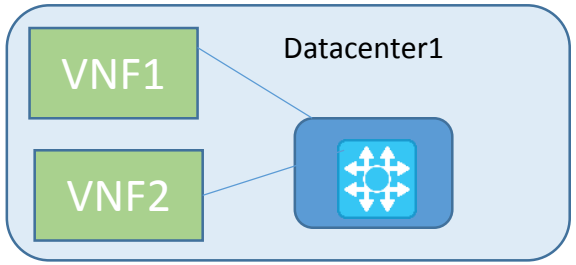
# SONATA SDK: service testing and debugging

start the emulator in ter,inal window:
ssh sonata@localhost –p2222
cd /home/ubuntu/son-emu
sudo python src/emuvim/examples/demo_topo_1pop.py
deploy a service from the editor

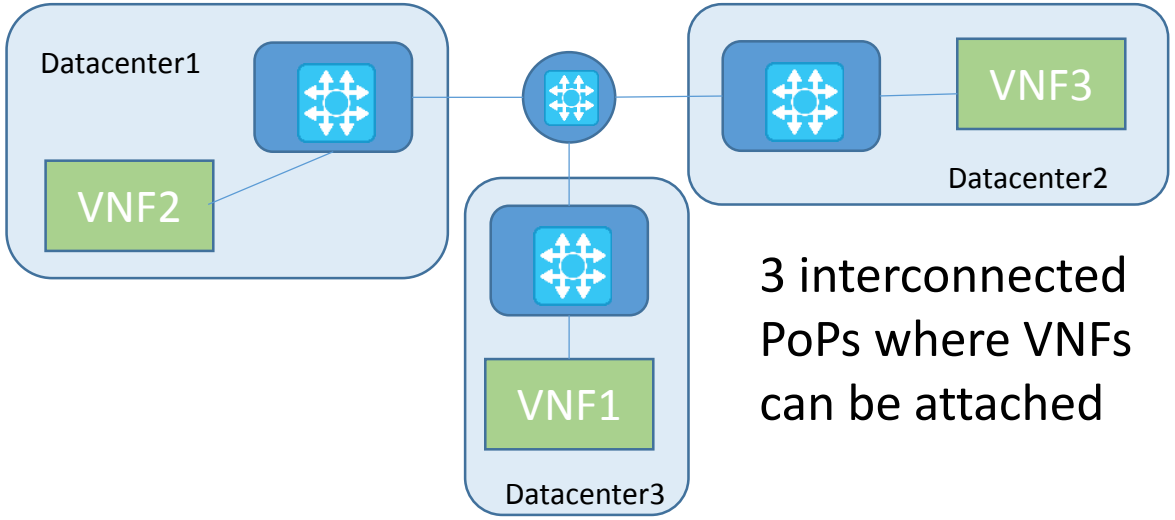
re-initialize the emulator with a new infrastructure topology
sudo python src/emuvim/examples/demo_topo_3pop.py
deploy a service from the editor

check the dashboard:
http://localhost:5001/dashboard/index.html




1 PoP where VNFs can be attached



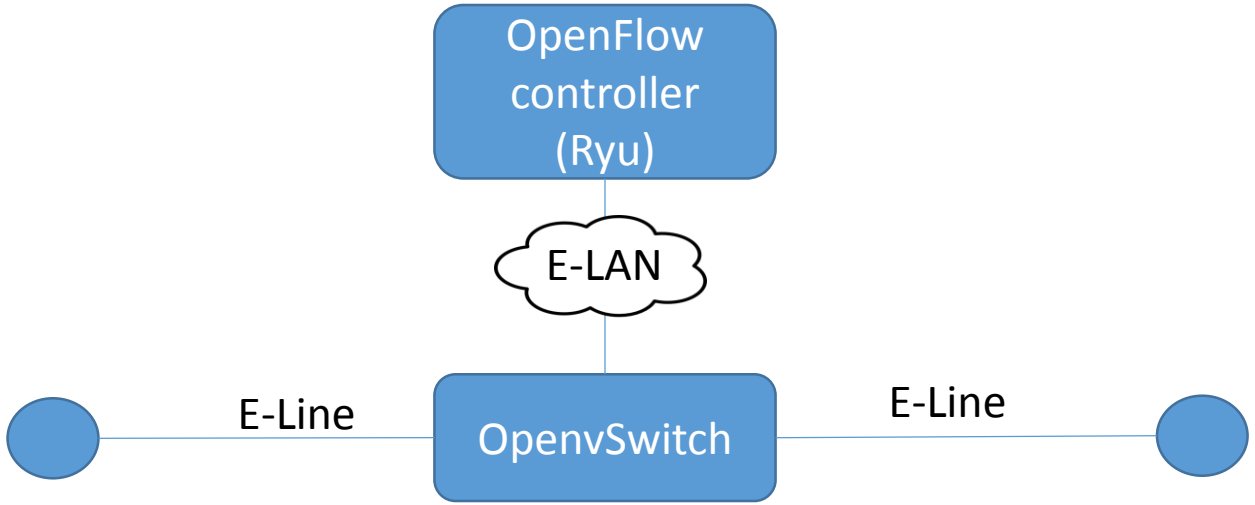

3 interconnected PoPs where VNFs can be attached

**The emulator allows to:**

- **emulate a custom defined infrastructure topology**
- **deploy a SONATA service descriptor**
- **placement can be customized**

# SONATA SDK: simple example

project: **sonata-ovs-user-service-project**
(coming from https://github.com/sonata-nfv/son-examples )




Verify if the controller is really connected to the ovs instance in this service?
check the ip of the controller
check in the ovs instance:

*ovs1 ovs-vsctl show*

*ovs1 ovs-vsctl set-controller 'ovs1' tcp:<ip of controller>:6633*

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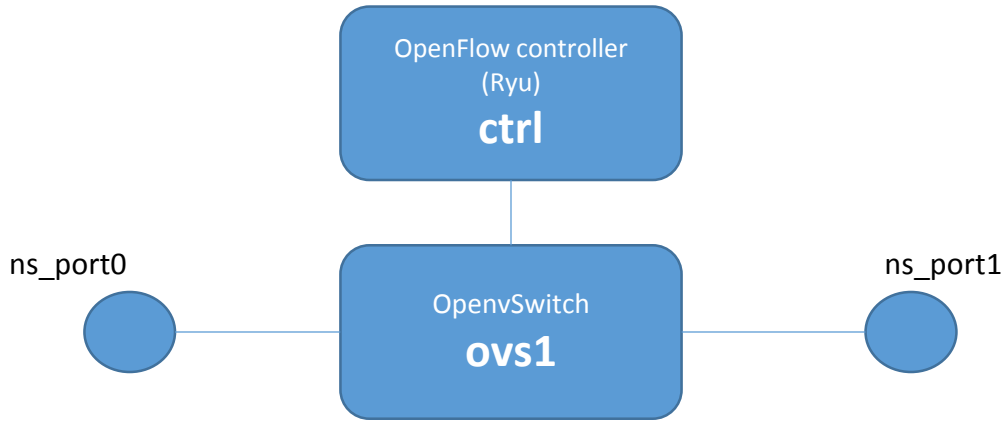
# SONATA SDK: simple example

project: **sonata-ovs-user-service-project**
(coming from https://github.com/sonata-nfv/son-examples )



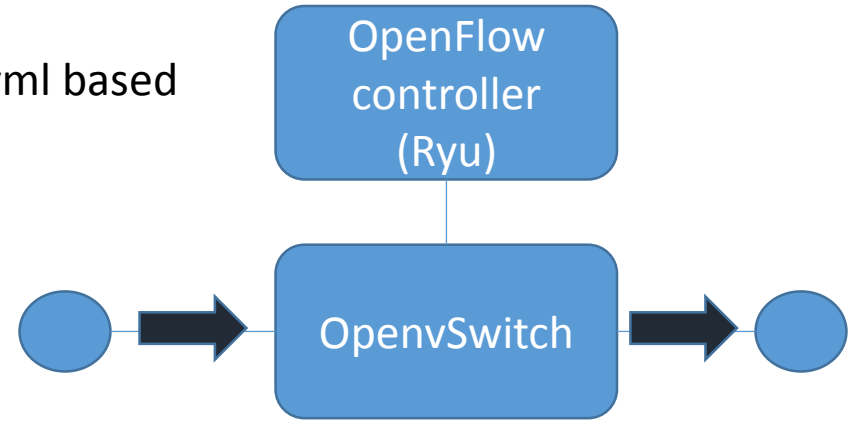

Test with generated traffic and monitor:
cd /home/ubuntu/son-examples/service-projects/sonata-ovs-user-service-emu/
nano msd.yml
son-monitor msd -f msd.yml

# SONATA SDK: service testing and debugging

Test scripts should be provided by the developer to test the service, eg. create traffic.
Each of the service's endpoints can be made available to external scripts.
A Service Access Point (SAP) in the emulator can be:

- A Docker container itself that does the traffic generation/ananlysis and is chained to the service
- A virtual interface on the host where traffic can be sent to and that is then chained to the service

During the testing a set of metrics to be monitored can be defined in a .yml based descriptor file (msd.yml)
These metrics are exported and visualized in Grafana (*admin,admin*)




Test scripts and monitoring can also be combined and automated using a profile tool in the SONATA SDK

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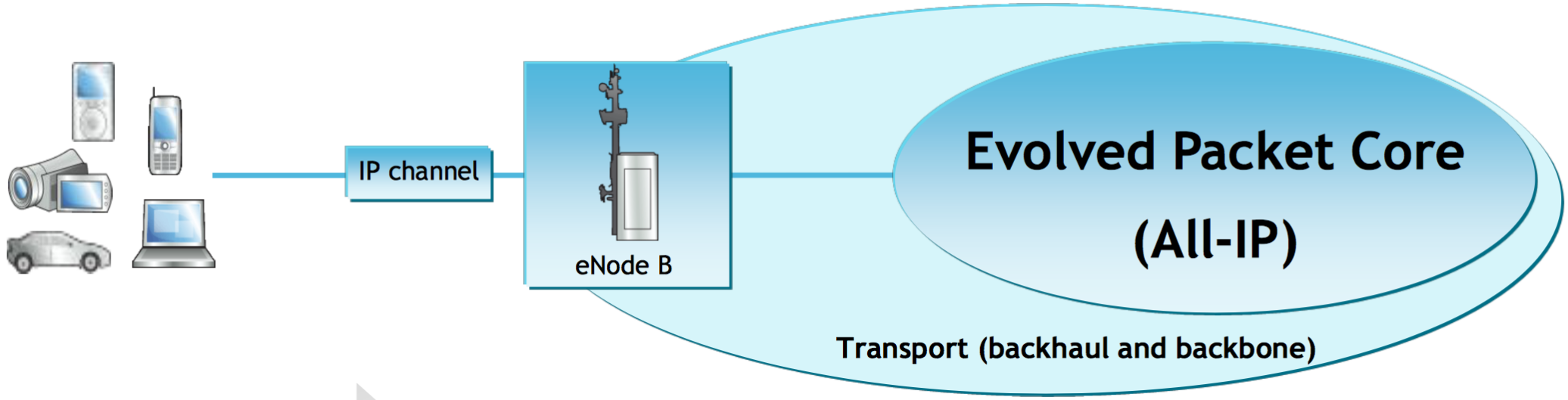
# Evolved Packet Core (EPC)




- What is EPC?
  - end-to-end IP network functionality in the network
  - necessary for enabling connectivity of mobile devices since LTE (4G) in moving conditions, with other mobile devices and with the external network
  - functionality: mobility management (MME), gateways to other networks (S/PGW), maintaining subscriber/user data (HSS)

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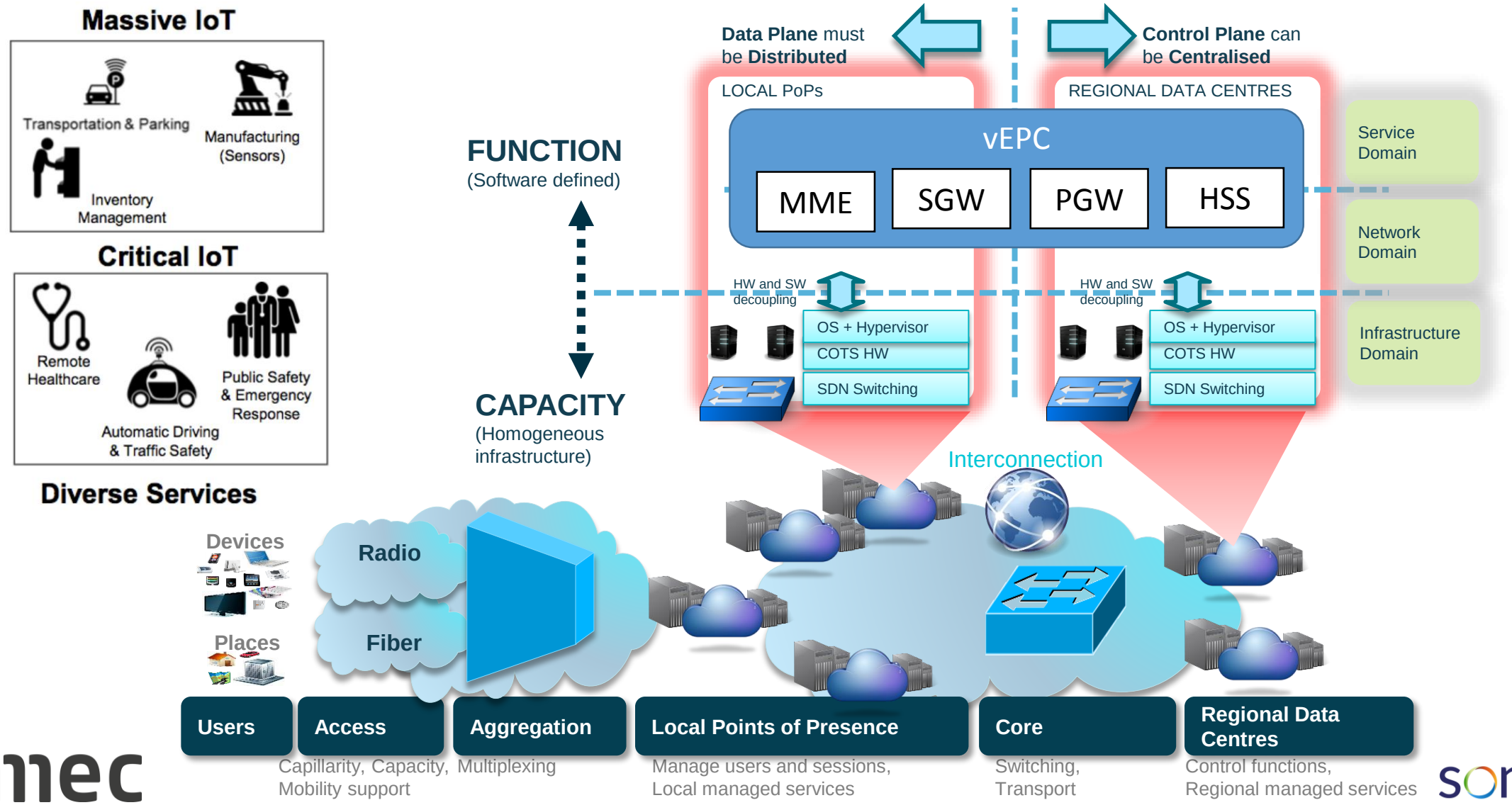
# EPC using SDN/NFV for 5G services

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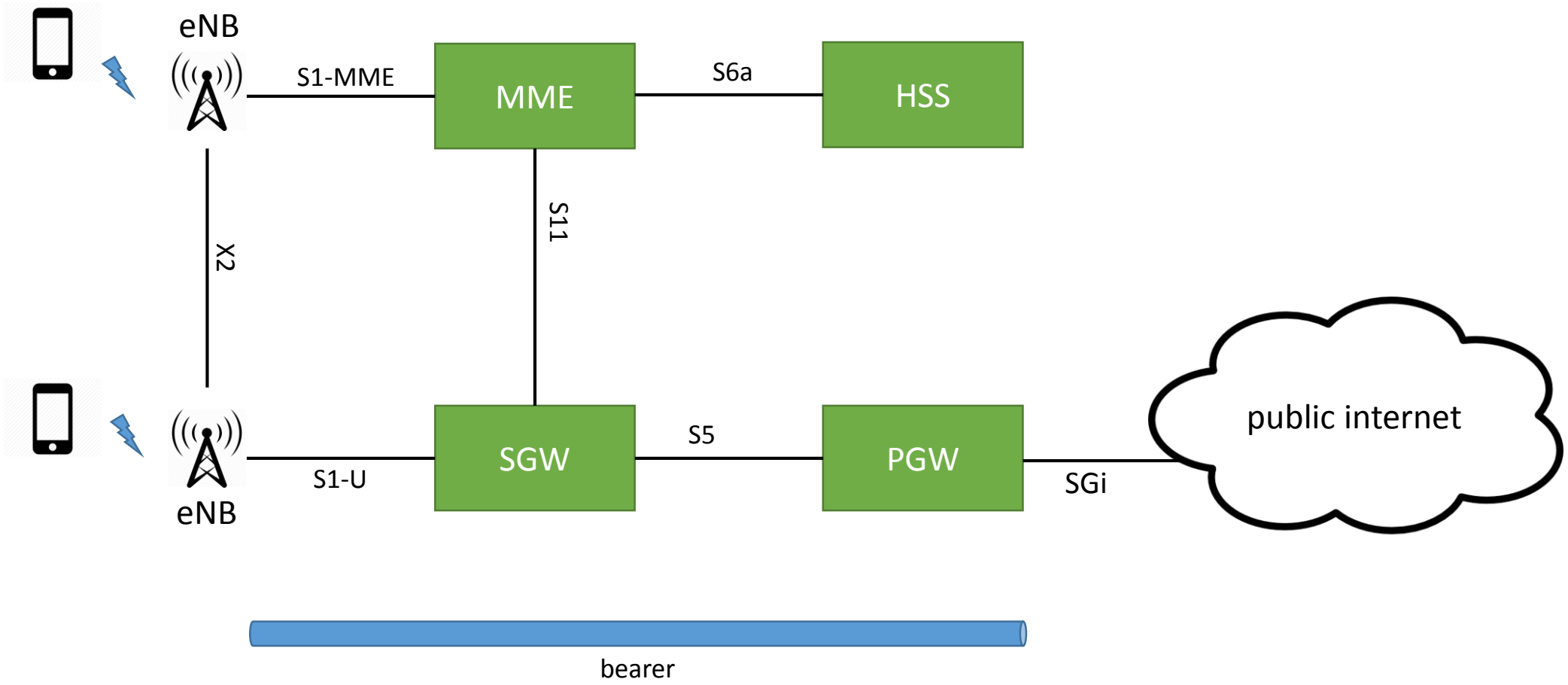
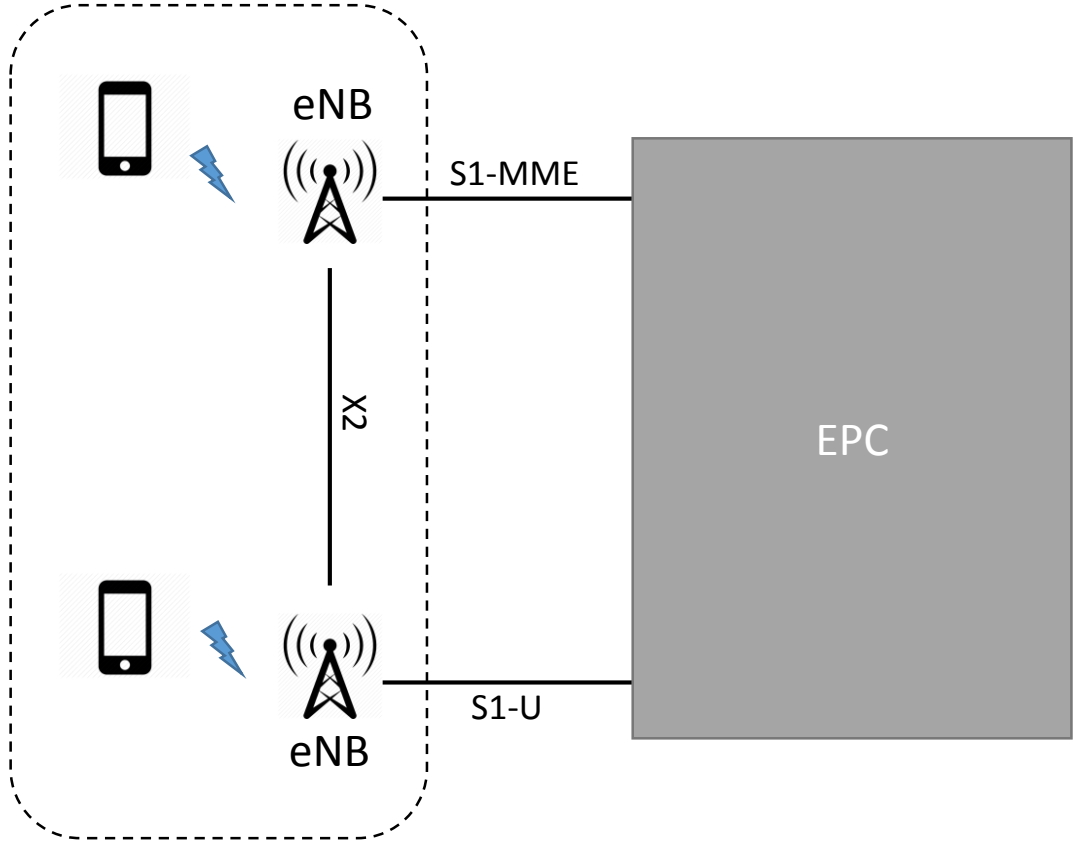
# vEPC service - Overview



# Radio Access Network (RAN)

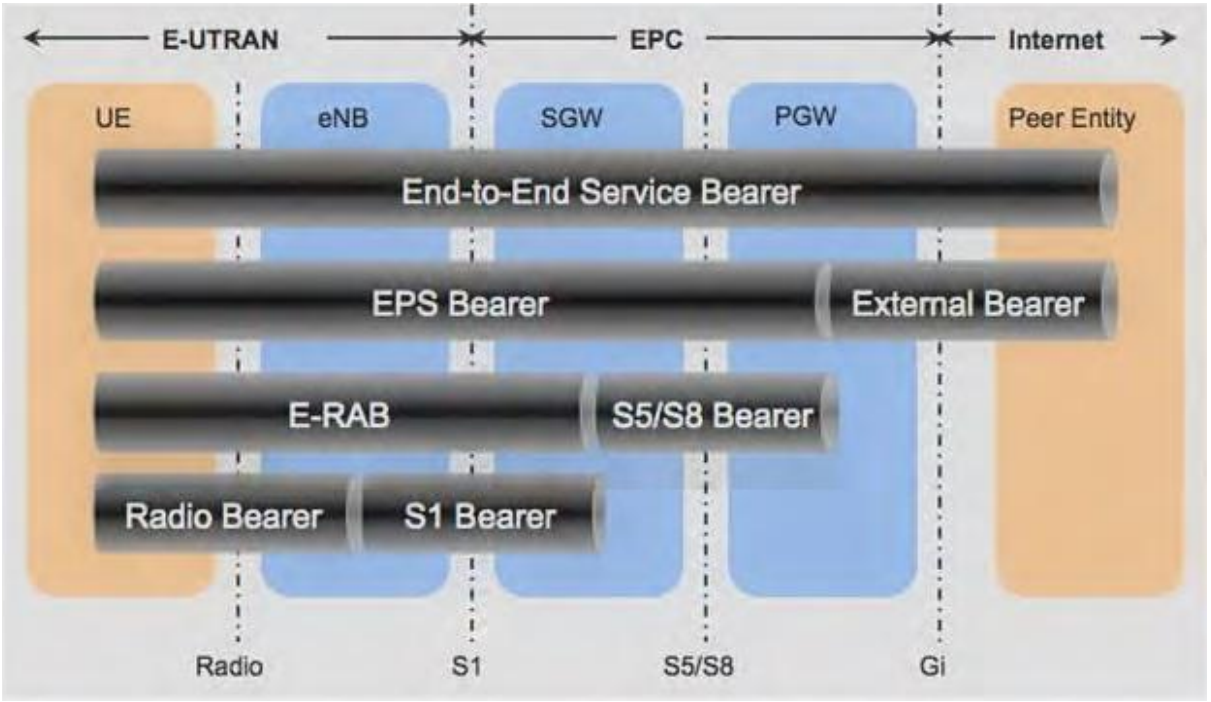



Radio Access Network

- eNodeB (eNB) = mobile tower/antenna infrastructure, with main functionalities:
  - radio resource management
  - compression/encryption to UE
  - routing to S-GW
- User Equipment (e.g. mobile phone)
  - Mobile Termination

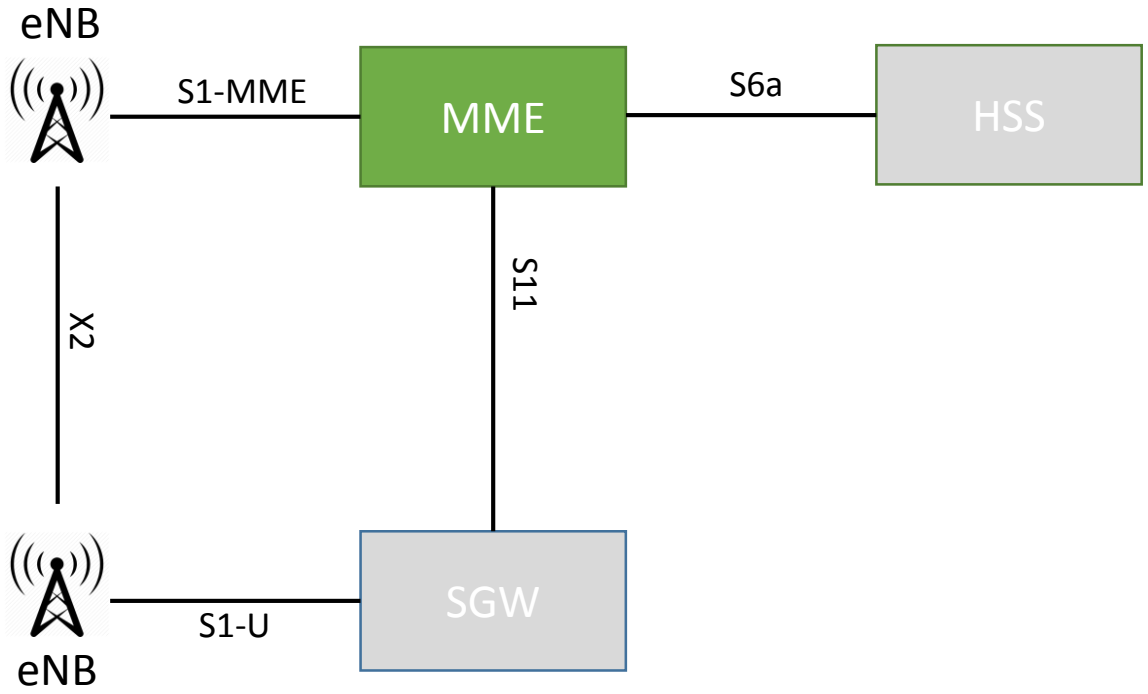
# vEPC - Bearer

- virtual concept for a tunnel classifying UE traffic across the network
- focus on EPS bearer = connection within EPC
- sub-bearers:
  - radio bearer
  - S1 bearer
  - S5/S8 bearer



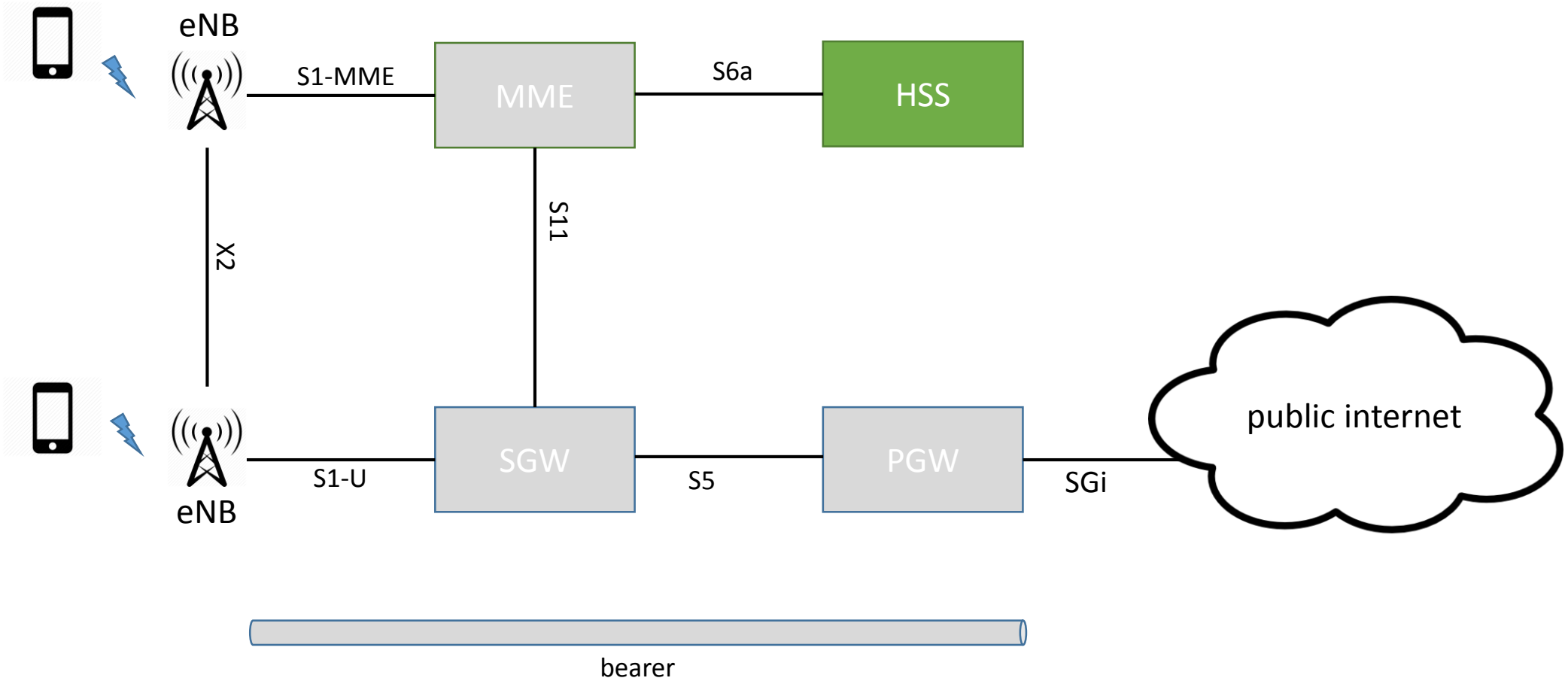
# vEPC– Mobility Management Entity (MME)

- Handles all control signal operations
- Maintains connection to eNodeBs through S1AP interface, HSS through S6 interface and serving GW through S11 interface as per 3GPP standards.



# vEPC – Home Subscriber Server (HSS)

- database for UE (User Entity) authentication information

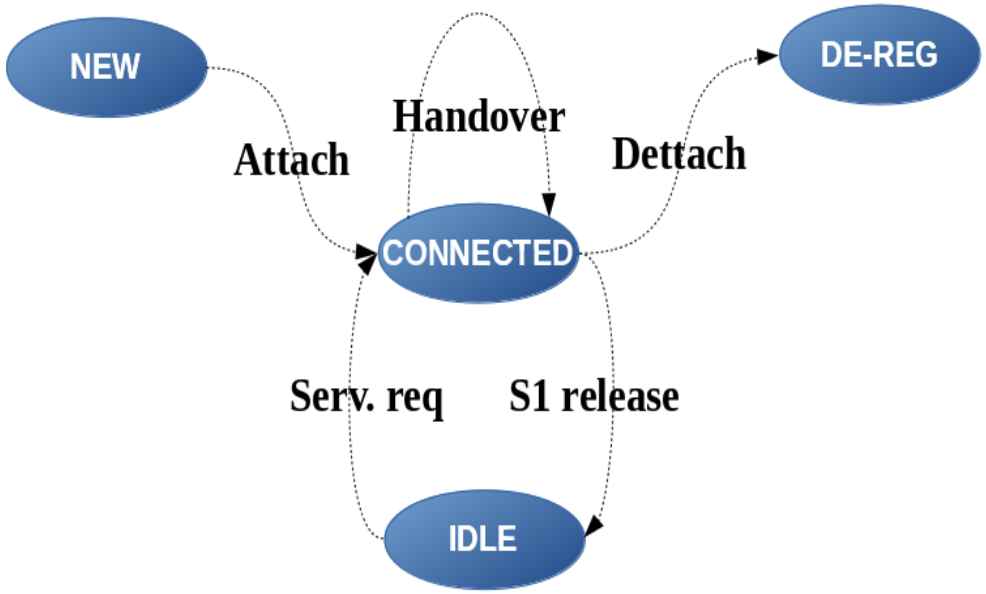


# vEPC – Serving GW (S-GW) & Packet Data GW (P-GW)

- S-GW
  - routes and forwards user data packets
  - the mobility anchor for the user plane during inter-eNodeB handovers
  - For idle state UEs, the SGW terminates the downlink data path and triggers paging when downlink data arrives for the UE.
  - manages and stores UE contexts, e.g. parameters of the IP bearer service

- P-GW
  - provides connectivity from the UE to external packet data networks by being the point of exit and entry of traffic for the UE
  - performs policy enforcement, packet filtering for each user, charging support, lawful interception and packet screening

# Main procedures




- **(re-)attach:** when Idle UE powers on or wants send traffic
  1. authentication via MME
  2. session setup with S-GW
  3. bearer setup
- **Tracking Area Update**: periodic location update from UE to MME
- **Paging**: waking up Idle UE when data needs to be delivered
- **Handover**: teardown change connection of UE with eNodeB to other eNodeB
- **Detach**: tear down of bearer

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# Using the SDK for developing an&d deploying a vEPC

- https://github.com/networkedsystemsIITB/NFV_LTE_EPC

- **Authors**
  - Sadagopan N S, Master's student (2014-2016), Dept. of Computer Science and Engineering, IIT Bombay.
  - Prof. Mythili Vutukuru, Dept. of Computer Science and Engineering, IIT Bombay.

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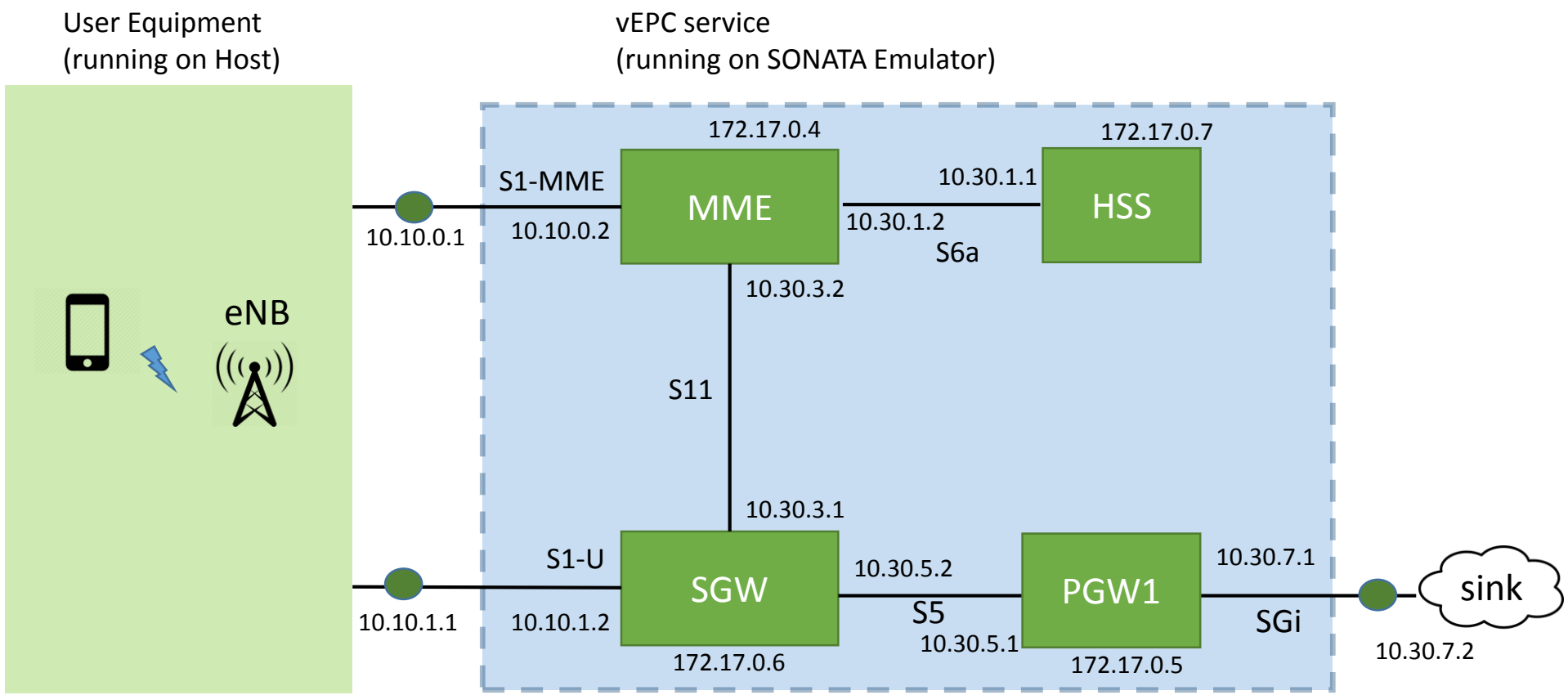
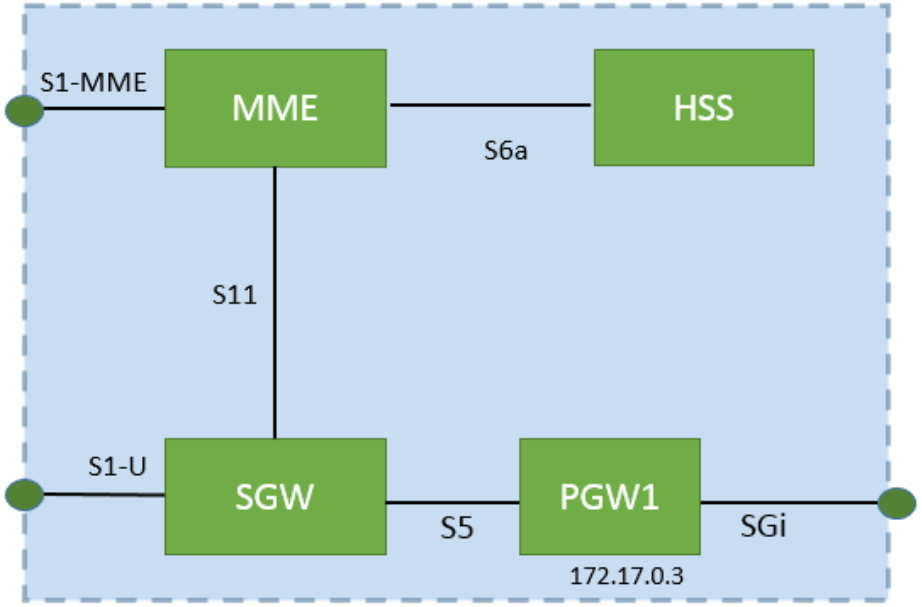
# SONATA SDK: the vEPC service

Upload from the Editor:

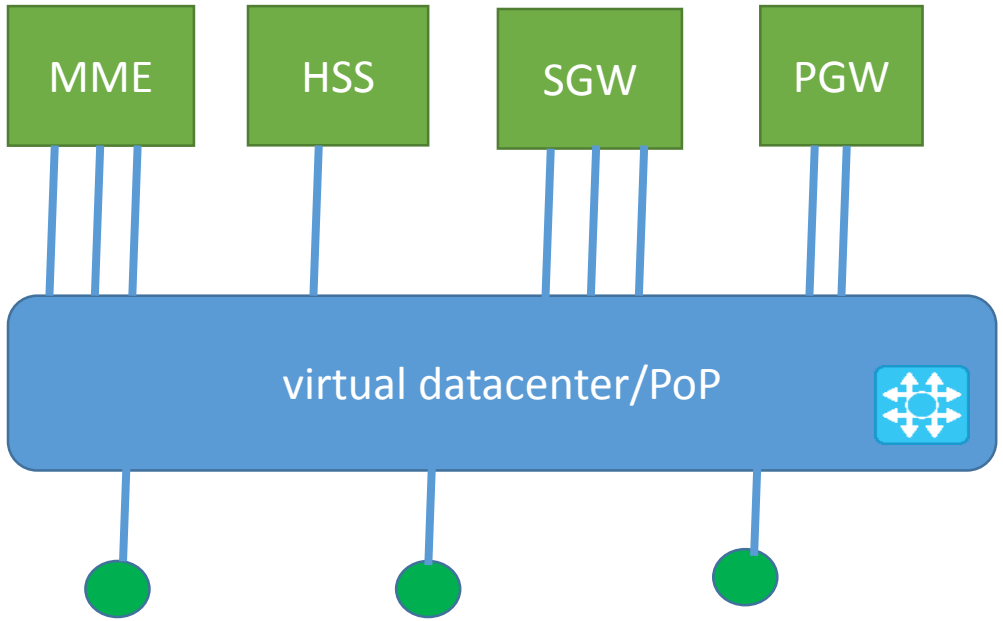


# SONATA SDK: service testing and debugging

The deployed service is configured like this:




Mapped to the infrastructure that is emulated:




refresh the dashboard:
http://localhost:5001/dashboard/index.html

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# SONATA SDK: service testing and debugging

upload the service from the editor
or
via the terminal:
cd /home/ubuntu/son-epc/SOFTNETWORKING_vEPC/vepc-descriptor
son-access -p emu push --upload vepc.son

The service is now deployed and ready to test.

**What has happened:**

- **the uploaded service descriptor is parsed by the emulator**
- **The VNFs are assumed to be available as Docker containers (check docker ps…)**
- **The VNFs get the number of interfaces as defined in their descriptors, and get an IP address**
- **The VNFs are chained together as defined in the service descriptor**

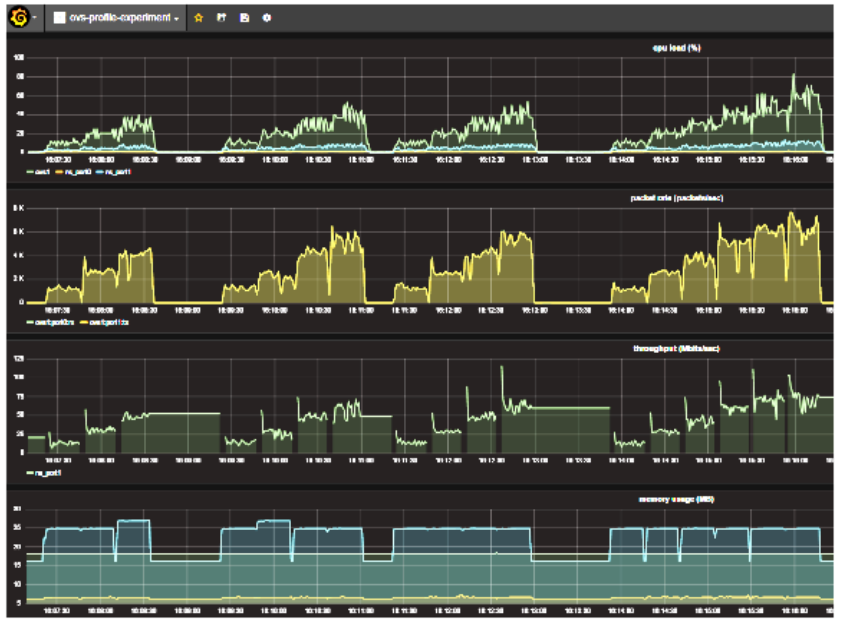
# SONATA SDK: service testing and debugging

Test scripts and monitoring can be combined and automated using a profile tool in the SONATA SDK

cd /home/ubuntu/son-epc/SOFTNETWORKING_vEPC/vepc-descriptor

emulate control traffic (user devices re-attaching to the vEPC):
son-profile -c ped_ctrl.yml --no-generation  --no-display

emulate data traffic (users sending data):
son-profile -c ped_data.yml --no-generation  --no-display



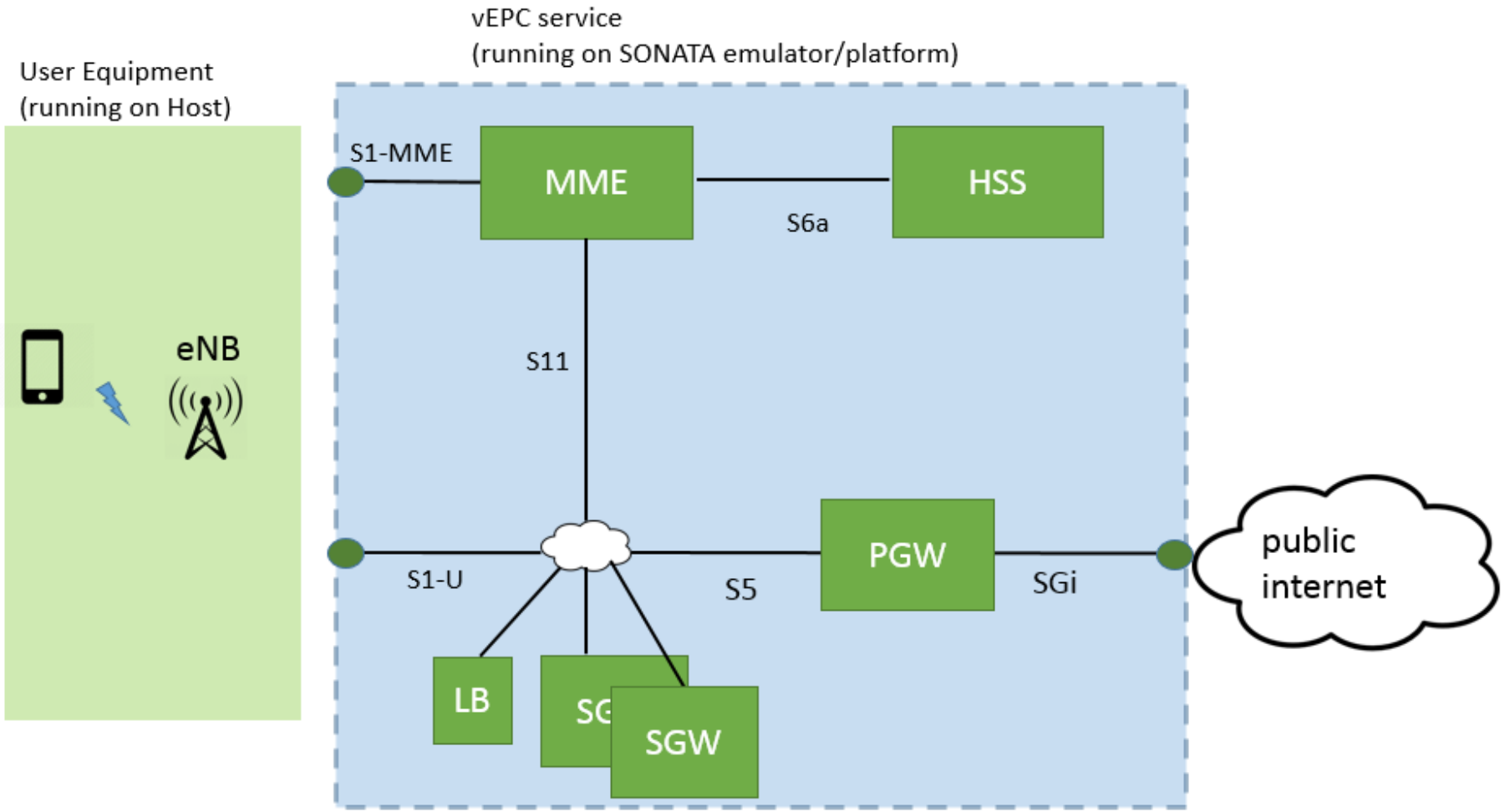
**The monitor and profiling tools allow to:**

- **automate the configuration of different traffic types/rates**
- **monitor a set of customizable metrics**
- **modify allocated resources (cpu/mem) to the VNFs**

# SONATA SDK: next steps for the vEPC service

The profiled performance of the VNFs in service allows a better resource and capacity planning.

-> optimized scaling in function of the loaded VNF

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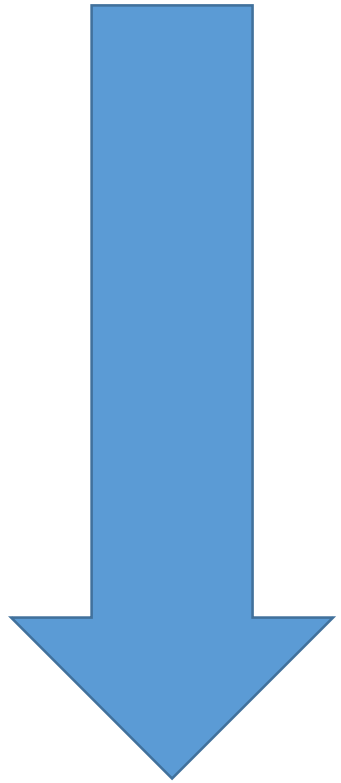
# Wrap-up

- SDK architecture
  - modular approach, different tools
- Building the Service Descriptor
  - visual editing and debugging using an editor
- Testing the service
  - deploy on multi-pop emulated, custom infrastructure
  - check and edit the configuration of the VNFs
  - install custom metrics to be monitored
  - generate test traffic
  - automate monitoring and testing

  to generate a performance profile

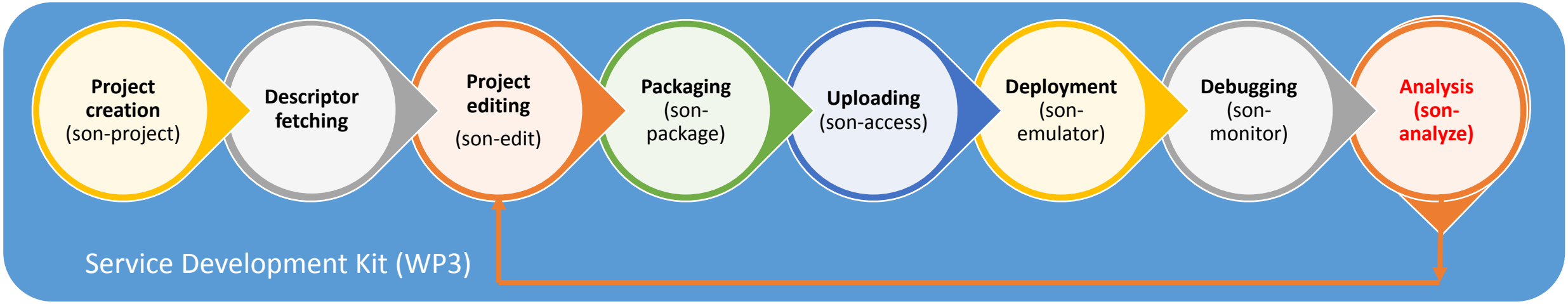


**Deploy the service in production!**

# SONATA SDK: deploy the service to the SP

- The service developer has used the SONATA SDK to verify and debug the service:

**A sandbox environment with different tools to try, test, debug NFV-based services**




→A final package of the service can be generated and pushed to the Service Platform in production!

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# Technologies used











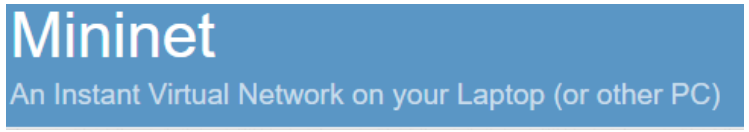



# Where to find SONATA

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**Service Programming and Orchestration for Virtualized Software Networks**

**The used software is open-source:**

- Developed in the European SONATA research project
- Available on GitHub

**https://github.com/sonata-nfv**

Part of 5G-PPP initiative:

**HORIZON 2020:**
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 671517.

@sonataNFV

**www.sonata-nfv.eu**

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