Latency-aware and self-Adaptive Service cHaining in reliable 5G/SDN/NFV infrastructures (LASH-5G)

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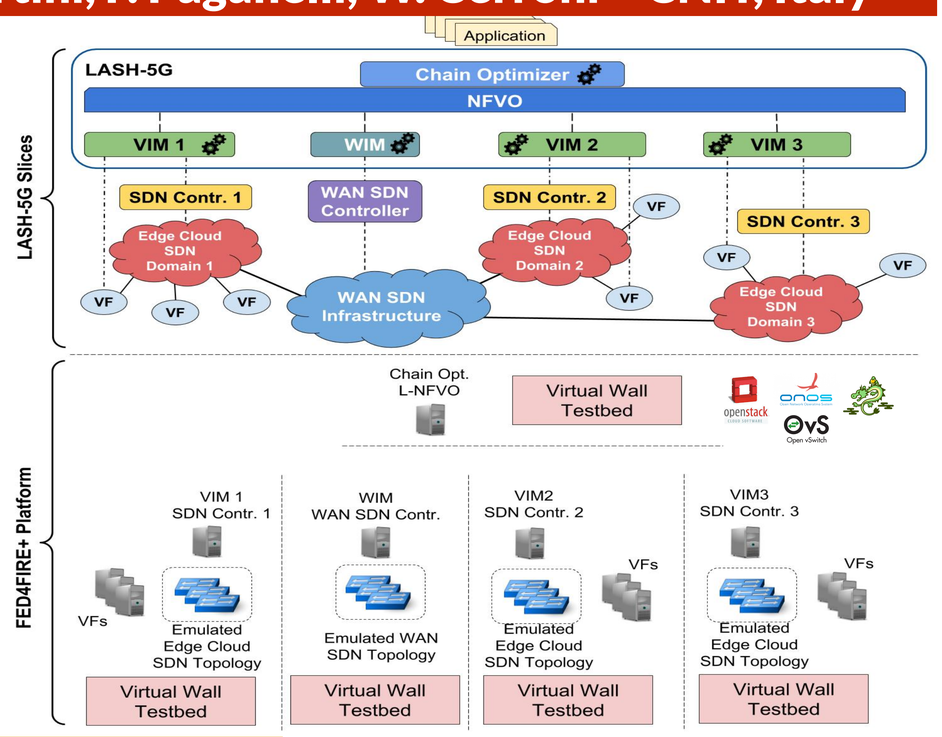
Fig. 16: SDN domain before service deployment

SCENARIO, CHALLENGES AND GOALS

Scenario: advent of SDN, NFV and the comprehensive 5G context: applications delivered as chains of application and network services deployed as virtual functions (VFs) in micro-clouds distributed at the Edge of the network.

Challenges: coping with (*i*) stringent end-to-end latency requirements (*ii*) adaptive service chains and allocation of resources (*iii*) multi-technology resource domains and capabilities, due to (*a*) high dynamicity of 5G services (*b*) geographical distribution of VFs and (*c*) heterogeneous network and cloud infrastructures.

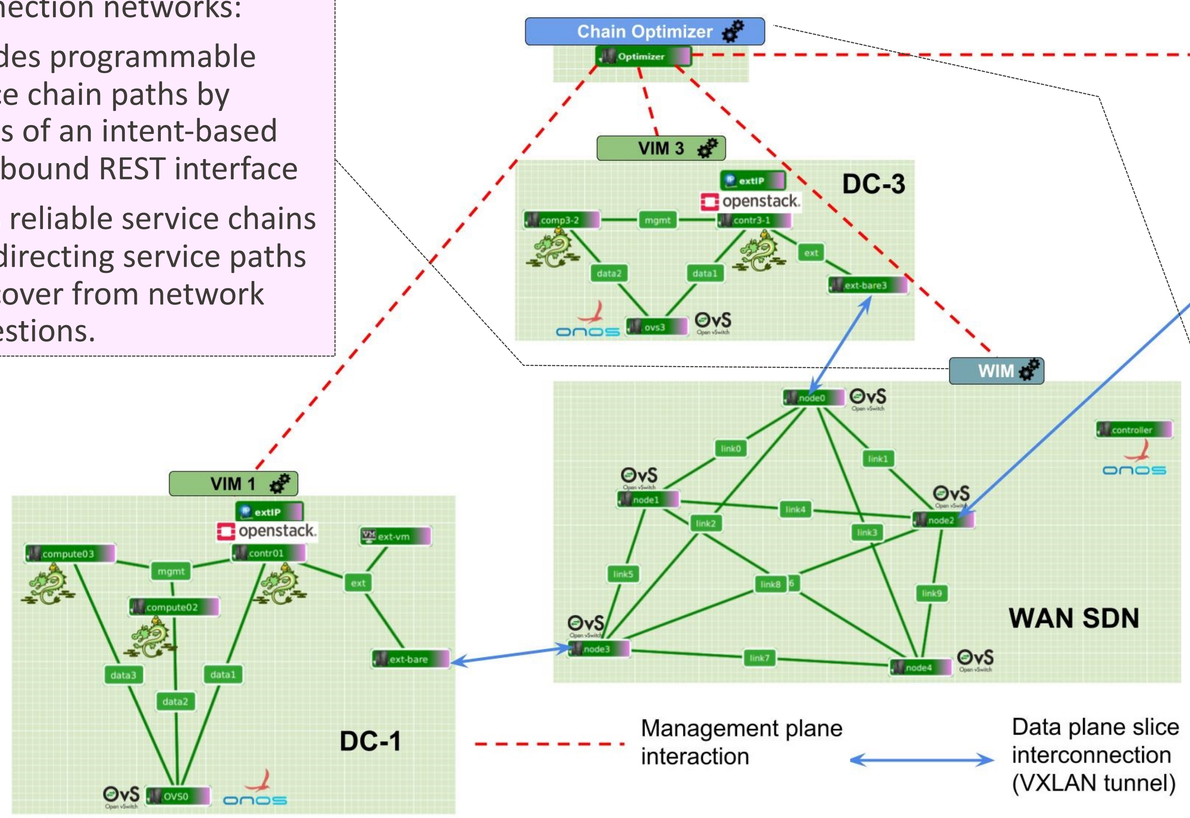
Goals: evaluate an enhanced service chaining mechanism toward end-to-end orchestration of resources over geographically distributed SDN-based Edge clouds (*i*) encompassing the following orchestration levels: end-do-end service orchestration – intra-DC orchestration – inter-DC WAN orchestration) (*ii*) aiming at addressing latency, adaptability and availability requirements of 5G applications.



SYSTEM COMPONENTS AND DEMO SETUP

WIM Orchestrator for SDN interconnection networks:

- provides programmable service chain paths by means of an intent-based northbound REST interface
- offers reliable service chains by redirecting service paths to recover from network congestions.



Enhanced VIM for SDN-based Edge cloud domains:

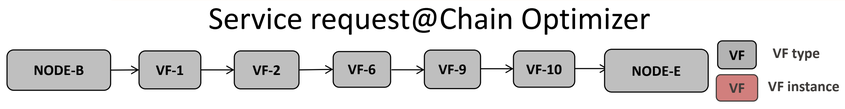
- exposes an intent-based northbound REST interface to specify service chains by means of a technology-agnostic descriptive syntax.
- dynamically adapts established service chains according to the current service context (e.g., user demands, operator needs).

Chain Optimizer handles service function chaining requests by:

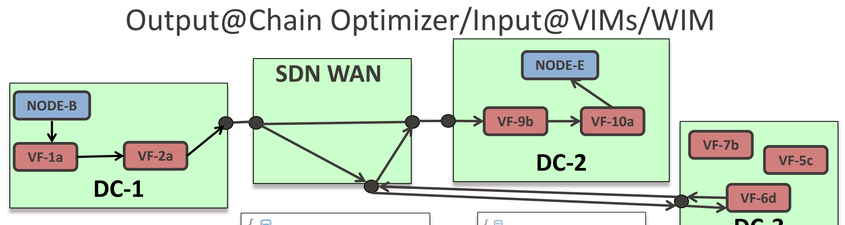
- maintaining an abstract view of the underlying resources and their status leveraging infrastructure monitoring information
- invoking an optimization algorithm to select VF instances from different clouds over the path that minimizes the end-to-end latency (i.e., network latency + processing latency)
- Orchestrating WIM/VIMs through intent-based northbound REST interfaces to enforce the traffic steering path along the selected VFs.

RESULTS

Service request@Chain Optimizer



Output@Chain Optimizer/Input@VIMs/WIM




```
{
  "src":"Node-B.dc1",
  "dst":"Node-E.dc2",
  "serviceType":"Type5",
  "maxLatency":300,
  "vnf":[
    {
      "name":"VF-1",
      "port_sym":false,
      "terminal":false,
      "path_syn":false
    },
    {
      "name":"VF-2",
      "port_sym":false,
      "terminal":false,
      "path_syn":false
    }
  ],
  "dup":[
  ]
}
```

```
{
  "src":"Node-B.dc1",
  "dst":"Node-E.dc2",
  "serviceType":"Type5",
  "maxLatency":300,
  "DC":[
    {
      "name":"dc1"
    },
    {
      "nam ":"dc3"
    }
  ]
}
```

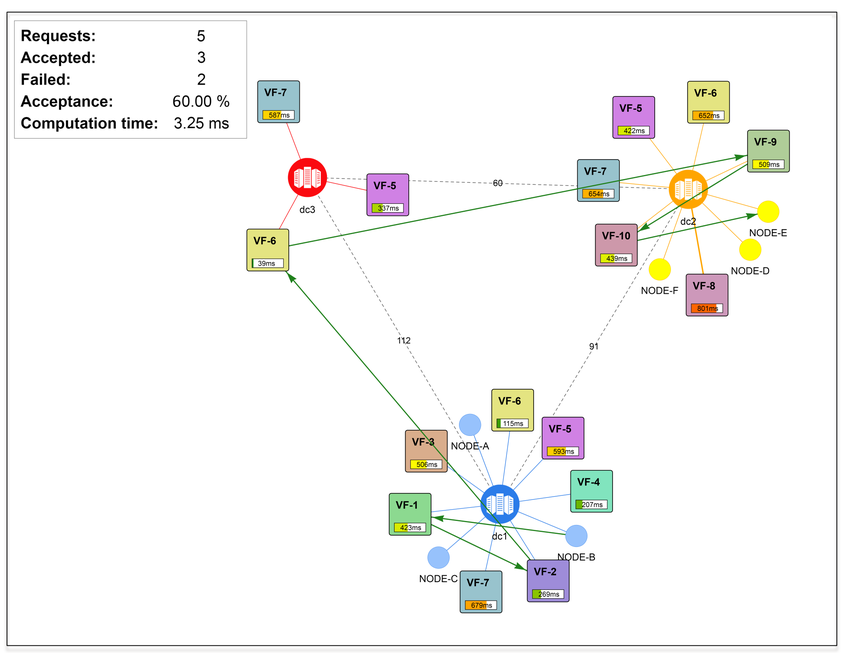
```
{
  "src":"Node-B.dc1",
  "dst":"Node-E.dc2",
  "serviceType":"Type5",
  "maxLatency":300,
  "vnf":[
    {
      "name":"VF-9",
      "port_sym":false,
      "terminal":false,
      "path_syn":false
    },
    {
      "name":"VF-10",
      "port_sym":false,
      "terminal":false,
      "path_syn":false
    }
  ],
  "dup":[
  ]
}
```

```
{
  "src":"Node-B.dc1",
  "dst":"Node-E.dc2",
  "serviceType":"Type5",
  "maxLatency":300,
  "vnf":[
    {
      "name":"VF-6",
      "port_sym":false,
      "terminal":false,
      "path_syn":false
    }
  ],
  "dup":[
  ]
}
```

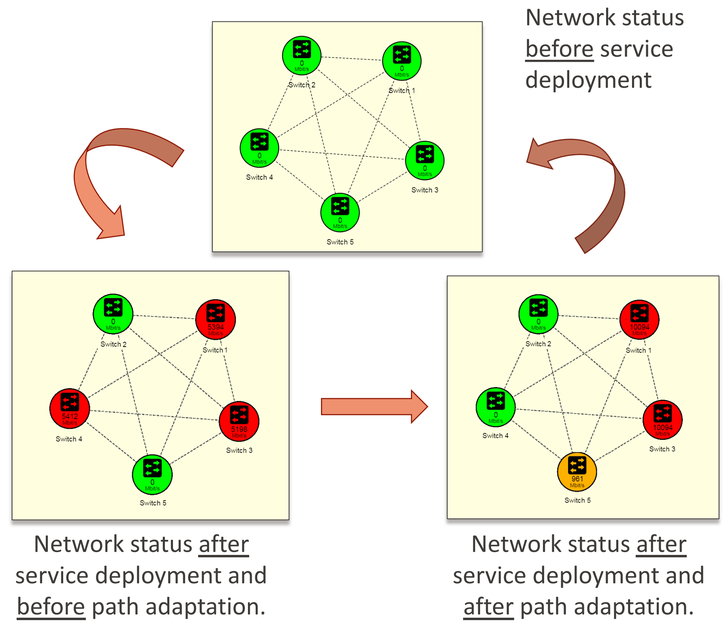

Each JSON specification describes the (piece of) chain to be implemented in each domain. Names define both nodes involved and properties:

→ `port_sym`: whether or not VNF entry/exit point order matters
→ `path_sym`: whether or not VNF is included in the backward path
→ `terminal`: whether or not VNF forwards traffic

Topology View @Chain Optimizer



SDN Network Topology View @WIM



CONCLUSIONS

LASH-5G can generate an industrial impact by fostering an adaptive 5G service ecosystem where the quality of experience to users is pursued through optimal service instance (i.e., VF) selections and context-aware adaptations.

We reproduced a typical 5G service infrastructure composed of distributed set of services deployed in micro-clouds as VFs running at the network Edge and interconnected via SDN.

We proved that our latency-aware orchestration system for end-to-end service chaining can be deployed and operated in a 5G/SDN/NFV environments.

We could obtain a significant system evaluation through massive experimentation on service chains set-up, deletion and adaptation thanks to a large set of resources and facilities Fed4Fire platform offers.

POST MORTEM

Relevant scientific benefits to CNIT in terms of (*i*) significant research outputs to disseminate, (*ii*) hand-on practice on SDN/NFV software platforms (OpenStack, ONOS, Ryu), (*iii*) increased collaborations and cross-fertilization of ideas and background across CNIT Research Units.

Further development of vendor-independent and intent-based northbound interface offered to service and resource orchestration functions.

Extension of service orchestration functionalities to include complete service chain lifecycle management and SLA and policy management support.

Study of possible integrations with ETSI MANO and ETSI MEC platform services, leveraging LASH-5G end-to-end service orchestration, multi-domain and adaptation capabilities.