Edge Cloud Experience Sharing

China Mobile NovoNet Experiment Network

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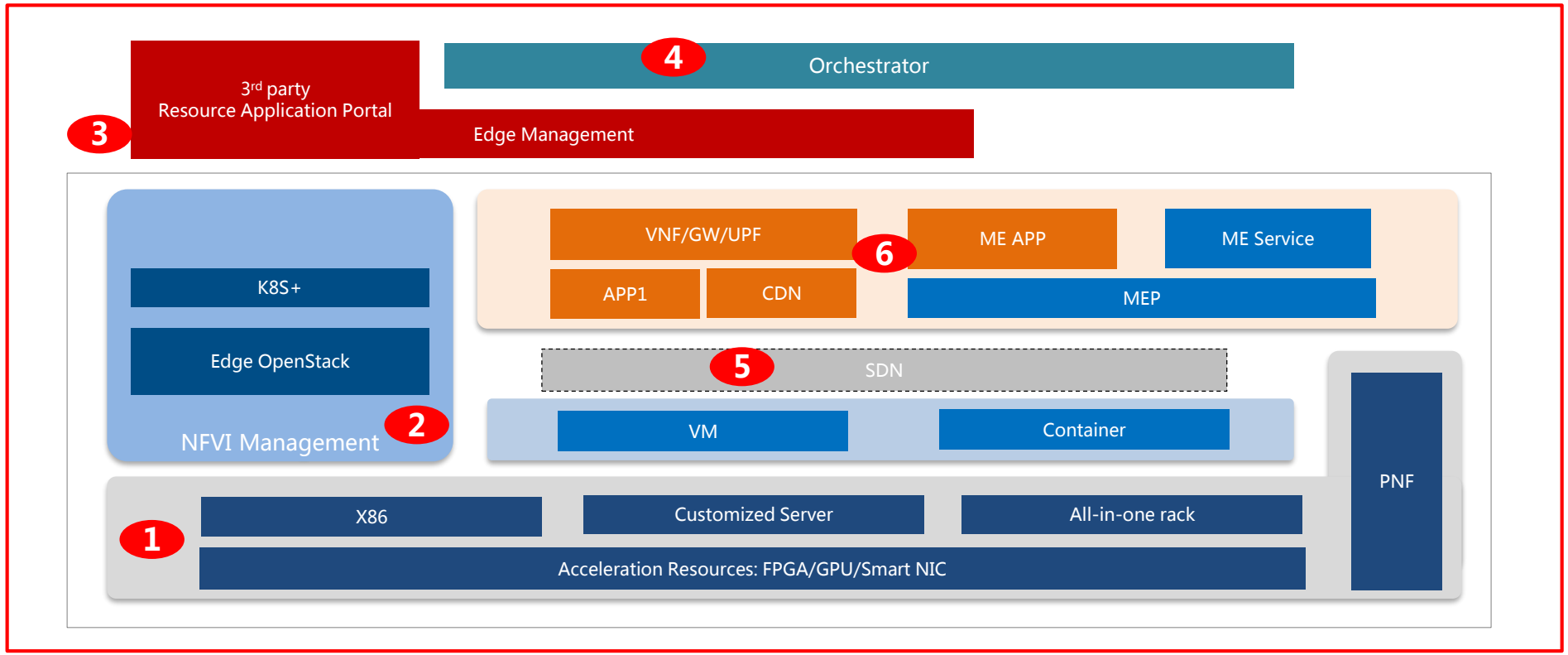
What should Telco Operators care to build large-scale edge cloud?

Technical Points We Care



1 Diverse Hardware
- ✓ x86
- ✓ Customized Server
- ✓ All-in-one rack
- ✓ PNF
- ✓ Acceleration hardware

2 Heterogeneous Cloud Platform
- ✓ Container+K8S
- ✓ VM+OpenStack
- ✓ Container in VM

3 Centralized O&M and Resource Providing
- ✓ Centralized O&M for distributed edge resource (HW & SW)
- ✓ Resource application portal for 3rd-party applications

4 Orchestration
- ✓ Simplified orchestration for IT App if needed
- ✓ Orchestration and cooperation of IT App and telco network ability

5 SDN
- ✓ SDN for edge

6 Service and MEC
- ✓ Provide MEC ability for edge Applications
- ✓ Provide ability of 5G wireless and core network
- ✓ Cooperation between IT and CT services

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China Mobile NovoNet Experiment Network

- **Targeting on future network structure validation**
- **Promote experiment in 4 thread: Integration, Testing, Key Feature Review, Industrial & Open Source Eco-system construction**

Testing

- Structure: NFV, edge cloud, unified orchestration and etc.
- Service: maturity of service under decoupled NFV structure, cooperation of ICT services on edge
- Key tech: SDN, acceleration and etc.

Integration

- Integrated hardware, virtualized software, SDN and orchestrator from multiple vendors
- Figure out potential problems during integration
- First hand experience for future network operation

Industrial & Open Source Eco-system

- Flexible network to combine ICT eco-system
- Promoting optimization and complement of open source product including ONAP, OpenStack, and etc.

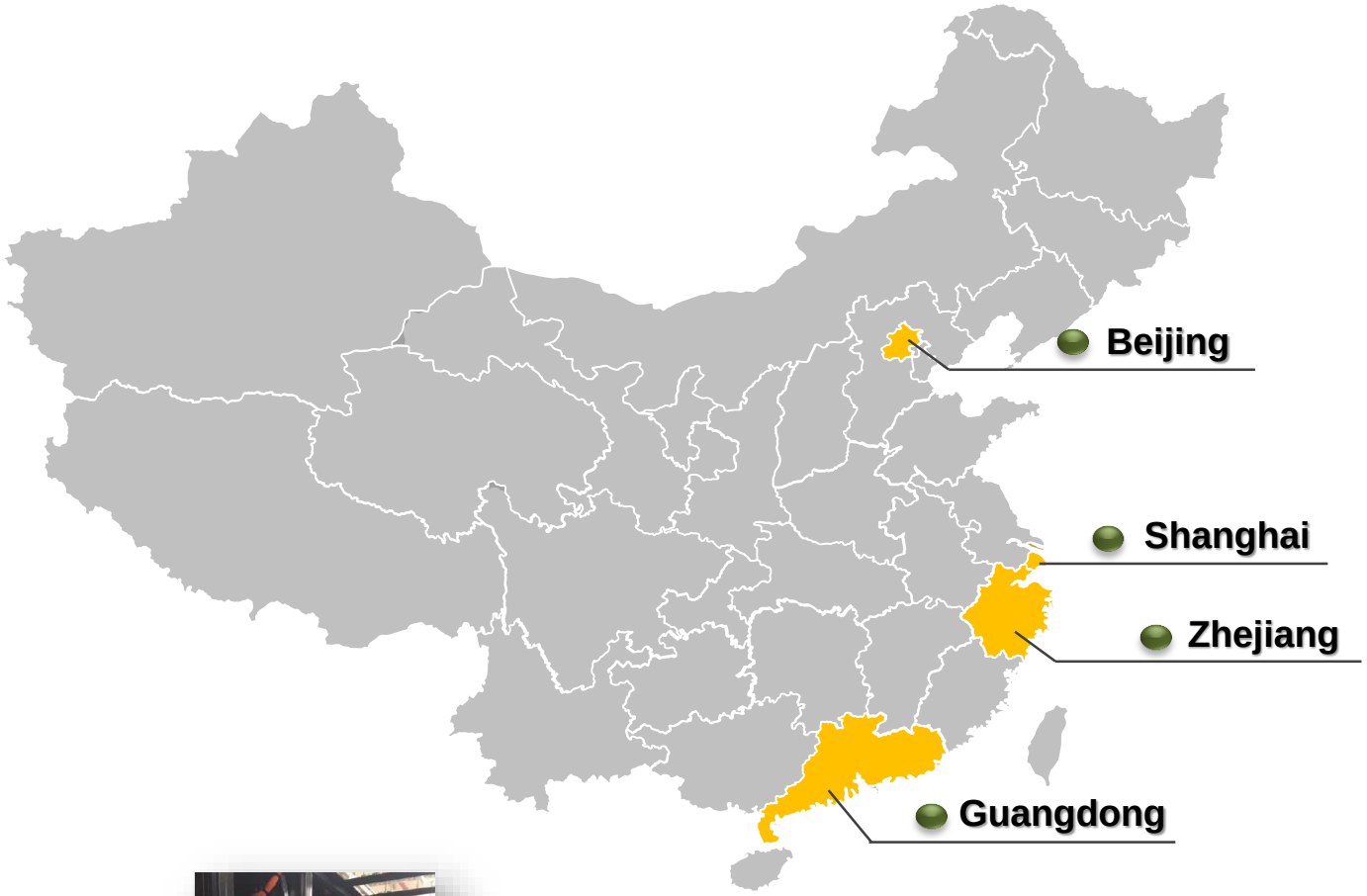
Key Feature Review

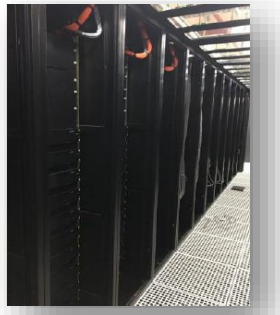
- How many resources should lightweight management system occupy in different edge scenario?
- How should we implement auto-collaboration between IT services and CT gateways?

Who's in?

Involved:

- 4 major provinces/cities: Beijing, Shanghai, Zhejiang, Guangdong
- 7 DC sites and up to 15 testing environments
- 6 VNFs: vEPC for NB-IoT, sCPE, E-BoD, vBRAS, vCDN, 5G-CU
- 9 virtual infrastructure vendors, 5 VNF vendors, 3 orchestrator vendors, 4 SDN vendors





What we have done?

Phase 1: 2016.12 ~ 2017.8

- 5 DC across 3 provinces (Shanghai, Zhejiang, Guangdong), 14 testing environments
- Tested: virtualization platform from 5 vendors, SDN from 1 vendor, 3 services (NB-IoT, sCPE, E-BoD)
- Explored: necessary functions of virtualization platform to carry telco VNF, SDN functions to manage network within DC

Phase 2: 2017.10 ~ 2018.8

- 6 DC across 4 provinces (Beijing, Shanghai, Zhejiang, Guangdong), 15 testing environments
- Tested: virtualization platform from 4 vendors, SDN from 3 vendors, orchestrator from 3 vendors, 4 services (NB-IoT, sCPE, E-BoD, vBRAS)
- Explored: requirements of VNF decoupling with virtualization layer, SDN functions to manage DCI network, general NFV DC model

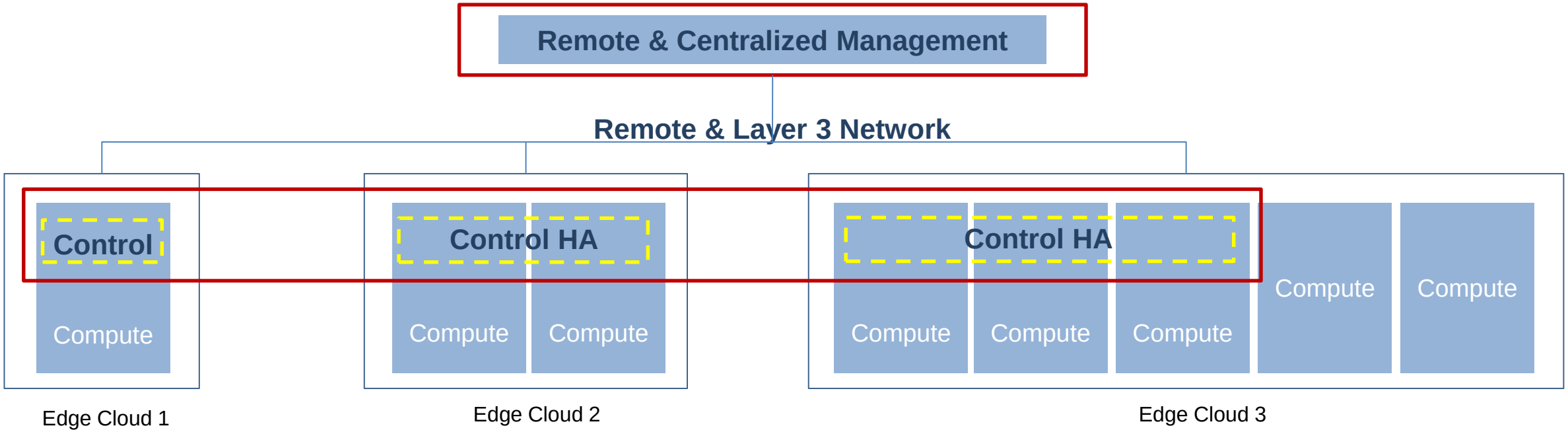
Phase 3: 2018.10 ~ 2019.4

- 7 DC across 4 provinces (Beijing, Shanghai, Zhejiang, Guangdong), 12 testing environments
- **Focused on: edge infrastructure, hardware acceleration, vCDN**
- Tested: virtualization platform from 4 vendors, OVS offloading solution from 1 vendor, vCDN

Edge Virtualization Platform

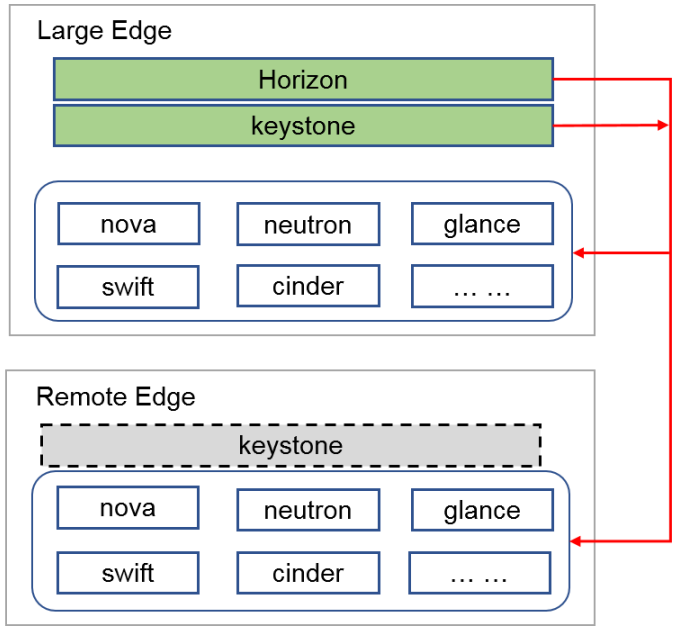
Test No.1: Edge Infrastructure

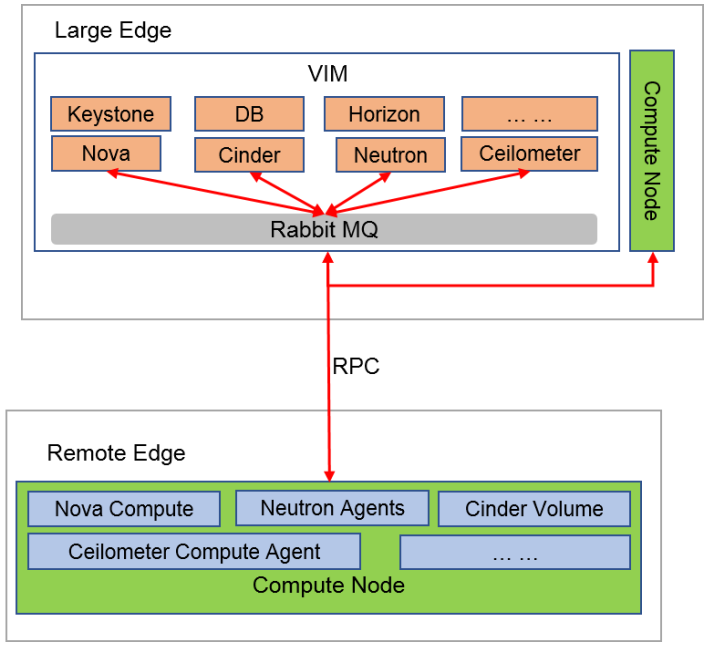
- **Purpose: exploring structure and features of large-scale edge virtualization layer of telco operators (OpenStack)**
- **Major testing points:**
  - **Lightweight OpenStack as controller for virtualization resources**
  - **Management and interoperability of multiple cloud on edge**
- **Environment description:**
  - **Two sites located 30 km away** from each other with the **latency of around 2ms**
  - An edge system including **3 independent virtualization environments, remote & centralized management ability** among those environments

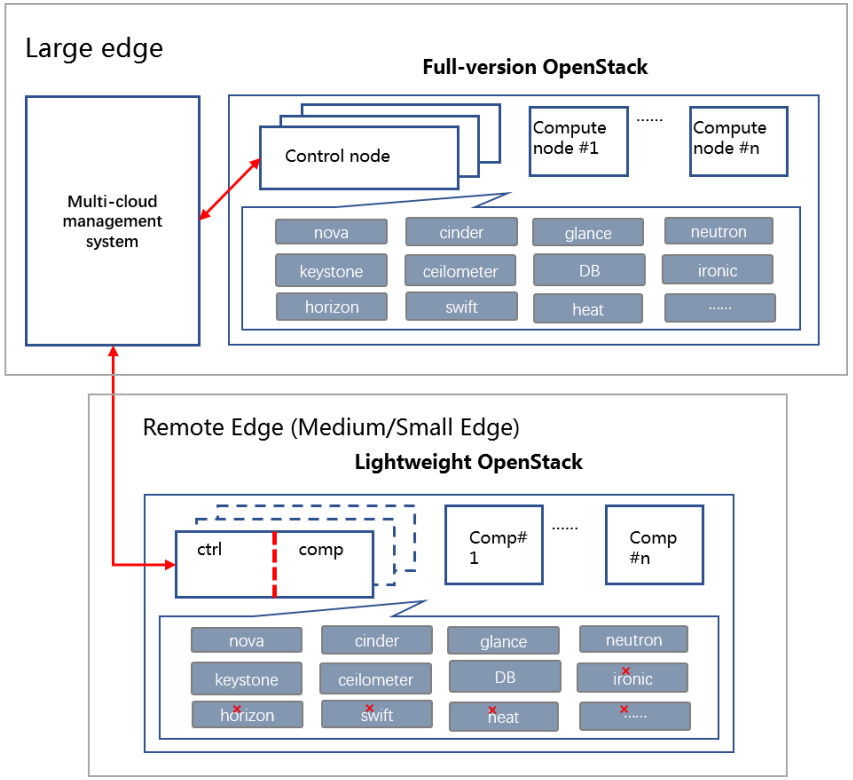


Test No.1: Edge Infrastructure – Solutions

- **No limitation on structure of virtualization platform, 3 different solutions have been tested:**
  - Enhanced Multi-Region
  - Centralized OpenStack control with remote compute
  - Independent lightweight OpenStack as VIM with external multi-cloud management system







Test No.1: Edge Infrastructure – Test Case

- **34 test cases covering edge functions of hypervisor and OpenStack as VIM, reliability, and interoperability of multiple clouds**

Functions of hypervisor and OpenStack as VIM + resource occupation

- OpenStack control services & compute services deployed on the same server
- Edge cloud use local LVM as storage backend
- OpenStack support cold migration of services VMs
- Investigate the minimum resource that OpenStack control services need

Reliability of edge system

- VM evacuation if the server is down
- OpenStack process self-healing
- Backup of management-related data

Interoperability of multiple OpenStack

- “Single sign on” in multiple cloud environment
- Support adding/removing an edge cloud from center of edge
- Provision a new edge hardware from center of edge
- Remote upgrading of edge VIM
- Alarm/warning of edge cloud displayed at the center of edge
- ……

Some test cases have been open sourced under opnfv edge cloud project at:
https://opnfv-edgecloud.readthedocs.io/en/latest/development/requirements/edge_cloud_test_case_reference.html

Test No.1: Edge Infrastructure – Conclusion

- **Currently no open-source solution can fully support requirements of large-scale telco edge virtualization layer**

- **Solution comparison:**

Solution	Enhanced multi-region	Centralized control with remote compute	Independent lightweight with external multi-cloud management system
Resource occupied by control services	Adjustable	Little	Adjustable
Centralized management	Support	Support	Support
Local management when lost connection	Not fully support	Not support	Support/Depends
Requirement on DCI management network quality	Medium	High	Medium
Suitable scenario	Medium-scale	Small-scale with reliable network	Large-scale multi-cloud environment
Pros	Easiest Sync	Most lightweight; One SDN for multiple sites	Most flexible and reliable; Local O&M
Cons	Not fully support local management; Indifferent sync waste resource	Not support local management; Require high network quality	Introduced non-OpenStack multi-cloud management platform

Test No.1: Edge Infrastructure – Conclusion

- **Footprint of OpenStack control services** (in VM/ containerized) **can be limited to as low as 2 to 3 physical cores**

- **Lightweight OpenStack has similar functions as normal OpenStack but poorer performance, vendor-version lightweight OpenStack can meet basic telco requirements**

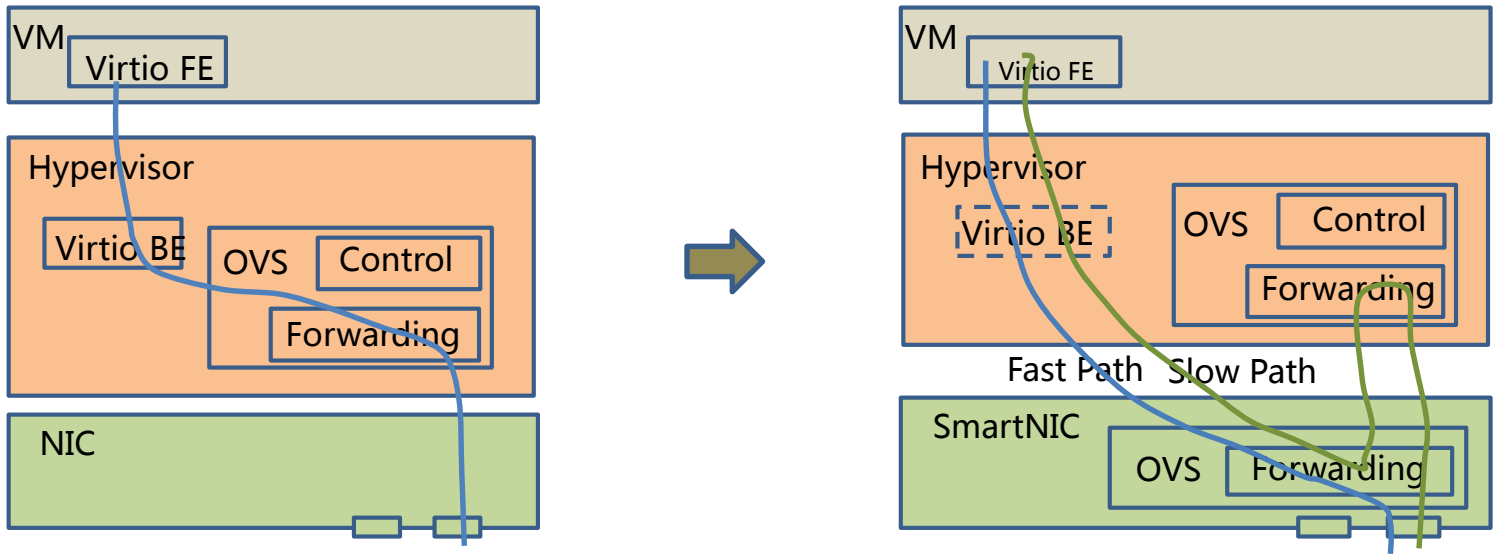
- **Features that an edge virtualization system should have:**
  - Consistent user data and different authority in different cloud
  - Flexible and centralized quota management
  - Single sign on
  - Flexible and directional image delivery and synchronization
  - Centralized and remote O&M
  - Easy resource application for third-party app/ users……

OVS Offload

Test No.2: OVS Offload

- **Background:**
  - 5G mobile data traffic would be 1000 times higher than 4G traffic
  - SR-IOV cannot meet flexible virtual network requirements (e.g. not supporting SDN VTEP, security group)
  - Simple increase in CPU quantity cannot guarantee high forwarding performance of OVS
  - Under edge scenario, OVS will occupy CPU resources which is limited and should be provided to edge services

- **Purpose:** **exploring the function and performance of OVS offloading**



Test No.2: OVS Offload

- **Testing content:**
  - NIC type: traditional OVS, 25G Smart NIC with OVS forwarding ability, 25G SR-IOV
  - Test basic network-related functions (Smart NIC with OVS forwarding ability):
    - Including: Massage forwarding, VLAN transparent, multicast, network isolation, VM migration, MTU, etc.
  - Test performance under different conditions
    - Flow number, packet size, CPU occupied by OVS on same NUMA or cross NUMA
  - Performance comparison between Smart NIC, traditional OVS and SR-IOV
- **Conclusion:**
  - Basic network-related functions can be met using OVS offloading, the same as traditional OVS
  - Performance (throughput & delay) of OVS offload is better than traditional OVS, but currently not as good as SR-IOV
  - Smart NIC with OVS offloading won't cost extra CPU to provide higher throughput
  - Influence on performance if offloading OVS forwarding ability:

Factor	Flow Number	Packet size	CPU Distribution
Influence on Performance	**Little** For a SmartNIC with the same configuration, performance of forwarding 1W flow is similar to performance of forwarding 25W flows	**Positive corelated** For packet in size of 512B, actual I/O speed is slightly lower than card throughput capacity	Performance (OVS' CPU on same NUMA) > Performance (OVS' CPU on different NUMA)

Thank You !