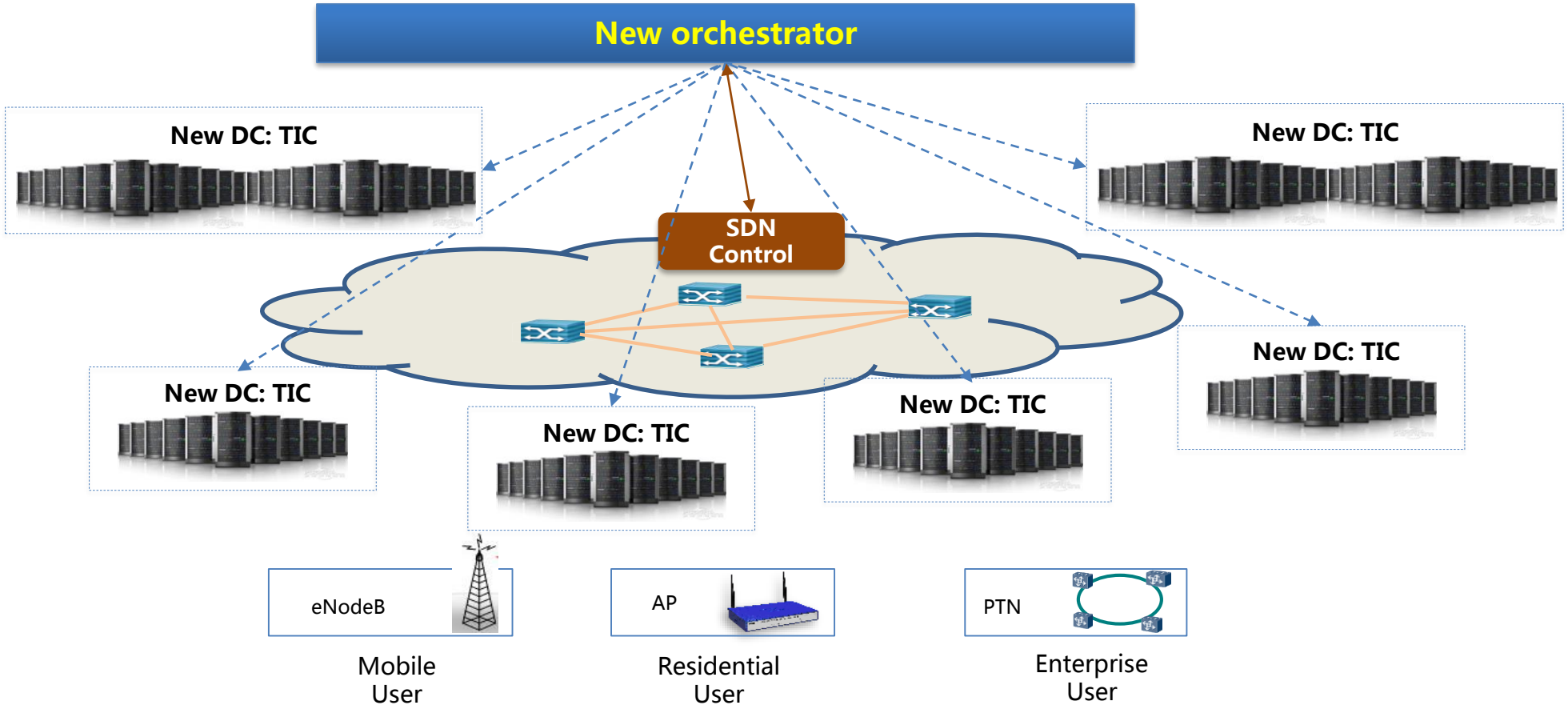
Experience Sharing: the National Experiment Network for NFV Testing in China Mobile

Fu Qiao
fuqiao@chinamobile.com

Future Network Framework for China Mobile

The Future Network of China Mobile is constructed with **New DC, New Network**, and **New Orchestrator**

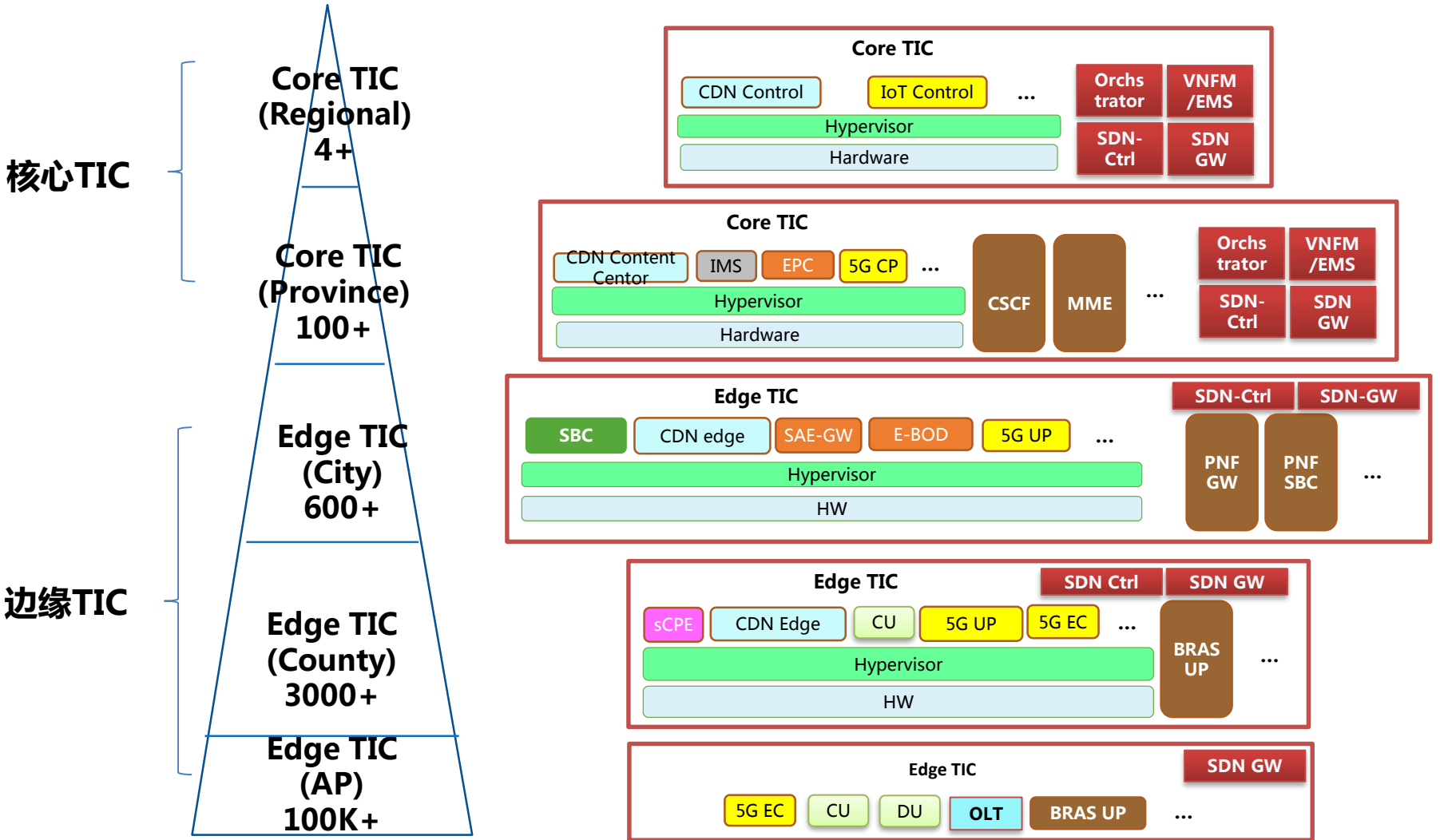
- **New DC:** Redesigned the traditional central office into DC, based on NFV to support the virtualized telecom service cloud
- **New Network**: Using SDN to accelerate network implementation and improve network agility
- **New Orchestration**: Using unified orchestrator to accelerate service on-line and improve service agility



TIC： Telecom Integrated Cloud

TIC is the standard unit constructing the future network. TIC is deployed in a hierarchical manner.

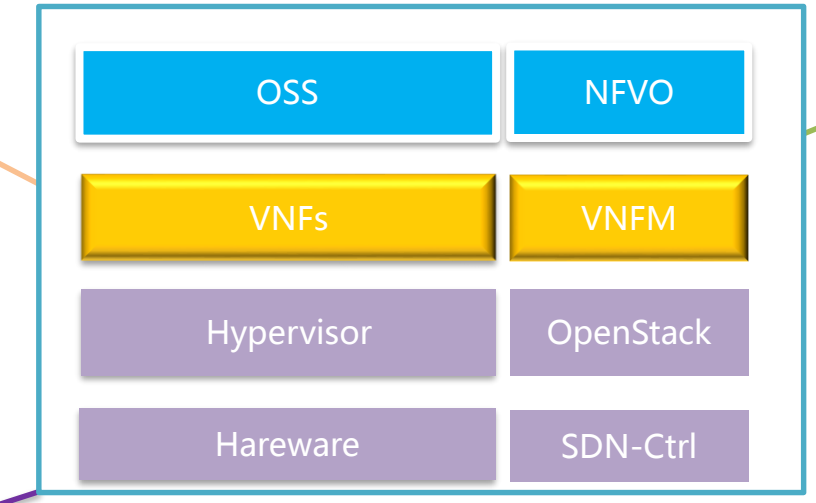
- Core TIC: Support centralized control plane services
- Edge TIC: support distributed user plane services and edge computing capability



TIC: Standard Unit for NFV Deployment

TIC is a standard unit for NFV Deployment

- ✓ Limited number of design template, including NFVI, VIM, and NFVO
- ✓ Unified Hardware model
- ✓ Standard network design



Standard Network

- Strict network plane partition, including Management net, service net, and storage net.
- SG design

Unified Hardware

- Unified hardware design with limited number of models suitable for different category of services.

Design Template

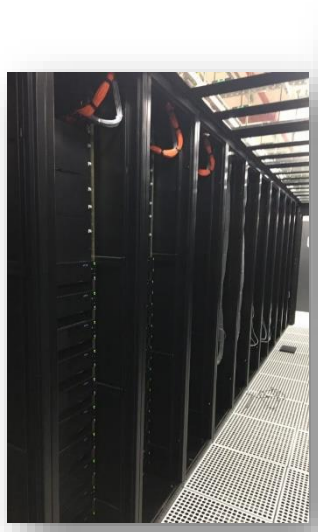
4 TIC design templates to carry VNF services of different kind, including:

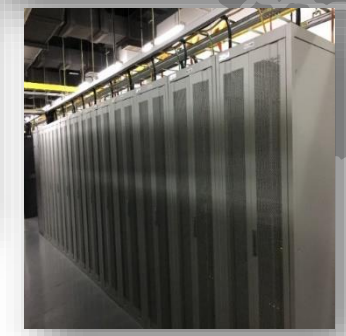
- ✓ Template for Control plane services, stressing on compute capability
- ✓ Template for Data plane services, stressing on data forwarding capability
- ✓ Template for Edge services, stressing on low cost and light weight
- ✓ Template for Storage services, stressing on storage capability

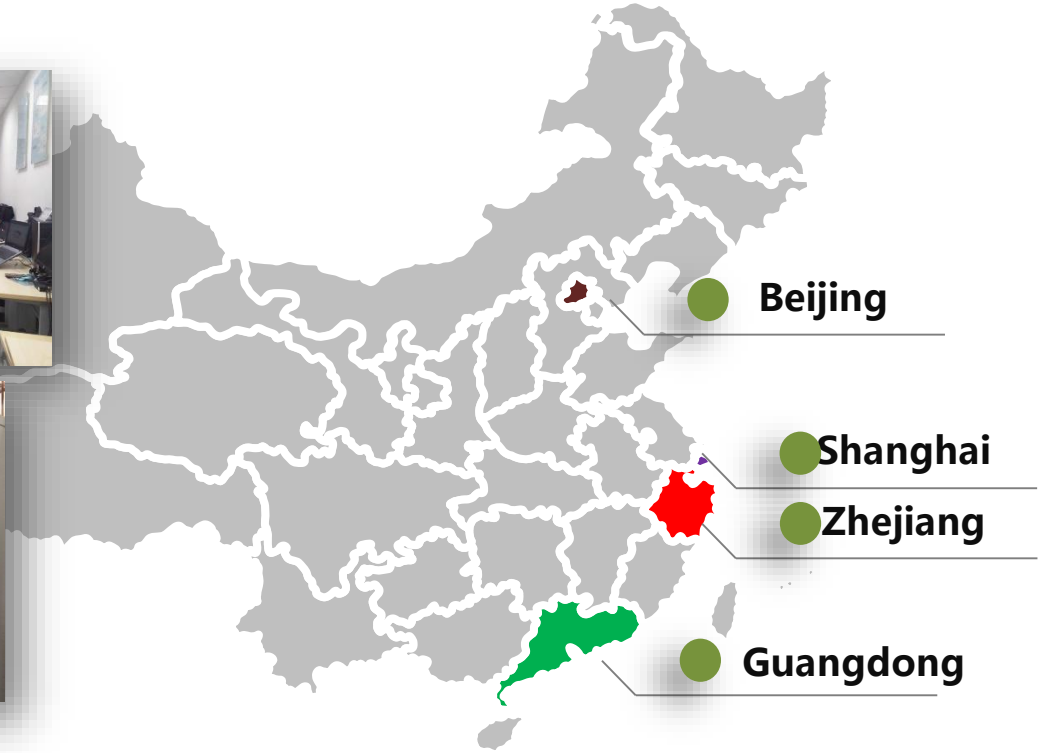
Key Features for TIC: Standard unit, Template-based, Easy to copy

China Mobile NovoNet Experiment Network

- Targeting on future network structure validation, Since 2016, China Mobile is building its Novonet Experiment Network in 4 Provinces.
- 7 DC sites are included in the network, 15 TICs are constructed
- VNFs include vEPC for NB-IoT, vBRAS, vCPE, and E-BoD
- 9 virtual infrastructure vendors, 5 VNF vendors, 3 orchestrator vendors, 4 SDN vendors, are included in the network



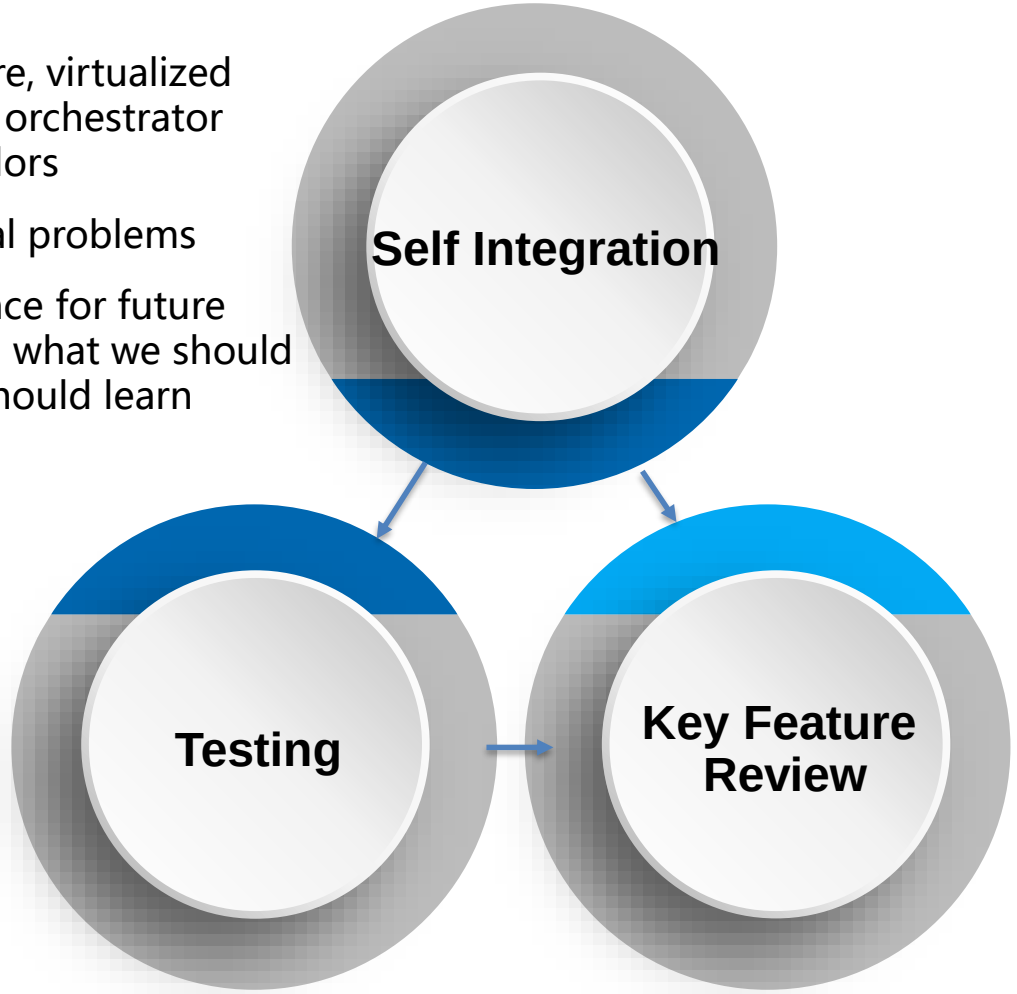




NovoNet Experiment Network, how we promote

We promote the whole work in 3 thread, Integration, Testing and Key feature review, making sure to figure out most of the possible obstacles for field deployment through thorough integration and testing, and solve them through feature review

- Integrated hardware, virtualized software, SDN and orchestrator from multiple vendors
- Figure out potential problems
- First hand experience for future network operation, what we should change, what we should learn



- Virtualize layer testing
- Service testing
- SDN testing
- …

- Is the virtualization of Telecom service ready for deployment?
- How should we benchmarking and choose virtualization platform vendor?
- Should we use a regional Orchestrator or Centralized one?
- Can SDN work with NFV? What are the key issues?
- …

Recap: what we have done

- **Begin since Dec. 2016; Two phases finished so far**
- **Phase 1 (2016.12-2017.7):**
  - Including 5 DC across 3 provinces(Shang Hai, Zhe Jiang, & Guang Dong)
  - Testing virtualization platform from 5 vendors
  - 1 SDN vendor is included for network control within DC
  - 3 Services: NB-IoT、sCPE、E-BoD
  - 14 TICs are constructed in total, including 3 VIM vendors, 1 SDN vendor, 3 Orchestrator vendors, and 4 service vendors
- **Phase 2 (2017.9-2018.2):**
  - Including 6 DC across 4 provinces(Beijing, Shang Hai, Zhe Jiang, & Guang Dong)
  - Continue the testing of virtualization platform with 3 chosen vendor from Phase 1, and add extra 4 vendors for Phase 2
  - 3 SDN vendors are included, and SDN control among DC are tested
  - 4 Services: NB-IoT, sCPE, E-BoD, vBRAS
  - 15 TICs are constructed in total, including 5 VIM vendors, 3 SDN vendors, 3 Orchestrator vendors and 5 service vendors

Lessons learned NO. 1:
What features should virtualized services be tested?

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- **Testing:**
  - 4 services from 5 vendors have been tested
  - Services include mobile core network service (vEPC), enterprise network (E-BoD), and residential network(sCPE, vBRAS)
  - Test cases including functional tests, performance tests, and availability tests
  - Due to lab resource constraints, huge throughput tests are excluded
  - Testing are conducted when virtualized service and platform are from different vendors
- **Things we observed:**
  - **Functional Testing:** functions that traditional network functions should have. Make sure virtualized function appears the same function as non-virtualized ones.
  - **Virtualization testing:** testing to make sure services have the so-called virtualization features, e.g., automatic scale in/out, automatic deployment
  - **High availability testing:** such testing can be designed for both VNF layer and VNFC layer
    - For VNF layer, the function should follow the same SLA as the traditional virtualized service
    - For VNFC layer, the VNFC should be capable of self recovery
  - **Performance testing:** With the same throughput requirement, work out how many servers are needed, and how is the performance(latency, packet loss rate). If there are too many servers required, or products can hardly meet the performance requirement, it probably makes sense not to virtualize such service for now.

Lessons learned NO. 2:
Are Telco services ready to be virtualized and deployed?

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- **Things we observed:**
  - **Virtualization for control plane services is ready**
  - **Virtualization for user plane services need further testing and verification**
    - **User plane for Mobile core**
      - ✓ may need software/hardware acceleration to improve the network forwarding performance
      - ✓ A certain difference observed for performance when using SR-IOV vs OVS-DPDK, though OVS-DPDK may experience a considerable performance fluctuation
    - **User Plane for Residential GW**
      - ✓ Considerable performance loss is observed for virtualized user plan, specific hardware acceleration should be utilized
    - **25G/40G NIC should be considered for user plane**
  - **Mobile Core services are mature enough, while the others should be improved for virtualized features, including scale in/out, high availability features, and etc.**

Lessons learned NO. 3:
What feature should OpenStack be tested for Telco Scenarios

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- **Testing:**
  - OpenStack from 9 Vendors have been tested
  - Vendors including pure open source vendors, and closed source vendors
  - 189 cases are tested, including basic functional tests, performance tests, and availability tests.
- **Things we observed:**
  - **Functional testing:** including the virtualization function for hypervisor, and the virtualization resource management function for VIM. These test cases are usually quite general, including the virtualization of compute/network/storage resources and the provisioning of these resources(create/get/delete/start/power off)
  - **Interface testing:** making sure the VIM north interface follow the open source OpenStack northbound API. However we do accept the API with enhanced features and adding new parameters for now, in case such feature is revealed to VNF layer
  - **Performance testing:**
    - stress testing: how many VM/Subnet can be created for given resource
    - Compute: how much time it takes to create/delete/recover a VM
    - network forwarding performance testing with OVS/SR-IOV
  - **Availability testing:** availability for VIM/hypervisor/VM/DB
  - **Physical infrastructure provisioning testing**

Lessons learned NO. 4:
Is the OpenStack Platform good enough for Telco Usecase?

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- **Things we observed:**
  - Almost all vendors gain high pass rate for functional tests
  - Major difference appears in performance tests, where closed source vendors somehow show better results
  - Most open source vendors can’ t meet the requirement for Telco Availability. Failed test cases including VM HA and hypervisor HA.
  - Almost all SUT remain to be improved for capability of managing and controlling physical infrastructure, which is a basic requirement for Telco

Lessons learned NO. 5:
Should we choose one vendor of OpenStack?

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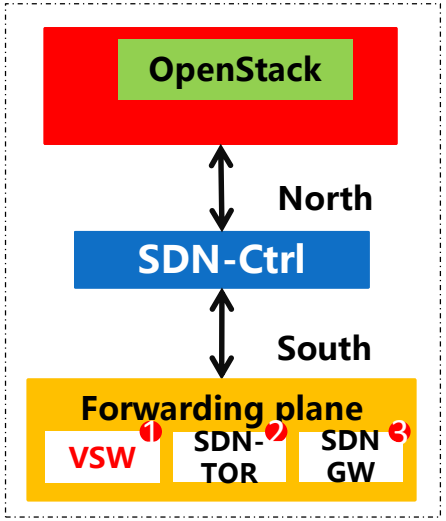
- **Things we observed:**
  - **Pros:**
    - OpenStack Restful APIs are something vendors strictly follows, however each one of them may have different extensions for parameters, which you may need to look more closely
    - IOT for hardware, OpenStack, SDN controller, VNF, VNFM and NFVO is a huge work load, especially when you have multiple OpenStack vendors
    - Different vendors have different version planning, it is difficult to coordinate vendor’ s versions for long term deployment
  - **Cons:**
    - It is risky to only rely on one vendor, especially when this industry changes so quickly
    - Unlike enterprise cloud, Telco clouds are widely spread. It is impossible for one vendor to support such huge number of clouds, especially in large countries, e.g. China

Lessons learned NO. 6: How should SDN work with NFV?



- **Testing:**
  - In our TIC, SDN controller and VIM can possibly come from different vendors
  - 4 matches of SDN vendors and VIM vendors are tested
  - Software defined network control of inter-TIC and intro-TIC are tested
- **Things we observed:**
  - It is possible that within one TIC, VIM and SDN controller are from different vendors
  - SDN controller’s northbound is interconnected with OpenStack Neutron. Following the standard Neutron Plugin API, northbound has little if any problems
  - SDN controller’s south API is interconnected with both to software (VSW) and hardware (SDN GW, TOR)
    - **Hardware:** it is almost impossible to decouple the controller with the hardware, since the interface has little standard bases
    - **Software:**
      - ✓ It is necessary to decouple SDN controller with VSW in Telco Scenario, since most VSW are enhanced to meet the performance requirement for Telco, and are closely bounded to hypervisor and VIM vendors
      - ✓ Openflow and OVS-DB are useful for such decoupling, however can not cover all the interfaces

Lessons learned NO. 7:
What’s the difference between Core and Edge?

- **Testing:**
  - 15 TICs are integrated in total, including 7 core TIC and 8 edge TIC
  - vEPC, vBRAS-CP are deployed on core TIC, while sCPE and E-BoD are deployed on edge TIC
- **Things we observed:**
  - Core TIC:
    - More “cloud-like” DC, with large amount of servers, lots of services, huge virtualized pool for resource sharing and scale in/out
    - Mainly designed for control plane, no specific requirement for acceleration
    - Capability for service management of both core and edge, with NFVO/VNFM/EMS deployed
  - Edge TIC:
    - More “cloud-like” DC in cities and counties, however will be very small at AP (less than 10 servers)
    - Mainly designed for user plane, specific requirement for acceleration and data forwarding
    - NO NFVO/VNFM/EMS

Lessons learned NO. 8:
How about edge cloud, what do operator need?

- **Things we observed:**
  - Light weight services and OpenStack due to limited resources are required. Container might be something that we should choose. However, how to provision the containerized resource, together with virtualized resources remain unsolved
  - Unmanned self provisioning due to remote location is required. This some how requires high reliability for edge, and probably might be contradicted with the limited resource.
  - Specific requirements for acceleration, including DPDK, SR-IOV, smart NIC, FPGA, and GPU. How to efficiently utilize multiple acceleration resources is important for edge. A unified API for acceleration resources might be the solution

Lessons learned NO. 9:
How should we integrated the new virtualized cloud?

- **Testing:**
  - 15 TICs are integrated in total
  - Integration for multiple vendors, with hardware, VIM, SDN, VNF and Orchestrator all from different vendors
  - More than 300 major issues are detected during the integration
- **Things we observed:**
  - Lots of issues can be found during integration, however the issues can decrease as our operating staffs gain more experience
  - On-boarding test is important, since software integration can change unexpectedly
  - It is almost impossible to integrate and test all these component pure manually, automatic integration and testing tools are important. This will help decrease the duration of integration from months to hours
  - A fine-grained, automated integration and testing procedure should be designed to replace the traditional integration and maintenance procedure in Operators. This will bring key value for network virtualization

Thanks