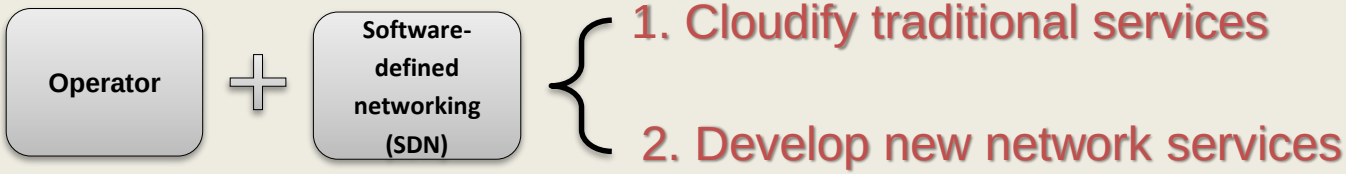
China Unicom SDN Practice in WAN

Lv Chengjin/Ma Jichun, China Unicom

What Will Operator SDN Do?

Two development directions



Data center (DC) SDN

- Highly integrated with cloud services, DC SDN focuses on support for traditional service evolution.
- DC SDN technologies in data centers are mature, and cloud providers' and vendors' solutions are numerous and diverse.

WAN SDN

- WAN is the basic capability of operators. SDN focuses on developing new services.
- The implementation solutions are complex and different between operators.

Problems to Be Tackled by WAN SDN

Operator WAN complexity

Complex networks	•Individual networks have large capacities, accommodate a great number of subscribers, run various types of services, and use complex techniques.
Complex devices	•Devices are numerous and come from various vendors, posing high requirements on inter-vendor interworking.
Complex services	•The controllability of common services is low, posing high requirements on solution adaptability.

SDN implementation feasibility

Insufficient cases	•There are a relatively few cases of SDN being successfully deployed on large WANs.
Highly tailored	•The live network service process is complex and highly tailored, which makes it difficult to generalize.

Deployment policies are important

SDN policies for China Unicom's IP bearer network: Use new service development to promote network reconstruction and gradually implement SDN on the entire network.

From IP Bearer Network to Industry Internet

China Unicom IP Bearer Network A

- **Customer group** Enterprise VICs
- **Services**
  - MPLS VPN leased lines
- **Characteristics**
  - Virtual private network security isolation
  - IP statistical multiplexing
  - Light load

China Unicom Industry Internet (CUII)

- **Changes in the technical environment:**
  - Mature cloud computing: Enterprise IT infrastructure cloudification
  - Rapid IoT development: Increasing demand for connections
- **Usage scenario changes:**
  - Cloud interconnection: DC → DC
  - Cloud access: Enterprise → DC, device → DC
- **Requirement changes:**

Performance	Efficiency	Price
Low latency High reliability	Fast provisioning Flexible adjustment	Differentiation Short lease

Introducing SDN to Implement New Services

Self-Services

- Order online: Place an order online.
- Quality on-demand: Match customer service requirements against quality assurance levels on service requirements.
- Visualized interface: The map mode can be selected to display network topology and routing paths.

Intelligent Path Selection

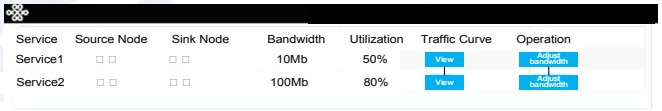
- Shortest delay: The minimum transmission latency is implemented.
- High availability: E2E route separation is supported.

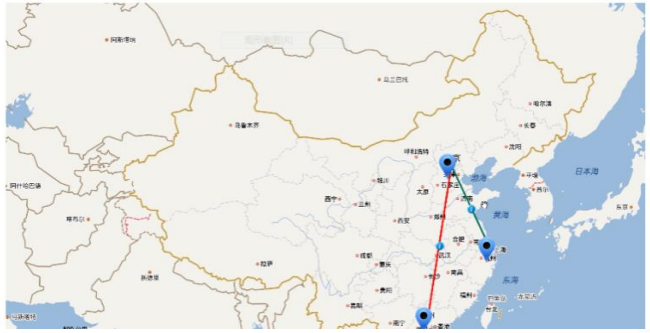
Real-Time Provisioning

- Dynamic configuration: Configurations are rapidly delivered and implemented.
- Flexible duration: The service provisioning time and service duration can be selected as needed.

Various Service Attributes

Selected Indicator	Supported Attributes
Bandwidth guarantee	Assured, best effort
Latency	Shortest, best effort
Service rollout time	Monthly/day, self-defined
Service access mode	VLAN,VXLAN
Service priority level	High, medium, low
Customer service assurance level	Diamond, gold, silver, copper



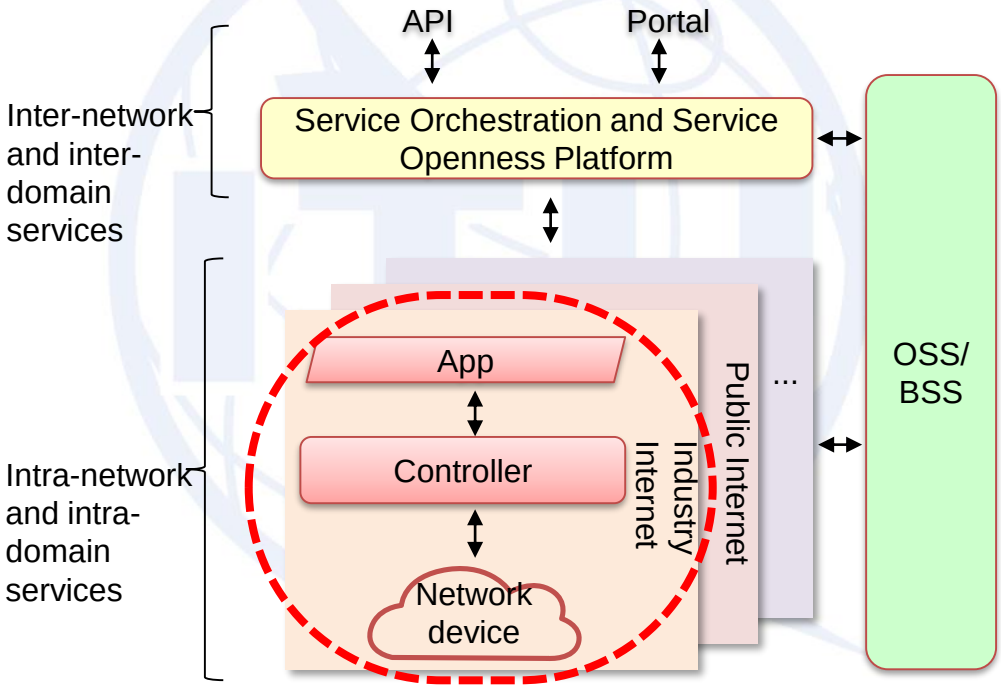


SDN Implementation Architecture

General Roadmap

- Unified service orchestration and management
- Independent networks and service domains, each with complete functions
- Hierarchical decoupling to ensure scalability

Professional networks are independently implemented, and capabilities are gradually integrated



Industry Internet SDN Solution

- **Layered architecture**
  - Apps provide APIs and GUIs.
  - The controller controls devices.
- **Multi-vendor support**
  - The controller and network devices are decoupled, and multi-vendor devices are supported.

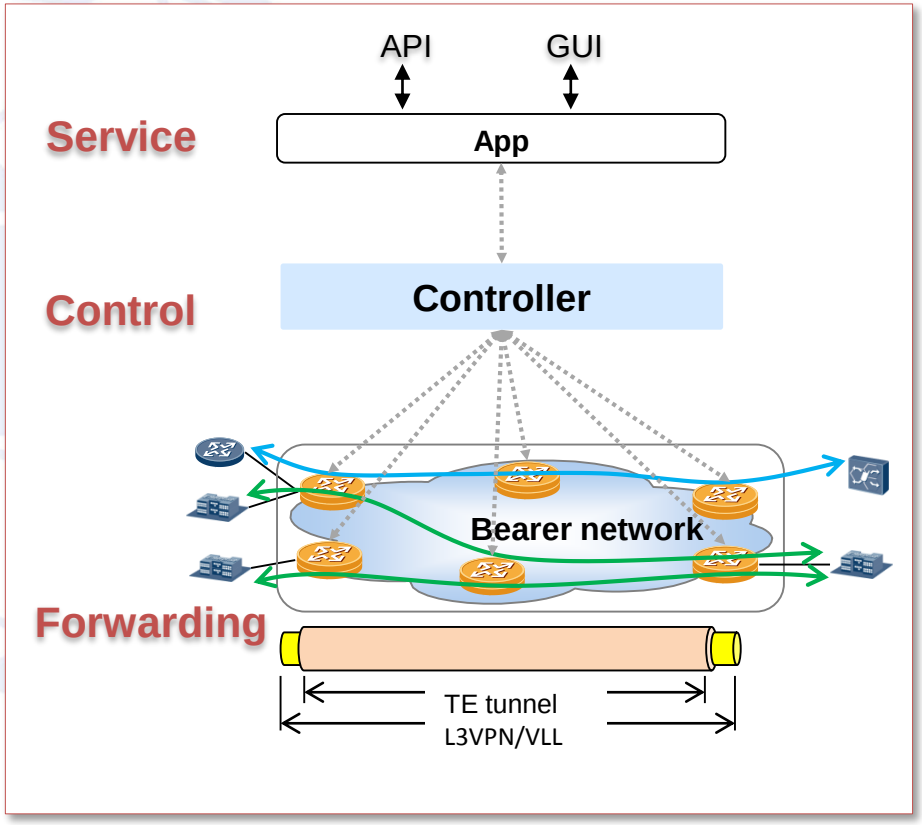
SDN Control Solution Selection

- **Service layer**
  - Refine service requirements and design products
  - Abstract service model and unify parameters
  - Define external interfaces

  Apps are self-developed, ensuring service flexibility

- **Controller layer**
  - Adapt the control model to multi-vendor devices
  - Deliver service paths
  - Collect configuration and topology information

  The controllers are mature products of partners



Model Driven

- **Northbound interface model of the controller**
  - Objectives: Define functions and shield differences.

    Service model definition: YANG

- **Southbound interface model of the controller**
  - Objectives: Control devices of multiple vendors.

    Device interface: NETCONF

Defined YANG models	China Unicom L3VPN YANG model
	Topology management YANG model
	SR-TE YANG model
	HA model

Service Model (YANG Model)

L3VPN Model

- Creates, deletes, and queries VPN-SVC instances.
- Creates, deletes, and queries sites and site-network-access.
- Creates, deletes, and modifies static routes.
- Modifies BGP peer relationships.
- Assigns, maintains, adds, deletes, and queries resource pools.

L3VPN Model Extension

- Modifies and extends QoS profiles.
- Creates, queries, and deletes VPN and TE tunnel bindings.

SR-TE Model

- Creates, deletes, queries, and modifies tunnel instances based on China Unicom's TE scenarios.

  (Tunnels can be created separately or for VPN services.)
- Provides the RPC request model for path computation.

Topology Management Model

- Queries information about all network topologies on the controller.
- Queries and modifies topology, link, and node information.

HA Model

- Synchronizes service configurations during a master/backup controller switchover.

Network Technology — SR

- Segment routing (SR): a source routing protocol that optimizes IP and MPLS network capabilities.
- Based on label switching, SR extends existing IGP protocols, controls routes on the source node, and supports a variety of functions, including TE and FRR.

The combination of SR and SDN provides obvious advantages

Highly efficient

- A great number of stateless TE connections are supported, and SR supports inter-domain solutions, which are implemented on physical networks, virtual networks, and servers.

Simple

- SR FRR implements protection switching for less than 50 ms, involving merely a few protocols.

Scalable

- Individual flows on a network are controlled, which improves network scalability. Application-based fine control capabilities are supported.

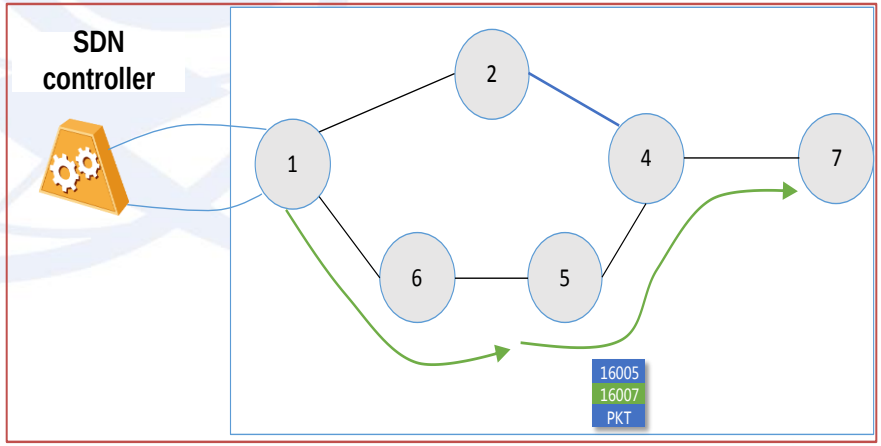
Programmable

- The SDN controller programs the infrastructure network to implement application requirements, which allows E2E flow-based program policies to be enforced.

SR Usage

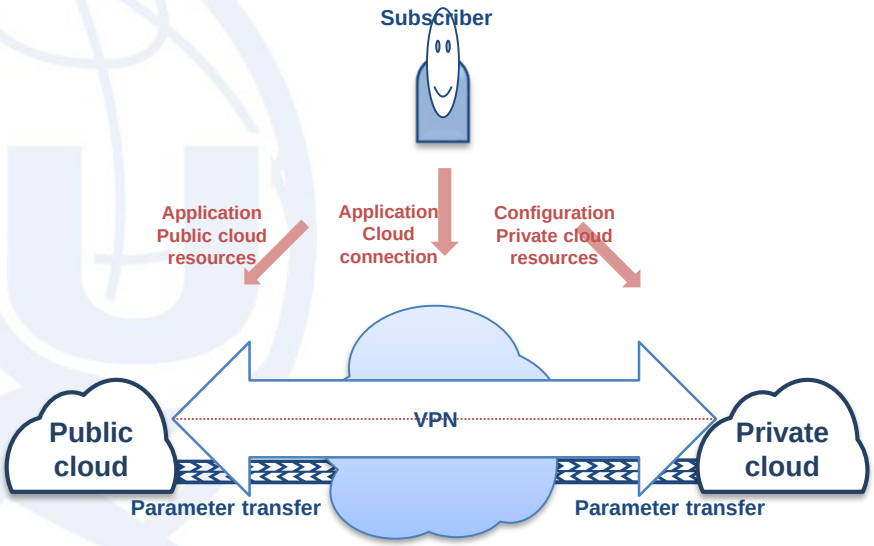
- Usage
  - SR-TE and SDN are jointly used in a multi-vendor environment for the first time.
  - Differentiated service requirements are met, and specific paths are selected.
  - PEs and Ps of different vendors can communicate using SR-TE and run SR-TE services.

- Resolved Issues
  - Devices of different vendors run inconsistent label distribution protocols.
  - Vendors implement BFD differently.
  - The SBFD solution is to be optimized in Uniform mode.



Collaborating with Public Cloud Service Providers

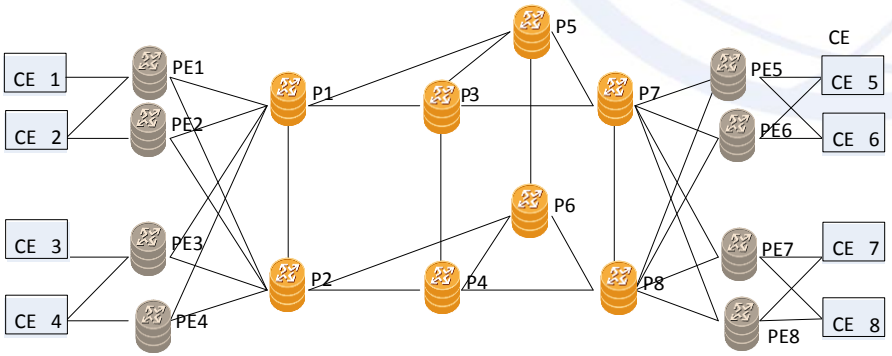
- **Collaborate with public cloud service providers to provide hybrid cloud connections.**
  - Team up with public cloud partners to implement VPN connections between public clouds and customer infrastructure.
  - Define a public cloud interface and transfer connection parameters to implement online handling and automatic provisioning.

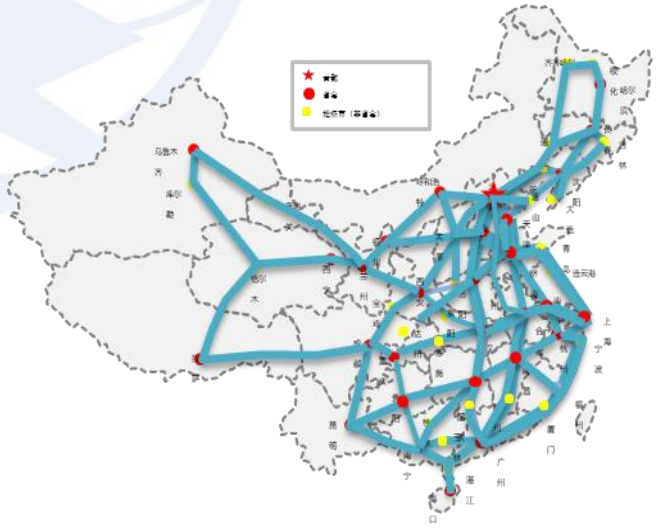


Interfaces have been developed and are being tested in collaboration with mainstream public cloud service providers

Implementation Status

- Implementation completed:
  - Main technical solutions and specifications (service, technical, and interface specifications)
  - App function development in phase 1 and phase 2
  - Joint commissioning testing in the laboratory
  - Online verification test
- Commercial launch of services in a total number of 35 cities across China will be completed in the near future.





Our Experience

The following aspects help implement WAN SDN:

1. **Find new services suitable for SDN to promote network transition to SDN.**
2. **Follow the multi-layer decoupling design to ensure flexible architecture adaptation.**
3. **Customize a solution based on operator networks, instead of requiring mandatory commonality.**
4. **Select suitable partners and closely cooperate with one another to optimally utilize the advantages of each.**

Thank you!