Performance investigation and comparison between virtual networks and physical networks based on Sea-Cloud Innovation Environment
Outline

• Background
• Architecture
• Software & Hardware
• Deployment
• Demonstration
• Performance investigation
Background

- Sea-Cloud Innovation Environment, a national wide testbed supported by the “Strategic Priority Research Program - New Information and Communication Technology” (SPRP-NICT) of the Chinese Academy of Sciences, is aiming to build an open, general-purpose, federated and large-scale shared experimental facility to foster the emergence of new ICT.
Background

Objective

• Providing shared and sliceable experimental facilities for academia and industry to bridge the gap between visionary research and large-scale experimentation.
• Establishing and practicing the methodology of experimentally-driven innovation for the clean-slate architecture of ICT.
• Evaluating and validating new protocols, devices and research achievements of SPRP-NICT.

Sea-Cloud Innovation Environment

Computing resources  Network resources  Data resources  ...
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• Background
• Architecture
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• Demonstration
• Experimentation
Architecture

- SCIE portal
- Scie.ac.cn
- Resource control framework
- Experiment measurement system
- SDN/VLAN-based network slicing
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• Background
• Architecture
• **Software & Hardware**
• Deployment
• Demonstration
• Performance investigation
Software--Overview

SCIE Portal
- Topology Editor
- Experiment Playground
- Resource Management
- Authorization & Accounting

Control Center
- Resource Management & Control System
- Experiment Measurement System

Resource Site
- Resource Control module
- Measurement Module
- Site manager
- Site manager
- ……
Software

SCIE Resource Control Architecture

- Distributed resource control framework with one control center and many site managers
- Defining resource control interfaces, measurement interfaces to integrate different resource
- Light-weight VM management tool
Software

SCIE measurement System

• External VM measurement without any plug-in in VMs
• AMQP based control message & measurement data transfer
• sFlow based network traffic measurement
• MongoDB as Storage Engine
Software

Experiment Service System

- Experiment life cycle Management
- Java & Python based experiment control library
- Topology and experiment process visualization
Hardware

Smart-Flow Switch

- OpenFlow 1.2
- GRE tunnel
- QoS supported
- 24*GE
- 1*10GE
- Four slots
- Line Card & UTM Card
Hardware

SCIE Rack

• Integrated network, computing and storage
• Built-in site management module
• Virtualization
• Dynamic scheduling
Outline

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Deployment

- Four countries & seven cities & 22 sites
- Data plane via GRE tunnel; Control plane via L3 network
- 2,234 cores, 1,510TB storage, 512TB experimental data
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• Performance investigation and comparison between virtual networks and physical networks based on an advanced testbed network
• Three cities & 4 sites
• VM based on KVM
• Data transmission via GRE tunnel built based on OVS
Deployment

• **Scenario**
  – single-thread vs. multi-thread

• **For each scenario**
  – the intra-domain case, from Beijing to Xinjiang in China
  – the inter-domain case, from Beijing in China to Michigan in US

• **Extensive performance evaluation tests**
  – UDP and TCP traffic in idle and non-idle period

• **Key performance metrics**
  – For UDP traffic
    • round trip time (RTT), throughput, packet loss, and jitter
  – For TCP traffic
    • RTT and throughput
Experimental results and analysis

- **UDP traffic**
  - throughput

- The virtual network is very similar to single-thread physical network
  - very similar to single-thread physical network scheme in intra-domain and in inter-domain
  - the deviation
    - less than 0.35% in intra-domain
    - about 0.21% in inter-domain

- The deviation is stable (multi-thread virtual network vs. single-thread physical network)
Experimental results and analysis

• UDP traffic
  – packet loss rate

- Single-thread virtual network and single-thread physical network are better than multi-thread virtual network scheme in all cases
- The deviation is less than 1% (multi-thread virtual network vs. single-thread physical network)
  ✓ 0.17% in intra-domain
  ✓ about 0.23% in inter-domain
Experimental results and analysis

- **UDP traffic**
  - **Jitter**

- The jitter of inter-domain environment was higher than that of intra-domain environment with about 13.5%
- Jitter in Multi-thread virtual network is higher than single-thread physical network
  - 2.6% higher in intra-domain environment
  - 10.2% higher in inter-domain environment
- The distance is the main factor affecting the jitter
Experimental results and analysis

• UDP traffic
  – RTT

• Single-thread physical network is more stable and smaller than single-thread and multi-thread virtual network
  • RTT is most stable and lowest in all cases in single-thread physical network
  • The RTT of single-thread physical network is about 3.3% smaller than single-thread and multi-thread virtual network schemes
• The RTT is not so stable in non-idle scenario, the deviation between idle and non-idle cases is 0.1%
• The background traffic is the key influence factor of RTT and the performance of network experiment in virtual network environment
Experimental results and analysis

- TCP traffic
  - throughput

- Throughput in Idle case is better than non-idle case
- Throughput in intra-domain environment is higher than that in inter-domain environment
- After slow start, the throughput of single-thread physical network is higher than that of single-thread and multi-thread virtual network scheme
- The throughput of single-thread virtual network is the most stable and is very similar to single-thread physical network in non-idle case
Experimental results and analysis

• TCP traffic
  – RTT

  (a) TCP RTT BJ-XJ (Idle)
  (b) TCP RTT BJ-XJ (Non-Idle)
  (c) TCP RTT BJ-MI (Idle)
  (d) TCP RTT BJ-MI (Non-Idle)

• Stability of RTT
  ✓ single-thread physical network > single-thread virtual network > multi-thread virtual network

• In idle traffic case, the deviation:
  ✓ 0.23% (single-thread physical network vs. single-thread virtual network)
  ✓ 0.55% (single-thread physical network vs. multi-thread virtual network)

• In non-idle traffic case, the deviation:
  ✓ 3.7% (single-thread physical network vs. single-thread virtual network)
  ✓ 4.5% (single-thread physical network vs. multi-thread virtual network)
Experimental results and analysis

• **Conclusion**
  - 1) the RTT and jitter of virtual networks have little deviation from physical networks,
  - 2) the throughput and packet loss rate of virtual networks are similar to physical networks,
  - 3) the performance of single-thread virtual network is more similar to the existing physical network than the multi-thread virtual networks,
  - 4) the multi-thread virtual networks have certain deviation from physical networks, but the deviation is stable and shows certain characteristics.

• **Thus, it is possible to get the performance of real physical networks in virtual networks**