StarlingX Enhancements for Edge Networking

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A Fully Featured Cloud for the Distributed Edge

STARLINGX

01 — 4’

EDGE NETWORKING

- What is Driving Edge Computing?
- Edge Computing Challenges
- Edge Networking Requirements

02 — 4’

WHAT IS STARLINGX?

- What Problems is StarlingX Solving?
- Intent of the StarlingX Project
- StarlingX – Edge Virtualization Platform
- StarlingX Scales Small or Large

03 — 12’

TECHNOLOGY DETAILS

- Network Performance and Efficiency
- Remote Management of Complex and Non-homogeneous Networks
- Reliability and Autonomous Site Operations with Limited Connectivity
- Enhanced Network Security

04 — 10’

BUSINESS CASES

- China Unicom‘s Full Stack Cloud Network Architecture
- StarlingX__Mapping to China Unicom‘s Edge-Cloud Platform Requirement
- Quote

05 — 4’

STATUS

- Upstream Scope & Flow
- OpenStack Networking Upstream Status
- Downstream Status

06 — 3’

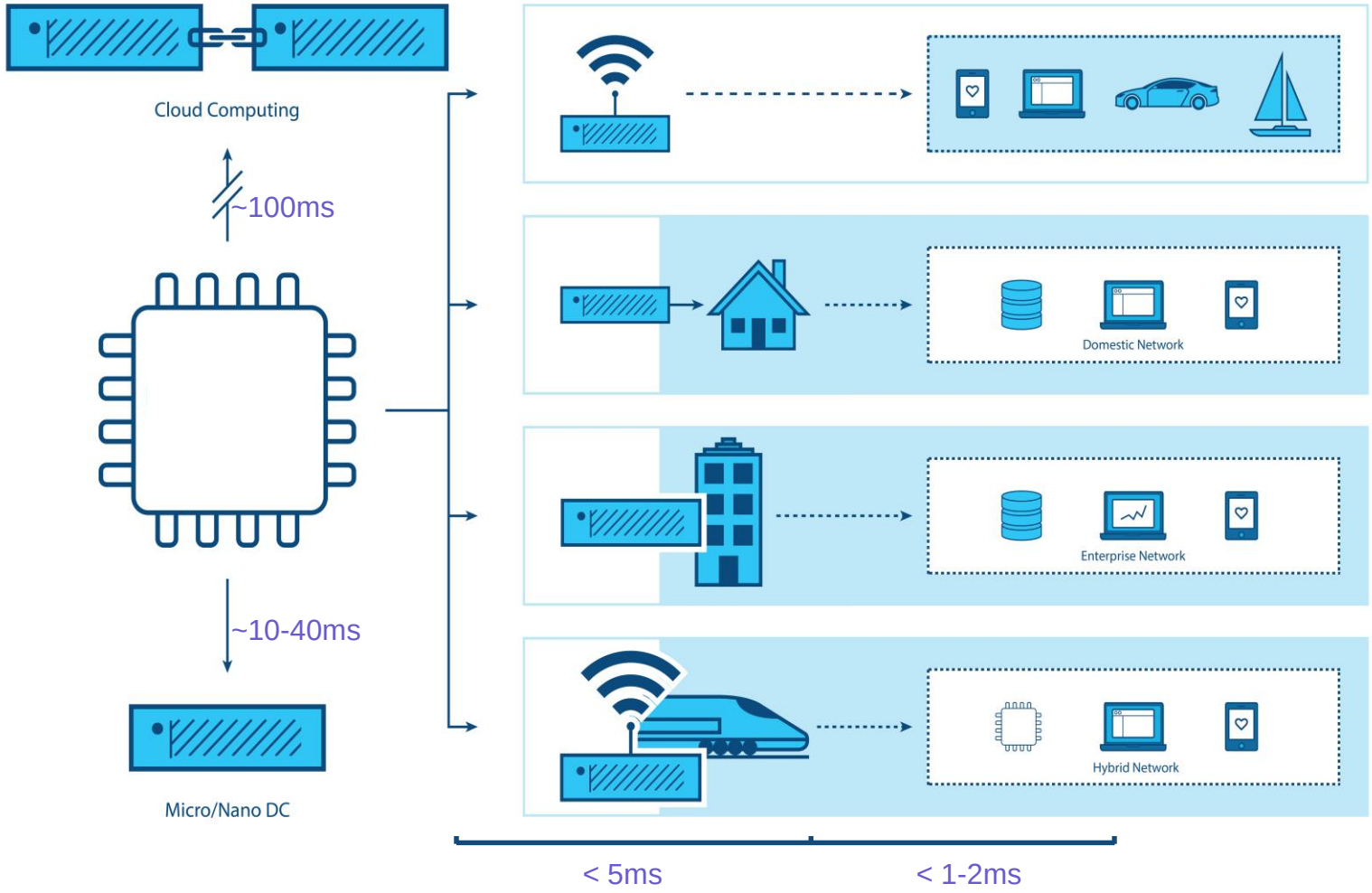
FUTURE PLAN

- Networking for Next-Gen Container Architecture

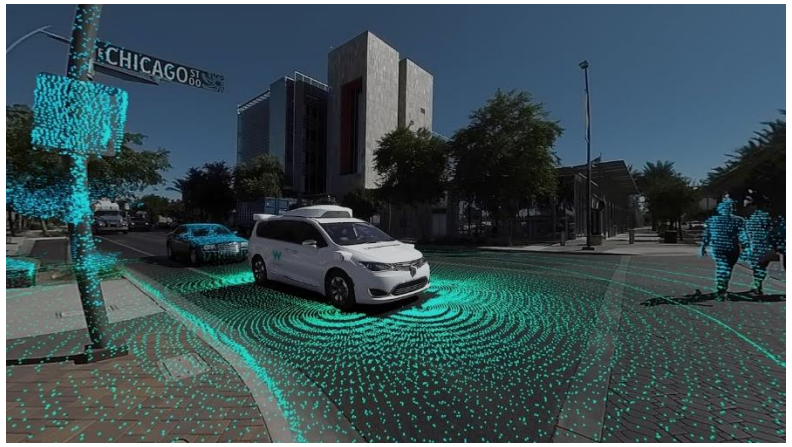
What is Driving Edge Computing?

A. **Latency**
B. **Bandwidth**
C. **Data Locality**
D. **Scalability**
E. **Connectivity**
F. **Security**

“WHERE” Matters!



Edge Computing Challenges



TO IMPROVE SERVICE CAPABILITIES

COMPLY WITH DATA LOCALITY

AND REDUCE APPLICATION LATENCY

Sources: https://virtualrealitypop.com/different-types-of-vr-ar-devices-making-sense-of-the-spatial-computing-landscape-605efe5b9f17; https://datafloq.com/read/how-edge-computing-will-give-new-life-health-care/3715; https://www.autotrader.ca/newsfeatures/20170109/continental-zf-debut-new-autonomous-driving-tech-at-ces-2017/

Edge Networking Requirements

“Networking” Plays a Key Role at the Edge!

1. **Network performance and efficiency**
   Latency, Bandwidth
2. **Remote management of complex and non-homogeneous networks**
   Data Locality, Scalability
3. **Reliability and autonomous site operations with limited connectivity**
   Connectivity
4. **Enhanced network security**
   Security
5. **Capex and Opex, Time To Market**

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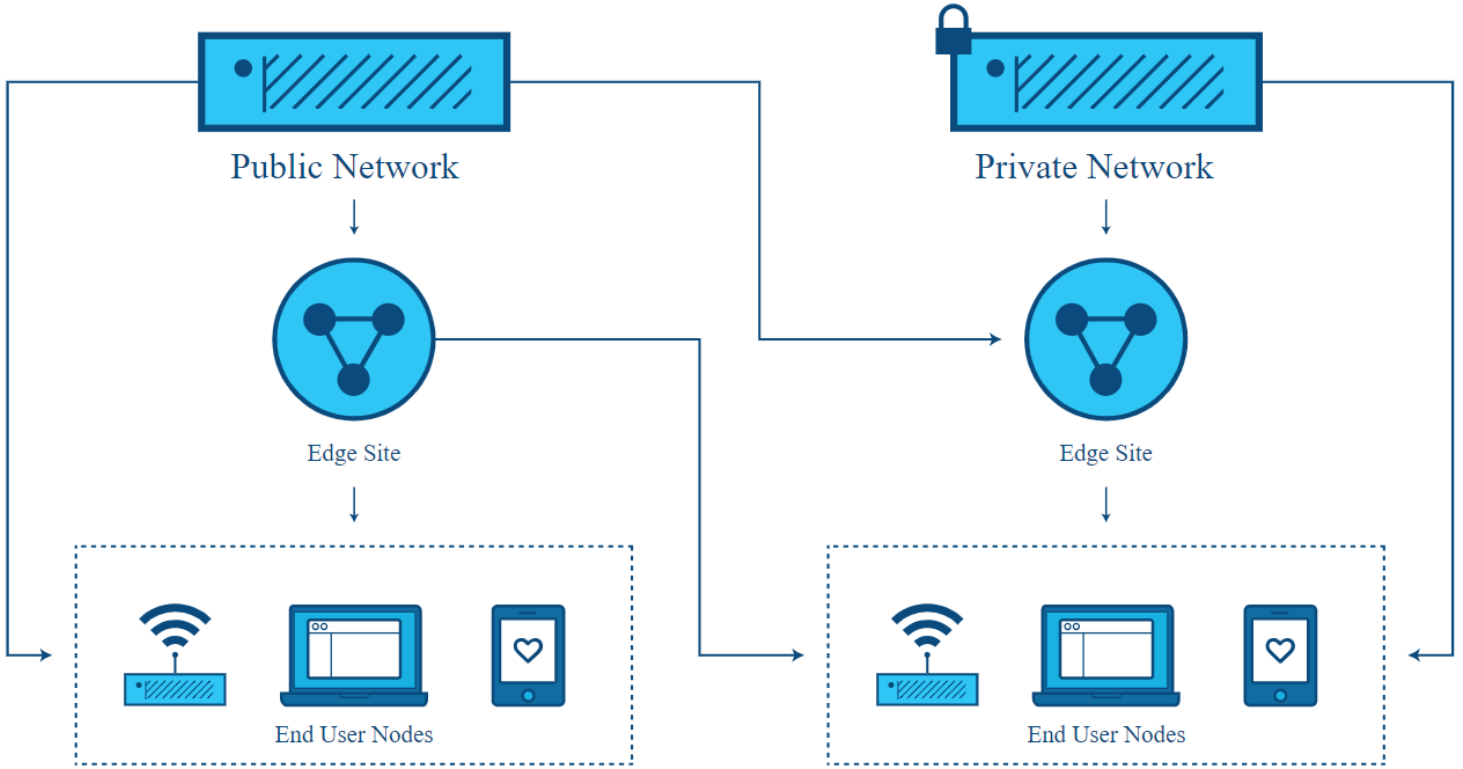
What Problems is StarlingX Solving?

Data growth is massive



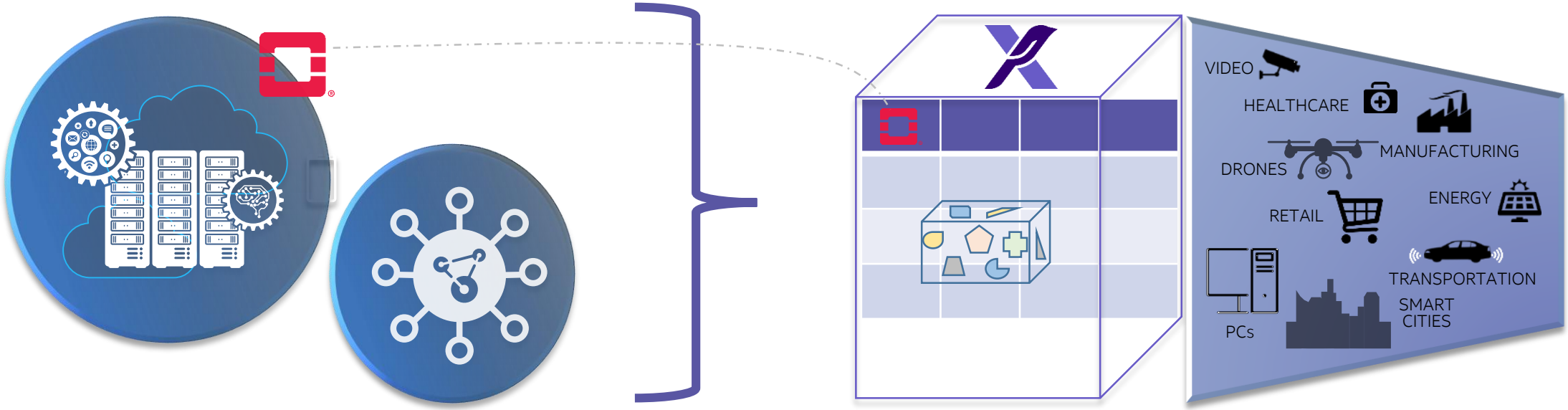
Network needs to be smarter

1. Distributed infrastructure demands a different architecture
2. Managing a massively distributed compute environment is hard
3. The maturity and robustness of Cloud is required everywhere

Intent of the StarlingX Project

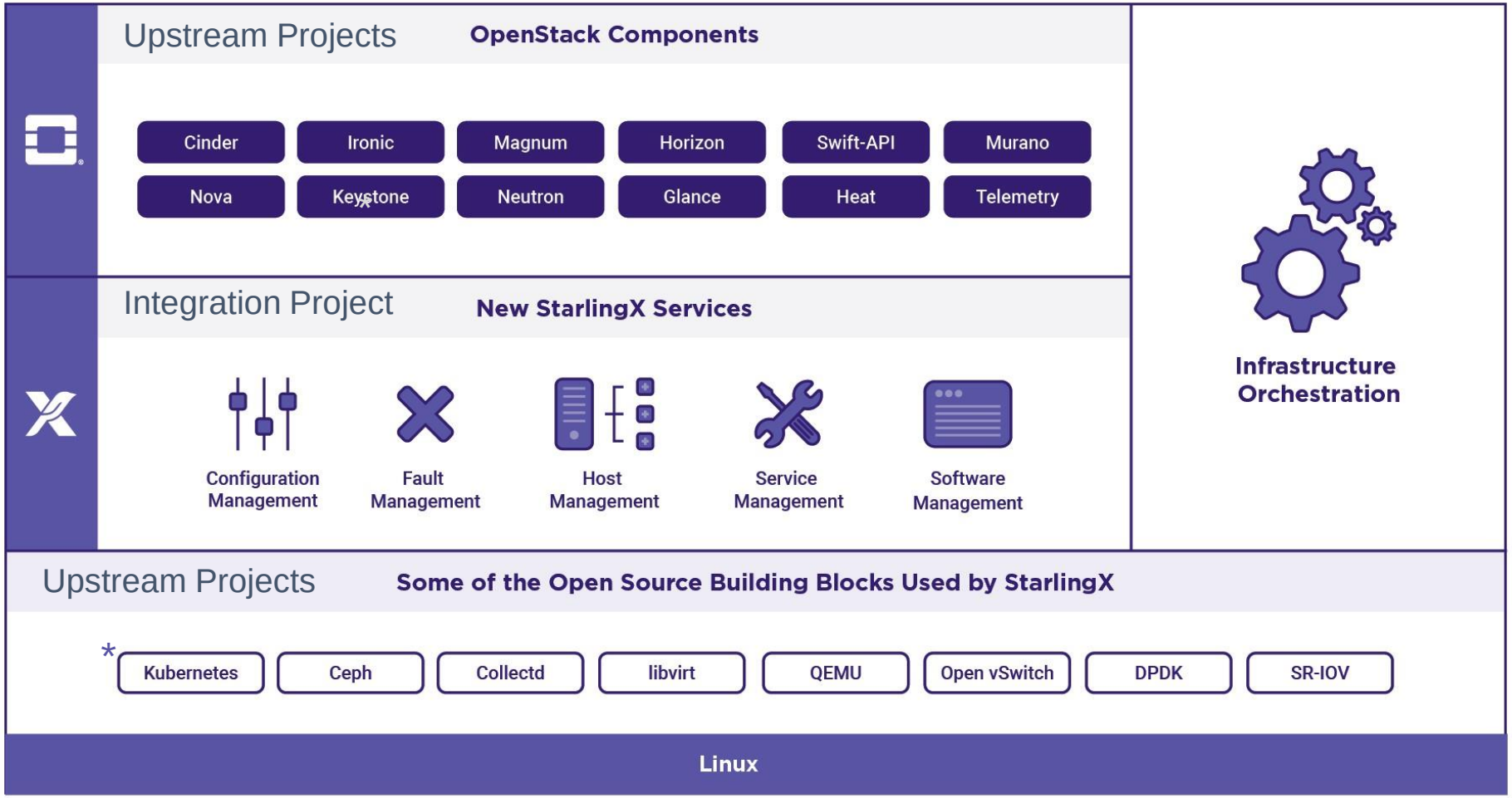
Re-Configure Proven Cloud Technologies for Edge Compute

- Orchestrate system-wide
- Simplify deployment to geographically dispersed, remote Edge regions
- Provide a deployment-ready, scalable, highly reliable Edge infrastructure software platform



StarlingX – Edge Virtualization Platform

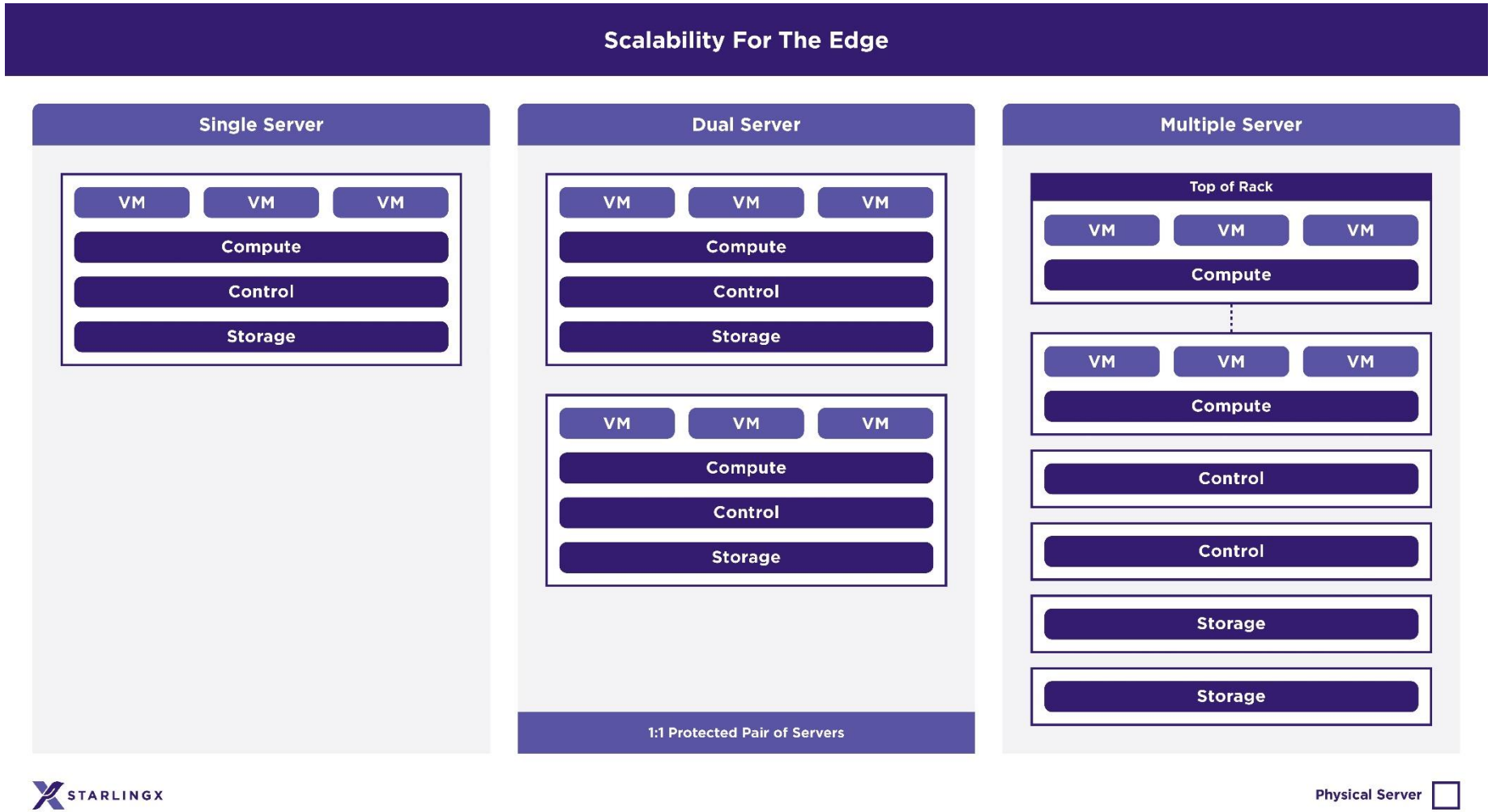
- Network performance and efficiency
- Remote management of complex and non-homogeneous networks
- Reliability and autonomous site operations with limited connectivity
- Enhanced network security



A Fully Featured Cloud for the Distributed Edge

StarlingX Scales Small or Large

- Single Server
  - Runs all functions
- Dual Server
  - Redundant design
- Multiple Server
  - Fully resilient and geographically distributable



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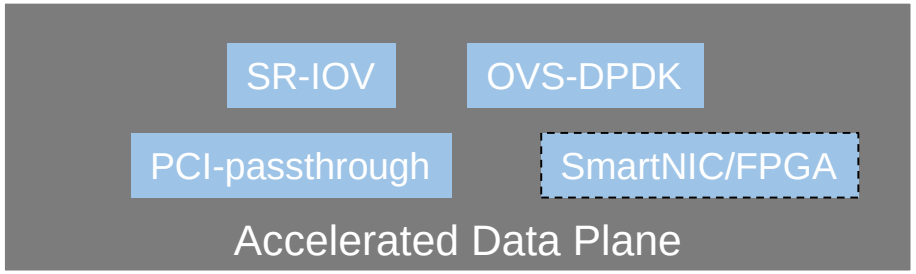
Network Performance and Efficiency

Mission-ready Network Performance

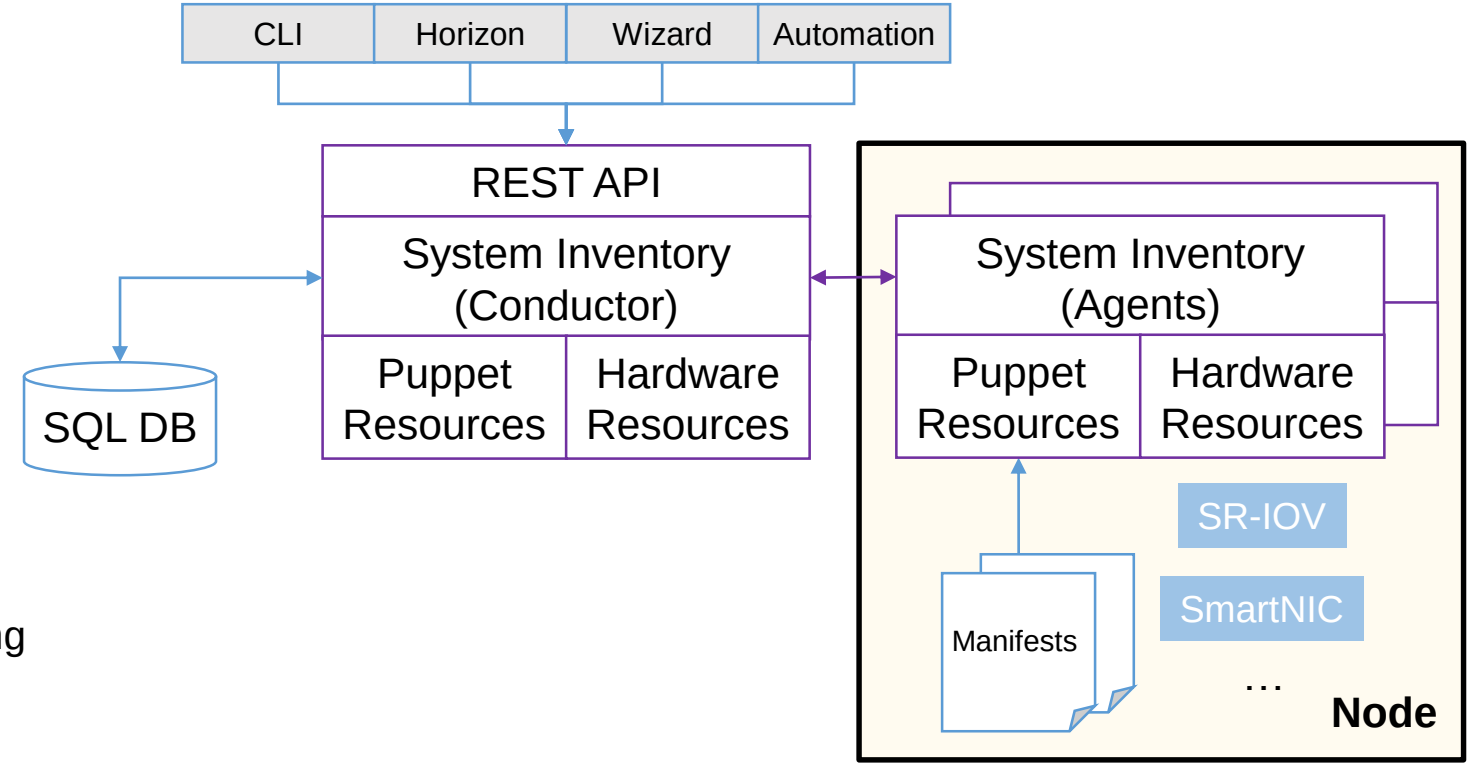
- **High performance** Node-to-Node, VM-to-VM networking
  - Enabled:
    - OVS-DPDK
    - SR-IOV
    - PCI-passthrough
  - WIP for OpenStack Upstream
    - SmartNIC/FPGA
- **Real-time** and **low latency** enhancements to KVM
  - Reduced variability of interrupt latency
  - Reduced high resolution timer latency
- “Hardware Acceleration for Edge Networking”
  - Thu 15, 11:40am - 12:20pm, Level 1 - Hall A1



Configuration Management

Acceleration technology support & Optimized configurations for Edge Cloud

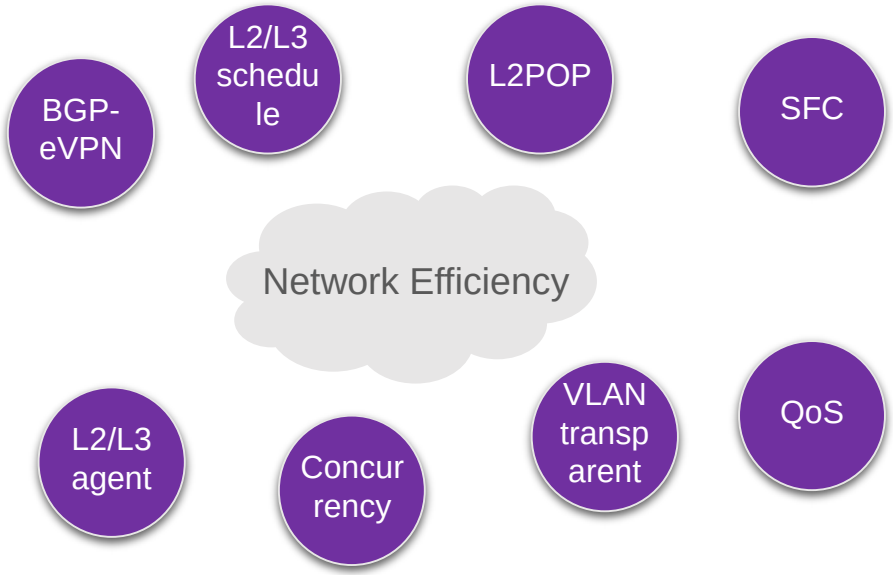
- Manage Installation and Configuration
  - Auto-discover new nodes in an edge site
  - Manage installation and configuration parameters (e.g. Neutron config, agent parameters etc.)
- Nodal Configuration
  - Network Interfaces (DPDK)
- Inventory Discovery
  - Physical NICs (# and bandwidth)
  - H/W acceleration devices for edge networking (SR-IOV, SmartNIC etc.)



System Configuration and Setup

Improved Network Efficiency

- Based on OpenStack Neutron
- L2/L3 scheduling/re-scheduling
  - Bulk operations; move away unnecessary operations
- L2/L3 agent
  - Event driven sync task
  - Stale RPC message handling
- Concurrency scenario enhancements
- L2POP
  - Registration mechanism for extension of L2POP fdb information
- VLAN transparent support
- QoS, BGP-eVPN, SFC…

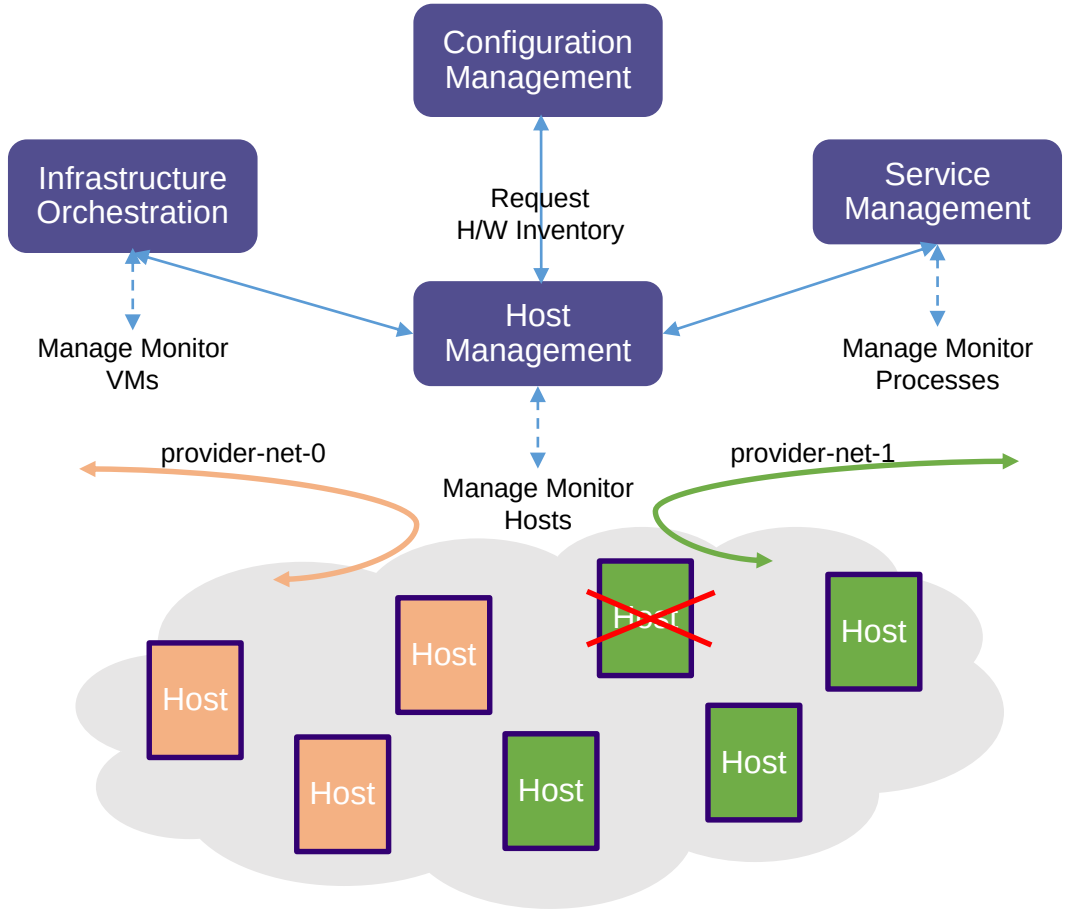


Remote Management of Complex and Non-homogeneous Networks

Host Management

Improved low touch manageability & Reliability

- Full life-cycle management of the host via REST API
- Detect and automatically handles host failures and initiate recovery
- Support automated and user level cluster connectivity tests
- Improve the way physical network topology is presented to the cloud/edge operator
- Monitoring and alarms for:
  - Critical process failures (etc. L2/L3 agents)
  - Resource utilization thresholds, interface states

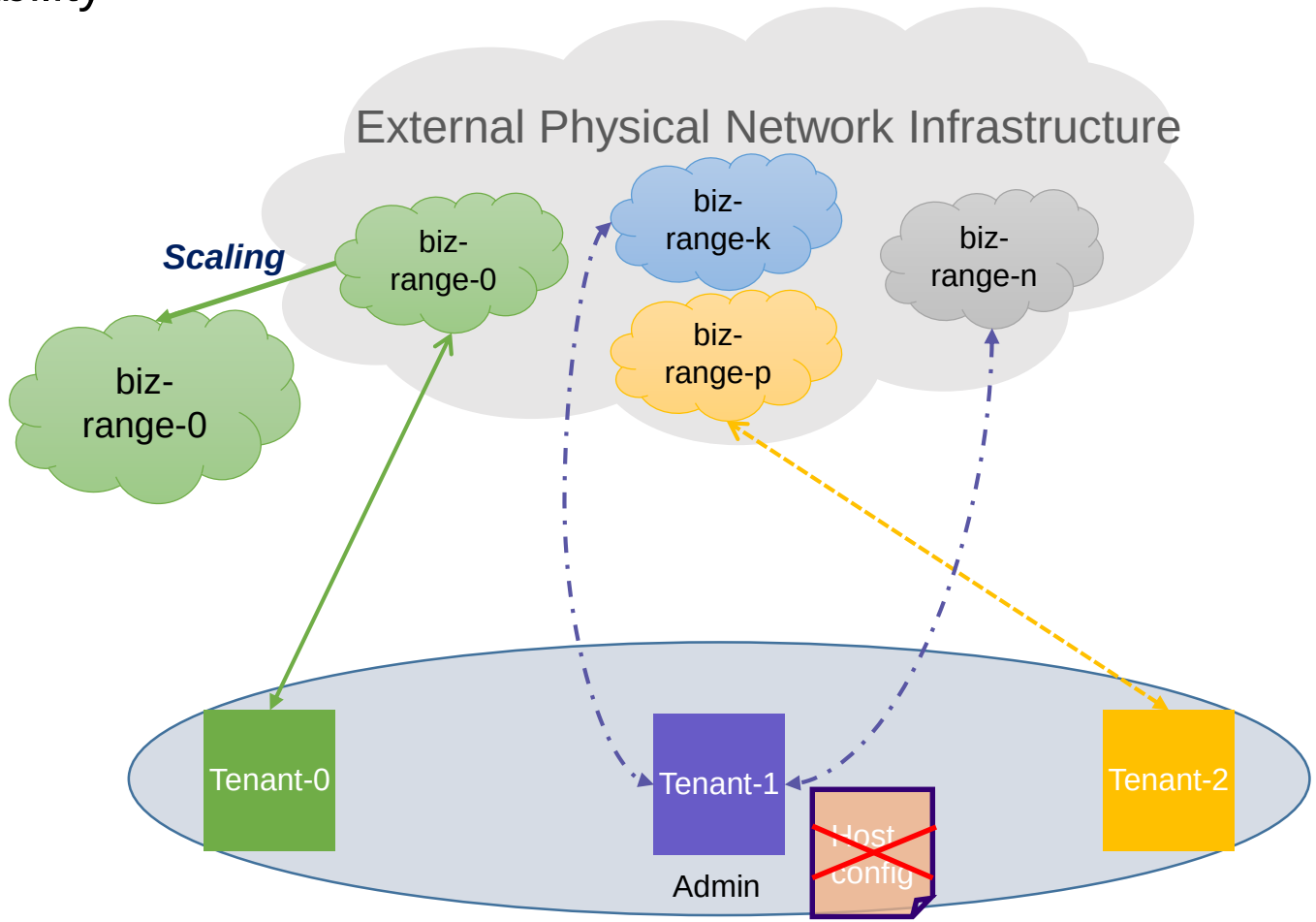


Vendor Neutral Host Management

Network Segment Management

Improved low touch manageability & Scalability

- Based on OpenStack Neutron
- Manage the underlying network segment ranges via REST API
  - Full network orchestration
  - No direct interact with host config
- Control the segment ranges globally or on a per-tenant basis
  - Complex and non-homogeneous network infrastructure deployments at the Edge
  - Varied business requirements
- Dynamic segment range scaling



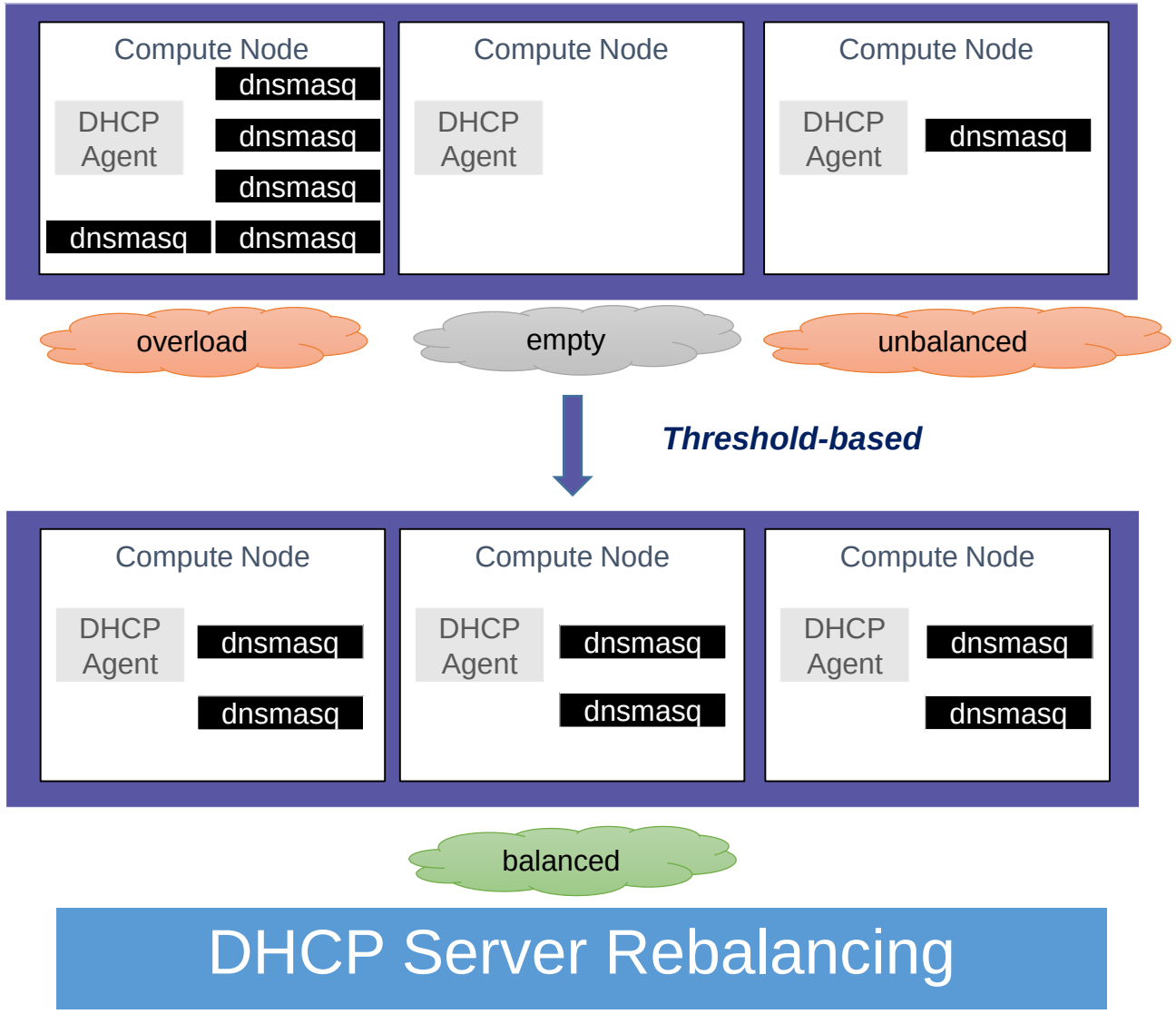
Network Segment Range Management

Reliability and Autonomous Site Operations with Limited Connectivity

L2/L3 Rescheduling

Enhanced high availability & Reliability

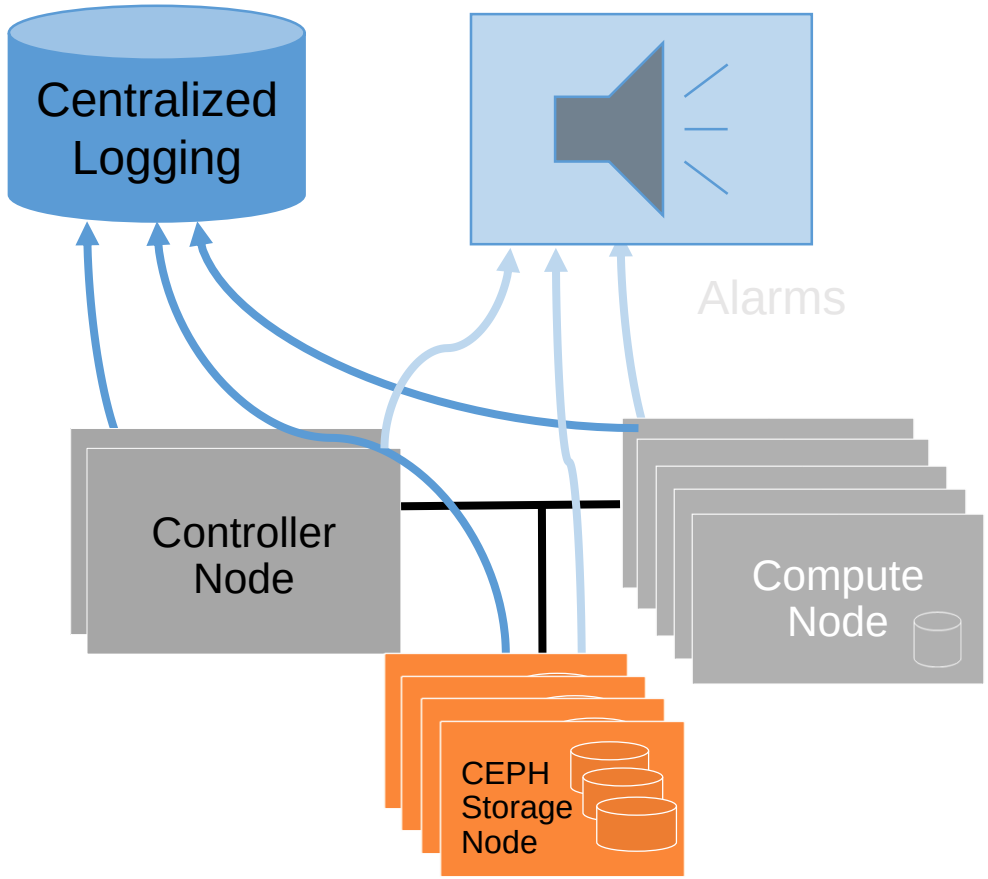
- Based on OpenStack Neutron
- Automatic rescheduling of DHCP servers and routers:
  - From offline L2/L3 agents to online L2/L3 agents
  - When new agents become active
  - When agents become overloaded
- Evaluation WIP:
  - Manual rescheduling via:
    - Script
    - API
  - Redistribution based on more sophisticated methodologies with additional info - CPU, memory, etc.
  - Re-configure default settings (L3-HA)



Fault Management

Enhanced high availability & Reliability

- Framework for infrastructure services via API:
  - Set, clear and query customer alarms & events of different severity levels
  - Generate customer logs for significant events
- REST API - alarms & events management
- Operator Alarms & Logs
  - On Platform Nodes & Resources
  - On Hosted Virtual Resources
- Network fault management
  - Network connectivity, ports, interfaces, Neutron agents
  - ML2 drivers
  - BGP peers

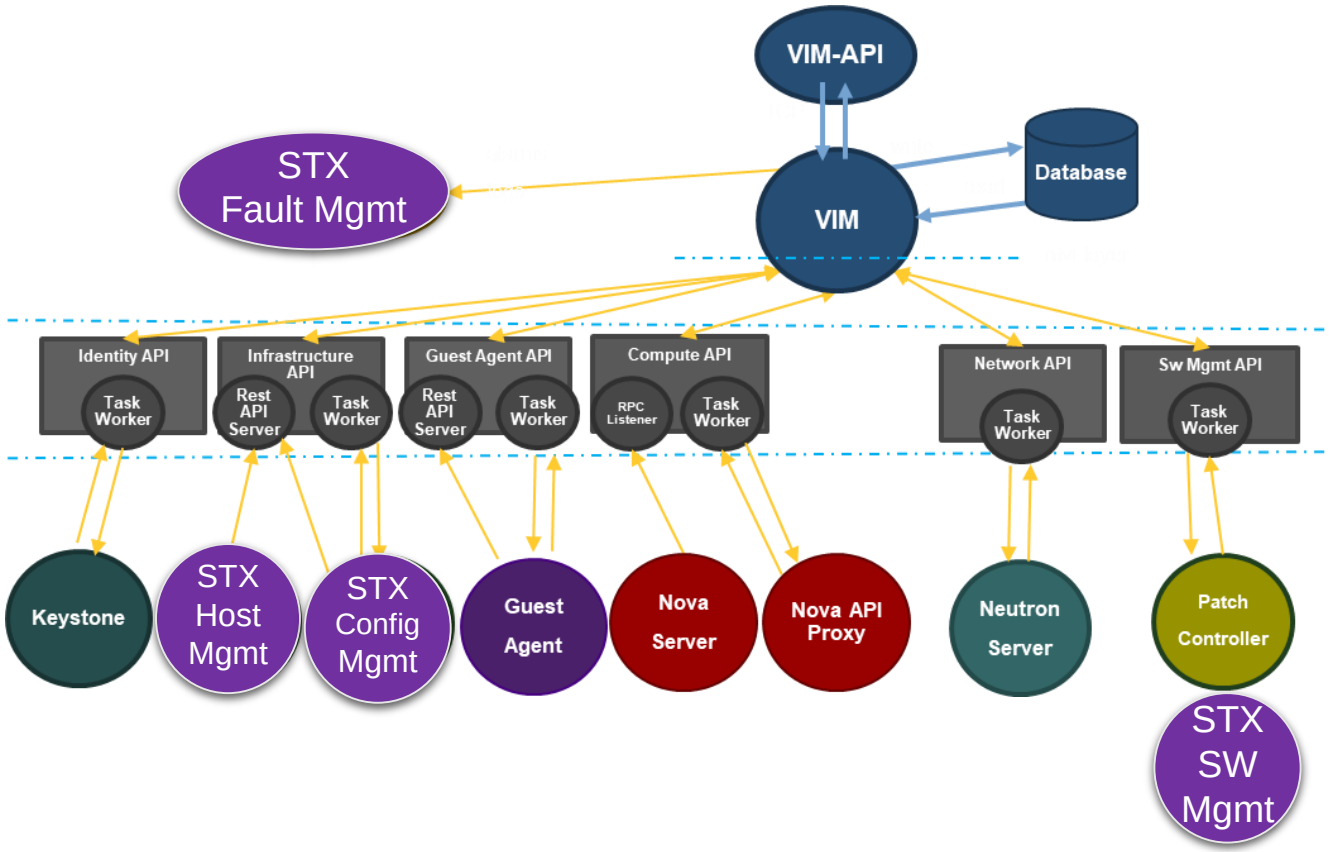


Fault Alarming and Logging

Infrastructure HA & Orchestration

Enhanced high availability & Reliability – A complete stack

- Manage and orchestrate VM carrier grade and high availability capabilities
  - Auto-healing of failed instances
  - Raising and clearing operator alarms
  - Generating operator logs about instances
- Orchestrate the migration of instances off of a compute host
- Automatically migrate VMs through procedure
- Controller fail-over
- Service monitoring and migration

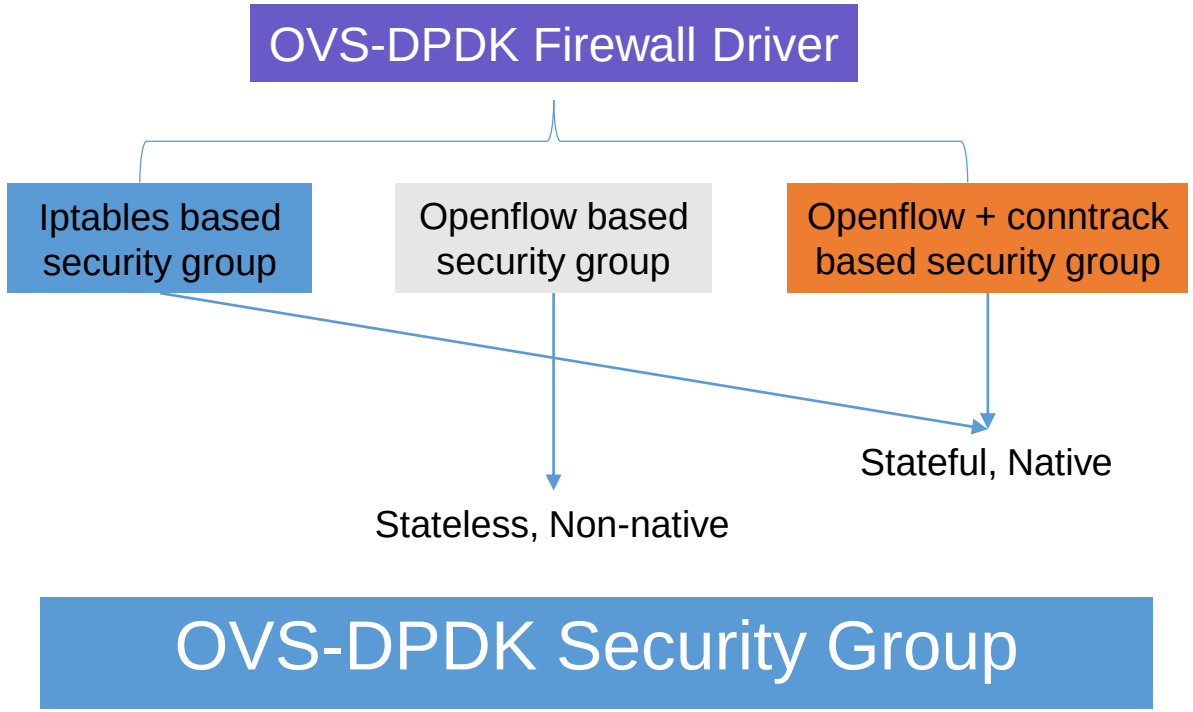


HA and Live Migration for VMs

Enhanced Network Security

Enhanced Network Security

- Based on OpenStack Neutron
  - OVS-DPDK firewall driver
    - Evaluation of security group implementations
    - Openflow + conntrack based security group: user-space, stateful, native
- Patching support via SW management



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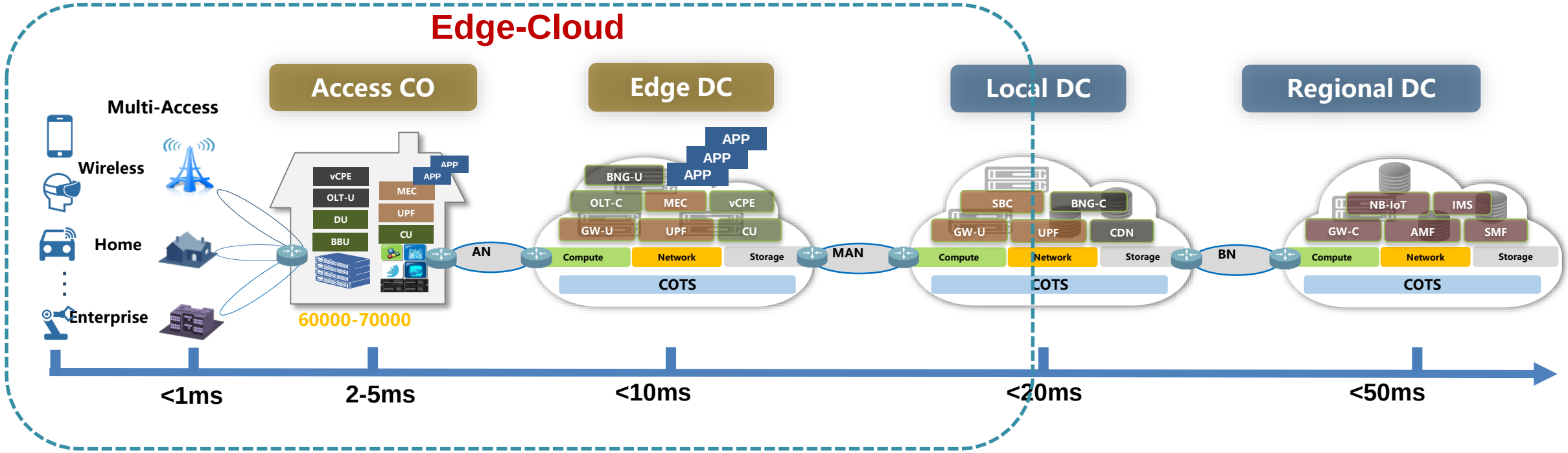
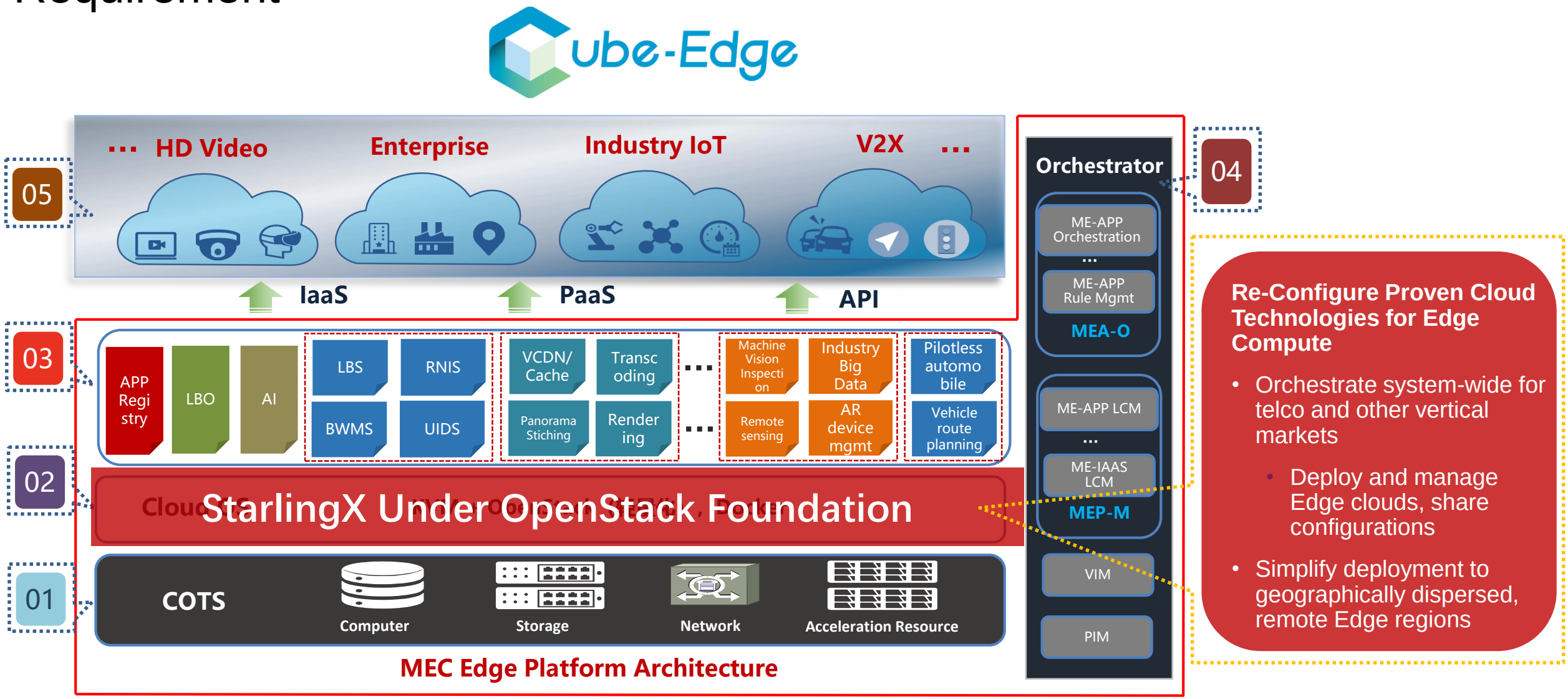
China Unicom‘s Full Stack Cloud Network Architecture

The 5G network of China Unicom will be an *Elastic*、*Open*、*Efficient*、*Agile* network based on Regional DC、Local DC、Edge DC and Access CO, which will quickly respond to and shorten the deployment time of new services.



- Edge DC: 6000-7000
- Local DC: 600-700
- Regional DC: 70-80

StarlingX__Mapping to China Unicom‘s Edge-Cloud Platform Requirement



Re-Configure Proven Cloud Technologies for Edge Compute

- Orchestrate system-wide for telco and other vertical markets
  - Deploy and manage Edge clouds, share configurations
- Simplify deployment to geographically dispersed, remote Edge regions

StarlingX Deep Dive__Fault Management & Event Suppression

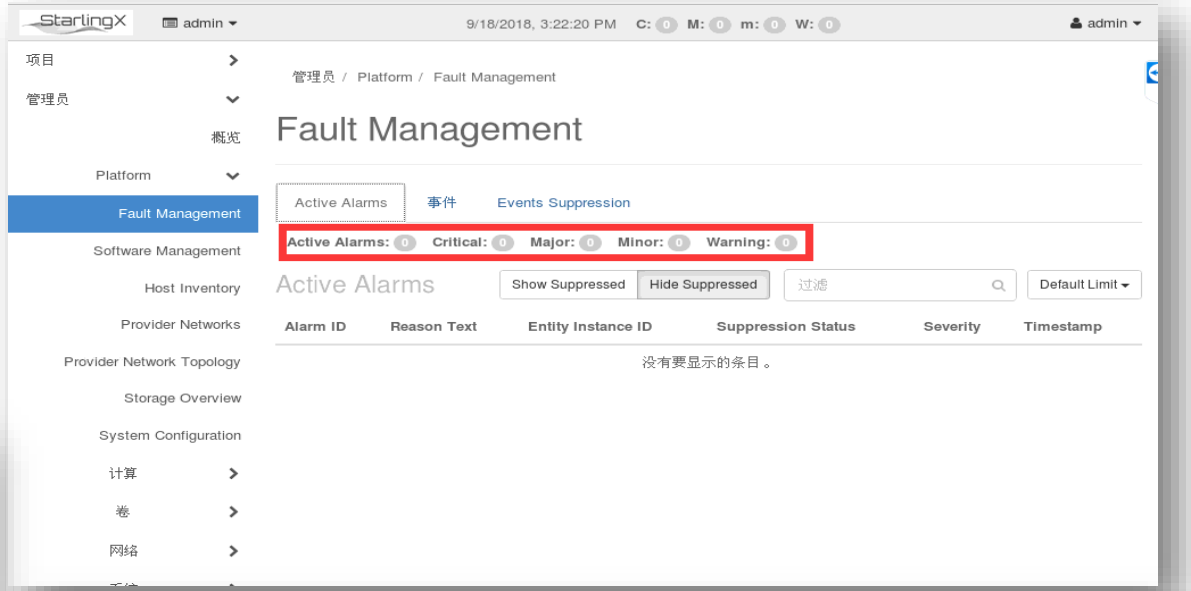
(Mapping to ETSI Interface Requirement)

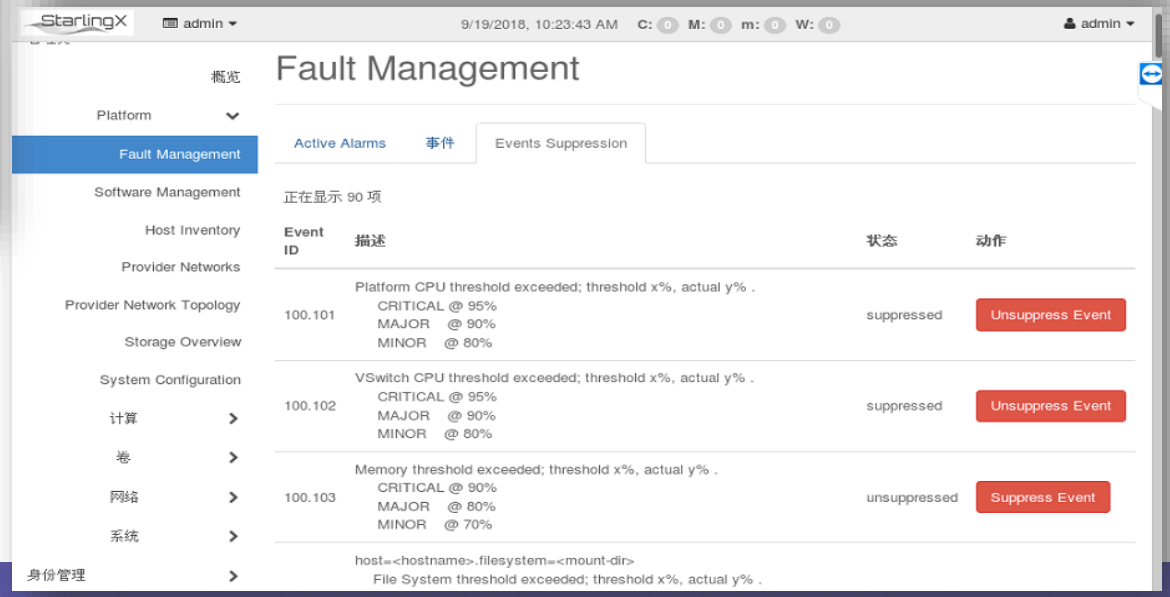
As ETSI GS MEC 010-1 V1.1.1 (2017-10) (*Mobile Edge Computing (MEC); Mobile Edge Management; Part 1: System, host and platform management*) defined:

7.3.1 Fault Management interface

For Alarm Management, the following 3GPP defined IRPs are used:

- ETSI TS 132 111-2 [4]: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Fault Management; Part 2: Alarm Integration Reference Point (IRP): Information Service (IS) (3GPP TS 32.111-2)".
- ETSI TS 132 332 [5]: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Notification Log (NL) Integration Reference Point (IRP); Information Service (IS) (3GPP TS 32.332)".





StarlingX Deep Dive_System Configuration

(Mapping to ETSI Interface Requirement)

As ETSI GS MEC 010-1 V1.1.1 (2017-10) (*Mobile Edge Computing (MEC); Mobile Edge Management; Part 1: System, host and platform management*) defined:

5.1.1 Requirements for reference point Mm2

5.1.1.1 Requirements related to the mobile edge host

5.1.1.1.1 Configuration Management requirements

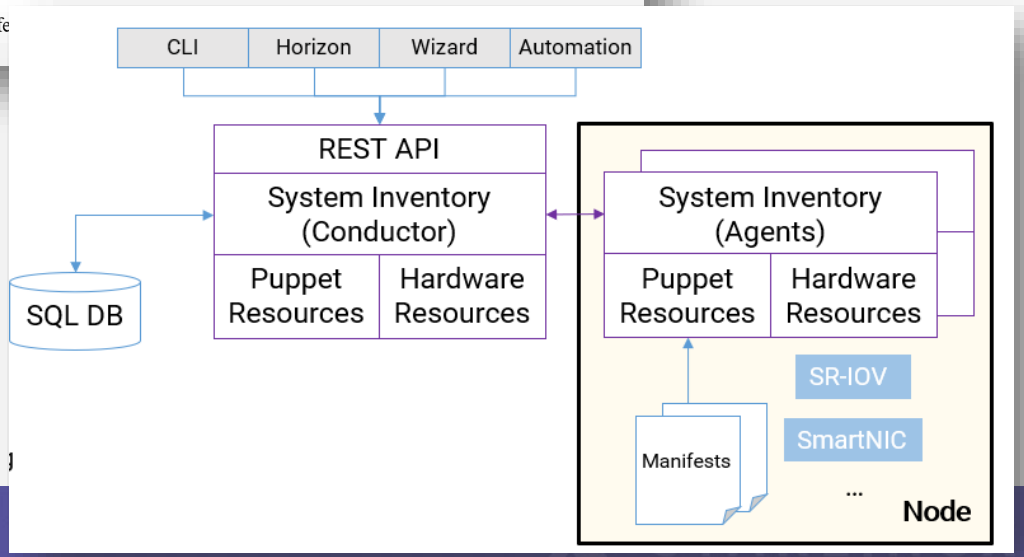
REQ-MM2-MEH-CM-1: The Mm2 reference point shall support a capability allowing the OSS to retrieve the information model of the mobile edge host, or parts thereof, from the mobile edge platform manager.

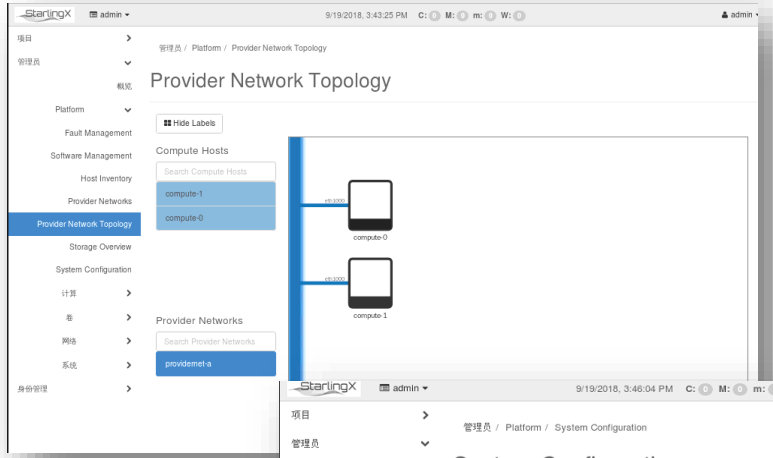
REQ-MM2-MEH-CM-2: The Mm2 reference point shall support a capability allowing the mobile edge platform manager to notify changes related to the information model of the mobile edge host to the OSS.

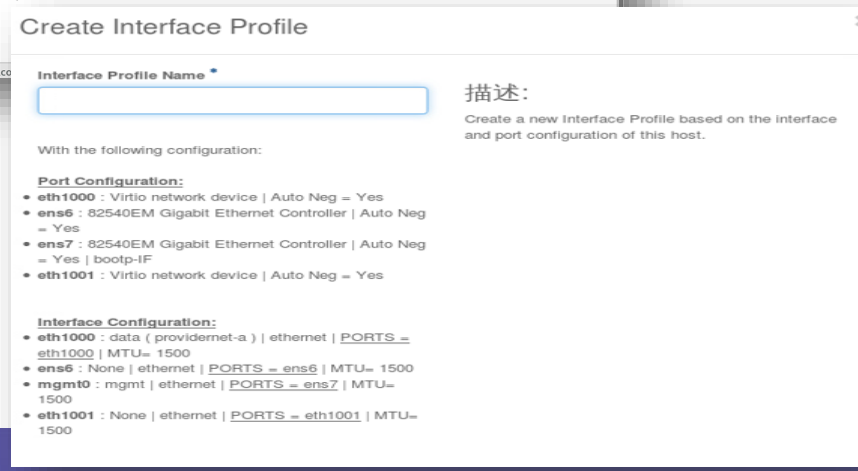
REQ-MM2-MEH-CM-3: The Mm2 reference point shall support a capability allowing the OSS to configure the mobile edge host.

REQ-MM2-MEH-CM-4: The Mm2 reference point shall support a capability allowing the OSS to configure the DNS rules.

REQ-MM2-MEH-CM-5: The Mm2 refe
rules.

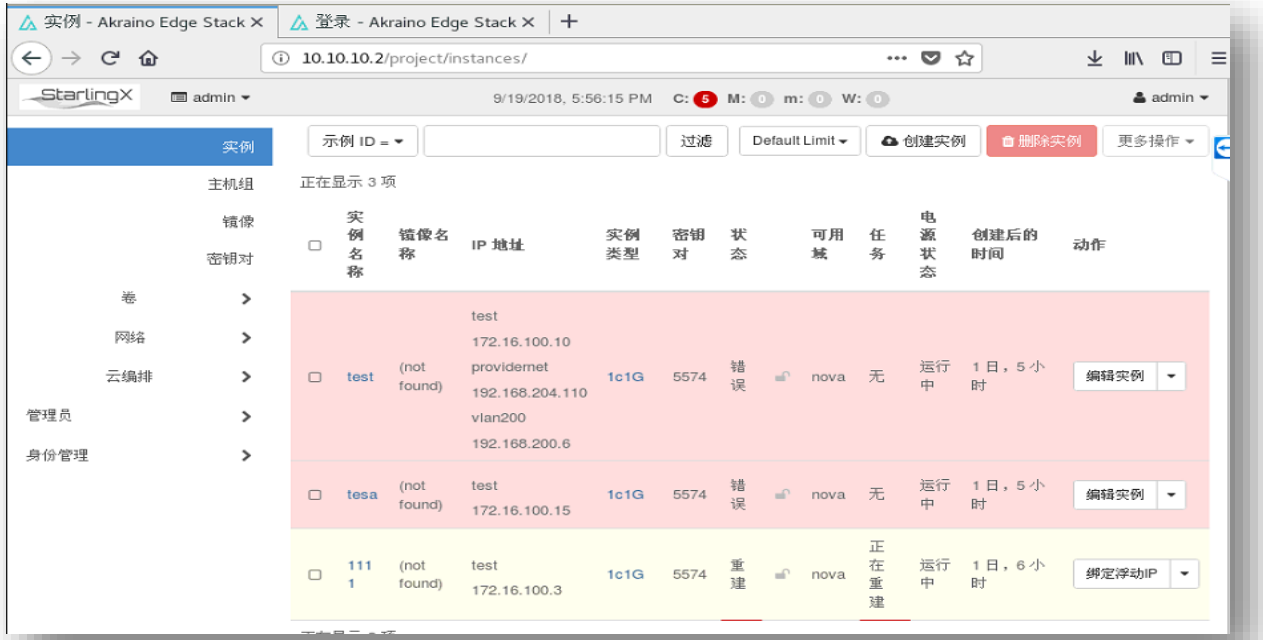






StarlingX Deep Dive - VM HA Acceleration

(Not ETSI Required but critical to Edge)



OS	Size	Restore Time
CentOS	800M	~30s
Cirros	12M	~20s

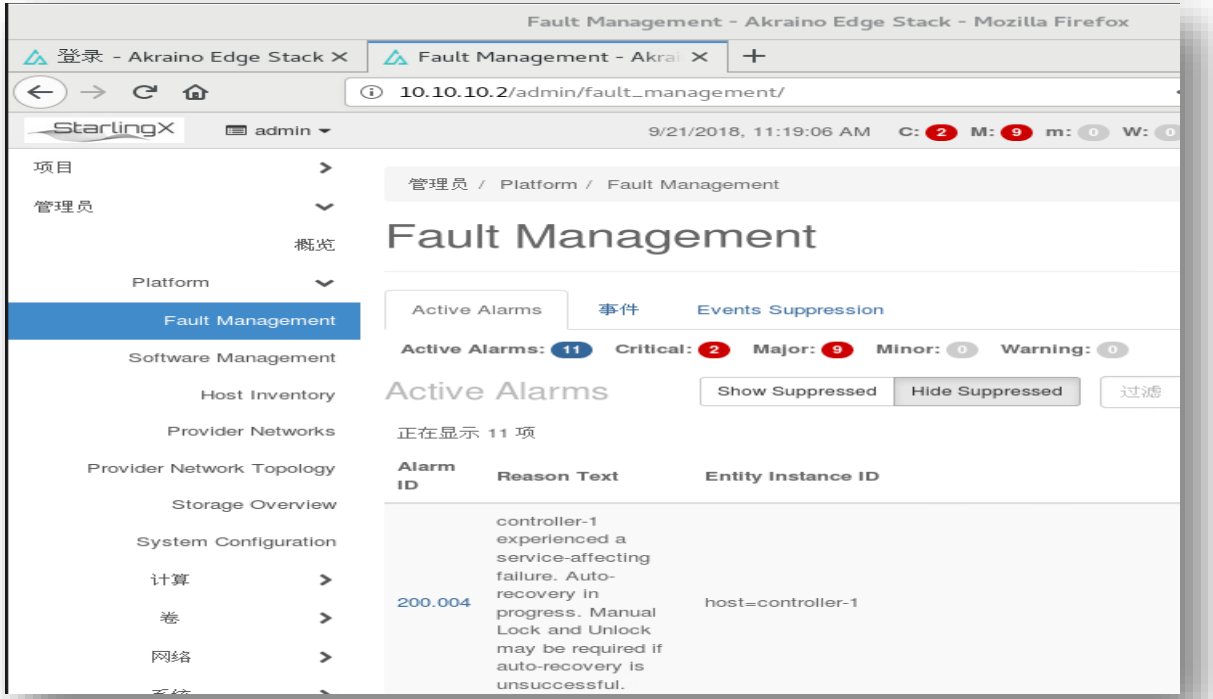
```
controller-0:~$  ping 172.16.140.152   | awk '{ print $0"\t" strftime("%H:%M:%S",systime()) } '
PING 172.16.140.152 (172.16.140.152) 56(84) bytes of data.      10:52:20
64 bytes from 172.16.140.152: icmp_seq=1 ttl=63 time=0.468 ms   10:52:20
64 bytes from 172.16.140.152: icmp_seq=2 ttl=63 time=0.265 ms   10:52:21
64 bytes from 172.16.140.152: icmp_seq=3 ttl=63 time=0.234 ms   10:52:22
64 bytes from 172.16.140.152: icmp_seq=4 ttl=63 time=0.218 ms   10:52:23
64 bytes from 172.16.140.152: icmp_seq=5 ttl=63 time=0.230 ms   10:52:24
64 bytes from 172.16.140.152: icmp_seq=6 ttl=63 time=0.206 ms   10:52:25
64 bytes from 172.16.140.152: icmp_seq=7 ttl=63 time=0.226 ms   10:52:26
64 bytes from 172.16.140.152: icmp_seq=8 ttl=63 time=0.232 ms   10:52:27
64 bytes from 172.16.140.152: icmp_seq=9 ttl=63 time=0.230 ms   10:52:28
64 bytes from 172.16.140.152: icmp_seq=10 ttl=63 time=0.244 ms  10:52:29
64 bytes from 172.16.140.152: icmp_seq=11 ttl=63 time=0.235 ms  10:52:30
64 bytes from 172.16.140.152: icmp_seq=12 ttl=63 time=0.252 ms  10:52:31
64 bytes from 172.16.140.152: icmp_seq=13 ttl=63 time=0.245 ms  10:52:32
64 bytes from 172.16.140.152: icmp_seq=14 ttl=63 time=0.217 ms  10:52:33
64 bytes from 172.16.140.152: icmp_seq=15 ttl=63 time=0.237 ms  10:52:34
64 bytes from 172.16.140.152: icmp_seq=16 ttl=63 time=0.253 ms  10:52:35
From 172.16.130.1 icmp_seq=46 Destination Host Unreachable      10:53:08
From 172.16.130.1 icmp_seq=47 Destination Host Unreachable      10:53:08
From 172.16.130.1 icmp_seq=48 Destination Host Unreachable      10:53:08
64 bytes from 172.16.140.152: icmp_seq=49 ttl=63 time=998 ms    10:53:09
64 bytes from 172.16.140.152: icmp_seq=50 ttl=63 time=0.191 ms  10:53:09
64 bytes from 172.16.140.152: icmp_seq=51 ttl=63 time=0.244 ms  10:53:10
```

VM Restored in 34s (CentOS, 800M)

StarlingX Deep Dive - Controller HA Optimization
(Not ETSI Required but critical to Edge)

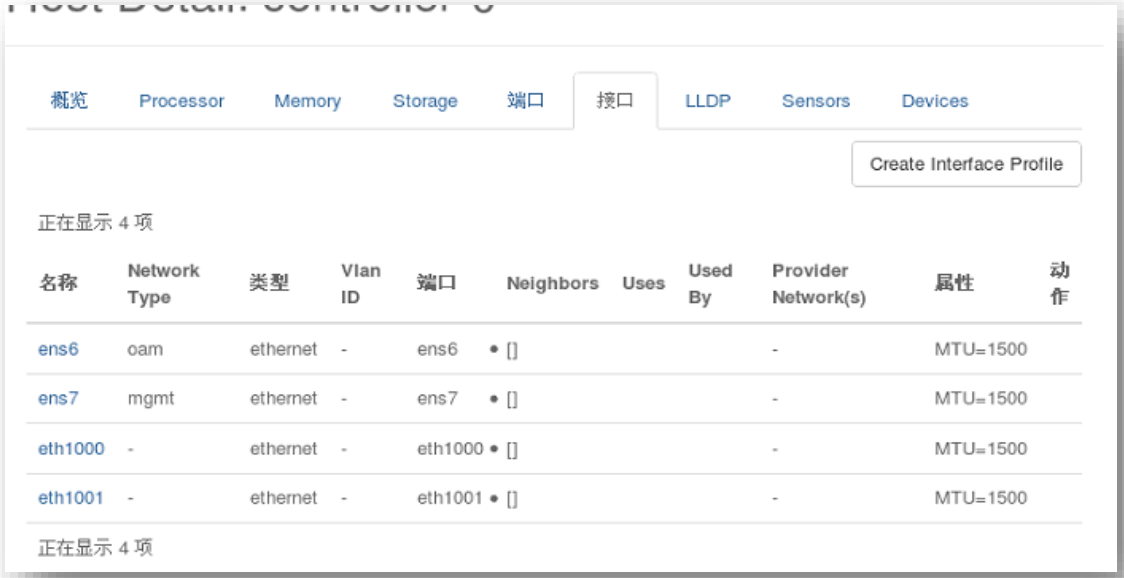
- Single Server
  - Runs all functions
- Dual Server
  - Redundant design
- Multiple Server
  - Fully resilient and geographically distributable

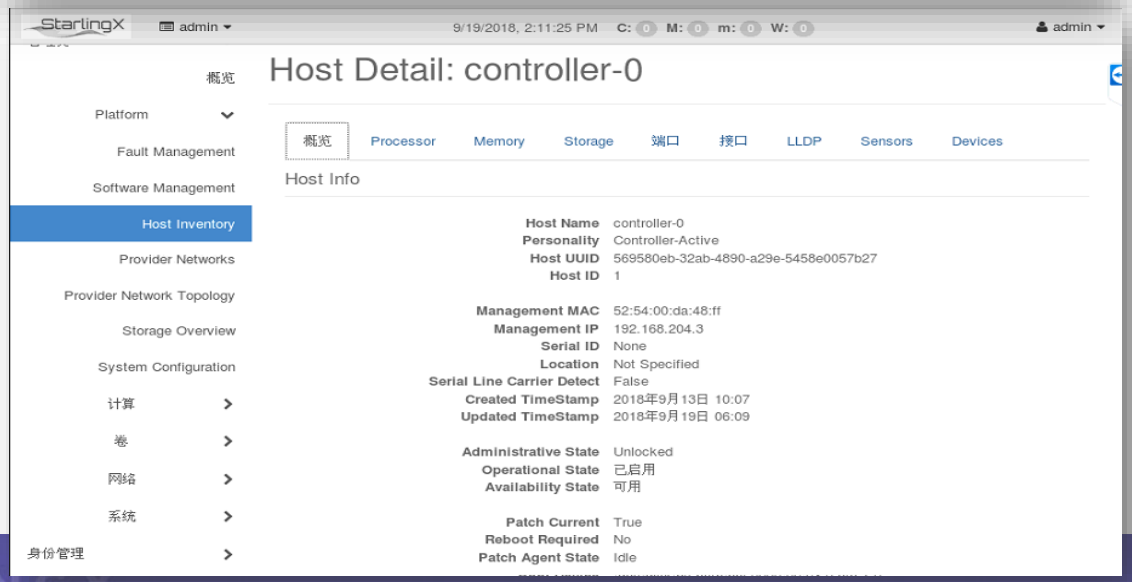
Test case	Platform Status	Restore Time
Stop 1 controller nova-compute	√ Running but w/ warning	1s
Disable 1 controller nova-compute	√ Running but w/ warning	15s
Shutdown1 controller Host	√ Running but w/ warning	Need manually start Neutron service



StarlingX Deep Dive - Inventory Management
(Not ETSI Required but critical to Edge)

- Network Interfaces (DPDK)
- Physical NICs (# and bandwidth)
- H/W acceleration devices for edge networking (SR-IOV, SmartNIC etc.)





Quote from China Unicom_StarlingX Release

“Comparing to the cloud in deployed in core-network, edge computing is requesting more capabilities on hands-off operation, remote management, telco-grade service reliability, telco-grade latency and open interfaces.

We had run a full validation on StarlingX in the past 6 months. StarlingX improved efficiency on high-availability in both VM and controller level. It also optimized the required nodes number to fit edge deployment scenarios. Features were added in fault management, rolling upgrading, inventory discovery and VNF acceleration, which are the interfaces recommended in ETSI MEC RA. StarlingX provided capability in VM-applications/VNFs hosting, it also can be extended to support containerized applications in the future.

It is one of the top strategies to China Unicom to build an “open” edge platform to provide open interfaces, support ecosystem applications hosting and avoid vendor lock-in. As an “Open Infra” technology for edge computing, StarlingX will play an essential role in China Unicom’s edge strategy.”

Dr. Dan Chen, Senior Director of Edge Computing, China Unicom

01 4’

EDGE NETWORKING

- What is Driving Edge Computing?
- Edge Computing Challenges
- Edge Networking Requirements

02 4’

WHAT IS STARLINGX?

- What Problems is StarlingX Solving?
- Intent of the StarlingX Project
- StarlingX – Edge Virtualization Platform
- StarlingX Scales Small or Large

03 12’

TECHNOLOGY DETAILS

- Network Performance and Efficiency
- Remote Management of Complex and Non-homogeneous Networks
- Reliability and Autonomous Site Operations with Limited Connectivity
- Enhanced Network Security

04 10’

BUSINESS CASES

- China Unicom‘s Full Stack Cloud Network Architecture
- StarlingX__Mapping to China Unicom‘s Edge-Cloud Platform Requirement
- Quote

05 4’

STATUS

- Upstream Scope & Flow
- OpenStack Networking Upstream Status
- Downstream Status

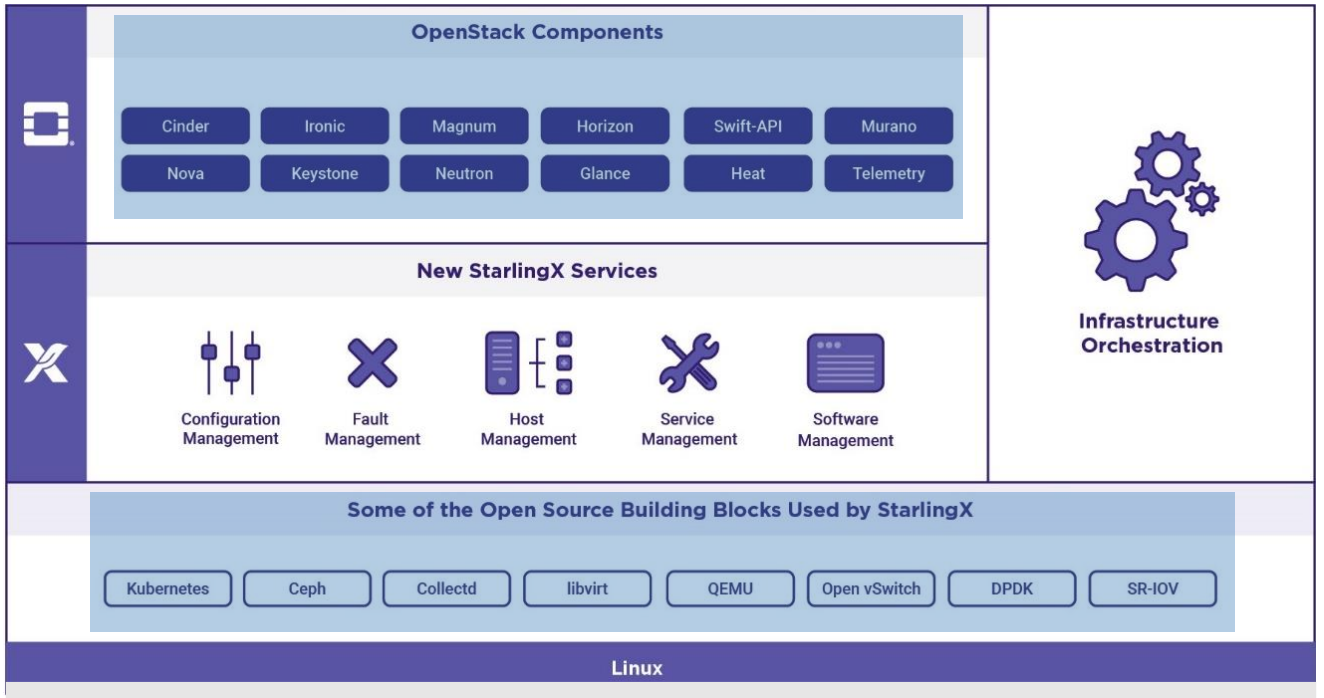
06 3’

FUTURE PLAN

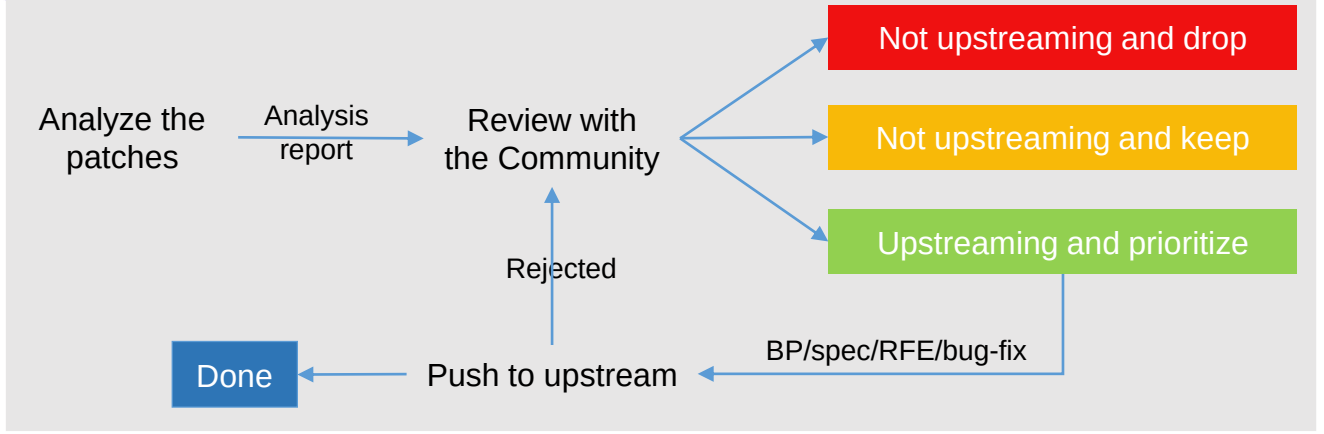
- Networking for Next-Gen Container Architecture

Upstream Scope & Flow

- StarlingX upstreaming scope
  - OpenStack components
  - Other Open Source blocks

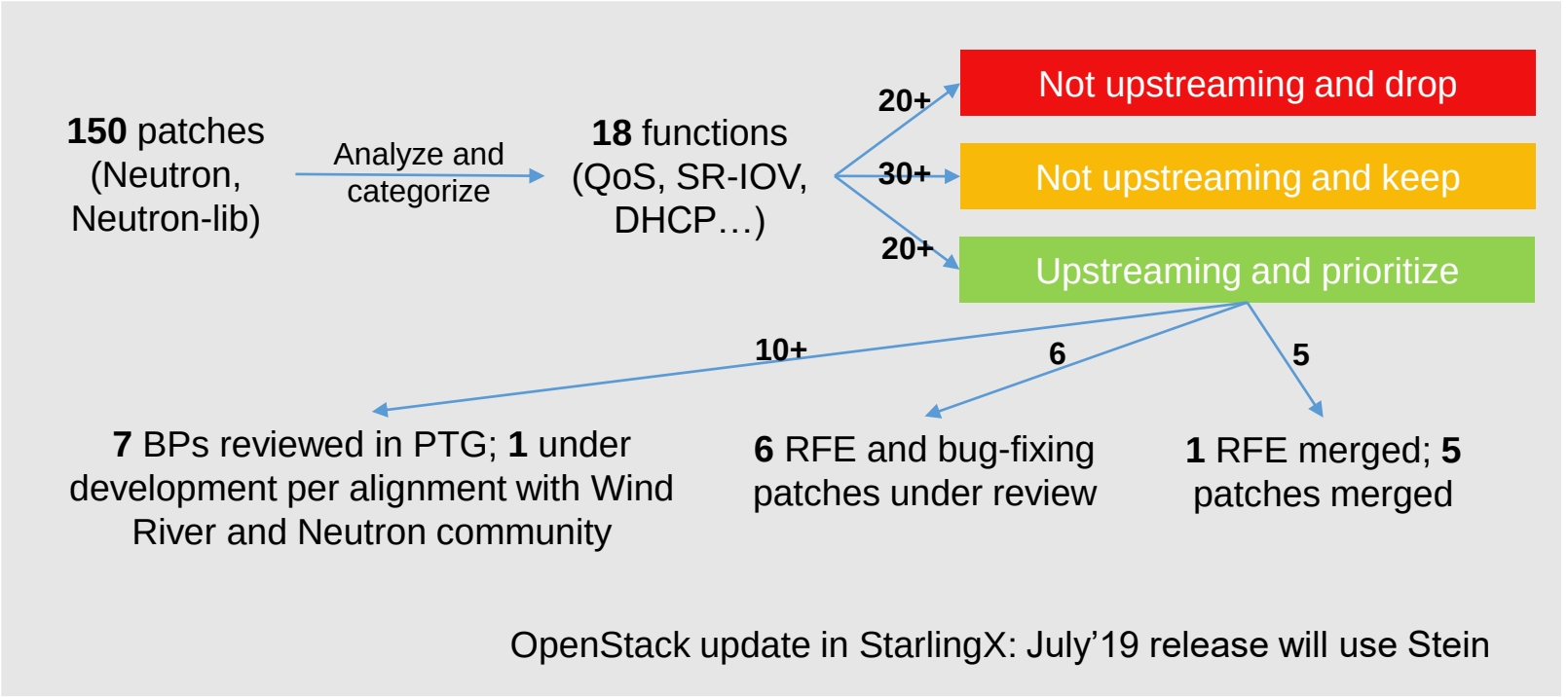


- StarlingX upstreaming work flow



OpenStack Networking Upstream Status

- StarlingX upstreaming progress (by Oct'18)
- Align with upstream!
  - Target **ZERO** patch
  - Update to OpenStack **Stein** for the StarlingX **2019.07.0** release.



Downstream Status

- StarlingX enhancements:
  - OVS-DPDK firewall driver
  - vSwitch configurability
  - OVS LLDP (Link Layer Discovery Protocol) inventory
  - OVS rx multi-queue affinity
- Containerized OpenStack services:
  - Generalized interface and network configuration for Kubernetes deployments
  - Enable vSwitch functions based on nodal labels

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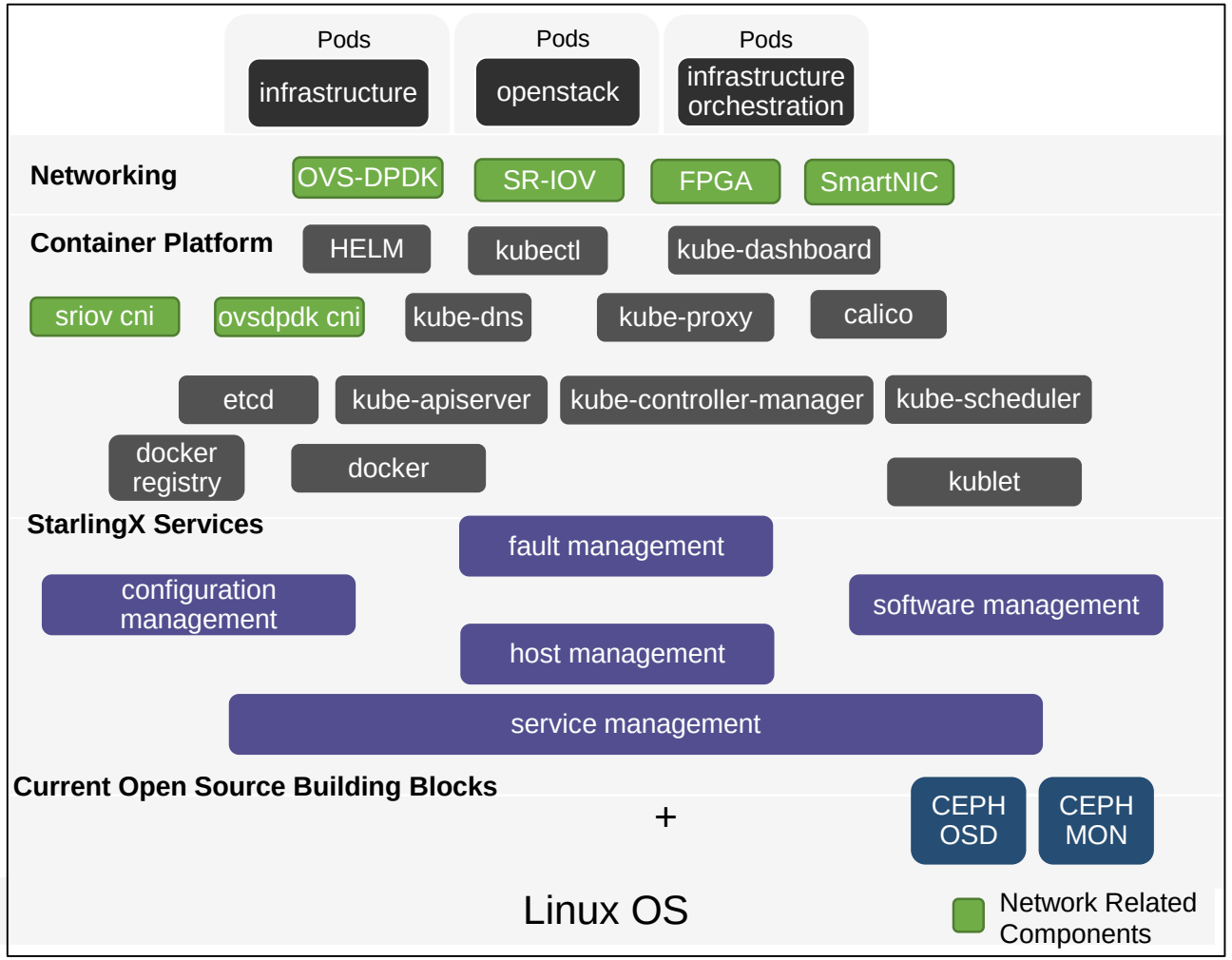
Networking for Next-Gen Container Architecture

- Container Architecture
  - Containerized OpenStack Service
    - Containerize OVS-DPDK: Support OVS-DPDK in OpenStack-HELM
  - Containerized Infrastructure (VNF):
    - Accelerated container networking with SR-IOV, OVS-DPDK and SmartNIC/FPGA
    - Support multiple interface
    - Support VM by virtlet
    - Multi-tenancy support for containers
    - Support for additional container runtimes including kata containers
    - Support SFC
- Support Time Sensitive Networking
- Integrate with ONAP and ONAP multi-cloud
  - Orchestration and Management for Edge Application with ONAP
    - Wed 14, 3:20pm - 4:00pm, Level 1 - Hall A1
- NEV (Network Edge Virtualization) SDK integration
  - reference libraries and APIs for MEC (Mobile Edge Computing)



Full Support for VMs and Containers

Thank You!

Q&A