

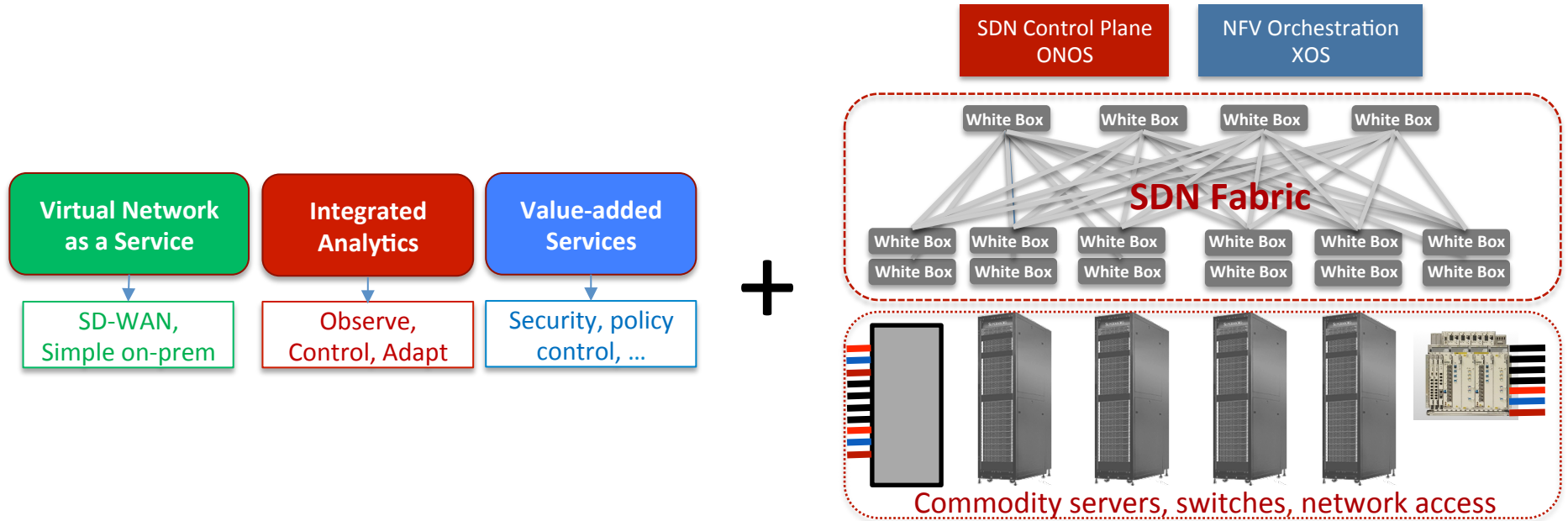


Enterprise CORD Roadmap



CORD
Central Office Re-architected as a Datacenter

E-CORD Value Proposition



Carrier-grade Network as a Service

Built on an open platform

Bring data center economy and cloud agility

Virtual Networks as a Service



- L2VPN
 - Provides broadcast domain between enterprise locations
 - Simple to use, scaling limitations, strong SLAs
 - Utilizes standards-based service model (MEF)
 - Offers limited choice of value-added services
- L3VPN
 - Provides private IP network
 - Requires routing config, highly scalable, strong SLAs
 - Offers broad choice of value-add services
- SD-WAN Overlays
 - Combines one or more broadband connections with LxVPN
 - Simple to use, highly scalable, but best effort service on broadband

All services need to support

1. On-demand creation between any location
2. Dynamic re-provisioning (SLA changes etc.)
3. Zero touch configuration

Value-Added Services



Examples:

- Traffic Analysis
- Active Testing
 - Probe network to verify connectivity and SLA
- Application Policies & Traffic Steering
 - Prioritize traffic based on user, location, application, ...
- Firewall
 - Access control
- WAN Acceleration
 - Minimize end-to-end traffic
- Encryption
 - Configurable end-to-end security

All services need to support

1. On-demand spawning
2. Customer interface for configuration and observing
3. API for analytics

Integrated Analytics



- **Observe**
 - Individual CORD components (CPE, VNF, fabric,...)
 - Transport network
 - End-to-end connections status (OAM probes)
 - Global view across multiple CORD sites
- **Analyze**
 - Root cause analysis across multi-domain network
 - SLA validation
 - More sophisticated analytics can be plugged in by others
- **Control**
 - Provisioning of additional service capacity
 - Automatic load balancing across sites
 - Automatic healing, routing around faults

Analytics should allow

- **Service Providers to:**
 - Monitor CO health (servers, fabric, edge devices)
 - Monitor transport network
- **Customers to:**
 - Monitor end-to-end connection status and SLAs
 - Monitor VNF performance

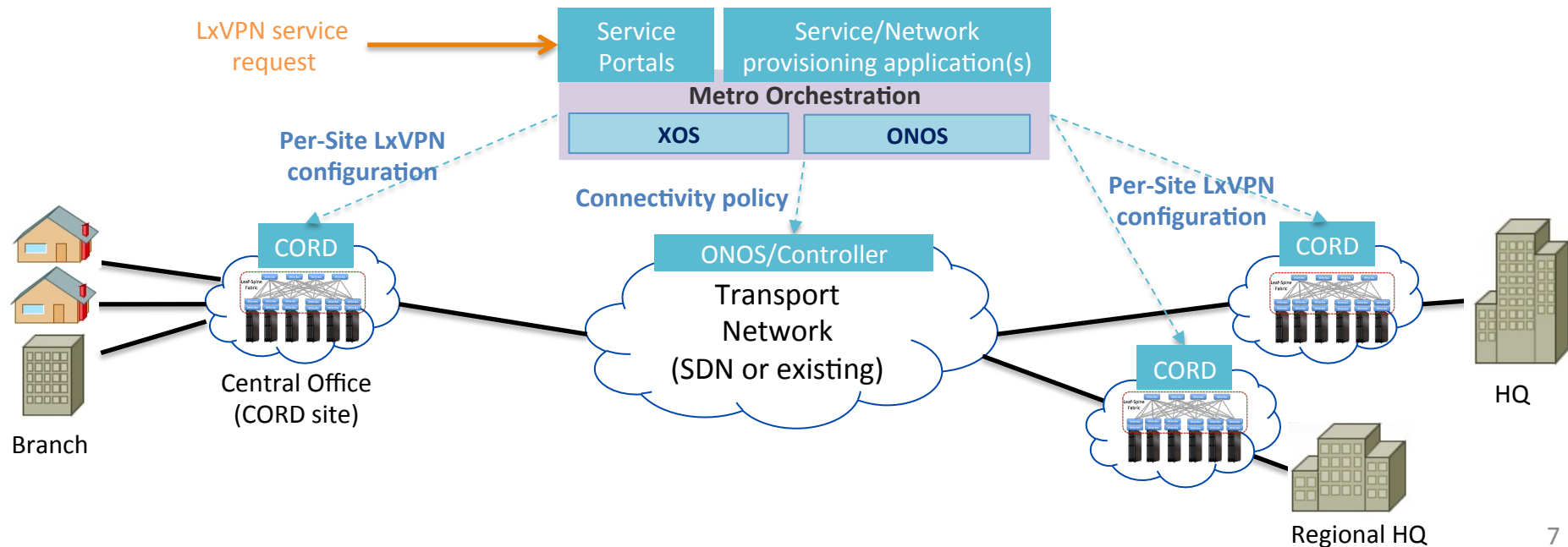
Implementation: Virtual Networks as a Service





Implementation: High-level View

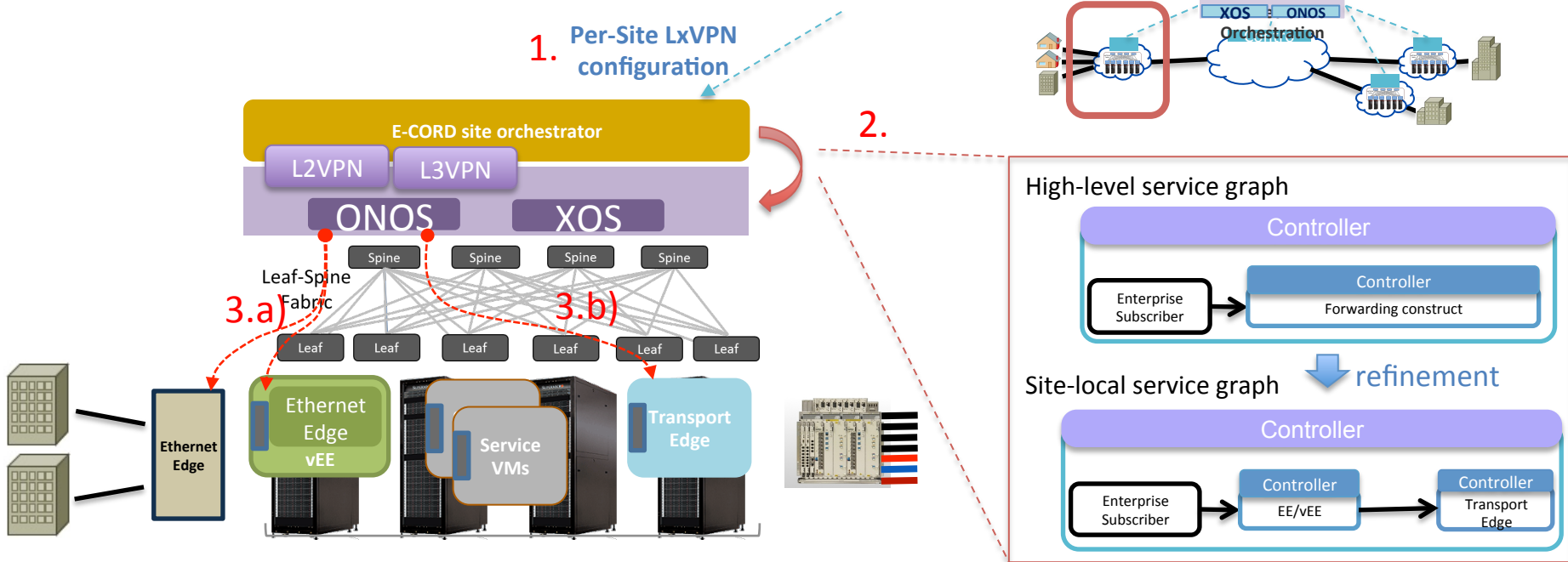
- Metro Orchestration:
 - Identifies transport path(s) and End-to-End resource constraints given services and virtual network type
 - Conveys constraints and service requirements to each CORD site(s)
- CORD sites configure fabric and service(s) for LxVPN





Implementation: CORD site

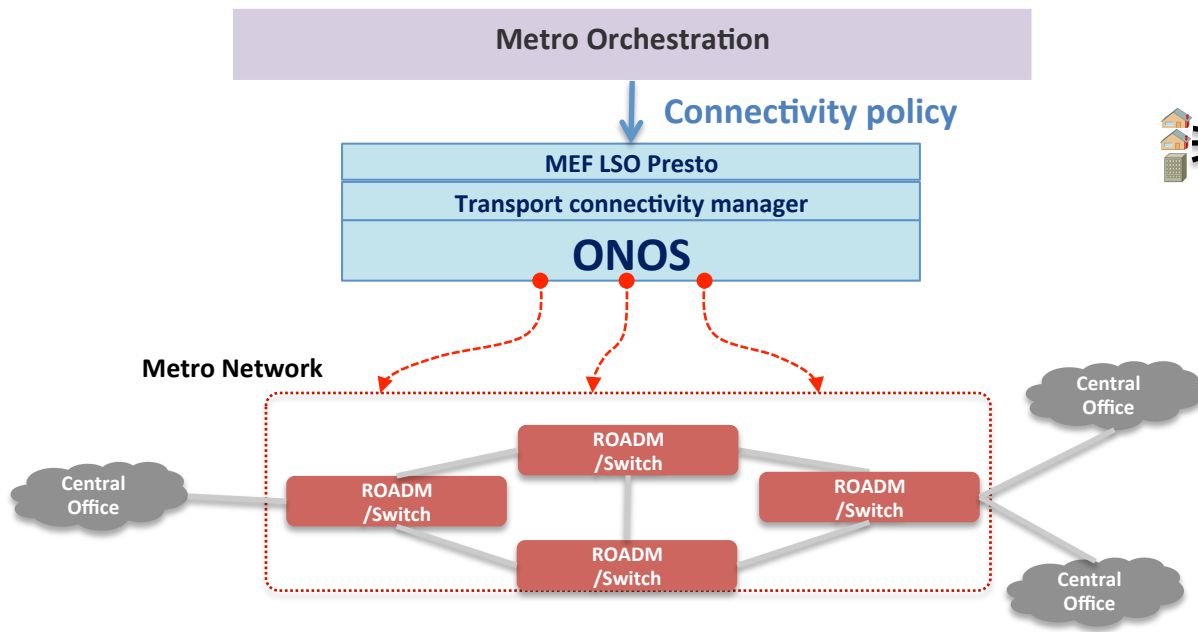
1. Per-Site LxVPN configuration specified as High-level service graph
2. Site orchestrator refines High-level service graph into site-local service graph
3. XOS instantiates the service graph, LxVPN app on ONOS configures the networking for service instances
 - a) Ethernet Edge (EE) & vEE: classifies traffic from user and maps them to site-local service graph
 - b) Transport Edge: Add/Remove required headers to be routed through the transport network





Implementation: Transport Network Control

- Transport network overview: (ONOS controlled transport SDN example)
 - Handles request from orchestration layer to provide connectivity between CORD sites (e.g., MEF LSO Presto, ONF TAPI, etc.)



ONOS wiki:
<https://goo.gl/UiMauo>



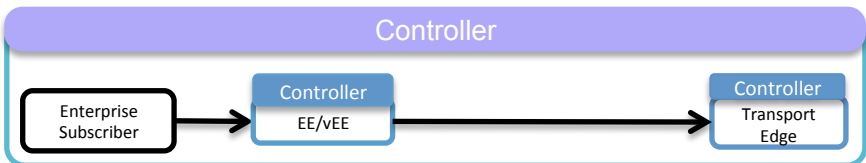
Implementation: Value-Added Services



Implementation: Value-Added Service Provisioning

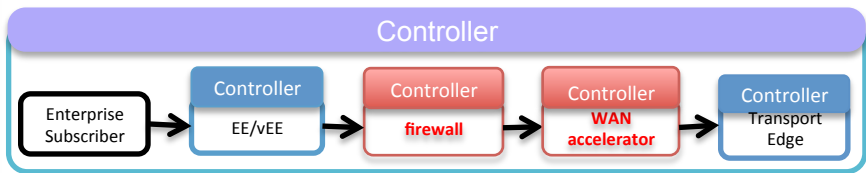


Connectivity service graph



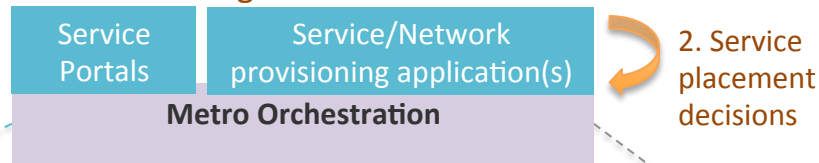
Value-added service graph

3. Instantiation/ configuration

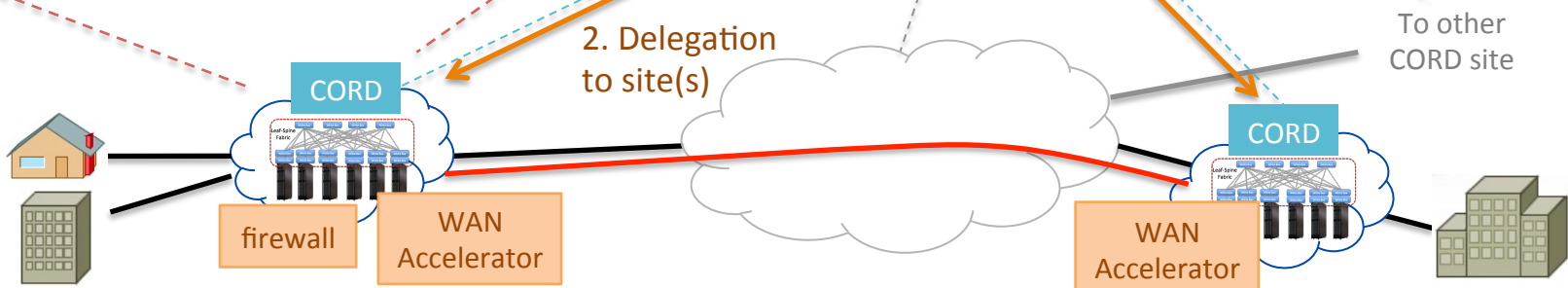


1. Request to add value-added services via service portal
2. Determine placements and request sites
3. Requested site(s) updates the service graph & instantiate the services

1. Add firewall + WAN accelerator to existing LxVPN service



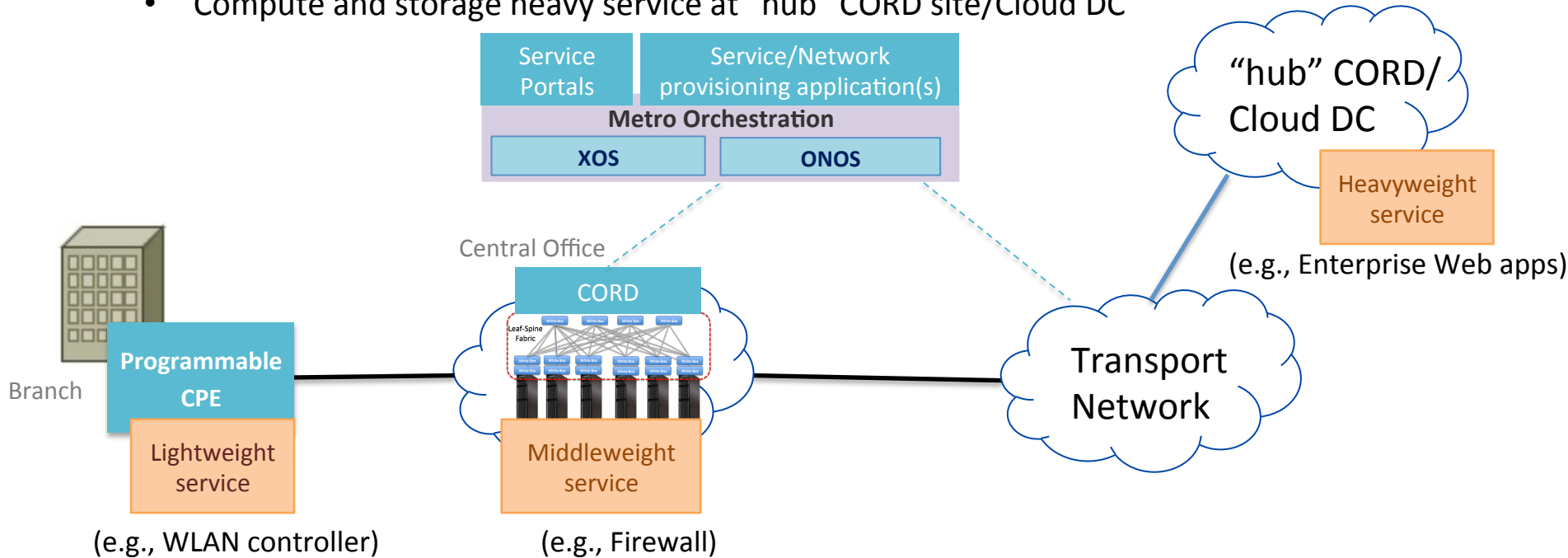
2. Delegation to site(s)



Implementation: Value-Added Service Placement



- Placement can depend on ‘weight’ and complexity of application
 - Majority of services at near by CORD site
 - Lightweight but latency sensitive services at CPE
 - Compute and storage heavy service at “hub” CORD site/Cloud DC

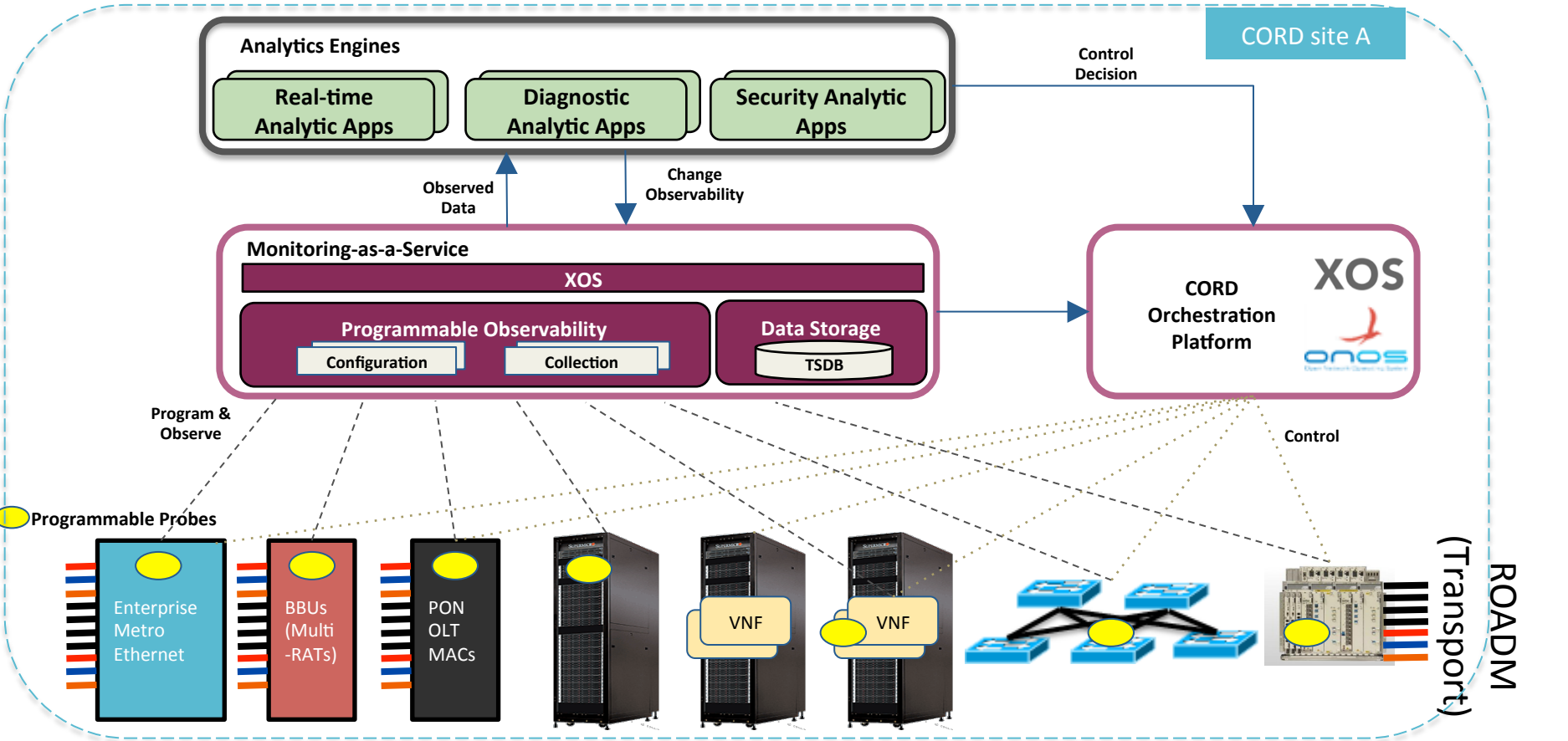


Implementation: Integrated Analytics





Recap: A-CORD overview



Programmable Probes: Enterprise Service VNFs



Service Level Events

vEE & vTE

- packet & byte counter
- queue length

Firewall

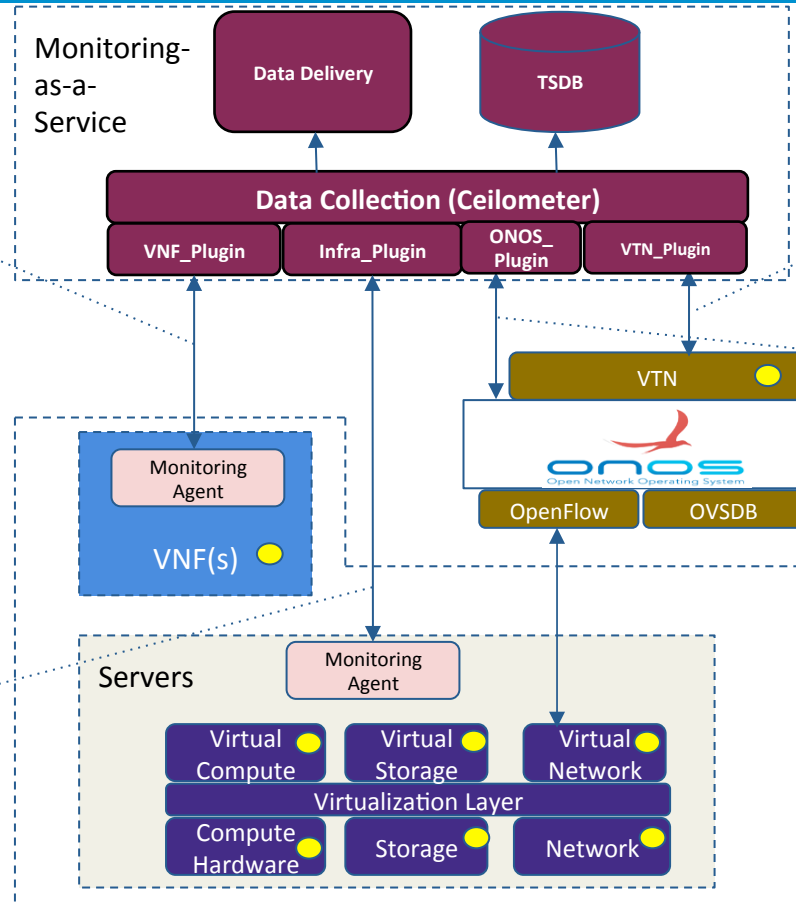
- throughput
- open connections

vOAM

- latency distribution
- packet-loss rate

Infrastructure Metrics

- instance.cpu
- instance.vcpu
- instance.memory.usage
- instance.network.incoming.bytes.rate
- instance.network.outgoing.bytes.rate
- instance.disk.usage
- instance.create
- instance.delete
- hardware.ipmi.node.cpu_util
- hardware.ipmi.node.mem_util
- hardware.ipmi.node.io_util

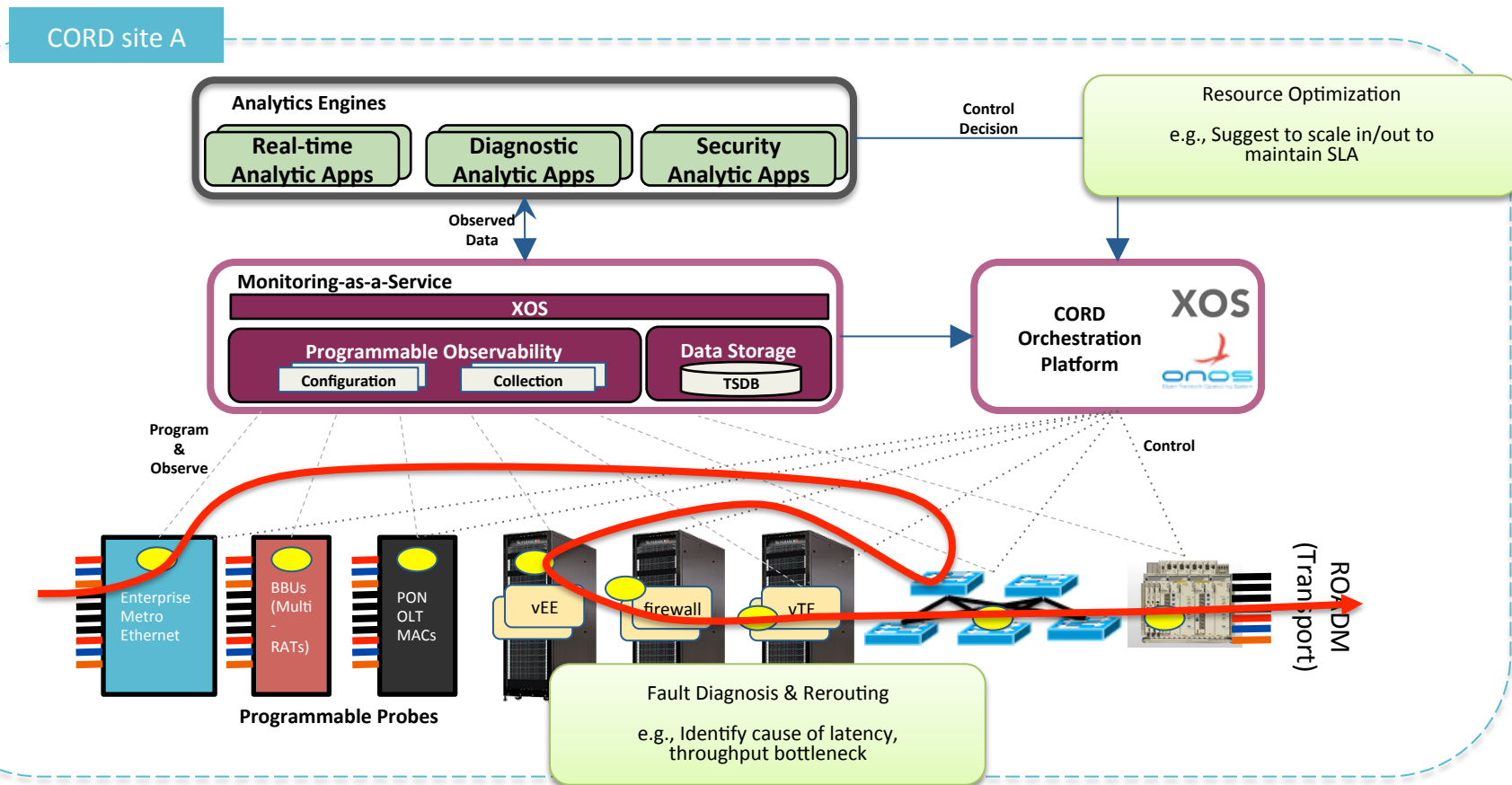


Virtual Tenant Networking App Events

OpenFlow Probes/Metrics
- From Virtual Network Switches



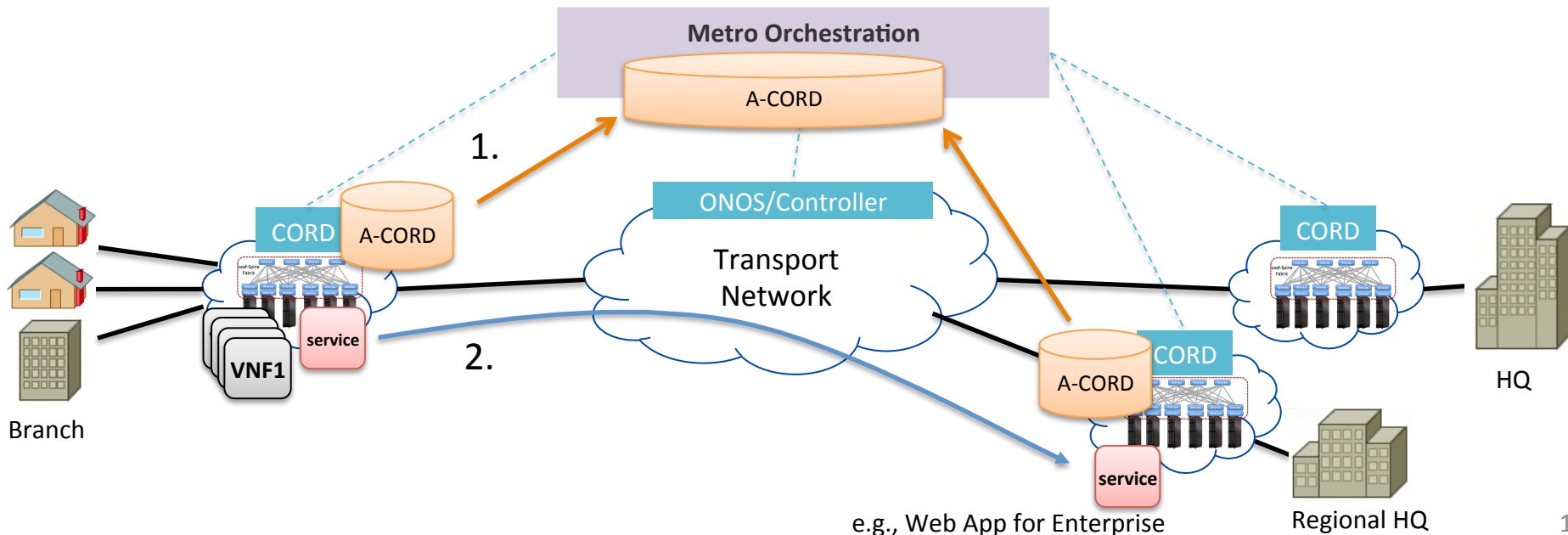
Implementation: site local analytics



Integrated Analytics: Cross Sites Action



- Example: Cloud-based Service migration across sites
 1. Trigger alarm requiring cross sites action
e.g., Detect high load on site A., Early warning for natural disaster
 2. Analyze available options in the region and execute coordinated actions
e.g., Relocate the service instance to site B, with spare capacity



Ongoing and Upcoming Activities



- Follow-up with latest MEF activities
 - Breakdown Ethernet Virtual Connection into Forwarding Constructs for sites and transport network
 - Consider leveraging Presto NRP API, OpenCS, ...
- Aligning implementation of L2VPN with common CORD platform
 - Metro Orchestrator
 - Integrate prototype service portal to XOS
 - Design service graph breakdown process details
 - Design abstraction for sites and transport network control delegation
 - Site Orchestrator
 - Define Ethernet and Transport Edge models
 - Refactor ONOS Apps to realize Ethernet and Transport Edge
 - Feedback fabric and VTN requirements to realize Ethernet and Transport Edge
 - Value-added services
 - Add variety to example services using open source VNFs
 - Define TOSCA model for example open source VNFs
 - Explore service examples beyond network functions. (Cloud-based web app, etc.)

Call for Contributions

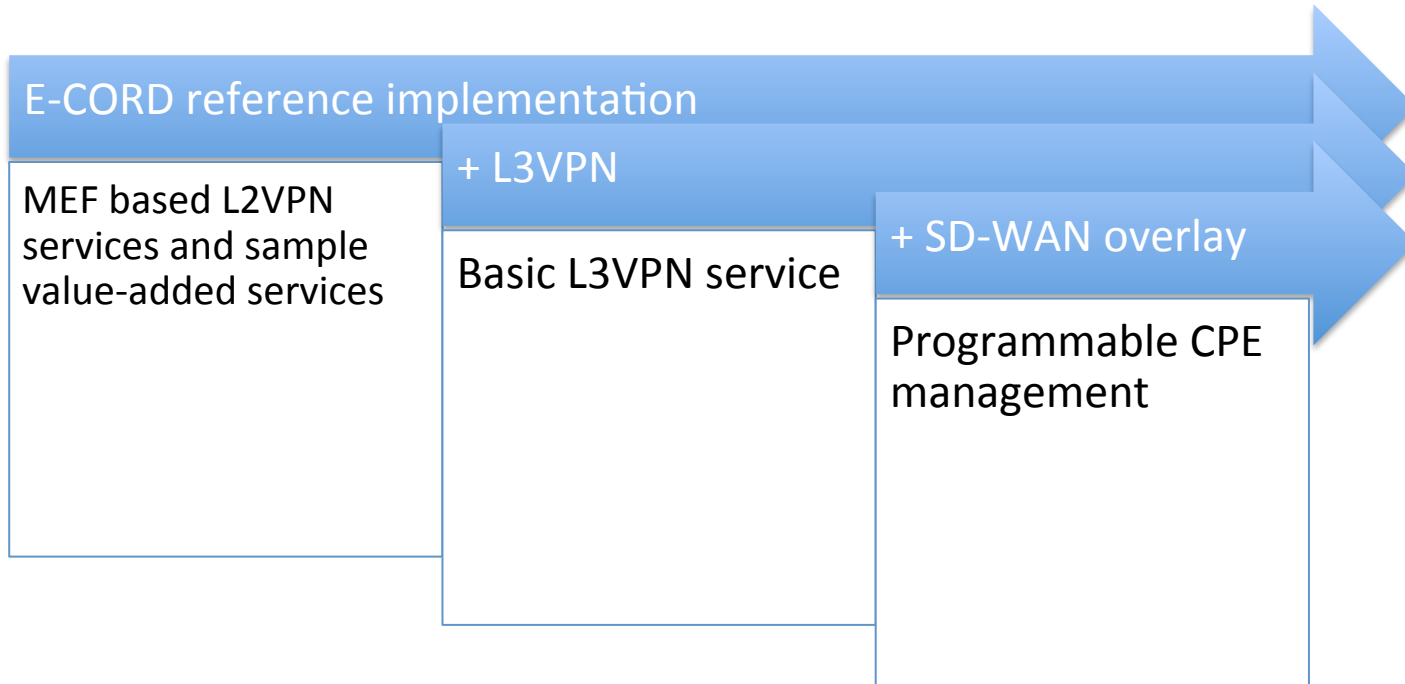


- Calling on collaborators for commitments:
 - In designing and implementing more network service types
 - Of hardware building blocks
 - White box switches with suitable features for Carrier Ethernet (OAM, deep buffers, high precision timing, ..)
 - CPE with programmability to run services
 - Of value-added services options (open and closed source service VNFs)
 - Carrier-grade services

Schedule and Milestones



- Milestones for next 6-12 month



E-CORD Software Distribution



- Build process is open source based on the CORD platform
- E-CORD will use the latest CORD releases for the platform software
 - ONOS, XOS, OpenStack, Docker, Fabric, Portals, Test Tools, ...
- Open source vs closed source VNFs
 - Open source VNFs bundled with platform
 - Closed source VNFs will become available, but not as part of core platform
- Open process questions
 - How to synch up with the latest CORD distribution?
 - How does E-CORD contribute back to the CORD distribution?

Summary



E-CORD is working towards an open reference implementation of a CORD distribution for enterprise services

Looking to partners and collaborators to accelerate progress!

- Find more details at:

<https://wiki.opencord.org/display/CORD/Enterprise+CORD>

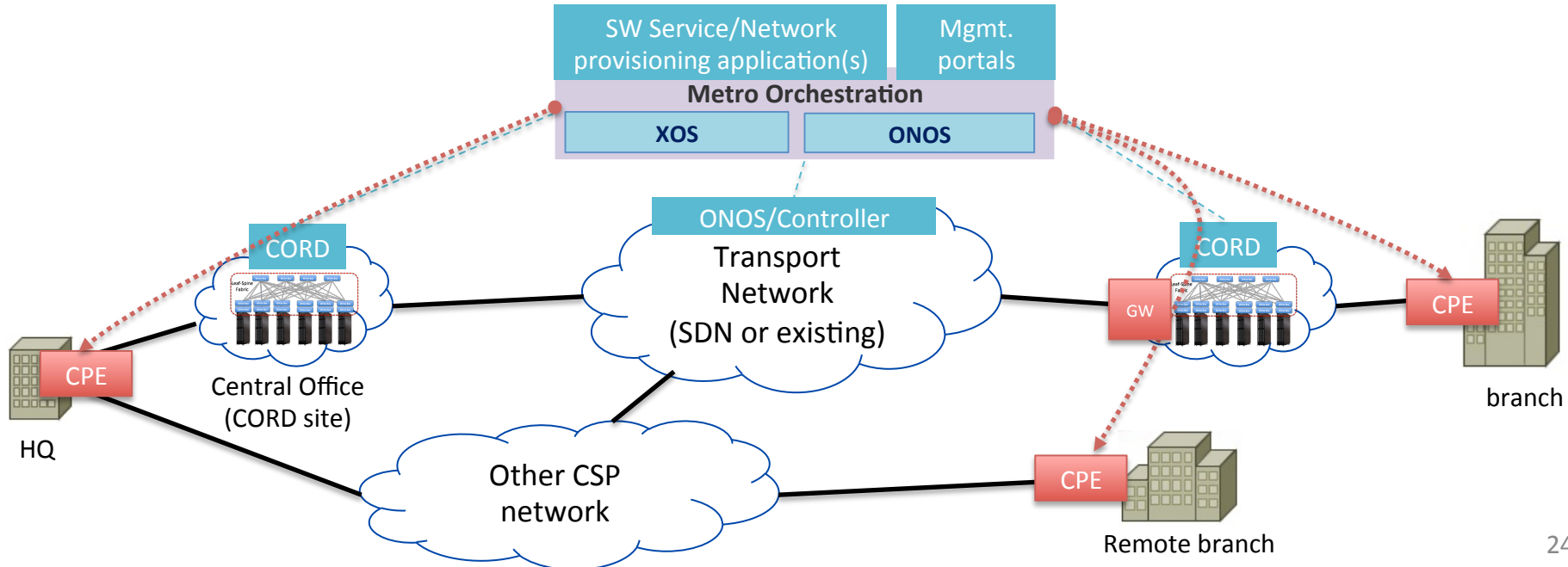


backup

Implementation: SD-WAN overlay



- CPE Control in SD-WAN case:
 - Programs virtual network usage policy
 - deploy light-weight VNFs on CPE itself



Integrated Analytics: Implementation

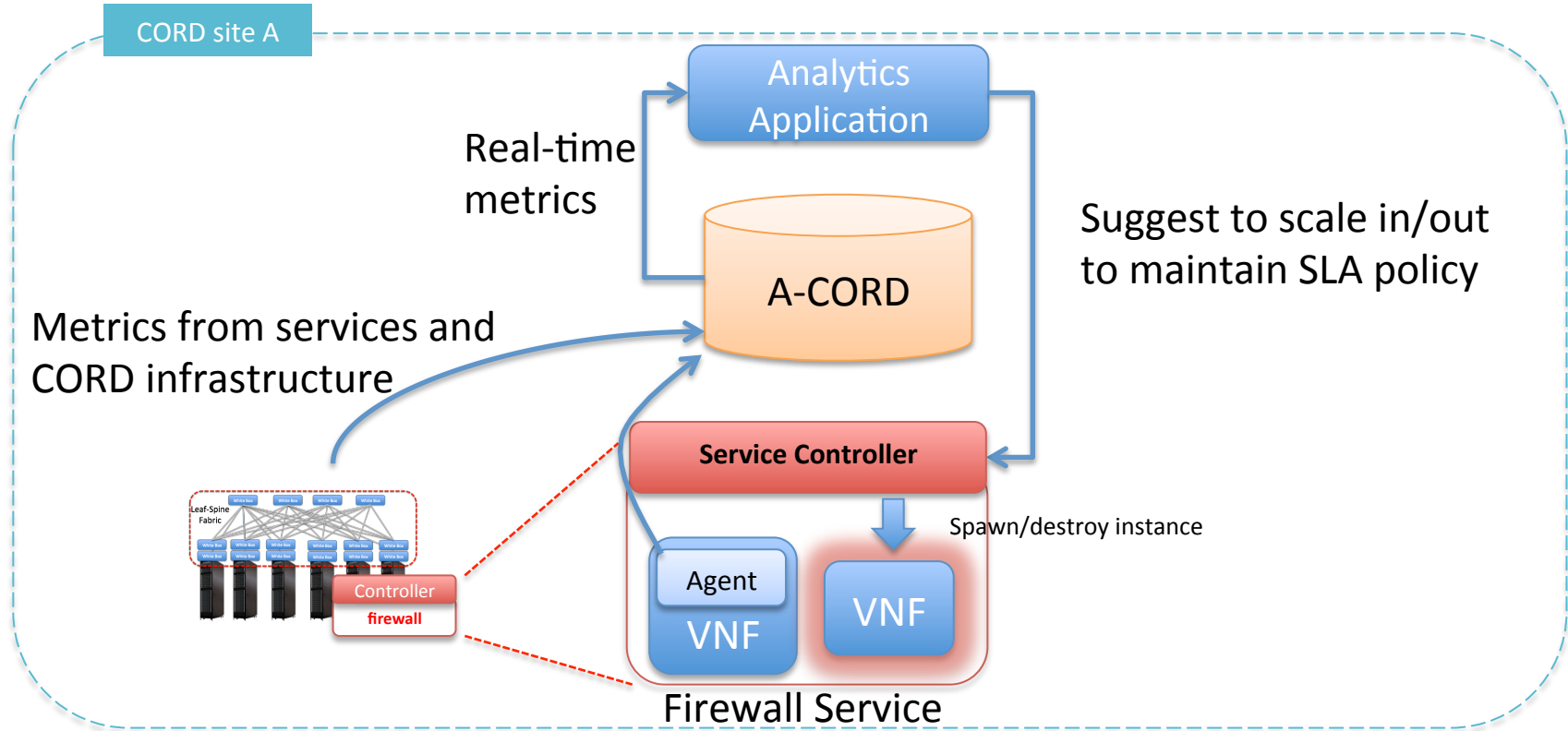


- Integration with A-CORD
- Data collection from multiple CORD sites
- Whitebox CPEs handling located offsite of CORD
 - Send telemetry to CORD site for end-to-end state visibility/collectability ?
 - Minimal analytics on CPE for self-diagnostics?

Implementation: Site-Local Analytics



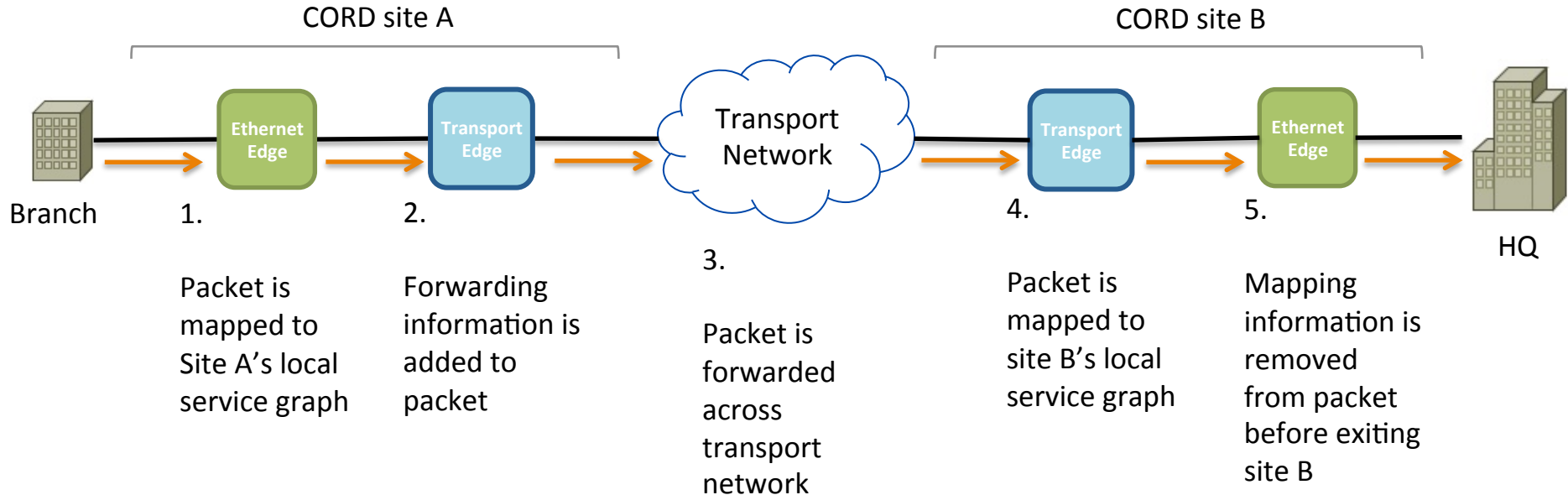
Example: Site-local service resource optimization



Implementation: Crossing the Transport



- Ethernet Edge maps user traffic to variety of service graph
- Transport Edge maps service graph to support variety of transport network



e.g., MPLS, VLAN, IP



Partners and Collaborators



Partners & Collaborators (1/2)



ONOS & XOS Core Enhancements

Feature	Partner	Comments
XOS Service Models	Nokia	
Multi-layer PCE	Adara Networks	
ONOS Delegation Framework	ON.Lab	

Hardware Support

Feature	Partner	Comments
Whitebox CPE		VNF-capable
Aggregation switch	EdgeCore	OAM, deep buffers, high precision timing

Deployments & Trials

Partner	Feature	Comments
China Unicom	DCI	

Partners & Collaborators (2/2)



Virtual Network Services

Feature	Partner	Comments
L2VPN	ON.lab	
L3VPN	ECI Telecom	
SD-WAN overlay		Requires CPE

Value-Added Services

Feature	Potential Partner	Open source alternatives
Active testing	EXFO, Netrounds, TeraVM	iperf3
Firewall		iptables, pfSense
WAN Accelerator		WANProxy
Encryption		SoftEther
Application policies		ntopng