Considerations for Deploying Virtual Network Functions and Services

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The NFV Concept

- Separate functionality from capacity
- Increase network elasticity
- Address heterogeneity

Source: ETSI
The Business Drivers

- Build the infrastructure as a pool of general resources
- Functionality is provided on-demand wherever it is needed
- The infrastructure can be updated in a much easier way
- New functions can be added or improved by just updating a software image

- Management and operation can be performed by means of software image configuration and orchestration
- Flatten network CAPEX by simpler procurement and reuse
- Lower network OPEX by reducing complexity and unifying operation mechanisms
- Shorten time to market and address long-tail services

Source: ETSI
CE and NFV – Building Blocks and Deployment Considerations

• Carrier Ethernet Use Cases – Present Mode of Operation (PMO)
• Virtual Network Function (VNF) Deployment Models
• Deployment Options at Customer Premises
• Considerations for Different Deployment Models and Options
Carrier Ethernet Use Cases – Present Mode of Operation (PMO)

• Carrier Ethernet used in many retail and wholesale applications:
  • Internet Access
  • Multi-Site L2 VPNs
  • Mobile Backhaul (MBH)
  • Off-Net E-Access services
  • Data Center Access (DCA) and Data Center Interconnect (DCI)
Carrier Ethernet Use Cases – Present Mode of Operation (PMO)

• Carrier Ethernet used in many retail and wholesale applications:
  • Internet Access, Multi-Site L2 VPNs, Mobile Backhaul (MBH)
  • Off-Net E-Access services,
  • Data Center Access (DCA) and Data Center Interconnect (DCI)
• Ethernet NID commonly deployed at customer premises
  • NID provides Carrier Ethernet service demarcation
• Carrier Ethernet services provide the fundamental connectivity
  • How do you leverage this widespread infrastructure to deliver new services?
Virtual Network Function (VNF) Deployment Models

• Three Models of Deployment:

  Centralized
  CSP Network
  NID
  Customer Premises
  EVC

  Decentralized
  CSP Network
  vCPE
  Customer Premises
  VNFs
  EVC

  Distributed
  CSP Network
  vCPE
  Customer Premises
  VNFs
  EVC
Virtual Network Function (VNF) Deployment Models

• Model 1: Centralized
  • Resources are shared among customers and applications
  • Not suitable for some network services (e.g. Security, WAN optimization, SD-WAN, high local capacity services)
  • initial investment
  • Simplifies the operation
  • Short TTM for new services activation
Virtual Network Function (VNF) Deployment Models

- Model 2: Decentralized
  - Resources are shared only among and applications
  - Invest as you grow model
  - Short time to first service, show results immediately
  - Moderate initial investment (DC investment is not required)
  - Short TTM for new services activation
  - Solution is dedicated to a customer
Virtual Network Function (VNF) Deployment Models

• Model 3: Distributed

• **Optimize VNF placement** based on the VNF requirements and network topology

• Service chaining between CP and DC may create complications
Deployment Options at Customer Premises

- Option 1: NID at Customer Premises
  - Supports CE 2.0 as PNFs
  - Used with Centralized VNF Model
Deployment Options at Customer Premises

• Option 2: vCPE at Customer Premises
  • Supports CE 2.0 as VNFs
  • Supports add’l VNFs based on CPU capacity
  • Used with Centralized and Distributed VNF Deployment Models
Deployment Options at Customer Premises

• Option 3: Hybrid
  • Supports CE 2.0 as PNFs
  • Supports add’l VNFs based on CPU capacity
  • Used with Centralized and Distributed VNF Deployment Models
Considerations for Different VNF Deployment Models

• Location of VNFs directly dependent on use cases and functionality
• Example Use Cases / Functionality
  • SD-WAN / WAN Optimization
    • Requires deep packet inspection and performs traffic steering over different WANs
    • Such functions must be performed at the customer premises
  • Encryption
    • Encryption must be performed at the customer premises to be effective
  • WiFi Controller
    • Functionality can be performed either centrally or on customer premises
The following are important operational considerations when comparing virtualization options:

- Established procedures
- MTTR
- Troubleshooting Skills
- Scalability
- Service Verification Tests
- Security
- SLA Performance Requirements
Summary

- NFV will transform how CSPs deliver network functions and services.
- Carrier Ethernet provides the foundational connectivity providing performance and security assurances.
- NFV enables additional virtual network functions and services to be layered onto the foundational CE 2.0 network.
- CE and NFV will help service providers offer, enhance, and expand their offerings with new and innovative services.
Multi-domains and Multi-operators Lifecycle Service Orchestration for Rapidly Introducing New Network Functionality

Dan Pitt, Senior Vice President, MEF
New Network Functionality - Agile/Dynamic, Assured and Orchestrated Services: Top Drivers and Challenges

What do you believe are the most important drivers and challenges for deploying agile/dynamic, assured and orchestrated services?

**Top Purchase Drivers**

- **#1 Faster service provisioning**
- **88%**
- **% Key + Very Important Drivers**
- Rapid adjustments to existing services
- Ability for customer to scale bandwidth on-demand

**Top Deployment Challenges**

- **#1 Orchestration over multiple provider networks**
- **91%**
- **% Serious + Major Challenges**
- Inadequacy of current OSS/BSS systems
- Integration of new dynamic services with legacy services infrastructures

Orchestrated On-Demand Connectivity Services

Orchestration over Own Network
- 69% of Service Providers surveyed say that the ability to deliver on-demand CE 2.0 Retail Ethernet connectivity over their own network is highest priority.

Orchestration over Multiple Networks
- 59% say the delivery of orchestrated, on-demand CE 2.0 Wholesale E-Access connectivity services over multiple provider is top priority.

How important for your company is the ability to offer orchestrated / on-demand connectivity services?

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Importance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>17%</td>
</tr>
<tr>
<td>CE 2.0 Wholesale</td>
<td>38%</td>
</tr>
<tr>
<td>E-Transit</td>
<td>45%</td>
</tr>
<tr>
<td>CE 2.0 Wholesale E-Access</td>
<td>42%</td>
</tr>
<tr>
<td>Subscriber</td>
<td>59%</td>
</tr>
<tr>
<td>IP Services</td>
<td>62%</td>
</tr>
<tr>
<td>CE 2.0 Retail Ethernet (E-Line, E-LAN, E-Tree)</td>
<td>69%</td>
</tr>
</tbody>
</table>

Source (Joint MEF-Vertical Systems Group): Emerging Third Network Services Enabled by LSO, SDN and NFV Study (January 2017)
LSO – Orchestrating Within and Between Providers
LSO Reference Architecture and Capabilities

- **Fulfillment**
- **Performance**
- **Control**
- **Assurance**
- **Usage**
- **Analytics**
- **Security**
- **Policy**

**CAPABILITIES**

- EMS: Element Management System
- PNF: Physical Network Function
- SOF: Service Orchestration Function

**End-to-End Network-as-a-Service**
MEF’s Inter-Operator APIs and Open Initiatives
MEF’s Intra-Operator APIs and Open Initiatives

Service Level Orchestration Open APIs

<table>
<thead>
<tr>
<th>Service Orchestration</th>
<th>Fulfillment</th>
<th>Performance</th>
<th>Policy</th>
<th>Security</th>
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<tbody>
<tr>
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<td>Analytics</td>
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</table>

Network Level Orchestration Open APIs

<table>
<thead>
<tr>
<th>Technology Domains</th>
<th>SD-WAN</th>
<th>Data Center</th>
<th>Packet WAN</th>
<th>Optical Transport</th>
<th>NFV</th>
<th>Cloud Exchange</th>
<th>5G Wireless</th>
</tr>
</thead>
</table>

Orchestrated Services

<table>
<thead>
<tr>
<th>Services</th>
<th>E-Line</th>
<th>E-LAN</th>
<th>E-Tree</th>
<th>E-Access</th>
<th>E-Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SECaaS</td>
<td>App Services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wavelength</td>
<td>Internet Access</td>
<td>L3 VPNs</td>
<td>IP Transit</td>
<td></td>
</tr>
</tbody>
</table>
• Accelerate pace and relevance of MEF APIs and standards
  • Validate APIs/standards
  • Provide feedback into technical committees
  • Create open source reference implementations, libraries, toolsets

• Collaboration across SDOs and Open Source communities
  • Increase awareness, open discussions
  • Support for LSO APIs in relevant open source projects
  • Upstream contributions
  • More running code!
Spirit of the Hackathon

- Collaborative, friendly competition
- Break down silos
- Share insights, tips, ideas
- Shared goals
  - Increase of pace and quality of LSO APIs and implementations
- Non-MEF members can participate
- Free
Hackathon History

- GEN15
- PRESTO
- Euro16
  - PRESTO, SONATA
- MEF16
  - PRESTO, SONATA, LEGATO
Euro17 Hackathon – April 24-26, Frankfurt

• Projects for Euro17 Hackathon are being determined now
• For reference, here is the list of projects from previous hackathon
  • Micro-services enabling a pre-order marketplace for wholesale Carrier Ethernet services
  • Inter-carrier automated product ordering
  • MEF Legato YANG models exposed using Cisco NSO
  • Automated inter-carrier L2 and L3 service fulfillment and change
  • Carrier Ethernet service fulfillment using OpenDaylight and PNFs/VNFs via LSO Presto
• Join us in Frankfurt!
To develop and demonstrate reference implementations of agile, assured and orchestrated services across three network domains to connect with a Cloud Operator in another country, using Third Network services.
LSO and Open API initiative

- To start the respective agile sprints to develop two sets of APIs to be used for orchestrating MEF-defined services (like E-Line, E-Access etc) at LSO Sonata and LSO Presto respectively that will culminate in publication of these open APIs during the course of 2017, and to ensure that they enable certification of orchestrated MEF-defined services.
Summary

• Today’s services need to be orchestrated across multiple network domains, as well as, across different service providers’ footprint.

• MEF, Service Providers members and industry partners are leading the work to define the requirements and deliver common APIs between SPs.
  • This is achieved through MEF’s Projects and Open Initiatives

• Will you be joining us, through MEF’s multiple activities, to deliver on the Lifecycle Service Orchestration promise?
SD-WAN Tutorial:
Service Components, Functionality, MEF Reference Architecture and Use Cases

Ralph Santitoro, Distinguished Fellow and Director, MEF Head of SDN/NFV Solutions Practice, Fujitsu
Contents

• Concept: Overlay vs. Underlay Network
• What is an SD-WAN ?
• SD-WAN Service Components and Functionality
• Why an SD-WAN Service ?
• SD-WAN Service using MEF LSO Reference Architecture
• SD-WAN Service Use Cases
Concepts: Overlay and Underlay Networks

• **Underlay Network**
  • The physical transport network

• **Overlay Network**
  • Virtual Network abstracted from the transport network (underlay network)

• **Overlay networks are tunneled over Underlay networks**
  • Using an encapsulation protocol, e.g., VxLAN, NVGRE, IPSec tunnel, etc.

• **Overlay/Underlay terminology used in DC Networking**
  • Terminology usage more recent with WAN (SD-WAN)
  • Although, MEF has defined Carrier Ethernet as a virtual overlay service
What is an SD-WAN?

- Currently no industry standard definition but described as follows:
  - Specific application of an SDN applied to WAN connections
  - A Virtual (Overlay) Network that runs on top of public Internet and VPNs
  - Operates over existing wireline or wireless networks
  - Has no interaction with the (underlay) network over which it operates

MEF is working to create a standardized SD-WAN Service Definition
• **SD-WAN Edge**  
  - Performs Traffic steering, Application classification, QoS and Security policy enforcement

• **SD-WAN Controller**  
  - Centralized control of SD-WAN Edge devices

• **SD-WAN Orchestrator**  
  - Service orchestration and policy management for traffic routing and QoS over different WANs  
  - Interfaces to customer web portal, OSS apps and SD-WAN Controller

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**SD-WAN Service Components**

- SD-WAN Edge
- SD-WAN Controller
- SD-WAN Orchestrator
- OSS Apps
- Subscriber Web Portal
- SD-WAN Overlay Network
- SD-WAN Service Components
- MPLS VPN
- CSP or MSP Network

**Diagram:**

- SD-WAN Orchestrator
- SD-WAN Controller
- SD-WAN Edge
- Internet
- OSS Apps
- Subscriber Web Portal
- SD-WAN Overlay Network
- MPLS VPN
- CSP or MSP Network

**Network Diagram:**

- SD-WAN Edge connected to SD-WAN Controller
- SD-WAN Controller connected to SD-WAN Orchestrator
- SD-WAN Orchestrator connected to OSS Apps
- OSS Apps connected to Subscriber Web Portal
- Subscriber Web Portal connected to SD-WAN Edge
- SD-WAN Edge connected to MPLS VPN
- MPLS VPN connected to CSP or MSP Network
- CSP or MSP Network connected to Internet
- Internet connected to SD-WAN Edge

**Legend:**

- Yellow: SD-WAN Overlay Network
- Red: SD-WAN Service Components
Traffic steering over secured tunnels between SD-WAN Edges
- Encryption over all WANs: Internet (broadband), MPLS VPN, LTE, WiFi, etc.
- SD-WAN service can operate over different CSP / ISP WANs

Real-time QoS performance measurements over each WAN
- QoS PMs used to determine which WAN to steer packets based on QoS Policies

Application-based traffic steering based on QoS or Security Policies
- Send Skype for Business traffic over Internet if packet loss < 1% and packet delay <70ms
- Block all sites from accessing cloud-based storage, e.g., box.com

Zero Touch Provisioning
- Making a business service installed with the automation of a residential service
### Why an SD-WAN Service?

#### Subscriber Benefits
- **Large OpEx Savings**
  - Steer traffic from expensive MPLS VPN to Internet when QoS policies met
- **Application-based QoS Management**
  - QoS Policies/Metrics per Application used to steer traffic over different WANs
- **Quickly add temporary or remote Sites**
  - Over ubiquitous Internet using wired or wireless connections
- **Achieve High Availability & Path Diversity**
  - Run SD-WANs over different ISPs plus VPN

#### Service Provider Benefits
- **Lower OpEx via Automation**
  - Zero-touch provisioning of SD-WAN Edges
  - Self-Service Customer Portals
- **Faster Time to Service Revenue**
  - Quickly add off-net sites via Internet or LTE
  - No need for inter-provider peering with off-net access network providers
- **Enter Competitor or Incumbent Markets**
  - Deliver SD-WAN service to subscribers even if you don’t provide network access to the site
SD-WAN Service using MEF LSO Reference Architecture (RA)

**Presto Interface**

- Enables a Service Orchestrator to manage different vendor SD-WAN Controllers
- SD-WAN Controllers manage SD-WAN Edges in their domain
- MEF OpenCS SD-WAN Project focusing on functionality (SOF) at the Presto Interface
SD-WAN Service
Use Cases
SD-WAN Service with Virtual SD-WAN Edge

Virtual SD-WAN Edge
- SD-WAN Edge VNF which terminates SD-WAN connection runs inside of server
SD-WAN Service with SD-WAN Edge vCPE

SD-WAN Edge vCPE
• SD-WAN Edge VNF which terminates SD-WAN connection runs on vCPE
• Ability to add more virtual network services as new VNFs on vCPE
SD-WAN Service Using Multiple Vendor SD-WAN Controllers

**Presto Interface**
- Each SD-WAN Controller supports Presto Interface
- SD-WAN Controllers manage SD-WAN Edges in their domain
- Using Presto, Service Orchestration can setup SD-WAN across each SD-WAN domain
• **SD-WAN provides a virtual overlay service**
  - Does not interact with the underlay (transport) network

• **SD-WAN provides tremendous benefits to SPs and Subscribers**
  - Service Agility, Time to Service Velocity, ↓OpEx, Application-level awareness

• **MEF work on SD-WAN Services will help industry move forward**
  - Standard MEF LSO Reference Architecture
  - OpenCS SD-WAN Project Reference Implementation of Presto Interface
  - Standardized SD-WAN Service Definition