Open. Together.
Network Services in a Multivendor Enterprise

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Agenda

- PayPal’s Core Network Services
- Automation Architecture Pillars
- AZ2.0 - Leaf/Spine Network
- Monitoring fabric
- Infrastructure as a Code (IaC)
- Network Services - a pragmatic approach
Roles/Responsibility @ PayPal:

- Director, Global Network Engineering & Operations
- PayPal’s Global Payments Network is to provide secure, resilient and efficient global connectivity to PayPal customers, merchants partners and business units.

Educational & Overall Industry Experience:

- 15+ Years industry experience; worked for LinkedIn, Xilinx, Dell, Nortel, Ciena, CDOT...
- CAB Member: Cumulus, BigSwitch, Aporeto...
- Web-scale datacenter network architecture, design, delivery & operations
- Systems Strategy for both Datacenter/Enterprise Networks
- Total 25+ patents (issued/pending) focused in cloud networking, SDN, NFV areas.
- B.E (ECE); M.B.A

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PayPal’s Core Network Services (CNS)

Provides a secure, reliable and efficient payments network to enable hybrid cloud deployments.

Current Network fleet:
• 1000’s of devices
• Multi-generation, evolved...

Global backbone:
• POP locations, MPLS network
• HybridCloud, Extranet, Secure connectivity

Network Security:
• Least privilege access & regularity policy audits

Operating Systems/ Tech:
• 1G/10G/25G/40G/100G & MACSec encryption

Drivers for Network Strategy:
• Always on & secure: create strong foundation
• Growth/modernization: Network-as-a-Service
• Zero-touch-operations: Autonomous fleet

Network-as-a-Service:
• Business Intent
• LCM automation/APIs
• Operational SLA
• HybridCloud enablement

Autonomous Fleet:
• Programmability
• Anomaly driven telemetry
• Remediation factory
• Self-service enablement

Create Strong Foundation:
• Innovation centered standardization
• Drift avoidance

Love all traffic, Serve all Apps

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Network Designs Over The Years

It is a journey. Network stack evolved over the years ...

Mid 2000’s
- eBay BB/ISP
- Boarder connectivity
- Core routers (+ FWs and LBs)
- DC Network Layer 1G/10G - Layer2
- Network in the compute layer (Physical world)

2013-2017
- Public Cloud
  - Backbone | ISP
  - WAN connectivity
  - Infra Switching (+ FWs and LBs)
  - Core Network Layer 10G/40G (ToR and Spine)
- Network in the compute layer (Physical, Virtual world)

2017-2019
- Multi-region Public Cloud
  - Backbone | ISP
  - Leaf/Spine DC Networks (+ FWs and LBs)
    25G/100G
  - Network in the compute layer (Physical, Virtual, Container world)

2019-2021
- Multi Cloud
  - Backbone | ISP
  - Leaf/Spine DC Networks (+ LBs, Distributed FW)
    25G/100G/400G?
Core Network Services (CNS) - Architecture Pillars

Disaggregation, Secure Global Network, Zero Touch Everything

Disaggregation Centered Networking Fleet:
- Disaggregation of network HW and SW innovation
- Cloud scale economics by leveraging white-box innovation
- Single SKU for DC network: context-based network functions

Network Security as a Service (NSaaS):
- Security as a service through programmability
- Security policy visibility/automation
- Distributed Firewall (DFW) for application level security

Global Payments Backbone as a Service:
- Template based PoP designs; Extranet-as-a-Service
- Flow level visibility; low-latency global customer connectivity
- Multi-cloud/multi-region enablement

Telemetry Driven Core Network Services (CNS):
- Zero Touch Provisioning (ZTP): deployment agility
- Zero Touch Operations (ZTO): self-healing networks
- Anomaly driven telemetry: HealthChecks & DVR for CNS

Powered by: CNS_Shell# programmability & visibility
Transformation approach:

- Leverage ASIC evolution through 1RU form factor
- Adopt common HW SKU/network design (leaf/spine)
- Adopt 3rd party optics and cables to work with all vendors
- Build life cycle management (LCM) for entire fleet
- Monitoring fabric comes standard
- Qualify dual vendors for each component:
  - Not to mix vendors in a given environment: for interop/stability reasons
  - Avoid supply chain shortages

Value Propositions:

- Reduce number of HW device types & spares
- Reduce network designs
- Common HW - leverage SW innovations from various vendors
- Financial Savings
AZ2.0 Network requirements

Next generation network build out

**HW simplification:**
- Single SKU: 32x100G switch device
- Flex port speed: 100G/50G/25G/10G network
- White-box switching OS powered
- Optics & cable consolidation: 3rd party optics/cables

**Design goals:**
- Extensible leaf/spine architecture: Bubble concept
- Eliminate IP Subnet depletion: Bubble level IP addressing
- Compute morphing: VM Mobility within the bubble
- Container support: Container mobility and address flexibility
- Layer2 adjacencies within the bubble: VxLAN overlay tunnel

**Network Automation:**
- Day0 automation: Zero Touch Provisioning (ZTP)
  - Automated Network build-out
  - Plug and play Rack-on-boarding
- Day0+ automation & service APIs
AZ2.0 Network Design - Lesson learned

Lessons learned:

• 15 Racks per POD + Infra rack
• IP addressing at POD level - helps with IP deletion issues in the POD
• VxLAN design & Interop tests with FW/LB/compute nodes
• Tune alerts to catch HW resource utilizations
• Do comprehensive failure & scale tests beforehand. Convergence times vary based on failure scenario.
• Single vendor VxLAN domain
Common Monitoring Fabric

Monitoring Fabric for US-West

Salient points:

- White Box Hardware
- 100gig fabric between Filter/Core/Delivery
- Delivery layer provides 10/25/40/50/100gig
- Firewall's will be tapped
- Switches will use Span
- NPB (Network Packet Broker)
  - Deduplication
  - NetFlow Generation
  - Packet Slicing
  - Header Stripping
  - (and more)
- Plug and play fabric
- Automatic traffic routing on failure
- Additional services
  - Analytics
  - Packet Recorders
100G/White-box Adoption: Roadmap
Path to transformation

- White-box HW for both core network as well as for common monitoring fabric
- Leverage common HW and personalize it with specific white-box/OEM SW
  - Helps to avoid mixing vendors in a given environment
- Helps to streamline spare inventory
Multivendor Network Automation Journey

Use cases

- **Service Fabric Enablement**
  - Zero Touch Provisioning
  - Declarative operations: WISI/WIRI

- **Fluid capacity with security**
  - Frictionless server move
  - Delightful security provisioning/Audit trail

- **Network Operations**
  - Reduction of manual changes
  - Increased visibility
  - Reduction in MTTD/MTTR

Actors

- **Infra and Cloud**
  - Private Cloud
  - InfraServices

- **NetEng/NetSec**
  - Configlets/playbooks & Templates

- **Slack BOTs**
  - Self-Service commands

Foundation

- **Network Automation**
  - Manually Managed
  - CLI & SNMP

- **Network State Insights**
  - Network State
  - Insights

- **Applications (Bots)**
  - Static & run time state
  - Self-service enablement

- **Autonomous Alert Management**
  - Self Healing
  - Closed loop processes

- **Network Analytics**

- **#1**
  - Life Cycle Managers/APIs
  - Central Source of truth (Inventory, configs)
  - Workflow integrations

- **#2**
  - Static & run time state
  - Streaming Telemetry

- **#3**

- **#4**

*MTTD - Mean Time To Detect
*MTTR - Mean Time To Resolution

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Infrastructure as Code (IaC)

The Journey: Remove human in-between

Core Benefits:
- Determinism and greater network insight
- Increased business agility and productivity
- Lower operation drifts and costs

Projects associated with each phase:
- Day 0: Zero Touch Provisioning (ZTP)
  - Device deployment
  - Day0 config push
  - SOR -Inventory management
- Day 1: Composable services
  - Common framework development
  - Service packs development
  - Orchestration layers integration
- Day 2: Fleet wide monitoring
  - Device static and dynamic state monitoring
  - NetFlow/SNMP based device counter collections
  - Syslog monitoring
- Day n: Zero Touch Operations (ZTO)
  - Device failure handlings/upgrades
  - WISB ← → WIRI: anomaly detection

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Spike: Network Services Common Framework
Enablement to develop composable services

Value Propositions:
• Uniform service layer interface to all CNS capabilities
• Self service capability enablement
• Integration with PayPal Cloud Services layer for Network APIs

Spike Services:
• LDAP integration
• Key Manager integration
• IPAM integration
• ServiceNow integration
• Workflow engine
• CMDB integration
• Maintain correlation IDs
• Built-in Database
• Device Layer to interact with LCMs
• REST based APIs
• Admin UI
Spike Framework - Architecture
Write once, leverage it for all CNS IaC initiatives

Value propositions:
- Repeatable Day0+ task are enabled through CRUD operations
- Eliminate Drift
- Reduce human touch/reduce manual changes
- Network APIs for IaaS orchestration layers
- Brownfield environment: vendor variety & device variety

Design Principles:
- Service layer for heterogenous network environment
- Reduce manual changes and provide APIs for workflow integrations
- Modular design to accommodate plug-n-play sub-components
- Config Consistency and availability
- No operational state persistency in data store
- Asynchronous execution for all APIs
- Auto re-try to handle downstream failures
Network Self-Service Enablement
Network Blackbox to Self-service capabilities

Value propositions:

• Telemetry and visibility at global network level
• Dynamic network map
• Enable self service capabilities
• Drift detection and auto remediation factory

Use Cases:

• Network global ‘path’ search is enabled through ‘Slackbot’
• Network state DB overlaid with SNMP logs
• Integrate with ping-pong service for latency measurements
Final Thoughts

• Build balanced skillset organization with SWdev/NetEng/NetOps
• Designs standardization/Reduce HW SKUs
• Take advantage of leaf/spine network architectures for DC - It works!
• Be pragmatic in your automation journey, leverage vendor tools where available
• Collaborate with like minded industry partners

Happy to share/collaborate:
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