Programmatic Internet

David Ward
dward@cisco.com
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SDN boiled way down

• Enables applications not resident in embedded OS’ to extract and program state into a networking node and across nodes

• Three major religious assumptions to overcome
  – State of the node or network not distributed out to configuration files
  – State/Objects not programmed with assumptions of persistency (i.e. not via a transaction that writes to the configuration file)
  – Centralized view of the topology in addition to distributed routing
What problem is trying to be solved?

• Operational ease of configuring network
  – Moving the industry from CLI
  – Standardized interface that allows for Applications/services to customize network policy, topology, and feature state

• Ephemeral state programmed into the network
  – Enables feedback loop and events between different subsystems (e.g. identity, routing, policy, state of the topology)
  – Faster deployment of compute, storage, services
  – New services not possible with existing technology/protocols

• Visibility to multiple layers of hierarchical topology
  – Otherwise invisible to any single node
  – Virtual networks across multivendor/multifunction equipment
  – Manage state across layers of: optical, transport, trunks, virtual networks, services
Issues with current SDN architecture

• Interfaces to HW drivers are enough (e.g. IPC or RPC-esque)
• No topology, BW, utilization, delay, loss, jitter attributes or discovery
• No node capability or resource discovery
• No assumptions of RIB, loop detection, errors in state, duplication checking
• No “horizontal communication” between controllers or between networking nodes
• External events from OAM, triggers, forwarding state changes missing
• Limited L2, encapsulation
SDO’s involved...

Technical Advisory Group Chair, Working Groups:
Config, Hybrid, Extensibility, Futures/FPMOD/OF2.0

802.1 Overlay Networking Projects, Cisco Innovations:
FEX Architecture

SDN Research
Open Network Research Center at Stanford University

Working Groups:
Quantum API
Donabe
Cisco Innovations:
OpenStack API for Nexus OpenStack Extensions

Overlay Working Groups:
NVO3, L2VPN, TRILL, L3VPN, LISP, PWE3
API Working Groups:
NETCONF, ALTO, CDNI, XMPP, SDNP, I2AEX, FORCES, IDR, OSPF, ISIS, IRS
Controller Working Groups:
PCE
Some Interfaces to Internet required
Lack of standards for many of these features

• Programmatic configuration – Yang data model via NetConf/ReST-HTTP, OMI
• Tunnels/Encapsulation: MPLS, IPnIP, GRE, L2TP, UDP, OTV, VXLAN
• Topology and “weather report” export
• Transport: Lambdas
• Cross Connect
• Routes, VPN
• Classifiers
• QoS
• Analytics

Future: Security, DPI, NAT, Gateways
Approaching Service Abstractions

- Abstractions allow the definition of layered APIs and NPIs

  Enable multi-layer APIs across all elements, to integrate with operator development environments

  Accelerate development of network applications: Integrated stack from device to network

  Multiple deployment modes, local and remote APIs

  Multiple Language and Virtualization options
Evolve the SDN Model ... the need for diverse information and interfaces
Not all Networking Interfaces are the same

• **WAN NPIs follow their Scope**

  • Defined by their *scope*
    
    API Scopes:
    Location independent; Area;
    Particular place; Specific device

    Approaches like device/network/service APIs not mapped to topology

    Location where an API is hosted can differ from the scope of the API

  • Different network planes require different programmatic interfaces, based on proper layer interaction

  ![Diagram](image_url)

  **Utility**
  
  Example: Get Auth, Publish Log,..
  Scope: Location independent

  **Area/Set**
  
  Example: Domain, OSPF-area,..
  Scope: Group/Set/Area

  **Place in the Network**
  
  Example: Edge Session, NAT
  Scope: Specific place/location

  **Element**
  
  Example: interface statistics
  Scope: Specific element

*A Router positioned on the Edge of a WAN != TOR*
Multi-Tenant Data Center Design 101

- 1 Layer
  - full mesh, distinct WAN edge

- 2 layers
  - WAN edge and DC aggregation combined

- 3 layers hierarchical
  - WAN edge and DC aggregation separate

- 3 layers + folded clos
  - Meshed aggregation
Assumptions about State of the Network Missing

Meshed Symmetric Topologies
Unconstrained Bandwidth
Simplified Abstraction Models
Workload Mobility Distributed Across L3 WAN
Integrated Service Virtualization
Secure Containers
Service Provider WANs
Hierarchical Multi-Domain Topologies
Multi-tenant Cloud Interconnect
Just One WAN = At Service of Many
What does this mean for the IETF

• There is a desire for real-time, full duplex state transfer with the network and nodes
  – Enable an augmentation of the deployed internet’s services
• Many of the critical features of networking nodes not standardized
• Required interfaces diminishing (e.g. SNMP configuration), not fully featured or nascent (netmod)
• Programmatic interfaces are the bridge between Ops, Apps, RT-Apps, Routing, Internet, Sec and Transport
• Architecture work will be required
• Given industry trends and desires, new WGcs must be formed and older silos, processes, requirements modified