



The OpenDaylight Project: Introduction and Overview

A large, abstract graphic element in the bottom-left corner consists of several overlapping triangles and rectangles in shades of yellow, orange, and red, creating a geometric pattern.

David Meyer

CTO and Chief Scientist, Brocade

Director, Advanced Technology Center, University of Oregon

Chair, OpenDaylight Technical Steering Committee

SDN Workshop

University of Arizona

Tucson, AZ

http://www.1-4-5.net/~dmm/talks/OpenDaylight_SDN_Workshop_AZ.pdf

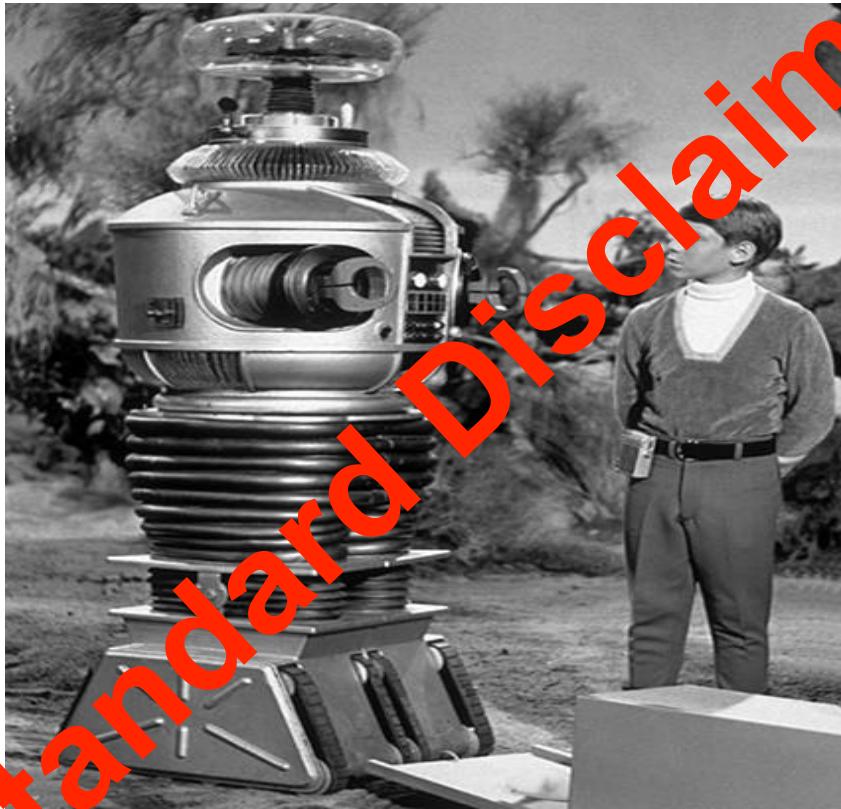
dmm@{brocade.com,uoregon.edu,1-4-5.net,...}

<http://www.sdn.arizona.edu/agenda>

Agenda

- A Couple of Macro Trends underlying SDN
- What is SDN?
- What is OpenDaylight?
 - BTW, What is a Open Source Project?
- Who is OpenDaylight?
- Hydrogen Simultaneous Release *Plan*
 - Projects in Hydrogen
 - Release Vehicles
- A Bit of OpenDaylight Technology
- Summary

Danger Will Robinson!!!



Standard Disclaimer

*This talk might be controversial/provocative
(and perhaps a bit “sciencey”)*

BTW, this is what I wanted to talk about 😊

Macro Trends, Architecture, and the Hidden Nature of Complexity (and what does this have to do with SDN?)



$$\int_0^\infty \ln |S(i\omega)| d\omega = \int_0^\infty \ln \left| \frac{1}{1 + L(i\omega)} \right| d\omega = \pi \sum Re(p_k) - \frac{\pi}{2} \lim_{s \rightarrow \infty} sL(s)$$

See http://www.1-4-5.net/~dmm/talks/macro_trends_complexity_and_sdn.pdf

Architectural Musings on SDN

(“and now for something completely different...”)



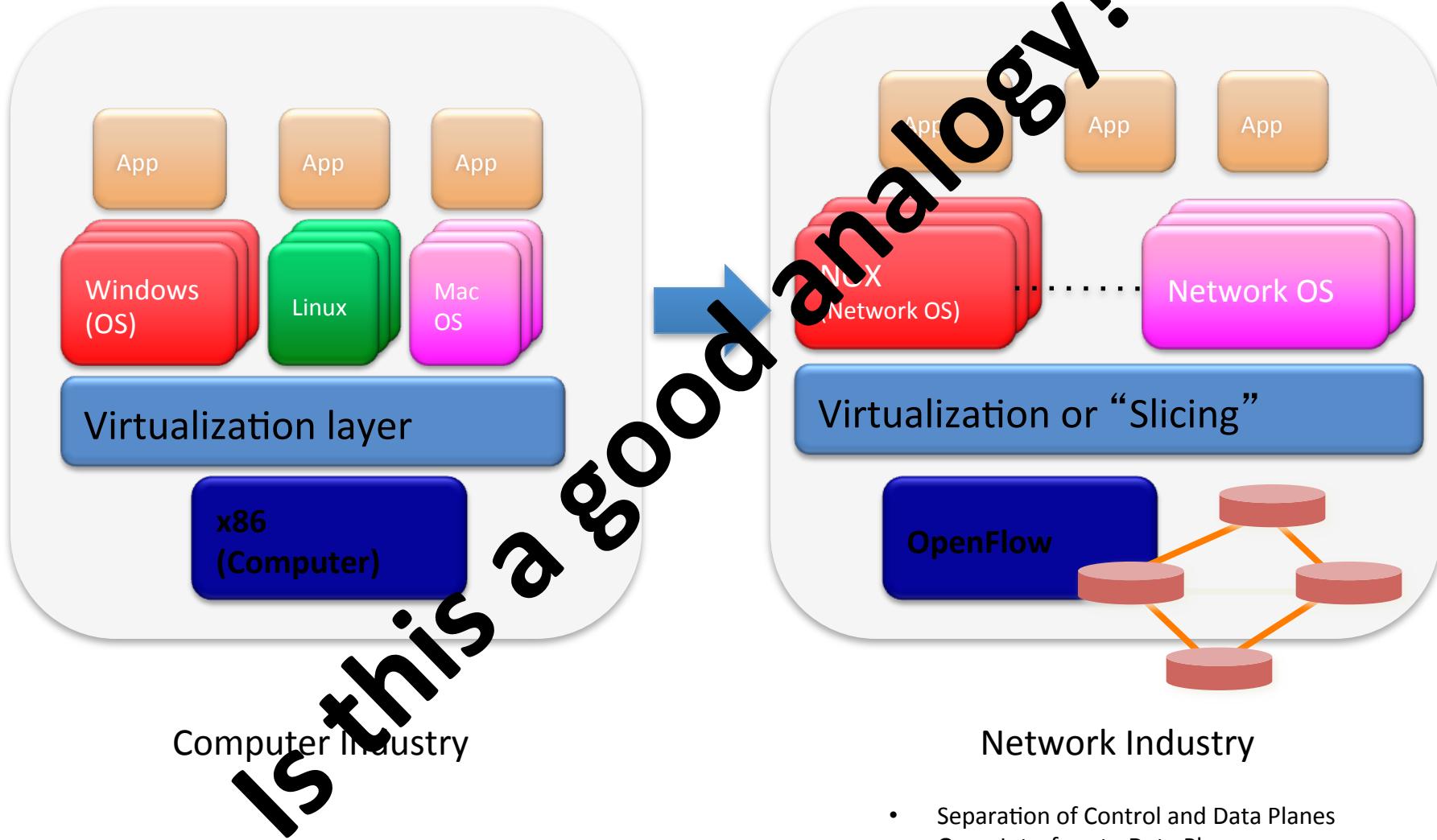
But hey, here's something interesting...

David Meyer
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Director, Advanced Technology Center, University of Oregon
RIPE 66
May 2013
Dublin, Ireland

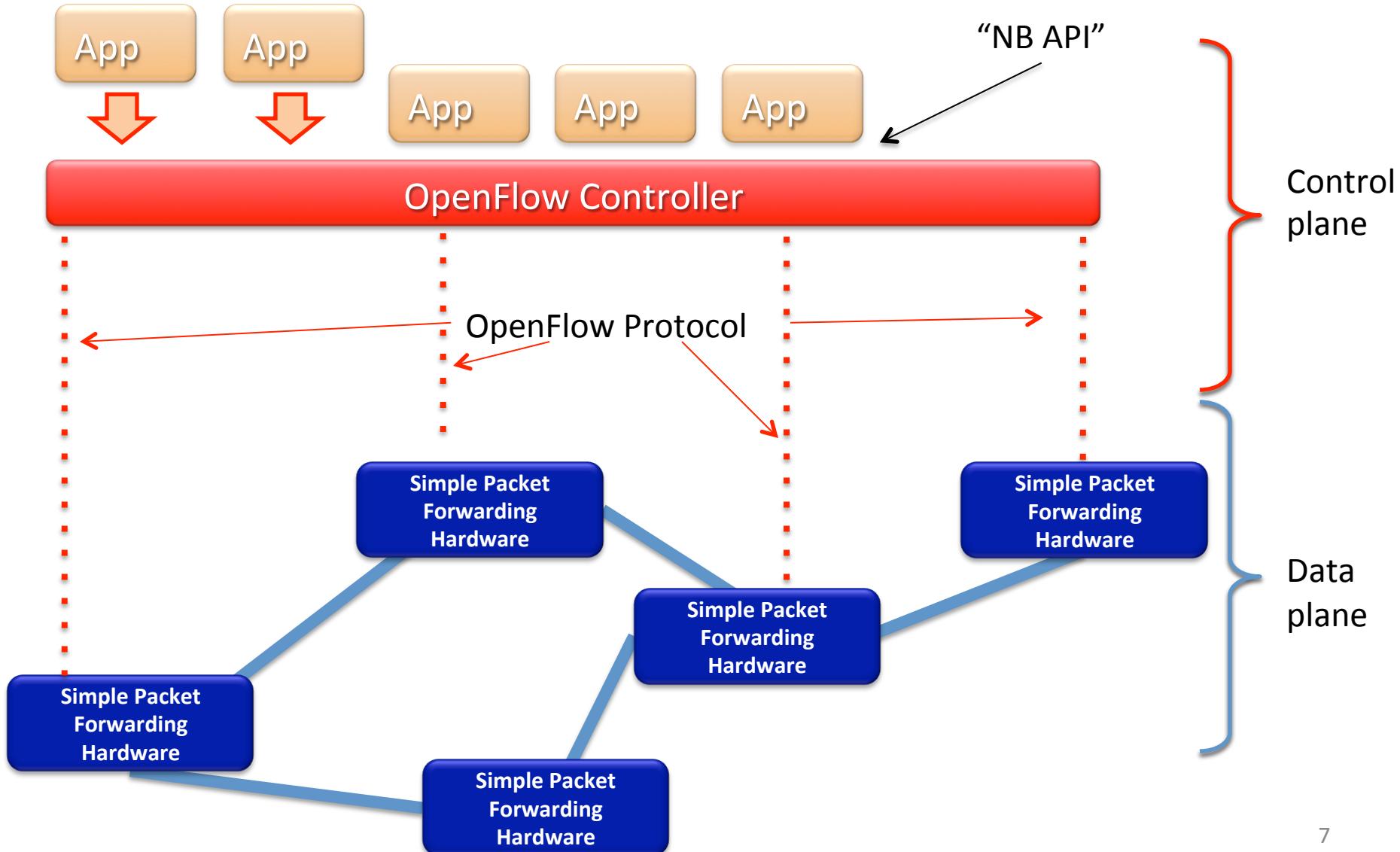
dmm@{brocade.com,uoregon.edu,1-4-5.net,...}
<http://www.1-4-5.net/~dmm/talks/ripe66.pdf>

So Let's Have a Look at OF/SDN

Here's the Thesis

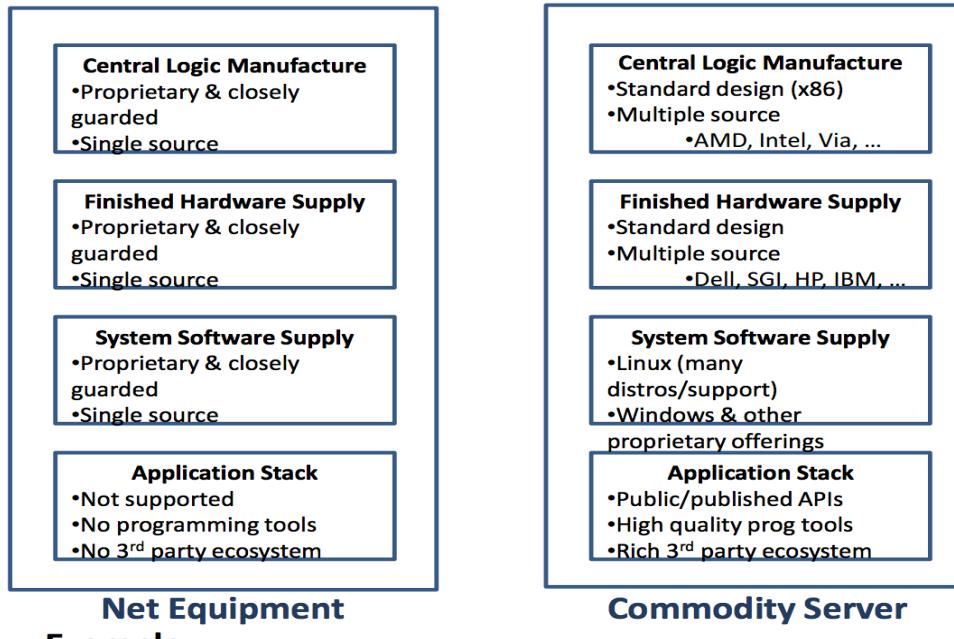


A Closer Look



So Does the OF/SDN-Compute Analogy Hold?

Mainframe Business Model



- **Example:**
 - Juniper EX 8216 (used in core or aggregation layers)
 - Fully configured list: \$716k w/o optics and \$908k with optics
- **Solution:** Merchant silicon, H/W independence, open source protocol/mgmt stack



Really Doesn't Look Like It

A better analogy would be an open source network stack/OS on white-box hardware

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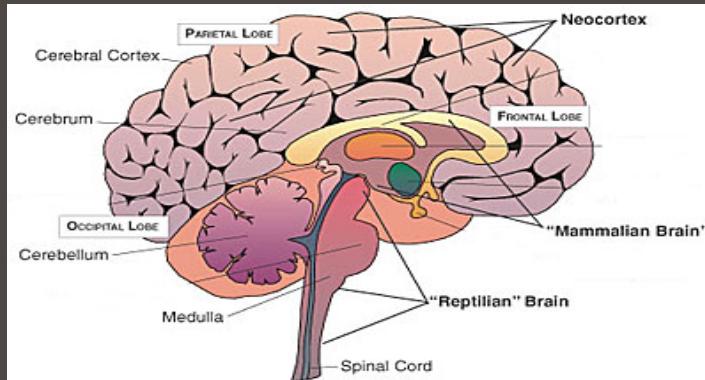
Trend: The Evolution of Intelligence

Precambrian (Reptilian) Brain to Neocortex → Hardware to Software

HARDWARE



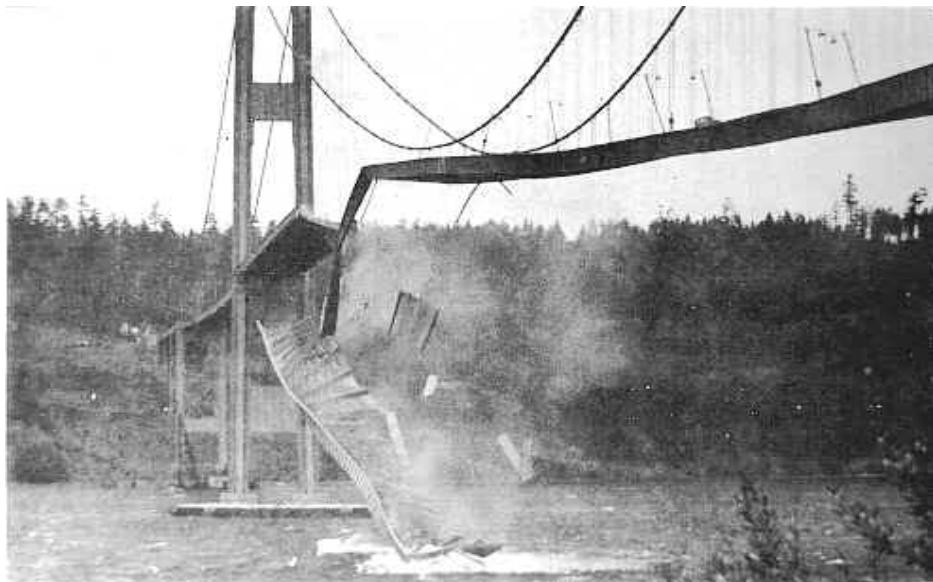
SOFTWARE



- Key Architectural Features of Scalable/Evolvable Systems
 - RYF-Complexity (behavior)
 - Layered Architecture
 - Bowties and Hourglasses
 - Horizontal Transfer (H^*T)

**Once you have HW
its all about code...**

Trend: Engineering artifacts are *no longer* the source of sustainable advantage and/or innovation



<http://en.wikipedia.org/wiki/Aeroelasticity - Flutter>

<http://www.slideshare.net/mestery/next-gennetworkengineerskills>

Perhaps surprisingly, the “hyper-scale” and open source communities have taught us that actual artifacts (in our case network applications as well as HW/SW) are ephemeral entities and that the only source of sustainable advantage/innovation consists of

- Engineering Systems
- Culture
- People/Process
- Multi-disciplinary Approaches
- BTW, what about *omics?
 - <http://www.youtube.com/watch?v=PXM4BbQIPQY>

To this point... (heard today...)

“The useful lifetime of our analysis toolchains is now 6 months”

-Matthew Trunnel, Broad Institute
37



Biologists are all bioinformaticians now.

Quotes courtesy Nirav Merchant (UA iPlanet Project)

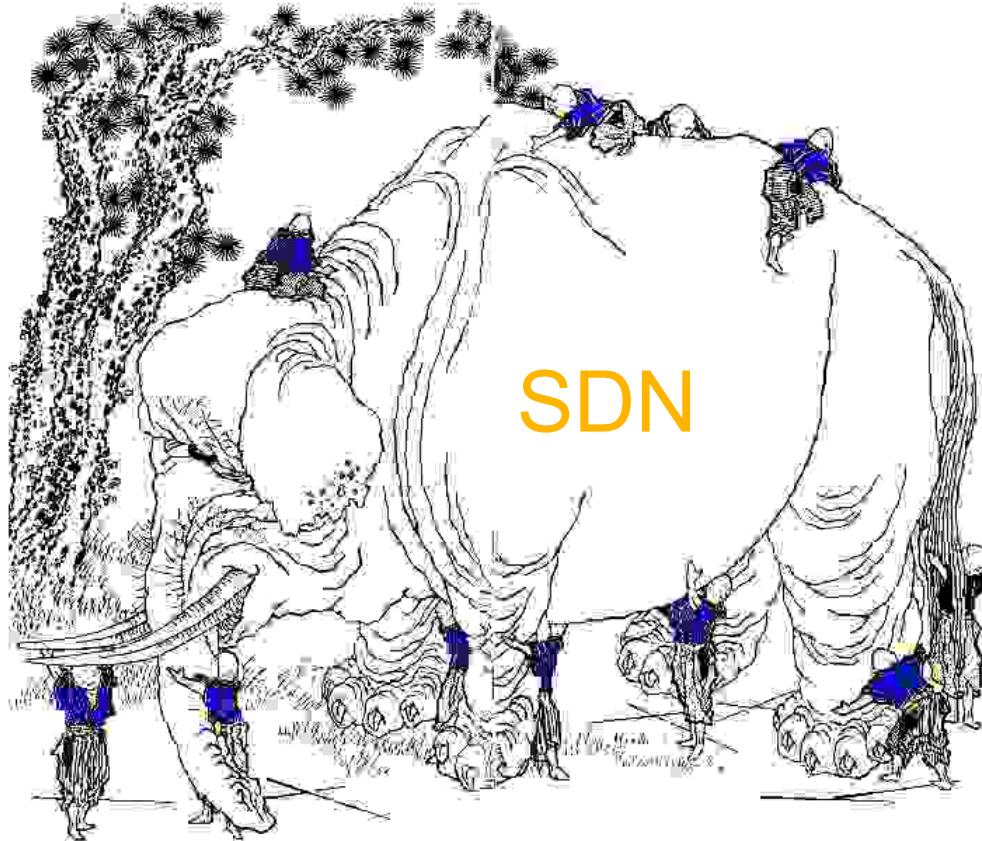
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What is SDN?

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But More Seriously...



What is SDN?

- SDN: Software Defined Networking
- Many things to many people...
 - Network virtualization in the cloud
 - Dynamic service chains for subscribers in SP
 - Dynamic traffic engineering
 - Dynamic network configuration
 - Network Function Virtualization
 - Many other use cases
- Networking is a bewilderingly diverse and general domain

What is SDN?

- Nonetheless, some commonalities
 - Bringing Programmability to the Network
 - Optimize speed/flexibility (Turing, really)
 - Move from configuration time to software time
- Lots of different good ideas on how to do it
- Everybody is still figuring it out – *evolvability* is key
 - There are lots of ways to skin the cat
 - Right tool for the job
- Need a general evolvable platform that recognizes the diversity of needs and approaches

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What is OpenDaylight?

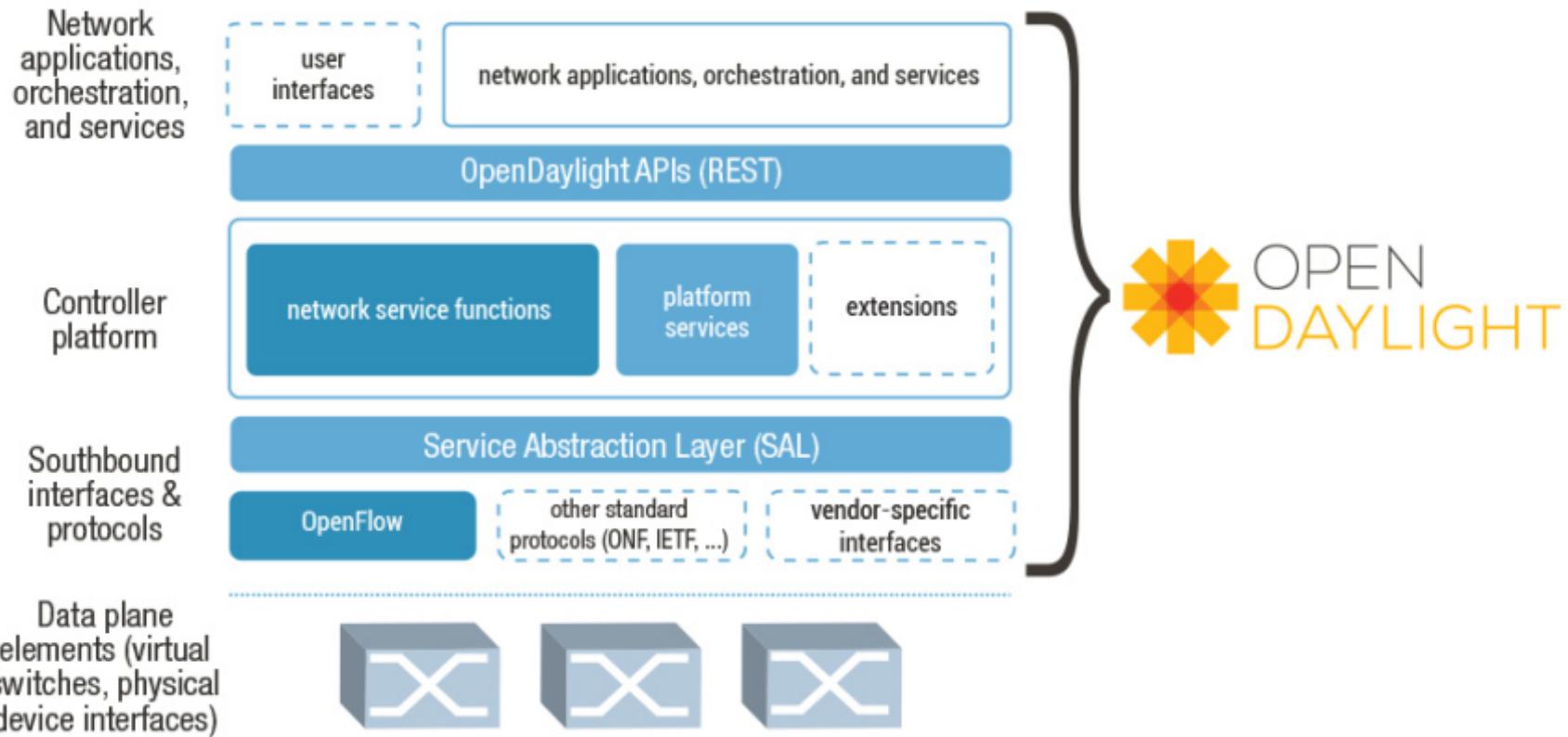
- OpenDaylight is **community** that is building:
 - An evolvable SDN platform capable of handling diverse use cases and approaches
 - Common abstractions of capabilities NBI people can program to
 - Intermediation of those capabilities to multiple Southbound implementations
 - Programmable Network services
 - Network Applications
 - Whatever the hell else we need to make it all work ☺

What is Key to an Open Source Project?

- Open Source license (of course)
- Ready code availability (again, of course)
- Evolvable Engineering Systems (tool chains, etc)
 - Feedback loops
- While these are required, they are not the key aspect(s)
- What are?
 - Vibrant developer and user communities
 - Contributor diversity
 - Committer diversity
 - Active Contributor → Committer → TSC Member → ... pipeline
 - Corporate backing

See Matt Palmer on this topic: <http://www.sdncentral.com/sdn-blog/opendaylight-challenger-aims-att-microsoft-new-years/2013/12/>

Project Framework



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Who is OpenDaylight? (the corporate view)

Platinum Members



Gold Members



Silver Members



Who is OpenDaylight? (really)

- Like any Open Source Project, OpenDaylight primarily consists of those who show up to do the work.
 - Currently commits from over 70 contributors from many different organizations (and unaffiliated individuals) and growing
 - Running around 100 commits per week and accelerating
 - Strong integration and testing community

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What is OpenDaylight Delivering

- OpenDaylight is multi-project
 - 14 current projects
 - Project diversity v. mono-culture
 - New Projects
 - Logical Switch Abstraction
 - Fiber Channel SAN
 - DPDK OVS
 - Application Policy Plugin
- We are delivering a Simultaneous Release
- CodeName: Hydrogen
- Due Date: Dec 9, 2013
 - Well....

Simultaneous Release Plan

Milestone	Offset 0 Date	Offset 1 Date	Offset 2 Date	Events
M0	6/24/2013	6/26/2013	6/28/2013	Simultaneous Release Open
M1	7/22/2013	7/24/2013	7/26/2013	1. Projects must have declared intent to participate in Simultaneous Release 2. Participating Projects must have published a candidate Release Plan for public comment
M2	8/19/2013	8/21/2013	8/23/2013	Participating Projects must have declared their final Release Plan
M3	9/16/2013	9/18/2013	9/20/2013	Latest possible Continuous Integration Test Start
M4	10/14/2013	10/16/2013	10/18/2013	1. API Freeze 2. Latest possible Continuous System Test Start
M5	11/11/2013	11/13/2013	11/15/2013	Code Freeze (bug fixes only from here) String Freeze (all internationalizable strings frozen to allow for translation) Latest possible date for commencing User Facing Documentation
RC0	11/18/2013	11/20/2013	11/22/2013	
RC1	11/25/2013	11/27/2013	11/29/2013	
RC2	12/2/2013	12/4/2013	12/6/2013	Participating Projects must hold their Release Reviews, including User Facing Documentation.
Formal Release	12/9/2013			

Well



Projects in the Simultaneous Release

- [Controller](#)
- [VTN](#)
- [OpenDove](#)
- [Affinity Management Service](#)
- [LISP Mapping Service](#)
- [Yang Tools](#)
- [Defense4All](#)
- [BGP-LS/PCEP](#)
- [OpenFlow Protocol](#)
- [OpenFlow SB Plugin](#)
- [OVSDB](#)
- [SNMP4SDN](#)
- [DiLUX](#)
- [SIT](#)

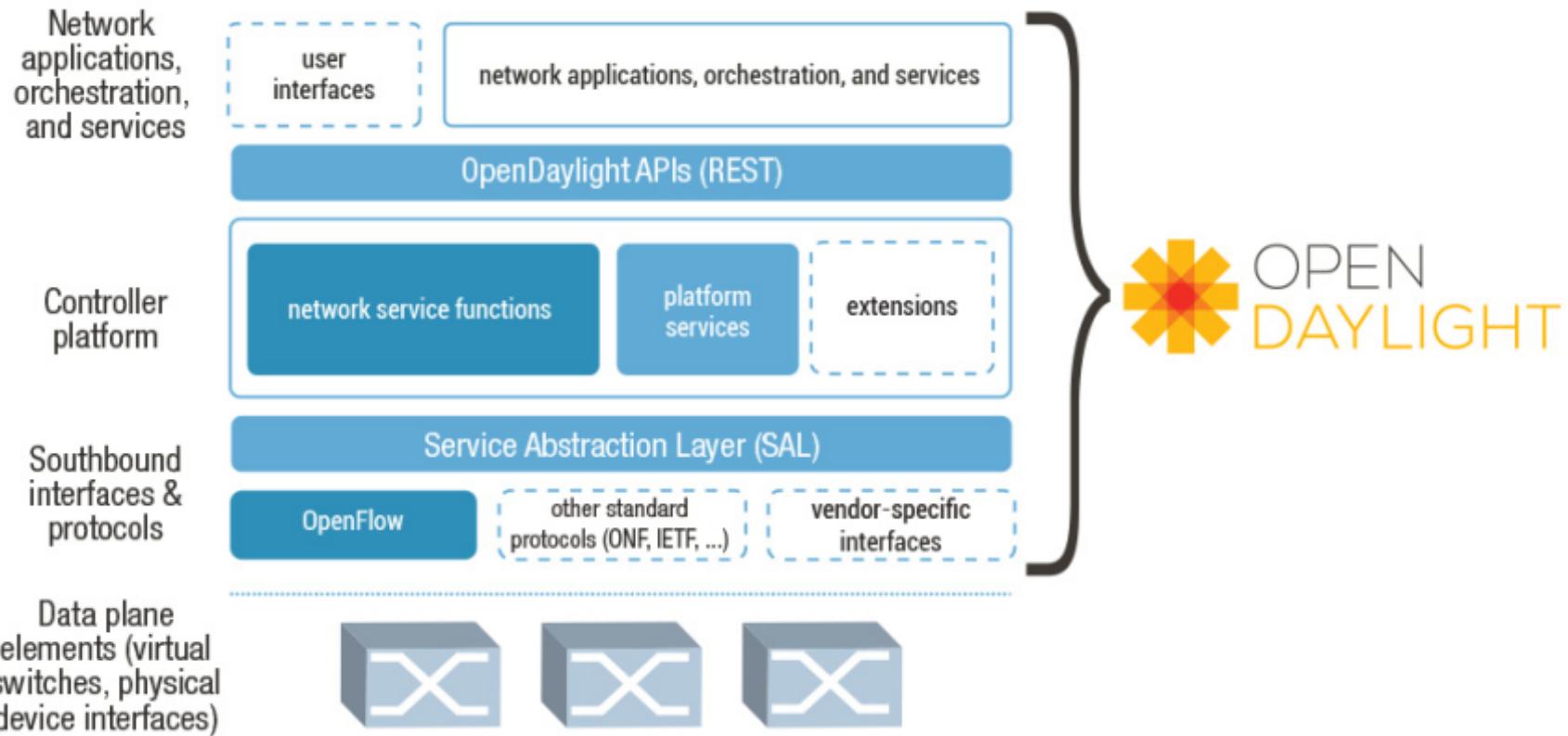


Controller

- Contributed by [Cisco](#)
- Includes:
 - Base OSGI Framework
 - HA, Clustering
 - Service Abstraction Layer (SAL)
 - OF 1.0 SB Plugin
 - ND API
 - Hosttracker
- Includes(cont) :
 - Stats Manager
 - GUI
 - Topology Manager
 - and more...
- [Controller Release Plan](#)



Controller

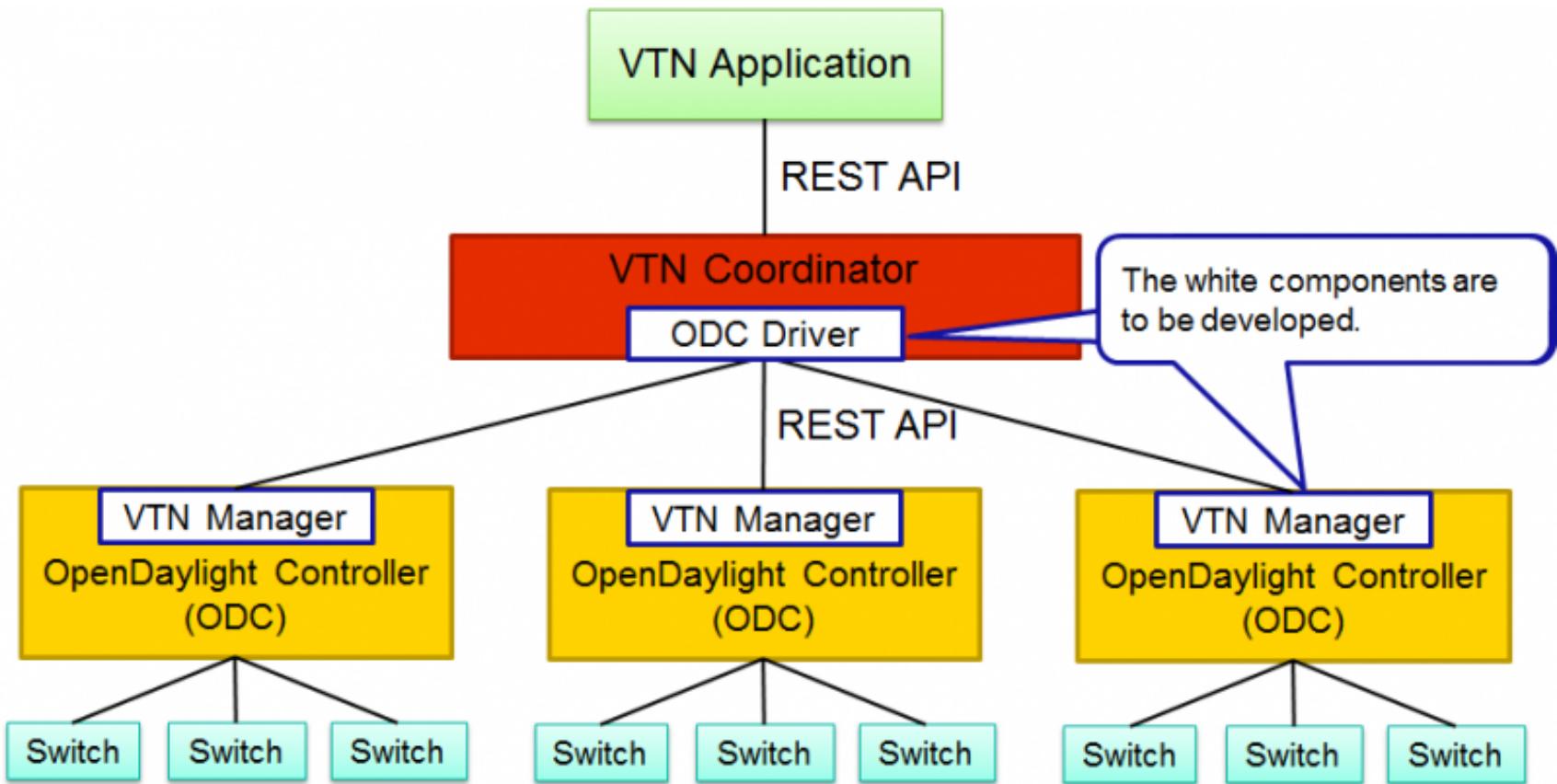


VTN

- Contributed by [NEC](#)
- Existing NEC Virtual Tenant Network Technology
- Virtualizes network for multiple tenants
 - vBridge, vRouter
- [VTN Release Plan](#)



VTN

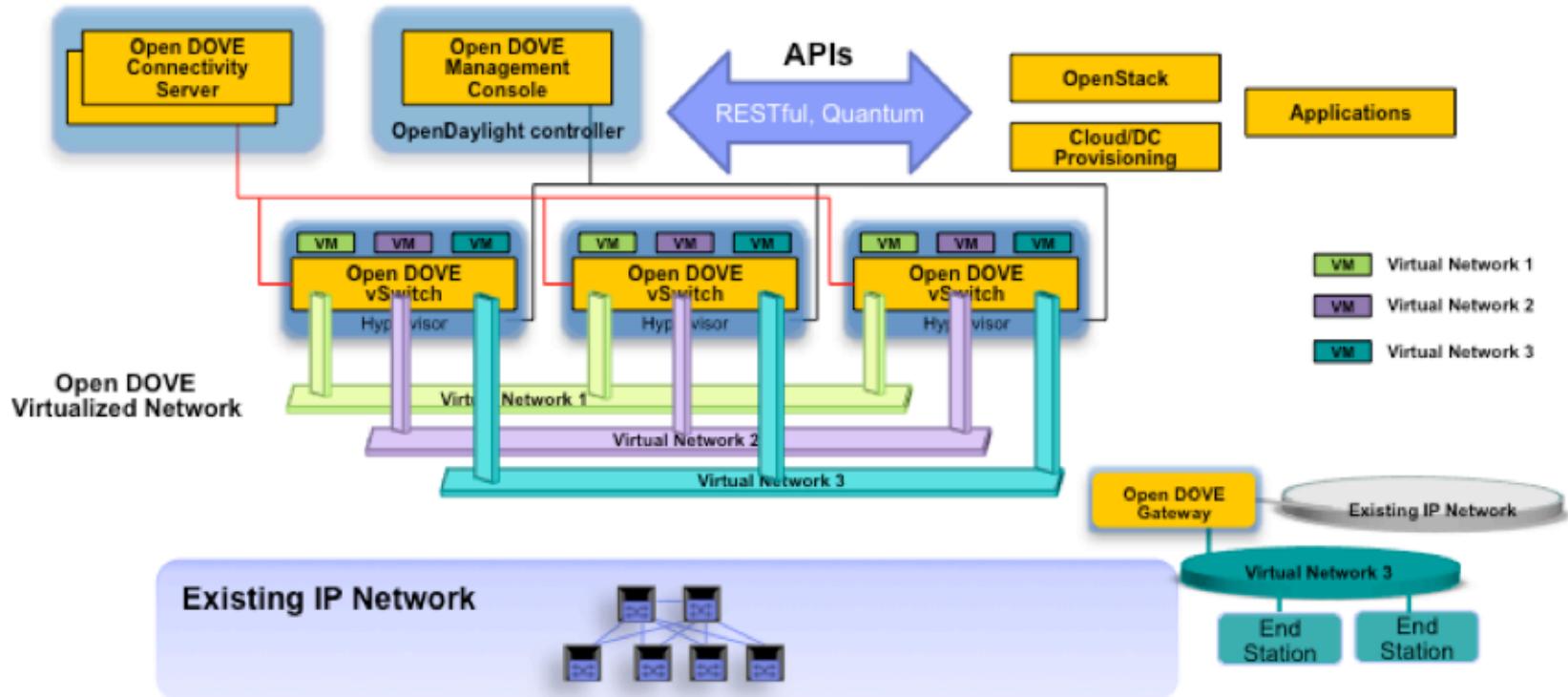


OpenDOVE

- Contributed by [IBM](#)
- Virtualizes Network using VXLAN
- Uses custom control plane instead of multicast
- [OpenDove Release Plan](#)



OpenDove



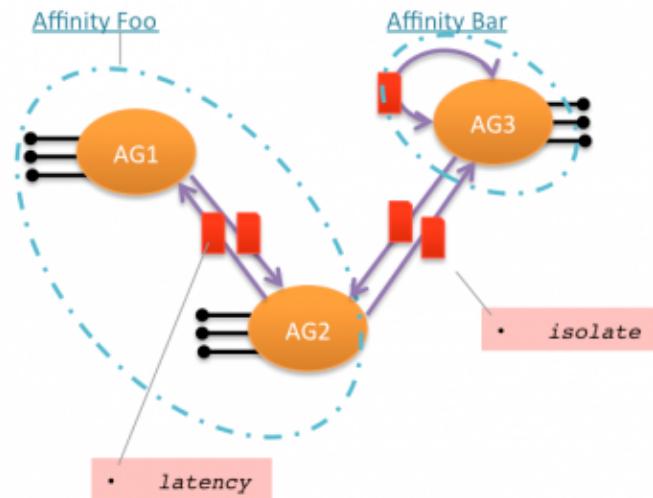
Affinity Management Service

- Contributed by Plexxi
- Service for storing Affinity Information
- Affinity Information allows association of metadata about workload
- Affinity Release Plan
- Examples:
 - Hop Count Sensitive
 - Isolate
 - Encrypt
 - Class of Service

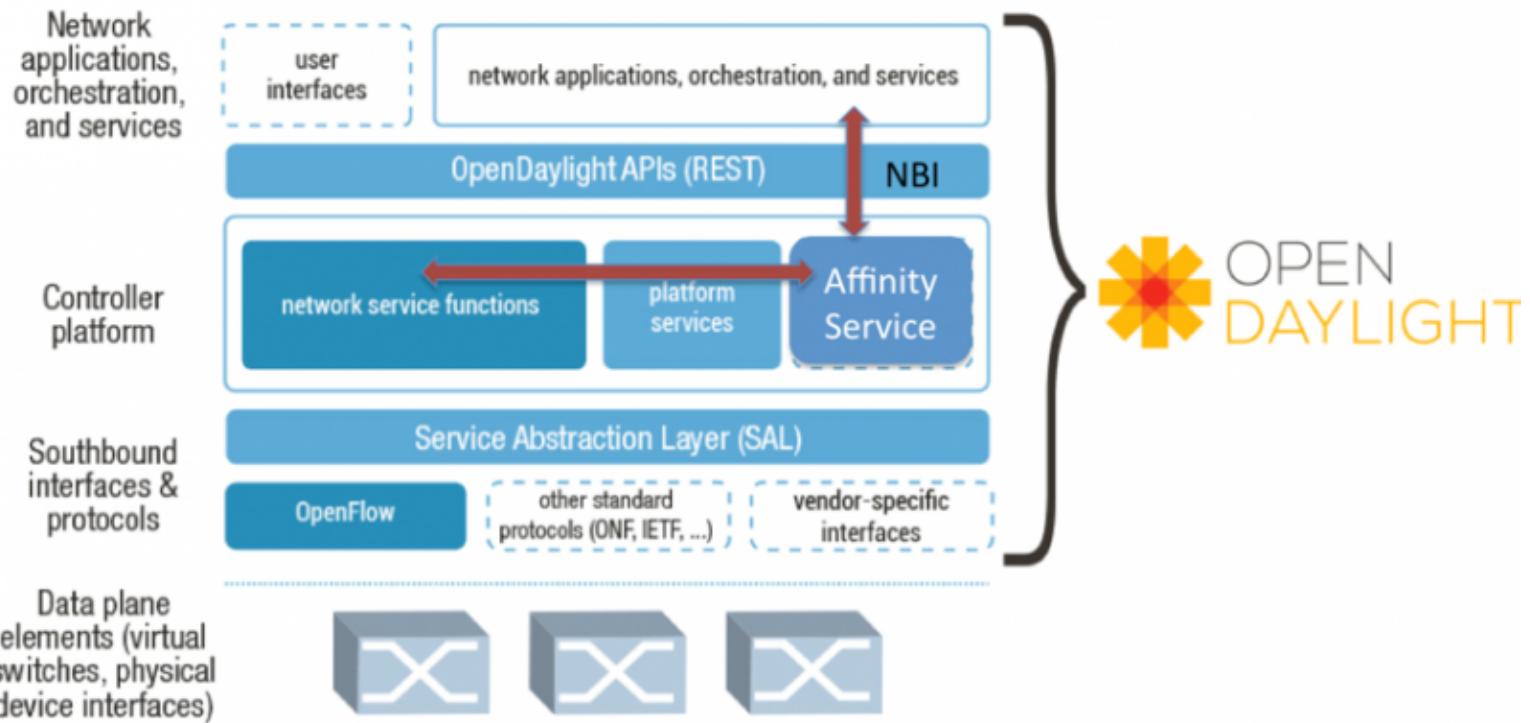


Affinity Management Service

Element	Name	Relationships
—	Affinity Identifier	<ul style="list-style-type: none">Part of 1+ affinity groups
○	Affinity group	<ul style="list-style-type: none">Has 1+ endpointsHas 1+ affinity links
←	Affinity link	<ul style="list-style-type: none">Has 1+ affinity groupsHas 0+ attributesIs directional
■	Affinity link attributes	<ul style="list-style-type: none">Has 1+ affinity groups
○—○	Affinity	<ul style="list-style-type: none">Relationship described by 1+ link and 1+groups
↔	Conversation	<ul style="list-style-type: none">May follow exactly 1 AffinityIs likely directional



Affinity Management Service

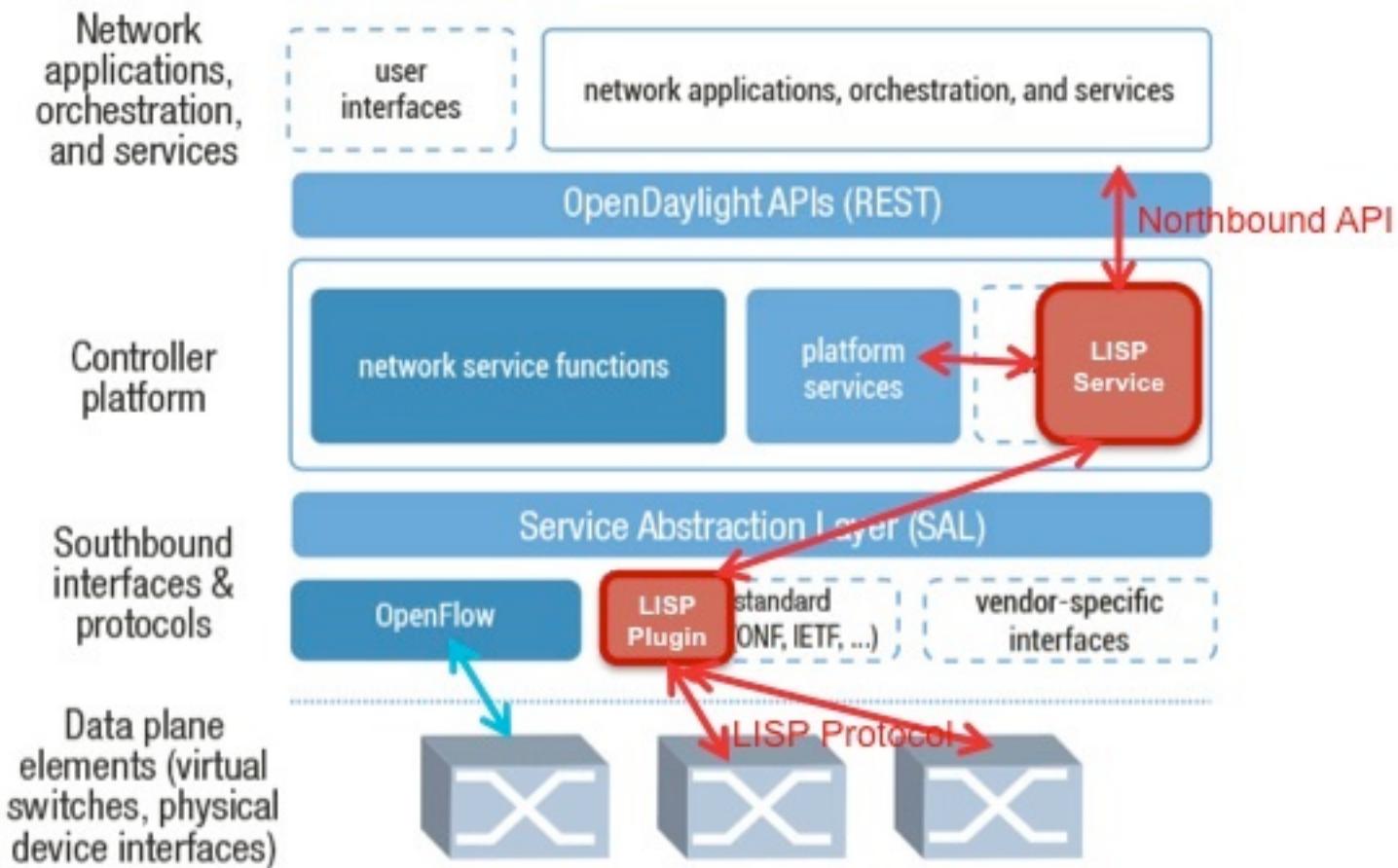


LISP Mapping Service

- Contributed by
Contextream with Cisco
- Programmable LISP
Mapping Service
- May include functions to:
 - Associate users to flows
 - Chain service flows
- LISP Release Plan



LISP Mapping Service



Yang Tools

- Contributed by [Cisco](#)
- Provides tooling to build Java bindings in yang from yang models
- Supporting tooling for Model Driven SAL
- [Yang Tools Release Plan](#)

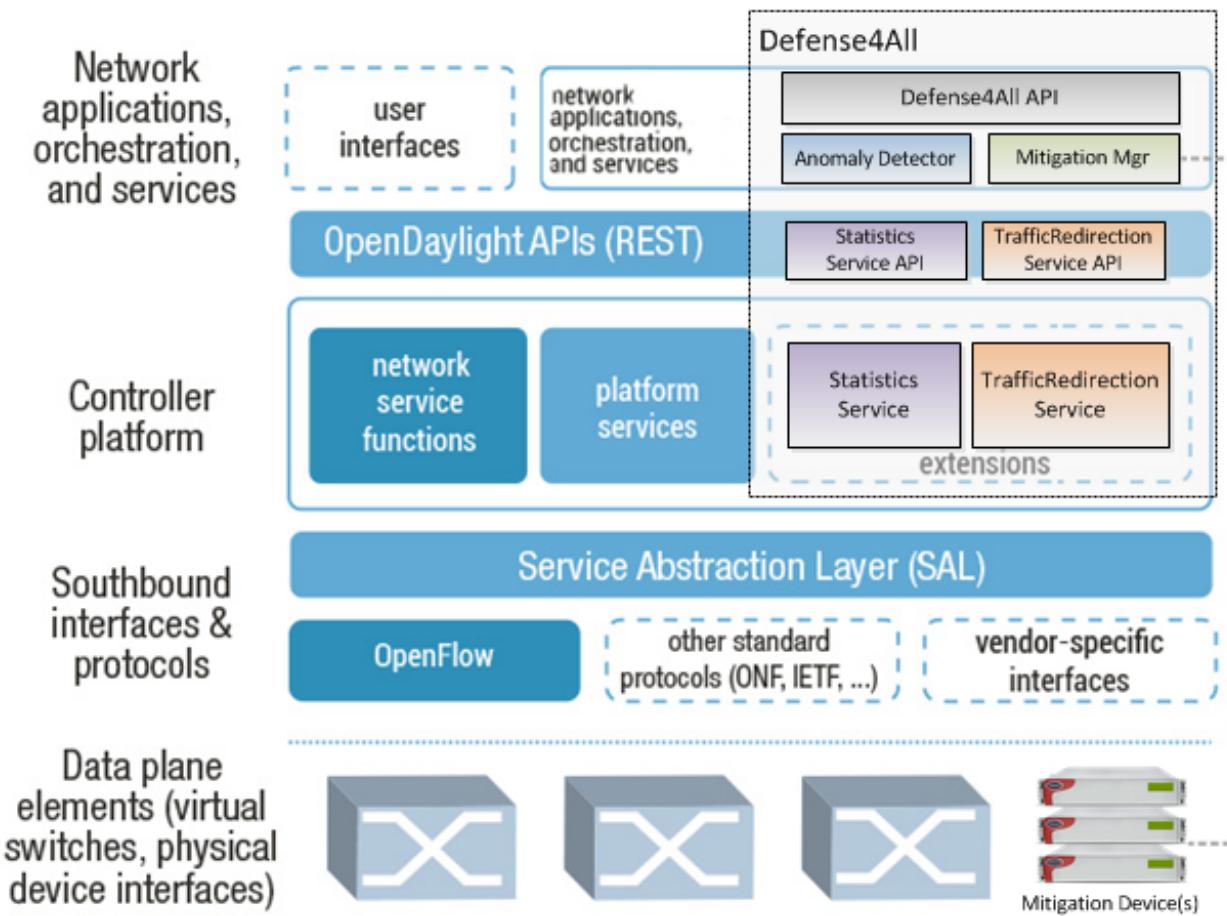


Defense4All

- Contributed by [Radware](#)
- Provides DDOS detection and mitigation
- Designed to allow plugging in additional detection and mitigation strategies
- [Defense4All Release Plan](#)



Defense4All



BGP-LS/PCEP

- Contributed by [Cisco](#)
- Provides support for discovering topology via BGP-LS
- Provides support for path programming via PCEP
- [BGP-LS/PCEP Release Plan](#)



OpenFlow Protocol Library

- Contributed by [Pantheon](#)
- Provides OpenFlow Protocol Stack for OF 1.0, 1.3+
 - Supports extensibility from 3rd party bundles
 - Vendor actions
 - Vendor Matches
- [OpenFlow Proto Lib Release Plan](#)



OpenFlow SouthBound Plugin

- Joint project between IBM/Ericsson/Cisco
- Provides OF 1.0, 1.3+ Southbound plugin for Controller
 - Based on OF Protocol Library project
- OpenFlow Plugin Release Plan



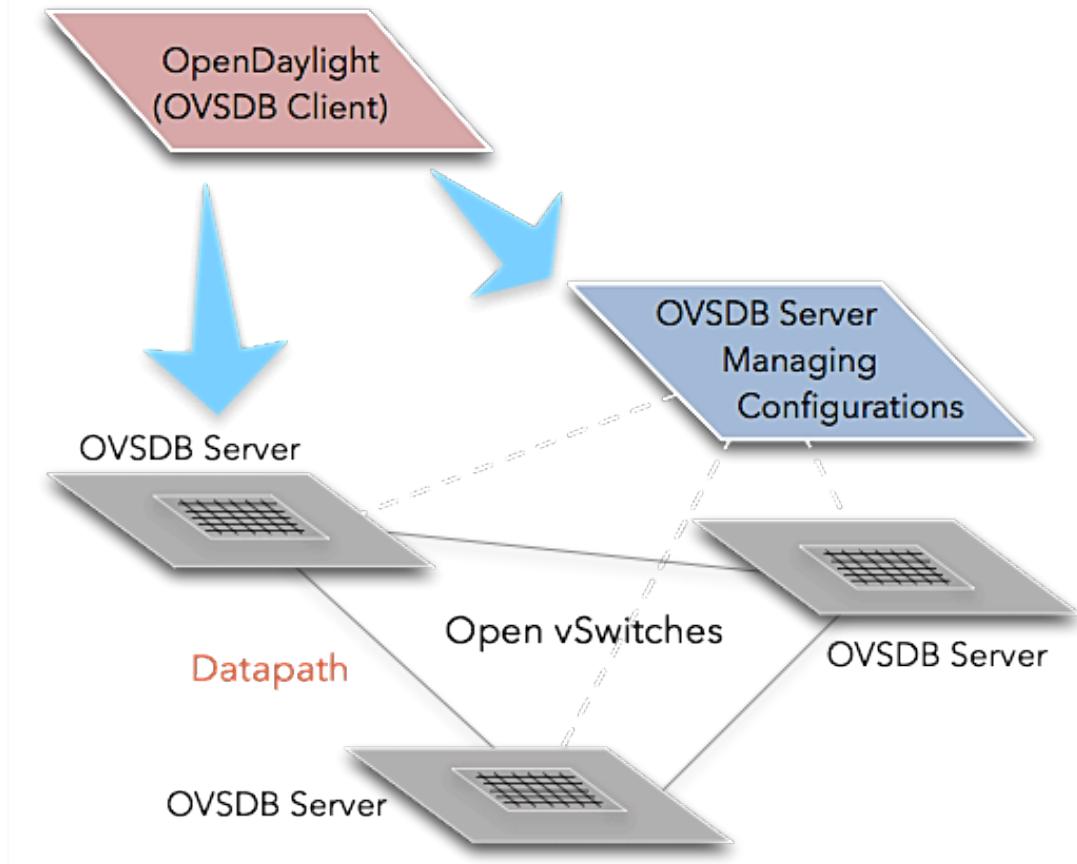
OVSDB

- Contributed by Individuals at
University of Kentucky/Redhat
- Allows Controller to configure OVS
using OVSDB
- OVSDB Release Plan



OVSDB

Provision Datpaths to the OVSDB Server or Directly to Elements

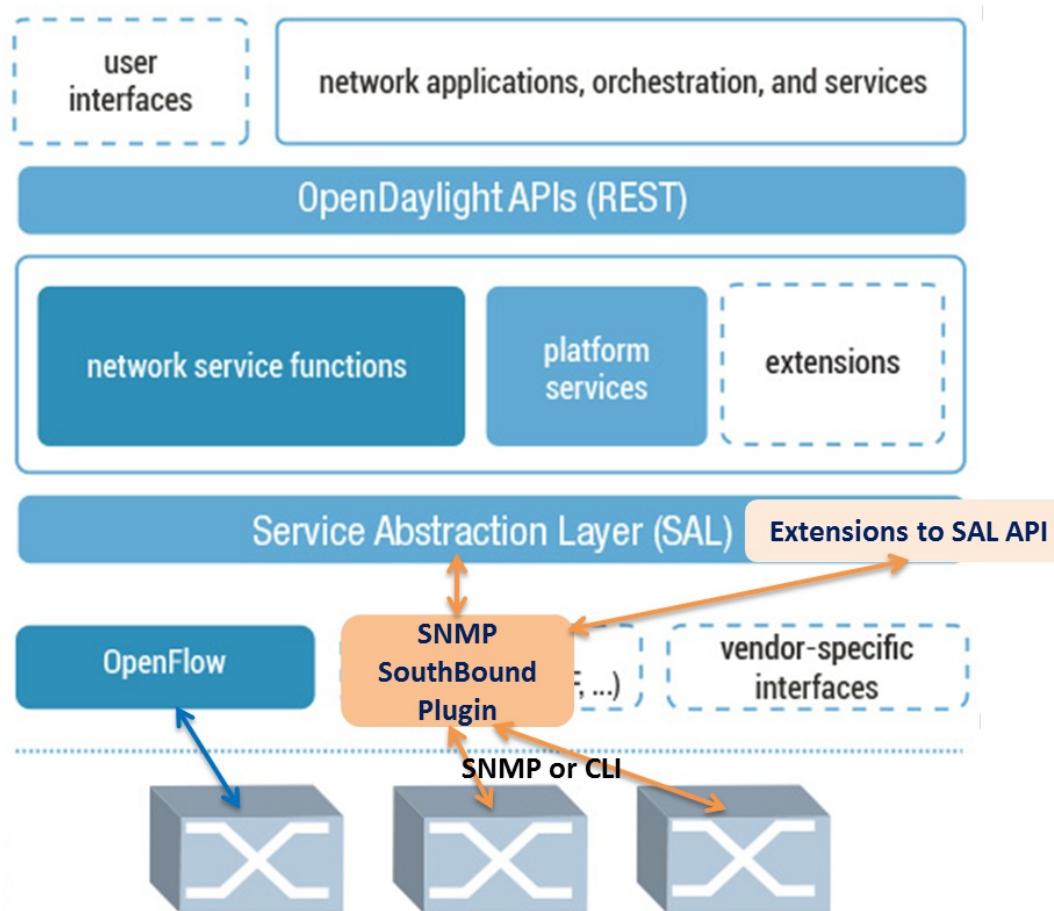


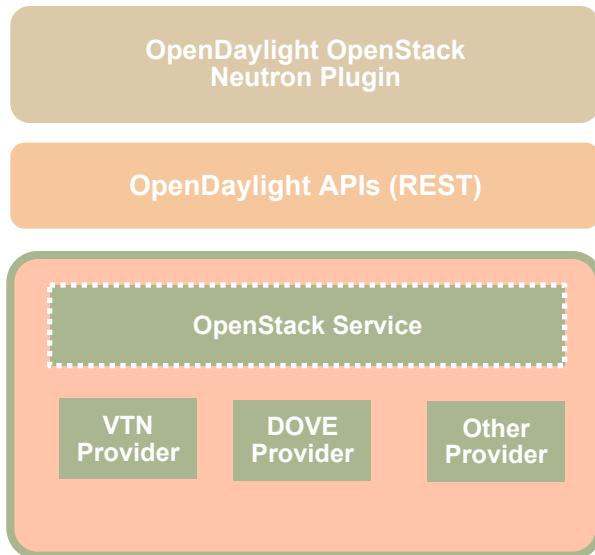
SNMP4SDN

- Contributed by [ITRI](#)
- Allows Controller to carry out some configuration tasks via SNMP
- [SNMP4SDN Release Plan](#)



SNMP4SDN



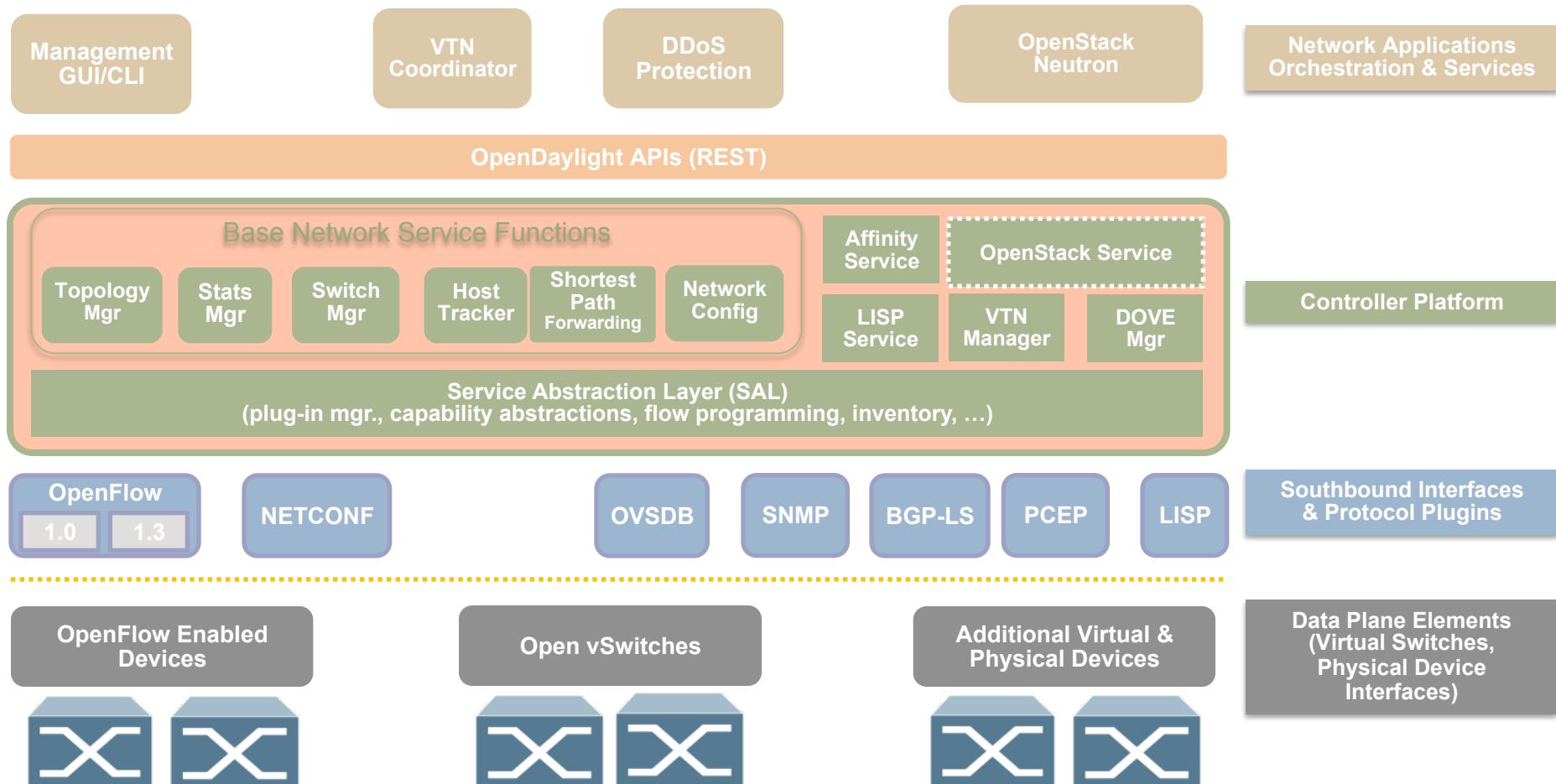


OpenStack Integration

- OpenDaylight exposes a single common OpenStack Service Northbound
 - API exposed matches Neutron API precisely
 - Different implementations plug in under it, in ODL, as provides
- OpenDaylight OpenStack Neutron Plugin simply passes through
- Improves evovability



Hydrogen Release



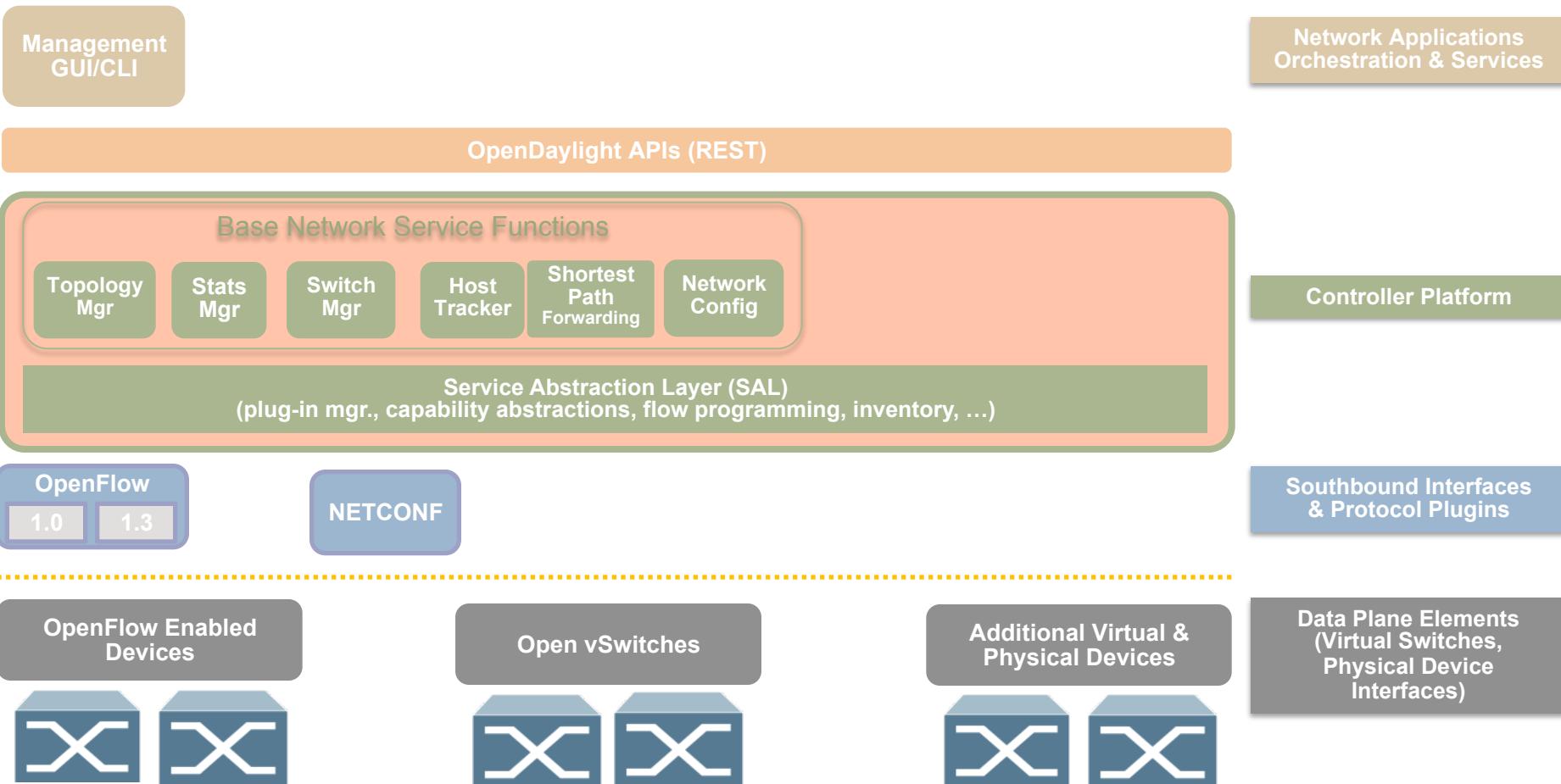
VTN: Virtual Tenant Network
DOVE: Distributed Overlay Virtual Ethernet
DDoS: Distributed Denial Of Service
LISP: Locator/Identifier Separation Protocol
OVSDB: Open vSwitch DataBase Protocol
BGP: Border Gateway Protocol
PCEP: Path Computation Element Communication Protocol
SNMP: Simple Network Management Protocol

Proposed Hydrogen Release Vehicles

- Release Vehicles and their contents are still being finalized
- Current proposal:
 - Base Edition
 - Virtualization Edition
 - Service Provider Edition



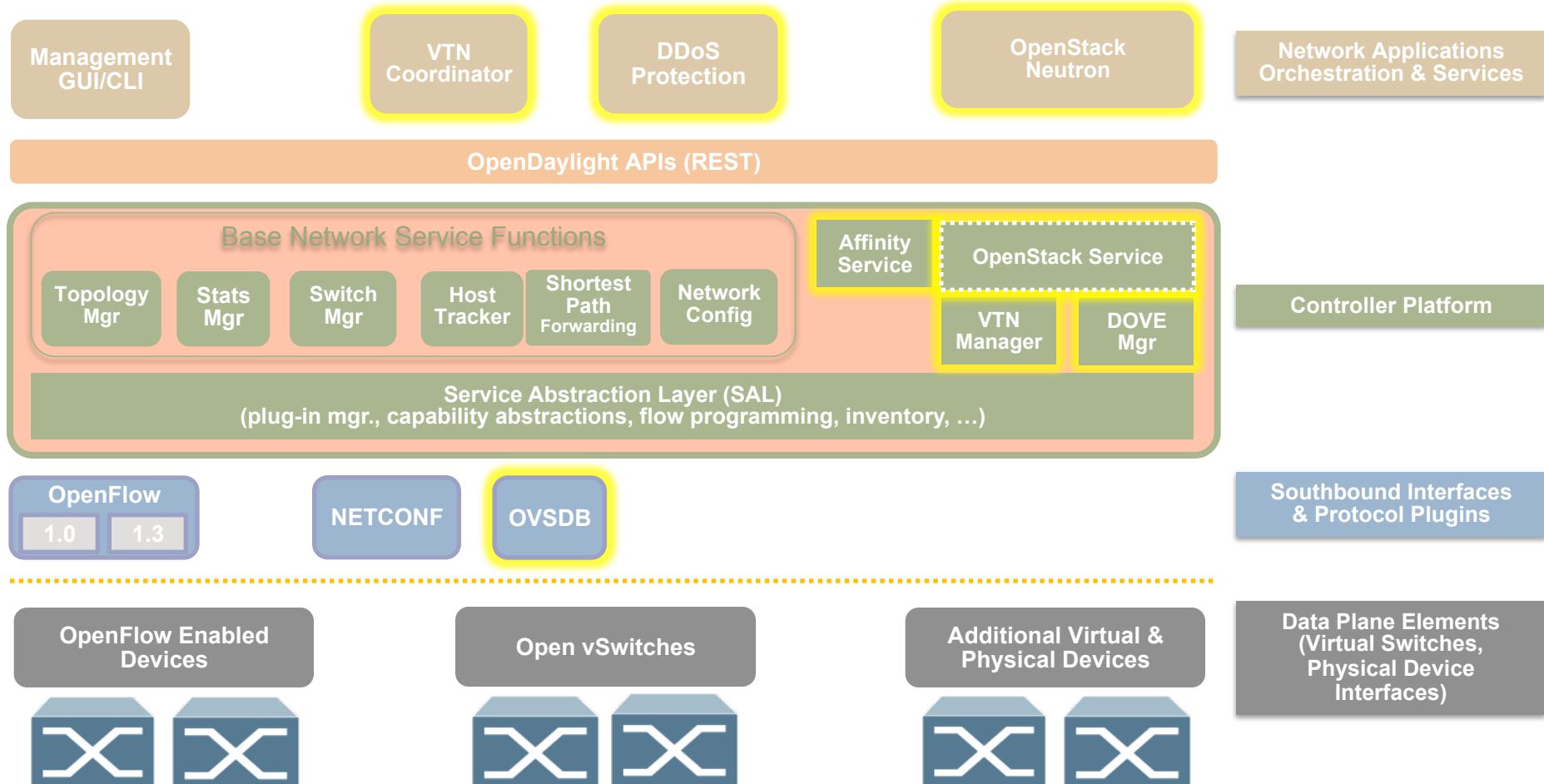
Base Edition



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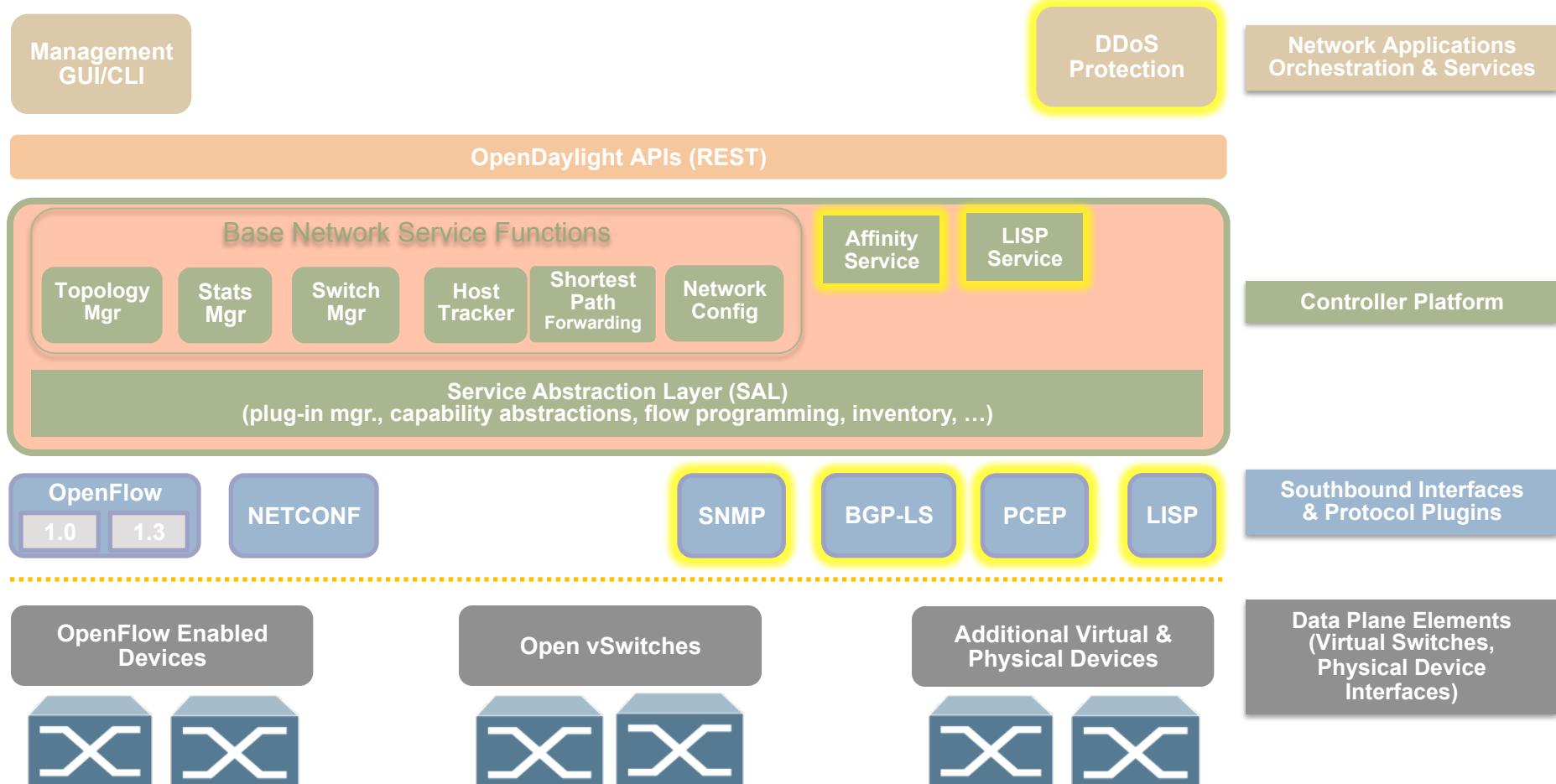
Virtualization Edition



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Service Provider Edition



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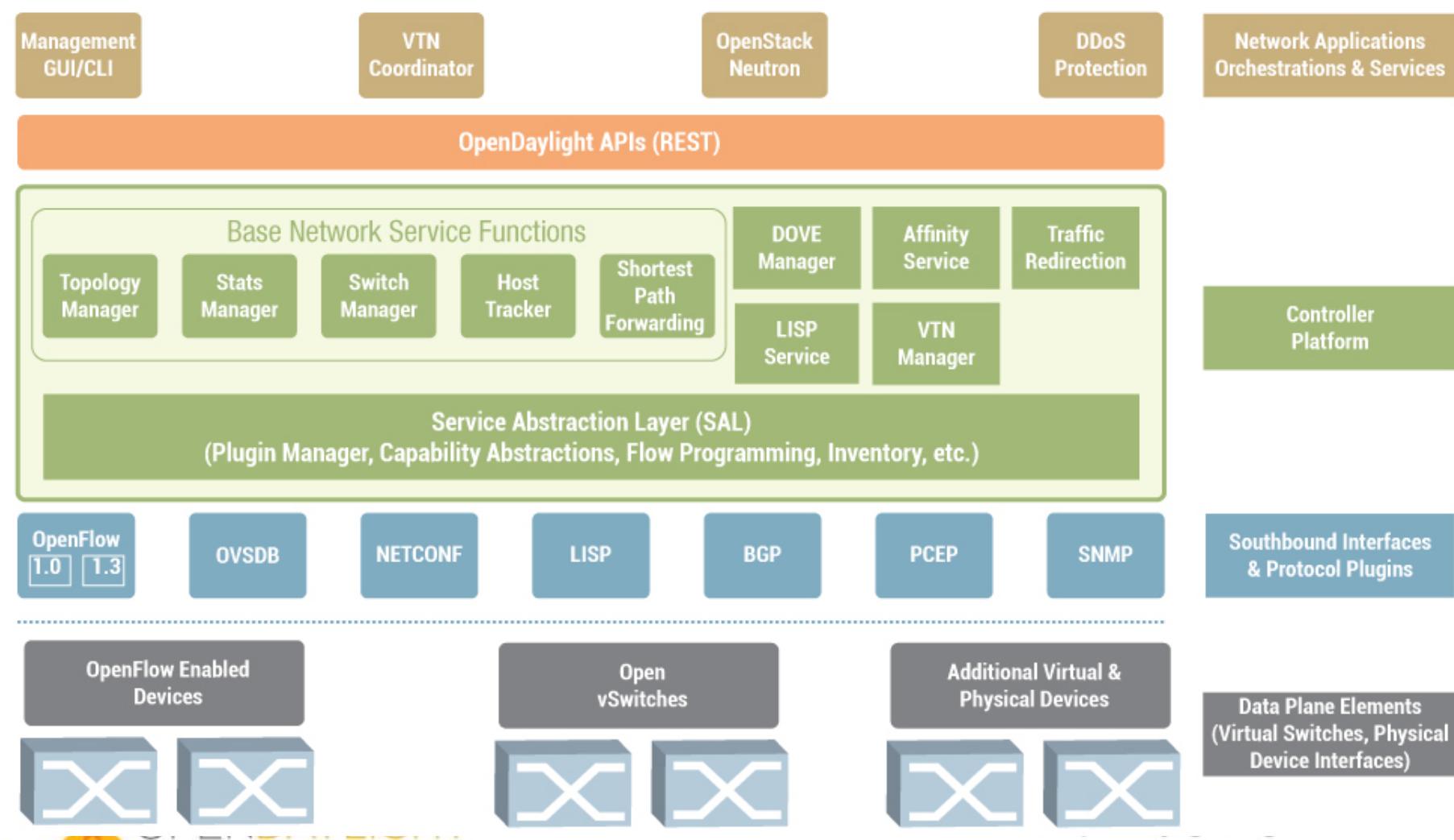
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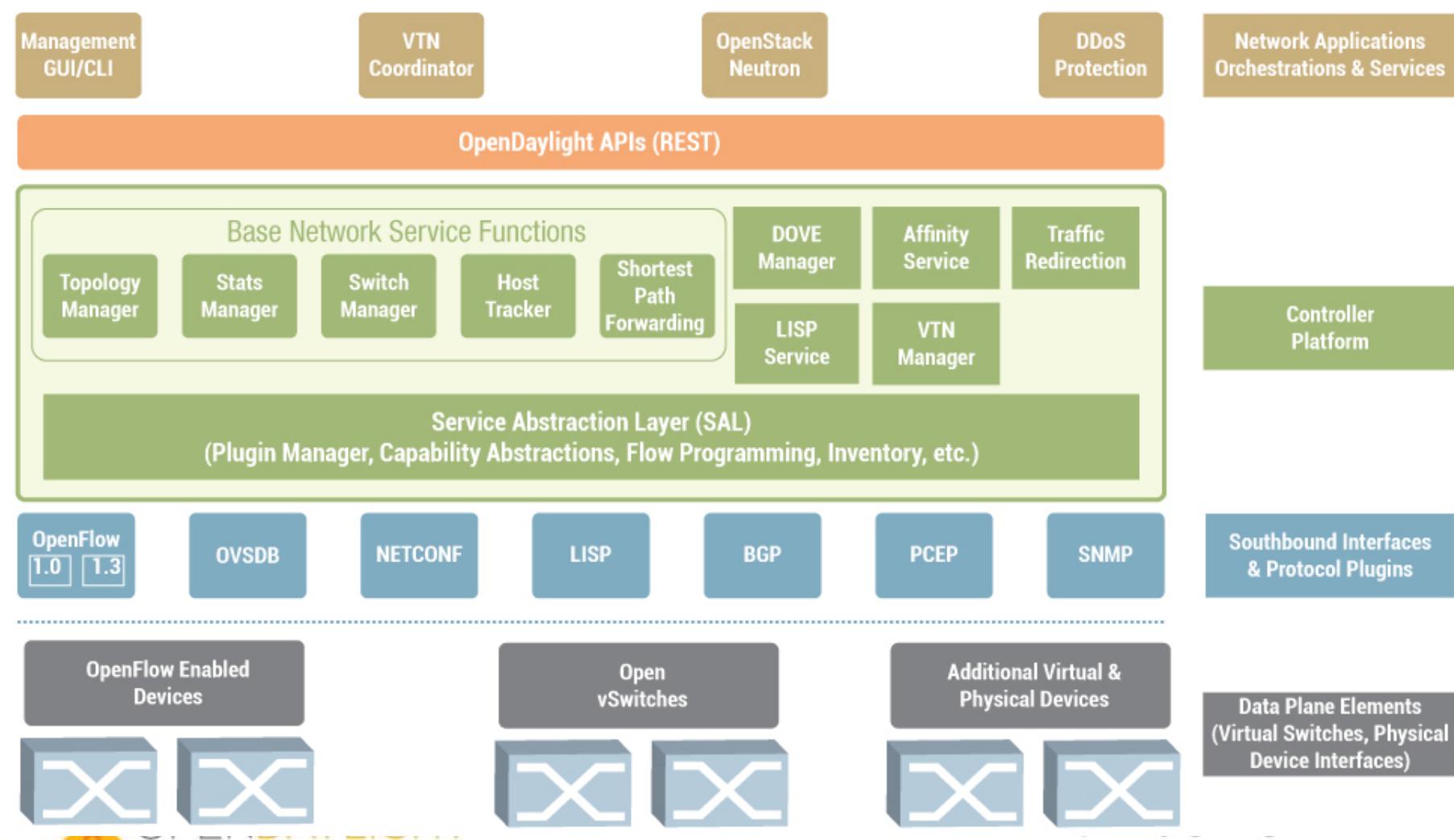
OpenDaylight Controller Architecture



OpenDaylight™

OpenDaylight™

OpenDaylight Controller Architecture



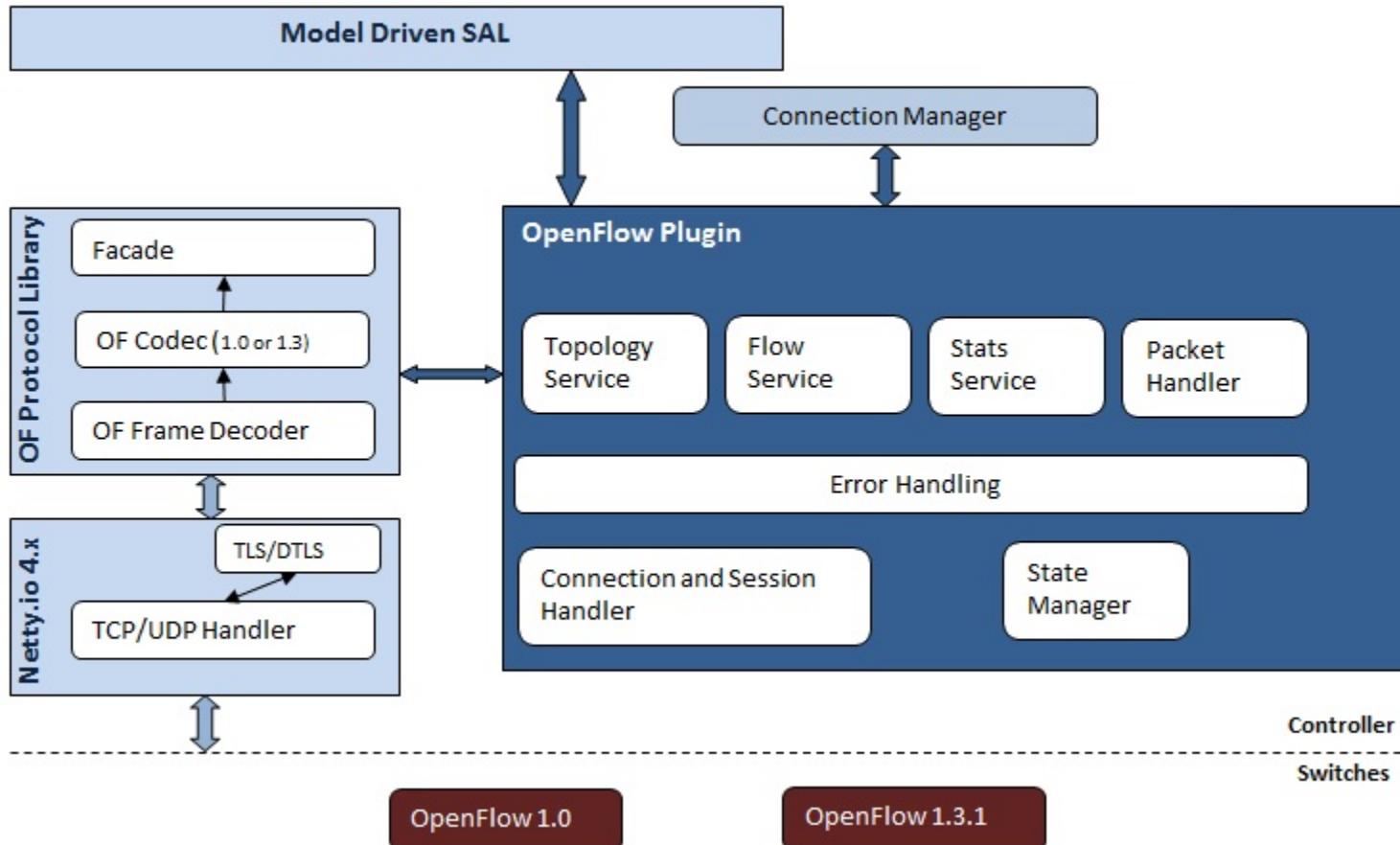
OpenDaylight™

OpenDaylight™

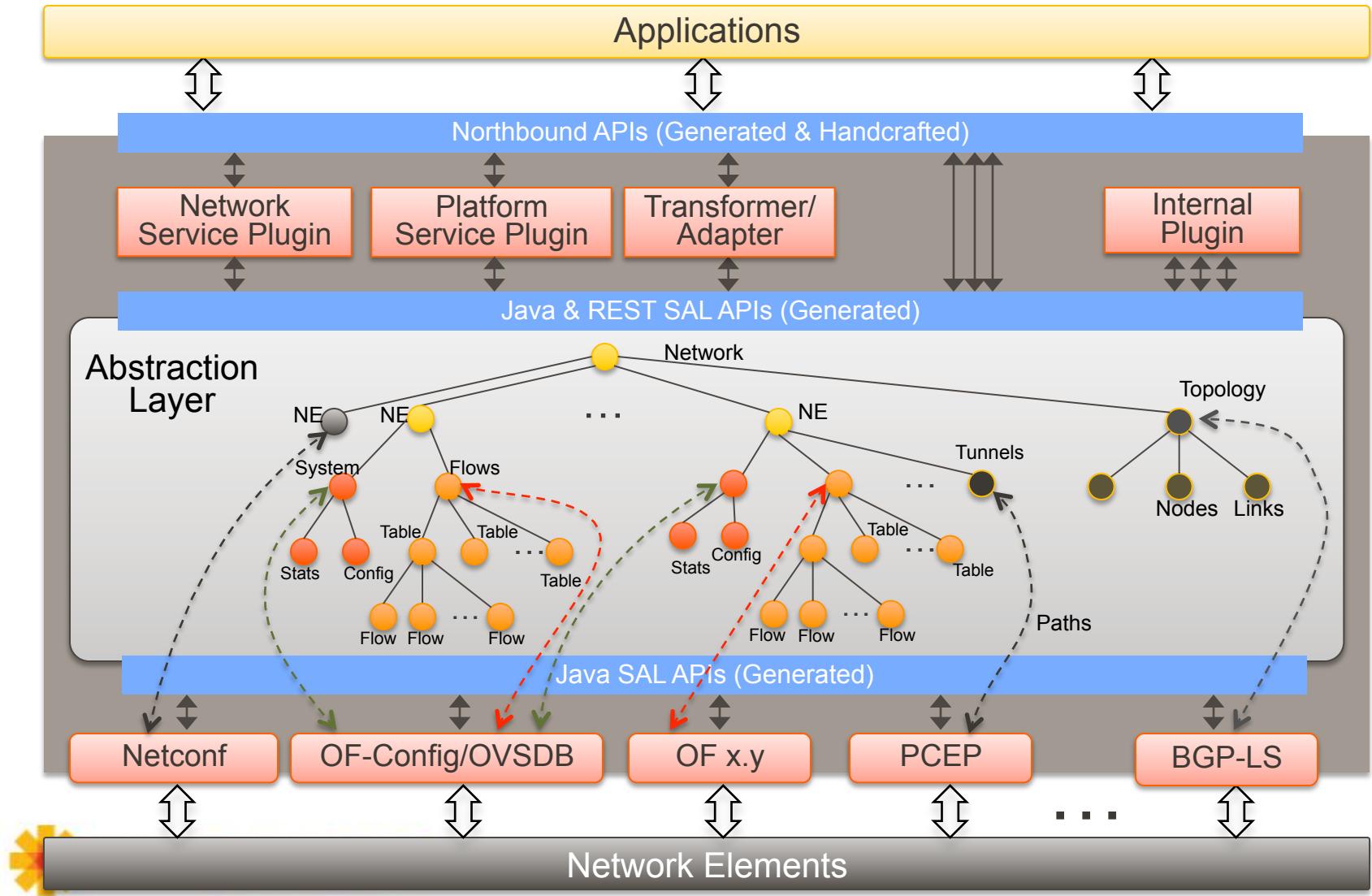
OpenFlow in Opendaylight

- The OpenDaylight OpenFlow plugin will provide:
 - Abstraction of OpenFlow networks to the MD-SAL
 - Interim support for Hard-SAL developed functions
 - Support for OpenFlow 1.0 and 1.3.1 in Hydrogen
- The OpenFlow projects will additionally:
 - Develop network functions for 1.3.1 network models
 - Expose 1.3.1 OpenFlow capabilities through the ODL NBI
 - Follow the ONF OpenFlow release cycle
 - Preliminary plan to support OF 1.5 in Helium

OpenFlow Plugin Architecture

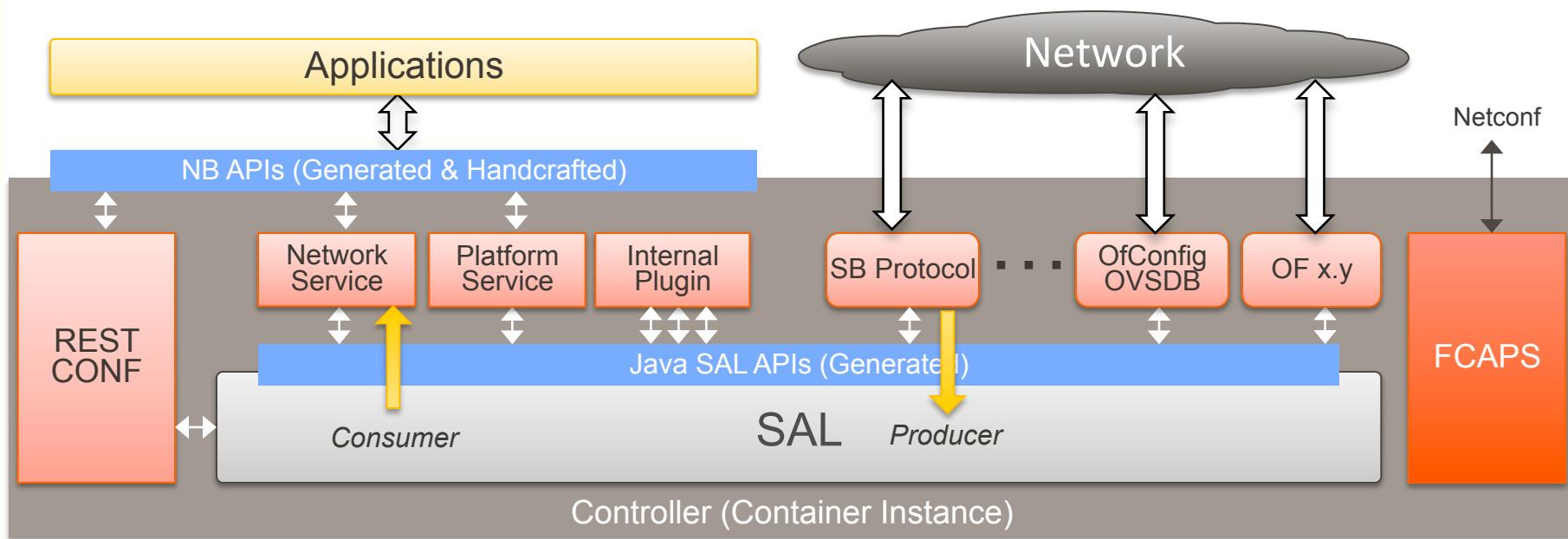


Moving to Model-Driven SAL

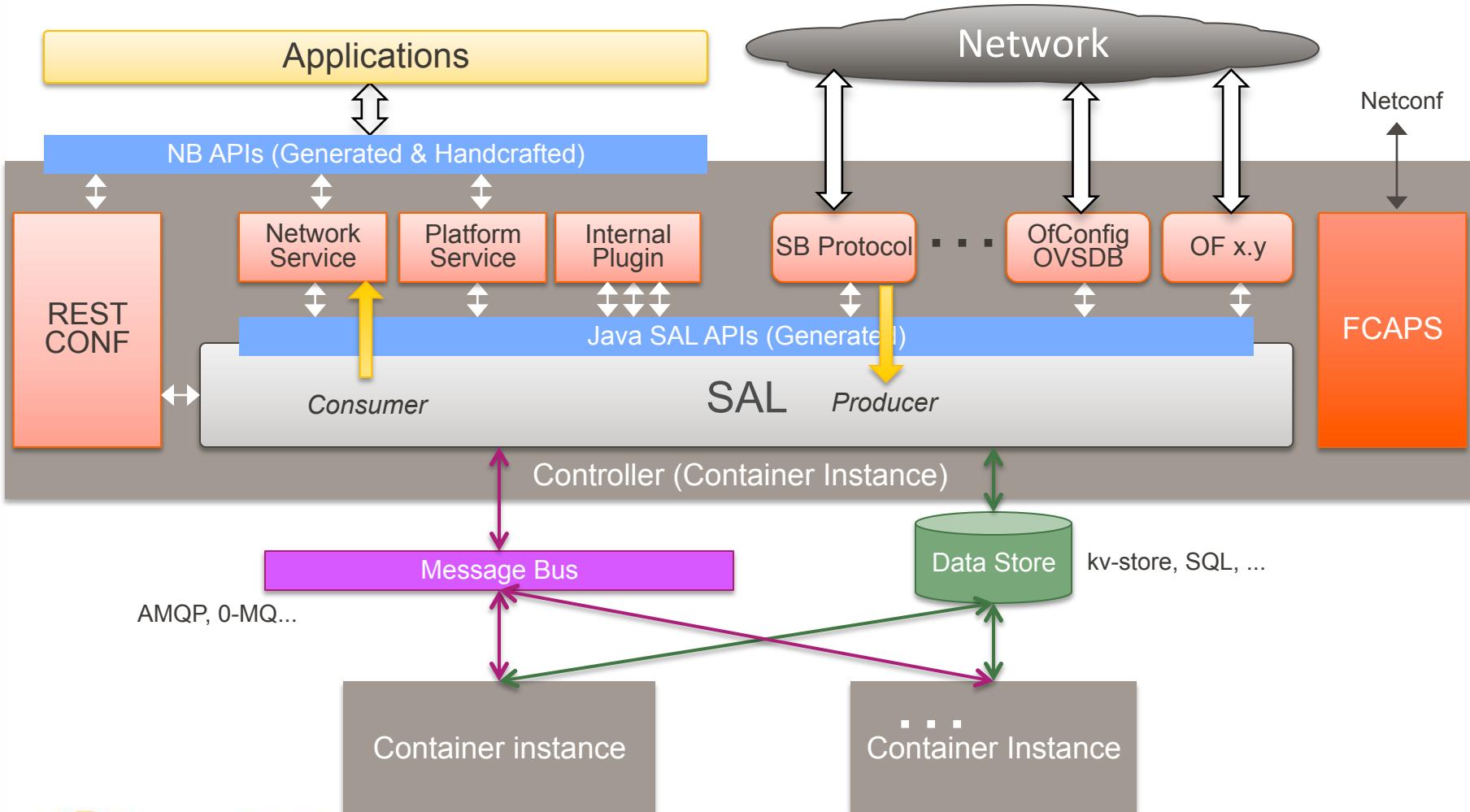


Moving to Model-Driven SAL:

The Software Engineer's View



Moving to Model-Driven SAL: Add Clustering



Demo: RPC Request Routing

```
Module sal-flow {
    namespace "urn:opendaylight:flow:service";
    prefix flow;
    import yang-ext {prefix ext;};
    import opendaylight-inventory {prefix inv;};
    import ietf-inet-types {prefix inet;};
    import opendaylight-flow-types {prefix types;};

    typedef flow-table-ref {
        type instance-identifier;
    }

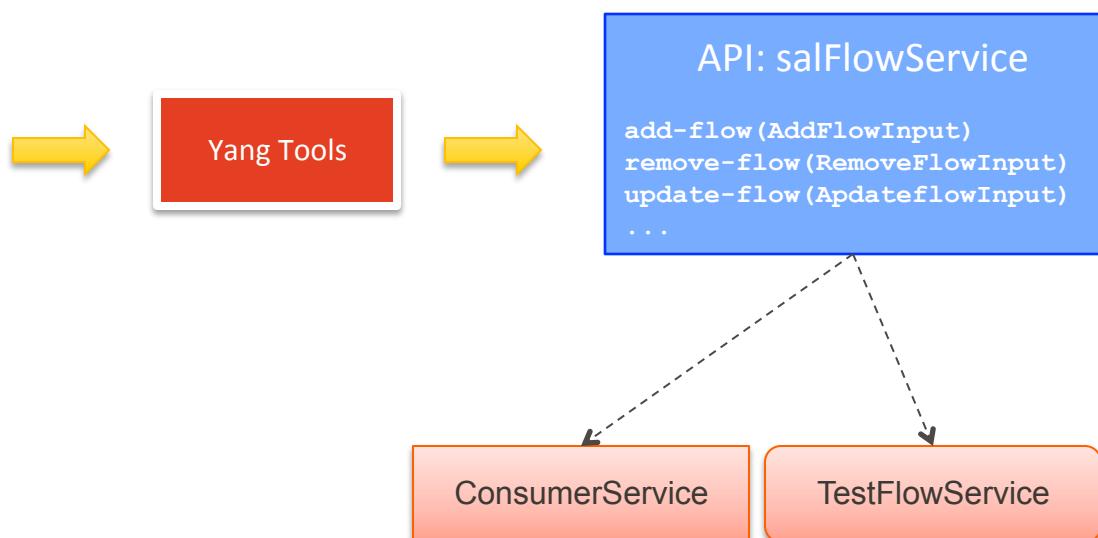
    grouping node-flow {
        leaf node {
            ext:context-reference "inv:node-context";
            type inv:node-ref;
        }
        leaf flow-table {
            type flow-table-ref;
        }
        uses types:flow;
    }

    grouping flow-update {
        container original-flow {
            uses types:flow;
        }
        container updated-flow {
            uses types:flow;
        }
    }

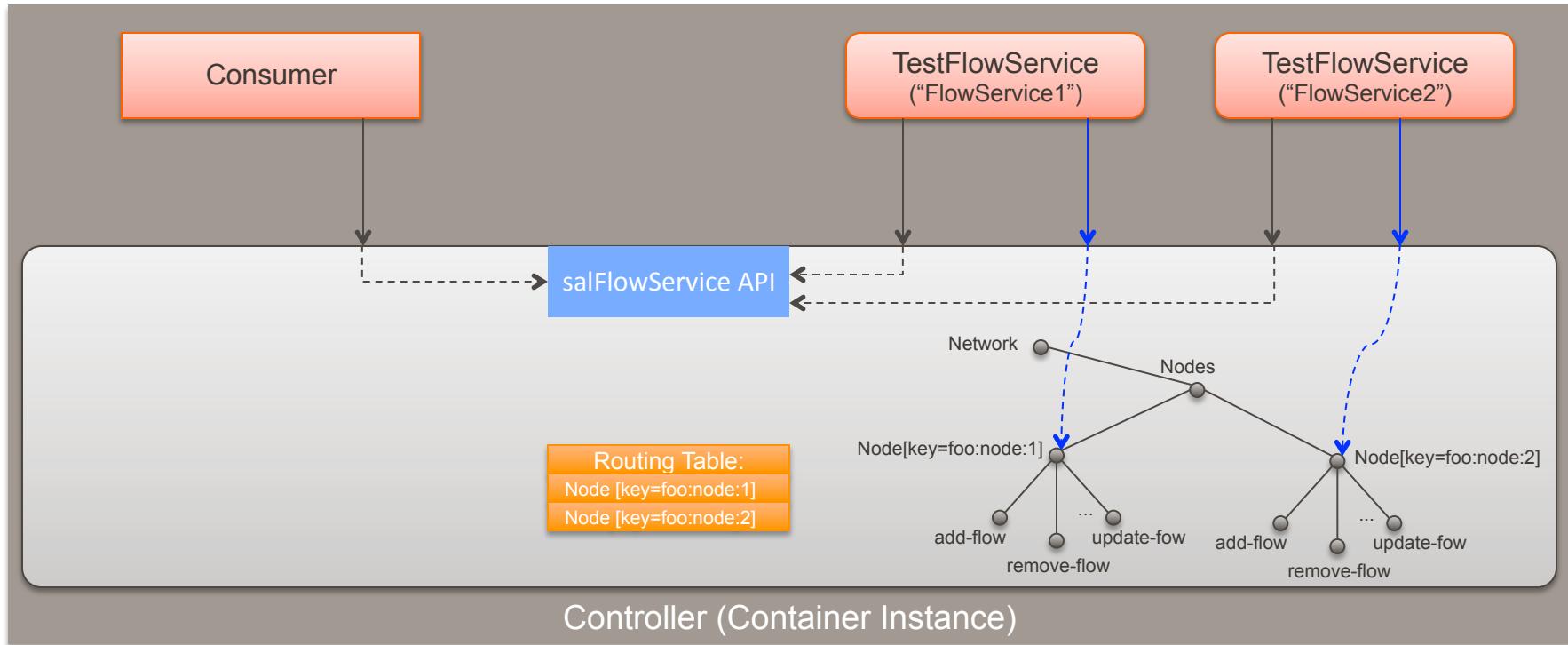
    rpc add-flow {
        input {
            uses node-flow;
        }
    }

    rpc remove-flow { ... }
    rpc update-flow { ... }

    ...
}
```

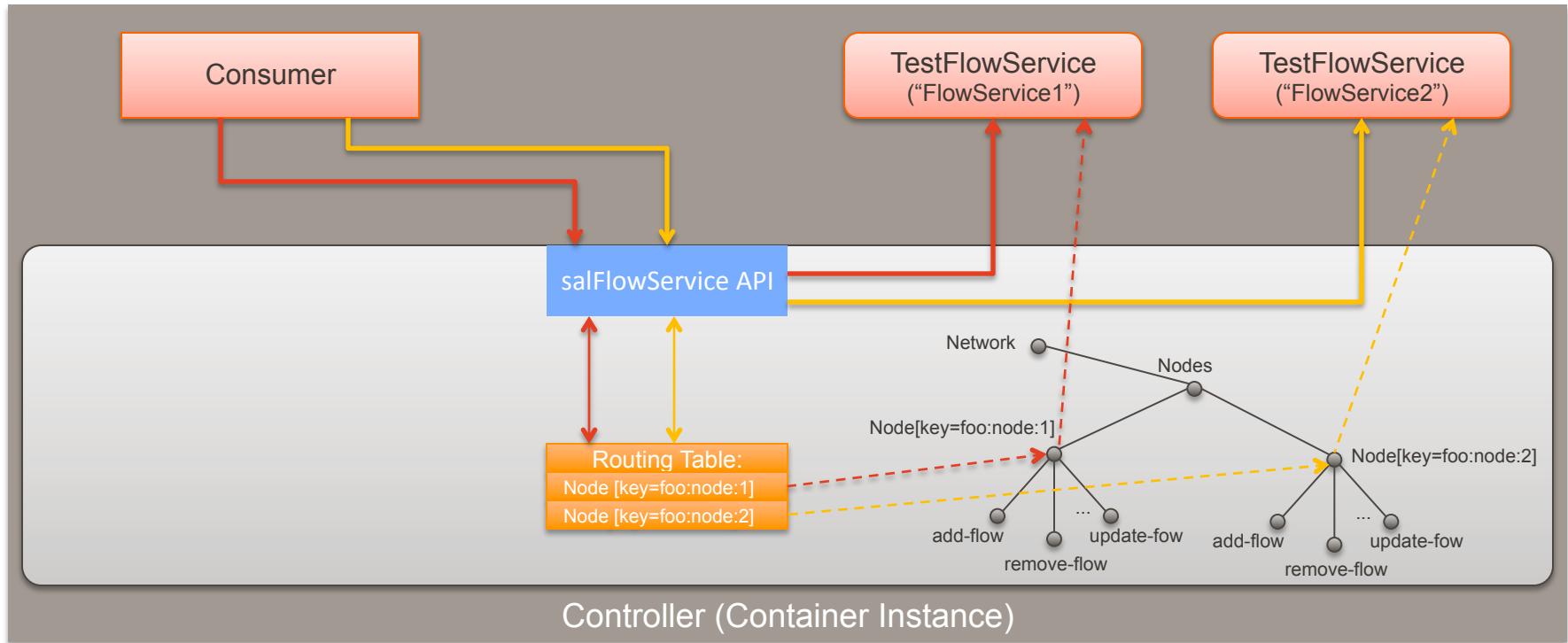


Demo: RPC Request Routing



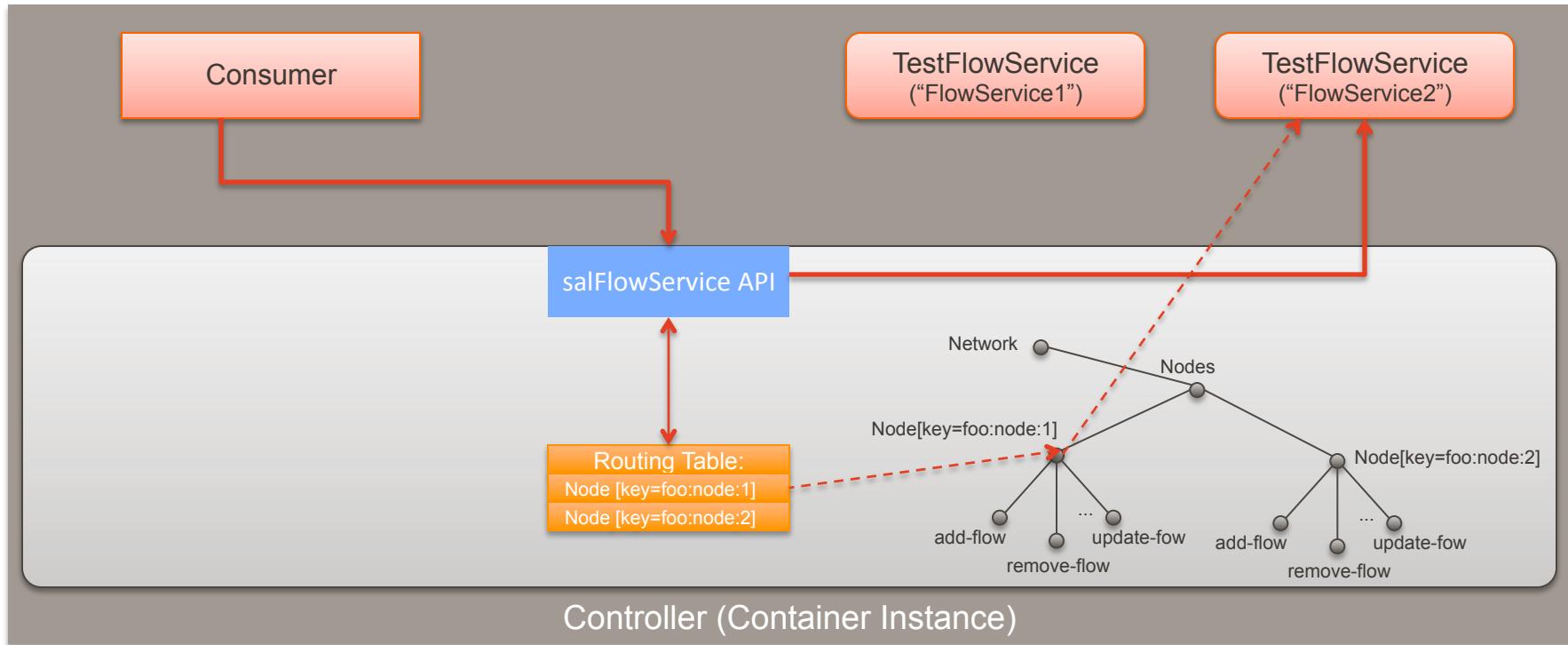
1. Create Deploy Providers and Consumer
2. Register “FlowService1” as the provider for the ‘salFlowService’ API
3. Register “FlowService2” as the provider for the ‘salFlowService’ API
4. Register “Consumer” as the consumer for the ‘salFlowService’ API
5. Register path /Nodes/Node[key=foo:node:1] for “FlowService1”
6. Register path /Nodes/Node[key=foo:node:2] for “FlowService2”

Demo: RPC Request Routing



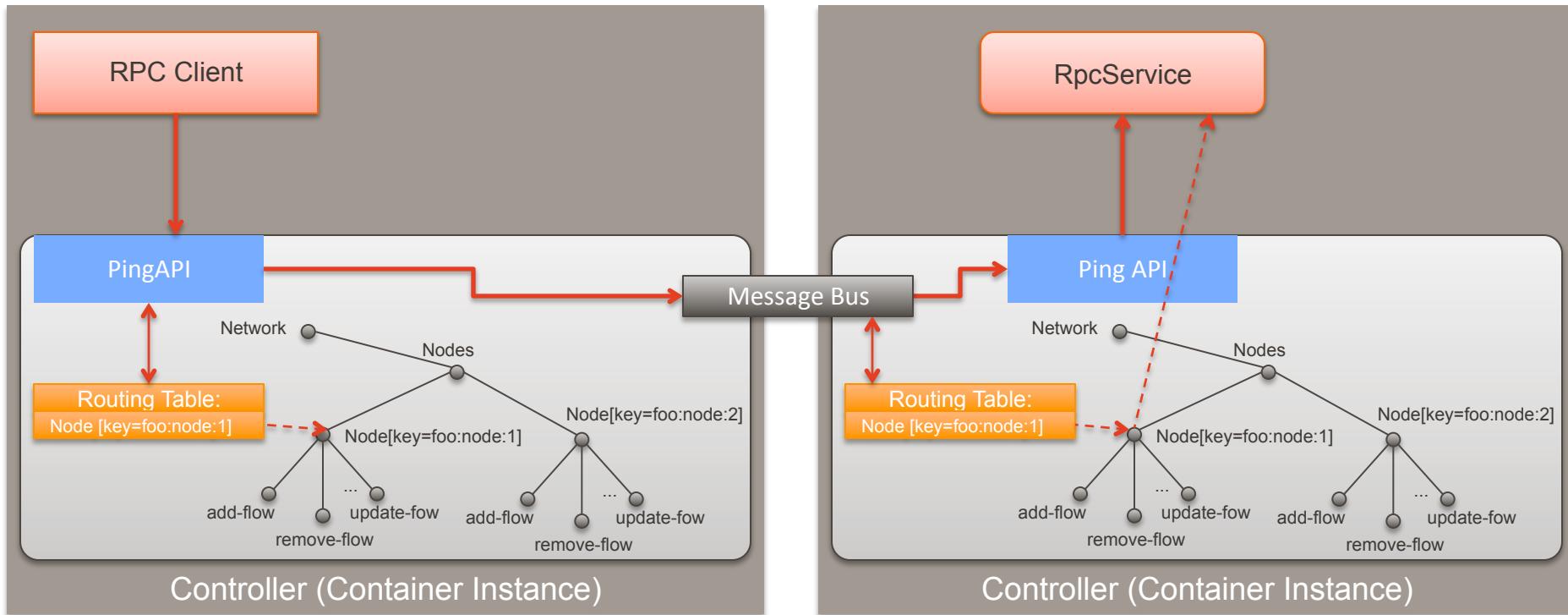
1. Consumer invokes 'add-flow' with node id 'foo:node:1'
2. Consumer invokes 'add-flow' with node id 'foo:node:2'

Demo: RPC Request Routing



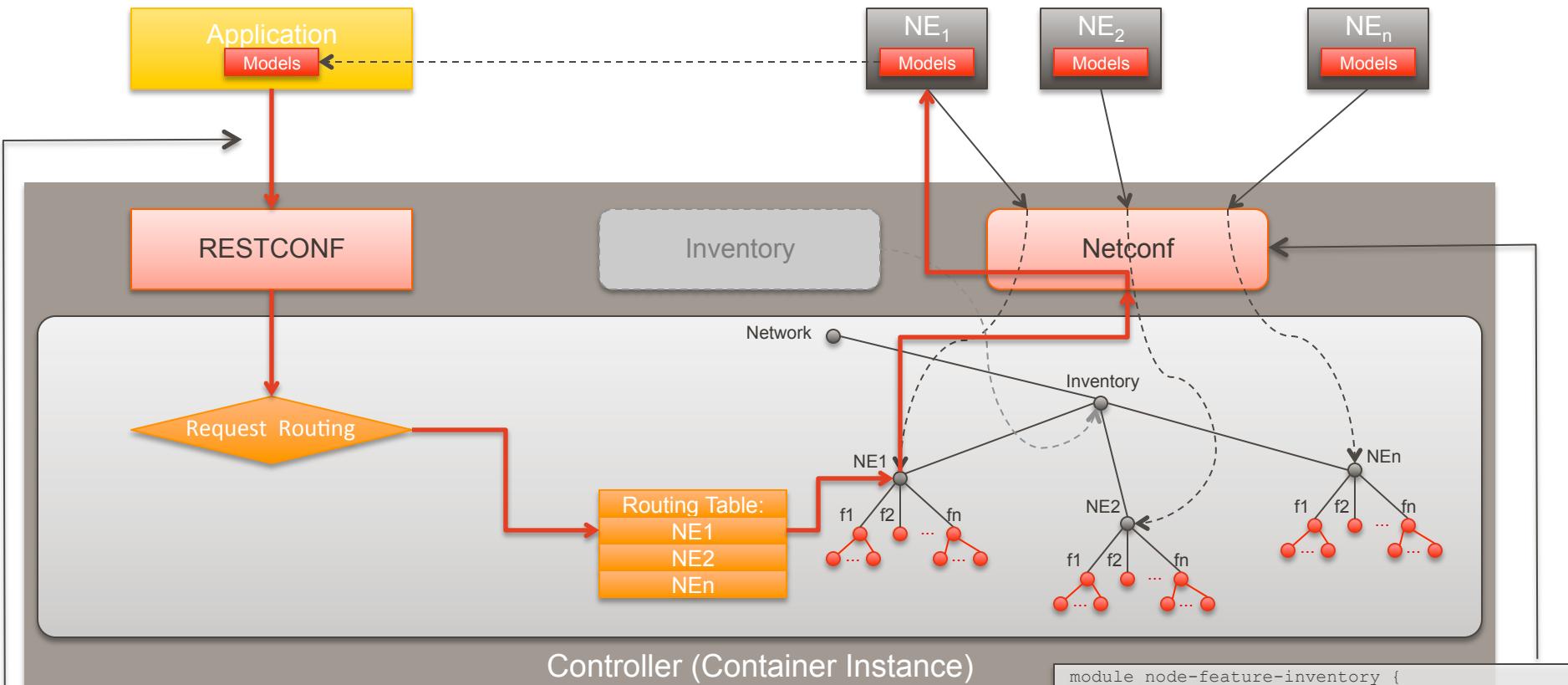
1. Consumer invokes 'add-flow' with node id 'foo:node:1'

Demo: Remote Request Routing



1. Consumer invokes 'add-flow' with node id 'foo:node:1'

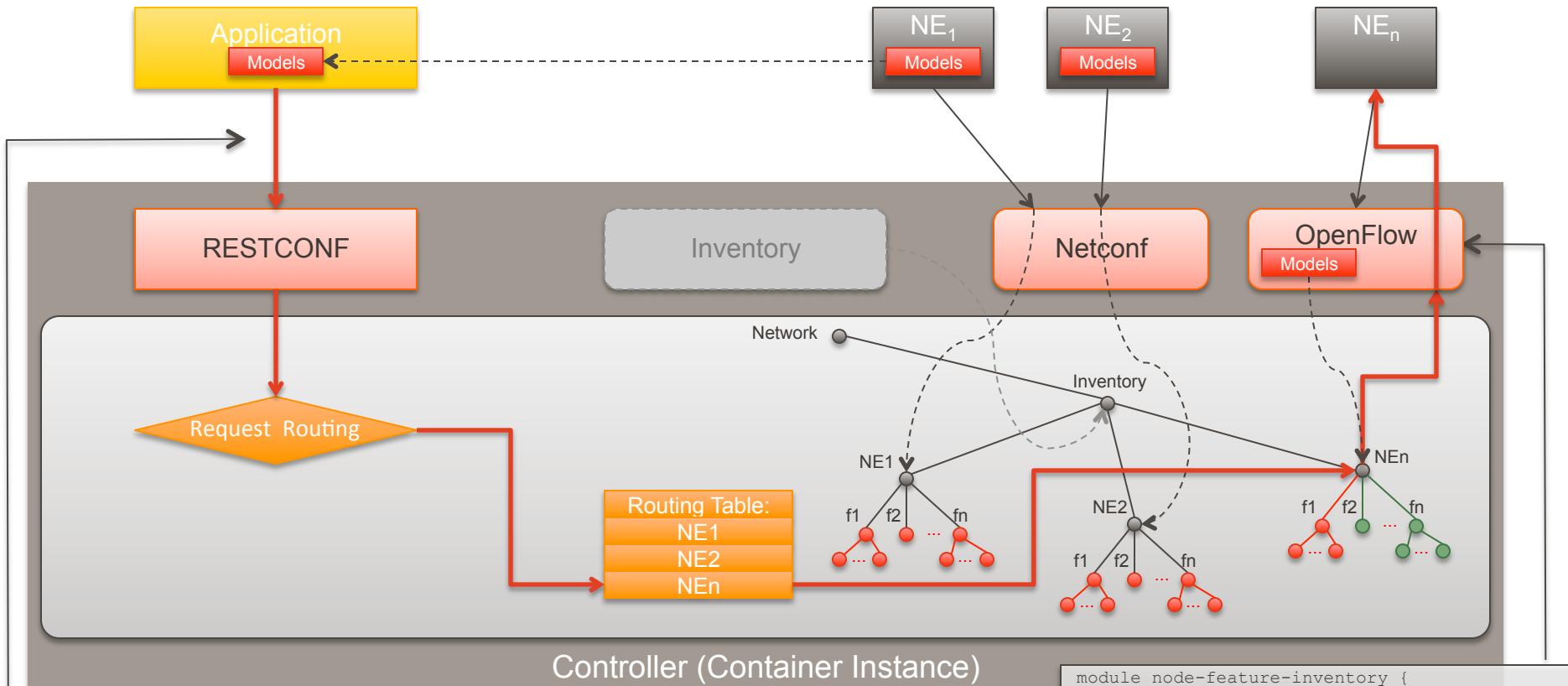
Request Routing (App->NE)



Path: "/inv:nodes/inv:node[id='NE1']/nf:mounted-data/f1"

```
module node-feature-inventory {  
    prefix nf;  
    import opendaylight-inventory {prefix inv};  
    import yang-ext { prefix ext};  
    import mount { prefix mount};  
  
    augment "/inv:nodes/inv:node" {  
        ext:context-instance "node";  
  
        ext:augment-identifier "netconf-node";  
        mount:mountpoint "mounted-data" {  
            mount:subtree "/";  
        }  
    }  
}
```

Request Routing (App->NE, Multi-Dest)



Path: "/inv:nodes/inv:node[id='NEn']/nf:mounted-data/f1"

```
module node-feature-inventory {
    prefix nf;
    import opendaylight-inventory{prefix inv};
    import yang-ext { prefix ext};
    import mount { prefix mount};

    augment "/inv:nodes/inv:node" {
        ext:context-instance "node";

        ext:augment-identifier "of-node";
        mount:mountpoint "mounted-data"
            mount:subtree "/";
    }
}
```

Agenda

- A Couple of Macro Trends underlying SDN
- What is SDN?
- What is OpenDaylight?
 - BTW, What is a Open Source Project?
- Who is OpenDaylight?
- Hydrogen Simultaneous Release Plan
 - Projects in Hydrogen
 - Release Vehicles
- A Bit of OpenDaylight Technology
- Summary

Call to Action

- Open Source is standards for the 21st Century
- OpenDaylight is rapidly becoming the focal point for SDN
- Code is the Coin of the Realm
 - Influence comes from contribution of code
- **Brings forth ideas to contribute and resources to do the work**



Resources

- More information and to join:
 - wiki.opendaylight.org
- Keep informed and join the conversation
 - IRC: #.opendaylight on Freenode
 - Open mailing lists: lists.opendaylight.org
 - [@openDaylightSDN](https://twitter.com/openDaylightSDN)
 - #OpenDaylight





Thanks!