



# *Network Virtualization & the Internet2 Innovation Platform*

*To keep our community at  
the “tip of the spear”,  
how can we support  
network virtualization?*

*Eric Boyd - Senior Director, Strategic Projects*



# Internet2 Mission



=

University  
Corporation  
for  
Advanced  
Internet  
Development

# INTERNET<sup>2</sup>

- The Community's Network Story (2014)
  - Abundant Bandwidth / 100G+
  - **Deeply Programmable (Native OpenFlow)**
  - Support for Data Intensive Science (Science DMZ)
- Interconnected with public Internet
- Supports production quality & disruptive innovation
- Open for your innovation!

Provides production & innovation platform to:

- Dozens of high performance compute clusters
- Hundreds of campus data centers
- Potentially thousands of SDN ports
- Hundreds of wireless access networks
- Thousands of researchers
- Millions of potential collaborators

# General Use Case

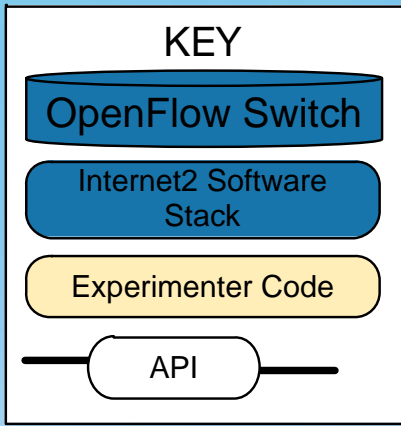
- For most applications run in a campus environment, the traditional routed Layer 3 infrastructure provided by the Internet2 Advanced Layer 3 Service (AL3S) provides all the needed functionality and performance.
- For some applications, the ability to run on a server in a campus environment or on a GENI Rack, connected by a Layer 2 VLAN, should suffice.
- For a few advanced applications, particularly in the network research arena, there is a need to run their own controller on a virtual network.

# Network Virtualization Implementation

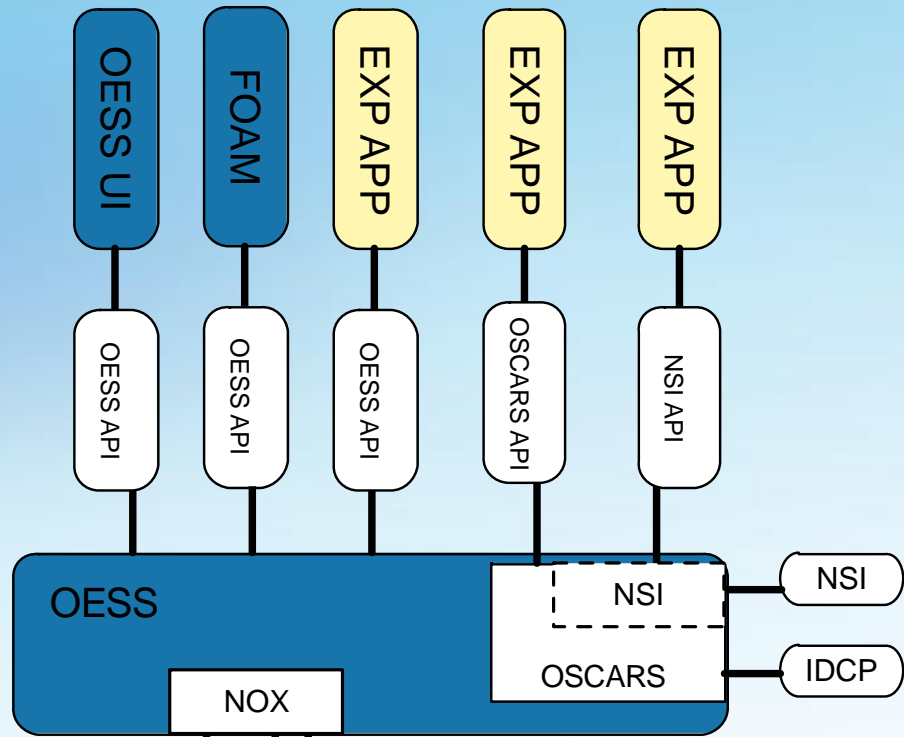
- After careful research into alternatives into OpenFlow-based Hypervisors ...
- Implemented Network Virtualization through FlowSpace Firewall
  - “VLAN Slicer”
  - Resource Protector
- Why not Flowvisor?
  - December 19, 2013 Webinar
  - <http://www.internet2.edu/products-services/advanced-networking/oess/>

# Network Virtualization: Working Definition

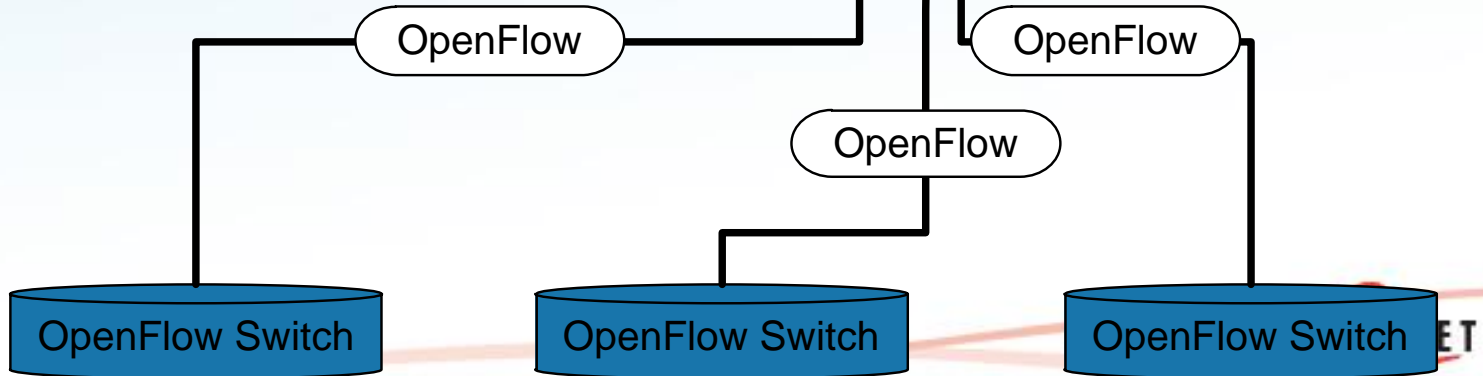
- From a customer perspective, what does the service offer and how it is utilized?
  - The Network Virtualization service/enhancement offers the ability to write a controller and control a slice of the national Layer 2 infrastructure.
  - The customer utilizes the service by operating their own “service” across the Internet2 service.
- From an internal operator perspective, how is the service implemented?
  - An instance of FlowSpace Firewall sits between the Layer 2 switches and other controllers (including those used in production services like AL2S)
- Who are the stakeholders? (e.g. NAOPpag, CIOs, etc.)
  - Decision Makers: Leading CIOs (early adopters of new network services), NAOPpag
  - Informed Parties: Adopters of AL2S
- Who is the target audience?
  - Advanced Networking Community
    - Network Researchers
    - Virtual Organizations
    - Innovative Application Developers
- What are the goals for the service?
  - Supporting network researchers
  - Deployment of private networks
  - Prototyping of new services

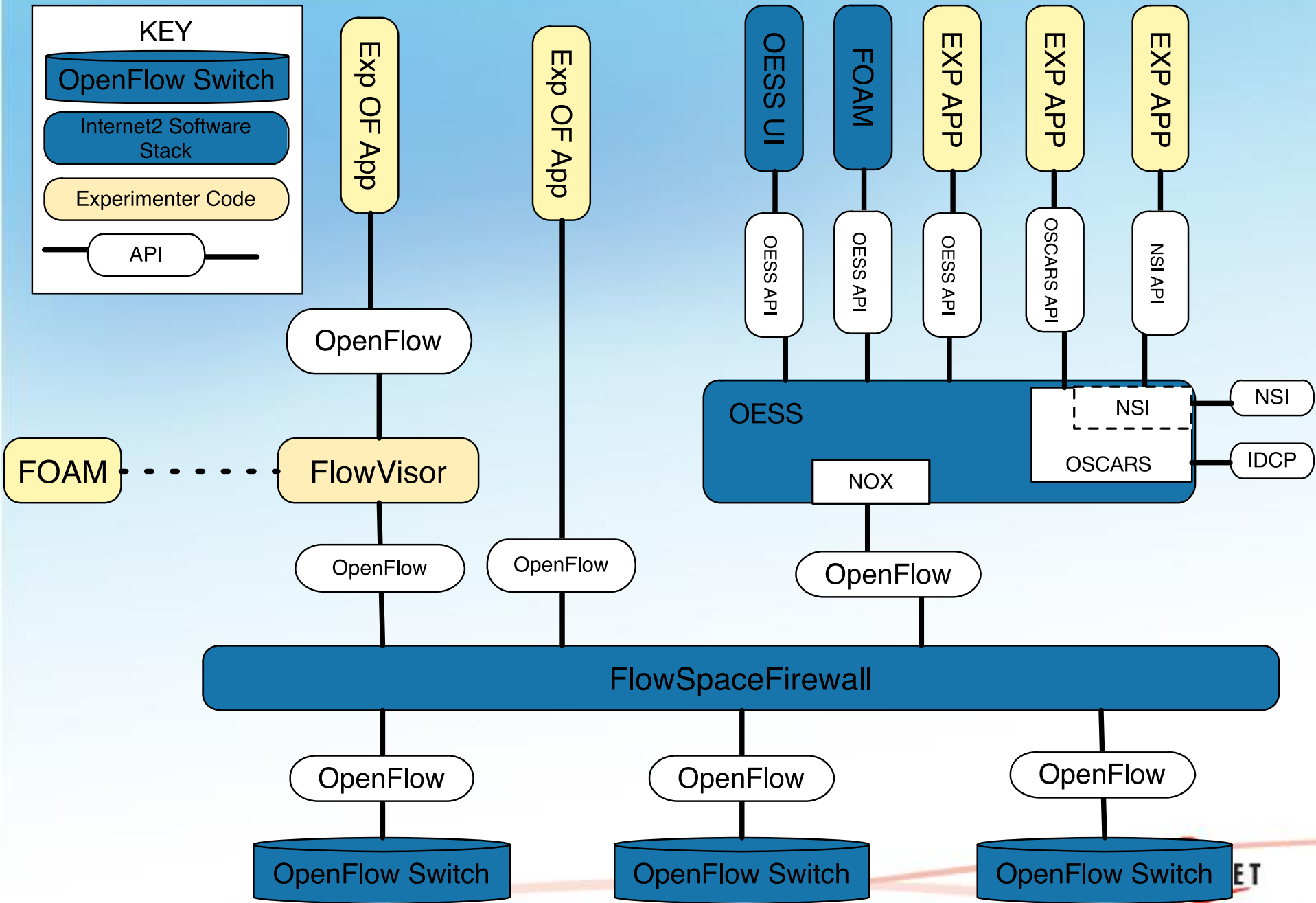
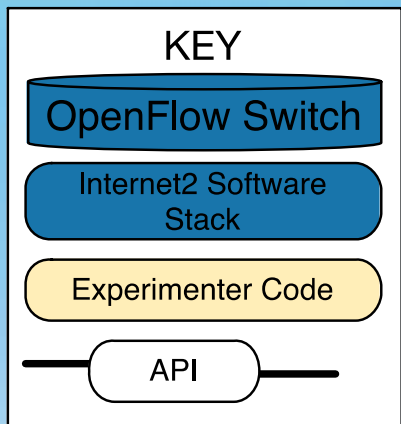


# Software Architecture

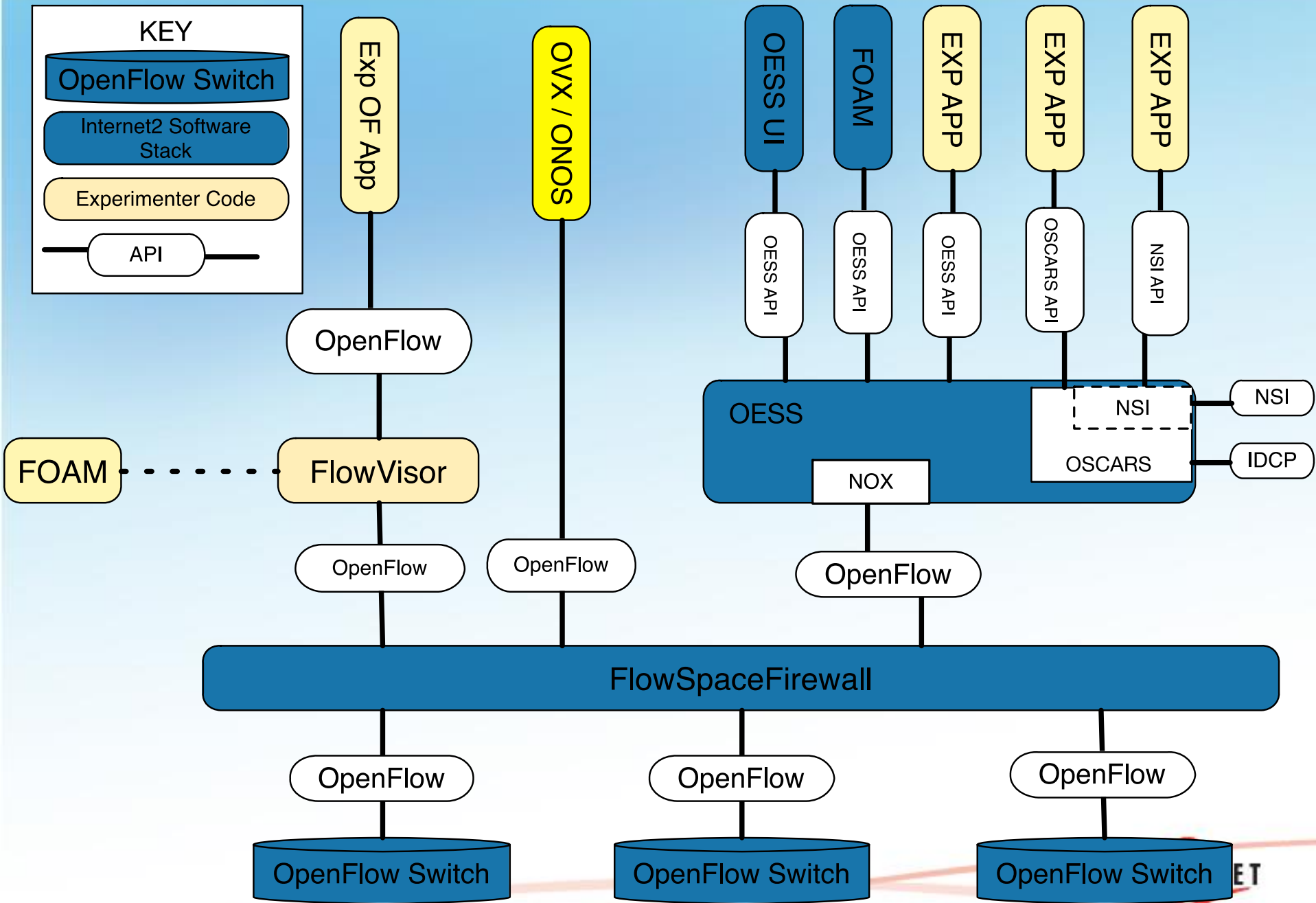
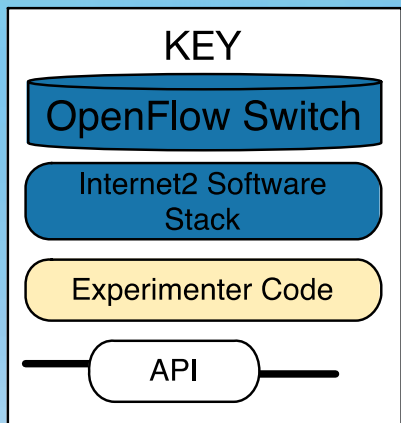


FOAM









# Use Case Examples

- Production Service Staging
  - GENI wants to move to Stitching v3.0, but Stitching 2.0 is in wide use
  - Set up a slice, deploy a second OESS, deploy new version of FOAM Stitching Aggregator
  - When it's tested and ready, move to the production OESS stack
- Network Research
  - Network researcher has a better idea how to do networking
  - Set up a slice, deploy new network controller, write paper
- Service Prototyping
  - Look at alternatives to AL3S
  - Implement a route server that speaks OpenFlow on southbound interface with no routers
  - Deploy in a slice, begin peering with other domains
  - Evaluate efficacy, operational savings
  - Over time transition to new service
- Private Networks
  - Want something akin to Atlantic Wave, original vision for LHCONE, or GENI Virtual Network
  - Set up a distributed SDX across multiple domains

# SDX



Local VLAN  
Provisioning  
Service

Text describing the service provided between OESS and the Firewall.

FlowSpaceFirewall

A dark blue rounded rectangular box representing the FlowSpaceFirewall component.

Virtual Switch

Text describing the Virtual Switch component.

Physical  
switch

Text describing the Physical switch component.

SDX1

Text identifying the SDX1 component.

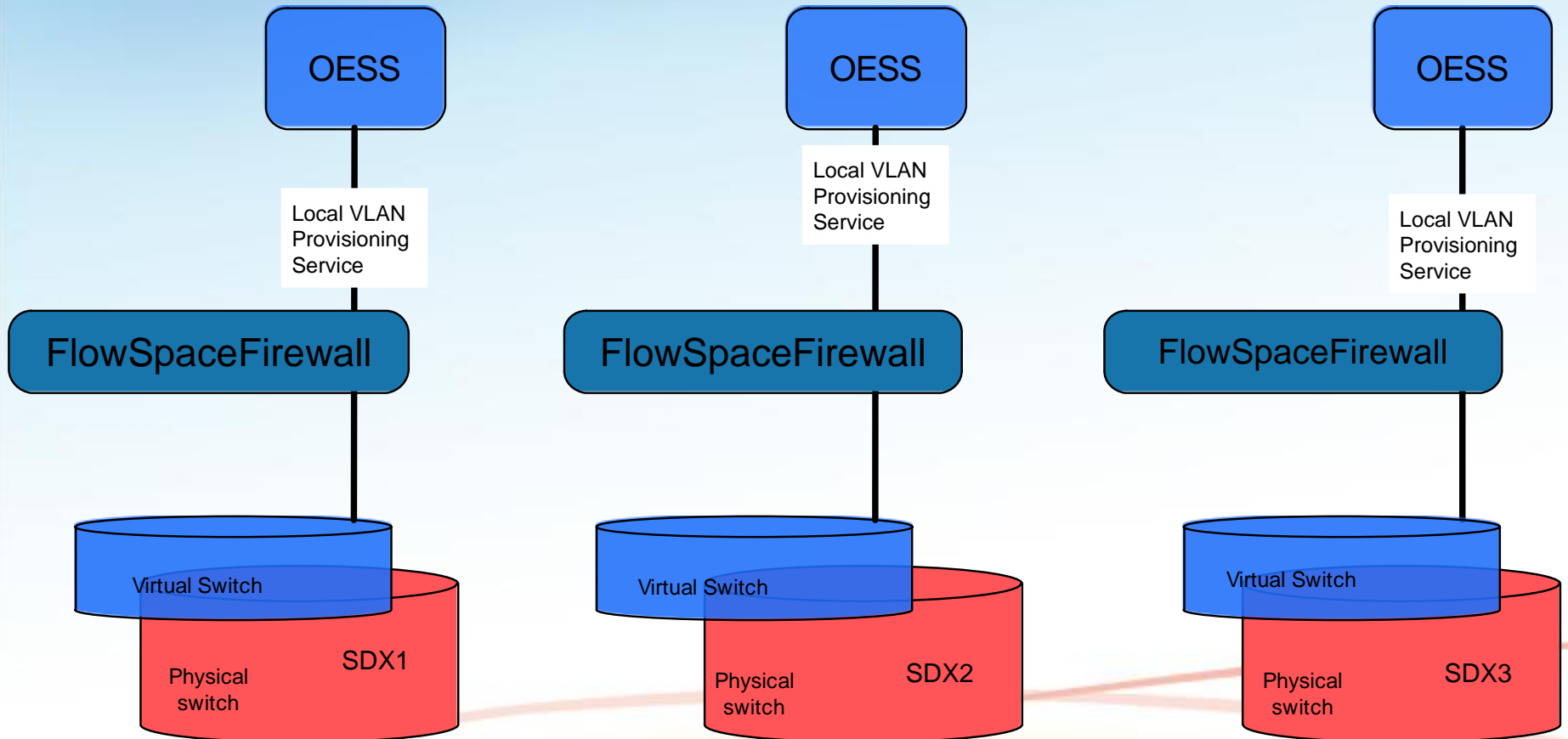
INTERNET



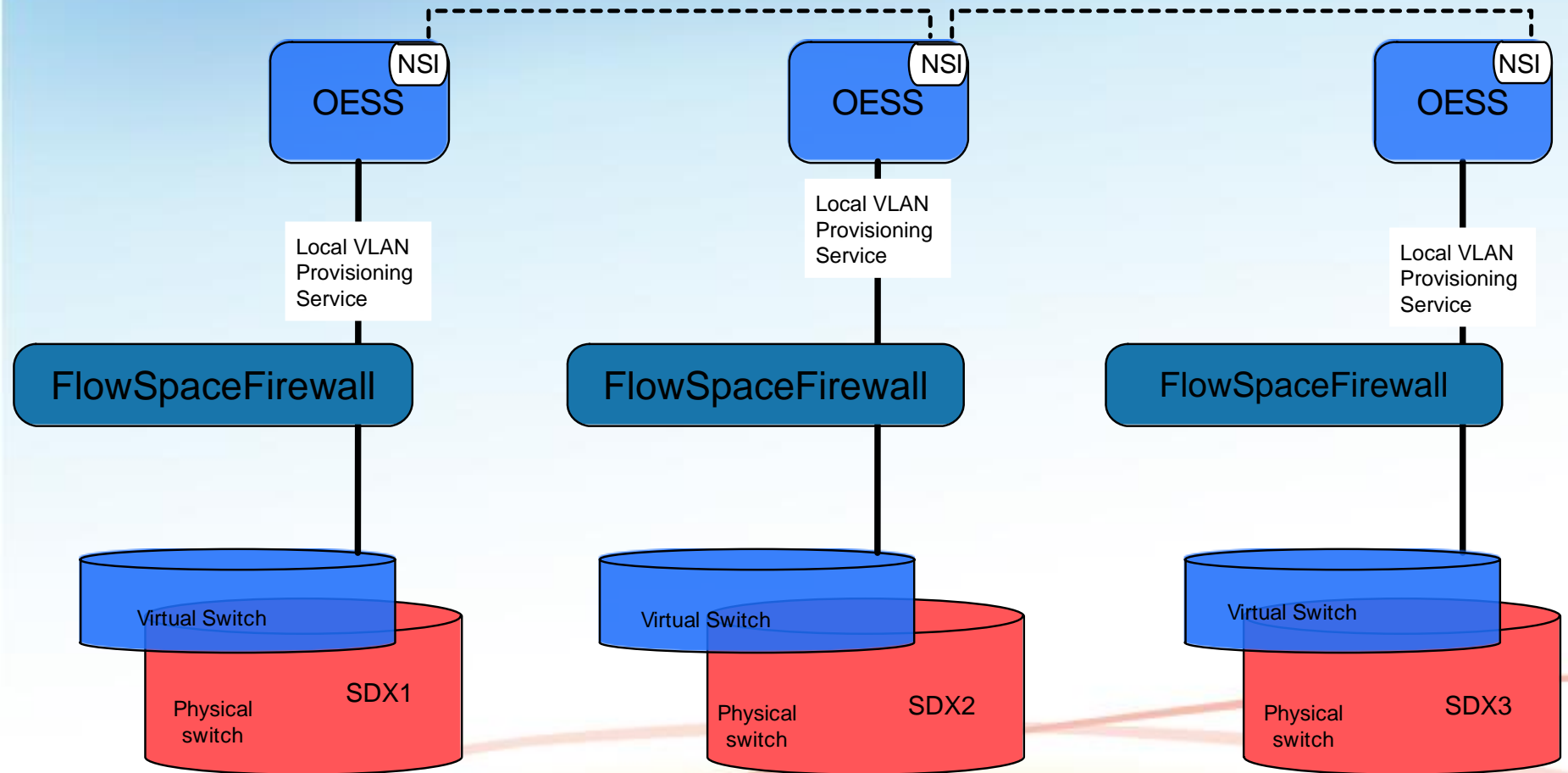
INTERNET

Logo for INTERNET, featuring the word in a bold, black, sans-serif font with a red stylized number '2' below it.

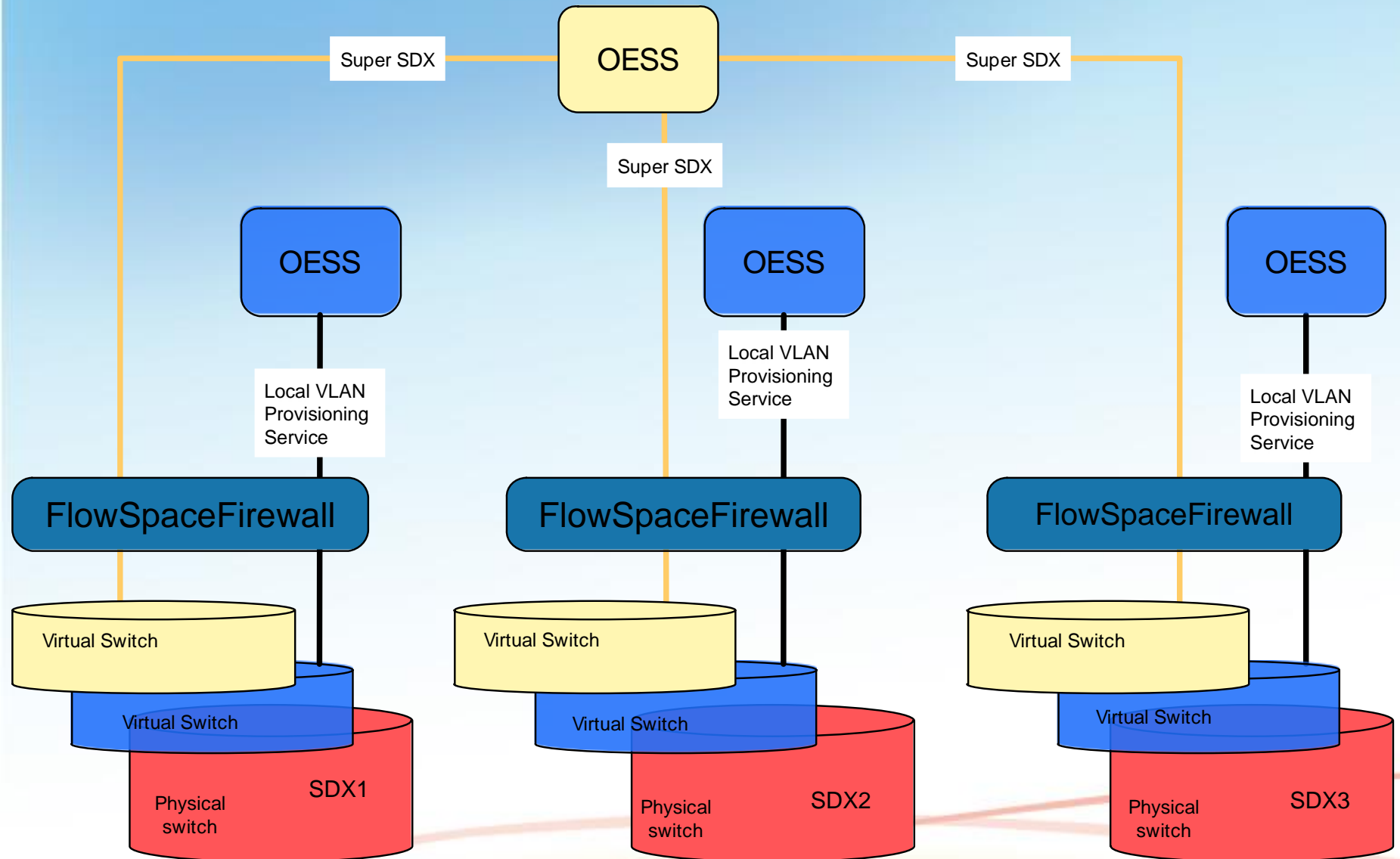
# SDX



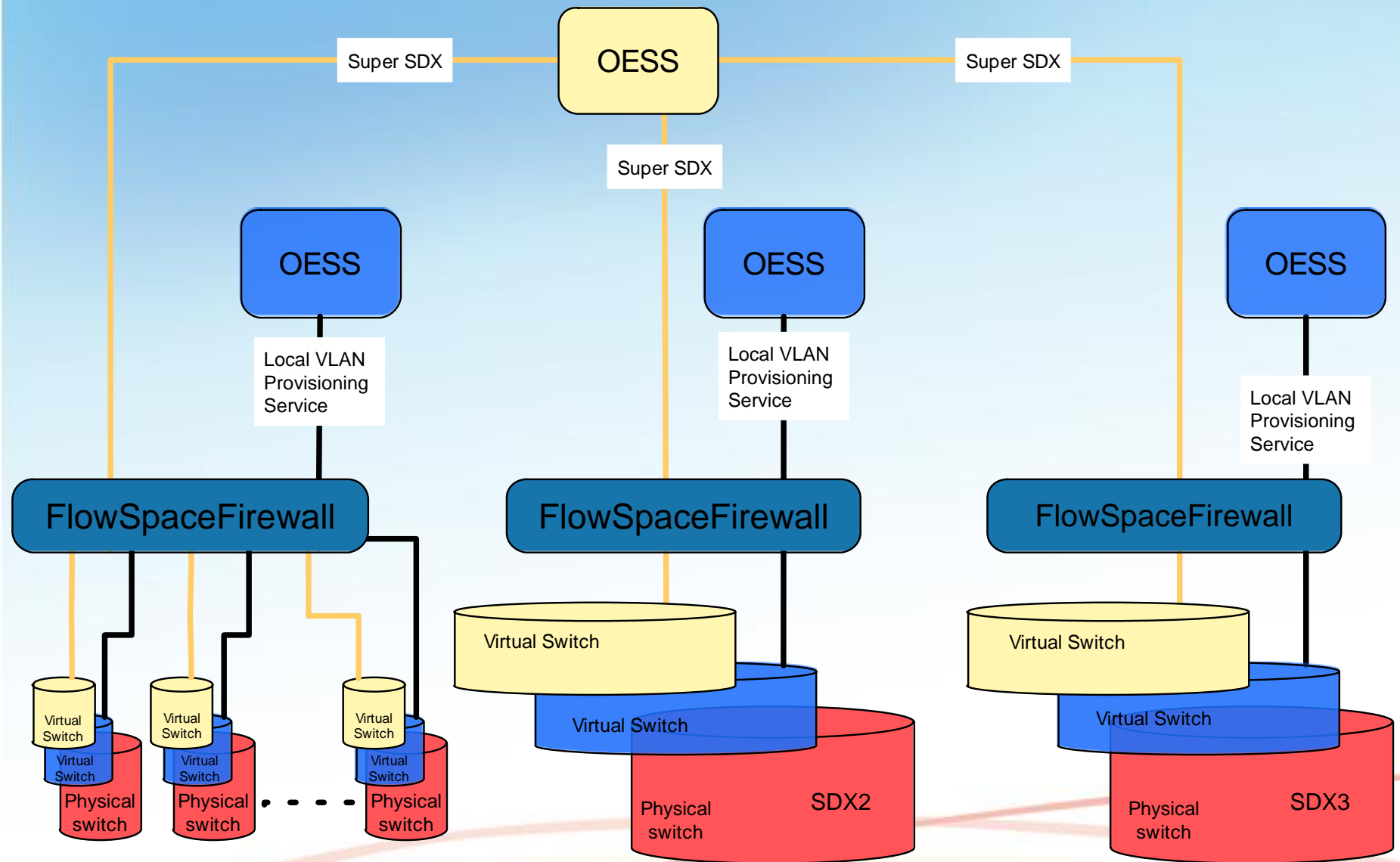
# SDX



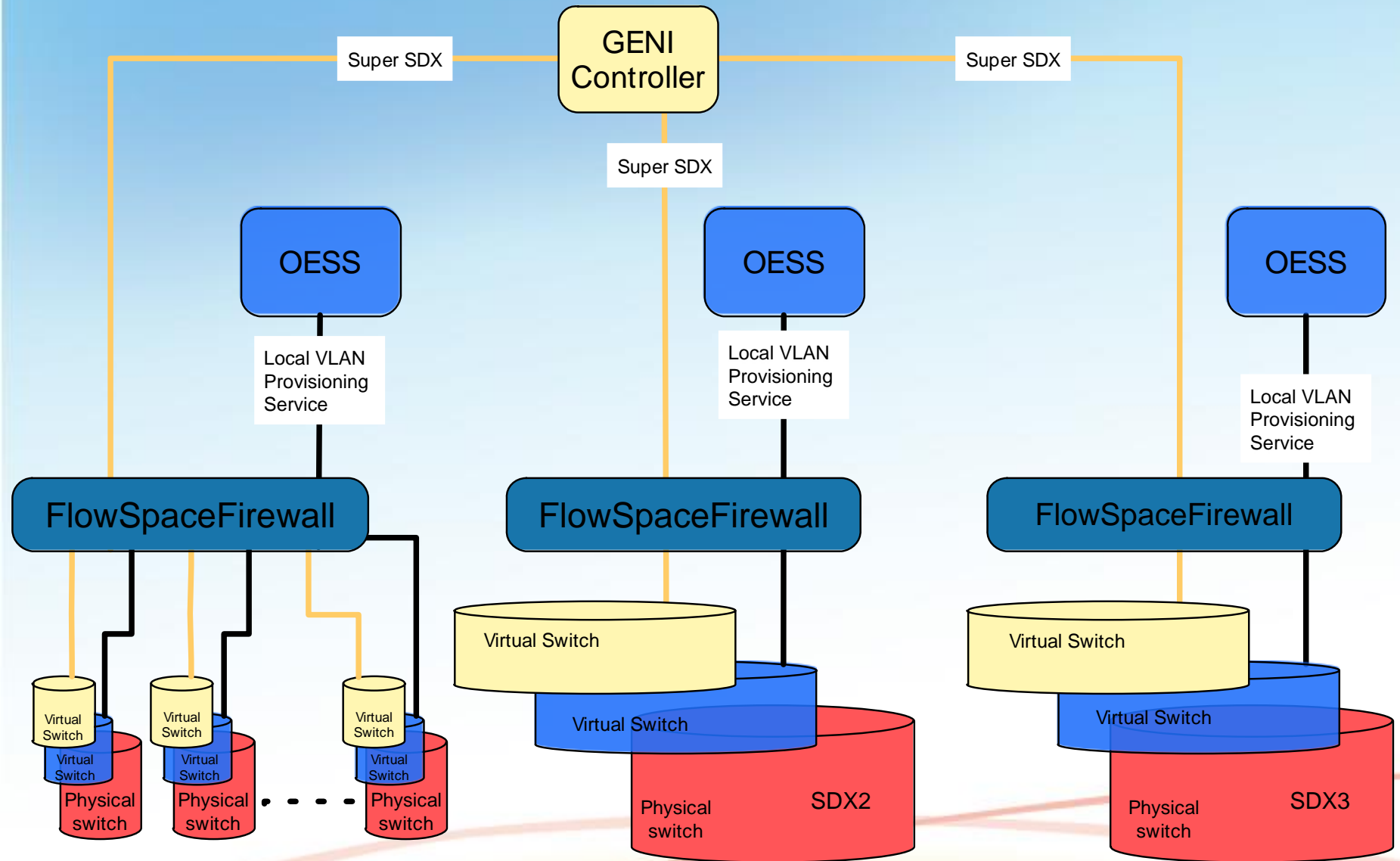
# Multi-Domain SDX



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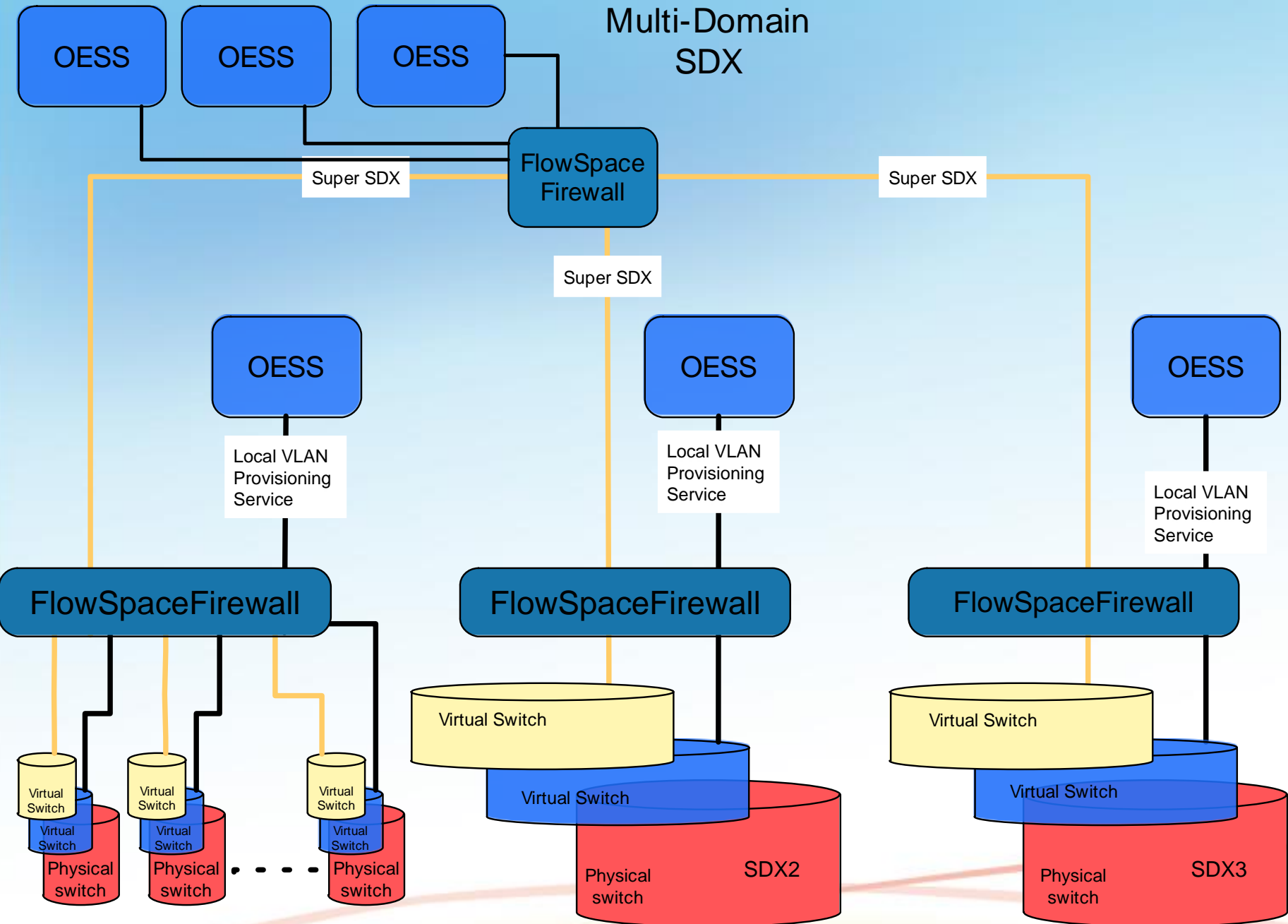


# Multi-Domain SDX

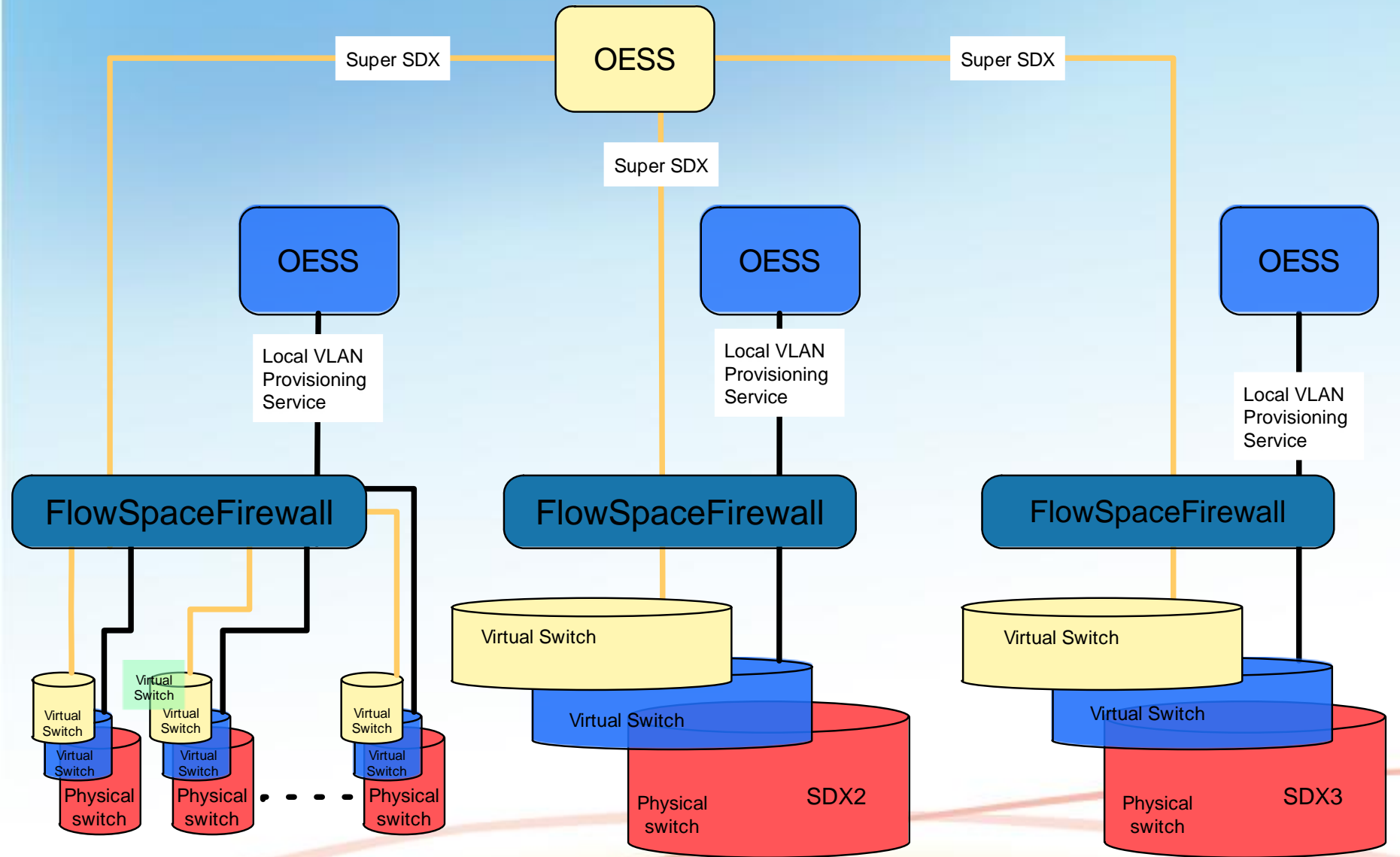




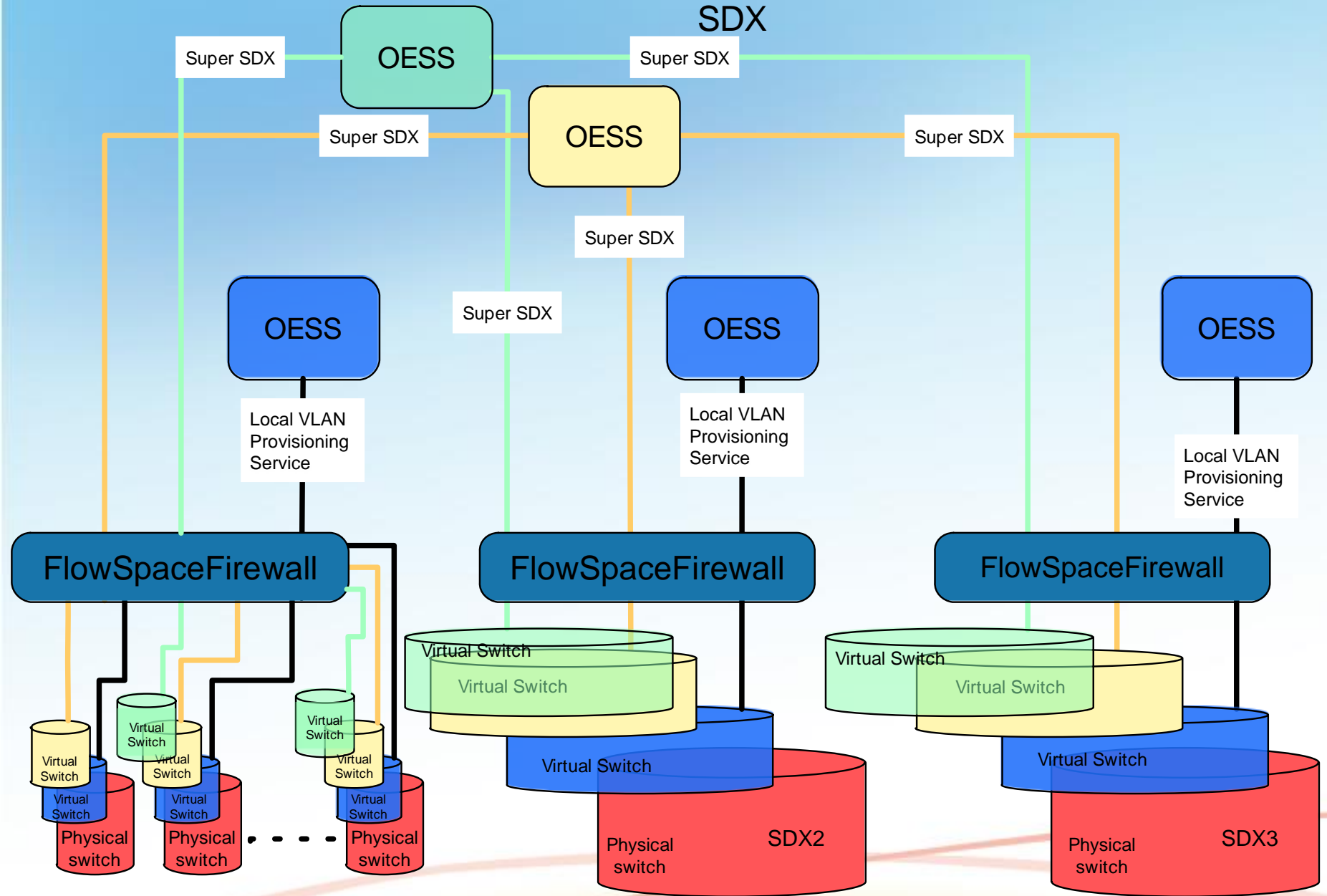
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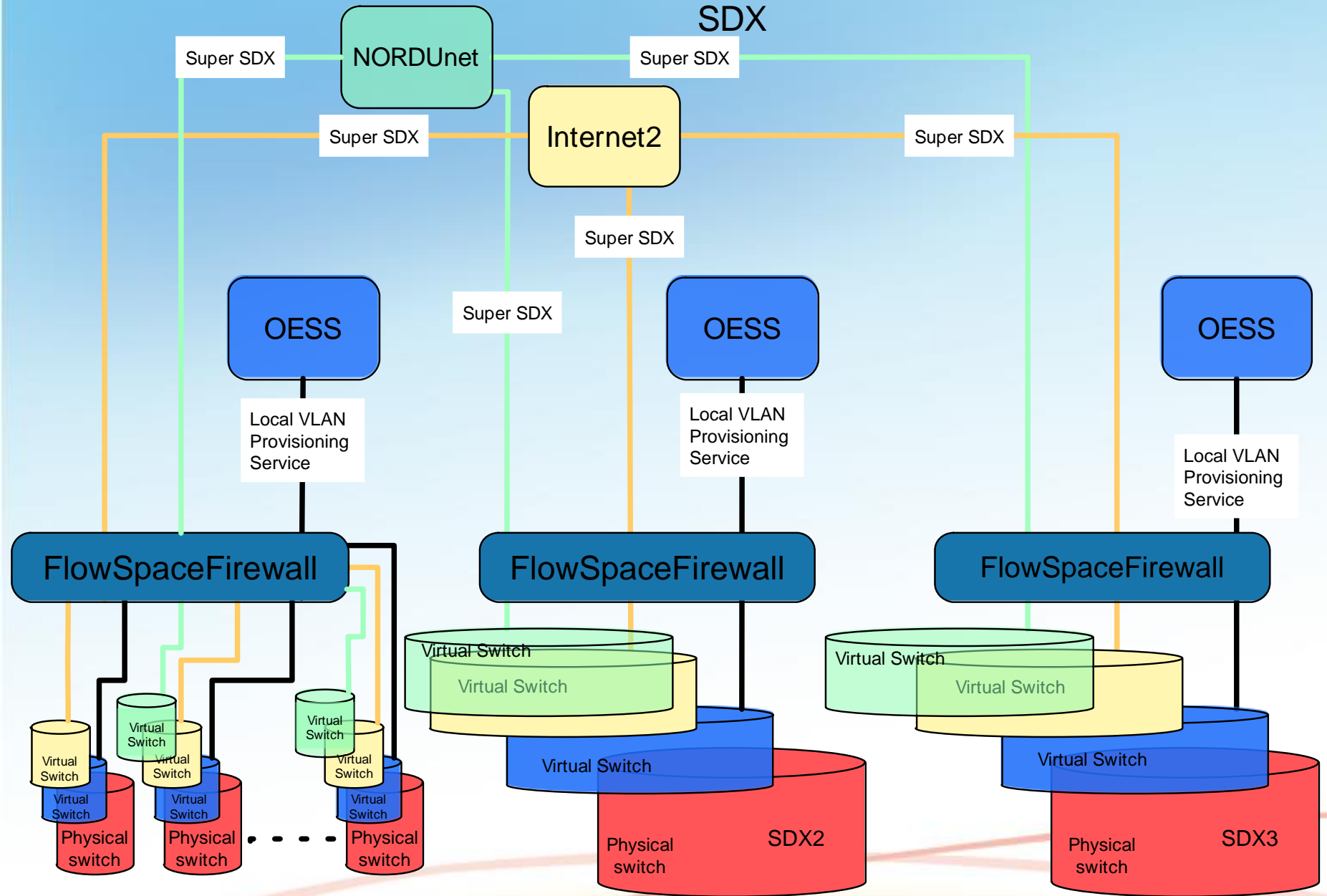
# Multi-Domain SDX



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# Multi-Domain SDX



# Documentation

- What is the name of the service? Are there any standard abbreviations?
  - Network Virtualization Service (NVS)
- How is the service being positioned vis-à-vis other services?
  - This underpins AL2S *and*
  - This is core piece of the Internet2 Innovation Platform
  - This provides functionality needed by the advanced networking community
- How is the service documented?
  - Under development (will be on the Internet2 website)
- How is the software documented?
  - <http://globalnoc.iu.edu/software/sdn.html>

# Rollout

- What is the proposed plan for launching the service to the community and internally?
  - Initial soft roll-out. Evaluate stability. Slow implementation by early adopters.
  - Webinar to Technical Community
    - June 24<sup>th</sup>, 4 PM ET
  - Formal rollout October, 2014 at Tech Exchange (Indianapolis)
  - <http://meetings.internet2.edu/2014-technology-exchange/>

# Metrics => Analysis and Growth

- How many concurrent customers?
  - Actual?
  - Maximum, given resources?
- What is the typical timeline from first inquiry to deployment?
- What percentage of projects make it onto the Internet2 network?
- What is the prioritization distribution of projects?
- What does availability mean?
  - Problems within the slice due to customer code
  - Problems within the slice due to FSFW implementation
  - Problems in the slice that impact underlying hardware (exposing vendor issues)
  - Problems in the slice
- What is the nature of their effort?
  - Early stage development? (Discouraged ... for now)
  - At -scale national deployment evaluation?
  - Prototype service?
  - Production service?
- What are their resource requirements?
  - FTEs?
  - VMs?
  - VLANs?
  - Flow rules?
  - Etc.
- What new features are required?

# Risks and Mitigation

- Risks:
  - We are complicating the software stack that supports AL2S and AL3S. By definition, that introduces risk.
  - There are unknown risks we have not planned for.
- Risk Mitigation:
  - The software has been designed to protect resources.
  - Our testing has been designed to expose resource overconsumption (failures by the software)
  - At 3 AM, we have a plan to back out of low priority services in order to maintain high priority services without waking up managers or developers
  - We have an escalation matrix



# What does strong success look like?

- No impact on AL3S availability
- No impact on AL2S availability
- 2 or 3 early adopters rolled-out by 12/31/14
  - including 1 by TechX
- Announcement of network virtualization service at Tech X

# Process: Deploying Your Own Controller

- Customer initiates process
  - Open a ticket with [noc@net.internet2.edu](mailto:noc@net.internet2.edu)
  - Fill out questionnaire.
- Internet2 replies with application constraints
  - VLAN Range
  - Constraints on number of flow rules
  - Constraints on rate of flow rule insertion
  - Constraints on rate of Packet-In/Packet-Out events
  - Etc.
- Internet2 tests application
  - Test on iDREAM GENI test lab
  - Test on NDDI
- Internet2 (not the experimenter ... yet) deploys application on Internet2 SDN Substrate. (Internet2 Network Virtualization Service? Name to be determined later.)

# What do you need to do ...

- Provide Enough documentation to setup and configure your application
- Provide enough logging (to a file) to be able to debug your application
  - If it breaks we will disable your slice, and send you the log, your slice will not be enabled until the problem is fixed
- Any API (besides OpenFlow) or UI must be secure
- Provide involved and reactive developers
- Application should already have been tested with FlowSpace Firewall to verify it will function properly
  - FlowSpace Firewall does not re-write rules, it allows or denies rules.
  - Your app needs to be able to work on a set of VLANs (and they wont be the same VLAN across all devices)
- Know the FlowSpace you want for your slice
  - Switches
  - EndPoints
  - Number of flows
  - Interfaces

# What do we want you to do

- Have well tested, well versioned, and packaged code
- Provide lots of documentation
- Provide lots of configurable logging
- Have a Ticketing/Bug reporting system
- Provide Installation and Operation instructions
- Given the FlowSpace be able to generate the proper Configuration for your application
- Be patient, it's a learning experience for all of us



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