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ENERGY SCIENCES NETWORK

Software Defined Exchanges: The new SDN?

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Exchange: Telephone Exchanges

Circuit switching at 64kbps

(manual or automatic)

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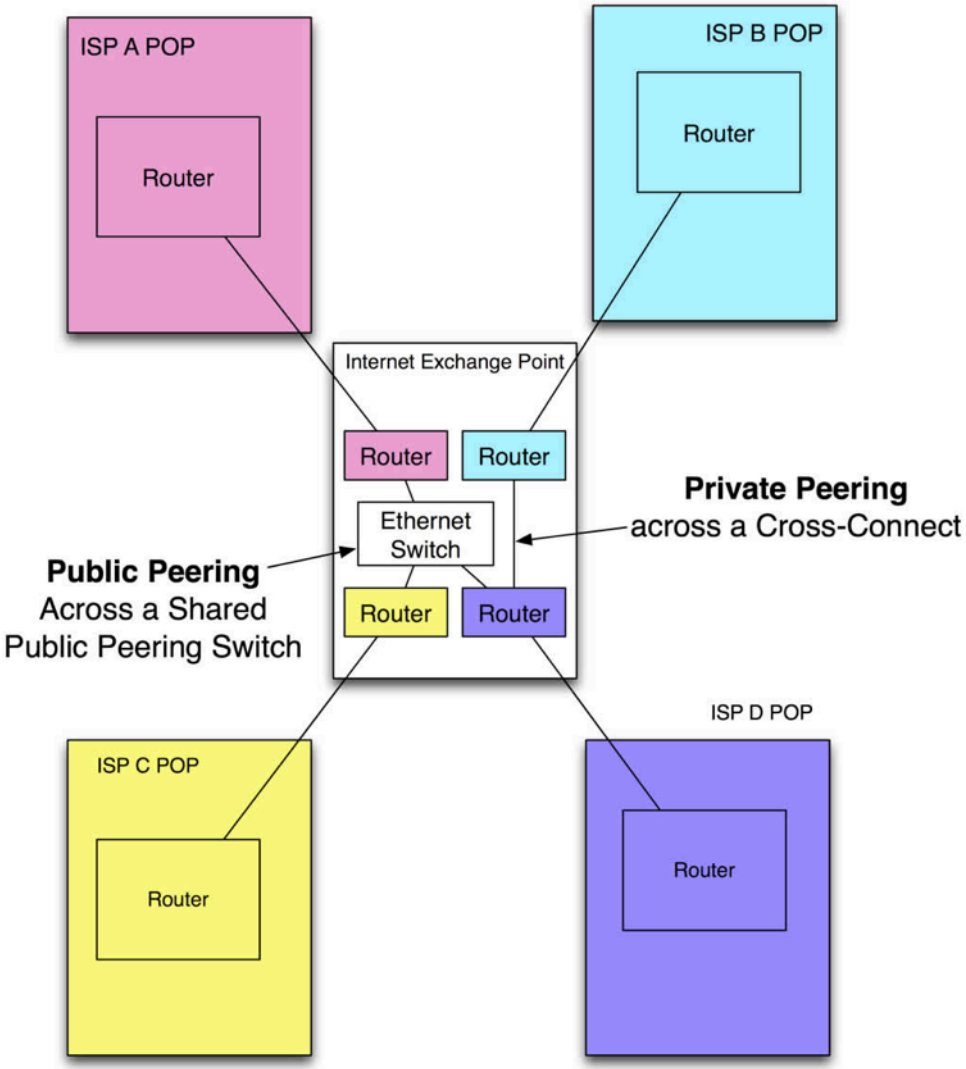
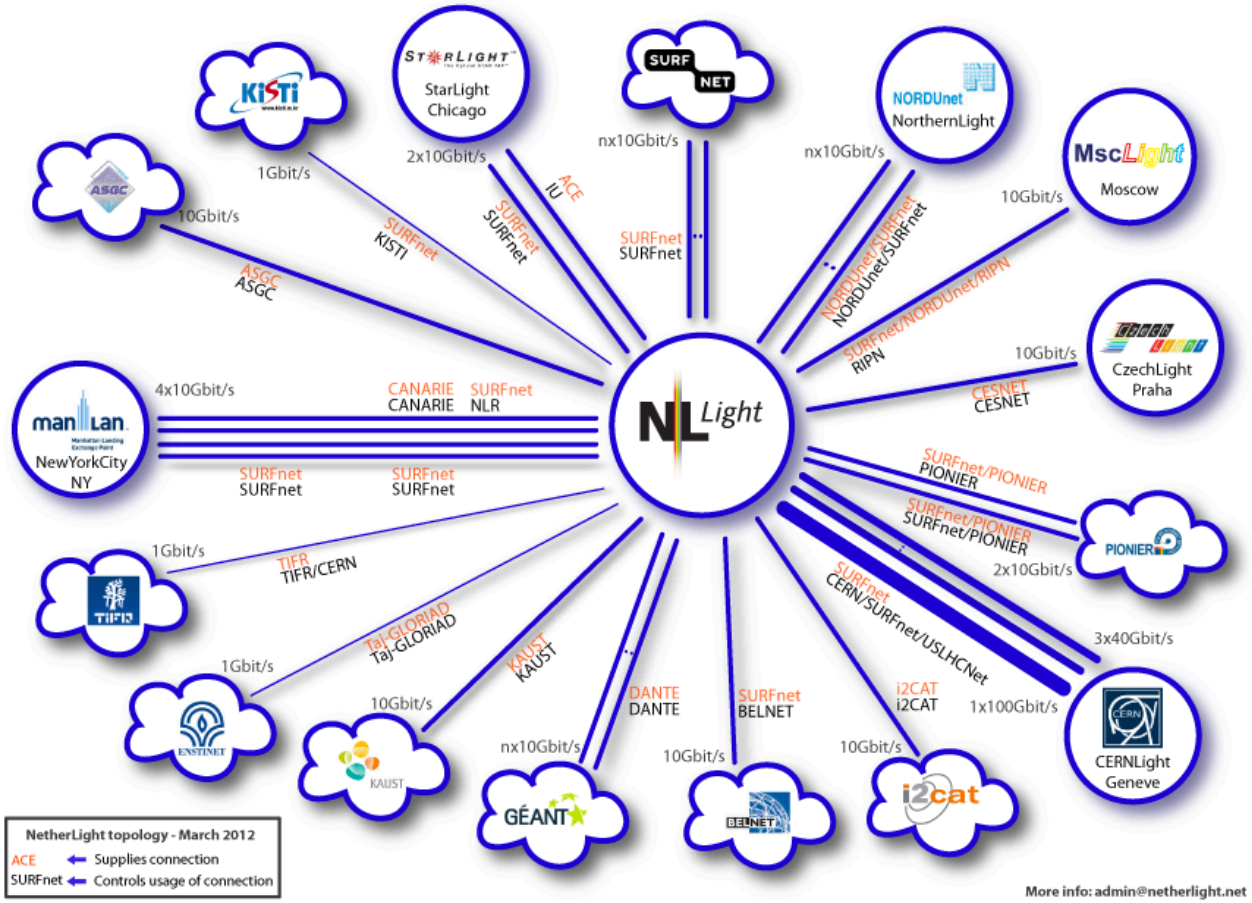
Exchange: Internet Exchange Point



- IP Traffic (L3) is exchanged
- VLANs used for plumbing

Exchange: GLIF Open Exchange Point (GOLE)



- Packet Traffic is exchanged
- Not necessary for it to be IP
- L2 usually

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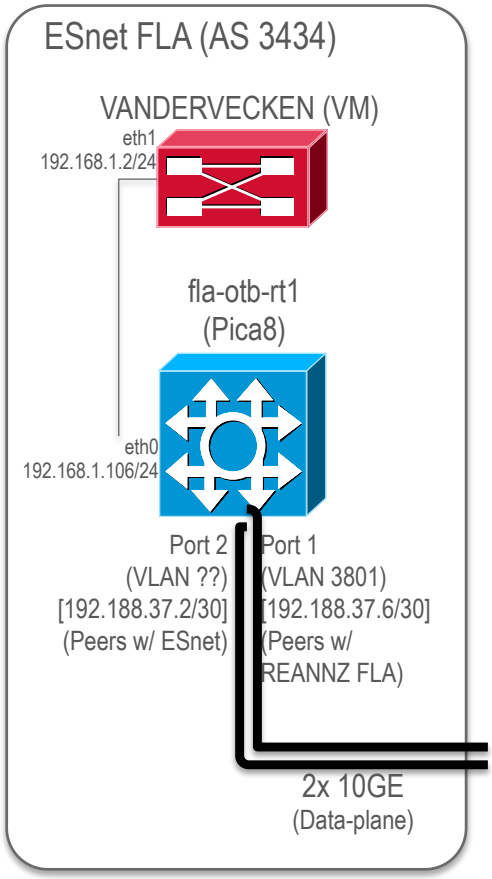
Exchange: Software-Defined Exchange?

March 2013



Treehouse Project

(REANNZ/ESnet/Google)

April 2013

SDX: A Software Defined Internet Exchange

Nick Feamster[†], Jennifer Rexford[⋆], Scott Shenker[‡], Dave Levin[◇], Russ Clark[†], Josh Bailey[*]
[*] Google, [†] Georgia Tech, [◇] University of Maryland, [⋆] Princeton University, [‡] UC Berkeley

December 2013

Operationalizing SDN: A multi-agency program review

August 2014

SDX: A Software Defined Internet Exchange

Arpit Gupta[†], Laurent Vanbever[⋆], Muhammad Shahbaz[†]
Sean P. Donovan[†], Brandon Schlinker[‡], Nick Feamster[†], Jennifer Rexford[⋆]
Scott Shenker[◇], Russ Clark[†], Ethan Katz-Bassett[‡]
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Exchange: Software-Defined Exchange?

OPERATIONALIZATION OF SOFTWARE-DEFINED NETWORKS (SDN) PROGRAM REVIEW

Dec 16-17, 2013

2. **An initial focus is needed on operational SDN deployments including Software-Defined Exchanges (SDXs)** to enable interoperability and use of these new approaches with the current Internet infrastructure. Initially, these efforts should be focused on defining the architectures/implementations that will support operational multi-domain SDNs; experimenting with these designs and iterating as necessary; encouraging the development and deployment of next-generation instruments and applications made possible by this infrastructure; growing the community of multi-SDN aware engineers, researchers, and students; and preparing for transition to an operational phase.

Conducted in Arlington, Virginia by

National Science Foundation

Department of Energy

National Coordination Office

Exchange: Software-Defined Exchange?

NSF's 2014 IRNC solicitation looked to fund SDX concepts

Proposals were due – July 7th, 2014

NSF is interested in supporting the continued research, development, experimental deployment and trialing of multi-domain SDN at a national and international scale. While not required, proposals in this area have an opportunity to propose the design and operation of a Software Defined Exchange (SDX) serving to interconnect SDN peers and connecting customers to these inter-connecting SDNs.

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What is a 'Software-Defined Exchange'?

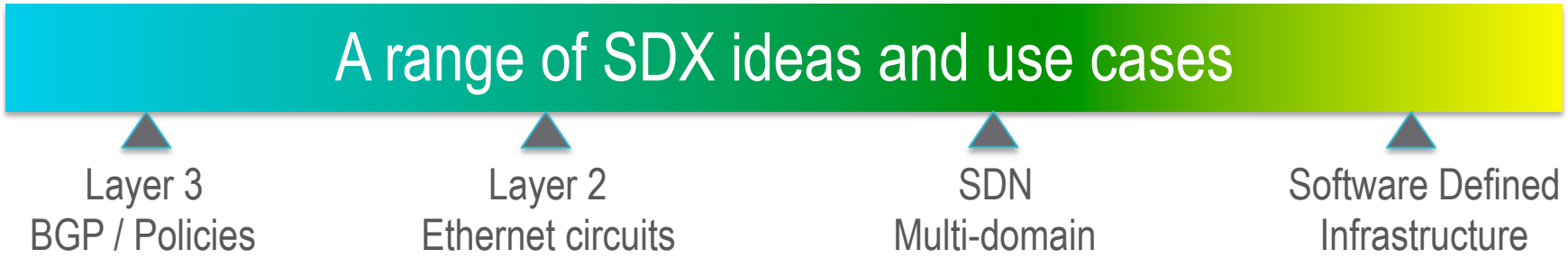

Image from SDX NSF workshop report

Washington DC, June 2014

- SDX =
  - New way to build an Internet Exchange Point (IXP)
  - New way to build a Layer 2 GOLE
  - New approach for multi-domain services
  - New approach to SDI/Network Functions Virtualization
- ΣSDX = New way of building software-defined networks?

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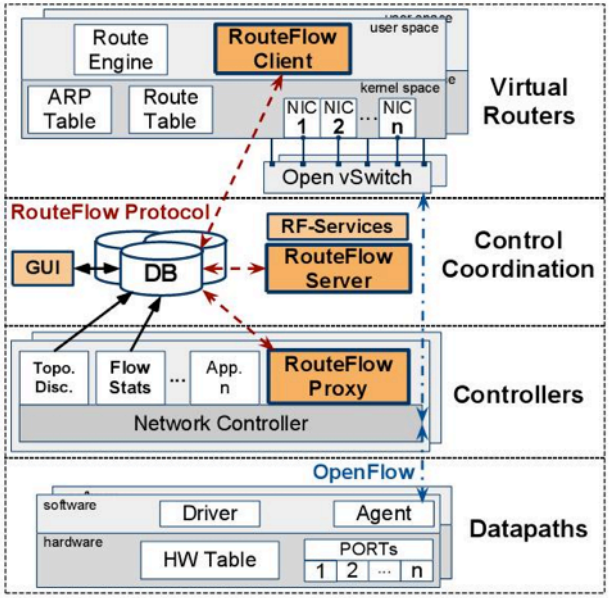
SDX for Layer 3



- How does one do routing with SDN?
  - Routing is an embedded function
  - Depends on reachability and topology (next-hop)
- SDN – separating control from data plane
  - Pull IP routing stack out of the network element
  - Leave forwarding decision in the network element
- RouteFlow – an approach to build BGP in the controller
  - Create a virtual model of the router in the controller
  - Forward BGP update packets to the virtual interface
  - Compute BGP route tables (RIB and FIB) based on virtual model
  - Translate FIB into Flow Tables based on real switch model
  - Install Flow Tables in the data plane

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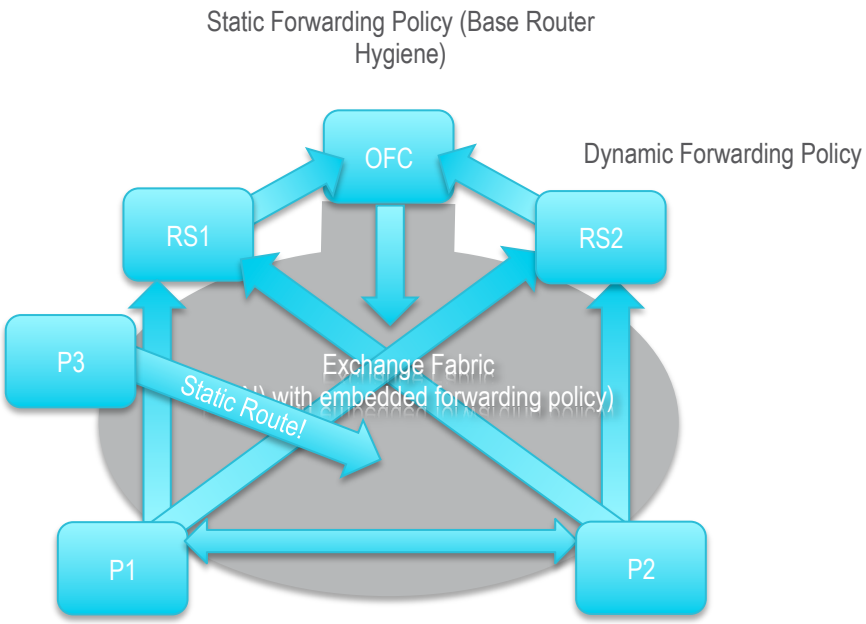
Building an Internet Exchange Point

- Build a SDN-based Router
  - Vandevecken Code based on RouteFlow (higher performance, simpler, 1.3 capable)
  - Documentation: http://goo.gl/IJRGHM
  - Code: http://goo.gl/IG6ELj
- Build peering fabric based on dynamic SDN policies (rather than static network constructs)
- Use SDN rules to scrub bad behavior*
  - Deal with Router hygiene issues (default deny instead of default allow).
  - Deal with "Capacity Theft" issues (as well as "noise" traffic)



** From Jamie Baddeley, Citylink, NZNOG*

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SDX for Layer 2 and multi-domain

- Mature set of L2 multi-domain technologies in R&E networks
  - NSI (protocol for multi-domain)
  - OSCARS
  - OESS
  - G-Lambda
  - AutoBAHN
- Functions include
  - L2 Traffic Engineering, using MPLS or other equivalent technologies
  - VLAN negotiation and translation, for end-to-end connectivity
  - QoS support, missing in most, but really important when supporting multiple peerings/port
- SDN networks are designed as islands
  - Nothing in SDN/OF set of protocols that help inter-domain

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SDXs cannot run without Servers and Storage

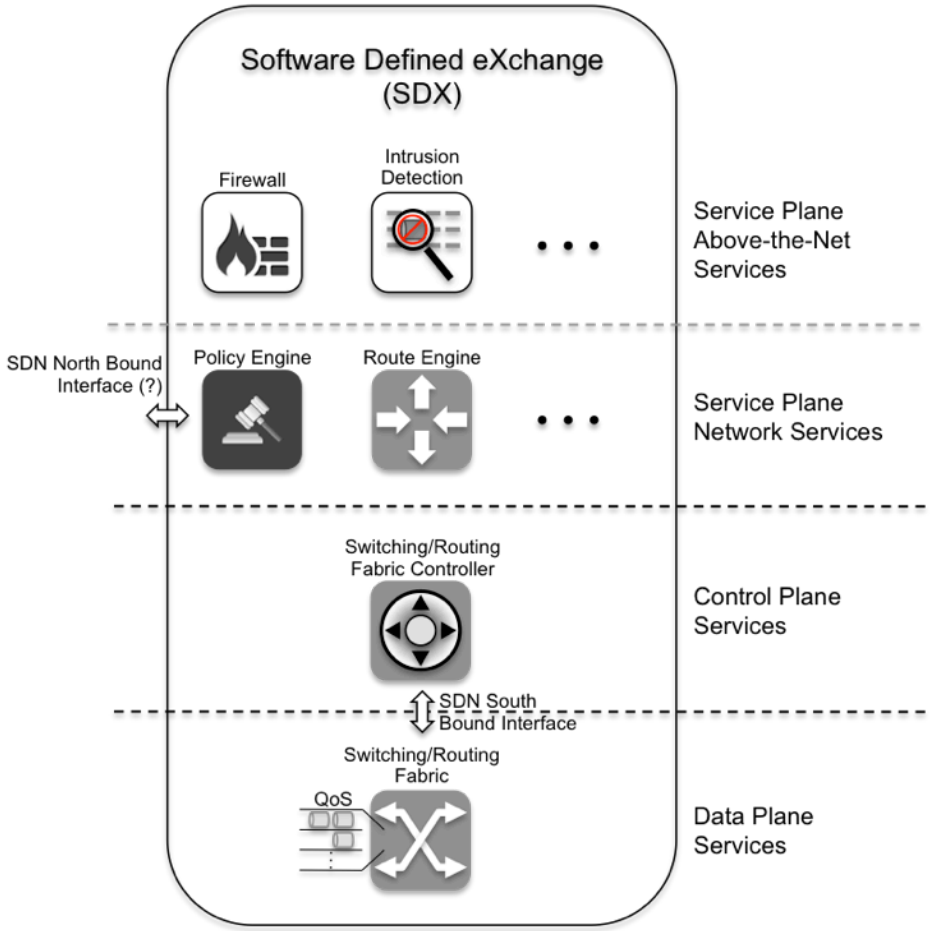
- Layer 3 SDX needs route servers, policy servers, OpenFlow controller, and (depending on the implementation), BGP speakers
- Layer 2 SDX needs NSI server, performance monitoring tools, and perhaps topology server
- SDN SDX needs an OpenFlow controller, policy database, and performance monitoring tools

Slide from SDX NSF workshop report by Larry Landweber

Washington DC, June 2014

From SDX → Software Defined Infrastructure (SDI)

- Once packets are being exchanged, why not offer above-the-network services?
- SDX's become a NFV marketplace
  - Compute, Storage and Network services offered at the exchanges
  - GENI software can be leveraged to do resource management of VM's, storage on a network slice
- User collaborations can allocate services based on their requirements



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Abstracting SDX – what are the common functions?

- A place where peering domains come together
- Peering domains need not be physically connected
- Supports establishment of inter-domain connectivity/routing
- A broker of inter-domain and inter-SRP trust
- Each SDX defines its rules of engagement
- Enforcer of individual domain policies but not itself a policy definer (with exceptions)
- Marketplace for Software Defined Services (SDS) can be built as a SDX overlay
  - For example, an application-specific exchange (a video marketplace)
- Resources may be virtual or physical

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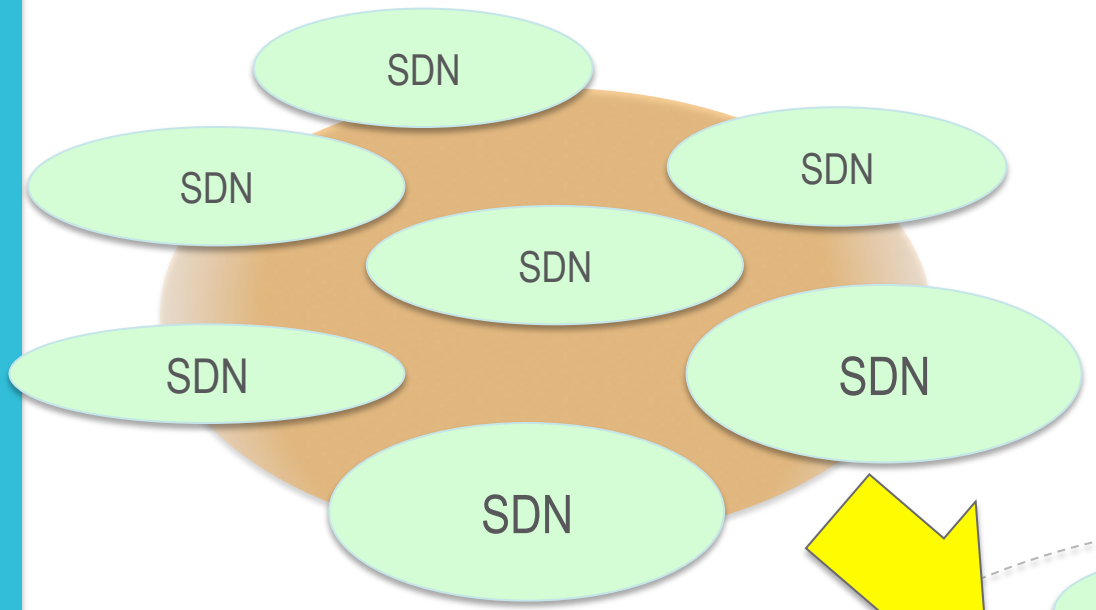
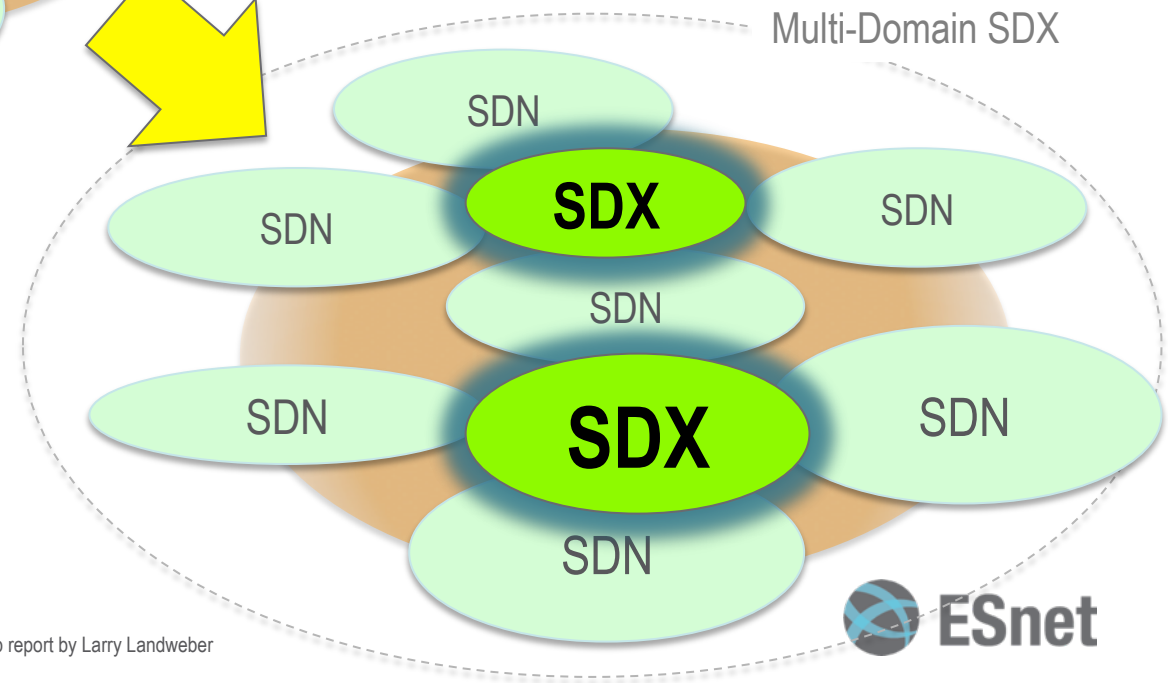
Multi-domain SDXs*



Today: "SDN islands"
GENI slices & VLAN stitching help point the way



Next Step: Add SDX's
Build a "Rev 0" control plane, run native next-gen apps and scientific instruments **spanning multi-domain SDNs**

Slide from SDX NSF workshop report by Larry Landweber

Washington DC, June 2014

SDX equivalent to a ‘bazaar’

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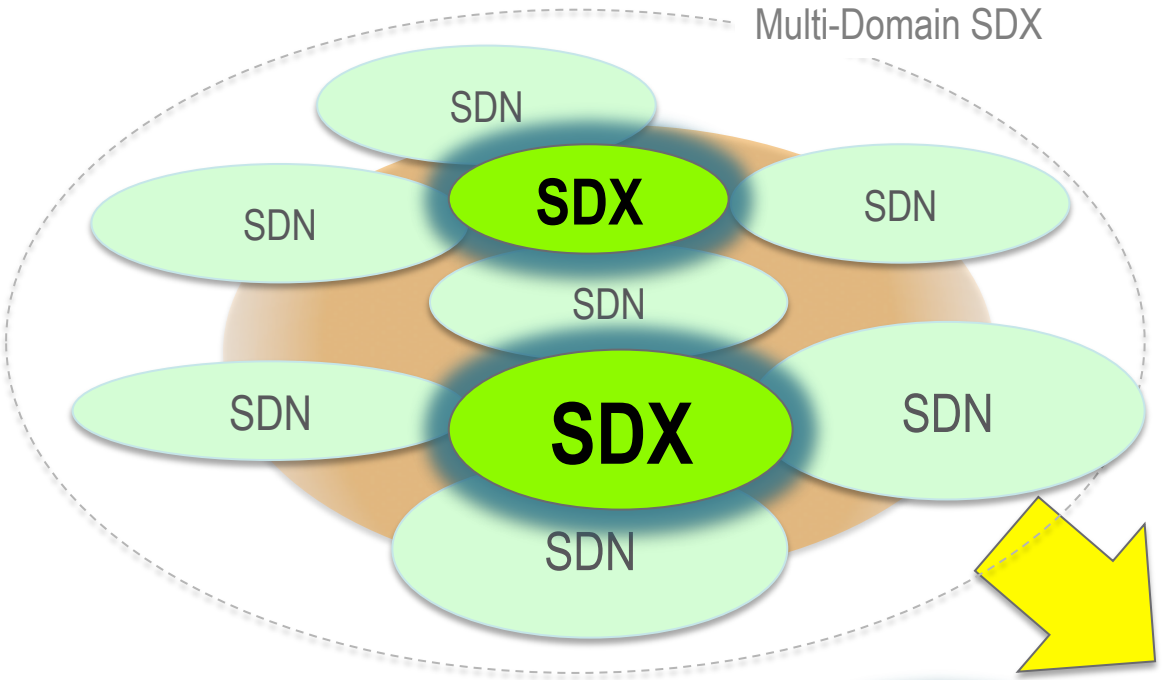
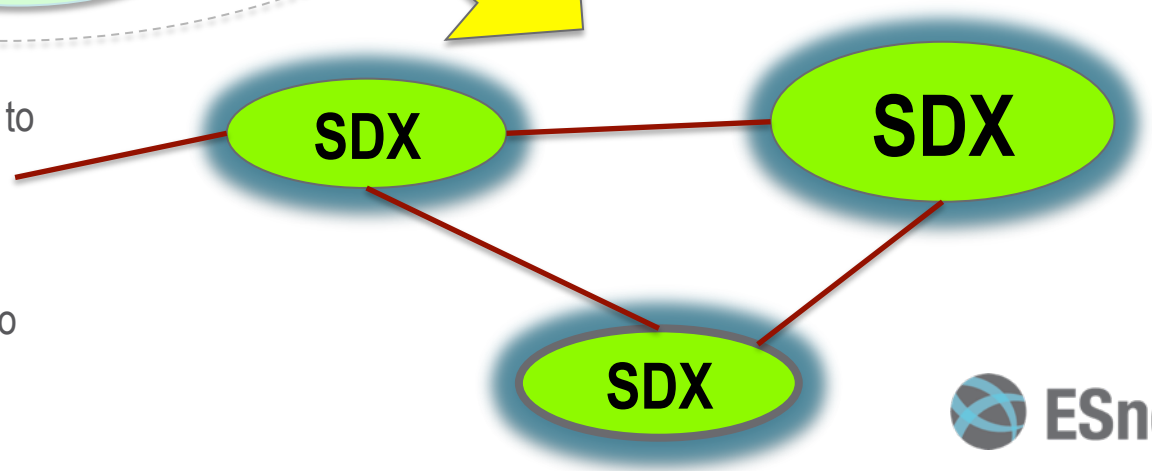
The *'Bazaar'* model of SDX



- Imagine there are no private peerings
- SDN networks are just on-ramps to access the SDX services
- End-user applications 'service-chain' SDXs to get end-to-end services

This SDX model is equivalent to the 'cloud' but for networking, where startup companies like Netflix do not have to build a global network infrastructure to provide differentiated content services worldwide



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Summary

- Software Defined Exchange model is new, hence free for re-imagining the new architectures
- Layerless Networks
  - Today's networks have clearly defined layers (e.g. L1-L3)
  - SDX (and SDN) are blurring the lines between the layers, and their control
- Services Exchange
  - Networks generally just provide connectivity
  - SDX based future networks will incorporate additional services to enhance the user experience
- Virtualization
  - No need to own global infrastructures (like the carrier's today) since policies can be applied safely on multi-tenant SDX infrastructure

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Questions?

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