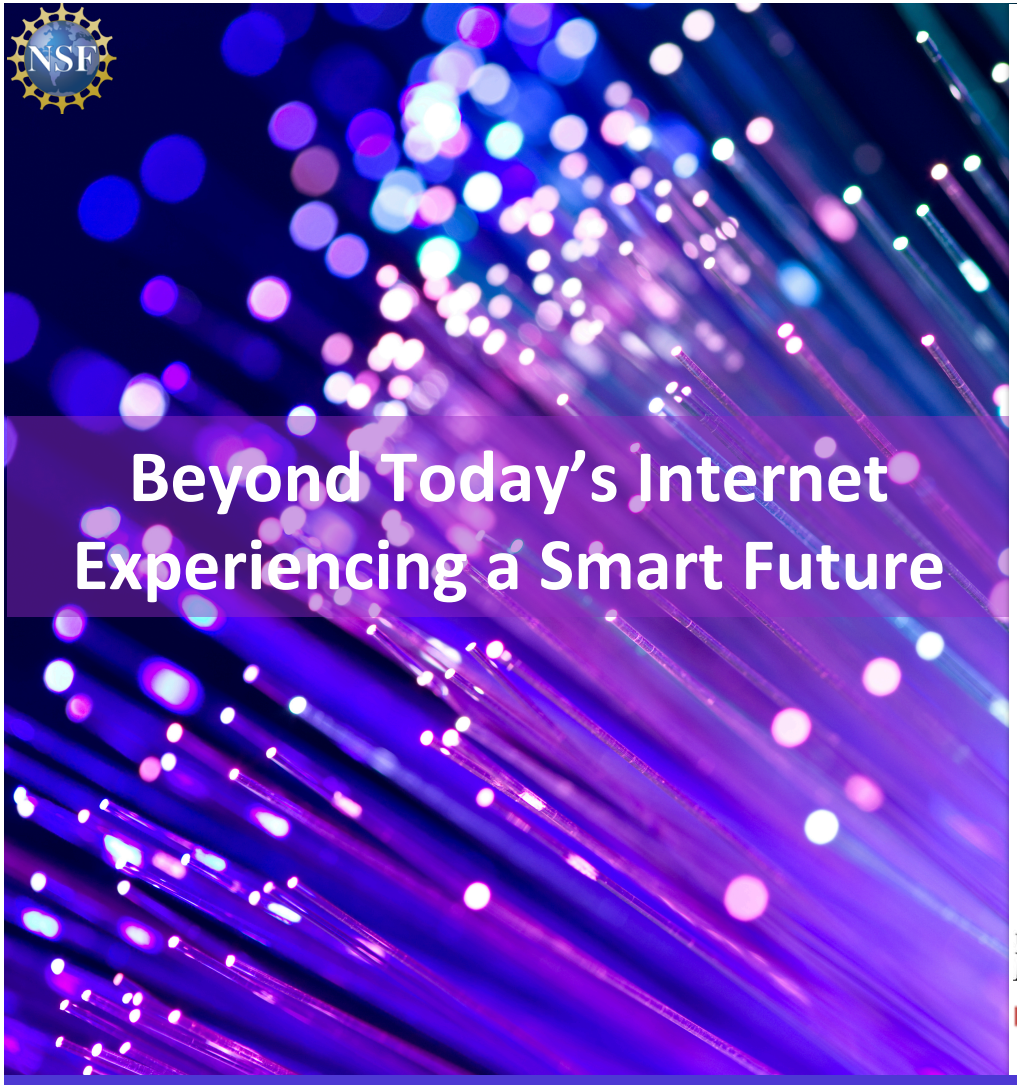

SDX: Software Defined Exchange

A New Internet Paradigm

Larry Landweber – BBN GPO
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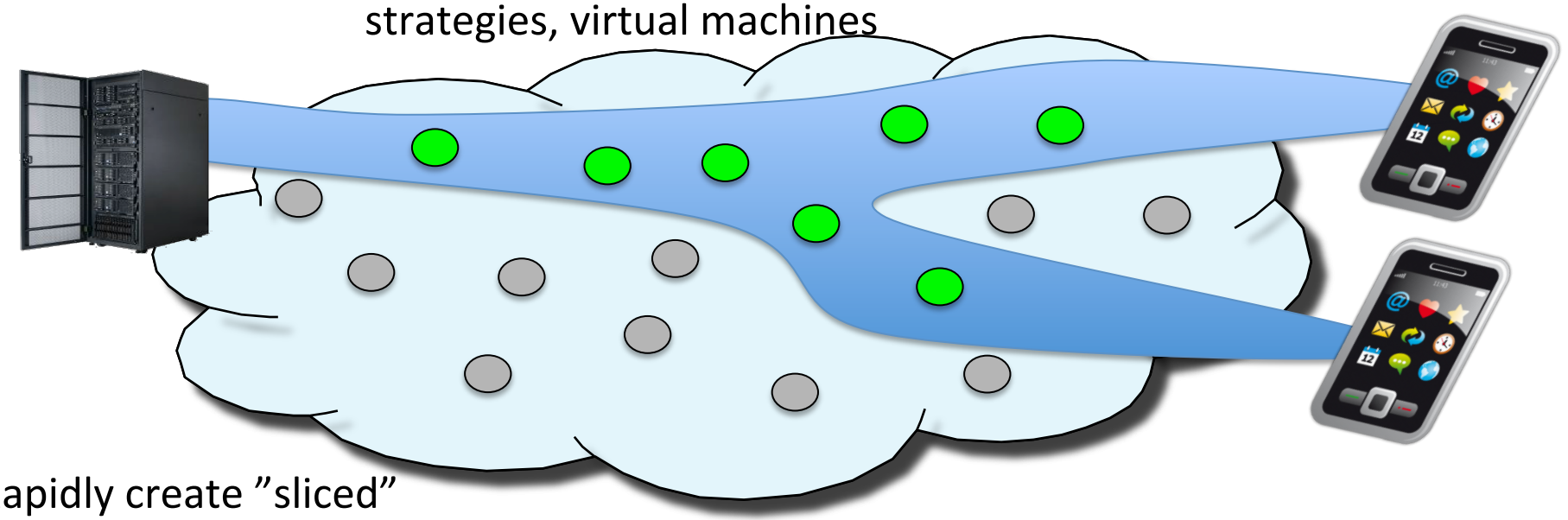
Software Defined Infrastructure (SDI)

- Deeply programmable on-demand physical or virtual network/compute/storage/ instruments/etc
- Radically decoupling infrastructure from services
- End to end, multi-domain
- Applications
  - Flexible “switches”
  - Content distribution networks (CDNs)
  - “On demand” cyber-physical systems
  - Cyber security
- Moving beyond the Internet’s vulnerabilities

Slicing: A Vision for future networks

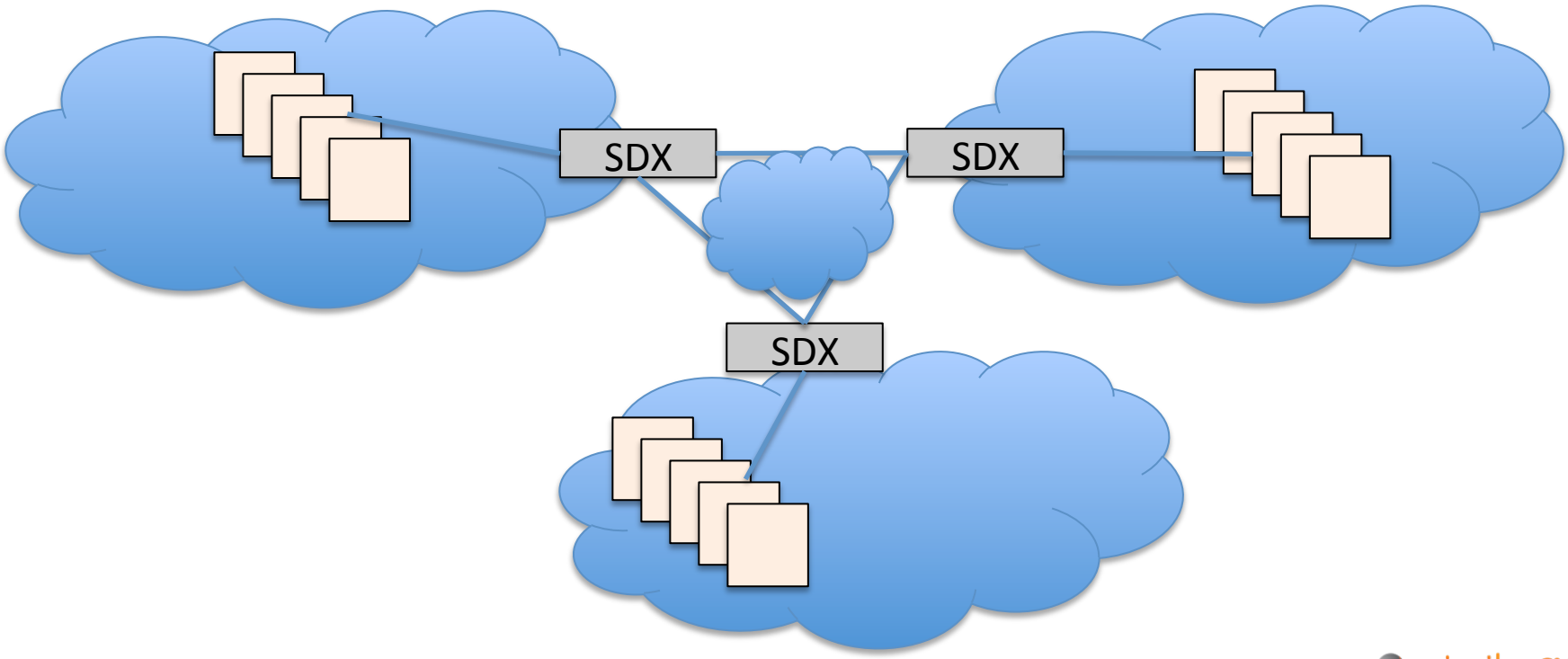
Fast spin new protocols, switching strategies, virtual machines



Rapidly create ”sliced” cyber-infrastructure / networks / services on demand

The Internet, running in a deeply programmable slice!

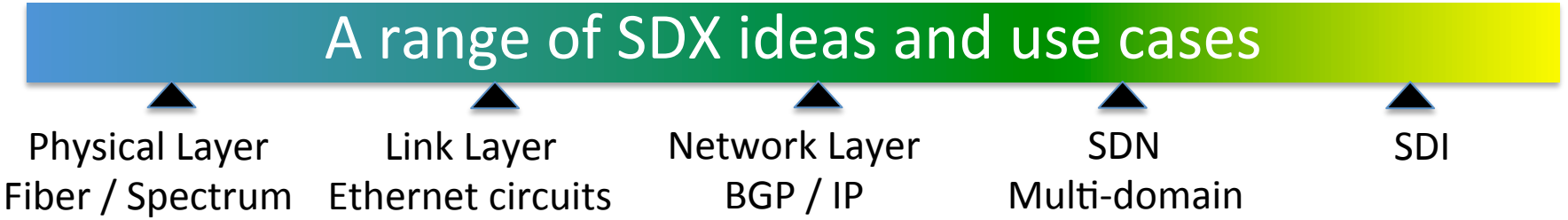
Software Defined Exchanges (SDXs) between Administrative Domains



SDX

- **A "meet-me" point and resource provider**
- **Translator**: Enable different networks that speak different protocols to interoperate
- **Broker**: Present/market resources of one domain to clients of another
- **Guard**: Monitor and enforce policies of one domain by users from other domains

Software Defined Exchanges (SDXs)



- Connectivity/routing
  - Physical Layer (Fiber / Spectrum) – e.g., allocate, share, connect waves
  - Link Layer (Ethernet) – e.g., multi-domain circuits
  - Network Layer (BGP/IP) – e.g., connect AS's
  - SDN – connect SDN islands
- SDI - compute/storage/network resources
  - Connect SDI islands
  - GENI as an early instance

What does a **Virtualized Meet-Me Point** look like?

Software Defined Infrastructure !

Physical Meet-Me Point (Colo)

- Bring your own equipment
- Cages keep us physically separate

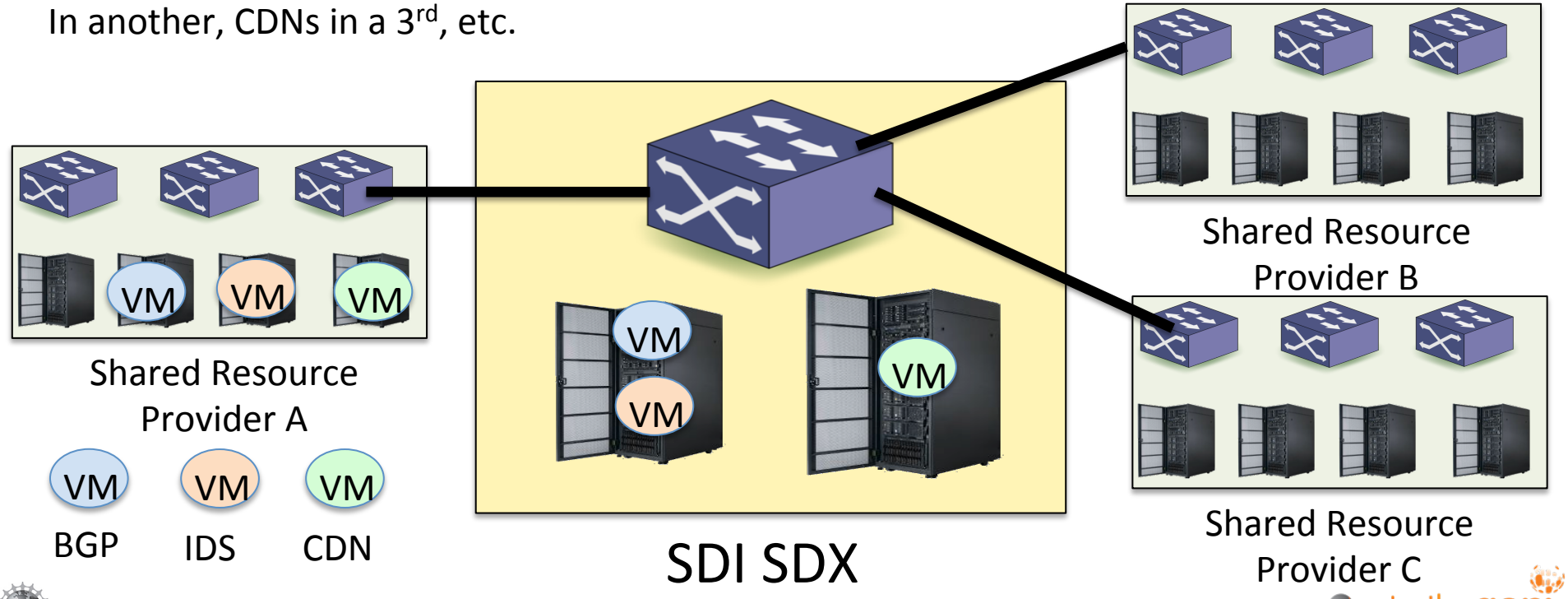
Virtualized Meet-Me Point

- Bring your own VMs
- Multi-tenant (slicing) keeps us separate

Software Defined Exchanges (SDXs)

A "meet me" point for *services*,
e.g., BGP in one slice, Ethernet circuits
In another, CDNs in a 3rd, etc.

Key research areas: federations, authN/Z, policy logics, cross-domain visibility, etc.

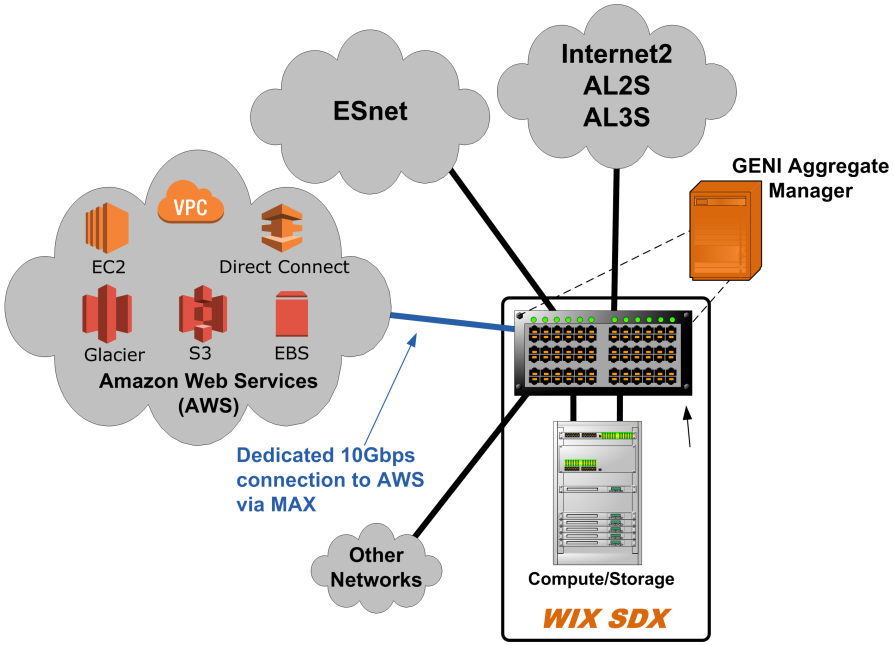


- Tom Lehman will now present the architecture of our GENI-based SDI SDX demo

- Brecht Vermuelen will then present a live demo, utilizing an international array of SDXs and resources

Deploying and Operating a prototype SDX

WIX as a Software Defined Exchange (SDX)



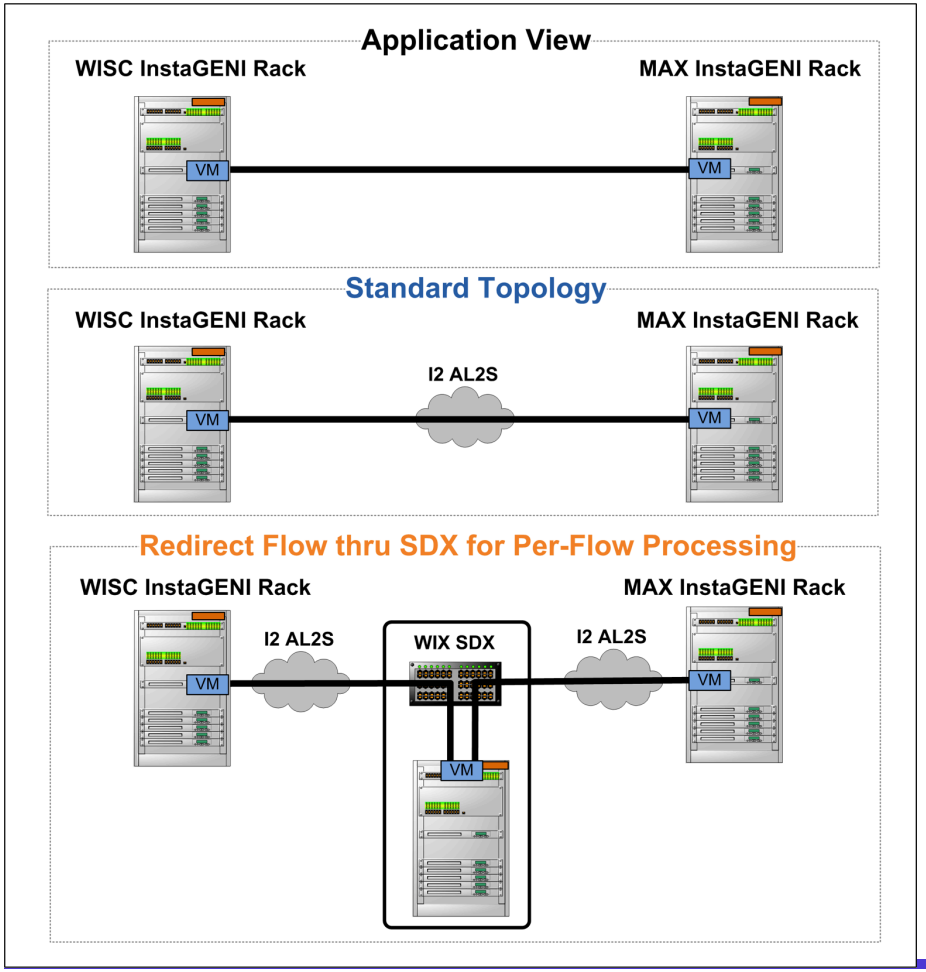
- WIX is a production Exchange Point in McLean, Virginia
- Jointly run by Internet2 and MAX
- Deployed WIX GENI Aggregate Manager "covers" the exchange point switch
- Compute resources from InstaGENI rack
- This has converted WIX into a prototype SDX (prototype service on production infrastructure)

- A GENI powered SDX can facilitate a marketplace of SDX "services"
- AWS Virtual Private Cloud (and other) services are available at the WIX SDX
- GENI users can create topologies and "stitch" to AWS resources
- MAX is providing this via a dedicated 10G "AWS Direct Connect" service

GENI Powered SDX

- GENI Technology can be utilized to convert an Exchange Point into a Software Defined Exchange (SDX)
- GENI resources are typically deployed at edges (regional network, campus)
- Value in placing more GENI technology/resources in the middle of the network where networks meet, i.e. Exchange Points.
  - Makes exchange points dynamic from a resource provisioning and a policy application perspective, where they are largely static in today's environment
  - Enables a market place to develop where third parties can bring their "services" to the GENI enabled SDX. Such as the AWS example.
  - Dynamic compute and storage along with dynamic network services inside the internet can enable per flow based processing.

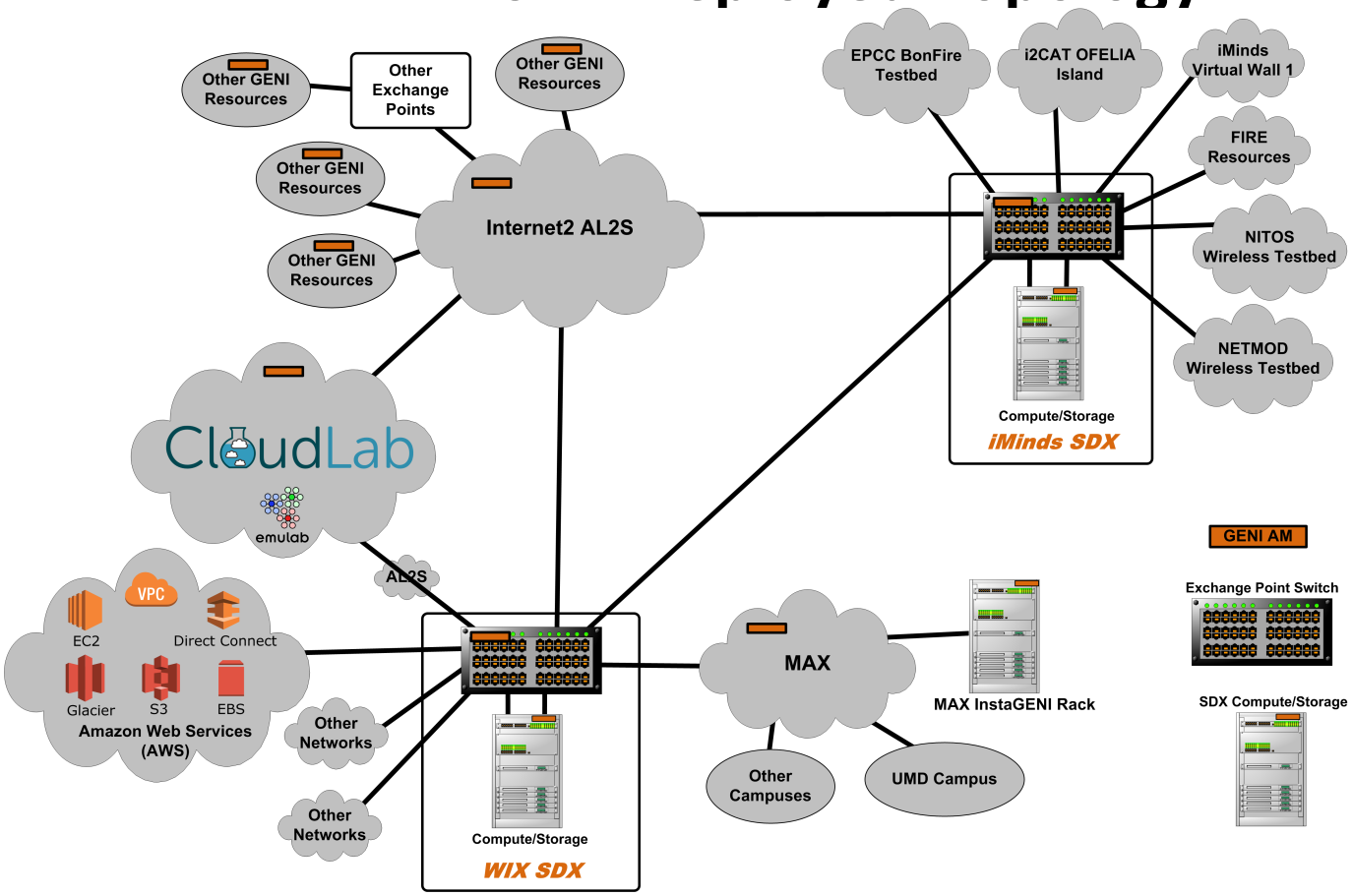
SDX Enabled Flow Based Services



- GENI mechanisms can be utilized to "redirect" flow thru an exchange point where "value added" processing can be accomplished
- With a distributed infrastructure of SDXs this can be done in much more dynamic and open manner then what is possible today.
- This type of capability can be used for single flow focus, or to build specialized service topologies
- Demo to follow focuses on the latter

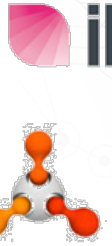
usignite geni

SDX Deployed Topology

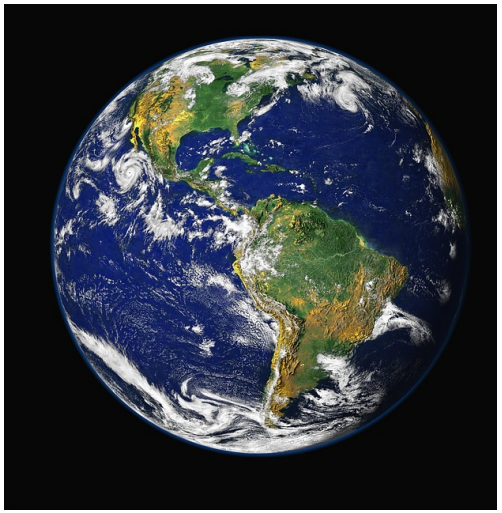


- This topology is based on production networks and GENI resources
- Prototype SDX and SDX enabled services have been deployed

Live Demo

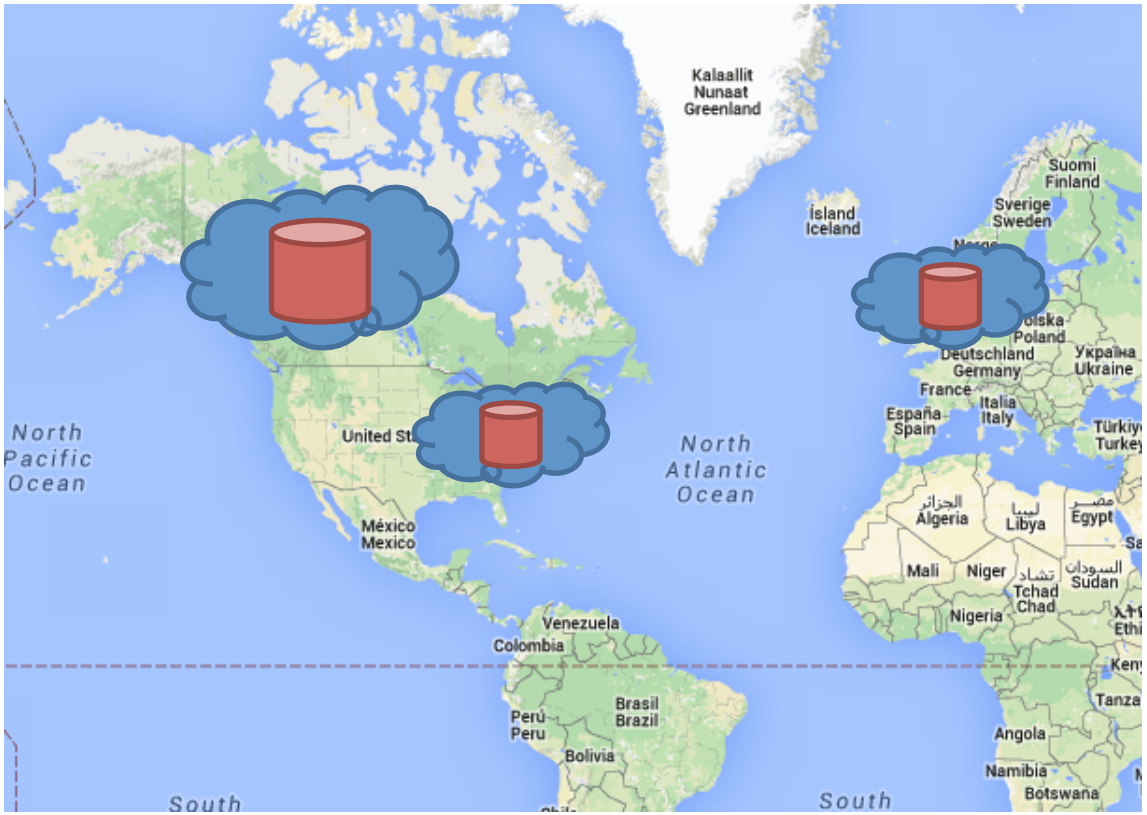


Company wants to deliver global video service

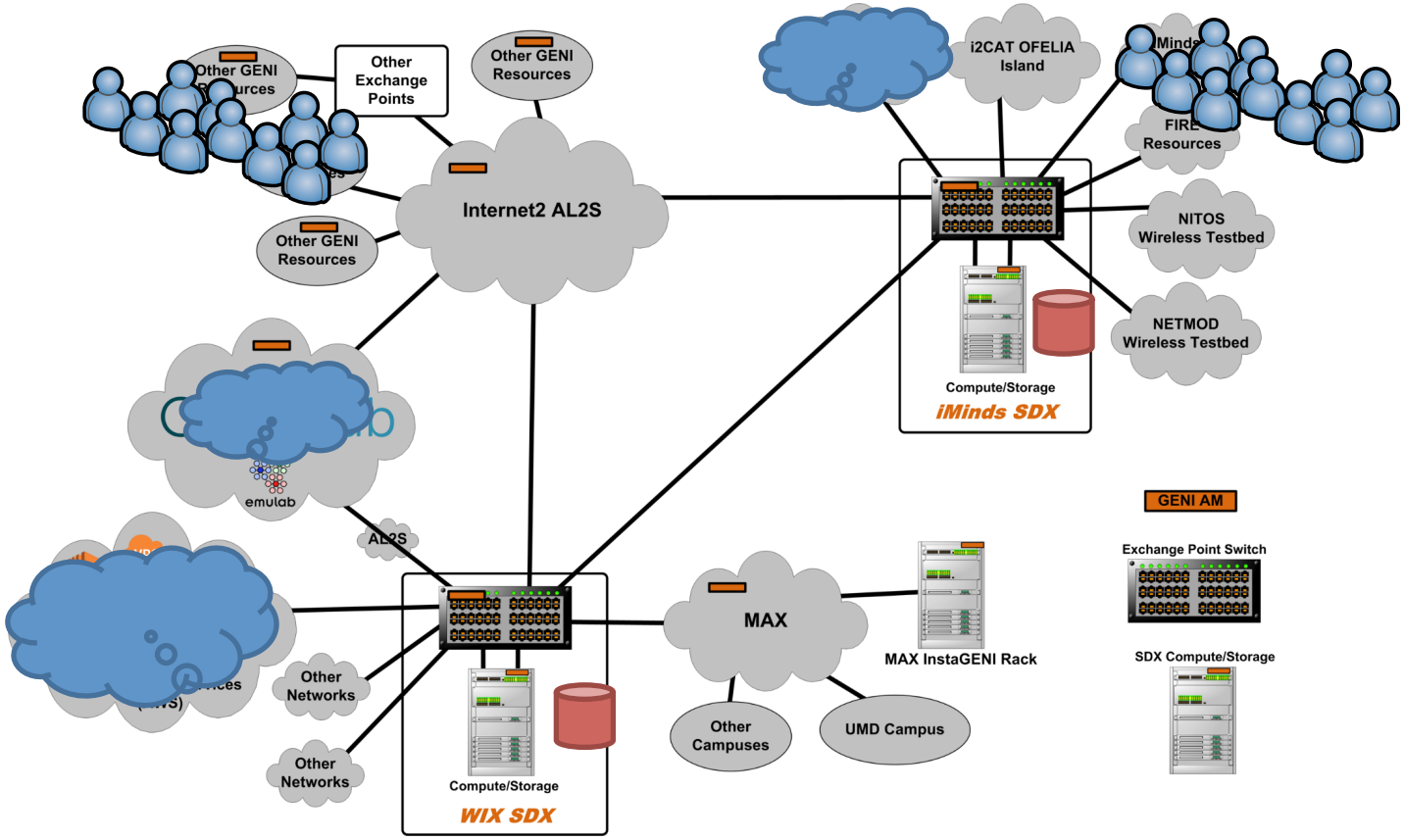


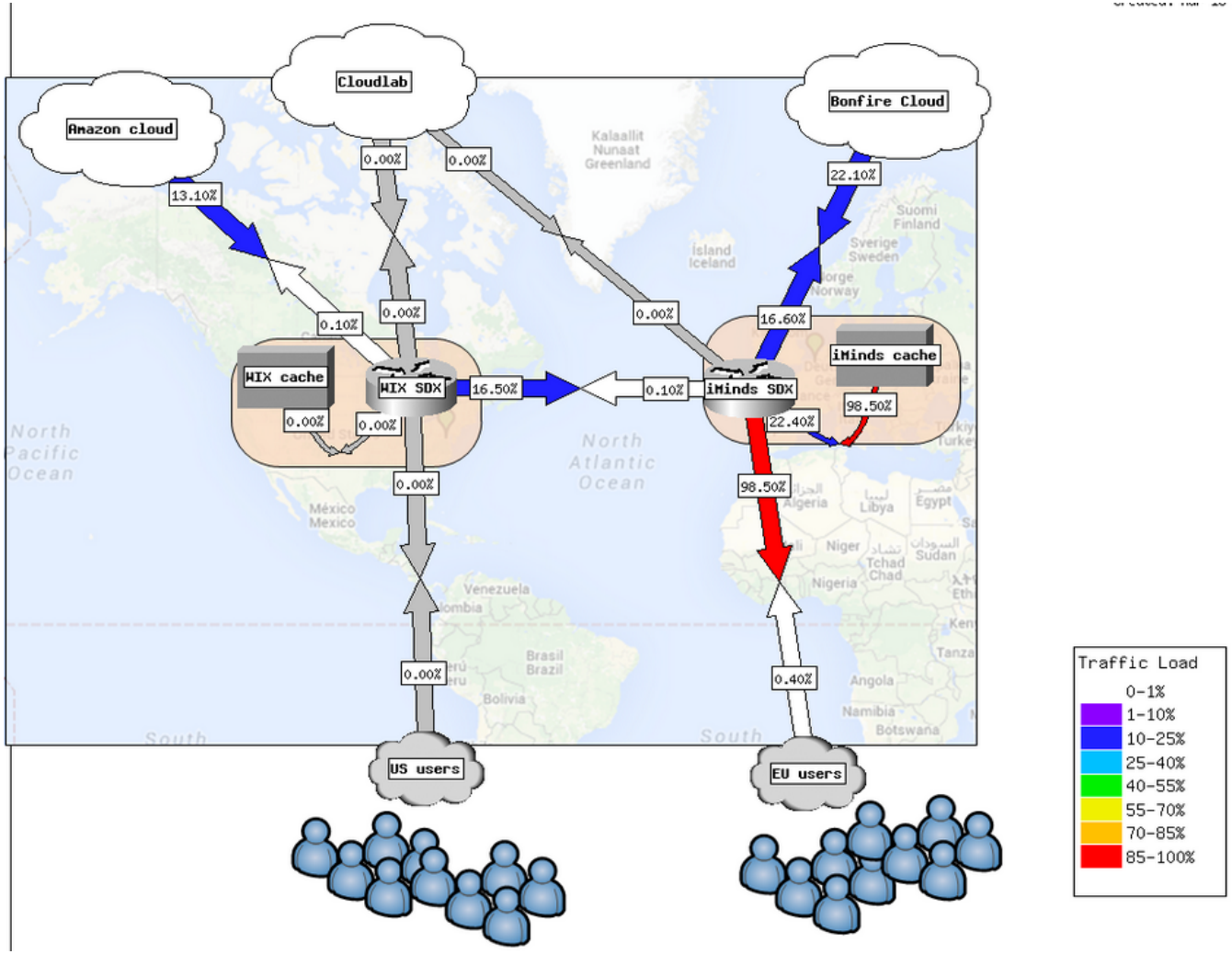
- Cost efficient
- Redundant

Design: start with US and EU users



Demo Deployment

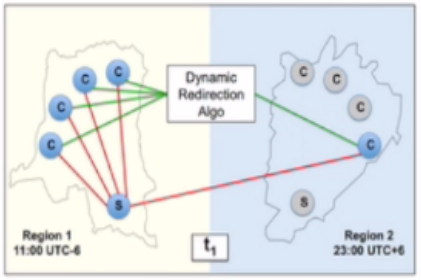



Cloudlab
Amazon cloud
Bonfire Cloud
13.10%
0.00%
0.00%
22.10%
0.10%
0.00%
0.00%
16.60%
WIX cache
WIX SDX
16.50%
0.10%
iMinds SDX
iMinds cache
98.50%
0.00%
0.00%
22.40%
0.00%
98.50%
US users
EU users
0.00%
0.40%
North Pacific Ocean
North Atlantic Ocean
South
South
Kalaallit Nunaat Greenland
Island Iceland
Suomi Finland
Sverige Sweden
Norge Norway
México Mexico
Venezuela
Brasil Brazil
Bolivia
Algeria
Libya
Egypt
Niger
Tchad Chad
Sudan
Nigeria
Angola
Namibia
Botswana
Traffic Load
0-1%
1-10%
10-25%
25-40%
40-55%
55-70%
70-85%
85-100%

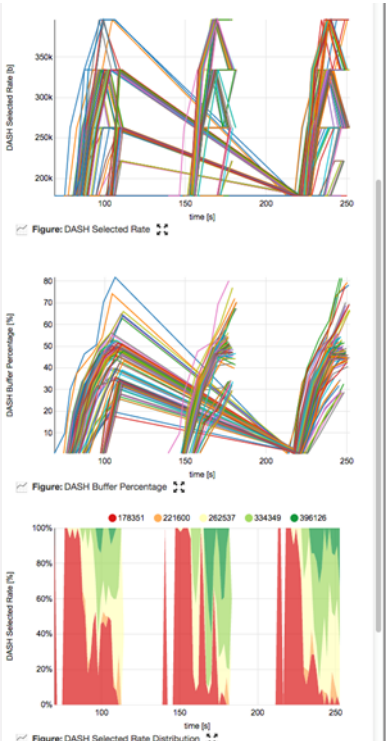
Follow the sun …

The 3-step orchestration of that experiment is further detailed below.

- Step 1: it is daytime in the geographic region #1, many clients from region #1 and a few client from region #2 request some DASH videos, the redirection algorithm directs them to a datacentre located in region #1



- Step 2: it is now daytime in the geographic region #2, many clients from region #2 and a few client from region #1 request some DASH videos, the redirection algorithm directs them to a datacentre located in region #2



Benefits of SDX for company

- Put caches as close as possible to the users
  - Use computing + storage offered by SDX
- Tiered design
  - storage and computing might be expensive at SDXs
  - Design with secondary datacenters house less storage then main datacenter
- Build its own world-wide layer 2 network (=slice) and do traffic engineering as it wants

The Future

- You have seen an early demo of two interoperating prototype SDXs in Ghent and College Park with resource providers in Edinburgh, Ghent, Salt Lake City and Amazon
- This work presages a major transformation of the Internet
- We can now catch glimpses of what lies beyond
- SDX, SDI and Slicing with virtualization have the potential to open the door to the future Internet
- **To get there potentially game changing research in a variety of areas is needed**

GET INVOLVED!

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