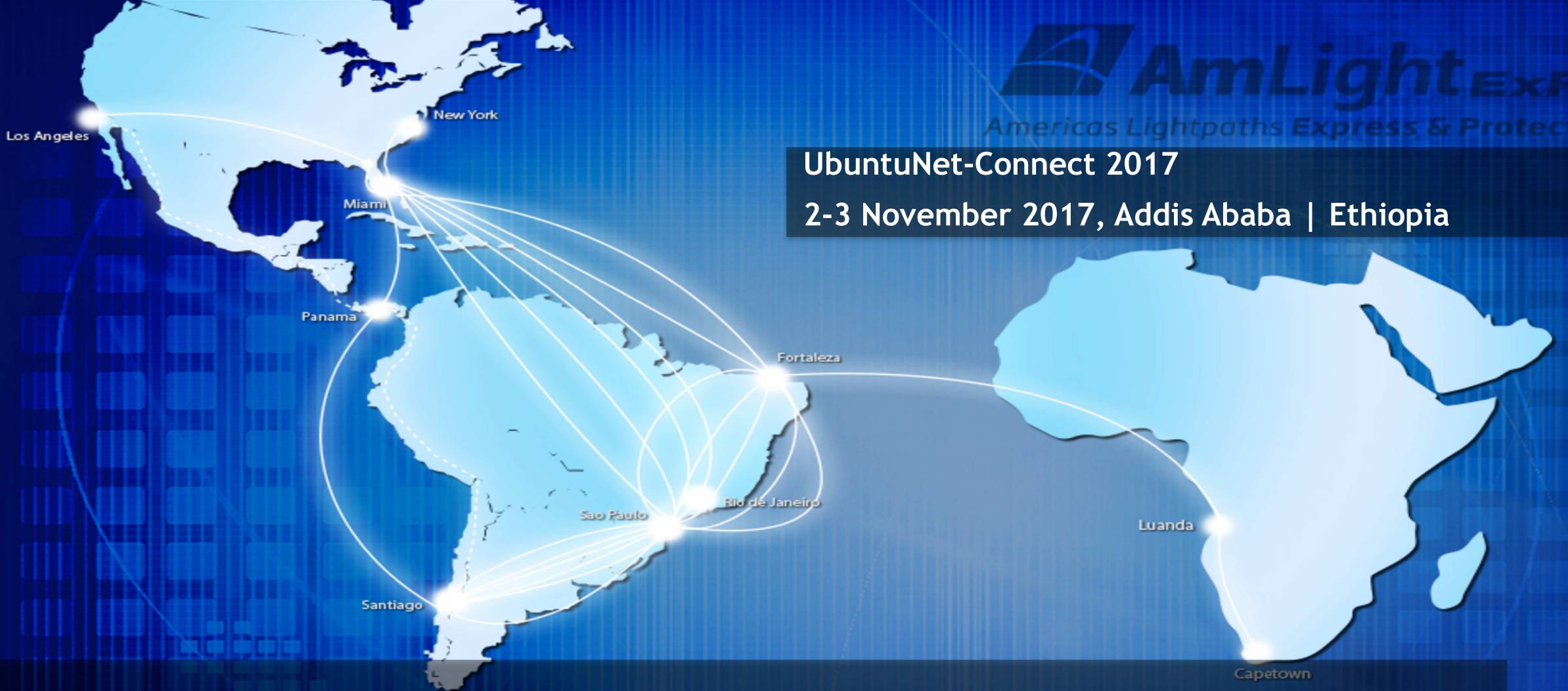


UbuntuNet-Connect 2017

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**Facilitating content distribution in Sub-Saharan Africa through
Software-Defined Exchange points**



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Phenomenon in Africa

- Africa is the fastest growing region of the world for international Internet bandwidth
 - Approximately 40-45% growth
 - Approximately 6 Tbps
 - SSA international Internet bandwidth growth approximately 3.2Tbps
 - In comparison, Europe and the U.S. are at 25% growth
- International content provider capacity remains high
 - Europe hosts 81% of international content
 - Latency is a significant issue (100-200ms latency)

Source: Telegeography Spotlight:
Data Centers are Coming to
Africa



Demand for Content Distribution

- Demand for content distribution within Sub-Saharan Africa is growing
- Intra-African content provider traffic is increasing
 - In 2017, intra-African traffic is 17%, compared to 9% in 2012
 - Content providers (Akamai, Google) have deployed caches
 - Google achieved 80% local traffic exchange in SSA (AfPIF 2017)
 - Microsoft is bringing two new data centers to South Africa. Amazon, Facebook, IBM, and others likely to follow
 - Growth in data center and cloud services is expected to increase traffic exchange within SSA (AfPIF 2017)
- Submarine cable deployments have led to growth in local content distribution
 - International transit in 2017 dropped to 30% from 40%
 - SACS cable: RFS Q3 2018
 - More content from Brazil, USA and the Americas



Role of Internet Exchange Points and Content Distribution

- Internet Exchange Points (IXPs) play a central role by interconnecting many networks
- IXPs facilitate peering and the sharing of content between networks
 - IXPs attract Content Distribution Networks (CDNs), such as Netflix, to increase cache hits
- Likewise, local content at an IXP attracts local networks to peer
 - Content provider caches (Google, Akamai, etc) attract more peers to an IXP



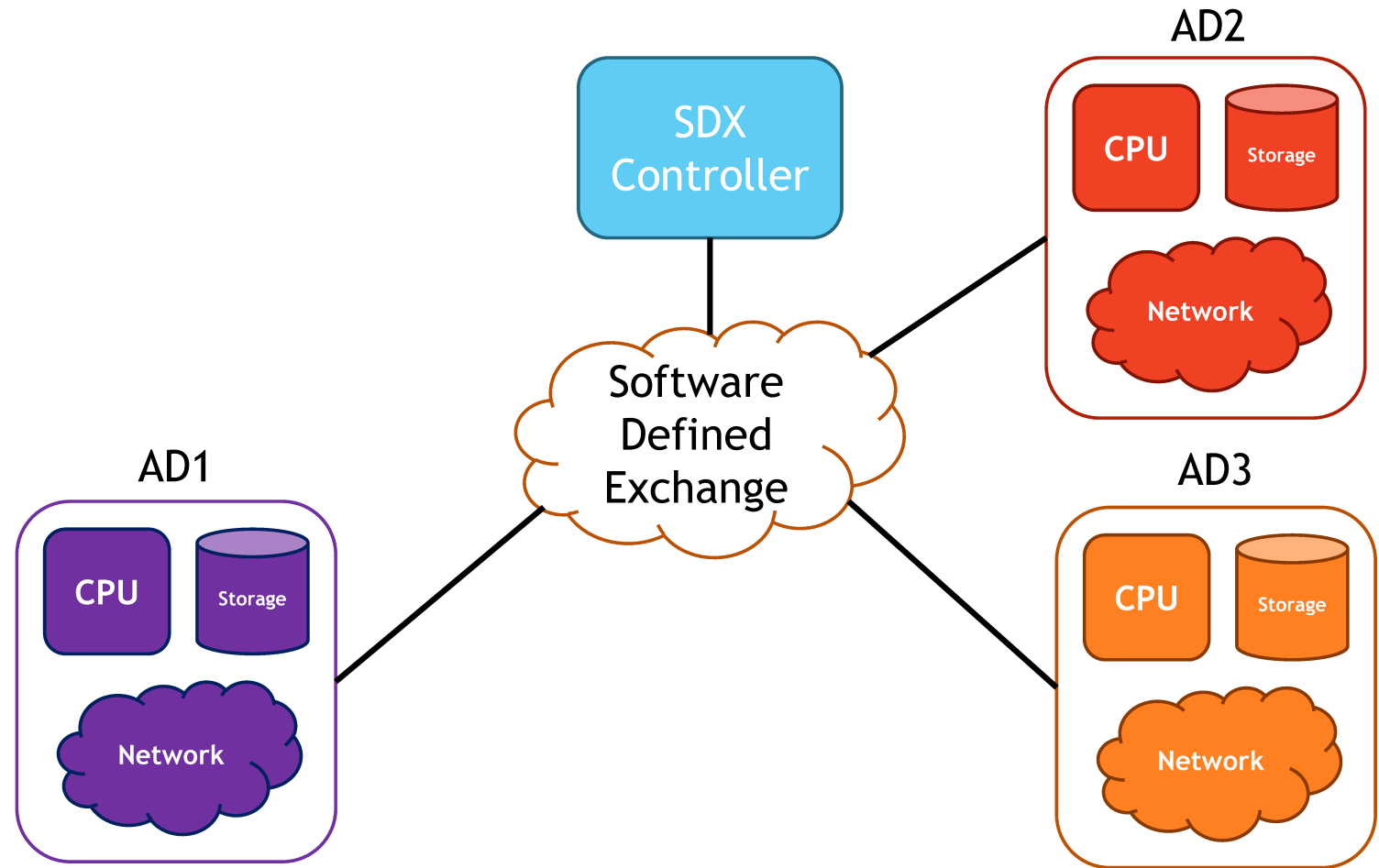
Software-Defined Exchange and Content Distribution

- A Software-Defined Exchange (SDX) facilitates content distribution
 - **Application-specific peering:** Enables two network domains exchange traffic only for certain applications
 - **Inbound traffic engineering:** Using BGP, content providers have little control over how traffic enters their networks
 - Using SDN-enabled switching at an IXP, a content provider has more flexibility to control inbound traffic
 - **Wide-area server load balancing:** Using DNS for server selection, content providers manage complex issues involving DNS cache misses, resulting in latency issues
 - Instead, an SDX can match the chosen hosting location based on any fields in the packet header
 - **Network Programmability:** Provides content distribution networks the capability to
 - Initialize, control, change, and manage network functions dynamically via programmable interfaces



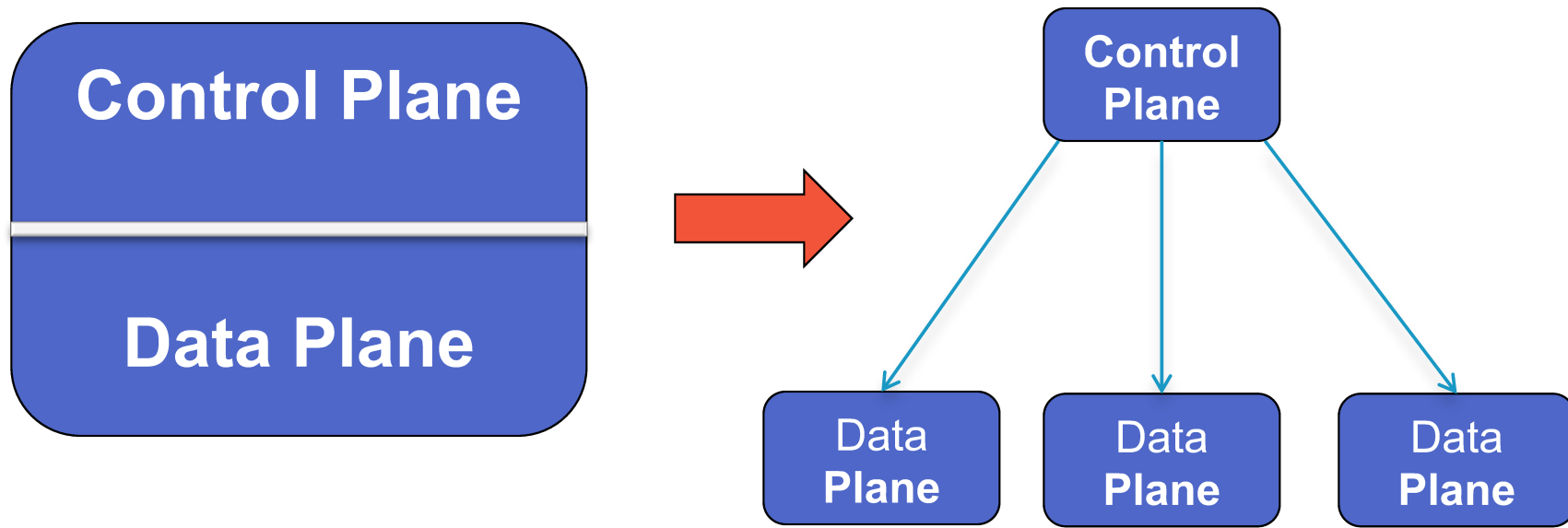
Software-Defined Exchange (SDX) definition

- A SDX is a novel cyberinfrastructure that
 - Facilitates multiple independent Administrative Domains (ADs) to share computing, storage, and networking resources in a programmable way



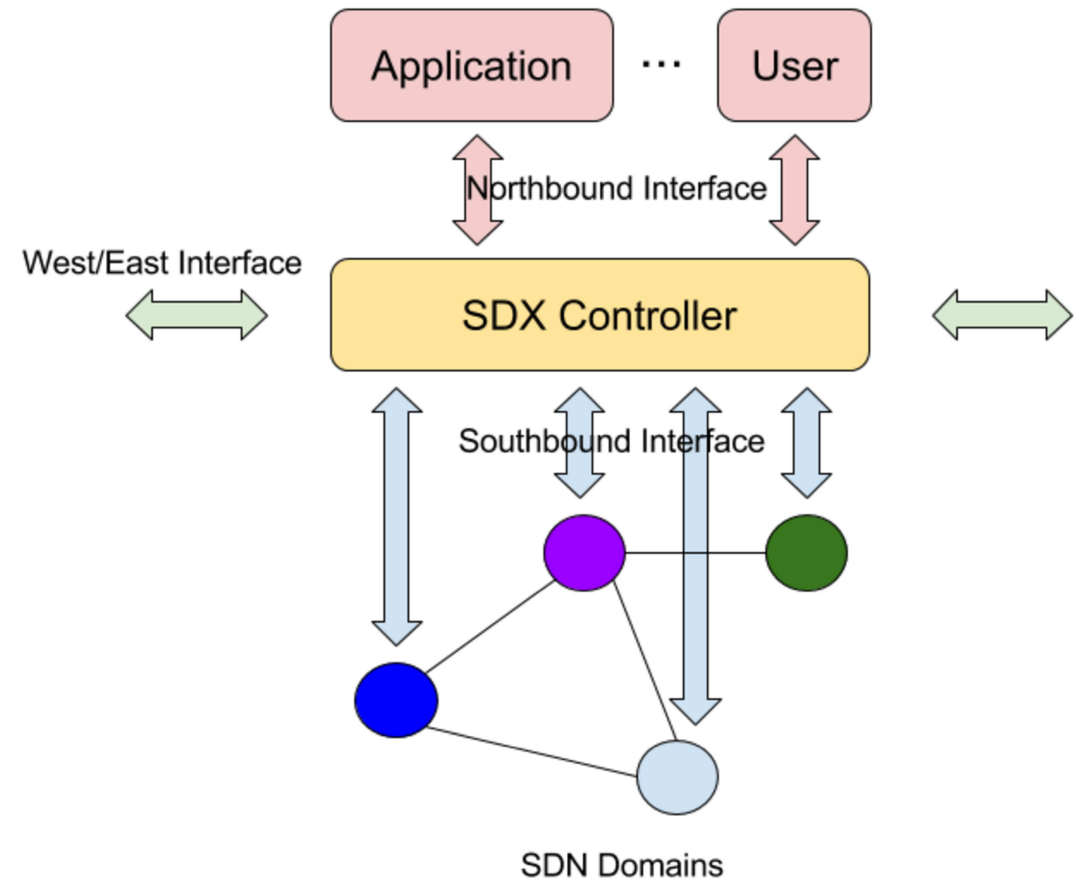
Software-Defined Networking (SDN) - What is it?

- Software Defined Networking (SDN) decouples the control plane from the data plane
- Control Plane decides how to handle the traffic
- Data Plane forwards traffic according to decisions that the control plane makes
- Via an API, an SDN control plane exercises control over the network's data-plane elements (switches, routers, etc.)



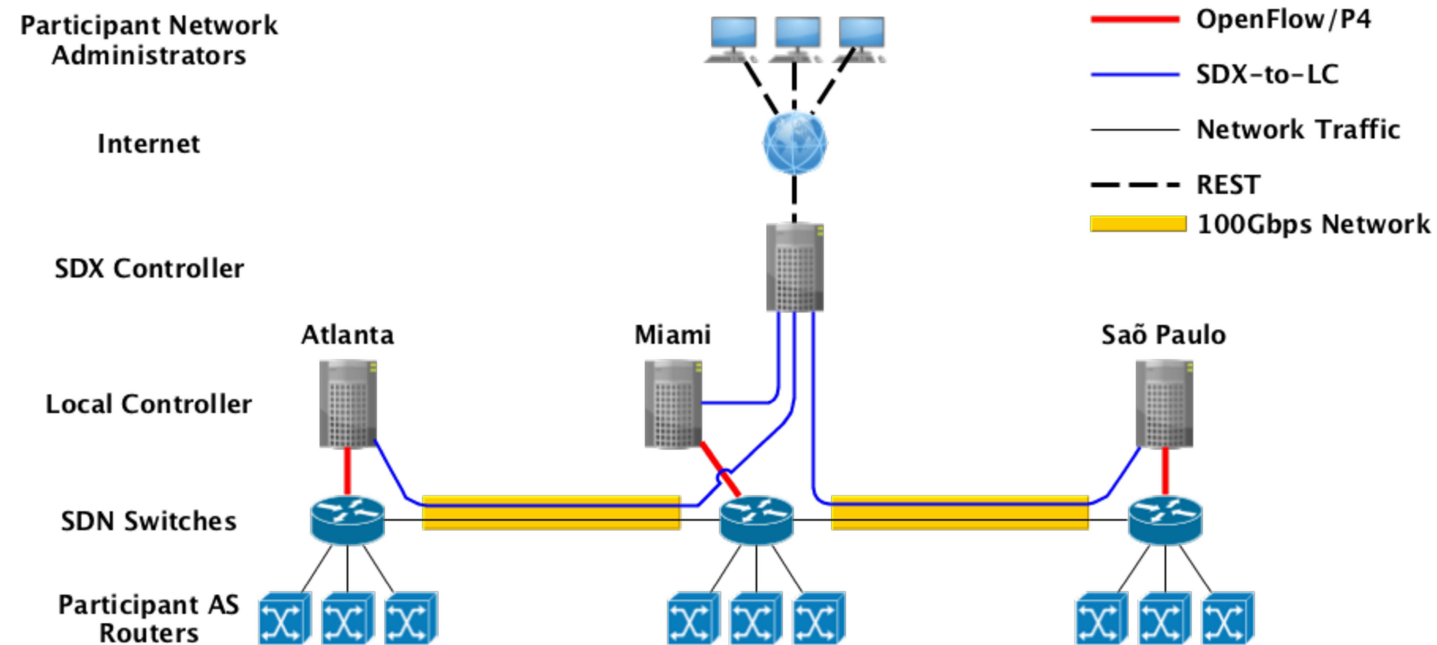
SDX Architecture Interconnecting Independent SDN Domains

- SDX controller interfaces:
 - Applications to SDX controller (e.g., science workflow manager or resource scheduler) → **Northbound**
 - Controller to SDN participant domains (match SDN northbound interface) → **Southbound**
 - Between SDX controllers → **West/East**
- SDX controller functions:
 - Resource management
 - Path computation
 - Resource provisioning



SDX Use Case: Experimenter Accessing Distributed Content

- Content is hosted in several locations
- Using an SDX provided user interface, an experimenter requests desired content
- The SDX will locate the closest content
- Next, the SDX provisions a network path between the content and the experimenter
 - If the path to the closest content is congested, the SDX can negotiate a new path to a more distant repository, but with less congestion
- Upon conclusion of the experiment, the network path is deallocated, and network resources are restored



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- Feamster, N., et al., “The Road to SDN: An Intellectual History of Programmable Networks”, ACM SIGCOMM Computer Communication Review, Volume 44 Issue 2, April 2014, Pages 87-98.



A world map with a blue background, showing major cities and network connections. Cities labeled include Los Angeles, New York, Miami, Panama, Santiago, Sao Paulo, Rio de Janeiro, and Luanda. Lines connect these cities, representing a global network.

THANK YOU!

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