



# Network Awareness and Virtualization Meets Cloud

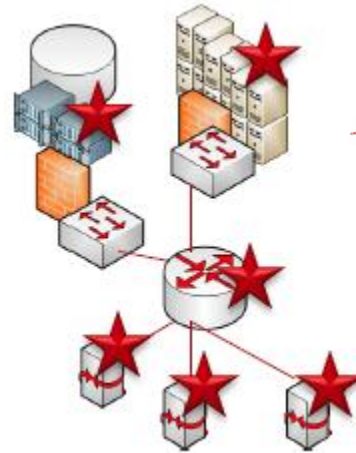
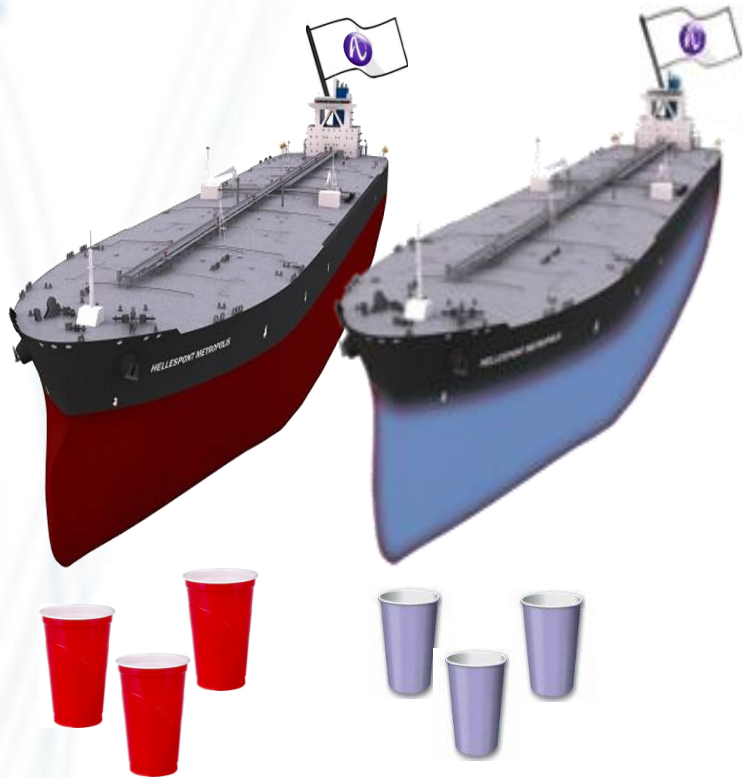
**Volker Hilt**  
**Bell Labs/Alcatel-Lucent**




# CUSTOMER STORIES



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I want a network which is elastic, that scales with my business, software definable and on-demand

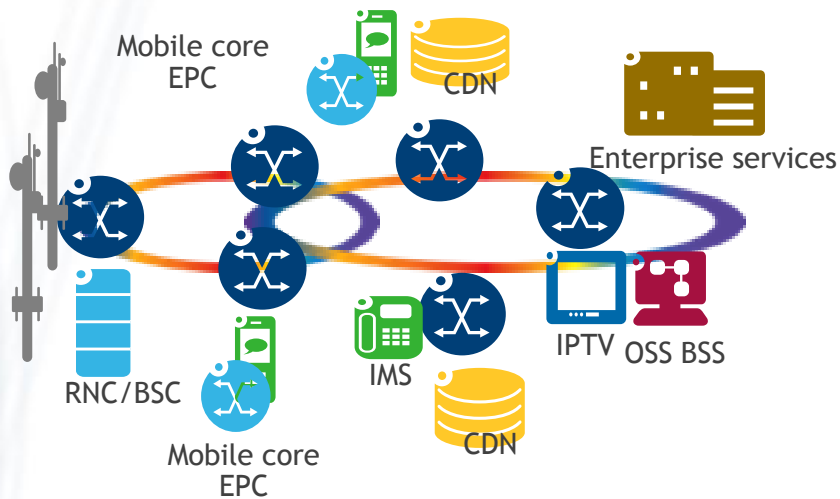
- John Donovan – COO AT&T 

Google has 1000 devices in spare parts inventory, a Telecom Provider has 50,000 Trained personnel needed to maintain all the different boxes  
For mobile and for fixed network

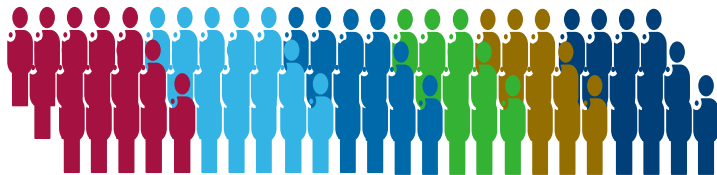
# NETWORK FUNCTION VIRTUALIZATION

## MOVING NETWORK FUNCTIONALITY TO THE CLOUD

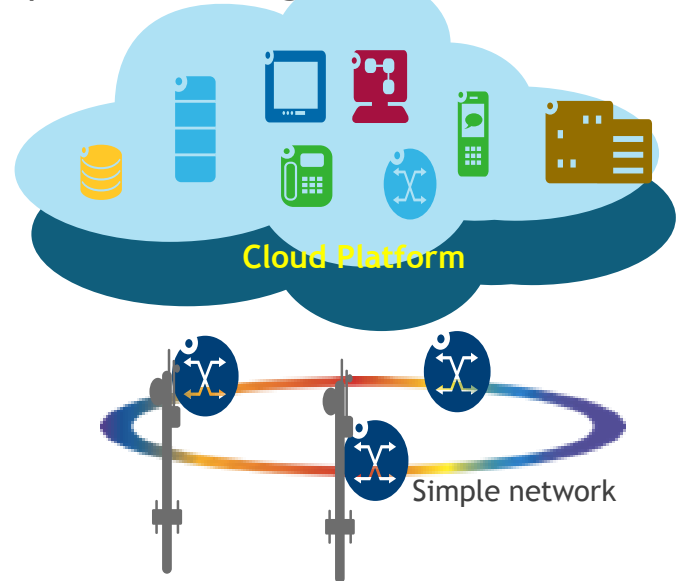
### Legacy Service Provider



Operational resource



### Virtualized Service Provider



Operational resource

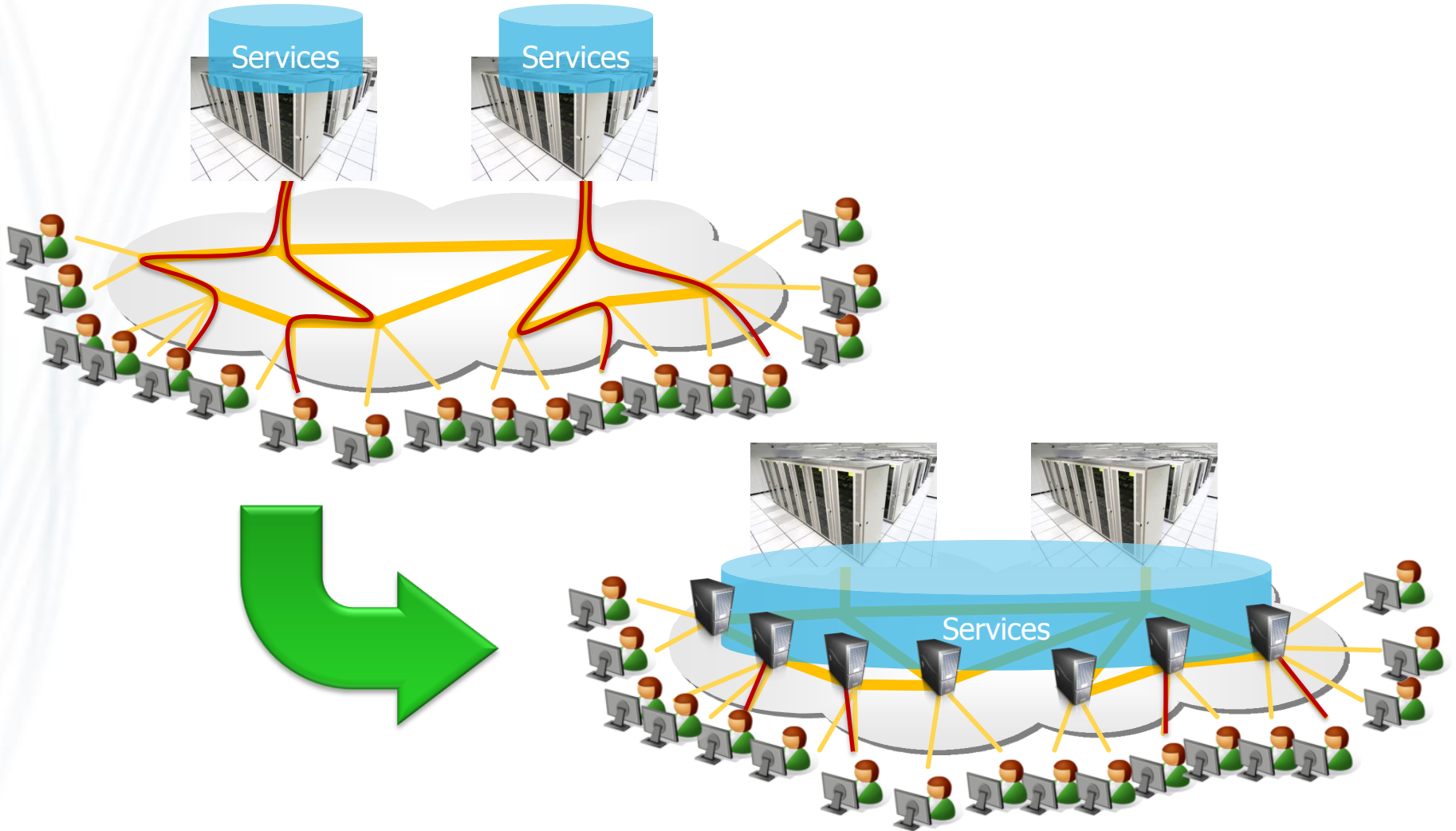


# The World Is My Data Center



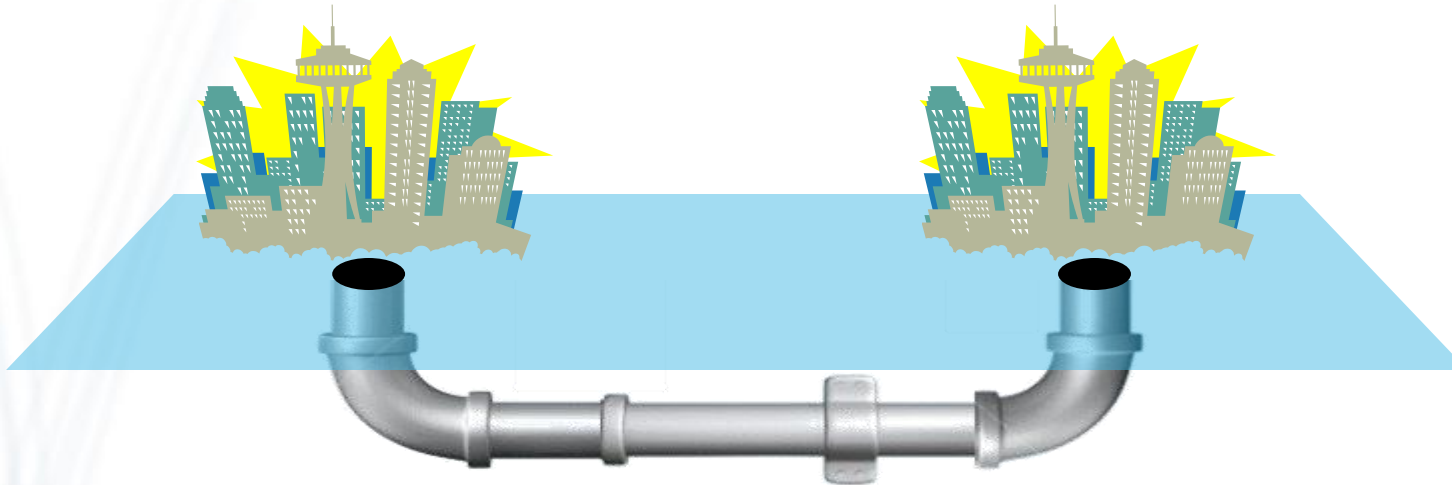
# TOWARDS TOMORROW'S CLOUDS

## FROM CENTRALIZED TO DISTRIBUTED CLOUDS

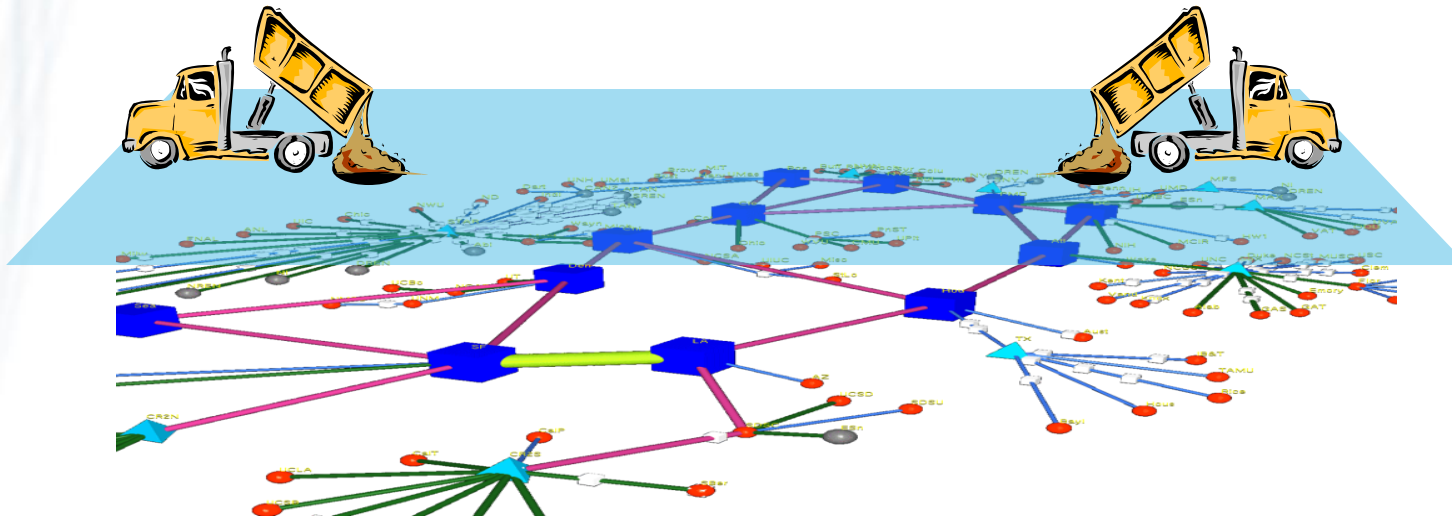


# CHALLENGE: TWO DIFFERENT WORLD VIEWS

## APPLICATIONS VS. NETWORK



Application View

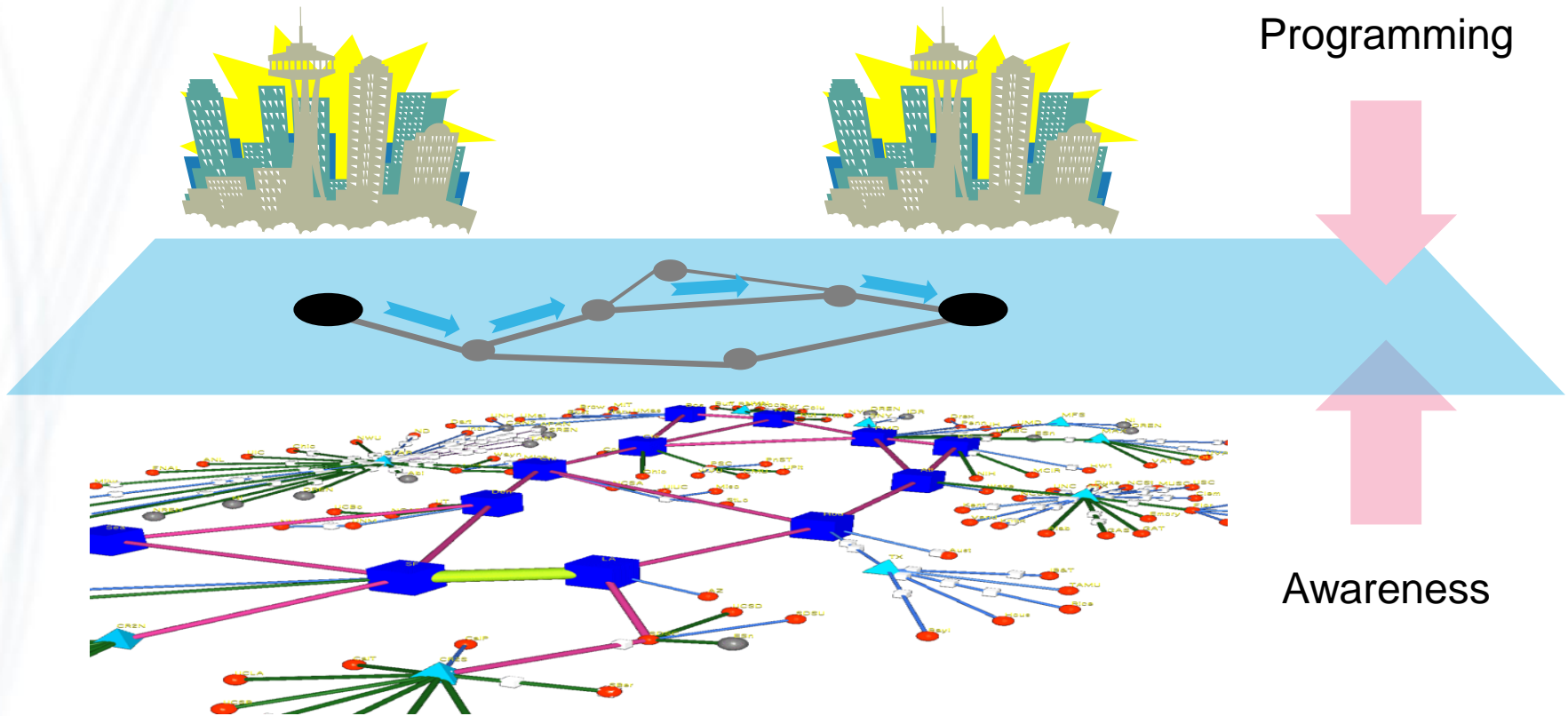


Network View



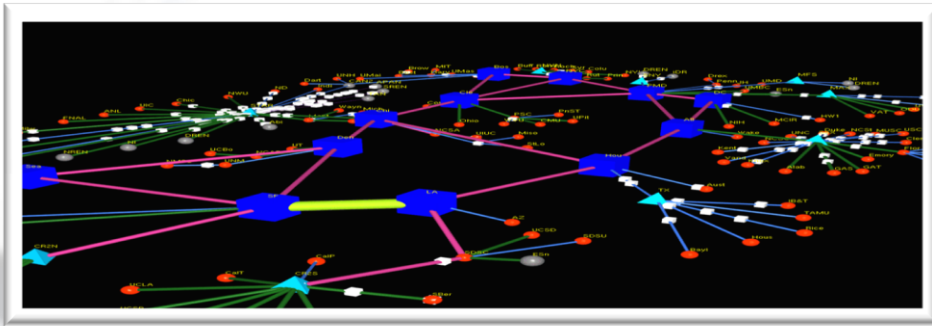
# THE NETWORKED CLOUD

## OVERCOMING THE NETWORK/APPLICATION GAP



# NETWORK AWARENESS

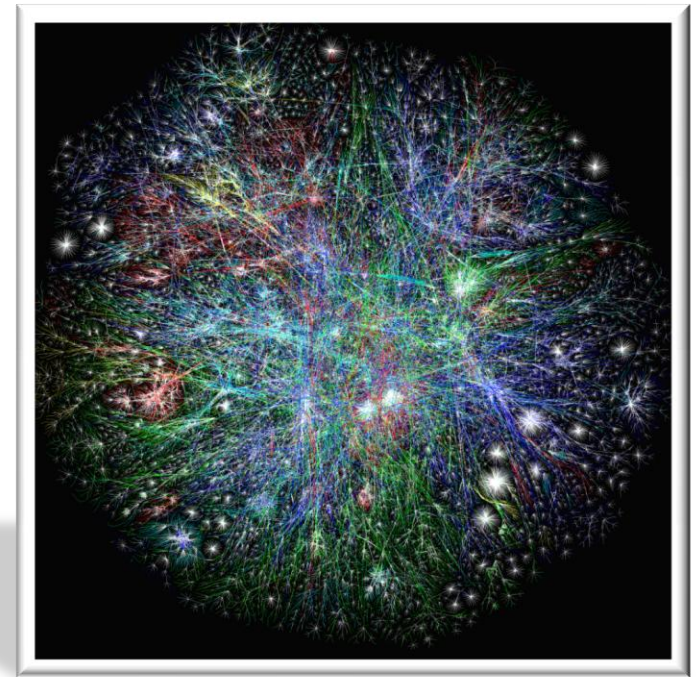
## WHY ARE NETWORKS HARD TO SEE?



Infrastructure Complexity



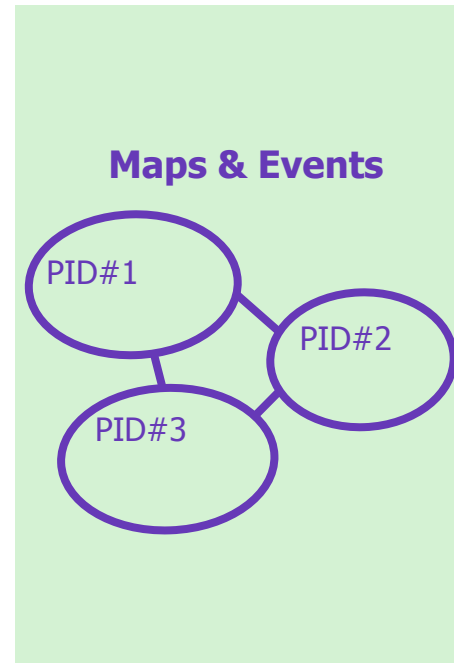
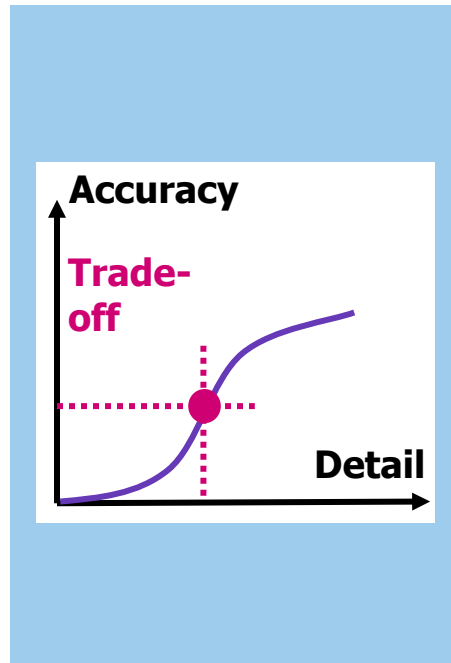
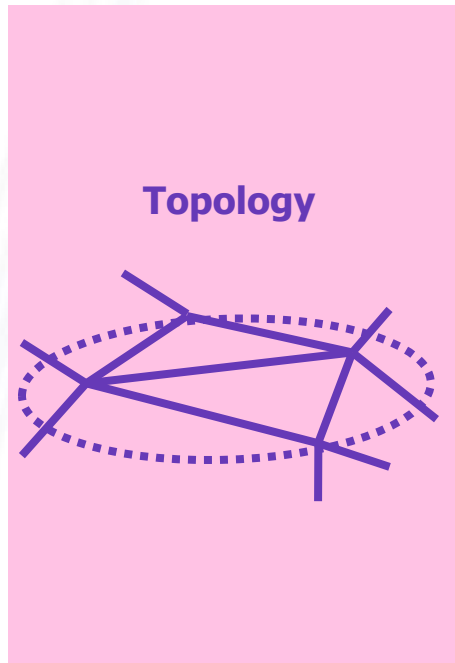
Policy



Measurement Data Volume\*

# EXPOSING NETWORK STATE

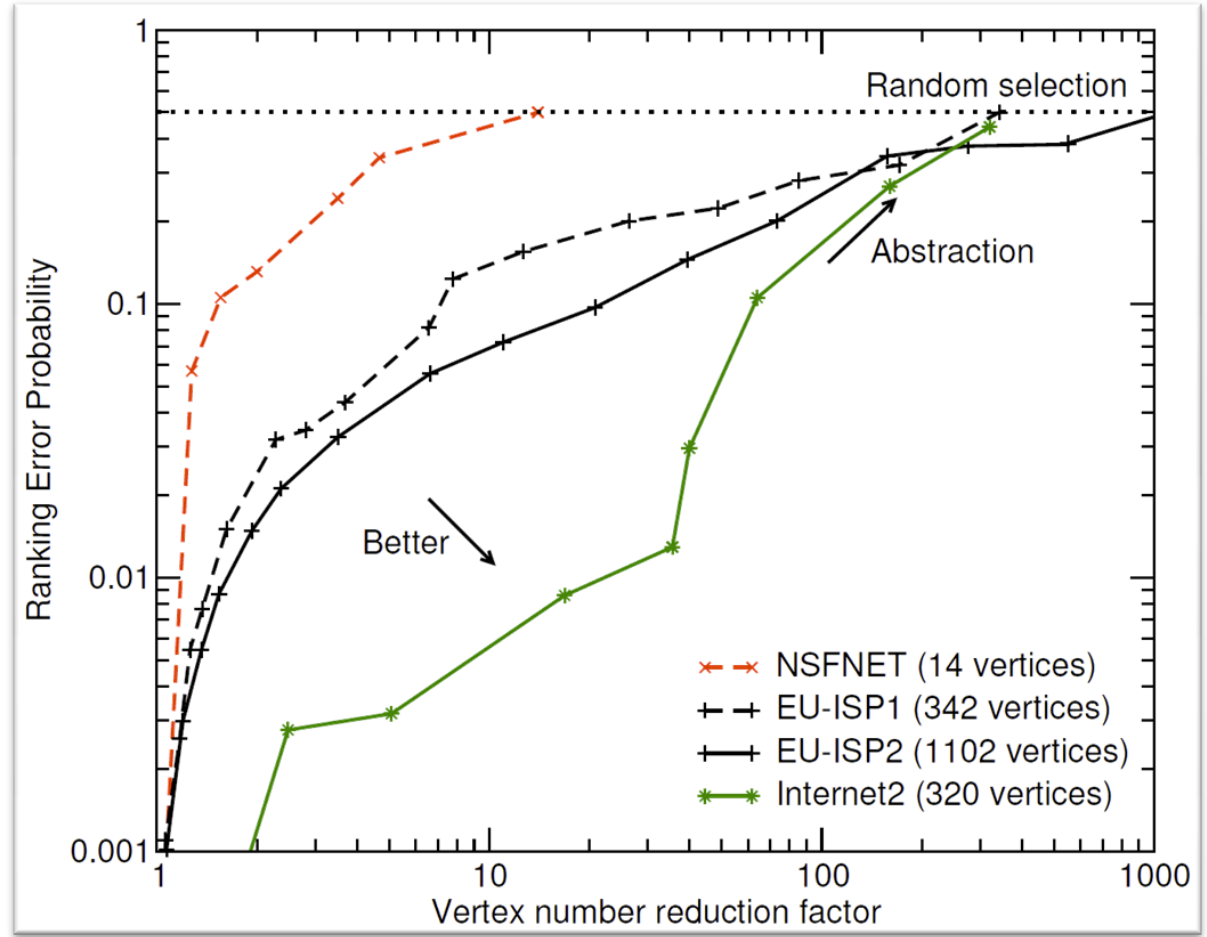
## KEY PROCESSING STEPS



# TOPOLOGY ABSTRACTION AT THE RIGHT LEVEL OF DETAIL

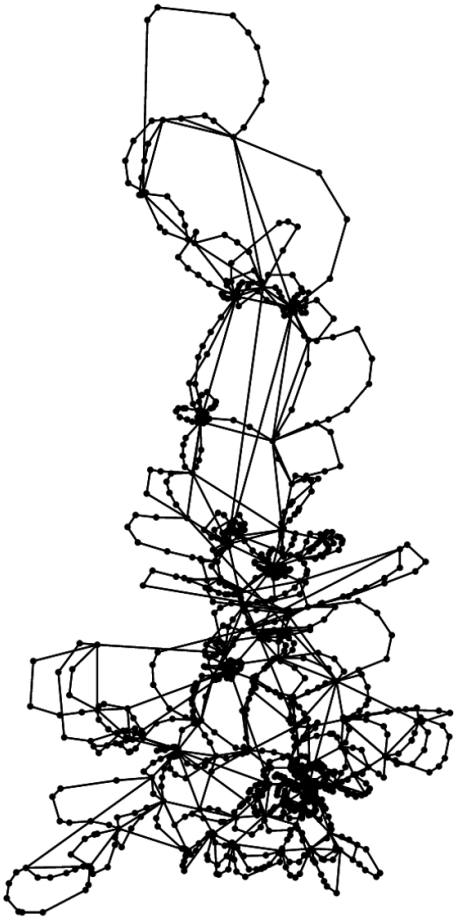
EU-ISP2	Nodes	MB
Original	1103	20
Abstraction	225	0,8
Reduction	80%	96%

Example Topology

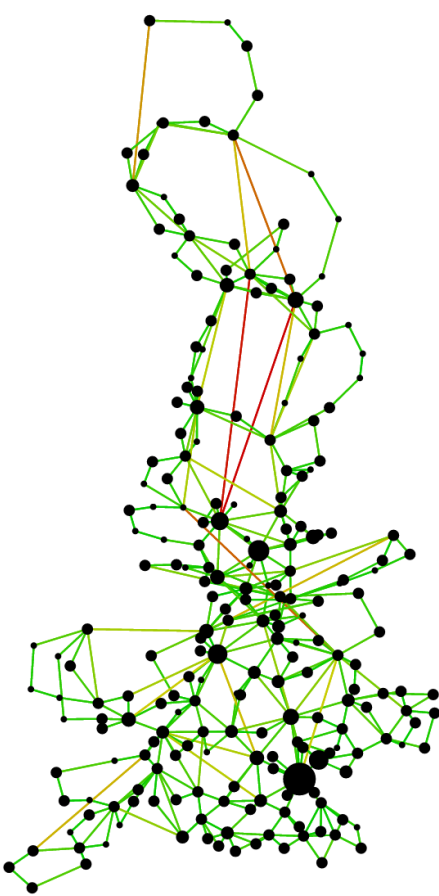


# TOPOLOGY ABSTRACTION

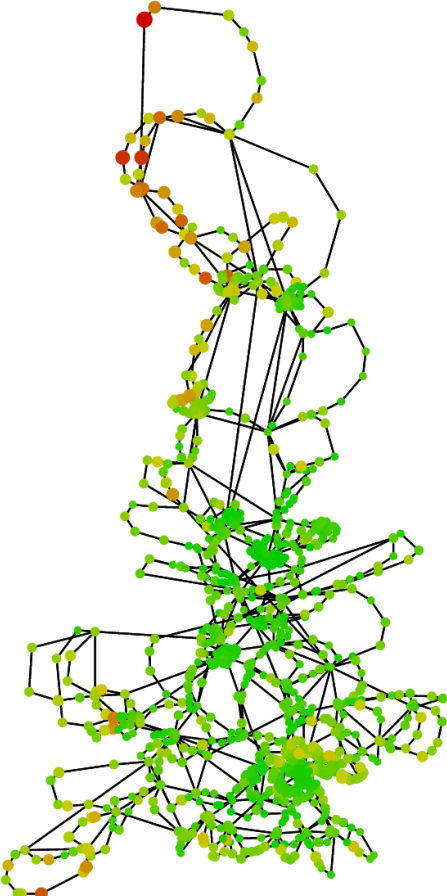
## EXAMPLE GRAPHS



Original



Abstraction



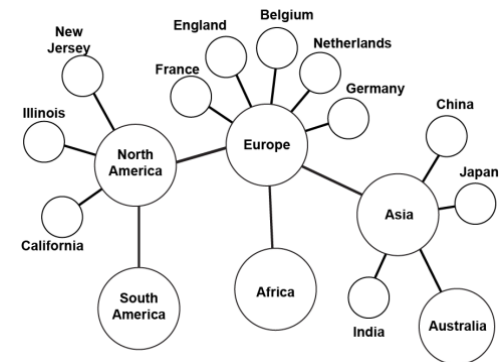
Penalty

# NETWORK TOPOLOGY INTERFACE

## HOW TO TALK TO AN APPLICATION?

### Application-Layer Traffic Optimization (ALTO)

- IETF standard network/application interface
- Enables network-aware selection of resources from a candidate set
- Format for topology & cost maps
- No specification of topology abstraction algorithms or information sources
- RESTful protocol based on HTTP/Json
- Initially focused on localizing P2P traffic but evolving towards CDN and Cloud use cases



# NETWORK TOPOLOGY INTERFACE

## EVOLVING ALTO TOWARDS CDN/CLOUD

ALTO extensions for new use cases

- Content Delivery Networks (CDNs)
- Data centers and clouds

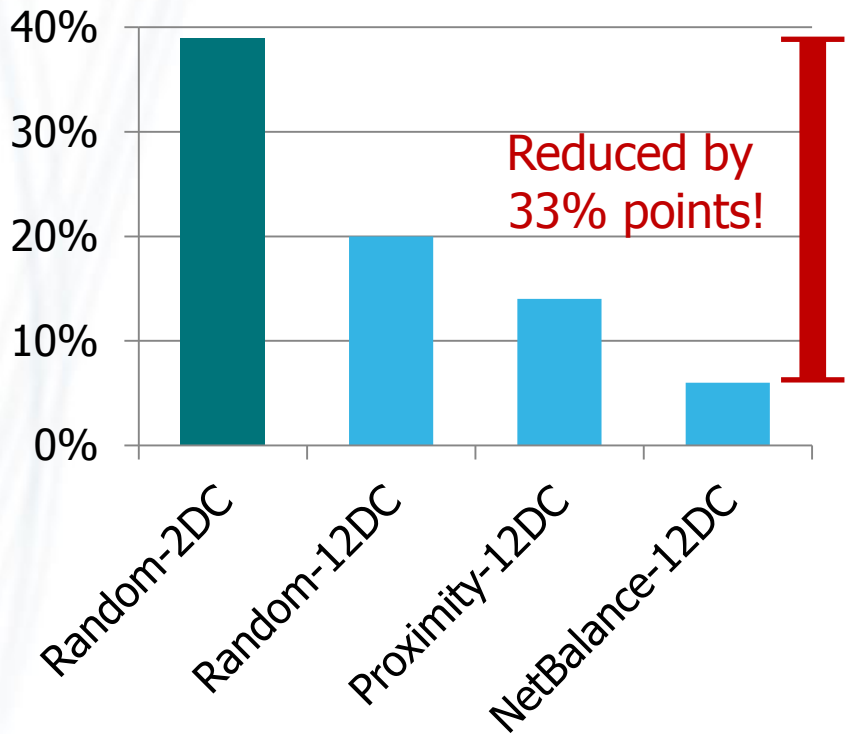
### ALTO Evolution in the IETF

CDN/cloud requirement	Internet-Draft
The Virtual Private Network (VPN) Service in ALTO: Use Cases, Requirements and Extensions	draft-scharf-alto-vpn-service
Scalable, incremental updates for dynamic data	draft-schwan-alto-incr-updates
Time scheduling for data center workload patterns	draft-randriamasy-alto-cost-schedule
Efficient maps for multiple costs (e.g., network+CPU)	draft-randriamasy-alto-multi-cost

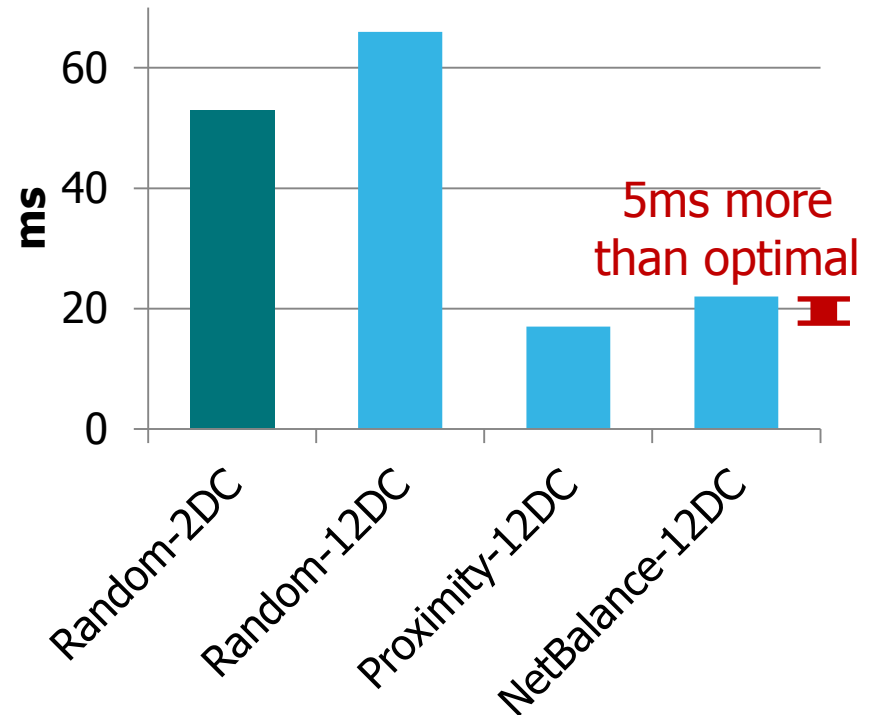
# NETWORK-AWARE SERVICES

## WHY UNDERSTANDING TOPOLOGY MATTERS

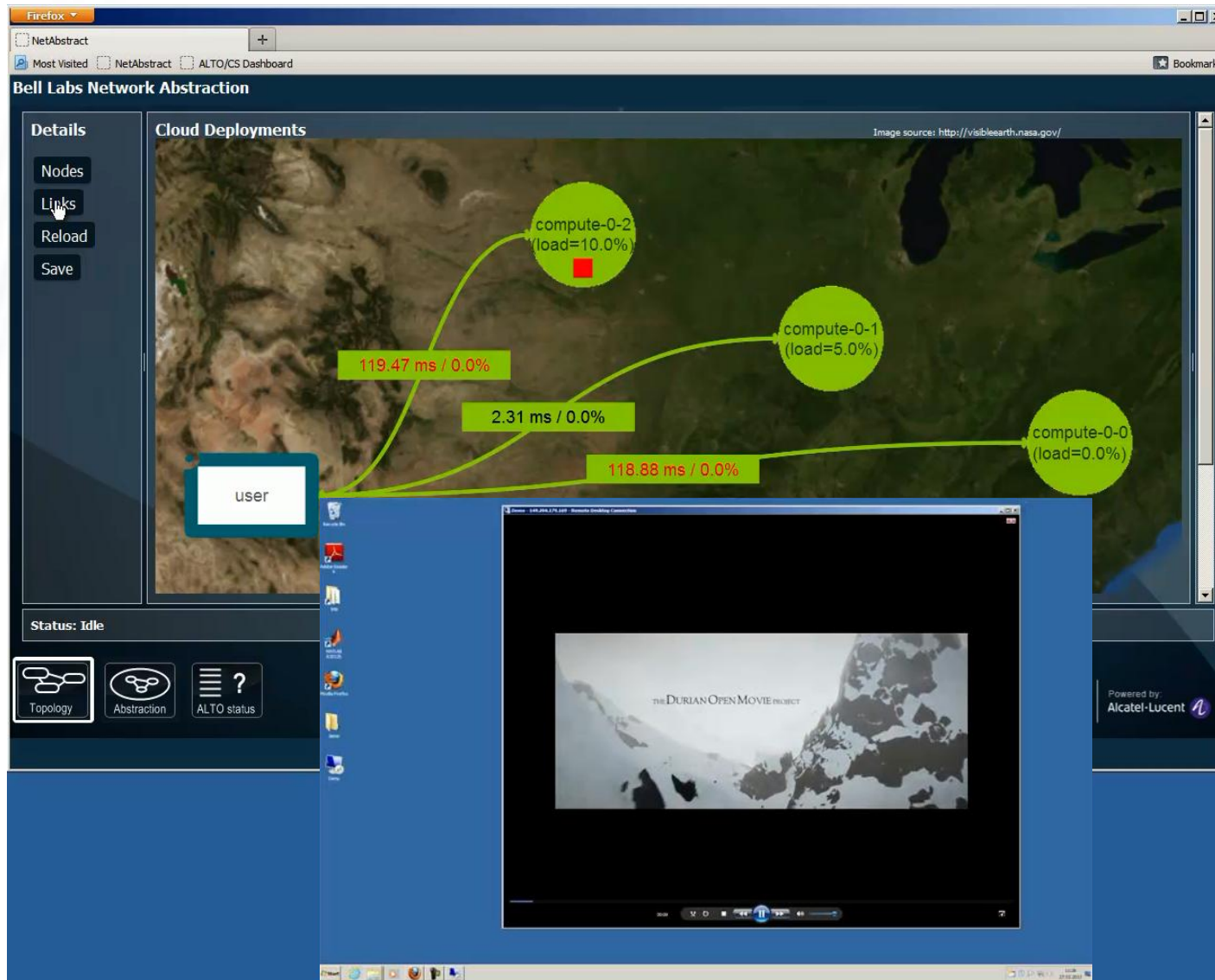
### Maximum Link Utilization



### Average Delay



# WHY SHOULD USERS CARE?



# MANAGING CONNECTIVITY FOR CLOUD SERVICES

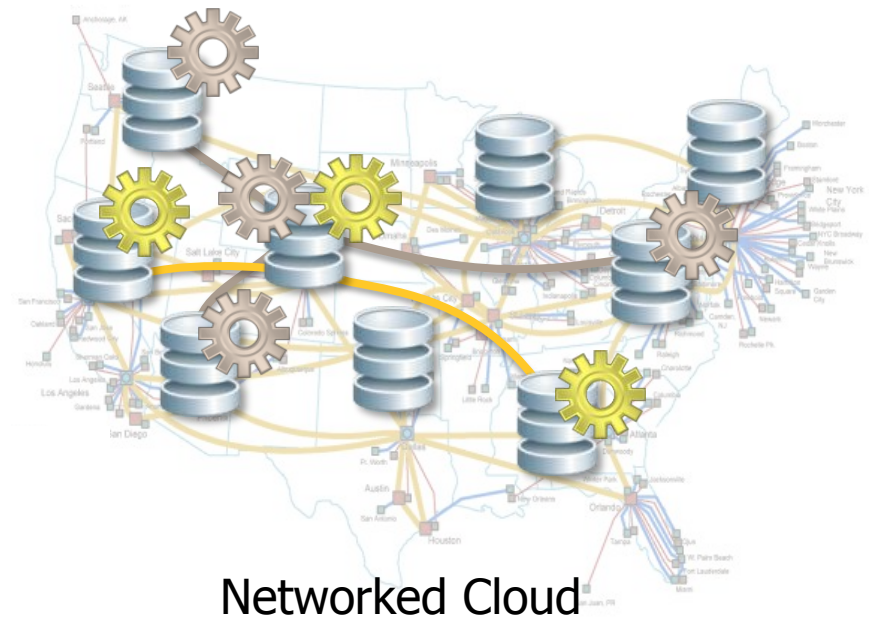
## BEYOND OBSERVING NETWORK STATUS

Data Centers host large number of tenants

- Synchronized delivery of network and compute resources
- Isolate service traffic
- Quality of experience

Current solutions have limitations

- Decoupled management of network and services
- VPNs: limited scalability
- Access Control Lists: limited mobility

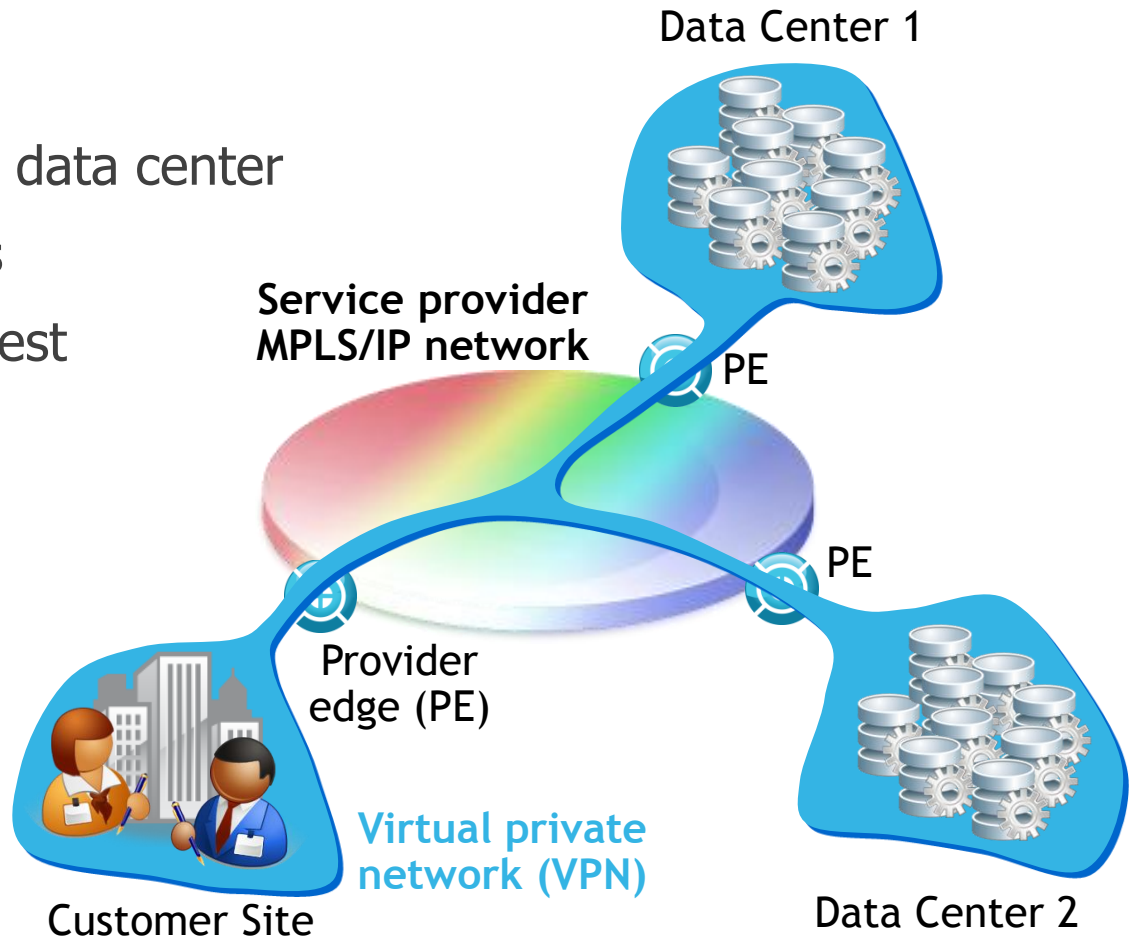


# NETWORK-AWARE VPN OPTIMIZATION

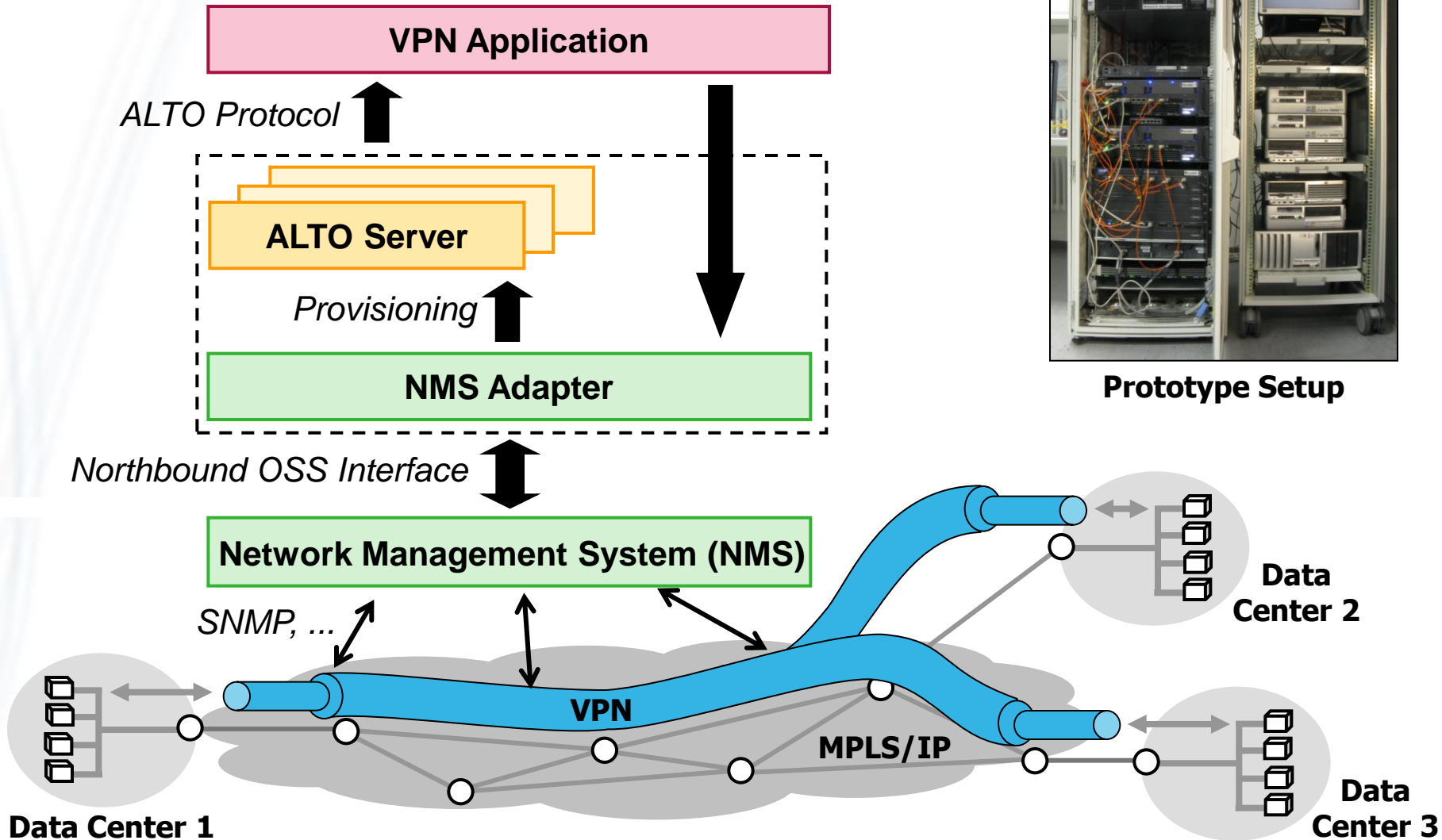
## JOINT MANAGEMENT OF NETWORKS AND SERVICES

### Example: Cloud Bursting

- Grow service to additional data center
- Extend VPN and start VMs
- Select site that provides best performance.



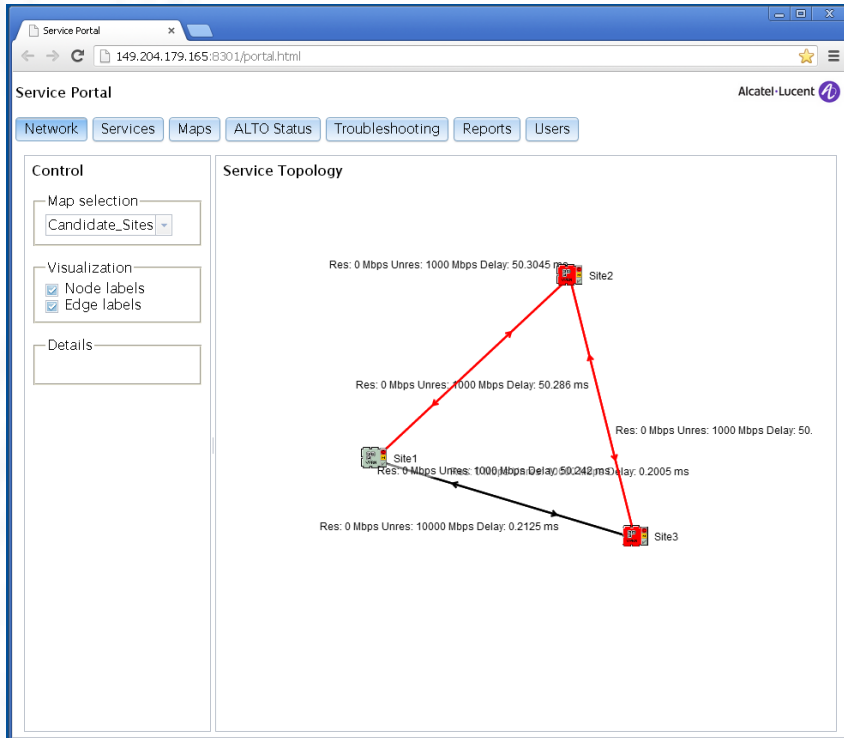
# PROTOTYPE



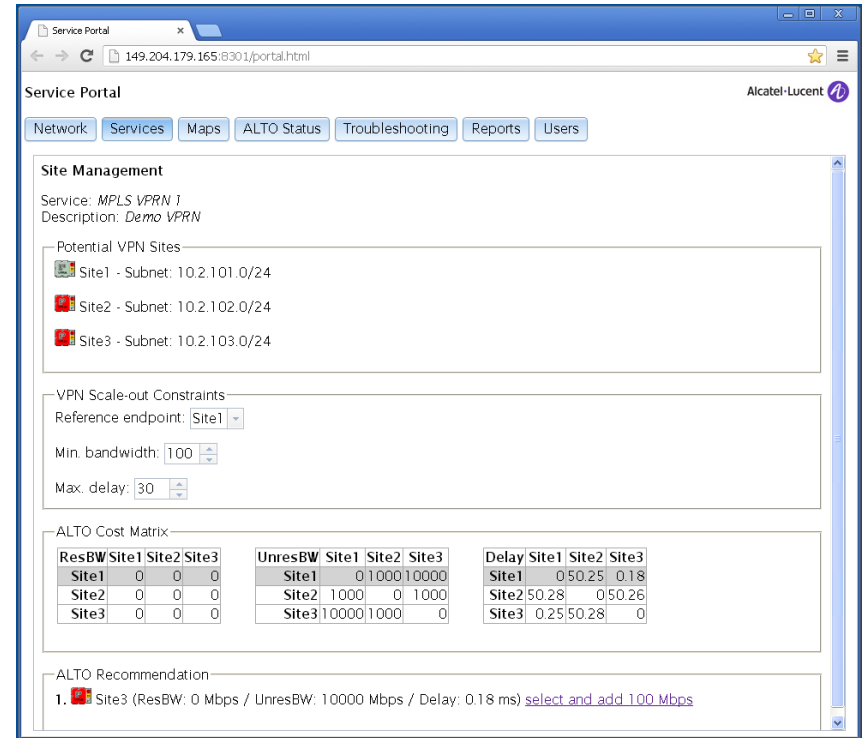
# PROTOTYPE

## SELF-SERVICE PORTAL FOR CONNECTIVITY MANAGEMENT

### VPN topology view

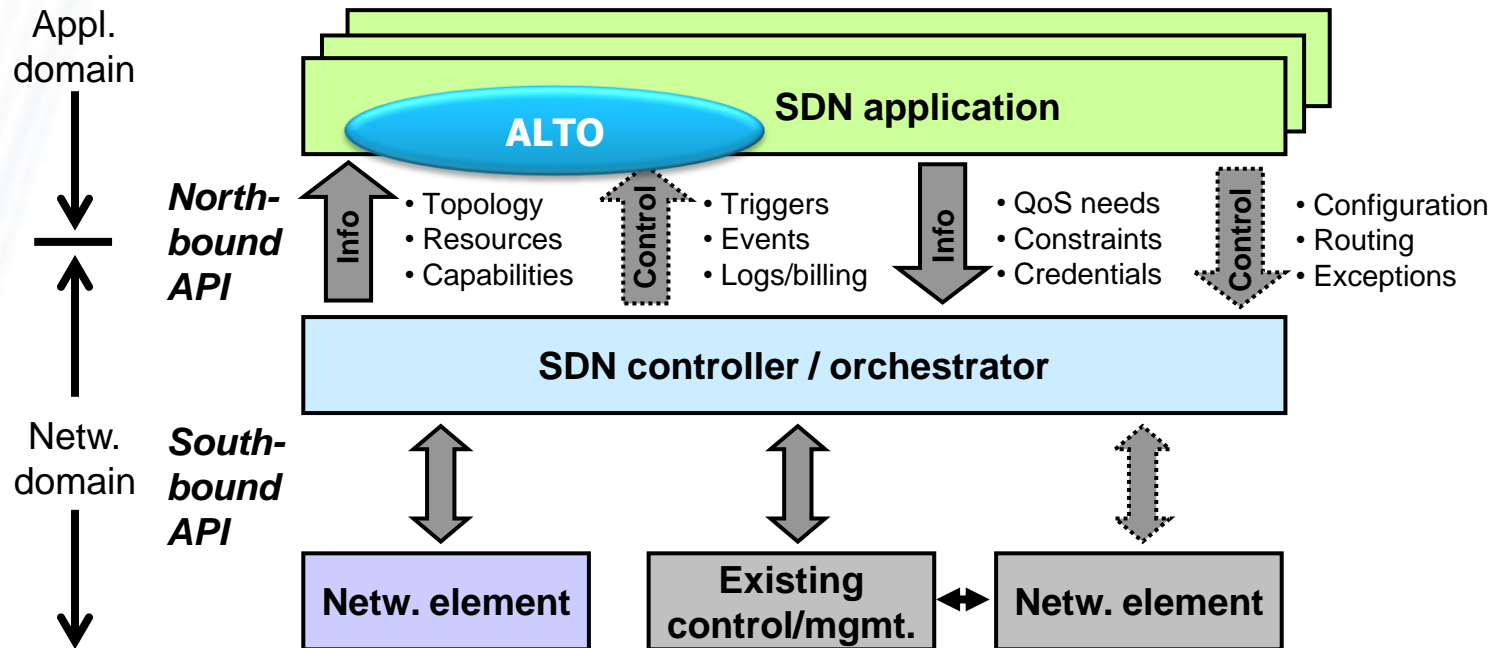


### Constraint-based scale-out



# NETWORK-AWARENESS AND VIRTUALIZATION

## UNDERSTANDING AND CHANGING NETWORK SERVICES



Software-Defined Networks (SDN) and ALTO concepts provide network-awareness and programmability

# CONCLUSION

- Expand the principles of cloud computing to new domains
  - Service providers are interested in Network Function Virtualization
- Network-oriented services require
  - Understanding of network state
  - Management of connectivity within and across data centers
- Bell Labs and the research community are addressing these issues
  - ALTO: industry standard providing network-awareness for services
  - Joint management of network and services
  - SDN: tailoring networks to meet service needs

