DARPA CORONET Program: Dynamic Networking Progress and Challenges

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The support of the DARPA CORONET Program, Contract N00173-08-C-2011 and the U. S. Army RDE Contracting is gratefully acknowledged

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CORONET
Dynamic MultiTerabit Core Optical Networks

A multi-year DARPA-funded program to enable

Dynamic network: Fast provisioning of packet and circuit Bandwidth on Demand services in 20-100 Tbps networks

High Network Resiliency: Fast restoration and recovery against up to 3 network failures

Capacity efficiency

Focus on commercial carrier environments

Program status:

Participants:

ACS (Telcordia), AT&T, IBM, Nortel, USC, Verizon, (other equipment suppliers…)

Final phase: Laboratory Testbed demonstrations of BoD for Cloud Applications

Technology transition to govt and standards

"Network Architectures and Protocols for Capacity Efficient Highly Dynamic and Highly Resilient Core Networks" JOCN Invited Paper 2012

"Network design and architectures for highly dynamic next-generation IP-over-optical long distance networks," Journal of LightwaveTechnology, Invited Paper (2009)

" CORONET: Testbeds, Cloud Computing, and Lessons Learned" A. Von Lehmen et al Invited Talk (OFC 2014)

" Using SDN Technology to Enable Cost-effective Bandwidth-on-Demand for Cloud Services" R. Doverspike et al Invited Talk (OFC 2014)

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CORONET Services

IP Services (75%)

- *Static tunnel routing but flexible use of tunnel bandwidth for fast provisioning*
- *Optical bypass to lower network costs*
- *MPLS TE yields extremely efficient IP network design*

Dynamic services are ~30% of total traffic

- *Call/connection setup rate: ~ a few/second*
- *Bandwidth requests span orders of magnitude (**100 Mbps -> 800 Gbps**)*
- *Holding times of **1 second to several hours***
- ***Stringent performance requirements** (setup times, blocking, QoS**)***
- ***Aggressive restoration** requirements (~100 ms, 1-3 failures)*
- *Requirement for **capacity efficiency/cost containment***

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CORONET Transport Services

- Designed for extremely fast connection setup in a high churn network environment

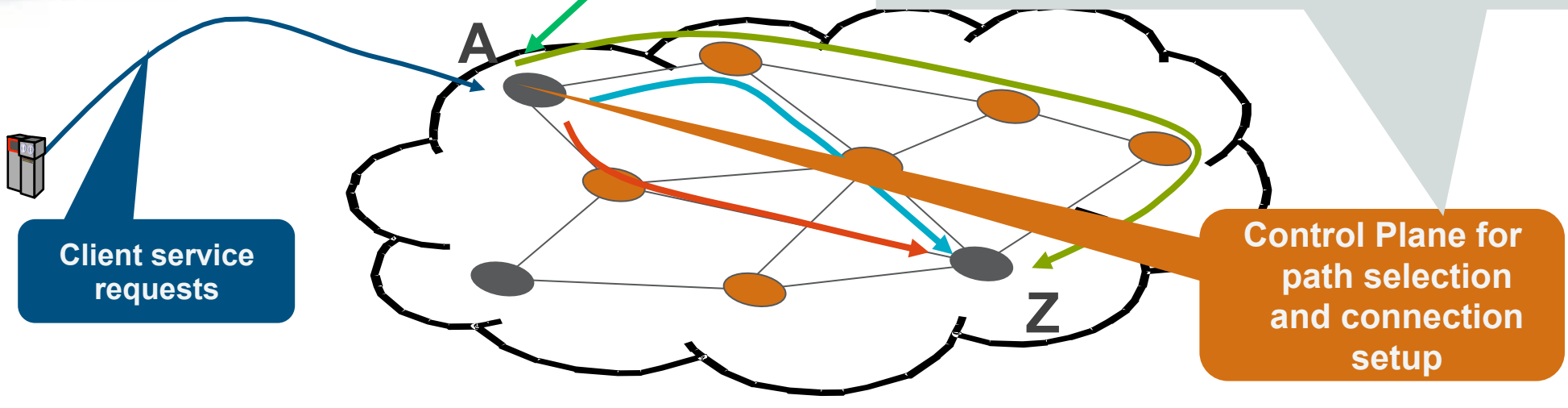
- Combines an enhanced PCE/SDN Controller with real time resource probing and path selection in a Control Plane

- Calculate candidate and restoration paths
- Export candidate paths to nodes
- *Offline process* – with periodic updates

PCE/ ControllerPath Computation

3-Way Handshake Protocol (3WHS)

- ***Probing of multiple fiber paths to get network state***
- ***Path selection/optimization done at Z-end***
- ***Fit w/ GMPLS framework***



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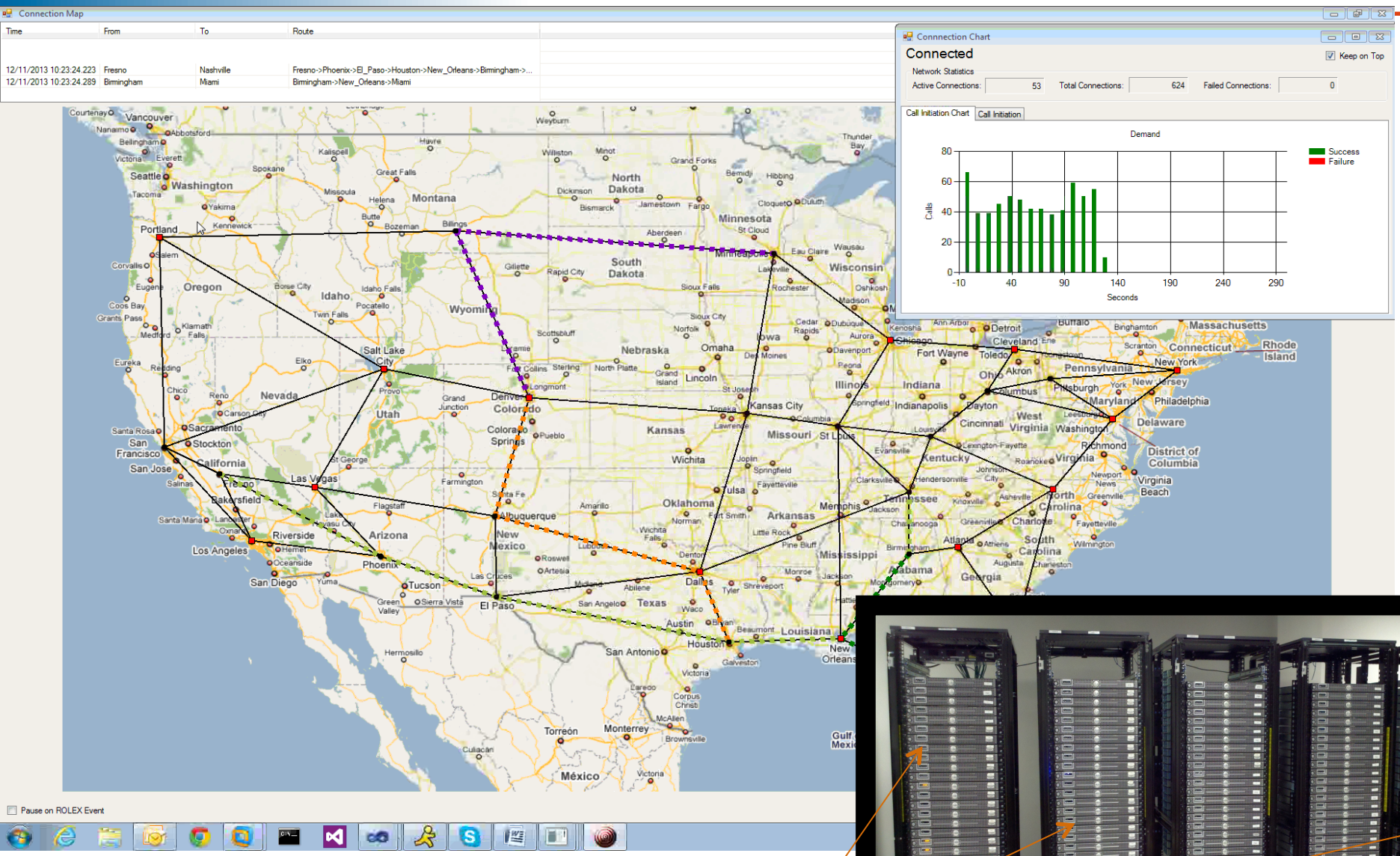
CORONET BoD Emulation Testbed
100 nodes, 6 PCEs; 20-100 Tbps

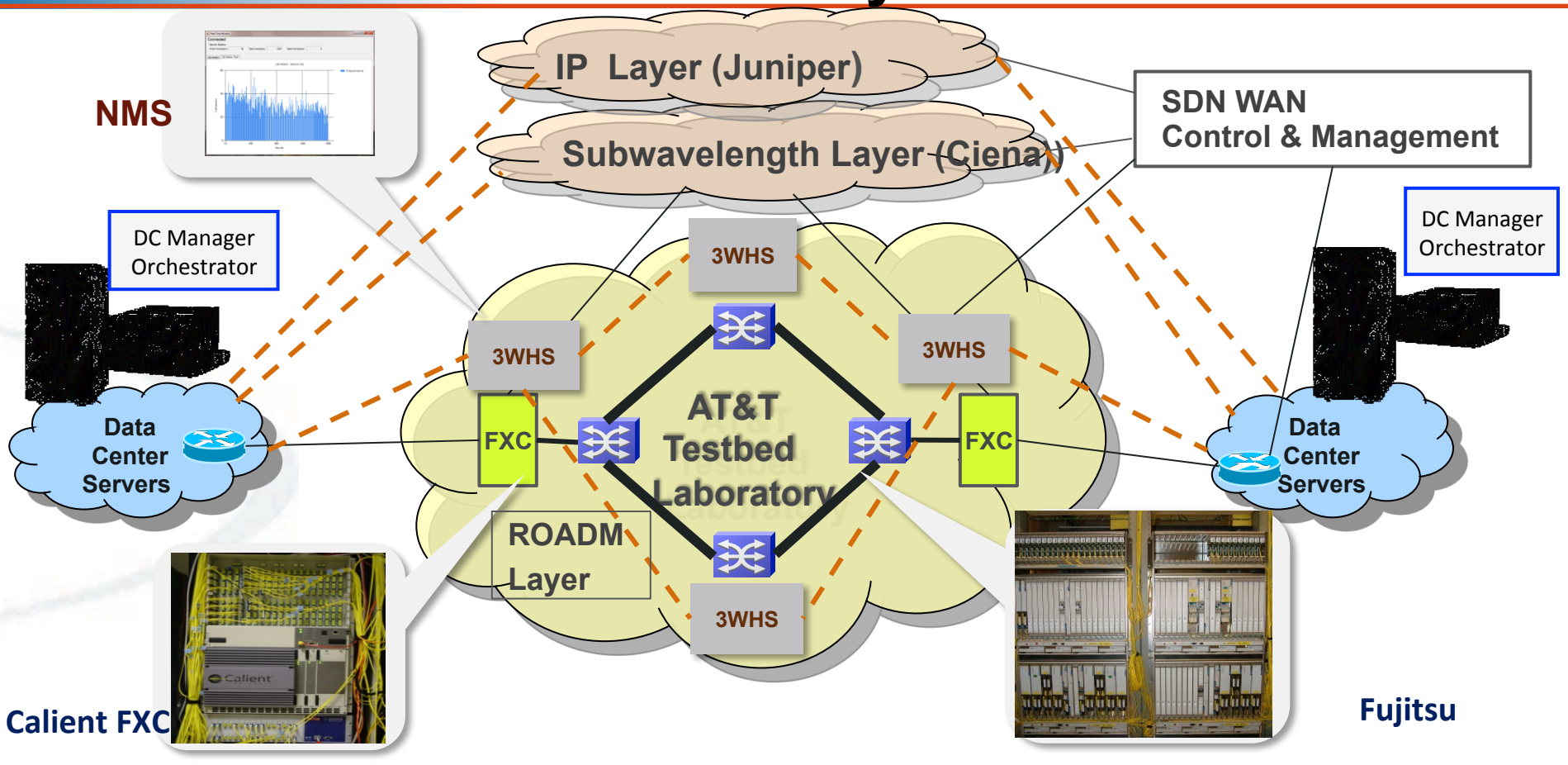


New York

San Francisco

Hong Kong

CORONET Bandwidth-on-Demand Laboratory Testbed



Multi-layer network with commercial equipment
CORONET protocols implemented on transport layer equipment
Cloud application triggers deployment of VM across network
Choice of network layer is transparent to the application

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Summary

- CORONET program focuses on an aggressive “use case”
  - Highly dynamic multi-layer, multi-service, multi Tbps global scale network
  - Stringent performance, restoration and QoS requirements
  - Efficient/cost effective network design

- *Asynchronous use* of PCE/Controller combined with multi-path probing protocol for provisioning circuit services enables
  - Rapid provisioning with low blocking in a high churn environment
  - Resilient to network failures, or loss of PCE connectivity
  - Extension to multi-domain networks
    - Minimal performance penalty, can preserve domain confidentiality

- Challenges
  - Multilayer operation
  - Approaches that scale (network, traffic, apps)
  - Capacity management
  - Resiliency

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Thank you!

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