IP/MPLS Network Planning, Design, Simulation, Audit and Management

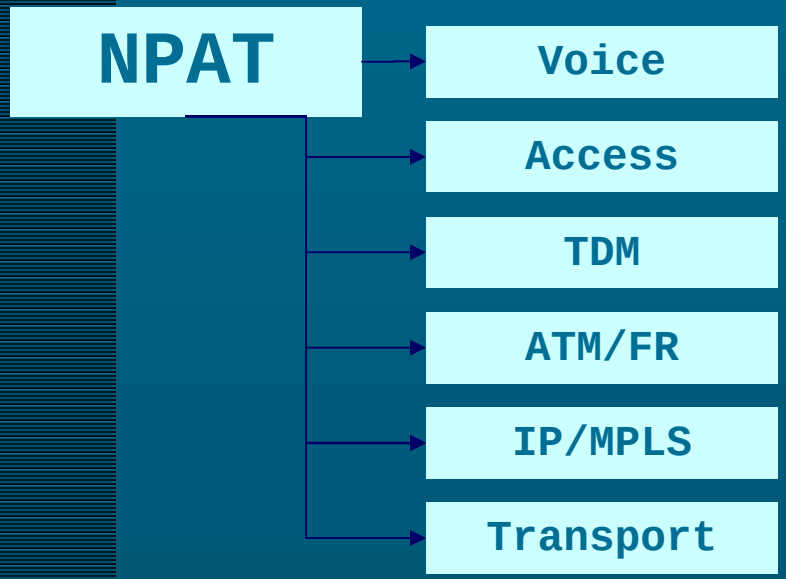
Dave Wang, WANDL

WANDL Overview

- Founded in 1986
- Headquarters in Piscataway, New Jersey
- Products: NPAT, IP/MPLSView,VPNView
- Locations
  - Domestic
    - New Jersey, Washington D.C., Illinois, California
  - International
    - United Kingdom, Belgium, Italy, Taiwan, China

WANDL Software Solutions

WANDL Network Planning Design & Optimisation



WANDL IP/MPLS Network Audit & Management

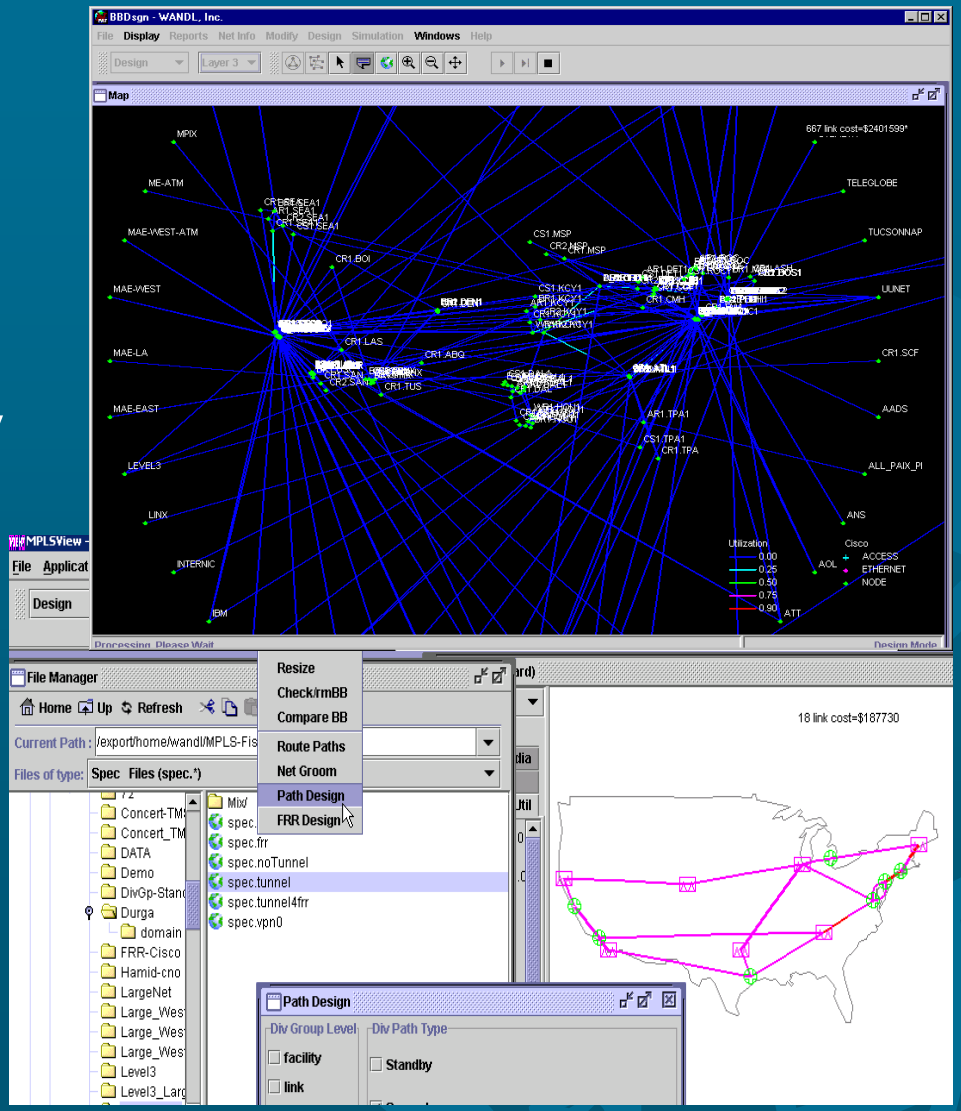
IP/MPLSView

Live Network Management

VPNView

WANDL Core Capabilities

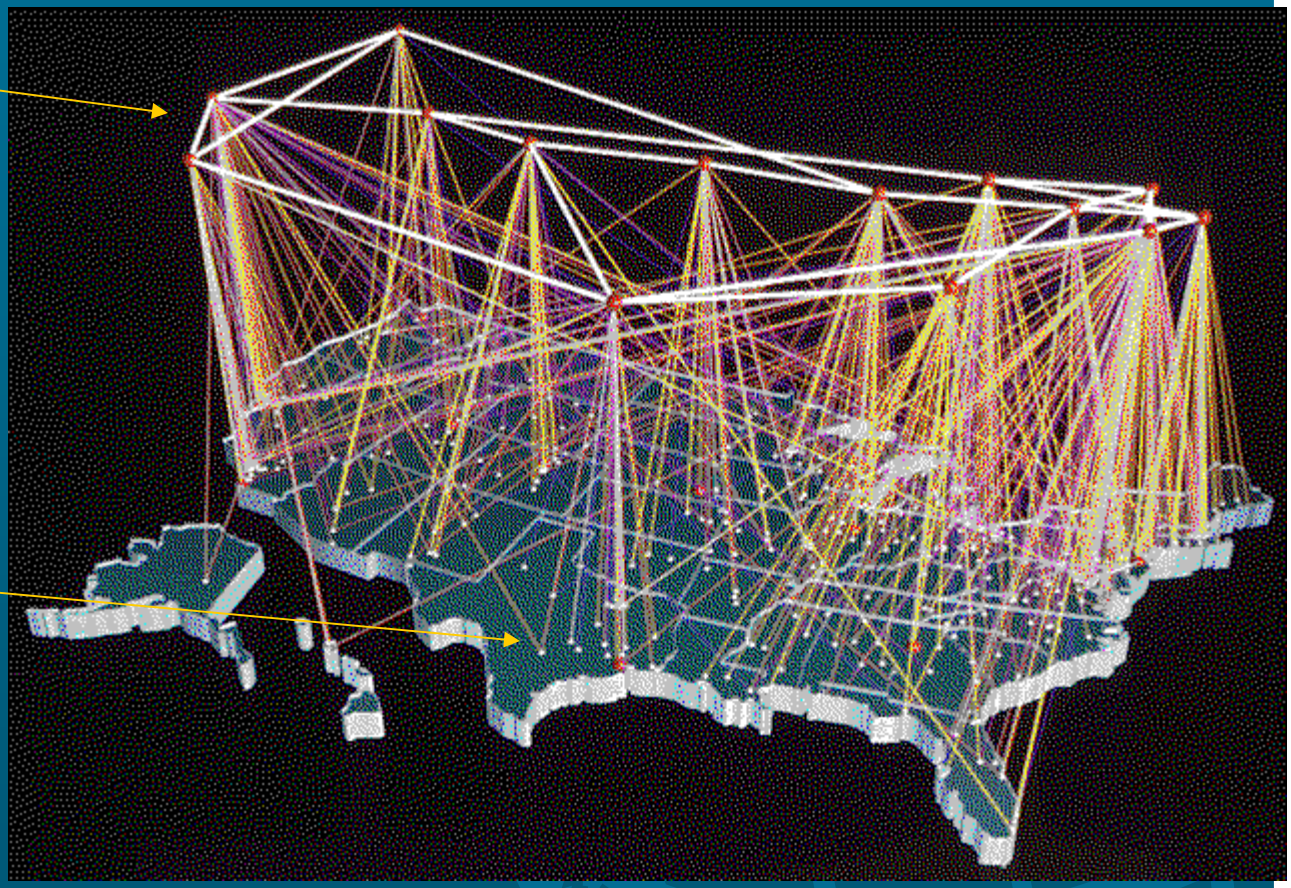
- Routing Analysis
  - Path Tracing
- Design
  - Greenfield and Diversity
- Failure Simulation
- Capacity Planning
- Optimization



Design

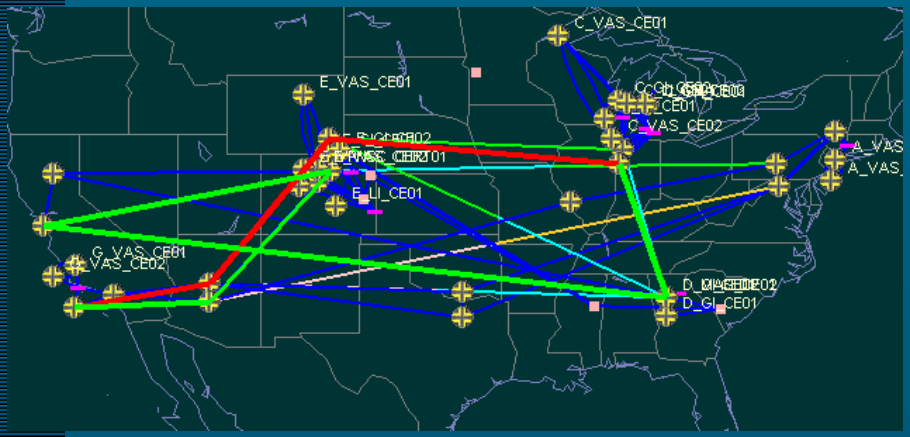
Backbone Design

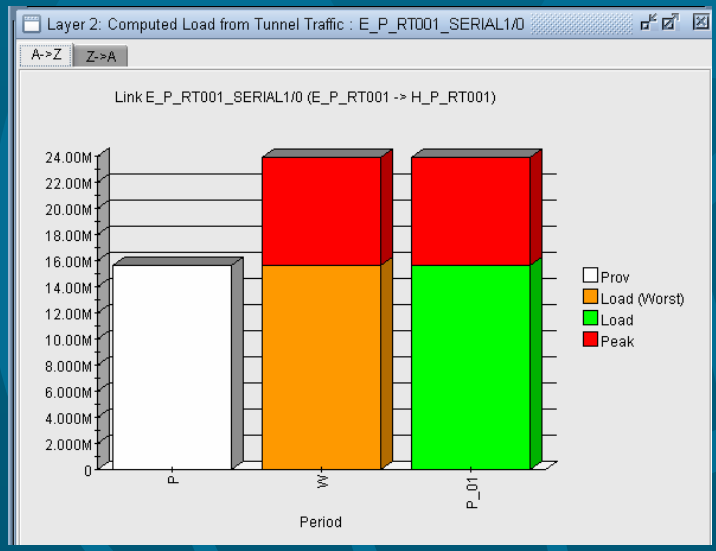
Access Design



Simulation

- Perform exhaustive failure simulation in script mode
- Verify detailed simulation results via simulation report
- Verify peak utilization for links under failure simulation to resize network (if necessary)





Capacity Planning

- Make recommendations on network expansion
  - forecasted network demands
- Determine where capacity is needed
- Determine trunks that can be pruned
- Tune link routing metrics
- Import NetFlow end-to-end traffic data
  - NetFlow v9, Arbor, cflowd, Crannog
- Guessing traffic matrix
  - if only interface traffic is available

Design Automation

- Basic or Diversity Design
- Path Computation
- Diverse Path Computation
- Network Grooming
- Fast Reroute Path Computation
- LSP Tunnel Sizing
- Metric Balancing

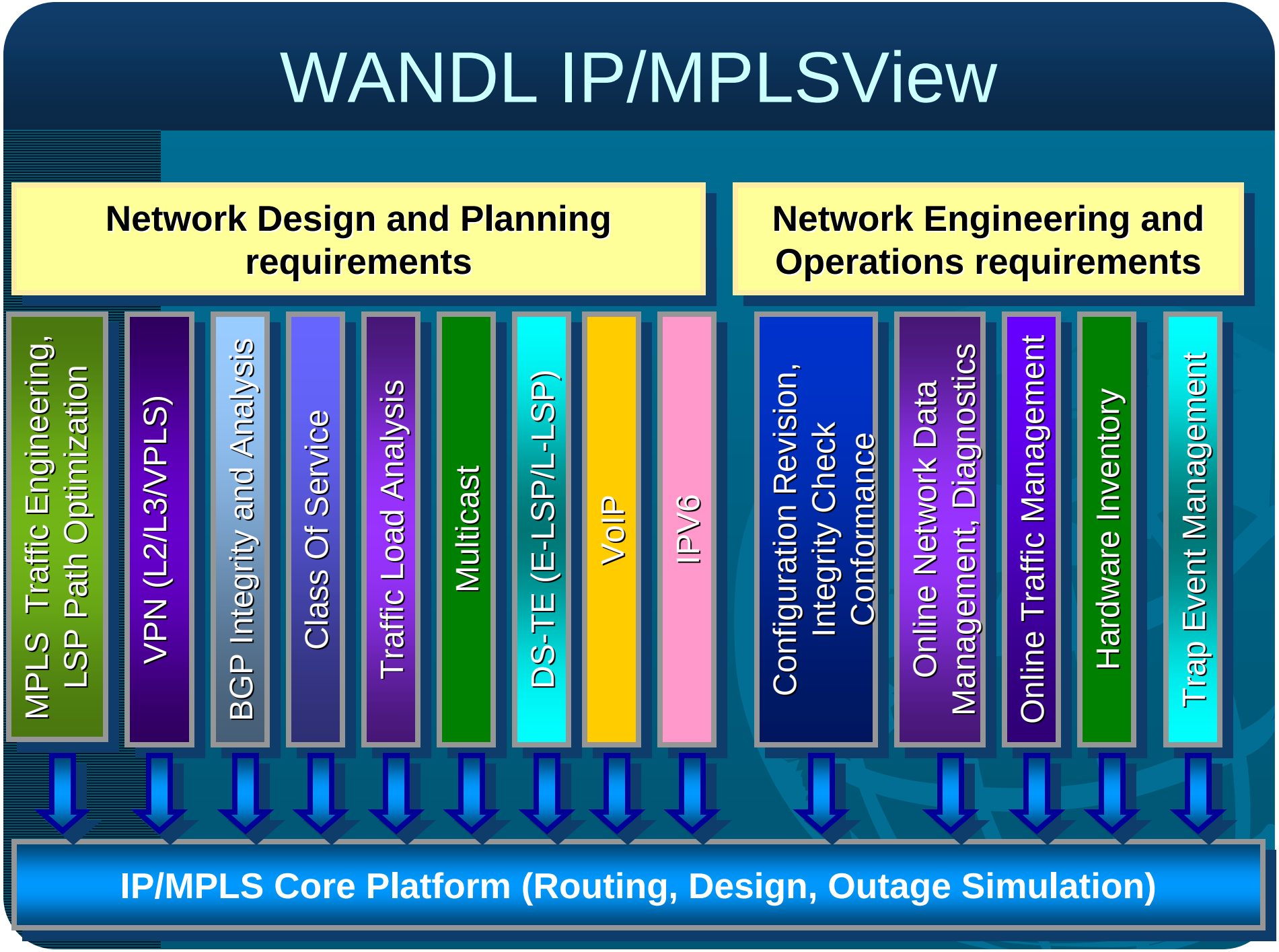
Proactive Service Audit

- Majority outages caused by human error
- Info in router configuration files
- Integrity Checks (IC) based on Config files
  - Detect human errors
  - Detect operational errors
- Intelligent IC based on routing simulation
  - Routing anomalies
  - Security and ACL reachability
  - Network element failures

IP/MPLS Management Features

- Integrated FCAPS
- Provisioning support
  - Generate VRF Configlets
  - Generate TE/FRR Configlets
- Multivendor support

WANDL IP/MPLSView



Service Provider Challenges

- Multivendor
- Multilayer
- Multiprotocol
- Multiservice

Multivendor Challenges

- Hardware Vendor

- Hardware Vendor NMS
  - 5620 SAM, IPSC, iManager, JUNOscope
- Many Service Management vendors
  - HP, IBM, Lucent, Oracle, …

Multivendor Challenges

- Language problems
- Defaults
- Inter-Op
- Versions/Features
- 3rd party NMS

Language Problems

- ATM example: PVC
  - Alcatel means 5620
  - Cisco and Lucent means SPVC
  - Marconi means Permanently nailed
- Issues for human operators
  - to deal with different terminology
- Issues for modeling software (WANDL)
  - deal with differences automatically

Language Problems

- Config files
  - Output of “show config”
  - IOS, IOX, JUNOS, …
    - Can be very similar (Command Line Interface)
    - Can be very different (languages)
  - Interfaces
  - Protocols
  - Routing, routing, routing, …

Language Problems

- Same meaning
  - MPLS Traffic Engineering Tunnel
  - Label Switched Path
- Same meaning
  - Affinity/Mask
  - Admin Group
- Different meaning: MPLS Fast Reroute
  - Path protection
  - Link / Node protection

Defaults

- 1000 means 1 MB or 1 Kb ?
  - Alcatel-Lucent, Cisco, Juniper, etc. different conventions
- MPLS-TE priority
  - Conventions and defaults on priority and hold settings for LSP
  - Different vendor implementations
- OSPF reference bandwidth
  - 100,000,000 is no longer adequate

Inter-Op

- MPLS TE multiple color constraints
  - And ? Or ?
  - Different vendor interpretations on logic
- Naming Convention
  - Must name as Tunnelxxx or Tunnelx/y/z
  - Can be arbitrary
- Features and implementation details can be different
  - DS-TE RDM, MAM, etc.

WANDL – 5620 SAM Integration

- Collect configuration and tunnel information from the 5620 SAM
- Offline design/analysis and upload changes to the live network
  - Service activation through SAM XML over SOAP
  - Upload changed information to the SAM
    - Bandwidth changes
    - Path (dynamic/explicit) and FRR properties
    - LSP definitions

Multilayer Challenges

- Shared Risk Link Groups (SRLG)
  - IP/ATM over TDM
  - ATM/TDM over IP
  - IP over Optical/DWDM
- Common failure points with multiple layers
  - Conduit failure>multiple fibre cuts>wavelengths failed>LSP paths down
- LSP backup paths may share common failure points with primary path

Multilayer Challenges

- MPLS itself is a multilayer technology
  - Layer 3 : IP
  - Layer 2 : MPLS-TE
- Interaction between IGP and MPLS-TE
  - AutoRoute Announce
    - Participate in topology state flooding or not
  - No AA

Multiprotocol Challenges

- IGP : OSPF, ISIS, static
  - OSPF areas
  - ISIS level1/level2
- BGP : iBGP, eBGP, mBGP
  - route reflectors, confederation
  - Carrier Supporting Carrier (CSC)
- MPLS : LDP, RSVP
  - LDP
  - RSVP, CSPF

MPLS Service Applications

- MPLS VPN
  - Layer 3 RFC2547-bis VPN
    - Replacing ATM/FR services
  - Layer 2, PW, VPLS, CCC
- MPLS TE/FRR
  - Voice, Video, NGN

Multiservice Challenges

- Voice
  - MPLS TE/FRR ?
- Data
  - Diversity
- Video
  - P2MP-TE ?
- CoS, QoS

Multiservice Challenges

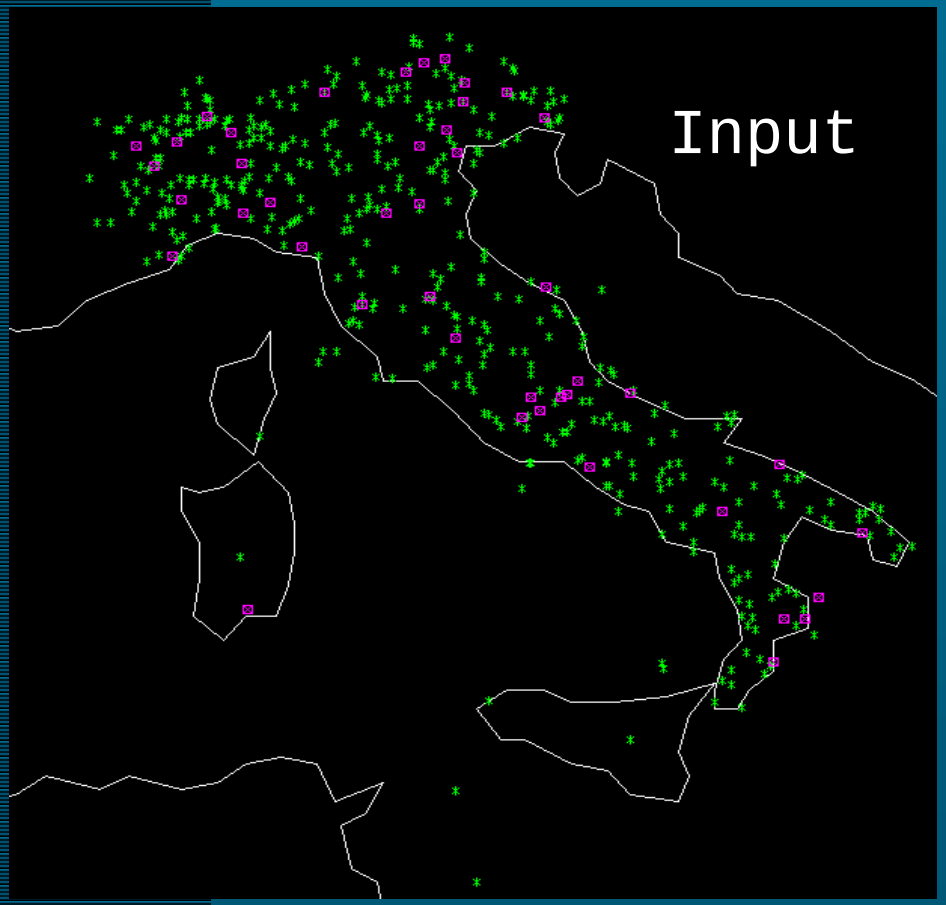
- Single or separate networks?
  - Internet
  - MPLS VPN
  - NGN
- Large service provider
  - may have separate network for each
- Small service provider
  - may merge all into a single network

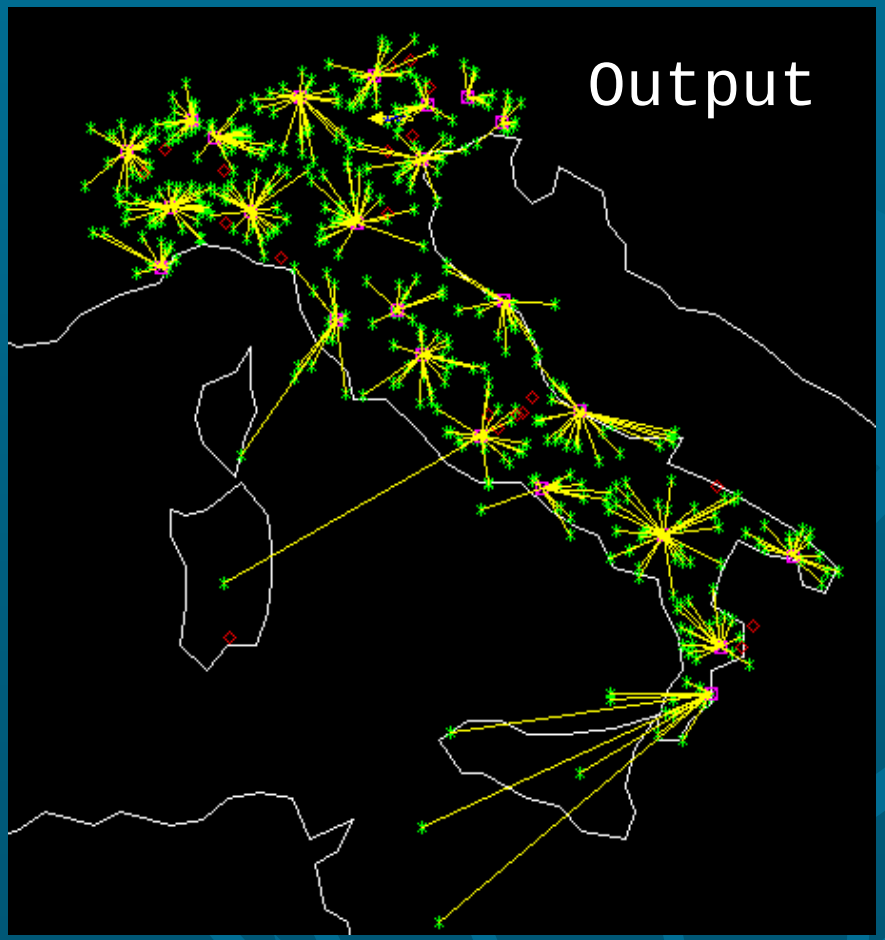
Summary

- In moving toward and IP/MPLS backbone, service providers are facing new and unexpected challenges including multiple vendor environments, multiple layer topologies, and multiple applications and services.
- Network management requires a high-level of visibility into the network in order to accurately model the various layers and interdependencies.
- The observed trend is toward consolidation of OSS tools to simplify data consistency across multiple sources, as well as tool management. Fewer tools that can address a broader scope.
  - WANDL's IP/MPLSView platform addresses fault-management, configuration and performance in the FCAPS framework.

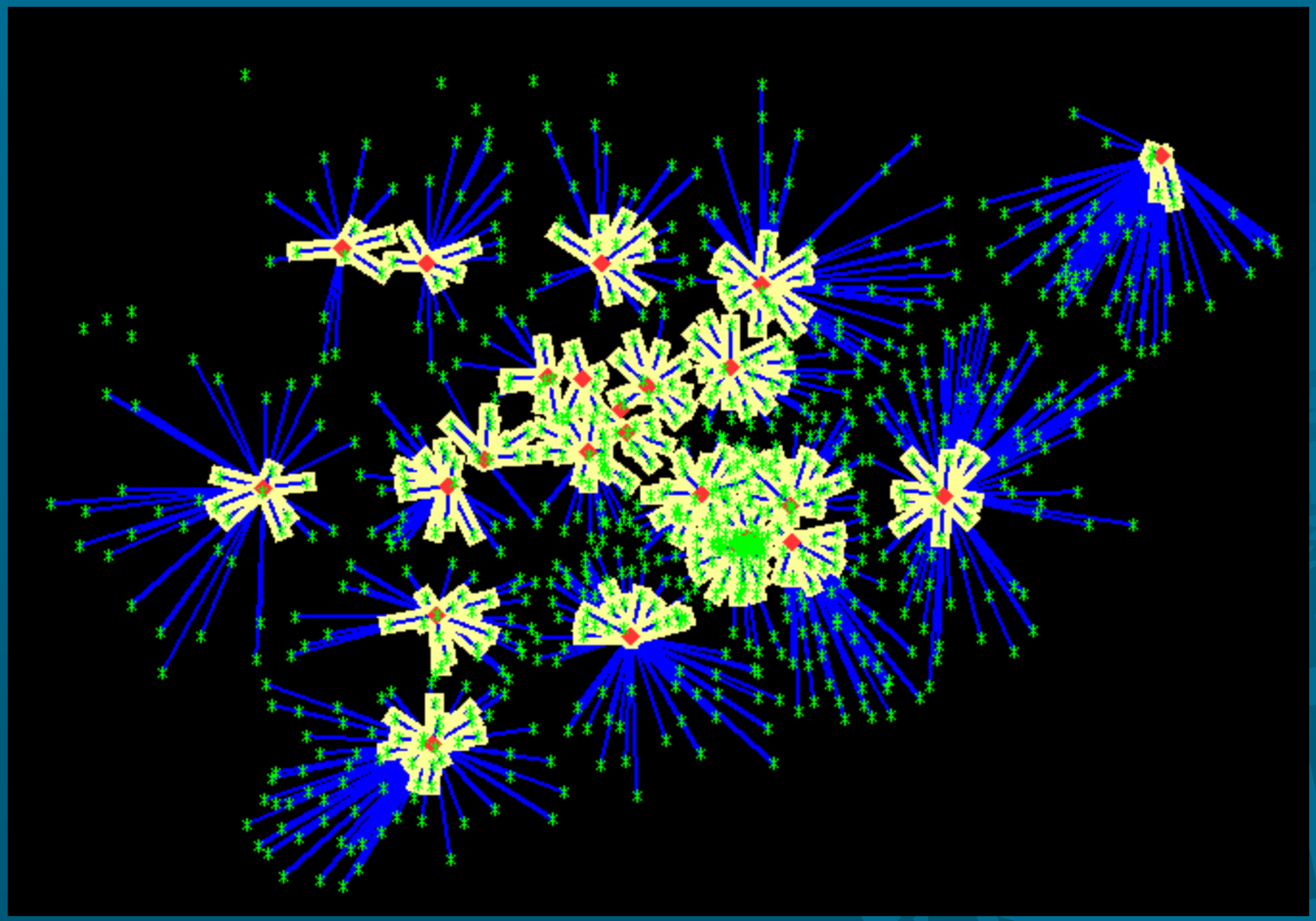
Network Visualization

Access Homing Design



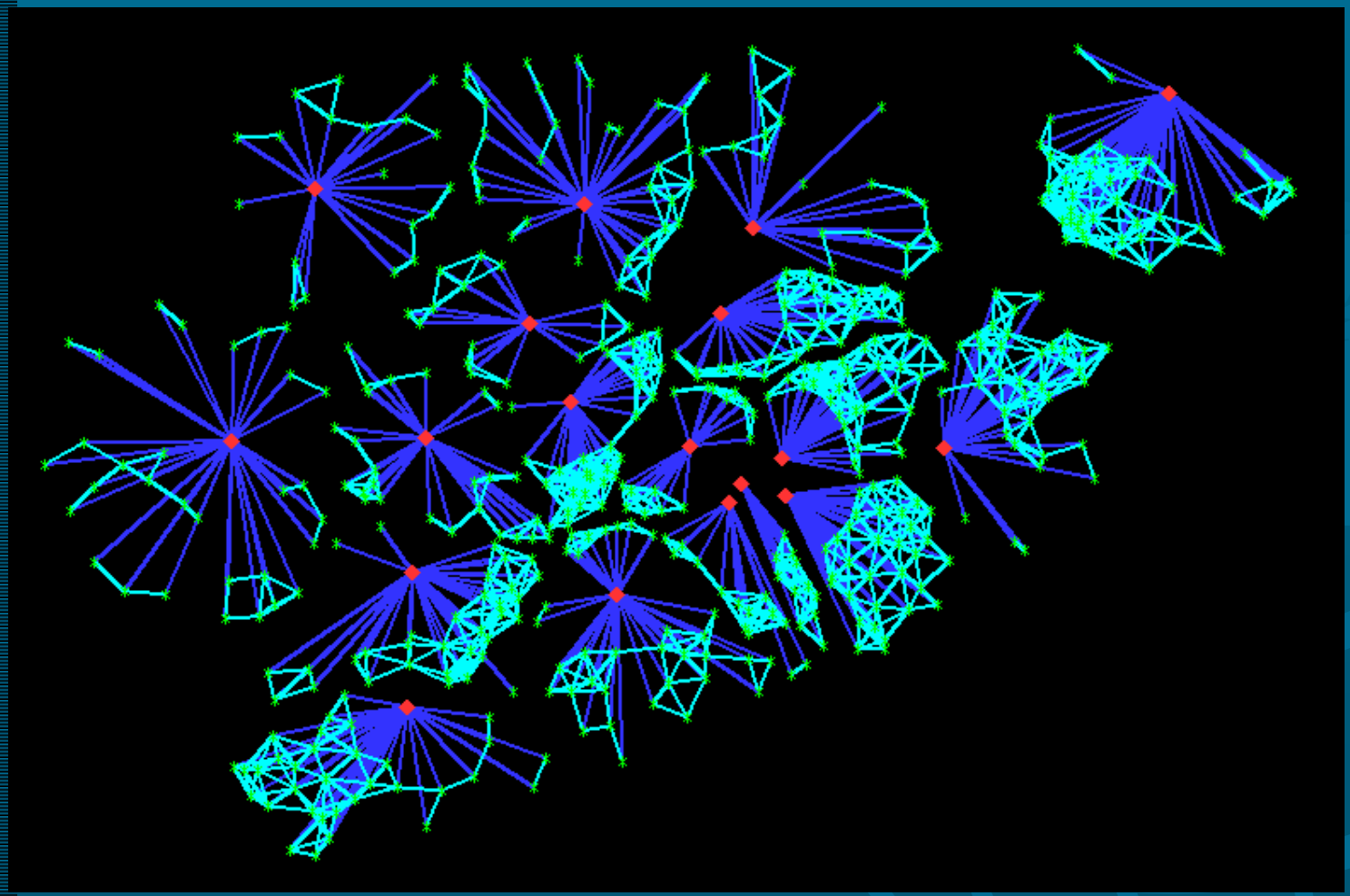


Wireless backhaul Design

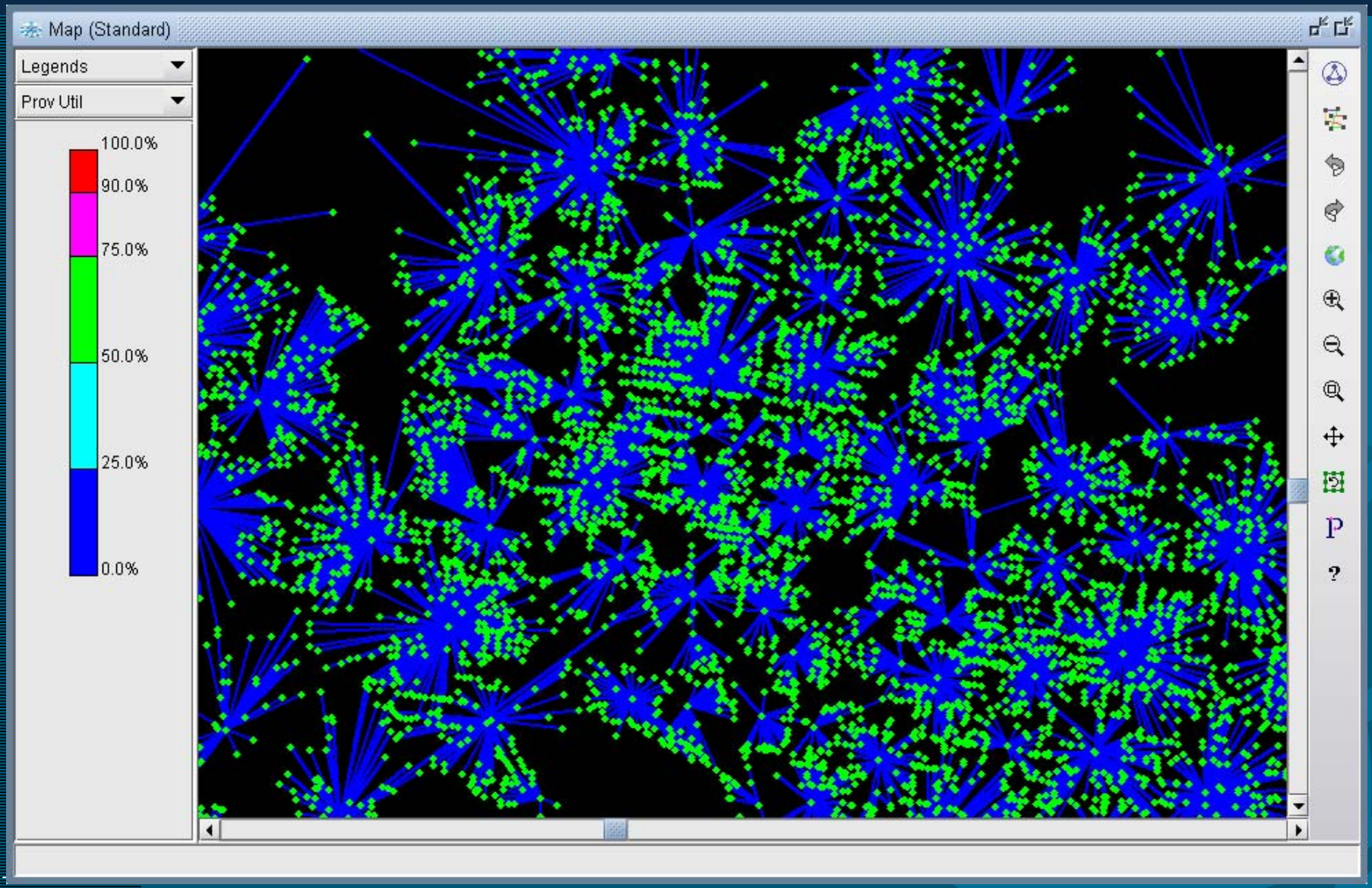


The highlighted links are less than 3.91 miles.

P2MP Hub selection

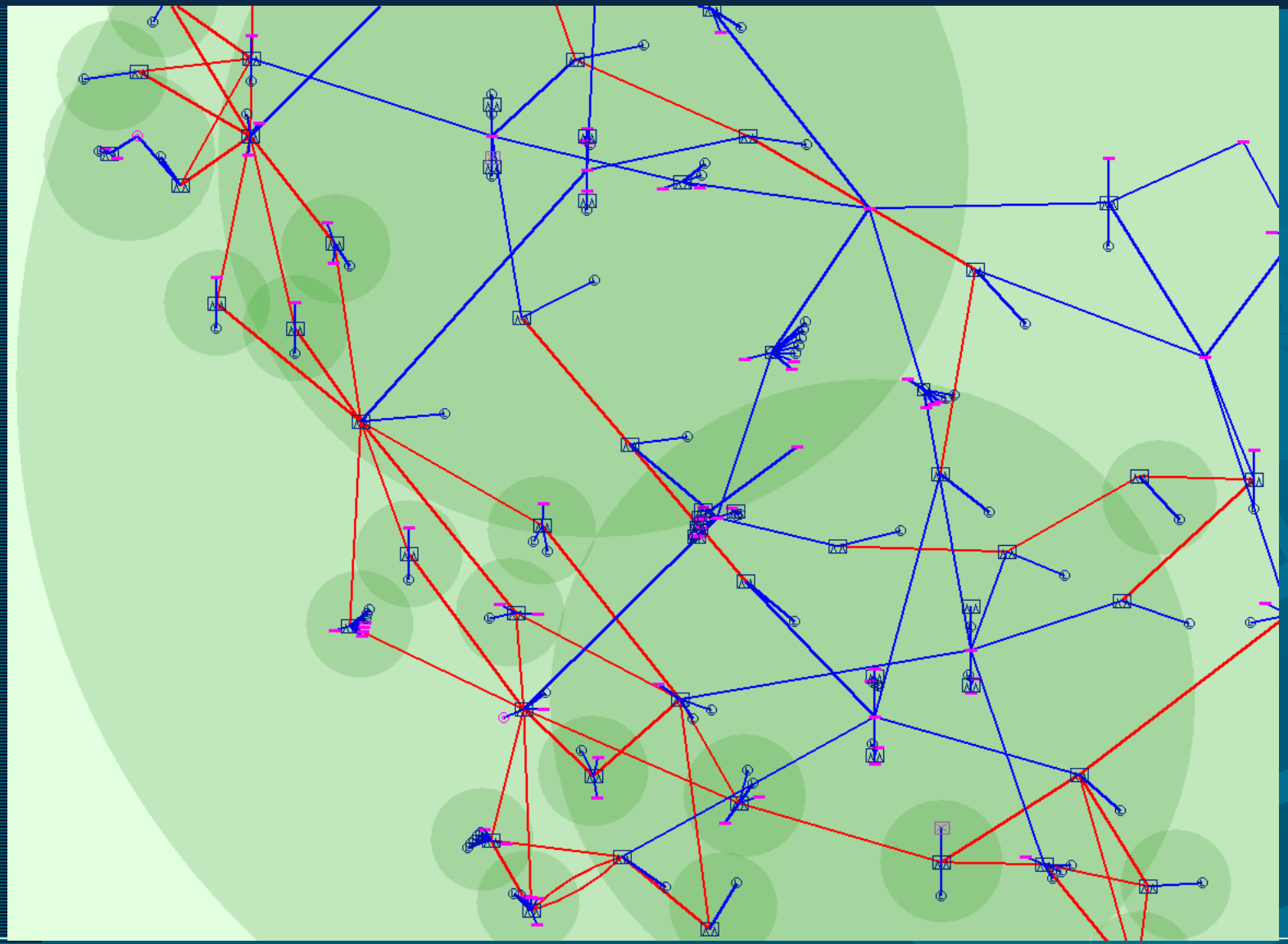


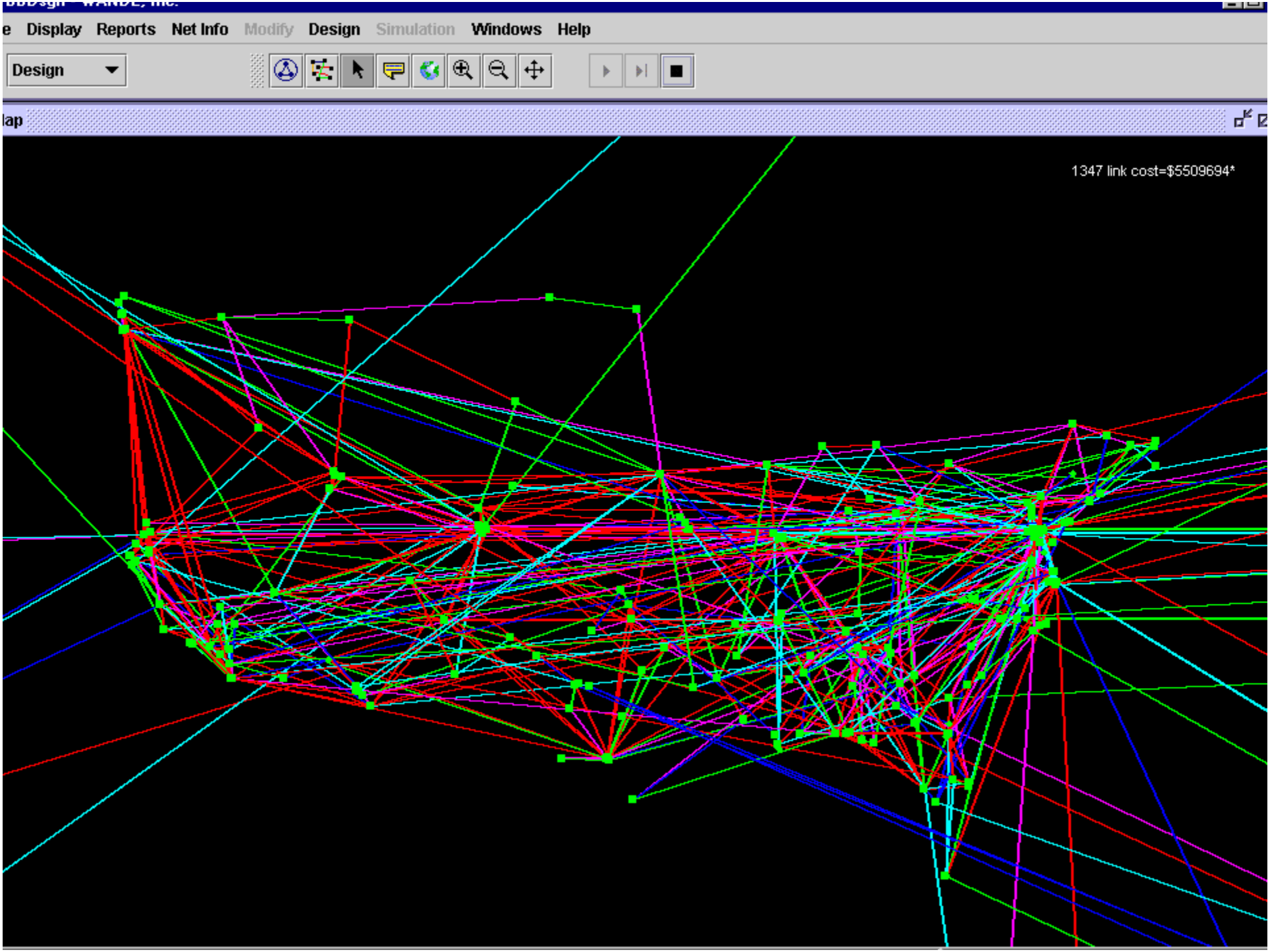
9000 locations



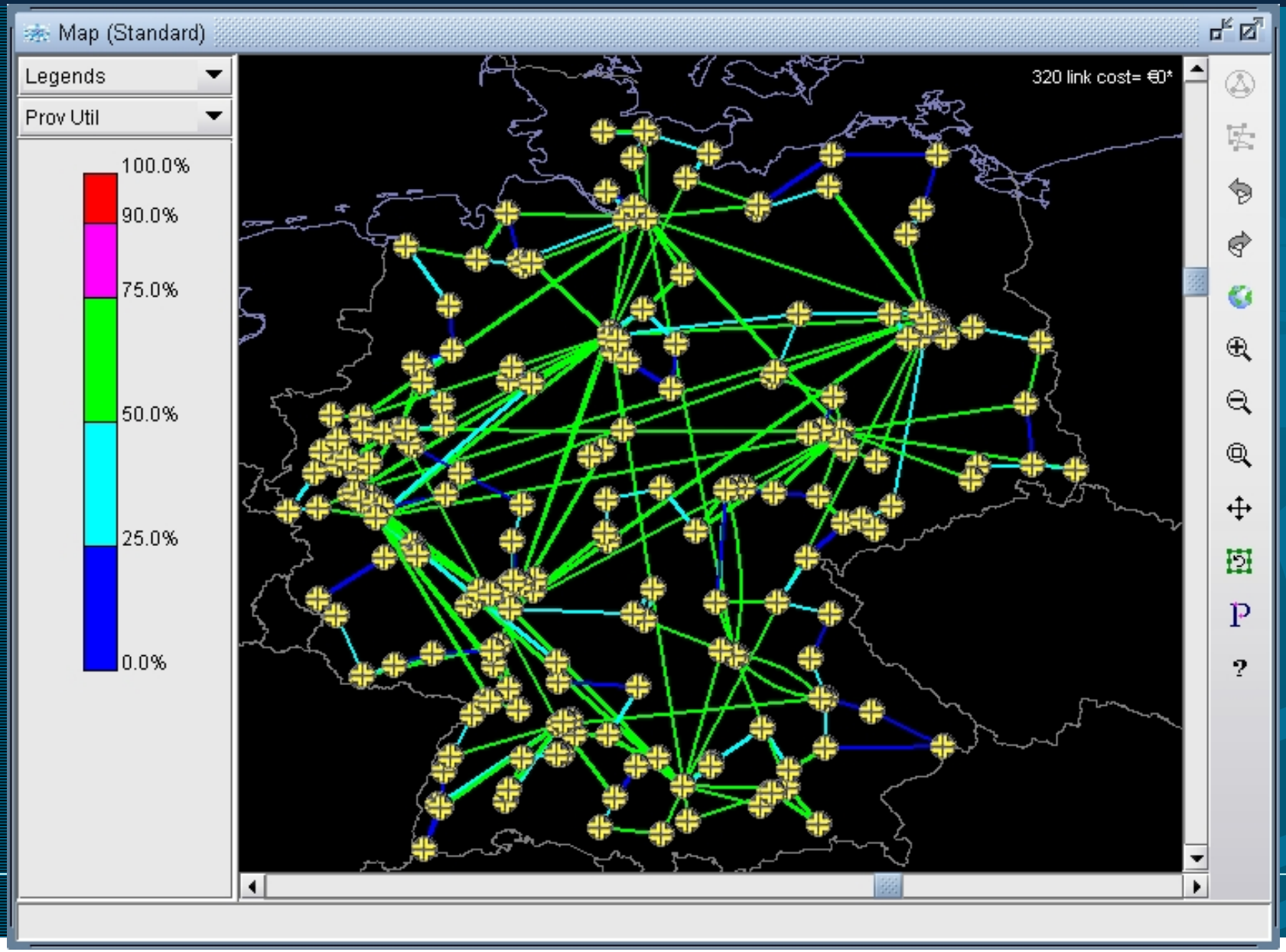
Backbone Topology Visualization

Mesh Topology

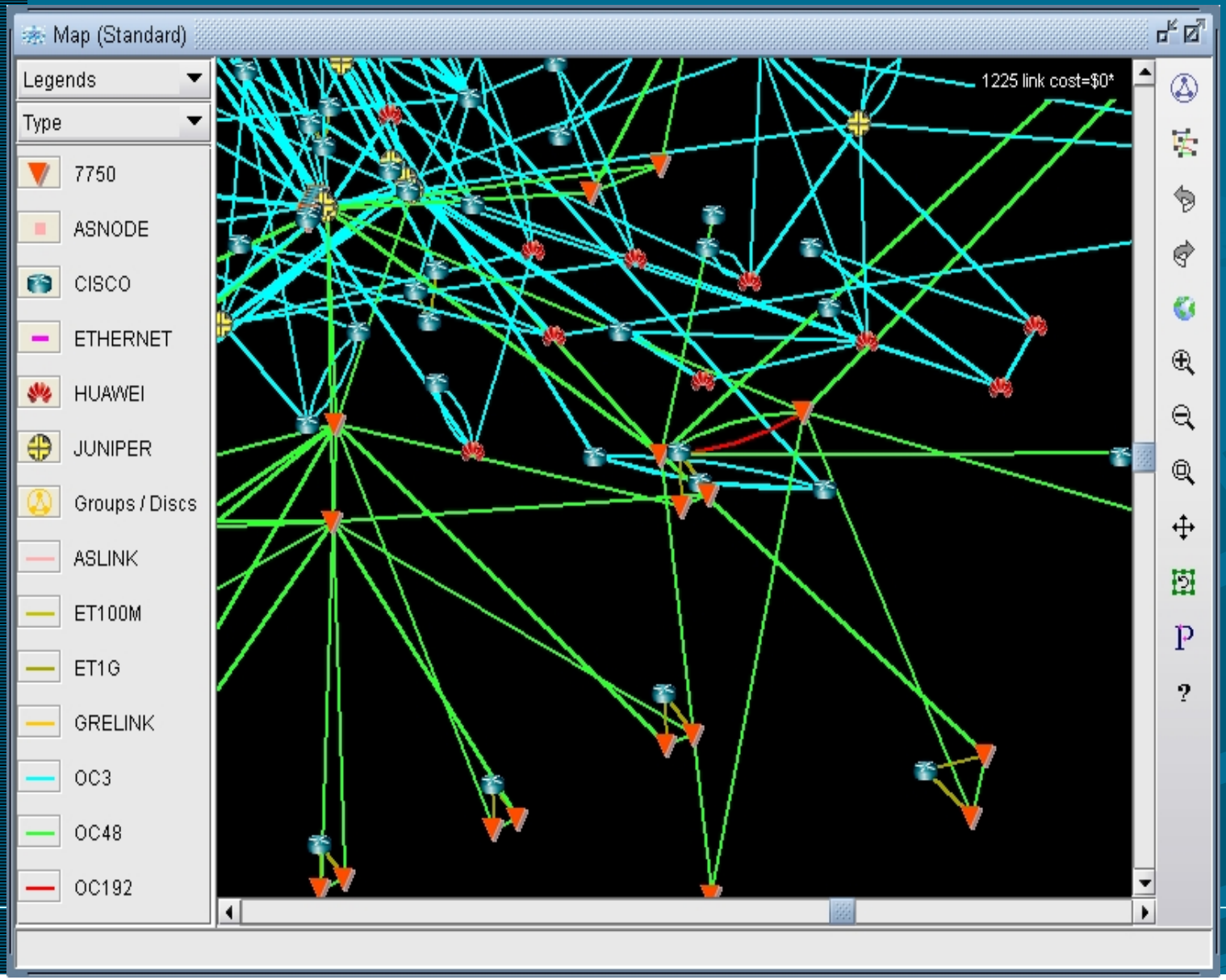



e Display Reports Net Info Modify Design Simulation Windows Help
Design
lap
1347 link cost=$5509694*

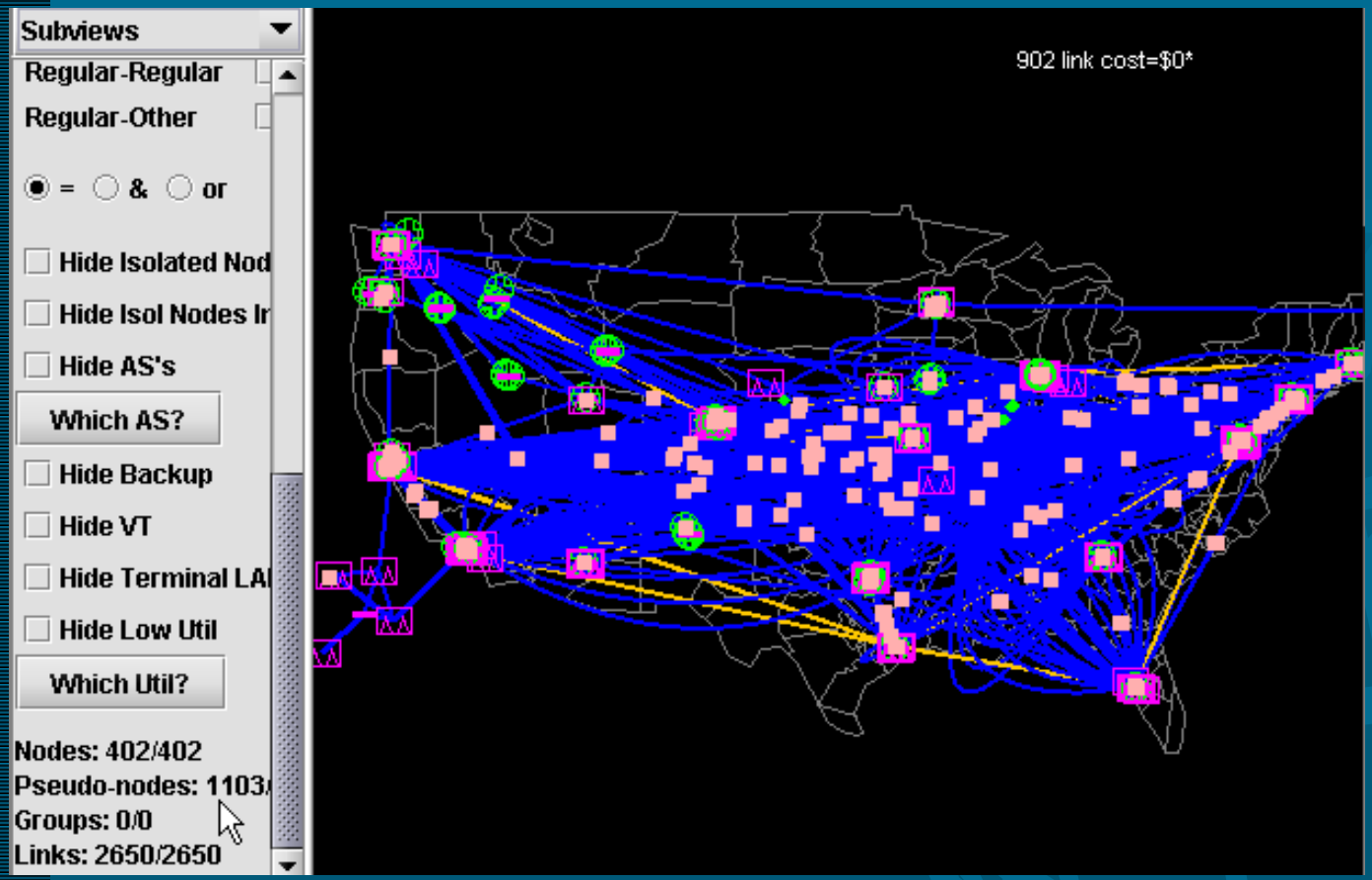
IP/MPLS Backbone



Multi-vendor network

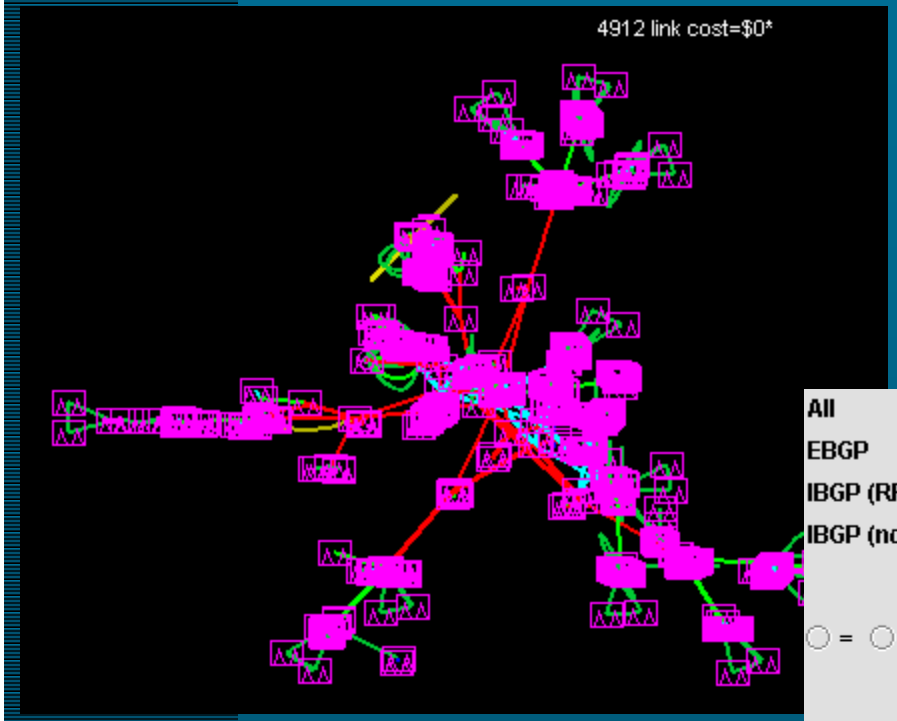


MPLS+BGP Network Scalability



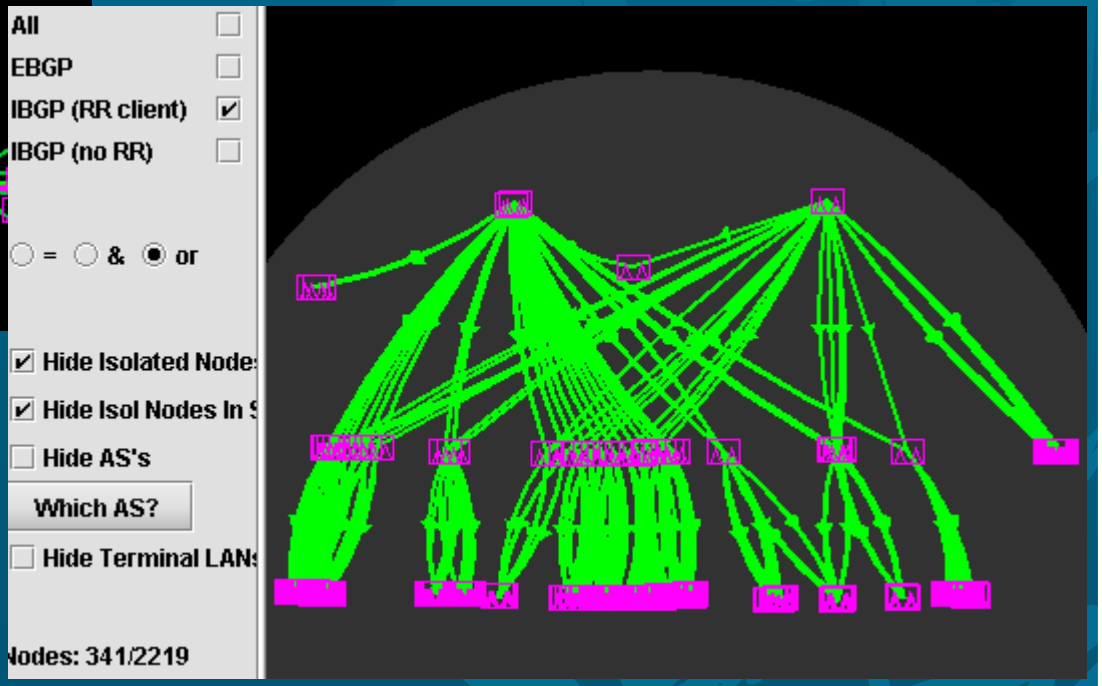
Routers: 402 Cisco + Juniper
Interfaces: 902 OC192 + OC48
AS Nodes: 1103 Peering
AS Links: 2650

Route Reflector Hierarchy

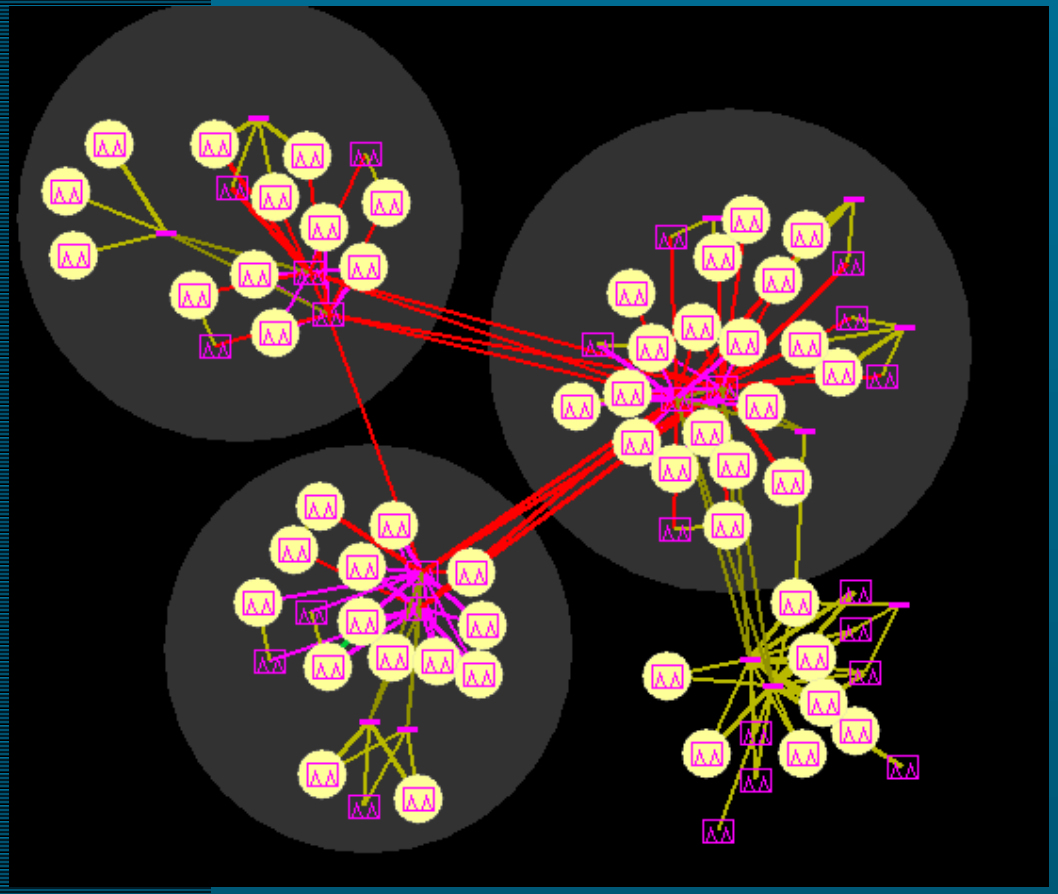


Network statistics
Routers: 3114 Cisco
Interfaces: 4912 ATM, OCx
BGP speakers: 391

Two Levels of RR



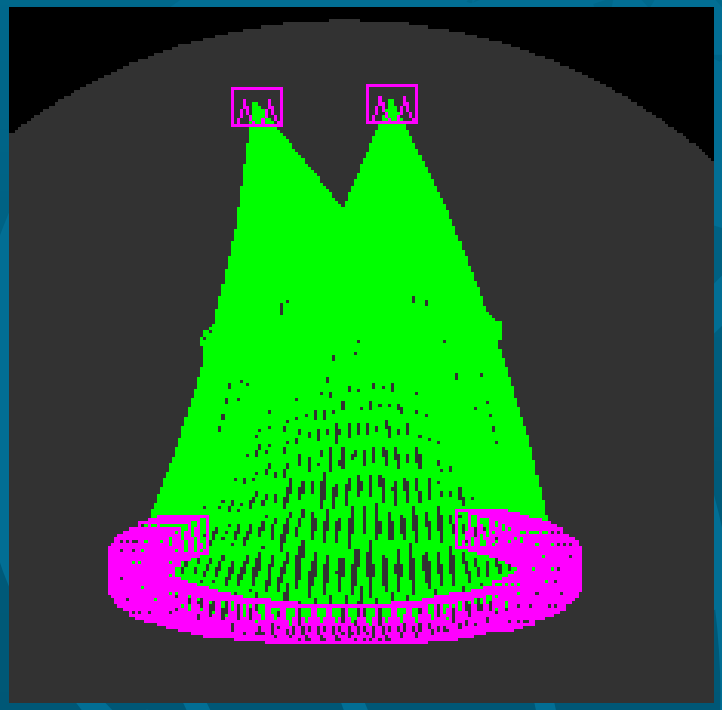
OSPF +MPLS VPN Network



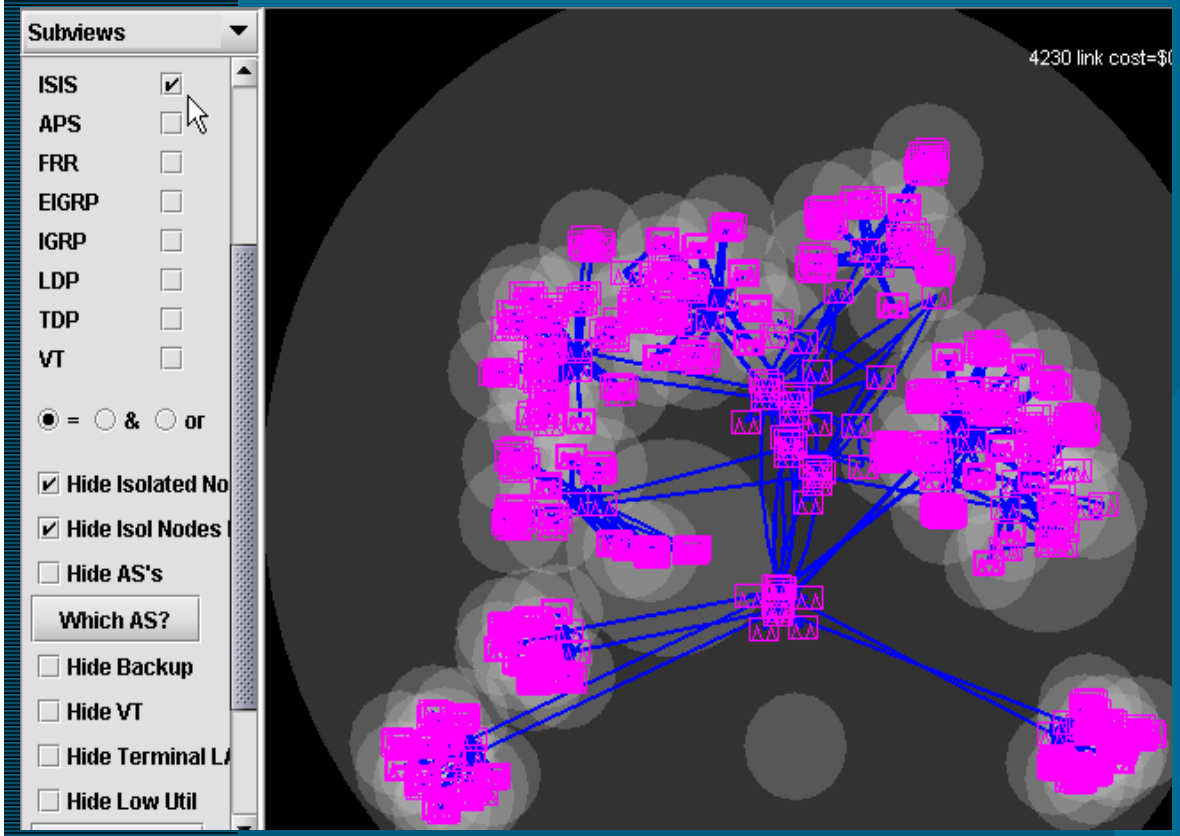
 # PE = 52

Routers: 77 Cisco
Interfaces: 158 OC3 + T3
VPNs: 255

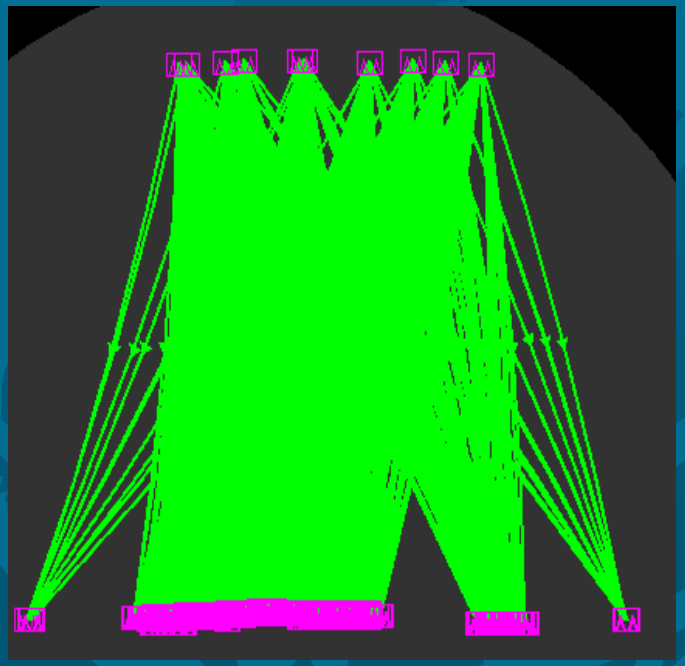
iBGP RR for VPN



ISIS + VPN Network



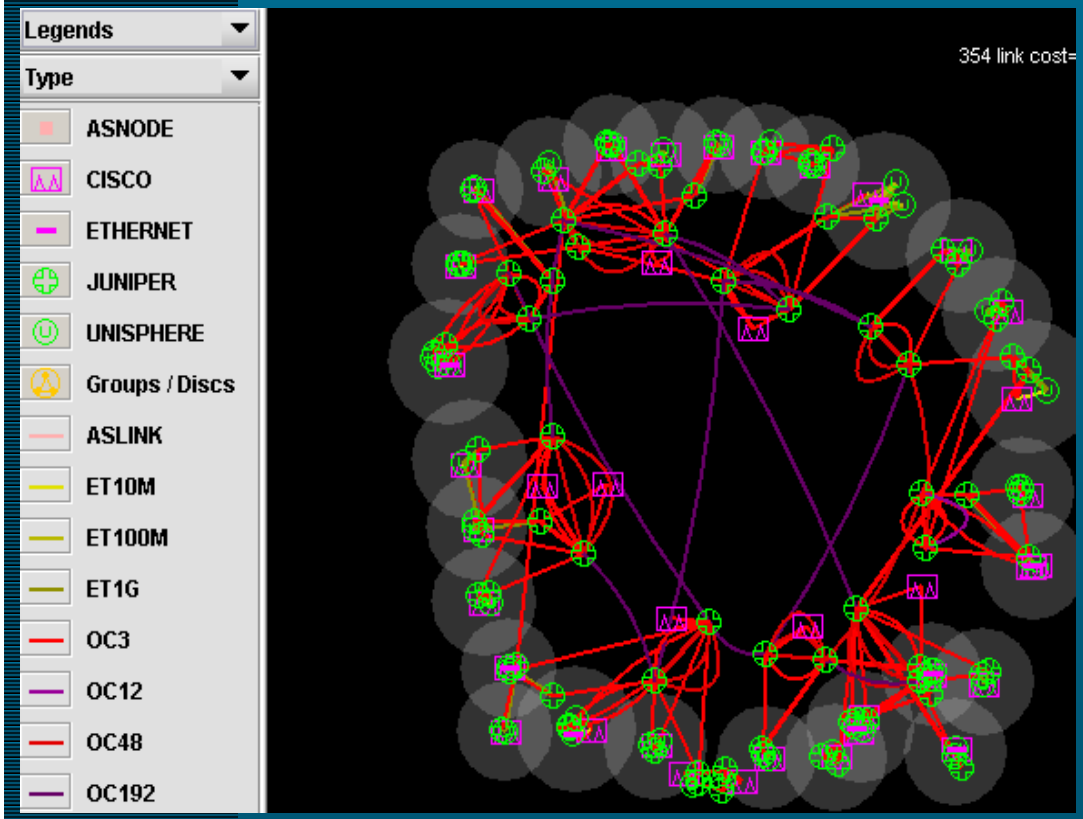
iBGP RR for VPN



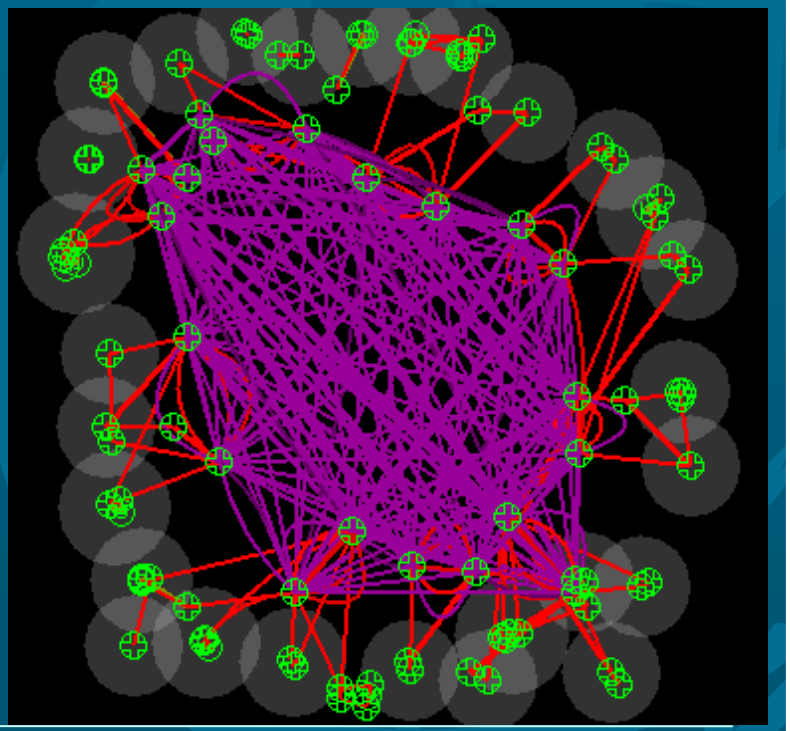
Routers: 1570 Cisco
Interfaces: 4,230 STM1, ATM156M
 # VPN: 4,243
1,862 BGP Neighbors

Multi-vendor MPLS Network

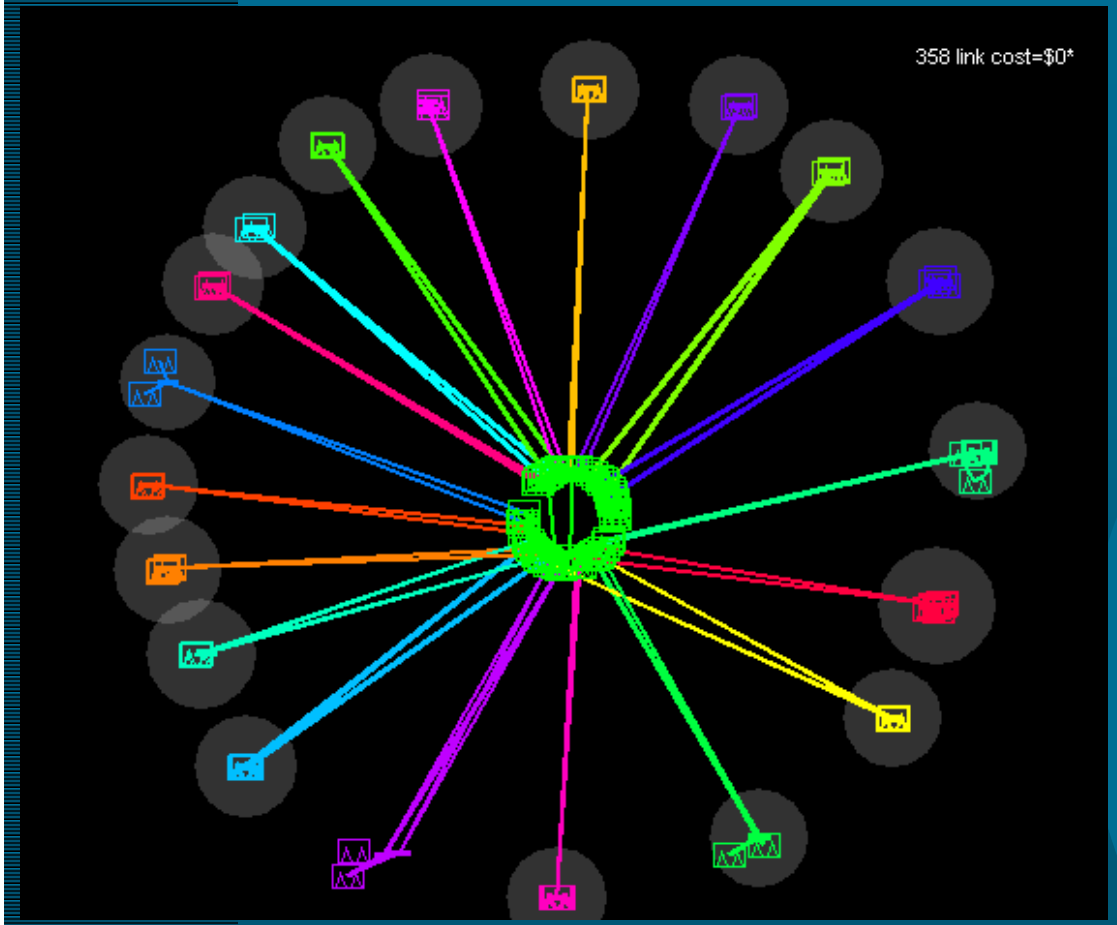
Routers: 159 Cisco, Juniper, Unisphere
Interfaces: 354 OC192/48/12/3, ET.,



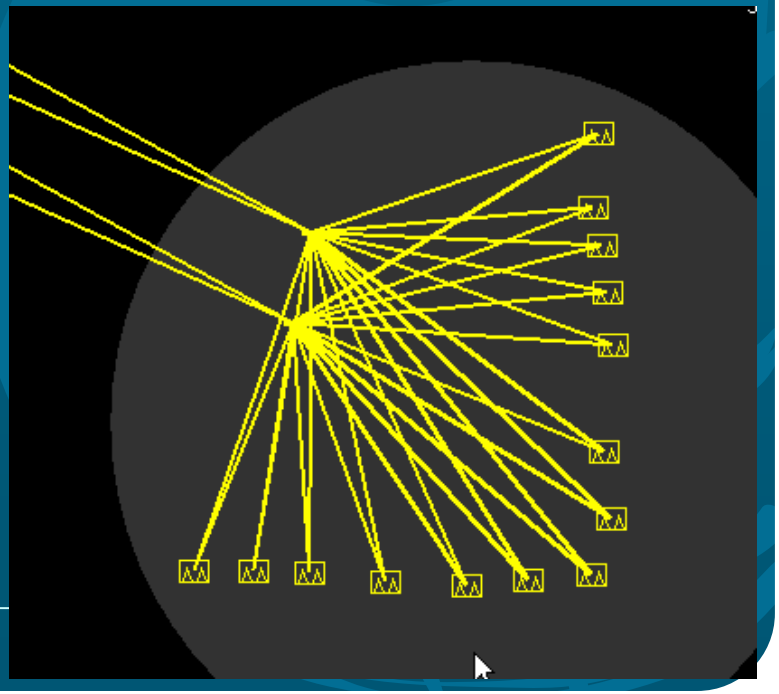
MPLS Map with VT



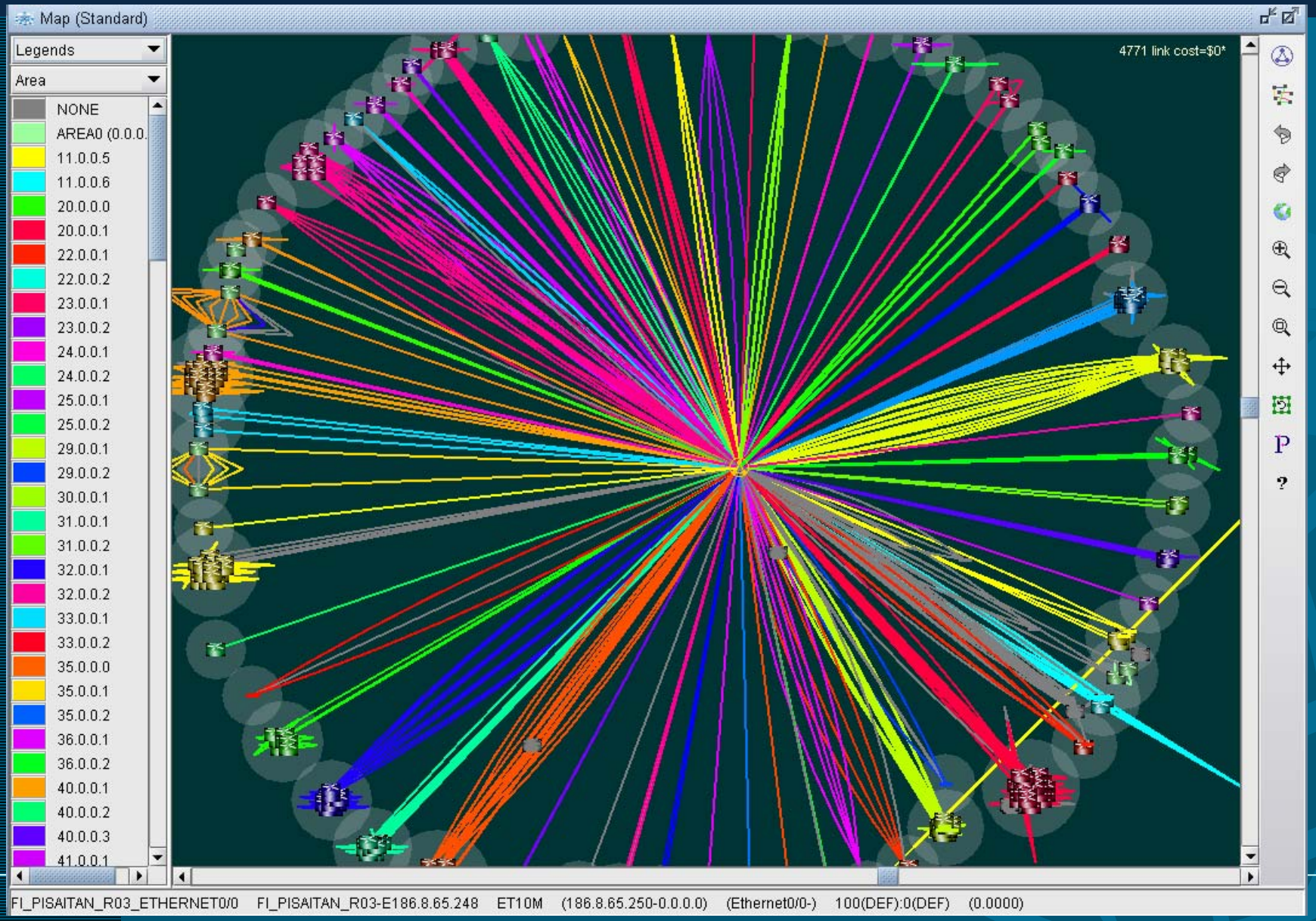
OSPF Area Scalability



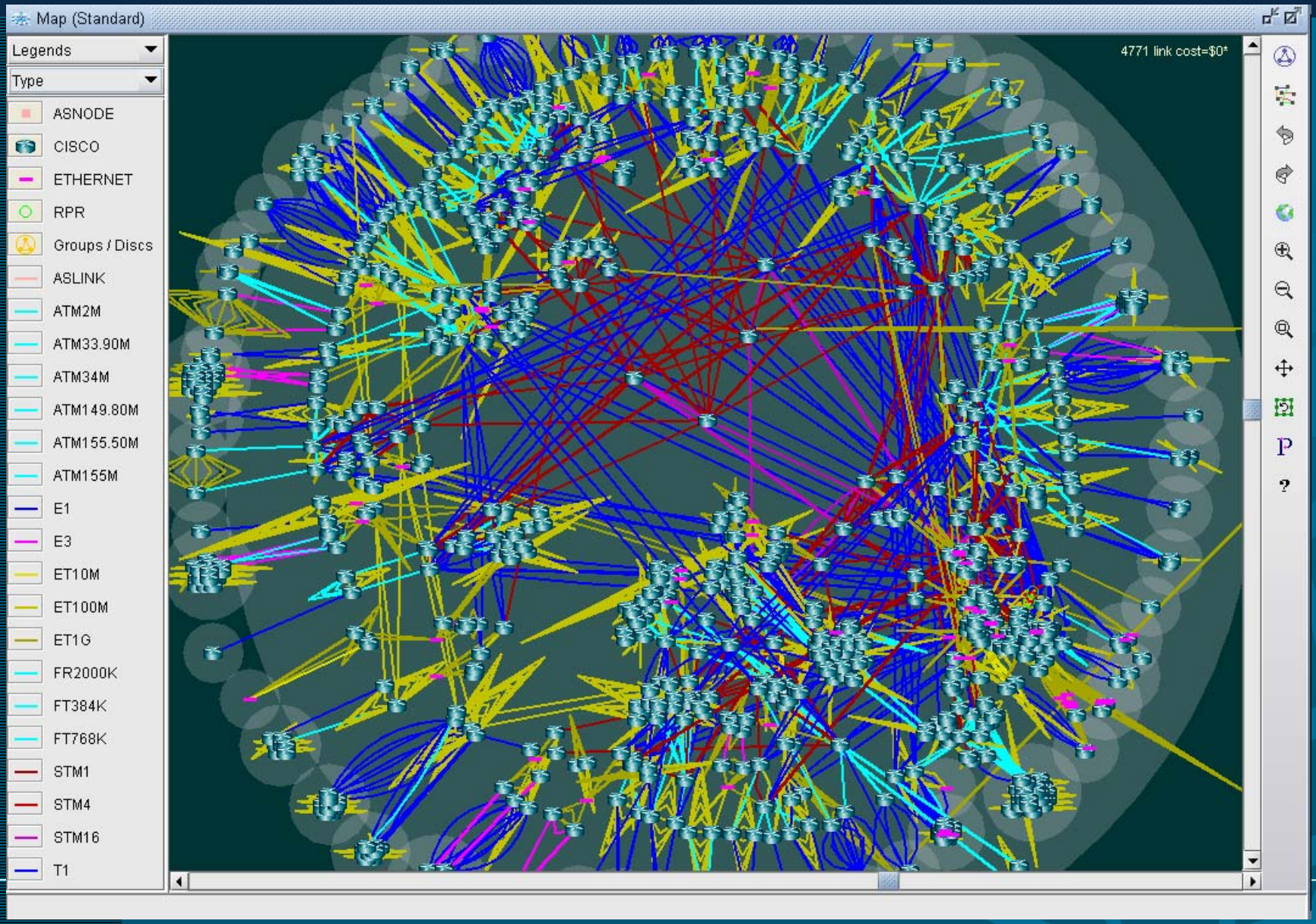
Routers: 143 Cisco
Interfaces: 358 OC3 + T3
OSPF Areas: 19



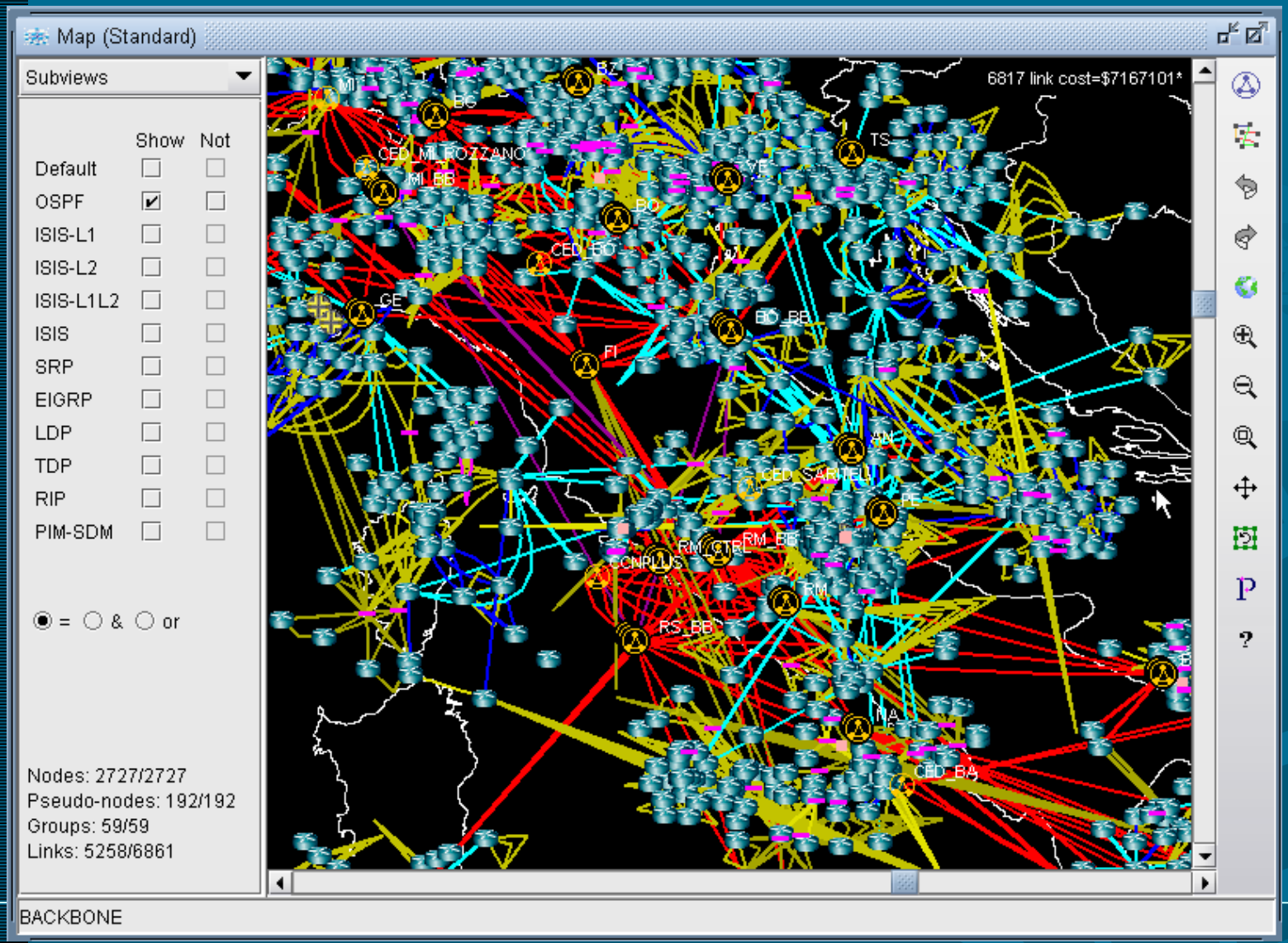
A Big OSPF Network



Another View

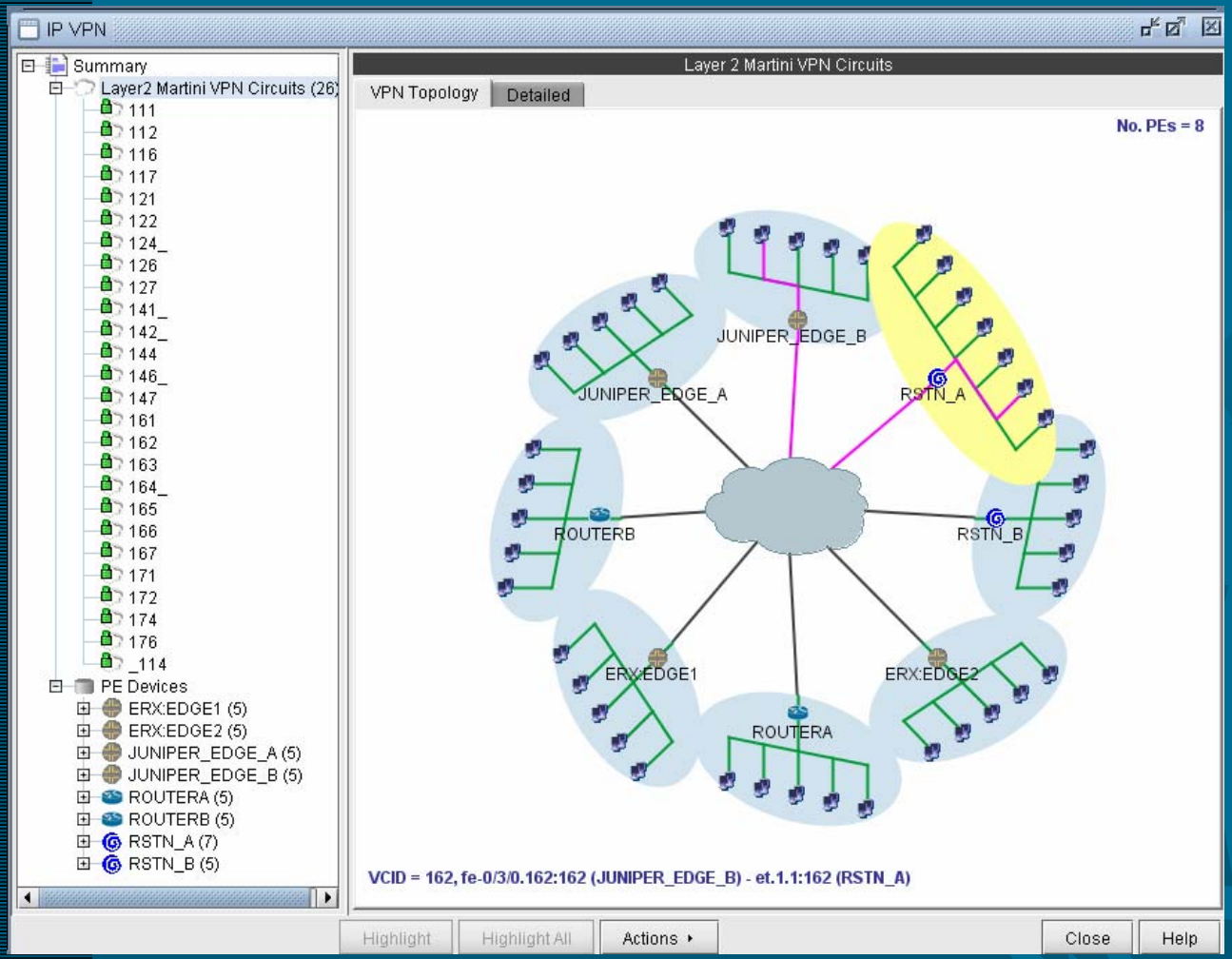


Topology: Advanced Protocol Filtering

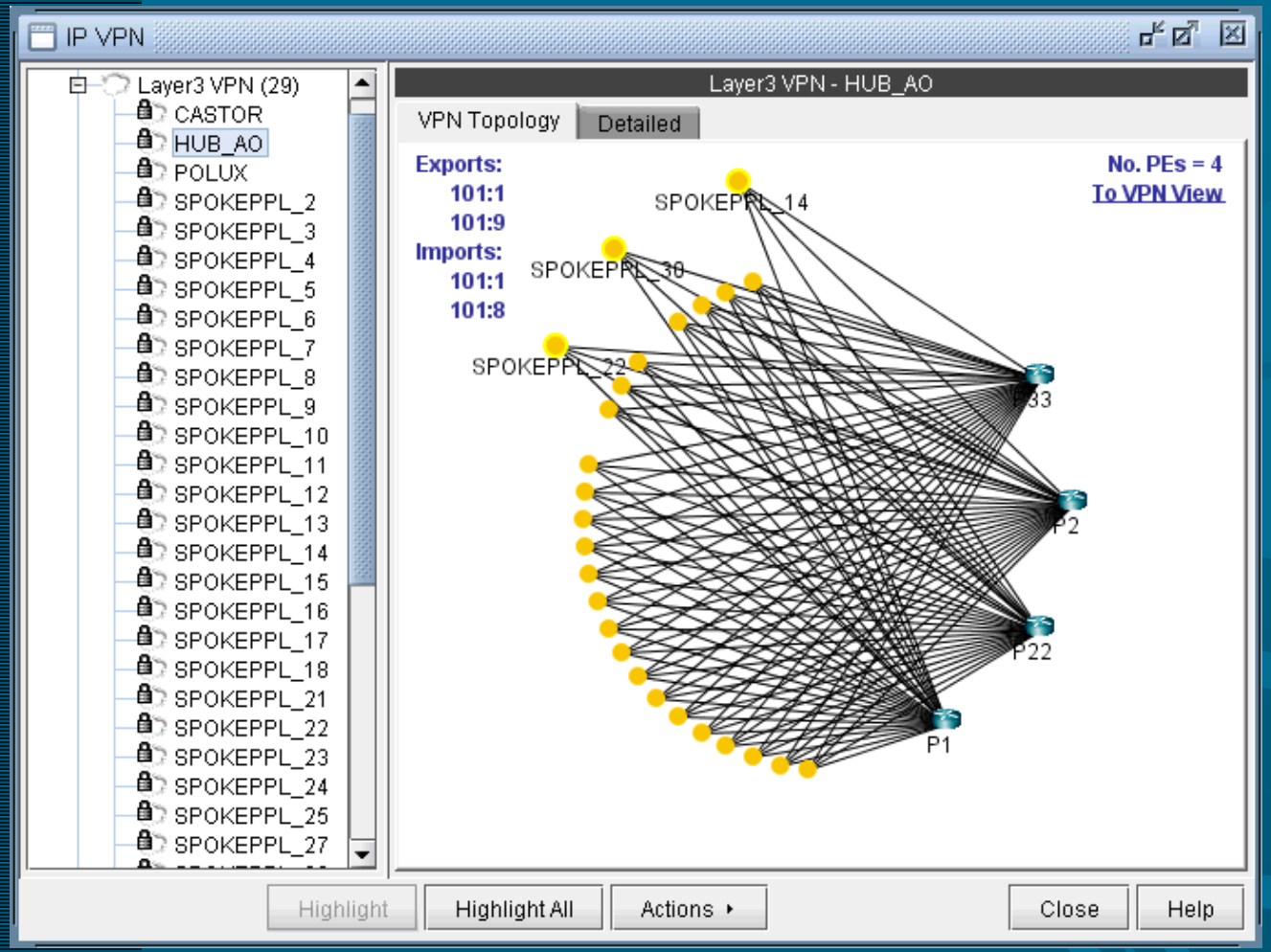


MPLS VPN

MPLS VPN


IP VPN
Summary
Layer2 Martini VPN Circuits (26)
111
112
116
117
121
122
124_
126
127
141_
142_
144
146_
147
161
162
163
164_
165
166
167
171
172
174
176
_114
PE Devices
ERX:EDGE1 (5)
ERX:EDGE2 (5)
JUNIPER_EDGE_A (5)
JUNIPER_EDGE_B (5)
ROUTERA (5)
ROUTERB (5)
RSTN_A (7)
RSTN_B (5)
Layer 2 Martini VPN Circuits
VPN Topology
Detailed
No. PEs = 8
JUNIPER_EDGE_B
JUNIPER_EDGE_A
RSTN_A
ROUTERB
RSTN_B
ERX:EDGE1
ERX:EDGE2
ROUTERA
VCID = 162, fe-0/3/0.162:162 (JUNIPER_EDGE_B) - et.1.1:162 (RSTN_A)
Highlight
Highlight All
Actions
Close
Help

Route Target Relationship View



Questions