Cisco WAE Workshop

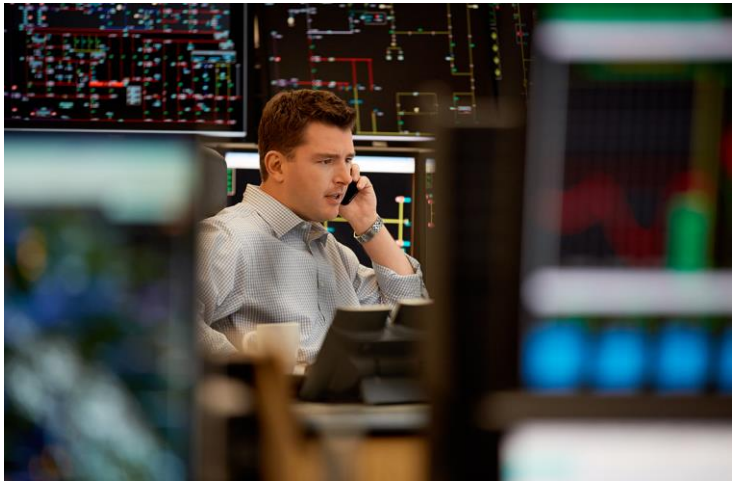
Topics

1. Cisco WAE Overview
2. WAE Planning
3. WAE Automation
4. Demo & Hands-on

WAN Limitations Impact Traffic Optimization

Provider Constraints

- Too Many Manual Steps
- Fragmented View of the WAN
- Lack of Visibility for Troubleshooting
- WAN Lacks Real-Time Agility



Service Providers need a better approach

What's Needed

- Multivendor Orchestration
- Unified WAN View for Scenario Analysis
- Network Visibility Over Time: Past, Present, and Future
- Automation at Scale

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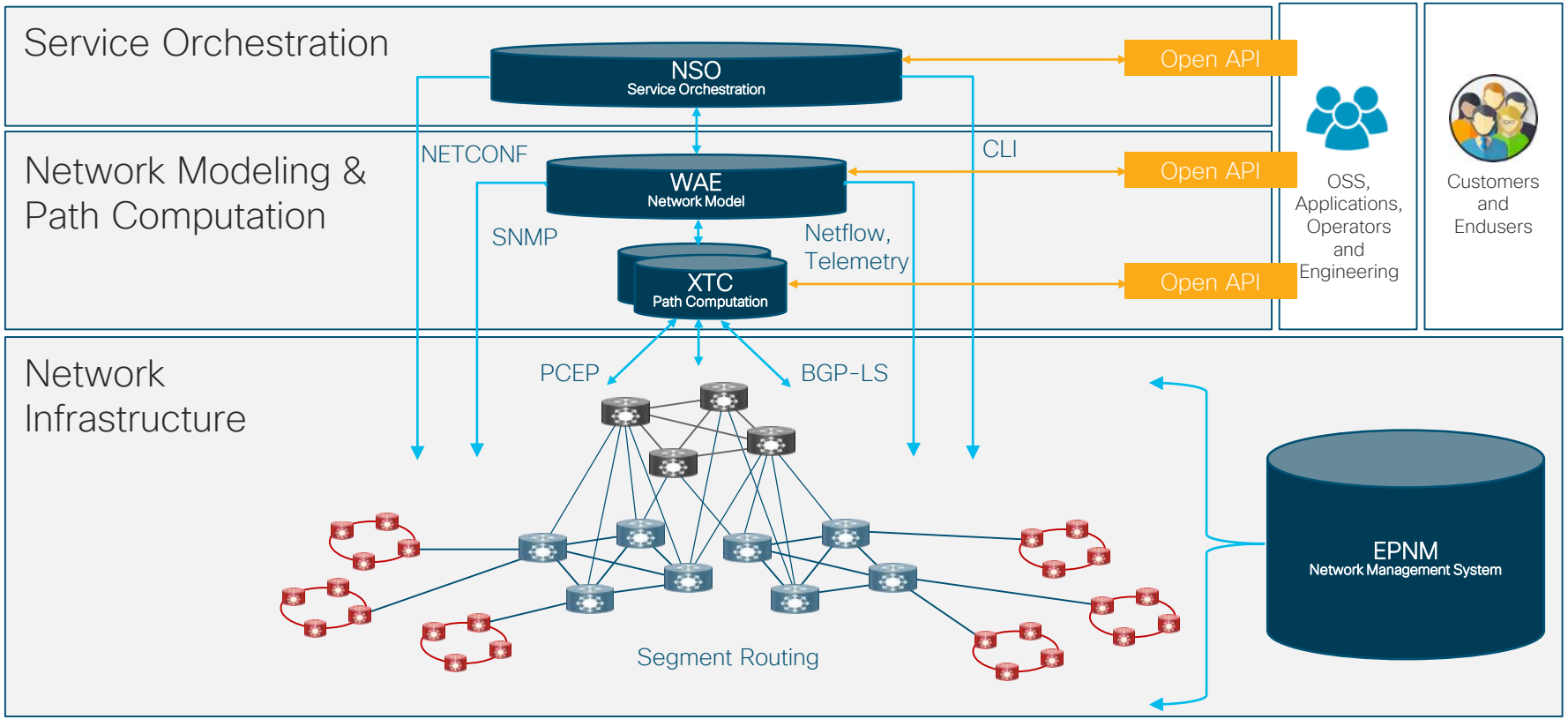
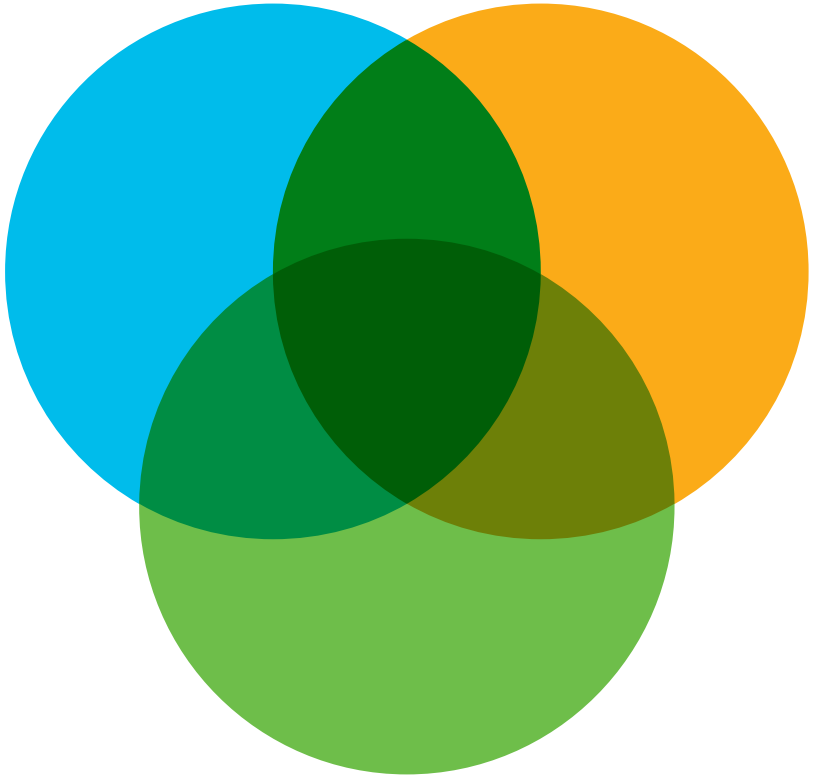
Cisco Transport Software Defined Network



Cisco WAE Overview



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Cariden MATE to WAE – Quick History

Cariden

- Founded in 2001
- Cisco Acquisition completed 12/15/2012
- WAE software for IP/MPLS traffic management
- Software to Discover, Design, Plan and Engineer Networks
- 85% of Tier 1s use Cariden software

Cisco has over the years revamped and enhanced the MATE applications along with building additional capabilities and new applications

MATE Portfolio → Cisco WAE

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Cisco WAN Automation Engine (WAE)

WAE for Planning

WAE for Automation

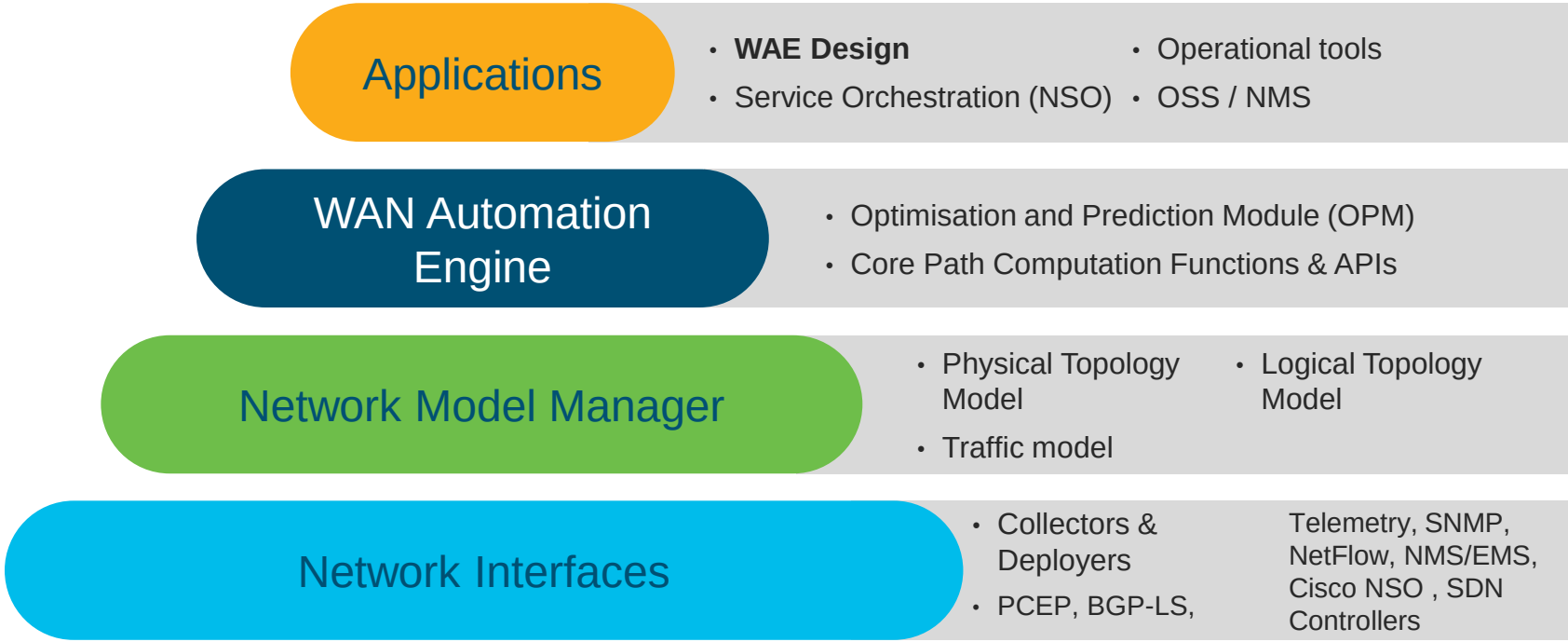
- Topology Model
- Traffic Model
- What if/predictive analysis
- Global optimisation

- Assess historical and real-time data
- Find and manage hot spots
- Network efficiency analysis

- Programmatic network control (APIs)
- Path Activation or Recommendation

- Monitor for path constraint violations
- Automate network changes to ensure path compliance

WAE Functional Architecture



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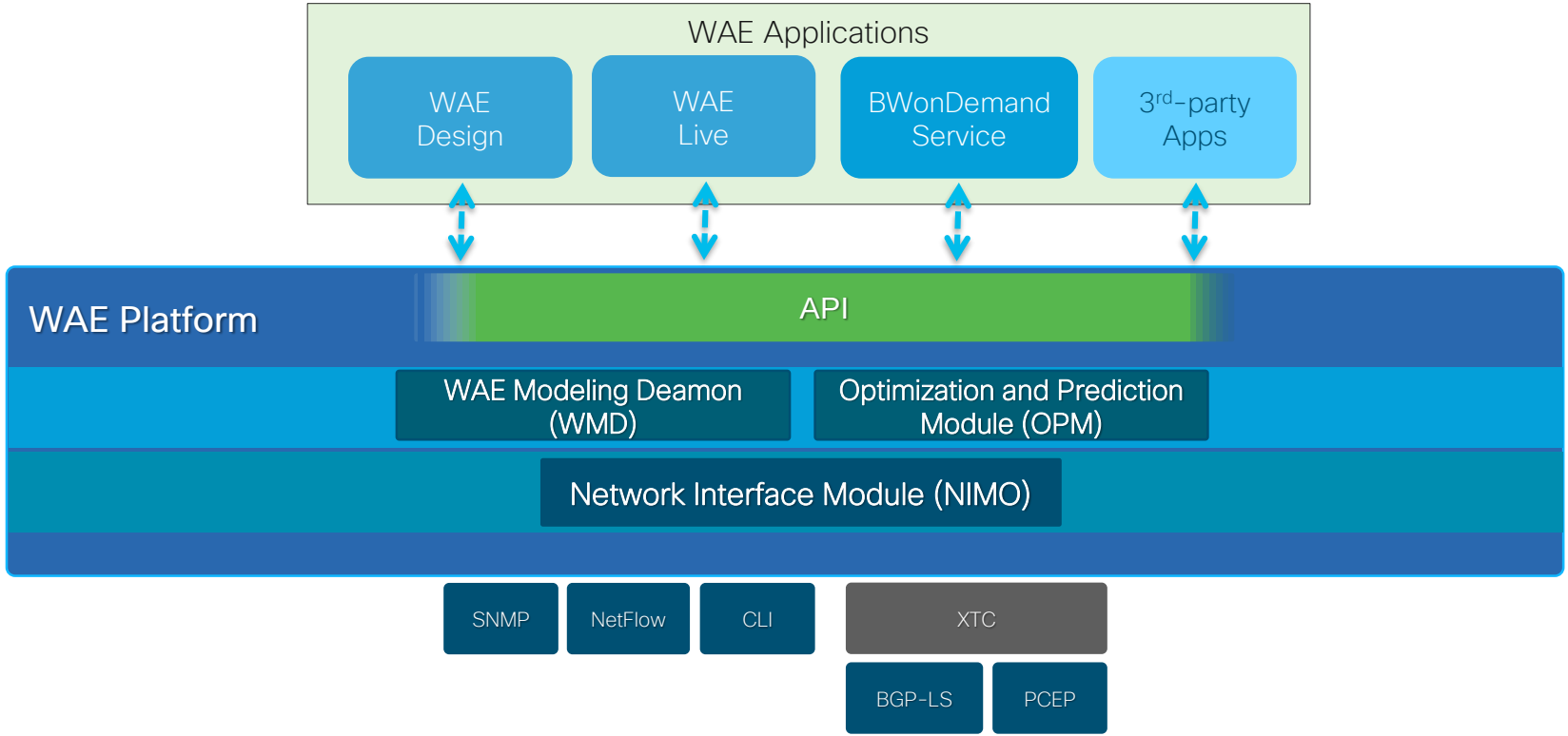
WAE Architecture Overview



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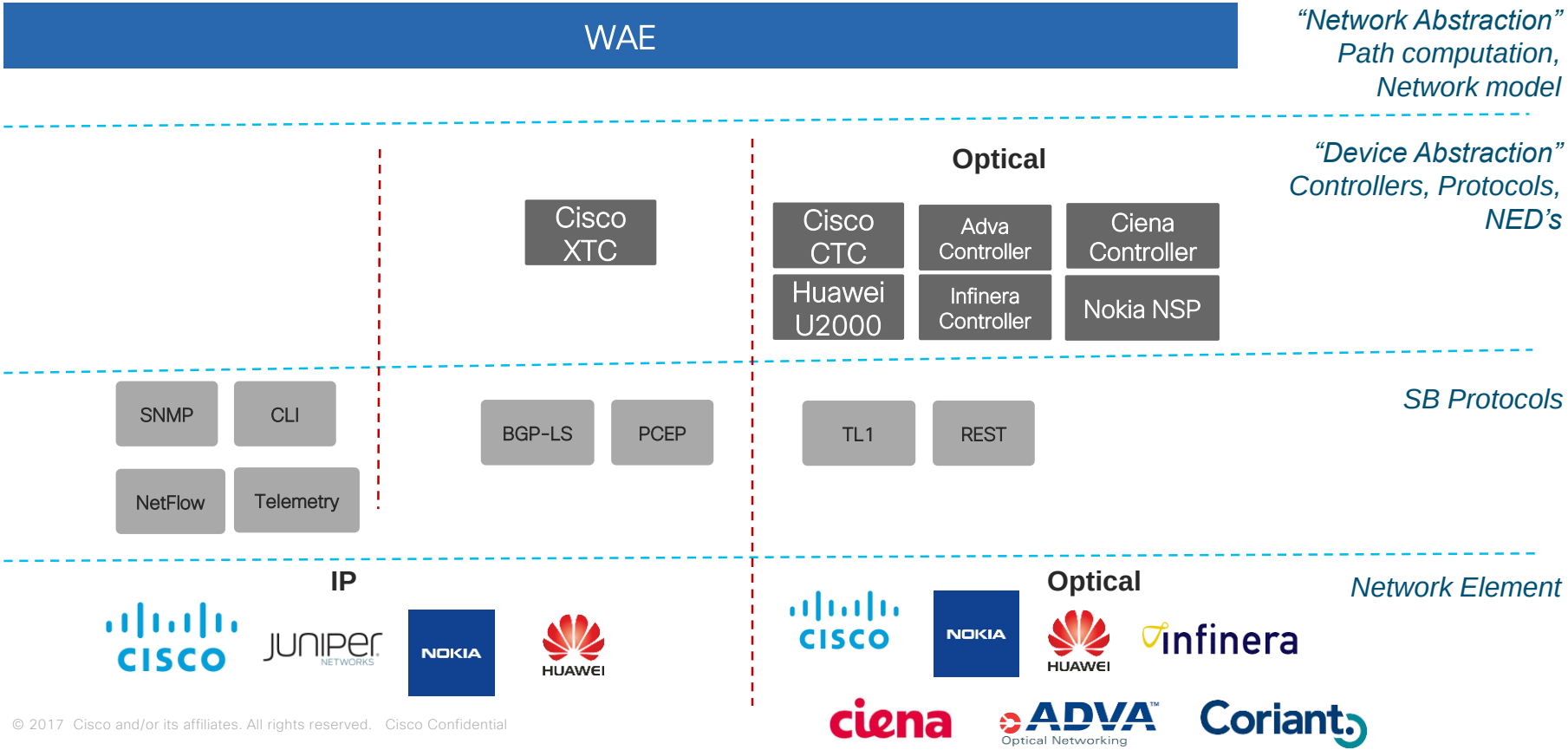
WAE Southbound Interfaces & Multi-vendor support



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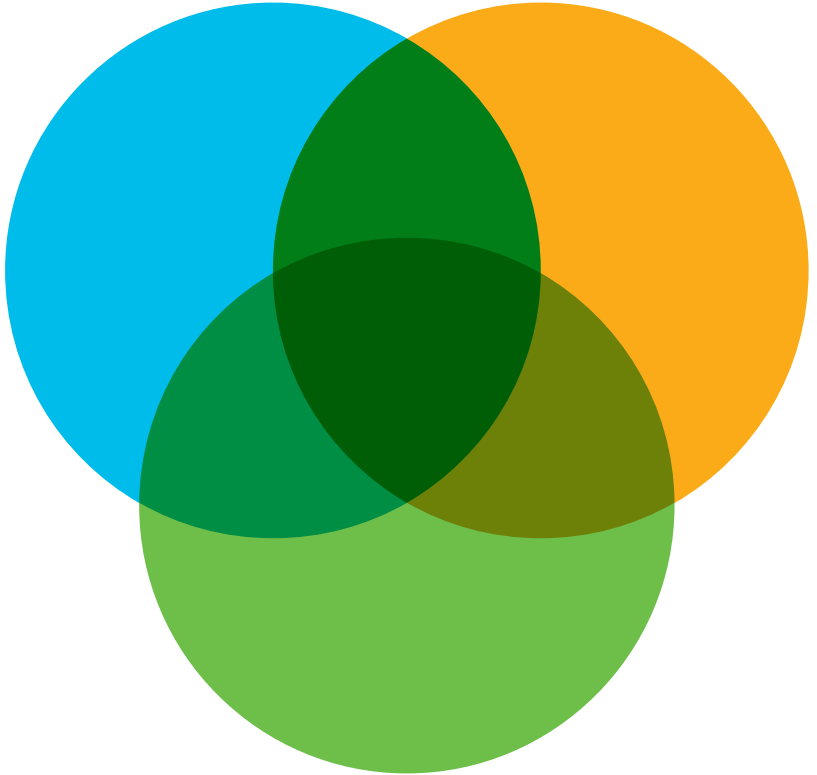
WAE Planning



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Cisco WAN Automation Engine (WAE)
Network Planning , Optimization, Automation

Visualization

- Graphical view of link traffic utilization
- Customized topology views
- Traffic paths, LSP paths and shortest path

Capacity Planning

- Full Traffic Matrix and Topology
- Traffic Trending/Forecasting
- Model Network adds/moves/changes

Optimization and Traffic Engineering

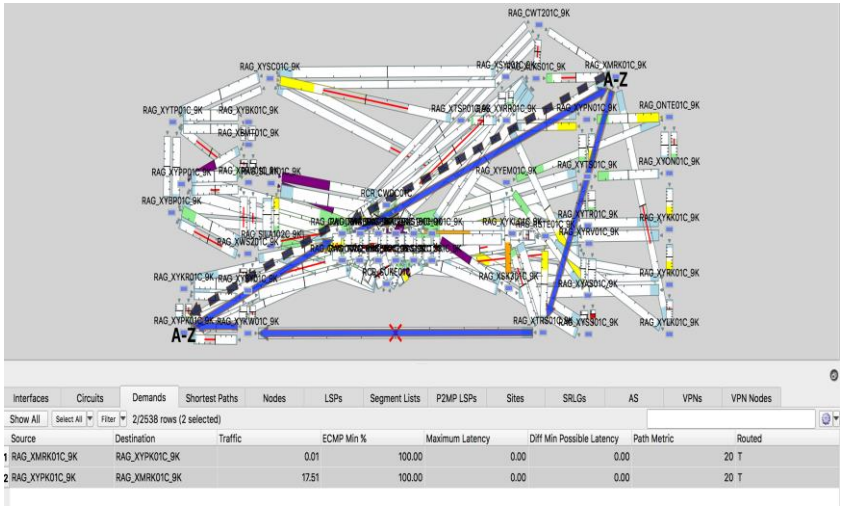
- IGP and LSP metrics with detailed reports and recommendations

Network-Wide Simulation Analysis

- Extensive network wide failure analysis
- ‘Worst Case’ analysis of Network

Maintenance Planning

- Risk Analysis of planned outages
- Model Node, Circuit and SRLG failovers



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WAE: SP Planning

Network Visibility

- Hot spots
- Traffic flows
- Traffic redistribution because of network failures

Predictive Growth Analysis

- Understanding Traffic trends
- Growth plan based on traffic trends/business projection
- Capacity planning and What-ifs

Service Velocity

- Customer Service roll outs
- SLA Compliance
- Optimized path deployment

Day to day Operation

- Failures and Demand Management
- Maintenance Operation-cost-in/cost-out
- Data analytics for traffic trending

WAE

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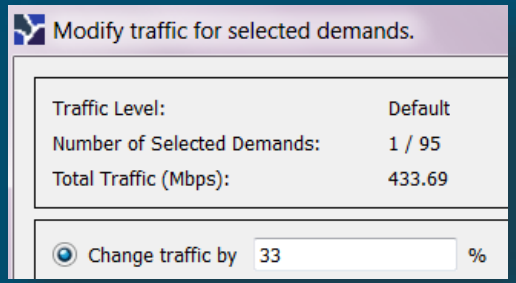
Use Cases

WAE Use Cases

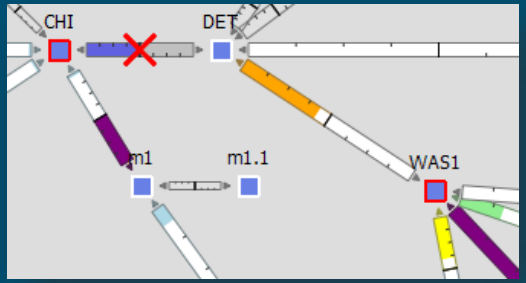
Planning

- Growth Forecasts
- Upgrade Analysis
- New Service Impact
- SLA planning



Engineering/ Architecture

- Failure Analysis
- Balancing Traffic
- Topology Design
- SR,QoS Design



Operations

- Network Health and Traffic Trends
- Maintenance Planning
- Troubleshooting
- Congestion Mitigation

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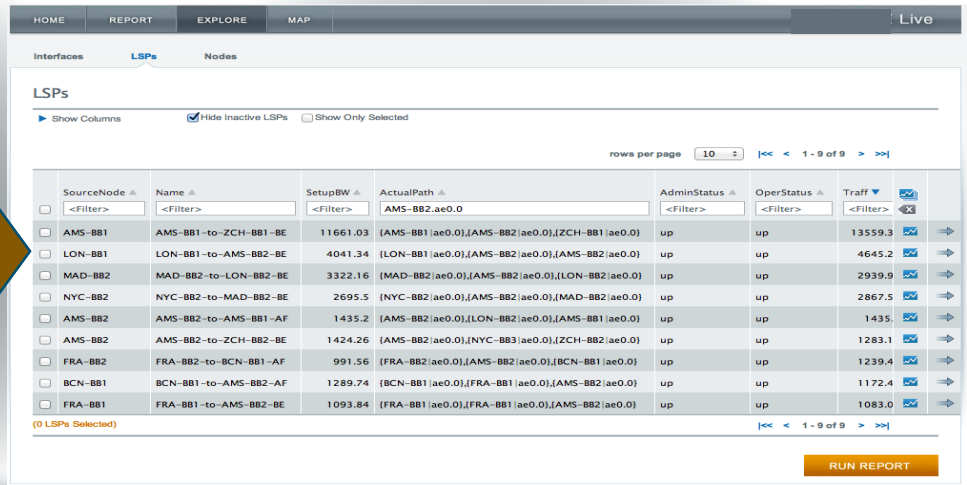
Use Case: Operations Team

Detect and resolve congestion

- Detect interface congestion on Map
- Navigate to related LSPs currently traversing interface and reroute

Value

Quickly Identifying congestion and resolving improves customer experience



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Use Case: Evaluate Onboarding of a New Service

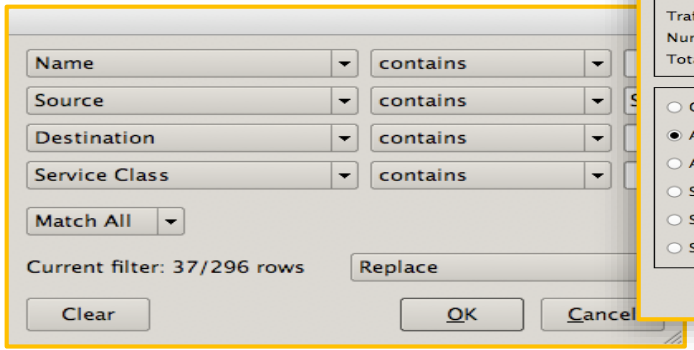
Scenario

Can a new service using 4Gbps at the San Francisco PoP be supported?

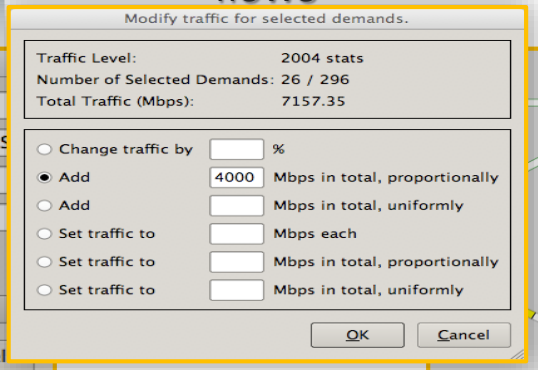
Value

Model and predict impact of the new service within minutes.

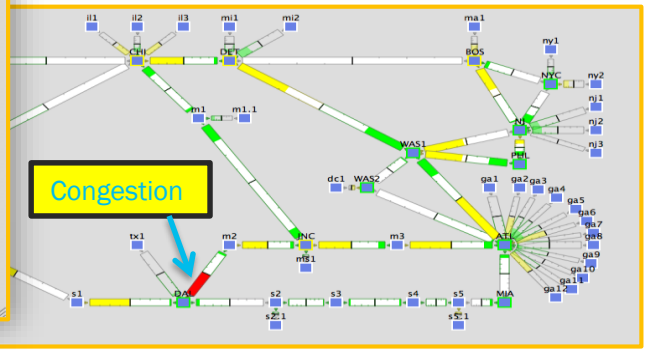
Identify flows for new Service



Add 4Gbps to those flows



Simulate results



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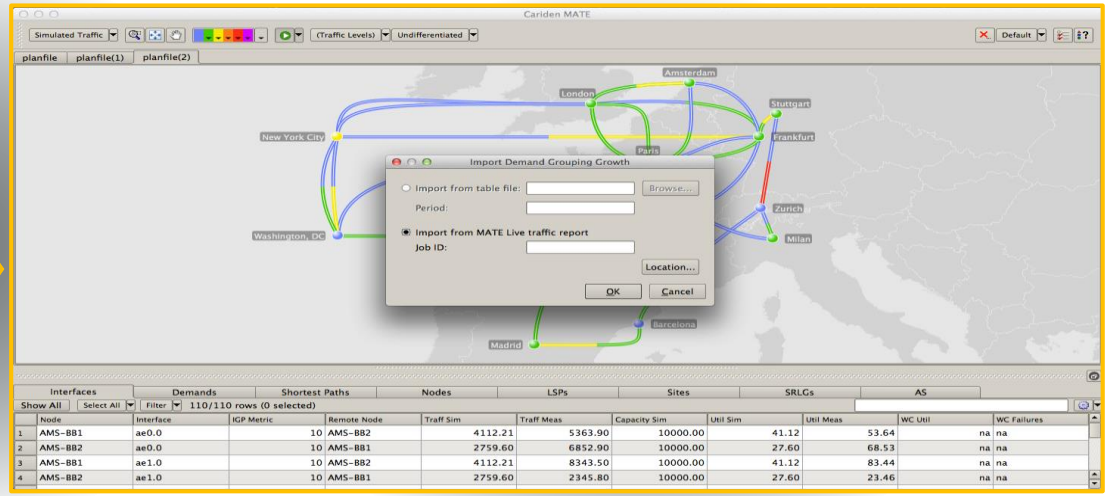
Use Case: Backbone Planner
Forecasting

- Generate network traffic growth reports
  - Per site or site to site, based on interfaces, LSPs or demand traffic
  - Use historic trending or import growth

Value

- Run projections and plan network changes accurately and quickly

Matrix	Number of LSPs	Traff (P95) Growth	
<Filter>	<Filter>	<Filter>	
ZCH -> ZCH	1	21.1%	
ZCH -> WAS	2	-51.28%	
ZCH -> STG	1	71.49%	
ZCH -> PAR	1	43.02%	
WAS -> STG	2	69.49%	
WAS -> NYC	1	46.18%	
STG -> STG	1	39.01%	
STG -> PAR	2	14.51%	
STG -> NYC	3	-33.63%	
PAR -> NYC	2	44.05%	



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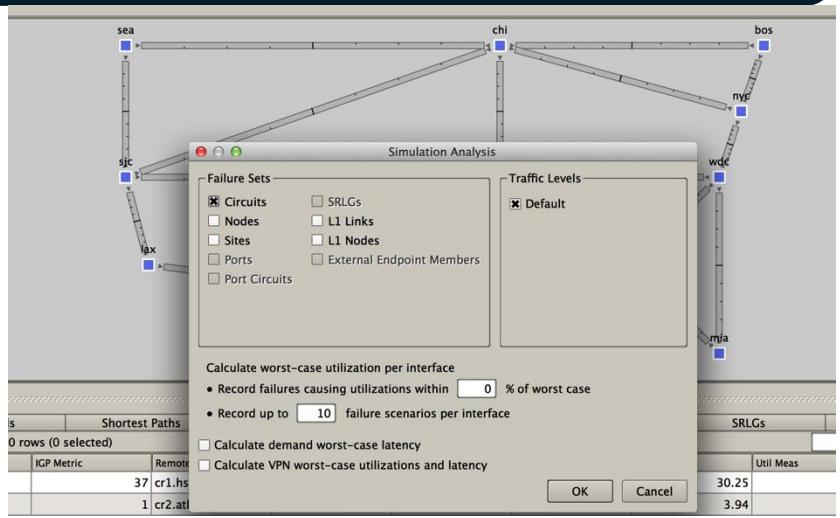
Use Case: Failover and What-If Analysis

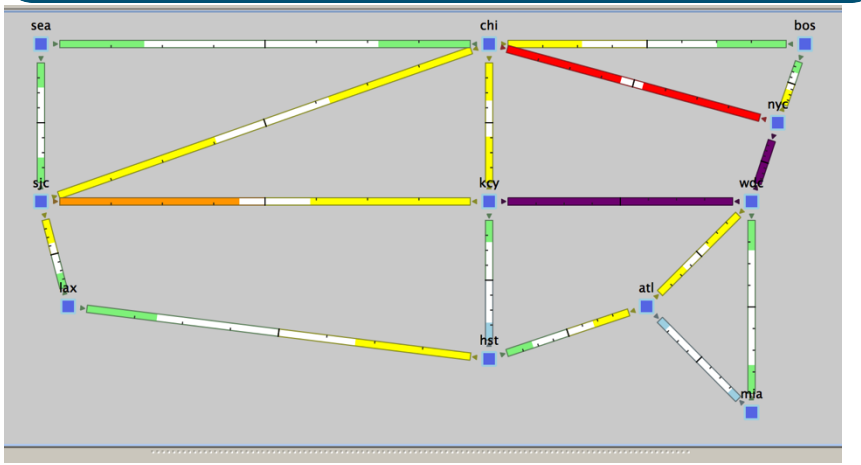
Scenario

What if a node / circuit / site/SRLG goes down ?

Value

Plan the network to **avoid any congestions** in any failure condition. Keep the network running in optimal state





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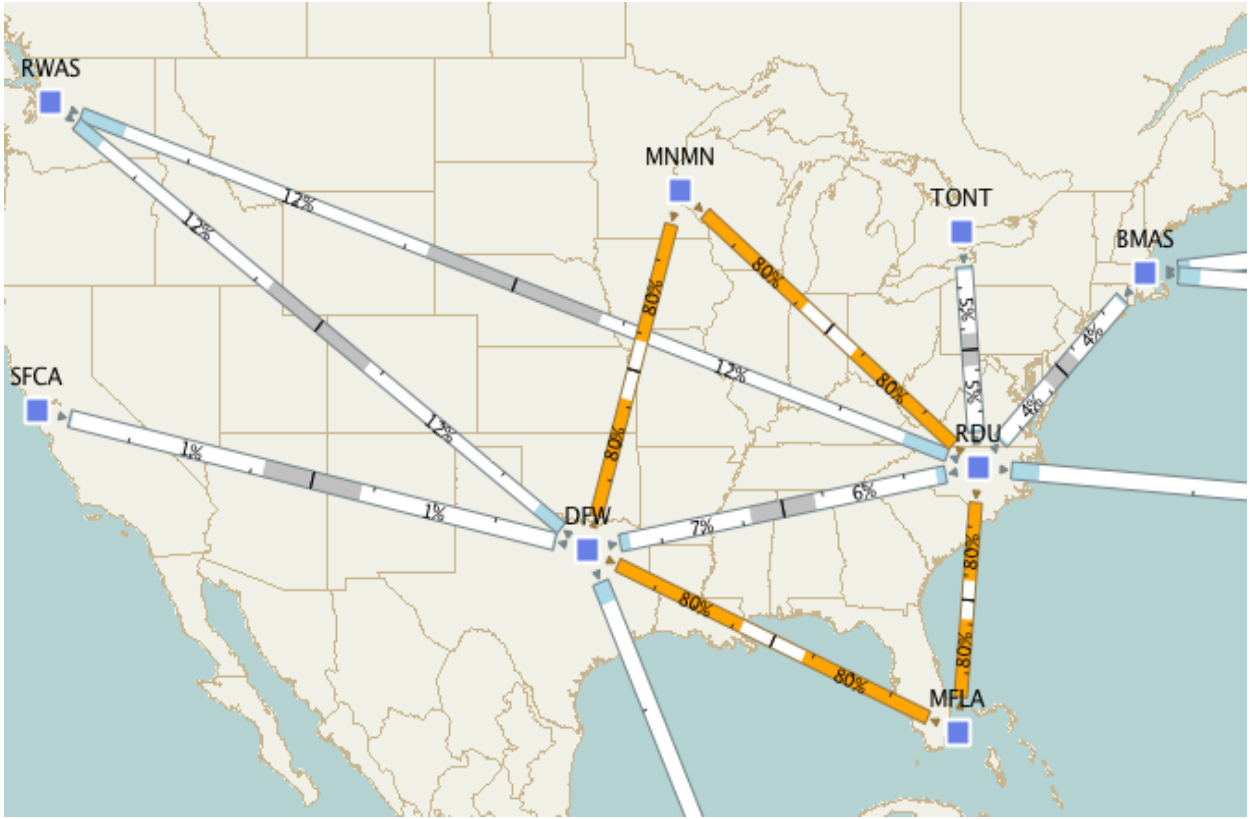
Use Case: Failure and SLA impact



Observation

Link failure increases utilization to 80%, but no traffic drops

Question

Is there SLA impact?

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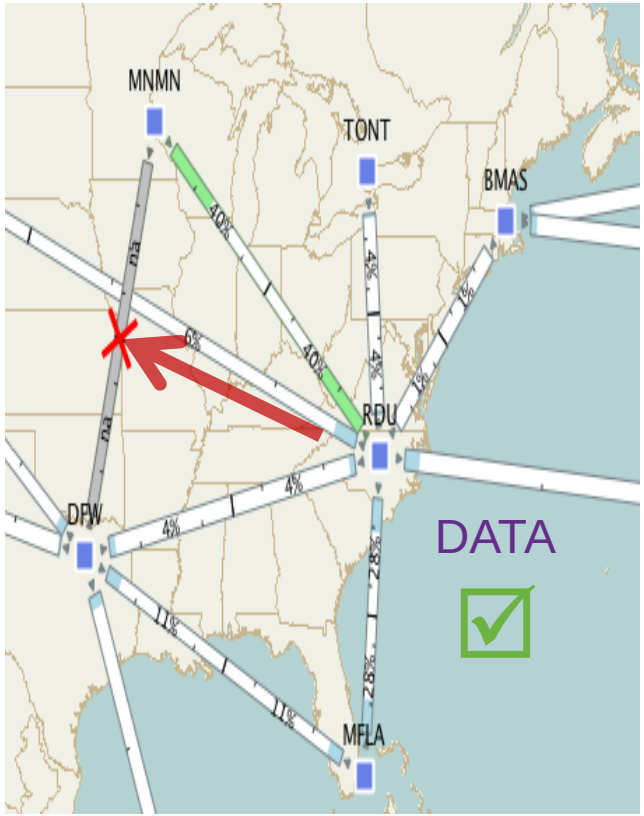
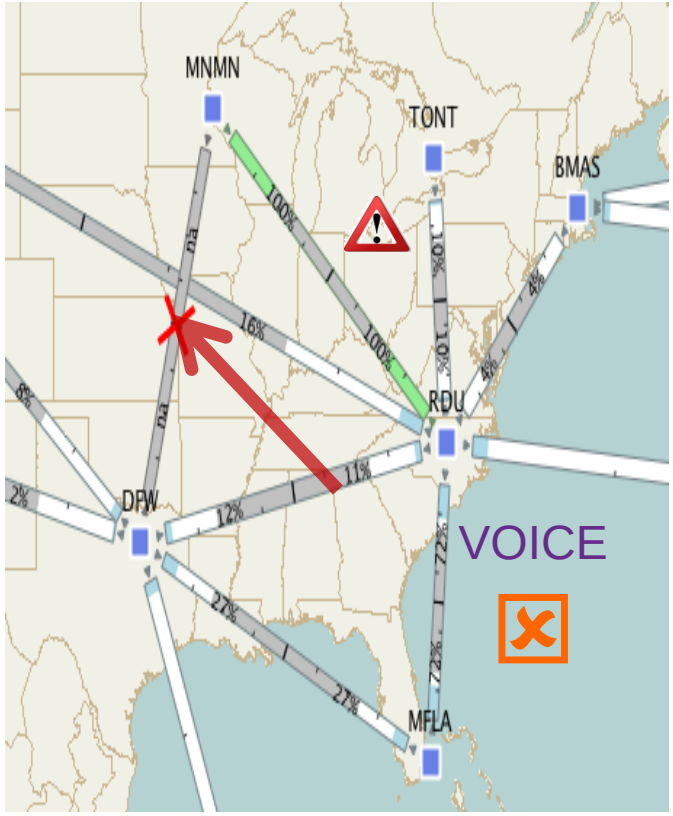
Use Case: Failure and SLA impact





Observations

VOICE Traffic drops under a single link failure

Analysis

Potential SLA violation

Recommendations

- Build redundant link
- Adjust metrics/policy
- Iterate

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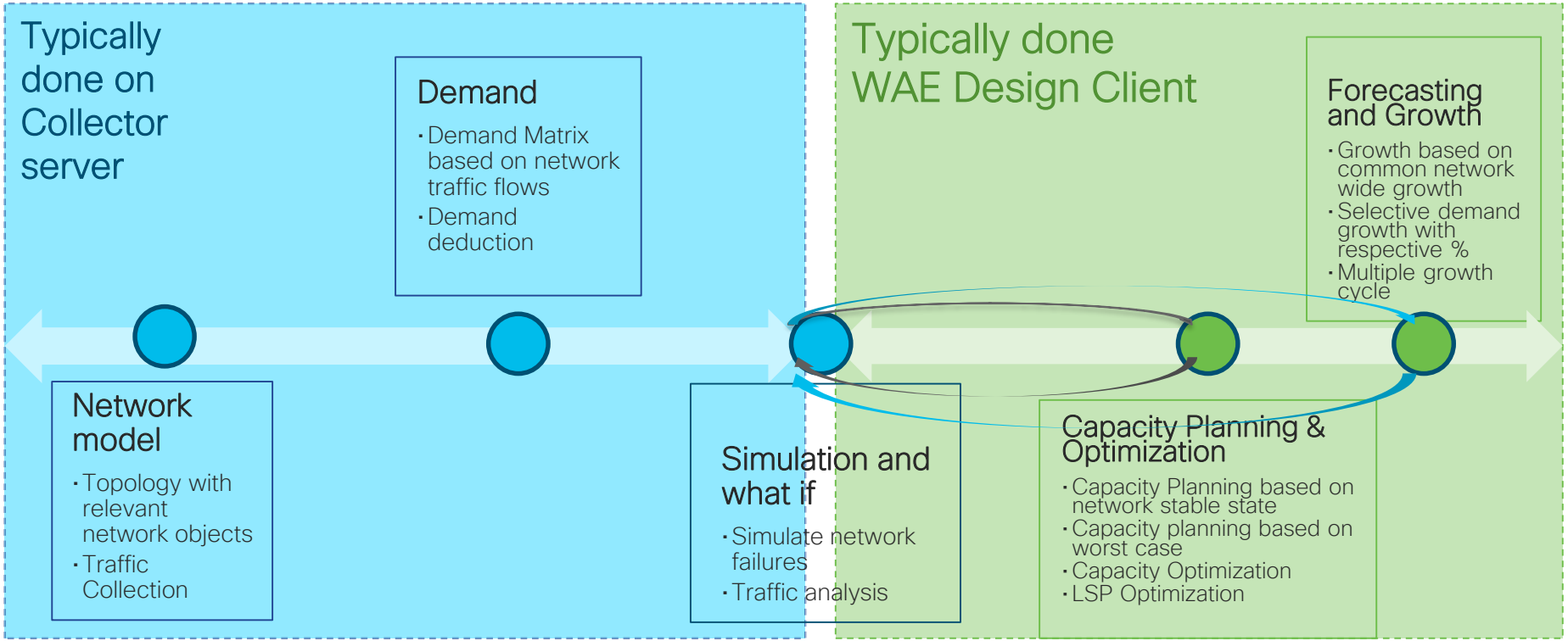
WAE Application Components & Steps for Planning

WAE: Steps for Planning



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WAE: Model Creation

Network Discovery

Network Polling

Discovery sequence

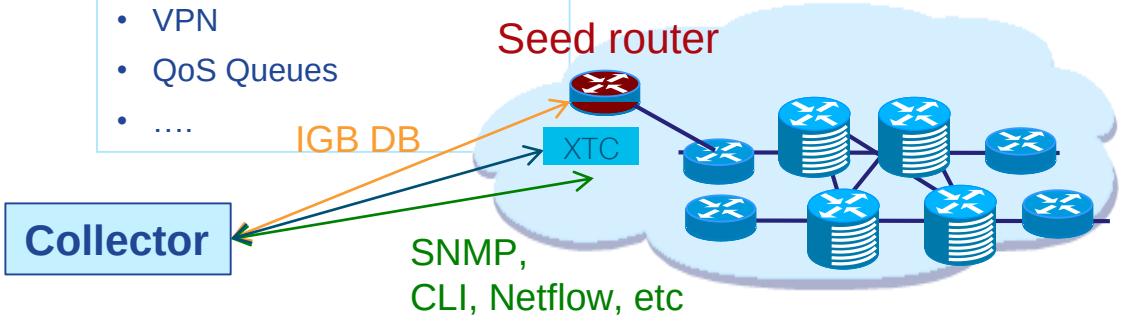
- IGP DB (topology)
- Node information
- Interfaces information
- BGP
- RSVP
- VPN
- Multicast
- …

Traffic Polling sequence

- Interfaces
- RSVP
- VPN
- QoS Queues
- ….

Save traffic profiles:

- Morning
- Evening
- Peak
- Low
- …



Outcome :
Network Topology and Visualization

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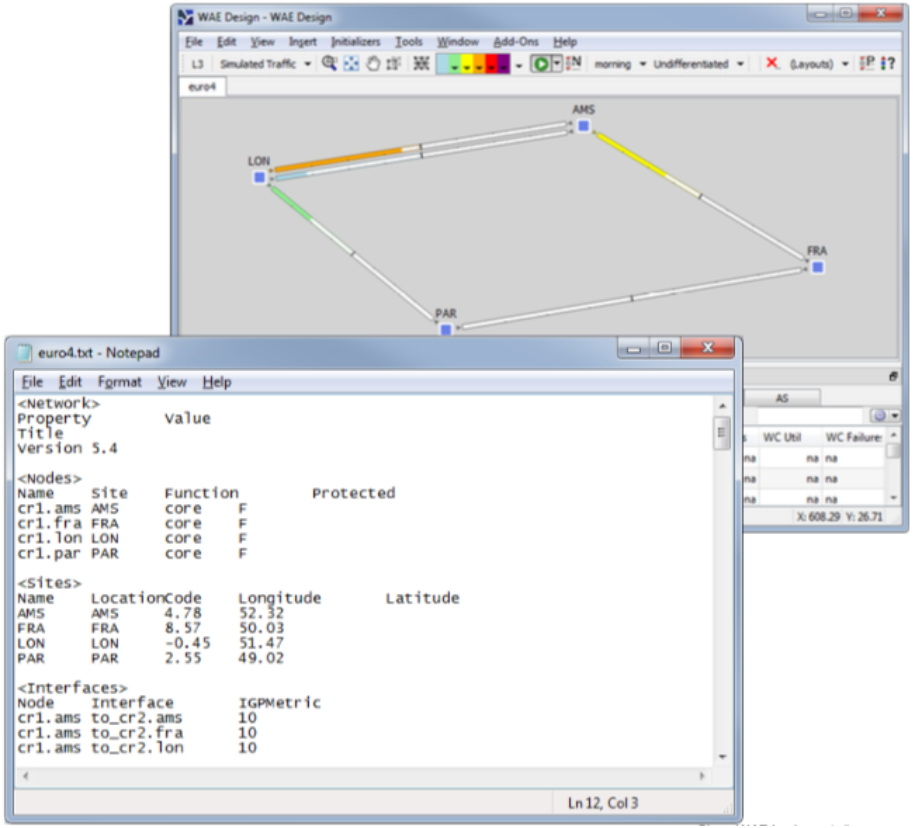
WAE : Plan File

- Unit of WAE data storage.
- Consist of a series of tables describing the network.
- Used by WAE applications to model the network.
- Typically created by WAE Collector.
- .pln format is compiled and can be read by applications or CLI tools.



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WAE Planning steps: Demand

- Measured traffic:
  - The Collector will poll the network to get amongst others interface traffic counters
  - That measured data does not really represent traffic flows and cannot be used as such.
- Demands - Simulated traffic:
  - For network-based simulations, the solution is to model a traffic matrix made of demands and simulated traffic.
  - Demands simulate an amount of traffic between source and destination endpoints (traffic flow).
  - WAE builds those demands using algorithms with measured traffic as input.
  - Demand routes are based on traffic, topology, network health, and the protocols used.
  - Used in what-if failure analysis, metric changes, and LSP routing.
  - Crucial for planning and determining network behavior under failure.

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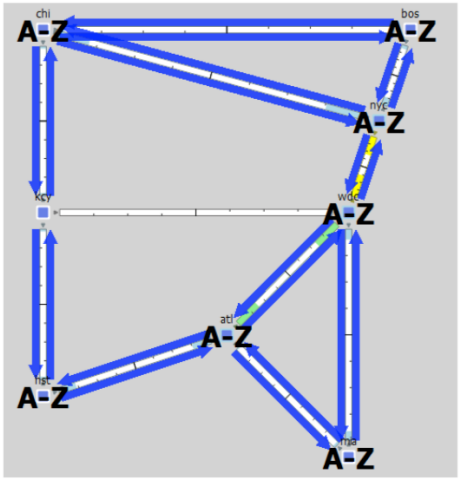
Outcome :
Traffic simulation

WAE Planning steps: Demand (Contd.)

Network Polling → Demand Deduction

Demand Meshes :

- With demand meshes you can quickly define several demands at once.
- Demand mesh is a set of demands, for example the demands between all pairs of nodes in the network.



Note:

Since demands determine how traffic is routed through the simulated WAE Design model, creating realistic demands and demand meshes is imperative to the accuracy of other information that can be derived from WAE Design.

Outcome : Traffic simulation

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WAE Planning steps : Simulation and What-if Analysis

- Select 1 or more network objects:
  - Circuits
  - Nodes
  - Sites
  - SRLG
  - L1 Links
  - …
- Perform failure based on different traffic profiles
- Observe hot spots and worst case traffic, and impacted network
  - Plan network maintenance
  - Identify impacted customer's services

Outcome :
Hot Spot identification, and Network steady state traffic

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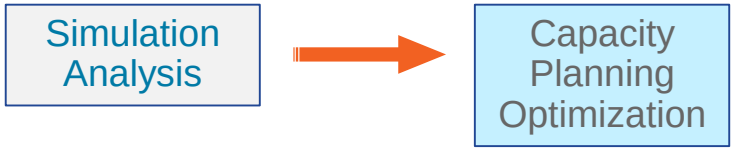
WAE Planning steps : Capacity Planning Optimization



- Perform network wide or selective optimization
- Cap optimization by Interface Util Measure
- Based on Utilization threshold augment capacity in chunks
- Achieve max. ECMP by modifying metrics (if required to divert traffic to meet threshold criteria)
- Produces capacity upgrade report
- Optionally, run failure analysis on upgraded network to observer impacted traffic because of an object failure

Outcome :
Network optimization, and Network Planning

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WAE Planning steps : Capacity Upgrade

- Perform network wide or selective Circuit Upgrade
- Circuit Upgrade based on Interface Utilization
  - Measured
  - Simulated
  - Worst Case
- Augment capacity in chunks
- Produces capacity upgrade report

Outcome :
Network Planning, BoM Creation, ROI evaluation

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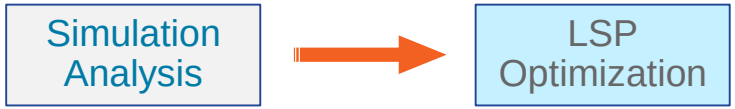
WAE Planning steps : LSP Optimization



- Identify the congested interfaces on Map
- Filter to LSP traversing through the congested interfaces
- Rank the LSP based on either traffic, customer
- Selectively optimize the LSPs

Outcome :
Congestion Mitigation and SLA verification.

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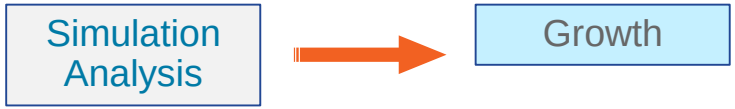
WAE Planning steps : Forecasting and Growth



- Get forecasted demand
  - From business requirements
  - From WAE LIVE trending reports
- Add forecasted demand to network model
  - Individual demand
  - Demand grouping
- Produce growth plan for a period or multiple periods
- Perform simulation analysis to analyze future state worst

Outcome :
Network future steady state, and host spots based on current traffic growth or business projection.

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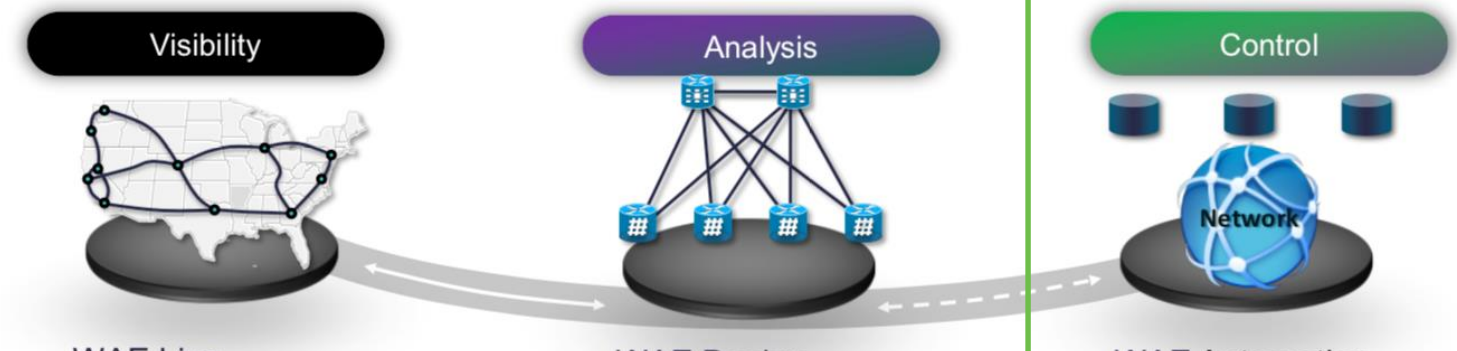
WAE Application Components



WAE Live

Visualize the Network

- Explore and understand infrastructure (filter, sort, drill down)
- Visualize hotspots in global context
- Report and analyze trends

WAE Design

Optimize the Network

- Evaluate traffic in conjunction with topology
- Predict ramifications of traffic changes
- Use risk assessment in planning
- Reclaim unused bandwidth

WAE Automation

Control the Network

- Fulfill customer demands with automation
- Enable high value applications to tune network
- Rapidly adjust network configuration to current-state demand matrix

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WAE Design : Model , Simulate, Analyze Failures

- How efficient is the network topology?
- How does traffic flow across the network? Can it be optimized?
- Can existing capacity be used more effectively?
- What is the least costly way to upgrade my network?
- How will my network function under risk of failure?
- How can I locate demands where they will incur the lowest delay?
- Which customers are impacted by planned outages?
- Can I redistribute traffic more effectively using IGP? Using MPLS?

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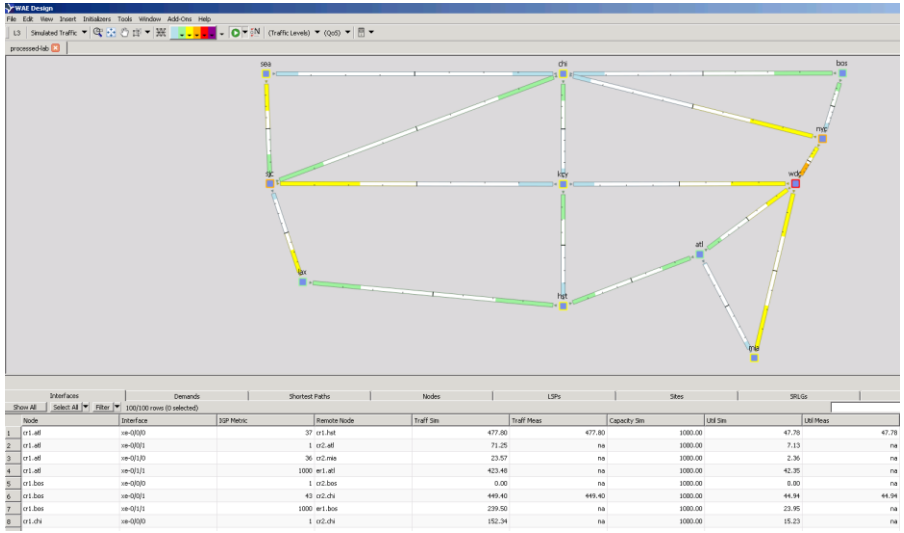
WAE Design : Model , Simulate, Analyze Failures

- WAE Design
  - Visualization
  - Simulation
  - Offline TE
  - Reporting
- Installed on the server or can be on dedicated machine
- Application available for Linux ,Windows ,MacOSX



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WAE Live : Immediate access to current & Historical Data

- Where are my hottest network congestion points?
- How much traffic is crossing each interface? Each LSP?
- Which LSPs are too large for the traffic they are carrying?
- Which LSPs may need to be split?
- How can I optimize my link access groups (LAGs)?
- Which interfaces/nodes/tunnels are carrying the most traffic?
- How can I use time-series data to form a more realistic trend analysis?
- Which peer(s) are causing congestion and at what times of day/week/month?

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WAE Live : Immediate access to current & Historical Data

- Web Client
- View a weather map of the network
- Drill-down to explore and analyze the latest data
- Create and run reports that analyze historical data

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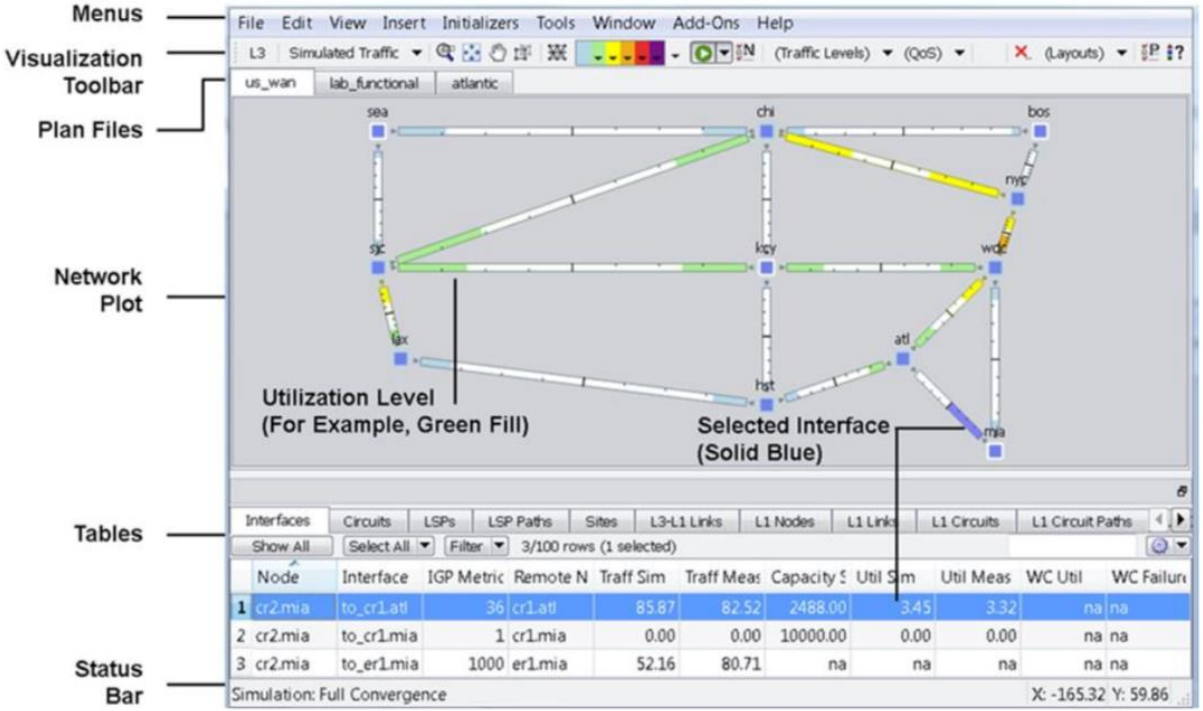
Demo 1: WAE Planning - Design

- Working with WAE Design
- Demand Mesh & Demand Deduction
- What-if analysis
- BOD & TE
- Capacity Planning
- Forecasting

Hands-On Exercises

WAE Design User Interface



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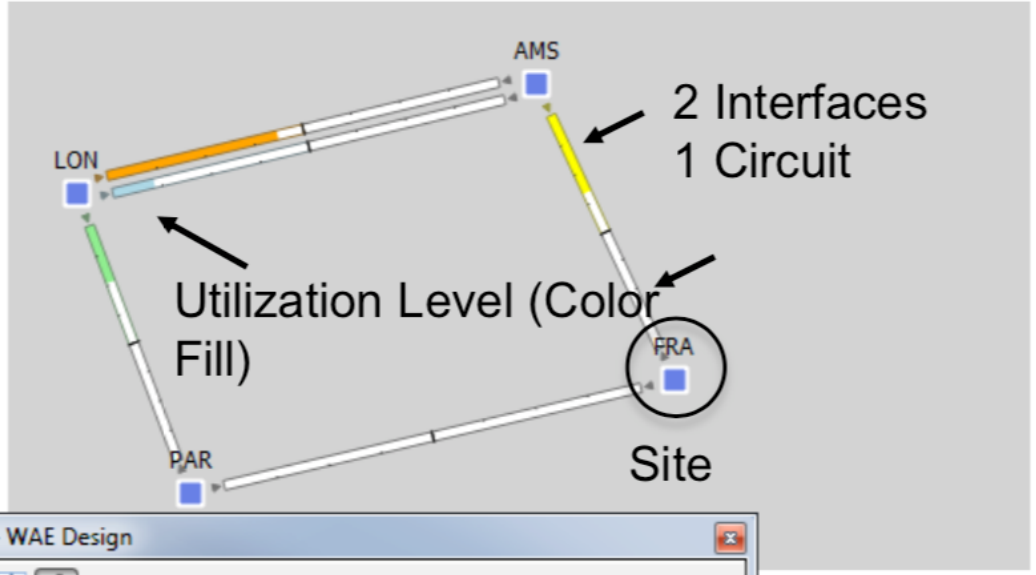
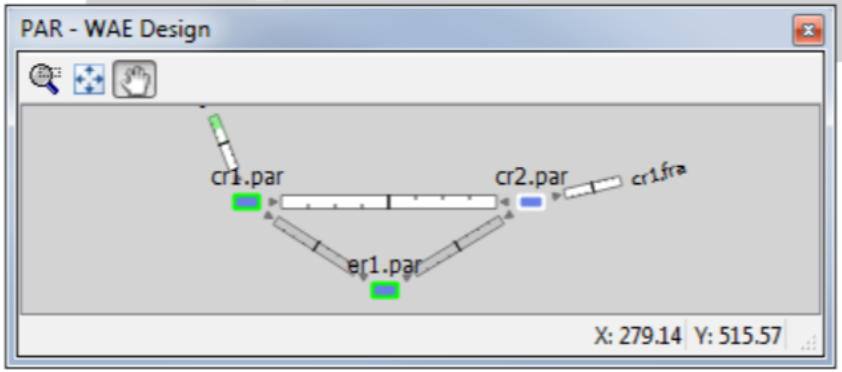
WAE Design: Network Plot

- Network plot shows sites (squares).
- Circuits appear to connect sites, although they actually connect nodes (routers) within each site.
- Each circuit consists of two interfaces with color fills to show outbound utilization.
- Double-click on site displays details including nodes.





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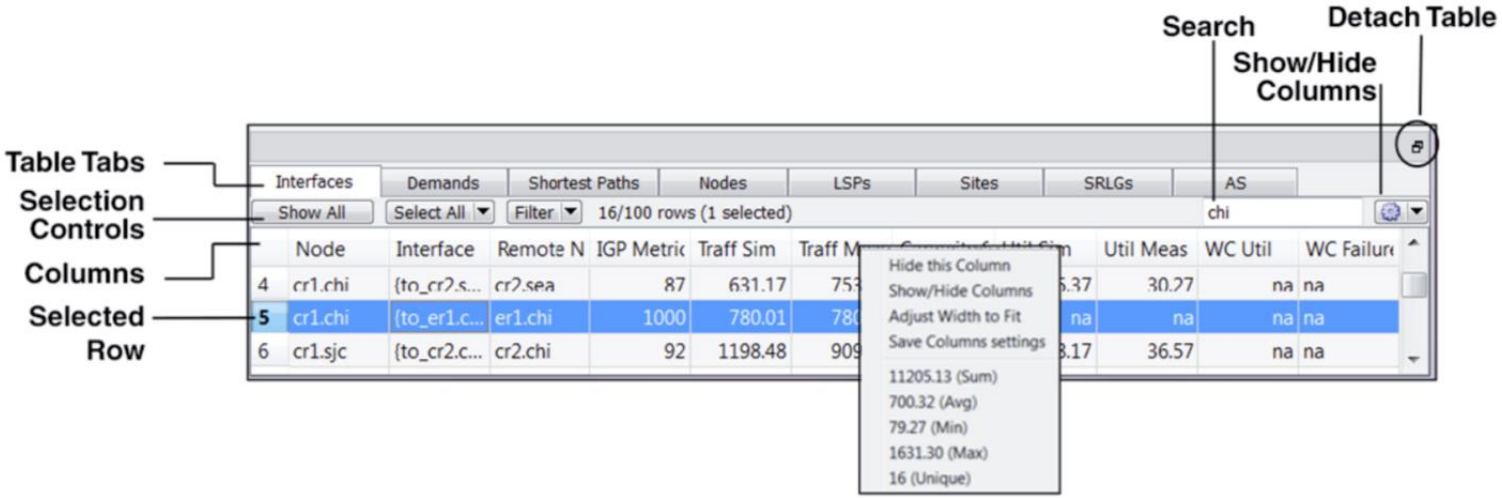
WAE Design : Tables



- You can customize which tables and columns appear.
- Right-click on column headings and table tabs to show/hide.
- Right-click column headings to get column-specific data (Sum, Avg,..).

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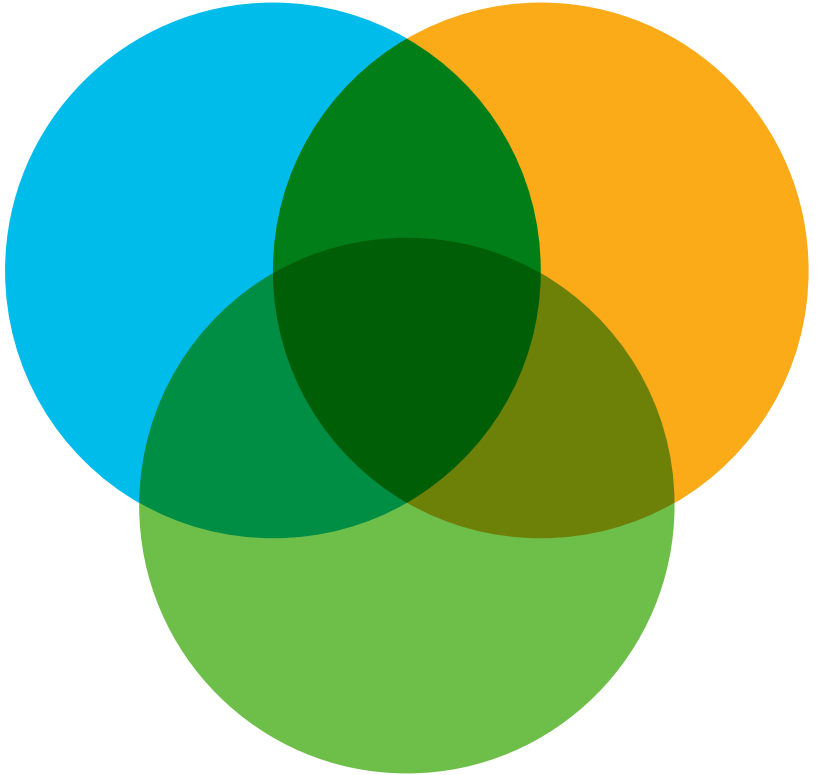
Demo 2: WAE Planning – WAE Live

- Weather map & Drill Down
- Analytics & Reports

* Demo only

WAE Automation



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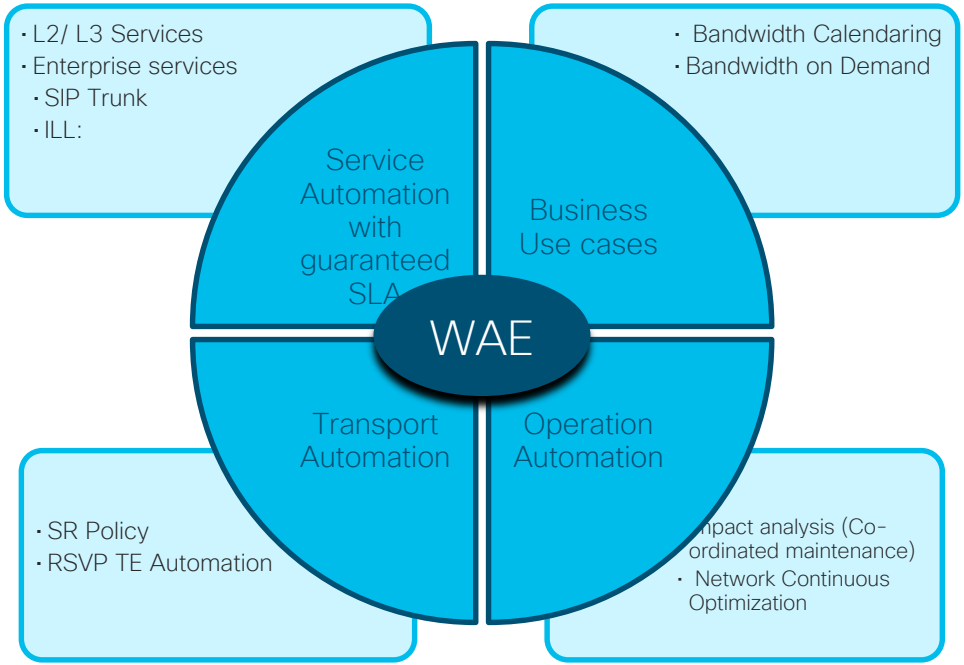
WAE Automation: Core To Intelligent Automation (Network Aware)

NSO integrates with WAE to validate SLA for the services.



Custom apps uses WAE API to evaluate the operation and Business use cases.

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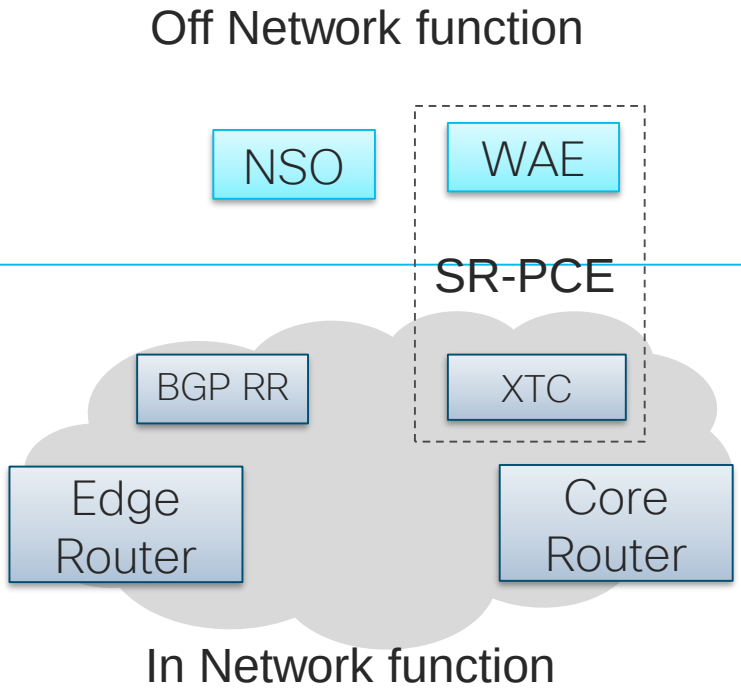
Cisco WAN Automation Architecture

Network : Segment Routing

Network Service Orchestration
(in charge of automating network service creation)

Wan Automation Engine
(in charge of capacity planning optimization: analytic or reactive mode: Bandwidth Optimization, Bandwidth Reservation,…)



BGP Router Reflector
(in charge of scaling MP-BGP: signal network services IPv4, IPv6, VPNv4, VPNv6, L2VPN,…)

SR-Path Compute Engine (XTC)
(in charge of scaling SR-TE: compute multi-domain path with constrain for Edge Router equipment; Disjoint path, Low Latency path,..)

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Cisco WAN Automation Architecture

Network : MPLS (RSVP)

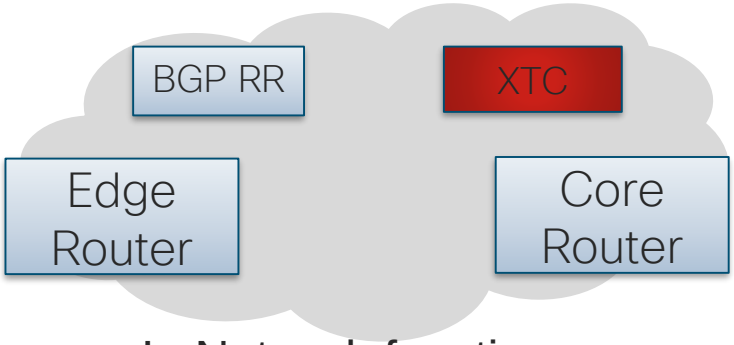
Network Service Orchestration
(in charge of automating network service creation)

Wan Automation Engine
(in charge of capacity planning optimization: analytic or reactive mode: Bandwidth Optimization, Bandwidth Reservation,…)

Off Network function

NSO

WAE



In Network function

BGP Router Reflector
(in charge of scaling MP-BGP: signal network services IPv4, IPv6, VPNv4, VPNv6, L2VPN,…)

SR-Path Compute Engine (XTC)
(in charge of scaling SR-TE: compute multi-domain path with constrain for Edge Router equipment; Disjoint path, Low Latency path,..)

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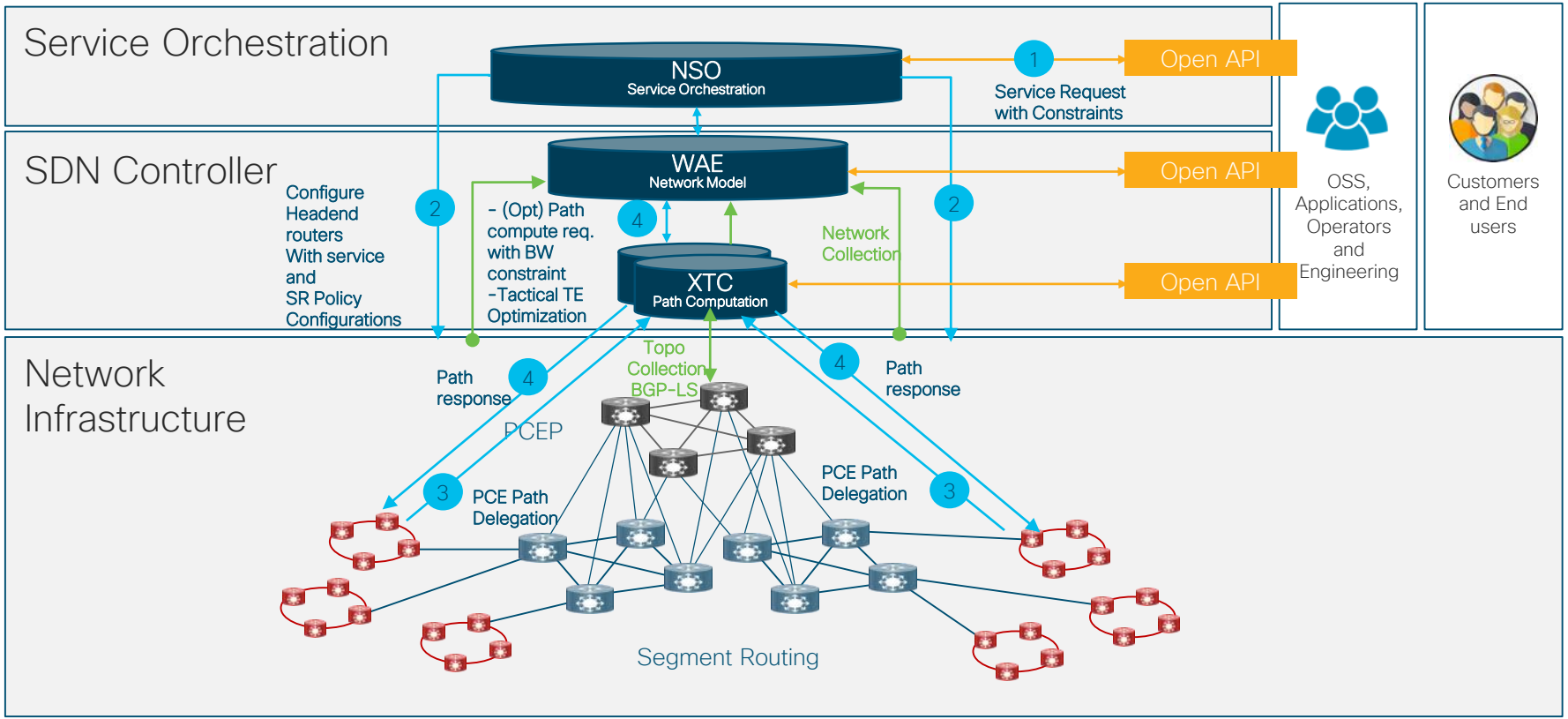
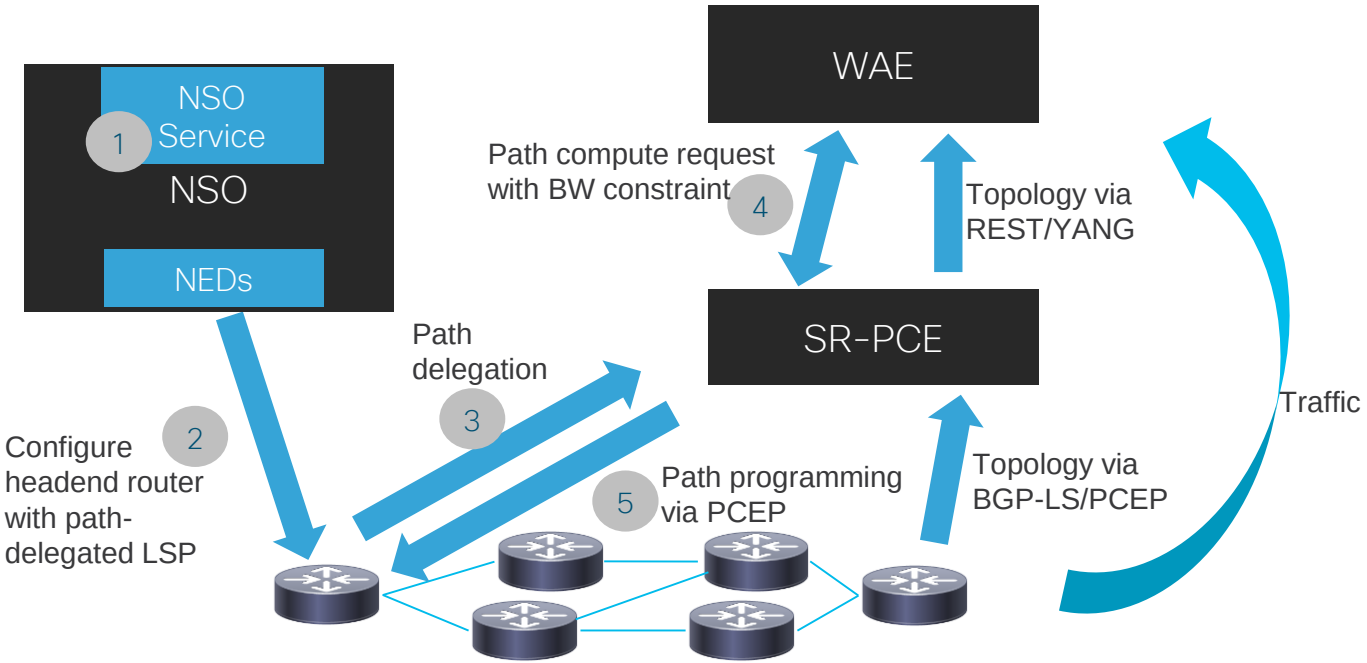
SDN Flow


Service Orchestration
NSO
Service Orchestration
1
Service Request
with Constraints
Open API
SDN Controller
WAE
Network Model
Open API
Configure
Headend
routers
With service
and
SR Policy
Configurations
2
- (Opt) Path
compute req.
with BW
constraint
-Tactical TE
Optimization
4
Network
Collection
2
XTC
Path Computation
Open API
OSS,
Applications,
Operators
and
Engineering
Customers
and End
users
Network
Infrastructure
Topo
Collection
BGP-LS
Path
response
4
PCEP
4
Path
response
3
PCE Path
Delegation
PCE Path
Delegation
3
Segment Routing

WAE: Automation Apps

WAE 7.1
XTC - XR 6.4.1

Service-driven BW on Demand



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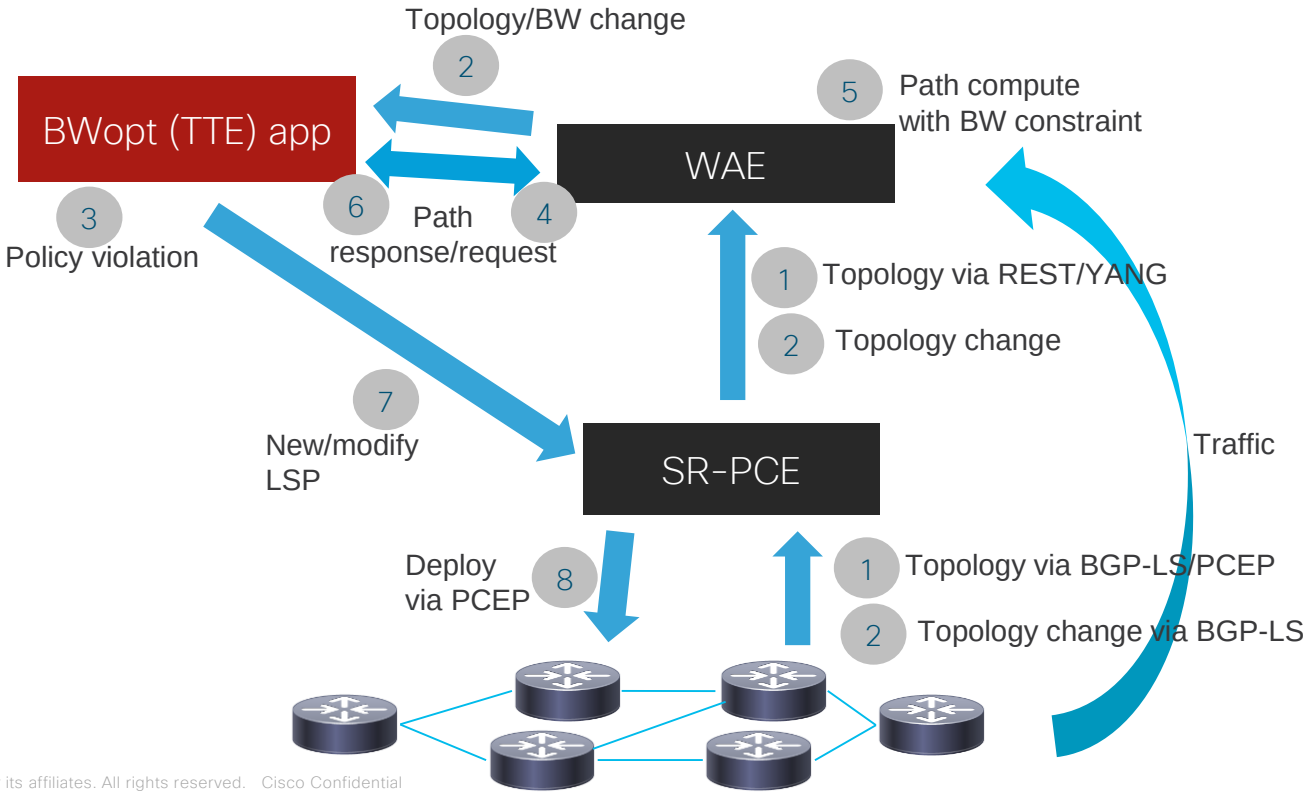
WAE 7.1
XTC – XR 6.4.1

Tactical BW Optimization



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Demo 3: WAE Automation

- Segment Routing Policy Orchestration using NSO
- BOD / BW Opt.*

* Demo only If time permits

WAE References

WAE References and Useful Links

- Product Documentation:
  - WAE Installation Guide: https://www.cisco.com/c/en/us/td/docs/net_mgmt/wae/7-1/server_installation/guide/b_Cisco_WAE_Installation_Guide_71.html
  - WAE 7 User Guide: https://www.cisco.com/c/en/us/td/docs/net_mgmt/wae/7-1/user_guide/b_Cisco_WAE_User_Guide_71.html
  - WAE & Design User Guide: https://www.cisco.com/c/en/us/td/docs/net_mgmt/wae/7-0-1/design/user/guide/WAE_Design_701_User_Guide.html
  - WAE LIVE User Guide: https://www.cisco.com/c/en/us/td/docs/net_mgmt/wae/6-4-1/live/user/guide/WAE_Live_User_Guide.html
  - WAE Design Tutorial: https://www.cisco.com/c/en/us/td/docs/net_mgmt/wae/7-0-1/design/tutorials/b_Cisco_WAE_Design_Tutorials_701.html
- API/Devnet: https://developer.cisco.com/docs/wan-automation-engine/

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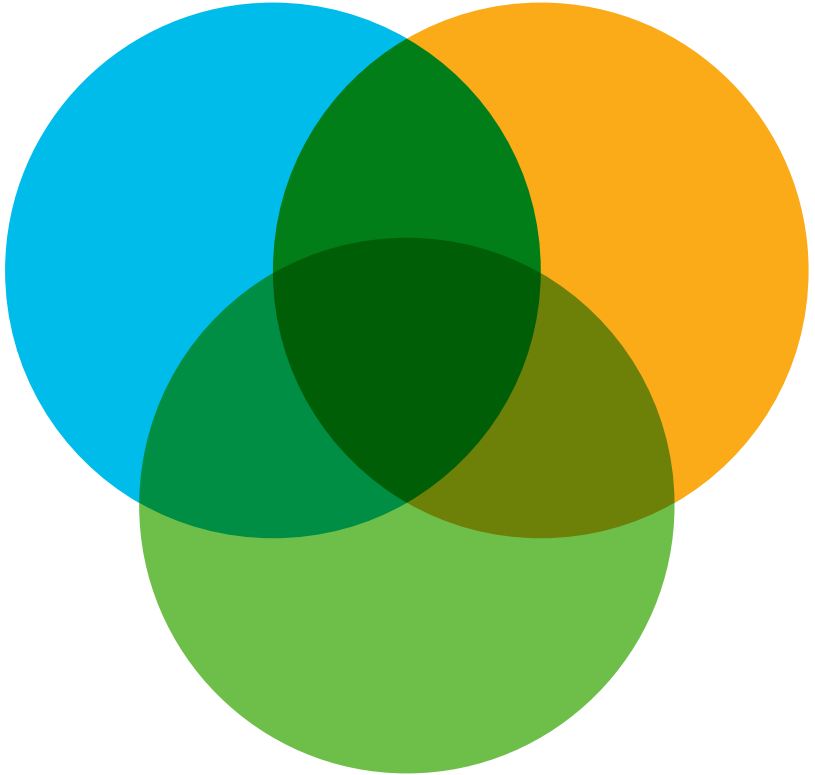
Key Takeaways



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WAE Key Differentiators

- **Industry Leading Algorithms** exposed via API's that enable automation and application development for traffic engineering, peering, forecasting, and planning
  - World class customer proven optimization algorithms for Capacity, Latency, Disjointness, and Avoidance
- **Network Model** driven platform for optimization, simulation, and automation:
  - Built for Multi-vendor, Multi-Area, and Multi-Layer networks
  - Prediction and analytics via time-series statistics, flow data, and traffic
- Key enabler for next-generation technologies: **Segment Routing** and **Unified Multi-Layer**
- **Comprehensive and Powerful SDN Automation Engine**

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