How to alleviate the Diff-Serv TE Network Design Complexity ?

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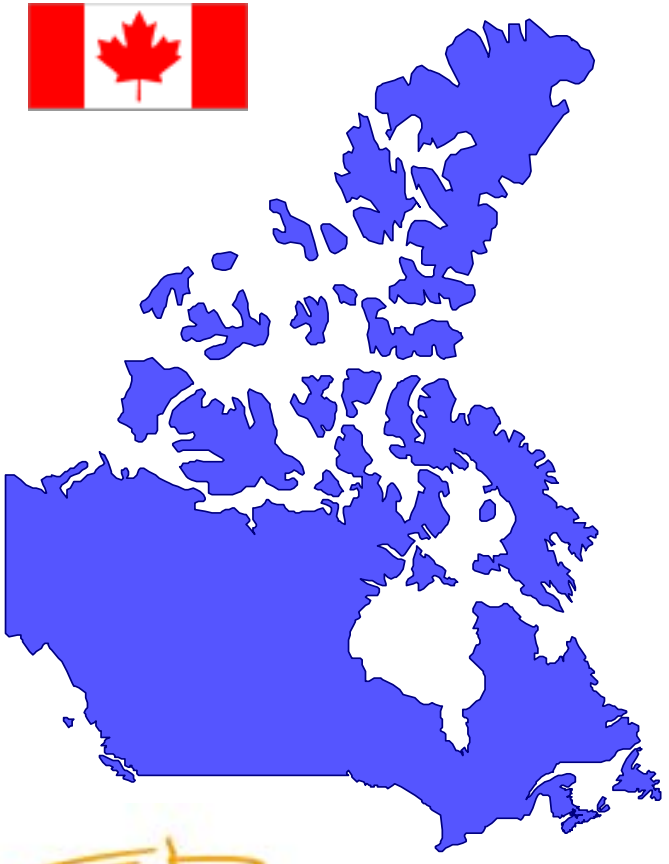
About Bell Canada



- Bell Canada is the leader in Telecom in Canada for IP Services: Tier 1- Internet Service Provider, Voice over IP, MPLS-VPN (RFC 2547), Ethernet (RPR), Frame & ATM Services.

About WANDL

- Head office in USA (NJ) with customer support offices in Singapore, UK, Italy and Belgium
- 19 year expertise in Network Design/Planning Automation/OSS.
- Technical Partnerships with Cisco, Juniper, Tellabs, Alcatel, Nortel, Lucent,…
- Customers
  - Telco, PTTs
  - ISPs, Service Providers

Quick reminder about DiffServ-TE

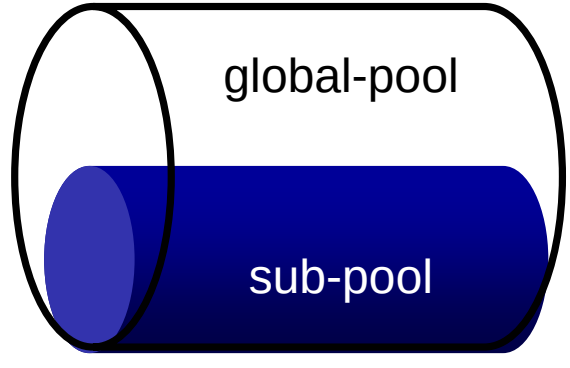
- DiffServ-TE adds the class of service dimension to “regular” MPLS-TE.
  - RSVP Resources in the network are specified on a class basis
  - Call Admission Control is performed per class

Feature	Resource reservation	Scope
DiffServ	Queuing reservation (data plane)	point to point
MPLS-TE	RSVP bandwidth (control plane)	end to end
DiffServ-TE	RSVP bandwidth per IP class (control plane)	end to end

Cisco DiffServ-TE IOS implementation

- Two types of tunnels can be defined:
  - “Data tunnels” are constrained by the RSVP Global Pool bandwidth
  - “Voice tunnels” ONLY are constrained by the RSVP Sub Pool bandwidth
- Cisco current DiffServ-TE is based on Russian Doll Model
- Sample configuration

```
interface POS5/1
     ip rsvp bandwidth 150000 150000 sub-pool 45000
!
interface Tunnel2000
    tunnel mpls traffic-eng bandwidth sub-pool 50000
 !
interface Tunnel3000
    tunnel mpls traffic-eng bandwidth 50000
```



Juniper DiffServ-TE implementation

- Two options for Juniper DiffServ TE:
  - Single class LSP
  - Multi-class LSP
- Two bandwidth models to perform Call Admission Control:
  - Russian Doll Model (RDM)
  - Maximum Allocation Model (MAM)

	Number of bandwidth constraints	Bandwidth sharing
Single class LSP (L-LSP)	1	RDM or MAM
Multi-class LSP (E-LSP)	Up to 4	RDM or MAM

Juniper DiffServ TE configuration

mpls stanza	class of service stanza

diffserv-te {
bandwidth-model mam;
}
label-switched-path l-lsp {
to 145.255.45.48;
bandwidth ct1 10m;
}
label-switched-path single-class-lsp {
to 145.255.45.48;
bandwidth ct2 5m;
}
	scheduler-maps {
	simple-map {
	forwarding-class AF scheduler fair;
	forwarding-class BE scheduler fair;
	forwarding-class NC scheduler fair;
	forwarding-class EF scheduler fair;
	}
	}
	schedulers {
	fair {
	transmit-rate percent 25;
	buffer-size percent 25;
	}
	}

Diff-Serv TE complexity

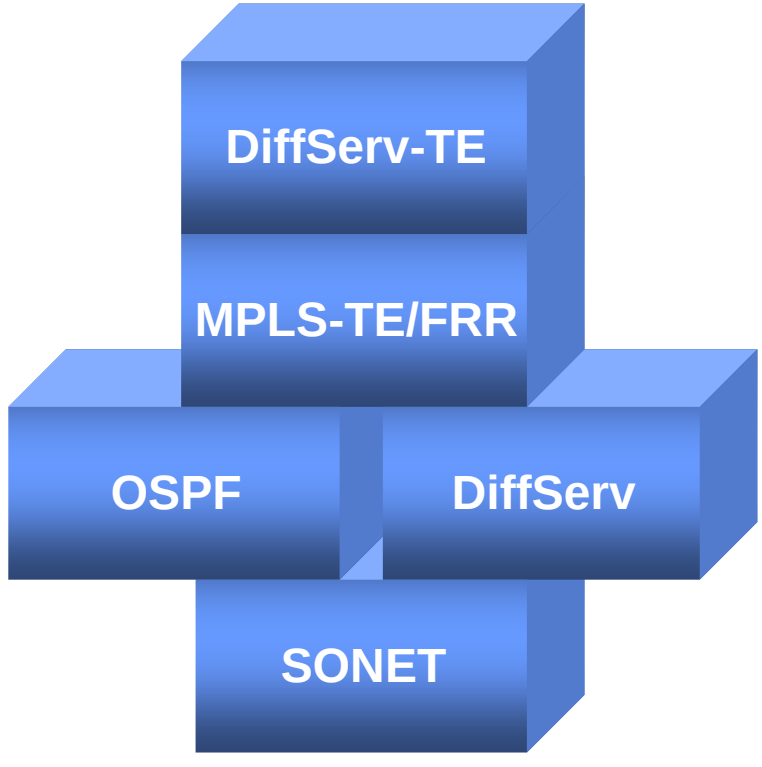
- DiffServ-TE is a very convenient mechanism for enabling bandwidth guarantees similar to ATM Class Of Service in multimedia networks.
- Yet DiffServ-TE is complex to manage:
  - Russian Doll Model is not so intuitive when available bandwidth is to be calculated per class
  - Tunnels/LSP for the “smallest doll” need to be assigned a high priority/preemption to get some shares of the bandwidth
- And because of MPLS-TE intrinsic complexity…

MPLS-TE design: many options…

Main purpose	☐ “Real” Traffic Engineering	☐ Network Protection only	☐ Deliver Traffic Matrix
Tunnel deployment	☐ Full mesh	☐ One-Hop Tunnel	☐ Limited/regional
Link colors	☐ All links	☐ Limited: e.g. only “transcontinental” links	☐ No
Primary Tunnel Bandwidth	☐ 0 BW	☐ auto-bandwidth	☐ User-defined
Backup Tunnel Bandwidth	☐ 0 BW	☐ % of interface BW	☐ % of Primary Tunnel BW
Inter-area TE	☐ Required	☐ Via verbatim path option	☐ No
Multicast TE	☐ Required	☐ Only for major sources of traffic	☐ No.

Recommendations for DiffServ-TE roll out

- DiffServ-TE is usually deployed on top of a multi-layer network.
  - Multi-layer Design requires a good knowledge of the interaction between the various layers.
  - Design of Layer “N” requires that Layer “N-1” is properly engineered
- Automate the engineering tasks:
  - audit/inventory/analysis of Baseline
  - Network Design
  - Network Provisioning



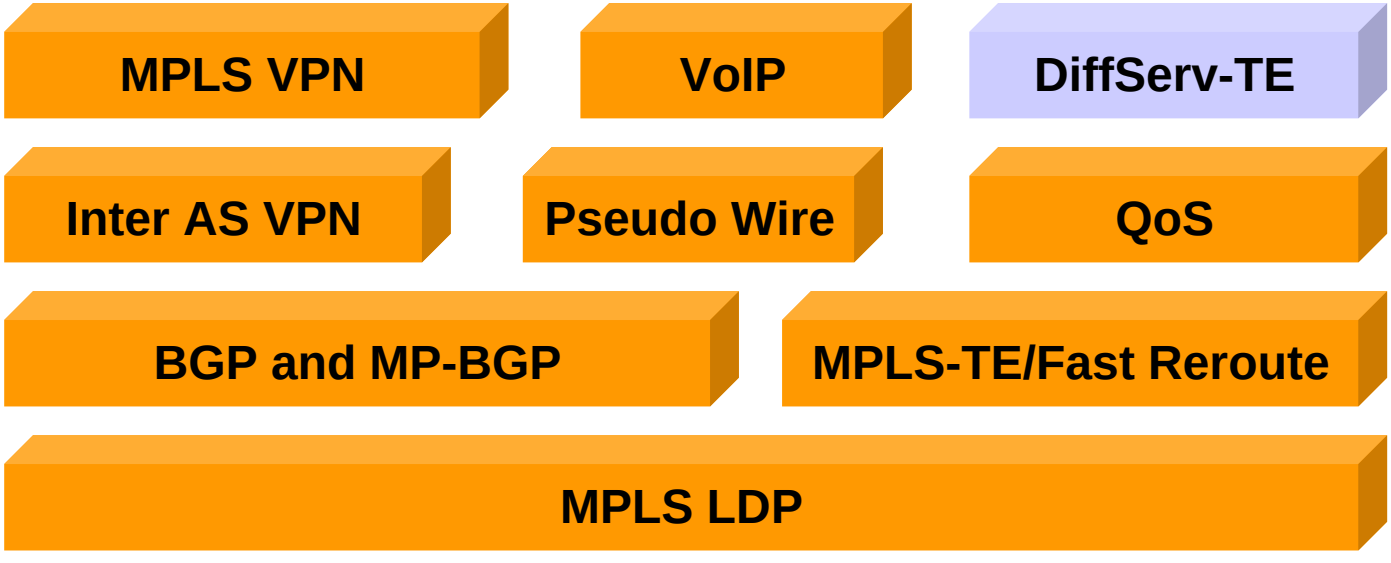
Real life case study

How to effectively manage the deployment and the organic growth of Toll Voice Trunks in a Multi-Service MPLS-IP Infrastructure

Bell Canada IP Network & Services

- Halifax (Canada) to Palo Alto (USA) ~8000 KM
- Internet Peering & Transit
- MPLS-TE/FRR Tunnels (WAN Consolidation)
- VPN IPSec Service
- VPN 2547 Service
- DSL PPOE Internet Retail & Wholesale Service
- Business Internet Retail & Wholesale Service
- FoMPLS Service
- Inter-AS VPN Service for World Wide Private VPN Connectivity

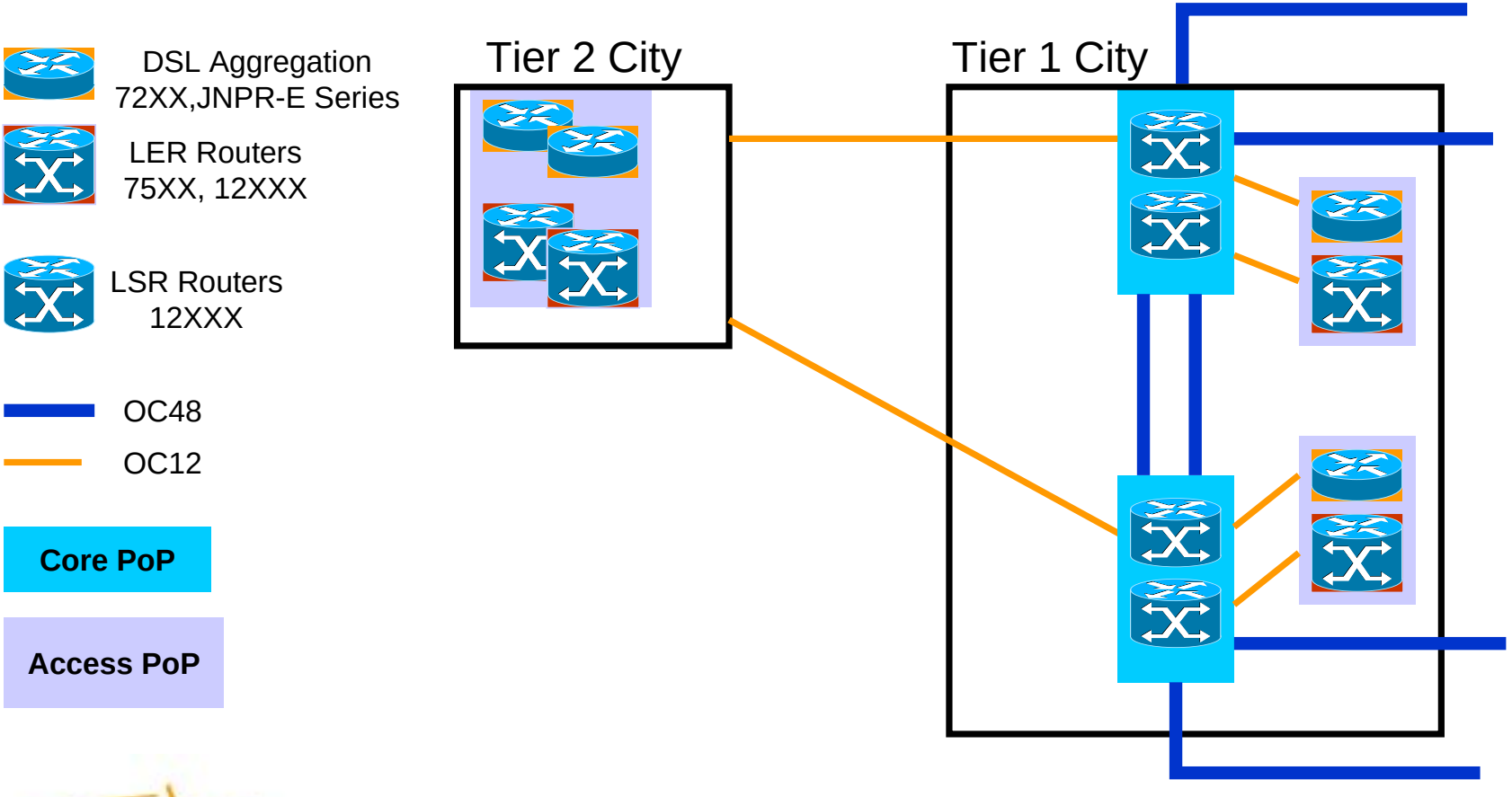
Bell Canada MPLS-IP Core Network Features



Existing features

2006 features

Bell Canada IP Network POP Architecture



Bell Canada Fast Reroute Deployment

Primary TE tunnels (Full mesh)

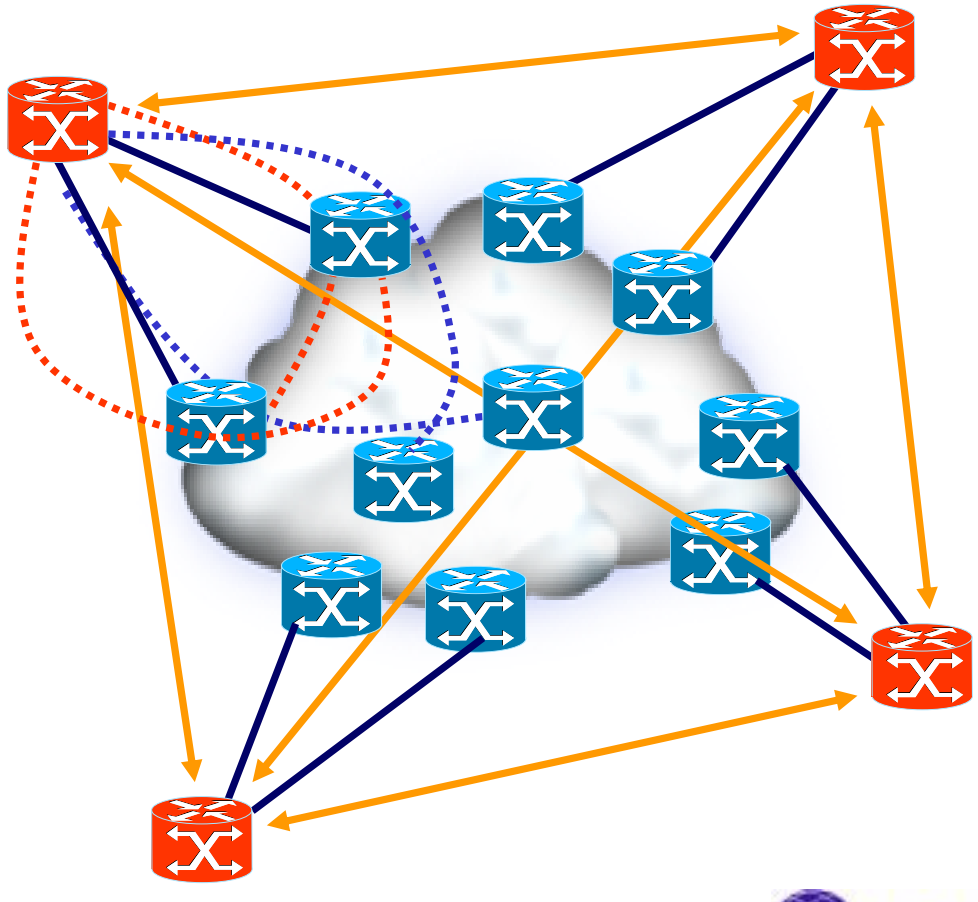
FRR node Protection NNHOP (for all Core routers)

FRR link Protection NHOP (for all POS interfaces In Area 0.0.0.0)

OC48 POS Interfaces

VoIP Gateways

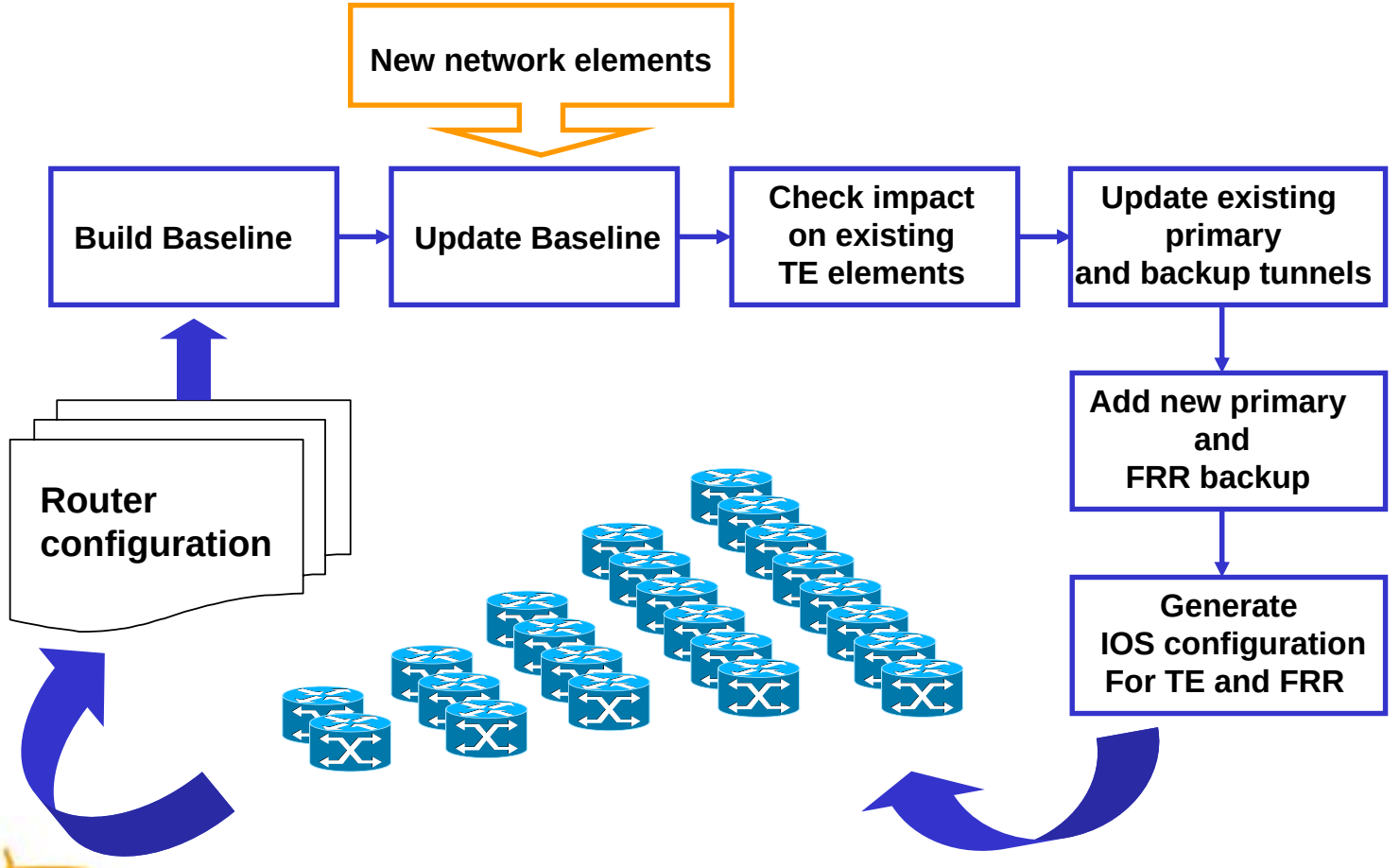
Core Routers



Network Investment & Growth

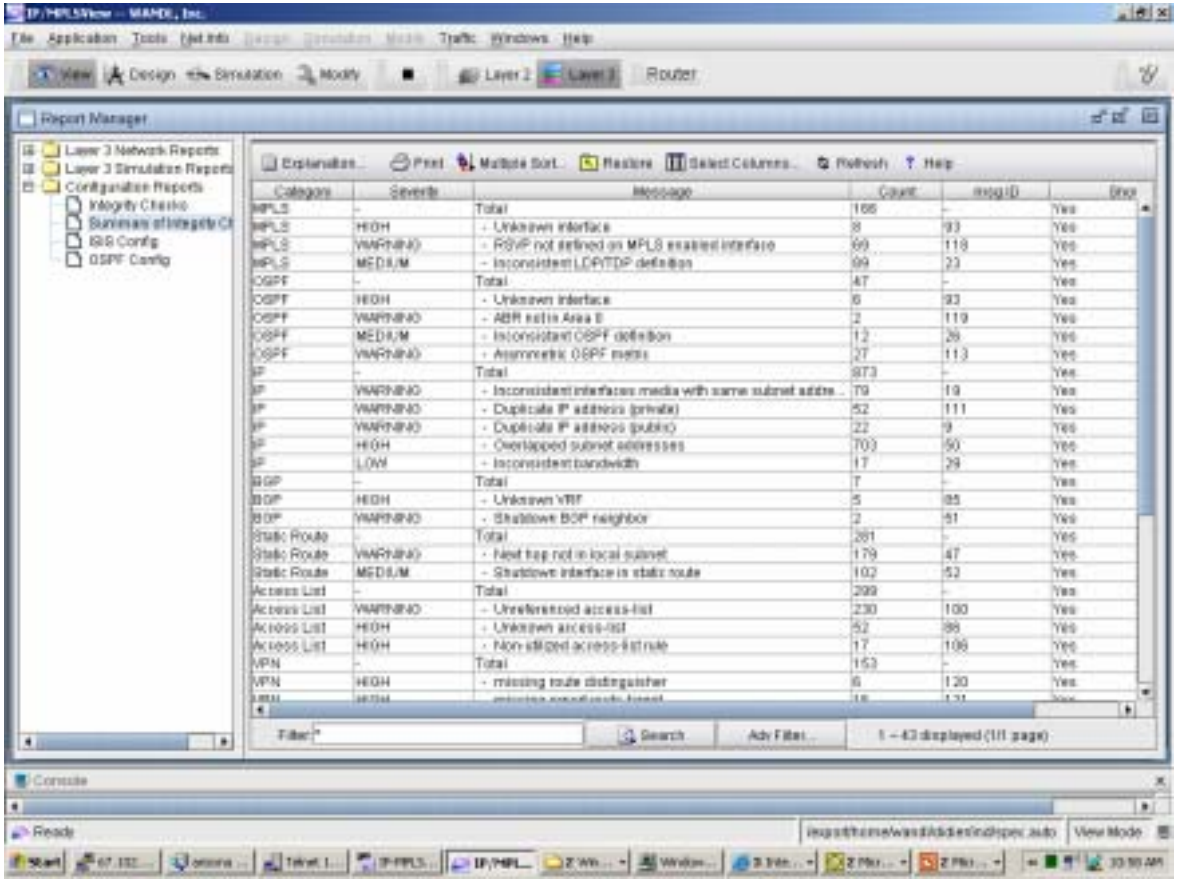
- One of the major challenge for Bell IP Network Designers is to manage the ongoing investment/growth in the MPLS-IP Infrastructure of new Service Areas (i.e. POP build out) while managing the MPLS TE/FRR as Core Network Service Offering.
- Example of network impact when a site is added:
  - New POS links
  - Re-use existing IP addresses
  - Optimize/Update routing path for existing primary and backup tunnels
  - Design Fast Reroute plan for new network elements
- Bell Canada chose WANDL IP/MPLSview to automate its MPLS TE/FRR Design and Engineering challenges

Bell IP Engineering Change Management Process



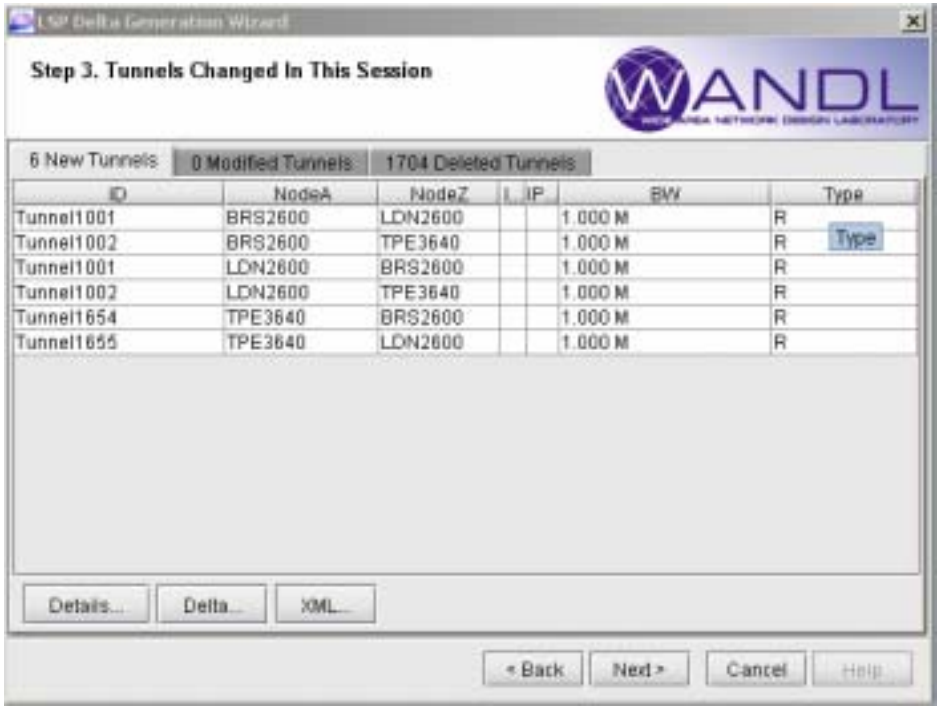
Step 1: Build and Crosscheck Baseline

- Baseline is built via router configuration files as input.
- OSPF and RSVP settings need to be verified for Quality Assurance as they can have a major impact on the tunnel routing



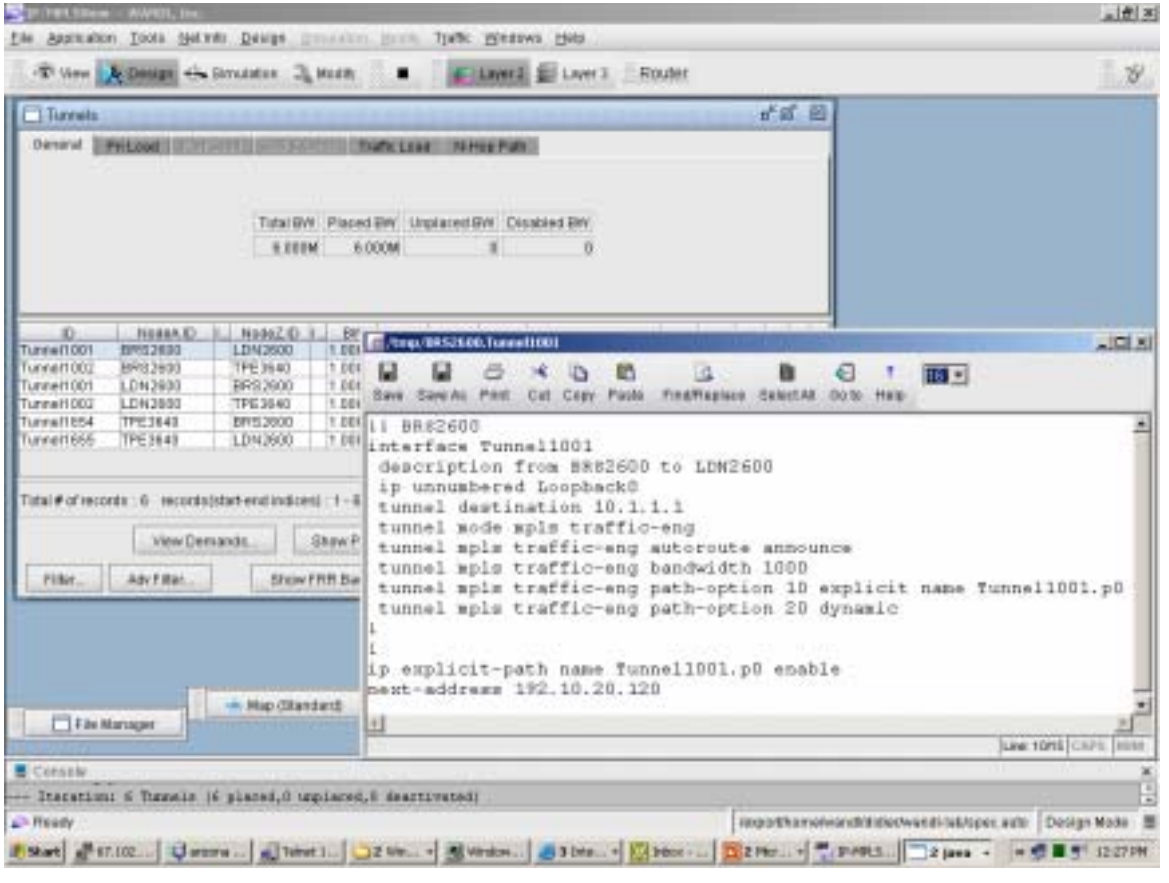
Step 2&3: Update Baseline and review the impact of new network elements

- New network elements contain new tunnels. They may also turn the existing FRR backup tunnels obsolete.
- IP/MPLSview Delta LSP feature can automatically identify the existing Primary and FRR tunnels that need to be modified or are now redundant.



Step 4: Provisioning new primary tunnels

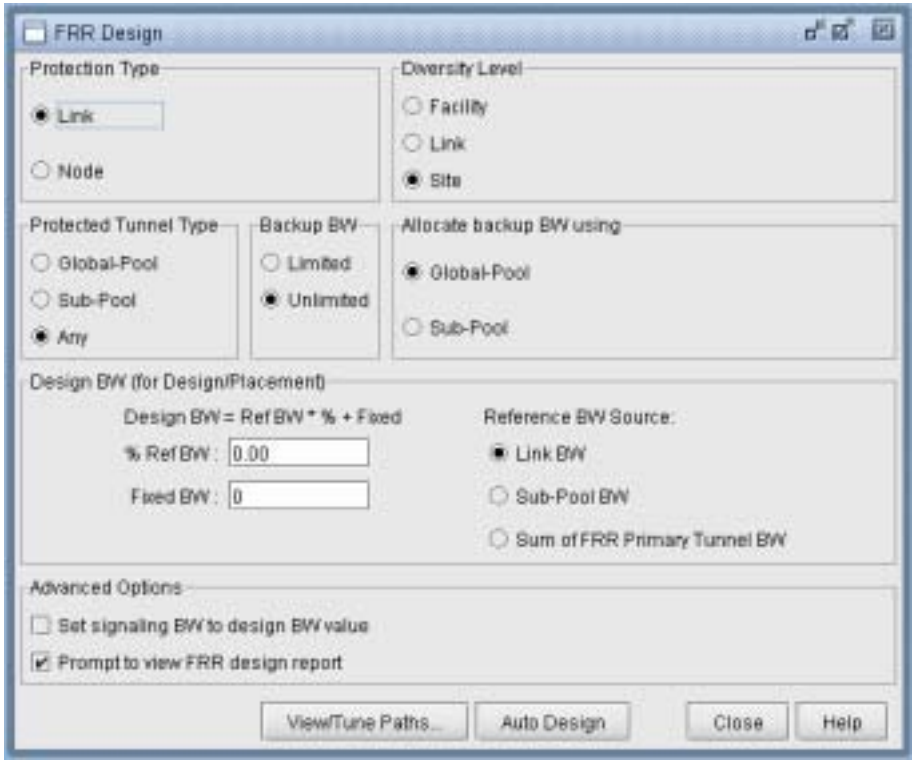
- Primary tunnels are configured with two path options.



Step 5: Provisioning Bell FRR backup tunnels

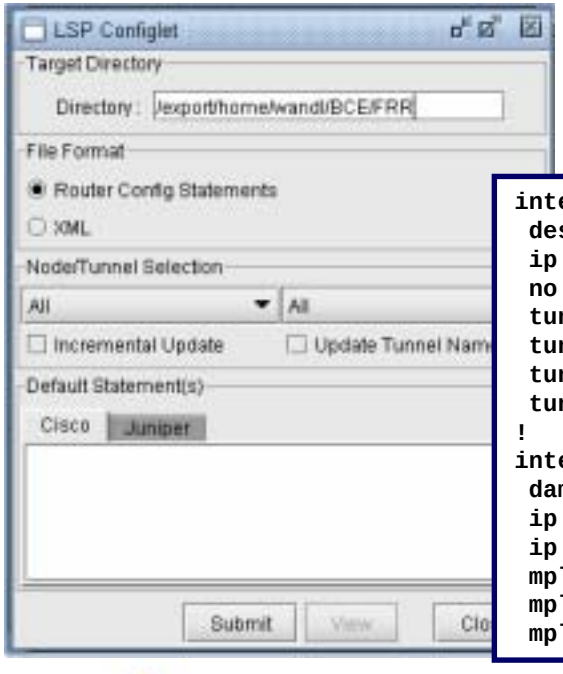
- Fast Reroute backup tunnels are calculated for both Node and Link Protection.
- FRR backup path does not share any router/site with primary tunnel path

⇒ best in class network protection.



Step 6: Support FRR provisioning

- Best vehicle/language to communicate a TE/FRR Design to our Operations team is in form of router commands.
- Wandl assists us in generating the related commands in a configlet.




```
interface Tunnel4
 description from TORONTO to MONTREAL; protected link=TORONTO_POS0/0
 ip unnumbered Loopback0
 no ip directed-broadcast
 tunnel destination 192.168.96.20
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng path-option 10 explicit name Tunnel4.p0
 tunnel mpls traffic-eng path-option 20 explicit name exclude_ 10.1.103.130
!
interface POS0/0
 dampening
 ip address 10.1.103.130 255.255.255.252
 ip ospf cost 500
 mpls label protocol both
 mpls traffic-eng tunnels
 mpls traffic-eng backup-path Tunnel4
```

Conclusion

- DiffServ-TE is a complex powerful mechanism to transport multimedia tunnels with many knobs to tune.
- DiffServ-TE networks tend to be large and multi-layer: usually MPLS-TE, FRR are also deployed
- Hence manual configuration is very tedious and not scalable.
- The objective for Bell Canada IP Engineering Team is to automate (i.e. OPEX Management) the MPLS-TE layer Design/Management , there by using intelligent and complementing Software from vendors such as WANDL.

Acknowledgement

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