



# Evaluating MPLS WAN Services for the Enterprise

Presented by:  
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# About Me

- ❖ Close to 20 years of Cisco based Network Engineering experience
- ❖ CCIE focusing on Routing, Switching, and Data Center technologies.
- ❖ Partner and Principal Engineer at LA Networks, a Cisco Silver VAR
- ❖ Help run one of the oldest Cisco user groups - The Southern California Cisco User Group (SCCUG)



# What we will cover

- ❖ Perspective – A company buying or evaluating MPLS services to replace existing WAN technology (Frame-Relay, ATM, Point-to-point, etc.).
- ❖ High level details surrounding such a project and network design from this perspective.
- ❖ We will talk about common terms, concerns, issues, and desires for a medium to large network.
- ❖ A “real world” perspective
  - ❖ Experience garnered through many migrations, at real companies, under real conditions.

# A Quick Note on Terminology

MPLS means something very different to an ISP than it does to an Enterprise. When we talk about MPLS in THIS presentation, we are really ONLY focusing on the Enterprise's perspective (which ironically involves little to no MPLS technology). Most ISP's these days do not call their MPLS networks an MPLS network anyway – it's just L3 VPN <*insert cool marketing term here*> to them.

# MPLS – Why do I care?

- ❖ Any-to-any connectivity is a more natural fit for today's applications
- ❖ MPLS provides an IP cloud ideal for converged, multiservice networks.
- ❖ Layer 2 access-protocol agnostic (PPP, ATM, Frame, Ethernet).
- ❖ QoS is a forethought, not an afterthought.
- ❖ Clearer delineation of troubleshooting boundaries.

# MPLS – What exactly is it?

- ❖ MPLS represents the current trend in WAN technology, and has for a while now
- ❖ ISP talent and time is spent engineering and maintaining the MPLS cloud rather than legacy L2 clouds like ATM and Frame Relay
- ❖ The Internet is a L3 cloud which can be used to route between sites
  - ❖ Security is much more difficult
  - ❖ No concept really of QoS.
  - ❖ No ability to use multicast
  - ❖ Difficult to provide any predictable delivery of information

# Can't tell the players without a program!

- ❖ **CE (CER)** – Customer Edge router, this is your router. This is the same concept as CPE and may or may not be managed by an SP, but is always on your prem.
- ❖ **PE (PER)** – Provider Edge router, this is the SP router, it equates to the edge of the cloud.
- ❖ **VRF** – Virtual Routing and Forwarding, like a virtual router just for you. This is often also referred to as “the VPN” – this is the epicenter of what effects your traffic and keeps it YOUR’S.
- ❖ **P-Router** – Provider router, this is in the MPLS Core, this is the inner “cloud” really.
- ❖ **IGP** – This is your routing protocol: EIGRP, OSPF, etc.
- ❖ **BGP** – This is the routing protocol which typically runs between you and the service provider.
- ❖ **QoS** – Quality of Service, what traffic is protected during times of congestion, what are the maximum and minimum amounts of traffic allowed per application type.

# What should I ask?

- ❖ What protocols do you support CE-PE?
  - ❖ Typical answers are BGP and/or Static, but other protocols are possible. If they do NOT support/prefer BGP – keep shopping!
- ❖ How many queues do you support? What is your QoS model?
  - ❖ This is a complex question, and may be guided by your internal needs during vendor selection.
- ❖ What is your policy regarding multicast?
  - ❖ Some providers support it, some do not. Those who do support it, usually have some caveats and/or fees.
- ❖ What is your policy regarding multi-VRF?
  - ❖ What if you want to run/define VRF's on your network and pass them to the Provider? Or have multiple VPN's be handed to you from the provider cloud?
- ❖ Do you support BGP Communities?
- ❖ How do they deal with load sharing? How about duplicate routes (like default)?



# What should I ask? (Cont.)

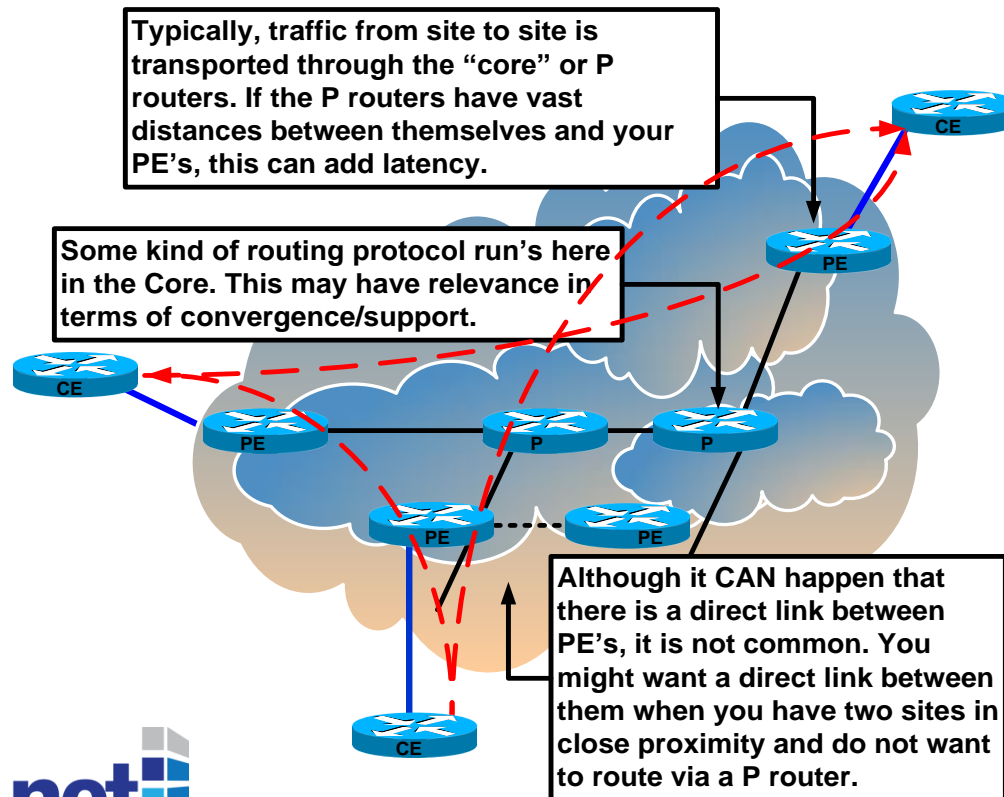
- ❖ Do you have limits on the number of routes you accept?
  - ❖ Some providers limit the number of routes transported across the cloud
  - ❖ “show ip route summ” can be your friend here.
- ❖ Can you provide PE redundancy?
  - ❖ If you need physically diverse paths/PE’s this may be an important factor.
- ❖ Where are the “P” or “Core” routers in relation to your sites?
  - ❖ City A and City B communicate a lot, where is the nearest “P” router?
  - ❖ Be aware of potential application issues related to geographic distance
- ❖ What does it look like IN the cloud?
  - ❖ What is IGP like?
  - ❖ What is convergence like?
  - ❖ What SLA can they provide?
- ❖ Do they support BGP Multipath?
- ❖ Do you support Ethernet handoff’s? Do you support BFD on the Ethernet links?

# What answers can I expect?

- ❖ **Routing Protocol's** – Solid understanding and familiarity of BGP, Route Redistribution, BGP, multiple filtering methods, BGP, etc.
- ❖ **QoS** – usually between 4 – 7 queue's – one being reserved for EF traffic. More vendors are now buying into Scavenger queues these days as well. Egress from the cloud make sure that the DSCP remains on the IP packet. What is the procedure like when I need to move/change my QoS settings (say I add more phones for example).
- ❖ **Diversity** – The more requirements you have for diversity, the longer and more complex the initial order/delivery of circuits can be.
- ❖ **Multicast** – Many providers DO support multicast, but may require an extra fee, or may have limitations on how it can be implemented.
- ❖ **Multi-VRF** – Typically you will have one VRF linking your sites together, but that might not always be the case.
- ❖ **BGP Communities** – Most vendors DO support them, but occasionally they do not. This can be a very handy feature for filtering.

# A Brief Look Into the “Cloud”

Each CE connects to a PE, and the PE places your traffic into a VRF, which is then transported to other PE's but VIA the P routers.



When the traffic leaves your site (CE) it lands on the ISP router (PE) at THAT point it is encapsulated and inserted into a VRF. This process IS MPLS, the encapsulation is an MPLS label, also called a VPNV4 or MPBGP packet. It is 96-bits in address length as opposed to 32 bits in IPv4.

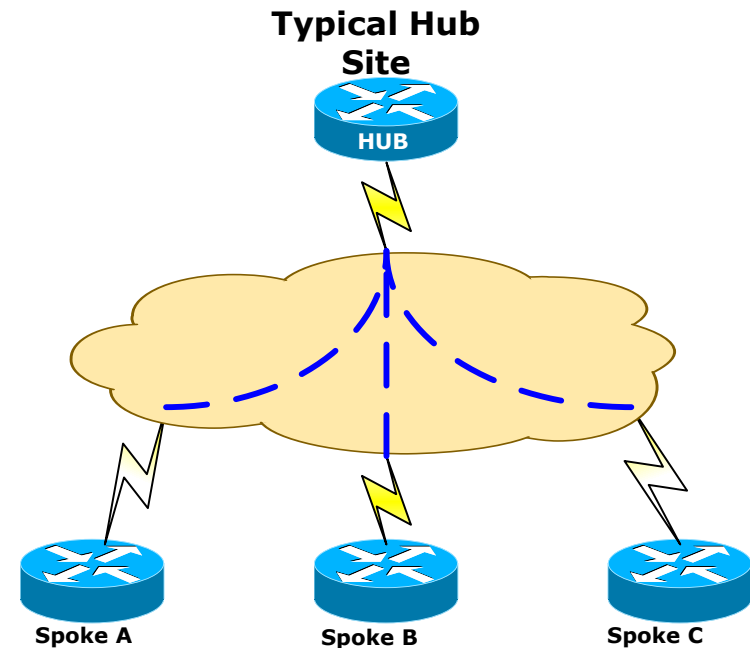
## Migrations will differ, but a few guidelines to assist you in early planning

- ❖ Run “newer” IOS versus “older” IOS. Nothing before 12.4 IMO. NX-OS works as well.
- ❖ Plan on supporting BGP, route redistribution, etc.
  - ❖ Plan for training?
- ❖ Is this a migration or is it greenfield?
  - ❖ Consider how and what will be involved
  - ❖ Consider how you will communicate between the NEW and the OLD environment

# PHASE 0 - How do I get there?

## Traditional Hub and Spoke WAN topology

- ❖ Frame-relay, ATM, DMVPN, etc.
- ❖ To speak to spoke B, Spoke A communicates through a Hub site.
  - ❖ This issue scales w/ additional sites
  - ❖ Creates additional PVC costs
  - ❖ Application diversity hampered
  - ❖ Complicates technologies like QoS and Voice



**Multiple spoke sites.  
The cloud could be any  
L2 cloud.**

# Phase 0 - Critical Steps

- ❖ Understand local routing at each site
  - ❖ Destination data from a tool such as NetFlow is helpful.
  - ❖ Have a strong understanding of which networks are “owned” at which sites
- ❖ Training for in-house staff
  - ❖ BGP and Strong IGP
- ❖ Hardware procurement

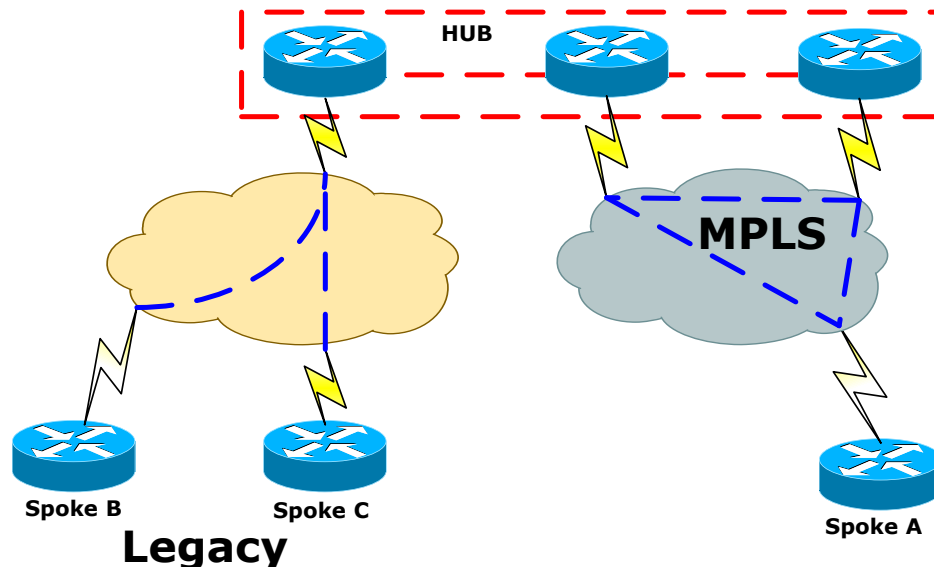
# PHASE I/II - How do I get there?

## Phase I

- ❖ Bring the MPLS cloud up in parallel with the legacy WAN
- ❖ Route filters might be required at the main site to avoid loops
- ❖ Note that there is even routing between the two CE routers.

## Phase II

- ❖ Bringing up MPLS service and connecting new routers
- ❖ This strategy allows us to have a fairly seamless migration
- ❖ Spoke A is no longer connected via PVC's
- ❖ Via dynamic routing, every site is connected to every site by default



# Phase I/II - Critical Steps

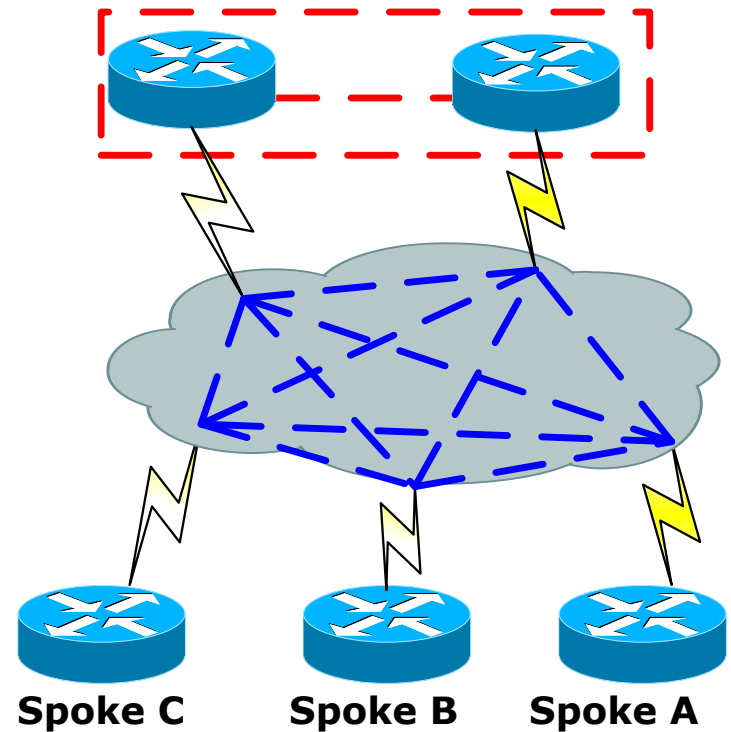
- ❖ Understand BGP layout
  - ❖ ASN Assignments, QoS, Advertised networks, etc.
  - ❖ Understand the difference between eBGP and IBGP – most times BOTH are recommended
  - ❖ Route introduction into the network
- ❖ Understand redundancy issues
  - ❖ CE-PE links, Legacy links, etc.
- ❖ Useful commands
  - ❖ `show ip bgp nei <IP Add> advertised-routes`
  - ❖ `show ip bgp summ`
  - ❖ `Show route-map <route-map name>`
  - ❖ `show ip bgp regexp _<SiteA ASN>$`
  - ❖ `Show ip bgp regexp _<transit ASN>_`



# PHASE III - How do I get there?

## Post Migration

- ❖ Spoke A and Spoke B now communicate directly
- ❖ Increase scalability w/ the addition of more sites



# Phase III - Critical Steps

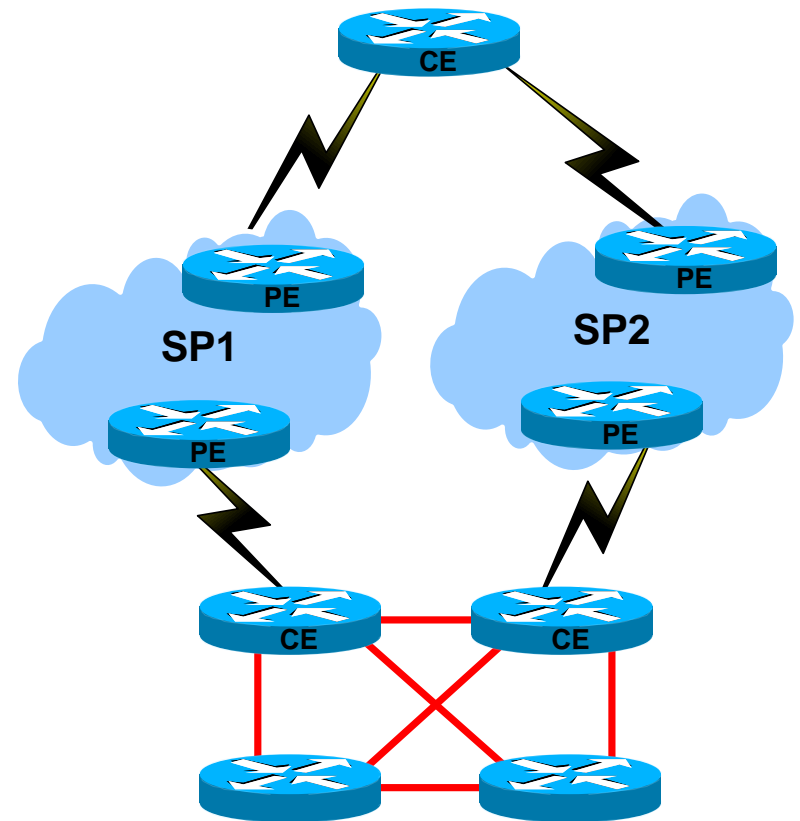
- ❖ Management
- ❖ QoS, IGP, Load Sharing, etc.
- ❖ Backdoor Links
- ❖ Multiple GOLR's
- ❖ Testing

# Common Design Considerations

- ❖ Single cloud or dual cloud? Redundancy versus complexity.
- ❖ Load balancing – this may NOT be as straightforward as you are used to!
- ❖ Routing protocol selection PE-CE
- ❖ How much filtering do you want to do? Complexity versus safety.
- ❖ Can your addressing be summarized?
- ❖ What is the new role of your IGP going to be?
- ❖ There are likely MANY ways to implement every aspect of your project, the more you consider and understand them, the better off you are.

# High Level View – Dual Provider

- ❖ Redundancy is the main driver for a multi provider deployment – the issue comes in that redundancy almost always turns to load-sharing quickly by those paying the bills
- ❖ Additional complexity involved to achieve things like load sharing per site. Will you do it based on application? Based on SLA? Based on geography? Each of this leads to a different solution!
- ❖ How do you deal with different cloud parameters (QoS, etc.)



# Lower Level Design – Load Balancing

- ❖ Two directions for load balancing consideration
  - ❖ Ingress to the cloud
  - ❖ Egress from the cloud
- ❖ Questions to consider
  - ❖ What does the provider recommend and why?
  - ❖ How do you feel about policy at “remote” sites?
  - ❖ Single provider, or dual provider?

Probably the most likely route you will want to load share is default. You might have two Internet POP's and want them to balance based on geography – but fail to one another in times of need for example.

# Routing Protocol Selection PE-CE

- ❖ Engineering cycles will largely focus on working with the PE-CE link
  - ❖ QoS
  - ❖ Redistribution and policy
  - ❖ Load Sharing
- ❖ Protocol selection
  - ❖ BGP is HIGHLY recommended
  - ❖ OSPF and EIGRP can have issues
  - ❖ Please use BGP
  - ❖ Please do not use an IGP
  - ❖ Please never use static.

- ❖ MPLS USES BGP within the cloud
  - ❖ Routing WITH the provider
  - ❖ More seamless
  - ❖ Truly autonomous areas making policy easier to define
- ❖ Main considerations w/ BGP
  - ❖ ASN's should be unique per site. Preferably from the private ASN range (64512 – 65534).
  - ❖ Keep in mind where your default routes are, and use them to help steer traffic as needed.
  - ❖ Load-sharing is more complex than in an IGP.
  - ❖ Test and prepare for changes in convergence
  - ❖ Deploy with fast convergence technologies like BFD where appropriate.

# Lower Level Design - Filtering

- ❖ Best practice – Filter routes between two protocols
- ❖ BGP offers additional features – auto route-tagging into IGP, auto filtering it's own ASN, etc.
- ❖ Main reason for filtering is to avoid routing loops and suboptimal path selection
- ❖ Common concerns w/ Filtering
  - ❖ Can I summarize my ranges for easy manipulation?
  - ❖ What might BGP filter by default?
  - ❖ Should I use any advanced BGP filters? ASN based, transit AS protection, etc.
  - ❖ Do I need to consider special filters just during migration?



# Lower Level Design –Address Space

- ❖ Can be dangerous if not done properly
- ❖ Summarization might be a requirement if the provider limits BGP table size.
- ❖ Makes filtering considerably easier
- ❖ Some business practices may defy easy summarization
  - ❖ Public networks (B2B VPN, etc.)
  - ❖ Pocket legacy networks AS/400, LAT, etc. Can I use route-tags?
  - ❖ Acquisitions which have not been converted

# Lower Level Design – IGP Challenges

- ❖ IGP is now likely to be “locally significant”
- ❖ Main considerations w/ IGP
  - ❖ Default route propagation
  - ❖ Administrative Distance concerns
  - ❖ Metric (Metric-type possibly as well) in redistribution
  - ❖ Summarization support/configuration
  - ❖ Route-Map/Route-tagging support
  - ❖ Path selection

# Lower Level Design – QoS Considerations

- ❖ Common practice is to have a strict priority queue for real time traffic that is **policed** ingress to the cloud
- ❖ Remaining bandwidth is divided between whatever remaining queues they support/provide (LLQ essentially)
- ❖ Typically they will tell you what characteristics (DSCP values) need to be set on YOUR end to enter into the proper queue on THEIR end
- ❖ Main considerations w/ QoS
  - ❖ Number of Queues supported
  - ❖ DSCP markings supported and level of service provided per marking (hi/low)
  - ❖ Do they have flexibility in what percent of the BW each queue gets?
  - ❖ Do you have a current QoS methodology in place? If so, does it need to adjust?
  - ❖ Is voice/real-time traffic a factor? If not now, when will it be?
  - ❖ What is the process like to change the QoS “profile” you have been assigned?

# Links and Final Considerations

- ❖ MPLS has replaced traditional WAN technologies at a rapid rate
- ❖ You must ask yourself how prepared are you in terms of staff, support, knowledge, etc?
- ❖ The term “MPLS” can be misleading, we are really talking about hard-core enterprise-class routing, not MPBGP and P-Routers.
- ❖ Valuable links:
  - ❖ **BGP Case Studies -**  
[http://www.cisco.com/en/US/tech/tk365/technologies\\_tech\\_note09186a00800c95bb.shtml](http://www.cisco.com/en/US/tech/tk365/technologies_tech_note09186a00800c95bb.shtml)
  - ❖ **BGP FAQ -**  
[http://www.cisco.com/en/US/tech/tk365/technologies\\_q\\_and\\_a\\_item09186a00800949e8.shtml](http://www.cisco.com/en/US/tech/tk365/technologies_q_and_a_item09186a00800949e8.shtml)
  - ❖ **MPLS WAN Services Whitepaper -**  
[http://www.cisco.com/en/US/netsol/ns341/ns121/ns193/networking\\_solutions\\_white\\_paper0900aec800f6d9a.shtml](http://www.cisco.com/en/US/netsol/ns341/ns121/ns193/networking_solutions_white_paper0900aec800f6d9a.shtml)

# Thank you for your time!

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