Enhancing the WAN Experience with PfR and WAAS

As applications are being centralized and users become increasingly distributed, the performance limitations of WAN such as limited bandwidth, significantly longer latency, and packet loss are seriously slowing down application delivery. Cisco® Wide Area Application Services (WAAS) and Cisco Performance Routing (PfR) can work together to intelligently optimize application delivery across the WAN—at both the application level and network level. Although Cisco WAAS provides WAN optimization and application-level acceleration to improve application performance over the WAN, Cisco PfR routes data packets through the best IP path between disparate network locations. Specifically, PfR provides best-path decision-making based on network latency, packet loss, monetary WAN usage cost, jitter, link capacity, and more. Cisco PfR complements Cisco WAAS to improve application delivery and help enable infrastructure consolidation while providing optimized path selection.

Accelerating Appliations Using Cisco WAAS and Cisco PfR

Cisco Wide Area Application Services

Cisco WAAS is a powerful application acceleration and WAN optimization solution for the branch office that improves the performance of any TCP-based application operating in a WAN environment. With Cisco WAAS, IT organizations can consolidate costly branch office servers and storage into centrally managed data centers and deploy new applications directly from a data center while offering LAN-like application performance for remote users.

Cisco WAAS allows organizations to accomplish three primary IT objectives:

- Deliver centralized applications with LAN-like speed to remote users, while preserving visibility and branch security
- Consolidate costly branch office servers, storage, and backup infrastructure into data centers, while optimizing WAN bandwidth usage
- Maximize regulatory compliance and data protection through consolidation of branch storage, as well as acceleration of branch backup applications
- Increase visibility of application data flows within the network

To accelerate applications and improve performance, Cisco WAAS incorporates advanced application acceleration and WAN optimization techniques, including compression, redundancy elimination, transport optimization, protocol optimization, and content distribution:

- Application acceleration—latency and bandwidth reduction: Advanced protocol optimizations such as read ahead, prediction, and suppression are coupled with sophisticated caching techniques to minimize latency and unnecessary data crossing the WAN.
- WAN optimization—bandwidth and throughput improvement:

- Data Redundancy Elimination (DRE) coupled with compression improves efficiency and mitigates unnecessary bandwidth consumption.
- TCP flow optimization (TFO) optimizes TCP to enable better performance and efficiency in WAN environments.

- Transparent network integration:
  - Dynamic auto discovery of endpoints helps ensure efficient deployment without the need to create and manage overlay networks.
  - Cisco WAAS offers end-to-end visibility and compatibility with existing network functions such as quality of service (QoS), firewall security, Cisco NetFlow monitoring, and high availability.

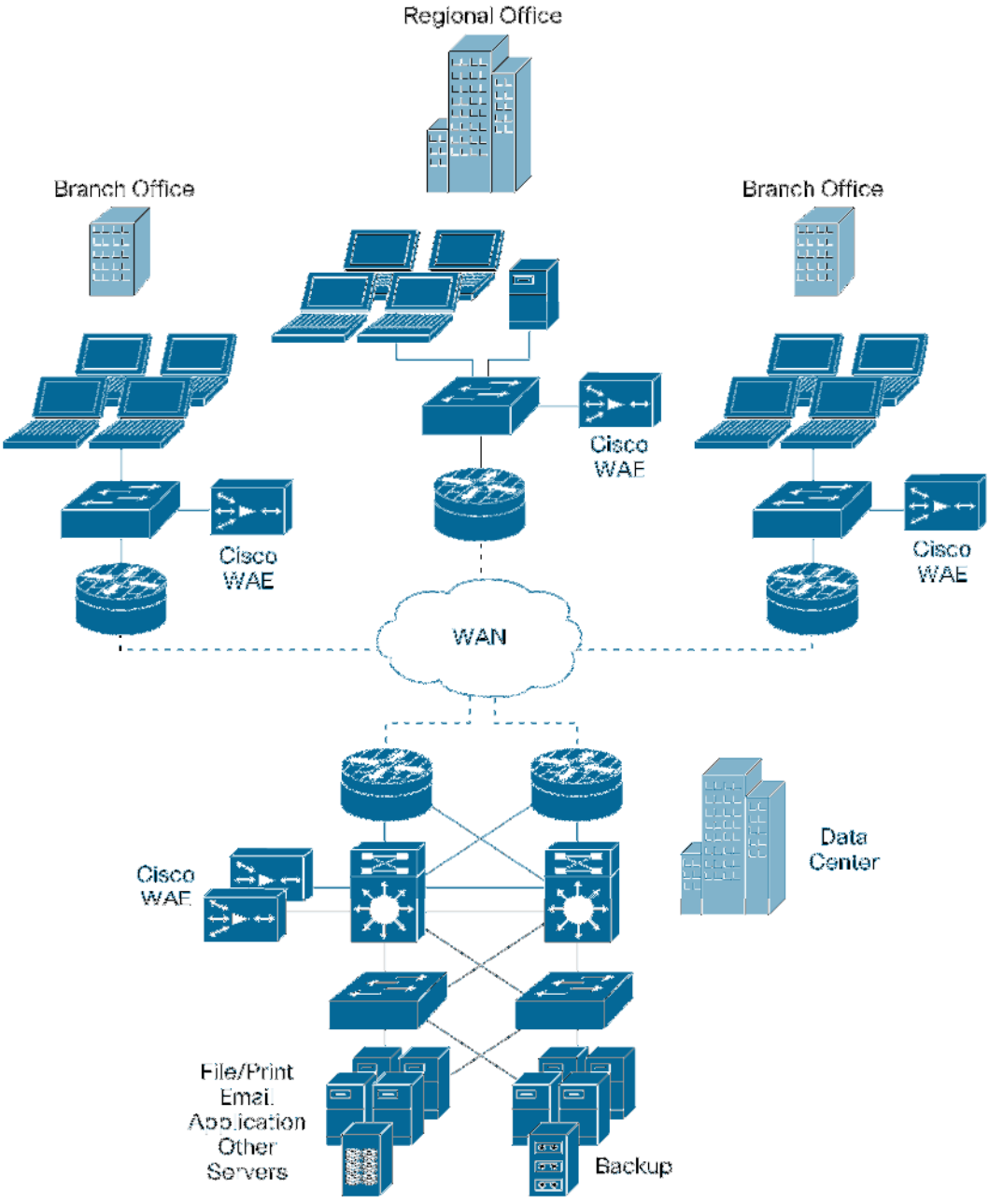
With Cisco WAAS, virtually any TCP-based application can benefit from the network and application-specific acceleration techniques, including Internet and intranet applications, databases, file services, file transfer, e-mail, data protection, remote desktop applications, client-server applications, and many others.

A Cisco WAAS deployment includes at a minimum (Refer to Figure 1 and Figure 2) :

- One Cisco Wide Area Application Engine (WAE) at each end of the WAN connection to be optimized: The WAE at the central data center can service multiple branch WAEs.
- One central manager, deployed at the data center for centralized administration, management, and monitoring of the services provided by the WAE devices

Figure 1. Cisco WAE Appliances and Router-Integrated Network Module

Figure 2. Typical Cisco WAAS Deployment Scenario



Cisco Performance Routing

Classic routing is undergoing a broad-based inflection momentum accelerated by new applications and business needs. Network performance must be a criterion for best-path calculation, and Cisco Performance Routing is fundamental to this market need. Cisco PfR helps enable intelligent path selection at the WAN edge based upon performance-sensitive routing metrics such as response time, packet loss, path availability, traffic load distribution, cost minimization, and composite metrics representing voice quality.

Whereas classic routing mechanisms can provide load sharing and failure mitigation, Cisco PfR can make real-time routing adjustments based on criteria other than static routing metrics. These real-time routing adjustments based upon performance make Cisco PfR an important component for building highly available paths across the Internet and WAN.

Cisco PfR is typically deployed when multiple connections to the WAN allow two or more possible network egress interfaces between the local network and remote networks. This technology is implemented in Cisco IOS® Software as an integrated part of its core routing capability.

Increased Uptime

- Users can experience improved response time because the automated route optimization in Cisco PfR can detect and route around poorly performing paths by finding an optimal Internet Service Provider (ISP) exit.
- Performance optimization can minimize the effects of network degradation because it can monitor for them. For example, when high latency or packet loss occurs, for example, the network traffic can be automatically rerouted around the affected path to an alternative, better-performing path.

Reduced Costs

- Bandwidth cost minimization allows companies to minimize traffic sent over expensive links or consolidate multiple flat-rate connections to fewer and lower-cost tiered services.
- Modeling and cost minimization for tier-based pricing models allows real-time cost estimation and intelligent cost-based WAN path selection.
- Automatic performance optimization reduces engineering operating expenses associated with manual network performance analysis and tuning of IP routing.
- Reports for traffic distribution and usage before and after route optimization help customers manage ISP service-level agreements (SLAs) more effectively because they now have more specific and detailed SLA reporting than the ISPs.

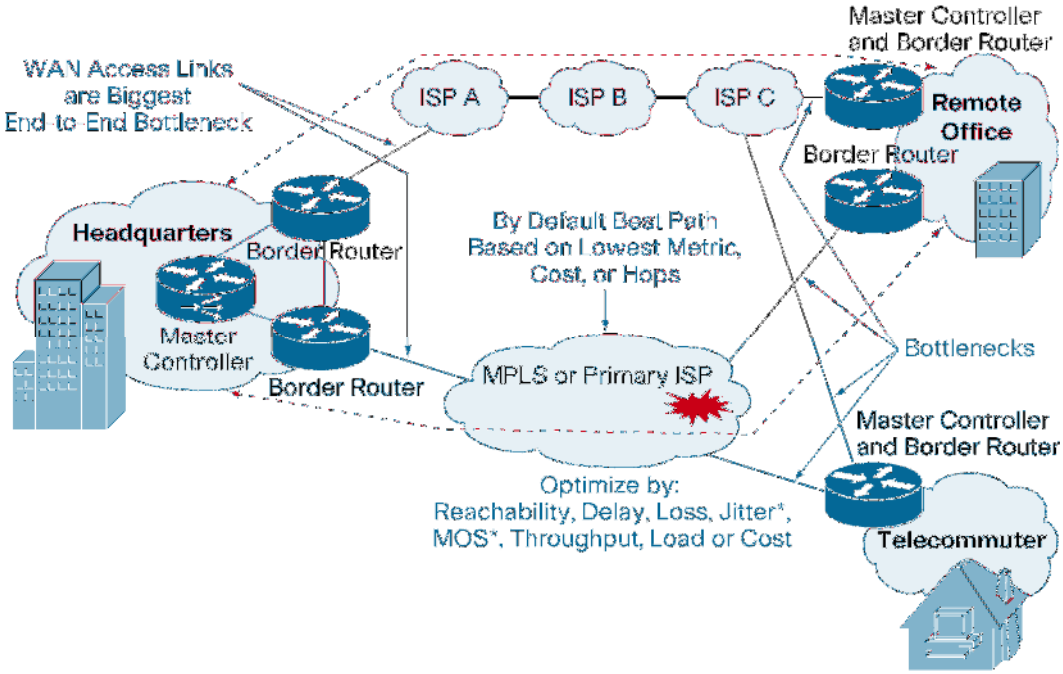
Cisco Performance Routing (Figure 3) takes advantage of the vast intelligence imbedded in Cisco IOS Software to determine the optimal path based upon network and application policies. Performance Routing is an evolution of the Cisco IOS Optimized Edge Routing (OER) technology with a much broader scope. The application intelligence and end-to-end network strategy of PfR are significantly broader than the scope of OER. The initial phase of PfR uses OER technology extensively to meet emerging application demands on the enterprise network.

Cisco PfR technology has three components:

- Master controller
- One or more border routers
- Two or more network egress interfaces

The Cisco PfR Master Controller is the intelligent decision maker. To make decisions the controller retrieves dynamically all required information from the border routers, which are the egress elements toward the Internet or external WAN network. Functions of both master controller and border router run on Cisco IOS Software routers, and they may run simultaneously on the same device.

Figure 3. Cisco PfR Topological Overview



A packet on its end-to-end journey encounters most latency and performance degradation across the WAN or Internet; IP routing typically chooses the WAN path with the best metric or cost to the content or end-user even if that path is experiencing excessive packet loss, delay, or errors. Cisco PfR measures the performance characteristics of each WAN path and enforces routing in such a way that traffic travels through the best-performing path.

Cisco PfR can dynamically compute a “best-performing” path within 3 seconds based on:

- Performance
  - Latency
  - Packet loss
  - Reachability
  - Throughput
  - Jitter or Mean Opinion Score (MOS)
- Load sharing and link usage
- Cost minimization

Combining Cisco PfR and Cisco WAAS Technologies

Both Cisco WAAS and Cisco PfR have a specific function to optimize the communication between two or more networks. Cisco WAAS functions on the application layer, whereas Cisco PfR monitors data flows and influences the routing layer to achieve best WAN network performance. This WAN performance includes the detection and mitigation of network soft errors that are not represented by the routing protocols. These two optimization technologies can be combined to provide powerful network intelligence and optimize the application behavior using network resources to maximum performance levels while taking advantage of existing capital and operational assets.

Cisco PfR and Cisco WAAS: Deployment Considerations

As the two Cisco WAE devices at opposite ends of the WAN connection are creating an optimized transport session between them, changing the network path may also change where specific WAEs are involved and may cause disruption of service. It is therefore highly recommended that the WAE devices sit “behind” (or “inside” in the case of NME-WAE module) the PfR devices such that the PfR-directed network path change is transparent to the WAEs (refer to Figure 4).

Figure 4. Logical Design for Integrating Cisco WAAS and Cisco PfR

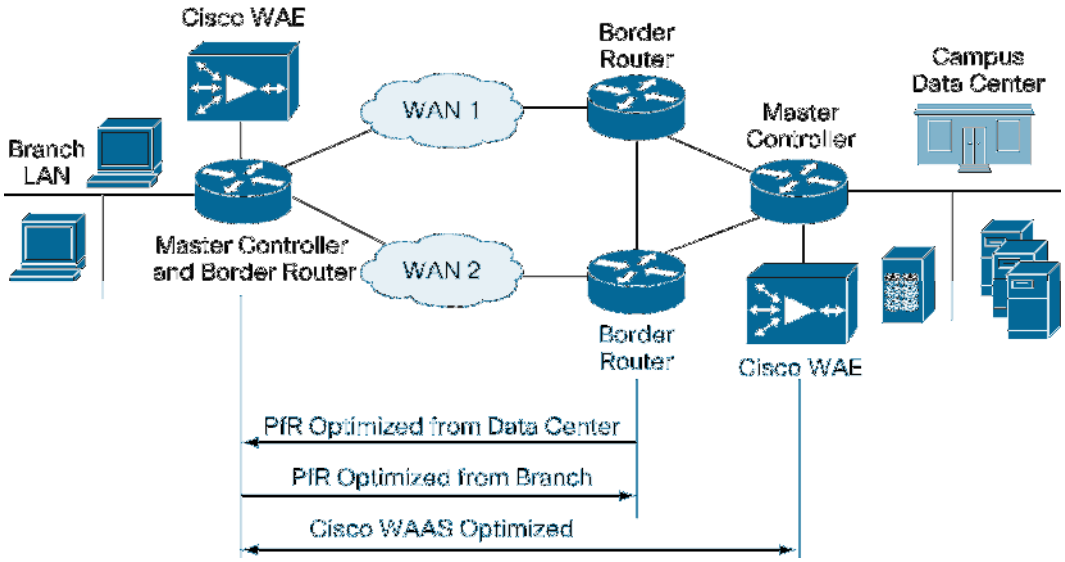
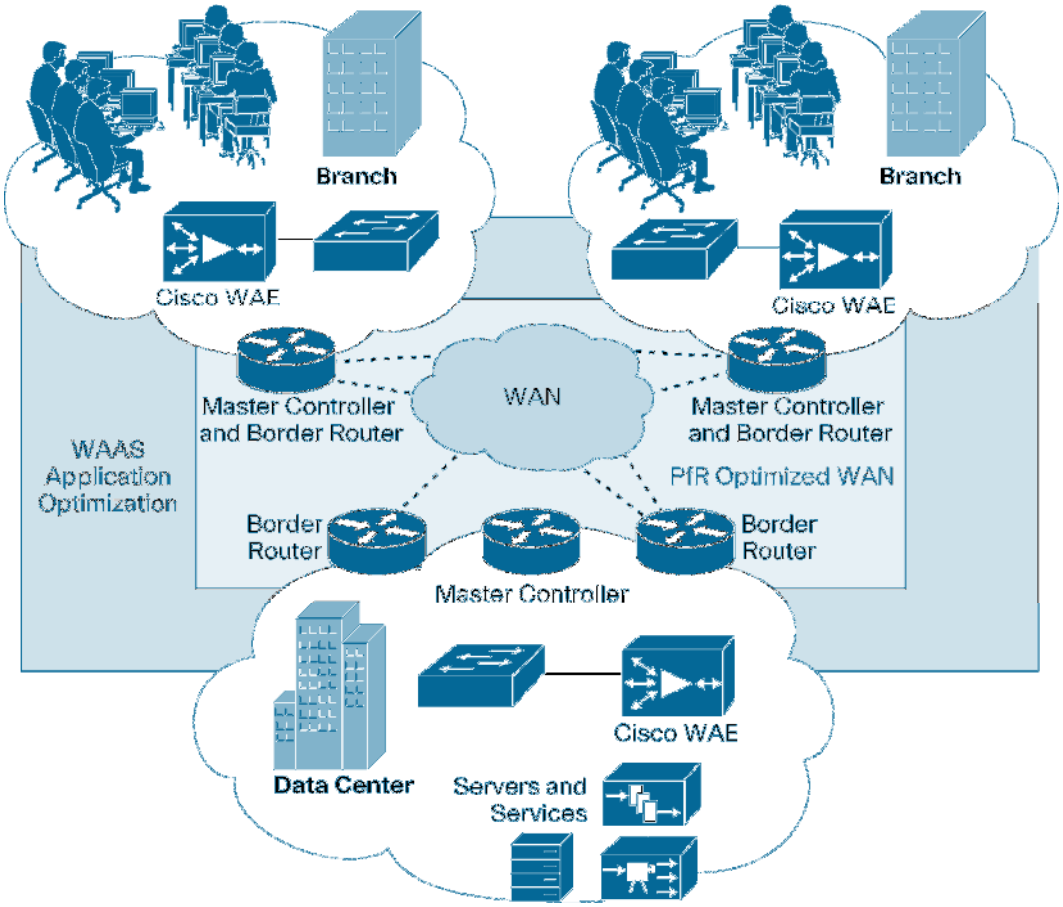


Figure 5 presents two designs that incorporate this recommendation for Cisco WAAS and Cisco PfR integration. The design on either half (branch side or data center) can be deployed on the branch or data center because both designs place PfR optimization “inside” the WAE optimization domain. It should be noted that having PfR on both ends of the network may create asymmetric paths, and this design allows for asymmetric paths. For the case that the PfR border router and the WAE are directly connected, the connecting interface needs to be configured in PfR as “internal”.

Figure 5. Topology Design for Cisco PfR and Cisco WAAS Deployment



Summary of Cisco PfR and Cisco WAAS Combination

- Cisco WAAS reduces bandwidth usage by DRE and LZ caching.
- Cisco WAAS improves throughput by reducing effects of network latency.
- Cisco WAAS offers application-specific acceleration.
- Cisco PfR allows for effective WAN usage by better load management on WAN links.
- Specific application traffic is directed to the measured best WAN path for each application.
- SLAs are measured on a per-application basis, and mitigation occurs during threshold-crossing events.

References

Performance Routing:

- Cisco online PfR technology page: http://www.cisco.com/go/pfr
- Cisco PfR reference guide for Cisco IOS Software Release 12.4:
  - http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124cg/hoer_c/index.htm
  - http://www.cisco.com/en/US/products/ps6441/products_configuration_guide_book09186a008049e22f.html

Cisco WAAS:

- Cisco Wide Area Application Services (WAAS): http://www.cisco.com/go/waas

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