White Paper

Cisco WAAS 4.4.1 Context-Aware DRE, the Adaptive Cache Architecture

What You Will Learn

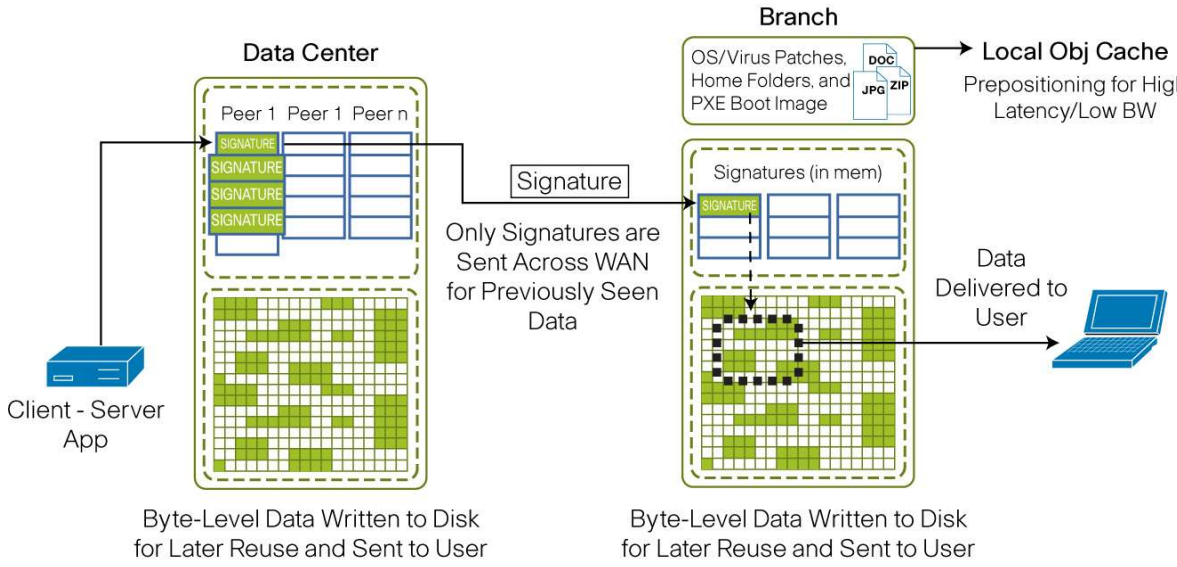
Enterprises face numerous challenges in the delivery of applications and critical business data to the enterprise edge. Typical challenges include poor application response time that users in remote sites experience and higher WAN bandwidth requirements to support new application deployment.

To address such challenges, Cisco® Wide Area Application Services (WAAS) provides a comprehensive WAN-optimization and application-acceleration solution that allows IT departments to centralize applications and storage while maintaining productivity for branch-office and mobile users. A technical overview of the Cisco WAAS solution is available at: http://www.cisco.com/en/US/prod/collateral/contnetw/ps5680/ps6870/prod_white_paper0900aecd8051d5b2.html.

Cisco WAAS provides protocol-specific and -agnostic optimizations while being transparent to clients, servers, and the network. Among the protocol-agnostic optimizations, Data Redundancy Elimination (DRE) is one of the critical technologies used to identify redundant data patterns in application traffic, replacing them with signatures that the Cisco WAAS devices transfer across the WAN to regenerate the original data. The result is optimal usage of WAN bandwidth and improved end-user response time.

Another advantage of Cisco WAAS is the Common Internet File System (CIFS) local object cache. File-server data and metadata can be copied into this object cache, in a scheduled manner, to improve performance for first-time access. This feature is helpful in environments where large objects must traverse the WAN. Examples include software distribution, video, and desktop-management applications (Figure 1).

Figure 1. Cisco WAAS DRE Cache Architecture



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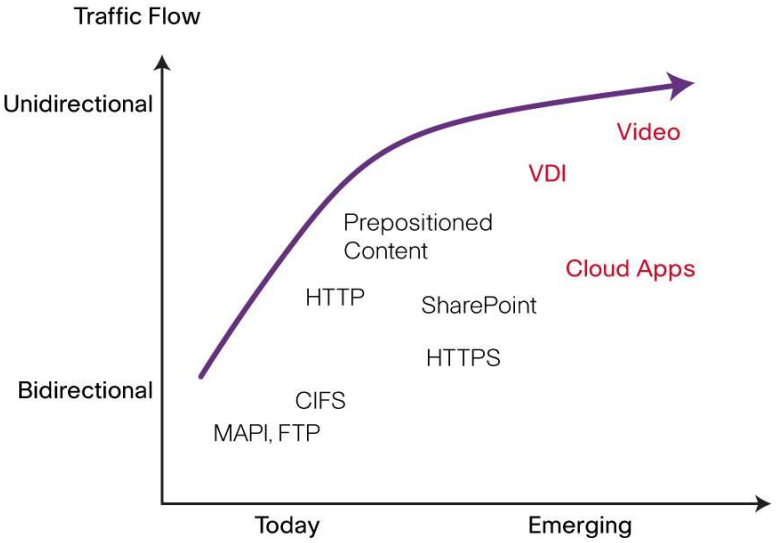
This document describes how emerging applications pose challenges to and present opportunities to a WAN-optimization system. Cisco WAAS Context-Aware DRE addresses these challenges and considerably increases system performance.

Brief Overview of Current and Emerging Applications

Figure 2 shows the trend in applications and protocols and the emerging characteristics of application traffic. The x-axis shows some of the currently commonly used applications, and the y-axis shows the directions of traffic flow of those applications. For example, applications such as Microsoft Exchange (Management Application Programming Interface [MAPI]) for email and file transfer (FTP and CIFS) are bidirectional, whereas emerging applications such as Virtual Desktop Infrastructure (VDI) and video traffic are predominantly unidirectional.

Figure 2. Application Trend



As Figure 2 illustrates, the traffic flow can be characterized into two categories:

- Bidirectional (traditional): The bidirectional traffic traverses between client and server. Examples include email send and receive, file upload and download, etc. Most traditional client-server applications fall in this category.
- Unidirectional (emerging): The unidirectional traffic predominantly tends to travel in only one direction. Examples include VDI, video streams, video on demand (VoD), and cloud-based applications such as backup. Unidirectional traffic occurs more frequently than in the past.

The predominant direction of applications traffic presents the network with a context, which elements in the network can exploit to improve the efficiency of data processing. Traditional data de-duplication architectures have been built to optimize current applications that are mostly bidirectional in context. Unidirectional applications, such as VDI, video streams, VoD traffic, and cloud applications, can be optimized more efficiently by exploiting the context.

WAN-Optimization Requirements for Unidirectional and Bidirectional Traffic

Exploiting the directional context of traffic flows necessitates the following technical requirements:

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- Performance fairness: When users in one branch office upload or download a huge file to or from the data center, it should not negatively affect the response time of users in other branch offices that simultaneously access applications from the data center.
- High scalability: The solution needs to support large WAN-optimization deployments and provide reliable performance. Using the unidirectional context increases the effective use of cache space across the data center and branch-office devices.
- Contextual awareness: Based on the context of the traffic, the DRE cache architecture must be intelligent enough to choose the optimal performance-improvement techniques. Latency-sensitive unidirectional traffic such as video streams and VoD traffic accelerate the need for efficient handling of read and write caching operations to minimize processing latency during optimization.
- Fast response for the first-time access: The solution should provide the best response time, even for the first-time access. Examples where this feature might be useful include delivery of OS and virus patches, access of home folders with frequently accessed files, and usage of Microsoft Office documents as part of usual business activity.

Cisco WAAS DRE Cache Architecture for Current and Emerging Applications

Addressing the technical requirements for using context within an optimization system provides a better user experience and increases bandwidth savings.

Cisco WAAS Version 4.4.1 delivers context-aware DRE, efficiently optimizing both uni- and bidirectional traffic. Figure 3 depicts the Cisco WAAS Cache Architecture.

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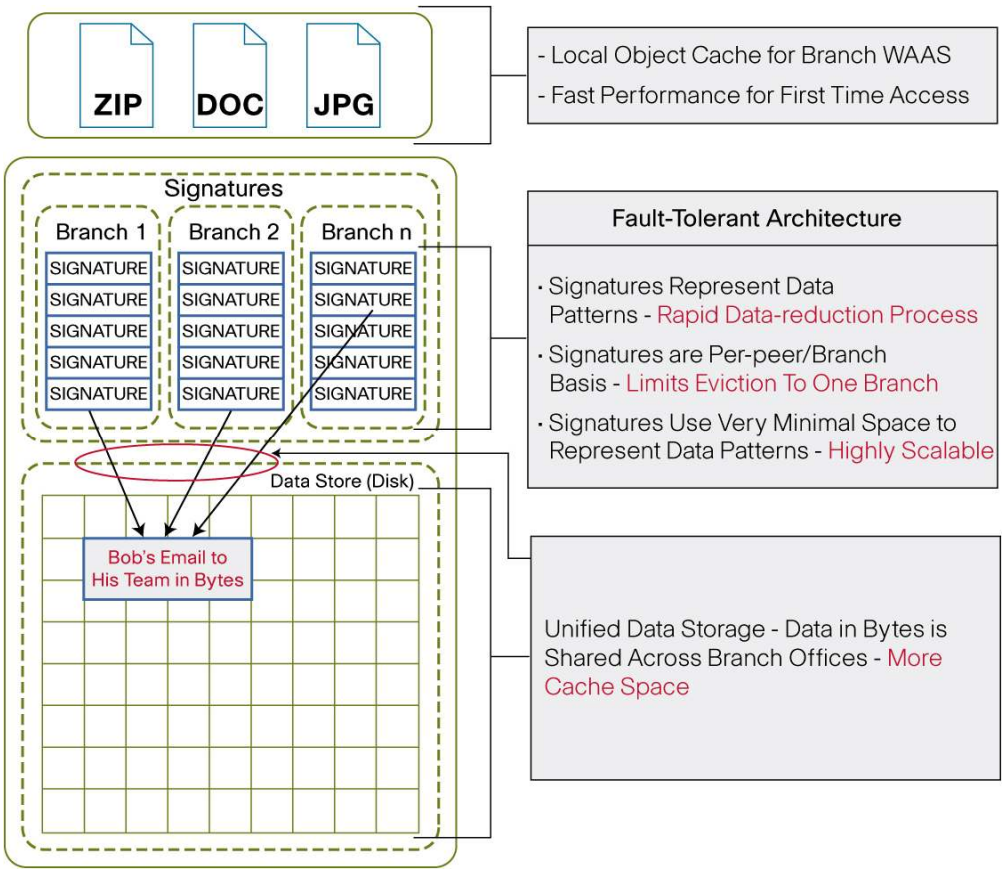
Figure 3. Cisco WAAS Context-Aware DRE Cache Architecture



Cisco WAAS Context-Aware DRE Cache Architecture: Performance Fairness

The cache performance of a WAN-optimization product placed in the data center is considered “fair” when a branch office having active users with a high data-transaction activity (that is, heavy upload and download content) does not adversely affect the performance of application delivery to other branch offices.

Consider a scenario in which a user at Branch-1 downloads a huge file from the data center such as enterprise VoD or a YouTube video. The following illustrates how this action of the Cisco WAAS Context-Aware DRE Cache Architecture with performance fairness handles it.

Data Center DRE “Before” the Download

In the Cisco WAAS Context-Aware DRE Cache Architecture, byte-level data patterns are shared in a data center device. The signatures that represent these data patterns are maintained on a per-branch-office basis. Before the download of huge files, data, or video, the data center device maintains a separate set of signatures for Branch-1 (red) and Branch-2 (blue), as illustrated in Figure 4.

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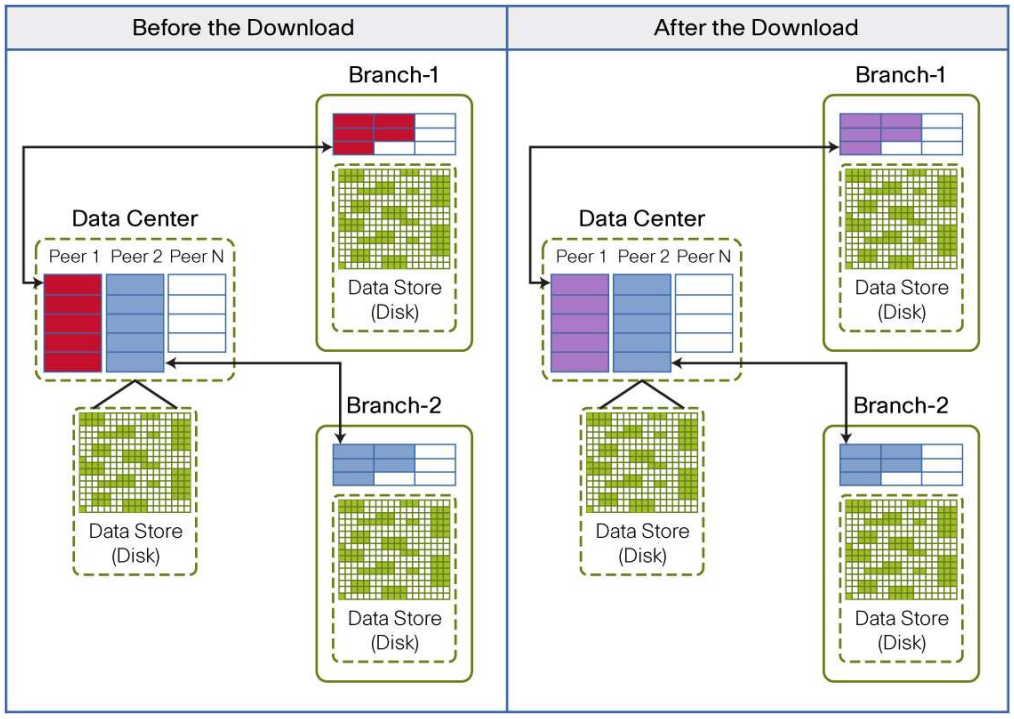
Figure 4. Cisco WAAS: Context-Aware DRE with Performance Fairness



Before the Download	After the Download
In Data Center	**In Data Center**
• = Branch-1 DRE signatures • =Branch-2 DRE signatures	• **Only Branch-1 signatures updated** • **Branch-2 signatures maintained as is** • Effect of data eviction on Branch-2 is minimized, resulting in performance fairness (i.e., optimal response time) for users in Branch-2.

Data Center DRE "After" the Download

After the download of data or video, the signatures pertaining to Branch-1 were updated with a newer set of signatures (purple) in the data center and branch-office devices. However, the signatures pertaining to Branch-2 were protected in the data center device, minimizing the effect of data eviction (caused by Branch-1 activity) for users at Branch-2. This branch-office-based signature eviction helps users in Branch-2 to continue to enjoy the improved response to applications.

Cisco WAAS Context-Aware DRE Cache Architecture: Highly Scalable and Context-Aware

In Release 4.4.1, Cisco WAAS introduces a vital DRE cache architecture feature called "Context-Aware DRE". Based on the direction of application traffic, an optimal caching technique is chosen to improve end-user response time and scalability.

Figure 5 illustrates that when unidirectional traffic traverses from the data center to the branch office, disk write operations are avoided. This behavior offers two important benefits:

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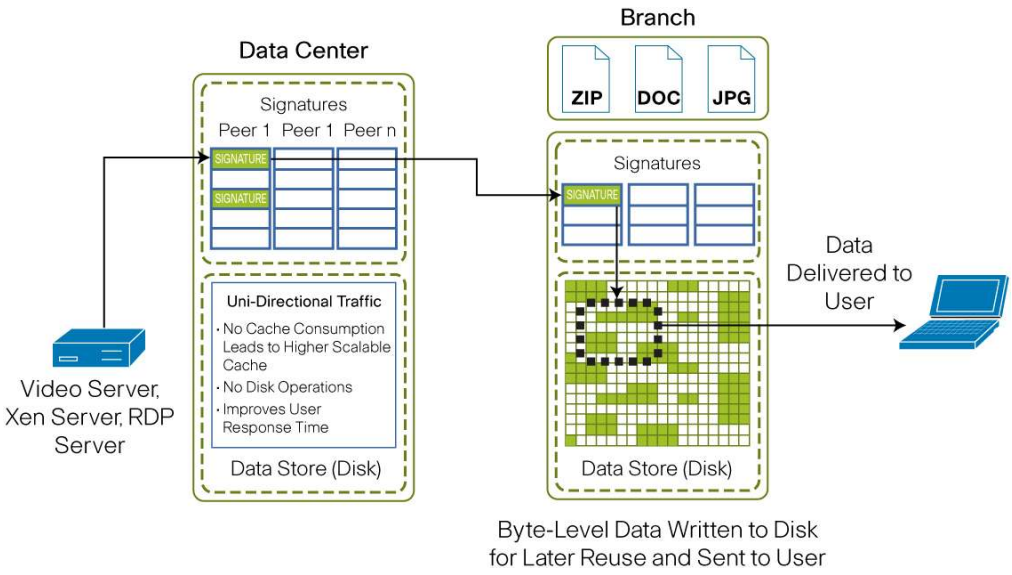
- Efficient use of disk: Avoidance of disk operations at the data center device reduces disk latency and improves the overall system throughput. The improved data throughput also contributes to better response time for users.
- Effective cache usage: Because data related to the unidirectional traffic is not written into the data center device, the available cache for bidirectional traffic grows, improving the effective scalability of the DRE cache in the data center device.

Figure 5. Cisco WAAS Cache Architecture with Unidirectional Capability



This system behavior can be applied either automatically by the system through its context-awareness feature or manually by explicit configuration by the Cisco WAAS administrator - if the administrator knows the direction of the application traffic and wishes to exercise greater control over policies.

Consider a scenario wherein the branch offices contain VDI thin-client terminals and thick clients such as PCs.

For thin-client users, application activities such as screen refreshes generate network traffic from the data center to the branch office, meaning that the traffic is largely unidirectional for VDI users. Context-Aware DRE identifies the traffic that is unidirectional. It stores the byte-level data chunks in the branch-office device only, and avoids storing them in the cache of the data center device. Because it is not necessary to write the unidirectional data at the data center device, the effectiveness of DRE cache usage improves, the needless disk “read-write” operations at the data center device are avoided, and the overall throughput for all branch-office users improves.

Cisco WAAS Caching Architecture: Local Object Cache

Cisco WAAS also supports a local object cache for applications using file services (CIFS). File-server data and metadata can be copied into this object cache, in a scheduled manner, to improve performance for first-user access. This feature is helpful in environments where large objects must traverse the WAN. Examples include software distribution, video, and desktop-management applications.

Consider users at Branch-1 downloading OS, virus patches, or home folders, which are typically large data transactions. Figure 6 illustrates how the local object caching can help customers get improved response time for

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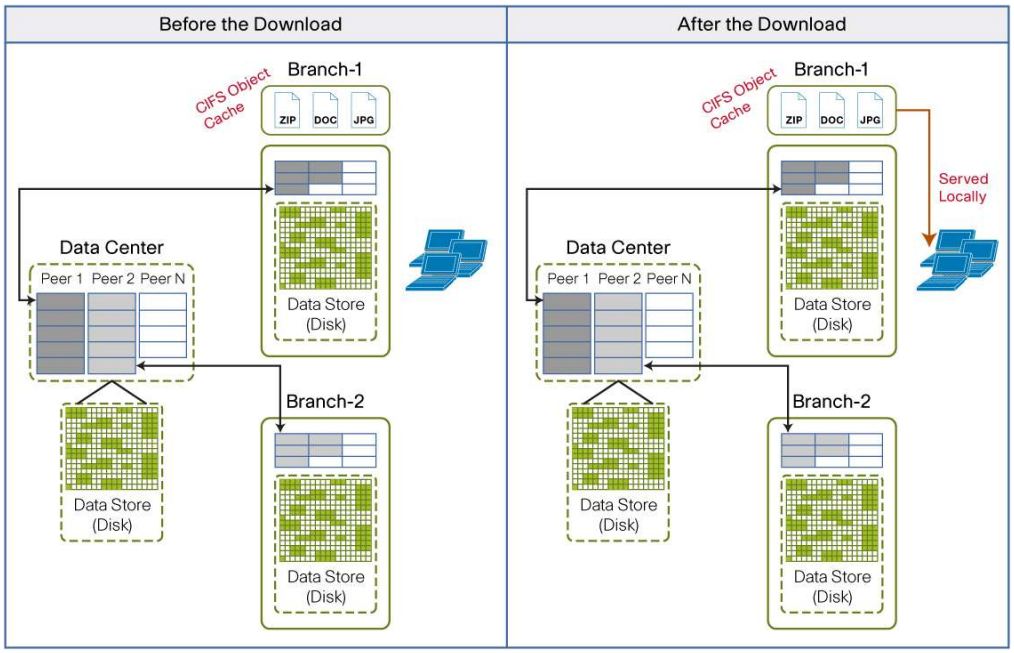
first-time access. For more information, refer to http://www.cisco.com/en/US/prod/collateral/contnetw/ps5680/ps6870/prod_white_paper0900aecd8051d5b2.html.

Figure 6. Cisco WAAS: Local Object Cache



Before the Download	After the Download
In Data Center	**In Data Center and Branch Office**
• **= Branch-1 DRE signatures** • **= Branch-2 DRE Signatures**	• **Signatures pertaining to Branch-1 and -2 were protected as represented by** • **Users are served from the branch-office local CIFS object cache.** ◦ Provides LAN-like performance for users at the branch office ◦ Dramatically reduces WAN bandwidth consumption, even if the data is compressed ◦ Protects the performance for non-CIFS traffic because the DRE cache is not evicted ◦ Offloads the file server

Summary of Features and Benefits

Table 1 summarizes the features and benefits of the solution.

Table 1. Features and Benefits

Features	Action	Benefits
Performance fairness	• Data center device maintains branch-office device (peer) information and synchronizes with the branch-office device	• Maintenance of per-peer signature information protects from widespread eviction across all branch offices, improving end-user response time and reducing WAN bandwidth usage
High scalability	• For unidirectional traffic, only signatures of data patterns are written in data center device ◦ Avoids unnecessary disk write operations • Data is stored in byte level and shared across all	• Throughput is higher • End-user response time Improves • DRE cache history size improves

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Features	Action	Benefits
	branch-office Cisco WAAS devices	
Contextual awareness	• The solution intelligently chooses between bidirectional and unidirectional algorithm based on traffic	• This feature provides flexibility by adapting to the appropriate cache based on the application traffic. This adaptation helps to ◦ Improve throughput ◦ Improve response time to end users ◦ Increase DRE cache history
Fast response for first-time access	• Files are stored locally at the branch-office Cisco WAAS device	• Fast response for first-time access improves the first user response time dramatically for accessing home folders, virus and OS patches, team folders, etc. • It protects against DRE eviction at the branch office • High performance is consistent because the data is served locally

Conclusion

Cisco WAAS is a leading WAN-optimization solution that accelerates applications and optimizes WAN bandwidth while delivering critical enterprise data to branch offices. It uses both protocol-specific and -agnostic optimizations.

Emerging applications, with their increasingly unidirectional nature, impose new caching requirements for WAN-optimization solutions. An enterprise-class WAN optimization solution should have a caching architecture that provides:

- Performance fairness for users across various branch offices, minimizing the effect of an active branch office with high data transaction activity
- High scalability by using contextual awareness of application traffic flows
- Fast response time even for first-time access

Cisco WAAS Software Version 4.4.1 introduces an innovative Context-Aware DRE cache architecture that uniquely satisfies these requirements, taking advantage of an intelligent cache that:

- Uses the per-peer signature to provide performance fairness to branch offices
- Understands the direction of application traffic to deliver context awareness and higher scale
- Continues to allow local storage of file objects to deliver the best-in-class response time for first-time access

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