Application Optimization and the Intelligent WAN (IWAN)

Bill Reilly Product Manager - IWAN

BRKRST-2514
Agenda

• Application Optimization – Why Do I Care?
• IWAN Application Optimization
  • How WAAS Works
  • Leveraging Akamai Connect
• Deploying Application Optimization
• WAN Optimization and AVC tools
Application Optimization - Why Do I Care?
App Performance Impacts Business Productivity

**REVENUE LOSS**

- **Source:** Walmart

Conversion Rate:
- Population %
- Conversion Rate
- Page Load Time (sec)
  - 0-1
  - 3-4
  - 7-8
  - 11-12
  - >15

**Abandonment Rate**
- Source: Akamai

Abandonment Rate (sec):
- iPhone

**EMPLOYEE PRODUCTIVITY**

- **Source:** Aberdeen Group

**Employee Experience**
- Decreased effectiveness of IT staff: 31%
- Damage to brand reputation: 32%
- Decreased responsiveness to needs: 47%
- Lost Revenue opportunity: 50%
- Decreased employee satisfaction: 58%
HTTP/S Traffic Is Overwhelming The Enterprise Network

I/P/SaaS, HD Video, HTTP/S Internet/Intranet/mobile app traffic growing fast

Bandwidth Requirements Will Increase by

20-50% per year

WHILE

60% of WAN Budgets are Flat to Declining
Latency & Bandwidth Impact Web & Video Experiences

**Page Load Time as bandwidth increases**

- 1 Mbps: 3500 ms
- 2 Mbps: 2500 ms
- 3 Mbps: 1500 ms
- 4 Mbps: 1000 ms
- 5 Mbps: 800 ms
- 6 Mbps: 600 ms
- 7 Mbps: 500 ms
- 8 Mbps: 400 ms
- 9 Mbps: 300 ms
- 10 Mbps: 250 ms

Source: @igrigorik & Mike Belshe “More Bandwidth Doesn’t Matter (much)”

**Page Load Time as latency decreases**

- 200 ms: 3500 ms
- 180 ms: 3000 ms
- 160 ms: 2500 ms
- 140 ms: 2000 ms
- 120 ms: 1500 ms
- 100 ms: 1000 ms
- 80 ms: 800 ms
- 60 ms: 600 ms
- 40 ms: 400 ms
- 20 ms: 250 ms

**Single digit % perf improvement after 5 Mbps**

**Linear improvement in page load time!**

Source: @igrigorik & Mike Belshe “More Bandwidth Doesn’t Matter (much)”
IWAN Application Optimization
Intelligent WAN Solution Components

- **AVC**: Internet, Private Cloud, Virtual Private Cloud, Public Cloud
- **WAAS**: Secure Connectivity
- **PfR**: Control & Management with Automation

### Transport Independent
- Consistent operational model
- Simple provider migrations
- Scalable and modular design
- IPsec routing overlay design

### Intelligent Path Control
- Dynamic Application best path based on policy
- Load balancing for full utilization of bandwidth
- Improved availability

### Application Optimization
- Application visibility with performance monitoring
- Application acceleration and bandwidth optimization

### Secure Connectivity
- Certified strong encryption
- Comprehensive threat defense
- Cloud Managed Security for secure direct Internet access
WAAS is a Leader

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Gartner’s *Magic Quadrant for WAN Optimization*
Bjarne Munch, Neil Rickard, March 2015
Cisco WAAS Components

AX Licensing
AppNav
Akamai Connect
Application Optimizer
WAAS: Application Optimization Cisco Wide Area Application Services (WAAS) Form Factors

**WAAS Appliance**
- Application acceleration
- Scalable platforms for range of deployments
- 200 – 150,000 optimized flows

**ISR-WAAS**
- Zero footprint integration on ISR 4000
- Identical features and management as other WAAS options
- Simple installation has you up and running in 7 minutes
- Seamlessly add capacity with AppNav

**Virtual WAAS on UCS-E**
- Ideal for hosting on UCS-E in ISR G2 or ISR 4K with other apps
- Flexible hardware options for WAAS & other apps
- Software on-demand provisioning
- No forklift upgrade

**Virtual WAAS**
- Application acceleration from private or virtual private cloud
- VMWare ESX/ESXi and Cisco UCS® deployments
- Agile, elastic, multi-tenant deployment
- Common management for physical and virtual WAAS
Cisco WAAS: WAN Optimization Deployment

Branch Office

Regional Office

Regional Office

WAN

Internet

Virtual Private Cloud

vWAAS

VMware ESXi Server

Nexus 1000v

Server VMs

FC SAN

Data Center or Private Cloud

vWAAS

VMware ESXi Server

UCS /x86 Server

ISR-WAAS on ISR 4000

Branch Office

WAAS Appliance

Regional Office

WAAS Appliance

Regional Office

Cisco WAAS Service Module/ UCS
How WAAS Works
Building Blocks of WAAS

- Object cache
- DRE
- LZ
- TCP flow optimization
- Latency
- Application behavior
- Bandwidth
- AO
- AO
- AO
Cisco WAAS Architecture

Platform Management and Services

- SMB/CIFS AO
- eMAPI AO
- HTTP AO
- SSL AO
- Video AO
- ICA AO
- NFS AO

Configuration Management System (CMS)

Cisco WAAS Operating System

- Auto-Discovery, Policy Engine, Filter-Bypass, Intercept Method, Directed Mode

Linux Kernel

- Disk Storage (DRE Cache, Object Cache, Akamai, etc.)

I/O

- Multiple, Independent Processes
- Fault Isolation and Containment
Transport Flow Optimization

TFO throughput improvement over standard TCP

- slow start
- Congestion avoidance
DRE Pattern Matching

DRE Signature Database

DRE Byte Cache

0101101100111...
1010010011000...
10001101...
0100011...
0011100...
0011100...
0101101100111...
0100011...
0011100...
0011100...
1010010011000...
1010010011000...
10001101...
10001101...

Original Message

Encoded Message
Adaptive DRE Cache – Bi-directional

- Applies for ‘traditional’ apps, symmetrical traffic profile
- Data chunk written to byte store on both WAAS devices for later re-use
- Only signatures cross WAN for previously seen data
- Data chunk available in DC WAAS byte store when file uploaded back to DC
Adaptive DRE Cache – Uni-directional

- Applies for VDI, video, etc., uni-directional in nature
- Signatures recorded both ends
- Data chunk written to byte store on branch WAAS only
- Only signatures cross WAN for previously seen data
- No write to DC byte store; lower disk consumption, reduced latency, probability of cache eviction = 0
Application-Specific Acceleration

Application and protocol awareness
- Eliminate unnecessary chatter
- Save WAN bandwidth
- Pre-populate edge cache as applicable

Intelligent protocol acceleration
- Read-ahead prediction, and batching
- Safe data and metadata caching
- Improves application response time
- Provide origin server offload

DRE Hints
- Application intelligence signals to DRE & LZ… whether to compress… whether to cache
Application-Specific Acceleration – SSL

SSL Handshake: client to core WAE
SSL Handshake: core WAE to server

Original Data - Encrypted
Optimized & Encrypted
Optimized - Encrypted
Application-Specific Acceleration – Citrix

WAAS acts as a transparent, trusted Man in the Middle

Transparent insertion into encrypted ICA/CGP communication.

WAAS applies TCP flow optimization to maximize bandwidth usage and mitigate packet loss.

WAAS applies inline compression algorithm over the optimized data, maximizing savings.

WAAS delivers Citrix-aware multi-user Context-Aware Data Redundancy that removes redundant data from across all end user connections.
Leveraging Akamai Connect
How To Improve Web App & Video Performance

- Get content as close to end-users as possible
- Accelerate requests/responses to data center/public cloud
- Optimize apps to reduce requests, bytes & accelerate rendering
Challenges

• Delivering corporate live video over the enterprise network - serving 70K+ end users across 250 branches globally

• End-users in South America and Asia suffer from WAN congestion and video quality issues with frequent re-buffering and slow load times

Benefits

• Cisco IWAN with Akamai Connect caches live and on-demand HTTP video fragments

• Resulted in significant WAN offload while improving video quality & end-user experiences

• Reduced IT tickets related to corporate video webcast quality/performance issues
Challenges

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Akamai Connect Use Case – Software Downloads

Software updates keep growing and consuming more enterprise network bandwidth

iOS 7 Update = ~700MB; iOS 8 Update = ~ 1.1GB

Akamai Connect can help by caching iOS and OS X updates locally in the branch

Improving performance

Offloading the enterprise network

Updating 3 iPads resulted in 2.67GB of WAN offload
Louis Vuitton Accelerates Video, Intranet & Internet Apps while Maximizing Network Bandwidth

“We have put this technology [Cisco IWAN with Akamai Connect] in the Saks Fifth Avenue store that has only 1.5 Mbps and we have better performance for our LouisVuitton.com site than in our head office on Madison Avenue that has a 100 Mbps+ connection.”

Philippe Zitoune
CTO, Louis Vuitton
### Akamai Connect Part of Cisco Intelligent WAN

#### Cisco Intelligent WAN

<table>
<thead>
<tr>
<th>Transport Independence</th>
<th>Intelligent Path Control</th>
<th>Application Optimization</th>
<th>Secure Connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMVPN/IPSec</td>
<td>Performance Routing (PfR)</td>
<td>Application Visibility and Control (AVC) Akamai Connect WAAS</td>
<td>IOS Firewall/IPS Cloud Web Security</td>
</tr>
</tbody>
</table>

#### Akamai Connect
- Transparent Cache
- Dynamic URL Cache
- Akamai Connected Cache
- Content Pre-positioning

#### Cisco WAAS
- LZ Compression
- TCP Optimization
- Data De-duplication
- Application Specific Acceleration

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Object Versus Byte Caching – 1st Pass

**Byte caching**
Symmetric deployment over WAN/MPLS
Functions at TCP layer

**Object caching**
Both symmetric & asymmetric deployment over WAN/MPLS & Internet
Functions at HTTP layer
Object Versus Byte Caching – 2nd Pass

Byte caching
Symmetric deployment over WAN/MPLS
Functions at TCP layer

Object caching
Both symmetric & asymmetric deployment over WAN/MPLS & Internet
Functions at HTTP layer
Akamai HTTP/S Object Caching Technology & Intelligence Integrated Into Cisco ISR-AX Routers & WAVE Appliances

Akamai Connect accelerates HTTP/HTTPS applications, video and content in the branch, while maximizing existing enterprise network bandwidth.
Preposition Content To Improve Performance & Offload

Improve performance and optimize network utilization by prefetching content when network is under minimal load

Cache Prepositioning fetches content proactively based on

- Predefined schedule
- URL and link depth level
- Excluded content types

Can warm both byte and object caches
Faster HTTP/S Apps, Video and Content from Orgs’ Own Data Center Over the WAN

e.g. Mobile-Assisted Selling, HTTP/S Enterprise Apps, HTTP/S Enterprise Video, etc.
Faster HTTP/S Apps, Video and Content from the Cloud over the Backhauled Internet

Data Center

end-user

Akamai Connect integrated into Cisco ISR-AX routers

WAN

Branch

e.g. Digital Signage, YouTube.com, HTTP/S Web & Mobile Apps, SaaS Apps, Software Updates, etc.
Faster HTTP Apps, Video and Content From the Cloud Over Direct Internet Access (DIA)

e.g. iOS and Mac OS X Software Updates, Guest Wi-Fi, HTTP Web & Mobile Apps etc.
How Do I Know If Objects Are Cacheable?

Look at the HTTP headers e.g. browser dev tools
Cache-Control HTTP Response Header Refresher

**Expires:**
- Tells cache how long the content is fresh for
  - After that time, cache will check back with the origin server to see if a document has changed

**Last-Modified:**
- The time that the document last changed
- Cache can use it to ask the server if the representation has changed since the last time it was seen, with an If-Modified-Since request

**Etag:**
- ETags are unique identifiers that are generated by the server and change every time the content does

**max-age:**
- Number of seconds (Time-To-Live, TTL) that an object is considered to be fresh

**s-maxage:**
- Number of seconds that shared content used by proxies can be considered to be fresh
Cache-Control HTTP Response Header Refresher

**must-revalidate:**
- Indicates the freshness directive must be obeyed and stale object cannot be served from cache

**proxy-revalidate:**
- Is identical to the must-revalidate header, but applied to proxy caches

**public:**
- Indicates that this is an authenticated response and that it can be cached

**no-cache:**
- That the object must be returned directly from the origin server to the client and cannot be cached by an intermediary

**no-store:**
- That the object cannot be stored in a cache at any time

**private:**
- Directs that the content can only be stored by the cache associated with the client that makes the request, typically the browser’s cache

For more detail
www.mnot.net/cache_docs/

HTTP/1.1 200 OK
< Accept-Ranges: bytes
< Cache-Control: max-age=604800
< Content-Type: text/html
< Date: Mon, 22 Dec 2014 16:06:59 GMT
< Etag: "359670651"
< Expires: Mon, 29 Dec 2014 16:06:59 GMT
< Last-Modified: Fri, 09 Aug 2013 23:54:35 GMT
WAAS and Akamai Connect Integration

Platform Management and Services

- SMB/CIFS AO
- eMAPI AO
- HTTP AO
- SSL AO
- Video AO
- ICA AO
- NFS AO

Configuration Management System (CMS)

Cisco WAAS Operating System

- Auto-Discovery, Policy Engine, Filter-Bypass, Intercept Method, Directed Mode

Linux Kernel

- Disk Storage (DRE Cache, OC, Akamai, etc.)

TCP Proxy with Scheduler Optimizer (SO)

- DRE, LZ, TFO

Disk Storage (DRE Cache, OC, Akamai, etc.)
Register WCM and WAAS devices with Akamai

Akamai Connect enabled device reaches out to Akamai for up to date metadata

Branch WAAS

Cache Engine (CE)

HTTP AO

CMS

Persistent Data Server

Branch Office Client

Internet / Intranet

WAN/MPLS

SaaS / Enterprise Server

CMS – Configuration Management Server
CE – Akamai Cache Engine
DS – Persistent Data Server
SaaS – Software-as-a-Service
WAAS & Akamai Connect Integration
WAAS & Akamai Connect Integration - Data Path

Single-sided Optimization

Dual-sided Optimization
Fully Integrated Into Cisco WAAS Central Manager

One Click Enablement

Easy Configuration

Visualization and Reporting
Deploying Application Optimization - AppNav
Pre-AppNav Deployment Challenges

- Traditional In-Line has limited scale

Mask based flow distribution
- Source/Destination IP and port
- Calculated Mask

<table>
<thead>
<tr>
<th>Mask</th>
<th>Value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>00:00:03:00</td>
<td>00:00:00:00</td>
<td>WAE-1</td>
</tr>
<tr>
<td>00:00:03:00</td>
<td>00:00:01:00</td>
<td>WAE-2</td>
</tr>
<tr>
<td>00:00:03:00</td>
<td>00:00:02:00</td>
<td>WAE-3</td>
</tr>
</tbody>
</table>

Redirect ACL
Several Hundred ACL Entries

- Traditional WCCP has
  - Un-deterministic Branch to DC
  - Heavy administration for redirect ACLs
  - TCAM memory and high CPU utilization
AppNav Solution

Data Center

Optimization

Load Distribution

Redirection

Interception

Asymmetric Traffic and H.A.

AppNav

AppNav-XE

Data Center

Cisco live!
AppNav Form Factors

AppNav IOM

AppNav Appliance

Both part of WAAS no explicit license needed

AppNav-XE on ISR 4xxx, part of AX

AppNav-XE on ASR 1K, part of AES or AIS

AppNav-XE on CSR, part of AX
Key Benefits of AppNav-XE

- No extra external equipment and cabling
- No other interception protocol needed such as WCCP or PBR
- VRF support
AppNav and WAAS Policy Engine

- **AppNav policy**
  - WN1
  - WN2
  - WN3
  - WN4
  - WN5
  - WN6
  - WN7
  - WN8
  - SN9
  - Pass-through

- **Optimization policy**
  - WN1
  - WN2
  - WN3
  - WN4
  - WN5
  - WN6
  - WN7
  - WN8
  - SN9
  - Unoptimized traffic

- **AppNav Controller**

Where do I send the Packets

What do I do with the Packets
WAAS Node High Availability

Cisco WAAS device down

Cisco WAAS device up

Branch Office

Data Center
TFO and AO Load-Based Optimization

- AO Not running (not configured, not licensed or disabled)

- AO running but no new connections accepted due to:
  - Its connection/resource thresholds exceeded
  - It is losing keepalives with policy engine (may be overloaded)
  - Overall device connection/resource thresholds exceeded
  - DRE processing latency is above threshold
AppNav Affinity Features

- AppNav’s powerful policy engine allows for easy separation of branch traffic.
- No knowledge of IP addresses or ACLs required.
- Split traffic into separate application clusters.
- Allows WAAS to easily adapt to application traffic increases and changes.
AppNav Cluster High Availability

- Each ANC gathers its own local view of the cluster.
- ICIMP shares local views so a Global View becomes known to all ANCs.
- An operational cluster consists of ANCs that have consistent views and can all see each other.
- *New ANCs enter the cluster gracefully by holding the ANC down until all flow states are synchronized.
- HA is built in as all the ANCs share the flow states. ANCs can exit the cluster at any time without impacting flows distribution.

*AppNav-XE does not hold down router interface, recommended that for ASR 1000s to use EMM script to hold down WAN interface during cluster sync when router is rebooted
**AppNav Cluster Backup WNGs**

- Up to 1 backup WNG per primary WNG.
- Both failure and overload conditions cause new flows to be redirected to backup.
- Backup WNG can also be primary WNG for another traffic class.

**Supported in AppNav-XE starting with WAAS 5.5 and IOS-XE 3.14**
Deployment Options – Off-Path

- All interfaces can have both interception and distribution role.

Port-channeling and 802.1q trunking supported

Same VLAN

Simple WCCP required here to distribute flows to AppNav Controllers.
Deployment Options – Inline

Control plane traffic (ANC-ANC and ANC-WN) uses same distribution interfaces

Bridge groups required for interception
- No BVI
- No Fail-to-wire
- Port-channeling and 802.1q trunking supported
- VLAN-filtering for passthrough
Deployment Options – AppNav-XE

- **Challenges/Needs:** Use a single Branch WAAS / Akamai Connect instance for DIA & Enterprise Apps
- **Solution:** AppNav-XE intercepts both FVRF & Global VRF bound traffic
- **Benefit:** Leverage common infrastructure across VRFs

![Diagram showing deployment options with ISR-4K, WAN, and Data Center with notes on deploying WAAS instance shared across VRFs and static route to /32 for Central Manager.](attachment:image.png)
1. ANC2 receives a TCP SYN packet from one of the branches containing a WAAS device.

2. The ANC2 classifies the flow, redirecting it to WN2. A pending entry is made into the flow database.

3. The frame is GRE-encapsulated and transmitted to WN2. WN2 processes the frame and continues the auto-discovery process.

4. The other ANCs are updated with the flow information and the frame is transmitted to its destination.
5. TCP SYN-ACK frame is returned from the destination device and goes to ANC1.

6. ANC1 checks the flow database, finds a matching entry, and sends the response frame to WN2.

7. WN2 processes the frame and returns it to ANC1 which in turn forwards the frame to the original requesting source.
AppNav Workflow Options
AppNav Tools in the WAAS Central Manager
WAAS Segment

Client-side Un-optimized (Segment 1)

Server-side Optimized (Segment 2)

Client-side Optimized (Segment 4)

Servers-side Un-optimized (Segment 8)

http://sharepoint.cisco.com

Client LAN

WAN

Server LAN

Optimized Connection

Pass-through (Segment 16)

No WAAS (Segment 0)

Pass-thru & Non-optimized Connection
Unified Monitoring & Export with WAAS

Overview

- With WAAS, ART monitors both Un-optimized and Optimized segments.
- Each device (branch and headend) exports two records per TCP connection.

<table>
<thead>
<tr>
<th>Segment ID</th>
<th>Src IP</th>
<th>Dst IP</th>
<th>Dst Port</th>
<th>Protocol Type</th>
<th>Resp Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1.1.1</td>
<td>2.2.2.2</td>
<td>80</td>
<td>6 (TCP)</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>1.1.1.1</td>
<td>2.2.2.2</td>
<td>80</td>
<td>6 (TCP)</td>
<td>100</td>
</tr>
</tbody>
</table>

- With WAAS, a TCP connection between client and server is split into 3 TCP connections.

**Cisco live!**
How AppNav Address NBAR2 & WAAS Interop?

Overview

If NBAR is enabled on WAN interface, and WAAS is enabled, automatically run NBAR on Uncompress Virtual Interface.
Can the Internet Deliver Enterprise Apps?  
Verizon Booth - Insights from Client Designs and Lab Testing

Opportunities

- Application-level path selection improves utilization and resiliency of hybrid WAN
- Beyond MPLS + Internet, IWAN also enables other architecture designs such as dual-MPLS
- Economic justification for increased Internet bandwidth at branch offices enables new options

Considerations

- Some applications (esp “as a service” comms apps) may require split tunneling / centralized provisioning
- Backhaul or breakout? Internet at branches changes security requirements
- Centralized policy orchestration requires unified global QoS standard
- Always-on transport requirements and wireless network design parameters

Hybrid WAN Designs with Cisco IWAN

- MPLS + Internet
- MPLS + MPLS
- Internet + Internet
- MPLS + Wireless or Satellite
- MPLS Cloud Gateway + Internet for Cloud Diversity

Getting Started with IWAN?  www.verizonciscocollaboration.com/HybridWANflightplan
Participate in the “My Favorite Speaker” Contest
Promote Your Favorite Speaker and You Could Be a Winner

• Promote your favorite speaker through Twitter and you could win $200 of Cisco Press products (@CiscoPress)

• Send a tweet and include
  • Your favorite speaker’s Twitter handle @reillybill
  • Two hashtags: #CLUS #MyFavoriteSpeaker

• You can submit an entry for more than one of your “favorite” speakers

• Don’t forget to follow @CiscoLive and @CiscoPress

• View the official rules at http://bit.ly/CLUSwin
Complete Your Online Session Evaluation

• Give us your feedback to be entered into a Daily Survey Drawing. A daily winner will receive a $750 Amazon gift card.

• Complete your session surveys though the Cisco Live mobile app or your computer on Cisco Live Connect.

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Thank you
TOMORROW starts here.