Web Cache Communication Protocol (WCCP)
Introduction

• Objective - Provide a *conceptual understanding* on what WCCP is, the factors that have gone into its development, and thoughts on what we (Cisco) can use for tomorrow.

• This is not in-depth technical
WCCP
Web Cache Communication Protocol (WCCP)

- Content Routing Technology first introduced in 1997
- Provides mechanism to redirect traffic flows [originally caches] in real-time
- Has in-built load-balancing mechanism, scaling, fault tolerance, and service-assurance (failsafe) mechanisms
First - what exactly is the name?

- WCCP’s many names:
  - Web Cache Coordination Protocol
  - Web Cache Control Protocol
- Web Cache *Communication* Protocol is the name was finally reached via internal consensus. (yes we need to change the names on the Internet-Drafts)
Second - WCCP is not just *Web*

- WCCPv2 works with any TCP/UDP port.
- The name suggest “web,” but the key value is it’s use for redirection of other applications.
Web Cache Communication Protocol (WCCP)

- WCCPv1/WCCPv2 implemented by several vendors:
  - ✓ Inktomi, NetApps, CacheFlow, Novell, Infolibra - original licensees
  - ✓ Squid has a version with WCCPv1 w/ WCCPv2 coming (when Lincoln has time)
Transparent Redirection of a Flow in the POP

Factors that went into the design of WCCP
Design Objectives for the ISP

- Transparent *Redirection* of a IP flow based on source, destination, and/or port number.

- Transparent *Integration* - no rebuilding the POP to add this service.

- Failed open - if the service fails, it should not effect the core IP service nor any other services.
Design Objectives for the ISP

- Not to effect the primary packet flow of the POP - if not redirected - then is CEF/dCEF Switched!
Design Objectives for the ISP

- Work with the multi-level L2/L3 redundancy of the ISP POP. Equal paths in the IGP + CEF leads packet asymmetry.
Design Objectives for the ISP

- Provide the ISP with Flexibility on the point of redirection.
Design Objectives for the Service Group

- Linear Scalability with the Cache - minimize object replication.
- Fault Tolerance and Maintenance.
- “Joe Smith the Telco Tech” test.
WCCP - Where Used Today
WCCP - Where used today

• Transparent Redirection into:
  ✓ Cache Service Cluster(s)
  ✓ Reverse Proxy Service Cluster(s)
  ✓ Replication Service Clusters(s)
  ✓ CDN Overlay Networks (Inktomi Mirror Image, and NetApps)
WCCP - Where used today

- ISP POPs

- Benefits:
  - Accelerated content delivery
  - Protection vs. uncontrollable bottlenecks (e.g. Web servers)
WCCP - Where used today

- Enterprise WANs
  - Monitor, manage, and report access to non-business and objectionable content
  - More productive WAN bandwidth usage
WCCP - Where used today

- Reverse Proxy
  - Cisco Cache Engines off-load traffic off the Web servers
  - Accelerate Web site, increase capacity
Co-Lo Partner

ISP-2

Cache Engine 500 Series

PIX™ Firewall

Web Servers

LocalDirector

Cache Engine 500 Series

Database Servers

Gigabit
Fast Ethernet
Backup Links

WCCP - Where used today
WCCP Basic Functionality
WCCP’s Basic Caching Function

- Connection initiated from web-browser or other service.
WCCP’s Basic Caching Function

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- Router intercepts flow and redirects it to new location (the original packet is encapsulated unchanged within a GRE frame)
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  - send somewhere else
  - masquerade as real server
WCCP’s Basic Caching Function

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- Cache Engine will serve flow (in case of *hit*), will initiate second flow if a *miss*
WCCP’s Basic Caching Function

Subsequent Requests

- Connection initiated from web-browser

Diagram:
- Internet
- Router running WCCP
- Cache/Service Group
- Web-browsers connected to Internet through Router
WCCP’s Basic Caching Function Subsequent Requests

- Connection initiated from web-browser
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WCCP’s Basic Caching Function  *Subsequent Requests*

- Connection initiated from web-browser
- Router *intercepts* flow and redirects it to new location (the original packet is encapsulated unchanged within a GRE frame)
- Cache masquerades as the web-server. Object is served locally from the cache
WCCP Features
WCCP’s Features

• WCCP’s Features are in two parts:
  ✓ Router Based - Benefiting the operation of the ISP Edge (POP) or Enterprise Gateway.
  ✓ Service Group - Benefiting the applications WCCP is servicing
WCCP’s Features (Router)

- Transparent Integration
- Fail Open on the Service Group Failure
- On-line Maintenance of the Service Group
- Multiple Router Support in one Service Group MD5 Authentication between Router and Service Group
WCCP’s Features (Router)

- CEF and dCEF Switched
- Multiple Service Groups
- Options on where the redirections happen
WCCP’s Features (Service Group)

- Fault Tolerance of the Service Group
- On-line Maintenance of the Service Group
- Linear Scalability of the Service Group
- WCCP Slow Start
WCCP’s Features (Service Group)

- Fault Prevention - Packet Return Feature (Overload and Bypass)
- Load Distribution (Hot Spots)
- Fail Open on the Service Group Failure
- Authentication By-pass
Transparent Integration

No Changes to Network Architecture, Browsers, or Servers

Configured Ports Are Redirected to Cache Engine
Fail Open

Internet

Web Server

Automatic WCCP Shutdown
Multi Router - POP Border Routers

Internet

Web Server

POP Border Router

Cisco Cache Engine Group

Router
Multi Router Support - POP
Edge Devices

Internet

MHSRP Router Pair

Cisco Cache Engine Group

Dial (PSTN/ISDN), Cable, xDSL, or Lease Line Access

Web Server

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Multihome Router via HSRP

Internet

MHSRP Router Pair

Cisco Cache Engine Group

Web Server
Multi-Service Group Support

Internet

MHSRP Router Pair

Web Server

Service Group 1
(Web)

Service Group 2
(Streaming Video)

Dial (PSTN/ISDN),
Cable, xDSL, or
Lease Line Access
Scalable Grouping

- Load balancing by hashing on destination IP address
- Linear, incremental scalability
- Hot insertion
- High availability, redundancy
Fault Tolerance

Automatic Redistribution

Buckets 86–128
Buckets 1–85

Buckets 86–170

Buckets 171–255

Fault Tolerance
Service Group Maintenance

- **Service Group “Shutdown”**
  - Stops accepting connections from WCCP
  - Tells WCCPv2 to stop sending flows

N + 2 Group Sizing
- One for failure
- One for Maintenance
• Service Group Convergence

✓ Tells WCCPv2 to start sending flows
✓ Gradual hand off from other units in Group
Fault Prevention: Overload

Request Refused

Internet

Origin Web Server

Cisco Cache Engine Group (Overloaded)

Client Requests URL
Fault Prevention: Overload

Internet

Origin Web Server

Cisco Cache Engine Group (Overloaded)
Fault Prevention: IP Authentication

Internet

Client Requests

URL

Cisco Cache Engine Group

Origin
Web Server

Client Requests URL
Fault Prevention: IP Authentication

Internet

Origin Web Server

IP Authentication Failure

Build a Bypass Pair

Cisco Cache Engine Group

Auto Retry Message

Origin Web Server

Origin Web Server
Fault Prevention: IP Authentication

Internet

Origin Web Server

Request Refused

Bypass Pair Match

Browser Retries

Cisco Cache Engine Group
Fault Prevention: IP Authentication

Internet

Origin Web Server

Successful IP Authentication

Cisco Cache Engine Group
WCCP - Which Software

Latest News
WCCPv2 Enhancements

• Announced late 1998, integrated into IOS 12.0(3)T

• Major Enhancement is that *anything* can be intercepted/redirected

  ✓ Router is instructed what to intercept and how to load-balance it

• Supports flows being *re-inserted* back into original traffic path
WCCPv2 Enhancements

- Supports multiple routers/switches to multiple caches
- MD5 Authentication of Service Group
- 12.0(4)T - CEF Switched
- 12.0(5)T - Customer can select between WCCPv1 and WCCPv2
WCCPv2 Enhancements as of 12.0(11)S

- Flow Acceleration support
  - Any ACLs used to match traffic for interception will only require ACL to match on first packet in flow.

- DCEF switching on 7500+VIP

- Input-interface switching
  - Intercept based on input interface where traffic is coming in (current is output-only)
WCCPv2 Enhancements as of 12.0(11)S

• Most enhancements addressing perceived ‘speed’ issue.
  ✓ WCCP can operate at hundreds of mbit/sec right now
  ✓ Enhancements will mean per-packet additional cpu will be <3%

• BGP Policy Propagation for WCCP- Ability to define traffic which can be intercepted via route-map.
  ✓ bgp community, as-path etc
WCCP Enhancement for the CAT6K (12.1E)

- **CAT6K Enhancements** - MLS path - this means that the first packet will be software-switched, but subsequent packets only go thru the hardware-switching path.

  - ✓ 12.1(2)E for sup1
  - ✓ 12.1(4)E for sup2
WCCP Enhancement for the CAT6K (12.1E)

1000x Performance Improvement

Sup I
SW switched
100 Kpps

Q1 CY ’00

Sup II
HW switched
15-150 Mpps
Requires Layer 2 Cache Adjacency

H2 CY ’00
WCCP - Which Software?

• Three Production flavors of WCCP:
  ✓ WCCPv1 - the original - 11.1CC
  ✓ WCCPv2 (first round - 12.0(3)T) Output Feature & CEF
  ✓ WCCPv2 (second round - 12.0(11)S) Input Feature & dCEF
  ✓ WCCPv2 (third round 12.1.(3)E) CAT 6K Support - GRE, L2, and L3 Forwarding to Service Group
  ✓ WCCPv2 (forth round - in progress) - pull together the features 12.0(11)S and 12.1(3)E
WCCPv2: GRE Encap, CEF/DCEF Switched
Accelerated WCCPv2: L2 Rewrites, No GRE

<table>
<thead>
<tr>
<th></th>
<th>MSFC 1</th>
<th>MSFC 1</th>
<th>MSFC 2</th>
<th>MSFC 2</th>
<th>MSFC 2</th>
<th>MSFC 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conns/sec</strong></td>
<td>50K</td>
<td>50K</td>
<td>150K</td>
<td>150K</td>
<td>150K</td>
<td>1M+</td>
</tr>
<tr>
<td><strong>Throughput</strong></td>
<td>170 Kpps</td>
<td>15 Mpps</td>
<td>510 Kpps</td>
<td>15 Mpps</td>
<td>510 Kpps</td>
<td>30 Mpps</td>
</tr>
</tbody>
</table>
Accelerated WCCPv2 for Catalyst 6x00

- **Today: Supervisor 1 support**
  - ✔ CE 590+SA6: Cache 2.2 software
  - ✔ Catalyst 6000: Catalyst OS 5.5, MSFC: Cisco IOS 12.1(2)E

- **Q1 CY ’01: Supervisor 2 support**
  - ✔ CE 7320+SA12 or CE 590+SA6: Cache 3.2 software
  - ✔ Catalyst 6000: Catalyst OS 6.1, MSFC: Cisco IOS 12.1(4+)E
Policy Propagation
with WCCP

Using MTRES vs ACLs
Problem: Caching is an *operational* savings. What ISPs and Co-Lo Providers are looking for is a new revenue stream - CDNs

Problem: How to maintain redirection ACLs and Route-Maps that will point redirected packets to the correct CDN service? (think 1000s of devices w/ ACLs)
BGP Policy Propagation for WCCP

• Answer - use the FIB!

✓ The FIB has the capability to add extra fields to describe a prefix.

✓ Currently (12.0(11)S) there are four extra FIB fields - precedence, qos_group, traffic_index, and wccp_tag

✓ Features would use a MTRE look-up in the FIB to get information on what to redirect.
BGP Policy Propagation for WCCP

Prefix 210.210.1.0/24
Community 210:5

Intercept all traffic bound for Community 210:5
Example - Step 1

Step 1- Router R2 (or another Router) mark the prefix with a community

```
! router bgp 210
!
! ip bgp-community new-format
!
access-list 1 permit 210.210.1.0 0.0.0.255
!
route-map comm-relay-prec permit 10
  match ip address 1
  set community 210:5
!
route-map comm-relay-prec permit 20
  set community 210:0
!```
Example - Step 2

Step 2 - Use the BGP Update to match the community and set the value in the FIB

```plaintext
! router bgp 210
  table-map precedence-map
  neighbor 200.200.14.4 remote-as 210
  neighbor 200.200.14.4 update-source Loopback0
! ip bgp-community new-format
! ip community-list 1 permit 210:5
! route-map precedence-map permit 10
  match community 1
  set ip wccp 50
!
route-map precedence-map permit 20
!
```
Example - Status

R1’s FIB Table

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Next-hop</th>
<th>WCCP_TAG</th>
</tr>
</thead>
<tbody>
<tr>
<td>210.210.1.0/24</td>
<td>h0/0/0</td>
<td>50</td>
</tr>
<tr>
<td>210.210.2.0/24</td>
<td>h0/0/0</td>
<td>0</td>
</tr>
</tbody>
</table>

Traffic Source

Service Provider AS

210.210.1.0/24

Premium Customer

Prefix 210.210.1.0/24
Community 210:5
Step 3 - WCCP used the a FIB lookup to get the WCCP_TAG. It then redirected based on the WCCP_TAG value.

```plaintext
! ip wccp version 2
ip wccp web-cache password <pass> policy source 50
!
interface <xyz>
ip wccp web-cache redirect in
!
```

Example - Step 3
Very powerful -- provides for selective inclusion in cache eligibility

✓ ‘Premium’ hosting
  ➞ Service Providers can offer transparent backbone caching. Peers/customers can choose to participate by setting bgp community/MED

✓ Cache-only-dial-pool
  ➞ Provider only wants to cache dial or DSL pool, yet address space is segregated.

✓ Selective intercept based on administrative pref
  ➞ Only cache traffic which is due to go out an expensive path (eg. International)

✓ Redirects into CDN Services
The following example shows only "premium" traffic being cached.

- "Premium" traffic is defined as traffic which has:
  - any traffic with community 4433:1050 set,
  - any traffic with community 4433:1055 set,
  - any traffic originating from directly-connected AS 65521,
  - any traffic passing thru directly-connected AS 65522,
  - any traffic passing thru AS 65523

- is eligible for intercept.

- Standard "web-cache" service is used -- which is a standard assignment of 'match tcp destination port 80', distribute traffic among participating caches as hashed by destination ip address.
Another Example

! ip cef distributed # ensure Distributed CEF is enabled
! ip wccp version 2 # enable WCCPv2
ip wccp web-cache password <pass> policy source 50 # enable WCCP standard web-cache service, apply policy
#"source"- match on WCCP route-tag 50
!
interface <xyz> # incoming i/face
    ip wccp web-cache redirect in # redirect on input traffic
!
router bgp XXXX
    table-map neighbor-xyz-in # BGP Updates the FIB’s WCCP_TAG field
    !
ip bgp-community new-format
    ip community-list 3 permit 4433:1050 # AS4433 community 1050 is premium
    ip community-list 3 permit 4433:1055 # AS4433 community 1055 is premium
!
ip as-path access-list 121 permit ^65521$ # only traffic from AS65521 is premium
ip as-path access-list 121 permit ^65522 # any traffic thru AS65522 premium
!
route-map neighbor-xyz-in permit 10 # incoming route filter on
    match as-path 121
    set ip wccp 50
!
route-map neighbor-xyz-in permit 15 # incoming route filter on
    match community 3
    set ip wccp 50
The Caveat

- BGP Policy Propagation for WCCP was only committed to 12.0(11)S.
  ✓ Hence it is currently in 12.0(11)S and it’s children - 12.0SC and 12.0SL

- Work is underway to have this committed to 12.1T and find ways for it to work on the EARL and GSR architecture (issue is the MTRE for the source address).
Where is WCCP going?
(WCCP in 3+ months)
IETF Status

- WCCPv1 spec released as an IETF Internet Draft (under the WREC WG) Will be updated and re-submitted in July’00
- WCCPv2 Internet Draft submitted in July’00
- Not standards track material - will work for Informational RFCs via WREC WG
WCCP Direction Forward

- IOS Sync between the 12.0(11)S improvements and the 12.1E improvements on the Cat6K.

- Working on WCCP functionality on the GSR Engine2, Engine3, and Engine4. Will not be able to support the full feature set.

- Most other IOS platforms have WCCPv2 12.XT support.
WCCP and our current CDN Solution?

- Currently *not* part of the solution.
  - ✓ DNS Flavor of Content Routing works in a ISP’s multi-level redundancy architecture.
  - ✓ WCCP is not needed - unless managing CE/CN service groups (i.e reverse-proxy)
  - ✓ WCCP + Boomerang will work (Edge-Interception)
WCCP and our current CDN Solution

- WCCP is a single ISP solution.
- Our DNS based CDN solution spans multiple ISPs.