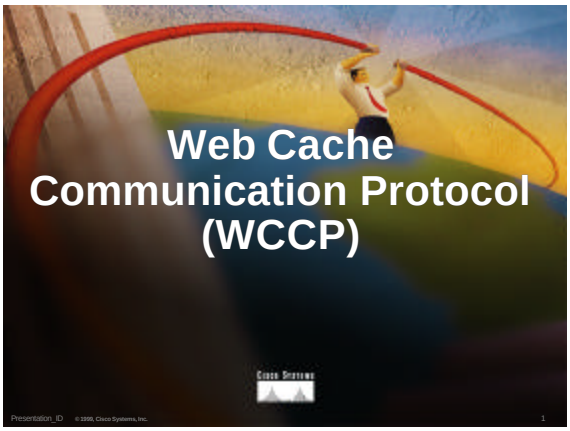


Introduction

- **Objective - Provide a *conceptual understanding* on what WCCP is, the factors that have gone into it's development, and thoughts on what we (Cisco) can use for tomorrow.**
- **This is not in-depth technical**

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 - orginal licensees
  - ✓ Squid has a version with WCCPv1 w/ WCCPv2 coming (when Lincoln has time)

Transparent Redirection of a Flow in the POP

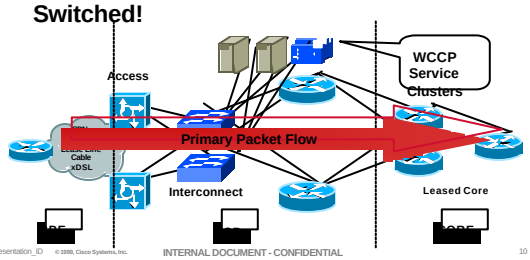
Factors that went into the design of WCCP

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.

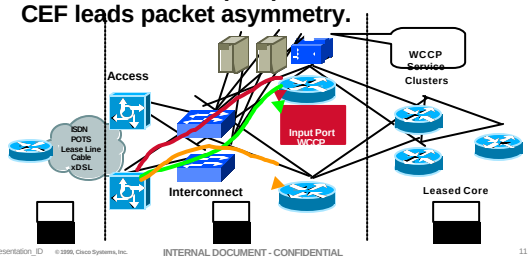
Design Objectives for the ISP

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



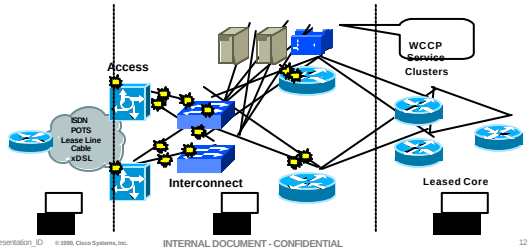
Design Objectives for the ISP

- 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.

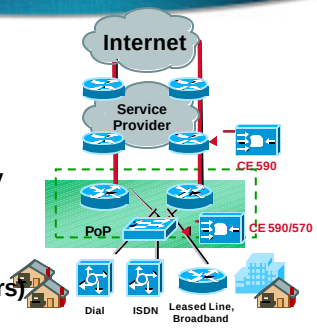
WCCP - Where Used Today

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)

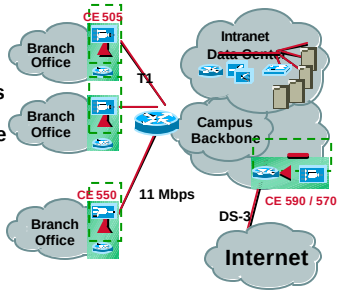
WCCP - Where used today

- ISP POPs
- Benefits:
  - ✓ Accelerated content delivery
  - ✓ Protection vs. uncontrollable bottlenecks (e.g. Web servers)

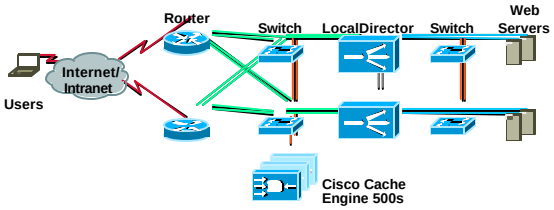


WCCP - Where used today

- Enterprise WANs
  - ✓ Monitor, manage, and report access to non-business and objectionable content
  - ✓ More productive WAN bandwidth usage

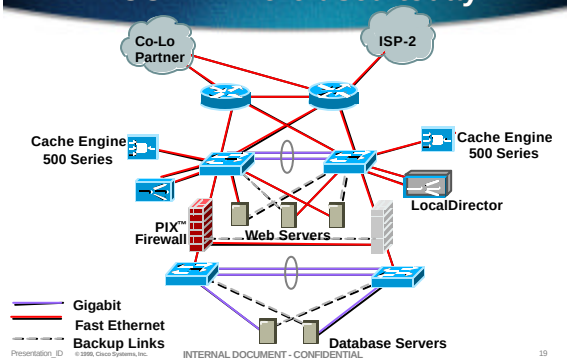


WCCP - Where used today



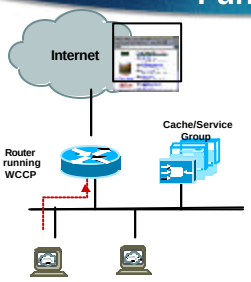
- Reverse Proxy
  - ✓ Cisco Cache Engines off-load traffic off the Web servers
  - ✓ Accelerate Web site, increase capacity

WCCP - Where used today



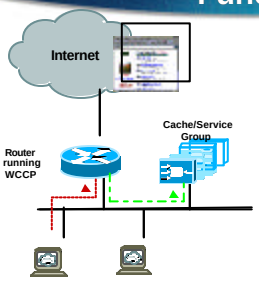
WCCP Basic Functionality

WCCP's Basic Caching Function



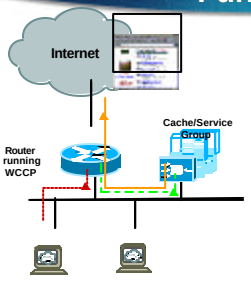
- **Connection initiated from web-browser or other service.**

WCCP's Basic Caching Function



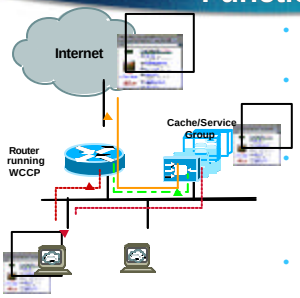
- Connection initiated from web-browser or other service
- **Router *intercepts* flow and redirects it to new location**
  (the original packet is encapsulated unchanged within a GRE frame)

WCCP's Basic Caching Function



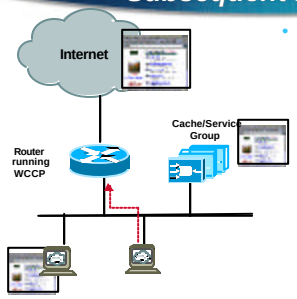
- Connection initiated from web-browser or other service
- Router *intercepts* flow and redirects it to new location
  (the original packet is encapsulated unchanged within a GRE frame)
- **Device that flow is redirected to can choose what to do with flow:**
  - ✓ **send somewhere else**
  - ✓ **masquerade as real server**

WCCP's Basic Caching Function



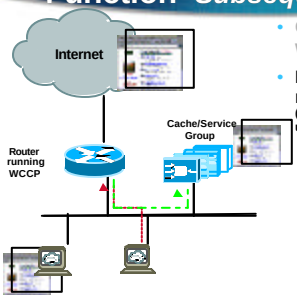
- Connection initiated from web-browser or other service
- Router *intercepts* flow and redirects it to new location
  (the original packet is encapsulated unchanged within a GRE frame)
- Device that flow is redirected to can choose what to do with flow:
  - ✓ send somewhere else
  - ✓ masquerade as real server
- **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

WCCP's Basic Caching Function *Subsequent Requests*



- Connection initiated from web-browser
- Router ***intercepts*** flow and redirects it to new location
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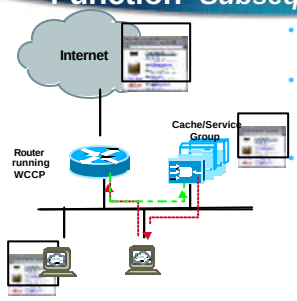
WCCP's Basic Caching Function *Subsequent Requests*



- 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'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 happens

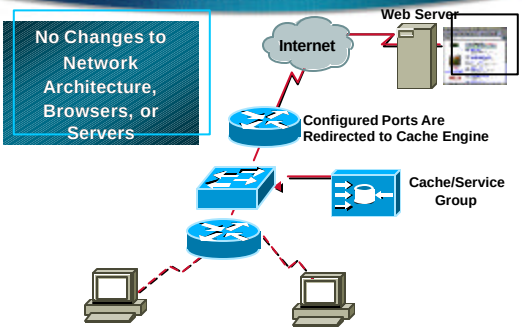
WCCP's Features (Service Group)

- Fault Tolerance of the Service Group
- On-line Maintenance of the Service Group
- Linear Scalability of the of the Service Group
- WCCP Slow Start

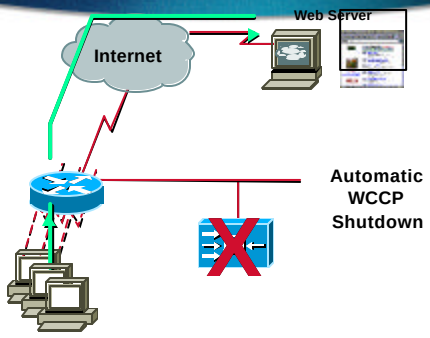
WCCP's Features (Service Group)

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

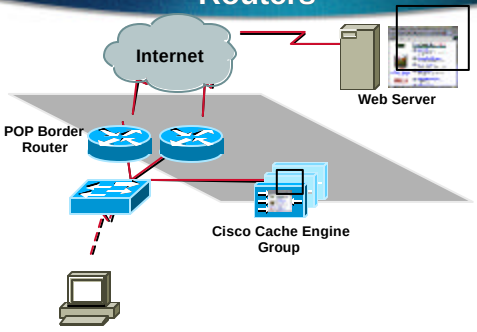
Transparent Integration



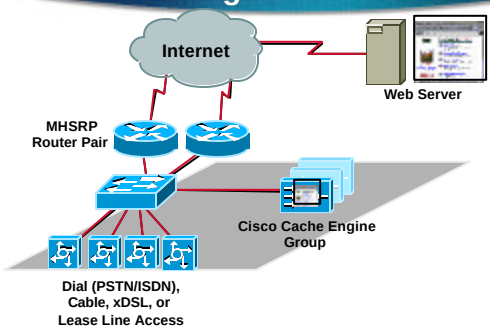
Fail Open



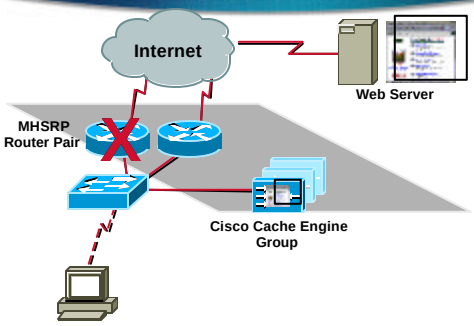
Multi Router - POP Border Routers



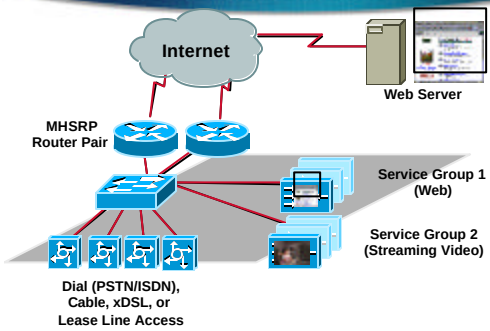
Multi Router Support - POP Edge Devices



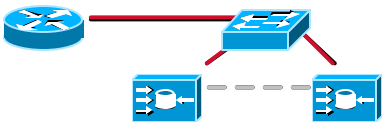
Multihome Router via HSRP



Multi-Service Group Support

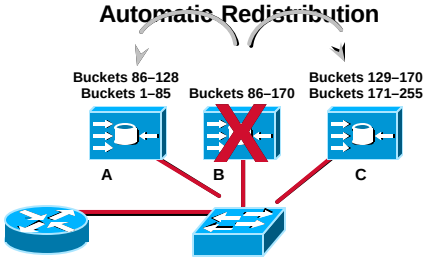


Scalable Grouping

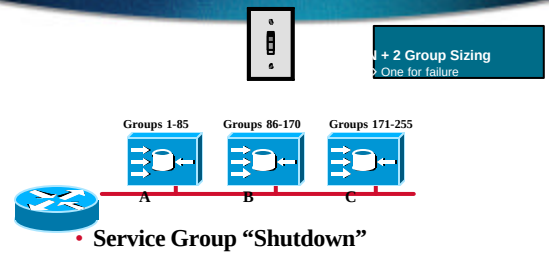


- Load balancing by hashing on destination IP address
- Linear, incremental scalability
- Hot insertion
- High availability, redundancy

Fault Tolerance

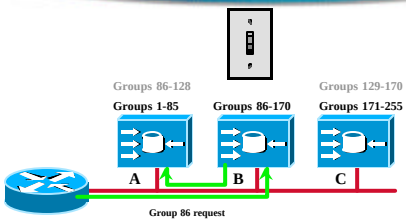


Service Group Maintenance



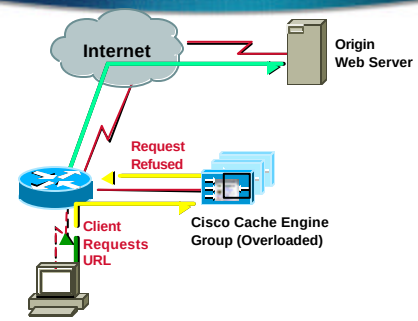
- Service Group "Shutdown"
  - ✓Stops accepting connections from WCCP
  - ✓Tells WCCPv2 to stop sending flows

Service Group Maintenance

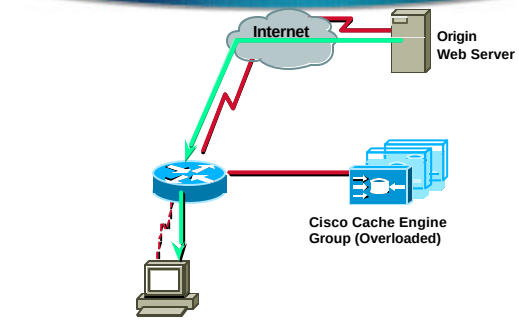


- **Service Group Convergence**
  - ✓Tells WCCPv2 to start sending flows
  - ✓Gradual hand off from other units in Group

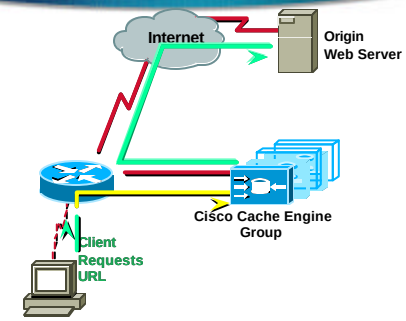
Fault Prevention: Overload



Fault Prevention: Overload



Fault Prevention: IP Authentication



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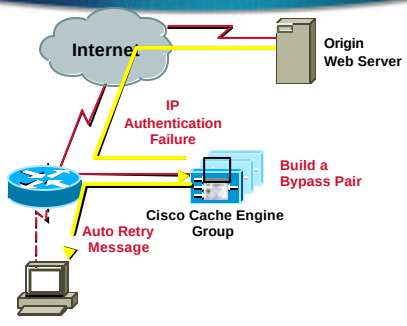
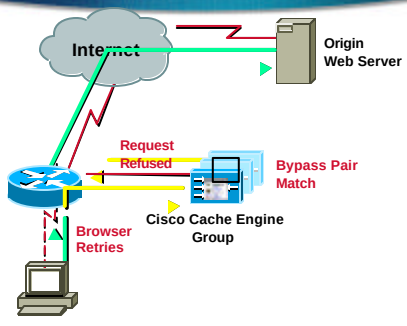
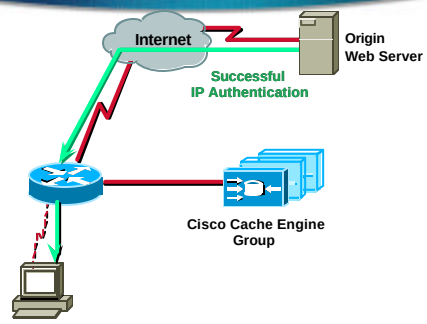
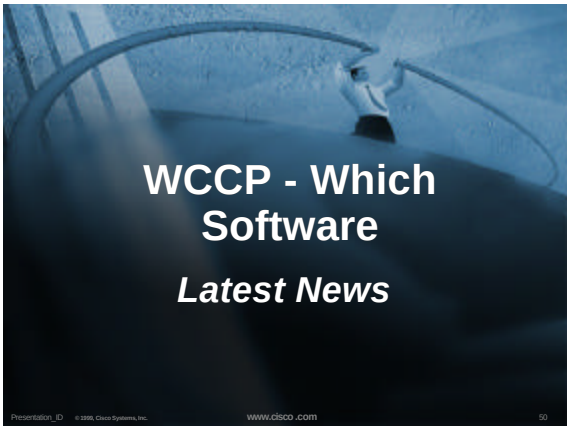


Fault Prevention: IP Authentication



Fault Prevention: IP Authentication





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**

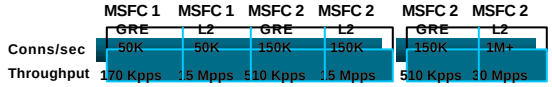
WCCP Enhancement for the CAT6K (12.1E)

WCCP - Which Software?

- **Three Production *flavors* of WCCP:**
  - ✓ **WCCPv1 - the orginal - 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**

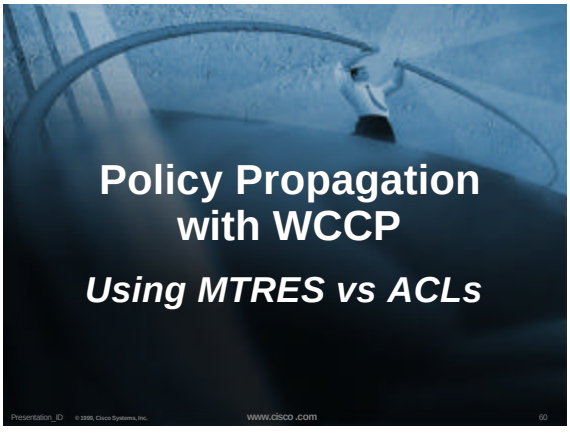
Accelerated WCCPv2 for Catalyst 6x00

WCCPv2: GRE Encap, CEF/DCEF Switched
Accelerated WCCPv2: L2 Rewrites, No GRE



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**



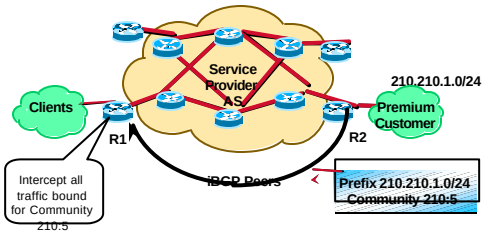
BGP Policy Propagation for WCCP

- **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



Example - Step 1

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

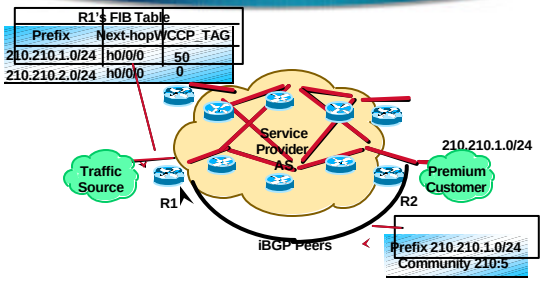
```
!
router bgp 210
 neighbor 210.210.14.1 remote-as 210
 neighbor 210.210.14.1 route-map comm-relay-prec out
 neighbor 210.210.14.1 send-community
!
ip bgp-community new-format
!
access-list 1 permit 210.210.1.0 0.0.0.255
!
route-map comm-relay-prec permit 10
 match ip address 1
 set community 210:5
!
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

```
!
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



Example - Step 3

Step 3 - WCCP used the a FIB lookup to get the WCCP_TAG. It then redirected based on the WCCP_TAG value.

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


BGP Policy Propagation for WCCP

- **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**

Another Example

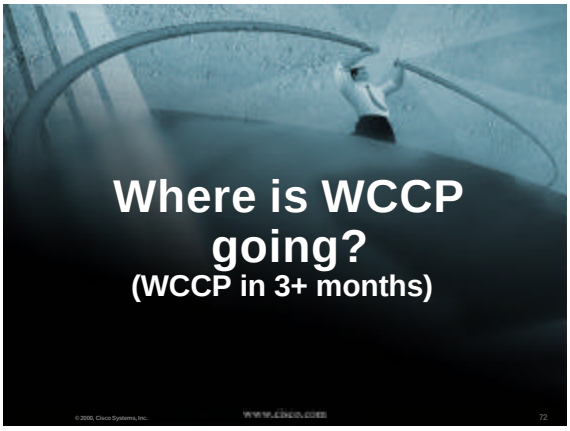
- **The following example shows only "premium" traffic being cached.**
  - ✓ **"Premium" traffic is defined as traffic which has:**
  - ✓ **The policy defined below is:**
    - → **any traffic with community 4433:1050 set,**
    - → **any traffic with community 4433:1055 set,**
    - → **any traffic 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
  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).*



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

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