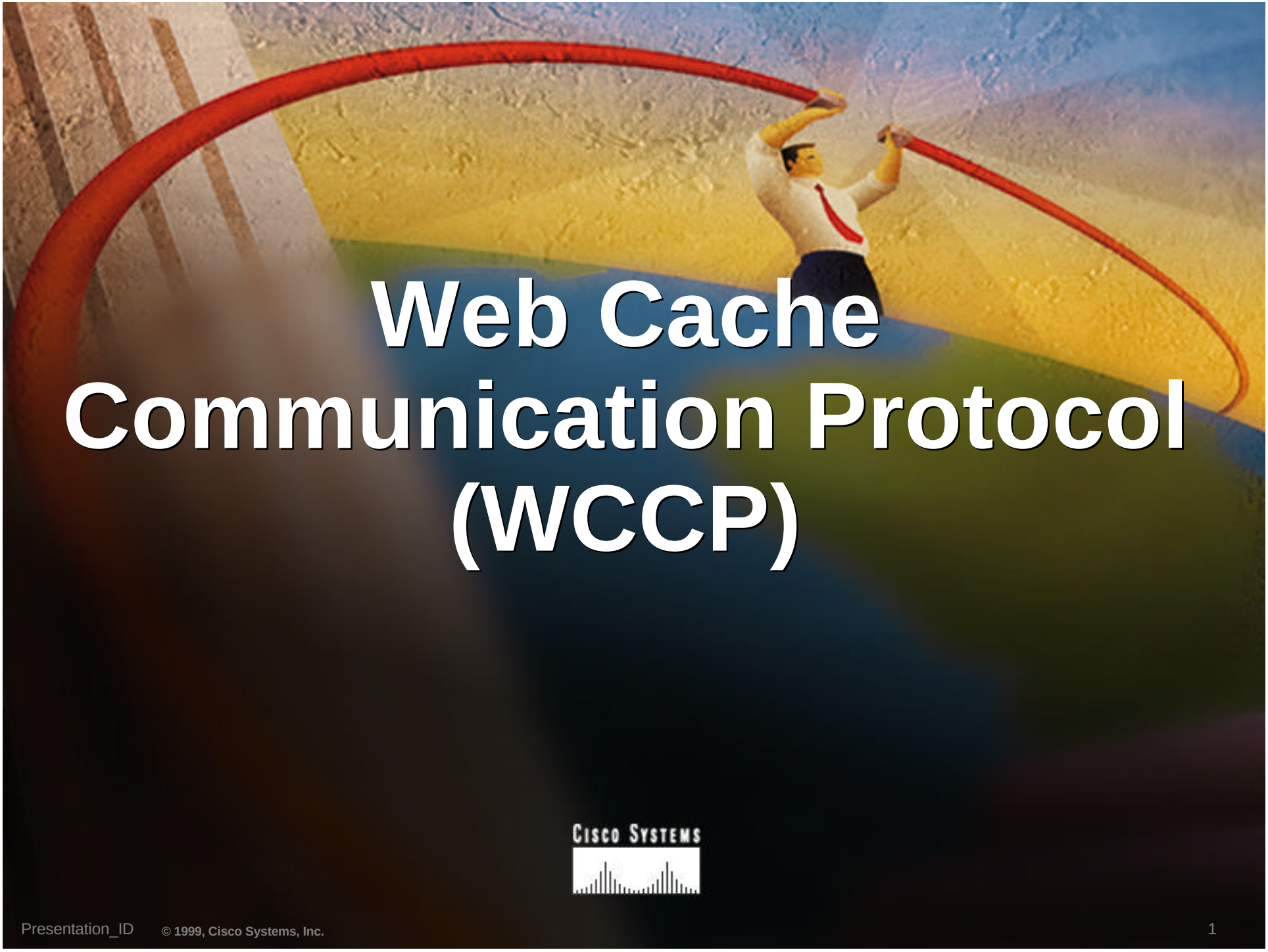


Web Cache Communication Protocol (WCCP)

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)

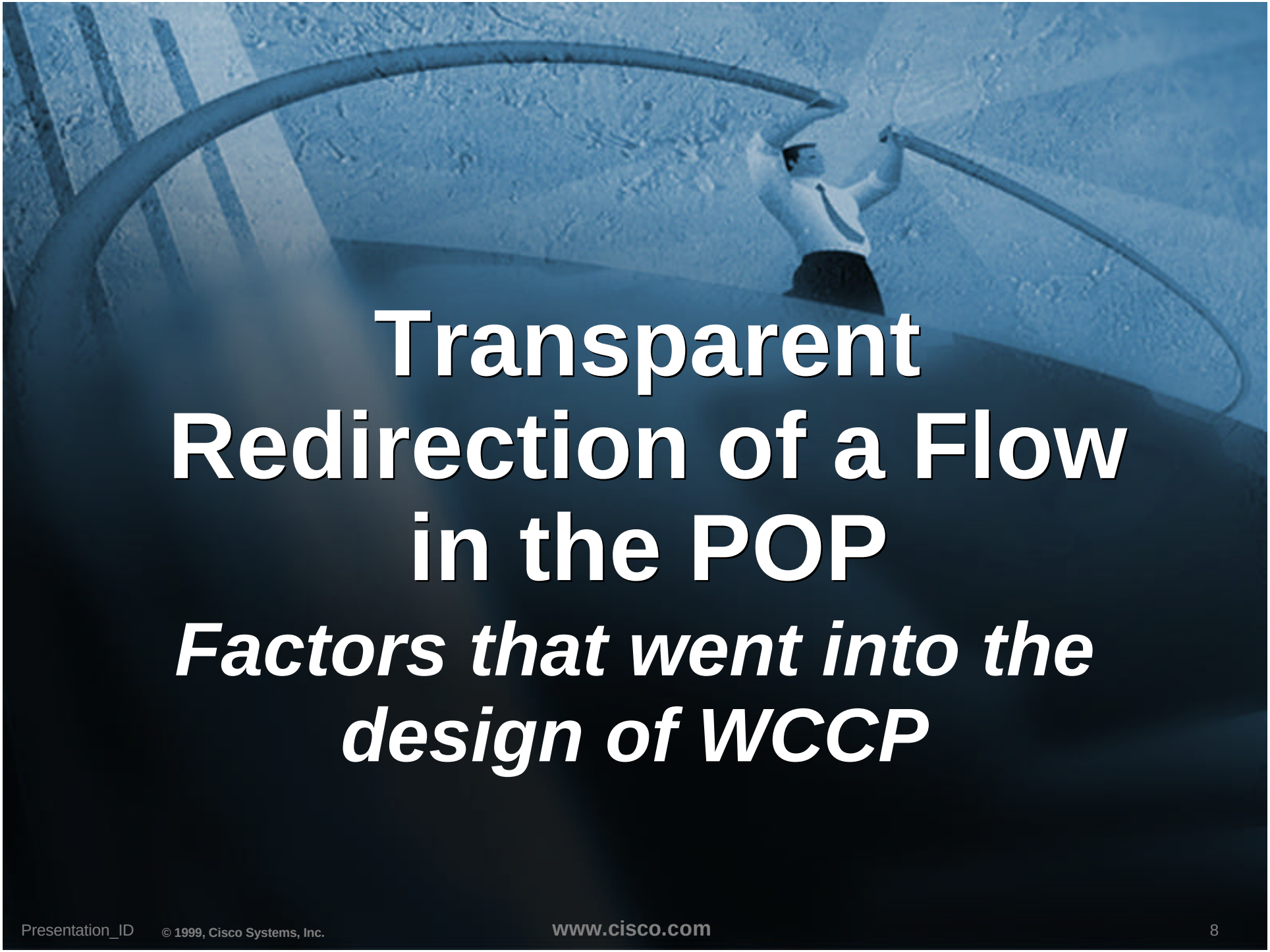
Second - WCCP is not just *Web*

- **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)**

Novell



Transparent Redirection of a Flow in the POP

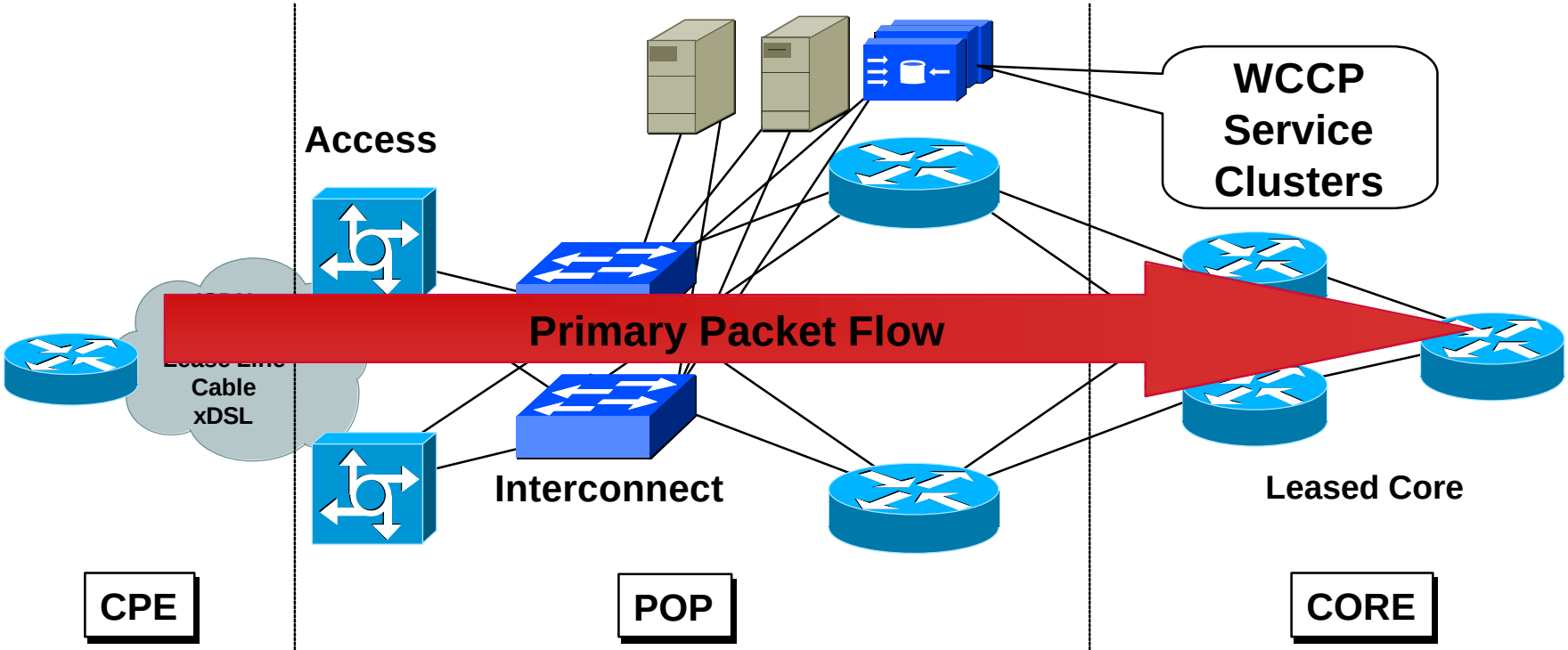
Factors that went into the design of WCCP

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.**

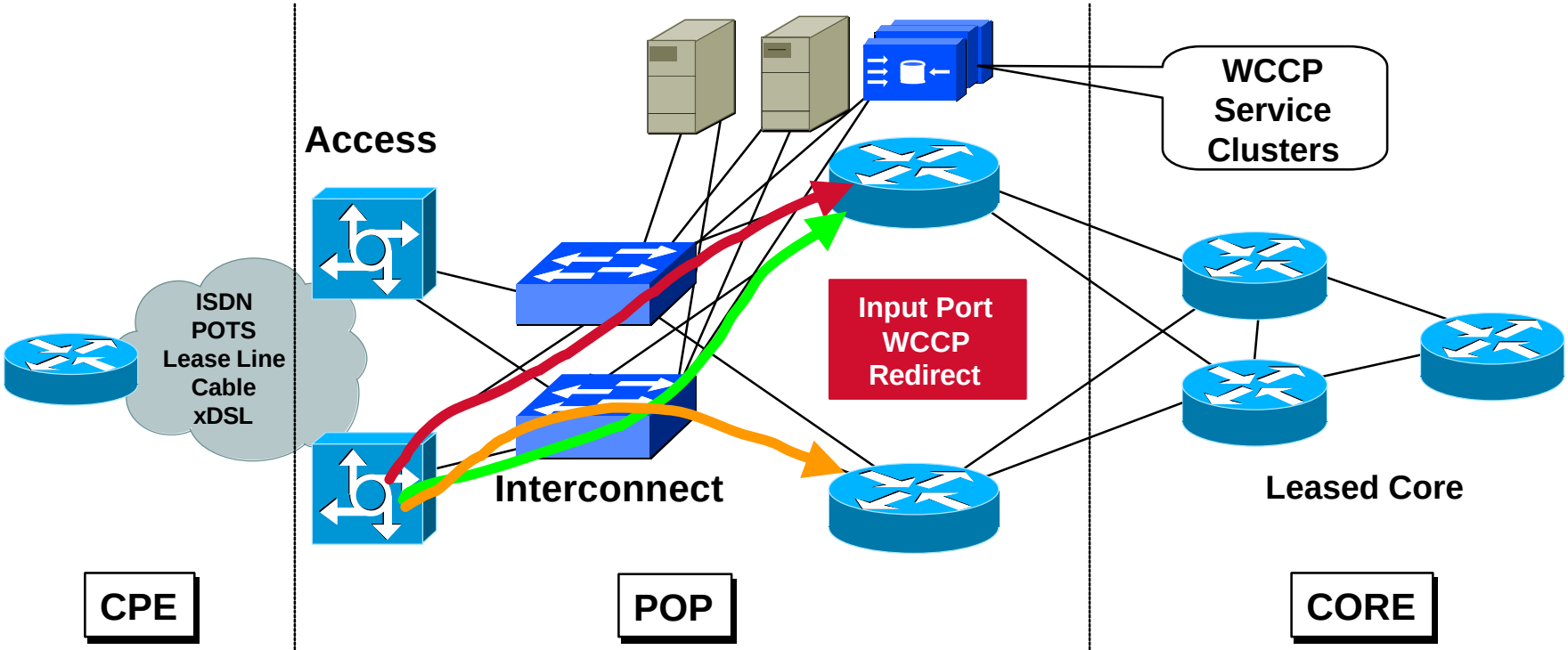
Design Objectives for the ISP

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



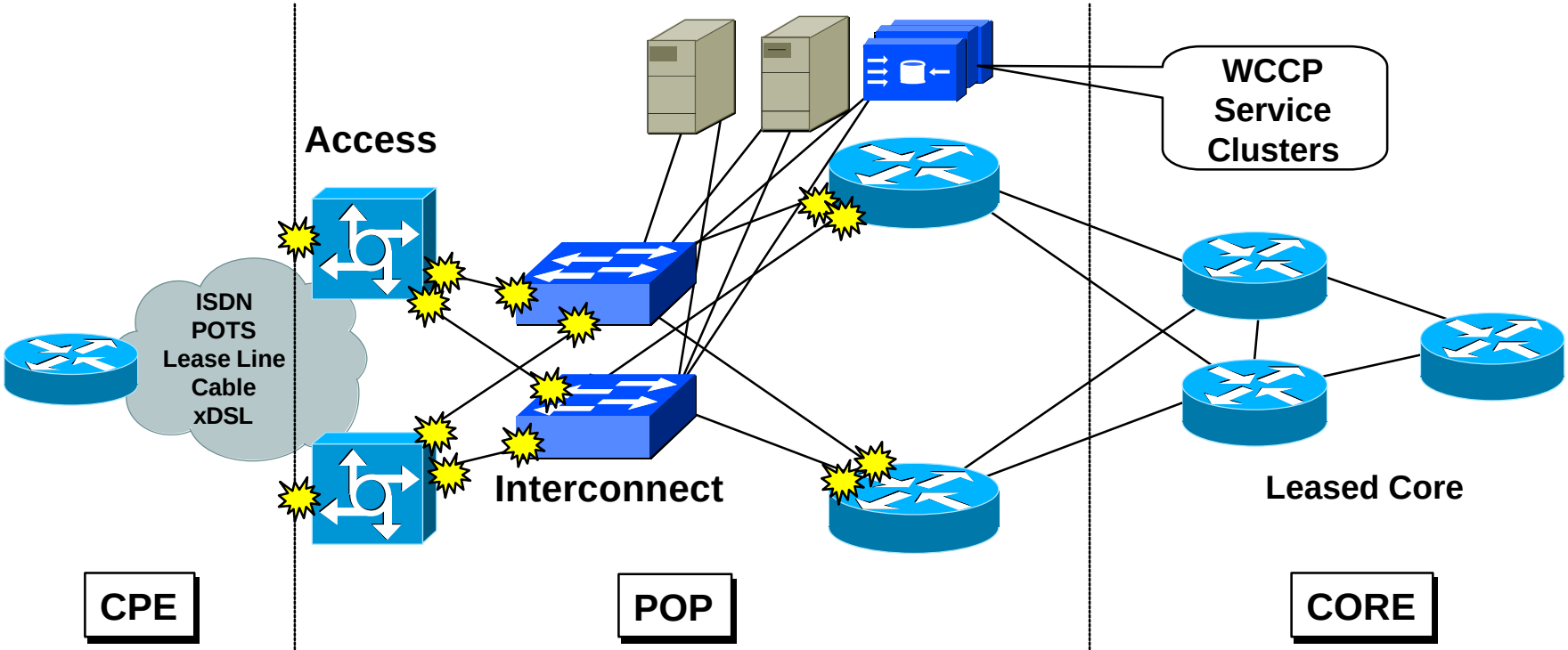
Design Objectives for the ISP

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



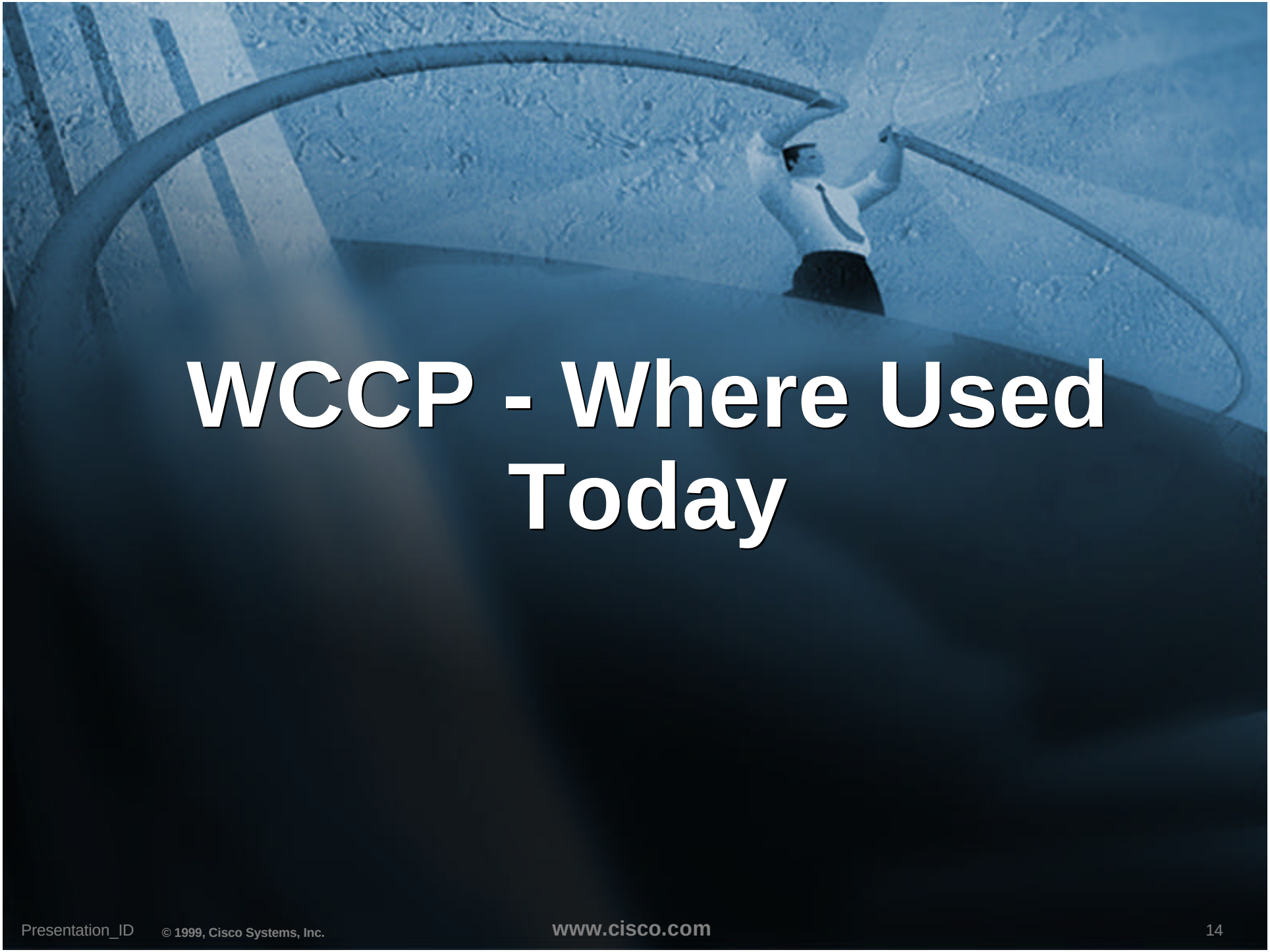
Design Objectives for the ISP

- **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.**



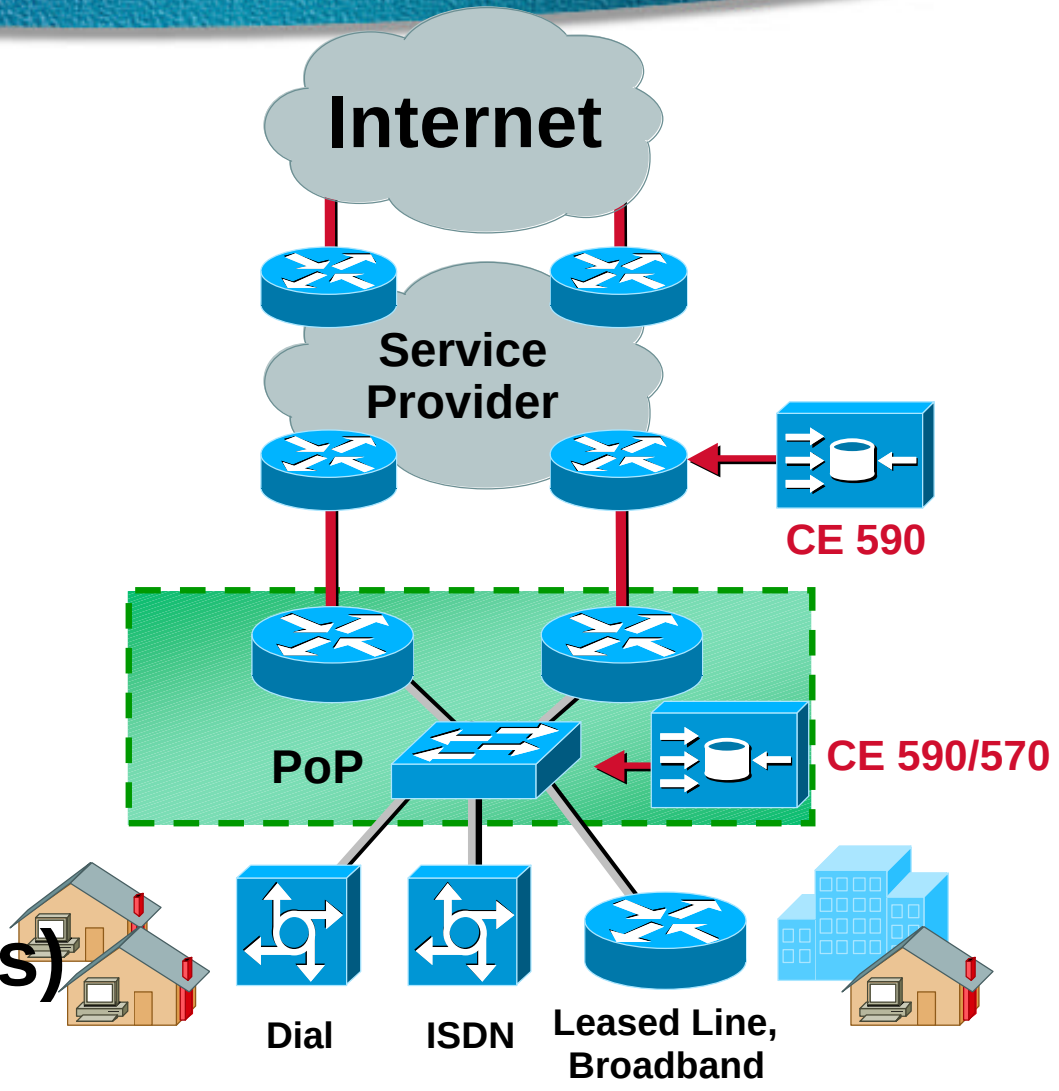
WCCP - Where Used Today

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)**

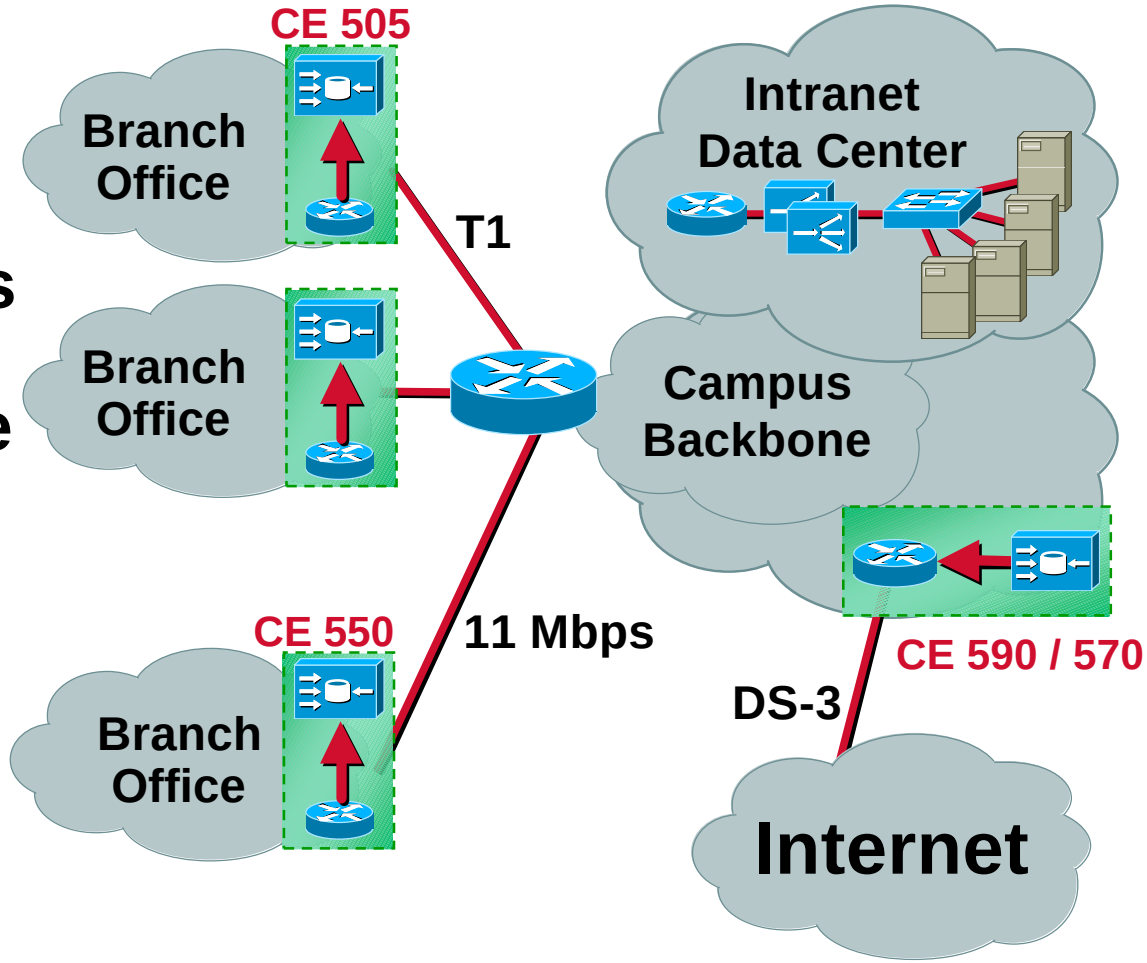
WCCP - Where used today

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

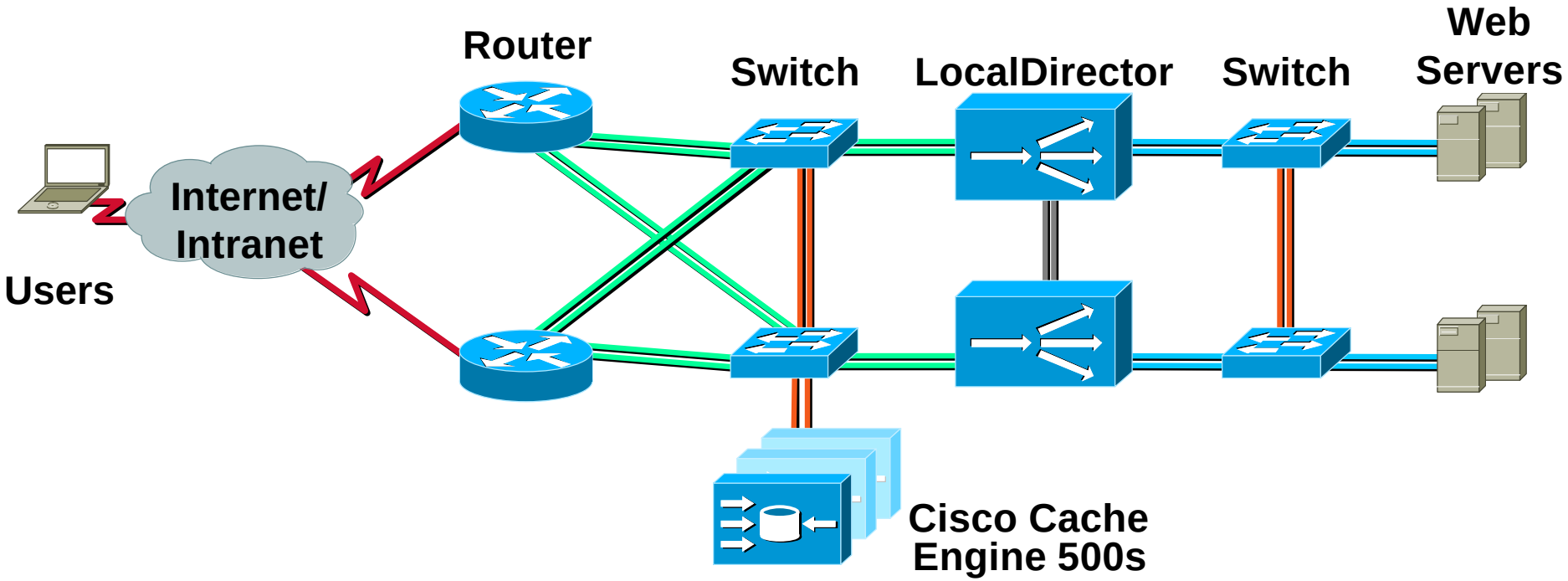


WCCP - Where used today

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

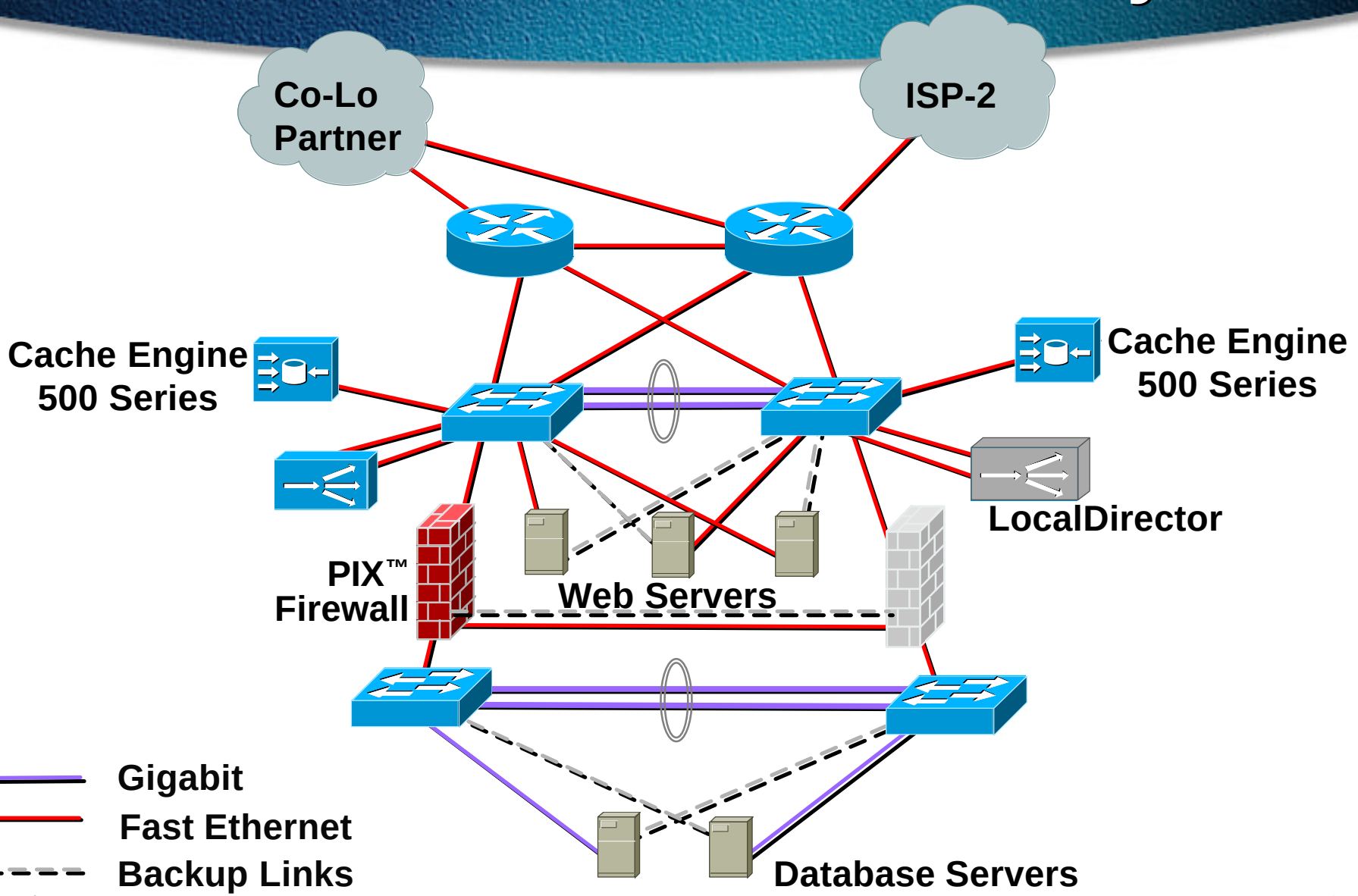


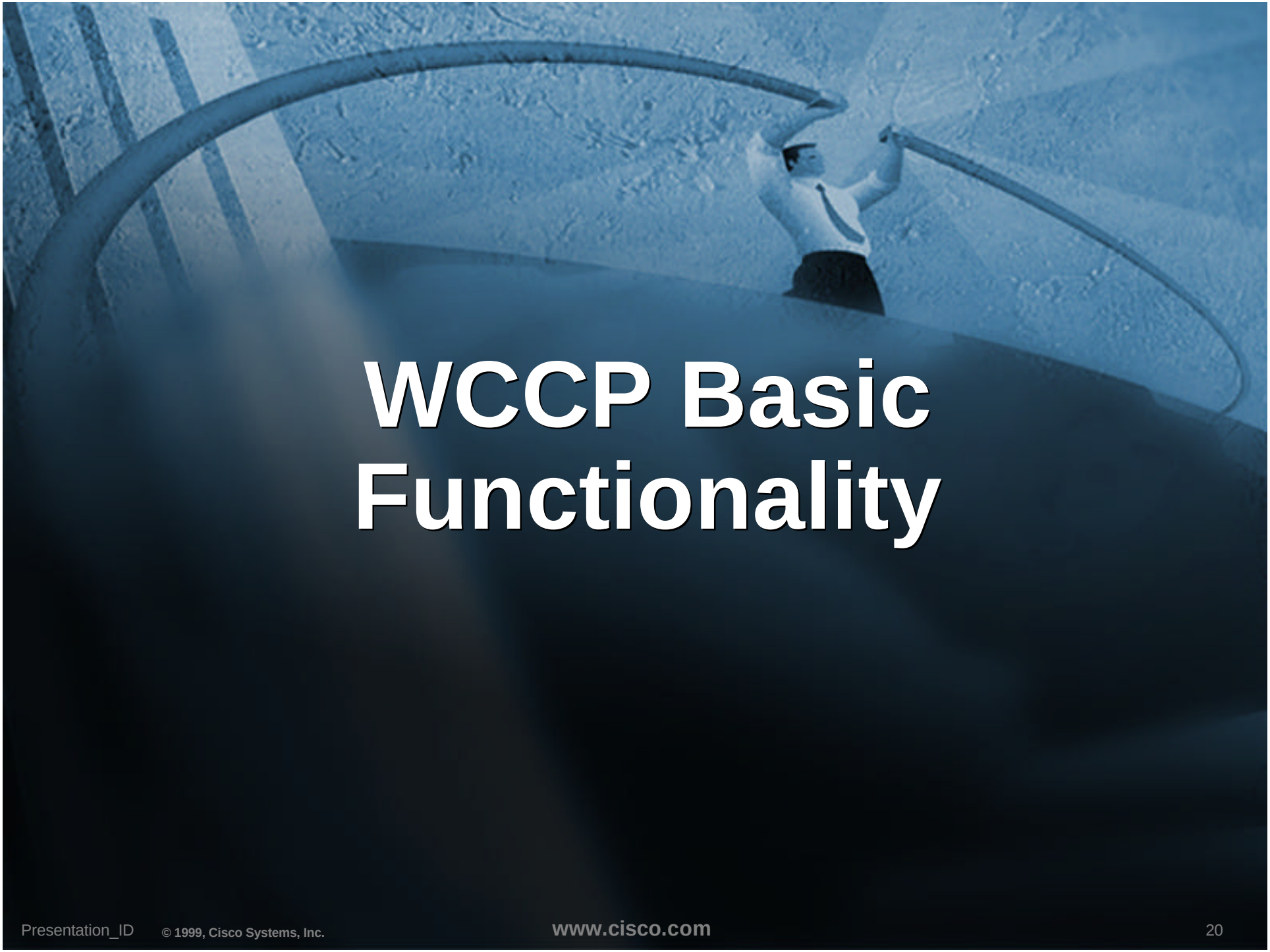
WCCP - Where used today



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

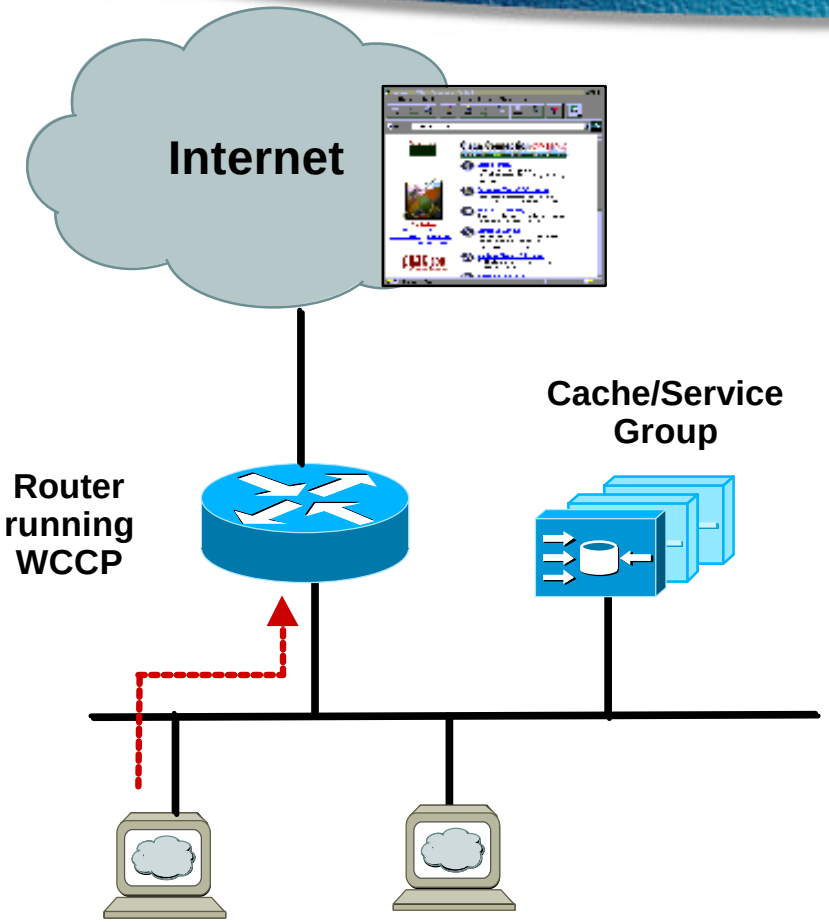
WCCP - Where used today





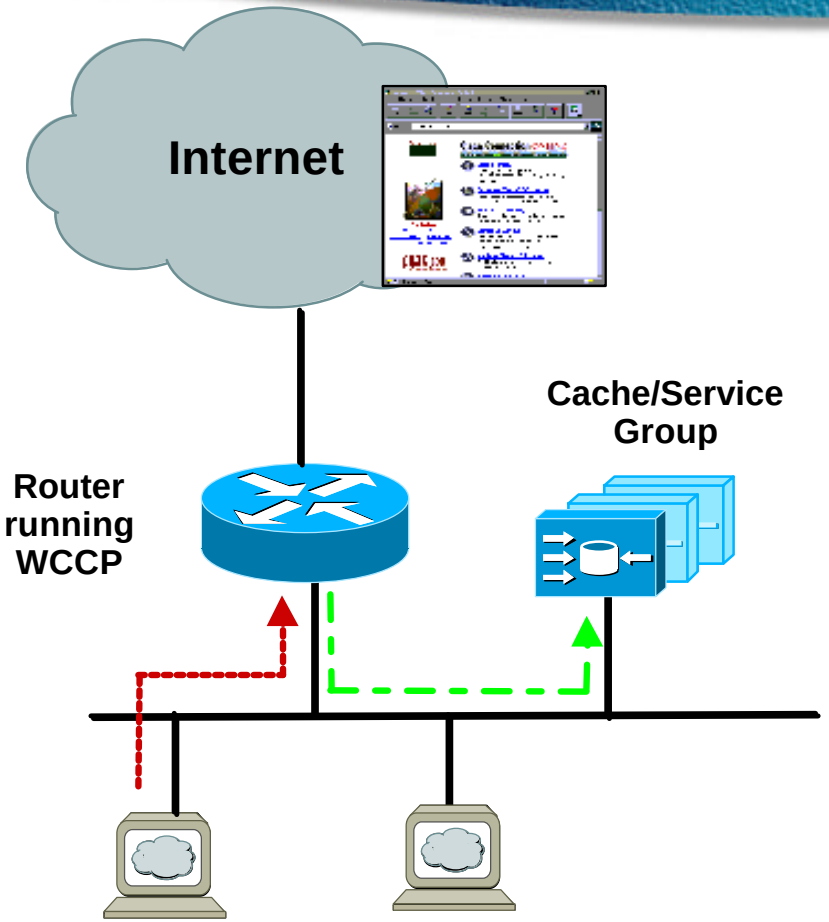
WCCP Basic Functionality

WCCP's Basic Caching Function



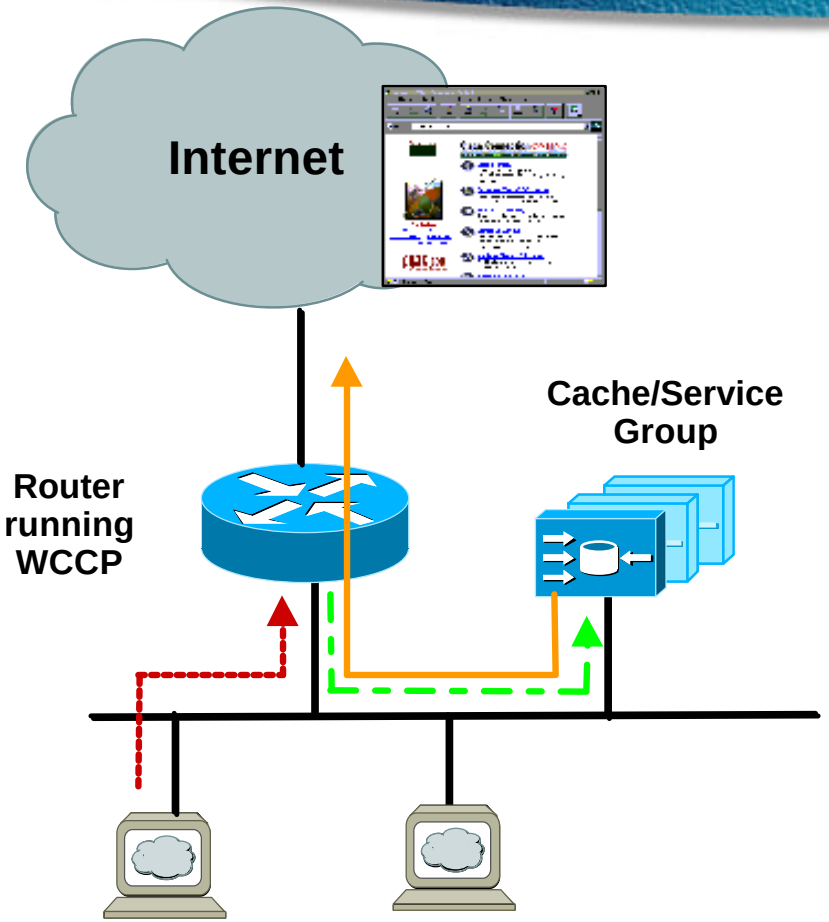
- **Connection initiated from web-browser or other service.**

WCCP's Basic Caching Function



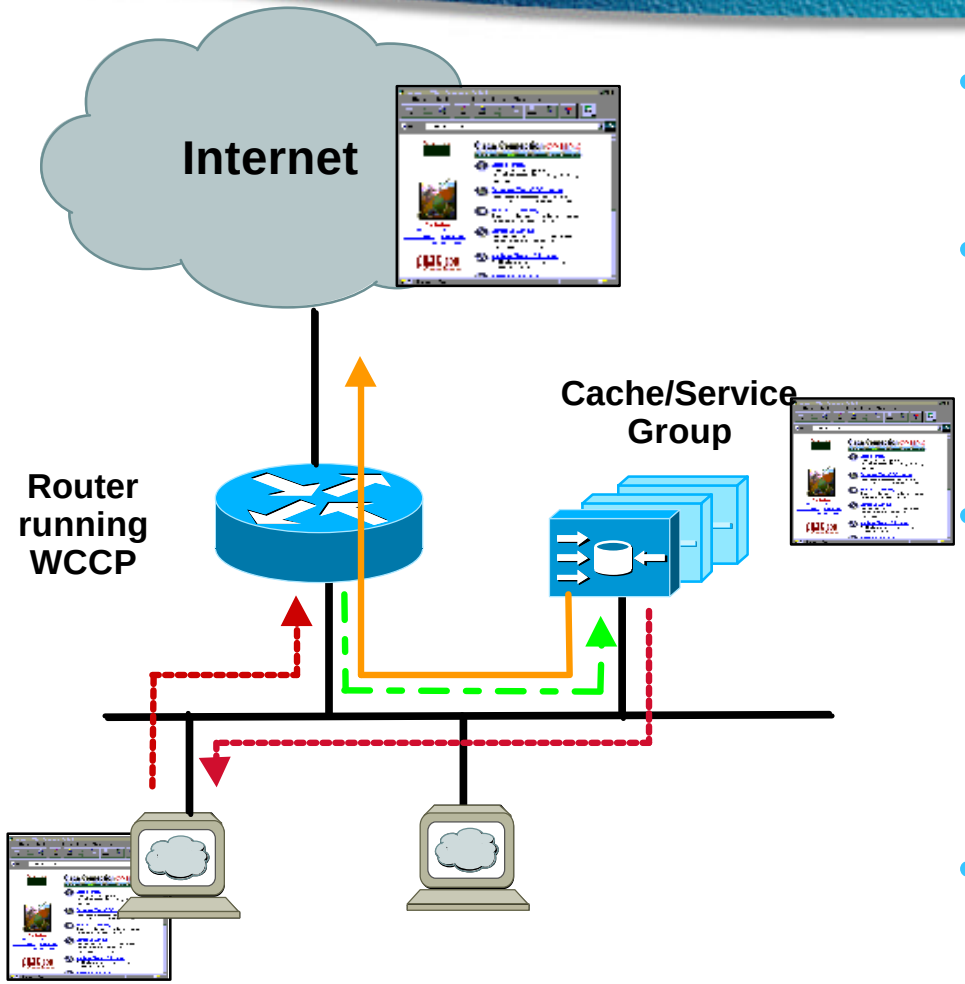
- Connection initiated from web-browser or other service
- **Router *intercepts* flow and redirects it to new location**
  (the original packet is encapsulated unchanged within a GRE frame)

WCCP's Basic Caching Function



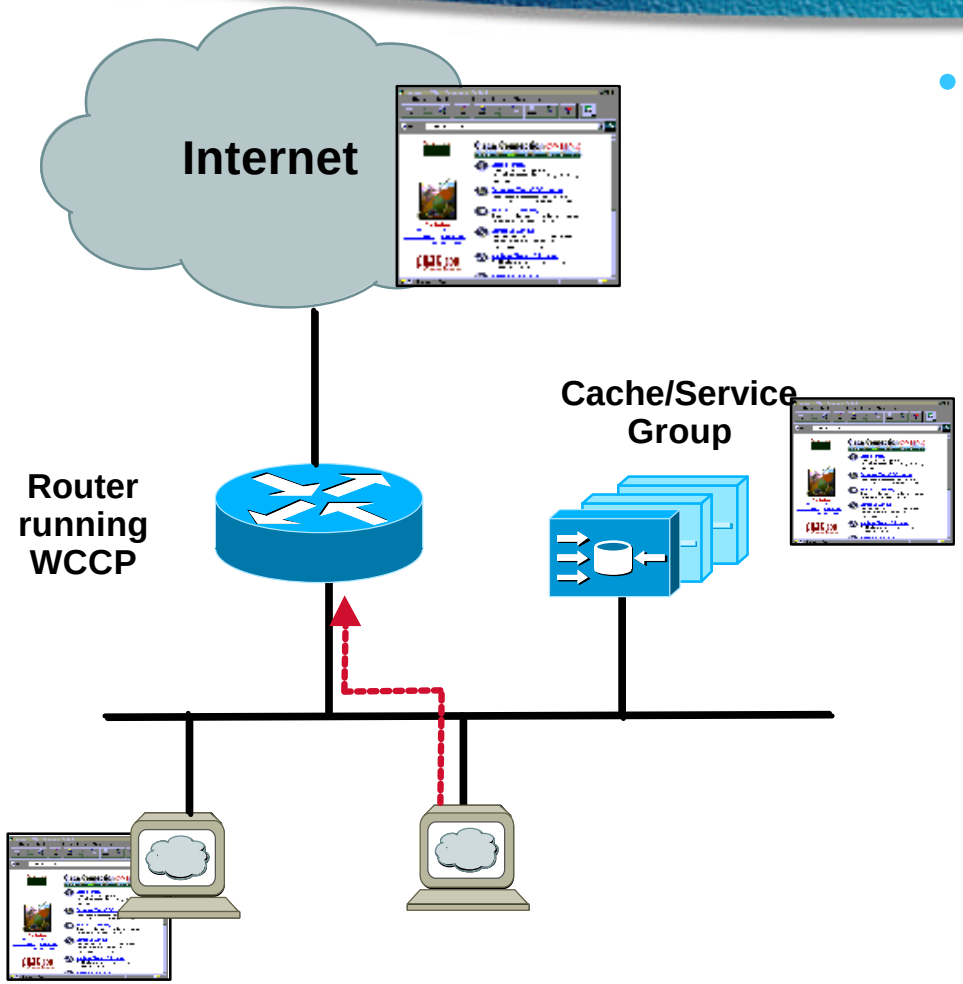
- Connection initiated from web-browser or other service
- Router *intercepts* flow and redirects it to new location
  (the original packet is encapsulated unchanged within a GRE frame)
- **Device that flow is redirected to can choose what to do with flow:**
  - ✓ **send somewhere else**
  - ✓ **masquerade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

WCCP's Basic Caching Function



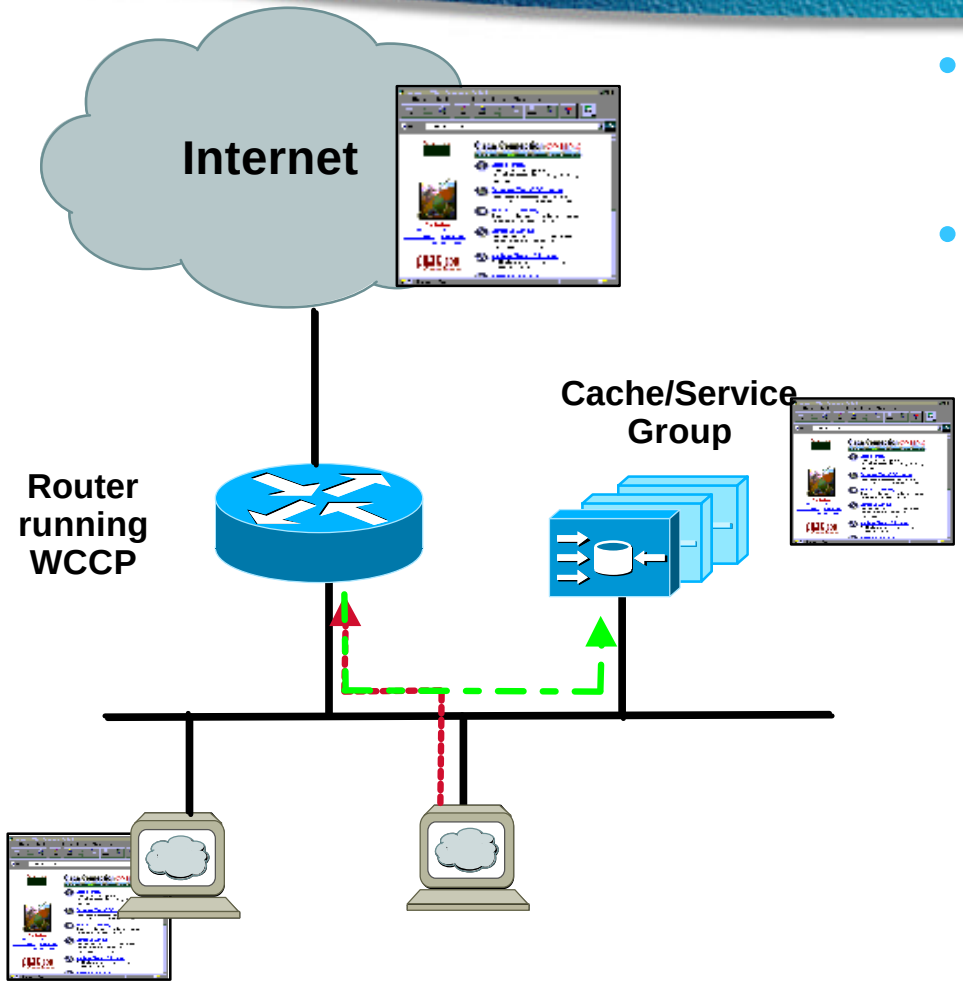
- Connection initiated from web-browser or other service
- Router *intercepts* flow and redirects it to new location (the original packet is encapsulated unchanged within a GRE frame)
- Device that flow is redirected to can choose what to do with flow:
  - ✓ send somewhere else
  - ✓ masquerade as real server
- **Cache Engine will serve flow (in case of *hit*), will initiate second flow if a *miss***

WCCP's Basic Caching Function
Subsequent Requests



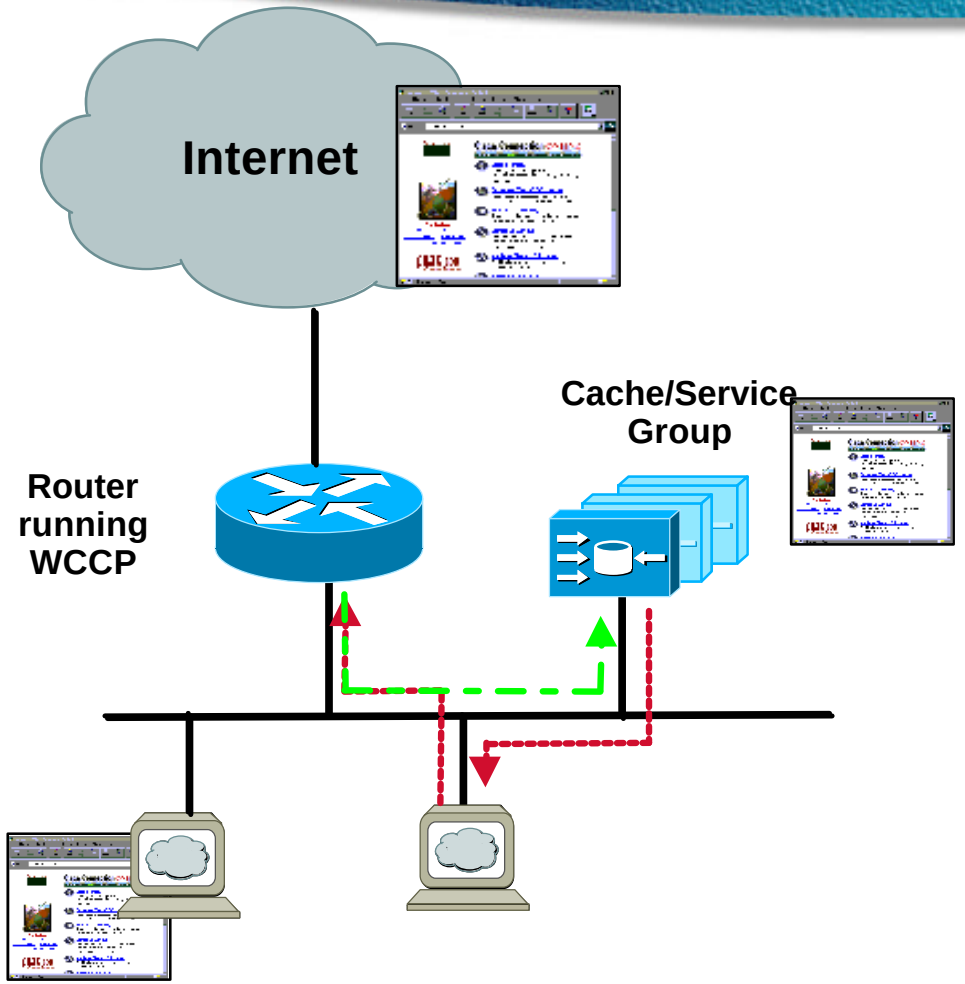
- **Connection initiated from web-browser**

WCCP's Basic Caching Function *Subsequent Requests*

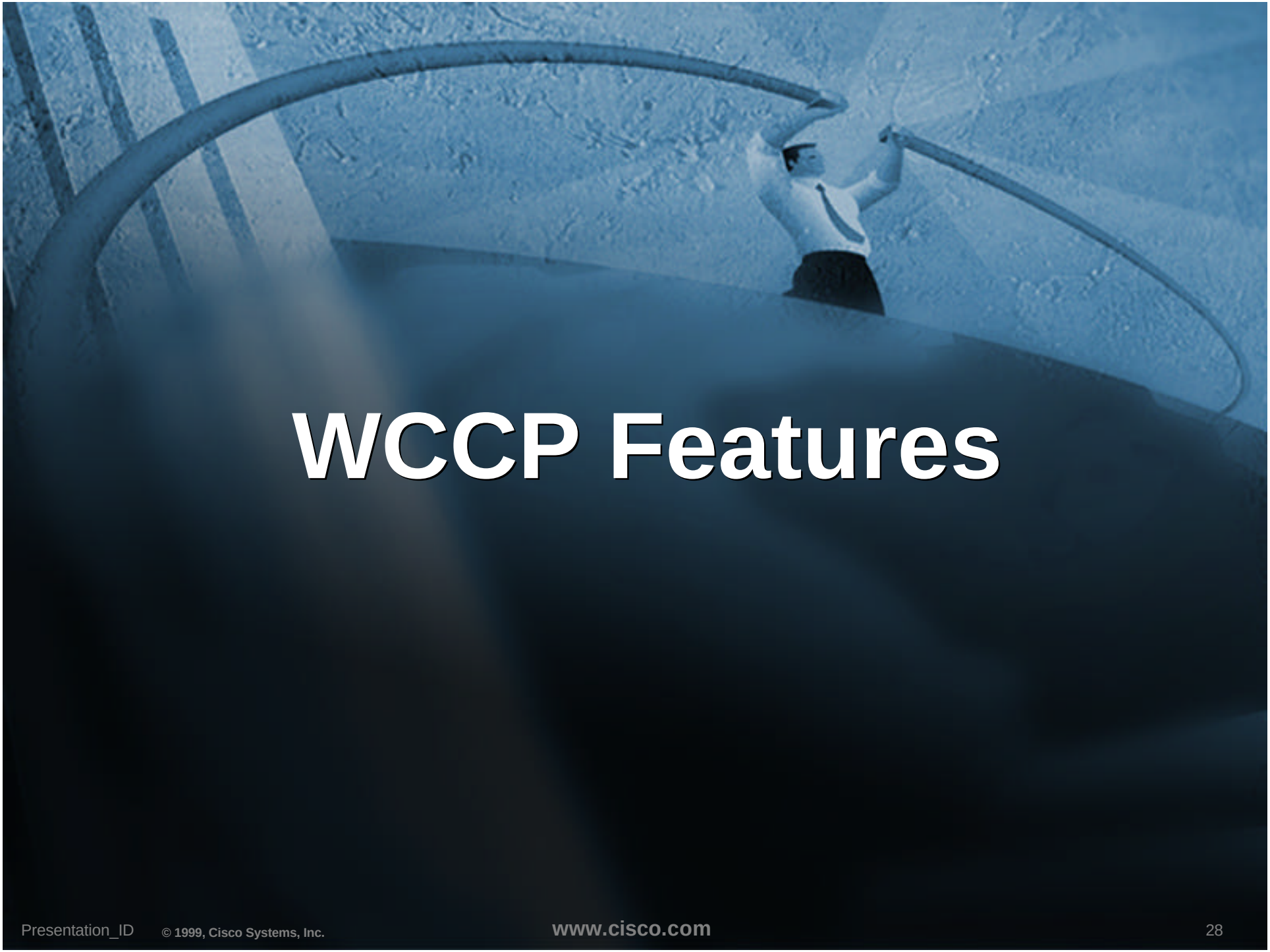


- Connection initiated from web-browser
- **Router *intercepts* flow and redirects it to new location**
  (the original packet is encapsulated unchanged within a GRE frame)

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 happens**

WCCP's Features (Service Group)

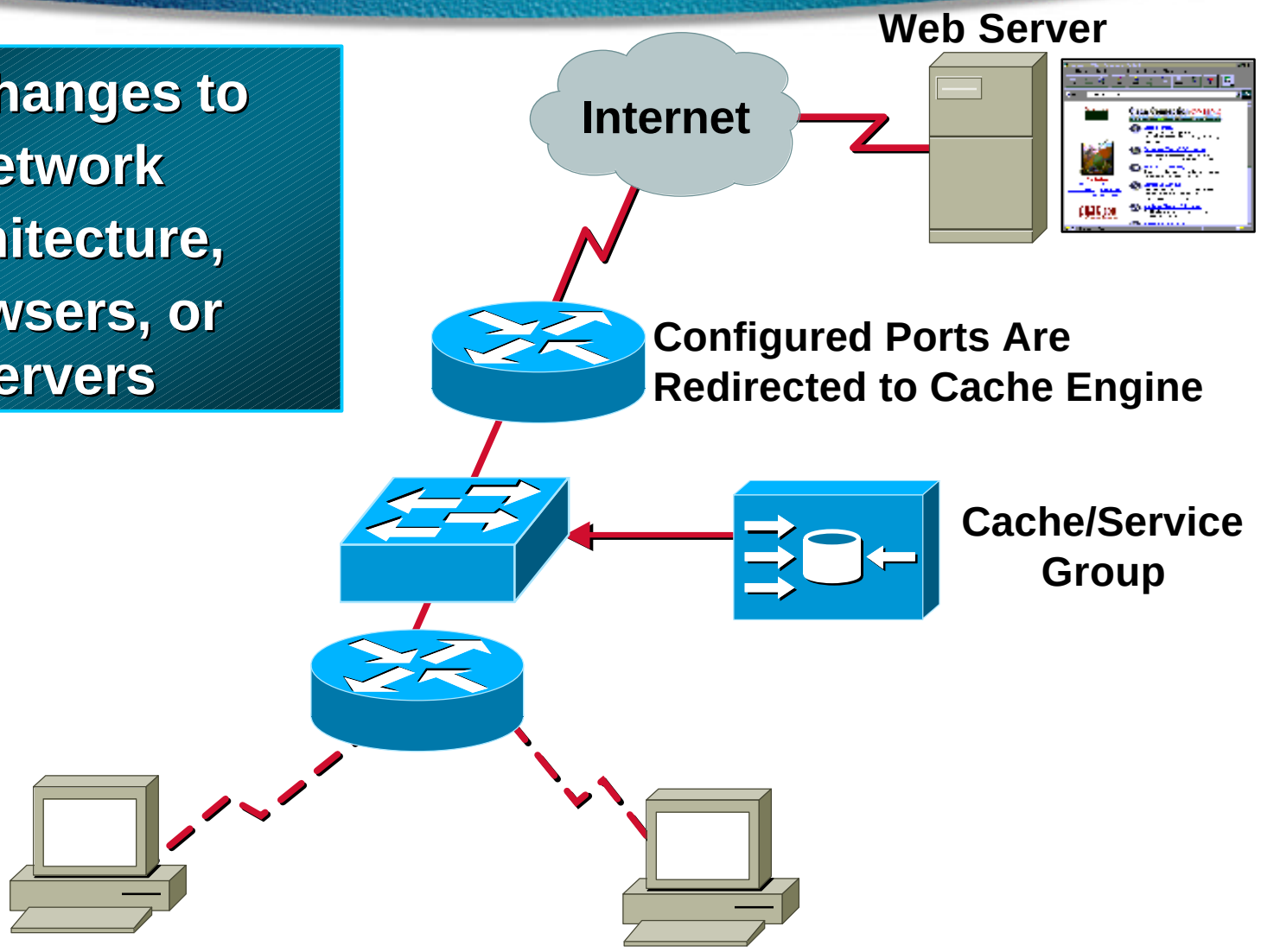
- **Fault Tolerance of the Service Group**
- **On-line Maintenance of the Service Group**
- **Linear Scalability of the of the Service Group**
- **WCCP Slow Start**

WCCP's Features (Service Group)

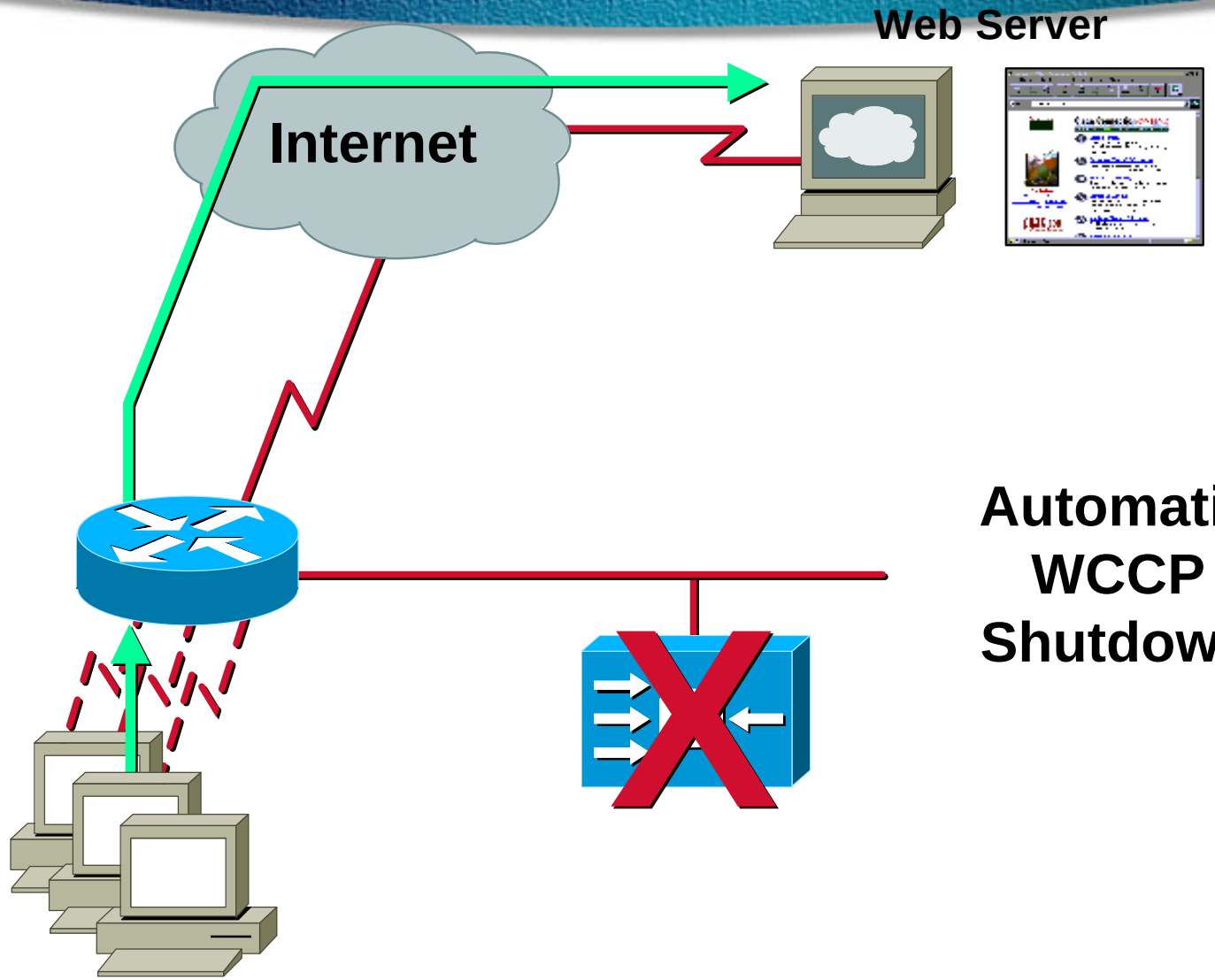
- **Fault Prevention - Packet Return Feature (Overload and Bypass)**
- **Load Distribution (Hot Spots)**
- **Fail Open on the Service Group Failure**
- **Authentication By-pass**

Transparent Integration

No Changes to Network Architecture, Browsers, or Servers

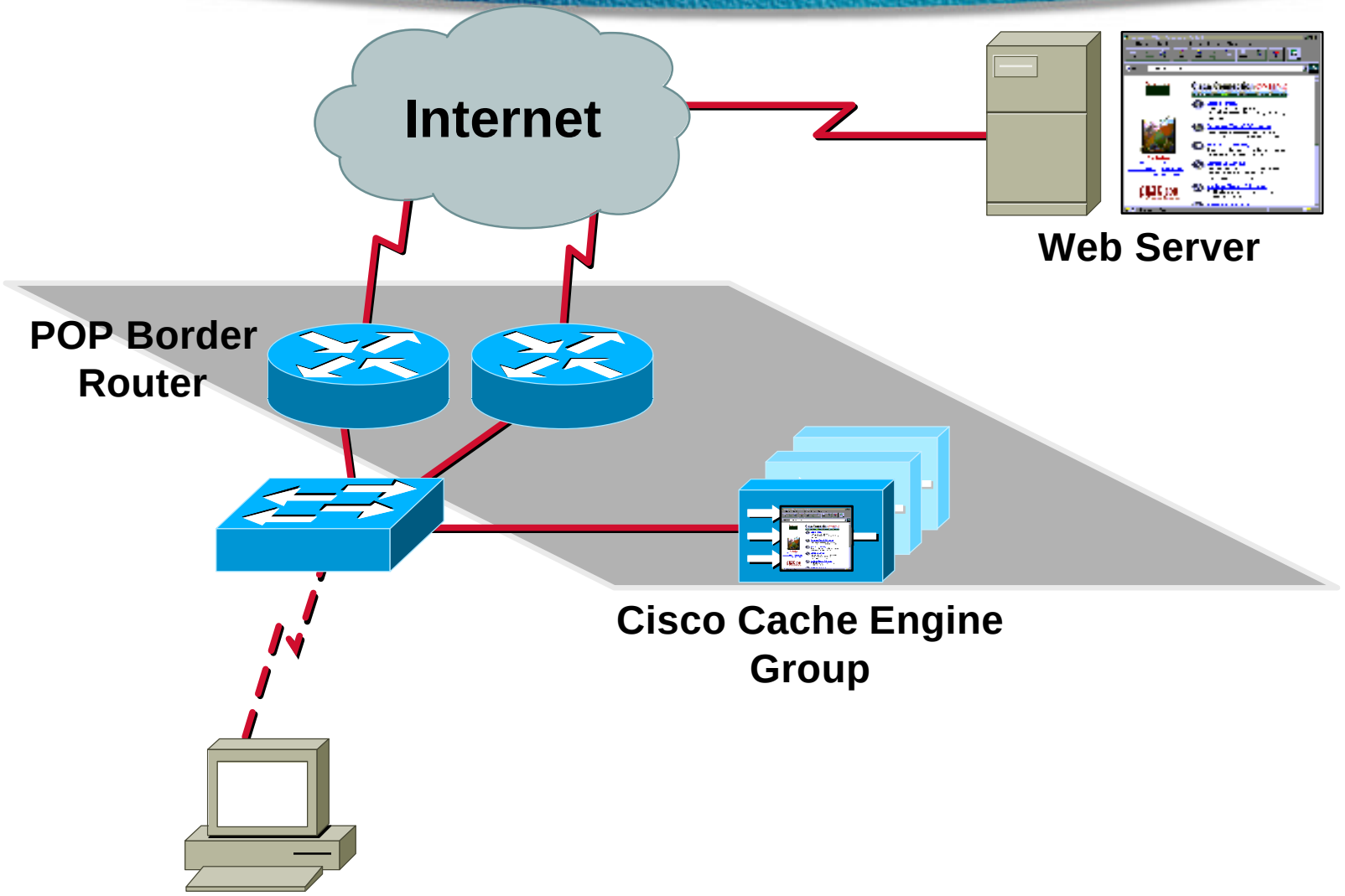


Fail Open

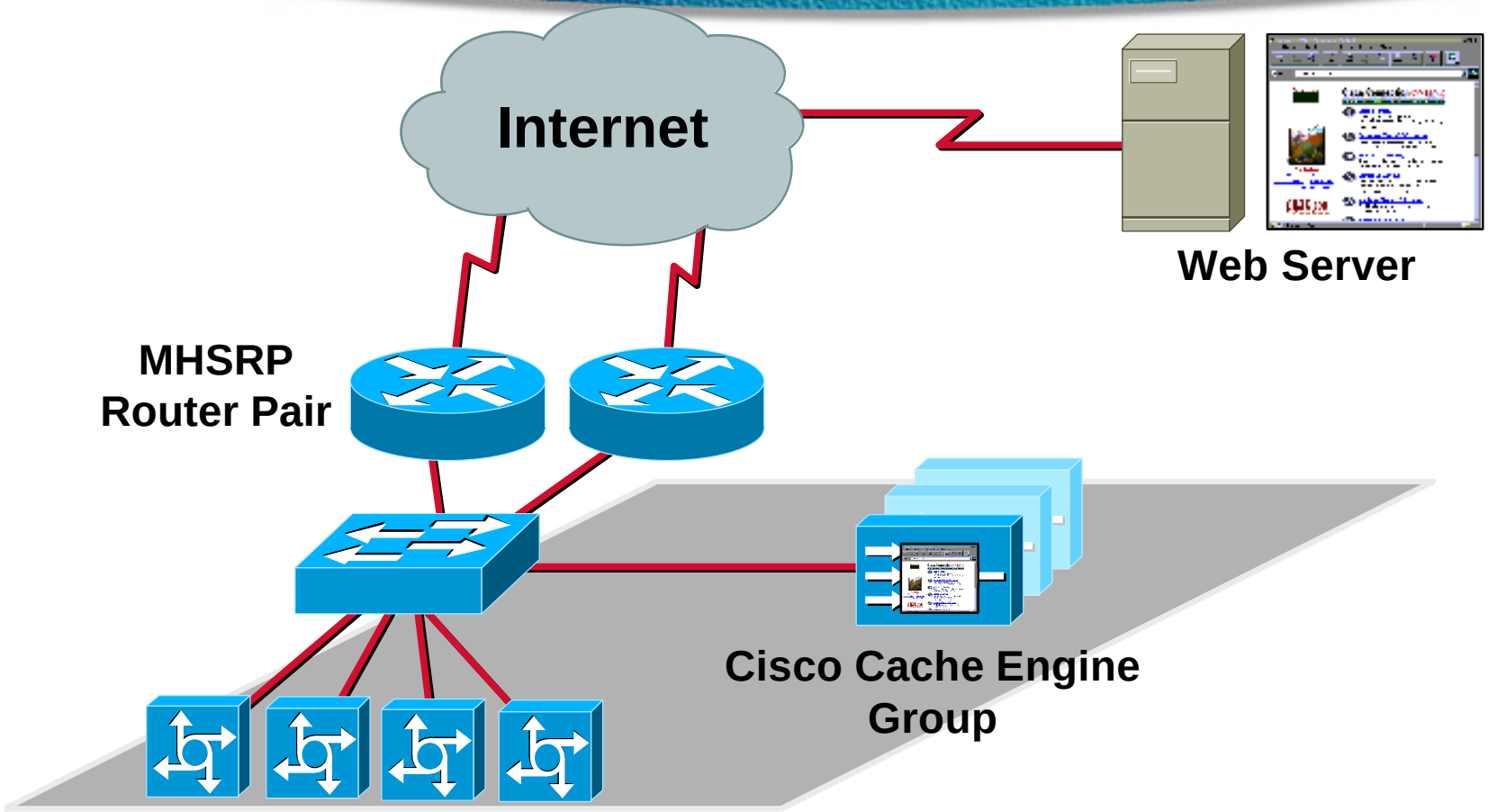


Automatic WCCP Shutdown

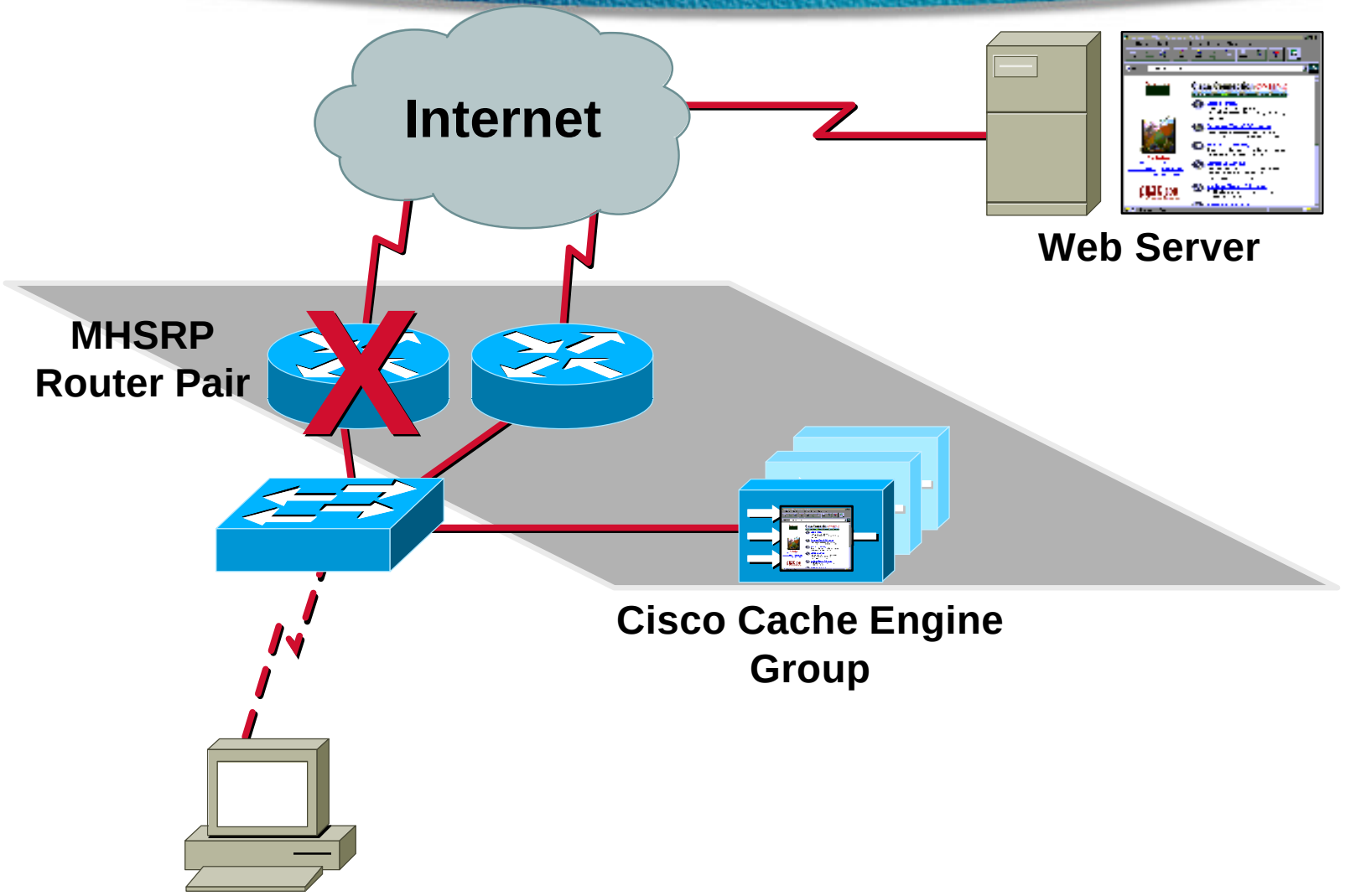
Multi Router - POP Border Routers



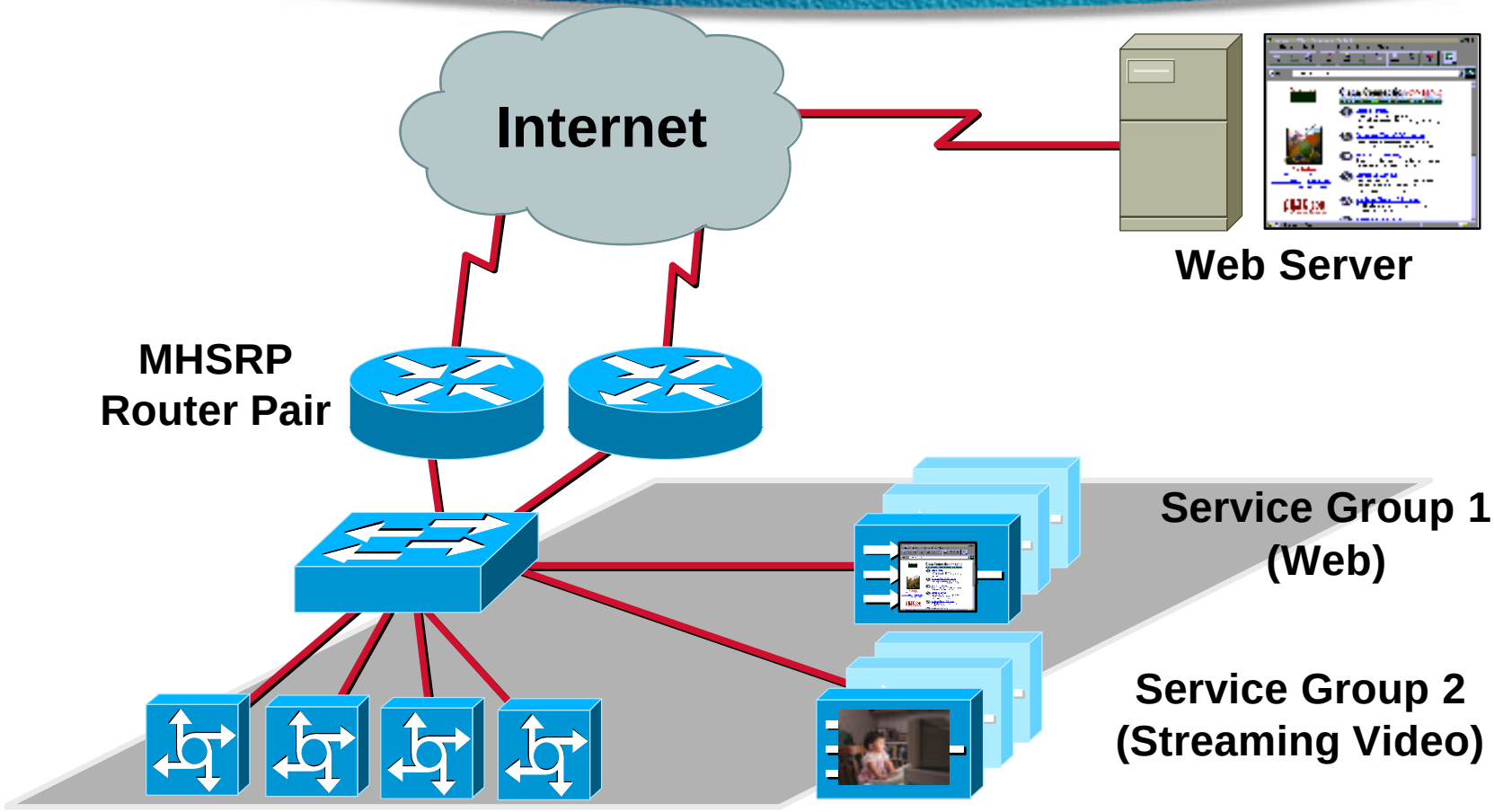
Multi Router Support - POP Edge Devices



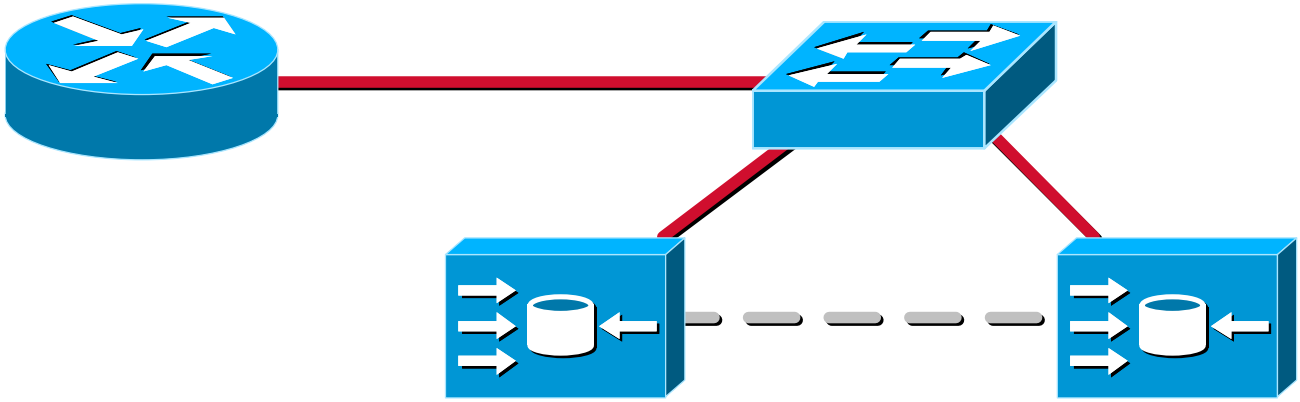
Multihome Router via HSRP



Multi-Service Group Support



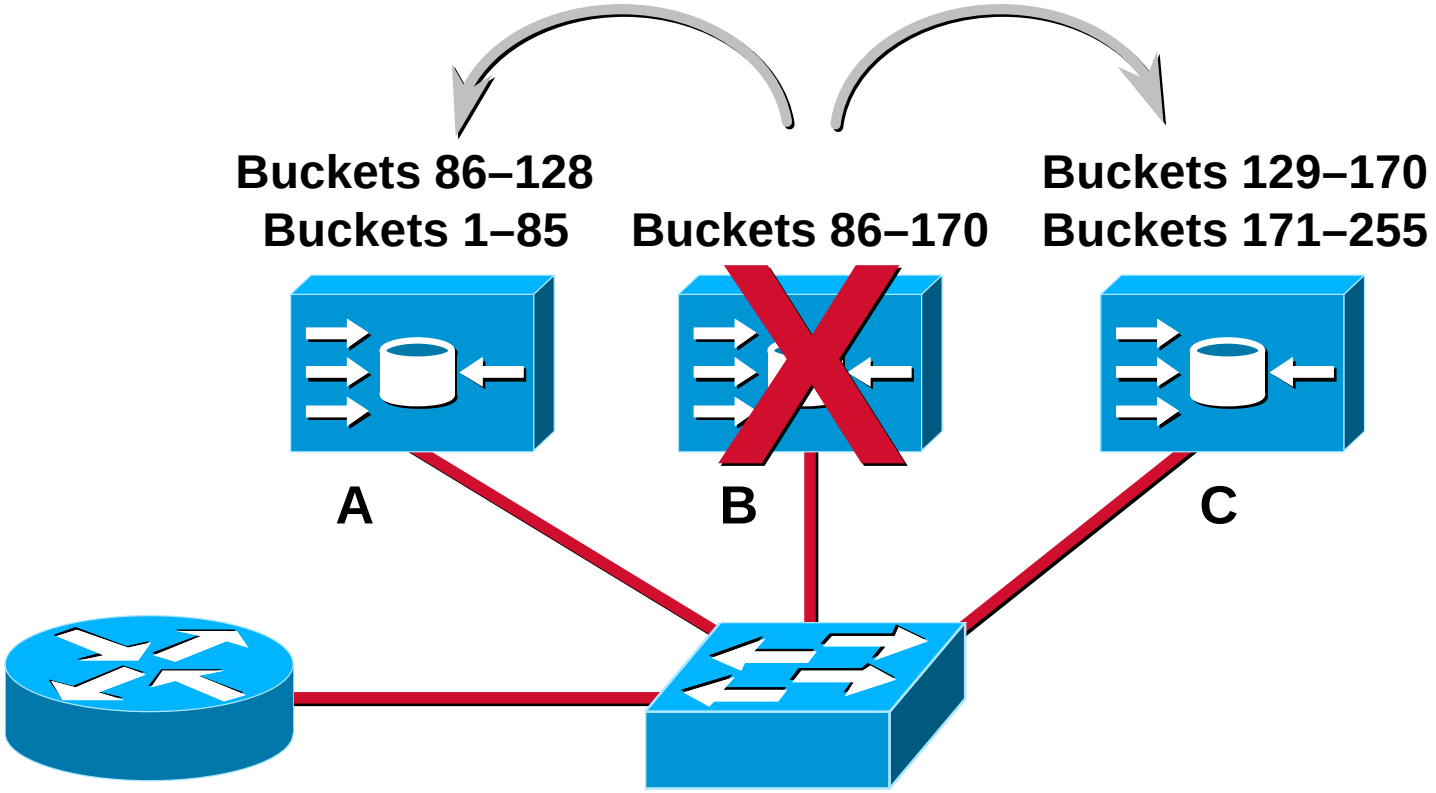
Scalable Grouping



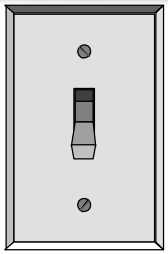
- **Load balancing by hashing on destination IP address**
- **Linear, incremental scalability**
- **Hot insertion**
- **High availability, redundancy**

Fault Tolerance

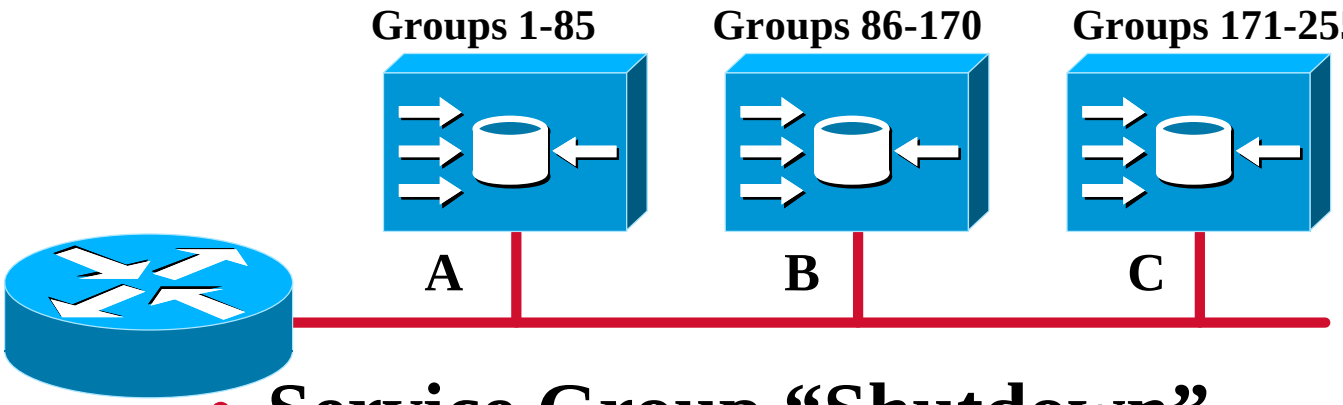
Automatic Redistribution



Service Group Maintenance

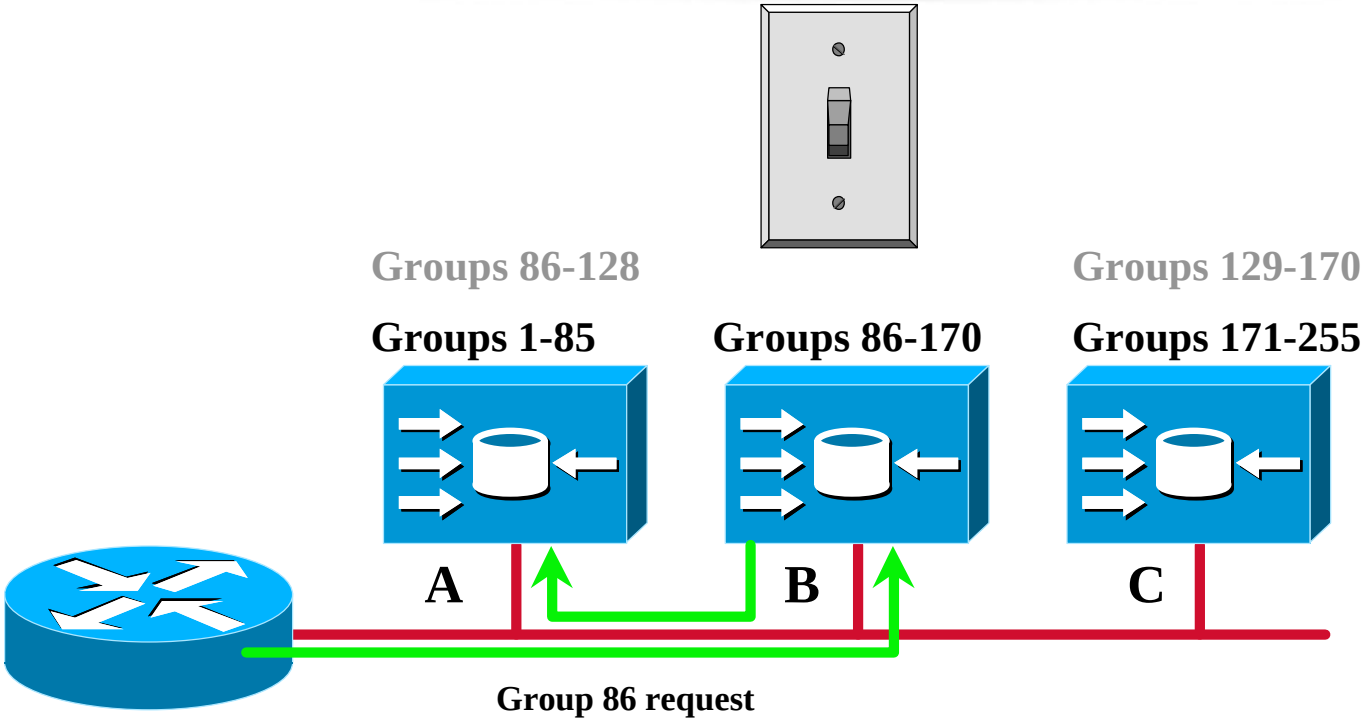


N + 2 Group Sizing
⇨ One for failure
⇨ One for Maintenance



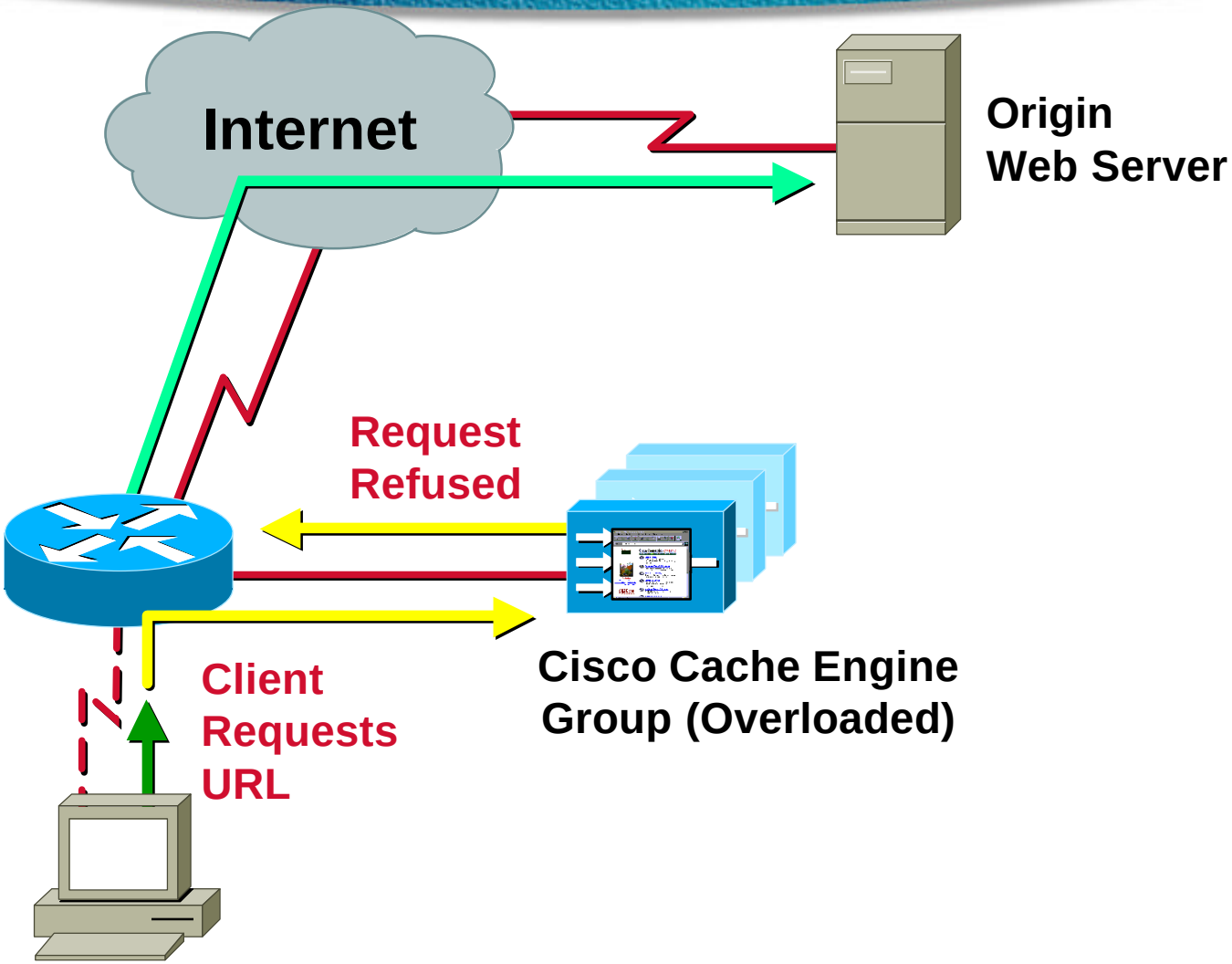
- **Service Group "Shutdown"**
  - ✓ Stops accepting connections from WCCP
  - ✓ Tells WCCPv2 to stop sending flows

Service Group Maintenance

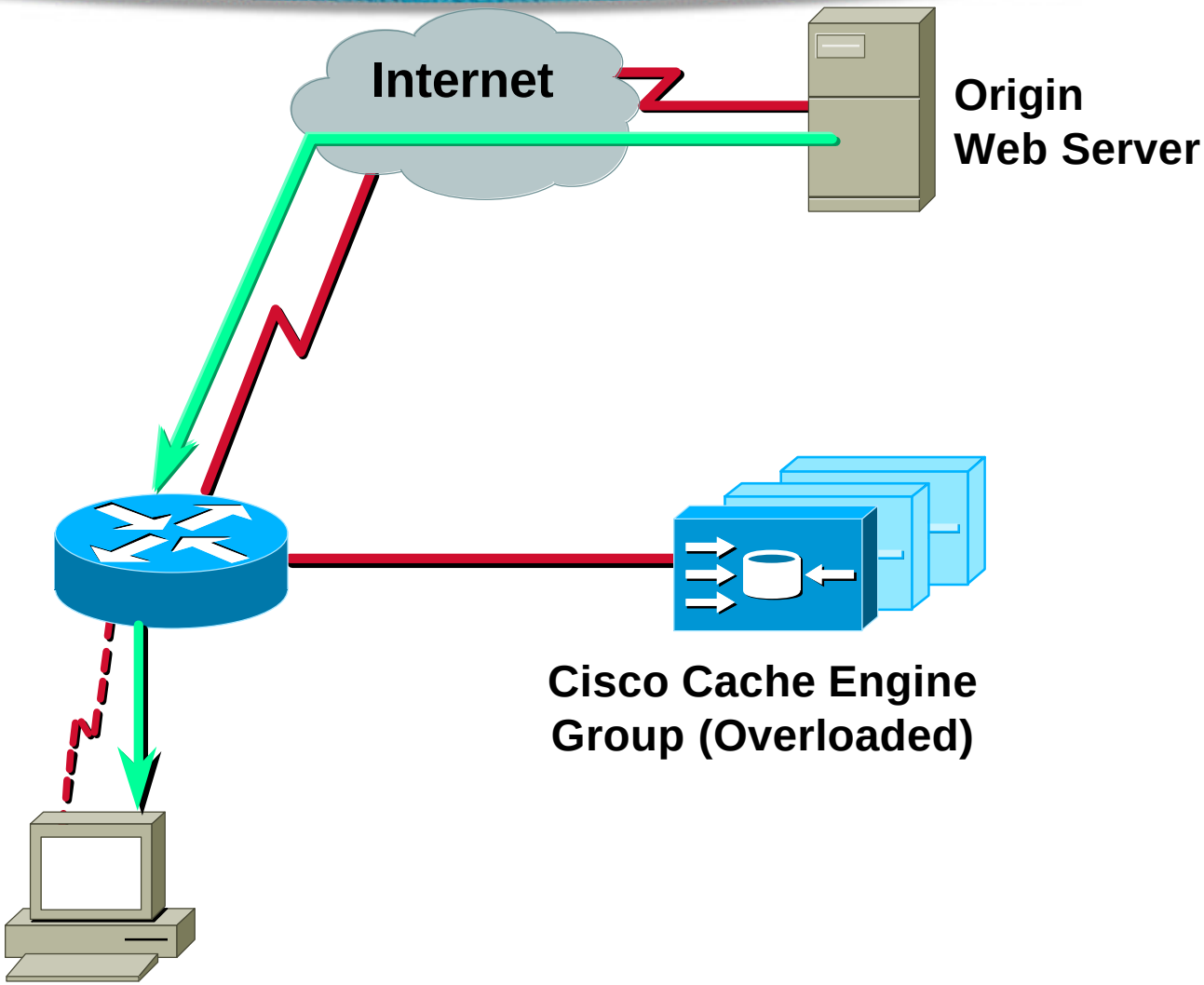


- **Service Group Convergence**
  - ✓ Tells WCCPv2 to start sending flows
  - ✓ Gradual hand off from other units in Group

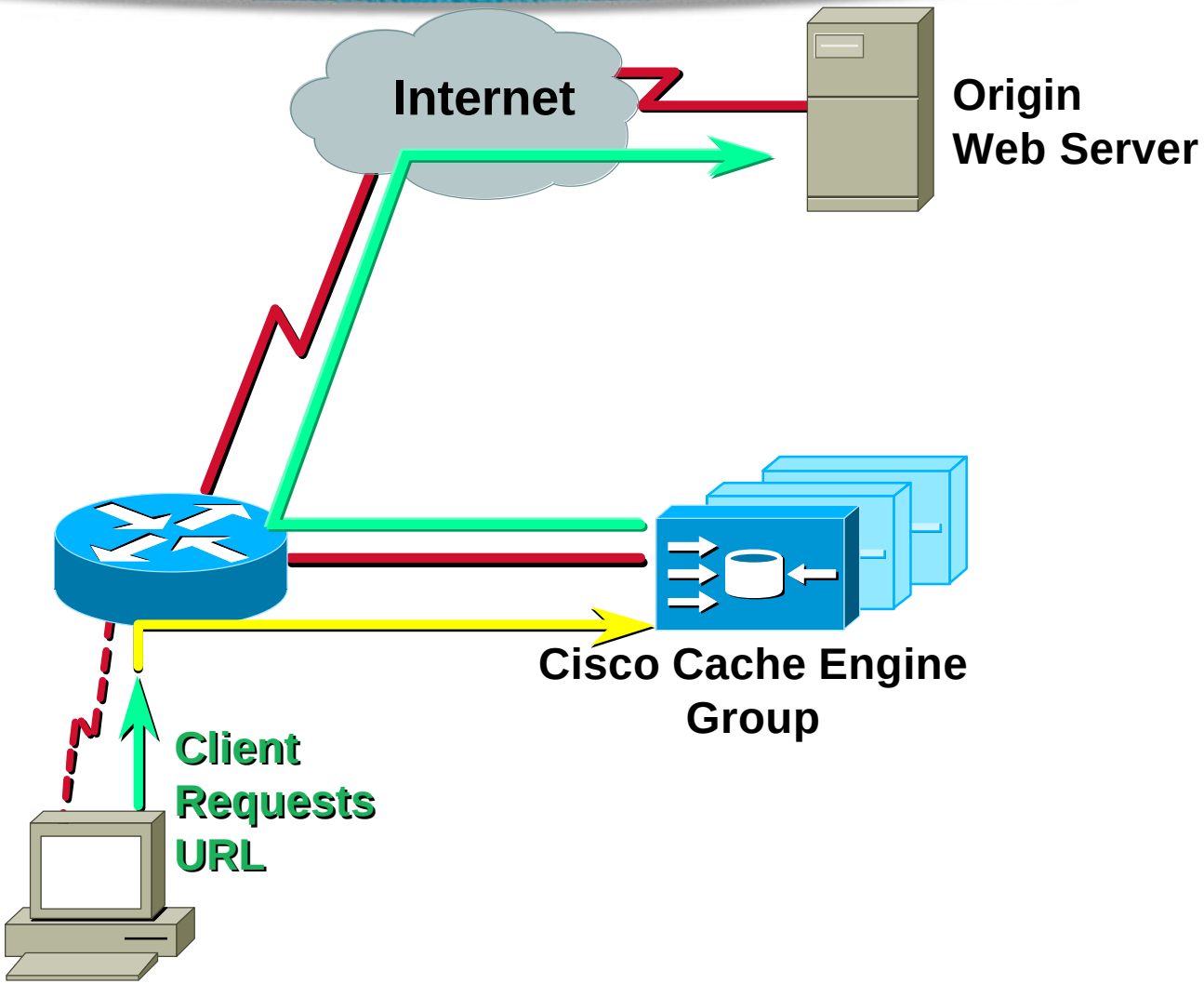
Fault Prevention: Overload



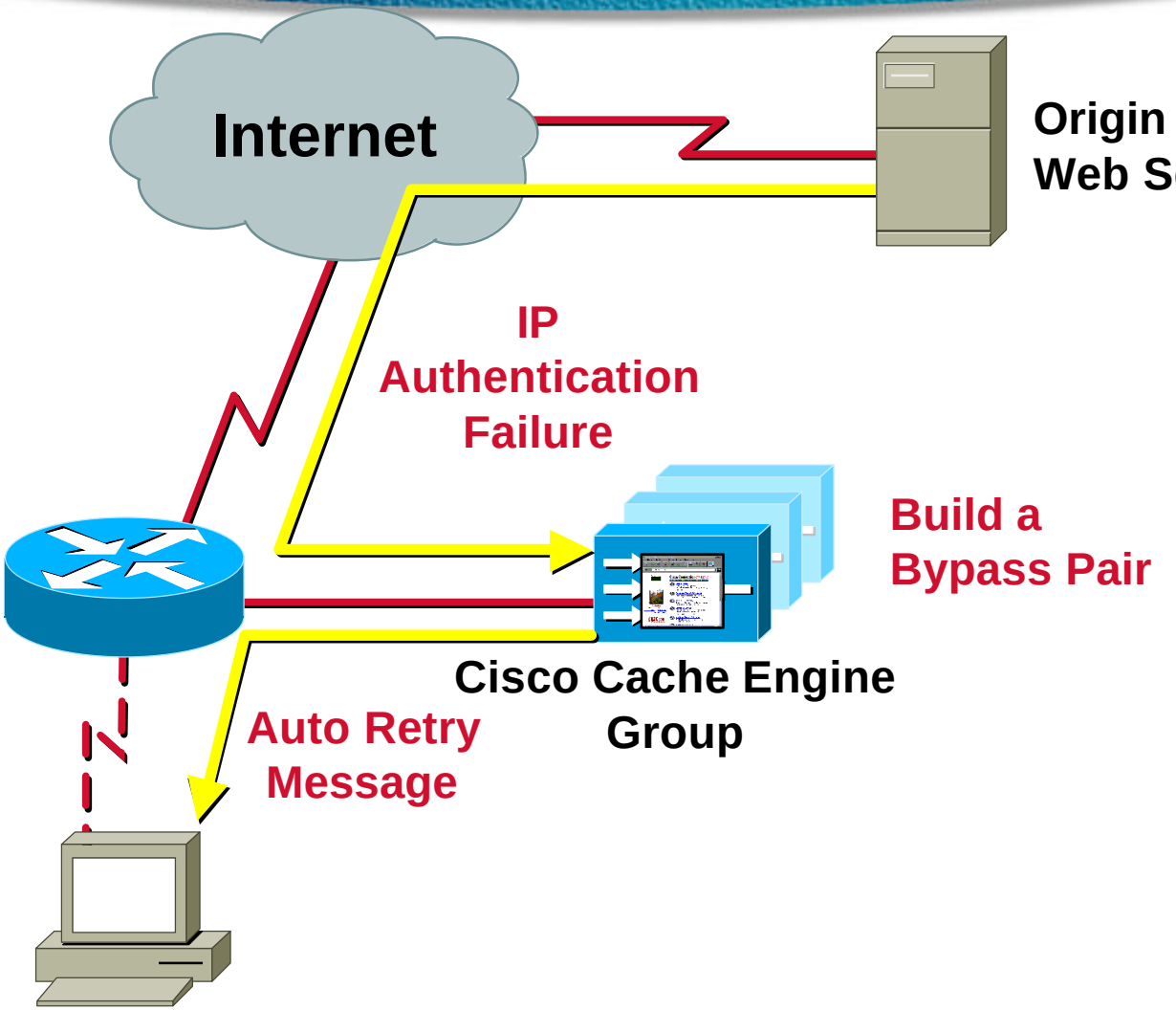
Fault Prevention: Overload



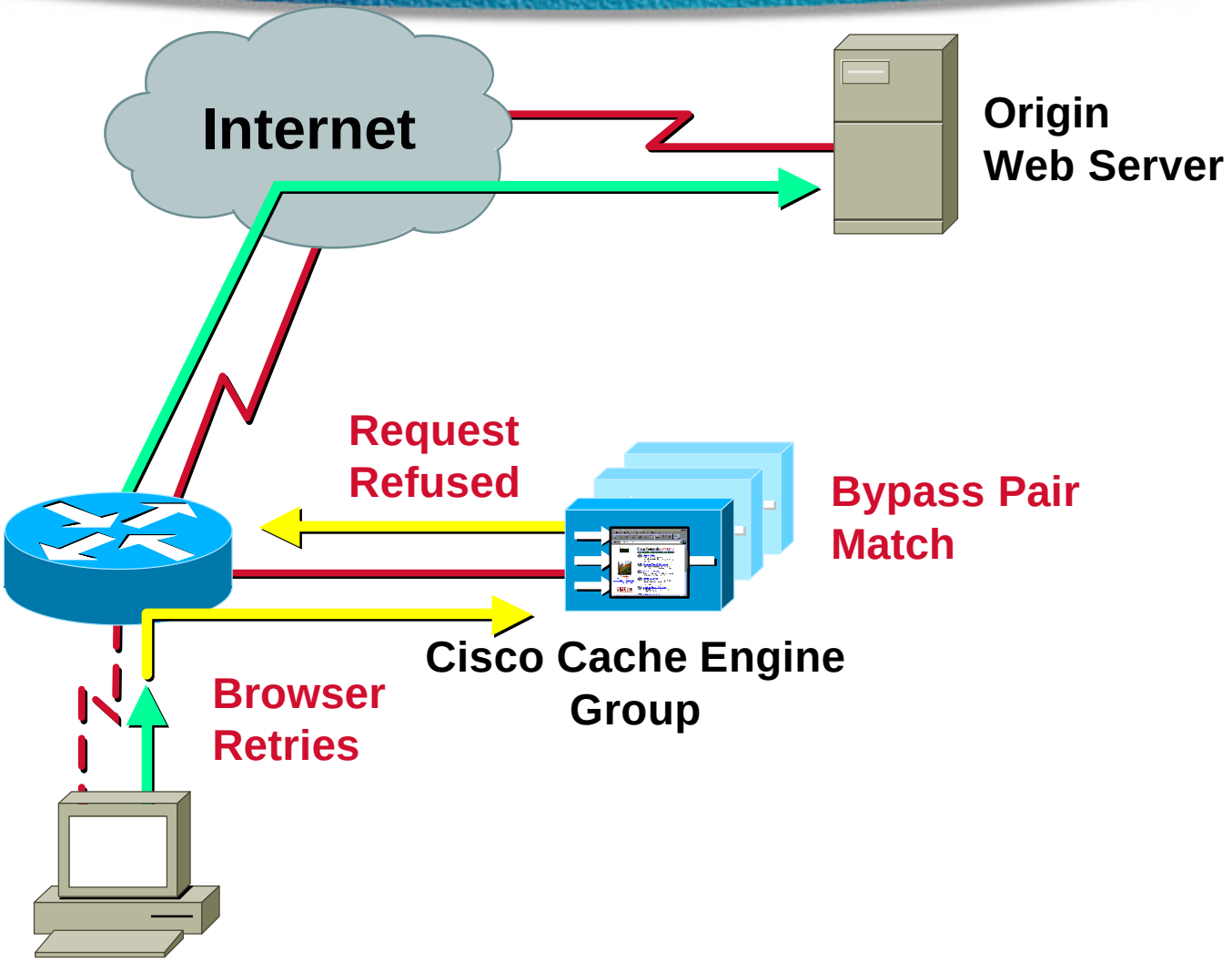
Fault Prevention: IP Authentication



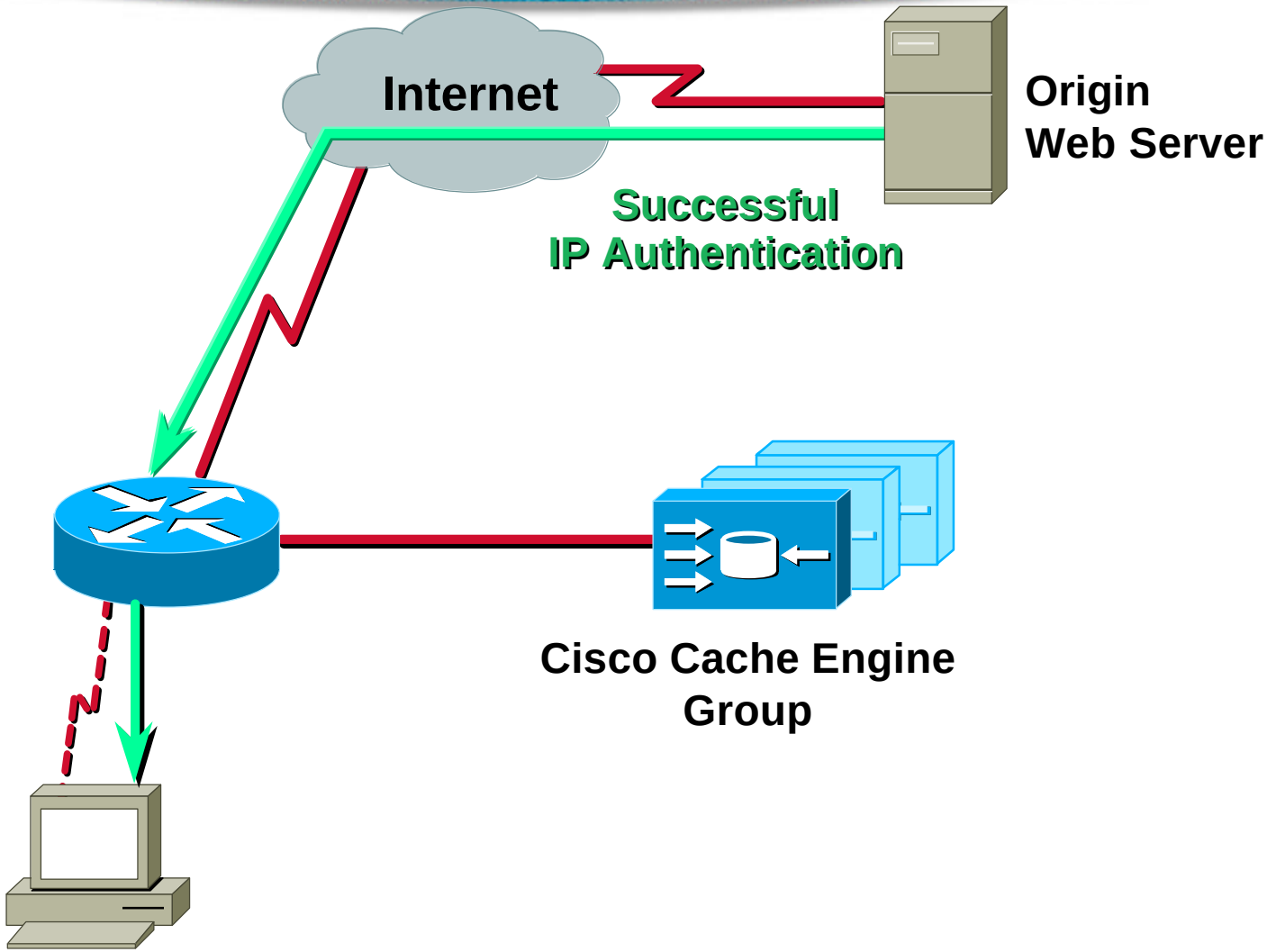
Fault Prevention: IP Authentication

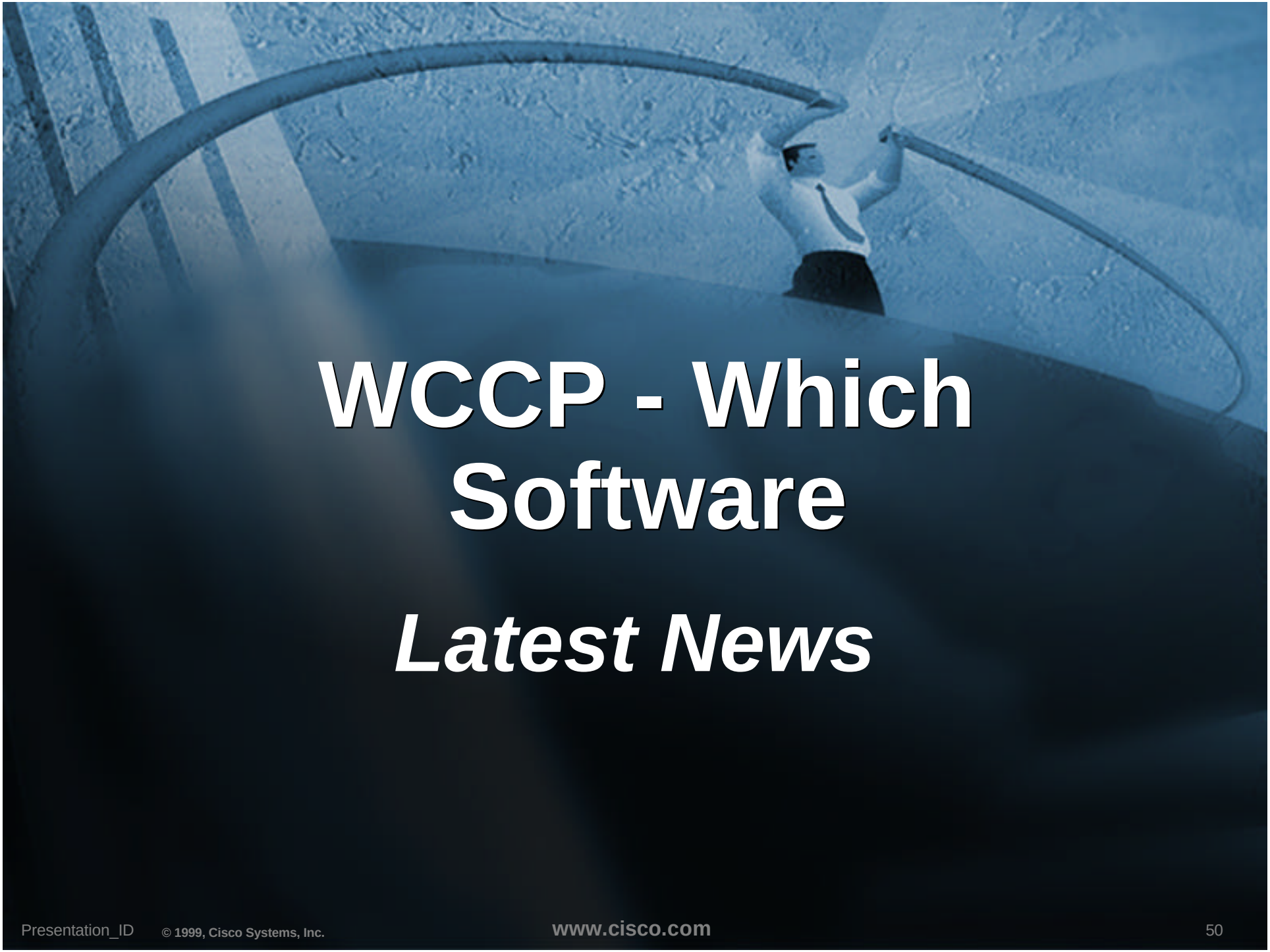


Fault Prevention: IP Authentication



Fault Prevention: IP Authentication





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 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**

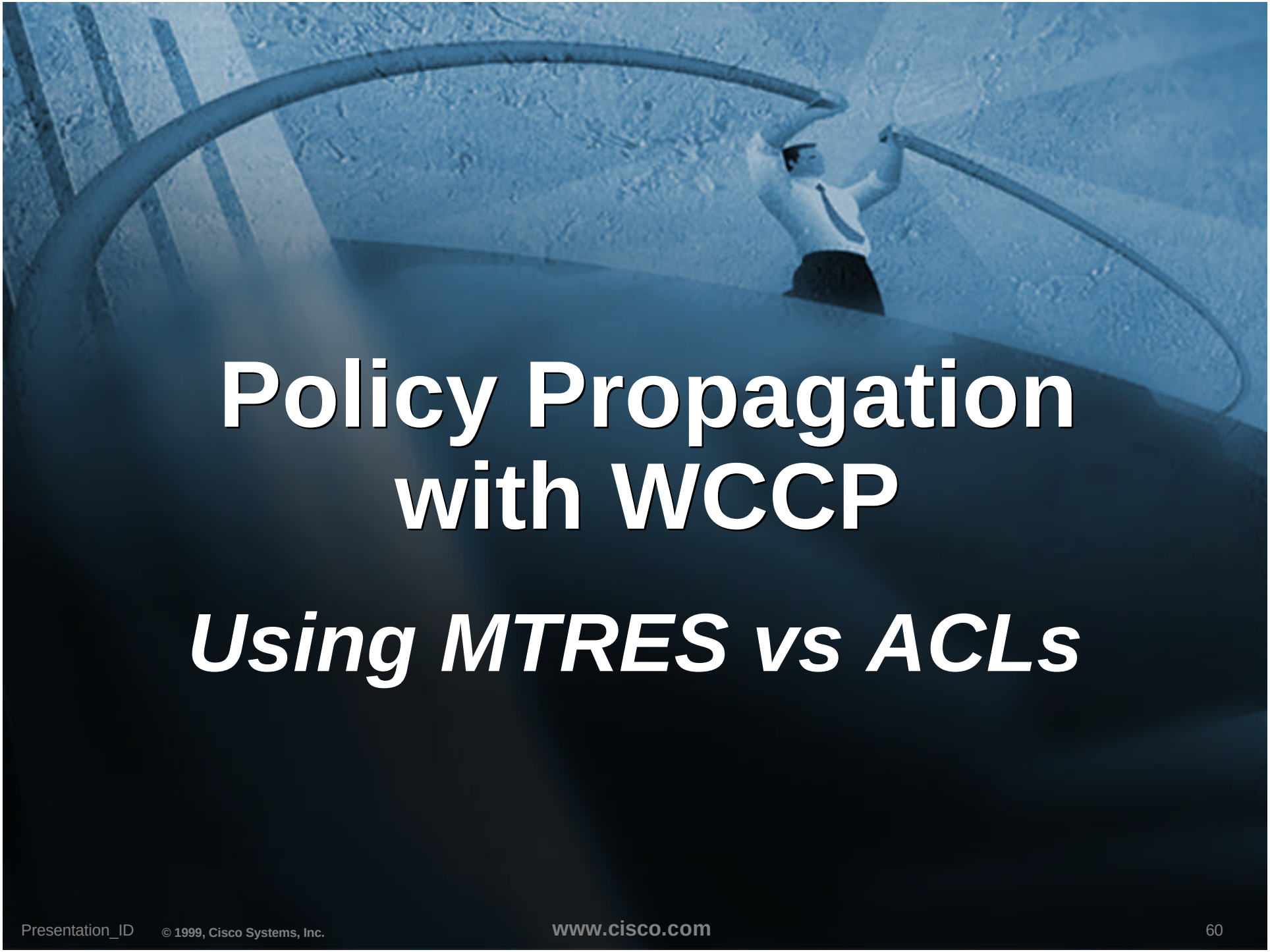
Accelerated WCCPv2 for Catalyst 6x00

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

	MSFC 1 GRE	MSFC 1 L2	MSFC 2 GRE	MSFC 2 L2	MSFC 2 GRE	MSFC 2 L2
Conns/sec	50K	50K	150K	150K	150K	1M+
Throughput	170 Kpps	15 Mpps	510 Kpps	15 Mpps	510 Kpps	30 Mpps

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

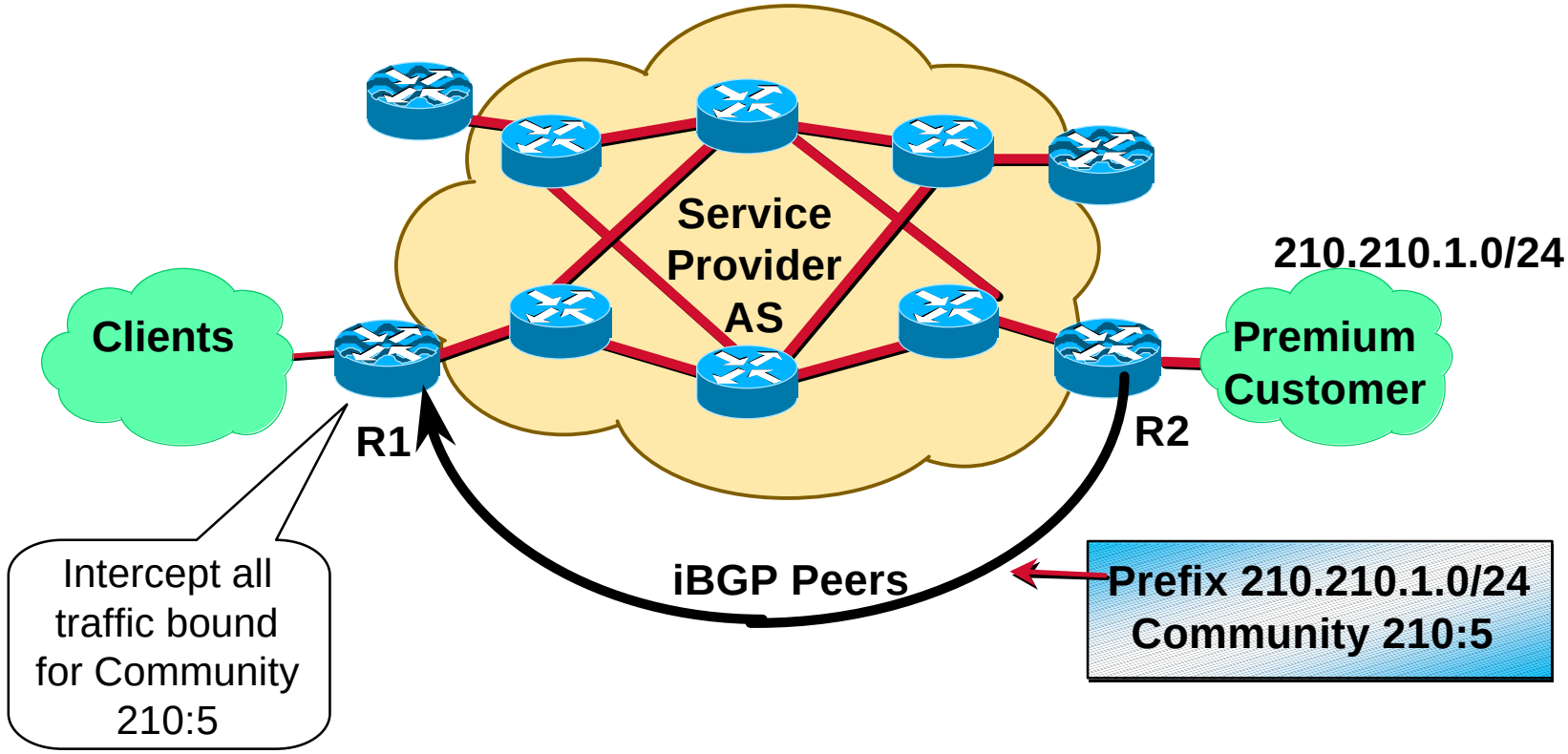
BGP Policy Propagation for WCCP

- **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

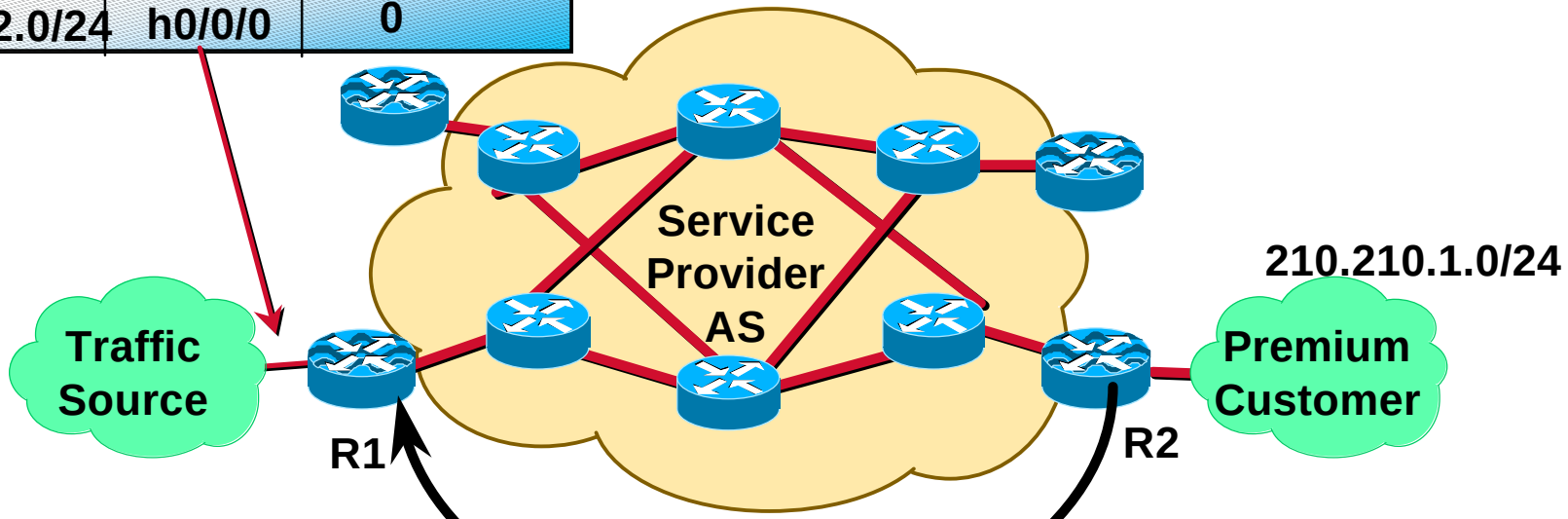
Step 2 - Use the BGP Update to match the community and set the value in the FIB

```
!
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

R1's FIB Table

Prefix	Next-hop	WCCP_TAG
210.210.1.0/24	h0/0/0	50
210.210.2.0/24	h0/0/0	0



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

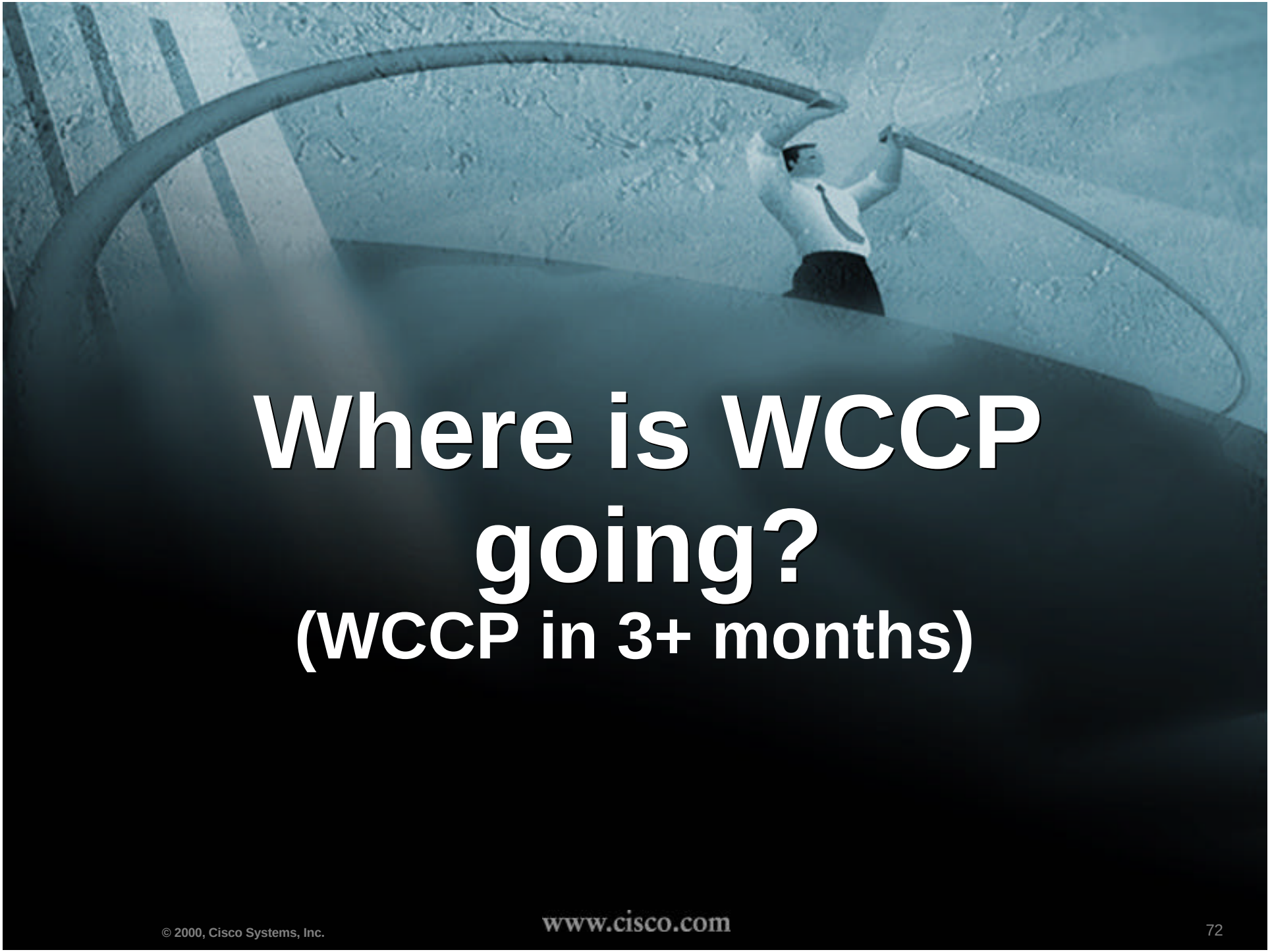
- **The following example shows only "premium" traffic being cached.**
  - ✓ **"Premium" traffic is defined as traffic which has:**
  - ✓ **The policy defined below is:**
    - ⇨ **any traffic with community 4433:1050 set,**
    - ⇨ **any traffic with community 4433:1055 set,**
    - ⇨ **any traffic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



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**