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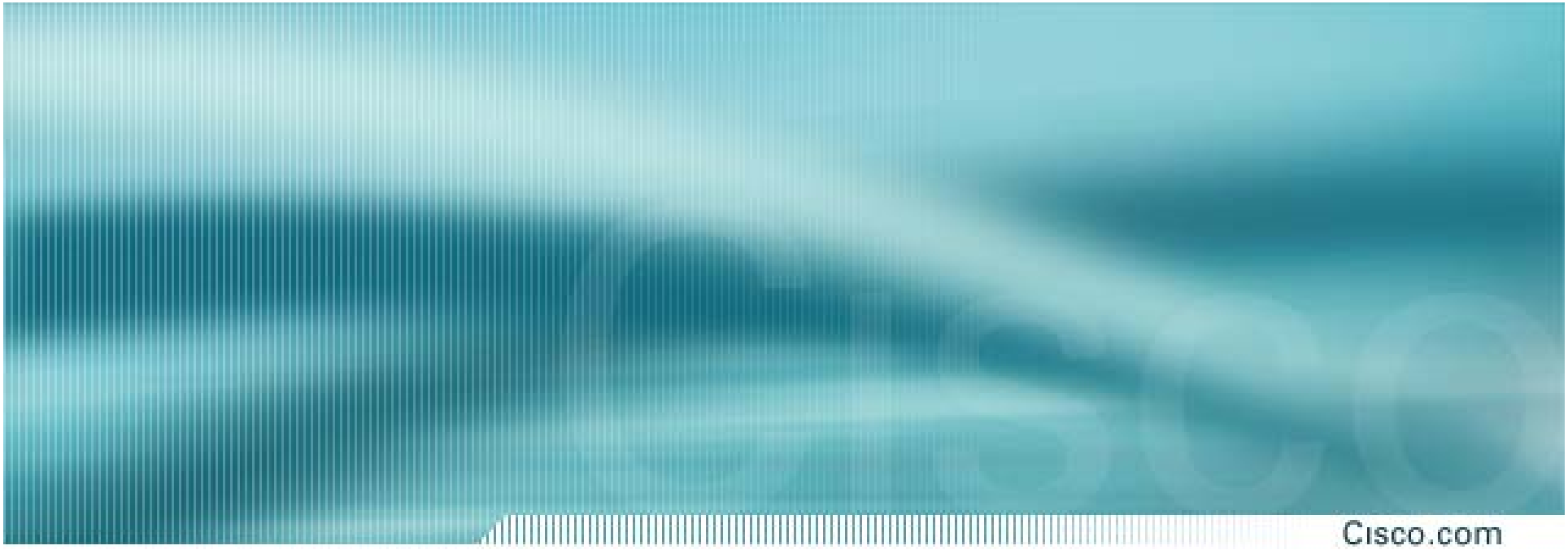
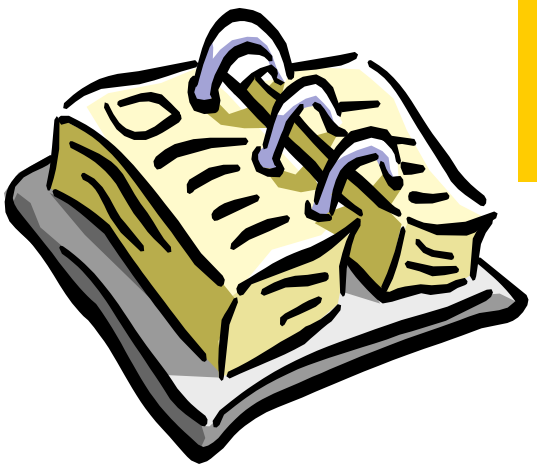


Understanding MPLS/VPN Security Issues

SEC-370

Michael Behringer <mbehring@cisco.com>

Agenda



- **Analysis of MPLS/VPN Security**
- **Security Recommendations**
- **MPLS Security Architectures**
  - **Internet Access**
  - **Firewalling Options**
- **Attacking an MPLS Network**
- **IPsec and MPLS**
- **Summary**

The Principle: A “Virtual Router”

Virtual Routing and Forwarding Instance

Route Distinguisher: Makes VPN routes unique

```
!
ip vrf Customer_A
  rd 100:110
  route-target export 100:1000
  route-target import 100:1000
!
interface Serial0/1
  ip vrf forwarding Customer_A
!
```

Export this VRF with community 100:1000

Import routes from other VRFs with community 100:1000

Assign Interface to “Virtual Router”

General VPN Security Requirements

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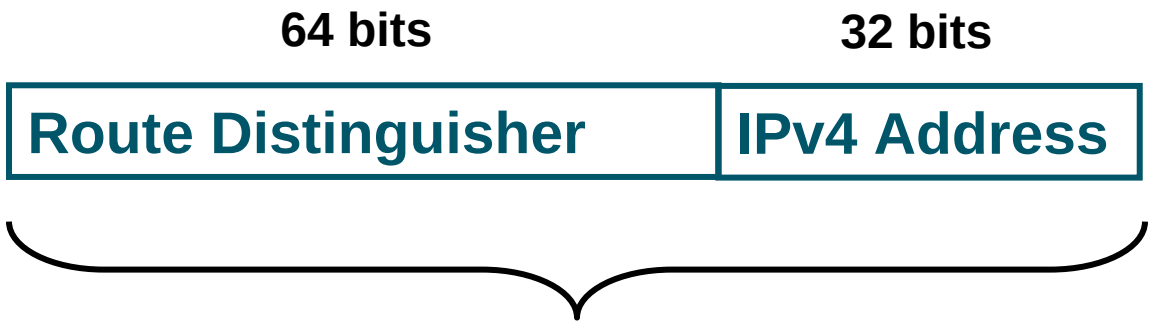
- Address Space and Routing Separation
- Hiding of the MPLS Core Structure
- Resistance to Attacks
- Impossibility of VPN Spoofing

Working assumption: The core (PE+P) is secure

Address Space Separation



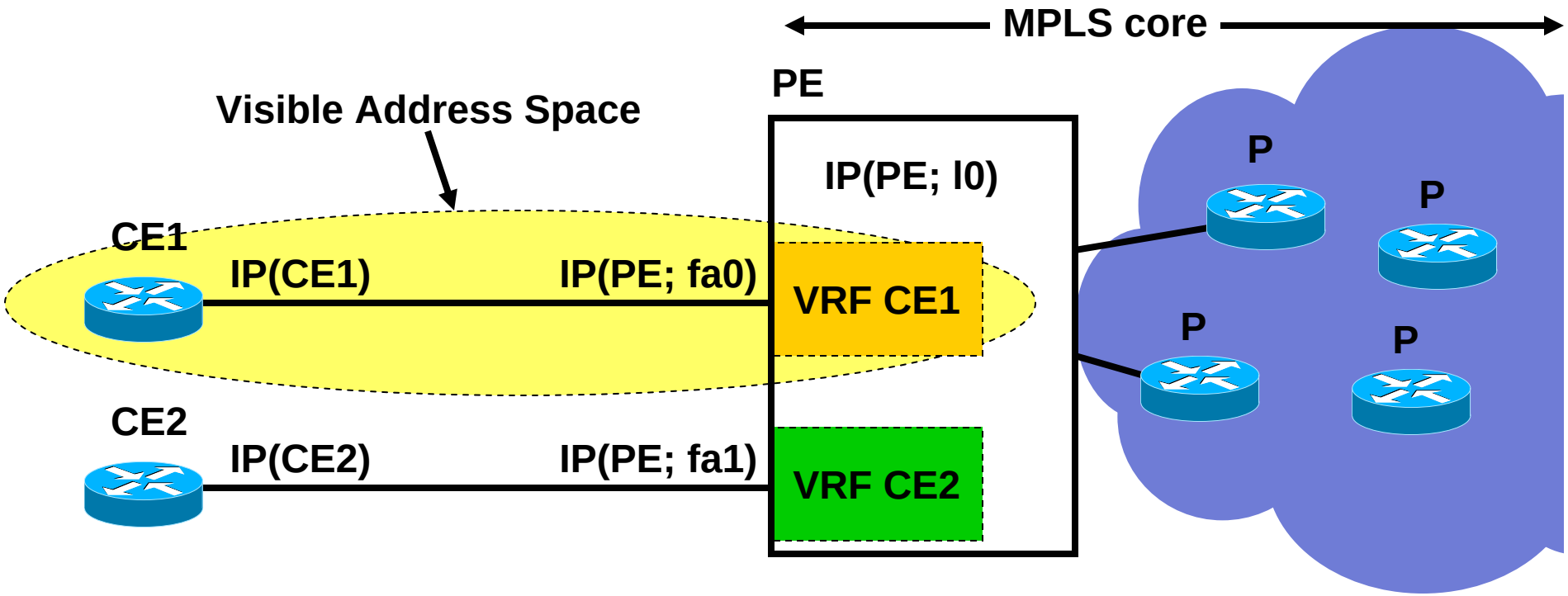
Within the MPLS core all addresses are unique due to the Route Distinguisher

Routing Separation

- Each (sub-) interface is assigned to a VRF
- Each VRF has a RD (route distinguisher)
- Routing instance: within one RD
  -> within one VRF

  -> Routing Separation

Hiding of the MPLS Core Structure



- VRF contains MPLS IPv4 addresses
- Only peering Interface (on PE) exposed (-> CE)! -> ACL or unnumbered

Resistance to Attacks: Where and How?

- **Where can you attack?**

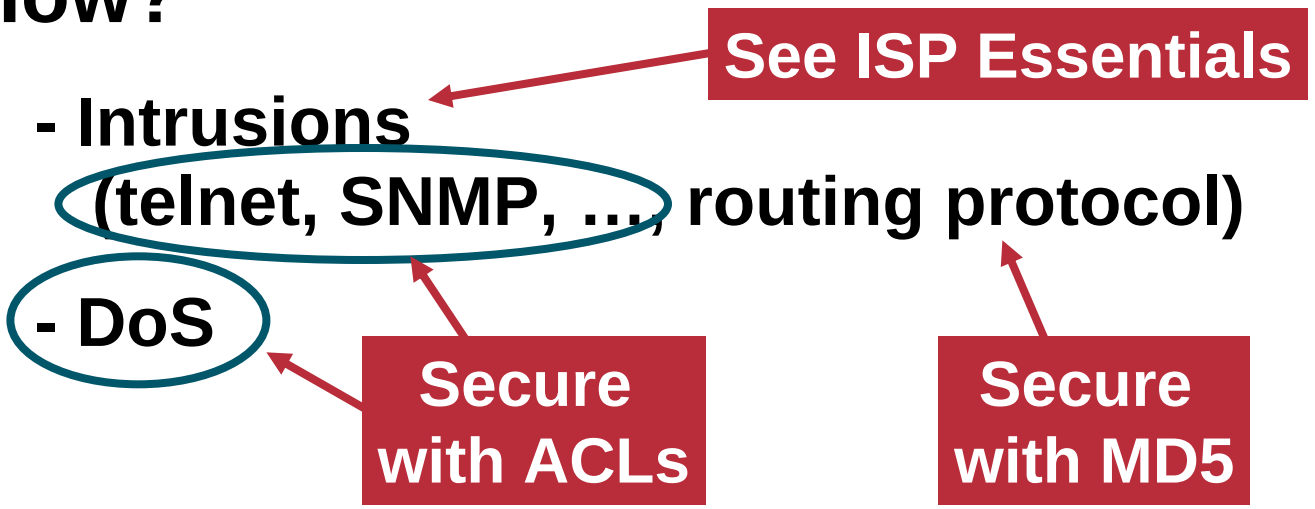
  Address and Routing Separation, thus:

  Only Attack point: peering PE

- **How?**

  - Intrusions
  (telnet, SNMP, …, routing protocol)

  - DoS



Label Spoofing

- PE router expects IP packet from CE
- Labelled packets will be dropped
- Thus no spoofing possible

Comparison with ATM / FR

	ATM/FR	MPLS
Address space separation	yes	yes
Routing separation	yes	yes
Resistance to attacks	yes	yes
Resistance to Label Spoofing	yes	yes
Direct CE-CE Authentication (layer 3)	yes	with IPsec

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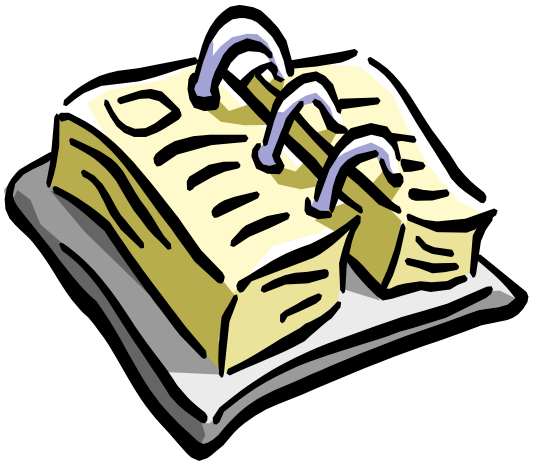

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Security Recommendations for ISPs

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- Secure devices (PE, P): They are trusted!
- CE-PE interface: Secure with ACLs
- Static PE-CE routing where possible
- If routing: Use authentication (MD5)
- Separation of CE-PE links where possible (Internet / VPN)
- LDP authentication (MD5)
- VRF: Define maximum number of routes

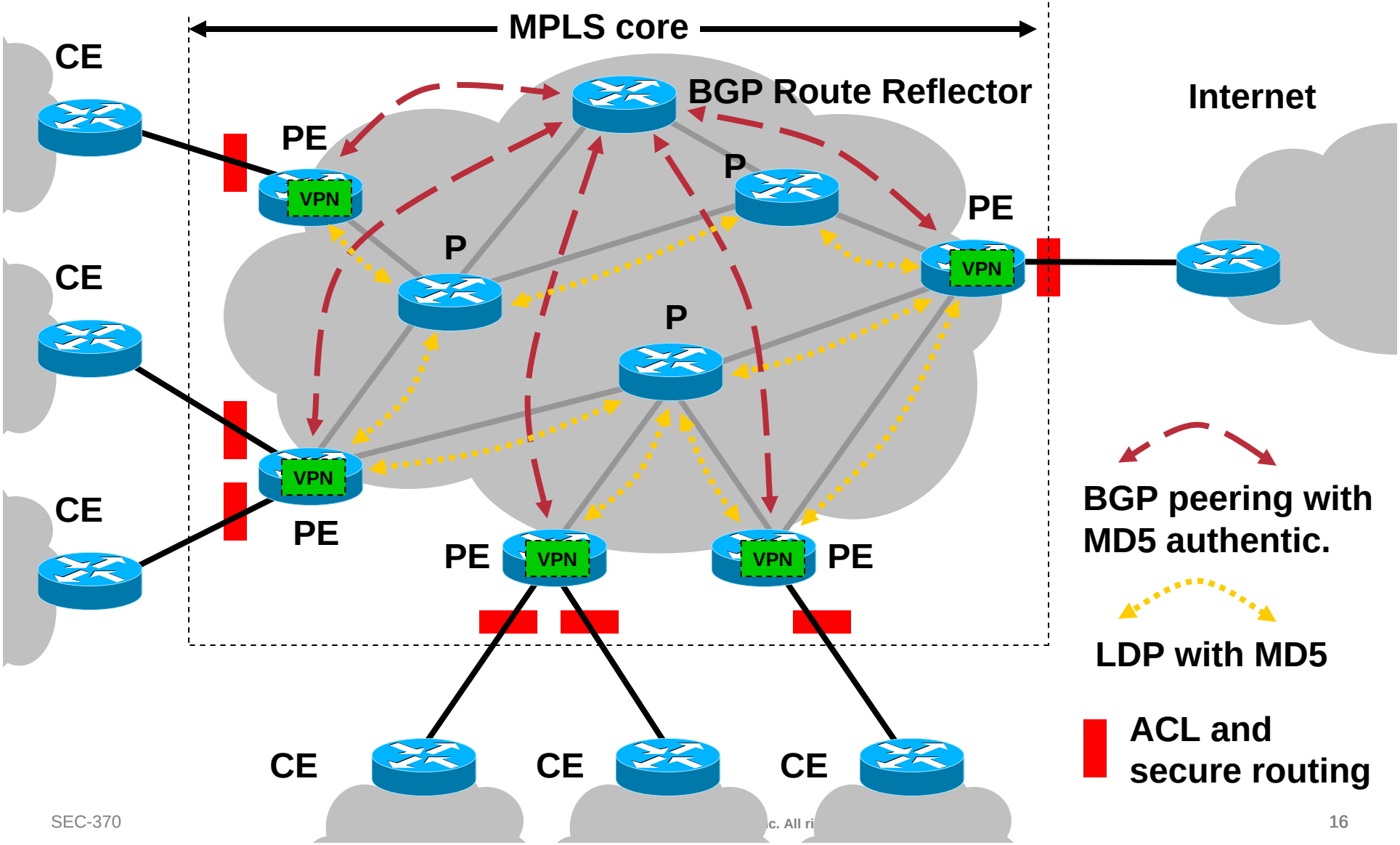
Note: Overall security depends on weakest link!

PE-CE Routing Security

In order of security preference:

1. **Static: If no dynamic routing required (no security implications)**
2. **BGP: For redundancy and dynamic updates (many security features)**
3. **RIPv2: If BGP not supported (limited security features)**

Securing the MPLS Core



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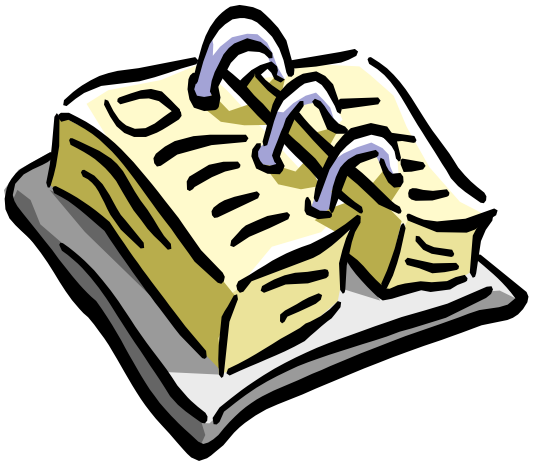

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MPLS Internet Architectures: Principles

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- **Core supports VPNs *and* Internet**
- **VPNs remain separated**
- **Internet as an option for a VPN**
- **Essential: Firewalling**

Separate VPN and Internet Access

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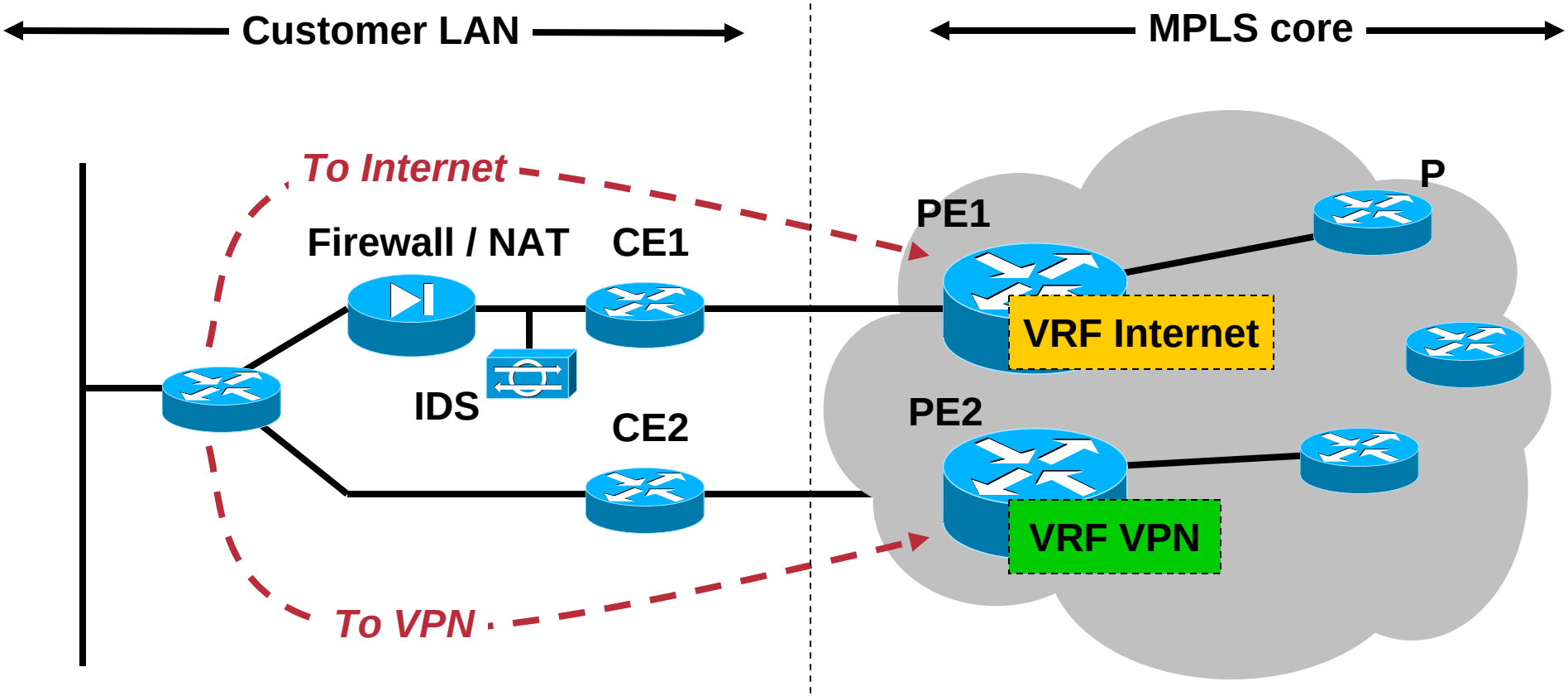
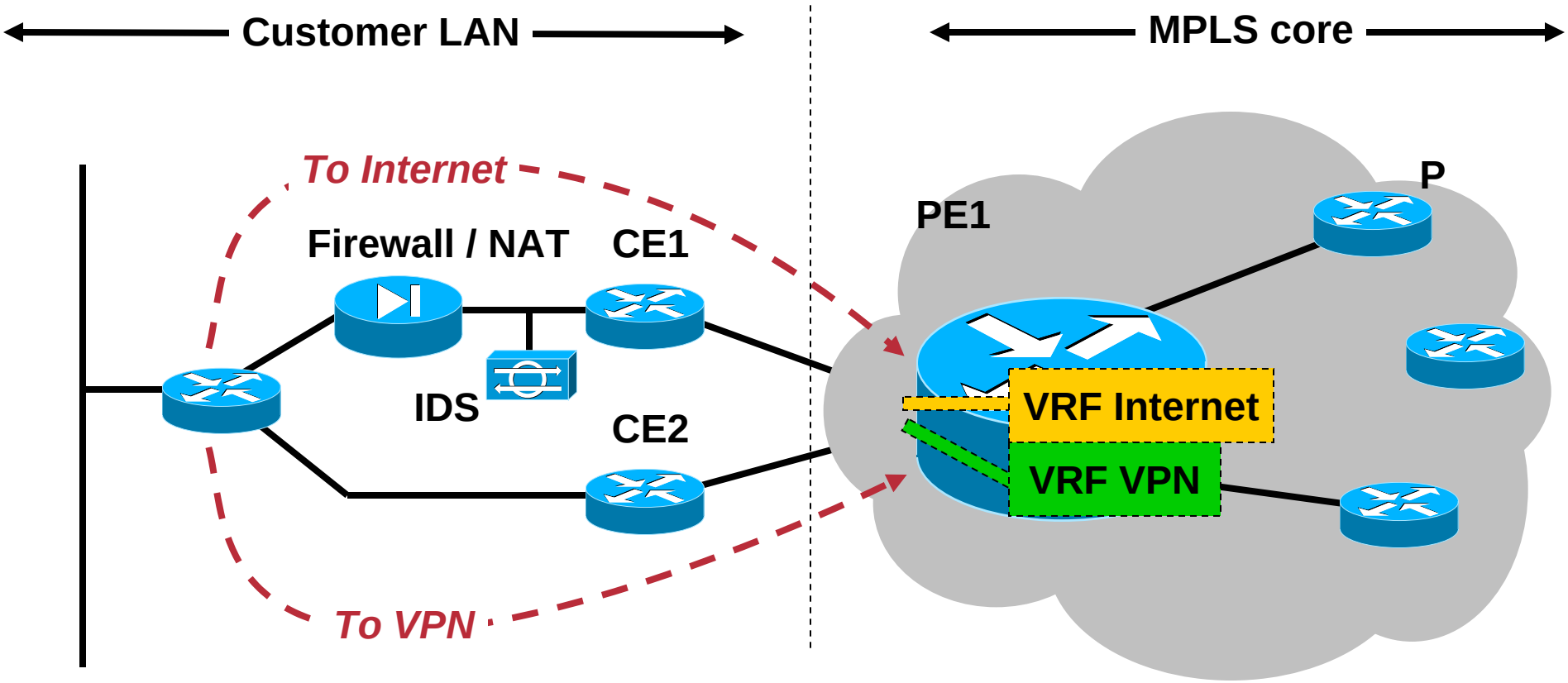


- **Separation: +++**
- **DoS resistance: +++**
- **Cost: $$$ (Two lines and two PEs: Expensive!)**

Separate Access Lines + CEs, one PE



- **Separation:** +++
- **DoS resistance:** ++ (DoS might impact VPN on PE)
- **Cost:** $$ (Two lines, but only one PE)

Using a Single Access Line

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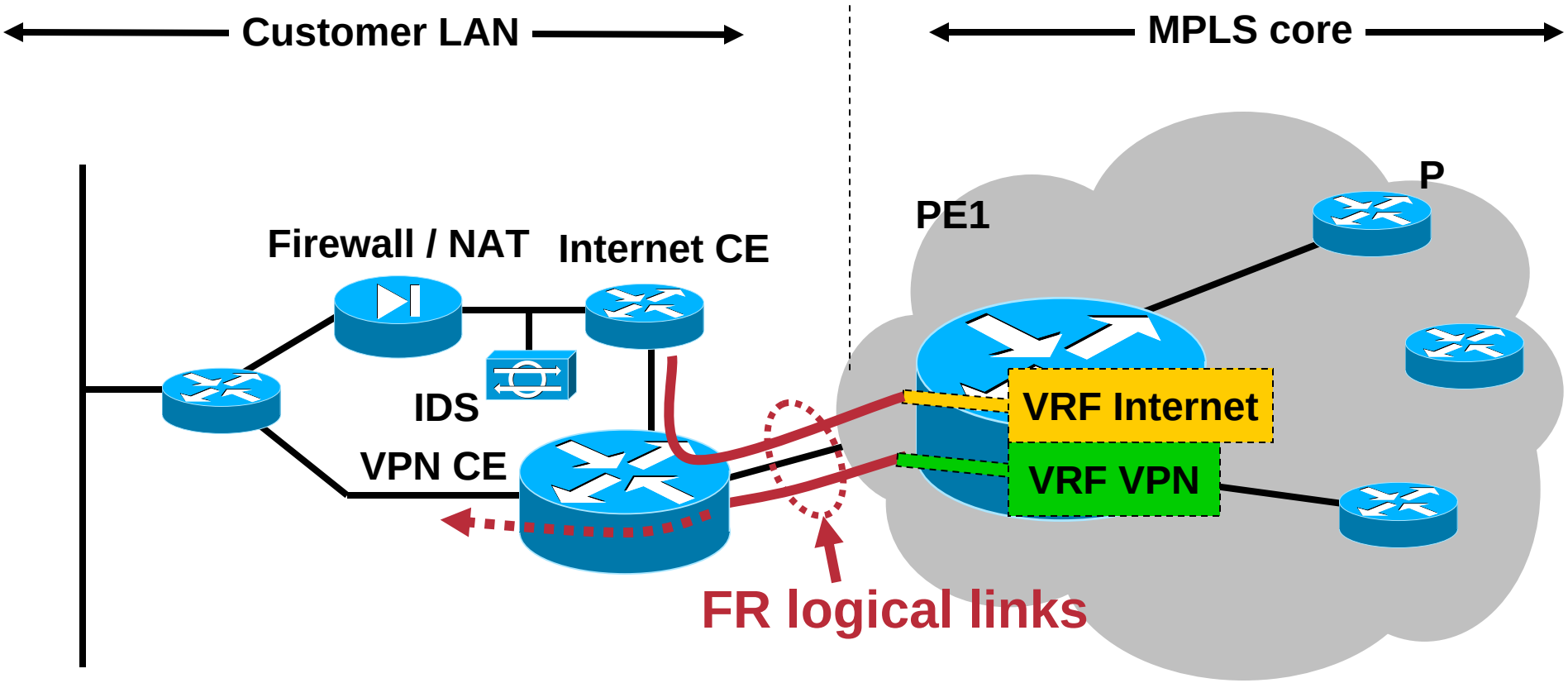
Requirements to share a line:

- **PE requires separate sub-interfaces**
- **CE requires separate sub-interfaces**
- **CE side requires separate routing**

Shared Access Line, Frame Relay



- **Separation: +++**
- **DoS resistance: +** (DoS might affect VPN on PE, line, CE)
- **Cost: $**

Shared Access Line, Policy Routing

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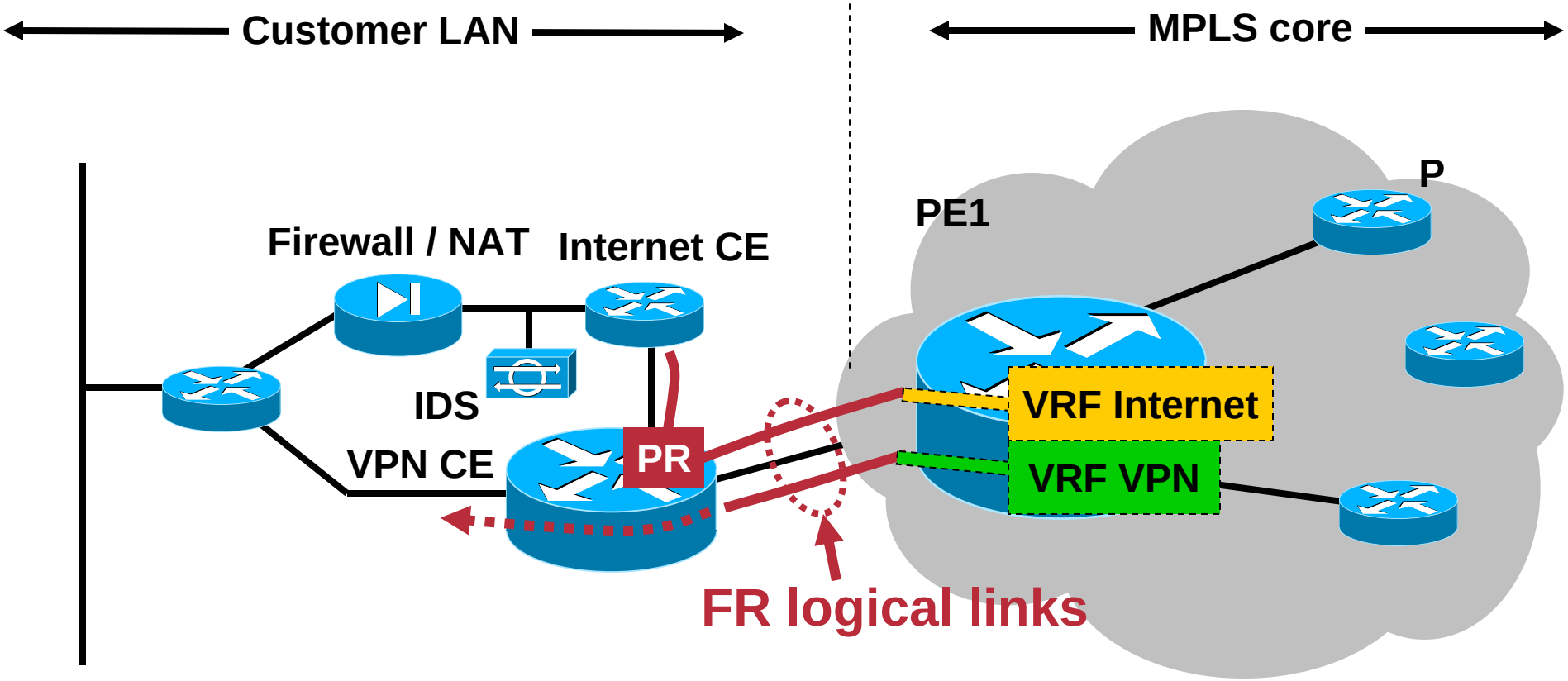

- **Separation: +++**
- **DoS resistance: +** (DoS might affect VPN on PE, line, CE)
- **Cost: $**

Shared Access Line, CE with VRFs

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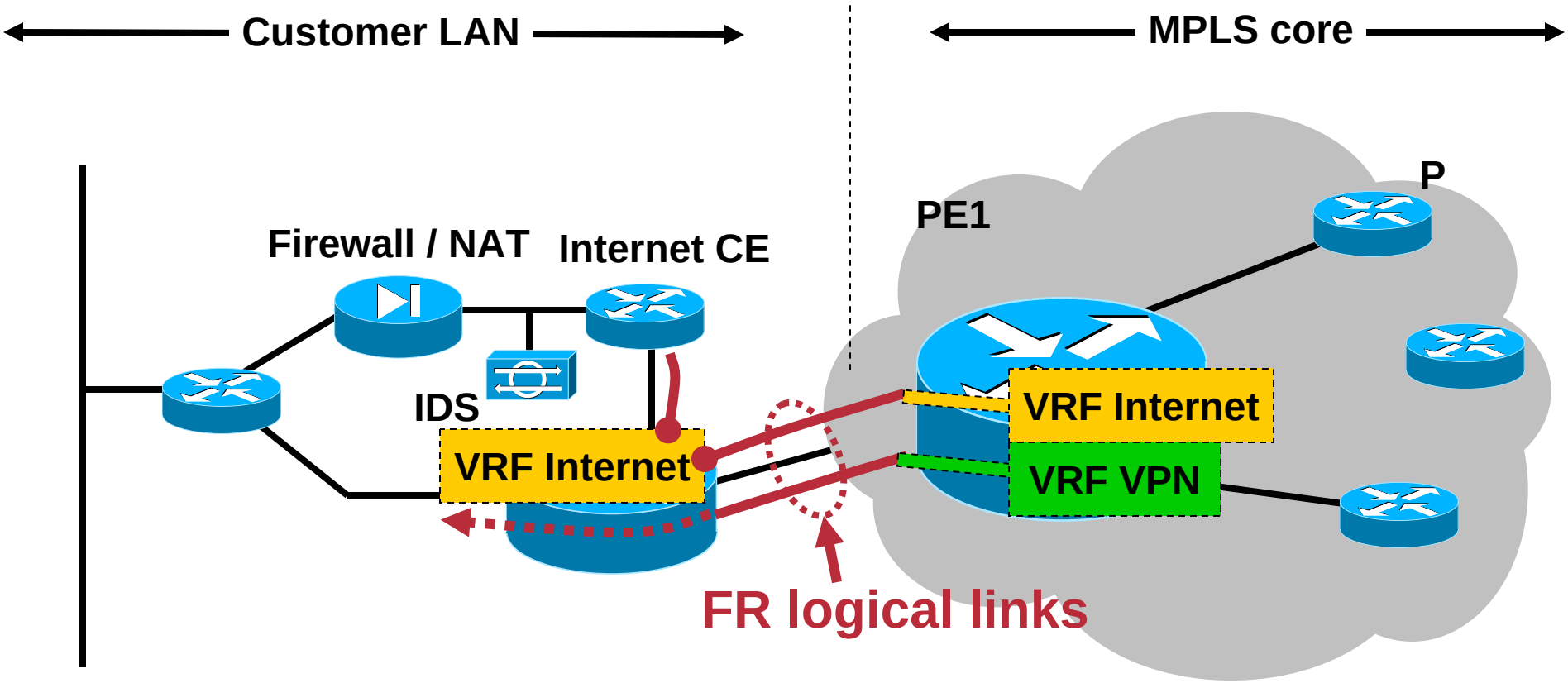
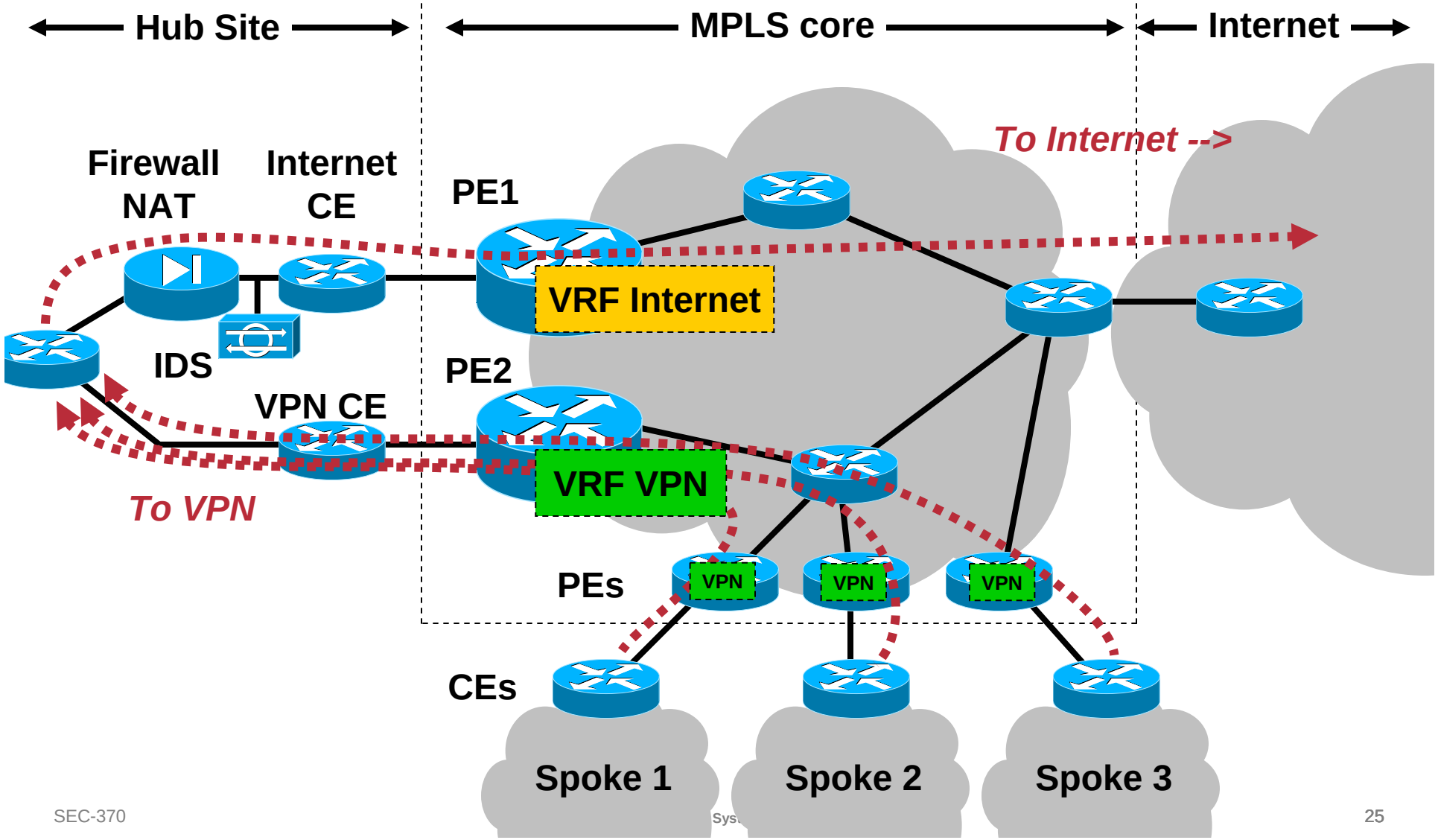


- **Separation: +++**
- **DoS resistance: +** (DoS might affect VPN on PE, line, CE)
- **Cost: $**

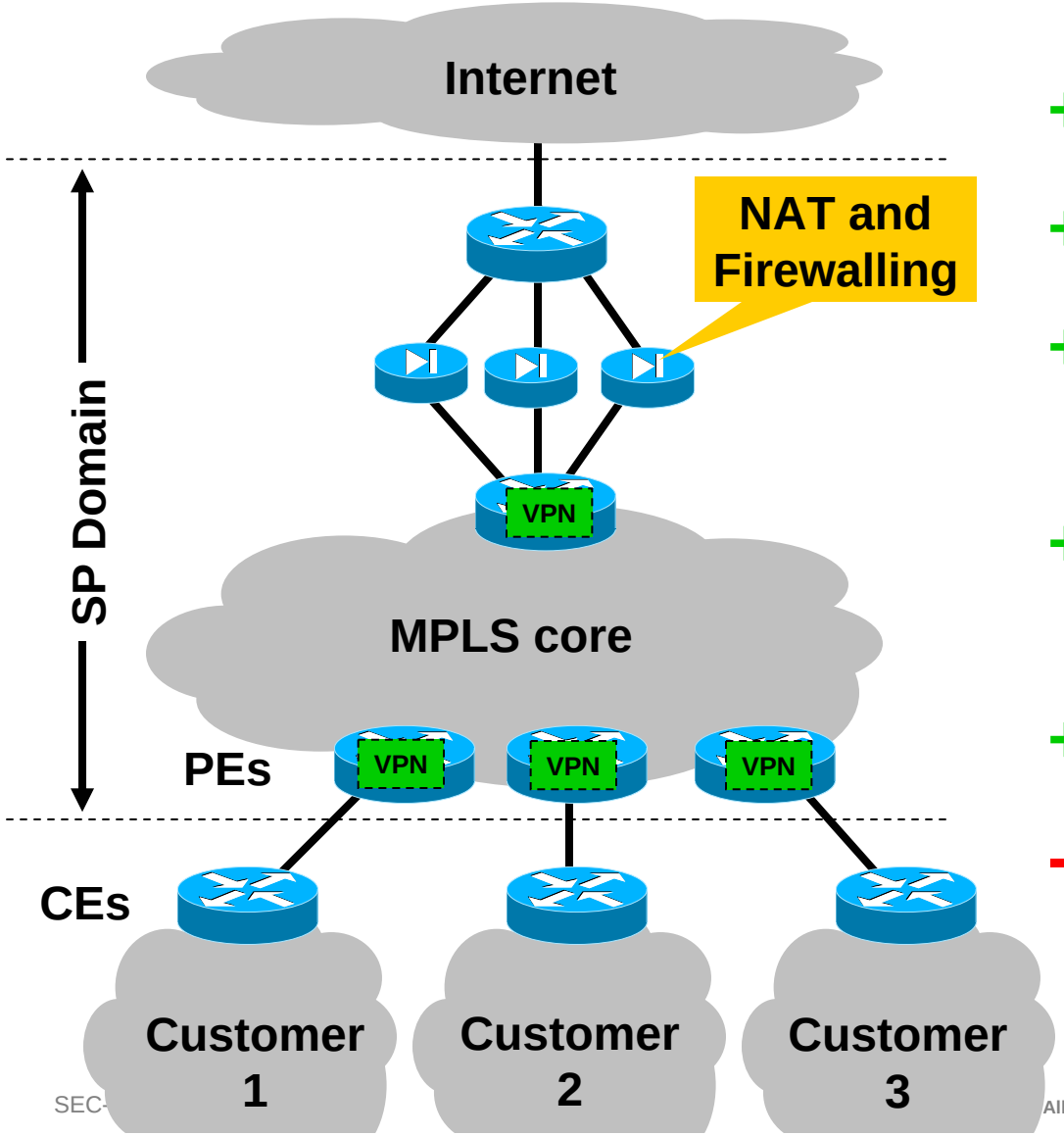
Hub-and-Spoke VPN with Internet Access



Alternative Topologies

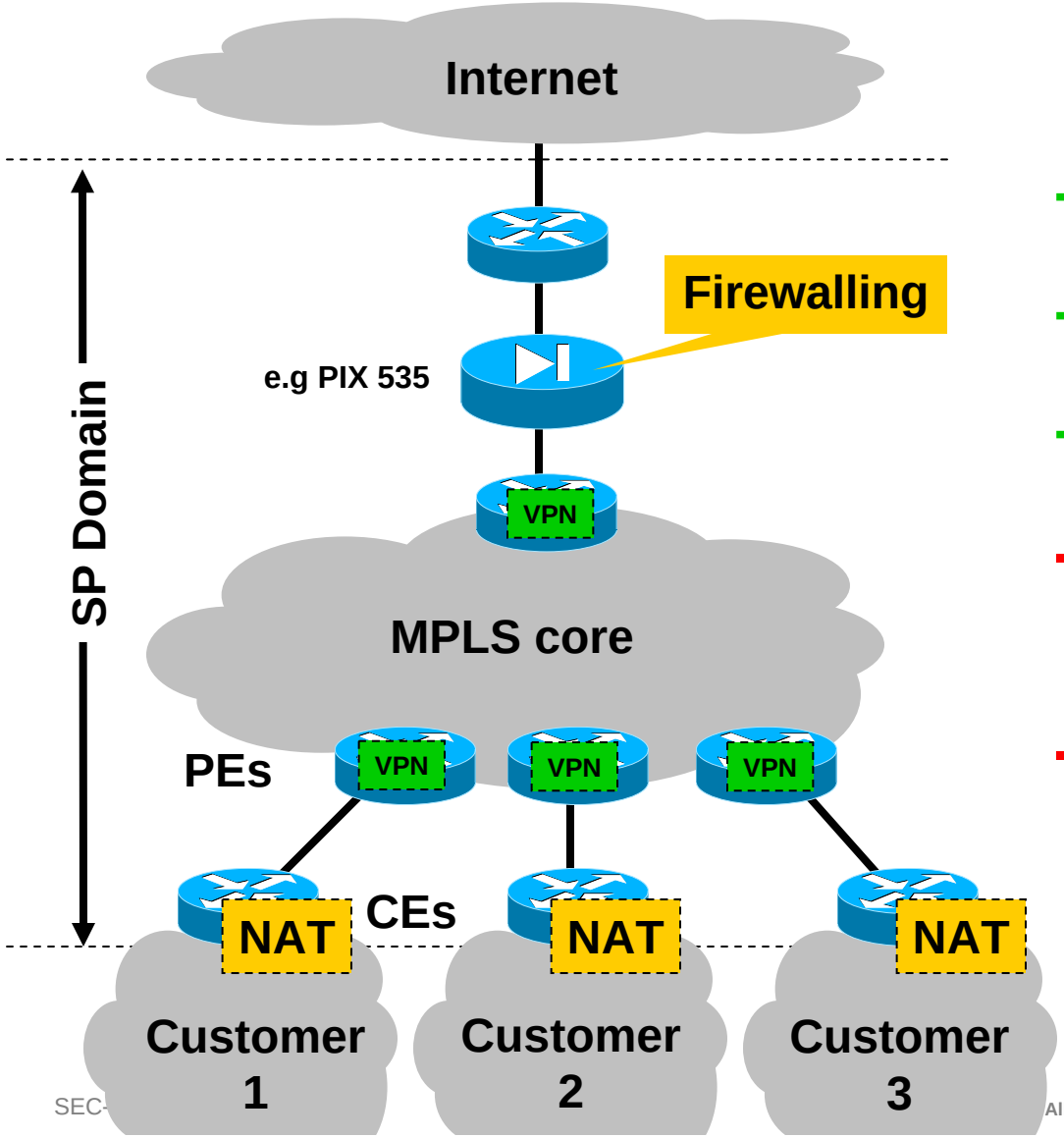
- **Full VPN mesh, one Internet Access**
- **Internet access at several sites**
  - **-> Several firewalls needed**
  - **-> More complex**
- **Internet Access from all sites**
  - **-> Complex, one firewall per site**

Central Firewalling: Option 1: Stacking Firewalls



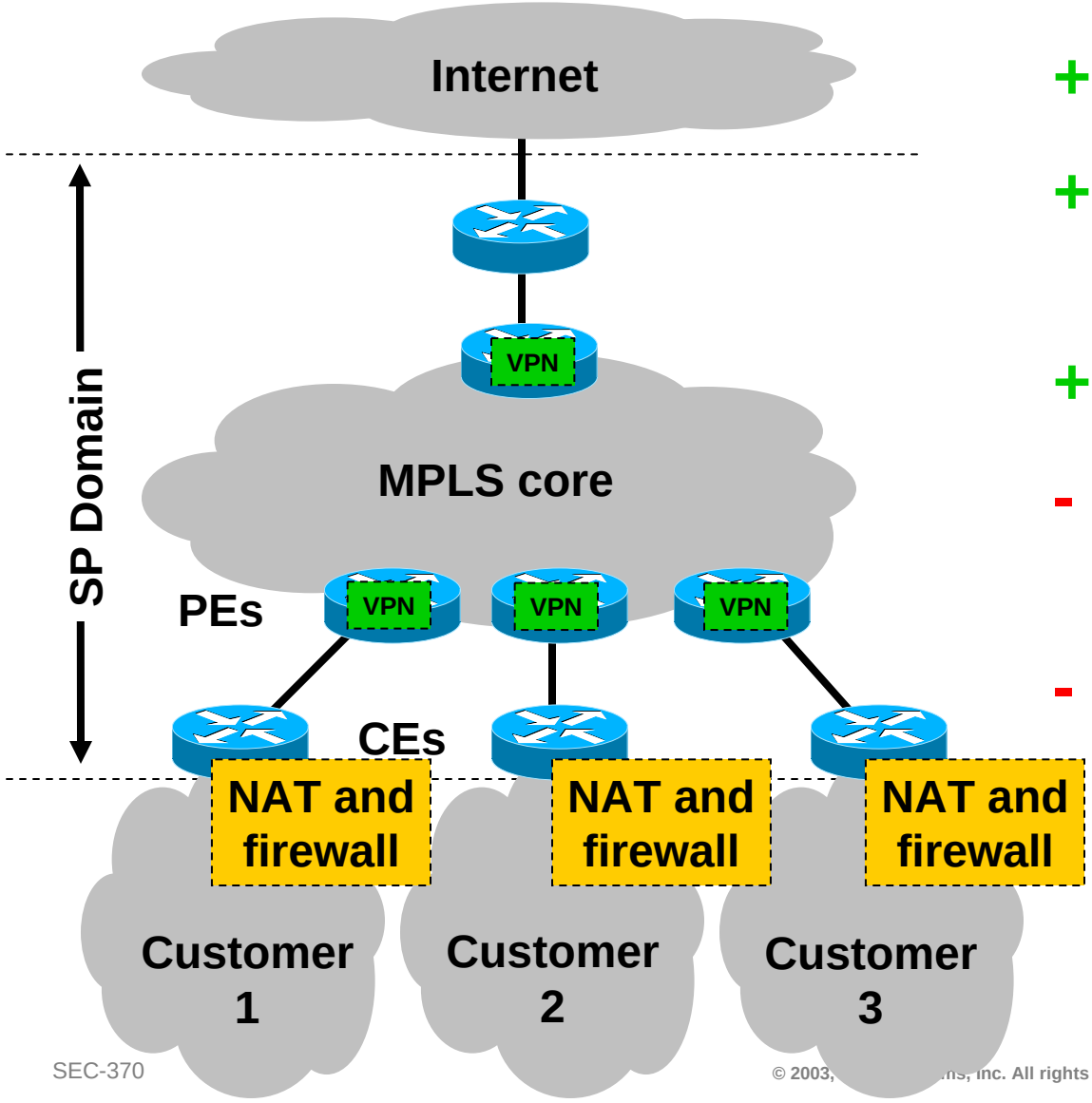
+ Central Management
+ Strong firewalls
+ Customer can choose firewall
+ Different policies per customer possible
+ CEs not touched
- One firewall per customer

Central Firewalling: Option 2: NAT on CE, one central FW



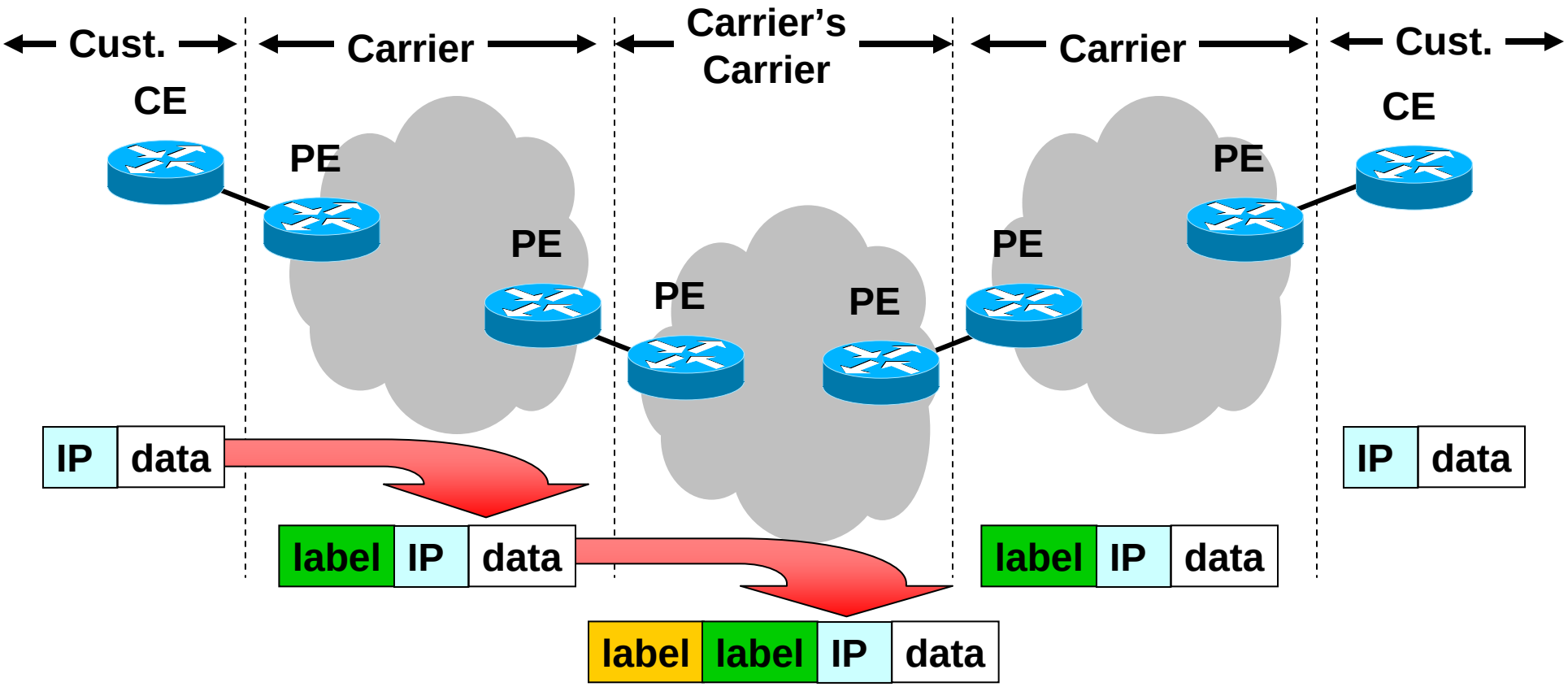
+ Central Management
+ One strong firewall
+ Easy to deploy
- Customer cannot pick his firewall
- CEs need config

Central Firewalling: Option 3: IOS Firewall on CE



+ Economic
+ One firewall per customer
+ No central devices
- Management more difficult
- CEs need config

A Word on Carrier's Carrier



- Same principles as in normal MPLS
- Customer trusts carrier who trusts carrier

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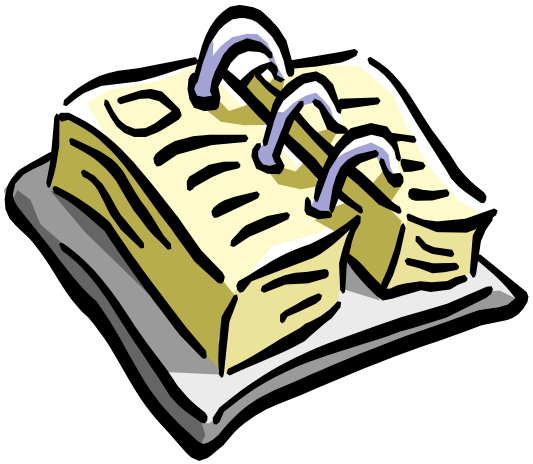

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Ways to Attack

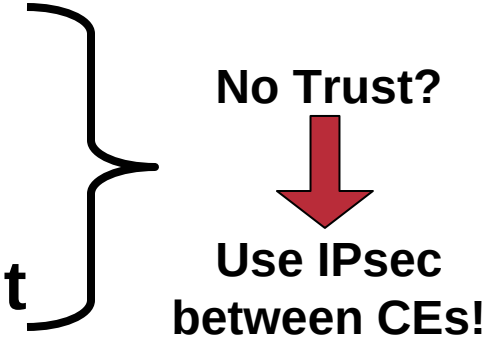
- **“Intrusion”: Get un-authorised access**

  Theory: Not possible (as shown before)

  Practice: Depends on:

  - Vendor implementation

  - Correct config and management

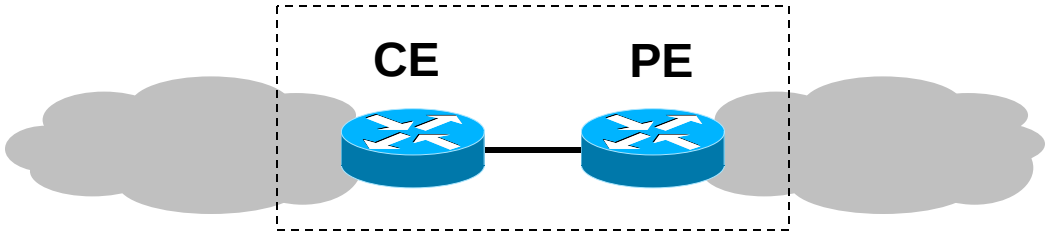


- **“Denial-of-Service”: Deny access of others**

  Much more interesting…

DoS against MPLS

- DoS is about Resource Starvation, one of:
  - Bandwidth
  - CPU
  - Memory (buffers, routing tables, …)
- In MPLS, we have to examine:



- Rest is the same as in other networks

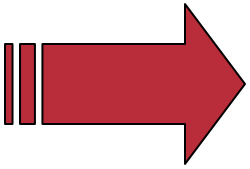
Attacking a CE from MPLS (other VPN)

- **Is the CE reachable from the MPLS side?**

  -> only if this is an Internet CE, otherwise not! (CE-PE addressing is part of VPN!)

- **For Internet CEs:**

  Same security rules apply as for any other access router.



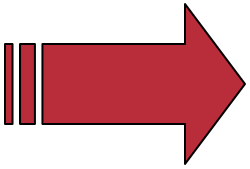
MPLS hides VPN-CEs: Secure!
Internet CEs: Same as in other networks

Attacking a CE-PE Line

- **Also depends on reachability of CE or the VPN behind it**
- **Only an issue for Lines to Internet-CEs**

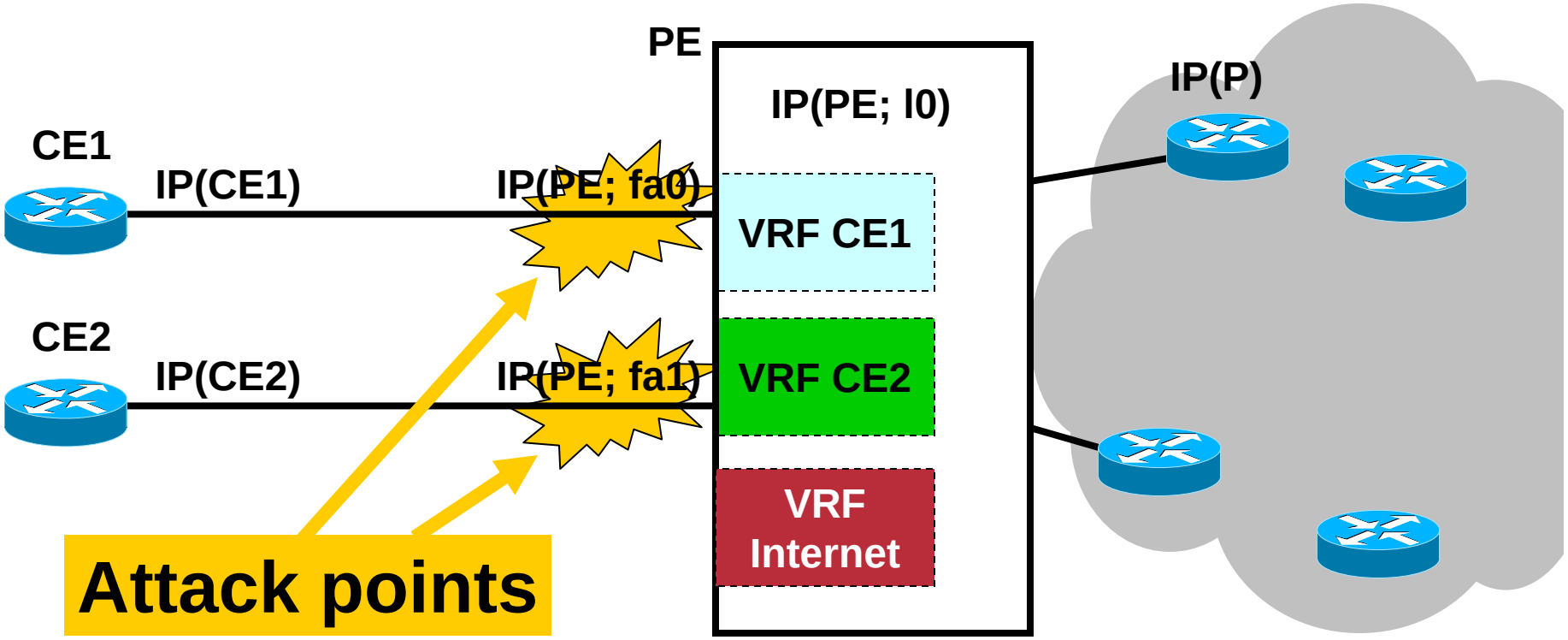
  Same considerations as in normal networks
- **If CE-PE line shared (VPN and Internet):**

  DoS on Internet may influence VPN! Use CAR!



MPLS hides VPN-CEs: Secure!
Internet CEs: Same as in other networks

Attacking a PE Router



Only visible: “your” interface and interfaces of Internet CEs

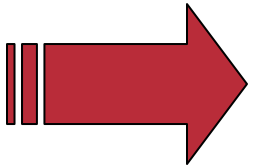
DoS Attacks to PE can come from:

- **Other VPN, connected to same PE**
- **Internet, if PE carries Internet VRF**

Possible Attacks:

- **Resource starvation on PE**

Too many routing updates, too many SNMP requests, small servers, …



Has to be secured

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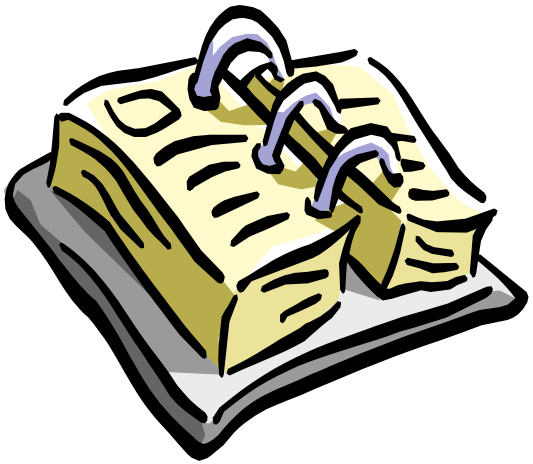

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Use IPsec if you need:

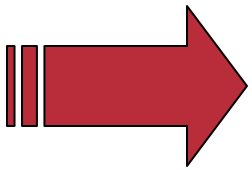
- Encryption of traffic
- Direct authentication of CEs
- Integrity of traffic
- Replay detection

- Or: If you don’t want to trust your ISP for traffic separation!

IPsec Topologies

- CE to CE (static cryptomap)
- Hub and Spoke (dynamic cryptomap)
- Full Mesh with TED: Ideal!!!

MPLS/VPN and TED are an ideal combination!!



IPsec is independent of MPLS
IPsec and MPLS work together

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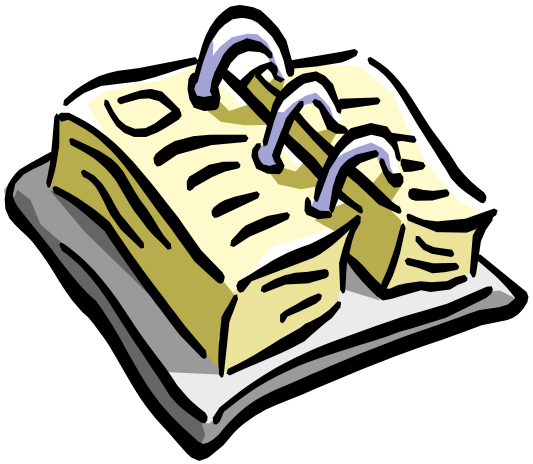

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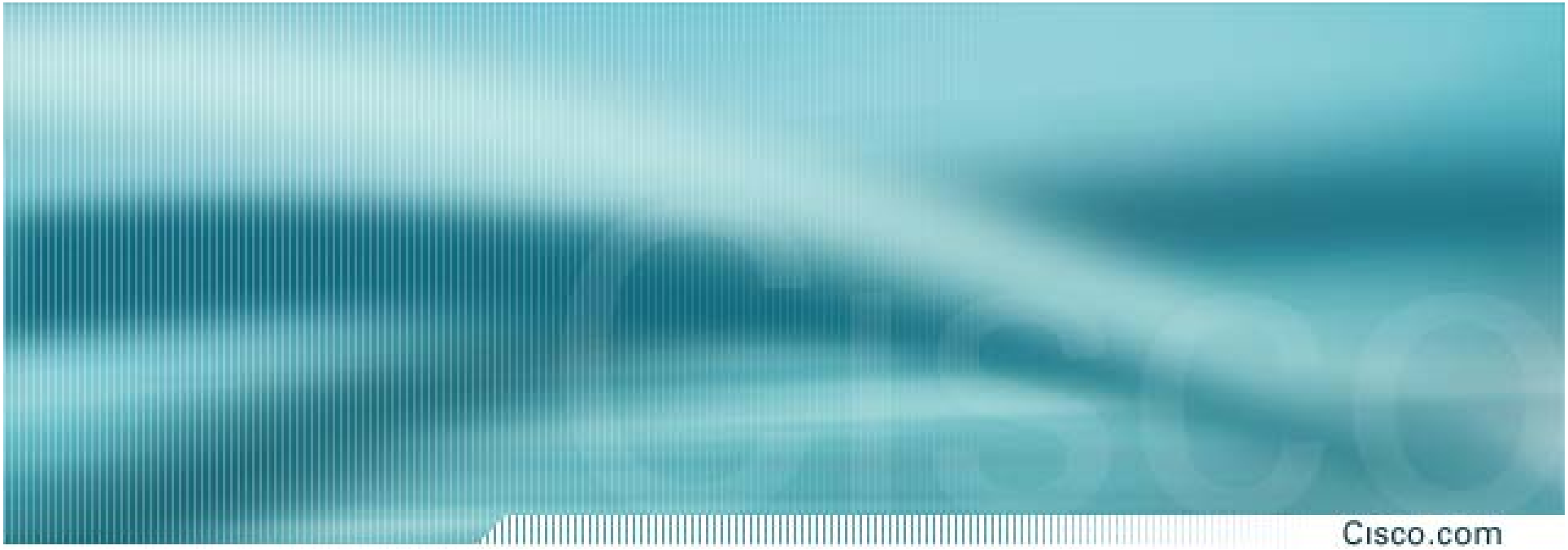
MPLS doesn't provide:

- **Protection against mis-configurations in the core**
- **Protection against attacks from within the core**
- **Confidentiality, authentication, integrity, anti-replay -> Use IPsec if required**
- **Customer network security**

Conclusions

- MPLS VPNs can be secured as well as ATM/FR VPNs
- Depends on correct configuration and function of the core
- Use IPsec if you don’t trust core
- There are many ways to map VPNs with Internet access securely onto MPLS



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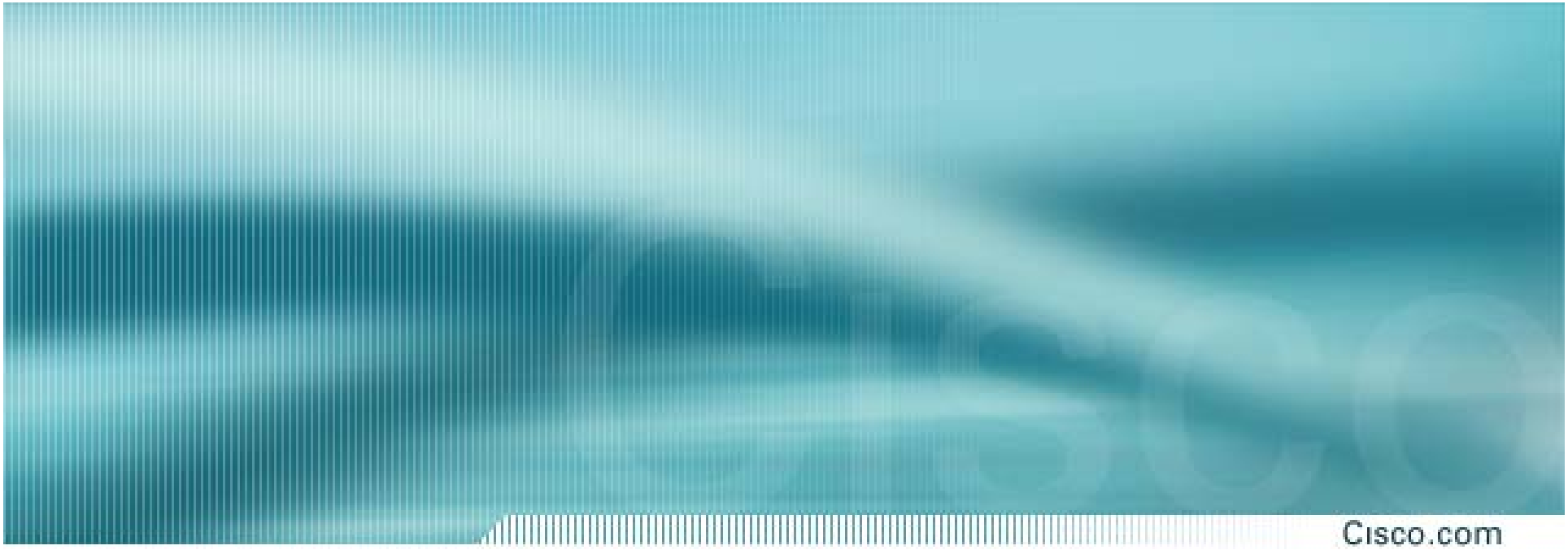

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