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All your packets are belong to us

–

Attacking backbone technologies

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Who we are

ERNW Living Security.

- **Old-school network geeks.**
- **Working as security researchers for Germany based ERNW GmbH.**
- **Fiddling around with devices and protocols makes the majority of our days.**

Agenda

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- **Introduction & Dimensions of this talk**
- **BGP**
- **MPLS**
- **Carrier Ethernet**
- **Summary & Outlook**

Dimensions of this talk

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- **We want you to reflect on the way $TECHNOLOGIES work**
  - => Some discussion of trust models
  - If you consider this “some esoteric shit”… throw things ;-)
- **We want you to have a mild laughter**
  - That’s why we included that “bingo stuff” (see next slide)
  - But, honestly, quite some time this is not too funny…
- **We want to entertain you**
  - Some demos might help to achieve this (the “Meat!” sections)

Bingo [www.crypto.com/bingo/pr]

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BGP

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- **Border Gateway Protocol**
- **Most current version as of RFC 1771 (March 1995)**

- **The glue that keeps the internet together.**
- **Has an interesting trust model.**
- **Was subject of some heavy debate last year.**

BGP - How it works

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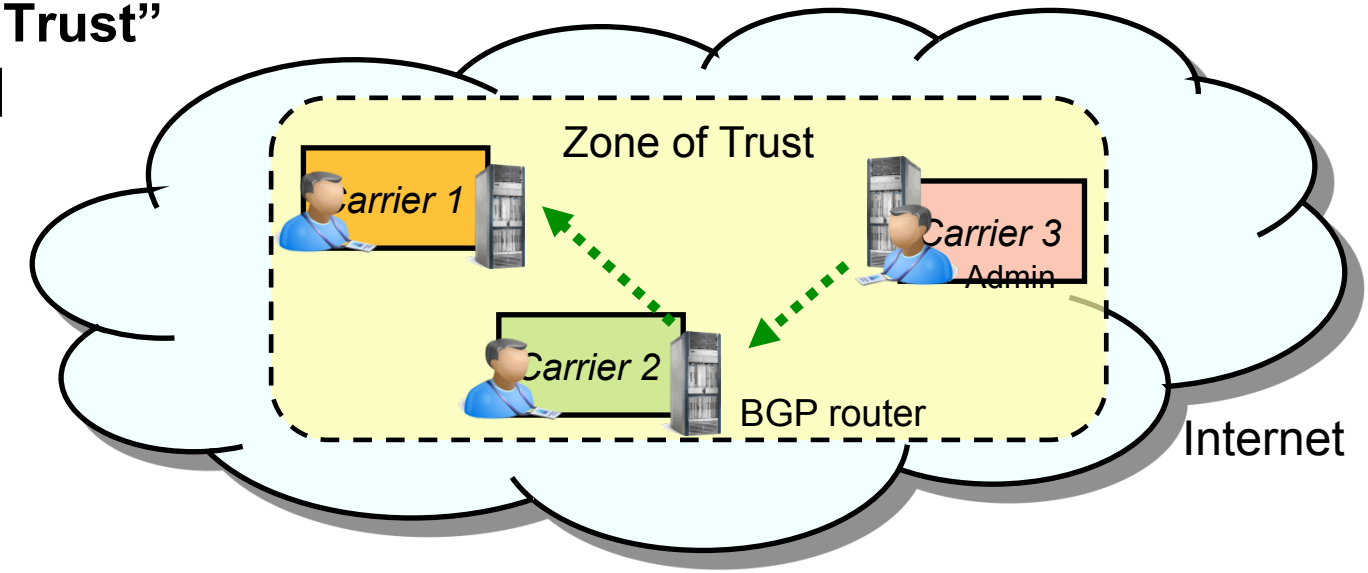
- **BGP speakers (“peers”) establish relationships with neighboring peers**
  - BGP works over /relies on TCP
  - => no multicasting (=> you can’t easily join a “group of BGP speakers”)
  - No (easy) spoofing
- **Peers announce “Network Layer Reachability Information” (NLRI)**
  - Think: “I know that some network can be reached via some way”
- **NLRIs (+ attributes) serve for *path* building/calculation.**

BGP - Trust Model

- **TCP based => mostly configured manually / by script**
- **=> “Intra Operator Trust” [amongst humans]**
- **Error prone**
  - AS7007 Incident
  - YouTube / Pakistan



- **Once you’re a member of the “old boys club” you might perform all sorts of nasty stuff**
  - Pilosov / Kapela 2008

BGP - Security mechanisms

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- **MD5 signature, mainly for integrity checking**
  - Uses “generic TCP MD5 Signature Option” (RFC 2385)
- **Certainly that bell in your head just rang… yes: “MD5”**
  - Anybody attended 25C3 recently? ;-)
  - Still, similar attacks would be quite difficult.
  - And “they’re working on it”
    - http://tools.ietf.org/id/draft-ietf-tcpm-tcp-auth-opt-04.txt
- **Use of MD5 key secured BGP considered Carrier BCP**
  - Does it really add security value?

Meat!

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- **ERNW tool “bgp_cli”**
  - Initially research tool for a student writing about trust (Hi Micele!)
  - Can be used to manually inject routes (role of “valid peer” assumed)
  - Can be used to bruteforce MD5 keys
    - In a direct session-based manner
- **ERNW tool “bgp_md5crack”**
  - Written in C => fast!
  - Can work “live” on interface or on pcap file
- **Demos ;-)**

For completeness' sake

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- **The BGP key used in the campus backbone of a 40K user environment we audited a while ago:**

```
(ciscocrack)> ./ciscocrack 070C285F4D06
Passwd: cisco
```

MPLS

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- ***Multiprotocol Label Switching*** **[RFC 3031 et.al.]**
- **Technology used for forwarding packets, based on *Labels* Packets may carry multiple labels (for different purposes).**
- **Deployed in most carrier backbones.**

- **We are going to cover two subsets of the MPLS technology called “MPLS Layer 3 VPNs” and “MPLS Layer 2 VPNs”**
- **To be found in most $$$ enterpri. for their global networks.**

MPLS Layer 3 VPNs

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- **MPLS-based technology [mainly RFC 4364] with it‘s own concepts and terminology.**
- **Comparable to Frame Relay/ATM in some respects.**
- **Highly ‘virtual‘ technology (shared infrastructure, separated routing).**
- **Additional (MPLS-) labels are used to establish logical paths/circuits for the traffic of single customers.**
- **Very flexible with regard to topologies.**

MPLS VPNs – Terminology

P network (Provider network)

- The ISP‘s backbone

P router (Provider router)

- Backbone router of ISP

PE router (Provider Edge router)

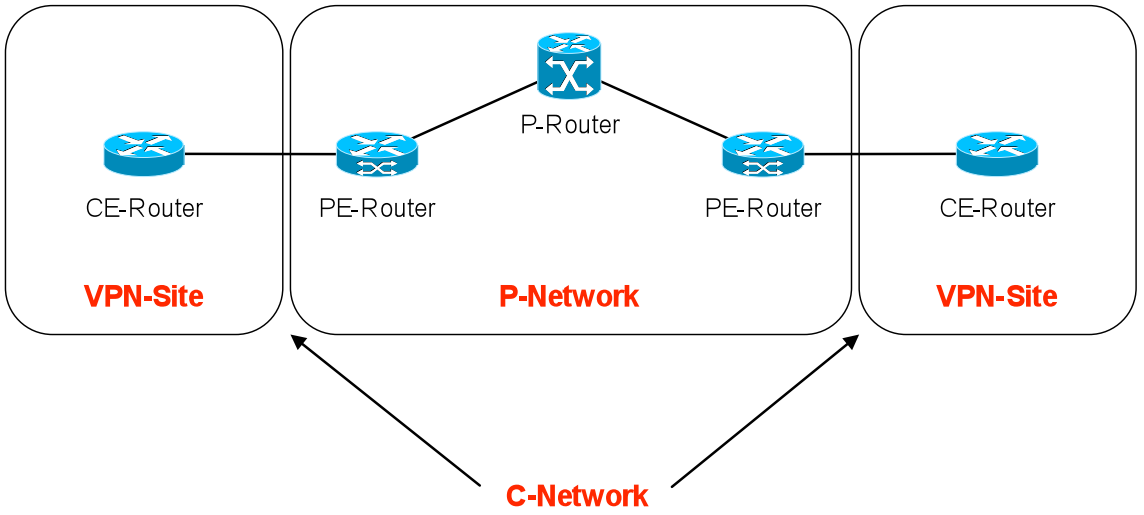
- ISP‘s router responsible for connecting the CE device to MPLS backbone

C network (Customer network)

- The customer‘s network

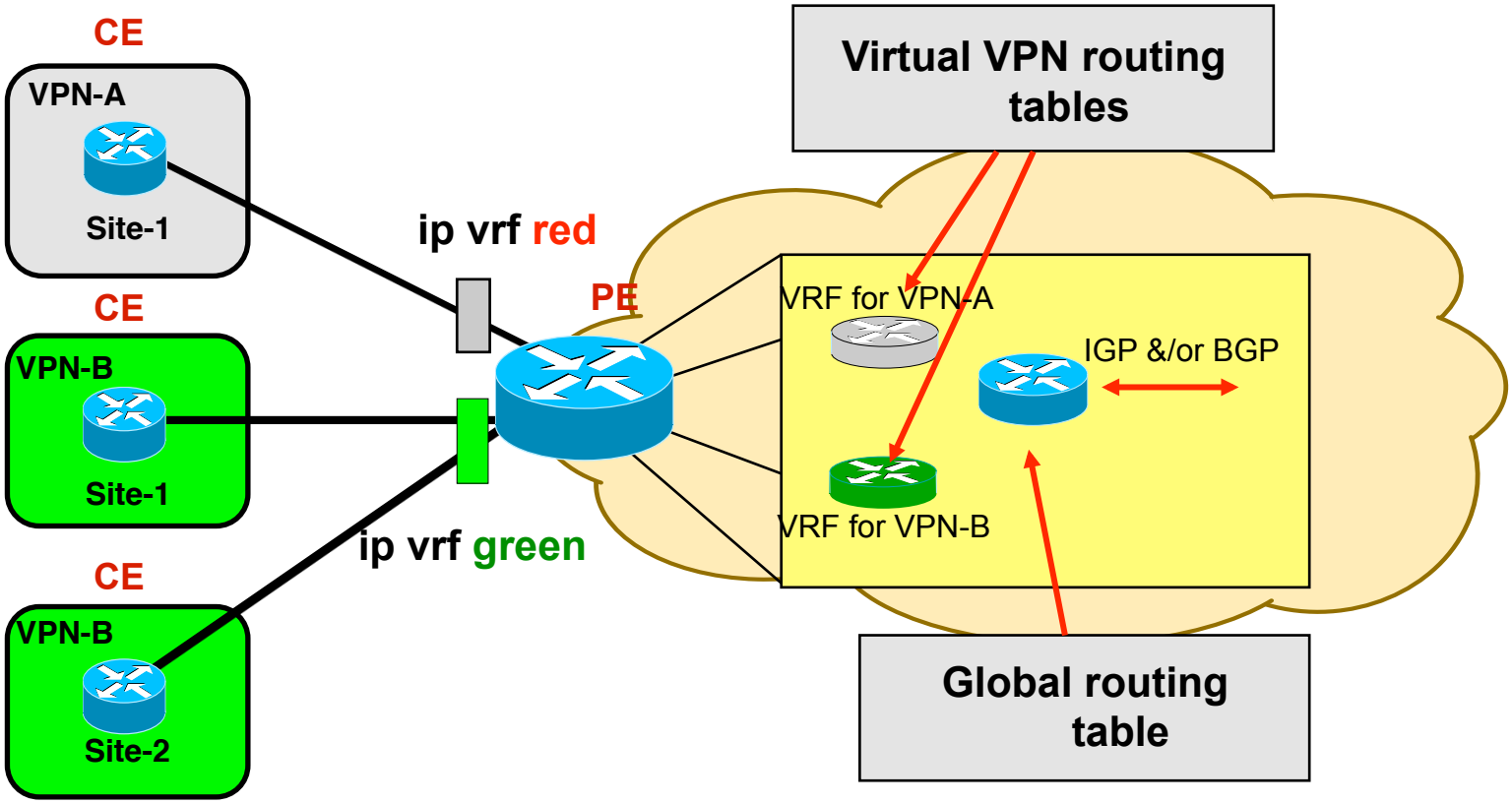
CE router (Customer Edge router)

- Router connecting the C network to the PE (may be under control of customer or ISP)



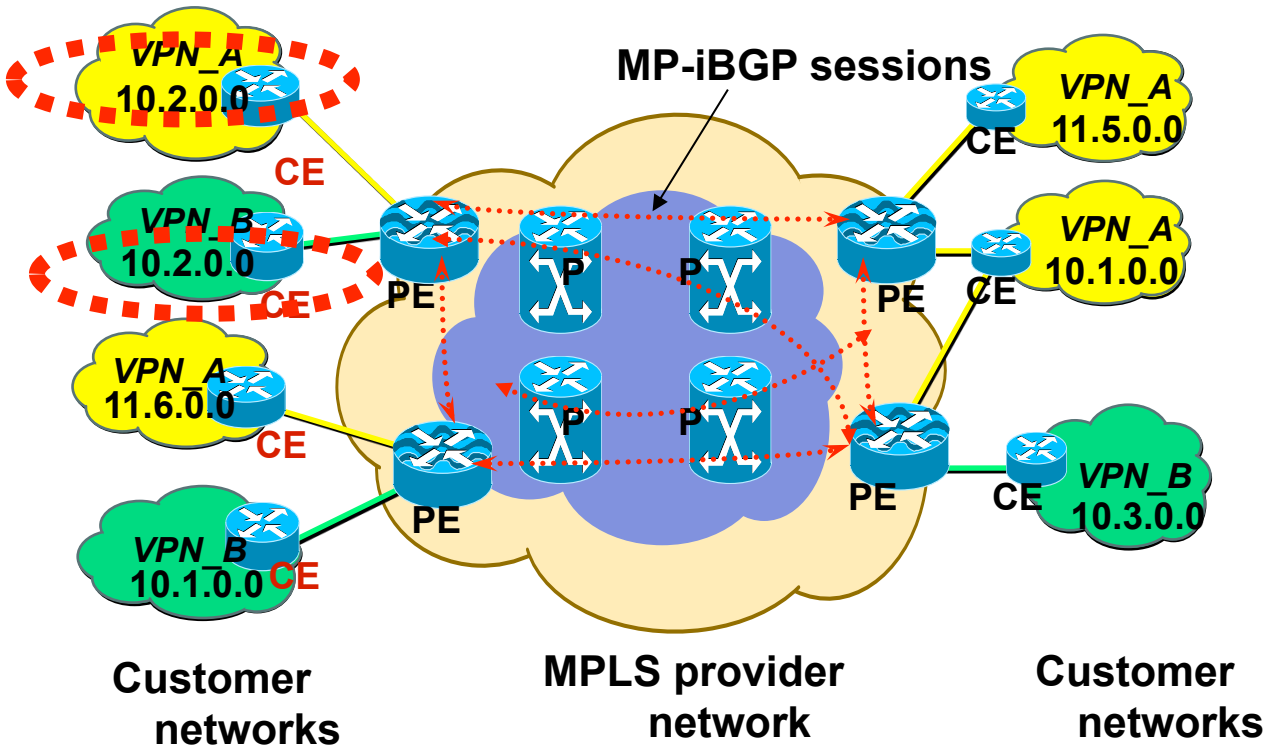
During transport two labels are used: one to identify the ‘egress PE‘, the other one to identify the customer/a particular VPN.

MPLS Layer 3 VPNs



MPLS Layer 3 VPNs

A more complex view



What happens here in detail

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- **PE routers assign labels to prefixes per VPN (*route distinguisher*).**
- **This information (label, route distinguisher, prefix) is then exchanged between PEs by *Multiprotocol BGP* [RFC 2283].**
- **=> one PE knows which other PE is responsible for a given prefix in a given VPN.**

- **When a packet leaves an ingress PE, usually the packet has (at least) two labels:**
  - one ‘forwarding label‘ for transport to the egress PE across the backbone.
  - a second one identifies the VPN (and prefix) of the destination.

- **In short: “labels do the whole VPN thing here“.**

MPLS VPNs, Trust Model

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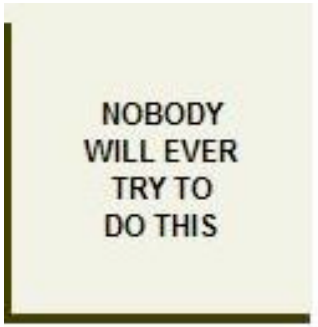
- ***Trusted Core* is assumed.**
- **No attacks from outside the core possible.**
- **No additional security controls available**
  - "Trust my blue eyes!"
  - Oh yes, there is MD5 protected LDP… please, would anybody mind explaining us the underlying threat model?

- **Source of grim debates between $Corp_Global_NW_Team and $Corp_Info_Sec.**



Meat!

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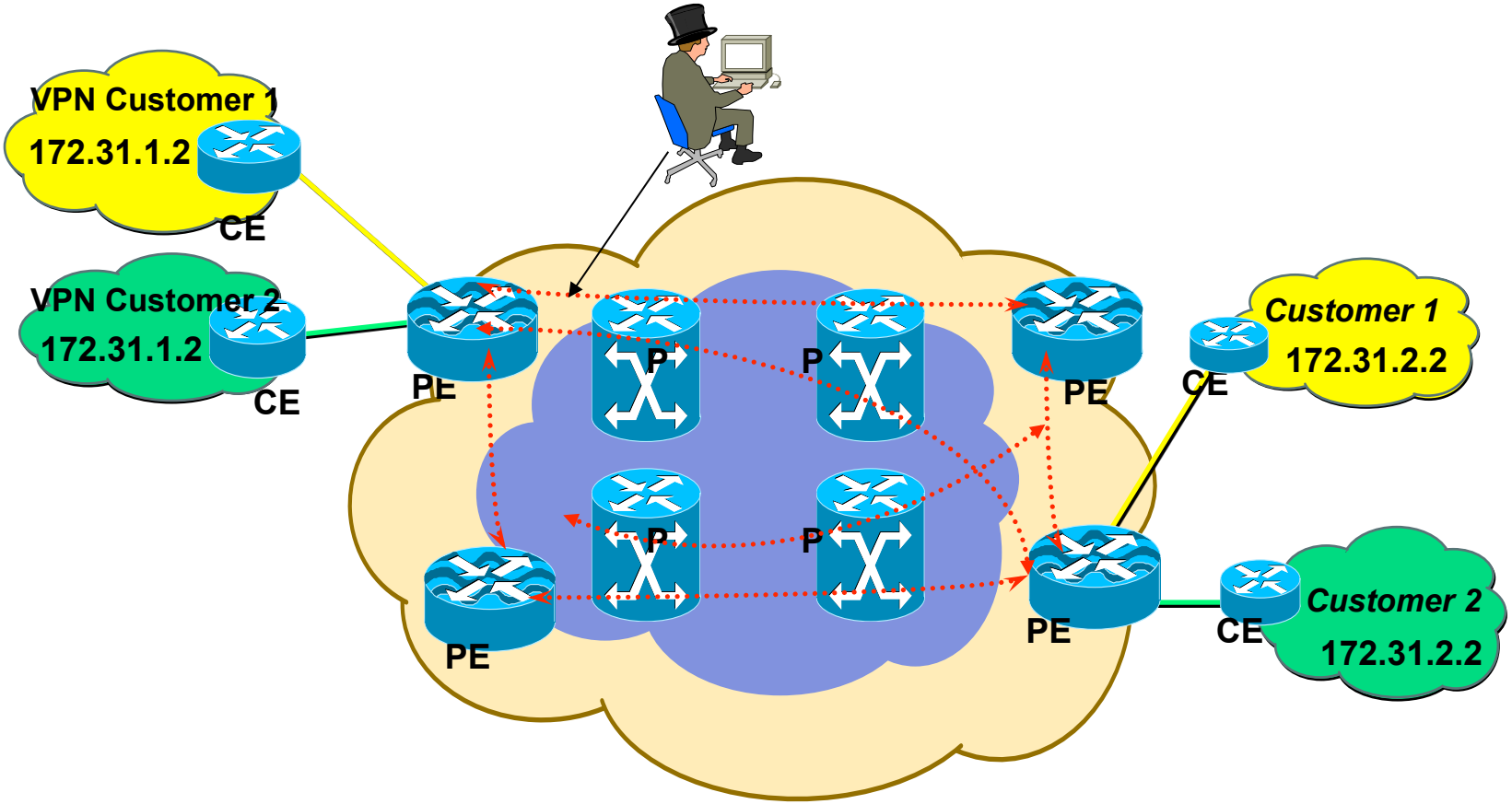
- **ERNW Tool “mpls_redirect”**
  - Assumes attacker has access to traffic path (in core).
  - Command line tool
  - Modifies “VPN labels” of packets
  - => Redirects traffic from one customer to another “customer” [yes, you clever guys, that’s what the name came from…]

- **Demo**

(Bi-directional) Modification of VPN Labels



What does this mean?

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- **It's not only about re-direction, it's about injection, too.**
  - Maybe we should have given another name to the tool ;-)
- **Attacker can get into VPNs.**
  - Attacker can set up fake "central authorization portal" and re-direct an enterprise's traffic to it.
  - Same for DNS
  - Same for LDAP
  - Same for …
- **Use your imagination ;-)**

Mitigating controls

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- **“Trust your carrier”**
  - This was _not_ a joke ;-) … if you do, you’re fine. We’re fine, too.
  - Contractual controls might kick in.

- **“Authenticate everything”.**
  - Breaks approach of “trusted networks”

- **Implement “borders of trust” (e.g. L3 devices) that encrypt/ decrypt all inbound traffic on a site level.**

Definition of *Carrier Ethernet*

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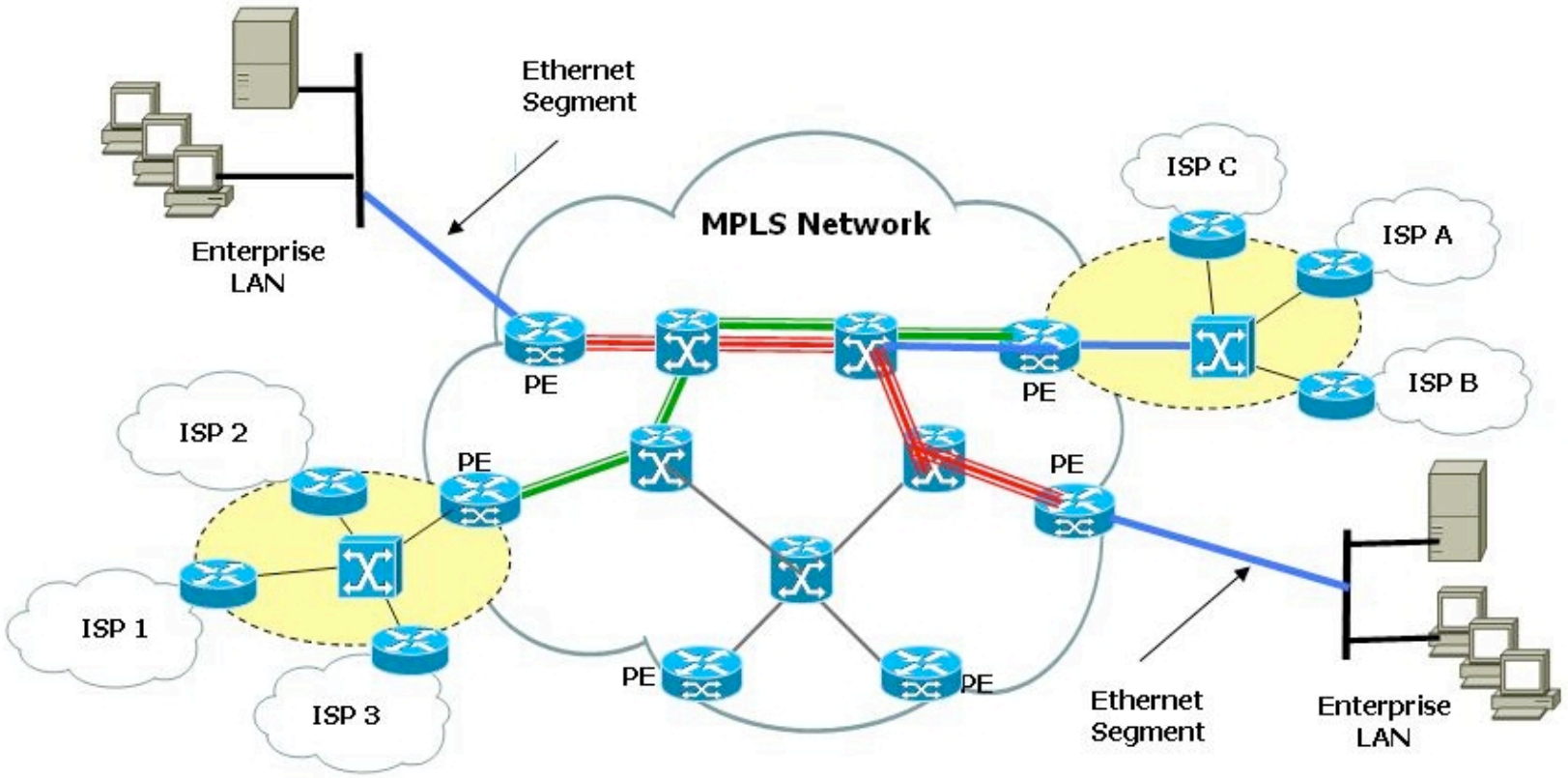
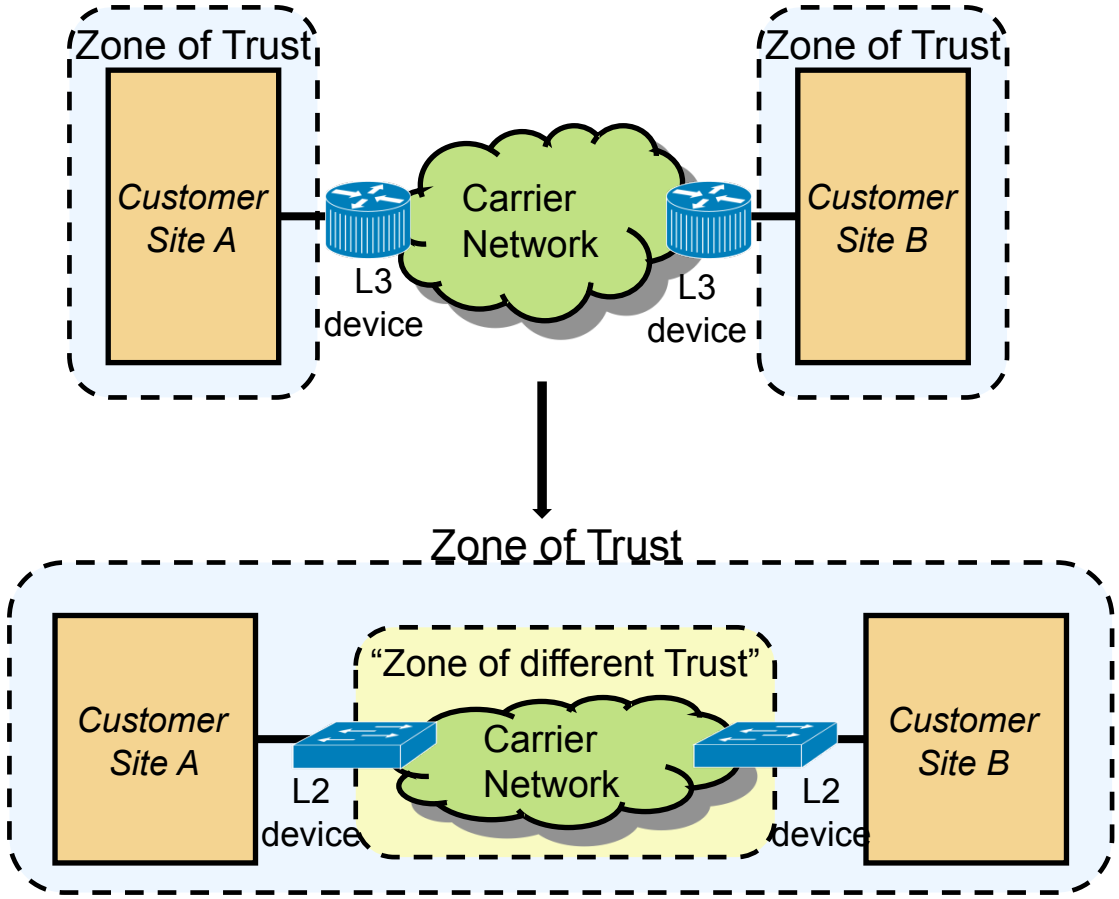
- ***Carrier Ethernet* basically means that ethernet frames are transported across (at least) one carrier‘s backbone.**
- **So ethernet is not (only) used as an *access medium* here, but offered as a *service*.**

- **Technologies**
  - Metro Ethernet
  - EoMPLS / VPLS
  - L2TPv3

Example: Ethernet over MPLS



Change of (ethernet) trust model



Full vs. Partial Transparency

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- **Depending on the (carrier's) service/product, potentially the devices used and the configuration of PE and CE the connection may or may not provide full transparency.**
- **"Full transparency" means, that *all* BPDUs (including e.g. STP, DTP, VTP, GVRP, LACP, 802.1x packets and the like) and *all* Layer2 Headers (incl. VLAN tags, CoS) are transparently transported from one site to another/others across the cloud.**
- **In contrast "partial transparency" means that some of the BPDUs or header information is filtered/discarded when entering the cloud.**

Security threats arising from this change

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- **Existing threats have new scope**
  - Ethernet based attacks may be performed “over the cloud”
    - E.g. attacker in site Brussels might *arp-spoof* (=read) traffic from site Amsterdam.
  - Misconfigurations will have larger impact
    - What about that old C2980 with a high VTP rev.-number, accidentally re-plugged in?
- **New threats may show up**
  - Existing ethernet protocol space not designed for worldwide networks.
    - Spanning Tree dates from 1980s.
    - Again: their whole trust model is built around a concept of “local networks”.
  - Segmentation capabilities of technologies involved may not be sufficient for some security needs.

Traditional Ethernet Attacks "over the cloud"

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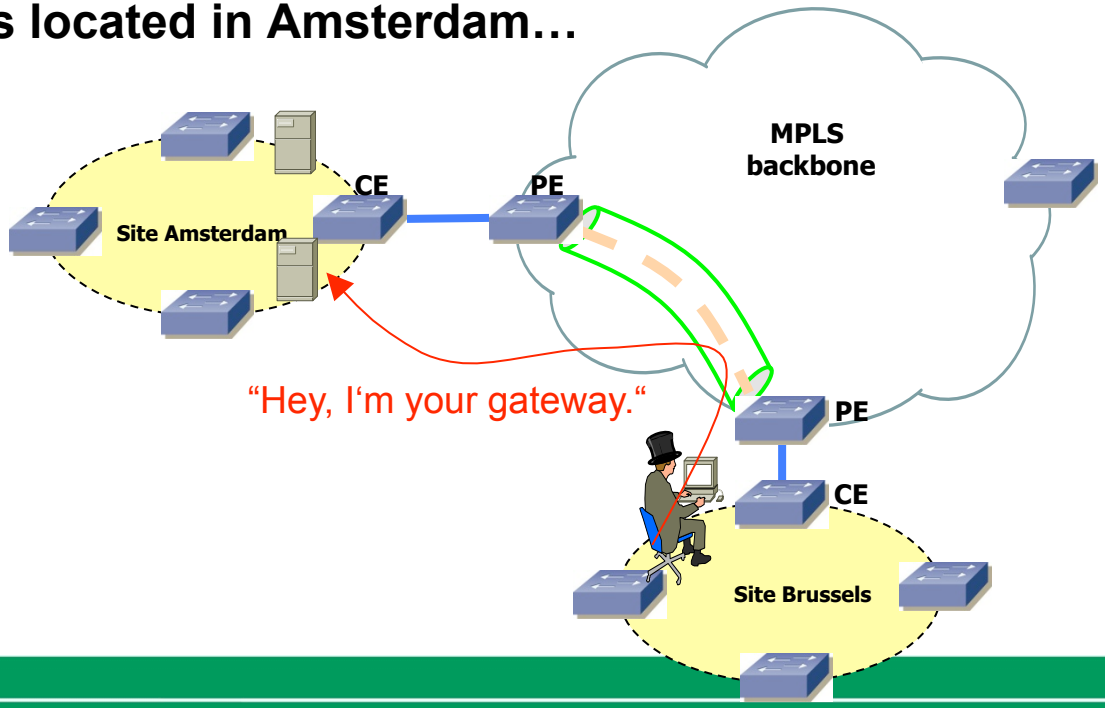
- **Depend highly on the level of transparency a "VPLS cloud" provides.**
- **Given full transparency (as in *Cisco*-based testbed we used)…**
- **… you can perform any traditional layer 2 attack over the cloud.**
- **We tested this successfully with *yersinia*.**
- **From an attacker's perspective this is pretty cool: sitting in Brussels and arp-spoofing some boxes located in Amsterdam…**



VTP over the cloud

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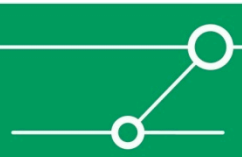
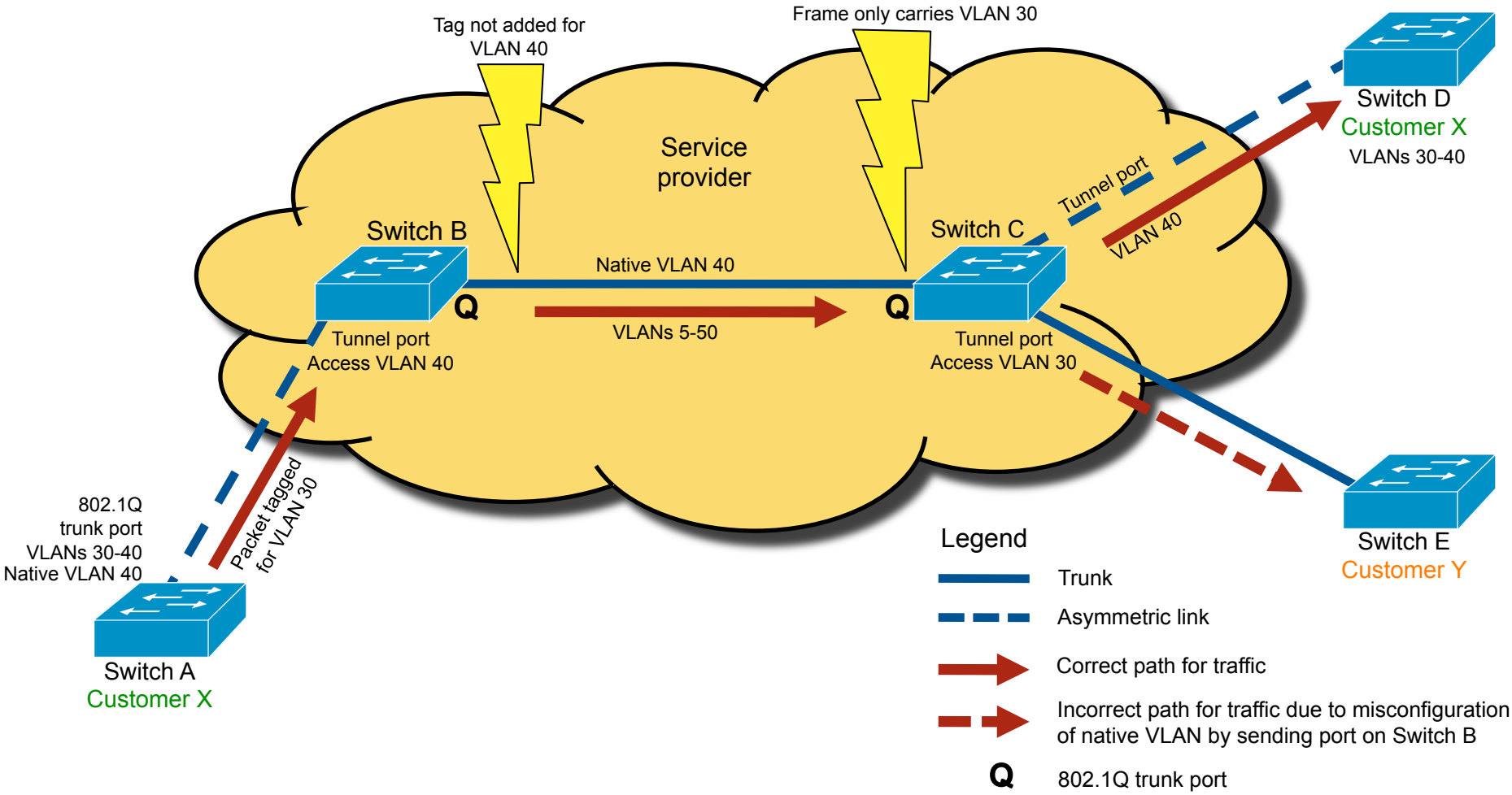
- **Demo**



Potential Problem with IEEE 802.1Q Tunneling and Native VLANs



Wrap-up on Carrier Ethernet

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- **Interesting approach ("as networkers" we pretty much like it).**
- **Changes whole trust model of Ethernet**
  - Might have large security implications.

Save the best for last

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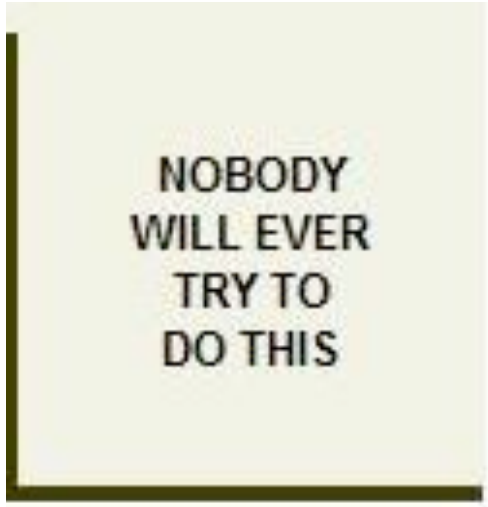

Some fun with MP-BGP…

Summary & Outlook

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- **There are some backbone technologies with a “debatable“ trust model**
  - And “debatable“ resulting security controls / control capabilities

- **Our talk‘s intent was to made you aware of that. It‘s just that simple ;-)**

Questions?

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Thanks for your attention!

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Final Wisdom

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Whatever you do... always remember the following two:

- **Ross Callon in *RFC 1925*:**

  “Some things in networking can never be fully understood by someone who neither builds commercial networking equipment nor runs an operational network.“

  => If really interested in this stuff get your hands on some devices ;-)

- ***Simplicity Principle* from**

  http://tools.ietf.org/rfc/rfc3439.txt