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Dynamic IPv6 Prefix Problems and VPNs

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  - Firewall
  - VPN/Crypto
  - Routing/Switching
  - Mail
- IPv6
- DNSSEC

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Agenda

- Migration from IPv4 to IPv6 -> Changed Concepts/Principles
- IPv6 Site-to-Site VPNs
- IPv6 Dynamic Prefix Problems
- Examples: Screenshots from Juniper ScreenOS
  - Yes, it‘s End-of-Everything
  - But: Cheap for labs, almost complete IPv6 functionalities: PPPoE w/ IPV6CP, DHCPv6-PD
  - ~~Palo Alto Networks, Fortinet FortiGate, Cisco ASA~~
  - (In the meantime, FortiGate v5.4 implemented DHCPv6-PD)
- ~~Stats: IPv6 Adoption~~

Wording

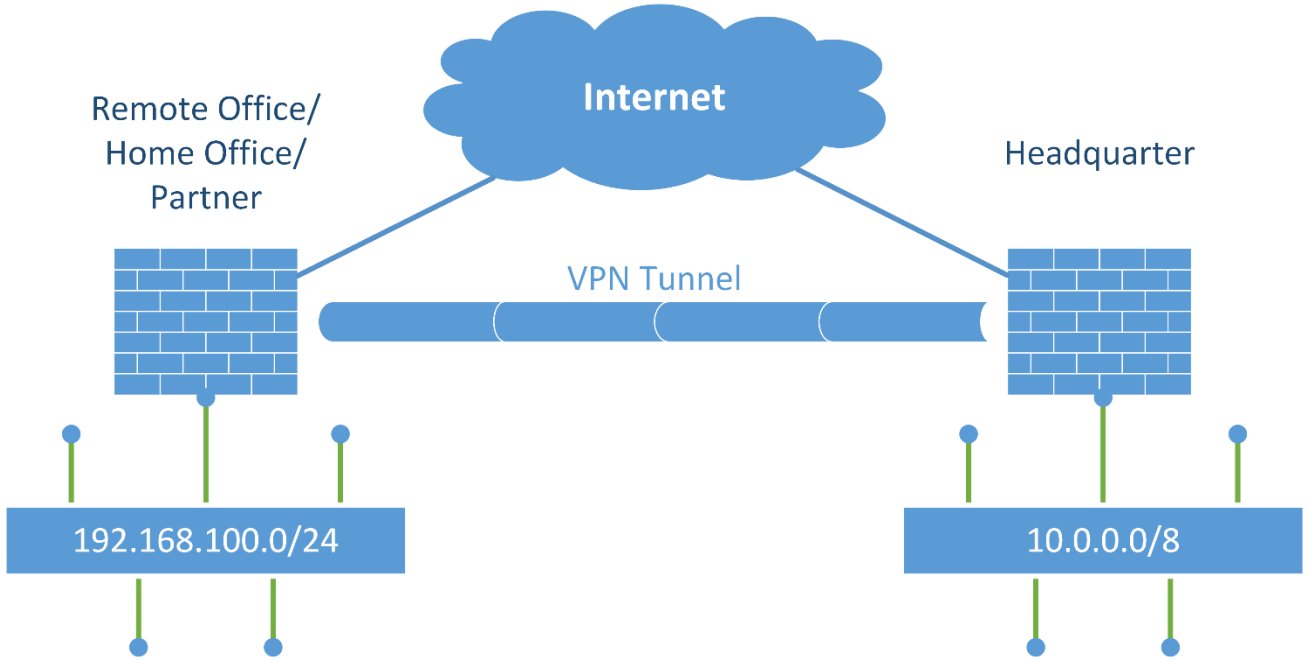
- Route-Based VPN Tunnels
  - Each VPN tunnel has a tunnel-interface
  - Appropriate routes into tunnel-interfaces
  - Tunnel-interfaces are bound to security-zones
- Scenarios
  - Three zones per firewall: **untrust**, **trust**, **vpn(-tunnel)**
  - Headquarter ←→ Remote Office / Home Office / Subsidiary / Partner

IPv6 Site-to-Site VPNs

What‘s a VPN Tunnel for?

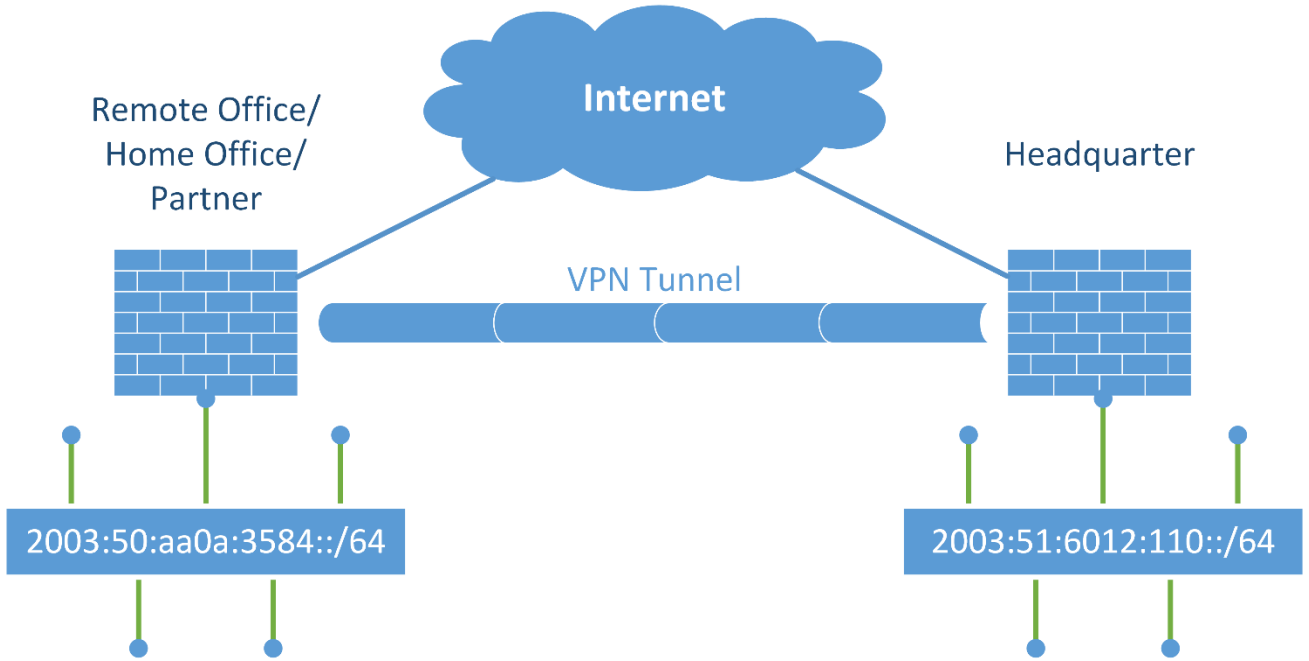
- Wikipedia: “A virtual private network (VPN) extends a private network across a public network [...]”
- “They are used to securely connect geographically separated offices of an organization […]”
- → Traffic intended for a **secure** VPN tunnel MUST NOT traverse the unsecure Internet!
- Example: securing mail transfers between two partner MTAs

IPv4 Site-to-Site VPN



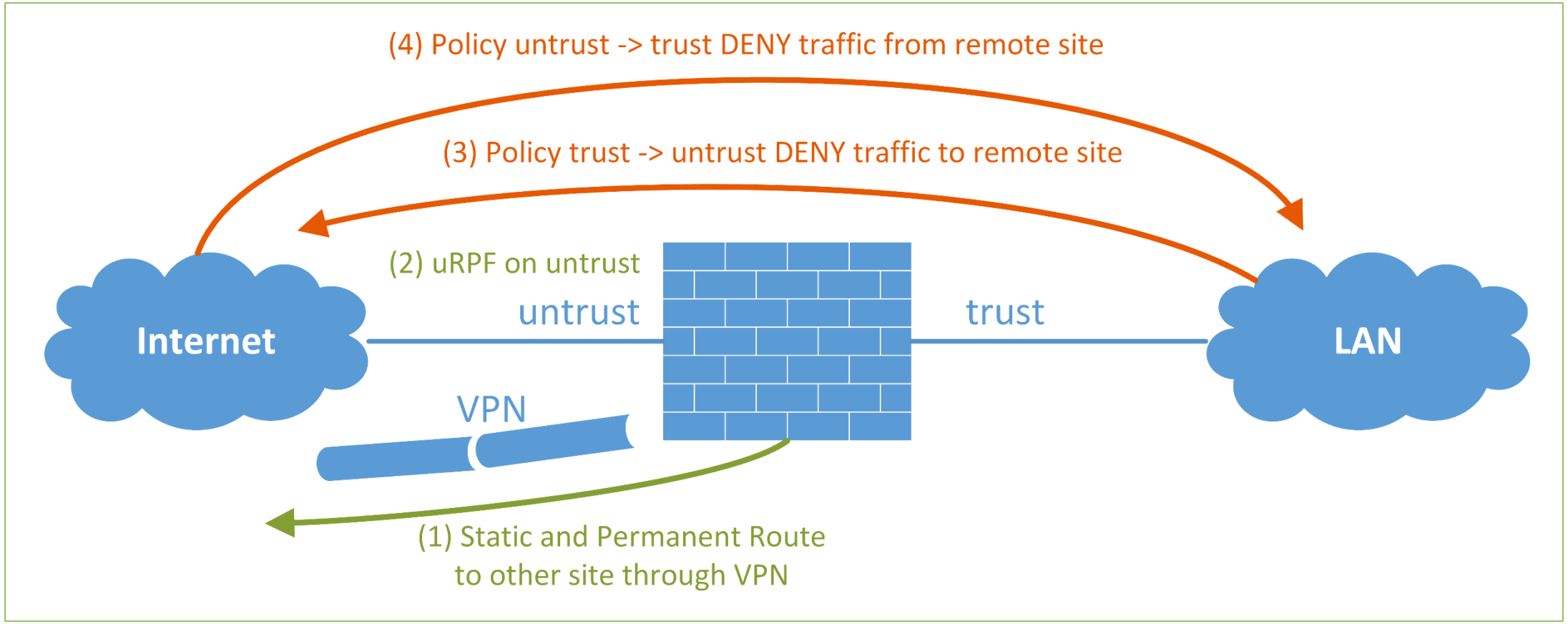
- Only private (RFC1918) IPv4 addresses on both sites
- Route into Tunnel Interface
- Security Policy from trust -> vpn (and vice versa)
- → If VPN tunnel is down, nothing happens. At least the ISP router discards private IPv4 addresses.
- → Both ends are neither addressable nor accessible

IPv6 Site-to-Site VPN



- Routable Global Unicast Addresses (GUA) on both sites
- → **If VPN tunnel is down, packets might traverse successfully through the (unencrypted) Internet!**
- → Both ends ARE addressable and possibly accessible (DMZ)

IPv6 Site-to-Site VPN Principles



Example

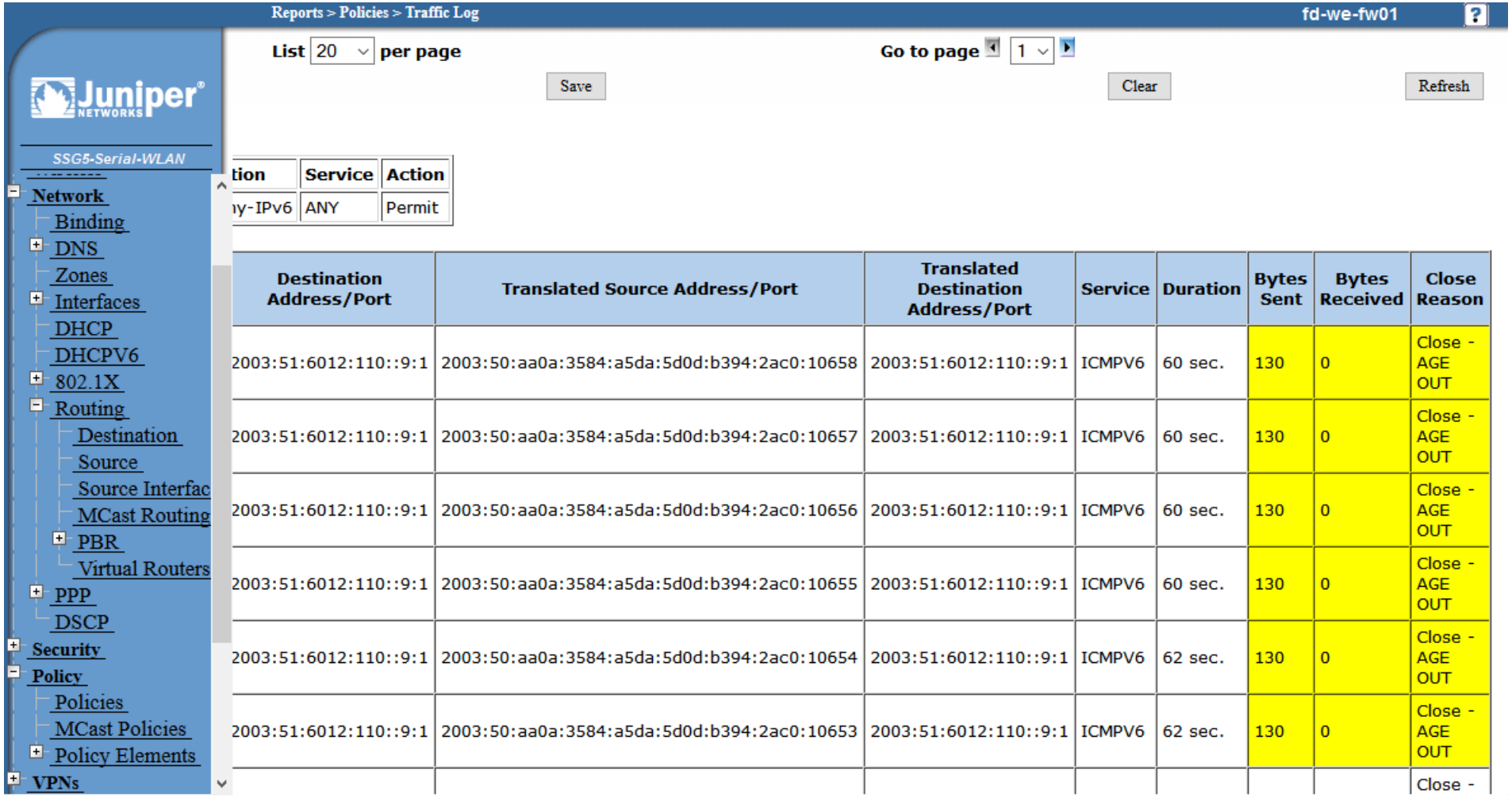
- End-to-End communication without VPN:

```
C:\Users\Johannes Weber>tracert -d lx.webernetz.net

Routenverfolgung zu jw-nb12.webernetz.net [2003:51:6012:110::9]
über maximal 30 Hops:

  1     1 ms     1 ms     1 ms  2003:50:aa0a:3584::1
  2     3 ms     2 ms     2 ms  2003:0:1301:4205::1
  3     4 ms     6 ms     6 ms  2003:0:1301:4238::2
  4     6 ms     7 ms     7 ms  2003:0:1302:403::1
  5     4 ms     3 ms     4 ms  2003:0:1302:403::2
  6     5 ms     4 ms     4 ms  2003:51:6012::2
  7     5 ms     5 ms     5 ms  2003:51:6012:110::9

Ablaufverfolgung beendet.
```

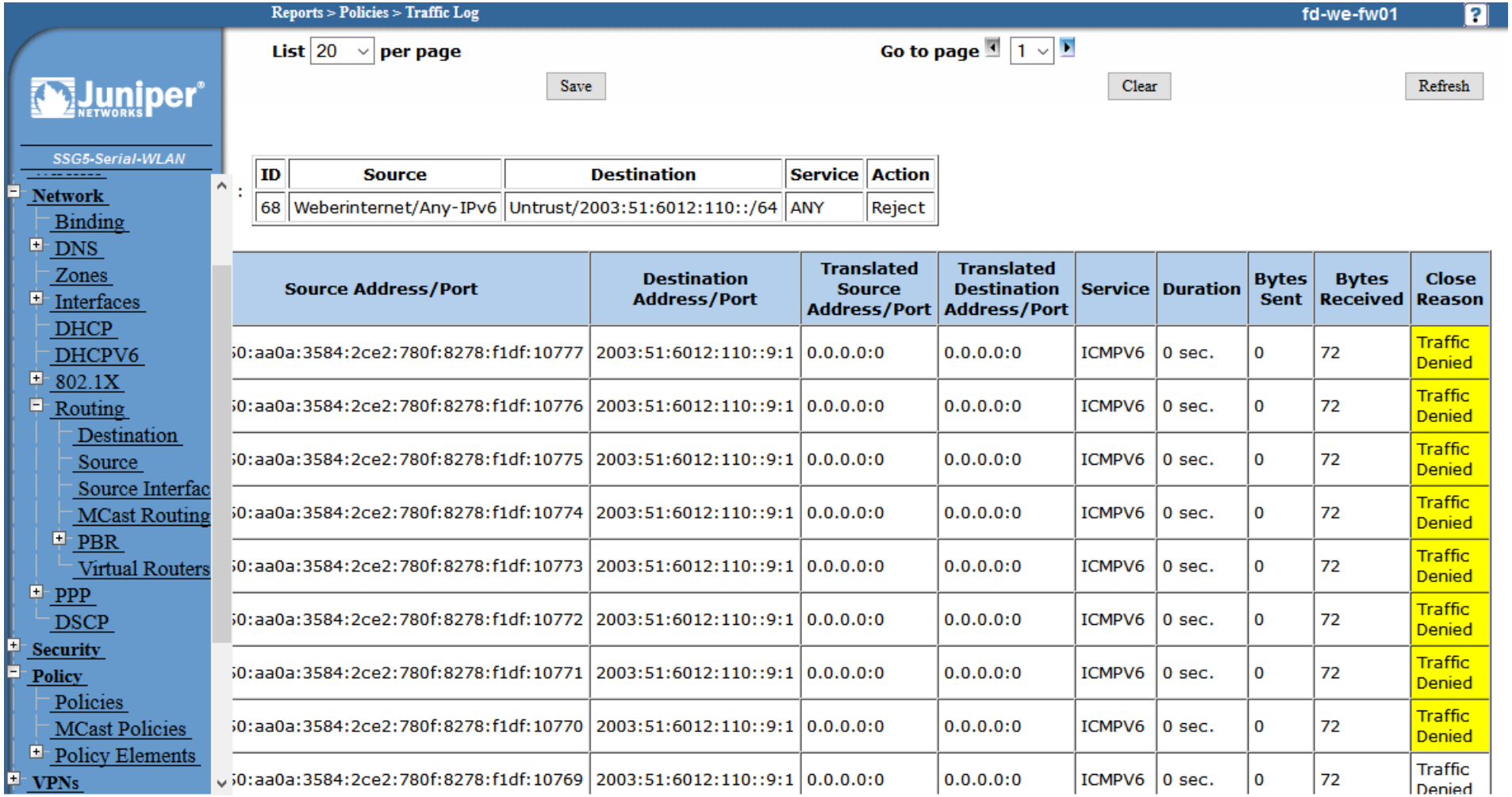
- And with VPN:

```
C:\Users\Johannes Weber>tracert -d lx.webernetz.net
Routenverfolgung zu jw-nb12.webernetz.net [2003:51:6012:110::9]
über maximal 30 Hops:

  1     1 ms     1 ms     1 ms  2003:50:aa0a:3584::1
  2     *        *        *     Zeitüberschreitung der Anforderung.
  3     6 ms     6 ms     7 ms  2003:51:6012:110::9

Ablaufverfolgung beendet.
```

Broken VPN -> Still Permanent Route (RO)



Deleted Route -> Still Deny Policy (RO)

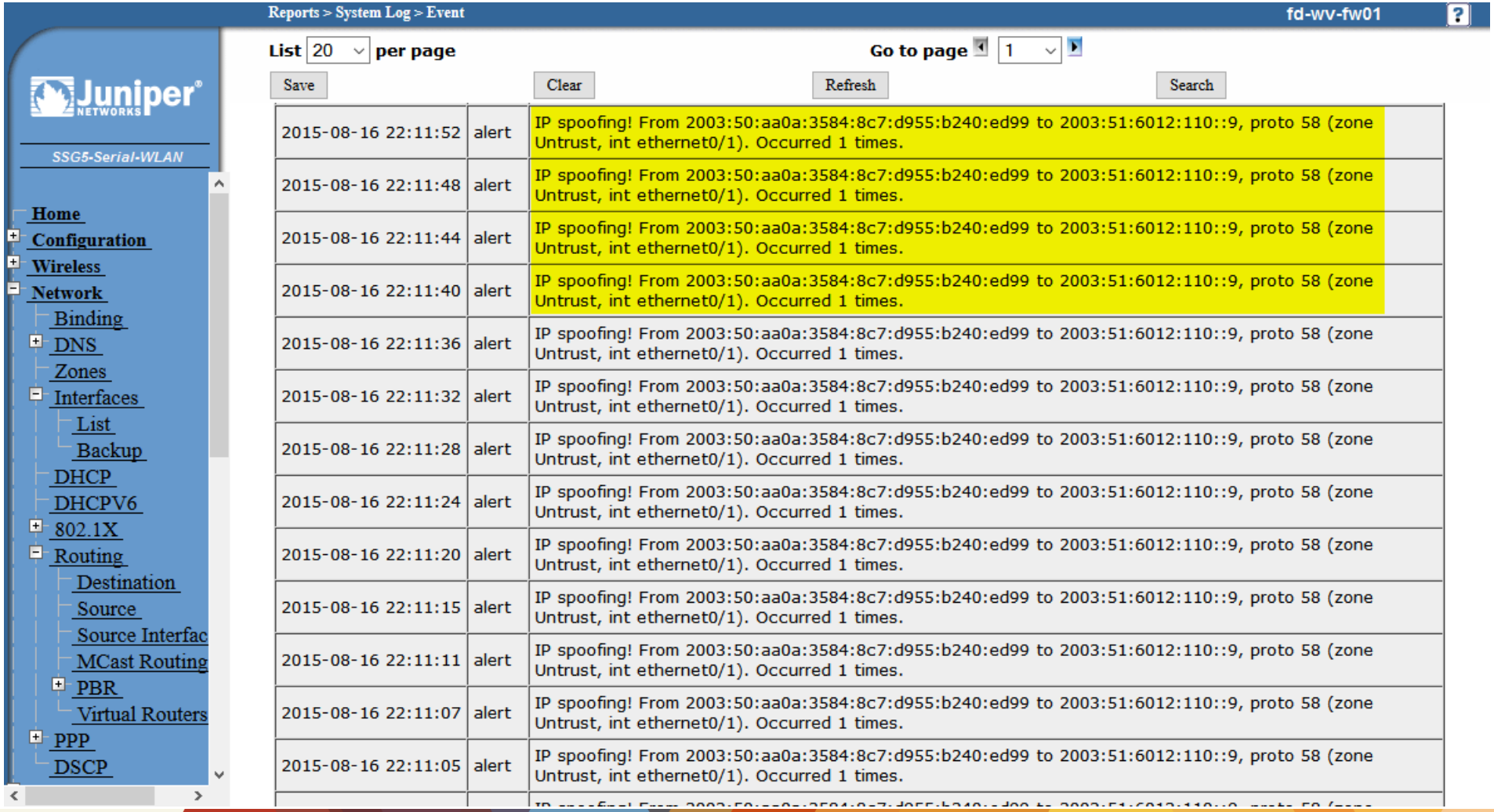


Deleted Remote Policy -> Still HQ Policy/uPRF

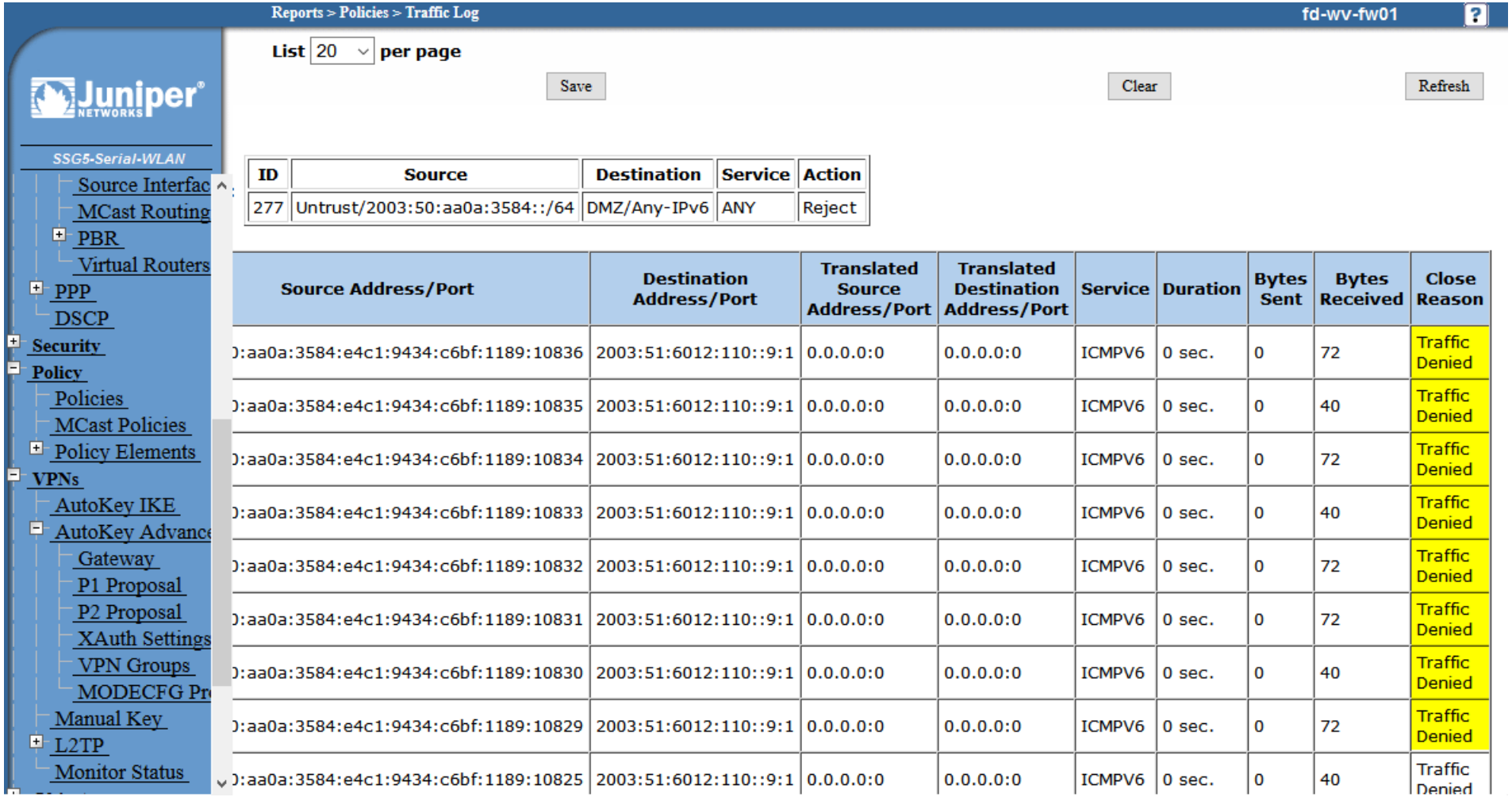
- Route and deny policy are deleted on remote site
- HQ still blocks connections

```
C:\Users\Johannes Weber>tracert -d lx.webernetz.net
Routenverfolgung zu jw-nb12.webernetz.net [2003:51:6012:110::9]
über maximal 30 Hops:

  1     1 ms     1 ms     1 ms  2003:50:aa0a:3584::1
  2     3 ms     3 ms     3 ms  2003:0:1301:4205::1
  3     7 ms     4 ms     5 ms  2003:0:1301:4238::2
  4     6 ms    18 ms    16 ms  2003:0:1302:403::1
  5     3 ms     3 ms     3 ms  2003:0:1302:403::2
  6     *        *        *     Zeitüberschreitung der Anforderung.
  7     *        *        *     Zeitüberschreitung der Anforderung.
  8     *        *        *     Zeitüberschreitung der Anforderung.
```

Deleted Remote Policy -> Still HQ **uRPF**



Deleted Remote Policy -> Still HQ **Policy**



IPv6 Site-to-Site VPN - Conclusion

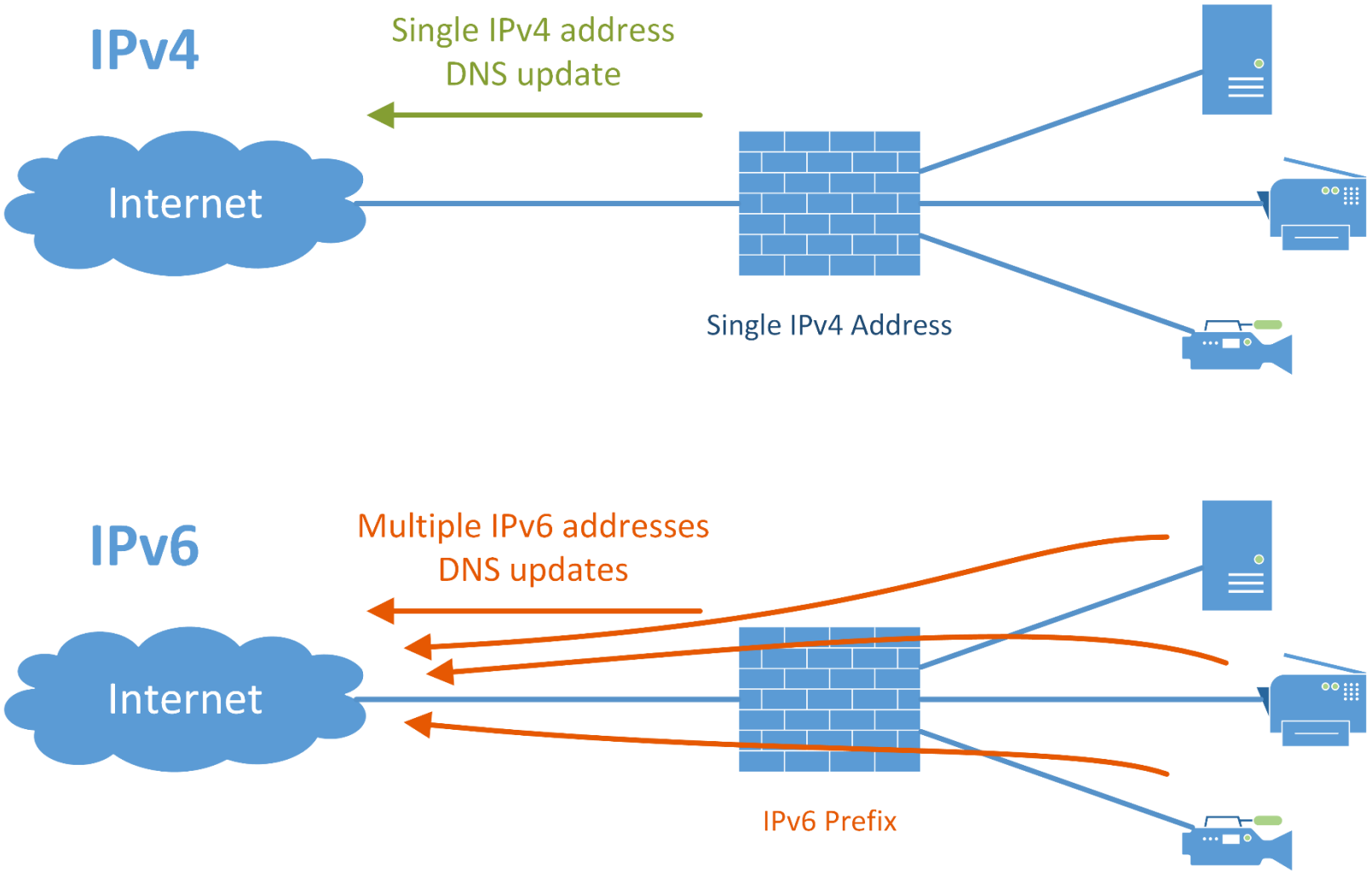
- With these four principles/recommendations it is possible to ensure that IPv6 traffic which should only traverse through a secure VPN connection **won't ever traverse through the Internet**, even in case of a VPN failure on any of those sites.
- They furthermore ensure, **that security is not made only at the network layer (routing), but at a firewall stage (policy)**.
- Questions so far?

Dynamic IPv6 Prefix Problems

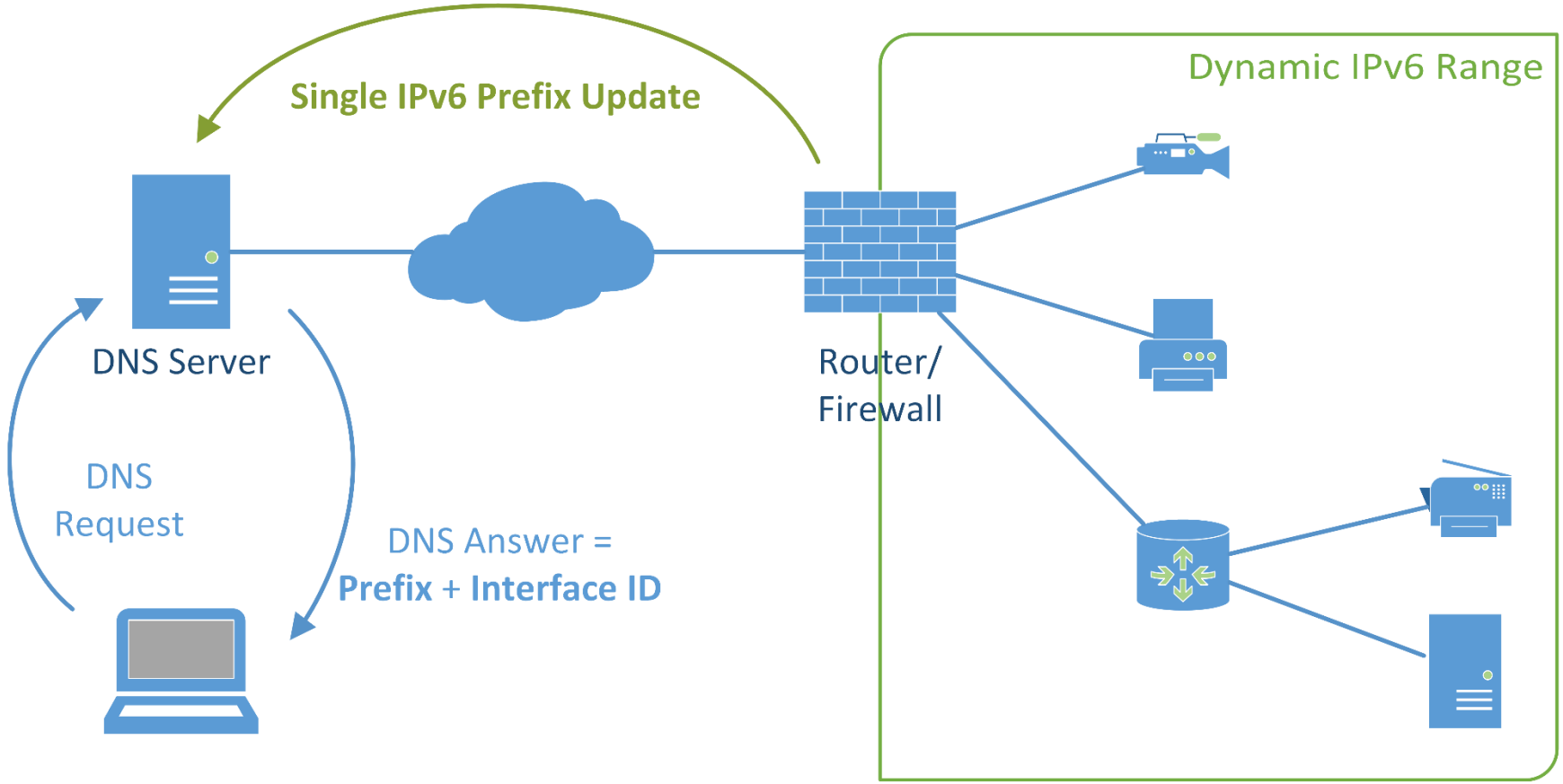
Dynamic Prefix/Address Assumptions

- Quite common on private ISP connections in Germany
- „Zwangstrennung“ every 6 month (formerly every 24 hours)
- And after every reboot of the router
- → Customers are using those cheap ISP connections for home offices, trade fairs, mobile stands, distributed disaster recovery offices, …
- And of course: IT admins at home ;)
- For the remainder of this talk:
  - GUAs, not ULAs (no NAT/NPT/othershit!)
  - Local breakouts (due to bandwidth; NextGen-Firewalls, APT-Sensors)

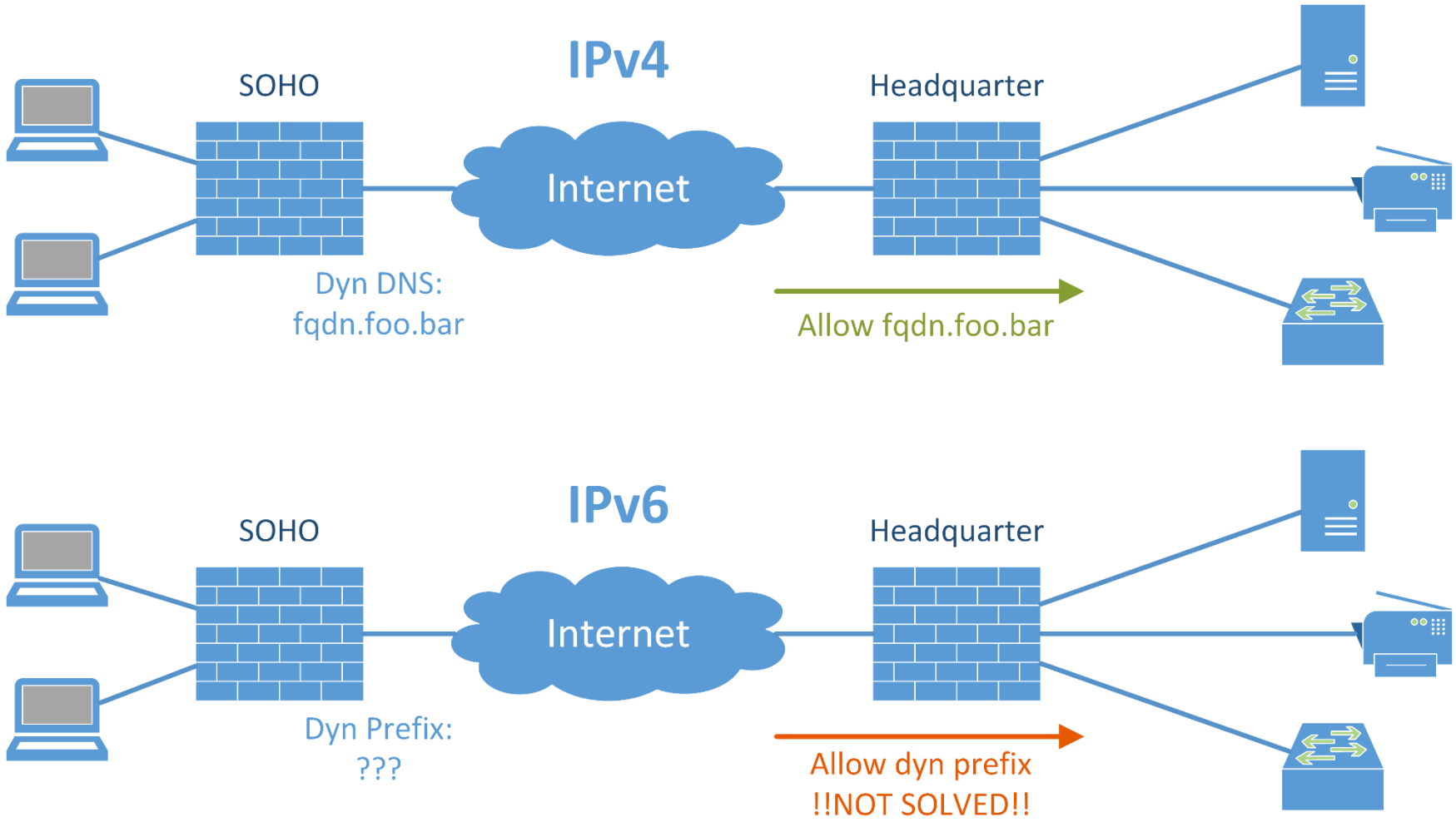
(1) Multiple DNS Updates



(1) Multiple DNS Updates -> Solution?



(2) FQDN-based Security Policies



(2) FQDN-based Security Policies -> Solution?

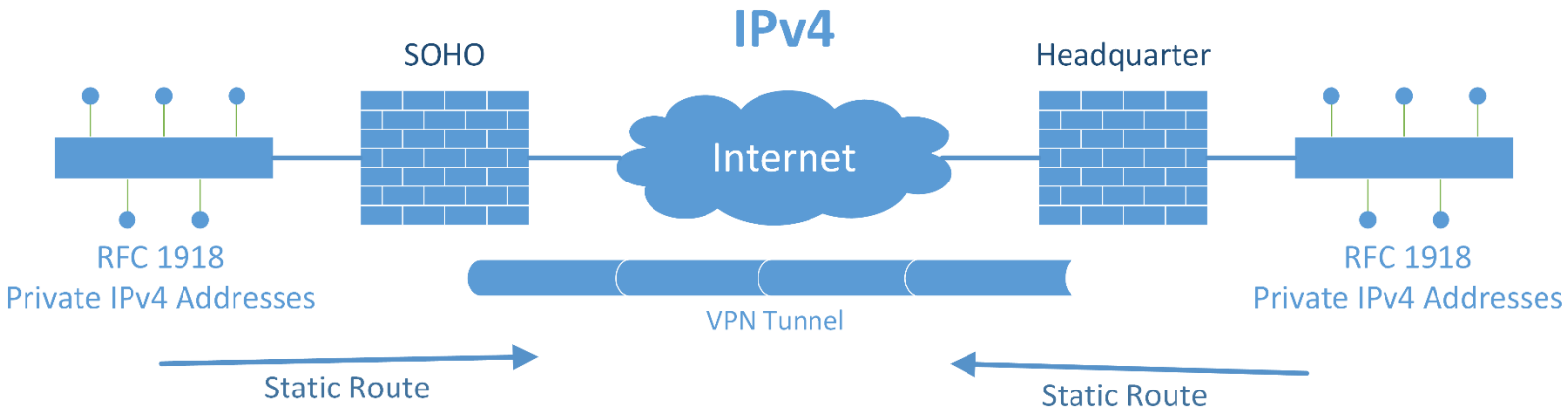
- DNS Resource Records „APL“, Lists of Address Prefixes, RFC 3123
- `ipv6-doc.weberdns.de. IN APL 2:2001:db8::/32`
- Only „experimental“ <- in fact: not used anywhere

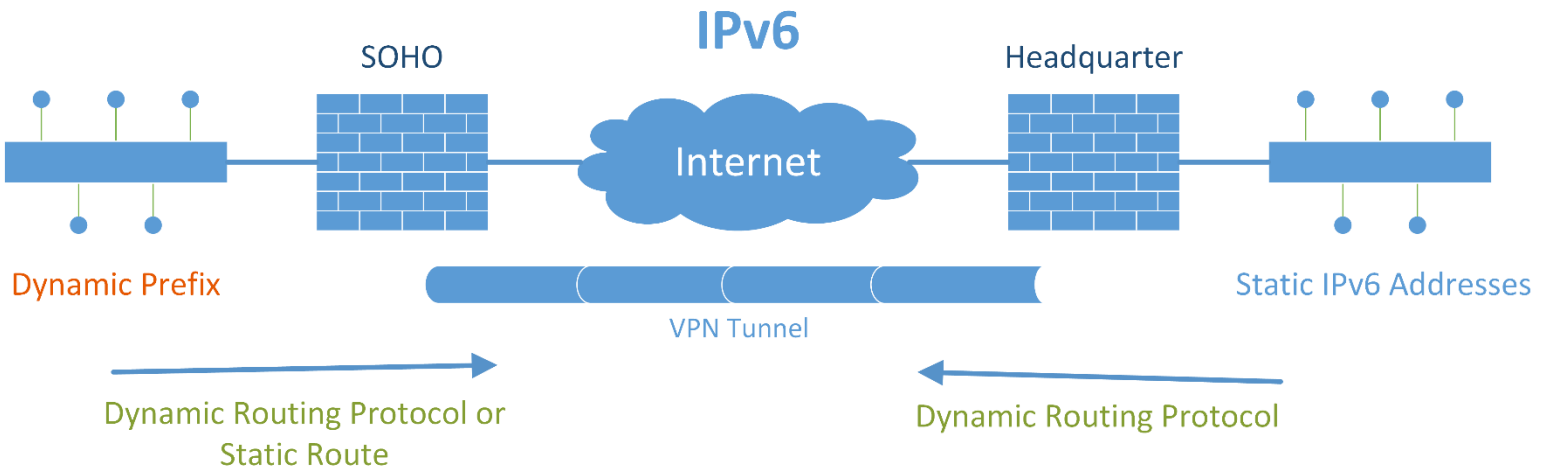
- Small challenge everyone?
- What‘s the APL of `tr18.weberdns.de`?

(2) FQDN-based Security Policies -> Solution?

- Another idea: Shifting the prefix length on FQDN objects
- E.g.: One device updates its /128 IPv6 DNS name
- Firewall interprets this object as a /56
- Not used anywhere, too

(3) Routing into VPN Tunnels & Solution!





(3) Routing into VPN Tunnels Example HQ

IPv6 Routing Table -- trust-vr									
	IP/Prefix	Gateway	Interface	Protocol	Preference	Metric	Vsys	Description	Configure
*	2003:51:6012:140::/64	2003:51:6012:101::4	ethernet0/6	S	20	1	Root		Remove
*	::/0	2003:51:6012::1	ethernet0/1	SP	20	1	Root		Remove
*	2003:51:6012::2/64	::	ethernet0/1	C			Root		-
*	2003:51:6012::2/128	::	ethernet0/1	H			Root		-
*	2003:51:6012:110::1/64	::	ethernet0/5.10	C			Root		-
*	2003:51:6012:110::1/128	::	ethernet0/5.10	H			Root		-
*	2003:51:6012:101::1/64	::	ethernet0/6	C			Root		-
*	2003:51:6012:101::1/128	::	ethernet0/6	H			Root		-
	2003:51:6012:110::/64	::	ethernet0/5.10	O	60	100	Root		-
	2003:51:6012:101::/64	::	ethernet0/6	O	60	100	Root		-
*	2003:50:aa0c:1300::/64	fe80::fce5:40ff:fe14:1	tunnel.2	O	60	10100	Root		-
*	2003:50:aa0c:1342:b2c6:9aff:fefd:ca97/128	fe80::fce5:40ff:fe14:1	tunnel.2	O	60	10000	Root		-
*	2003:51:6012:102::/64	fe80::21a:6cff:fea1:2b98	ethernet0/6	O	60	200	Root		-
*	2003:51:6012:130::/64	fe80::2a94:fff:fea8:772d	ethernet0/6	O	60	200	Root		-

(3) Routing into VPN Tunnels Example RO

IPv6 Routing Table -- trust-vr									
	IP/Prefix	Gateway	Interface	Protocol	Preference	Metric	Vsys	Description	Configure
*	::/0	fe80::462b:3ff:fe19:300	ethernet0/0	D	252	1	Root		Remove
*	2003:50:aa7f:8c13:b2c6:9aff:fefd:ca80/64	::	ethernet0/0	C			Root		-
*	2003:50:aa7f:8c13:b2c6:9aff:fefd:ca80/128	::	ethernet0/0	H			Root		-
*	2003:50:aa0c:1300:b2c6:9aff:fefd:ca8c/64	::	bgroup1	C			Root		-
*	2003:50:aa0c:1300:b2c6:9aff:fefd:ca8c/128	::	bgroup1	H			Root		-
	2003:50:aa0c:1300::/64	::	bgroup1	O	60	100	Root		-
*	2003:51:6012:101::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10100	Root		-
*	2003:51:6012:110::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10100	Root		-
*	2003:50:aa0c:1342:b2c6:9aff:fefd:ca97/64	::	wireless0/2	C			Root		-
*	2003:50:aa0c:1342:b2c6:9aff:fefd:ca97/128	::	wireless0/2	H			Root		-
	2003:50:aa0c:1342:b2c6:9aff:fefd:ca97/128	::	wireless0/2	O	60		Root		-
*	2003:51:6012:102::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10200	Root		-
*	2003:51:6012:130::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10200	Root		-
*	2003:51:6012:160::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10200	Root		-
*	2003:51:6012:180::/64	fe80::d2fc:c0ff:fe14:2	tunnel.1	O	60	10110	Root		-

(3) Routing into VPN Tunnels & Solution?

- Another possible solution: Two prefixes on the link
  - A) dynamic prefix from the ISP
  - B) static prefix from the HQ through VPN tunnel
  - But „Source-Address-Dependet Routing“ brings other problems! (RFC 8043)
- Or: ULAs with NPT

Dynamic IPv6 Prefix Probems - Conclusion

- Yes, IPv6 solves the address problem
- Yes, you can greatly structure your address plan
- BUT: Common workarounds for „dynamic IPv4 addresses“ do NOT work for „dynamic IPv6 prefixes“!

Dynamic IPv6 Prefix Probems - Conclusion

- → Go for static/persistent IPv6 prefixes!
- At least in customer environments
- If not: you have to deal with it ;(
- RIPE 690 Best Current Operational Practice for Operators:
  - "Non-persistent prefixes are considered **harmful** in IPv6 as you can't avoid issues that may be caused by simple end-user power outages, so assigning **persistent prefixes** is a safer and simpler approach."
  - "Trying to deploy new services or applications with non-persistent prefixes is always **more difficult and costly**, and will increase time spent on troubleshooting.“
- → Go for static/persistent IPv6 prefixes!

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Questions? Comments?

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