DNSSEC Support by Home Routers in Germany

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Content

- Motivation / BSI activities
- Previous Tests
- Objectives
- Test Methodology / Testbed
- Reviewed Devices
- Results
- Conclusions

Motivation / BSI-Activities

- DNS is crucial part of Internet-infrastructure
- Vulnerable by design
- DNSSEC helps to improve the security of the internet
- Adoption of DNSSEC strongly required from BSI point of view
- Launch of DNSSEC-Initiative by DENIC, eco (german provider association) and BSI to evaluate the introduction of DNSSEC for .de domains
    - DENIC: Provision of test environment for collecting and reviewing operational and technical experiences
- Raising awareness, discussions with public and private sector, universities
- German government domain “.bund.de” was signed a few weeks ago
- Home router study

Previous Tests

- Origin in 2007:

  DNSSEC-signed zones were suddenly unreachable for some users in Sweden

  → Reason: Some Home Routers couldn't handle DNSSEC-Flags
- Tests of Home Router capabilities in Sweden (Feb. 2008) and GB (Sept. 2008) followed
  - Findings:
    - Only few devices could **proxy** DNSSEC queries without limitations
    - Most devices could **route** DNSSEC queries to upstream resolvers
  - Tested devices mostly relevant for Swedish / British market
  - Further development / technical progress since 2008 ?
  - Specification of IETF RFC 5625 „DNS Proxy Implementation Guidelines“
- → Necessity to examine the situation in Germany

Objectives of BSI-Study

- Assess router support for DNS queries relating to DNSSEC-signed domains
  - Is the router able to **proxy** DNSSEC requests ?
  - Is the router able to **route** DNSSEC requests ? (Bypassing the integrated DNS-Proxy)
- In detail:
  - Handling of Signaling-Flags (D0, AD, CD), introduced with DNSSEC
  - Handling of UDP-Packets > 512 Byte (EDNS0 Support)
  - TCP-Fallback
- Other security issues, i.e. factory security settings for Wireless-LAN

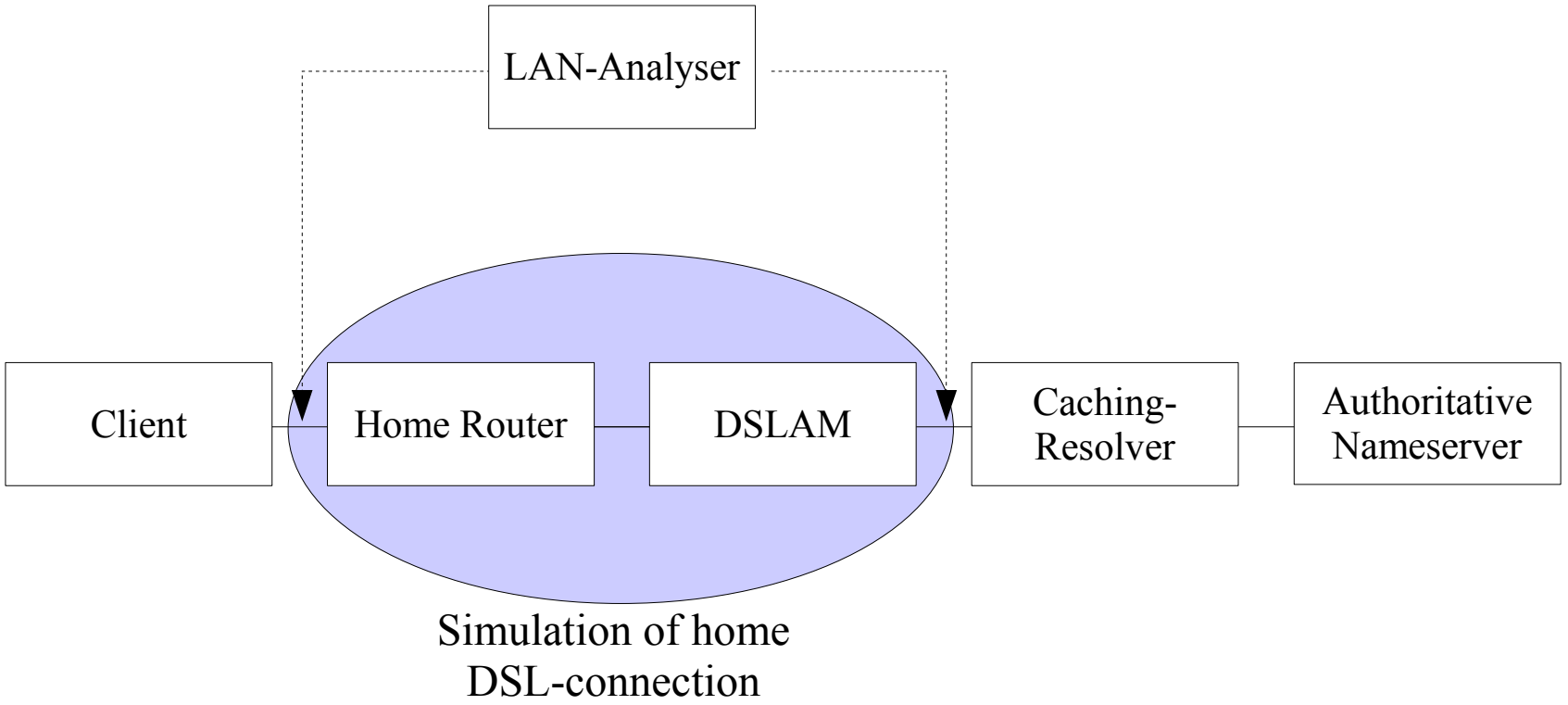
- Study published under
  https://www.bsi.bund.de/cae/servlet/contentblob/995592/publicationFile/63661/DNSSEC_pdf.pdf

Test Methodology

- Several DNS queries of various Resource Records to examine capabilities
  - UDP and TCP-based queries
  - EDNS0 queries with various buffer sizes
  - Resource Records with various length
  - Signed and unsigned Resource Records
  - Use of DNSSEC-related flags
- Using and bypassing of internal DNS-proxy

Testbed

- DNS-client
- DNSSEC-aware caching-resolver
- DSLAM
- Authoritative nameserver



- N.B.: Internet-based tests not reliable, i.e. due to lack of configuration parameter for queried caching-resolver

Reviewed Devices

- 36 devices tested
- Thereof 23 with integrated DSL-modem
- Study considers about 90% of home routers supplied by broadband providers
- BUT: No representative study
- Support by different ISPs (20 devices) and manufacturers (no hidden study)
- Additionally: Tests of some devices from German “free market”
- Each router was tested in supplied condition with factory defaults

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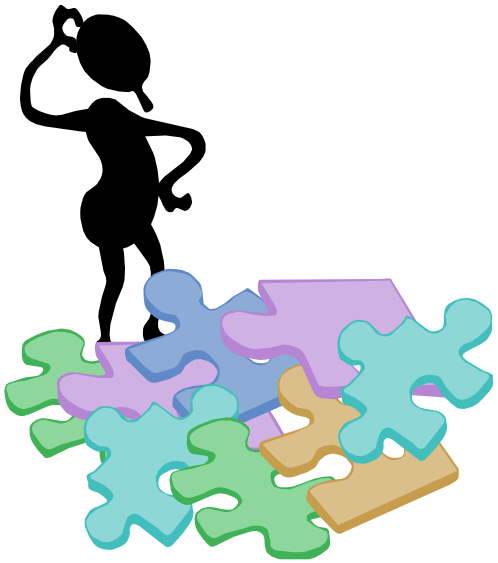
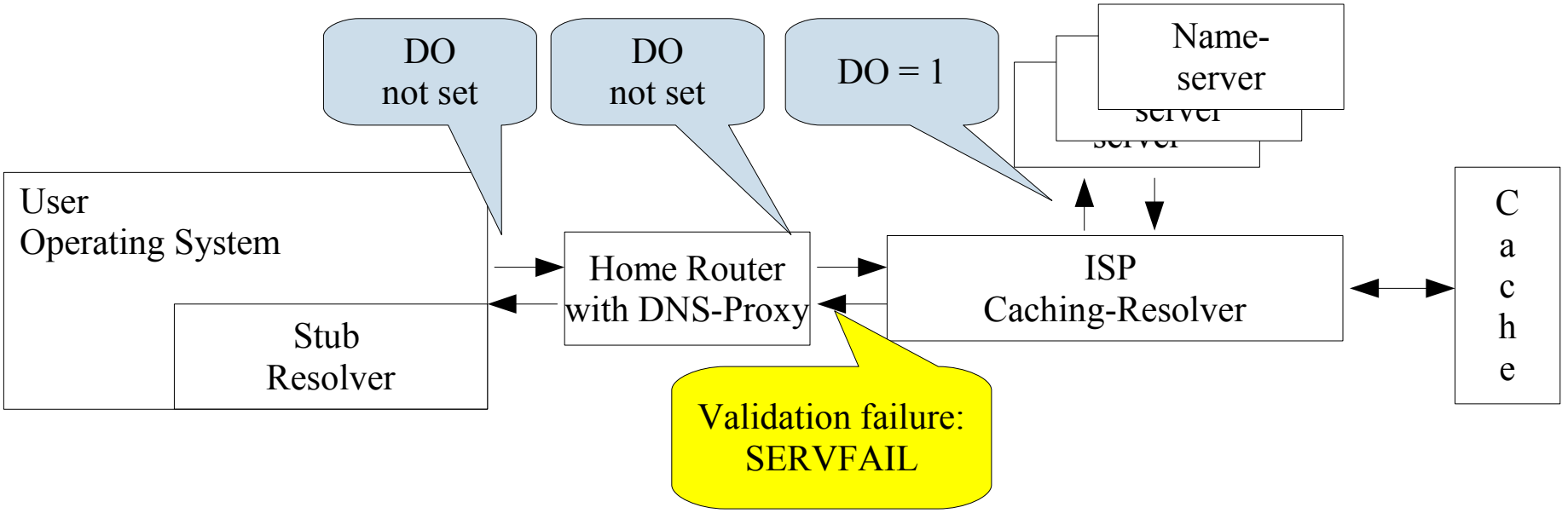


Test scenarios
1. Proxy DNS queries

- DNSSEC-validation by caching-resolver of ISP
  - → Client queries DNS-proxy of home router without setting of DNSSEC-bits
  - → DNS-caching-resolver answers with SERVFAIL or NXDOMAIN if validation fails
  - → No modification of hard- and software from user needed



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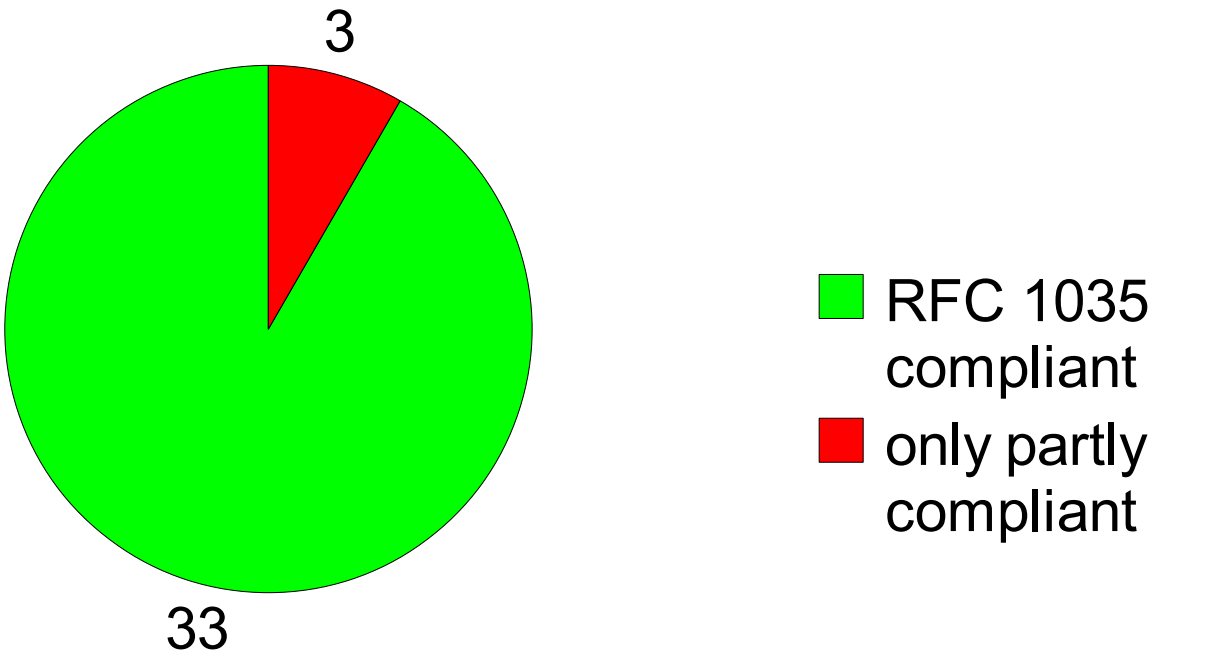
Test Results
DNS-proxy: RFC-1035 Compliance

Can the router proxy standard DNS queries over UDP ?



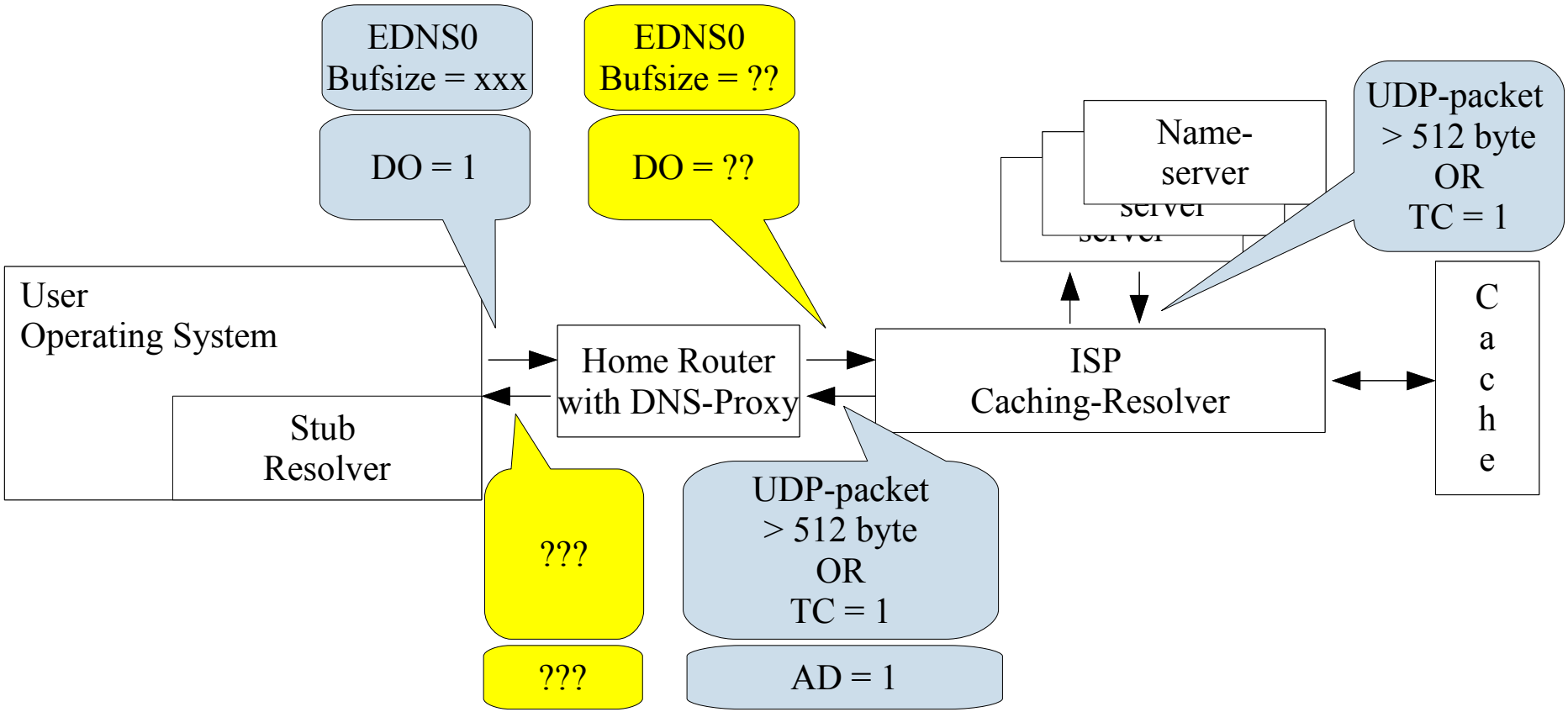
- 3 devices could not handle all Resource Records (RR) types
- Excluded from further proxy-tests

Test scenarios
2. Proxy DNSSEC queries

- DNSSEC-validation by caching-resolver of ISP

  → Client is DNSSEC-aware and sets DO

  → DNS-caching-resolver delivers signatures and sets AD in case of successfully validated domain



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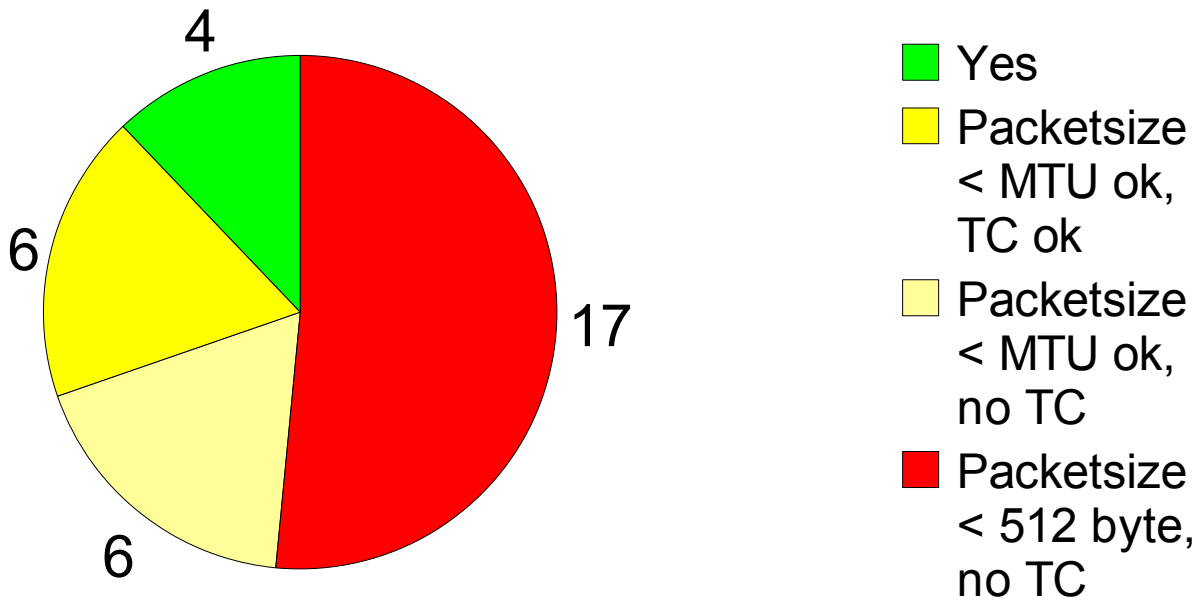
Test Results
EDNS0-Support

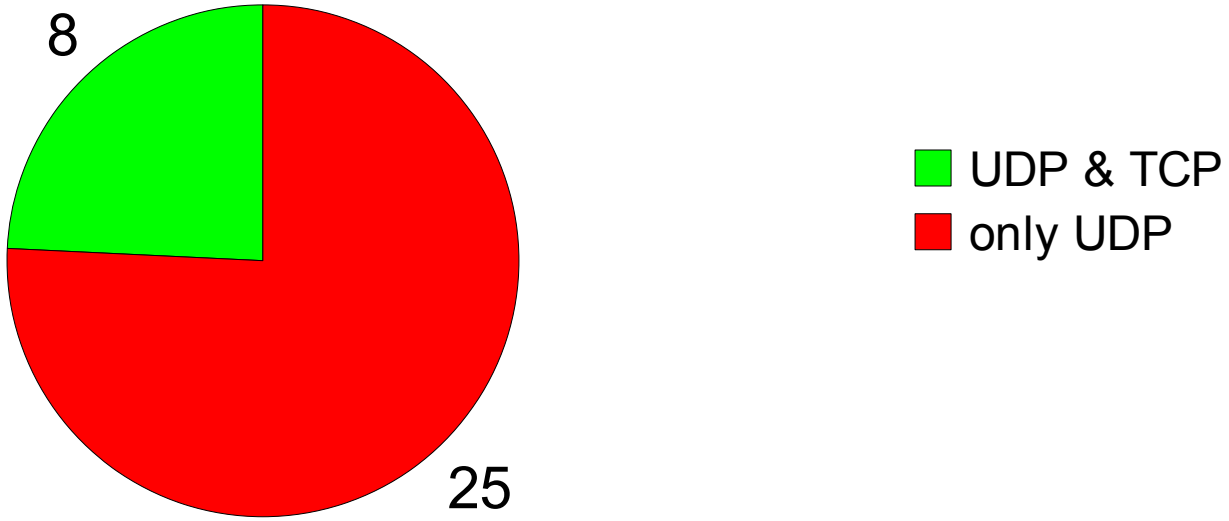
Can the router proxy DNS queries over UDP using EDNS0 ?



- Main problems:
  - Packets were discarded
  - TC was not set or passed through

Test Results
TCP-Support

Does the router accept DNS queries over TCP?



- Only 8 DNS-proxies accept DNS queries over TCP

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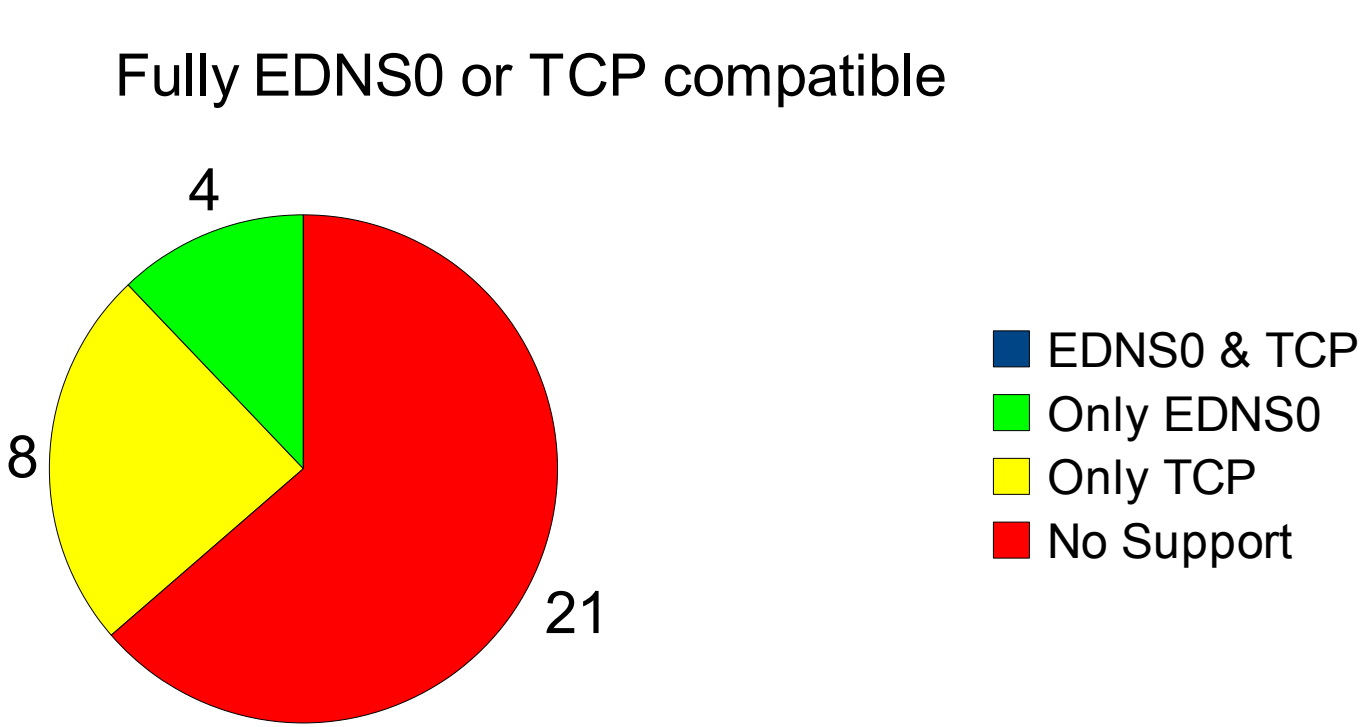
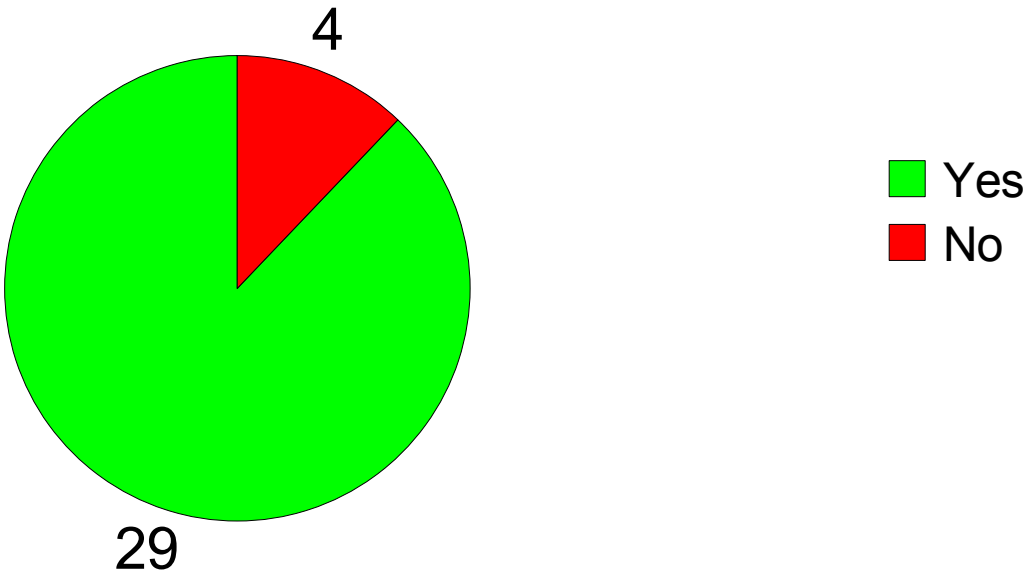
Test Results
EDNS0 or TCP Compatibility



- No integrated DNS-proxy supported both EDNS0 and TCP

Test Results
DNSSEC-Flags Compatibility

Can the router proxy DNS(SEC) queries
that set DNSSEC-related flags ?



- Most devices can handle DNSSEC-flags
- 3 devices modify DNSSEC-flags
- 1 device returns „Connection Timeout“ with AD or CD set

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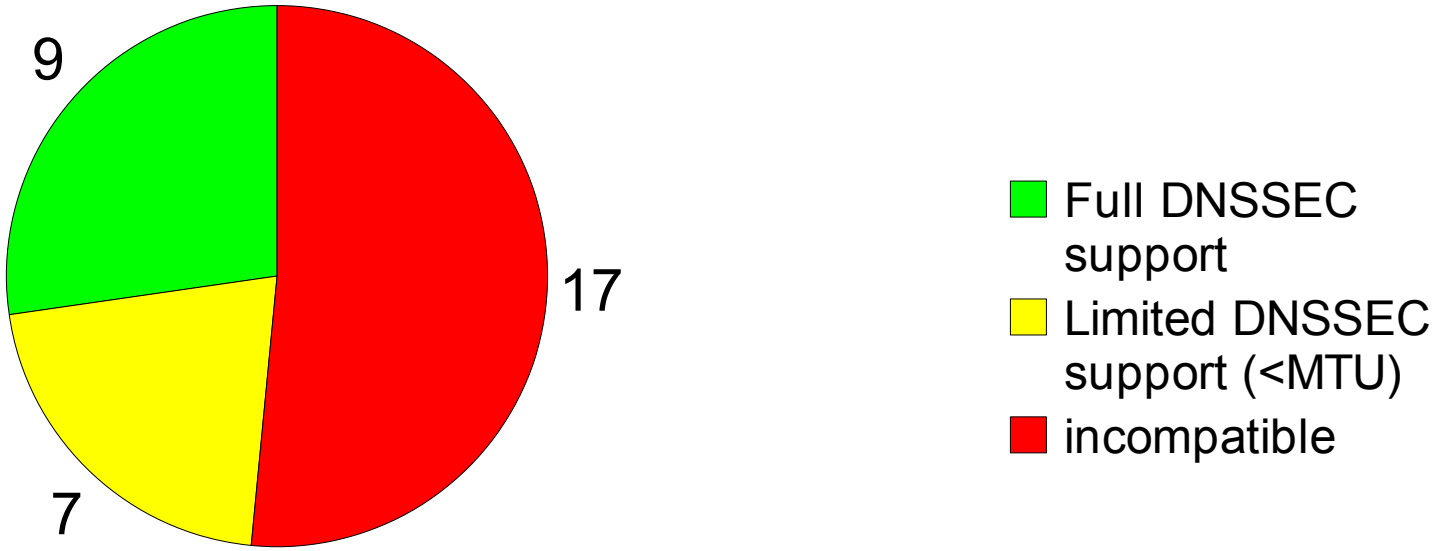
Test Results
DNS-Proxy DNSSEC Support

Overall DNSSEC-compatibility of DNS-proxy



- Only 9 of 33 tested DNS-proxy implementations fully support DNSSEC
- Additionally, 7 devices have limited support (Answering packet size < MTU-size)

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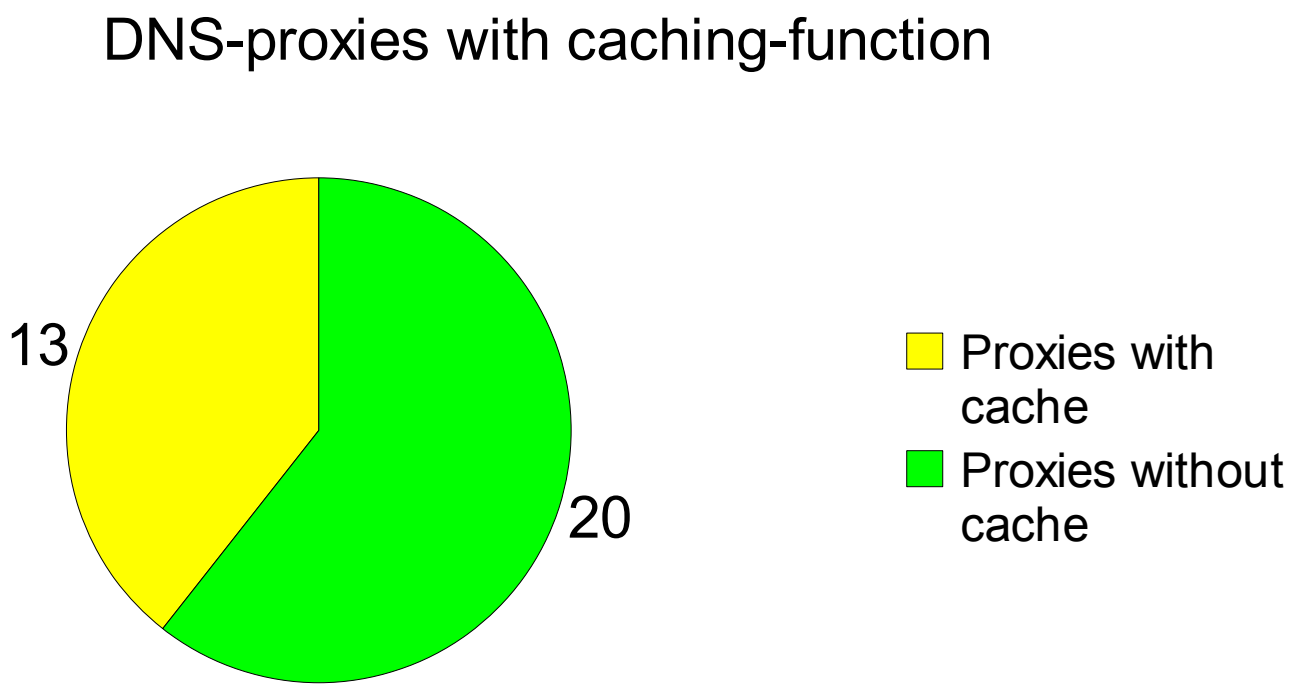
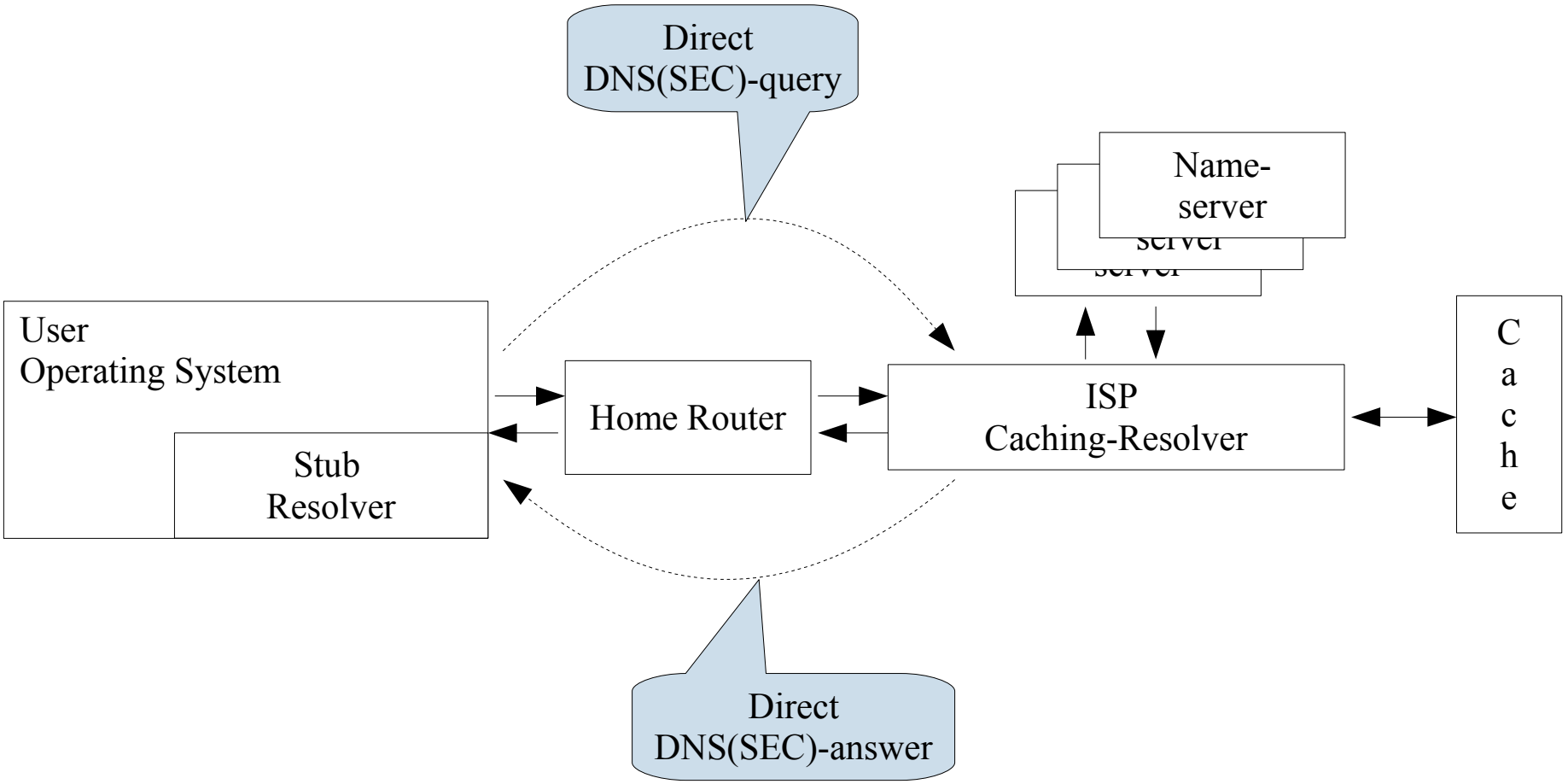
Test Results
Proxy & Caching



- All proxies with caching-function had problems to distinguish between DNSSEC and non-DNSSEC queries. That leads to problems in mixed environments.

Test scenarios
3. Route DNS(SEC)-Queries

- Direct DNSSEC-queries to ISP caching-resolver



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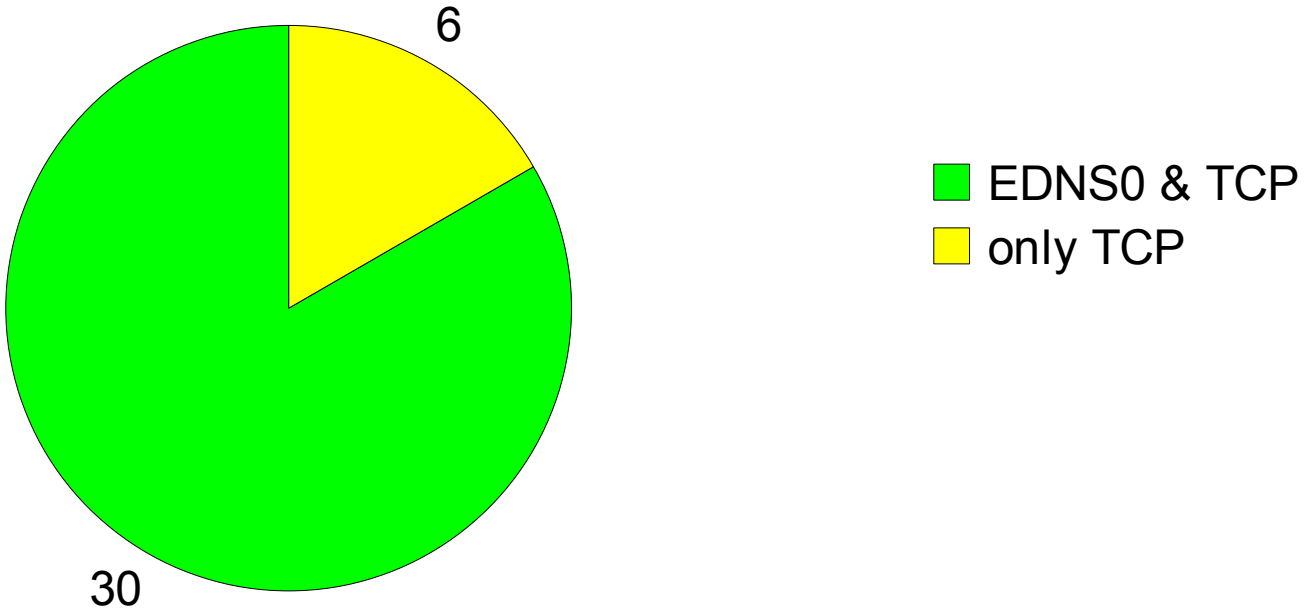
Test Results
Bypass of DNS Proxy

Can the router route DNS(SEC) queries
with set of DNSEC-related flags and use of EDNS0?



- All tested devices fully support DNSSEC when the implemented DNS-proxy is bypassed
- 6 of the tested devices only via TCP-fallback, due to routing limitations with fragmented packets

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Test Results
Configuration of DHCP DNS parameters

- With LAN DHCP defaults many (30) devices supply themselves as the local DNS
- Some (5) devices supply the ISP's DNS address, inherited from WAN link
- Unfortunately 6 devices with a DNSSEC incompatible DNS-Proxy have no DHCP configuration option

	Manual configuration of DHCP DNS parameters possible	Manual configuration of DHCP DNS parametes **not** possible
Integrated DNS-proxy DNSSEC-capable	9 (Default proxy: 9) (Default ISP: 0)	0
Integrated DNS-proxy with limited DNSSEC-support	7 (Default proxy: 5) (Default ISP: 2)	0
No DNSSEC-support by integrated DNS-proxy	11 (Default proxy:10) (Default ISP: 1)	6 (Default proxy: 5) (Default ISP: 1)
Incomplete DNS-proxy implementation	2 (Default proxy:1) (Default ISP: 1)	1 (no DHCP)

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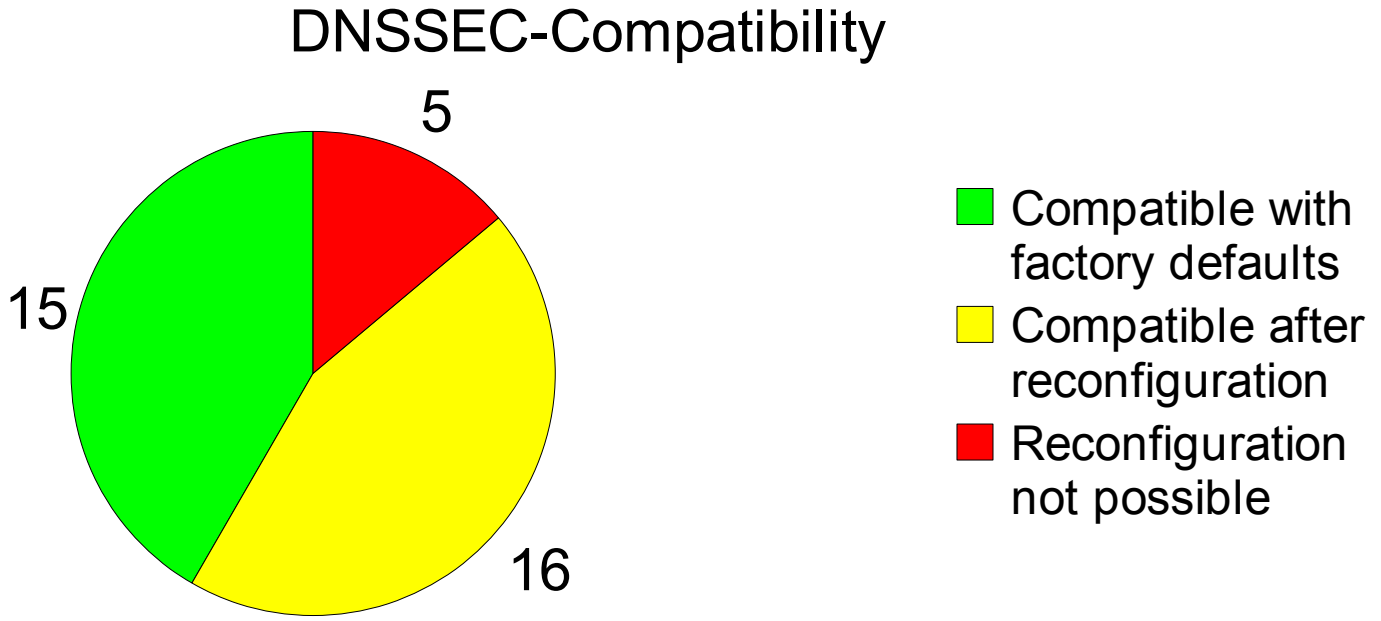
Test Results
DNSSEC-Compatibility



- 15 devices are DNSSEC-compatible with factory defaults, due to the fact that either the implemented DNS-proxy fully supports DNSSEC or they provide the ISP's DNS-server settings via DHCP
- 16 devices can be reconfigured to provide the ISP's DNS-server settings via DHCP
- 5 devices lack reconfigurable DHCP DNS parameters

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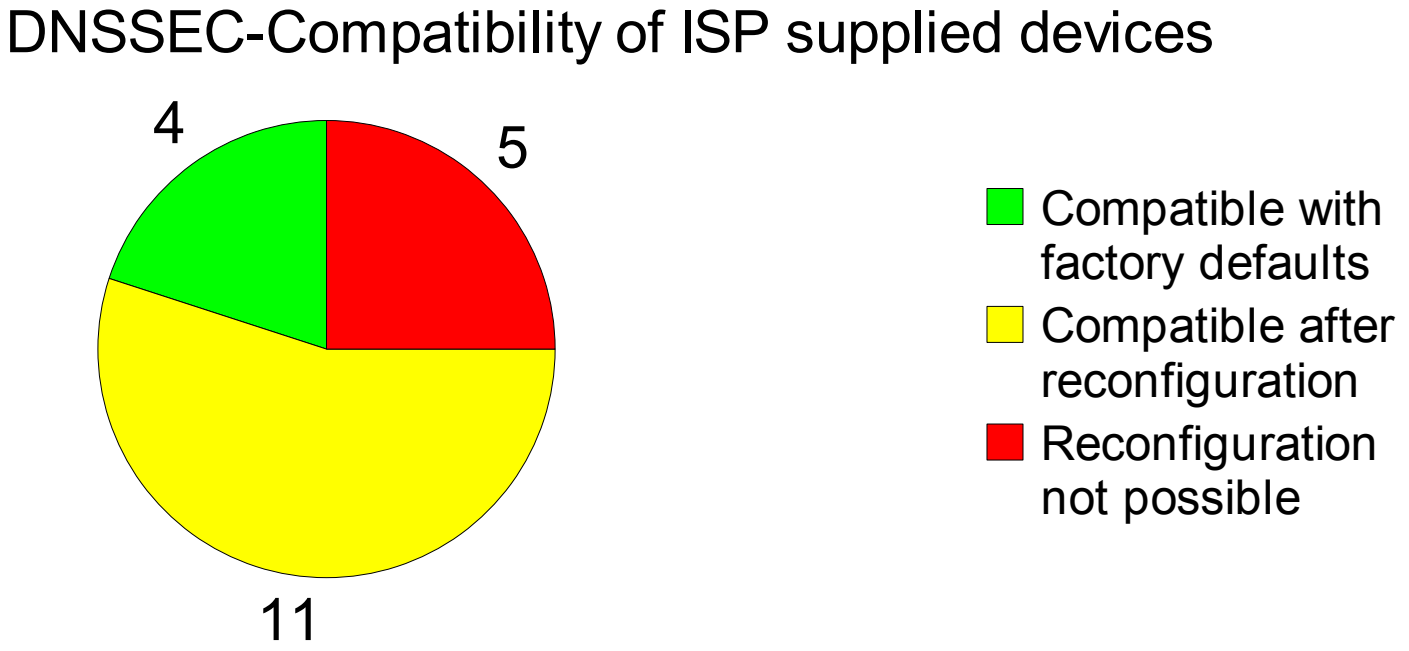
Test Results
DNSSEC-Compatibility (ISP devices only)



- 4 devices are DNSSEC-compatible with factory defaults, due to the fact that either the implemented DNS-proxy fully supports DNSSEC or they provide the ISP's DNS-server settings via DHCP
- 11 devices can be reconfigured to provide the ISP's DNS-server settings via DHCP
- 5 devices lack reconfigurable DHCP DNS parameters

Conclusions

- Non DNSSEC-aware client operating system:
  - No compatibility issues
- DNSSEC-aware client operating system:
  - 15 devices can be used out of the box
  - 16 devices can be reconfigured to be DNSSEC compatible
  - 5 devices lack reconfigurable DHCP DNS parameters
    → individual reconfiguration of DNS settings on each client
- Compatibility issues mostly due to missing EDNS0- and TCP-support of built-in DNS-proxy
  - Only 9 of 36 devices have full DNSSEC proxy support
  - 7 devices have limited DNSSEC proxy support
    (packet size < MTU)

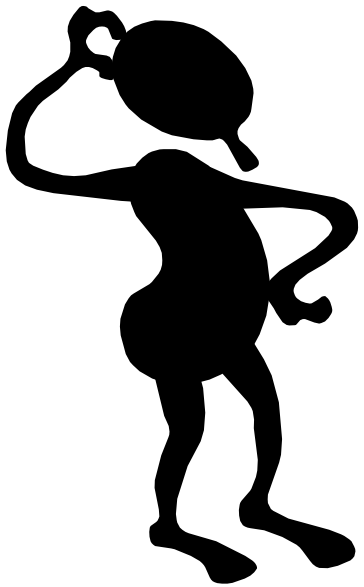
Comparison with .se und .uk studies

	.se	.uk	.de
EDNS0 compatible	3/10	4/22	4/33
TCP-support	3/10	1/22	8/33
DNSSEC-flag support	7/10	16/22	29/33
DNSSEC compatible as router	-	24/24	36/36
DNSSEC compatible with factory settings	3/12 (25%)	6/24 (25%)	15/36 (42%)
DNSSEC compatible after reconfiguration	-	9/24 (38%)	16/36 (44%)

Perspective

- Results were communicated to Manufacturer's and ISP's
- Positive feedback
- One manufacturer already released beta-firmware with improvements
- Others want to adopt recommendations at least in future products

Thanks for your attention!



Questions?

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Contact

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