Measuring the Deployment of DNSSEC over the Internet

System & Network Engineering — Research Project

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What DNSSEC?

DNS

Domain Name System

- Essential foundation of the Internet
- Translates domain names into IP addresses

Problem

DNS is notoriously insecure

Solution: DNSSEC

- Public key cryptography
- Signatures for al resources
- Hierarchical chain of trust

History

DNS Development

1983 DNS specification published

1984 First TLDs defined

1987 DNS becomes IETF standard

DNSSEC Development

1997 DNSSEC specification published

1999 DNSSEC specification revised

2005 DNSSEC final revision

DNSSEC Deployment

2010 Root level deployment

2011 Most TLDs signed

Research scope

Research question

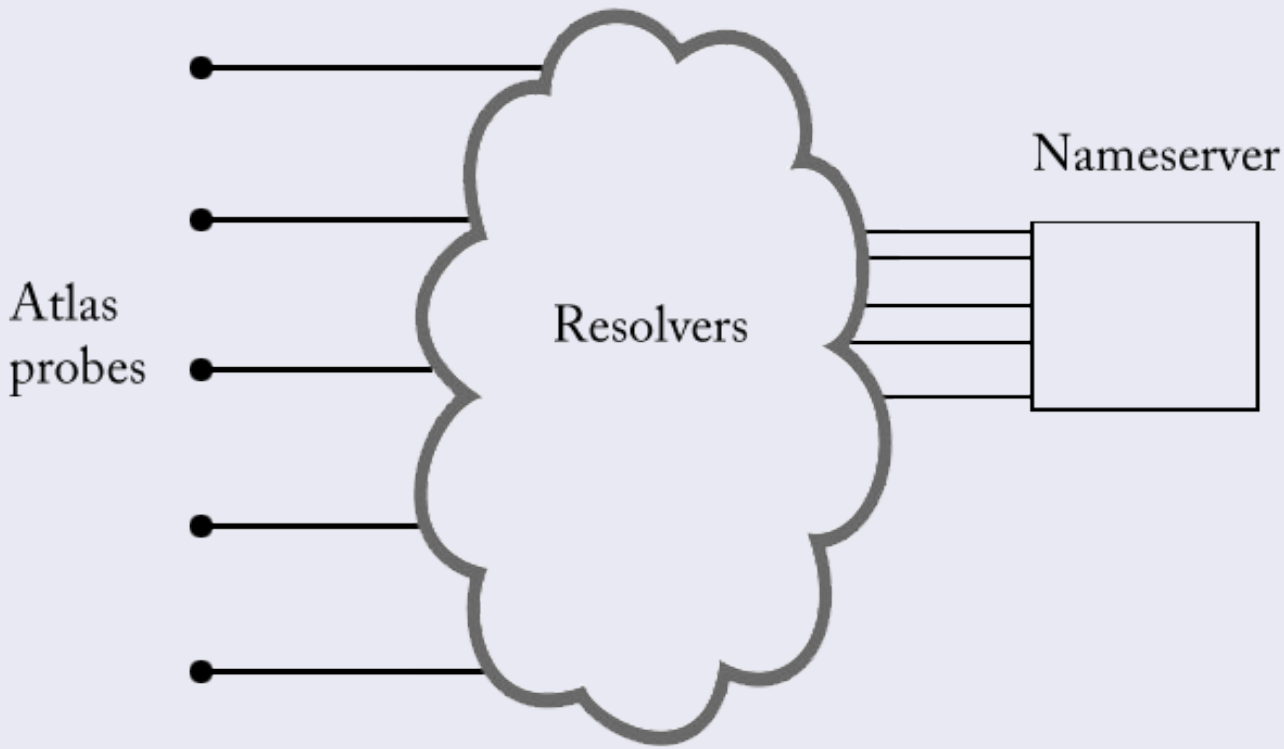
What is the status of DNSSEC deployment over the Internet and how does it impact Internet users?

- Which DNS resolvers can be queried from clients?
- What methods can properly assess DNSSEC support?
- How does DNSSEC support influence user experience?

The Atlas network

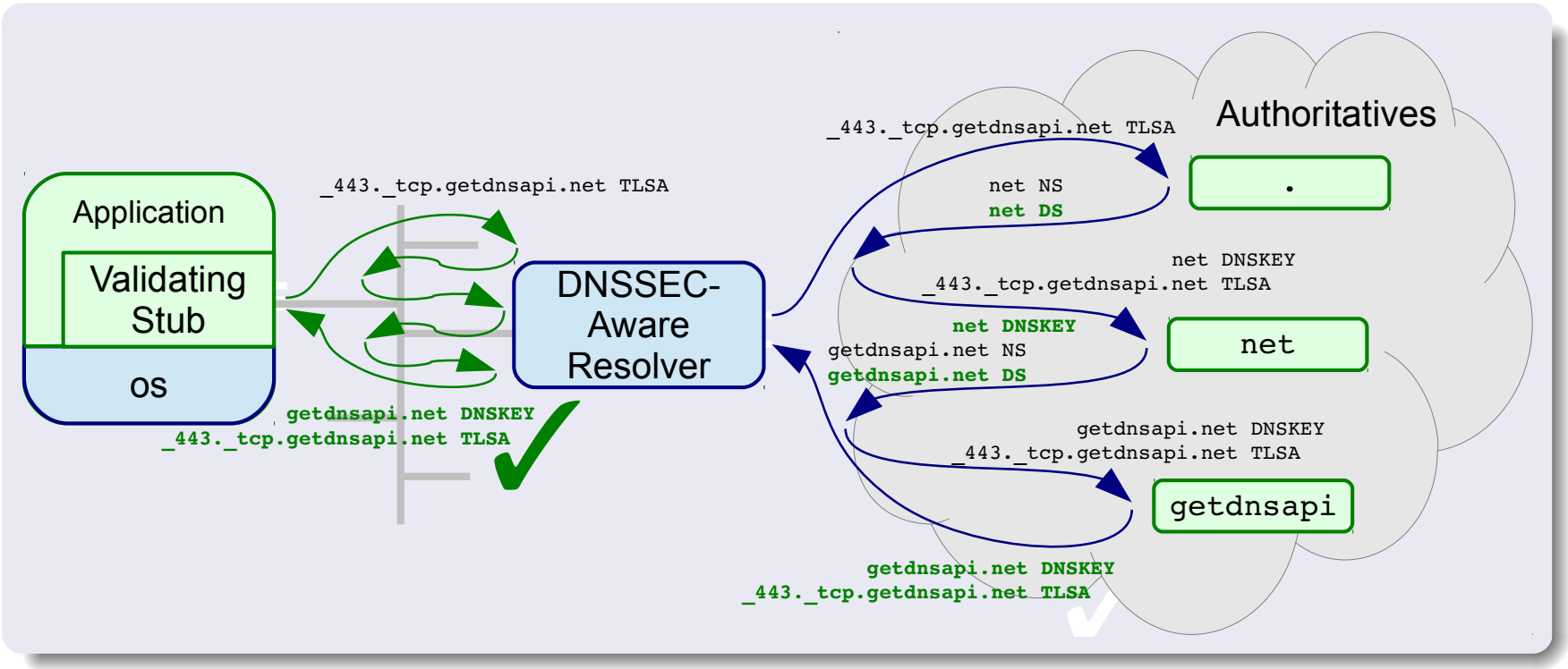
- 6,200 active probes
- Worldwide — mostly Europe

Setup



- Altlas probes: presence in client network
- Controlled nameserver with packet capture

Challenges (1)



- DNSSEC-aware: fetch `DS` and `DNSKEY`
- Client gets data for application-level validation

Challenges (2)

Probes-resolvers

- IP address seen by the probe: `8.8.8.8`
- IP address seen by the nameserver: `74.125.18.209`

Solution: pre-pend probe ID and use wildcards
Probe `1234` requests `1234.example.com`

Resolving setup

- Probes with multiple resolvers
- Probes using forwarders
- Misconfigured resolvers

Limitations

Atlas ≠ Internet

Atlas Top10

Country	Probes
United States	853
Germany	819
Russia	724
United Kingdom	605
Netherlands	457
France	397
Ukraine	364
Belgium	184
Italy	166
Czech Republic	161

Internet Top10

Country	Internet users (in 2012)
China	568,192,066
United States	254,295,536
India	151,598,994
Japan	100,684,474
Brazil	99,357,737
Russia	75,926,004
Germany	68,296,919
Nigeria	55,930,391
United Kingdom	54,861,245
France	54,473,474

Process

Steps

1. List all active probes
2. Start packet capture at the nameserver
3. Launch measurement on Atlas probes
4. Wait for measurement results
5. Stop packet capture
6. Repeat steps 2-5 until all active probes have been used

Zones

`secure` `insecure` `badlabel`, `badrrsigs`, `norrsigs`

Software

Python, `atlas`, `dpkt` `nsd`, `ldns` Wireshark

Resolvers

DO bit support

Requests on TXT record from secure zone with DO bit set

Probes	Resolvers	DO bit	RRSIGs
4673	5139	4534 [88.23%]	3448 [67.09%]

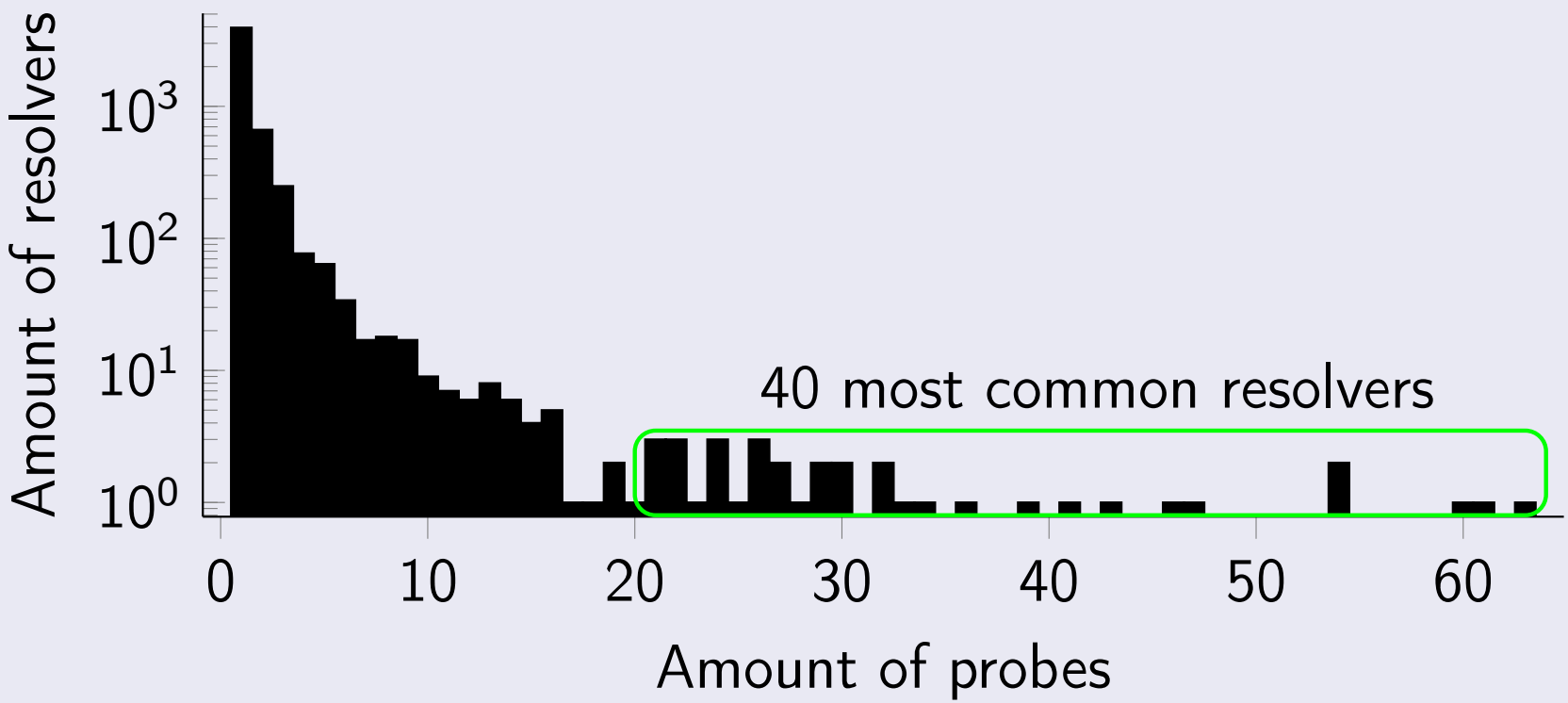
DS type support

Requests on DS record from secure zone with DO bit set

Probes	Answers	AD bit	RRSIGs	No RRSIGs	FORMERR
5602	5323 [95.01%]	1557 [27.79%]	2176 [38.84%]	1590 [28.38%]	268 [4.78%]

DNSSEC-awareness

Resolvers distribution



40 most common resolvers: Google (38), OVH (2)

Validation and protection

Answer

Zone	Probes	Total	AD bit	RRSIGs+NSEC	RRSIGs only	Just answer
secure	5457	5160 [94.55%]	1472 [26.97%]	1109 [20.32%]	967 [17.72%]	1612 [20.54%]
badlabel	5366	3631 [67.66%]	0 [0.00%]	1014 [18.90%]	1004 [18.71%]	1613 [30.06%]
badrrsig	5427	3688 [67.95%]	0 [0.00%]	1017 [18.74%]	1034 [19.05%]	1636 [30.15%]
norrsigs	5491	3754 [68.37%]	0 [0.00%]	0 [0.00%]	0 [0.00%]	3754 [68.37%]

No answer

Zone	Probes	Total	SERVFAIL	FORMERR	Parse Error
secure	5457	297 [5.44%]	12 [0.22%]	263 [4.82%]	100 [1.83%]
badlabel	5366	1735 [32.33%]	1410 [26.28%]	302 [5.63%]	81 [1.51%]
badrrsigs	5427	1739 [32.04%]	1417 [26.11%]	299 [5.51%]	67 [1.23%]
norrsigs	5491	1737 [31.63%]	1416 [25.79%]	306 [5.57%]	20 [0.36%]

Findings

DNSSEC-awareness

- `DO` bit indicates 88%... maybe more
- `DS` type indicates 95%... maybe less

Validation and protection

- `AD` bit indicates 27% validation
- Bad zones indicate 25-26% protection

Information available

- 88-95% can get `DS`
- 65% can get `RRSIG`
- 47% can get `RRSIG` and wildcard `NSEC`

Thanks to...

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Questions?