DNSSEC

DNS SECURITY EXTENSIONS

INTRODUCTION TO DNSSEC FOR SECURING DNS QUERIES AND INFORMATION

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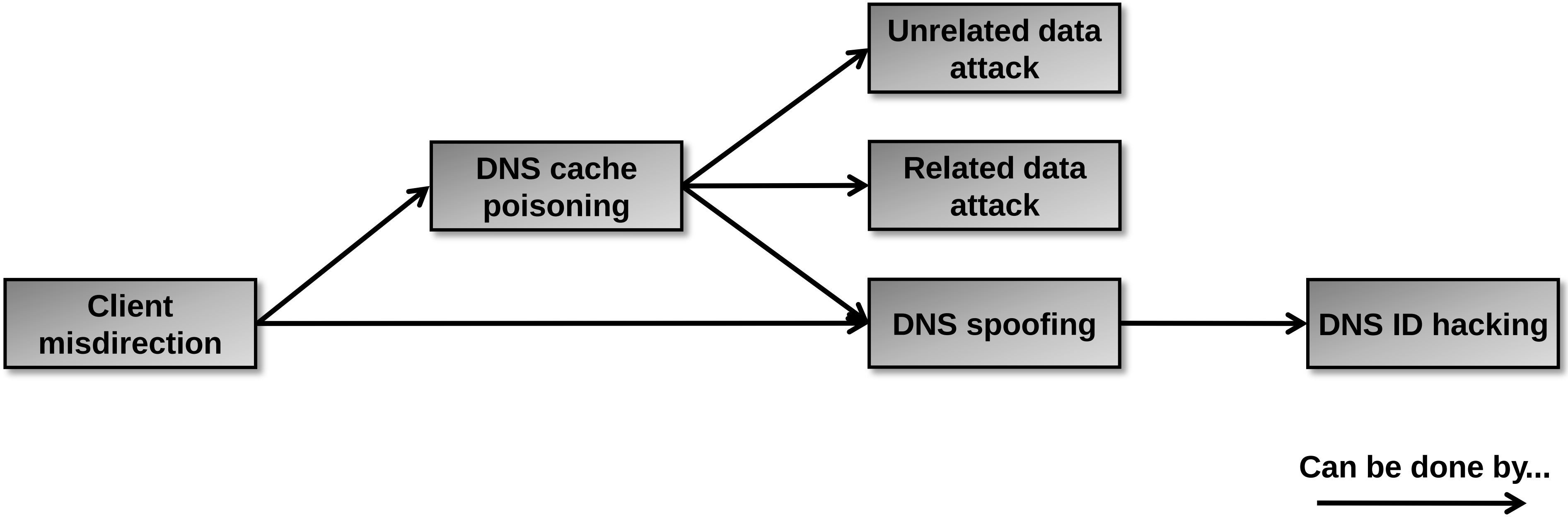
Contents

1. Security Problems of DNS
2. Solutions for securing DNS
3. Security with DNSSEC
4. How to find the signer's public DNS key
5. DNS lookup: Recursive name servers
6. DNSSEC deployment

1. Security problems of DNS (1/3)

DNS is vulnerable to a number of attacks.
The attacks are usually targeted at misdirecting a client to a malicious server under the control of the attacker.

Some attacks are now difficult to conduct since DNS servers like BIND fixed the software.
Still, DNS is too important thus warranting the need for cryptographic protection against poisoning and spoofing.



1. Security problems of DNS (2/3)

DNS Cache Poisoning:

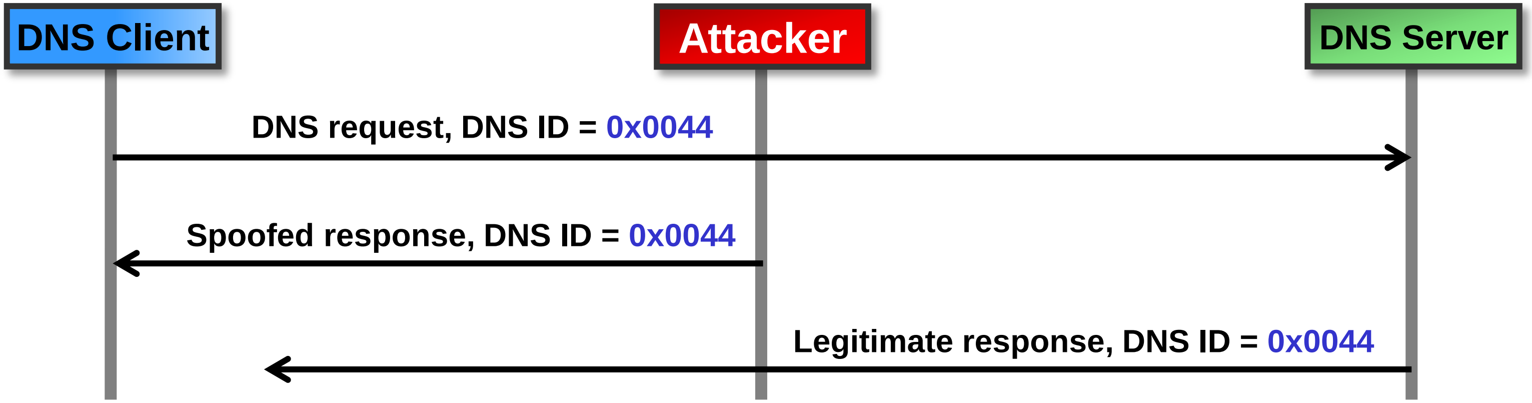
Inject false information into a DNS server's or a client's DNS cache.

DNS spoofing:

In a DNS spoofing attack, an attacker pretends to be a real DNS server and sends a spoofed DNS answer back to the requestor (either a DNS server or a DNS client). The spoofed answer contains a false mapping of the requested name to IP address.

DNS ID hacking:

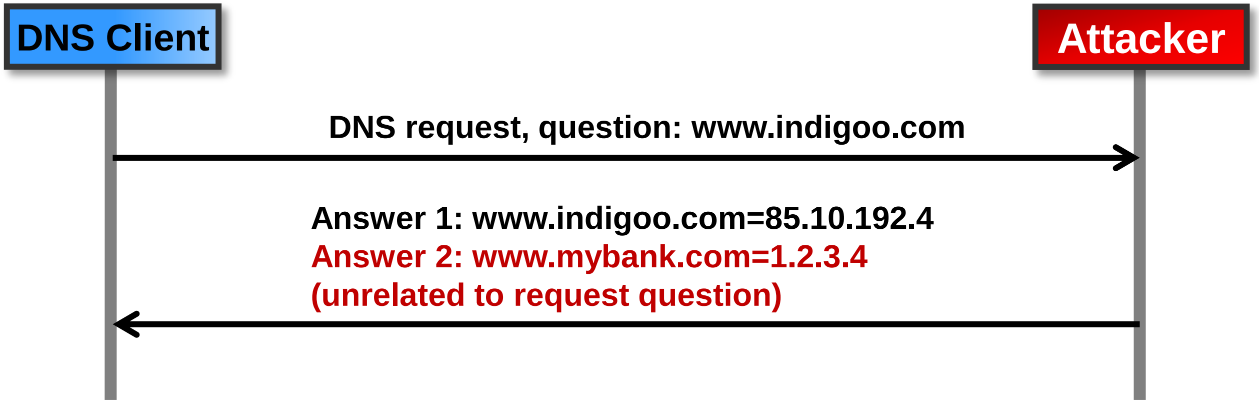
Spoofing requires to match the DNS answer ID with the DNS request ID (DNS transaction ID). Thus the attacker must either intercept the DNS request message or "estimate" the DNS transaction ID in the spoofed response (e.g. in Windows XP the DNS ID is monotonically increasing!).


DNS Client
Attacker
DNS Server
DNS request, DNS ID = 0x0044
Spoofed response, DNS ID = 0x0044
Legitimate response, DNS ID = 0x0044

1. Security problems of DNS (3/3)

Unrelated data attack:

In an unrelated data attack, the attacker sends back an answer to the query question, but adds additional and unrelated IP→name mappings to misdirect the client to a malicious site.


DNS Client
Attacker
DNS request, question: www.indigoo.com
Answer 1: www.indigoo.com=85.10.192.4
Answer 2: www.mybank.com=1.2.3.4
(unrelated to request question)

Related data attack:

A related data attack is similar to an unrelated attack with the difference that the attacker sends extra information related to the query question such as spoofed MX, NS or CNAME records.

Example question:

```
www.indigoo.com
```

Spoofed response with unrelated data:

```
www.indigoo.com. 1D IN NS www.attacker.com
www.attacker.com. 1D IN A 1.2.3.4
```

2. Solutions for securing DNS

TSIG and SIG(0) are older solutions for securing DNS.

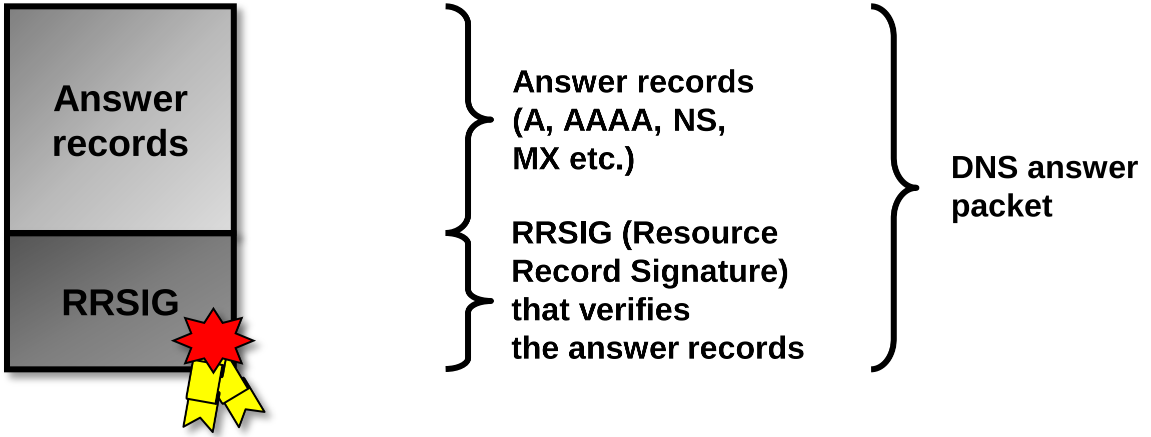
DNSSEC is a comprehensive approach for securing DNS (secure DNS database as well as DNS queries).

It is expected that DNSSEC will become the standard solution for securing DNS.

Protocol	RFC	Protection of transfer of DNS record	Protection of DNS database	Built-in PKI (automated key distribution)	Hash algorithms	Comment
TSIG	*RFC2845*	*Yes*	*No*	*No, but* *TKEY (RFC2930) adds Diffie-Helman to TSIG*	*RSAMD5* *RSASHA1* *RSASHA256*	*Based on MAC (Message Authentication Code).* *Used for protecting zone transfers (widely used).* *No levels of authority (every host with the secret key may update a DNS record).*
SIG(0)	*RFC2931*	*Yes*	*No*	*No*	*RSAMD5* *RSASHA1* *RSASHA256*	*Not widely used.* *Uses digital signature instead of MAC.*
DNSSEC	*RFC4033* *RFC4034* *RFC4035*	*Yes*	*Yes*	*Yes*	*RSAMD5* *DH* *ECC* *RSASHA1*	*Used to secure DNS transactions as well as the DNS database.*

3. Security with DNSSEC

DNSSEC adds a digital signature to the answer records.



Answer records

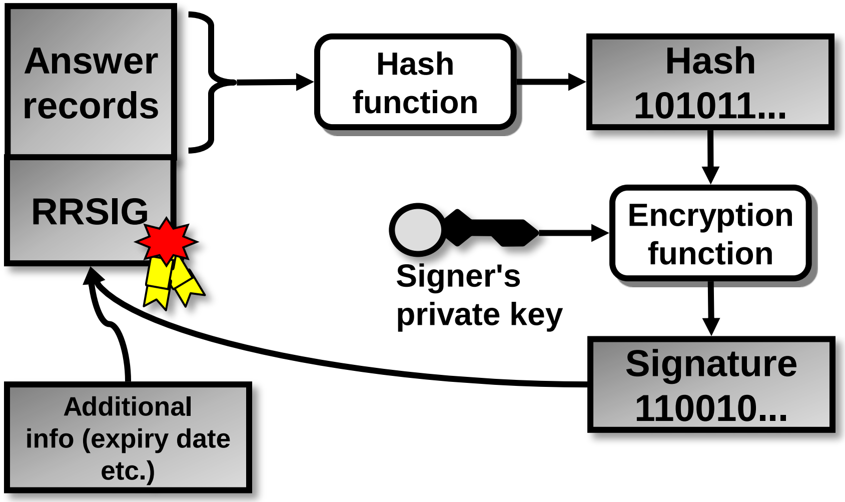
RRSIG

Answer records (A, AAAA, NS, MX etc.)

RRSIG (Resource Record Signature) that verifies the answer records

DNS answer packet

DNS server signing process:



Answer records

RRSIG

Hash function

Hash 101011...

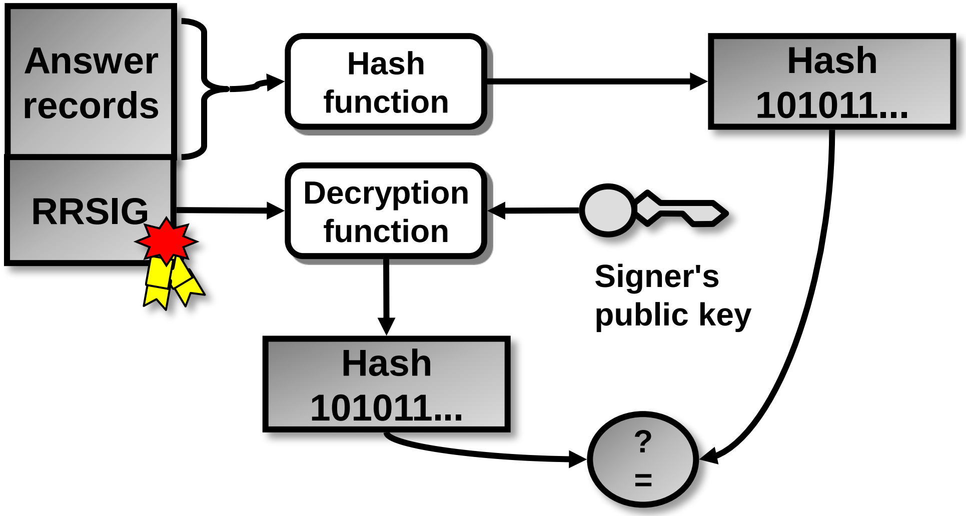
Encryption function

Signer's private key

Signature 110010...

Additional info (expiry date etc.)

DNS resolver verification:



Answer records

RRSIG

Hash function

Hash 101011...

Decryption function

Signer's public key

Hash 101011...

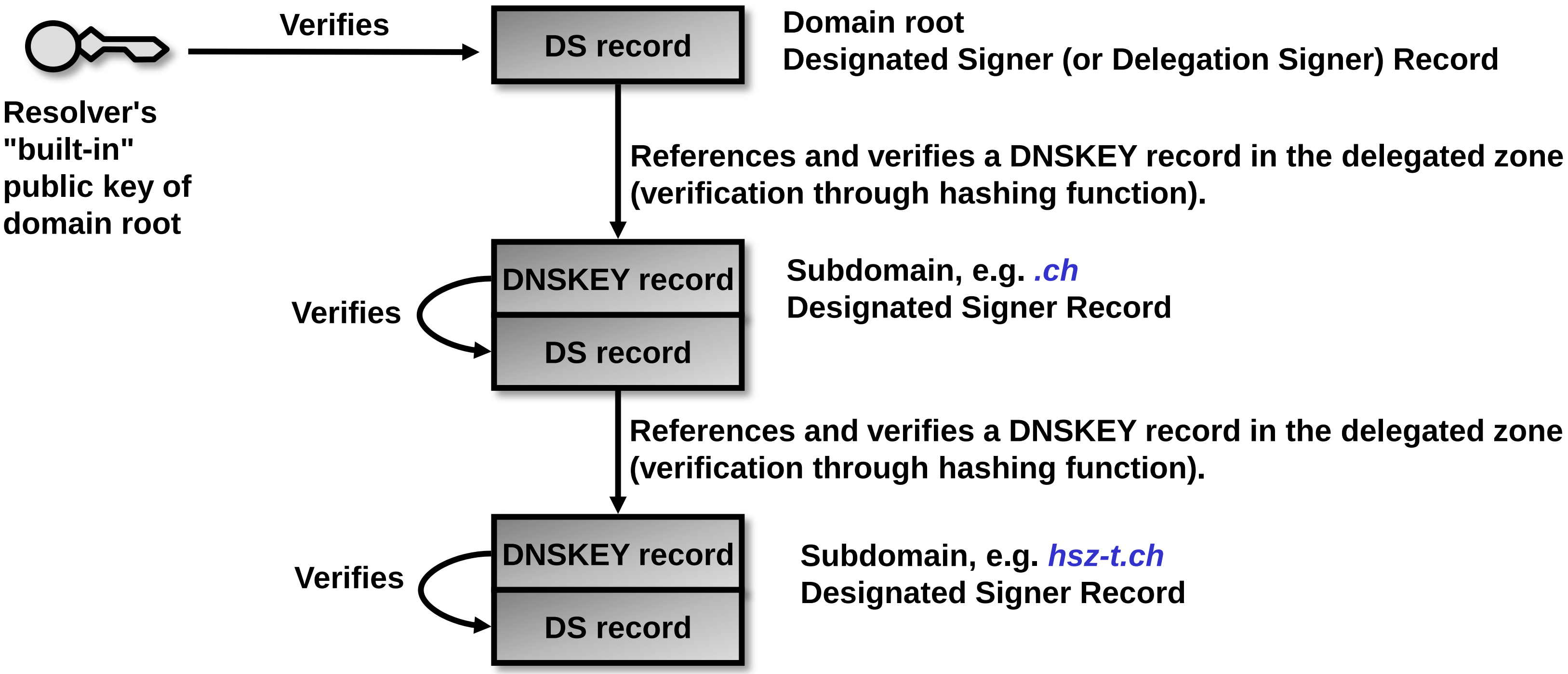
? =

4. How to find the signer's public DNS key

An authentication chain leads from root to leaf-domain. Each level contains DS records that reference / point to DNSKEY records in a subdomain.

N.B.: The parent domain is authoritative for its subdomains.

The starting point of the chain of trust is an anchor point (known good public key = trust anchor).


Verifies
DS record
Resolver's
"built-in"
public key of
domain root
References and verifies a DNSKEY record in the delegated zone
(verification through hashing function).
Verifies
DNSKEY record
DS record
References and verifies a DNSKEY record in the delegated zone
(verification through hashing function).
Verifies
DNSKEY record
DS record

Domain root
Designated Signer (or Delegation Signer) Record

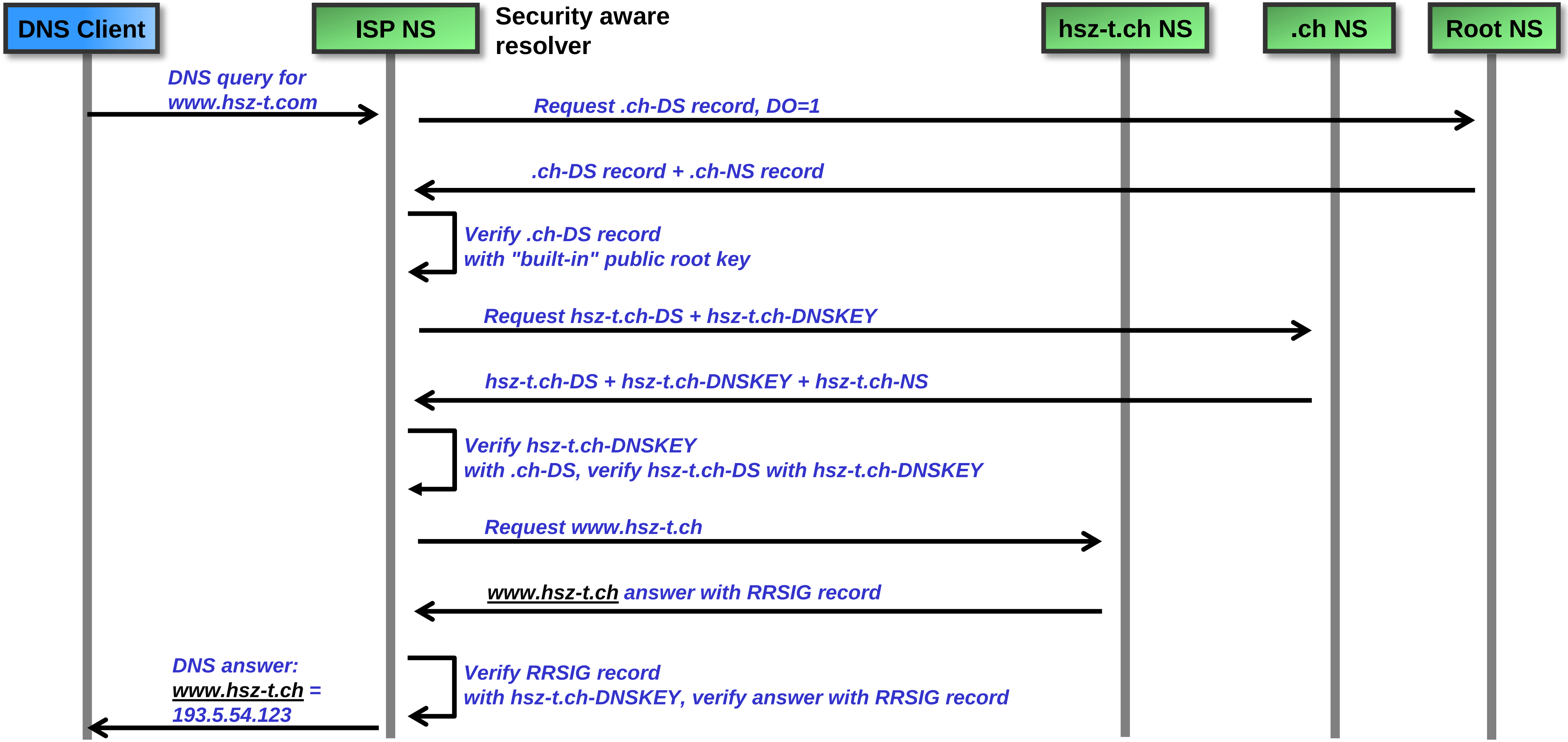
Subdomain, e.g. *.ch*
Designated Signer Record

Subdomain, e.g. *hsz-t.ch*
Designated Signer Record

5. DNS lookup: Recursive name servers

Standard setup where only name servers (e.g. ISP name servers) are security-aware. DNS clients are not security aware (simpler deployment, no trust anchors required in client).

TLD:	Top Level Domain
NS:	Name Server
DO:	"DNSSEC OK" flag


DNS Client
ISP NS
Security aware resolver
hsz-t.ch NS
.ch NS
Root NS
DNS query for www.hsz-t.com
Request .ch-DS record, DO=1
.ch-DS record + .ch-NS record
Verify .ch-DS record with "built-in" public root key
Request hsz-t.ch-DS + hsz-t.ch-DNSKEY
hsz-t.ch-DS + hsz-t.ch-DNSKEY + hsz-t.ch-NS
Verify hsz-t.ch-DNSKEY with .ch-DS, verify hsz-t.ch-DS with hsz-t.ch-DNSKEY
Request www.hsz-t.ch
www.hsz-t.ch answer with RRSIG record
DNS answer: www.hsz-t.ch = 193.5.54.123
Verify RRSIG record with hsz-t.ch-DNSKEY, verify answer with RRSIG record

6. DNSSEC deployment

As of 2013 DNSSEC is not (yet) widely deployed, but since the root zone has been signed in 2010, DNSSEC deployment is gradually picking up speed.
Deployment see https://labs.ripe.net/Members/wnagele/dnssec-deployment-today

Problems that prevent fast deployment:
1. "Bootstrap" problem:
DNSSEC requires a certain level of deployment to deliver an increase in security.
But as long this level is not reached, people will not see a benefit and thus not deploy DNSSEC ("chicken and egg problem").

2. Complexity:
DNSSEC is (as many security protocols) rather complex (defined in multiple RFCs).

3. DNS server load:
DNSSEC puts additional load on DNS servers (hashing, encryption / decryption).