D N S S E C

or

How to secure your (reverse) zone

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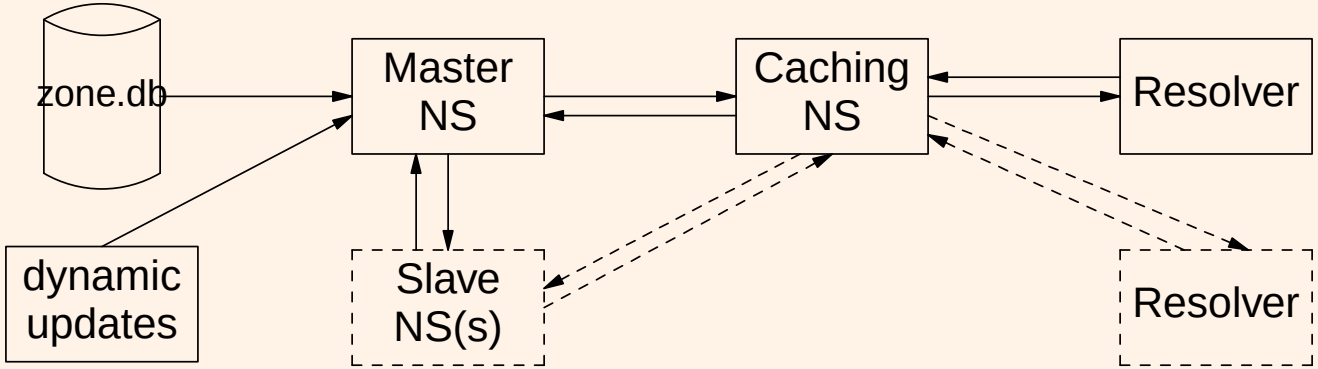
Agenda

- Secure DNS
  - Why do we need it ?
  - What is that ?
- Overview
  - Signing
  - Key generation
  - Chain of Trust
  - Secure Resolver
- DNSsec Practice
- Key rollover
- DNSsec Tools

Why DNSsec ?

- DNS (RFC1034, RFC1035) is bad designed! ('86, first vulnerability '90)



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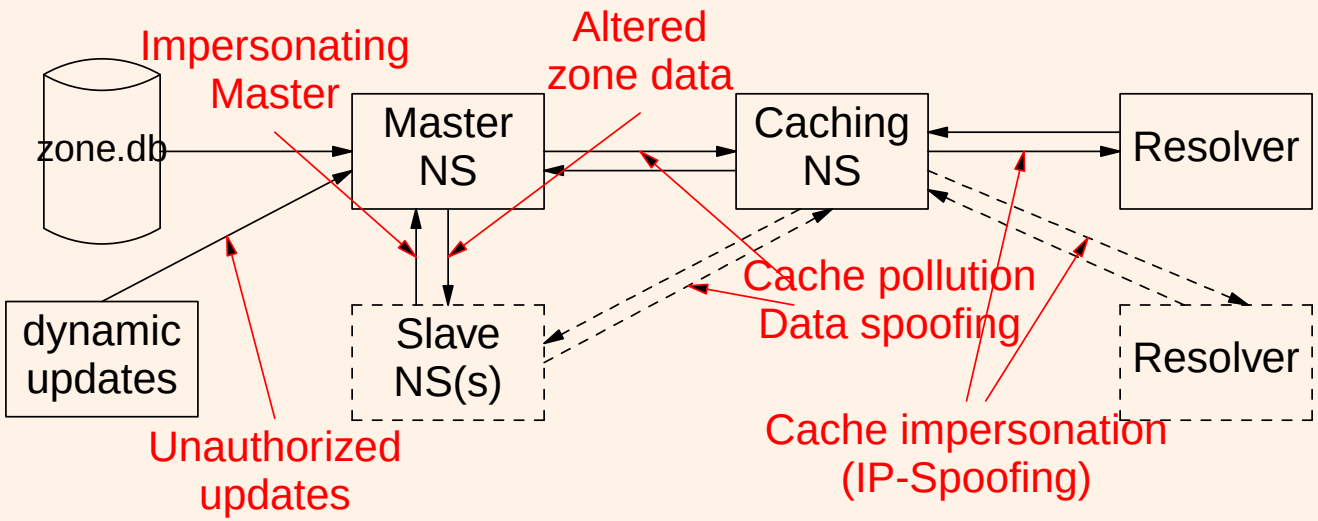

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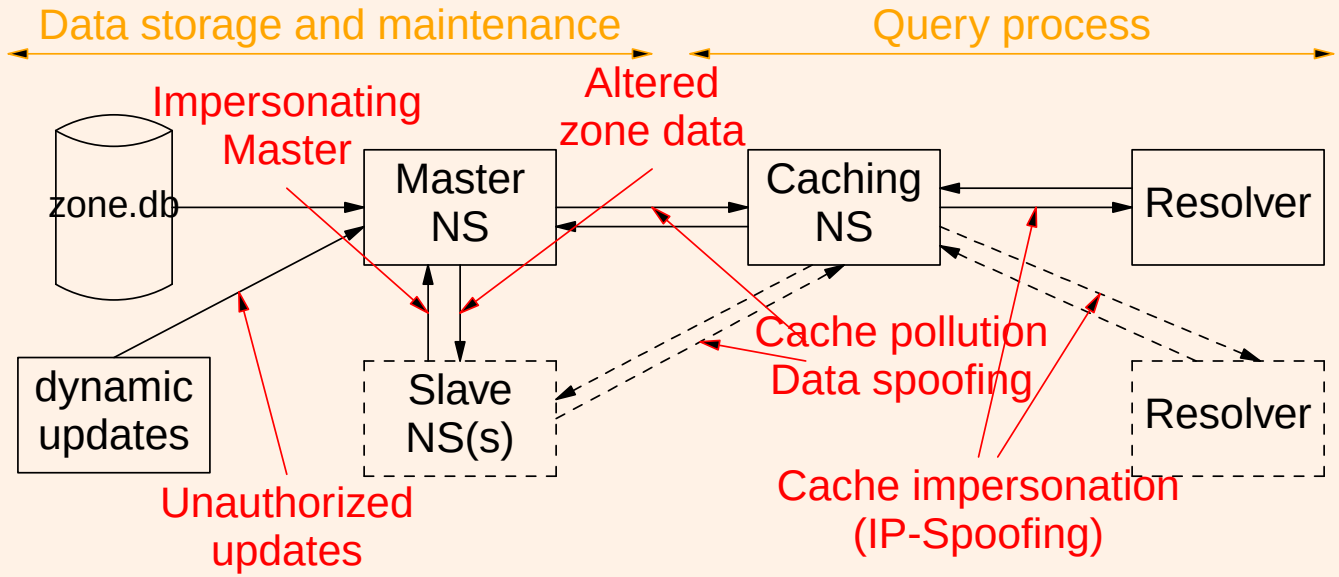

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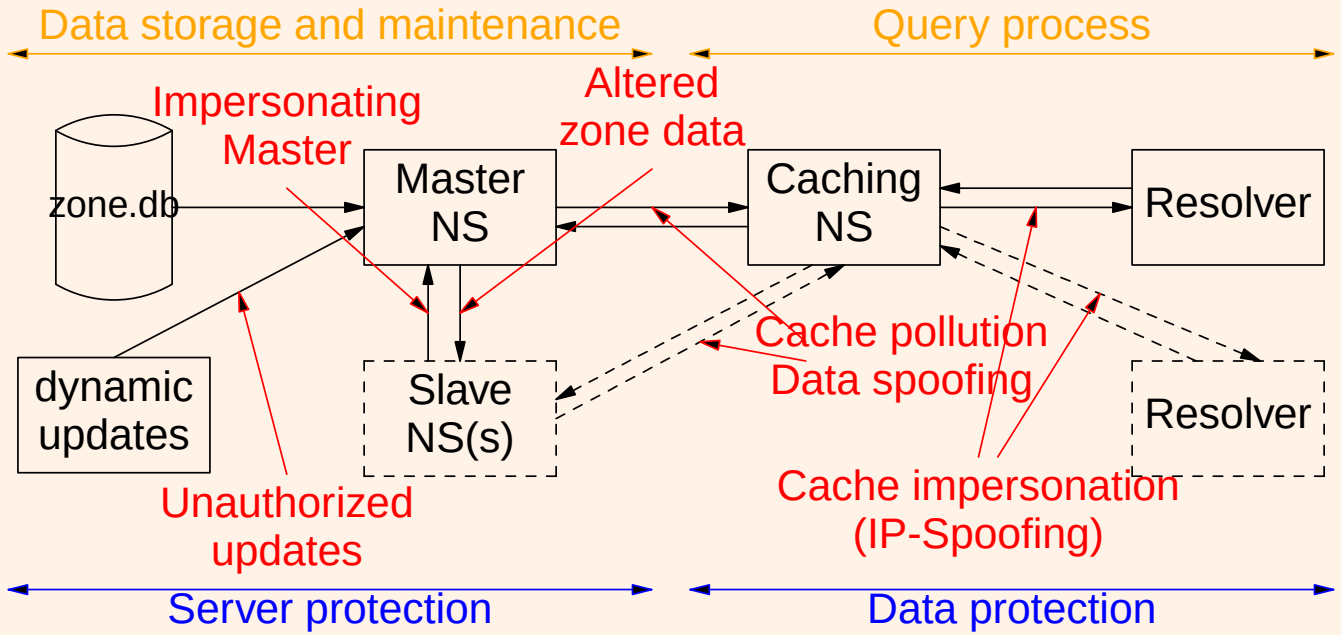

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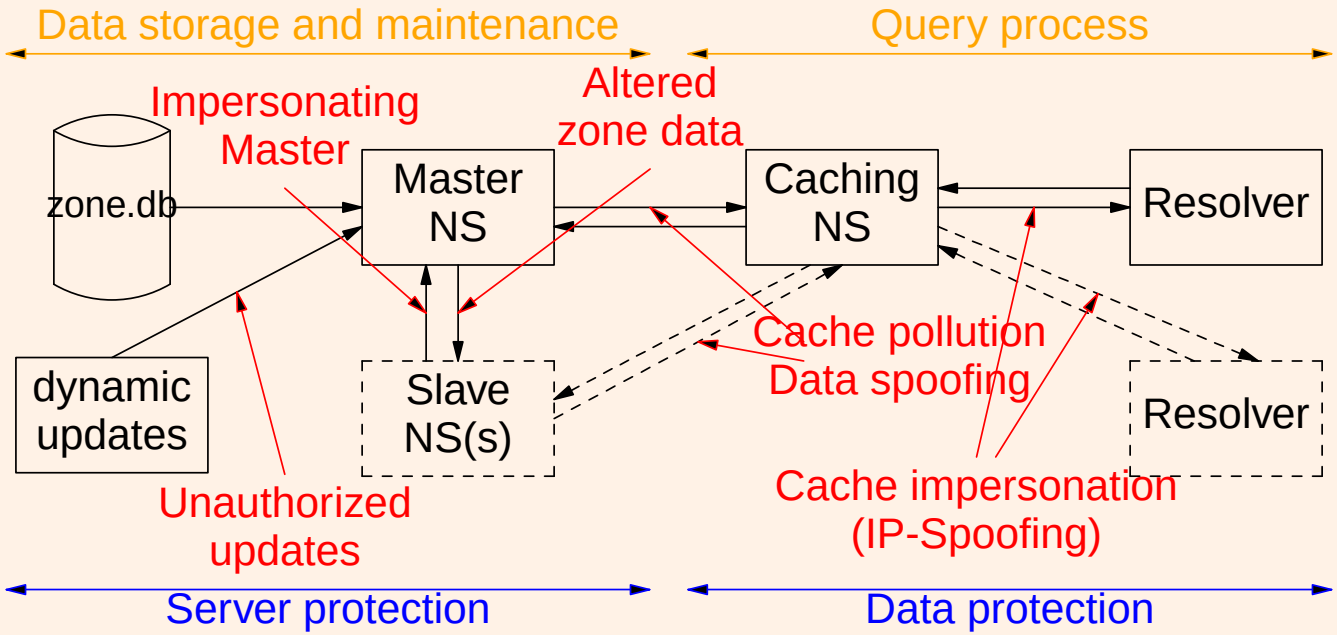


- Server protection
  Authenticate communication between servers (TSIG/SIG0)
- Data protection
  Authenticity and integrity of data (DNSKEY/RRSIG/NSEC)

What is DNSsec ?

- Started 1995; RFC2535 published 1999
- Revised March 2005
  RFC4033, RFC4034, RFC4035
- Secure DNS addresses different issues:
  a. Authenticated zone transfer
     TSIG between authoritative name server (master/slave)
  b. Secure dynamic updates (RFC3007)
     TSIG/SIG0 between updater and master server
  c. Authenticated zone data
     Signed resource record sets
  d. Authenticated queries
- Implemenation: bind-9.3.x, NSD 2.1.x
- Applications are more and more depending on DNS
  (Anti SPAM (MARID/MASS/DKIM), ENUM, SSH-Fingerprints, SRV-Records)

DNSsec specific Resource Records

- TSIG (RFC2845) Pseudo-RR
  Secret key transaction authentication for DNS (hashed MD5)
  Used by authenticated zone transfer and signed query/updates

- TKEY (RFC2930) Pseudo-RR
  Secret key establishment for DNS (Diffie-Hellman, Sig(0), GSSAPI)

- SIG(0) (RFC2931) Pseudo-RR
  DNS request and transaction signatures
  (Public-Key: RSA-MD5, RSA-SHA1, DSA)

- RRSIG, DNSKEY, NSEC (RFC4034)
  Old: SIG, KEY, NXT (RFC2535, RFC3845)
  Signed resource records (Public-Key)

- DS (RFC3658)
  Delegation signer resource record

DNSsec Overview

- Authenticated data origin
- Signing of the zone data
  No encryption; authenticity and integrity only
- Based on asymmetric keys
  - The private part is used to create the signature
  - The public part of the key is used for verification
- Build a chain of trust, up to the root
  The parent must be secure
- Provide the trust-anchor to the verifying resolver
  Zone status could be:
  - Verifiable Secure
  - Verifiable Insecure
  - Bad

RRSIG − Resource Record Signature

- Signed Resource Record Sets
  Every resource record is signed and the result is published via RRSIG Record

```
$ORIGIN example.net.
host    7200 IN A     1.2.3.4
        7200 IN A     2.4.5.6
        7200 IN RRSIG A 1 3 7200 (
                20050918041800 20050819041800   ; Sig. Lifetime
                18140 example.net.              ; Keytag+Name
                AK9adL3Ov7VkVLYoan/5CHUO...== ) ; Signature

host    7200 IN AAAA  2001:0db8:900:2af::2
        7200 IN RRSIG AAAA 1 3 7200 (
                20050918041800 20050819041800
                18140 example.net. Zq0+A2...==)
```

- Same is possible for reverse zones (in-addr.arpa, ip6.arpa) and e.g. e164.arpa.
- Signature: Hash over the RR Data, encrypted with private part of the asymetric zone signing key
- To create a signature obviously we need a key

DNSKEY − Keys for zone signing

- The public part of the zone signing key is part of the zone

```
$ORIGIN example.net.
example.net.  7200 IN DNSKEY 256 3 3 (
                    AQOfy1zMaX1b2qCJjLIZXrHfsma8GXbTrsL+TocUB6Z6
                    0m0zdE4s1y0zRrdmgktamXxX0OXx9FMlDw37WI9npZ6R) ; key id = 42398
              7200 IN DNSKEY 256 3 3 (
                    AQO3OeR3JpgGm1EfwMDVmGLYZYvUvSB0ewBgqU9EdKI3
                    Bwkf233G9fwQ9nK8fErYhkabUWEo3lXOAXR2BmqQRtw/) ; key id = 18140
              7200 IN DNSKEY 257 3 5 (
                    AQP1PstpDYkKzruSFKBIQmrKQbiaoPI09PE7GVzlaZtk
                    /FKDqyRVgXaUSKl3egIQgQ5LH8pJYZZqul+YxXDhbVIJ
                                  ...
                    FdjdSkBnTsyS/tDWiD98Qho8+0gwbpxvRRu5sTglGfIc
                    bBxrL2EvY8uP8ci0mOXbDGSNwY3PmHi+b9Vf) ; key id = 65100
```

- Oops, so many keys ...
- Two type of signing keys
  - Zone signing keys (ZSK) are used to sign the zone data
  - Key signing keys (KSK) sign the ZSK only
- More than one KSK/ZSK is used during key replacement

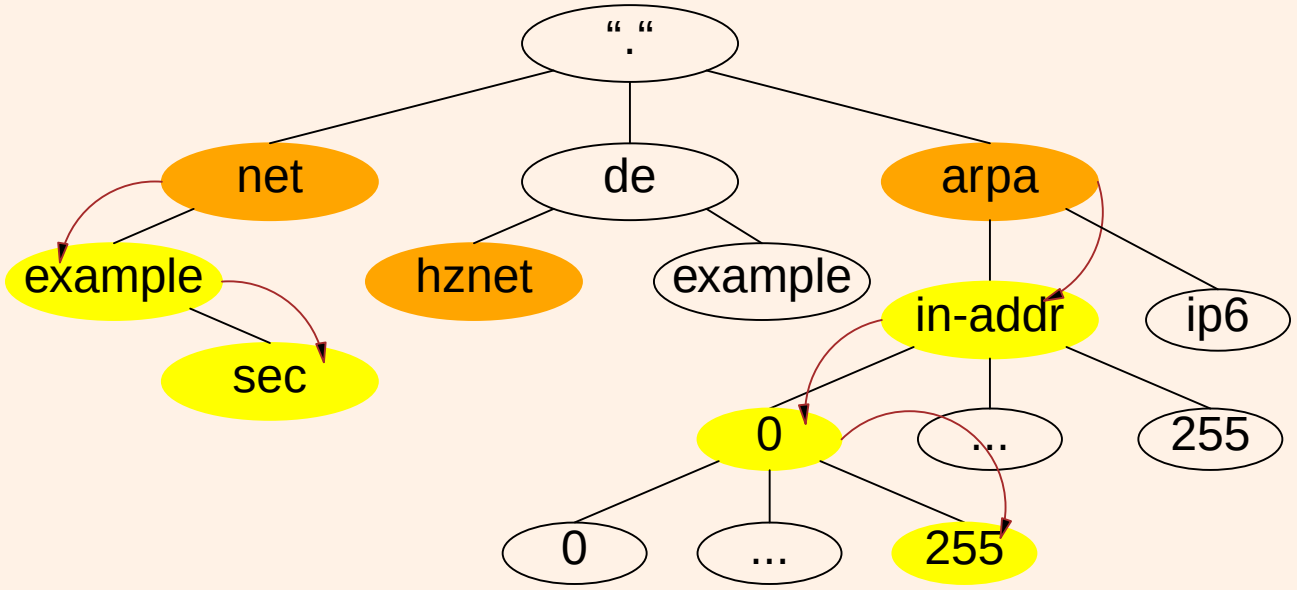
DS − Delegation Signer Record (Chain of Trust)

- Build a chain of trust: Secure Delegation

```
$ORIGIN net.
example   14400  IN NS     ns1.example.net.
          14400  IN NS     ns2.example.net.
          14400  IN DS     65100 5 (
                           1 5AB7376A226EBEA87BFE490A0E55E02FA5FE9147)
          14400  IN RRSIG  DS 1 3 14400 (
                           20050918041800 20050819041800 28040 net.
                           O/d4As9zzkN+fxjshohV1OY/aX38UvDzWA74
                           leLD+uLuWpflV6D3XwWwvvTYnqMHM5kuLnbM
                           EE1KtDml+0tQhA== )
```

- The delegation signer record (DS) is a pointer to the KSK of the delegated zone
- The DS is signed by the parent!
- The NS is not signed by the parent!
  The NS records are originated in the delegated zone.
- The DS is the only record wich is solely allowed in the parent zone

Chain of Trust / Secure Entry Points



- Chain of Trust build with DS Records
- The resolver needs some „Secure Entry Points“ (aka: trust anchor)
  Ideally: Only one trust anchor necessary

Trusted Keys − Trust Anchor

- The resolver requires a trust anchor to verify the chain of trust
  Also known as secure entry point (SEP)
- Ideally this is the KSK of the root zone, but many SEPs are allowed
- Example: BIND as verifying resolver

```
options {
    recursion yes;
    dnssec-enable yes;
    edns-udp-size 4096;     # this is the default!
};
trusted-keys {
    "example.net."      257 3 5 "
                        AQP1PstpDYkKzruSFKBIQmrKQbiaoPI09PE7GVzlaZtk/FKDqyRVgXaU
                        SKl3egIQgQ5LH8pJYZZqul+YxXDhbVIJPXK/3E2uxaZ8yWn+BIYm3DbY
                        lftBvRU3pzDEpOjxfU2RrFR7H38hj+jQOEYLnZxRrmfS7PlSXDEYHdN3
                        c2u0dXZmcVIGFLG0XAirr/ZJ0Mb2LAqvMRvhf9KSp5bTM/dNm0l6/WHE
                        TPwQ/gjHj4fBoL2yjF/3IcAaQjd4LNPjzWJcDCd7FdjdSkBnTsyS/tDW
                        iD98Qho8+0gwbpxvRRu5sTglGfIcbBxrL2EvY8uP8ci0mOXbDGSNwY3P
                        mHi+b9Vf" ; # key id = 65100
    "213.in-addr.arpa." 257 3 5 ".....";
};
```

Stub-Resolver (dig)

```
$ dig +multiline +dnssec host.example.net
; <<>> DiG 9.3.1 <<>> +multiline +dnssec host.example.net
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 1730
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 3, AUTHORITY: 5, ADDITIONAL: 11

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags: do; udp: 4096
;; QUESTION SECTION:
;max.hznet.de.          IN A

;; ANSWER SECTION:
host.example.net.   14400 IN A 1.2.3.4
host.example.net.   14400 IN A 2.3.4.5
host.example.net.   14400 IN RRSIG A 1 3 14400 20050908041800 (
                             20050809041800 18140 example.net.
                             WeUoDexKRUZj3rqGICyi2X4U+w+/q3RGYUg1HtLLatyc
                             pei813WTKqi2Jd1/v14KSFZLNyfWxr5DWu7jmgI7uQ== )

;; Query time: 103 msec
;; SERVER: 127.0.0.1#53(127.0.0.1)
;; WHEN: Tue Aug  9 20:29:18 2005
;; MSG SIZE  rcvd: 770
```

DNSsec Practice (Bind Tools)

- Create the key material
  - Key signing key (KSK)

```
$ dnssec-keygen -f KSK -n ZONE -a DSA -b 1024 example.net
```

  - Zone signing key (ZSK)

```
$ dnssec-keygen -n ZONE -a RSASHA1 -b 512 example.net
```

```
$ ls -l
-rw-r--r--   1 dnsop  dnsop   581 2005-08-14 13:55 Kexample.net.+003+18710.key
-rw-------   1 dnsop  dnsop   688 2005-08-14 13:55 Kexample.net.+003+18710.private
-rw-r--r--   1 dnsop  dnsop   121 2005-08-14 13:55 Kexample.net.+005+57705.key
-rw-------   1 dnsop  dnsop   545 2005-08-14 13:55 Kexample.net.+005+57705.private
```

- Store the public part of the key in the zone file (ok, do this only once)

```
$ cat Kexample.net+*.key >> zone.db
```

- Increment SOA serial number (How ?)
- Sign the zone file

```
$ dnssec-signzone -g -o example.net zone.db
zone.db.signed
```

DNSsec Practice (2)

- Configure named

```
options {
    dnssec-enable yes:
};

zone "example.net" {
    type master;   file "example.net./zone.db.signed";
};
```

- Reload the zone

```
$ rndc reload example.net
```

- Re-sign the zone before the signature times out
  But: Don’t forget to increment the serial number

- Start a key rollover if the lifetime of the key is over
  There are two different ways to do this

Key Rollover

- DNSSEC Operational Practices define two algorithms for key rollover
- ZSK Rollover (pre-publish key)
  1. Generate second ZSK
  2. Publish both (public) keys, but use only the old one for signing
  3. Wait at least propagation time + TTL of the key set
  4. Use new key for zone signing; leave old one published
  5. Wait at least propagation time + maximum TTL of the old zone
  6. Remove old key
- KSK Rollover (double signature)
  1. Generate new KSK
  2. Use both keys for key signing
  3. Send new DS-set to the parent
  4. Wait until the DS is propagated + maximum TTL of the old zone
  5. Remove the old key

DNSsec Tools

- KROd − Key Rollover Daemon (www.idsa.prd.fr/index.php?page=kro&lang=en)
  - Full automatic ZSK rollover
  - Full automatic KSK rollover
    incl. KSK key exchange with the parent domain
- DNSSEC Key Maintenance Tools (www.ripe.net/disi/code.html)
  - Secure private key storage
  - Semi-automatic [KZ]SK rollover (pre-publish & double signature)
- DNSsec Tools (www.dnssec-tools.org)
  - Zone signing and key management tool
- Zone Key Tool (www.hznet.de/zkt/)
  - Automatic ZSK rollover
  - Full automatic re-signing of the zone (incl. SOA incrementation)
  - Parses secure zones out of named.conf

Zone Key Tool (ZKT)

- Provides Tools for key management and zone signing

```
$  dnssec-zkt
$  dnssec-signer -N /etc/named.conf
```

- Simple configuration file (extract of `dnssec.conf`)

```
#   zone specific timing values
ResignInterval: 3d      # (259200 seconds)
Sigvalidity:    30d     # (2592000 seconds)
Max_TTL:        6h      # (21600 seconds)
Propagation:    5m      # (300 seconds)

#   signing key parameters
KSK_lifetime:   0
KSK_algo:       DSA     # (Algorithm ID 3)
KSK_bits:       1024
ZSK_lifetime:   10d     # (864000 seconds)
ZSK_algo:       RSASHA1 # (Algorithm ID 5)
ZSK_bits:       512
```

- Full automatic ZSK rollover (pre-publish key algorithm)
- Automatic serial number incrementation
  Supports sequential serial number and `YYYYmmDDxx` Format

ZKT – Configuration

- Create a directory for each secure zone (dirname = domainname)

```
$ mkdir example.net.
$ cd example.net.
```

- Create the zone file (default name: `zone.db`)

```
$  head -15 zone.db
$TTL    7200
;   Be sure that the serial number below is left
;   justified in a field of at least 10 spaces!!
;               0123456789;
@   IN SOA  ns1.example.net. hostmaster.example.net.  (
                63          ; Serial
                43200   ; Refresh
                1800    ; Retry
                2W      ; Expire
                7200 )  ; Minimum

          IN  NS  ns1.example.net.
          IN  NS  ns2.example.net.

$INCLUDE dnskey.db          ;include the DNSKEY records
    ...
```

ZKT – Configuration(2)

- Create a (just empty) `zone.db.signed` file

```
$ touch zone.db.signed
$ ls -l
-rw-r-----   1 dnsop  dnsop   916 2005-08-14 13:54 zone.db
-rw-r--r--   1 dnsop  dnsop     0 2005-08-14 13:55 zone.db.signed
```

- Sign the zone

```
$ dnssec-signer -v -o example.net.
parsing zone "example.net." in dir "."
        No active KSK found: generate new one
        No active ZSK found: generate new one
        Re-signing necessary: Modified keys
        Writing key file "./dnskey.db"
        Incrementing serial number (64) in file "./zone.db"
        Signing zone "example.net."
$ ls -l
-rw-r--r--   1 dnsop  dnsop   581 2005-08-14 13:55 Kexample.net.+003+18710.key
-rw-------   1 dnsop  dnsop   688 2005-08-14 13:55 Kexample.net.+003+18710.private
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-rw-------   1 dnsop  dnsop   545 2005-08-14 13:55 Kexample.net.+005+57705.private
-rw-r--r--   1 dnsop  dnsop  1136 2005-08-14 13:55 dnskey.db
-rw-r--r--   1 dnsop  dnsop    71 2005-08-14 13:55 dsset-example.net.
-rw-r--r--   1 dnsop  dnsop   702 2005-08-14 13:55 keyset-example.net.
-rw-r-----   1 dnsop  dnsop   916 2005-08-14 13:55 zone.db
-rw-r--r--   1 dnsop  dnsop  4080 2005-08-14 13:55 zone.db.signed
```

ZKT – Configuration(3)

- Show current key status

```
$  dnssec-zkt -a .
Keyname              Tag Typ Sta Algorit Generation Time            Age
example.net.     18710 KSK act DSA     Aug 14 2005 13:55:24     13m42s
example.net.     57705 ZSK act RSASHA1 Aug 14 2005 13:55:24     13m42s
```

- Change the zonefile in `named.conf`

```
zone "example.net." in {
        type master;
        file "example.net./zone.db.signed";
};
```

- Force re-signing and reload the zone

```
$  dnssec-signer -r -f -v -N named.conf
parsing zone "example.net." in dir "./."
        Re-signing necessary: Option -f
        Writing key file "././dnskey.db"
        Incrementing serial number (65) in file "././zone.db"
        Signing zone "example.net."
        Reload zone "example.net."
```

- Check messages in `/var/log/named`

14-Aug-2005 14:34:43.198 general: info: zone example.net/IN: loaded serial 65 **(signed)**

ZKT – Configuration(4)

- Periodic re-sign your zone
  Call dnssec-signer at least once a day

- `cron` is your friend

```
$ crontab -l
21  6 * * * /home/dnsop/dnssec-cron 2>&1 | logger -t dnssec-cron -p daemon.info
21 18 * * * /home/dnsop/dnssec-cron 2>&1 | logger -t dnssec-cron -p daemon.info
```

- The `dnssec-cron` script looks simple

```
echo "current zone signing keys"
/home/dnsop/bin/dnssec-zkt -z
echo "dnssec re-signing process started"
/home/dnsop/bin/dnssec-signer -v -v -r -N /var/named/named.conf
```

- Create the trusted-keys Section for your resolver configuration

```
$ dnssec-zkt -T -l example.net.
trusted-keys {
"example.net."   257 3 3 "CJEUcyN1ES5bAnBI4O+m7nLhbmTfxVtF31O4agNVe+6Hu8kZ8EKzm+/U
                          +qh2NXv6+UgowadnPlfHHwLzpfNP4aZXfXa2qog1P5dp7POUquW6zn25
                                    ...
                          Wdlf/F/2lJh2LF4bU616EyOeRichLvlBXn15nkkLr4usbPitr68DrVas
                          o6bci4LJlPJBkHVS/3MtBo0lSY3XvoiBJtgp" ; # key id = 18710
};
```

References

Miek Gieben, Internet Protocol Journal (Vol. 7, Issue 2, June 2004)
„DNSSEC: The Protocol, Deployment and a Bit of Development“

Nominum
BIND v9 Administrator Reference Manual

Olaf Kolkman, Ripe-NCC DISI
„DNSSEC Howto Version 1.3“

RFCs 1034, 1035, 2535, 2848, 2930, 2931, 3007, 3655, 3658, 3757, 3833, 3845

4033 (DNS Security Introduction and Requirements)
4034 (Resource Records for the DNS Security Extentions)
4035 (Protocol Modifications for the DNS Security Extensions)

Drafts DNSSEC Operational Practices
draft-ietf-dnsop-dnssec-operational-practices-04.txt

Links http://www.dnssec.net
http://www.ietf.org/html.charters/dnsext-charter.html
http://www.hznet.de/dns/dnssec-denic040929.pdf

Questions ?

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http://www.hznet.de/dns/dnssec-decix050916.pdf

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Thank you very much
for your attention!

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