Offline KSK with Knot DNS 2.8

DNS-OARC 30 - Bangkok

KNOT DNS

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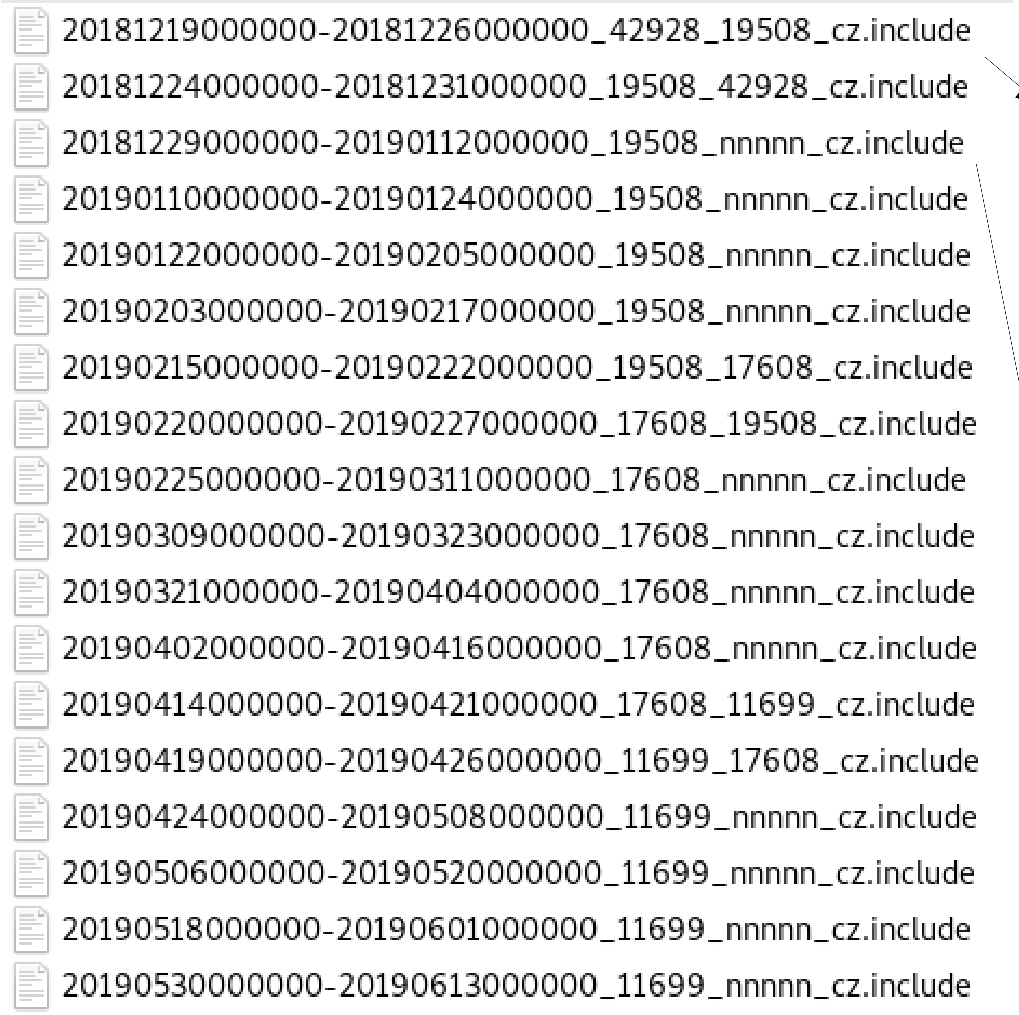
DNSSEC in CZ

- CZ signed in **2006**
  - No HSM
  - Responsibility for key management fully in hands of sysadmins
- Major change in **2013**
  - Split responsibility between sysadmins (ZSK team) and CSIRT (KSK team)
  - KSK goes **offline** into safe
  - Inspired by root zone operations

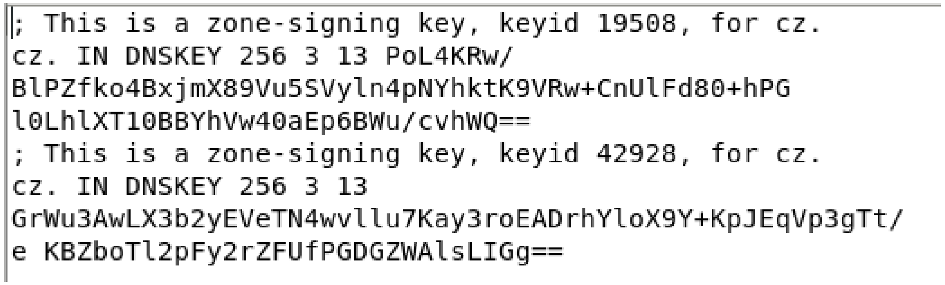
ZSK operations

- 3 new keys generated every 6 month
  - ZSK rollovers after 2 month
- KSR (Key Signing Request) is prepared and send to KSK team
  - All ZSK combinations prepared for next 6 month as DNSKEY RRsets
  - Signed with PGP of ZSK team

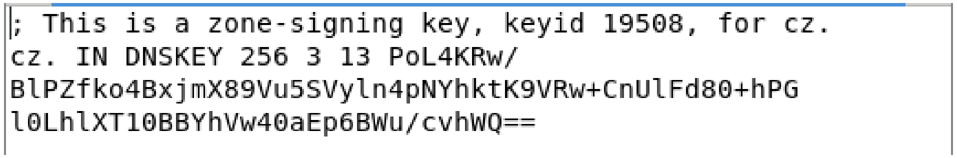
KSR



```
20181219000000-20181226000000_42928_19508_cz.include
20181224000000-20181231000000_19508_42928_cz.include
20181229000000-20190112000000_19508_nnnnn_cz.include
20190110000000-20190124000000_19508_nnnnn_cz.include
20190122000000-20190205000000_19508_nnnnn_cz.include
20190203000000-20190217000000_19508_nnnnn_cz.include
20190215000000-20190222000000_19508_17608_cz.include
20190220000000-20190227000000_17608_19508_cz.include
20190225000000-20190311000000_17608_nnnnn_cz.include
20190309000000-20190323000000_17608_nnnnn_cz.include
20190321000000-20190404000000_17608_nnnnn_cz.include
20190402000000-20190416000000_17608_nnnnn_cz.include
20190414000000-20190421000000_17608_11699_cz.include
20190419000000-20190426000000_11699_17608_cz.include
20190424000000-20190508000000_11699_nnnnn_cz.include
20190506000000-20190520000000_11699_nnnnn_cz.include
20190518000000-20190601000000_11699_nnnnn_cz.include
20190530000000-20190613000000_11699_nnnnn_cz.include
```



```
; This is a zone-signing key, keyid 19508, for cz.
cz. IN DNSKEY 256 3 13 PoL4KRw/
BlPZfko4BxjmX89Vu5SVyln4pNYhktK9VRw+CnUlFd80+hPG
l0LhlXT10BBYhVw40aEp6BWu/cvhWQ==
; This is a zone-signing key, keyid 42928, for cz.
cz. IN DNSKEY 256 3 13
GrWu3AwLX3b2yEVeTN4wvllu7Kay3roEADrhYloX9Y+KpJEqVp3gTt/
e KBZboTl2pFy2rZFUfPGDGZWAlsLIGg==
```



```
; This is a zone-signing key, keyid 19508, for cz.
cz. IN DNSKEY 256 3 13 PoL4KRw/
BlPZfko4BxjmX89Vu5SVyln4pNYhktK9VRw+CnUlFd80+hPG
l0LhlXT10BBYhVw40aEp6BWu/cvhWQ==
```

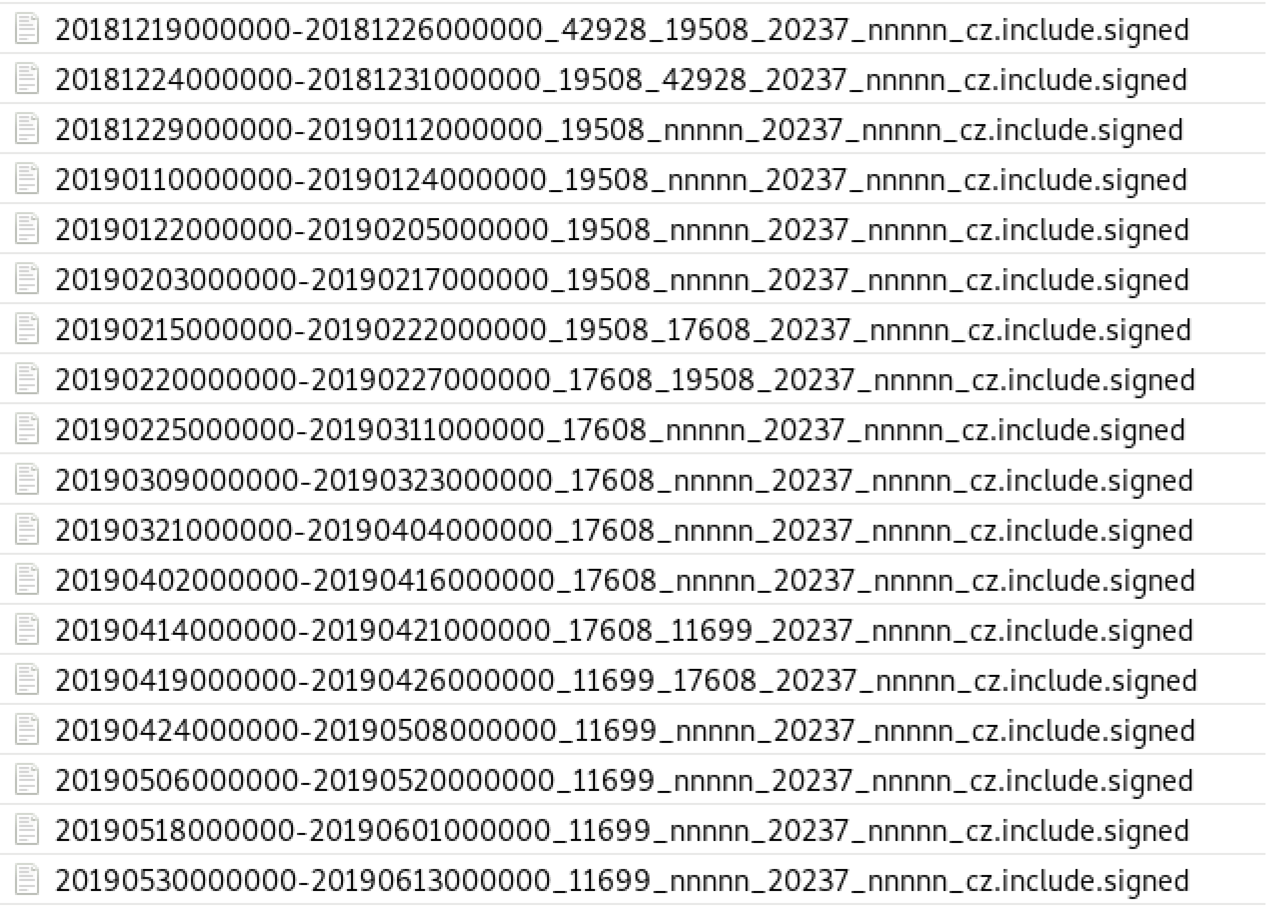
KSK operations

- KSK environment is laptop w/o wifi, fixed bootable image and private part of KSK in the safe
- Signing ceremony is held with multiple witnesses and signed report
- SKR (Signed Key Response) is created, signed with PGP of KSK team and sent back to ZSK team

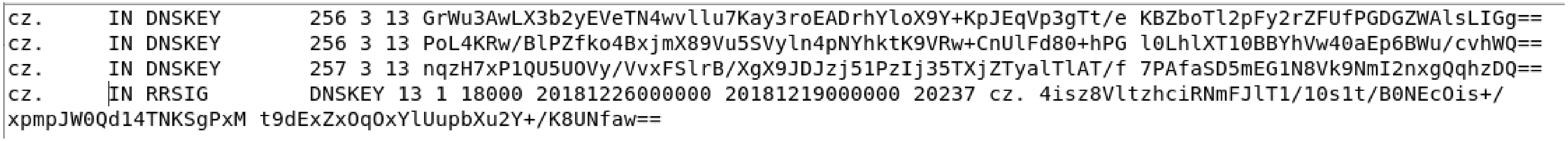
SKR generation

- Public part of KSK appended to each DNSKEY RRset
- DNSKEY RRsets transformed to zonefiles
- Zonefiles are signed with KSK
- DNSKEY and RRSIG records extracted from zonefiles

SKR



```
20181219000000-20181226000000_42928_19508_20237_nnnnn_cz.include.signed
20181224000000-20181231000000_19508_42928_20237_nnnnn_cz.include.signed
20181229000000-20190112000000_19508_nnnnn_20237_nnnnn_cz.include.signed
20190110000000-20190124000000_19508_nnnnn_20237_nnnnn_cz.include.signed
20190122000000-20190205000000_19508_nnnnn_20237_nnnnn_cz.include.signed
20190203000000-20190217000000_19508_nnnnn_20237_nnnnn_cz.include.signed
20190215000000-20190222000000_19508_17608_20237_nnnnn_cz.include.signed
20190220000000-20190227000000_17608_19508_20237_nnnnn_cz.include.signed
20190225000000-20190311000000_17608_nnnnn_20237_nnnnn_cz.include.signed
20190309000000-20190323000000_17608_nnnnn_20237_nnnnn_cz.include.signed
20190321000000-20190404000000_17608_nnnnn_20237_nnnnn_cz.include.signed
20190402000000-20190416000000_17608_nnnnn_20237_nnnnn_cz.include.signed
20190414000000-20190421000000_17608_11699_20237_nnnnn_cz.include.signed
20190419000000-20190426000000_11699_17608_20237_nnnnn_cz.include.signed
20190424000000-20190508000000_11699_nnnnn_20237_nnnnn_cz.include.signed
20190506000000-20190520000000_11699_nnnnn_20237_nnnnn_cz.include.signed
20190518000000-20190601000000_11699_nnnnn_20237_nnnnn_cz.include.signed
20190530000000-20190613000000_11699_nnnnn_20237_nnnnn_cz.include.signed
```



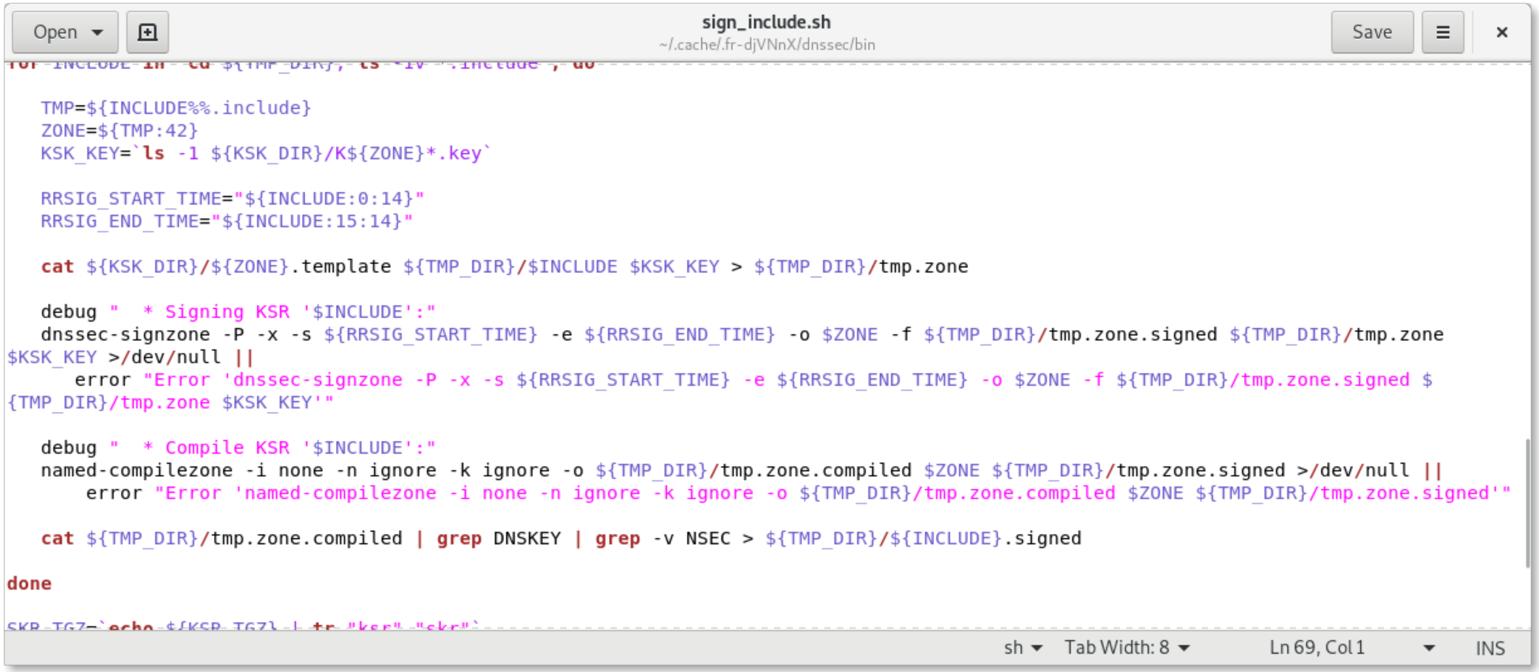
```
cz.       IN DNSKEY       256 3 13 GrWu3AwLX3b2yEVeTN4wvllu7Kay3roEADrhYloX9Y+KpJEqVp3gTt/e KBZboTl2pFy2rZFUfPGDGZWAlsLIGg==
cz.       IN DNSKEY       256 3 13 PoL4KRw/BlPZfko4BxjmX89Vu5SVyln4pNYhktK9VRw+CnUlFd80+hPG l0LhlXT10BBYhVw40aEp6BWu/cvhWQ==
cz.       IN DNSKEY       257 3 13 nqzH7xP1QU5UOVy/VvxFSlrB/XgX9JDJzj51PzIj35TXjZTyalTlAT/f 7PAfaSD5mEG1N8Vk9NmI2nxgQqhzDQ==
cz.       IN RRSIG        DNSKEY 13 1 18000 20181226000000 20181219000000 20237 cz. 4isz8VltzhciRNmFJlT1/10s1t/B0NEcOis+/
xpmpJW0Qd14TNKSgPxM t9dExZxOqOxYlUupbXu2Y+/K8UNfaw==
```

Zone signing

- Unsigned zone is generated every 30min
- Set of checks is applied to verify content
- Appropriate SKR file (based on time) is included into zonefile
- Signatures from previous signing are included as well to speed up signing
- Zone is signed with ZSK based on the tag in the filename

Toolbox

- Set of shell scripts around:
  - dnssec-keygen
  - dnssec-signzone
  - named-checkzone
  - named-compilezone
  - ldns-compare-zones
  - ldns-read-zone



```
for INCLUDE in `cd ${TMP_DIR}; ls -1v *.include`; do

   TMP=${INCLUDE%%.include}
   ZONE=${TMP:42}
   KSK_KEY=`ls -1 ${KSK_DIR}/K${ZONE}*.key`

   RRSIG_START_TIME="${INCLUDE:0:14}"
   RRSIG_END_TIME="${INCLUDE:15:14}"

   cat ${KSK_DIR}/${ZONE}.template ${TMP_DIR}/$INCLUDE $KSK_KEY > ${TMP_DIR}/tmp.zone

   debug "  * Signing KSR '$INCLUDE':"
   dnssec-signzone -P -x -s ${RRSIG_START_TIME} -e ${RRSIG_END_TIME} -o $ZONE -f ${TMP_DIR}/tmp.zone.signed ${TMP_DIR}/tmp.zone
$KSK_KEY >/dev/null ||
      error "Error 'dnssec-signzone -P -x -s ${RRSIG_START_TIME} -e ${RRSIG_END_TIME} -o $ZONE -f ${TMP_DIR}/tmp.zone.signed $
{TMP_DIR}/tmp.zone $KSK_KEY'"

   debug "  * Compile KSR '$INCLUDE':"
   named-compilezone -i none -n ignore -k ignore -o ${TMP_DIR}/tmp.zone.compiled $ZONE ${TMP_DIR}/tmp.zone.signed >/dev/null ||
       error "Error 'named-compilezone -i none -n ignore -k ignore -o ${TMP_DIR}/tmp.zone.compiled $ZONE ${TMP_DIR}/tmp.zone.signed'"

   cat ${TMP_DIR}/tmp.zone.compiled | grep DNSKEY | grep -v NSEC > ${TMP_DIR}/${INCLUDE}.signed

done

SKR_TGZ=`echo ${KSR_TGZ} | tr "ksr" "skr"`
```

Challenges

- Algorithm rollover modifications
- Manual backup & HA
- Scripts are aging
- Staff is changing
- Who should be responsible for scripts? Registry development team or sysadmins?

Challenges

- Why the hell CZ.NIC’s signer is Bind and not Knot DNS?
- Can we switch to automated signing?
- No support for automated signing with offline KSK in DNSSEC signer implementations

Way forward

- Sysadmins and Knot DNS developers worked together to collect requirements
- Offline KSK support implemented in **Knot DNS 2.8** released few months ago

Knot DNS & DNSSEC

- Authoritative DNS server with automated DNSSEC signing
  - Just set the policy and you can forget DNSSEC
- Accepts also DNS transfers on input - can serve as “bump-in-the-wire” signer
- Full DNSSEC feature set:
  - PKCS11, CDS/CDNSKEY, Shared KSK, Algorithm rollover, Combined Signing Key, ...

Knot DNS & DNSSEC

- RIPE NCC selected Knot DNS as DNSSEC signer of their choice 6 months ago
  - 116 zones
  - Update will be presented at RIPE 78
- DNSSEC signer performance study by DK Hostmaster
  - Will be presented at CENTR TechWG

Automated signing

```
policy:
 - id: my_policy
   algorithm: ECDSAP384SHA384
   zsk-lifetime: 60d

zone:
 - domain: example.com.
   dnssec-signing: on
   dnssec-policy: my_policy
```

Offline KSK signing

```
policy:
 - id: my_policy
   algorithm: ECDSAP384SHA384
   zsk-lifetime: 60d
   manual: on
   offline-ksk: on

zone:
 - domain: example.com.
   dnssec-signing: on
   dnssec-policy: my_policy
```

Offline KSK signing – ZSK team

- Pregenerate ZSKs for next 6 month

```
$ keymgr -c zsk-team.conf example.com. pregenerate +6mo
```

- Create KSR

```
$ keymgr -c zsk-team.conf example.com. generate-ksr +0 +6mo > ksr
```

Offline KSK signing – KSR

```
;; KeySigningRequest 1.0 1544709874 ===========
example.com.	5	DNSKEY 256 3 14
PVP1IF7CtEu3+BiERm4jvZ0LaboxY0jSrb69gpaY5RJhIsuazjekjPQRlFGUMnH7LMH+TWRFM1Zz5zpk
4C0p1QfaTPcdOzOuis+QsfCftsrd5J7JprPQz22C+H2rt8qf
;; KeySigningRequest 1.0 1544710698 ===========
example.com.	5	DNSKEY 256 3 14
PVP1IF7CtEu3+BiERm4jvZ0LaboxY0jSrb69gpaY5RJhIsuazjekjPQRlFGUMnH7LMH+TWRFM1Zz5zpk
4C0p1QfaTPcdOzOuis+QsfCftsrd5J7JprPQz22C+H2rt8qf
example.com.	5	DNSKEY 256 3 14
/5l3LxwUhcDB7CwLolL5OmWCV+TcMzudehZVlt8QKn7DcxXYaKoabrN0jXtPhpyZ4cPE+/
UMpT+008cTqrNr1luqFxUWYpHKeEzrYUB9FirnSMHM22z2CugQZ+KulKxc
;; KeySigningRequest 1.0 1544710763 ===========
example.com.	5	DNSKEY 256 3 14
PVP1IF7CtEu3+BiERm4jvZ0LaboxY0jSrb69gpaY5RJhIsuazjekjPQRlFGUMnH7LMH+TWRFM1Zz5zpk
4C0p1QfaTPcdOzOuis+QsfCftsrd5J7JprPQz22C+H2rt8qf
example.com.	5	DNSKEY 256 3 14
/5l3LxwUhcDB7CwLolL5OmWCV+TcMzudehZVlt8QKn7DcxXYaKoabrN0jXtPhpyZ4cPE+/
UMpT+008cTqrNr1luqFxUWYpHKeEzrYUB9FirnSMHM22z2CugQZ+KulKxc
;; KeySigningRequest 1.0 1544710828 ===========
example.com.	5	DNSKEY 256 3 14
/5l3LxwUhcDB7CwLolL5OmWCV+TcMzudehZVlt8QKn7DcxXYaKoabrN0jXtPhpyZ4cPE+/
UMpT+008cTqrNr1luqFxUWYpHKeEzrYUB9FirnSMHM22z2CugQZ+KulKxc
;; KeySigningRequest 1.0 1544711074 ===========
```

Offline KSK signing – KSK team

- On the first usage generate KSK (or import)

```
$ keymgr -c ksk-team.conf generate
```

- Sign KSR during ceremony

```
$ keymgr -c ksk-team.conf example.com. sign-ksr ksr > srk
```

Offline KSK signing – SKR

```
;; SignedKeyResponse 1.0 1544709874 ===========
example.com.        5     DNSKEY 256 3 14
PVP1IF7CtEu3+BiERm4jvZ0LaboxY0jSrb69gpaY5RJhIsuazjekjPQRlFGUMnH7LMH+TWRFM1Zz5z
pk4C0p1QfaTPcdOzOuis+QsfCftsrd5J7JprPQz22C+H2rt8qf
example.com.        5     DNSKEY 257 3 14
eTcVgRXNDrZGLYvHkVu/e8uAIHjL4HdYkQdMlh/top2tnaVAmgaXCvr8BtgGDFLKy84DcCYTMtzzSl8
uzB5ef/ZGWH2QHFYgYTl03NTlluUqxcfeYe3ycQ0u5DzL2YYS
example.com.        5     RRSIG     DNSKEY 14 2 5 20181213140634 20181213123434 11919
example.com. qJuUZYqHt1N5YDnh4/Qp7lc4FBC6lXl0tRR/ZDPul+V3znltfyiqrMDjDhT5+tVYsr/
0iycLs604gWpdMiUtSIOUE8+nUSW3dqXqr8hv7P0o9/S88le//eiMi1JcYKPA
;; SignedKeyResponse 1.0 1544710698 ===========
example.com.        5     DNSKEY 256 3 14
PVP1IF7CtEu3+BiERm4jvZ0LaboxY0jSrb69gpaY5RJhIsuazjekjPQRlFGUMnH7LMH+TWRFM1Zz5z
pk4C0p1QfaTPcdOzOuis+QsfCftsrd5J7JprPQz22C+H2rt8qf
example.com.        5     DNSKEY 256 3 14
/5l3LxwUhcDB7CwLolL5OmWCV+TcMzudehZVlt8QKn7DcxXYaKoabrN0jXtPhpyZ4cPE+/
UMpT+008cTqrNr1luqFxUWYpHKeEzrYUB9FirnSMHM22z2CugQZ+KulKxc
example.com.        5     DNSKEY 257 3 14
eTcVgRXNDrZGLYvHkVu/e8uAIHjL4HdYkQdMlh/top2tnaVAmgaXCvr8BtgGDFLKy84DcCYTMtzzSl8
uzB5ef/ZGWH2QHFYgYTl03NTlluUqxcfeYe3ycQ0u5DzL2YYS
example.com.        5     RRSIG     DNSKEY 14 2 5 20181213142018 20181213124818 11919
example.com.
CrPvdWwkCnYiirqhFOLW9npkW92tmuf2Nz3UM/MM1+/7dCvbslmolD0hw+skaMtlvw8F34SV8wvmD
11uZLE8+b3RFgNT5iAei4mXScQpF5VfWp2CMXFzkeMVnGk77FZ+
;; SignedKeyResponse 1.0 1544710763 ===========
```

Offline KSK signing – ZSK team

- Import output from KSK team

```
$ keymgr -c zsk-team.conf example.com. import-skr skr
```

- Inform knot daemon to refresh state

```
$ knotc -c zsk-team.conf zone-sign example.com.
```

Knot DNS 2.8 – other features

- Configurable multithreaded DNSSEC signing for large zones
- New 'double-ds' option for CDS/CDNSKEY publication
- New knotc trigger 'zone-key-rollover' for immediate DNSKEY rollover
- … and many more

Future

- Testing, testing, testing…
- Hopefully migration of CZ will finish this year
- Any other TLD operating similar way?

Thank You

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https://www.knot-dns.cz/

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