Root Zone DNSSEC KSK Rollover

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ALAC Capacity Building Webinar

13 June 2018

The Basics

- **This talk is related to the Domain Name System, in particular, the security extensions made to it**
  - DNSSEC – DNS Security Extensions
  - The addition of digital signatures to data, using a hierarchy of asymmetric cryptographic keys to achieve massive scale
  - Two of the cryptographic roles defined for keys
    - Key Signing Key – a key that signs a bundle of other keys
    - Zone Signing Key – a key that is used to sign data

DNSSEC – Signing vs. Validation

- **DNS Security Extensions**
  - Digital signature is the basic element of work

- **Signing**
  - Zone Administrators add digital signatures
- **Validation**
  - Recursive resolvers, stub resolvers check the signatures in a few ways, cryptographic and other (time, authorization, sanity, etc.)

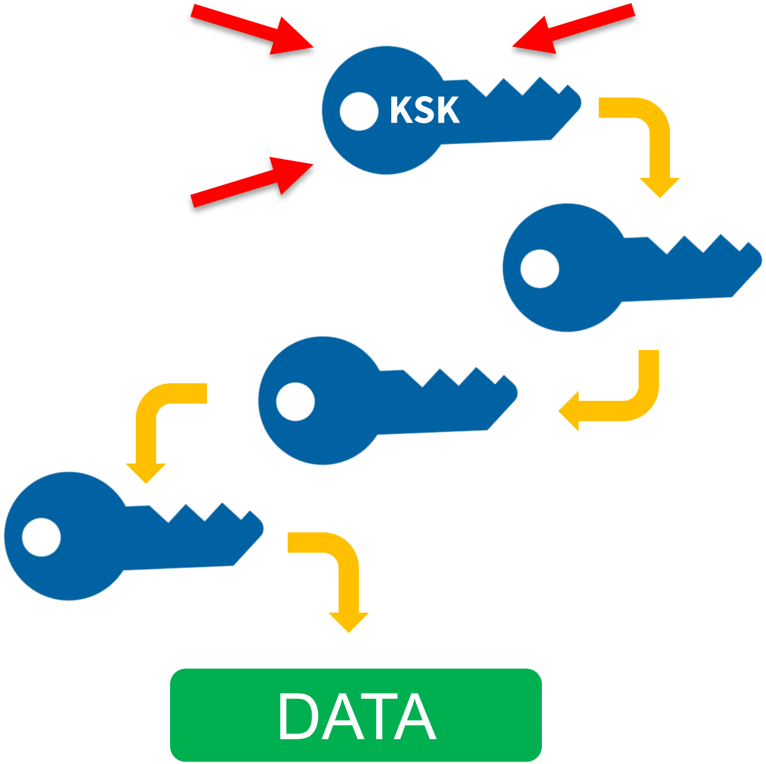
- **Impact of Root Zone DNSSEC KSK rollover**
  - DNSSEC validators (e.g., recursive resolvers run by some ISPs or enterprises) need to prepare, new "root" of trust

The Root Zone DNSSEC KSK

- The Root Zone DNSSEC KSK is the top most cryptographic key in the DNSSEC validation hierarchy

- Public portion of the KSK is a configuration parameter in DNS validating revolvers

- The other "role" is ZSK, zone signing key



Rollover of the Root Zone DNSSEC KSK

- **There has been one functional, operational Root Zone DNSSEC KSK**
  - Called "KSK-2010"
  - Since 2010, nothing before that

- **A new KSK will be put into production later this year**
  - Call it "KSK-2017"
  - An orderly succession for continued smooth operations

- **Operators of DNSSEC recursive servers may have some work**
  - As little as review configurations
  - As much as install KSK-2017

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Not a Typo

A result of the delay

Approach to the KSK Rollover

- **The rollover process emerged from plans developed in 2015**

- **The approach chosen is "slow and steady", taking advantage of existing practices and adhering to *Automated Updates of DNSSEC Trust Anchors***
  - RFC-Editor STD 74, also known as RFC 5011

- **Earlier recommendations were for operators to rely on "RFC 5011"**
  - But crucial milestones have passed for trusting the new key
  - Still we are still adhering to it for the revocation
  - In the future, we will likely rely on it again

Important Milestones

Event	Date
Creation of KSK-2017	October 27, 2016
Production Qualified	February 2, 2017
Out-of-DNS-band Publication	February 2, 2017, onwards
Automated Updates Publication	July 11, 2017, onwards
Sign (Production Use)	**October 11, 2017,** onwards
Revoke KSK-2010	January 11, 2018
Remove KSK-2010	Dates TBD, 2018

The "Was To Be"

Important Milestones - Updated

Event	Date
Creation of KSK-2017	October 27, 2016
Production Qualified	February 2, 2017
Out-of-DNS-band Publication	February 2, 2017, onwards
Automated Updates Publication	July 11, 2017, onwards
Sign (Production Use)	***October 11, 2018, tentative***
Revoke KSK-2010	***TBD***
Remove KSK-2010	***TBD***

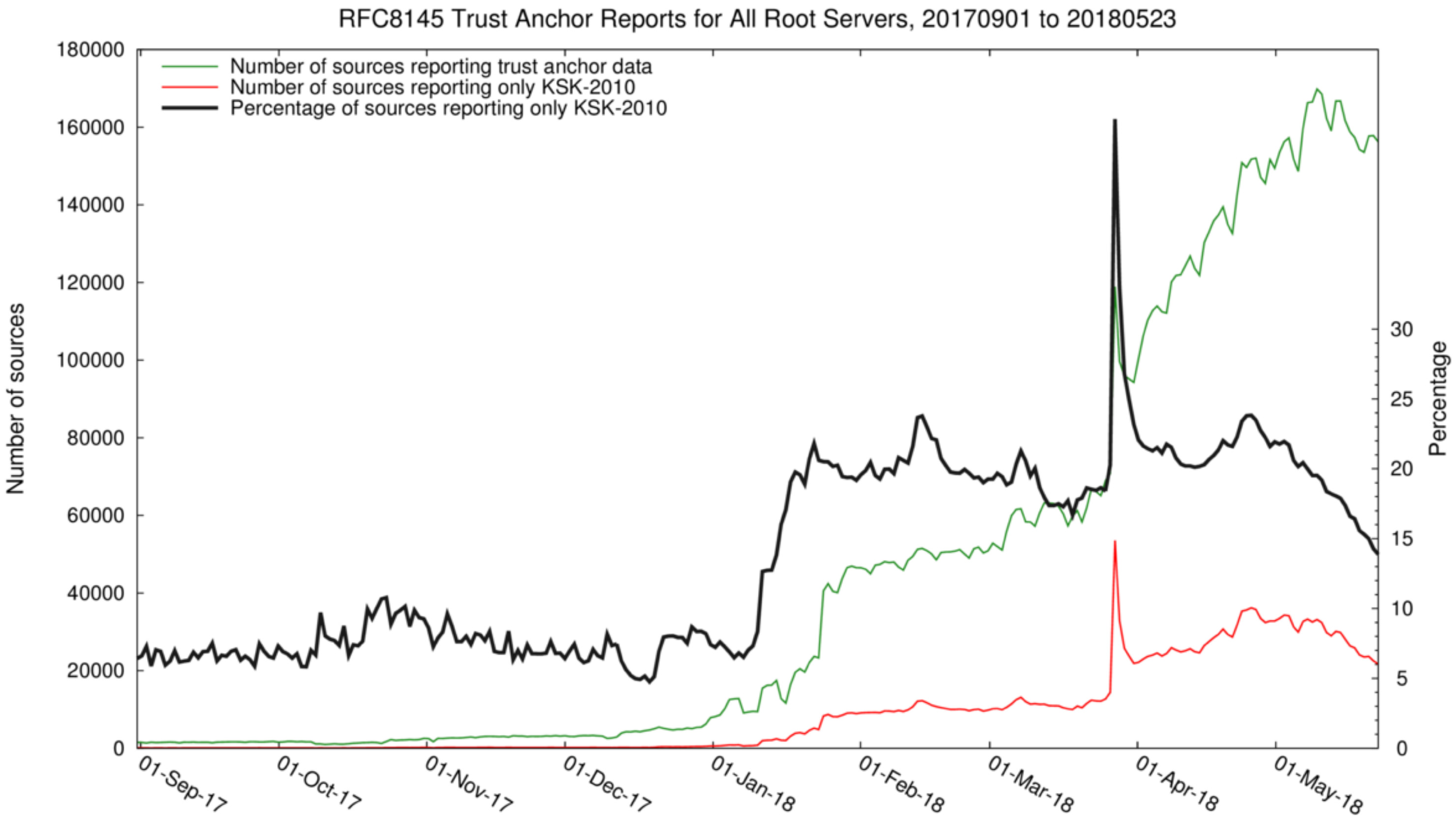
Why the Updated Milestones?

- When the rollover started there was no way to measure resolver configurations
- During the project, a new measure was invented, implemented and rolled out
- The new measure's results were at best confusing and concerning
- So the rollover was paused to have a look

The Measure

- **A readiness measure invented in the IETF**
  - *Signaling Trust Anchor Knowledge in DNS Security Extensions (DNSSEC)*, aka RFC 8145
  - Quickly turned into code
  - Combined with a noticeable "tech refresh"

High-level Look at Data



The Data

- **Starting with a Verisign researcher, looking at two root of the servers**
  - Noticed that the number of DNSSEC Validators having only the KSK-2010 was uncomfortably high (7%)

- **Results were confirmed by ICANN and better reporting set up**
  - Feed of data from nearly all of the root servers
  - Rates of "only KSK-2010" seemed to rise over time or as more reporters came on-line

- **But data is not always informative!**

The Early Analysis

- **Is the data clean?**
  - Some doubt about the measurement accuracy emerged
- **Look for some systematic cause**
  - No identifiable fault in popular DNS code
  - Although there is late-breaking news of a faulty app
- **Brute force investigation**
  - Contact sources of the "alarm"
  - Proved difficult
  - When there were responses, no significant systemic reason
  - Many dynamic addresses, raising questions about known use cases (running a DNS server on a dynamic address?)

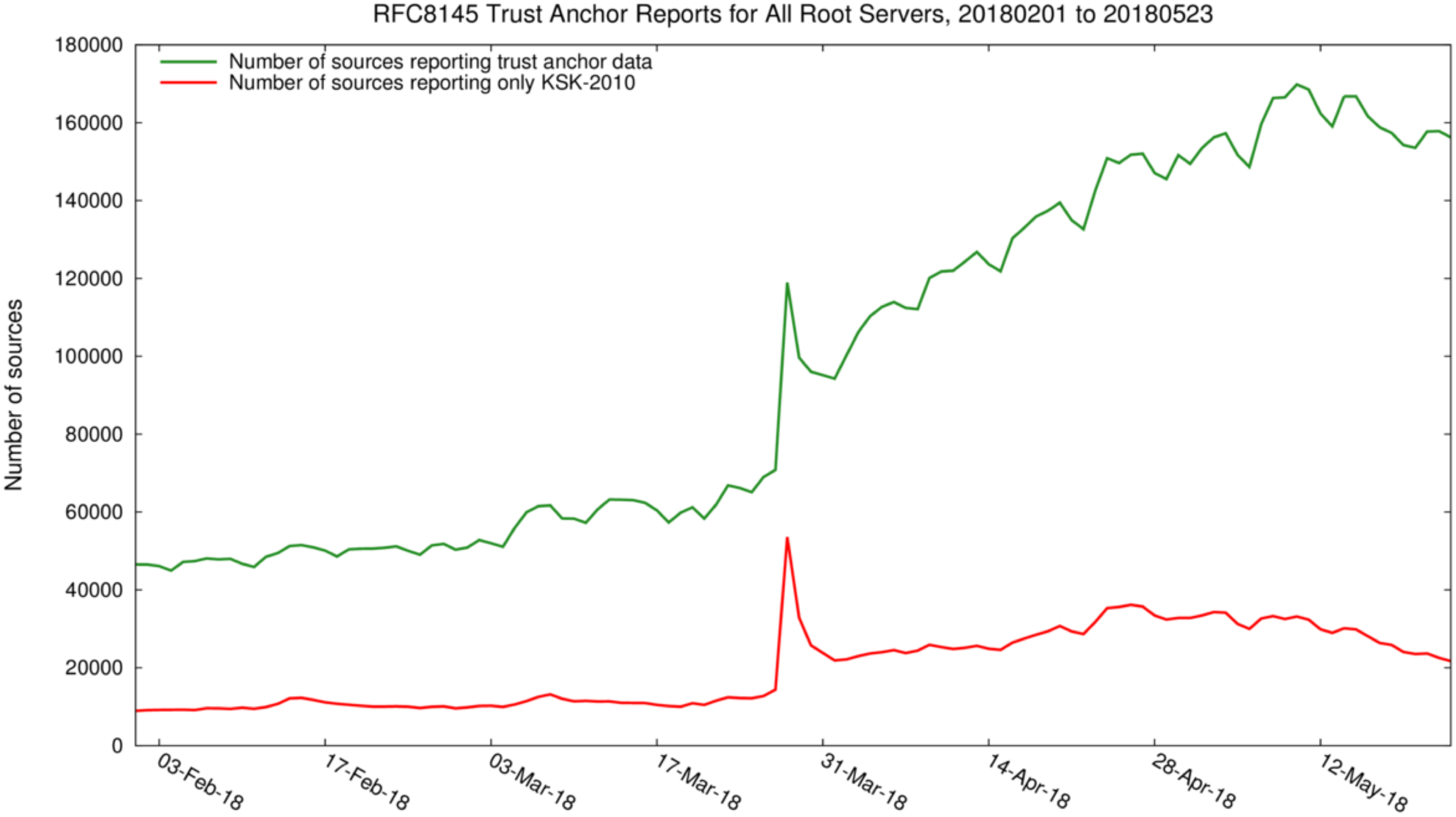
Decision to Pause the Rollover

- **September 2017, paused due to uncertainty**

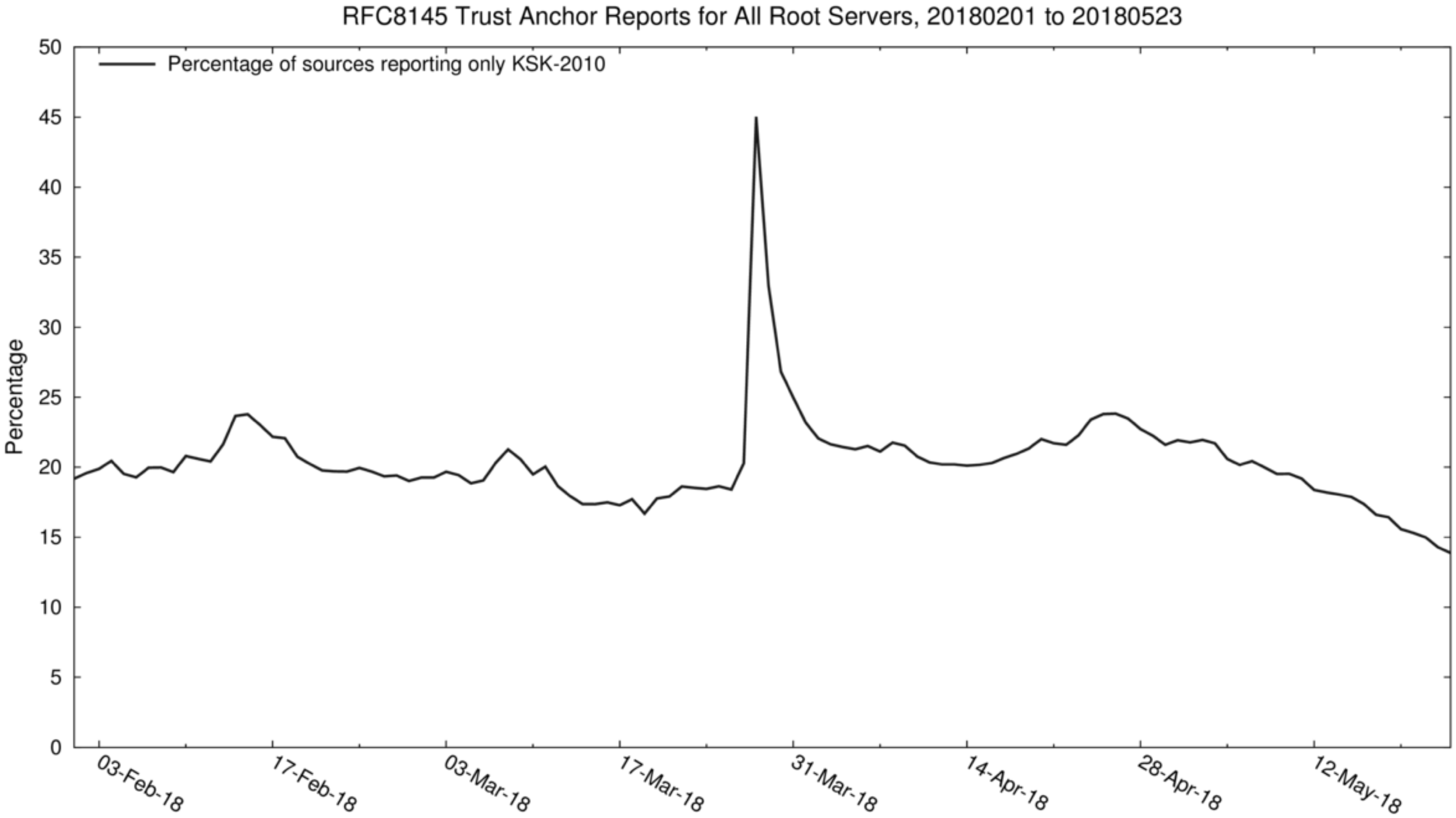
- **No fault in the project plan or execution**
  - (Which would have made this easier to fix)
  - Found that the plan's "backout/fallback" plans worked, no work was needed to enter the pause state

- **ICANN has engaged the community for ways forward**
  - Proposed an updated plan, asked for public comment
  - Open to external research on the issue
    - We don't have all the data, we can't/shouldn't in some cases

Since 2018 Feb 1



Since 2018 Feb 1



What Do These Graphs mean (for a CERT)?

- **When the rollover happens, there will be outages from operators not updating their configurations**
- **The dilemma: these are people who have not gotten the message despite massive efforts to get the word out**
  - In a pinch, these operators will reach out
  - If they sense it is "security" a CERT may be the place to call
- **Help is needed in preparing operators when possible, and mopping up afterwards**

Recognizing KSK-2017

- **The KSK-2017's Key Tag (defined protocol parameter) is**

  20326

- **The Delegation Signer (DS) Resource Record for KSK-2017 is**

```
.        IN   DS      20326 8 2
                        E06D44B80B8F1D39A95C0B0D7C65D084
                        58E880409BBC683457104237C7F8EC8D
```

"Root"

Note: liberties taken with formatting for presentation purposes

KSK-2017 in a DNSKEY Resource Record

- **The DNSKEY resource record is:**

```
. IN DNSKEY  257 3 8
          AwEAAaz/tAm8yTn4Mfeh5eyI96WSVexTBAvkMgJzkKTOiW1vkIbzxeF3
          +/4RgWOq7HrxRixHlFlExOLAJr5emLvN7SWXgnLh4+B5xQlNVz8Og8kv
          ArMtNROxVQuCaSnIDdD5LKyWbRd2n9WGe2R8PzgCmr3EgVLrjyBxWezF
          0jLHwVN8efS3rCj/EWgvIWgb9tarpVUDK/b58Da+sqqls3eNbuv7pr+e
          oZG+SrDK6nWeL3c6H5Apxz7LjVc1uTIdsIXxuOLYA4/ilBmSVIzuDWfd
          RUfhHdY6+cn8HFRm+2hM8AnXGXws9555KrUB5qihylGa8subX2Nn6UwN
          R1AkUTV74bU=
```

"Root"

Note: liberties taken with formatting for presentation purposes

Current "State of the System"

- **Sunny, as in “sunny day scenario” (despite the pause)**

  - The KSK is changed under good conditions
  - Slow and cautious approach
  - Following the *Automated Updates of DNSSEC Trust Anchors* protocol (also known as "RFC 5011")

- Most appropriate point regarding "Automated Updates"
  - Requires 30 days to adopt the new key, but the "required 30 days" has long since past

Rollover Process (Validator view)

- **Assumes DNSSEC is operating/configured to run**
  - The KSK rollover is following the Automated Updates process
    - But the original add hold down time has expired
  - (All) validators ***SHOULD ALREADY*** list the new KSK as trusted
    - Whether automatically updated or manually added
  - If KSK-2017 is not there now, manual updating is needed
- **Questions: How can one tell? How does one fix?**

How Can one Tell (if DNS Cache Validates)?

- **Send query for "dnssec-failed.org A" with DNSSEC flags**
  - If the response holds a return code of SERVFAIL, DNSSEC validation is enabled
  - If the response holds an IPv4 address, DNSSEC validation is not enabled

Testing for DNSSEC

```
$ dig @$server dnssec-failed.org a +dnssec
```

```
; <<>> DiG 9.8.3-P1 <<>> dnssec-failed.org a +dnssec
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: SERVFAIL, id: 10492
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL: 1


;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags: do; udp: 4096
;; QUESTION SECTION:
;dnssec-failed.org. IN A


;; Query time: 756 msec
;; SERVER: 10.47.11.34#53(10.47.11.34)
;; WHEN: Tue Sep  5 19:04:04 2017
;; MSG SIZE  rcvd: 46
```

DNSSEC validation is enabled!

Testing for DNSSEC

```
$ dig @$server dnssec-failed.org a +dnssec
```

DNSSEC validation is disabled!

```
; <<>> DiG 9.8.3-P1 <<>> dnssec-failed.org a +dnssec
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 5832
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags: do; udp: 512
;; QUESTION SECTION:
;dnssec-failed.org. IN A

;; ANSWER SECTION:
dnssec-failed.org. 7200 IN 69.252.80.75

;; Query time: 76 msec
;; SERVER: 192.168.1.1#53(192.168.1.1)
;; WHEN: Tue Sep  5 18:58:57 2017
;; MSG SIZE  rcvd: 62
```

How Can one Tell (if KSK-2017 is Trusted)?

- **BIND**
  - 9.11.x and onward "rndc managed-keys status"
  - 9.9.x and 9.10.x "rndc secroots"
- **Unbound**
  - Inspect the configured root.key file
- **PowerDNS**
  - "rec_control get-tas"
- **Knot Resolver**
  - Inspect the configured root.keys file
- **Microsoft Server**
  - "Administrative Tools"->"DNS"->"Trust Points"

Details on Checking Trust Anchors

- For further information, consult

https://www.icann.org/dns-resolvers-checking-current-trust-anchors

What Should Be Seen

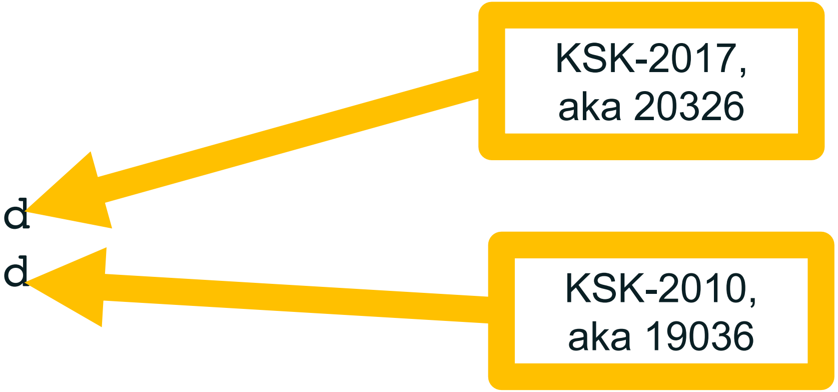
- **Two listed trust anchors for the root zone**
  - KSK-2017, key-id 20326
    - If you don't see this, the validator will fail beginning about October 11
  - KSK-2010, key-id 19036
    - If you don't see this, the validator is not working now!
- **Eventually KSK-2010 will "go away" - but not just yet**

E.g., BIND

```
bind-9.9.5-testconfig $ rndc -c rndc.conf secroots
bind-9.9.5-testconfig $ cat named.secroots
05-Sep-2017 09:24:06.361


 Start view _default


./RSASHA256/20326 ; managed
./RSASHA256/19036 ; managed
```



KSK-2017,
aka 20326

KSK-2010,
aka 19036

E.g., unbound

```
unbound $ cat root.key
; autotrust trust anchor file
;;id: . 1
;;last_queried: 1504239596 ;;Fri Sep  1 00:19:56 20[illegible]
;;last_success: 1504239596 ;;Fri Sep  1 00:19:56 2[illegible]7
;;next_probe_time: 1504281134 ;;Fri Sep  1 11:5[illegible]14 2017
;;query_failed: 0
;;query_interval: 43200
;;retry_time: 8640
. 172800 IN DNSKEY 257 3 8
AwEAAaz/tAm8yTn4Mfeh5eyI96WSVexTBA[illegible]MgJzkKTOiW1vkIbzxeF[illegible]/4RgWOq7HrxRi[illegible]IFlExOLAJr5[illegible]
mLvN7SWXgnLh4+B5xQlNVz8Og8kvArMt[illegible]ROxVQuCaSnIDdD5LKyW[illegible]d2n9WGe2R8PzgC[illegible]3EgVLrjyBxW[illegible]zF
0jLHwVN8efS3rCj/EWgvIWgb9ta[illegible]DK/b58Da+sqqls3eNb[illegible]/pr+eoZG+SrDK[illegible]eL3c6H5Apxz7[illegible]jVc1
uTIdsIXxuOLYA4/ilBmSVIzuDW[illegible]UfhHdY6+cn8HFRm+2[illegible]AnXGXws9555KrU[illegible]ihylGa8subX[illegible]n6UwN
R1AkUTV74bU= ;{id = 20326 (ksk), size = 204[illegible]} ;;state=2 [  VALID  ] ;;count[illegible]0
;;lastchange=1502438004 ;;Fri Aug 11 03:[illegible].24 2017
. 172800 IN DNSKEY 257 3 8
AwEAAagAIKlVZrpC6Ia7gEzahOR+9W29eu[illegible]nVVLOyQbSEW0O8gcCjFFVQUTf6v58fLjw[illegible]0YI0EzrAcQqB
GCzh/RStIoO8g0NfnfL2MTJRkxoXbfDa[illegible]VPQuYEhg37NZWAJQ9VnMVDxP/VHL496M/Q[illegible]kjf5/Efucp2gaD
X6RS6CXpoY68LsvPVjR0ZSwzz1a[illegible]N9dlzEheX7ICJBBtuA6G3LQpzW5hOA2hzCT[illegible]PJ8LbqF6dsV6DoB
QzgulOsGIcGOYl7OyQdXfZ57re[illegible]geu+ipAdTTJ25AsRTAoub8ONGcLmqrAmRLK[illegible]dfwhYB4N7knNnulq
QxA+Uk1ihz0= ;{id = 19036 (ksk), size = 2048b} ;;state=2 [  VALID  ] ;;count=0
;;lastchange=1459820836 ;;Mon Apr  4 21:47:16 2016
```

KSK-2017,
aka 20326

KSK-2010,
aka 19036

Both are VALID

If One Sees Both KSKs trusted

- Take a nap during the next few slides

How does one fix?

- If one does not see both KSKs as trusted, then manual adjustments need to be made

- "How to's" are tool and environment dependent

https://www.icann.org/dns-resolvers-updating-latest-trust-anchor

Where to Get KSK-2017 Manually

- **Via the official IANA trust anchor XML file at https://data.iana.org/root-anchors/root-anchors.xml**
  - Contains the same information as a DS record for KSK-2017
  - Validate root-anchors.xml with the detached signature at https://data.iana.org/root-anchors/root-anchors.p7s
- **Via DNS (i.e., ask a root server for "./IN/DNSKEY")**
  - Validate the KSK-2017 by comparison with other trusted copies
- **Via "Other means" ...**

What “other means” for a manual approach?

- **Most software/OS distributions of DNSSEC**
  - Embed copies of the KSK (now KSK-2010, later KSK-2017)
  - In contact with as many distributors as possible

- **Compare with the key from these slides**
  - Presuming you trust the contents of this presentation and the presenter :-)

- **Obtain a copy from another operator, or other trusted source**
  - How well do you trust "them"?

Symptoms of the Wrong Trust Anchor

- **DNSSEC validation fails for everything, resulting from an inability to build a chain of trust**

- **All DNS responses will "SERVFAIL"**
  - Even if the target zone is not DNSSEC signed

- **Look in logs for validation failures, implementation specific**

The Future

- **Revocation of KSK-2010 in ~~2018~~ the future**
  - Automated Updates will be used

- **There will be more KSK rollovers**
  - When, we don't know (yet)

  - What to do – consider and configure Automated Updates capabilities
    - Whether it fits operational architectures

Tools and Resources Provided by ICANN

- **Following slides will describe these further**

- **A python-language script to retrieve KSK-2010 and KSK-2017**
  - get_trust_anchor.py

- **An *Automated Updates* testbed for production (test) servers**
  - https://automated-ksk-test.research.icann.org

- **Documentation**
  - https://www.icann.org/resources/pages/ksk-rollover
  - plus what was mentioned earlier

get_trust_anchor.py

- **A tool that retrieves "https://data.iana.org/root-anchors/root-anchors.xml" and validates all active root KSK records**

  https://github.com/iana-org/get-trust-anchor

  - Contains extensive in-code comments/documentation
  - Download & run in python v2.7, v3 or newer

    ```
    $ python get_trust_anchor.py
    ```

  - Writes DS and DNSKEY records to files that can be used to configure DNSSEC validators

ICANN’s *Automatic Updates* Testbed

- **Designed to allow operators to test whether production resolver configurations follow *Automated Updates***
  - The goal is to test production resolvers with live test zones executing a KSK rollover in real time
    - A full test lasts several weeks
  - Joining the testbed involves:
    - Configuring a trust anchor for a test zone such as *2018-05-13.automated-ksk-test.research.icann.org*
    - Receiving periodic emails with instructions for what to do and what to watch for
  - ***https://automated-ksk-test.research.icann.org***

Educational/informational Resources

- **ICANN organizes KSK rollover information here:**

  https://www.icann.org/resources/pages/ksk-rollover

  - Link to that page can be found on ICANN's main web page under "Quicklinks"

  - Contains links to what's been covered in this presentation, the get_trust_anchor.py script and information on ICANN's live testbeds

Those Reference URLs, once again

https://www.icann.org/dns-resolvers-checking-current-trust-anchors

https://www.icann.org/dns-resolvers-updating-latest-trust-anchor

Engage with ICANN

Join the ksk-rollover@icann.org mailing list

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