Technical and Business Considerations for DNSSEC Depolyment

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Objectives

- Understanding the main technical & business impacts
- Are these helping or hindering DNSSEC deployment?
- What could or should be done to improve things?

TECHNICAL CONSIDERATIONS AND MYTHS

Zone size
CPU load
Traffic levels, need for rate-limiting & traffic shaping
Key rotation (rollover)
Tooling & debugging
Use cases

Zone & Cache Size

- Signed zones are typically 5-10 times larger than unsigned ones
  - Approximately 4 times as many resource records
  - RRSIGs are big
- So what?
  - Commodity RAM is cheap: ~$20 for 4GB of DDR3
  - Disk space is cheap too: 1TB costs ~$50
- Name server's RAM footprint might be an issue

CPU Load Considerations

- 1024-bit RSASHA1 keys, 3GHz Xeon, 1 CPU
- Signing:
  - ~1800 signatures/second
- Validation:
  - ~24,000 validations/second
- Off-the-shelf hardware & software should be good enough most (or all?) of the time

Network Considerations

- DNSSEC **requires** EDNS0
  - DO bit, larger payloads, etc.
  - Want to avoid truncation in both DNS response and the underlying MTU for packets/frames
- Lots of broken stuff assumes DNS only goes over UDP and always has packets < 512 bytes
  - DNSSEC kills these false assumptions
  - Firewalls sometimes get misconfigured like this
  - CPE is notorious for getting this wrong too

DDoS Exposure

- DNSSEC is a vector for DDoS amplification attacks
  - 50-60 byte query typically generates 1-2KB of response
- Use Response Rate Limiting (RRL)
  - Provided in BIND9.10+ source distribution
    - Patches available for BIND9.9
  - Also in recent versions of other DNS implementations
- Traffic shaping might also help
  - Edge routers and/or kernels

Secure Hardware

- Hardware Security Modules (HSMs)
  - Tamper-proof hardware for storing keys
    - Expensive and concerns about managing lots of keys
      - Largely a niche solution for very important security-critical zones
  - Security protocols for managing access tokens
- HSM hardware isn't really needed most of the time
  - HSM in software (OpenDNSSEC) might be good enough for a large registrar or small TLD registry

DNSSEC SIGNING CHOICES

The main choices and trade-offs to consider when deploying Secure DNS include:

Which versions of DNSSEC to use
Crypto algorithms
Managing keys & signatures
Monitoring & reporting
Tools & tooling
What functionality & UIs should customers see?

Key Lengths - 1

- How large should the key signing keys (KSK) and zone signing keys (ZSK) be?
- Obvious Goldilocks trade-offs:
  - Not too big or too small; just nice
- Don't assume large keys are "stronger" than small ones or *vice versa*
- Could key size (or algorithms) be something to discuss with stakeholders?
  - Some might care (a lot), most probably won't

Key Lengths - 2

- What's the window for cryptanalysis of some key?
- Some rules of thumb:
  - Short-lived keys don't need to be big
  - Long-lived keys should be reasonably big
- Suggestion:
  - Change a small ZSK once a week/month (maybe)
  - Change a large KSK once a year (maybe)
- Whatever's done for the . *`tld`* zone or at the root should be more than good enough for your zones

Signature Duration

- Signature expiry intervals need careful thought too
- Obvious Goldilocks trade-offs again:
  - Not too short or too long; just nice
    - Short expiry => more CPU cycles for validators
    - Long expiry => “stale” signatures may cause validation failures when something has to be changed in a hurry
- Potential for cryptanalysis of long lived signatures?
- Might be best to start off by following what the parent zone does and adjust in light of experience

Key Rollover - 1

Key Rollover - 2

- This should happen at regular, planned intervals
  - Might have to happen sooner in an emergency: ie when current key(s) are considered tainted/compromised
- Hard to get the choreography right
  - Too many moving parts for KSK rollovers
- Signing tools are getting a lot better at managing key rollovers and signing policies in general
  - Metadata in BIND's ***`K*.private`*** files
  - OpenDNSSEC

Tooling

- Early signing and validating tools were clunky
- Much improved now but could be better still
  - Stronger focus on supporting local policies
  - Use obvious primitives that hide icky detail:
    - **`pdnssec secure-zone/add-zone-key`** in PowerDNS
    - Windows GUI-based DNS Manager
- Essentially just click "Sign My Zone"

UI Considerations

- Most end users and administrators won't want or need to see DNSSEC
  - How best to "hide" DNSSEC operations on the control panel or web site?
    - Perhaps just add a "click here to sign" button?
- Might be the end of the road for anyone managing DNS zone files with **`emacs`** or **`vi`** or **`perl`**
  - No user serviceable parts inside...

Monitoring & Reporting

- Add DNSSEC elements to name server monitoring and reporting systems
  - Check that zones get signed when expected (or not)
  - Look out for zones with close-to-expiring signatures
  - Monitor key rollovers closely
- Check that zone signing behaves as expected
- Are KSK changes getting notified to the parent?
  - Does the parent's DS match the child's KSK?
  - Does the parent publish new DS records in good time?

Key Management for Customer & End User Zones

- Who will generate/manage the keys for ***example*.com**, you or the customer?
- Risks and benefits in both approaches
  - Who gets blamed if something breaks?
  - Is this an extra (chargeable?) service?
  - Who has responsibility for choosing the keys, rotating them, revoking them, etc?
  - What about customer support and helpdesk staff?

Validation Challenges

- Switching on validation breaks response rewriting
  - RPZ, content filtering, anti-abuse protection measures, NXDOMAIN rewriting, parental controls, etc.
  - Government and law enforcement blacklists
  - IPR takedown/block requests
- Clumsy workarounds
  - Forward "vanilla" queries to validating resolvers, send the dodgy ones elsewhere
  - Might be seen as needless extra complexity

What deployment barriers?

- The software and tools work reasonably well
- However it's not always clear:
  - How to put them together and use/debug things
  - Define policies or understand the trade-offs
- Where are the white papers, case studies and business justifications?
  - "We switched on DNSSEC and…."
  - Are experiences at the root or a TLD registry or a big ISP meaningful for ***`example.com`***?

Advice Needed!

- DNS administrators need guidance on DNSSEC deployment considerations and trade-offs:
  - Local policy choices on: key selection, signature duration, rollovers, negative trust anchors, etc.
- NIST report 800-81-2 is wonderful
  - Tough reading for non-experts — 130+ pages!
- Need something similar (and shorter) on business justifications
  - Convince the CEO that using DNSSEC is a Good Thing

Where's the killer app?

- Not much software uses or needs DNSSEC today
  - Proof of concept web plug-ins mostly
- DANE could/should be the driver
  - Lookup certificates and other crypto material from the DNS
  - IETF's ACME WG standards coming to browsers Real Soon Now
    - Let's Encrypt certificates as an alternative to ones issued by conventional CAs
  - DANE support emerging in MTAs

Deployment Today - 1

- Most of the important TLDs are signed
  - Contractual requirement for new gTLDs
  - Some European ccTLDs have 70%+ signed delegations
    - Registrar discounts rather than DNSSEC enthusiasm
- Very few of the busiest domain names are signed
  - Just **`paypal.com`** and **`nih.gov`** of the Alexa top 100
- The number of signed zones looks OK-ish quantitatively but not so good qualitatively

Deployment Today - 2

- Validation uptake is a **lot** healthier
  - Around 15% of users world-wide depend on a validating resolver
  - See **`https://stats.labs.apnic.net/dnssec`**
- Much of this is attributed to just three providers:
  - Comcast, google's 8.8.8.8 and TeliaSonera
- This is great, but are they validating anything that actually matters?
- What are the other big ISPs doing?

Externalities

- For signers:
  - Why sign if almost nobody is thought to be validating?
  - What's the impact when/if someone else's validator fails?
- For validators:
  - Why validate if hardly anyone important signs their zones?
  - When someone else's signer screws up, you end up taking the hit(s) for their mistake(s). What will the impact(s) be?
    - i.e. A rival ISP's customers have no problem getting to ***badlysigned*.com** because that ISP doesn't validate while your customers can't because we are validating

Customer Support

- Training & education for helpdesk/support staff
  - Ditto for customers
- DNSSEC troubleshooting
  - N-th level support staff will need training
    - How to tell the difference between a Secure DNS validation error **`SERVFAIL`** and a regular **`SERVFAIL`**
    - How to troubleshoot validation problems and fix or escalate them
      - Expired signatures, key mismatches, etc.

Documentation

- Make sure everything gets properly documented:
  - Design/architecture, deployment plans & roadmap
- Policies (e.g. key sizes, rotation, signing interval, audit, etc.)
- Write a DNSSEC Policy/Practice Statement - DPS
  - RFC6841 is a good starting point
- DPS for the root zone is an excellent template:
  - **`https://www.iana.org/dnssec/icann-dps.txt`**
- Document DNSSEC tools and new processes
- Produce white papers and use cases for stakeholders?

Training

- How will your staff get trained?
  - Knowledge transfer from in-house and external experts
  - Commercial training courses, webinars, etc.
- Not just for your DNS team
  - Network operations & system administrators
  - Developers & helpdesk
  - Customer relations & support staff
  - Upper management

The “Last Mile” Issue

- AD header bit is set by the validating resolver
  - Vulnerable to spoofing by an attacker
- Can the path between some stub resolver and its resolving server be trusted?
  - Windows uses IPsec to protect this
- If the local net isn’t considered secure, run a validating resolver on the edge device itself
- IETF’s DNS-over-TLS could be the answer

Validator Crunch Time!

- Major test is just around the corner
  - First ever rollover of root zone's KSK due Real Soon Now
- Validators which don't support or use RFC5011 key rollover will almost certainly break
  - BIND configurations with **`trusted-keys{}`** statements
  - Old/clunky/buggy DNSSEC implementations
- IANA's giving plenty of advance warning
- Nothing important should fail
  - Famous last words….

Negative Trust Anchors

- How to tell the validator that DNSSEC for some domain(s) are broken
  - Don't validate these domains for now, but carry on validating elsewhere
  - Provably insecure (and possibly bad) data might be better than nothing
- Features in BIND and **`unbound`** to support this
  - A necessary evil - unfortunately
  - Workarounds for other people's mistakes

DNSSEC Troubleshooting

- Can be **very** painful
- Debugging vanilla DNS problems is hard enough
- DNSSEC makes things even harder
  - Checking DNSSEC-related RRtypes, keeping track of key IDs & flags, algorithm numbers, etc.
- Tools are getting better, but still **far** too difficult for many DNS administrators
  - Error messages should be clearer: "you forgot to re-sign", "that signature has the wrong hash value", "there's no DS record for this KSK", etc.

`drill`

- The best DNSSEC debugging tool **by far**
  - Also replicates **`dig`**'s commonly used functionality
  - Open source from NLnetLabs
- Can illustrate validation in action
  - Shows which keys (algorithms & key lengths) are used
  - Work on a single signature or top-down from the root
- Pinpoint stale keys & signatures
- Identify DS record and KSK mismatches
- **`drill -TD`** ***`some-domain`*** is just awesome!

`delv`

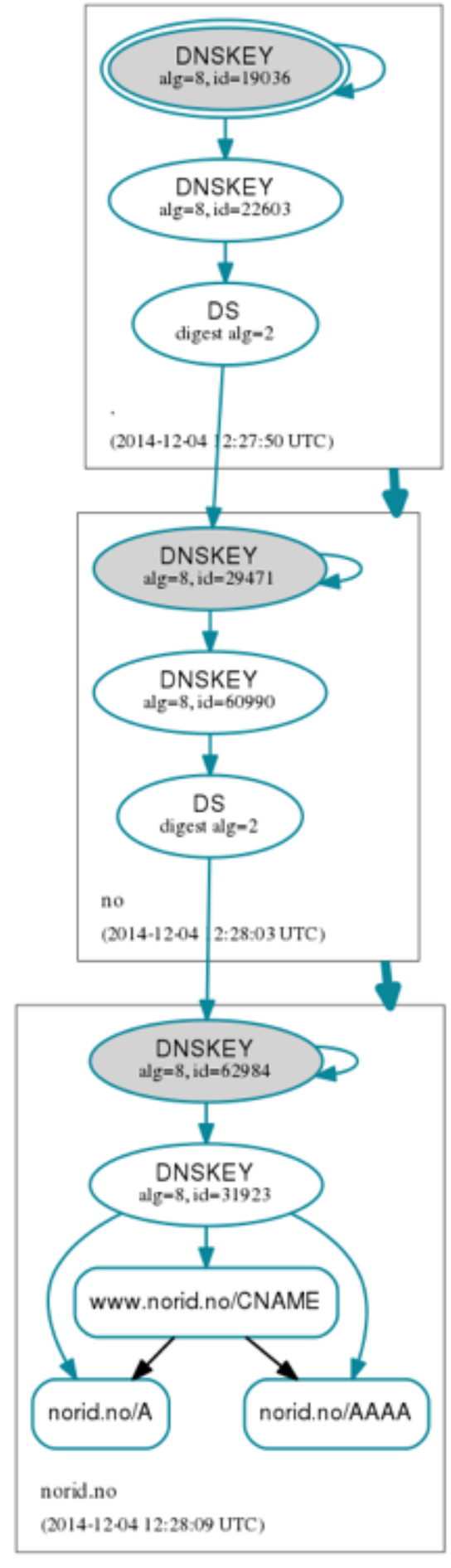
- ISC's answer to **`drill`**
- Distributed in BIND9.10+
- Command-line options almost identical to **`dig`**
- Not as chatty as **`drill`**
- Use the **`+vtrace`** option to see the validations

DNSVIZ

- A web-based DNS visualisation tool
  - Draws nice pictures
  - Can display details of revoked keys
- Visit **`dnsviz.net`** and type in your favourite signed domain name
  - Uses the web site's validating resolver, not yours
  - Doesn't check your validator's configuration
  - Can't check internal-only signed domains
    - Download DNSVIZ source code and run it locally?

DNSVIZ Example

- Hover over elements to see details of the key, algorithm, TTL, key tags, etc
- Shaded elements are the KSKs
- Double circle around the trust anchor: the root's KSK



A Never Ending Task?

- Keeping DNSSEC software and tools up-to-date
  - Can you rely on your vendor/supplier?
- Crypto arms race
- Changing DNSSEC keys regularly
- Tweaking DNSSEC policies
- Interactions with parent zone(s)
- New operational problems and failure modes
- Customer service/support and helpdesk issues

QUESTIONS?