Automation of DNSSEC Provisioning & Maintenance

Shumon Huque & Steve Crocker
September 6th 2023
DNS-OARC 41 Workshop
Da Nang, Vietnam

Goals

- Fully automate DNSSEC provisioning & maintenance.
- Initial provisioning: zone signing and initialization of DS records.
- Ongoing maintenance:
  - SEP Key Rollovers and corresponding updates of DS records
- Multi-Signer operation
  - Coordinating keys (& other configuration) across multiple DNS providers serving a zone
- Seamless Transfer to a new Operator
  - Transitioning a signed zone non-disruptively to another DNS operator, and without loss of security. (Uses multi-signer techniques)
- *Robust automation in this space will make it easier to deploy & manage DNSSEC, and also help reduce operational errors.*

Automating Updates of DS Records

- **DS: Delegation Signer** record ([RFC 4034](#)) - a signed record in the parent zone that indicates that a child zone is signed, and also indicates which key (SEP/KSK/CSK) is valid for the child zone.
- Establishing a new or updated DS record (e.g. when a child zone is newly signed or changes its SEP key) requires **coordination with the parent zone, and the goal is to smoothly automate this interaction**.

DS Automation: Registrar (or registrant) operates the zone

- When the DNS Registrar is also the DNS Operator, automating DS record updates is relatively straightforward
- Registrar is operating the zone and thus performing initial DNSSEC signing, and ongoing key rollovers
- Thus knows precisely when a DS update is needed
- This can automatically trigger updates of DS via their pre-existing authenticated channels to the DNS registry (e.g. EPP)

(Note: Zone owner operating DNS server infrastructure themselves can also automate DS updates fairly easily by having direct access to the authenticated registrar APIs)

DS Automation: 3rd party DNS operator

- When the DNS Operator is a 3rd party (i.e. not the registrar), then things are a bit more complicated.
- The main mechanism we have today is the use of **CDS and/or CDNSKEY records** ([RFC 8078](#) - "Managing DS Records from the Parent via CDS/CDNSKEY")
- These are published in the child. They signal to the parent that a key change for the zone has happened and the DS record (set) needs to be updated.

Detection of CDS/CDNSKEY: Scan or Notify?

- How does parent detect the new CDS/CDNSKEY records?
- Dominant method today: **Polling the child zone**.
- Doing this comprehensively at a registry means periodically scanning all the secure delegations and querying each of them.
- **Scanning is time consuming & inefficient**. Will it scale very large registries, or as DNSSEC deployment truly ramps up?
- An explicit notification based system would be more efficient.
  - REST API based systems could employ an HTTP based mechanism (web hook?)
  - Proposed enhancement: **Generalized NOTIFY:**
    https://datatracker.ietf.org/doc/draft-thomassen-dnsop-generalized-dns-notify/

Bootstrapping signed zone

- Enabling DNSSEC for the first time?
  - The signed CDS/CDNSKEY records in the child cannot be trusted, because there is no pre-established secure chain of trust.
- RFC 8078 permits weak forms of initial validation. Some have adopted additional methods: multi-vantage point confirmation of responses, etc. But ideally, we should have strongly authenticated bootstrapping.
- "Authenticated Bootstrapping" protocol, can solve this problem in some configurations
  - https://datatracker.ietf.org/doc/draft-ietf-dnsop-dnssec-bootstrapping/
  - Where the DNS operators manages the nameserver names in a signed zone.
  - Doesn't work in other cases, e.g. in-domain nameservers, or nameserver names in other unsigned zones.

Possible Ways to Convey the DS key from 3rd party DNS Provider

	Direction	
Upper Side	Push (Calling) DNS Provider calls API at Ry, Rr	Pull (Polling) DNS Provider publishes CDS and/or CDNSKEY
Registry	1. Requires API	3. RFC 8078
Registrar	2. Requires API	4. RFC 8078

Some ccTLDs

Registry

Registrar

?

DNS provider

Possible

Some ccTLDs Use
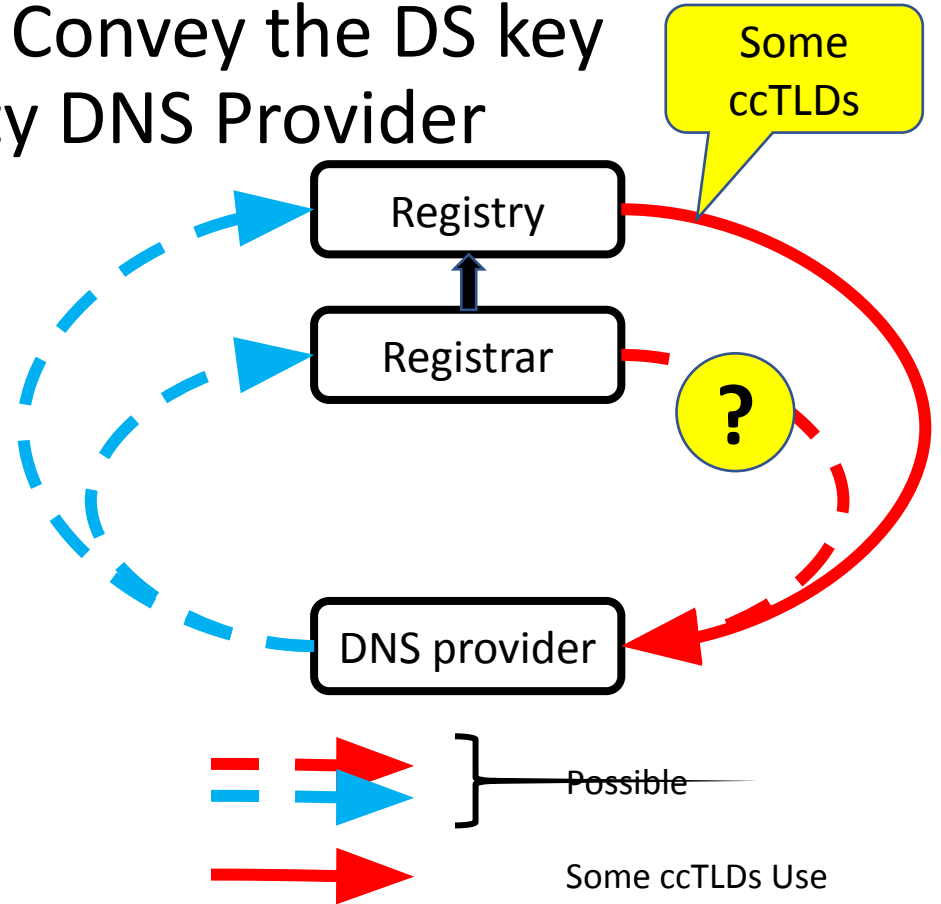
Scanning by the Registrar?

Easier integration of 3rd-party DNS operators

Registrar (rather than registry) polls CDS and CDNSKEY records in domains under their management but hosted at 3rd parties.
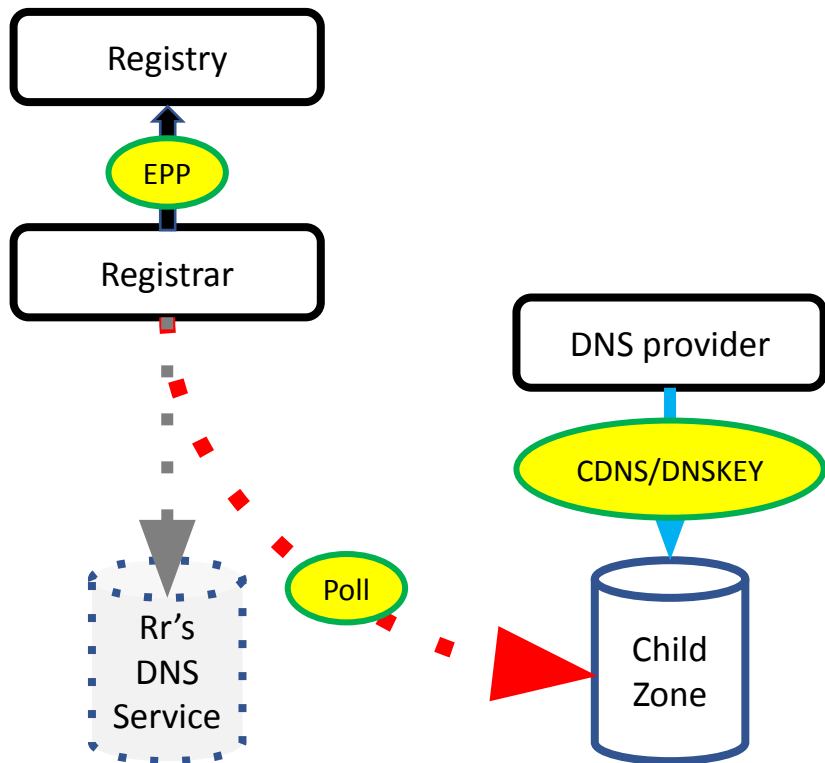
Then automatically updates DS records in the registry via the usual means at their disposal (e.g. EPP or some other authenticated channel)

GoDaddy: Current and proposed DS updates - B. Dickson, ICANN 76, Mar 2023

DomainNameShop: https://domainname.shop/faq?id=395&section=7&currency=USD&lang=en
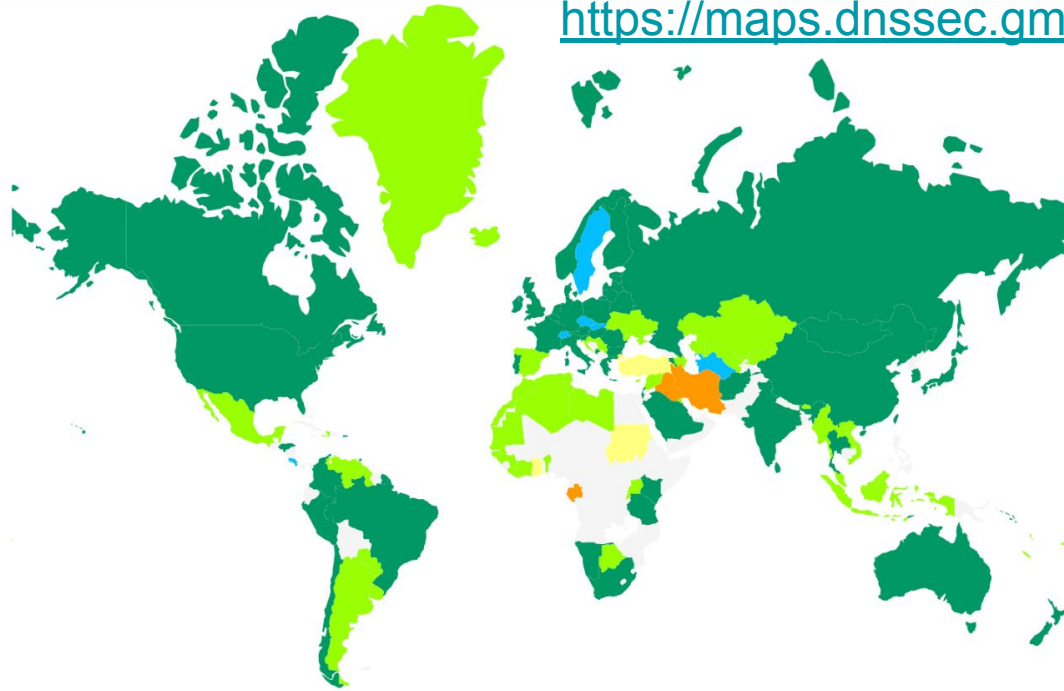
Is scanning by GTLD registries possible?

- Almost all CDS/CDNSKEY scanning today is done by ccTLDs.
- Is a GTLD registry allowed to scan & take action on CDS/CDNSKEY records in registrant zones directly?
- Lack of clarity around possible ICANN contractual impediments.
- Are formal RSEP (Registry Services Evaluation Policy) requests required?
- See ICANN 69, October 2020
  - [DS Automation - Non Technical Considerations](#) - Jim Galvin
- Also ICANN 76, March 2023
  - [DNS Child Updates in the gTLD Space](#) - Francisco Arias
  - [CDNSKEY in Tango Registry Services](#) - Michael Bauland

https://maps.dnssec.gmu.edu/

General Statistics

Total ccTLD's

160

●	Experimental	8	5%
●	Announced	4	3%
●	Partial	0	0%
●	DS in Root	69	43%
●	Operational	69	43%
●	DS Automation	8	5%

Ascension Isl...	ARUBA	BRAZIL	COTE D'IVOIRE	DENMARK	FRANCE	GREECE	INDONESIA	JERSEY	LAO PEOPLE'...	LIBYAN ARAB ...	MONTSERRAT	NIUE	REUNION	SWEDEN	FRENCH SOU...	TAIWAN, PRO...	VIET NAM
ANDORRA	ALAND ISLAN...	BHUTAN	CHILE	DOMINICA	GABON	SOUTH GEOR...	IRELAND	JAPAN	LEBANON	MOROCCO	MAURITIUS	NEW ZEALAND	ROMANIA	SINGAPORE	THAILAND	TANZANIA, U...	VANUATU
AFGHANISTAN	AZERBAIJAN	BOUVET ISLA...	CHINA	ALGERIA	UNITED KING...	GUINEA-BISS...	ISRAEL	KENYA	SAINT LUCIA	MONACO	MEXICO	PERU	SERBIA	SAINT HELEN...	TIMOR-LESTE	UKRAINE	WALLIS AND ...
ANTIGUA AN...	BELGIUM	BOTSWANA	COLOMBIA	ESTONIA	GRENADA	GUYANA	INDIA	KYRGYZSTAN	LIECHTENSTE...	MOLDOVA, RE...	MALAYSIA	POLAND	RUSSIAN FED...	SLOVENIA	TURKMENIST...	UGANDA	SAMOA
ANGUILLA	BULGARIA	BELARUS	COSTA RICA	SPAIN	GUERNSEY	HONG KONG	BRITISH INDI...	KIRIBATI	SRI LANKA	MONTENEGRO	NAMIBIA	SAINT PIERRE...	RWANDA	SVALBARD A...	TUNISIA	UNITED STAT...	MAYOTTE
ARMENIA	BAHRAIN	BELIZE	CHRISTMAS I...	FINLAND	GHANA	HONDURAS	IRAQ	KOREA, REPU...	LIBERIA	MADAGASCAR	NEW CALEDO...	PUERTO RICO	SAUDI ARABIA	SLOVAKIA	TONGA	URUGUAY	SOUTH AFRICA
ARGENTINA	BENIN	CANADA	CYPRUS	FIJI	GIBRALTAR	CROATIA	IRAN, ISLAMI...	KUWAIT	LITHUANIA	MYANMAR	NORFOLK ISL...	PORTUGAL	SOLOMON IS...	SENEGAL	TURKEY	UZBEKISTAN	ZAMBIA
AUSTRIA	BERMUDA	COCOS (KEEL...	CZECH REPU...	MICRONESIA, ...	GREENLAND	HAITI	ICELAND	CAYMAN ISL...	LUXEMBOURG	MONGOLIA	NETHERLANDS	PALAU	SEYCHELLES	SINT MAARTE...	TRINIDAD AN...	SAINT VINCE...	
AUSTRALIA	BRUNEI DARU...	SWITZERLAND	GERMANY	FAROE ISLAN...	GUINEA	HUNGARY	ITALY	KAZAKHSTAN	LATVIA	MAURITANIA	NORWAY	PARAGUAY	SUDAN	SYRIAN ARAB...	TUVALU	VENEZUELA, ...	

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General Statistics

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- CH - Switzerland
- .LI - Lichtenstein
- .CZ - Czech Republic
- .SK - Slovakia
- .SE - Sweden
- .NU - Niue
- .CR - Costa Rica
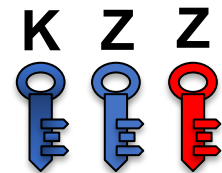
DS Automation support in Implementations

- DNS Software Implementations.
  - ISC BIND - CDS/CDNSKEY publication plus parent DS set polling
  - Knot DNS ("Fully automated KSK rollovers")
  - PowerDNS (base CDS/CDNSKEY publication support)
- Operators/Managed DNS Providers?
  - For polling based implementations, perhaps nothing needs to be supported, apart from base CDS/CDNSKEY publication support.
  - But base CDS/CDNSKEY support is lacking at many DNS providers.
  - Known operators: Cloudflare, DNSimple, deSEC

Multi-Signer DNSSEC

- Multi-Signer DNSSEC Models
  - RFC 8901: https://www.rfc-editor.org/rfc/rfc8901.html
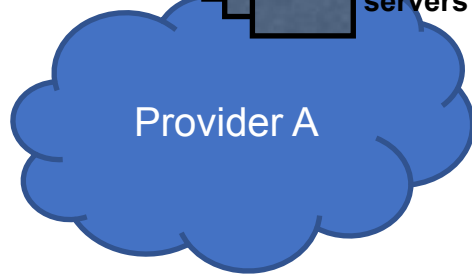- Mechanisms to enable multiple DNS providers to cooperatively serve the same DNS zone, but signing independently with their own keys.
- Presentation from OARC30 Workshop in 2019:
  - https://indico.dns-oarc.net/event/31/contributions/683/attachments/667/1096/multi-signer.pdf
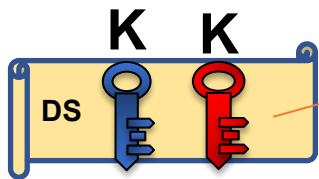
● Cross import provider ZSKs
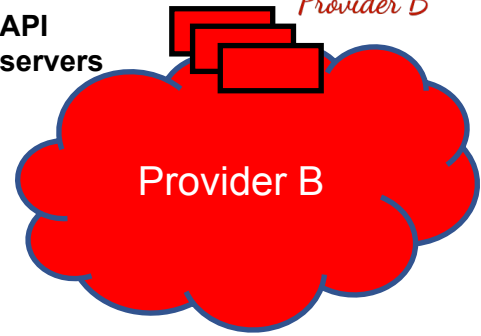● Publish each provider's KSK hash in the parent DS RRset.

DS

Zone Owner

K Z Z
Provider A

K Z Z
Provider B

API servers

API servers

Provider A

Provider B

Authoritative Server Network

Authoritative Server Network

MultiSigner Model 2
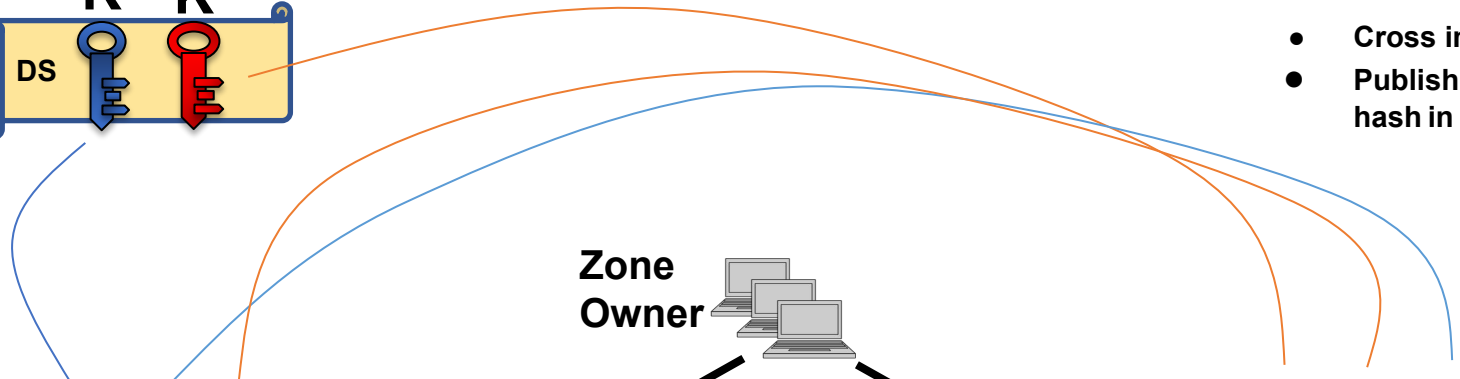
Multi-Signer for non-disruptive provider transfer

- Non-disruptive = No loss of resolution & no loss of validation
- Use Model-2 of the Multi-Signer DNSSEC Models as a transitional state
- Details in "DNSSEC Automation" IETF draft
    - https://datatracker.ietf.org/doc/html/draft-ietf-dnsop-dnssec-automation-01
    - Employs DS automation and Multi-Signer enhancements to show how a DNS zone can be initially signed on one provider, transitioned to a multi-signer configuration across multiple providers, and then have some providers removed.
    - Uses CDS, CDNSKEY, and CSYNC records.
    - Allows non-disruptive transfer of a signed zone across providers.

Provider xfer: Why not go insecure briefly?

- Seems easier

- Who would notice?

- Secured applications like **DANE** depend on DNSSEC *

- DNSSEC outages => Application outages

- No validation => Secured applications may break

- DNSSEC as a security protocol will not be taken seriously, if going insecure is a normal mode of operation.

Link: DANE (DNS Based Authentication of Named Entities) Tutorial from DNS-OARC38 Talk Series, July 2022

Multi-Signer support: Name Server Software

22 Aug 2022	BIND			Knot DNS			PowerDNS			(Others TBD)					
	C	D	R	C	D	R	C	D	R	C	D	R	C	D	R
Add DNSKEY records	✓	✔		✓	✔		✓	✔	✔						
Remove DNSKEY records	✓	✔		✓	✔		✓	✔	✔						
Add CDS/CDNSKEY records	✓	✔		✓	✔		✓	✔	✔						
Remove CDS/CDNSKEY records	✓	✔		✓	✔		✓	✔	✔						
Add CSYNC record	✓	✔		✓	✔		✓	✔	✔						
Remove CSYNC record	✓	✔		✓	✔		✓	✔	✔						

C = Command Line Interface

D = Dynamic DNS

R = Rest API

✔ **Complete**

☐ **In progress**

o **Planned but not started**

Not Planned

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Multi-Signer support: DNS Providers

23 August 2023	deSEC			NS1			Neustar			Cloudflare			(Others)					
	C	D	R	C	D	R	C	D	R	C	D	R	C	D	R	C	D	R
Add DNSKEY records			✔			✔			❑			✔						
Remove DNSKEY records			✔			✔			❑			✔						
Add CDS/CDNSKEY records			✔			❑			❑			❑						
Remove CDS/CDNSKEY records			✔			❑			❑			❑						
Add CSYNC record			✔			❑			❑			o						
Remove CSYNC record			✔			❑			❑			o						

C = Command Line Interface

D = Dynamic DNS

R = Rest API

✔ **Complete**

❑ **In progress**

o **Planned but not started**

Not Planned

Multi-Signer Controller: MUSIC

- Software developed by .SE to centrally manage the configuration of multiple DNS signers and handle seamless provider transition.
- ICANN presentation on MUSIC, Sep 2022: https://tinyurl.com/5h4wr8zj (Johan Stenstam, Roger Murray)
- Proof of Concept
- Interfaces to DNS servers that support DNS UPDATE, and a small number of proprietary REST APIs of a few providers

What can you do to help?

- **DNS software implementers and operators**
  - Support DS automation and Multi-Signer DNSSEC.
- **DNS Operators**
  - Help us formalize a role for the DNS Operator in the ICANN registration ecosystem (presently no defined role, no direct access to registries, challenges for DNSSEC automation)
- **DNS Zone owners**
  - Ask DNS vendors, registries, registrars to support DS automation and multi-signer enhancements.
- **Protocol development work at the edges.**

Questions/Comments?

Topic Summary

- Fully automate DNSSEC provisioning & maintenance - make it easier to deploy, manage, and reduce operational errors.
- Initialization and updates of DS record sets, via registrar channels, or via publication of CDS and/or CDNSKEY records.
- Scanning of CDS/CDNSKEY by Registries or Registrars.
- Explicit Notification schemes.
- Steady state Multi-Signer configuration.
- Non-disruptive Transfer of signed zones to a new operator, using a transitional state of Multi-Signer DNSSEC.
- State of software & vendor support

For Reference Only

The topics mentioned in this presentation have been explored in more detail in a panel series at the ICANN DNSSEC & Security Workshops. Links to material from those panels follow.

DNSSEC Provisioning Automation "Episodes" Standing Panel at ICANN DNSSEC Workshops

Episode	Date	Meeting	DNSSEC Provisioning Automation Sessions
1	11 Mar 2020	ICANN 67 "Cancún"	https://tinyurl.com/5dwxfz2v
2	22 Jun 2020	ICANN 68 "Kuala Lumpur"	https://tinyurl.com/m8eraezu
3	21 Oct 2020	ICANN 69 "Hamburg"	https://tinyurl.com/f8ma6347
4	24 Mar 2021	ICANN 70 "Cancún"	https://tinyurl.com/bj69sn87
5	14 Jun 2021	ICANN 71 "The Hague"	https://tinyurl.com/t2fcefr6
6	27 Oct 2021	ICANN 72 "Seattle"	https://tinyurl.com/32aeptd3
7	9 Mar 2022	ICANN 73 "San Juan"	https://tinyurl.com/yzyb29s9
8	13 Jun 2022	ICANN 74 The Hague	https://tinyurl.com/yn4c45t7
9	21 Sep 2022	ICANN 75 Kula Lumpur	https://tinyurl.com/46fhfkjs
10	15 Mar 2023	ICANN 76 Cancún	https://tinyurl.com/yefd64hw
11	12 Jun 2023	ICANN 77 Washington DC	https://tinyurl.com/37vsk438

Episode 1: 20 March 2020 "Cancún"

#	Title	Speaker	TinyURL
	Steve Crocker will outline the problems and the space of possible solutions	Steve Crocker, Shinkuro, Inc	https://tinyurl.com/4w2eck8j
DS Automation			
	Registry:	James Galvin, Afilias; Erwin Lansing, DK; and Gavin Brown, CentralNic for SK	
Multisigner Project			
	Registrar	Brian Dickson, GoDaddy; Jothan Frakes, PLISK; and Ólafur Guðmundsson, Cloudflare	
	DNS Provider	Ólafur Guðmundsson, Cloudflare	

Episode 2: 22 June 2020 "Kuala Lumpur"

#	Title	Speaker	TinyURL
	DS Updates and Multi-Signer Coordination	Steve Crocker, Shinkuro, Inc	https://tinyurl.com/vzu58xzv
DS Automation			
	Multi-Signer DNSSEC	Shumon Huque, Salesforce, Inc	https://tinyurl.com/6sche46m
Multisigner Project			
	Support for Multi-Signer DNSSEC	Paul Ebersman, Neustar	https://tinyurl.com/4kmcxmfw
	GoDaddy DNSSEC Signing and DS Updates	Brian Dickson, GoDaddy	https://tinyurl.com/bev24h6u
	Managing DNSSEC via API	Jothan Frakes, PLISK	https://tinyurl.com/w6ce9mu9
	Automated DNSSEC in CZ	Jaromír Talíř, CZ.NIC	https://tinyurl.com/dphwhby4
	Support for and adoption of CDS in .CH and .LI	Oli Schacher, SWITCH	https://tinyurl.com/22c6t6sn

Episode 3: 21 October 2020 "Hamburg"

#	Title	Speaker	TinyURL
I.	Overview: Framing the Issues	Shumon Huque and Steve Crocker	https://tinyurl.com/44dttx7p
II.	• SE DNSSEC History Present Future	Ulrich Wisser, SIF*	https://tinyurl.com/35m44a67
	• Deploying DNSSEC in a Large Enterprise	Han Zhang & Allison Mankin, Salesforce	https://tinyurl.com/jn8d9cv8
	DS Automation		
III.	• DS Automation	Shumon Huque, Salesforce	https://tinyurl.com/nnma8aau
	• DS Automation: Non-technical Considerations	James Galvin Ph.D., Afilias, Inc	https://tinyurl.com/p692jjzu
	• GoDaddy DNSSEC DS – Current and Proposed DS Update Methods	Brian Dickson, GoDaddy	https://tinyurl.com/8d695va9
	• Gathering the Childrens DS'	Mark Elkins, Posix	https://tinyurl.com/59697hm5
	• Evolving the DNSSEC Deployment Maps	Dan York, Internet Society	https://tinyurl.com/ytz9xw8k
	Multisigner Project		
IV.	• DNSSEC Census: Are DNSKEY Transitions Working?	Eric Osterweil, George Mason Univ	https://tinyurl.com/7tzwr6hr
	• Automating Multiple Signers	Shumon Huque, Salesforce	https://tinyurl.com/va53mwy8
V.	• Action Items:	Steve Crocker	https://tinyurl.com/2zykj7zs

*SIF = The Swedish Internet Foundation

Episode 4: 24 March 2021 "Cancún"

#	Title	Speaker	TinyURL
4.1	Panel Overview	Steve Crocker, Shinkuro, Inc	https://tinyurl.com/msaakbud
DS Automation			
4.2	DS Automation at GoDaddy	Brian Dickson, GoDaddy	https://tinyurl.com/hwx6hy52
Multisigner Project			
4.3	Multisigner Project Foundations	Shumon Huque, Salesforce	https://tinyurl.com/4cwcndrr
4.4	Multisigner Protocols	Ulrich Wisser, SIF*	https://tinyurl.com/v4y727sj
4.5	Multisigner Testbed	Ulrich Wisser, SIF*	https://tinyurl.com/cm3uuhk3
4.6	Multisigner support at deSEC	Peter Thomassen, Secure Systems Engineering	https://tinyurl.com/eyymfh2z
4.7	DNSKEY Transition Observatory	Ravichander, Osterweil, GMU	https://tinyurl.com/vdwpj4wp
4.8	Anatomy of DNSSEC Transitions	Osterweil, Tehrani, Schmidt, Waehlisch	https://tinyurl.com/ssfxwr3x

*SIF = The Swedish Internet Foundation

Episode 5: 14 June 2021 "The Hague"

#	Title	Speaker	TinyURL
3.1	DNSSEC Provisioning Automation Overview	Steve Crocker, Shinkuro, Inc	https://tinyurl.com/5a66kvpx
	DS Automation		
3.2	CDS scanning at RIPE NCC	Ondřej Caletka, RIPE NCC	https://tinyurl.com/t673a7px
3.3	The State of DNSSEC Automated Provisioning	Wilco van Beijnum, University of Twente	https://tinyurl.com/ntv5um3k
	Multisigner Project		
3.4	Multi-Signer Project Overview and Status	Ulrich Wisser, SIF*	https://tinyurl.com/4uyvps4u
3.5	BIND DNSSEC Provisioning Interfaces	Matthijs Mekking, Internet Systems Consortium	https://tinyurl.com/56p3pye7
3.6	PowerDNS DNSSEC Provisioning Interfaces	Peter van Dijk, PowerDNS	https://tinyurl.com/vracytyp

*SIF = The Swedish Internet Foundation

Episode 6: 27 October 2021 "Seattle"

#	Title	Speaker	TinyURL
6.1	DNSSEC Provisioning Automation Overview	Steve Crocker, Shinkuro, Inc	https://tinyurl.com/5n7fccdv
6.2	Recent DNSSEC Automation Developments in .CZ	Jaromír Talíř, CZ.NIC	https://tinyurl.com/2ddcukaj
6.3	CDS & CDNSKEY Verification in Zonemaster	Mats Dufberg, SIF	https://tinyurl.com/4jr3nyzx
6.4	Authentication Bootstrapping of DNSSEC Delegations	Peter Thomassen, deSEC	https://tinyurl.com/mswzz84x
6.5	DNS Resolver Observatory	Pouyan Tehrani, Freie Universität Berlin	https://tinyurl.com/mry4rrmr
6.6	Introduction to CSYNC	Ulrich Wisser, SIF	https://tinyurl.com/yxhf22a5

*SIF = The Swedish Internet Foundation

Episode 7: 9 March 2022 "San Juan"

#	Title	Speaker	TinyURL
3.1	Overview: DNSSEC Provisioning Automation	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/4nxjzucn
	DS Automation		
3.2	GoDaddy CDS Support Update	Brian Dickson, GoDaddy	https://tinyurl.com/5n7hs98s
3.3	CSYNC implementation	Ulrich Wisser, SIF	https://tinyurl.com/589m8uw2
3.4	Authenticated Bootstrapping of DNSSEC Delegations	Nils Wisiol, deSEC, Technische Universität Berlin	https://tinyurl.com/5e65sdpp
3.5	SSAC DS Automation Work Party	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/p9f3auyu
	Multi-Signer Project		
3.6	Making MUSIC with DNSSEC	Johan Stenstam, Roger Murray, SIF	https://tinyurl.com/2turpbuh
3.7	RFC Adjustments for Multi-Signer	Shumon Huque, Salesforce	https://tinyurl.com/3cvuspnp
3.8	DNS(SEC) Views	P.F. Tehrani, et al, Weizenbaum Institute / Fraunhofer FOKUS	https://tinyurl.com/566t57s2

*SIF = The Swedish Internet Foundation

Episode 8: 13 June 2022 The Hague

#	Title	Speaker	TinyURL
5.1	Overview: DNSSEC Provisioning Automation	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/bdcwym2c
DS Automation			
5.2	GoDaddy DNSSEC DS	Brian Dickson, GoDaddy	https://tinyurl.com/bw95csdu
5.3	Updating Secure Delegations in the DNS Root Zone	Kim Davies, ICANN/PTI	https://tinyurl.com/yzkuthnu
5.4	Update on Authenticated DNSSEC Bootstrapping	Peter Thomassen, deSEC/SSE	https://tinyurl.com/ea7vdr4e
5.5	SSAC DS Automation Work Party	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/5235c7he
Multi-Signer Project			
5.6	Making Music with DNSSEC: Status Update; The Need to Avoid False Notes	Johan Stenstam, Swedish Internet Foundation	https://tinyurl.com/46bz9yh6
5.7	Provisioning Multi-Signer DNSSEC with Cloudflare	Christian Elmerot, Cloudflare	https://tinyurl.com/4cz36r5b

Episode 9: 21 September 2022 Kuala Lumpur

#	Title	Speaker	TinyURL
3.1	Overview: DNSSEC Provisioning Automation	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/mry27pd2
DS Automation			
3.2	GoDaddy DNSSEC DS	Brian Dickson, GoDaddy	https://tinyurl.com/4yu9934p
3.3	Automation of DS Management	Peter Thomassen, deSEC/SSE	https://tinyurl.com/2p9h8wxx
Multi-Signer Project			
3.4	MUSIC : Multi-Signer Controller - Status Update	Johan Stenstam & Roger Murray , Swedish Internet Foundation	https://tinyurl.com/5h4wr8zj
3.5	Multi-signer DNSSEC with NS1 Managed DNS	Jan Včelák, NS1	https://tinyurl.com/3amn7ekd
3.6	Multi-Signer Testing: Testbeds and Scenarios	Steve Crocker, Shinkuro, Inc.	https://tinyurl.com/ya7kfw3j

Episode 10: 15 March 2023 Cancún

#	Title	Speaker	TinyURL
4.1	Overview: DNSSEC Provisioning Automation	Steve Crocker, Edgemoor Research Institute	https://tinyurl.com/y439v4uu
4.2	DNS child updates in the gTLD space	Francisco Arias, Sr. Director, GDS Technical Services, ICANN org	https://tinyurl.com/4ytwajs2
4.3	GoDaddy DNSSEC CDS to DS Polling Status	Brian Dickson, GoDaddy	https://tinyurl.com/ym3avrmc
4.4	CDS Scanning rollout at CentralNic	Gavin Brown, Technical Fellow, CentralNic Group PLC	https://tinyurl.com/3d7kdzce
4.5	CDNSKEY Support in TANGO Registry Services	Michael Bauland, Knipp Medien und Kommunikation GmbH	https://tinyurl.com/mr37vut9
4.6	The State of DS Automation: Deployments and Current Work	Peter Thomassen, deSEC/SSE	https://tinyurl.com/3dxzjz3k
4.7	The New DNSSEC Deployment Maps and DNSSEC Views	Koushik Sura Bhaskar, George Mason University	https://tinyurl.com/y8zcdp59

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#	Title	Speaker	TinyURL
1	DNSSEC DS Automation Workshop Part 1		https://tinyurl.com/37vsk438
2	DNSSEC DS Automation Workshop Part 2		https://tinyurl.com/pmyfr6fy