Signing the Root

MENOG 7
Istanbul, Turkey
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ICANN

AS SEEN IN ROOT

and my T-Shirt

```
. IN DS 19036 8 2
49AAC11D7B6F6446702E54A
1607371607A1A41855200FD
2CE1CDDE32F24E8FB5
```

Since July 15, 2010

How did we get here?

Little bit of DNSSEC History

1997

RFC 2065 Domain Name System Security Extensions

1999

- RFC 2535 Domain Name System Security Extensions
- Obsoletes RFC 2065
- DNSSEC appears to be complete
- BIND9 is being developed to implement DNSSEC

2000

- BIND 9.0.0 is released
  - First implementation of DNSSEC

2001

- Key handling in RFC 2535 is causing operational problems that will make deployment impossible.
- The Delegation Signer resource record is proposed to solve the problems. It only exists in the parent zone, so introduces protocol difficulty of it's own.
- BIND9 doesn't understand the new DS RR.
- It's decided to rewrite RFC 2535 in 3 new drafts.

2003

- BIND9 snapshots appear that support what is now known as DNSSEC-bis
- NLnet Labs SECREG shows that DNSSEC-bis is ready for deployment

2004

- BIND 9.3 and NSD 2 have support for DNSSEC-bis

2005

- The DNSSEC-bis RFCs are published
  - RFC 4033: DNS Security Introduction and Requirements
  - RFC 4034: Resource Records for the DNS Security Extensions
  - RFC 4035: Protocol Modifications for the DNS Security
- .SE (Sweden) is the first signed ccTLD
- RIPE NCC begin signing their portion of the in-addr.arpa tree

2006

- ISC launches their Domain Lookaside Validation Registry: dlv.isc.org
- .PR (Puerto Rico) is signed (I was there..)

2007

- .BR (Brazil) is signed
- .BG (Bulgaria) is signed

2008

- .CZ (Czech Republic) is signed
- RFC 5155: DNS Security (DNSSEC) Hashed Authenticated Denial of Existence
  - New RR type: NSEC3
  - Solves zone enumeration
  - Opt-in allows incremental growth in delegation-centric zones
- Dan Kaminsky discovers a new cache poisoning vulnerability
- The US DoC NTIA publish a Notice of Inquiry entitled "Enhancing the Security and Stability of the Internet's Domain Name and Addressing System"

2009

- IANA launches the ITAR
- .GOV is signed
  - First major use of NSEC3
- .ORG is signed
  - The first gTLD to be signed
- ICANN and VeriSign announce a joint project to sign the root

Signing the Root

The Project

A cooperation between ICANN & VeriSign
with support from the U.S. DoC NTIA

Roles and Responsibilities

ICANN

IANA Functions Operator

- Manages the Key Signing Key (KSK)
- Accepts DS records from TLD operators
- Verifies and processes request
- Sends update requests to DoC for authorization and to VeriSign for implementation

DoC NTIA

U.S. Department of Commerce
National Telecommunications and Information Administration

- Authorizes changes to the root zone
  - DS records
  - Key Signing Keys
  - DNSSEC update requests follow the same process as other changes
- Checks that ICANN has followed their agreed upon verification/processing policies and procedures

VeriSign

Root Zone Maintainer

- Manages the Zone Signing Key (ZSK)
- Incorporates NTIA-authorized changes
- Signs the root zone with the ZSK
- Distributes the signed zone to the root server operators

Design

The guiding principle behind the design is that the result must be trustworthy

Transparency

Processes and procedures should be as open as possible for the Internet community to trust the signed root

Audited

Processes and procedures should be audited against industry standards, e.g. ISO/IEC 27002:2005

High Security

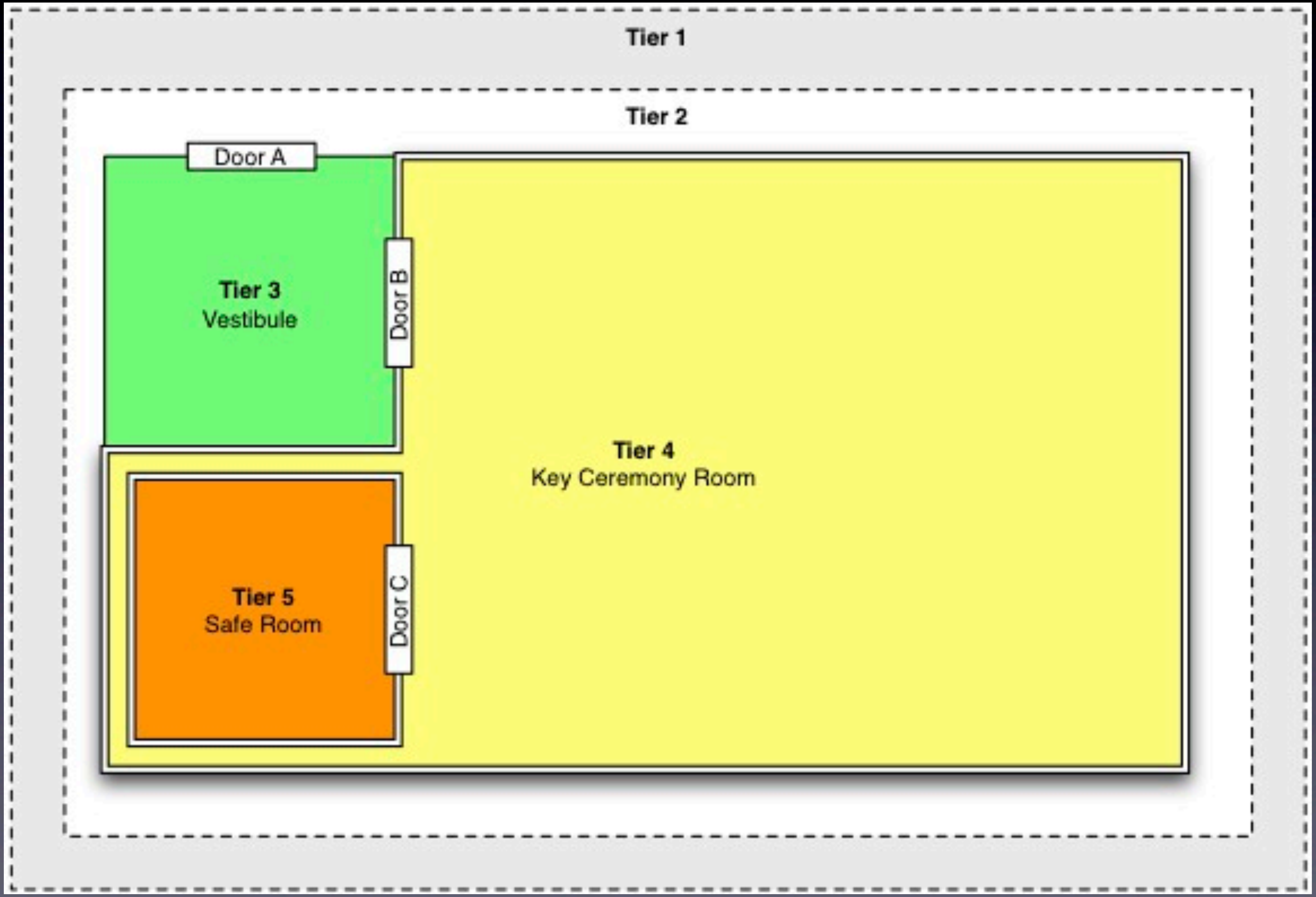
Root system should meet all NIST SP 800-53 technical security controls required by a HIGH IMPACT system

Community Involvement

Trusted representatives from the community are invited to take an active role in the key management process

Approach to Protecting the KSK

Physical Security



Physical Security

NOTICE
ALL EMPLOYEES AND VISITORS MUST WEAR IDENTIFICATION BADGES
NOTICE
UNAUTHORIZED PERSONS NOT PERMITTED BEYOND THIS POINT
NOTICE
NO FOOD OR DRINK BEYOND THIS POINT
NOTICE
TURN OFF
CELLULAR PHONES, PAGERS AND OTHER WIRELESS DEVICES
NOTICE
NO FIREARMS OR WEAPONS ALLOWED ON THIS PROPERTY

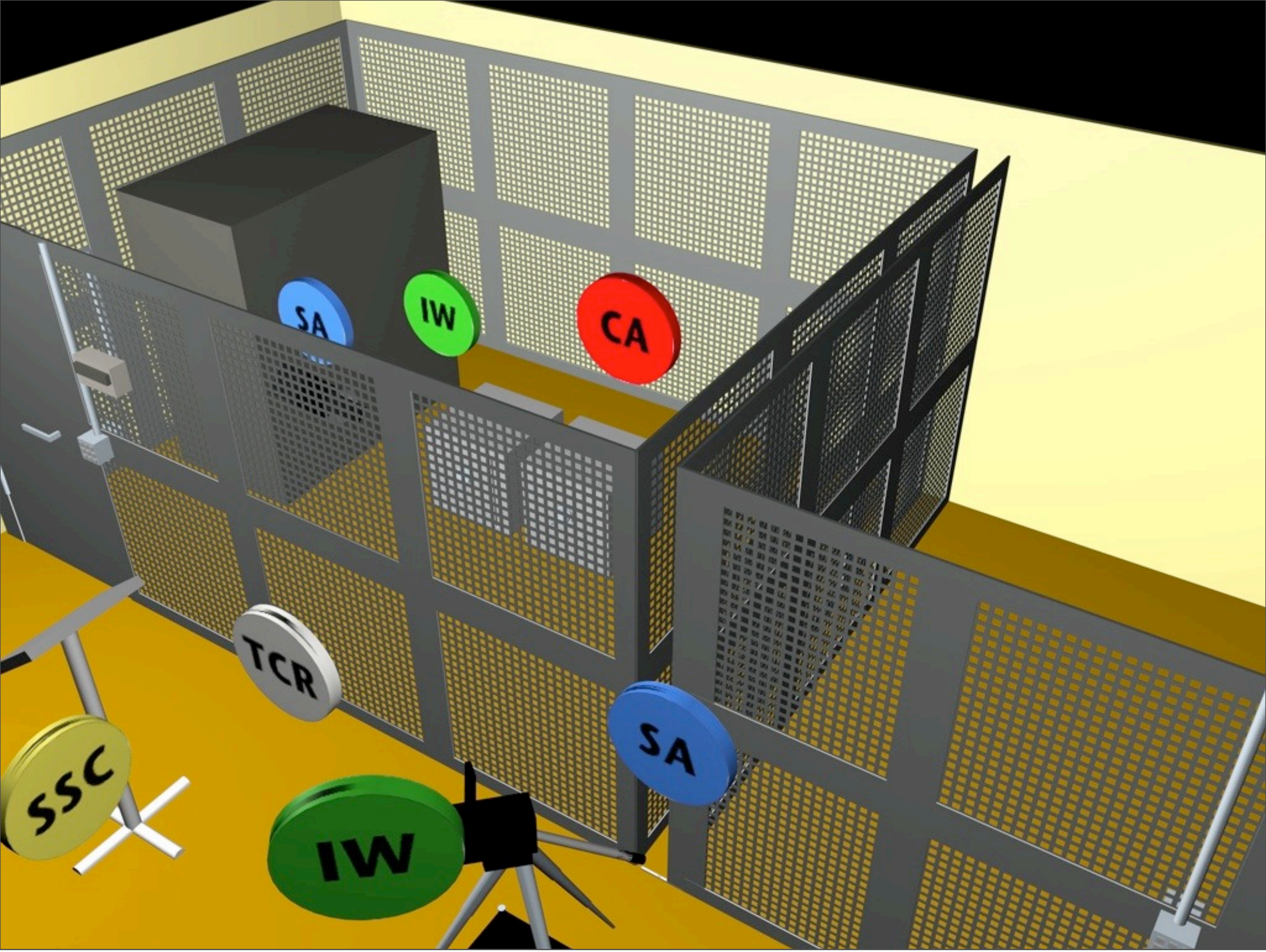
Physical Security

More photos on http://dns.icann.org

Enforced Dual Occupancy
Separation of Duties
External Monitoring
Video Surveillance
Motion, Seismic other Sensors
..and more

ICANN Staff Roles

Roles related KSK Ceremonies can be summarized as ;
Ceremony Administrator (CA) is the staff member who runs the ceremony.
Internal Witness (IW) is the ICANN staff witnessing and recording the ceremony and exceptions if any.
System Administrator (SA) is technical staff members responsible IT needs.
Safe Security Controllers (SSC) are the ICANN staff who operates the safe.


SA
IW
CA
TCR
SA
SSC
IW

DPS

DNSSEC Practice Statement

- States the practices and provisions that are employed in root zone signing and zone distribution services
    - Issuing, managing, changing and distributing DNS keys in accordance with the specific requirements of the U.S. DoC NTIA
- Comparable to a certification practice statement (CPS) from an X.509 certification authority (CA)

Auditing & Transparency

- Third-party auditors check that ICANN operates as described in the DPS
- Other external witness may also attend the key ceremonies
- Working toward having a Systrust audit performed later this year

Trusted Community Representatives (TCRs)

- Have an active roll in the management of the KSK
  - as Crypto Officers needed to activate the KSK
  - as Recovery Key Share Holders protecting shares of the symmetric key that encrypts the backup copy of the KSK

- Have physical keys to safe deposit boxes holding smartcards that activate the HSM
- ICANN cannot generate new key or sign ZSK without 3-of-7 COs
- Able to travel up to 4 times a year to US.

- Have smartcards holding pieces (M-of-N) of the key used to encrypt the KSK inside the HSM

- If both key management facilities fall into the ocean, 5-of-7 RKSH smartcards and an encrypted KSK smartcard can reconstituted KSK in a new HSM

- Backup KSK encrypted on smartcard held by ICANN

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DNSSEC
Protocol Parameters

Split keys

- The Zone Signing Key (ZSK) is used to sign the zone
- The Key Signing Key (KSK) is used to sign the ZSK
- This split is not required by the protocol, but it enhances security by reducing access to the key which forms the trust anchor while reducing the importance of the key which must be exercised often to sign the zone.

Key Signing Key

- KSK is 2048-bit RSA
    - Rolled as required
    - RFC 5011 for automatic key rollovers
- Signatures made using SHA-256

Zone Signing Key

- ZSK is 1024-bit RSA
    - Rolled once a quarter (four times per year)
- Zone signed with NSEC
- Signatures made using SHA-256

Signature Validity

- DNSKEY-covering RRSIG (by KSK) validity 15 days
    - new signatures published every 10 days
- Other RRSIG (by ZSK) validity 7 days
    - zone generated and resigned twice per day

Key Ceremonies

- Key Generation
  - Generation of new KSK
- Processing of ZSK Signing Request (KSR)
  - Signing ZSK for the next upcoming quarter
  - Every quarter

Root Trust Anchor

- Published on a web site by ICANN as
  - XML-wrapped and plain DS record
    - to facilitate automatic processing
  - PKCS #10 certificate signing request (CSR)
    - as self-signed public key

Deployment

Goals

- Deploy a signed root zone
  - Transparent processes
  - Audited procedures
  - Community involvement

Staged Deployment

Deploy Incrementally

- The goal was to leave the client population with some root servers not offering large responses until the impact of those large responses is better understood
- Relies upon resolvers not always choosing a single server

DURZ

- Deploy conservatively
  - It is the root zone, after all
- Prevent a community of validators from forming
  - This allows us to un-sign the root zone during the deployment phase (if we have to) without collateral damage

DURZ

- “Deliberately Unvalidatable Root Zone”
- Sign RRSets with keys that are not published in the zone (but with matching keytag…)
- Publish keys in the zone which are not used, and which additionally contain advice for operators (see next slide)
- Swap in actual signing keys (which enables validation) at the end of the deployment process

Testing

- A prerequisite for this plan was a captive test of the deployment
  - Test widely-deployed resolvers, with validation enabled and disabled, against the DURZ
  - Test with clients behind broken networks that drop large responses

Deploy Incrementally

L	27 January
A	10 February
M, I	March 3rd
D, K, E	March 22nd
B, H, C, G, F	April 12th
J	May 5th

Communication

Project Web Page

- http://www.root-dnssec.org
  - Status updates
  - Documents
  - Presentation Archive
  - Contact information

Communication

- Reaching the technical audiences via mailing lists and other means, such as showing up in person to make presentations
  - IETF DNS lists (e.g. DNSOP)
  - non-IETF DNS lists (e.g. DNS-OARC)
  - General operator lists (e.g. NANOG)

Milestones

2009

- August
  - Project to sign the root formally announced
- October
  - The plan receives first public airing at RIPE 59
- December
  - http://www.root-dnssec.org site launched

2010

- January through May
  - Incremental roll-out of the DURZ to the root servers
- June
  - First ceremony in Culpeper, Virginia
    - Created initial root zone KSK
    - Processed initial KSR for Q3/2010
  - First DS records added to the root zone

ICANN
NOTICE
NO EATING OR DRINKING IN THIS AREA
NOTICE
NOTICE
SEASTROM
3066

2010

- July
  - Second ceremony in Los Angeles, California
    - Key material from the first ceremony replicated and stored
    - Q4/2010 KSR processed
    - Live streamed to the world.
  - The fully validatable signed root zone is published to the root servers by VeriSign

One World. One Internet. Everyone Connected.
2:00 22:01 19:01

Root DNSSEC Design Team

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The root is signed!

DNSSEC is now part of standard operations

ARPA

- ARPA is signed since March
  - Keys currently managed by Verisign, will change to a joint model like the root
- E164.ARPA signed by RIPE NCC since 2007
- Other ARPA children, with the exception of IN-ADDR.ARPA are signed by ICANN since April
  - Addition of DS records to ARPA in progress

DS Submission

- TLD operators can submit DS records to the IANA for inclusion in the root zone
- Instructions
  - http://www.iana.org/procedures/root-dnssec-records.html

Secured delegations

As of the start of this week the root zone contains 41 secured delegations

be bg biz br

cat ch cz dk

edu eu info lk

museum na org

pm se tf pr ..

tm uk us th ..

...and the 11 test IDN TLD zones

http://stats.research.icann.org/dns/tld_report/

Start your validators!

- The trust anchor is available at
  - https://www.iana.org/dnssec/

Next KSK Ceremony

- The next ceremony will take place in Culpeper, VA on 2010 November 1-2
    - Detailed schedule can be found at
        - http://dns.icann.org/ksk/ceremony/ceremony-3/
        - Watch the HD Live Stream at
            - http://dns.icann.org/ksk/stream/

Questions?

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