Assessing and Improving the Quality of DNSSEC Deployment

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AIMS-4
CAIDA, SDSC, San Diego, CA
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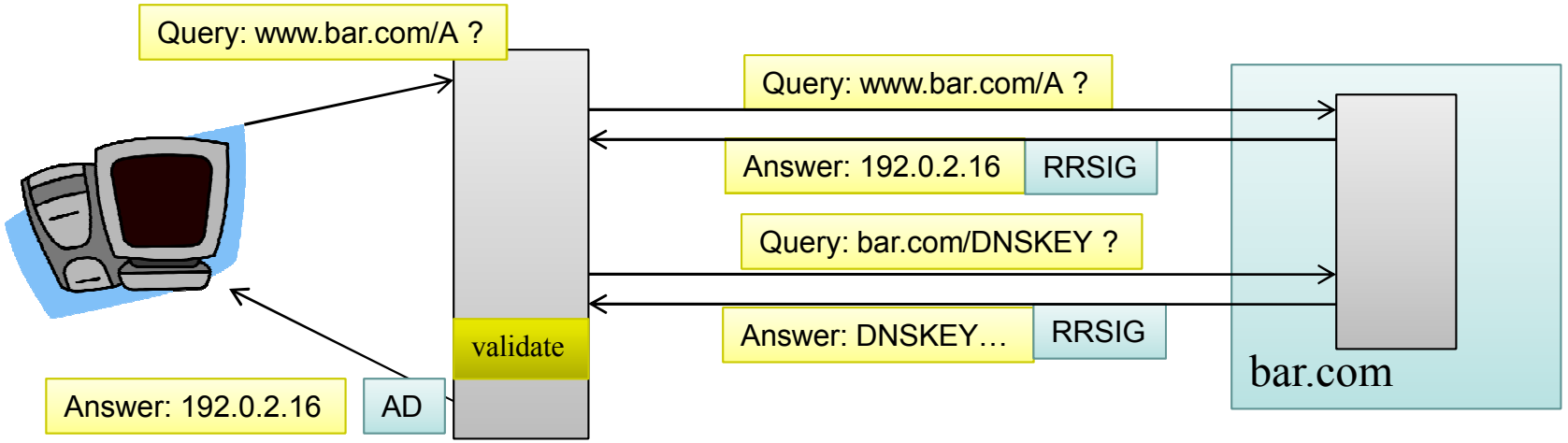
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Outline

- DNSSEC protocol review
- DNSSEC maintenance and misconfiguration
- DNSSEC survey and results
- Conclusions and solutions

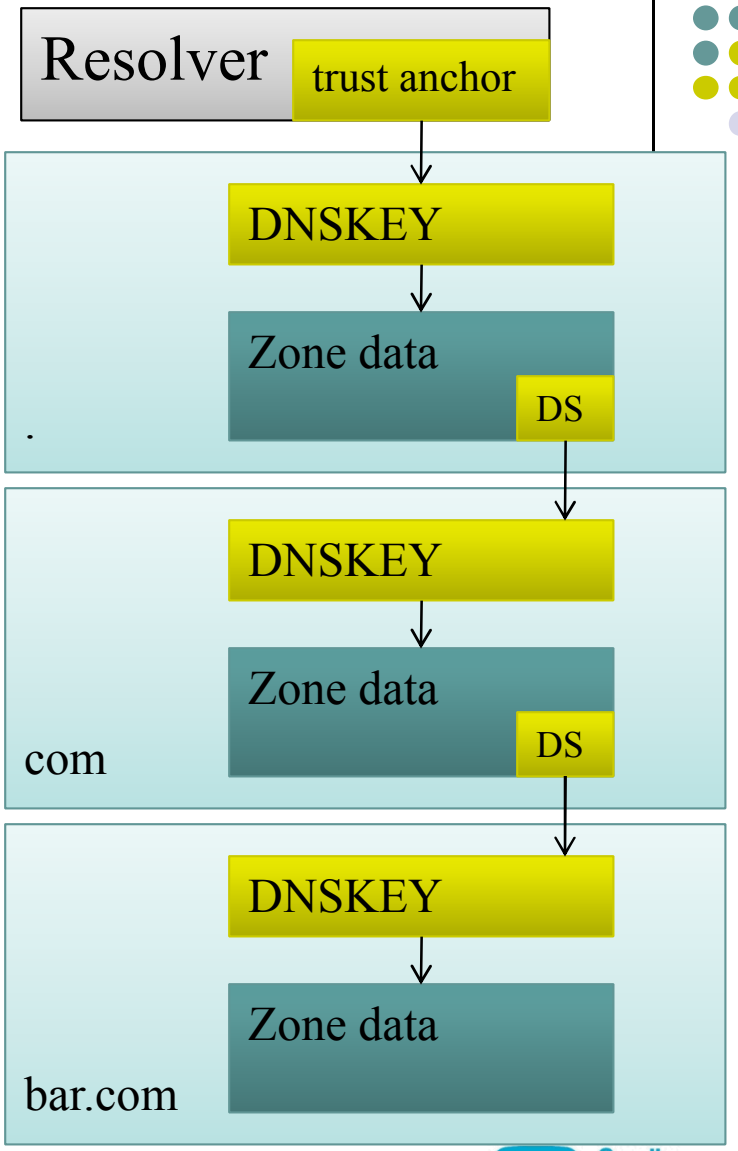
DNS Security Extensions (DNSSEC)

- RRsets signed with zone's private key(s)
- Signatures covering RRsets returned by server as RRSIGs
- Public keys published in zone data as DNSKEYs
- Resolver validates response
  - If authentic: Authenticated data (AD) bit is set
  - If bogus: SERVFAIL message is returned



Scalable authentication via a chain of trust

- DNSKEY must be authenticated
- Resolver must have some notion of trust
- Trust extends through ancestry to a trust anchor at resolver
- DS resource record – provides digest of DNSKEY in child zone



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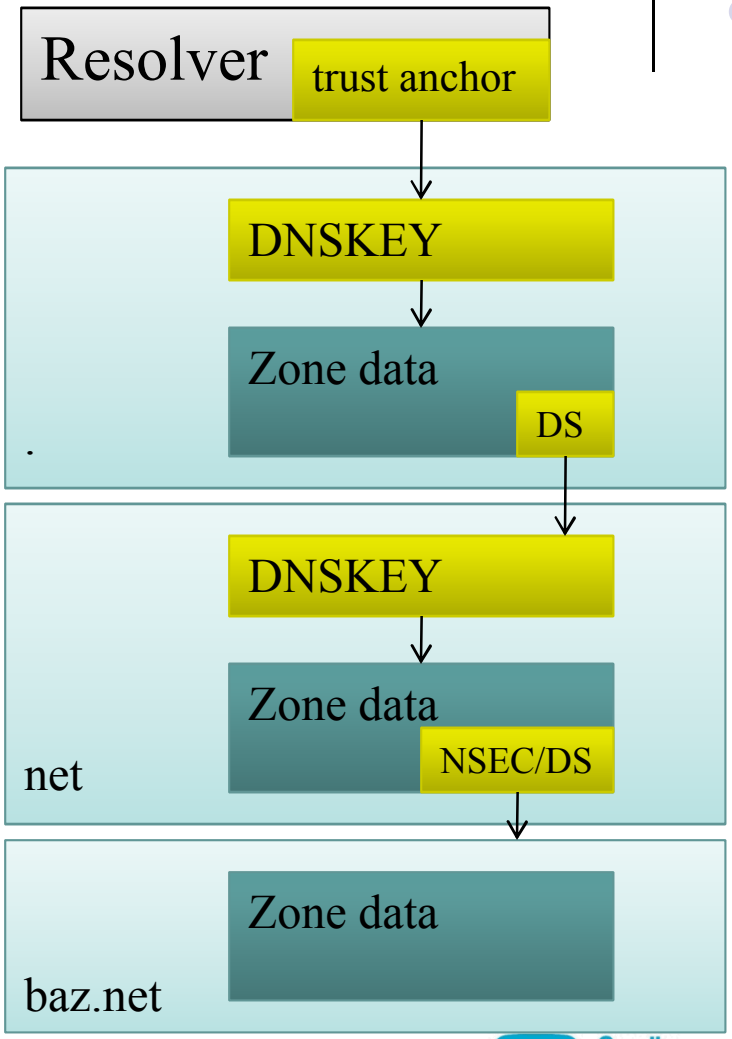
Backwards compatibility… kind of

- If no secure link exists between parent and child, referring (parent) server must prove non-existence of DS RRs
- NSEC/NSEC3 resource records provide authenticated denial of existence
- Child zones of insecure delegations may be unsigned or signed (“islands of security”)



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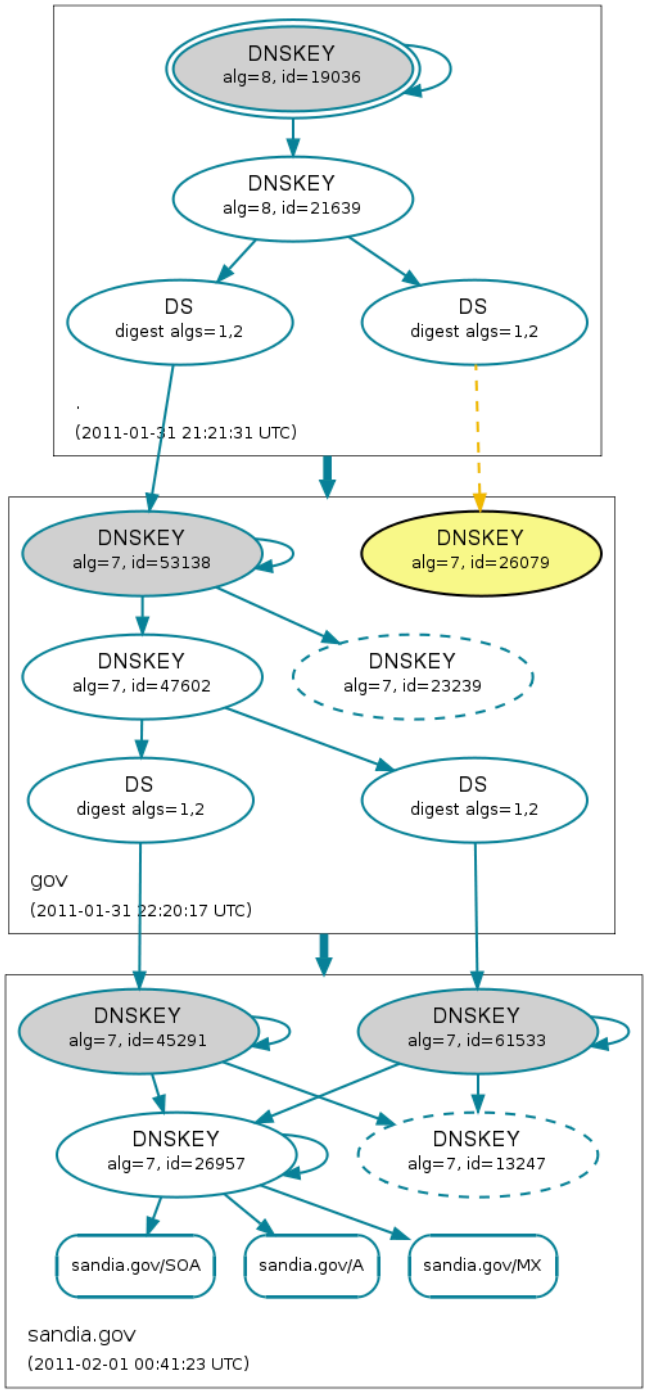
DNSSEC validation status

- **Secure** – unbroken chain from anchor to RRset

sandia.gov/SOA



(Image from http://dnsviz.net/)

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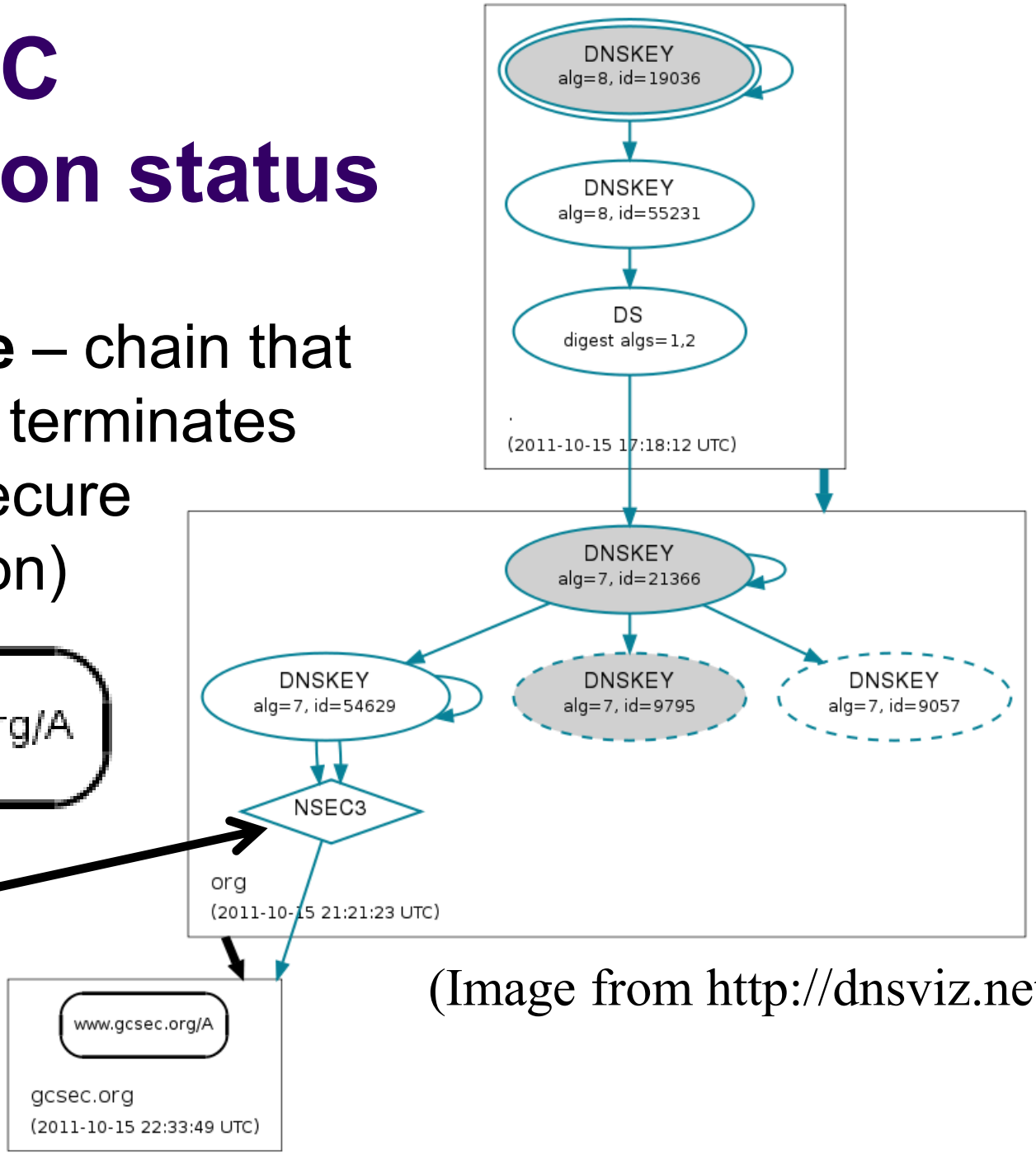
DNSSEC validation status

- **Insecure** – chain that securely terminates (i.e., insecure delegation)

www.gcsec.org/A

Secure chain termination

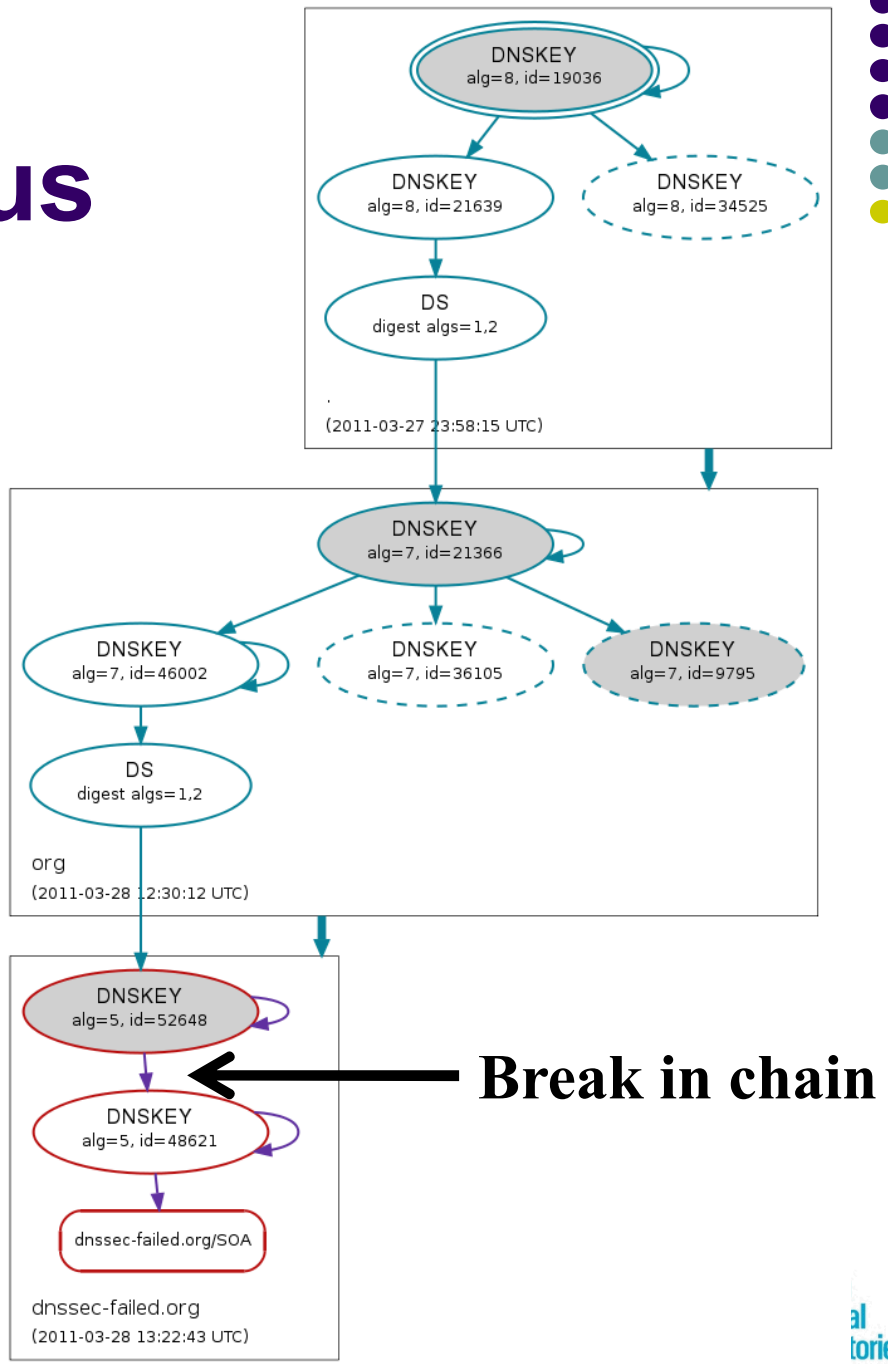


(Image from http://dnsviz.net/)

DNSSEC validation status

- **Bogus** – broken chain

dnssec-failed.org/SOA



(Image from http://dnsviz.net/)

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DNSSEC Maintenance

- RRSIG refresh
- DNSKEY rollovers
  - ZSK rollovers – non-SEP (secure entry point), self-contained
  - KSK rollovers – SEP requires interaction with parent or trust anchor
- Algorithm changes

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DNSSEC Misconfiguration

- **DS Mismatch** – No DNSKEY matching DS in parent zone
- **DNSKEY Missing** – DNSKEY not available to validate RRSIG
- **NSEC Missing** – NSEC RRs not returned by authoritative server
- **RRSIG Missing** – RRSIGs not returned by some servers
- **RRSIG Bogus** – Signature in RRSIG does not validate
- **RRSIG Dates** – Expired or premature RRSIG dates

DNSSEC is hard.

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Jan 10, 2012 – Comcast turned on DNSSEC validation for all its residential customers.

http://blog.comcast.com/2012/01/comcast-completes-dnssec-deployment.html

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Jan 18, 2012 – Comcast customers could not access nasa.gov.

NASA.gov blocked
01-18-2012 04:01 PM

Comcast has blocked access to NASA.gov. I am outraged! Is this China or something worse?

Comcast Blocks Customer Access to NASA.gov

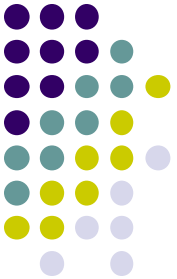
By Keith Cowing on January 18, 2012 1:17 PM 16 Comments

Keith's note: Comcast has decided to block customer access to *.NASA.gov due, I am told, to an issue involving how NASA maintains its DNS records. Why these geniuses at Comcast chose the SOPA/PIPA protest day to do this is curious to say the least. Right now, if you are a Comcast customer, you are being purposefully denied access to one part of your government's services.

http://forums.comcast.com/t5/Connectivity-and-Modem-Help/NASA-gov-blocked/td-p/1169657
http://nasawatch.com/archives/2012/01/comcast-blocks.html

Jan 22, 2012 – Comcast customers could not access bitcoinica.com.

http://www.reddit.com/r/Bitcoin/comments/orzpq/attention_comcast_users_we_have_been_censored/



Comcast is *clearly* "censoring" these sites. But why?

Enter DNSViz…

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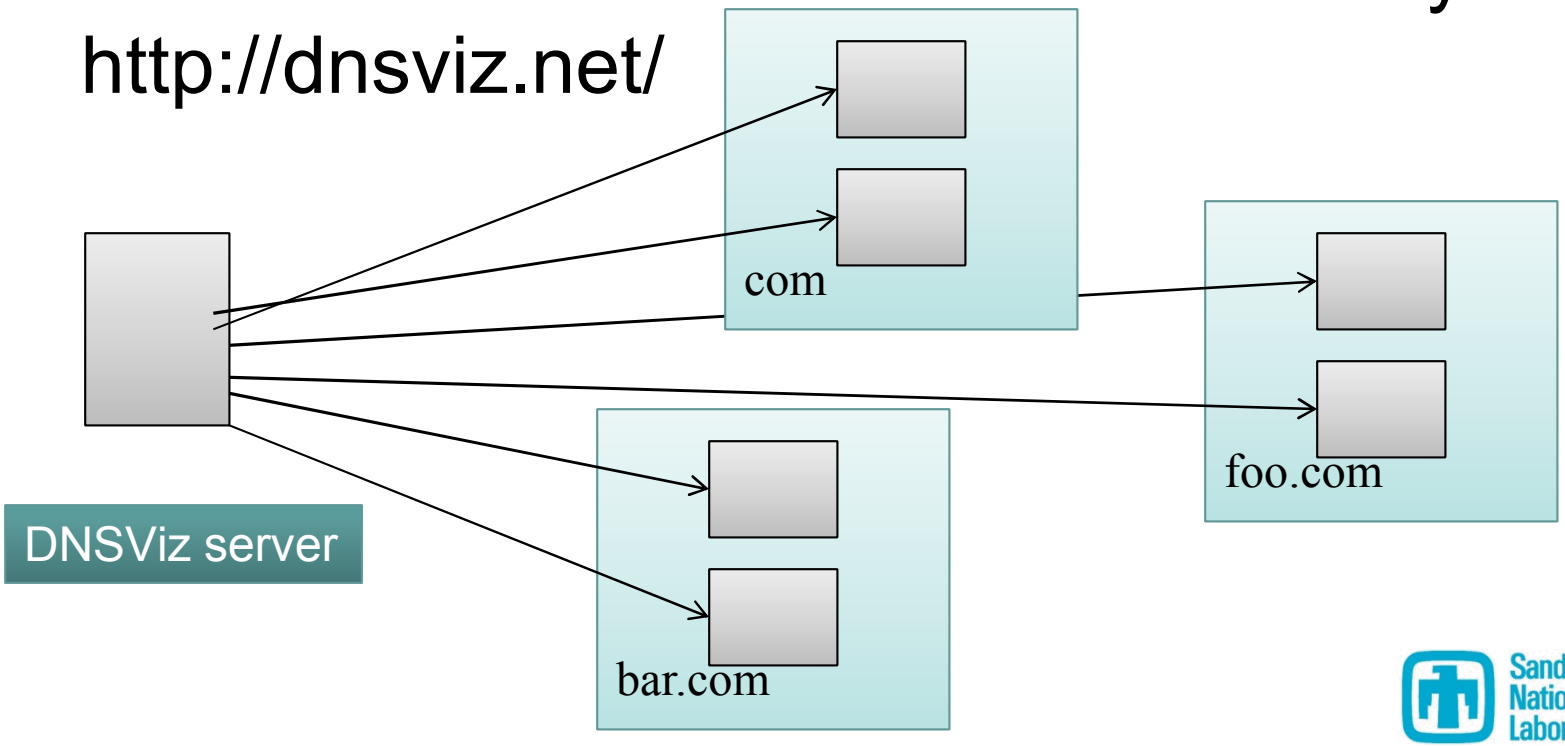
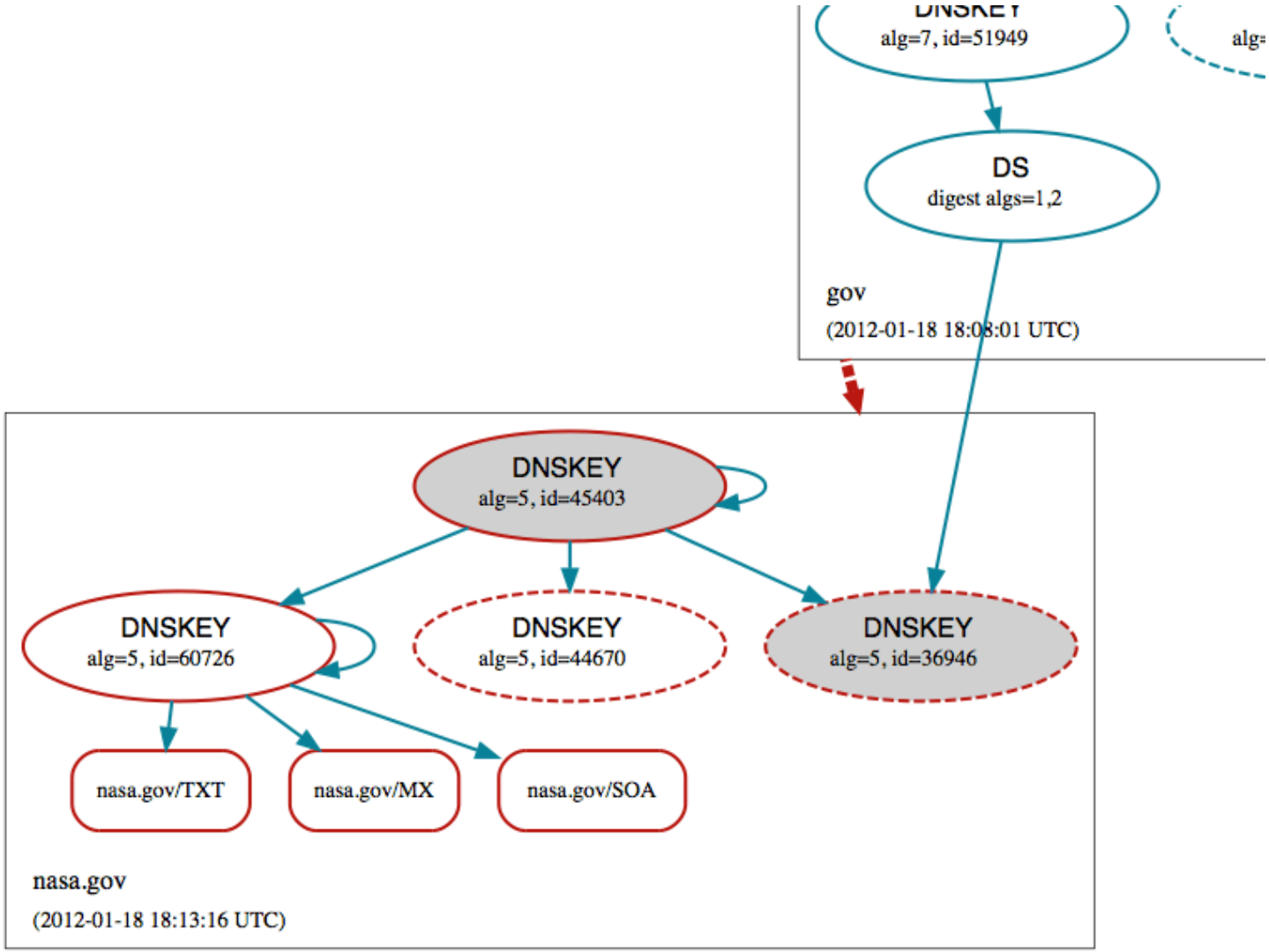
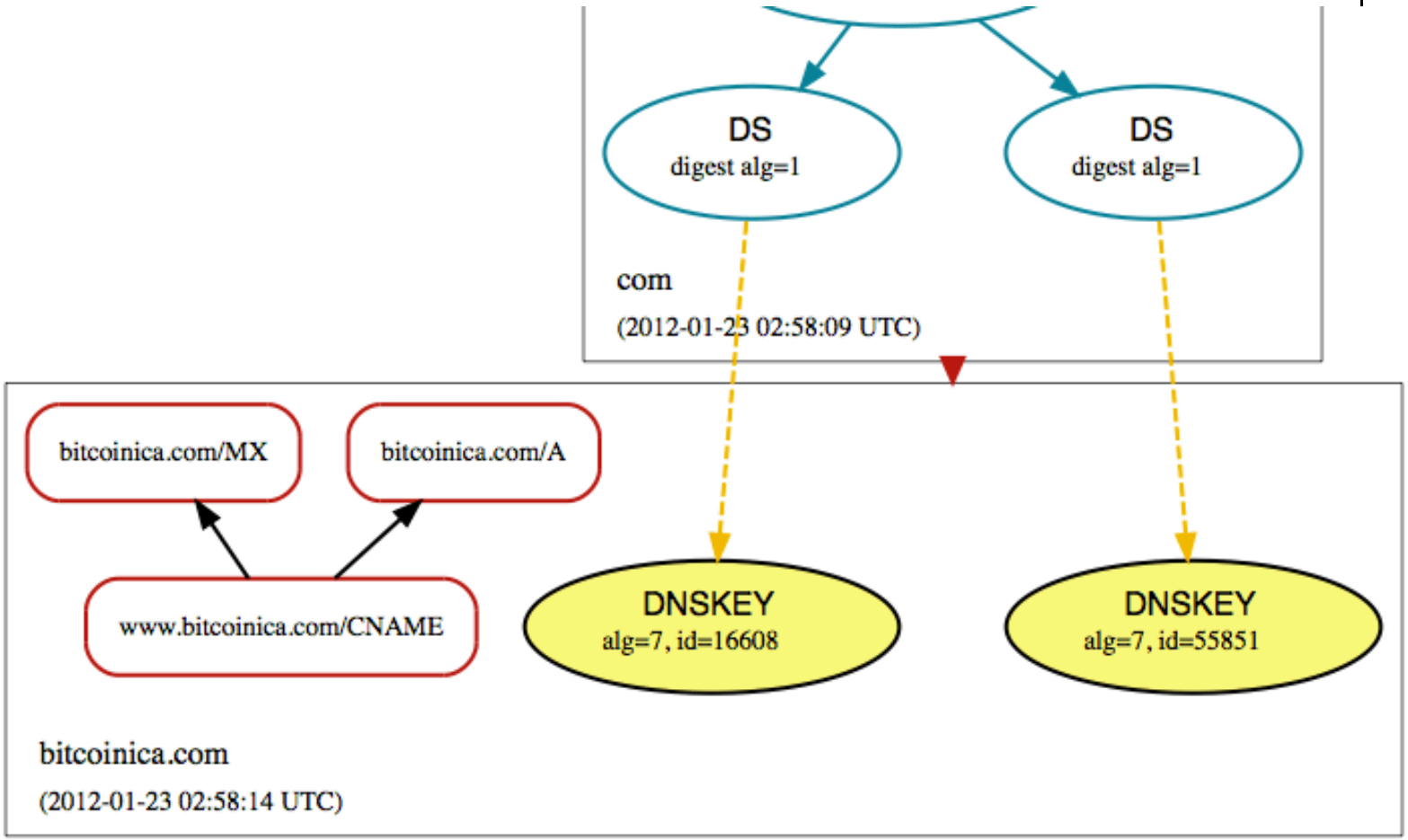
DNSViz

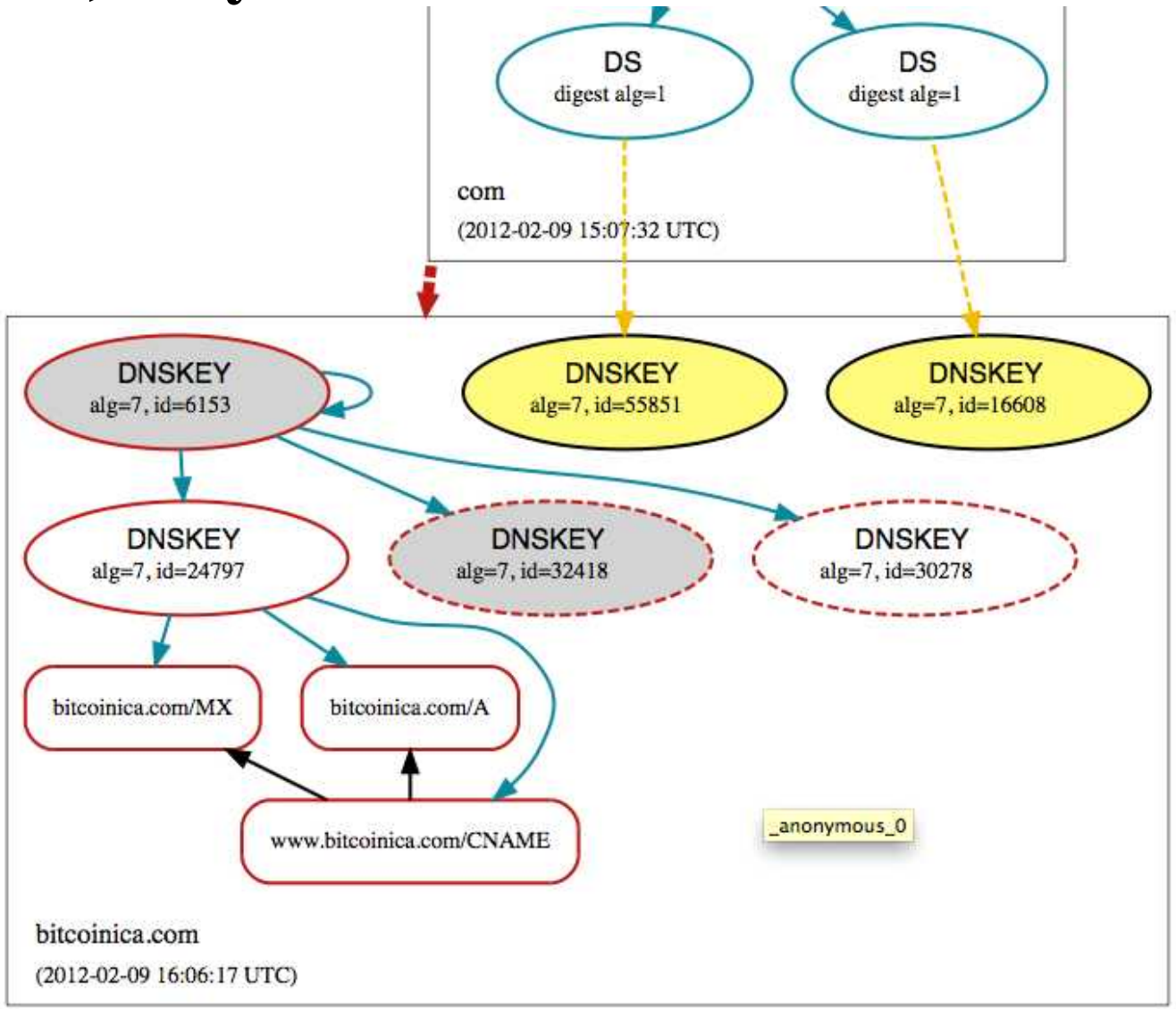
- Actively monitors domains from single vantage point
- Makes results available for visual analysis at http://dnsviz.net/




DNSKEY
alg=7, id=51949
DS
digest algs=1,2
gov
(2012-01-18 18:08:01 UTC)
DNSKEY
alg=5, id=45403
DNSKEY
alg=5, id=60726
DNSKEY
alg=5, id=44670
DNSKEY
alg=5, id=36946
nasa.gov/TXT
nasa.gov/MX
nasa.gov/SOA
nasa.gov
(2012-01-18 18:13:16 UTC)


DS
digest alg=1
DS
digest alg=1
com
(2012-01-23 02:58:09 UTC)
bitcoinica.com/MX
bitcoinica.com/A
www.bitcoinica.com/CNAME
DNSKEY
alg=7, id=16608
DNSKEY
alg=7, id=55851
bitcoinica.com
(2012-01-23 02:58:14 UTC)

But, they “fixed” it…



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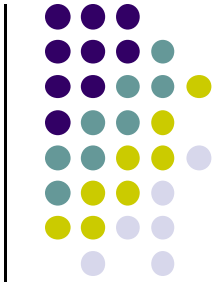
DNSSEC deployment survey



- Polled ~2,700 production signed zones over a year time frame (May 2010 – July 2011)
- Validation of SOA RR analyzed several times daily, anchored at ISC DLV or root zone (after July 2010 root signing)
- Identified maintenance and misconfigurations

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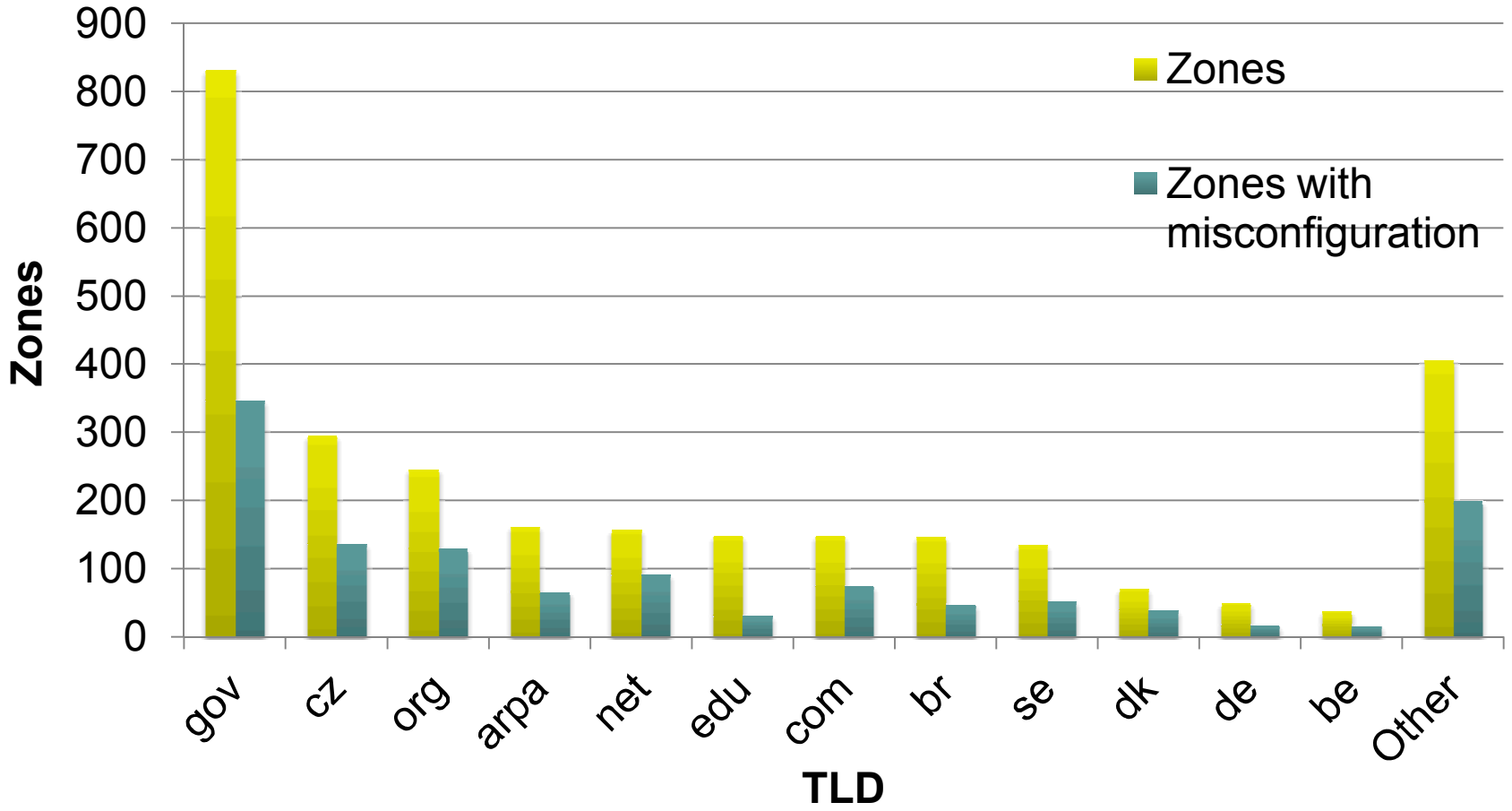
Survey breakdown by TLD



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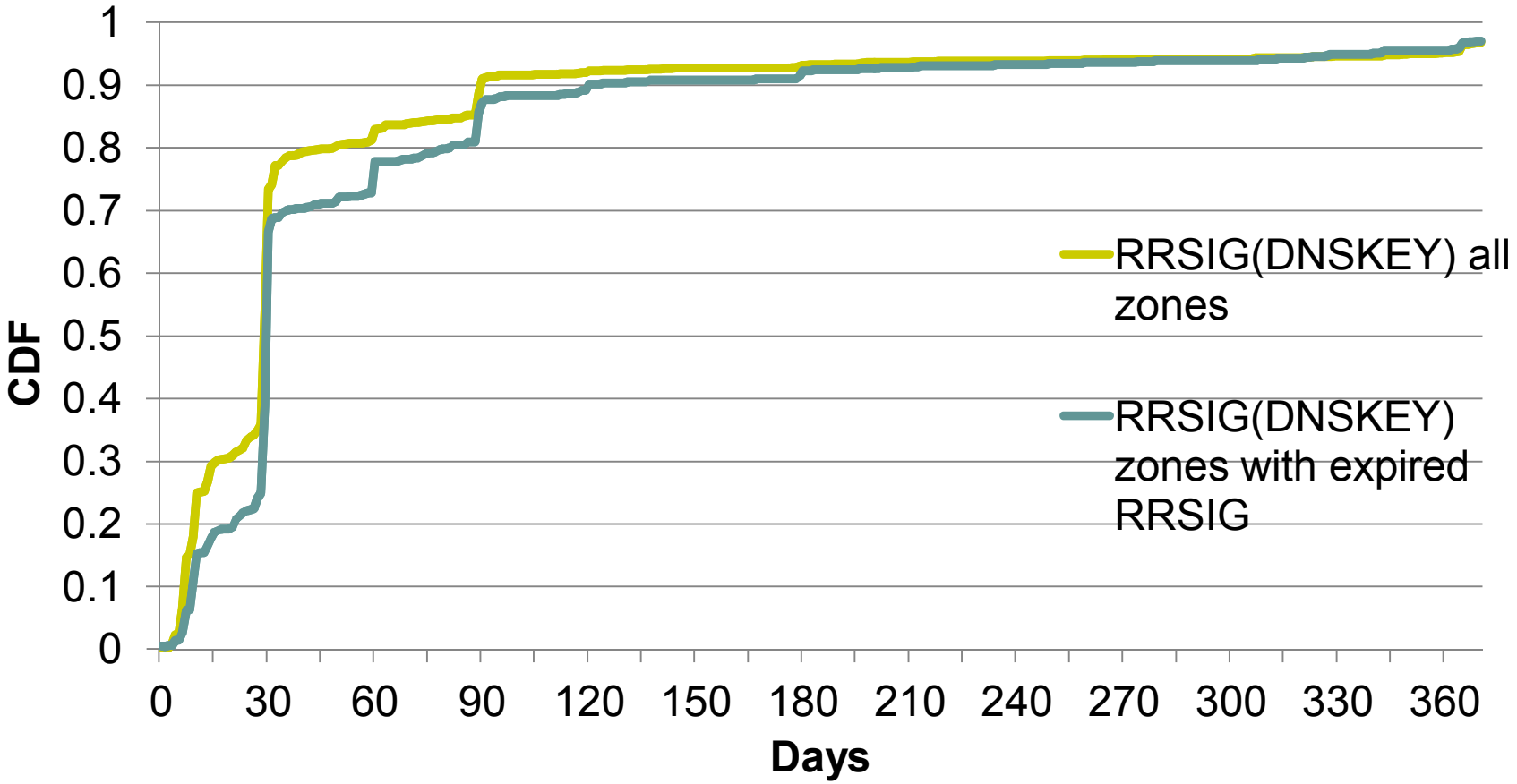
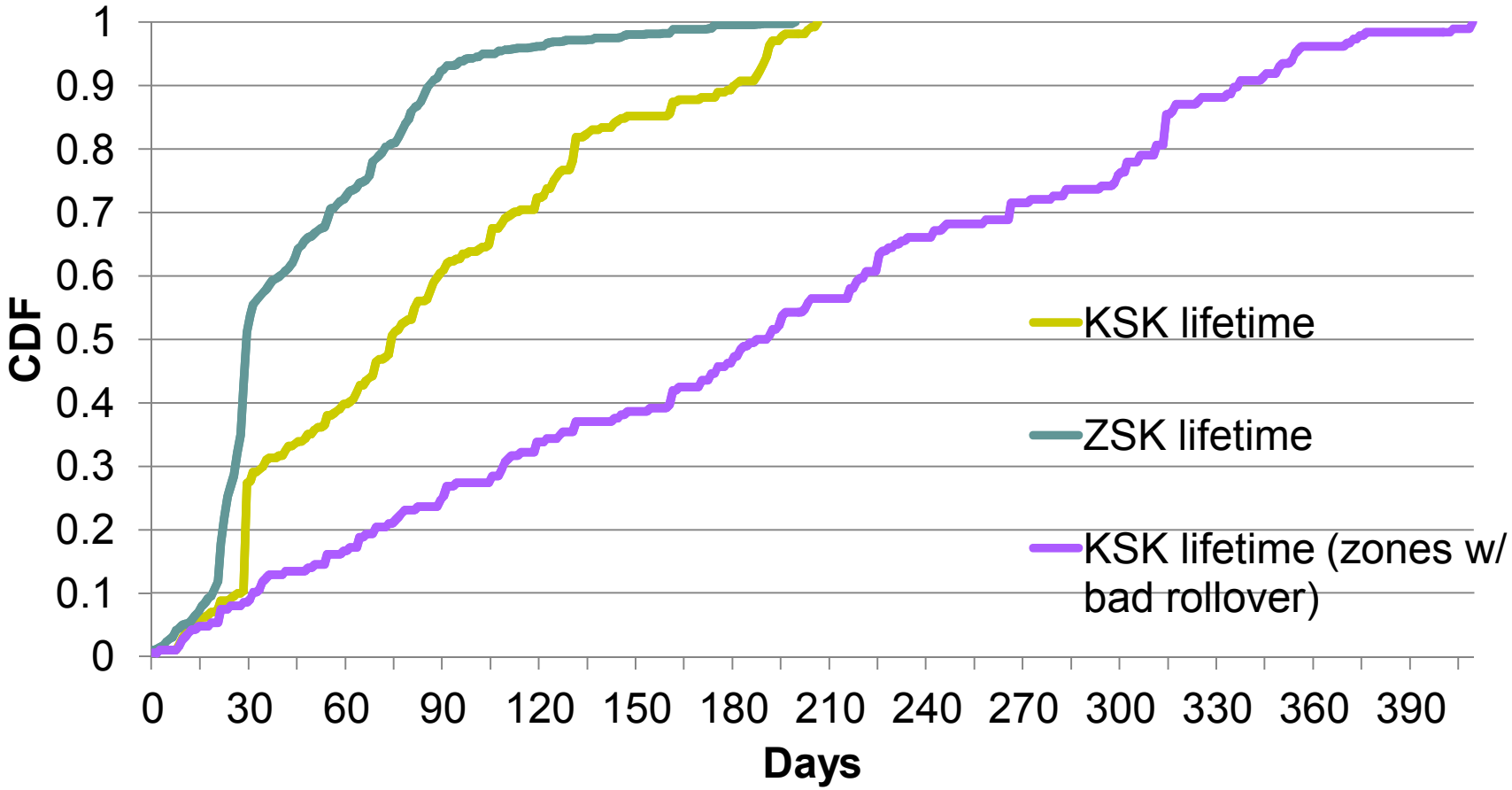
RRSIG lifetimes



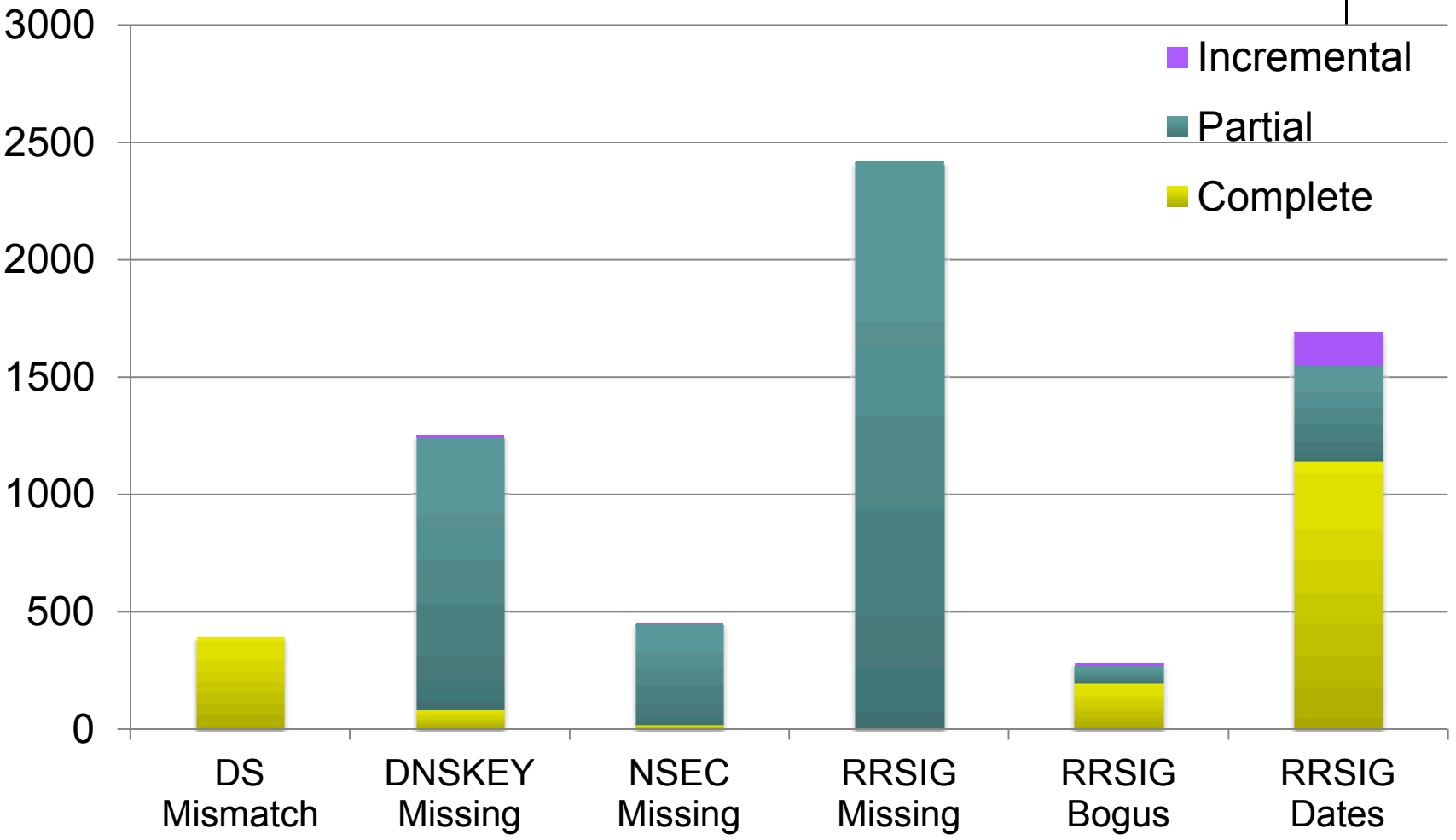
DNSKEY rollovers

Key role	Zones that did not roll key (0)	Zones that rolled key once (1)	Zones that rolled key more than once (>1)
ZSK	37%	11%	52%
KSK	72%	17%	10%

DNSKEY lifetime



Misconfigurations by type



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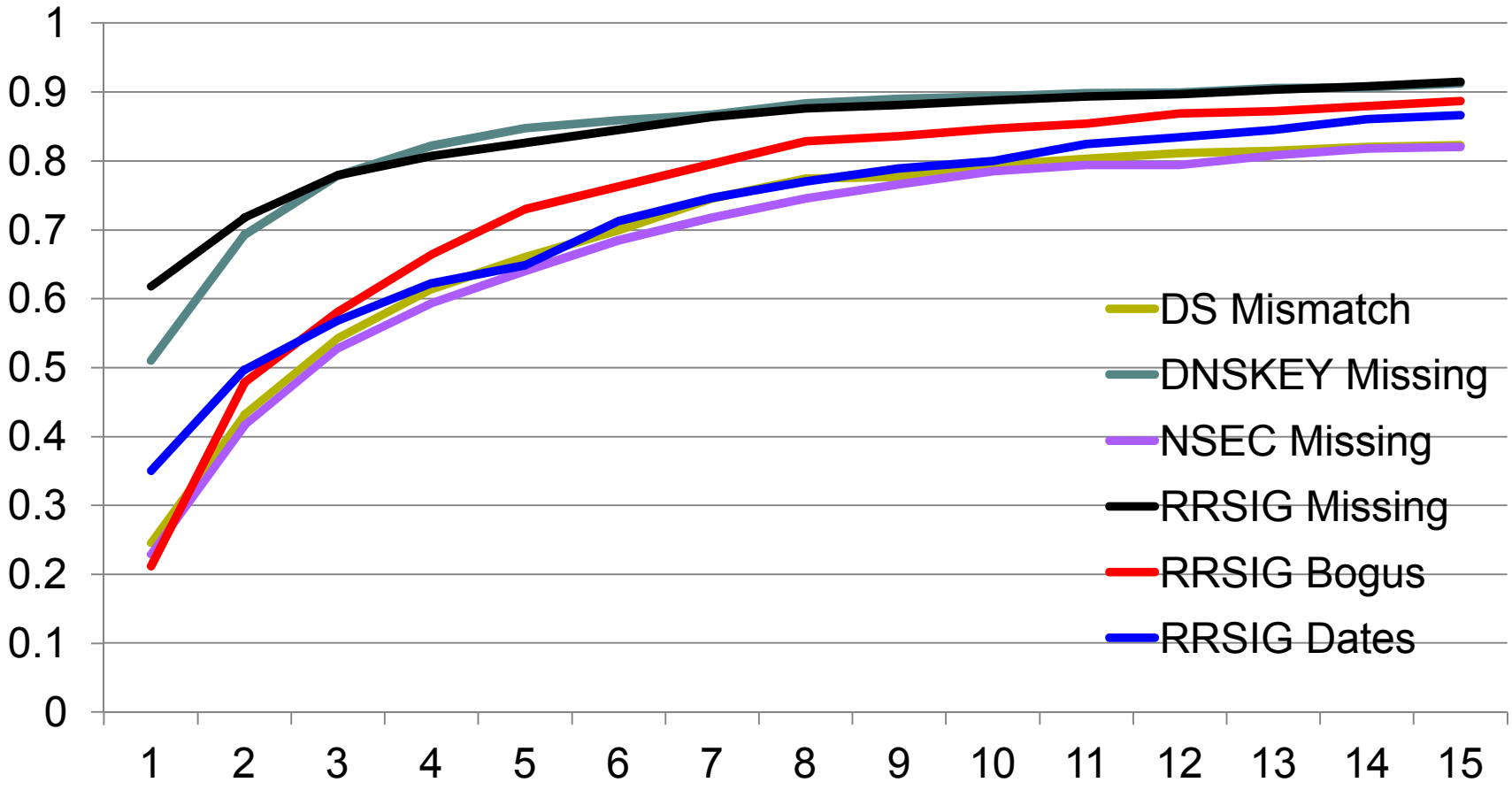
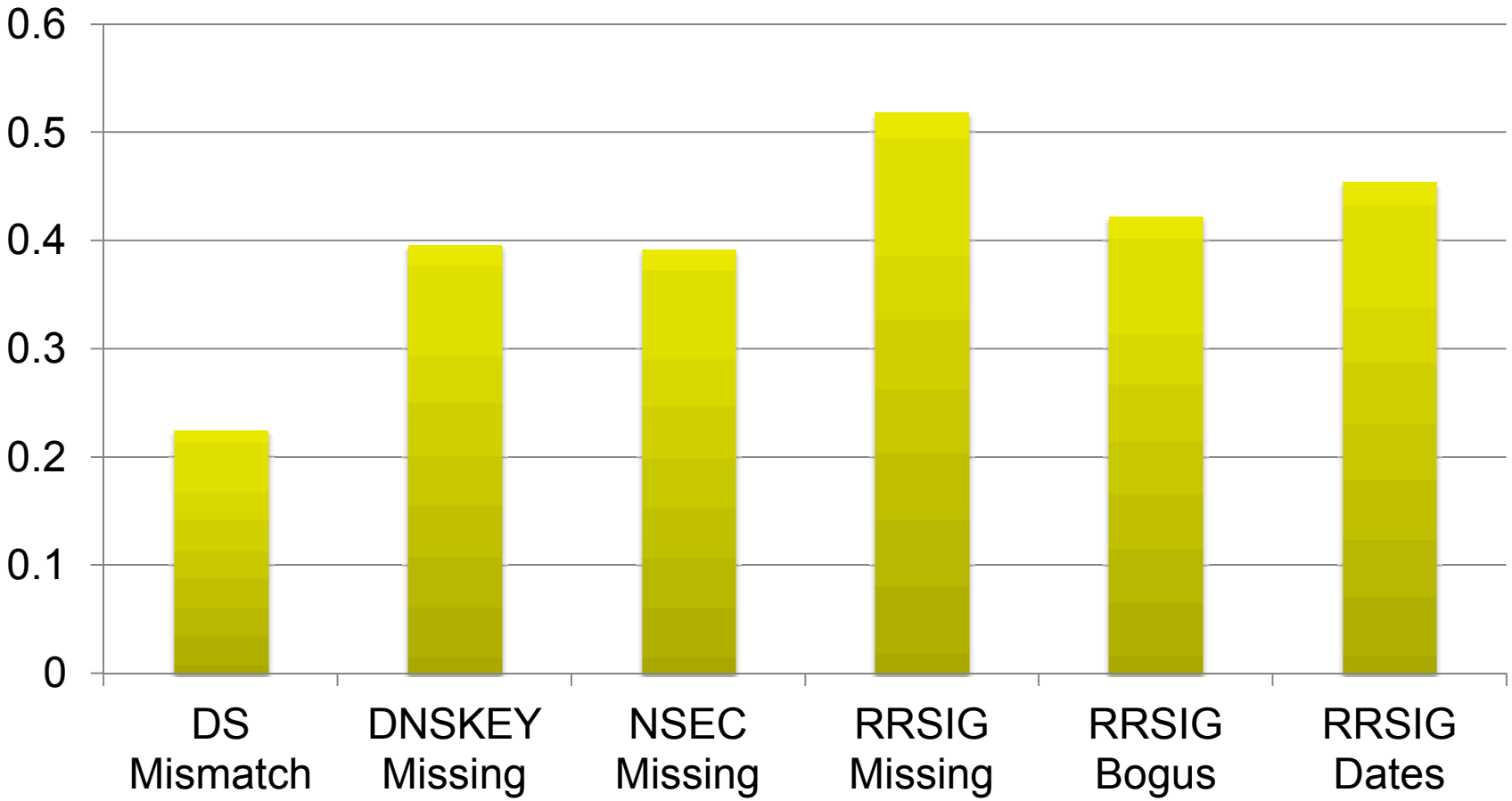
Event duration



Repeat offense rate



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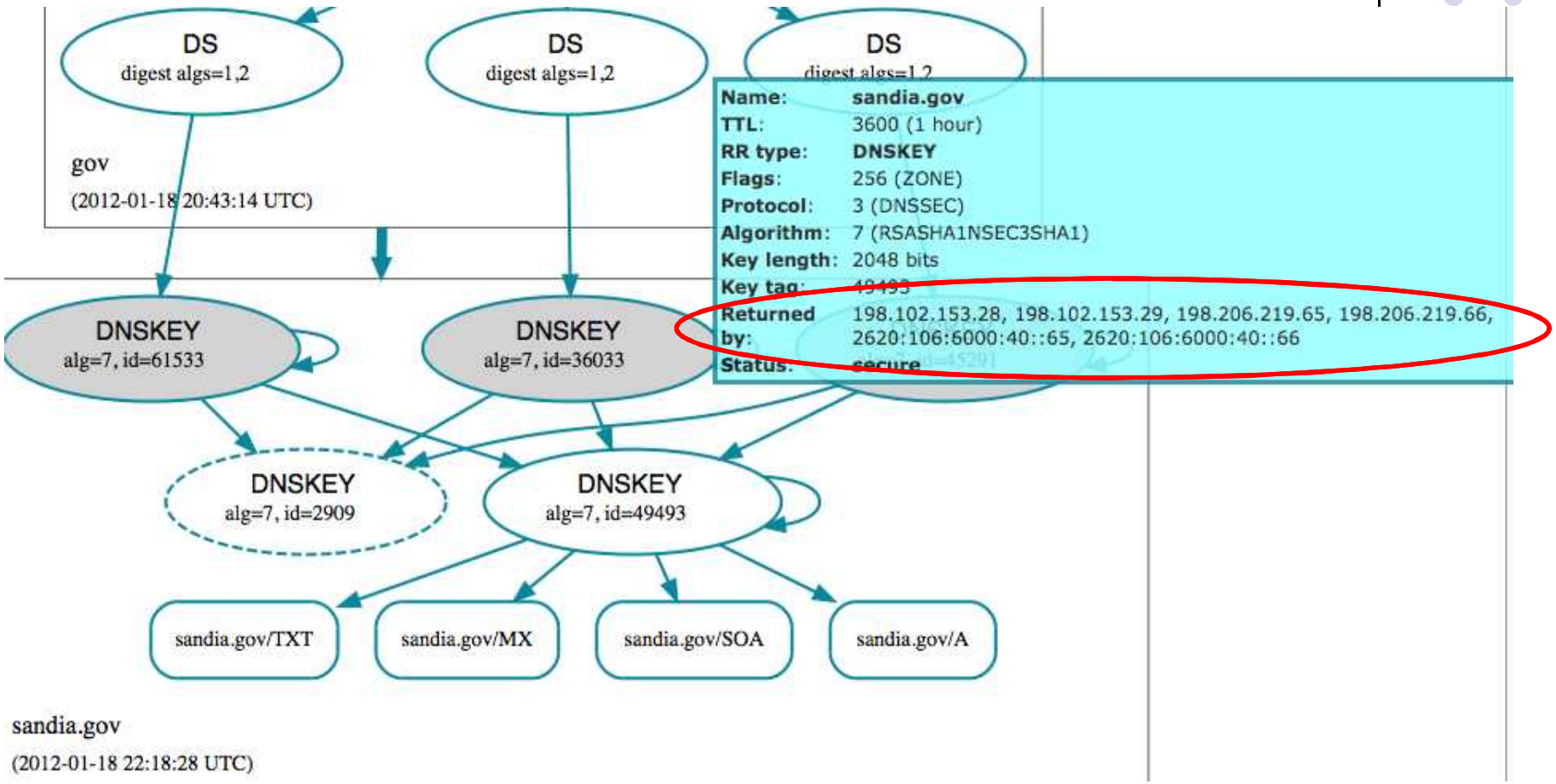
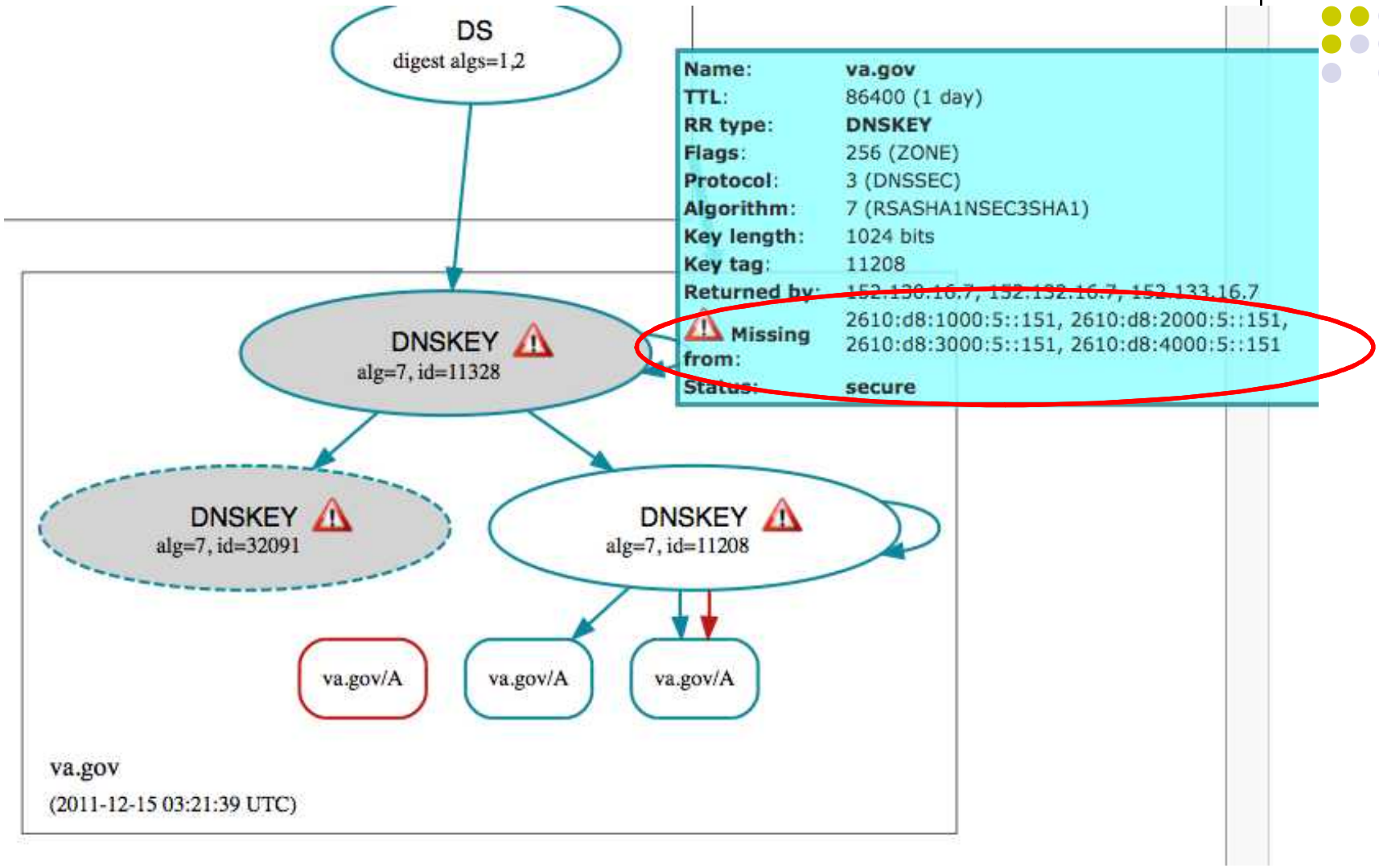
IPv6 analysis



IPv6 inconsistencies



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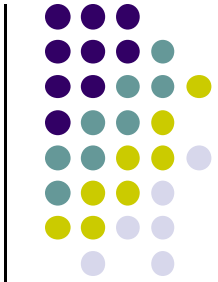
Summary of Observations



- Resolver operators are learning about third-party DNSSEC misconfigurations from their customers.
- Administrators aren't detecting and correcting their DNSSEC problems in a timely fashion.
- Administrators aren't learning from past mistakes.

Solutions

- Tools for DNSSEC comprehensive analysis
  - Hierarchical analysis (chain of trust)
  - Dependency analysis (CNAME, MX, NS, etc)
  - Server consistency analysis
  - Pointers to specification
  - Resources for corrective action
- Tools/resources for detection/notification of misconfiguration
  - Individual monitoring and alerts
  - Global monitoring and alerts

DNSViz – future plans

- Expansion of detailed analysis
- Passive monitoring, in addition to active monitoring
  - Diverse backend support
    - e.g., ISC Security Information Exchange (SIE)
  - Prioritized active probing
  - Alerts of misconfiguration
- RESTful API for programmatic third-party monitoring
- Cache analysis/local perspective
- Availability of software for diverse uses

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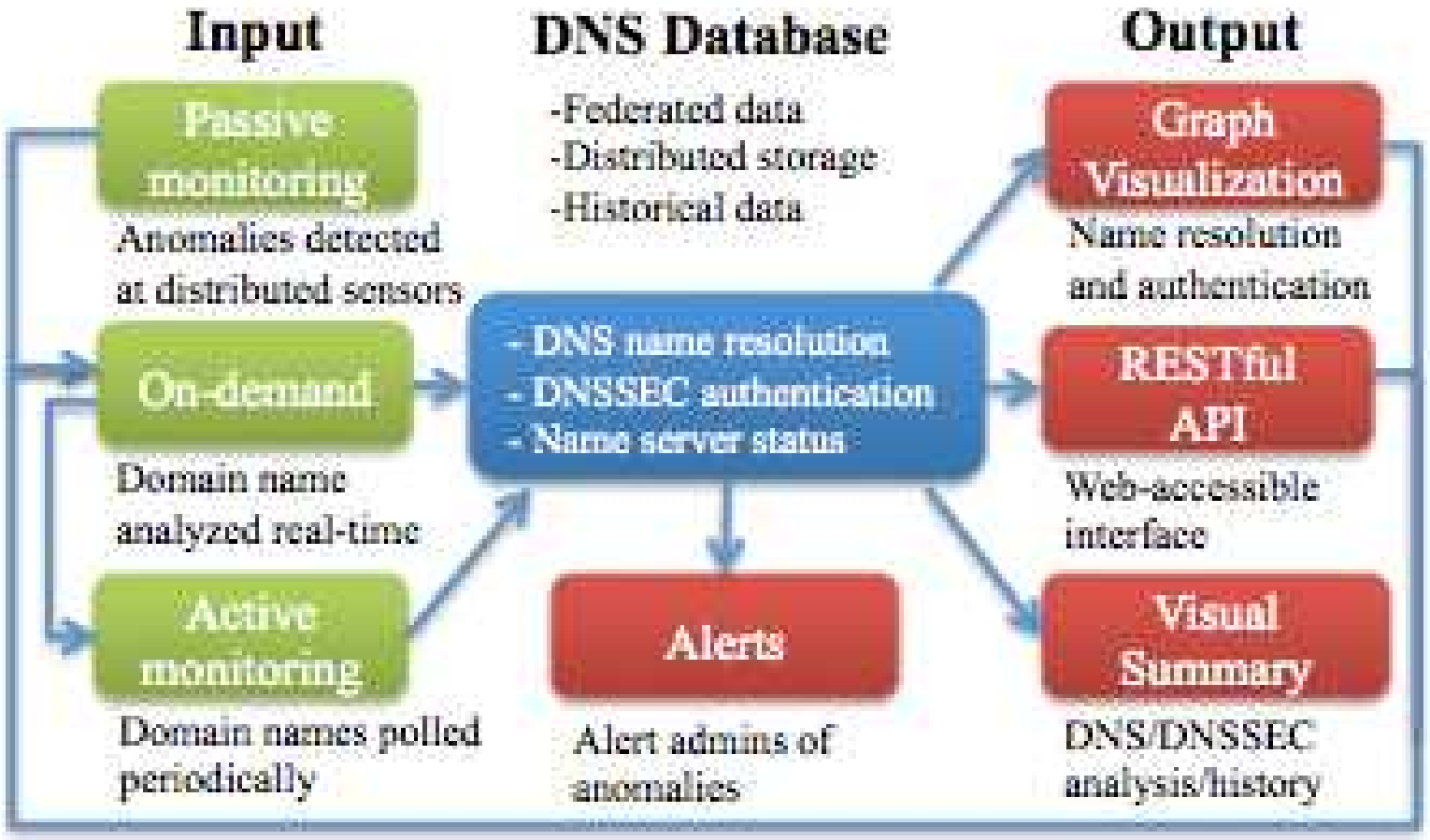
Input
DNS Database
Output
Passive monitoring
Anomalies detected at distributed sensors
On-demand
Domain name analyzed real-time
Active monitoring
Domain names polled periodically
-Federated data
-Distributed storage
-Historical data
- DNS name resolution
- DNSSEC authentication
- Name server status
Alerts
Alert admins of anomalies
Graph Visualization
Name resolution and authentication
RESTful API
Web-accessible interface
Visual Summary
DNS/DNSSEC analysis/history

Questions?

- ctdecci@sandia.gov