Understanding the Role of Registrars in DNSSEC Deployment

Taejoong (tijay) Chung, Roland van Rijswijk-Deij, David Choffnes, Dave Levin, Bruce M. Maggs, Alan Mislove, Christo Wilson
DNSSEC 101

DNS Resolver

example.com's Authoritative DNS Server
DNSSEC 101

DNS Resolver

example.com's Authoritative DNS Server
DNSSEC 101

DNS Resolver

example.com's Authoritative DNS Server

A records

w/ DO bit
DNSSEC 101

DNS Resolver

A records

RRSIG

example.com's Authoritative DNS Server

A records

w/ DO bit
DNSSEC 101

DNS Resolver

A records

RRSIG

A records

w/ DO bit

example.com's Authoritative DNS Server

Previous work

DNSSEC deployment is very rare (~1%) but 30% of them tried (but failed to deploy correctly)
DNSSEC 101

DNS Resolver

A records

example.com's Authoritative DNS Server

A records

w/ DO bit

Previous work

DNSSEC deployment is very rare (~1%) but 30% of them tried (but failed to deploy correctly)

Why?
DNSSEC 101

DNS Resolver

example.com's Authoritative DNS Server
DNS Resolver

example.com's
Authoritative
DNS Server
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example.com's Authoritative DNS Server

A records w/ DO bit
DNSSEC 101

DNS Resolver

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RRSIG

example.com's Authoritative DNS Server

A records

w/ DO bit
DNS Resolver

A records

RRSIG

DNSKEY

example.com's Authoritative DNS Server

A records w/ DO bit
DNSSEC 101

DNS Resolver

A records

DNSKEY

RRSIG

A records w/ DO bit

.example.com's Authoritative DNS Server

.com

.(root zone)
DNSSEC 101

DNS Resolver

A records

DNSKEY

RRSIG

A records w/ DO bit

.example.com's Authoritative DNS Server

.com

.(root zone)
DNSSEC 101

DNS Resolver

A records

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example.com's Authoritative DNS Server

A records w/ DO bit

.(root zone)

.com
DNS Resolved

A records

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A records w/ DO bit

example.com's Authoritative DNS Server

DNSKEY

.(root zone)

.com
DNSSEC 101

DNS Resolver

A records

RRSIG

A records

w/ DO bit

example.com's Authoritative DNS Server

.(root zone)

.com

DNSKEY

DNSKEY

DNSKEY

DNSKEY
DNSSEC 101

- A records
- DNSKEY
- Chain-of-Trust
- . (root zone)
- .com
- example.com's Authoritative DNS Server
- A records w/ DO bit
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

DNSKEY

DNSKEY

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

- DNSKEY
  - DNSKEY
  - DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

- DNSKEY
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DNSSEC 101
Hierarchical Structure

Chain-of-Trust

DNSKEY

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

DNSKEY

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

DNSKEY

.com

e.example.com's Authoritative DNS Server
DNSSEC 101

Hierarchical Structure

Chain-of-Trust

DNSKEY

Dotted box containing:

DNSKEY

Dotted box containing:

DNSKEY

Dotted box containing:

example.com's
Authoritative
DNS Server

Dotted box containing:

.com

Dotted box containing:

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

[Diagram showing the hierarchical structure of DNSSEC, including DNSKEY and DS Record]
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

DNSKEY

.com

DS Record

=Hash(DNSKEY)

example.com's Authoritative DNS Server

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust

- DNSKEY
- DNSKEY
- DNSKEY
- RSIG
- RRSIG
- RRSIG

example.com's Authoritative DNS Server

DS Record

=Hash(DNSKEY)

.com

DNSKEY

DNSKEY
DNSSEC 101
Hierarchical Structure

Chain-of-Trust
- DNSKEY
  - DNSKEY
  - DNSKEY

.example.com's Authoritative DNS Server
- DS Record
  = Hash(DNSKEY)

.com
- RRSIG

~ 30% of domains w/ DNSKEY
DO NOT DO THIS!
Registry, Registrar, and DNS Operator

- Registry (TLD) (Verisign)
- Registrar (GoDaddy)
Registry, Registrar, and DNS Operator

Registry (TLD)

.COM (Verisign)

Registrar

GoDaddy

Buy example.com
Registry, Registrar, and DNS Operator

- Registry (TLD)
  - .COM (Verisign)
- Registrar
  - GoDaddy
- Buy example.com
Registry, Registrar, and DNS Operator

- Registry (TLD): .COM (Verisign)
- Registrar: GoDaddy
- DS Record: example.com

Buy example.com
Registry, Registrar, and DNS Operator

- Registry (TLD)  
  - COM (Verisign)
- Registrar  
  - GoDaddy
- Buy example.com
Registry, Registrar, and DNS Operator

Registry (TLD)

.COM (Verisign)

Registrar

GoDaddy

Buy

example.com
Registry, Registrar, and DNS Operator

Registry (TLD)

.COM (Verisign)

Registrar

Godaddy

Buy
example.com

Owner
Registry, Registrar, and DNS Operator

Registry (TLD)

.TLD (Verisign)

Registrar

GoDaddy

Buy example.com

Owner

DS Record
Registry, Registrar, and DNS Operator

Registry (TLD)

Registrar

.COM (Verisign)

GoDaddy

Buy example.com

Owner

DS Record
Registry, Registrar, and DNS Operator

- Registry (TLD): .COM (Verisign)
- Registrar: GoDaddy
- Owner: example.com

Flow: Owner → Buy example.com → Registrar (GoDaddy) → Registry (TLD)
Registry, Registrar, and DNS Operator
Registry, Registrar, and DNS Operator

Registry (TLD)
.COM (Verisign)
Registrar
GoDaddy
Third-Party DNS Operator
CloudFlare
Buy example.com
Delegate
Registry, Registrar, and DNS Operator

Registry (TLD)
- .COM (Verisign)

Registrar
- GoDaddy

Third-Party DNS Operator
- CloudFlare
  - DS Record

Buy example.com
Delegate
Registry, Registrar, and DNS Operator

- **Registry (TLD)**: .COM (Verisign)
- **Registrar**: GoDaddy
- **Third-Party DNS Operator**: CloudFlare

GoDaddy delegates the DNS management to CloudFlare. A user buys example.com from GoDaddy and sets up a DS record for DNS security.
Registry, Registrar, and DNS Operator

- Registry (TLD): .COM (Verisign)
- Registrar: GoDaddy
- Third-Party DNS Operator: CloudFlare

Buy example.com
Delegate

DS Record
Registry, Registrar, and DNS Operator

- Registry (TLD): .COM (Verisign)
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- Third-Party DNS Operator: Cloudflare

Buy example.com
Delegate
Registry, Registrar, and DNS Operator

Registry (TLD): .COM (Verisign)
Registrar: GoDaddy
Third-Party DNS Operator: CloudFlare

Buy example.com
Delegate
Registry, Registrar, and DNS Operator

- Registry (TLD)
  - .COM (Verisign)
    - Registrar
      - GoDaddy
    - Third-Party DNS Operator
      - CloudFlare
    - Delegate
Registry, Registrar, Reseller, and DNS Operator

Registry (TLD)

.COM (Verisign)

Registrar

ASCIO

Reseller

Antagonist

Buy example.com

Third-Party DNS Operator

CloudFlare

Delegate
Registry, Registrar, Reseller, and DNS Operator

Registry (TLD)

.COM (Verisign)

Registrar

ASCIO

Reseller

Antagonist

Third-Party DNS Operator

CloudFlare

Buy example.com

Delegate

DS Record
Registry, Registrar, Reseller, and DNS Operator

Registry (TLD)  
.COM (Verisign)  

Registrar  
ASCIO  

Reseller  
Antagonist  

Third-Party DNS Operator  
CloudFlare  

Buy example.com  
Delegate  
DS Record
Registry, Registrar, Reseller, and DNS Operator

- Registry (TLD)
- Registrar
- Reseller
- Third-Party DNS Operator

CloudFlare

Buy example.com
Delegate
Registry, Registrar, Reseller, and DNS Operator

- Registry (TLD)
  - .COM (Verisign)
    - Registrar
      - ASCIO
        - Reseller
          - Antagonist
            - Third-Party DNS Operator
              - CloudFlare

- Buy example.com
- Delegate
Registry, Registrar, Reseller, and DNS Operator

- Registry (TLD) (.COM (Verisign))
- Registrar (ASCIO)
- Reseller (Antagonist)
- Third-Party DNS Operator (CloudFlare)

Buy example.com
Delegate
Anecdotal Examples
Anecdotal Examples

**Experiment**

We saw the DNSKEY deployed (but not DS records) so asked why you don’t upload DS records.

**Result**
Anecdotal Examples

Experiment

We saw the DNSKEY deployed (but not DS records) so asked why you don’t upload DS records.

Result

[1] They removed a DNSSEC menu
Anecdotal Examples

Experiment

We saw the DNSKEY deployed (but not DS records) so asked why you don’t upload DS records.

Result

[1] They removed a DNSSEC menu
[2] “Most people do not understand DNS, so imagine the white faces when I mention DNSSEC”
### Anecdotal Examples

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<th>Experiment</th>
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Anecdotal Examples

**Experiment**

We saw the DNSKEY deployed (but not DS records) so asked why you don’t upload DS records.

We asked a registrar to upload a DS record by email from the different email address than the one that registered

We asked a registrar to upload a DS record to our domain via web live chat

**Result**

[1] They removed a DNSSEC menu

[2] “Most people do not understand DNS, so imagine the white faces when I mention DNSSEC”

It was installed successfully
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1. They removed a DNSSEC menu.
2. “Most people do not understand DNS, so imagine the white faces when I mention DNSSEC.”

It was installed successfully.

It was installed on someone else’s domain due to a mistake by the customer service agent.
Details of the Last Example
Details of the Last Example

3:45:32 PM tijay hg-dnssec.com 3600 IN DS 2371 13 2
129f34c04ac58ece5218b9894148304a736a63757f58ff0cddd9b8df4989
Details of the Last Example

3:45:32 PM tijay hg-dnssec.com 3600 IN DS 2371 13 2
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3:57:19 PM tijay paananenmusic.com?

3:57:28 PM tijay my domain is hg-dnssec.com?
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3:57:19 PM tijay paananenmusic.com?

3:57:28 PM tijay my domain is hg-dnssec.com?

3:58:41 PM Jeniffer S I apologize, you are right, silly me, one moment
Open Question
Open Question

Why is so hard to deploy DNSSEC?
Open Question

Why is so **hard** to deploy DNSSEC?

How does registrar policy **impact** the deployment?
Outline

Why is so **hard** to deploy DNSSEC?
Outline

Why is so hard to deploy DNSSEC?

Popular registrar with lots of (1) domains and (2) DNSSEC-enabled domains
Checking Registrar’s DNSSEC Policy

Registrar DNS Operator

Registrar Supports DNSSEC?
Checking Registrar’s DNSSEC Policy

Registrar Supports DNSSEC?

Registrar Supports DS upload?

Registrar DNS Operator

Owner DNS Operator
Checking Registrar’s DNSSEC Policy

Registrar

Supports DNSSEC?

Registrar

Supports DS upload?

Registrar

Validates DS record?

Registrar DNS Operator

Owner DNS Operator
Popular Registrar’s DNSSEC Policy

- Registrar Supports DNSSEC?
- Registrar Supports DS upload?
- Registrar Validates DS record?
## Popular Registrar’s DNSSEC Policy

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<th>Supports DNSSEC?</th>
<th>Supports DS upload?</th>
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<td>GoDaddy (domaincontrol.com)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>NameCheap (registrar-servers.com)</td>
<td>Yes</td>
<td>Yes</td>
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<td>OVH (ovh.net)</td>
<td>Yes</td>
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<td>HostGator (hostgator.com)</td>
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<td>Google (googledomains.com)</td>
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<td>Yes</td>
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<td>123-reg (123-reg.co.uk)</td>
<td>Yes</td>
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<td>Yes</td>
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<tr>
<td>RightSide (name.com)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>eNom (name-services.com)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>NameBright (namebrightdns.com)</td>
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<td>DreamHost (dreamhost.com)</td>
<td>Yes</td>
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<td>The others (10 registrars)</td>
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<th>DNS Operator</th>
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<td>![Green Circle]</td>
<td></td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
<td>![Orange Triangle]</td>
<td></td>
</tr>
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⚠️ Some nameservers don’t support DNSSEC
## Popular Registrar’s DNSSEC Policy

### Registrar Supports DNSSEC? (2.5/20)
- GoDaddy (domaincontrol.com)
- NameCheap (registrar-servers.com)
- OVH (ovh.net)
- HostGator (hostgator.com)
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- NameBright (namebrightdns.com)
- DreamHost (dreamhost.com)
- The others (10 registrars)

### Registrar Supports DS upload? (11/20)

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<th>Web</th>
<th>Email</th>
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<td><img src="green.png" alt="Green" /></td>
<td>—</td>
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## Popular Registrar’s DNSSEC Policy

### Registrar Support for DNSSEC

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<td>NameBright (namebrightdns.com)</td>
<td>2/20</td>
</tr>
<tr>
<td>DreamHost (dreamhost.com)</td>
<td>2/20</td>
</tr>
<tr>
<td>The others (10 registrars)</td>
<td>2/20</td>
</tr>
</tbody>
</table>

### Owner DNS Operator Support

<table>
<thead>
<tr>
<th>Registrar</th>
<th>DS Upload</th>
<th>DS Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoDaddy (domaincontrol.com)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>OVH (ovh.net)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>HostGator (hostgator.com)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>Amazon (aws-dns)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>Google (googledomains.com)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>123-reg (123-reg.co.uk)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>RightSide (name.com)</td>
<td>⬤</td>
<td>✗</td>
</tr>
<tr>
<td>eNom (name-services.com)</td>
<td>✗</td>
<td>⬤</td>
</tr>
<tr>
<td>NameBright (namebrightdns.com)</td>
<td>⬤</td>
<td>⬤</td>
</tr>
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<td>✗</td>
<td>⬤</td>
</tr>
<tr>
<td>The others (10 registrars)</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
### Popular Registrar

<table>
<thead>
<tr>
<th>Support DNSSEC?</th>
<th>DNS Operator</th>
<th># of Registrar</th>
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</thead>
<tbody>
<tr>
<td>Registrar</td>
<td>2.5/20</td>
<td></td>
</tr>
<tr>
<td>Owner</td>
<td>11/20</td>
<td></td>
</tr>
<tr>
<td>Check DS Validation</td>
<td>Owner</td>
<td>2/11</td>
</tr>
</tbody>
</table>

DNSSEC Support for popular registrars is quite poor. Each registrar has different policy for supporting DNSSEC.
## Popular DNSSEC Support Registrars

<table>
<thead>
<tr>
<th>Registrar</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVH (ovh.net)</td>
</tr>
<tr>
<td>Loopia (loopia.se)</td>
</tr>
<tr>
<td>DomainNameShop (hyp.net)</td>
</tr>
<tr>
<td>TransIP (transip.net)</td>
</tr>
<tr>
<td>MeshDigital (domainmonster.com)</td>
</tr>
<tr>
<td>OVH (anycast.me)</td>
</tr>
<tr>
<td>TransIP (transip.nl)</td>
</tr>
<tr>
<td>Binero (binero.se)</td>
</tr>
<tr>
<td>KPN (is.nl)</td>
</tr>
<tr>
<td>PCExtreme (pcextreme.nl)</td>
</tr>
<tr>
<td>Antagonist (webhostingserver.nl)</td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
</tr>
</tbody>
</table>
## Registrar DNS Operator

<table>
<thead>
<tr>
<th>Registrar</th>
<th>DNSSEC Default</th>
<th>Publish DS Records?</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVH (ovh.net)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Loopia (loopia.se)</td>
<td>✓</td>
<td>▲</td>
</tr>
<tr>
<td>DomainNameShop (hyp.net)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TransIP (transip.net)</td>
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⚠️ Selective support
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<td>NameCheap (registrar-servers.com)</td>
</tr>
</tbody>
</table>

**Owner DNS Operator**

10/12

**Registrar Supports DNSSEC?**

**Registrar Supports DS upload?**

**Registrar Validates DS record?**
<table>
<thead>
<tr>
<th>Registrar</th>
<th>Owner DNS Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVH (ovh.net)</td>
<td><img src="Green.png" alt="Green" /></td>
</tr>
<tr>
<td>Loopia (loopia.se)</td>
<td><img src="Green.png" alt="Green" /></td>
</tr>
<tr>
<td>DomainNameShop (hyp.net)</td>
<td><img src="Green.png" alt="Green" /></td>
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<td>TransIP (transip.net)</td>
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<td>MeshDigital (domainmonster.com)</td>
<td><img src="Green.png" alt="Green" /></td>
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<tr>
<td>OVH (anycast.me)</td>
<td><img src="Green.png" alt="Green" /></td>
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<td>TransIP (transip.nl)</td>
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</tr>
<tr>
<td>Binero (binero.se)</td>
<td><img src="Green.png" alt="Green" /></td>
</tr>
<tr>
<td>KPN (is.nl)</td>
<td><img src="Red.png" alt="Red" /></td>
</tr>
<tr>
<td>PCEExtreme (pcextreme.nl)</td>
<td><img src="Green.png" alt="Green" /></td>
</tr>
<tr>
<td>Antagonist (webhostingserver.nl)</td>
<td><img src="Red.png" alt="Red" /></td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
<td><img src="Green.png" alt="Green" /></td>
</tr>
</tbody>
</table>
# DS Validation

<table>
<thead>
<tr>
<th>Registrar</th>
<th>Owner DNS Operator</th>
<th>DS Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DS Upload</td>
<td></td>
</tr>
<tr>
<td>OVH (ovh.net)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Loopia (loopia.se)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>DomainNameShop (hyp.net)</td>
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<tr>
<td>TransIP (transip.nl)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Binero (binero.se)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>KPN (is.nl)</td>
<td>X</td>
<td>—</td>
</tr>
<tr>
<td>PCEXtreme (pcextreme.nl)</td>
<td>●</td>
<td>△</td>
</tr>
<tr>
<td>Antagonist (webhostingserver.nl)</td>
<td>X</td>
<td>—</td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
<td>●</td>
<td>X</td>
</tr>
</tbody>
</table>

⚠️ Fetches a DNSKEY from the nameserver
### Other Security Issues

<table>
<thead>
<tr>
<th>Registrar</th>
<th>Owner DNS Operator</th>
<th>DS Validation</th>
<th>DS Upload</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supports DNSSEC?</strong></td>
<td></td>
<td></td>
<td></td>
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<td>OVH (ovh.net)</td>
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<td><strong>Supports DS upload?</strong></td>
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<tr>
<td>NameCheap (registrar-servers.com)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Validates DS record?</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>OVH (ovh.net)</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
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<th>Registrar</th>
<th>Owner DNS Operator</th>
<th>DS Validation</th>
<th>DS Upload</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVH (ovh.net)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
</tr>
<tr>
<td>Loopia (loopia.se)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
</tr>
<tr>
<td>DomainNameShop (hyp.net)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
</tr>
<tr>
<td>TransIP (transip.net)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
</tr>
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<td>MeshDigital (domainmonster.com)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
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<td>OVH (anycast.me)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
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<td></td>
</tr>
<tr>
<td>TransIP (transip.nl)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
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<td></td>
</tr>
<tr>
<td>Binero (binero.se)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
</tr>
<tr>
<td>KPN (is.nl)</td>
<td><img src="https://example.com/red.png" alt="Red" /></td>
<td></td>
<td><img src="https://example.com/gray.png" alt="Gray" /></td>
</tr>
<tr>
<td>PCEExtreme (pcextreme.nl)</td>
<td><img src="https://example.com/green.png" alt="Green" /></td>
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<td><img src="https://example.com/red.png" alt="Red" /></td>
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<td><img src="https://example.com/gray.png" alt="Gray" /></td>
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<tr>
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<td><img src="https://example.com/green.png" alt="Green" /></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Registrar</th>
<th>Web</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVH (ovh.net)</td>
<td><img src="https://example.com/gray.png" alt="Gray" /></td>
<td><img src="https://example.com/gray.png" alt="Gray" /></td>
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<td><img src="https://example.com/gray.png" alt="Gray" /></td>
</tr>
<tr>
<td>NameCheap (registrar-servers.com)</td>
<td><img src="https://example.com/gray.png" alt="Gray" /></td>
<td><img src="https://example.com/gray.png" alt="Gray" /></td>
</tr>
</tbody>
</table>
Outline

Why is DNSSEC deployment so rare?

How does a registrar policy impact the deployment?
Outline

Why is DNSSEC deployment so rare?

How does a registrar policy impact the deployment?

We need historical dataset
## Dataset

<table>
<thead>
<tr>
<th>TLD</th>
<th>Measurement Period (Daily Scan)</th>
<th>Domains</th>
<th>Percent w/ DNSKEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>.com</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>118,147,199</td>
<td>0.7%</td>
</tr>
<tr>
<td>.net</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>13,773,903</td>
<td>1.0%</td>
</tr>
<tr>
<td>.org</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>9,682,750</td>
<td>1.1%</td>
</tr>
<tr>
<td>.nl</td>
<td>2016/02/09 ~ 2016/12/31</td>
<td>5,674,208</td>
<td>51.6%</td>
</tr>
<tr>
<td>.se</td>
<td>2016-06-07 ~ 2016/12/31</td>
<td>1,388,372</td>
<td>46.7%</td>
</tr>
</tbody>
</table>
## Dataset

<table>
<thead>
<tr>
<th>TLD</th>
<th>Measurement Period (Daily Scan)</th>
<th>Domains</th>
<th>Percent w/ DNSKEY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>.com</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>118,147,199</td>
<td>0.7%</td>
</tr>
<tr>
<td>.net</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>13,773,903</td>
<td>1.0%</td>
</tr>
<tr>
<td>.org</td>
<td>2015/03/01 ~ 2016/12/31</td>
<td>9,682,750</td>
<td>1.1%</td>
</tr>
<tr>
<td>.nl</td>
<td>2016/02/09 ~ 2016/12/31</td>
<td>5,674,208</td>
<td>51.6%</td>
</tr>
<tr>
<td>.se</td>
<td>2016-06-07 ~ 2016/12/31</td>
<td>1,388,372</td>
<td>46.7%</td>
</tr>
</tbody>
</table>

Over 750 billion DNS Records
[I] Registry: Financial Incentive

![Graph showing percent of domains with DNSKEY and DS record over time for .com, .net, .org, .se, and .nl for KPN and Loopia.]

<table>
<thead>
<tr>
<th>Date</th>
<th>.com</th>
<th>.net</th>
<th>.org</th>
<th>.se</th>
<th>.nl</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>05/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>08/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11/16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Registry: Financial Incentive
[1] Registry: Financial Incentive

- **KPN**: Financial Incentive
- **Loopia**: Measurement begins here

**Graph Details**:
- **Y-axis**: Percent of domains with DNSKEY and DS record
- **X-axis**: Date from 05/15 to 11/16
- **Domain Extensions**:
  - .com
  - .net
  - .org
  - .se
  - .nl

**Flag Information**:
- KPN: Netherlands
- Loopia: Sweden
[I] Registry: Financial Incentive

![Diagram showing percent of domains with DNSKEY and DS record over time for .com, .net, .org, .se, and .nl domains.]

- .com
- .net
- .org
- .se
- .nl

Date:
- 05/15
- 08/15
- 11/15
- 02/16
- 05/16
- 08/16
- 11/16

- KPN: Financial Incentive
- Loopia: Financial Incentive

05/15: .nl measurement begins here
02/16: .se measurement begins here
[1] Registry: Financial Incentive

The diagram shows the percentage of domains with DNSKEY and DS records for various domains (.com, .net, .org, .se, .nl) for two different registries: KPN and Loopia. The x-axis represents dates from May 2015 to November 2016. The y-axis represents the percentage of domains.

- **KPN** (.is.nl): The .nl measurement begins here.
- **Loopia** (.loopia.se): The .se measurement begins here.

Registry: Financial Incentive
[1] Registry: Financial Incentive

![Graph showing percent of domains with DNSKEY and DS record for different TLDs (com, net, org, se, nl) over time. The x-axis represents dates from May 2015 to November 2016, and the y-axis represents the percentage of domains. Two separate graphs are shown for KPN and Loopia, with flags indicating their regions.]

- **KPN**: Measurement begins here
- **Loopia**: Measurement begins here

- **Registry**: Financial Incentive

---

- **Country Flags**: Netherlands and Sweden

---

- **Note**: [1] Source or reference for financial incentive.
Financial gain is a huge incentive for deploying DNSSEC.

Percent of domains with DS record

Date

05/15 08/15 11/15 02/16 05/16 08/16 11/16

OVH
GoDaddy

Percent of domains with DS record against Date for OVH and GoDaddy.

Percent of domains with DS record vs. Date:
- OVH: Red line
- GoDaddy: Blue line

Date:
- 05/15
- 08/15
- 11/15
- 02/16
- 05/16
- 08/16
- 11/16

Y-axis: Percent of domains with DS record

X-axis: Date
Free DNSSEC support encourages users to deploy DNSSEC.
[3] Reseller (.com, .org, .net) vs. Registrar (.nl)

- Percent of domains with DS and DNSKEY record
- Number of domains in .com, .net, .org, .nl

Date:
- 05/15
- 08/15
- 11/15
- 02/16
- 05/16
- 08/16
- 11/16
[3] Reseller (.com, .org, .net) vs. Registrar (.nl)

Percent of domains with DS and DNSKEY record

Date: 05/15, 08/15, 11/15, 02/16, 05/16, 08/16, 11/16

- .com
- .net
- .org
- .nl

# of domains
Reseller (.com, .org, .net) vs. Registrar (.nl)

Percent of domains with DS and DNSKEY record

# of domains

Date

05/15 08/15 11/15 02/16 05/16 08/16 11/16
[3] Reseller (.com, .org, .net) vs. Registrar (.nl)
[3] Reseller (.com, .org, .net) vs. Registrar (.nl)

Changed their registrar to one that supports DNSSEC.
[3] **Reseller (.com, .org, .net) vs. Registrar (.nl)**

Complex relationship between reseller and registrar also result in slow deployment of DNSSEC

- Changed their registrar to one that supports DNSSEC
Cloudflare announced universal DNSSEC
Third-Party DNS Operator

Cloudflare announced universal DNSSEC
Third-Party DNS Operator <Cloudflare>

Cloudflare announced universal DNSSEC
Third-party DNS Operator

Deploying DNSSEC is even harder for users using third-party DNS Operators

Cloudflare announced universal DNSSEC
Conclusion
Conclusion

• **Registrars** play a critical role in supporting DNSSEC today
  • **Only 3** out of 20 registrars support DNSSEC on their authoritative nameservers
  • **Only 11** out of 20 registrars support uploading a custom DS record
Conclusion

• **Registrars** play a critical role in supporting DNSSEC today
  • *Only 3* out of 20 registrars support DNSSEC on their authoritative nameservers
  • *Only 11* out of 20 registrars support uploading a custom DS record

• DNSSEC deployment depends on many policies
  • **Registrar**: Free
  • **Registry**: Financial incentive
  • **Reseller**: Beware to choose a partner (i.e., registrar)
  • **Third-party**: CDS/CDNSKEY
Thanks!

http://SecurePKI.org

Taejoong Chung
http://tijay.me