

Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI

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NANOG 82 Virtual, June 14-16, 2021.

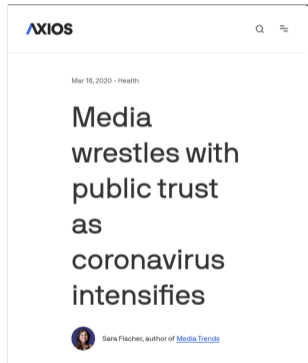


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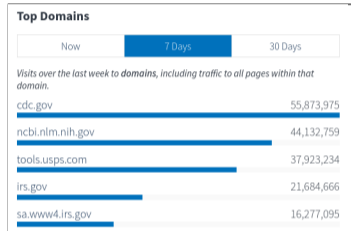
Alerting Authorities are crucial during crises.

- People rely on **trustworthy sources**.



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- People rely on **trustworthy sources**.
- Authorities provide services **via web**.



Alerting Authorities are crucial during crises.

- People rely on **trustworthy sources**.
- Authorities provide services **via web**.
- Evaluating **trustworthiness** is a challenge.

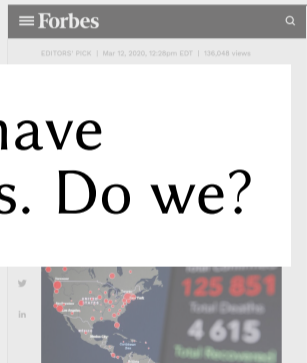
The image shows a screenshot of a Forbes article. At the top, the Forbes logo is visible. Below it, the article title is "Coronavirus Scam Alert: Watch Out For These Risky COVID-19 Websites And Emails". The author is Thomas Brewster, a Forbes Staff member in Cybersecurity. The article is dated March 12, 2020, and has 136,048 views. Below the text, there is a social media sharing bar with icons for Facebook, Twitter, and LinkedIn. To the right of the sharing bar is a map of the United States with red dots indicating locations. To the right of the map is a statistics box with the following data:

Category	Value
Total Confirmed	125,851
Total Deaths	4,615
Total Recovered	

Alerting Authorities are crucial during crises.

- Pe
- Au
- Ev

But wait, we do have protection mechanisms. Do we?

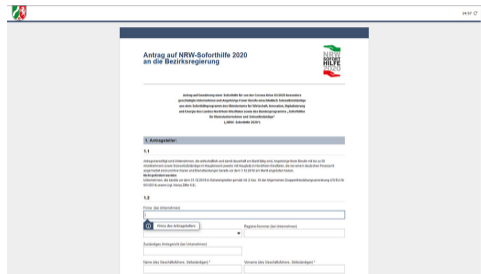


Scammers Attack a German Paycheck Protection Plan. True Story.



<https://nrw-corona-soforthilfe.de>

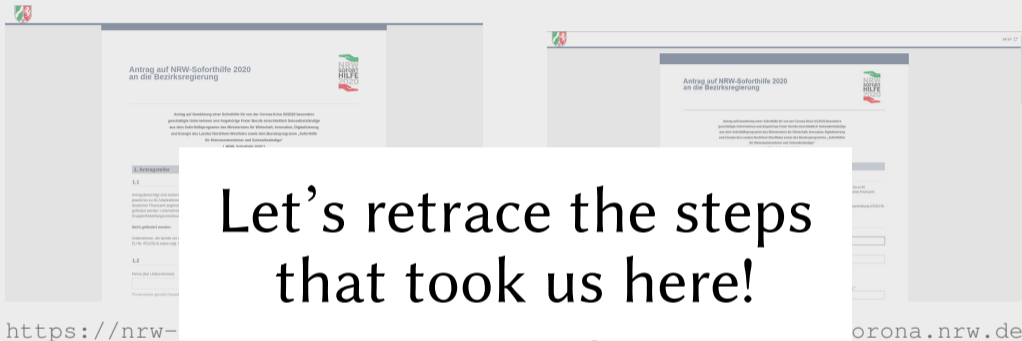
- ✓ Sound domain name under .de
- ✓ HTTPS enabled
- ✓ DNSSEC enabled



<https://soforthilfe-corona.nrw.de>

- ✓ Sound domain name under .de
- ✓ HTTPS enabled
- ✗ DNSSEC not enabled

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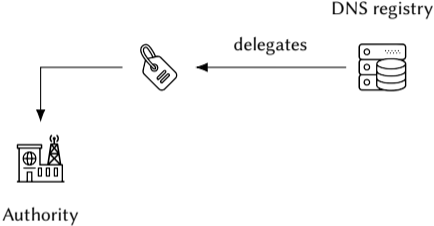
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Secure Web-based Communication. A Complex System.

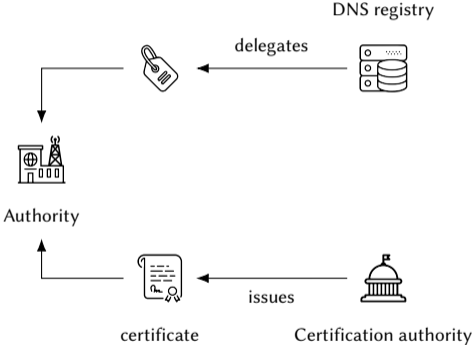


Authority

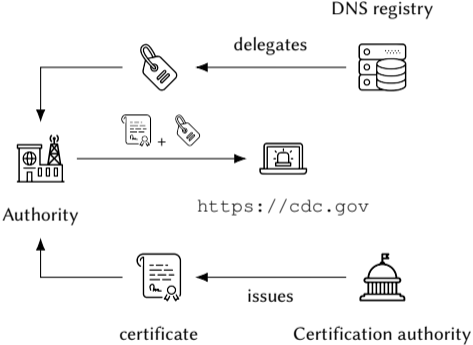
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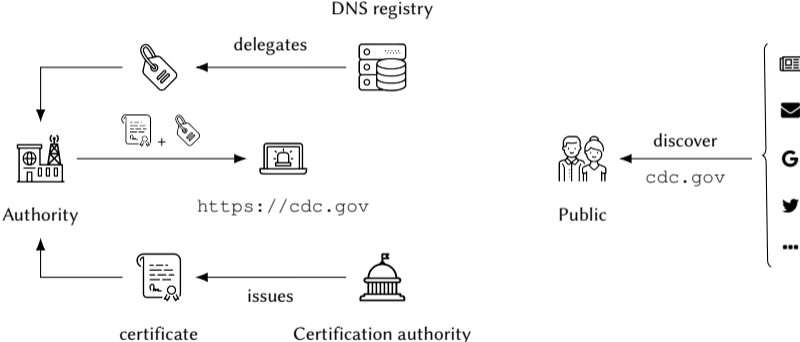
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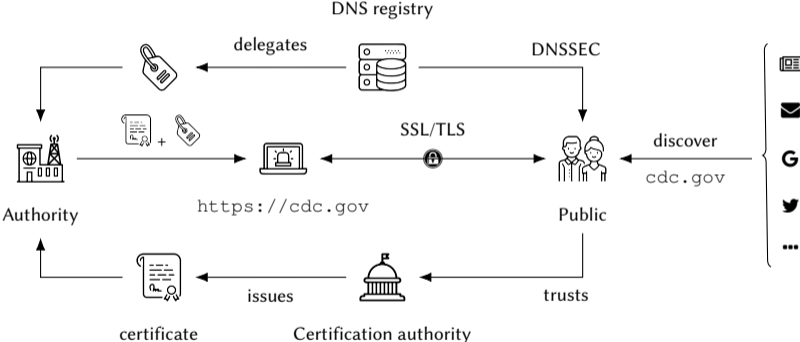
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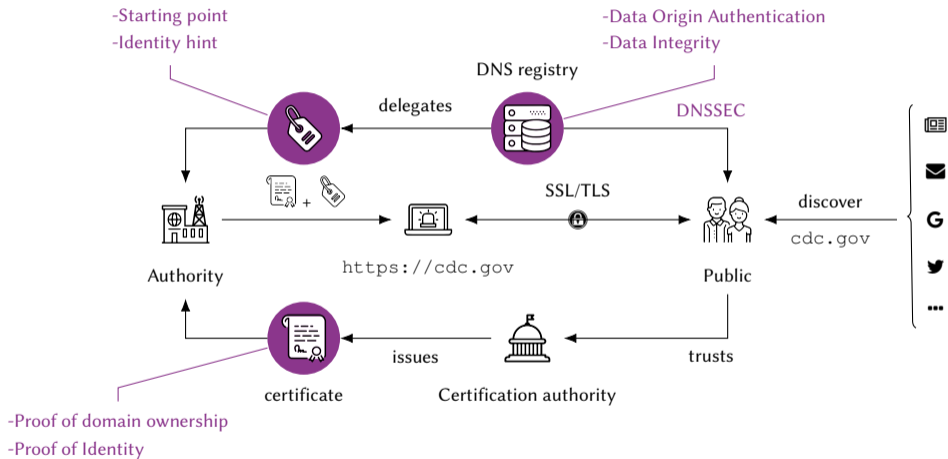
Secure Web-based Communication. A Complex System.



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Secure Web-based Communication. A Complex System.

-Starting point

-Identity hint

-Data Origin Authentication

-Data Integrity

DNS registry

We contribute:

- (1) A threat model for Web-based communication.
- (2) A method to discover and analyze Alerting Authorities.
- (3) Web security profiles of Alerting Authorities in the US.

certificate

Certification authority

-Proof of domain ownership

-Proof of Identity

Threat Model. Three Dimensions.

Identification Securely authenticating the person, etc. behind the service name.

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Resolution Securely verifying that users have not been misdirected and are transacting with the service name they have identified.

Threat Model. Three Dimensions.

- Identification** Securely authenticating the person, etc. behind the service name.
- Resolution** Securely verifying that users have not been misdirected and are transacting with the service name they have identified.
- Transaction** Ensuring that the content was not altered, leaks privacy etc. during the session.

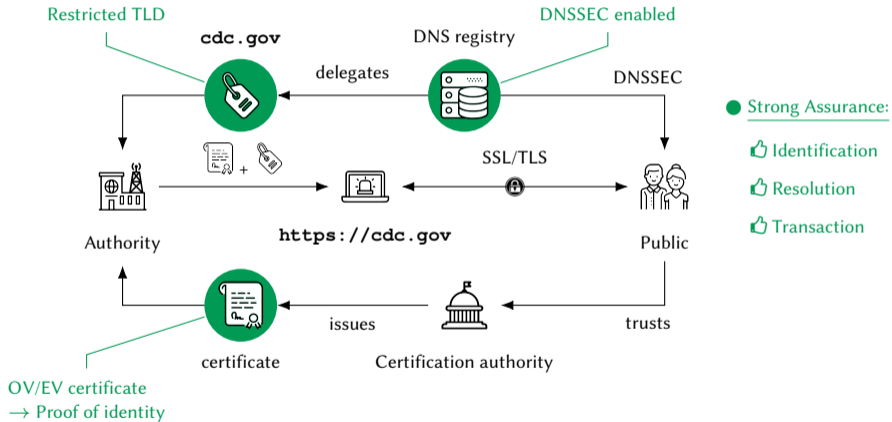
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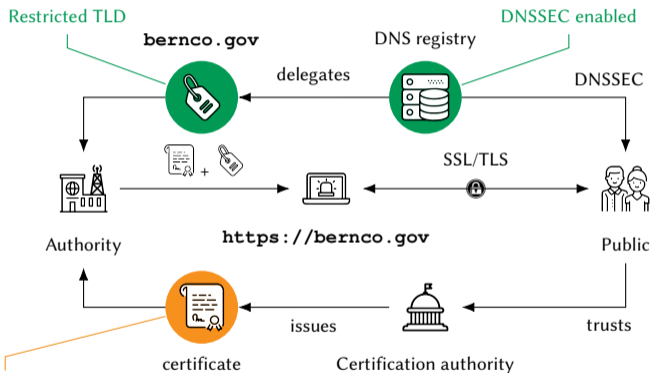
**How DNS(SEC) and WebPKI
amount to secure communication?**

the session.

Secure Web-based Communication. Assurance Profiles.



Secure Web-based Communication. Assurance Profiles.



Weak Assurance:

Identification

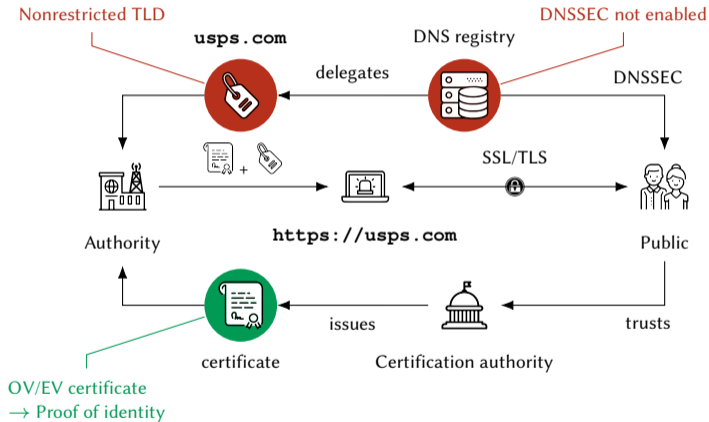
Resolution

Transaction

DV certificate

→ Proof of domain ownership

Secure Web-based Communication. Assurance Profiles.



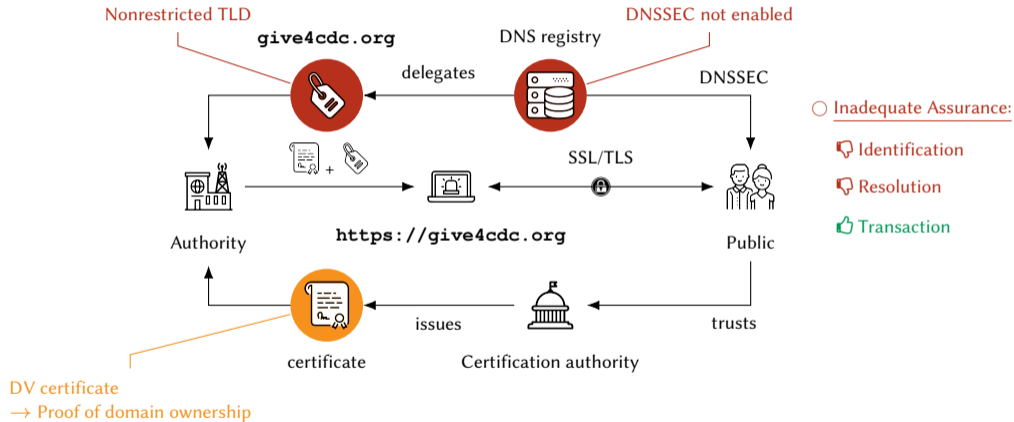
Weak Assurance:

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Transaction

Secure Web-based Communication. Assurance Profiles.



Threat Model in context. Assurance profiles.

#	DNS		Web PKI		Security Implications			Weakness	Assurance Profile
	Restricted TLD	DNSSEC	DV	OV/EV	Identification	Resolution	Transaction		
01	✓	✓	-	✓	👍	👍	👍	N/A	●
02	✓	✓	✓	✗	⚠️	👍	👍	Ambiguous identification	◐
03	✗	✓	-	✓	⚠️	👍	👍	Possible impersonation through name spoofing	◐
04	✓	✗	-	✓	⚠️	👎	👍	DNS hijacking	◐
05	✗	✗	-	✓	⚠️	👎	👍	Name spoofing, DNS hijacking	◐
06	✓	✗	✓	✗	⚠️	👎	👍	DNS hijacking and ambiguous identification	○
07	✗	✗	✓	✗	👎	👎	👍	Impersonation and DNS hijacking	○
08	✗	✓	✓	✗	👎	👍	👍	Impersonation	○
09	✓	✓	✗	✗	👎	👎	👎	Content poisoning	○
10	✓	✗	✗	✗	👎	👎	👎	DNS hijacking, content poisoning	○
11	✗	✓	✗	✗	👎	👍	👎	Impersonation, content poisoning	○
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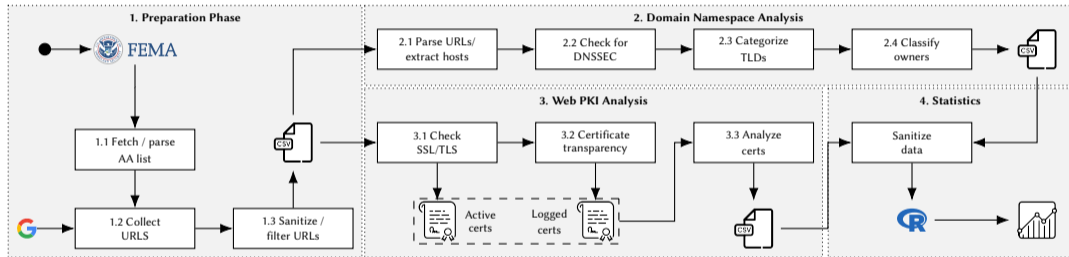
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Security of Alerting Authorities in the WWW:
Measuring Namespaces, DNSSEC, and Web PKI

Methodology, Toolchain, and Data Set

Measurement Period October 2019 – March 2020



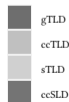
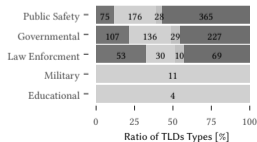
1388 Alerting Authorities in the US → 1365 URLs → 1327 unique hosts

Security of Alerting Authorities in the WWW:
Measuring Namespaces, DNSSEC, and Web PKI

Results: Namespace and DNS(SEC) Analysis

1327 Unique Hosts

- Does each AA have its own dedicated domain name?
- How do AAs integrate in the global DNS namespace?
- Do AAs secure their names using DNSSEC?



DNSSEC for <state>.us

Results: Namespace and DNS(SEC) Analysis

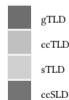
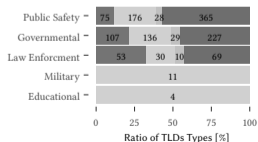
1327 Unique Hosts

■ Does each AA have its own dedicated domain name?

About 49% of Alerting Authorities do not have dedicated names,

e.g., <https://www.vercounty.org/ema.htm>

→ unnecessary dependencies, *e.g.*, for X.509 certificates.

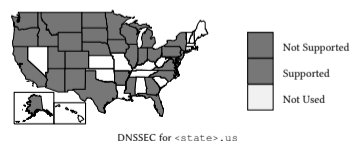
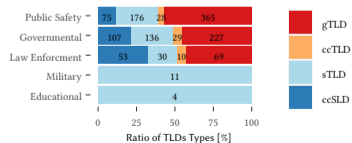


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Results: Namespace and DNS(SEC) Analysis

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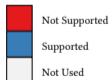
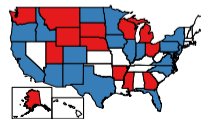
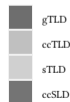
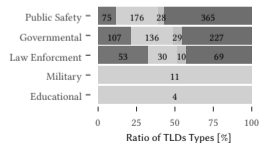
- About 49% of Alerting Authorities do not have dedicated names
- **How do AAs integrate in the global DNS namespace?**
More than 50% of unique names are under **non**-restricted TLDs
→ poor recognizability and inferior security.



Results: Namespace and DNS(SEC) Analysis

1327 Unique Hosts

- About 49% of Alerting Authorities do not have dedicated names
- More than 50% of unique names are under **non**-restricted TLDs
- **Do AAs secure their names using DNSSEC?**
96% of unique hosts do not support DNSSEC
→ high susceptibility to DNS hijacking

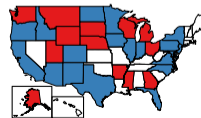
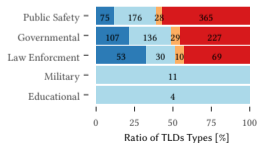


DNSSEC for <state>.us

Results: Namespace and DNS(SEC) Analysis

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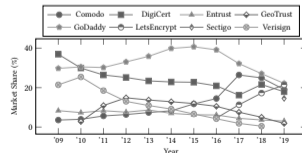
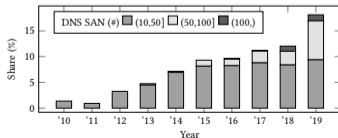
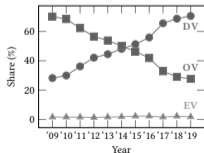
DNSSEC for <state>.us

Security of Alerting Authorities in the WWW:
Measuring Namespaces, DNSSEC, and **Web PKI**

Results: Web PKI Analysis

1327 Unique Hosts

- To what extent do AAs adapt web PKI?
- How is the historic landscape of X.509 certificates shaped among AAs?



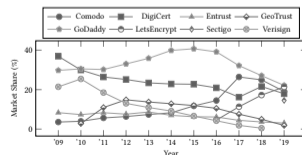
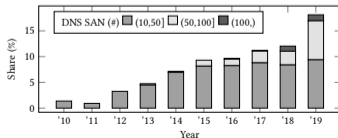
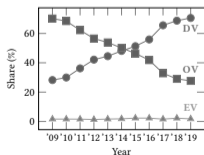
Results: Web PKI Analysis

1327 Unique Hosts

■ To what extent do AAs adapt web PKI?

About 15% provide none or invalid certificates (OpenSSL validation)

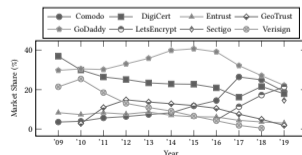
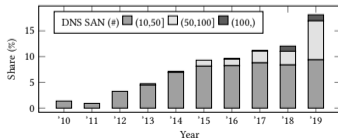
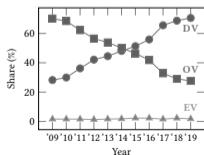
→ secure identification and transaction impossible



Results: Web PKI Analysis

1327 Unique Hosts

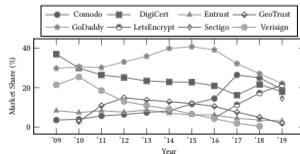
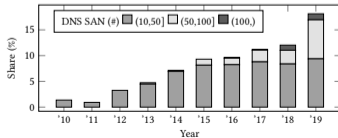
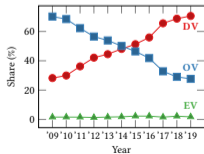
- About 15% provide none or invalid certificates
- **How is the historic landscape of X.509 certificates shaped among AAs?**



Results: Web PKI Analysis

1327 Unique Hosts

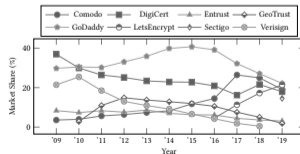
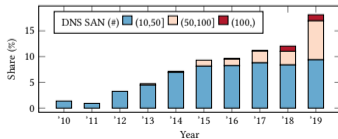
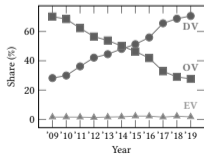
- About 15% provide none or invalid certificates
- **How is the historic landscape of X.509 certificates shaped among AAs?**
 - **Which validation types have been popular?**
OV/EV certificates are losing popularity



Results: Web PKI Analysis

1327 Unique Hosts

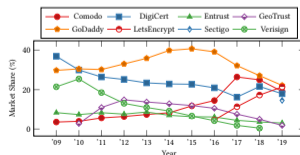
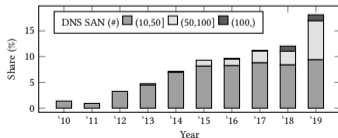
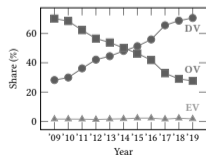
- About 15% provide none or invalid certificates
- **How is the historic landscape of X.509 certificates shaped among AAs?**
 - OV/EV certificates are losing popularity
 - **Has certificate usage been exclusive?**
Certificate sharing is on the rise
→ fate-sharing is increasing



Results: Web PKI Analysis

1327 Unique Hosts

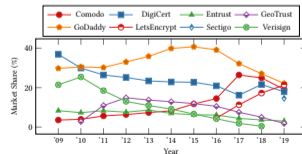
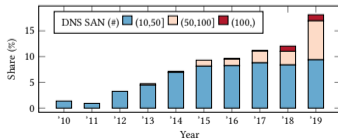
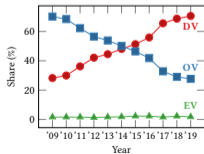
- About 15% provide none or invalid certificates
- **How is the historic landscape of X.509 certificates shaped among AAs?**
 - OV/EV certificates are losing popularity
 - Certificate sharing is on the rise
 - **How has the CA market been changed?**
 - CA giants are losing to free and automated DV certificate issuers
 - AAs care more about encryption than identification



Results: Web PKI Analysis

1327 Unique Hosts

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Security of Alerting Authorities in the WWW:
Measuring Namespaces, DNSSEC, and Web PKI

Putting the Pieces Together

- Only about 22% exhibit strong or weak assurance profiles.

DNS		Certificate			# Names
Restricted delegation	Supports DNSSEC	DV	O/EV	Assurance profile ¹	
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Total:					262 (≈ 20%)
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Total:					1036 (≈ 78%)
Grand Total:					1327

¹ ● strong, ◐ weak, ○ inadequate

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- Consider TLSA domain issued certificates (DANE EE)
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- Use dedicated domain names and certificates.
Avoids fate-sharing.

Data? More Details? Check out <https://aa.secnow.net/>!



Summary

Alerting Authority

AZ - Graham County Emergency Management

Graham County Emergency Management (AZ) is accessible under <https://www.graham.az.gov/243/Emergency-Management>. It's domain name is registered under .gov, a Sponsored Top-Level Domain (sTLD). It is not securely delegated (DNSSEC). Transport layer security is enabled for this host with a valid certificate. Provided certificate is a(n) Domain Validation (DV) certificate.

Details

Identification

Your domain name is registered under a restricted top-level domain (TLD) and as such provides the first hint about its owner (e.g., .edu TLD is only reserved for higher education institutes). A domain validation (DV) certificate lacks identification information. Moreover, lack of DNSSEC can lead to DV certificate misissuance. Finally, insecure domain names (no DNSSEC) are susceptible to hijacking and can lead to forwarding to malicious hosts regardless of the certificate provided.

Resolution

You don't seem to have DNSSEC enabled (verify [here](#)) and as such susceptible to DNS hijacking.

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You are using a valid certificate and as such transactions with users are secure against eavesdropping or manipulation.

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SECNOW!

Home Alerting Authority Browser Paper Contact

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Question, critique, cooperation? pft@acm.org



Backup Slides

Select Results

DNS and Web PKI alongside assurance profiles

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Select Results

Validation types and assurance profiles per sector

Type	Certificate				Assurance profile ¹		
	N/A	DV	OV	EV	●	◐	○
Public Safety	102	415	119	8	10	120	514
Governmental	73	318	102	6	7	104	388
Law Enforcement	21	110	31	0	5	28	129
Military	1	4	5	1	6	3	2
Educational	0	0	4	0	0	4	0
Other	0	3	3	1	1	3	3
Total	197	850	264	16	29	262	1036

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