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

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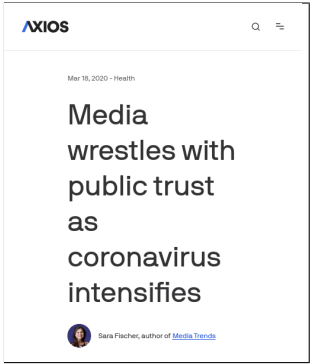
NANOG 82 Virtual, June 14-16, 2021.

Alerting Authorities are crucial during crises.

- People rely on **trustworthy sources**.



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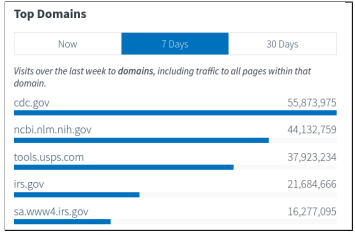
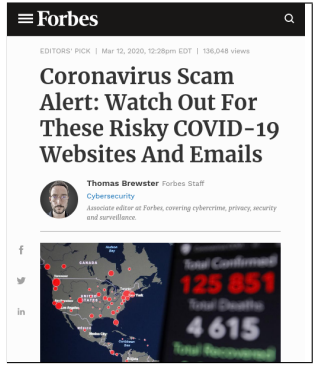


Alerting Authorities are crucial during crises.

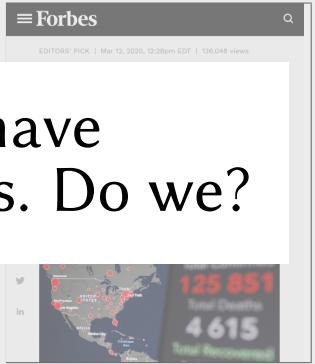
- People rely on **trustworthy sources**.
- Authorities provide services **via web**.
- Evaluating **trustworthiness** is a challenge.



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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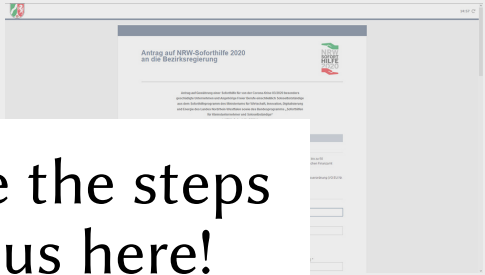

Let’s retrace the steps that took us here!

`https://nrw-` … `orona.nrw.de`

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

- ✓ Sound domain name under `.de`
- ✓ HTTPS enabled
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Secure Web-based Communication. A Complex System.

Authority

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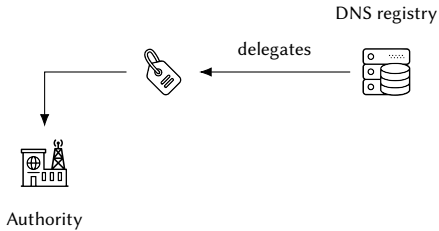

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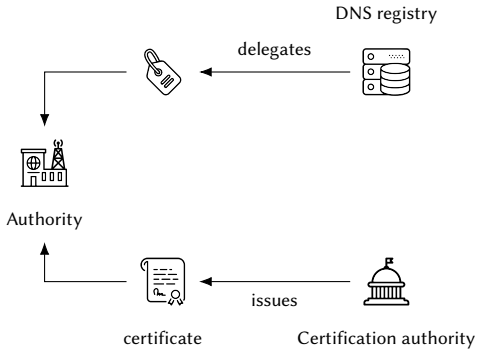

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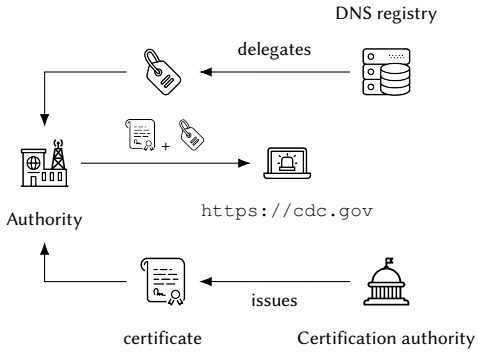

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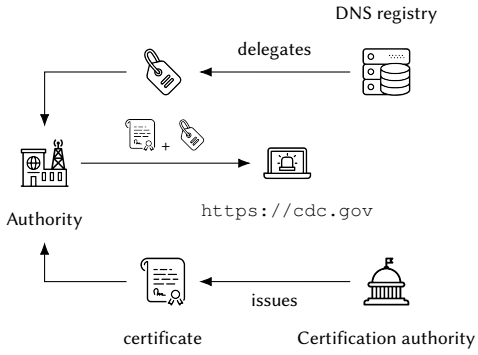

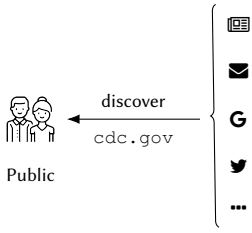

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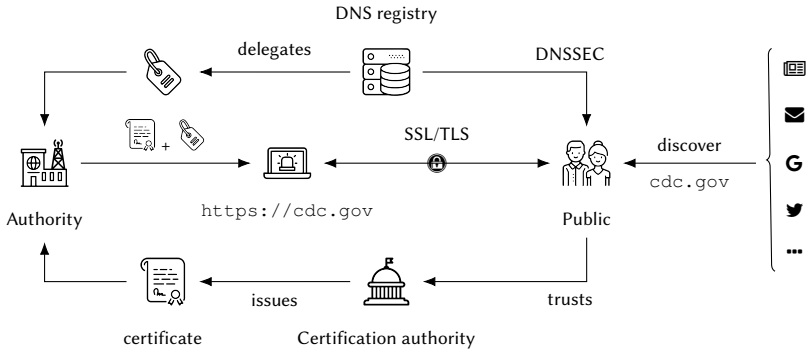

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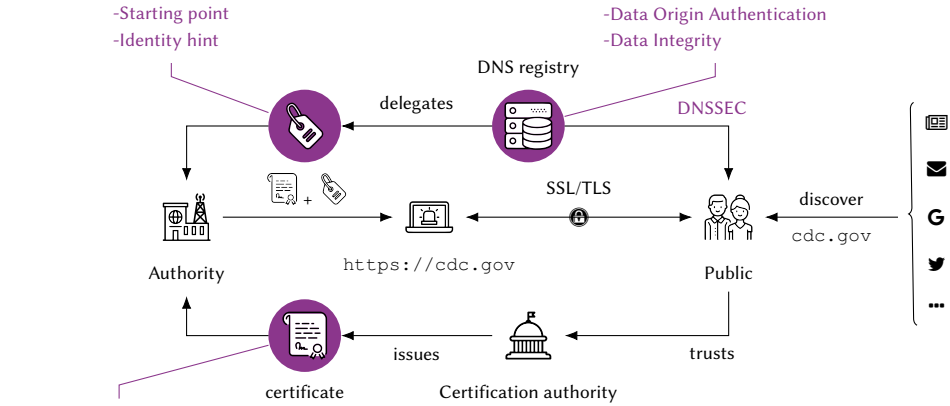

Secure Web-based Communication. A Complex System.

-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 Authorites.

(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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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.

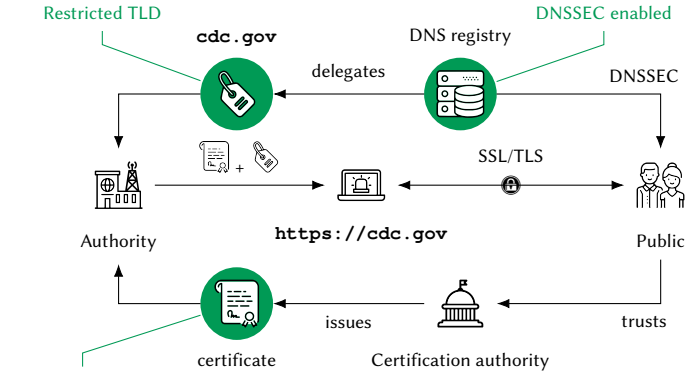
Threat Model. Three Dimensions.

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

How DNS(SEC) and WebPKI amount to secure communicaiton?

the session.

Secure Web-based Communication. Assurance Profiles.



- Strong Assurance:
  - Identification
  - Resolution
  - Transaction

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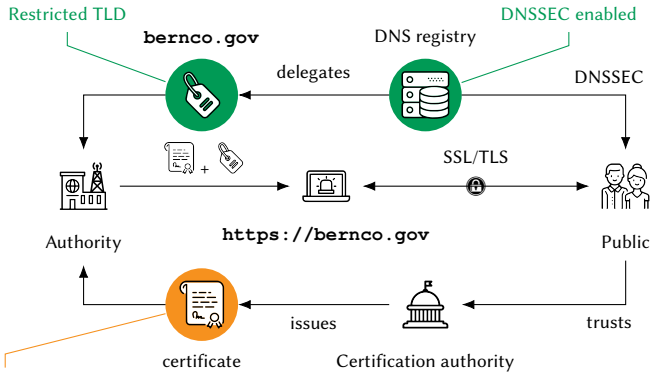

◐ Weak Assurance:

- ⚠ Identification
- 👍 Resolution
- 👍 Transaction

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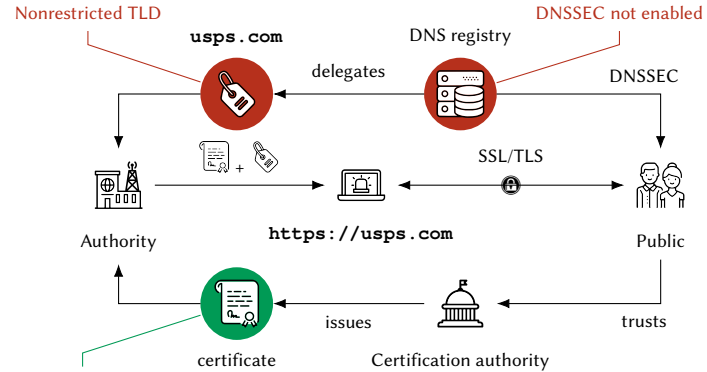

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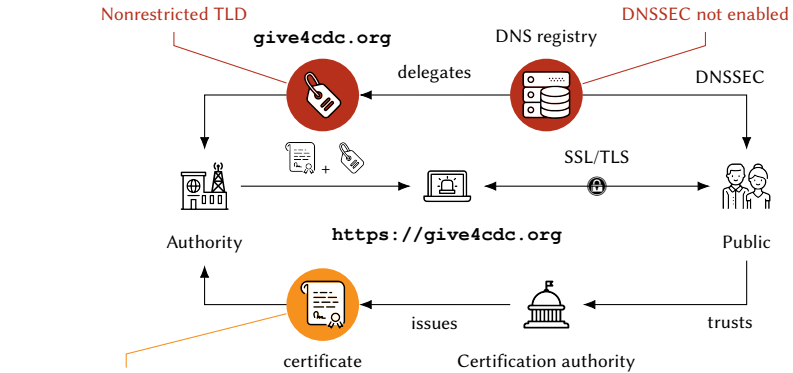

- Inadequate Assurance:
  - Identification
  - Resolution
  - Transaction

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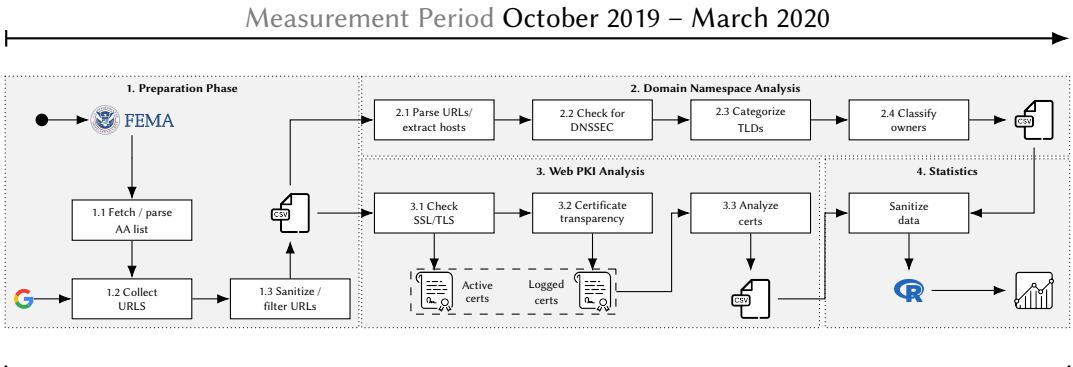
Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI

Methodology, Toolchain, and Data Set



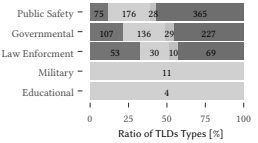
1388 Alerting Authorities in the US → 1365 URLs → 1327 unique hosts

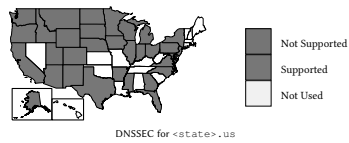
Security of Alerting Authorities in the WWW: Measuring Namespaces, DNSSEC, and Web PKI

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?**





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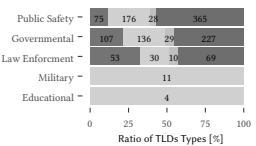
- **Does each AA have its own dedicated domain name?**
  About 49% of Alerting Authorities do not have dedicated names,
  e.g., `https://www.vercounty.org/ema.htm`
  → unnecessary dependencies, *e.g.,* for X.509 certificates.



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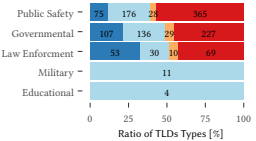
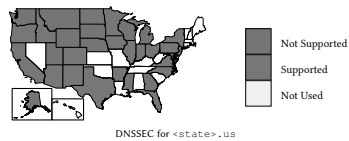
- About 49% of Alerting Authorities do not have dedicated names
- **How do AAs integrate in the global DNS namespace?**
  More than 50% of unique names are under **non**-restricted TLDs
  $\rightarrow$ poor recognizability and inferior security.





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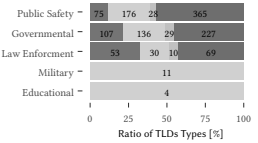
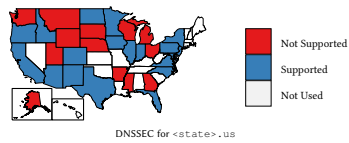
- **Do AAs secure their names using DNSSEC?**
  96% of unique hosts do not support DNSSEC
  $\rightarrow$ high susceptibility to DNS hijacking





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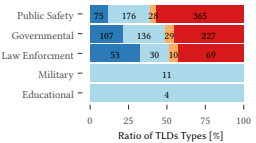

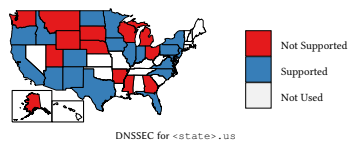

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Results: Web PKI Analysis

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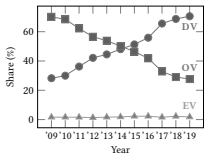
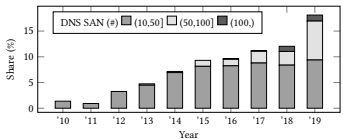
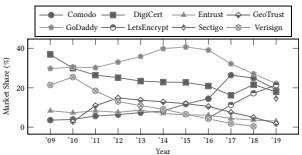
- **To what extent do AAs adapt web PKI?**
- **How is the historic landscape of X.509 certificates shaped among AAs?**







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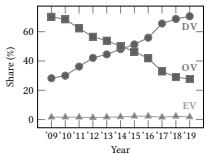
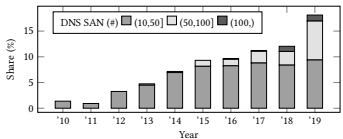
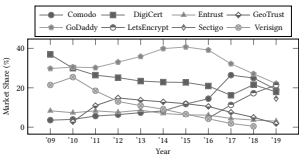
- **To what extent do AAs adapt web PKI?**
  About 15% provide none or invalid certificates (OpenSSL validation)
  $\rightarrow$ secure identification and transaction impossible







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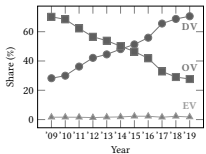

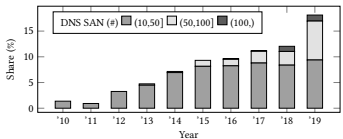

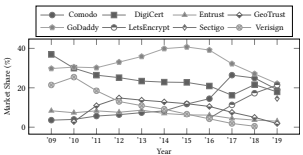

Results: Web PKI Analysis

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- About 15% provide none or invalid certificates
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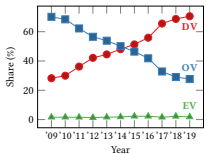
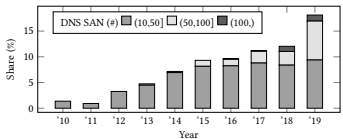
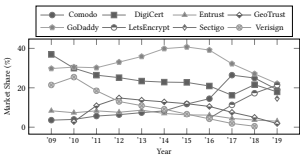
  - **Which validation types have been popular?**
    OV/EV certificates are losing popularity







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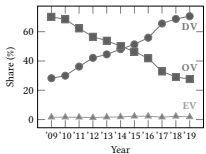
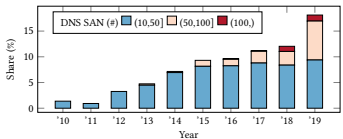
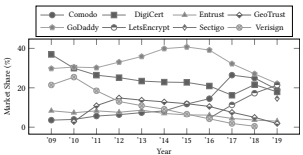
    → fate-sharing is increasing







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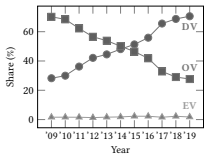
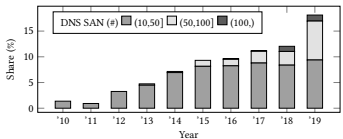
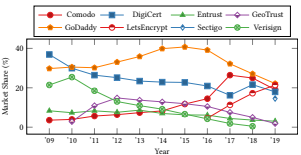
    CA giants are losing to free and automated DV certificate issuers
    → AAs care more about encryption than identification







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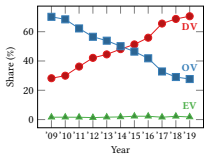

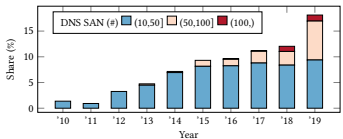

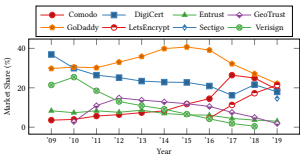

Security of Alerting Authorities in the WWW:
Measuring Namespaces, DNSSEC, and Web PKI

Putting the Pieces Together

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

DNS		Certificate			
Restricted delegation	Supports DNSSEC	DV	O/EV	Assurance profile[1]	# Names
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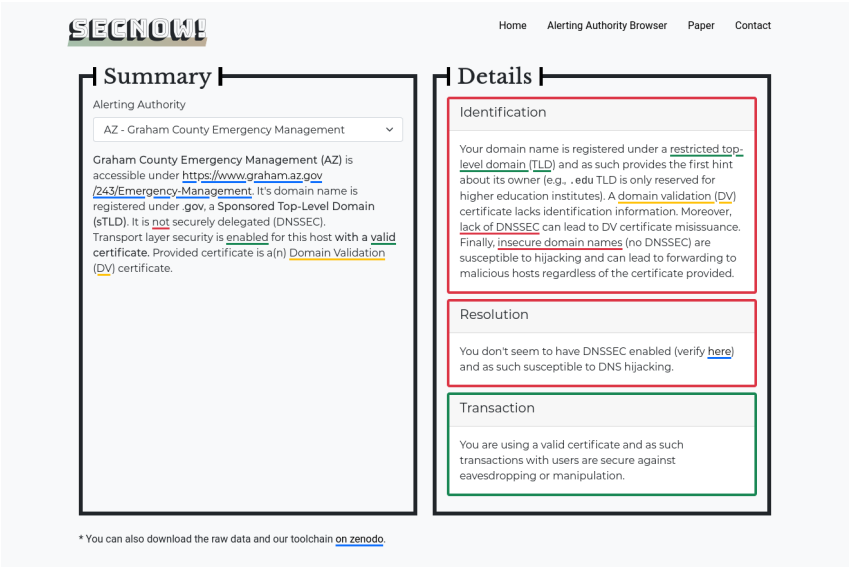
Data? More Details? Check out **https://aa.secnow.net**!



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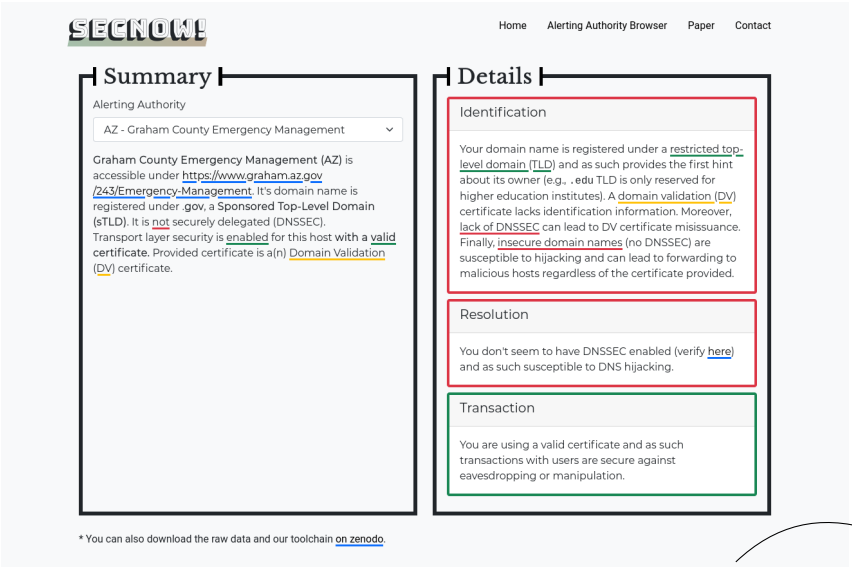

Question, critique, cooperation? pft@acm.org

Backup Slides

Select Results

DNS and Web PKI alongside assurance profiles

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Select Results

Validation types and assurance profiles per sector

	Certificate				Assurance profile[1]		
Type	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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