Can I Take Your Subdomain?
Exploring Same-Site Attacks in the Modern Web

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30th USENIX Security Symposium

August 11–13, 2021

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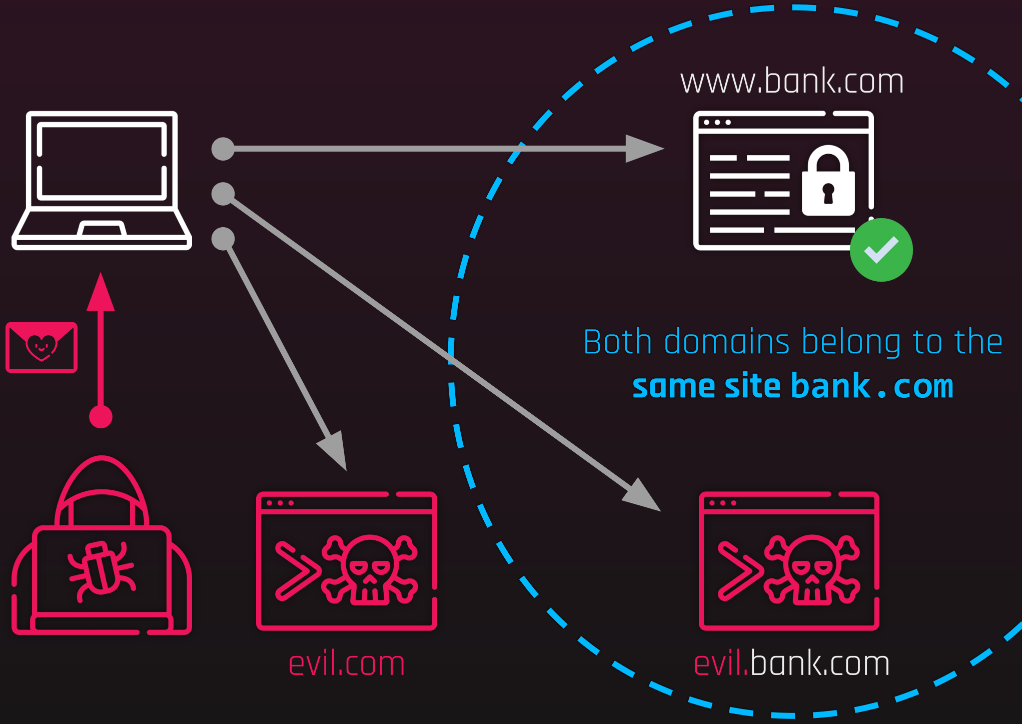
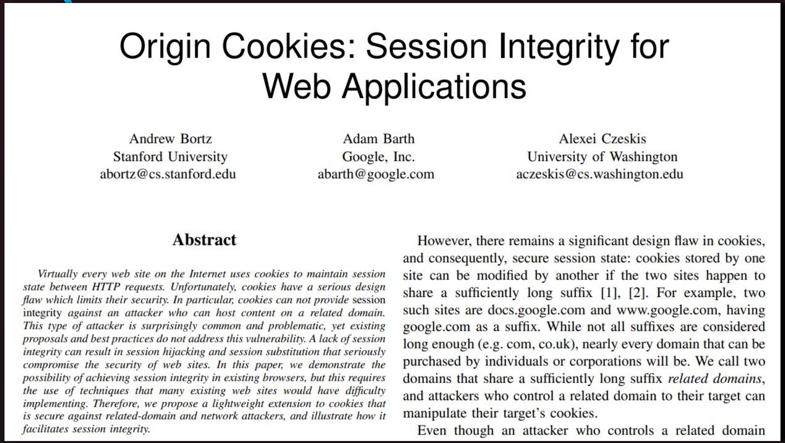
[1] TU Wien, [2] Ca' Foscari Venezia

The Related-Domain Attacker (RDA)



Both domains belong to the same site **bank.com**



Origin Cookies: Session Integrity for Web Applications

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Abstract

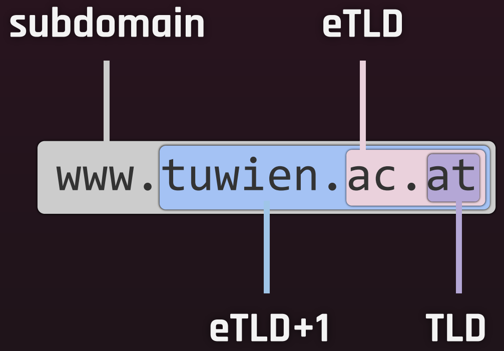
Virtually every web site on the Internet uses cookies to maintain session state between HTTP requests. Unfortunately, cookies have a serious design flaw which limits their security. In particular, cookies can not provide session integrity *against an attacker who can host content on a related domain. This type of attacker is surprisingly common and problematic, yet existing proposals and best practices do not address this vulnerability. A lack of session integrity can result in session hijacking and session substitution that seriously compromise the security of web sites. In this paper, we demonstrate the possibility of achieving session integrity in existing browsers, but this requires the use of techniques that many existing web sites would have difficulty implementing. Therefore, we propose a lightweight extension to cookies that is secure against related-domain and network attackers, and illustrate how it facilitates session integrity.*

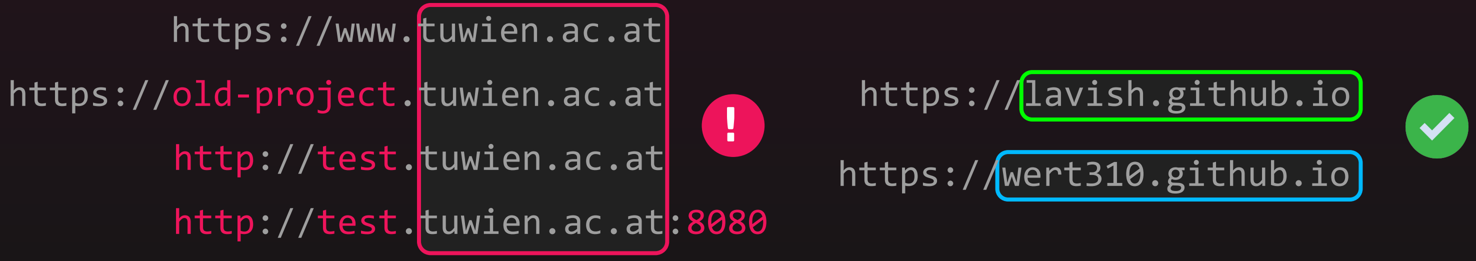
However, there remains a significant design flaw in cookies, and consequently, secure session state: cookies stored by one site can be modified by another if the two sites happen to share a sufficiently long suffix [1], [2]. For example, two such sites are docs.google.com and www.google.com, having google.com as a suffix. While not all suffixes are considered long enough (e.g. com, co.uk), nearly every domain that can be purchased by individuals or corporations will be. We call two domains that share a sufficiently long suffix *related domains*, and attackers who control a related domain to their target can manipulate their target's cookies.

Even though an attacker who controls a related domain

Same-Site Relation

- **eTLDs** (Effective Top Level Domains) are defined by the **Public Suffix List** (**PSL**) 🔗 publicsuffix.org
- **eTLDs+1** are also called **registrable domains**
- 2 domains belong to the same site if they share a **common registrable domain**





```
    https://www.tuwien.ac.at
https://old-project.tuwien.ac.at
       http://test.tuwien.ac.at
       http://test.tuwien.ac.at:8080
```

!

```
 https://lavish.github.io
https://wert310.github.io
```

✓

Same-Site Security Boundary

- **Site Isolation** in Chromium / **Fission** in Firefox

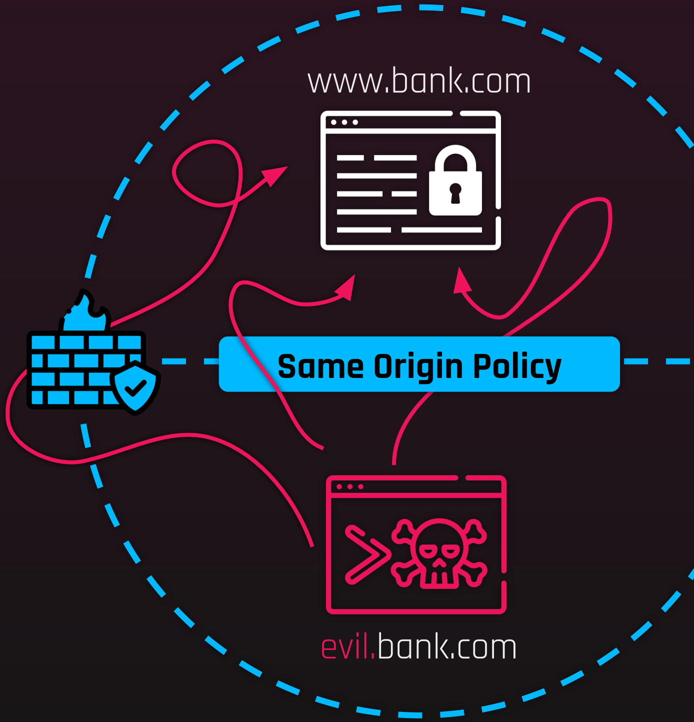
  "*cross-origin attacks within a site are not mitigated*"

  -- from the original Site Isolation paper (USENIX'19)

- **Same-Site cookies** are effective **against CSRF**

  … but they do not apply to same-site requests!

- **Trust abuses** against site operators and web users



Contributions

- **Systematic characterization of the RDA threat model**

  Not all sites are vulnerable to RDAs: attack vectors?

  Are all the RDAs created equal?

  Mapping between attack vectors and RDA's capabilities

- **Identification of the main web security threats available to RDAs**

  Which web mechanisms are at harm?

  Which capabilities are required to exploit them?

  What is the improvement over a traditional web attacker?

- **Measurement platform for large-scale evaluation**

  Evaluation of Tranco Top 50k

  Analysis of the security implications on sites with subdomains vulnerable to takeover

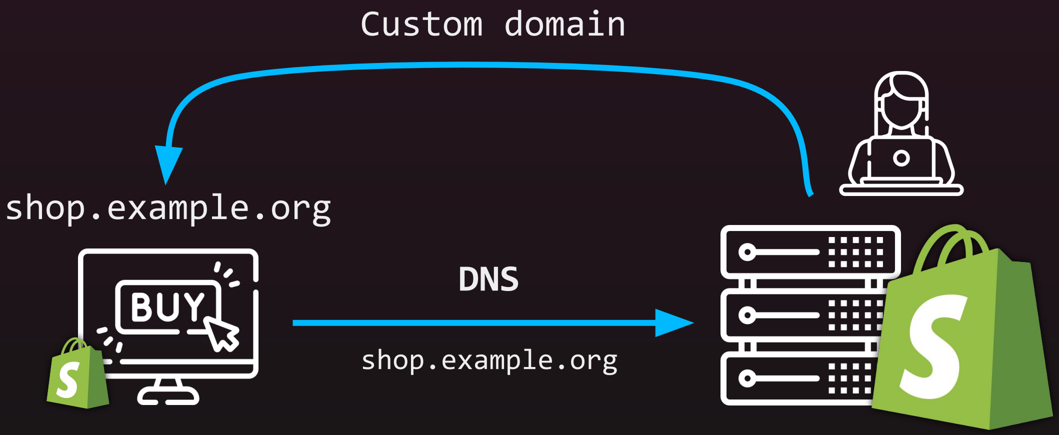
Attack Vectors

- A **wide range of attack vectors**
- We focus on **Dangling DNS records**, DNS misconfigurations exploitable by attackers

Expired Domains

Discontinued Services

Deprovisioned Cloud Instances



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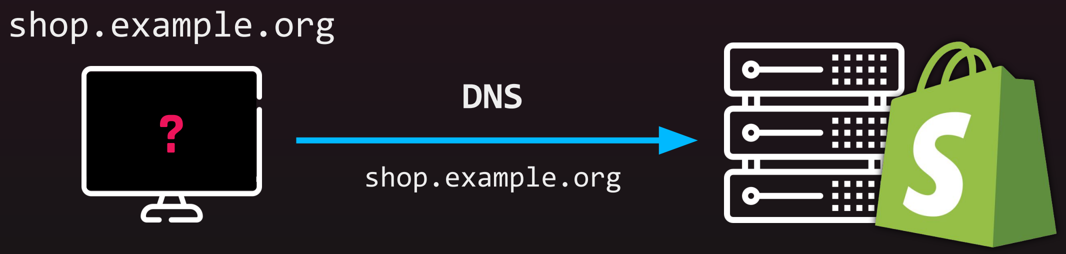

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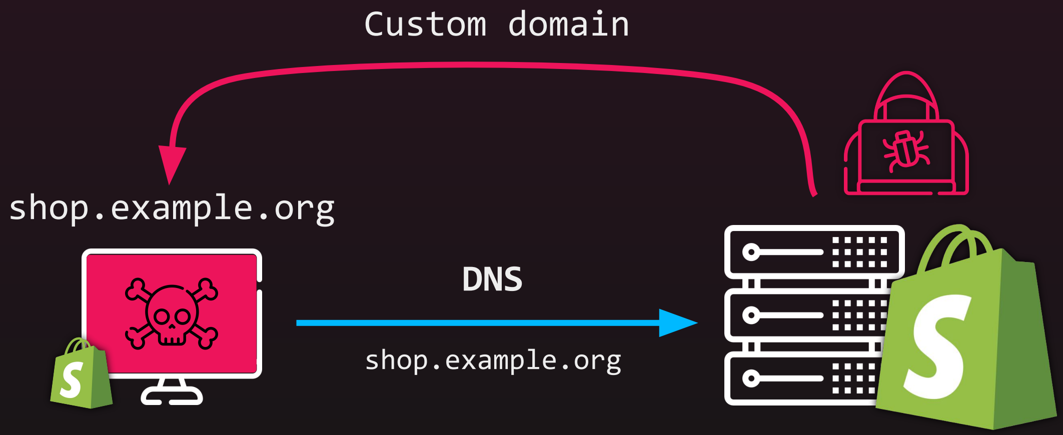

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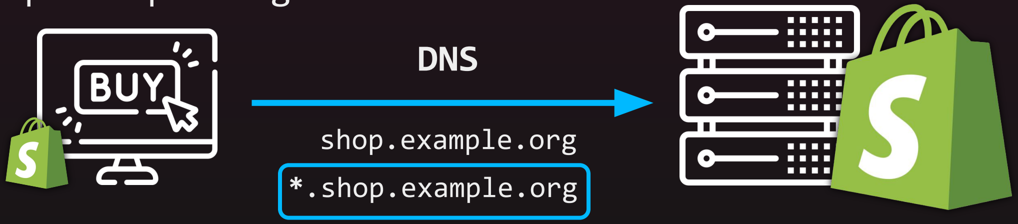
www.shop.example.org



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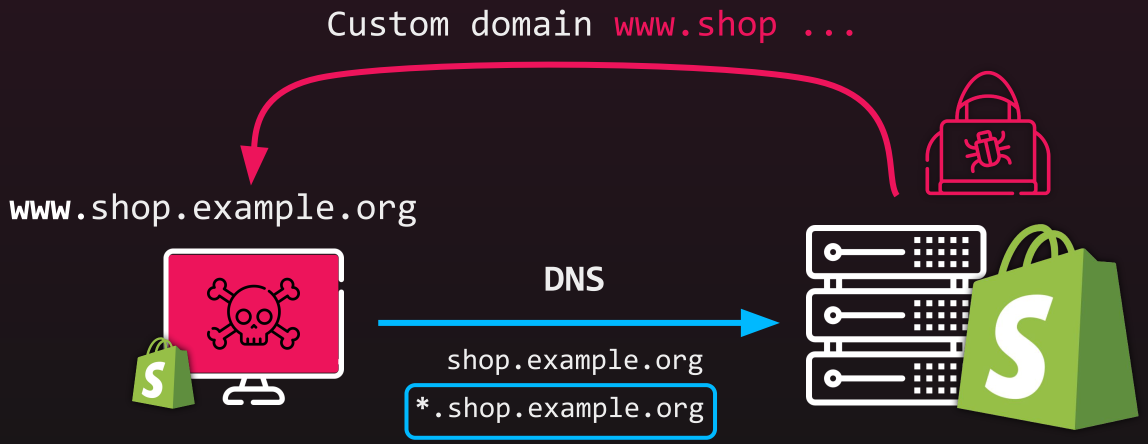
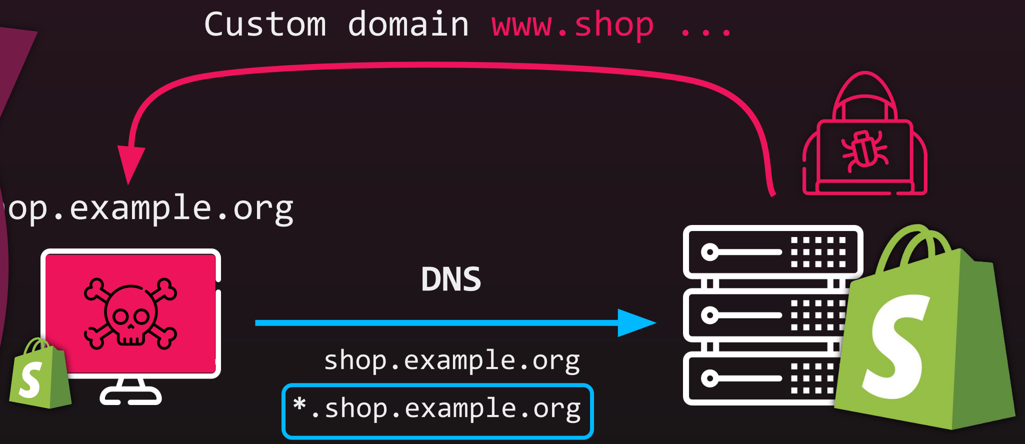


usenix THE ADVANCED COMPUTING SYSTEMS ASSOCIATION
Università Ca'Foscari Venezia
S&P
TU WIEN

Attack Vectors

- A **wide range of attack vectors**
- We focus on **Dangling DNS records**, DNS misconfigurations exploitable by attackers

- Analysed **26 services**
  WordPress, Shopify, Tumblr, GitHub, ...
- **17 vulnerable services** where attackers can claim a subdomain of an already mapped domain



Threats to Web Application Security

- Practical **web application security vulnerabilities** by intersecting the capabilities on vulnerable domains with the web security threats found on their related-domains
- Analyzed **5 mechanisms** across up to **200 domains of each vulnerable site**

Cookies

Domain cookies are leaked to subdomains (**confidentiality**)

Cookies can be *shadowed* from subdomains (**integrity**)

CSP

Policies might have milder restrictions on related domains and allow for **content inclusion** or **framing**

CORS

Test deployment of server-side policies which might enable **SOP bypasses**

postMessage

Dynamic testing of the postMessage API to identify dangerous sinks (e.g., **code execution**) due to lax or missing origin checking

Relaxation

Testing the legacy API `document.domain` to **sidestep the SOP** if the target and the RD set its value to a common ancestor

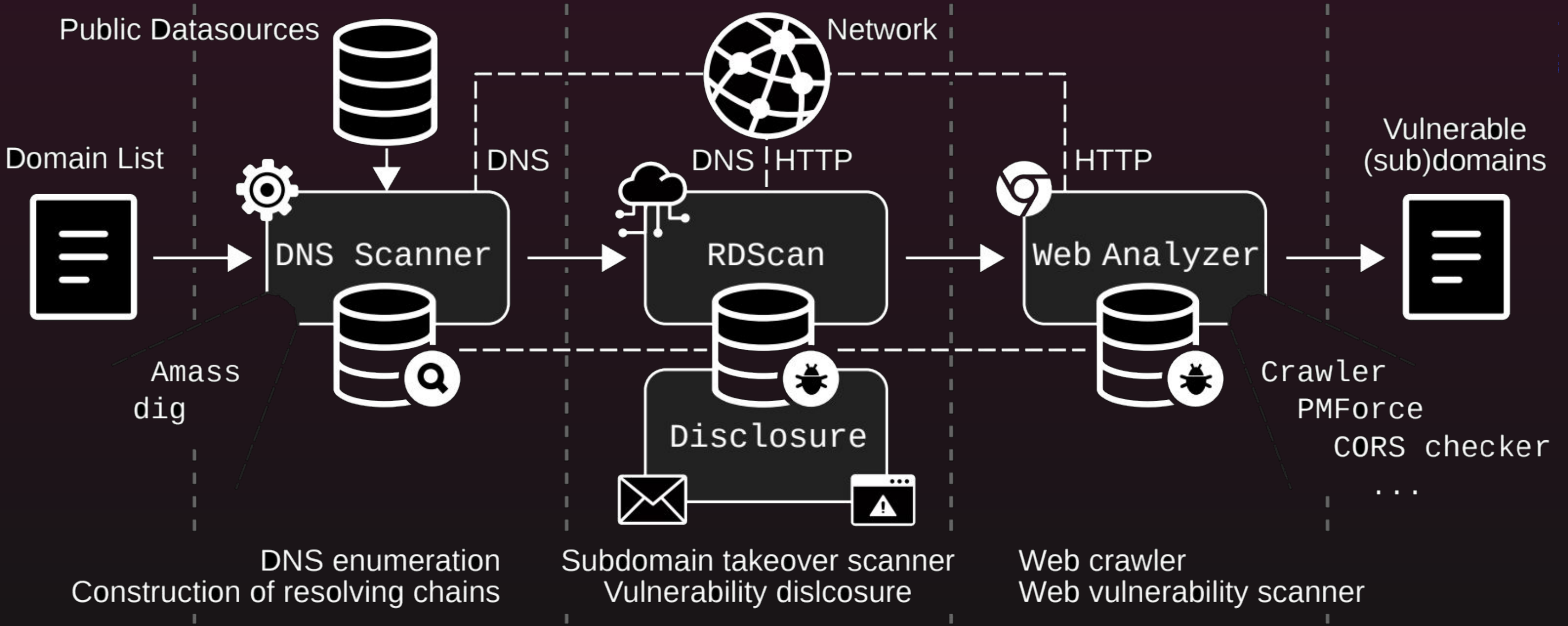
Modeling Approach: Example on Cookies

- RDAs put the **confidentiality** of **domain cookies** at risk

No security attribute	`js` OR `headers`
HttpOnly attribute	`headers`
Secure attribute	(`js` OR `headers`) AND `https`
Both attributes	`headers` AND `https`

- When a site has a **vulnerable subdomain**
  - Identify the RDA's **capabilities** granted by the attack vector
  - Inspect the security attributes of (session) cookies on related domains
  - Draw conclusions!

Measuring Subdomain Takeovers



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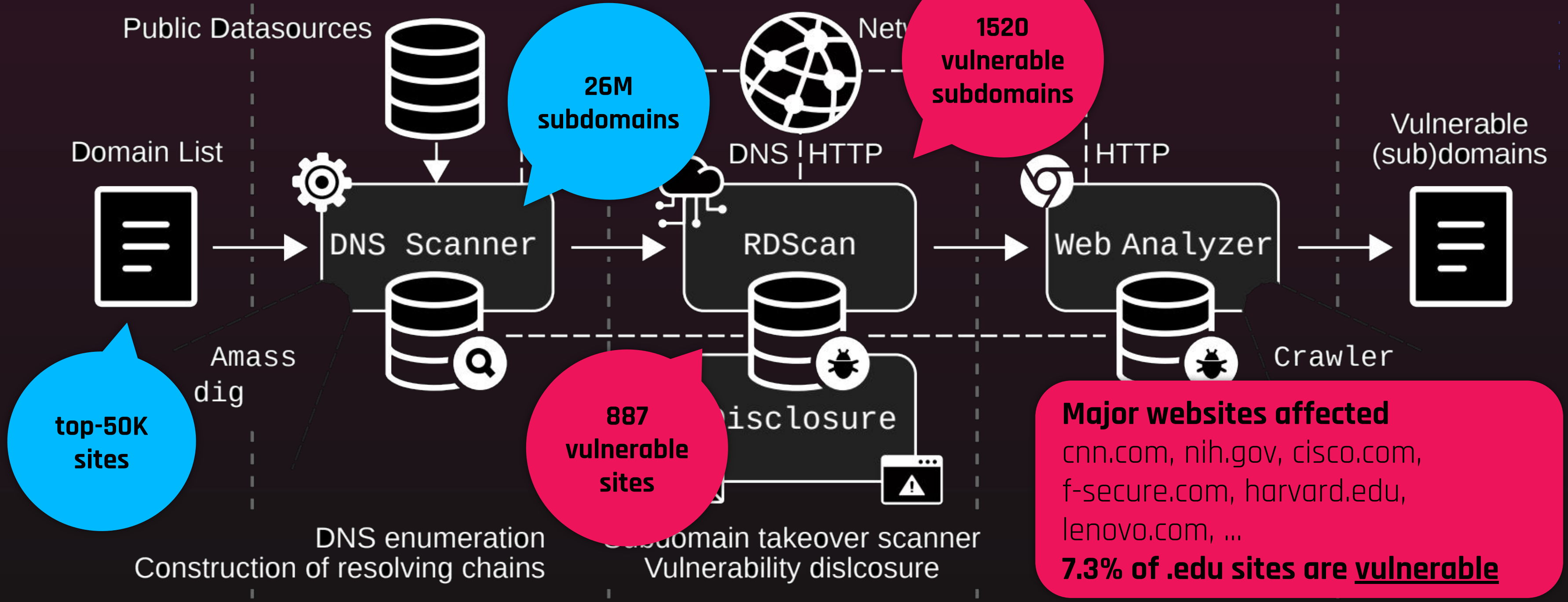


26M subdomains

1520 vulnerable subdomains

top-50K sites

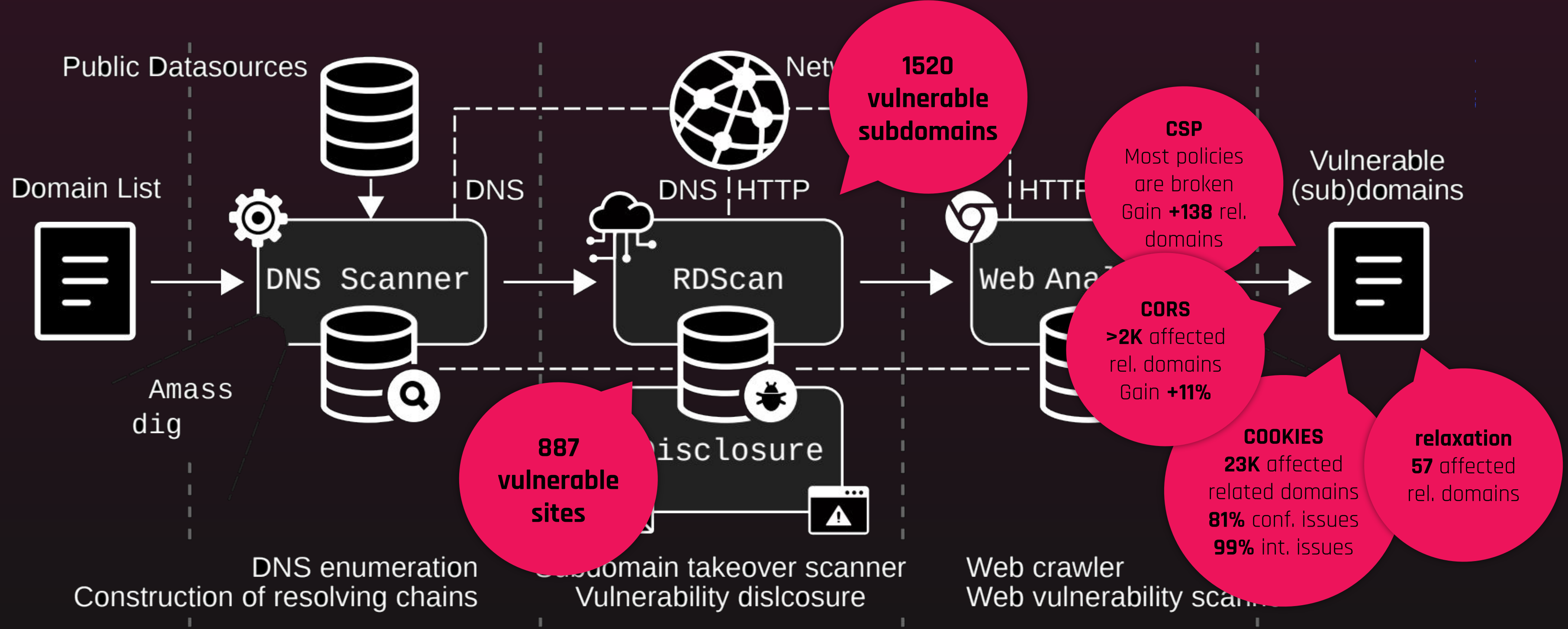
887 vulnerable sites

Major websites affected

cnn.com, nih.gov, cisco.com, f-secure.com, harvard.edu, lenovo.com, ...

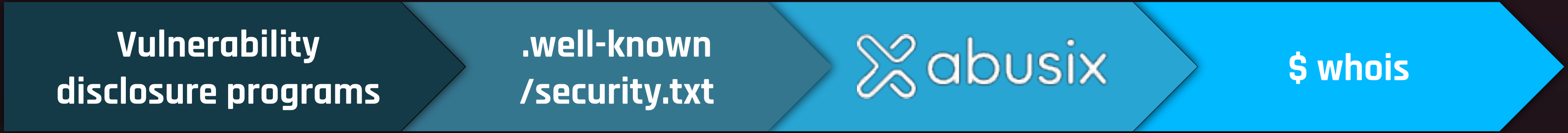
7.3% of .edu sites are vulnerable

Measuring Web Application (in)Security



Vulnerability Disclosure

- With **great power** comes **great responsibility**
- Developed a methodology to maximise the chances of identifying the **correct security point of contact** of a website



Vulnerability disclosure programs

.well-known /security.txt

abusix

$ whois

After 6 months

- 34% visited the full advisory on our web portal
- **31% fix rate**

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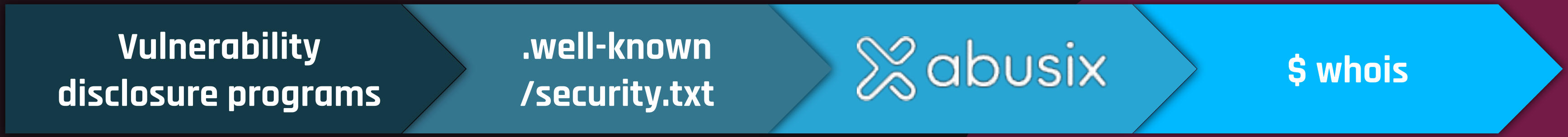

Vulnerability disclosure programs

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- 34% visited the full advisory on our web portal
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- Could not identify a point of contact for the **62% of the sites**
- **10% fix rate**

CERT.at

Conclusions

- **Subdomain takeover** is still a **prevalent threat** that affects high profile websites
- **Third-party services** are often the cause

  Weaknesses in the **(sub)domain ownership verification mechanisms** are pervasive: site operators are not always to be blamed!
- RDAs are a **concrete and dangerous threat** against sensitive targets

  Considerable gain wrt traditional web attacker, taking over a subdomain to **escalate privileges** is practical and convenient
- **Low remediation rate** (15% of the sites after 6 months):

  1 vulnerable subdomain can void the security of the whole site

Find out more at

https://canitakeyoursubdomain.name 🔗

https://canitakeyoursubdomain.name 🔗

Thank you!

Questions?

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