DNS-OARC
Domain Name System Operations Analysis and Research Center

Misty Registry: An Empirical Study of Flawed Domain Registry Operation

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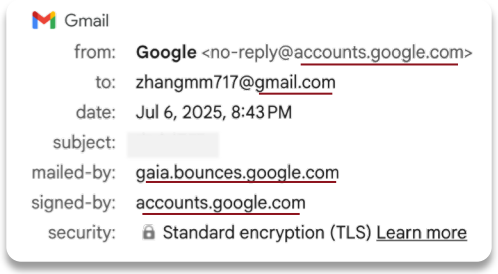
Overview

- **A top-down security analysis at the domain registry level**
  - Revealing domain status overlaps and complex operation triggers (e.g., ICANN policies, registrar/registrant settings).
- **Uncovered three flawed operation practices**
  - Redundant domain creation
  - Siloed DNS host management
  - Insufficient domain deletion
- **Impact of theses flawed practices**
  - **6** mainstream registry backends and **812** TLDs face security risks
  - More than **1.6M** domain names are at risk of **domain takeover and hijacking**.

Domain Name: The Gateway of Our Digital Life

- **Domain Names:** Vital identifiers for Internet services

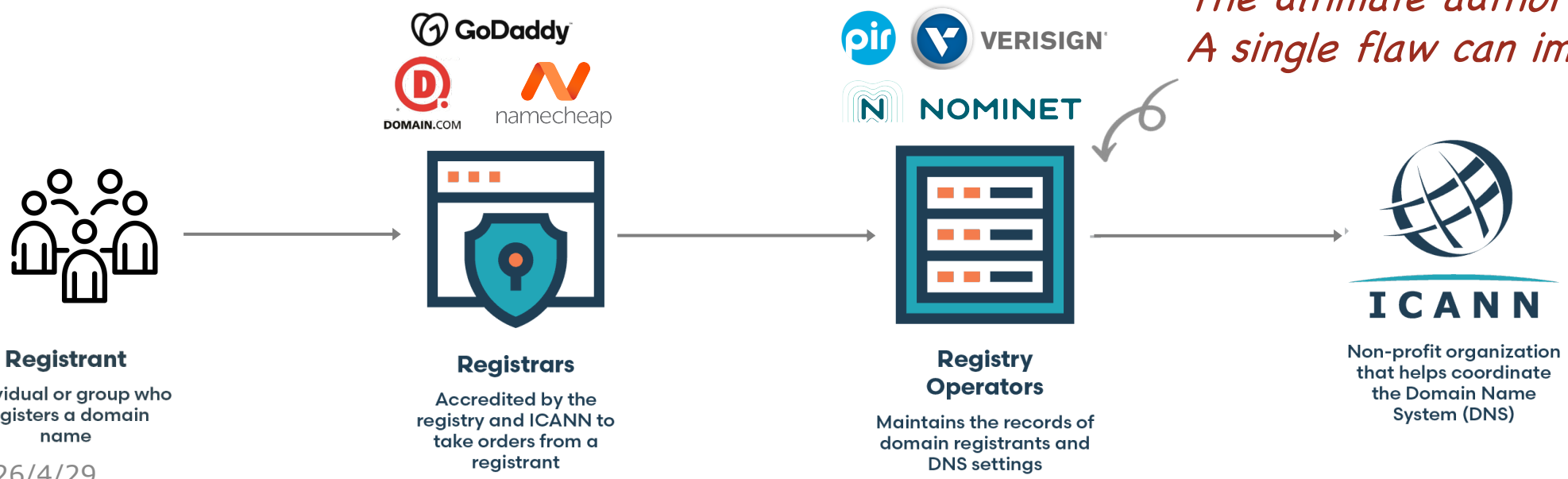
Website Access



Email Communication

- Managed by **Registrars & Registries**

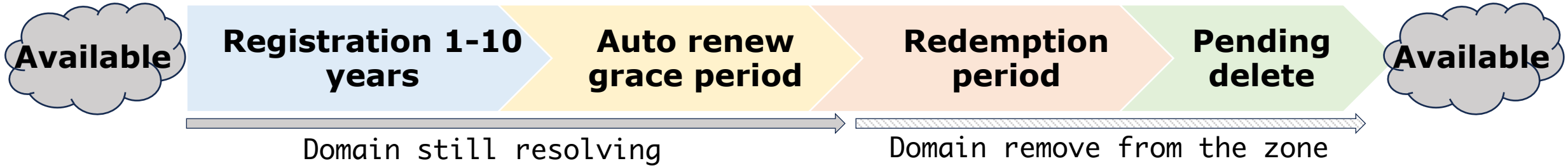
The ultimate authority for TLDs.
A single flaw can impact millions.



Domain Name Management

- Registrars and registries follow the **Extensible Provisioning Protocol (EPP)** across the domain name lifecycle, managing domain resource objects via EPP interfaces and commands.

Domain Name Lifecycle



EPP Status Codes reflect the phase in the domain lifecycle

EPP Status Code	RDAP Status Mapping
addPeriod	add period
autoRenewPeriod	auto renew period
inactive	inactive
ok	active
pendingCreate	pendingCreate

Standards define 18 status codes [STD69, RFC 3915]

Unregistered Domain Names in DNS

xn--4gq220j14gckc.top (一谕终见.top)

Registered with Alibaba Cloud

xn--4gqz56iuyholb.top (一諭終見.top)

Unregistered Domain Names in DNS

xn--4gq220j14gckc.top（一谕终见.top）

Registered with Alibaba Cloud

域名 **一谕终见.top** 的注册信息

以下信息获取时间：2023-12-09 23:57:18 获取最新信息

所有者联系邮箱 Registrant E-mail	如要进行联系，请在线填写信息 了解更多 委托阿里云购买
注册商 Sponsoring Registrar	Alibaba Cloud Computing Ltd. d/b/a HiChina (www.net.cn)
注册日期 Registration Date(UTC)	2023年11月22日
到期日期 Expiration Date(UTC)	2024年11月22日
	2024年11月22日前，域名可正常使用。请在2024年11月22日前及时续费延期。
域名状态 Domain Status	正常状态（ok） https://icann.org/epp#OK
DNS服务器 Name Server	DNS1：dns1.hichina.com DNS2：dns2.hichina.com

domain name registration data

xn--4gqz56iuyholb.top（一諭終見.top）

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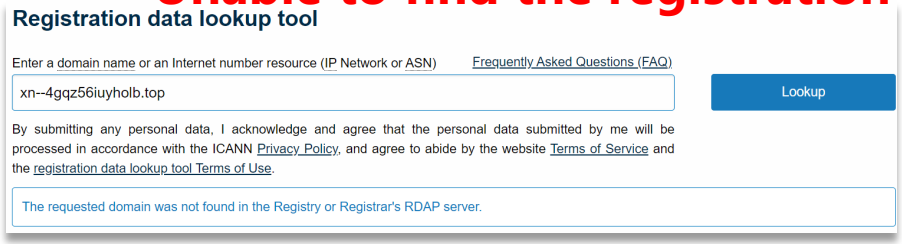
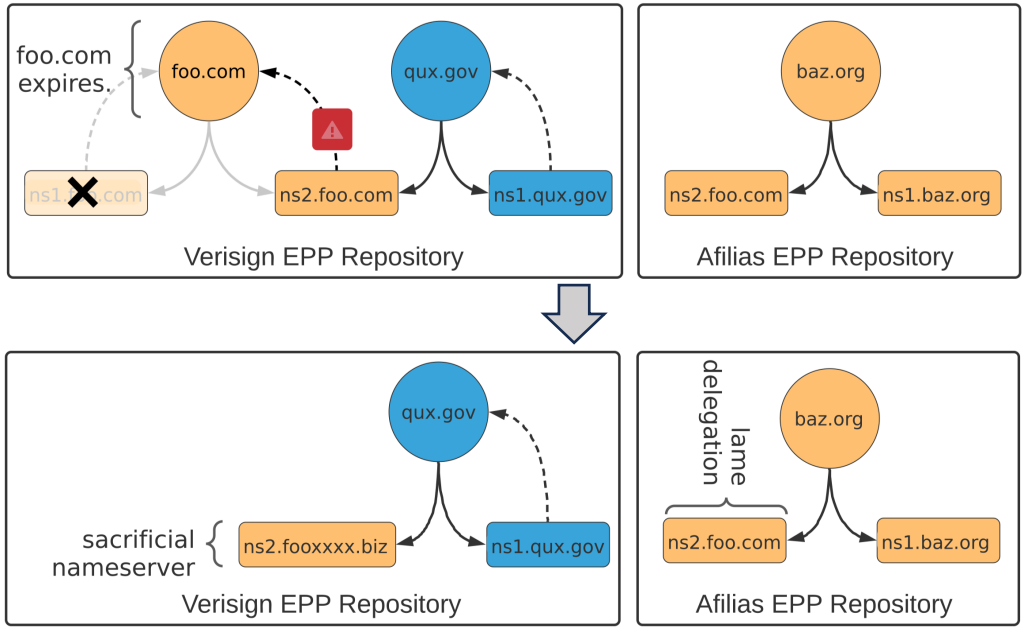
Unable to find the registration data



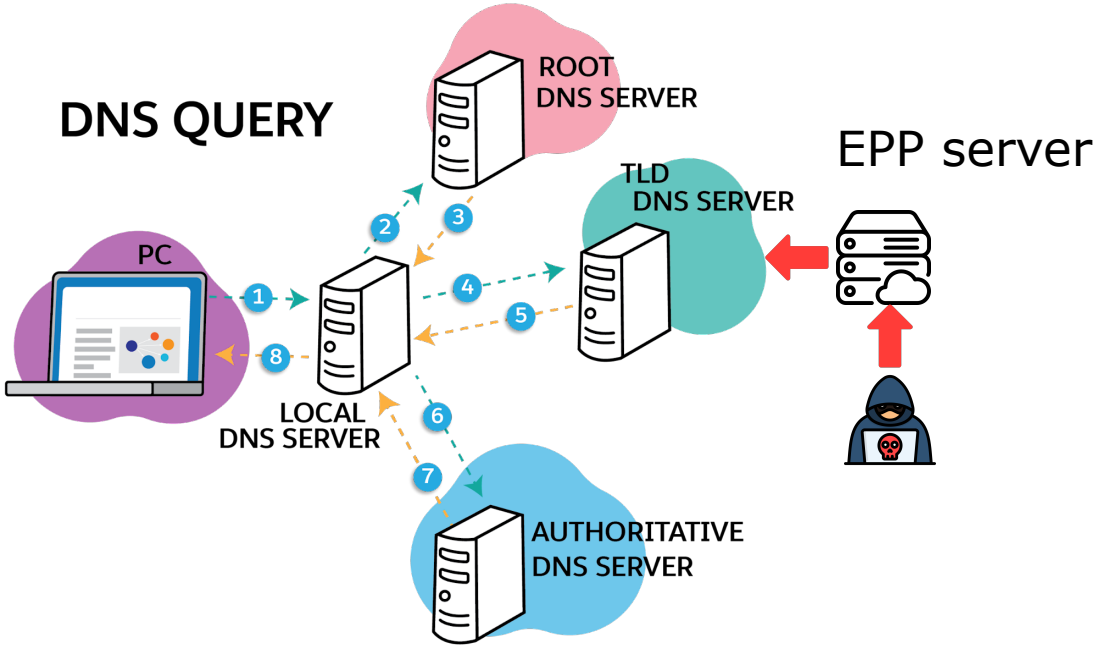
However, it is possible to access its website.

Threats Involving Domain Name Management

- Hijacking domains by sacrificial nameservers [IMC 2021]
- Controlling the TLD by controlling the EPP server [1]



The undocumented registrar practices of the registration bureau pose a risk of domain name hijacking.

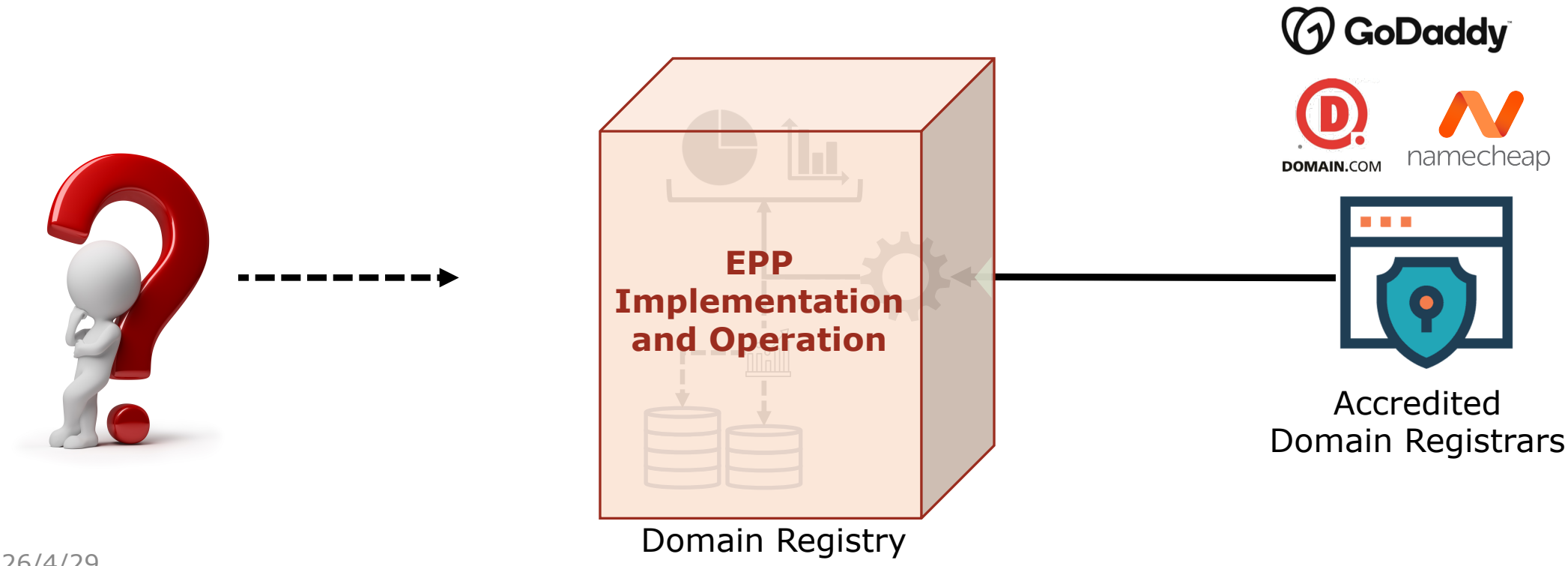


Registry software implementation flaw caused TLDs to be compromised.

[1] hackcompute 2023, https://hackcompute.com/hacking-epp-servers/

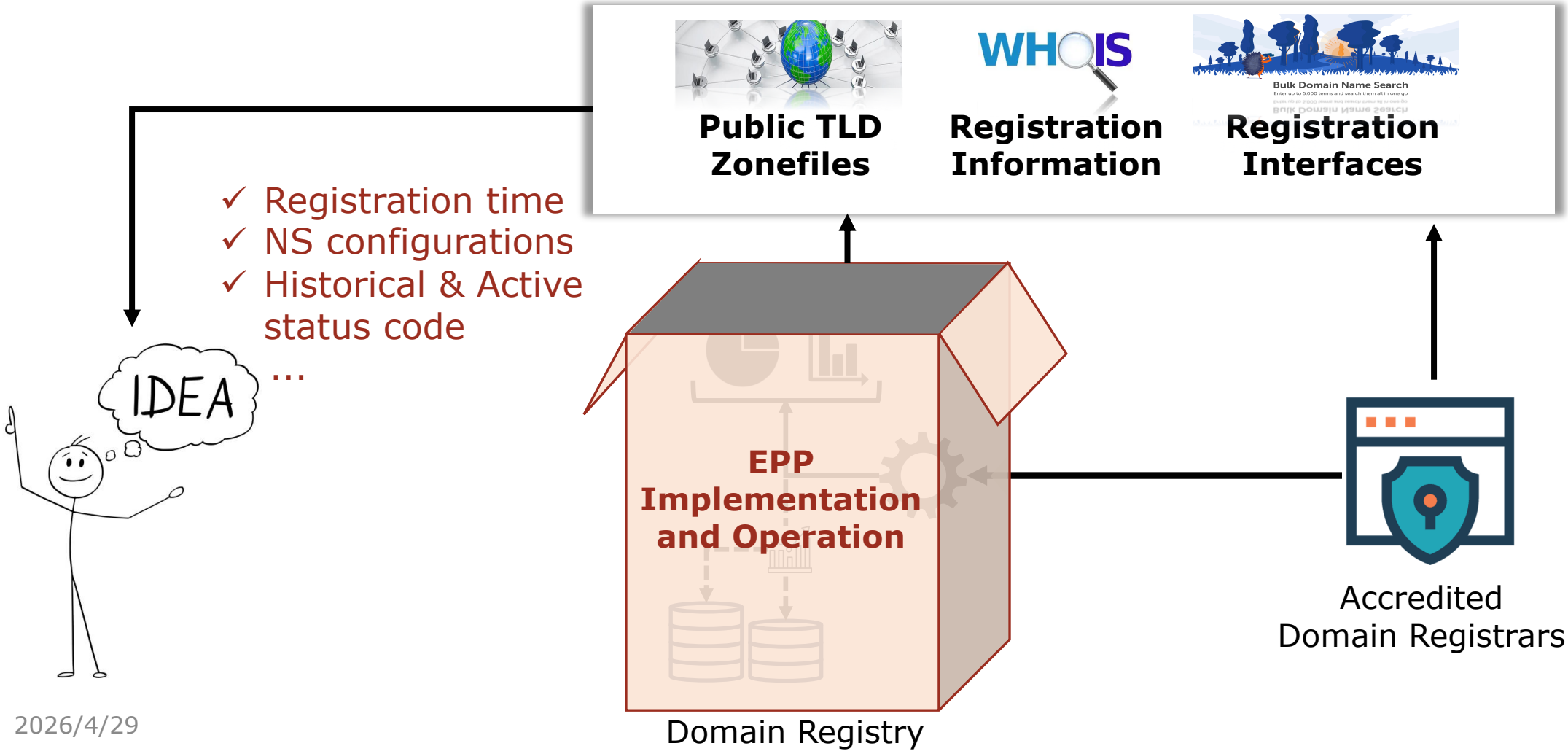
However, Registry Security Remains Underexplored

- **Challenges**
  1. The EPP implementations are diverse and opaque.
  2. Access is restricted to accredited registrars.



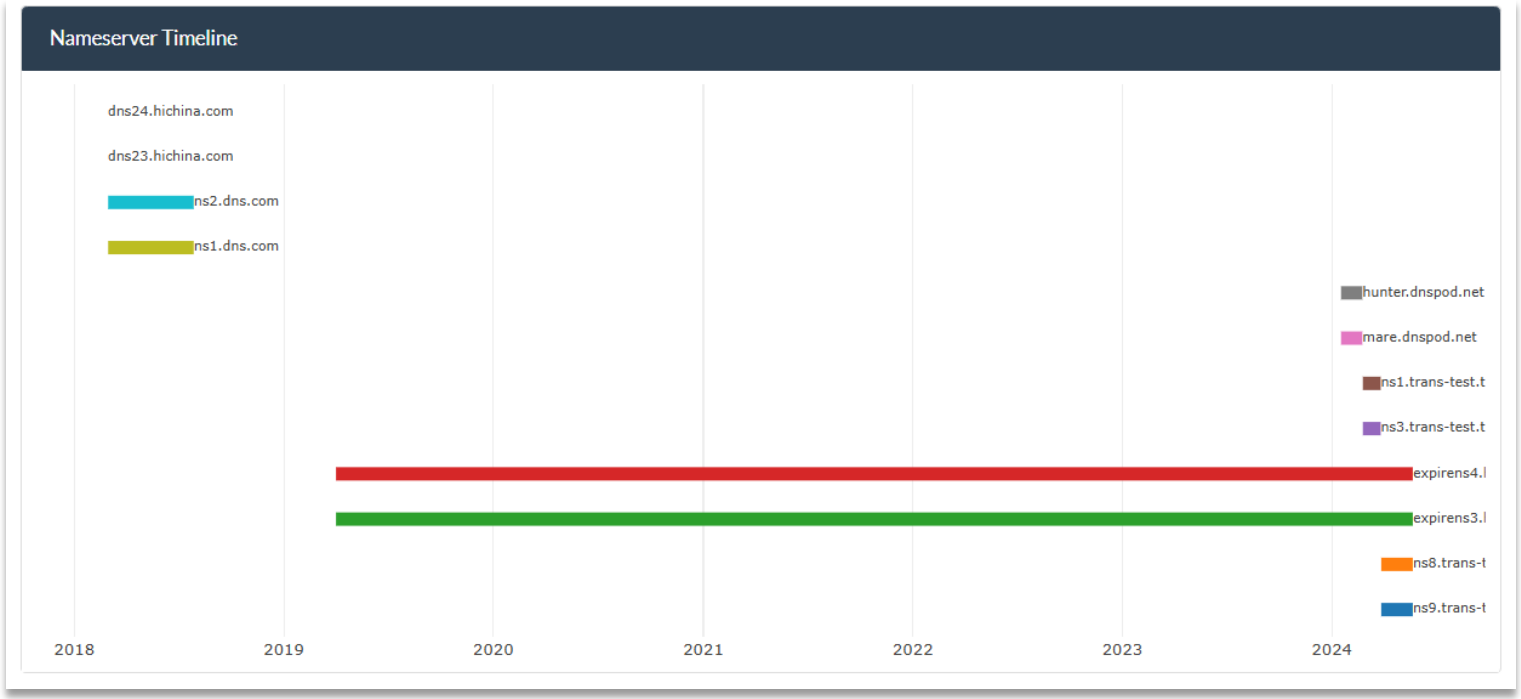
Infer inside operations from an outside view

- Publicly updated domain data enables coarse inference of EPP operations.



Infer inside operations from an outside view

- All changes to a domain name's delegation records involve the Registry
  - The registrant initiates the changes, and the Registry provides assistance.
  - The Registry makes changes on its own initiative
- An example



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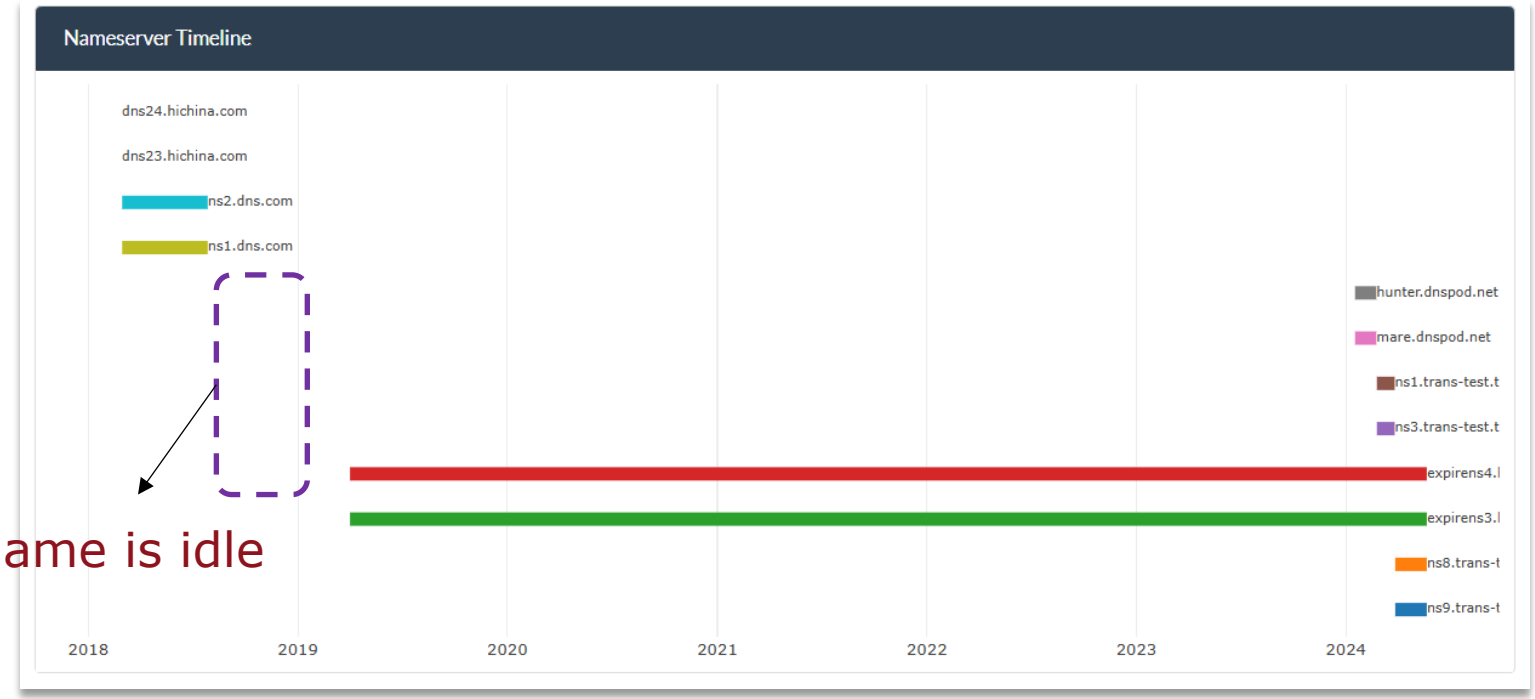

domain name is idle

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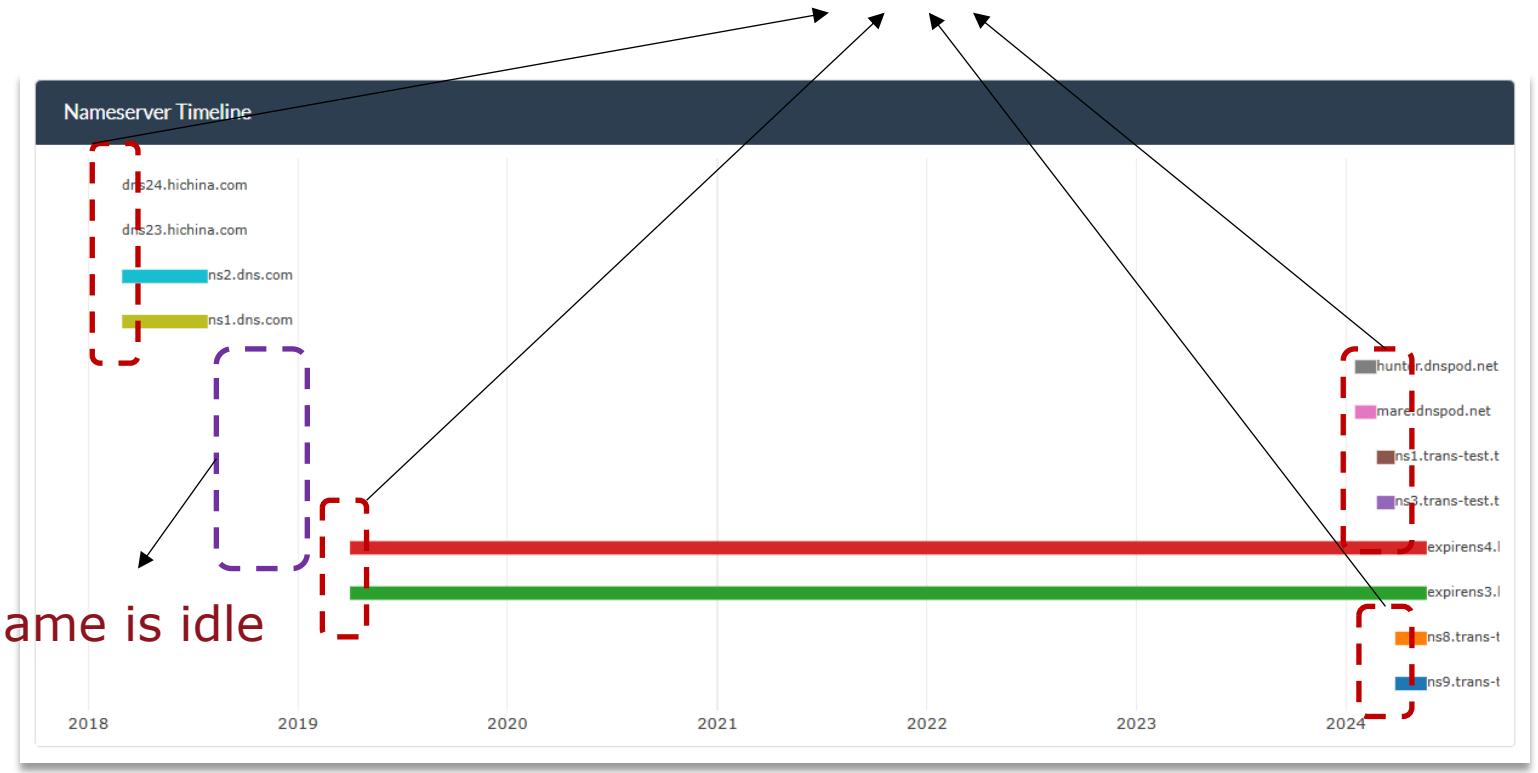
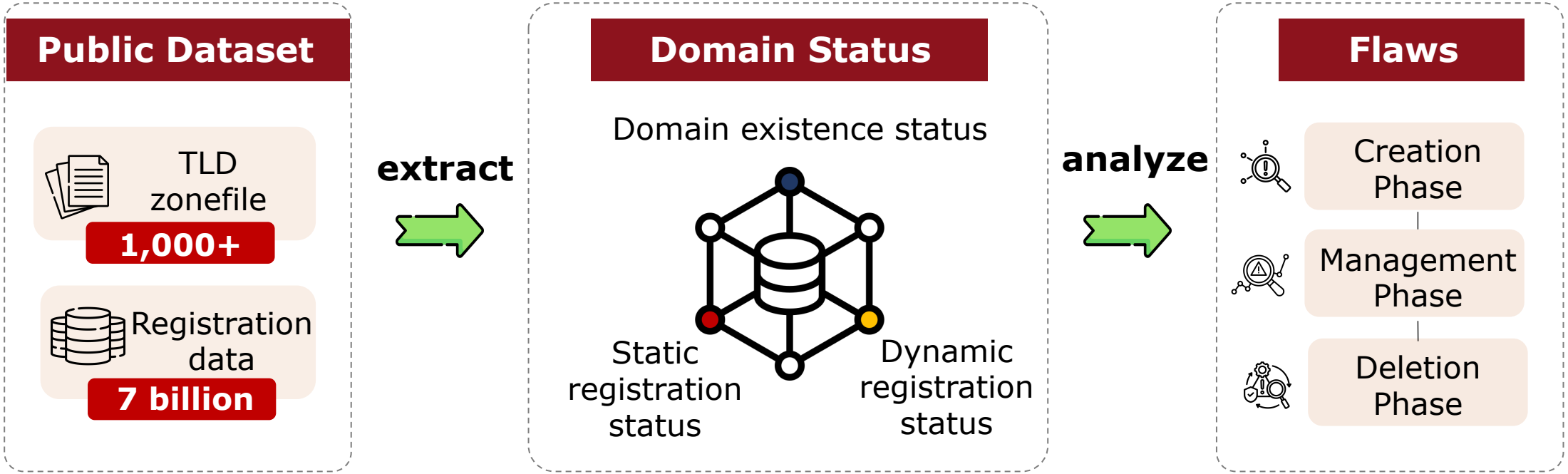
Modification of the Domain Name Delegation Records



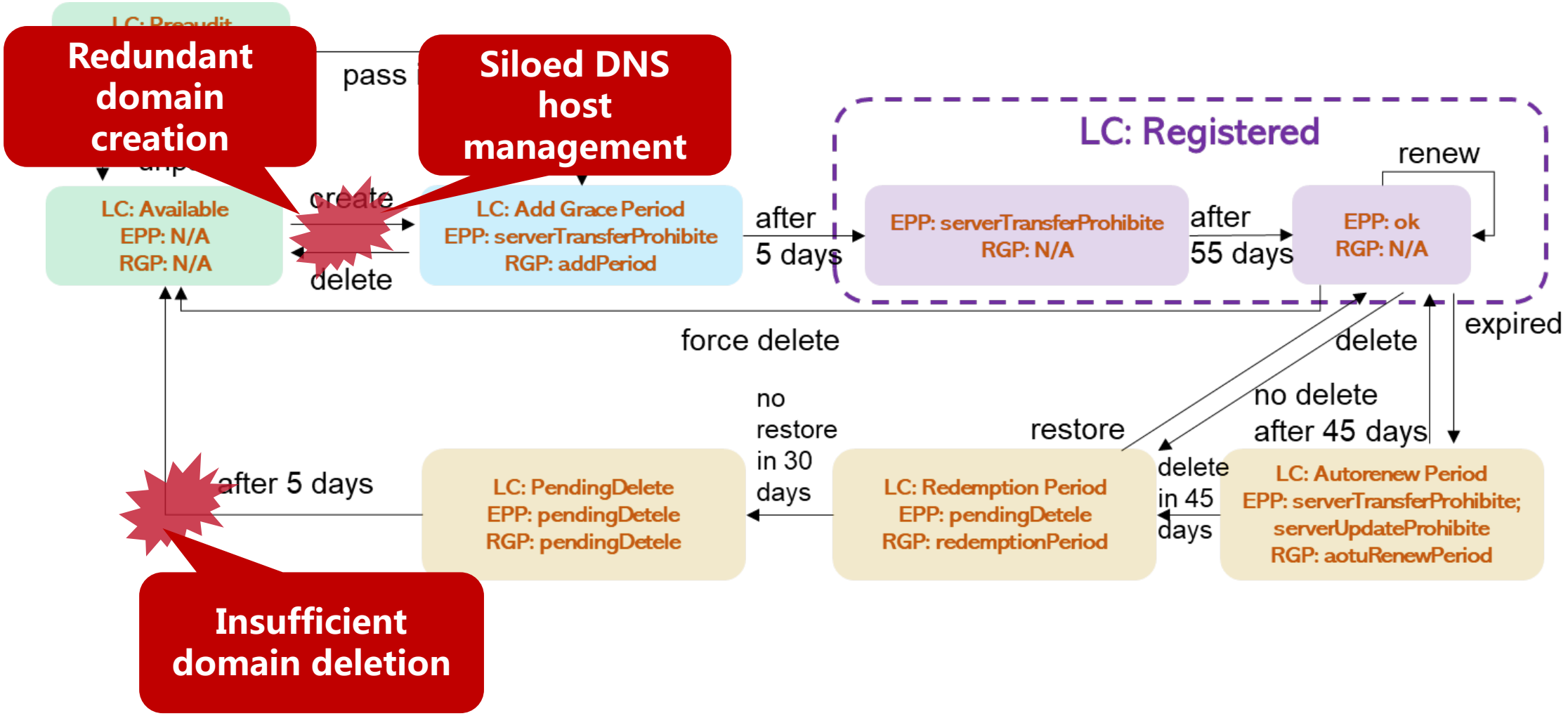
domain name is idle

Pipeline

➢ **Analyze domain name status using publicly available authorization and registration data**

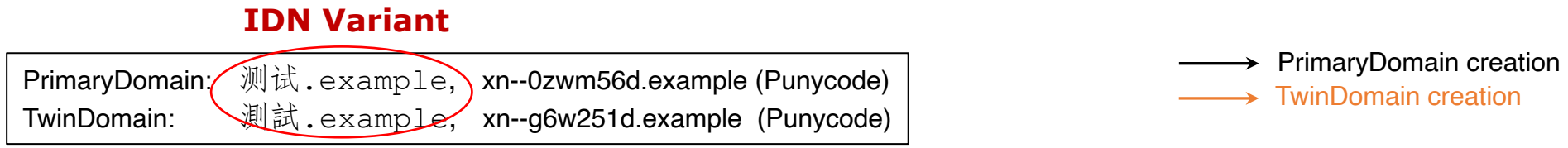


Uncover three registry operation flaws



Creation Phase: The "Twin Domain" Trap

When a registrant registers an internationalized domain name, the registry automatically adds the corresponding twin domain without notifying the registrant.



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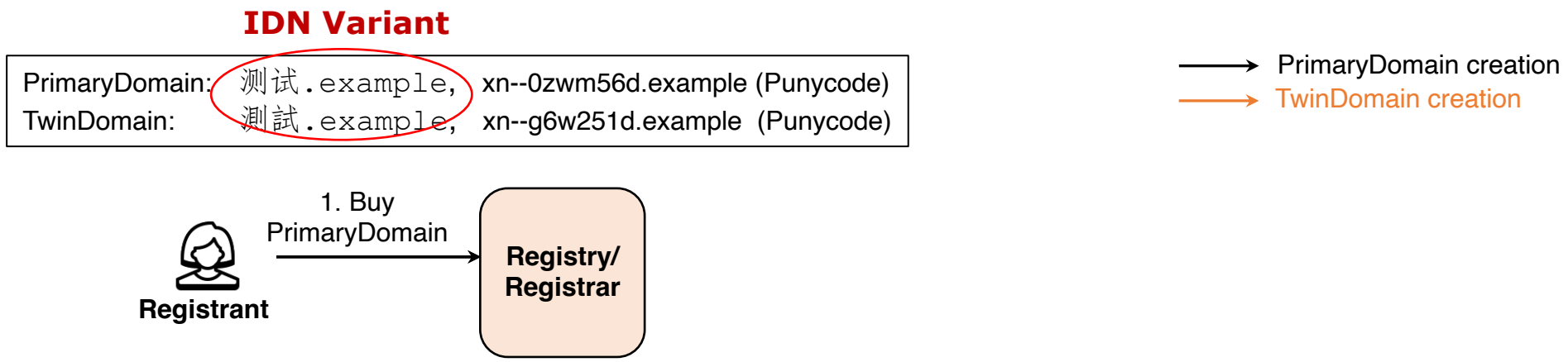

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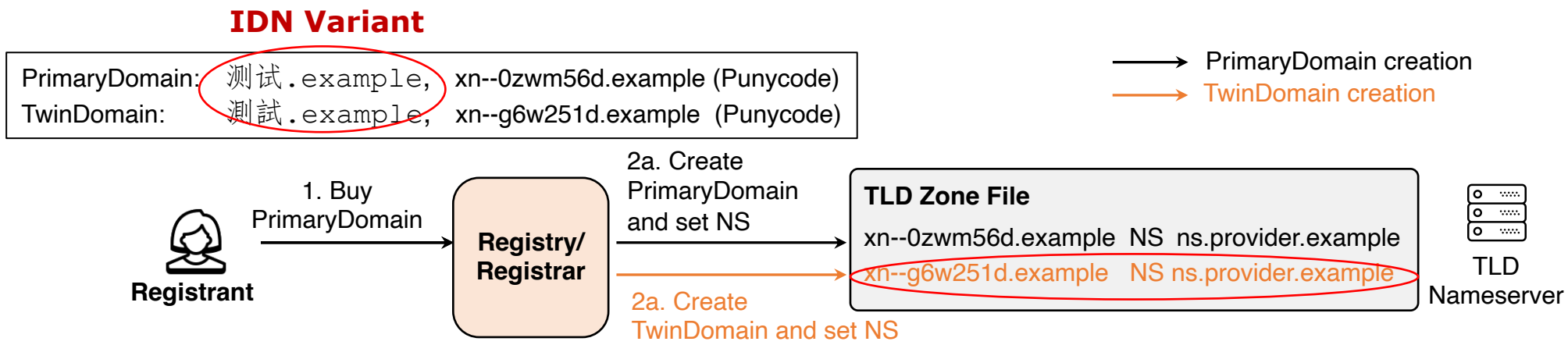

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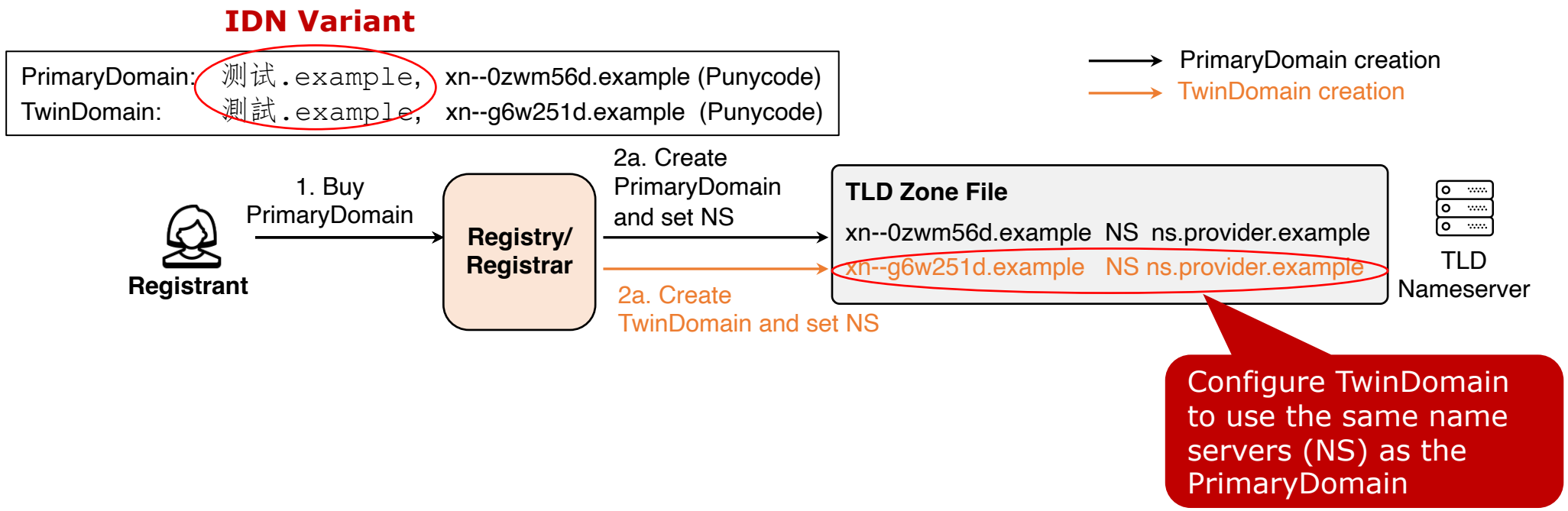


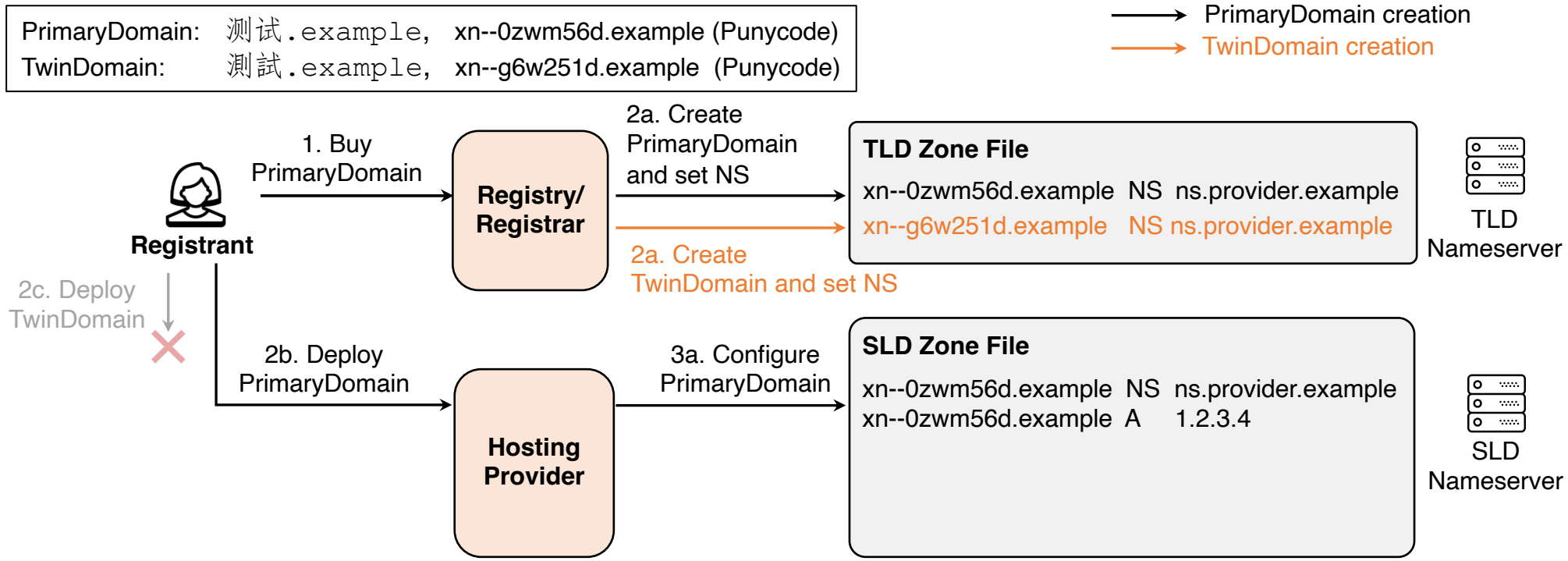
Creation Phase: The "Twin Domain" Trap

Attackers exploit twin domains to carry out abuse activities at zero cost.

Threat Model

1. The registrant deploys only **测试.example** on the hosting provider and does not deploy **測試.example**, as they are unaware of its existence.

2. The attacker unauthorizedly hosts the domain **測試.example** on the hosting provider and gains control over it.



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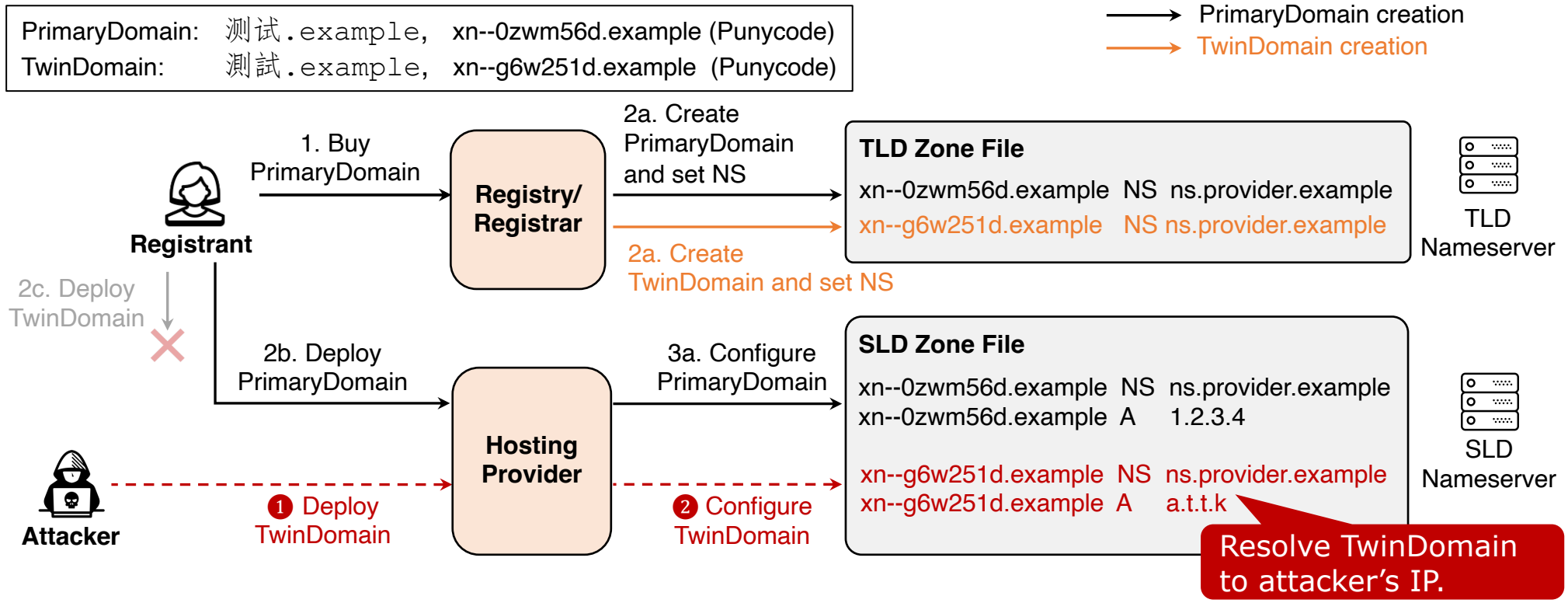


Creation Phase: The "Twin Domain" Trap

Impact

- We identified 8,866 sets of twin domains, include domains under .top, .商城, .wang, .我爱你, and .com.
- Among them, 6,017 are vulnerable to potential domain takeover, and some have already been exploited.

xn--4gqz56iuyholb.top (一諭終見.top)

162

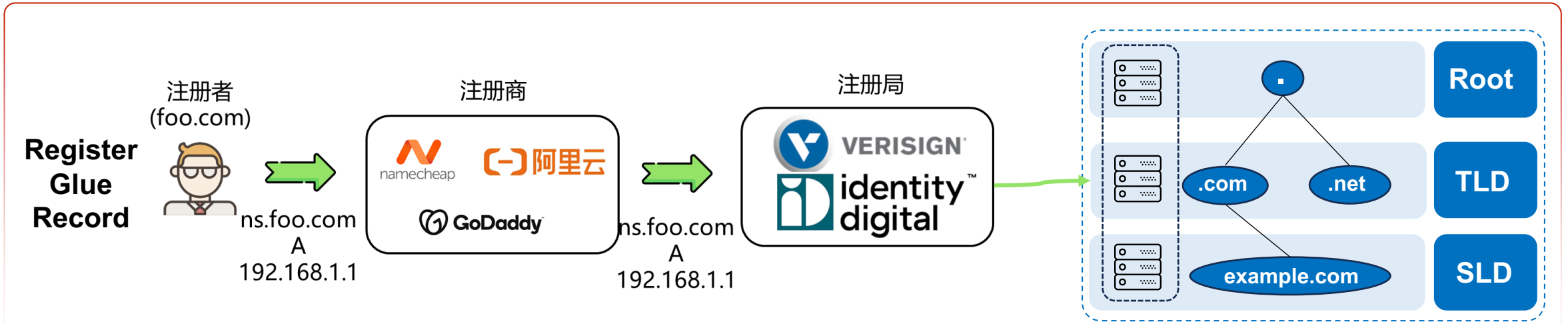
25 About - 裸聊直播 #Near me Visnagar 283 928753416 43 42 4187635 93 14 52

A twin domain was used for multiple fraudulent activities within a month

Twin domains are actively being abused

Management Phase: Unchecked Host Objects

Some registries often add all registrant-configured host objects to zone files without proper checks or purging.



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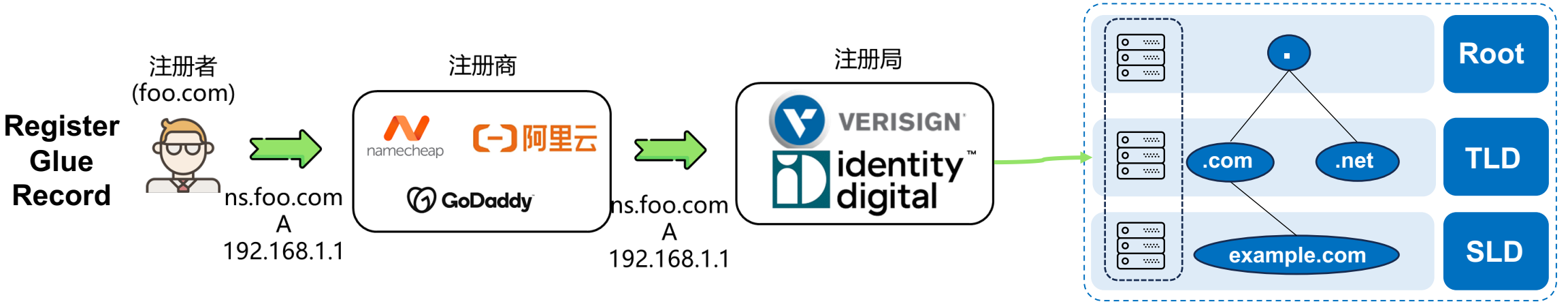
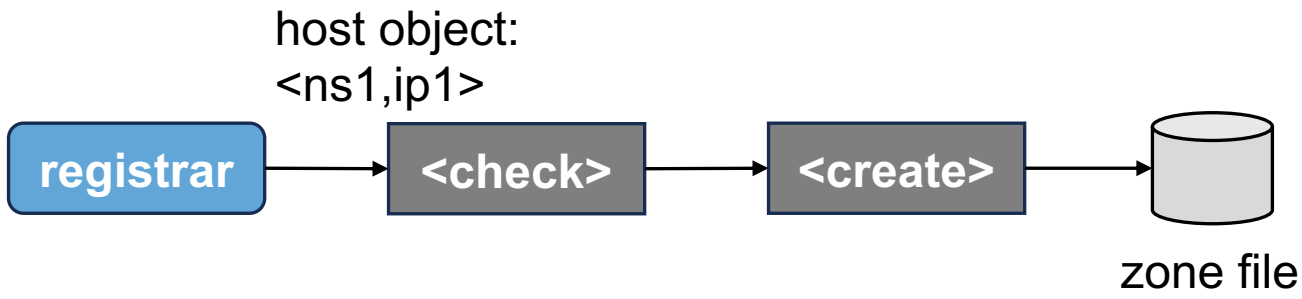


Mode 1

Write to zone file whenever you register the hosts objects: **top**, **com**



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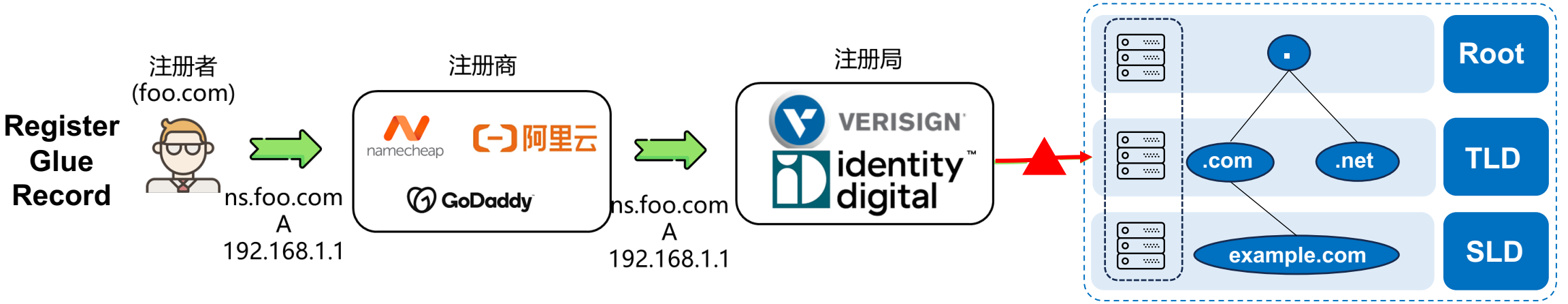

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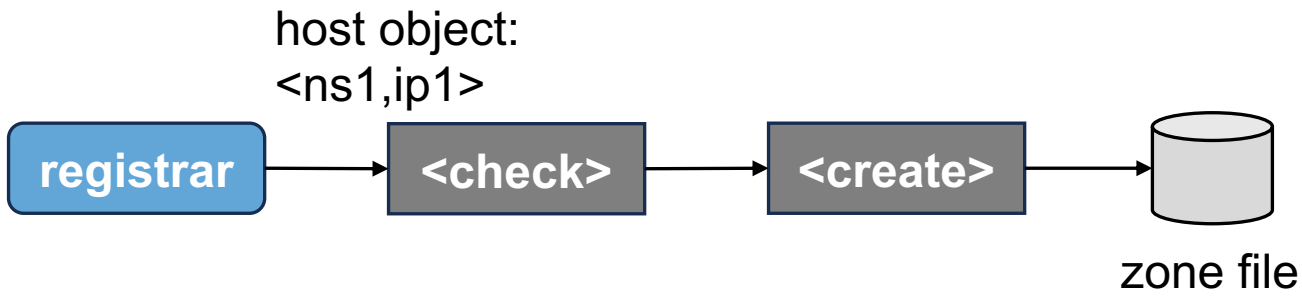

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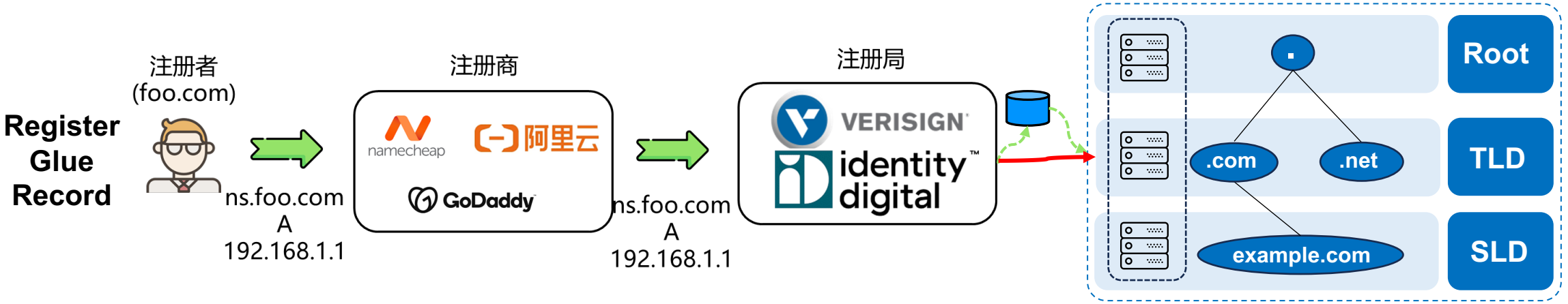
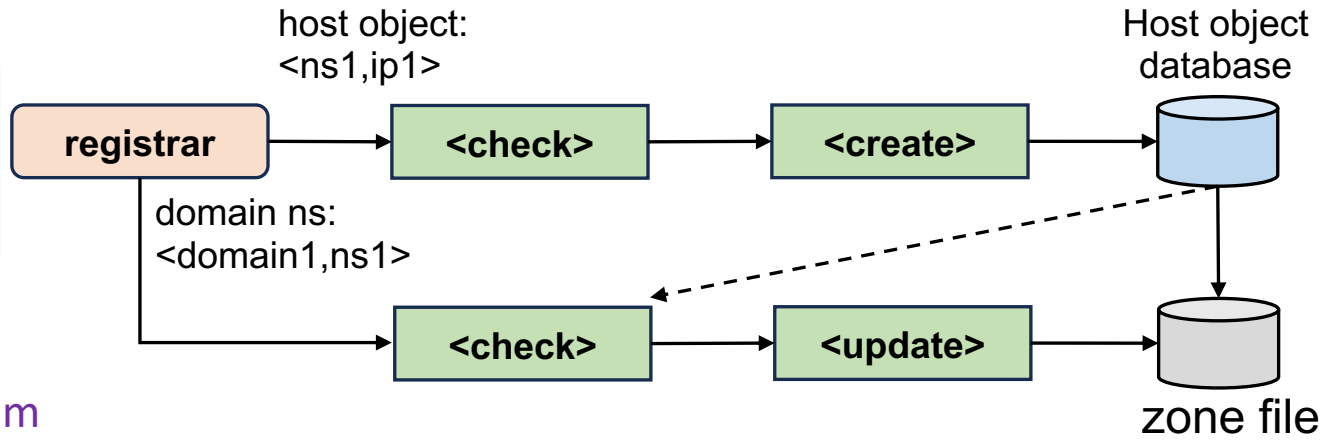


Mode2

Write to zone file only when used by in-domain delegations, such as .xyz, .site

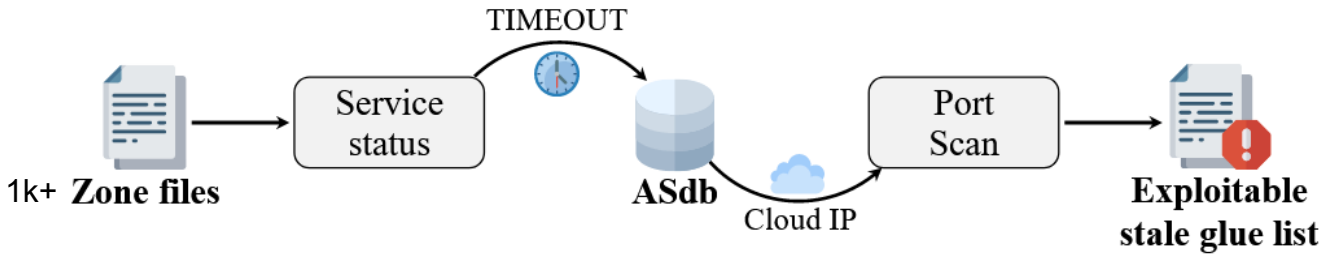
In-domain delegation :

google.com NS ns1.google.com



Management Phase: Unchecked Host Objects

Identifying stale glue records [1]



Impact

80,251 stale glue records that can be exploited, affecting **1,600,253** domain, including .com, .org, .net

All Glue Records 2,303,951 (100%)
- Abandoned 532,363 (23.11%)
- Active Glue Records 1,771,588 (76.89%)
  - Lack in-domain delegation 963,182 (54.37%)
    - Exploitable stale glue records 80,251 (8,33%)

TLD	# glue record	ratio
.com	47,593	13.34%
.org	18,926	6.58%
.info	4,157	4.31%
.net	3,707	7.84%
.top	1,645	12.11%

[1] Zhang et al., Rethinking the Security Threats of Stale DNS Glue Records, USENIX Security 2024

Management Phase: Unchecked Host Objects

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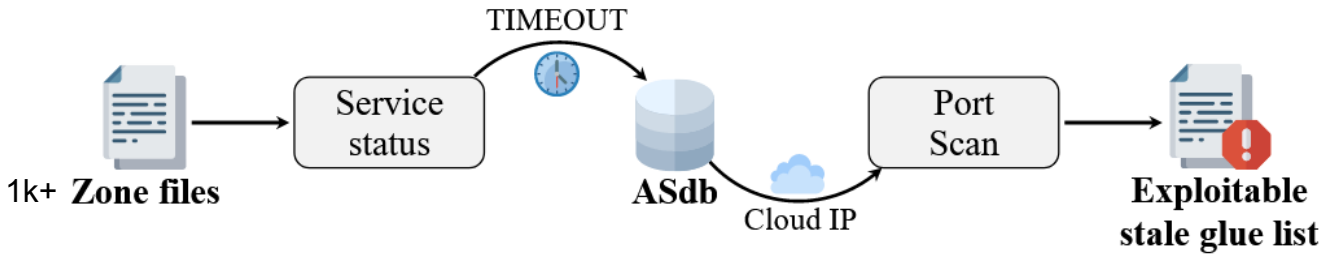

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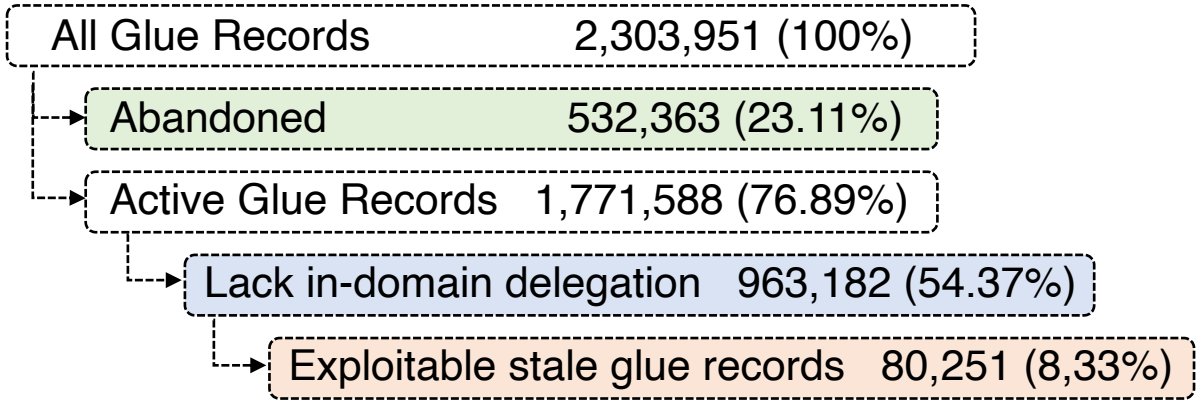

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We confirmed that the registry's glue record management strategy is the key factor leading to a large number of stale glue records

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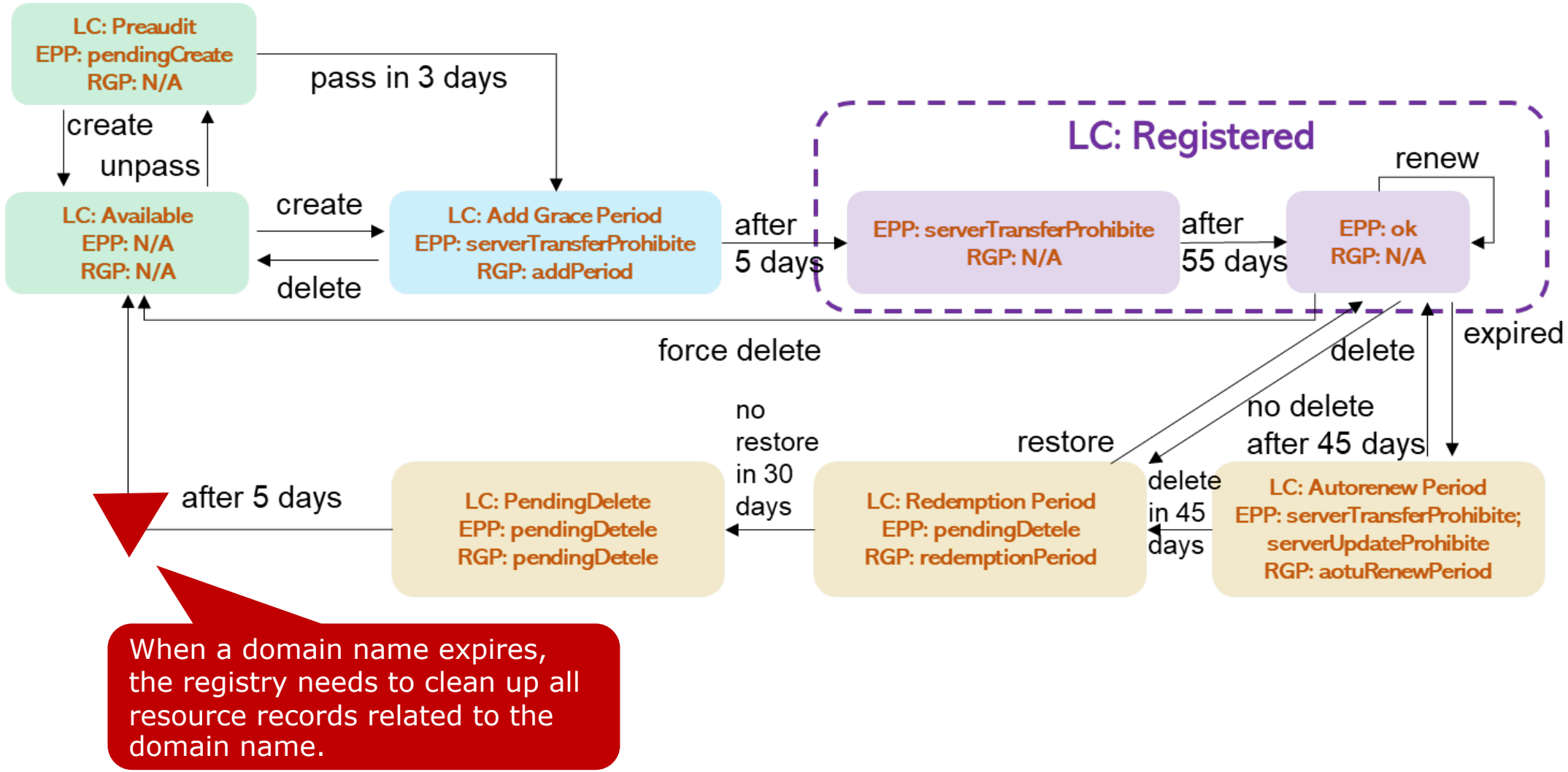
Deletion Phase: Relic Domains and Hijacking Risks



Deletion Phase: Relic Domains and Hijacking Risks

After a domain name expires, some of its delegation records remain uncleared.

untapped relic domains

The domain's delegation record has lost its administrator, so it remains in the zone file.

No WHOIS, but the NS record exists

relic domain

resurrected relic domains

The new registrar/registrant does not have authority over the old delegation records. It can add new records but cannot delete zombie records.

The NS records in WHOIS are inconsistent with the NS records in the zone file.

Inconsistent NS records	NS (zone)	NS (WHOIS)	Expiry Date	Static Registration Status	Dynamic Registration Status
exa.com	ns.foo.com	ns.exa.com	2025-04-08	registered	registered
exa.com	ns.exa.com				
bar.com	ns.bar.com	/	2023-03-08	unregistered	unregistered

domain not registered

Deletion Phase: Relic Domains and Hijacking Risks

Impact in the wild

Untapped relic domains

3,425 domains confirmed, covering **11** TLDs, including top , app , vip, 我爱你.
Registrie backends: GoDaddy、Nominet、Google、ZDNS 和 Beijing Tele-infoNetwork

Resurrected relic domains

19 domains confirmed, covering **13** TLDs, including top , ren, courses , biz , cymru
Registrie backends : Identity Digital、GoDaddy、Nominet 和 ZDNS

Regstry[1]	#TLD[2]	Resurrected relic domain		Untapped relic domain	
		TLD	#Domain	TLD	#Domain
Identity Digital [3]	447	zone	1	-	-
GoDaddy [24]	216	courses, design, party, club, wiki, rugby	8	vip	1
Nominet [45]	73	cymru, bot, wales	3	cymru	4
Google [25]	46	-	-	app, page, dev, みんな	47
ZDNS [8]	20	top, ren	5	top, wang, ren, 我爱你	3,374
Beijing Tele-info [6]	10	-	-	信息	1
Total	**812**	-	**17**	-	**3,425**

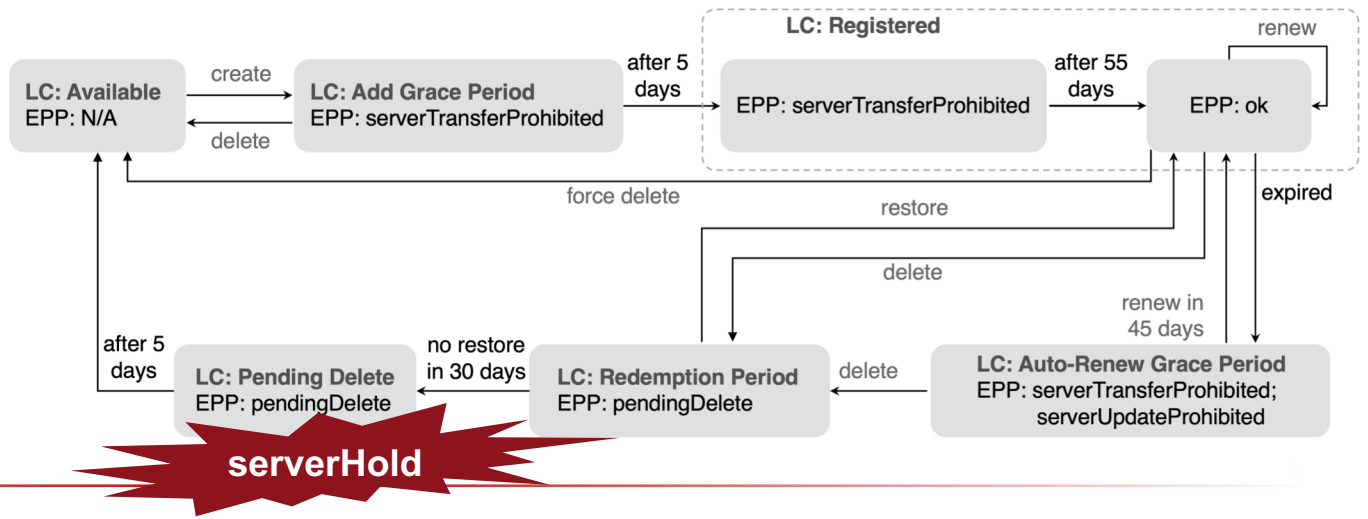
[1]: The relationship between new gTLDs and their registry backends is derived from the project nTLDStats [26].
[2]: The number of new gTLDs supported by the registry backend.

The affected registrie backends serve a total of 812 TLDs

Deletion Phase: Relic Domains and Hijacking Risks

Root Cause Analysis

The **pendingDelete** status and the **serverHold** status of the domain overlap, causing the software to be unable to clean up the delegation records normally.



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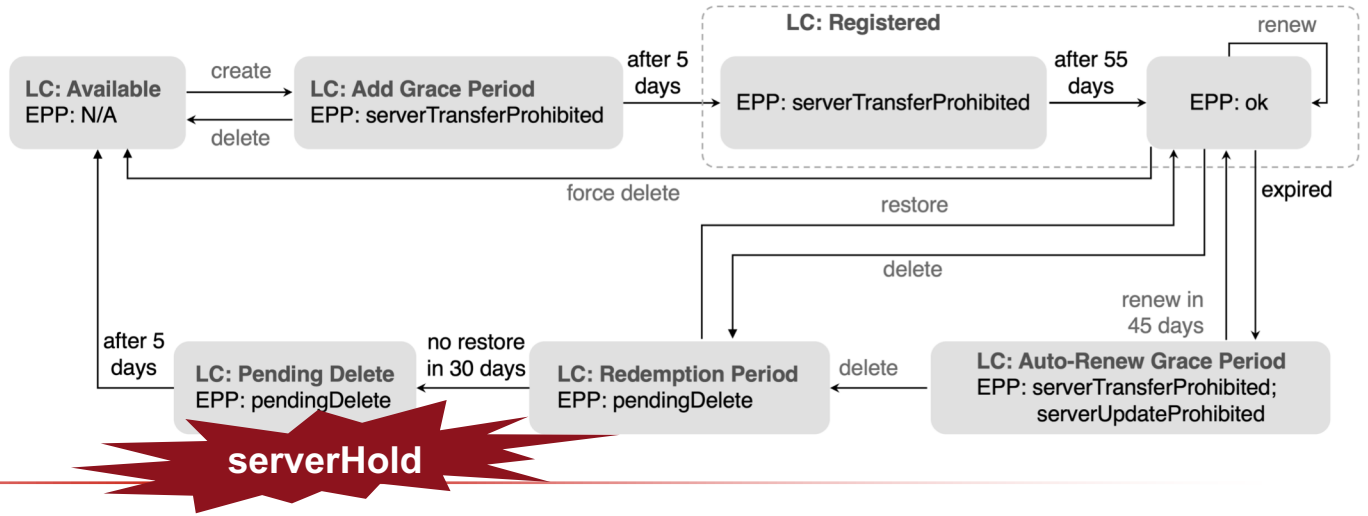
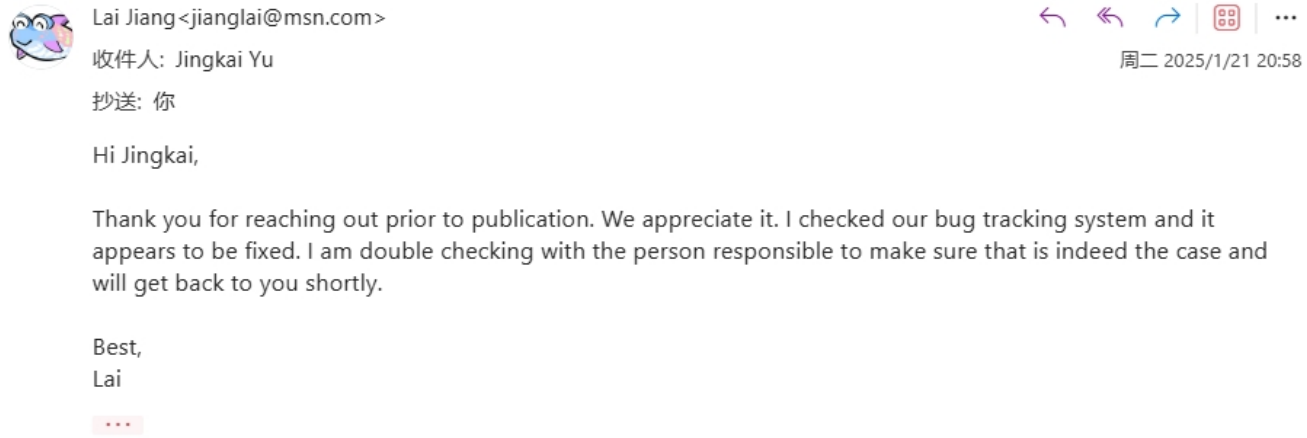


Disclosure

Google and ZDNS have confirmed the issue and have completed the fix



Stale and Dangling records are harmful, But …

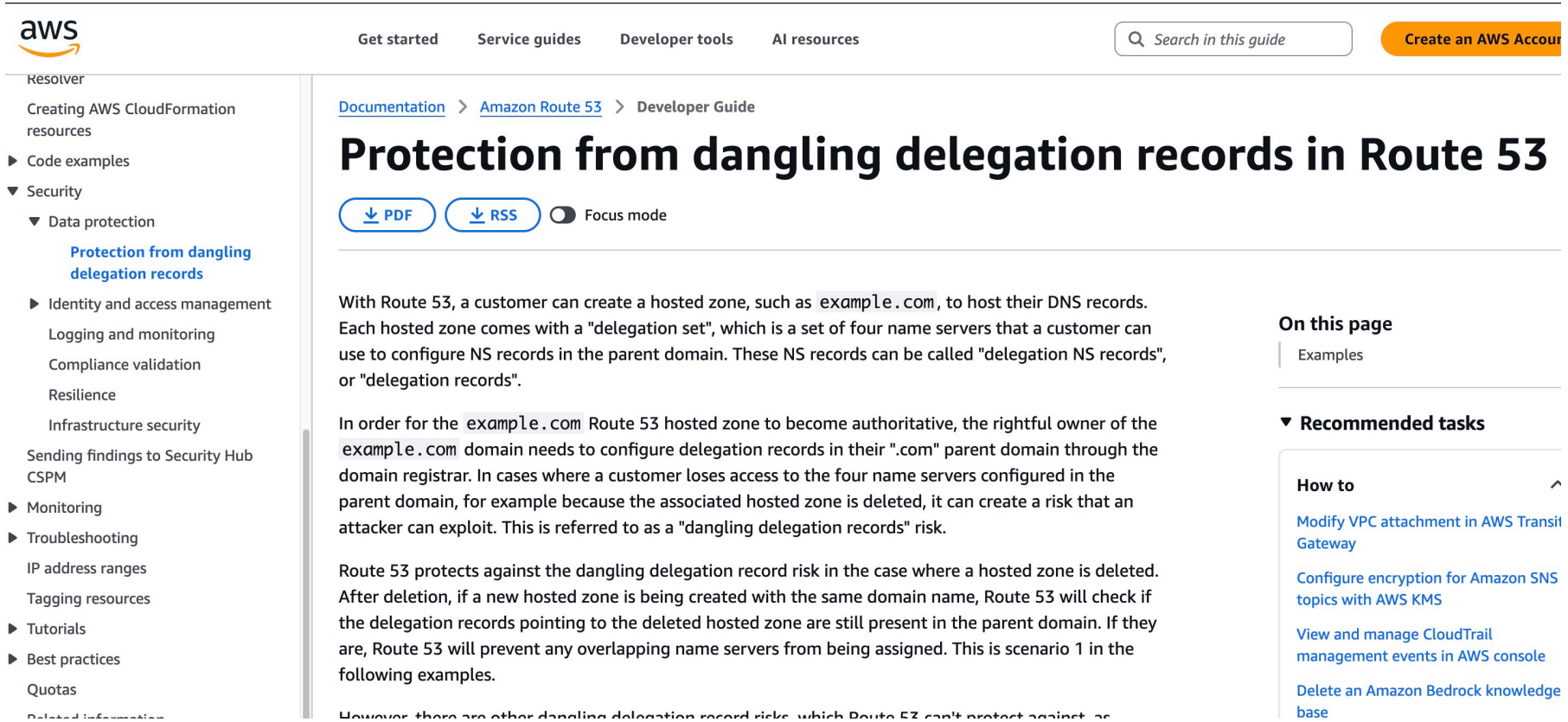
- Dangling record risk was first identified in 2016
- Zombie awakening attack (2020)
- XDAuth attack (2024)
- Sitting Ducks attack (2024)

Dangling resource records are being widely abused.

We can do it …

EXAMPLE

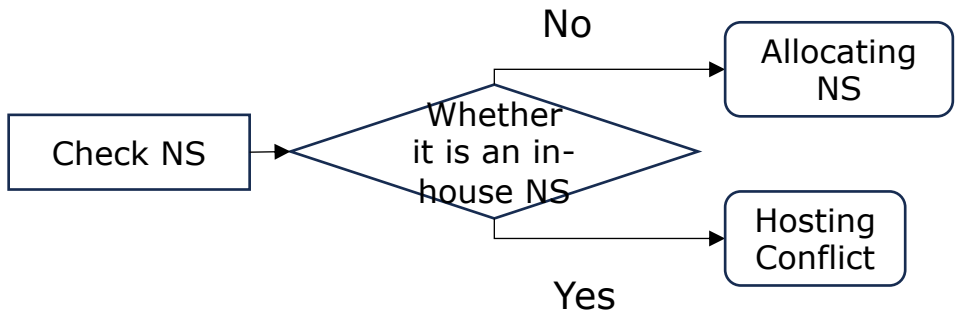
Route 53 protects child.example.com from dangling delegation records risk by preventing <ns1>, <ns2>, <ns3>, and <ns4> from being assigned to newly created hosted zones with the same domain name.



How to do it ...

Double Clear

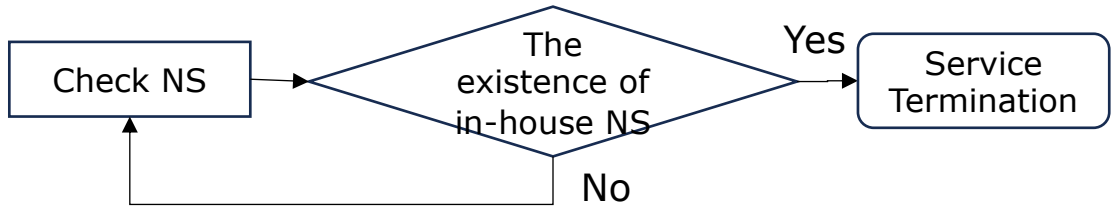
FIRST: When a user intends to host a domain



When domain hosting providers assign specific Name Servers (NS) to a user, they first perform an **NS check** to verify if any **stale or legacy NS records** exist.

GOAL: prevent vulnerable domains from being exploited by malicious actors

SECOND: When a user terminates the hosting service



The provider enforces the removal of the domain's NS records through an active verification mechanism.

GOAL: inhibit the creation of additional dangling records at the source

DNS-OARC
Domain Name System Operations Analysis and Research Center

Thank You & Get in Touch!

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