Privacy-Preserving & Incrementally-Deployable Support for Certificate Transparency in Tor

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A flash-back into the past

- June, 2011
- Netherlands, Beverwijk
- DigiNotar

What happened?

- DigiNotar issued web certificates
- Did not live up to expectations
- Then tried to cover it up[1]

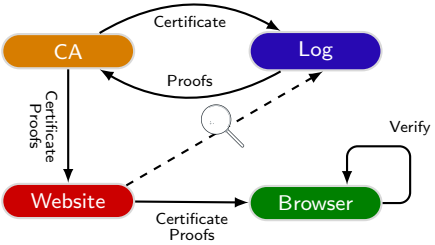
https://www.bbc.com/news/technology-14989334

A stealthy attacker might have gotten away with it!

[1] FoxIT. Black Tulip: Report of the investigation into the DigiNotar Certificate Authority breach. Page 3.

Larger problem and solution?

- Digitar was not a one-time incident[2]
- Many other parties can get it wrong
- Add visibility into issued certificates[3]



[2] https://sslmate.com/certspotter/failures
[3] https://certificate.transparency.dev/

Certificate Transparency (CT) compliance[4]

"Two logs promised that they will make the certificate public"

[4] https://github.com/chromium/ct-policy/blob/master/ct_policy.md & https://support.apple.com/en-us/HT205280

Problem statement

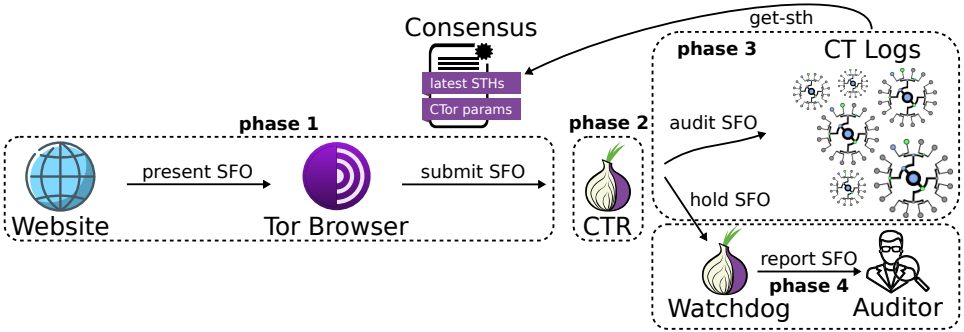
- Tor Browser does not enforce CT
- Guard against prominent threats
  - DigiNotar style attacks
  - Interception to deanonymize
- Aim higher than CT compliance

Attacker with browser exploit, CA, CT logs, and usual Tor capabilities

Gradual roll-out plan

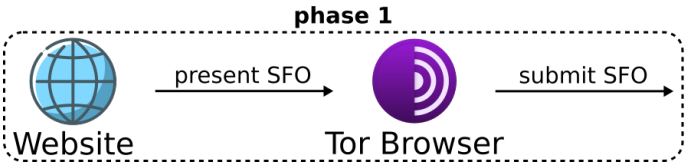
1. Catch up with CT compliant browsers — *pairs of logs* are trusted blindly
2. Steps towards decentralized verification — *some log* is trusted blindly
3. Fully decentralized verification — *no log* is trusted blindly

Overview of the full design



Security? Difficult to interfere without detection in any phase

Submission phase



Straw man proposals

- Fetch an inclusion proof
- Rely on a centralized party

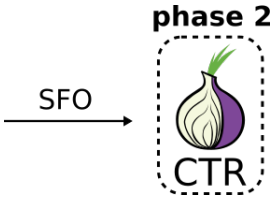
What we do instead

- Use Tor relays, “CTRs”
- Probabilistic submit

It must be difficult to infer which CTR received an SFO

Buffering phase

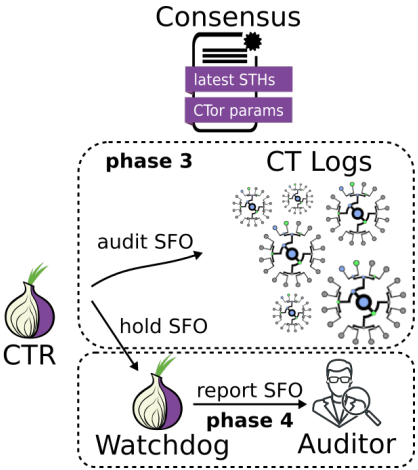
- Buffer until logging is required
- Add a random delay to leak less
- Cache audited SFOs to leak less



The attacker's best bet to interfere is trivially detectable

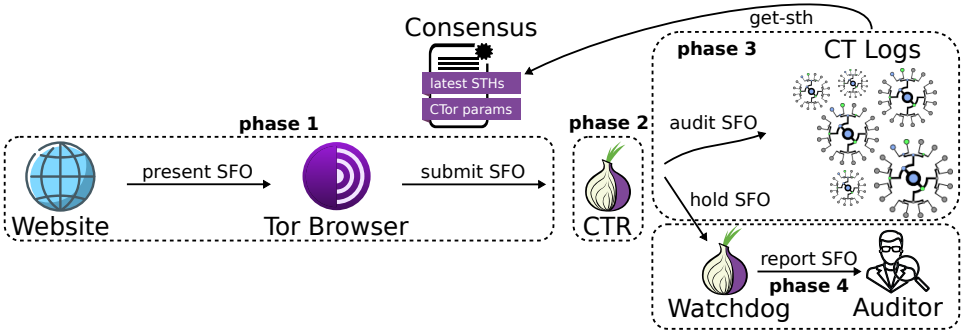
Audit and report phases

- Fetch inclusion proof against a specific STH
- Rely on Tor's consensus to agree on STHs
- Watchdog CTRs do the reporting if needed
  - Protects against CTR identification



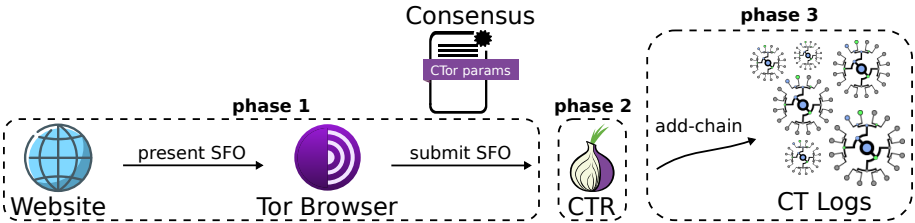
Why not just send to a trusted auditor immediately?

Putting it all together



This is quite a leap from CT compliance

Incremental design



Use the log ecosystem against the attacker

Take away

- Tor Browser would benefit from CT
- CT would benefit from more auditing
- Delegated auditing is key in our setting