Working Towards Digital Archive Transparency

It is time to add cryptographic timestamps to all the things

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archive.rip

July 2nd, 2025

Working towards Digital Archive Transparency

1. Introduction
2. What is the problem?
3. How can we fix this?
4. What about transparency logs?
5. Where I'm at? (a work in progress)

1. Introduction

What, When, Where

This applies to:

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We want to authenticate their
"when" & "where"

Roleplay (as a cryptographer)

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  The website & document metadata say "published in 2015"

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trusting metadata? in this economy?

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You were not there ten years ago!

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  You just don't know what could have happened!

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What about people *ten years in the future*? [1]

[1] note that to these future people, we are that "someone in the past" :)

Is this really an issue?

no problem if document stored on me computer

2. What is the problem?

Relying on an Informal Chain of Trust

The informal approach is flawed, because we have monkey brains

Relying on an Informal Chain of Trust

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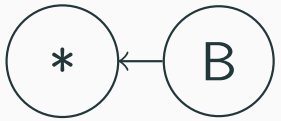

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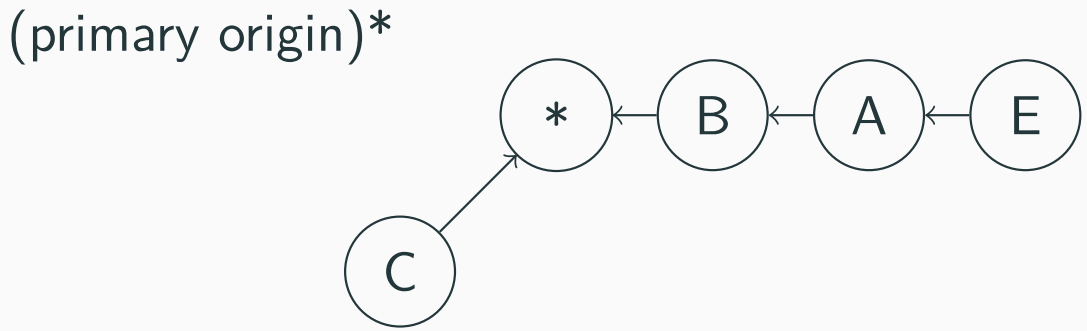

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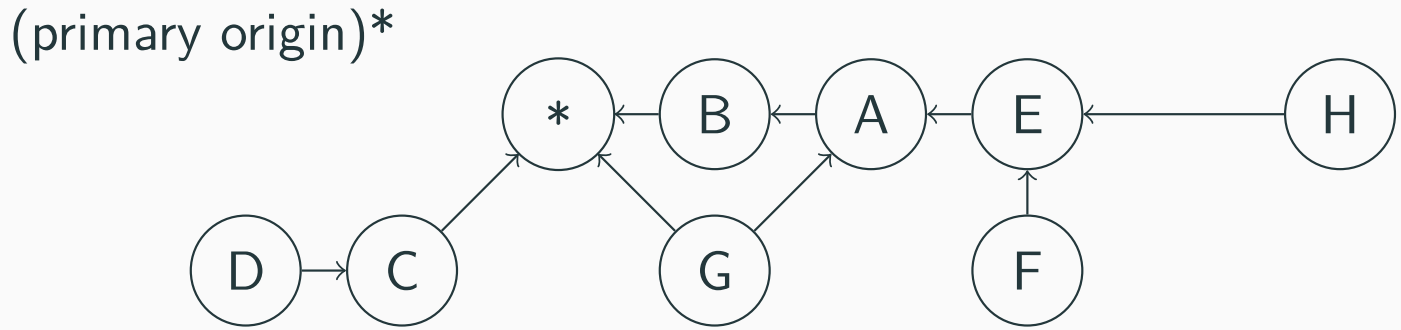

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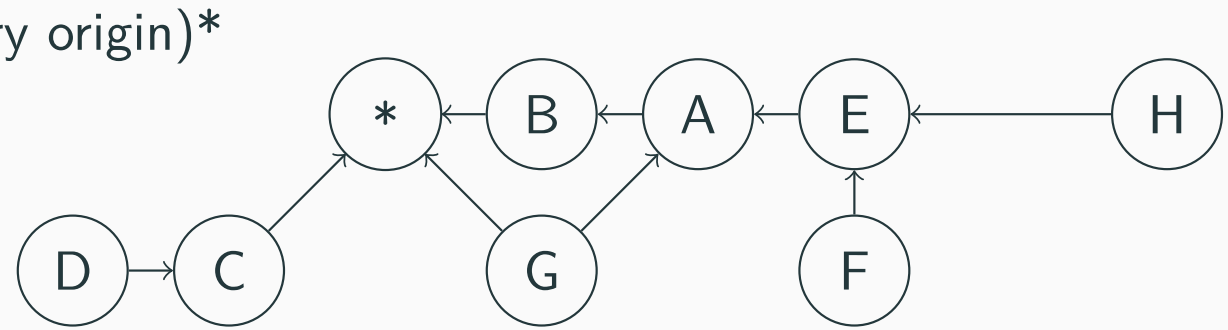

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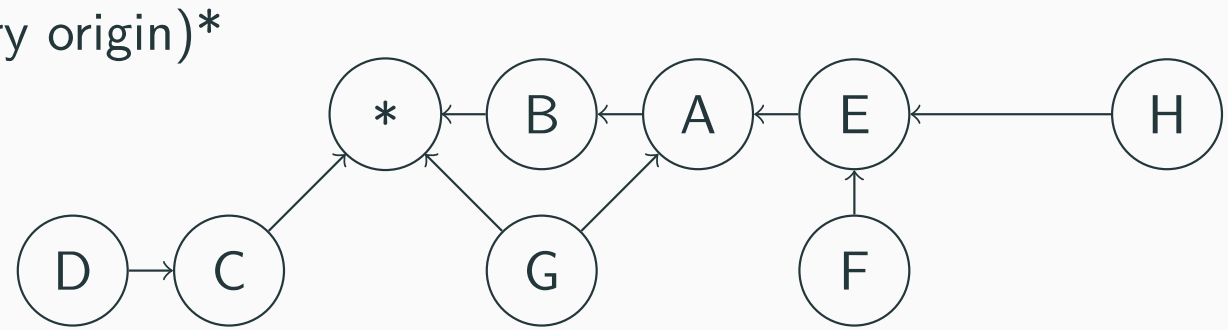

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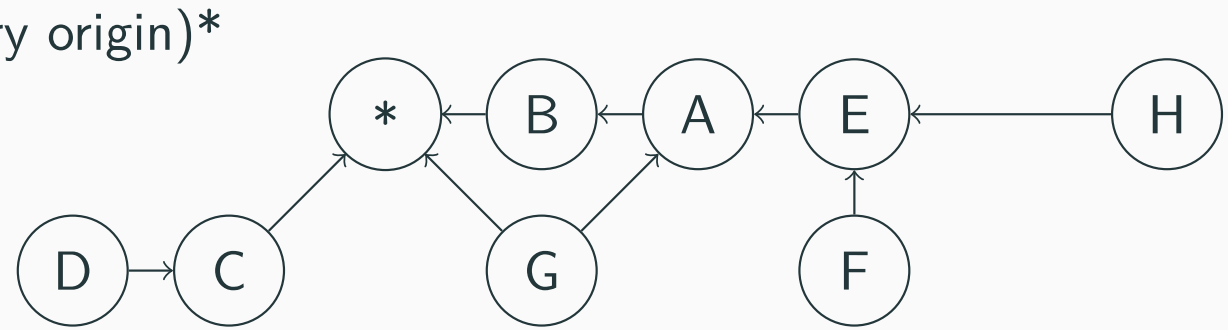

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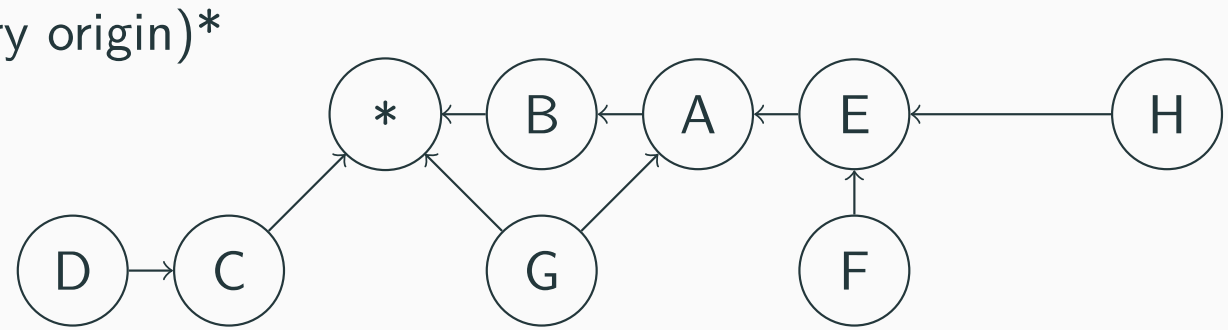

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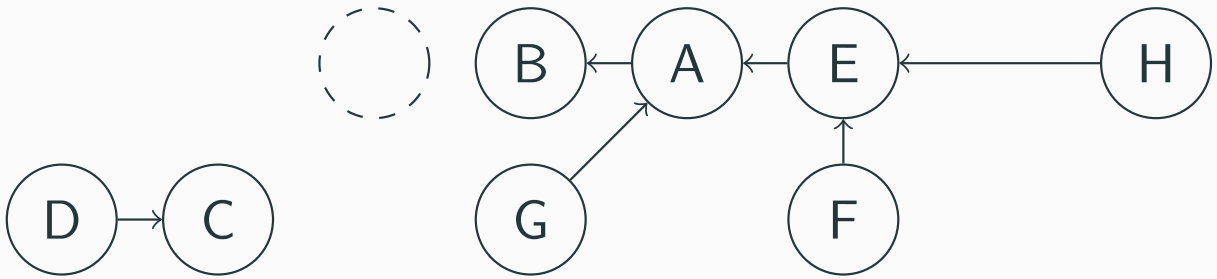

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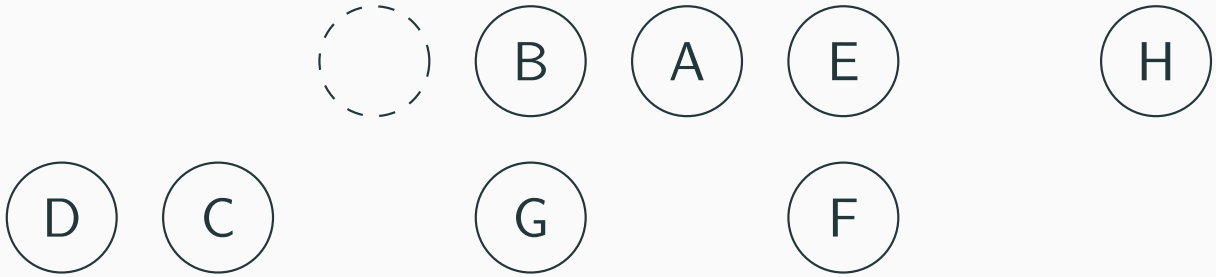

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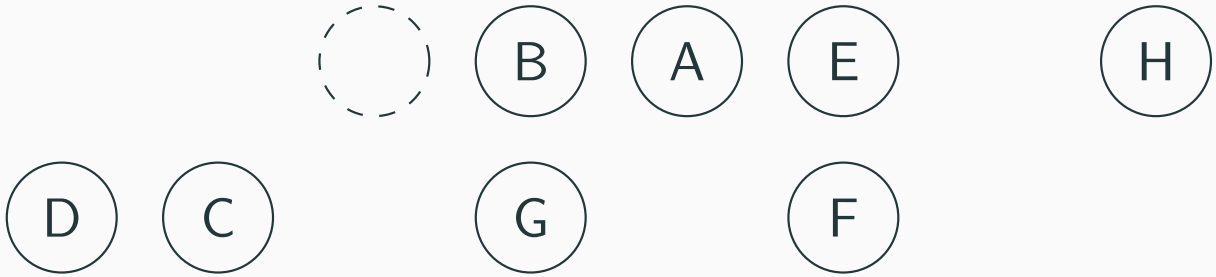

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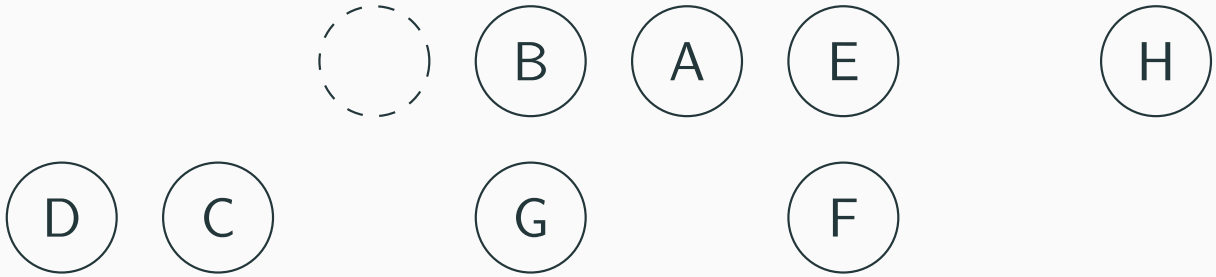

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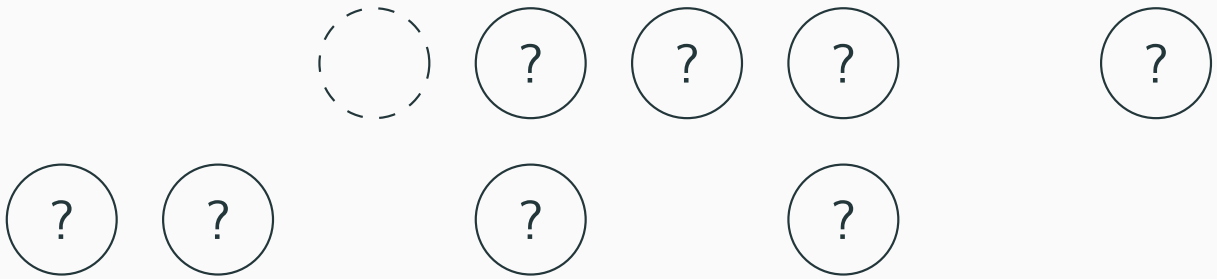

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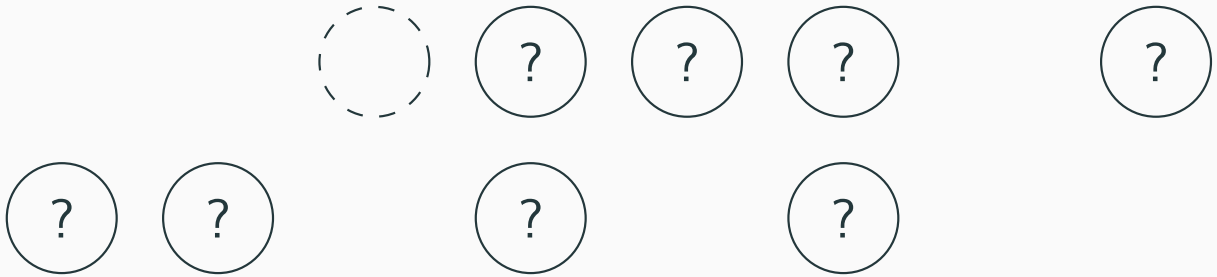

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We have no way to "revert back" to a "trusted past" 😟

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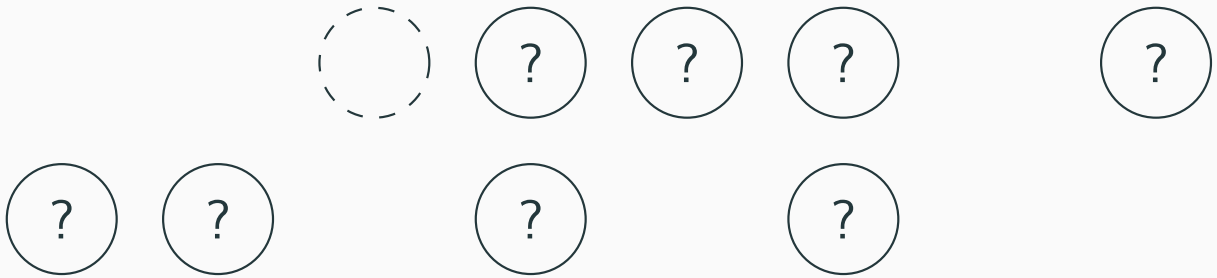

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The digital past is **indistinguishable from backdated data**

”Just go to The Internet Archive”

There exist **online digital archives** with snapshots of the past 🎉

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Bad actors capabilities[2] to generate convincing fakes are *expanding fast*

We need to fix this now[3] 💣

[2] as well as their economic incentives to attempt such attacks

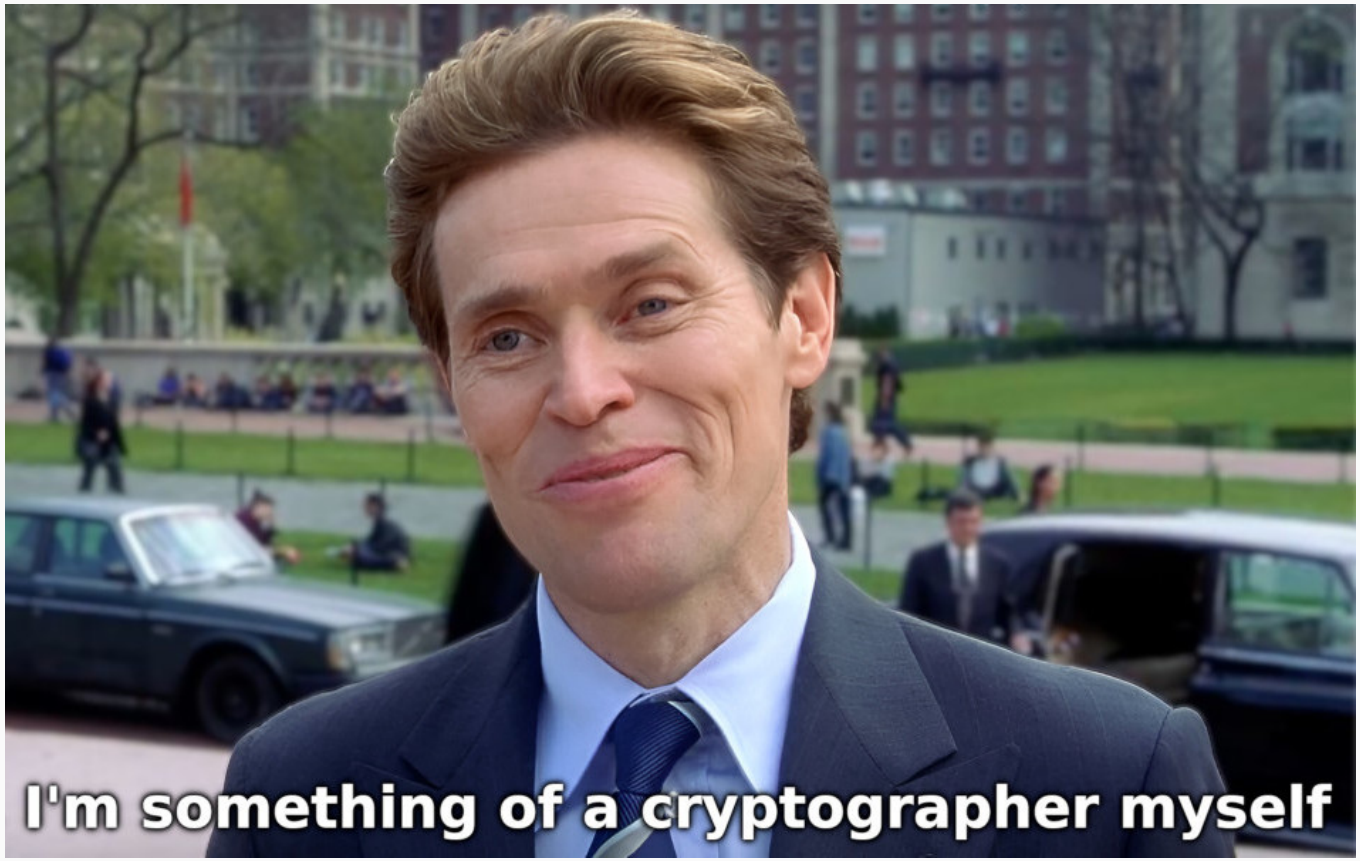
[3] and we should have started 5 years ago

The fix is digital signatures, no?

just add cryptogrophy

The fix is digital signatures, no?

You're in luck!



3. How can we fix this?

What about Trusted Timestamps?

"RFC3161: Internet X.509 PKI Time-Stamp Protocol (TSP)" *2001*

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- Used in legal compliance & other *business-for-business* industries

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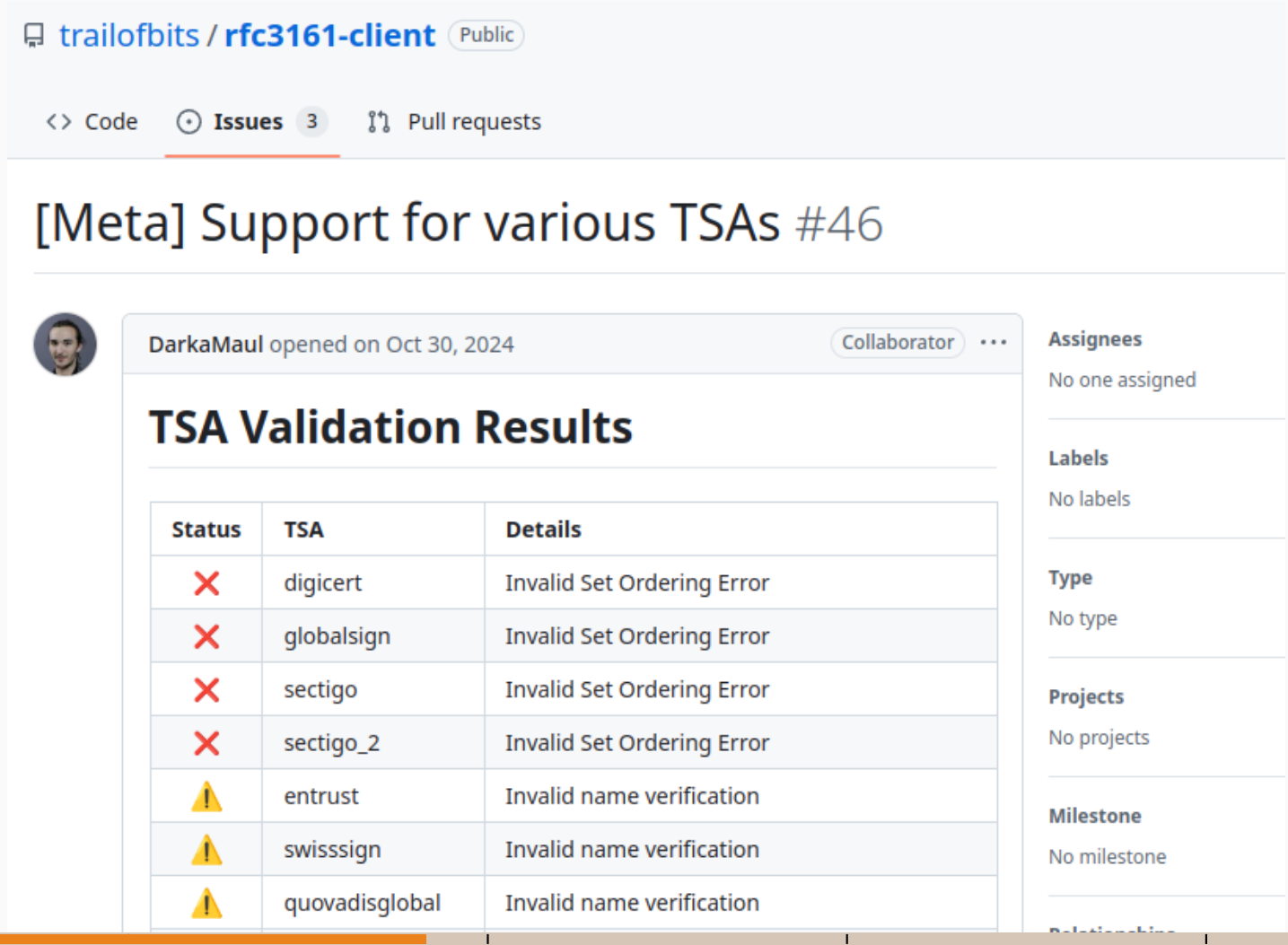

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Let's take a look at what they are doing! 🧐

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The missing ”chronology oracle”

(a look at an existing usage of trusted timestamp in digital archives)

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1. **Build a web capture** (a WACZ archive) for a document collection
2. Use your domain certificate[7] to sign an inventory of the documents
3. Reach out to a public RFC3161 server and get a trusted timestamp

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All the pieces are already there! ⚡

Where are the transparency logs?

transparency in title but not in talk??

4. What about transparency logs?

Transparency logs, you say?

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...is this a transparency log we need?

Digital Archive Transparency

Why using **transparency logs in digital archives**?

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Let's add a transparency log in our trust model! 🎉

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Let's build it now!

gonna build it meself

Let's build it now!

gonna build it meself [10]

[10] a very humbling experience in software engineering

5. Where I'm at?
(a work in progress)

Step 1/4: getting the documents

Where to get documents?

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In most cases, write custom code[12] on a case-by-case basis...

[11] most only exposes `md5` or `sha1` in their metadata (unfit for digital signatures...)
[12] such as some batch PDF processing with some basic metadata extraction

Step 2/4: specifying ”what we sign”

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[13] see bitcoin's BIP-0173 and BIP-0350

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What does your "manifest" look like?

[13] see bitcoin's BIP-0173 and BIP-0350

What does these ”manifest” looks like?

a manifest authenticating miscellaneous documents

File /tmp/manifest-r2mh1kejsmkl3n7w37rykcjskm7ssgf4vr5wrvw8yhkulzescssuzcdhq1jmcard.txt

```
  +xapdid:9c99865e-e5d1-483b-924c-98181467f144
  @file:12_April_2023.pdf
  @date:20230502T140309Z
  @title:"CVE Board Meeting Summary - 12 April 2023"
  @author:"CVE&#174; Program"
rip-add pdf 00023 r2ah166fsr0ug92e830rqqqlzffqjkel43gp6cqnj3c6eegqjwszdad0s1h094nw 2334622
  +md5:r2h51d7gped8nuel7qeqn0u46vs577q16uwcvy
  +sha1:r2h01jpypqvyy83s8ddghjlchadl9hphtglyq1efdkvg
  +doi:10.1194/jlr.D085217
  +xapdid:6c0610ac-1dd2-11b2-0a00-9209271dd700
  @file:1301.full.pdf
  @date:20180621T055501Z
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  @title:"High-throughput, nonperturbing quantification of lipid droplets with digital holographic %
      % microscopy"
rip-add pdf 00024 r2ah1vvzdzsqezmsym03muet6kv2shn2ksg30y70hcz4dhdy9rxptyxqq14j0a7c 1360233
  +md5:r2h51upd2ezxun6s0l4yakae0k8c28514x7nju
  +sha1:r2h017jg997n3kv7dz6arspefh28t6hatp8vp1uwk56m
  @file:13TCASII_replica.pdf
  @date:20140115T110003Z
  @title:"Replica Technique for Adaptive Refresh Timing of Gain Cell embedded DRAM"
rip-add pdf 00025 r2ah1e4s6ctsgafpam35zf4qxm2hn7k7pxu9m3sdpvvfm985mxn8kxzus1fxkulm 472315
  +md5:r2h51ws22dphq54hd2fd9w03c7yg4jy1hkqkmy
  +sha1:r2h01ncumglytgctkvpxerexmppnrea83vg5uh15kn790
```

What does these ”manifest” looks like?

documents are referred to using their sha256 hashes

File /tmp/manifest-r2mh1kejsmkl3n7w37rykcjskm7ssgf4vr5wrvw8yhkulzescssuzcdhq1jmcard.txt

```
  +xapdid:9c99865e-e3d1-483b-924c-98181467f144
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  +md5:r2h51d7gped8nuel7qeqn0u46vs577q16uwcvy
  +sha1:r2h01jpypqvyy83s8ddghjlchadl9hphtglyq1efdkvg
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  +md5:r2h51ws22dphq54hd2fd9w03c7yg4jy1hkqkmy
  +sha1:r2h01ncumglytqctkvpxerexmpnrea83vq5uh15kn790
```

documents fingerprint (sha256)

What does these ”manifest” looks like?

other identifiers / ”codes” are included for cross-reference

File /tmp/manifest-r2mh1kejsmkl3n7w37rykcjskm7ssgf4vr5wrvw8yhkulzescssuzcdhq1jmcard.txt

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  +sha1:r2h01ncumglytqctkvpxerexmpprea83vq5uh15kn790
```

other identifiers (or "codes")

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document metadata is explicitly stored for third-party analysis

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  +sha1:r2h01ncumglytqctkvpxerexmpnrea83vq5uh15kn790
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other document metadata (title, date, ...)

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[14] Time-Stamp Authority – each with a subtly unique & non-standard behavior ✨

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- then we append a signature[15] bound to a given observer identity

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[15] likely some hybrid `ed25519`+`MAYO3` digital signature scheme (*wip pqc yadiyada*)

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Time to supercharge this with transparency logs! 🚀

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sorry, this is future works[16]

[16] insert `meme_not_much_but_honest_work.jpg`

Conclusion & Thank you

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To keep you posted, write to:
contact@archive.rip

thank you for listening! 

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Appendix: Links & Resources

Several resources for the curious mind:

- The Century Scale Storage as an introduction to digital archiving
- The LOCKSS / CLOCKSS project as precursor in distributed archives
- The WACZ Signing & Verification from WebRecorder for reference
- Both Signed HTTP Exchanges & HTTP Message Signatures 🎶
- and many more I'm sure :)