Auditing Key Transparency

Advancing WhatsApp tampering protection for millions

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WhatsApp / Meta

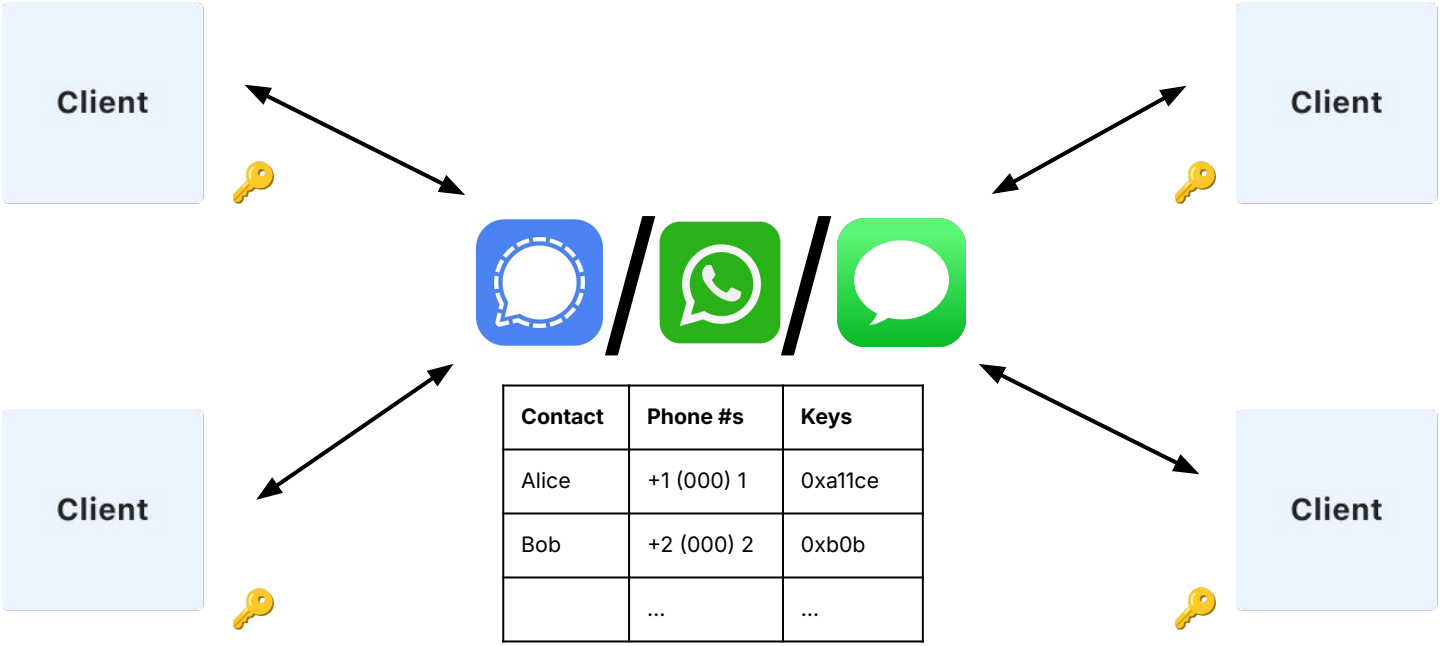
Agenda

1. A refresher on Key Transparency
2. Auditor system design
3. Real-world deployment
4. What’s next

Section

A refresher on Key Transparency

E2EE Messaging

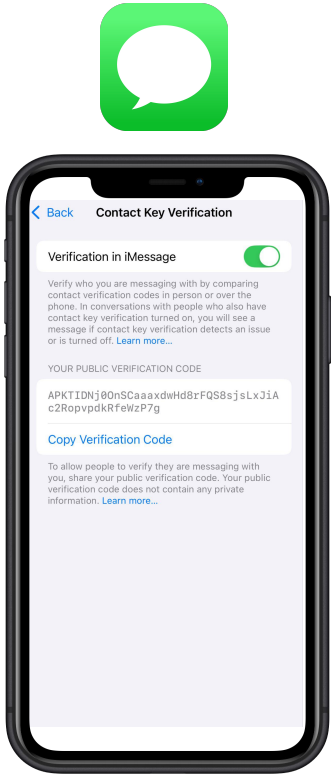


Contact	Phone #s	Keys
Alice	+1 (000) 1	0xa11ce
Bob	+2 (000) 2	0xb0b
	...	...

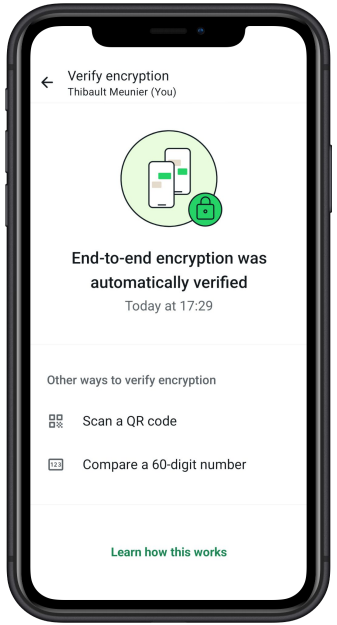
QR Codes

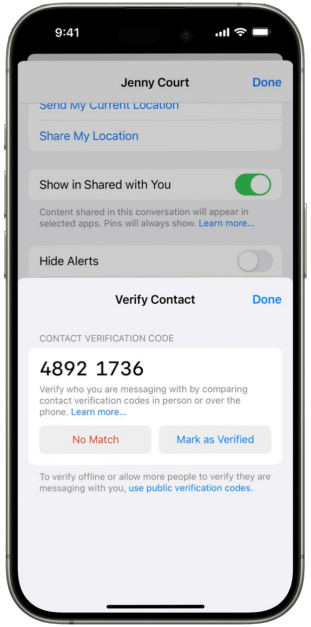

Done
Verify Safety Number
Tap to Scan
38934 23325 62030 61757
17656 35652 72172 76330
95462 95329 03104 63049
To verify end-to-end encryption with Mari, compare the numbers above with their device. You can also scan the code on their device. Learn More
Mark as Verified


00260 12239 05283 69774
61217 31583 87017 85796
03779 12268 33454 42807
To verify that messages and calls with Hart Montgomery are end-to-end encrypted, scan this code on their device. You can also compare the number above instead. Learn more
Scan code

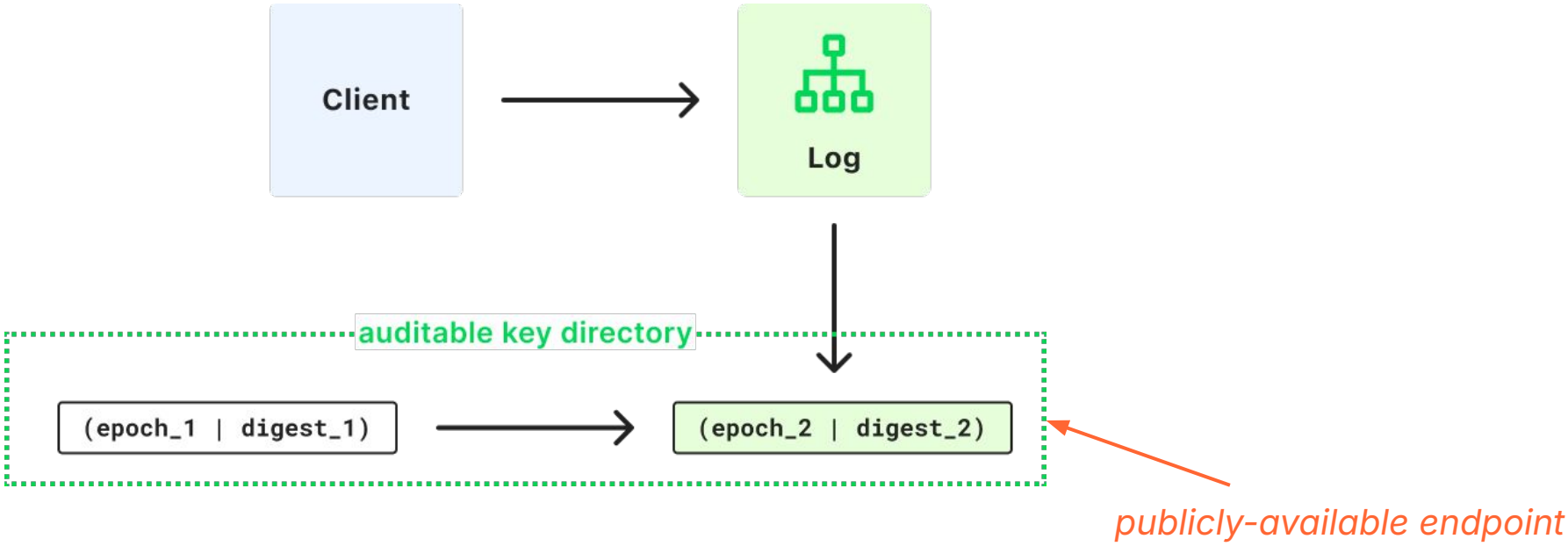

Back
Contact Key Verification
Verification in iMessage
Verify who you are messaging with by comparing contact verification codes in person or over the phone. In conversations with people who also have contact key verification turned on, you will see a message if contact key verification detects an issue or is turned off. Learn more...
YOUR PUBLIC VERIFICATION CODE
APKTIDNj0OnSCaaaxdwHd8rFQS8sjsLxJiAc2RopvpdkRfeWzP7g
Copy Verification Code
To allow people to verify they are messaging with you, share your public verification code. Your public verification code does not contain any private information. Learn more...

Key Transparency

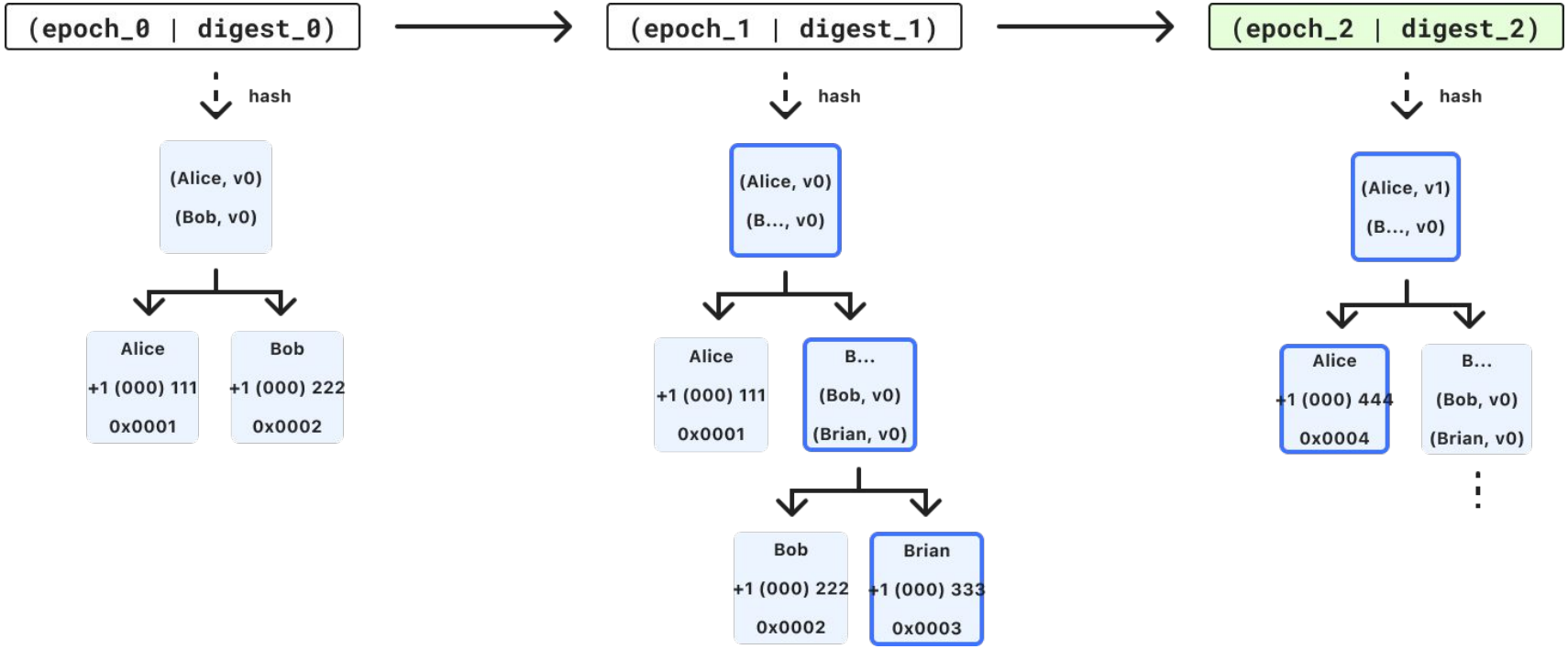




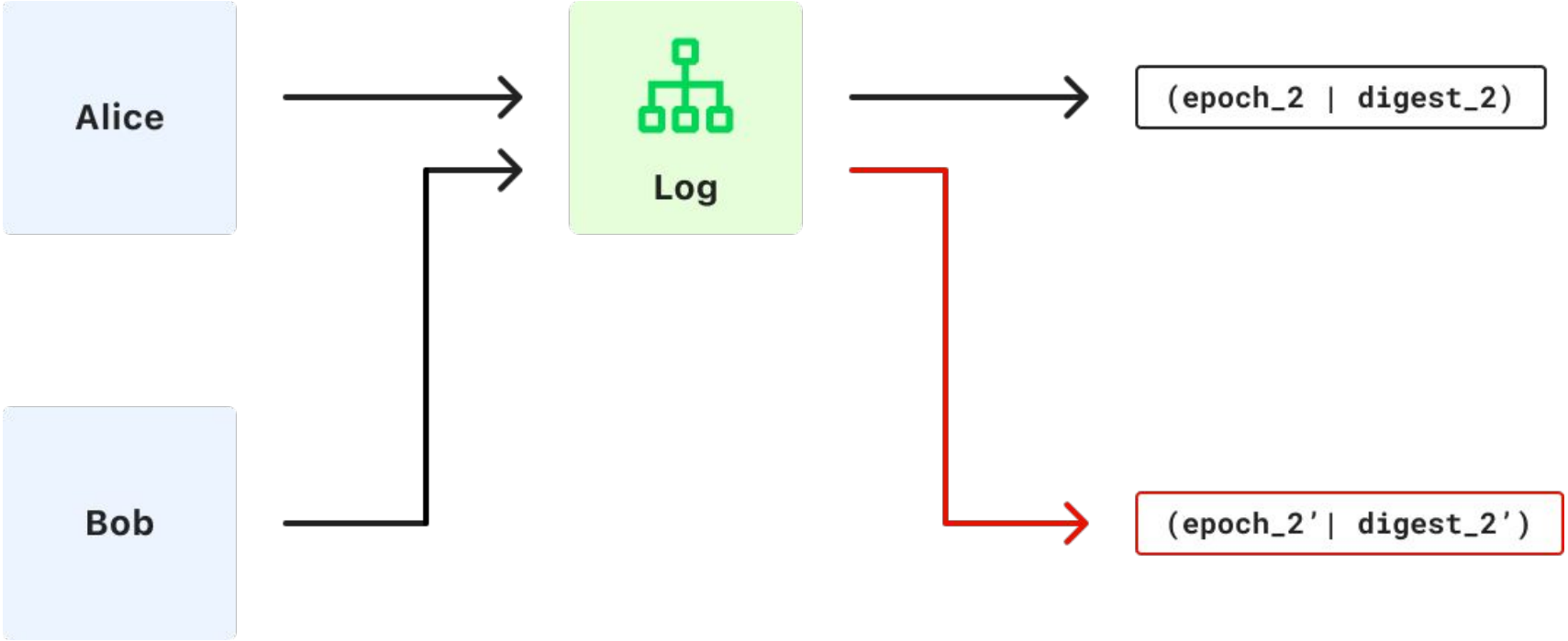
Key Transparency – Client and AKD



Key Transparency – Auditable Key Directory (AKD)



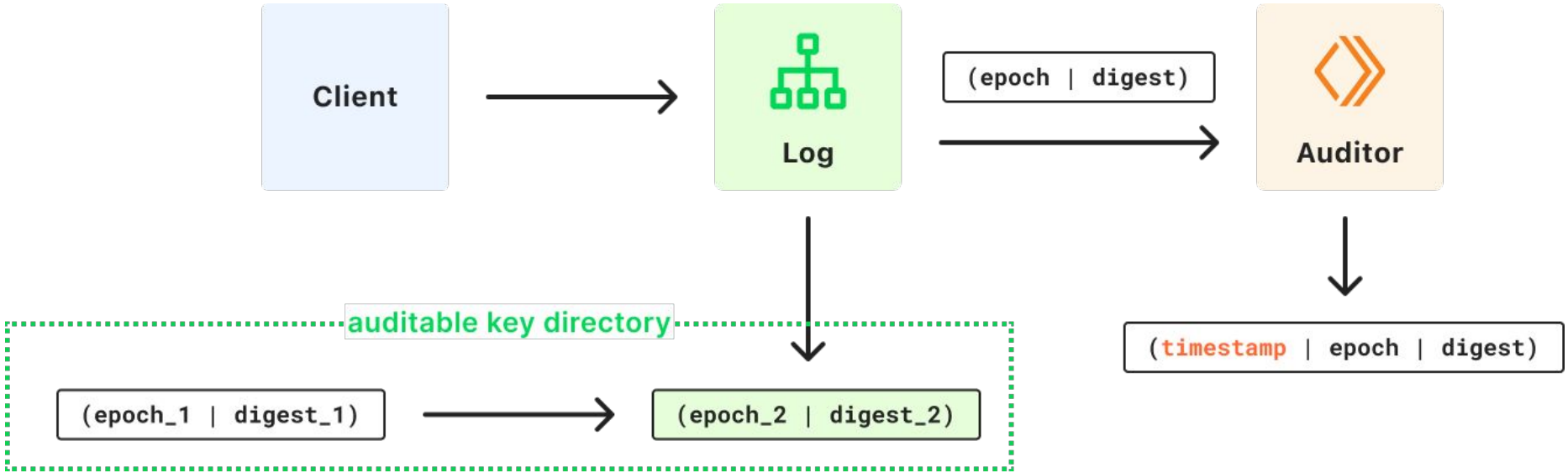
Key Transparency – split view attack



Section

Auditor system design

Introducing the Auditor



What is the Auditor responsible for?

Witnessing

Ensures epochs are unique and in sequential order.

Monitoring

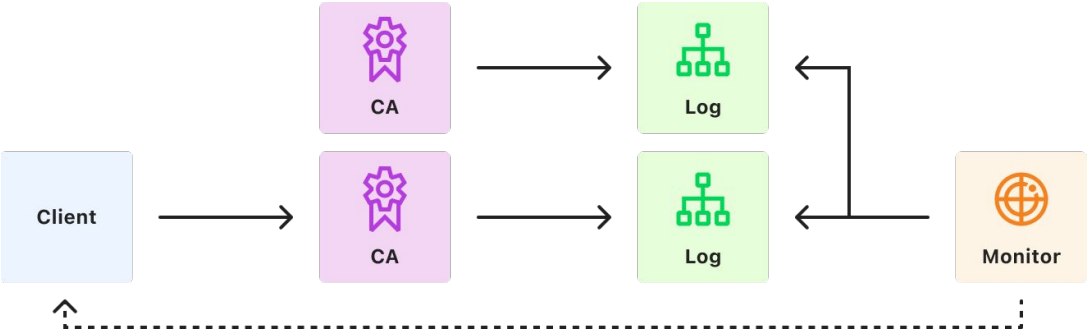
Making sure that the AKD is correctly constructed and that all epochs transitions are valids.

Privacy preserving

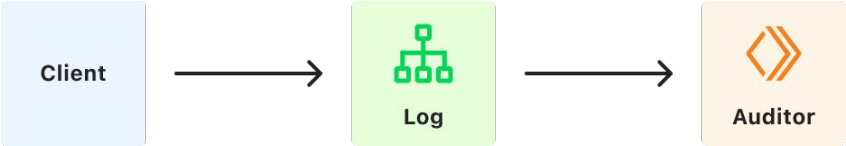
Does not see users' private information: no name, no phone number, no public key. It is a trusted third party.

How does that relate to Certificate Transparency

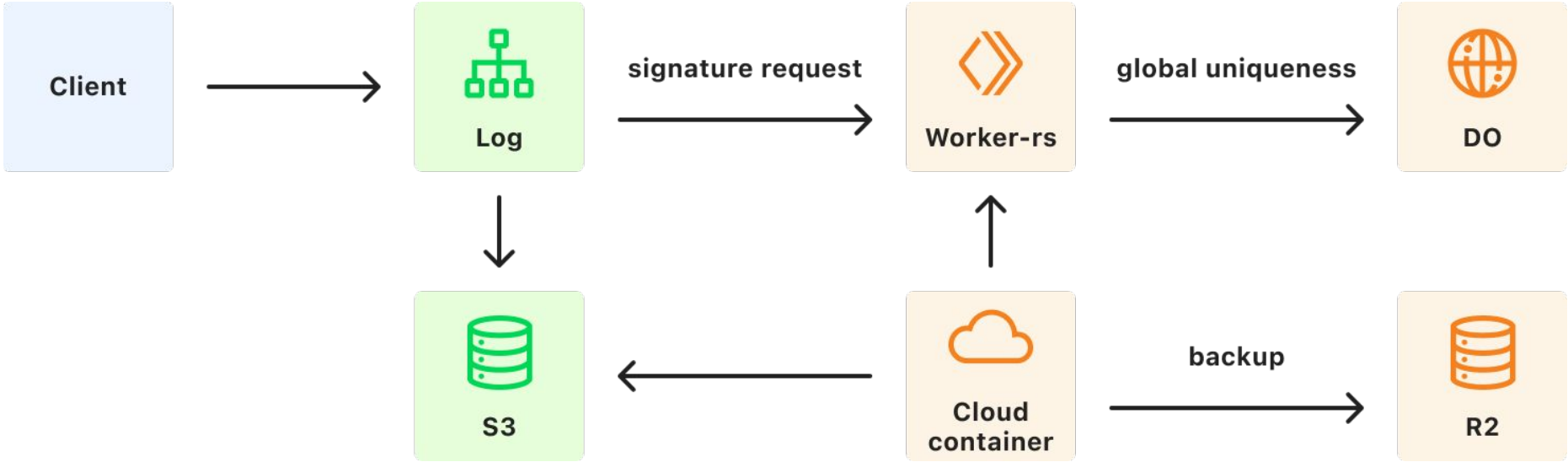
Certificate Transparency



Key Transparency



Validating epoch uniqueness and transitions



Section

Real world deployment

A command line interface

```
> # Hello RWC!
> # Let's do a demo
```

Recorded with
charmbracelet/vhs

Code on
cloudflare/plexi

A command line interface

```
> # Install Plexi
> cargo install plexi
    Updating crates.io index
     Ignored package `plexi v0.1.2` is already installed, use --force
to override
>
```

Recorded with
charmbracelet/vhs

Code on
cloudflare/plexi

A command line interface

```
> # List audited logs
> plexi ls --remote-url 'https://plexi.key-transparency.cloudflare.com
'
test.11092024
test.n1.cloudflare.plexi.example.com
test.whatsapp.key-transparency.v1
whatsapp.key-transparency.v1
>
```

Recorded with
charmbracelet/vhs

Code on
cloudflare/plexi

A command line interface

```
> # Audit the latest epoch
> plexi audit \
      --remote-url 'https://akd-auditor.cloudflare.com' \
      --namespace 'whatsapp.key-transparency.v1' \
       --long
Audit proof verification enabled. It can take a few seconds
.....
```

Recorded with
charmbracelet/vhs

Code on
cloudflare/plexi

A command line interface

```
Audit proof verification enabled. It can take a few seconds
......
Namespace
  Name                    : whatsapp.key-transparency.v1
  Ciphersuite             : ed25519(protobuf)

Signature (2025-03-21T16:57:41Z)
  Epoch height            : 1001282
  Epoch digest            : 5ebc1ef0b528acab3f6aa47fa7b728f8318dd751c87e
3eb18939546805e07475
  Signature               : 54595ddc6c20c04e2183cc6001268f692f6c52fc6e8e
acb05b5db08b142ae390f1d7c92c8bb55cebefb42097afda8e2037d1e8da78737dc9ea
968da13d6e5903
  Signature verification: success
  Proof verification      : success
>
```

Recorded with
charmbracelet/vhs

Code on
cloudflare/plexi

Section

CLOUDFLARE

WhatsApp

Real world deployment

... in reality

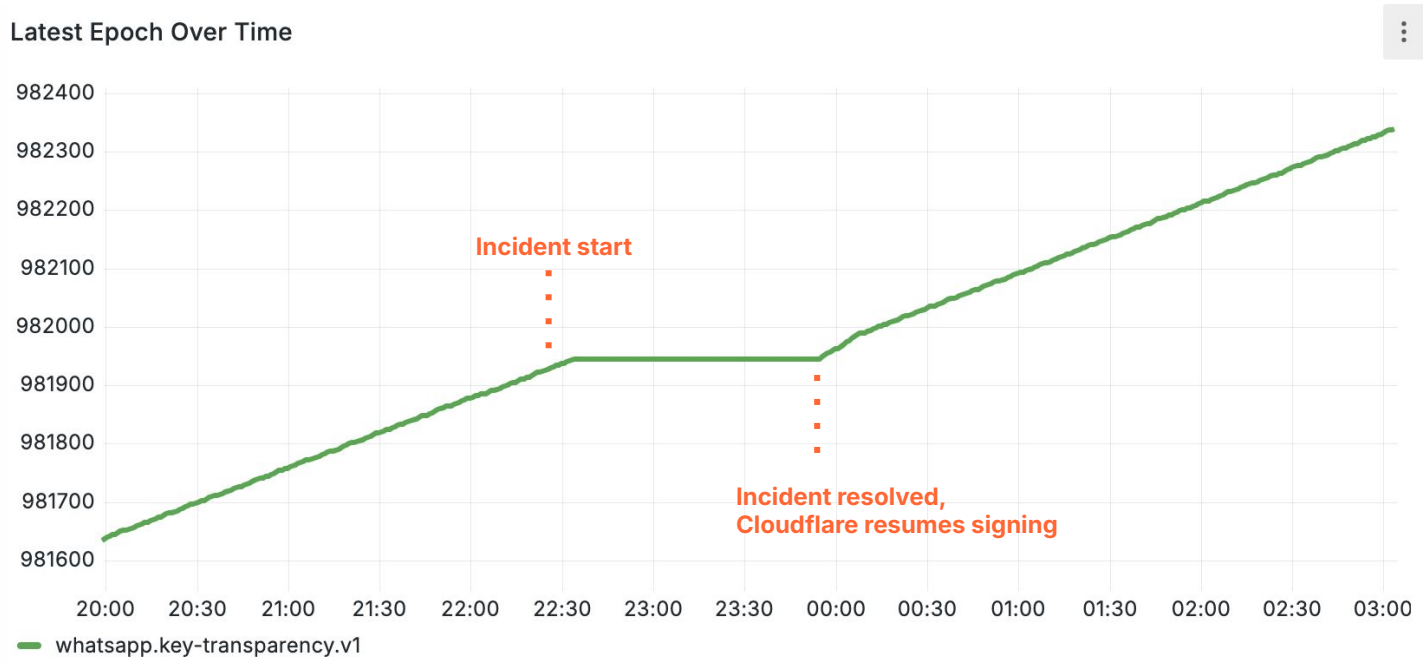
Incidents

Privacy Eng Pages App Fri 11:41 PM

Incident 1466211 triggered by Privacy Eng: 1 alert for Plexi Worker Production Epoch Not Increasing

38 replies Mon 11:04 AM

During an incident, epochs fail to progress



When epochs get bigger, verification latency increases

More incidents

Publishes every 30s

Theory

The Log publishes new heads.

Practice

When that failed, the backlog of updates grew, increasing the proof size 6x, going beyond our initial provisioning threshold.

Global ordering

Theory

Global ordering scales easily.

Practice

In practice, the auditor signs a timestamp. This means that it's hard to replay signatures.

Integrity

Theory

No party gets corrupted.

Practice

This is true! So far, both the Log and the Auditor managed to remain in a non-corrupted state, despite hiccups.

Section

What’s next

Transparency – a timeline

2013

Certificate Transparency

Google launches their first Certificate Transparency Log.

RFC 6962 published at the IETF.

2014

Keybase

End-to-end encrypted messaging app relying on signature chains.

2015

Key transparency paper

CONIKS introduces Key Transparency.

2017

Google Key Transparency

Inspired by CONIKS and Certificate Transparency.

2019

One more paper

SEEMLess formalises some of CONIKS designs and improves performance with a new data structure.

2023

Key Transparency Logs

Parakeet paper makes SEEMLess practical at scale.

iMessage, Proton, WhatsApp launch their Log.

IETF forms the keytrans working group.

2024

Public auditing

Cloudflare releases Plexi Auditor in collaboration with WhatsApp, the talk you are listening to.

2025+

More?

RFC, auditing network, adoption

Why there aren’t more auditors… yet!

Technical expertise

Key Transparency is new

There needs to be more expertise and understanding about the guarantees it provides with and without auditing.

Implementations

There are a lot

CONIKS, CT-based, AKD, tlog-based.

IETF keytrans is developing a standard.

Performance at scale

Real world is big

Scale makes the system more expensive to audit, or less performant than on a off-the-shelf device.

Where can I see / use it?

Key Transparency Dashboard GitHub

Last updated: 2025-03-20T12:34:12Z

Key Transparency aims to secure the distribution of public keys for end-to-end encrypted (E2EE) messaging systems, such as Whatsapp. It achieves this by building a verifiable append-only data structure called a Log, similar to Certificate Transparency.

Cloudflare verifies Key Transparency Logs to ensure the transparency of end-to-end encrypted messaging public keys. This component is called an Auditor. Cloudflare provides an API for anyone to monitor the work of the Auditor, and verify the state of its associated Logs locally. This local validation can be done with cloudflare/plexi cli for instance.

Log status

Name	Status	Updated
WhatsApp	Online 🟢	2025-03-20T12:34:10Z

Log list

WhatsApp

Status: Online 🟢

Last update: 2025-03-20T12:34:10Z

Latest epoch: 997875 ↗

Root: 458298/3ae9497069cc722dc9e00f8251da87071646a57dae2fc7882f1d8214961d80bd ↗

Log name: whatsapp.key-transparency.v1

README | Code of conduct | Apache-2.0 license | Security

Plexi

Plexi is a flexible auditor for Key Transparency systems.

Tables of Content

- Features
- Installation
- Usage

🔑 dash.key-transparency.cloudflare.com

🦀 github.com/cloudflare/plexi

Towards a transparency ecosystem

Key Transparency Dashboard GitHub

Log list

WhatsApp

Status: Online 🟢

Last update: 2025-03-20T10:45:20Z

Latest epoch: 997875 ↗

Root: 458298/3ae9497069cc722dc9e00f8251da87071646a57dae2fc7882f1d8214961d80bd ↗

Log name: whatsapp.key-transparency.v1

✨ **Your app here** ✨

Status: Online 🟢

Last update: 2025-03-20T12:34:10Z

Latest epoch: 997875 ↗

Root: 458298/3ae9497069cc722dc9e00f8251da87071646a57dae2fc7882f1d8214961d80bd ↗

Log name: my-e2ee-messenger.key-transparency.v1

Thank you

blog.cloudflare.com

engineering.fb.com

Section

Backup slides

Key Transparency Tradeoffs

Active vs Passive

Active: Users report to a 3rd party/gossip
Passive: 3rd party signature

Sync vs Async

Sync: 3rd party is on-path for publishing
Async: Delayed detection

Human vs Automated

WhatsApp can prompt for confirmation
Automated systems have no direct interventions

Two signatures

The witness provides a sync signature.
The monitor does an async signature.
They have the same format but not the same public key.

Auditor endpoint

No endpoint: lightweight auditor
Endpoint: more accountability and trust

Frequency

The faster you publish epochs, the smaller the epochs, but the more availability you need.

Multiple papers and deployment

CONIKS: Bringing Key Transparency to End Users

Marcela S. Melara and Aaron Blankstein, *Princeton University;* Joseph Bonneau, *Stanford University and The Electronic Frontier Foundation;* Edward W. Felten and Michael J. Freedman, *Princeton University*

https://www.usenix.org/conference/usenixsecurity15/technical-sessions/presentation/melara

SEEM*less*: Secure End-to-End Encrypted Messaging with *less* Trust

Parakeet: Practical Key Transparency for End-to-End Encrypted Messaging

Harjasleen Malvai*†, Lefteris Kokoris-Kogias‡§, Alberto Sonnino‡¶, Esha Ghosh‖, Ercan Oztürk**, Kevin Lewi**, and Sean Lawlor**
*UIUC, †IC3, ‡Mysten Labs, §IST Austria, ¶University College London (UCL), ‖Microsoft Research, **Meta

OPTIKS: An Optimized Key Transparency System

Julia Len, *Cornell Tech;* Melissa Chase, Esha Ghosh, Kim Laine, and Radames Cruz Moreno, *Microsoft Research*

https://www.usenix.org/conference/usenixsecurity24/presentation/len

ELEKTRA: Efficient Lightweight multi-dEvice Key TRAnsparency*

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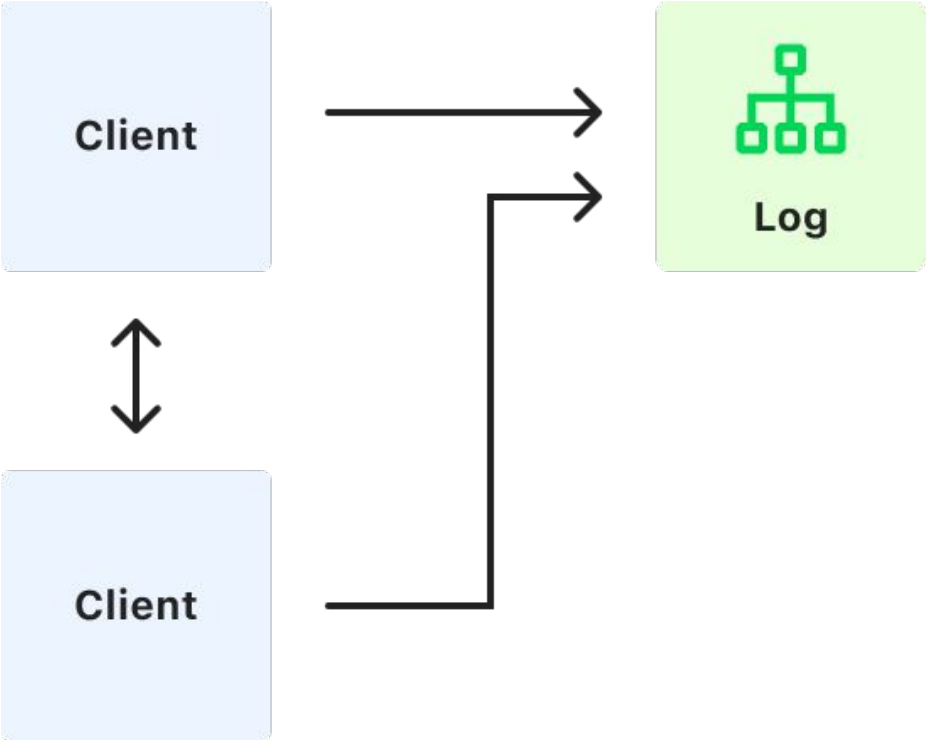
Gossip



The Log is corrupted, now what

1. Users update are stale
2. Restore from backups
3. Start from a last known good state, or from scratch
4. Discuss with the auditor, will need to provision a new namespace
5. Communicate about it
6. Cut a new release of WhatsApp