Certificate Transparency

Supporting Critical Internet Infrastructure

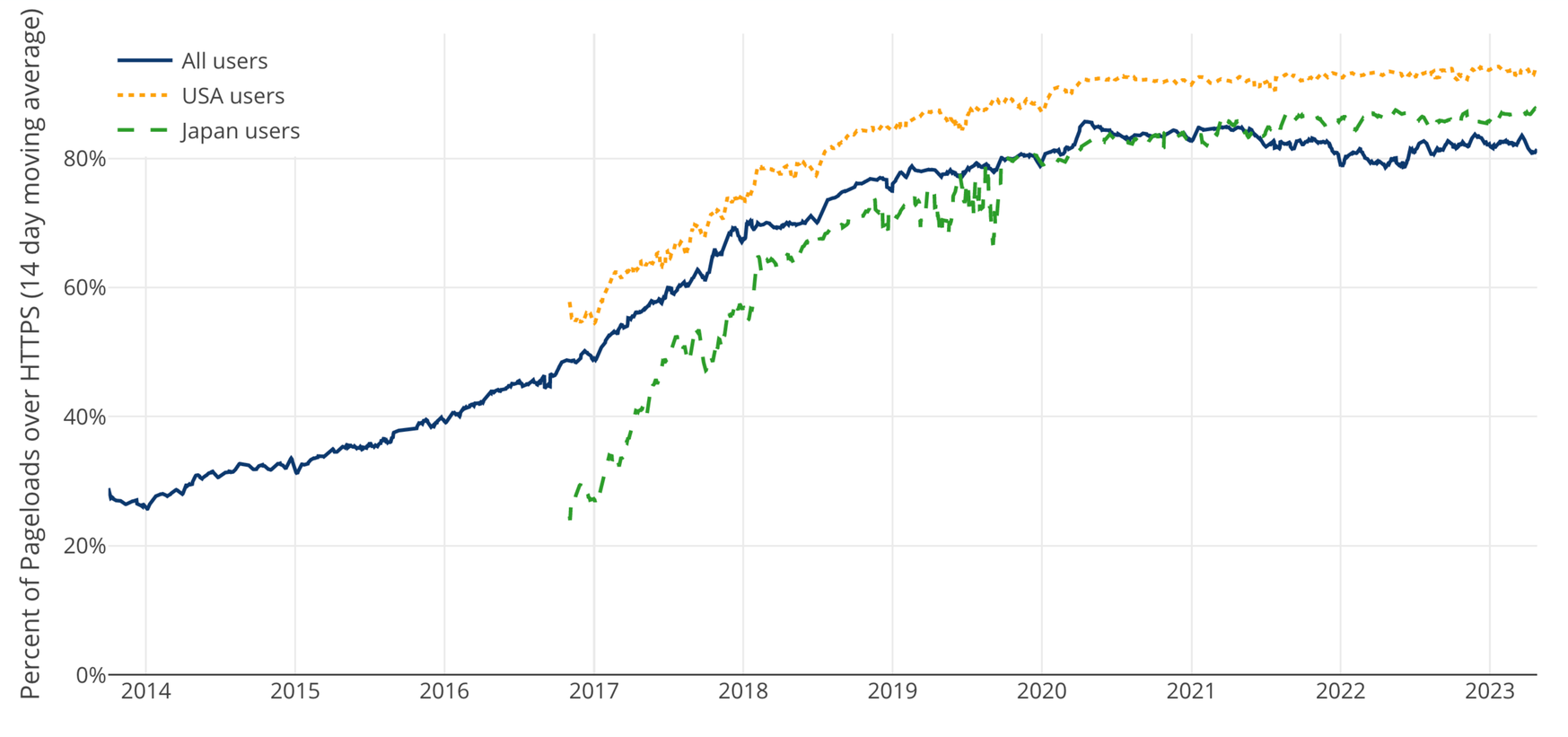
certificate.transparency.dev

Brought to you by:

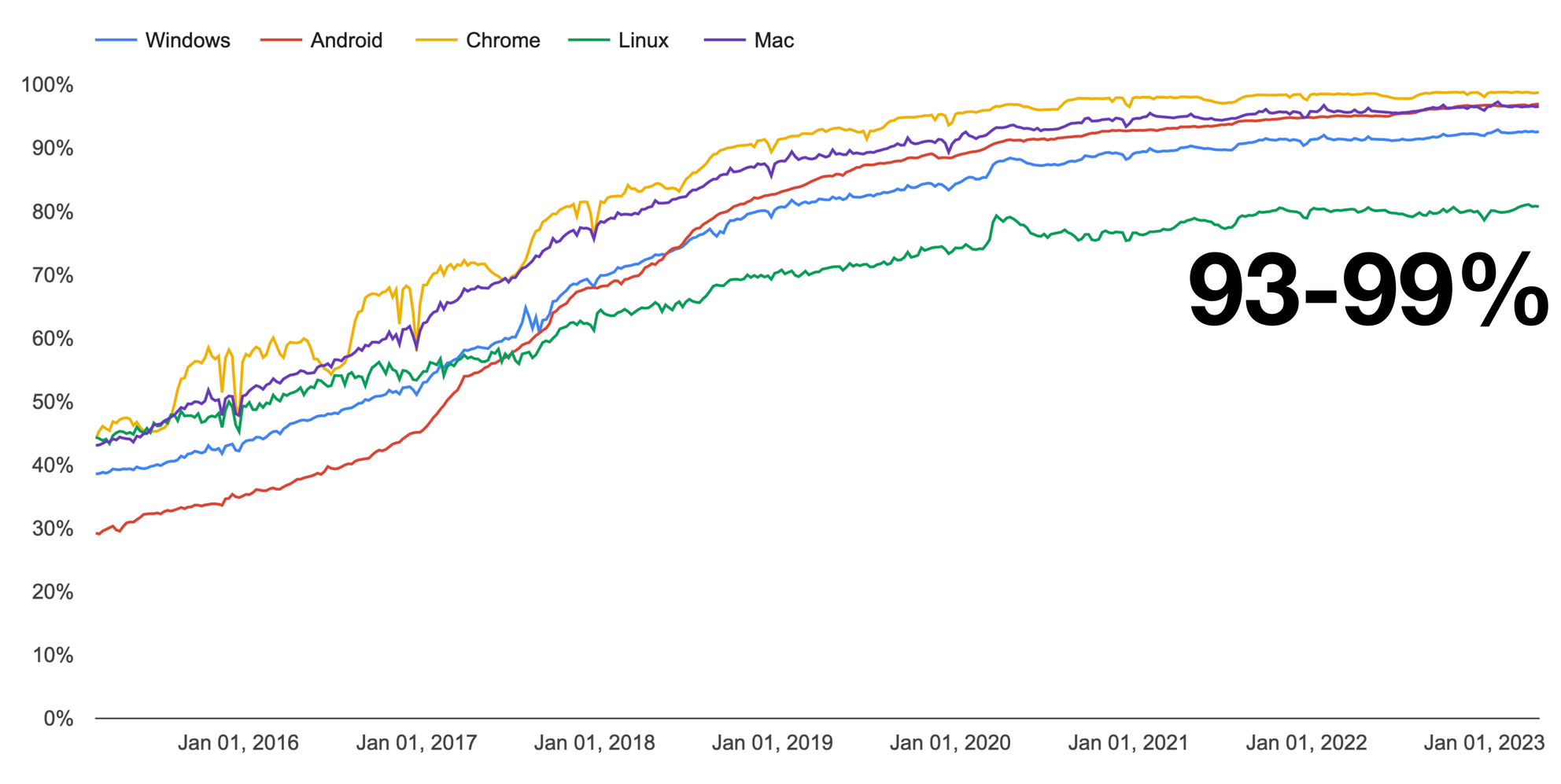
Let's Encrypt

HTTP

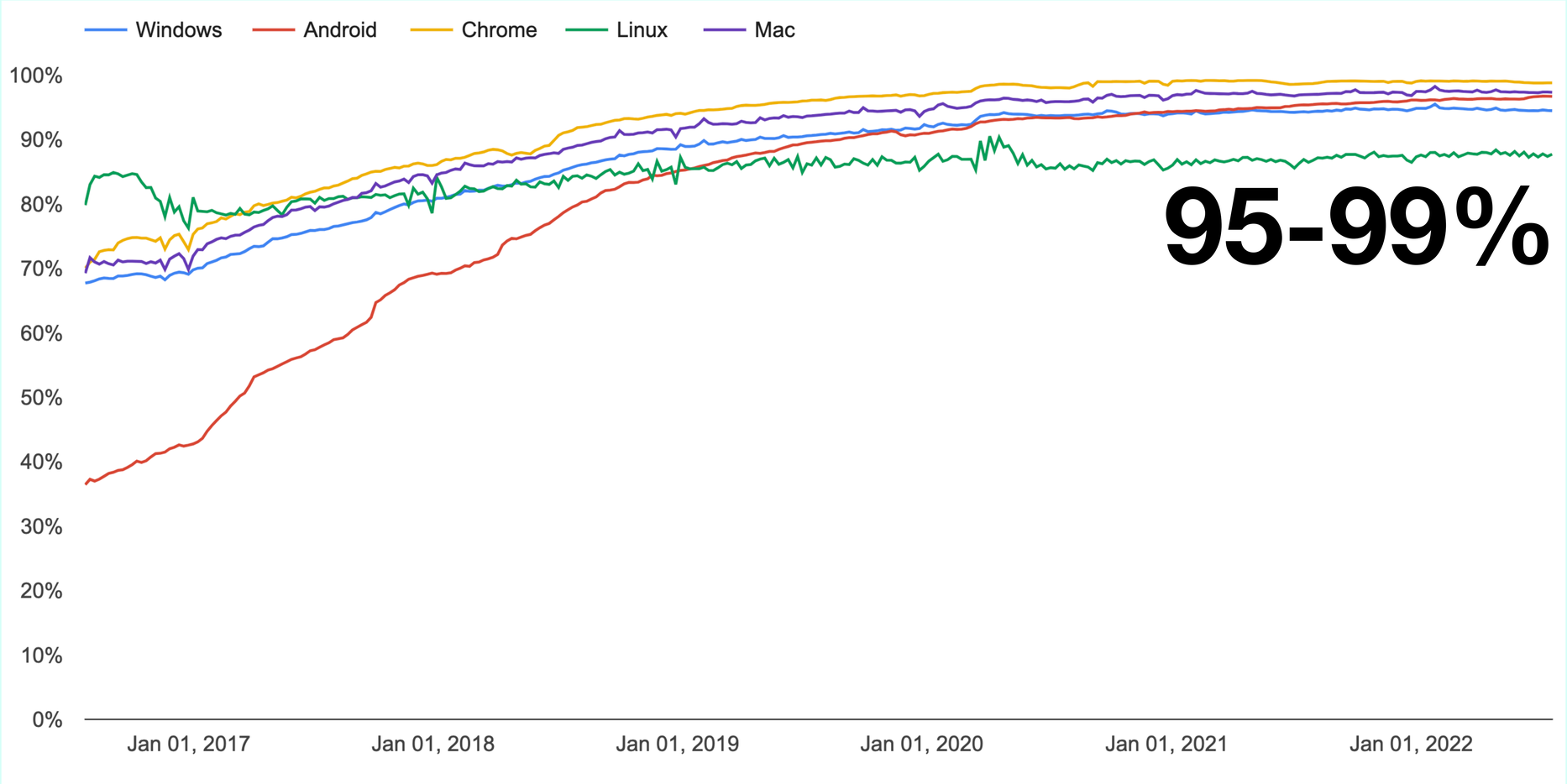
HTTPS



Percentage of Web Pages Loaded by Firefox Using HTTPS
Source: Mozilla

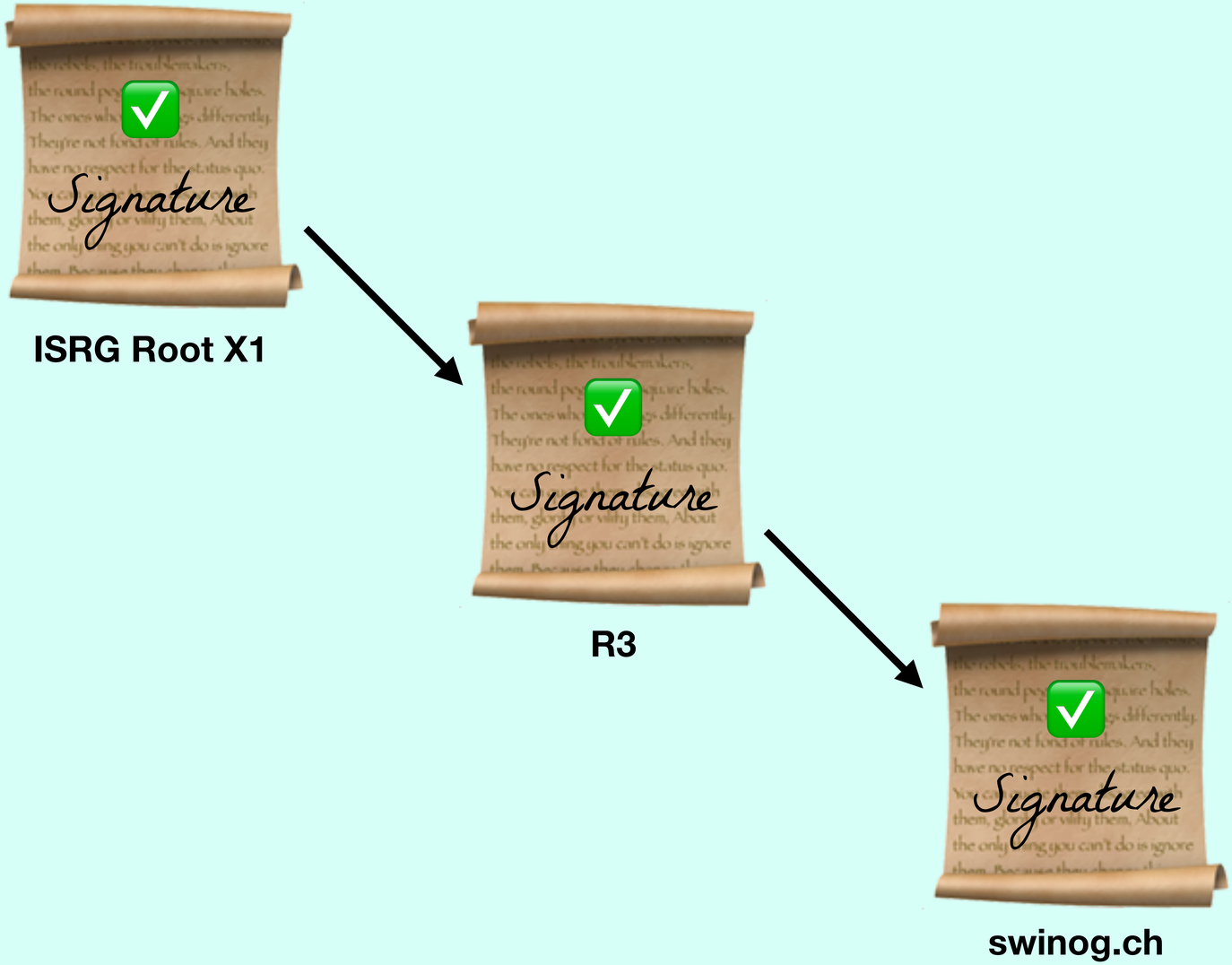


Chrome page loads over HTTPS (with TLS)
Source: Google



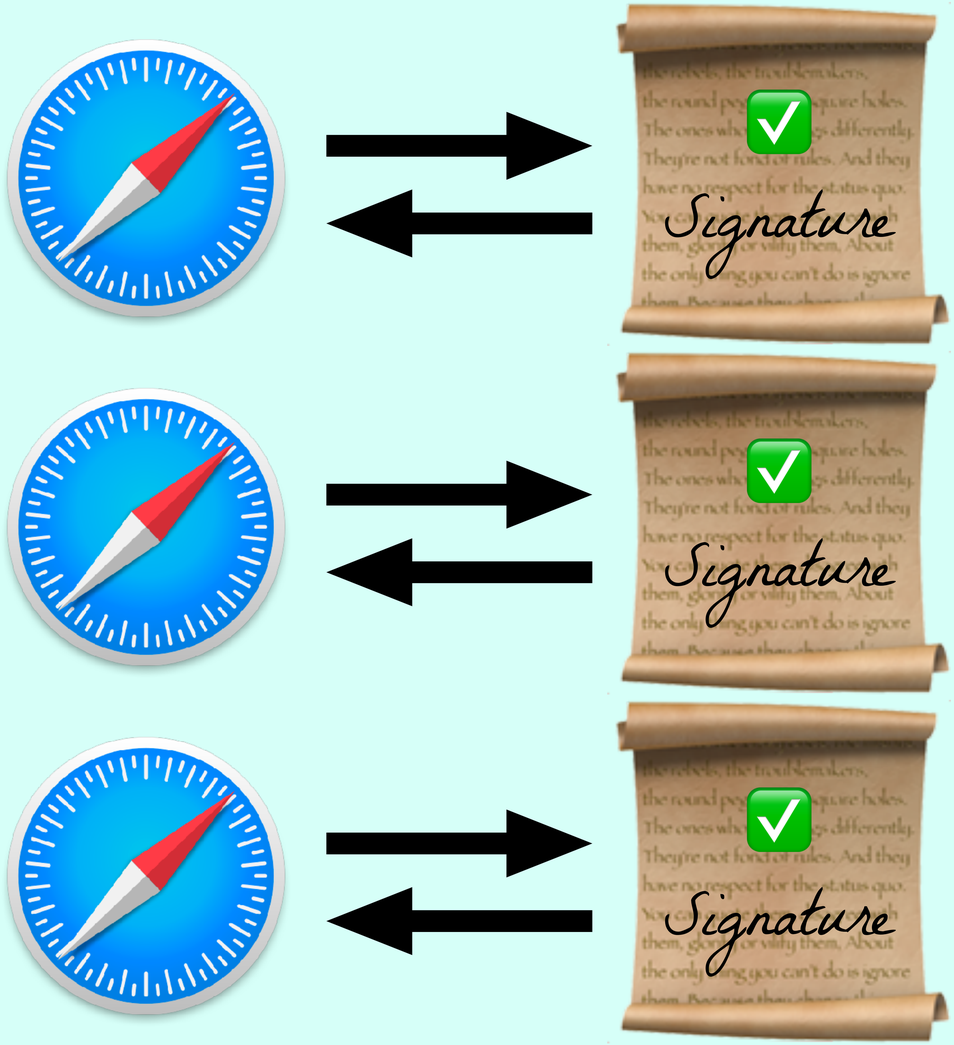
Chrome browsing time over HTTPS (with TLS)
Source: Google

TLS


Signature
ISRG Root X1
Signature
R3
Signature
swinog.ch

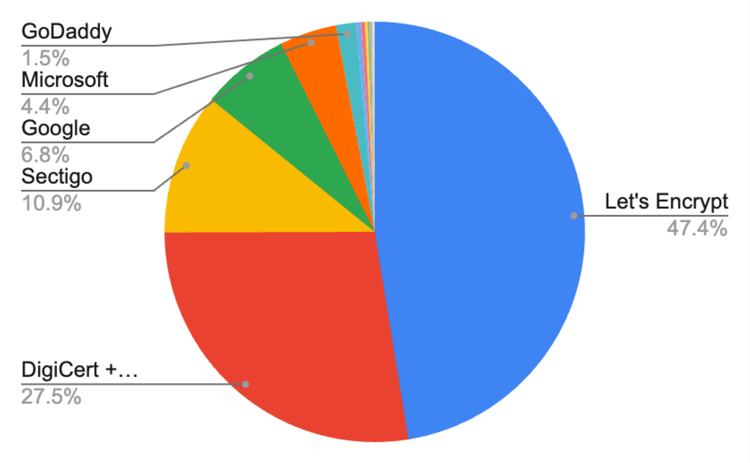
WebPKI

RPKI vs WebPKI

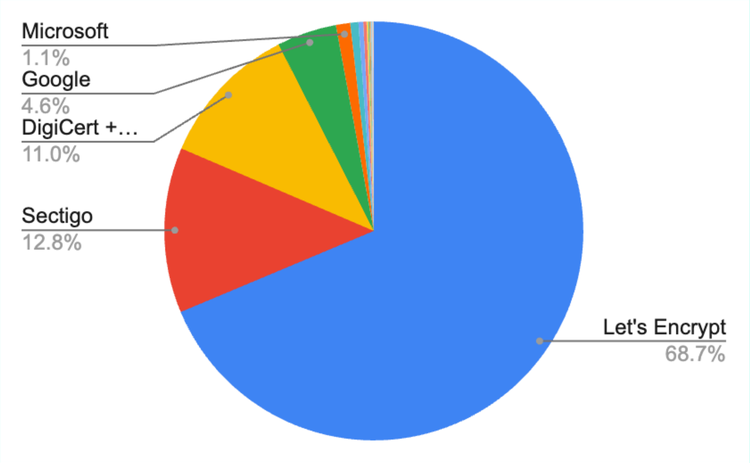


WebPKI Size

- Over 4.8 **B**illion Certificates stored
  - Over 0.5 Billion Active / Unexpired
- Over 250,000 new certificates per hour



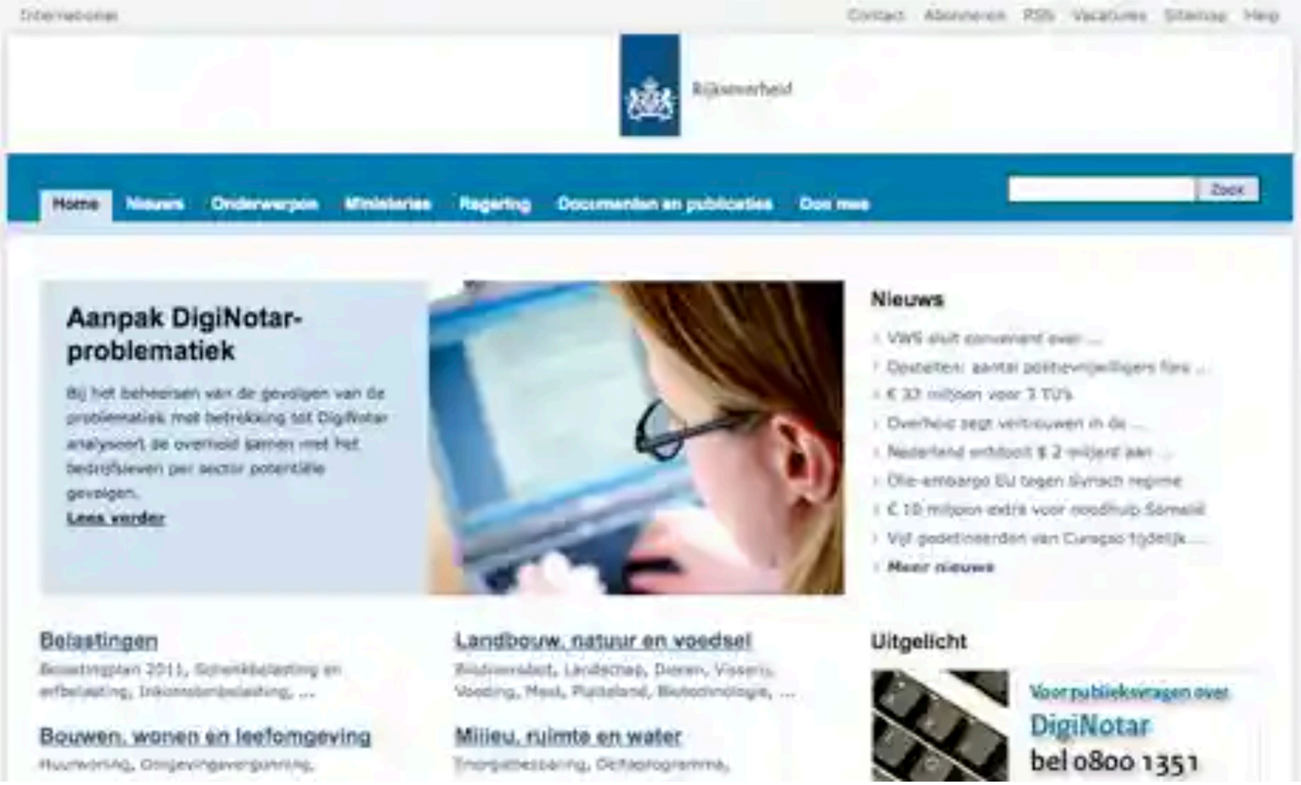
Currently Active / Unexpired



Total collected

DigiNotar SSL certificate hack amounts to cyberwar, says expert

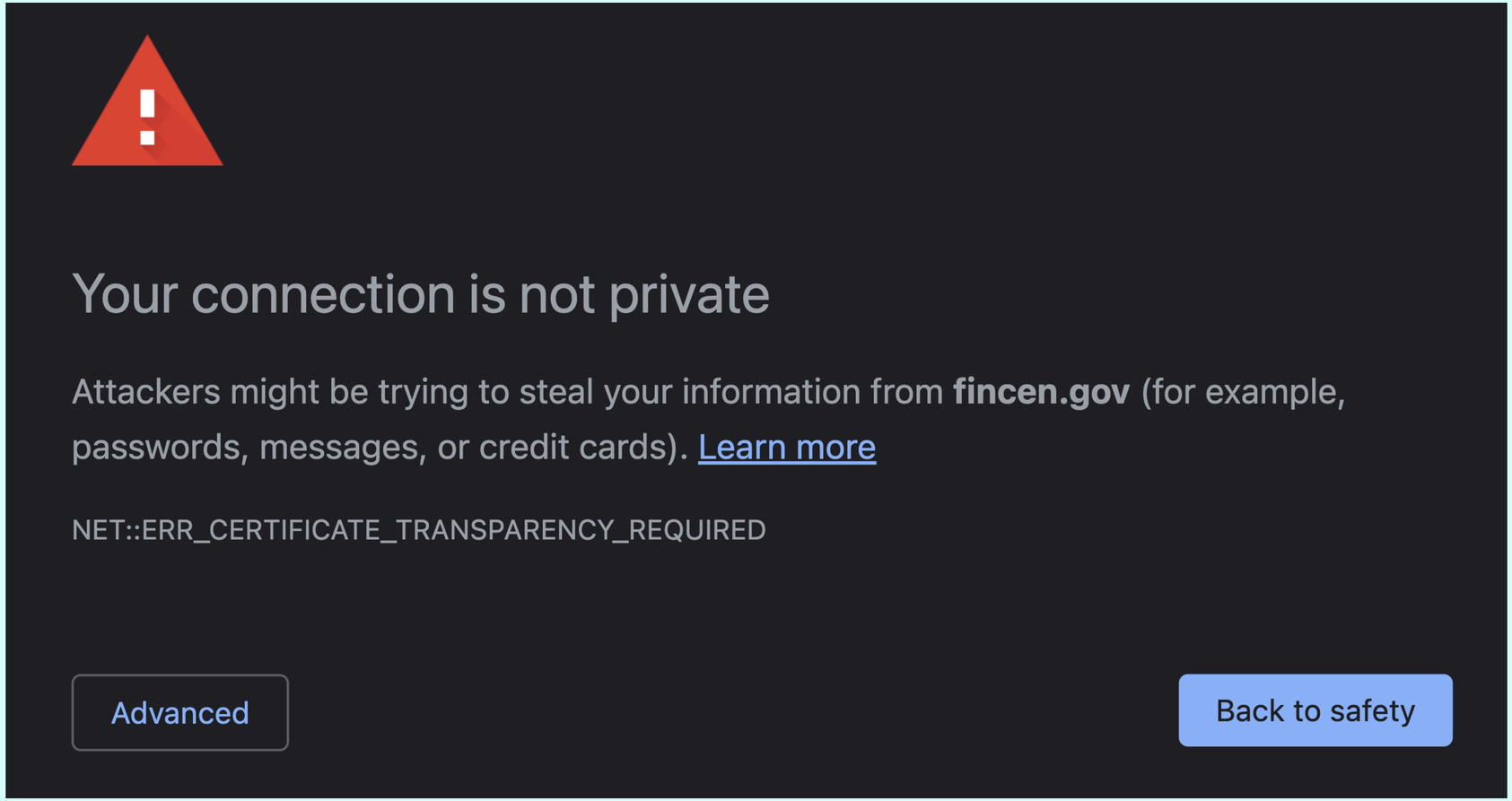
Dutch government revokes certificates used for all its secure online transactions, while CIA, Google, Microsoft and others affected by hack called 'worse than Stuxnet'



The Dutch government has revoked all trust in digital certificates issued by DigiNotar

Certificate Transparency

CT Log


Your connection is not private
Attackers might be trying to steal your information from fincen.gov (for example, passwords, messages, or credit cards). Learn more
NET::ERR_CERTIFICATE_TRANSPARENCY_REQUIRED
Advanced
Back to safety

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TRUSTAsia

Google

SECTIGO®

Phil, what does it take to operate one of these?

Operating CT Logs

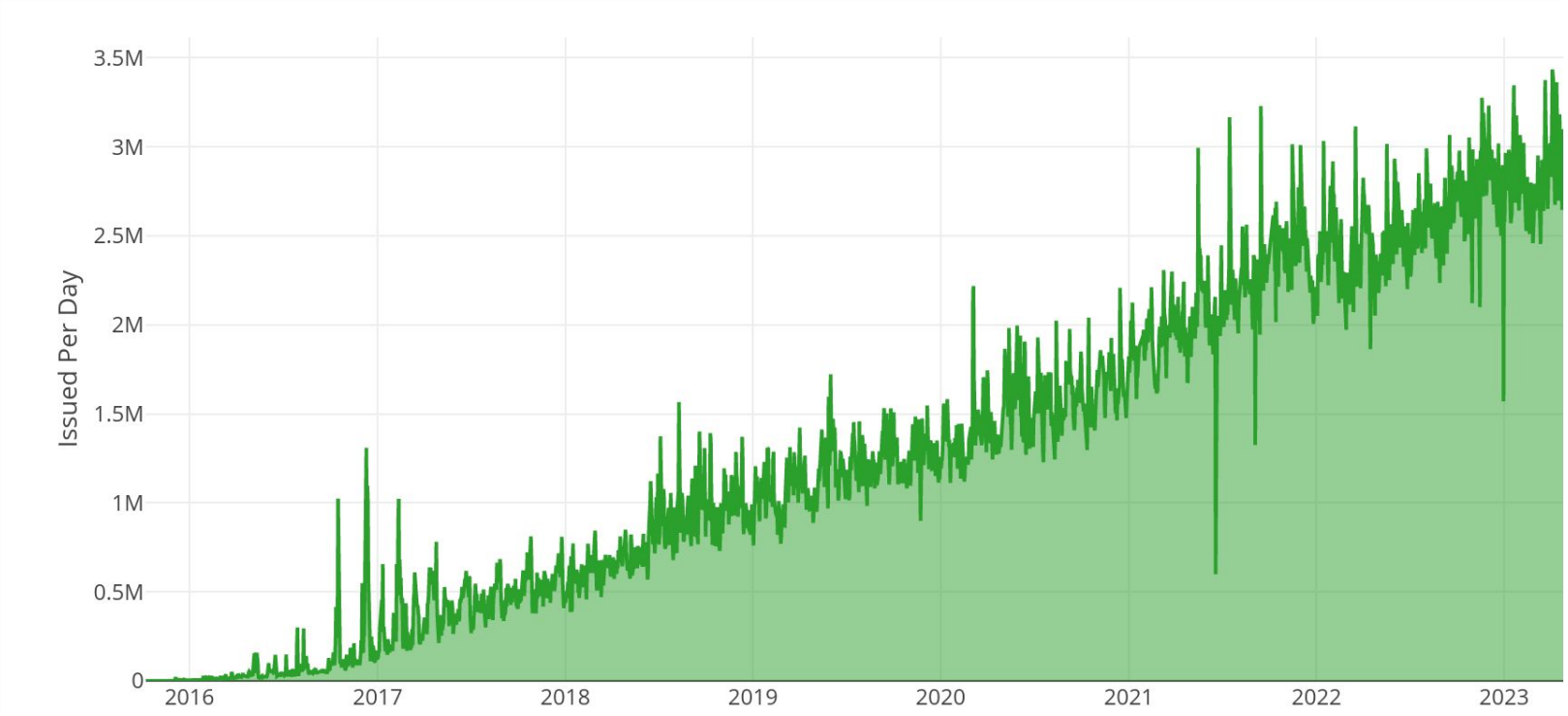
Wins and Woes

Who am I?

- phil@letsencrypt.org
- github.com/pgporada
- linkedin.com/in/philporada

What is Let's Encrypt?

Let's Encrypt Certificates Issued Per Day



Blogs we've written about CT

2019

Introducing Oak, a Free and Open Certificate Transparency Log

https://letsencrypt.org/2019/05/15/introducing-oak-ct-log.html

How Let's Encrypt Runs CT Logs

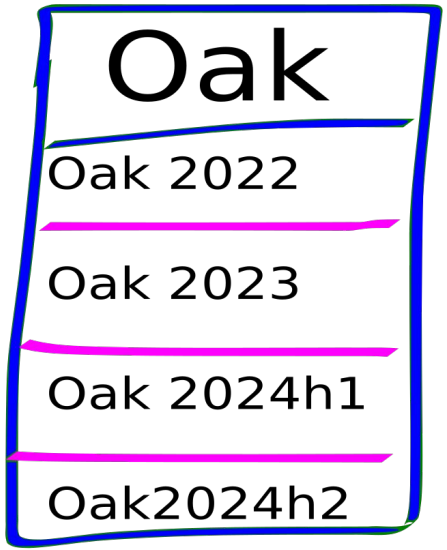
https://letsencrypt.org/2019/11/20/how-le-runs-ct-logs.html

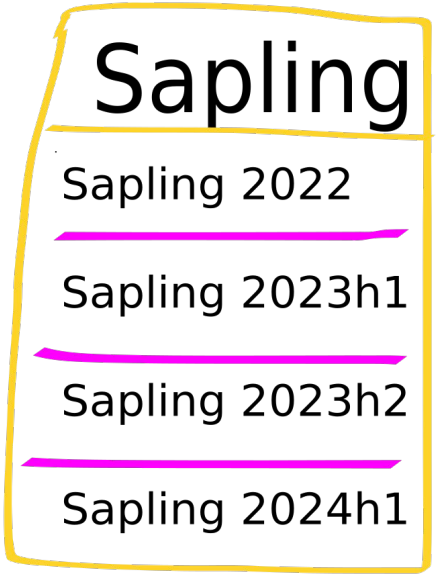
2022

Nurturing Continued Growth of Our Oak CT Log

https://letsencrypt.org/2022/05/19/nurturing-ct-log-growth.html

Logs? Shards? Oh my!



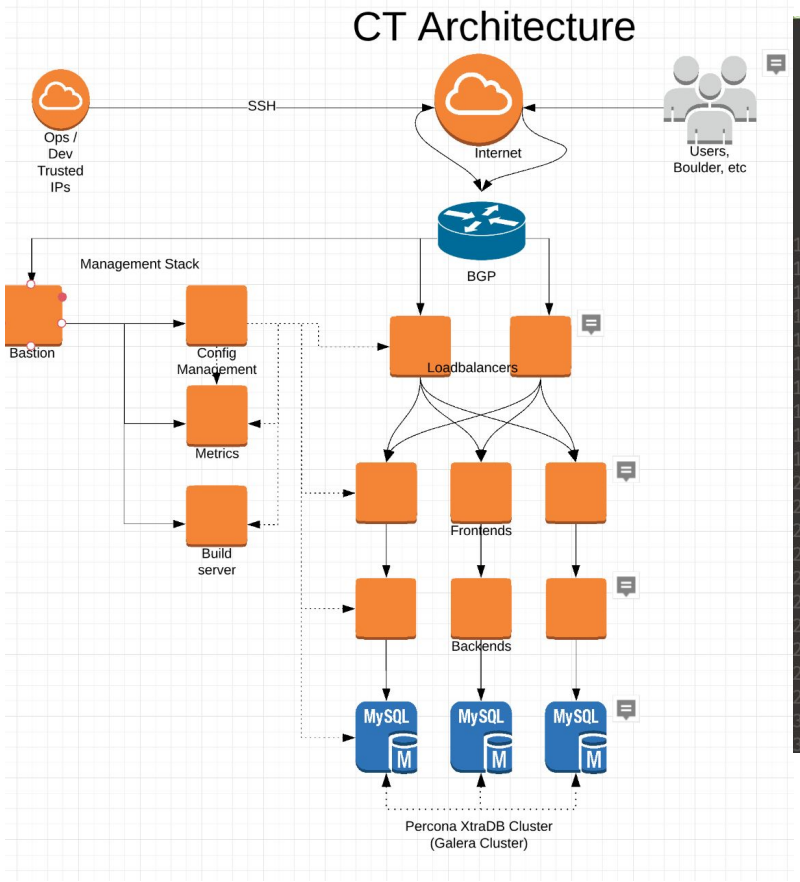


How does a CT log benefit a CA?

Embedded SCTs

Log ID	B7:3E:FB:24:DF:9C:4D:BA:75:F2:39:C5:BA:58:F4:6C:5D:FC:42:CF:7A:9F:35:C4:9E:1D:0...
Name	Let's Encrypt Oak 2023
Signature Algorithm	SHA-256 ECDSA
Version	1
Timestamp	Thu, 01 Jun 2023 23:20:23 GMT
Log ID	7A:32:8C:54:D8:B7:2D:B6:20:EA:38:E0:52:1E:E9:84:16:70:32:13:85:4D:3B:D2:2B:C1:3...
Name	Cloudflare “Nimbus2023”
Signature Algorithm	SHA-256 ECDSA
Version	1
Timestamp	Thu, 01 Jun 2023 23:20:23 GMT

Initial Failed Architectures




```
galera:
  # Path to Galera library
  wsrep_provider: /usr/lib64/galera3/libgalera_smm.so

  # Cluster connection URL contains IPs of nodes
  # If no IP is found, this implies that a new cluster needs to be created,
  # in order to do that you need to bootstrap this node
  wsrep_cluster_address: gcomm://10.88.162.21,10.88.162.23,10.88.162.29

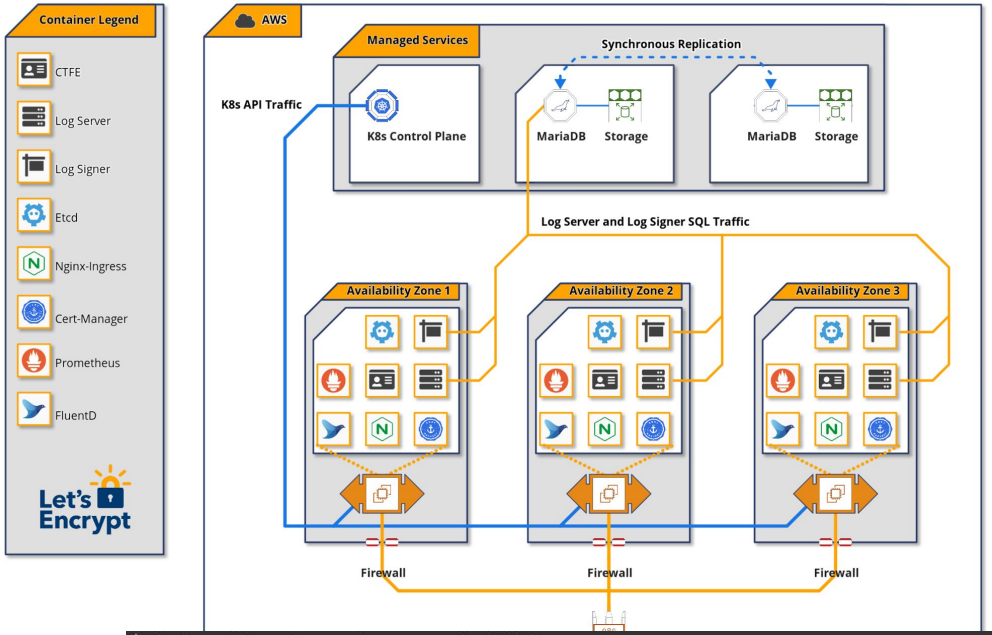
  # In order for Galera to work correctly binlog format should be ROW
  binlog_format: ROW
  default_storage_engine: InnoDB
  wsrep_slave_threads: 8
  wsrep_log_conflicts: NO_VAL

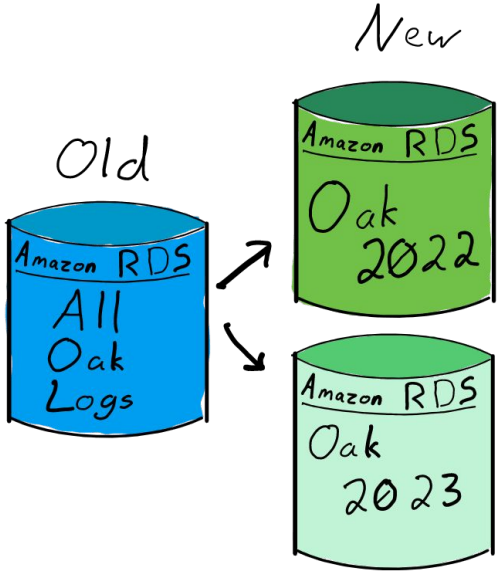
  # This changes how InnoDB autoincrement locks are managed and is a requirement for Galera
  innodb_autoinc_lock_mode: 2

  wsrep_node_address: {{ salt['grains.get']('ipv4')[0] }}
  wsrep_cluster_name: birch_ct
  wsrep_on: ON
  pxc_strict_mode: ENFORCING
  wsrep_sst_method: xtrabackup-v2

  # Encrypted as sstuser:GENERATEDPASSWORD
  wsrep_sst_auth: |
    -----BEGIN PGP MESSAGE-----
    -----END PGP MESSAGE-----
  skip_external_locking: NO_VAL
  wsrep_retry_autocommit: 5
  wsrep_sst_donor: birch-db-99
```

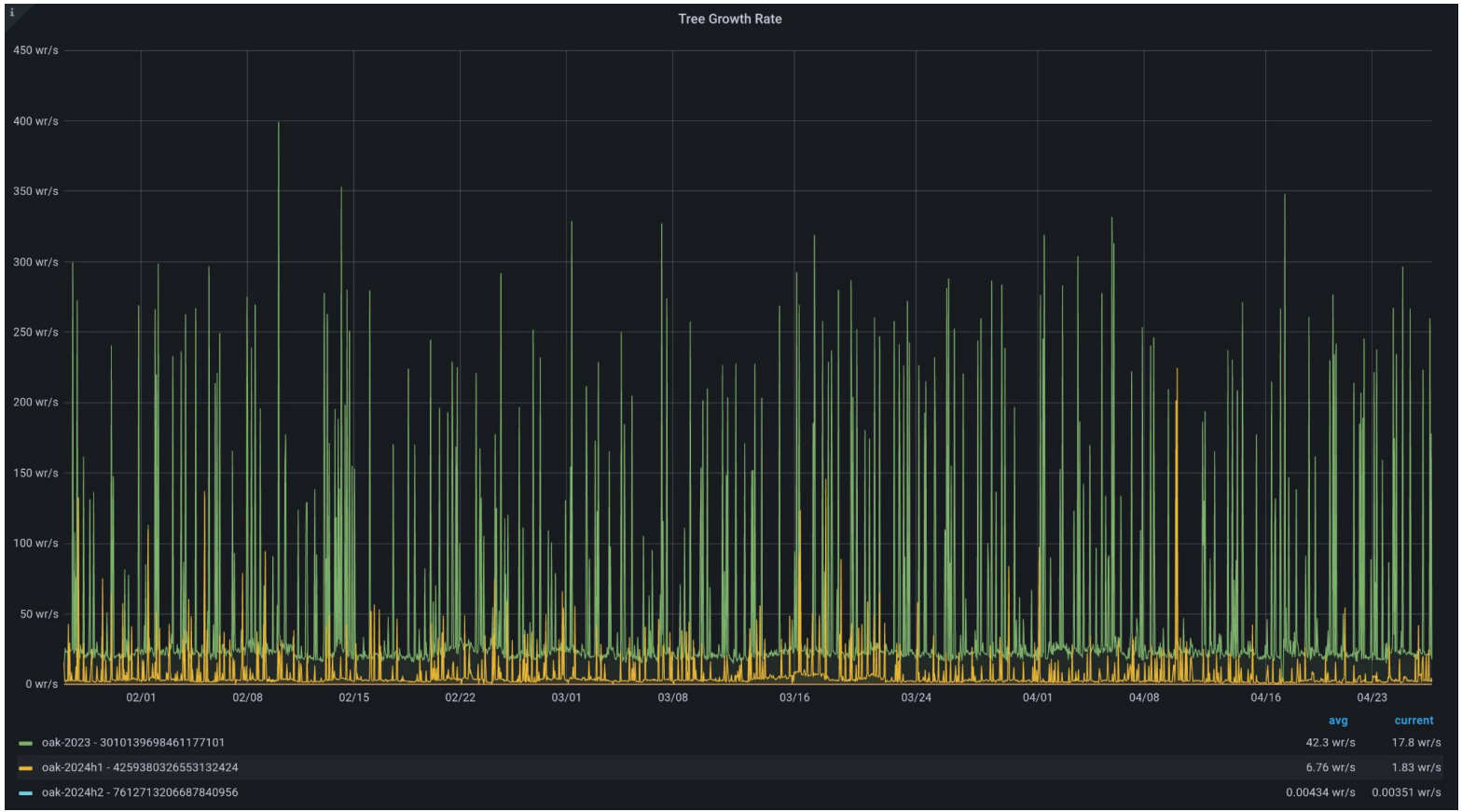
Current Functioning Architecture



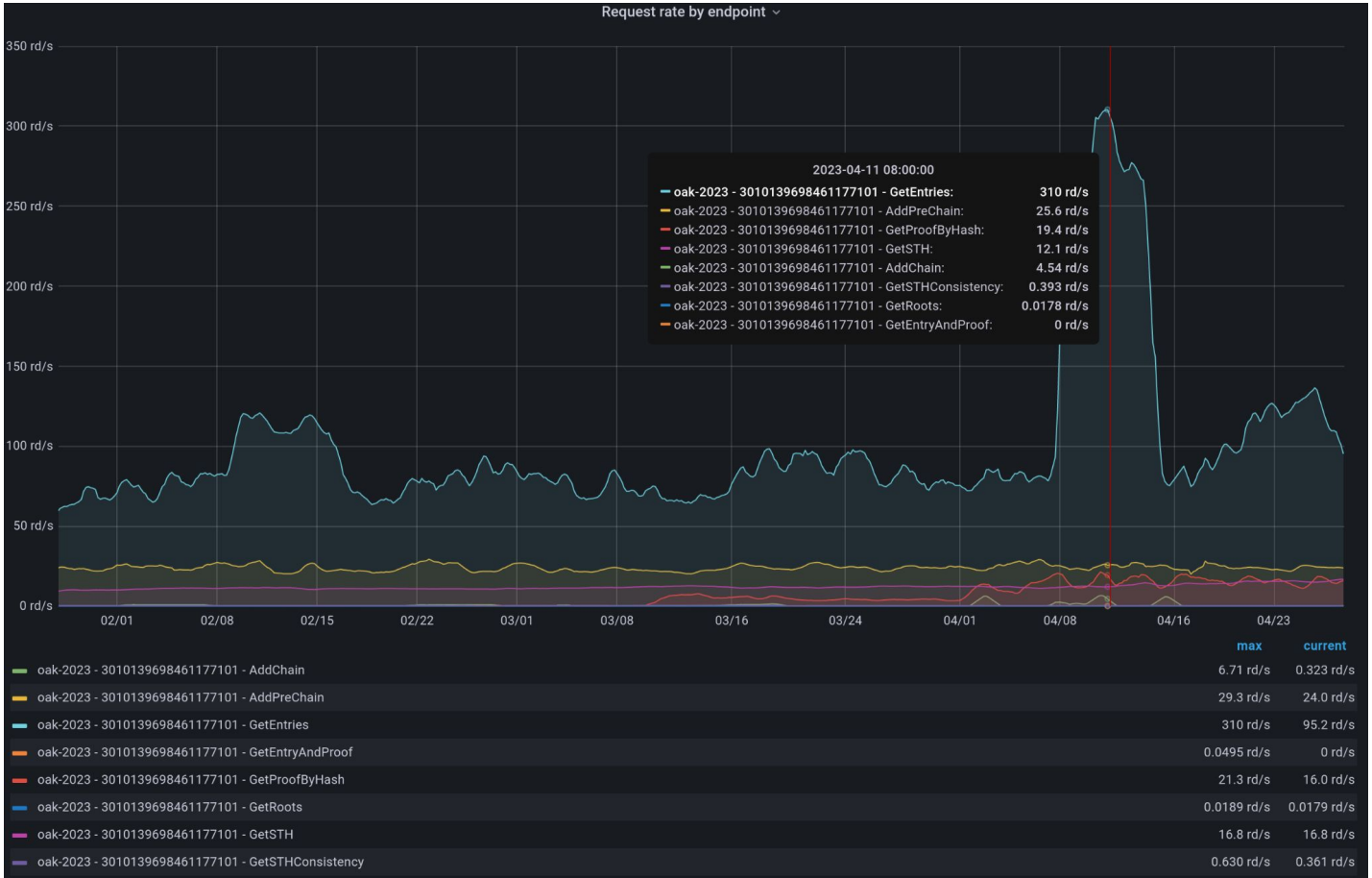



```
$ kubectl get pods -n oak-2023
NAME                                                          READY   STATUS    RESTARTS        AGE
oak-2023-etcd-operator-etcd-operator-etcd-operator-77968f6j66vs   1/1     Running   0               42m
prometheus-mysqld-exporter-deployment-65c58775f7-sp2kn        1/1     Running   2 (147d ago)    351d
trillian-ctfe-deployment-6fc9cff9d6-8f2nq                     1/1     Running   0               15md
trillian-ctfe-deployment-6fc9cff9d6-f4rjw                     1/1     Running   0               42m
trillian-etcd-cluster-jrfm7b4nqp                              1/1     Running   0               351d
trillian-etcd-cluster-n8fjkfpht8                              1/1     Running   0               41m
trillian-etcd-cluster-pld2rzj8q8                              1/1     Running   0               90d
trillian-logserver-deployment-785d5c444d-b5kd8                1/1     Running   0               21d
trillian-logserver-deployment-785d5c444d-qpj9v                1/1     Running   0               21d
trillian-logsigner-deployment-d68cc6bf7-fnmvl                 1/1     Running   0               21d
```

Tree Growth Rate

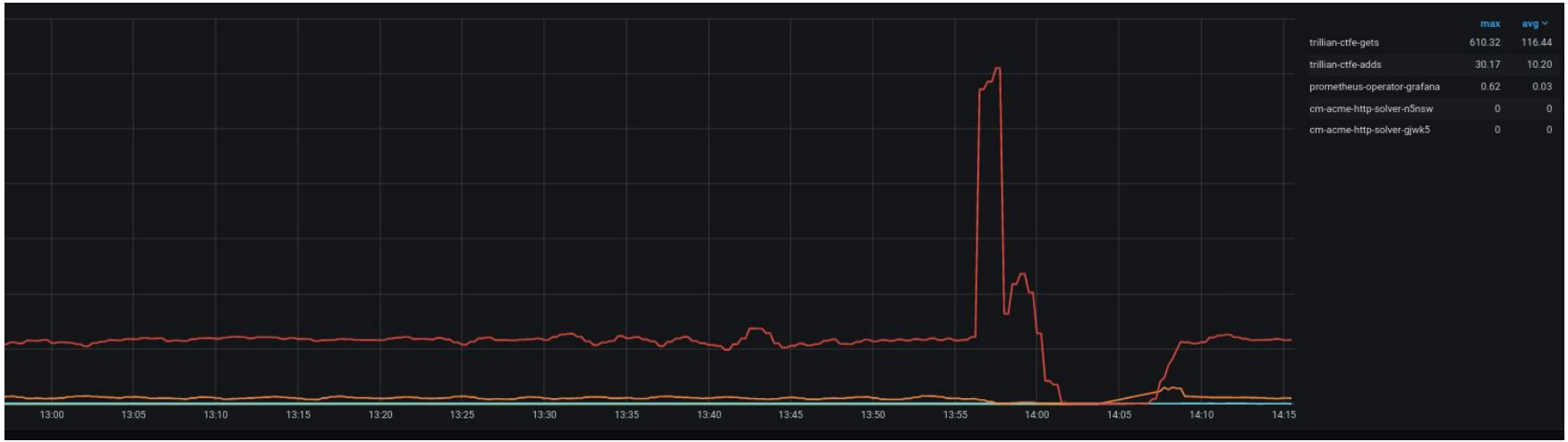


Request rate by endpoint



A Fun Incident

```
"log":"W0808 19:22:35.000186       1 tree_storage.go:81] Failed to set strict mode on mysql db: commands
out of sync. Did you run multiple statements at once?",
```



Error reproduction: github.com/koshatul/go-mysql-sync-issue

Cost of running our CT logs

Human

- 1 - 2x SREs spending ~3 months worth of time over the course of a year

Compute

- Compute nodes are basically commodity hardware.
- Storage and RAM for compute nodes is also negligible. Just enough to run applications.

Database

- This will be your pain point. Horizontal scaling continues to be the solution, and is straightforward to apply
- Faster storage will give better log performance to a point when data is read from disk.

Lessons Learned and Takeaways

- Have a testing log so you don't prematurely ruin your production log.
- Logs are ephemeral. When your log fails, root cause why and build a new better log with the lessons learned.
- ```
  sql> SET GLOBAL event_scheduler=ON;
  sql> CREATE EVENT analyze_subtree ON SCHEDULE EVERY 1 DAY DO ANALYZE TABLE Subtree;
  ```
- Separation of concerns: run each binary in a different container, VM, or physical host. You're after reliability.
- The log_signers (sequencers) perform an etcd election to determine which cluster member will communicate with the database. Make an alert if more than 1 cluster member has mastership for a particular shard because it will indicate a split brain scenario and cause an incident. We've been there.
- Build a rate limiting story to protect your log.
- We don't run database backups for CT logs.
- More automation is better than less. That's why we put our logs in Kubernetes.
  ```

Cool!

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We need more CT Logs!

Setting up a CT Log

- Apple & Google have guidelines & requirements
- You can apply like this for consideration
- You can join the community mailing list

You’re not alone!

Use the mailing list, or feel free to contact morectlogs@daknob.net for discussion, help, insights, advice, or anything we can do at any phase of the project :)