Serving Wikipedia with ATS

ATS Summit Sunnyvale, California

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Traffic Server is now being used to serve Wikipedia

Outline

- Introduction to Wikimedia Foundation
- Old CDN Architecture with Varnish
- New CDN Architecture with ATS
- Work done
- Conclusions

Wikimedia Foundation

Wikimedia Foundation

- Non-profit organization focusing on free, open-content, wiki-based Internet projects
- No ads, no VC money
- Entirely funded by small donors
- 350 employees (of which 33 SRE and 80 SWE)

The Wikimedia Family

WIKIPEDIA
The Free Encyclopedia

Wiktionary
The free dictionary

Wikiquote

WIKIBOOKS

WIKISOURCE

WIKINEWS

WIKISPECIES
free species directory

WIKIDATA

WIKIVERSITY

MediaWiki

WIKIMEDIA
COMMONS

wiki
voyage

WIKIMEDIA
FOUNDATION

Why our own CDN?

- Autonomy
- Privacy
- Risk of censorship

Traffic Volume

- Average: ~100k rps, peaks: ~140k rps
- Can handle more for large-scale DDoS attacks

DDoS Example

Source: jimieye from flickr.com (CC BY 2.0)

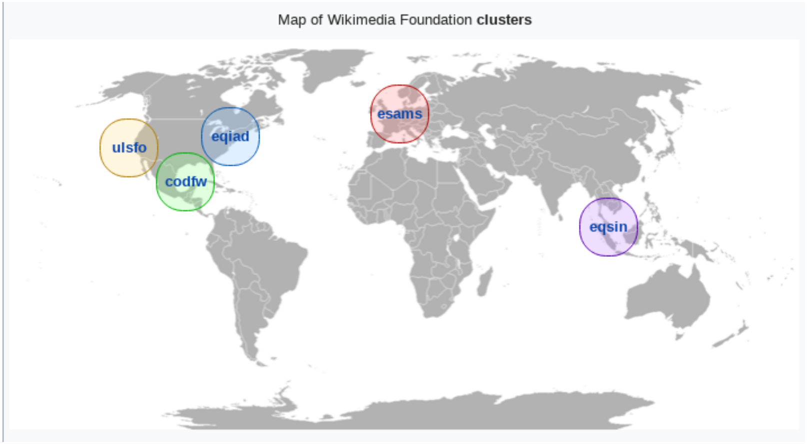
Values

- Deeply rooted in the free culture and free software movements
- Infrastructure built exclusively with free and open-source components
- Design and build in the open, together with volunteers

Build In The Open

- github.com/wikimedia
- gerrit.wikimedia.org
- phabricator.wikimedia.org
- wikitech.wikimedia.org
- grafana.wikimedia.org

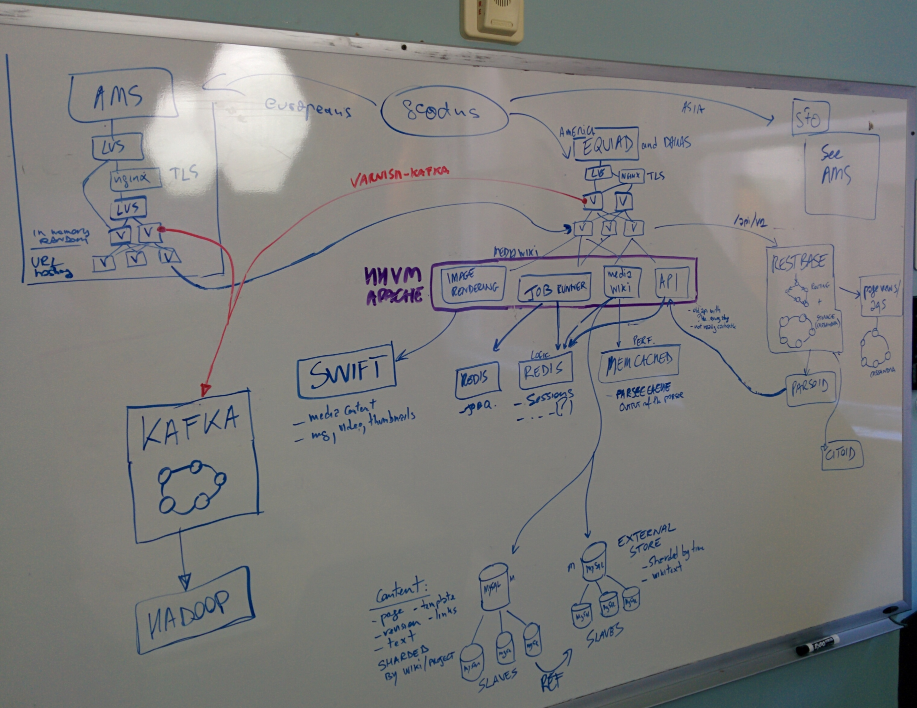
Cluster Map



eqiad: Ashburn, Virginia - cp10xx
codfw: Dallas, Texas - cp20xx
esams: Amsterdam, Netherlands - cp30xx
ulsfo: San Francisco, California - cp40xx
eqsin: Singapore - cp50xx

A day in the life of an HTTP request

- ~~Geographic DNS Routing~~
- L4 Load Balancing
- ~~TCP connection establishment~~
- ~~TLS Termination~~
- HTTP Caching
- L7 Load Balancing


AMS
europeans
8codus
ASIA
sfo
America
EQIAD and DALLAS
See AMS
LVS
nginx TLS
LVS
in memory RANDOM
URL hashing
V
VARNISH-KAFKA
LB
NGINX TLS
/api/v2
mediawiki
HHVM APACHE
IMAGE RENDERING
JOB RUNNER
media wiki
API
- old api with ?blah... query string
- not really cacheable
RESTBASE
ROUTING
+
STORAGE (CASSANDRA)
page views/ 2qs
CASSANDRA
SWIFT
- media content
- img, video, thumbnails
REDIS
- JOBQ.
LOGIC
REDIS
- Sessions
- . . . (?)
PERF.
MEMCACHED
- PARSER CACHE
output of the parser
PARSOID
CITOID
KAFKA
HADOOP
Content:
- page - template
- revision - links
- text
SHARDED BY WIKI/PROJECT
MySQL M
MySQL
SLAVES
REF
EXTERNAL STORE
- Sharded by time
- wikitext
m MySQL
SLAVES

Old CDN (Varnish)

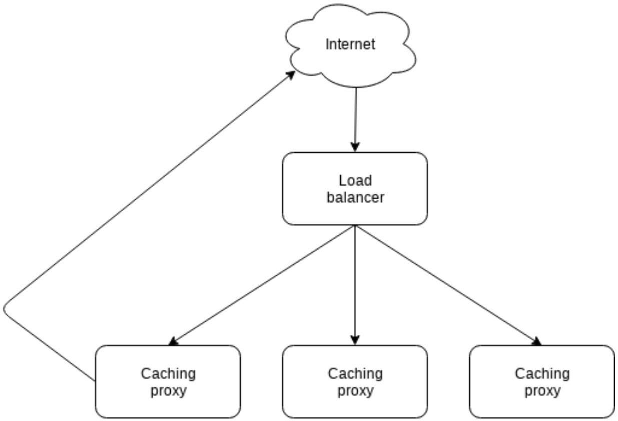
Load balancers and cache servers

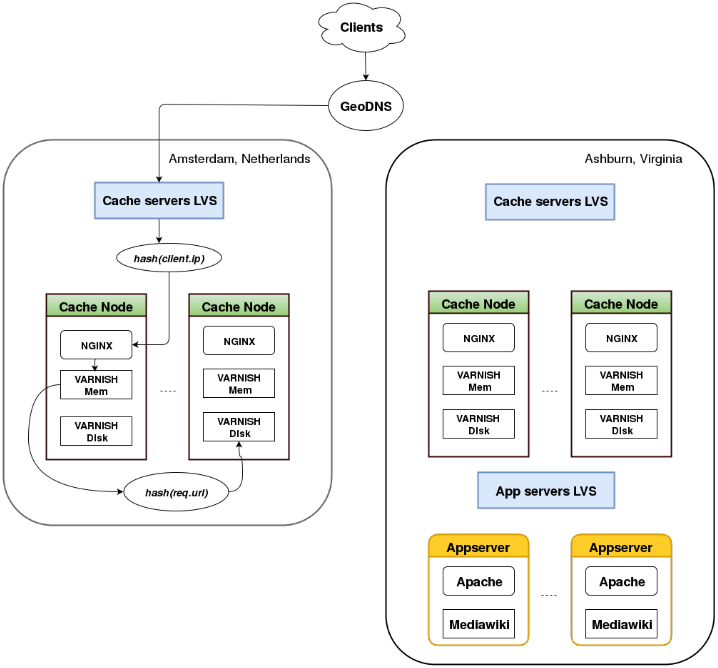
- Load balancers running Linux Virtual Server
- HTTP cache proxies running two Varnish instances per server
  - In-memory: faster, smaller. Effective cache size: ~avg(total mem size)
  - On-disk: slower, much larger. Effective cache size: ~sum(total disk size)

Load balancing

- All requests go through the load balancer
- Responses go straight to the client

Load balancing: direct routing

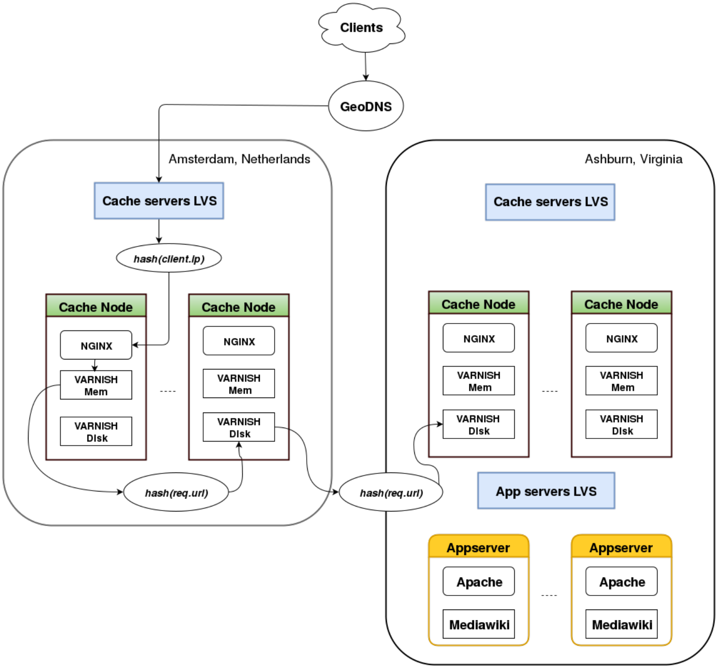



Clients
GeoDNS
Amsterdam, Netherlands
Cache servers LVS
hash(client.ip)
Cache Node
NGINX
VARNISH Mem
VARNISH Disk

Cache Node
NGINX
VARNISH Mem
VARNISH Disk
hash(req.url)
Ashburn, Virginia
Cache servers LVS
Cache Node
NGINX
VARNISH Mem
VARNISH Disk

Cache Node
NGINX
VARNISH Mem
VARNISH Disk
App servers LVS
Appserver
Apache
Mediawiki

Appserver
Apache
Mediawiki



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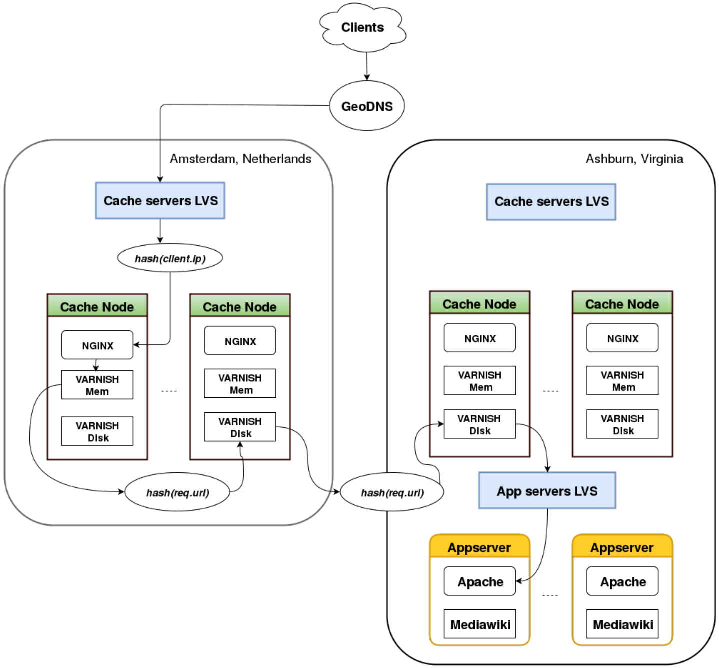

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Mediawiki
Appserver
Apache
Mediawiki

Inter-DC Traffic

- Encryption between data centers necessary
- IPsec between cache servers
- Minimal hitrate on "remote DCs"
- Architectural constraints due to Varnish not supporting outgoing TLS

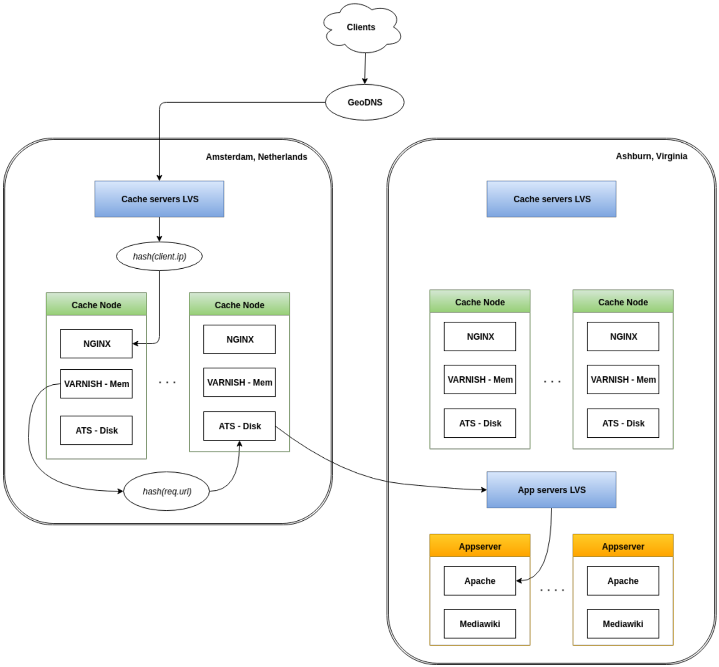
Problems with Varnish

- Bad scalability issues with the "file" storage backend
- No TLS support whatsoever, neither incoming nor outgoing
- Open-core business model, crucial features made proprietary

New CDN (ATS)

ATS Sandwich

- In the process of replacing Nginx with ATS for TLS termination
- Work done by my colleague Valentín Gutierrez
- This presentation focuses on large on-disk caches instead


Clients
GeoDNS
Amsterdam, Netherlands
Cache servers LVS
hash(client.ip)
Cache Node
NGINX
VARNISH - Mem
ATS - Disk
Cache Node
NGINX
VARNISH - Mem
ATS - Disk
hash(req.url)
Ashburn, Virginia
Cache servers LVS
Cache Node
NGINX
VARNISH - Mem
ATS - Disk
Cache Node
NGINX
VARNISH - Mem
ATS - Disk
App servers LVS
Appserver
Apache
Mediawiki
Appserver
Apache
Mediawiki

Simpler architecture

- IPsec removed entirely thanks to outbound TLS support in ATS
- No need for caches to be aware of those in other DCs
- Saving primary DC caches lots of requests
- No need to change inter-DC routing when depooling a site

Upload cache cluster

- Multimedia files, OpenStack Swift
- 42 servers
- 45k rps
- Fully converted to ATS

Issues found during transition

- Segmentation fault in verify_config #4466
- RAM cache usage growth #5179
- Segmentation fault due to compress plugin #5787
- FIFO logfile removed on configuration reload #4635

Detailed transition info:
`https://phabricator.wikimedia.org/T213263`

Text cache cluster

- Primary wiki traffic
- 36 servers
- 100k rps
- ATS on one of those for production traffic testing
- Converting the remaining 35 this quarter!

Work done

Debian Packaging

- 8.x packages backported to Debian Stretch. GCC in Stretch does not support C++17, using Clang instead
- Upgrading CDN nodes to Buster soon, switching back to GCC
- Now co-maintaining official Debian packages with Jean Baptiste Favre and Aron Xu

Puppet

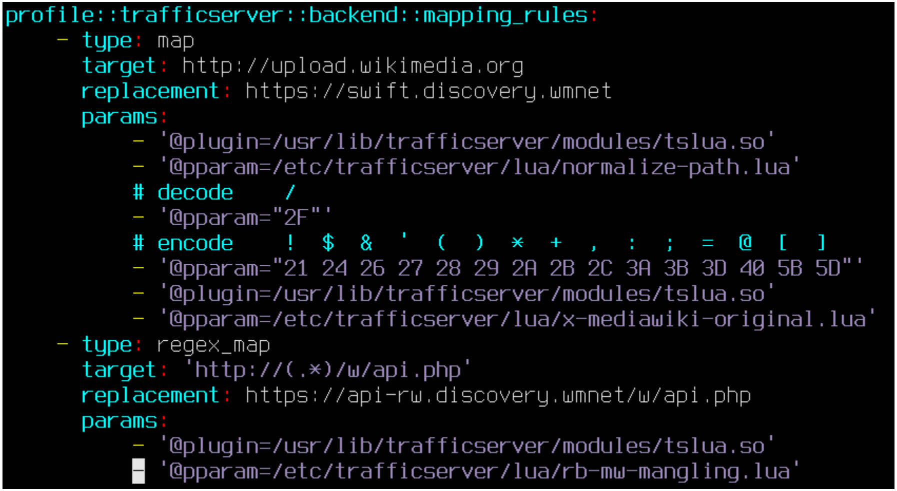
- Remap rules
- Caching rules
- Storage
- Logging
- Multi-instance support with traffic_layout

`https://github.com/wikimedia/puppet`

Lua

~700 lines of custom Lua code, of which ~350 are tests

- Per-remap scripts calling ts.hook()
  - MediaWiki request mangling
  - Path normalization, RFC 3986 section 6
- Default code calling do_global_
  - X-Cache response header
  - Force caching
  - Avoid caching



```
profile::trafficserver::backend::mapping_rules:
    - type: map
      target: http://upload.wikimedia.org
      replacement: https://swift.discovery.wmnet
      params:
          - '@plugin=/usr/lib/trafficserver/modules/tslua.so'
          - '@pparam=/etc/trafficserver/lua/normalize-path.lua'
          # decode     /
          - '@pparam="2F"'
          # encode     !  $  &  '  (  )  *  +  ,  :  ;  =  @  [  ]
          - '@pparam="21 24 26 27 28 29 2A 2B 2C 3A 3B 3D 40 5B 5D"'
          - '@plugin=/usr/lib/trafficserver/modules/tslua.so'
          - '@pparam=/etc/trafficserver/lua/x-mediawiki-original.lua'
    - type: regex_map
      target: 'http://(.*)/w/api.php'
      replacement: https://api-rw.discovery.wmnet/w/api.php
      params:
          - '@plugin=/usr/lib/trafficserver/modules/tslua.so'
          - '@pparam=/etc/trafficserver/lua/rb-mw-mangling.lua'
```

Cacheability

- Initially used heuristics and Negative Response Caching
- Finally decided to require explicit Cache-Control instead
- Unset Cache-Control in do_global_read_response for what we consider uncacheable, set it for negative responses we want to cache
- Restore the original CC value in TS_LUA_HOOK_SEND_RESPONSE_HDR

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Does server permit storing?

- Wrote a SystemTap probe to inspect cache/no-cache decisions
- Instrument is_response_cacheable
- Print request details unless does_server_permit_storing

Origin server connection establishment

```
probe process("/usr/bin/traffic_server").statement(
  "state_http_server_open@./proxy/http/HttpSM.cc:1718")
{
  server_name = user_string_n(
    $this->t_state->current->server->name, 128)

  t = &$this->t_state->txn_conf

  printf("%s %d\n",
          server_name, t->origin_max_connections)
}
```

---

appservers-rw.discovery.wmnet 0
swift.discovery.wmnet 0

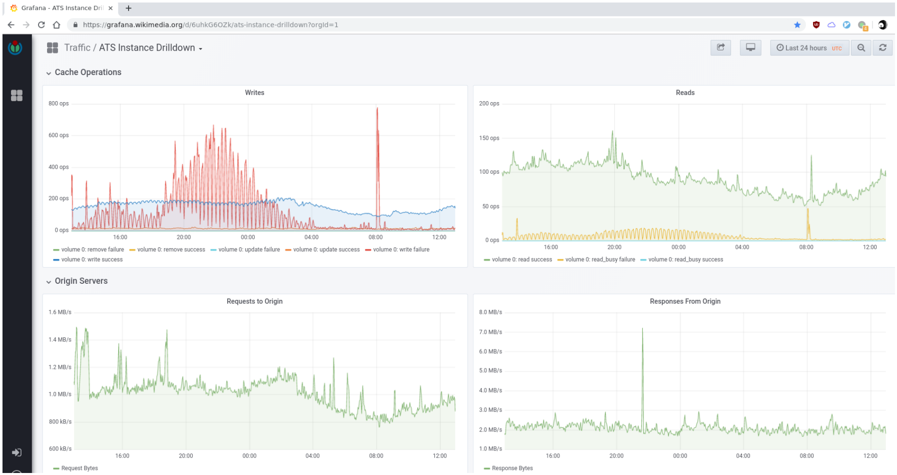
Logging

- Logging to named pipe
- Golang program called fifo-log-demux reading from the pipe
- Multiple clients connecting via Unix domain socket
- Client program called atslog to inspect logs at runtime
- Issues:
  - FIFO logfile removed on configuration reload #4635
  - Error messages logged if there is no reader

Prometheus integration

- prometheus-trafficserver-exporter for all stock trafficserver metrics
- Valentin and I maintain the package in Debian
- atsbackend.mtail exposing ttfb on a per-origin basis
- atsmtail.service boling down to atslog | mtail

Grafana



Grafana - ATS Instance Dri
https://grafana.wikimedia.org/d/6uhkG6OZk/ats-instance-drilldown?orgId=1
Traffic / ATS Instance Drilldown
Last 24 hours UTC
Cache Operations
Writes
800 ops
600 ops
400 ops
200 ops
0 ops
16:00
20:00
00:00
04:00
08:00
12:00
volume 0: remove failure
volume 0: remove success
volume 0: update failure
volume 0: update success
volume 0: write failure
volume 0: write success
Reads
200 ops
150 ops
100 ops
50 ops
0 ops
volume 0: read success
volume 0: read_busy failure
volume 0: read_busy success
Origin Servers
Requests to Origin
1.6 MB/s
1.4 MB/s
1.2 MB/s
1.0 MB/s
800 kB/s
600 kB/s
Request Bytes
Responses From Origin
8.0 MB/s
7.0 MB/s
6.0 MB/s
5.0 MB/s
4.0 MB/s
3.0 MB/s
2.0 MB/s
1.0 MB/s
Response Bytes

Thundering herd avoidance

- Tried collapsed forwarding, decided to go for read while writer instead
- Conservatively returned 502 upon coalesce timeout expiration (failure to obtain cache open write lock) for a few months. Failing open now
- Optimal value for max_open_write_retries identified instrumenting state_cache_open_write with SystemTap
- How to avoid stalling on uncacheable responses?

Much more!

- Read-Only /etc #2505
- Systemd unit hardening
  `https://phabricator.wikimedia.org/T200178`
- Icinga checks
  `https://phabricator.wikimedia.org/T204209`

Conclusions

Positives

- Persistent storage
- TLS
- Lua
- Community! We would like to collaborate even more

Conclusions

- Wikipedia moving from Varnish and nginx to ATS
- Currently converting all on-disk caches and TLS terminators
- Big plans for the future!