Reliable High-Performance HTTP Infrastructure with nginx and Lua

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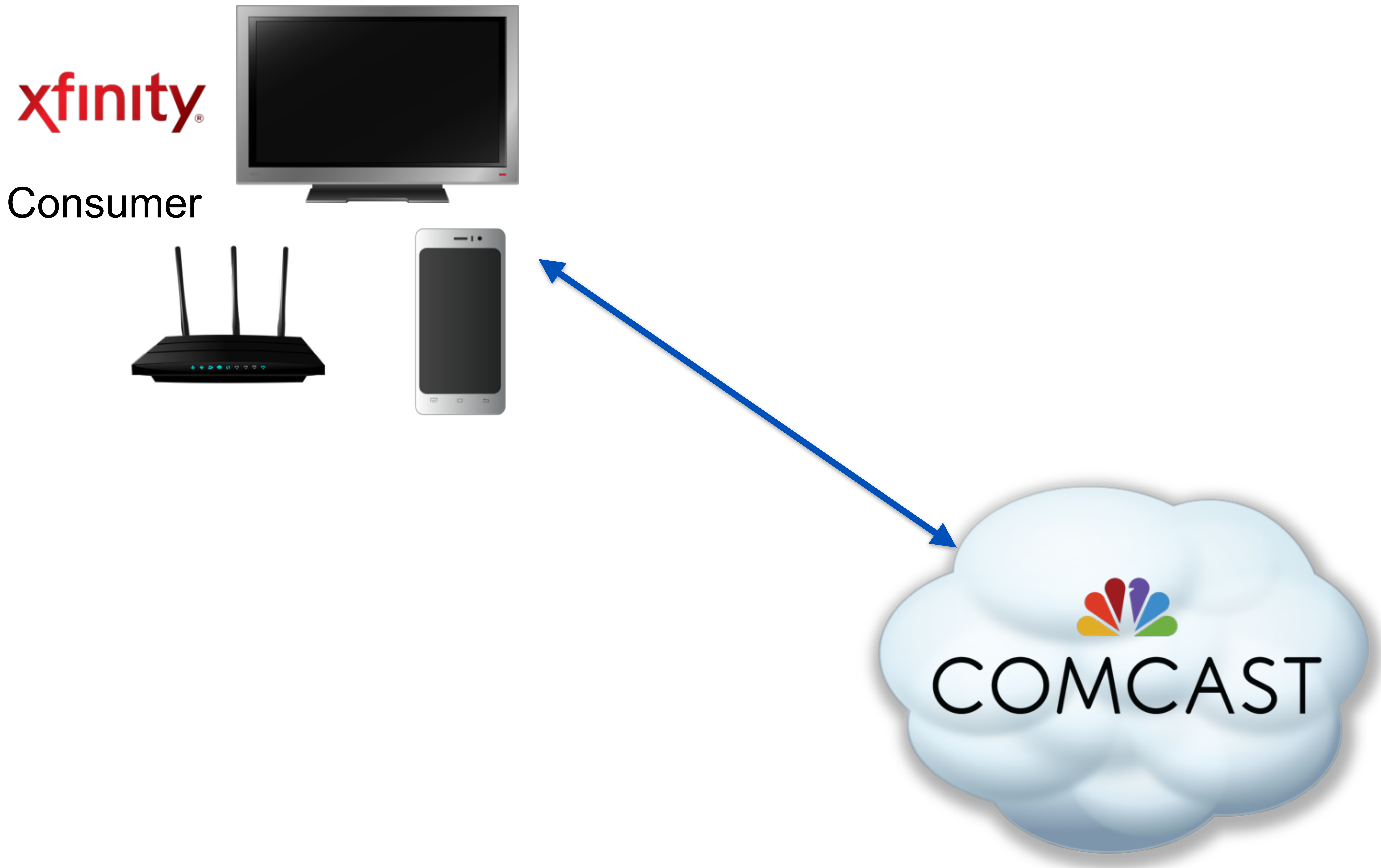
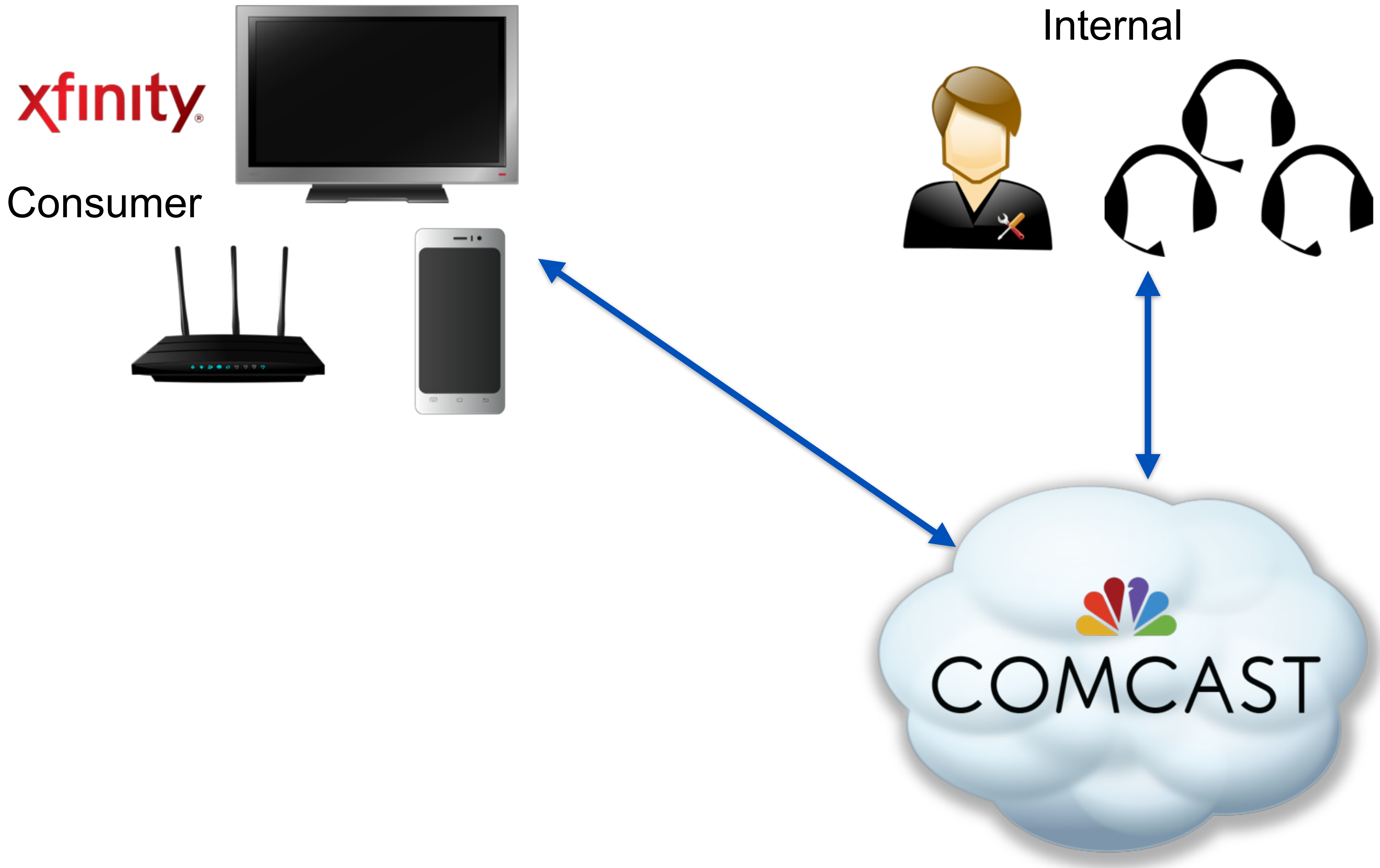
@seancribbs

Background

COMCAST


xfinity
Consumer
COMCAST



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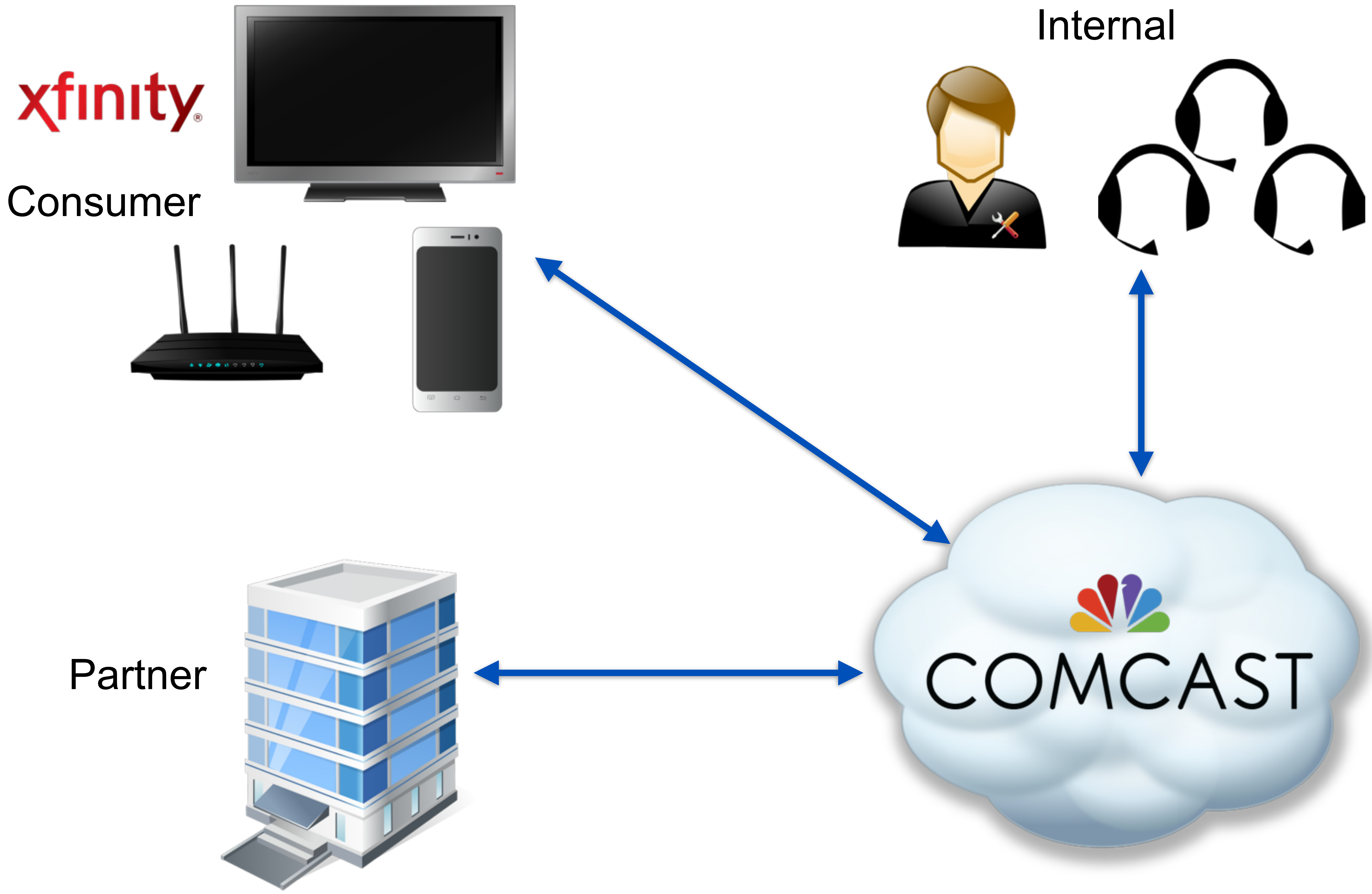

xfinity
Consumer
Internal
Partner
COMCAST

API Management

API Management

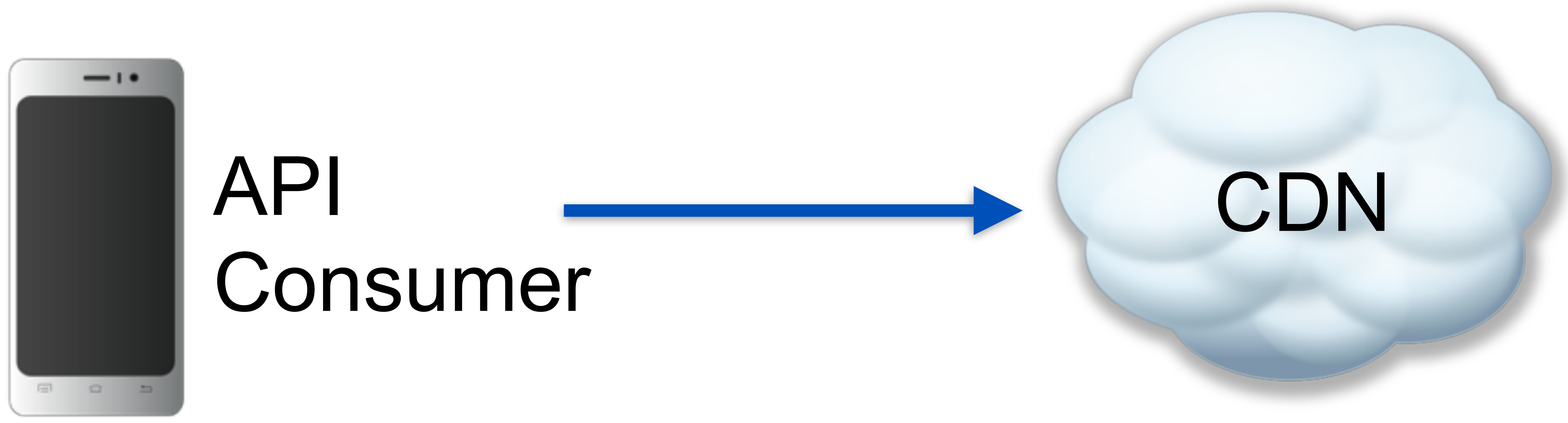
access control

capacity management

CodeBig 1

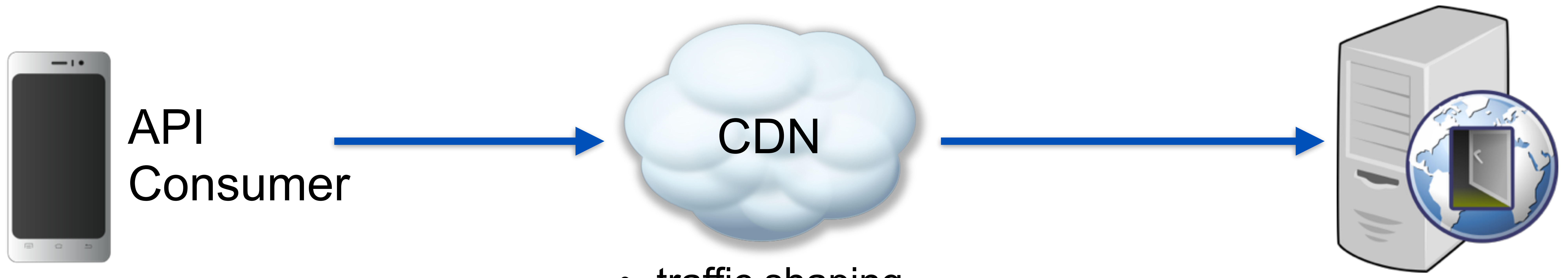
API
Consumer

CodeBig 1



- traffic shaping
- caching

CodeBig 1



- traffic shaping
- caching

- access control
- rate limiting

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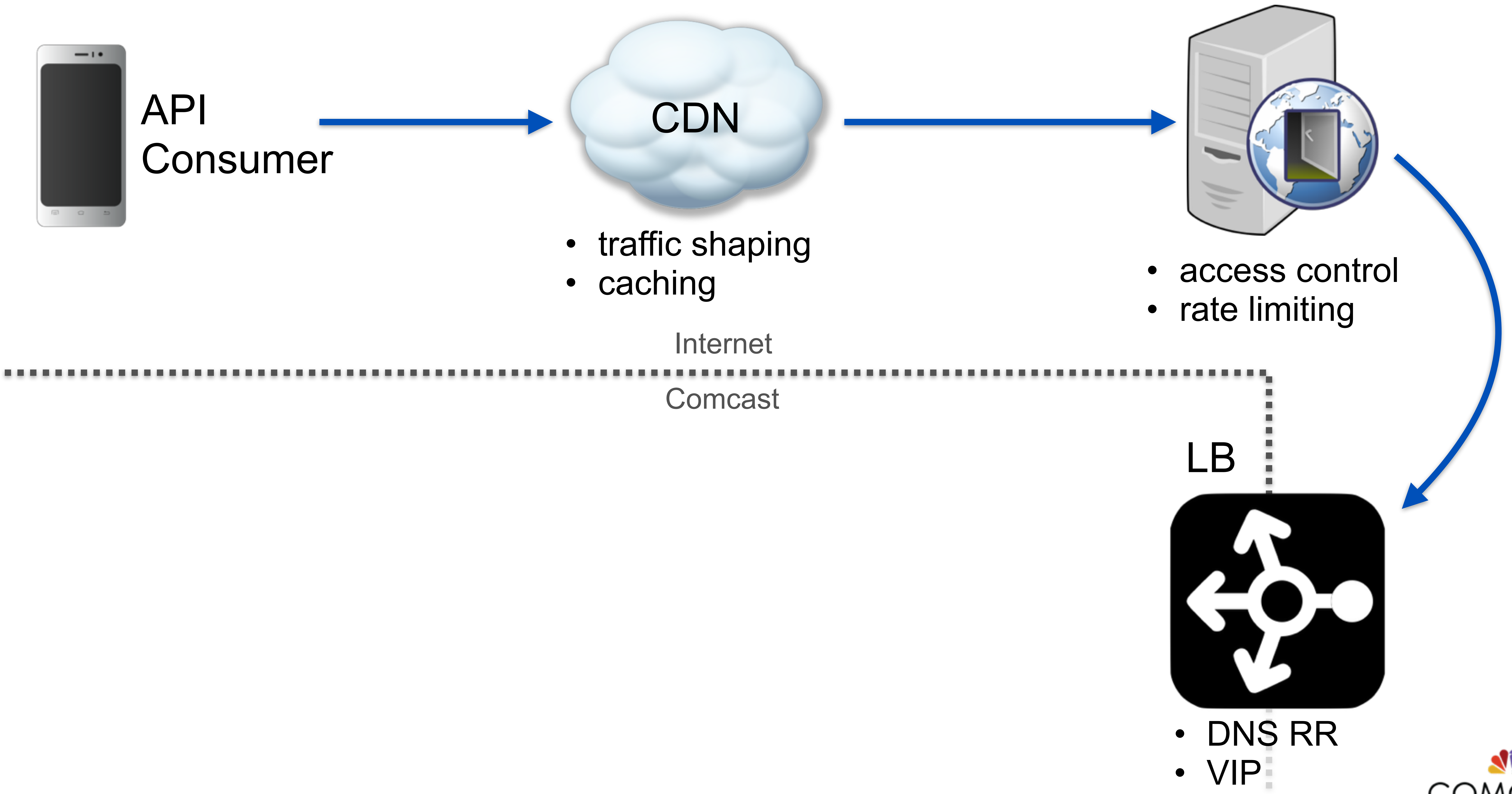
CodeBig 1



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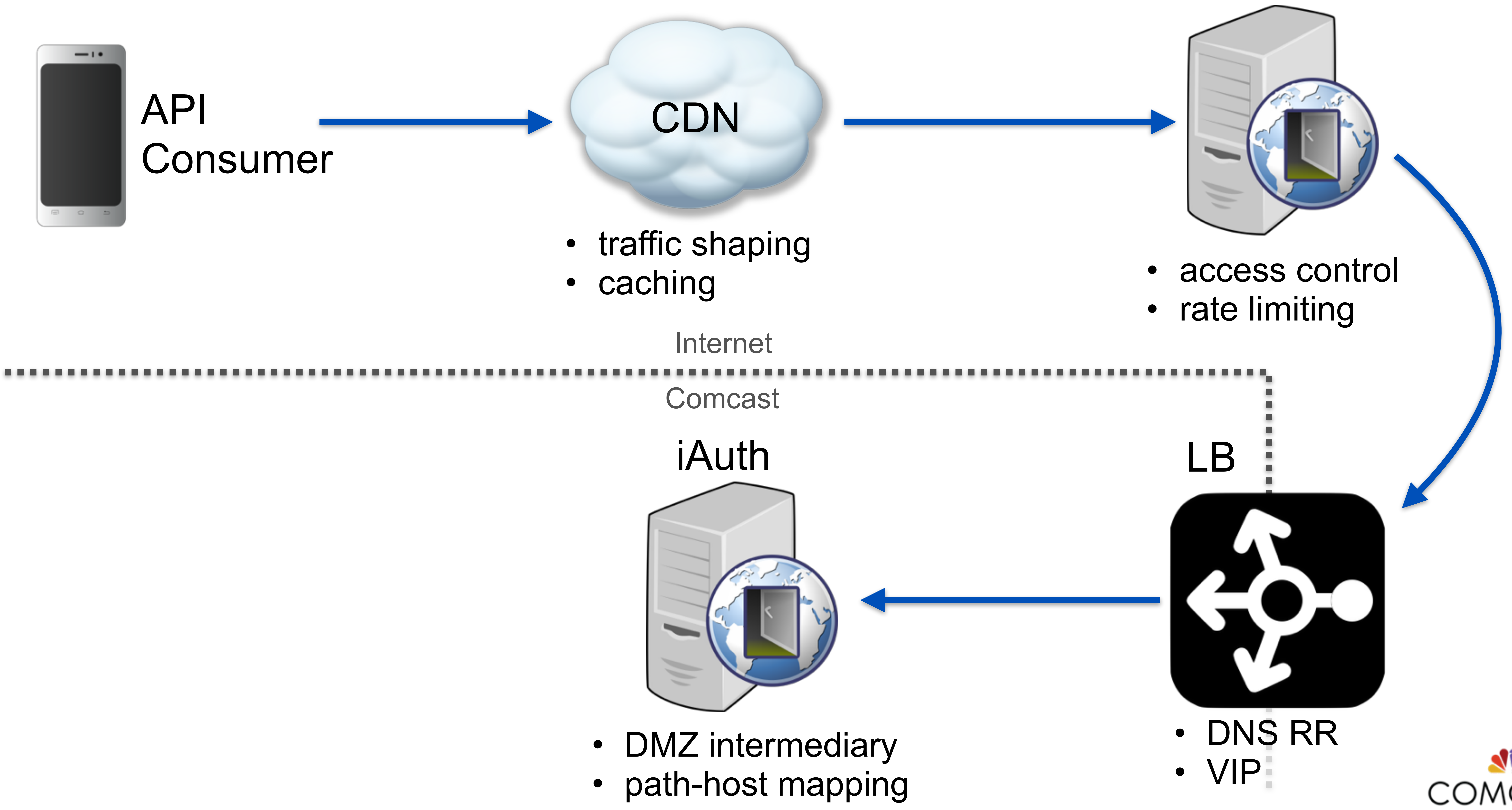
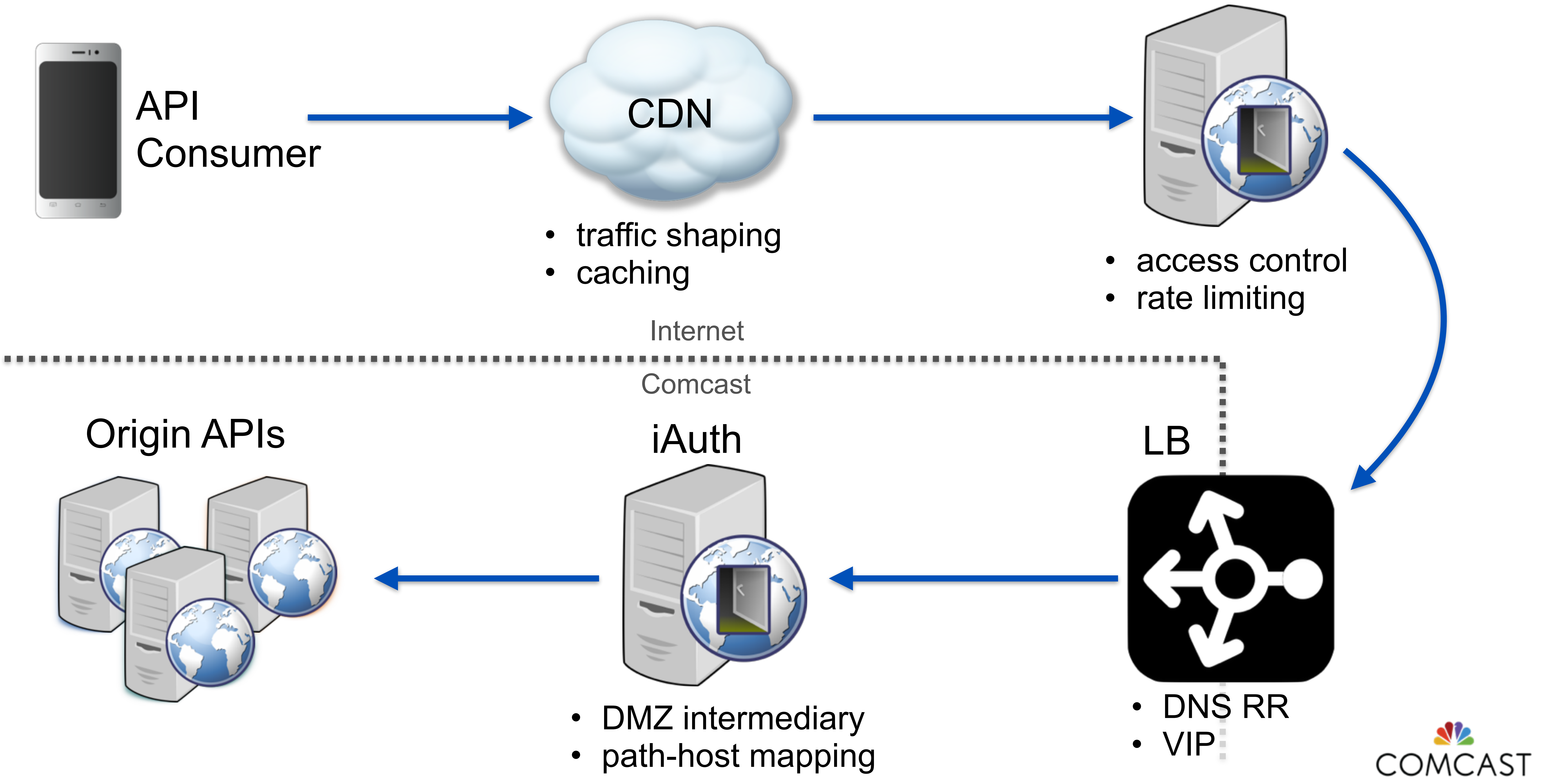
CodeBig 1


API Consumer
CDN
• traffic shaping
• caching
Vendor APIM
• access control
• rate limiting
Internet
Comcast
iAuth
• DMZ intermediary
• path-host mapping
LB
• DNS RR
• VIP

CodeBig 1


API Consumer
CDN
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traffic shaping
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path-host mapping
DNS RR
VIP
COMCAST

Challenges

Challenges

visibility

Challenges

visibility
responsibility

Challenges

visibility
responsibility
scope

Challenges

visibility
responsibility
scope
latency

Challenges

visibility
responsibility
scope
latency
security

CodeBig 2

CodeBig 2

simplify architecture

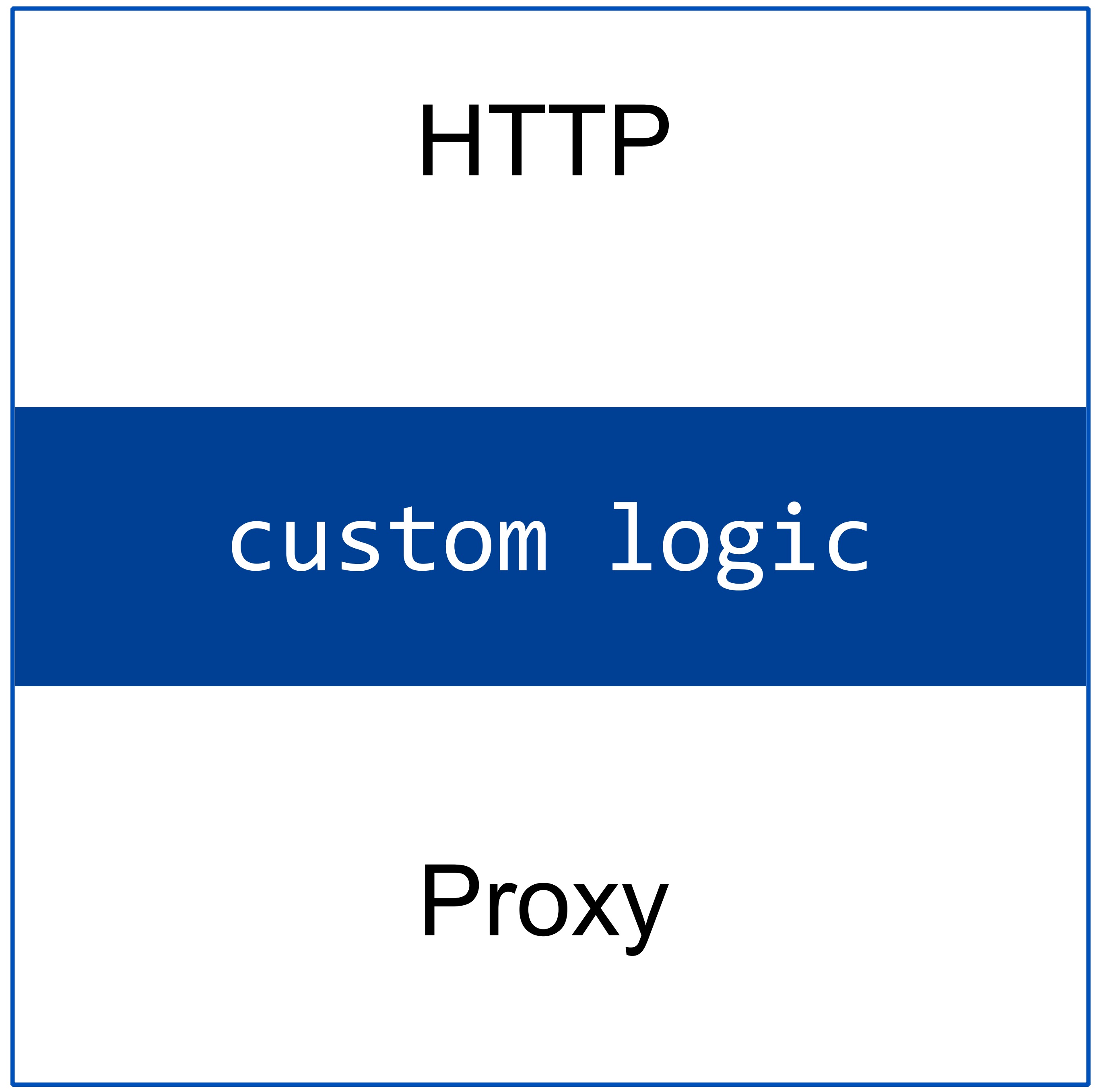
CodeBig 2

simplify architecture
increase visibility

CodeBig 2

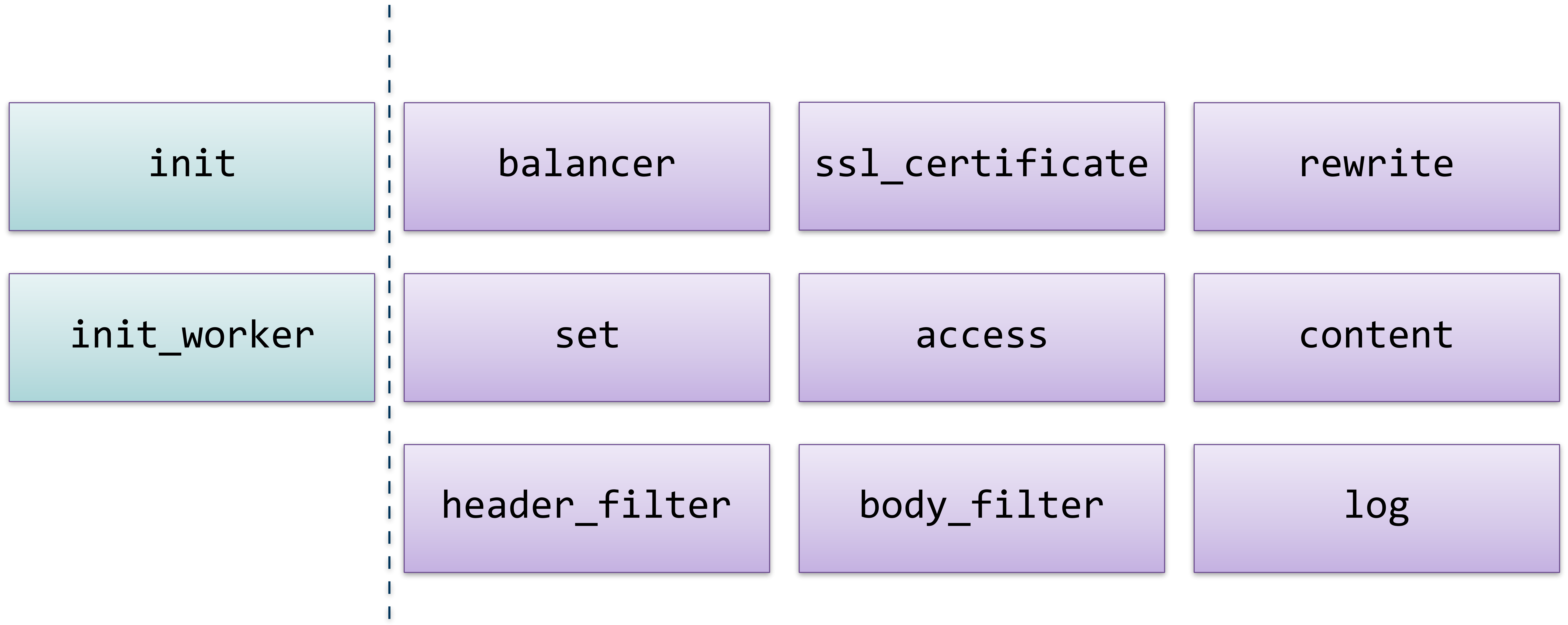
simplify architecture
increase visibility
use open-source tools

Architecture


HTTP
custom logic
Proxy

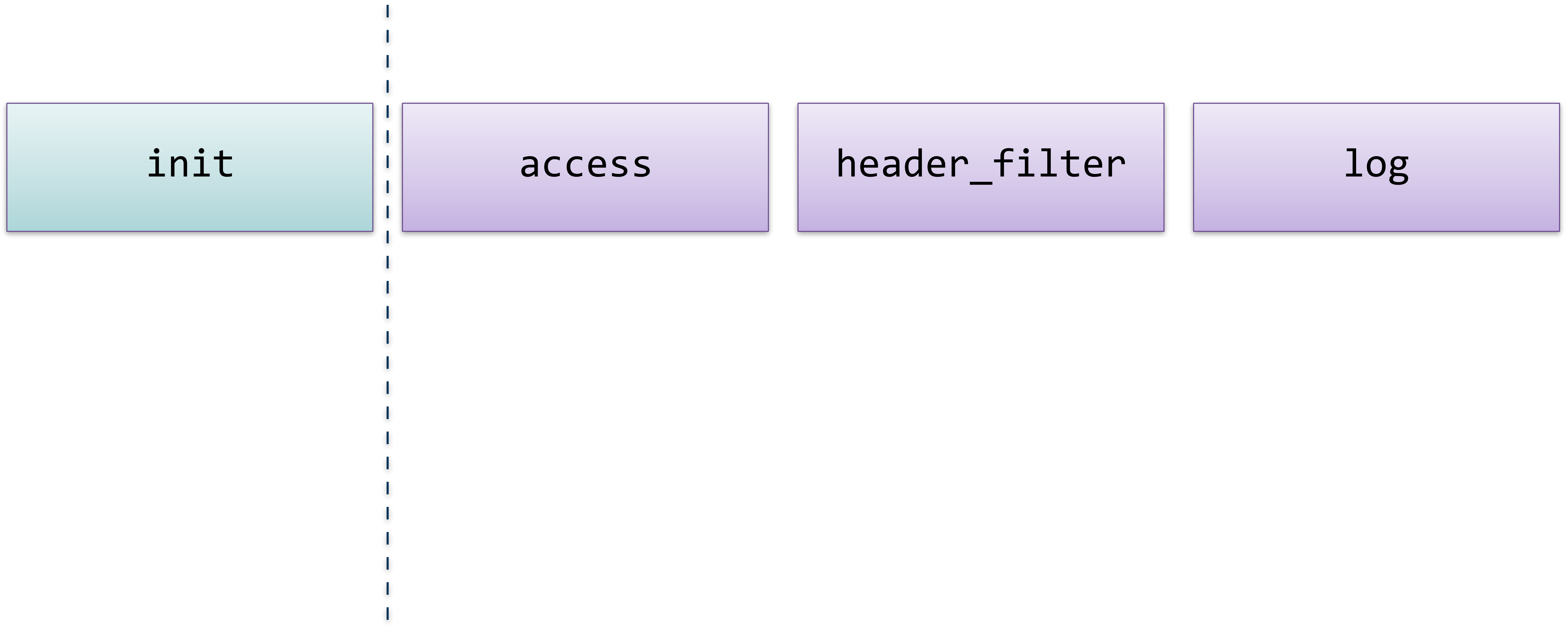
NGINX
Lua

nginx+Lua extension points



+ _by_lua
_by_lua_file
_by_lua_block

CodeBig Request Phases



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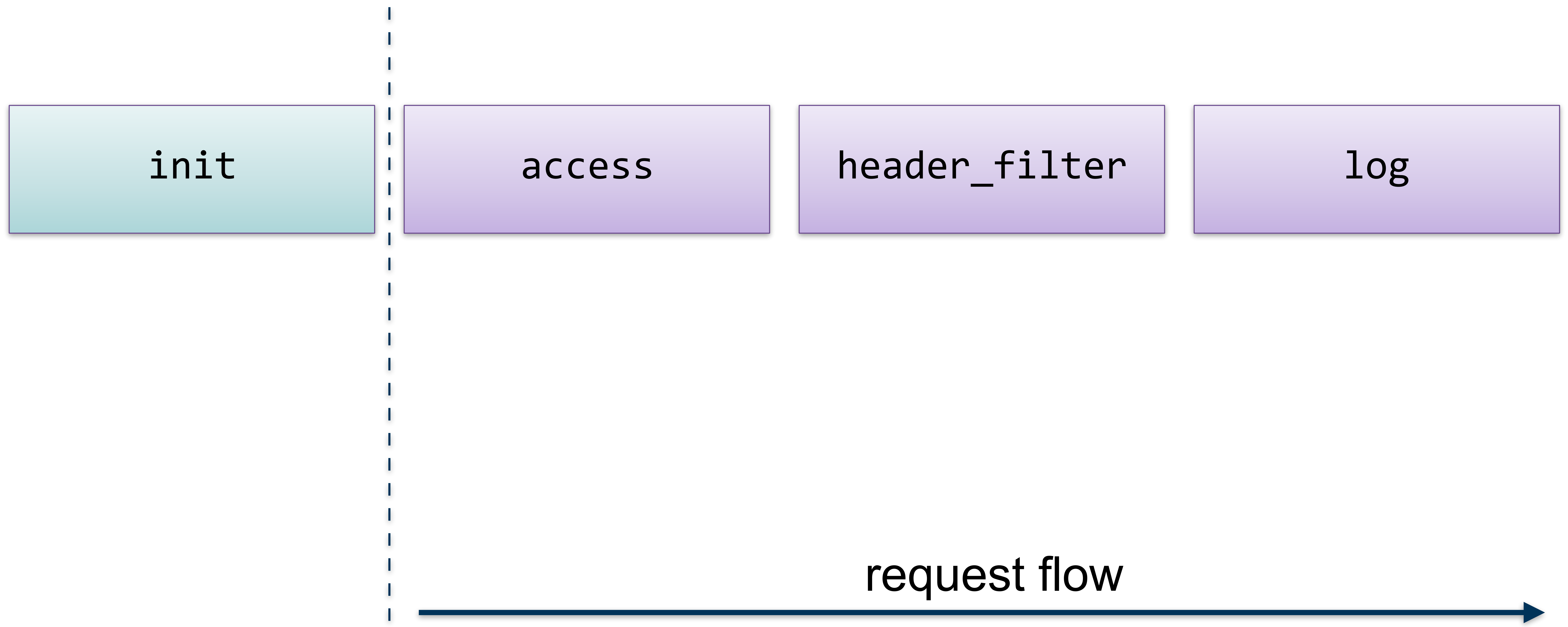
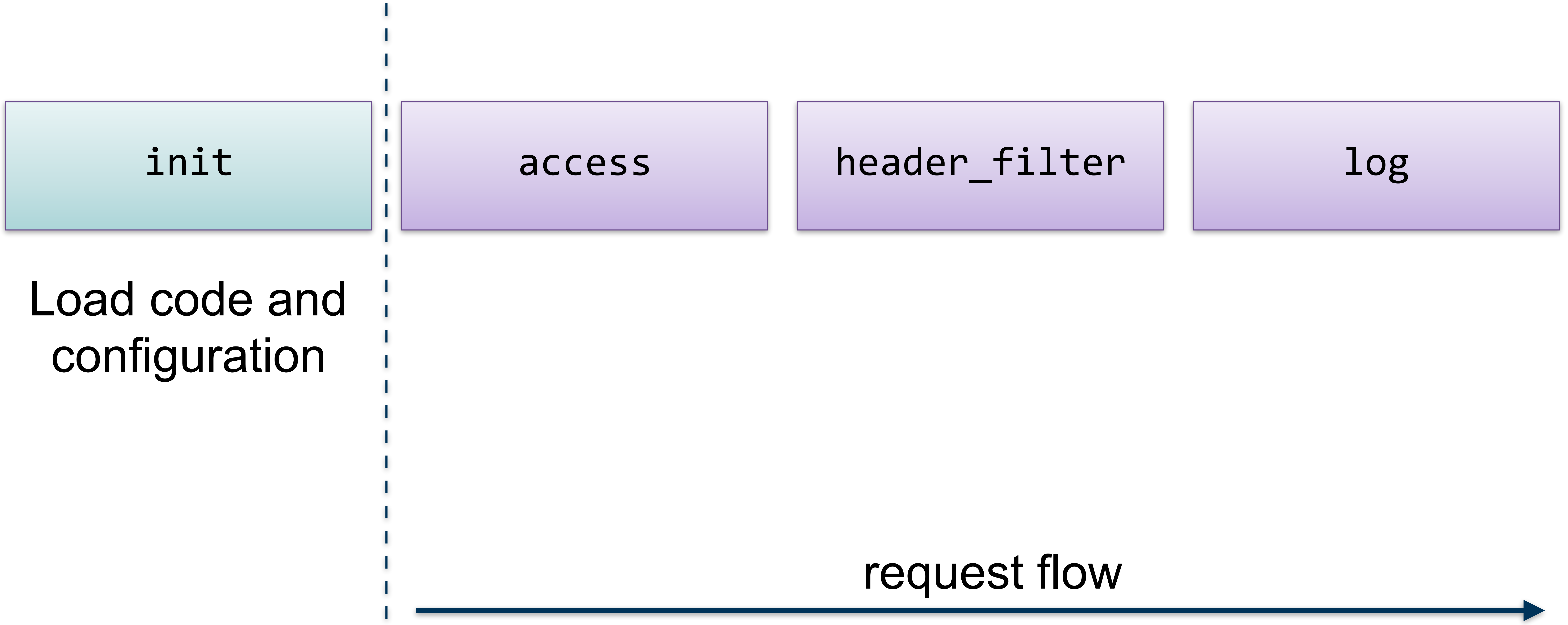
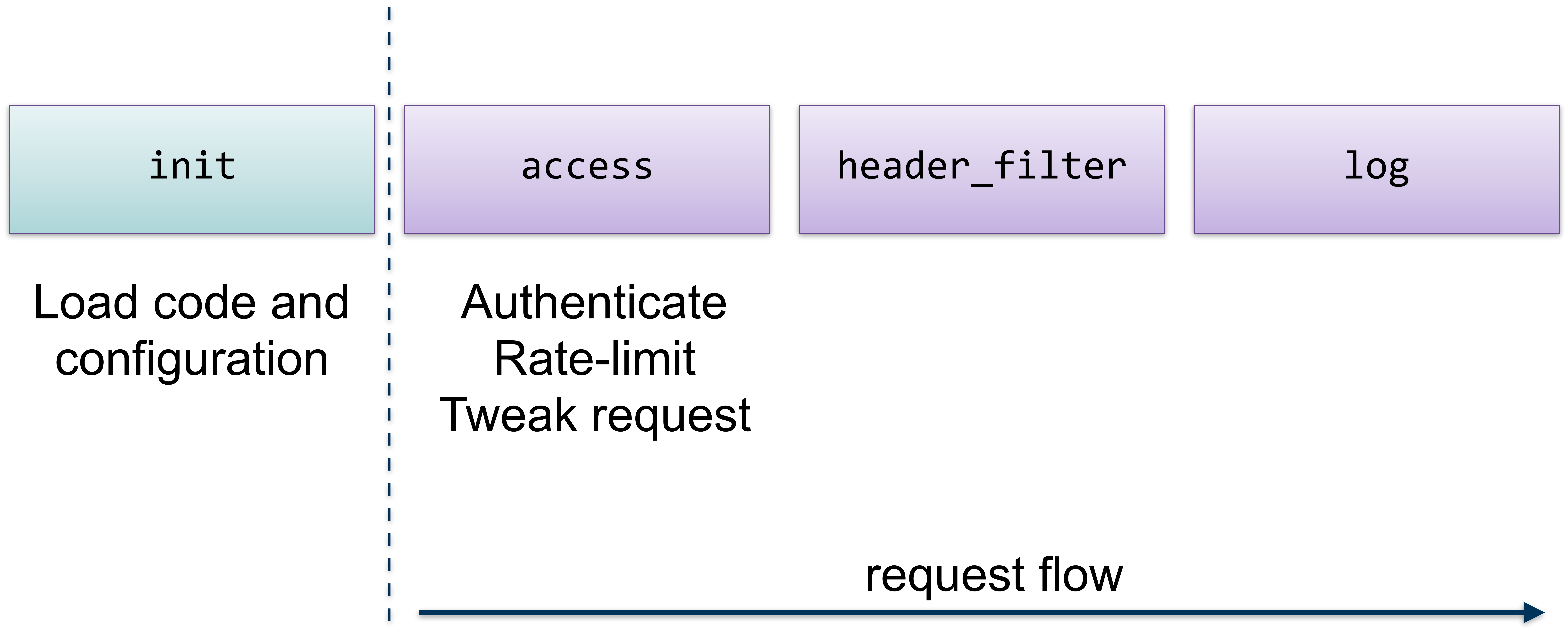
CodeBig Request Phases



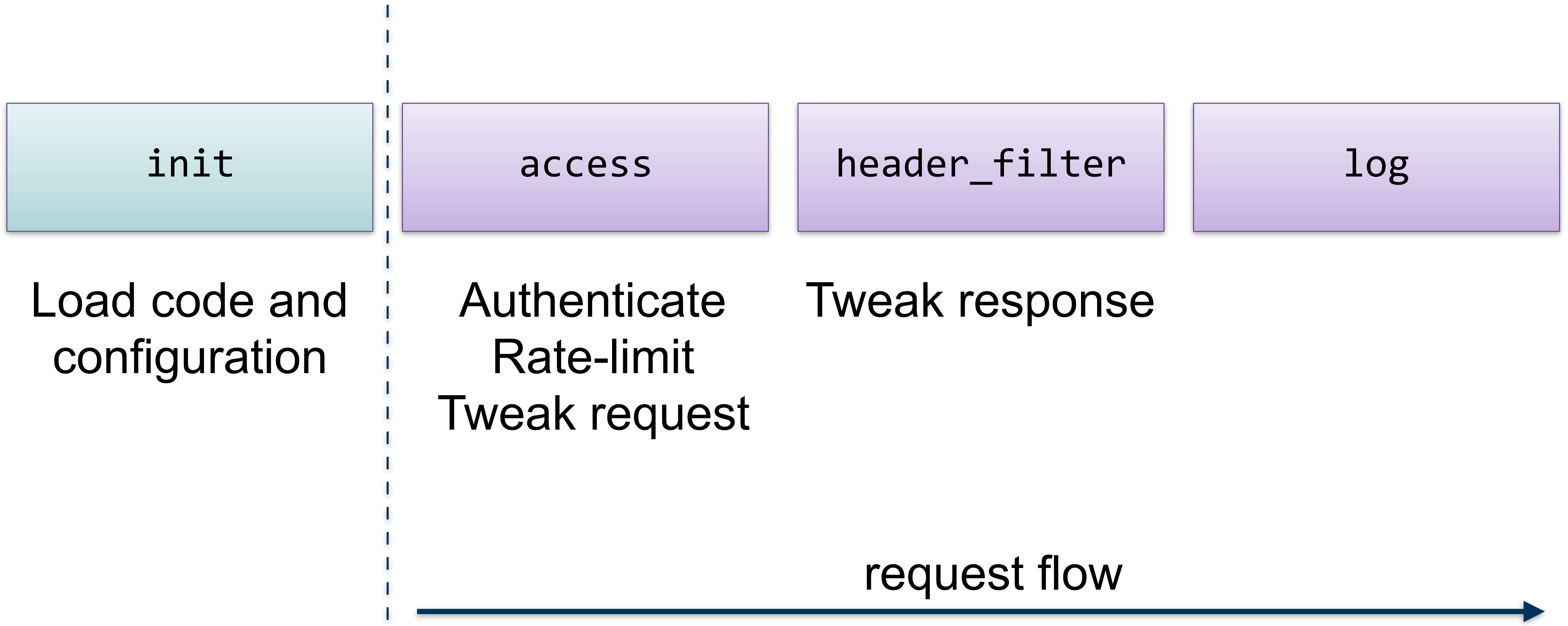
CodeBig Request Phases



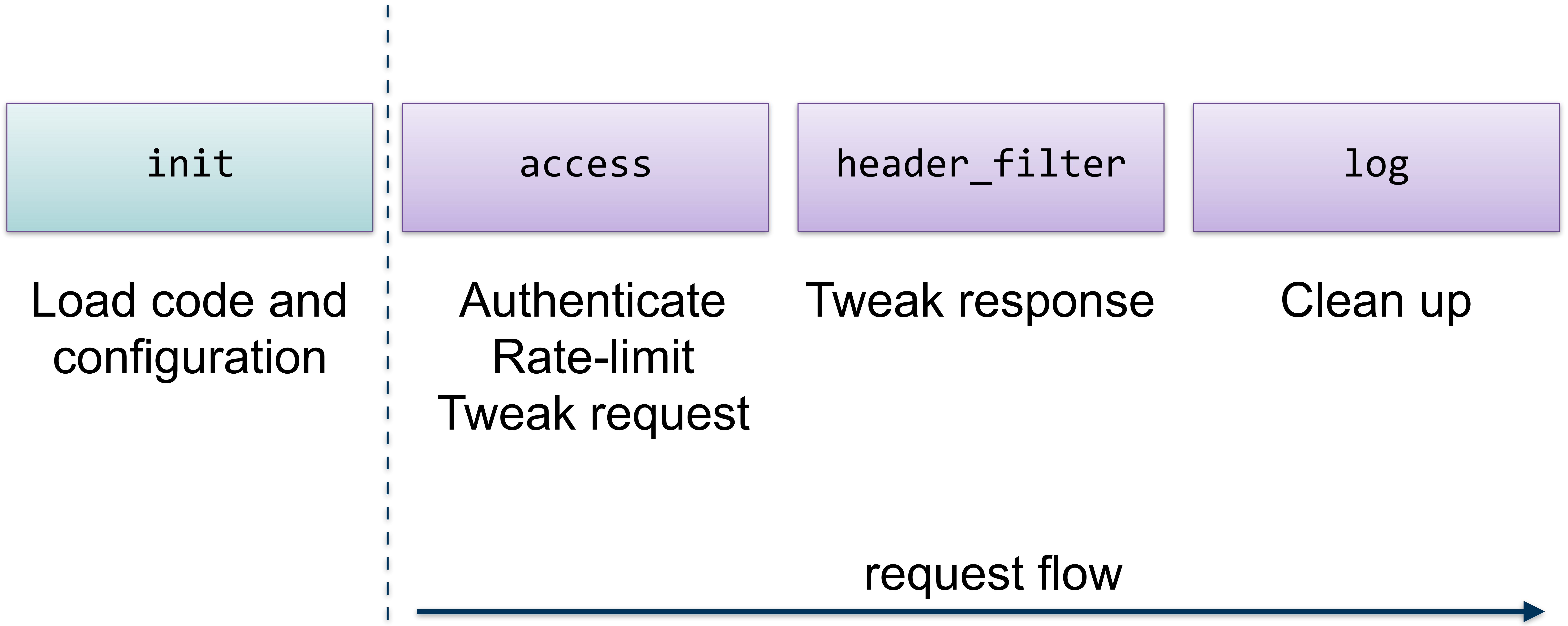
CodeBig Request Phases



CodeBig Request Phases



CodeBig Request Phases



```lua
local setmetatable = setmetatable

local _M = {}

function _M:new(ctx, conf)
    local o = {
        _ctx = ctx,
        _conf = conf
    }

    o.super = self
    setmetatable(o, self)
    self.__index = self
    return o
end

function _M:access()
    return true
end
```

```lua
function _M:post_access()
    -- nop
end

function _M:header_filter()
    -- nop
end

function _M:log()
    -- nop
end

return _M
```

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```lua
for _, name in ipairs(conf.plugins) do
    -- load plugin by fully qualified name
    local plugin = require(name):new(ctx, conf)

    -- exit immediately upon first rejection
    local is_ok, err = plugin:access()
    if not is_ok then
        ngx.status = err.code
        ngx_say(err.error)
        ngx.var.access_error = err.error
        return ngx_exit(ngx.HTTP_OK)
    end

    insert(plugins, plugin)
end

for _, plugin in ipairs(plugins) do
    plugin:post_access()
end
```

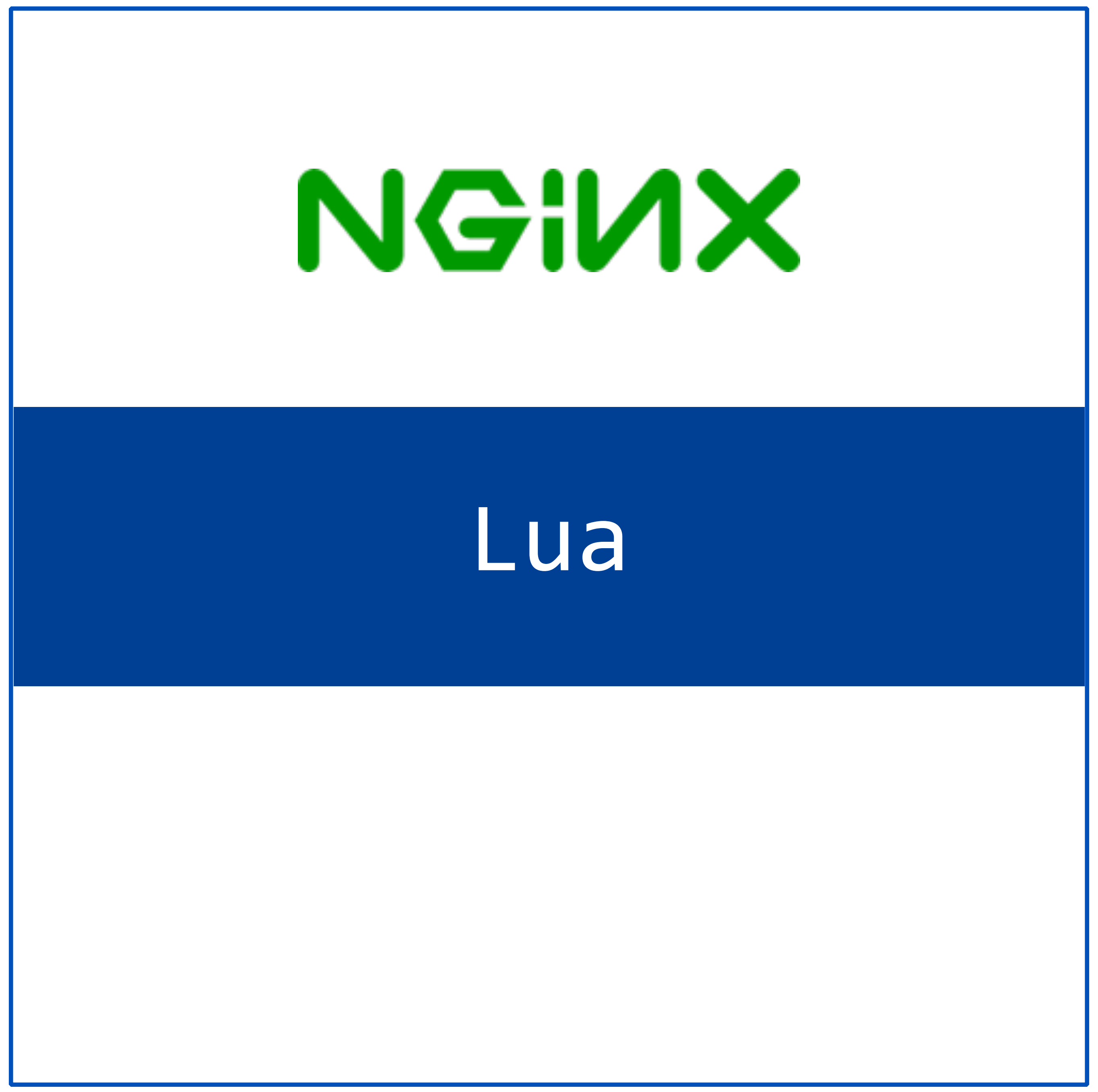
COMCAST

```lua
function _M.header_filter()
    local plugins = ngx.ctx.plugins or {}

    for _, plugin in ipairs(plugins) do
        plugin:header_filter()
    end
end
```

COMCAST

```
# nginx.conf
  lua_package_path      '/usr/share/?/init.lua;/usr/share/?.lua;;';

  lua_shared_dict       memory  50M;

  init_by_lua_block         {
    codebig = require("codebig")
    codebig.init(“/path/to/configs“)
  };

# vhost.conf
    location        / {
        access_by_lua 'return codebig.access("somehost")';

        header_filter_by_lua 'return codebig.header_filter()';

        log_by_lua 'return codebig.log()';
    }
```

COMCAST

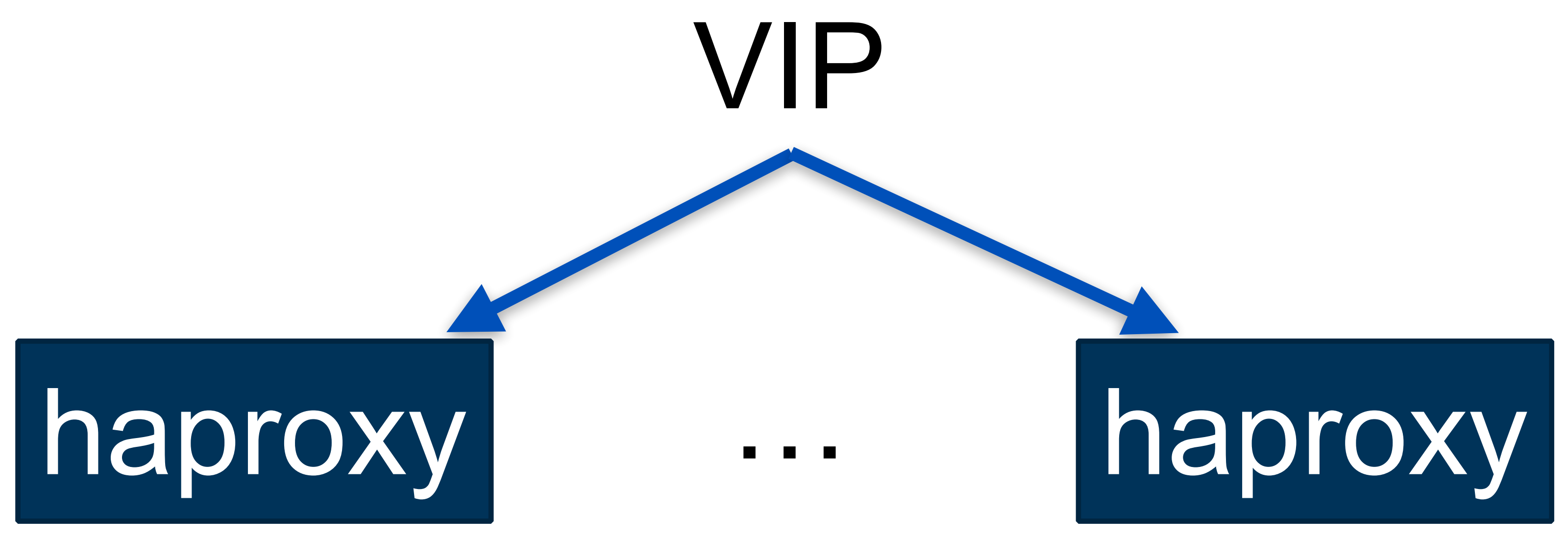


~ 3K LoC!!

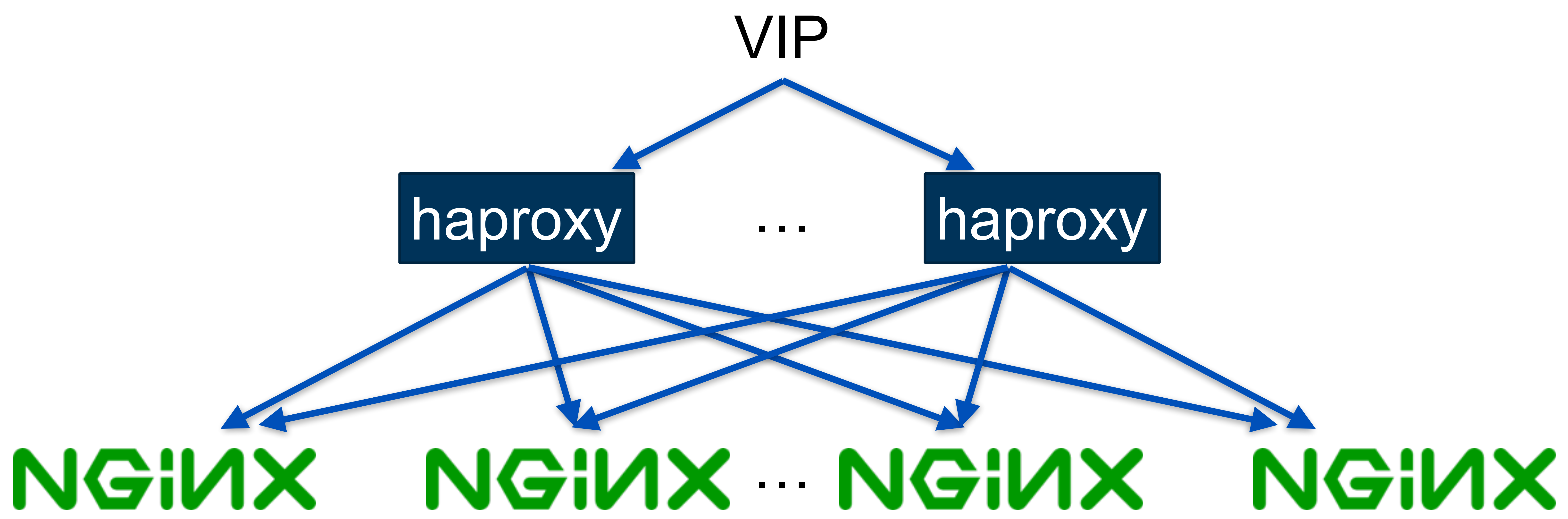
Intra-Datacenter

VIP

Intra-Datacenter



Intra-Datacenter



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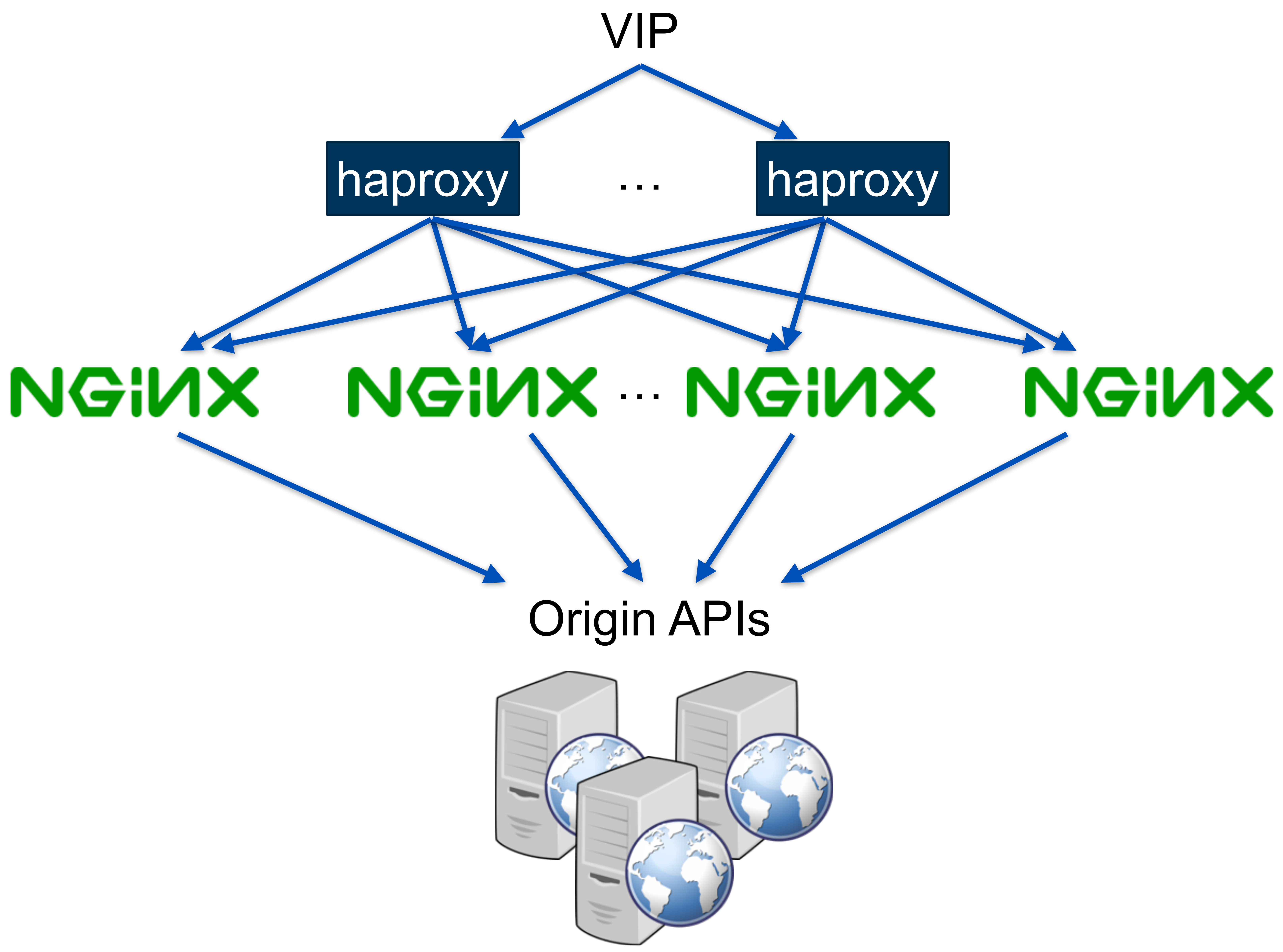

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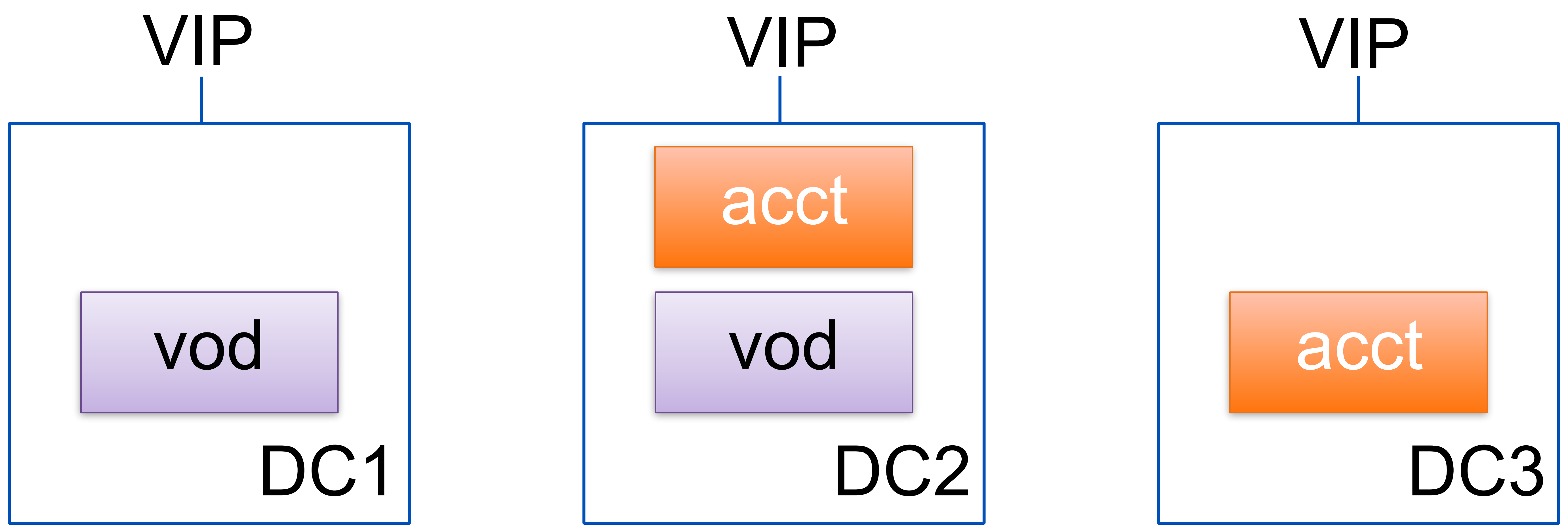
Cross-Datacenter

```
vod.            CNAME   vod-dc1.
vod-dc1-fo.     CNAME   entry-vip-dc1.
vod-dc1.        CNAME   entry-vip-dc1.
vod-dc2.        CNAME   entry-vip-dc2.
entry-vip-dc1.  A       10.1.0.1
entry-vip-dc2.  A       10.2.0.1
entry-vip-dc3.  A       10.3.0.1
```



Capacity Management

$$N = XR$$

$$\overset{\text{\# concurrent requests}}{\searrow}$$

$$N = XR$$

$$\overset{\text{\# concurrent requests}}{\downarrow}\hspace{-1em}N = \underset{\uparrow \atop \text{transaction rate}}{X}R$$

$$\overset{\text{\# concurrent requests}}{N} = \underset{\text{transaction rate}}{X}\,\underset{\text{response time}}{R}$$

# concurrent
requests

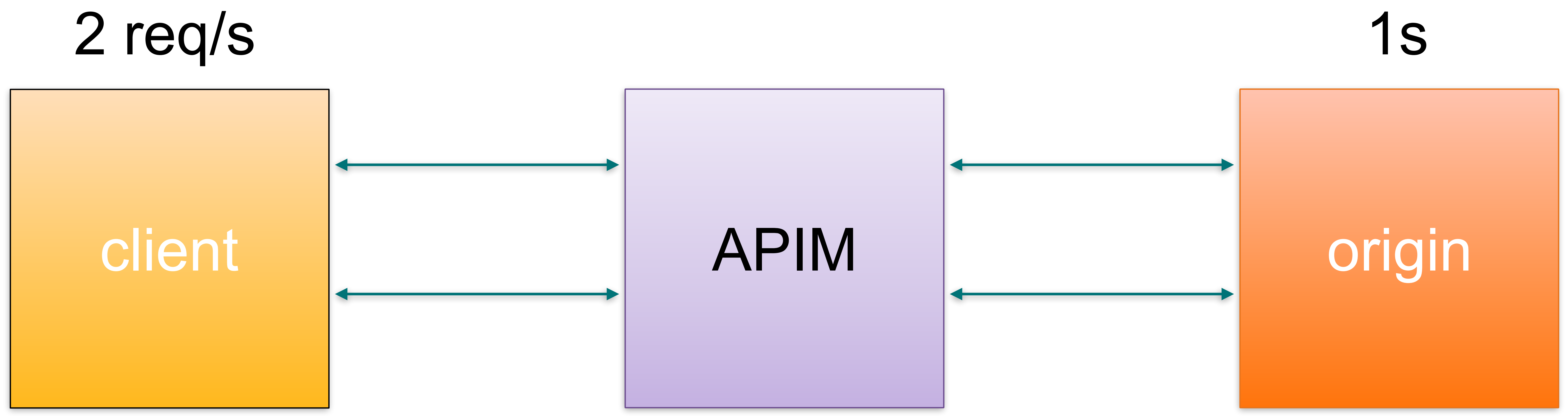
$$N = XR$$

transaction
rate

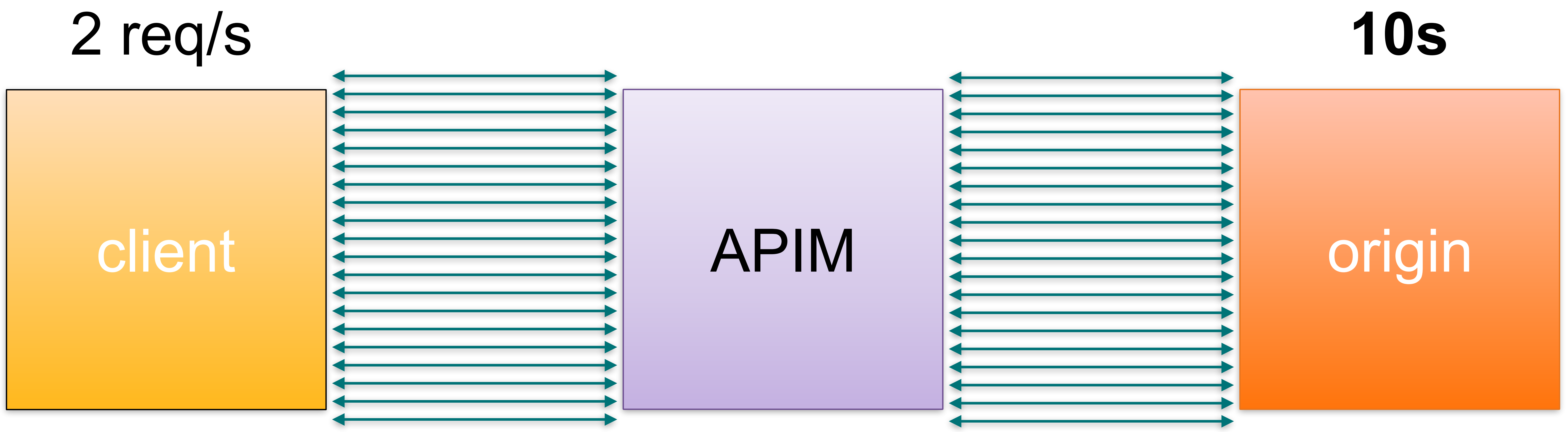
response
time

Little’s Law

$$N = XR = 2 \text{ req/s x } 1\text{s} = 2 \text{ concurrent}$$



$$N = XR = 2 \text{ req/s} \times \mathbf{10s} = \mathbf{20\ concurrent}$$



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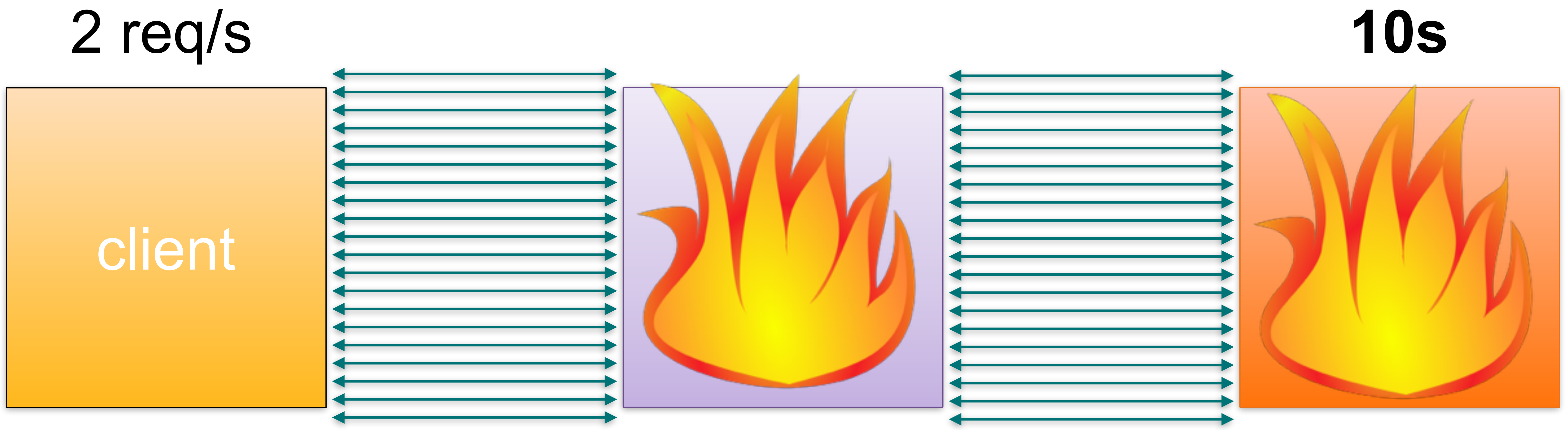


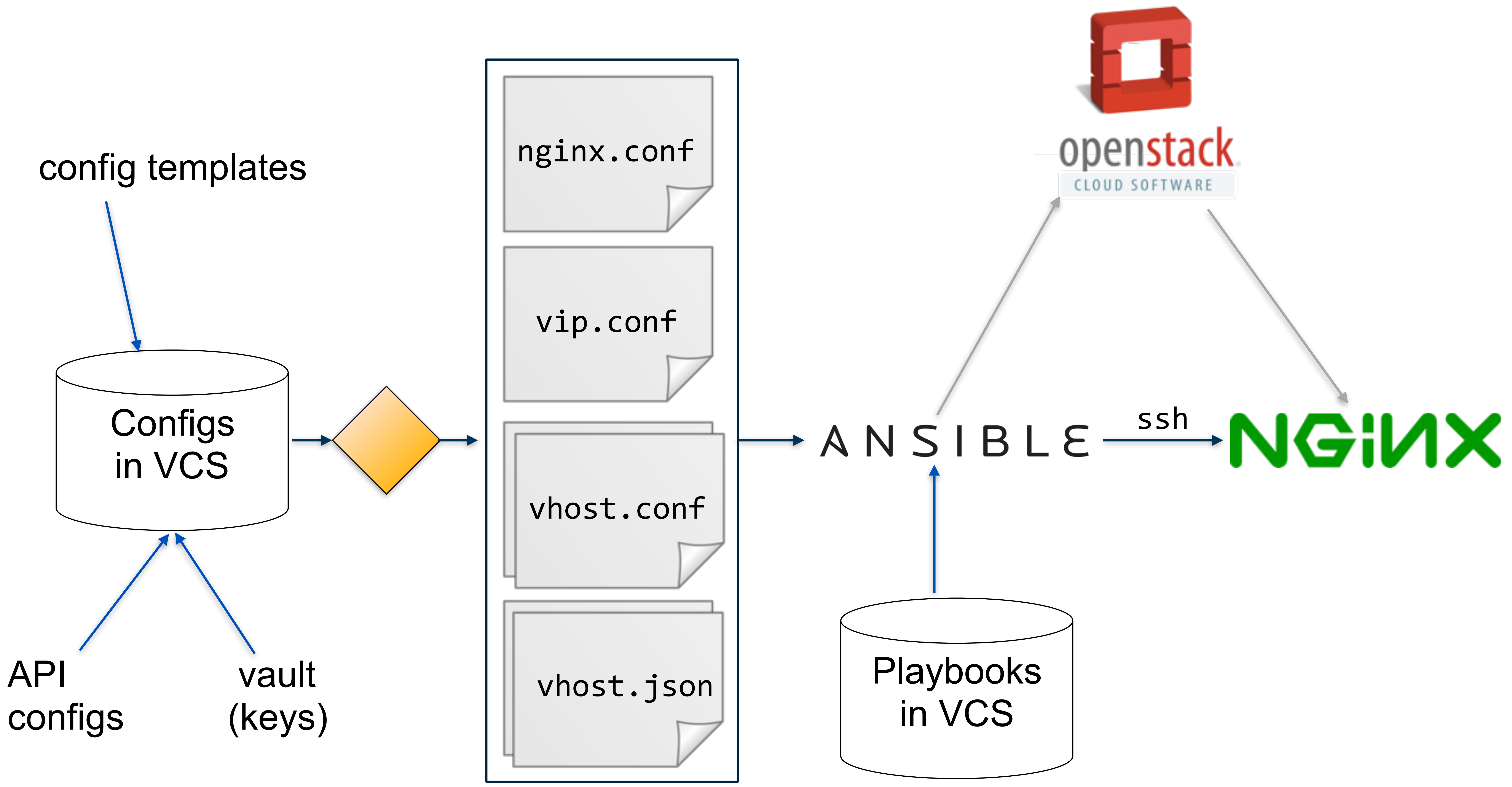
Concurrent Request Limiting

```
lua_shared_dict       memory  50M;

access_by_lua     …   +1

log_by_lua        …   -1
```

Deployment

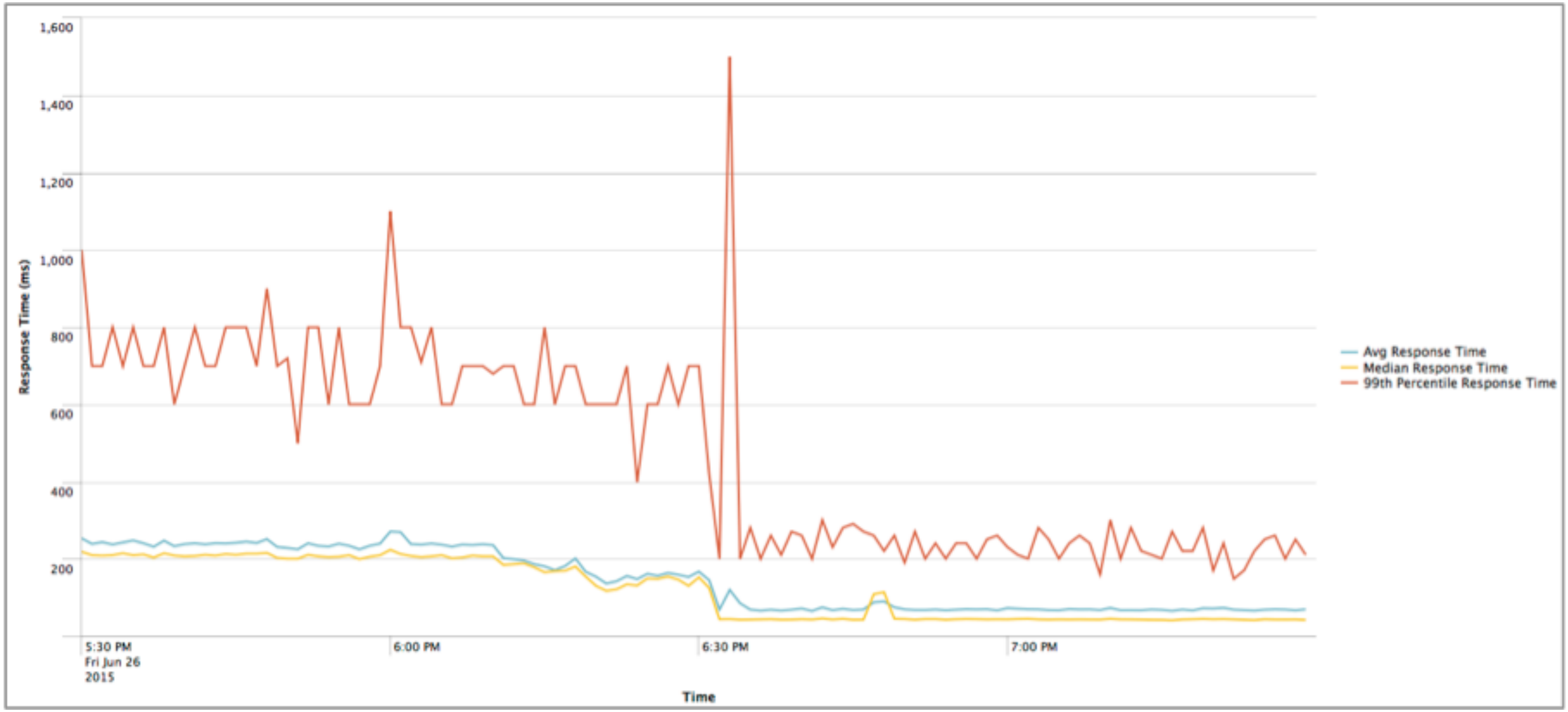
ANSIBLE

COMCAST


config templates
Configs in VCS
API configs
vault (keys)
nginx.conf
vip.conf
vhost.conf
vhost.json
ANSIBLE
Playbooks in VCS
openstack CLOUD SOFTWARE
ssh
NGINX

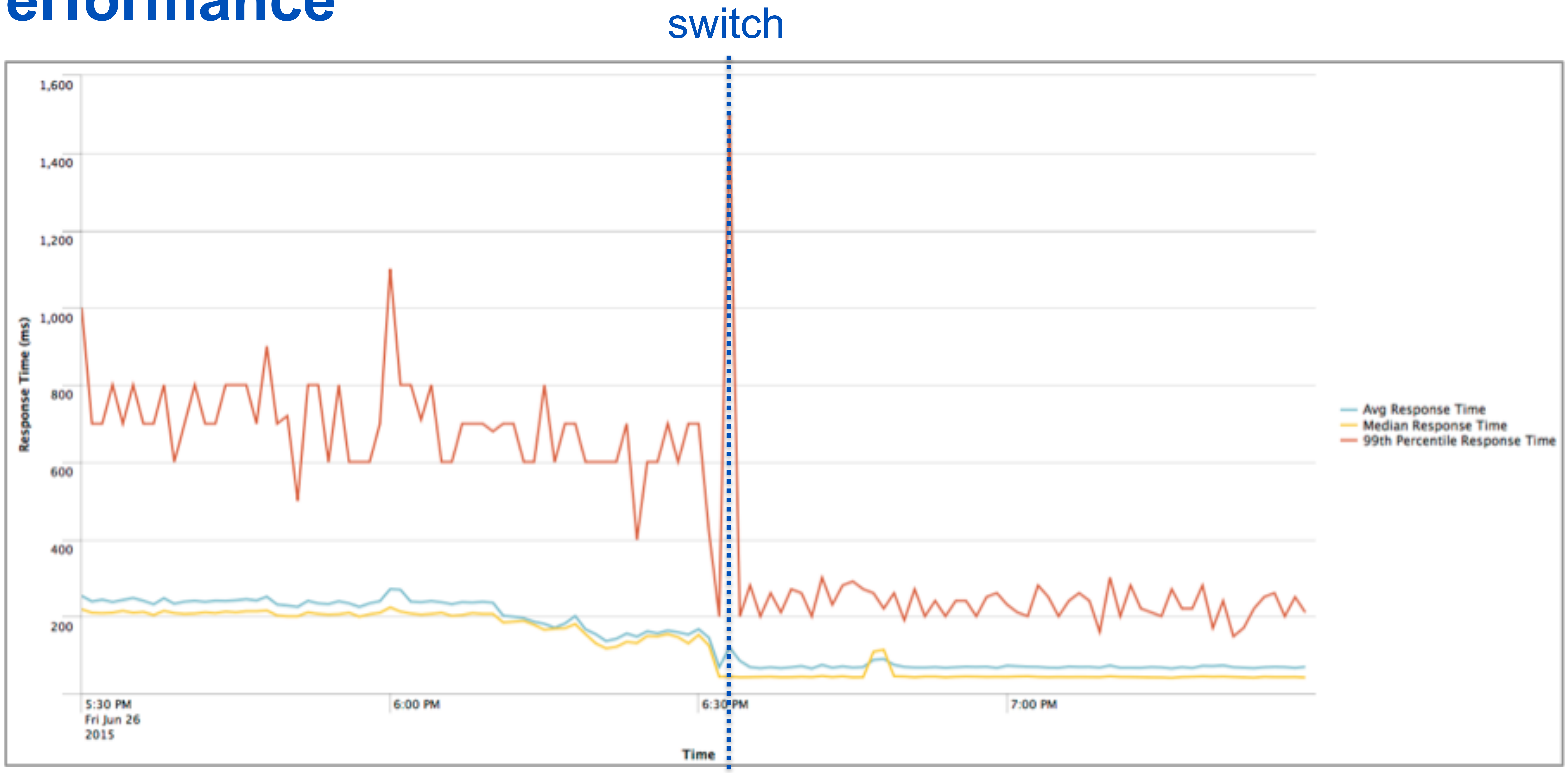
Results

Performance



COMCAST

Performance



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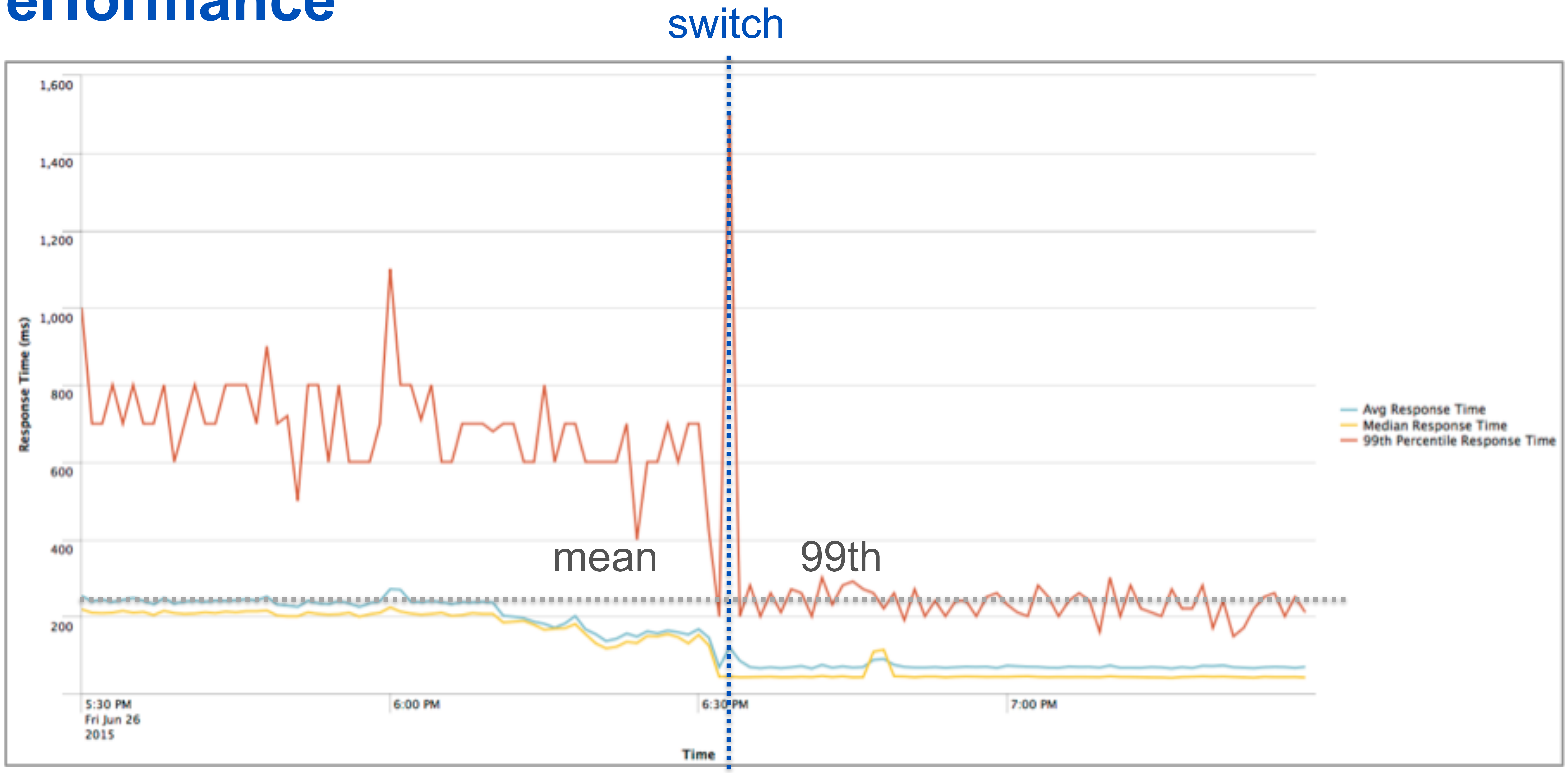

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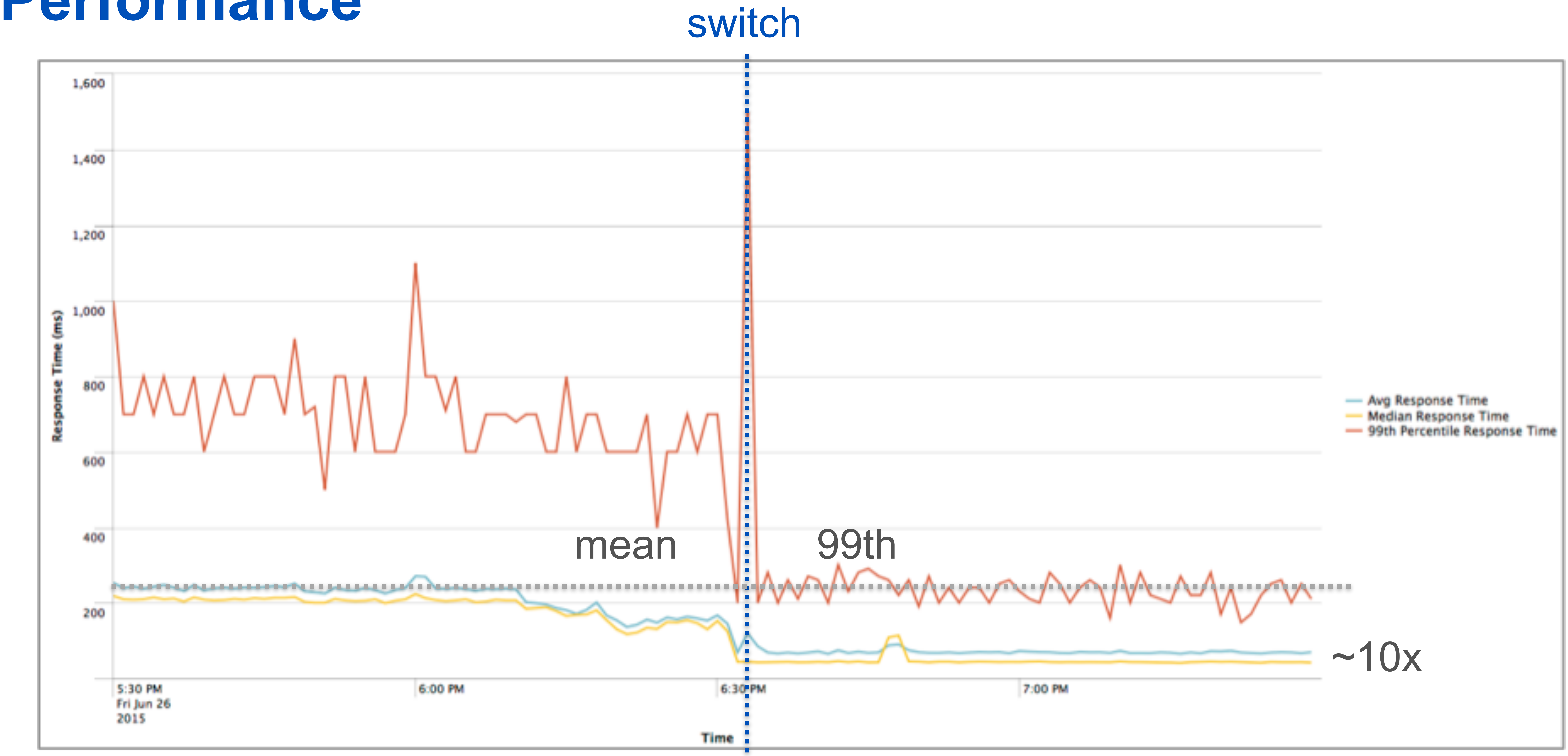
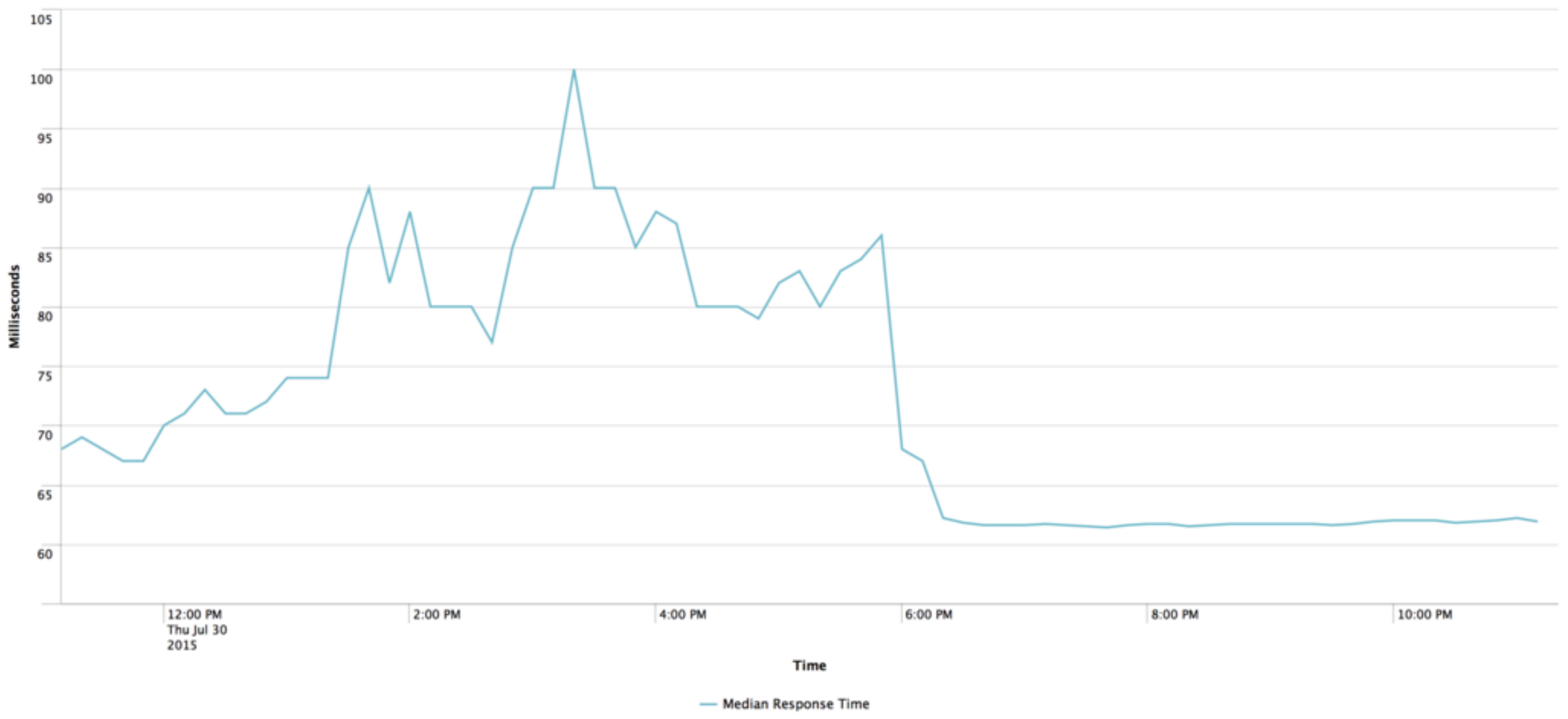


Stability



COMCAST

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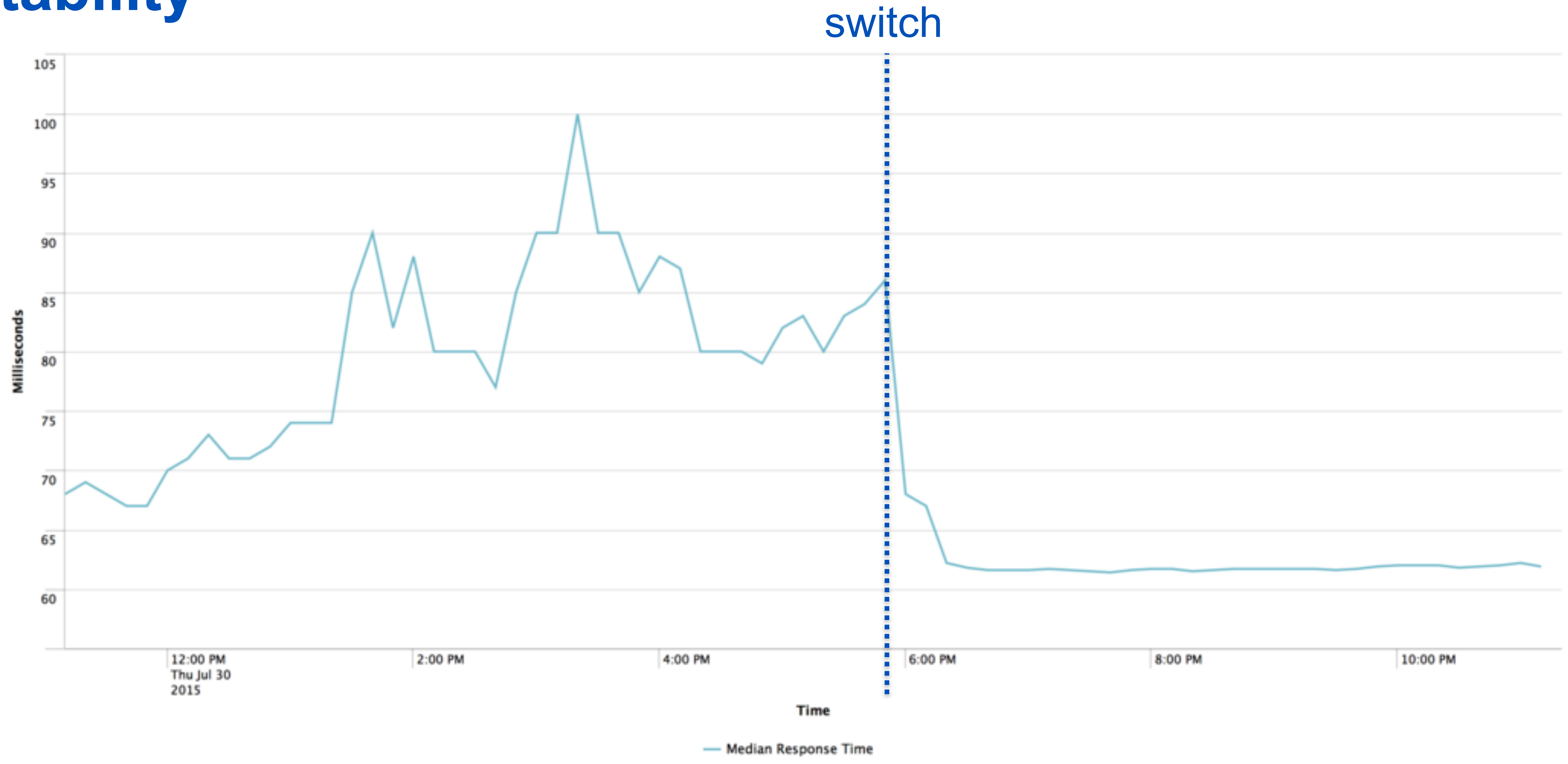

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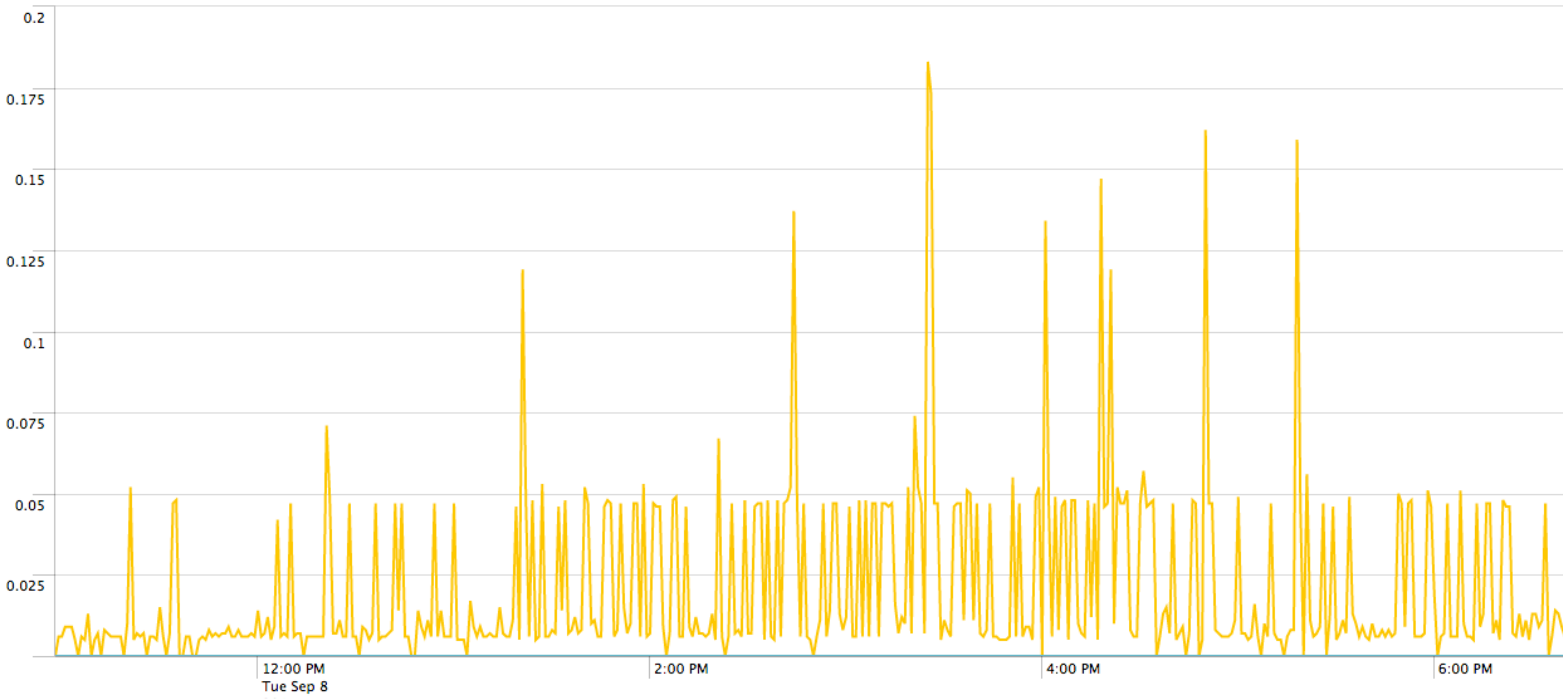
Impact

```
index=codebig host=*.cimops.net source="/var/log/nginx/access.log" |
eval d = request_time - upstream_response_time |
timechart span=1m perc99(d) max(d)
```



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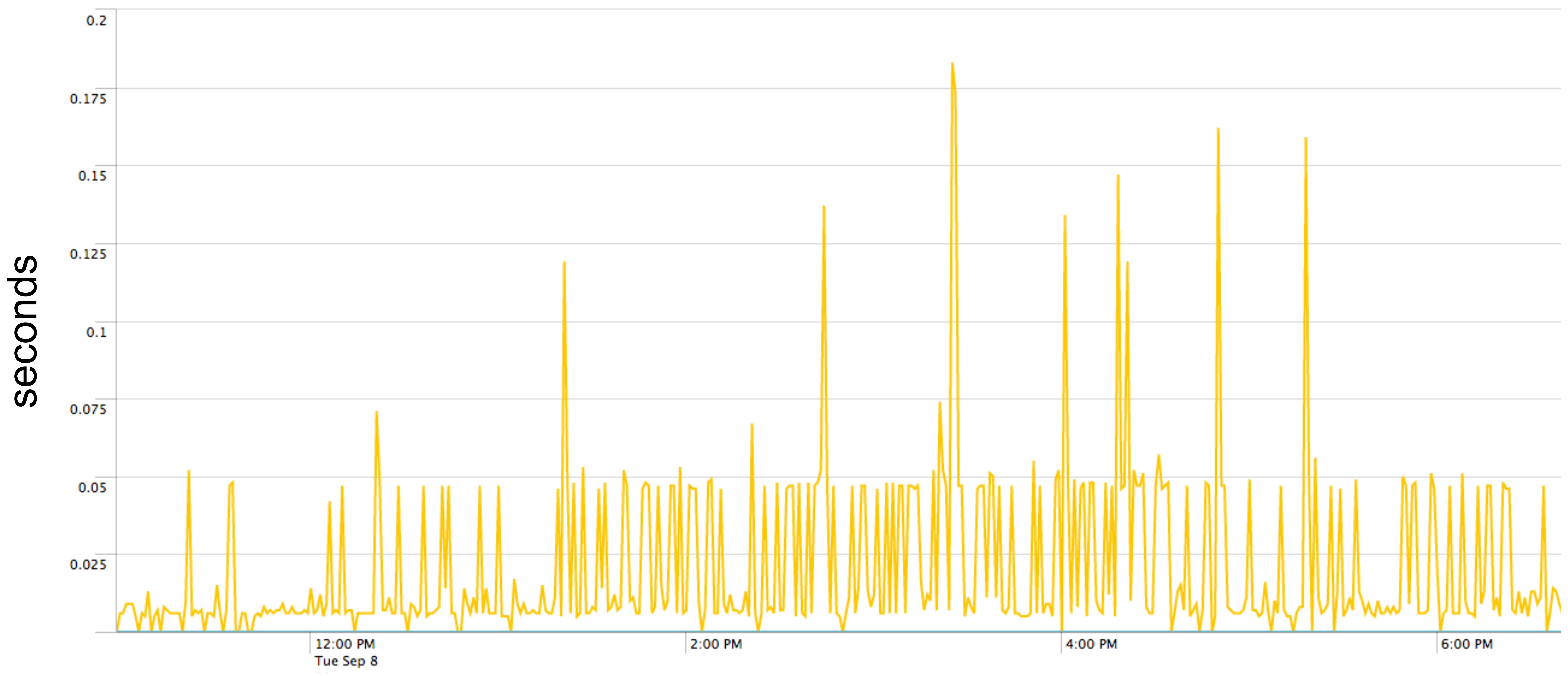

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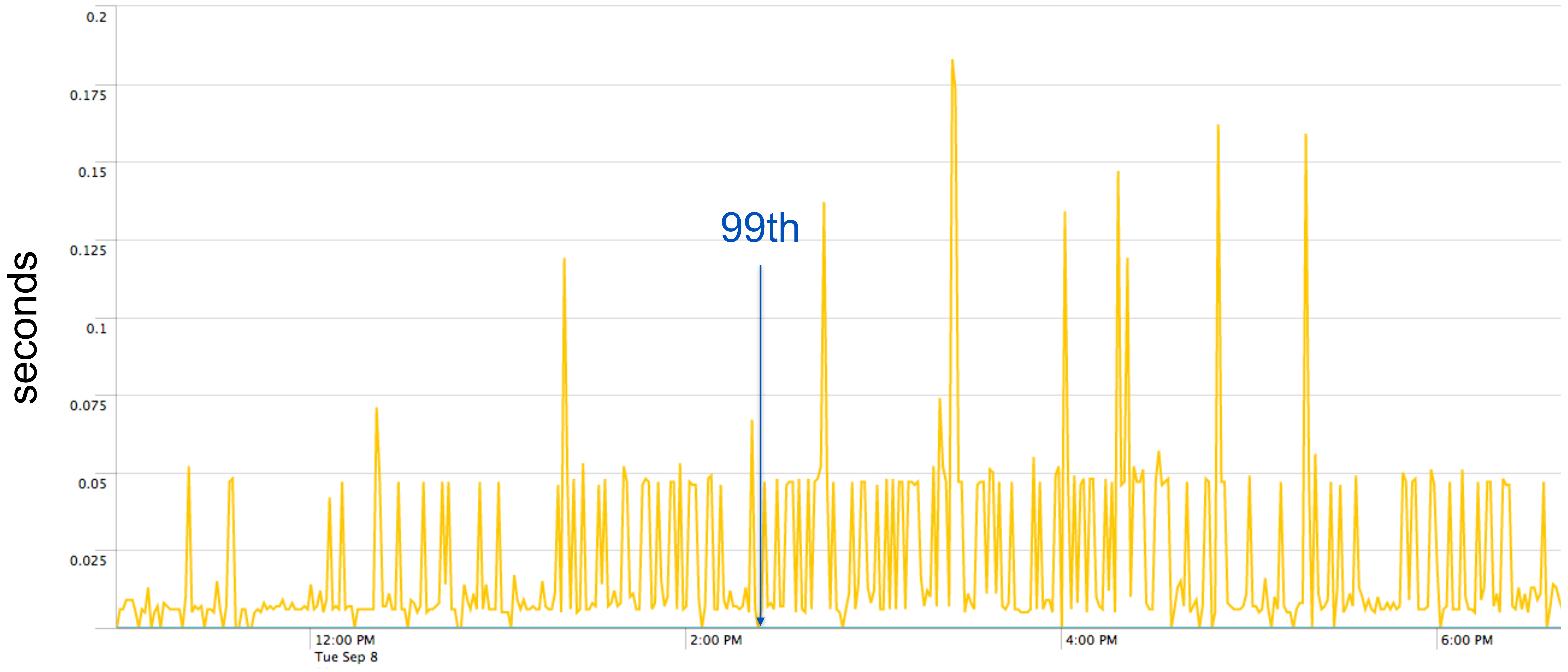

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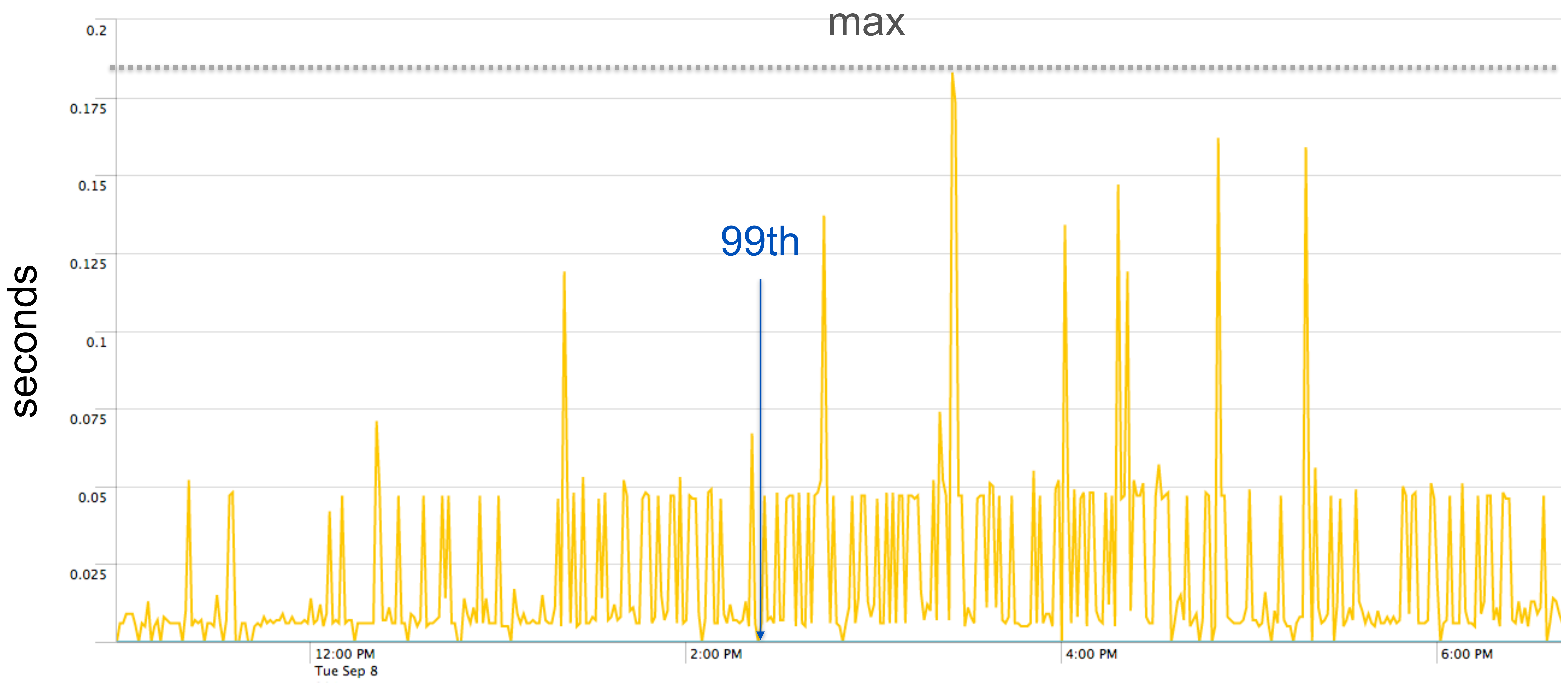

Successes

Successes

great performance improvements

Successes

great performance improvements

hosting ~400 endpoints

Successes

great performance improvements

hosting ~400 endpoints

> 367MM requests a day

Successes

great performance improvements
hosting ~400 endpoints
> 367MM requests a day
prevented upstream downtime

Challenges

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3rd-party Lua ecosystem

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3rd-party Lua ecosystem
not self-service yet

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configuration file size

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3rd-party Lua ecosystem
not self-service yet
configuration file size
kernel tuning

Challenges

3rd-party Lua ecosystem
not self-service yet
configuration file size
kernel tuning
owning availability

Conclusion

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NGINX + Lua for HTTP middleware

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NGINX + Lua for HTTP middleware
Automated deployment pipeline

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NGINX + Lua for HTTP middleware
Automated deployment pipeline
Concurrent request limiting

Conclusion

NGINX + Lua for HTTP middleware
Automated deployment pipeline
Concurrent request limiting
Operational flexibility

Thanks