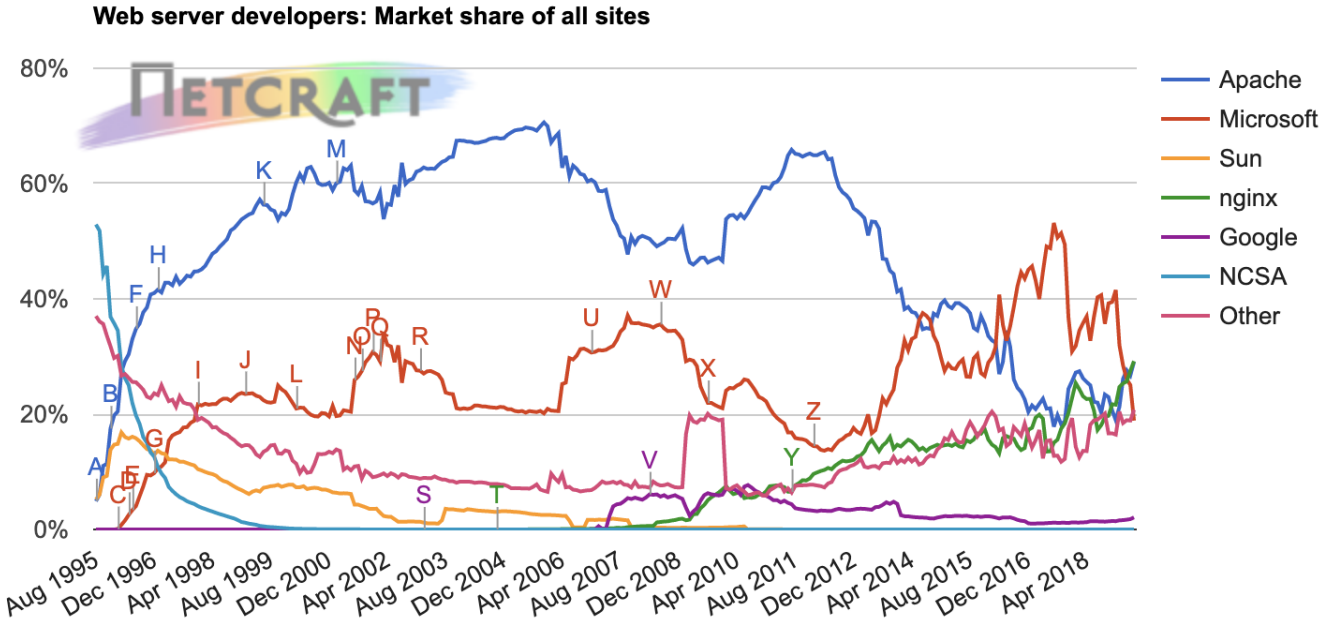
NGINX: Basics and Best Practices

NGINX

Agenda

- Introducing NGINX
- ADC Augment and Modernization
- Installing NGINX and NGINX Plus
- Essential files, commands, and directories
- Basic configurations
- Advanced configurations
- Monitoring and Logging
- Summary

Introducing Nginx



NGINX is the most used web server on the internet

Source: w3techs, May 2019

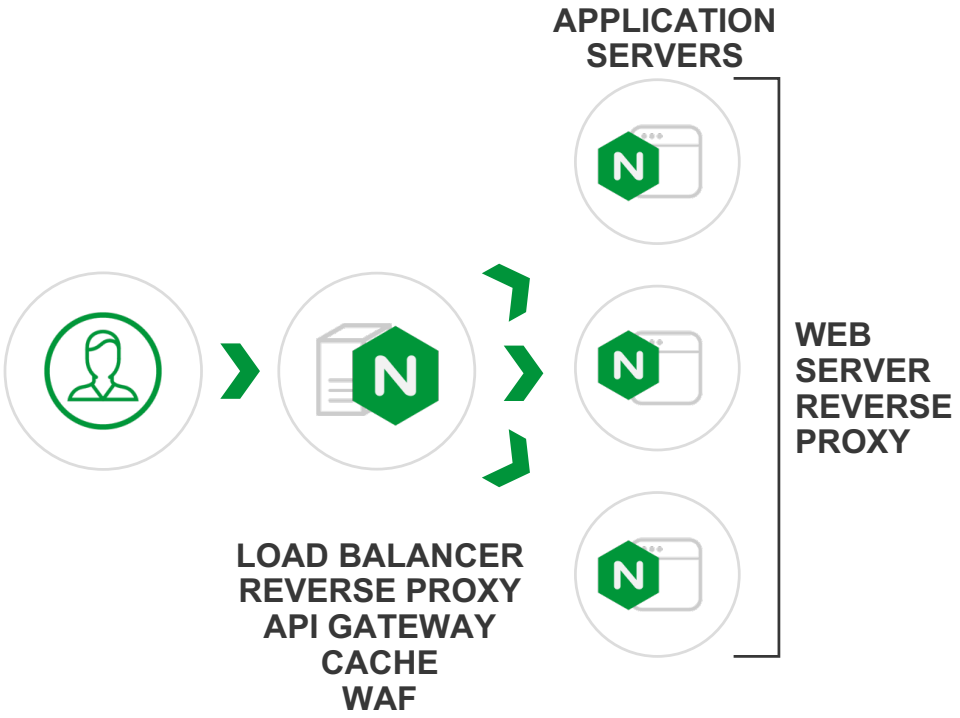
What is NGINX?

NGINX

- Basic load balancer
- Reverse Proxy and Web Server
- Content Cache
- SSL termination
- Rate limiting
- Basic authentication

NGINX PLUS

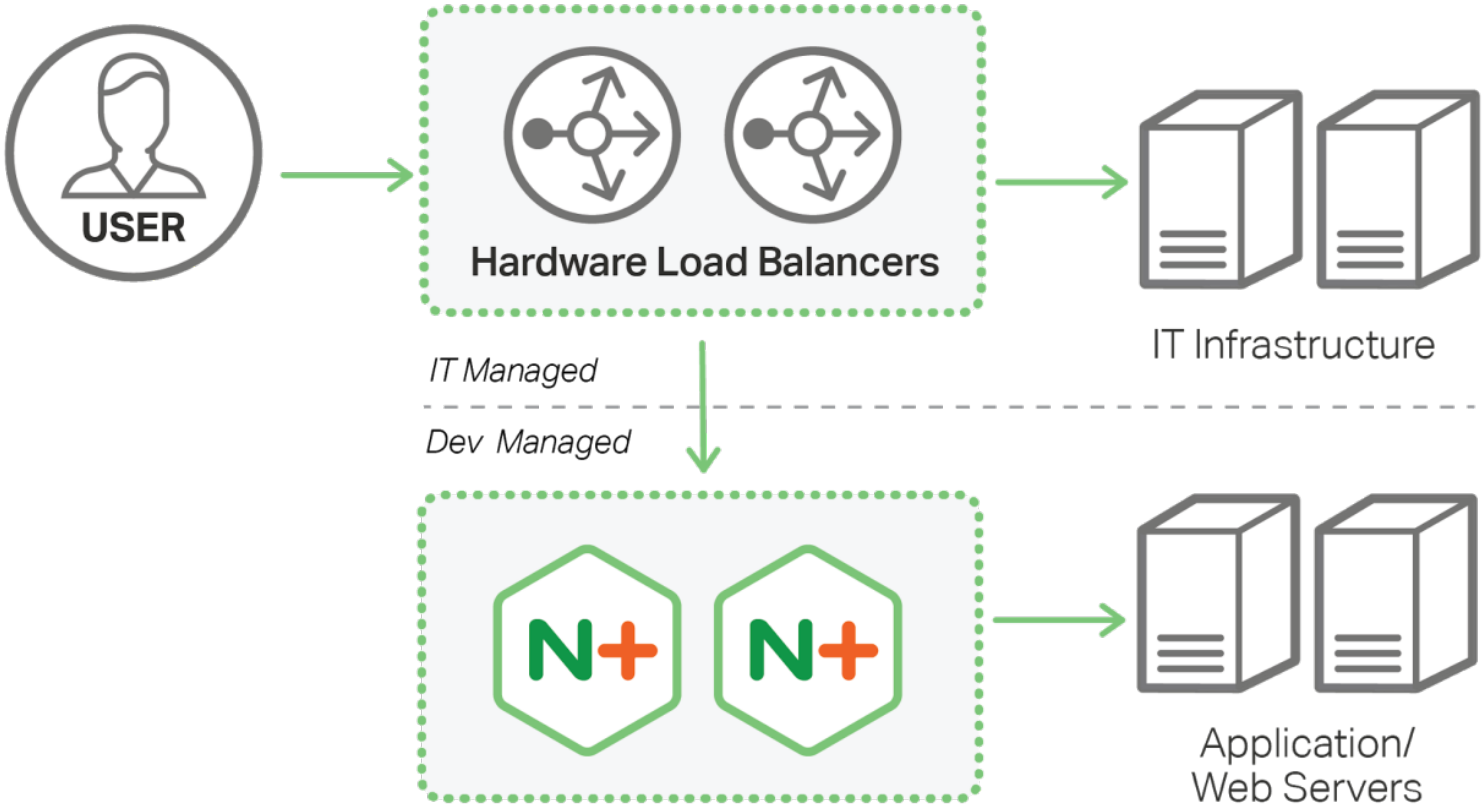
- Active health checks
- Session persistence
- DNS service discovery integration
- Cache-purging API
- JWT authentication and OpenID Connect
- Live Activity monitoring (100+ real time metrics)
- Dynamic Modules
- API for Dynamic reconfiguration, Cache-purge, key-value store
- High Availability, Cluster State sync ……much more.



ADC Augment and Modernization

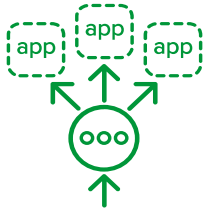
What's happening now

Traditional Application Infrastructure are being augmented



ADC Augment - key use cases

Key use cases

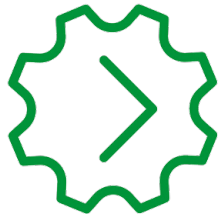


ADC Augment

Enhancing existing app environments

ADC for Multi-Cloud

Scale and Secure Apps across multi-cloud



API Management

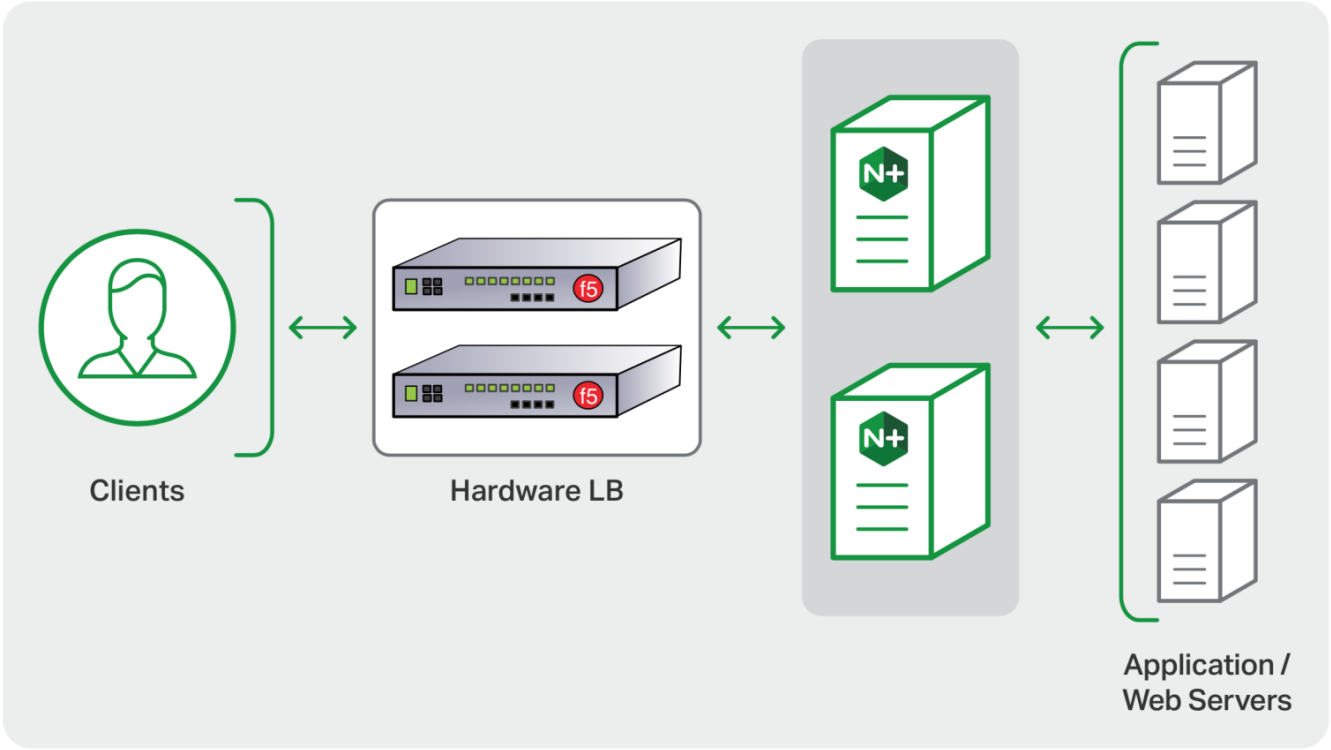
End-to-end API lifecycle services

Kubernetes Integration

Flexible and scalable app services

1. Augment Traditional Load Balancers

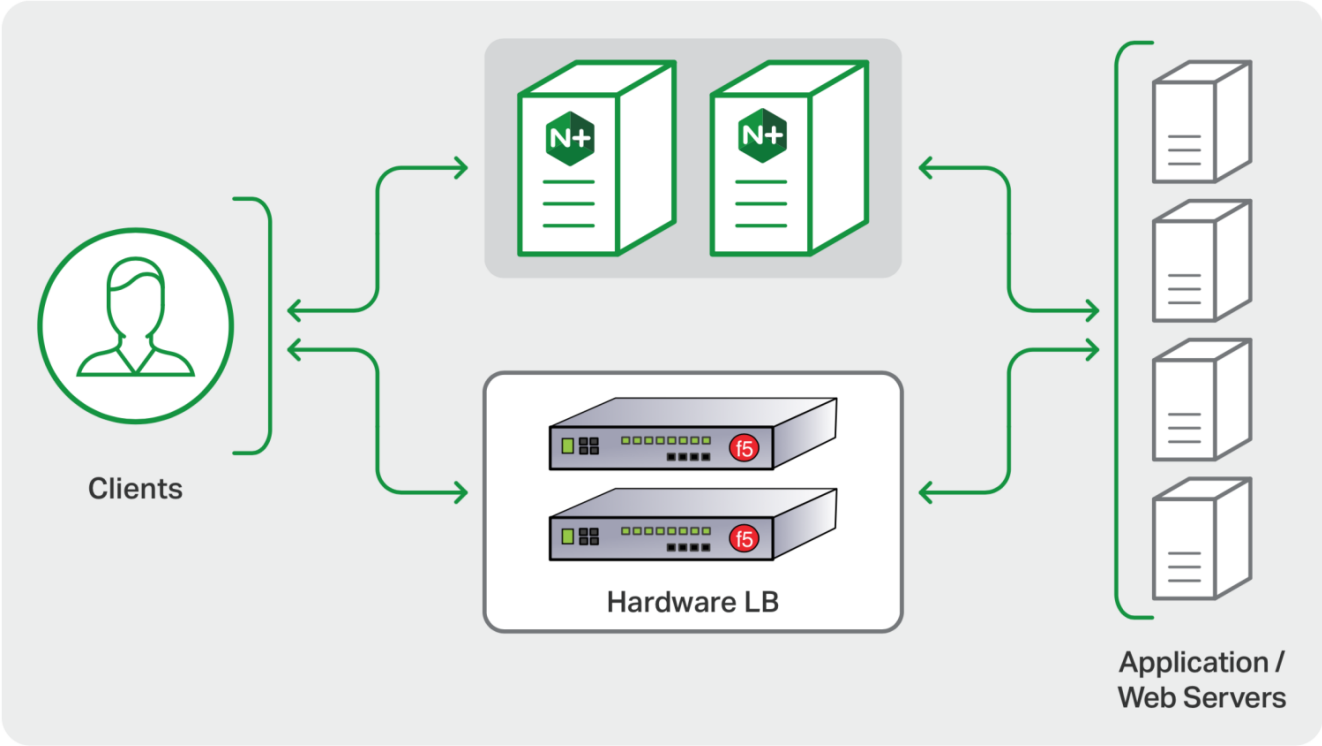
Traditional Application Infrastructure are being augmented



- Easiest way to introduce NGINX into your network
- Hardware layer 4 load balancer to NGINX
- Can start small with one application being behind NGINX and then expand

2. NGINX Alongside Hardware ADCs

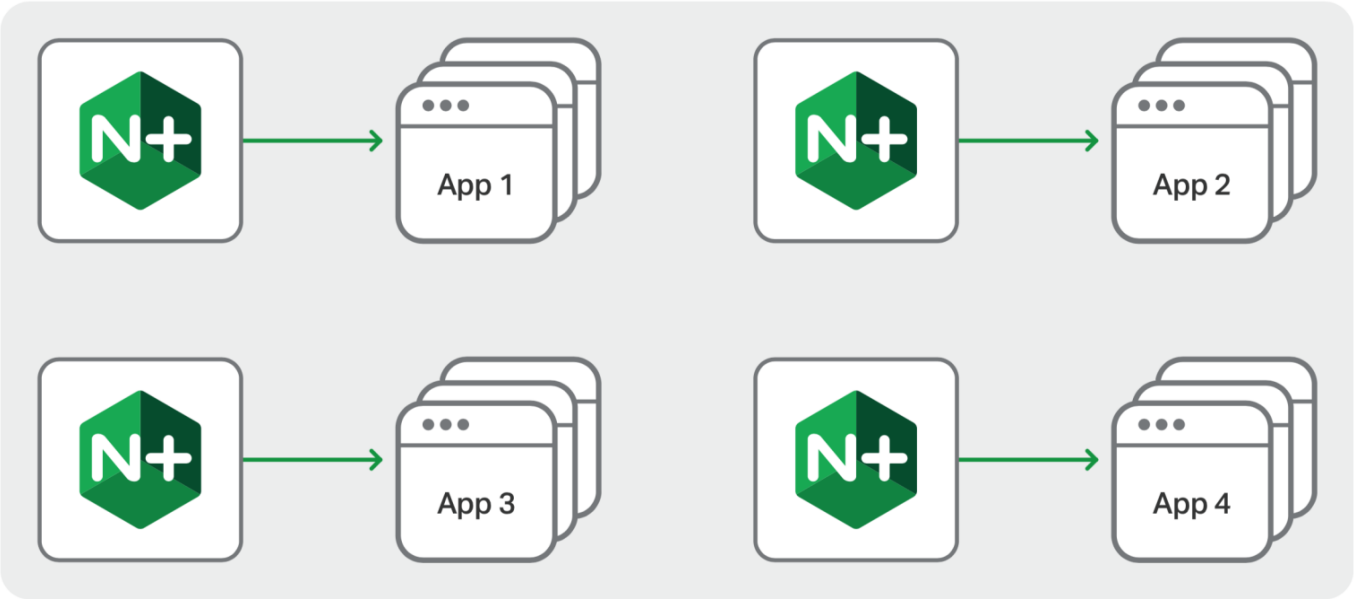
Offload or Migrate new application workloads



- Parallel NGINX deployment
- Good architecture if adopting public cloud while still keeping private datacenter
- Can also start small with one application being behind NGINX and then expand

3. Micro Load Balancers/Gateways

Legacy Hardware ADC replace to a application centric architecture

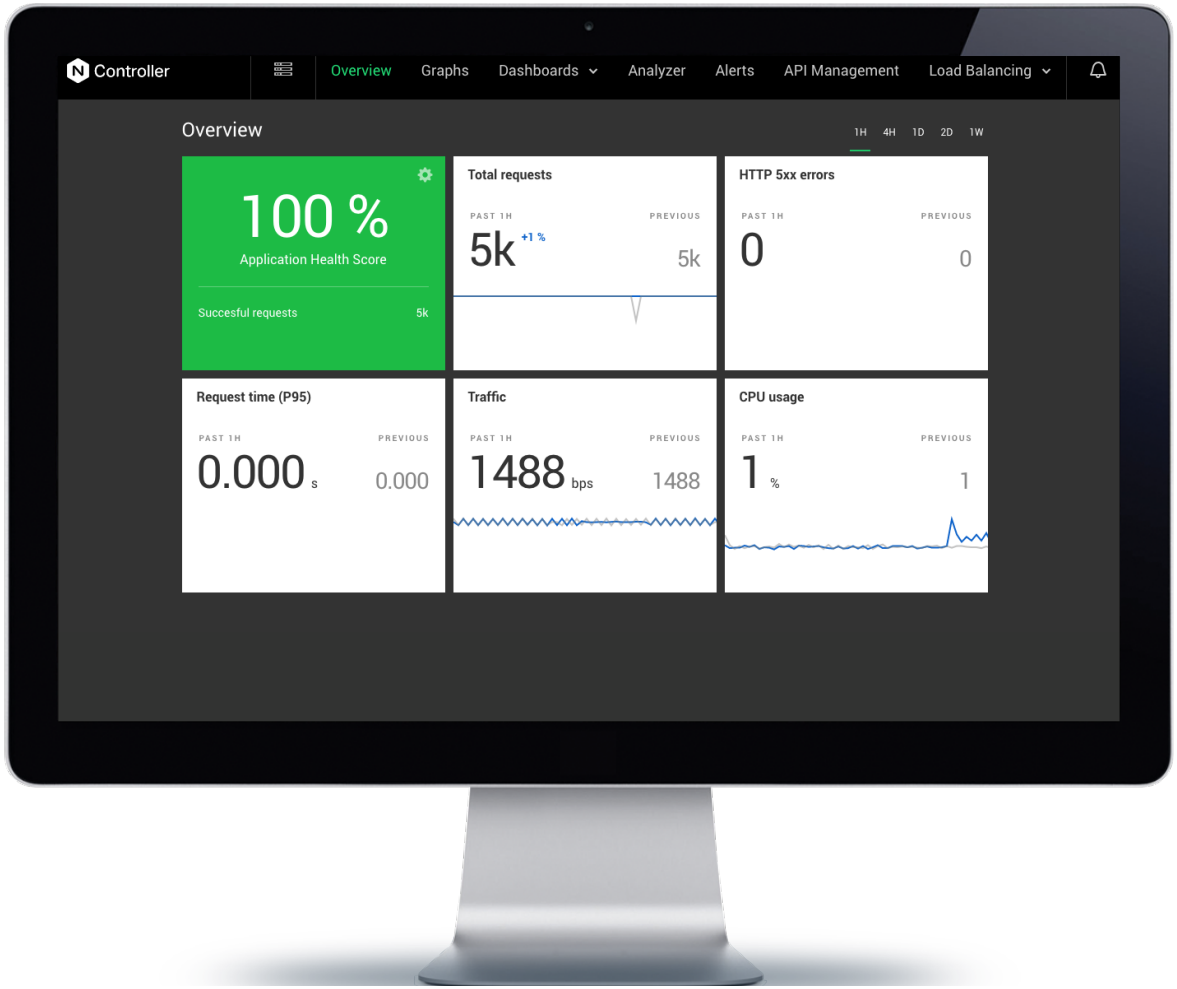


- Load balancer per application
- Load balancer per customer for SaaS providers
- Configuration stored along with application in GitHub
- Fully portable

What is the NGINX Controller?

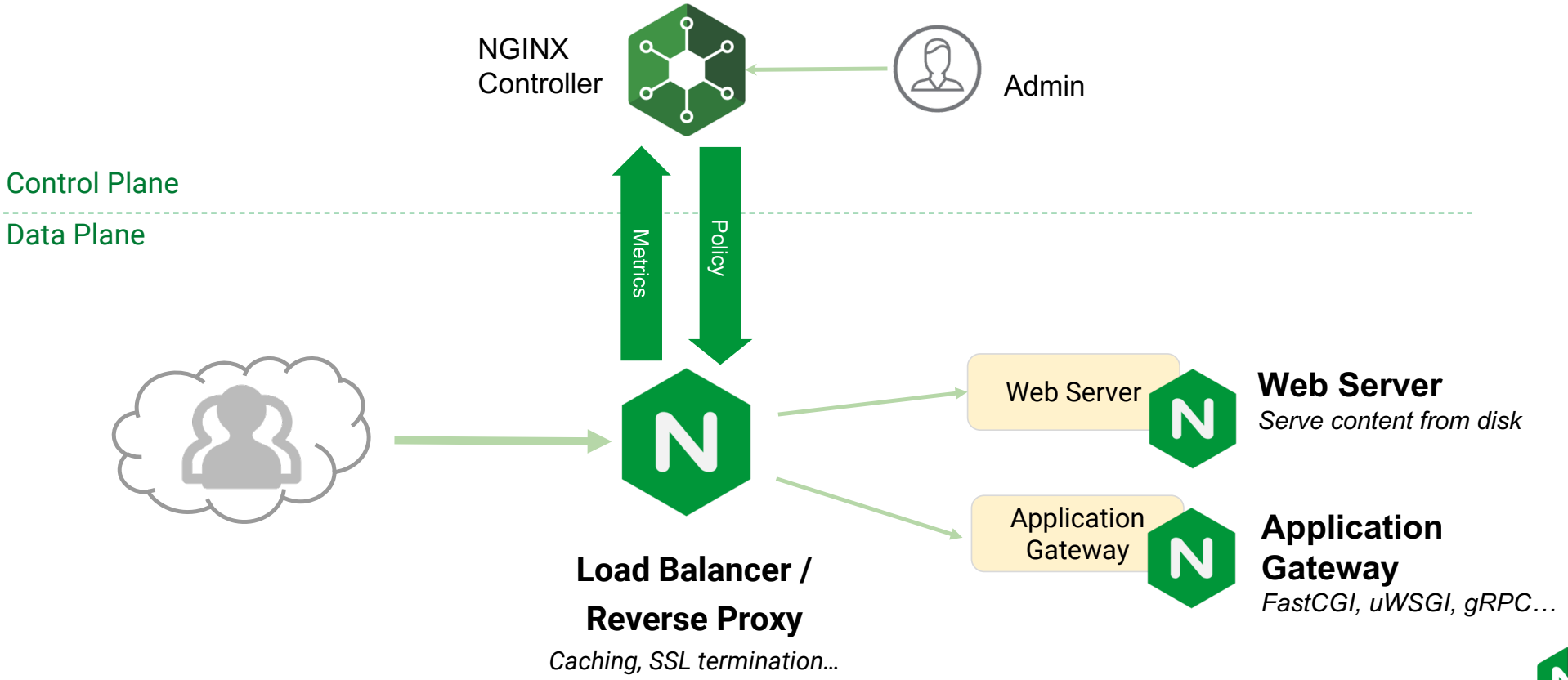
Centralized Monitoring and management

- Alerting
- API management
- Load balancer management
- Configuration analysis
- Customizable dashboards
- Monitoring



What is NGINX and NGINX Controller?

Nginx and the Nginx Controller



Installing NGINX

Nginx Installation Options

- **Official NGINX repo**
  - **Mainline (recommended) - Actively developed; new minor releases made every 4-6 weeks with new features and enhancements.**
  - **Stable** - Updated only when critical issues or security vulnerabilities need to be fixed.
  - **NGINX PLUS -** receives all new features, once they have been tested and proven in NGINX mainline. Additional enterprise-specific features are included in NGINX Plus.
- **OS vendor and other 3rd party repos**
  - Not as frequently updated; e.g. Debian Jessie (8.9) has NGINX 1.6.2
  - Typically built off NGINX mainline branch, sometimes with 3rd party mods
- **Compile from source**
  - Most difficult.-Download the latest version of the NGINX source code, configure, build and install it. You will have the option of building various Nginx module

NGINX Installation: Debian/Ubuntu

Create `/etc/apt/sources.list.d/nginx.list` with the following contents:

```
deb http://nginx.org/packages/mainline/OS/ CODENAME nginx

deb-src http://nginx.org/packages/mainline/OS/ CODENAME nginx
```

- OS – `ubuntu` or `debian` depending on your distro
- CODENAME:
  - `jessie` or `stretch` for `debian`
  - `trusty`, `xenial`, `artful`, or `bionic` for `ubuntu`

```
$ wget http://nginx.org/keys/nginx_signing.key
$ apt-key add nginx_signing.key
$ apt-get update
$ apt-get install –y nginx
$ /etc/init.d/nginx start
```

NGINX Installation: CentOS/Red Hat

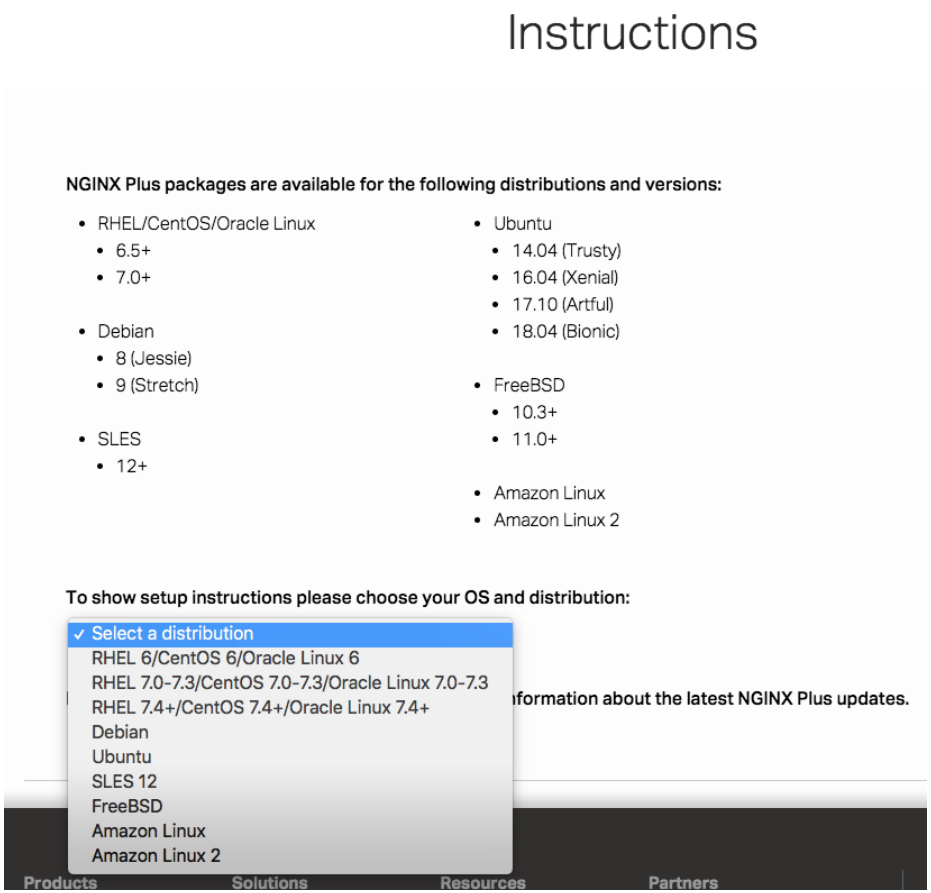
Create `/etc/yum.repos.d/nginx.repo` with the following contents:

```
[nginx]
name=nginx repo
baseurl=http://nginx.org/packages/mainline/OS/OSRELEASE/$basearch/
gpgcheck=0
enabled=1
```

- OS -- `rhel` or `centos` depending on your distro
- OSRELEASE -- `6` or `7` for 6.x or 7.x versions, respectively

```
$ yum –y install nginx
$ systemctl enable nginx
$ systemctl start nginx
$ firewall-cmd --permanent --zone=public --add-port=80/tcp
$ firewall-cmd --reload
```

NGINX Plus Installation



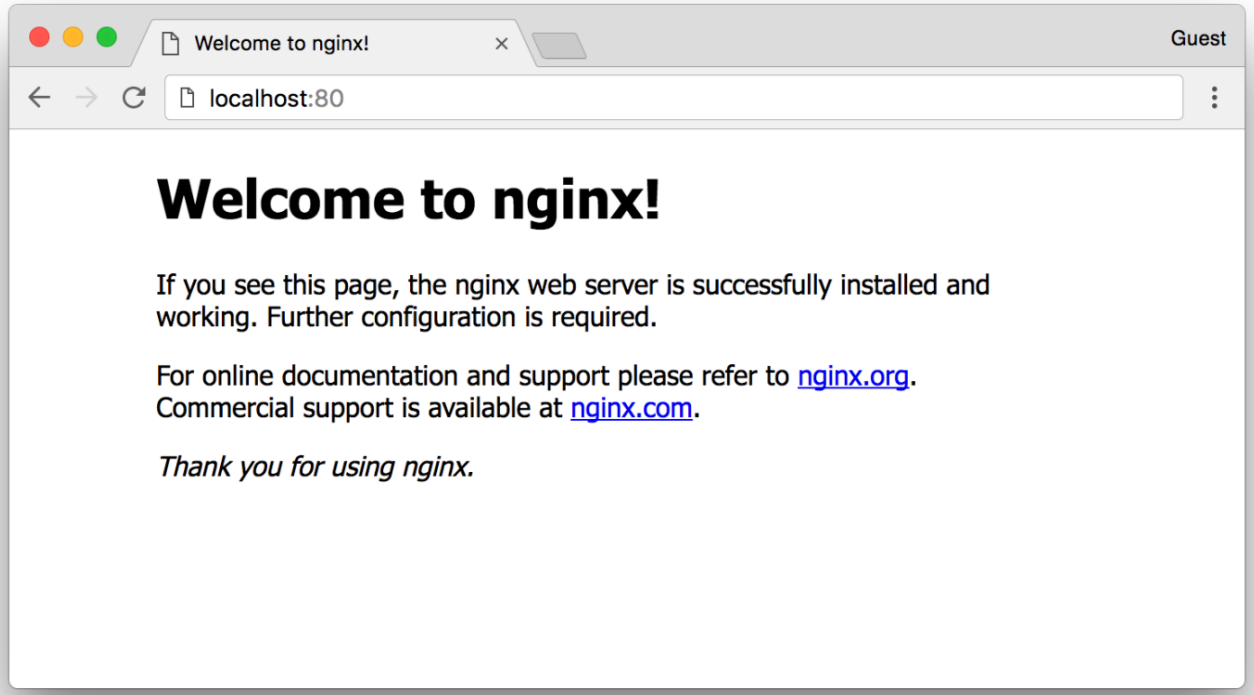
- Visit `cs.nginx.com/repo_setup`
- Select OS from drop down list
- Instructions similar to OSS installation
- Mostly just using a different repo and installing client certificate

Verifying Installation

```
$ nginx -v
nginx version: nginx version: nginx/1.15.7 (nginx-plus-r17)

$ ps -ef | grep nginx
root       1088      1  0 19:59 ?        00:00:00 nginx: master process /usr/sbin/nginx -c /etc/nginx/nginx.conf
nginx      1092   1088  0 19:59 ?        00:00:00 nginx: worker process
```

Verifying Installation



MORE INFORMATION AT
NGINX.COM

NGINX Installation Misc

- For more installation details: `http://nginx.org/en/linux_packages.html`
  - List of all supported distros and CPUs

- For **NGINX Plus**, see: `https://cs.nginx.com/repo_setup`
  - List of all supported distros and CPUs, including FreeBSD

Essential files, commands and directories

Key NGINX Commands

nginx -h	Shows all command line options
nginx -t	Configuration syntax check
nginx -T	Displays full, concatenated configuration
nginx -V	Shows version and build details
nginx –s reload	Gracefully reload NGINX processes

```
$ sudo nginx –t && sudo nginx –s reload
nginx: the configuration file /etc/nginx/nginx.conf syntax is ok
nginx: configuration file /etc/nginx/nginx.conf test is successful
```

```
$ sudo nginx -T > nginx_support_mm-dd-yy.txt
```

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Key System Commands

`ps aux | grep nginx`	To check running processes
`ps -ef --forest | grep nginx`	To check running processes (Show Process Hierarchy in Forest Format)
`service nginx status` `systemctl status nginx`	Show Nginx Status
`netstat -tulpn`	Information and statistics about protocols in use and current TCP/IP network connections.
`sudo lsof -i -P -n`	Check the listening ports and applications on linux

```
# Path to executable path
$ /usr/sbin/nginx

# Default Log Path
$ /var/log/nginx
```

Key Files and Directories

- **`/etc/nginx/`** `# Where all NGINX configuration is stored`
- **`/etc/nginx/nginx.conf`** `# Top-level NGINX configuration, should not require much modification`
- **`/etc/nginx/conf.d/*.conf`** `# Where your HTTP/S configuration for virtual servers and upstreams goes, e.g. www.example.com.conf`
- **`/etc/nginx/stream.d/*.conf`** `# Where your TCP/UDP Streams for virtual servers and upstreams goes, e.g. DNS_53.conf`
- **`/var/log/nginx/access.log`** `# Details about requests and responses`
- **`/var/log/nginx/error.log`** `# Details about NGINX errors`

Key Files and Directories

/etc/nginx/

nginx.conf

```
#global settings here

http {
    # HTTP global settings
here

include conf.d/*.conf;
}
```

Global settings (tunings, logs, etc)

HTTP block

/etc/nginx/conf.d/

example.com.conf

```
server {
    listen <parameters>;

    location <url> {
        ----------------
    }
}

upstream {
    ------------------
}
```

Listen for requests

Rules to handle each request

Optional: upstreams configurations in same file,

something.com.conf.disabled Not loaded

Basic configurations

Simple Virtual Server

```
server {
    listen       80 default_server;
    server_name  www.example.com;

    # ...
}
```

- `server` defines the context for a virtual server
- `listen` specifies IP/port NGINX should listen on. No IP means bind to all IPs on system
- `server_name` specifies hostname of virtual server

Basic Web Server Configuration

```
server {
    listen       80 default_server;
    server_name  www.example.com;

    location / {
        root   /usr/share/nginx/html;
        index  index.html index.htm;

    }
}
```

- `root` specifies directory where files are stored
- `index` defines files that will be used as an index

- `www.example.com maps to /usr/share/nginx/html/index.html (then index.htm)`
- `www.example.com/i/file.txt -> /usr/share/nginx/html/i/file.txt`

Multiplexing Multiple Sites on One IP

```
server {
    listen       80 default_server;
    server_name  www.example.com;
    # ...
}
server {
    listen       80;
    server_name  www.example2.com;
    # ...
}
server {
    listen       80;
    server_name  www.example3.com;
    # ...
}
```

- NGINX can multiplex a single IP/port using the `Host:` header.
- `default_server` defines the virtual server to use if `Host` header is empty. It is best practice to have a `default_server`.

Basic SSL Configuration

```
server {
    listen       80 default_server;
    server_name  www.example.com;
    return 301 https://$server_name$request_uri;
}
server {
    listen 443 ssl default_server;
    server_name  www.example.com;
    ssl_certificate cert.crt;
    ssl_certificate_key cert.key;
    ssl_ciphers HIGH;

    location / {
        root   /usr/share/nginx/html;
        index  index.html index.htm;
    }
}
```

- Force all traffic to SSL is good for security, customer trust and SEO
- Use Let's Encrypt to get free SSL certificates
- Use Mozilla SSL Configuration Generator to generate recommended nginx SSL configurations: `https://mozilla.github.io/server-side-tls/ssl-config-generator/`

Basic HTTP/2 Configuration

```
server {
    listen 443 ssl http2 default_server;
    server_name  www.example.com;

    ssl_certificate cert.crt;
    ssl_certificate_key cert.key;
}
```

- HTTP/2 improves performance with little to no backend changes
- Add `http2` parameter to `listen` directive of existing SSL-enabled virtual server. HTTP/2 is only supported with SSL in all browsers.
- NGINX only does HTTP/2 client side, server side is still HTTP/1.1. gRPC is a special case.
- Note: HTTP/2 requires OpenSSL 1.0.2 or later to work properly

Basic Reverse Proxy Configuration

```
server {
    location ~ ^(.+\.php)(.*)$ {
        fastcgi_split_path_info ^(.+\.php)(.*)$;

        # fastcgi_pass 127.0.0.1:9000;
        fastcgi_pass unix:/var/run/php7.0-fpm.sock;

        fastcgi_index index.php;
        include fastcgi_params;
    }
}
```

- Requires PHP FPM:
  `apt-get install –y php7.0-fpm`
- Can also use PHP 5
- Similar directives available for uWSGI and SCGI.
- Additional PHP FPM configuration may be required

Basic Load Balancing Configuration

```
upstream my_upstream {
    server server1.example.com:80;
    server server2.example.com:80;
    least_conn;
}
server {
    location / {
        proxy_set_header Host $host;
        proxy_pass http://my_upstream;
    }
}
```

- `upstream` defines the load balancing pool
- Default load balancing algorithm is round robin. Others available:
  - `least_conn` selects server with least amount of active connections
  - `least_time` factors in connection count and server response time. Available in NGINX Plus only.
- `proxy_pass` links virtual server to `upstream`
- By default NGINX rewrites `Host` header to name and port of proxied server. `proxy_set_header` overrides and passes through original client `Host` header.

Layer 7 Request Routing

```
server {
    # ...

    location /service1 {
        proxy_pass http://upstream1;
    }

    location /service2 {
        proxy_pass http://upstream2;
    }

    location /service3 {
        proxy_pass http://upstream3;
    }
}
```

- `location` blocks are used to do Layer 7 routing based on URL
- Regex matching can also be used in `location` blocks

Basic Caching Configuration

```
proxy_cache_path /path/to/cache levels=1:2
                 keys_zone=my_cache:10m max_size=10g
                 inactive=60m use_temp_path=off;

server {
    location / {
        proxy_cache my_cache;
        # proxy_cache_valid 5m;
        proxy_set_header Host $host;
        proxy_pass http://my_upstream;
    }
}
```

- `proxy_cache_path` defines the parameters of the cache.
- `keys_zone` defines the size of memory to store cache keys in. A 1 MB zone can store data for about 8,000 keys.
- `max_size` sets upper limit of cache size. Optional.
- `inactive` defines how long an object can stay in cache without being accessed. Default is 10 m.
- `proxy_cache` enables caching for the context it is in

Advanced configurations

Modifications to main nginx.conf

```
user  nginx;
worker_processes auto;

# ...

http {
    # ...

    keepalive_timeout 300s;
    keepalive_requests 100000;
}
```

- Set in main nginx.conf file
- Default value for worker_processes varies on system and installation source
- `auto` means to create one worker process per core. This is recommended for most deployments.
- `keepalive_timeout` controls how long to keep idle connections to clients open. Default: 75s
- `keeplive_requests` Max requests on a single client connection before its closed.Default: 100
- `keepalive_*` can also be set per virtual server

HTTP/1.1 Keepalive to Upstreams

```
upstream my_upstream {
    server server1.example.com;
    keepalive 32;
}
server {
    location / {
        proxy_set_header Host $host;
        proxy_http_version 1.1;
        proxy_set_header Connection "";

        proxy_pass http://my_upstream;
    }
}
```

- `keepalive` enables TCP connection cache
- By default NGINX uses HTTP/1.0 with `Connection: Close`
- `proxy_http_version` upgrades connection to HTTP/1.1
- `proxy_set_header` enables keepalive by clearing `Connection: Close` HTTP header

SSL Session Caching

```
server {
    listen 443 ssl default_server;
    server_name  www.example.com;

    ssl_certificate cert.crt;
    ssl_certificate_key cert.key;

    ssl_session_cache   shared:SSL:10m;
    ssl_session_timeout 10m;
}
```

- Improves SSL/TLS performance
- 1 MB session cache can store about 4,000 sessions
- Cache shared across all NGINX workers

Advanced Caching Configuration

```
proxy_cache_path /path/to/cache levels=1:2
                 keys_zone=my_cache:10m max_size=10g
                 inactive=60m use_temp_path=off;

server {
    location / {
        proxy_cache my_cache;
        proxy_cache_lock on;
        proxy_cache_revalidate on;
        proxy_cache_use_stale error timeout updating
                 http_500 http_502 http_503 http_504;
        proxy_cache_background_update on;

        proxy_set_header Host $host;
        proxy_pass http://my_upstream;
    }
}
```

- `proxy_cache_lock` instructs NGINX to only send one request to the upstream when there are multiple cache misses for the same file.
- `proxy_cache_revalidate` instructs NGINX to use `If-Modified-Since` when refreshing cache.
- `proxy_cache_use_stale` instructs NGINX to serve stale content instead of an error.
- `proxy_cache_background_update` instructs NGINX to do all cache updates in the background. Combined with `proxy_cache_use_stale updating`, stale content will be served.

gRPC Proxying with SSL Termination


```
server {
    listen 443 ssl http2;
     ssl_certificate     server.crt;
     ssl_certificate_key server.key;

    location / {
        grpc_pass grpc://localhost:50051;
    }
}
```

- Configure SSL and HTTP/2 as usual
- Go sample application needs to modified to point to NGINX IP Address and port.

Active Health Checks

```
upstream my_upstream {
    zone my_upstream 64k;
    server server1.example.com slow_start=30s;
    server server2.example.com slow_start=30s;

}
server {
    # ...
    location @health {
        internal;
        health_check interval=5s uri=/test
            match=statusok;
        proxy_set_header HOST www.example.com;
        proxy_pass http://my_upstream;
    }

match statusok {
    # Used for /test.php health check
    status 200;
    header Content-Type = text/html;
    body ~ "i'm is alive";
}
```

- Polls `/test` every 5 seconds
- If response is not `200`, server marked as failed
- If response body does not contain "I'm alive", server marked as failed
- Recovered/new servers will slowly ramp up traffic over 30 seconds
- Exclusive to NGINX Plus

Sticky Cookie Session Persistence

```
upstream my_upstream {
    server server1.example.com;
    server server2.example.com;

    sticky cookie name expires=1h
        domain=.example.com path=/;
}
```

- NGINX will insert a cookie using the specified *name*
- `expires` defines how long the cookie is valid for. The default is for the cookie to expire at the end of the browser session.
- `domain` specifies the domain the cookie is valid for. If not specified, domain field of cookie is left blank
- `path` specifies the path the cookie is set for. If not specified, path field of cookie is left blank
- Exclusive to NGINX Plus

Monitoring and Logging

NGINX Access Logs

```
access_log  /var/log/nginx/access.log;
```

```
192.168.179.1 - - [15/May/2017:16:36:25 -0700] "GET / HTTP/1.1" 200 612 "-" "Mozilla/5.0 (Macintosh; Intel Mac OS X
10_12_3) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/58.0.3029.110 Safari/537.36" "-"
192.168.179.1 - - [15/May/2017:16:36:26 -0700] "GET /favicon.ico HTTP/1.1" 404 571 "http://fmemon-redhat.local/"
"Mozilla/5.0 (Macintosh; Intel Mac OS X 10_12_3) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/58.0.3029.110
Safari/537.36" "-"
192.168.179.1 - - [15/May/2017:16:36:31 -0700] "GET /basic_status HTTP/1.1" 200 100 "-" "Mozilla/5.0 (Macintosh; Intel
Mac OS X 10_12_3) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/58.0.3029.110 Safari/537.36" "-"
```

- Enabled by default. Can be disabled with the `access_log off` directive.
- Nginx uses the **combined log format** (also used by Apache) and includes IP address, date, request , referrer, user agent, etc. You can add additional NGINX variables, e.g. timing and a Log format configurable with the `log_format` directive
- Can enable access logs at a virtual server scope

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NGINX Error Logs

```
error_log  /var/log/nginx/error.log [level];
```

```
2018/03/22 11:29:08 [error] 12696#12696: upstream timed out (110: Connection timed out) while connecting to upstream,
health check "" of peer 10.70.88.24:8832 in upstream "Dev.InternalApi"
2018/03/22 11:29:23 [error] 12696#12696: upstream timed out (110: Connection timed out) while connecting to upstream,
health check "" of peer 10.70.88.15:8832 in upstream "Dev.InternalApi"
2018/03/23 15:25:35 [error] 19997#0: *1 open() "/var/www/nginx-default/phpmy-admin/scripts/setup.php" failed (2: No such
file or directory), client: 80.154.42.54, server: localhost, request: "GET /phpmy-admin/scripts/setup.php HTTP/1.1",
host: "www.example.com"
```

- Enabled by default. Can be disabled with the `error_log off` directive.
- Can enable access logs at a virtual server scope
- Log to file, stderr, syslog or memory
- Option to log for selected clients

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Error Log Levels

```
error_log  /var/log/nginx/error.log [level];
```

debug	Detailed Trace
info	General Info
notice	Something Normal
warn	Something Strange
error	Unsuccessful
crit	Important Issue(s)
alert	Fix Now!
emerg	Unusable

MORE INFORMATION AT
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Extra examples

```
log_format simple escape=json
 '{"timestamp":"$time_iso8601","client":"$remote_addr","uri":"$uri","status":"$status"}';

server {
    server_name  www.example.com;
    access_log /var/log/nginx/example.log simple;
    error_log syslog:server=192.168.1.1 debug;
}

server {
    server_name  www.example2.com;
         map $status $condition {
        ~^[23] 0;
        default 1;
    }
    access_log /var/log/nginx/example2.log simple custom if=$condition;
    error_log  /var/log/nginx/example2_error.log info;
}
```

Example log parsing commands:

`tail -f 10 error.log`	Tail error logs (last 10 lines)
`tail -f 10 access.log | grep 127.0.0.1`	Tail and grep (filter) access logs
`cat access.log | cut -d '"' -f3 | cut -d ' ' -f2 | sort | uniq -c | sort -rn`	Sort access by Response Codes
`awk '($9 ~ /404/)' access.log | awk '{print $7}' | sort | uniq -c | sort -rn`	Which links are broken (HTTP 404)?
`awk -F\" '{print $2}' access.log | awk '{print $2}' | sort | uniq -c | sort -r`	What are my most requested links?

NGINX Stub Status Module

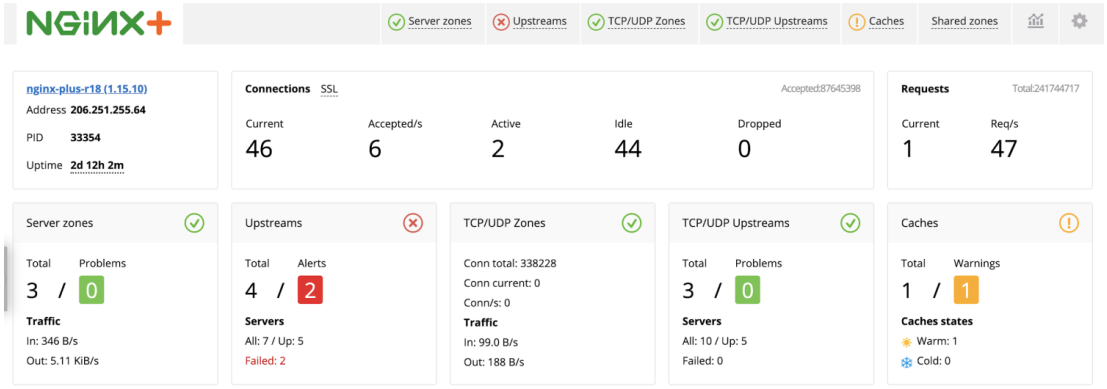
```
server {
    location /basic_status {
        stub_status;
    }
}
```

```
$ curl http://127.0.0.1/basic_status
Active connections: 1
server accepts handled requests
 7 7 7
Reading: 0 Writing: 1 Waiting: 0
```

- Provides aggregated NGINX statistics
- Restrict access so it’s not publicly visible

MORE INFORMATION AT
NGINX.COM

NGINX Plus Extended Status Module



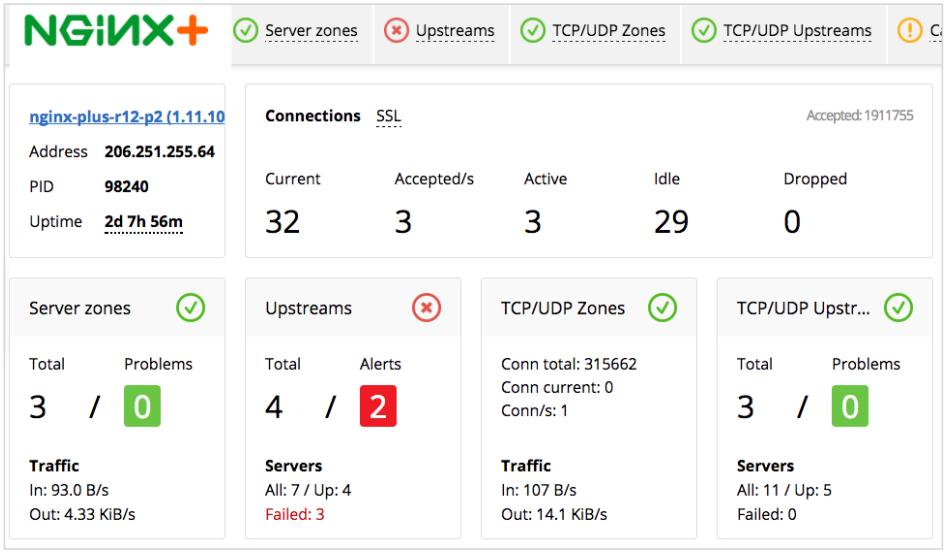

```
upstream my_upstream {
    #...
    zone my_upstream 64k;
}

server {
    #...
    status_zone my_virtual_server;
    }
```

- Provides detailed NGINX Plus statistics
- Over 100+ additional metrics
- Monitoring GUI also available; see **demo.nginx.com**
- Exclusive to NGINX Plus

MORE INFORMATION AT
NGINX.COM

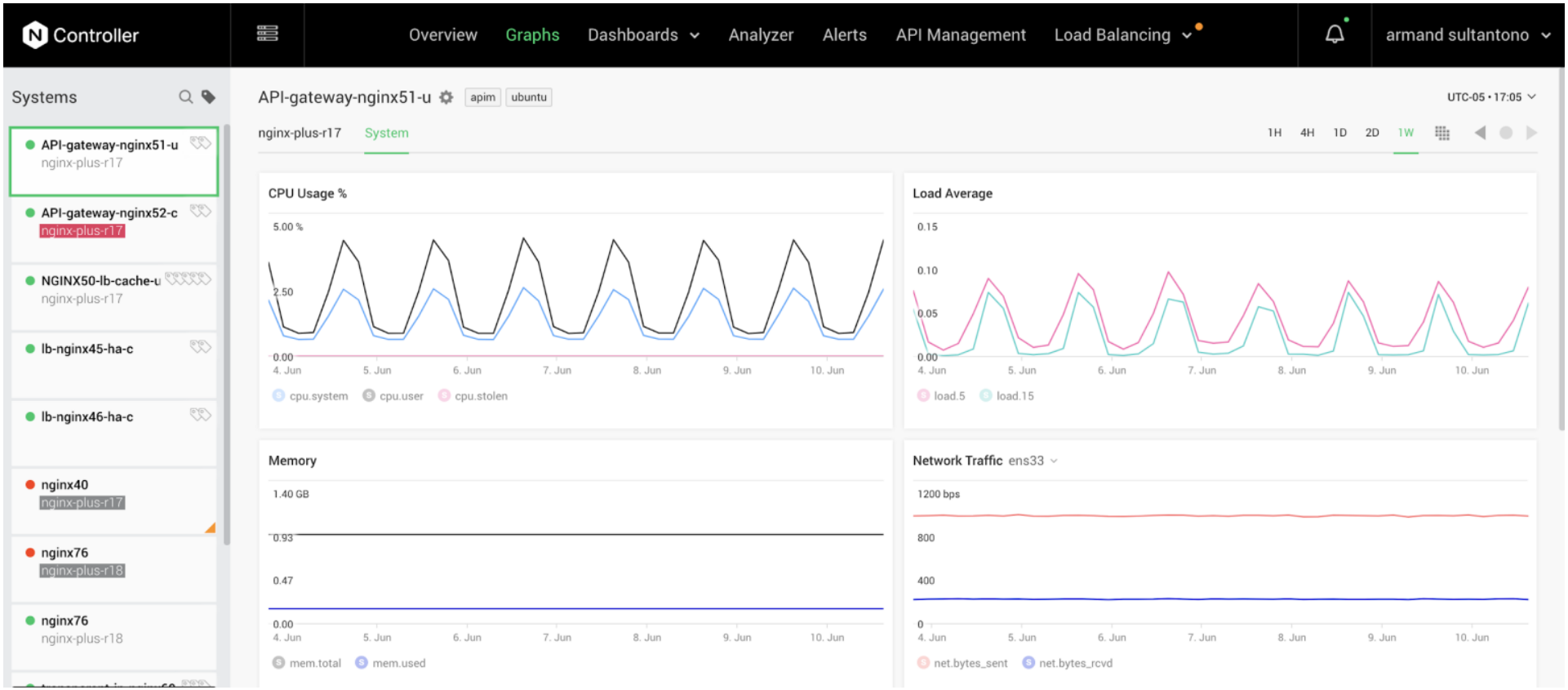
NGINX Plus Dashboard



- Over 0 metrics compared to open source NGINX
- Per virtual server and per backend server statistics
- JSON output to export to your favorite monitoring tool
- See demo.nginx.com for live demo


```
"nginx_build": "nginx-plus-r12-p2",
"nginx_version": "1.11.10",
"pid": 98240,
"ppid": 50622,
"processes": {
    "respawned": 0
},
"requests": {
    "current": 1,
    "total": 9915307
},
"server_zones": {
    "hg.nginx.org": {
        "discarded": 9150,
        "processing": 0,
        "received": 146131844,
        "requests": 597471,
        "responses": {
            "1xx": 0,
            "2xx": 561986,
            "3xx": 12839,
            "4xx": 7081,
            "5xx": 6415,
            "total": 588321
        },
        "sent": 14036626711
    },
```

NGINX Controller



Summary

Summary

- It is recommended to use the NGINX mainline branch for most deployments
- All configuration should go into separate files in `/etc/nginx/conf.d/*.conf`
- Forcing all traffic to SSL improves security and improves search rankings
- Keepalive connections improve performance by reusing TCP connections
- SSL session caching and HTTP/2 improve SSL performance
- NGINX status module and logging capability provide visibility
- NGINX Plus is recommended for all production, load balancing, API gateway deployements

Try NGINX Plus for free at **`nginx.com/free-trial-request`**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Q & A

Try NGINX Plus free for 30 days: nginx.com/free-trial-request

FAQs

- Is NGINX Plus a software package or a “virtual appliance” (an image of a virtual machine for ESX/Xen/etc.)
- What kind of 3rd party software is bundled along with NGINX Plus?
- Does NGINX Plus gather user details or installation details, or phone home?
- Can we leave everything as-is after we successfully do a trial of NGINX Plus and have purchased subscriptions, or will we need to re-install/re-deploy NGINX Plus?
- What happens when my NGINX Plus subscription expires?