

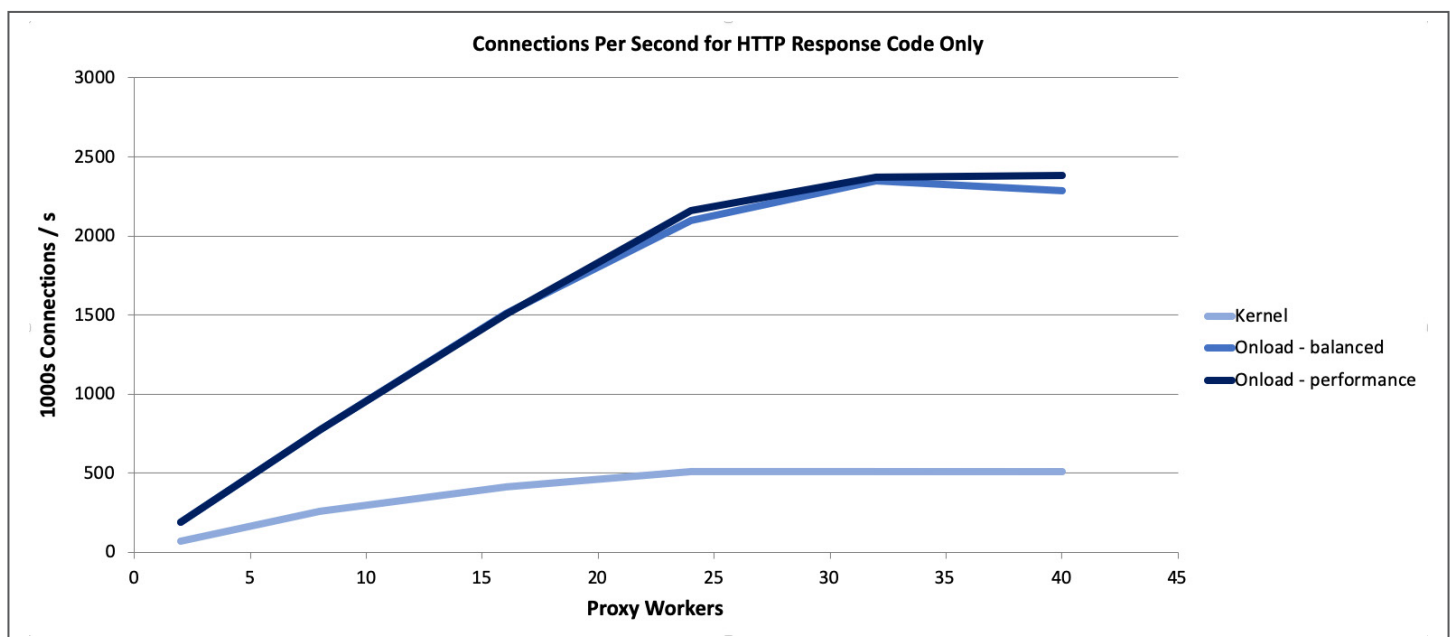
# NGINX Proxy with Cloud Onload™ Sees a 280% Performance Gain



## What is NGINX Proxy?

Open source NGINX is an HTTP and reverse proxy server, a mail proxy server, and a generic TCP/UDP proxy server. NGINX Plus is a software load balancer, web server, and content cache built on top of open source NGINX. NGINX Plus has exclusive enterprise-grade features beyond what's available in the open source offering, including session persistence, configuration via API, and active health checks. Open source NGINX was used for this benchmarking.

NGINX is heavily network dependent by design, so its performance can be significantly improved through enhancements to the underlying networking layer.



### Key Observations from Performance Testing

- Solarflare's Cloud Onload™ delivers an average performance gain of 280% for NGINX Proxy when measuring connections per second (CPS) across the range of two to 40 workers.
- When processing 1KB GET requests using 40 or fewer NGINX Proxy instances Cloud Onload on 100GbE delivers an average performance gain of 178%.
- When processing 10KB Get requests using 40 or fewer NGINX Proxy instances Cloud Onload on 100GbE delivers an average performance gain of 108%.
- When looking at the 99th percentile tail latency Cloud Onload averaged out at 30% better than the kernel at 2.2ms with a peak value of 2.9ms through 4 million requests per second (RPS). It should be noted that at 1.1 million RPS the kernel latency shot through the roof at 70ms and kept climbing.

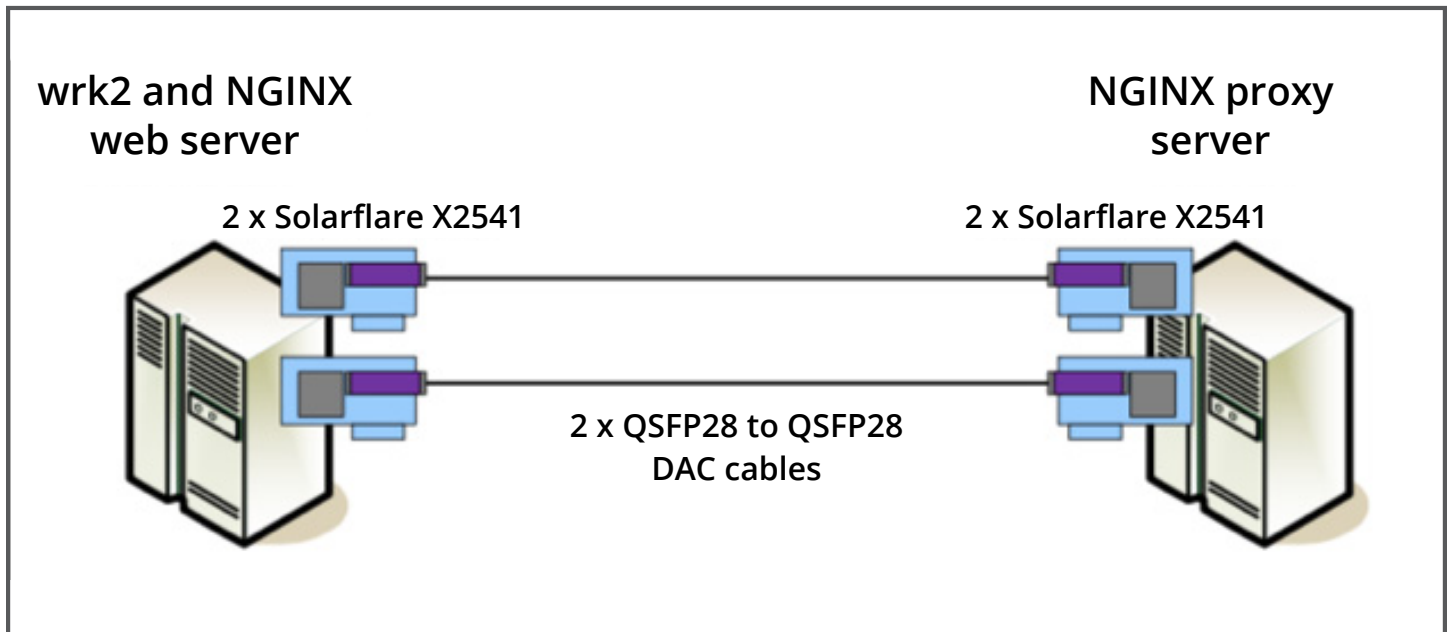
## Why NGINX Proxy Benefits from Kernel Bypass

Since NGINX Proxy is network intensive, every request includes network processing overhead. Whenever an application like NGINX Proxy touches hardware, other than the CPU or memory, and in this case the network, it must make at least one, and sometimes several calls to the operating system kernel. Each request is additional overhead that requires both CPU cycles and processing time. Solarflare's Cloud Onload moves the network processing required by NGINX Proxy from the kernel into NGINX Proxy's own application space in memory. This single modification improves NGINX Proxy performance by 280% on average as can be seen in the graph.

## Description of Test Platforms

For this testing, we used two Dell EMC PowerEdge R640 dual socket Intel Xeon systems, each with a pair of 100GbE Solarflare X2541 cards. These cards were then connected back to back for this testing.

Both systems had two Intel Gold 6148 CPUs clocked at 2.40GHz with 20 cores per processor, 192 GB of memory.



## Tuning Configuration

Below are the changes we made to the standard install beyond simply leveraging Cloud Onload:

- Enable clustering (multiple `EF_CLUSTER_*` options) so that the adapter does the work of spreading the load to different workers.
- Enable socket caching (`EF_SOCKET_CACHE_MAX`) to improve performance of establishing both accepted and outgoing active connections.
- Use TCP shared local ports feature (multiple `EF_TCP_SHARED_LOCAL_PORTS_*` options) for outgoing connections further improving performance.
- Use Epoll mode 3 (`EF_UL_EPOLL=3`) which gives best epoll performance when a large number of sockets are in the epoll set.
- Enable event polling without interrupts within `epoll_wait` calls to reduce latency and avoid context switches (`EF_POLL_USEC` and multiple `EF*_SPIN` options)
- Use scalable filter mode (`EF_SCALABLE_FILTERS` and `EF_SCALABLE_FILTERS_ENABLE` options) to avoid resource constraints when using a very large number of connections.

## Observations

NGINX Proxy relies on the operating system's communications stack to process network I/O requests, but in high core count environments, this stack has become the new bottleneck. Here are some additional points to consider:

- The connections per second shows great improvement with Cloud Onload, peaking at an improvement of 366% over the kernel stack. With large numbers of proxy workers (32 to 40) the Cloud Onload performance begins to level out.
- The requests per second also shows great improvement with Cloud Onload, peaking at an improvement of 204% over the kernel stack. With 40 worker processes, results continue to improve, indicating that further performance is available from Cloud Onload.
- The throughput shows significant improvement with Cloud Onload, peaking at an improvement of 139% over the kernel stack. With large numbers of proxy workers (32 to 40) the Cloud Onload performance again begins to level out.

- The latency figures output by wrk2, show the time from when the packet should have been sent (according to the configured packet rate), until when the packet was actually received. The 99th percentile figure is reported. When the kernel stack packet rate is raised above 1.1 million requests per second, it can no longer maintain this rate. Jitter increases, the number of outliers exceeds 1%, and so the reported latency suddenly and dramatically increases. Any further small increase in load would make the server appear completely unresponsive to an end user. In contrast, Cloud Onload continues to deliver low latency with 4 million requests per second and is actually trending towards even lower latency. The stable and low value for the 99th percentile of latency indicates low jitter and predictable performance.

### For More Testing Details

Check out Solarflare's **Cloud Onload NGINX Proxy Cookbook** for the exact installation and testing process.

The above benefit statements are the result of benchmarking designed to focus on the value of optimizing networking through Cloud Onload kernel bypass. Real world use cases are not the same as benchmarks and as such the role that networking plays may vary, so your overall measurable benefits may be different.

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