TR-4626: Load balancers

How to enable StorageGRID in your environment

NetApp
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TR-4626: Load balancers

Use third-party load balancers with StorageGRID

Learn about the role of a third-party and global load balancers in an object storage systems like StorageGRID.

General guidance for implementing NetApp® StorageGRID® with third-party load balancers.

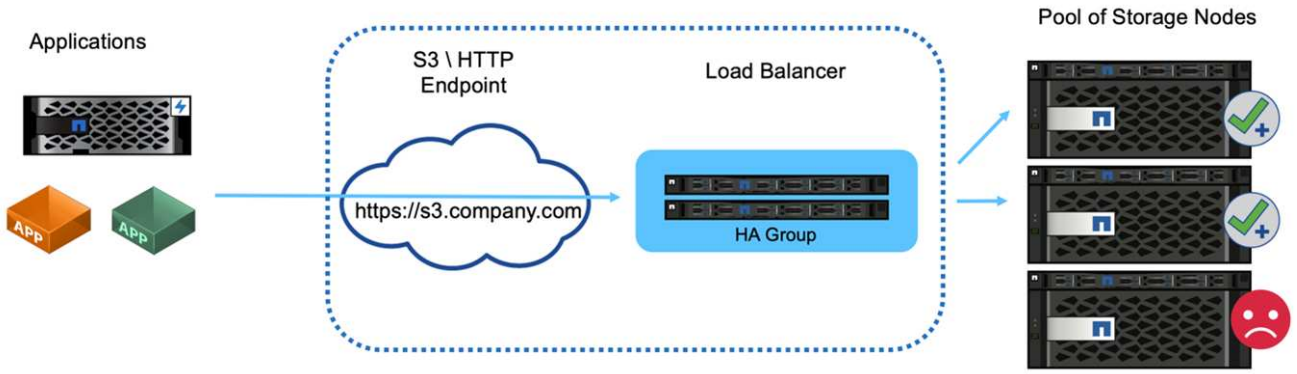
Object storage is synonymous with the term cloud storage, and, as you would expect, applications that leverage cloud storage address that storage through a URL. Behind that simple URL, StorageGRID can scale capacity, performance, and durability in a single site or over geo-distributed sites. The component that makes this simplicity possible is a load balancer.

The purpose of this document is to educate StorageGRID customers about load balancer options and provide general guidance for the configuration of third-party load balancers.

Load balancer basics

Load balancers are an essential component of an enterprise grade object storage system such as StorageGRID. StorageGRID consists of multiple storage nodes, each of which can present the entire Simple Storage Service (S3) name space for a given StorageGRID instance. Load balancers create a highly available endpoint behind which we can place StorageGRID nodes. StorageGRID is unique among S3-compatible object storage systems in that it provides its own load balancer, but it also supports third-party or general-purpose load balancers such as F5, Citrix Netscaler, HA Proxy, NGINX, and so on.

The following figure uses the example URL/ fully qualified domain name (FQDN) “s3.company.com”. The load balancer creates a virtual IP (VIP) that resolves to the FQDN through DNS, then directs any requests from applications to a pool of StorageGRID nodes. The load balancer performs a health check on each node and only establishes connections to healthy nodes.



The figure shows the StorageGRID provided load balancer, but the concept is the same for third-party load balancers. Applications establish an HTTP session using the VIP on the load balancer and the traffic passes through the load balancer to the storage nodes. By default, all traffic, from application to load balancer, and from load balancer to storage node is encrypted through HTTPS. HTTP is a supported option.

Local and global load balancers

There are two types of load balancers:

- **Local Traffic Managers (LTM)**. Spreads connections over a pool of nodes in a single site.
- **Global Service Load Balancer (GSLB)**. Spreads connections over multiple sites, effectively load balancing LTM load balancers. Think of a GSLB as an intelligent DNS server. When a client requests a StorageGRID endpoint URL, the GSLB resolves it to the VIP of an LTM based on availability or other factors (for example, which site can provide lower latency to the application).
  While an LTM is always required, a GSLB is optional depending on the number of StorageGRID sites and your application requirements.

StorageGRID Gateway Node load balancer versus third-party load balancer

StorageGRID is unique among S3-compatible object storage vendors in that it provides a native load balancer available as a purpose-built appliance, VM, or container. The StorageGRID provided load balancer is also referred to as a Gateway Node.

For customers that do not already own a load balancer such as F5, Citrix, and so on, implementation of a third-party load balancer can be very complex. The StorageGRID load balancer greatly simplifies load balancer operations.

The Gateway Node is an enterprise grade, highly available, and high-performance load balancer. Customers can choose to implement the Gateway Node, third-party load balancer, or even both, in the same grid. The Gateway Node is a local traffic manager versus a GSLB.

The StorageGRID load balancer provides the following advantages:

- **Simplicity**. Automatic configuration of resource pools, health checks, patching, and maintenance, all managed by StorageGRID.
- **Performance**. The StorageGRID load balancer is dedicated to StorageGRID, you do not compete with other applications for bandwidth.
- **Cost**. The virtual machine (VM) and container versions are provided at no additional cost.
- **Traffic classifications**. The Advanced Traffic Classification feature allows for StorageGRID-specific QoS rules along with workload analytics.
- **Future StorageGRID specific features**. StorageGRID will continue to optimize and add innovative features to the load balancer over upcoming releases.

For details about deploying the StorageGRID Gateway Node, see the StorageGRID documentation.

Where to find additional information

To learn more about the information that is described in this document, review the following documents and/or websites:

- NetApp StorageGRID Documentation Center
  https://docs.netapp.com/us-en/storagegrid-118/
- NetApp StorageGRID Enablement
  https://docs.netapp.com/us-en/storagegrid-enable/
- StorageGRID f5 load balancer design considerations
  https://www.netapp.com/blog/storagegrid-f5-load-balancer-design-considerations/
- Loadbalancer.org—Load balancing NetApp StorageGRID
  https://www.loadbalancer.org/applications/load-balancing-netapp-storagegrid/
- Kemp—Load balancing NetApp StorageGRID

https://support.kemptechnologies.com/hc/en-us/articles/360045186451-NetApp-StorageGRID

Learn how to implement SSL certificates for HTTPS in StorageGRID

Understand the importance and the steps to implement of SSL certificates in StorageGRID.

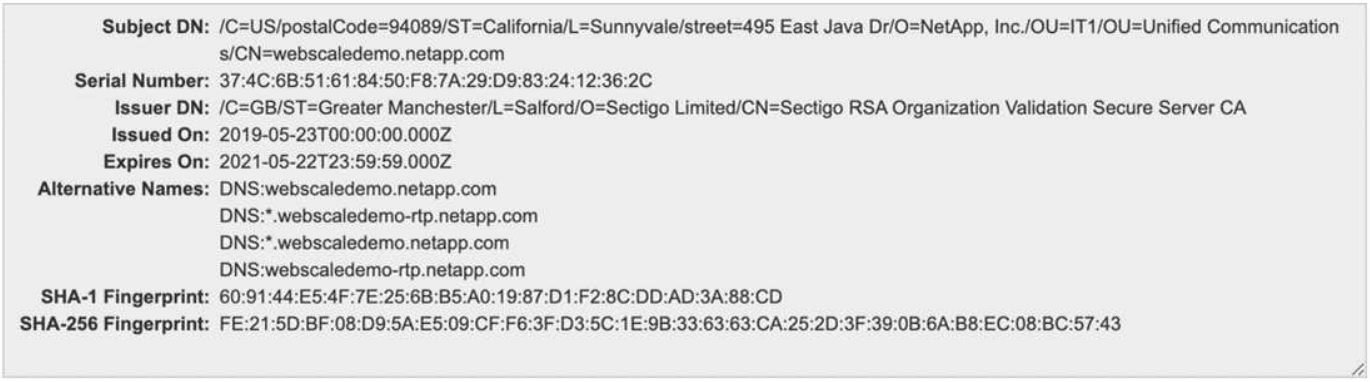
If you are using HTTPs, you must have a Secure Sockets Layer (SSL) certificate. The SSL protocol identifies the clients and endpoints, validating them as trusted. SSL also provides encryption of the traffic. The SSL certificate must be trusted by the clients. To accomplish this, the SSL certificate can be from a globally trusted Certificate Authority (CA) such as DigiCert, a private CA running in your infrastructure, or a self-signed certificate generated by the host.

Using a globally trusted CA certificate is the preferred method as there is no additional client-side actions required. The certificate is loaded into the load balancer or StorageGRID, and the clients trust and connect to the endpoint.

Using a private CA requires the root and all subordinate certificates be added to the client. The process to trust a private CA certificate can vary by client operating system and applications. For example, in ONTAP for FabricPool, you must upload each certificate in the chain individually (root certificate, subordinate certificate, endpoint certificate) to the ONTAP cluster.

Using a self-signed certificate requires the client to trust the provided certificate without any CA to verify the authenticity. Some applications might not accept self-signed certificates and have no ability to ignore verification.

The placement of the SSL certificate in the client load balancer StorageGRID path depends on where you need the SSL termination to be. You can configure a load balancer to be the termination endpoint for the client, and then re-encrypt or hot encrypt with a new SSL certificate for the load balancer to StorageGRID connection. Or you can pass through the traffic and let StorageGRID be the SSL termination endpoint. If the load balancer is the SSL termination endpoint, the certificate is installed on the load balancer and contains the subject name for the DNS name/URL and any alternative URL/DNS names for which a client is configured to connect to the StorageGRID target through the load balancer, including any wild card names. If the load balancer is configured for pass through, the SSL certificate must be installed in StorageGRID. Again, the certificate must contain the subject name for the DNS name/URL, and any alternative URL/DNS names for which a client is configured to connect to the StorageGRID target through the load balancer, including any wild card names. Individual Storage Node names do not need to be included on the certificate, only the endpoint URLs.



Configure trusted third-party load balancer in StorageGRID

Learn how to configure trusted third-party load balancer in StorageGRID.

If you are using one or more external layer 7 load balancers, and an S3 bucket or group policies that are IP based, StorageGRID must determine the real sender's IP address. It does this by looking at the X-Forwarded-For (XFF) header, which is inserted into the request by the load balancer. As the XFF header can be easily spoofed in requests sent directly to the Storage Nodes, StorageGRID must confirm that each request is being routed by a trusted layer 7 load balancer. If StorageGRID cannot trust the source of the request, it will ignore the XFF header. There is a Grid Management API to allow a list of trusted external layer 7 load balancers to be configured. This new API is private and is subject to change in future StorageGRID releases. For the most up to date information, see the KB article, How to configure StorageGRID to work with third-party Layer 7 load balancers.

Learn about local traffic manager load balancers

Explore the guidance for local traffic manager load balancers and determine the optimal configuration.

The following is presented as general guidance for configuration of third-party load balancers. Work with your load balancer administrator to determine the optimal configuration for your environment.

Create a resource group of Storage Nodes

Group StorageGRID Storage Nodes into a resource pool or service group (the terminology might differ with specific load balancers).
StorageGRID Storage Nodes present the S3 API on the following ports:

- S3 HTTPS: 18082
- S3 HTTP: 18084

Most customers choose to present the APIs on the virtual server through the standard HTTPS and HTTP ports (443 and 80).

Each StorageGRID site requires a default of three Storage Nodes, two of which must be healthy.

Health check

Third-party load balancers require a method to determine the health of each node and its eligibility to receive traffic. NetApp recommends the HTTP `OPTIONS` method to perform the health check. The load balancer issues HTTP `OPTIONS` requests to each individual Storage Node and expects a `200` status response.

If any Storage Node does not provide a `200` response, that node is not able to service storage requests. Your application and business requirements should determine the timeout for these checks and the action your load balancer takes.

For example, if three of four Storage Nodes in data center 1 are down, you might direct all traffic to data center 2.

The recommended polling interval is once per second, marking the node offline after three failed checks.

S3 health check example

In the following example, we send `OPTIONS` and check for `200 OK`. We use `OPTIONS` because Amazon S3) does not support unauthorized requests.

```
curl -X OPTIONS https://10.63.174.75:18082 --verbose --insecure
* Rebuilt URL to: https://10.63.174.75:18082/
*   Trying 10.63.174.75...
* TCP_NODELAY set
* Connected to 10.63.174.75 (10.63.174.75) port 18082 (#0)
* TLS 1.2 connection using TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
* Server certificate: webscale.stl.netapp.com
* Server certificate: NetApp Corp Issuing CA 1
* Server certificate: NetApp Corp Root CA
> OPTIONS / HTTP/1.1
> Host: 10.63.174.75:18082
> User-Agent: curl/7.51.0
> Accept: /
>
< HTTP/1.1 200 OK
< Date: Mon, 22 May 2017 15:17:30 GMT
< Connection: KEEP-ALIVE
< Server: StorageGRID/10.4.0
< x-amz-request-id: 3023514741
```

File or content-based health checks

In general, NetApp does not recommend file-based health checks. Typically, a small file — `healthcheck.htm`, for example — is created in a bucket with a read-only policy. This file is then fetched and evaluated by the load balancer. This approach has several disadvantages:

- **Dependent on a single account.** If the account that owns the file is disabled, the health check fails, and no storage requests are processed.
- **Data protection rules.** The default data protection scheme is a two-copy approach. In this scenario, if the two storage nodes hosting the health check file are unavailable, the health check fails, and storage requests are not sent to healthy storage nodes, rendering the grid offline.
- **Audit log bloat.** The load balancer fetches the file from every storage node every X minutes, creating many audit log entries.
- **Resource intensive.** Fetching the health check file from every node every few seconds consumes grid and network resources.

If a content-based health check is required, use a dedicated tenant with a dedicated S3 bucket.

Session persistence

Session persistence, or stickiness, refers to the time a given HTTP session is allowed to persist. By default, sessions are dropped by Storage Nodes after 10 minutes. Longer persistence can lead to better performance because applications do not have to reestablish their sessions for every action; however, holding these

sessions open consumes resources. If you determine that your workload will benefit, you can reduce the session persistence on a third-party load balancer.

Virtual hosted-style addressing

Virtual hosted-style is now the default method for AWS S3, and while StorageGRID and many applications still support path style, it is best practice to implement virtual hosted-style support. Virtual hosted-style requests have the bucket as part of the host name.

To support virtual hosted-style, do the following:

- Support wildcard DNS lookups: *.s3.company.com
- Use an SSL certificate with subject alt names to support wildcard: *.s3.company.com
  Some customers have expressed security concerns around the use of wildcard certificates. StorageGRID continues to support path style access, as do key applications such as FabricPool. That said, certain S3 API calls fail or behave improperly without virtual hosted support.

SSL termination

There are security benefits to SSL termination on third-party load balancers. If the load balancer is compromised, the grid is compartmentalized.

There are three supported configurations:

- **SSL pass-through.** The SSL certificate is installed on StorageGRID as a custom server certificate.
- **SSL termination and re-encryption (recommended).** This might be beneficial if you are already doing SSL certificate management on the load balancer rather than installing the SSL certificate on StorageGRID. This configuration provides the additional security benefit of limiting the attack surface to the load balancer.
- **SSL termination with HTTP.** In this configuration, SSL is terminated on the third-party load balancer and communication from the load balancer to StorageGRID is nonencrypted to take advantage of SSL off-load (with SSL libraries embedded in modern processors this is of limited benefit).

Pass through configuration

If you prefer to configure your load balancer for pass through, you must install the certificate on StorageGRID. Go to **Configuration › Server Certificates › Object Storage API Service Endpoints Server Certificate**.

Source client IP visibility

StorageGRID 11.4 introduced the concept of a trusted third-party load balancer. In order to forward the client application IP to StorageGRID, you must configure this feature. For more information, see How to configure StorageGRID to work with third-party Layer 7 load balancers.

To enable the XFF header to be used to view the IP of the client application, follow these steps:

Steps

1. Record the client IP in the audit log.
2. Use `aws:SourceIp` S3 bucket or group policy.

Load balancing strategies

Most load balancing solutions offer multiple strategies for load balancing. The following are common strategies:

- **Round robin.** A universal fit but suffers with few nodes and large transfers clogging single nodes.
- **Least connection.** A good fit for small and mixed object workloads, resulting in an equal distribution of the connections to all nodes.

The choice of algorithm becomes less important with an increasing number of Storage Nodes to choose from.

Data path

All data flows through local traffic manager load balancers. StorageGRID does not support direct server routing (DSR).

Verifying distribution of connections

To verify that your method is distributing the load evenly across Storage Nodes, check the established sessions on each node in a given site:

- **UI Method.** Go to **Support › Metrics › S3 Overview › LDR HTTP Sessions**
- **Metrics API.** Use `storagegrid_http_sessions_incoming_currently_established`

Learn about few use cases for StorageGRID configurations

Explore few use cases for StorageGRID configurations implemented by customers and NetApp IT.

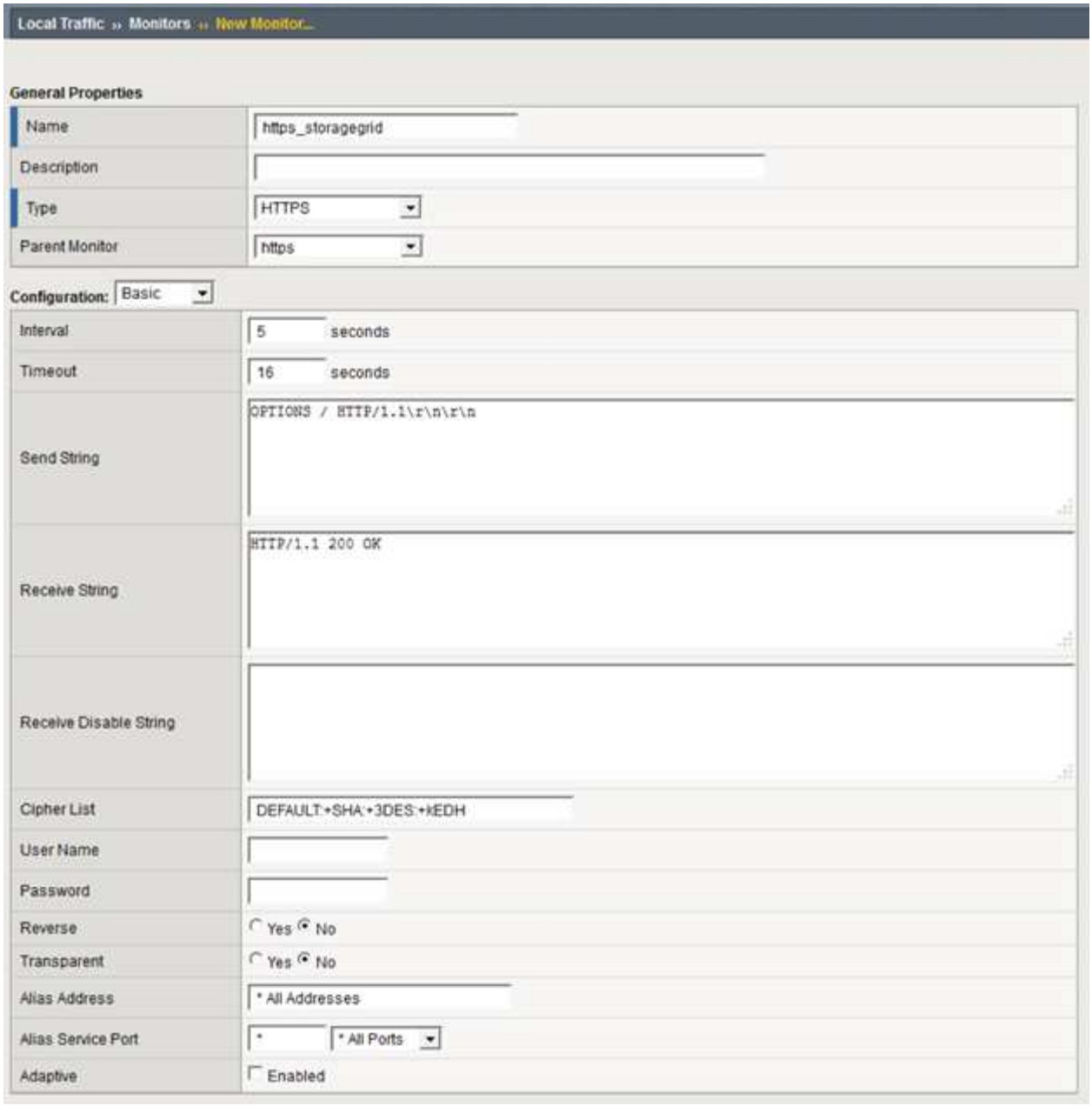
The following examples illustrate configurations as implemented by StorageGRID customers, including NetApp IT.

F5 BIG-IP local traffic manager health check monitor for S3 bucket

To configure the F5 BIG-IP local traffic manager health check monitor, follow these steps:

Steps

1. Create a new monitor.
   a. In the Type field, enter `HTTPS`.
   b. Configure the interval and timeout as desired.
   c. In the Send String field, enter `OPTIONS / HTTP/1.1\r\n\r\n.`
   \r\n are carriage returns; different versions of BIG-IP software require zero, one, or two sets of \r\n sequences. For more information, see https://support.f5.com/csp/article/K10655.
   d. In the Receive String field, enter: `HTTP/1.1 200 OK`.



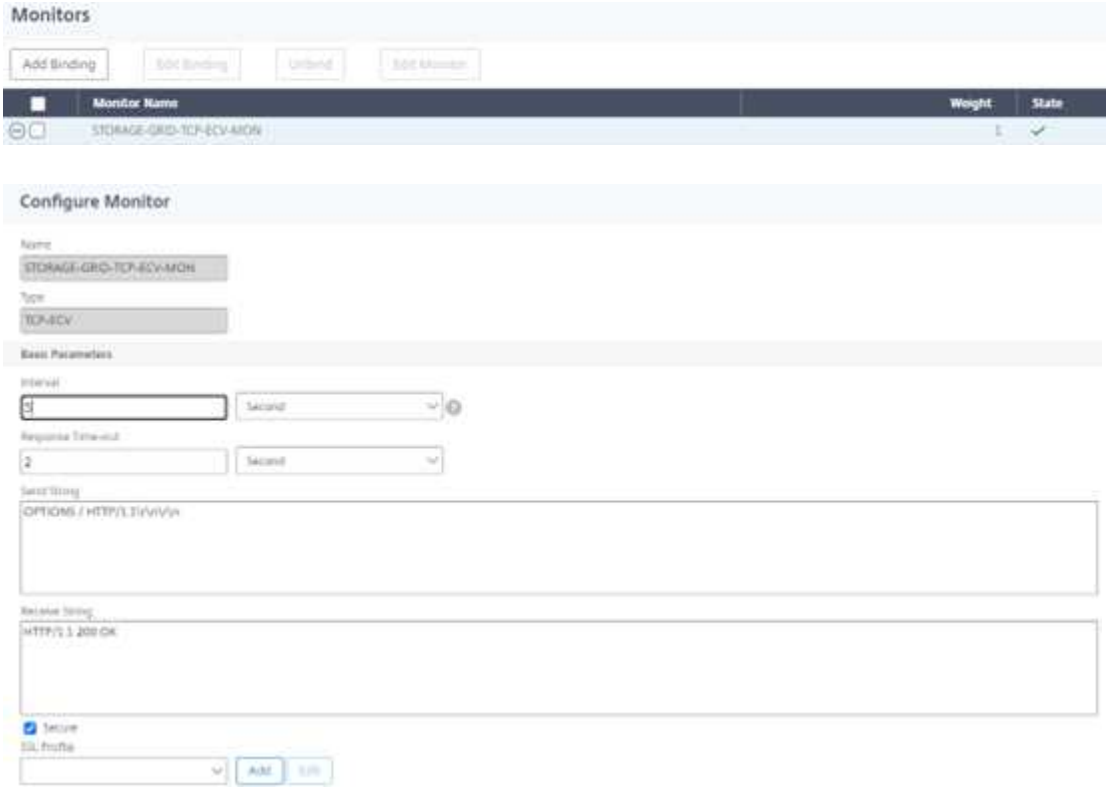
2. In Create Pool, create one pool for each port required.
   a. Assign the health monitor that you created in the previous step.
   b. Select a load-balancing method.
   c. Select service port: 18082 (S3).
   d. Add nodes.

Citrix NetScaler

Citrix NetScaler creates a virtual server for the storage endpoint and refers to StorageGRID Storage Nodes as Application Servers, which are then grouped into Services.

Use the HTTPS-ECV health check monitor to create a custom monitor to perform the recommended health check by using the OPTIONS request and receiving `200`. HTTP-ECV is configured with a send string and validates a receive string.

For more information, see the Citrix documentation, Sample configuration for HTTP-ECV health check monitor.



Loadbalancer.org

Loadbalancer.org has conducted their own integration testing with StorageGRID and has an extensive configuration guide: https://pdfs.loadbalancer.org/NetApp_StorageGRID_Deployment_Guide.pdf.

Kemp

Kemp has conducted their own integration testing with StorageGRID and has an extensive configuration guide: https://kemptechnologies.com/solutions/netapp/.

HAProxy

Configure HAProxy to use the OPTIONS request and check for a 200 status response for the health check in haproxy.cfg. You can change the bind port in the front end to a different port, such as 443.

The following is an example for SSL termination on HAProxy:

```
frontend s3
       bind *:443 crt /etc/ssl/server.pem ssl
       default_backend s3-serve
rs
backend s3-servers
       balance leastconn
       option httpchk
       http-check expect status 200
       server dc1-s1 10.63.174.71:18082 ssl verify none check inter 3000
       server dc1-s2 10.63.174.72:18082 ssl verify none check inter 3000
       server dc1-s3 10.63.174.73:18082 ssl verify none check inter 3000
```

The following is an example for SSL pass-through:

```
frontend s3
       mode tcp
       bind *:443
       default_backend s3-servers
backend s3-servers
       balance leastconn
       option httpchk
       http-check expect status 200
       server dc1-s1 10.63.174.71:18082 check-ssl verify none inter 3000
       server dc1-s2 10.63.174.72:18082 check-ssl verify none inter 3000
       server dc1-s3 10.63.174.73:18082 check-ssl verify none inter 3000
```

For full examples of configurations for StorageGRID, see Examples for HAProxy Configuration on GitHub.

Validate SSL connection in StorageGRID

Learn how to validate the SSL connection in StorageGRID.

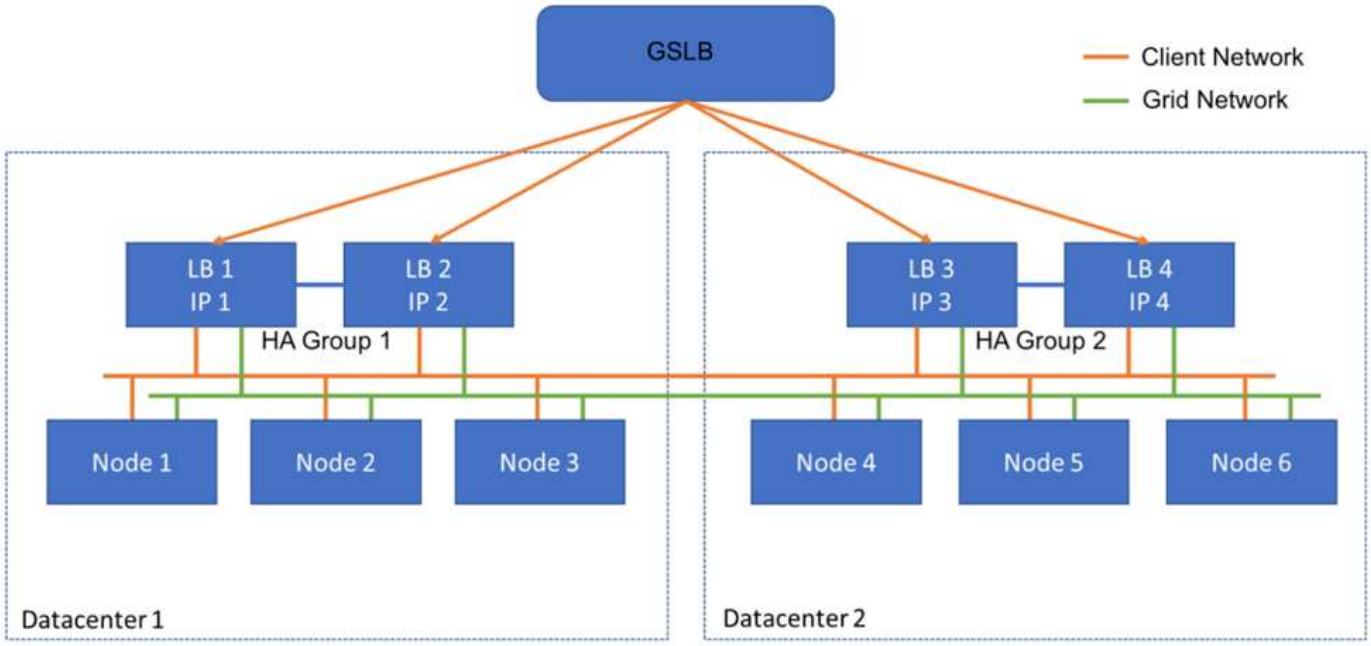
After your load balancer is configured, you should validate the connection using tools such as OpenSSL and the AWS CLI. Other applications, such as S3 Browser, might ignore SSL misconfiguration.

Understand global load balancing requirements for StorageGRID

Explore the design considerations and requirements for global load balancing in StorageGRID.

Global load balancing requires integrating with DNS to provide intelligent routing across multiple StorageGRID sites. This function falls outside of the StorageGRID domain and must be provided by a third-party solution such as the load balancer products discussed previously and/or a DNS traffic control solution such as Infoblox. This top level load balancing provides smart routing to the closest destination site in the namespace, as well as

outage detection and redirection to the next site in the namespace. A typical GSLB implementation consists of the top level GSLB with site pools containing site-local load balancers. The site load balancers contain pools of the local site Storage Nodes. This can include a combination of third-party load balancers for GSLB functions and StorageGRID providing the site-local load balancing, or a combination of third parties, or many of the third parties discussed previously can provide both GSLB and site-local load balancing.



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