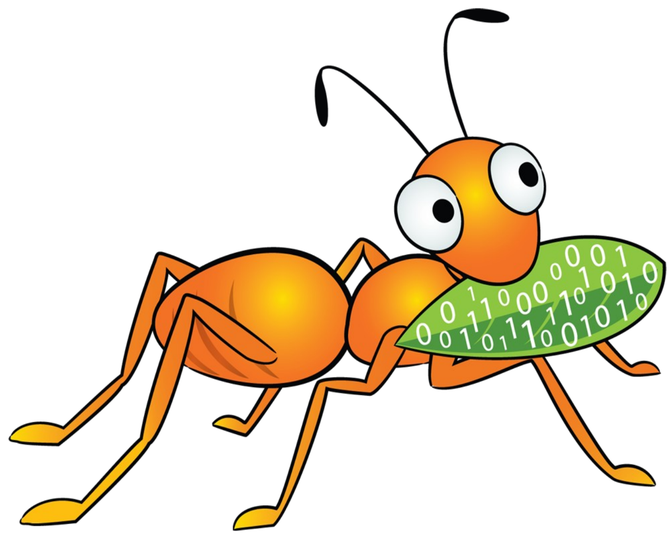
NFS-Ganesha and Clustered NAS on Distributed Storage System, GlusterFS



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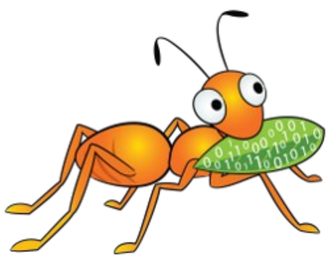
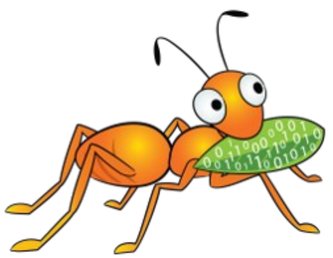
Red Hat

AGENDA

- NFS(-Ganesha)
- Distributed storage system - GlusterFS
- Integration
- Clustered NFS
- Future Directions
- Step-by-step guide
- Q&A



NFS

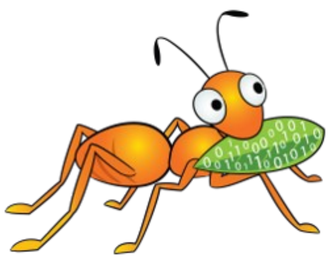


NFS

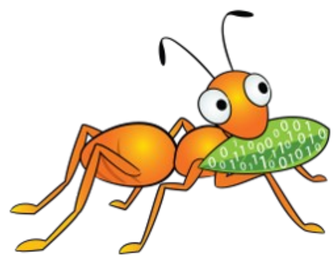
- Widely used network protocol
- Many enterprises still heavily depend on NFS to access their data from different operating systems and applications.

Versions:

- Stateless NFSv2 [RFC 1094] & NFSv3 [RFC 1813]
  - Side-band protocols (NLM/NSM, RQUOTA, MOUNT)
- Stateful NFSv4.0 [RFC 3530] & NFSv4.1/pNFS [RFC 5661]
  - NFSv4.2 protocol being developed



NFS-Ganesha

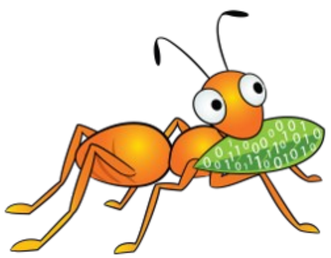


NFS-Ganesha

- A user-space, protocol-complaint NFS file server
- Supports NFS v3, 4.0, 4.1, pNFS and 9P from the Plan9 operating system.
- Provides a FUSE-compatible File System Abstraction Layer(FSAL) to plug in to any own storage mechanism
- Can provide simultaneous access to multiple file systems.

Active participants:

- CEA, Panasas, Red Hat, IBM, LinuxBox

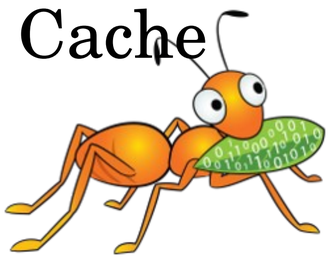


Benefits of NFS-Ganesha

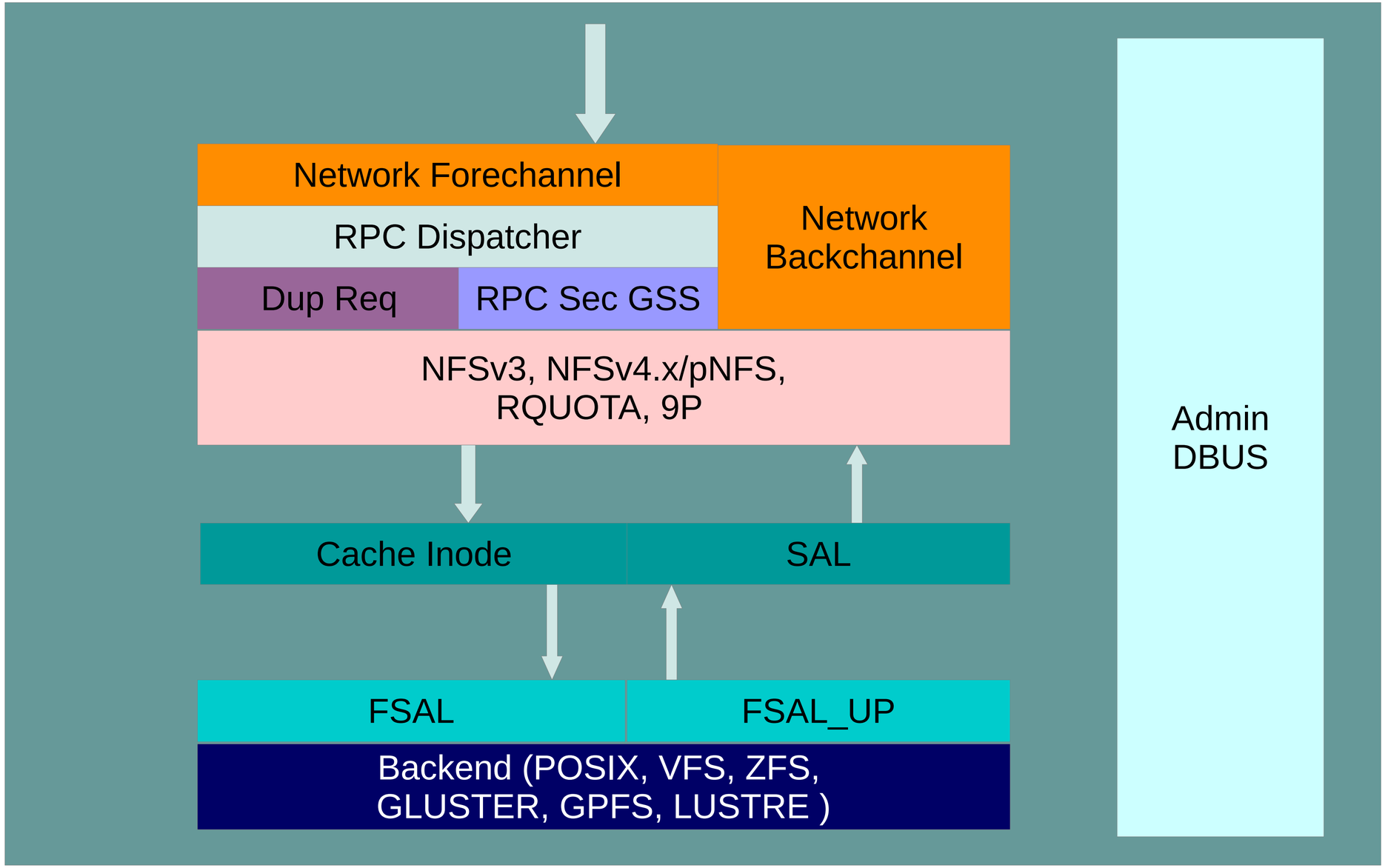
- Dynamically export/unexport entries using D-Bus mechanism.
- Can manage huge meta-data and data caches
- Can act as proxy server for NFSv4
- Provides better security and authentication mechanism for enterprise use
- Portable to any Unix-like file-systems
- Easy access to the services operating in the user-space (like Kerberos, NIS, LDAP)

Modular Architecture

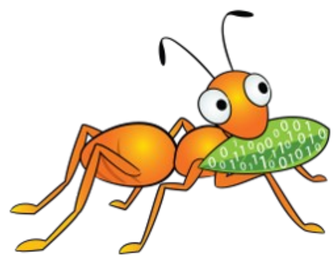
- **RPC Layer**: implements ONC/RPCv2 and RPCSEC_GSS (based on libntirpc)
- **FSAL**: File System Abstraction Layer, provides an API to generically address the exported namespace
- **Cache Inode**: manages the metadata cache for FSAL. It is designed to scale to millions of entries
- **FSAL UP**: provides the daemon with a way to be notified by the FSAL that changes have been made to the underlying FS outside Ganesha. These information is used to invalidate or update the Cache Inode.



NFS-Ganesha Architecture

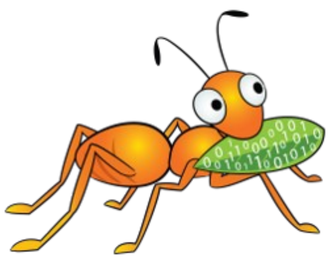


Distributed storage - GlusterFS



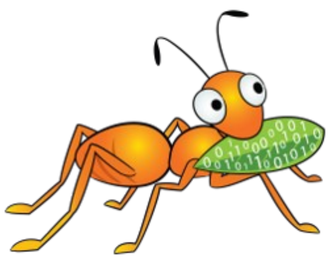
GlusterFS

- An open source, scale-out distributed file system
- Software Only and operates in user-space
- Aggregates Storage into a single unified namespace
- No metadata server architecture
- Provides a modular, stackable design
- Runs on commodity hardware



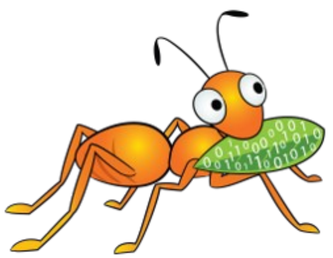
Architecture

- Data is stored on disk using native formats (e.g. ext4, XFS)
- Has client and server components
  - Servers, known as storage bricks (glusterfsd daemon), export local filesystem as volume
  - Clients (glusterfs process), creates composite virtual volumes from multiple remote servers using stackable translators
  - Management service (glusterd daemon) manages volumes and cluster membership



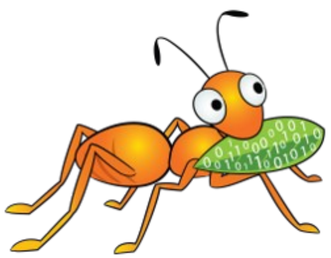
Terminologies

- **Trusted Storage Pool:** A storage pool is a trusted network of storage servers.
- **Brick:** Brick is the basic unit of storage, represented by an export directory on a server in the trusted storage pool.
- **Volume:** A volume is a logical collection of bricks. Most of the gluster management operations happen on the volume.

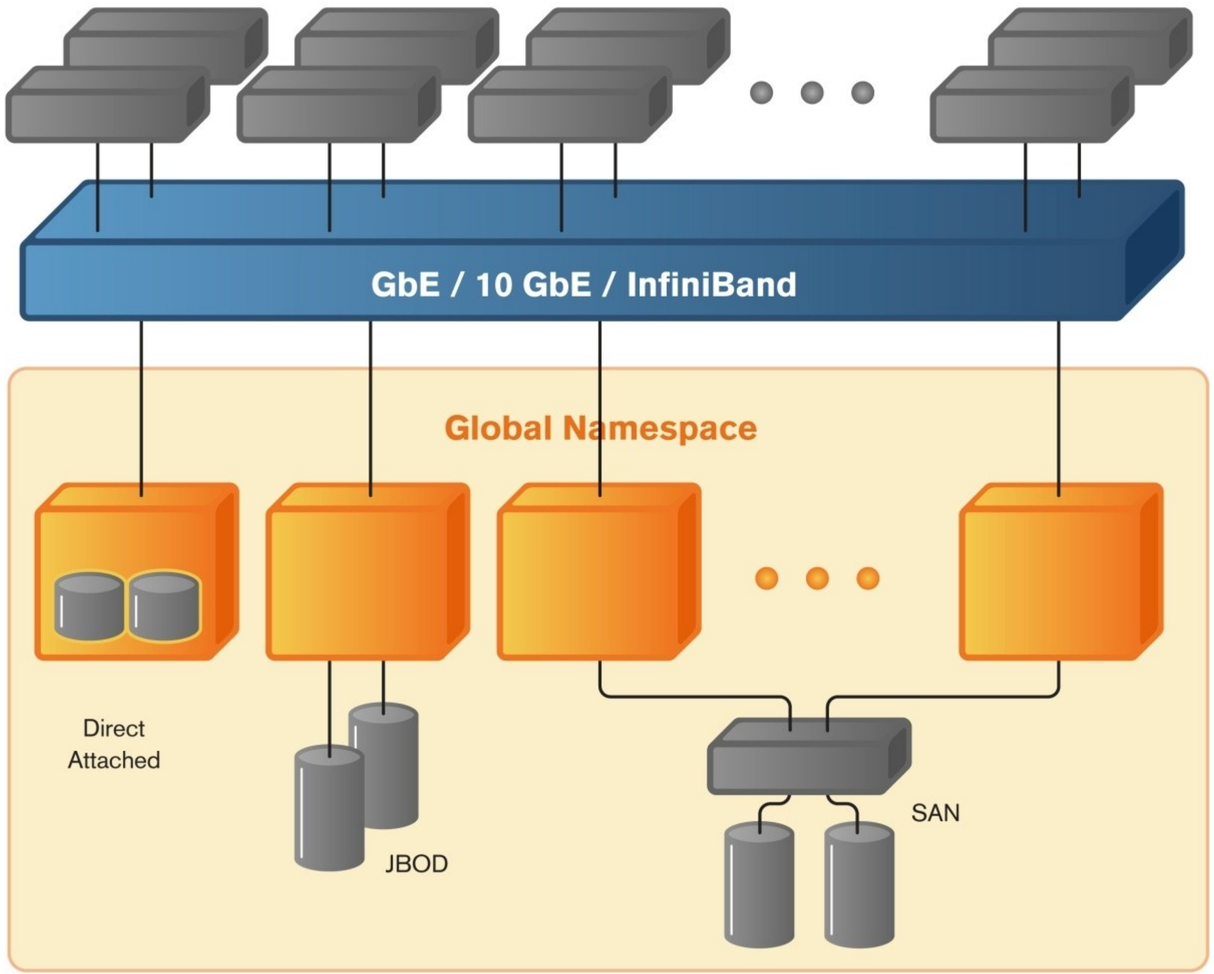


Workloads

- **Best Fit and Optimal Workloads:**
  - Large File & Object Store (using either NFS, SMB or FUSE client)
  - Enterprise NAS dropbox & object Store / Cloud Storage for service providers
  - Cold Storage for Splunk Analytics Workloads
  - Hadoop Compatible File System for running Hadoop Analytics
  - Live virtual machine image store for Red Hat Enterprise Virtualization
  - Disaster Recovery using Geo-replication
  - ownCloud File Sync n' Share
- **Not recommended**
  - Highly transactional like a database
  - Workloads that involve a lot of directory based operations



GlusterFS Deployment

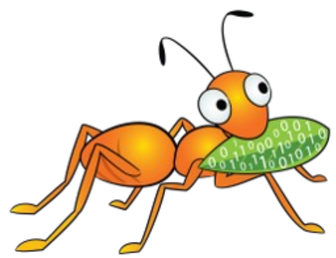


Multiprotocol Client Support

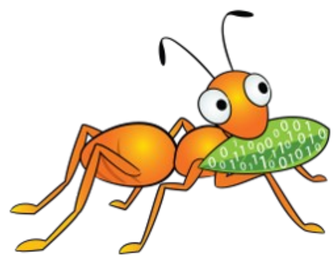
- GlusterFS Native
- NFS
- CIFS
- HTTP
- WebDAV
- FTP

Clustered Storage Building Blocks

Flexible Back-end

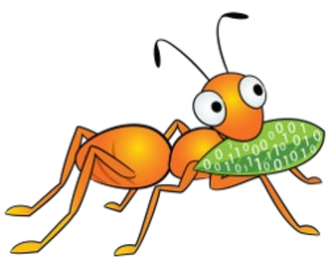


Integration with GlusterFS

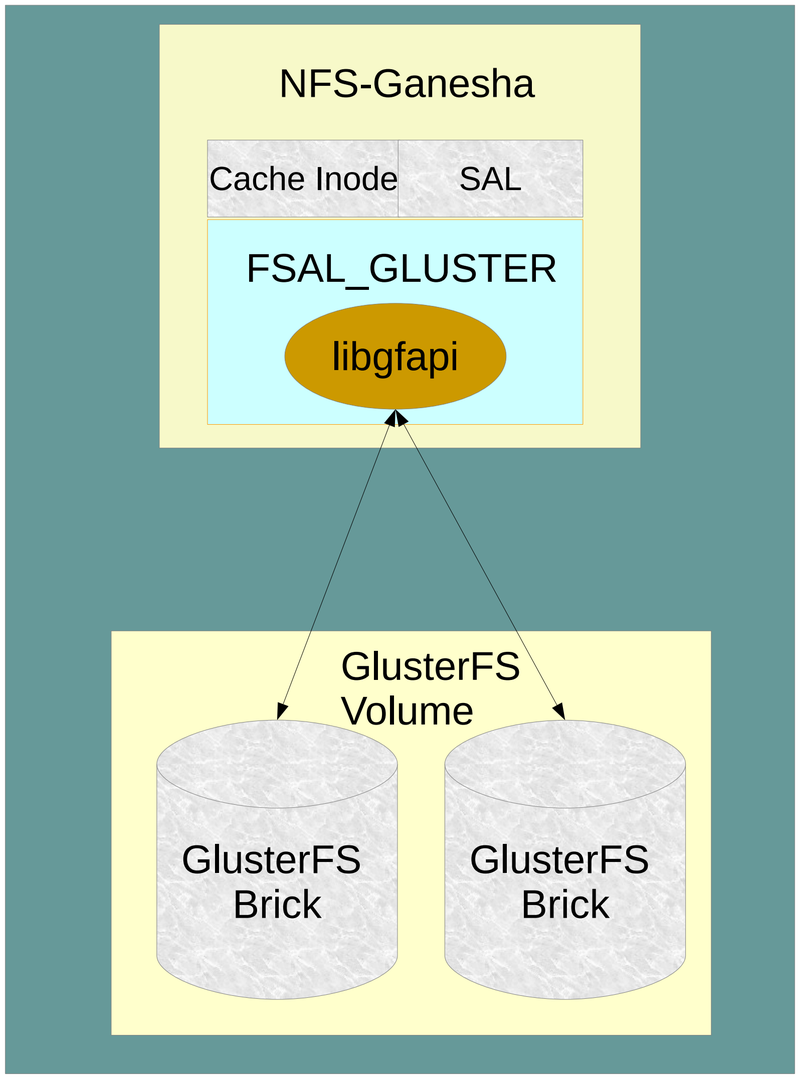


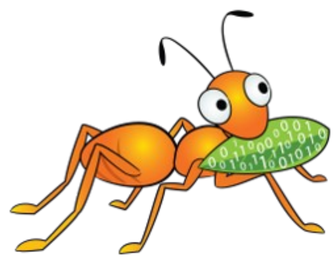
libgfapi

- A user-space library with APIs for accessing Gluster volumes.
- Reduces context switches.
- Many applications integrated with libgfapi (qemu, samba, NFS Ganesha).
- Both sync and async interfaces available.
- C and python bindings.
- Available via 'glusterfs-api*' packages.



NFS-Ganesha + GlusterFS



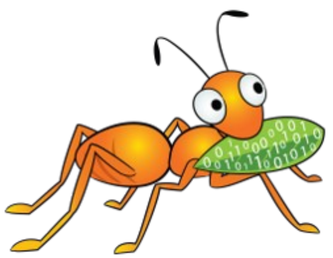


Integration with GlusterFS

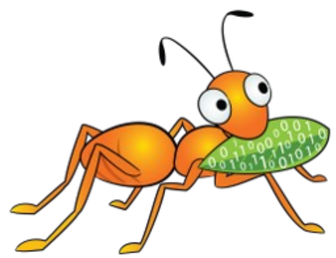
- Integrated with GlusterFS using 'libgfapi' library

That means,

- Additional protocol support w.r.t. NFSv4, pNFS
- Better security and authentication mechanisms for enterprise use.
- Performance improvement with additional caching

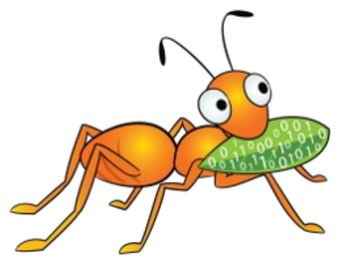


Clustered NFS



Clustered NFS

- Stand-alone systems :
  - are always bottleneck.
  - cannot scale along with the back-end storage system.
  - not suitable for mission-critical services
- Clustering:
  - High availability
  - Load balancing
  - Different configurations:
    - Active-Active
    - Active-Passive

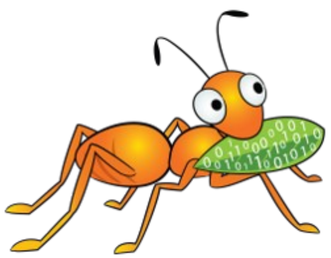


Server Reboot/Grace-period

- **NFSv3**:
  - Stateless. Client retries requests till TCP retransmission timeout.
  - NLM/NSM:
    - NSM notifies the clients which reclaim lock requests during server's grace period.
- **NFSv4.x**:
  - Stateful. Stores information about clients persistently.
  - Reject client request with the errors NFS4ERR_STALE_STATEID / NFS4ERR_STALE_CLIENTID
  - Client re-establishes identification and reclaims OPEN/LOCK state during grace period.

Challenges Involved

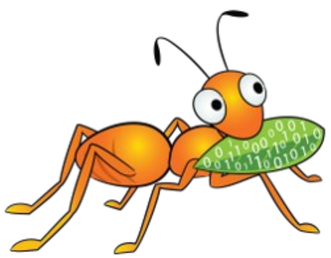
- Cluster wide change notifications for cache invalidations
- IP Failover in case of Node/service failure
- Coordinate Grace period across nodes in the cluster
- Provide “high availability” to stateful parts of NFS
  - Share state across the cluster
  - Allow state recovery post failover



Active-Active HA solution on GlusterFS

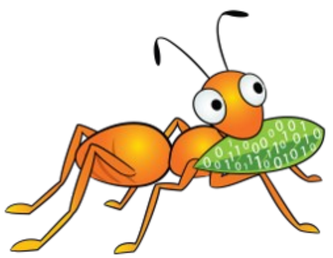
Primary Components

- Pacemaker
- Corosync
- PCS
- Resource agents
- HA setup scipt ('ganesha-ha.sh')
- Shared Storage Volume
- UPCALL infrastructure



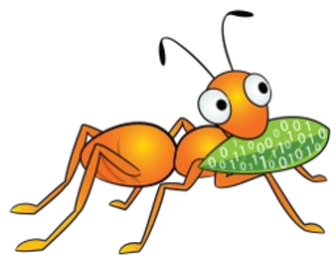
Clustering Infrastructure

- Using Open-source services
- **Pacemaker**: Cluster resource manager that can start and stop resources
- **Corosync**: Messaging component which is responsible for communication and membership among the machines
- **PCS**: Cluster manager to easily manange the cluster settings on all nodes



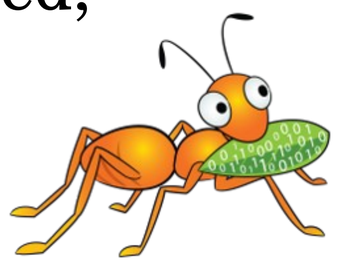
Cluster Infrastructure

- **Resource-agents** : Scripts that know how to control various services.
- New resource-agent scripts added to
  - **ganesha_mon**: Monitor NFS service on each node & failover the Virtual IP
  - **ganesha_grace**: Puts entire cluster to Grace using d-bus signal
- If NFS service down on any of the nodes
  - Entire cluster is put into grace via D-bus signal
  - Virtual IP fails over to a different node (within the cluster).



HA setup script

- Located at `/usr/libexec/ganesha/ganesha-ha.sh`.
- Sets up, tears down and modifies the entire cluster.
- Creates resource-agents required to monitor NFS service and IP failover.
- Integrated with new Gluster CLI introduced to configure NFS-Ganesha.
- Primary Input: `ganesha-ha.conf` file with the information about the servers to be added to the cluster along with Virtual IPs assigned, usually located at `/etc/ganesha`.



Upcall infrastructure

- A generic and extensible framework.
  - used to maintain states in the glusterfsd process for each of the files accessed
  - sends notifications to the respective glusterfs clients in case of any change in that state.
- Cache-Invalidation: Needed by NFS-Ganesha to serve as Multi-Head

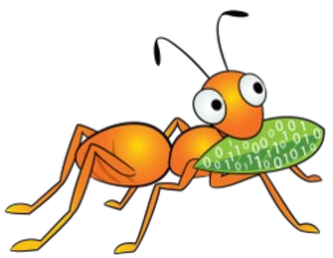
Config options:

```
#gluster vol set <volname> features.cache-invalidation
on/off
#gluster vol set <volname> features.cache-invalidation-
timeout <value>
```

Shared Storage Volume

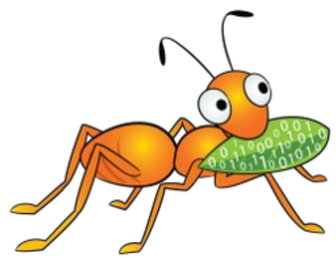
- Provides storage to share the cluster state across the NFS servers in the cluster
- This state is used during failover for Lock recovery
- Can be created and mounted on all the nodes using the following gluster CLI command -

```
#gluster volume set all cluster.enable-shared-storage enable
```

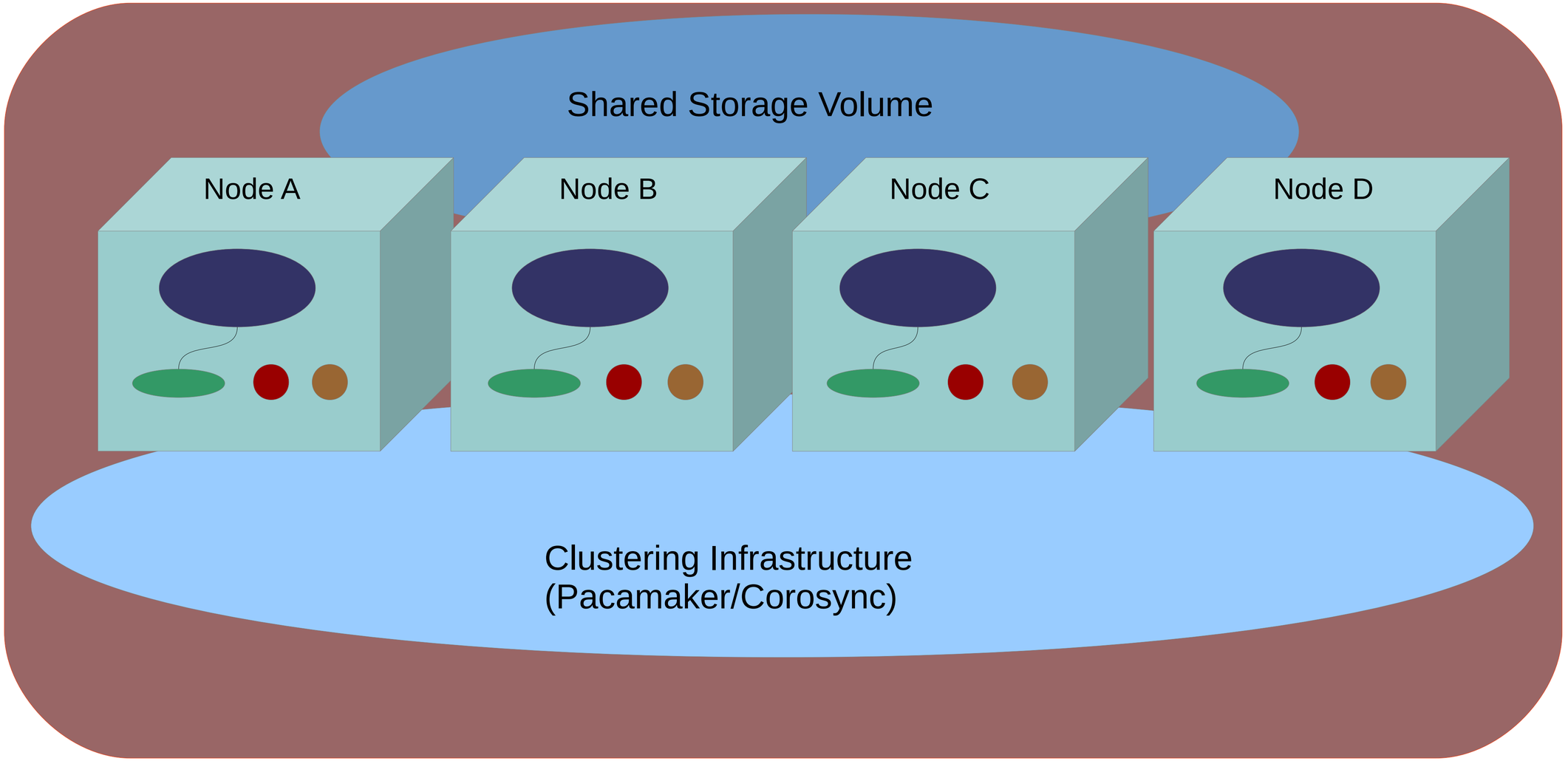


Limitations

- Current maximum limit of nodes forming cluster is 16
- Heuristics for IP failover
- Clustered DRC is not yet supported



Clustered NFS-Ganesha

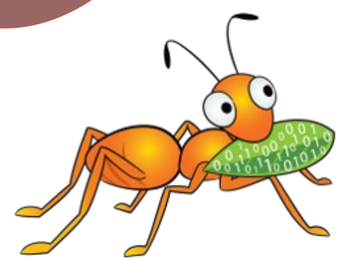


NFS-Ganesha service

Virtual IP

ganesha_mon

ganesha_grace



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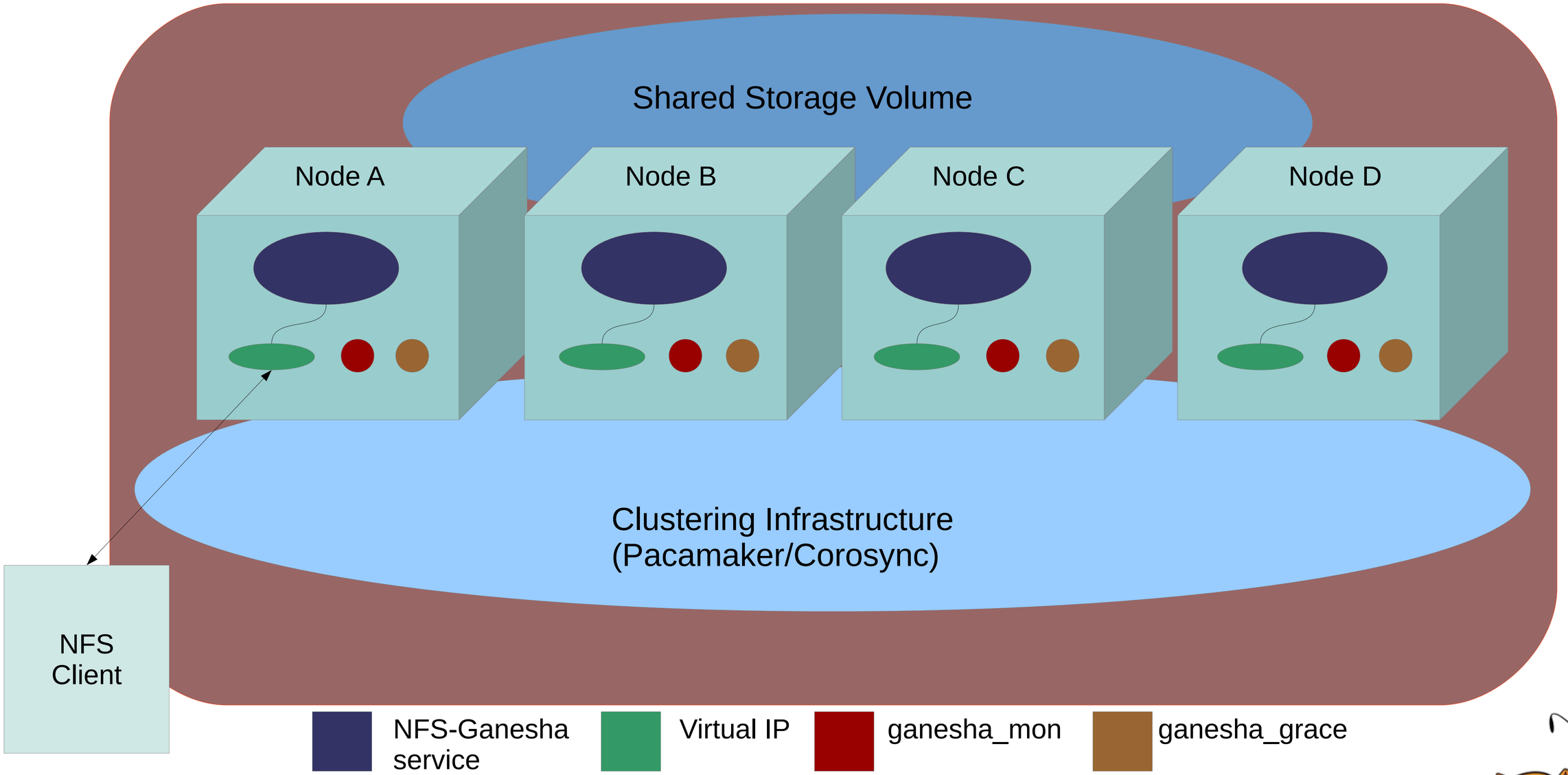

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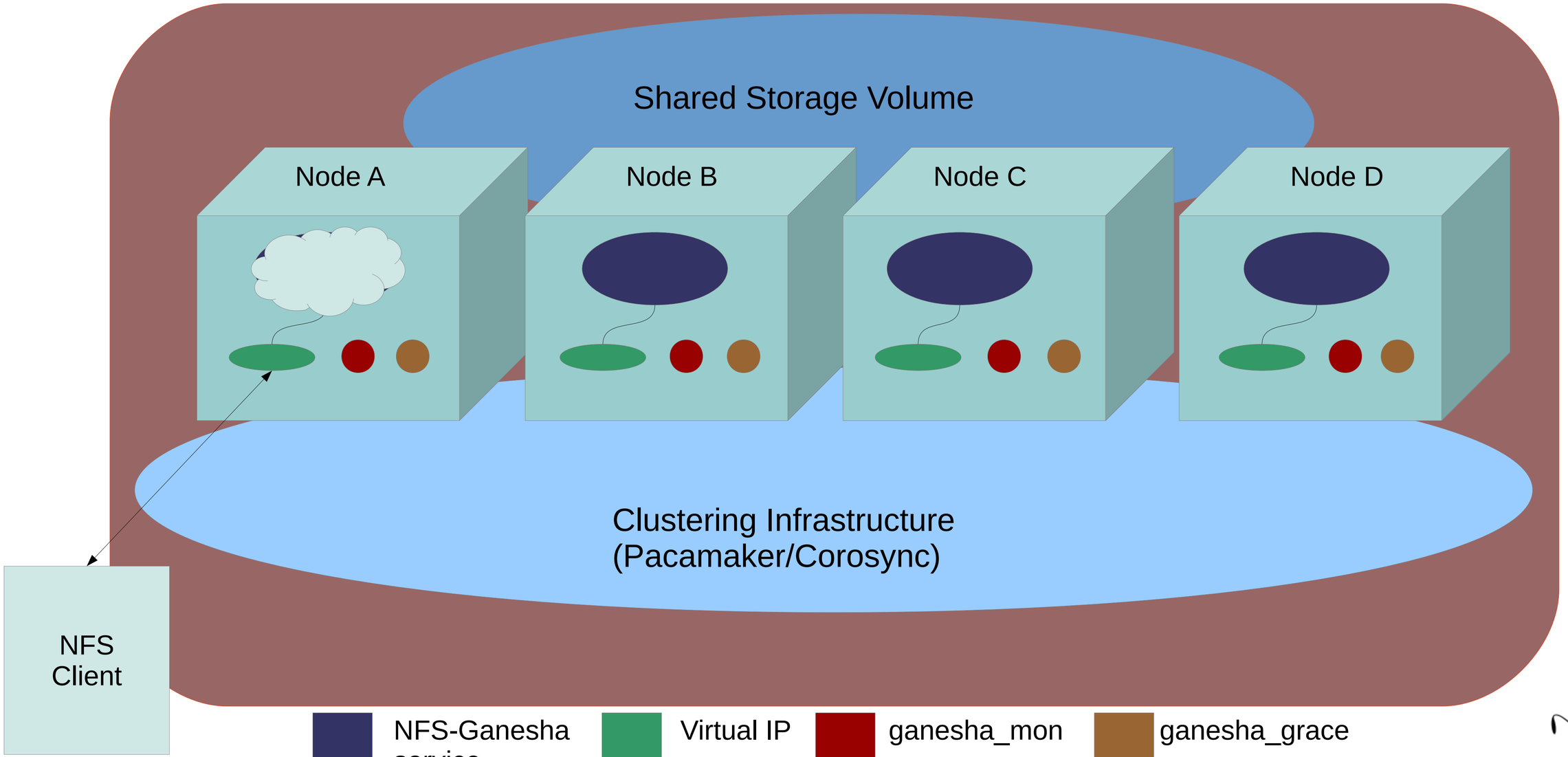

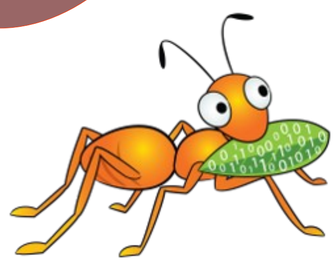

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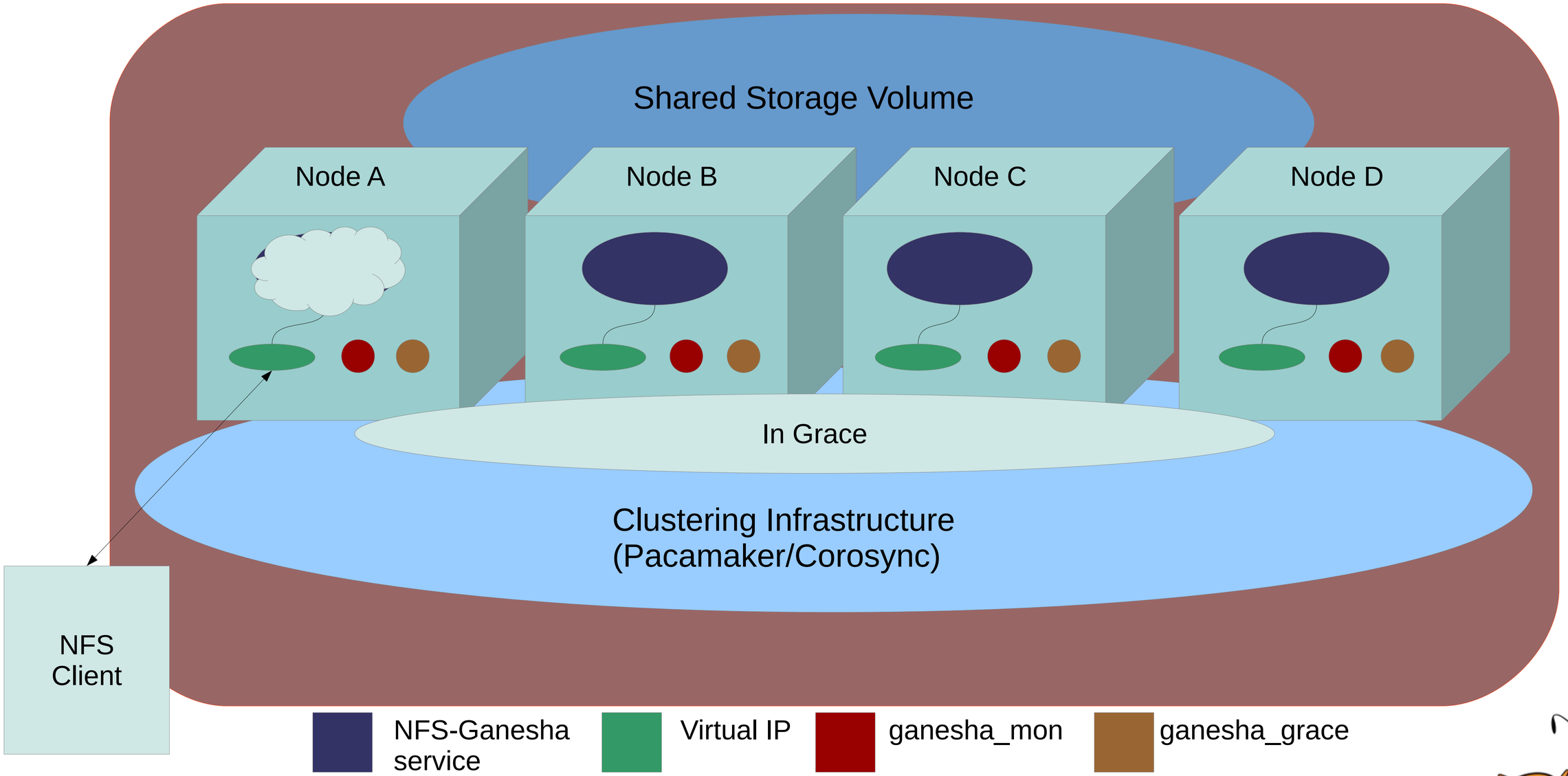

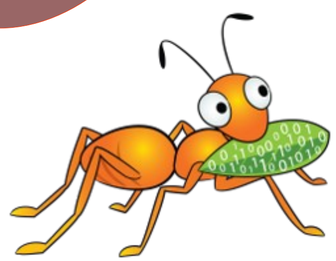

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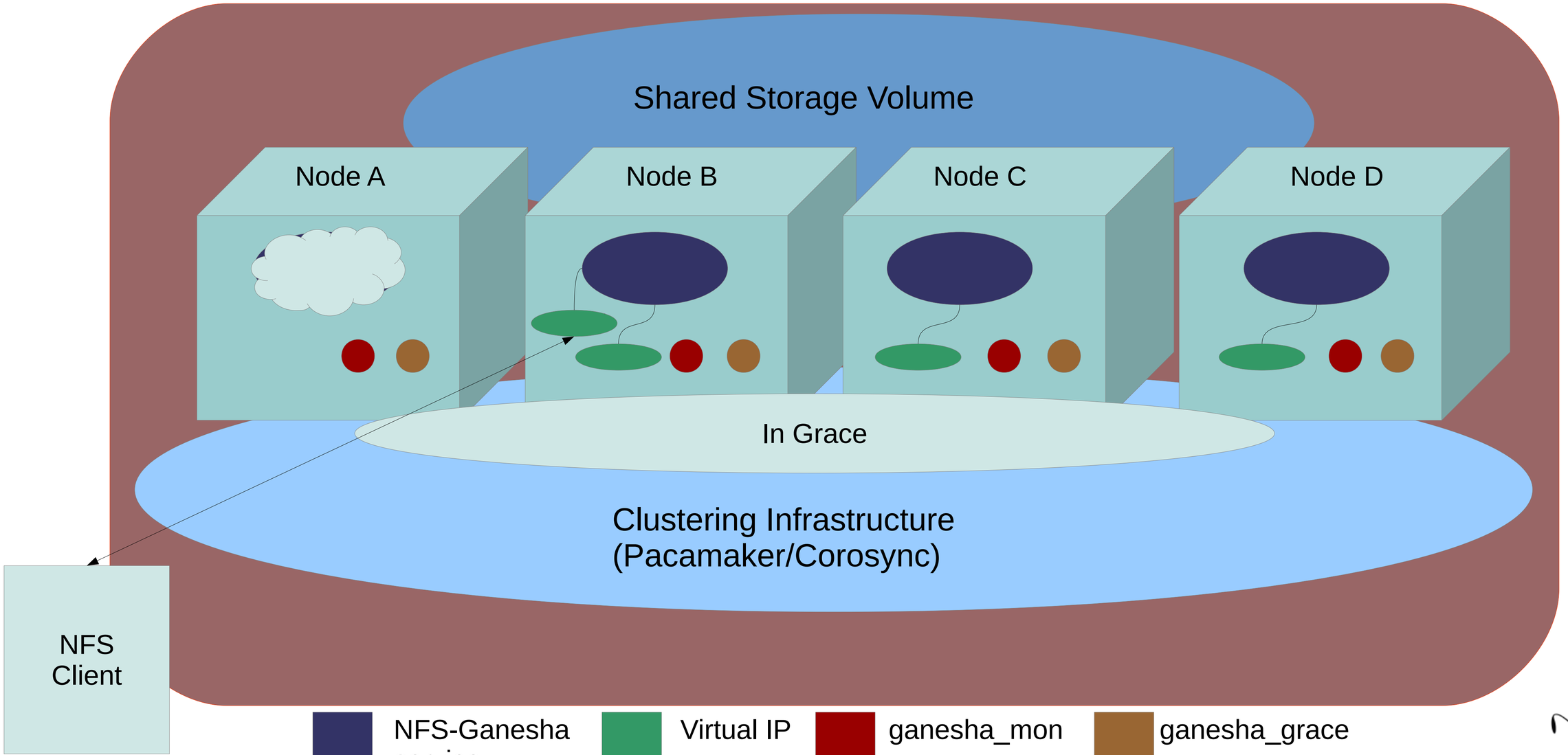

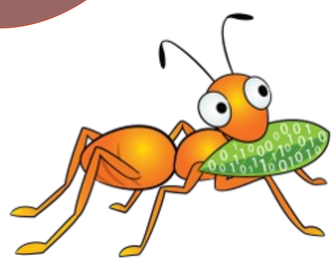

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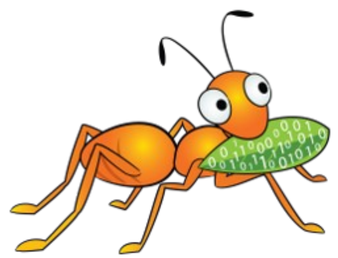
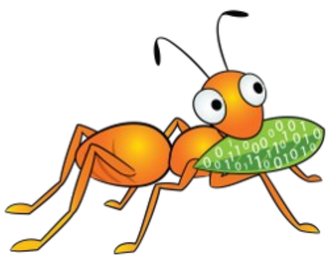


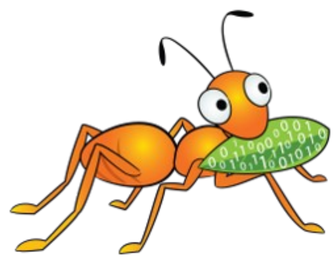
pNFS (Parallel Network File System)

- Introduced as part of NFSv4.1 standard protocol
- Needs a cluster consisting of M.D.S. (meta data server) and D.S. (Data server)
- Any filesystem can provide pNFS access via NFS-Ganesha by means of the FSAL easy plugin architecure
- Support for pNFS protocol ops added to FSAL_GLUSTER
- Currently supports only FILE LAYOUT



Future Directions

- NFSv4 paves the way forward for interesting stuff
- Adding NFSv4.x feature support for GlusterFS
  - Directory Delegations
  - Sessions
  - Server-side copy
  - Application I/O Advise (like posix_fadvise)
  - Sparse file support/Space reservation
  - ADB support
  - Security labels
  - Flex File Layouts in pNFS



Contact

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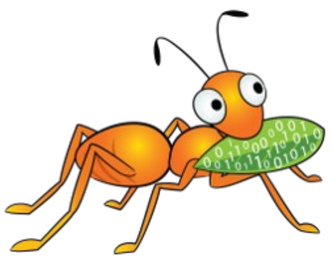
#gluster and #gluster-dev on freenode

team: Apeksha, ansubram, jiffin, kkeithley, meghanam, ndevos, saurabh, skoduri



References & Links

Links (Home Page):

https://github.com/nfs-ganesha/nfs-ganesha/wiki

http://www.gluster.org

References:

http://gluster.readthedocs.org

http://blog.gluster.org/

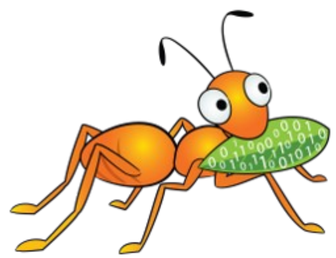
http://www.nfsv4bat.org/Documents/ConnectAThon/2012/NFS-GANESHA_cthon_2012.pdf

http://events.linuxfoundation.org/sites/events/files/slides/Collab14_nfsGaneshа.pdf

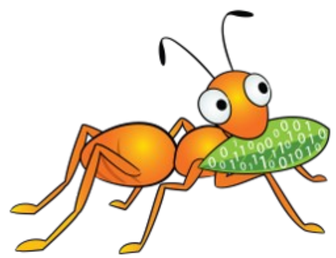
http://www.snia.org/sites/default/files/Poornima_NFS_GaneshaForClusteredNAS.pdf

http://clusterlabs.org/doc/

Q & A



BACKUP-
Step-by-step guide



Required Packages

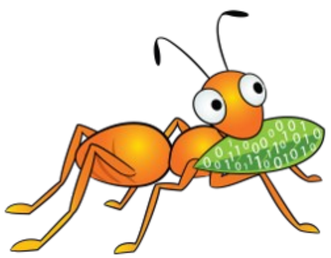
Gluster RPMs (>= 3.7)

- glusterfs-server
- glusterfs-ganesha

Ganesha RPMs (>= 2.2)

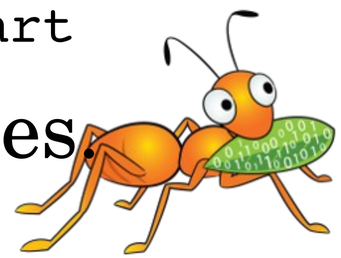
- nfs-ganesha
- nfs-ganesha-gluster

Pacemaker & pcs RPMs



Pre-requisites

- Ensure all machines are DNS resolvable
- Disable and stop NetworkManager service, enable and start network service on all machines
- Enable IPv6 on all the cluster nodes.
- Install pacemaker pcs ccs resource-agents corosync
  - `#yum -y install pacemaker pcs ccs resource-agents corosync` on all machines
- Enable and start pcsd on all machines
  - `#chkconfig --add pcsd; chkconfig pcsd on; service pcsd start`
- Populate `/etc/ganesha/ganesha-ha.conf` on all the nodes.



Pre-requisites

- Create and mount the Gluster shared volume on all the machines
- Set cluster auth password on all machines

```
#echo redhat | passwd --stdin hacluster
#pcs cluster auth on all the nodes
```

- Passwordless ssh needs to be enabled on all the HA nodes.
  - On one (primary) node in the cluster, run:

    #ssh-keygen -f /var/lib/glusterd/nfs/secret.pem
  - Deploy the pubkey ~root/.ssh/authorized keys on _all_ nodes, run:

```
#ssh-copy-id -i /var/lib/glusterd/nfs/secret.pem.pub root@$node
```

Sample 'ganesha-ha.conf'

Name of the HA cluster created. must be unique within the subnet

HA_NAME="ganesha-ha-360"

The gluster server from which to mount the shared data volume.

HA_VOL_SERVER="server1"

The subset of nodes of the Gluster Trusted Pool that form the ganesha HA cluster.

Hostname is specified.

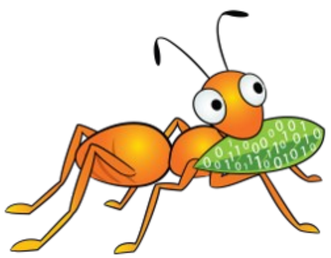
HA_CLUSTER_NODES="server1,server2,..."

#HA_CLUSTER_NODES="server1.lab.redhat.com,server2.lab.redhat.com,..."

Virtual IPs for each of the nodes specified above.

VIP_server1="10.0.2.1"

VIP_server2="10.0.2.2"



Setting up the Cluster

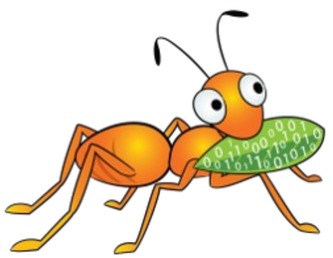
New CLIs introduced to configure and manage NFS-Ganesha cluster & Exports

```
#gluster nfs-ganesha <enable/disable>
```

- Disable Gluster-NFS
- Start/stop NFS-Ganesha services on the cluster nodes.
- Setup/teardown the NFS-Ganesha cluster.

```
#gluster vol set <volname> ganesha.enable on/off
```

- Creates export config file with default parameters
- Dynamically export/unexport volumes.



Modifying the Cluster

- Using HA script `ganesha-ha.sh` located at `/usr/libexec/ganesha`.
- Execute the following commands on any of the nodes in the existing NFS-Ganesha cluster
- To add a node to the cluster:

```
#./ganesha-ha.sh --add <HA_CONF_DIR> <HOSTNAME> <NODE-VIP>
```

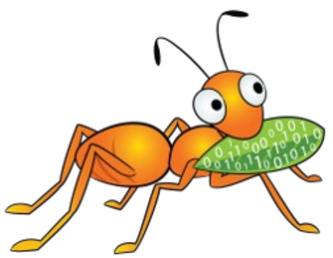
- To delete a node from the cluster:

```
#./ganesha-ha.sh --delete <HA_CONF_DIR> <HOSTNAME>
```

Where, HA_CONF_DIR: The directory path containing the ganesha-ha.conf file.

HOSTNAME: Hostname of the new node to be added

NODE-VIP: Virtual IP of the new node to be added.



Modifying Export parameters

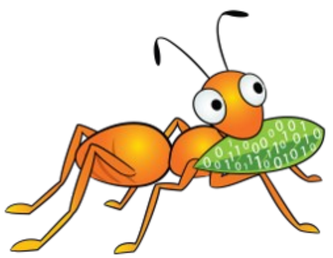
On any of the nodes in the existing ganesha cluster:

- Edit/add the required fields in the corresponding export file located at `/etc/ganesha/exports`.
- Execute the following command:

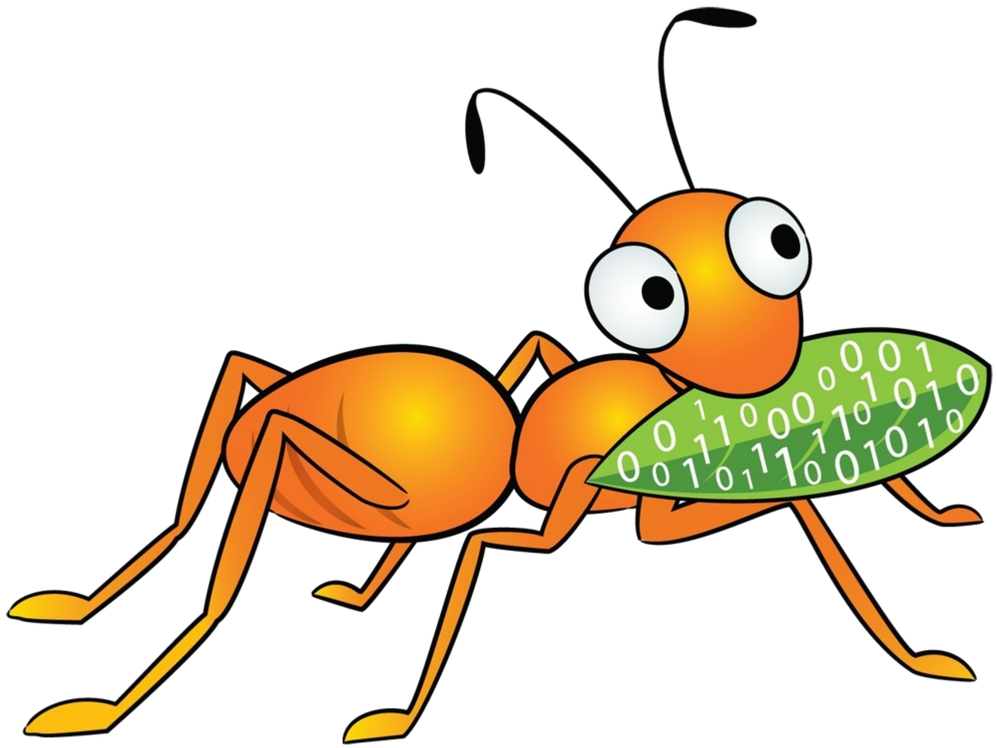
  ```
  #./ganesha-ha.sh --refresh-config <HA_CONFDIR> <Volname>
  ```

  Where,

  - HA_CONFDIR: The directory path containing the ganesha-ha.conf file
  - Volname: The name of the volume whose export configuration has to be changed.



Thank you!



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