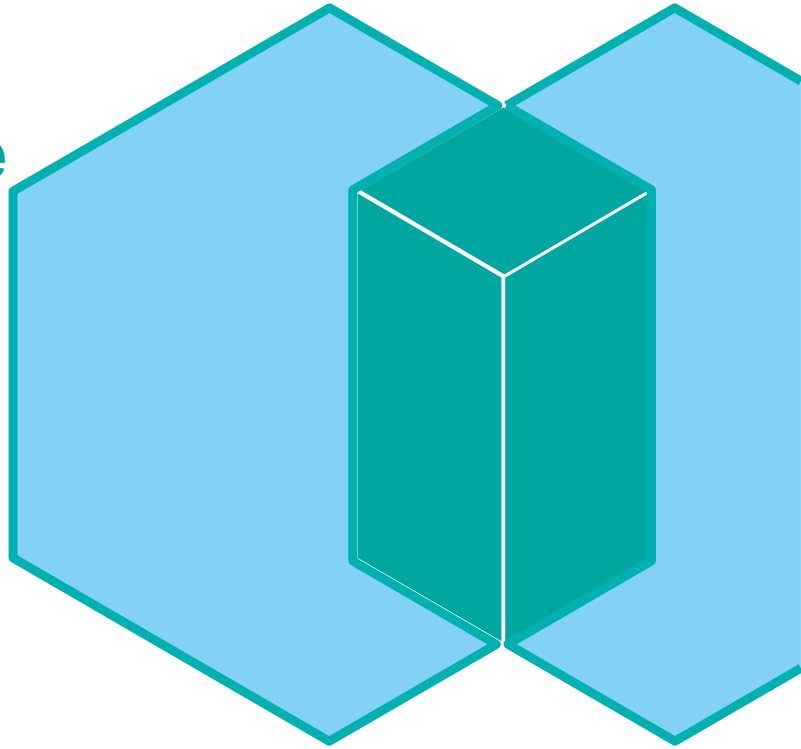

Deep-dive on Spectrum Scale Reliability, Availability and Serviceability improvements

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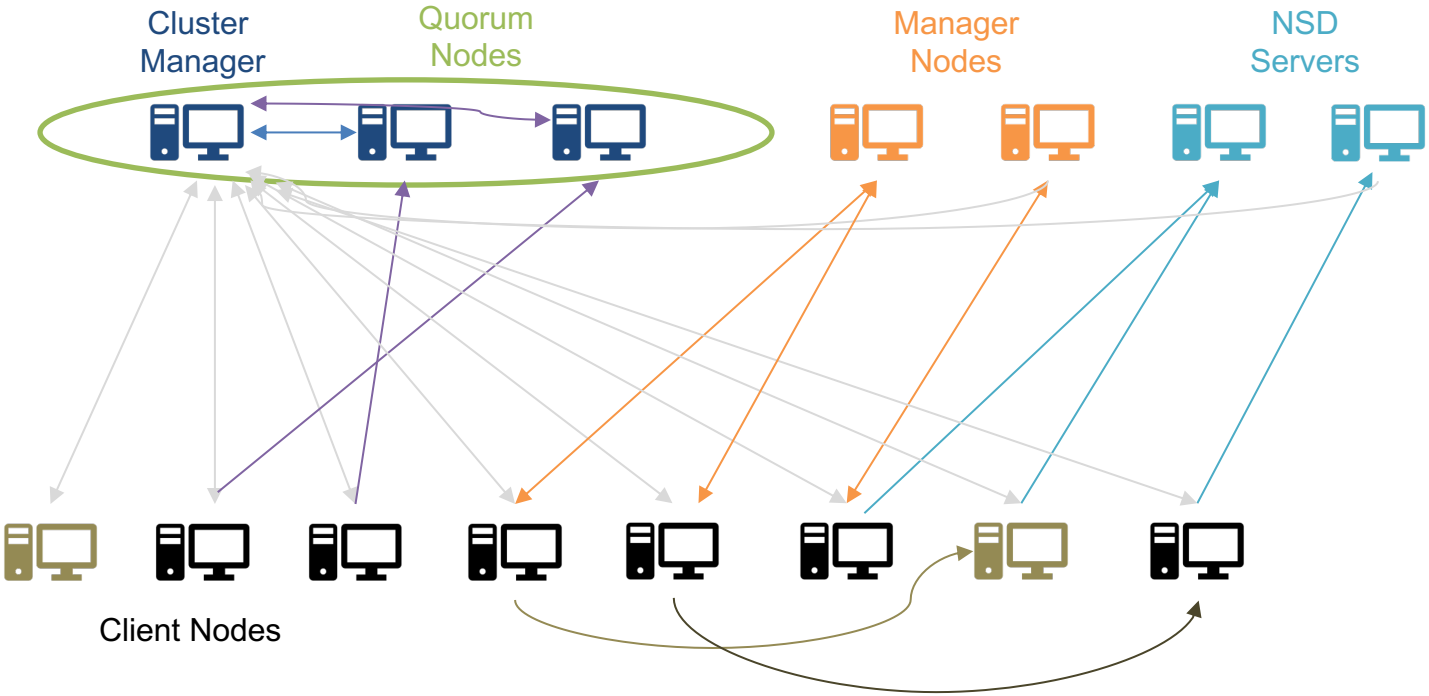
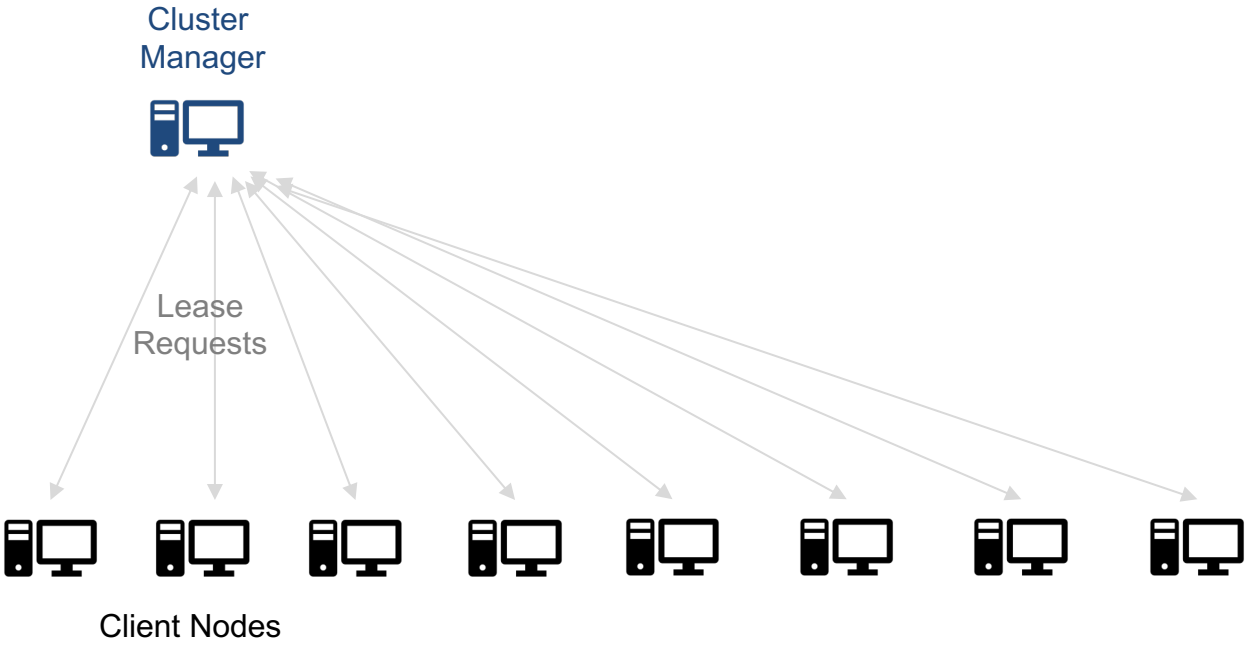
NETWORK RESILIENCY

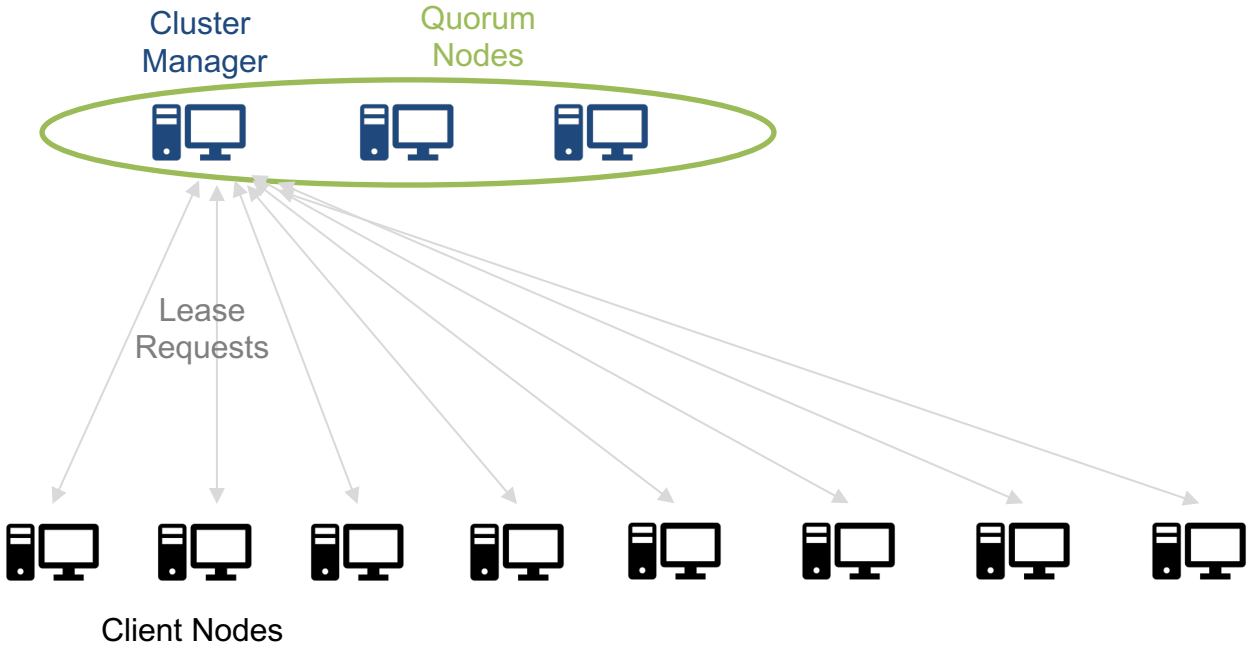
Spectrum Scale Network Communication



Spectrum Scale Network Communication



Spectrum Scale Network Communication



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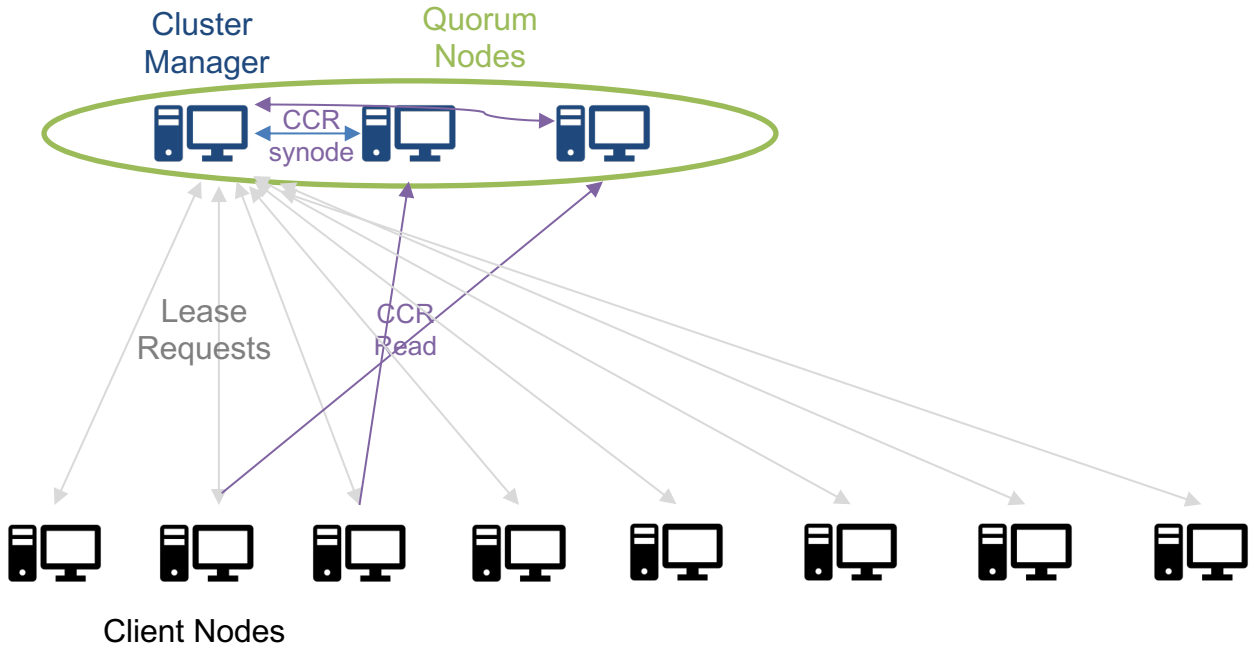
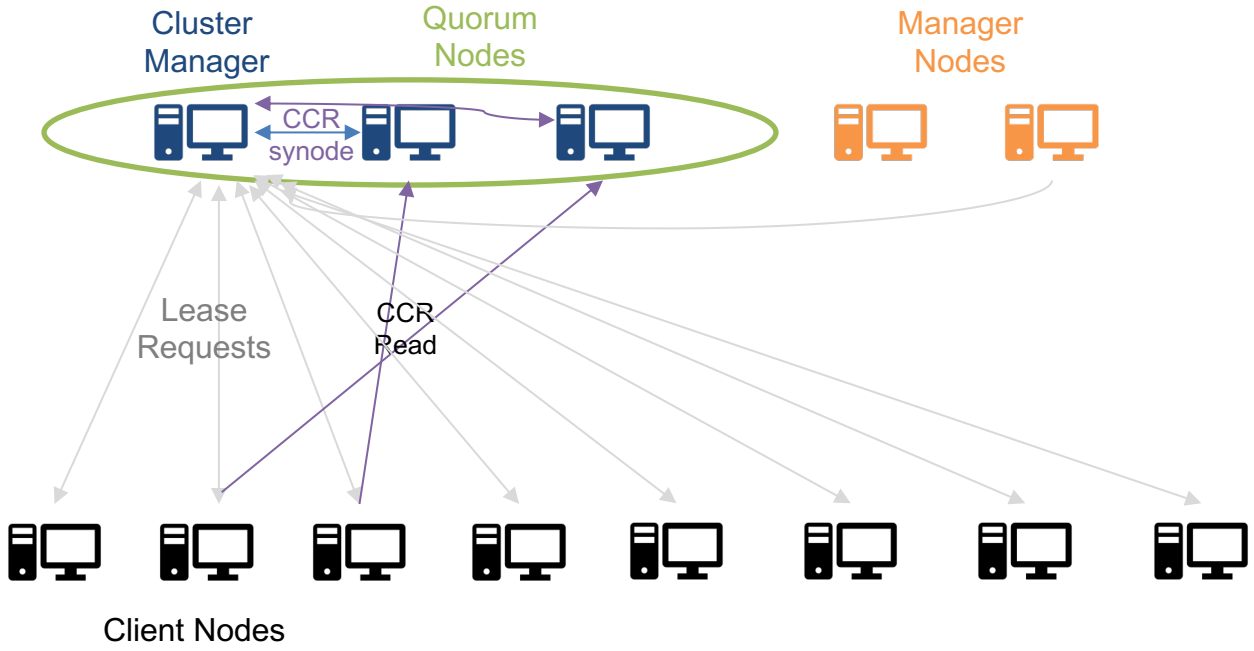
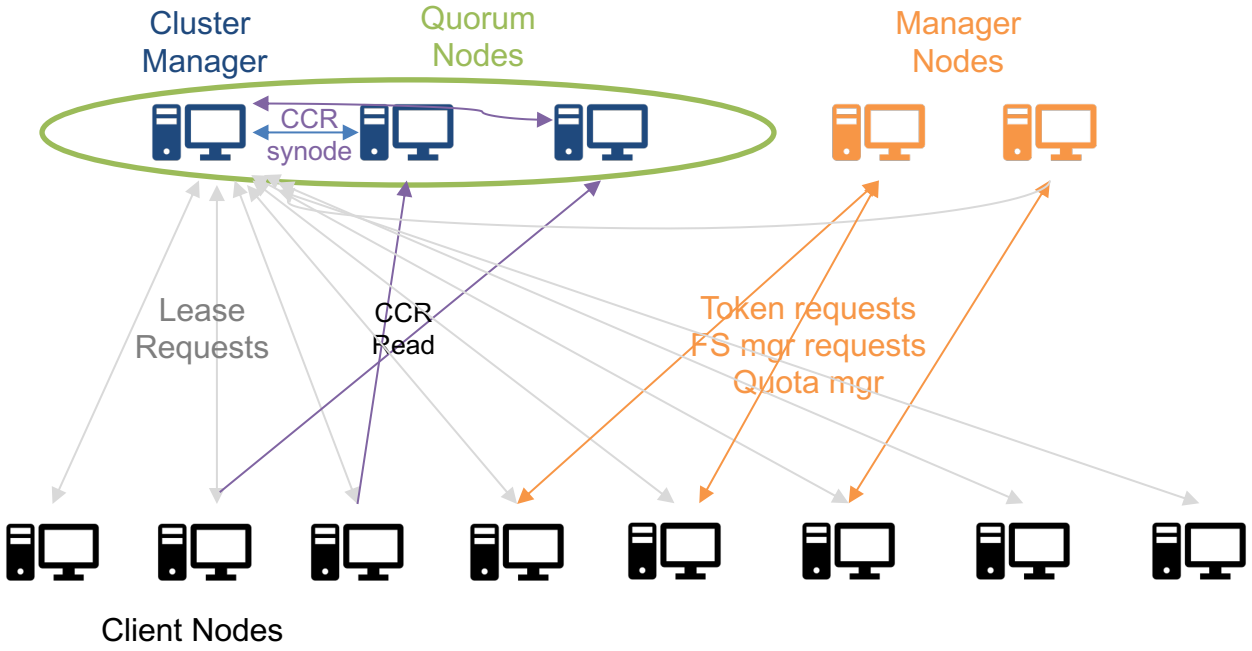


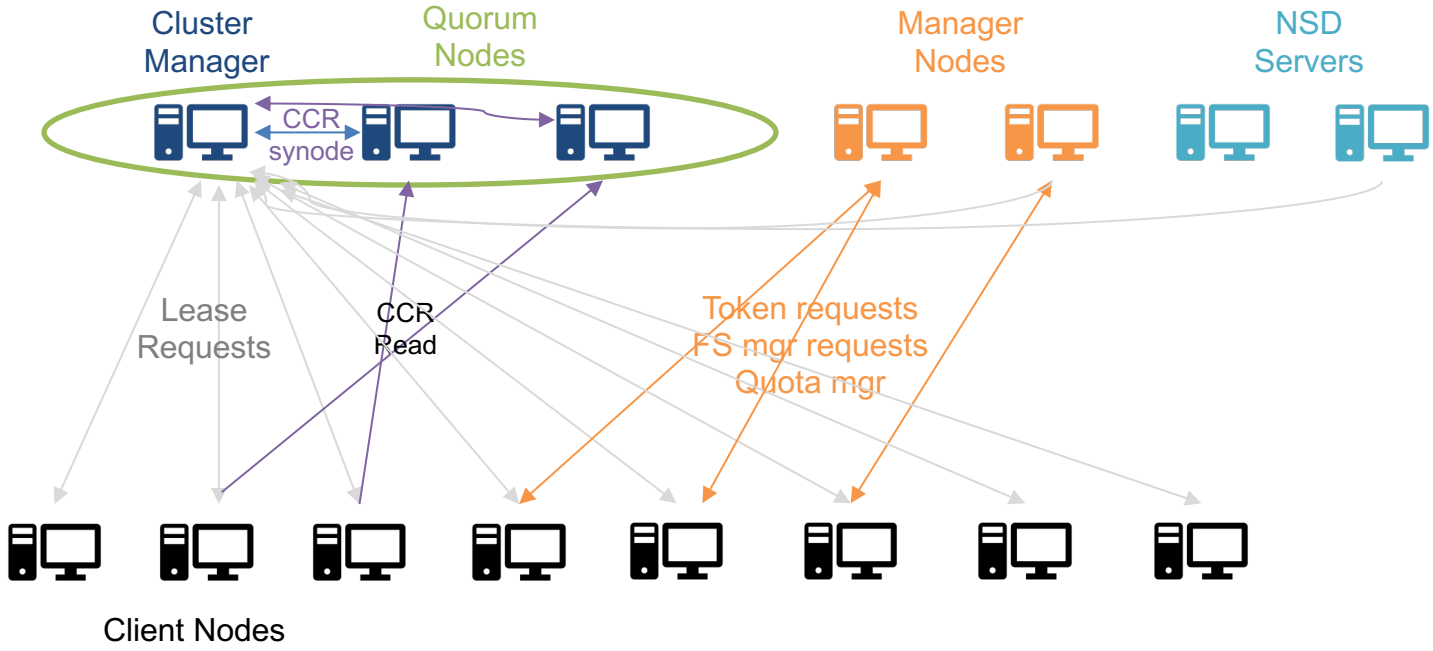
Spectrum Scale Network Communication



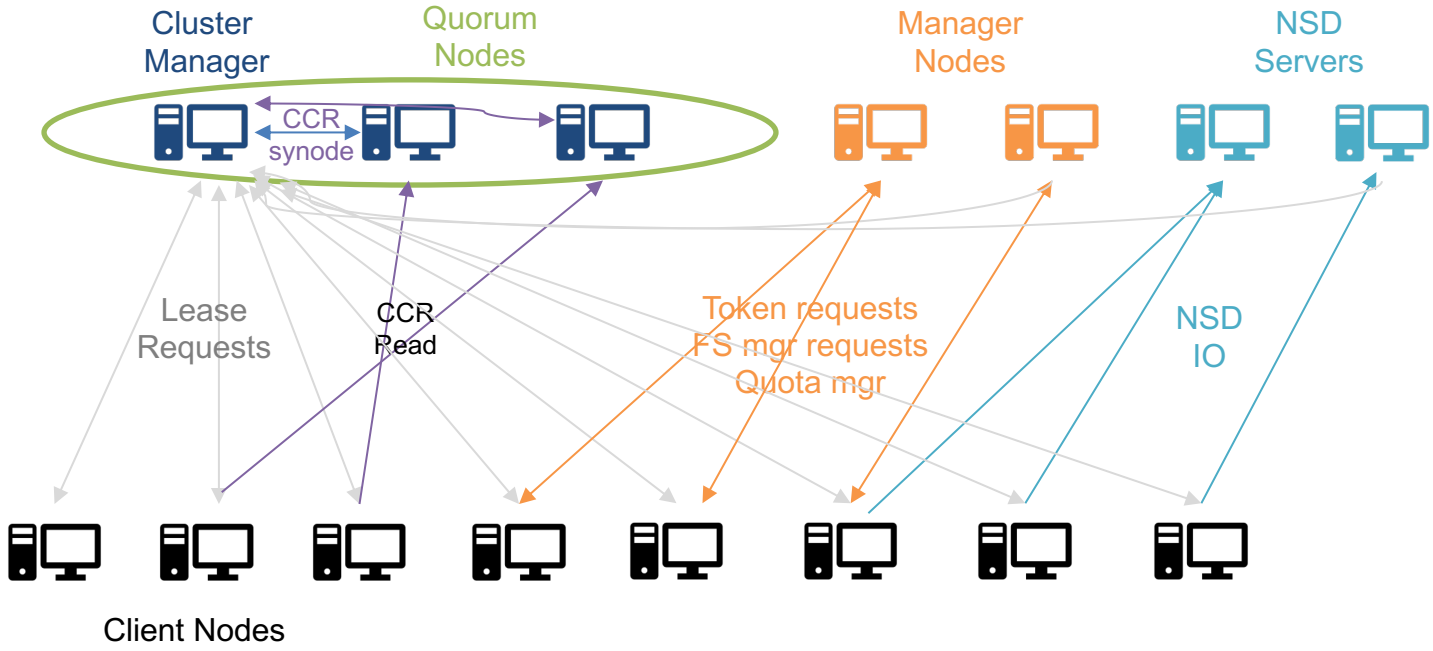
Spectrum Scale Network Communication



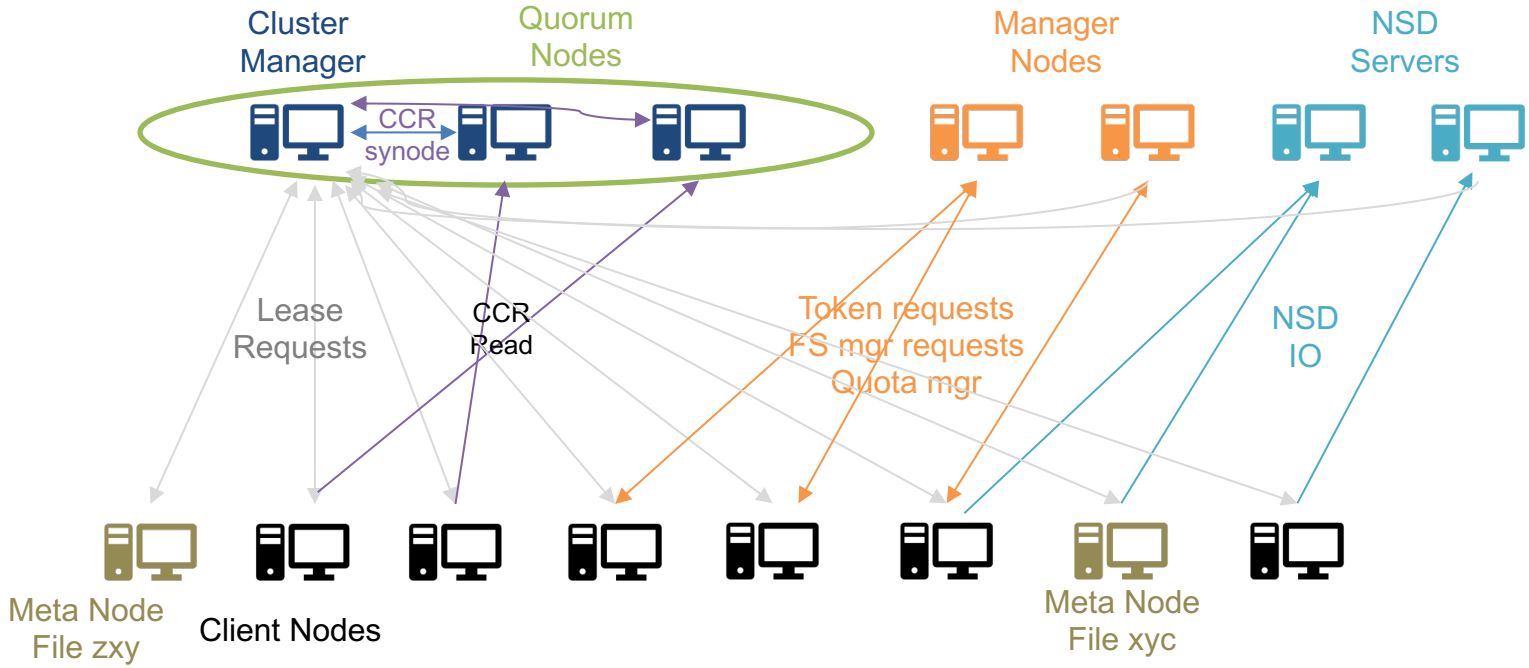
Spectrum Scale Network Communication



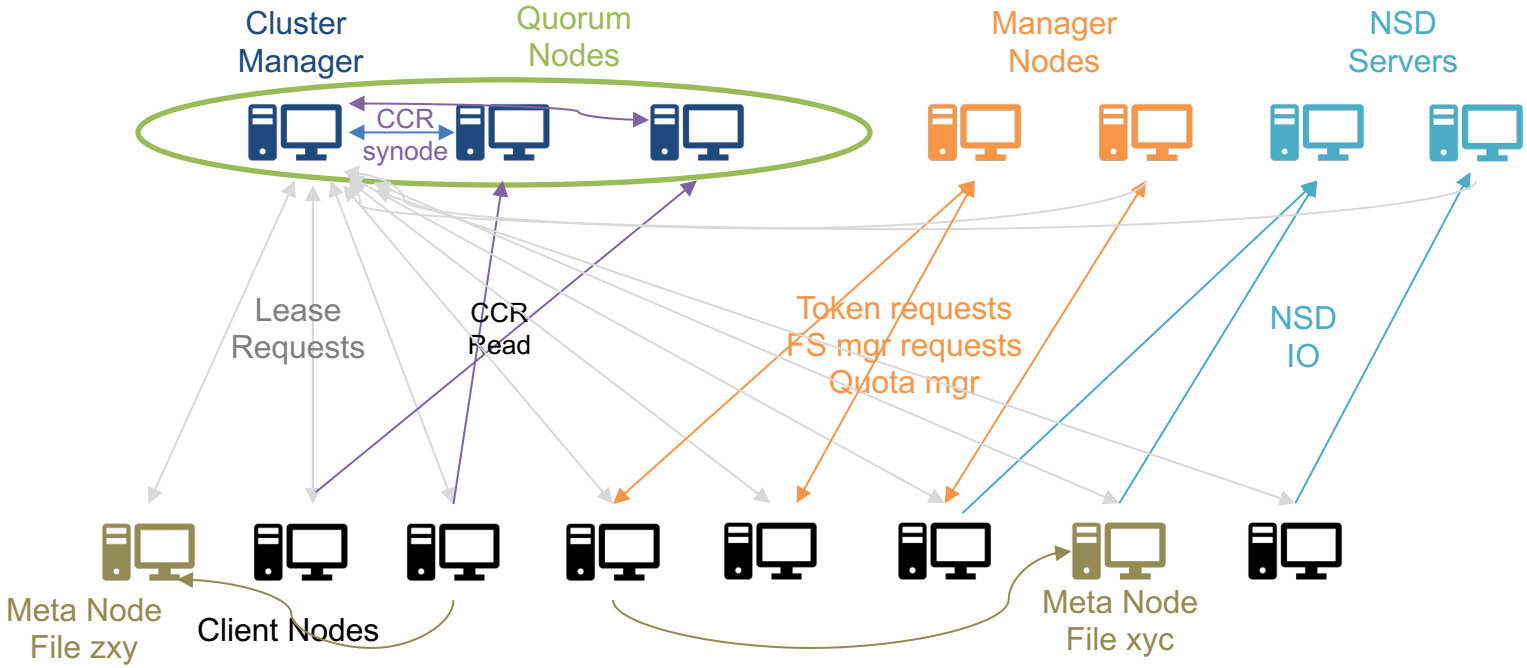
Spectrum Scale Network Communication



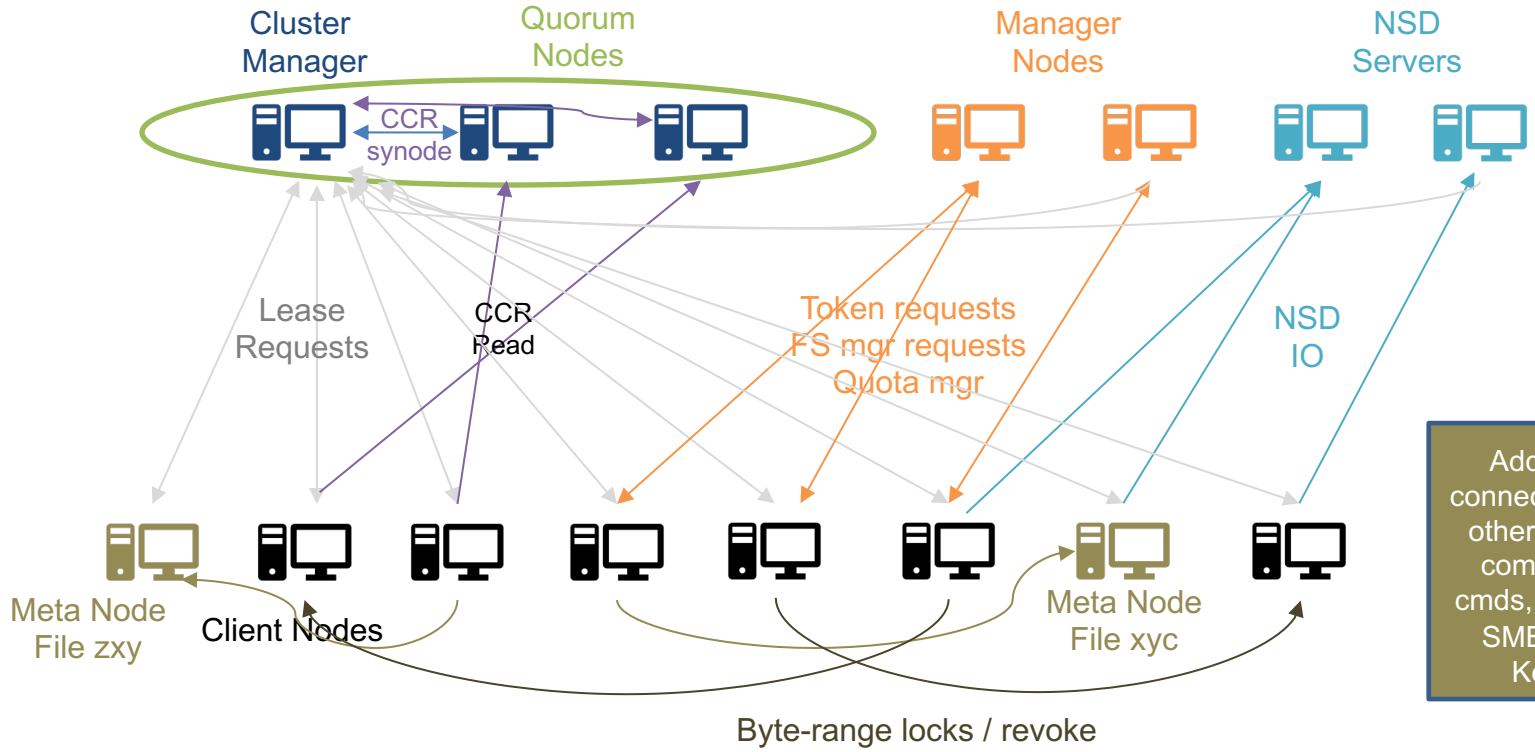
Spectrum Scale Network Communication



Spectrum Scale Network Communication



Spectrum Scale Network Communication



Additional network connections are done by other Spectrum Scale components (admin cmds, AFM, Monitoring, SMB(ctdb), Object / Keystone, etc.)

Blocked network communication between two nodes = expel

- If node cannot talk to Cluster Manager (CM), then node will be expelled
- If node A cannot talk to node B but both can talk to the Cluster Manager, then the CM will decide which node to expel (A or B):
  1. quorum nodes over non-quorum nodes
  2. local nodes over remote nodes
  3. manager-capable nodes over non-manager-capable nodes
  4. nodes managing more FSs over nodes managing fewer FSs
  5. NSD server over non-NSD server
  6. Otherwise, expel whoever joined the cluster more recently.
  - A custom callout script can be configured to customize the behavior

Node expels are often caused by instable network infrastructure or invalid firewall configurations !

Use mmnetverify to test network connectivity

mmnetverify can test any-to-any node connectivity

- Supports many different operations (connectivity, port, protocol, data, etc.)
- -v = additional verbose output

```
#> mmnetverify connectivity
  md-12 checking communication with node md-13.
  Operation resolution: Success.
  Operation ping: Success.
  Operation shell: Success.
  Operation copy: Success.
  ....
#>  mmnetverify port –N all
  md-12 checking communication with node md-13.
  Operation daemon-port: Success.
  Operation sdrserv-port: Success.
  Operation tsccmd-port: Success.
  md-13 checking communication with node md-12
  ….
```

*tsccmd-port: picks one port out of the tscCmdPortRange (used by admin cmds)

mmnetverify RDMA

- mmnetverify RDMA connectivity test
  - Test connectivity between local and target nodes on all active infiniband adapter ports which share the same fabric. (ibtracert)
  - Verifies that the configured ports exist and are active (ibv_devinfo)
  - Takes the config values verbsRdma, verbsPorts into account

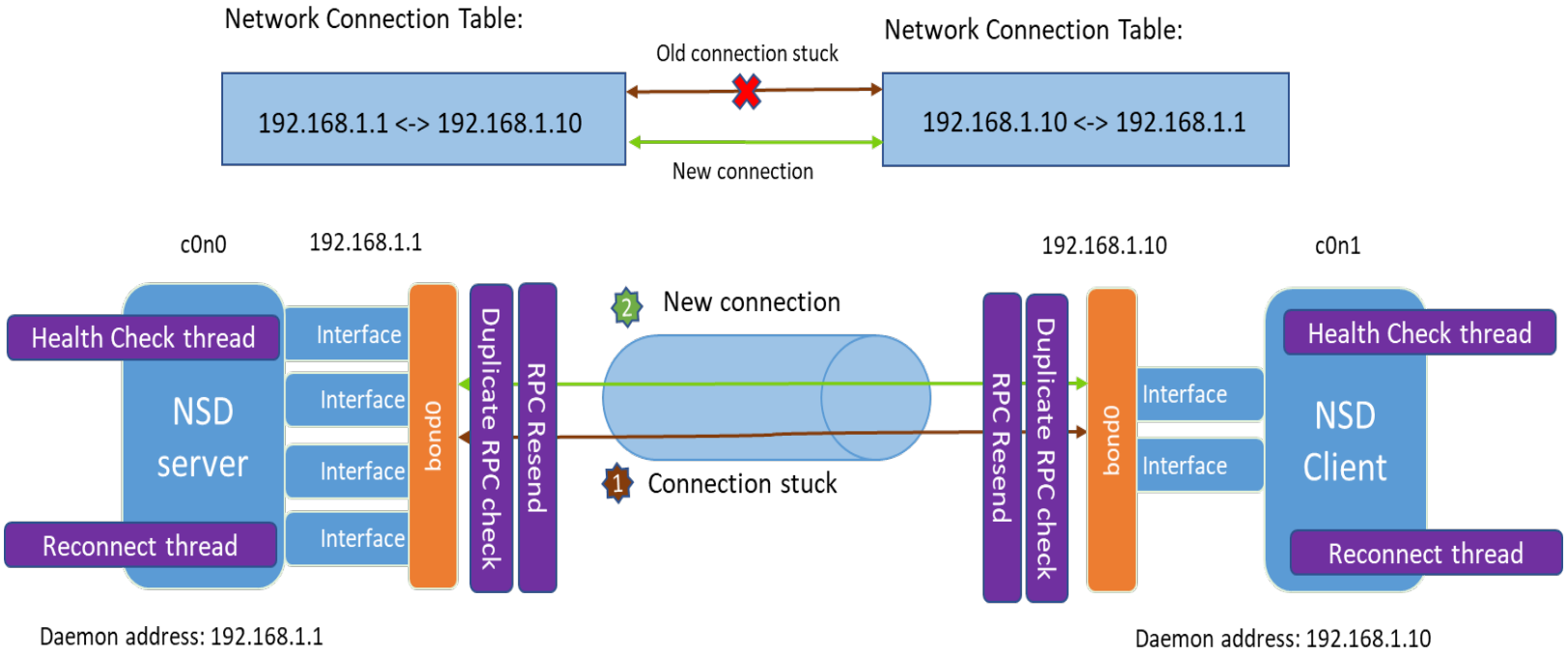
#> mmnetverify rdma

fscc-p8-24-b checking communication with node fscc-p8-24-c.
Operation rdma-connectivity: Success.

fscc-p8-24-b checking communication with node fscc-p8-24-b.
Operation rdma-connectivity: Success.

fscc-p8-24-b checking communication with node fscc-p8-24-e.
Failed to get IB devices list: Function not implemented
Node fscc-p8-24-e.mainz.de.ibm.com has no ports configured which match the verbsPorts configuration value.
Operation rdma-connectivity: Fail.

Network Proactive Reconnect



Proactive Reconnect

To enable proactive reconnect:

- *mmchconfig proactiveReconnect=yes*

1) Detects if a socket connection is in a bad state, by looking at

- Socket ca_state = TCP_CA_LOSS
- Retransmission Timeout > tcpiRTOThreshold(10s) + outstanding segments (tcpi_unacked)

2) Proactively establish a new socket connection and rerun outstanding RPCs

- Duplicate RPC check !

#> mmhealth node eventlog

```
2019-03-10 23:17:22.013791 CET   reconnect_start    WARNING  Attempting to reconnect to 10.0.100.23 md-11 <c0n0>
2019-03-10 23:17:37.880504 CET   reconnect_failed   ERROR    Reconnect to 10.0.100.23 md-11 <c0n0> failed
2019-03-10 23:17:37.904809 CET   reconnect_aborted  INFO     Reconnect to 10.0.100.23 md-11 <c0n0> aborted
```

#> tail /var/adm/ras/mmfs.log.latest

```
[W] The TCP connection to IP address 10.0.100.23 md-11 <c0n0> (socket 28) state is unexpected: state=1 ca_state=4
snd_cwnd=1 snd_ssthresh=4 unacked=1 probes=0 backoff=8 retransmits=8 rto=51712000 rcv_ssthresh=506364 rtt=1198
rttvar=1169 sacked=0 retrans=1 reordering=14 lost=1
[E] Bad TCP state detected. Initiating proactive reconnect to node 10.0.100.23 md-11.
```

CLUSTER HEALTH STATE

Cluster Health State

Problem: Where to start with checking the cluster health ?

Need a single entry point to show the health state of the entire cluster and the ability to drill down into the details.

Recommended approach:

1) **Run *„mmhealth cluster show“* to get a consolidated cluster state view**
   - Add –unhealthy to filter for FAILED or DEGRADED components

```
#>  mmhealth cluster show --unhealthy
Component                Total     Failed    Degraded  Healthy   Other
-------------------------------------------------------------------------------------------------
FILESYSTEM               2         0         1         1         0
CESIP                    1         0         1         0         0
FILEAUDITLOG             4         3         0         0         1
```

Cluster Health State

2) Drill down into cluster level details using *“mmhealth cluster show <component>“*

- <component> can also be „node“ to see the status of each node
- Add –v option to see sub-components of the node

```
#> mmhealth cluster show node -v
Component       Node             Status         Reasons
-------------------------------------------------------------------------------------
NODE            md-11.novalocal  TIPS           auditc_service_failed, unmounted_fs_check, gpfs_maxstatcache_low
  PERFMON                        HEALTHY        -
  GUI                            HEALTHY        -
  GPFS                           TIPS           gpfs_maxstatcache_low
  FILEAUDITLOG                   FAILED         auditc_service_failed
  FILESYSTEM                     DEGRADED       unmounted_fs_check
  NETWORK                        HEALTHY        -
NODE            md-12.novalocal  HEALTHY        -
  GPFS                           HEALTHY        -
  PERFMON                        HEALTHY        -
  …
```

* Permanently hide Tips using *„mmhealth event hide <eventname>“*

Cluster Health State

3) Check details on node level running *„mmhealth node show -v“ on the node*

- Use –N <nodename> to run command on a particular node
- Add –v option to see sub-components and entities

```
#> # mmhealth node show
Node name:      md-12.novalocal
Node status:    TIPS
Status Change:  1 min. ago

Component       Status       Status Change     Reasons
------------------------------------------------------------------------------------------------
GPFS            TIPS         1 min. ago        gpfs_maxstatcache_low, gpfs_pagepool_small
NETWORK         HEALTHY      1 min. ago        -
FILESYSTEM      DEGRADED     1 min. ago        unmounted_fs_check(gpfs0)
CES             TIPS         1 min. ago        ip_not_hostable
CESIP           DEGRADED     1 min. ago        ces_ips_unassigned
FILEAUDIT       FAILED       1 min. ago        auditc_service_failed(gpfs0)
PERFMON         HEALTHY      1 min. ago        -
```

* To get a detailed description of an event use *„mmhealth event show <eventname>“*

Cluster Health State

3) Check details of failed component by running *„mmhealth node show <component>“*

- Use –N <nodename> to run command on a particular node
- Add –v option to see sub-components and entities

```
#> mmhealth node show gpfs

Node name:      md-12.novalocal

Component     Status       Status Change     Reasons
------------------------------------------------------------------------------------------
GPFS          TIPS         27 min. ago       gpfs_maxstatcache_low, gpfs_pagepool_small


Event                         Parameter     Severity    Active Since      Event Message
-------------------------------------------------------------------------------------------------------------------------------
gpfs_maxstatcache_low         GPFS          TIP         27 min. ago       The GPFS maxStatCache is lower than the maxFilesToCache setting.
gpfs_pagepool_small           GPFS          TIP         27 min. ago       The GPFS pagepool is smaller than or equal to 1G.
```

Cluster Health State inconsistencies

Problem:

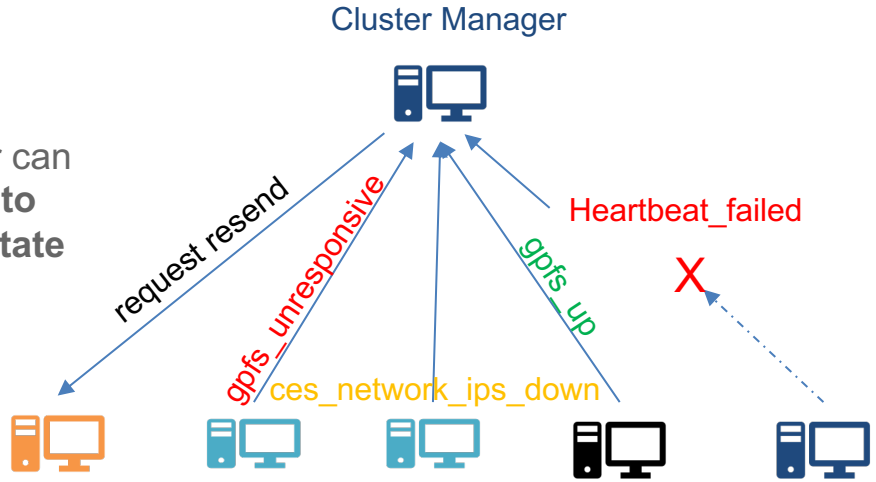
Sometimes the cluster state shows different results than the node state.

E.g. SMB state FAILED on cluster level but already HEALTHY on node level.

To answer this we need to explain how the cluster state consolidation works.

Cluster Health State

A **consolidated cluster state view** is build on the cluster manager



Cluster Manager can **request a node to resend its full state**

Each node sends **regular heartbeat events** and **forwards the state change events** to the cluster manager node.

Health monitoring runs on any GPFS node (Linux, AIX), monitors Spectrum Scale components and checks for common failure conditions (e.g. local fs full)

Cluster Health State

Summary:

- Event forwarding to cluster state manager can be delayed or interrupted when network issues happen, but should cleanup itself and is **“eventually consistent”**
- If in doubt, local node state (**mmhealth node show) is always right**
- In case of permanent network issues or node outage, **heartbeat_missing event** will indicate that the node is not sending any event for the last 30min.
- Since 5.0.3 a manual resync can be triggered:

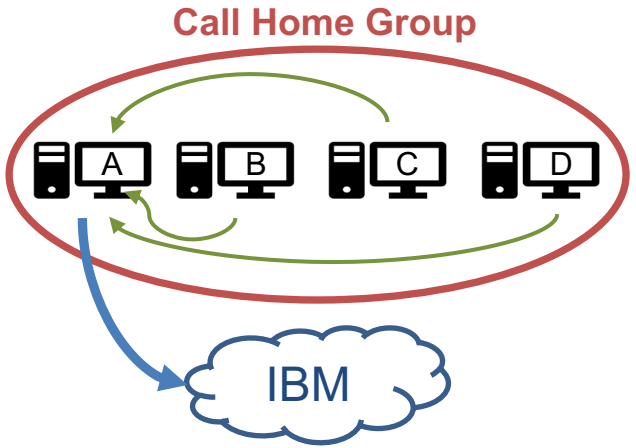
```
#>  mmhealth node show --resync
Resend events to cluster state manager
```

CALL HOME -> PROACTIVE SERVICE

Spectrum Scale Call Home becomes Proactive

Main features today:

- Upload of daily/weekly data collection (general cluster informations*)
- Event-based data collection and upload (event specific informations*)
- On-demand sharing data with support (snap upload)
- Supported on RHEL7, SLES and Ubuntu (x86, ppc, s390)



Why enable?

- Faster service response times
- Easier/faster sharing data with support
- Better test coverage for your configuration

Please note:

- ESS Hardware Call Home ≠ Spectrum Scale Software Call Home
- Recommendation: Enable both!

*See Spectrum Scale Knowledge Center for details of collected and transferred configuration data and logs

Spectrum Scale Call Home becomes Proactive

New in 5.0.3:

- Performance / scalability
  - Faster + much better scalable data collection
- Simplified setup / less dependencies
  - Integrated with gpfs.base package, less rpm dependencies
- Introduced Call Home heartbeats
- Enhancements for event-based uploads
  - more mmhealth events trigger call home
- mmhealth reports if no connection to ECuRep

Spectrum Scale Call Home becomes Proactive

Future of Call Home (Subject to change):

- Proactively detect:
  - Common misconfigurations & known issues
  - System/component failures by using AI / ML
  - Receive real-time tuning suggestions

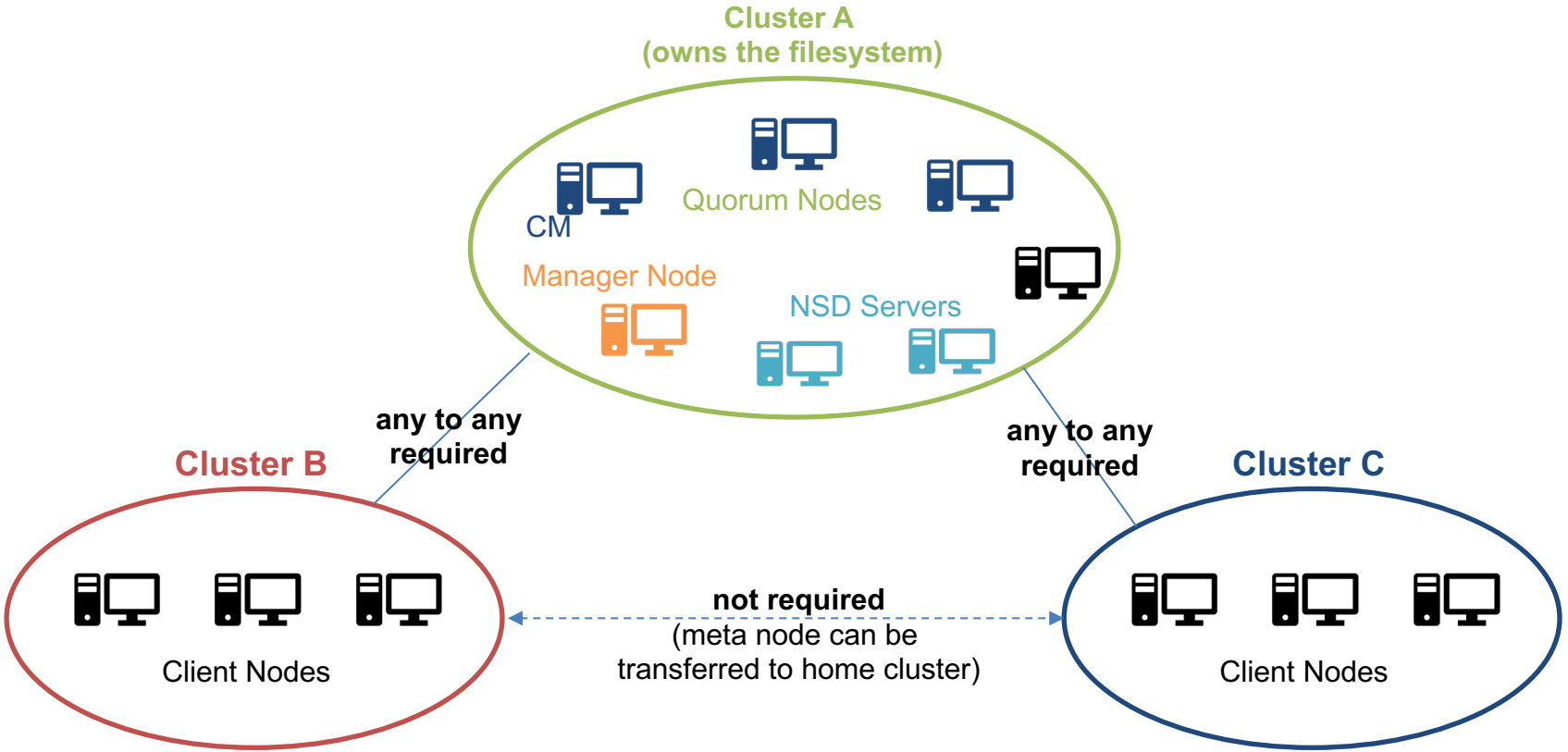
- Customer insight reports for support and development (ElasticSearch)
  - Quickly better understand customer systems

- Ticket/PMR creation via Call Home

- Backchannel – pushing alerts back to the customer system:
  - Latest insights without Spectrum Scale upgrade

MULTI-CLUSTER NETWORK

Spectrum Scale Network Communication - Multicluster



mmnetverify multi-cluster check

- mmnetverify can test remote-cluster connectivity
  - --cluster <remote cluster name> <contact_node>,…

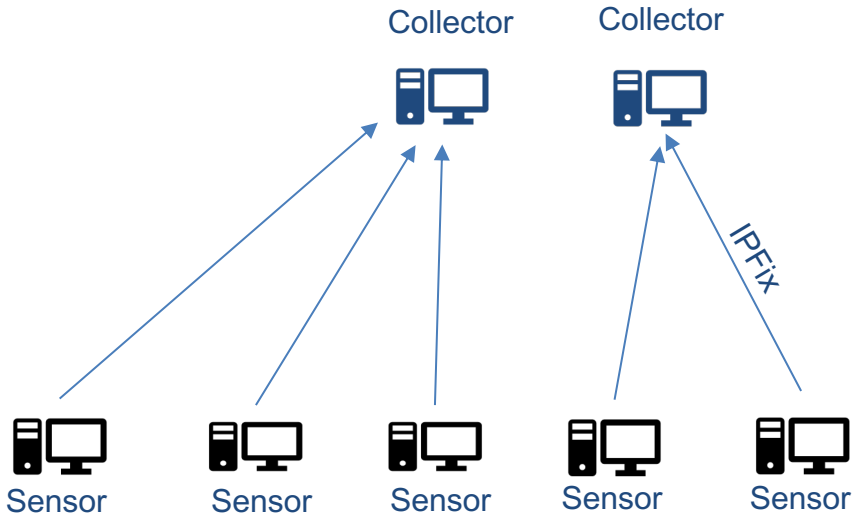
```
#> mmnetverify remote-cluster -v
md-11 checking cluster communications.
  Checking that remote cluster nodes are reachable.
    Obtaining remote cluster configuration.
    Checking connectivity with node-22.novalocal of cluster gpfs-cluster-2.novalocal.
    Pinging node-22.novalocal of cluster gpfs-cluster-2.novalocal (10.0.100.28).
    Ping time for node-22.novalocal of cluster gpfs-cluster-2.novalocal (10.0.100.28): 0.000853 seconds.
    Node node-22.novalocal of cluster gpfs-cluster-2.novalocal is not active.
    Checking connectivity with node-21.novalocal of cluster gpfs-cluster-2.novalocal.
    Pinging node-21.novalocal of cluster gpfs-cluster-2.novalocal (10.0.100.27).
    Ping time for node-21.novalocal of cluster gpfs-cluster-2.novalocal (10.0.100.27): 0.000363 seconds.
    Node node-21.novalocal of cluster gpfs-cluster-2.novalocal is not active.
  Operation remote-cluster: Success.
```

- If ssh is not allowed to remote cluster contact nodes, start mmnetverify daemon
  - *mmnetverify --remote-cluster-daemon [--remote-cluster-port portNumber]*

PERFORMANCE MONITORING

Performance and Usage Monitoring

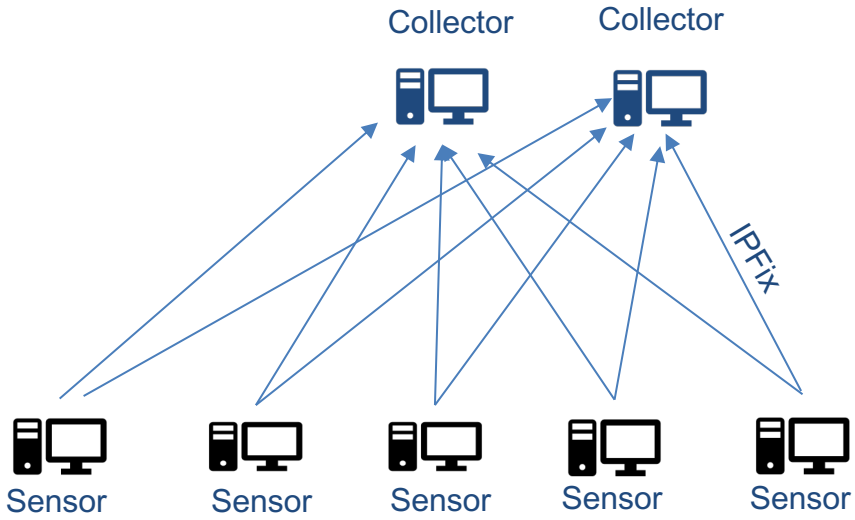
Collectors keep a in-memory time series database with performance data of the individual nodes



Sensors gather the performance metrics from Spectrum Scale components, Linux, etc. and send it through the IPFix protocol to collectors

Performance and Usage Monitoring

Collectors keep a in-memory time series database with performance data of the individual nodes

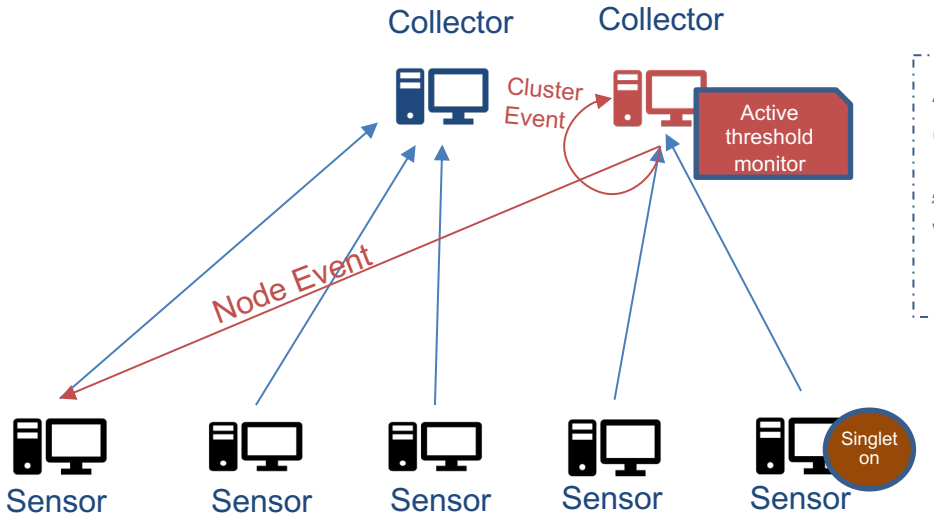


Setting „**Collector Redundancy**“ to 2 will ensure that the performance data is mirrored to two collectors

Sensors gather the performance metrics from Spectrum Scale components, Linux, etc. and send it through the IPFix protocol to collectors

Performance and Usage Thresholds

Custom thresholds can be set on any performance and usage metric using mmhealth cmd or GUI.



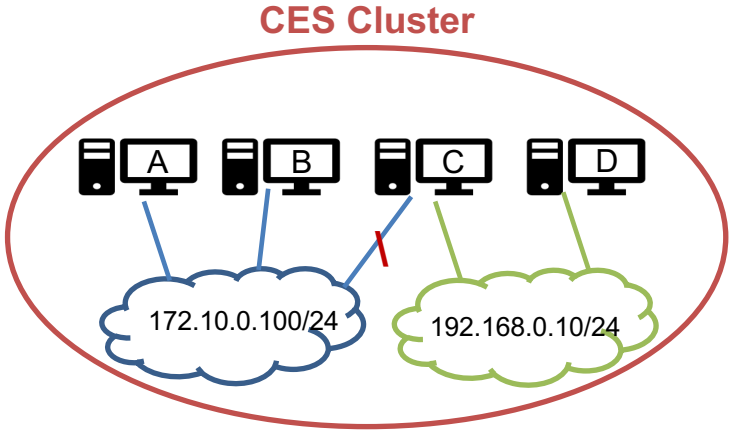
An „active thresholds collector“ is choosen out of the collector nodes.

„mmhealth cluster show threshold –v“ will show which node it is.

Node specific threshold events are forwarded to the corresponding node and shown there in mmhealth. Cluster wide threshold events will be shown on the active threshold monitor node.

PROTOCOL SERVICEABILITY

CES Clusters with multiple subnets / VLANs



CES supports hosting of multiple subnets or VLANs.
Inhomogeneous network connectivity can mask problems

Example:
Node A,B,C can host 172.10.x.x ip range
Node C,D can host 192.168.x.x ip range

Without CES groups defined :

- CES will try to assign any IP to any node (fails if node has no connecetivity)
- CES can not know if a node is supposed to have connectivity or not
  - e.g. Failure of one network link on node C might remain undiscovered

Recommendation: Always define CES Network groups if multiple subnets/VLANs are used.

CES Clusters with multiple subnets / VLANs

Health monitoring will detect if a particular CES IP cannot be hosted anywhere in the cluster.
mmces address list –full-list will report nodes which cannot host a particular CES IP

```
#> mmhealth cluster show cesip
Component     Node                Status            Reasons
-------------------------------------------------------------------------------------
CESIP         md-12.novalocal     DEGRADED          ces_ips_unassigned


#> mmces address list --full-list
cesAddress      cesNode          attributes   cesGroup   preferredNode   unhostableNodes
--------------- ---------------- ------------ ---------- --------------- -----------------
172.0.0.12          unassigned       none         none       none          md-12.novalocal,md-13.novalocal,md-14.novalocal
192.168.0.150   md-14.novalocal  none         none       none            none
192.168.0.151   md-13.novalocal  none         none       none            none
192.168.0.152   md-14.novalocal  none         none       none            none
192.168.0.153   md-14.novalocal  none         none       none            md-12.novalocal
```

NFS Ganesha conflicts with kNFS lockd

Problems:

- Doing a local nfsv3 mount on a CES node will start the kNFS lockd. This will prevent Ganesha lock manager to work properly.
- A running kNFS server conflicts with Ganesha NFS (mountd)

mmhealth will detect those conditions by looking at rpcinfo port registration:

```
#> mmhealth node show nfs -v
Component     Status        Status Change          Reasons
-------------------------------------------------------------------------------------
NFS           DEGRADED      2019-03-12 16:19:09    rpc_nlockmgr_inv_user, rpc_mountd_inv_user
```

Maintenance of CES filesystems (ces suspend/resume)

Problem: Filesystems used by CES could not be easily unmounted to do maintenance (e.g. fsck)

CES suspend function has been extended:

1) to optionally stop all running CES services (closing file handles on the fs)
2) CES services will not be started after a reboot if node is suspended

#> mmces node suspend –stop
NFS: service succesfully stopped.
SMB: service succesfully stopped.
CTDB: service succesfully stopped.
Node md-12 now in suspended state.

-> Now do your maintenance operation (e.g. mmfsck, reboot,..)

#> mmces node resume --start
CTDB: service succesfully started.
SMB: service succesfully started.
NFS: service succesfully started.
Node md-12 no longer in suspended state.

CES IP Failover

Problem: Sometimes hard to understand the reason for a CES IP failover.
Improvement: Improved failure notification for CES IP failover events.

#> mmhealth node eventlog | grep move_cesips
2019-03-12 15:15:35.438213 CET move_cesips_info INFO A move request for ip addresses was executed. **Reason: …**

Possible reasons are:

Move_address_due_to_balanced_load_policy, node_affinity_policy, even_coverage_policy.
enableIP_ip_not_assigned
enableIP_try_to_enable
disableIP_link_down
disableIP_interface_not_active
Remove_all_IPs_from_starting_node
Remove_all_IPs_from_dead_node
mmces node suspend / resume
Release_address_due_to_network_shutdown_detected_by_mmhealth.
Release_address_due_to_network_shutdown_detected_by_ces.

QUESTIONS ?

THANK YOU

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