Problem Determination

Spectrum Scale >= 4.2.2 and outlook

System Health

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System Health Monitoring

System Health Monitoring?

- **Why**: Detect common failure scenarios and guide users through the fix process.
- **How**: Uses callbacks, internal APIs, mmpmon data and mm-commands to monitor the component health
  - Dedicated monitoring daemon - independent from core mmfsd
  - Runs on all cluster nodes (>= 4.2.1) / part of GPFS base package
  - Full Linux support on x86/pSeries/zLinux and partial AIX support (no Windows support)
- **What**: New mmhealth command (4.2.1) - Provide a central view of the system state with well-defined error events and states.
  - Drill down to find defective components
  - Shows current reasons of the found problems
  - User actions for fixing problems

Monitored services

- Over 500 events! Over 150 checks!

GPFS
- quorumloss, ccr_paxos_12_fail
- gpfs_down, longwaiters_found

PERFMON
- pmsensors_up /-down
- pm_collector_up /-down

DISK
- disk_found /-vanished
- disk_up /-down

FILESYSTEM
- fserrinodenummismatch, stale_mount
- fserrallocblock, fserrbaddirblock

CLOUDGW
- cloudgateway_down
- cloudgw_restart

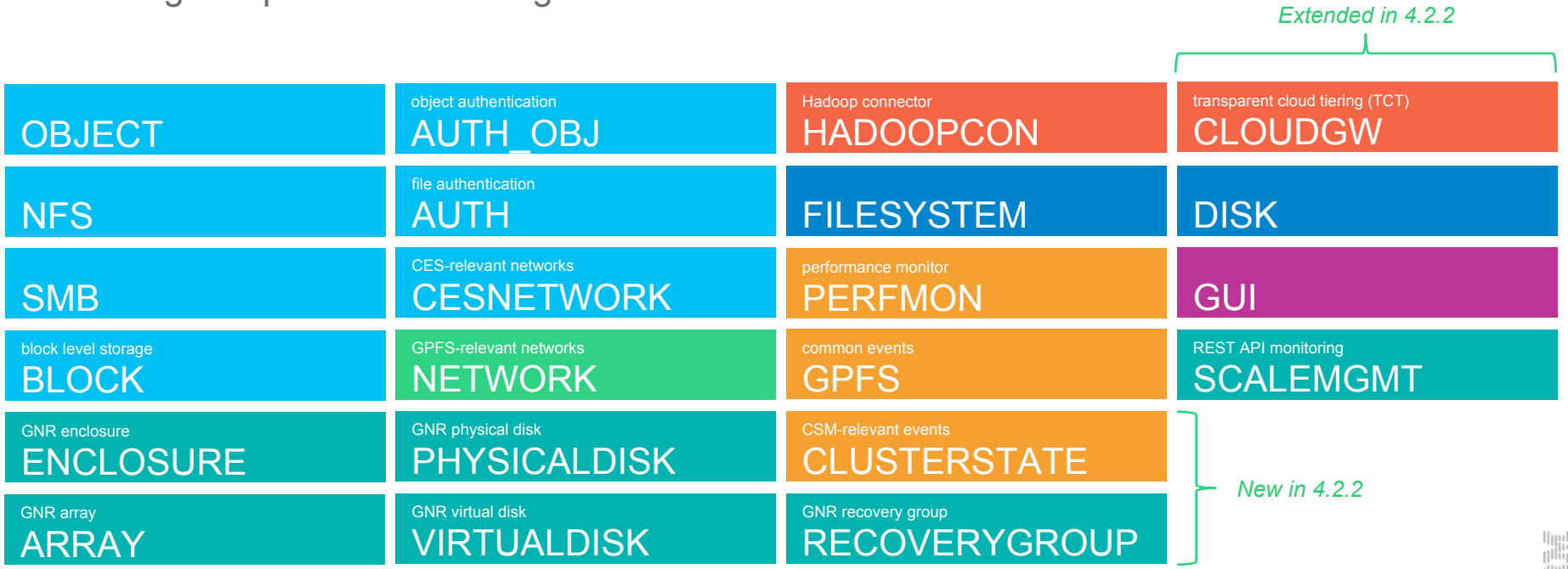
HADOOPCON
- hadoop_namenode_up /-down
- hadoop_datanode_up /-down

NETWORK
- network_down, network_ips_down
- bond_down, network_link_down

GUI
- gui_up /-down
- gui_warn

Monitored services

- More components added in 4.2.2
- Existing component monitoring has been extended



Extension details (ESS only)

- GNR (Native RAID):
  - Recovery Groups
  - Declustered Arrays
  - Virtual Disks
  - Physical Disks
  - Enclosures
    - DCM, ESM
    - Temp & Voltage Sensors
    - Fans
    - Power Supplies
  - Firmware Levels
    - Enclosure Firmware
    - Drive Firmware
    - Adapter Firmware
    - Adapter Bios

```
[root@gssio1 ~]# mmhealth node show  -v

Node name:              gssio1-hs.gpfs.net
Node status:            HEALTHY

Component               Status                  Reasons
------------------------------------------------------------------
GPFS                    HEALTHY                 -
FILESYSTEM              DEGRADED                stale_mount, stale_mount, stale_mount
  Basic1                  FAILED                  stale_mount
  Custom1                 HEALTHY                 -
GNR                     DEGRADED                  gnr_array_needsservice,enclosure_needs..
 ARRAY                   DEGRADED                gnr_array_needsservice
  rg_gssio1-hs/DA1         DEGRADED                gnr_array_needsservice
  rg_gssio1-hs/NVR         HEALTHY                 -
  rg_gssio1-hs/SSD         HEALTHY                 -
  rg_gssio2-hs/DA1         HEALTHY                 -
  rg_gssio2-hs/NVR         HEALTHY                 -
  rg_gssio2-hs/SSD         HEALTHY                 -
 ENCLOSURE               DEGRADED                enclosure_needsservice
  SV52122944               DEGRADED                enclosure_needsservice
  SV53058375               HEALTHY                 -
 PHYSICALDISK            DEGRADED                gnr_pdisk_replaceable, gnr_pdisk_re..
  rg_gssio1-hs/e1d1s01     HEALTHY                 -
  rg_gssio1-hs/e2d5s03     FAILED                  gnr_pdisk_replaceable
  rg_gssio2-hs/e1d1s01     FAILED                  gnr_pdisk_replaceable
 RECOVERYGROUP           HEALTHY                 -
  rg_gssio1-hs             HEALTHY                 -
  rg_gssio2-hs             HEALTHY                 -
 VIRTUALDISK             HEALTHY                 -
  rg_gssio1_hs_Basic1_data_0HEALTHY               -
  rg_gssio1_hs_Basic1_system_0HEALTHY             -
  rg_gssio1_hs_loghome     HEALTHY                 -
  rg_gssio1_hs_logtip      HEALTHY                 -
  rg_gssio1_hs_logtipbackupHEALTHY                 -
  rg_gssio2_hs_Basic1_data_0HEALTHY               -
  rg_gssio2_hs_Basic1_system_0HEALTHY             -
…
```

Monitoring details

- **TCT**
  - 5 events in 4.2.1 → 47 events in 4.2.2
  - Monitoring service, account and filesystem
- **DISK**
  - Increased performance and stability
  - Reduced system load
- **GUI**
  - Integrated GUI's own monitoring data
- **REST API**
  - Basic Monitoring (http request)

Mmhealth command and GUI integration

Improvements to mmhealth

New in 4.2.2

- Listing cluster health overview
- Show date/time of last state change
- Show detail information about an event
- Improved Performance - reduced impact on system load in 4.2.1
- GUI - Health Overview page
- GUI - Finer granularity for Notification configuration

Listing cluster health overview

- The cluster overview
  - Shows cluster related events / incl. node connectivity checks (heartbeat)

`mmhealth cluster show <component_name>`

- Is my cluster working fine?

```
[root@ch-41 ~]# mmhealth cluster show

Component           Total         Failed       Degraded        Healthy          Other
-------------------------------------------------------------------------------------
NODE                    5              0              1              4              0
GPFS                    5              0              0              5              0
NETWORK                 5              0              0              5              0
FILESYSTEM              1              0              0              1              0
DISK                    2              0              0              2              0
CES                     2              1              0              1              0
PERFMON                 3              0              0              3              0
```


Drilling down

- Where/what is the CES problem?

```
[root@ch-41 ~]# mmhealth cluster show ces

Component                Node                       Status        Reasons
-------------------------------------------------------------------------------
CES                      ch-41.localnet.com         HEALTHY        -
CES                      ch-42.localnet.com         FAILED         ces_network_ips_down,
                                                                    nfs_in_grace, nfsd_down
```

Show date/time of last state change

- Time context for the last state change
  - human and machine-readable: at your choice!
- When did it happen?

```
[root@ch-41 ~]# mmhealth node show -N ch-42

Node name:      ch-42.localnet.com
Node status:    DEGRADED
Status Change:  10 min. ago

Component       Status        Status Change     Reasons
------------------------------------------------------------------------------------
GPFS            HEALTHY       7 days ago        -
NETWORK         HEALTHY       8 days ago        -
FILESYSTEM      HEALTHY       7 days ago        -
DISK            HEALTHY       7 days ago        -
CES             FAILED        9 min. ago        nfsd_down, ces_network_ips_down, nfs_in_grace
PERFMON         HEALTHY       8 days ago        -
```

Show detail information about a event

- Instant help
  - **`mmhealth event show <event_name>`**
- What is nfsd_down and how do I fix it?

```
[root@ch-41 ~]# mmhealth event show nfsd_down
Event Name:              nfsd_down
Event ID:                999167
Description:             Checks for a NFS service process
Cause:                   The NFS server process was not detected
User Action:             Check the health state of the NFS server and restart, if
                              necessary. The process might hang or is in a defunct state
Severity:                ERROR
State:                   FAILED
```


Follow user action to fix the problem

- Let us fix the problem:

```
[root@ch-41 ~]# ssh ch-42
Last login: Wed Nov  9 11:09:42 2016 from ch-41.localnet.com
[root@ch-42 ~]# systemctl status nfs-ganesha
nfs-ganesha.service - NFS-Ganesha file server
   Loaded: loaded (/usr/lib/systemd/system/nfs-ganesha.service; disabled)
   Active: inactive (dead) since Wed 2016-11-09 11:10:31 CET; 14min ago
     Docs: http://github.com/nfs-ganesha/nfs-ganesha/wiki
  Process: 15220 ExecStop=/bin/dbus-send --system --dest=org.ganesha.nfsd --
type=method_call /org/ganesha/nfsd/admin org.ganesha.nfsd.admin.shutdown (code=exited,
status=0/SUCCESS)
 Main PID: 25484 (code=exited, status=0/SUCCESS)

Oct 31 15:56:14 ch-42.localnet.com systemd[1]: Starting NFS-Ganesha file server...
Oct 31 15:56:14 ch-42.localnet.com systemd[1]: Started NFS-Ganesha file server.
Nov 09 11:10:21 ch-42.localnet.com systemd[1]: Stopping NFS-Ganesha file server...
Nov 09 11:10:31 ch-42.localnet.com systemd[1]: Stopped NFS-Ganesha file server.
```

Problem solved

- Let us fix the problem:

```
[root@ch-42 ~]# systemctl start nfs-ganesha
[root@ch-42 ~]# mmhealth node show

Node name:      ch-42.localnet.com
Node status:    HEALTHY
Status Change:  3 min. ago

Component      Status        Status Change     Reasons
------------------------------------------------------
GPFS           HEALTHY       7 days ago        -
NETWORK        HEALTHY       8 days ago        -
FILESYSTEM     HEALTHY       7 days ago        -
DISK           HEALTHY       7 days ago        -
CES            HEALTHY       3 min. ago        -
PERFMON        HEALTHY       8 days ago        -
```

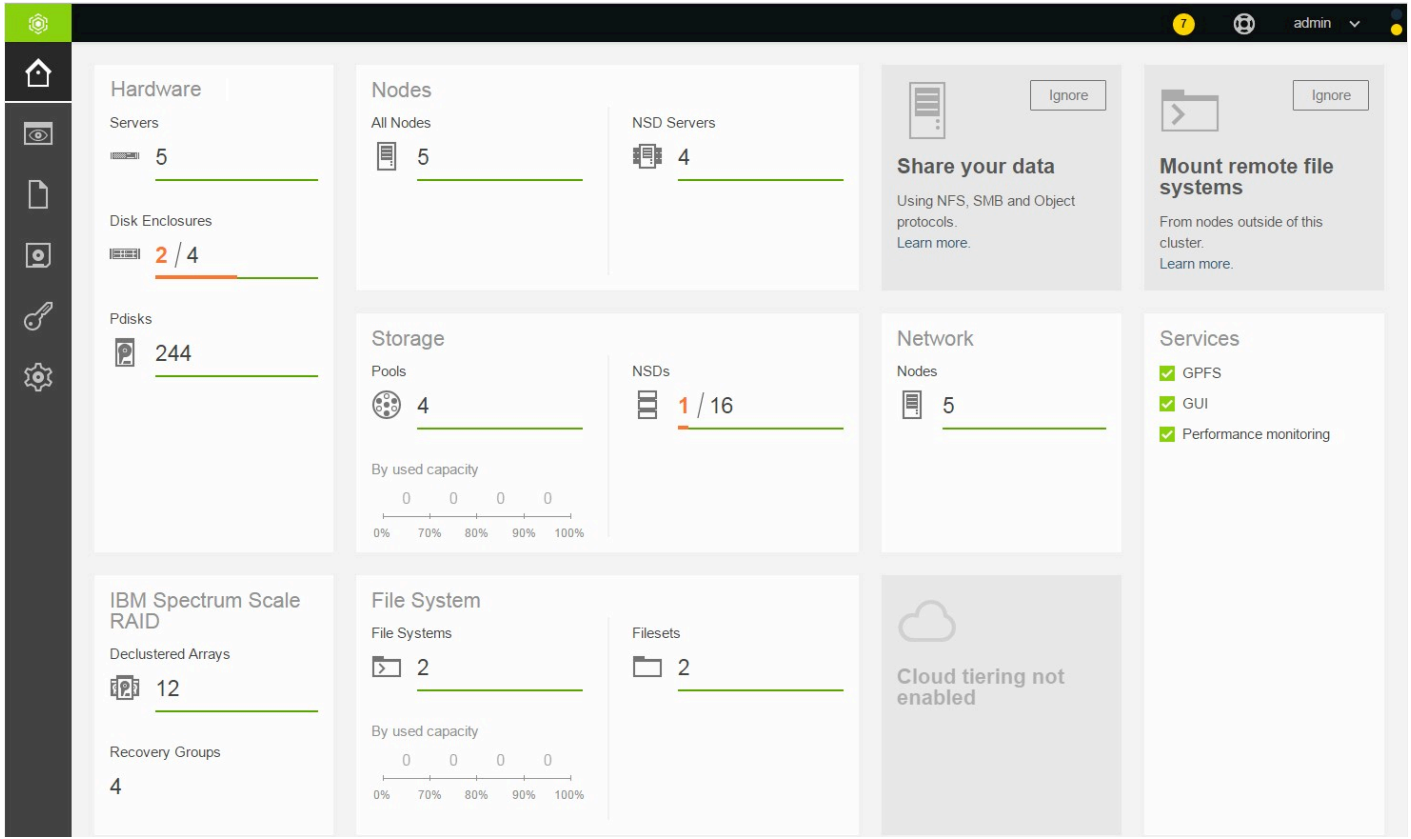

Problem solved

- What is with the cluster?

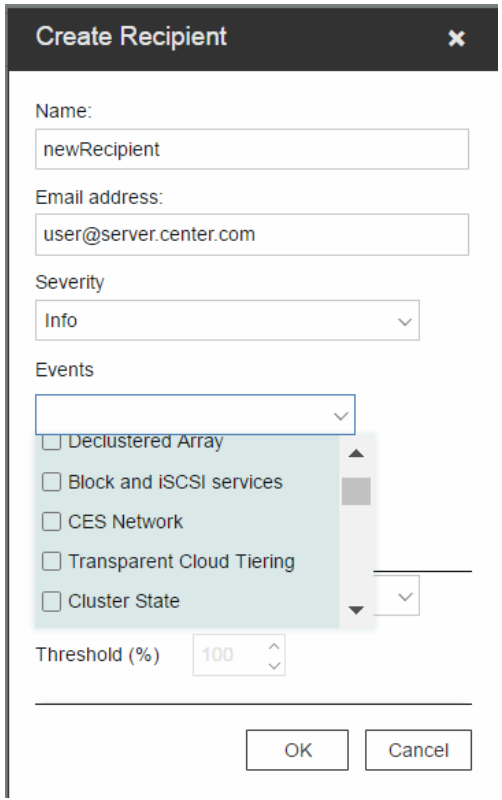
```
[root@ch-42 ~]# mmhealth cluster show

Component            Total         Failed       Degraded        Healthy          Other
-------------------------------------------------------------------------------------
NODE                     5              0              0              5              0
GPFS                     5              0              0              5              0
NETWORK                  5              0              0              5              0
FILESYSTEM               1              0              0              1              0
DISK                     2              0              0              2              0
CES                      2              0              0              2              0
PERFMON                  3              0              0              3              0
```

Health Overview page



Finer granularity for Notification configuration



- Create a list of of recipients and define which events should trigger sending an email for this recipient
- Categories have been extended to match the categories in mmhealth in 4.2.2
- Events: send all events as they occur
- Report: generate a mail with all aggregated messages once per day
- Quota report: monitor usage of the system

Problem isolation / FTDC

First Time Data Capture

First **T**ime **D**ata **C**apture

Collect enough data to be able to debug a problem without asking for recreates

- **gpfs.snap tool**
  - Cluster-wide snapshots with debugging relevant data / Easy to use and powerful
  - Collecting Hadoop-relevant data
    - `gpfs.snap --hadoop`
    - Customizable to include user defined files
  - Collecting Performance Monitor-relevant data

Details on the collected data: In the Spectrum Scale Documentation (“Using the gpfs.snap command”)

Protocol Tracing improvements in 4.2.2

mmprotocoltrace - automated tracing of protocol issues. Making a complex task quick and trivial

- SMB tracing already in 4.2.1
  - Did not help for AD-authentication related issues
- Added winbind tracing
  - Collecting isolated level 10 winbind logs from relevant nodes
  - Leaving system logs intact
  - Usage:

```
mmprotocoltrace start winbind
... # recreating the issue
mmprotocoltrace stop winbind
```

Isolate Network Problems

mmdiag command has been enhanced to show more details about the network connection

mmnetverify command can verify the network connectivity for a given list of nodes.It helps with isolating cluster networking issues

- Connect to other nodes through ssh
- Spawn netverify daemon on each node
- Verify port connectivity from any to any node
- Generate network traffic and evaluate network performance

Network Verification Tool

Command Syntax:

mmnetverify Operation [Operation…] [--N {Node[,Node...] | all}] [-a]
[--target-nodes [Node,[Node...] | all}] [{--configuration-file File} | --no-configuration]
[--log-file File] [--min-bandwidth Number] [--verbose]

Supported Operations (4.2.2):
Local interface check, hostname resolution, ping, remote shell execution, remote copy, time sync, port checks (daemon, sdrserv, tsccmd), network data transfer (small/medium/large size packets), bandwidth, flood

Isolate Active Directory Problems

With the help of mmadquery tool, users can verify that their authentication environment fulfills the requirements of Spectrum Scale and isolate Active Directory related problems.

Connectivity to Authentication servers
Find connectivity issues to domain controllers, e.g. caused by wrong firewall
Trust relationships
Verify multi-domain trust relationships
ID Mapping inconsistencies
Verify required UID/GID fields are filled and fit into configured id ranges to isolate the root cause of access failures.

The command has been introduced with SpectrumScale 4.2.1 and enhanced with 4.2.2

Active Directory Tool

mmadquery Command Syntax

List AD Server objects

mmadquery list user|uids|gids|groups|dc|trusts|idrange

Check whether uids or gids are within locally defined id mapping range

mmadquery check uids|gids|idrange

Print number of users by group or number mapped and un-mapped user

mmadquery stats user|uids

Additions in 4.2.2

- user and user groups for all and by domain
- number of users by user group and domain
- number of un-mapped user (user with no uidNumber)
- id ranges by domain
- user details (ids, primary group id....)

Performance / Capacity Monitoring

Predefined filesystems capacity thresholds

Performance Monitoring:
>50 Performance sensors (GPFS IO, AFM, SMB, Object,NFS ...) and >1000 Metrics

Spectrum Scale 4.2.2 introduced **predefined filesystem capacity/inode thresholds.**
The capacity metrics will be frequently compared with the rules boundaries by internal monitor process. As soon as one of the metric values exceeds their threshold limit the system health daemon will receive an event notification from monitor process and generate log event and update filesystem status

The predefined filesystem capacity threshold limits break down to the following thresholds rules:

- Fileset-inode spaces
- Data pool capacity
- Metatadata pool capacity

Predefined filesystems capacity thresholds

```
>#  mmhealth node show -v

Node name:      node-11.novalocal
Node status:    TIPS
Status Change:  2017-03-07 22:18:54

Component        Status        Status Change            Reasons
-------------------------------------------------------------------------------------------
GPFS             HEALTHY          2017-03-07 22:18:54   -
NETWORK          HEALTHY       2017-03-07 22:18:53      -
  eth0           HEALTHY       2017-03-07 22:18:53      -
FILESYSTEM       DEGRADED      2017-03-07 23:04:37      inode_high_error(gpfs0/lowinode)
  gpfs0          FAILED        2017-03-07 23:04:37      inode_high_error
  objfs          HEALTHY       2017-03-07 22:27:51      -
DISK             HEALTHY       2017-03-07 22:19:06      -
  disk1          CHECKING      2017-03-07 22:20:06      -
  disk2          CHECKING      2017-03-07 22:27:37      -
GUI              HEALTHY       2017-03-07 22:23:20      -
PERFMON          HEALTHY       2017-03-07 22:20:40      -
```

Predefined filesystems capacity thresholds

To view the list of defined threshold rules on the system, issue this command:

mmhealth thresholds list

```
mmhealth thresholds list
```

The system displays output similar to this:

```
### Threshold Rules ###
rule_name             metric                error  warn    direction  filterBy  groupBy                                                                                  sensitivity
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------
InodeCapUtil_Rule     Fileset_inode         90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_fset_name                                            300
DataCapUtil_Rule      DataPool_capUtil      90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_diskpool_name                                        300
MemFree_Rule          mem_memfree           50000  100000  low                  node                                                                                     300
MetaDataCapUtil_Rule  MetaDataPool_capUtil  90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_diskpool_name                                        300
```

Performance Monitoring Bridge for Grafana

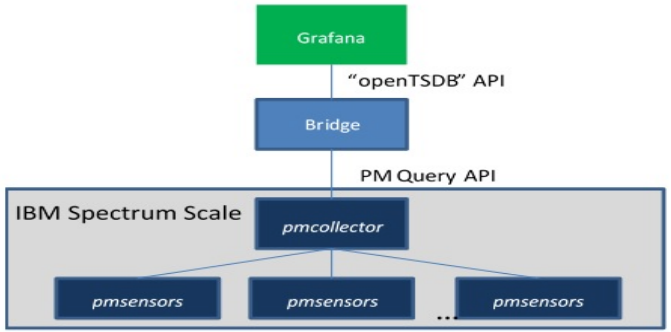


Figure 1. IBM Spectrum Scale integration framework for Grafana

Grafana

- an open source performance data graphical visualizer
- provides a powerful and elegant way to create, explore, and share dashboards and data with your team and the world.

IBM Spectrum Scale Performance Monitoring Bridge

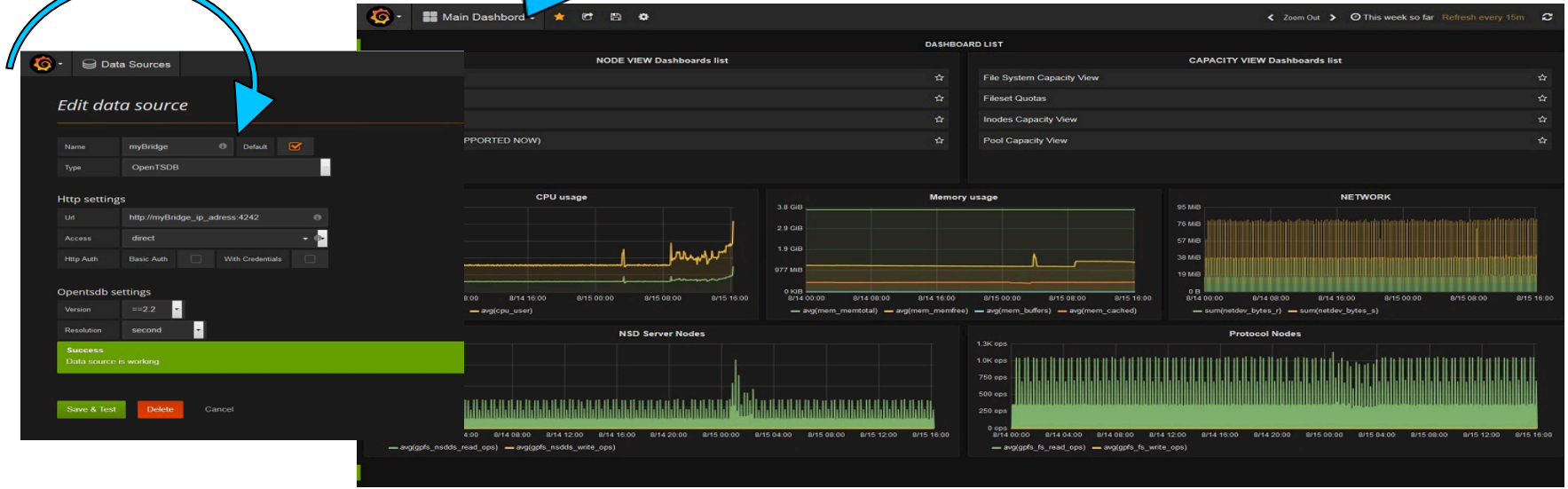
- a Python application
- provides IBM Spectrum Scale performance data to Grafana in „openTSDB“ data exchange format
- communicates with active pmcollector via port 4242

Not part of the product, can be downloaded from DeveloperWorks including documentation:
https://www.ibm.com/support/knowledgecenter/en/STXKQY_4.2.2/com.ibm.spectrum.scale.v4r22.doc/bl1adv_pmbridgewtgrafana.htm

Performance Monitoring Bridge for Grafana

1.Establish connection

2. Create Dashboard



4.2.3 Release

Problem Determination Enhancements 2017

Further enhance problem detection / health monitoring in 4.2.3

- AFM cache monitoring
  - Runs on AFM gateway nodes
  - Monitors AFM Filesets → connection, queue drops, failover, recovery, etc

```
#> mmhealth node show afm
Node name:      afmGW-31.localnet.com
Component               Status                    Status Change                                    Reasons
-------------------------------------------------------------------------------------------------------------
AFM                     FAILED                    Now                 afm_cache_unmounted(afmFs/afmCacheFset2)
  afmFs/afmCacheFset2   FAILED                    21 days ago         afm_cache_unmounted


Event                   Parameter             Severity    Active Since  Event Message
-------------------------------------------------------------------------------------------------
afm_cache_unmounted     afmFs/afmCacheFset2   ERROR       Now           Fileset afmFs/afmCacheFset2 is in
                                                                          Unmounted state
```


Problem Determination Enhancements 2017

- Extended Network monitoring for Infiniband
  - Monitor Infiniband adapters (link state, port state)
  - Checks if RDMA is correctly configured and actually works (e.g. rdma libpath)
  - 17 new events: IB RDMA state and assist with problem solving

```
#> mmhealth node show network

Node name:      ifs6serv1.mainz.de.ibm.com

Component      Status        Status Change     Reasons
-------------------------------------------------------------------------------------------
NETWORK        FAILED        Now               ib_rdma_libs_wrong_path, ib_rdma_nic_unrecognized(mthca0)
  eno3         HEALTHY       1 day ago         -
  mthca0       FAILED        Now               ib_rdma_nic_unrecognized


Event                         Parameter     Severity    Active Since      Event Message
-------------------------------------------------------------------------------------------
ib_rdma_libs_wrong_path       NETWORK       ERROR       Now           The library files could not be found
ib_rdma_nic_unrecognized      mthca0        ERROR       Now           IB RDMA NIC mthca0 was not recognized
```

Problem Determination Enhancements 2017

Tips/Recommendations

- Inform customers about “potential” issues in the system
  - Warn users about common mis-configurations and non-optimal settings
    - e.g. pagepool is too small, performance sensors configuration wrong, etc
  - Introduce a new type of mmhealth events -> TIPS
  - Provide the ability to acknowledge/ignore a tip

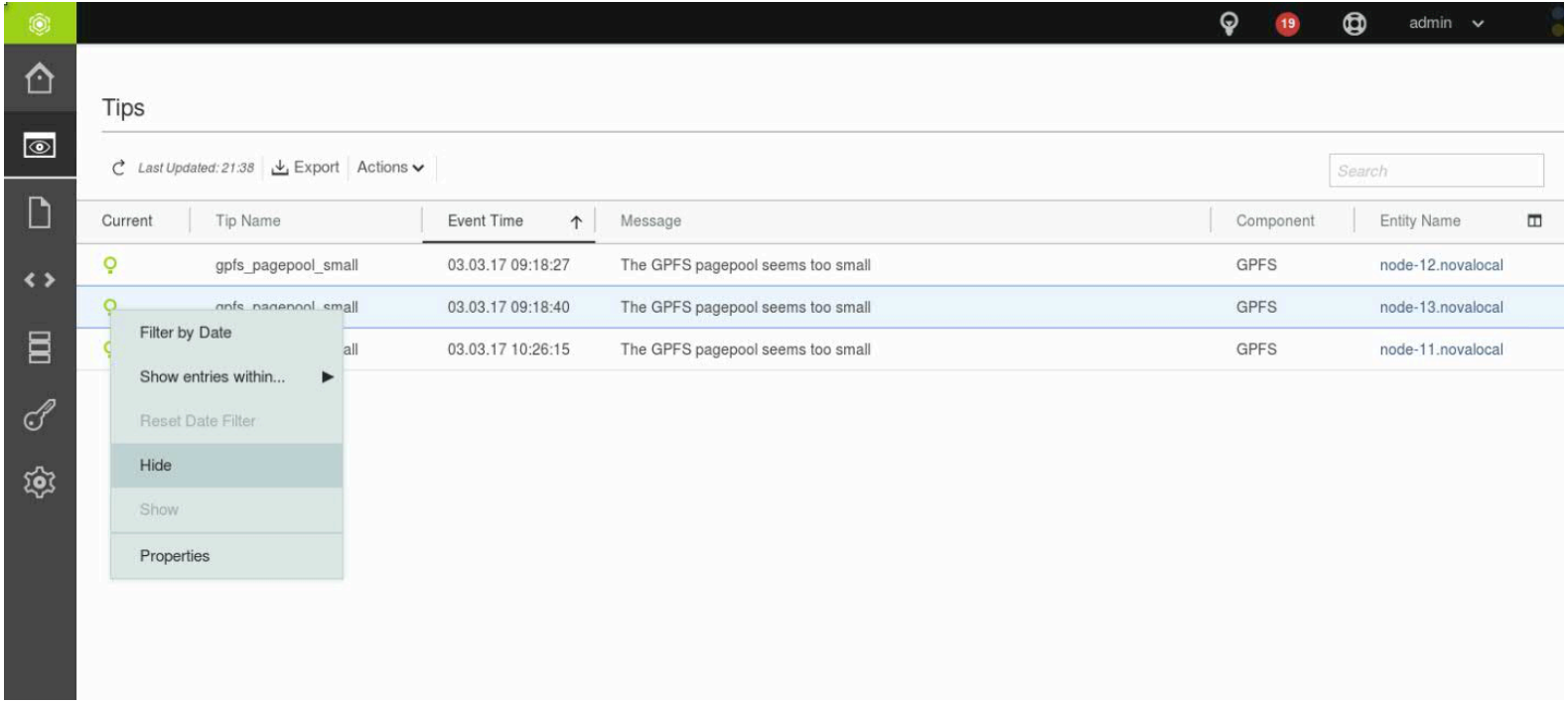
```
# mmhealth node show gpfs
Node name:      node-11.novalocal

Component      Status        Status Change     Reasons
------------------------------------------------------------
GPFS           TIPS          3 days ago        gpfs_pagepool_small


Event                    Parameter     Severity    Active Since      Event Message
-------------------------------------------------------------------------------------------------
gpfs_pagepool_small      GPFS          TIP         3 days ago        The GPFS pagepool seems too small
```


Problem Determination Enhancements 2017

Tips in the GUI



Problem Determination Enhancements 2017

Enhancements to the System Health framework

- Allow some control on health monitoring frequency
  - Monitoring interval High, Medium, Low
  - Trade-off: Failure detection time vs resource consumption
  - Examples:
    - Low = run monitors rarely → less overhead but longer failure detection time
    - High = run monitors very often → higher overhead, quick failure detection time

Command:

mmhealth config interval off | low | medium | high

Problem Determination Enhancements 2017

Customer defined thresholds

- Allow customers to define thresholds on any performance metric
  - e.g. average network latency > 200ms
  - Ability to specify / configure warning and error levels
  - Set thresholds through command line (later through GUI)
  - Events will show up in mmhealth and GUI

Command:

mmhealth thresholds add { metric[:sum|avg|min|max|rate]|measurement [--errorlevel{threshold error limit} [--warnlevel{threshold warn limit}]|--direction {high|low}} [--sensitivity {bucketsize}] [--hysteresis {percentage}] [--filterBy] [--groupBy] [--name {ruleName}] [--errormsg {user defined action description}] [--warnmsg {user defined action description}]

Problem Determination Enhancements 2017

- New pre-defined thresholds for memory usage
  - memory free <50MB leads to error event, <100MB to warning event

```
[root@gpfsgui-11 ~]# mmhealth thresholds list
### Threshold Rules ###
rule_name            metric                error  warn    direction  filterBy  groupBy                                                  sensitivity
-------------------------------------------------------------------------------------------------------------------------------------------------
InodeCapUtil_Rule    Fileset_inode         90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_fset_name            300
DataCapUtil_Rule     DataPool_capUtil      90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_diskpool_name        300
MemFree_Rule         mem_memfree           50000  100000  low                  node                                                     300
MetaDataCapUtil_Rule MetaDataPool_capUtil  90.0   80.0    high                 gpfs_cluster_name,gpfs_fs_name,gpfs_diskpool_name        300
[root@gpfsgui-11 ~]#
```

- Rules can be deleted (or changed by adding them with different options)

Command:

mmhealth threshold delete { RuleName | All }

Problem Determination Enhancements 2017

REST API for System health state

- Query component state and events
- "https://localhost:443/scalemgmt/v2/nodes/ak-52/health/states?filter=state!=HEALTHY"


```
{ "states" : [ {
    "activeSince" : "2017-03-07 13:46:06,370",
    "component" : "PERFMON",
    "entityName" : "ak-52.localnet.com",
    "entityType" : "NODE",
    "oid" : 175,
    "reportingNode" : "ak-52.localnet.com",
    "state" : "FAILED"
  }, {
    "activeSince" : "2017-03-07 13:46:06,375",
    "component" : "NODE",
    "entityName" : "ak-52.localnet.com",
    "entityType" : "NODE",
    "oid" : 176,
    "reportingNode" : "ak-52.localnet.com",
    "state" : "DEGRADED"
  } ],
  "status" : {
    "code" : 200,
    "message" : "The request finished successfully"
  }}
```


Problem Determination Enhancements 2017

More…..

- Improvements to mmnetverify tool to check protocol ports, bandwidth and better performance
- Better diagnostics of network issues inside the GPFS daemon
- FTDC improvements

Outlook
2H 2017 and beyond

Problem Determination Enhancements

Further enhance problem detection / health monitoring

- Extend existing monitoring to detect more problems, add additional Events and Tips !
  - GPFS Memory monitoring
  - Monitor critical threads (core daemon)
  - Extend network monitor, leverage mmnetverify command
  - Time sync checks
  - Zimon monitor, add connection check

- 500+ events, sometimes need more details and improved error recovery description
  - Define more detailed user actions
  - Add more DMPs (directed maintenance procedures)
  - Best practice guides

Problem Determination Enhancements

- Improve Callhome
  - Semi automatic PMR creation (PMR opening through UI by User)
  - Upload snap data to existing PMR's
  - Enable Callhome at installation time (opt-out)

- Problem isolation
  - Extend mmnetverify for infiniband
  - Improve means to isolate protocol issues
  - Improve install tookit error output for better usability
  - Improve FTDC
    - Extend gpfs.snap to collect additional data
    - Avoid gpfs.snap hangs on broken clusters
    - Investigation: Improve data collections for daemon crashs

Problem Determination Enhancements

- Performance monitoring
  - Externalize Top K process list
  - Improve usability/robustness of mmperfmon command
  - Improve performance monitoring
    - installation and setup of performance sensors
    - Improve scalability of performance queries (multi-threading)
    - Update Grafana bridge to support latest Grafana releases

- GUI PD enhancements
  - Manage user defined thresholds
  - Performance monitoring (Zimon) configuration

Questions ?

IBM

Thank you !!!