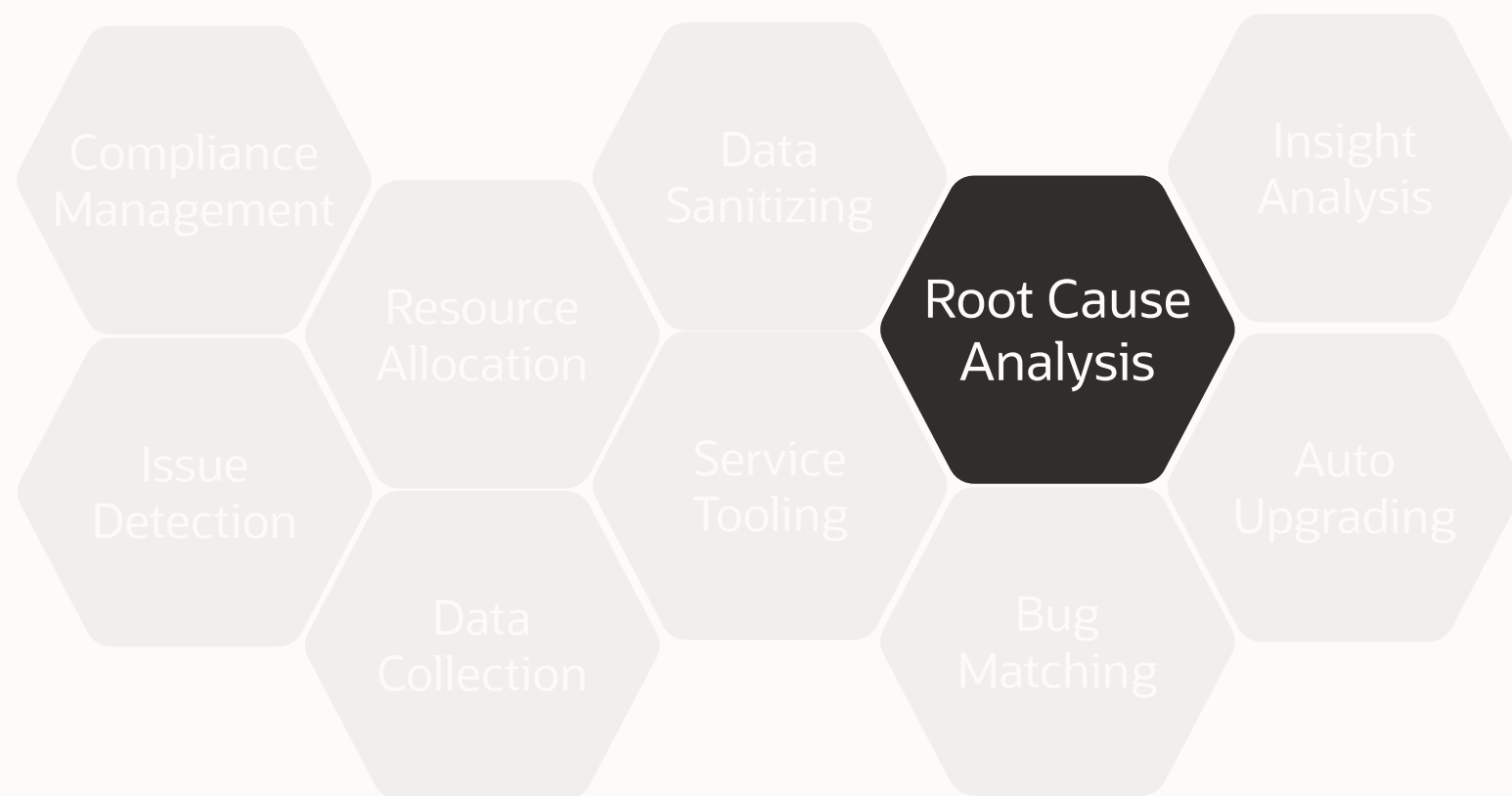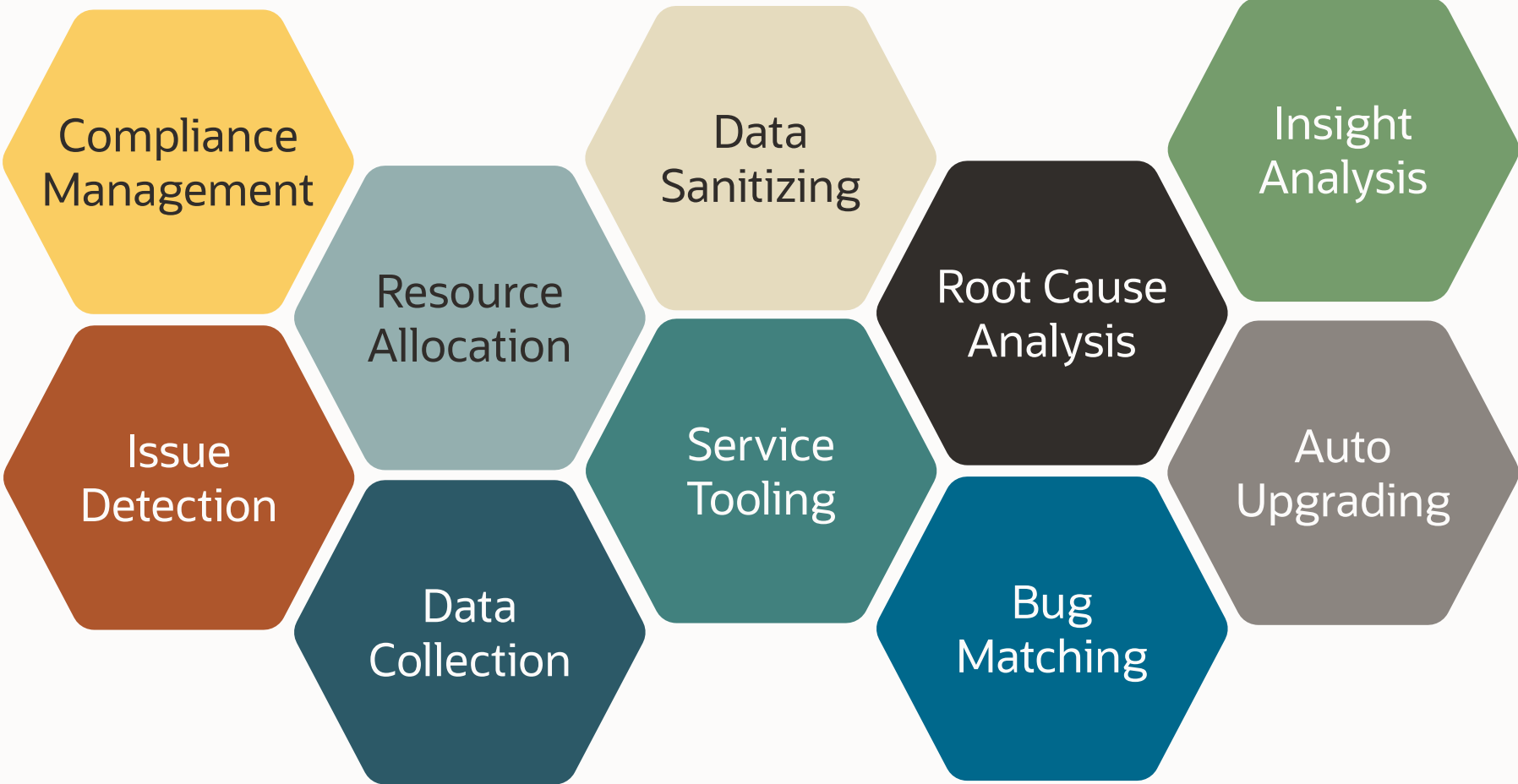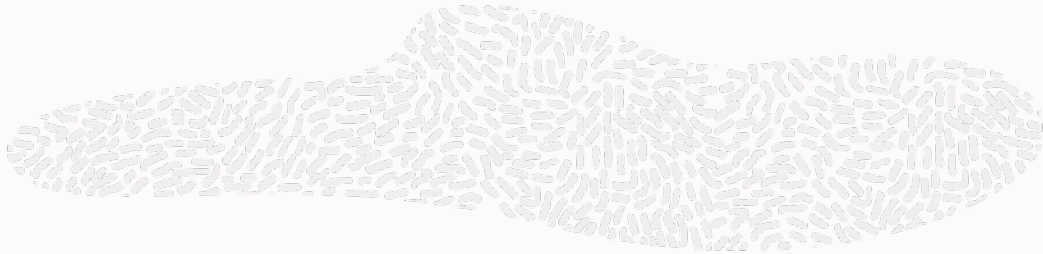# ORACLE

# Autonomous Health Framework
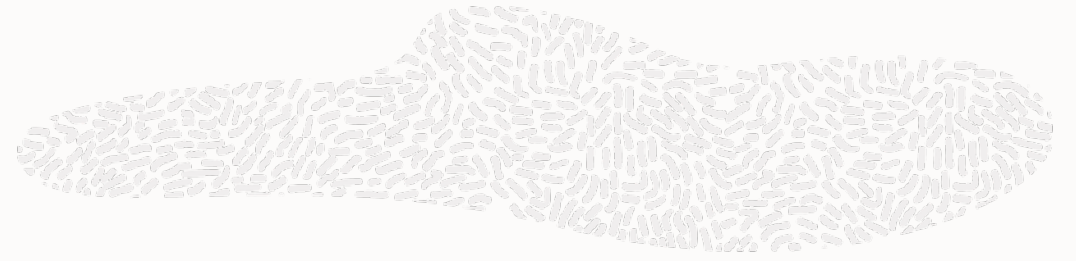
## Root Cause Analysis

# Oracle Autonomous Health Framework

# Oracle Autonomous Health Framework

AI Powered
Root Cause
Analysis

Compliance
Management

Resource
Allocation

Data
Sanitizing

Root Cause
Analysis

Insight
Analysis

Issue
Detection

Service
Tooling

Auto
Upgrading

Data
Collection

Bug
Matching
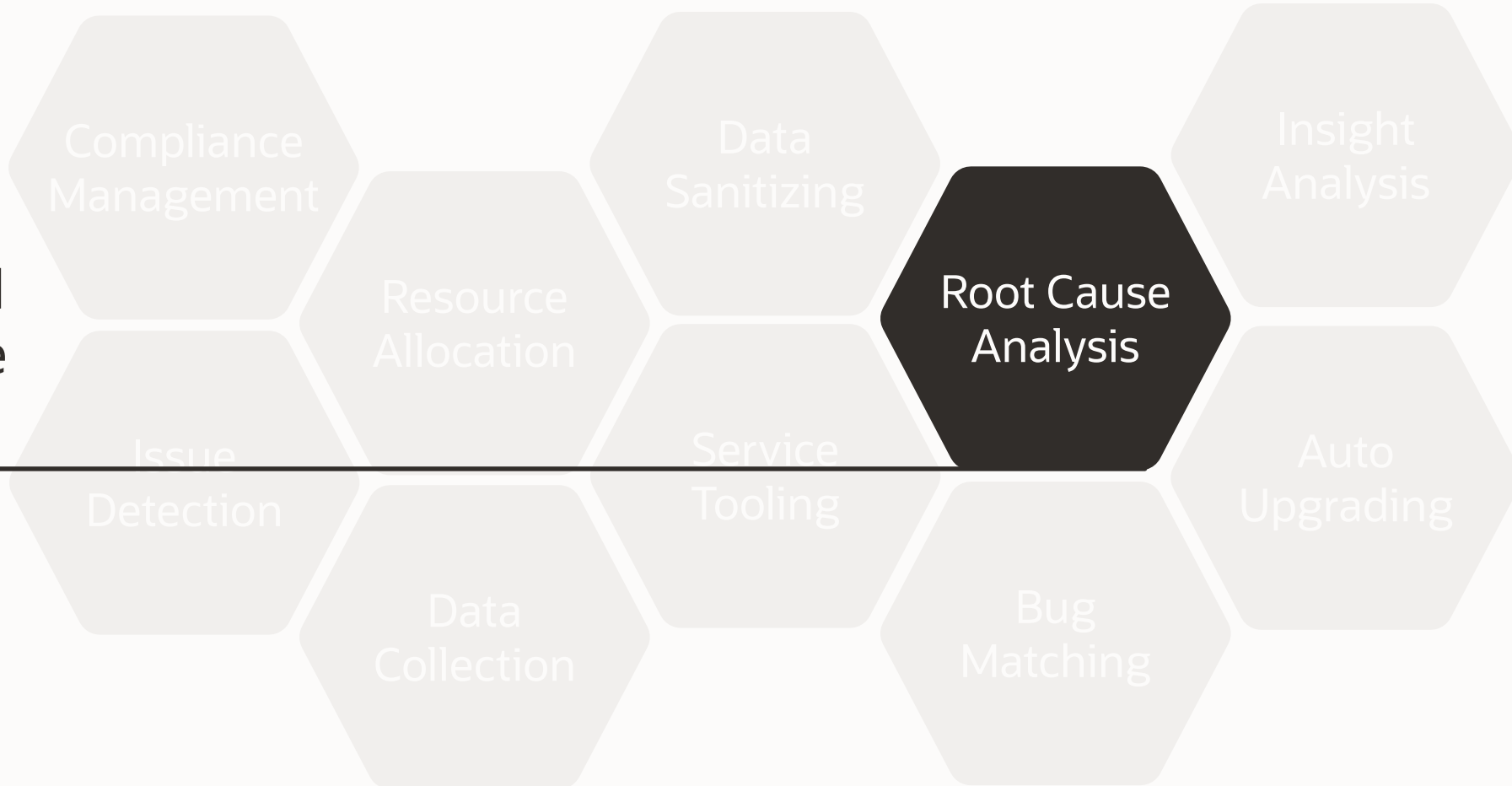
# Find if anything has changed

# Has anything changed recently?

```
tfactl changes
Output from host : myserver69
------------------------------
[Apr/28/2023 04:54:15.397]: Parameter: fs.aio-nr: Value: 95488 => 97024
[Apr/28/2023 04:54:15.397]: Parameter: fs.inode-nr: Value: 764974 131561 => 740744 131259
[Apr/28/2023 04:54:15.397]: Parameter: kernel.pty.nr: Value: 2 => 1
[Apr/28/2023 04:54:15.397]: Parameter: kernel.random.entropy_avail: Value: 189 => 158
[Apr/28/2023 04:54:15.397]: Parameter: kernel.random.uuid: Value: 36269877-9bc9-40a3-82e0-
1619865096f2 => 7551c5e7-c59f-40fa-b55f-5bd170e8b1ab
[Apr/28/2023 05:46:15.397]: Parameter: fs.aio-nr: Value: 119680 => 122880
[Apr/28/2023 05:46:15.397]: Parameter: fs.inode-nr: Value: 1580316        810036 => 1562320
        768555
[Apr/28/2023 05:46:15.397]: Parameter: kernel.pty.nr: Value: 19 => 18
[Apr/28/2023 05:46:15.397]: Parameter: kernel.random.uuid: Value: 37cc31aa-ee31-459e-8f2a-
0766b34b1b64 => f5176cdc-6390-415d-882e-02c4cff2ae4e
...
```

# Has anything changed recently?

```
...
Output from host : myserver70
-------------------------------
[Apr/28/2023 04:54:15.397]: Parameter: fs.aio-nr: Value: 95488 => 97024
[Apr/28/2023 04:54:15.397]: Parameter: fs.inode-nr: Value: 764974 131561 => 740744 131259
[Apr/28/2023 04:54:15.397]: Parameter: kernel.pty.nr: Value: 2 => 1
[Apr/28/2023 04:54:15.397]: Parameter: kernel.random.entropy_avail: Value: 189 => 158
[Apr/28/2023 04:54:15.397]: Parameter: kernel.random.uuid: Value: 36269877-9bc9-40a3-82e0-
1619865096f2 => 7551c5e7-c59f-40fa-b55f-5bd170e8b1ab
[Apr/28/2023 05:46:15.397]: Parameter: fs.aio-nr: Value: 119680 => 122880
[Apr/28/2023 05:46:15.397]: Parameter: fs.inode-nr: Value: 1580316       810036 => 1562320
        768555
[Apr/28/2023 05:46:15.397]: Parameter: kernel.pty.nr: Value: 19 => 18
[Apr/28/2023 05:46:15.397]: Parameter: kernel.random.uuid: Value: 37cc31aa-ee31-459e-8f2a-
0766b34b1b64 => f5176cdc-6390-415d-882e-02c4cff2ae4e
[Apr/28/2023 16:56:15.398]: Parameter: fs.aio-nr: Value: 97024 => 98560
```

# Analyze Cluster Health

# CHM data usage for diagnostic analysis

➢ **CHM Analyser**

- A python based utility that looks at CHM data and generates reports with relevant findings for CPU, memory, network, disk, I/O  based on critical OS signatures.

➢ **CHM Visualisation**

- Built Using DASH application for viewing and analysing CHM data graphically.

➢ **CHM Lrg Analyser**

-  A python based utility that analyses and maps diffs from watson.log and CHMOS data on a timeline. Critical system metrics like CPU utilization, Memory Utilization, CPU steal percent, load averages, etc are analyzed to detect if a diff has occurred due to depletion of critical system resources and also identify the processes which are causing system resource depletion.

# CHM Metrics Viewer

"**oclumon**" - CHM metric viewer CLI to query the expanse of metric and metrics sets

- Python based utility (compatible with both Python 2.7 and Python 3.8)

- Can query metric data both in historical and continuous mode

- Directly queries compressed files (without uncompressing)

- Provides expansive set of CLI options to view metric data

# Querying SYSTEM Metric Set

System metric-set detailing the summarizing state of the system.

**ex : oclumon dumpnodeview local -system**

```
---------------------------------------------------
Node : den03ceb Clock :   2023-04-28 07.31.34
---------------------------------------------------

SYSTEM:
[CPU]  <--
pCpus[#]:4, cores[#]:4, vCpus[#]:4, cpuHT:Y, osName:Linux, chipName:Intel Core Processor (Haswe
ll, no TSX, IBRS), usage[%]:2.7, system[%]:1.02, user[%]:1.68, nice[%]:0.0, ioWait[%]:0.15, ste
al[%]:0.0, cpuQ[#]:0, loadAvg1:0.69, loadAvg5:0.76, loadAvg15:0.6, intr[#/s]:3597, ctxSwitch[#/
s]:8027

[MEMORY]  <--
totalMem[KB]:14770492, freeMem[KB]:734904, avblMem[KB]:9257560, shMem[KB]:1830780, bufferAndCac
he[KB]:10574276, buffer[KB]:258528, cache[KB]:10315748, pgCache[KB]:7738936, slabReclaim[KB]:25
76812, swapTotal[KB]:15359968, swapFree[KB]:14498448, hugePageTotal[#]:0, hugePageFree[#]:0, hu
gePageSize[KB]:2048, swpIn[KB/s]:0, swpOut[KB/s]:0, pgIn[#/s]:1, pgOut[#/s]:59

[DEVICE]  <--
disks[#]:2, ioR[KB/s]:1, ioW[KB/s]:59, numIOs[#/s]:15

[NETWORK]  <--
nics[#]:2, rxTotal[KB/s]:18.04, txTotal[KB/s]:9.38, nicErrs[#/s]:0

[PROCESS]  <--
procs[#]:446, procsOnCpu[#]:1, procsBlocked[#]:0, rtProcs[#]:13, procsDState[#]:0, fds[#]:21056
, sysFdLimit[#]:6815744

[NFS]  <--
nfs[#]:87
```

# Querying Process Aggregate

➤ Metrics aggregated by Process Groups (DB FG/DB BG/Other/Clusterware)

•    ex. OTHER group is consuming ~96% ( across 350 processes) and DB BG  ~4%(across 75 processes) of total 29.56% CPU utilization.

• **ex : oclumon dumpnodeview local -procagg**

```
-----------------------------------------------------------
Node : den03ceb Clock :  2023-04-28 07.35.32
-----------------------------------------------------------

PROCESS_AGGREGATE:
  category cpuWeight[%]  cpu[%]     rss[KB]  shMem[KB] thrds[#] fds[#] processes[#]      sid
     OTHER       95.93    28.36    5147760      86344     1055   6495          350      N/A
     MDBBG        3.36     0.99   19986580    1084556       83   4638           75  -MGMTDB
     CLUST        0.70     0.21     117908     102372        4     10            1      N/A
     MDBFG        0.00     0.00    2253296     994304        7    234            7  -MGMTDB
```

# Querying Process Metric Set
 Processes ordered by  CPU, RSS, IO and Open FD's
**ex : oclumon dumpnodeview local -process**

```
--------------------------------------------------------------------
Node : den03ceb Clock : 2023-04-28 06.42.04
--------------------------------------------------------------------

PROCESS:
[CPU]
                name       pid   pri  cpu[%]   vmem[KB]      rss[KB]  shMem[KB]  fds[#]  thrds[#]  ioT[KB/sec]  state
              python     23673    20    8.34     195068        14412       6928       5         1         0.00      S
     ora_vktm_-MGMTDB    18841    -2    1.66    2442188        28104      24184      54         1         0.00      S
                java     19078    20    1.24    4813692       207476       5360     120        28         0.02      S
             osysmond    29857    20    1.22     385116       117744     102372      10         4         0.15      S
           orarootagent   4380    20    0.94    1433248        30308       5772     125        14         0.00      S


[RSS]
                name       pid   pri  cpu[%]   vmem[KB]      rss[KB]  shMem[KB]  fds[#]  thrds[#]  ioT[KB/sec]  state
      ora_m000_-MGMTDB    1958    20    0.00    2525688      1155016    1088284      76         1         0.00      S
      ora_m002_-MGMTDB   19028    20    0.00    2558296      1125832    1056432      76         1         0.00      S
      ora_m003_-MGMTDB   10088    20    0.18    2525592      1003764     951680      76         1         0.00      S
      ora_m001_-MGMTDB   18654    20    0.00    2541848       950980     899164      75         1         0.00      S
         oracle-MGMTDB   30646    20    0.17    2464824       925180     916904      16         1         0.00      S


[IO]
                name       pid   pri  cpu[%]   vmem[KB]      rss[KB]  shMem[KB]  fds[#]  thrds[#]  ioT[KB/sec]  state
             osysmond    29857    20    1.22     385116       117744     102372      10         4         0.15      S
                rwhod     1447    20    0.19       6488           64          0       4         1         0.15      S
      ora_lgwr_-MGMTDB   18910    -2    0.00    2461940        41720      34688      62         1         0.14      S
          jbd2/vda1-8      533    20    0.00          0            0          0       2         1         0.07      S
      ora_ckpt_-MGMTDB   18916    20    0.18    2461940        85928      78996      74         1         0.05      S


[FD]
                name       pid   pri  cpu[%]   vmem[KB]      rss[KB]  shMem[KB]  fds[#]  thrds[#]  ioT[KB/sec]  state
             ohasd.bin    2431    20    0.57    2398124        77148      18492     300        60         0.00      S
              oraagent    4001    20    0.56    2323864        66408      19376     258        31         0.00      S
                 crsd     3116    20    0.37    2425116        80548      18508     218        62         0.00      S
             osysmond    30461   -30    0.70    1756256       107308      34108     196        24         0.04      S
           orarootagent   2479    20    0.19    1698328        29176      12532     194        22         0.01      S
```
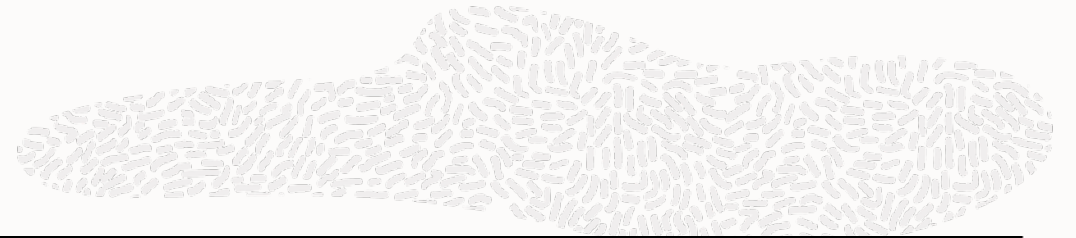
# Querying Device and NIC Metric Set

➢ Devices details ordered by **service time**.

```
-----------------------------------------------------------------------------
Node : den03ceb Clock : 2023-04-28 07.31.34
-----------------------------------------------------------------------------

DISK:
    name    ioR[KB/s]   ioW[KB/s]  numIOs[#/s]  qLen[#]  aWait[msec]  svcTm[msec]  util[%]              type
     vdb         1.80       46.90        12.00     0.00         0.00         0.43     0.55              DISK
    vda1         0.00      130.40        28.00     0.00         1.00         0.14     0.41         PARTITION
     vda         0.00      130.40        28.00     0.00         1.00         0.14     0.41              DISK
```

➢ Network interfaces ordered by  **net transmission rate** .

**ex : oclumon dumpnodeview local -nic**

```
-----------------------------------------------------------------------------
Node : den03ceb Clock :  2023-04-28 07.37.53
-----------------------------------------------------------------------------

NIC:
    name    rx[KB/s]   tx[KB/s]  total[KB/s]  rxErr[#/s]  txErr[#/s]  rxDscrd[#/s]  txDscrd[#/s]
    eth0        2.51      37.02        39.53           0           0             0             0
      lo        7.65       7.65        15.29           0           0             0             0
```

# Querying CPU and File System Metric Set

➤ Individual CPU Core Details (ordered by usage)

```
--------------------------------------------------------------------------------
Node : den03ceb Clock : 2023-04-28 07.31.34
--------------------------------------------------------------------------------

CPU:
    cpuId    usage[%]    system[%]      user[%]     nice[%]    ioWait[%]     steal[%]
        3       31.84       13.79        18.05        0.00         0.20         0.00
        2       31.28       13.29        17.99        0.00         0.00         0.00
        0       29.37       13.88        15.49        0.00         0.00         0.00
        1       28.01       12.67        15.33        0.00         0.20         0.00
```

➤ File System Details

**ex : oclumon dumpnodeview local -filesystem**

```
--------------------------------------------------------------------------------
Node : den03ceb Clock : 2023-04-28 08.15.12
--------------------------------------------------------------------------------

FILESYSTEM:
    mount      type    total[KB]    used[KB]     avbl[KB]    used[%]   ifree[%]         tag
        /       ext4    51473888    33168200     15667916      68.00      86.00   GRID_HOME
```

# Metrics Repository

➢ Metric Repository is auto managed on the local filesystem (location and repository size are configurable)
➢ "Nodeview" samples are continuously written to repository (JSON record)
➢ Historical data is auto-archived into hourly zip files (for extended retention)
➢ Archived files are automatically purged once default retention limit is reached (default : 100MB)
• ex : Snapshot of metric repository directory

```
utsising@den02sxr /scratch$ ls -al  /scratch/chmdata/json
total 10764
drwxr-xr-x 2 root       root       4096 Sep   6 09:00 .
drwxrwxrwx 3 utsising dba        4096 Sep   6 01:56 ..
-rw-r--r-- 1 root       root      77530 Sep   6 02:00 chmosdata_den02sxr_2020-09-06-0800.log.gz
-rw-r--r-- 1 root       root    1440450 Sep   6 03:00 chmosdata_den02sxr_2020-09-06-0900.log.gz
-rw-r--r-- 1 root       root    1425036 Sep   6 04:00 chmosdata_den02sxr_2020-09-06-1000.log.gz
-rw-r--r-- 1 root       root    1475615 Sep   6 05:00 chmosdata_den02sxr_2020-09-06-1100.log.gz
-rw-r--r-- 1 root       root    1415354 Sep   6 06:00 chmosdata_den02sxr_2020-09-06-1200.log.gz
-rw-r--r-- 1 root       root    1498497 Sep   6 07:00 chmosdata_den02sxr_2020-09-06-1300.log.gz
-rw-r--r-- 1 root       root    1477239 Sep   6 08:00 chmosdata_den02sxr_2020-09-06-1400.log.gz
-rw-r--r-- 1 root       root    1465193 Sep   6 09:00 chmosdata_den02sxr_2020-09-06-1500.log.gz
-rw-r--r-- 1 root       root     717271 Sep   6 09:04 chmosdata_den02sxr_2020-09-06-1600.log
-rw-r--r-- 1 root       root       6358 Sep   6 01:56 chmosmeta_211000.json
```

# Command line operations

Check for Health Issues and Corrective Actions with CHACTL QUERY DIAGNOSIS

```
chactl query diagnosis -db oltpacdb -start "2023-04-28 01:42:50" -end "2023-04-28 03:19:15"

2023-04-28 01:47:10.0 Database oltpacdb DB Control File IO Performance (oltpacdb_1) [detected]
2023-04-28 01:47:10.0 Database oltpacdb DB Control File IO Performance (oltpacdb_2) [detected]
2023-04-28 02:59:35.0 Database oltpacdb DB Log File Switch (oltpacdb_1) [detected]
2023-04-28 02:59:45.0 Database oltpacdb DB Log File Switch (oltpacdb_2) [detected]


Problem: DB Control File IO Performance
Description: CHA has detected that reads or writes to the control files are slower than expected.
Cause: The Cluster Health Advisor (CHA) detected that reads or writes to the control files were
slow because of an increase in disk IO.
The slow control file reads and writes may have an impact on checkpoint and Log Writer (LGWR)
performance.
Action: Separate the control files from other database files and move them to faster disks or
Solid
State Devices.
Problem: DB Log File Switch
Description: CHA detected that database sessions are waiting longer than expected
for log switch completions.
Cause: The Cluster Health Advisor (CHA) detected high contention during log switches
because the redo log files were small and the redo logs switched frequently.
Action: Increase the size of the redo logs.
```

# Command line operations

HTML diagnostic health output available (**-html <file_name>)**

| Timestamp | Target Information | Event Name | Detected/Cleared |
|---|---|---|---|
| 2023-04-28 01:49:30.0 | Host svr02 | Host CPU Utilization | detected |
| 2023-04-28 01:49:50.0 | Host svr01 | Host CPU Utilization | detected |
| 2023-04-28 05:54:55.0 | Host svr01 | Host Memory Consumption | detected |
| 2023-04-29 03:40:00.0 | Host svr02 | Host CPU Utilization | cleared |
| 2023-04-29 03:40:05.0 | Host svr01 | Host CPU Utilization | cleared |
| 2023-04-29 03:40:05.0 | Host svr01 | Host Memory Consumption | cleared |

| Problem | Description | Cause | Action |
|---|---|---|---|
| Host CPU Utilization | CHA detected larger than expected CPU utilization on this node. The available CPU resource may not be sufficient to support application failover or relocation of databases to this node. | The Cluster Health Advisor (CHA) detected an unexpected increase in CPU utilization by databases or applications on this node. | Identify CPU intensive processes and databases by reviewing Cluster Health Monitoring (CHM) data. Relocate databases to less busy machines, or limit the number of connections to databases on this node. Add nodes if more resources are required. |
| Host Memory Consumption | CHA detected that more memory than expected is consumed on this server. The memory is not allocated by sessions of this database. | The Cluster Health Advisor (CHA) detected an increase in memory consumption by other databases or by application not connected to a database on this node. | Identify the top memory consumers by using the Cluster Health Monitor (CHM). |

# Diagnose cluster health

```
chactl query diagnosis -db oltpacdb -start "2023-04-28 01:42:50.0" -end "2023-04-28 03:19:15.0"

2023-04-28 01:47:10.0  Database oltpacdb   DB Control File IO Performance (oltpacdb_1) [detected]
2023-04-28 01:47:10.0  Database oltpacdb   DB Control File IO Performance (oltpacdb_2) [detected]
2023-04-28 02:52:15.0  Database oltpacdb   DB CPU Utilization (oltpacdb_2) [detected]
2023-04-28 02:52:50.0  Database oltpacdb   DB CPU Utilization (oltpacdb_1) [detected]
2023-04-28 02:59:35.0  Database oltpacdb   DB Log File Switch (oltpacdb_1) [detected]
2023-04-28 02:59:45.0  Database oltpacdb   DB Log File Switch (oltpacdb_2) [detected]
```

# CHA Diagnoses Focus Areas
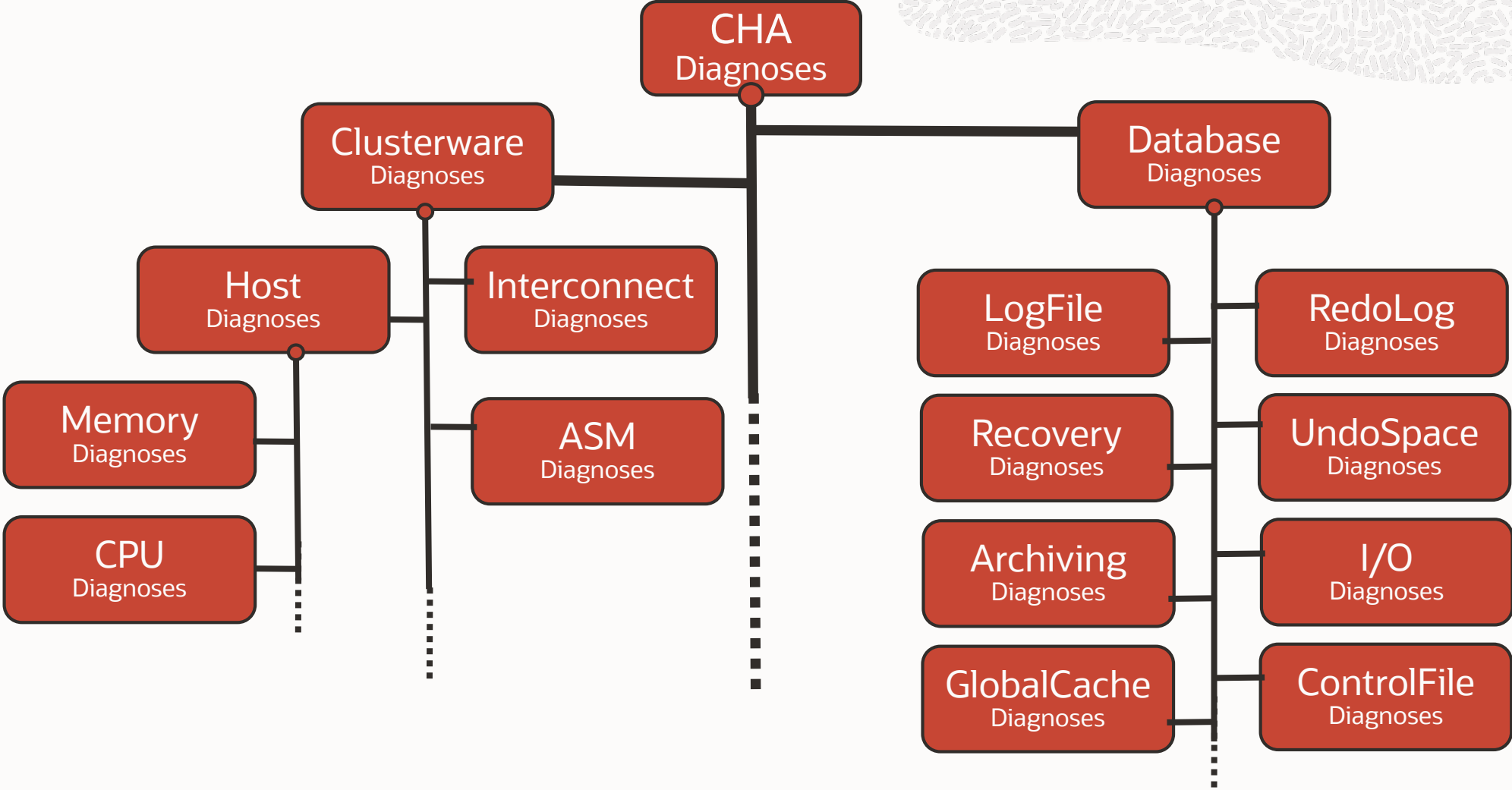
# Critical CHA Diagnoses and Their Impacts

| Diagnosis ID | Description | Impact |
|---|---|---|
| CHA_PRIV_NW_PATH | CHA detects abrupt, significant decrease in message traffic on the cluster Interconnect | Instance Eviction Node Eviction |
| CHA_PRIV_IC_LOSS | CHA detects slow response times for Global Cache messages | Hang Instance Eviction |
| CHA_GCS_BUSY | CHA detects a capacity issue in the Global Cache Services | Hang |
| CHA_PRIV_NETWORK_MSG | CHA detects Socket Buffer Overflows | Hang Instance Eviction |
| CHA_GC_NIC_CONFIG | CHA detects network packets are discarded by private network interface | Hang Instance Eviction Node Eviction |
| CHA_GC_IPC_CONGESTION | CHA detects global cache messages on the private interconnect are lost | Hang Instance Eviction |

# Critical CHA Diagnoses and Their Impacts

| Diagnosis ID | Description | Impact |
|---|---|---|
| CHA_GC_CLUSTER_RECONFIG | CHA detects an instance is joining or leaving the cluster or a PDB open/close is taking long time | Application Performance Issue |
| CHA_GCS_LOG_SYNC | CHA detects slow log file writes are leading to increased contention on other instances | I/O issue |
| CHA_REDO_LOG_SIZE | CHA detects database sessions are waiting longer than expected for log switch completions | Hang |
| CHA_FRA_PERF | CHA detects database sessions are waiting longer than expected for log file switches | Hang |
| CHA_FRA_SPACE | CHA detects database sessions are waiting for a log switch complete | Hang |
| CHA_UNDO_SPACE_CONTENTION | CHA detects high contention for undo segment space | Hang |

# Critical CHA Diagnoses and Their Impacts

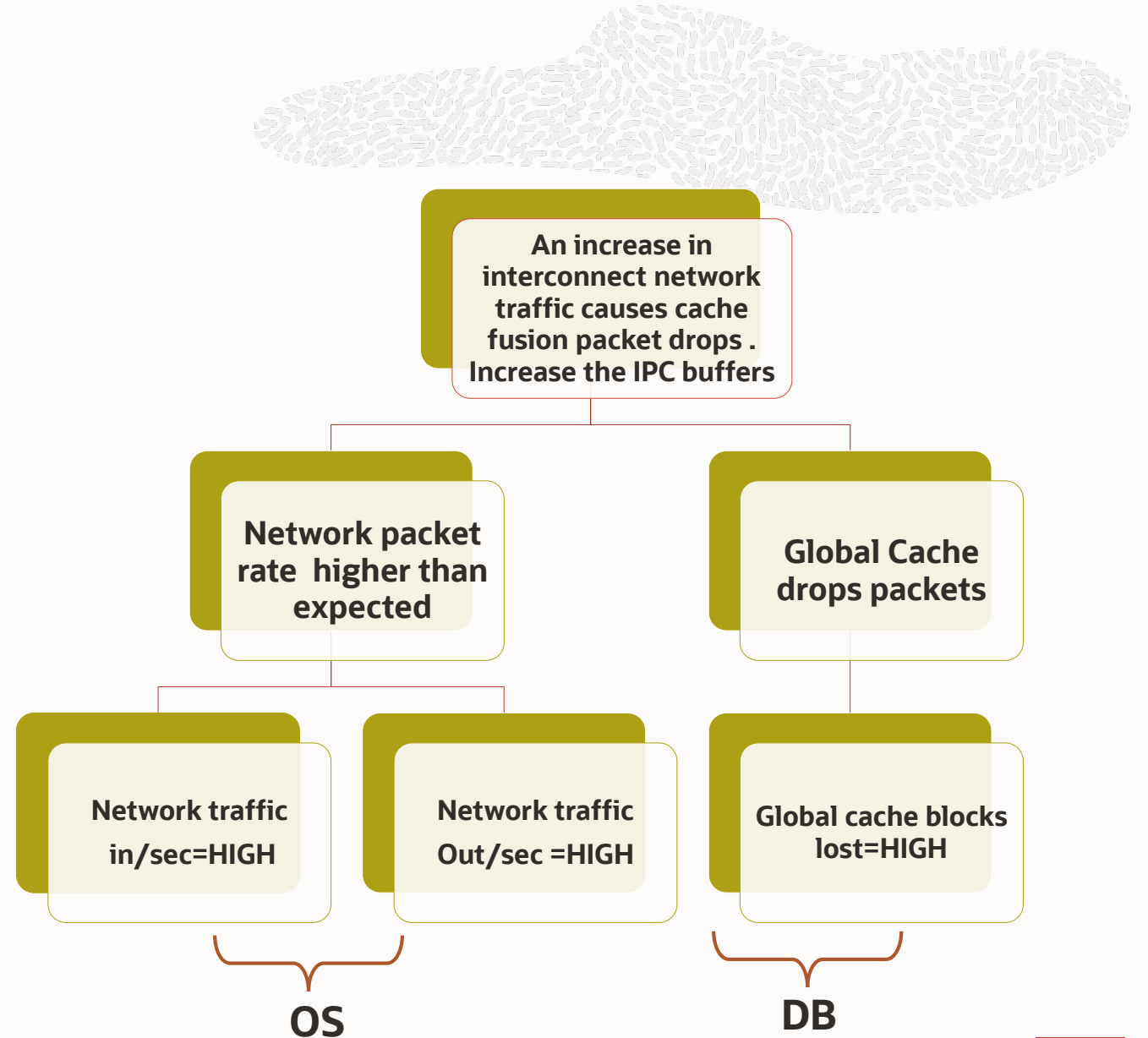| Diagnosis_ID | Description | Impact |
|---|---|---|
| CHA_LOG_SYNC_HANG | CHA detects commits were blocked for several seconds | Hang |
| CHA_GC_HANG | CHA detects global cache messages are taking long time | Hang |
| CHA_CFENQ_HANG | CHA detects processes are waiting for the Control File enqueue for several seconds | Hang Instance Eviction |
| CHA_REDODG_HANG | CHA detects the Log Writer Process (LGWR) is waiting several seconds for a log write completion | Hang Instance Eviction |
| CHA_DATADG_HANG | CHA detects database read I/O's take several seconds to complete | Hang |
| CHA_MEM_RUL | CHA detects high rate of memory consumption, | Instance Eviction Node Eviction |

# CHA Diagnoses, Over 50 … and Expanding

| | | | |
|---|---|---|---|
| CHA_PRIV_NW_PATH | CHA_FRA_PERF | CHA_DATADG_HANG | CHA_SESSION_RATE_WARNING |
| CHA_PRIV_IC_LOSS | CHA_FRA_SPACE | CHA_MEM_RUL | CHA_SESS_PGAPROC_CUM |
| CHA_GCS_BUSY | CHA_UNDO_SPACE_CONTENTION | CHA_SESSION_RATE_WARNING | CHA_GCS_DRM |
| CHA_PRIV_NETWORK_MSG | CHA_LOG_SYNC_HANG | CHA_PHYSICAL_WRITES | CHA_GC_LOG_SYNC |
| CHA_GC_NIC_CONFIG | CHA_GC_HANG | CHA_REDO_WRITES | CHA_GC_CLUSTER_RECONFIG_TIME |
| CHA_GC_IPC_CONGESTION | CHA_CFENQ_HANG | CHA_RECO_CKPT | CHA_NODE_MEM_SWAP |
| CHA_REDO_LOG_SIZE | CHA_REDODG_HANG | CHA_SB_CPU | CHA_NODE_CPU |

. . .

# CHA Diagnostics Model
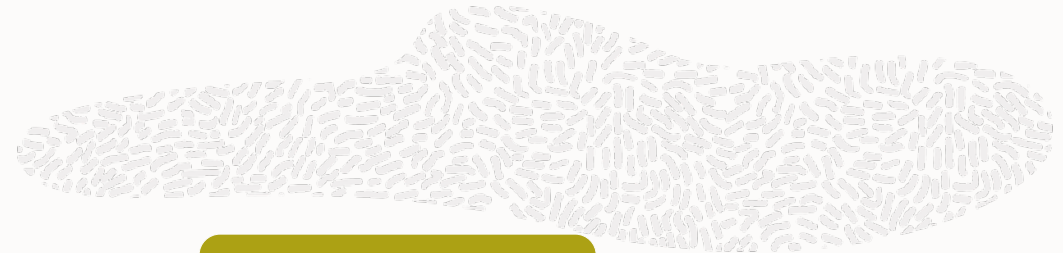*Why CHA Diagnoses are Correct?*

They are not based on ad hoc rules!

At the core of CHA diagnostics model, an inference engine is utilized, it knows how to combine probability-measured uncertainty with our domain experience.
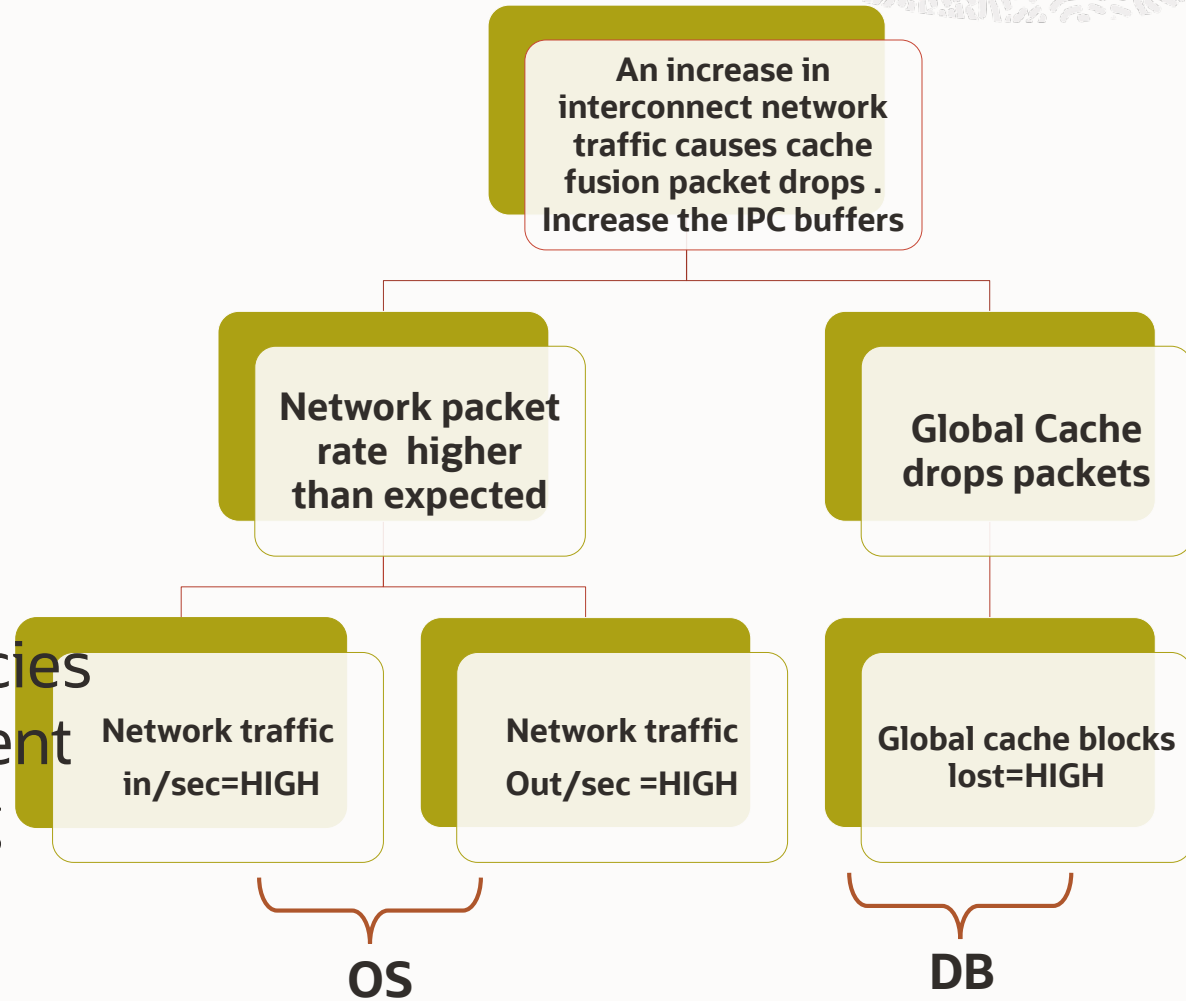
An increase in interconnect network traffic causes cache fusion packet drops . Increase the IPC buffers

Network packet rate higher than expected

Global Cache drops packets

Network traffic in/sec=HIGH

Network traffic Out/sec =HIGH

Global cache blocks lost=HIGH

**OS**

**DB**

# CHA Diagnostics Model

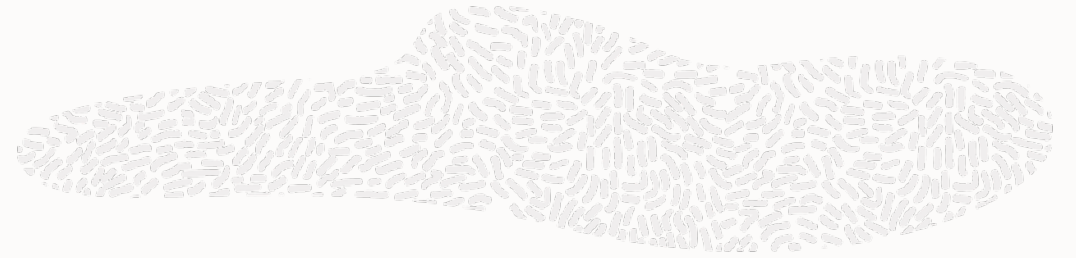*CHA Diagnostics Logic: What is in a "Model" ?*

When multiple faults are detected, they are passed as evidence
to a Probabilistic Bayesian Belief Network for Cause and Effect Analysis

Prior Probabilities and Dependencies are determined during development
Based on historical cases and bug database

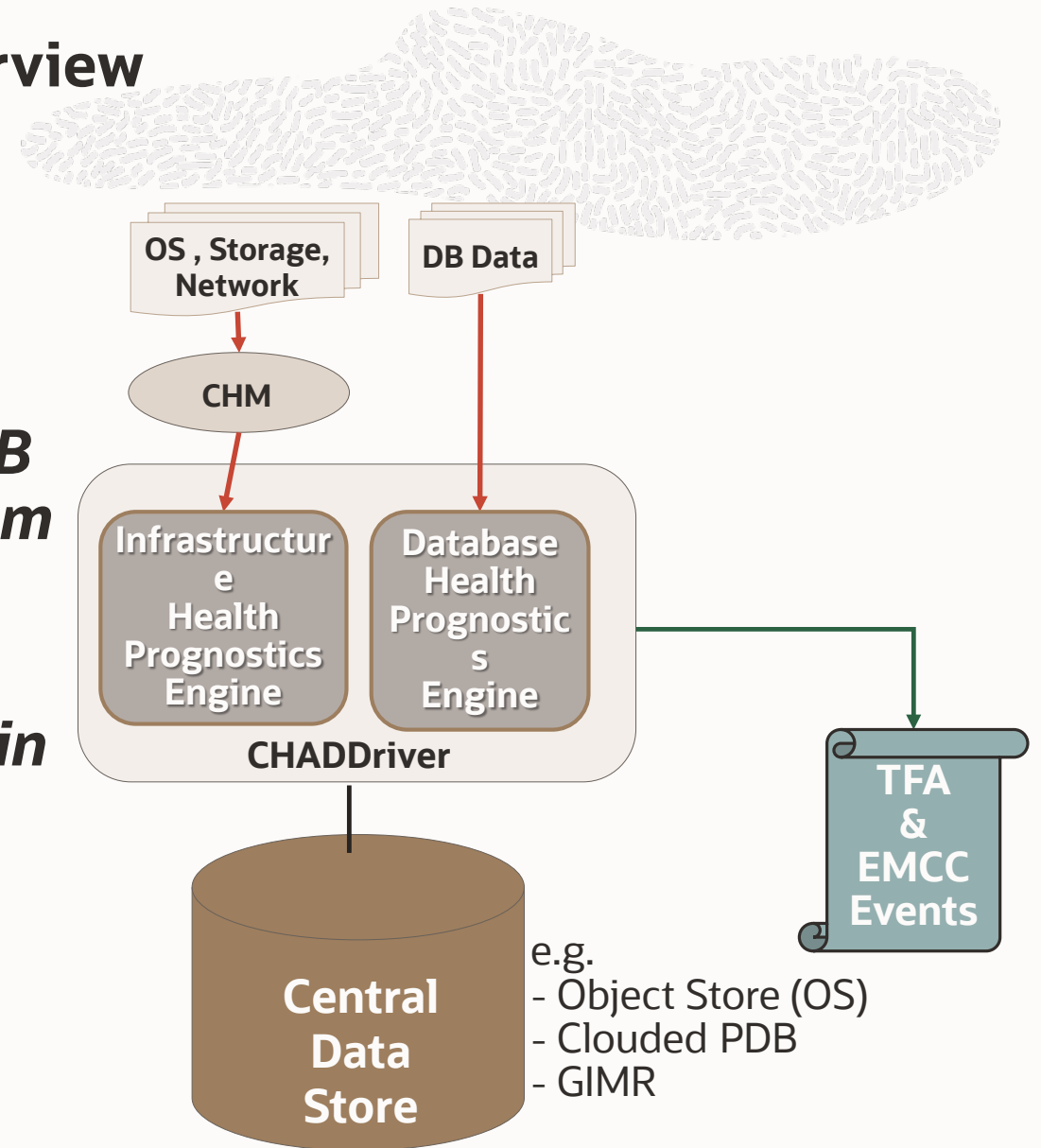An increase in interconnect network traffic causes cache fusion packet drops . Increase the IPC buffers

Network packet rate higher than expected

Global Cache drops packets

Network traffic in/sec=HIGH

Network traffic Out/sec =HIGH

Global cache blocks lost=HIGH

**OS**

**DB**

# 1. Architectural Overview and GI Integration

# Cluster Health Advisor Architecture Overview

- **cha** – *Cluster node resource*

- Single Java oracle.cha.server.CHADDriver daemon per node

- Reads *Cluster Health Monitor data and DB System and session statistics directly from memory*

- Monitors GI, Storage, Network, Clusterware and DB *and performs anomaly detection in real-time*

- *Sync data, analysis, and evidence* in a central Data Store
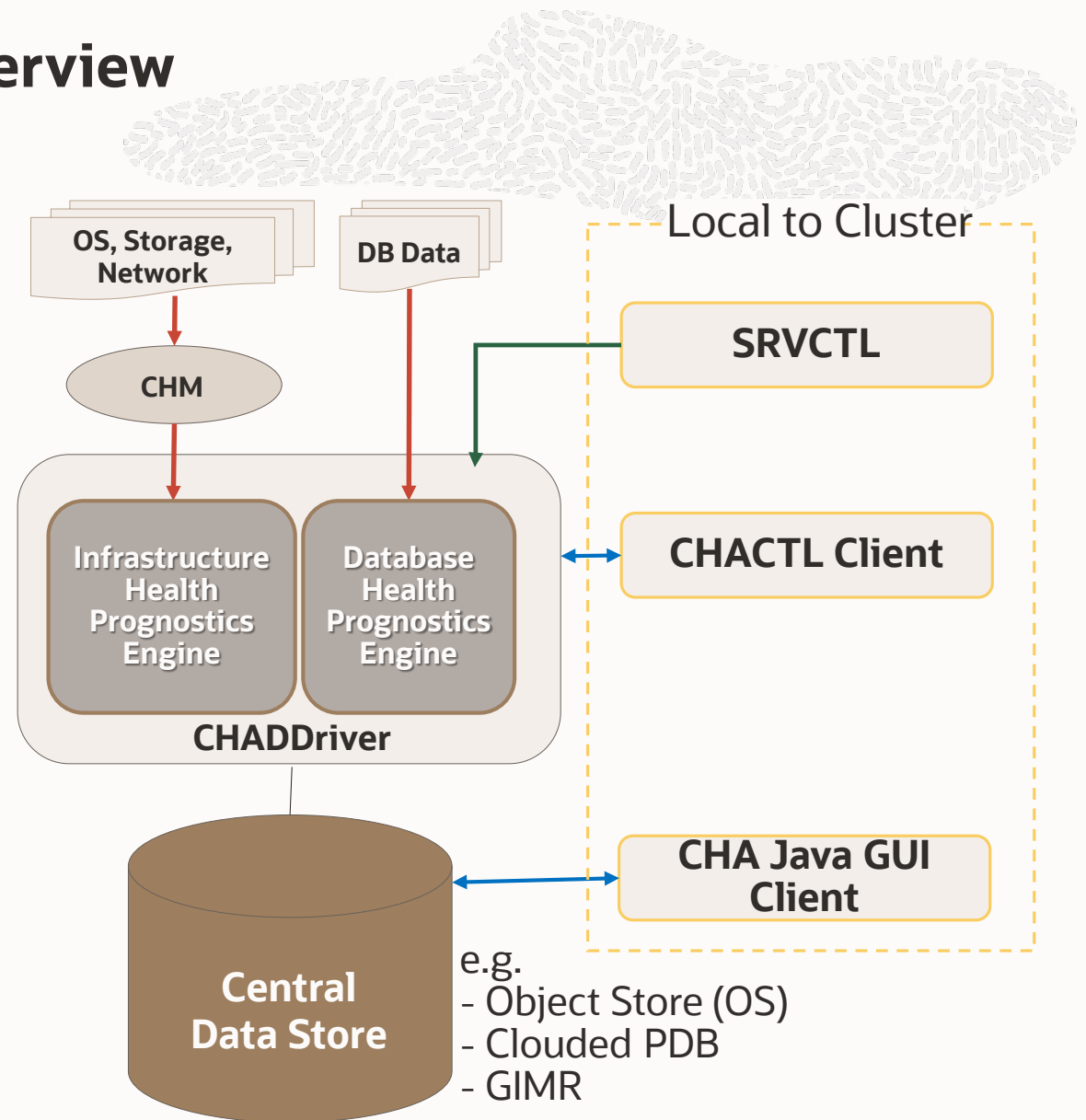
- *Sends events* to TFA & EMCC Incident Manager

OS , Storage, Network

DB Data

CHM

**Infrastructure Health Prognostics Engine**

**Database Health Prognostics Engine**

CHADDriver

**Central Data Store**

e.g.
- Object Store (OS)
- Clouded PDB
- GIMR

TFA & EMCC Events

# Cluster Health Advisor Architecture Overview

*Fully Integrated into Clusterware: CHA Resource and Daemon*
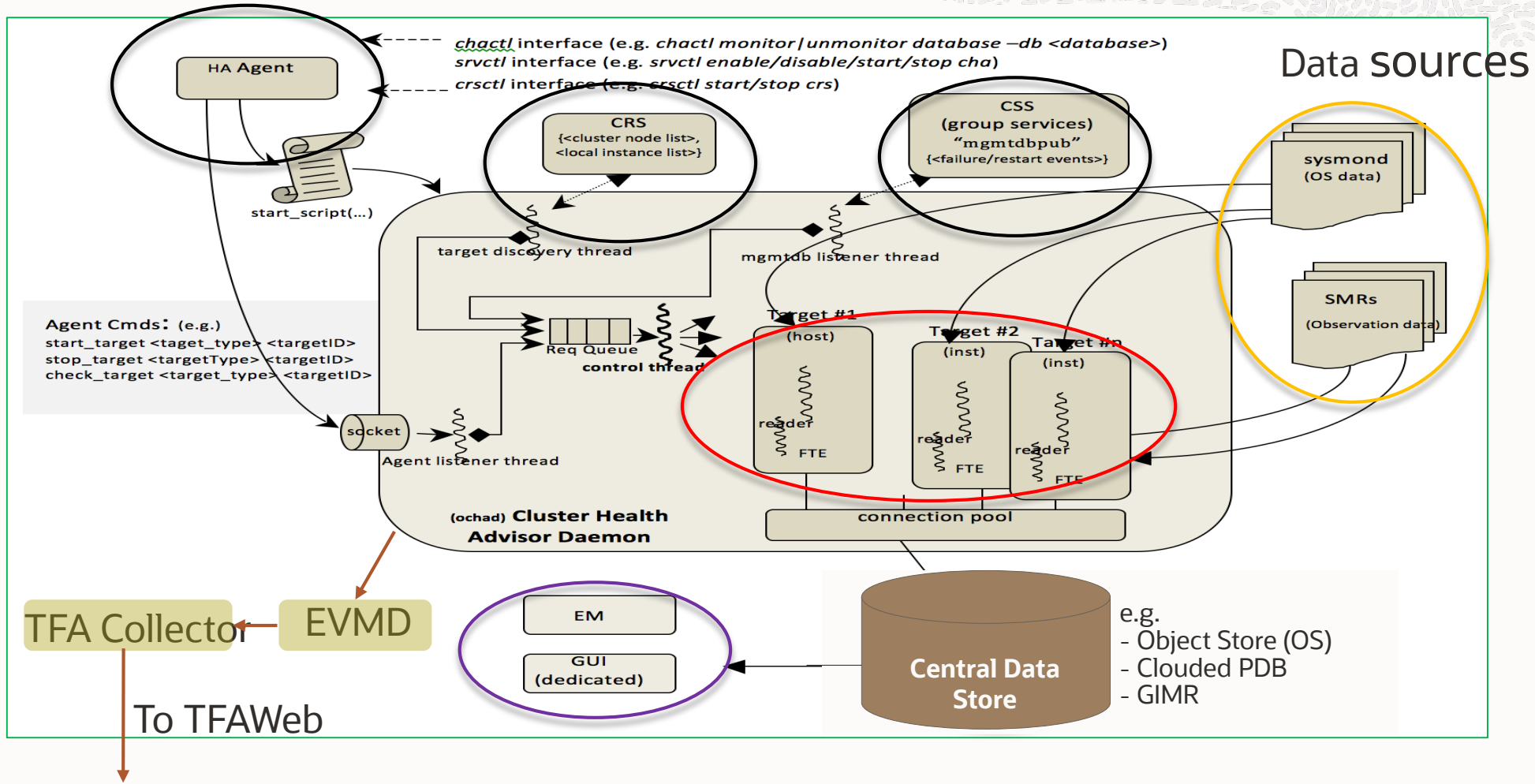
# Cluster Health Advisor Operation Overview

- SRVCTL lifecycle daemon management

- Enabled by default – Activates when 1st RAC instance starts

- Comprehensive **CHACTL command line** tool for all local operations

- **TFAWeb** *provides GUI interface to CHA diagnostic events*

- Monitoring has no impact on DB performance or availability

- **Light footprint:**
  ~ 2% of a single HT core for :   9 targets
  ~ 5% of a single HT core for: 36 targets
   (512 MB –Xmx max heap memory)



OS, Storage, Network

DB Data

Local to Cluster

CHM

SRVCTL

Infrastructure Health Prognostics Engine

Database Health Prognostics Engine

CHACTL Client

CHADDriver

Central Data Store

CHA Java GUI Client

e.g.
- Object Store (OS)
- Clouded PDB
- GIMR

# 2. In-Memory Real-Time Data Acquisition

# Cluster Health Advisor
*Data Sources*

**Operating System and Infrastructure** data on each Cluster Node

**DB System Statistics** ( e.g. physical reads , user calls ) for each monitored instance and pdb

**DB Session History** ( ASH enhanced by event history ) for each monitored instance

**Data from all sources is synchronized and sampled at the same frequency and forms and input vector**

**CHA also collects selected statistics at the PDB level.**

# Cluster Health Advisor
*Data Sources and Data Points*

A CHA *Data Point* contains > 150 signals (statistics, metrics , events) from *multiple sources*

**OS, ASM , Clusterware, Network** ⟶    ⟵ **DB ( ASH, AWR session, system and PDB statistics )**

| Time | CPU | ASM IOPS | Network % util | Network _Packets Dropped | Log file sync | Log file parallel write | Gc cr request | Gc current request | Gc current block 2-way | Gc current block busy | Enq: CF - contention | .. |
|------|-----|----------|----------------|--------------------------|---------------|-------------------------|---------------|--------------------|------------------------|-----------------------|----------------------|----|
| 15:16:00 | 0.90 | 4100 | 13% | 0 | 2 ms | 600 us | 0 | 0 | 300 us | 1.5 ms | 0 | |

Statistics are collected at a *1 second internal sampling* rate , synchronized, smoothed and aggregated to a Data Point *every 5 seconds*

All database Components: Latches, Locks,
SQL Execution, Interconnect, Cache Fusion etc.

System Statistics, Time Model Metrics , Wait Events
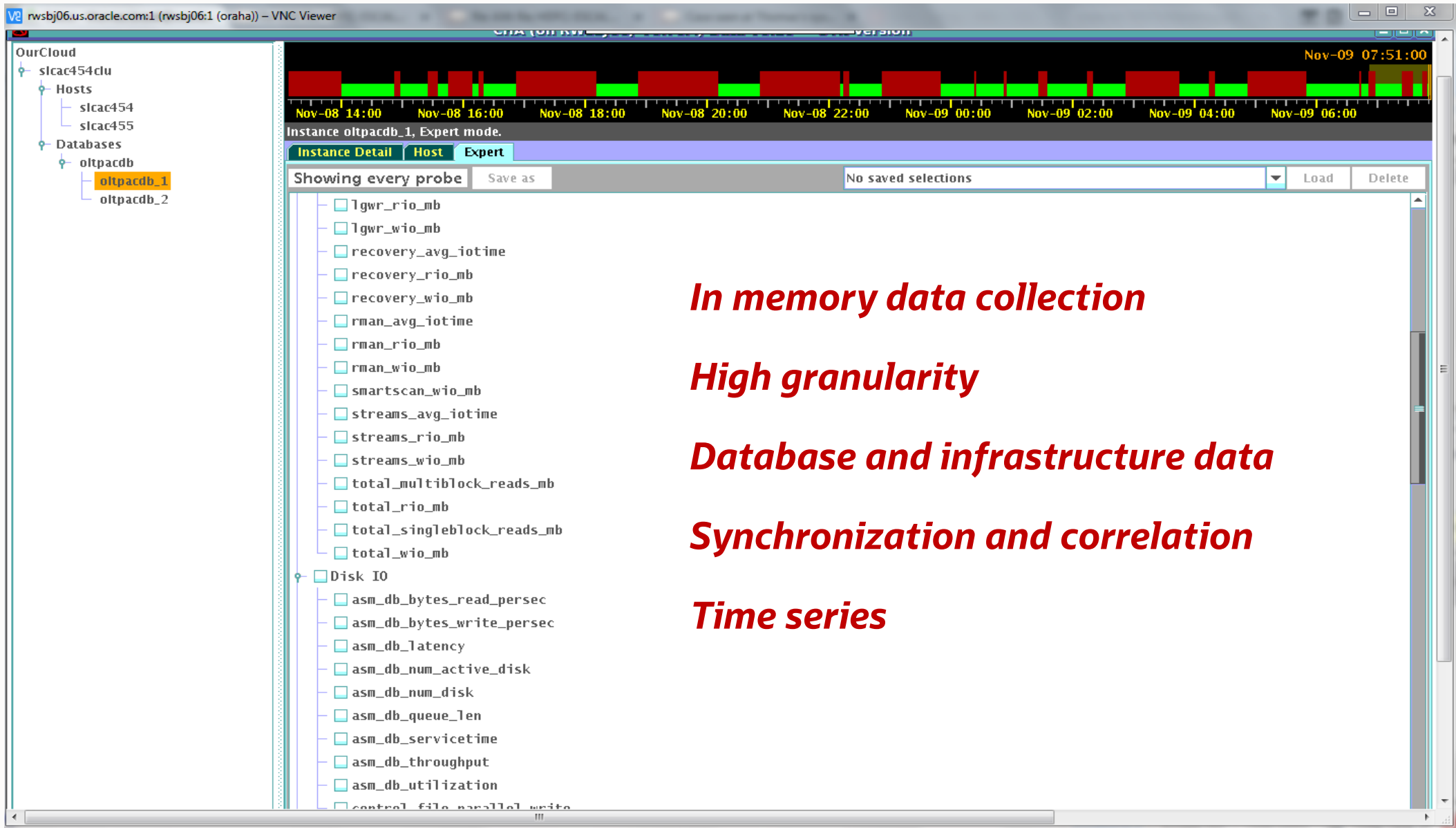
In memory data collection

High granularity

Database and infrastructure data

Synchronization and correlation

Time series

OurCloud
- System|ODA bare-metal
  - slcac454clu
    - slcac455
    - slcac454
  - Databases
    - oltpacdb
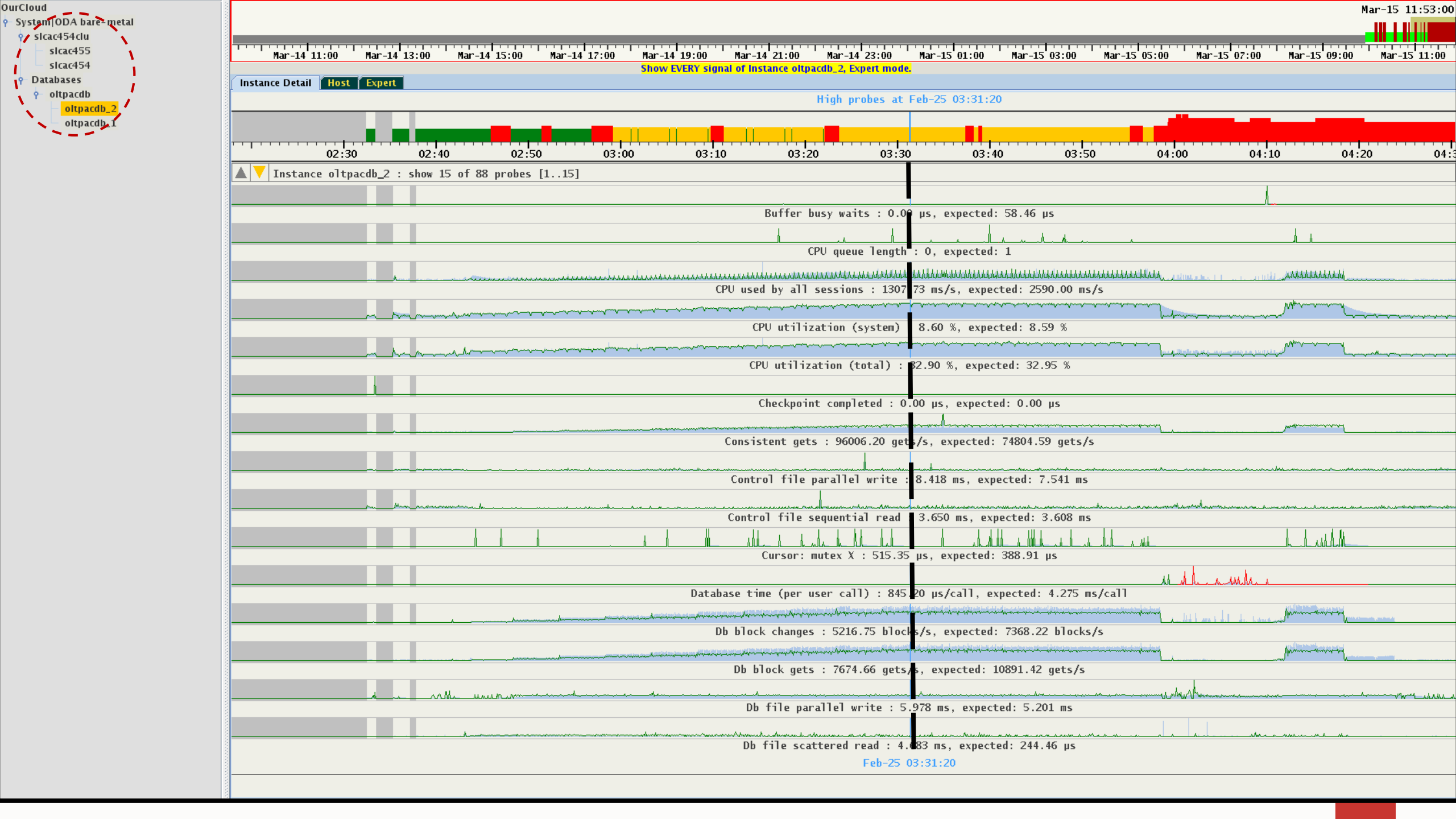      - oltpacdb_2
      - oltpacdb_1

Mar-15 11:53:00

Mar-14 11:00  Mar-14 13:00  Mar-14 15:00  Mar-14 17:00  Mar-14 19:00  Mar-14 21:00  Mar-14 23:00  Mar-15 01:00  Mar-15 03:00  Mar-15 05:00  Mar-15 07:00  Mar-15 09:00  Mar-15 11:00

Show EVERY signal of Instance oltpacdb_2, Expert mode.

| Instance Detail | Host | Expert |

High probes at Feb-25 03:31:20

02:30  02:40  02:50  03:00  03:10  03:20  03:30  03:40  03:50  04:00  04:10  04:20  04:3

Instance oltpacdb_2 : show 15 of 88 probes [1..15]

Buffer busy waits : 0.00 µs, expected: 58.46 µs

CPU queue length : 0, expected: 1

CPU used by all sessions : 1307.73 ms/s, expected: 2590.00 ms/s

CPU utilization (system) : 8.60 %, expected: 8.59 %

CPU utilization (total) : 32.90 %, expected: 32.95 %

Checkpoint completed : 0.00 µs, expected: 0.00 µs

Consistent gets : 96006.20 gets/s, expected: 74804.59 gets/s

Control file parallel write : 8.418 ms, expected: 7.541 ms

Control file sequential read : 3.650 ms, expected: 3.608 ms

Cursor: mutex X : 515.35 µs, expected: 388.91 µs

Database time (per user call) : 845.20 µs/call, expected: 4.275 ms/call

Db block changes : 5216.75 blocks/s, expected: 7368.22 blocks/s

Db block gets : 7674.66 gets/s, expected: 10891.42 gets/s

Db file parallel write : 5.978 ms, expected: 5.201 ms

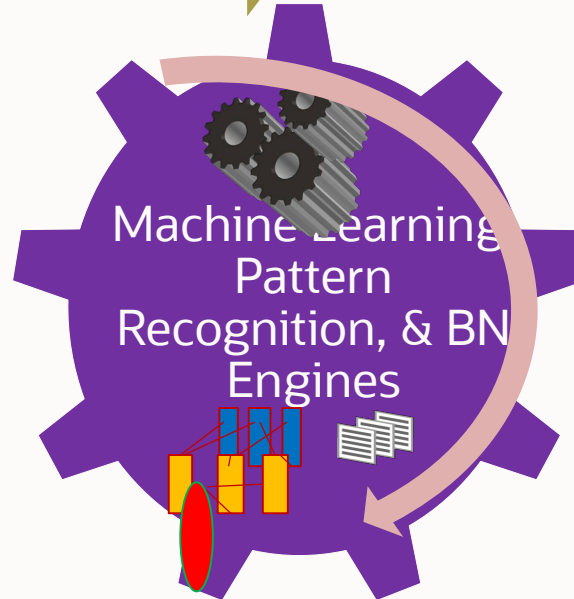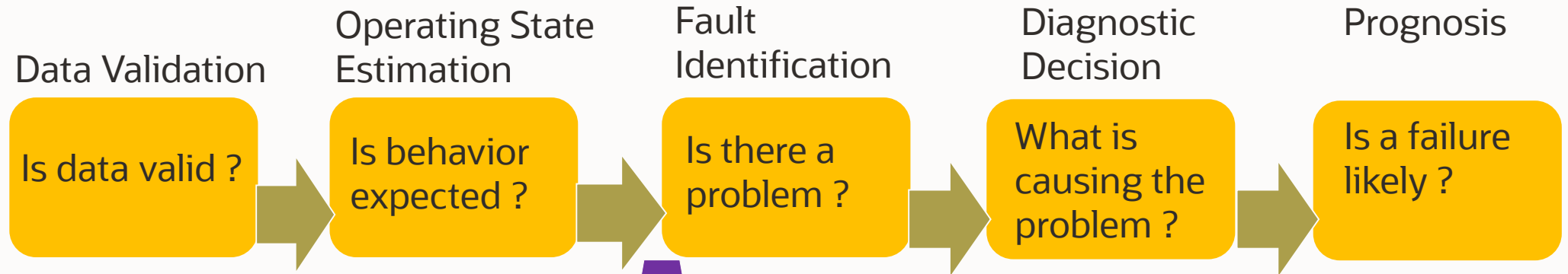Db file scattered read : 4.883 ms, expected: 244.46 µs

Feb-25 03:31:20

# 3. Prediction of Normal Operation and Anomaly Detection

# Cluster Health Advisor

*CHA Operational Flow : Anomaly Detection -> Diagnostics -> Prognosis*

*For each data point …*

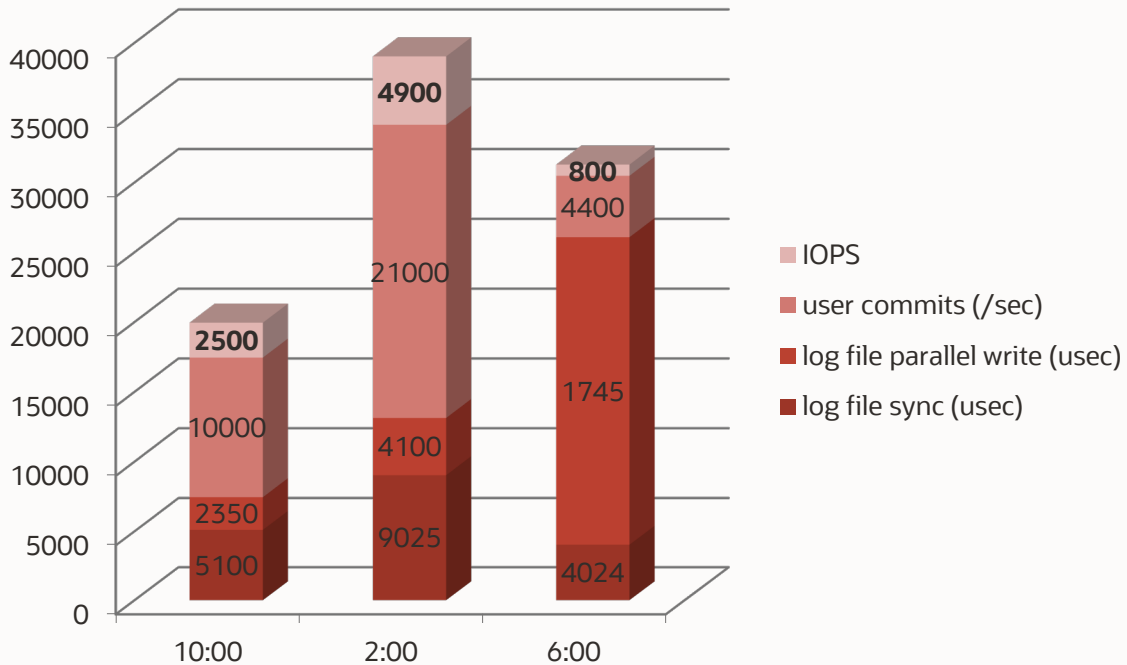| Data Validation | Operating State Estimation | Fault Identification | Diagnostic Decision | Prognosis |
|---|---|---|---|---|
| Is data valid ? | Is behavior expected ? | Is there a problem ? | What is causing the problem ? | Is a failure likely ? |

Machine Learning Pattern Recognition, & BN Engines

## Cluster Health Advisor

- **Machine Learning and Statistical Inference** address **scale, dynamics and interdependency** in Clusters and Clouds

- **An ML Mode**l is **an in-memory representation** of a **normally behaving application** over time**, learned from historical operational data ,** in the form of a collection of **vectors of operational data**

- The **similarity or distance** of a monitored data point to a vector in the in-memory model is the **basis to for a comparison between the normal data and the actual data**

# Models Capture all Normal Operating Modes
*Normal load and response time variation and cyclical behavior of workloads*



| | | | | |
|---|---|---|---|---|
| Log file sync | **5.4** | **9.0** | **4.0** | ***** |
| Log file parallel write | **2.3** | **4.1** | **1.7** | ***** |
| User commits | **10000** | **21000** | **4400** | ***** |
| IOPS | **2500** | **4900** | **800** | ***** |

In-Memory Reference Matrix
(*Part of "Normality" Model*)

Chart values:
- 10:00: IOPS **2500**, user commits 10000, log file parallel write 2350, log file sync 5100
- 2:00: IOPS **4900**, user commits 21000, log file parallel write 4100, log file sync 9025
- 6:00: IOPS **800**, 4400, 1745, 4024

Legend:
- IOPS
- user commits (/sec)
- log file parallel write (usec)
- log file sync (usec)

A model captures *the **normal load phases** and their performance characteristics. One could say **that *the model REMEMBERS the normal operational dynamics***

# Cluster Health Advisor

*CHA Model: Find Similarity with Normal State Vectors*
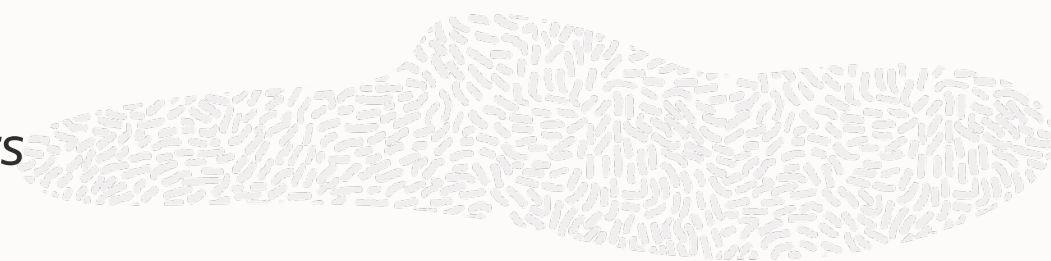
### In-Memory Reference Matrix (*Part of "Normality" Model*)

| | | | | | | |
|---|---|---|---|---|---|---|
| Log file sync | * | * | 4.0 | * | * | * |
| Log file parallel write | * | * | 1.7 | * | * | * |
| User commits | * | * | 4400 | * | * | * |
| IOPS | * | * | 800 | * | * | * |

### observed values (*Part of a Data Point*)

| | |
|---|---|
| Log file Sync | 9 |
| Log file parallel write | 5 |
| User commits | 600 |
| IOPS | 980 |

### Predicted values

| |
|---|
| 4.3 |
| 1.8 |
| 4440 |
| 1100 |

### Residual

| |
|---|
| 4.7 |
| 3.2 |
| 3840 |
| 280 |

**CHA estimator/predictor (ESEE):** *"based on my normality model, the value of log file sync should be in the vicinity of ~ 4ms, but it is reported as 9ms, this is causing a residual of ~ 5 ms in magnitude"*,

**CHA fault detector:** *"such high magnitude of residuals should be tracked carefully! I'll keep an eye on the incoming sequence of this signal log file sync and if it remains deviant I'll generate a fault on it".`*
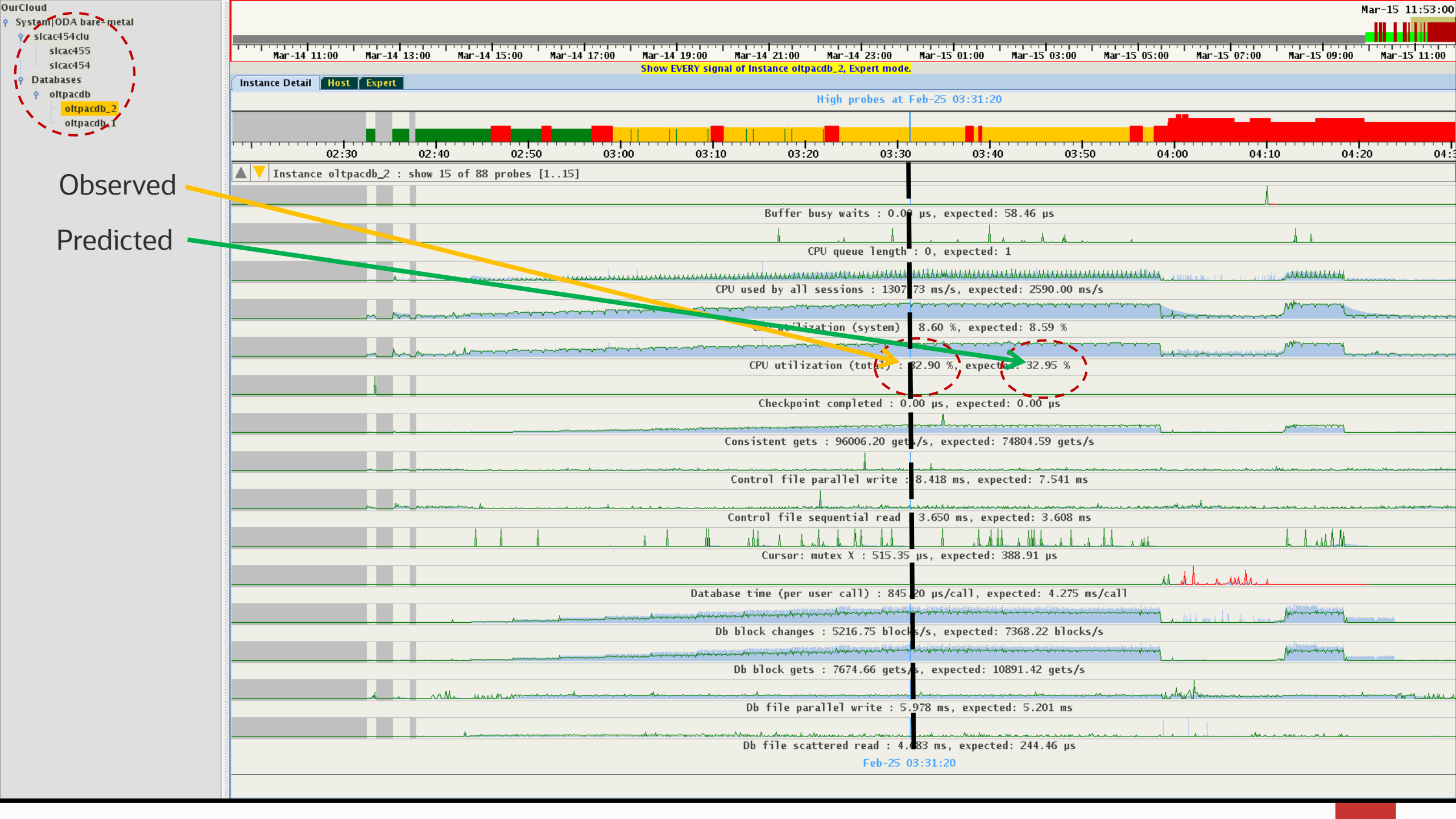
# Cluster Health Advisor
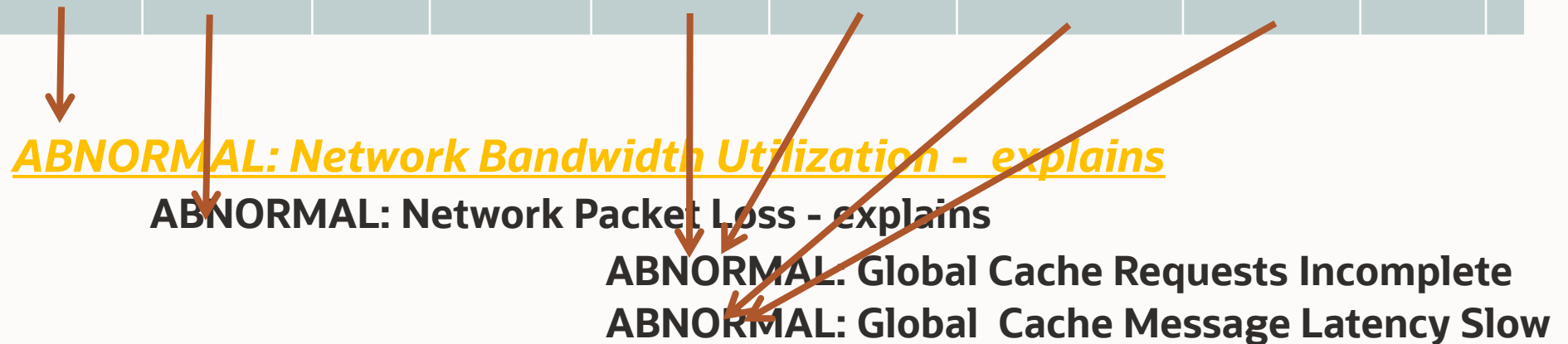*Fault Detection and Diagnostic Inference*

**Input : Data Point at Time t**

| Time | CPU | ASM IOPS | Network % util | Network_Packets Dropped | Log file sync | Log file parallel write | Gc cr request | Gc current request | Gc current block 2-way | Gc current block busy | Enq: CF - contention | .. |
|------|-----|----------|----------------|--------------------------|----------------|--------------------------|----------------|---------------------|-------------------------|------------------------|----------------------|----|
| 15:16:00 | 0.90 | 4100 | 88% 39% | 105 0 | 2 ms | 600 us | 504 ms 200 us | 513 ms 250us | 2 ms 250 us | 5.9 ms 1.5 ms | 0 | |

**Fault Detection and Classification**

| 15:16:00 | OK | OK | HIGH | HIGH | OK | OK | HIGH | HIGH | HIGH | HIGH | OK |
|----------|-----|-----|------|------|-----|-----|------|------|------|------|-----|

**Diagnostic Inference**

*ABNORMAL: Network Bandwidth Utilization - explains*

**ABNORMAL: Network Packet Loss - explains**

**ABNORMAL: Global Cache Requests Incomplete**

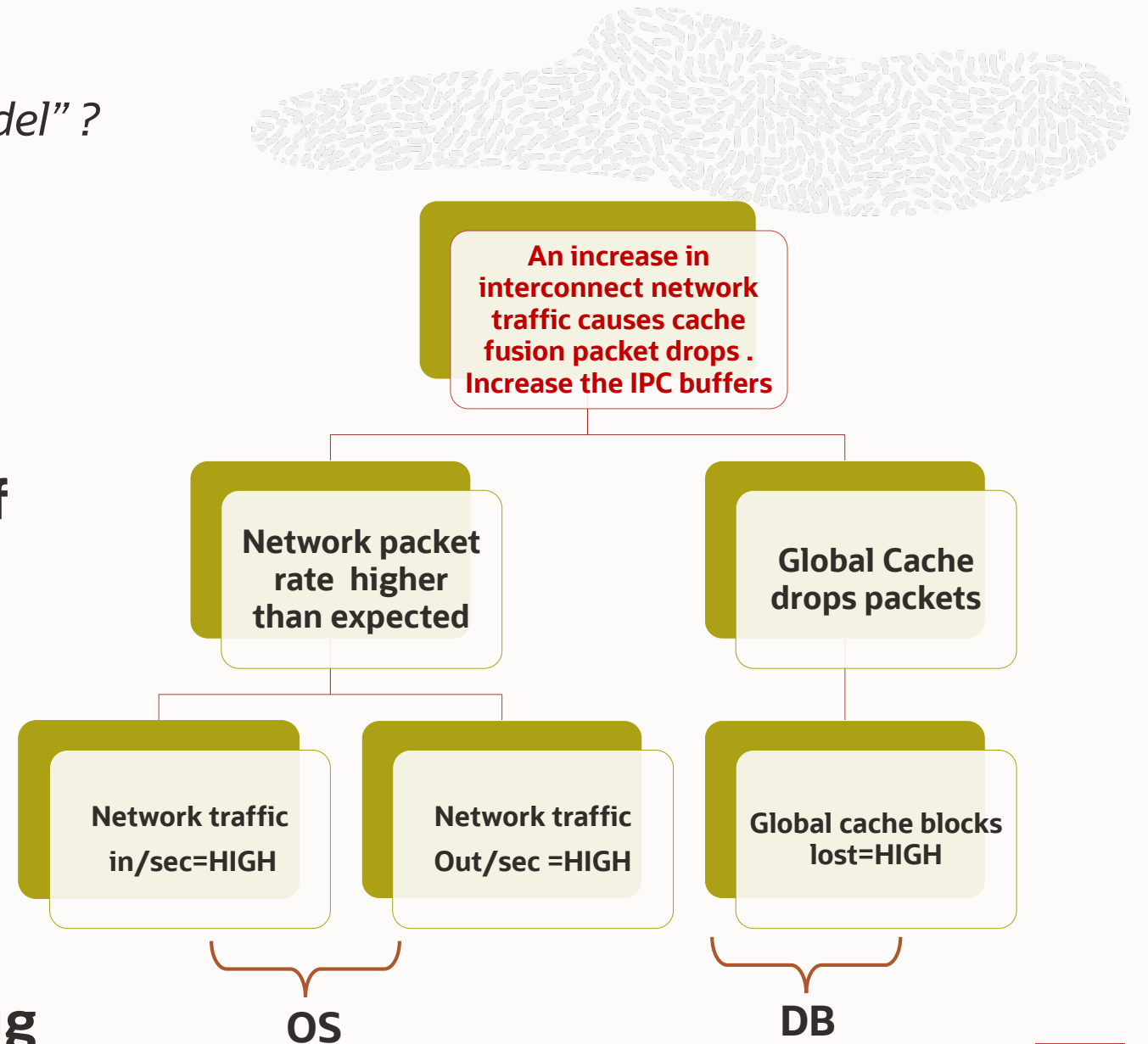**ABNORMAL: Global Cache Message Latency Slow**
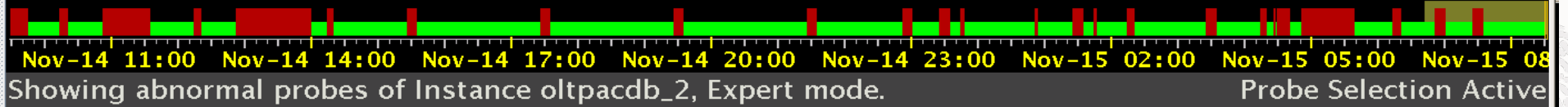
# Cluster Health Advisor

*CHA Diagnostics Logic: What is in a "Model" ?*

**When multiple faults are detected, they are passed as evidence
to a Probabilistic Bayesian Belief Network for Cause and Effect Analysis**

**Prior Probabilities and Dependencies
are determined during development
Based on historical cases and bug database**

An increase in interconnect network traffic causes cache fusion packet drops . Increase the IPC buffers

Network packet rate higher than expected

Global Cache drops packets

Network traffic in/sec=HIGH

Network traffic Out/sec =HIGH

Global cache blocks lost=HIGH

OS

DB

CHA (on SLCAC455.US.ORACLE.COM) V0.76.4, Data V0.20 -- OTN Version

OurCloud
- slcac454clu
  - Hosts
    - slcac454
    - slcac455
  - Databases
    - oltpacdb
      - oltpacdb_1
      - oltpacdb_2

Nov-15 08:31:00

Nov-14 11:00  Nov-14 14:00  Nov-14 17:00  Nov-14 20:00  Nov-14 23:00  Nov-15 02:00  Nov-15 05:00  Nov-15 08

Showing abnormal probes of Instance oltpacdb_2, Expert mode.                    Probe Selection Active

**Instance Detail**  Host  Expert

Alarm at Nov-15 06:55:45

06:50   07:00   07:10   07:20   07:30   07:40   07:50   08:00   08:10   08:20   08:3

Instance oltpacdb_2

91.5% The Cluster Health Advisor (CHA) detected that global cache messages are taking a long time.

Buffer busy waits*: 40.959 s

DB FG Wait Ratio*: 99.4 %

Database time (per user call)*: 1.369 s/call, expected: 22.537 ms/call

Gc buffer busy acquire*: 908.390 ms

Gc cr request*: 11.684 s

Gc current request*: 8.597 s

Nov-15 06:55:45

OurCloud
- slcac454clu
  - Hosts
    - slcac454
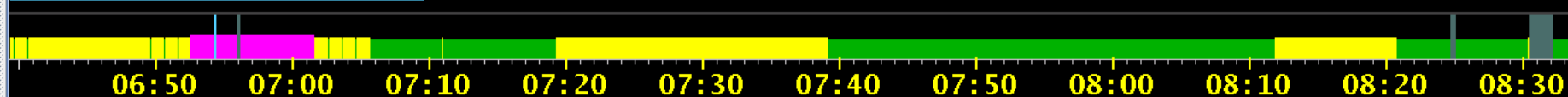    - slcac455
  - Databases
    - oltpacdb
      - oltpacdb_1
      - oltpacdb_2

Nov-15 08:34:00

Nov-14 12:00   Nov-14 15:00   Nov-14 18:00   Nov-14 21:00   Nov-15 00:00   Nov-15 03:00   Nov-15 06:00

Showing abnormal probes of Instance oltpacdb_2                                    Probe Selection Active

**Instance Detail**  Host

Alarm at Nov-15 06:54:20

06:50   07:00   07:10   07:20   07:30   07:40   07:50   08:00   08:10   08:20   08:30

△ ▼ Instance oltpacdb_2   Shows 2 of 6 probes [1..2]

▽ 1: The Cluster Health Advisor (CHA) detected that global cache messages are taking a long time.

Cause:
CHA detected that global cache messages have not completed and are blocking database sessions, because a process on another instance of this database was pinning a block in the buffer cache and was waiting for a resource.

Activated at:
2017-11-15 06:52:15

Corrective Action:
Check whether incidents are detected and diagnosed on other nodes and instances in the cluster using the command 'chactl query diagnosis'.

Buffer busy waits*: 119.906 s
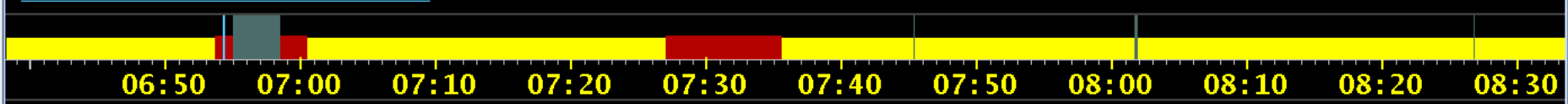
DB FG Wait Ratio*: 98.3 %
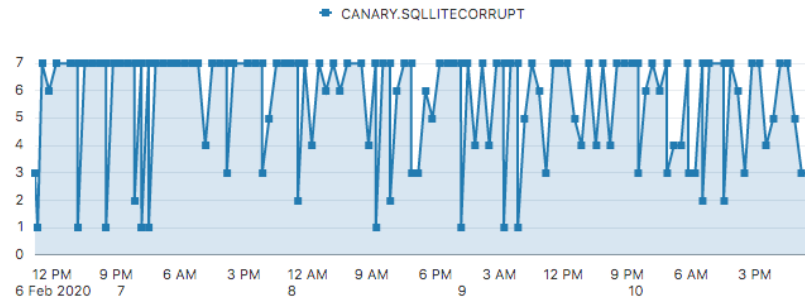
Nov-15 06:54:20

ORACLE® Trace File Analyzer v20.1.1

Load SR

TFAADMIN

oldashburn-preview-iad101605exd-d0-05-06-cl-07-09-clu01-atpd-exa-2itfs1-hozel4qo.underscore.iad187-hozel4qo1

✕

Metrics

Graph　Clear

— CANARY.SQLLITECORRUPT
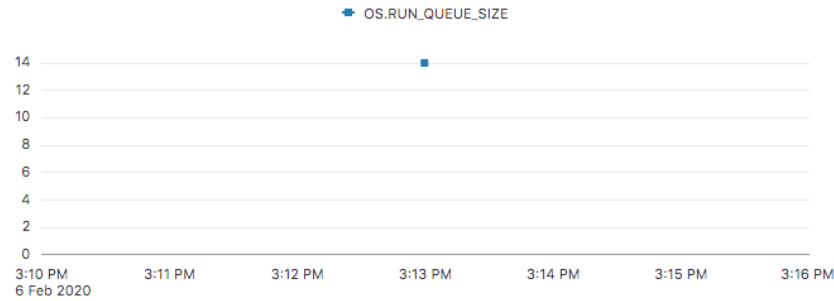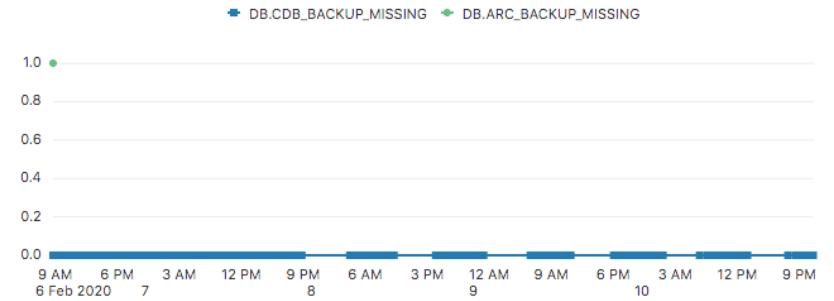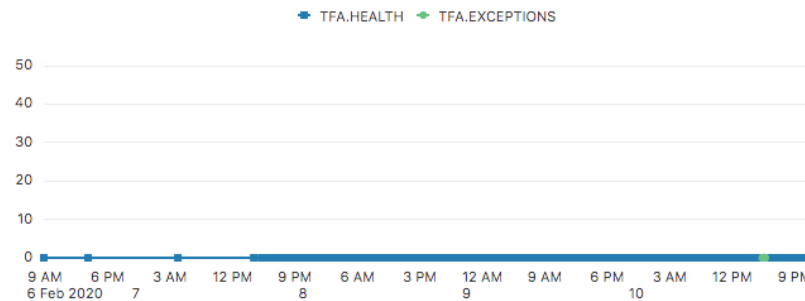
7
6
5
4
3
2
1
0

12 PM　9 PM　6 AM　3 PM　12 AM　9 AM　6 PM　3 AM　12 PM　9 PM　6 AM　3 PM
6 Feb 2020　7　8　9　10

— DB.CDB_BACKUP_MISSING　● DB.ARC_BACKUP_MISSING

1.0
0.8
0.6
0.4
0.2
0.0

9 AM　6 PM　3 AM　12 PM　9 PM　6 AM　3 PM　12 AM　9 AM　6 PM　3 AM　12 PM　9 PM
6 Feb 2020　7　8　9　10

**Performance Load & Run Queue - 1 Issues**　Show Details

**API Status Error - 17 Issues**　Show Details

— OS.RUN_QUEUE_SIZE

14
12
10
8
6
4
2
0

3:10 PM　3:11 PM　3:12 PM　3:13 PM　3:14 PM　3:15 PM　3:16 PM
6 Feb 2020

— API_STATUS

2.0
1.6
1.2
0.8
0.4
0.0

9 AM　6 PM　3 AM　12 PM　9 PM　6 AM　3 PM　12 AM　9 AM　6 PM　3 AM　12 PM　9 PM
6 Feb 2020　7　8　9　10

**Health TFA - 6 Issues**　Show Details
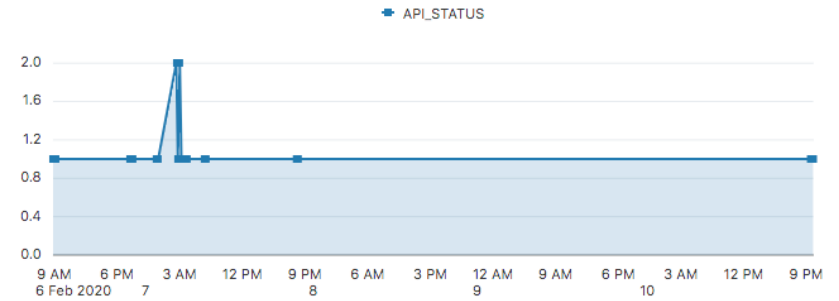
**CHA Global Cache - 1 Issues**　Show Details

— TFA.HEALTH　● TFA.EXCEPTIONS

50
40
30
20
10
0

9 AM　6 PM　3 AM　12 PM　9 PM　6 AM　3 PM　12 AM　9 AM　6 PM　3 AM　12 PM　9 PM
6 Feb 2020　7　8　9　10

— CHA.CHA_GC_CLUSTER_RECONFIG_TIME

1.0
0.8
0.6
0.4
0.2
0.0

10:09 AM　10:10 AM　10:11 AM　10:12 AM　10:13 AM　10:14 AM　10:15 AM
6 Feb 2020

Dashboard    SR    Notes    Anomaly Timeline    Timeline Search    Content Search    **Cluster Health Advisor** ✕

# Cluster Health Advisor

## Found 3 ABNORMAL events

This Service Request contains Cluster Health Advisor (CHA) analysis dump files. **CHA Diagnoses and identifies the most likely root causes for faults in OS/GI/ASM and Database and provides corrective actions for targeted triage.**
Please download the CHA GUI application to your desktop to analyze the CHA analysis files.
More information about CHA GUI and download options are available in MOS Note 2340062.1

| Timestamp | seliicbl00466-rac2 | | seliicbl00433-rac1 |
|---|---|---|---|
| 2020-02-10 02:25:50 | 67.9 | | ASM I/O Service Time [ + ] |
| 2020-02-10 03:04:10 | 67.9 | | ASM I/O Service Time [ + ] |
| 2020-02-10 06:02:10 | 87.7 | | Host Memory Swapping [ + ] |
| 2020-02-10 06:29:10 | 53.8 | | Host Memory Consumption [ + ] |
| 2020-02-10 06:29:55 | 87.7 | | Host Memory Swapping [ + ] |
| 2020-02-10 07:21:10 | 53.8 | | Host Memory Consumption [ + ] |
| 2020-02-10 07:21:32 | 87.7 | | Host Memory Swapping [ + ] |
| 2020-02-10 07:44:20 | 53.8 | Host Memory Consumption [ + ] | |
| 2020-02-10 07:44:20 | 53.8 | Host Memory Consumption [ + ] | |
| 2020-02-10 11:02:20 | 53.8 | | Host Memory Consumption [ + ] |

| Description | The Cluster Health Advisor (CHA) detected that more memory than expected is consumed on this server. |
|---|---|
| Cause | CHA detected an increase in host memory utilization because the number of databases processes on this server probably increased. |
| Action | Validate the CHA memory findings for all databases on this node. |

| 2020-02-10 11:05:20 | 53.8 | | Host Memory Consumption [ + ] |

**Sidebar navigation:**

▲ Apply Filters ❓

▶ Time Filter ❓
Applied : 2020-01-27 06:43:06 - 2020-02-10 12:00:00
Available : 2020-01-27 06:43:06 - 2020-02-10 12:00:00

- 📊 Timeline
- ⚙ System Info
- ▲ 📁 Browse Files
  - 📋 List Files
  - ▲ 📁 By Directory
    - ▶ 📁 uc
  - ▲ 📁 By File Type
    - ▶ 📁 Clusterware (209)
    - ▶ 📁 Database (1959)
    - ▶ 📁 Exawatcher/OSW (21)
    - ▶ 📁 OS (2)
    - ▶ 📄 TFA (1122)
    - ▶ 📄 Generic (1703)
  - ▲ 📁 By Host
    - ▶ 📁 SELIICBL00433-RAC1 (74)
    - ▶ 📁 seliicbl00433-rac1 (3179)
    - ▶ 📁 Unknown Host Files (1763)
  - ▲ 📁 By Database
    - ▶ 📁 EOCECM (10)
    - ▶ 📁 BSCS (52)
    - ▶ 📁 Unknown (3109)
    - ▶ 📁 bscs (197)
    - ▶ 📁 eocecm (1648)
  - ▲ 📁 By Collection
    - ▶ 📁 TFA
- ▲ 📁 Analyzers
  - 📑 Block Dump Analyzer
  - 📑 Cluster Health Advisor
  - 📑 Instance Eviction
  - 📑 Node Eviction

# Analyze AHF Diagnostic Collections in MOS

Give Feedback...

## ORA-00600-Troubleshooting Tool

■ ——————— ☐ ——————— ☐                     Back    Step 1 of 3    Next    Cancel
**Describe Problem**    Upload Files    Review Recommendations

## What is the Problem? ❓

What would you like to do ?    ◉ Troubleshoot a new issue

                                ○ Review a troubleshooting report    [                    ▾]

### ☑ Tip

This tool will provide recommendations to resolve ORA-600 issues based on details found in the uploaded IPS or Trace/Incident files. Click Document 1521912.1 to see why you should use this tool!

To fully benefit from this tool all requested files should be uploaded to this tool. For details regarding the requested files and how to obtain them, see Document 1521912.1 (ORA-600 Troubleshooting Tool).

If you don't have a trace file please use the Document 153788.1 (ORA-600 / ORA-7445 Error Look-up Tool).

Press the NEXT button to continue.

Guided Resolution is always available from

Dashboard    Knowledge    Service Requests    Patches & Updates    More... ▾    ⭐▾    🕐▾    🔍

## ORA-00600-Troubleshooting Tool

☐————————◼————————☐          Back    Step 2 of 3    Next    Cancel
Describe Problem    **Upload Files**    Review Recommendations

### Upload Files

Choose the radio button for one of the below sets of requested files to use for troubleshooting
-Diagnostic files will be analyzed and a personalized solution will be provided if exists
-SR fields will be automatically populated if you choose to create an SR

Click the UPLOAD button after choosing files from your local file system to use for troubleshooting.

Refer to Document 1521912.1 to see why you should use this tool.

**Note:** Do not submit any personal information of European residents, protected health information subject to HIPAA, or any other sensitive personal information (such as payment card data) that requires protections greater than those specified in the Oracle GCS Security Practices.

Select File Group    ◉    * TFA package (Recommended approach.)  ⓘ    Choose File  myserver69....C_2018.zip

Select File Group    ○    * IPS Package  ⓘ    Choose File  No file chosen

Select File Group    ○    * tracefile  ⓘ    Choose File  No file chosen
                          Alertlog(Optional)  ⓘ    Choose File  No file chosen

### ☑ Tip

To obtain the most accurate diagnosis, upload the requested files.

Ensure you are uploading the correct files from the instance in which you are having issues. File upload combinations are:

- TFA is the recommended approach and will gather all relevant diagnostics for the problem using one command **"tfactl diagcollect -srdc ora600"**. For more information refer to TFA Document Document 2165632.1
- Incident Packaging Service (IPS) package or any archive file containing trace files with the error
- Alert log AND Incident dump file (Release 11g or higher)/Trace file (Prior to Release 11g)

For details regarding the requested files and how to obtain them, see Document 1521912.1 (ORA-600 Troubleshooting Tool).

Dashboard | Knowledge | Service Requests | Patches & Updates

More... ▼   ☆▼   ⏱▼   🔍

Give Feedback...

## ORA-00600-Troubleshooting Tool

☐————☐————■
Describe Problem    Upload Files    **Review Recommendations**

Back | Step 3 of 3 | Finish | Restart

### Troubleshoot a new issue: ORA-00600

Enter a report name and click 'Save'  [＿＿＿＿＿]  Save

Copyright (c) 2018, Oracle. All rights reserved. Oracle Confidential.

☆ **ORA-600 [ktfbtgex-7] "Bitmap Managed Extent goes past end of file" (Doc ID 178643.1)**  ⌄ To Bottom

Modified: 04-Aug-2018    Type: REFERENCE      +/-  ✉  ⬈  🖨

Note: For additional ORA-600 related information please read Document:1092832.1

This article represents a partially published OERI note.

It has been published because the ORA-600 error has been reported
in at least one documented bug and/or confirmed Support Related Article.

Therefore, the SUGGESTIONS section of this article may help
in terms of identifying the cause of the error.

### ☑ Tip

Based on the data available, it was not possible to identify a known bug or solution. A knowledge document containing details for the error is provided when available. In most cases the knowledge document will contain a list of known bugs which have been resolved for the error.

For further assistance click on the 'Create SR' button below to log an SR with Oracle Support.

Help us improve this tool by providing feedback using the feedback form on this page.