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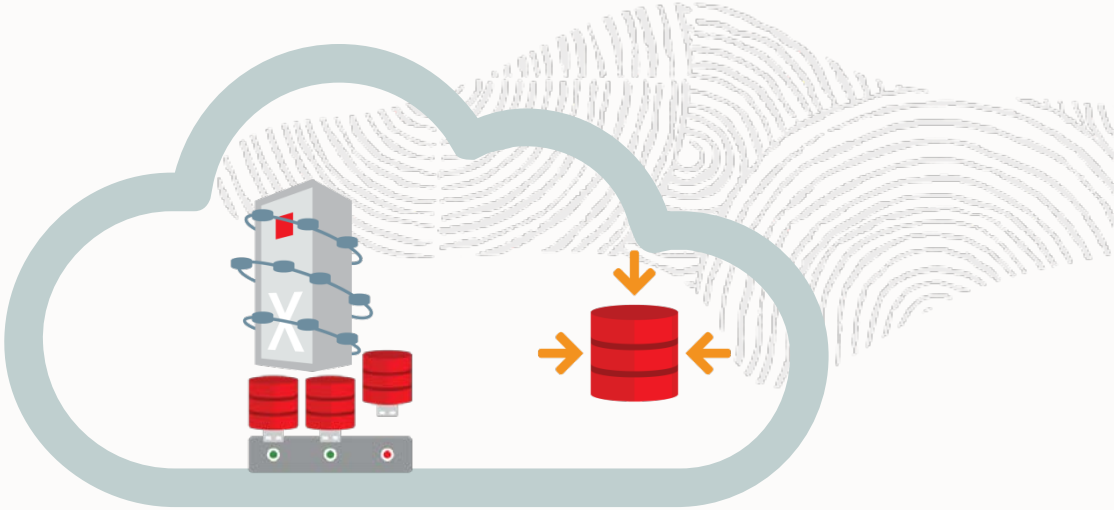

ExaCS Database Backup and Restore with Object Storage Performance Observations

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Agenda

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3. Backup and Restore Throughput Summary
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Goals

Provide backup and restore performance results based on default settings and optional higher RMAN parallelism

Results from MAA and Cloud development

Configuration Details

RMAN/Backup/Restore

- Backup location: Object Storage Service
- Level 0 backups with section size 64GB, filesperset 1[1]
- Compression: Tested with OFF vs RMAN LOW[1]
- Backup channels use SCAN service to spread across RAC[1]
  - **For these observations**, backups channel allocation was based on OCPU count
  - Refer to Appendix A for recommended BACKUP channel counts and modification details.
- Restore RMAN channels use one database node[1]
  - **For these observations**, the restore was executed outside the DBaaS tooling: A manual restore run block was configured to use SCAN instances or TNS alias across the RAC with 2 * backup channels.
  - Refer to Appendix B for manual run block RESTORE examples.

[1] Current defaults for DBaaS tooling

Configuration Details

Shape 1: Environment configuration – ExaCS Full Rack (X7-2)

- Database: 8 Node RAC CDB (RDBMS 19.7)
- With 40 PDBs: Used space of ~70+TB : TDE : No RDBMS compression
- OLTP workload: Total of ~98K+ TPS against the PDBs – running from two clients.
- 2 iterations: @ 368 OCPUs

Shape 2: Environment configuration – ExaCS Quarter Rack (X7-2)

- Database: 2 Node RAC CDB (RDBMS 19.7)
- With 2 PDBs: Used space of ~7 TB : TDE : No RDBMS compression
- OLTP workload: Total of ~5K+ TPS against the PDBs – running from one client.
- 3 iterations each: @ 92, 48 & 24 OCPUs

Backup and Restore Throughput Summary

Backup Throughput Summary

Configuration	Low Impact[1] Approximate < 5% CPU overhead	Medium Impact[1] Approximate < 10% CPU overhead	High Impact[1] Approximate < 25% CPU overhead
ExaCS Full Rack 368 CPUs	14 TB/hour[2]	19.6 TB/hour	33.0 TB/hour
ExaCS ¼ Rack 92 CPUs	5.4 TB/hour	9.3 TB/hour	13.7 TB/hour
ExaCS ¼ Rack 48 CPUs	2.8 TB/hour	5.3 TB/hour	9.2 TB/hour
ExaCS ¼ Rack 24 CPUs	1.3 TB/hour	2.6 TB/hour[3]	4.8 TB/hour[3]

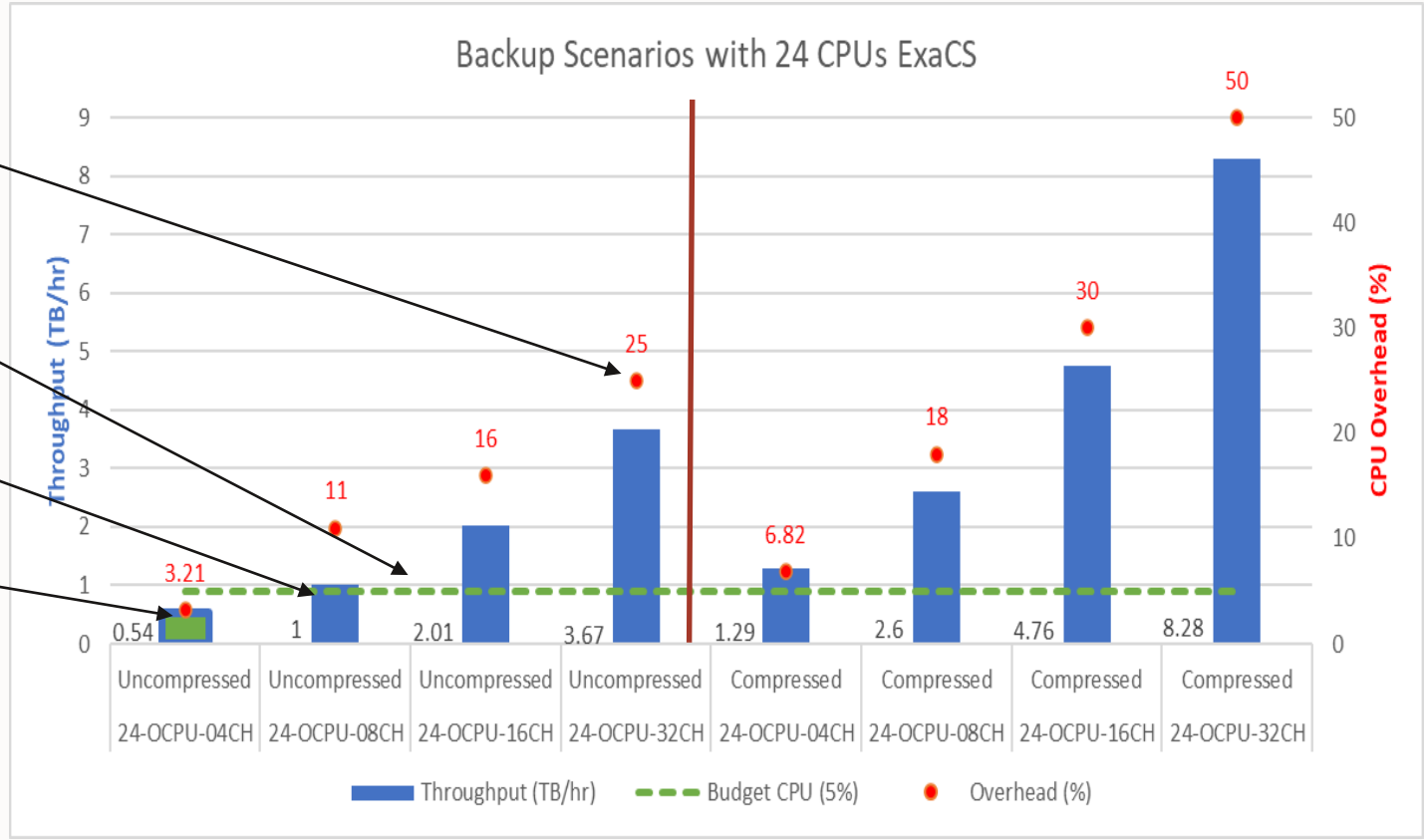
Restore Throughput Summary

Configuration	Low Impact[1] Approximate < 10% CPU overhead	Medium Impact[1] Approximate < 25% CPU overhead	High Impact[1] Approximate < 50% CPU overhead
ExaCS Full Rack 368 CPUs	28.0 TB/hour	31.0 TB/hour	31.0 TB/hour
ExaCS ¼ Rack 92 CPUs	12.8 TB/hour	17.8 TB/hour	24.1 TB/hour[2]
ExaCS ¼ Rack 48 CPUs	8.3 TB/hour	14.1 TB/hour	18.3 TB/hour
ExaCS ¼ Rack 24 CPUs	4.4 TB/hour	8.8 TB/hour	14.0 TB/hour

[1] Low, Medium & High impacts are based on channels allocation in Appendix A & B
[2] Throughput numbers for these cells are not reflected in the result charts
[3] Impact exceeds CPU Overhead, see result charts

Reading the Result Charts

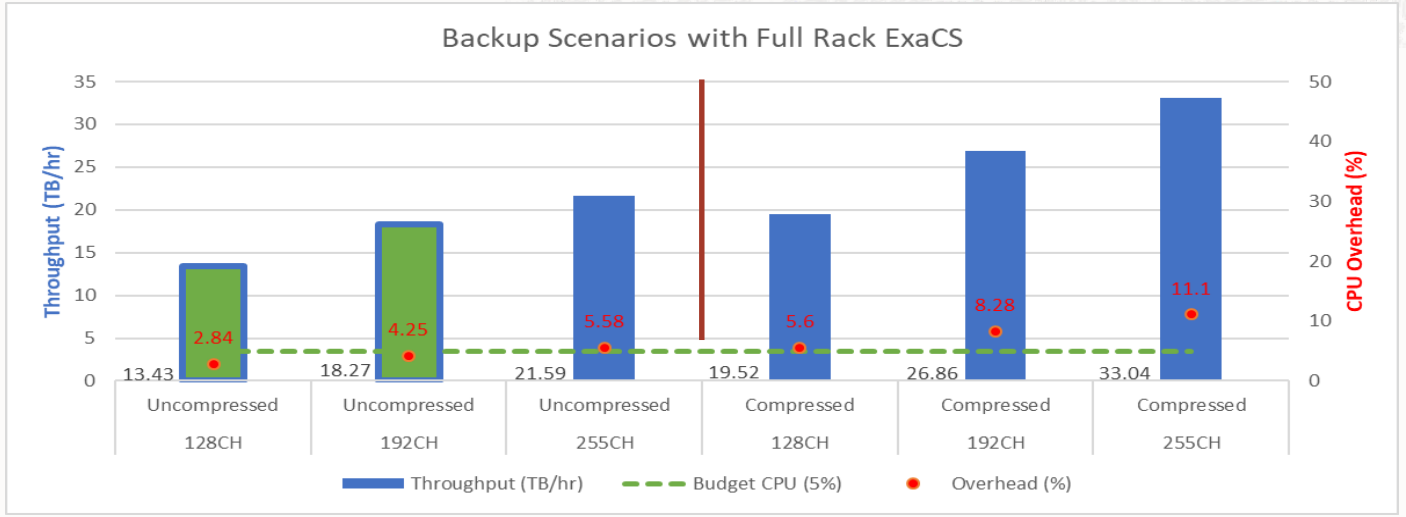
- Each test was performed three times to eliminate any possible outlier.
- The red dots represents the CPU overhead – averaged per node across the cluster, as percentage
- The green line is the Low Impact 5% targeted CPU
- The blue bar represents the total throughput (TB/hr) across the cluster.
- A green fill within the blue bar represents an acceptable result – CPU overhead is approximately 5% or less
- RMAN compression runs shown to the right of the red bar

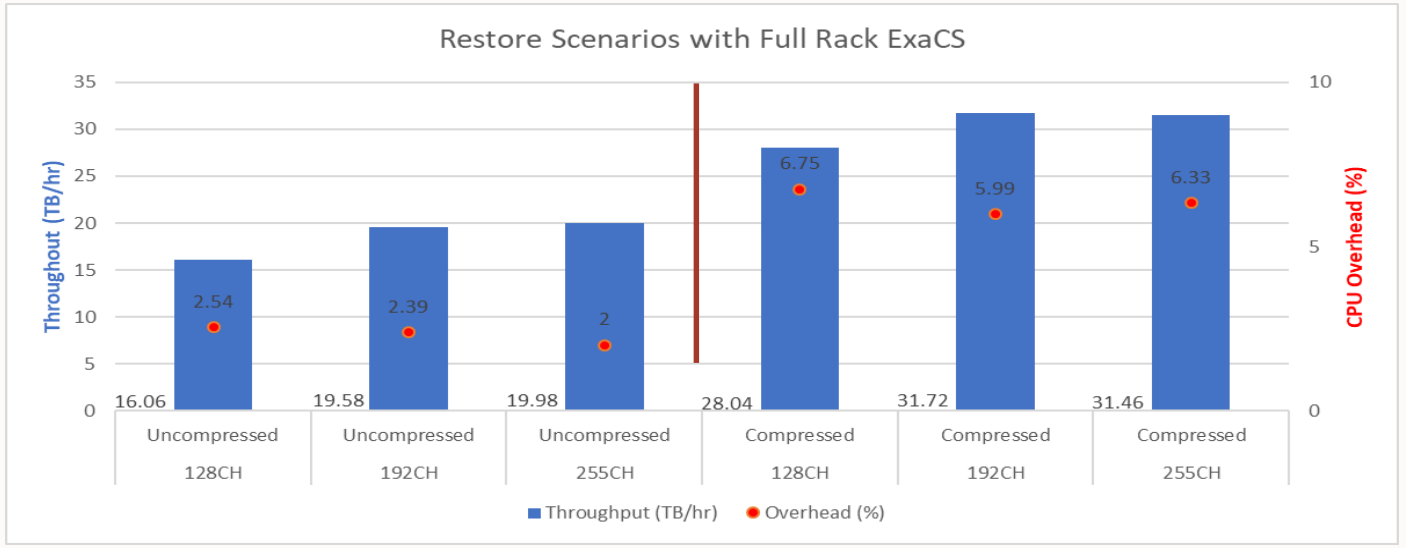


ExaCS full rack – 368 OCPUs per cluster

Observations

- Backup: 64 channels total + compression
  1. 14 TB/hour
  2. Less than 4% CPU overhead
- Restore: 128 channels total (compressed)
  1. 28 TB/hour
- Effective backup rates for incremental backups can be 2-10X depending on change rate
- To improve backup or restore rates, increase RMAN channel parallelism with trade off of higher CPU and IOPS utilization

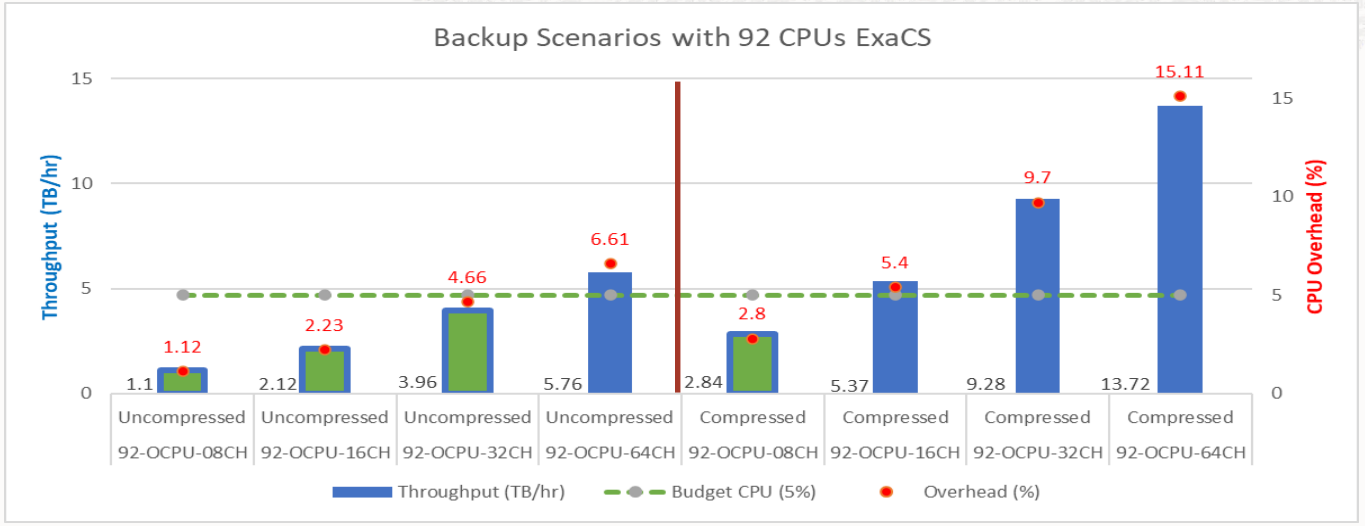


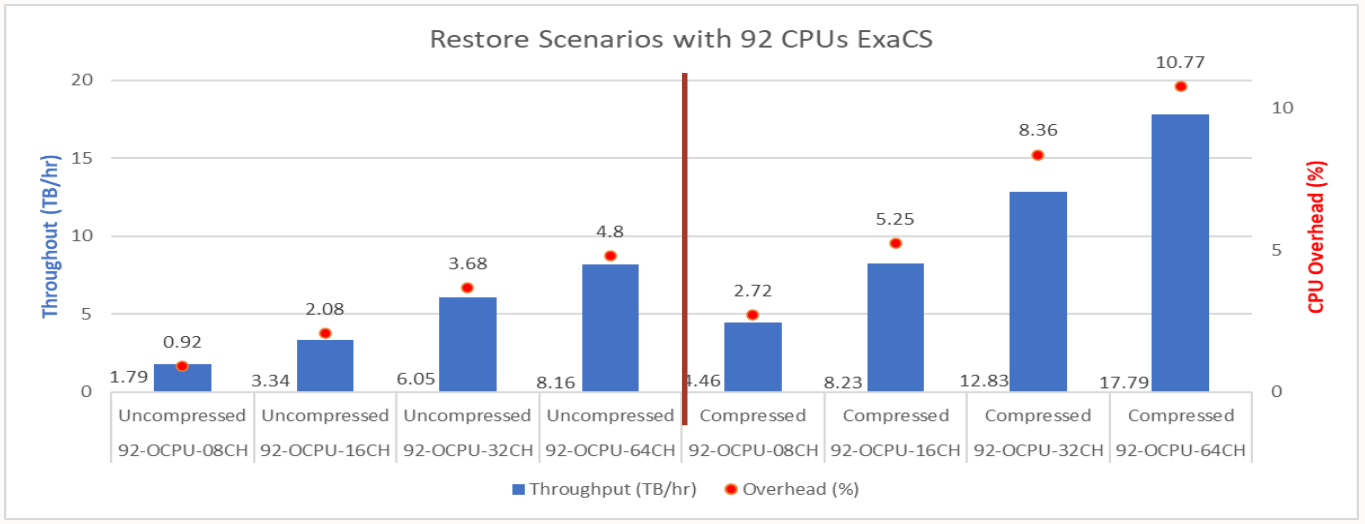


ExaCS quarter rack - 92 OCPUs per cluster

Observations

- Backup: 16 channels total + compression
  1. 5.4 TB/hour
  2. Less than 6% CPU overhead
- Restore: 32 channels total (compressed)
  1. 12.8 TB/hour
- Effective backup rates for incremental backups can be 2-10X depending on change rate
- To improve backup or restore rates, increase RMAN channel parallelism with trade off of higher CPU and IOPS utilization

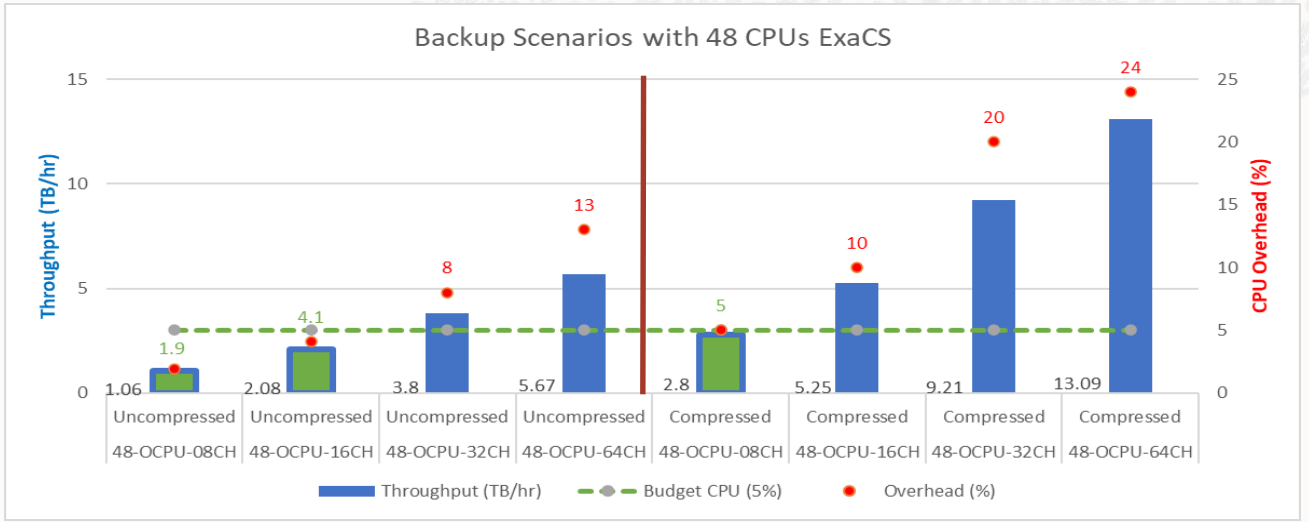


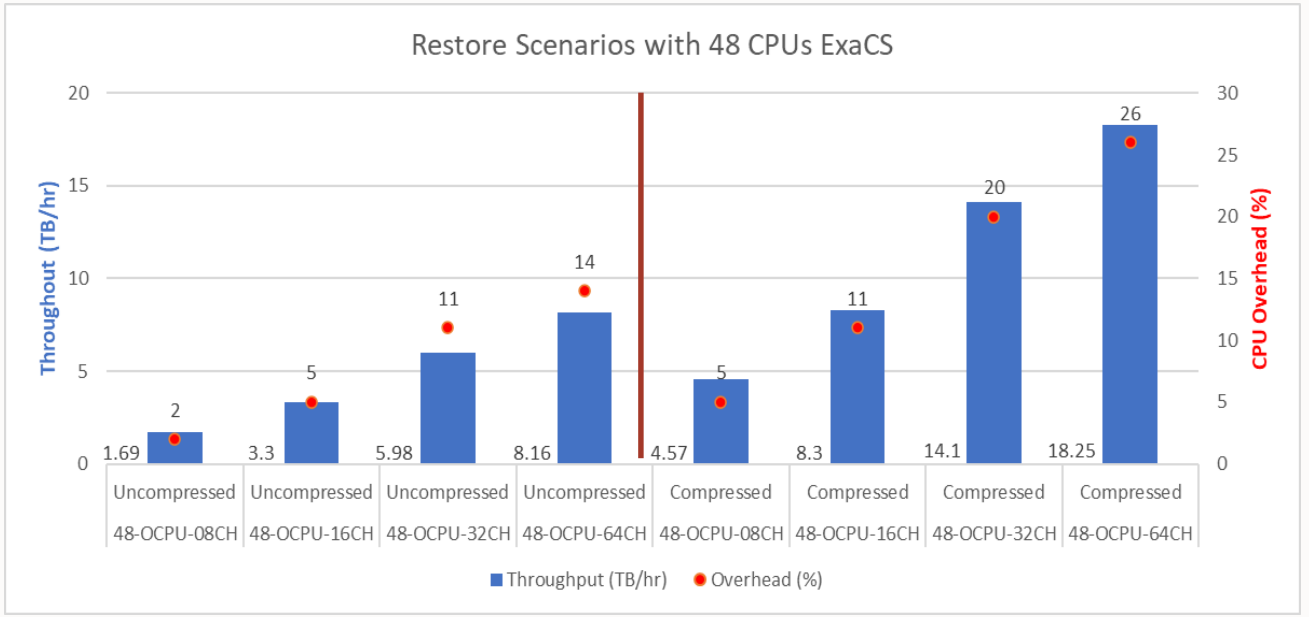


ExaCS quarter rack - 48 OCPUs per cluster

Observations

- Backup: 8 channels total + compression
  1. 2.8 TB/hour
  2. Less than 5% CPU overhead
- Restore: 16 channels total (compressed)
  1. 8.3 TB/hour
- Effective backup rates for incremental backups can be 2-10X depending on change rate
- To improve backup or restore rates, increase RMAN channel parallelism with trade off of higher CPU and IOPS utilization

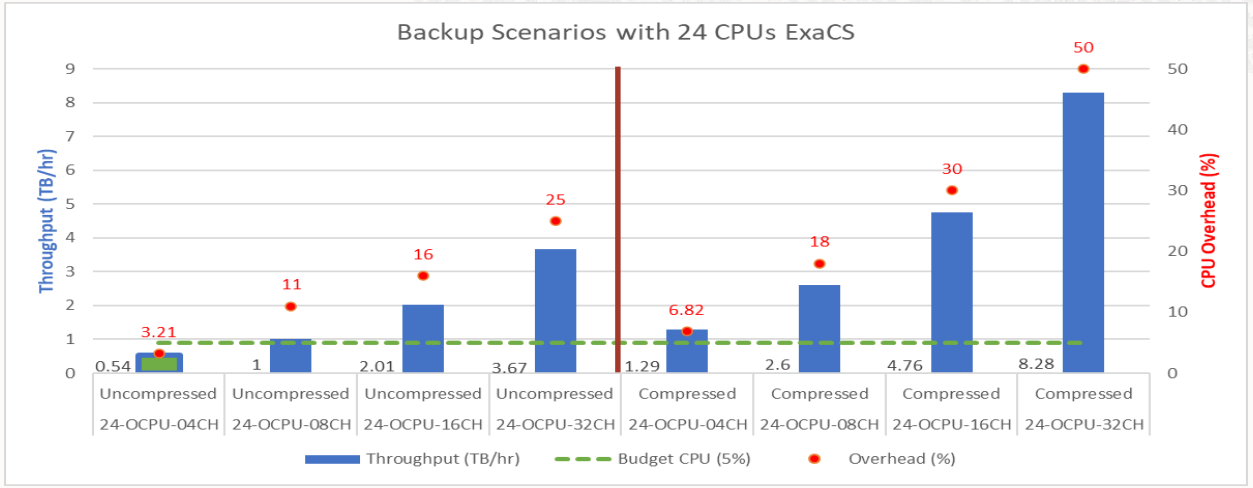


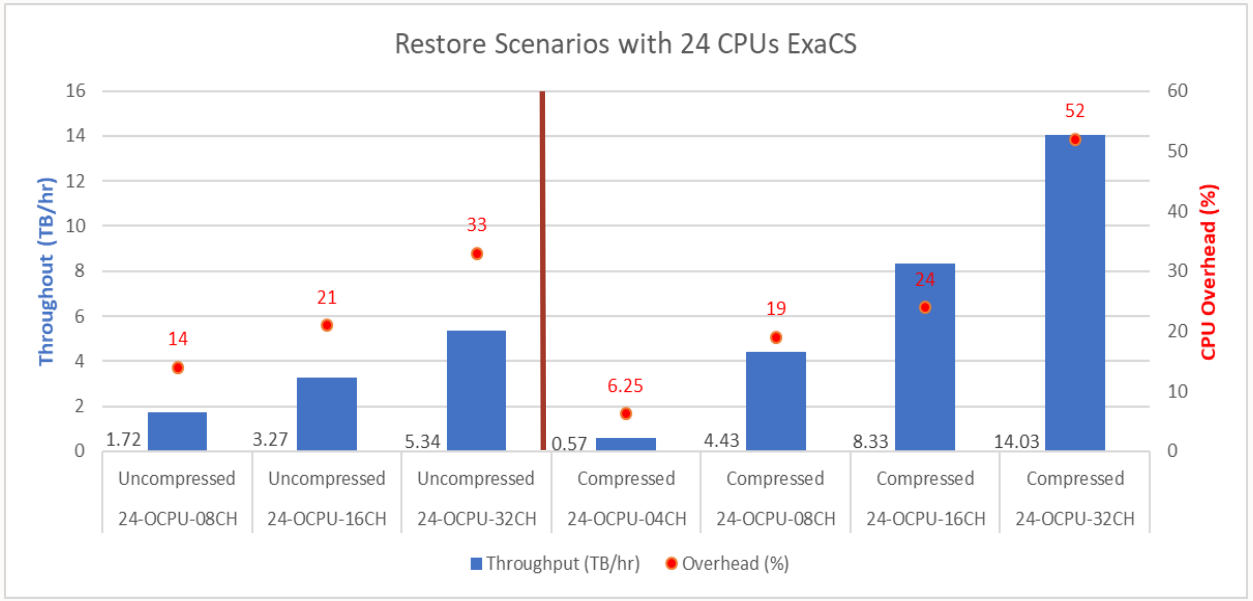


ExaCS quarter rack - 24 OCPUs per cluster

Observations

- Backup: 4 channels total + compression
  1. 1.3 TB/hour
  2. Less than 7% CPU overhead
- Restore: 8 channels total (compressed)
  1. 4.4 TB/hour
- Effective backup rates for incremental backups can be 2-10X depending on change rate
- To improve backup or restore rates, increase RMAN channel parallelism with trade off of higher CPU and IOPS utilization





Appendix A

Changing RMAN channel parallelism: backups

- Follow the documentation to modify bkup_channels_node
  - Guidance for setting the value of bkup_channels_node

OCPU Criteria per database node	RMAN Channels Low Impact[1]	RMAN Channels Medium Impact	RMAN Channels High Impact
OCPU per node > 24	8	16	32
12 < OCPU per node <= 24	4	8	16
6 < OCPU per node <= 12	2	4	8
OCPU <= 6	1	2	3

[1]-Recommended channel settings

Appendix B

Changing RMAN channel parallelism: restore

- Allocate channels across all nodes using CONNECT clause
- Allocate twice the number of channels used by BACKUP.

Example of an RMAN RESTORE VALIDATE:

```
RUN
{
ALLOCATE CHANNEL SBT_01 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/service as sysdba';
ALLOCATE CHANNEL SBT_02 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/service as sysdba';
.
.
ALLOCATE CHANNEL SBT_16 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/service as sysdba';
ALLOCATE CHANNEL SBT_16 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/service as sysdba';
RESTORE DATABASE VALIDATE;
}
```

Example of an RMAN RESTORE / RECOVER to latest:

```
RUN
{
ALLOCATE CHANNEL SBT_01 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/inst1 as sysdba';
ALLOCATE CHANNEL SBT_02 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/inst2 as sysdba';
.
.
ALLOCATE CHANNEL SBT_16 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/inst1 as sysdba';
ALLOCATE CHANNEL SBT_16 DEVICE TYPE SBT parms='SBT_LIBRARY=/path_to/libopc.so, ENV=(OPC_PFILE=/path_to/opcDB.ora)' CONNECT 'sys/****@scan/inst2 as sysdba';
RESTORE DATABASE;
RECOVER DATABASE;
}
```

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