Oracle Database

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USCellular

United States Cellular Corporation provides a comprehensive range of wireless products and services, excellent customer support, and a high-quality network to 5.0 million customers in 23 states. The Chicago-based company had 7,000 full- and part-time associates as of June 30, 2013.

2012 Customer Service Champion Award

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Who am I?

Lead Infrastructure Architect at USCellular

Oracle OCP since Oracle 7

Member of the IOUG Conference Committee

- Infrastructure Track Member 2011
- Infrastructure Track Lead 2012
- Engineered System Manager 2013

IOUG Collaborate Speaker 2012 & 2013

Contributor to IOUG's Exadata Tip Booklet

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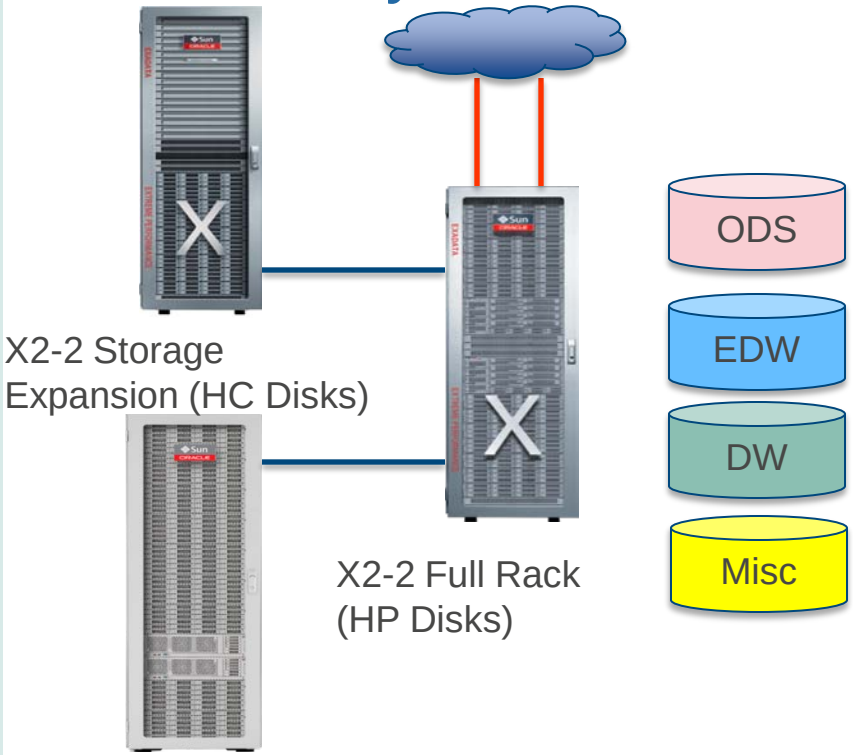
Exadata System



4 Databases

ODS – Primary loaded via GoldenGate, some batch loading. Mixed workloads on access. Majority of workload on server.

EDW – Warehouse with atomic layer in 3NF with some star schema built in

DW – Traditional Warehouse, star schema.

Misc – Small adhoc workload

All Databases are

- Multi-instance
- Have Physical Standby's
- Backed up to the ZFFSA

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Previous Solution – ODS Only

10gR2 Database built around Oracle's Reference Architecture

Monolithic Unix Server
- 24 cores,
- 384 GB RAM
- 10gE Networking
- 8 8G FC SAN connectivity

Enterprise Grade Storage Array
- 15K SAS drives (short armed disks)
- Lots of cache
- Dedicated to Database

Note: The 2 solutions had similar architectures, loaded via GoldenGate and Informatica and mixed workload applications accessing. The Exadata based system is from a newer billing system, which is 2-3x the amount of changes to load via GG. We also have a lot more applications accessing the ODS. The new workload is larger than what the previous hardware could handle.

What Did We See - Exadata ODS

	Wait		Event		Wait Time			Summary Avg Wait Time (ms)				
I#	Class	Event	Waits	%Timeouts	Total(s)	Avg(ms)	%DB time	Avg	Min	Max	Std Dev	Cnt
*	User I/O	cell single block physical read	109,907,413	0.00	163,574.19	1.49	42.67	2.68	1.03	6.34	2.12	6
		DB CPU			103,236.10		26.93					6
	User I/O	cell smart table scan	7,569,597	38.00	39,383.62	5.20	10.27	5.44	4.09	7.95	1.71	6
	User I/O	cell list of blocks physical read	1,840,214	0.00	17,490.27	9.50	4.56	12.23	1.56	40.87	14.54	6
	Configuration	free buffer waits	561,823	0.00	17,171.88	30.56	15.02	30.56	30.56	30.56		1
	User I/O	direct path read	3,970,516	0.00	12,722.28	3.20	3.32	4.84	0.81	7.15	2.70	6
	Administrative	Backup: MML write backup piece	4,464,570	0.00	11,318.13	2.54	2.95	2.70	1.52	3.50	0.77	6
	Administrative	Backup: MML create a backup piece	83	0.00	4,666.91	56215.78	1.22	68356.68	52790.56	104085.18	22729.19	6
	User I/O	direct path write temp	63,712	0.00	3,932.20	61.72	1.03	56.29	15.49	89.46	28.88	6
	System I/O	db file parallel write	488,771	0.00	3,917.23	8.01	1.02	9.85	4.50	17.15	4.59	6

What? Writes are supposed to be fast! Wait until later slides.

	Reads MB/sec			Writes MB/sec				Reads requests/sec			Writes requests/sec			
I#	Total	Buffer Cache	Direct Reads	Total	DBWR	Direct Writes	LGWR	Total	Buffer Cache	Direct Reads	Total	DBWR	Direct Writes	LGWR
1	421.08	93.77	288.43	2.58	0.93	0.57	0.63	13,626.77	11,869.15	582.90	134.81	84.79	4.22	38.60
2	400.24	140.96	204.98	20.87	1.46	19.07	0.14	19,320.78	18,023.39	1,224.78	370.41	179.05	158.39	28.60
3	93.63	1.91	1.89	5.44	1.31	0.98	2.03	348.29	202.73	44.90	64.07	28.85	4.20	27.61
4	23.22	1.60	2.38	17.21	3.48	2.38	7.63	74.30	35.66	10.41	132.27	80.21	9.86	35.92
5	69.49	0.04	0.54	0.61	0.01	0.54	0.02	85.12	1.68	4.13	32.32	0.92	3.95	25.24
6	160.77	68.10	0.00	208.74	92.81	0.18	77.59	8,834.21	8,715.62	0.16	10,258.19	9,871.10	21.63	285.09
Sum	1,168.43	306.39	498.23	255.45	100.01	23.71	88.03	42,289.47	38,848.23	1,867.27	10,992.07	10,244.91	202.25	441.06
Avg	194.74	51.06	83.04	42.58	16.67	[illegible]	14.67	7,048.24	6,474.71	311.21	1,832.01	1,707.49	33.71	73.51

1.49 ms single block reads

While doing 42K read IOPS and 11K write iops over an hour period.

Note: The other databases were active on the Exadata System during this time.

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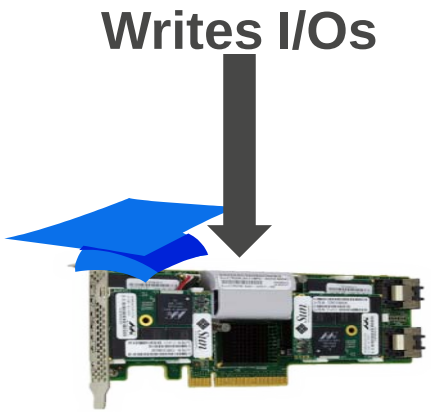
Comparison to Old system

Metric	Exadata ODS	Monolithic Hardware ODS	Comparison
Single Block Reads	1.5 ms	3.8 ms	> 2x
Log File Synch Waits	.85 ms	5.7 ms	> 6x

Note: The Exadata ODS is over twice the workload as the previous version. In addition, the Exadata system is shared with several databases, while the Monolithic Hardware was dedicated.

Write Back Flash Enablement



Design to accelerate write intensive workloads.

From previous slide, we had lots of “free buffer waits”.

Enabled this feature on X2-2.

Result: No more “free buffer waits”.

I#	Class	Event	Waits	%Timeouts	Total(s)	Avg(ms)	%DB time	Avg	Min	Max	Std Dev	Cnt
*	User I/O	cell smart table scan	14,284,936	53.33	230,906.11	16.16	35.90	24.30	9.53	60.09	19.12	6
	User I/O	cell single block physical read	48,230,613	0.00	219,661.68	4.55	34.15	7.15	3.51	21.00	6.82	6
		DB CPU			75,069.31		11.67					6
	User I/O	direct path read	4,699,822	0.00	54,744.99	11.65	8.51	9.98	4.34	19.87	5.84	6
	Cluster	gc buffer busy acquire	268,463	0.00	14,779.13	55.05	2.30	867.60	15.56	2118.01	954.84	6
	System I/O	log file sequential read	85,273	0.00	11,675.35	136.92	1.82	108.10	34.63	141.03	41.74	6
	Administrative	Backup: MML write backup piece	1,935,436	0.00	8,092.09	4.18	1.26	4.26	3.80	4.50	0.25	6
	Cluster	gc cr block lost	5,598	0.00	6,836.16	1221.18	1.06	1044.20	662.23	1253.03	294.07	6
	Cluster	gc current block busy	10,084	0.00	6,637.47	658.22	1.03	453.70	18.65	1128.37	387.97	6
	User I/O	direct path read temp	158,540	0.00	6,588.04	41.55	1.02	57.56	30.41	84.71	38.39	6

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Maintenance Activities

Preventative Maintenance Operations

- Battery replacement
- Proactive disk replacement

Unplanned Operations

- Disk Replacement
- Flash Drive Replacement
- Motherboard Replacements

Patching

- All patches for over a year…

All Have Been Done in a Rolling Fashion!

What This Means to Us

More Flexibility in System Use

- We are less concern about unplanned activities on the system. The users can go after the system when they need to, not during certain windows.
- Maintenance activities have less impact on system availability.

More Use of the Data

- Exadata's Flash reduces the i/o contention of the mixed workloads within the database and between competing databases
- More concurrent users mean more business questions being answered.

Faster Access to the Data

- Faster I/O means less time waiting for queries to return, more time to analyze the results