



Five Steps to Reducing Storage Costs

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Despite falling hardware prices, the overall cost of storage continues to go up. As environments become increasingly complex with more robust service level agreement (SLA), security, data protection and compliance requirements, the time, effort, and budget required to manage these environments is skyrocketing.

There are ways of reducing the overall cost of owning storage, however. This includes understanding the current state of storage environments, reclaiming unused capacity, improving optimization and utilization, enhancing the intelligence and visibility into environments and curbing out-of-control storage consumption by users.

This white paper will discuss:

- Five ways organizations can reduce the overall cost of storage
- Examples from Veritas APTARE IT Analytics™ in applying these lessons
- Next steps in getting a better handle on storage growth, management and economics

WHAT DO I SAVE BY REDUCING STORAGE GROWTH?

The top priority for businesses today is to reduce spending growth, and, not surprisingly, storage is often identified as a key target, accounting for 60 percent of the total IT budget. At the same time, capacities are growing on average by around 30 percent, pushing spending ever higher.

Many organizations have implemented new technologies to slow the growth of storage costs but in most cases have found that it only makes a short-term impact and often has the unwanted side effect of increasing spending in other areas. Adding complexity to the storage infrastructure almost always results in new challenges in managing growth.

Addressing these challenges with an existing storage vendor or engaging a new supplier can result in a better short-term deal but, as always, the storage vendors' agendas are often tied to selling more storage and services.

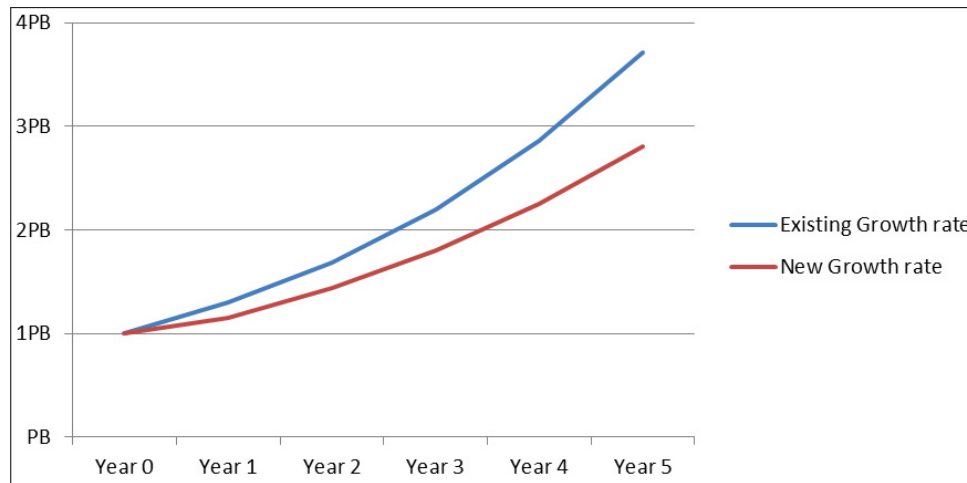
APTARE IT Analytics helps clients get their storage under control by achieving better visibility throughout the storage infrastructure while identifying ongoing improvements and better utilization and reducing risk to the business. APTARE IT Analytics is the software platform that helps organizations constantly manage their storage costs and provide valuable data and insight to drive new storage projects.

By adopting a phased approach, APTARE IT Analytics has helped organizations achieve significant savings with existing infrastructure and provide an understanding of whether new technologies will bring benefit before having to invest.

Even small reductions in growth will compound over multiple years and create significant savings.

Starting with 1 petabyte of storage capacity, organizations can reduce storage growth from 30 percent down to 25 percent while providing a cumulative savings of nearly 1PB over 5 years.

Now imagine the additional cost incurred for that extra storage and you will see why the APTARE IT Analytics solution makes sense. All of these savings are achieved without incurring additional risk to the business from running out of storage.



Reducing Storage Growth: The Veritas APTARE IT Analytics Phased Approach

APTARE IT Analytics enables partners to deliver immediate and measurable return on investment (ROI) as well as continual savings over a sustained period of time.

A typical project will follow most if not all of the following phases:

1. **Base-lining the current storage infrastructure** and understand the current state of storage infrastructure, including utilization rates and growth patterns.
2. **Easy reclamation targets** by identifying obvious areas of savings through reclamation of unused or under-utilized storage.
3. **Improve Optimization and Utilization** rates without additional risks by visualizing storage usage and connectivity in near real time.
4. **Infuse Intelligence throughout Storage Operations** and implement phases for better capacity planning and provisioning.
5. **Improve Storage consumption** behavior through an effective chargeback or showback project.

1) BASE-LINING THE CURRENT STORAGE INFRASTRUCTURE

Before you can start reducing storage costs and growth, you need understand what the storage environment looks like today, what business unit is using the storage, and what is responsible for the growth.

You need to be able to answer the following questions:

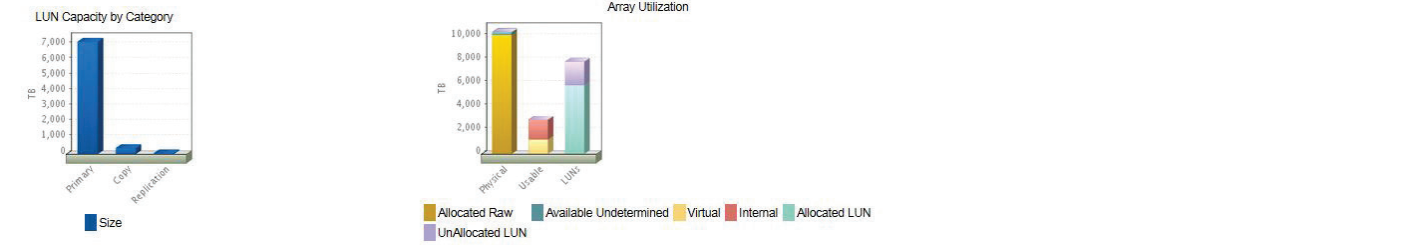
- How much storage do I currently have? How much is available? Used?
- How is the storage divided by tier? How much is available by tier?
- How much storage is each Business Unit/Department using? Which storage tier?
- How efficiently is the storage utilized? By storage tier? How much do I lose to overhead?
- Can I drill-down to more detailed information?

Without this critical information and constant measurement, it can be difficult to know where to focus and whether efforts are helping.

A good starting point to understand your current environment is an overview of all storage arrays in the environment (Figure 1 - Array Executive Summary). This single-pane-of-glass view shows total storage, available storage, how effectively you have utilized thin provisioning, and how that storage has been allocated by tier—and the information is sorted by vendor. A more detailed view combines multiple reports into a single dashboard to help develop a complete picture of storage usage (Figure 2 - Array Utilization Dashboard). This tells you if you already have enough available storage to avoid a near term storage purchase.

Vendor Name	Raw		Usage			Protection			Efficiency			Tier				
	Capacity	Frames	Total Usable	Used	Available	Primary	Replica	Thick	Thin	Overprov	Tier 1 Policy	Tier 1 Capacity	Tier 2 Policy	Tier 2 Capacity	Tier 3 Policy	Tier 3 Capacity
DELL	74.23 TB	2	43.09 TB		0.00 TB	43.09 TB	0.00 TB	43.09 TB	0.00 TB	0.00%		0.00 TB		0.00 TB		0.00 TB
EMC	634.84 TB	8	460.35 TB		220.22 TB	445.38 TB	14.97 TB	255.13 TB	205.22 TB	42.65%	AMS-Chrgbk-Policy	0.00 TB	Platinum	0.00 TB	Gold	0.00 TB
HDS	8,488.06 TB	61	952.85 TB		1,851.29 TB	N/A	1,225.56 TB	N/A	3,547.92 TB	88.81%	AMS-Chrgbk-Policy	27.98 TB	Platinum	3,193.10 TB	Gold	144.18 TB
HP	318.75 TB	5	184.42 TB		50.56 TB	184.42 TB	0.00 TB	184.33 TB	0.09 TB	3,277,333.33%		0.00 TB		0.00 TB		0.00 TB
IBM	239.49 TB	3	110.40 TB		56.32 TB	110.40 TB	0.00 TB	39.45 TB	70.95 TB	0.00%	AMS-Chrgbk-Policy	0.00 TB	Platinum	0.00 TB	Gold	0.00 TB
NETAPP	511.02 TB	17	0.03 TB		0.02 TB	0.03 TB	0.00 TB	0.03 TB	0.00 TB	0.00%		0.00 TB		0.00 TB		0.00 TB
	187.53 TB	2	76.41 TB		33.56 TB	76.41 TB	0.00 TB	76.41 TB	0.00 TB	0.00%		0.00 TB		0.00 TB		0.00 TB
	10,433.91 TB	98	1,927.56 TB		2,211.97 TB	859.74 TB	1,240.53 TB	598.44 TB	3,824.18 TB			27.98 TB		3,193.10 TB		144.18 TB

Figure 1 - Array Executive Summary



Array Utilization Summary

Total Row(s): 1

Physical / RAID				Usable							LUNs			
Raw Capacity	Configured RAID	# RAID Groups	Internal Capacity	Virtualized Capacity	External Capacity	Total Capacity	Used Capacity	Free Capacity	Free Thin Capacity	# LUNs	Total Capacity	# Allocated	Allocated Capacity	
10,433.91 TB	10,183.19 TB	7,752	1,704.06 TB	1,086.23 TB	1,225.54 TB	2,808.64 TB	2,322.58 TB	423.90 TB	1,733.78 TB	91,502	7,911.54 TB	47,404	5,859.62 TB	

Chargeback Policy Capacity

Total Row(s): 5

Policy	Cost Per GB	RAID					LUNs			Thin Provisioned		
		Total Capacity	Virtual Capacity	Local Capacity	Used	Available	Total	Allocated	UnAllocated	Total	Used	Pool Available
AMS-Chrgbk-Policy	\$ 15.00	27.98 TB	0.00 TB	27.98 TB	27.98 TB	0.00 TB	27.98 TB	27.98 TB	0.00 TB	0.00 TB	0.00 TB	0.00 TB
Gold	\$ 25.00	91.15 TB	18.79 TB	94.03 TB	84.04 TB	4.24 TB	144.18 TB	45.88 TB	98.33 TB	1,884.21 TB	1,322.05 TB	562.16 TB
HDS	\$ 17.50	190.17 TB	37.38 TB	155.94 TB	130.84 TB	56.17 TB	304.10 TB	304.06 TB	0.04 TB	310.67 TB	102.38 TB	208.19 TB
Platinum	\$ 50.00	322.90 TB	965.66 TB	331.16 TB	237.23 TB	77.40 TB	3,193.10 TB	2,821.07 TB	372.03 TB	1,188.09 TB	514.67 TB	673.43 TB
Silver	\$ 0.00	0.03 TB	0.08 TB	0.08 TB	N/A	9.36 TB	91.83 TB	89.18 TB	2.64 TB	0.00 TB	0.00 TB	0.00 TB
		632.22 TB	1,021.89 TB	609.10 TB	480.08 TB	147.17 TB	3,761.19 TB	3,288.15 TB	473.05 TB	3,382.87 TB	1,939.09 TB	1,443.78 TB

Figure 2 - Array Utilization Dashboard

Next, it is helpful to view the storage allocation by business entity such as department, business unit, project, or application. APTARE IT Analytics allows you to create any number of these logical business entities and track the storage usage. This allows you to quickly see the amount and type of capacity each application has been allocated by tier (Figure 3 - Business Usage by Application). In this case, we optionally added a cost to the storage usage based on tier.

Finally, you need to track the growth of your storage over time. Historical growth allows you to set a baseline measurement to compare against future growth to determine if policies are making a difference. APTARE IT Analytics allows you to measure growth against anything in your environment, including hosts, arrays, applications, and any business entity. Growth can be shown from an array perspective including forecasted and modeled growth (Figure 4 - Array Growth).

Business Usage By Application Server Group=Global Storage Infrastructure
Nov 4, 2013 2:37:01 PM

Total Row(s): 10

Application	Policy	Cost Per GB	Total Usage	Total Cost
AHU	Bronze	\$ 5.00	316.53 GB	\$ 1,582.63
CRM	Bronze	\$ 5.00	431.29 GB	\$ 2,156.47
DHU	Bronze	\$ 5.00	442.36 GB	\$ 2,211.81
Exchange	Bronze	\$ 5.00	67.99 GB	\$ 339.93
Exchange	Platinum	\$ 50.00	52.97 GB	\$ 2,648.44
SAP	Bronze	\$ 5.00	67.99 GB	\$ 339.93
SAP	Platinum	\$ 50.00	27,899.46 GB	\$ 1,394,972.75
SHS	Bronze	\$ 5.00	4,529.93 GB	\$ 22,649.64
WHS	Bronze	\$ 5.00	101.80 GB	\$ 507.98
eSupport	Bronze	\$ 5.00	644.95 GB	\$ 3,224.75
			34,555.07 GB	\$ 1,430,634.33

Figure 3 - Business Usage by Application

Array Allocated Forecast Jul 1, 2013 12:00:00 AM - Oct 31, 2013 11:59:59 PM

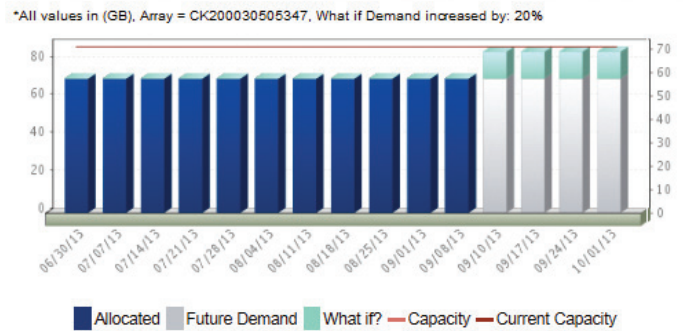


Figure 4 - Array Growth

2) EASY RECLAMATION TARGETS

You've spent a lot of money on your existing infrastructure, and it's safe to say that you'd want to get the most out of it.

Consider the following questions:

- Once I allocate storage, where does it go? How is it used?
- Are any policy changes I make improving my utilization?
- How do we get the server, application, and storage teams all on the same page?
- Where do I start? What are the low hanging fruits?
- How do I buy less storage next year or at least slow my storage growth?

APTARE IT Analytics agentless technology makes it easy to collect information throughout your environment, allowing you to really focus on utilization and making certain you're getting the most out of your existing infrastructure. Reclaiming storage that is under-utilized helps save you immediate money by reducing the amount of storage you'll need to purchase in the future. Since APTARE IT Analytics can see the array, host, AND application views there are many different areas where storage can be reclaimed including:

1. Unallocated LUNs
2. LUNs allocated to a host that haven't been discovered
3. LUNs allocated and discovered but not used
4. LUNs allocated to a decommissioned host
5. Unused space inside a volume group
6. Unused space inside a database such as SQL Server or Oracle
7. Over- and under- provisioned hosts

APTARE IT Analytics provides a dashboard views that summarizes all of the areas of reclamation (Figure 5 - Reclamation Summary). You can run this report across your entire enterprise or by any logical grouping as shown below by application.

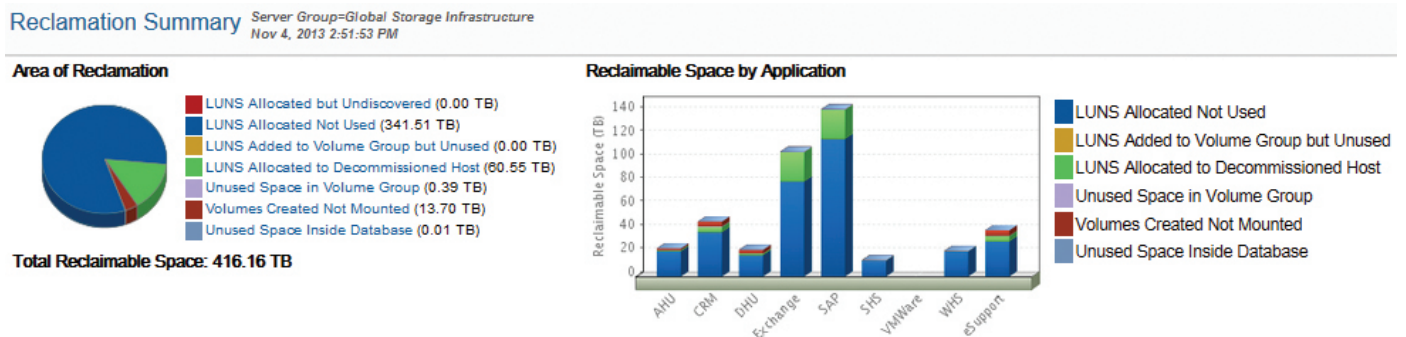


Figure 5 - Reclamation Summary

Unallocated LUNs

Unallocated LUNs are storage that is immediately available. While this information is usually easy to see array by array, it becomes more difficult when you have multiple arrays, locations, vendors, and tiers. APTARE IT Analytics provides a single view that breaks down available storage and available LUNs (Figure 6 - Array Utilization Summary). In addition, the report may show that there might be additional usable capacity available for each array.

LUNs Allocated to a Host That Have not Been Discovered

Probably the easiest storage to reclaim are LUNs allocated to a host. LUN Masking from the array side may have been completed, but the host is unable to "see" the storage for one reason or another. Typically this storage is difficult for storage administrators to find because they can only view the storage from the array perspective. Since APTARE IT Analytics collects from both arrays and hosts, it makes it easy to find storage that the host is unable to utilize. In the view below, the first box on the left highlights storage from the array perspective — LUNs allocated to the host. The second box shows storage from the host perspective or the number of LUNs the host operating system "sees" (Figure 7 - Host Capacity and Utilization).

Total Row(s): 11 - This report has a filter applied

Storage Array	Physical / RAID			Usable			LUNs					
	Raw Capacity	Configured RAID	# RAID Groups	Free Thick Capacity	Free Thin Capacity	# LUNs	Total Capacity	# Allocated	Allocated Capacity	# UnAllocated	UnAllocated Capacity	Total Free Capacity
ETCDH32356	302,759.08 GB	302,759.08 GB	282	2,004.18 GB	0.00 GB	6,524	225,057.75 GB	3,360	173,825.50 GB	3,164	51,232.25 GB	53,236.43 GB
ETCDHVTP3_32343	305,979.92 GB	305,979.92 GB	285	0.20 GB	0.00 GB	273	223,043.56 GB	273	223,043.56 GB	0	0.00 GB	0.20 GB
ETCDHVTP4_32345	305,979.92 GB	305,979.92 GB	285	0.20 GB	0.00 GB	273	223,043.56 GB	226	184,393.42 GB	47	38,650.15 GB	38,650.35 GB
ETCFDHTP6_19454	658,143.10 GB	658,143.10 GB	236	2,542.62 GB	94,027.42 GB	1,583	1,030,046.83 GB	407	339,486.42 GB	1,176	691,100.41 GB	787,730.45 GB
ETCFRRDHDATA2_28123	469,393.73 GB	469,393.73 GB	286	1,230.53 GB	257,055.09 GB	3,746	607,969.04 GB	3,460	257,154.68 GB	286	350,814.36 GB	609,099.99 GB
ETCFRRDHVTP2_28052	901,020.76 GB	901,020.76 GB	362	128.55 GB	285,319.54 GB	2,691	1,463,793.83 GB	625	626,379.80 GB	2,066	837,414.04 GB	1,122,862.12 GB
ETCFRRDHVTP3_48053	901,020.76 GB	901,020.76 GB	362	0.24 GB	266,429.42 GB	1,234	1,573,351.57 GB	340	247,928.28 GB	894	1,325,423.29 GB	1,591,852.95 GB
ETCFUSPVCDDHDATA4_28093	78,506.00 GB	78,506.00 GB	603	2,952.62 GB	158,820.66 GB	13,017	1,023,116.10 GB	0	0.00 GB	13,017	1,023,116.10 GB	1,184,889.38 GB
ETCFUSPVCDDHDATA6_28521	78,506.00 GB	78,506.00 GB	603	6,662.11 GB	355,014.43 GB	10,960	957,312.09 GB	5,398	249,837.50 GB	5,562	707,474.59 GB	1,069,151.14 GB
ETCSM22200	302,759.08 GB	302,759.08 GB	282	2,000.77 GB	0.00 GB	9,476	225,060.66 GB	5,936	142,675.38 GB	3,540	82,385.28 GB	84,386.05 GB
PCCUSP@172.16.1.140	55,145.70 GB	55,145.70 GB	388	7,198.54 GB	0.00 GB	1,394	106,785.03 GB	914	98,030.47 GB	480	8,754.56 GB	15,953.10 GB

Figure 6 - Array Utilization Summary

Total Hosts: 6 - This report has a filter applied

Host	# of Allocated LUNs	Allocated Capacity	# of Used LUNs	Seen by Host	# of Arrays	Related Host	# of Volumes			Volume Capacity					Volume Usage	
							SAN/DAS	NAS	At Risk	Shared	Unshared	Total DAS/SAN	DAS/SAN	NAS	DAS/SAN	NAS
aptare1-external	526	27,899.46 GB	480	25,415.46 GB	3	aptare2	10	6	0	27,846.49 GB	0.00 GB	27,846.49 GB	27,846.49 GB	67.90 GB	22,410.85 GB	40.10 GB
aptare2	526	27,899.46 GB	480	25,415.46 GB	3	aptare1-external	10	7	0	27,846.49 GB	0.00 GB	27,846.49 GB	0.00 GB	70.78 GB	22,377.44 GB	42.01 GB
hds-sun1	19	23.00 GB	0	0.00 GB	1		8		3	0.00 GB	69.51 GB	69.51 GB	69.51 GB	N/A	59.40 GB	N/A
hemera	16	2,946.00 GB	16	2,946.00 GB	2	heracles	5	2	0	2,946.00 GB	0.00 GB	2,946.00 GB	2,946.00 GB	397.57 GB	1,189.30 GB	126.23 GB
heracles	16	2,946.00 GB	16	2,946.00 GB	2	hemera	5	1	0	2,946.00 GB	0.00 GB	2,946.00 GB	0.00 GB	348.33 GB	1,020.49 GB	94.82 GB
phame	31	1,363.59 GB	0	0.00 GB	1		0	0	0	0.00 GB	0.00 GB	0.00 GB	0.00 GB	N/A	0.00 GB	N/A

Figure 7 - Host Capacity and Utilization

LUNs Allocated and Discovered But Not Used

LUNs that the operating system of the host has discovered but hasn't been used can be easy to reclaim as well through APTARE IT Analytics, because the solution provides insight into whether an application (usually a database) is using the storage outside of the operating system. APTARE IT Analytics Host Detail View makes it easy to find the LUNs that are not being used by a host (Figure 8 - Utilization Detail).

LUNs Allocated to a Decommissioned Host

In a medium- to large- sized environment, hosts are added and removed from the environment quite frequently. The problem starts when the storage team is not always alerted to hosts being decommissioned. Over time, considerable amounts of storage can still be allocated to hosts that are no longer present in the environment. APTARE IT Analytics provides a simple view (Figure 9 - Suspected De-Provisioned Hosts) to show storage allocated to hosts that have not been contacted in more than a user defined period of time (three weeks in this example). This is storage that is easily reclaimed.

Allocated and Unused LUNs

Total Row(s): 19

Name	RAID Type	Storage Array	Array Group	Product	Capacity	Host
LUN 14[14]	Disk	CK200030505347	100507,raidGroup 1	CX400	1.00 GB	hds-sun1
LUN 15[15]	Disk	CK200030505347	100507,raidGroup 1	CX400	1.00 GB	hds-sun1
LUN 1[1]	RAID1	CK200030505347	100506,raidGroup 0	CX400	2.00 GB	hds-sun1
LUN 24[24]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 25[25]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 26[26]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 27[27]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 28[28]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 29[29]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 2[2]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 30[30]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 31[31]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 32[32]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 33[33]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 34[34]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 4[4]	RAID1	CK200030505347	100506,raidGroup 0	CX400	4.00 GB	hds-sun1
LUN 5[5]	RAID1	CK200030505347	100506,raidGroup 0	CX400	1.00 GB	hds-sun1
LUN 7[7]	Disk	CK200030505347	100507,raidGroup 1	CX400	1.00 GB	hds-sun1
LUN 9[9]	Disk	CK200030505347	100507,raidGroup 1	CX400	1.00 GB	hds-sun1
					23.00 GB	

Figure 8 - Utilization Detail

Total Row(s): 20 - This report has a filter applied

Name	RAID Type	Array Group	Storage Array	Capacity	Estimated Used	Estimated Available	Mount Point Used	Host	Host LUN	Mount Point	Filesystem	Volume Group	Host Storage Domain	Array Port WWN
1	RAID5(3D+1P)	1-3-1	USP V	401.67 GB	0.06 GB	401.61 GB		hds_win2	0					30:06:0E:80:05:27:95:00
4	RAID5(3D+1P)	1-5-1	USP V	401.67 GB	0.00 GB	401.67 GB		hds_win3	0					30:06:0E:80:05:27:95:00
5	RAID5(3D+1P)	1-6-1	USP V	401.67 GB	0.01 GB	401.67 GB		hds_win1	0					30:06:0E:80:05:27:95:00
6	RAID5(3D+1P)	1-7-1	USP V	401.67 GB	0.00 GB	401.67 GB		hds_ax	0	/aptare1	/dev/rlv00	aptarevg		30:06:0E:80:05:27:95:00
7	RAID5(3D+1P)	1-3-1	USP V	401.67 GB	0.02 GB	401.66 GB		hds_hpux	0					30:06:0E:80:05:27:95:00
8	RAID5(3D+1P)	1-3-1	USP V	401.67 GB	0.05 GB	401.62 GB		hds_linux	0	/aptare1	/dev/sdf1			30:06:0E:80:05:27:95:00
* LUN 1103[1103]	RAID5	raidGroup 11	CX_ARRAY01	140.00 GB	N/A	N/A			9				PreMMMd01-02	30:06:01:68:30:60:04:81 30:06:01:68:30:60:04:81 30:06:01:61:30:60:04:81 30:06:01:69:30:60:04:81
								N/A	hemera				PreMMMd01-02	
								N/A	heracles				PreMMMd01-02	

Figure 9 - Suspected De-Provisioned Hosts

Unused Space inside a Volume Group

Once a host has added a LUN to a volume group, it is more difficult to reclaim that storage. There are two instances worth discussing that are both shown in the screen shot below in the host detail view provided by APTARE IT Analytics (Figure 10 - Utilization Detail). The first volume group shows a LUN that is entirely unused. This is storage that might be reclaimed or at a minimum would prevent additional storage from being allocated until this current storage is used. The second volume group also has added a LUN from an array but there have been volumes created from the LUN. This is space difficult to reclaim but still potentially available for future use.

aptare2 Utilization Detail Nov 4, 2013 4:31:37 PM

dm-9					Total Row(s): 1		Total Row(s): 1	
Type	Name	Array	Physical Disk Name	Size	Logical Volume	Size		
LUN	20:6A	USPE@192.168.139.59	dm-9	52.97 GB	Un-Allocated	52.97 GB		
				52.97 GB				

fiber-vg1					Total Row(s): 1		Total Row(s): 6	
Type	Name	Array	Physical Disk Name	Size	Logical Volume	Size		
LUN	01:EE	USPE@192.168.139.59	dm-62	52.97 GB	/dev/fiber-vg1/bcf	2.00 GB		
				52.97 GB	/dev/fiber-vg1/oraapporaproduct	14.00 GB		
					/dev/fiber-vg1/oracle	14.00 GB		
					/dev/fiber-vg1/ushome	10.00 GB		
					/dev/fiber-vg1/usropenv	4.00 GB		
					Un-Allocated	8.97 GB		
						52.97 GB		

Figure 10 - Utilization Detail

APTARE IT Analytics can also show logical volumes that were created but not used in a file system (Figure 11 - Unused Partitions). For non-database servers, this is usually a sign of unused storage.

Unused Partitions / Logical Volumes Server Group=Global Storage Infrastructure Nov 4, 2013 4:49:51 PM

Total Row(s): 1 - This report has a filter applied

Host Name	Vol Group/Disk Name	Vol Group/Disk Size	Vol Group/Disk Avail	Logical Volume	LV Size	RAID Type
hds_linux	VolGroup00	2.05 TB	0.00 TB	/dev/VolGroup00/LogVol01	0.00 TB	

Figure 11 - Unused Partitions

Overprovisioned Hosts

A key view into your environment is list of hosts that are under-utilizing the storage allocated. APTARE IT Analytics allows you to set multiple thresholds in order to determine what constitutes under-utilized in your environment. As shown in the view below (Figure 13 - Over- Provisioned Hosts), APTARE IT Analytics tracks current usage as well as a date range of historical values chosen by the user to determine the high-water mark, so it can compare it against actual utilization.

Application Storage Dashboard Server Group=Global Storage Infrastructure Nov 4, 2013 4:44:48 PM

Total Row(s): 3

Application	Host	Application Storage			Filesystem Storage			Array Storage			Arrays	LUNs
		Total	Free	Used	Total	Free	Used	Total	Free	Used		
EXCHANGE	1 Host(s)	0.07 GB	N/A	0.07 GB	9.99 GB	1.00 GB	8.99 GB	N/A	N/A	N/A		
ORACLE	4 Host(s)	123.54 GB	68.21 GB	55.32 GB	214.83 GB	40.19 GB	174.64 GB	70.73 GB	0.00 GB	70.73 GB		
hbsm_sotb(hds_sotb)	hds_win2	25.03 GB	5.41 GB	19.61 GB	N/A	N/A	N/A	N/A	N/A	N/A		
sotb(sotb)	aptaresqa	8.97 GB	2.90 GB	6.07 GB	31.94 GB	6.93 GB	25.00 GB	70.73 GB	0.00 GB	70.73 GB		
sotb(sotb)	aptaredev2	64.52 GB	54.48 GB	10.03 GB	91.09 GB	14.56 GB	76.53 GB	70.73 GB	0.00 GB	70.73 GB		
sotb(sotb)	kiwi	25.03 GB	5.41 GB	19.61 GB	91.81 GB	18.70 GB	73.10 GB	70.73 GB	0.00 GB	70.73 GB		
APTARE_TBS_DATA_1M		0.98 GB	0.14 GB	0.84 GB	91.81 GB	18.70 GB	73.10 GB	70.73 GB	0.00 GB	70.73 GB		
/data01/oradata/sotb/ptare_tbs_data_1m_01.dbf		0.94 GB	0.10 GB	0.84 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
/data04/ptare_tbs_data_1m_04.dbf		0.01 GB	0.01 GB	0.00 GB	0.45 GB	0.44 GB	0.01 GB	70.73 GB	0.00 GB	70.73 GB	CK200030505347	LUN 20[20]
/data05/ptare_tbs_data_1m_05.dbf		0.01 GB	0.01 GB	0.00 GB	0.09 GB	0.08 GB	0.01 GB	N/A	N/A	N/A		
/data00/ptare_tbs_data_1m_06.dbf		0.01 GB	0.01 GB	0.00 GB	0.09 GB	0.08 GB	0.01 GB	N/A	N/A	N/A		
/data07/ptare_tbs_data_1m_07.dbf		0.01 GB	0.01 GB	0.00 GB	0.09 GB	0.08 GB	0.01 GB	N/A	N/A	N/A		
APTARE_TBS_DATA_200M		3.84 GB	0.78 GB	3.06 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_TBS_DATA_20M		6.88 GB	0.18 GB	6.70 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_TBS_IDX_100M		1.89 GB	0.88 GB	1.21 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_TBS_IDX_10M		5.70 GB	0.55 GB	5.15 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_TBS_IDX_1M		2.00 GB	0.05 GB	1.95 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_TEMP_TBS		1.00 GB	1.00 GB	0.00 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
APTARE_UNDO_TBS		1.44 GB	1.36 GB	0.08 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
SYSAUX		0.31 GB	0.08 GB	0.23 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
SYSTEM		0.50 GB	0.11 GB	0.39 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
VPX		0.49 GB	0.49 GB	0.00 GB	91.09 GB	18.03 GB	73.06 GB	N/A	N/A	N/A		
SQL Server	1 Host(s)	0.03 GB	0.01 GB	0.02 GB	9.99 GB	1.00 GB	8.99 GB	N/A	N/A	N/A		

Figure 12 - Array Utilization Summary

Total Row(s): 5 - This report has a filter applied

Host Name	Projected			Current			
	As of	Usage	High-Water Mark	Disk Capacity	File System Capacity	Usage	High-Water Mark
hebe	May 4, 2014 12:00:00 AM	27.34 GB	27.34 GB	675.27 GB	78.47 GB	27.11 GB	27.13 GB
hemera	May 4, 2014 12:00:00 AM	34.70 GB	36.92 GB	3,573.83 GB	70.02 GB	28.27 GB	28.22 GB
aptare2	May 4, 2014 12:00:00 AM	2.94 GB	2.94 GB	25,483.44 GB	14.12 GB	2.94 GB	2.94 GB
aptare1-external	May 4, 2014 12:00:00 AM	4.52 GB	4.52 GB	25,483.44 GB	14.12 GB	4.52 GB	4.52 GB
heracles	May 4, 2014 12:00:00 AM	31.38 GB	33.92 GB	3,573.83 GB	70.02 GB	24.26 GB	24.24 GB

Figure 13 - Over-Provisioned Hosts

3) IMPROVE OPTIMIZATION AND UTILIZATION

Existing Storage Utilization

APTARE IT Analytics has been specifically designed to provide the information necessary to support the provisioning process. Once you have visibility into the host details, you can further examine the need for additional capacity by validating unused or under-utilized storage already allocated to the host. With a few clicks, storage administrators can easily validate the host's current utilization in any of the following areas:

Consider the following questions:

- Unbound / Orphaned LUNs
- Excess Capacity at the Volume Manager level
- Unused space inside a VMWare Datastore
- Current File System Utilization Rates
- Excess Capacity at the application/database

Total Hosts: 6 - This report has a filter applied

Host	# of Allocated LUNs	Allocated Capacity	# of Used LUNs	Seen by Host	# of Arrays	Volume Capacity					Volume Usage	
						Shared	Unshared	Total DAS/SAN	DAS/SAN	NAS	DAS/SAN	NAS
hds_aix	4	472.60 GB	4	472.60 GB	4	0.00 GB	25.19 GB	25.19 GB	25.19 GB	N/A	5.99 GB	N/A
hds_hpux	4	472.60 GB	4	472.60 GB	4	0.00 GB	11.37 GB	11.37 GB	11.37 GB	N/A	6.96 GB	N/A
hds_linux	4	472.60 GB	1	401.67 GB	4	0.00 GB	39.16 GB	39.16 GB	39.16 GB	N/A	3.27 GB	N/A
hds_win1	4	472.60 GB	4	472.60 GB	4	0.00 GB	34.87 GB	34.87 GB	34.87 GB	N/A	8.03 GB	N/A
hds_win2	4	472.60 GB	4	472.60 GB	4	0.00 GB	128.71 GB	128.71 GB	128.71 GB	N/A	14.85 GB	N/A
hds_win3	4	472.60 GB	4	472.60 GB	4	0.00 GB	34.83 GB	34.83 GB	34.83 GB	N/A	16.12 GB	N/A

Figure 14 - Host Capacity and Utilization

Often the largest source of excess capacity and easy reclamation opportunities are unused or orphaned LUNs. Typically, once the LUN has been allocated, the storage administrator no longer has visibility to the utilization of the storage. The APTARE IT Analytics host view can quickly show LUNs that are allocated but not used by the host highlighted in the screenshot below (Figure 14 - Host Capacity and Utilization).

Disk Partitions / Volume Group Details						
Volume Group	Composed of				Logical Members	
dm-0	Total Row(s): 1				Total Row(s): 1	
	Type	Name	Array	Physical Disk Name	Size	Logical Volume
	LUN	20.73	USPE@192.168.139.59	dm-0	52.97 GB	Un-Allocated
					52.97 GB	52.97 GB
dm-1	Total Row(s): 1				Total Row(s): 1	
	Type	Name	Array	Physical Disk Name	Size	Logical Volume
	LUN	20.72	USPE@192.168.139.59	dm-1	52.97 GB	Un-Allocated
					52.97 GB	52.97 GB

Figure 15 - Disk Partitions / Volume Group Details

APTARE IT Analytics can look inside the host's volume manager to see how capacity has been allocated to volume groups and how that storage is being utilized. In the example below (Figure 15 - Disk Partitions / Volume Group Details), we see two LUNs that have not been used by the volume manager. This represents more than 100GB of free capacity that might be leveraged to satisfy the current allocation request.

In addition to making sure there are not any LUNs not being used at the physical machine level, storage administrators also need to verify the utilization of the datastores available in the ESX cluster when a request is made for more space to an ESX host for a VM guest. It is also helpful to check for VMs not in inventory - notice the highlighted 690GB of space taken by VMs no longer available (Figure 16 - Datastore Utilization Summary).

It is possible that all the allocated space has been used by the host and given to filesystems/volumes on the host. APTARE IT Analytics can also show if these filesystems are being utilized effectively. The report example below (Figure 17 - Filesystem Summary) indicates an ASM mount point with nearly 2TB of free capacity available. Depending upon the nature of the provisioning request, this information could serve as a justification of denial.

Host Mapping

It is necessary to understand the place of the host in the overall storage environment. In other words, how is it connected through the SAN backbone to the storage arrays? Will I need to create new masking or connections?

Datastore Utilization Summary Server Group: Global Storage Infrastructure
Nov 5, 2013 9:59:26 AM

Total Row(s): 4 - This report has a filter applied

Name	Total Capacity	Used	Free	Usage	Total VM Used	VMDK Used	VM Disk Capacity	VM Not In Inventory	# Sharing VM Servers	# VMs	# Extents	# Disks	# Arrays
aptesx04_raid1_datastore	2,793.75 GB	1,817.27 GB	976.48 GB		1,821.22 GB	1,617.48 GB	1,153.07 GB	85.41 GB	1	47	3	3	0
datastore1 (1)	200.25 GB	175.20 GB	25.05 GB		174.44 GB	159.53 GB	90.00 GB	0.20 GB	1	4	1	1	0
iscsi_vm_archive	999.50 GB	755.18 GB	244.32 GB		754.50 GB	54.96 GB	54.96 GB	699.54 GB	3	6	6	6	0
storage1	557.50 GB	534.14 GB	23.36 GB		534.00 GB	414.64 GB	311.49 GB	91.05 GB	1	19	1	1	0

Figure 16 - Datastore Utilization Summary

Total Row(s): 10

Mount Point	Raw Filesystem	Filesystem Type	Storage Type	Volume Group	Capacity	Used	% Available
+ASM1		Oracle ASM	SAN	DISKGROUP1	2,160.00 GB	354.96 GB	83.57%
+ASM1		Oracle ASM	SAN	DISKGROUP2	9,163.59 GB	8,140.47 GB	11.17%
+ASM1		Oracle ASM	SAN	DISKGROUP3	11,281.88 GB	9,677.83 GB	14.22%
/	/dev/sda2	reiserfs	DAS		3.00 GB	0.16 GB	94.60%
/boot	/dev/sda1	reiserfs	DAS		0.10 GB	0.04 GB	60.52%
/tmp	/dev/sda8	reiserfs	DAS		1.00 GB	0.11 GB	88.71%
/usr	/dev/sda5	reiserfs	DAS		3.00 GB	2.24 GB	25.43%
/var	/dev/sda6	reiserfs	DAS		3.00 GB	0.28 GB	90.72%
/var/spool	/dev/sda7	reiserfs	DAS		3.00 GB	0.08 GB	97.35%
/var/tmp	/dev/sda9	reiserfs	DAS		1.00 GB	0.03 GB	96.85%
					22,619.59 GB	18,176.20 GB	

Figure 17 - Filesystem Summary

In the below example (Figure 18 - Host to Storage Dashboard), we have a storage request from the host Hemera. APTARE IT Analytics provides the detailed topology map along with any connections to the storage and any zones for that host.

Likewise in the virtual environment, storage administrators want to know how a VM guest is mapped to the storage they are providing (Figure 19 - VM Guest End-to-End LUN Mapping).

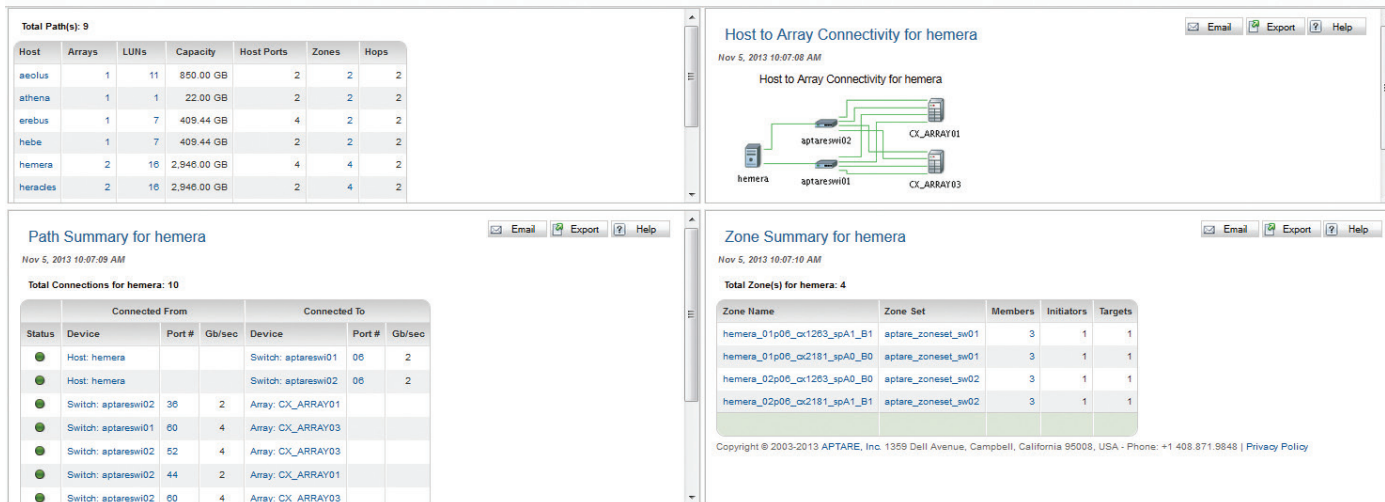


Figure 18 - Host to Storage Dashboard

Page 1 displaying 1,000 Row(s) Next >>

VM Guest	Guest Host Name	VM Server	Status	Datstore	File Name	Path	Type	Size(GB)	Array	LUN	Last Updated
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	Centos 5.5 x86 Template.nvram	Centos 5.5 x86 Template	VmNvram	0.00000762939453125			Jan 31, 2011 11:45:25 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	Centos 5.5 x86 Template.vmsd	Centos 5.5 x86 Template	VmDisk	6.75678990625			Jan 28, 2011 1:01:09 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	Centos 5.5 x86 Template.vmsd	Centos 5.5 x86 Template	VmSnapshotMetadata	0			Jan 28, 2011 11:45:25 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	Centos 5.5 x86 Template.vmtx	Centos 5.5 x86 Template	VmConfigFile	0.0000019073486328125			Jan 31, 2011 11:45:25 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	Centos 5.5 x86 Template.vmxr	Centos 5.5 x86 Template	VmConfigTeam	0.00000286102294921875			Jan 28, 2011 1:23:33 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	vmware-1.log	Centos 5.5 x86 Template	VmLog	0.000186920166015625			Jan 28, 2011 10:00:13 AM
Centos 5.5 x86 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	vmware.log	Centos 5.5 x86 Template	VmLog	0.00000896453857421875			Jan 31, 2011 11:45:25 AM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template	RHEL 6 x64 Template	FolderFile	9.5367431640625E-7			Feb 3, 2011 11:31:54 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template.nvram	RHEL 6 x64 Template	VmNvram	0.00000762939453125			Feb 2, 2011 12:46:10 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template.vmsd	RHEL 6 x64 Template	VmDisk	5.5556640625			Feb 2, 2011 12:45:20 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template.vmsd	RHEL 6 x64 Template	VmSnapshotMetadata	0			Feb 2, 2011 12:45:20 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template.vmtx	RHEL 6 x64 Template	VmConfigFile	0.0000019073486328125			Feb 3, 2011 11:31:45 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	RHEL 6 x64 Template.vmxr	RHEL 6 x64 Template	VmConfigTeam	0.00000286102294921875			Feb 3, 2011 11:31:45 PM
RHEL 6 x64 Template	localhost.localdomain	aptexx04.corp	●	iscsi_shared_datstore	vmware.log	RHEL 6 x64 Template	VmLog	0.0001468858447285625			Feb 2, 2011 4:25:30 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	RH4-small-master-000001.vmsd	StevesVM	VmDisk	2.328125			Jun 6, 2010 11:47:22 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	RH4-small-master.vmsd	RH4-SteveVM	VmDisk	8			Dec 1, 2009 4:49:08 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM	StevesVM	FolderFile	0.0000019073486328125			Feb 13, 2011 11:42:47 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM-8b7c1864.vmas	StevesVM	VmSuspendState	1.891857147216796875			Feb 26, 2009 12:22:52 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM-Snapshot1.vman	StevesVM	VmSnapshot	1.89185619354248046875			Nov 10, 2008 5:49:38 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM.nvram	StevesVM	VmNvram	0.00000762939453125			Nov 12, 2010 1:39:49 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM.vmsd	StevesVM	VmSnapshotMetadata	0			Dec 1, 2009 4:50:26 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM.vmxr	StevesVM	VmConfigFile	0.0000019073486328125			Feb 13, 2011 11:42:47 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	StevesVM.vmtx	StevesVM	VmConfigTeam	0.00000286102294921875			Feb 13, 2011 11:40:13 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	vmware-21.log	StevesVM	VmLog	0.00002193450927734375			Jul 15, 2009 12:46:29 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	vmware-22.log	StevesVM	VmLog	0.00002384185791015625			Sep 29, 2009 5:57:54 PM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	vmware-23.log	StevesVM	VmLog	0.00006961822509765625			Dec 19, 2009 1:07:17 AM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	vmware-24.log	StevesVM	VmLog	0.00003814697285625			Feb 23, 2010 9:43:22 AM
RH4-Portal_infrastructure_164	localhost.localdomain	esx.corp	●	storage1	vmware-25.log	StevesVM	VmLog	0.00005054473876953125			Nov 12, 2010 1:39:52 PM

Figure 19 - VM Guest End-to-End LUN Mapping

What Array/Tier Should I Use?

When determining what array to use to allocate storage, most administrators need to “just know” what array offers each tier. It is very difficult to show an enterprise-wide view of the storage environment by tier. However, this is the most helpful place to start to determine what array makes the most sense to satisfy the storage request.

Drilling down on a tiering policy shows all of the arrays that provide storage for that policy tier (Figure 21 - Chargeback Array Capacity), making it easy to choose the array that best fits the request made by the business entity.

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Chargeback Policy Capacity Server Group:Global Storage Infrastructure
Nov 5, 2013 10:39:48 AM

Total Row(s): 5

Policy	Cost Per GB	RAID					LUNs			Thin Provisioned		
		Total Capacity	Virtual Capacity	Local Capacity	Used	Available	Total	Allocated	UnAllocated	Total	Used	Pool Available
AMS-Chrgbk-Policy	\$ 15.00	28,648.59 GB	0.00 GB	28,648.59 GB	28,648.59 GB	0.00 GB	28,648.59 GB	28,648.59 GB	0.00 GB	0.00 GB	0.00 GB	0.00 GB
Gold	\$ 25.00	93,340.78 GB	19,242.56 GB	96,283.28 GB	86,053.91 GB	4,344.33 GB	147,643.17 GB	46,955.64 GB	100,687.53 GB	1,929,431.03 GB	1,353,778.74 GB	575,652.29 GB
HDS	\$ 17.50	194,729.24 GB	38,278.91 GB	159,679.98 GB	133,978.05 GB	57,521.54 GB	311,399.59 GB	311,355.00 GB	44.59 GB	318,021.54 GB	104,832.12 GB	213,189.42 GB
Platinum	\$ 50.00	330,644.85 GB	988,831.52 GB	339,109.93 GB	242,924.85 GB	79,255.01 GB	3,269,737.12 GB	2,888,778.93 GB	380,958.20 GB	1,216,609.24 GB	527,020.92 GB	689,588.32 GB
Silver	\$ 0.00	30.00 GB	60.00 GB	0.00 GB	N/A	9,580.88 GB	94,032.00 GB	91,324.00 GB	2,708.00 GB	0.00 GB	0.00 GB	0.00 GB
		647,393.44 GB	1,046,412.99 GB	623,721.79 GB	491,605.40 GB	150,701.56 GB	3,851,460.47 GB	3,367,062.16 GB	484,398.31 GB	3,464,061.81 GB	1,985,631.79 GB	1,478,430.02 GB

Figure 20 - Chargeback Policy Capacity

Chargeback Array Capacity Nov 5, 2013 10:44:28 AM

Total Row(s): 13

Array			RAID					LUNs			Thin Provisioned		
Name	Policy	Cost Per GB	Total Capacity	Virtual Capacity	Local Capacity	Used	Available	Total	Allocated	UnAllocated	Total	Used	Pool Available
AMS2500B0@192.168.139.197	Gold	\$ 25.00	0.92 GB	0.00 GB	0.92 GB	0.00 GB	0.92 GB	13,741.00 GB	0.00 GB	13,741.00 GB	0.00 GB	0.00 GB	0.00 GB
AMS2500E@192.168.139.199	Gold	\$ 25.00	0.92 GB	0.00 GB	0.92 GB	0.00 GB	0.92 GB	13,741.00 GB	8,192.00 GB	5,549.00 GB	0.00 GB	0.00 GB	0.00 GB
AMS500@10.177.153.74	Gold	\$ 25.00	0.00 GB	0.00 GB	19,242.56 GB	0.00 GB	0.00 GB	19,242.56 GB	19,242.56 GB	0.00 GB	0.00 GB	0.00 GB	0.00 GB
ETCFDHSVTP6_18454	Gold	\$ 25.00	517,292.74 GB	0.00 GB	517,292.74 GB	517,292.74 GB	0.00 GB	6,441.69 GB	3,220.85 GB	3,220.85 GB	446,104.93 GB	423,652.52 GB	22,452.40 GB
ETCFRRDHVTP2_28052	Gold	\$ 25.00	807,120.52 GB	0.00 GB	807,120.52 GB	807,077.09 GB	43.43 GB	440.09 GB	0.00 GB	440.09 GB	705,598.20 GB	465,757.07 GB	239,841.12 GB
ETCFRRDHVTP3_48053	Gold	\$ 25.00	807,120.52 GB	0.00 GB	807,120.52 GB	807,120.33 GB	0.19 GB	0.00 GB	0.00 GB	0.00 GB	706,180.21 GB	461,439.89 GB	244,740.32 GB
ETCFUSPVCDDATA4_28093	Gold	\$ 25.00	55,030.94 GB	0.00 GB	55,030.94 GB	54,521.21 GB	509.73 GB	40,763.46 GB	0.00 GB	40,763.46 GB	0.00 GB	0.00 GB	0.00 GB
ETCFUSPVCDDATA6_28521	Gold	\$ 25.00	55,030.94 GB	0.00 GB	55,030.94 GB	48,368.84 GB	6,662.10 GB	9,528.75 GB	0.20 GB	9,528.55 GB	17,013.24 GB	0.00 GB	17,013.24 GB
USP_V@10.177.153.115	Gold	\$ 25.00	5,900.01 GB	7,787.87 GB	0.00 GB	5,900.01 GB	N/A	5,900.01 GB	5,900.01 GB	0.00 GB	0.00 GB	0.00 GB	0.00 GB
USP_V@10.177.153.116	Gold	\$ 25.00	10,400.02 GB	11,454.68 GB	0.00 GB	10,400.02 GB	N/A	10,400.02 GB	10,400.02 GB	0.00 GB	0.00 GB	0.00 GB	0.00 GB
VSP@10.67.72.101	Gold	\$ 25.00	33,016.70 GB	0.00 GB	33,016.70 GB	33,016.50 GB	0.20 GB	5,502.75 GB	0.00 GB	5,502.75 GB	30,519.64 GB	783.56 GB	29,736.08 GB
VSP@10.67.72.102	Gold	\$ 25.00	33,016.70 GB	0.00 GB	33,016.70 GB	33,016.50 GB	0.20 GB	11,005.50 GB	0.00 GB	11,005.50 GB	24,014.81 GB	2,145.69 GB	21,869.12 GB
VSP@10.67.74.98	Gold	\$ 25.00	11,005.48 GB	0.00 GB	11,005.48 GB	10,936.32 GB	69.16 GB	10,936.32 GB	0.00 GB	10,936.32 GB	0.00 GB	0.00 GB	0.00 GB
			2,334,936.42 GB	19,242.56 GB	2,337,879.94 GB	2,327,649.57 GB	7,286.85 GB	147,643.17 GB	46,955.64 GB	100,687.53 GB	1,929,431.03 GB	1,353,778.74 GB	575,652.29 GB

Figure 21 - Chargeback Array Capacity

Performance Profiling

It is necessary to understand the current performance profile before suggesting a lower tier or higher tier of storage for any allocation request. APTARE IT Analytics creates a performance profile for each type of storage and compares the performance each of each host against that profile (Figure 22 - Storage Performance). This analysis provides a quick method for storage administrators to see how the host requesting storage is performing against the benchmarked norm.

Properly distributing masked capacity across the storage array and fabric ports is essential in maintaining performance levels and mitigating risk from higher utilization rates of storage from the utilization phase of the project. APTARE IT Analytics provides performance metrics that can assist an administrator with determining the ports that are least utilized (Figure 23 - Port Throughput by Array).

Storage Performance- Last 10-Days

Server Group=Global Storage Infrastructure | Mar 03, 2013 12:00:00AM - Mar 12, 2013 07:10:59PM
 ● Fast ● Normal ● Slow ○ No data collected false

Total host(s): 48

Host	LUNs	Mar 03	Mar 04	Mar 05	Mar 06	Mar 07	Mar 08	Mar 09	Mar 10	Mar 11	Mar 12
▶ hds_hpux	1 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ hds_atx	1 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ hds_win1	LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ hds_win2	1 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ hds_win3	1 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ p57005	4 LUN(s)	○	○	○	○	○	○	○	○	○	○
▶ ONEVH22	33 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ ONEVH21	2 LUN(s)	●	●	●	●	●	●	●	●	●	○
▶ ONEVH25	33 LUN(s)	●	●	●	●	●	●	●	●	●	○

Figure 22 - Storage Performance

Port Throughput by Array

2 Arrays
 Oct 7, 2013 12:00:00 AM - Nov 5, 2013 10:55:08 AM

Show Chart

Total Row(s): 6

Storage Array	Port #	Role	Port Name	IO/Sec	IO %	MB Transferred	Transferred %	ShowChart
Hitachi Thunder 9570V RD80	1	Target	CTL0-B	26	48.15%	44,799	48.31%	<input type="checkbox"/>
Hitachi Thunder 9570V RD80	16	Target	CTL1-A	28	51.85%	47,924	51.69%	<input type="checkbox"/>
				54		92,723		
Hitachi USP V	16		CL1-C	25	23.58%	43,572	24.22%	<input type="checkbox"/>
Hitachi USP V	145		CL4-C	26	24.53%	43,915	24.41%	<input type="checkbox"/>
Hitachi USP V	3	Target	CL7-A	27	25.47%	45,892	25.51%	<input type="checkbox"/>
Hitachi USP V	15	Target	CL7-F	28	26.42%	46,490	25.85%	<input type="checkbox"/>
				106		179,889		

Figure 23 - Port Throughput by Array

Port Performance Details

Nov 4, 2013 10:57:00 AM - Nov 5, 2013 11:59:59 PM

Switch : aptareswi01 Port # 08 Gb/sec : 2

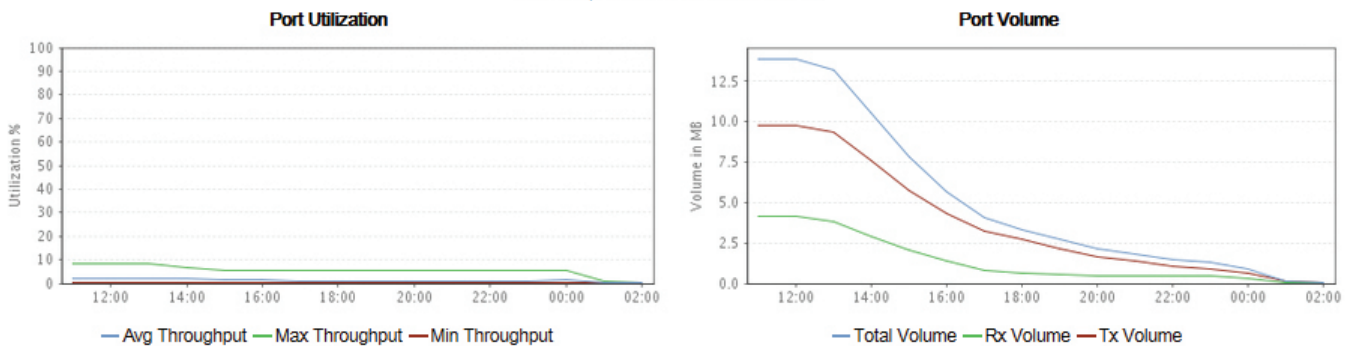


Figure 24 - Port Performance Details

It is also necessary to look at the performance of the switch ports used by both the host and array (Figure 24 - Port Performance Details) in order to determine that additional storage allocations will not cause undue stress on the existing infrastructure.

4) INFUSE INTELLIGENCE THROUGHOUT STORAGE OPERATIONS

Capacity Planning

Accurate capacity planning is a crucial function of any organization. The IT team needs to be able to analyze the storage requirements of the business and align them with buying cycles. To accurately predict storage by vendor, location, and tier enables IT to dramatically reduce the amount of excess storage that is purchased with a “just in case” justification. Capacity planners with a lack of visibility tend to buy every terabyte of storage that is requested or even add more to avoid the more critical out of storage condition.

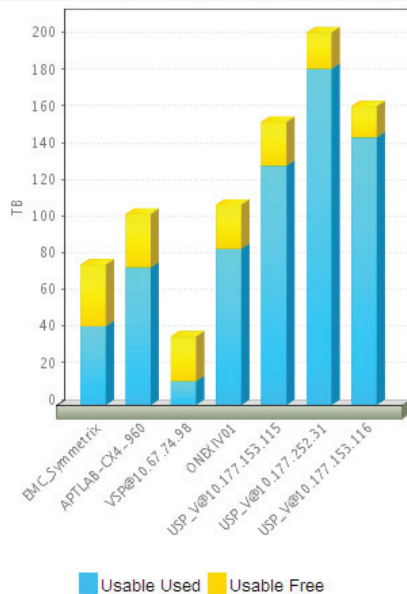
When performing Capacity planning activities, you need to ask the following:

- How fast is my storage growing based on:
 - Vendor
 - Storage Tier
 - Location
 - Department/Cost Center
- How long will my un-allocated capacity last?
- Can I normalize my storage across different vendors to create defined storage tiers?
- Are there specific amounts of storage that have to be allocated at a known date in the future?
- How much capacity do I have in the SAN infrastructure and does it match my storage requirements?
- How many new hosts or VMs are being added to the storage infrastructure?
- Are new technologies like thin provisioning helping to slow storage growth?
- Do I have enough backup infrastructure to protect all data in the storage environment?

For effective capacity planning, it is necessary to be able to analyze the trending of storage usage in numerous ways – by tier, business unit, project, internal customer, or any other logical grouping needed. In other words, you need to track usage by what is most critical to your business. APTARE IT Analytics reports (Figure 25 – Allocated Available by Array / Array Allocated Forecast) show growth trends by storage array, even allowing the capacity planners to add “what if” capacity to the projections.

The Hosts at Risk report (Figure 26 – Hosts at Risk) provides a projected “risk date” where the host has a potential to run out of space based on past actual utilization of the storage allocated. An alert is commonly set on this report to identify hosts at risk in the next 30 days. In addition, it is helpful to find hosts that are over-provisioned – more storage allocated than being used (Figure 27 – Over-Provisioned Hosts). The Aptare2 server has 25 TBs allocated and is only using 14 GBs of space. Effective capacity planning can spot these cases of under-utilized storage.

Allocated Available by Array 7 Arrays
Nov 12, 2013 3:23:05 AM



Array Allocated Forecast Oct 14, 2013 12:00:00 AM - Nov 12, 2013 3:28:59 AM

*All values in (GB), Array = USP_V@10.67.72.103, What if Demand increased by: 30%

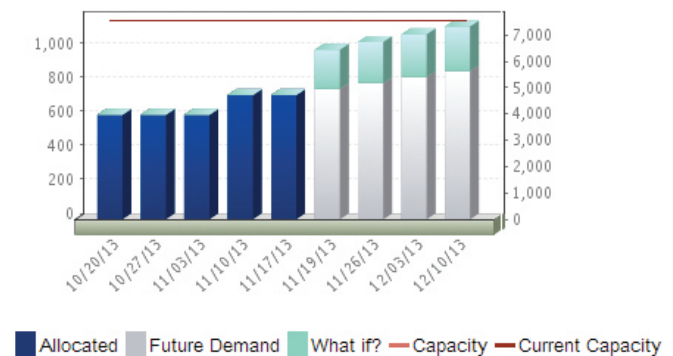


Figure 25 – Allocated Available by Array / Array Allocated Forecast

Hosts At Risk Server Group=Global Storage Infrastructure
May 16, 2013 1:00:00 AM - May 12, 2014 12:58:59 AM

Total Row(s): 4

Host Name	Risk Date	Projected			Capacity	Current Usage	Threshold
		Usage	High-Water Mark	File System Capacity			
aptarew2003-external	Feb 9, 2014 12:00:00 AM	61.03 GB	61.22 GB	67.79 GB	67.79 GB	56.20 GB	90.00%
aptex02.corp	Nov 12, 2013 12:00:00 AM	2,002.97 GB	2,150.38 GB	1,899.25 GB	1,905.00 GB	1,115.62 GB	90.00%
aptex04.corp	Feb 2, 2014 12:00:00 AM	3,845.05 GB	3,845.05 GB	2,355.25 GB	4,223.38 GB	909.73 GB	90.00%
aptex04.corp	Dec 1, 2013 12:00:00 AM	5,413.93 GB	6,338.65 GB	4,286.00 GB	5,223.38 GB	2,674.26 GB	90.00%
					11,419.56 GB	4,755.80 GB	

Figure 26 - Hosts at Risk

Over-Provisioned Hosts Server Group=SAN Hosts
May 8, 2013 1:00:00 AM - May 4, 2014 12:58:59 AM

Total Row(s): 5 - This report has a filter applied

Host Name	As of	Projected			Current		
		Usage	High-Water Mark	Disk Capacity	File System Capacity	Usage	High-Water Mark
hebe	May 4, 2014 12:00:00 AM	27.34 GB	27.34 GB	675.27 GB	78.47 GB	27.11 GB	27.13 GB
hemera	May 4, 2014 12:00:00 AM	34.70 GB	36.92 GB	3,573.83 GB	70.02 GB	28.27 GB	28.22 GB
aptare2	May 4, 2014 12:00:00 AM	2.94 GB	2.94 GB	25,483.44 GB	14.12 GB	2.94 GB	2.94 GB
aptare1-external	May 4, 2014 12:00:00 AM	4.52 GB	4.52 GB	25,483.44 GB	14.12 GB	4.52 GB	4.52 GB
heracles	May 4, 2014 12:00:00 AM	31.38 GB	33.92 GB	3,573.83 GB	70.02 GB	24.28 GB	24.24 GB

Figure 27 - Over-Provisioned Hosts

Intelligent Provisioning

One of the most difficult aspects of a storage administrator's job is to provision storage without having all the necessary data. Making sure the storage amount and tier is provisioned appropriately based on actual usage dramatically reduces both the cost and growth of storage.

Some of the data points that are typically missing revolve around these questions:

- Are we over-allocating to avoid future requests?
- Has the requestor used all of the LUNs already allocated?
- Does the requestor already have unused storage on their server(s) or ESX host?
- Is there free Volume Group Capacity?
- Is there excess File System Capacity?
- Are there decommissioned servers that still have allocated storage?
- What tier of storage is the requestor currently using for this particular application?
- What are the backup/replication requirements for the request?
- Based on growth projections, which array/pool makes the most sense to use for the allocation?
- Is there storage already reserved for other projects?
- What does the existing I/O performance look like?
- Do we have enough of the requested storage tier?
- Are we creating thin-provisioned storage to thin-provisioned Virtual Guests?

APTARE IT Analytics has unique integrated view of storage, SAN fabric, virtual and physical hosts, backup needs, and applications and provides storage administrators with the information needed to answer the tough questions about any allocation request. The single pane of glass provided by the APTARE IT Analytics not only makes it incredibly efficient to make the provisioning process more intelligent, it makes it possible for every storage allocation.

Here are the areas you should consider to make your provisioning process more intelligent:

- Host Views
- Existing Storage Utilization
- Host Mapping
- What Array/Tier Should I Use?
- Performance Profile

Host Views

APTARE IT Analytics consolidates all the information from the hosts in the environment to show both an allocated and utilized view of the storage. The latter view is generally missing for storage administrators, making it nearly impossible to determine if the host is already using the storage previously allocated.

APTARE IT Analytics provides an unparalleled level of detail including:

- Fibre Channel host connections
- Clustered host information
- HBA make, model, firmware, etc.
- Volume manager disk usage and mapping including versions
- Filesystem and volume usage
- Host OS, version, make, and model
- Multipathing software, version, and connections
- CPU, memory, and IP network performance
- Oracle ASM mapping and usage
- Oracle, SQL Server, and Exchange allocation and utilization metrics

As you can see from the following examples (Figure 28 – Utilization Detail), APTARE IT Analytics provides detailed information about basic host information, topology through the SAN and storage, any related hosts that are using the same LUNs (like in a cluster), the mounted volumes, and any NAS shares present.

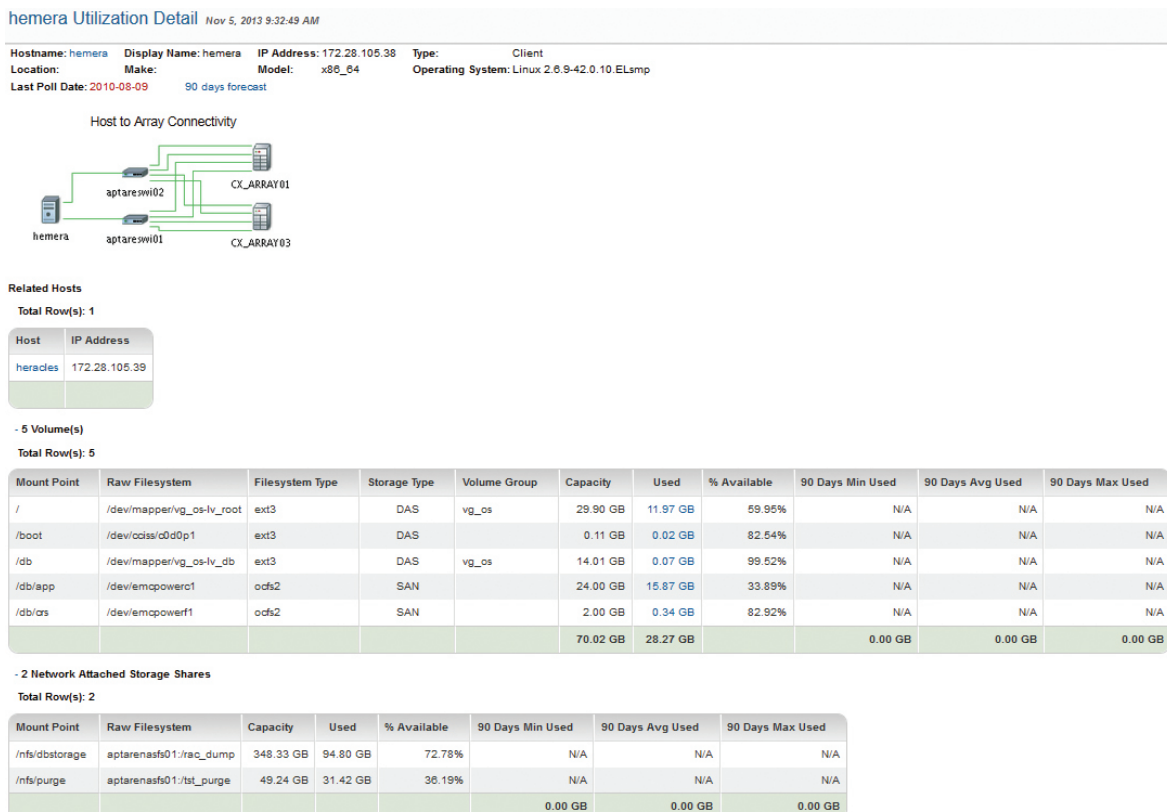


Figure 28 - Utilization Detail

For virtual hosts, APTARE IT Analytics also provides detailed information about the VM guest that includes OS, VM Path, volumes including utilization metrics, and disks provided to the VM (whether raw mapped or through a datastore) (Figure 29 – VM Detail).

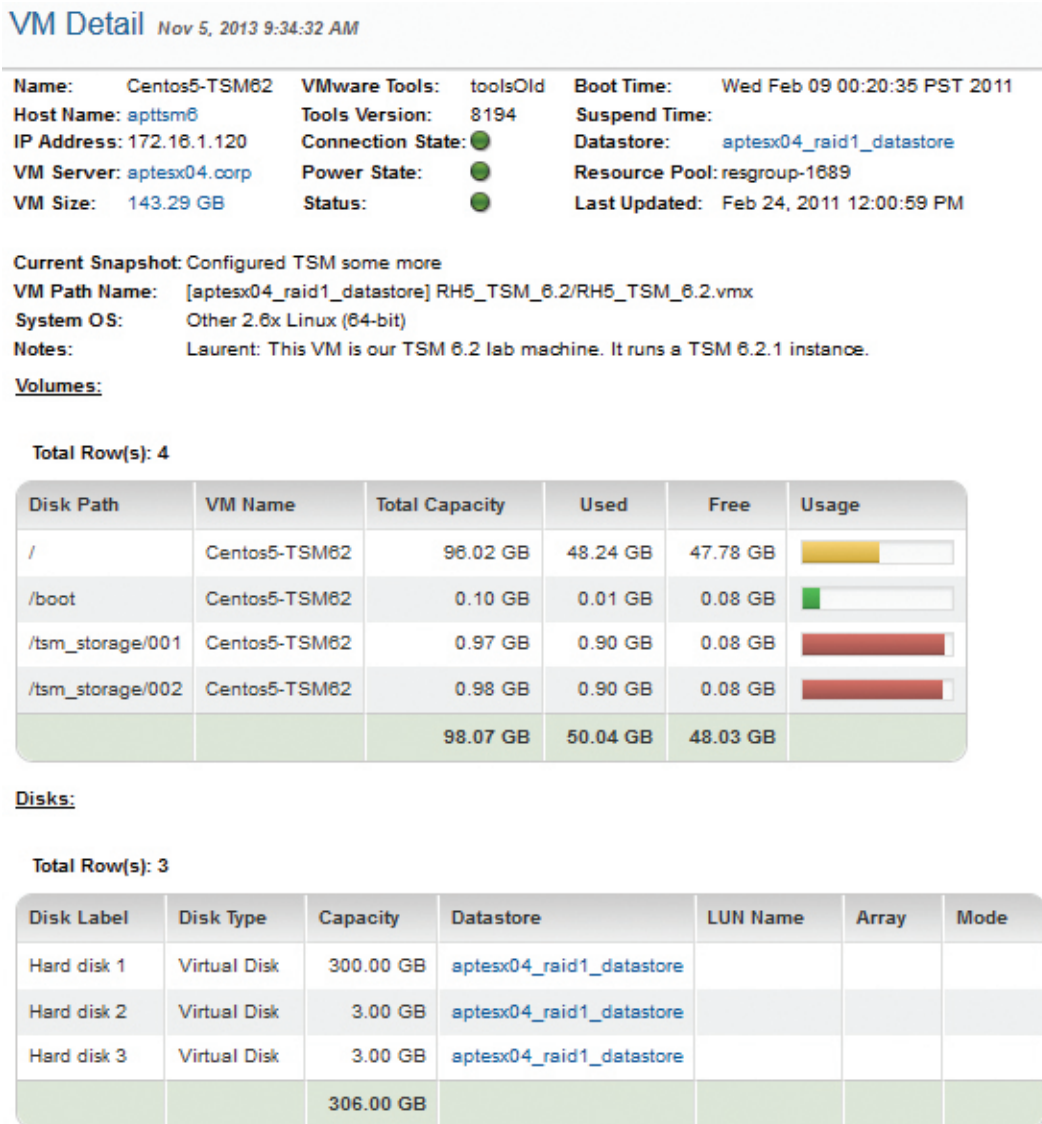


Figure 29 – VM Detail

5) IMPROVE STORAGE CONSUMPTION

Chargeback/Showback

Storage growth is inevitable, but reclamation can help mitigate that growth to find the underutilized storage today. Charging business units for their storage use is the most effective way to slow future growth. If you're not ready to actually charge your business units for their storage usage, showback is the next best thing. Here are the key questions:

- How much storage is each Business Unit allocated? Utilizing? On which tier?
- How do I remove manual steps in determining storage allocation?
- What do I do with thin provisioning? Automated tiering? Virtualized storage?
- Do I charge for actual used vs. allocated?
- Does storage use align with business direction?
- What is the true cost of storage use?

Utilizing APTARE IT Analytics chargeback/showback features provides automated chargeback/showback by allocated storage, utilized storage, storage tier, heterogeneous arrays, SAN storage, NAS storage, and even DAS. You can now show or charge a Business Unit, division, project, application, data center, or any other logical grouping you can envision.

APTARE IT Analytics storage chargeback provides the following benefits:

- Flexible, automated chargeback to fit an infinite number of chargeback models
- Slows storage growth moving forward
- Encourages efficiencies and better decisions based on actual costs
- Serves as a building block towards a storage utility model
- Identifying (and recovering) storage costs of projects, departments, business units
- Instant information available to each department - no black box
- Verify that all storage is assigned to some business entity

The first step in defining chargeback/showback is to create policies around tiers of storage. APTARE IT Analytics' flexible model allows tiers to be defined by array families, array name, array type, drive speed, drive type, drive capacity, whether raid type is local, DAS, or thin provisioned, domains, replicated, pool name, FAST policies, device type, and more (Figure 30 - Tier Creation). This allows for creation of tiers with the following attributes: DMX or VMAX with 15k Fibre Channel drives that are replicated and thin provisioned. Once the policies are defined for each of your tiers, you can also assign a cost. Most customers choose a fully loaded cost per terabyte (including software, switch ports, heating/cooling, etc.). APTARE IT Analytics solution is flexible enough to allow each individual business entity to define storage tiers (and costs).

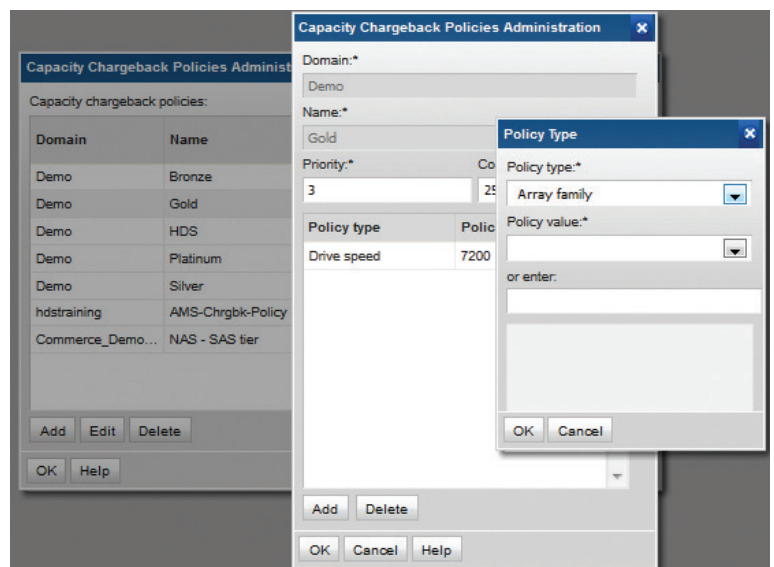


Figure 29 - VM Detail

APTARE IT Analytics provides views into your storage based on the custom storage tiering policies you've defined. You can quickly see by tier total capacity, used, available, LUNs created, allocated, unallocated, and even if there is thin provisioned storage meeting the policy definition (Figure 31 - Chargeback Policy Capacity).

This allows storage administrators a quick method of determining:

- Total amount of storage for each tier
- How much storage is available to allocate in each tier
- Fully loaded cost per tier
- RAID storage not being utilized

Next you would assign an attribute (or multiple attribute) that defines your logical grouping to one or more of the APTARE IT Analytics objects - host or VMs or applications or volumes or arrays or pools. This provides the ultimate flexibility in how storage usage is displayed back to your internal or external customers. These attributes are usually synced with some external source like a CMDB. Once the attributes are defined and assigned, aggregated or detailed views of the usage by those business entities are always available. It is also useful to view storage costs by multiple logical entities at once as shown in the dashboard view below (Figure 32 - Chargeback Views).

It is also necessary to provide detailed views of usage at a host level to allow the business units to determine where they are using storage and how best to allocate their purchasing dollars. APTARE IT Analytics provides those usage views by host in a particular business grouping (Figure 33 - Chargeback by Host).

Chargeback Policy Capacity Server Group=Global Storage Infrastructure
Nov 5, 2013 7:52:13 AM

Total Row(s): 5

Policy	Cost Per GB	RAID					LUNs			Thin Provisioned		
		Total Capacity	Virtual Capacity	Local Capacity	Used	Available	Total	Allocated	UnAllocated	Total	Used	Pool Available
AMS-Chrgbk-Policy	\$ 15.00	28,648.59 GB	0.00 GB	28,648.59 GB	28,648.59 GB	0.00 GB	28,648.59 GB	28,648.59 GB	0.00 GB	0.00 GB	0.00 GB	0.00 GB
Gold	\$ 25.00	93,340.76 GB	19,242.56 GB	96,283.28 GB	86,053.91 GB	4,344.33 GB	147,643.17 GB	46,955.64 GB	100,687.53 GB	1,929,431.03 GB	1,353,778.74 GB	575,652.29 GB
HDS	\$ 17.50	194,729.24 GB	38,278.91 GB	159,679.98 GB	133,978.05 GB	57,621.54 GB	311,399.59 GB	311,355.00 GB	44.59 GB	318,021.54 GB	104,832.12 GB	213,189.42 GB
Platinum	\$ 50.00	330,644.85 GB	988,831.52 GB	339,109.93 GB	242,924.85 GB	79,255.01 GB	3,269,737.12 GB	2,888,778.93 GB	380,958.20 GB	1,216,609.24 GB	527,020.92 GB	689,588.32 GB
Silver	\$ 0.00	30.00 GB	60.00 GB	0.00 GB	N/A	9,580.68 GB	94,032.00 GB	91,324.00 GB	2,708.00 GB	0.00 GB	0.00 GB	0.00 GB
		647,393.44 GB	1,046,412.99 GB	623,721.79 GB	491,605.40 GB	150,701.56 GB	3,851,460.47 GB	3,367,062.16 GB	484,398.31 GB	3,464,061.81 GB	1,985,631.79 GB	1,478,430.02 GB

Figure 31 - Chargeback Policy Capacity

Chargeback by Line of Business					Chargeback by Region				
<small>Server Group=Global Storage Infrastructure Nov 5, 2013 8:11:56 AM</small>					<small>Server Group=Global Storage Infrastructure Nov 5, 2013 8:12:02 AM</small>				
Total Row(s): 7					Total Row(s): 5				
Line of Business	Policy	Cost Per GB	Total Usage	Total Cost	Region	Policy	Cost Per GB	Total Usage	Total Cost
Corporate	Bronze	\$ 5.00	145.81 GB	\$ 729.04	AMERS	Bronze	\$ 5.00	407.79 GB	\$ 2,038.95
Corporate	Platinum	\$ 50.00	27,899.46 GB	\$ 1,394,972.75	AMERS	Platinum	\$ 50.00	27,899.46 GB	\$ 1,394,972.75
Database	Bronze	\$ 5.00	267.41 GB	\$ 1,287.03	APAC	Bronze	\$ 5.00	4,793.03 GB	\$ 23,965.13
Finance	Bronze	\$ 5.00	285.65 GB	\$ 1,428.27	EMEA	Bronze	\$ 5.00	1,750.20 GB	\$ 8,751.01
Retail	Bronze	\$ 5.00	247.68 GB	\$ 1,238.40	EMEA	Platinum	\$ 50.00	52.97 GB	\$ 2,648.44
Retail	Platinum	\$ 50.00	52.97 GB	\$ 2,648.44				34,903.45 GB	\$ 1,432,376.28
eCommerce	Bronze	\$ 5.00	275.67 GB	\$ 1,378.35					
			29,164.65 GB	\$ 1,403,682.28					

Figure 32 - Chargeback Views

You can then drill-down to the exact LUN and array that host is utilizing storage from. These details help to right size the environment (Figure 34 – Chargeback Detail).

Chargeback by Host <small>Server Group=SAN Hosts Nov 5, 2013 9:14:06 AM</small>				
Total Row(s): 18				
Host	Policy	Cost Per GB	Total Usage	Total Cost
aptare1-external	Bronze	\$ 5.00	67.99 GB	\$ 339.93
aptare1-external	Platinum	\$ 50.00	27,899.46 GB	\$ 1,394,972.75
			27,967.45 GB	\$ 1,395,312.68
aptare2	Bronze	\$ 5.00	67.99 GB	\$ 339.93
aptare2	Platinum	\$ 50.00	52.97 GB	\$ 2,648.44
			120.96 GB	\$ 2,988.37
aptarebue11d	Bronze	\$ 5.00	10.00 GB	\$ 49.98
			10.00 GB	\$ 49.98
aptaredev1	Bronze	\$ 5.00	136.61 GB	\$ 683.06
			136.61 GB	\$ 683.06

Figure 33 – Chargeback by Host

Chargeback Detail <small>Nov 5, 2013 9:14:34 AM</small>						
Total Row(s): 1						
Host	Policy	Array	LUN	Unit Cost	Total Usage	Total Cost
aptare2	Platinum	USPE@192.168.139.59	01:EE	\$ 50.00	52.97 GB	\$ 2,648.44
					52.97 GB	\$ 2,648.44

Figure 34 – Chargeback Detail

IN CONCLUSION

Organizations have been dealing with rising storage needs and exploding costs for too long. APTARE IT Analytics provides complete end-to-end visibility into storage environments from host to LUN to backup to recovery in a single reporting solution. This valuable insight—collected automatically and in near real time—allows organizations to get a handle on their current environments, reclaim under-used capacity, improve optimization and utilization, infuse intelligence into storage operations and improve the storage consumption habits of users. Put together, APTARE IT Analytics helps organizations reduce the rate of storage growth while stymieing the overall cost of owning storage.

A successful storage strategy is just one more step toward a more flexible and dynamic business.

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