PAC STORAGE

PAC Storage PS NVMe Series Supporting 100 GbE

Version: 1.2
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Summary

PAC Storage PS NVMe series unified storage system. Equipped with U.2 NVMe SSD, PS NVMe series deliver better performance with lower latency.

Contents

1 Applicable Models

For your reference, below are the applicable models in this performance report:

Series	Applicable Models
PS 3024U	PS 3024UR
PS 4024U	PS 4024UR

2 Audience

This performance report is intended for the PAC Storage partners, customers, and employees who want to deploy PAC Storage PS NVMe series as their storage.

3 Terminology

- **PAC Storage PS Family** – PAC Storage PS Family is an enterprise unified storage which can be configured as SAN or NAS.
- **EonOne** – Management software for PAC Storage PS Family.
- **Block-level** – Commonly deployed as SAN storage to store structured data.
- **File-level** – Commonly used for storing unstructured data, and shares data with multiple clients via file system protocol, such as CIFS/SMB, NFS and FTP.
- **Logical Drive (LD)** – Combination of multiple drives via RAID technology.
- **Pool** – Combination of one or more LD(s).
- **Volume** – Space divided from pool which can be created as block-level volume or file-level volume.
- **Better performance for block data access** – Assign more CPU cores for block-level IO. Referred as block mode in the rest of this report.
- **Better performance for file access service** – Assign more CPU cores for file-level IO. Referred as file mode in the rest of this report.

4 Performance Results

The following section demonstrates the highest performance of each system. Please also check the configuration in System Configuration section to see how we run the tests. There are also some descriptions

of the results in the Conclusion section.

***Color of Performance optimization value:**

Better performance for block data access (Referred as block mode in this report) / Better performance for file access service (Referred as file mode in this report)

4.1 Block-Level Section

4.1.1 IOPS with small block size

Host Type: FC_16G		Block Level				
		Profile	End-to-End			All Cache Hit
		IO Behavior	Random			Sequential
		Size	4KB	8KB	64KB	512B
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (IOPS)	970,373	952,500	401,645	1,665,502
		Write (IOPS)	192,539	187,868	59,916	972,013
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (IOPS)	1,075,327	1,058,197	401,701	1,723,290
		Write (IOPS)	225,722	220,254	69,080	1,104,188

Host Type: FC_32G		Block Level				
		Profile	End-to-End			All Cache Hit
		IO Behavior	Random			Sequential
		Size	4KB	8KB	64KB	512B
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (IOPS)	991,116	974,343	401,440	2,062,735
		Write (IOPS)	199,886	195,219	62,307	1,015,571
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (IOPS)	1,099,043	1,081,808	376,421	2,311,210
		Write (IOPS)	226,984	221,472	69,151	1,020,539

Host Type: iSCSI_25G		Block Level				
		Profile	End-to-End			All Cache Hit
		IO Behavior	Random			Sequential
		Size	4KB	8KB	64KB	512B
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (IOPS)	861,044	818,880	360,587	1,116,357
		Write (IOPS)	187,895	182,178	55,080	896,018
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (IOPS)	954,473	923,246	374,737	1,225,344
		Write (IOPS)	225,484	219,332	65,522	976,995

Host Type: iSCSI_100G		Block Level				
		Profile	End-to-End			All Cache Hit
		IO Behavior	Random			Sequential
		Size	4KB	8KB	64KB	512B
PS 3024 UR FW: 1.62K.18 Block mode	RAID 5	Read (IOPS)	842,667	812,010	306,085	1,210,650
		Write (IOPS)	191,772	186,174	52,163	860,133
PS 4024 UR FW: 1.62K.15 Block mode	RAID 5	Read (IOPS)	948,458	855,208	266,120	1,332,653
		Write (IOPS)	221,802	215,384	66,364	1,000,773

Host Type: iSCSI_100G RDMA		Block Level				
		Profile	End-to-End			All Cache Hit
		IO Behavior	Random			Sequential
		Size	4KB	8KB	64KB	512B
PS 3024 UR FW: 1.64A.21 Block mode	RAID 5	Read (IOPS)	726,681	624,679	347,597	2,803,322
		Write (IOPS)	169,745	163,278	59,409	2,251,118
PS 4024 UR FW: 1.64A.21 Block mode	RAID 5	Read (IOPS)	832,135	724,317	348,340	2,885,066
		Write (IOPS)	195,888	189,778	64,980	2,469,206

4.1.2 IOPS with Response Time

Host Type: FC_16G		Block Level					
		Profile		End-to-End			
		Application		Random Read	Random Read	Database R/W = 70%/30%	VDI R/W = 20%/80%
		Response Time	Size	4K	32K	8KB	4KB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	< 0.3ms	IOPS	1,017,614	623,326	228,195	113,764
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	< 0.3ms	IOPS	1,122,854	706,204	281,313	137,533

Host Type: FC_16G		Block Level					
		Profile		End-to-End			
		Application		Random Read	Random Read	Database R/W = 70%/30%	VDI R/W = 20%/80%
		Response Time	Size	4K	32K	8KB	4KB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	< 0.5ms	IOPS	1,043,296	765,408	278,291	148,154
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	< 0.5ms	IOPS	1,128,677	786,593	358,074	179,078

4.1.3 Throughput with large block size

Host Type: FC_16G		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (MB/s)	25,085	25,103	25,148
		Write (MB/s)	9,697	11,182	18,384
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (MB/s)	25,082	25,110	25,148
		Write (MB/s)	11,026	12,294	18,398

Host Type: FC_32G		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (MB/s)	25,057	25,127	25,150
		Write (MB/s)	10,305	11,620	18,285
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (MB/s)	24,344	25,124	25,150
		Write (MB/s)	11,305	12,619	18,191

Host Type: iSCSI_25G		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	Read (MB/s)	23,195	23,557	23,563
		Write (MB/s)	7,416	7,525	8,067
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	Read (MB/s)	23,089	23,565	23,580
		Write (MB/s)	7,446	7,577	8,284

Host Type: iSCSI_25G RDMA		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62K.09 Block mode	RAID 5	Read (MB/s)	22,842	23,335	23,353
		Write (MB/s)	8,776	12,048	18,318
PS 4024 UR FW: 1.62K.17 Block mode	RAID 5	Read (MB/s)	23,049	23,339	23,354
		Write (MB/s)	9,170	13,446	18,327

Host Type: iSCSI_100G		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62K.18 Block mode	RAID 5	Read (MB/s)	19,837	20,550	21,286
		Write (MB/s)	5,019	5,268	7,127
PS 4024 UR FW: 1.64A.21 Block mode	RAID 5	Read (MB/s)	21,989	21,462	24,979
		Write (MB/s)	7,557	8,255	8,313

Host Type: iSCSI_100G RDMA		Block Level			
		Profile	End-to-End		All Cache Hit
		IO Behavior	Sequential		Sequential
		Size	64KB	1MB	1MB
PS 3024 UR FW: 1.62K.18 Block mode	RAID 5	Read (MB/s)	21,756	21,073	23,861
		Write (MB/s)	10,478	1,0491	18,401
PS 4024 UR FW: 1.64A.21 Block mode	RAID 5	Read (MB/s)	21,987	20,754	23,883
		Write (MB/s)	11,735	13,322	18,406

4.1.4 Application Simulation

Host Type: FC_16G		Block Level			
		Profile	End-to-End		
		Application	Database R/W = 70%/30%		VDI R/W = 20%/80%
		Size	4KB	8KB	4KB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	IOPS	380,225	370,999	218,533
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	IOPS	451,134	441,603	256,947

Host Type: FC_32G		Block Level			
		Profile	End-to-End		
		Application	Database R/W = 70%/30%		VDI R/W = 20%/80%
		Size	4KB	8KB	4KB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	IOPS	398,787	388,346	227,795
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	IOPS	456,108	446,479	257,731

Host Type: iSCSI_25G		Block Level			
		Profile	End-to-End		
		Application	Database R/W = 70%/30%		VDI R/W = 20%/80%
		Size	4KB	8KB	4KB
PS 3024 UR FW: 1.62C.04 Block mode	RAID 5	IOPS	364,652	352,879	215,942
PS 4024 UR FW: 1.61P.05 Block mode	RAID 5	IOPS	438,648	429,942	257,874

Host Type: iSCSI_100G		Block Level			
		Profile	End-to-End		
		Application	Database R/W = 70%/30%		VDI R/W = 20%/80%
		Size	4KB	8KB	4KB
PS 3024 UR FW: 1.62K.18 Block mode	RAID 5	IOPS	371,595	358,969	224,102
PS 4024 UR FW: 1.62K.15 Block mode	RAID 5	IOPS	438,330	426,829	256,064

4.2 File-Level Section

Host Type: Ethernet_25G			File Level - NFS (XFS)			
		IO Type	Sequential (MB/s)		Random (IOPS)	
		Size	1MB	512KB	4KB	Database 8KB (R/W: 70%/30%)
PS 3024 UR FW: 1.62C.04 File mode	RAID 5	Read	13,152	13,188	342,912	114,248
		Write	4,472	4,065	64,672	
PS 4024 UR FW: 1.61P.05 File mode	RAID 5	Read	14,590	14,560	490,232	160,471
		Write	5,412	4,995	94,980	

Host Type: Ethernet_25G			File Level - CIFS (XFS)			
		IO Type	Sequential (MB/s)		Random (IOPS)	
		Size	1MB	512KB	4KB	Database 8KB (R/W: 70%/30%)
PS 3024 UR FW: 1.62C.04 File mode	RAID 5	Read	15,547	14,833	190,339	69,356
		Write	4,514	4,172	78,044	
PS 4024 UR FW: 1.61P.05 File mode	RAID 5	Read	18,536	18,046	312,467	89,327
		Write	5,710	5,404	111,757	

Host Type: Ethernet_100G			File Level - NFS (XFS)			
		IO Type	Sequential (MB/s)		Random (IOPS)	
		Size	1MB	512KB	4KB	Database 8KB (R/W: 70%/30%)
PS 3024 UR FW: 1.62K.18 File mode	RAID 5	Read	13,837	13,712	347,250	103,073
		Write	4,579	4,123	53,071	
PS 4024 UR FW: 1.64A.21 File mode	RAID 5	Read	16,019	16,463	506,976	158,119
		Write	5,506	5,153	93,179	

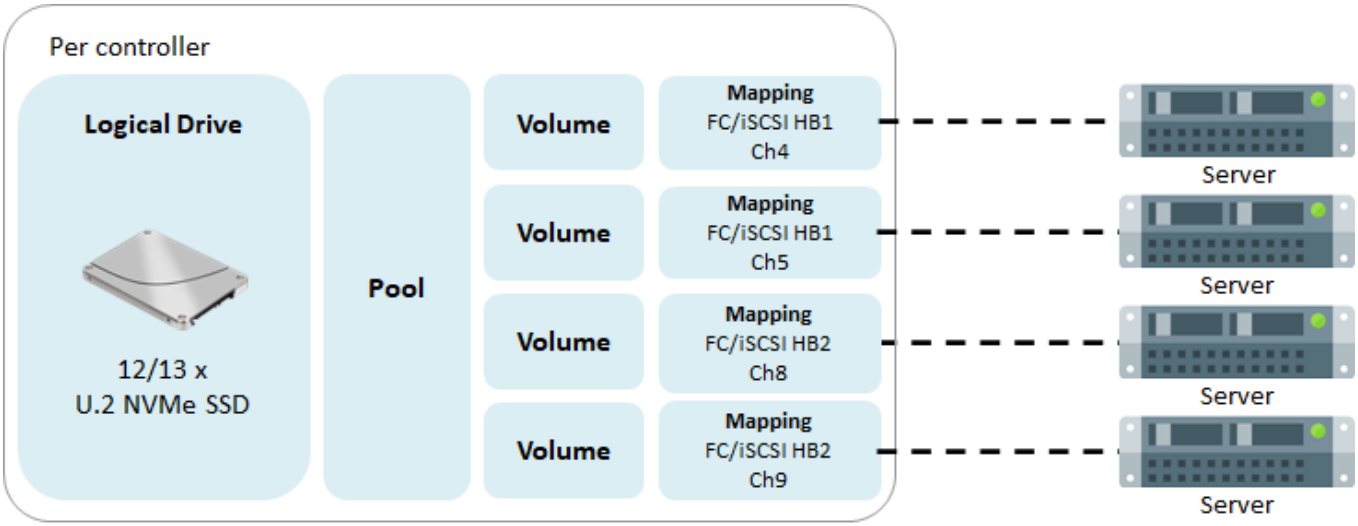
Host Type: Ethernet_100G			File Level - CIFS (XFS)			
		IO Type	Sequential (MB/s)		Random (IOPS)	
		Size	1MB	512KB	4KB	Database 8KB (R/W: 70%/30%)
PS 3024 UR FW: 1.62K.18 File mode	RAID 5	Read	15,337	15,472	210,948	69,148
		Write	4,780	4,369	79,792	
PS 4024 UR FW: 1.64A.21 File mode	RAID 5	Read	17,260	17,164	325,652	88,982
		Write	5,781	5,447	114,017	

Host Type: Ethernet_100G RDMA			File Level - NFS (XFS)			
		IO Type	Sequential (MB/s)		Random (IOPS)	
		Size	1MB	512KB	4KB	Database 8KB (R/W: 70%/30%)
PS 3024 UR FW: 1.64A.21 File mode	RAID 5	Read	14,614	14,672	378,411	110,979
		Write	5,076	4,558	68,088	
PS 4024 UR FW: 1.64A.21 File mode	RAID 5	Read	15,040	15,215	511,468	158,583
		Write	6,029	5,570	99,165	

5 Topology

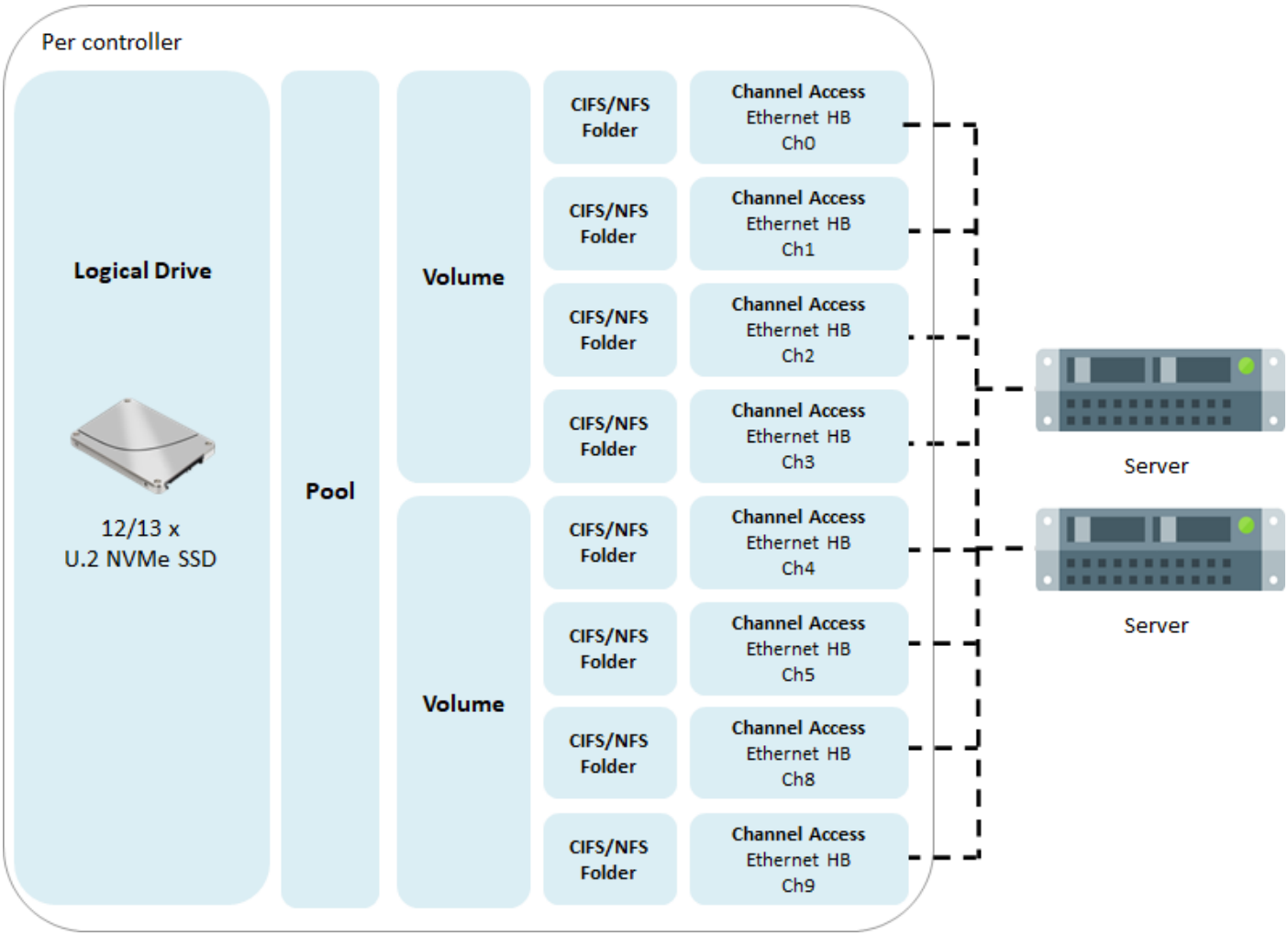
This section illustrated the principle of the network topology and storage configuration. Please refer to topology section and the system configuration section to get the best performance from PAC Storage PS family. **Note**: To leverage the advantage of multi-thread, please create multiple shared folders to run the file-level tests.

5.1 Block-Level



Note: The diagrams above are just for your references. If you need detailed number of channels, please refer to below forms.

5.2 File-Level



Note: The diagrams above are just for your references. If you need detailed number of channels, please refer to below forms.

Block-level	Model	# of Host Board per controller	# of Channel per controller
FC 16G	PS 3024UR	2	4
	PS 4024UR	2	8
FC 32G	PS 3024UR	2	4
	PS 4024UR	2	4
iSCSI 25G	PS 3024UR	2	4
	PS 4024UR	2	4
iSCSI 100G	PS 3024UR	1	2
	PS 4024UR	1	2

File-level	Model	# of Host Board per controller	# of Channel per controller
Ethernet 25G	PS 3024UR	2	4
	PS 4024UR	2	4
Ethernet 100G	PS 3024UR	1	2
	PS 4024UR	1	2

6 System Configurations

6.1 Storage Configuration Profile

The following table shows the configuration adopted from our PS best practice with a storage pool and a shared folder. To provide a single namespace sharing solution, we configured the PS dual controller models with an active-standby configuration.

As a tradeoff between usable capacity and failure tolerance, we recommend building the LD within 15 drives.

6.1.1 Block-Level SSD

Model	# of Drive	# of LD	# of Pool	# of Volume	# of Client
PS 3024UR	24	2	2	8	4
PS 4024UR	24	2	2	8	4

6.1.2 File-Level SSD

Model	# of Drive	# of LD	# of Pool	# of Volume	# of Folder	# of Client
PS 3024UR	24	2	2	4	8	4
PS 4024UR	24	2	2	4	8	4

6.2 Storage System Settings

We use the following parameters to optimize the media workload, which differs from the PS default settings. For detail parameter settings on EonOne, please refer to EonOne software manual.

RAM (per controller)	48GB (16GB x 3)
Stripe size	128K
Maximum Tag Count	64
Periodic Drive Check Time	Disable
Periodic SAF-TE and SES Device Check Time	Disable
Max Drive Response Timeout	Disable
Drive Access Delay Time	No Delay

6.3 Client Workstation Information

The following table shows the specification of the client workstation we used for the performance test. To ensure optimal system performance, we recommend that you deploy a solution with better specifications, especially PCIe lanes and CPU.

M/B	Super Micro X12SPL-F
CPU	Intel Xeon Silver 4309Y CPU 3.60GHZ
RAM	DDR IV 2933 32G*8 (256GB)
PCI	2 PCI-E 4.0 x8, 2 PCI-E 3.0 x8
System Drive	SATA WD 500G (WD5003ABYX-01WERA1)
OS	Windows Server 2019
HBA card	Intel(R) Ethernet Controller E810-C for QSFP (Packet Size:9014) (Receive Buffers:4096) (Transmit Buffers:4096)
MPIO	OS native
Power Option	High Performance
Jumbo Frames	Linux MTU 9000

6.4 Benchmark Tool Settings

Benchmark Tool	IOmeter 2006.07.27	
I/O setting	Outstanding	Random – 256, Sequential – 64
	Ramp Up Time	30 sec
	Run Time	180 sec
	All Cache: Maximum Disk Size 102400	
	One LD Corresponds to One Worker.	
	Align I/Os on	

Benchmark Tool	Vdbench	
I/O setting	Sequential	Files=10, Size=5g, Threads=10, elapsed=120, interval=10, warmup=20
	Random	Files=10, Size=5g, Threads=64, elapsed=120, interval=10, warmup=20
	All Cache	Files=6, Size=10m, Thread=4, elapsed=120, interval=10, warmup=20
	Random32K(Linux)	Files=125000, Size=32k, Threads=5, elapsed=60, interval=5, warmup=10
	Random32K(Windows)	Files=45000, Size=32k, Threads=5, elapsed=60, interval=5, warmup=10

7 Conclusion

Comparing to SAS/SATA SSD, U.2 NVMe SSD can communicate with CPU via PCIe interface directly, so the latency can be much lower. With lower latency and larger bandwidth, U.2 NVMe SSD can deliver higher performance, and users can reach the performance limit of controller with fewer drives. This makes U.2 NVMe PS a more cost-effective All-Flash solution.

8 Legal Information

All PAC Storage products, including the product/s that customers have purchased from PAC Storage, are subject to the latest Standard Warranty Policy.

PAC Storage may from time to time modify, update or upgrade the software, firmware or any accompanying user documentation without any prior notice. PAC Storage will provide access to these new software, firmware, or documentation releases from certain download sections of our website or through our service partners. Customer will be responsible for maintaining updated version of the software, firmware, or other documentation by downloading or obtaining from PAC Storage, and installing designated updated code, including but not limited to firmware, microcode, basic input/out system code, utility programs, device drivers, and diagnostics delivered with PAC Storage product.
Before installing any software, applications or components provided by a third party, customer should ensure that they are compatible and interoperable with PAC Storage product by checking in advance with PAC Storage. Customer is solely responsible for ensuring the compatibility and interoperability of the third party's products with PAC Storage product.

Customer is further solely responsible for ensuring its systems, software, and data are adequately backed up as a precaution against possible failures, alternation, or loss. For any questions of hardware/ software compatibility, and the update/ upgrade code, customer should contact PAC Storage sales representative or technical support for assistance.

To the extent permitted by applicable laws, PAC Storage will NOT be responsible for any interoperability or compatibility issues that may arise when (1) products, software, or options not certified and supported by PAC Storage are used; (2) configurations not certified and supported by PAC Storage are used; (3) parts intended for one system are installed in another system of different make or model.

9 Contact Information

Website

For more information of PAC Storage's products and service:

www.pacstorage.com

Customer Support

Contact your system vendor or visit the following support site:www.pacstorage.com