WHITE PAPER

MECHANISMS FOR COST SAVINGS USING READVERIFY™ APPLIANCE (RVA)

CROSSROADS®

The SurePath ReadVerify™ Appliance (RVA) is an out of band, tape system environment monitoring appliance. RVA has been specifically designed to provide information on the physical tape environment, allowing the users to minimize backup and recovery failures and to identify points of error when failures do occur. Along with the improved visibility and information available to the user, the five areas of cost savings RVA provides are:

- Reduction of backup failures—45% to 56%
- Reduction of recovery errors—90%
- Reduction of media purchases—50% to 70% annually
- Reduction of hardware capital purchases—20% to 30% of annual capital budget
- Reduction of labor time—9 man hours per backup failure and 22 man hours per recovery error

This paper will first discuss the various methods for cost savings that RVA supports, and it will use case examples from client experiences to date. Of course, every environment is different, and the savings will vary based on the processes and use of the tape backup systems.

MINIMIZED BACKUP AND DATA RECOVERY FAILURES

ReadVerify Appliance enables the user to minimize backup and recovery failures. This enables lower costs throughout the backup system environment as well as significant resource savings.

Tape Drive Performance

One major area of tape failure (both backup and recovery) occurs when the data transfer rate written to the tape drive drops below the drive's streaming rate. Typically, tape drive manufacturers report their performance at native rate and then 2:1 compression rate (which is the typical compression rate of data in the IT environment). The streaming rate, however, is even more critical because if the I/O does not meet this level, then the drive is going to constantly go into what is called "shoe shining" mode. This is where the drive must stop writing to the tape, rewind a little bit and then restart. The drive must read the date previously written then splice the new data exactly at the end of the last data. There are many, many issues that are created by shoe shining:

- Splicing the tape with new data doesn't give the same quality level as when the data was written in one complete pass.

- It is best practice to rewind a tape when it is out of the tape path and in the cartridge since there are multiple physical mechanisms that could cause damage to the tape surface during the rewind motion. Shoe shining rewinds with the tape engaged in the tape path—the worse the data rate, the more shoe shining occurs as does the greater the potential for media damage. The opportunity for media damage is again increased when the drive/tape/library isn't located in the proper environment, allowing dust and other particulates to get into the mechanism. This can particularly be an issue with LTO tape drives. Because the read/write heads of LTO drives are in physical contact with the tape media, the back-hitch will cause what is, effectively, a "small rock" to scrape the media during every rewind.

- The data already written to the tape has already been confirmed "good" with the backup application and is in all likelihood no longer available. The back-hitch requires that data to be read such that the splice discussed above can occur. If the shoe shining process damages the media then the drive will not be able to read the data and won't be able to splice. Since the data has already been verified, there isn't a method left to retry or retrieve the lost data; therefore, the backup will fail.

- Because the shoe-shining operation is done in the data path, the media could be damaged in multiple locations—either by the drive mechanisms themselves or some foreign object in the tape path. Since the data verification was performed on the write operation, and this type of damage occurs post-verification, there is

the possibility of a read error occurring during a recovery operation.

Crossroads ReadVerify Appliance provides the users the visibility into the tape drive environment to not only track the real-time drive performance, but to also provide alerts to the user when the drives are at or below the streaming rate. There are other tools that show the performance of tape drives, but unless they are tracking each drive during the complete I/O process, they might not detect the non-streaming events.

ROI—*Minimized Backup Failures:* Since RVA provides alerts to non-streaming events, the user can tune the tape system to maximize throughput or balance the environment. (It is possible that the environment cannot support the streaming rate for certain tape drives and therefore other drives might be required to balance the I/O performance). Tape drives, media or the combination of the two accounts for 65% to 80% of backup fail ures. Non-streaming or defective drives are directly accountable for over 50% of those failures—if the non-streaming events were removed, the user would see a reduction in backup failures of 32% to 40%.

Use Case: In nearly 85% of installations, RVA has shown the impact of non-streaming drives on the backup process and allowed the user to identify areas of improvement to the environment. This has directly translated to time and cost savings since every backup or recovery failure requires the user to analyze the result, report on the failure and its impact and attempt to resolve it. Without RVA, isolating the failure is usually a shot in the dark and typically involves throwing away the media and trying again.. The bigger the environment, the bigger the issue and the bigger the savings with RVA. One customer with a 3,500 slot library cut their backup failures in half and decreased the time to analyze and report on failures by over 66 percent. This customer will save at least one IT resource, and combined with the media cost and analysis time, they will save an estimated $200,000 per year—almost 15% of their IT budget.

ROI—*Minimized Recovery Errors:* Since the shoe-shining process can damage media post-write and without the user's knowledge, there is exposure for a recovery to fail during its read process. The cost associated with recovery errors range from business downtime to the value of complete data loss (cost of data varies depending on whether the data can be regenerated or not). In the case of a services organization, research labs or government suppliers, this can result in significant penalties for not achieving the agreed upon service level agreement. Recovery errors occur less frequently than backup failures; however, they are much more costly to deal with. Our analysis has shown that the typical cause of a recovery error falls into three areas (assuming the data has been successfully written):

1. Damage to media
2. Poor interoperability between drives
3. Degradation of media.

The primary cause is media damage, which accounts for 90% of the recovery errors. However, both the interoperability and degradation exacerbate the recovery challenges, and the longer media is stored, the greaterthe risk of media degradation. If the environment is corrected such that non-streaming events are removed, the damage associated with shoe-shining will be eliminated and the recovery errors can be reduced from 70 to 80 percent.

Use Case: Multiple clients, ranging from small institutions to large government agencies, have experienced this exact issue. In all cases, there was one drive performing very poorly due to both a sub-streaming data transfer rate and because the drive required maintenance. In all cases, the shoe-shining process was occurring and the media was being damaged. In these cases, the customers had tapes written "successfully," but in reality, the tapes could not be read. In all cases, the drives could be easily repaired, but the stored media was now suspect and immediate full backups were performed to create a solid starting point. In one case, a small bank would have lost their daily journals updates, which would have cost them over $60,000 per day for the required data recovery.

Drive and Media Error Rates

The quality of tape media is very high, but every analog-based system has a distribution curve associated with it, and tape media is no different. Every batch of media is different than the next, but all still pass minimum quality requirements. However, as media is used, the quality of it will degrade. As stated earlier, if the media is installed in a drive where I/O performance doesn't match the streaming rate, there is a higher likelihood that the media will be damaged.

As with all mechanical devices, tape drive operation will degrade over time. A drive that needs cleaning or requires maintenance can introduce errors onto perfectly good media. It's a very real challenge for the IT manager to correlate the root cause of write errors to either the drive or the media. This is typically another "shot in the dark", and a lot of time and money can be wasted by throwing away good media if it's a drive problem, or taking drives out of service for maintenance when it's really a media problem.

RVA provides a simple, intuitive report for error rate performance. RVA can also be configured to alert the user when the error rate grows to a certain level. In this manner, degrading media can be proactively removed from the library, or degrading tape drives can be serviced before backup or recovery failures occur.

ROI—*Minimized Backup and Recovery Errors:* The cost associated with detection and recovery from backup errors along with the variable expense associated with recovery failure can be minimized through the proactive removal of degrading media. Bad or degrading media account for approximately 20% of the failures associated with tape drives and media interactions. By removing this media from the environment, the user could see a reduction of backup failures of 13-16 percent. Ninety percent of recovery errors are associated with either poorly written media (due to shoe-shining or degraded drives) or bad media. RVA provides the ability to identify error trends and correlate the root causes to poor drive performance, required drive maintenance or degrading media. By utilizing and acting on the information provided by RVA, nearly 90% of recovery errors can be prevented.

Use Case: A large airplane manufacturer was able to use RVA to detect and isolate defective media very quickly. One of the challenges in using the backup application is that when a piece of media is reused, its old data metrics are erased. RVA keeps a complete record and so the customer was able to see that certain sets of media were performing much worse than the general population and, in fact, were contributing to the poor performance of the backup and backup errors. Of course, if this continued to go undetected, the media would be unreadable. This customer performs daily backups, but even the loss of one day's worth of the data would cost hundreds of thousands of dollars in data recovery.

ROI—*Minimized Media Costs:* The cost of a single media cartridge can vary from $25 to more than $100 depending on the type of media and drive technology. The cost per terabyte stored is quite compelling; however, in many large operations, the media budget (new media purchased yearly) can be significant. Since detecting and diagnosing backup and recovery errors is difficult, and since most failures are reported as a 'MEDIA ERROR' of some type, the user typically removes the reported media as a "quick fix." Again, this is a complete shot in the dark, but it, at least, serves a purpose of some sort of corrective action. Some businesses require a media cycle such that after a certain number of uses, the media is removed and thrown away. This is done to reduce the risk of recovery errors, but as discussed earlier, the main cause of recovery errors has little to do with individual media and more to do with the drive/media interaction. Since RVA gives actual error rates on media that can be coordinated with usage in individual drives, it is a simple exercise to detect degrading or failing media and remove it from operation. The converse is also true. By correlating multiple reported media errors to a single drive needing service, cost savings are achieved by avoiding misdiagnosis and throwing away good tapes. In addition, by retiring media based on actual error trends versus metrics such as load counts, media which hasn't degraded can remain in the library. Initial results are showing that this can result in significant savings. If a user follows the "throw away on failure" process, then the media savings are

approximately 10% of the annual media purchase budget. However, if a use cycle is utilized, then the annual savings will grow to greater than 50% of the annual budget. Quickly isolating backup failures to the drive instead of the tapes can save another 10- 30 percent of the media budget.

Use Case: A few customers have utilized RVA long enough for us to see some of the results associated with media savings. The largest installation utilizes a cycle process for media and has already delayed their traditional media purchase by six months. Estimates show that they will not need to purchase new media for another 8 months showing over 100% improvement in their media purchase budget—more than $250,000 pushed to their IT budget for the next year, which more than pays for RVA systems.

Archive Media Verification

One of the biggest challenges and most labor-intensive processes is to verify tape media that has been written and stored for a period of time. Tape media degrades over time as it is stored. The failure rate can vary depending on the condition of the environment (ie. temperature, humidity, dust), the number of times the tape has been rewritten to, the condition of the tape drive (ie. needing cleaning or maintenance), and the quality of the write operation (ie. Was it performed at streaming speed?). Current standard practices typically rely on an IT administrator who manually spot-checks portions of randomly-selected tapes within the archive. RVA, with the addition of the Archive Verification feature, will automatically load tapes into designated tape drives and verify readability based on policies set by the user. The Archive Verification (AV) feature insures that all targeted tapes are checked and that the entire length of the media is readable. This will be done automatically, with no human IT resources required. Instant alerts can notify the administrator of any immediate problems within the environment, such as a non-responsive drive or a stuck tape, and automatically generated reports will indicate which tapes have been verified and whether any errors were detected on the media. Armed with this data, the storage administrator can take proactive measures to ensure the data is recoverable (rewrite degraded media or recreate data sets that are corrupted)—before the data is needed by the enterprise.

As this feature utilizes the SCSI Verify command, a level of security is maintained through the process. The Verify command performs the data check at the drive level, not at the system or server level. This keeps the content securely contained at the tape and drive. Also, as the checks are performed at the block level, both encrypted and non-encrypted tapes can be verified. If AV success fully reads the tape, then the data is assured to be the same as originally written.

ROI—*Minimized Recovery Errors:* The costs associated with recovery errors range from hours of downtime to complete data loss, which varies based on the criticality of that data and whether the data can be recreated. In the case of a services organization or government suppliers, this could also result in significant fines or restitution payments. Most recovery errors are due to poorly written or degraded media. However, media will degrade over time as it is stored. This degradation varies based on the original quality of the media, time and environment. Assuming the data was written correctly, RVA will detect and alert the user to this media degradation. The archive verification feature will detect all cases of recovery problems which exist. This includes poorly-written tapes (from non-streaming events, or defective drives) or degradation that occurs over time. If the policies are setup to verify the media on a consistent basis, RVA archive verification can alert the userin time to take corrective actions. In this case, RVA can enable the user environment to remove 98% of recovery errors.

Use Case: One of our customers provides a service of media storage and management for their customers. It is implied in their service that they guarantee the recovery of the customers' data as required—in fact they have service level agreements stating this. While this customer knows the odds are high that they will have a recovery error, they are currently living with the risk. The archive verify feature is desired to automatically validate the data they are retaining—but the critical element is that the data is never exposed such that security is kept at all times. We were not given the penalties they would have incurred for

not being able to read the data, but one event would cost more than the entire RVA implementation.

ROI—*Labor Reduction:* In some organizations with significant volume of tape, they apply human resources to verify and certain set of media, much like an audit. The challenge is that all media isn't verified and rarely does a piece of media get verified more than one.

Use Case: Another customer is in the business of data reparation and currently uses human resources with separate systems to audit their data pool. Of course the media in the pool doesn't follow standard lot based statistics such that an audit provides no guarantee that the pool is good and all media is recoverable. The Archive Verify feature with RVA will give them the ability to automate this process and increase the analysis to 100 percent. The savings from human labor will pay for the system in 14 months; however, if enough labor was added to cover 100% of the tapes stored, RVA would have been paid for in 4 months.

MAXIMIZED TAPE ENVIRONMENT RESOURCES

The ReadVerify Appliance provides information and visibility into the real-time operations of the tape backup environment such that maximized efficiency and utilization of the physical assets can be achieved.

Tape Drive Utilization

Backup applications and even tape libraries report on drive utilization; however, the utilization they are reporting on is measured by the time the drive has a tape in it versus the time it does not. RVA reports this as occupancy (i.e. the drive is occupied) but reports utilization as the time I/O is being performed on the drive versus no I/O. In multiple installations, RVA has shown a major discrepancy between occupancy and utilization. The backup application and its configuration have typically been the primary factor, but the performance of the tape drives also plays a role.

ROI—*Reduced backup window / Reduced physical resources:* IT professionals are constantly dealing with the ever increasing backup window. Maximizing the efficiency of the backup systems will result in a limitation of capital purchases (tape drives, libraries, backup server licenses, etc) and/or the reduction of required time for backup services. Depending on the skill level, complexity and data volume of the end-user environment, the benefits will vary. At a minimum, the user will see a 10% improvement in backup window, and we have seen this reach up to 40%. The value of system time varies based on the business; however, the benefit of delaying capital purchases is more quantifiable. The average business's data grows by 38% each year. With the efficiency improvements, businesses can delay capital purchases for 1½ to 2 years. Typically this can provide 20% to 30% of the IT capital budget.

Use Case: One of our first customers was willing to look at RVA, but had just purchased a new library with new drives because their backup window had grown beyond their allowed time and the old library had a reported utilization of 100 percent. When RVA was installed, it immediately showed that the actual utilization was around 60 percent. While the drives were occupied nearly 100% of the time, the inefficiency of the backup application, the network configuration and their servers was causing the significant discrepancy. In this case, the customer could have saved the over $150,000 in the new library and drive costs for a single RVA and their smaller library. It is estimated that they wouldn't have needed a new system for more than two years due to their current data growth. This isn't a large business such that the one library purchase accounted for nearly 50% of their allotted capital budget for the year and therefore they couldn't spend that money on infrastructure and network security that was also required.

Tape Drive Load Balancing

Most of the ReadVerify Appliance installations have shown that not only is the occupancy/utilization imbalanced, but

the tape drives are also imbalanced between themselves. When backup environments are initially configured, the data backed up from the servers is typically evenly distributed across the tape drives. However, organizations change over time: Projects are completed, departments are reorganized and/or new initiatives are started. The balance of the data across the enterprise changes, yet the configurations of the backup environments are typically not modified regularly to accommodate these chances. Consequently, over time, the load to the tape drives becomes unbalanced. Certain drives are used significantly more than others. This leads to two major, and often misdiagnosed, types of failures: 1) backups taking longer and failing to complete in time, and 2) premature wear and tear on over-used drives.

ROI—*Maximized Use of Existing Resources:* As the balance of data written to the tape drives becomes more lopsided, the length of time to complete backup increases, leading to increased backup failures due to inability to complete within the specified backup window. An administrator may attribute these increasing failures to data growth within the organization. The conventional solution to this problem is to simply purchase another tape drive. By using RVA to realign and balance backup traffic evenly across all drive resources, the administrator can delay or even eliminate the need to purchase additional tape drives.

Use Case: Several customers, including our own Crossroads IT department, had seen their backup window growing to the maximum time allocated. By rebalancing the data directed to the tape drives, backup times were reduced by as much as 50 percent. The cost savings associated with delaying the purchase of a tape drive can range from a few thousand dollars to over $40K, depending on the tape technologies and drive maintenance costs.

ROI—*Extended Resource Life:* The other effect of an unbalanced system is the premature wear and tear on the overused devices. This situation is difficult to diagnose without a tool like RVA, and an IT manager is likely to associate any failure with tape media, thus perpetuating a continual misdiagnosis and ultimately continuing the cycle of backup and recovery failure. The value associated with removal of backup and recovery errors was discussed earlier. The added advantage provided here is the extension of capital resources for their effective life. It is difficult to measure exactly, but if the user continually balances the devices per RVA reports, they should see an average extension of system life of 10 percent. In some businesses, the duty cycle is low enough such that normal system upgrades occur before the life of the drive is reached; however, there could be some environments where this could result in hundreds of thousands of dollars in delayed capital.

Use Case: We have multiple customers with environments that demonstrated the same “single drive overuse” scenario described above. For example, in one case, a customer’s single drive was utilized nearly 100% of the time, and its other drives ran at 40%, 20% and even 10% of the time. In all cases, the overused drive was performing poorly and causing significant damage to the media due to shoe shining. The drives could be fixed by cleaning (no indication from the drive, library or backup application that the drive needed cleaning). However, the real fix was to balance the use of the tape drives. This not only improved the backup window but will extend the life of the drives. Also, the backup failures were reduced due to fixing the defective drives. Again, the long term benefit is that the drives won’t require repair well before the maintenance plan calls for it.

Backup System Performance

One of the biggest challenges with fibre channel networks is the lack of visibility into the overall environment. This problem is especially visible with tape systems since (1) the data packets are usually very large and (2) there are multiple data buffers within different systems in the network that may impede ideal traffic flow. An example of this would be in-line encryption from appliance or switch vendors. Data traffic is halted and then restarted. The problem for the IT administrator is finding where bottlenecks or poorly behaving systems are located in the network. Typically the problem is “solved” by trial and error and left at “good enough.”

ROI—*Resource / Time:* Typically the IT users only know there is a problem with their backup or recovery when they are in the process of doing a backup or recovery. This is of course the worst time to discover this, and there is little to no time available for diagnostics as the requirements of the business take precedence over engineering analysis. In most environments, there are multiple vendors and there are always situations of finger pointing to isolate an issue, which can take days if not weeks or months to resolve. In the case of service providers, this can cause a direct impact to the bottom line—the longer the customer is down, the more the cost against the SLA. In any case, delay impacts productivity, which impacts the business' affectivity. Data provided by RVA enables other vendors to isolate the problem and provide timely fixes. In the end, downtime from tape environment failures can be reduced by more than 50 percent.

Use Case: The common theme from all of our customers is the lack of visibility into their backup environment. Downtime and resource drain due to long troubleshooting diagnosis are expensive in terms of cost and loss of productivity. RVA can shave days off of analysis and even remove the need for expensive engineering onsite visits.

RESOURCE EFFICIENCIES

ReadVerify Appliance provides intuitive reports for the user that can be leveraged in their daily requirements. In the case of a backup failure, many of our customers must perform root cause analysis and provide a detailed report of the event and cause.

ROI—With RVA they have been able to significantly reduce the failures, but when one does occur, RVA reports are used to diagnose and provide content such that their reports are done faster and with more detail enabling a cleaner root cause analysis and corrective action process. Simply put, RVA enables IT resources to focus on more pressing issues than diagnosing and creating reports. Ultimately, the savings vary from one business to another depending on the reporting requirements and any penalties that might be incurred for poor performance. If RVA is deployed and action taken as recommended, backup failures could be reduced by 30% and recovery errors by over 98 percent. The resources required to deal with these failures are directly related to these failures. A single backup failure on average will required six man hours to deal with, and a recovery error will require an average of 22 hours (for IT staff). However, recovery errors could result in hundreds of man hours lost in critical functions within the company.

Use Case: One of our government customers has the requirement to perform root cause with a diagnosis and corrective action report for every backup failure and more so for any recovery errors. The savings they have seen from the reduction of backup errors has already been spoken about earlier in the paper, but the resource savings on diagnosis and paperwork has also been quite extensive. At this customer, they have already reduced their IT resource growth requirements due to the time savings in reporting and analysis that RVA provides. It is difficult to quantify since every resource is used in many roles, but a conservative estimate is one resource savings per 15000 slots in just reporting labor.

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ABOUT CROSSROADS

Headquartered in Austin, Texas, Crossroads Systems delivers flexible solutions to protect, secure and restore business-critical "data-at-rest." Crossroads (symbol:CRDS) is currently traded on Pink Sheets and also posts its financial disclosure reports, press releases and other related documentation on the OTCIQ webservice of the Pink Sheets website. For more information, please visit www.crossroads.com.

Crossroads promotes institutional and personal environmental responsibility within the company, with our partners and with the users of our products. We are committed to providing the best products and services while encouraging practices consistent with sustainable living and resource conservation.

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