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StorageTek SL8500 Modular Library System Analysis of Reliability and Availability

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Executive Overview

To stay ahead of rapidly changing business conditions, organizations depend on fast and easy access to the information maintained in their corporate datacenters. Having a highly available system with 24x7 access to data is critical in meeting business demand. This document discusses Oracle's StorageTek SL8500 Modular Library System availability and the importance of hardware component redundancy for improved system availability.

Introduction

Oracle's StorageTek tape automation systems are well known in the industry as highly reliable products. However, data center operators are much less concerned with component reliability than with actual overall system availability. If a customer cannot backup or retrieve their data, it makes little difference whether the system is down for scheduled maintenance, a feature upgrade, or to replace a component. Knowing that the cost of downtime can be extremely expensive, the design goal of StorageTek libraries is to address major issues that affect downtime – reliability, availability and serviceability.

Today's libraries are highly complex systems, and no matter how reliable the design, there is always some exposure to downtime, whether scheduled or unscheduled. By improving the reliability of a system, availability is improved. However, reliability is limited by the current state of the technology, and a probability of failure exists that may be unacceptable in the 24x7 data center.

System availability can be vastly improved by added redundancy to the key components or sub-systems in a library. Redundancy adds a standby component that performs the function when the primary component fails. In reliability terms, a complex system like a library is called a series system, where a single failure in the series can result in the failure of the system. When certain components or sub-systems have a higher risk of failure, a parallel stand-by

component can dramatically increase the probability of success of the sub-system. This, in turn, improves the availability of the overall system.

Improvements in robotic and software design have dramatically increased the reliability of the StorageTek SL8500 over the early StorageTek PowderHorn 9310, which was released in 1993. A 9310 library system has an availability of roughly 0.995, which includes scheduled maintenance time twice per year for code and hardware upgrades, break/fix activity, and required maintenance. In contrast, the SL8500 modular library system with full redundancy such as redundant power, redundant robotics and library electronics with non-disruptive serviceability improve library availability to 0.99996.

Redundancy and Availability

Oracle's StorageTek SL8500 modular library system offers an improved level of redundancy over past products. Field data on past products show that 85 – 90% of library hardware is made up of three key sub-systems: robotics, control modules and power supplies.

The SL8500 was the first library product in the industry that offered redundancy on all three key sub-systems. Thus the intent is not only to provide a highly reliable system, but a fully redundant system, meeting the ultimate goal of high availability to the customer. Another key aspect of the SL8500 architecture is that all redundant components are designed for "live service". This means that in a fully redundant system the robotics, library electronics, power supplies, and fans may all be serviced while the library remains fully operational. Adding redundancy with live service capability to all three key subsystems increases the operational reliability of the SL8500.

Overall, the availability of the SL8500 with full redundancy improves from 0.99988 to 0.99996. Table 1 below equates availability to down time per year.

Table 1: Estimated Downtime per Year based on Availability

Availability	Estimated Downtime per Year
0.99	3.65 days
0.999	8.76 hours
0.9999	52.56 minutes
0.99999	5.26 minutes

There are several different types of parallel redundancy implemented in SL8500:

- Active parallel redundancy is where both components share the operational load. This lowers the duty cycle of both units improving the reliability of each. If one fails, the parallel unit assumes the full load until the other component is replaced.

- Standby parallel redundancy means the parallel component is passive, waiting to be switched on if the first unit fails. The standby component is assumed to have a "zero" failure rate in standby capacity.

- N+1 adds redundancy to a series of components, where the parallel standby component can replace any one of the "N" components.

- 2N adds redundancy to each of the "N" components in the series.

By adding redundancy to key sub-systems, the system availability is improved. The end result is that a failure of a parallel component in a redundant system has virtually no impact on the customer's ability to access data.

Major Components Impacting Availability

Robotics

A base SL8500 is designed for the operation of one robot or HandBot per rail. One HandBot has a reliability of .64. In other words it has a probability of 64% of lasting 5 years. A robot redundancy option offers a 2nd HandBot per rail, which functions as an active parallel redundancy. With this feature, both robots per rail share the load under normal operating conditions, each having a 50% duty cycle. The reliability of both robots working together is 93%. This is a 29% improvement over a single robot configuration. If one robot fails, the other robot takes up the full load until a service engineer replaces the failed robot. The service safety door allows the failed robot to be replaced non-disruptive to normal library operations. The probability of the 2nd HandBot going down in the next 24-hour service period making the data unavailable to the customer or the host computer system is .0005.

Control Cards

The SL8500 offers redundant library electronics, acting as a standby parallel system. The first set of library control cards (HBC / HBT pair) has an estimated reliability of .59. If the primary set of control cards fails, the standby pair takes over. In terms of availability the failure of the active control cards has no impact to the customer or host computer system. The reliability of a redundant electronics system is .84, a 24% improvement in reliability over a single electronics system.

Power Supplies

Standby redundant power supplies are offered for the library electronics, pass-through ports, cartridge access ports (CAPs), and Z-Elevator. There are also two redundant configurations of power supplies offered for the robots and tape drives: N+1 or 2N. An N+1 configuration provides DC power redundancy, while a 2N configuration provides full AC and DC redundancy.

Under normal operation, two power supplies are required for a minimum configuration of four robots. An N+1 redundant configuration would use three power supplies, and a 2N power configuration would require four power supplies. For redundant robot configurations using eight robots, the N+1 power system would have five power supplies and the 2N power configuration would require eight power supplies.

A single power supply has a reliability of .83. A standby power supply redundancy predicts a reliability of .97, or a 14% improvement. The N+1 configuration of the power supplies for the robots improves the reliability by 16% to .995. The 2N power supply configuration for the robots offers a reliability of .999.

Code Upgrades and Scheduled Maintenance

Library availability is also affected by downtime to perform code upgrades and scheduled maintenance activities such as hardware upgrades. The SL8500 procedure for control software will allow the installation and distribution of new software versions to occur without customer operations interruption. Switching from one code version to the other (IPL) only takes a few minutes and with redundant electronics the switch is non-disruptive to host applications. Also, the previous software version will be retained in the hardware elements for rapid re-activation in case undesirable behaviors are found in the new installation. The hardware redundancy allows for hardware upgrade and repair without library downtime.

Library Availability

The real improvement to the customer for StorageTek libraries can also be expressed in terms of availability. Assuming the same premium service level, library availability would go from 0.99988 for a basic SL8500 library system to 0.99996 for a fully redundant SL8500 library system. An availability of 0.99996 implies an average downtime of 21 minutes per year.

Table 2: Library System Availability

Library Configuration	Availability	Estimated Downtime per Year
PowderHorn 9310	0.995	43.8 Hours
L700	0.999	8.76 Hours
Basic SL8500	0.99988	63 Minutes
Fully redundant SL8500 with 2N power, redundant robotics, and redundant electronics	0.99996	21 Minutes

Conclusion

Oracle's StorageTek SL8500 modular library system keeps risk at bay, with innovative technologies that have been proven in the most-demanding enterprise environments. Non-disruptive, on-the-fly replacement of robotics, library electronics, power supplies, and drives helps sustain 24x7 operations. Dedicated TCP/IP library control paths with optional dual- or multi- control path technology increase overall library availability. All of these advances bring the availability of a fully redundant SL8500 library to 0.99996, a 100x improvement in availability over its predecessor, the PowderHorn 9310.

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