IBM® Storage

Optimize the Value of Your Data with Oracle and IBM Flash Storage Solutions

IBM

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In this multicloud and cognitive era, information continues to grow rapidly. By 2025, IDC says worldwide data will grow by 61% to 175 zettabytes, with as much of the data in data centers as in the cloud[1]. IT environments with Oracle deployments will need to accommodate that data growth, including storing, copying, mirroring, and protecting the data. When IT budgets are constrained but data keeps growing, storage costs can consume more than their fair share of the IT budget.

The leading-edge portfolio of storage solutions and essential technologies of IBM® can help organizations stay ahead of the information explosion. Designed with built-in efficiency, these solutions represent preferred practices that address the following main storage objectives for hybrid multicloud environments:

- Stop storing so much

    Storage efficiency technologies, such as data deduplication and real-time data compression, can help organizations that run Oracle to reduce the amount of data that must be stored. With IBM Real-time Compression™, organizations can reduce their storage capacity requirements by up to 80%. Data deduplication capabilities built into Data Reduction pools of the IBM Spectrum® Virtualize™ storage system can enable up to 95% smaller disk backups[2].

- Store more with what you have

    Advanced capabilities, such as thin provisioning and storage virtualization, help organizations extend the value of their storage investments by increasing utilization. IBM Storage virtualization solutions can enable up to 30% more utilization, and IBM thin provisioning solutions can increase utilization up to 35%[3].

- Move Oracle and related data to balance performance and efficiency

    Automated storage tiering and automated data migration can help organizations match the value of the data to the cost of the platform, which ensures that storage resources are used in the most effective way. AI-enhanced IBM Easy Tier® provides automatic migration of frequently accessed data to high-performance flash storage or multiple tiers of flash drives, which enhances storage efficiencies. Operating at fine granularity, the optional Easy Tier function automatically moves data to the optimal storage type based on input/output patterns and drive characteristics, which requires no administrative interaction.

IBM offers true enterprise class storage support for Oracle deployments at a low total cost of ownership (TCO). With flash disk, tape, storage network hardware, consolidated management console, software-defined storage solutions, and security software, IBM can provide Oracle customers the full spectrum of products to meet their availability, retention, security, and compliance requirements.

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[1] The Digitization of the World From Edge to Core, November 2018.
[2] Compression data based on IBM measurements; compression rates vary by data type and content.
[3] Based on IBM internal measurements.

Services, such as storage optimization and integration, information lifecycle management, data mobility, business continuity and resiliency, security and privacy, product implementation, and managed services expand the IBM portfolio for Oracle customers.

Solutions, including storage virtualization, data warehousing, archiving compliance, remote site replication, consolidation, and tape encryption, complete the IBM portfolio. Such solutions make it easy for IBM and Oracle to partner, offering our mutual customers a complete solution.

This IBM Blueprint publication outlines the IBM Storage portfolio offerings. It highlights such offerings as IBM FlashSystem® family, IBM SAN Volume Controller, the enterprise class IBM DS8900F family, and robust complementary software-defined storage solutions from the IBM Spectrum Storage™ family. This paper is written for organizations that are seeking powerful and easy-to-use storage solutions that can provide significant improvements in efficiency for their Oracle environments.

Oracle Real Application Cluster and Oracle Automatic Storage Management

IBM storage systems, combined with Oracle Real Application Cluster (Oracle RAC), provide a reliable solution for the high-availability requirements of small-to-large businesses.

The Oracle Automatic Storage Management (ASM) provides the following benefits:

- Simplified and automated storage management
- Increased storage utilization and uptime
- Delivering predictable performance and availability service levels
- Striping and mirroring
- Online storage reconfiguration and dynamic rebalancing
- Managed file creation

For mirroring, there can be a normal redundancy disk group (2-way mirroring), a high redundancy disk group (3-way mirroring), or an external redundancy disk group, which leaves data protection to storage. You can benefit from fast and effective RAID solutions of IBM Storage (and from other features, such as IBM FlashCopy®), to create a point-in-time copy of a production Oracle Database. The FlashCopy target can be used for development purposes or for backing up the point-in-time database image. Capacity from any IBM Storage product, including IBM SAN Volume Controller, IBM FlashSystem family, or DS8900F family can be added as disks in an Oracle ASM disk group.

IBM FlashSystem family

The IBM FlashSystem family combines the performance of flash and end-to-end Non-Volatile Memory Express (NVMe) with the following benefits:

- Reliability and innovation of IBM FlashCore® technology
- Ultra-low latency of Storage Class Memory (SCM)
- Rich features of IBM Spectrum Virtualize
- AI predictive storage management
- Proactive support by Storage Insights

Built in a powerful 2U enterprise-class, blazing fast storage all-flash array, as shown in Figure 1. Providing intensive data-driven multicloud storage capacity, FlashSystem allows you to easily add in the multicloud solutions that best support your most critical demands.

Figure 1   IBM FlashSystem 9200 control enclosure

NVMe protocol

NVM Express (NVMe) is an optimized, high-performance scalable host controller interface that is designed to address the needs of systems that utilize PCI Express (PCIe)-based solid-state storage. The NVMe protocol is an interface specification for communicating with storage devices. It is functionally analogous to other protocols, such as serial-attached SCSI (SAS). However, the NVMe interface was designed for fast storage media, such as flash-based solid-state drives (SSDs) and low-latency non-volatile storage technologies.

NVMe storage devices are typically directly attached to a host system over a PCI Express bus. That is, the NVMe controller is contained in the storage device, which alleviates the need for another I/O controller between the CPU and the storage device. The architecture results in lower latency, throughput scalability, and simpler system designs. NVMe protocol supports multiple I/O queues, versus older SAS and Serial Advanced Technology Attachment (SATA) protocols that use only a single queue.

However, the PCIe bus presents certain challenges for storage systems at scale. Practical challenges limit the number of NVMe drives that can be attached to a host over PCIe to a few tens of devices. NVMe over Fabrics (NVMe-oF) overcomes the limitations of the PCIe bus by extending the benefits of low latency and high efficiency of the NVMe technology across network fabrics to support sharing of NVMe storage at a large scale (hundreds or thousands of devices) and over distance (see Figure 2).
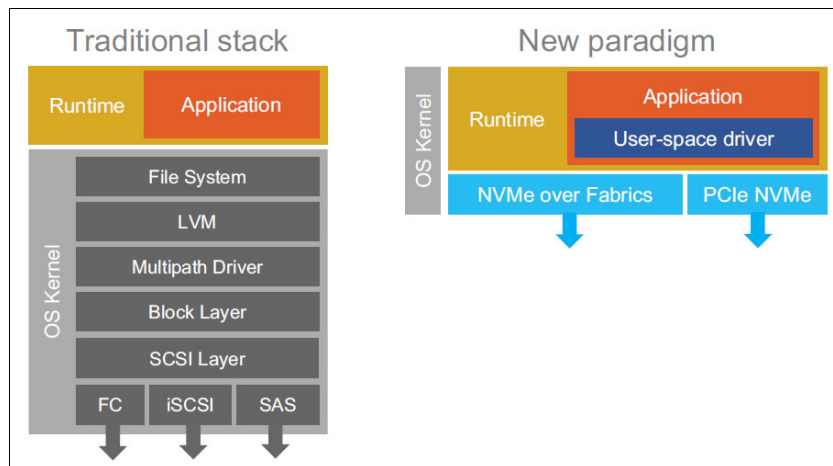

Figure 2   Traditional I/O stack and the new paradigm

According to Fibre Channel Industry Association (FCIA) publications, as a result of the simplicity, parallelism, and efficiency of NVMe, it delivers significant performance gains versus SCSI protocol.

IBM Spectrum Virtualize for Public Cloud

Available in IBM Cloud™ and AWS, IBM Spectrum Virtualize is the leading software-defined storage that was proven for years in IBM SAN Volume Controller and FlashSystem families of storage systems. With more than 180,000 systems running IBM Spectrum Virtualize and managing more than 11 exabytes of data[4], users can perform the following tasks:

- Migrate Oracle data between on-premises and public cloud data centers or between public cloud data centers.

- Implement disaster recovery strategies between on-premises and public cloud data centers.

- Enable cloud-based DevOps with easy replication of data from on-premises sources.

- Improve cyber resiliency with Oracle backups on AWS using "air gap" snapshots to S3.

These all-flash systems include IBM Spectrum Virtualize software and introduce the following remarkable new features in comparison to the predecessor models:

- End-to-end NVMe support: NVMe is a logical device interface standard from 2011 for accessing non-volatile storage media that is attached by way of a PCI Express bus.

- Lower latencies through Remote Direct Memory Access (RDMA): Direct memory access from the memory of one node into that of another without involving either one's operating system.

- Data reduction pools (DRP) represent a significant enhancement to the storage pool concept. With the introduction of data reduction technology, compression, and deduplication, DRP enables an easy way to stay "thin" and compressed.

- FlashCore Modules (FCMs) or industry standard NVMe drives can be used for IBM FlashSystems. If the FCM option is chosen, the user can take advantage of the built-in hardware compression that automatically attempts to compress the stored data when written to the drives.

- Thin-provisioned IBM FlashCopy uses disk space only when updates are made to the source or target data, and not for the entire capacity of a volume copy.

- IBM HyperSwap® capability enables each volume to be presented by two IBM FlashSystem storage systems. This high-availability configuration tolerates combinations of node and site failures (using host multipathing driver) based on the one that is available for the regular IBM FlashSystem.

- The IBM FlashSystem 9200 supports the new low latency, high-speed Storage Class Memory (SCM). SCM is a non-volatile memory device that performs faster (~10μs) than traditional NAND SSDs(100μs), but slower than DRAM (100ns).

- IBM Storage Insights is another part of the monitoring capability of the IBM FlashSystem 9200 system, and supplements the views available in the GUI.

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[4] Based on IBM internal measurements – October 2019.

Additional information

For more information about the IBM FlashSystem family, see the following resources:

- *IBM FlashSystem 9200 and 9100 Best Practices and Performance Guidelines*, SG24-8448
- IBM Flash Storage: hybrid multicloud made simple web page
- *High Availability for Oracle Database with IBM PowerHA SystemMirror and IBM Spectrum Virtualize HyperSwap*, REDP-5459

IBM SAN Volume Controller

Built with IBM Spectrum Virtualize software, IBM SAN Volume Controller is a hardware and software storage virtualization solution through which diverse storage devices can be grouped into a common pool that is available to the SAN. It also assists Oracle customers who are seeking to simplify storage management and reduce storage costs with SAN installations.

The IBM SAN Volume Controller offers the following highlights:

- Transparent migration of back-end storage for performance tuning and disk migration without needing to stop or modify the application.
- A 25-Gbps iSCSI server attachment that supports high performance at a lower cost.
- Takes control of storage and retains all information, which helps to speed and simplify implementation in addition to minimizing the need for more storage.
- When combined with IBM Spectrum Control, allows the user to tune storage and improve performance and utilization.
- Provides information about the amount of available storage, the amount of storage being used at which location, the hosts that are attached to which storage, and potential or actual outages, performance reporting, and trending.
- Scales from small configurations (1 TB) to large enterprises (500 TB and larger). New IBM SAN Volume Controller engines deliver dramatically better throughput that supports larger and more I/O intensive environments.
- The IBM SAN Volume Controller supports more than 500 flash, hybrid, and disk storage systems from IBM and other storage vendors[5].

IBM SAN Volume Controller provides in-band storage virtualization by creating a pool of managed disks from attached back-end disk storage systems. These managed disks are then mapped to a set of virtual disks for use by various host computer systems. The IBM SAN Volume Controller is flexible and can manage all host storage requirements. It also offers an alternative for IBM FlashCopy, VolumeCopy, and Enhanced Remote Mirroring for disaster recovery, maintenance, and high availability.

Disk storage systems with a lower internal cache feature performance value that is on the amount of cache that they can offer. Introducing IBM SAN Volume Controller in front of these storage systems improves the overall performance. Cache also reduces the latency of write commands by completing them without sending the write blocks to disks.

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[5] IBM IBM SAN Volume Controller data sheet

IBM SAN Volume Controller (see Figure 3) consists of two nodes for high availability. All write blocks are stored in both nodes. If a disk failure occurs, written blocks are stored in the cache. The blocks are then marked as a pinned memory block. For read cache, all IBM SAN Volume Controller memory is available, minus any pinned blocks.

Figure 3   IBM SAN Volume Controller nodes

Additional information

For more information about IBM SAN Volume Controller, see the following resources:

- *Implementing the IBM SAN Volume Controller with IBM Spectrum Virtualize V8.3.1*, SG24-8465

- IBM Knowledge Center

IBM DS8900F family

The IBM DS8900F family is the trusted storage foundation for mission-critical multicloud environments. It is ideally suited for enterprise customers who are running Oracle Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM). The DS8900F family also supports Oracle RAC and Oracle ASM.

The DS8900F family delivers the highest levels of performance, scalability, resiliency, and total overall value. At the heart of the system are the IBM POWER9™ controllers, which are complemented by two other tiers of high-performance processors within the host and device adapters of the system. These three tiers of processors work together to deliver the balanced performance of the DS8900F. With IBM Easy Tier and other workload optimization capabilities, the DS8900F can determine the right balance between extraordinary performance and cost effectiveness.

With industry-unique advanced cache algorithms, its fully redundant design and advanced business continuity capabilities, the DS8900F family offers the highest levels of availability with more than seven 9s (99.999996%) of availability for the most demanding, mission-critical workloads. The IBM FlashCopy point-in-time copy functions support online backups for high application availability and continuity of operations. IBM Metro Mirror and Global Mirror local and long-distance replication features ensure business continuity for almost any recovery point or recovery time objective. IBM also offers a full range of storage design and implementation services to help you implement a tailored storage solution for your specific business continuity needs.

The DS8900F family includes the following highlights:

- Exceptional, scalable performance with the latest hardware advancements and innovative software functions.

- Extraordinary system availability with full hardware redundancy and resiliency, which is built on the market-proven IBM Power Systems architecture.

- Optimized storage tiering that optimizes performance by automating placement of data across the appropriate drive tiers dynamically.

- Scalability of systems up to 384 high-performance or high-capacity flash cards and multi-petabytes with a combination of different drive tiers.

- Flexibility that addresses the broad scope of storage workloads that exist in the complex data centers of today.

- Transparent Cloud Tiering (TCT) enables direct data movement from the DS8900F back end into IBM Cloud Object Storage, tape or external cloud, which helps with the million instructions per second (MIPS) value for IBM z/OS® clients during backup periods.

- IBM Storage Enabler for Containers with IBM Spectrum Connect and an orchestration layer, such as Kubernetes or IBM Cloud Private, enables an application to store data separately from the container in persistent, highly available DS8900F block storage.

- With the "Safeguarded Copy" function, the DS8900F offers another l level of protection against logical data corruption, such as ransomware attacks.

- The DS8910F rackless model can be built into an IBM Z® Business Class, or LinuxONE Business Class rack.

- The DS8900F family enables the highest security in the SAN with the Fibre Channel Endpoint Security function (SAN authentication or encryption of data in-flight) for the IBM z15™ Enterprise, and Business Class models.

- IBM z/OS clients having the chance of ultra-low latency accesses (below 20 µs response time) when the new zHyperLink connections are used for selected I/Os.

- The DS8900F family excels in the most-demanding and complex 3-site and 4-site replication scenarios, including those with wide distances or short RPO requirements.

The DS8900F family (see Figure 4 on page 8) is an ideal storage platform to use for high-throughput Oracle applications that require the highest level of performance and availability. With superior performance for online transaction processing (OLTP), sequential and batch workloads through its innovative caching technology, the DS8900F family is designed for mission-critical database applications.

Figure 4   IBM DS8900F storage system

Additional information

For more information about the DS8900F family, see the following resources:

- *IBM DS8900F Architecture and Implementation*, SG24-8456
- *IBM DS8880 and Z Synergy,* REDP-5186
- IBM Knowledge Center

IBM Solutions for Modern Data Protection

The IBM Modern Data Protection portfolio includes IBM Spectrum Protect for Databases, IBM Spectrum Protect Snapshot, IBM Spectrum Protect Plus, and IBM Spectrum Copy Data Management (CDM). Together, these solutions offer clients holistic and modern data protection that deliver simplicity, scalability, data reuse, and replication for Oracle environments.

IBM Spectrum Protect for Databases: Data Protection for Oracle

IBM Spectrum Protect for Databases: Data Protection for Oracle helps protect Oracle data no matter where the data is stored. You can continue running primary applications on your database servers while backing up and restoring data to and from auxiliary storage by using automated tasks, utilities, and interfaces. This software performs online, consistent, and centralized backups to help you avoid downtime, protect vital enterprise data, and minimize operational costs. It includes the following features:

- RMAN and Data Protection for Oracle

  IBM Data Protection for Oracle interfaces with the Oracle Recovery Manager (RMAN), to send backup versions of Oracle databases to the IBM Spectrum Protect server. Data Protection for Oracle currently supports Oracle 19c databases with the Oracle Recovery Manager.

- LAN-free data transfer

  Data Protection for Oracle supports backup and restore operations in a LAN-free environment. This environment shifts the movement of data from the communications network to a storage area network (SAN). Data moves over the SAN to a SAN-attached storage device by the IBM Spectrum Protect Storage Agent. Running Data Protection for Oracle in a LAN-free environment avoids constraints of the network. The load on the IBM Spectrum Protect server is decreased, which allows the server to support a greater number of simultaneous connections.

- Automated failover for data recovery

  When an outage occurs on the IBM Spectrum Protect server, Data Protection for Oracle can fail over to a secondary server for data recovery operations.

Additional information

For more information, see IBM Knowledge Center.

IBM Spectrum Protect Snapshot

IBM Spectrum Protect Snapshot provides a method to back up and restore data by using the advanced snapshot (also know as FlashCopy) technologies of IBM storage systems. With one Spectrum Protect Snapshot instance, you can protect, clone, and manage multiple Oracle Database instances. The following applications can be protected and cloned with IBM Spectrum Protect Snapshot:

- Oracle databases
- Oracle in an SAP environment
- Oracle with Automatic Storage Management (ASM)
- Oracle in a RAC environment

IBM Spectrum Protect Snapshot can backup Oracle databases that are on snapshot-oriented storage systems or file systems. IBM Spectrum Protect Snapshot supports AIX® and Linux operating systems.

Additional information

For more information, see IBM Knowledge Center.

IBM Spectrum Protect Plus

IBM Spectrum Protect Plus (see Figure 5 on page 10) is a modern data protection solution that provides near-instant recovery, replication, retention, and reuse for VMs, databases, and containers in hybrid multicloud environments. It is easily deployed as a virtual appliance and the agentless architecture is easy to maintain. It unlocks the value of your data by improving the quality and speed of development, testing, and analytics. Cost-effective data retention, data compliance, and disaster recovery are achieved by using data offload to on-premises and cloud-based object storage and IBM Spectrum Protect, including support for the physical and virtual tape.

IBM Spectrum Protect Plus includes Oracle backup and recovery with secure, self-service, user-facing portals for management and monitoring.

While data protection is its main use case, IBM Spectrum Protect Plus is more than just a backup solution. You can use it to derive significant business value from your protected data.

With IBM Spectrum Protect Plus, you can quickly and easily spin up an Oracle Database, including an alternative instance. This can then be used for any situation where users or developers need access to databases. Examples of these use cases are disaster recovery (DR), DevTest, reporting, and analytics. Because IBM Spectrum Protect Plus also offers Representational State Transfer (RESTful) application programming interfaces (APIs), it can be used as part of a DevOps workflow, which helps to enhance modern, automated software development processes.
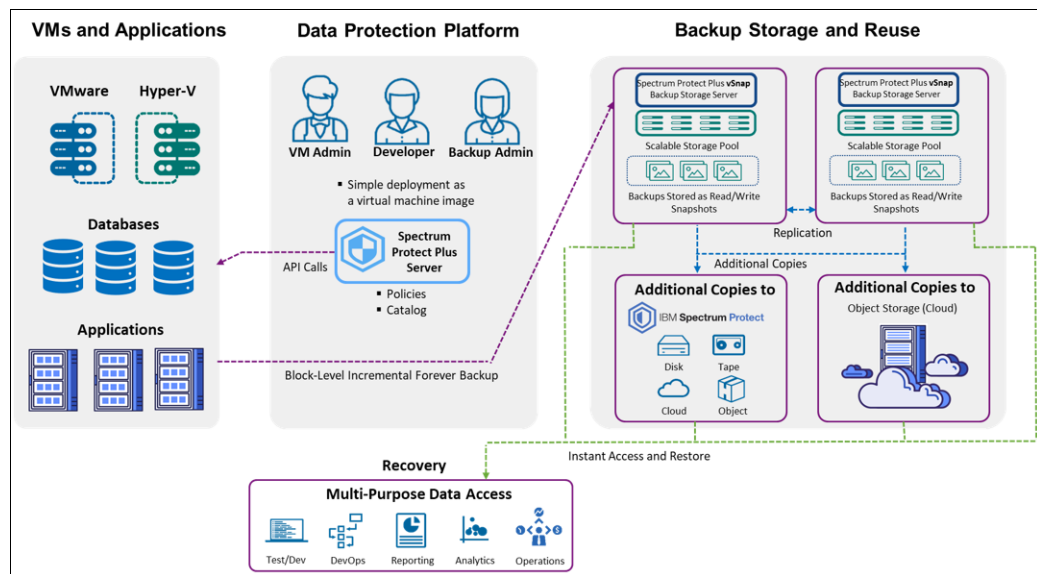

Figure 5   IBM Spectrum Protect Plus architecture

Additional information

For more information about Spectrum Protect Plus, see the following resources:

- IBM Knowledge Center
- *IBM Spectrum Protect Plus Practical Guidance for Deployment, Configuration, and Usage*, REDP-5532

IBM Spectrum Copy Data Management

IBM Spectrum Copy Data Management (see Figure 6 on page 11) provides copy management for databases through application-consistent backup creation, cloning, and recovery. IBM Spectrum Copy Data Management uses the snapshot and replication features of the underlying storage platform to create, replicate, clone, and restore backups of Oracle databases. Archive log destinations and universal destination mount points are supported. Archived logs are automatically deleted upon reaching defined retention. IBM Spectrum Copy Data Management auto-discovers databases and enables backups only of eligible databases. To be eligible for backup, application databases must be on supported storage platforms.
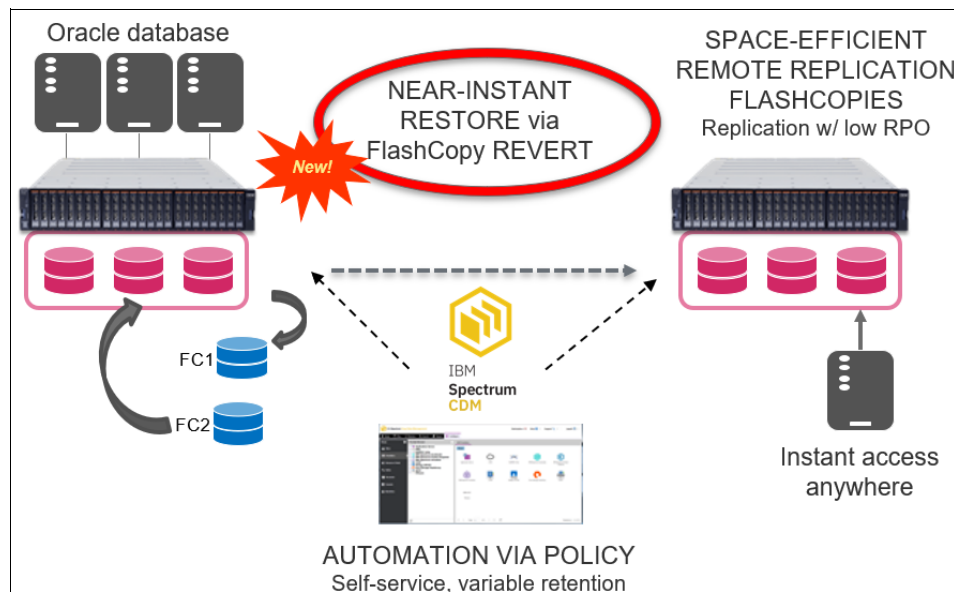

Figure 6   IBM Spectrum Copy Data Management architecture

The following options are available for Oracle Backup jobs:

- Oracle Recovery Manager (RMAN) Integration

  RMAN, a command-line and Enterprise Manager-based tool, is the method that is preferred by Oracle Database administrators for backup and recovery of Oracle databases, including maintaining an RMAN repository. The retention of RMAN cataloged data is managed by settings in Oracle. IBM Spectrum Copy Data Management automates cataloging of Oracle database backups in the RMAN recovery catalog, which enables database administrators to use RMAN for verification and advanced recovery.

- Data Masking

  Data masking is used to hide confidential data by replacing it with fictitious data. This feature is used when making data copies for DevTest or other use cases.

- Log Backup

  The log backup feature enables continuous backups of archive logs to a specified destination. Archive log retention is managed by settings in RMAN. IBM Spectrum Copy Data Management uses archived logs to enable point-in-time recoveries of databases to facilitate RPOs.

  ### Additional information

  For more information, see IBM Knowledge Center.

Summary

Since 1986, Oracle and IBM provided customers with compelling joint solutions that combine Oracle's technology and application software with IBM's complementary hardware, software, and storage solutions. More than 100,000 joint customers benefit from the strength and stability of the Oracle and IBM alliance, which offers technology, applications, services, and hardware solutions that mitigate risk, boost efficiency, and lower total cost of ownership.

Data is now considered the new natural resource. It is the energy behind business today. Placing your data on high-performance IBM FlashSystem, IBM SAN Volume Controller or IBM DS8900F family storage systems get the most out of your Oracle Database.

Protecting and creating copies of Oracle databases with the use of IBM Spectrum software offerings is simple and quick and requires only a few mouse clicks. Accessing and reusing Oracle Database data is just as simple with Instant Access and Test restores. Restoring your production data in case of a disaster is done easily.

The IBM Spectrum Protect software products also offer solutions that can make access to data on tape as easy and fast as disk. Tape drives from IBM offer significantly higher storage density than previous generations, which helps to lower the cost of storing large data volumes. Tape can offer powerful solutions for specific threats and use cases at a cost per gigabyte that is unmatched by other storage technologies.

Other related resource

The IBM System Storage™ Interoperation Center (SSIC) is an online search tool for all information about IBM storage interoperability.

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