Amazon Elastic Block Store (EBS) Detailed Notes

Overview: Amazon Elastic Block Store (EBS) is a cloud-based block storage service provided by AWS. It allows users to create persistent block storage volumes to be used with Amazon EC2 instances. These volumes are independent of the lifecycle of the EC2 instance, providing durability and flexibility in managing data.

Key Features:

1. **Persistent Storage:**
   - EBS volumes are persistent, meaning that data remains intact even after the EC2 instance to which they are attached is stopped or terminated.
2. **High Availability and Durability:**
   - EBS volumes are automatically replicated within the Availability Zone to protect against component failure, offering high availability.
   - Designed for 99.999% availability.
3. **Volume Types:** EBS offers different volume types optimized for various workloads:
   - **General Purpose SSD (gp3/gp2):**
     - Ideal for a broad range of use cases such as boot volumes, small and medium-sized databases, and development/test environments.
     - Provides a balance of price and performance.
     - **gp3** offers consistent baseline performance with the option to provision additional IOPS and throughput independent of capacity.
   - **Provisioned IOPS SSD (io1/io2):**
     - Designed for mission-critical, I/O-intensive applications, such as large databases.
     - Provides high and consistent IOPS.
     - **io2** volumes offer higher durability and more IOPS per GiB than io1.
   - **Throughput Optimized HDD (st1):**
     - Suitable for big data, data warehousing, and log processing.
     - Optimized for throughput rather than IOPS.
   - **Cold HDD (sc1):**
     - Lowest cost storage for infrequently accessed data.
     - Suitable for workloads where performance is less critical, such as backups or cold storage.
4. **Performance Metrics:**
   - **IOPS (Input/Output Operations Per Second):** Measures how many read/write operations the volume can handle in a second.
   - **Throughput:** Measures the volume's data transfer speed in megabytes per second (MB/s).

Snapshots:

1. **Overview:**
   ○ EBS snapshots are incremental backups of EBS volumes stored in Amazon S3.
   ○ They capture a point-in-time state of the volume and can be used to create new volumes or restore existing ones.
2. **Incremental Nature:**
   ○ Snapshots only save changes made after the last snapshot, reducing the time and storage required.
3. **Cross-Region and Cross-Account Snapshots:**
   ○ Snapshots can be shared between AWS accounts and copied to different regions for redundancy and faster recovery.
4. **Automated Backups:**
   ○ AWS provides lifecycle management tools like **Amazon Data Lifecycle Manager** to automate snapshot creation and retention policies.

EBS Encryption:

1. **Built-in Encryption:**
   ○ EBS volumes support encryption at rest, in transit, and during snapshots.
   ○ Encryption is integrated with **AWS Key Management Service (KMS)** to manage encryption keys.
2. **Performance Impact:**
   ○ EBS encryption has minimal performance impact, and encrypted volumes offer the same performance as unencrypted ones.
3. **Automatic Encryption:**
   ○ You can configure automatic encryption for new volumes using AWS KMS. Snapshots and copies of encrypted volumes are also encrypted.

Attach and Detach Operations:

1. **Attaching Volumes:**
   ○ EBS volumes can be attached to EC2 instances within the same Availability Zone. Once attached, they function as a traditional block device.
   ○ An EBS volume can only be attached to one EC2 instance at a time, except for **io1/io2 multi-attach** volumes, which can be attached to multiple instances simultaneously.
2. **Detaching Volumes:**
   ○ EBS volumes can be detached from an EC2 instance and re-attached to another without data loss. Volumes should be properly unmounted before detaching to avoid data corruption.

3. **Multi-Attach (io1/io2):**
   ○ Multi-Attach-enabled volumes (io1/io2) allow a single volume to be attached to multiple EC2 instances simultaneously within the same AZ. This is useful for clustered or distributed applications requiring shared block storage.

Resize and Modify Volumes:

1. **Dynamic Resizing:**
   ○ EBS allows resizing volumes without downtime. You can increase capacity, adjust volume types, or change IOPS settings on the fly using the **Elastic Volumes** feature.
2. **Performance Changes:**
   ○ Performance characteristics like IOPS and throughput can also be modified in real-time, allowing you to adjust volume performance based on evolving workload demands.

Pricing and Cost Management:

1. **Pay-as-you-go Pricing:**
   ○ EBS pricing is based on the provisioned storage size, performance characteristics, and data transfer.
   ○ Snapshot storage and data transfer between regions have separate charges.
2. **Cost Optimization:**
   ○ Select appropriate volume types based on workload to avoid over-provisioning IOPS or throughput.
   ○ Use **Amazon Data Lifecycle Manager** to automate the deletion of old snapshots to reduce storage costs.

Use Cases:

1. **Database Applications:**
   ○ EBS io1/io2 volumes are ideal for databases requiring high IOPS and low-latency access.
2. **Big Data and Analytics:**
   ○ Throughput Optimized (st1) volumes are well-suited for high-throughput applications like big data and log processing.
3. **Backup and Archival:**
   ○ Cold HDD (sc1) volumes provide cost-effective storage for backups, snapshots, and archival.
4. **Boot Volumes:**

- General Purpose SSD volumes are typically used for boot and root volumes of EC2 instances due to their cost-effective performance.

Monitoring and Management:

1. **Amazon CloudWatch:**
   - EBS integrates with Amazon CloudWatch to provide real-time monitoring of key metrics such as read/write latency, throughput, and IOPS.
2. **Elastic Volumes:**
   - With the Elastic Volumes feature, users can monitor and modify volume size and performance without detaching the volume or restarting the EC2 instance.
3. **Data Lifecycle Manager:**
   - Automates the creation, retention, and deletion of EBS snapshots, helping to optimize backup costs.

Best Practices:

1. **Right-Sizing Volumes:**
   - Select the correct volume type and size to balance cost and performance. Avoid over-provisioning for workloads with predictable performance needs.
2. **Backup Strategies:**
   - Implement regular backups using EBS snapshots and automate lifecycle management to retain only necessary backups.
3. **Encryption:**
   - Enable encryption for sensitive data, using KMS to manage keys and enforce encryption policies across your EBS volumes and snapshots.
4. **Monitoring:**
   - Use CloudWatch to monitor performance and adjust volume types or configurations based on usage patterns to maintain performance levels.

EBS is essential for durable, scalable storage in AWS, particularly for workloads demanding high-performance block-level access. Its flexibility in performance tuning, volume management, and automation makes it suitable for a wide range of use cases.