**EBS - Elastic Block Store Learning Material**

**1. EBS Service Introduction**  
Amazon Elastic Block Store (EBS) provides persistent block-level storage for EC2 instances. EBS volumes behave like raw, unformatted block devices that can be mounted to EC2 instances. EBS is designed for high availability, scalability, and durability.

**Key Benefits of EBS**:

* **Persistent Storage**: Data is retained even after instance termination.
* **Scalable**: Can scale storage capacity as your application grows.
* **High Availability**: EBS volumes are automatically replicated within their Availability Zone.
* **Snapshots**: Create backups of volumes, which can be used to restore data or create new volumes.

**2. EBS Volume Types**  
AWS provides different EBS volume types, each designed to meet specific performance and cost requirements.

* **General Purpose SSD (gp3/gp2)**:
  + Best for most workloads.
  + Provides a balance of price and performance.
  + gp3 allows independent scaling of IOPS and throughput.
* **Provisioned IOPS SSD (io2/io1)**:
  + Designed for I/O-intensive applications like databases.
  + Provides high throughput and low latency.
  + io2 provides 4x higher durability compared to io1.
* **Throughput Optimized HDD (st1)**:
  + Ideal for large, sequential workloads like big data or log processing.
  + Offers high throughput at lower costs compared to SSD options.
* **Cold HDD (sc1)**:
  + Best for infrequently accessed data.
  + Suitable for cold storage where performance is not a priority.

Each volume type offers specific performance characteristics, so choosing the right one depends on your use case and performance needs.

**3. EBS Volume Creation**  
Creating an EBS volume is simple and can be done via the AWS Management Console, CLI, or API.

**Steps to Create an EBS Volume**:

1. **Log in to AWS Management Console**.
2. Navigate to the **EC2 Dashboard** and click on **Volumes**.
3. Click **Create Volume**.
4. Select the **Volume Type** (e.g., gp3, io2, st1).
5. Set the **Size** and other configurations (e.g., IOPS, Throughput).
6. Choose the **Availability Zone** where your EC2 instance is located.
7. **Create the Volume** and attach it to your EC2 instance once created.

**4. EBS Multi-Attach Concept**  
**EBS Multi-Attach** allows you to attach a single EBS volume to multiple EC2 instances within the same Availability Zone. This feature is useful for highly available applications that require multiple instances to read and write to the same volume simultaneously.

* **Use Case**: Multi-Attach is ideal for clustered applications like databases that need shared storage with failover capabilities.
* **Limitations**: Multi-Attach is only available for io1/io2 volume types.

**5. EBS Volume Mount and Modification**  
Once an EBS volume is created, you need to mount it to your EC2 instance to start using it.

**Steps to Mount an EBS Volume**:

1. **Attach the Volume to the EC2 Instance**:
   * From the EC2 Dashboard, select your volume and click **Actions** → **Attach Volume**.
   * Choose the instance to attach the volume to and specify the device name (e.g., /dev/sdf).
2. **Format the Volume (if new)**:
   * After attaching, SSH into your EC2 instance and use lsblk to identify the new volume.
   * Format the volume using the following command:
   * sudo mkfs -t ext4 /dev/xvdf
3. **Mount the Volume**:
   * Create a mount point:
   * sudo mkdir /mnt/data
   * Mount the volume:
   * sudo mount /dev/xvdf /mnt/data
   * To automatically mount the volume on reboot, add the entry to /etc/fstab.
4. **Modify the Volume**:
   * You can modify an EBS volume (resize, change IOPS) from the console or CLI:
     + Navigate to the **Volumes** section in the EC2 Dashboard.
     + Select the volume, click **Actions**, and choose **Modify Volume**.
     + After modifying, you may need to extend the file system on your EC2 instance to reflect the new size.

**6. EBS Snapshot Introduction**  
An **EBS Snapshot** is a point-in-time backup of an EBS volume. Snapshots are incremental, meaning only the blocks that have changed since the last snapshot are saved. Snapshots are stored in Amazon S3 and provide a cost-effective way to backup your data.

**Key Features of EBS Snapshots**:

* **Incremental Backups**: Only changes since the last snapshot are saved.
* **Durability**: Snapshots are stored across multiple AWS Availability Zones.
* **Restore**: You can create a new volume from a snapshot to restore data.

**7. Snapshot-to-Volume Conversion**  
You can create a new EBS volume from a snapshot at any time. This process is useful for restoring data or creating a copy of the original volume for other instances.

**Steps to Convert Snapshot to Volume**:

1. **Create a Snapshot** of an existing EBS volume (right-click on the volume → Create Snapshot).
2. Navigate to the **Snapshots** section in the EC2 Dashboard.
3. Select the snapshot and click **Actions** → **Create Volume**.
4. Choose the **Volume Type** and **Size** (optional), and ensure it’s in the same Availability Zone as the original instance.
5. **Create the Volume** and attach it to an EC2 instance.

**8. Hands-On**  
In this section, students will perform practical exercises on EBS volumes and snapshots to solidify their understanding.

**Hands-On Steps:**

1. **Create an EBS Volume**:
   * Create a new EBS volume and attach it to an EC2 instance.
2. **Mount and Format the Volume**:
   * Format and mount the volume to the instance.
3. **Take a Snapshot**:
   * Create a snapshot of the EBS volume.
4. **Restore from Snapshot**:
   * Create a new volume from the snapshot and attach it to another instance.
5. **Modify Volume Size**:
   * Resize the volume and extend the file system on the EC2 instance.