AWS Lambda

What is AWS Lambda?

AWS Lambda is a serverless computing service that lets you run code without provisioning or managing servers. It automatically scales, only charges for execution time, and integrates with other AWS services.

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1. How AWS Lambda Works

- **Event-Driven**: Executes code in response to events (e.g., file uploads to S3, API calls, database updates).
- **Stateless**: Each invocation is independent; data must be stored in databases like DynamoDB or S3.
- **Auto-Scaling**: AWS automatically scales Lambda functions based on demand.
- **Pay-Per-Use**: You only pay for the execution time and memory usage.

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2. Key Components of AWS Lambda

1. **Function**: The actual code that runs when triggered.
2. **Handler**: The entry point where execution starts. Example in Python:

```
def lambda_handler(event, context):
    return {"message": "Hello, World!"}
```

3. **Runtime**: The programming language environment. AWS supports Python, Node.js, Java, Go, .NET, and others.
4. **Triggers**: Events that invoke the function (S3 uploads, API Gateway calls, DynamoDB updates, etc.).
5. **Execution Role**: IAM role that gives Lambda permissions to interact with other AWS services.
6. **Environment Variables**: Store configuration settings for your function.
7. **Memory & Timeout**: Allocate resources (128MB to 10GB RAM, max execution time of 15 minutes).

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3. Setting Up AWS Lambda

AWS Console

1. **Go to AWS Lambda Console**

2. Click **"Create Function"**
3. Choose **"Author from Scratch"**
4. Set:
    - Function name
    - Runtime (e.g., Python 3.9)
    - IAM role (create a new one or select an existing one)
5. Click **"Create Function"**
6. Write your code in the **Editor**
7. Click **"Deploy"** and **"Test"**

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4. Lambda Triggers (Event Sources)

AWS Lambda works with many AWS services, such as:

- **S3**: Trigger a function when a file is uploaded.
- **API Gateway**: Create a REST API that calls Lambda.
- **DynamoDB Streams**: React to database changes.
- **SNS/SQS**: Process messages asynchronously.
- **CloudWatch Events**: Schedule cron jobs.
- **Step Functions**: Orchestrate workflows.

Example: Lambda Triggering on S3 File Upload

```
def lambda_handler(event, context):
    for record in event['Records']:
        bucket = record['s3']['bucket']['name']
        key = record['s3']['object']['key']
        print(f"New file uploaded: {bucket}/{key}")
```

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5. Deploying & Updating Lambda Functions

- **Manual Deployment**: Via AWS Console or CLI
- **Automated Deployment**: Using CI/CD (AWS CodePipeline, GitHub Actions)
- **Versioning & Aliases**: Maintain different versions of your function (e.g., `dev`, `prod`).

Update Function via CLI:

```
aws lambda update-function-code --function-name MyLambda --zip-file
fileb://new_function.zip
```

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6. Security Best Practices

- **Use IAM Roles**: Grant only necessary permissions.
- **Encrypt Environment Variables**: Use AWS KMS.
- **VPC Security**: Attach to a VPC for database access.
- **API Gateway Authentication**: Secure APIs with IAM or Cognito.

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7. Monitoring & Debugging

- **AWS CloudWatch Logs**: Captures function logs.
- **AWS X-Ray**: Traces Lambda execution across AWS services.
- **AWS Lambda Insights**: Monitors performance metrics.

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8. Cold Starts & Performance Optimization

Cold Start: Delay when function executes after being idle.

Ways to Reduce Cold Starts

- **Provisioned Concurrency**: Keeps function warm.
- **Optimize Dependencies**: Reduce package size.
- **Use Smaller Runtimes**: Prefer lightweight languages like Python or Node.js.

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9. Cost & Pricing

AWS Lambda pricing is based on execution time and memory used.

- **Free Tier**: 1M requests/month, 400,000 GB-sec free.
- **Paid Pricing**:
    - **Requests**: $0.20 per 1M requests
    - **Compute Time**: $0.00001667 per GB-sec

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10. Advanced Features

- **Lambda Layers**: Share code between multiple functions.
- **Container Image Support**: Deploy functions as Docker containers.
- **Step Functions**: Chain multiple Lambda functions together.

- **Custom Runtimes**: Use languages not natively supported.

Conclusion

AWS Lambda is a powerful, scalable, and cost-efficient serverless computing solution. It simplifies backend development, reduces infrastructure overhead, and seamlessly integrates with AWS services.