AWS re:Invent

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SVS311

AWS Lambda Extensions: What, why, and how

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Agenda

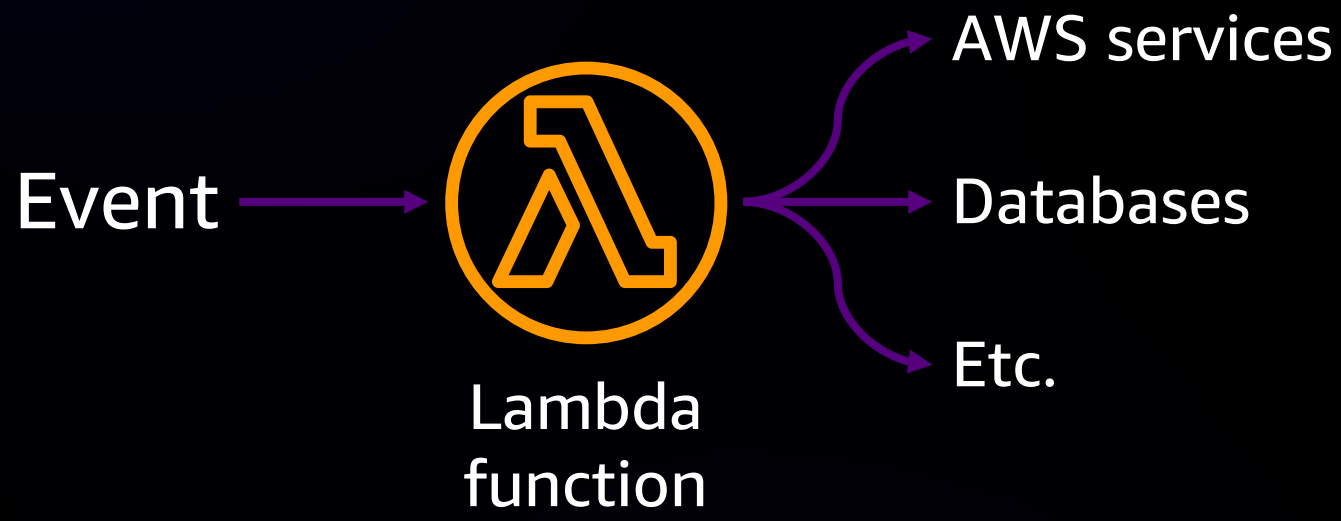
- AWS Lambda
- Lambda extensions
- Building Lambda extensions

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What is AWS Lambda?

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The high-level view



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Lambda extensions

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What are Lambda extensions?

Lambda extensions are companion processes that run within Lambda's execution environment that easily integrate Lambda with your favorite tools for monitoring, observability, security, and governance.

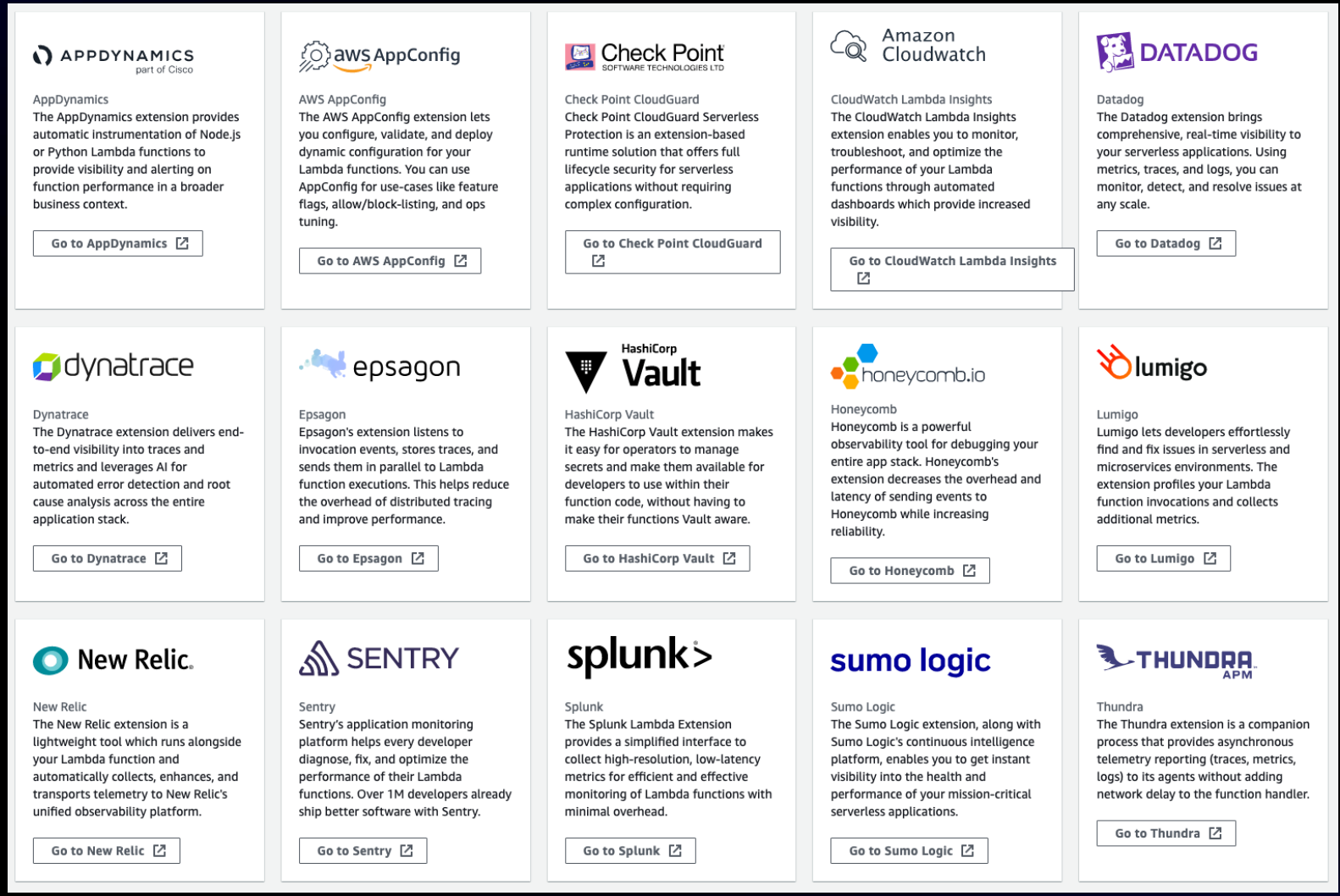
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Use cases

- Integrate AWS Lambda with your favorite monitoring, observability, security, and governance tools
- Capture diagnostic information before, during, and after function invocation
- Fetch configuration settings or secrets before the function's invocation
- Detect and alert on function activity through hardened security agents, which can run as separate processes from the function

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Extensions for AWS Lambda



https://console.aws.amazon.com/lambda/home#/extensions

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Internal vs. external extensions

Internal extensions

- Run as part of the runtime process, as a separate thread, with the function code
- Requires code changes in the function to start/shutdown the extension

External extensions

- Run as separate processes from the runtime but still within the same execution environment
- Start before the runtime process, and can continue after the runtime shuts down
- Can be written in a different language than the function itself; compiled language recommended

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Installation

- Packaged as a Lambda layer (in a .zip archive), or include in the image for functions deployed as container images
- Layer installed using your preferred tool
- Up to 10 extensions for each function

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Configuration

- Extensions share resources with the function, such as CPU, memory size, /tmp disk storage, and environment variables
- Configured using the function's environment variables
- Also share permissions, using the same AWS Identity and Access Management (IAM) role as the function

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Running

- The function and all extensions must complete within the function's configured timeout setting
- Response from function does not wait for extensions to finish
- May impact the performance
- Measure the additional time the extension runs after the function invocation, using the *PostRuntimeExtensionsDuration* CloudWatch metric
- Can communicate with the function using files in /tmp or by creating an HTTP server

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Pricing

- No additional cost for installing extensions
- Share the same billing model as Lambda functions
  - Invocations and duration
- Other services used may incur cost
- Charged for all lifecycles
- Partner offerings may be chargeable
  - See the relevant partner website for details

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Runtime modifications

Language-specific environment variables

- JAVA_TOOL_OPTIONS
- NODE_OPTIONS
- DOTNET_STARTUP_HOOKS

Wrapper scripts

AWS_LAMBDA_EXEC_WRAPPER

Node.js 14.x, Node.js 12.x, Node.js 10.x, Python 3.8, Ruby 2.7, Java 11, Java 8 (java8.al2), .NET Core 3.1

Script packaged as a layer

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Sample wrapper script

```
#!/bin/bash

# the path to the interpreter and all of the originally intended arguments
args=("$@")

# the extra options to pass to the interpreter
extra_args=("-X" "importtime")

# insert the extra options
args=("${args[@]:0:$#-1}" "${extra_args[@]}" "${args[@]: -1}")

# start the runtime with the extra options
exec "${args[@]}"
```

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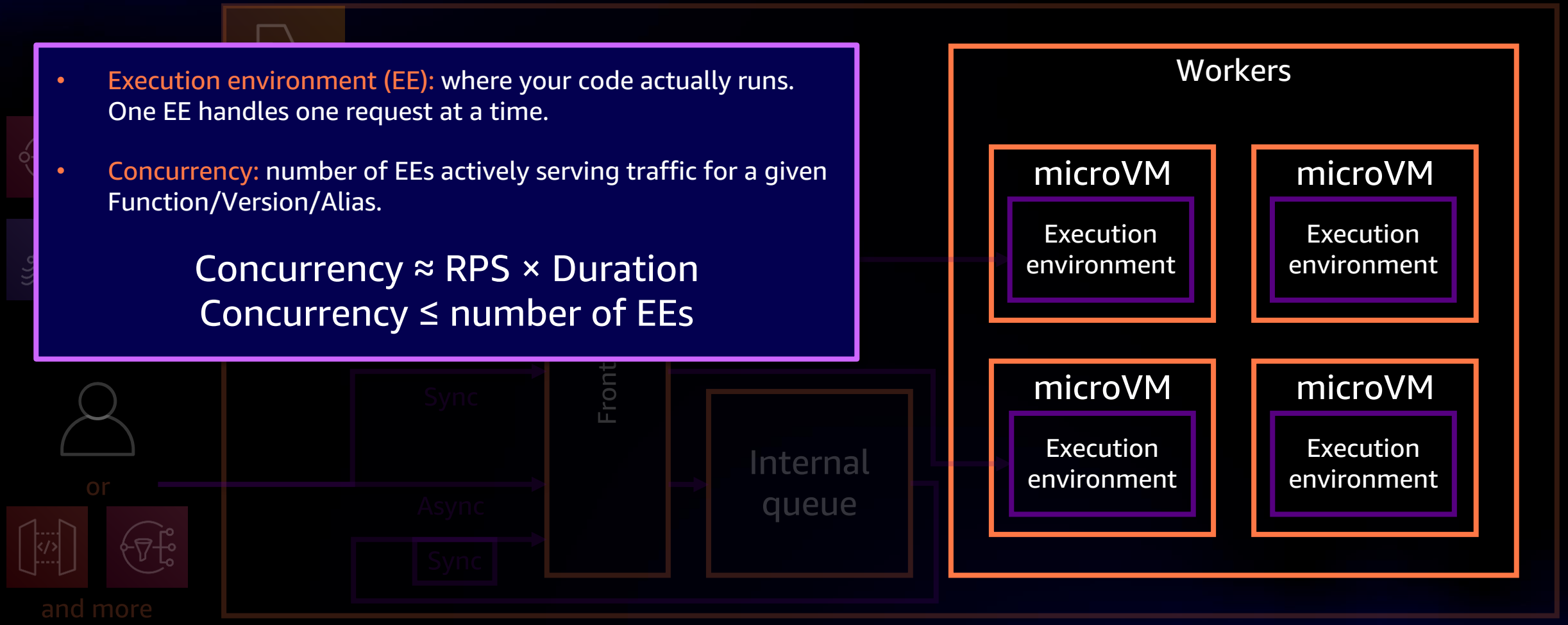
Building Lambda extensions

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Lambda execution environments

- Execution environment (EE): where your code actually runs. One EE handles one request at a time.
- Concurrency: number of EEs actively serving traffic for a given Function/Version/Alias.

Concurrency ≈ RPS × Duration
Concurrency ≤ number of EEs



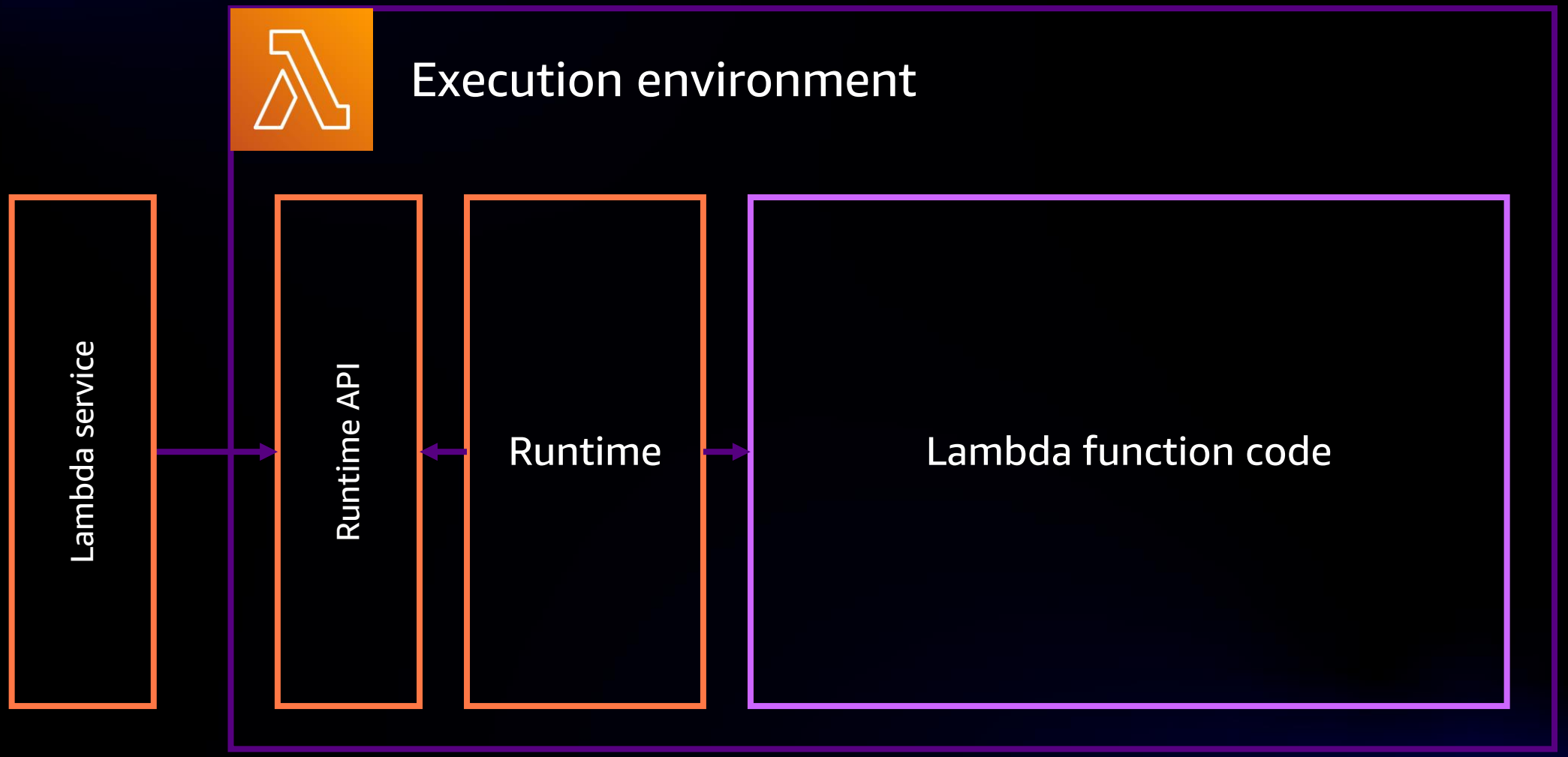
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Execution environment lifecycle



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Handling requests (managed runtimes)



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Runtime API

An HTTP API for custom runtimes (and most of the provided runtimes) to receive invocation events from Lambda and send responses back to Lambda within the Lambda execution environment

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Runtime API

"http://${AWS_LAMBDA_RUNTIME_API}/2018-06-01/runtime/invocation/next”

GET {base}/runtime/invocation/next

Response payload: Event object

POST {base}/runtime/invocation/*AwsRequestId*/response

Request payload: Response object

POST {base}/runtime/init/error

POST {base}/runtime/invocation/*AwsRequestId*/error

https://docs.aws.amazon.com/lambda/latest/dg/samples/runtime-api.zip

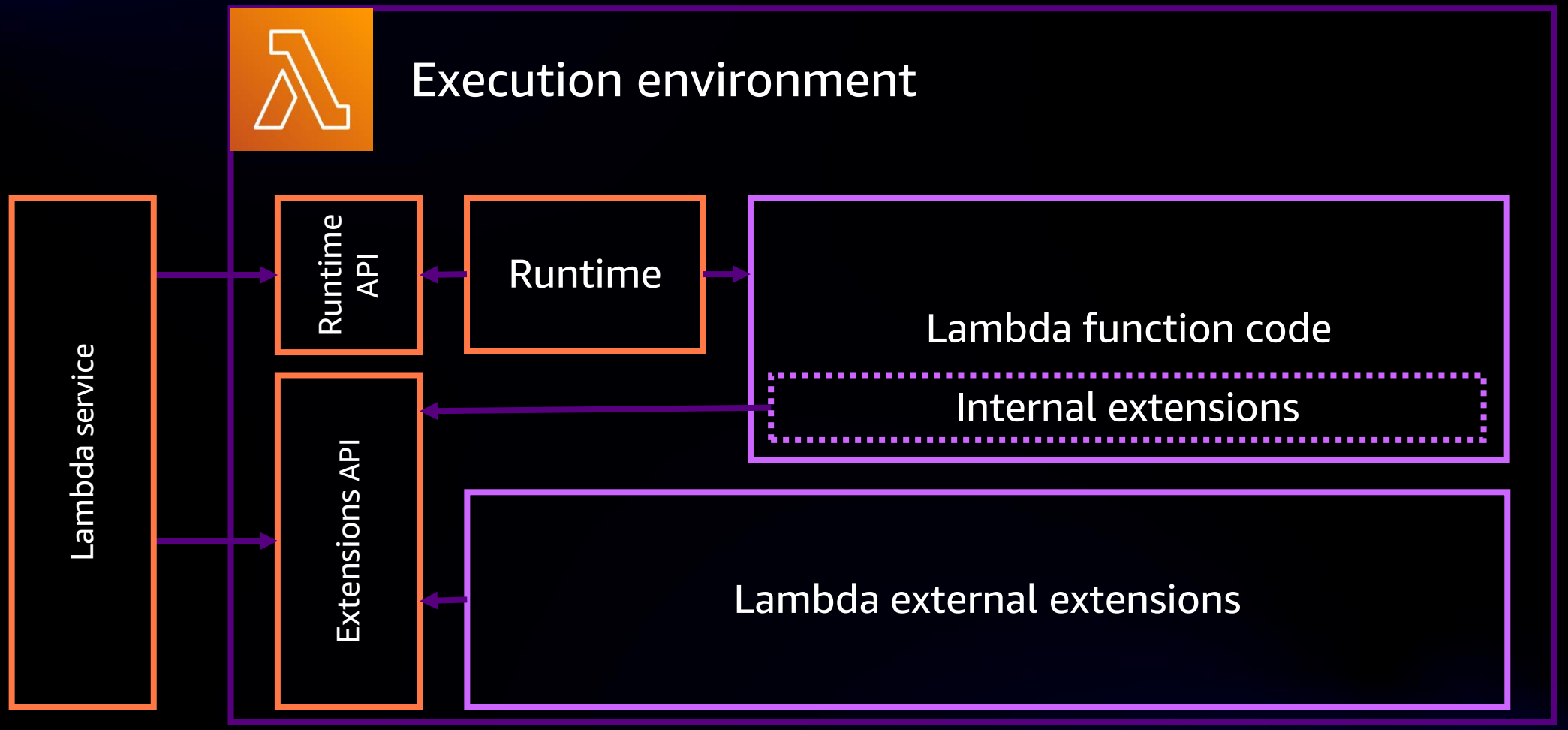
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Custom runtime pseudo-code

```
initialize();
While True {
        event = runtime_api.next();
        response = lambda_handler (event);
        runtime_api.response(response);
}
```

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Handling requests with extensions



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Extensions API

An HTTP API for Lambda extensions to receive invocation and shutdown notifications from Lambda within the Lambda execution environment

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Extensions API

"http://${AWS_LAMBDA_RUNTIME_API}/2020-01-01/extension/register"

```
POST {base}/extension/register
       events: [INVOKE, SHUTDOWN]

GET  {base}/extension/event/next

POST {base}/extension/init/error

POST {base}/extension/exit/error
```

https://docs.aws.amazon.com/lambda/latest/dg/samples/extensions-api.zip

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Invoke payload

```
{
    "eventType": "INVOKE",
    "deadlineMs": 676051,
    "requestId": "3da1f2dc-3222-475e-9205-e2e6c6318895",
    "invokedFunctionArn": "arn:aws:lambda:us-east-
                                1:123456789012:function:ExtensionTest",
    "tracing": {
        "type": "X-Amzn-Trace-Id",
        "value": "Root=1-5f35ae12-
                    0c0fec141ab77a00bc047aa2;Parent=2be948a625588e32;Sampled=1"
    }
}
```

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Shutdown payload

```
{
    "eventType": "SHUTDOWN",
    "shutdownReason": "reason for shutdown",  [SPINDOWN | TIMEOUT | FAILURE]
    "deadlineMs": "the time and date that the function
                          times out in Unix time milliseconds"
}
```

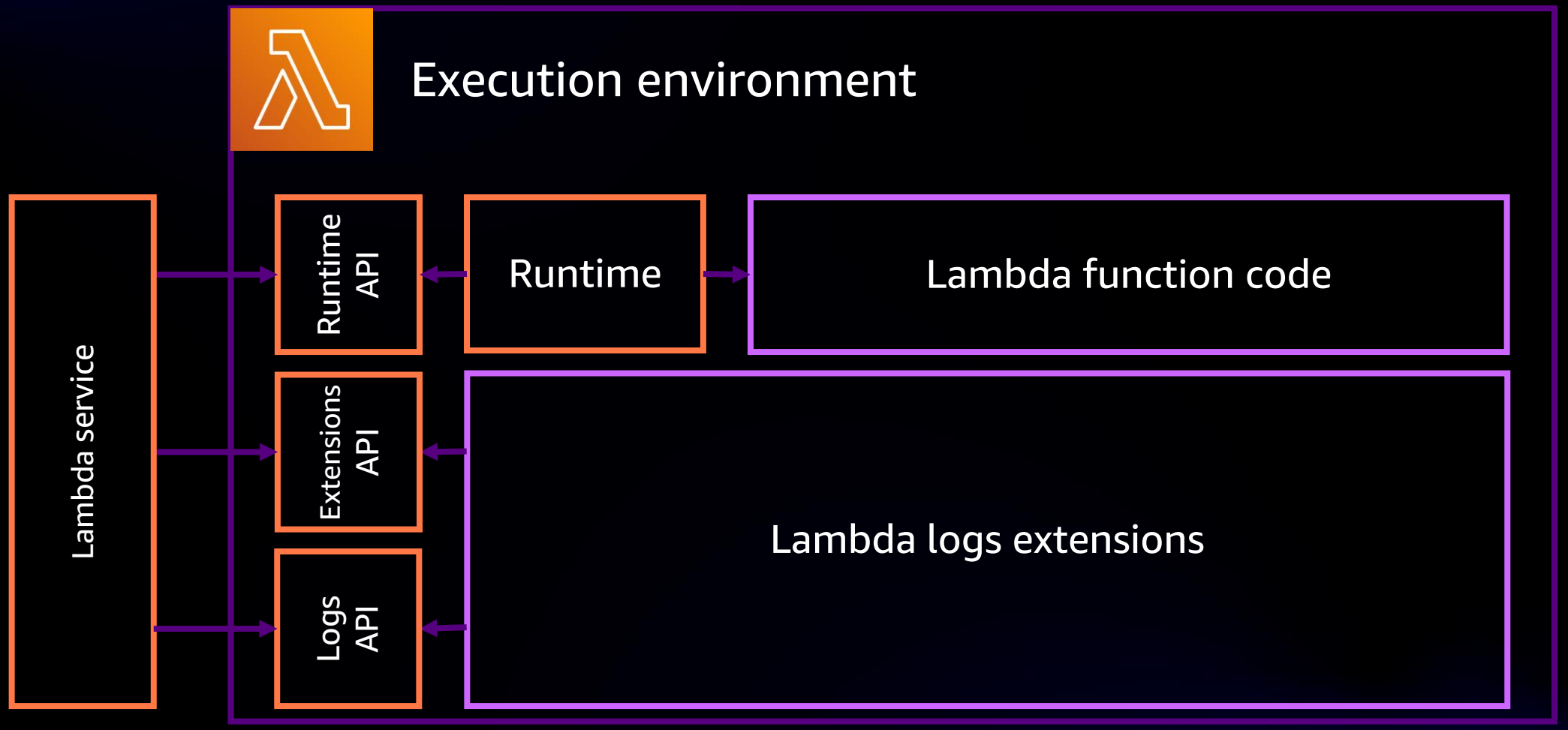
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Extension pseudo-code

```
extentions_api.register();
While True {
        response = extentions_api.next();
        if (response.type == “shutdown”)
                break;
        do_something();
}
shutdown_code();
```

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Handling requests with Logs extension



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Logs API

An HTTP API for Lambda extensions to subscribe to log streams from Lambda within the Lambda execution environment

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Logs API

"http://${AWS_LAMBDA_RUNTIME_API}/2020-08-15/logs”

```
PUT  {base}/logs
       destination: [HTTP, TCP], buffering, types: [function, extensions, platform]
```

https://docs.aws.amazon.com/lambda/latest/dg/samples/logs-api-request.zip

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Sample subscription

```
{
    "schemaVersion": "2021-03-18",
    "types": [
        "platform", "function"
    ],
    "buffering": {
        "maxItems": 1000, "maxBytes": 262144, "timeoutMs": 100
    },
    "destination": {
        "protocol": "HTTP",
        "URI": "http://sandbox.localdomain:8080/lambda_logs"
    }
}
```

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Sample payloads


```
{
    "time": "2020-08-20T12:31:32.123Z",
    "type": "platform.report",
    "record": {"requestId": "6f7f0961f83442118a7af6fe80b88d56",
        "metrics": {
            "durationMs": 101.51, "billedDurationMs": 300, "memorySizeMB": 512,
            "maxMemoryUsedMB": 33, "initDurationMs": 116.67
        }
    }
}

{
    "time": "2020-08-20T12:31:32.123Z",
    "type": "function",
    "record": "Hello World"
}
```


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Logs extension pseudo-code

```
extentions_api.register();
URI = http://sandbox.localdomain:8080/lambda_logs;
create_http_server(URI).run_forever();
logs_api.subscribe();
While True {
        response = extentions_api.next();
        if (response.type == “shutdown”)
                break;
        send_buffered_logs_to_destination();
}
shutdown_code(); // Send remaining logs to destination

http_server:
doPost(event) { // May be called multiple times
        buffer(event);
}
```

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Additional resources

- Lambda extensions blog posts:
  - https://aws.amazon.com/blogs/aws/getting-started-with-using-your-favorite-operational-tools-on-aws-lambda-extensions-are-now-generally-available/
  - https://aws.amazon.com/blogs/compute/introducing-aws-lambda-extensions-in-preview/
  - https://aws.amazon.com/blogs/compute/using-aws-lambda-extensions-to-send-logs-to-custom-destinations/
  - https://aws.amazon.com/blogs/compute/building-extensions-for-aws-lambda-in-preview/
- Extension samples:
  - https://github.com/aws-samples/aws-lambda-extensions

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Thank you!

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