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The Ultimate Checklist for Serverless Monitoring

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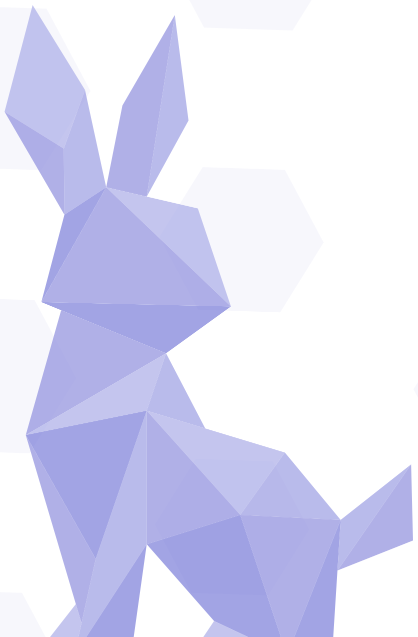
Overview



Introduction

In November 2014, AWS Lambda was launched, extending the cloud's as-a-service model to code functions. Functions-as-a-service (FaaS) allows developers to write a function's runtime code and pre-define its usage requirements, leaving infrastructure and other underlying software issues to the service provider. It was not long before all of the major public cloud providers introduced their own FaaS offerings, which also came to be known as "serverless" since DevOps teams were now freed from compute (and storage) resource issues such as provisioning, scaling, and balancing. And here's the icing on the cake: You only pay for the time your code is running!

Serverless is one of the cornerstones and drivers of the microservice architecture that underlies today's modern distributed applications. The serverless universe now extends far beyond FaaS to include:

- Cloud-native queuing and messaging services, as well as API gateways
- Services such as Step Functions that overcome the inherent statelessness of functions-as-a-service
- Fully managed databases that are optimized for distributed applications, such as DynamoDB
- Serverless data ETL and analytics tools such as Athena

Along with all of the advantages, however, serverless applications create a whole new set of monitoring and observability challenges. Traditional monitoring paradigms break down in the face of highly distributed, modular, event-driven applications that are running on fully managed cloud infrastructures and platforms.

This ebook aggregates material that we have written over the last few years to create the ultimate checklist for effectively monitoring the performance and health of serverless applications. Although the insights and guidelines are applicable to all serverless platforms, our frame of reference is AWS Lambda and related services since AWS continues to dominate the serverless market.

What You Need to Monitor

In order to understand which AWS Lambda metrics are important to monitor, let's just quickly remind ourselves of how they work in the runtime environment. An event trigger—which can be anything from an image uploaded to S3 or an HTTP request to an SQS queue—invokes the Lambda function. The function first tells AWS Lambda to create a function instance, which is basically a container, but AWS has its own proprietary containerization software to manage AWS Lambda function instances.

Once the instance spins up, the code is deployed into the container. This is when the code runs, executes, and returns a value. During this period, the function is considered alive and running, and the idle period is when it has finished executing the code.

AWS Lambda monitors functions and sends the metrics to Amazon CloudWatch, where you can build graphs, dashboards, and alerts. The key AWS Lambda metrics to track are:

Invocations: The number of times a function code is executed, whether successfully or resulting in a function error. (Invocations are not recorded if a request delivers an invocation error.) Anomalous upticks and downticks in invocations can be indicators of faulty function code or problems with how the function interfaces with the event source.

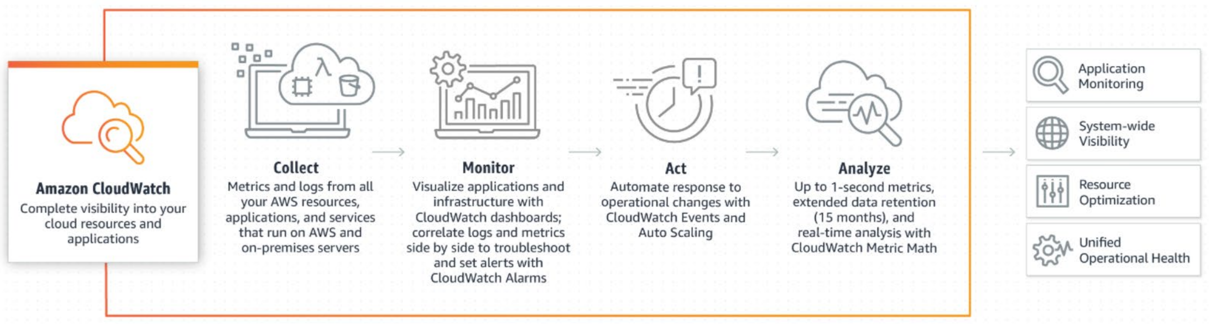
Errors: The number of invocations resulting in a function error, such as exceptions thrown by the code (API timeout, bad type-casting, dividing by zero, etc.) or by the Lambda runtime. The error rate is calculated as the division of Errors by Invocations. A high error rate can be an important indicator of poor application performance and user experience.

Timeouts: CloudWatch does not report this metric, but you can set up an alert manually based on a hardcoded timeout. This effort is worthwhile since timeouts can be very detrimental to application performance. If the function duration hits the pre-configured timeout, the invocation will terminate mid execution.

Out of Memory: Rightsizing function memory is important. If you have not allocated enough memory, execution will be slower. Even worse, if the function exceeds the memory limits, AWS Lambda will stop the execution and throw an exception. On the other hand, over-allocation of memory unnecessarily bumps up costs. You can use the Max Memory Used metric (per function execution) to fine-tune memory allocations and achieve the right balance between performance and cost.

Average Duration: CloudWatch tracks the run duration of each Lambda function. This metric has an impact on a number of key issues including billing, application performance, and preventing premature function termination due to timeout limits. Note: CloudWatch does not record the metric when a function times out.

Estimated Monthly Cost: CloudWatch can alert you when your bill is likely to exceed the targeted monthly budget. You should never run any workload on AWS without this alarm.

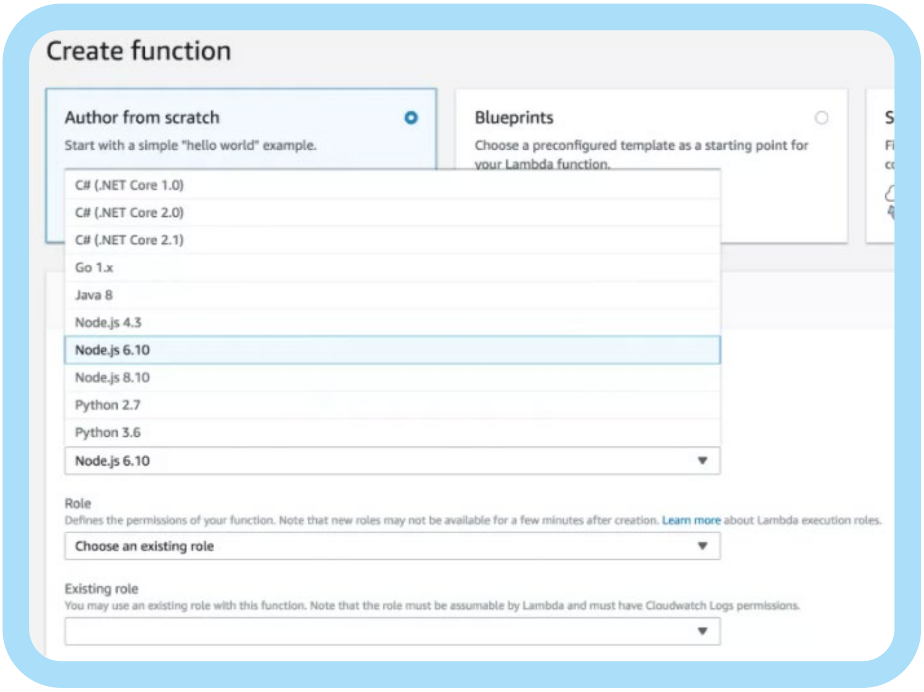

Amazon CloudWatch
Complete visibility into your cloud resources and applications
Collect
Metrics and logs from all your AWS resources, applications, and services that run on AWS and on-premises servers
Monitor
Visualize applications and infrastructure with CloudWatch dashboards; correlate logs and metrics side by side to troubleshoot and set alerts with CloudWatch Alarms
Act
Automate response to operational changes with CloudWatch Events and Auto Scaling
Analyze
Up to 1-second metrics, extended data retention (15 months), and real-time analysis with CloudWatch Metric Math
Application Monitoring
System-wide Visibility
Resource Optimization
Unified Operational Health

Key Challenges and How to Overcome Them

Lambda Cold Starts

AWS Lambda implements a hot-cold architecture, whereby the frequency of function invocation impacts its availability. Frequently called functions are "hot," i.e., the associated AWS resources required to invoke the function are continuously available. If a function is idle, however, AWS Lambda may reclaim those resources, which will then have to be spun up again the next time the function is called. This is what's called a "cold start."

Another cause of cold starts is how AWS Lambda deals with concurrent requests. For example, if you have 10 concurrent requests to the same function, AWS will create 10 containers to serve the requests. Each one of those initializations is a cold start. Depending on the language you're using, the latency introduced by cold starts can often be well over a few seconds.


Create function

Author from scratch
Start with a simple "hello world" example.

Blueprints
Choose a preconfigured template as a starting point for your Lambda function.

C# (.NET Core 1.0)
C# (.NET Core 2.0)
C# (.NET Core 2.1)
Go 1.x
Java 8
Node.js 4.3
Node.js 6.10
Node.js 8.10
Python 2.7
Python 3.6

Node.js 6.10

Role
Defines the permissions of your function. Note that new roles may not be available for a few minutes after creation. Learn more about Lambda execution roles.

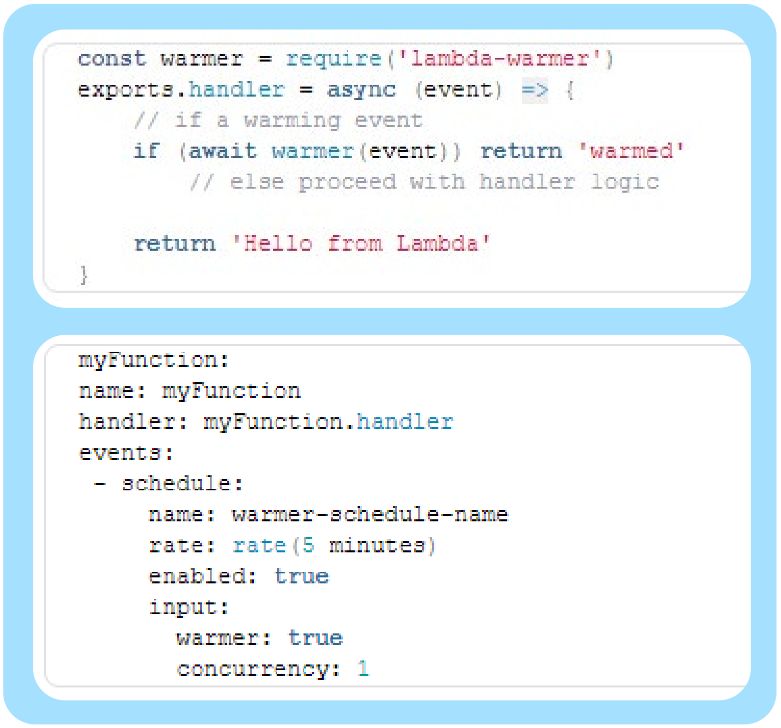
Choose an existing role

Existing role
You may use an existing role with this function. Note that the role must be assumable by Lambda and must have Cloudwatch Logs permissions.

There are two main tactics you can use when battling cold starts: minimizing the duration of the cold start (meaning cutting down the latency of the cold start itself) or minimizing the number of times cold starts occur. The former is done by using interpreted languages (Node.js, Python, Go, for example) or by choosing higher memory settings for your functions. Memory size has a big impact on cold start time—the more CPU resources the function has, the faster it is able to initialize the language runtime.

Minimizing the number of times cold starts is achieved with a technique called function warming, i.e., sending ping events to keep the functions alive and at-the-ready to serve requests. To correctly warm your functions, you should follow a few simple steps:

- Don't invoke the function more often than once every five minutes.
- Invoke the function directly with Amazon CloudWatch Events.
- Pass in a test payload when running the warming.
- Create a handler logic that doesn't run all function logic when it is running the warming.



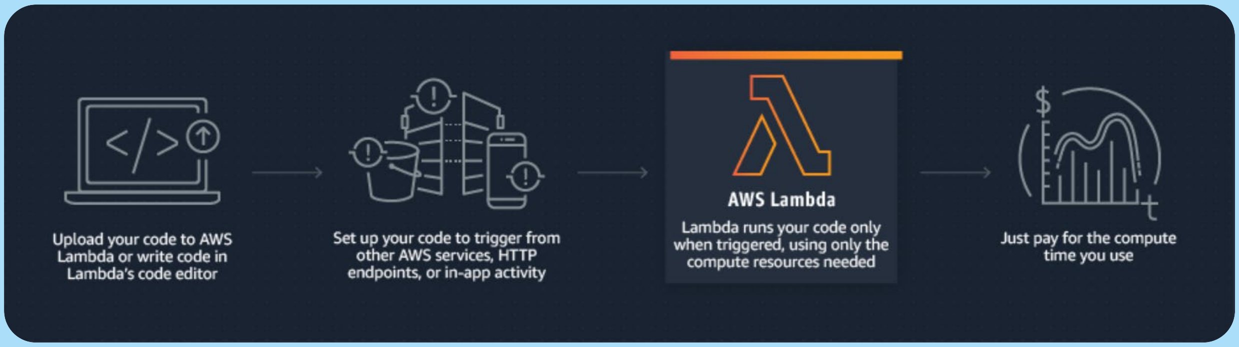
```
const warmer = require('lambda-warmer')
exports.handler = async (event) => {
    // if a warming event
    if (await warmer(event)) return 'warmed'
        // else proceed with handler logic

    return 'Hello from Lambda'
}
```

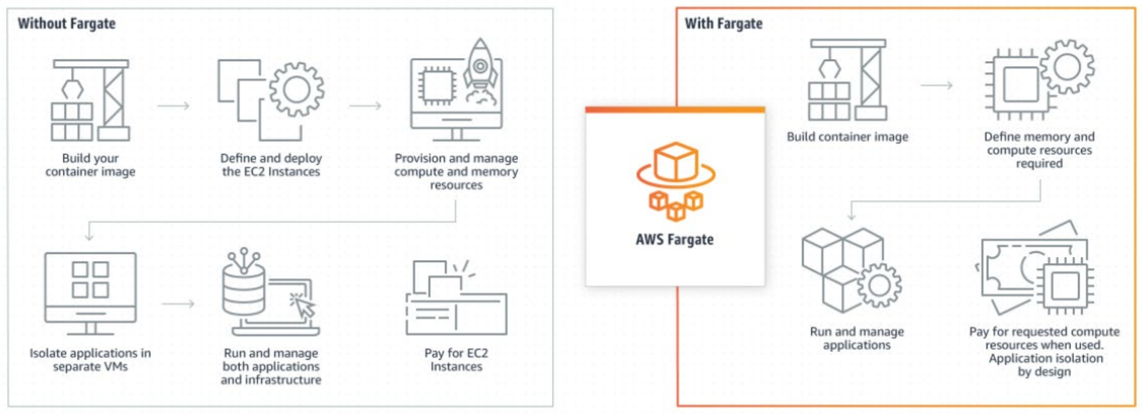
```
myFunction:
name: myFunction
handler: myFunction.handler
events:
 - schedule:
     name: warmer-schedule-name
     rate: rate(5 minutes)
     enabled: true
     input:
       warmer: true
       concurrency: 1
```

Lambda Timeouts

One of the most important configurations for an AWS Lambda function is the timeout value. The AWS Lambda timeout dictates how long a function invocation can last before it's forcibly terminated by the Lambda service.


Upload your code to AWS Lambda or write code in Lambda's code editor
Set up your code to trigger from other AWS services, HTTP endpoints, or in-app activity
AWS Lambda
Lambda runs your code only when triggered, using only the compute resources needed
Just pay for the compute time you use

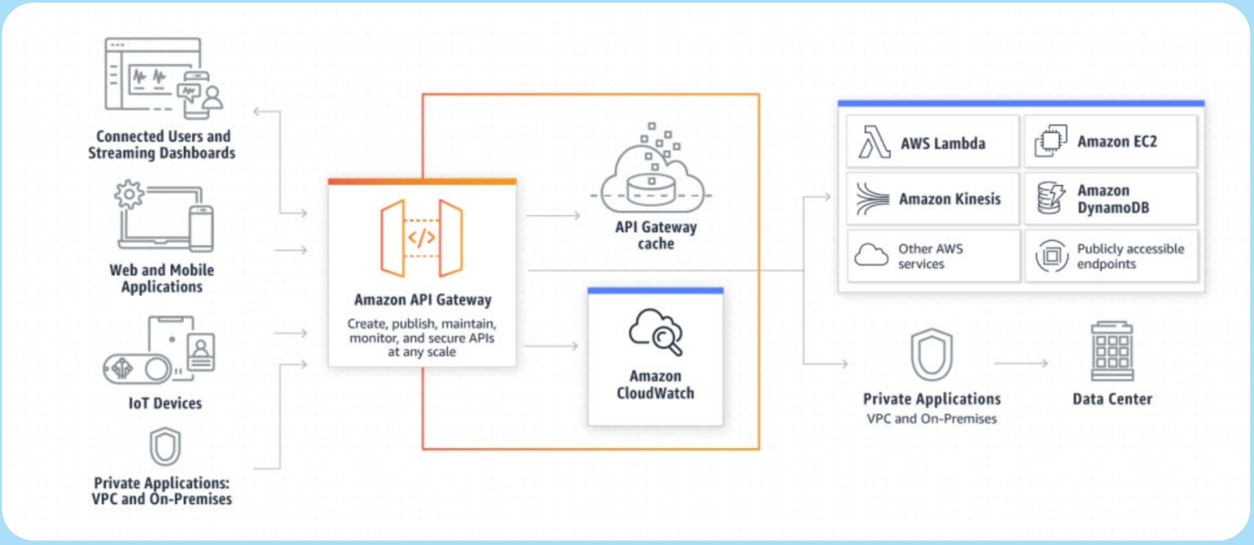
A Lambda function can run for 15 minutes (900 seconds) at most. If what you're doing cannot be comfortably completed within 15 minutes, you should consider moving that workload elsewhere. AWS Fargate became generally available in 2018 and is a good solution for this type of long-running task that doesn't quite fit with Lambda's execution limit, which affects the Lambda timeout.


Without Fargate
Build your container image
Define and deploy the EC2 Instances
Provision and manage compute and memory resources
Isolate applications in separate VMs
Run and manage both applications and infrastructure
Pay for EC2 Instances
AWS Fargate
With Fargate
Build container image
Define memory and compute resources required
Run and manage applications
Pay for requested compute resources when used. Application isolation by design

There are also other limits to consider. For example, Amazon API Gateway has a hard limit of 30 seconds before an integration timeout. This means that even if your function can complete execution within the 15-minute limit, API Gateway would have timed out after 30 seconds and returned a 500 Error to the caller.

The rule of thumb in microservices is to use short timeouts on API endpoints, and the same wisdom applies when building APIs with API Gateway and Lambda. You could wait for API Gateway to timeout the request after 30 seconds. But a better practice is to proactively timeout the function after a few seconds in order to not reach the limit.

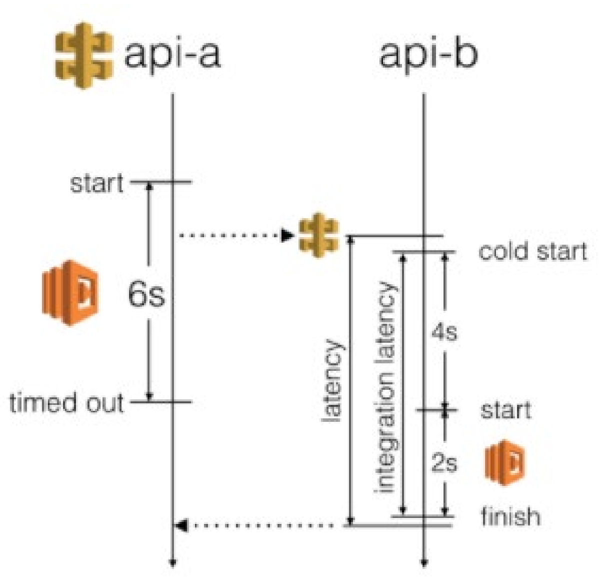
Note that the timeout value for your functions can also have a subtle impact on how frequently you experience cold starts (see above). When API Gateway receives an HTTP request, it will first see if it can reuse an existing container. If all existing containers are executing already, then a new container would be spawned to handle the request. This invocation would, therefore, be a cold start and would take longer to complete.


Connected Users and Streaming Dashboards
Web and Mobile Applications
IoT Devices
Private Applications: VPC and On-Premises
Amazon API Gateway
Create, publish, maintain, monitor, and secure APIs at any scale
API Gateway cache
Amazon CloudWatch
AWS Lambda
Amazon EC2
Amazon Kinesis
Amazon DynamoDB
Other AWS services
Publicly accessible endpoints
Private Applications
VPC and On-Premises
Data Center

Interservice Interaction and Dependencies

Sometimes, a function is unable to respond in a timely manner because it is dependent on a downstream system that has reached its saturation point or is otherwise struggling. Just as a short Lambda timeout is a good practice, you should use short timeouts on your integrationpoints as well. Since you have to give up at some point, it is better to fail fast. Otherwise, your own function might be timed out by AWS Lambda.

We can go a step further and set the timeout for these API calls based on how much time is left in the invocation. This approach strikes a good balance between giving the requests the best chance to succeed versus protecting yourselves against slow downstream responses.



A circuit breaker is a resilience pattern that is often used in a microservice architecture to prevent cascade failures. When requests to a downstream system consistently time out, it trips the circuit. The application stops forwarding requests to the downstream system and gives it time to recover from its current demise. Note, however, that to avoid the anti-pattern of sharing the state of the circuit across multiple callers, do not share the state of the circuit across concurrent executions of functions.

Last but not least, a partial or even wrong answer from a downstream system that is tripping the circuit may be better than no answer at all. This is a UX consideration that you can incorporate into the application code.

Alerts Without Context

Alert fatigue is a common problem in the world of application performance monitoring. It occurs when the teams responsible for keeping applications up and running become overloaded with more metrics-based alerts than can be handled. If they do not have the tools or processes in place to differentiate between low-risk and high-risk situations, there is a danger that alerts will be routinely ignored and real issues overlooked. The bottom line is that if the team is not responding appropriately to alerts, you might as well not be monitoring at all.

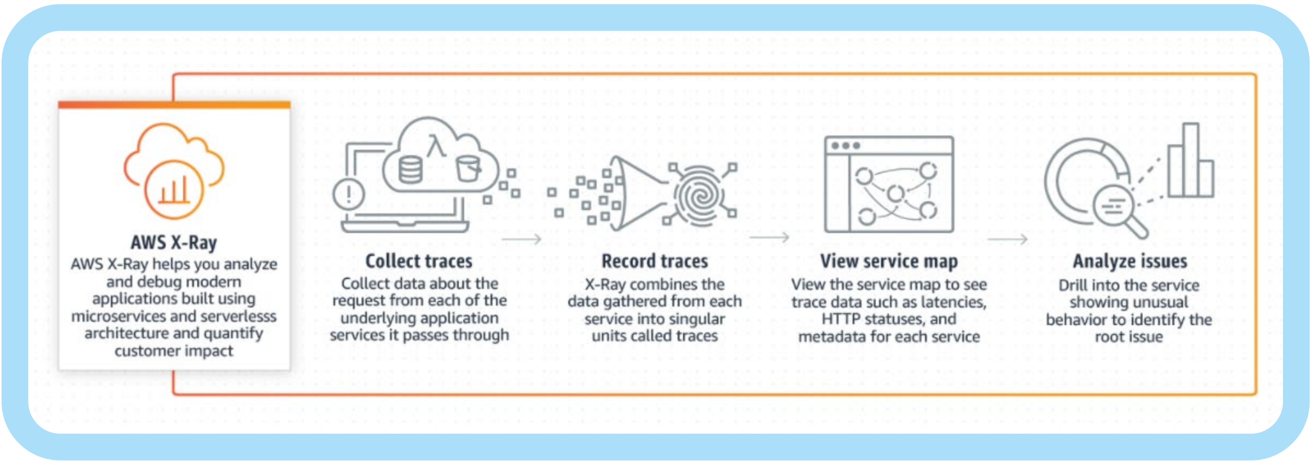
Alert fatigue when monitoring serverless applications can be mitigated if the alerts include contextual trace information such as payload and other related data. It is also important that alerts be as granular as possible, with the ability to define thresholds for any trace, function, or payload metric. Contextual, granular alerts make it easier for teams to prioritize alerts and focus their attention on situations that pose a real risk to application and service performance and health.

Correlated Logs

The cloud vendor's console is the first and most direct approach to attempting to solve issues in your serverless system. Anyone using AWS Lambda is well familiar with the CloudWatch console. There, you can find log groups for each of your functions, and each group contains all the logs of the function. The logs refresh asynchronously, and it can take anywhere from seconds to minutes for the logs to update.

However, when things become a bit more complicated, i.e., in a distributed system with multiple functions, queues, triggers, and more, it can be quite challenging to understand the whole picture and connect all the different log items. Imagine a chain of five Lambda functions withtriggers in between—not to mention, it's unlikely you'll remember to log everything. As the number of functions grows, teams quickly discover challenges in using the default console to understand their systems—some even refer to it as "log hell."

AWS X-Ray is a distributed tracing service to help debug and troubleshoot serverless applications. One drawback of X-Ray is that it requires the developer to insert traces manually. More significant, however, is that AWS X-Ray does not correlate metrics, logs, and traces, which can complicate root cause analyses and lengthen MTTR. In addition, AWS X-Ray only supports AWS services, which is a serious drawback in the multicloud and third-party, API-heavy environments favored by organizations these days. For these and other reasons, it can be quite challenging to troubleshoot complex issues with X-Ray.


AWS X-Ray
AWS X-Ray helps you analyze and debug modern applications built using microservices and serverlesss architecture and quantify customer impact
Collect traces
Collect data about the request from each of the underlying application services it passes through
Record traces
X-Ray combines the data gathered from each service into singular units called traces
View service map
View the service map to see trace data such as latencies, HTTP statuses, and metadata for each service
Analyze issues
Drill into the service showing unusual behavior to identify the root issue

Log aggregation is another possible approach to the challenge of gaining meaningful insights from diverse logs. Log aggregation is performed by a number of existing open-source and third-party tools and services, many of which are based on the Elasticsearch, Logstash, and Kibana (ELK) Stack. These tools provide powerful query and search mechanisms that enable you to match patterns in the recorded data. However, you still have to log everything manually, and you still can't get to the bottom of the asynchronous nature of the system. It only captures data for individual services, meaning the logged data lacks the relevant contextual data to show the wider impact of the problem. Where are all the triggers and events? How are they connected? Also, these log aggregation tools do not come cheap.

Another disadvantage of the log aggregation approach is that, due to storage restrictions, the text files themselves may not be preserved for the time prescribed by an organization's policies. This means that the logging data required to spot long-term trends will not be available. Many cloud-based services offer unlimited log storage, enabling you to catch such long-term trends, but using a cloud-based solution can be expensive over the long term.

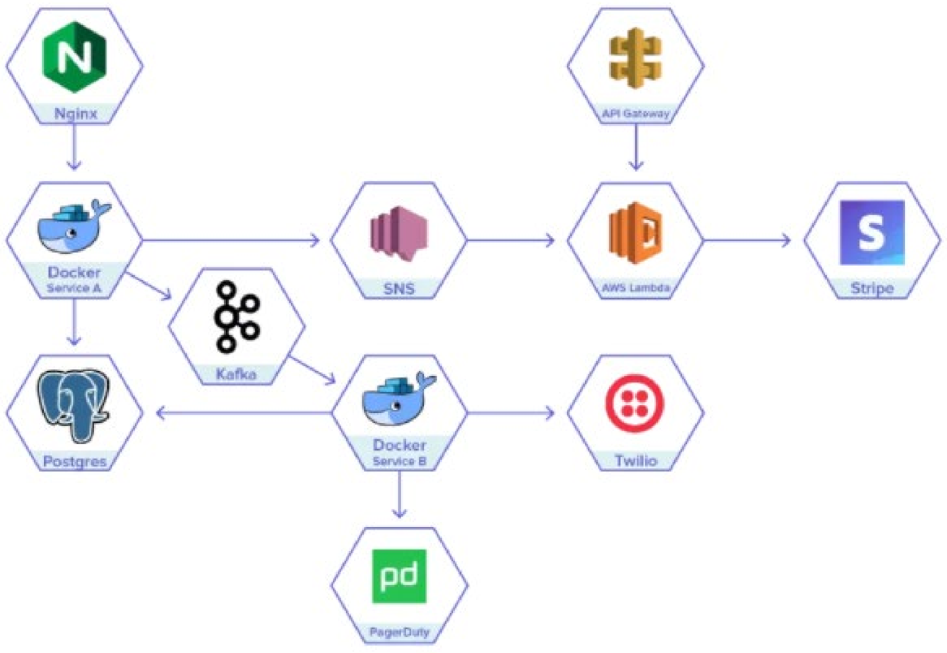
At the end of the day, the only way to effectively and proactively monitor and observe serverless architectures—which are inherently dynamic, always evolving, and a complex mesh of external third-party services—is to leverage advanced AI-based data analytics.

Best Practices and Tips

In this section, we focus on selected best practes and tips that can boost your serverless monitoring.

Trace Every API call, Adding as Many Tags as Possible

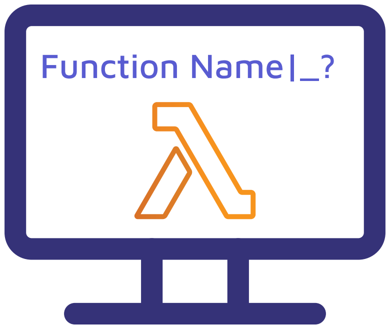
Distributed tracing follows the progress of a single request from its origin to its destination, across multiple systems/domains, and takes into account all participants and processes. In a serverless environment, such as AWS Lambda, distributed tracing can be used to capture and forward correlation IDs through different event sources, making it easier to locate serverless application failures and improve their performance.Because modern microservice applications are abstracted from the infrastructure, developers cannot deploy heavy agents that rely on bytecode instrumentation for application monitoring in general or distributed tracing in particular. Thus, the way to achieve visibility through distributed tracing is to deploy light agents, relying on protocols such as SNMP, WMI, or SSH to relay infrastructure data to the central monitoring system.



Understand Your Serverless Functions with Contextual Service Maps

You should automatically monitor the asynchronous communications typical of microservices and automatically map and trace these distributed requests in real time. Unfortunately, it's hard to anticipate the exact timing and sequencing of these requests as they go across the many components in a transaction. Latency or availability issues anywhere along the request route can significantly impact application performance and the end-user experience. Connecting and automatically correlating metrics, alerts, logs, traces, and payloads in a highly visual architecture view or service map facilitates rapid issue identification and MTTR.

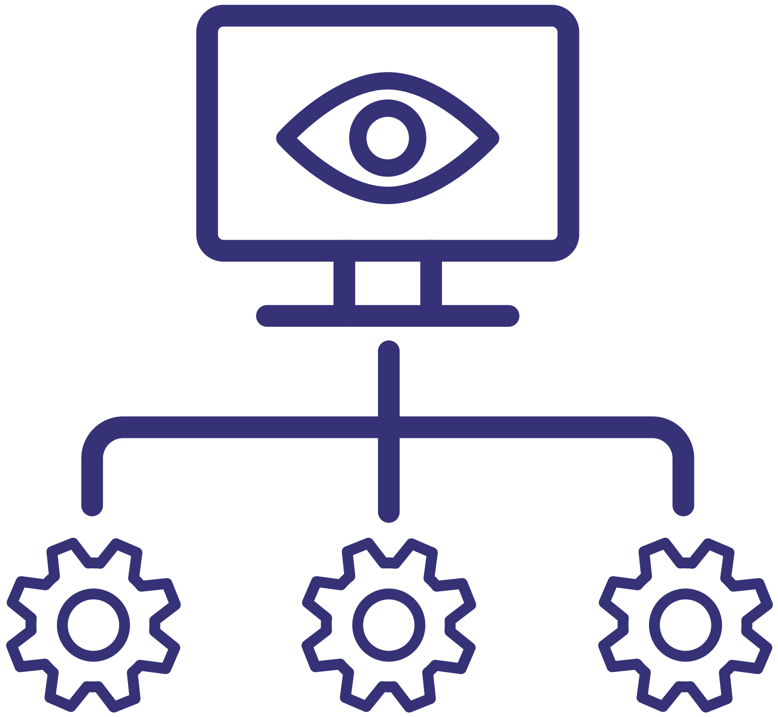
Dead serverless functions are a real issue—but can be handled rather easily. Best practices such as giving your functions meaningful names are relevant in serverless as well. Tools like list-lambdas and others can help keep your architecture clean and steady, which ultimately leads to better software.



Leverage Automation and Use Light Agents

New monitoring and observability solutions must keep pace with the need for very rapid, iterative, and automated development, testing, staging, and deployment cycles. They must support real-time decision-making despite having to handle growing volumes of diverse data. In the modern application, incoming log data from many distributed components can grow exponentially in volume and complexity and overwhelm developers with tedious, manual tasks.

In order to deliver operational and business insights, serverless observability solutions must be able to scale to hundreds of trace views and provide payload visibility, using developer-oriented, best-practice-based metrics. This requires very high levels of monitoring and troubleshooting automation, including the ability to auto-discover the many components that make up the application architecture and the dependencies between them, as well as auto-instrumenting and auto-deploying, using no-code/low-code agents that don't consume a lot of CPU/memory.



Epsagon's Approach

Modern applications built with microservices like AWS Lambda and cloud-managed services require cloud-native monitoring and troubleshooting that is highly automated and provides a holistic, intuitive view of all the "moving parts" as well as the real-time interactions among them. This way, developers can see and quickly drill down to the root cause of an issue and fix it in seconds or minutes—not days or weeks.

Epsagon is the only fully managed provider that integrates and correlates metrics, logs, traces, and alerts in the same solution. Epsagon is built around monitoring transactions, where a transaction is literally a list of traces that are connected together. Transaction IDs give you a complete overview of your function architecture and let you actually see what's going on!

One of Epsagon's most powerful features is the Issues Manager, a visual tool that shows you a list of all errors, warnings, timeouts, and anything else that could be a risk to the health of your system. This means you can take a quick glance at all the errors without having to sift through tons of logs.

Epsagon alerts are easy to define across four main alert types: Lambda Events, LambdaMetrics, Kubernetes, and Trace. Epsagon supports serverless alerting best practices such as monitoring aggregated metrics across a group of Lambda functions; reducing alert fatigue by, for example, taking into account the number of times an error must occur before an alert is triggered; and highly customizable and granular alert settings across multiple dimensions such as environment, resource, or customer.

The onboarding for Epsagon is quick and painless. You can even choose auto-instrumentation to deploy a CloudFormation stack to your AWS account, which will ship all of your logs to your new Epsagon dashboard. Or you can manually instrument your functions with agents.

Epsagon is an AWS Advanced Technology Partner with DevOps, Data and Analytics, and Retail competencies and is sold directly in the AWS Marketplace as a subscription-based SaaSservice. Epsagon is also an AWS Lambda Layers Launch and Public Sector Partner. It enhances product integration with a multitude of AWS services (Lambda, ECS and Fargate, DynamoDB, API Gateway, ElastiCache, EKS, RDS, and more), along with other management services, programming languages, and API-level integrations. Epsagon is the first provider of automated tracing for AWS AppSync, with no code changes required. The solution also automatically connects AWS CloudWatch metrics and AWS metadata with other sources.

In short, as a cloud-native platform based on a lightweight agent SDK, Epsagon provides automated instrumentation and tracing without any gaps in coverage, giving you full visibility for containers, VMs, serverless, and more—with no training, manual coding, tagging, or maintenance required. Epsagon enables DevOps teams to easily monitor modern applications, troubleshoot less, and fix issues faster. Using Epsagon, customers have reported a 95% reduction in troubleshooting time and a 75% reduction in errors—accelerating their time to business value.

Start your Epsagon free trial and get valuable insights immediately.

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About Epsagon:
Epsagon simplifies modern cloud application development as the pioneering microservices observability platform, used by Engineering leaders and Architects to promote team knowledge of architecture, and confidently scale and iterate services faster.

Our platform offers an intuitive view of container and serverless environments, from the overall architecture to individual transactions, that enables teams to rapidly develop, troubleshoot, and monitor microservices applications.

As a new layer of the Observability tech stack where teams can see the behavior of their features, identify and communicate dependencies more effectively, and build intuition around the most cutting edge services launching today, **Epsagon is how teams build faster in the cloud.**

epsagon.com
info@epsagon.com