

Serverless Architecture

Software Architecture

Richard Thomas

May 12, 2025

Oxymoron 1. Serverless

Logic running on someone else's server.

Developers can focus on logic, not infrastructure to deliver it.

Definition 0. Backend as a Service (BaaS)

Cloud-hosted applications or services that deliver functionality used by an application front-end.

- Front-end may be a SPA or mobile app.
- Back-end provides sophisticated functionality (e.g. database, machine learning, location services, authentication, ...).
- Front-end ties back-end services together to deliver the application's functionality.

BaaS Iceberg *[Brunko, 2019]*



BaaS Example



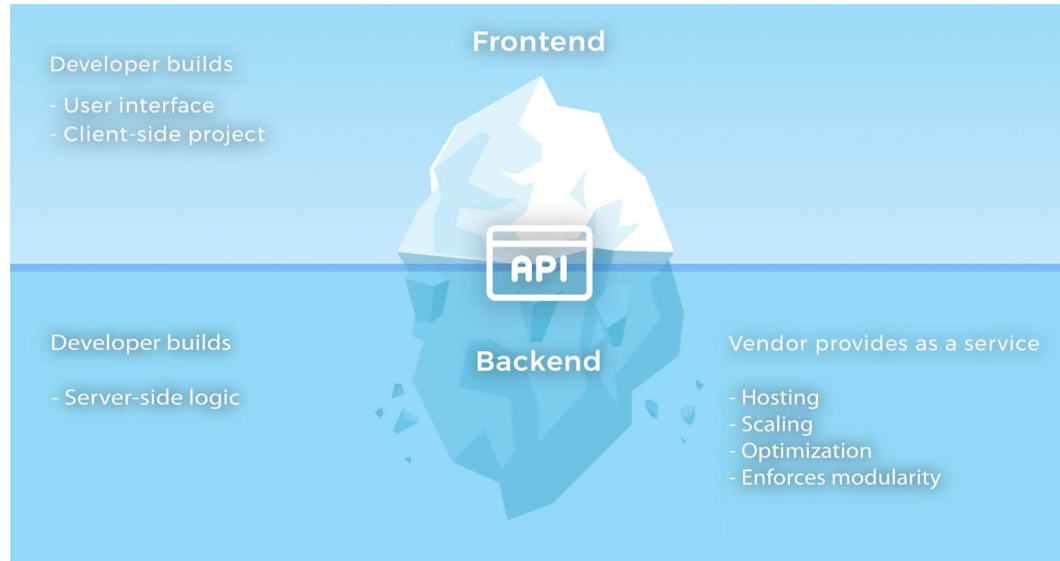
- Example of simple system with back-end functionality delivered *entirely* via BaaS.
- Feature-rich front-ends coordinate behaviour delivered by BaaS.
- Consequence: Front-ends are tightly coupled to BaaS.
- Consequence: Front-ends have both UI and functional behaviour logic.
- Front-end could have a layered design, though many SPAs don't.

Definition 0. Functions as a Service (FaaS)

Application logic that is triggered by an event and runs in a *transient*, *stateless* compute node.

- Node may only exist for duration of function call.
- Server infrastructure (e.g. type of node, lifespan, scaling, ...) are managed by hosting provider.
- e.g. AWS Lambda, Google App Engine, Azure Automation,

FaaS Iceberg *[Brunko, 2019]*



FaaS Example



- Example of simple system with back-end functionality delivered by FaaS.
 - Some services delivered via BaaS.
(e.g. Authentication – not shown on diagram for simplicity.)
- Feature-rich front-ends coordinate behaviour delivered by FaaS.
- Front-ends invoke functions via an API.
- API Gateway provides some separation between front-end and functions.
- Allows a bit more separation between UI and logic.

Definition 0. Serverless Architecture

Software system delivering functionality through BaaS or FaaS.

- Many people focus on FaaS when considering Serverless.
- Mobile App or Single Page Web App (SPA) coordinate services.
- Front-end ties back-end services together to deliver application's functionality.

Sahara Browse & Order — Serverless



- Only browse, search and purchase are shown.
- Uses both BaaS & FaaS.
- Shopping cart is implemented within the web and mobile app for this architecture.
- Order Scenario 1: Customer checks out their shopping cart in the web or mobile app.
- Order Scenario 2: App calls Purchase Products function via API Gateway.
- Order Scenario 3: Purchase Products stores order in DB and sends a payment request to Payment Provider.
- Order Scenario 4: We provide Payment Provider with API end point to call to report payment result.
- Order Scenario 5-9: Notes continue on *next slide*.

The diagram illustrates a cloud-based order management system architecture. It shows the flow of data and control between various AWS services and a mobile application.

Key Components:

- API Gateway:** Acts as the entry point for the system, handling requests from the Fulfillment App and the Order Status function.
- Order Status:** A function that responds to customer queries with the current status of an order.
- Order Shipped:** A function that sends an email to the customer when an order has shipped.
- Order Database:** A database storing orders, which is updated when an order is shipped.
- Message Queue:** A queue that receives messages from the Order Database and triggers the Fulfill Order function.
- Lambda Service:** A service that polls the Message Queue and batches messages to send to the Fulfill Order function.
- Email Service:** A service that sends emails to customers when an order is shipped.
- Fulfill Order:** A function that sends a pick list to the warehouse when an order is picked.
- Fulfillment App:** A mobile application that coordinates the fulfillment of orders.
- Fulfillment Mobile Device:** A device that interacts with the Fulfillment App.

Flow of Data and Control:

- The Fulfillment App sends a request to the API Gateway.
- The API Gateway sends a query to the Order Status function.
- The Order Status function responds to the API Gateway with the current status of the order.
- If the order is shipped, the Order Shipped function is triggered.
- The Order Shipped function sends an email to the customer via the Email Service.
- The Order Shipped function updates the Order Database.
- The Order Database sends a message to the Message Queue.
- The Message Queue triggers the Fulfill Order function.
- The Fulfill Order function sends a pick list to the warehouse.
- The Fulfillment App coordinates the fulfillment of orders.

- Fulfilment Scenario 5-8: Notes continue on *next slide*.

Serverless Benefits

- Automatic scaling
 - Multiple instances of function

Serverless Benefits

- Automatic scaling
 - Multiple instances of function
- Reduced cost for dynamic loads
 - No server idle time

Serverless Benefits

- Automatic scaling
 - Multiple instances of function
- Reduced cost for dynamic loads
 - No server idle time
- Reduced server management

Serverless Benefits

- Automatic scaling
 - Multiple instances of function
- Reduced cost for dynamic loads
 - No server idle time
- Reduced server management
- Easier to run closer to client
 - Launch in same zone as client

BaaS Tradeoffs

- Front-end accesses database directly
 - Front-end needs to sanitise inputs
 - Easy to spoof messages from front-end
 - Hope DB provider is secure

Spoofing messages is an issue for all BaaS services.

BaaS Tradeoffs

- Front-end accesses database directly
 - Front-end needs to sanitise inputs
 - Easy to spoof messages from front-end
 - Hope DB provider is secure
- Application logic is in front-end
 - Less modularisation
 - Duplication of logic with multiple front-ends
 - Web, mobile, ...
- Modern expectations are that almost all systems will have multiple front-ends.
- Duplication of front-end logic is a smaller, but still partial, concern for FaaS.

BaaS Tradeoffs

- Front-end accesses database directly
 - Front-end needs to sanitise inputs
 - Easy to spoof messages from front-end
 - Hope DB provider is secure
- Application logic is in front-end
 - Less modularisation
 - Duplication of logic with multiple front-ends
 - Web, mobile, ...
- No control over server optimisation

FaaS Tradeoffs

- No server state
 - All state needs to be saved (e.g. Redis, S3, ...)
 - Not just persistent state
- Server running function can be killed when function is not running.
- Can occasionally send messages to functions to keep them alive — Not ideal.

FaaS Tradeoffs

- No server state
 - All state needs to be saved (e.g. Redis, S3, ...)
 - Not just persistent state
- Execution duration
 - Can't be long running process
 - AWS Lambda – up to 15 minutes

FaaS Tradeoffs

- No server state
 - All state needs to be saved (e.g. Redis, S3, ...)
 - Not just persistent state
- Execution duration
 - Can't be long running process
 - AWS Lambda – up to 15 minutes
- Startup latency
 - Functions take time to start
 - Some languages worse than others (e.g. Java)

Java has concurrency benefits over other languages.

FaaS Tradeoffs

- No server state
 - All state needs to be saved (e.g. Redis, S3, ...)
 - Not just persistent state
- Execution duration
 - Can't be long running process
 - AWS Lambda – up to 15 minutes
- Startup latency
 - Functions take time to start
 - Some languages worse than others (e.g. Java)
- Proliferation of functions
 - Loss of encapsulation

Question

When is serverless appropriate?

Question

When is serverless appropriate?

Answer

- Rich client apps with common backend
 - BaaS

Question

When is serverless appropriate?

Answer

- Rich client apps with common backend
 - BaaS
- High latency processing
 - Within function duration constraints

Question

When is serverless appropriate?

Answer

- Rich client apps with common backend
 - BaaS
- High latency processing
 - Within function duration constraints
- Apps with variable load
 - Take advantage of auto-scaling

Question

When is serverless *not* appropriate?

Question

When is serverless *not* appropriate?

Answer

- Quick response required
 - Can't wait for FaaS to start

Question

When is serverless *not* appropriate?

Answer

- Quick response required
 - Can't wait for FaaS to start
- Compute intensive processing

Question

When is serverless *not* appropriate?

Answer

- Quick response required
 - Can't wait for FaaS to start
- Compute intensive processing
- Apps with steady load
 - Server-based approaches are cheaper

Self-Study Exercise

- Redesign your scalability assignment to be serverless.
 - What parts of your design would benefit from being serverless?
- Implement your revised design.

Pros & Cons

Extensibility



Reliability



Interoperability



Scalability



Deployability



Modularity



Testability



Maintainability



Security



Simplicity



- Modularity: Deployed functions are naturally modular.
- Modularity: Higher-level abstractions to group deployed functions is difficult.
- Testability: Unit testing FaaS functions is easy.
- Testability: Integration testing is harder.
- Maintainability: Backend modularity and independence should facilitate its maintenance.
- Maintainability: Frontend contains UI and application logic.
- Security BaaS: Front-end access database directly. No server-side protection of db.
- Security FaaS: Every function needs its own security policy (e.g. IAM), which is easy to get wrong.

References

- [Brunko, 2019] Brunko, P. (2019).
Serverless architecture: When to use this approach and what benefits it gives.
<https://apiko.com/blog/serverless-architecture-benefits/>.