

Serverless Architecture

Software Architecture

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Oxymoron 1. Serverless

Logic running on someone else's server.

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

Definition 1. Backend as a Service (BaaS)

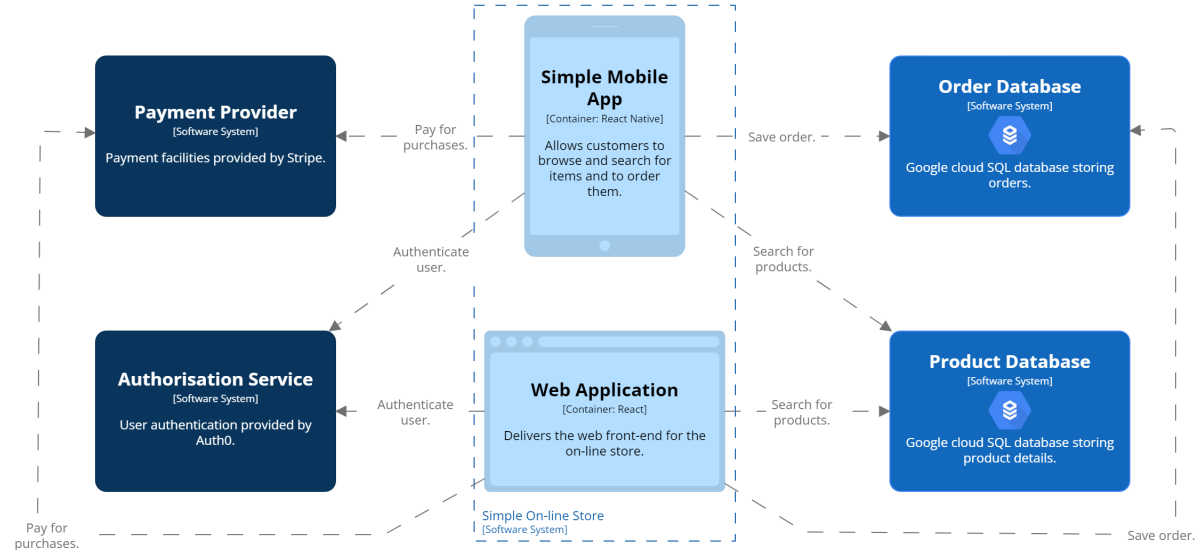
Cloud-hosted applications or services that deliver functionality used by an application front-end.

- 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 are have both UI and functional behaviour logic.
- Front-end could have a layered design, though many SPAs don't.

Definition 2. 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 entirely by FaaS.
- 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.
- May allow a bit more separation between UI and logic.

Definition 3. Serverless Architecture

Software system delivering functionality through BaaS or FaaS.

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

Sahara Browse & Order



- Sahara eCommerce example as a serverless app.
- Only browse, search and purchase are shown.
- Point out that it 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: Payment success causes Payment

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 API Gateway [Container] and the API Gateway [Deployment Node].
- Order Status:** A service that responds to customer queries with the current status of an order. It uses the Order Status Query Function [Deployment Node: java].
- Order Shipped:** A service that sends an email to the customer when an order has shipped. It uses the Order Shipped Function [Deployment Node: java].
- Order Database:** A database storing orders, using the Order Database [Deployment Node].
- Message Queue:** A service that handles events like 'Order Shipped' and 'Order Picking'. It uses the Message Queue [Deployment Node].
- Email Service:** A service that sends emails to customers. It uses the Email Service [Deployment Node].
- Lambda Service:** A service that polls the Message Queue and batches messages to send to Lambda Functions. It uses the Lambda Service [Deployment Node].
- Fulfill Order:** A service that sends a pick list for an order to the warehouse. It uses the Fulfill Order Function [Deployment Node: java].
- Fulfillment App:** A mobile application that coordinates fulfillment of orders, running on a Fulfillment Mobile Device [Deployment Node: Android or iOS].

Flow of Data and Control:

- The **API Gateway** receives a **Query Order Status** request from the **API Gateway [Container]**.
- The **API Gateway** sends the request to the **Order Status** service.
- The **Order Status** service responds to the customer query with the current status of the order.
- The **Order Status** service sends an **Order Shipped** event (REST API JSON/HTTPS) to the **Order Shipped** service.
- The **Order Shipped** service sends an email to the customer with the message that the order has shipped.
- The **Order Shipped** service sends an **Order Shipped Event** (Message) to the **Message Queue**.
- The **Message Queue** sends a **Query Order Details** request (REST API JSON/HTTPS) to the **Order Database**.
- The **Order Database** sends a **Query Order Status** request (REST API JSON/HTTPS) to the **Order Status** service.
- The **Message Queue** sends a **Order Picking Event** (Message) to the **Fulfill Order** service.
- The **Fulfill Order** service sends a **Send pick list for order to warehouse** message to the **Fulfillment App**.
- The **Fulfillment App** sends a **Send Pick List** (HTTPS) message to the **Fulfillment Mobile Device**.
- The **Fulfillment Mobile Device** sends a **Send Order Shipped Message** to the **Email Service**.
- The **Email Service** sends an email to the customer with the message that the order has shipped.
- The **Message Queue** sends a **Poll for Messages** request to the **Lambda Service**.
- The **Lambda Service** sends a **Ship Order Message Batch** to the **Fulfill Order** service.

Legend:

- API Gateway [Container]:** AWS API Gateway.
- API Gateway [Deployment Node]:** AWS API Gateway.
- Order Status [Container: java]:** Order Status Query Function [Deployment Node: java].
- Order Shipped [Container: java]:** Order Shipped Function [Deployment Node: java].
- Order Database [Container: MySQL 8.0]:** Order Database [Deployment Node].
- Message Queue [Container]:** Message Queue [Deployment Node].
- Email Service [Container]:** Email Service [Deployment Node].
- Lambda Service [Container]:** Lambda Service [Deployment Node].
- Fulfill Order [Container: java]:** Fulfill Order Function [Deployment Node: java].
- Fulfillment App [Container: React Native]:** Fulfillment Mobile Device [Deployment Node: Android or iOS].

- Sahara eCommerce example as a serverless app.
- Only fulfilment functions are shown.
- Shows Lambda Service polling Queue, demonstrating how Lambda Functions are invoked via events in a message queue.
- Fulfilment Scenario 1: Lambda Service monitors Queue for 'ship order' messages.
- Fulfilment Scenario 2: Lambda Service batches groups of 'ship order' messages and sends them to Fulfill Order function.
- Fulfilment Scenario 3: Fulfil Order gets order details from DB and sends pick list to Fulfilment App.
- Fulfilment Scenario 4: When order is shipped, Fulfilment App calls Order Shipped function via API Gateway.

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- Automatic scaling
 - Multiple instances of function

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- 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.

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- 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.

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

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- Startup latency
 - Functions take time to start
 - Some languages worse than others (e.g. Java)

Java has concurrency benefits over other languages.

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 - 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?

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Answer

- Rich client apps with common backend
 - BaaS

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- High latency processing
 - Within function duration constraints

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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?

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Answer

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

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- 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/>.