

Serverless Architecture

Software Architecture

Richard Thomas

May 8, 2023

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)

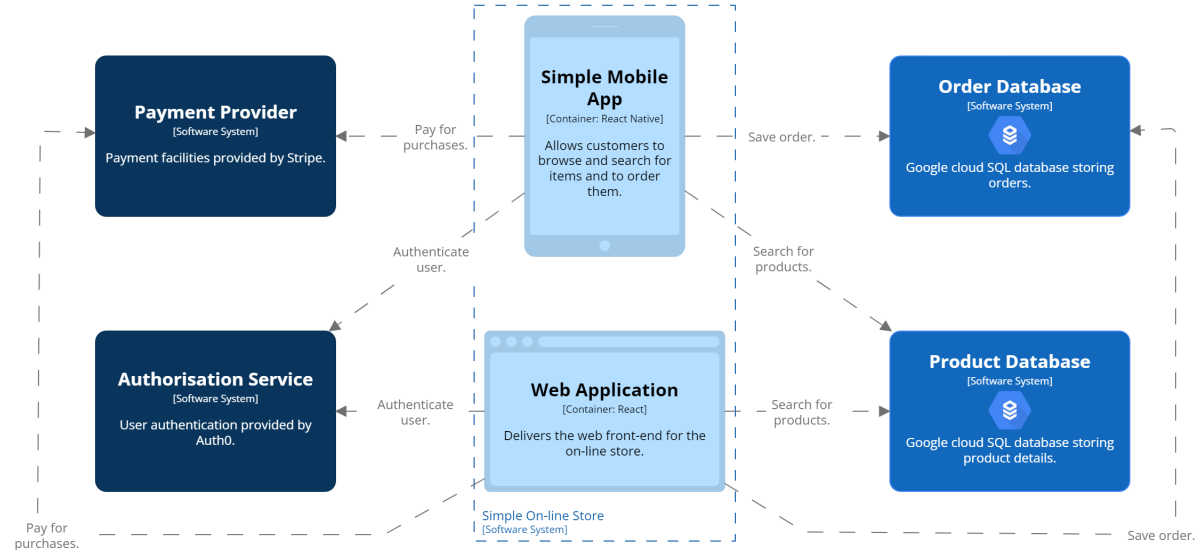
Cloud-hosted applications or services that deliver functionality used by an application front-end.

- 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 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

```

graph TD
    subgraph "AWS Services [Deployment Node]"
        APIGateway[API Gateway  
from API Gateway  
[Container]  
AWS API Gateway.]
        OrderStatus[Order Status  
from Order Status  
[Container: Java]  
Respond to customer query with current status of order.]
        OrderShipped[Order Shipped  
from Order Shipped  
[Container: Java]  
Send email to customer with message that order has shipped.]
        EmailService[Email Service  
from Email Service  
[Container]  
AWS SES.]
        LambdaService[Lambda Service  
from Lambda Service  
[Container]  
AWS Lambda Service polls Message Queue and batches messages to send to Lambda Functions.]
        OrderDatabase[Order Database  
from Order Database Host  
[Container: MySQL 8.0]  
Database storing orders.]
        MessageQueue[Message Queue  
from Message Queue  
[Container]  
AWS SQS.]
        FulfillOrder[Fulfill Order  
from Fulfill Order  
[Container: Java]  
Send pick list for order to warehouse.]
    end

    subgraph "Custom Components"
        APIGatewayDeployment[API Gateway  
[Deployment Node]]
        OrderStatusDeployment[Order Status Query Function  
[Deployment Node: Java]]
        OrderShippedDeployment[Order Shipped Function  
[Deployment Node: Java]]
        EmailServiceDeployment[Email Service  
[Deployment Node]]
        LambdaServiceDeployment[Lambda Service  
[Deployment Node]]
        OrderDatabaseDeployment[Order Database  
[Deployment Node]]
        MessageQueueDeployment[Message Queue  
[Deployment Node]]
        FulfillOrderDeployment[Fulfill Order Function  
[Deployment Node: Java]]
    end

    subgraph "Mobile Device"
        FulfillmentMobileDevice[Fulfillment Mobile Device  
[Deployment Node: Android or iOS]  
Coordinates fulfillment of orders.]
    end

    APIGatewayDeployment -- "Query Order Status [REST API JSON/HTTPS]" --> OrderStatusDeployment
    OrderStatusDeployment -- "Update Order Details [REST API JSON/HTTPS]" --> OrderDatabaseDeployment
    OrderStatusDeployment -- "Order Shipped [REST API JSON/HTTPS]" --> OrderShippedDeployment
    OrderShippedDeployment -- "Send Order Shipped Message" --> EmailServiceDeployment
    OrderShippedDeployment -- "Order Shipped Event [Message]" --> MessageQueueDeployment
    MessageQueueDeployment -- "Poll for Messages" --> LambdaServiceDeployment
    LambdaServiceDeployment -- "Ship Order Message Batch" --> FulfillOrderDeployment
    FulfillOrderDeployment -- "Order Picking Event [Message]" --> MessageQueueDeployment
    FulfillOrderDeployment -- "Send Pick List [HTTPS]" --> FulfillmentMobileDevice
    FulfillmentMobileDevice -- "Coordinates fulfillment of orders." --> FulfillmentMobileDevice

```

- 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.

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.

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/>.