Building a cloud-based serverless Space Invaders Game

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Who I am

Electrical Engineer
M.Sc. in Control Systems
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20+ years as professor for undergrad/graduate programs
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Agenda

• Let’s play (we already did this… I hope)
• Walk through on the solution architecture
• Resources (source code it will be available)
• Q&A
Possible way of expressing the requirements

I need a **web application**:

- That allows my users to register themselves, with proper access control
- Users produce a large amount of small chunks of data (120 bytes), at a rate of 1 chunk per 20 ms or so
- We need to store the data for future needs
- We need to be able to consume processed data in (near) real-time
- *We need to minimize our costs related to infrastructure management*
Producer–Consumer pattern at scale

Gamers (producers)

Manager (consumer)
High-level block architecture

Gamers

- Ingesting
- Processing
- Consuming
- Storing

Security

Hosting

Operations | Security | Reliability | Performance | Cost
Hosting services in traditional data centers
Capacity planning challenge with traditional infrastructure

- On / Off
- Predictable growth
- Variable peaks
- Predictable peaks
Capacity planning challenge with traditional infrastructure

- On / Off
- Predictable growth
- Variable peaks
- Predictable peaks
- Waste
- Dissatisfied customers
Capacity planning on the cloud

On / Off

Predictable growth

Variable peaks

Predictable peaks

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Cloud computing

Computing power
On Demand
Elastic
Automated
Standardized
Visible
Self-Service
API

CAPEX → OPEX
Cost → TCO
Stop guessing capacity and costs
Optimizing computing power usage
Benefit from economy of scale
Cloud computing

Systems & Applications

API
Web Server
App Server

Databases
Platforms
AD/LDAP

Container Layer

Virtualization layer

Bare metal servers

DNS
Firewalls
IDS
IPS
Networking

Virtual Appliances

VM
VM
VM

Hyperv layer
Network
DC Network
Cloud computing

Region 1

AZ-a
AZ-b
AZ-c

VPC

Region 2

AZ-a
AZ-b

Region N

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Serverless

The underlying server infrastructure and management details are hidden from the user, without affecting the ability of delivering results.

Less investment/effort in coding and managing well-defined application and infrastructure patterns

Focus on the business needs

Effort is put on the application and integration sides
Serverless – removing the heavy lifting
Space Invaders
A serverless designing adventure

Gamers

Manager

Identification and Authentication

Ingesting

Containers with webserver

Server with webserver

Consuming

Static website serving
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Gamers

Managed DNS

Amazon Route 53

Ingesting

Managed containers

AWS Fargate

Storing

Managed Object Storage with web-hosting capabilities

Amazon S3

Static website serving

Manager

Identification and Authentication
“Web-hosting” Layer

100% SLA
Global

99.99% Availability
99.999999999% Durability
Multi-AZ (regional)

Sample Pricing

$0.50 per hosted zone / month
for the first 25 hosted zones

$0.400 per million queries
for the first 1 Billion queries / month

GET, SELECT and all other Requests
$0.0004 per 1,000 requests

$0.023/GB/Month for the first 50TB
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Gamers

Manager

DIY Access control system
3rd party tools running over VMs
3rd party tools running SaaS

Ingesting
Processing
Consuming
Storing

Security

Amazon Cognito
AWS Identity and Access Management
Security layer

Cloud access control and permissions service

User Pools/Identity/Federation for application users

Native RBAC

Sample Pricing
No cost

Based on Monthly Active Users (MAU)
- First 50K → Free
- $0.00550/user for the next 50K
...
let baseArn = 'arn:aws:apigateway:' + props.region + ':+props.accountId+':' + this.api.restApiId + '/prod/*/';

let playerRole = (<IAM.Role> props.getParameter('security.playersrole'));

playerRole.addToPolicy(
  new IAM.PolicyStatement()
    .describe('APIGatewayGETPermissions')
    .allow()
    .addAction('apigateway:GET')
    .addResources(
      baseArn + 'config',
      baseArn + 'session',
      baseArn + 'scoreboard'
    )
);
Defining RBAC with Cognito

UserPool

IdentityPool

Groups
- Managers
- Players

Rules
- Access coming from
  - Managers
  - Players
- Attach this role
  - ManagersRole
  - PlayersRole
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Gamers → Processing → Hosting

API Gateway and/or Stream Processing (Kafka) and/or IoT Gateway

DYI
3rd party running over VMs
3rd party running over containers
3rd party SaaS
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Gamers → Ingesting → AWS IoT Core → Processing → Consuming → Amazon Kinesis Data Streams → Manager

- Identification and Authentication Manager
- Amazon API Gateway
- Amazon Kinesis Data Streams
Ingestion/Consumption layer

**Managed IoT Gateway for connection management and message exchange**

- $0.080 per MM minutes of connection
- Up to 1B messages (5Kb) = $1.00

**Fully managed service for REST APIs and websockets definition and management**

- $3.50 for the first 33 MM API calls

**Fully managed platform for real-time streaming data**

- $0.015/shard/hour
- $0.014/1MM messages (25Kb)
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Gamers

Ingesting

Processing

Consuming

Identification and Authentication

VM with App Server and/or Container with App Server

DYI
3rd party running over VMs
3rd party running over containers

Manager
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Gamers → Ingesting → Processing → Consuming → Manager

Identification and Authentication

Gamers

Manager

Amazon Kinesis Data Analytics

AWS Lambda
Processing layer

Real-time data stream processing service

Run code per request/event billed at each 100ms

$0.110/hour (1 KPU = 1 vCPU + 4Gb RAM)

Free tier
- 1MM Requests/month
- 400K Gb-seconds

After free tier
- $0.20 for 1MM /requests
- $0.00001667 for every GB-sec

Sample Pricing
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Database + [ Block | Object ] Storage for raw data
Running over VMs
Managed Services

Gamers

Manager

New options here:
Timestream
QLDB

Amazon Kinesis Data Firehose
Amazon S3

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Gamers

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Amazon Kinesis Data Streams
Amazon ElastiCache
Amazon Aurora
Amazon DynamoDB
Amazon Neptune
AWS Systems Manager

Ingesting
Processing
Consuming

Storing

Manager

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Storing layer

Fully managed service for delivering real-time streaming data to S3, Redshift, Elasticsearch,…

**Parameter Store** is a centralized store to manage configuration data

Key-value and document database that delivers single-digit millisecond performance at any scale

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**Sample Pricing**

- **$0.029** (First 500 TB / month)
- **No cost**
- **For Provisioned Capacity**
  - $0.00065 per WCU (1Kb chunks)
  - $0.00013 per RCU (4Kb chunks)
  - First 25 GB stored per month is free
Change Request !!!

Space Invaders – A serverless designing adventure
“I want all gamers starting at the same time. When the Manager pushes ‘start’, I want everybody together”

Your customer
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Gamers

... 

Identification and Authentication

Push notifications

Websocket-enabled web server

Running over VMs
Running over container

Hosting

Manager
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Gamers

Identification and Authentication

Push notifications

Ingesting
Processing
Consuming

Manager

Amazon SNS
Amazon Pinpoint
AWS IoT Core

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Gamers

Manager

Websockets

Ingesting

Consuming

AWS IoT Core

Storing

Hosting

Identification and Authentication

New options here:

APIGTW Websockets
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The implemented architecture
(for now)
From here…
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Related use cases
Related use cases

- Near real-time sales reporting
- Near real-time financial transactions reporting
- Near real-time event processing (mobile apps, IoT)
- Gamification scenarios (where a scoreboard can be handy?)
- Near real-time event reporting from beacons in intelligent retail stores

And, a question:
Can this architecture be used to implement a system for the stock market (buy/sell)? Can it be totally serverless? Or will it need a mix?
#GoBuild

Go to

https://github.com/fabianmartins/spaceinvaders.workshop.git

and follow the instructions

Thank you!!!

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