Case Study for Software – Cloud Software Architect

Assumptions:

1) Goldfinger has already created Azure Active Directory B2C tenant to ensure user can register themselves with personal emailid and pwd
2) A web application has been registered in Azure Active Directory B2C and roles have been created in the manifest which ensures roles are present when we get the JWT after authentication to the application

Mobile Device of Activation and set up

https://raw.githubusercontent.com/amitabh-github/goldfinger/master/DeviceProvisioning.jpg
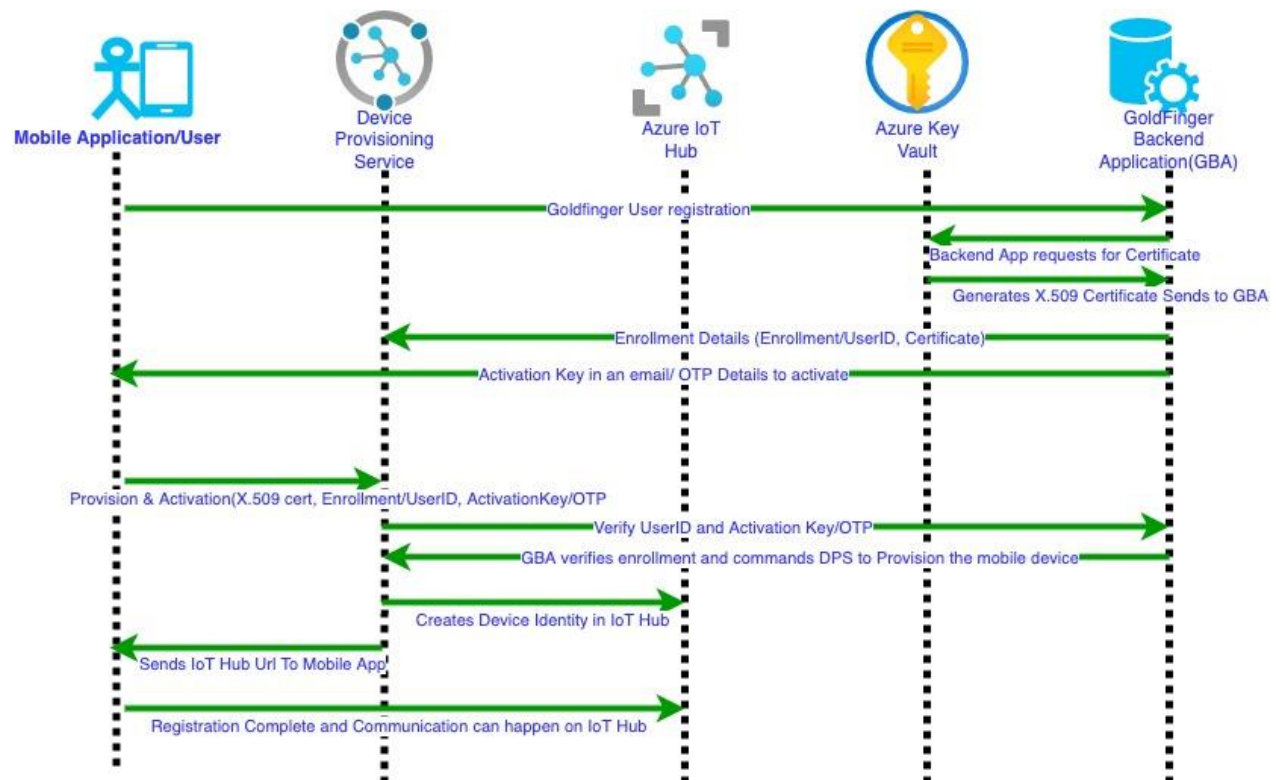
Device Activation Message – D2C

- Once the Registration is complete the first message is sent from device to cloud as follows:

```json
{
  "DeviceId": "1953b126-91e0-4024-80ab-e79e92dcc6cf",
  "IMEI": "******7890*****3458***",
  "DeviceModel": "GALAXY",
  "MsgType": "MSG-ACTIVATION-REQ",
  "Timestamp": "TimeUtc",
  "Manufacturer": "SAMSUNG ",
  "OSName": "Android",
  "PrivateIP": "10.0.0.1",
  "OSVersion": "11.1.8.930",
  "AppName": "GoldFinger Application"
}
```

- Code to send the message in C#

```csharp
private async Task SendMessageToIOTHubAsync(DeviceClient deviceClient)
    {
      try
      {
        var payload = "{" +
        "\" DeviceId\":\"" + deviceID+ "\", " +
        "\" IMEI\":\"" + imei + "\", " +
        "\" MsgType\":\"MSG-ACTIVATION-REQ\"" +
        ---------****************----------------------------------------------etc—etc..
        var msg = new Message(Encoding.UTF8.GetBytes(payload));
        //Add to log – Sending message --------------------
        await deviceClient.SendEventAsync(msg);
      }

      catch(Exception ex)
      {
        //mobile phone exception handling
      }
    }
```

Device Activated and Read to send Telemetry – C2D

- **After the activation request is received in IoT hub, activation response is sent with configurations**

```
private static async void ReceiveC2dAsync()
{
    //Some Logging——————————
    while (true)
    {
        Message receivedMessage = await s_deviceClient.ReceiveAsync();
        if (receivedMessage == null) continue;
        //Some Logging
        Encoding.ASCII.GetString(receivedMessage.GetBytes()));


        await s_deviceClient.CompleteAsync(receivedMessage);
    }
}
```

Response payload

```
[
 {
   "DeviceId": "1953b126-91e0-4024-80ab-e79e92dcc6cf",
   "MsgType": "MSG-ACTIVATION-RESPONSE",
   "MsgId": "123456",
   "Timestamp": "TimeUtc",
   "Status": "ACTIVATION_SUCCESS",
   "Reason": ""
 }
]
```

Device Telemetry – Sending GPS coordinates every 1 minute

Once Activation is successful and complete, the app can start sending gps coordinates at every 1 min interval.

```
[
 {
   "DeviceId": "1953b126-91e0-4024-80ab-e79e92dcc6cf",

   "MsgType": "MSG-DEVICE-TELEMETRY",

   "MsgId": "123456-98098",

   "Timestamp": "TimeUtc",

   "Latitude": "51.50072",

   "LatitudeDirection": "N",

   "Longitude": "0.1276",

   "LongitudeDirection": "W",

   "Altitude": 100"
 }
]
```

Task 1

Please provide 2 API descriptions: one stateless API and one stateful API that is to be reviewed by Goldfinger.

Amitabh – From the requirements it is clear that we should be using a stateless API. The data is sent by a mobile device and there are millions of such devices sending gps coordinates so having a stateful API where sessions are maintained in the server is an expensive affair. As long as each request can have an unique id (pseudonymized) identifiable by the backend a stateful API is not required.

What kind of protocol for the API do you think fits the best ? Can you explain the advantages / disadvantages of the alternatives

Amitabh – There are 3 protocols with which D2C IoT Hub communication can happen.

- MQTT (secure/non-secure)
- AMQP secure/non-secure)
- HTTPS

We will choose "MQTT over WebSockets" on Port 443 as the Protocol of choice.

Why? MQTT is lightweight, uses low bandwidth, can work on low cpu and low memory scenarios.

Disadvantages of HTTPS:

- For starters, HTTPS is inefficient way to send this information as it is document–centric and not data-centric.
- For the IoT hub HTTPS messaging guidelines are to send once every 25 mins else requests will be throttled on IoT hub so this is not ideal for our requirement.
- HTTPS communication from device will require larger payload size compared to MQTT for the same information.
- The device needs to have higher computational power to send HTTPS message compared to MQTT.

Disadvantage of AMQP:

- Though it is advanced protocol, it is resource intensive – requires higher bandwidth and compute.
- Bigger message sizing capacity is available which is an overkill for this requirement.

Task 2

Describe what kind of service(s) should be used in black box 1 to achieve the requirements. Please remember we need separate deployments for each and every cloud provider.

Amitabh – For the black box, Azure IoT hub, event hub and processing microservices is required. Please see the diagram for the setup.

● Please specify all services starting from the API ingestion

   ○ These services can be cloud agnostic or not.

   ○ Goldfinger wants to have the maintenance to be as generic as possible.

Amitabh: Maintenance will be cloud agnostic.

As above. Maintenance can be generic as this is a distributed architecture.

● Provide some high level code describing how the processing of time slicing will happen.

Amitabh: As it is an event driven architecture each event/message will be processed by the listener service and it will follow. The event create and publish example is here: https://docs.microsoft.com/en-us/azure/event-hubs/event-hubs-dotnet-standard-getstarted-send

● How can the rest API be restricted to the customers of Goldfinger?

   ○ How would you set up such restricted accesses in a scalable way?

Amitabh: The IoT hub is designed to provide restricted access to each device. It does device provisioning for zero touch deployment of device and can handle big data scenarios.

Task 3

Say you are using a library that takes a set of GPS coordinates and a maximum haversine distance. The library maintains all hot spots dynamically in a noSQL DB. This library is usable in an OOP language of your choice (Java, C#, C++, Python, ...) and provides the following API (provided in Java notation):

class GPSCoordinates

{

double longitude;

double latitude;

}

GPSCoordinates getClosestHotSpot(List<GPSCoordinates>, int maxHaversineDistance)
getClosestHotSpot

returns null if no hotspot is found in the maximal haversine distance.

Please provide the code that will:

1. Use the API to know if a user approaches a hot spot.

Amitabh - The API endpoint that takes the input as the GPS coordinates and calculates if there is any hotspot in max haversine distance is called by the serverless Azure Function implementation.

Each message exiting out of the event hub is processed by the Azure Function which in turn calls the API endpoint to pass this GPS coordinates and get the value.
Code to call the API which uses the HttpClient class in C#: https://github.com/amitabh-github/goldfinger/blob/master/APICall.cs

2. If a hot spot is found, a counter in a serverless / fully managed NoSQL DB must be increased (non serverless or non managed DBs are not acceptable).

Amitabh - If any hotspot is found, the counter is updated. This is present in the function app.

3. The increment should happen using a key of type string composed of the longitude concatenated with the latitude.

Amitabh – The logic to increment is present in the function app.

4. Your code should be able to support the 3 mentioned clouds and support millions of parallel requests

Amitabh – The serverless feature is available in other clouds as well and Yes, it can handle millions of parallel requests.

Azure – Functions

AWS – Lambda

GCP – Cloud Function

Task 4

An operator who is an employee of the Goldfinger company must be able to read or clear the data. The operator will access the endpoint a maximum of 6 times per month.

● Provide the services needed in black box 2

Amitabh – APIM, App Gateway, Mobile app service are required. Details are provided in Solution Architecture.

● Provide the API to be sent for review to Goldfinger

Amitabh – The API is hosted in Mobile app service. It uses AAD JWT to identify role of the operator.

The operator can access the endpoint a maximum of 6 times per month requirement can be achieved by creating a rate limiting policy in the APIM.

● How would you secure the API?

Amitabh – The API is secured with the help of Application Gateway implementing WAF for all the requests originating from Public Internet. The request then goes to Azure API Management. The internal traffic also goes through APIM.
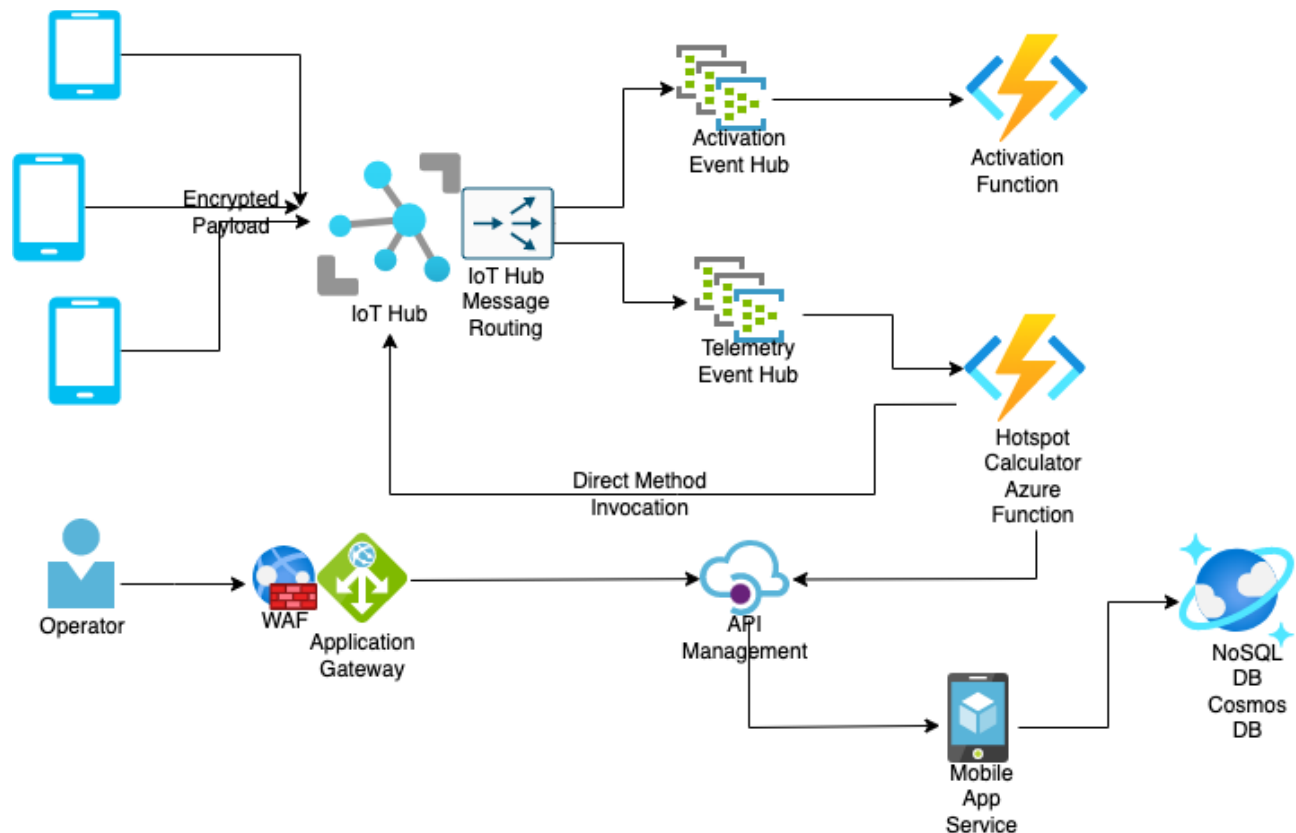
Task 5

Can you provide a yearly cost estimation of the whole solution for one cloud provider ?

Amitabh - Costing is done using cost calculator and chosen service levels. Using https://azure.microsoft.com/en-gb/pricing/calculator/ for reference.

Microsoft Azure Estimate					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Azure IoT Hub		North Europe	Standard Tier, S2: Unlimited devices, 6,000,000 msgs/day, $250.00/mo, 1 IoT Hub Units; IoT Hub Device Provisioning: 10,000 Operations	£198.98	£0.00
Event Hubs		North Europe	Standard tier: 2 Throughput unit(s) x 730 Hours, 300 million Ingress events	£41.38	£0.00
Azure Functions		North Europe	Consumption tier, 1024 MB memory, 100 milliseconds execution time, 50,000,000 executions/mo	£66.11	£0.00
App Service		North Europe	Standard Tier; 1 S2 (2 Core(s), 3.5 GB RAM, 50 GB Storage) x 730 Hours; Windows OS	£115.74	£0.00
Azure Cosmos DB			Serverless, Single Region Write (Single-Master); 10 million RUs; 1 GB transactional storage, 2 copies of periodic backup storage; Dedicated gateway not enabled	£2.44	£0.00
Application Gateway		North Europe	Web Application Firewall V2 tier, 730 Fixed gateway Hours, 5 GB Data transfer	£258.33	£0.00
API Management		North Europe	Consumption tier, 10,000 calls	£0.00	£0.00
Support			Support	£0.00	£0.00
			Licensing Program	Microsoft Customer Agreement (MCA)	
			Billing Account		
			Billing Profile		
			Total	£682.99	£0.00
Disclaimer					
All prices shown are in United Kingdom – Pound (£) GBP. This is a summary estimate, not a quote. For up to date pricing information please visit https://azure.microsoft.com/pricing/calculator/					
This estimate was created at 6/21/2022					

Assuming costs are a concern, would you have some suggestions to improve the architecture to reduce the costs ?

Amitabh – We can discuss on the presentation day.