

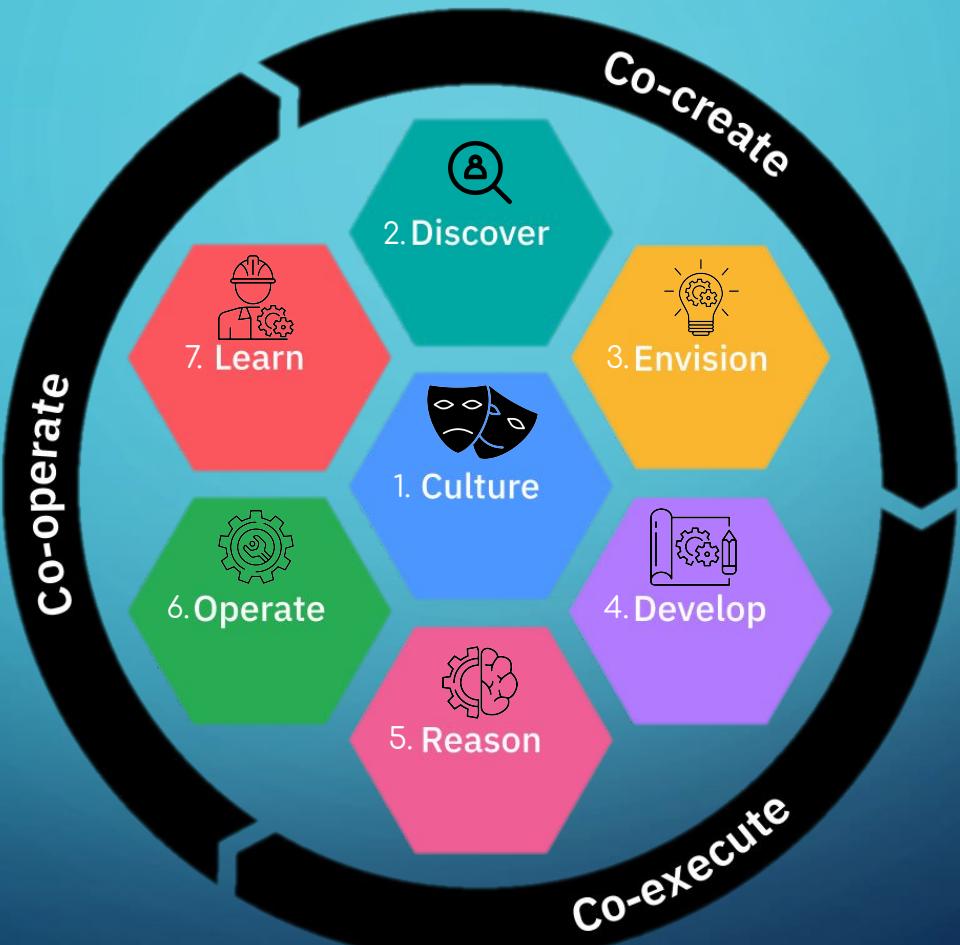
IBM CLOUD COMPUTING PROJECT TEAM 1

Matthew Tan

Vincent Oh Ong Swee San

Jeremy Wang Gayathri Someswaran

PROJECT OVERVIEW



SECTION 1

1. Culture



Defining the right set of organizational roles and ensuring that teams respect and understand those roles are important aspects of a successful business that moves with speed and can pivot based on feedback.

- DevOps - Our Roles
- How We Foster DevOps Culture

DEVOPS - OUR ROLES

DevOps Roles



Gayathri
Product Owner

Understands how the app should run to deliver value to the users, and what cloud infrastructure is needed to support the app in production

Matthew
Team Lead

Analyze the required skill set for each project and delegate the DevOps responsibilities across the team

Vincent
Cloud Architect

Ample experience with building cloud infrastructures & understanding what they have to include to support various types of apps and services in production

Jeremy
Site Reliability
Engineer

Ensuring stable performance and uninterrupted availability of high-load apps across large-scale systems

Swee San
DevOps System Administrator

Desire to drive organizations to be successful on exploring and evaluating new and emerging software tools and technologies. help transform the organization to take advantage of DevOps best practices methodologies.



Culture

HOW WE FOSTER DEVOPS CULTURE

1. Promote communication and collaboration
2. Set common goals
3. Constantly make improvements
4. Encourage exploration
5. Allow room for failure
6. Share knowledge

SECTION 2

2. Discover

Co-create

The Discover practices help our team to dig deep into our problem domain, align everyone on common goals, and to identify potential problems and bottlenecks.

- Business Opportunity
- Stakeholder Mapping
- Persona
- As-Is Scenario / Empathy Map
- Pain Points

BUSINESS OPPORTUNITY

Today, there is a growing trend of app-based home utility software that enables home owners to better track and monitor their domestic affairs, we found an opportunity on the utilities space to provide a simple solution for the household needs

Provide easy to use devices to monitor high consumption appliances

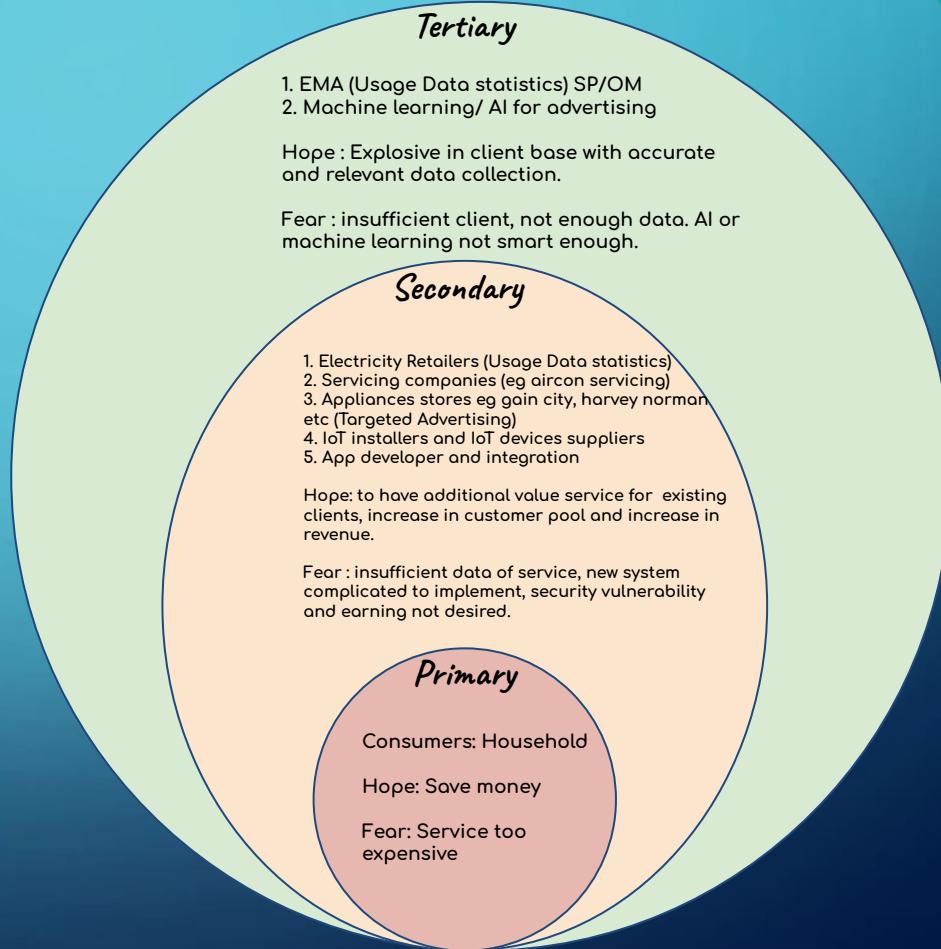
for homeowners

so that information is easy to understand and readily available

STAKEHOLDER MAPPING

We have identified the possible stakeholder and their relationship for this project, this involves how they might impact on the success of this project.

To understand our stakeholder we will be sharing their hopes and fears about this project so that we may stand higher chance in winning them over.





Discover

PERSONA



Name Jane

Age Middle-Age

Education Tertiary educated

Family Married with kids

Jane is a homeowner who is working from home. She is a little tech savvy and pays bills online, not afraid to use apps

Motivations

- busy with many chores and job
- does not track electricity consumptions but wants to know information
- must be convenient
- save more money without any changes to their current routines, habits and lifestyles

Needs

- provide reminder and alerts
- compare usage with others
- provide visibility of usage in real time
- not costly
- effortless to use

Goals

- there are cost breakdown information available currently
- A little tech savvy, simple app would be great
- addresses to high usage appliance to save 20% - 30% electricity bills
- pricing must be affordable

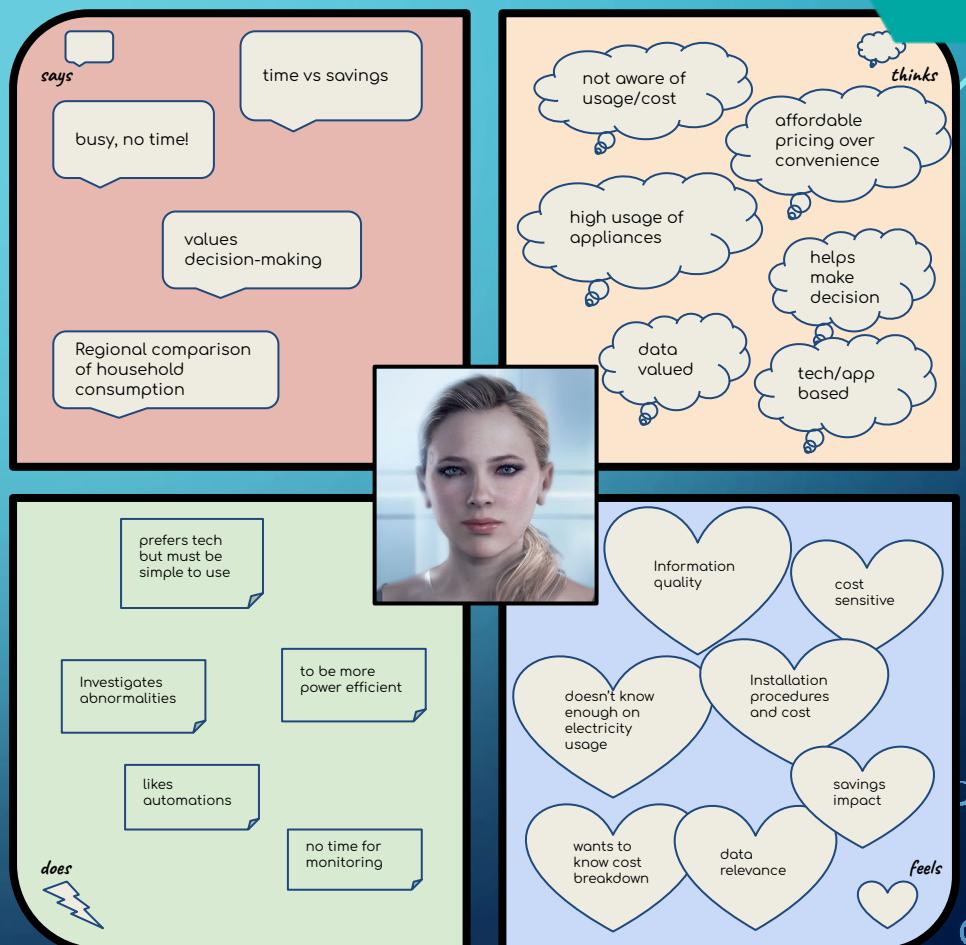
AS-IS SCENARIO

Jane did nothing to find out how much electricity is used apart from checking her monthly bill.

She feels that her bill is getting higher but unsure about the average, maybe the cause is aircon since Singapore is so warm.

She often wonder how much energy is wasted and cost involved for those appliances that doesn't switch off.

It would be useful for her if she can track usage and her consideration will be the amount of effort and cost involved since she is not a techie person but will try to keep up and dabble with newer tech therefore it must be trouble free installation.



PAIN POINTS

Data Relevance

Lack of real time
energy consumption
data on each device

Uncertain of how
easy/difficult to
install/use/maintain

SECTION 3



Co-create

The Envision practices provide development teams with a repeatable approach to rapidly deliver innovative user experiences.

- Big Ideas
- Prioritization
- Storyboard
- Hills
- Assumptions & Risks
- Identify High-Risk Uncertainties/ Build on Action Plan
- To-Be Scenario
- MVP Statement & Hypothesis
- MVP Goals, Future Goals, Next Steps
- Prototype



Envision

BIG IDEAS

Smart Home



Automated
Smart
Home

Smart home or home automation access and control devices in your home from a mobile device using sensors, switches and controllers



AR

Using an Augmented reality app to read energy readings and control the appliances

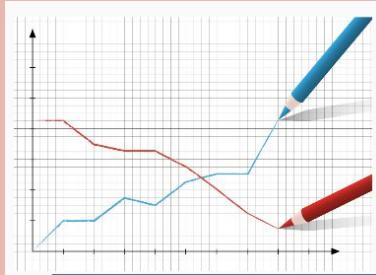
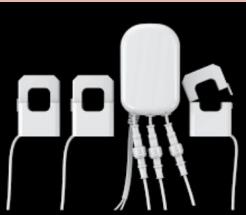


Envision

BIG IDEAS



Using easy to install electricity monitoring devices and an app to monitor high energy consumption appliances



Easy to read usage reports for users

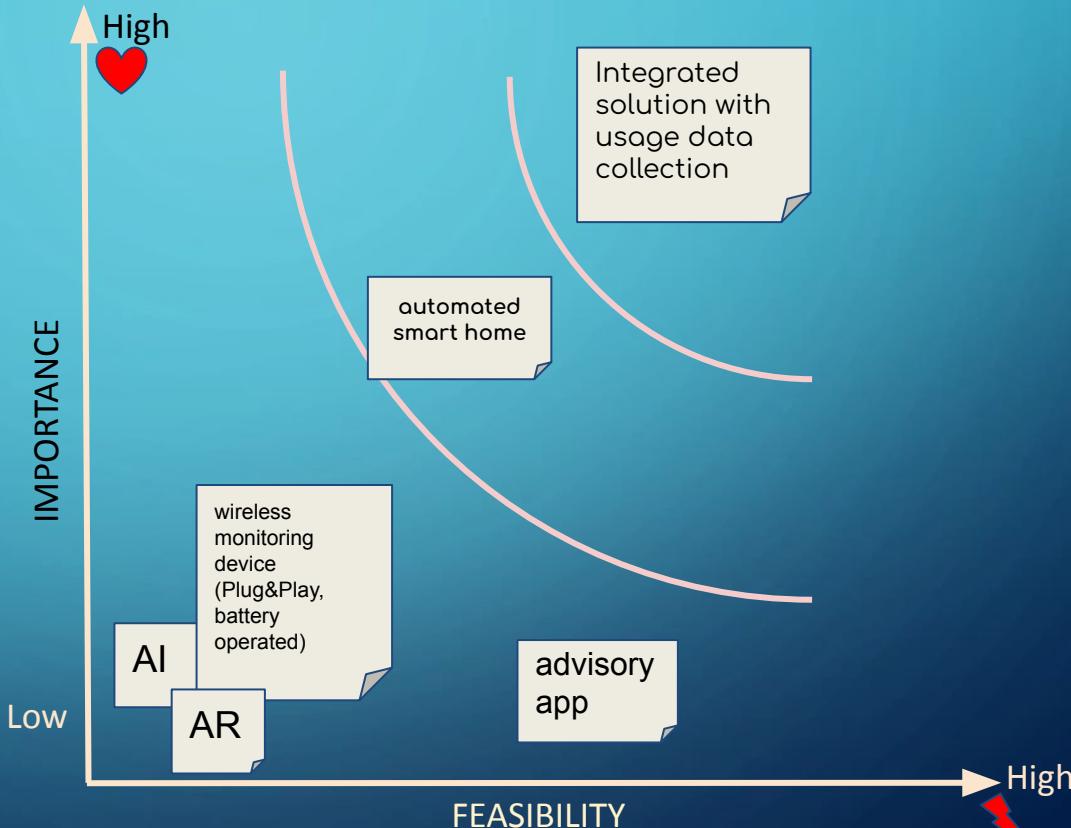




Envision

Prioritization

- Smart Home Automation
 - Highly valuable to user
 - Feasible for the team

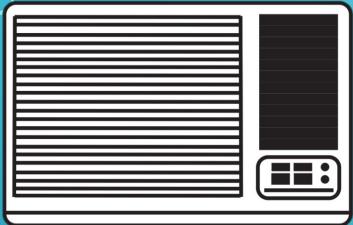




Envision

STORYBOARD

Our persona Jane is a busy women with many chores and responsibilities. She has no time to carefully manage the appliances and devices she uses.



Her bills vary month to month and she wonders how she can track and manage her usage better.



Envision

STORYBOARD

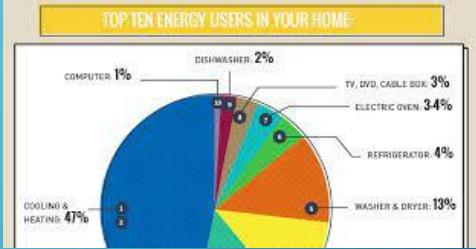
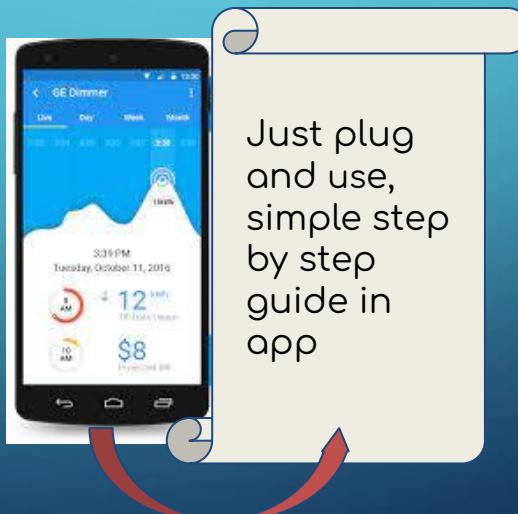
where to get recommendation based on real energy use cases

How can I track my appliance energy usage?



She goes online to look for solutions

- She finds an affordable and great service.
- Installs the app and signs up as a new user.
- chooses the monitoring devices in the app as part of the package.



App provides an easy step by step guide for app usage, including appliance(s) brands and model registration.

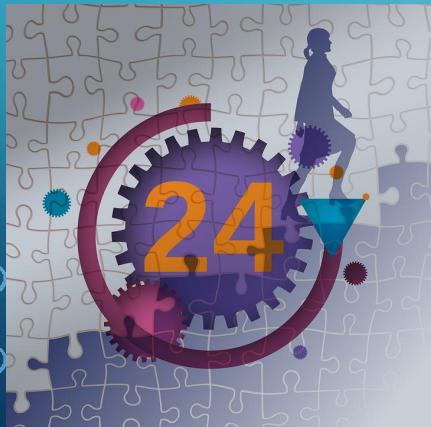
The system will start to track and monitor individual appliances energy usage.



Envision

STORYBOARD

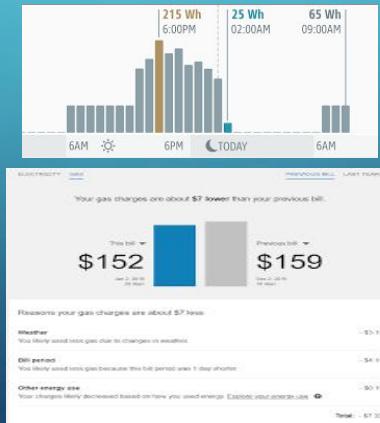
- The system monitors usage 24 hours.
- No user intervention is required.
- At any time she can get details by choosing the appliance on the app.



Basic App Function

- 1) tracking consumption in a graph format (easy to read)
- 2) having past usage records for Jane to refer to, as well as consumption usage for individual appliance (in \$ format)

We ensure that the UI is easy to use

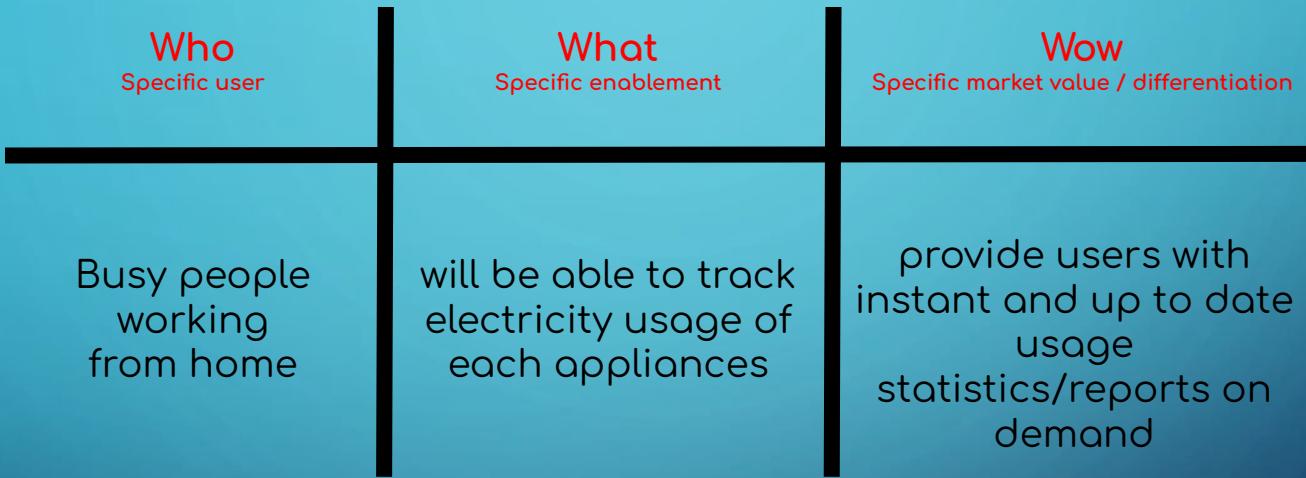


There is now peace and love at home because there is more time and there is better awareness of electrical usage and actions that can be taken





Who is going to be able to do What with a Wow experience with our solution?



Extract from Pain statement

Lack of real time energy consumption data on each device



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ASSUMPTIONS & RISKS

HIGH RISK

Collect data from IOT devices

User constantly monitor devices

UI is easy in navigation

All data are relevant to user

All devices at user residences are compliant with the app features

Linking up other suppliers, ad company to bring down cost for user

Connection to 3rd party API

CERTAIN

UNCERTAIN

User awareness on handling multiple user profiles

no latency

Security issues involving IOTs

single sign on

Linking up with various hardware provided by 3rd party and sync information

Personal data protection act

seamless service

App updates and bug fixes are updated by user on demand

Users able to identify and add new devices correctly

LOW RISK



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Identify high-risk uncertainties / Build an action plan

ASSUMPTION QUESTIONS

MEANS TO RESOLVE

All devices at user residences are compliant with the app features

Select top 10 API for MVP

Most IoT Devices needs to comply with an open standards for the smart home devices..

Manufacturers will provide the necessary API to connect to their devices based on the open standards..

Connection to 3rd party API

Top 100 common smart devices are accept in MVP

Linking up other suppliers, ad company to bring down cost for user

Onboarding of Suppliers will be done in batches over time on updates

we will establish confidence in them by providing accurate data and increase our client base tremendously. this will result in increasing investor and thus bringing the cost down for our consumers.

Providing Win-Win situation for us and IoTs suppliers . our app can help them increase exposure, increase in client base and get accurate data. they might in return provide us with cheaper or free hardware

TO-BE SCENARIO

- Busy working adults will be able to track electricity usage of each appliances and receive instant and up to date usage statistics/reports on demand
- Solve the problem - lack of real time energy consumption data for each of the appliances
- User will have information they need on demand
- No more guessing



Envision

MVP STATEMENT & HYPOTHESIS

- Problem Statement: Any homeowner who pays electric bills will find they lack of real time energy consumption data for individual appliances. Currently there is no simple or easy way to obtain that information.
- Hypothesis: User will use our app to connect all their electrical appliances in their household and be able to monitor them in real time.
- Test: Add 5 high electrical consumption appliances and retrieve their current electrical usage information.

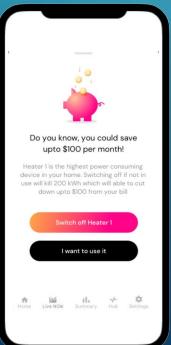
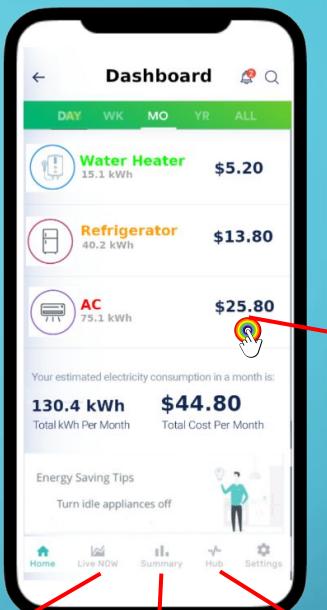
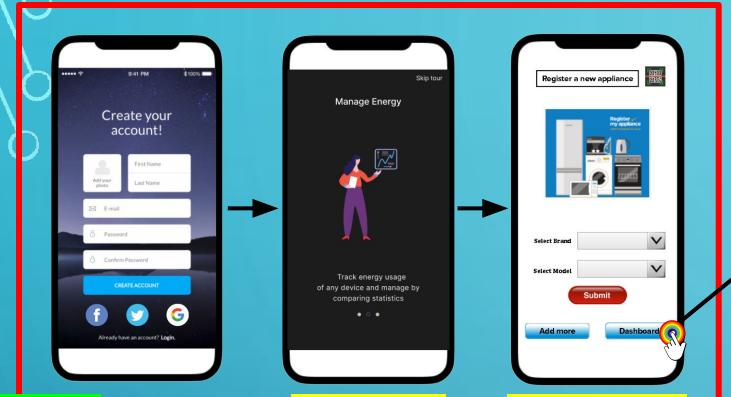
MVP GOALS, FUTURE GOALS, NEXT STEPS

MVP Goals	Future Goals
User can create account and login	Remotely control the appliances via the APP
Add up to 50 known devices	Add all market available smart devices
Retrieve Electrical Usage Information	Collecting user feedbacks
Analyse Data and generate reports	Provide direct login to IOT providers portal using AWS SSO and SAML
Compare with others	

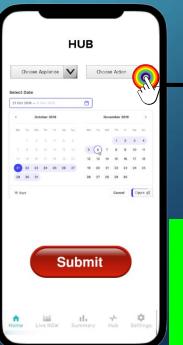


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PROTOTYPE



Assumption: User Already sign up, and login and monitoring Hardware devices installed.



- Actions:**
- 1) Set servicing reminder
 - 2) Past usage (Date range)

- Hub**
- 1) Set reminder
 - 2) Check use over a time frame

SECTION 4

4. Develop

Co-execute



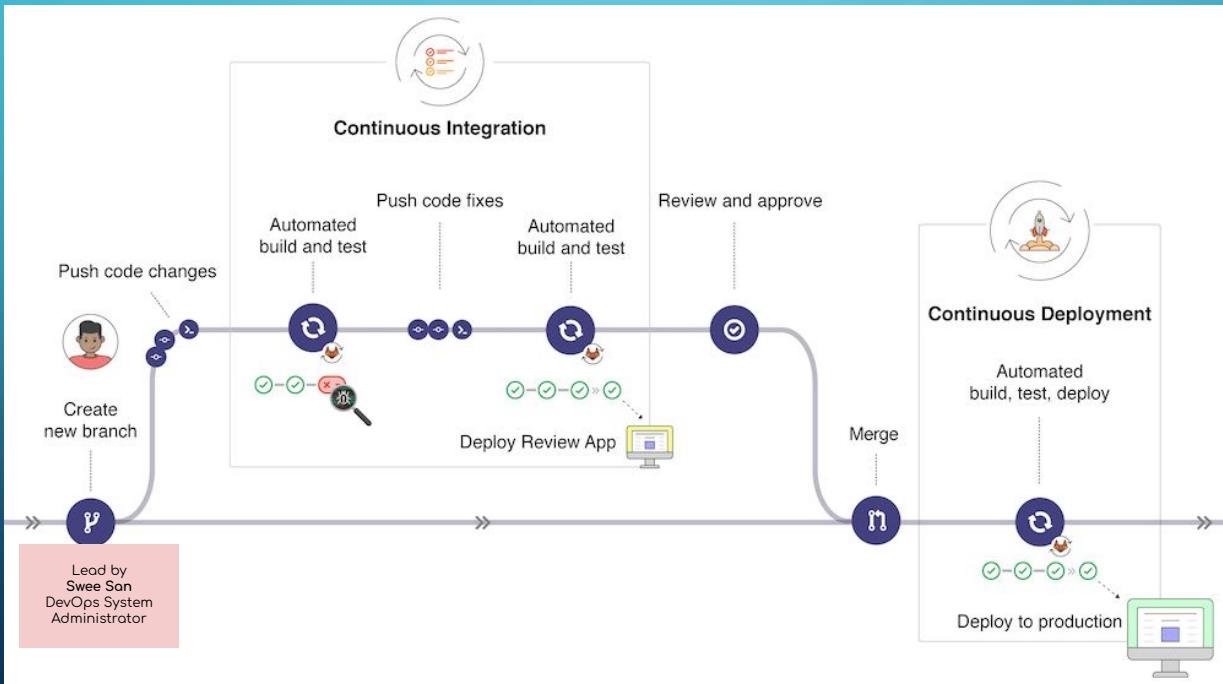
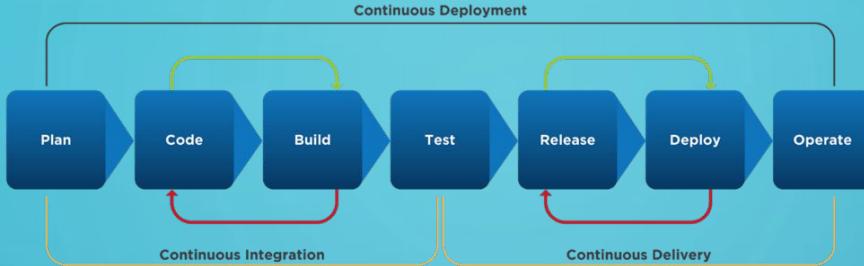
In Develop, we learn about using DevOps tools to ensure a repeatable, automated delivery process that results in a fully tested production app.

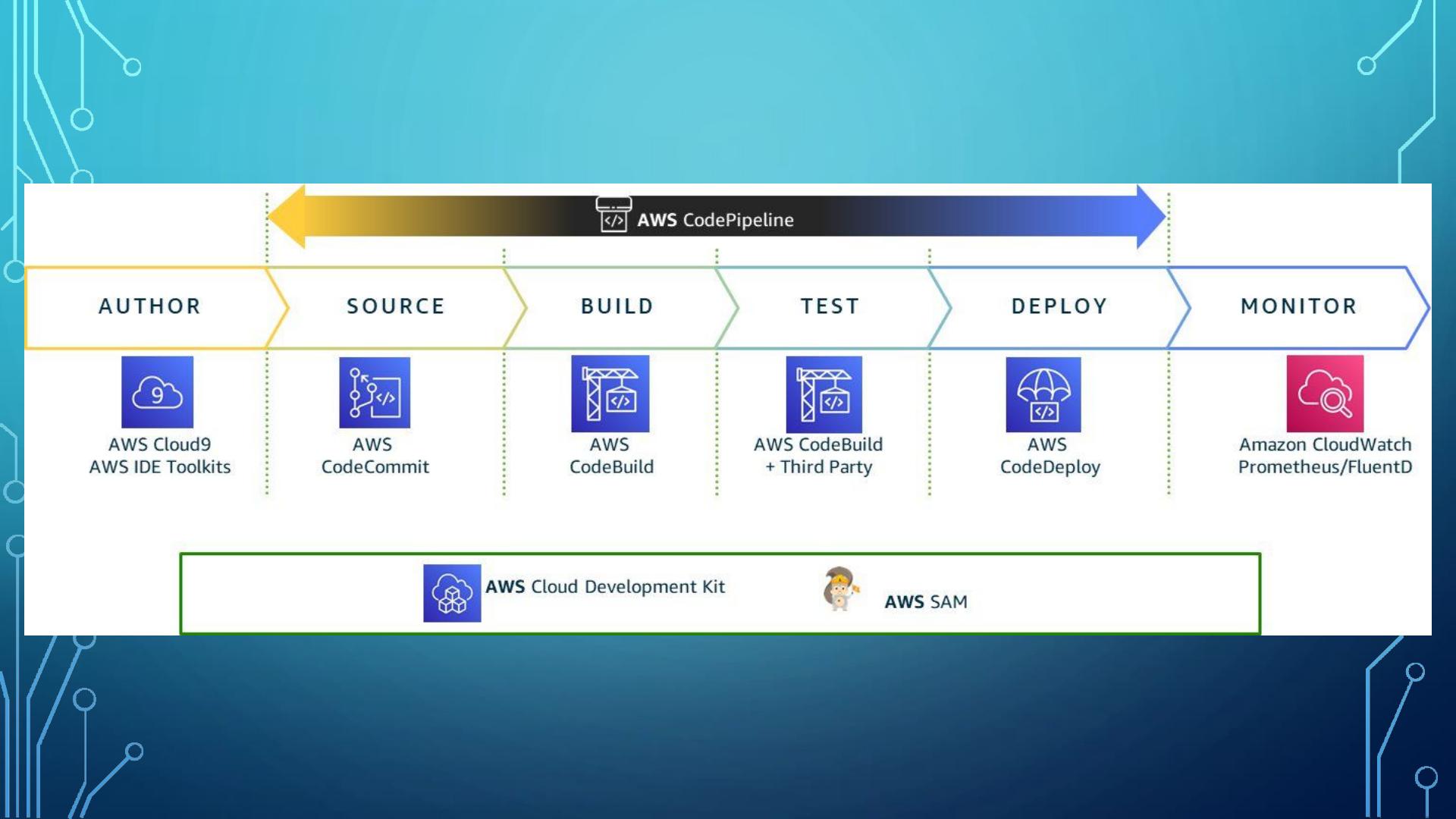
- Code Deployment Pipeline



Develop

CODE DEPLOYMENT PIPELINE





SECTION 5

5. Reason

Co-execute

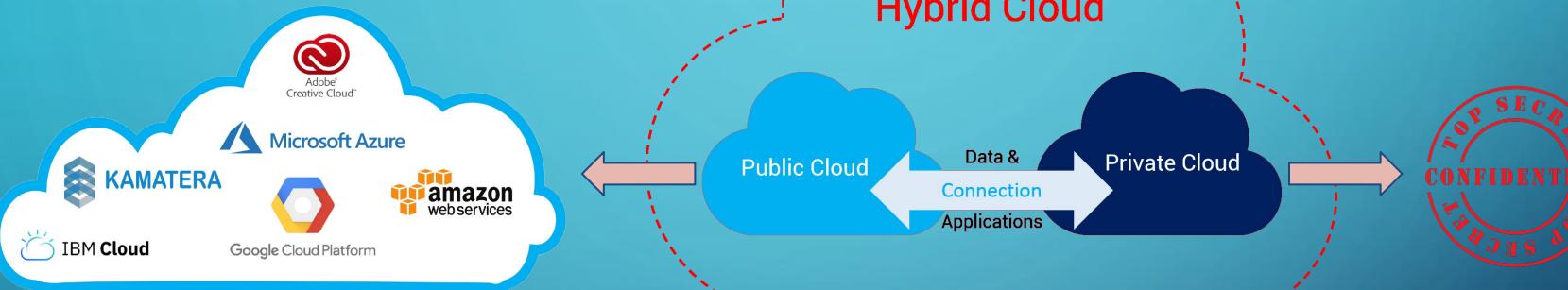
Select, develop, evaluate, and optimize our data science models and make them ready for production

- Cloud Model
- Cloud Computing Architecture
- AWS Architecture
- User Interface / User Experience
- Tools Deployed for UI Creation & Authentication
- Application Gateway & User Authentication Architecture
- AWS IoT Core
- AWS Notifications
- Realtime Telemetry Analytics Pipeline
- Anomaly Detection



Develop

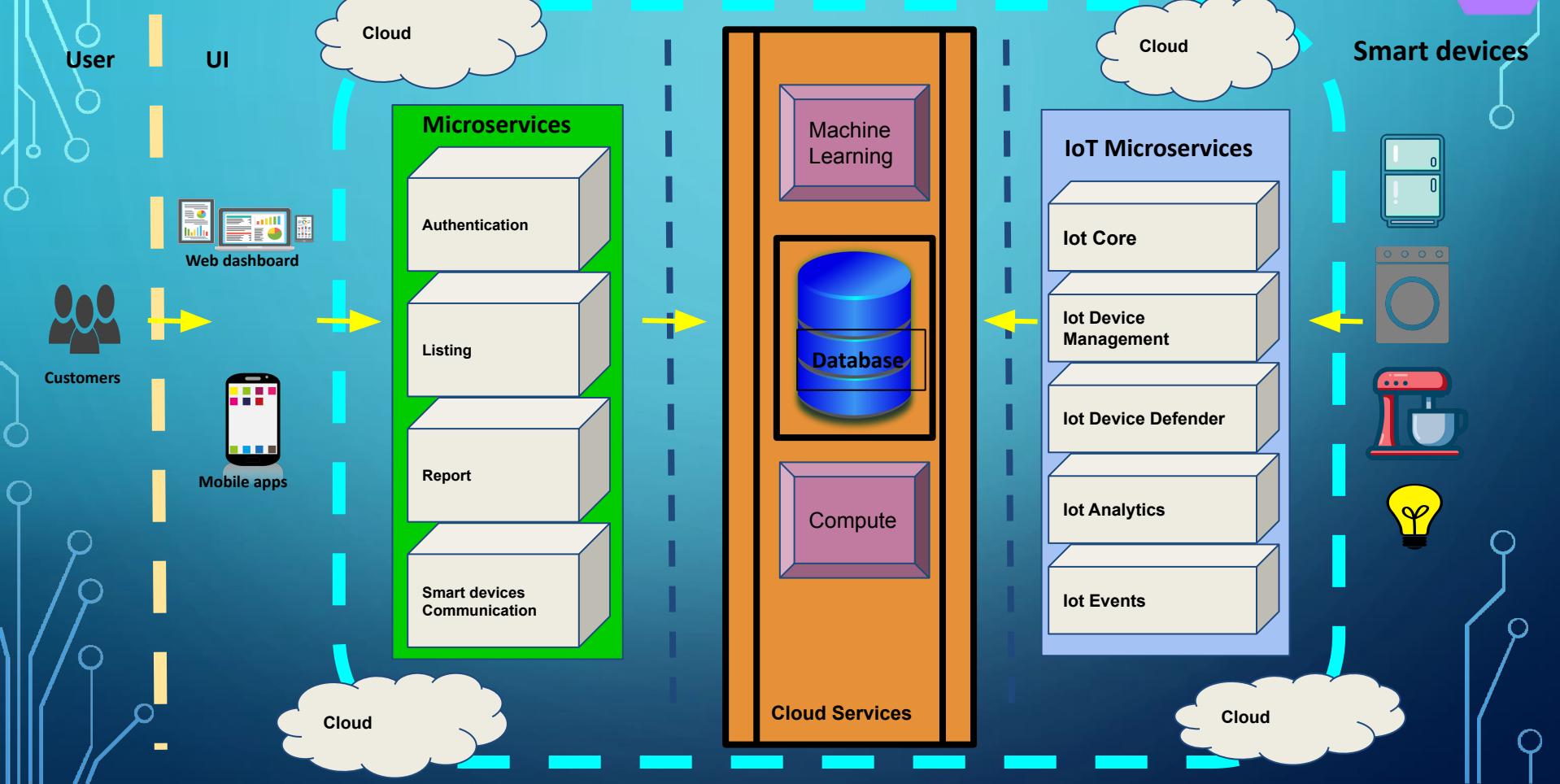
CLOUD MODEL



Our selection for deployment model is Hybrid Cloud because we need to store information such as user's particulars as well as their household appliances which are sensitive informations. (These information will be stored in our Private Cloud)

Public Cloud provides us scalability, cost-efficiency and unlimited storage this enable us with continuous integration and continuous deliver on our app. (Software as a service, SaaS)

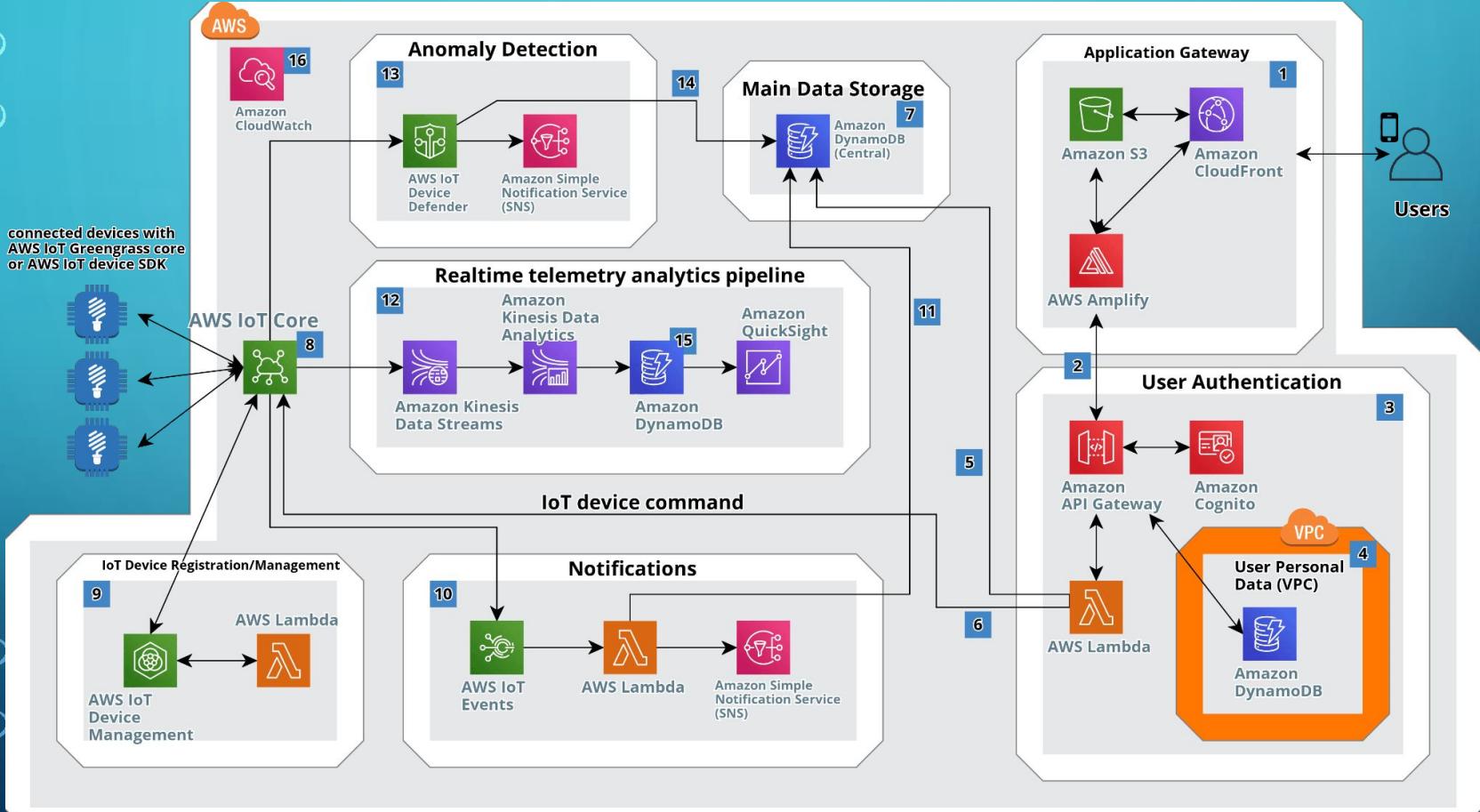
CLOUD COMPUTING ARCHITECTURE



AWS Architecture (Overview)



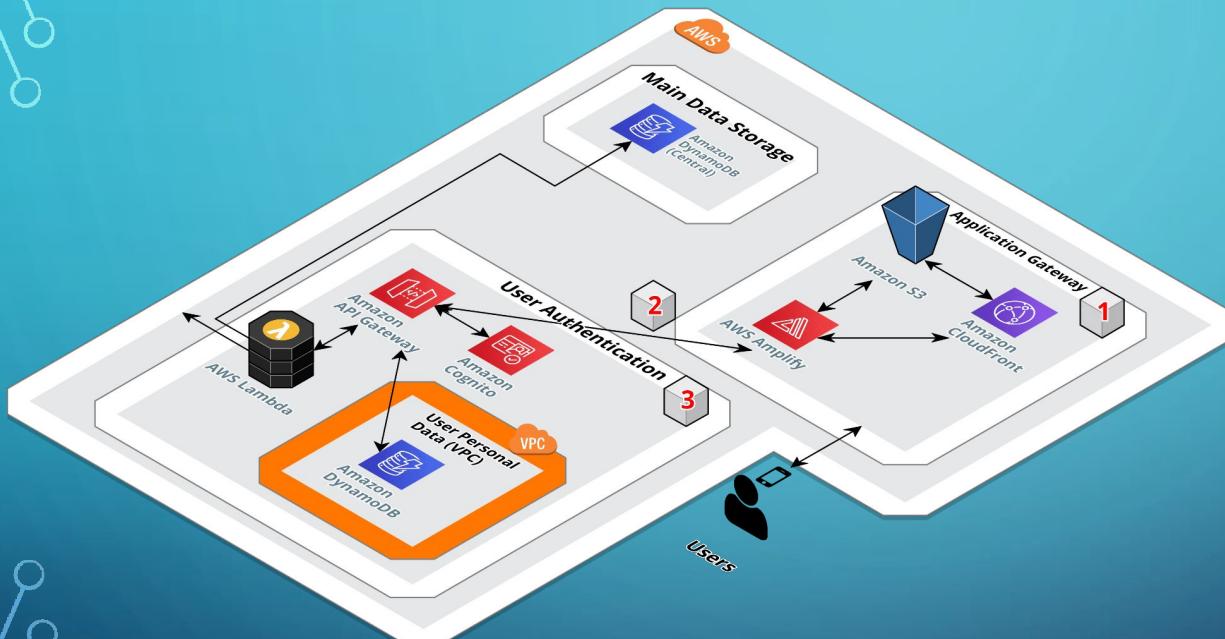
Reason



AWS Architecture (Part 1)



Reason



1

The application gateway is powered and managed by [AWS Amplify](#) and will be deployed into an [Amazon Simple Storage Service](#) (Amazon S3) bucket configured for web hosting and storage of the static application resources. [Amazon CloudFront](#) is used to provide public access to the bucket.

2

[AWS Amplify](#) provides an interface for making API calls to your backend via [Amazon API Gateway](#).

3

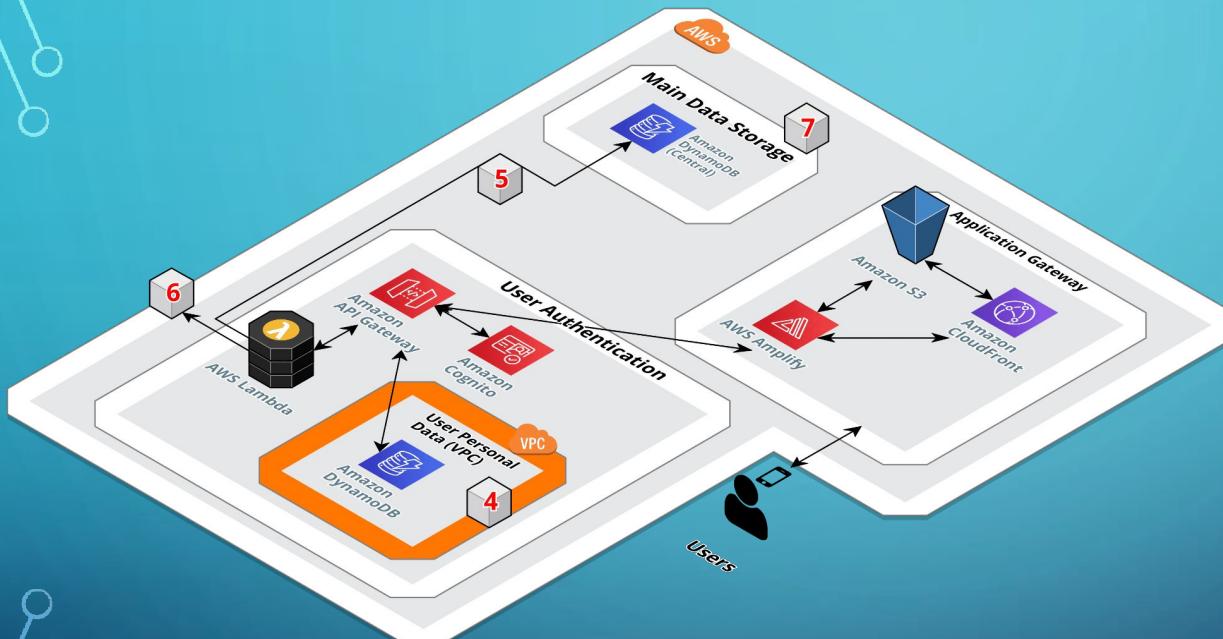
[Amazon API Gateway](#) functions as a gateway to the app's RESTful APIs, together with [Amazon Cognito](#), this section allows users to sign-up, sign-in easily and securely.

Based on the request, [Amazon API Gateway](#) invokes the appropriate [Lambda](#) functions to perform the necessary tasks on the data stored in [Amazon DynamoDB](#).

AWS Architecture (Part 2)



Reason



4 Private user personal data and user connection sessions is stored in **AWS DynamoDB** within a Virtual Private Cloud environment (VPC) and can only be access via secured API calls.

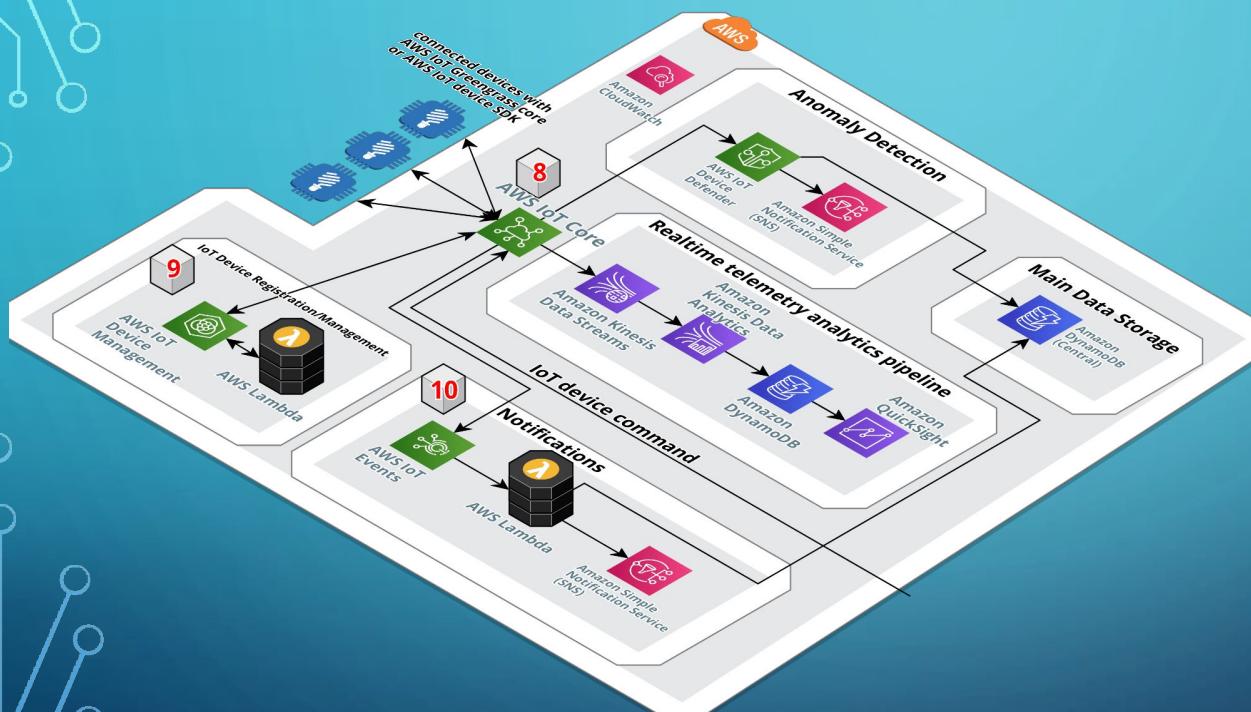
5 REST API calls to **AWS API Gateway** will invokes **AWS Lambda** functions that provide the business logic to perform dynamic operations based on data stored in **AWS DynamoDB**; send remote commands to your IoT devices.

6 This **Amazon DynamoDB** is the main data storage service that this solution uses, it stores various details about the IoT devices.



Reason

AWS Architecture (Part 3)



8

AWS IoT Core is a service that helps to build an architecture for an IoT solution and connect the IoT devices to AWS Services.

It guarantees secure IoT data transmission to and from the cloud.

AWS IoT Core incorporates all necessary IoT services to create an IoT solution and can be connected to other AWS services.

9

This solution uses **AWS IoT Device Management** within the **AWS IoT Core** to register, track, monitor, and remotely manage your fleet of IoT devices.

10

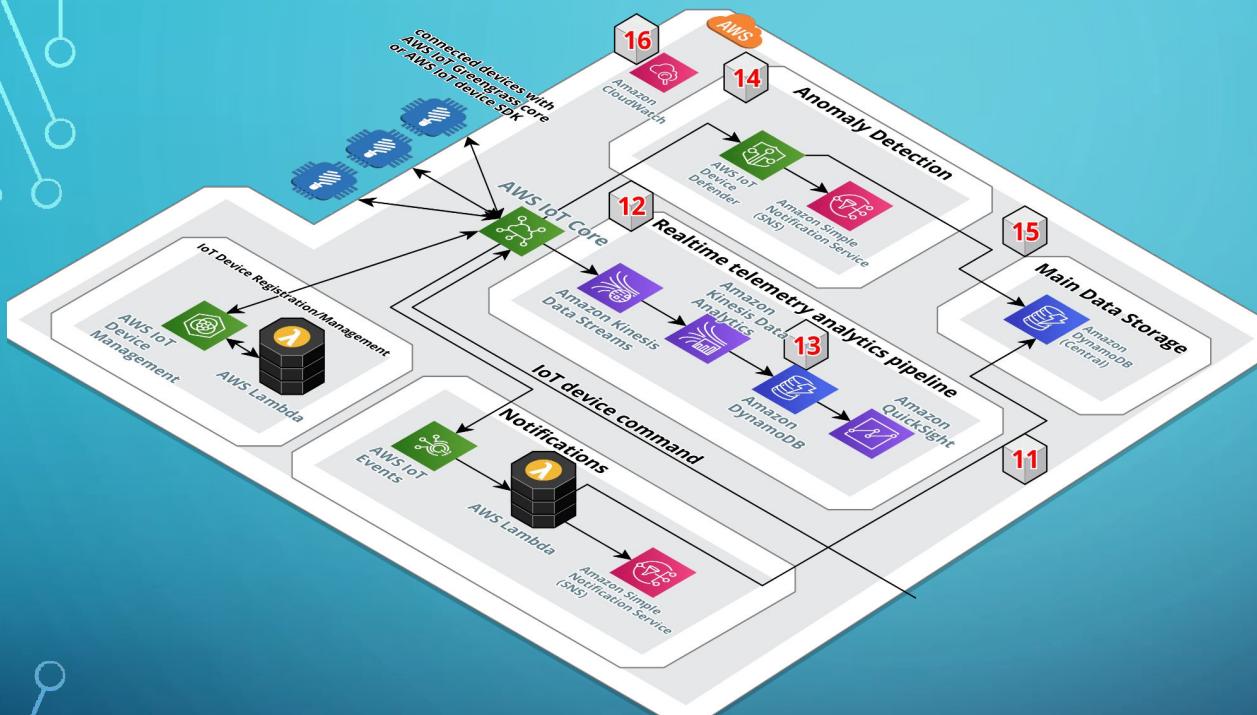
AWS IoT Events within the **AWS IoT Core** is used to detect complex events and to trigger alerts or notifications.

Together with **Amazon SNS**, the app can send push notifications to users based on the triggered events.

AWS Architecture (Part 4)



Reason



16

AWS CloudWatch is a monitoring and logging service. CloudWatch provides us with data and actionable insights to monitor our application, respond to system-wide performance changes, optimize resource utilization, and get a unified view of operational health.

AWS CloudWatch works with the **AWS SNS** service to push notifications / alerts to users.

11

AWS Lambda function to send command back to the IoT devices on certain events through **AWS IoT Core**, and send processed data to **Amazon DynamoDB (Central)**.

12

Ingest real-time telemetry data from IoT devices using **Kinesis Data Streams**, and process it using **Kinesis Data Analytics**, and send the results to **Amazon DynamoDB**.

By leveraging on **Amazon QuickSight** with its built-in Business Intelligence (BI) to visualize the data into useful reports which can be requested by end user via REST api call to the **AWS API Gateway**.

13

Using **Amazon DynamoDB** to store real-time telemetry data and analyzed data.

14

AWS IoT Device Defender to continuously audit your devices to ensure they don't deviate from security best practices and monitor their performance and report on suspicious behavior.

15

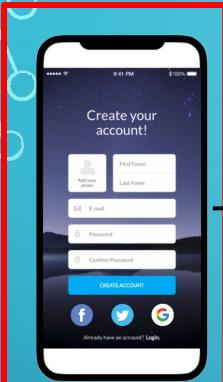
Send suspicious data to **Amazon DynamoDB (Central)**.

USER INTERFACE / USER EXPERIENCE



Reason

User Sign-in and Sign-up

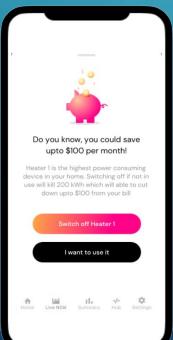


Sign up process

IoT Device Registration



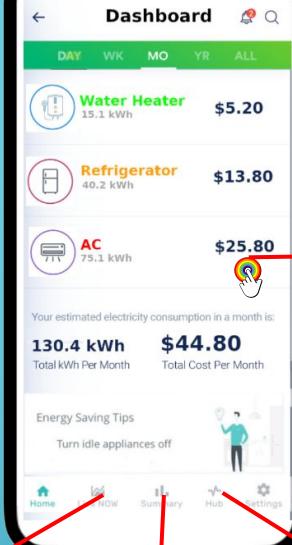
Popup notification / Alert



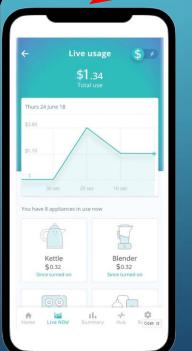
Notifications

User Authentication

Assumption: User Already sign up, and login and monitoring Hardware devices installed.



Real-time telemetry analytic pipeline



Real-time telemetry analytic pipeline



APPLICATION GATEWAY & USER AUTHENTICATION ARCHITECTURE



Reason



Mobile client



IDENTITY PROVIDERS LISTED IN COGNITO



Secure Token Service

Keeping the user experience as top priority, Amazon Cognito is chosen to provide login via different platforms.

The Identity Providers (IDP) are predefined in Cognito which uses STS to assign temporary credentials to the IDPs

1. Jane selects LOGIN/SIGNUP API from the landing page of APP.

2. The API requests for ID token from the IDPs.

3. The API receives the token ID and triggers the AWS Lambda function.

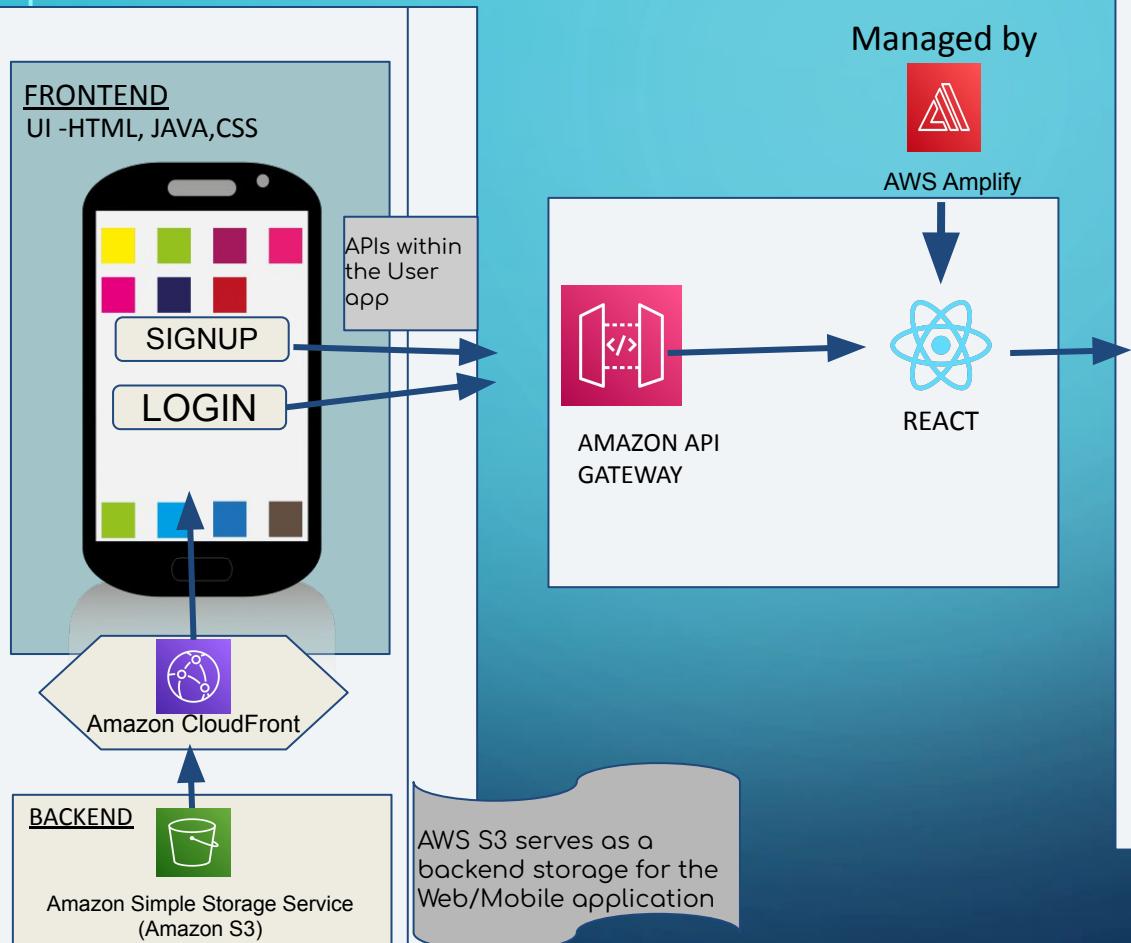
4. AWS Lambda function uses CRUD method and creates new user / Gets existing login details from DYNAMODB.

5. Jane can now view her dashboard and add devices

Tools deployed for Application creation and authentication



Reason



BACKEND



AWS Lambda

In AWS console, two API Gateways are created for SIGNUP and LOGIN.

The API for SIGNUP has a LAMBDA function defined with POST method.

The API for LOGIN has a LAMBDA function defined with GET method.



Amazon Cognito

Both the LAMBDA functions have authorisation setup with Amazon Cognito Identity Pool.



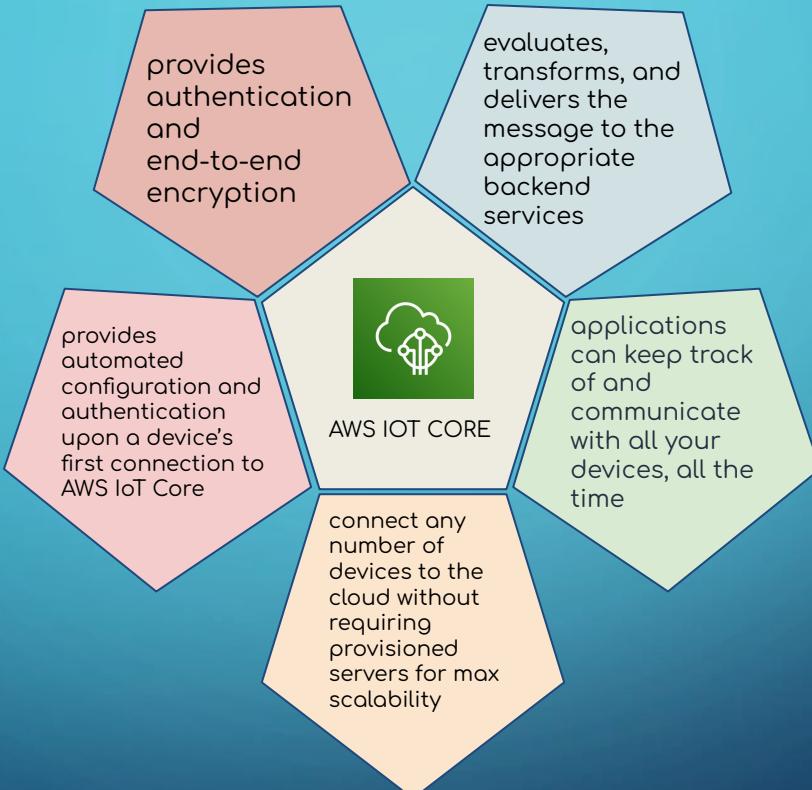
Amazon
DynamoDB

The LAMBDA functions retrieve/create the user credential details from DYNAMODB



Reason

AWS IOT CORE





Reason

AWS NOTIFICATIONS

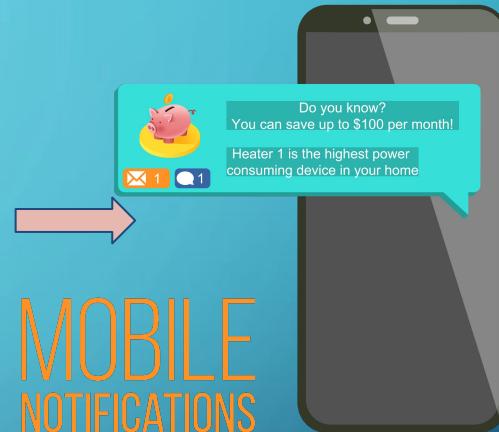


AWS Lambda Functions;

- 1) Notification reminder for forgetting to off appliances
- 2) Set a schedule servicing reminder.



SNS topic
"Potential-Savings" &
"Servicing-Reminder"
SMS and Email Notification



When Lambda Function is triggered our user Jane will receive notification in her mobile (Email & SMS).



Reason

REALTIME TELEMETRY ANALYTICS PIPELINE

Collect > Process > Store > Analyse > Build



AWS IOT CORE

- ◆ real time performance
- ◆ massive scalable and durable real time data streaming service
- ◆ continuously capture huge amount of encrypted data



AMAZON KINESIS DATA STREAMS



AMAZON KINESIS DATA ANALYTICS

- ◆ serverless analysis of streaming data in real time
- ◆ built-in functions to filter, aggregate and transform data for advanced analytics
- ◆ supports sql, java, scala and python



AMAZON DYNAMODB

- ◆ scalable, serverless machine learning business intelligence service
- ◆ easily customization of the look and feel of interactive dashboards on apps



AMAZON QUICKSIGHT

- ◆ unlimited throughput
- ◆ scales tables up and down to adjust for capacity and maintain performance
- ◆ exports data to perform analytics at any scale



Reason

ANOMALY DETECTION



AWS IOT CORE

continuously audit your devices



AWS IOT DEVICE DEFENDER

- ◆ organizes smart products, monitors and enables troubleshooting functionality issues
- ◆ detects anomalies in device behavior
- ◆ maintain and enforce IoT configs, ensure device identity, authentication, authorization and encrypting data

sends an alert if there are any gaps in IoT configs that create security risk

DATA STORAGE



AMAZON DYNAMODB

- ◆ fully managed serverless document database
- ◆ highly scalable with unlimited throughput and storage
- ◆ ACID transactions supporting instant and huge backup copies



AMAZON SNS

ALERTS

- ◆ fully managed messaging service
- ◆ push-based messaging between microservices and applications
- ◆ send messages to users at scale via SMS, mobile push, and email.

SECTION 6



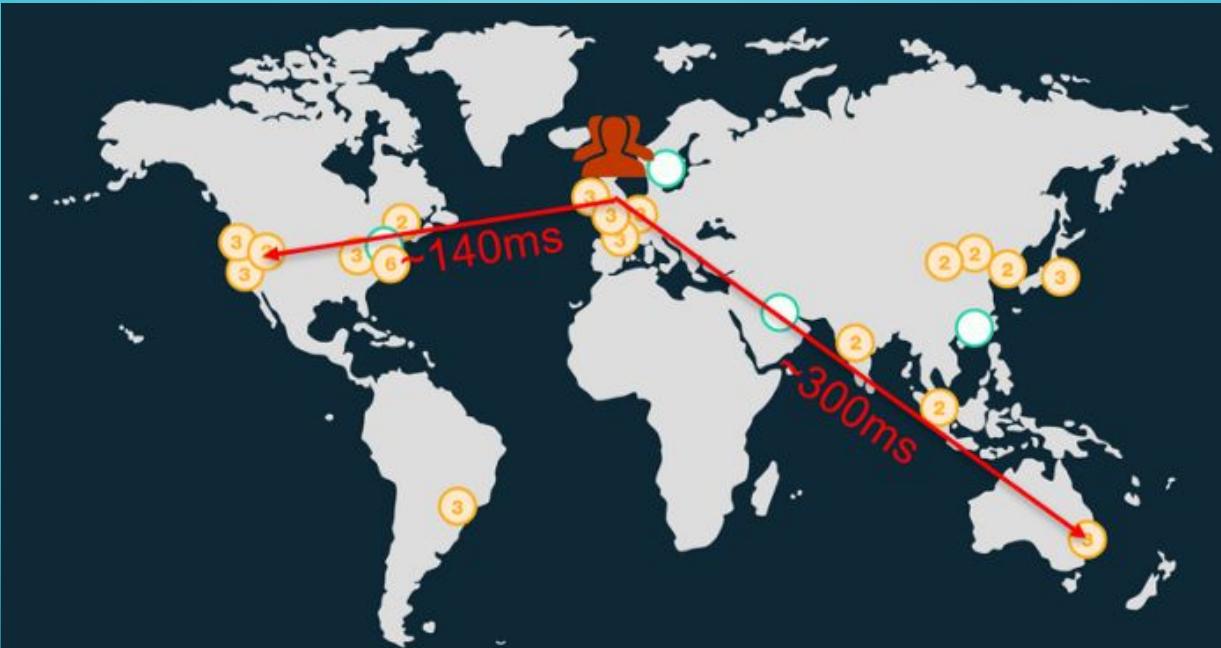
6. Operate

Co-operate

Ensure operational excellence by continuously monitoring app status and performance.

- Improve Latency for End-User
- Disaster Recovery

IMPROVE LATENCY FOR END-USERS



The AWS Cloud infrastructure is built around AWS Regions and Availability Zones, providing redundant power, networks and connectivity, housed in separate global facilities. This creates a global low latency service network for connected users anywhere in the world.

DISASTER RECOVERY

POINT-IN-TIME
recovery (PITR) helps protect DynamoDB from accidental write/delete

Built-in high availability and fault tolerance

AMAZON DYNAMODB



AMAZON S3



The Amazon S3 Glacier runs on the world's largest global cloud infrastructure, with 99.999999999% of durability.

Data is automatically distributed across min 3 physical Availability Zones geographically separated within an AWS Region



AMAZON CLOUDWATCH

Amazon CloudWatch is a monitoring and observability service that provides data and actionable insights to monitor applications, respond to system-wide performance changes, optimize resource utilization, and get a unified view of operational health

Natively integrates with all our Amazon Services and automatically publishes up to 1-second granularity metrics to dive deep into logs

sends notifications on job status

Disaster recovery in the AWS Cloud has the below advantages:

- Recover quickly from a disaster
- Regional diverse in Availability Zones
- Remote test anytime anywhere
- Scalable automated DR Planing



AMAZON SNS

Engineers notified on status change



Outages detected by Amazon CloudWatch will be notified through Amazon SNS service to our inhouse engineers for their quick actions

SECTION 7



7. Learn

Co-operate

Learn how your team works together and how customers use the apps that you deliver by studying analytics data.

- User Feedback
- FeedBack Loop
- Learn



Learn

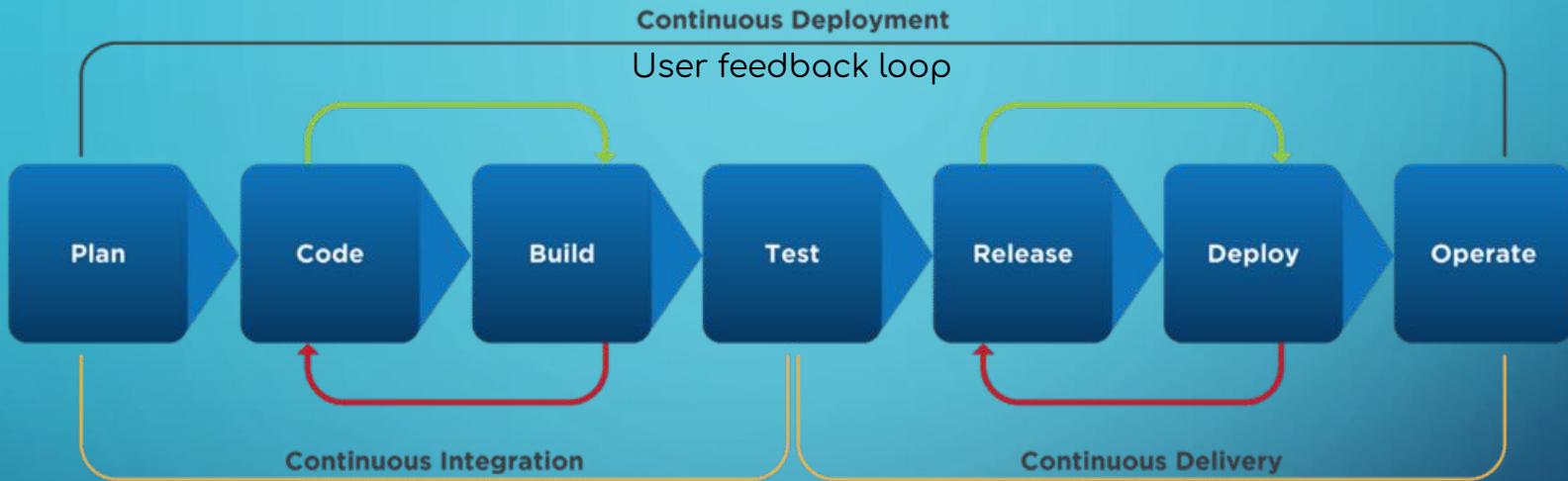
USER FEEDBACKS

Our first iteration feedback is from Jane, we build and develop in accordance to her requirement and needs.

After operating for sometime, we iterate again to get user feedback so that we can continue to improve our APP.



FEEDBACK LOOP



After getting enough user feedbacks we will improve our application based on these factors;

1. Providing user with the greatest user experience,
2. Easy to use for our users,
3. providing the greatest cost benefits to our users,
4. And lastly, new feature(s) suggested by our user.



Learn

LEARN

Learning from our Customers

- Analytics data from Application
- User feedbacks from App store and feedback forms.

Create new hypothesis for next iteration of MVP based on feedback gathered

Learning from our processes

- Cloud logs and metrics
- Code Quality
- CI/CD Process efficiency

What we learn are used to create KPI to measure and guide our progress

Conclusion

- We used the IBM garage methodology to solve the problem of homeowner lacking real time energy consumption data for individual appliances.
- Homeowner can use our MVP to connect all their electrical appliances in their household and be able to monitor them in real time.
- Our solution is built on cloud computing in a cost effective and efficient way. Cloud solutions provides unlimited scalability and business continuity.
- DevOps automation allows iterative updates to be deploy faster in production.