



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

PART 1 PROJECT : ONLINE APPOINTMENT BOOKING SYSTEM FOR UTM HEALTH CENTRE WITH THE INTEGRATION OF IoT DEVICES

SECP1513 - Technology and Information System

Semester 1 2021/2022

School of Computing

Faculty of Engineering

Group 6

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1. INTRODUCTION

We are in the midst of a technology revolution that will transform the way we live, work, and interact with one another. We don't know how it will play out, but we do know that the reaction must be broad and integrative, engaging all competition in global politics, from the public and corporate sectors to education and civil society.

Since the middle of the past century, the fourth industrial revolution has been building on the third industrial revolution, often known as the digital revolution. It is defined by a convergence of technology that blurs the distinctions between the physical, digital, and biological realms. Technology and linked gadgets are being employed in innovative ways in business and society as a result of the fourth industrial revolution. The Internet of Things (IoT) is one of the developing technologies in the fourth industrial revolution [1].

The Internet was nearly entirely reliant on humans for information, according to Kevin Ashton, the guy who coined the term "Internet of Things." The issue is that people have extremely limited time, attention, and accuracy, which is a major issue [2]. As a result, the Internet of Things concept aims to extend the Internet's ubiquity by integrating every item for interaction via embedded systems, resulting in a widely spread network of devices communicating with humans and other devices.

There are a few sectors where IoT is eagerly anticipated, and businesses are gearing up to introduce smart devices. Wearable gadgets are one of them, and they are in high demand in marketplaces all over the world. Large corporations including Samsung, Apple, and Google have invested in the development of such gadgets. Sensors and software are included into wearable devices to collect data and information about their users. This information is then pre-processed to obtain key information about the user. These gadgets address a wide range of exercise, health, and entertainment needs.

However, the Internet of Things has yet to take off in the healthcare business. But research indicates that IoT in healthcare will be huge in the upcoming years, since the idea of a

connected healthcare system and smart medical equipment holds immense promise not just for businesses, but also for people's well-being [3]. Furthermore, IoT in healthcare aims to enable individuals to live better lifestyles by allowing them to wear connected gadgets. The information gathered will aid in the individualized study of an individual's health and the development of customized methods to treat sickness.

2. SELECTION OF 4TH IR TECHNOLOGY & POTENTIAL CLIENT

The 4th Industrial Revolution technologies that we have chosen for this project is **Internet Of Things (IoT)**. We are proposing an **online appointment booking system for UTM Health Centre** that is located in UTM Skudai, Johor Bahru. Our respective users and potential clients of the system are **the students of UTM Skudai, staff of UTM Skudai and the staff of UTM Health Centre**.

Traditionally, any individual who wants to get medical assistance or consultation in UTM Skudai has to go to the UTM Health Centre, take a number for their turn and wait for their number to be called for their turn. This method has been causing slight inconvenience for the students or staff of UTM that wants to seek medical treatments as they must wait in line for a lengthy period after receiving their number. Nowadays, not only do the students have a packed schedule due to their classes and workload of assignments, the staff or lecturers also do not have a lot of free time because they have to give lectures, and deal with their other duties. As a result, having to wait in line for a long period of time and not having any estimation time of how long they will have to wait will just waste their valuable time. Other than that, it will also irritate the individual that needs medical treatments because of this issue, causing them to avoid going to the clinic even if they are sick because the process is quite troublesome for some people. The old method has been known to have a bad relative user experience, because it does not ease the process to get medical treatment at all. On top of that, in this pandemic, spending longer time in the clinic than is necessary may increase the risk of catching the deadly virus COVID-19 as there usually is always a crowd waiting for their turn in a clinic and we do not know where the other individuals have been to. Furthermore, there have been a few cases of human error where when registering, the staff who are in charge missed or forgot to input the patient's data in the

system, causing a problem when it is the patient's turn to be checked by the doctor, where they have to return to the registration counter to double-check the error because no data of theirs was entered into the system.

That being the case, we are proposing to develop an **online appointment booking system for UTM Health Centre** which will be utilised by the students, UTM personnel, and UTM Health Centre staff for them to manage and maintain their data using an online system rather than a manual approach. Using this system, any students or staff that need medical services can book and schedule their appointment according to their free time using the system. When the user has booked for their appointment time, they simply need to go to the UTM Health Centre at the time of their appointment and can straight away be checked by the doctors. Users are no longer required to wait a lengthy period of time for their turn for an appointment that usually only takes 20 minutes to complete. It is well known that the wait time for an appointment at a clinic these days is much longer than the visit itself. Therefore, being able to book for their appointment according to their own schedule and free time could ease the patients that need to be treated and there will no longer be the issue of time being wasted. Not everyone who receives medical treatment gets a medical certificate, because sometimes the condition might not be serious but is uncomfortable to the individual, therefore, no students or lecturers will need to miss their classes to get treatment. Other than that, the system will allow the staff of UTM Health Centre to retain and maintain their data online, where once the users have booked for an appointment, they can manage the data through the system, reducing the risk of human errors that might occur and also could reduce the workload on the staff as the work that needs to be done can be done online. For instance, once the patient has registered themselves in the system to get treatment, the staff no longer needs to manually register the patient. The system will also provide a high quality and improved user experience because it helps and assists every individual in the process of getting treatment and managing treatment. Using this system, any individual that needs treatment from UTM Health Centre will no longer feel irritated or annoyed just to get an appointment. Moreover, the system will implement an online payment system where the user will be able to pay their clinic bill through the system. In addition, using an online booking system will no longer require the clinic to use manual file documentation to store patient's data. The data will be stored online using the cloud, which is backed up and can prevent any data loss.

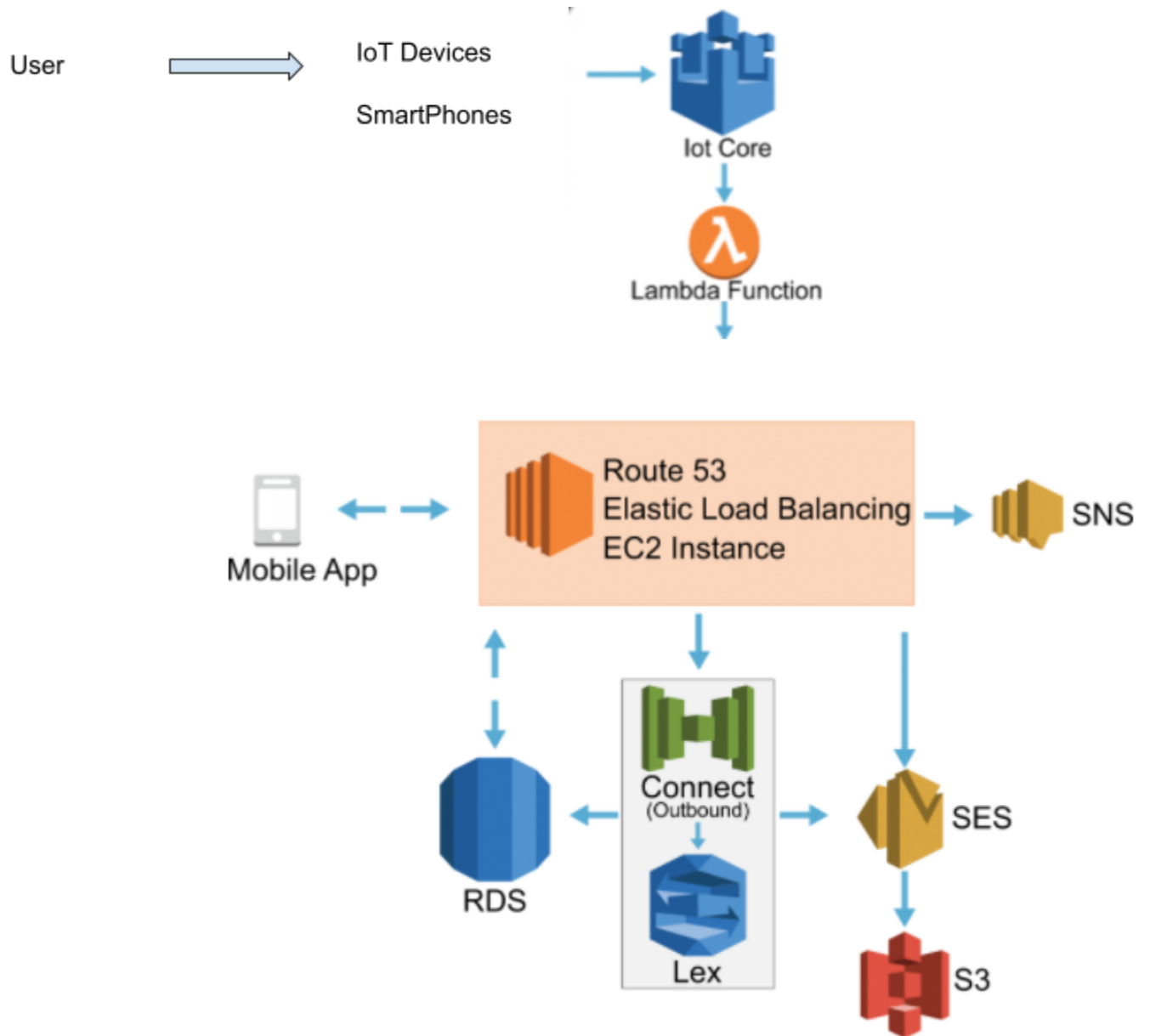
To top that, using the system, the data collected and stored in the system will be more secure as a high security system is also applied.

Our system will also connect with any users who have a wearable device that monitors their health, such as heart rate, vital signs, activity patterns, and calories rate, among other things. The wearable device will provide the basic checkup information needed when users first get to UTM Health Center for their appointment such as their heart rate and body temperature. The information gathered from the sensors of the wearable device will then be displayed in the system as the device used to access our online appointment booking system will communicate with the wearable device using the internet of things technologies. Though not all individuals have a wearable device, therefore only users that have one will connect with our system to provide the basic checkup information. Users that do not have a wearable device will get their basic checkup traditionally by the doctor at the clinic.

The system will integrate with the **Internet Of Things (IoT)** as one of the Fourth Industrial Revolution technologies. Internet of things is a network of interconnected computing equipment, including mechanical and digital machines that can convey data without the need for human-to-human or human-to-computer interaction [4]. The Internet of things is also known as the countless devices linked to the internet worldwide that gather and analyze data with one another [5]. The components of Internet of Things consist of four elements, which are the sensors or devices, connectivity, data processing and user interface [6]. Our proposed system will be used by the user using any devices that are connected to the internet such as mobile phones. The web-enabled devices will collect the data and process the data through the system. When the data is acquired, it will be sent to the cloud for processing and storage, the software will then analyse the data and provide further action. Through the user interface, the user will be able to enter the required data to book an appointment and their data will be processed instantly. The system also connects with other smart devices such as wearable devices that are able to monitor user's health. Both the related devices will communicate real-time data with one another without the need for human intervention. The sensors from the wearable device will collect data from the user, send the collected information to the cloud for processing with the system and provide the required information to the system. The Internet of Things (IoT) will undoubtedly

benefit patients by enabling remote monitoring in the healthcare industry, therefore releasing the potential to keep patients safe and healthy. Through the internet of things technologies, the staff at the UTM Health Centre, including physicians and nurses, may use the smart device to record data from the patients and send the data directly to the cloud instead of entering the information manually. This will synchronize the system and save time in data management. The utilisation of the internet of things in web-enabled devices and smart devices to access our online system will also make management easier, resulting in increased system efficiency. Furthermore, because contacts with doctors have grown easier and more efficient, it will boost patient involvement and satisfaction. Moreover, remote monitoring of a patient's health helps to shorten hospital stays and avoid readmissions. Our appointment booking system can be accessed by patients 24 hours a day, 7 days a week via the internet of things, at a significantly cheaper cost than the manual approach which entails hiring additional employees to handle and maintain data.

3. ARCHITECTURE PLANNING AND DESIGN



User

Users are the UTM students or UTM staff that use the application to book an appointment to get a medical treatment at UTM Health Centre.

Mobile Phone

Mobile Phone is needed as the application will be installed in user's mobile devices to run the application.

IoT Devices

The application can also be used in IoT Devices such as wearable gadgets. It can detect the user's heart rate, calorie and other health info, using a sensor that can record health data from the user.

AWS IoT Core

AWS IoT Core lets you connect billions of IoT devices and route trillions of messages to AWS services without managing infrastructure.

Lambda Function

AWS Lambda is a zero-administration compute platform. AWS Lambda enables administrators to run code without provisioning or managing servers. This serverless technology concept is relatively new to many IT professionals. However, it is becoming more popular because it supports cloud-native architectures, which enable massive scalability at a lower cost than running servers 24/7 to support the same workloads

AWS Lambda is a serverless, event-driven compute service that lets you run code for virtually any type of application or backend service without provisioning or managing servers. Lambda can be triggered from over 200 AWS services and software as a service (SaaS) applications.

When using AWS Lambda, an administrator can create a Lambda function, which is the AWS resource that contains the code that the administrator uploads. Admin then set the Lambda function to be triggered, either on a scheduled basis or in response to an event. The code only runs when it is triggered.

AWS Route 53 -Networking

Amazon Route 53 is a highly available and scalable cloud Domain Name System (DNS) web service. It is designed to give developers and businesses a reliable and cost-effective way to route users to internet applications by translating names (like www.example.com) into the numeric IP addresses (like 192.0.2.1) that computers use to connect to each other. In addition, Amazon Route 53 is fully compliant with IPv6

Amazon Route 53 effectively connects user requests to infrastructure running in AWS — such as Amazon EC2 instances, Elastic Load Balancing load balancers, or Amazon S3 buckets — and can also be used to route users to infrastructure that is outside of AWS.

Amazon Route 53 can be used to configure DNS health checks so administrators can route traffic to healthy endpoints or independently monitor the health of your application and its endpoints. Amazon Route 53 traffic flow helps manage traffic globally through several routing types, which can be combined with DNS failover to enable various low-latency, fault-tolerant architectures. Amazon Route 53 can be used to traffic flow's simple visual editor to manage how users are routed to application's endpoints — whether in a single AWS Region or distributed around the globe.

AWS Elastic Load Balancing - Monitoring

Elastic Load Balancing is an AWS service that distributes incoming application or network traffic across multiple targets—such as Amazon Elastic Compute Cloud (Amazon EC2) instances, containers, internet protocol (IP) addresses, and Lambda functions—in a single Availability Zone or across multiple Availability Zones. Elastic Load Balancing scales load balancer as traffic to the application changes over time. It can automatically scale to most workloads.

AWS Elastic Compute Cloud (EC2) Instance - Compute

Amazon EC2 provides virtual machines, and can be referred to as infrastructure as a service (IaaS). IaaS services provide flexibility and leave many of the server management responsibilities to the administrator. The admins choose the operating system, and the admins also choose the size and resource capabilities of the servers that will be launched. For IT professionals who have experience using on-premises computing, virtual machines are a familiar concept.

AWS Simple Notification Service (SNS) - Notified User Application

Amazon Simple Notification Service (Amazon SNS) is a fully managed messaging service for both application-to-application (A2A) and application-to-person (A2P) communication.

The A2A pub/sub functionality provides topics for high-throughput, push-based, many-to-many messaging between distributed systems, microservices, and event-driven serverless applications. Using Amazon SNS topics, the publisher systems can fan out messages to a large number of subscriber systems, including AWS Lambda functions, HTTPS endpoints, and Amazon Kinesis Data Firehose, for parallel processing. The A2P functionality enables you to send messages to users at scale via SMS, mobile push, and email.

AWS Simple Email Service (SES) - Notification Management

Amazon Simple Email Service (SES) is a cost-effective, flexible, and scalable email service that enables developers to send mail from within any application. Admins can configure Amazon SES quickly to support several email use cases, including transactional, marketing, or mass email communications. Amazon SES's flexible IP deployment and email authentication options help drive higher deliverability and protect sender reputation, while sending analytics measure the impact of each email. With Amazon SES, admins can send email securely, globally, and at scale.

AWS Simple Storage Service (S3) - Storage

Amazon S3 is persistent storage where each file becomes an object and is available through a Uniform Resource Locator (URL); it can be accessed from anywhere

Amazon S3 is object-level storage, which means that if you want to change a part of a file, you must make the change and then re-upload the entire modified file. Amazon S3 stores data as objects within resources that are called buckets.

Amazon S3 is a managed cloud storage solution that is designed to scale seamlessly and provide 11 9s of durability. Admins can store virtually as many objects as they want in a bucket, and admins can write, read, and delete objects in the bucket. Bucket names are universal and must be Unique across all existing bucket names in Amazon S3. Objects can be up to 5 TB in size. By default, data in Amazon S3 is stored redundantly across multiple facilities and multiple devices in each facility.

The data that is stored in Amazon S3 is not associated with any particular server, and admins do not need to manage any infrastructure yourself. Admins can put as many objects into Amazon S3 as they want. Amazon S3 holds trillions of objects and regularly peaks at millions of requests per second.

Objects can be almost any data file, such as images, videos, or server logs. Because Amazon S3 supports objects as large as several terabytes in size, admins can even store database snapshots as objects. Amazon S3 also provides low-latency access to the data over the internet by Hypertext Transfer Protocol (HTTP) or Secure HTTP (HTTPS), so users can retrieve data anytime from anywhere. Users can also access Amazon S3 privately through a virtual private cloud (VPC) endpoint. Users get fine-grained control over who can access their data by using AWS Identity and Access Management (IAM) policies, Amazon S3 bucket policies, and even per-object access control lists.

AWS Connect - User Support Service

An easy-to-use omnichannel cloud contact center that helps provide superior customer service at a lower cost. In other words, it is a contact center that would give our user personal, dynamic, and natural experiences.

Some of the major feature of AWS Connect; Contact Center Automation, Real Time & Historical Analytics, Task Management, Web and Mobile Chat

AWS Lex - AI that will be used in User Support Service

Amazon Lex is a fully managed artificial intelligence (AI) service with advanced natural language models to design, build, test, and deploy conversational interfaces in applications

AWS Relational Database Service (RDS) - Databases

Amazon RDS is a managed service that sets up and operates a relational database in the Cloud.

To address the challenges of running an unmanaged, standalone relational database, AWS provides a service that sets up, operates, and scales the relational database without any ongoing administration. Amazon RDS provides cost-efficient and resizable capacity, while automating time-consuming administrative tasks.

Amazon RDS enables admins to focus on the application, so they can give applications the performance, high availability, security, and compatibility that they need. With Amazon RDS, the primary focus is the data and optimizing the application.

With Amazon RDS, admins manage the application optimization. AWS manages installing and patching the operating system, installing and patching the database software, automatic backups, and high availability.

AWS also scales resources, manages power and servers, and performs maintenance.

4. CONCLUSION

Achievement (Benefits)

- ❖ Decrease the time consume in Healthcare system
 - Old system consumes time where we need to queue or need to go to the healthcare just to see a normal checkup. So instead of wasting time, technology has enabled us to create an efficient and simpler system. The booking system will ease a lot of users hence helping the society to have a healthier environment.
- ❖ Better Healthcare data management system - synchronized, easily accessible
 - The data that is gathered from the previous healthcare system sometimes has a human error where it might have misinformation or it is not up to date with the current situation. Instead of using the old system, having the healthcare data stored in the cloud will synchronise all the data throughout the ecosystem. Administrators can manage and get the data easily from the cloud from anywhere while users can see their current information of their health data up to date. This would be beneficial to everyone especially during pandemic Covid-19 where society should stay safe by distancing themselves from others.
- ❖ Reduce human error and workload pressure
 - Since the system is replaced with IoT technology, data could easily be managed. This will prevent errors such as nurses putting misinformation in the system or the data is not updated to the latest. In addition to that, the workload pressure for the healthcare workers could be decreased and be put to better use.
- ❖ Better analytics and performance between user and healthcare
 - From the data gathered in the cloud and IoT Devices, healthcare administrators could analyse the data and make a prevention and improvement toward the healthcare system. This would be useful in predicting diseases and catastrophe, hence students can study and staff of UTM works without worrying about their health.
- ❖ Reduce additional documentation
 - Iot Devices can ease the documentation that is needed from the healthcare staff. Instead of consuming a lot of time doing unnecessary but required check up, users could use the IoT devices and input their data into the system wherever they are. They can focus more on the serious matter during the check up in the healthcare.

Limitation

- ❖ IOT Devices requirement
 - In the era of IR 4.0, everyone should already have the technology of a minimal one smartphone. However, in order for the booking system to be best used, external IoT devices are required for the data to be gathered. This limitation is usually a concern for those who are not favorable in using external IoT devices other than smartphones.
- ❖ Internet Connectivity Dependant
 - IoT devices and cloud computing is a technology that helps to increase the efficiency of work in a system. However, these technologies required internet connectivity in order for them to run smoothly. The better the connectivity between the devices and cloud, the data will be more reliable.
- ❖ User should be IT literate
 - Since the targeted user is staff and student from the UTM, the user should have the basic knowledge of using IT equipment. However, if there is another user such as children or an elderly, there might be some difficulties in using the system depending on how the user knows how to use IT equipment.
- ❖ Exposure of using the system is necessary
 - Even Though everyone could use the system easily, training the user for the operation of the system will help the user to use the system more efficiently and the wide feature of the system will be well used by the user.

Summary of Proposed System

The **online appointment booking system for UTM Health Centre** brings together all the features that Healthcare systems need to solve the problem of data management and Patients by enabling them to easily deploy thousands of IoT devices to customers without a complicated provisioning process. Once deployed, Healthcare Providers and/or Patients can simply use their IoT devices in their sample closet or medicine cabinet to contact sales representatives and get the information needed in order to write proper prescriptions or get educational materials. AWS Lambda's ability to integrate with other AWS services also makes it easy to attach other services such as Amazon Connect and Amazon Lex, allowing the system to provide amazing automated language support through Alexa to both Healthcare providers and Patients.

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