Automatic Meter Reading of Electric Energy Meter

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Abstract
In this research project, we describe a Global System for Mobile Communications-based self-sufficient remote meter-reading system (GSM). Because this paper is so useful, meter readers do not need to visit each customer's location in person to obtain energy consumption information. Using a microcontroller, it is possible to monitor and maintain track of the meter readings. It is unnecessary for the electricity company to dispatch personnel to physically disconnect a delinquent client. Using short messaging service (SMS), the energy supplier may temporarily disconnect and then reconnect a customer's service (SMS). In addition, the client may monitor the load (the power condition) from any location. GSM is used in this case for the transfer of data from energy meters.

Keywords- Smart Energy Meter (SEM), Automatic Meter Reading (AMR), Global System for Mobile (GSM), Short Messaging System (SMS).

I. INTRODUCTION
Automatic meter reading, or AMR, is a system that remotely reads and uploads data on energy use, diagnostics, and status to a centralized database. This information may then be utilized for research, maintenance, and invoicing. Cost reductions associated with regular meter readings done by utilities is the principal advantage of using this strategy. Another benefit is that customers may be charged based on their actual use rates, as opposed to expected pricing that are calculated by looking at historical data or making assumptions. This resource provides timely data and analysis that benefits not only power producers but also electricity consumers.

Figure 1: Automatic Meter Reading (AMR).

Handheld AMR depends on a portable device that functions as a printer. This is what the meter reader uses. This method is commonly referred to as "walk-by" meter reading since the meter reader must physically traverse the zones containing the meters to perform the assignment. As an alternative to lugging portable equipment, meter readers may utilize mobile phones with built-in printers as a substitute.
The automatic meter reading reads the meter data and saves it in the database by using the QR Code scanner, also uses OCR (Optical Character Recognition, image processing technology) to process the image of the meter and extracts the meter reading automatically from the image.
We will discuss how the system works and how to communicate between the frontend and backend using API (Application Programming Interface).

II. BACKEND AND FRONTEND
In software engineering, the display layer of a program is known as the "front end," while the data access layer is known as the "back end." These terms refer to the separation of a program's presentation layer (front end) and data access layer (back end) from the remainder of the program or the hardware on which it operates. The client is often referred to as the "front end" in the client-server concept, while the server is referred to as the "back end." Even if some presentation work is performed on the server, this is the case.

A. Frontend (Dart Language)
Dart is an efficient, cross-platform programming language developed from the ground up to simplify the creation of user-friendly applications. It aims to provide the most effective language for cross-platform programming as well as a flexible runtime environment for application frameworks. This will be achieved by offering both of these characteristics.

The decisions taken throughout the development of a language influence both its technical envelope and its resultant strengths and limits. Dart is designed for a technical space that is well-suited to client-side development, with an emphasis on quick prototyping (with sub-second stateful hot reload) and robust, high-quality production releases across a wide variety of platforms and devices. In addition, Dart is meant to be portable across a broad range of settings, including PCs, mobile devices, and embedded systems (web, mobile, and desktop).

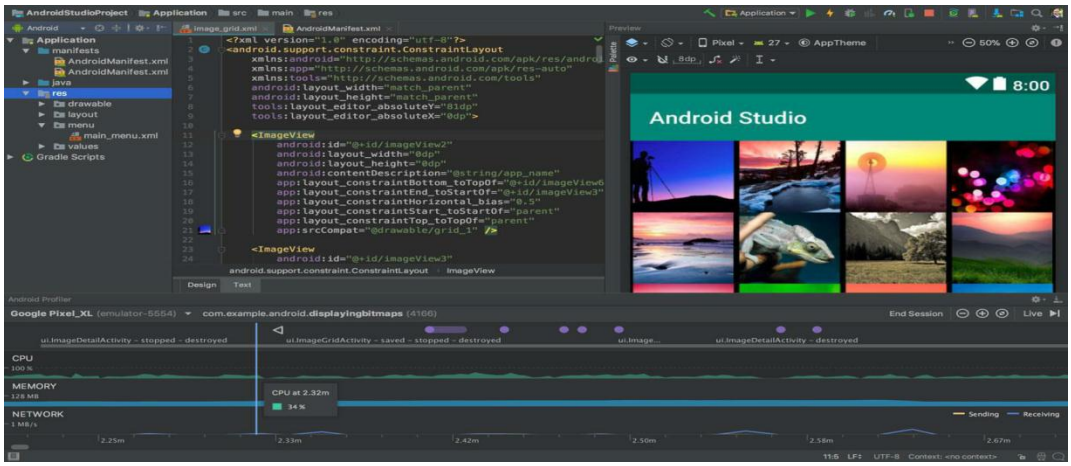
The Dart infrastructure serves as the foundation for the development of Flutter. Dart offers considerable support for core developer tasks like as code formatting, analysis, and testing, in addition to providing the language and runtimes upon which Flutter applications rely.

B. Frontend (Flutter Framework)

Flutter is a free and open-source software development kit (SDK) for creating user interfaces that was developed by Google. It is used to create programs for several platforms, including but not limited to Android, iOS, Linux, Mac, Windows, Google Fuchsia, and the web, using a single piece of source code. These platforms include Android, iOS, Linux, Mac, Windows, and Google Fuchsia, but are not restricted to these.

Flutter applications use a substantial amount of Dart's sophisticated capabilities, making the language a perfect match for the framework.

Flutter makes use of the Dart virtual machine on all supported platforms, including Windows, macOS, and Linux, due to Dart's just-in-time execution engine. Flutter utilizes Just in Time compilation, which enables "hot reload." This permits the injection of changes to source files into a live application while it is being developed or debugged. The majority of the time, changes to the source code are immediately reflected in the operating application without the need for a restart or loss of state. This feature is expanded by Flutter's support for stateful hot reloading.



C. Android Studio

Android Studio, an integrated development environment (IDE) that is based on IntelliJ IDEA, is the official tool for developing Android apps. Android Studio is designed to make the process of developing apps for Android devices more efficient by providing features such as the powerful code editor and developer tools provided by IntelliJ. This is only the beginning of what Android Studio has to offer:

1) Gradle-based framework that allows for customization.
2) Highly effective and quick emulation program.
3) One location for Android development across all devices.

The Make Changes option eliminates the need to restart the application in order to apply changes to the code and resources currently being utilized by the application.

By integrating code templates and Get Hub into the app development process, it is feasible to produce typical app features quickly and easily.

A set of frameworks and tools for doing exhaustive testing.

lint tools assess C++ and NDK code for effectiveness, usability, and version compatibility, among other characteristics.

The native support for Google Cloud provided by App Engine simplifies the integration of Google Cloud Messaging. This is one of the primary reasons behind App Engine's popularity.

D. Android/IOS Application

In this part, we will talk about Automatic meter reading application programming And how it works, which will include:

1) Login and token authentication.
2) Reading and saving meter data in the database with two modes:

a- Online Mode.

b- Offline Mode.

3) Payment.

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4) Print the wages bill.
5) Full report about the data.

E. Login and Token Authentication

When opening the application, an interface appears for logging in, you should enter a username and password of the meter reader and without them, he will not be able to enter the application as shown in the image below:

F. Main Menu

After completing the login, open the main menu in the top right of the application, and we will find five options as follows:

G. Reading and Sending Meter Data to The Database

The meter data reading works in two Modes:

1) Online Mode.
2) Offline Mode.

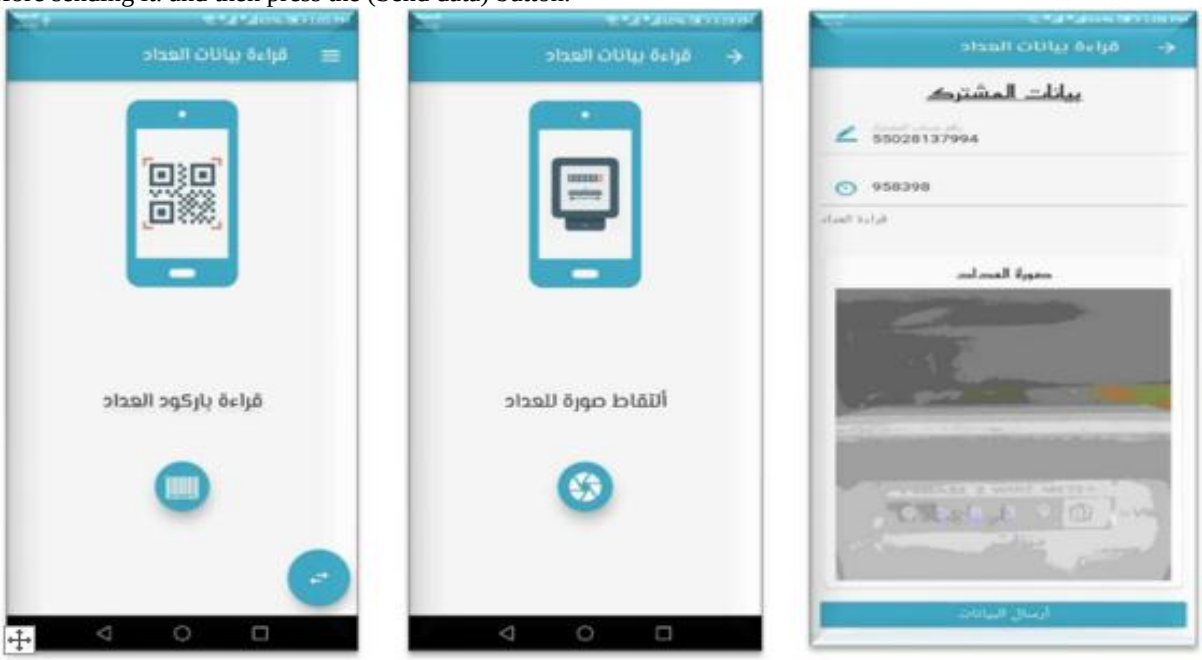
In both cases, the application will switch automatically from one case to another after confirming the service of the Internet as shown below:

1) Online Mode

- Reading the QR Code of the meter (account number): After reading the QR Code and verifying the existence of the account number in the database, the transfer is done automatically to another page to take a picture of the meter.

Note: in case that the QR Code (account number) has been read and turns out that this account is not registered in the database the app then will display a message stating that this account is invalid, and must be registered in the database.

- Taking a picture of the meter: When taking a picture of the meter, its size is compressed before sending it to the database to 1/8 of its original size, and after the success of the operation, it will automatically move to the homeowner information page to display (account number, meter reading, and meter picture) so that the meter reader can verify from the information that will appear to him before sending it. and then press the (Send data) button.



1- Reading the QR Code 2- Taking a picture 3- verify and send data

Sample of (sending data)

Note: In the following cases, data will not be sent and an alert message will be displayed:

1) The entered meter reading is smaller or equal to the previous month's reading.
2) An incorrect meter reading was entered.
3) The reading has pre-registered for the current month in the database. B- Offline Mode

It goes through the same steps as online mode, but instead of sending data to the server, it will be stored temporarily on the phone in the (SQLite Database) until the Internet service becomes available, then the meter reader can send the data and view a full report on that data. Therefore, this mode goes through two stages:

First Stage: (reading data)

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1- Reading the QR Code

2- Taking a picture

3- Data verification

4- saving data on device

second Stage (Sending data)

At this stage, the meter reader must send the data to the database from a place where the Internet service is available after it has been saved on the phone in the first stage, as shown below:

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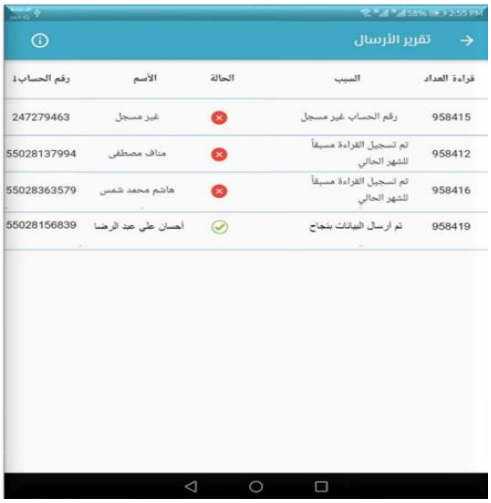
After clicking on the Send Data button, a page will appear that contains:
Number of users: The total number of users whose data have been read.

1) User's information: account number, meter reading, meter image.
2) Send data button: Send the data to the database.

The purpose of displaying the data before it sent so that the meter reader can make sure of the data that has previously read, as shown in the image below:

After pressing the "Send data" button and verify that the transmitted data has successfully processed, will a message appear, through which the meter reader can see a report on that data and see if it has been sent or rejected as shown in the pictures below:

After pressing the "View Report" button, a list of the sent data and the data that have not sent will appear with the reason stated in case the data has not sent:



It is also possible to make ascending or descending order of the data by clicking on the field name for easy errors tracking.
Reasons for not sending data:

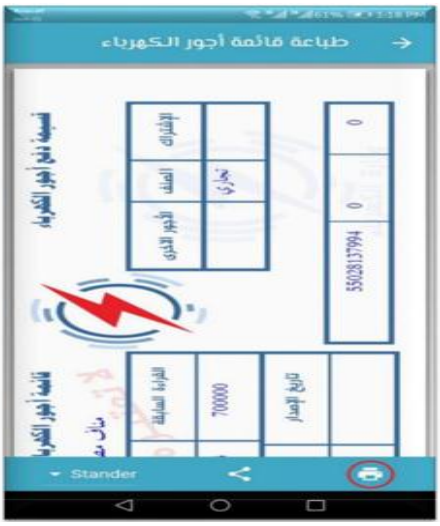
1) The account number is not registered or incorrect.
2) The entered meter reading is smaller or equal to the previous month's reading.
3) The reading has pre-registered for the current month in the database.

Note: clicking on the icon in the top left of the screen will show a summary of the sent data like the total number of accounts, the number of accounts that have successfully sent, the number of accounts that have not successfully sent, as shown in the picture:

H. Payment

In order to pay and print the wages bill, we follow the following steps:

After reading the QR Code and verifying it, will appears a window contains the user's account number, the homeowner's name, and the amount that he wants to pay. And after entering the specified amount and pressing the pay wages button, if the payment was successful, you will automatically go to the bill printing page, and then we will click on the print button, as shown:



I. View and Print the Bill

If we want to print the wages bill only without the payment process,
We should follow the following steps:

1) printing the wages bill.
2) Reading the QR Code to ensure this account number exists.
3) Choose the print command.

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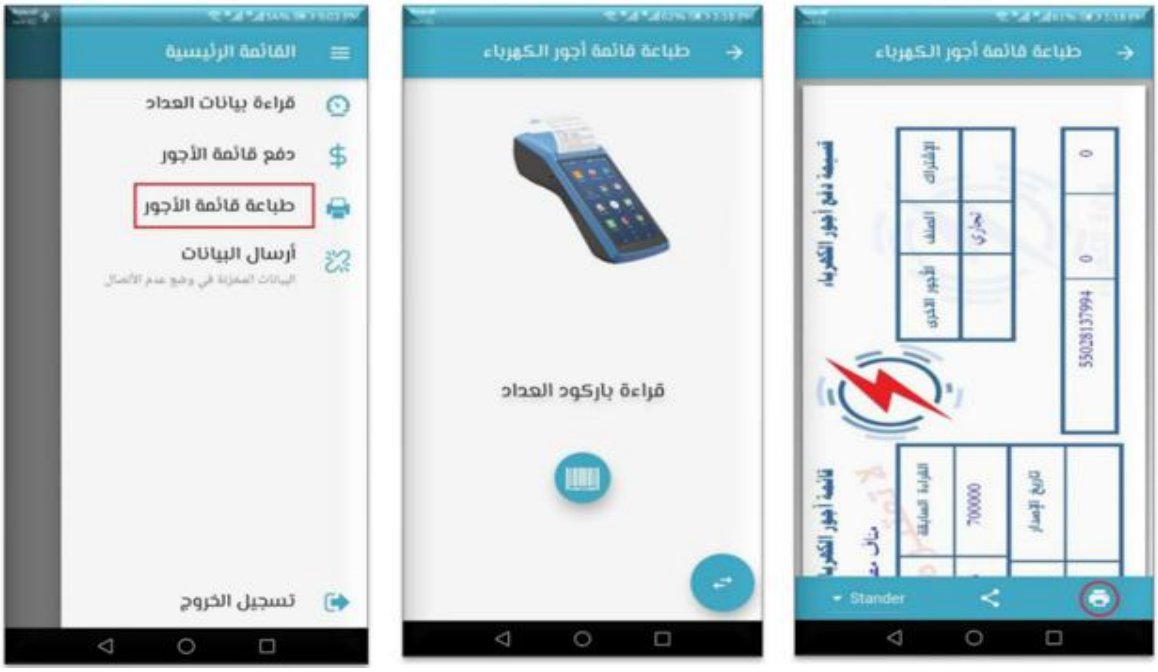


J. Logout

After the completion of the data transmission, it is necessary to logout of the application to protect the data and not to tamper with it.

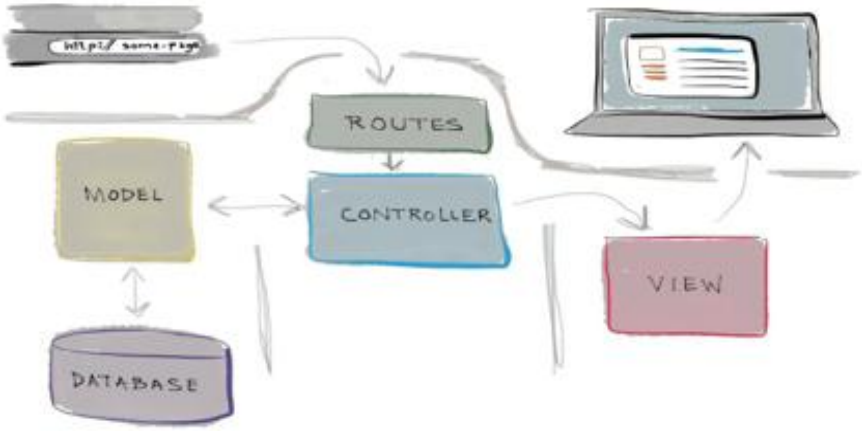
III. BACKEND (PHP LANGUAGE)

PHP, which stands for "Hypertext Preprocessor," is a server-side programming language used for a variety of applications. In 1994, Danish-Canadian computer programmer Rasmus Leadoff built it. The PHP Group is responsible for the development of the official PHP reference implementation at this time. Personal home page was the original meaning of the abbreviation PHP. PHP is currently a recursive initialism. The acronym for "Hypertext Preprocessor" is often abbreviated as PHP.

A PHP interpreter is often used by a web server to execute PHP code. A PHP interpreter for the Common Gateway Interface may be a module, a daemon, or an executable (CGI). After PHP code has been parsed and exercised, it is capable of generating a wide variety of data types. These data types, which may contain HTML and binary image data but are not restricted to them, are subsequently supplied to the client as either a part or the whole HTTP response. Using any of the several web frameworks, web content management systems, or online template systems that are already available online, it is feasible to organize or ease the production of such a response. PHP may be used for a broad range of non-web programming activities, including the control of robotic drones and standalone graphical apps. Additionally, arbitrary PHP code may be interpreted and run using PHP's command line interface (CLI).

A. Backend (Laravel Framework)

Taylor Orwell is the author of the Laravel PHP web framework, which was patterned after the Symfony web framework and intended to simplify the development of MVC-based web applications. Among the many characteristics of Laravel are its modular packaging system and dedicated dependency management, a variety of approaches for connecting to relational databases, tools for deploying and maintaining applications, and a focus on syntactic sugar.



1) MVC Architecture
2) Advantages of Laravel
3) Authentication and Authorization.
4) Template Tool.
5) Migration of database.
6) Artisan Tool for Command Line.
7) Inbuilt Libraries.
8) Integration with Mail Services.
9) URL Generations.
10) Community Support is strong.
11) more scalable.
12) MVC Architecture Support.
13) Fine Unit Testing.

B. Backend (XAMPP Server)

The open-source XAMPP software stack was developed by the Apache Software Foundation, making it freely available to the entire public. The XAMPP stack consists of four distinct Apache Software Foundation-developed distributions. The Apache server, MariaDB, PHP, and Perl are included in these packages. It is identical to connecting to your computer as if it were your own server, sometimes referred to as the localhost. If desired, this private server may be installed on a personal computer. XAMPP enables you to test your website on your local computer prior to uploading it to the internet.

server. XAMPP enables local testing of web development projects since it is a server package that includes MySQL, PHP, Apache, and Perl.

XAMPP may be split down into its component elements as follows: X represents compatibility for several platforms; A represents Apache, M represents MariaDB, P represents PHP, and P represents Perl. Frequently, cross-platform compatibility refers to the condition of being compatible with any hardware running on any operating system.

Next MariaDB, which was built by the same individuals that created MYSQL, has become the industry standard. PHP offers a standard platform for website development. The Hypertext Preprocessor, or PHP, is a kind of computer programming designed for use on web servers. Perl is a computer language used to construct applications for use on the Internet.

What XAMPP Is and Which Programs Constitute Its Principal Components XAMPP has a variety of pre-installed programs, including Apache, MySQL, PHP, and Perl. These musical instruments will be shown.

1) Apache

The Apache software foundation is currently responsible for the administration of the Apache server, which is an open-source piece of free software that was built by a group of programmers and is freely accessible to the public. When a web browser user requests a file, picture, or document, the request is handled by a distant machine known as an Apache HTTP server. The location of this computer might be anywhere in the globe. This program is virtually entirely used by hosting companies to setup virtual private servers and shared hosting for their customers.

If you are contemplating switching web hosts for your testing website, we highly advise you to use FastComet Cloud Hosting since their service is superior to that of the other major providers.

2) MYSQL

The MYSQL database management system is available for free. It is a management solution for relational database systems (RDBMS). SQL is the shorthand for this specific kind of query language. The relational database management system is the industry standard and is used to create a broad range of online applications. Using MYSQL, you are able to store data in a well-organized database, which you can then manage, access, and alter at your convenience.

3) PHP

PHP is an acronym for "Hypertext Preprocessor." In other words, it is a server-side scripting language that allows the building of interactive web pages. This language is mostly used in the creation of software applications intended for usage on the World Wide

Web. Because it is free and compatible with MYSQL, you cannot go wrong with this choice. In real operation, PHP code is performed on the server, while HTML code is shown in the browser.

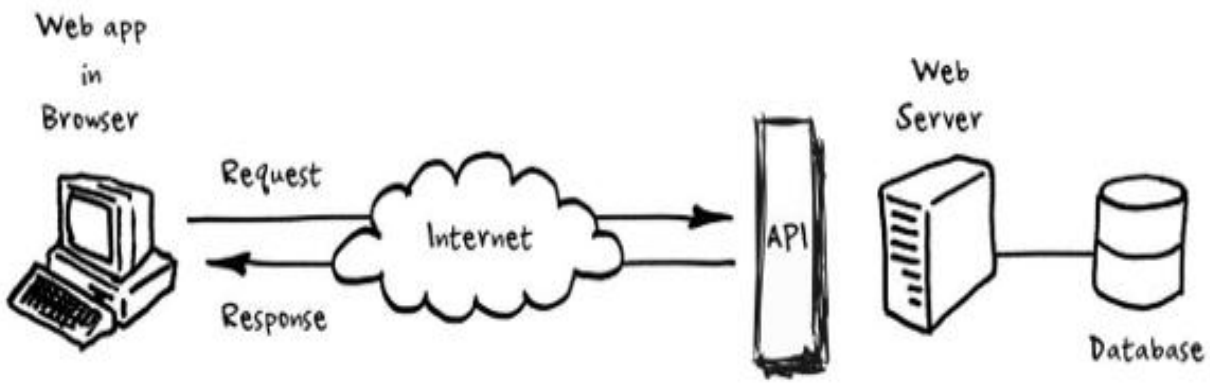
4) Perl

Perl is the programming language with the highest degree of freedom, as is commonly accepted. The questioned Perl scripts are extremely interpretable and dynamic. This language is used in a variety of contexts, including the production of websites, the creation of graphical user interfaces, the management of computer systems, and other related endeavors. In addition to HTML and XML, Perl can handle a broad range of markup languages.

The most recent version of XAMPP includes additional software, such as the Mercury email server, OpenSSL, phpMyAdmin, and several more programs. You will be able to develop a functional desktop server utilizing the previously listed resources.

C. API (Application Programming Interface)

API is the acronym for Application Programming Interface, it's a set of programming code that enables data transmission between one software product and another. It also contains the terms of this data exchange.



Types of APIs

Depending on the release policy in place, APIs may be accessible exclusively to partners or to the general public.

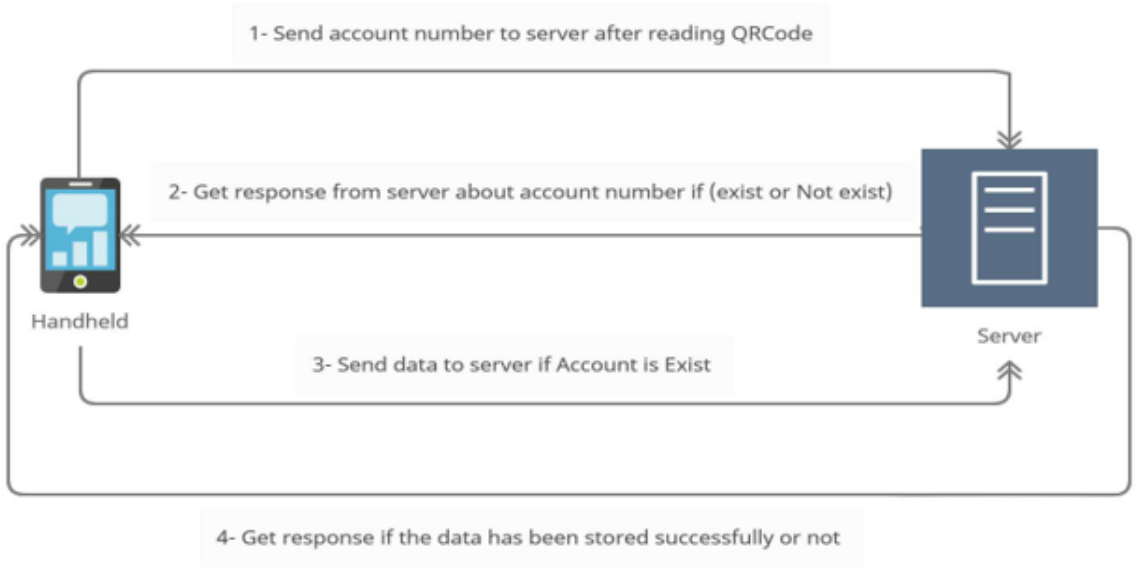
APIs that are exclusively accessible from inside the organization. These application programming interfaces (APIs) are designed to enhance a variety of internal services and solutions. These application programming interfaces (APIs) may be used by software developers working inside an organization or those recruited outside to build new applications or systems that interact with the ones currently in use by the company. The application programming interface (API) may be accessible to developers, but direct collaboration with the API publisher is required to use the interface. Using a private method, a firm may have complete control over how its API is used by other parties.

Communication protocols between the partners. The publisher encourages consumers to use the application programming interfaces (APIs) supplied by its business partners, however these APIs are available only to customers who have entered into a formal partnership agreement with the company. Enterprises often use application programming interfaces to combine the software that runs on each of their individual machines. Providing partners with access to data or capabilities results in an increase in revenue for the firm granting access. In addition, it is able to maintain a consistent corporate identity throughout its applications and oversee the way in which API-using third-party solutions engage with users.

application programming interfaces that are freely accessible. These APIs are accessible to any developer working on a third-party application; hence they are frequently referred to as developer-facing or external APIs. It is feasible to improve brand exposure and generate more revenue by deploying a public API program effectively.

How API works with AMR (Automatic Meter Reading)

When a user makes a request, frontend applications are those employed on mobile phones and other portable devices; these programs link to servers via the internet (Backend). The server will then receive the data, process it, and provide the findings to your mobile device. The computer will then analyze the data and provide it to you in a style that is easy to comprehend and absorb. This is only possible due to the existence of an application programming interface.



IV. CONCLUSION

This project aims to create a GSM Smart Energy Meter based on Adriano for an advanced metering and billing system. This meter will be able to operate both the meter and the line connection, as well as read and send data using a GSM-based wireless protocol and GSM modem. It is probable that the project need more modifications to make it more dependable and to increase the amount of pleasure and security it provides. Utilizing a SIM card with a GSM module may result in coverage difficulties, which will make using the network more challenging than necessary.

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