System Design Report

Smart Electric Metering System

Version: 1.1

Group 3

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Purpose:

This document features high level system design of our proposed smart electric metering system. Along with that the document also lists the requirements we have covered in the form of use cases specific to each user roles and all the assumptions we have made while designing and developing a prototype of the system. Also, the document explicitly mentions the key stakeholders associated with the system and highlights several key risk factors that must be taken into consideration while implementation.

Key Stakeholders:

Consumers, Electricity Supplier, Electricity Network Operator, Backend administrators

Intended Audience:

This document is mainly targeted for the use of development and testing team and for the end users who want to have a comprehensive overview of the list of functionalities exposed by the system.

Overview of the System:

The smart meters as opposed to the traditional household electric meters are primarily aimed at providing high scalability and reducing the overall operational cost of the electricity distribution company. This is primarily achieved by connecting the meters to the cloud infrastructure of the distribution company where it can be remotely monitored and controlled. Also, the system makes its convenient for the consumers to keep track of their consumption by means of web-based interface. The meter comes with an intelligent alert system to make it fault tolerant and to avoid potential security breaches.

User Roles and Their Specific Use Cases:

For our proposed system, the entire user space can be broadly subdivided into two categories.

Consumers:

These are the end users of the system, who will have such meters installed in their households. They should be able to do the following-

1. Users should be able to login using the web-based interface, which provides them a means to directly interact with the meter. They should use their respective consumer ID and password while logging in.
2. The web-based interface must allow the user to,
    a. Update profile information such as, mobile number to receive alerts etc.
    b. Set a daily threshold limit of consumption
    c. View the total units consumed after the last billing period
    d. View monthly and daily consumption statistics
    e. Update meter balance by making on-line payments (in case of a prepayment mode)
    f. Request for update tariff plan
3. The user should be able to receive alerts for the following
    a. Balance is below the minimum balance threshold
    b. Daily consumption limit reached
    c. Meter has been tampered physically
    d. Meter tariff rate has been changed
    e. Line disconnected as the meter is out of balance.

Alerts can be both in the form of SMS and Email depending upon customer opting preference. Additionally, these should be available to view over the web interface historically.

Electricity Supplier:

They will be the owner of smart meters and responsible for providing service to the end user. He will be having explicit admin rights to control the meter. So, this group of users will be having several special privileges such as,

1. Updating the tariff rate of the meter
2. Bill generation in case of Credit tariff
3. Remote power on/off in case any tampering gets detected
4. Remote flashing of firmware update of the meter
5. Extraction of monthly consumption statistics

Network Operator:

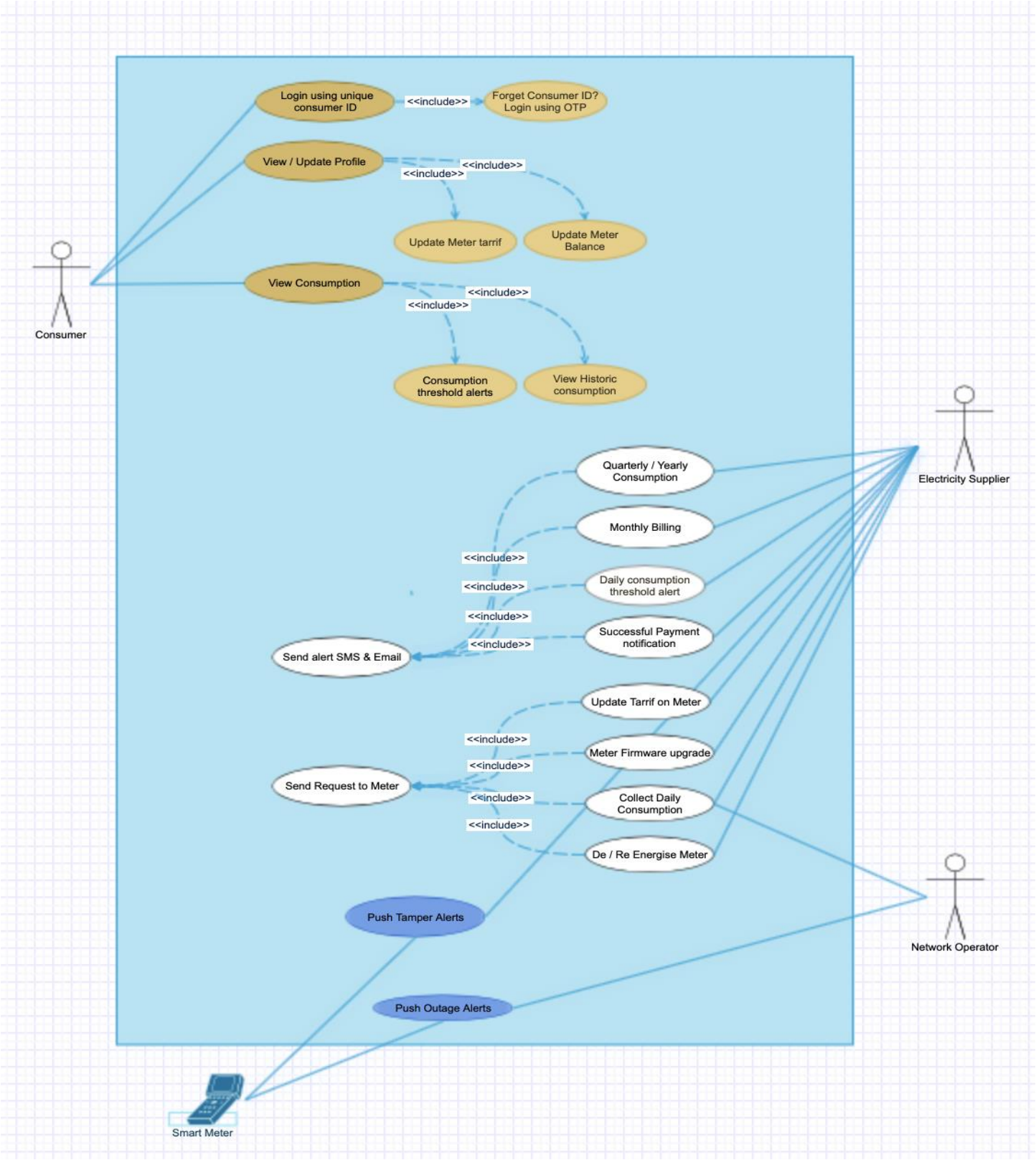
They are intermediate party between Electricity generating companies and the suppliers and provide the network to carry the electricity (Management of grid). So, this group of users need not have access to modify the smart meter but will require access to collect data from the meter

1. Collect daily consumption (to later bill the supplier for providing the grid maintenance service)
2. Receive outage alerts to restore service within SLA.

Key Design Assumptions:

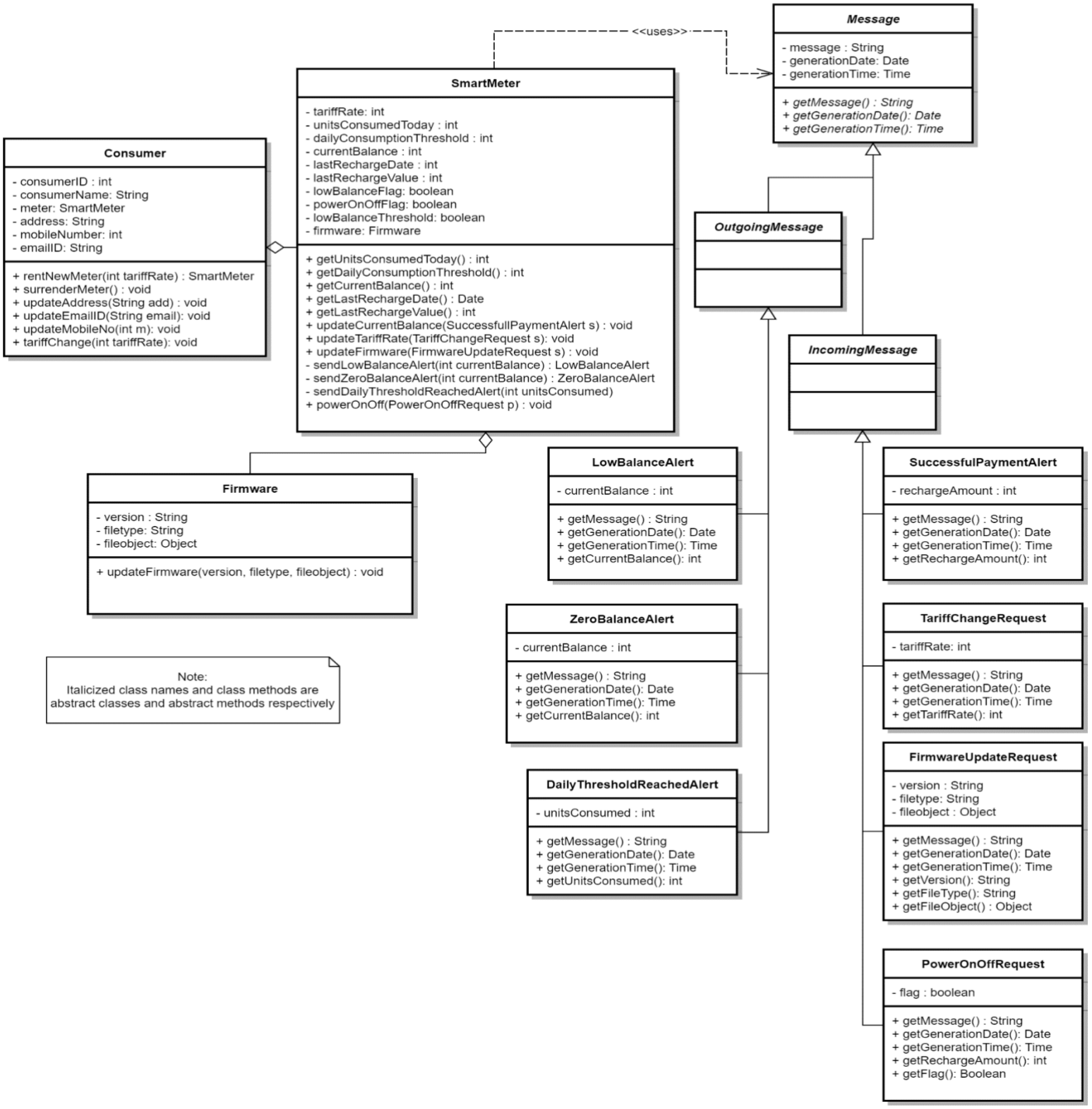
We have assumed the meters to be both credit and prepayment, and have considered designing the basic required functionalities to support both payment modes

Use case Diagram



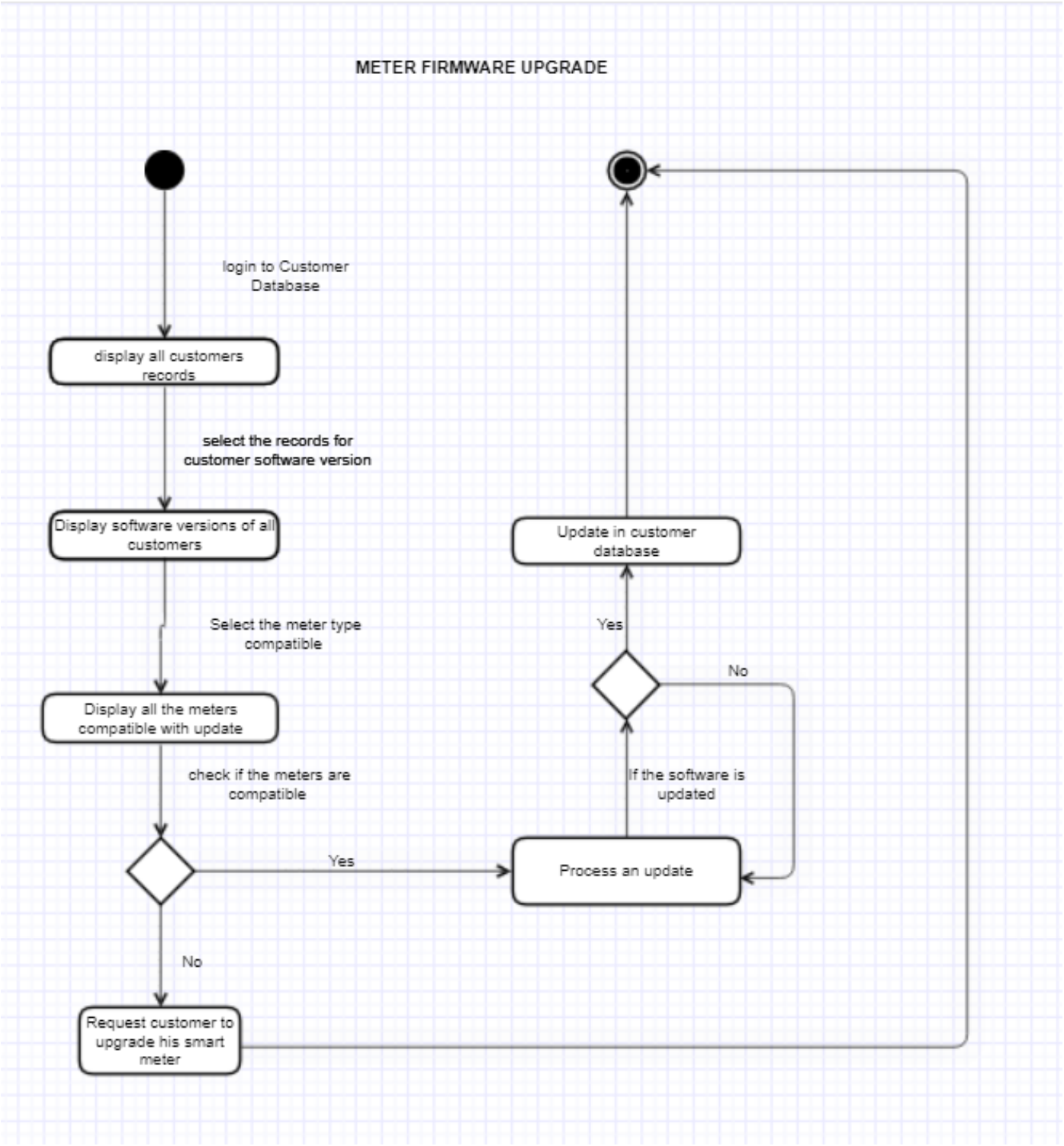
Class Diagram

Class Diagram - Smart Metering System

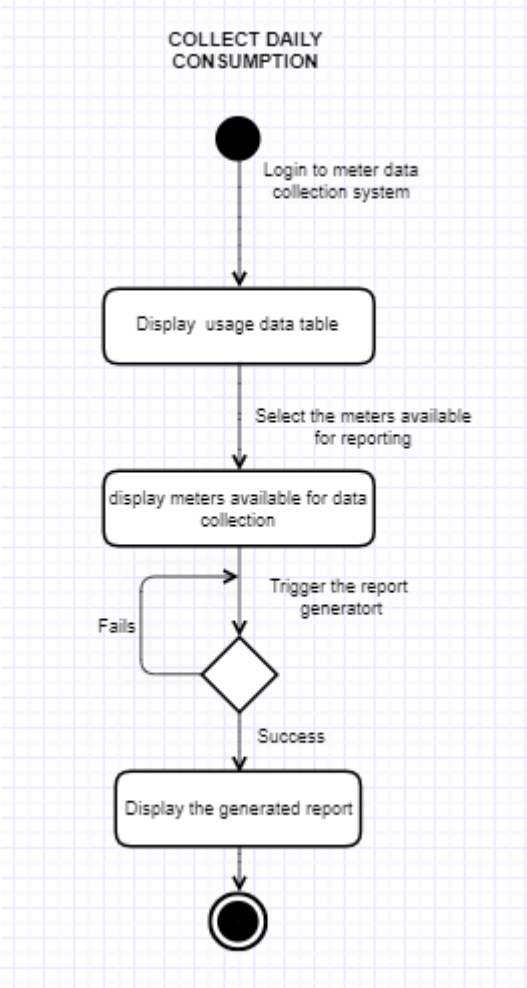


State-chart Diagram

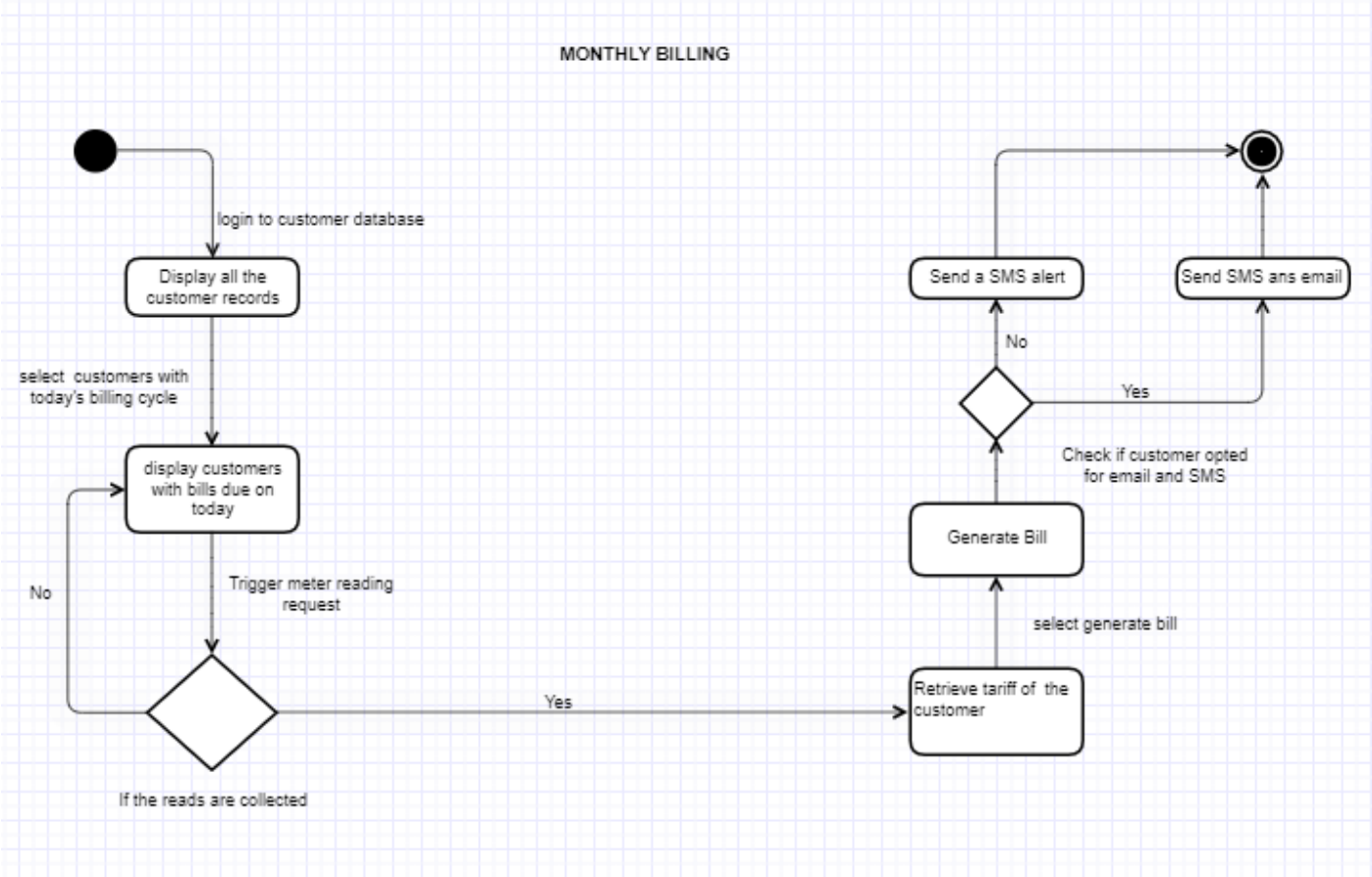
Supplier- Meter firmware upgrade:



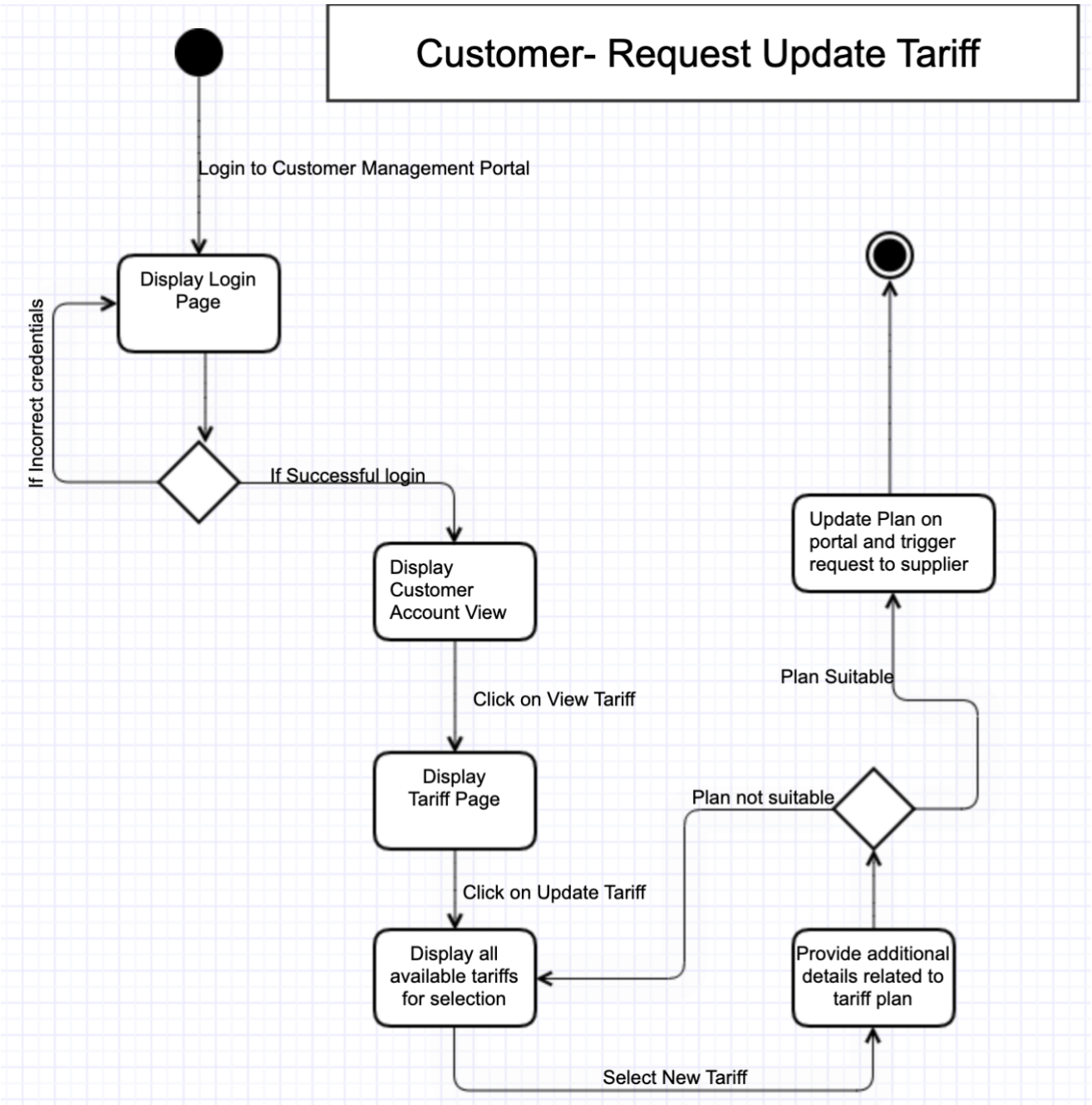
Network Operator- Collect Daily Consumption:



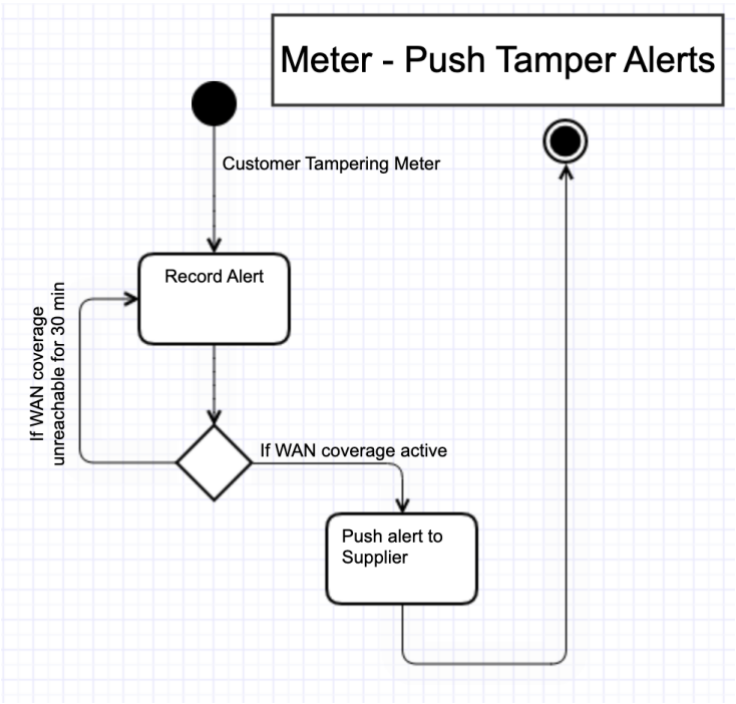
Supplier- Monthly Billing:



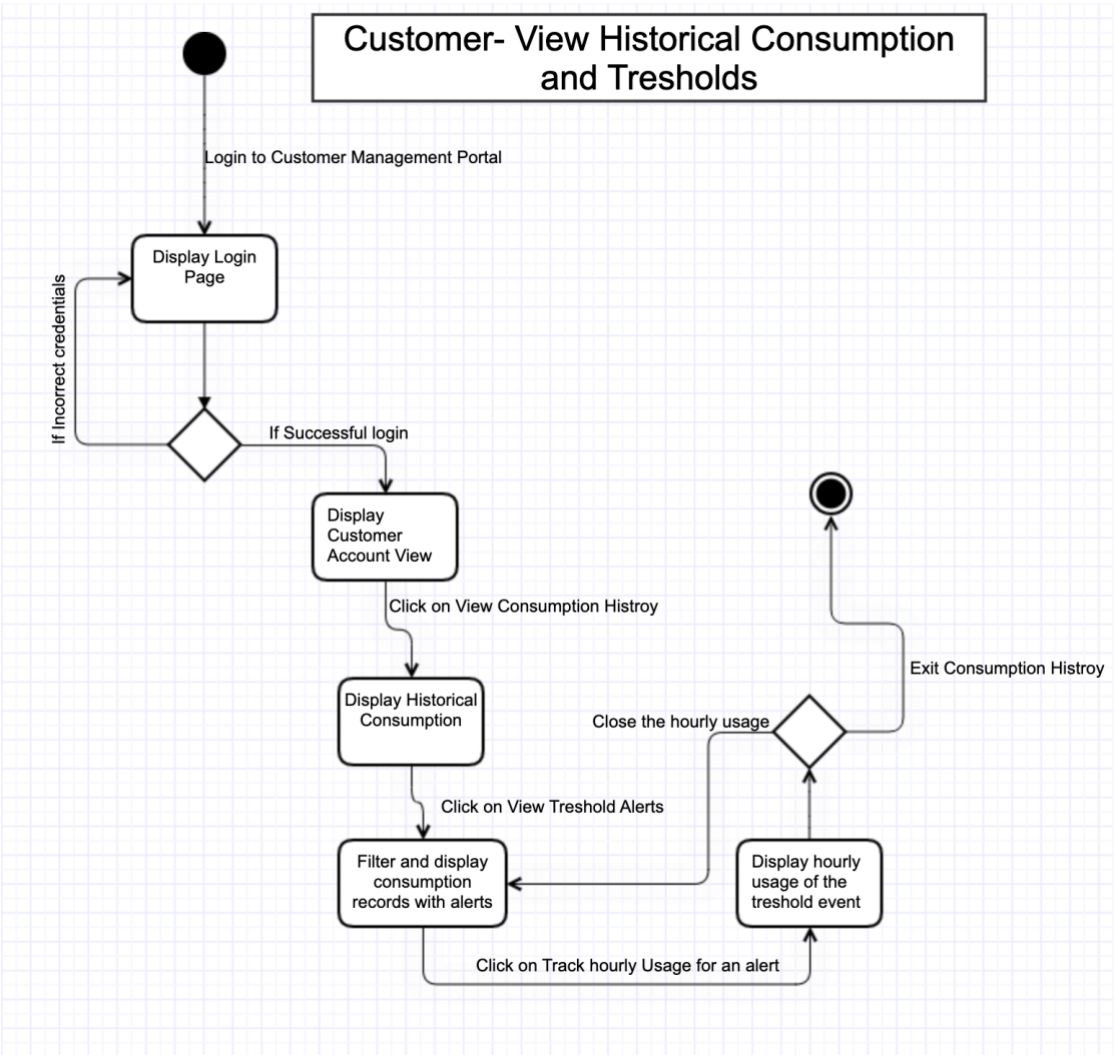
Customer- Request Update Tariff plan:



Meter- Tampering Alert:



Customer- Daily/Hourly Consumption Alert:



Key Risk Factors:

Following are the identified risk factors that need to be taken into consideration while implementing the above design.

1. What happens if the firmware updating fails in-between and how to recover from such failures? Firmware file must come with parity bits that needs to be validated after every download, to ensure that the file downloaded has not got corrupted.
2. Backend grid, from where all the meters will be controlled needs to be secured. What will be the most appropriate security considerations in this case?