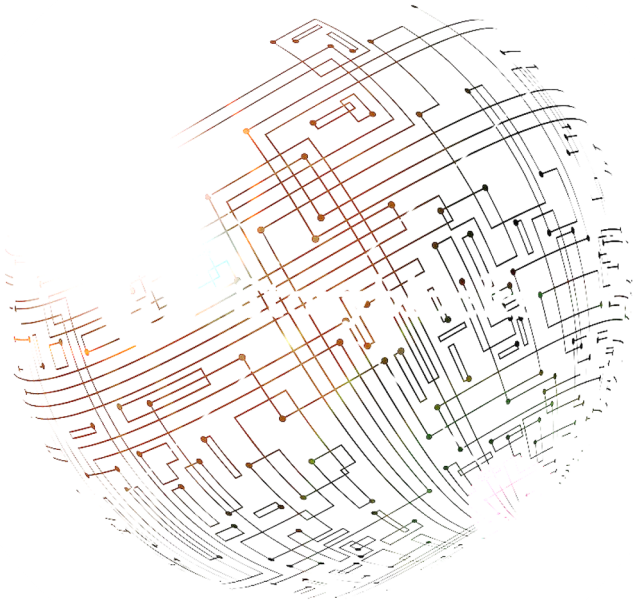

Verticross India Pvt. Ltd.

(Meter Data Acquisition System)

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INTRODUCTION

A Meter Data Acquisition System (MDAS) is specialized software designed to efficiently collect, manage, and analyze meter data from various sources, including power utilities, industrial setups, commercial and residential establishments, and smart city projects. MDAS plays a crucial role in advancing energy management and achieving energy efficiency by facilitating real-time consumption monitoring, energy analysis, and accurate billing.

MDAS integrates with meters using multiple metering protocol drivers, such as DLMS/COSEM, Mod-bus, and M-bus, to ensure reliable and secure data collection. These protocols allow it to communicate with diverse meter types (Feeders, Distribution Transformers (DTRs), and consumer meters) via internet connectivity.

MDAS serves as a central repository for all meter data collected from various Automated Meter Reading (AMR) systems and mobile applications. This consolidated database provides a robust platform for storing, archiving, and managing data for current and historical analysis.

It supports real-time energy consumption monitoring and detailed energy analytics. This includes generating consumption patterns, load profiling, and identifying peak usage hours, which helps utilities and organizations optimize their energy usage, detect anomalies, and minimize wastage.

MDAS incorporates validation and verification algorithms to ensure data accuracy and reliability. These algorithms detect and filter erroneous or abnormal meter readings, reducing the risk of billing errors and helping in compliance with regulatory standards.

The system generates Feeder reports that provide insights into energy usage patterns, operational efficiency, and meter performance. These reports support decision-making for power management, demand response, and resource allocation.

The Meter Data Management System (MDMS) is an essential integration with MDAS. MDMS acts as a layer to further process and store meter data, supporting more extensive analytics, long-term data storage, and customer usage insights. MDAS sends validated data to MDMS, which enables utilities to perform deeper analysis and improve energy management strategies.

MDAS has feature to integrate data with billing systems to ensure accurate and timely billing for consumers. The billing system uses MDAS-provided data to generate invoices based on actual consumption, thereby reducing estimation errors and improving customer satisfaction.

For smart cities, MDAS is configured to work alongside other infrastructure systems to support broader city management goals, like load balancing, demand forecasting, and outage management. Its compatibility with multiple protocols enables it to handle diverse metering devices deployed in urban setups.

MDAS is scalable , making it adaptable to small establishments as well as large enterprises and utilities. It employs security measures to safeguard data during transmission over the internet, ensuring that meter data is collected and processed without breaches.

MDAS provides enhanced accuracy in billing, reduced operational costs, and valuable data for energy distribution optimization. It enables proactive energy monitoring, aiding in cost savings and energy efficiency. It provides transparency in billing, helping users understand their energy consumption patterns and optimize usage accordingly.

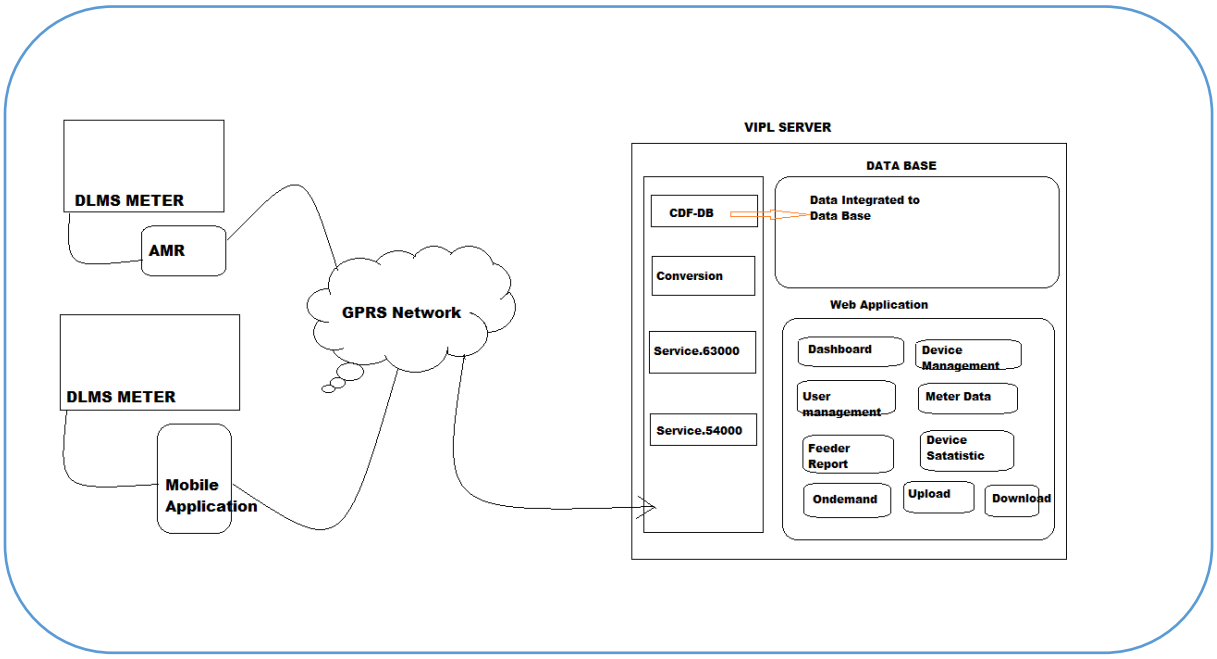
This document provides information on the functions and features of indigenous developed Meter Data Acquisition System (MDAS).

COMPONENTS OF MDAS

MDAS consists of three component:

- DATA COLLECTED FROM AMR/DCU/MOBILE APPLICATION
- HEAD END SYSTEM
- WEB PORTAL

ARCHITECTURE & FUNCTIONALITIES



Data collected from AMR/DCU/Mobile application

Remote devices such as (AMR/DCU/Mobile Application) reads the data using appropriate communication protocol (DLMS/COSEM), which is in encrypted form. Data is transferred over GPRS to the HES server at the Data Centre. The conversion API in the HES system converts the encrypted data or Raw data to readable form.

Head End System

The Objective of the HES is to acquire meter data from meters automatically avoiding any human intervention. It convert the encrypted raw data to MIOS I.e .XML format. HES internally run services on different port with unique functionality.

- **Service.54000:** It is designed to receive diagnostic information from the Automated Meter Reading (AMR) system, specifically related to the modem's status. This service allows for monitoring modem health, connectivity, and operational state, helping to identify any potential issues or alerts related to the modem's performance or connection stability.
- Service.63000:It is designed receive encrypted raw meter data send by AMR in .txt format.
- Meter Data Conversion API: Convert raw data to readable MIOS format.
- CDF-DB API: It process the MIOS file and save the data in to data base.

MDAS Web Application

Meter data acquisition software is a web based application that predominantly slicing, GUI and reporting. Following are various module of MDAS:

- Dashboard
- Device Management
- User Management
- Meter Data
- Feeder Reports
- Device Statistics
- On Demand
- Downloads
- Uploads

DASHBOARD

Dashboards provides various reports in both textual and graphical report related to real time monitoring.

Device Summary
Graphical reports depicts live monitoring of the following:

- **Live communication** :This report provides a snapshot of all devices that are currently communicating with the HES . The purpose of this report is to ensure real-time monitoring of active devices, indicating meters are online and communicating successfully.
- **Last Seven days communication :** The status of modem communication across all nodes is available for a week, in graphical format.
- **Signal strength** :Standard signal strength is consider as good if it is measured above 20.If the signal strength is poor the chance of acquiring data is a challenge.
- **Load Curve:** Energy consumed(Load) on a real time basis with scheduled interval is represented graphically.
- **Power failure:** Day wise power failure count across sll circle for a period of month is represent graphically**.**
- **Over Loaded Feeder Low Power Factor Feeder:** Display of over load feeder and low power factor feeder

Live Status
Number of communicating feeder/meter information, is provided graphically on real time basis.

In case of Industrial Feeder, reports are generated to provide live status and its corresponding load details including SAIDI/SAIFI value.

DEVICE MANAGEMENT

Following features are the feature of device management:

- Hierarchy Management :
- Network Hierarchy :Hierarchy based on network topology.
- Bulk Upload: Bulk upload of hierarchy data.
- Modem Master/Meter Master :creation of master data relating to field/site information.

USER MANAGEMENT

Authorization of various type of user based on role and responsibility.

User role master

The User Role Master is a critical module for setting up roles, which define the permissions and access rights to various modules in the application.

Role Creation**:** Admin create various user. Each user can access various module based on role.

Module and Sub-Module Access Configuration

- For each role, administrators assign specific **modules** (e.g., Dashboard, User Management) and **sub-modules** (e.g., Create User, Delete User).
- This granular control allows roles to access only the functionalities they are authorized to use.
- Example: An "Admin" role may have access to all modules, while a "User" role may only have access to limited sections.

Authorization:

- The role-based access control ensures that when a user logs in, they only see and interact with the modules and sub-modules that their role permits.
- This helps in securing the application by preventing unauthorized access to sensitive areas.

The **User Master** is responsible for managing individual user accounts. It allows administrators to create and manage users by setting up their credentials and assigning them roles defined in the **User Role Master** module.

User Creation

- Admins can create a new user by inputting essential information such as name, email, and other details.
- A secure password is either created by the admin or generated by the system.

Role Assignment

- During user creation or later, the admin assigns a role to the user (e.g., Admin, Manager, User).
- This role determines what the user can access once they log in.
- The roles assigned here are managed through the User Role Master module, ensuring consistency in access rights.

User Management:

- Admins can update user details such as email, contact information, and passwords.
- User statuses (Active/Inactive) can be managed here, ensuring only authorized users are active.

Password Management

- Users are assigned a password upon creation, which they can change later.
- Admins can reset passwords for users if needed.

METER DATA

Meter data consists of energy data, consumer data and tamper data (alerts, alarms, errors).

- Energy meter measures the consumption of energy by various consumers like Low Tension (LT), High Tension (HT), Distributed Transformer (DTR), etc.
- Meter data is acquired from the meter through GPRS or RF technologies. The data can be acquired using a AMR (Automatic Meter Reader) / DCU (Data Concentration Unit)/Mobile Application.
- Data is made available at the data centre for validation and processing by MDAS (Meter Data Acquisition System). MDAS data forms the basic input for the MDMS system.
- Energy data has various parameters which includes Instantaneous data, Billing data, Load profiling, etc

Meter Information / Name Plate Details

These parameters are electrical and non-electrical quantities and are static in nature, grouped as 'Name Plate Details', containing pertinent information about the supplied meter. The parameters identified and grouped as 'Name Plate Details' under this classification are applicable for all categories of meters. Name Plate Details contains the information about the following parameters.

- Meter serial number: This is the metering device ID which uniquely identifies the metering device and can be alphanumeric. Few manufacturers are using "-" in the meter serial numbers and other special characters are not allowed in the serial number. Example: CRI00007
- Meter type: Meter type means HT(3ph-3W), HT(3ph-4W), LT(3ph-3W), LT(3ph4W), WC(3ph-4W), WC(1ph-2W).
- CT Ratio: CT Primary to Programmed CT secondary in meter. Example: 1
- PT Ratio: PT Primary to Programmed PT secondary in meter. Example: 1
- Real Time Clock (RTC): Holds the value of date time stamp as per meter at the time of reading. The format of date time is dd-MM-yyyy HH:mm:ss. Example: 29-09-2022 06:12:40
- Meter version number: Meter Program Name including version number. Example: M1XXG02
- Demand integration period: This parameter gives information that at what frequency maximum demand gets recorded in the meter. Examples: 15 minutes / 30 minutes / 1 hour.
- Profile integration period: This parameter gives information that at what frequency load profile data gets recorded in the meter. Examples: 15 minutes / 30 minutes / 1 hour.
- Meter Range/Rating: Holds the value of Meter rating. (5-6, 5-20)

Instantaneous Data/Parameters

The instantaneous parameters shall be continuously updated by the meter hardware/software as per internal sampling and computation time. The energy values in the table shall be cumulative readings from the date of manufacturing or installation of meter as the case may be. These shall be continuously updated and last updated value shall be available for downloading as and when required. In general these parameters will be read at 15 minutes, 30 minutes and 1hour intervals

Instantaneous data contains the information about the following parameters

- Voltage (VR volt) -R phase: R-Phase phase to neutral voltage.
- Voltage (VY volt)-Y phase: Y-Phase phase to neutral voltage.
- Voltage (VB volt)-B phase: B-Phase phase to neutral voltage.

Below are the different voltage levels:

1. LV (Low Voltage)
    a) 440 Volts
    b) 230 Volts
2. HV (High Voltage)
    a) 11 KV
    b) 33 KV
3. EHV (Extra High Voltage)
    a) 66 KV
    b) 132 KV
4. MHV (Modern High Voltage)
    a) 400 KV
5. UHV (Ultra High Voltage)
    a) 765 KV

- Line Currents (IR- amp) -R phase:
- Line Currents (IY- amp) -Y phase:
- Line Currents (IB- amp) -B phase
- Power Factor (PF) -R phase
- Power Factor (PF) -Y phase
- Power Factor (PF) -B phase
- Power Factor (PF) -AVG
- Frequency (Hz)
- Apparent Power (kVA)
- Active Power (kW)
- Reactive Power (kVAR)
- Apparent Energy (kVAh)
- Active Energy (kWh)
- Reactive Energy (kVARh)

Billing Data

These are parameters identified for accounting/billing purposes. These are generated by the meter for each billing cycle and stored in the memory. The set of data for last 12 cycles shall be stored in the memory.

It contains the information about energy parameters, maximum demands (MD) along with Time of the Day (TOD) parameters.

- Billing Timestamp: For every billing history, meter firmware records the timestamp of readings that are stored in the registries.
- System power factor for billing period: power factor for the specific month and generally remains positive and in several case value is equal to 1.This value is derived from energy data
- kWh: Active Energy
- Cumulative energy, kWh for Time Zones: Based on the client requirements, meter manufacturers facilitate 3 to 8 active energy time zones i.e., 24 hours of a day is divided into different time zones.

- kVARh (Lag): Reactive Energy Lag
- kVARh (Lead): Reactive Energy Lead.
- kVAh: Apparent Energy
- Cumulative energy, kVAh for Time Zones: Based on the client requirements, meter manufacturers facilitate 3 to 8 apparent energy time zones i.e., 24 hours of a day is divided into different time zones.
- Maximum Demand, MD, kW: Maximum Demand Active Power. This is the maximum load utilised at the installation point in the specific month.
- Maximum Demand, MD, kW for Time Zones: Based on the client requirements, meter manufacturers facilitate 3 to 8 active maximum demand time zones i.e., 24 hours of a day is divided into different time zones.
- Maximum Demand, MD, KVA: Maximum Demand Apparent Power. This is the maximum load utilised at the installation point in the specific month.
- Maximum Demand, MD, KVA for Time Zones: Based on the client requirements, meter manufacturers facilitate 3 to 8 apparent maximum demand time zones i.e., 24 hours of a day is divided into different time zones.

Load Profile Data

45 days of energy parameter that stored in meter transferred to mads, this is called load profile.Data can be acquired in interval of 15 and 30 min

Load Profile Data contains the information about energy utilization, currents, voltages as per the load profile integration period.

- Real time clock / Timestamp
- Current, IR
- Current, IY
- Current, IB
- Voltage, VRN
- Voltage, VYN
- Voltage, VBN
- Voltage, VRY
- Voltage, VBY
- Block energy, kWh
- Block energy, kvarh (lag)
- Block energy, kvarh (lead)
- Block energy, kVAh

Meter Events / Tampers

Any abnormal or a tamper condition is defined as an event. The meters shall identify and log both occurrence and restoration of such events. The meters shall also capture some of the parameters at the instance of above said log.

These events further are classified into sub groups for easy handling. The sub groups are:

- Voltage related events

- Current related events
- Power failure related events
- Transnational events
- Other events
- Non-rollover events
- Control events.

Parameters that can be capture at the instance of any events other than power failure events.

- Date and time of event
- Event code
- Current IR
- Current lY
- Current IB,
- Voltage, VRN
- Voltage, VYN
- Voltage, VAN
- Voltage, VRY
- Voltage, VYB
- Power factor, R-Phase
- Power factor, Y-Phase
- Power factor, B-Phase
- Cumulative energy, kWh

Snapshot Data / Daily Profile Readings

This is an array of data captured as a profile generic at the end of 24 h. The capture period attribute shall be statically fixed as 24 h.

- kWh(I): Active Energy and it is a cumulative value recorded in the meter registries starting from zero.
- kVArh Lag(I): Reactive Energy and it is a cumulative value recorded in the meter registries starting from zero.
- kVArh Lead(I): Reactive Energy Lead and it is a cumulative value recorded in the meter registries starting from zero.
- kVAh(I): Apparent Energy and it is a cumulative value recorded in the meter registries starting from zero.

The above said data is made available as an input data to the MDMS system. Data can be in various formats like MIOS, JSON format, etc.

FEEDER REPORT

Feeder report provides various analytical report based on client requirement .These reports helps utility to monitoring and decision making for future requirement.

Reports are as follows:

Communication Summary

- Purpose: This report provides insights into the total number of meters communicating successfully, categorized by geographical areas such as circles.
- Utility: Helps in identifying areas where meters are not transmitting data, allowing the utility to pinpoint communication failures and address them for reliable data collection.

Energy Input Report (Daily, Monthly, Consumption)

- Purpose: Shows the initial and final kWh values for each meter within a specified period (daily or monthly), along with the total energy consumed.
- Utility: Essential for energy accounting, tracking consumption trends, and comparing energy input versus consumption. This assists utilities in loss detection and energy balancing.

Load Report (Hourly, Division-Wise)

- Purpose: Provides division-wise hourly load data, representing the power demand over time.
- Utility: Allows utilities to monitor the load distribution and consumption patterns, helping to manage grid stability and plan for load forecasting and capacity enhancements.

Supply Hours Report (Average, Daily)

- Purpose: This report tracks the average and daily supply hours across different feeders or regions.
- Utility: Enables monitoring of electricity supply reliability and quality, ensuring customers receive power as expected. This is critical for analyzing under-served areas and planning improvements.

Energy Saving Report (During Single Phase Supply, Daily/Monthly)

- Purpose: Shows energy savings achieved when a feeder operates in single-phase mode rather than three-phase mode.
- Utility: Highlights areas where energy-saving initiatives are in place, enabling the utility to assess the effectiveness of power-saving strategies.

Feeders with Single-Phase Supply (Daily/Monthly)

- Purpose: Lists feeders operating under single-phase conditions during the given period (daily/monthly).
- Utility: Identifies regions affected by reduced supply quality, allowing the utility to target these feeders for maintenance or upgrades.

Power Failure Report (Total Power Failure Duration)

- Purpose: Tracks the total duration of power failures for each feeder or region over a specified period.
- Utility: Assists in evaluating feeder performance and identifying areas where infrastructure improvements or investments in reliability are necessary.

Supply Deviation Report

- Purpose: Tracks deviations from the expected power supply in terms of voltage, frequency, and duration. It measures how far the actual supply deviates from the planned or required levels.
- Utility: Helps utilities to ensure customers are receiving power within the agreed parameters. This report is important for compliance with regulatory standards and for identifying regions that require voltage correction or grid improvements.

DEVICE STATISTIC

Device statistics serve as an essential tool for monitoring the system performance of modems, which are crucial in enabling data transmission between meters and servers. The reports provided by device statistics help in understanding the current status of the device and troubleshooting any issues that might arise in the communication network. Here's an elaboration on the different reports provided:

Alerts

This section provides real-time alerts that are crucial for monitoring the modem's operational status. These alerts can help quickly identify issues that may affect communication or performance. Examples include:

- Power Failure**:** This alert notifies when the modem loses power, indicating a potential disruption in the data collection process.
- DLMS Frame Check Error: This alert refers to errors in the DLMS (Device Language Message Specification) protocol, which is commonly used for meter data exchange. Errors in the frame check can point to communication issues between the meter and modem.
- GSM Network Change to 4G: This indicates that the modem has switched its network connection, for example, from 2G/3G to 4G. It is useful for understanding changes in network quality and availability. These alerts are vital for diagnosing any communication issues related to the modem.

Diagnosis

The Latest Diagnosis report provides real-time data about the modem's current health and functionality. Some of the key details include:

- SIM Number: Displays the active SIM card number in the modem, useful for identifying and managing the modem in the system.
- IMEI Number: The modem's unique identifier, which helps in tracking and troubleshooting individual devices.
- Signal Strength: Gives information about the current GSM/4G signal strength. This is critical for determining if the modem is able to communicate effectively.
- Temperature: Monitors the internal temperature of the modem. High or low temperatures can affect the modem's performance, so this metric helps in identifying any environmental issues that may impact functionality.

Instant all

This report provides real-time, or instant, values that are essential for understanding the immediate electrical and time-based conditions of the system:

- **R, Y, B Phase Voltage**: Displays the voltage for each phase of a three-phase system. It helps in assessing the power quality and diagnosing any imbalances in the system.
- **RTC Check**: The Real-Time Clock (RTC) check ensures that the modem's internal clock is synchronized correctly. Accurate timekeeping is crucial for timestamp meter data and events.

MODEM DIAGNOSIS

The Modem Diagnosis report gives a deeper level of data on the modem's performance and configuration. Some of the information provided includes:

- **GSM Signal Strength**: Provides details about the strength and stability of the modem's network connection, which directly affects data transmission reliability.
- **Firmware Version**: Displays the current firmware version installed on the modem. This is important for tracking updates and ensuring compatibility with other system components.
- **IP Address**: Shows the modem's current IP address, which is necessary for remote communication and identification on the network.

Overall, these device statistics allow system administrators and technicians to monitor the modem's performance in real-time, identify potential issues early on, and ensure the system's reliability.

ON-DEMAND

On demand provide feature for downstream communication. We can initiate request from server to mater for getting complete data(CD) or instantaneous parameter (IP).

DOWNLOADS

Downloads provides following reports:

Device Summary

This report likely provides a summary of all devices within the system. It might include:

- Device ID or serial number
- Installation details (location, date, etc.)
- Device type (meter, modem, etc.)
- Communication status
- Firmware or software version

Non-Communicating Device Summary

This report focuses on devices that are currently not communicating with the system. It includes:

- Device ID or serial number
- Last communication date
- Location of the device
- Possible reasons for non-communication (e.g., network issues, power failure)
- Number of days since the last successful communication

MASTER DATA

Master data refers to the essential, static information needed for managing devices and operations. This report includes:

- Device serial numbers
- Device models and manufactures
- Location details

MIOS

This seems to represent more specific or detailed data related to metering infrastructure, and could involve:

- **MIOS**: Meter Inter-Operability Solution

UPLOADS

We can upload raw data file from this module which may collected from other sources like MRI . The raw data file will be placed at HES source path for processing.

MDAS has various other features that are as follows:

- MDAS to MDMS integration
- SMS alert
- Programme Over The Air(POTA)

MDAS to MDMS integration

The received raw data from meter in .txt format converted into .xml by conversion API. At the time of conversion we capture the data and create the .json file. The .json data is latter filter and valid data is integrated to MDMS by integration web services.

SMS Alert

Various critical alerts are send to designated officer by SMS.

Program over the air (POTA)

Firm ware of AMR device can be updated using POTA.

TECHNICAL SPECIFICATIONS

(Prerequisite)

• **Database Technology:** Uses SQL-based relational databases (like MySQL or PostgreSQL) for effective data management.

• **Server Architecture:** Can be deployed on cloud or on-premises servers with load balancing for reliability.

• **Programming Languages:** Built using Java, Python, or .NET for backend; HTML, CSS, and JavaScript for the frontend.

• **Operating System Compatibility:** Works with various operating systems (Windows, Linux) for flexible deployment.

Application/ Web Server

- **Processor:** 16 vCPU
- **RAM:** 256 GB
- **Storage:** 1 TB (for backup of data from HES solutions)
- **Operating System:** Windows Server 2019 Standard Edition

Database Server

- **Processor:** 16 vCPU
- **RAM:** 64 GB
- **Storage:** 500 GB (initial storage, increasing by 500 GB annually)
- **Operating System:** CentOS Linux