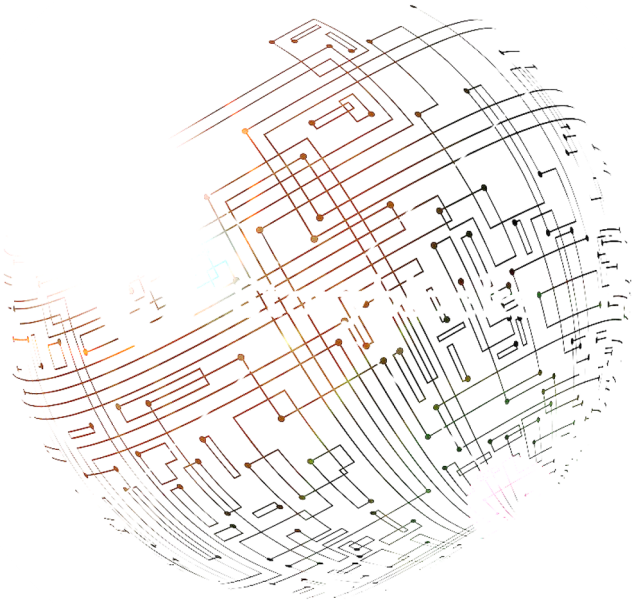

Verticross India Pvt. Ltd.

Automated Metering Infrastructure (AMI)

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INTRODUCTION

AMI (Advanced Metering Infrastructure), is a fixed-network integrated technology that allows utilities and customers (consumers) to communicate bi-directionally. The technology measures, acquires, stores, analyses, and displays data on energy usage on real-time basis, resulting in enhancing operational efficiency.

Use of smarter technology helps to transform and shape the philosophy of creating a smart utility. With rapid growth in communication technology, the possibility of integrating various components related to automation has become less challenging.

Quality of Power, Outage, Pilferage, tampers, alerts & alarms, Energy audit, Peak load management and Demand forecasting forms the Key Performance Indicators for the Utility. The use of technology is to minimise transmission and distribution losses.

Billing for actual usage with focus on consumer awareness is an essential feature of AMI. The entire system as mentioned in the architecture delivers the expected outcome without compromising on technology with more emphasis on cost saving measures.

Forecasting and predictive analysis helps provide timely maintenance of various equipment's resulting in continuous quality power being provided to consumers. Machine learning helps strengthen the Grid operations and addresses various dependencies.

Advanced Metering Infrastructure (AMI), is an integrated and combination solution to acquire data from energy meters and other assets and generate various analytical reports.

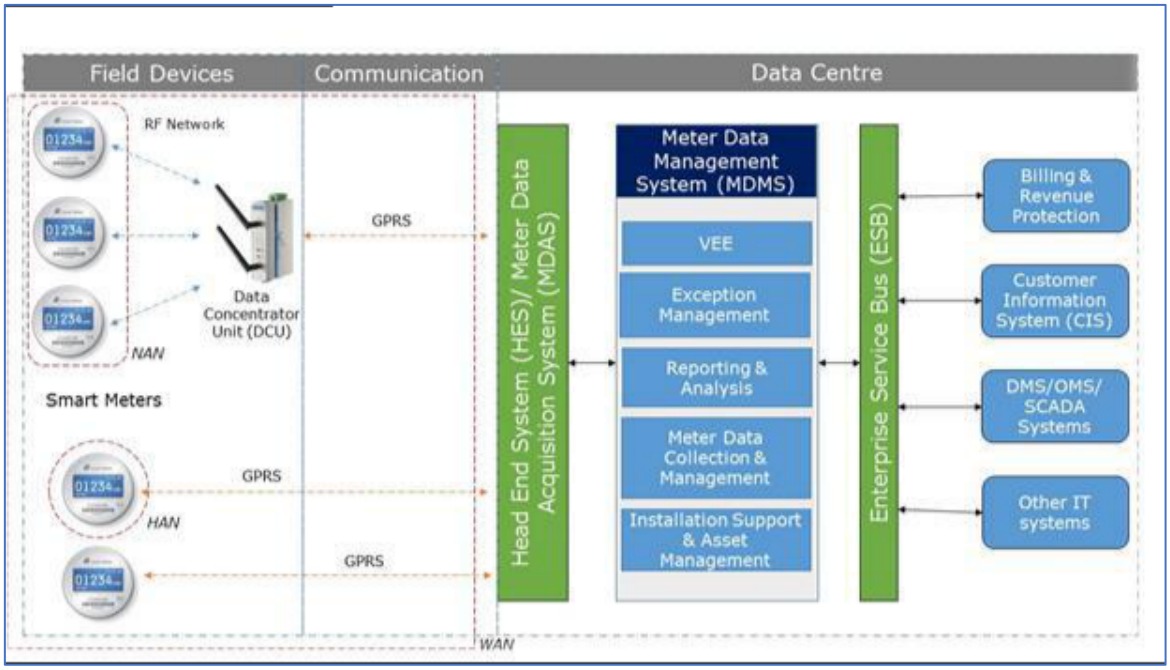
Various components of AMI are

1) AMR (Automated Meter Reader)
2) DCU (Data Concentrator Unit)
3) Mobile APP
4) FRTU (Feeder Remote Terminal Unit)
5) Smart Meters
6) HES (Head End System)
7) MDAS (Meter Data Acquisition System)
8) MDMS (Meter Data Management System)

Various Communication technology are used such as

1) RF
2) GPRS

AMI System Architecture



This document describes about various components of AMI solution. There are various dependencies which involve ISP and CSP apart from AMR, DCU and FRTU hardware manufacturers and software solutions like HES, MDAS and MDMS. It is advisable to take-up site survey before we start the deployment of such large projects.

Acquiring validated data by various means is a challenge and integrating all of these to a centralised system makes this solution interesting. The need for such a solution is necessary and this is going to be the future of power reform in most countries.

SCOPE

Following are the scope of the AMI solution deployment:

- Supply, Installation, Commissioning of Smart Meters with GPRS/RF Mesh compatible NIC (Network Interface Card).
- Supply / Planning /Setup / tuning of RF Mesh Communication Infrastructure including DCU, Network Management System (NMS) & Head End System (HES), etc., for the project area.
- Assessment of backhaul connectivity (SIM/ MPLS/ Fibre) for data transfer from DCU/ Gateway / Router / Access Point to HES.
- Supply, installation and commissioning of AMR Modems for HT Services & Ring Fencing locations and DCUs for Sub Station for Energy Audit.
- Supply , installation and commissioning of FRTU for feeder data monitoring at substation.
- The scope involves provision of Comprehensive Software Solution and Integration for Meter Data Management System (MDMS), Energy Auditing (EA) and report generation.
- Planning, deployment & tuning of communication system including Cellular network (if required) to meet the performance requirements.
- Business Intelligence, Analytics and Reporting.
- Training and knowledge transfer.
- Operation and Maintenance of system for 7 years after completion of implementation period.
- Mobile application for installation of smart meters
- Mobile application for consumers.

SMART METERS

Smart Meters are advanced electronic energy measurement devices having the capacity to collect information about energy usage at various intervals and transmitting the data through a communication network to utility and receiving instructions from utility as well. In addition to conventional electronic metering functionality, smart meters through its built-in communication module can undertake load switch activities for disconnecting/ connecting the load. Smart meters transmit readings and other relevant data to central server at periodic interval. Smart metering system aims to deliver multiple benefits by:

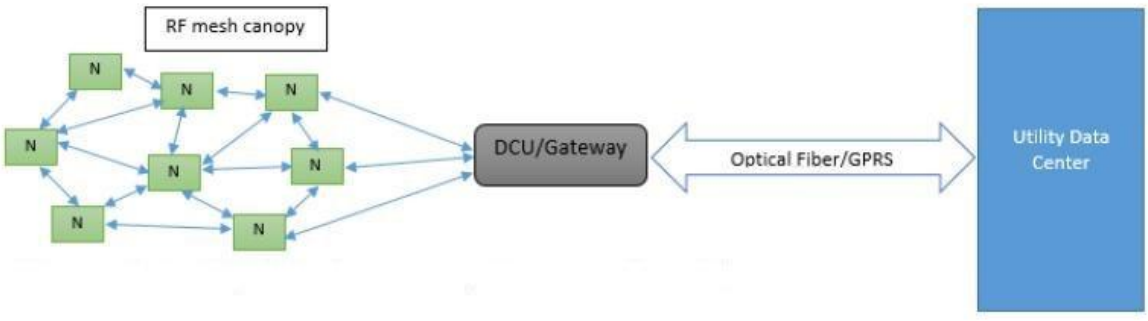
- Providing a platform for improved customer service, e.g. timely and accurate readings support billing without need for estimation.
- Detailed and in time information of energy usage for identifying opportunities for energy savings.
- Building a platform for future smart grids.
- Allow remote connection / disconnection of supply
  Measurement of electricity exported

The basic smart metering system is based on two-way communication (data transferred to and from the meter). The two-way communication provide data to the utilities.However, additional functionalities like power quality monitoring, outage management, load limiting, and remote cut-off requires availability of ancillary devices. Smart Metering is an integrated technology that pays for itself through reduced AT & C losses, improved energy savings, and operational efficiencies.

Smart meter communication infrastructure

The communication infrastructure is primarily based on RF mesh network for thickly populated areas and cellular network for scattered areas. The communication network is based on suitable standards from ITU/IEC/IEEE/CEN/ CENELEC/ETSI for NAN and WAN network. Communication network shall provide reliable medium for two-way communication between various nodes i.e. Smart meter & HES. RF based network would use license free frequency band available in India. The engagement of network service provider (GPRS) is necessary to meet the desired SLA.

Smart Meter with RF Communication

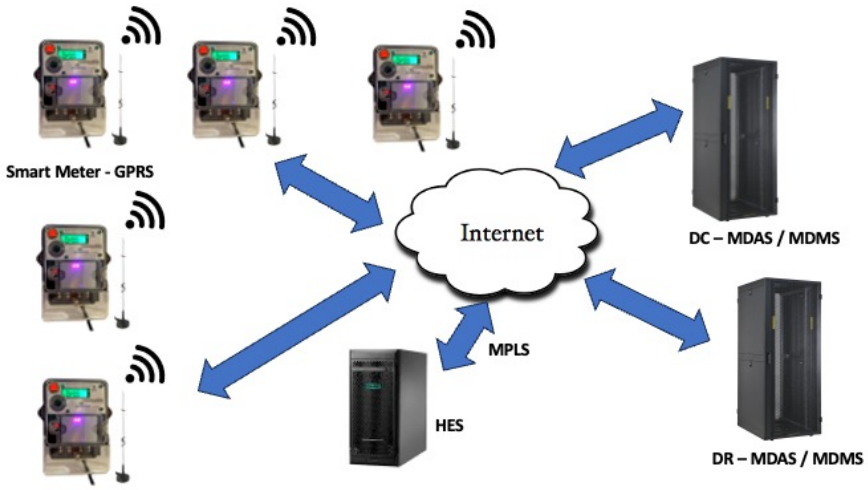


Cc

RF mesh communication canopy is proposed in order to create coverage to connect current and future devices. In this type of communication network, different nodes (smart meters) shall interconnect with each other using RF mesh network and they shall communicate with nearby routers to transfer the data to gateway/router/access points/DCU. In such communication network, if any routers/repeaters/access points/gateway/DCU fail, then nodes connected on that device shall automatically reconfigure the mesh with available nearby nodes.

GPRS / Cellular communication technology is also used to acquire data from smart meters and the same is then transmitted to the HES system.

Smart Meter with GPRS Communication



HEAD END SYSTEM (HES)

The main objective of HES is to acquire meter data automatically avoiding any human intervention and monitor parameters acquired from meters. HES ensures data integrity checks, for example, checksum, time check, pulse, overflow, etc. on all metered data. HES is developed on an open platform based on distributed architecture for scalability without degradation of the performance using additional hardware. HES supports storage of raw meter data, alarms and alerts.

The main functions of HES are :

- Acquisition of meter data on demand & at user selectable periodicity
- Acquire data from smart meter, AMR, Mobile APP and FRTU . Convert data from raw file to readable form
- Two-way communication between meter/ DCU.
- Signals for connect & disconnect of switches present in end points like meter.
- Audit trail and Event & Alarm Logging
- Encryption of data for secure communication

- Maintain time sync with DCU / meter
- Store raw data for defined duration
- Handling of Control signals / event messages on priority.
- Setting of Smart meter configurable parameters.
- Communication device status and history.
- Network information in case more than one technology is deployed in field between the two devices.
- The suggestive critical events are alarms and event log for meter events like tamper /power failures etc., if data is not received from DCU/ Meter, if relay does not operate for connect / disconnect or there is communication link failure with DCU/Meter or network failure while non-critical events may be retry attempts on communication failure, periodic reading missing and failure to connect, etc

HES supports integration through web-services / APIs to exchange data with other systems like third party MDMs, Billing, GIS, OMS, Streetlight Management System, and SCADA etc., is integrated through MDMS. The solution is Service Oriented Architecture (SOA) enabled. HES will be able to integrate with telecom service providers' M2M platforms for deriving status of Cellular SIM cards of Gateways, DMS nodes, Network Interface Card (NIC). This will interface with MDMS over SOA/Web services, and the data exchange models and interfaces shall comply with CIM/XML / IEC 61968/62056.

NETWORK MANAGEMENT SYSTEM (NMS)

NMS manages, monitors and controls mesh network, nodes and gateways by way of receiving parameters viz. terminal status, device status, next hop information, RF signal strength, Hardware/software version numbers, logs, events etc.

NMS performs ping & trace-route to any node/gateway or group of nodes/gateways of mesh network. NMS have remote configuration and remote firmware upgrade feature where a node / gateway or group of nodes / gateways can be upgraded with its latest firmware. Updated firmware is always be backward compatible to all its previous versions.

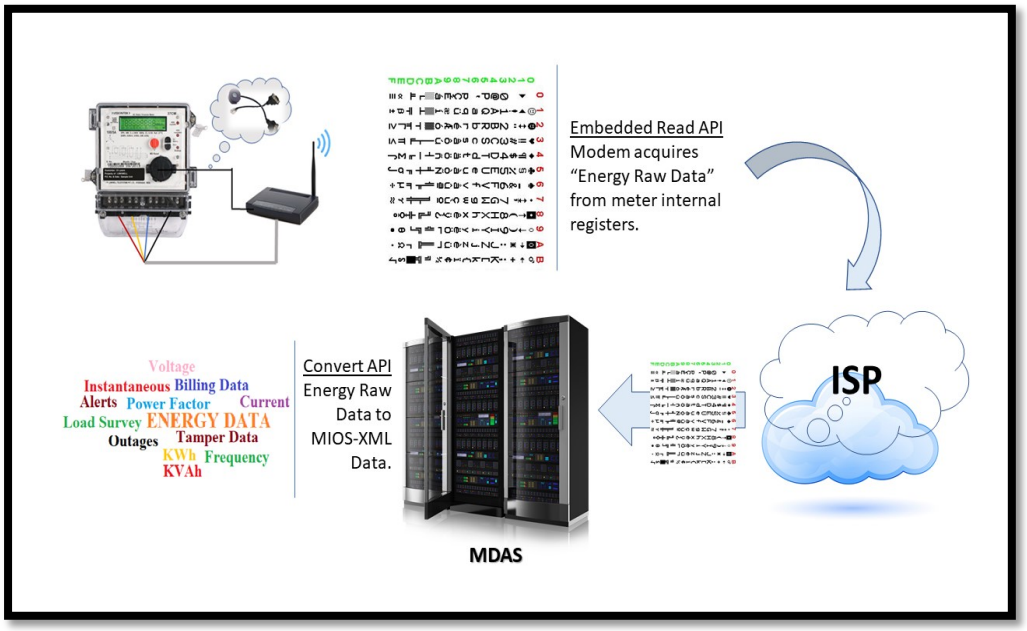
NMS supports self-discovery and self-registration of nodes upon deployment. System allows provisioning of parameters. Mesh topology and location of all terminals is visualized on interactive map along with status indication. Location of gateways, location of nodes and network topology is depicted in layers so that status are visualized during Zoom-in/Zoom-out.

NMS has management of security keys and certificates and set of KPIs regarding network performance. Provides real time and historical information. NMS keeps DNS server up to date so that external systems, at all times, can address a given mesh node.

Automated Meter Reader (AMR)

AMR system is used to obtain data from DTR, HT meters & boundary (Ring fencing) meter. The main objective of the AMR is to acquire meter data from HT meters, Ring fencing meters automatically avoiding any human intervention, monitor important distribution parameters, use meter data to generate exceptions and MIS report for proper planning monitoring, decision support and taking corrective actions on the business activities of the management. The system is capable of handling meters which are of different makes/model complying with DLMS/COSEM/ IS 15959 standards. The system will capture the following data through the software:

- Load survey profiles
- Date and time of collection of data
- Acquire real time instantaneous data like voltage, current, frequency, power factor, active power, reactive power, etc at the specified regular intervals for online monitoring anywhere across utility.
- GPS co-ordinates of meter location
- Alarm list, Event lists, limit value violations, System Interruption Information, etc
- Generate spread sheets and MIS reports as per TANGEDCO requirement.



Periodicity of data collection System is capable of collecting data from all the meters. Generally, the software is configured in such a way that data from meters to be collected automatically with the help of PUSH and PULL scheduler feature.

The AMR with intelligent features is suitable for communication with any make of DLMS compliant electronic energy meter. Modem is capable to communicate to the HES/MDAS. The commands received from HES/MDAS server should be conveyed to meter and data from meter should be conveyed to data acquisition server without any changes in the AMR. The required meter data should be acquired at Data Acquisition

server end at pre-configured times or intervals. The date of receipt of meter data in HES/MDAS will be considered as the date of commissioning of modem/DCU after showing continuous communication/data from Meter for 15 days without interruption.

The modem is compatible with 4G service providers and with fall back option to 4G(LTE)/ 3G (UMTS/HSPA)/2G(EDGE/GPRS) depending upon the network availability. Inbuilt rechargeable battery / Super Capacitor is provided to capture events and communicate with the server in case of power failure during the entire contract period.

The AMR has the following features

- Capable of continuous and reliable 24/7 operation
- Auto restart function with built-in watchdog timers and intelligence
- Automatic connection to network with connection monitoring i.e. auto-reconnect on any disconnections.
- Automatic AT-interfacing and PDP enabling
- capable of communicating the health status, signal strength etc .
- Minimum 32Mb of Flash for storage and application
- Bluetooth interface for Mobile apps for diagnostics

Alerts may be generated for the following:

- Modem power failure and restoration
- Modem to meter communication failure & restoration
- The above Outage detection should be accessed from remote end so as to achieve faster restoration. Events to be notified via alerts to the server-end applications and via SMS to pre-configured nos. There should be continuous polling of tamper events. In the event of an outage, SMS should be sent to predefined numbers to notify the outage event with date and time of occurrence/restoration.

The AMR should be supplied with power cable, antenna with co-axial cable of suitable length, RJ 45, RS 232 connecting cable. The modem firmware should be upgraded from the server remotely using Firmware Over the Air (FOTA). Time synchronization with Server or Network to be enabled.

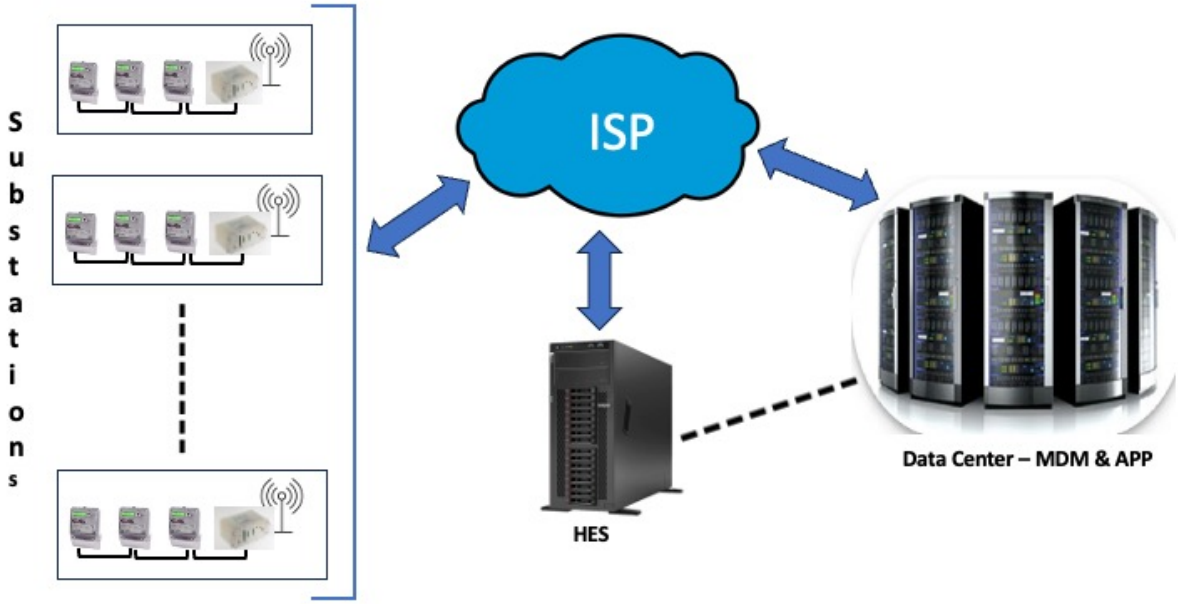
DATA CONCENTRATOR UNIT (DCU)

DCU is used to read data from feeder meters in a substation. Scope of a typical [project involves ; Supply, Installation, Testing and Commissioning of Data Concentrator units (panel comprising of DCU + Terminal Block + wiring from field) at Sub-station

RS 485 to RS 232 data DCU unit which is part of the Data Concentrator Unit (DCU) is installed in the 110/33/11 KV Sub Station. All the Feeder meters installed in the substation have RS 485 ports. The DCU is used to transfer the meter data from RS 485 port of all the Feeder Meters installed in the Substation to Data Centre Via an in-built Modem.

The DCU is fast Asynchronous bi-directional RS485 <=> RS232/RS485 intelligent interface; DCU for 2-wire (Single twisted wire pair), half-duplex operations, with an automatic TX enable circuit, that will operate at data rates up to 115.2Kbps.
The master port is configured for RS-232/RS485 and uses Transmit Data, Receive Data and Ground. The unit has jumpers for bias, termination, RS232 DTE/DCE selection and operating mode settings. Galvanic (Opto/Xformer) isolation between the RS232 and RS485 ports is provided to eliminate noise and protect equipment from destructive transients due to switching operation of Feeders / Transformers.
Power supply unit for the DCU is built inside the enclosure. Every port is surge protected and the unit is equipped with a grounding stud to allow a connection to earth for diversion of the otherwise deadly effects of induced surges.

Normally, there will be 8 to 12 outgoing and 2 to 4 incoming Feeders in a substation. The Data DCU unit supports future expansion of substation / feeders and is scalable and flexible enough to accommodate the expansion. The DCU has a real time processor (min 400 MHZ) for reliable standalone operation, signal processing, control, acquisition and Real Time Deterministic Control with following capabilities



DCU must have the following features…

- 1(one) numbers RS232 serial port to communicate with peripheral devices
- In-built 4G Modem with fall back to 3G and 2G
- 4 nos. of RS 485 port to connect to the meters.
- 1 nos. of Ethernet port 10/100 Mbps for WAN connectivity.
- 2 nos of 16 ports DI card for monitoring status of circuit breaker
- 24 nos CMR relays for capturing breaker on/off status.
- DCU is modular and expandable to add additional capacity of DI/DO/AI (100 %)
- DCU at 110/33/11 kV Sub Stations has the provisions to install a PC for local monitoring.
- Two watchdog timers
- Time synchronization over network

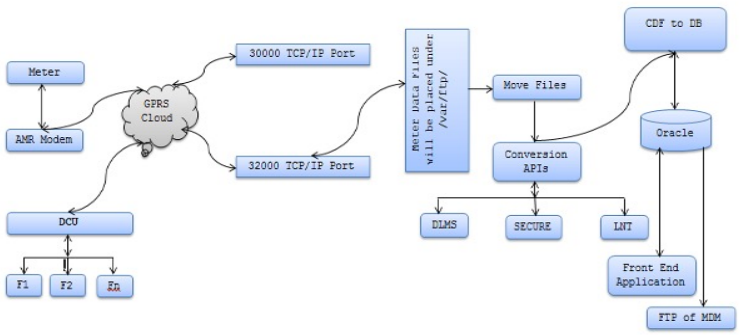
- Network signal quality/strength monitoring over control centre.
- The network will use standard, open, vendor neutral communication protocols.
- DCU must support the MODBUS/DLMS protocol to communicate
- Protocol with MODBUS/DLMS enable peripheral devices and the Ethernet port to
- Support IEC 60870-5-104 protocol/HTTP/TCP-IP.

METER DATA ACQUISITION SOFTWARE (MDAS)

METER DATA ACQUISITION SOFTWARE (MDAS) application is interoperable with any make of AMR modem, DCU, Smart meter , Mobile APP, etc. The Software is capable of integrating APIs of different devices that acquire data . After establishment of connectivity of all devices with the server for successful data transfer, reading process would automatically start as per pre-defined frequency. Data security and reliability during the data acquisition is ensured. The system is capable of defining the type of communication and other required information like device type, baud rate, serial port (if applicable)/ IP address, port number, time-out, number of retry etc. Also, the system is also capable of defining the activities to be performed such as reading the meter, performing authenticated transactions or configuring the field device, the specific meters to be read (selectable by different filter criteria such as area, device type etc).

The METER DATA ACQUISITION SOFTWARE (MDAS) is designed to work in a 'Main' and 'Standby' mode wherein two instances of the software will be running on different systems with the 'Standby' assuming functionality in the event of failure of the 'Main' system. Also, the MDAS software should support Active/Active mode through server load balancer. The data from the METER DATA ACQUISITION SOFTWARE is directly stored in the Oracle database. Using the above database, the user is able to view the meter data including Instantaneous parameters, Load survey, Tamper Data, etc. and generate Customized reports. The metering data is sent in a specific format as required for integration with the MDMS software.

Meter Data Acquisition Architecture



A Dashboard is developed to view the processed data by different levels of users (admin, general user, etc), identify the number of readings fetched through AMR, number of readings fetched through CMRI, date and last data available through AMR, Modem status, modem signal status, PDP status, analytical data etc.

The dashboard has the online reporting of

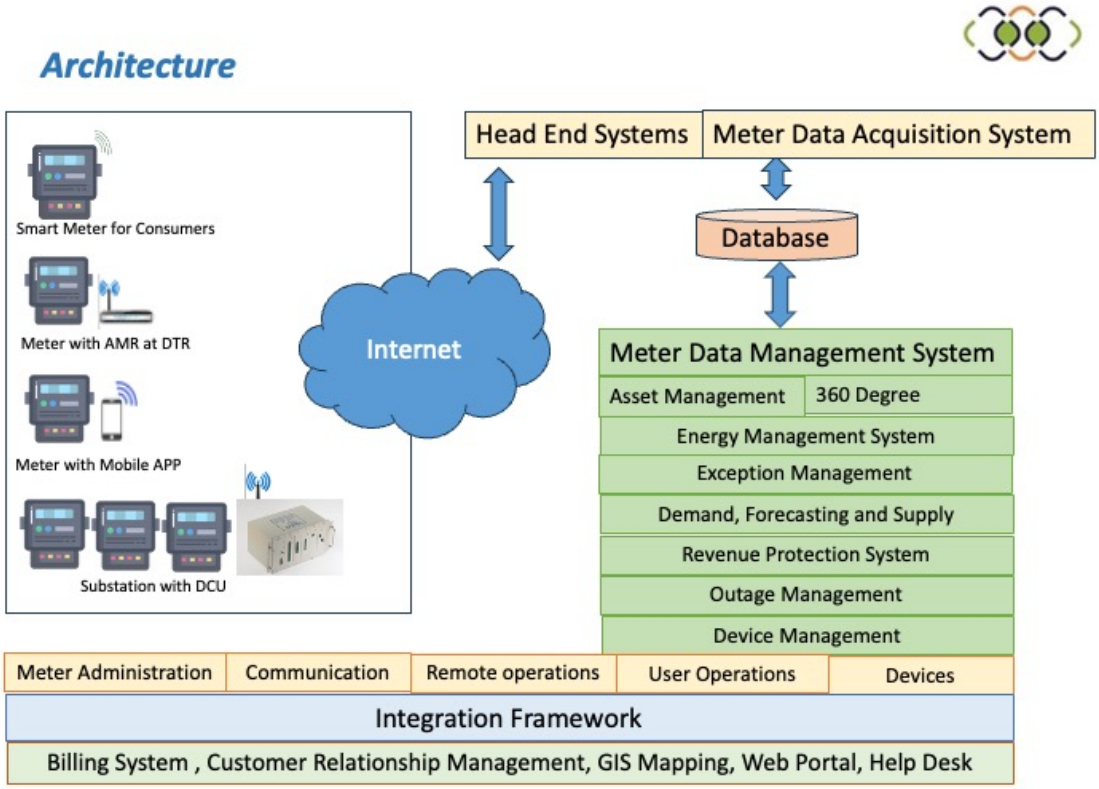
- Count of Online / Offline / Toggling modems (toggling modems are modems that have intermittent connectivity) and count of total number of installed modems
- The above counts should also be presented circle / division wise/section wise.
- Graphical view of the online / offline counts over the last one week / one month
- Alerts / events: like tamper events, connectivity loss, power loss / restore at a location, any other abnormal operational conditions, or events of interest, etc
- Main dashboard to present summary of online / offline meters, events, PF range, Consumption, Hourly demand, Load duration curve, Peak hour, etc.

The MDAS facilitates issuing commands to carry out the following operations:

- Get instantaneous data
- Get load survey data (current day or for a date range with a limit of 90 days)
- Get event / tamper data (current day or for a date range with a limit of 60 days)
- Configuration change:
- Modem configuration changes
- Server-end configuration required for modem Schedule for meter data
- Firmware upgrades
- Get current configuration
- Remote reset of modem
- Modem & Meter name plate information – serial number, firmware version,
- IMEI number, date & time of meter and modem, etc.
- It is possible to issue the above commands to individually selectable meters or a collection of meters (user defined) or all meters within a circle/division/sub-division, section, etc.
- Monitor the status of the command and report on the count of meters wherein the command has succeeded and number of meters wherein command has failed. A command is automatically re-attempt to connect to modems up to a maximum of number of times in predefined intervals.
- There should be automatic detection of missing data and issue commands to attempt to retrieve the same.
- The daily / weekly / monthly reporting of Online/offline/ toggling counts of modems and their lists should be e-mailed to pre-configured e-mail ids.
- Provision to enter planned outage information

METER DATA MANAGEMENT SYSTEM (MDMS)

The MDMS stack involves provision of Comprehensive Software Solution and Integration for Meter Data Management System (MDMS), Energy Auditing (EA) and report generation. The MDMS shall integrate with the HES of AMI system and MDAS provided for Energy Audit with various devices like AMR, smarty meter, etc for various consumer services & Ring fencing points and DCUs for substations.



The Meter Data Management System supports storage, archiving, retrieval & analysis of meter data and various other MIS along with validation & verification algorithms. It acts as a central data repository. MDM is capable to import raw or validated data in defined formats and export the processed and validated data to various other systems sources and services in the agreed format. It can provide validated data for upstream systems such as billing, consumer Information system, customer care, analytics, reporting, Network planning & analysis, load analysis/forecasting, Outage management, etc.

Asset Management

Maintains information and relationships between the current installed meter location (apartment, shop, industry/ address etc.), Consumer information (Name etc.), Consumer account no., Meter ID, Type of Meter (type of consumer, 1 phase/3phase, with or without relay, etc.), Meter configuration (Demand integration period, Load profile capture period

etc.), GIS supplied information (longitude, latitude, connection with feeder/ transformer/ pole etc.) etc.

- Support tracking the status of meters and communication equipment from the date when they are installed in the field. The history of in-service asset location is maintained throughout the device life with start and end dates associated with each in-service location reference.
- Ability to report and log any damage / deterioration in the meter attributable to consumer/utility.

AMI Installation Support

The MDM supports device lifecycle management from device registration, installation, provisioning, operations and maintenance to decommissioning etc.

- The MDM generates exceptions for smart meter not delivering the correct meter data after installation.
- The MDM provides a reconciliation report that identifies the meters that have been installed but not communicating for a designated period.
- MDM generates reports on the number of meters installed in comparison to the number of meters successfully communicating.

Meter Data

The MDM accept input, process, store, and analyse Meter data from HES and meter data collected through hand held meter reading instruments and manualmeter reads.

- In case of manual reads, provision should be there to insert associated notes like assessed energy, etc. It accepts input, process, store, and analyse non-billing meter data such as voltage and power quality data (like under/over voltage etc.) as they are available from AMI Head End Systems. The MDM should also support schedule and on-demand meter reads and pinging of meter energized states by authorized users and by other utility systems.
- It provides storage of all collected Meter Data, events and alarm for 5 years or more via archiving. Correctly track & resolve energy usage across meter changes with no loss of individual meter data.
- Provide complete history and audit trail for all data collected from meters including commands sent to meters and other devices for minimum 30 days.
- Execute on-demand read processes.
- Handle special metering configurations like net metering, prepaid metering /multiple meters at same premises.
- It has the ability to manage a minimum 15-minute interval data.
- Data Integrity- AMI Implementing Agency (AIA) ensures data integrity checks on all metered data received from data collection systems.

Data Validation, Estimation, and Editing(VEE)

The validation and estimation of metered data is based on standard estimation methods.

The MDM supports and maintains the following data:

- Registered Read Data including register reads, daily billing cycle, as well as derived billing determinants like TOU.
- Interval Data channels with variable intervals and variable units of measure.
- Calculated data that is derived or computed such as billing determinants and aggregated loads.
- Event data storage of all collected event and alarm data from meters, network equipment, and MDMS itself.
- MDM flags, alarm and trigger an estimating process including but not limited to when the following anomalies occur in the cumulative register reads
- CUM Decrements within a billing cycle (except net-metering) CUM reads increments more than configurable threshold
- MDM shall detect, flag, alarm and trigger an estimating process
- The MDM shall maintain both the original received raw data in a non-manipulated state, in addition to VEE data. Not with-standing the latency of data collection via the AMI system, once the MDM receives meter read data, the VEE process occurs in real-time and the post-VEE data is then immediately available to user or external systems.
- The MDM is able to automatically flag data changes from manual edits, VEE (Validating, Editing and Estimating) rules and data source corrections and electronically generate audit trail with timestamps and user-ids.

Billing Determinants Calculations

Allows configuring multiple TOU/TOD options (e.g. the number and duration of TOU rate periods) by customer type, tariffs and day type (weekend, weekdays, and holidays) and by season.

Supports the processing of interval data into billing determinants to include the following at a minimum:

- Total Consumption
- Consumption in different time blocks for ToU billing
- Maximum Demand (in kW and kVA)
- Number of tamper counts
- Average power factor

Processes interval data and frame, it into the appropriate TOU periods for consumption and demand; for example, roll up 15/30-minute data intervals into hourly data.

The system has the ability to properly account for special metering situations such as check metering, sub metering, prepaid metering and net metering when calculating billing determinants and sending them to billing and other systems.

Exception Management

- Ability to capture and log data exceptions, problems and failures and to generate management reports, provide trend analysis, automate generation of service requests and track corrective actions.
- Ability to group, prioritize, filter and send system generated alarms and events to predetermined Email addresses, cellular text messages to phone numbers/ SMS/ Customer Care etc.
- Exception Generation - Generates exceptions based on configurable business rules

Service Orders

- Generates service orders based on configurable rules for various events and alarms such as stop meter, tampers, problem in communication networks, AMI host server, etc.
- Sends service orders via SMS, Email, etc. with the email addresses / phone numbers being configurable. MDM shall receive feedback on action taken on the service order and track the status of service orders.

Customer Service Support

- Provides customers with access to current and historical consumption and interval data, outage flags, voltage and power quality indications in graphical and tabular form depending on user choice. The Customer may also access data through customer portal. The solution shall integrate via a user friendly graphical interface.
- MDM supports Email/ SMS notification of configured alarms & events to configured users.
- The MDM is a web portal and have the ability to interface with the MDMS Customer portal developed by MDMS vendor to provide the consumer near real time online views of both usage and cost and helping consumers to understand electricity usage and cost information, alerts and notifications and energy savings tips with different levels of detail.
- The portal also enables the user to view the past electricity usage, last year,last week's, yesterday's, current days or other period etc. as per selection. The portal should provide user friendly access to consumer for their data via colourful graphs and charts.
- Supports mobile app through which consumer is able to log in through android and iOS based mobile app to see information related to his energy consumption.

Business Intelligence Analytics and Reporting

The MDM has the capability of configuring business rules including but not limited to the following:

- Display consumption/load profiles by configurable period (15/30 min, hour, day,month, year etc.) day type (weekday, weekend, holiday, festival wise etc.) and by tariff, customer type, or any userspecified collection of meters.
- Generate peak & off-peak load patterns by aggregating all loads of DT/Feeder/consumer group.
- Provide the data to load forecasting, load research or demand response applicationsand perform error management like: Missed reads and intermittent meter reads before taking into forecasting, load research or demand response

Ability to configure the system to effectively visualize consumption trends, identify unusual patterns, and visualize load analysis to understand which assets are being over utilized.

Analysing data to identify new patterns of usage, transformer overload alerts /demand–supply gap alert etc. Ability to receive and store outage and restoration event data from smart meters and outage systems and to log all such events for analysis.

Key features of MDM:

- 1.Daily data collection report
- 2.Usage exceptions
- 3.VEE validation failures
- 4.Missing interval Read date and times (on hourly, daily, weekly & monthly basis)
- 5.Physical meter events (install, remove, connect, disconnect) & meter reset report
- 6.Meter flags
- 7.Meter inventory
- 8.Defective meters
- 9.AMI performance measurements
- 10.Threshold Exception

All MDM reports are in standard digital format such as PDF, Excel etc. Ability for GUI (Graphical User Interface) to set up or change report delivery to configurable email addresses, network file directories, ftp sites or printer systems without modifying source program code and without any proprietary language skills.

Provides daily & weekly interface exception reports between MDM and other subsystems e.g. billing, outage etc. In case more than one technology of AMI (example GPRS and RF between Smart Meter & DCU) deployed in the field, the MDM shall generate report on the performance and availability of data being delivered per AMI technology. Monitoring of Sanctioned Load versus Maximum Demand for consumers. Reporting of Nodes with regular communication failures or where communication success rate is below a user defined value. Dashboard for daily / monthly monitoring by Management. Supply variation for consumers with respect to other consumers.

Revenue Protection Support

- Analyse meter tampering flags, power outages, usage trends and usage profiles to identify potential energy diversion situations, and produce daily reports, monthly reports and service order requests for investigation.
- The business rules for revenue protection alerts are configurable via user-friendly interface.
- Can filter out revenue protection alerts that may be caused by field activities if the field activity information is provided to the MDM.
- Support the analytics/investigation (i.e. view current and historical usage patterns) to valid suspected revenue protection issues.

Net Metering

MDM flags, alarm and trigger an estimating process including but not limited to when the following anomalies occur:

- CUM decrements of forward energy within a billing cycle
- Register decrements for Time of Use (ToU) of forward energy
- Power generated (exported) by any net-metering consumer more than the installed capacity of solar PV rooftop system
- Energy exported(exported) in any given day by any net-metering consumer more than the programmable threshold value.

Prepaid metering

The prepaid functionality can be availed at smart meter level and through MDM. In MDM, following are the features:

- The MDM supports pre-payment metering and capability to interface with pre-payment application.
- Payment and connection parameters are stored centrally and the details are being updated to consumer portal and Mobile App.
- The system periodically monitors the energy consumption of prepaid consumer and decrease the available credit based on consumption.
- The system sends connect/disconnect command on the basis of available credit as per notified rules & regulations.
- System sends low-credit notifications to the consumer when their balance approaches a threshold.

Utility

User interface for utility shall have ability for at least the following functionality:

- Compare total energy costs on one rate schedule Vs one or many alternative rates.
- Enable the user to see how different options within a rate affect costs.
- Enable the user to see how adjusting load or consumption levels or shifting them to different time periods influences costs.

- Display meter data at a user defined configurable cycle through a GUI that allows authorized users to view energy usage patterns and the data behind them for selected customers.
- Allow authorized users to view metered data, initiate and view reports, modify configurations, and initiate and update service requests via a GUI.
- Display via a GUI the energy usage profile for a single meter or group of meters. The load profile shall illustrate energy consumption and peak demand in user defined intervals for a user-specified time period.
- Display via a GUI the energy usage profile for a single meter or group of meters according to Time of Use (ToU) Tariff.
- Access to a minimum of 5 years of historical energy usage and meter reads through the GUI.
- GUI to clearly and visually distinguish between metered, estimated, allocated and substituted data.
- GUI to provide role-based access based on user identity and user role.
- Ability for utility through user interface to set up alarm and event notifications that can be directed to a combination of configurable email addresses, cellular text messages or phone numbers.
- User interface for utility to update the credit number of prepaid consumers to MDM. Such type of user interface before login shall require password & login ID. for authentication. User interface after getting information like consumer ID, mobile number & recharge amount etc. shall update the same to MDM. The details of payment information shall also update to consumer through SMS, email etc.

Consumer

User interface for all authorized consumers shall have ability for at least the following functionality:

- View metered data, initiate and view reports
- View data according to Time of Use(ToU) tariff
- Can make request for connection/disconnection
- User can update mobile number/email after due validation.
- Can initiate service requests for maximum demand updating, meter checking etc.
- In case on net-metering consumers, user can view data for both import & export
- In case of prepaid consumers, consumers can view recharge history & present balance.
- Prepaid consumers is provided with the facility to recharge their account by logging on userinterface. User interface uses consumer id., mobile number & password for secure login. This user interface is integrated with the present online payment gateway of utility.

Integration with other systems

MDM shall preferably interface with other systems on standard interfaces and the data exchange models and interfaces shall comply with CIM / XML / IEC 61968/IS15959/ Indian Companion Specification/ any other open standard. MDM solution is Service Oriented Architecture (SOA) enabled.

MDM integration with other systems shall include but not limited to the following:

- HES for data exchange from other AMI solutions
- Proposed HES for data from boundary meters, feeder meters and HT consumers in ABD area.
- Utility Administration
- Existing other Data Collection Systems
- IVR system, CRM, Consumer Portal system Billing and collection system
- Revenue Management System
- GIS Systems integration with CIS and with MDM system support of interface with HHU or manual reading system etc.

Energy Audit (EA)

Energy auditing with various calculations for town wise/feeder wise/DT wise, Monitor important distribution parameters, capture hierarchical view of energy accounting, Network assets of power distribution utilities, intelligent analysis tools for plugging loop holes and identifying revenue leakage, adding into perform network planning and management activities, calculate / identify technical and commercial losses at any point in the network with appropriate report as per the stipulated formats.