Reform within the power sector in India have been going on for more than a decade. Initially the focus was on bringing about structural changes like unbundling of the state electricity boards (SEBs) and the creation of independent generation, transmission and distribution companies. Subsequently, power generation became the focus. However, in the recent past, it has been felt that power distribution is the weakest link in the entire value chain, and that sustainable development and economic viability of the power sector is not possible unless electricity distribution issues are resolved.

With these objectives in mind, India's national Ministry of Power launched the Restructured Accelerated Power Development and Reform Programme (R-APDRP) scheme in the year 2009-10. The programme covers towns with a population of more than 30,000 (10,000 in case of special category states). For its implementation, more than Rs500 billion (US$9.2 billion) has been allocated to this project. Separate funds have been allocated for R-APDRP Part A and Part B.

Part A of the scheme essentially covers the application of information technology in distribution utilities across the country. The scheme involves implementation of:
- GIS-based consumer indexing and asset mapping
- Meter data acquisition system (MDAS) for distribution transformers and feeders
- SCADA in big towns and cities
- Energy accounting and auditing
- Establishment of baseline data
- IT applications to run business processes that address consumer grievances and integrate meter reading, billing and collection.

This entire exercise is aimed at establishing baseline data and a data collection system for the distribution utilities to capture aggregated technical and commercial losses (AT&C) in a precise manner without manual intervention and also to plan and implement corrective measures in Part B.

Part B of the scheme covers the strengthening, improvement and augmentation of the distribution system. This involves:
- Identification of high loss areas
- Preparation of investment plans for the areas identified above
- Implementation of plan
- Monitoring of losses.

Further, distribution utilities have to work with their respective regulatory commissions to ensure that a part of the financial benefits arising from AT&C loss reduction are passed on to the consumers within the project area.

The main focus of the R-APDRP is:
- Adopting a systematic approach for information management
- Reducing AT&C loss to 15%
- Making the distribution segment commercially viable

Decreasing power outages and interruption in supply
Improving quality and reliability of power availability
Improving consumer satisfaction.

MDAS is a key module of the R-APDRP. It comprises automatic meter reading of distribution transformers, feeders at substations and consumers in order to provide meter data for further accounting of AT&C losses in the project areas.

**PRIME OBJECTIVE OF MDAS IN R-APDRP**

The main objective of the MDAS is to acquire meter data from meters within the distribution system and consumer meters for:
- System performance monitoring and decision support
- Network analysis and system planning
- Monitoring and collecting data of consumer energy usage for billing and CRM and for tamper, outage detection and notification
- Monitoring energy flows in the energy supply chain to provide information for energy auditing.

An MDAS commences with the installation and connection of modems to meters in the field, perhaps more than 10 to 15 makes, and potentially across an entire state. The modem has to be configured with the appropriate parameters (baud rate, make of meter, network service provider (NSP) access point name (APN), etc.). It must be installed with the right communication cables for the different makes of meters. Meter data should be successfully polled to a back-end compatible application at central data centre (CDC) of that state over a GPRS network. That data should be sent at regular intervals, i.e. hourly or daily, based on requirements, without fail.

**FEATURES OF MDAS**

- AMR data collection from system meters (distribution transformer, HVDS, feeder, etc.)
- AMR data collection from HV and selective LV consumers’ meters
- Polling of data to the CDC
- Generation of alarms and notifications based on system conditions and validation logic
- Reading of energy usage parameters including instantaneous load, load survey, event logging, etc.
- Use of user defined dashboards
- Reports based on the above mentioned parameters for feeder/distribution transformer MIS.

**MDAS IMPLEMENTATION**

After the rollout of the R-APDRP by each state, deliveries of MDASs were commenced by the system integrators, the Power Finance Company (PFC) and the selected MDAS suppliers.

When the MDAS suppliers started implementation in the field and at the data centre, they faced issues that they had not envisaged. These later became impediments to the successful delivery of R-APDRP projects. These bottlenecks impacted the project delivery schedule,
commercial viability and desired success from remote meter reading. Experience of R-APDRP projects and other AMR projects shows that 80-90% of meters can be read successfully using GPRS.

There are many challenges which need to be addressed before and during implementation of the MDAS solution to deliver a successful R-APDRP project. These challenges can be categorized under field, network, application and interface.

**MDAS CHALLENGES**

**Challenges in the field**

- When the teams visited the sites they found that modem installation was not possible at many locations as many of the distribution transformer/substations were unmetered and meter installation was progressing at a very slow pace. The field teams had to visit the sites more than once to check whether the meters had been installed or not. This impacted the timelines and increased project cost.

- Successful modem installation depended on timely execution of the GIS field survey. The field GIS teams were to furnish the details of actual locations of distribution transformers with their serial numbers to initiate modem installation. At many places modems were installed prior to GIS field survey, which resulted in incorrect mapping of base data. The GIS survey also took too much time to complete for a project area the size of a state, which slowed down modem installation.

- When the installation commenced the teams found many different makes of meters in the field. For the meters to be read by the back-end a proper API has to be provided by the meter manufacturer to the utility. As there were many makes of meters, it took time to get all the meter specific APIs.

- Initially, when an MDAS was rolled out, there were around 10-15 makes of meters in most of the utilities, on which modems were to be installed. But in the absence of pin configuration and API availability, it was decided by some of the utilities that modem installation should continue on a few (3-4) makes of meters rather than on all 10-15. The remaining meters, which were either very old or obsolete, would be replaced by newer ones in the course of time.

- Data communication cables linked problems arose:
  - Incorrect communication cables used when connecting modems to different makes of meters
  - The pin configuration for the communication cable was to be provided by the utility but this information was not readily available. The installer had to carry communication cords for all makes of meters due to uncertainty of the meter to be found in the field
  - Even for the same make of meters, different cables are used for communication for different series of meters, which added to the confusion.

- Data communication port of the meters was not working at many locations due to exposure to the environment.

- Wrong alignment of optical port with cable. This, in many cases, resulted in inconsistent meter readings.

- Meters were replaced by the utility but the MDAS installer was not informed of the changes. Modems were also removed during meter installation but the data centre team kept trying to read the meter.

- Connections from modem to meter were removed by the utility’s maintenance team working in the field without informing the data centre.

- Different baud rates for different makes of meters and even for the same make of meters. This resulted in the wrong installation and configuration of modems leading to some meters not being read.

- The modem or antenna was found missing when visiting the field for maintenance. This led to meters not being read where the network signal strength was weak.

- If the modem was reinstalled by the utility during/after meter replacement and was not configured according to the make of meter, remote readings would not be possible.
Challenges because of network signal strength

- To read a meter, a minimum signal strength of 18 CSQ (equivalent to -77 dbm) is required. Weak signal strength at many locations across vast areas impacted successful reading cycles (poor signal strength does not allow the modem to poll the data back to the CDC).
  - The quality of the available signal strength should be consistent. Even when a signal strength greater than the minimum 18 CSQ, is achieved, the inconsistency does not allow the modem to send data to the CDC.
  - High latency, i.e. round trip time for data was more than 700 msec (to ping) from the GPRS/GSM service node (modem) to the server at the data centre.
  - Variable network signal strength across the area of a network operator.
  - Proper bandwidth allocation at the CDC end to enable meter reading.
  - In some cases the SIMs provided were configured to a public APN (not barred from using the internet) rather than a private APN (barred from using the internet) resulting in misuse of the SIM and consequently high bills.
  - Reduced GPRS channel allocation resulted in a low volume of data getting through, especially during times of network congestion.
  - Deactivation of GPRS services because it has not been used for some time.
  - Wrong mapping of SIM at the back-end of NSP resulted in failure to establish data connection.

- Disconnection of services due to non-payment of data usage bills. The meters for HV consumers are read hourly. This leads to higher data usage and increases the monthly bills (GPRS charges) for utilities.

- Some teams encountered situations where the reported signal for voice was very poor, nearly at the lower limit, but they were able to make GPRS connection, and where the signal strength for voice was exceptional but GPRS was down. There does not seem to be a direct correlation between the required signal strengths for voice and data. The bit error rate (BER) was noted to be a better indicator of GPRS signal strength.

- The operator reserving most of the channels for GSM not GPRS.

- No free GPRS channels available when trying to connect.

- The modem polling the data was installed between two base transceiver stations.

- GSM and GPRS signals are transmitted on the same carrier frequency but at different time slots. GPRS (data) time slots are shared with GSM (voice) time slots, so when there is heavy voice traffic in a network, voice calls might occupy the data time slots (voice calls are given a priority over data calls), reducing the ability to poll data.

Application challenges

- API support for different makes of meters for AMR application to be deployed at CDC of respective states.

- API compatibility, i.e. the API provided should be read on GPRS. Sometimes the API provided was for GSM only and the teams struggled to read via GPRS.

- The quality and maturity of API allowing all readings and parameters to be communicated smoothly in minimal time. Sometimes the API was provided with inadequate features and sequentially. This made integration with the application time consuming.

- Performance of the API could be an issue, i.e. the capacity and speed of the API for reading multiple meters at a single instance is different for different makes of meters. While the MDAS integrates all the APIs, the AMR software can be configured to any one configuration or speed only.

- API might not be compatible for a few series of meters for a particular make of meter.

### Table: Recommended GPRS parameters

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>GPRS Parameters</th>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Signal Strength (CSQ)</td>
<td>18 to 31</td>
<td>Good levels</td>
</tr>
<tr>
<td>2</td>
<td>Interference levels (dB)</td>
<td>0 to 6</td>
<td>Good levels</td>
</tr>
<tr>
<td>3</td>
<td>No. of GPRS Timeslots (downlink, uplink)</td>
<td>3+4/3+4+2</td>
<td>Good levels</td>
</tr>
<tr>
<td>4</td>
<td>GPRS Data Rates Uplink</td>
<td>3+2</td>
<td>Average levels</td>
</tr>
<tr>
<td>5</td>
<td>GPRS Data Rates Downlink</td>
<td>more than 14 kbps</td>
<td>Good levels</td>
</tr>
</tbody>
</table>

- API for meters should support both optical/ RJ11 with GSM/GPRS.

- Meter data size, with some meters sending big file sizes which result in reading failure over GPRS.

Interface challenges

- Execution of all modules in a sequential manner is the key challenge in smooth execution of an MDAS. Success is monitored for only 60-70% of installed modems as their GIS interface data is not pushed to the MDAS for reading.

RECOMMENDATIONS FOR MITIGATING THE CHALLENGES

- Field installation of modems must be rolled out only once all field locations (distribution transformer, feeder and consumer meters) are metered by the utility. If meter procurement is ongoing then simultaneous installation of meter and modem may reduce the delay in execution of programme.

- It is suggested that installation of only one or two makes of meters should be encouraged rather than installation of many different makes of meters in the field.

- Field updating and rework activity for the towns should commence immediately after the successful pilot for modem reading has been done and integrated with the back-end. Unsuccessful updating of data from the field and a downward trend of success because of SIM deactivation or modem removal will reduce the benefits expected. The utility will not be able to get and analyze the data, which is needed to provide better understanding of the health of system and what can be done to improve it.

- Facility management services must be started for all installed modems otherwise the failure count for reading will keep on increasing.

- Modem installation is recommended over the RJ11 port for better success rate.

- Utility personnel should be trained to configure and install modems, or this activity should be carried out jointly with the system integrator and the MDAS agency for successful changes in the field.

- The utility must be proactive and drive the project towards success.

- In the agreement with the NSP, all the desired GPRS parameters must be agreed upon. Bandwidth should also be ensured in order to transfer meter readings at regular intervals, i.e. hourly or daily as desired.