Electricity Metering
to
Revenue Management System
Agenda

• Metering Applications & Key Features Requirement

• Role of Communication Technology in Energy Metering

  Short Break

• Installation Audits Requirements

• Field Testing Requirements

• Growing Metering Technologies Methods

• Prepayment Technologies

• Load Management
The History of Energy Metering

- Ferrari wheel meters served well for more than 100 years
- Static meters were introduced in late 80’s
- Introduction of new metering technologies driven by:
  - Revenue protection
  - Regulatory requirements
  - Remote Meter Reading Concept
  - Complete System planning requirements
Metering Applications & Key Feature Requirement
Single Phase Domestic Metering
Major Key Areas in Domestic Metering ....

- Quality and reliability of single phase meters in circuit
- Hybrid meters offering limited functionality
- Manual Meter reading and billing errors
- Meter tampering
Single Phase – Features Requirement

- Wide voltage & Current Range Requirement
  - Current Rating: 5-30A, 10-60A, 20-80A
  - Voltage rating: 240V, -40% to +20%

- Real Time clock & Built in Memory for real time data recording, data storage in meter for billing and analysis

- Optical communication port support for electronically data retrieve from meter memory
  - Avoid Manual Biasing
Single Phase – Features Requirement

- Tamper Immunity requirement
  - Phase & Neutral Current Measurement
  - Forward recording in case of connection abnormalities i.e current reverse, phase & neutral interchange, earth loading etc.
  - Break to open type meter cover/ ultrasonic welding capabilities
  - Link Less design

- External Magnet Compliance- CBIP-88, event recording
Single Phase – Features Requirement

- LCD Display – Multiple Parameter display
- Cage Clamp Design ensuring effective transmitting contact & faster connection and reduction in connection joint losses
- Self billing feature (ABC i.e. Authenticated Billing Code support for billing parameter)
  - Authenticated Manual Meter reading for fast billing cycle
  - No Manual Biasing
  - Futuristic solution to support Self Billing – Through telephone, Internet, terminal exchanges
Single Phase — Features Requirement

— **Vision Ahead**

- Time of day feature support offering flexibility to address present & future tariff needs
- Maximum Demand Recording for stabilizing demand supply management
- Load profiling for consumer load assessment, trend analysis and forecasting
Three Phase Domestic Metering
Three Phase — Features Requirement

- **Wide voltage & Current Range Requirement**
  - Current Rating: 5-30A, 10-60A, 20-100A
    - Inventory of meters can be kept under control
    - Lower the variants, lower the maintenance & overhead cost
    - Better load fluctuation handling
  - Voltage rating: 240V, -40% to +20%

- **Optical communication port support for electronically data retrieve from meter memory**
  - Avoid Manual Biasing
Three Phase – Features Requirement

- Large backlit LCD display with Parameter Identification
- Phase Indicators with connection check
- Scroll Lock Display features for continuous display of desired parameter
- Maximum Demand Recording
  - Useful for demand monitoring of individual consumer.
  - Tariff category can be selected by recording of actual demand
  - Prevention of unsanctioned overload by consumer.
  - Effective Demand management - Automatic Reset at predefine date & time
Three Phase – Features Requirement

- Meter works even when one phase & neutral or two phases are available
- Provision of meter reading & display in the absence of power supply
- Extended Transparent Terminal Cover with sealing arrangement.
- Monthly Average Power factor recording for reactive power management or optimum use of the capacitors at consumer premises
- Billing point & History support for effective billing & revenue monitoring
Three Phase – Features Requirement

- Tamper Immunity requirement
  - Phases & Neutral Current Measurement
  - Forward recording in case of current reversal
  - Break to open type meter cover/ ultrasonic welding capabilities
  - Link Less design

- External Magnet Compliance- CBIP-88, event recording
Three Phase – Features Requirement

- Tamper detection and evidence
  - Detection of connection tampers, wrong connections or external influence
  - Intelligent tamper detection logic: System condition not to be logged as an event.
  - Tamper evident: Event logging with date and time in meter memory for evidence & cross check
  - Snapshot of Electrical condition and logged parameters
  - Event logging of meter configuration change
Three Phase – Feature Requirement

• Tamper deterrence
  – Detection of abnormal magnetic influence and event logging
  – Fast recording under abnormal magnetic influence to discourage such type tampering

• Load Survey profiling for energy & instantaneous parameters for consumer load trend analysis
Three Phase Commercial/ Industrial & Feeder Metering
CT/VT Operated – Features Requirement

- Metering Requirement
  - Import Metering
  - Forwarded Metering
  - Import & Export Metering (True four quadrant metering)
- Class of Accuracy: 0.5s, 0.2s
- Features support similar to three phase domestic metering i.e phase indicator, scroll lock, sealing arrangement, tamper logging, Maximum demand recording etc.
CT/VT Operated – Features Requirement

- Time of day register
  - Different Time zones and eight registers selectable through tariff
  - TOD support for energy & demand register
  - Better load management as industries are tries to use more electricity in off peak time

- Voltages, currents and energy parameter profiling support for 15/30 minute for last 50 days based on application i.e consumer tariff, feeder metering, voltage & load fluctuation analysis
CT/VT Operated – Features Requirement

- Advance Communication Support
- Additional RS232 serial communication port for Remote Meter Reading application
  - Periodic Feeder Monitoring
  - Billing data from central station
  - Faster Billing Cycle
- External Modem need to be used at either ends for data transfer at central station
- Low Power Radio Communication – Ideally suitable for distribution transformer metering up to 100 meter distance
Integrated Solution For Bulk Power Metering
Grid Metering - Features Requirement

- Overall system accuracy
  - True 0.2s class four quadrant metering system

- Instrument transformer errors
  - Dynamic compensation of measurement transformer errors
  - Improves overall accuracy of the metering system

- Suitable for different tariffs
  - Two part tariff, ABT etc.
Grid Metering - Features Requirement

- Modular Rack mount construction
  - The 19 “sub Rack Assembly is an internationally accepted standard
  - Draw out type meter with automatic CT shorting
- Auxiliary power supply
  - Back up redundancy
  - Remote reading in case of feeder power failure
- Communication capability
  - Optical port on each meter for local communication
  - Serial port on metering rack for remote data transfer
  - Compatibility with modern communication technologies
Three Phase LT  Consumer/Distribution Transformer Metering
Metering in the LT CT Segment

- **Consumer Metering**
  - Complex arrangement of static energy meter, external CTs, meter box and accessories such as fuses, cabling etc

- **Distribution Transformer Metering**
  - Performed using the same meters as for consumer metering
  - Virtually no differentiation for this specialized application
LT CT Segment Metering

- Major problems with existing implementation
  - LT CT metering installations are quite complex as they involve:
    - External CTs, Static Energy Meter, Meter Box, connecting cables etc.
  - Overall system accuracy is not as good as ‘Class 0.5’ implies
  - Terminal joints and other connections provide an easy path for fraud and other losses
  - Poor installation practices aggravate these problems
LT CT Segment Metering

- Major problems with existing implementation...
  - Metering units have to be segregated according to their CT ratios, e.g. 50/5, 100/5, 150/5, 200/5
  - Some consumers hinder or even prevent Utility meter readers from entering premises to read meters
  - Distribution Transformer Metering is often found to be tampered or damaged by miscreants, yet no one is accountable for such meters
LT CT Metering: Problem vs. Solution

- Collection of external accessories for metering (external CTs, Static Energy Meter, Meter Box, connecting cables etc)
  - Integrated Metering Unit specially designed for LT metering – no need for external accessories.
- Poor system accuracy – determined by the errors in the energy meter and errors in the external CTs
  - Integrated Metering Unit has better inherent accuracy
- Terminal joints and connections make theft easy, and can also introduce other losses due to poor contact
  - Innovative design eliminates the need for a terminal block, thereby preventing fraud and reducing other losses
Distribution Transformer Metering - Scheme

- Meter with Low Power Radio
- Radial distance of 100 Meter
- Service line
- 5-6m above ground level
- HHU

Meter Reader
LT CT Segment Metering

• Major problems with existing implementation...

  – Metering units have to be segregated according to their CT ratios, e.g. 50/5, 100/5, 150/5, 200/5

  – Some consumers hinder or even prevent Utility meter readers from entering premises to read meters

  – Distribution Transformer Metering is often found to be tampered or damaged by miscreants, yet no one is accountable for such meters
Remote Meter Reading for commercial reading
/feeder Monitoring Requirement
Traditional Meter Reading...

Central station → Local station → Meter Reader → Hand Held Unit → Meter
Key Constraints for large revenue consumers/ feeder monitoring

- Have to be hand carried to each meter
- Data has to be uploaded to a computer for processing
- Limited storage capacity of HHU

leads to

Long Cycle Time leads to
Delayed revenue realization/ feeder analysis
Remote meter reading

Remote Meter Reading is a technique to transfer the Meter data / information to a remote location via suitable communication media and necessary hardware set up.

RMR uses various Communication technologies as PSTN/GSM/GPRS/CDMA
Advantages of GSM over PSTN

• Being wireless, there are no hassles of wiring and the setup is simpler.

• Secure installation and having no wires it is difficult to vandalize.

• Cost: The GSM service providers have flexible tariff plans like bulk concession.
Intelligent GSM Modem – Key Features

GSM modem with an advanced feature of store – forward to enable fast data transfer from meter to central server.

It can be used to in three different configurations:

1. Inbound Dialing
2. Event Based Dialing
3. Outbound Dialing
RMR- GSM Modem

Inbound Dialing

Data is stored in modem memory and transferred to Central Station at pre-configured interval.
RMR – GSM Modem

Inbound Dialing

- The modem has inbound dialing facility to a particular GSM number at specified time (everyday/weekly/monthly etc) for the purpose of meter reading. This configuration of the modem is available to the user via offered software.
RMR- GSM Modem
Event Based Dialing

SYSTEM SET UP
Central Station
GSM modem
Communication Network
ECD-200
GSM modem with Store Forward facility
Meter

EVENT BASED DIALLING
Call initiated by modem

Tamper details sent to Central Station
SMS alert on tamper sent to pre-defined cellphone number
AMR- GSM Modem

Event Based Dialing

- Other then regular dialing, the modem has a feature of event based dialing in case of occurrence of deliberate tampering initiated from Meter end itself, without waiting for the interrogation from central station and relevant data is made available on base computer software.

- Further, the modem sends an SMS containing Meter details.
AMR – GSM Modem

Outbound Dialing

**SYSTEM SET UP**

Central Station -> GSM modem -> Communication Network -> ECD-200 (GSM modem with Store Forward facility) -> Meter

**OUTBOUND DIALLING**

Call initiated by Central Station

Meter Data can be requested from Central Station. Data is transferred in Store Forward/Transparent Mode
AMR- GSM Modem

Outbound Dialing

• In case the data is required by dialing from the server end, then connection is established by the server to the device

• User has an option to get the current data directly from the meter or data already available in the memory of store & forward device.
End of Session -1

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Installation Audit & Testing Requirements
Need for an Installation Audit

- Check the installation for healthiness
- Assess the standard of installation
  - to evolve better practices
- Identify the conditions leading to Accidents / Hazards
  - and minimize the same
- Deter malafide efforts by unscrupulous consumers
Installation Audit Component

- ✔ Meter
- ✔ CTs
- ✔ PTs
- ✔ Enclosure
- ✔ Wiring and connections
Visual Examination

- Neatness
- Integrity
- Safety
Visual examination

- Neatness of installation
  - Mounting method
  - Dressing of cables
  - Colour coding, Ferruling & its common nomenclature

- Safety aspects
  - Bare wires, Naked joints
  - Earthing requirements

- Integrity of installation
  - Physical / visual evidence of tampering
  - How prone is it to tampering
Electrical examination

- Correctness
- Appropriateness
Electrical Examination

- Correctness of connections
  - General wiring check
  - Polarity check
  - Phase association errors etc.

- Appropriateness w.r.t. application
  - Meter type, Meter rating vs. connected load
  - CT/PTs
  - Size of wires, thimbles, connectors
  - Size of neutral wire
  - Sealing Type & Management system
In-situ testing of

- Meters
- CT/PTs
- Wiring
- Earthing
Testing Solutions at Site

- **Meter**
  - Meter accuracy check as per various standards applicable: viz. IS 13779, IS14697, CBIP report 88 etc.
  - Equipment to be used: Calibrators (Accuchek).
  - CTs, PTs
  - CT/PT error testing at Site
  - Equipment to be used: CT/PT testing equipments (Red phase instrument)
  - Mobile Van (Mobilab) for substations.
Pre Paid Electricity Metering Systems
What is Pre payment?

- “Pay as you go” electricity sales system
- Revenue collected in advance - eliminating the complete billing system
- It is not a new system
- Newer administrative techniques are evolving
- Over 5 million installations worldwide
The Prepayment Cycle
What is pre payment?

- Purchase and consume
- Consumption restricted to payment
- Automatic disconnection on credit expiry
- Buy as and when you can
Why Pre payment?

- Utility’s View point
  - A solution that improves the revenue cycle.
  - Improved financial management
  - Lower overheads.
  - Improves management of fraud
  - Better customer services.
Why Pre payment?

- **Consumer’s Viewpoint**
  - ✓ Improved budgeting
  - ✓ Convenience of payment
    - ✏️ Avoid long Q’s
    - ✏️ Choose when to pay
  - ✓ Confidence in the system
  - ✓ No billing errors
  - ✓ Improved quality of supply
Pre payment technologies

- Coin operated meters
- Magnetic cards
- Smart cards
- Key pad meters
Traditional Prepayment

Coin

- Inexpensive
- Money easily stolen
- Easy to tamper or fraud
- Expensive to maintain
- Requires access to banking system
- Errors subject to change with time
Current Prepayment Systems

Simple Electric

Magnetic Card

- Relatively inexpensive
- Acceptance problems
- Not always erased
- Cards often lost or damaged
- Cards could be copied
- Accountancy backup needed

Rs. 100
Current Prepayment Systems

Smart card

- Secure
- Tokens expensive
- Vending hardware expensive
- Acceptance problems - contacts wear or become contaminated
- Requires access port in meter
The Pros and Cons of Smart Token Systems

Reusable Token

No money in meter

Additional data can be transferred

Convenient for consumers

Tokens are expensive > Rs. 1000 each

Prone to acceptance problems

Up 25% a year require replacing
Innovative Prepayment Systems

Keypad

✓ No tokens - reduced costs
✓ No aperture - no token acceptance problem
✓ Codes easily reproducible if lost
✓ Codes can be vended from many sources
### Comparing The technologies

<table>
<thead>
<tr>
<th>Keypad</th>
<th>Token Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Inexpensive Paper based token</td>
<td>✗ Expensive token (encapsulated ASIC)</td>
</tr>
<tr>
<td>✓ Reproducible at any outlet if lost</td>
<td>✗ Token must be replaced by supplier</td>
</tr>
<tr>
<td>✓ No token acceptor in meter</td>
<td>✗ Meter requires token acceptor</td>
</tr>
<tr>
<td>✓ No token acceptor in vend outlet</td>
<td>✗ Vend outlet requires token acceptor</td>
</tr>
<tr>
<td>✓ Telephone vending possible</td>
<td>✗ Telephone vending not possible</td>
</tr>
<tr>
<td>✓ Internet vending possible</td>
<td>✗ Internet vending not possible</td>
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</table>
Vending technologies

- Distributed Vending
  - Vending Stations
  - Automatic Vending Machines

- Centralized Vending
  - Vending Terminals

- Internet Vending
SECURITY

• Encrypted Tokens
  – Not reusable
  – Meter specific
  – TDES encryption system
• Operator access control
• Access Control for third party vendors
• Full Audit Trail and Engineering Log
• Security against vend terminal misuse
Alarms and Emergency Credits

- User programmable alarm levels
- Emergency Credit
- Friendly Credit hours and days
Thanks

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