

# APDRP & AMR Embedded with Power Quality for Customer

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# BACKGROUND



- Several methods for meter reading
- Traditional to optimized one using new technologies
- Electromechanical to Electronics
- Modem, GSM radio (coverage Problems), PLC (economic). Mixer of one or more techniques makes it technically sound overcoming some limitations of a method & make it economically viable.
- A combination of hardware and software that enables two way communication between energy service organizations and equipment within the consumers premises, generally < 6 secs.
- Some countries in Europe have adopted AMR faster than others. Hundreds of installations have taken place in countries like Italy, Germany, France providing a real management alternative. It appeared not so long ago that the UK was lagging behind in spite of - or because of - deregulation.

# AMR Benefits for Distribution Utilities

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## IMPROVEMENTS IN:

- Billing
- Electricity losses
- Costs
- Balance settlement
- Tariff control
- Load shedding (control)
- Network planning
- Service control
- Load profile
- Change of the electricity seller
- Reporting
- Quality of electricity [EnergyIndustry05]

# AMR Risks for Distribution Utilities

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## RISKS:

- **Exceeded general costs**
- **Communication costs**
- **Supplier changes**
- **Unfinished products**
- **Short life cycle of technologies**
- **Wrongly selected solutions**
- **Malfunctions**
- **Disturbances, viruses, etc.**
- **Information system risks**
- **Personnel risks**
- **Changes in legislation**
- **Electricity Market Legislation, EU**
- **Data privacy**
- **Consumer Protection**
- **Vandalism**
- **Bad reputation in a case of a failure [EnergyIndustry05]**

- **1) Outage** : An outage event is defined as a voltage drop below 50% on any phase for a user defined time (from 1 to 10 minutes).
- **2) High / Low Voltage Event** : A high/low voltage event is defined as the voltage on any phase deviating from the normal voltage on any phase by a user defined percentage (from +/- 5% to 20%) for a user-defined time (from 1 to 30 minutes).
- **3) Voltage Unbalance** : A voltage unbalance event is a deviation of any of the three phase-to-phase voltages from the average voltage on by a user-defined percentage (from 2% to 6%) for a user-defined time (from 15 to 30 minutes). The average voltage is the sum of the three phase-to-phase voltages divided by three. Voltage unbalance should be calculated at a minimum every 5 minutes.

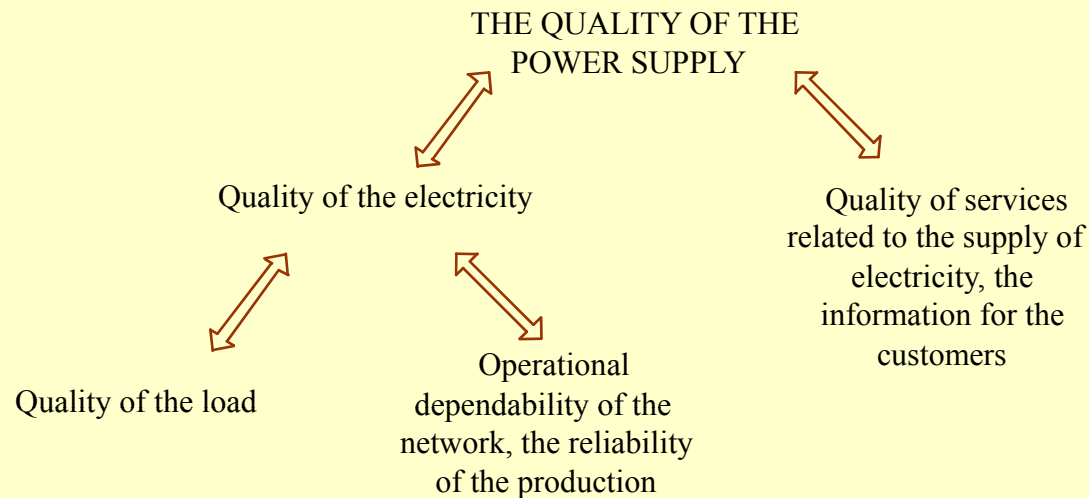
# POWER QUALITY ISSUES



- **4) Momentary Interruption/Voltage Sag :** A momentary interruption/voltage sag (MIVS) is defined as the voltage on any phase deviating from the normal voltage on any phase by a user defined percentage (below 80%) for more than 3 cycles (50 ms). A MIVS event should have occurred when a user programmable number of MIVS events (1 to 10) have occurred within a user defined time window (from 1 to 60 minutes).
- **5) Power Quality Log :** The system should be able to communicate with any C&I meter via wireless or dial out to request a table listing all recent power quality events. Each event should be time-tagged to the nearest second, and contain a static text description of the event. Each MIVS should each be recorded as an event.

# Quality Control in Distribution of Electricity

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- The quality of the power supply is determined by the quality of the electricity and the quality of the service
- The quality of the electricity can be divided further into the quality of the load and the operational dependability of the electrical network
- The standards :  
EN 50160

# Outage and Quality Management

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- The following outage and quality data could be obtained from AMR meters:
  - Outage durations,
  - Voltage swells and sags,
  - Over voltage and
  - Harmonic waves
- This outage and quality data could be used in the distribution network management in:
  - Adjustment of the outage reports in the medium and low voltage networks
  - Customer information databases
  - Network analyses

## November 2004

- IEC 61107 standard (today IEC 62056-21) based on the FLAG protocol
- The DLMS/COSEM specification is standardised by both the IEC and CEN
- Market liberalisation brings new requirements for data exchange
- customers get more concerned with the quality of electrical energy supplied creating the need for power quality information
- On the liberalised markets, metering data are not only used for billing purposes. Instead several commercial partners may need access to metering data for their respective applications. This brings the need for mechanisms to control the access to meter data and to make data available according to well defined access rights
- The amount of data to be read has considerably increased and meters had to be read more often, so instead of manual or on-site meter reading automatic reading became the only viable solution
- All data can be unambiguously identified
- New: meter data exchange via the internet

# Migration Ensured



- To date, meters using proprietary protocols, or protocols according to earlier standards like FLAG (IEC 61107, replaced by IEC 62056-21) Euridis (IEC 61142, replaced by IEC 62056-31) and many more.
- To facilitate migration, IEC TC 13 has defined a new mode E in IEC 62056-21. This mode allows to switch during the opening sequence to the new, DLMS/COSEM based mode data exchange. Most DLMS/COSEM based meters also support the traditional Mode C, however the functionality available in this mode may be limited.

- As per the estimate of the Integrated Energy Policy of the Planning Commission, generating capacity need to grow from the current level to 778 GW by 2032 (132329 MW as on 31.03.2007)

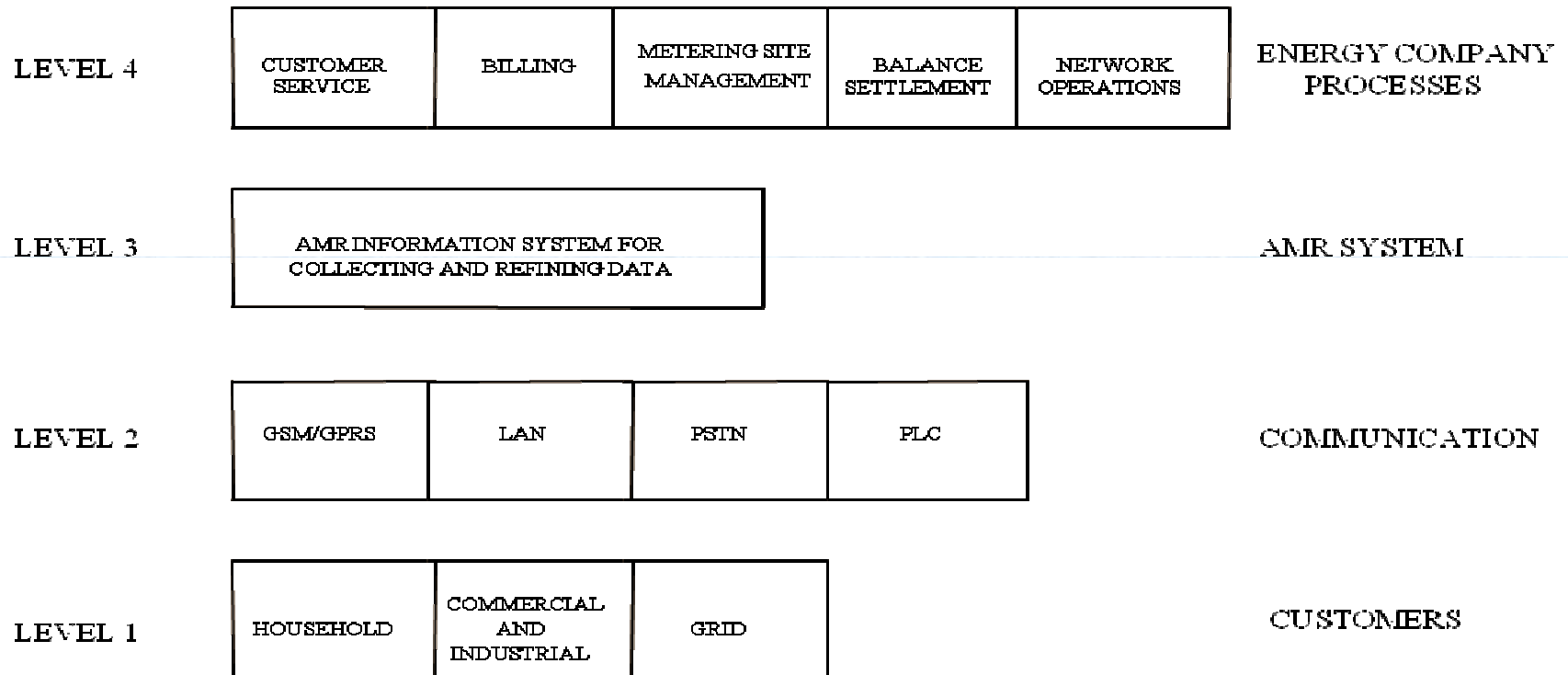
# Distribution Improvement

- System operation and dispatch
  - Real time power supply monitoring and control
  - Energy accounting and auditing
  - Load management
  - Distribution automation
  - Outage management
  - System reliability and availability
  - Control centre

# Distribution Improvement

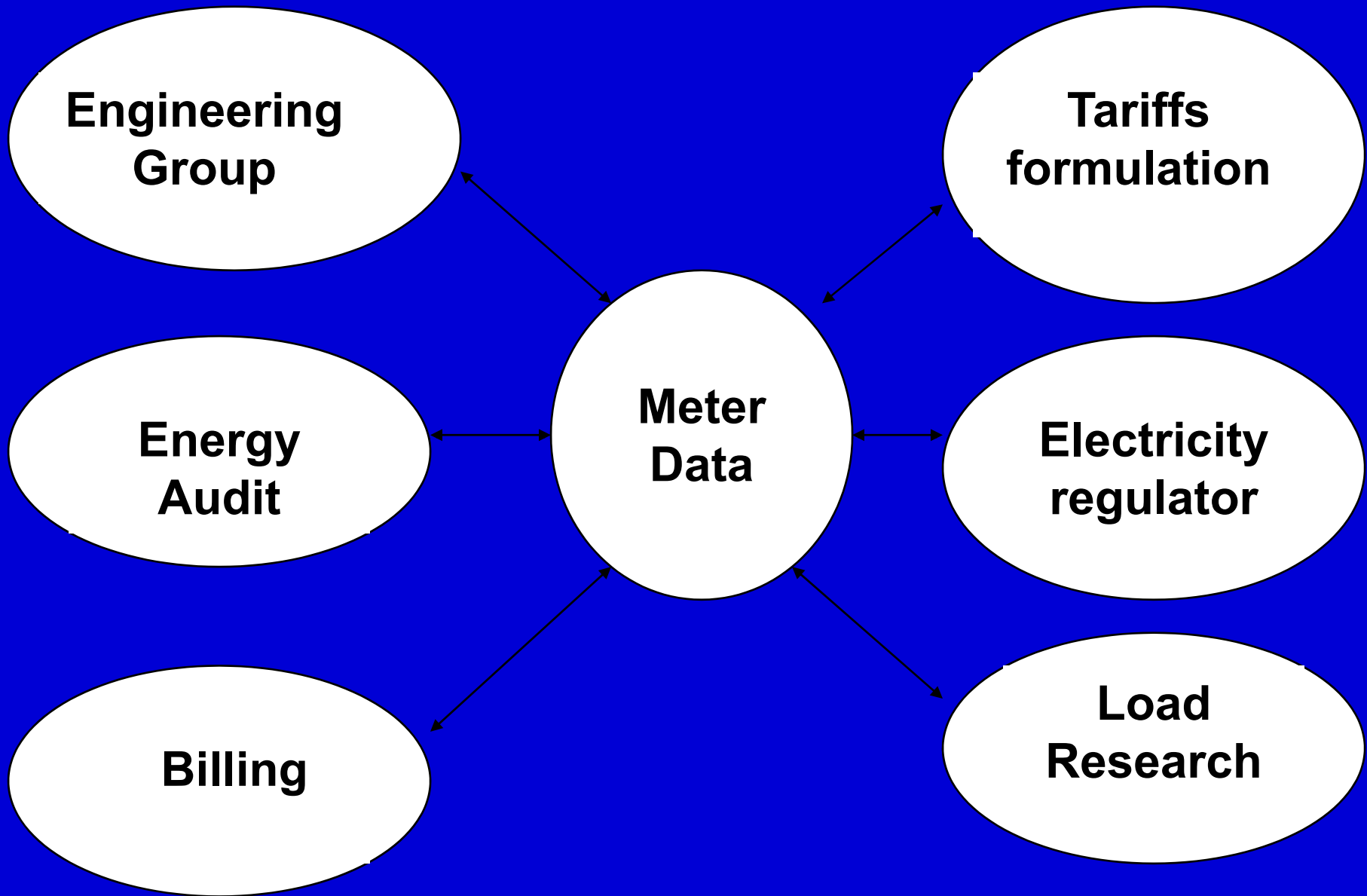
- Field operations
  - Safety
  - Revenue expenditure analysis
  - Trouble call management
- Customer processes
  - Metering, billing & collection

# AMR: System



- An AMR System consists of four levels

- Meters, Communication, AMR system, Energy Company Processes



# AMR Meter functions

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- Measurement Frequency
  - Regularly
    - Once a month/day/hour
  - On a need basis
- Consumption Measurements
  - Household
    - Real power with different tariffs
  - Industry and real estate
    - Real and reactive power and maxim powers
    - Hat
    - Water [EnergyIndustry05]
- Customer and Vendor Offered Services
  - Controls
    - Tariffs
    - Load
    - Overload
  - Remote connection and disconnection
- Other Information
  - Quality of electricity
    - Voltage level
    - Interruptions
    - Phase errors
  - Meter self diagnostic

# (1) Standards in meter data exchange

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- IEC standards
  - IEC 62056-21 (formerly IEC 61107),
  - IEC 62056-53 (DLMS) / IEC 62056-62 (COSEM),
  - IEC 62056-31 (EURIDIS),
  - IEC 60870-5-101, IEC 60870-5-102
- ANSI standards
  - ANSI C12.18, ANSI C.19
- Other standards
  - MBUS,
  - LON,
  - TURTLE,
  - ELCOM and
  - PQDIF [Internet; OPEDAD41]

ONE OF THE MODEL...

ADVANCED  
ENERGY & REVENUE  
MANAGEMENT SYSTEM

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(AERMS)

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# Metering Arena



**AMR solutions, including that on  
GSM, PLC, RF etc.**

**Pre & Post paid  
Revenue Management System**

# Why is such a high-end system required??

- High Non-Technical losses due to non payment, metering bypass, line tapping that are experienced in the distribution network
- Hand-in-glove operation by installer and/or inspector, makes the detection/correction difficult
- Large and growing Arrears amounts
- **Large and increasing customer base will compound the problems of managing multiple tariff system and manual connection/disconnection**
- **No load management possible, except for relenting to power-cuts, thus annoying the customers**
- **This ultimately leads to non-sustainable service provision in the long run**

# Why Conventional metering and pre-payment techniques failed??

- **Keypad or card token based pre payment meters**
  - One way communications: No automatic reporting of tampering
  - Conventional PPM needs intensive management effort with regular physical inspections
- **Non-split meter**
  - Easily bypassed due to the proximity mounting with customer
  - Dishonest vendors (re-selling)
  - Loss of customer data integrity (meter movement)
  - The tamper <- > detection time is too slow to be effective
- **Next Generation features like real time complete system monitoring, load management & remote operation are absent**

So where's and what's the  
solution...???

It is Here!!!

# Advanced Energy & Revenue Management System

**Integrated and Automated approach on metering, tamper detection, load management, prepayment, post-payment & revenue management, embracing,**

- AMR with full two-way communications
- Split Metering
- Online Tamper detection and reporting
- Load control
- TOU (different tariff with time of day)
- Different Credit Policies (Simultaneous operation of pre and post payment)
- Control on energy and revenue
- Easy visibility of usage to customer

# A few pictures of system components

GSM/GPRS Cell Conc



4- way Split system



Displays



16- way Split system

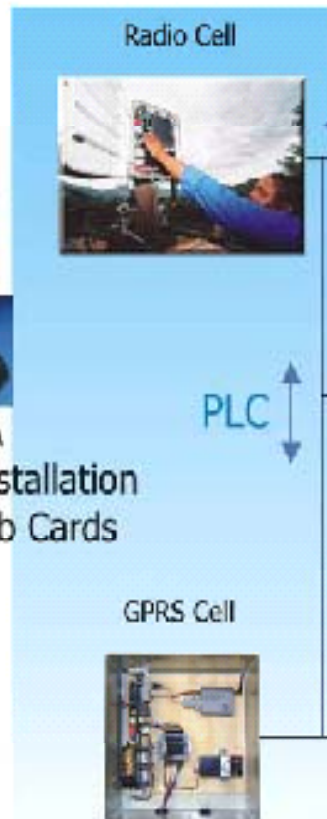


# System Overview: Technologies Used

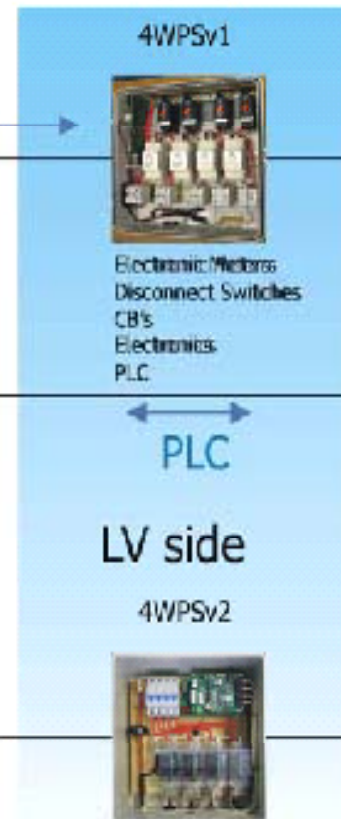
## Customer Care



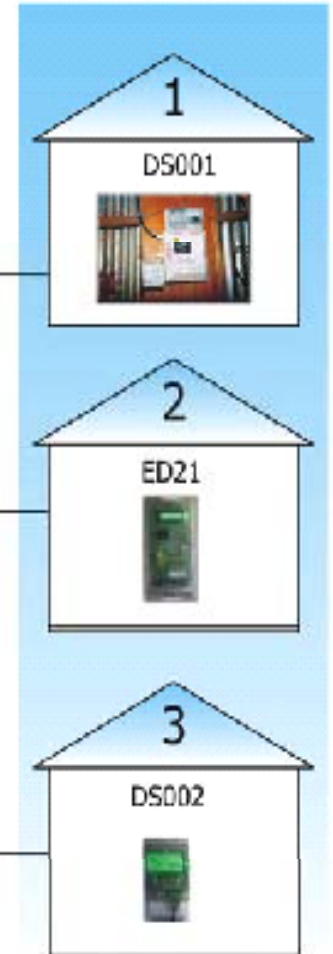
## Cell Concentrator



## 'n' way kiosk 1 < 'n' < 32



## Display



# Block Functions

## Display Unit (DS)

- It is a simple unit with PN input and communicates with SMU via PLCC
- Displays customer related information like Meter no, Meter reading in kWh, and can also display Balance Credit, Tariff in use, when configured in prepayment mode

## Split Metering Unit (SMU)

- Can be configured from 416 units in single box. Preferably pole/remote mounted
- Does the complete metering function as per IEC61036, Class 1.0
- Has an individual connection, integrated remote connection/disconnection facility
- Maintains all critical data in local storage, and communicates with CC and Displays via PLCC

## Cell Concentrator Unit (CC)

- Is mounted on LV side of transformer to support all 3 phases
- Polls data from SMUs and sends them to Server via GSM/GPRS
- Has internal battery backup, and can be supported by local downloads via RF

## Central Server (CS)

- Has complete Oracle based database to manage more than 200,000 connections
- Stores and analyses all data to control actions and generate exception notice on real time basis.
- Handles Point-of-sale (POS) as well as links with remote Vending machines on XMLVend via LAN/GPRS/Optic Fibre etc

# Typical faults detected by AERMS



- Opening of covers of any of the units
- Meter Bypassed
- Summation faults for incoming and outgoing currents at SMU
- Wrong connections
- All different connection tampers at input and output prevalent in India
- No communication to display
- No Units Measured in 24 Hours
- Disconnected but Units Measured
- Meter self diagnosis
- Contactor Failed
- Registration Error for new or replaced meter
- Any other programmable fault conditions

# Next generation feature available with AERMS

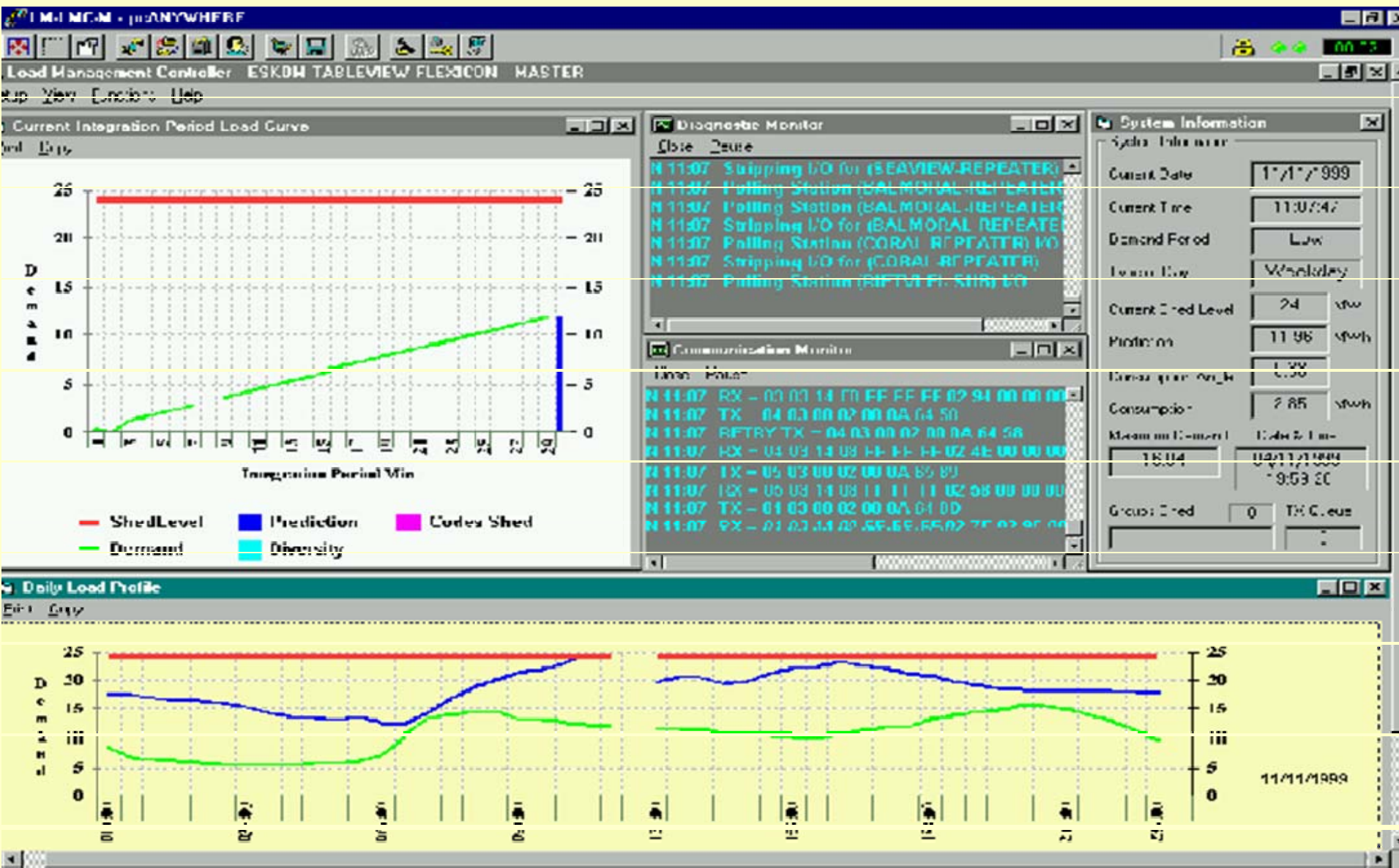


- Summation of meters per transformer/split block
- Programmable Current Safety Levels per connection/split block
- Optional Free Text Messaging or community messages
- High level of automation during commissioning and maintenance processes
- Immunity to 33kV line spikes
- High level of data integrity due to coded interdata xfer
- Distributed work processes by CC possible, with report back on completion
- Automatic number propagation & registration through the system. Thus no rerun of data agt serial no allotted to customer.
- GPS Positional Data/Customer
- Optional features like relaying data of meter or alerts on cell phones of customers or utility persons possible

# Load Management



## Optional Builtin Load Management capabilities



# Current Experiences of Transmission lines



# Example 1: Alexandra

**Conventional PPM (Keypad) are replaced with ISMS due to major bypassing problem**  
**Revenue up with 588% with only 21% of customer base**



# Prepayment Meters: Trend

- The prepaid program in South Africa was started in 1992, since then they have installed over 6 million meters. (roughly 1/2 by Eskom)
- Roughly 35% of household has Prepayment meters
- Eskom spear-headed the STS meter development
- STS : 20- digit paper token and keypad based (unidirectional)
- Non- split STS meters has been found to be
  - Cheap and easy to install
  - very labor intensive (almost impossible) to manage; many times the installers bridge/bypass at a fee
  - Impossible to inspect successfully for tampering and bypasses
  - Easy to loose track of where the meters are installed (customers move meters)
  - Vending patterns is checked to guess bypassing; but if you do not know where the customers are ..
- Electronic metering is required due to the accuracy improvement and better tamper immunity
- There is a move towards AMR with more and more municipalities going out to tender on AMR meters, due to the real- time management advantages offered
- Specifications for “open platform” two- directional Prepayment meters are now being finalized
- In summary: AMR Prepay Split meters

# .....SUGGESTS

- There will be no additional costs to the consumer to install the AMR system. There is no rate increase anticipated
- the new meter reading system should not increase the risk of hacking
- Routine inspections of all meters and services shall continue in order to look for safety hazards, theft or other problem
- utility to offer variable rates and encourage price responsive behavior among customers.
- Cost displacement payback (ROI) within two (2) years.

## ....SUGGESTS

- Verification of compliance as per DLMS/COSEM is costly and fully dependent on Europeans Agency
- So, ERDA can coordinate for preparing one common software for checking the compliance of ENERGY METER (with AMR feature) as per standards (ETD 13 - 5998-PART 42;5997 PART 21; 5999 PART 46; 6000 PART 53; 6001 PART 61; 6002 PART 62) with the help (Technical and financial) of manufacturers.

# Conclusions

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- Automatic Meter Reading can enable the use of new the low voltage network data in the distribution network management. This data includes realtime alarm data, quality data and accurate consumption data.
- Three main application areas for the respective data in the distribution network management could be divided into the low voltage network fault management, outage and electricity quality management, and network analyses.
- Possible benefits from this new data include efficiency in the clearance of the fault cause and magnitude, improved outage reporting, improved awareness of the power distribution situation and improved planning of the distribution network, among others.

# Conclusions

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- IEC 62056-53 / IEC 62056-62 (DLMS/COSEM) is one of the few meter reading standards that is compatible with several suppliers' meters and AMR systems. It supports event-based communication to some detail. Proprietary standards and systems also tend to support event-based data, but they function only inside the respective supplier's systems.
- The alarm functionality of the AMR systems is developing as we speak but the connection with the electrical network control systems is still minor. The meters will be configured according to the meter situation in the network to alarm of only certain types of events. With the customized configuration unnecessary alarm messages are avoided and the telecommunication network congestion can be reduced.

# Conclusions

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- GPRS seems to be the main AMR communication technology in the Nordic Countries, whereas PLC is the typical technology in South Europe. In the case of a large scale outage in the distribution network, simultaneous alarm messages can possibly get the GPRS network temporarily congested quite easily. In the future, Flash-OFDM and WiMAX could be considered as alternatives for the GPRS communication. They have better congestion tolerance and data rates but at the moment have no solutions for AMR and the prices are high. AMR PLC systems enable also spontaneous alarm messages, but the PLC in general does not seem to be very reliable communication technology. The time that is needed for the PLC systems (1-stage or 2-stage) to transmit various alarm messages at the same time was not clarified and needs further studies.
- According to our calculations, the direct GPRS communication is a cost effective alternative in transforming circuits that have 4 or less customers. When the number of customers increases, the two-stage alternative should become more cost effective. However, when excluding the connection costs the direct communication is more economical up to 50 meters LV circuits and from thereon the solution costs are equal.

**Thank you**

CPU, NDPL, IndiaCore