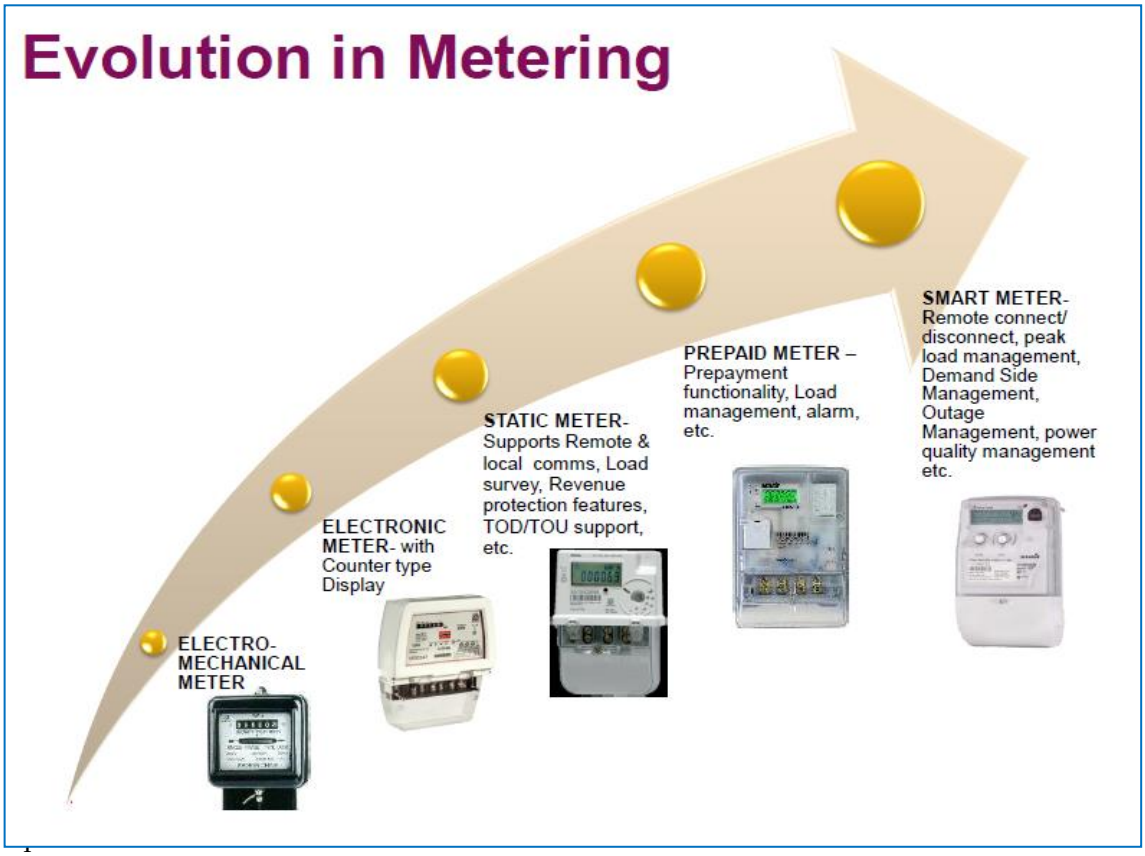
Evolution of Smart Meters

2.1 History of Electricity Meters:

The journey of Electricity meters is now over 140 years. It started with the advent of Electrolytic meters in 1881. It passed through various stages viz Electromechanical, Electronic & Static meters till the evolution of the Smart Meters.



utions of Meters

2.1.1 Conventional Electromechanical Meters:

Electromechanical meters were very common till few years back. They have a non-magnetic metallic disc attached to it internally which rotates proportional to the power passing through the meter. Since there is rotation of a disc involved, it is bound to consume some electrical energy itself to facilitate the rotations.

These Meters were used to measure only one quantity i.e. energy consumption in terms of : KWh. The Sole purpose of metering used to be recording of consumption for the purpose of consumer billing.

Limitations of Electromechanical Meters

- It is not possible to get high accuracy through disk method. It is therefore mandatory to change the technology to get more accuracy.
- **Limited measurements:** As disk meters have only one dial so they only measure active or reactive power at a time. Moreover, they cannot measure Maximum Demand, instantaneous power, voltage, current or other important factors.

Figure 2.2 Electromechanical Meters

- **Highly prone to electricity theft:** These meters are easy to manipulate because meter reversing or disk blocking techniques are really easy to implement on it.
- **Prone to wear & tear :** The mechanical parts are always prone to wear and tear which resulted in deterioration of their accuracy.

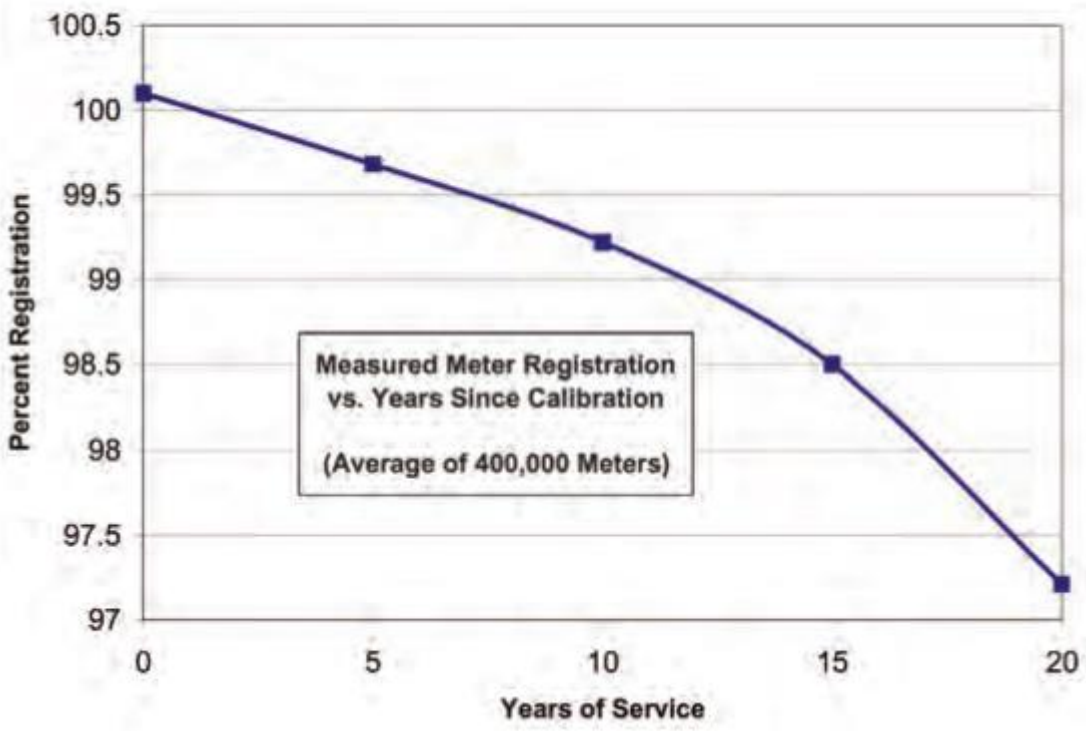


Figure 2.3 Electromechanical Meters

2.2 Evolution of Proprietary protocol based Static meters:

To do away with the microprocessor based Static/ Electronic meters emerged in the market. They are data loggers & store-time stamped data. They store various other parameters in addition to consumption like Voltage, Current, Power Factor etc.

Since there was no defined protocol, the manufacturers of electronic meters used multiple data formats on proprietary protocols. Hence the Utilities had to buy and maintain separate Application Program Interface (API) software from each meter manufacture in order to make use of the data from different versions of meters.

The advent of static meters also resulted in changes in the method of meter data collection. The reading used to be taken manually, downloaded into a hand held device or transferred through a communication media to a Central location.

In addition third party handheld readers and remote metering systems have to be updated for every new meter type/ version added to the

utility system. *The proprietary protocols results in dependence of the DISCOMs on the vendors of meters as the APIs are needed for integration of metering information with the IT infrastructure. This resulted in focus on the development of open protocol. To ameliorate the difficulty in dealing with a number of proprietary protocols and to ensure inter-operability of different makes/types of meters, open protocols have been evolved and standardized by American National Standards Institute (ANSI) and International Electro-technical Commission (IEC).*

2.3 Evolution of DLMS/COSEM (Open) Protocol.

- It is a protocol standard for Metering data.
- It is adoptable for all Energy Utilities Electricity / Water / Gas.
- Unique codes for parameters (Objects) Standardized 3-layer architecture:

1. **COSEM –** Companion Standard For Energy Metering : Association, Request/Response handling
2. **HDLC** – Addressing, Data integrity and verification, Flow Control, Sequencing
3. **Physical Layer** – Communication services

Meters Type:

Category A: Energy Accounting & Audit Metering

Category B: Boundary Metering

Category C: Consumer Metering [HT (PT/CT) & LT(CT)]

The specification consists of the following parts:

1. IEC-62056-21: Direct Local Data Exchange
2. IEC-62056-42: Physical Layer
3. IEC-62056-46: Data Link Layer using HDLC
4. IEC-62056-53: COSEM Application Layer

5. IEC-62056-61: Object Identification System (OBIS)
6. IEC-62056-62: Interface Classes
7. IEC-62056-47:COSEM Transport Layers for IPv4 Networks

Parameters Types

1. Instantaneous Parameters
2. Block Profile / Load Survey Parameters.
3. Daily Profile Parameters.
4. Parameters for accounting / billing.
5. General Purpose quantities: Name Plate Details.
6. Programmable Parameters: Event Conditions

Profile generic or Load Survey

1. Data storage = 45 days for 30 min capture time
2. Data storage = 22 days for 15 min capture time
3. Block period (15 / 30 min) - programmable by utility.
4. The parameters are the average values stored at the end of that time block.
5. Energy entries are actual energy consumption during that time block.
6. These parameters can also be read at any instant of time by the host/ CMRI
7. The other required daily accounting parameters can be computed at the host end

2.4 Evolution of Smart Meters:

Smart Meters are defined to be those which have bidirectional communication provision and have disconnection facility. The specifications of Smart meters are defined in IS15959.

Smart meter records consumption of electric energy and communicates the information to the electricity supplier for monitoring and billing. Smart meters typically record energy hourly

or more frequently, and report at least daily. Smart meters enable two-way communication between the meter and the central system. Such an advanced metering infrastructure (AMI) differs from automatic meter reading (AMR) in that it enables two-way communication between the meter and the supplier.

Communications from the meter to the network may be wireless, or via fixed wired connections such as power line carrier (PLC). Wireless communication options in common use include cellular communications (which can be expensive), Wi-Fi (readily available), wireless ad hoc networks over Wi-Fi, wireless mesh networks, low power long range wireless (LORA), ZigBee (low power low data rate wireless), and Wi-SUN (Smart Utility Networks).

Benefits of Smart Meters

1. **From Utilities Point of view:**
   - Eliminates manual monthly meter readings
   - Help in remote disconnection of defaulter consumers
   - Makes it possible to use power resources more efficiently
   - Provides real-time data that is useful for balancing electric loads while reducing power outages.
   - Enables dynamic pricing, which raises or lowers the cost of electricity based on demand
   - Helps to demand and supply.

2. **From Consumers Point of view:**
   - Far more informed of the energy usage.
   - Enable consumers to adjust their usage in order to lower the electricity bills.
   - Reduces the number of blackouts and system-wide electricity failures.

3. **Smart Meters & its protocol**.
   - Smart Meters are based on IS 16444 Protocol.

- The details of the specifications of Smart Meters are annexed as under

  Annexure 1: Single Phase Meters.

  Annexure 2: Three Phase Meters

  Annexure 3: Three Phase CT Operated Meter

2.5 AMI Architecture :

Advanced metering infrastructure (AMI) is the architecture for automated, two-way communication between the utility's control centre and the smart meter at customers' premise.

The main objective of AMI is to enable two way communications between smart energy meter and Head End System(HES) to enable remote reading, monitoring & control of electrical energy meters (consumer, feeder, DT meters etc.) to serve as repository of record for all raw, validated and edited data.

For AMI various architectures can be employed, the most common being one having data concentrators that collect data from groups of meters and transmit that data to a central server via a backhaul channel.

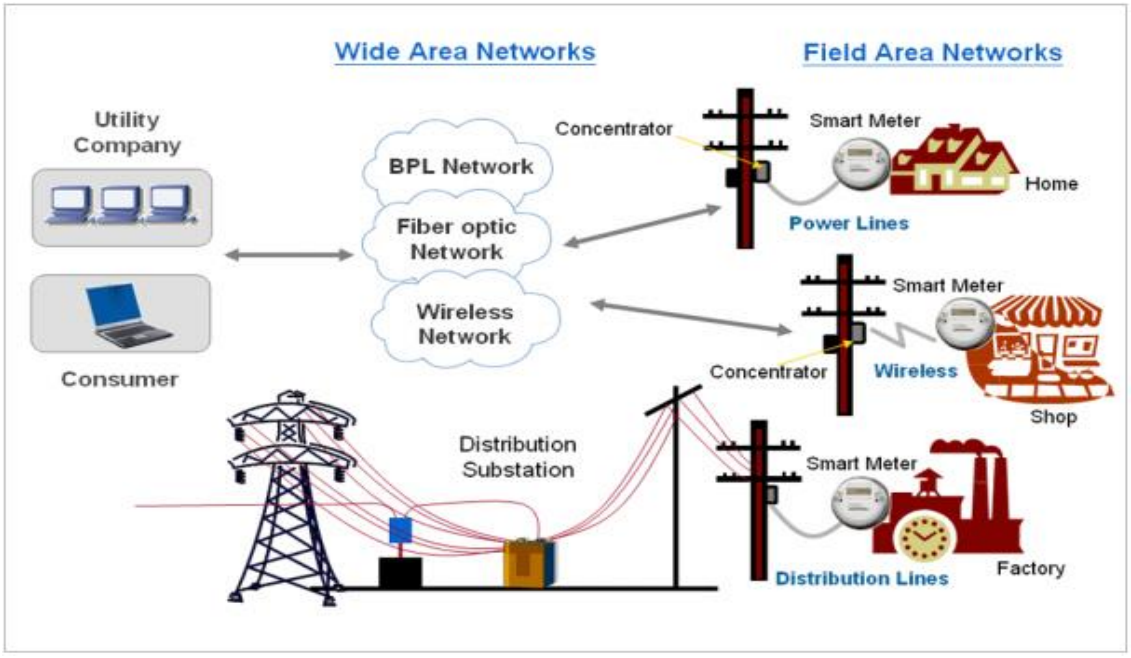


Figure 2.4: A typical Advanced Metering Infrastructure

AMI architecture has two variants as shown in figure below:

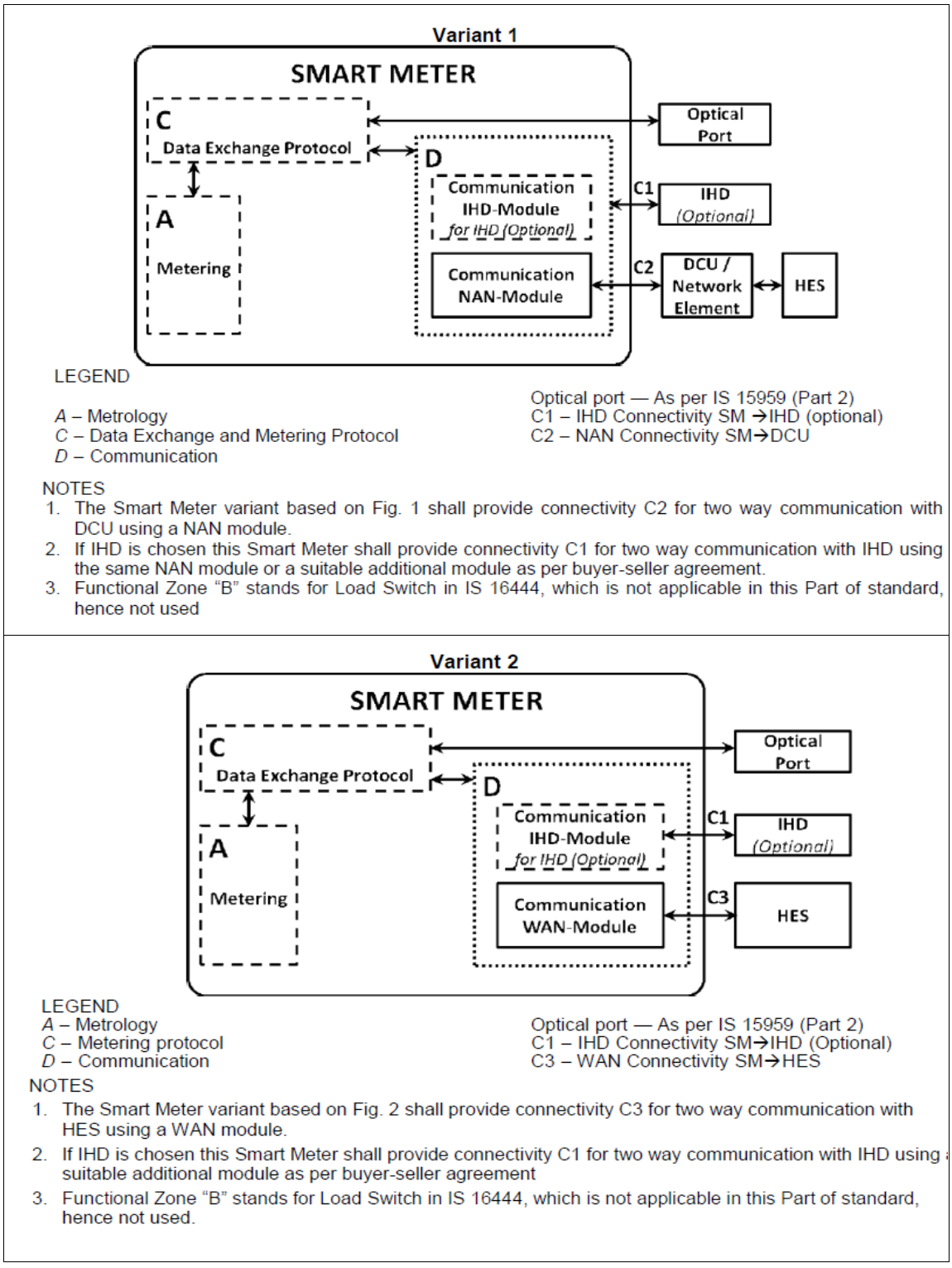


Figure 2.5: AMI architecture's variants

Key Components of AMI:

- Home area networks
- Smart Meters

- Data Concentrators/Gateways to collect the data from Smart Meters through RF/PLC.
- Data Concentrators/Gateways to send data to the Control Centre via
- GPRS/OFC Network
- Utilities Control Centre comprising requisite servers and MDMS.