

**GUIDELINES**  
**FOR**  
**COMMUNICATION SYSTEM**  
**OF**  
**SMART METERS**  
**PLC, RF,**  
**CELLULAR NETWORK (3G/4G)**

CENTRAL ELECTRICITY AUTHORITY

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**1. Requirement of Advanced Metering Infrastructure (AMI) :** The following are the essential parts of Smart Metering/AMI -

- Smart Meters -Single Phase & Three Phase whole current smart meters shall comply with the Technical Specifications (As per IS 16444)
- Communication infrastructure – RF/PLC/Cellular or combination of these
- Head End System(HES)
- Meter Data Management System (MDMS)

Along with, the following are also essential for consumer empowerment and consumer participation in management of load-

- Web application with updated on-line data of consumers etc.
- Mobile App through which consumer shall be able to see information related to his energy consumption. App shall also provide platform for implementation of peak load management functionality by providing existing tariff & incentives rates, participation options etc.

The success of smart metering depends up on strong and reliable communication technology. In communication technology, there are various medium available to choose like PLC/RF/GPRS etc. These all have their own distinct advantages and disadvantages based on the area to be covered and the network back bone available in the area.

**2. Power-line communication (PLC)** is a communication technology that uses electrical wiring to simultaneously transmit both data and electric power without any interference as both are at different frequency. The PLC system is very old and reliable communication medium as compare to all other mediums. In the PLC communication, the network should be roughed, confined and parameter like phasing etc. are taken care since beginning of network laid. Some of the limitation of this technology are :

- slower data transfer,
- interruption on operation of switches, disconnectors in Electrical system
- Distortion of signals during passing through power transformers, inductors etc

Power-line carrier communication (PLCC) is currently being effectively used for telecommunication, tele-protection and tele-monitoring between electrical substations through EHV power lines and proved to be best low cost communication media but the use of PLC through LT distribution lines from

consumer meter up to the DCU would depend upon the condition of the distribution lines .

However, depending up on the network strength and site feasibility, PLC may be used in the smart metering of apartments and colonies where the system is robust and data can be collected at a central server through PLC communication. Ipv6, G3-PLC and PRIME are widely used protocols to enable large scale PLC communication on the electrical grid.



**3. Radio frequency (RF)** is the communication technology whose frequencies lies in the range extending from around 20 kHz to 300 GHz, typically these are used in radio communications. This is also called as wireless communication as compared to wired connection between point of communication in PLC or PLCC.



In RF, higher is the frequency lower is the band width available reducing the range of communication. The distance over which radio communications is useful depends significantly on various factors like wavelength, transmitter power, receiver quality, type, size, and height of antenna, mode of transmission, noise, and interfering signals etc.

As the allocation of special spectrum for the Discoms for meter usages is a lengthy process and involve the recurring cost which may not be cost effective for project, it would be advisable to consider the use of license free ISM band for use RF communication.

In India, following are the free band as notified by department of the telecommunication.

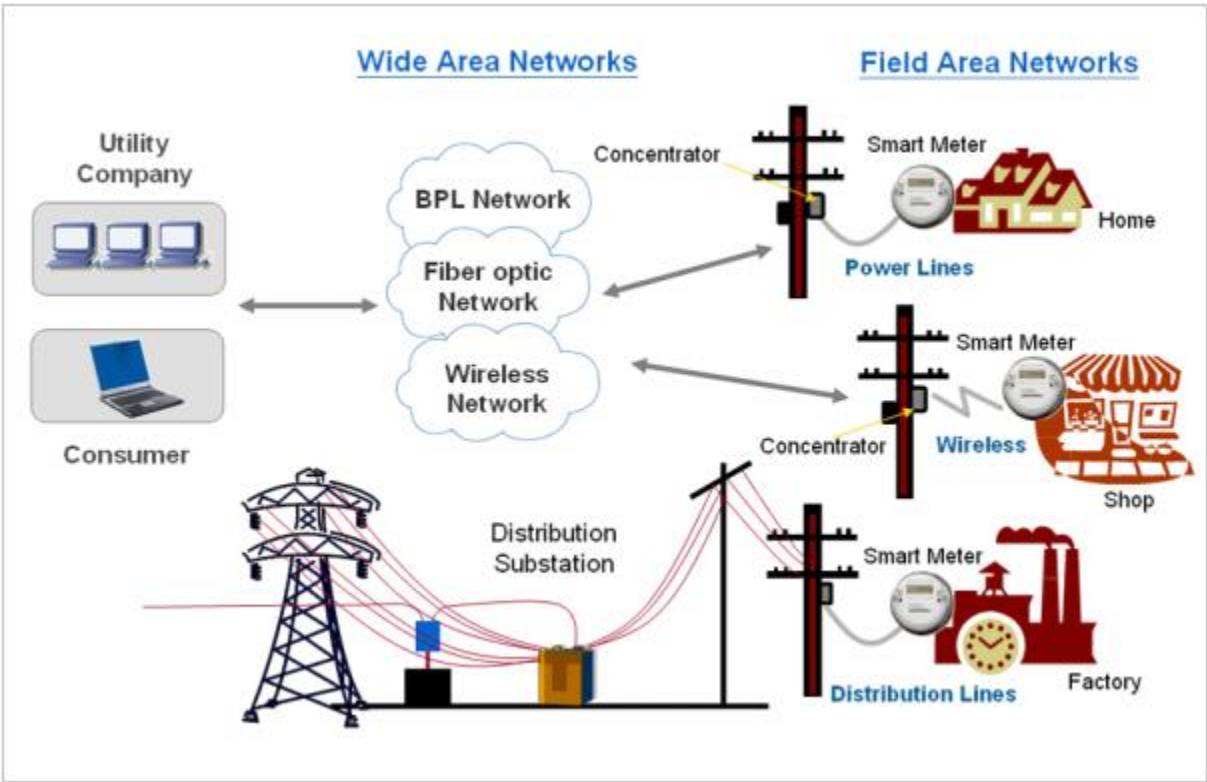
- a. Frequency Band: 865-867 MHz – Use: Low power RFID equipment or any other low power wireless devices or equipment  
Power: Maximum transmitter output power of 1 Watt (4 Watts Effective Radiated Power)  
Carrier Bandwidth: 200 KHz,  
Reference: GSR 564 (E) dated 30 July 2008
- b. Frequency Band: 2.4-2.4835 GHz, Use : Low power equipment  
Power: Maximum transmitter output power of 1 Watt (4 Watts Effective Radiated Power)  
Carrier Bandwidth: spectrum spread of 10 MHz or higher,  
Reference: GSR 45E dated 28.1.2005
- c. Frequency Band: 5.825 to 5.875 GHz, Use : Low power equipment  
Power: maximum transmitter output power of 1 Watt (4 Watts Effective Radiated Power)  
Carrier Bandwidth: spectrum spread of 10 MHz or higher  
Reference: GSR no 38E dated 19.1.2007

The best part of this technology is that the data transmission range can be increased by hopping of the signal over the modems/ frequencies to reach the target destination. For effective hopping of the signal, the overlapping of the range of each radio frequency is very important and can be taken care while designing a network RF canopy.

With the use of this technology, there is a advantage that there is no running cost for using this technology and hence it turns out to be economical for utilities in long run. Only one time canopy installation cost is the main cost which may I be recovered in few years of operation.

There is one challenge in RF due to reduction in range when line of sight of modem/radio is not clear as the signals does not penetrate through concrete structures. To mitigate this, the use of repeaters and high gains antennas need to be installed according to the network topology and geological positioning of modems. Additionally, there is also an interoperability issue as the smart meter would be designed based on the NIC card/ RF card of only one company which would provide the communication medium from smart meter to MDM. However, now a days, a plug and play type configuration of smart meters are available from where the NIC card of one company may be removed and another may be put up in case of change of communication provider.

This technology can be used in smart meters with proper management of the RF canopy communication back bone in any confined area like city or townships etc. The use of this technology ensures lower costing hence lower impact on tariff of consumers in long run.



**4. Cellular network - 3G/4G technology:** This is fast changing wireless mobile telecommunications technology as this has been evolved every around 5-10 year interval from 1G,2G with GPRS to 3G and latest 4G. From 2G GPRS to 3G& 4G, the mobile technology developed to handle voice and data on the same network with good speed.

As this wireless network has expanded upto many small towns/villages, this technology may be used widely in remote area also. Many countries have used 3G technology in smart metering successfully transferring data to central servers of utility.

This is best suitable technology to use the wide spread existing network of mobile operator for handling data. With use of this technology, the utilities are relieved from the maintenance of communication network but they have to bear the monthly rentals/ data charges for using the network of Mobile service provider. This technology provides data at faster speed and found very beneficial in many cities where competition between service providers ensures cost competitions along with good network reach, however, there may be data delay/data loss in the remote areas/ villages where the network strength is poor.

This is having a disadvantage that there is running cost involved for each meter and in long run and for large area coverage, the cost turns out to be significant part of operating cost. Also, there may be many dark patches where we don't get good network coverage many times so collecting data from meters installed in those areas shall pose a challenge in remote villages.

This will have big challenge of obsolescence of the technology in long run ( as from 3G to 4 G and from 4G to 5 G etc) hence the maintenance of communication modems and chips along with rental charges may increase the Opex budget of utilities.

## **5. Comparison of various Communication Technologies**

In comparison of the PLC and RF, the initial investment cost for implementation of PLC at micro level is higher than laying the RF network as more number of collectors are required compared to RF. Also the biggest advantage of RF over other media is self-healing nature of RF hence more reliable. Some time PLC communication may be affected by interference/noise in some cases.

Once the RF canopy is developed then all the other smart equipment can also be communicated over the same canopy hence there shall be leap in automation in micro level and better monitoring of the network and effective implementation of Smart Grid.

A comparative study of RF and GPRS is as below to enunciate the needs:

Functionality Description	RF Based AMI	GPRS based AMI
Quality of Service	☹	☹
Latency	☹	☹
Service Level Agreement	☹	☹
Total Cost of Ownership over 10 years	☹	☹
Initial Cost of Investment	☹	☹
Independent Infrastructure Augmentation	☑	☒
Auto-discovery and self-healing	☑	☒
Independent Troubleshooting	☑	☒
Communication success rate	☹	☹
Dependency on network provider	☹	☹
Additional network IED inclusion	☑	☒
Power Consumption	☹	☹
Maintenance cost	☹	☹

Depending on the utility road map of AMI and smart grids implementation the utilities needs to choose these technologies keeping in view the long term benefits of the AMI keeping the total cost minimal in long run perspectives and embracing to new technologies for becoming smart utilities. However, The ideal solution for successful smart metering may be mix of all the technologies based on the geographical and network conditions in particular area.