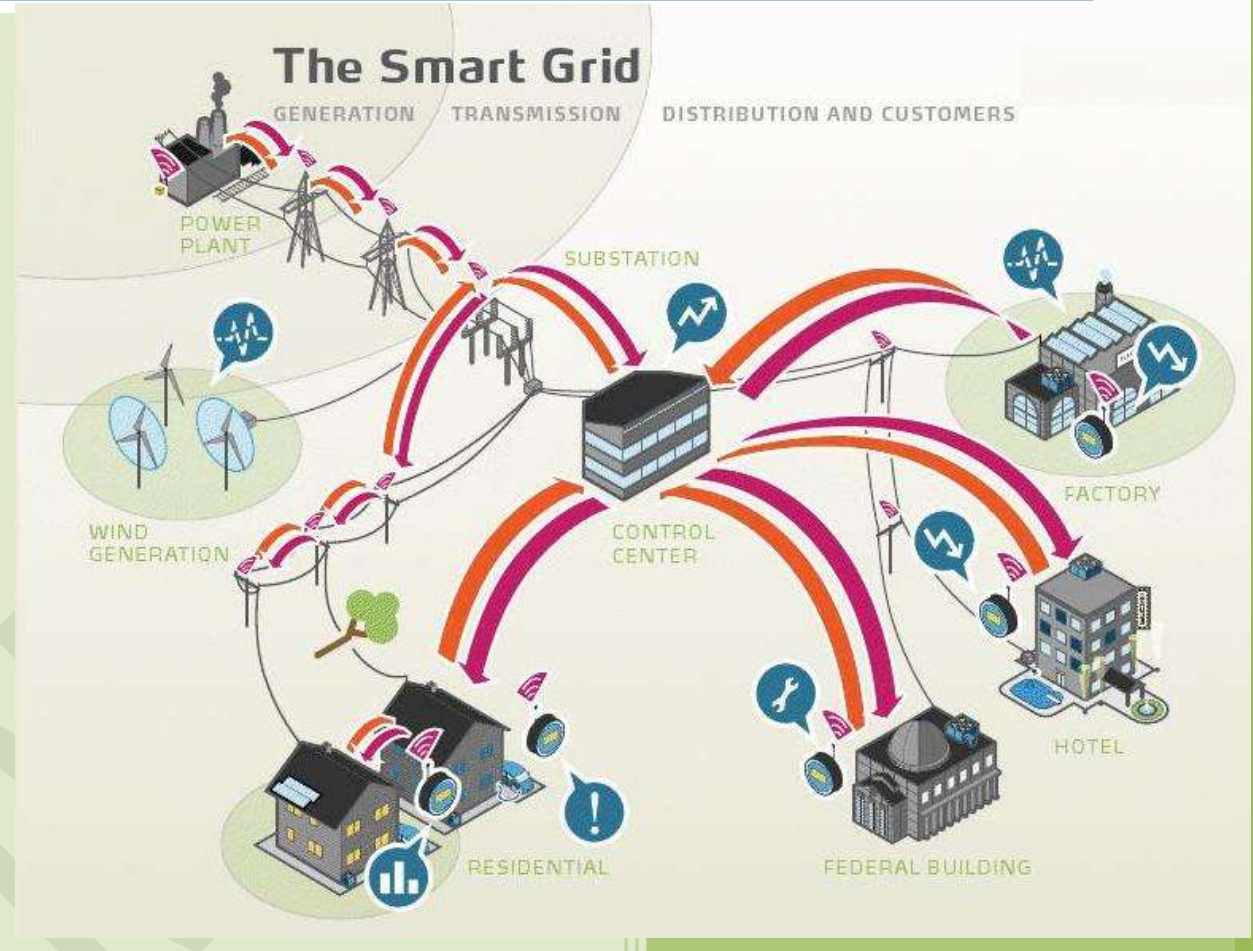
2012

Smart Grid
Intelligent Energy Management System



IEMS
INTELLIGENT ENERGY MANAGEMENT SOLUTIONS

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Table of Contents

1. INTRODUCTION

RF Arrays was established in Silicon Valley, USA during the summer of 2004 to develop and deploy Radio Frequency based products and systems for the global market. Later that year in November, RF Arrays Systems Pvt. Ltd. was launched in Nagpur, MH in order to leverage the technical expertise in India. Our initial & primary goal was to design & manufacture wireless data acquisition and control systems as envisioned by our parent Company.

Over the years, RF Arrays has developed products and solutions which are at the forefront of the technological spectrum. RF Arrays is one of the first companies in the global market to design and develop wireless chipsets and modules based on a 2.4GHz frequency band. Today, these devices are exported to many companies all over the globe, as the 2.4GHz ISM/Wi-Fi bands are internationally accepted as license free bandwidths. Subsequently, all of our turnkey solutions have been developed to work on this frequency band.

With the ever growing demand in the energy utility sector, RF Arrays Systems ventured into developing wireless energy management solutions. With a solution portfolio comprising of 'Wireless Substation Automation Systems and Wireless Automated Meter Reading Systems', iEMS (Intelligent Energy Management Solutions) as a brand concept was launched in 2009. We are proud to mention that iEMS has been widely accepted as a progressive solution in the energy utility sector.

Specifically, iEMS is designed to manage the infrastructure of the respective utilities. 'Knowledge is Power', and having the real time data of one's infrastructure allows for better monitoring and control. Our systems have the ability to conduct energy audits, identify areas of T&D losses, and find solutions in reducing the same. With very high T&D losses, it is increasingly becoming a necessity for the utilities to implement automation systems. The concept is also changing given the analysis of 'Return on Investment' given the immediate tangible and intangible benefits of these kinds of systems. Our systems are designed to take into consideration the many practical issues prevalent, all the while maintaining commercial competitive advantage over our global competitors.

2. SMART GRID

Smart grid is the answer to ensuring a safe, reliable and economical supply of electrical power in the future. Essentially, a smart grid is an intelligent electricity delivery system, in which energy suppliers and consumers are all interconnected through a network. Smart meters are installed in homes and businesses to monitor energy consumption and transmit that information back to energy providers. Energy providers not only have the ability to track energy consumption, but also to automatically throttle down energy consumption on a granular level when demand gets too high.

The Smart Grid is a combination of hardware, management and reporting software, built atop an intelligent communications infrastructure.

In the world of the Smart Grid, consumers and utility companies alike have tools to manage, monitor and respond to energy issues.

The flow of electricity from utility to consumer becomes a two-way conversation, saving consumers money, energy, delivering more transparency in terms of end-user use, and reducing carbon emissions.

Modernization of the electricity delivery system so that it monitors, protects and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the high-voltage network and distribution system, to industrial users and building automation systems, to energy storage installations and to end-use consumers and their thermostats, electric vehicles, appliances and other household devices.

The Smart Grid in large, sits at the intersection of Energy, IT and Telecommunication Technologies.

2.1 WHY SMART GRID?

- Integrate isolated technologies: Smart Grid enables better energy management.
- Proactive management of electrical network during emergency situations.
- Better demand supply / demand response management.
- Better power quality.
- Reduce carbon emissions.
- Increasing demand for energy: requires more complex and critical solution with better energy management.

2.2 SMART GRID IMPLEMENTATION LEADS TO .....

- Deliver sustainable energy
- Increased efficiency
- Empower consumers
- Improve reliability
- Economic Development
- Customer Satisfaction.

2.3 BENEFITS OF SMART GRID.

New Jobs: The manufacture, installation, operation and maintenance of the smart grid and its components will create new jobs within the state.

Innovation: Smart grid innovation will enable the growth of business while rewarding customers with valuable new products.

Lower Costs: Costs rise over time and energy is no exception, but the smart grid should provide less costly energy than otherwise would be possible. As such, it will save customers money which can be invested or consumed as they choose.

Higher Customer Satisfaction: The combination of lower costs, improved reliability and better customer control will raise satisfaction among all types of customers (residential, commercial, industrial, institutional).

Improved Reliability: Smart grid will reduce and shorten outages and improve the quality of power.

Shorter Outages: The incorporation of advanced sensors and measurement (PMU), communication networks and smart systems will allow an unprecedented degree of system visibility and situational awareness of the electric power system. Smart grid will result in shorter outages through its “islanding” and “self-healing” features.

Customer Energy/Cost Savings: As pricing becomes more transparent and is aligned with the underlying economics of generation and distribution, customers’ decisions to save money will benefit society as well

Highest Security: Security will be incorporated into the design of the smart grid and will require the implementation of practices and procedures by individual stakeholders. In this way, the physical and cyber security risks can be managed to the highest standards possible.

Timely renewable: Smart grid is the enabler of more renewable energy. Its development will allow for the timely incorporation of these sustainable sources of power in a user-friendly, cost-effective manner.

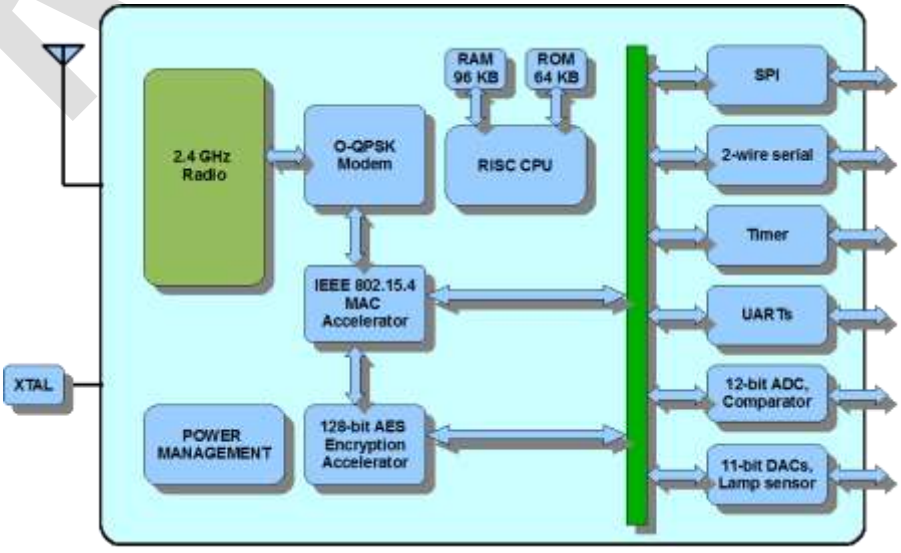
3. WIRELESS TECHNOLOGY (BRIEF SUMMARY)

RF Arrays' Smart Grid wireless solutions are developed on 'ZigBee' Technology, which is a published specification designed on high level communication protocols based on IEEE 802.15.4 standards. ZigBee is the most recent wireless standard optimized for low cost & low power consumption wireless applications. This technology operates in a worldwide license free band of 2.4 GHz and communicates in mesh networks.

The salient features of RF Arrays' ZigBee Modules are:

- RF Arrays's ZigBee Micro is a 32-bit RISC processor, and Every Module has a 64-bit MAC (Medium Access Control) IP Address.
- ZigBee Micro is integrated with RFAs power amplifying chipset, enabling greater wireless range vs. standard solutions.
- Enables Data Compression to achieve better processing dynamics, which further enables scalability of the wireless network.
- Reduced Packet Size
- Greater processing power means mesh networks scalable
- Highly reliable network
- Allows 128bit H/W encryption:
- Secure & Highly Reliable Network.
- No flash on board therefore very low cost
- Integrating RFAs front end enabling greater range vs. standard solutions.
- Developed code can move to mask ROM, protecting IP of client & customer.
- Supports Line, Tree, & Mesh network configurations, which drastically reduces hardware requirements by eliminating point-to-point communication networks implemented in conventional systems.

The block diagram of RF Arrays ZigBee Module is as below:



The Salient features of ZigBee Technology are:

- License free band 2.4GHz
- Can be used even when other 2.4GHz networks are available
- Self-Healing Multi-Hop Mesh network
- Low power consumption
- High data reliability and security
- DSSS, Bi-directional, Message acknowledgment, Low latency
- CSMA-CA channel access yields high throughput and does not get affected by the operations of other devices on the same frequency.
- Designed for minimal cost (no recurring cost).
- The devices in this network can be connected in a tree, star or a combination of both.

4. WIRELESS SUBSTATION AUTOMATION

RF Arrays`s Substation Automation is a Wireless Solution to Measure, Monitor the following parameters at each Electricity Distribution Station and transmit the same to the designated Data Collection Center.:

- Voltage levels (110 V) at three phases (R,Y,B)
- Min 3 Max 9 Current levels up to 5 Amps
- Min 8 Max 25 Digital Inputs which can be used to monitor various processes.
- Min 2 Max 10 Digital Output Relays (125 V AC, 7A). These can be used to control processes within the substation.

- IDMT Relay for earth fault diagnosis (RS 232 & RS 485 Compatible)(for 3 Feeder RTU Only).
- Priority Input feedback - Priority inputs are provided through which instantaneous messages are sent to the Central Control room when the operable limits of parameters are exceeded.

The data will be sent from each distribution substation to the Central Data Collection Center at 30 Minute Intervals unless a priority parameter is triggered at the substation, in which case the data will be sent instantaneously.

The transmission of data will be through a wireless GSM link where this data can be viewed through the front end software on a Computer. Each Substation will have identification protocols to segregate the collected data Center-wise.

The data will be stored on a Server at the collection center. RF Arrays will provide the Front End software to display the various Data Parameters collected from each of the Substations. This software will also display the status of parameters that are to be monitored and is capable of controlling these from the central data collection center. Faults will be displayed instantaneously to enable take fast remedial action.

4.1 HARDWARE

RF ARRAYS DATA ACQUISITION UNIT

The card in the Data Acquisition Unit reads the energy meter parameters connected in 485 MODBUS - ASCII or 485 MODBUS - RTU (remote terminal unit) format(any one format).

Each of the RTU can be connected to 3 feeders in the field.

The Energy meter parameters read are:

1. Energy (KWH) (5 digit)
2. Time (6 digit)
3. Date (6 digit)
4. Active Power (KW) (4 digit)
5. Frequency (3 digit)
6. PF (3 digit)
7. Voltage R phase (3 digit)
8. Voltage Y phase (3 digit)
9. Voltage B phase (3 digit)
10. Current R phase (4 digit)
11. Current Y phase (4 digit)
12. Current B phase (4 digit)

All the above parameters can be modified for data size and/or more parameters can be added as required.

The digital inputs are typically used for:

- Breaker ON/OFF Status
- Trip Circuit Status
- Spring Coil Charge/discharge Status
- Local / Remote Selector Switch Position
- Breaker Isolation status

Digital Relay outputs are used for:

- Switching ON/OFF the breakers
- Switching ON the capacitor banks
- Transformer changing Tap for Increment & Decrement

Data Acquisition & Control Unit

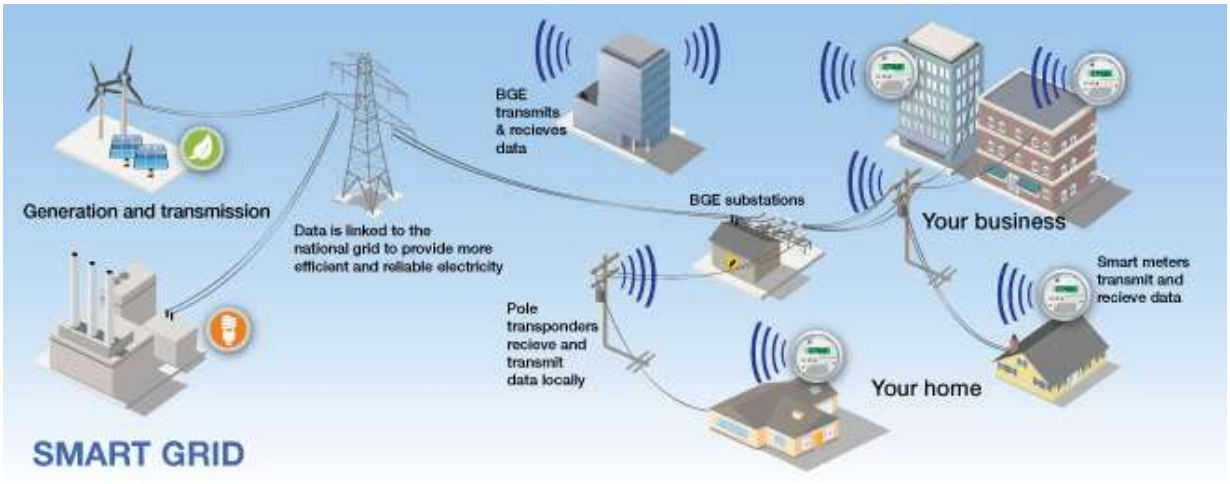
4.2 BENEFITS OF WIRELESS SUBSTATION AUTOMATION

The benefits of Wireless Substation Automation are:

- No need to lay signal cables between the substations.
- Unplanned outages and failures are avoided.
- Minimizes damage and repair costs.
- Maximize Transformer loading through Transformer Tap setting.
- Reduces maintenance costs.
- Extends maintenance cycles.
- Improves Operational Efficiency.
- Sub-Metering and Demand Aggregation at one or across multiple sites.
- Monitor and Document Incoming Power Quality through VAR control.
- Helps Track Problems remotely.
- Provides Effective Distribution Management
- Brings Intelligence to the distribution system.

5. WIRELESS AUTOMATED METER READING

The proposed RF ZigBee based AMR system is to automate the collection of data from the DTC & consumer meters and would be a significant step in meeting the smart grid objective.



The proposed system broadly provides the following functionality:

RF enabled Trivector meters will be provided at distribution transformer (DTC) & Single phase / Three Phase meters at each of the vendors premises. A RF ZigBee network will be created to transmit the data from each meter to a datalogger finally to the server at a Central location for monitoring and analysis. Following parameters among others on real time basis will be displayed and stored:

- Current
- Voltage
- Frequency
- Power Factor
- KW Consumed

5.1 BENEFITS OF RF ZIGBEE BASED AUTOMATIC METER READING SYSTEMS:

- Smart automated process instead of manual
- Accurate information from the network load to optimize maintenance and investments
- Customized rates and billing dates
- Streamlined high bill investigations
- Detection of meter tampering
- Demand and distribution management
- Better network performance and cost efficiency
- Accurate measurement of transmission losses
- More intelligence to business planning

6. COMMUNICATION

The communication offered is a Hybrid Wireless Data Transmission one that uses a ZigBee Wireless Mesh Network and back-haul as GPRS /Optic Fiber/Lease Line Technology.

6.1 ZIGBEE

ZigBee is a published specification, a set of High Level Communication Protocol designed to use small, low power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs). ZigBee is the most recent wireless standard optimized for low cost, low power wireless applications. This technology operates in the license free band of 2.4 GHz and communicates in mesh networks.

6.2 RF ARRAYS ZIGBEE MODULE

The RF Arrays ZigBee module is a low power, low cost IEEE 802.15.4 compliant Wireless micro controller. Combining on a chip 32-bit RISC core, a fully compliant 2.4 GHz IEEE 802.15.4 transceiver, 64kB of ROM and 96kB of RAM provides a versatile & low cost solution for wireless data networking applications. The high level of integration helps reduce the overall system cost. In particular, the ROM enables integration of point-to-point & mesh network stack protocols, and the RAM allows support of router and controller functions without the need for additional external memory. The RF Arrays ZigBee module uses hardware MAC (Medium Access Control) and highly secure AES encryption accelerators for low power and minimum processor overhead. Integrated sleep oscillator and power saving facilities are provided, giving low system power consumption. The device also incorporates a wide range of digital and analogue peripherals for the user to connect to their given applications. This module will transmit data from the Sub Station/DTC/Consumer Meters to a GPRS Modem/Lease Line/Optic fiber from where it will be sent to the Data Collection Center. It will also receive commands sent from the Data Collection Center server through the selected back-haul.

7. SYSTEM DESCRIPTION

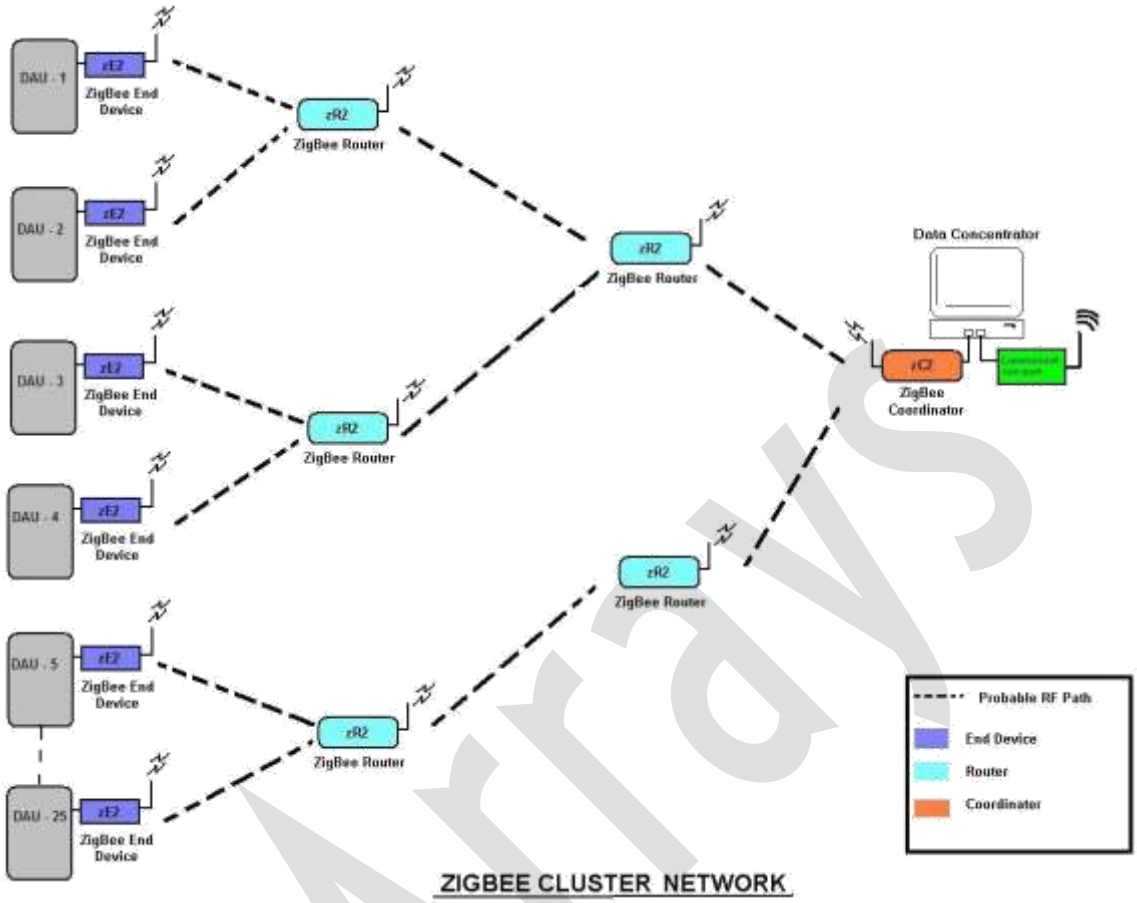
The project execution starts with our carrying out the RF Survey at the substations/DTC & consumer premises where the wireless automation is intended to. Based on the RF Survey, the Substations, DTC & Consumer Meters that can be connected through our Wireless license-free ZigBee network are grouped into a cluster.

Routers are installed, between the Substations, DTC, Consumer Meters based on the RF survey to boost/maintain the signal strength.

At the substations& meters, Data Acquisition Units (DAUs) are installed. Each DAU can help monitor and control the application. The DAU have our RF Wireless ZigBee Modules. The electrical data from one substation/meter hops to the next and a chain is formed. These are then collected and stored in our Data Concentrator on a continuous basis. The Data Concentrator can store up to 15 days of data. The Data Concentrator is equipped with both our ZigBee Wireless and GPRS Modem. The data of all the Substations/DTC/ Consumer Meters are then sent to the Central control location at preset times as required by you through the Back-haul.

In case of events/alarms, these are sent immediately to the central control location and have more priority over the normal data. This helps take immediate action from the central control location. The system can also offer ON/OFF operations from the central control location.

A typical scheme for the monitoring and control of the substations/DTC/ Consumer Meters is as below:



Apart from the data that is received at the Central Control location at preset times, the operator can also get instant data through the network, whenever required.

ZigBee is a highly advanced and most recent communication technology. The data is transferred between the nodes only on receipt of a communication from the receiver that the communication medium is clear. The system also has a self-healing feature. In case, the wireless link is not available for transmission of the data, the system finds alternate routes to make the communication complete. This feature ensures that the system downtime is minimal and also provides increased reliability.

7.1 GRAPHICAL USER INTERFACE (GUI) SOFTWARE

The monitoring and control of various electrical parameters in a substation, DTC, AMR is done through our Graphical User Interface (GUI) Software.

A computer system and a server would be required for monitoring, controlling and data logging.

The front end software will be installed on Desk top at the central control location & will display the required parameters collected from the Substations, DTC, Consumer meters.