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A Result Paper on: Power Grid Associated With Web Using Non-Conventional Energy Source

Kalpesh Rasane[1], Prakash Baviskar[2]
[1]PG Student, Dept. of Electronics Engg., SSVPS COE. Dhule-5, Maharashtra, India
[2]Associate Professor, Dept. of Electronics Engg., SSVPS COE. Dhule-5, Maharashtra, India
E-mail: *kalpeshrasane4@gmail.com* and *baviskarpv@rediffmail.com*

Abstract—This paper proposes a household power unit which is able to automatic switching and will communicatethrough Ethernet/Wi-Fi so utilization of the Non-conventional energy sources like solar energy will become more reliable. Further it will have madeready to end-user through electrical setup. The Arduino MEGA processor is preferred to work as an Embedded Device. The program loaded on this device will be work as Real time operating system. It isnecessary to process, control and communication.
Other services are provided on the top of embedded device. It includes communication with server about the real-timeinformation on energy meters at customer`s location.Energy source selection, power-up the connection and disconnection are some of the services that areprovided through the online web portal. The web browser available at subscriber`s end, can act as an interface to these services provided..
Greater integration of renewable energy generation may be achieved by facilitating battery energy storage systems like integrating remote access to manage the set up like Ethernet, Web communication etc. The smart energy management of the resources is very important aspect. It allows collection of energy from multiple sources. In case of commercial and large scale implementation, the generated power at distribution level can be directly fed to the utility distribution network. Inthis paper, the smart energy management system is used where the battery monitoring systemworks alternately. ARDUINO MEGA 7 microcontroller is used to regulate the actual operating function as a core part of the setup. It is ideally appropriate for residential premises along with commercial applications.

Keywords-*Embedded system with WLAN, Embedded device as a server, Non-conventional Energysource etc.*

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I. INTRODUCTION

In present, we all are contributing to the carbon emissions of this planet earth cumulatively. This takes place in both way: direct and indirect. Global warming has raised because of these carbon emissions and depletion of the ozone layer. Applications of non-conventional Energy Sources in domestic electric grid has always been the greateffective method to minimize the proportion of carbon emissions. We can reduce carbon emission at individual level upon the environment by using alternatives like solar water heaters, solar cooker, and bio-gas plant. But these solutions are dependent on location and climate. The restructuring the electrical setup of the entirehome is a lengthy and expensive process for the residential user. The use of generatedrenewable energy can be efficiently utilized if the way to use the power supply of their homes will be as per necessary. The contribution among the total carbonemissions due to the power generation from conventional energy sources can be minimized by these alternative solutions.

Energy is the basic factor required for progressing the humanlife. The utilization of energy by thehuman beings for their needs is the dominant parameter used to measure the economic, social and industrial development ofa country. Energy demands for industrialization and transportation are increasing day by day as the population is increasing. It leads to energycrisis. To satisfy the world'sgrowing demand is one of the society's foremost challenges. And solution is to discover OR invent the more non-conventional energy resources. Renewable energy resources are abundant in nature and low in cost. They also do not provide carbon emissions. We can contribute forstimulating the economy and providing job facilities by increasing the use of these non-conventional energy sources. It is concluded that solar energy is an efficient, safeand more secure way for generating and providing the clean energy.

The potential of renewable energy sources is large enough and they can meet demand of energy of the world in many times. Renewable energy sources like wind, biomass, solar,hydropower, and geothermal can provide sustainable energy, based on the use of widelyavailable, enough resources. Solar energy is available during day time only and solarirradiation levels are varying due to sun intensity, change in weather and also unpredictable shadows caused by clouds, birds,trees etc. The number of power systems like PV/FC combined have been proposed and discussed. Because of relatively high cost compared with other traditionalenergy sources, manyPV systems are not gaining popularity. Fuel cell cannot store energy. Also it has several shortcomings as slowresponse, it is difficult to cold start and its output fluctuates as the load gets vary. Since strong winds are mostly flow during nighttime. Wind power andbattery are

complementary to some extent. Because, battery has dynamic response and peak power capacity. It also enhances the power generation capability as itcompensates the load by charging and discharging. Hence a hybrid generation system can offer high reliability to maintain continuouspower output than any other individual power generation systems.

The user interface to the services available on web can provided by using embedded system for user which is able to communicate through Ethernet. The user can gain the information from server through a web browserwith an Ethernet connection.

This paper is arranged as further; the section I is about the introduction of the subject. Section II contains the Literature Survey which includes different relevant research presented before with their authors and publication details. In Section III, we describeblock diagram of the whole system and it`s descriptions. The different hardware and components which supports for collection of data fromenergy meter and WLAN communication. Data acquisition process to the embedded system as well as the way used to establish theWLAN/Wi-Fi connectivity aredescribed here. The necessary units fordevelopment of the embedded system, is presented in section IV.Section V is regarding the resultant web-pages and information we achieved after communicating through WLAN. Section VI is regarding future scope and scalability of the whole project. We concluded the whole project in section VII.

II. RELATED BACKGROUND

"Implementation of a Web of Things based Smart Grid to remotely monitor and controlRenewable Energy Sources" by *SaswatMohanty, Bikash Narayan Panda, Bhawani ShankarPattnaik*- 2014 IEEE Students' Conference on Electrical, Electronics and Computer Science, 978-1-4799-2526-1/14/$31.00 ©2014 IEEE [1]

This paper describes a Smart Grid architecture implemented with the help of Web of Things. Web of Things comprise of a set of Web services provided on top of a number of Internet enabled Embedded devices. The Web browser on any computer can act as an interface to the services provided by these Web of Things. The Embedded devices are ARM Cortex M3 Processor based devices withEthernet capabilities. Real Time Operating System is used for process control on each of theseembedded devices. LwIP Protocol Stack is implemented on top of each of these devices so that IPconnectivity can be established. The Web interfaces provides us real time information on each ofthe energy meters that are installed on site and communicate to the Embedded Internet devicesusing Ethernet communication protocol. Real Time energy source scheduling, energy sourceselection, power connection and connection are some of the services that are provided to an online authenticated user. [1]

"The Internet of Energy: A Web-Enabled Smart Grid System" by *Nicola Bui, Universityof Padova and Patavina Technologies Angelo P. Castellani and Paolo Casari, University ofPadova Michele Zorzi, University of Padova and Patavina Technologies*- IEEE Network •July/August 2012 0890 8044/12/$25.00 © 2012 IEEE [2]

The energy generationscenario was started to changeover by different factors. At the end of 20th century, the shortage of the crude oil brought great efforts to research to new and non-conventional energy sources; the raising demand for energy called abrupt efficiency development in the energy generation and feeding processes, and new policy towards the environment changed theprogress of many energy production firms. A more "green" friendly usage of energy resources is becoming an expected and profitable policy. Inthe energy market, the initial attempts of these policies will be considered as a model change. These days, scenario of single energy provider who offers the monopoly getting less preference by society. This market is suffering through the multiple transition stages involving different organizations. These are mostly the providers and vendors, and it isdesired to make open approached model: customers should become energy producers at themselves. It isthankful to the availability and mobility of less expensive photovoltaic array and several reasonable sources of thisenergy which will be renewable. This resultant model of market is very dynamic in the transition point of view due to its distributive feature. This is becoming feasiblebecause of the immediate availability of energy as it depends on wind, sunlight and other similar different sources. [2]

"Smart Grid with Renewable Energy" by *Mrs. N. V. Vader,* Research student (Reg.141012208) JJT University, Rajsthan Head of Elect. Power System Depart V.P.M.'s Polytechnic,Thane India ***Mr. Mandar V. Bhadang***, Lecturer, and Electrical Power System Depart. V.P.M.'sPolytechnic, Thane, India published in Renewable Research Journal (Issue 1-2013) - JJTUniversity and COSIA [3]

Every day, energy demands are raising and hence it causes unbalance in the current grid distributionwhich gives outcomes in several other undesirable situations like load shedding, fluctuations in voltage etc. So it affectsthe customers ultimately. The only solutions to avoid such all situations, is to serve the increasing the demand by present generation of energy. Even we are behind the expectation in case of the conventional energy sources. And hence, by producing more power isnot sufficient by conventional ways also. Therefore, the application of non-conventional energy is most important. The amount of solar powerspread over the surface of the earth is approximately about 86 k Terra Watt. It covers only 0.22% of our planet by solarpanels and collectors. It has efficiency about 8%, it would be more than enough to satisfy the current global powerconsumption. Solar power has

huge potential for satisfying the increasing energy needs of world. And smart grids facilitate the efficient operation of the grid distribution system. “Smart”grids which uses the data and communication technologies, so it makes the electric power systems to be more efficient and reliable, further it is adopted by power industry.

Though the production of power in India has increased and improved in previous years, but there is consistency in demand and we are lagging out of supply. Also high shortages of energy are faced in these years. Lots of skills set are requiring, so the Smart grid and renewable energy can be integrated into a system. [3]

III. IMPLEMENTED SYSTEM

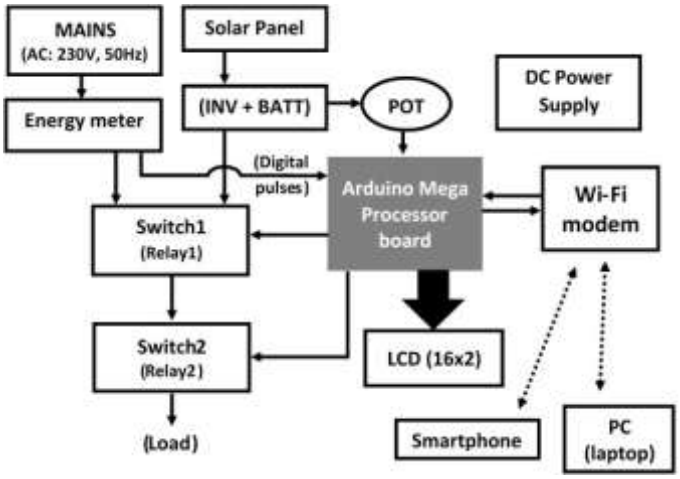

Fig.:1 Block diagram of the system

Power grid architecture presented above has two energy inputs. The first is conventionalenergy source which is typically the mains that left most of the carbon emission residuals within the environment. The conventional energysources includes the Atomic Energy, Steam-turbine power, Thermal power plants etc. Anotherkind of energy source consist of number of renewable energy sources which areenvironment friendly. Our aim is to increase the utilization of these renewable energy sources. Energy derived from solar panels, bio-fuel and energy from Wastes, wind turbines, biogas plant, these are well-known non-conventional energy sources.The digital pulses of energy meter are cumulatively received and processed by embedded system. The collection of data from the digital meter isupdated into the system memory. The web services areavailable on the web page. To establish this, the embedded system is used as server for WLAN communication. These services includes percentage of battery voltage, display of current energy source, meter information on LCD screen etc. As it communicates through the wireless network and serves data available in the memory. Embedded system controlsand makes switching between the energy sources.The sources are switched between non-conventional source to mains byembedded device as per the need arises. Also the embedded system senses the battery voltage continuously. It switches from the inverter to mains when battery voltage goes below than threshold level. (It is 11 Volts in our system.) In case of commercial implementation, it is operated by an authenticated officer to switch between the energy sources and other control actions.

The switching between the energy sources is carried by using relay logic. Embedded device will control these relay circuit.

Hardware units:

A. Non-conventional energy sources:

There are multiple ways to obtain the clean energy. It includes solar Energy, Wind energy, energy extracted from Wastes, Bio-Fuel and Bio-gases, energy from sea-waves etc.We are preferring solar panel as a non-conventional source of energy. A solar panel is not only used to supply the clean electric energy but to charge the battery also.

We have battery to be charge, it is about to 12Volts with 8 AH. Means its maximum backup current will be 8 ampere for an hour. It requires constant voltage charge about 14.4-15 Volts. So, we preferred the solar panel with output voltage of 17 V and it is followed by a regulating IC. (IC7815)

B. Inverter and Battery:

Inverter is there to gain AC output fromDC input signal to supply load. Generally output from energy sources is fluctuating and it needs to be stored in battery. Hence it will provide stable supply of energy to the inverter. Battery is also used to supply DC power in case of failure OR non-availability of renewable energy source. We are preferring the inverter which is capable to run with maximum 45 Watts of load with battery which is supplying 12 Volts.

C. Switching between energy sources:

When the both units (i.e. Battery/NC energy source) are not able to supplythe necessary amount of energy or in case of maintenance/failure, the load will be automatically switched to the mains. Forthis, we are preferring the relay logic circuit. One of the relay is for switching between Mains and Inverter and another is to act as additional switch used in case of maintenance, failure of electrical setup or to control supply.

D. LCD module:

A 16x2 LCD module is interfaced there to display the few of parameters, it includes the current battery voltage level in both the measurements: Volts and percentage, current energy source, the usage of energy consumed from mains in units etc.

IV. DEVELOPMENTOF EMBEDDED SYSTEM

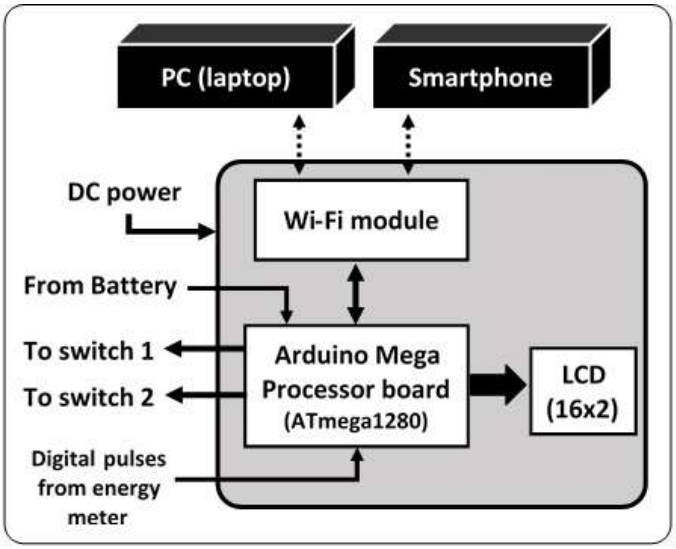

Fig.:2Arduino MEGA is used as an embedded systemand connection with wireless LAN module

4.1 Arduino MEGA is used as a CPU:

Generally we start with identifying the requirements of embedded system which is going to develop. Then the selection of microcontroller or CPU is taken place according to project OR system needs.

The Arduino Mega is chosen to be used as embedded device which has several advantages over other high-end CPUs available in market environment. Arduino processors are consists with enough I/O pins (Digital I/O pins are up to 54) to support the more peripherals. It also has enough memory (Flash memory is up to 128 KB) to operate with real-time operating system. The biggest beneficial thing with the Arduino processor is the availability of large library files. Hence, it is very easy and convenient way to develop the source code. It can supports many of the new peripherals without interfacing with the separate lengthy coded modules. There is no need to prepare the different code modules when interfacing the typical hardware. Examples are: LCD, keypad, Wi-Fi module, DC motor etc. All these features are makes up the Arduino MEGA as a better choice for future advancements.

Also the singlesoftware needs for developing, preparing and debugging the source code. It is only Arduino IDE which is able to support all the programming activity. Even another tool does not needed to download OR burn the code into CPU. Arduino IDE is capable of the same.

In this setup, an embedded system is designed by using Arduino MEGA processor and it'spreferred to work as Ethernet/WLAN enabled embedded device. The program loaded on this device willbe act as Real-time operating system. It is necessary for processing as well as control and communication. The Arduino Mega is a microcontroller board based on the ATmega1280. It has 54 digital input/output pins (out of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. These features of the microcontrollers are particularly suitable forindustrial control, medical systems, and access control and point-of-sale. With a wide range of Ethernetcommunications interfaces, they are also very well suited for communication gateways, protocolconverters and embedded soft modems as well as many other general-purpose applications.

4.2 Connection with energy meter:

The digital pulses are collected from the energy meter. A red LED on the energy meter is usually blinks as per the power consumption takes place. These impulses can be used to measure the energy usage. A connection is made from LED to CPU via anopto-coupler to take place this. We considered an impulse as a unit of energy usage. It is going to stored and retrieved back to display on web page.

4.3 Measurement of the battery voltage:

A connection from battery terminals need to take for sensing the available real time voltage level. This will be analog input and it's given to the ADC of CPU. Digital output is taken from ADC, its gets processed and displayed on the LCD as well as on the web page.

The real time voltage level from battery is varyingaround 12 Volts. But the input pin of the ADC of the Arduino Mega islimited to sink up 4.5 Volts. Hence battery voltage cannot be given directly to I/O pins of ADC. A voltage divider inserted to use for scaling the higher voltage levels as down as compatible with the ADC. It is placed between the battery and input pin of the ADC.

4.4 Wireless LAN module:

We preferred the Wi-Fi module: ESP8266 which is compatible with full of IEEE 802.11 b/g/n protocol services. It is very compact in size and also easy to configure by using predefined set of AT commands. It`s not only serve as a Wi-Fi adapter but wireless internet access can be added also to any Microcontroller-based design with simple connectivity through UART interface.

4.5 Communication with Wi-Fi module:

The serial reception and transmission pins are available on CPU board which is used to interfacing with the ARDUINO MEGA processor in order to establisha wireless local area network.

This is usually done as per the following steps:

1) Initially, CPU setups the serial communication with Wi-Fi module as per the configuration available in its running code.
2) Wi-Fi module establishes the wireless LAN around its coverage region.
3) And the Wi-Fi enabled devices can access the web page by simply entering the IP address into the Web browser.

V. WEB-PAGE DEVELOPMENT

A user interface is designed in the form of web page and it is programmed by using HTML (Hypertext Mark-up Language). It can be accessed on the computerconnected to the WLAN. The user may be subscriber, operator or any authority. The user is provided the data like his/her subscriber ID & name/site name as well as other necessary details. This can be done on theweb page accessed through WLAN**.**These options are like power units consumed by subscriber, current energy source and other parameters like current energy source, the usage, billing amount, battery voltage, control buttons to operate the switches.

We used Wireless LAN as a way of communication from CPU to Wi-Fi enabled device. For that purpose, we developed CPU to use as sever. Web pages are programmed in HTML code and stored in the memory of Arduino processor. These are accessed over WLAN and it is established by a Wi-Fi module. (i.e. ESP8266)These web-pages are displayed at web browser on Wi-Fi enabled device. (Laptop OR Smartphone)

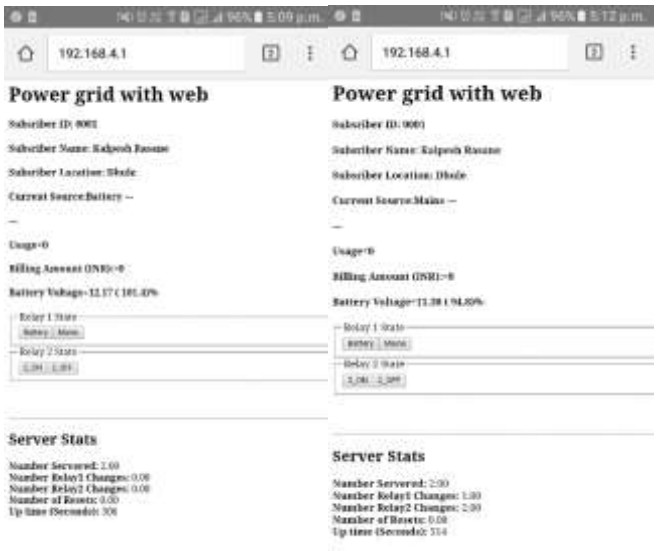

Fig.:3 Web-pages displayed initially when there is switching is between battery and mains.

The information presented on these web-pages includes subscriber`s ID, his/her name, site/location. The basic parameters like current energy source, usage of subscriber, its amount to pay and Battery voltage level in both measurements: Volts and its percentage.

Controls are there to make switching between mains and battery and ON/OFF. Alert message (Battery Low) will be shown when battery level is below than threshold. Loads gets switched to mains from battery at the same.

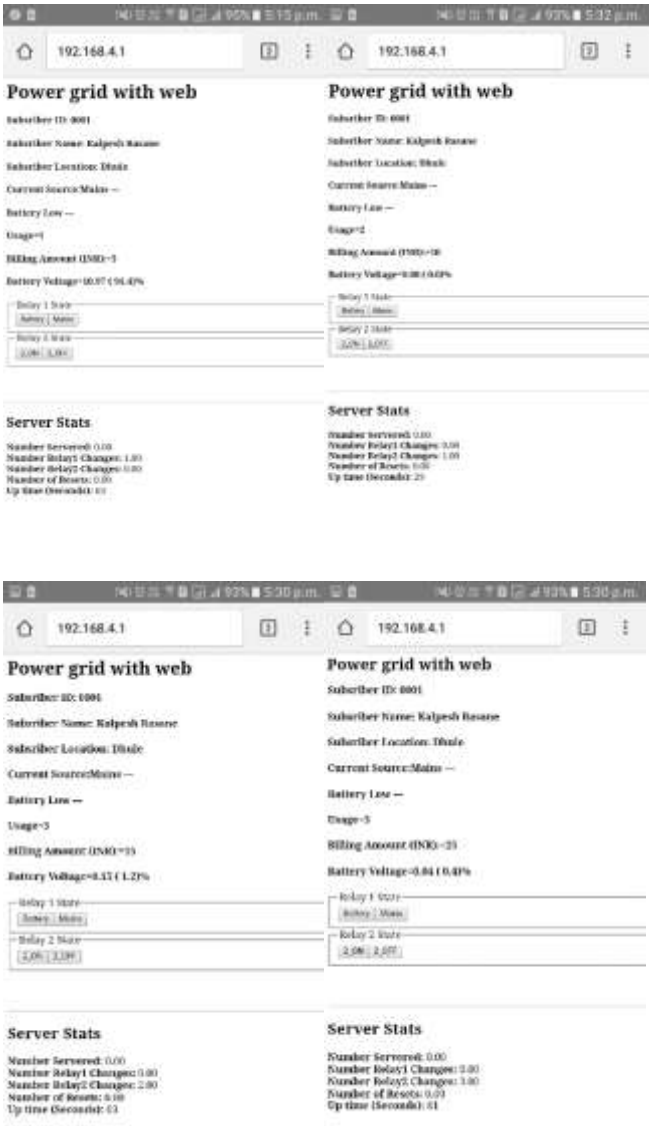

Fig.:4 Web-pages when usage get increases.

When usage gets increased, its amount of payment is also get updated in memory. The updated information can be accessed by simply refreshing the web-page on the browser.

As we are using the CPU as a server, its statistics is also shown at the below of each web-page. It consists communication parameters like no. of served by server, no. of relays switched, no. of resets and session time in seconds.

VI. RELIBILITY

The presented model is reliable to mount up on terrace of residential locations. The whole set upcan be developed with the electrical components and these can be choose according to size of the project.So it will be a cheaper installation on a

countryside region. It can be expanded up to a large scale project with high security. Now days, most services are made available through the Web, the operations and procedures can be reconfigured from remote and it depends on requirements and feedback from user side. The additional services can bedeveloped and managed frequently at the time when the necessary arises.

VII. CONCLUSION

The described system can be easily build up and it is also scalable according to requirements. Itgives an effective way to use our renewable energy sources. It has been underutilized otherwise. We can conclude that; it gives very efficient techniques for deploying greenenergy concept on a scale which may vary from domestic applications to industrial. The integration of WLAN with existing architecture of subscriber power gridwill offer lots of opportunities to us for advancements in our techniques to save energy.

REFERENCE

[1] **"Implementation of a Web of Things based Smart Grid to remotely monitor andcontrol Renewable Energy Sources" by *SaswatMohanty, Bikash Narayan Panda, BhawaniShankar Pattnaik*-** 2014 IEEE Students' Conference on Electrical, Electronics and ComputerScience, 978-1-4799-25261/14/$31.00 © 2014 IEEE

[2] **"The Internet of Energy: A Web-Enabled Smart Grid System" by *Nicola Bui,University of Padova and Patavina Technologies Angelo P. Castellani and Paolo Casari,University of Padova Michele Zorzi, University of Padova and Patavina Technologies*** - IEEENetwork • July/August 2012 0890 8044/12/$25.00 © 2012 IEEE

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AUTHORS PROFILE

Kalpesh V. Rasane, Heis a post-graduate student of Communication Engineering pursuing from SSVPS BSD College of Engineering, Dhule-5, affiliated to North Maharashtra University, Jalgaon, India**.** He also carried the Bachelor of Engineering in Electronics and Telecommunication from Savitribai Phule Pune University, Pune. In present, He is studying the discipline of Communication Engineering in North Maharashtra University, Jalgaon and is currentlyworking as an Associate Engineer in dept. of Network and Systems Services at Cognizant Technology Solutions Pvt. Ltd., RGITP, Pune.

Prakash V. Baviskar, He is an Associate Professor in the department of Electronics Engineering at SSVPS BSD College of Engineering and Polytechnic, Dhule-5, affiliated to North Maharashtra University, Jalgaon,Maharashtra, India**.**