2015-16

Annual Report

Reliance-IITM Telecom Centre of Excellence

Telecom Centre of Excellence, IIT Madras

INDEX

I. INTRODUCTION

Reliance IITM Telecom Center of Excellence was established in 2008 at IIT Madras based on the triparty Memorandum signed between the Department of Telecommunication, Government of India, IIT Madras and Reliance Communication Limited under Private Public Partnership. India has achieved a commendable growth rate in telecom. The real challenge before the country now is to sustain or further accelerate the growth so that the benefits reach the masses.

A Public Private Partnership initiative for capacity building to sustain the telecom growth and help build an environment of innovation by creating synergies among premier academic institutions, telecom companies and the Government of India.

RITCOE has been undertaking the R&D activities in the areas of Telecom Technology and applications, as well as in energy system and applications. During the year, TCoE has been successfully completed Aakash projects funded by MHRD and has been working on the development of communication protocole for charging infrastructure management for electric vehicle.

II.FINANCIAL OVERVIEW

RITCOE started facing funding challenges since 2012, the sponsor has not been releasing any further funds. RITCoE will attempt to raise its own funding through projects and carry out these projects independent of RCOM.

Cost Reduction and Management

After 2012, Management also took following efforts to reduce cost and mobilize resources to meet funding requirement to run the Centre. During the financial year, RITCoE is mobilised funding support from Department Of Heavy Industries (DHI), .RITCOEhas reduced the operation cost, by giving away 50% of the Lab space to IIT Madras Incubation Cell.

III. ACTIVITIES AT THE CENTRE

We are functioning on our own to maintain the talent pool and infra structure needed for the centre and have taken up some R&D projects sponsored through some Government agencies like Department of Heavy Industries (DHI), development projects with IIT Madras Solar Centre, small grants from other corporate and some communication projects which have been internally defined at IITM and found useful.

We are working on Solar DC and communication protocols for Electric vehicles. This would broadened the scope to 'Telecom and Electric Vehicle Centre for Excellence'.

The centre is currently working on following major projects which demands extensive R & D activities.

Project Summary

Closed Projects (2015 - 2016)	On Going Projects	Proposed Projects
Village Communication Network – Funded by MHRD	EV Charging Infrastructure Management - Funded by Department of Heavy	Centre for Battery Engineering and Electrical Vehicles C-BEEV - Proposal submitted and technical

Closed Projects (2015 - 2016)	On Going Projects	Proposed Projects
	Industries	Approved by DHI Commitment from Industrial Partners
Novel Educational / pedagogical application on Aakash - Funded by MHRD	Intelligent Fire Alarm System Internally Funded	Projects at CBEEV - Cell to Battery Pack Design - Battery Lifecycle Tester - Grid Tied Inverters Programmable Electronic Loads
Aakash - Enhancements & Roadmap Funded by MHRD	Building Automation and management System Internally Funded	
WiFi Indoor Positioning Internally Funded	Communication Network for solar DC solution Internally Funded	
	Remote monitoring of Inverterless Internally Funded	

1. CURRENT PROJECTS

1.1 Communication network for solar DC solution

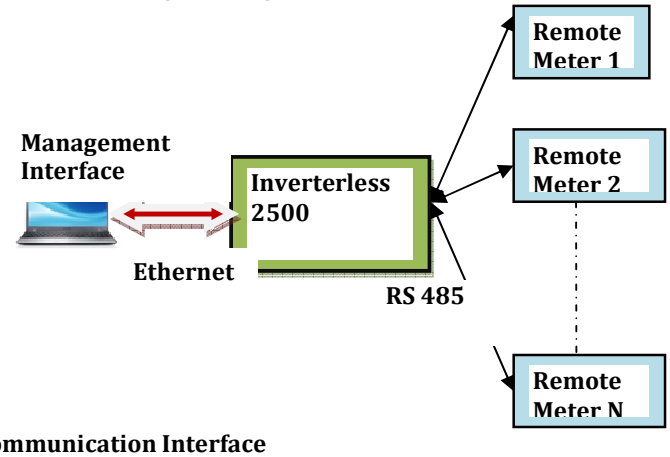
(Internally funded)

This project is aimed at developing a Communication management interface for energy management for SolarDC solution developed by IIT, Madras.

IIT Madras is working on solar DC solutions. This is an intelligent modular scalable solution that enables expansion of the energy requirements based on Solar DC conceived by IITM. The Inverterless 2500 Central unit supplies a 48V DC power line to multiple houses or Office premises.

The Solar power, grid power and battery for backup are intelligently managed by the central unit to utilize maximum power from Solar. A Remote Buzzer and Metering module(RBM) meters and manages the power utilized per apartment/office block.

The central unit is managed remotely with a management system. The Central Unit communicates with the management system using an open standard protocol on Ethernet. The parameters from different sources of power such as power and energy from Solar, power and energy from Grid(Centralized metering) , Voltage and Current limit for Solar and



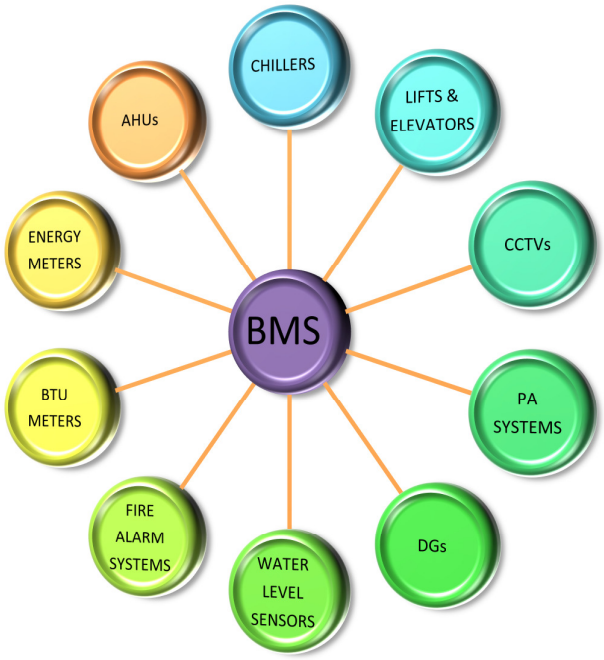
Communication Interface

Grid output is managed with this communication system. We can monitor Power and Energy consumed by each Apartment or office from different sources of power. The power fed by the Inverterless to each apartment (or office) can also be managed for the amount of power that can be supplied during normal operation or during load shedding condition.

1.2. Building Automation System

(Internally funded)

This project provides solution for centralised control for electrical and mechanical equipments of the building.

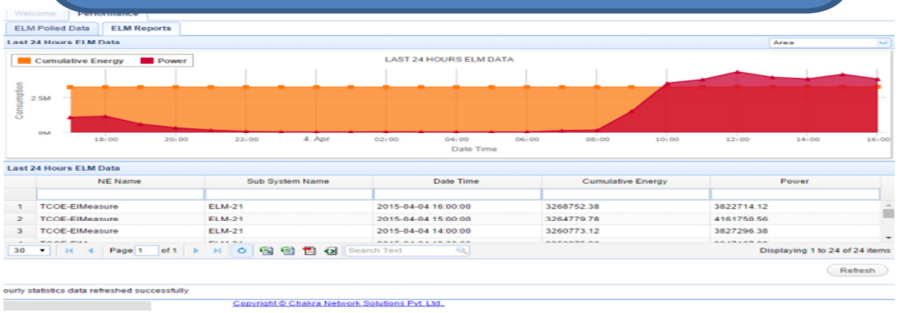


Top view structure of Building automation system

A Building Management System (BMS) is an innovative solution to provide centralized, interlinked networks of hardware and software, to control and monitor the building's mechanical and electrical equipments such as ventilation, lighting, power systems, fire systems, cooling systems, and security systems.

This solution involves implementing protocols like MODBUS to access devices such as energy meters. A Generic interface is developed to access MODBUS devices. Graphic User Interface (GUI) is developed for accessing the parameters. It can plot graphs and generate reports.
Further development work involves the controllers to be built for AHUs, Chillers, Fire Alarms, DG sets, Water tank level measurements, Lighting and control.

Tabular and Graphical Views



Geo-Location based View

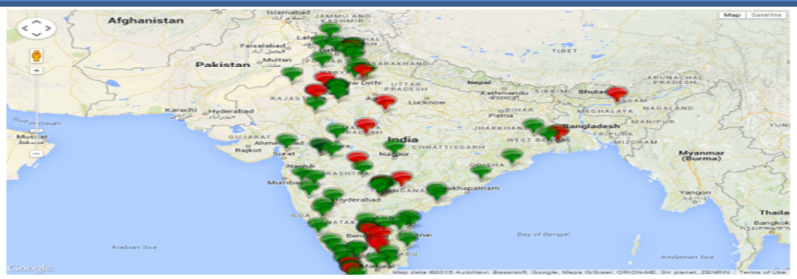
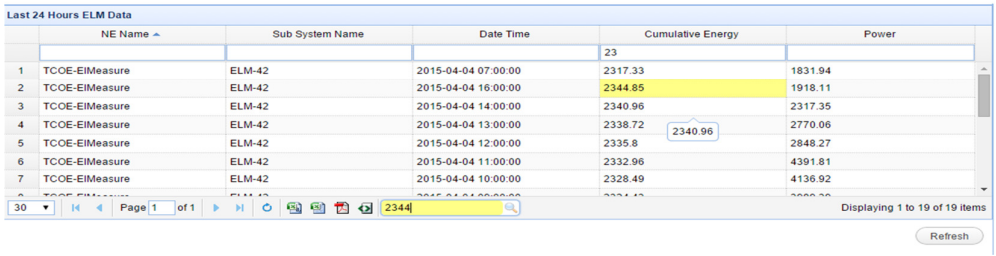
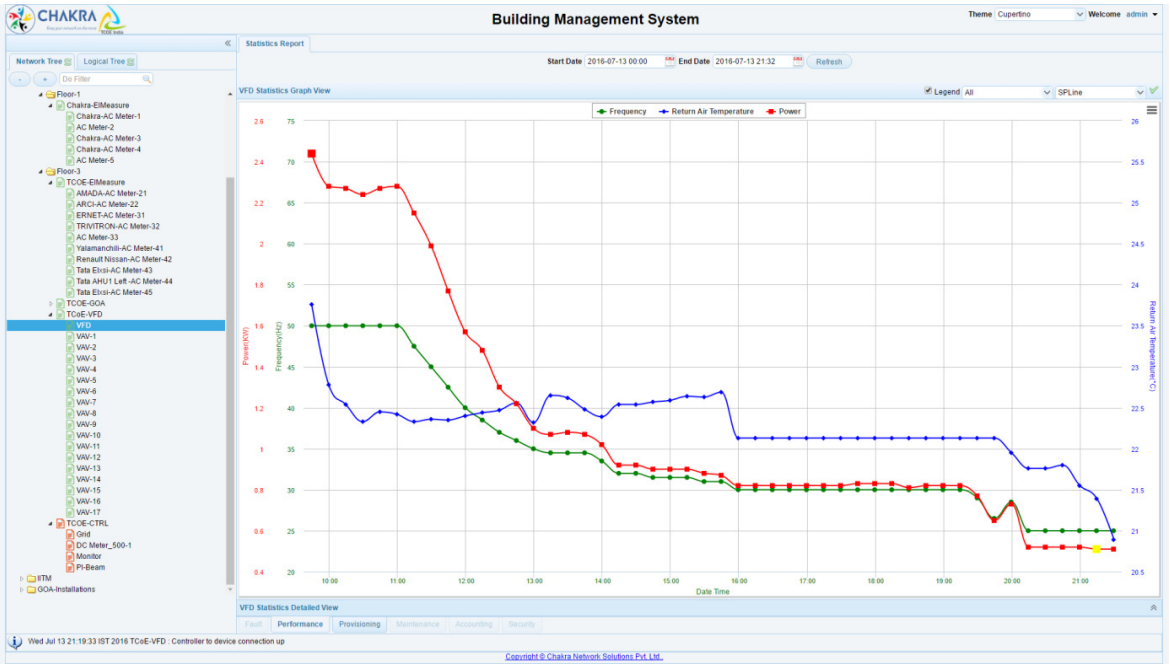


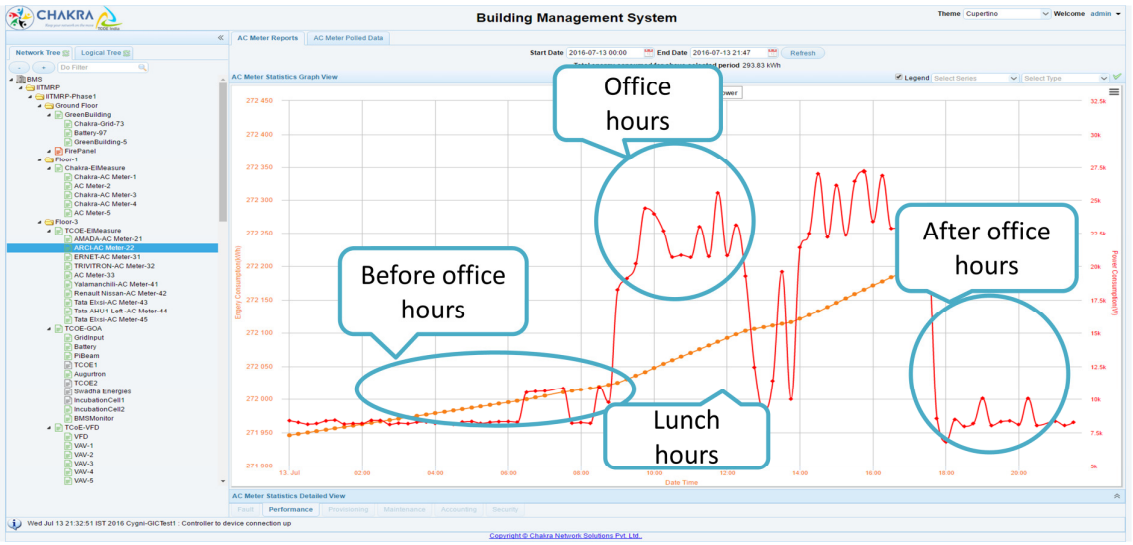
Table Features Export data



Monitoring Samples



Energy Meters



1.3 Remote Monitoring Of Inverterless

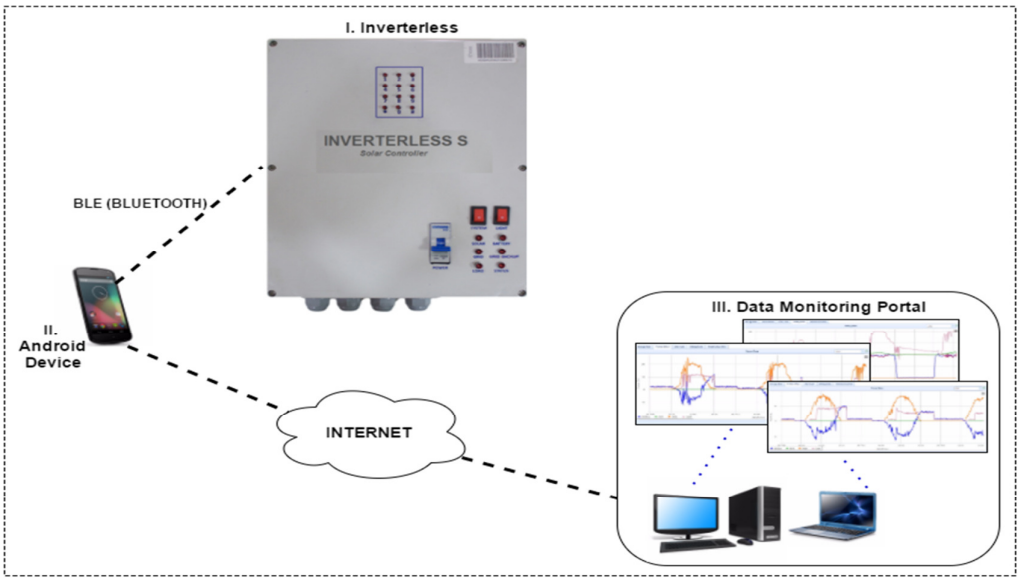
(Internally funded)

Inverterless installations can be remotely monitored in order to track the system's performance and identify issues in a timely manner. The Inverterless controller has an internal data logging mechanism that reads and stores data/measurements pertaining to system operations. This stored data can be read via Bluetooth (BLE)using a compatible Android device installed with the data reader app software. The data collected by the device can then be sent via internet to a central data monitoring server. Once available on this server, the data readings from the remote Inverterless

installation can be viewed on a data monitoring portal (URL) where they are displayed in the form of charts and graphs.

In order to remotely access and monitor data from Inverterless installations, the following are needed:

- *Android device*: A compatible Android device with BLE support and Internet connectivity is used to wirelessly read the data from the Inverterless controller (through BLE) and send this data via the Internet to the central data monitoring server.
- *Android Data Reader app*: The Data Reader Android app is installed on the Android device. It is this software that enables reading of data from the Inverterless controller, viewing data readings on the device and sending this data to the central data monitoring server.
- *PC/Laptop*: A laptop/PC with a working Internet connection is used to access the Inverterless Data Monitoring Portal (URL) in order to view the data pertaining to various remote Inverterless installations.This URL displays the data in the form of charts and graphs so it is easy for the user to interpret and analyse the same.



Inverterless - Remote monitoring of data

The Inverterless controller (I.) performs the principal control functions for operating an Inverterless system. It also logs the data parameters/measurements pertaining to system operations and stores them. For an Inverterless installation, the controller logs and stores data parameters like daily energy consumption, power availability/consumption, state of charge of battery and voltage/current for solar, grid, battery and load. The controller can also wirelessly interface via BLE with any compatible device.

In order to read/access the data logged by the Inverterless controller, a compatible Android device (II.) is used. On this device (smartphone or tablet), the Data Reader Android app is installed. Using this app, one can read the data readings from the Inverterless controller via the BLE interface. Once the data has been read by the app, one can view the readings on the device. These data readings show usage parameters and also indicate if the installation is running as expected and issues, if any.

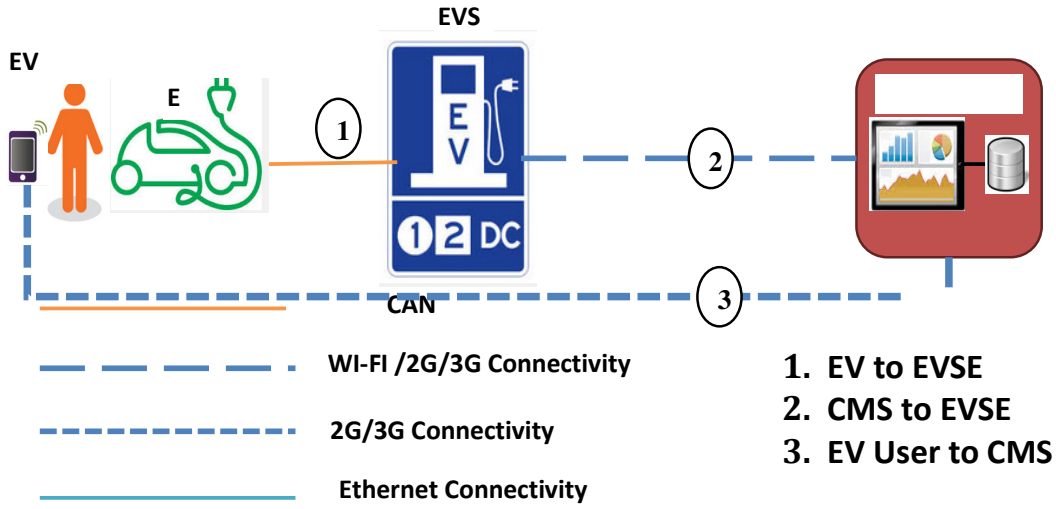
Using the Data Reader app, one can also send the data read from the Inverterless controller to a central data monitoring server via the internet. Once the data is available on this server, it can be viewed remotely on the Inverterless Data Monitoring Portal (III.). On this URL, the data readings

from the Inverterless installation are presented in the form of charts – for example, daily energy usage graphs, power vs. time graphs et al. Options are available to the user to view historical data for an installation and also display the data in various chart formats. The data/charts can also be exported to other file formats (pdf,csv, xls etc.) for further analysis.

1.4 EV Infrastructure Management

(funded by Department Of Heavy Industries (DHI) govt. of India)

India does not have its own oil fuel bank to power its auto vehicles. To be self-sustainable for our transportation requirements, electric vehicles (EV) offer a promising solution. In line with this, Govt. of India is promoting EV and to help the industry grow is participating in various research and commercialization initiatives through grants, incentives and funds. However to scale the manufacturing and sales of EV, a good charging infrastructure needs to be built and managed. Management of the infrastructure is important to understand the health of EV charging stations and to know the charging statistics. This was taken up as a project by RITCoE and is funded by Department of Heavy Industries (DHI), govt. of India. The mandate of the project is to develop a charging Infrastructure Management platform that can manage the EV infrastructure. A typical architecture of EV network is shown below



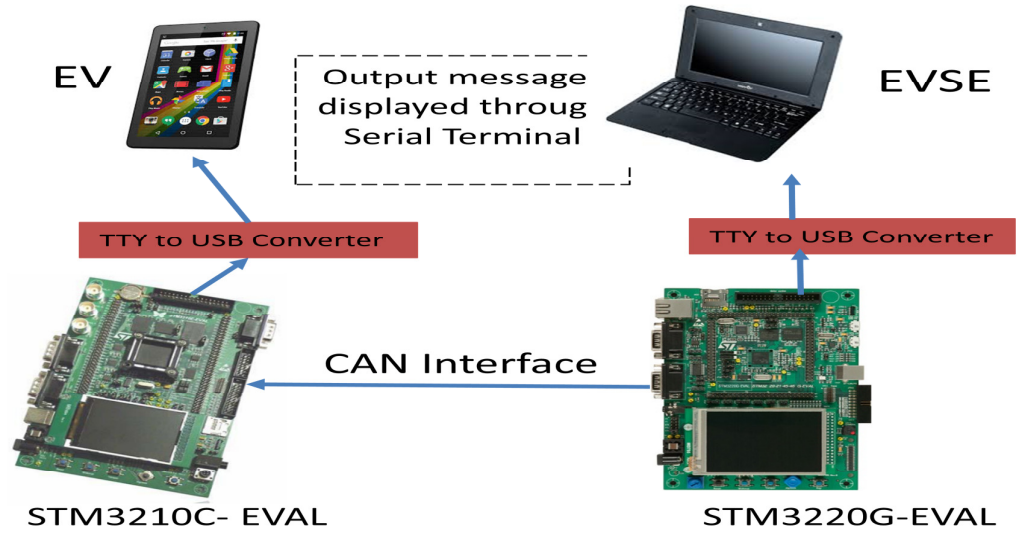
EV Network Infrastructure and communication among different actors

There are three important parts of the infrastructure; EV, EV supply equipment (EVSE) and central management system (CMS). Apart from these three, the EV user is also an important actor. The communication between these actors is shown in Fig 1.

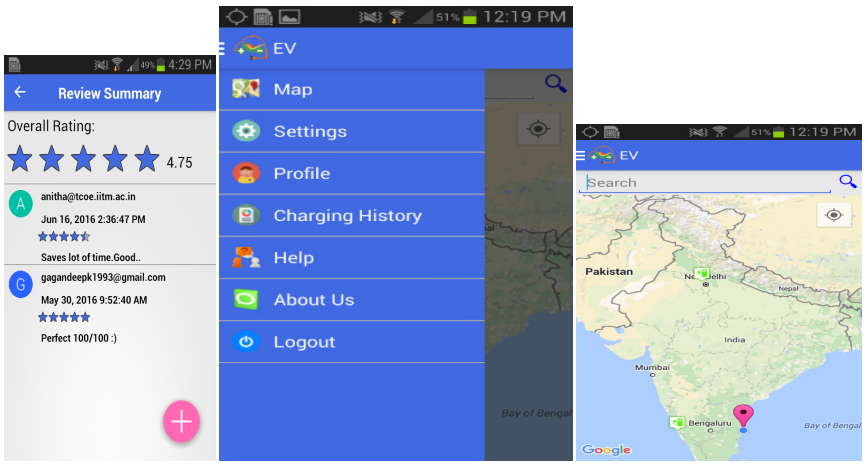
The purpose of the project is to propose and demonstrate the protocols needed for communication between EV and EVSE used for handshaking the information between these two entities essentially required for of charging the batteries and billing the user as per his consumption. IEC61850 standard is being followed for implementing the protocol, the three sets of protocols given by this standards as Chademo (System A), GB/T (System B) and CCS (system C) have been studied and compared. After discussion in the committee, the protocol being implemented is GB/T.

Additionally, the project also intends to implement the communication protocol between CMS and the EV charging station. The protocol being implemented here is Open Charge Point Protocol (OCPP).

For the same project, an app is also intended to be built that will tell the user of the nearest Charging stations, free slots and types of Chargers etc. This side of the communication implementation, targets to monitor the resources used by any given EV and his energy profiling. This will also help in informing the user for his CO2 reduction due to his vehicle being on batteries instead of Petrol/Diesel.



GB/T 27930 Protocol Implementation



CMS – Mobile App. Communication

1.5. Intelligent Fire Alarm System

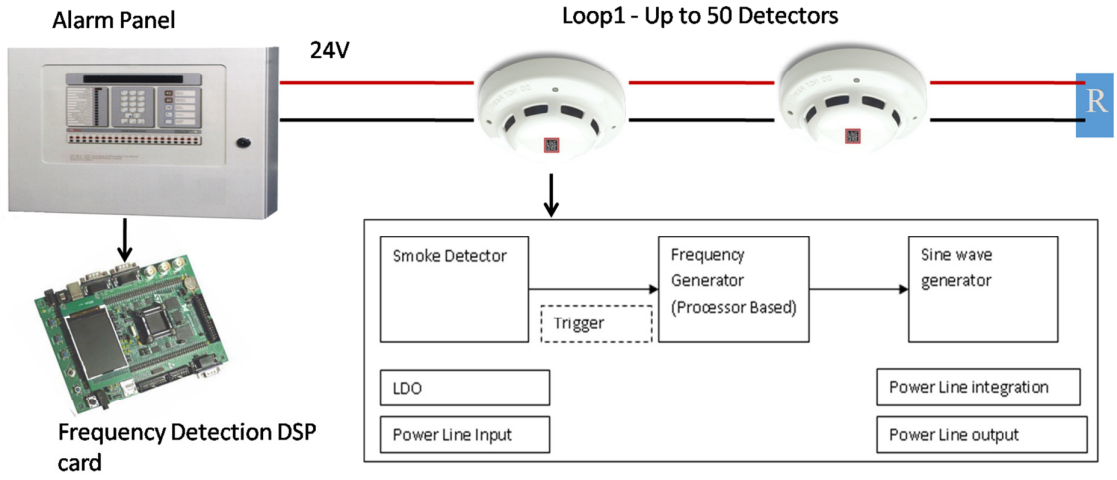
(Internally funded)

A conventional fire Alarm system normally consists of a control panel linked to a number fire detector sensors and a manual call points. The main Fire Alarm control panel has DC power supply source with charger and batteries is located at the entrance of the building.

The smoke/heat detectors are connected in a 2 wire loop to the panel. In case of Alarm condition, the panel drives the hooters and provides LED indication. The first device which senses fire is detected by loop current sensing and Fire Alarm is generated.In this method, the location of fire is not known.

Today, the addressable Fire Alarm systems which can give additional information of the location of fire are available at huge extra cost. They are not reliable since the programming and maintenance of these systems is very complex and expensive. They use special expensive sensors and control panels.

There is a need for a non complex, cost effective and easily maintainable fire alarm system. Our Intelligent Fire Alarm system has a normal inexpensive sensor which sends an unique signal to the Intelligent Line card in the Alarm Panel. The signal is unique for the location at which the fire alarm is triggered. The signal is sent on the two wire loop on which power is fed to the detectors.



Intelligent Fire Alarm Network

The signal is detected at the line card and the information is sent to the Building management system on a Ethernet connection using a reliable protocol . The alarm panel is capable of receiving and processing information from devices other than smoke and heat detectors, and is capable of controlling external equipment, e..g., a sprinkler system, Air handling Unit. The location of the fire is detected and Public Announcement System is

2. PROPOSED PROJECTS

2.1. BLT – Battery Life Cycle Tester

A good understanding of Battery life is key to cost-optimization of Electric Vehicle as well as decentralized solar systems. The batteries need to be analyzed for a real time performance as they

behave differently for different applications. The Battery Life Cycle tester (BLT) is a customizable battery tester which can perform various tests on batteries as per our application's requirement. This can help us determine the number of life cycles the cells can undergo before reaching its end of life. The system can test multiple cells and can log the data of each cell which is helpful in further analysis.

2.2. Li-Ion Cell to Pack Kit

The kit is developed to aid in building Li-Ion Battery pack from Li-Ion cells of different formats. It includes the assembly of the Li-Ion cells and designing the Battery Management System (BMS) with cell voltage monitoring, pack current, temperature monitoring, balancing and protection algorithm. The BMS is designed with passive balancing of the cells to maintain voltage uniformity among the cells while charging. The Battery packs are meant to be used for energy storage in electric vehicles and as backup in solar installations.

2.3. Integrated Efficient Electric Power Train for Electric Vehicles

The project aims at developing a fully Integrated Electric Vehicle to maximize the overall system efficiency and provide a higher operating range. Electric Powertrain forms the heart of every EV. It has various modules which includes Motors, Power electronic modules, Battery & Battery Management systems, Battery Chargers etc which are individually designed and interfaced with other subsystems with their respective embedded controllers and algorithms. The efficient operation of this platform provides a high operating range for EV's.

2.4. Interconnected Multi-village Micro-grids

The primary objective of the project is to develop a power-management system enabling optimum power exchange between grids and micro-grids and load management to obtain maximum benefit. The Solar PV units are integrated into a microgrid and many such microgrids are integrated within a district / taluk / village-clusters into the existing distribution grid to augment the peak power demand and also provide assured electricity when the grid power is not available. A combination of centralized and decentralized energy storage with appropriate energy management system will yield lower cost of ownership and unit price.

3. COMPLETED PROJECTS:

RITCOE has successfully completed the following projects. The completion reports for these projects are submitted to MHRD and the balance fund would be returned to MHRD.

3.1 Village Communication Network

The aim of this project is to provide suitable cost effective last mile broadband access solution in rural areas. Three different technologies were tested to provide a suitable cost effective solution for the last mile broadband access in rural areas leveraging on Fibre penetration being taken up by DOT to reach each village. (National Optical Fibre Network, NOFN). Details regarding the technologies are explained in overall summary.

The most suitable technology (TV white space technology) was recommended to provide broadband services in rural area. One of the major impediments to providing broadband connectivity in semi-urban and rural India is the lack of robust and affordable backhaul. Fiber connectivity in terms of backhaul that is being planned (or provided) by the Government of India would reach only till the Gram Panchayat in the rural areas. In such a scenario, the problem of connecting the Wi-Fi clusters

to the optical fiber PoP can be addressed using a TV white space based backhaul (middle-mile) network.

We believe that a cost effective solution for backhaul would require a license exempt database assisted approach for TV white space spectrum management. Since UHF band is sparsely utilized in India by the broadcaster.

3.2 Aakash Enhancement and Roadmap

The aim of this project To improve the Aakash tablet with respect to higher usability, power consumption, cost and ruggedness. Study of the design and conduction experiments. Review improved performance and cost effectiveness

Aakash Enhancement specifications were approved and published by Deity.
<<http://deity.gov.in/content/proposed-aakash-iv-technical-specifications >.

3.3 Novel Educational / Pedagogical application on Aakash

An educational ecosystem was created with a team of skilled people to create high quality educational content with software tools for delivering the content and manage the learning process. This report covers detailed findings of this project.
URL: http://aadl.tenet.res.in/
Aakash labs were setup in 5 IIT's with TCoE-IITM as the lead member. The Aakash labs were set in IIT Madras, IIT Kanpur, IIT Kharagpur, IIT Mandi and IIT Guwahati

3.4 WiFi Indoor Positioning

(Internally Funded)

This project proposes solution for Indoor tracking, has huge potential for location based services applications like positioning, tracking, navigation, security etc for indoors. Indoor Positioning / Localization are a technique that can locate and track people / things with WiFi devices inside the building. As people are inside the building approximately 80% of time, this has tremendous use for location based services applications ranging from positioning, tracking, navigation, security, time attendance, personnel/things management, automation, etc. These applications can be deployed in all types of indoor environments such as offices, homes, industries, schools, malls, museums, theatres, lodges, airports, railway stations, bus stations, etc.

Among various techniques, WiFi based one is quite popular due to wide spread availability of WiFi infrastructure. The Received Signal Strength Indicator (RSSI) of the received WiFi signal by the WiFi device (e.g. Smart Phone with WiFi connectivity) indicates approximately how far it is away from the associated WiFi Access Point. Using RSSIs from four or more WiFi Access Points, the WiFi device can be located any where inside the building and across different floors also.

We have developed innovative algorithms that gives 3m resolution with 90% accuracy in the same environment. These algorithms exploit the balanced / orderly behaviors of various WiFi Access Points surrounding the area by creating the amount of imbalance equal to the difference between mean RSSI strengths received at two nearby reference locations among which the best location is to be estimated.

Our solution can locate with 3m resolution by more than 90% accuracy (less than 0.1 probability of error).

IV. AUDITED ACCOUNTS

SIVASUBRAMANIAN & RAO
Chartered Accountants

Flat D-2, 3rd Floor, B-Block,
Parsn Paradise, No.46,
G.N. Chetty Rd, T.Nagar, Chennai-17.
Phone : 044-4260 5611 / 4260 5612
E-mail : sandr@sandr.co.in

The Members
Reliance – IITM Telecom Centre of Excellence (TCoE)

Dear Sirs,

1. We have completed the audit of accounts of the Reliance – IITM Telecom Centre of Excellence (TCoE), the Society, and enclose the Balance Sheet and Receipts and Payment Account as at 31st March,2016 together with the Income and Expenditure Account for the period ended on that date duly signed by us under a reference to this letter.. These financial statements are the responsibility of the management of the Society. Our responsibility is to express an opinion on these financial statements based on our audit.

2. We conducted our audit in accordance with the auditing standards generally accepted in India, those standards requires that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatements. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the members, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

3. We report that :

   (a) We have obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purposes of our audit;

   (b) In our opinion, proper books of account have been kept by the Society, so far as appears from our examination of the books;

   (c) The Balance Sheet, Receipts & Payments Account and Income and Expenditure Account dealt with by this report are in agreement with the books of account ;

   (d) In our opinion, and to the best of our information and according to the explanations given to us, the Balance Sheet gives a true and fair view of the state of affairs of the Society as at 31st March 2016, the Receipt and Payment Account and the Income and Expenditure Account gives a true and fair view of the transactions for the period ended on that date.

For **SIVASUBRAMANIAN & RAO**
Chartered Accountants
Firm Reg No : -003904S

Place: CHENNAI
Date : 25/08/2016

(G. SIVASUBRAMANIAN)
Partner
M.No.22806

RELIANCE - IITM Telecom Centre of Excellence (TCoE)

331, Electrical Science Block, IIT Madras, Chennai - 600 036

Income and Expenditure Account for the period from 1.04.2015 to 31.03.2016

EXPENDITURE	AMOUNT	INCOME	AMOUNT
To Workshop expenses	350,452	By Workshop Grant	347,348
Salary / Consultancy fees	573,000	Miscellenious Income	213,599
Audit fee and Certification fee	28,500	Interest from Bank	196,175
Bank Charges	229		
		Excess Expenses over Income	195,059
TOTAL	952,181	TOTAL	952,181

Balance Sheet as on 31.03.2016

LIABILITIES	AMOUNT	ASSETS	AMOUNT
Capital Fund (Schedule : A)	3,380,748	**Capital expenditure (Schedule : C)**	
		Computer & Accessories	2,636
		Plants & Equipments	205,097
		Lab Furniture & Fittings	2,565,554
General fund (Schedule :B)	2,516,420	Office Rent Deposits	607,460
Specific fund for TCoE (Schedule : D)	21,154,013	**Closing Balances**	
		Cash at Bank	24,221,583
Outstanding payments / Advance	681,218	Cash in hand	3,528
		TDS receivable	123,840
		Sundary Advance	2,700
TOTAL	27,732,398	TOTAL	27,732,398

Notes to accounts - Schedule

As per our report of even date
For SIVASUBRAMANIAN & RAO
Chartered Accountants
FRN : 003904S

G.SIVASUBRAMANIAN
Partner
M.No. 22806
Date : 25/Aug/2016
Place : Chennai

For Reliance - IITM Telecom center of Excellence (TCoE)

Dr. Ashok Jhunjhunwala
Co-Chairman

Dr. Andrew Thangaraj
Treasurer

Reliance – IITM Telecom Center of Excellence (TCoE)

ESB-331, Department of Electrical Engineering, IIT Madras, Chennai –600 036

NOTES TO THE ACCOUNTS

Schedule # D

SIGNIFICANT ACCOUNTING POLICIES:

i. Reliance-IITM Telecom Centre of Excellence is a Registered Society under Section 10 of the Tamilnadu Societies registration Act, 1975 (Tamilnadu Act 27 of 1975).

ii. The main objects of the Society being to focus on research and development in telecom as well as energy technology and applications.

iii. As per the charter of documents of the Society, all the incomes, earnings, movable and/or immovable properties of the Society shall be solely utilized and applied towards the promotion of the objects only as set forth in this Memorandum of Association and no portion thereof shall be paid or transferred directly or indirectly by way of dividends, Bonus, Profit or any other manner, whatsoever to the members of the Society or to any person or persons claiming through any one or more of the members. No member of the Society shall have any personal claim on the movable and/or immovable properties of the Society or make any profit, whatsoever by virtue of his membership."

iv. The financial statements are prepared under the historical cost convention on an accrual basis.

v. The amount spent towards specific grants are adjusted against the specific grants receipts and the balance unspent amounts are shown in the Balance sheet under the specific grants account.

vi. Capital Fund: Capital expenditure made out of specific grants are accounted under fixed assets by creating corresponding Capital Fund Account for control purposes and hence no depreciation has been provided in the accounts

vii. Society had set apart following amounts for the specified future activities with conditions to use within 5 years.

Year of set apart	Set apart amount	Date of Resolution
2010-11	2,00,000	Sept 5, 2011
2011-12	3,00,000	Sep 17, 2012
2013-14	9,00,000	Sept 15, 2014

viii. Application made for registration of IP is under process by the Controller of Patent authorities as detailed below.

TITILE	Application Number	App. Date
Voice authenticated lock mechanism	2813/CHE/2009	16/11/2009
Method of interference management for cell-edge users in CDMA systems	2922/CHE/2010	01/Oct/2010

For Sivasubramanian and Rao
Chartered Accountants
Firm Reg. No.003904S

G. Sivasubramanian
Partner
M.No. 22806.
Place : Chennai
Date : 25-Aug-2016

For Reliance-IITM Telecom Centre of Excellence

Dr. Ashok Jhunjhunwala
Co - Chairman

Dr .Andrew Thangaraj
Treasurer

RELIANCE - IITM Telecom Centre of Excellence (TCoE)

331, Electrical Science Block, IIT Madras, Chennai - 600 036

Receipts and Payments account for the period from 1.04.2015 to 31.03.2016

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
To **Grants from**		By Human Resources cost	3,974,932
ABB	250,000	Labspace & Infrastructure recurring	925,151
DHI, GoI	10,000,000	Materials and consumables	35,282
		Workshop and meetings	339,143
		Travel & Accommodation	10,349
To **Other Income**		Administration expenses	180,385
Technology Consultnacy/Services	465,817	Grants to IITs -setting up of Aakash Lab	137,688
Sundary Advance settlement	1,510,000	**Advance payment**	3,528
Bank interest	772,419		
Opening Balances		**Closing Balances**	
Cash at Bank	16,829,805	Cash at Bank	24,221,583
GRAND TOTAL	**29,828,041**	**GRAND TOTAL**	**29,828,041**

As per our report of even date
For SIVASUBRAMANIAN & RAO
Chartered Accountants
FRN : 003904S

G.SIVASUBRAMANIAN
Partner
M.No. 22806
Date : 25/Aug/2016
Place : Chennai

SIVASUBRAMANIAN & RAO * CHENNAI * CHARTERED ACCOUNTANTS

For Reliance - IITM Telecom center of Excellence (TCoE)

Dr. Ashok Jhunjhunwala
Co-Chairman

Dr. Andrew Thangaraj
Treasurer