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Implementation of cloud base Intereactive user interfaces for embedded web server for realization of IoT based home automation

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Abstract -: Internet of things is very promising technology emerging and having potential to connect billions of embededd devices, harnessing true power of connectivity. IoT will provide power and extradimension for working which is currently undreamed by users. But traditional methods of implementation of embedded web server have many limitations on implementation and realization of Internet of Things.Traditional embedded web server lacs in power of computing, rich intereactive user interface, number of maximum supported connections, security and many other problems. latestdeveloped cloud server based user interfaces has potential to become integral part of Internet of Things and can provide intereactive enhanced user interfaces, compared to capabilities of traditional embedded web server. The present paper illustartes the importance of such cloud intarfaces in embedded web server implematations and its ability and possible impact on future applications by illustarting home automation case study.

Keywords: IoT, Cloud computing, embedded web server,

INTRODUCTION :

Embedded systems are the integral part of human lives and plays important role in many real world applicationsfrom simple ones like coffee makers, watches, shoes, to complex likes airplanes, satellite and radars. Human life has been transformed due to automation brought by such embedded systems in ambient environment. An interaction with machines has been changed and had brought tonew dimensions by intelligence of tiny inbuilt embedded systems [1]. There is new transaction is coming in consumer, industrial and electronicsappliances because of Internet of Things. Internet of Things connects day-todays embedded devices over internet and gives them capacity and power to communicate over Internet and capability to interact with other systems. Internet of things bringing completely new applications and possibilities which previously not possible [2].But to connect embedded system over Internet embedded systems requires embedded web sever which can provide them capability to communicate and send data over Internet. There are many implemented HTTP web servers on microcontrollers and embedded computing platforms which can provides data over Internet in the form of HTML pages [3]. Such traditionally implemented embedded web servers havemany limitations and drawbacks as they are implemented on low power, low memory microcontrollers. These embedded web servers even though provide HTML pages, they lag in enhanced modern age, user friendly, interactive user interfaces. They lag in the interfaces available on powerful servers like Google [4]. Big Serves like Google have developed advance tools and methods to present data graphically and in user friendly manner. Such methods are very important and essential for real world data presentation and processing. Tiny embedded web servers lag in implantation of such advance data presentation tools, and have tight limitations on presenting images, animations, and graphics. Cloud base tools have big powerful servers with tremendouscomputing powers and higher end data processing and presentation tools. By integrating cloud server in the development of embedded web server , it enhances the abilities and potential of embedded web server than conventional one [5]. The primary requirement of development of IoT is not only the connectivity to tiny embedded devices and data collections from these nodes, but also convenient data presentation to the end user [6]. Data gathered from such vast nodes is difficult to maintain, process, sort and present. If we look into great details, then we can see that user is interested more in trends, or in decision making based on data, or future predictions, rather than data or absolute value of data. It is now becoming necessary to collect data in neat format ,process it in real time, and draw conclusions and present it as per user need and requirement. Tiny embedded web servers are capable to connect and send data over Internet but it is very difficult for them to satisfy the entire requirementsof modern users. Internet of things will generate big data and it requires correspondingly developed tools for analysis and decision making. Such big data analysis should be done on higher endcomputer base servers. Such requirements arenotsatisfied by low power embedded web servers. As Tim Hartford of the Financial Times notes, “Big data has arrived, but big insights have not” [7].Special data analysis tools also required as along with simple data collection tools and summary of data.

One of the key factorhave to be considered in modern web technology is the highly developed data presentation tools, support from higher level and

scriptlanguages, which is the outcomeof hard work of nearabout twodecadesin computer science and web technology. If such developed modern age tools are used in development of embedded web server then enhanced version of traditional embedded web server having new capabilities can be implemented, which can become basic building block of IoT. The present paper discusses the capabilities of such embedded web server by using such cloud tools compared to traditional embedded web server by developing simple home automation embedded web server application and its front user interface.

Traditional Embedded web server:

Traditional embedded web server consistof implementation of HTTP web server on Microcontroller or custom hardware which serves web pages containing data to remote user. Normally this data is in the form of text, because of limitation on memory, calculating power, and limitations of development tools [8]. If we want to provide rich-text and graphics enrich content web pages, then it will become very difficult to develop such pages, configure them in real time and provide pages to end user as per need on microcontroller. The basic architecture of traditional embedded web server is shown in figure 1.

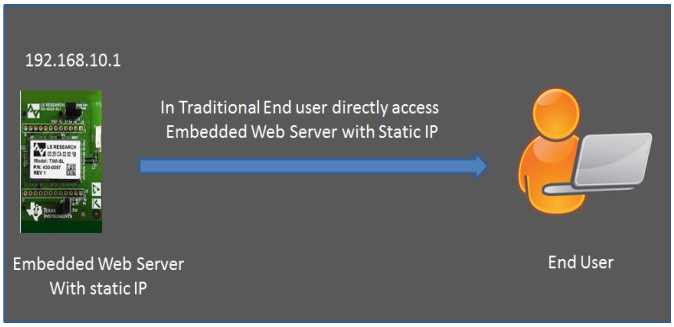


Figure 1: traditional implementation of embedded web server.

In traditional implementations user directly access to embedded web server, and sends HTTP request for desired information. Then the embedded web server searches it database for required information, if such information is available then it configures the required information in the form web pages and send it in the form HTML pages. In traditional methods webpage typically displayed on end user computer screen when accessed,and data is displayed only in textual manner due to limitations of embedded device. The traditional web server lags in implementations of advanceuser interfaces, which we use on Internetin day –today life.Today users are accessing rich web pages implemented with graphics and animations, which has tremendous capacity to present and visualize data to user in very convenient format. These traditional methodsalso limitssecure login methods to the users, because higher end encryption-decryption algorithms are very difficult to implement of low computing power microcontrollers. Embedded web server implemented on microcontroller has many limitations,and needs new way which can integrate the advance facilities available in web technologies to the end users while accessing these tiny embedded web devices. The cloud interface is one of the solutions evolved to integrate such facilities and enhance the capabilities of tiny embedded web servers [9].

Cloud Interface based embedded web servers:

Cloud Interfacesapproach in the development of embedded web server development integrates cloud server between embedded device and user as shown in Figure 3.

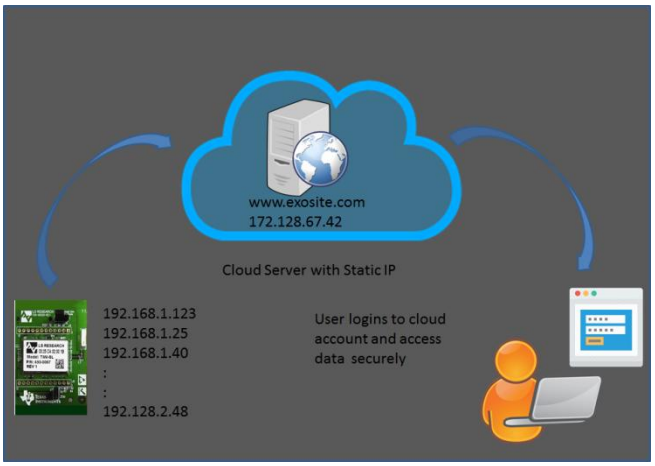


Figure 3: Embedded web server: a Cloud server interface based approach

In this approach embedded web server sends data to cloud server typically in HTTPpacket format. This data is collected by cloud server and stored in its database and organized by cloud server. User has to login to this cloud server using its login id and password to access data. In this model cloud server provides very secure way to access data. The cloud server has different accounts for each user and each account has portal where all connected devices and data form these devices is displayed. In this paper we will focus on power of cloud servers and cloud service providers for data storage and data presentation using advance tools by developing a home automation solution on cloud server.

Exosite: a cloud server provider:

For home automation application development we had selected the Exosite : a cloud service provider, which provides different tools and solutions for development of Internet of things. Exosite provides portal to the users to add devices and create dashboards. The Figure 4 shows such

successfully created and added device on Exosite portal for our home automation purpose.

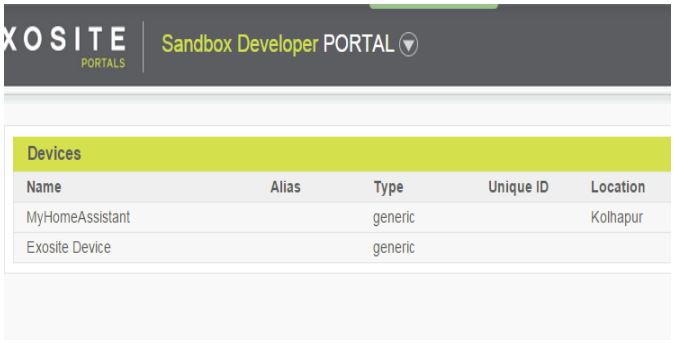


Figure 4: Added device for home automation onExosite cloud.

numbers of devices can be added on the portal. Exositeautomatically isolate and channelize data coming from different devices without any collision between them. On Exosite data is get properly organized without any user interference or any other required assistance, it has built in capbility to organize and channelize data, which is primary requirement when thousands of devices will getconnected to Internet. Also user can access it's all devices in one single account and on one single page compared to traditional techniques of different domain name and web page for each device. User can select device on portal, about which he wants to know and want to control.

User ingerfaceon Exosite cloud server:

On ExositeEach device have its own data ports, which collects data coming from device, channelizing and separating it according to each data source. For example home automation server "MyHomeAssistant" has data sources of ,

- Temperature
- LPG lealage
- Door status
- Lights
- Fan
- PIR sensor
- Fire sensor

Data collected from all these sources is routed to the same device but with different data ports, which simplifies data management and processing. Figure 5 shows the display of data from all these data ports on "ListView" widget. Exosite has different widgets to display data to the user. Widgets are a graphical tool whichdisplays ,visualizes the data and along withinsights to the end user. These widgets are ready to use on Exosite and developer can pick up any widget and link such widget to any data source to visualize data to theend user. List-View is one such widget where data from all sources of deviceis listed according to data source, and it display its name, last received value and time of reception.

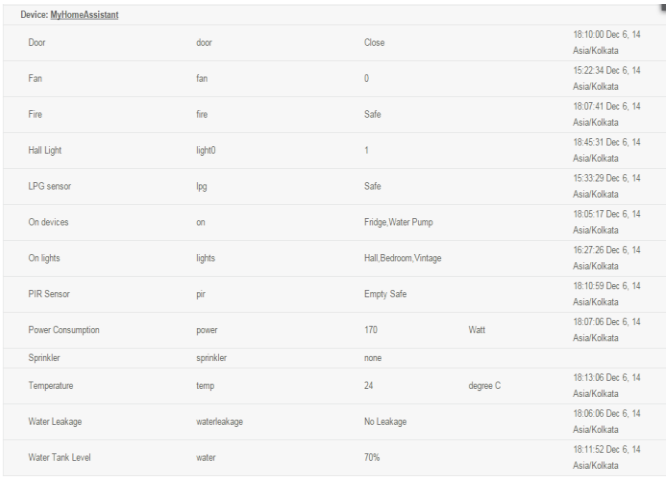


Figure 5: Data list view of "Home Assistant " device.

We can use different widgets for different devices to visualize the data. Such widgets can be organized on the dashboard of the device for user visual interpretation.

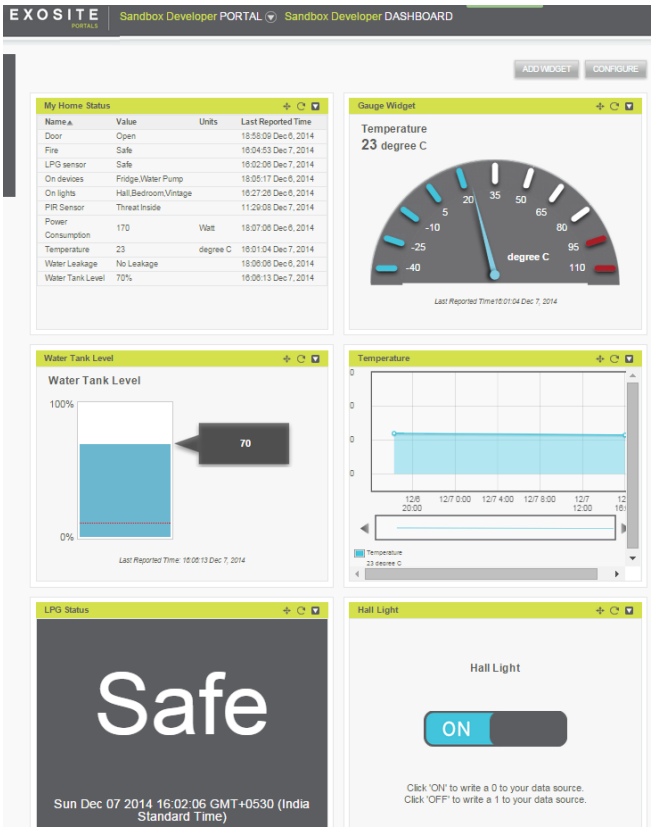
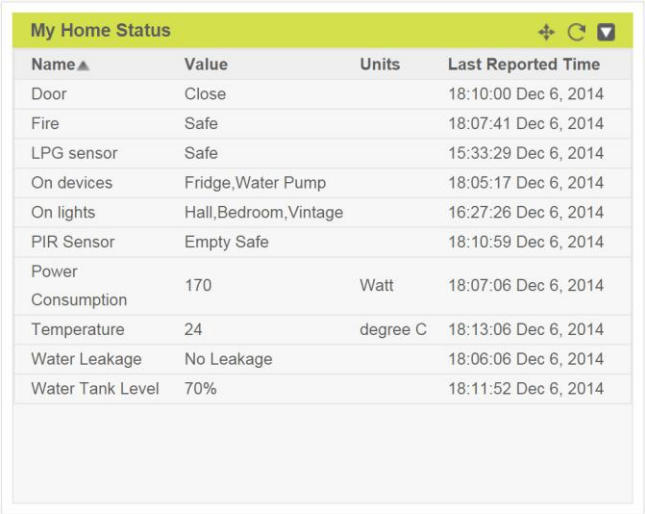


Figure 6: Dashboard of "MyHomeAssistant"

Figure 6, shows the developed dashboard of the device entitled "MyHomeAssistant" on Exosite. The dashboard displays the different widgets configured for different data sources, user can alter it and also rearrange it as per its need. He can also add or delete different widgets on dashboard as per need. Dashboard in figure 6 is sufficient to prove the power of cloud base tools to display and visualize data compared to simple text based data presentation. Human brain has simplicity to find and draw conclusion from graphs and images than text base data. In one look on dashboard user get required status and information of device.He can understand the exact status of home without any further detail investigation and take decisions accordingly. The readily available widgets are very important tools to visualize data. Developer can assign any particular widget to the data port as per necessity and requirement. Figure 7 shows the data displayed form source in "list widget" of server. Here user can get current status of all the data sources in well-arranged manner.



Name	Value	Units	Last Reported Time
Door	Close		18:10:00 Dec 6, 2014
Fire	Safe		18:07:41 Dec 6, 2014
LPG sensor	Safe		15:33:29 Dec 6, 2014
On devices	Fridge,Water Pump		18:05:17 Dec 6, 2014
On lights	Hall,Bedroom,Vintage		16:27:26 Dec 6, 2014
PIR Sensor	Empty Safe		18:10:59 Dec 6, 2014
Power Consumption	170	Watt	18:07:06 Dec 6, 2014
Temperature	24	degree C	18:13:06 Dec 6, 2014
Water Leakage	No Leakage		18:06:06 Dec 6, 2014
Water Tank Level	70%		18:11:52 Dec 6, 2014

Figure 7: View of "HomeAssistant" in the list-view widget.

List-view widget display data with normal attention but in well-arranged manner, so user can easily understandit. But many data sources requires quick user attention when some important event happens. For example if LPG leakage is detected then information from data source should be display in such way that it will gather the attention of user. Exosite has " Big data display" widget for such purposes. It Displays data in big fonts and grabs the attention of user.

Figure 8: "Big data display" widget to provide information to user.

The widgets provided by cloud server are not only limited to the text base data, but they also provide graphical data presentation tools like graphs and maps. The temperature of home is displayed in line graph giving interpretation of trends intemperature changes, which is more important to user for taking decisions. Many times data is not important to the user but the trend posing by data is moreimportant. widgets like bar graphs and line plots are available to applications which requires predictions in trends. These tools are ready to use on cloud tools like Exosite, which can be used without writing any code or requirement of anyother development.

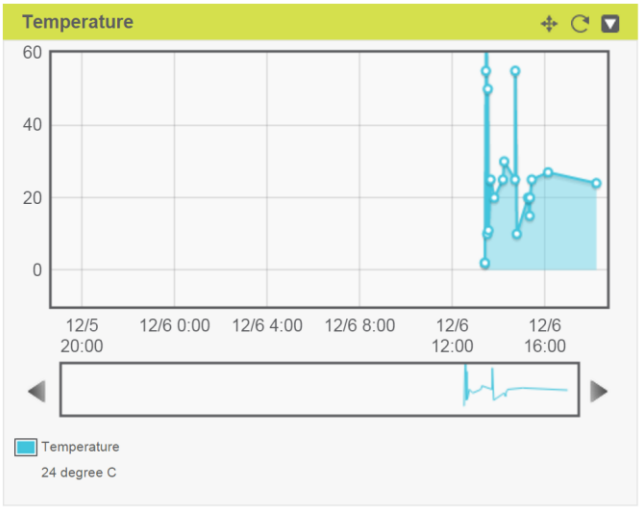


Figure 9: Temperature Display by "line Graph" widget indicating trends.

There are many other graphical tools are available which can be used to indicate other types of data like liquid levels. "Tank"widget is available on Exositeto display levels of liquids. It is very difficult for human brain to take decision instantly when liquid quantity is given in liters or in the form of percentage of tank level. But as shown in figure10 the "Tank" widget on Exosite provide graphical indication of water level in the home tank. User can get states of water instantaneously by just looking at the widget. Such powerful data presentation tools are available on cloud servers which can be used to present data in more advance and user friendly way.

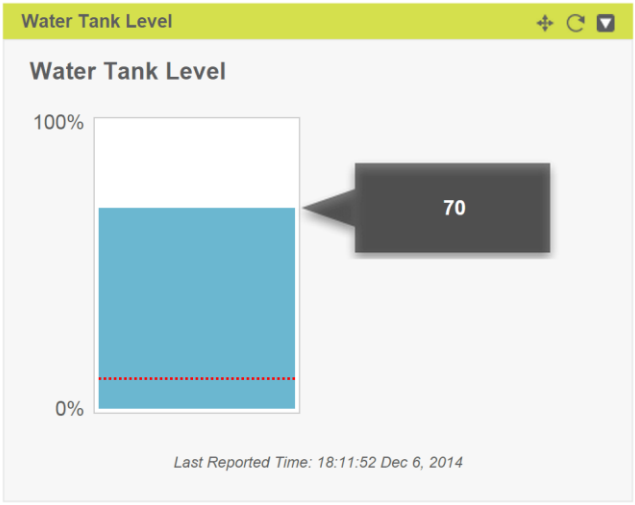


Figure 10: Water level indication in smart home by "tank "widget.

IoTconnecting thousandsof movable sensors to the Internet. It is very important to locate these sensors and nodes online to the users. Such movable and portable devices can be easily tracked and there accurate positions can be displayed on maps by cloud servers. In traditional methods user can get only coordinates of device, but in cloud based servers these devices are displayed on maps, and there locations are displayed very accurately on maps, as in figure 11.

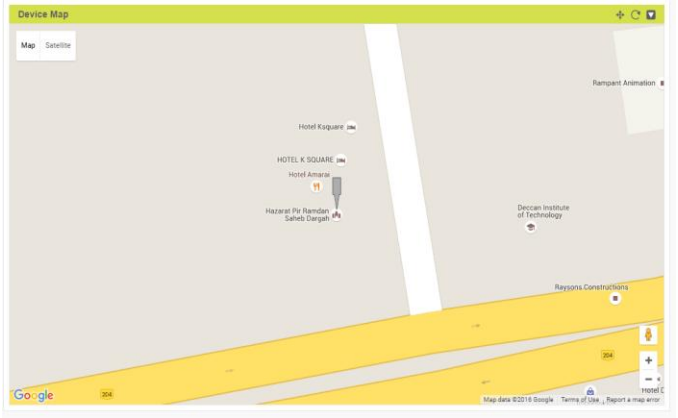


Figure 11: Device location tracking using maps.

There are also many other widgets are availablewhich can be used for data presentation according to data type like bar graphs, gauges and many others. These cloud servers not onlyprovide tools to display data and to control the devices but also provide toolsfor detection of real time events and send alarms to the user. These real time events can be programmed for particular event on Exositeand can be get triggered when such event happens in real time. Figure 11 shows such event concept on Exosite.

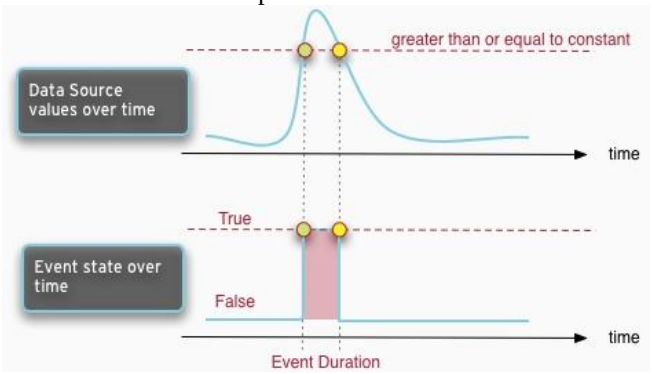
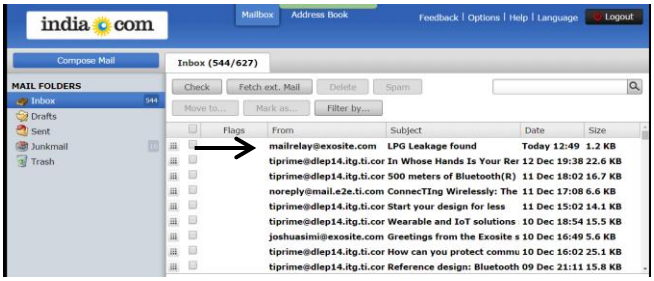


Figure 12: Event creation on Exosite

After creation of such events on Exosite, server can send alert mails and SMS to the user, in real time, generating real time alarms to the user.
Figure 12 shows the mail delivered to user when LPG gas leakage is detected.



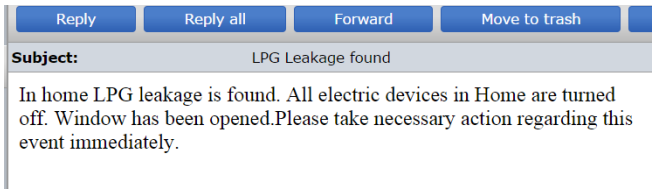


Figure 13: Mail received from Exosite on LPG leak event

Using such alerts and alarms on cloud servers, the performance like real time embedded system can be achieved which is not possible in traditional methods.

Results:

Use of cloud based tools can simplify the development of embedded web server. The requirementsof IoT can easily be satisfied by such Cloud based tools. Cloud interfaces provide new way to present and analyze data to the user which is not possible before.

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