ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.5

Implementation of IoT using Raspberry Pi

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Abstract:
Any individual "thing" or communication-device, when connected to other devices that are capable of sending and receiving information to/from one another, form a special group of devices that can perform multiple dedicated tasks and increase their efficiency at the same time by constantly passing information to each other. The device used to illustrate this is a simple yet powerful invention in the field of smart electronic-devices, the Raspberry Pi. Consisting of modules as simple as a processor combined with RAM and external-storage to an architecture as complex as that of a complete motherboard containing Wi-Fi, Bluetooth, USB ports and Ethernet ports, the RPi acts as a smart portable computer on its own. When integrated with an Operating system (like the official Raspbian, Windows-10 IoT Core or Linux) and a programming interface such as Python, along with other software segments like a Web-page, Mobile Application and a web-server, the RPi is fully capable of creating a low-cost solution to automation of an entire house, a hotel or even a small-scale industry, which is exactly what has been proposed in this paper. This will lead to a system that can be controlled from anywhere on any network

Keywords: Premise-Automation, IoT, Remote Access, Web-Server, Any-Where, Any-Network

1. INTRODUCTION

The Raspberry Pi is a pocket-friendly and pocket-sized version of a Central Processing Unit, complete with a processor, memory and RAM among other components. Originally developed in the UK, the rpi was intended to act as a means to provide processing power to those individuals for whom the traditional computers were way too costly or just out of reach. It, thus, opened up a new gateway of possibilities to the common user, thereby creating a revolution of its own in the field of technology.

Recent innovations of various RPi models have led to a promising start of an affordable yet powerful, automated system that can be applied in multiple domains. Showing some serious potential for smart-systems, the RPi may hold the key to creating efficient, autonomous computing sub-systems. The capabilities of this wonderful device, however, are not restricted to automation only. The GPIO (General Purpose Input/output) in particular, is a very crucial part of the RPi. It allows the attaining of useful information through a logical data-flow mechanism and processes it to decide the RPi's response. It consists of various pins that provide a means to connect the necessary hardware with the RPi. This paper presents a basic application of RPi in the field of home automation and Internet of Things, in which the control signal of the respective GPIO pin of the Raspberry Pi is controlled by the status of the appliance stored in a MySQLite Database table as binary values which is read by the Python script that is run on the RPi continuously as soon as it boots. The interfaces used to change the status of the appliance in the database are a custom-made Android App or a web-page. This status value is stored in the database as 0 or 1.Depending on this value, the appliance is either turned ON or OFF. The purpose of the python script, here, is to manipulate the signal via GPIO and set it as either high or low based on user-action through the Android App or Web-browser. A multimeter is used to effectively check the actual status (ON/OFF) of the GPIO pins in the RPi and thus, confirm that the device is working successfully.

2. SMART PREMISES

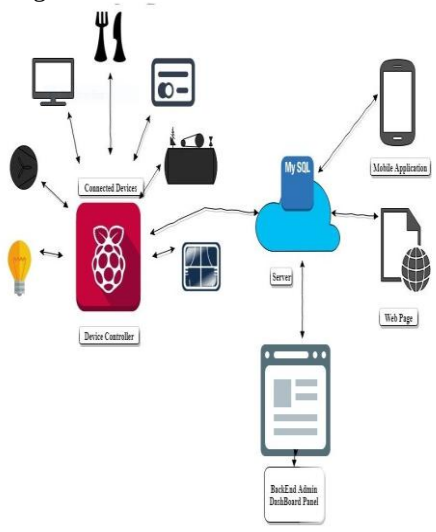
2.1 Internet of Things

The Internet of Things (IoT) , in its most basic form, can be described as a system comprised of various "things" that are interconnected to each other for the sole purpose of creating, sending, manipulating and processing data. A thing, in this definition, could be any device, machine, object, or an organism capable of doing one or all of the aforementioned tasks. Although it was perceived as an idea quite a long time ago, the IoT did not officially come into the picture of technological advancements until the 90's which was also around the same time that there was a major boom in the devices using Internet and the web itself. With the popularity of the Internet and the public welcoming various new horizons of the modern world into their daily life, it became possible for both commercial and non-commercial developers and innovators to create devices and systems that were previously not explored, either due to being unpopular or having limited functionality. But now, every device that was on the Internet was in one way or another, part of an IoT system without even realizing it. The model of the World Wide Web was actually synonymous with a spider's web and it could be said that each device that was connected, was passing information on the web that could be used by another device on the web to perform certain tasks. But, this group of connected devices would need

to be logical, in order to work as an efficient system. For example, integrating the temperature sensor in your room to your AC system would be a nice touch of automation. But, trying to integrate the garage door system with your bathtub would make no sense at all. The key here is trying to understand, which of the systems or sub-systems would benefit through integration and which ones are better left alone. Once we are able to identify this, we regulate the data flow from one-device to another and hence, create a chain of linked devices, that can not only function as individual entities, but also work as a module of a group to generate new data and perform operations based on input from other similar devices. In essence, we create an IoT system that can work autonomously or have some extent of control by waiting for user-action to do something.

2.2 Premise Automation

The concept of a fully automated, smart premise is one of the most popular technologies out there in the world which has been praised by both the Common User and Tech Gurus alike. The sudden increase in the development and innovation of such systems/sub-systems, of course, is due to the extent of control and ease we have gained from the Internet. With the Internet growing into an ever expanding Universe of more and more people joining it per second, we have also started using the Internet for more than just a Google search or posting our favorite moments for others to see. The true potential of the Internet lies in the amount of data that it can generate and support in terms of the processing power and storage facilities among others. Connecting and controlling multiple devices by adding them to a common interface that flows through all of them seamlessly, is pretty much the definition of the IoT and when combined with multiple platforms like Web and Android, we can further stretch the limits of what such a system can achieve through a simple User-Action. This connection and control is not confined to a few devices, however. With the right kind of tools, we can grow this feature by moving into premise automation. An automated/smart premise (like a Smart Home or Smart Hotel) is pretty much a physical area consisting of multiple electronic-devices that we use in our daily lives. No matter what the size or purpose of the device is, if it is on the grid and connected to its peers, you can control it remotely with a few simple actions ranging from a simple hand gesture to a complete biometric authentication. The most uncomplicated example of this, though, is the one described below, where a User can control multiple devices using one touch or click.

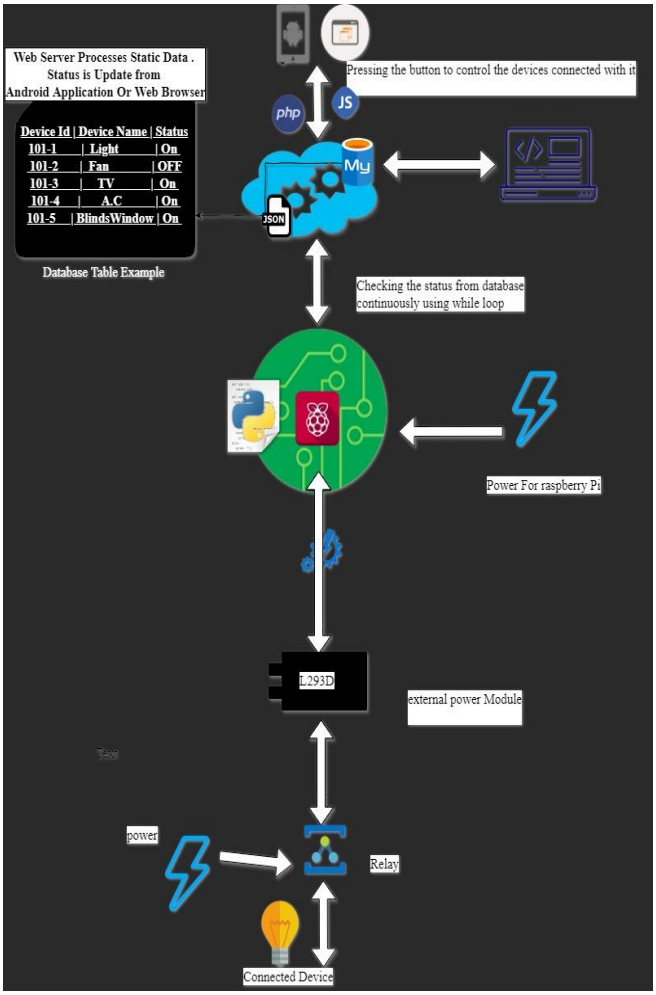


3. METHODOLOGY

The methodology used and illustrated in this paper consists of the following categorization :

3.1 Software Implementation

The RPi runs on Raspbian O.S. which is based on the Debian Wheezly Linux O.S. and uses a Python script to operate the appliances connected to it. The user has the following two interface options to send device data to the database in real-time which is read by the Python script continuously on the RPi :



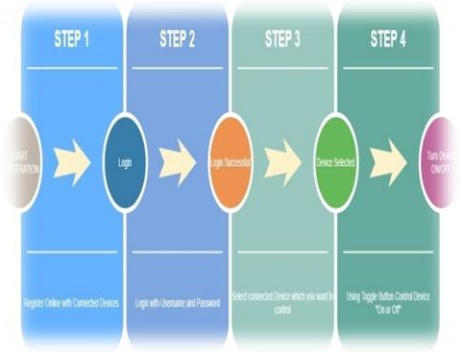
3.1.1 Web Page

For development of the web-page implemented on the user-end, HTML5 & JavaScript were used. On the server-end we have PHP to read static data containing information about the GPIO ports that are in use and the devices connected to each room in JSON format. The web-page offers control of remote devices via three main interfaces which are as follows :

- ***Login Form :*** The login form is a simple PHP script that interacts with a MySQLite database. On successful login, the user can see a screen that lets him/her select a room.
- ***Screen For Selecting A Room :*** On this screen, the user selects a room of their choice from the entire premise layout available. As soon as the user does this, he/she will get a pop-up to enter credentials provided to them at the time of registration (like hotel check-ins etc). The following information is stored about the rooms in JSON format:
  - Room Name/Room No
  - Description
  - Type

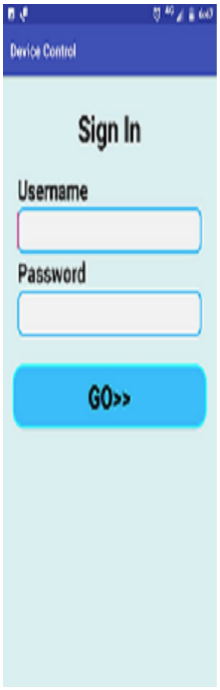
Each room is represented by a JSON object containing the above mentioned data for each room.

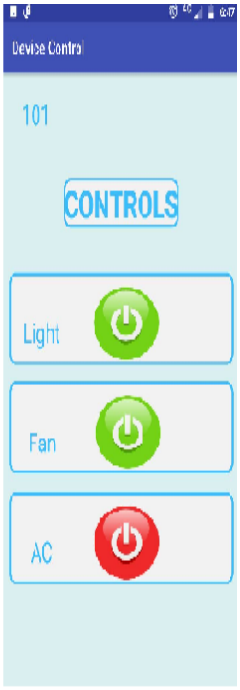
- ***View of The Room And Corresponding Connecting Devices :*** This screen shows the information about the room selected in the previous screen and all the connected devices in the room. Each individual device is represented by an icon that displays the type, name, description and status of that device. Other than these, there will be two separate operational buttons attached to each device. These two buttons will be labeled ON and OFF and used to remotely turn a particular device ON or OFF.



3.1.2 Android Application

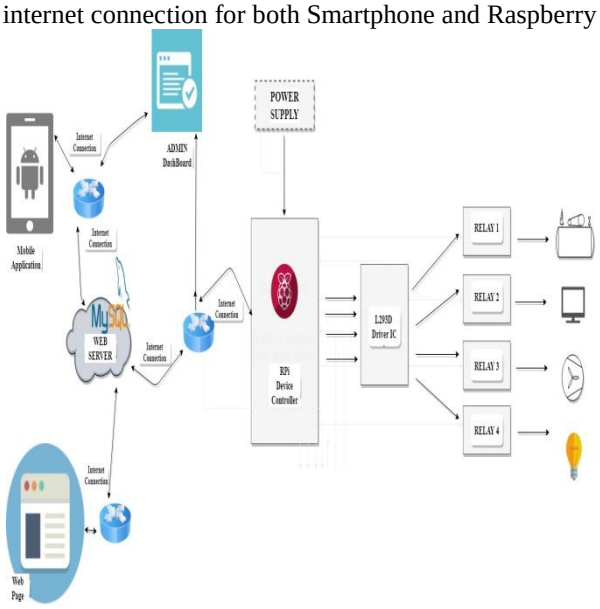
The working of the Android Application is similar in function to the web-page to some extent. Initially, the user has to login to the app using a login screen. After the successful login of user, he/she will be asked for an extra credential provided at the time of registration. After this authentication, the user will be able to see the selected room of their choice. The room will further contain icons/images representing various devices that are interconnected to each other inside the room. The device that is selected by user will display certain information like type, name, description and status of the device. The device status can be manipulated by using one of the two toggle buttons labeled ON and OFF respectively for each individual device. The user will then toggle one of the two buttons to send status value for that device to the MySQLite database via the PHP script.The data gathered from the User action through any of the two interfaces (Web , or Android) will ultimately be passed on to the MySQLite database and later read by the Python script running continuously on the RPi to actually switch ON or OFF the device.





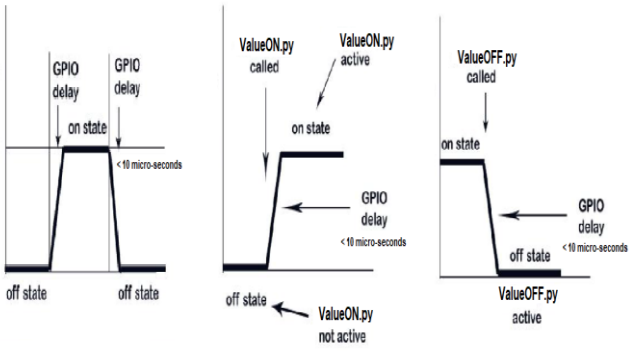
3.2 Hardware Implementation

The core of the premise (home. hotel or per user requirement) automation system consists of Raspberry-pi 3 Model B board. The integration of electronic components into the Raspberry-pi we have used are: Raspberry Pi 3 Model B, power supply module for Raspberry Pi, 830 Tie Points MB102 Breadboard, Bulb, 8 Channel DC 5V Relay Module for RPi, Smartphone, a internet connection for both Smartphone and Raspberry Pi.



4. PERFORMANCE EVALUATION

To efficiently evaluate and assess the overall implementation of "Premise Automation" using RPi, we incorporated a multi-meter into the existing circuit by connecting it to the individual GPIO pins of the RPi. For our current scheme, the following pin configuration was used - BCM with pin 26. The multi-meter was attached to the RPi by connecting its positive node to the GPIO pin 26 and the negative node to the RPi's GND. When the user toggles the power-button of a device to turn it ON, a PHP script fetches the data of that particular device as ON and stores it in a MySQL table. This data is read by a Python script which turns that particular device ON by making the GPIO pin 26 HIGH. In the same way, when the user toggle the button to turn it OFF, the same PHP script fetches the data and stores it in the MySQL table, to be read by the Python script and turn the pin 26 OFF and as a result, turn the device OFF. The following graphs show the status of the device as read by the Python program from the MySQL database. It also indicates the GPIO delay (time taken by the Python program to turn the device ON or OFF after it has read the device status).



Graphical Evaluation of Performance

The overall delay between the user toggling the device power using the interface (mobile/web-page) and the actual device turning ON/OFF is < 10 micro-seconds.

5. OTHER APPLICATIONS

There some more really interesting areas where the RPi can be implemented. Following is a list of such possible applications of RPi :

5.1 Remote Camera: When connected to a camera, the RPi has the ability to transmit images to end-user remotely by responding to an event or command initiated by the user.

5.2 Chat Bot: The ability of the RPi to accept and respond to content from the end user makes it an ideal candidate for its implementation as a bot. To make things further interesting, you can also create another bot instead of an actual user sending data to the RPi.

5.3 Digital Advertisement Screen: The RPi can also be used to display digitally created advertisements like video/animation etc by simply connecting it to a display device or a projector. Any change in display screen we can edit or operate remotely by owner/user from anywhere, anytime using internet.

5.4 Android TV: Another interesting application of the RPi is that you can turn your regular TV into an Android TV by simply integrating it with an RPi having an Android TV operating system.

5.5 Automated Printer Machine: One of the most innovative ideas is to create a smart photo-copy/printing machine that accepts all parameters like number of pages, print format etc from the user, along with a payment for the photo-copy/print and automatically prints the required number of pages for the customer. It would even display messages like out of ink/paper etc. Also we can add credentials (like Barcode Reader, RFID card) to the machine for authenticating a free user or employee in the system.

5.5 Customizable Device: The RPi can be customized to create multi-purpose systems like a visual device such as a Tablet and personalized audio-video systems that include a combination of various display screens and audio-cards. Also, the RPi can be tweaked to create a streaming device for your network requirements with a highly-configurable design.

5.6 Physical Computing Device: The RPi can serve the purpose of a physical computing device that interacts with the outside world using many digital/virtual projects like home media centers, arcade gaming centers or custom-made servers.

6. SHORTCOMINGS

Even though the RPi has such wonderful advantages, it suffers certain shortcomings of its own, which are as follows :

6.1 Varied Cost: The RPi is advertised to be a very cheap solution to your high-processing demands. But this is only true if only the cost of the RPi is considered. In any advanced development system including an RPi, there are a variety of additional modules that add extra cost to the budget of the advanced system.

6.2 Limited RAM: The RPi has a limited RAM of 1024 MB in most of the models with some models having RAM as low as 512 MB. This is a major drawback of the RPi which confines its processing power and other activities.

7. FUTURE SCOPE

There are many other high-end applications for the RPi, one of which is a Smart Traffic Control System. This system will not only save fuel consumption of vehicles and the waiting time of the commuters, but also make the entire system more easy to handle from a centralized traffic-control room. The data generated from this system will prove to be priceless in analyzing the traffic patterns of the commuters, which will in turn, provide a smooth and traffic-less path for everyone without any hassle or congestion. It is literally impossible to sum up all the applications of the RPi in a single description, as, with the addition of a few add-on devices, there is no limit to the possibilities of what one can create using such a simple device. It covers a huge collection of unlimited applications ranging from an effortless audio-video device to a fully integrated IoT application. It can even be used as a remote Work Supervision System or to control your own AI Robot. The RPi board is highly customizable and can be rearranged as per the requirements. The RPi has already transformed many domains like programming, education, gaming, client-server systems and will further change the game for the education domain in rural areas when implemented for basic computer programming and training.

8. CONCLUSION

After much research and thought to the various capabilities of the RPi discussed here, we conclude that it not only a revolutionary product in the field of electronics and data-communication, but also a boon to the field of IoT. Taking into consideration the various factors like extent of user-control, data privacy, ease of customization and the cost involved in making any significant, progressive system/sub-systems, the RPi is a really good choice for the common user to start experimenting and understanding about IoT and its various domains. It acts as a medium for the newcomers to quickly understand through practical application, the true power of the Internet of Things. The commercial IoT systems that are already available in the market are overwhelmingly pricey and require a certain amount of experience with the IoT as a concept. The RPi however, is quite simple to setup and use, comparatively. Also, there is the issue of security of our data gathered by these smart systems as we have no idea what data exactly is being recorded in these systems. But the RPi, when used for Home/Premise Automation, will be completely controlled and customized by the User, and thus, very much safe and secure. Not to mention, it is already very much affordable for a common user. The RPi is a product under continuous development and research. As a result of its brilliant capabilities and increasing demand in the market, the parent company - Raspberry Pi Foundation - has already launched a latest version of the RPi - Raspberry Pi 3 Model B+ - while I was writing this paper.

8. REFERENCES

[1] Benisch, M., Kelley, P. G., Sadeh, N. & Cranor, L. F. Capturing location privacy preferences: quantifying accuracy and user-burden tradeofs. Personal Computing, in 15, (2011), 679-694.

[2] Patel, S. N., Gupta, S. & Reynolds, M. S. The design and evaluation of an end-user-deployable, whole house, contactless power consumption sensor. In Proc. CHI 2010, ACM Press (2010), 2471-2480.

[3] Gaver, W. W., Bowers, J., Boehner, K., Boucher, A., Cameron, D. W. T, Hauenstein, M., Jarvis, N. & Pennington, S. Indoor weather stations: investigating a ludic approach to

environmental HCI through batch prototyping. In Proc. CHI 2013, ACM Press (2013), 3451-3460.

[4] Grosse-Puppendahl, T., Braun, A., Kamieth, F. & Kuijper, A. Swiss-Cheese extended: an object recognition method for ubiquitous interfaces based on capacitive proximity sensing. In Proc. CHI 2013, ACM Press (2013), 1401-1410.

[5] Harrison, C., Tan, D. & Morris, D. Skinput: appropriating the body as an input surface. In Proc. CHI 2010, ACM Press (2010), 453-462.

[6] Brush, A. J. B., Lee, B., Mahajan, R., Agarwal, S., Saroiu, S. & Dixon, C. Home automation in wild: challenges and opportunities. In Proc. CHI 2011, ACM Press (2011), 2115-2125.

[7] Botterman, M. Internet of Things: an early reality of the Future Internet. Report of Internet of Things workshop. European Commission Information Society and Media Directorate General (2009) at Pragua.

[8] Carretero, J. & García, J. D. The Internet of Things: connecting the world. Personal Ubiquitous Computing (2013).

[9] Costanza, E., Panchard, J., Zufferey, G., Nembrini, J. Freudiger, J., Huang, J. & Hubaux, J. SensorTune: mobile

[10] http://www.raspberrypi.org/.

[11] Jaosn Lengstorf, Phil Leggetter, Book: "Realtime Web Apps with HTML5 WebSocket, PHP, and jQuery", 2013.

[12] http://tools.ietf.org/html/rfc6455.

[13] G. Kortuem, F. Kawsar, D. Fitton, and V. Sundramoorthy, "Smart objects as building blocks for the internet of things," Internet Computing, IEEE, vol. 14, pp. 44-51, 2010.

[14] http://whatis.techtarget.com/definition/Internet-of-Things

[15] http://en.wikipedia.org/wiki/Home_automation.

[16] Soundhar Ganesh, Venkatash, Vidhyasagar, Maragatharaj, "Raspberry Pi Based Interactive Home Automation System through Internet of Things", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol: 3, Issue 3, March - 2015, pp: 809-814

[17] http://developer.android.com.

[18] http://pi4j.com/

[19] DIY Hacking, "IOT Based Raspberry Pi Home Automation using IBM Bluemix", http://diyhacking.com /raspberry-pihome-automation-ibm-bluemix/.

[20] Dr. S. Kanaga Suba Raja, C. Viswatnathan, Dr. D. Sivakumar, M. Vivekanandan, "Secured Smart Home Energy System (SSHEMS) Using Raspberry Pi", Journal of Theoretical and Applied Information Technology, 10 th August 2014. Vol: 66 No.1, pp: 305-314.

[21] P Bhaskar Rao, S. K. Uma, "Raspberry P I Home Automation with Wireless Sensors Using Smart Phone", International Journal of Computer Science and Mobile Computing, Vol.4 Issue.5, May- 2015, pp. 797-803.

[22] Jayavardhana, G., Rajkumar, B., Marusic, S. and Palaniswami, M. (2013) Internet of Things: A Vision, Architectural Elements, and Future Directions. Future Generation.

[23] Gigli, M. and Koo, S. (2011) Internet of Things, Services and Applications Categorization. Advances in Internet of Things, 1, 27-31. http://dx.doi.org/10.4236/ait.2011.12004 [15] (2005) ITU Internet Reports, International Telecommunication Union. The Internet of Things: 7th Edition. www.itu.int /internetofthings /on

[24] Li, B.A. and Yu, J.J. (2011) Research and Application on the Smart Home Based on Component Technologies and Internet of Things. Procedia Engineering, 15, 2087-2092. http://dx.doi. org/10 .1016/j.proeng.2011.08.390

[25] Razzak, F. (2012) Spamming the Internet of Things: A Possibility and its probable Solution. Procedia Computer Science, 10, 658-665. http://dx.doi.org/ 10.1016/j.procs. 2012. 06.084

[26] Shao, W. and Li, L. (2009) Analysis of the Development Route of IoT in China. Perking: China Science and Technology Information, 24, 330-331.

[27] Aggarwal, R. and Lal Das, M. (2012) RFID Security in the Context of "Internet of Things". First International Conference on Security of Internet of Things, Kerala, 17-19 August 2012, 51-56. http://dx.doi.org/10.1145/2490428.2490435.

[28] Biddlecombe, E. (2009) UN Predicts "Internet of Things". Retrieved July 6. [7] Butler, D. (2020) Computing: Everything, Everywhere. Nature, 440, 402-405. http://dx.doi.org/ 10.1038/ 440402a