

## **INTERNET OF THINGS AND DRONES**

**Svetoslav Zabunov**

*Sofia University St. Kliment Ohridski*  
e-mail: s14@ialms.net

**Keywords:** *Internet of Things, Unmanned Aerial Vehicles*

**Abstract:** *“Internet of Things” (IoT) is a modern term gathering all or almost all devices that connect to the Internet. But why not connect drones to the Internet and control them using the Internet?*

*Drones are another modern trend in the high-end technological revolution and all innovations in the unmanned aerial vehicle avenue are most welcome by industry and the general user.*

*There are a few benefits from implementing Internet of Things in the drones and a few drawbacks. The current paper tries to disclose all aspects of using drones as Internet of Things. The author also proposes a new approach that is a partial Internet of Things realization thus avoiding the disadvantages of IoT that may be dangerous and simultaneously harvesting some of the advantages an IoT application may bear.*

## **ИНТЕРНЕТ НА НЕЩАТА И ДРОНОВЕТЕ**

**Светослав Забунов**

*Софийски университет «Св. Климент Охридски», Физически факултет*  
e-mail: s14@ialms.net

**Ключови думи:** *Интернет на нещата, Безпилотни летателни апарати*

**Резюме:** *“Интернет на нещата” е модерен термин, обхващащ всички или почти всички устройства, свързани към Интернет. Но защо да не приложим интернет на нещата при дроновете и да ги управляваме чрез Интернет?*

*Дроновете са друго модерно течение във високо-технологичната революция и всички иновации при безпилотните летателни апарати са добре посрещнати от индустрията и потребителите.*

*Съществуват няколко полезни момента при използването на интернет на нещата при дроновете и няколко недостатъка. Настоящата статия се опитва да разкрие всички аспекти на използването на дроновете чрез интернет на нещата. Авторът предлага един нов подход, който представлява частична реализация на интернет на нещата и така избягва недостатъците на интернет на нещата, които могат да бъдат опасни. В същото време чрез този подход се оползотворяват някои от предимствата, които едно приложение на интернет на нещата може да породи.*

### **Introduction**

“Internet of Things” (IoT) is a modern technology, or rather a field of technologies. It is not like drones, which date back from the 1930s. But what is Internet of Things? How do we define it?

Assuming that we know what the Internet is, we might think that defining IoT is an easy task, but practice has proven that it is not. There is still no universal definition of IoT that most institutions and universities have agreed upon. Without a formal and official definition we could use a broader definition that is drawn from the words in the term and also from its practical and obvious implementations. IoT is about things. With ‘things’ it is meant devices. It is about all kinds of devices from refrigerators, doors, cooking ovens to robots, smart phones, sensors and so on. Any device that can connect to the Internet through a LAN card or other means is a thing in the IoT avenue. But Internet of Things presumes mostly wireless connections. And of those wireless connections mostly Wi-Fi is meant. Some more radical devices that may become IoT are food packages like mink cans, bottles of wine and so on. Then IoT may be also clothes, luggage bags, shoes and hats. Well, anything

that is connected to the Internet might be qualified as Internet of Things, as long as this thing has electronics in it that communicate some information to and/or from the Internet.

If so many things are IoT then a question arises quickly: "What is not Internet of Things?". The answer goes like this: All things that are not connected to the internet or those connected to the Internet that have been connected for a quite a while, like laptops, tablets and smart phones. But for the smart phones no one is quite sure.

On a larger scale, IoT might be defined as smart grids, connected cities, industrial Internet.

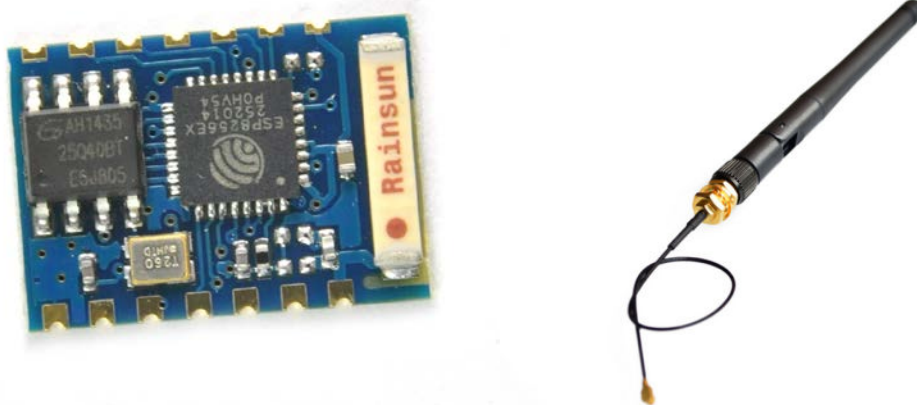


Fig. 1. Wi-Fi module with ceramic antenna (on the left) and external antenna for it (on the right).  
Note: scale of the two images is not equal.

### Drones and the Internet

This paper is about drones, no, it is about Internet and drones, or the reverse. Anyway, drones are obviously things and they do have a lot of electronics inside. Almost every drone has an onboard computer. Also almost every drone communicates with the base station. This communication is wireless. Then the questions arises: "Why not connect a drone to the base station through the Internet?". Of course it is possible and has been done many times. We shall examine the benefits and drawbacks of such an approach first. Then we shall suggest an approach that is a compromise, something in the middle of ordinary wireless connection and IoT method.

### The Benefits of an IoT Drone

These are rather obvious. You may not need to establish a wireless network, but rather use a readymade one. Options are many. Let's elaborate on some of them.

1. Use a satellite phone. These are not very heavy and may be carried with ease by a mid-sized drone. If the satellite phone operator provides Internet access then you have IoT drone that can fly anywhere under the blue sky having the satellite network has coverage where the drone is flying. A nice solution. Universal one, one might say.
2. Use a terrestrial cell phone network. As in the previous point, but this time a cell phone, rather than a satellite phone. Having the operator provide Internet access, you have an IoT drone ready to fly. Now you may fly wherever there is coverage. If the operator is in one state – you may fly in one state. If the terrestrial cell phone operator supports roaming you might well extend your range. For example roaming got much cheaper in the European Union recently. Why not fly from London to Sofia using IoT drone carrying your cell phone (and enough fuel)?
3. Use local Wi-Fi networks. As long as you have access to these networks, wherever they are, you may connect your drone using a Wi-Fi LAN card onboard to these networks (see fig. 1). You may fly in a city, in a small region or have you.
4. Use some other wireless technology that connects to the Internet, like Bluetooth for example. Yes, the range may be shorter, or ever larger than Wi-Fi. Such a solution, nevertheless, will not be so universal, but it is still IoT, isn't it?



Fig. 2. Wi-Fi router

The benefits, as said are obvious:

1. You get cheap network access (not always), you pay for the access to it and the device on board.
2. You get almost worldwide coverage using a satellite phone.
3. Your drone may extract information from the Internet directly, not passing through your base station or the IoT server.
4. Your drone may post information directly to the Internet, not passing through your base station or the IoT server, having the places where the drone tries to post information allow robots to post.
5. Your base station needs to be connected to the Internet, but you don't always need a dedicated base station. You may use an improvised base station – your smart phone, your desktop computer, you name it.
6. You may want to use an IoT server, but for a highly autonomous drone you may go without even an IoT server. How about e-mail conversation between you and your drone?



Fig. 3. Wi-Fi amplifier

### The Drawbacks of an IoT Drone

Most of the denoted drawbacks are true for all IoT devices, not only to drones. Internet is not a safe place and when a device is connected to the Internet it may be hacked. If this device can do harm then it is not a good idea to connect it to the Internet. The drone is a dangerous device, it may do a lot of damage if used improperly and enabling a potential access to it from an offender through the Internet is a drawback. Some countermeasures are always possible like super strong encryption and protection of the IoT server, the base station and the drone computer from attacks, but the risk is there and it is crucial. Another drawback is that some drones may need stable connections. The Internet is not so stable and has downtimes. On the other hand there are no networks with guaranteed coverage or with 0% downtime. A gap in communication due to the network infrastructure or the Internet connection may lead to catastrophic results in some scenarios.

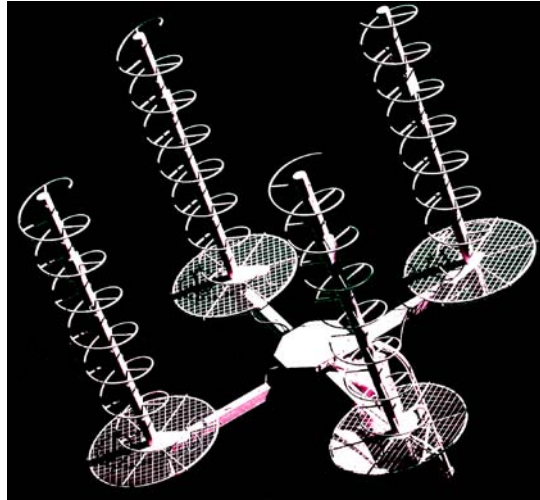


Fig. 4. Wi-Fi helix antenna

### **A Compromise between IoT Solution and a Standard Wireless Communication Solution**

One might utilize some of the benefits of IoT method and also implement certain aspects of the classic wireless communication used to control drones. An example of such an approach is proposed by the author of the current article in the following sections.

Using a readymade wireless network meant for the Internet is a benefit. There are over the shelf devices for wireless Internet connectivity available for a very low cost. These are the Wi-Fi devices used for the IoT connectivity and the well-known wireless network routers, repeater and amplifiers. The idea is to create such a dedicated wireless Wi-Fi network that will connect the unmanned aerial vehicles and the base station without going through the Internet. The drone should be equipped with a micro-WLAN card (see fig. 1). The ground base station might use an ordinary Wi-Fi router (see fig. 2) whose performance could be enhanced using a Wi-Fi amplifier (see fig. 3) and a special purpose 2.4 GHz high gain directional antenna with circular polarization (see fig. 4). 5.8 GHz Wi-Fi frequency band is also an option, but the higher frequency has its drawbacks.

The circular polarization would eliminate some unwanted effects that deteriorate the wireless connection when applying high frequencies in the decimetre and centimetre bands.

### **Conclusions**

Internet of Things is beneficial to drones control, but implementing it fully or partially should be done with care in order to avoid the dangers that accompany it. Drones are among the most hazardous devices of the modern technological advances and coupled with the weaknesses of IoT may result to catastrophic result if not dealt with as needed. On the other hand utilizing the benefits of IoT in the drones sphere bears new horizons for the inventors and engineer to harvest.

### **References:**

1. Denise E. Zheng, William A. Carter. Leveraging the Internet of Things for a More Efficient and Effective Military, A Report of the CSIS Strategic Technologies Program, 2015.
2. Raman Chitkara, Werner Ballhaus, Olaf Acker, Dr. Bin Song, Anand Sundaram and Maria Popova. The Internet of Things: The next growth engine for the semiconductor industry, PricewaterhouseCoopers AG Wirtschaftsprüfungsgesellschaft, 2015.
3. MICHAEL MILLER. The Internet of Things. How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, ISBN-13: 978-0-7897-5400-4, ISBN-10: 0-7897-5400-2.
4. Mark Heckler, James Weaver, Sean Phillips. Creating Our Robot Overlords. Autonomous Drone Development with Java and IoT. Copyright © 2014, Oracle and/or its affiliates.
5. Eric A. Fischer. The Internet of Things: Frequently Asked Questions, Congressional Research Service, 2015
6. Roberto Minerva, Abyi Biru, and Domenico Rotondi, Towards a Definition of the Internet of Things (IoT), IEEE Internet Initiative, May 27, 2015.
7. Adam Thierer. The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation, Mercatus Center (George Mason University), November 19, 2014.