

Authors of [2] state the three main system-level characteristics of IoT:

- Anything communicates: smart things have the ability to wirelessly communicate among themselves, and form ad-hoc networks of interconnected objects.
- Anything is identified: smart things are identified with a digital name.
- Anything interacts: smart things can interact with the local environment through sensing and actuation capabilities whenever present.

Thus, to realize the IoT vision of bringing technology to people anytime, anywhere, with any device, service, or application (Fig. 2), not only must users be aware of their device capabilities but the "things" must also be aware of users' activities, preferences, and context [3]. In other words, the realization of the "Internet of Things" requires dramatic changes in systems, architectures and communications which should be flexible, adaptive, secure, and pervasive without being intrusive [4].

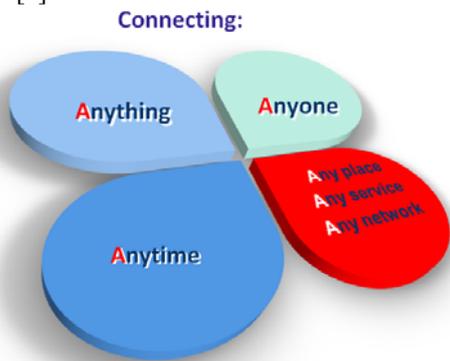


Figure 2. The Internet of Things vision

As more intelligent devices are connected to the Internet, the potential privacy implications and general false sense of security associated with weak key management and data compromise become critical. Thus, security (protection of data and privacy) represents a critical component for enabling the widespread adoption of IoT technologies and applications (Fig. 3). Without guarantees in terms of system-level confidentiality, authenticity and privacy the relevant stakeholders are unlikely to adopt IoT solutions on a large scale [2].

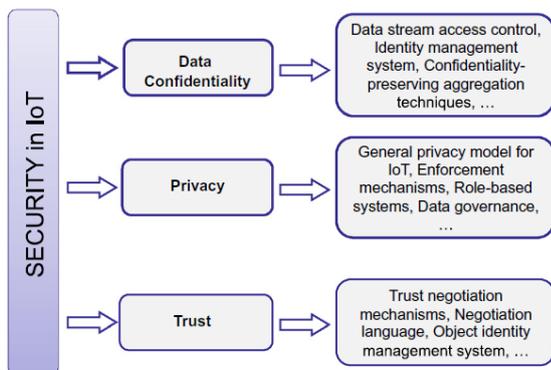


Figure 3. Security challenges in Internet of Things

Wireless sensor networks (WSNs) are finding a wide range of applications in various domains, including health-care, assisted and enhanced-living scenarios, industrial and production monitoring, control networks, and many other fields. WSNs' integration into the "Internet of Things" opens new perspectives [5]. One of the most important challenges in convincing users to adopt such emerging technologies is the protection of data and privacy. Concerns over privacy and data protection are widespread, particularly as sensors and smart tags can track users' movements, habits and ongoing preferences. When everyday items come equipped with some or all of the five senses combined with computing and communication capabilities, concepts of data request and data consent risk becoming outdated. Invisible and constant data exchange between things and people, and between things and other things, will occur unknown to the owners and originators of such data [6]. Protecting privacy must not be limited to technical solutions, but encompass regulatory, market-based and socio-ethical considerations (Fig. 4). Unless there are concerted efforts involving all government, civil society and private sector players to protect these values, the development of the Internet of Things will be hampered if not prevented.

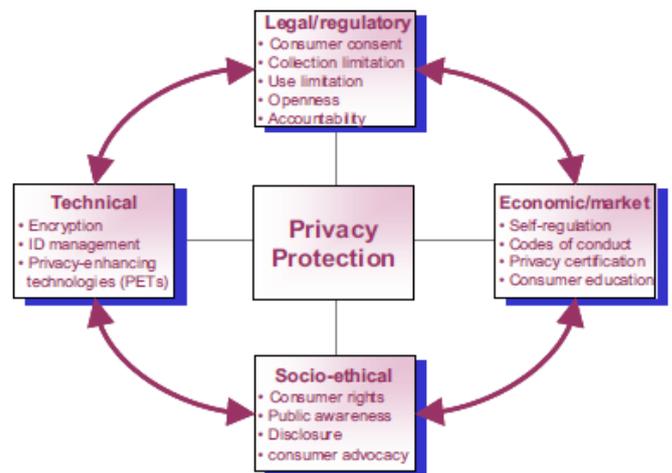


Figure 4. The many facets of privacy protection

This paper seeks to define the elements of the Internet of Things as they relate to Civil law, and to examine the Civil law implications and remedies as they apply to these elements. As will become clear, the biggest legal questions reside in the field of information produced by the sensor web and other IoT components. Thus we define and examine information in the light of Civil law in general and Property law in particular.

II. LEGAL NATURE OF THE ELEMENTS COMPRISING THE INTERNET OF THINGS AT THE LEVEL OF THE OWNER

As we are, in this paper, primarily interested in the Civil law aspects of the Internet of Things elements, we will be

focusing on the characteristics of said elements that most pertain to Civil law. Also we will be focusing on the level and the perspective of the owner or property rights holder of the elements comprising the Internet of Things.

First off we must categorize such elements and determine the possible norms that govern legal aspects that pertain to them.

As is the case with computers in general, so can we divide the elements comprising the Internet of Things in to two elements: hardware and software.

2.1 Hardware as an element comprising the Internet of Things

We do not believe it is necessary to define hardware to the respected reader.

It is well established that hardware is an object of Property law, i.e. can be owned by natural or legal persons as any other piece of property.

The questions of property rights and Property law in general in B&H are governed by [7] and [8] respectively.

2.1.1 Legal protection of the user regarding hardware comprising the Internet of Things

The owner of hardware that comprises the Internet of Things is protected by the legal norms governing Property law.

Among other things the owner of hardware comprising the Internet of Things can sell and use said property any way the owner sees fit, so long as the provisions of the Law or the rights of others are not breached. The owner of the hardware can allow other individuals to access said hardware just as she or he can allow others to visit his home. Equally the owner of hardware can exclude all others from physically accessing her or his hardware. If an individual accesses said hardware contrary to the expressed will of the owner, than the said individual is breaking the law and is in breach of the hardware owner property rights, and can be prosecuted to the fullest extent of the law. See more in [9] and [12].

2.2 Software as an element comprising the Internet of Things

We equally believe that it is not necessary to define software to the respected reader.

Software as an element comprising the Internet of Things can also be divided into two further elements: the computer programs being run on the hardware and the information produced by the hardware and software performing tasks set and authorized by the user.

2.2.1 Legal protection of computer programs being run on the user's hardware comprising the Internet of Things

Computer programs as such can be the objects of Copyright, and are thus protected by Copyright as written works by Art. 4 of [10], in accordance with the Berne Convention for the Protection of Literary and Artistic works, and by the Trade Related Aspects of Intellectual Property Rights (TRIPS). Agreement of the World Trade Organization. Unless the owner of the hardware has written or otherwise created the software herself or himself, then she or he will not have the full set of rights regarding said software.

The ownership and the use of software thus are determined by the legal basis on which the owner of the hardware is allowed to use the software present on it. See more [11].

Usually that legal basis will be some sort of a contract, and usually it will be some sort of a license contract.

Generally speaking there are two types of license contracts that can be relevant, the closed source license and the open source license, as it relates to the availability and the ability of the user to see and to adapt the code comprising the software. There is no one type of license contract. In fact license contracts run the gamut from extremely restrictive to wantonly open, as is befitting the dispositiveness of contract law and Civil law in general.

Legal norms in general [10] and in particular also regulate what can and can not be done with computer programs.

Owner of an Internet of Things object is then well advised to study the licenses she or he entered into (usually by clicking the "I agree" button or checkbox when installing the computer program) especially seeing as how the courts have ruled that, as the long standing maxim goes, Ignorantia iuris nocet, or that saying one does not know what she or he signed is not justification for breach of contract.

2.3 Information as an element comprising the Internet of Things

This paper primarily deals with the legal nature of information as it pertains to the Internet of Things, and how to legally protect said information. While in the case of hardware and software the legal status and the methods of protection were well established and relatively clear, this is not the case with information.

The legal status of information is very much uncertain, as per, among others [11]. If such basic tenants are uncertain, it follows that legal protection of information will equally be troublesome.

Information as an element comprising the Internet of Things is different from the general meaning of the term "information". So, our first task must be to define the relevant aspects of information.

III. THE DEFINITION OF INFORMATION AS IT RELATES TO THE INTERNET OF THINGS

For the purposes of this article we define information as a single or series of symbols that describe a fact regarding the actual and particular status of the real natural world, created as a direct result of the performance of operation of the Internet of Things hardware working in tandem with software. Information in this regard consists of the following important aspects:

- Information is a single or series of symbols - this represents the form or the materialization of information in the real world. Without such materialization it would be impossible to understand, interpret, manipulate or otherwise to interact with said information. Information that is not a single or series of symbols, in the broadest meaning of the term, information without form, is legally

insignificant and can in no way be protected. It is not particularly relevant if these symbols can be understood by the owner of the hardware with or without the aid of specialized tools, such as computers or sensor readouts. The symbol/s must describe the fact they pertain to. Other symbols that are not directly related to the information are not the topic of this paper.

- Information is a fact – this relates to the nature of the message the information is inherently carrying. In order to be a fact, said information must not maintain an element of doubt or guessing. It must be a definitive statement of how a certain thing is or is not.
- Information relates to an actual status of the real world – information must relate a message that pertains to the way relevant parameters in the real world are, and not in anyway deviate or relate a message that deviates from the relevant parameters.
- Information relates to a particular status of the real world – which means that information does not need to encase a message of all the parameters of the real world or all aspects or other relevant aspects of the same. Information can and indeed needs to only relate to those aspects of the real world and to that status of the real world that is relevant to the user vis-à-vis the task and purpose of the hardware running the software as part of the Internet of Things.
- Information is a fact about the real world – meaning that as relevant, information needs to contain a message regarding the actual and particular status of the natural, corporeal, real world and not other, meta or otherwise defined realities.
- Information is created by the functioning of the hardware that is a part of the Internet of Things.
- Information is created by the software being executed on the hardware, which can, as a result be stored and transmitted and interpreted by said or other software.

IV. CIVIL LAW PROTECTION OF INFORMATION AS IT RELATES TO THE INTERNET OF THINGS

We have concluded that the two branches of Civil law likely to provide fullest protection to the owner of the hardware producing information as part of the Internet of Things to be Property law and intellectual Property law. Property law is a group of legal norms regulating the relations of the subjects of law (the owner on the one side and everyone else on the other) regarding the property and other property rights on the objects of Property law – things. In order for information to be, “protected” (only the subject of the law is protected) by Property law information must be, legally speaking – a thing.

4.1 Property law protection of information

According to [7] and [8] things are parts of nature that can be owned by physical and legal persons, except if they are, due to their natural characteristics or limitations, on the basis of a special Law, not able to be owned or for the subject of law to have property rights regarding them.

So, in other words, things are parts of nature that can be owned unless the law states otherwise. For something to be, legally speaking, a thing, two conditions must be met according to the laws regulating Property law. They must be material parts of nature, and they must not have been prohibited by a special law from being things.

Is information a part of nature?

We believe that, for the purposes of this legal consideration information is a part of nature. As we had stated when we gave the definition of information, in order for it to exist, information must have a form. To exist information must be materialized in some, any way. So, by its very essence, information, or rather the materialization of information, be it in the form of a printout on a piece of paper, or, more commonly, be it some digital file, information is in any shape or form a part of nature.

Secondly we must consider if information has by some law been expressly prohibited from being owned by natural or legal persons.

We have looked at the laws governing the subject matter and have not found any relevant legal rules that would expressly state information as such, within the context we have outlined, to be excluded from ownership and thus, legally speaking not a thing.

Therefore, having examined and concluded that information is a part of nature and that there is no law that expressly or otherwise states that information is not to be an object of ownership, we conclude that for ownership purposes and for the purposes of Property law, information is to be regarded as, legally speaking, a thing. Thusly if information is a thing, it is also an object of Property law. If information is an object of Property law, it can be bought and sold like any other qualified thing. Rules governing the ownership of say a refrigerator are the same rules governing the ownership of information.

4.1.1 The classification of information as an object of Property law

Having concluded that information is an object of Property law we now must consider how to classify information within the organized system of other objects of Property law.

First we have to ask ourselves whether information is separate from the hardware and software that produces it.

We believe information to be legally separate from the hardware and software that produces it, just as this paper is different from the hardware and software that was used to produce it.

Information is both physically and legally different from the machines and their programs that produced it.

That information is physically different is taken as a given.

As for legal difference we consider the fact that information as such is capable of existing outside of the hardware and the software. It is possible to separate the information from the hardware and the software and both will continue to exist, all the while not affecting the essence, nature and purpose of either object of the law.

Here we consider it wholly irrelevant if the sole purpose of the hardware and software is to produce such information, as what is important for the legal qualification of information within the framework of Property law is not the process or how information came about to be created, but what is important is the final end result.

Thus we conclude that information is legally separate from the hardware and software that produced it. The hardware is an object of Property law all its own, and so is the information.

We then ask how is information as object of Property law legally related to the hardware as object of Property law that produces it.

In Property law there exists a concept of the main thing and the pertinent thing or the thing that legally belongs to the main thing. The thing that legally belongs to the main thing is defined as the thing that the owner has intended to be permanently used towards the main thing.

The main question here is what is the main thing in the Internet of Things? Is the hardware and software the main thing? We conclude that the hardware and software that the Internet of Things consists of is not the main thing, as it serves a purpose, and said purpose is not to exist for the sake of existing. Rather, the purpose of the Internet of Things is to serve the thing the hardware and software that produces the information is tasked with producing the information about.

The main thing, in other words, is whatever the thing in the Internet of Things is. In our previous example, the main thing was the bridge.

In the Internet of Things, the main thing is the particular object on which the information gathering is centered at, while the equipment gathering the information is the thing that belongs to the main thing.

What is the similar Property law status of the information thusly gathered?

The information gathered directly pertains to the object about which the information is gathered about. The information is gathered for the express purpose of the owner to obtain the information regarding said object, to use that information for whatever means, but directly related to the use of the object itself. Outside that frame of reference information significantly, for the most part, loses its commercial if not, perhaps, scientific value.

It is clear, that said information is a servant of the main thing, as it is used for the purposes relating to the main thing.

We conclude that the information, on the whole, and all things considered, is most likely to be classified as the thing that belongs to the main thing.

It is worth noting that the key subjective element in the determination whether a thing is a pertinent thing or main thing is the legal will of the owner to subserve the pertinent thing to the main thing. It is thus possible for the owner of the

object the information is gathered about to separate, to discontinue the legal link of the information to the main thing.

Is information a pertinent thing to the hardware and software? To this we give a negative answer, as information does not serve the hardware and the software. If anything hardware and the software might be said to serve the information, though this might be a matter for consideration elsewhere.

Is information a fruit of the main thing or of the hardware and software that produced it? This classification is important for several Property law reasons, not the least of which is the ability to trade in information and the determination when information is considered a separate thing and thus a valid object of the law.

In Property law terms a fruit is that which the object of Property law regularly produces, naturally, or as a result of work by a person, in accordance with its purpose, without significantly changing or having other effect on its essence and purpose as a result of bearing fruit.

Is information a product of some thing? To this the answer is an obvious yes. The regular operation of the hardware and software within the framework of the Internet of Things produces, as its direct result information. Thusly information as a thing is, legally speaking, a fruit of the hardware and the software, just as an apple is a fruit of the apple tree.

As information is a fruit of the hardware and software, property rights on information will belong to whoever is the legal owner of the hardware and software that produced it. The owner of the hardware and software that produces the information will become the owner of the information at the moment of the, legally speaking, picking of the fruit that is the information, or at the exact moment the information is separated from the hardware and software. When that moment will be exactly is something to be determined by the technology applied and will depend in each case.

Is the information at the same time a fruit of the main thing, the object component of the Internet of Things? To this we give a negative answer. Information is a fruit of the hardware and software because it is produced by them, at the same time the information, though it relates to the main thing, is not, in its materialized form produced by the main thing itself, and thus is not its fruit.

All objects of Property law – things can be divided into real estate or immovable things and in to moveable things, depending on whether or not their essence is destroyed by physical movement.

Is information an immoveable thing or a moveable thing?

In order to fully understand this, we must once again separate the hardware and software that produces the information from the information itself. While the hardware and the accompanying software, in the shape of, say, a sensory network permanently imbedded in the concrete of a bridge is indubitably immovable and thus an immovable thing, and legally regarded as such, the information itself can be and often is transferable and transferred without any significant loss of quality or damage to the essence of information. We conclude that information is a moveable thing. This consideration will be particularly important when we consider

the buying and selling and other legal methods of using information.

4.1.2 How is information protected by Property law?

If information is an object of Property law, can be owned, as we have concluded it is, then, information is no different from the hardware we considered previously or indeed a car, a bike, a shovel, or any other possible object.

Just as the owner of a car can exclude all others from accessing the car and driving the car and selling the car, so can the owner of the information limit the access to and the processing or indeed, any other use of said information.

Anything that relates to any other object of Property law, analogously relates to the property rights of the owner on the information.

Property law protects the ownership and other property right on information in the same way it protects ownership and other rights upon any other thing.

Owner of the main thing or of the hardware and software can trade and transfer ownership or indeed do with information anything that she or he can do with any other thing in their ownership. See more [12].

4.2 Copyright protection of information

Information, in the broadest sense of the term can be protected by Copyright, if it is objectively and subjectively original.

Information, as we have defined it in this paper can not be protected by Copyright because it lacks subjective originality. Subjective originality, previously referred as spiritual content, relates to the creative and individualistic characteristics of the immaterial good that is a Copyrighted work.

We believe that, in our expert opinion, under no circumstances, raw, unprocessed information as we defined it can be protected by Copyright as such.

It is possible to protect such information by Copyright though. This can be done by integrating said information in a database. A database, defined as an organized and systematic collection of data, can be Copyright protected, even if it contains information which is not Copyright protectable.

The creator/owner of such a database would then be able to effectively limit the access of all persons to the information by limiting, as is their right, access to the database. However, such limiting of access would go against the principles upon which the Internet of Things is based, and will thus not be endorsed by us at this time, and in this paper.

V. CONCLUSION

Internet of Things as a concept and an ideology can play an immensely important role in the future development of computer science in general and the internet in particular. This will not come to be, however, unless significant legal concerns of privacy and information protection are of such nature to satisfy the legal and otherwise interests of the users.

In this paper we have reviewed some civil law aspects of the elements comprising the Internet of Things. We focused on the aspect of the owner of the hardware and the software that comprised the Internet of Things.

We reviewed the civil law aspects and protection afforded by civil law of said hardware and said software.

We then defined and examined the legally relevant aspects of information as it pertains to the concept of the Internet of Things. We concluded that of all Civil law branches, Property law and Copyright seemed to offer greatest protection of said information.

Having regarded all we concluded that information is an object of Property law that is separate from both the hardware and software that produced it and the main thing it relates to.

We further concluded that information is a thing belonging to the main thing, or a pertinent thing relating to the main thing, or rather that it can be if so desired by the owner of the thing and the information. We also concluded that information is a fruit of the hardware and software but not of the main thing. We also found that information, Property law speaking is a moveable thing.

We concluded that information is already protected by Property law as any other object and that the user can transfer property and do all that she or he can do with any other object of Property law.

We examined and concluded that Copyright does not protect information, but it could through databases, but that such action would go against the central tenants of the concept of the Internet of Things.

REFERENCES

- [1] Internet of Things, European Research Cluster on the Internet of Things, Available: http://www.internet-of-things-research.eu/about_iot.htm
- [2] D. Miorandi et al., Internet of Things: Vision, applications and research challenges, *Ad Hoc Networks* 10 (2012) 1497–1516
- [3] A. Zaslavski, Internet of Things and Ubiquitous Sensing, September 2013, Available: <http://www.computer.org/portal/web/computingnow/archive/september2013>
- [4] L. Yan, Y. Zhang, L.T. Yang, H. Ning, THE INTERNET OF THINGS, From RFID to the Next-Generation Pervasive Networked Systems, Auerbach Publications, Taylor & Francis Group, 2008
- [5] D. Christin et al., Wireless Sensor Networks and the Internet of Things: Selected Challenges, *Proceedings of the 8th GI/ITG KuVS Fachgespräch Drahtlose Sensornetze (FGSN)*, August 2009.
- [6] The Internet of Things – Executive Summary, ITU Internet reports Geneva, 2005
- [7] Zakon o stvarnim pravima (Sl. novine Federacije BiH br. 66/13 and 100/13)
- [8] Zakon o stvarnim pravima (Službeni glasnik Republike Srpske, br. 124/08, 58/09, 95/11)
- [9] N. Gavella et al., *Stvarno pravo*, Informator, Zagreb, 1998.
- [10] Zakon o autorskim i srodnim pravima Bosne i Hercegovine (Sl. glasnik BiH 63/10)
- [11] R. H. Weber and R. Weber, *Internet of Things Legal Perspectives*, Springer, Zurich, 2010
- [12] Rašović and Korač, *Tužbe u obrascima i sudska praksa iz stvarnog prava*, Službeni list Republike Crne Gore, Podgorica, 2001.

