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IoT – review of critical issues

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***Abstract*—Science – research transformation of the Internet of Things (IoT) has a number of colours and shadows, many dimensions including technical, social, community, financial, economic and civilization. This transformation has many wide development roads but also numerable pitfalls and traps. It does not take place solely at the level of scientific and technical progress and innovation. It preliminarily takes place in a complex socio-political-economic context, narrowed for simplification as social acceptance and education only. Such acceptance, for example expressed simply by demand and market popularity, for simple items supplemented by useful functions, such as an iron that recognizes the type of fabric and matches its work accordingly, a completely autonomous vacuum cleaner, etc., is trivial. We aim at much deeper relations of IoT with society. If IoT were only adding such functionalities, it would not be worth the time to consider it here. IoT causes a lot of confusion for much more important reasons in many areas of life. Somewhere further on the potential paths of IoT development, it has been noted with interest, but also with anxiety, the possibility of its empowerment as local but also global, superintendent surveillance system, gathering enormous amounts of information, creating knowledge and making autonomous decisions. Potential subjectivity must include such attributes as acquiting from the creator, autonomy, consciousness, morality and further building by the society the whole legal system around the new entity. It will not be a single entity, it will be a whole virtual society, with electronic people. The consequences can be far-reaching and appear as an inevitable option on such a scale for the first time in the history of our human society. Overcoming certain barriers recognized by us may mean that the intelligence and consciousness are not only attributes of the human biological mind. Such reasoning, not without a reason, encounters strong resistance. However, there is a fundamental difference between the opposition to some genetic research and the potential modification of man himself, and the opposition to machine building, a system of superintendence that far exceeds the possibilities of a single man and of entire societies.**

***Keywords*—Internet of Things, IoT, Industrial IoT, machine to machine communications, Industry 4.0, IoT civilization, artificial super-intelligence, cyber-man, future of work,**

I. INTRODUCTION

THE Internet of Things, simultaneously a social phenomenon, a scientific and technical branch, transformed today to an industrial specialty, is becoming a part of the reconstructed civilization infrastructure as well as the culture. It may be easier to say, perhaps with some exaggeration, what the Internet of Things is not. At the same time, with representation of the multifaceted complexity of the technical basis of this phenomenon, we show subjectively, in various aspects, perhaps a bit futuristically and philosophically, its surroundings. Based on many areas of knowledge and existing for less than twenty years, the IoT can be presented in many different ways in terms of economics, architecture and technology, including the humanities. Some, half jokingly, say that IoT is really and deeply transforming our civilization. Scientific and technical background of the IoT is relatively rich, and it is possible to describe this phenomenon from the point of view of IT, telecommunications, electronics or computer engineering, but also ontology. There is a growing wealth of scientific and social literature on the subject, including economics, health, the environment, entertainment and culture, sociology, and the humanities, as a proof of the structural complexity of the IoT. IoT is growing dynamically, and largely spontaneously, taking advantage of market demand and large individual and organized investments. The investement area has been structured for some time in a more organized way by standardization, technical, financial and economic institutions, but also scientific, industrial and social organizations.

Someone needs to do the order in the IoT world, and making this is a complex process. Formally, different organizations are responsible to build technical, legal and social foundations. IoT encompasses several different but adjacent fields like organizations, markets, economy, interaction with humans, environment, society, and more. IoT is popularly considered as a purely cold, technical layer. In practice it is an area of increasingly intensive, multilayer and multidirectional interaction with human beings. And this latter interaction seems to be more important than all the technicalities. We observe new influence of the intelligent technology on humans, and vice-versa. A new digital cyber generation of humans may result from these processes in the future. Now we are observing transformation processes, which are full of technical details dissipated in everyday life, industry, civilization infrastructures and natural environment. IoT brings potentially blessings and curses. Considered positively, the IoT seems as a friendly intelligent environment for our life in the future. IoT development is illustrated today in the best way by giving various and current, individual application examples, which may sometime be combined, we hope, to an integrated homogeneous and extensive functional system. The IoT uses its own particular language, in some parts quite hermetic, full of abbreviations for hardware and software specimens, functionalities and application details. Removing this specific language would flatten the description of the IoT world. IoT terms and abbreviations are now so popular that it is no longer necessary to provide their web links. A simple query immediately gives you a full explanation.

Without understanding of the fundamental weight of the snowball phenomenon of the IoT for the humanism and civilization, it could not be described sufficiently precisely. In such a case we are considering only a complex thing, while our generation, and for sure the generation of our successors, will definitively witness its subjectivization and the status change

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from an observed thing/process to an autonomous observer. Transformation of the IoT ex Scientia at Industria has numerable paths and ways, some of them simple, some more complex. Some IoT development areas create a complex labyrinth. Not all of the paths, as we are able to evaluate these processes today, in the developmental IoT labyrinth go to the appropriate direction. Some of them, disappearing behind the horizon line, seem to go nowhere. Some of them, shorter ones, have a clearly defined aim. We have excellent achievements in many areas of the IoT, nothing but to apply, industrialize, spread and use. And this is a solution today in many area, where a lot of crowded IoT ways go. Sometimes obstacles in IoT acceptation have strong psychological background. Wide acceptance of block chain system and cryptocurrency has to take some time. During the IoT research we start to notice deeper and interesting attributes of this phenomenon which cannot be describes in a simplified way. Only partial and careful antropomorphization of IoT is justified today by adding a cognitive feature. IoT is not a hermetic knowledge. IoT background is of technical nature but not technology will decide of its global understanding and potential widespread acceptance. Almost all IoT sub region has, or soon will have, a humanistic and societal anchor.

II. IoT CIVILIZATION

What really has given to us the digital era? Millionth acceleration of creation, gathering, transmission and processing of information. What we can expect from the quantum computing era, if it comes at all? Further millionth, or perhaps billionth acceleration in comparison with the digital era. IoT is a belated child of the digital era. IoT is yet an unfulfilled promise of the quantum era. Why belated? It may have been developed earlier? Perhaps because the digitization brought to us a shock with which we had to acquaint ourselves and get used to it, which took a lot of time. Why a promise? The IoT computational intelligence, based on processing of large amounts of data, billion times more efficient than today may overcome the natural intelligence of human beings. When it crosses that critical point, the civilization may irreversibly change. This crossing seems today inevitable sooner or later. For some people outside the research area it may seem seditious. Different faces of the IoT are named as Infrastructural Internet, Silent Intelligence, Industrial, Cooperative, Touch, Social, Consumer, Big Data, Internet of Everything, M2M communications, Fog and Cloud Computing, and Industry 4.0, but also SMAC – Social, Mobile, Analytics and Cloud Computing, service environments like AWS by Amazon but also Microsoft Azure, IBM Watson, and many more. IoT is very interdisciplinary not only in technical terms. IoT celebrates its international day on 9 April, which shows its global popularity. In 2018 it will celebrate its holiday for the sixth time in different places of the world in the form of meetings, shows, research, technical and commercial conferences. IoT represents a key term, opening doors to the new knowledge, but also to the business, money and transformation of the society. In technical domain, or its basic material background, the IoT uses profusely the achievements of such disciplines as electronics and telecommunications, material engineering and mechatronics, sensors and metrology, information and computer engineering. In the boundary area between technology and humanism, the IoT uses information sciences, sociology and media, stimulating their development in new directions. Integrates these development threads in to a new quality. The effect of this interdisciplinary, or unlimited use of the progress in many areas of science and technology is abrupt technical and non-technical development of the IoT. Avalanche like development of IoT awakes strong social and psychological barriers, especially in practical applications which are located close to human beings. These barriers and their attributes are subject to extensive research. The IoT surrounds men closer and closer, and this distance is all the time smaller. IoT earned new (digital) attributes combined with the distance to men like: closeness and touch, bow, addiction, hysteria, ideology, isolation, superstitions, fascination, education, learning, generation, vision, prediction, safety, threat, immersion, etc. IoT separation from men would mean that we do not understand what is going now around us. The IoT managing today road traffic, business, bridge, air conditioning and refrigerator, and in the future most of the technical infrastructure, seems to be really quite simple and primitive and far away from human beings. This is however a wrong interpretation and illusion. IoT is evidently a future personal attribute of a man and his civilization, but predominantly will serve a man. IoT will be an emanation and a considerable extension of human intelligence and personality. IoT will be a projection of human intelligence on a multidimensional space, four-dimensional physical and multidimensional social, psychological, cultural and religious spaces. These theses may be difficult to accept for some conservatives. For some progressives this will happen sooner than we tend to think. Maybe we are waiting for dethroning of the intelligence and its separation from a man. Then we will look for humanity is some other attributes of people. Not in the intelligence but in the heart. Similar to Copernicus who dethroned the Earth from the centre of the universe. E-religion, Internet serving the religion, is Internet threating the Church, immersion participation in holy masses, impermanence of division of the word to online and offline, the World becomes a real-virtual hybrid, Internet paths to nowhere, these are contemporary and hard research subjects of psychologists, sociologists, experts in religion and culture. We notice many traps on this complex path of initial development of the IoT. Vivid discussion is going on all kinds of dangers, progressive plague of Internet gadgets, addictions, trash and junk, dark recesses, where a man wants to digitize all around himself, cybersecurity, and potentially very big environmental costs of the future IoT. But we also speak about an unbridled passion of the active IoT creators. The industry adds to these processes trying to meet the demand, while in many cases creating it by himself, sometimes honestly, sometimes less honestly, but always more and more aggressively.

The global Internet has been created initially in research and military communities. Today it is still developed there but in a completely different way than during the pioneering years, several decades ago. There are researched attributes particularly useful is such functional areas like: determinism of data transmission, sub-nanosecond time precision, cooperation with real time operational systems, mass hardware and software scalability, new technical standards, especially high level of reliability, ruggedness and immunity to harsh work environments. Today, the massiveness of common Internet

applications in all varieties changes everything around us. IoT, the silent intelligence spills around changing the directions and accelerating the civilization transformation processes. IoT penetrates infrastructure and many areas of social activities including sports, education and culture. Developed in a variety of scientific, social and industrial environments, the different features of IoT seem to eventually come across in many common applications. IoT is created everywhere, also developed in non-professional and amateur environments. We ask questions about IoT. Where and how is it formed? What is its overall structure? How does it transfer between science and industry? What gives us such a development? How will the development of civilization help? Specifically: Will it improve our well-being, health care, accelerate the world, change our education, change our business and translate it into economic growth? We ask even more in detail: How and when will the developed technologies in materials engineering, electronics, photonics, mechatronics, telecommunications, automation and robotics, and computer science, hardware and software, develop into more mature and useful IoT functional products? We are just in the beginning, we discovered IoT and some of its components as artificial intelligence just a moment ago. Many of the technological achievements have not yet been translated into the practical language of IoT. We will look at these possibilities, rather than limiting ourselves to the scientific and technical level, and reducing our reflections on what is already available or almost available today. IoT's technical foundation is a network, practically unlimited in diversity, bandwidth, access and mobility. The wisdom of IoT are databases, local specialized, standardized global without limitation in their creation and access, and the way they use and extract knowledge, also new, artificial intelligence methods. These IoT components are technically developing but are subject to different restrictions. The foundation for the further development of the IoT is not only the technology but also the overcoming of barriers in the social sphere. By introducing a new level of globalization, unification and technical and social standardization, the IOT can lead to a completely different concept of product usability, service and functionality. We will be infrastructural even more similar to each other than today. And even now, the momentary reversal of globalization towards regionalization will not change. Technology knows no boundaries. In the area of data, their vast quantities, and potentially hidden knowledge, globalization means inevitably entering the world beyond technology, ideology, politics, sociology and psychology, as well as culture. Good data, called structured or clear, of high quality and in large quantities, from sources such as the IoT, could already potentially speed up the solution of many economic issues, provide sustainable development, food, education, energy, fight poverty and increase health. Today we have a lot of unstructured data, called dark, only indirectly useful for IoT. In many cases you have to start collecting data again, and IoT is already doing it on a massive scale.

The idea of the Internet of Things has been functioning for a long time, though, twenty or more years ago, under other names such as distributed functional systems, advanced control systems, technical cybernetics, database mapping, etc. On this construction road, then the unnamed IoT - whose fundamental component is the data source, the data itself, and the ability to use it, the science has made many mistakes. We did not fully understand the essence and the completely different character and properties of gigantic data sets from only large and very large data sets. In their great research experiments, which are the source of gigantic amounts of measurements, science collected as much of that data as possible. And it was a mistake. Today this mistake seems to be committing the industry to its various complicated IoT conversion routes. At that time, we talked about Terabytes and Petabytes of data, and those numbers really scared us. How to save them electronically? How can they be easily extracted from the slow streams of large streamers libraries? Offline analysis lasted for years. Today in science we are talking about Exabytes, Zettabytes and Yottabytes, and Terabytes and even Petabytes have gone into the category of small and medium-sized collections. What was the error, which is definitely not worth repeating? Today, we strictly categorize and select data in the science, already at the initial stage of the acquisition. We do it in science, not knowing if we lose something valuable by chance. We are probably losing, but the belief of a few decades ago that it was necessary to collect all possible data from experiments led to the fact that much of this data is gently speaking of little value. Contemporary scientific experiments in physics, chemistry, biology and medicine seem to confirm our belief that knowledge is hidden and can be extracted in gigantic data sets but well targeted and closely systematized. The hope of finding knowledge in large sets of irregular data is still quite remote. You need a new math and new, no existing computers. We are on this path to build new quantum computers and new analytics just in the beginning. We put this new field of big-data bricks on a brick. Relatively recently we have seen the need for systematic research in this direction. If we had the genetic data of billions of people today, which is not possible for many reasons, and adequate analytical tools, then the cancerous plagues of mankind would probably have been mastered. But such knowledge could also be used against humanity and entire societies. The power of destruction of giant data sets managed by superintelligence is also gigantic. We started collecting ordered data so recently. Now we accelerate the collection with tools like the IoT. We now realize where on this scale we are. All of the human knowledge that has been stored, including the genetic data of us all and all of our environment, would probably fit in a relatively small, but this time cosmic, Noah's Ark with a capacity of one Yottabyte.

The Big-data field was not born immediately, and today it functions in every major analytical system. Initially, a new area of technology was created that could be called reading, triggering, and acquisition of large amounts of data, something that physicists and technicians refer to as the commonly used TRIDAQ abbreviation. The ability to find and classify valuable data sources, collect and store large amounts of data, and then efficiently retrieve and process data is now called big-data. With the achievements of this decades-old field of science, today the IoT and industry can benefit. The contemporary big-data field, for science, IoT, industry, business, and services is the ability to gather, store, transmit, select, and also analyse ordered data. For now, the analysis is still relatively easy to use, even if it seems complicated today. It is looking for common patterns, correlations, associations, connections, indirect relationships, and ultimately the information. This is definitely not enough, because data structures can be much more complex. Even for simple data structures, the knowledge can be

hidden in a completely unknown way for us. For science the big-data is a field of potential generation, in the near future, of new fundamental and applied knowledge. Knowledge about our health and the environment, quality of life, economy, our future on this planet, matter, energy and the universe. Big-data analysis requires new mathematics, physics, chemistry, biology, new logic and psychology, even new axiology, and finally requires artificial intelligence. We need intelligence faster and more efficient than our biological. Speaking more gently to man, we need intelligence that is different from ours. Without this we will not go much further. For the manufacturing industry the big-data is, however, something completely different than to the science. It is greater standardization and flexibility, greater accuracy, predictability, responsiveness, time savings, rapid prototyping, better production, lower costs, fewer failures and downtime. For economy the big-data is the beginning of new business models, never met any time ago. For business it is not only supporting the use of data analytics in the form of known from Excel tables, charts and trends of market development, and in a sense passive. It is primarily, in some future, a deep integration of analytics into the business model of the company and the courage to give back some big-data-based decisions to the calculation intelligence. For the consumer zone, the big-data is a true revolution in services, commerce, immediate environment of human life, health, education and vocational training, sports and leisure. Seeing this socially and psychologically, it will be even more difficult, because how can we give our health, not just money, to the "hands" of the computational using big-data directly related to our person? This requires deep social acceptance and building a new legal system. Big-data must be managed by computational intelligence. The intelligence of a person in a direct confrontation with such a mass of numbers cannot directly cope with sufficient efficiency. Big-data penetrates into many areas of human activity, and it's just one of the IoT components, working together with computational intelligence.

The widespread and irreversible internetization of our civilization, and in particular the Internet of Things called also Intelligent Infrastructure, undoubtedly deserves a free essay lighter and more serious, somewhat futuristic and more embedded in real possibilities, touching such aspects as: scientific, technical and industrial but also humanistic, sociological and psychological. The internetization has 'caught up' our generation and we have to deal with it, address it in our own words, see those words printed, and hear them in the reading. As a co-creator, user or IoT analyst, can compare these said or written modest ideas to the vastness of words and multimedia nowadays generated in the form of dozens of books, thousands of articles, application notes and technical guides, as well as more popular comments. Not talking about it and not documenting it in a material way, not making a modest intellectual contribution, deprives us somehow of the right to participate actively with understanding in the IoT transformation processes and in the IoT criticism. Internetisation is not only a great quantitative change, but it is primarily a qualitative change, like a change in the state of matter. And it's not a trivial change in ice water, but rather in high-temperature plasma. It is an entirely new, yet little-known matter, just like plasma. Astonishing consensus has been observed for some time among the world's leading experts in Internet engineering, neural networks and artificial intelligence. There is a fairly widespread opinion that from an artificial self-conscious superintelligence, which surpasses much of the intelligence of the man, to which the Internet is largely responsible, is only a few decades away. Pessimists say that it will be the last great work of man. Optimists say we will somehow maintain control over superintelligence. Superintelligence will not be left alone, will then have subordinated intelligent infrastructure, whose modest origins are called today the IoT. The IoT, at a certain high level, will be managed by a superintelligence. We do not want it to be cold, in other words only logical and unreflective, or inhuman. Today, large multidisciplinary teams work in the world's leading laboratories on IoT foundations - mathematicians and computer scientists, electronics, biophysics, behavioural and cognitive specialists, physiologists and neuroscientists, sociologists and psychologists, cultural scientists and experts in formal logics. More and more anthropomorphic machine components are researched by system scientists, like emotional intelligence such as self-awareness, self-recognition and emotion, and ability to recognize the feelings and needs of others, ease of establishing and maintaining relationships, associative memory, and much more. These studies are supported by a large European HBP project on the human brain. Where are the above mentioned features physically located and realized, if not in the human brain, which consists of about 85% of water? Physical background of computational intelligence components are more and more sophisticated energy-efficient large-scale VLSI circuits, and system on chips, which contain billions of transistors with single-nanometre-scale gateways, thousands of independent programmable processors operating trillions of per-second operation in non-deterministic neuronal architectures with high memory and computing power, capable of performing many scenarios of action, etc. Only on such substrates is it possible to implement sufficiently complex behavioural, emotional and cognitive algorithms. It is important to point out that these projects face strong resistance from certain parts of the scientific community. Even if the machine intelligence soon surpasses humanity, not in a logical sense what has become simple, but in the behavioural, conscious and emotional way, there can be a barrier created by energy efficiency. Although, in this respect, the works are developing very quickly over transistors with several atomic gates, and monatomic magnetic memories, not to mention the progress of photonics and quantum optical processors. If these further arguments are unconvincing why computers, using advanced game theory algorithms, have irresistibly defeated human chess checkers, and GO masters, and recently the Deep Stack machine defeated people in the most advanced version of Texas poker? This version of poker demands stumps and bluffs? Poker is a gambling game, but the Deep Stack can help physicians diagnose and select the most effective treatments. Why in some countries like Japan and China there are starting to replace human workforce with AI and IoT software? And it is done in the area of quite advanced intellectual functions requiring analytical and synthetic abilities. People who are starting their professional careers are already preparing to work there, even for team building, with intelligent machines that take up advanced human-related discussions. Why do some countries allow autonomous passenger cars? Why some countries introduce a law system for an electronic person? Why

there are millions of kilometres of optical fibre needed to build the IoT and the new economy around us?

III. IoT DEVELOPMENT

Physics in the year 2116 is only partially a fun of the well-known, popular science journal of the American Physical Society "Physics Today". The last issue in 2016 is devoted to such issues. What do physicists and engineers predict in a hundred years' time from now? In astronomy, this is the construction of a network of robotic super-telescopes that are part of a scientific IoT that orbits around the sun with distributed mirrors and with the ability to monitor the surface of planets in the nearest planetary systems as we see from the Earth the Moon using the best of today's telescopes. This prediction is strongly anchored in recent discoveries of not so distant Earth-like planets and is a reflection of our insurmountable longing for finding another life in space. In power engineering it is mastering of thermonuclear fusion and its use as a secure source of infinite energy. In elementary particle physics, it is an understanding of the nature of black energy and mass and the construction of the next collider after the CERN LHC, and the potential discovery of further unification of elementary forces, and the quantization of gravity and space, and thus the possibility of long distance cosmic travels. In artificial intelligence it is, already mentioned above, overcoming the barrier of self-consciousness and building emotional intelligence of machines. In the area of security, freedom, quality of life and lifestyle, these are complete changes in the human environment associated with the ease of collecting vast amounts of data across the global network and the use of these data by the society to build intelligent infrastructures that can improve and significantly change our lives.

Similar considerations regarding the time of future technology take place once a year, in one of the most influential technical journals IEEE Spectrum. In the last year's scientific and technical achievements there are sought potential future solutions. No wonder, for a number of years now, a large part of these broadly discussed achievements relates directly or indirectly to the construction of intelligent civilizational infrastructure based on the IoT. In many disciplines of science, the IoT creates new research directions such as in: philosophy, law, economics, medicine, organization and management, pedagogy, psychology, sociology, computer science, architecture, telecommunications, electronics and information technology, and others. IoT creates in some of these disciplines new scientific specialties such as co-design and integration of software and infrastructure, machine cognitive science, deep machine learning, IoT engineering, also Industrial and Services IoT. Someone may ask why there is the philosophy behind it. The power of future infrastructure intelligence, which creates a potentially new civilization framework, also in the area of virtualization, makes certain philosophers, psychologists and sociologists, and also us, look at our world and re-ask many fundamental, ontological, living questions, like if we do not live in the matrix? This time we are asking ourselves about the essence of things, this time supporting ever-growing evidence of the subtle essence of our consciousness and the potential for its reproduction, with relatively simple software of our DNA, if we had a quantum computer. There are many strange remnants in our DNA, as if not quite hit by attempts to write proper software. Another barrier to the quantum computer has recently been overcome. Google and NASA are installing a prototype of a D-Wave computer running at 2000 qubit in a research facility in Ames. The computer is an equipment in a research laboratory on the quantum artificial intelligence solutions. Self-conscious artificial intelligence and full information about our local human world, collected in a standardized manner, consistently and systematically for some time, may lead to full local knowledge, and thus to the situation for man to become unnecessary to produce anything. However, emotion, ephemeral thought, imagination, friendship, love, and idea will remain, but also eventually dolce far niente. Full (almost) local knowledge, and the potential consciousness of captive-nothingness is probably not meant for human well-being and happiness. To paraphrase Shakespeare, to be or not to be part of an upcoming, ever more virtual reality, we will be leveraging whether we can handle this unknown burden, here are the questions?

First and foremost, the word intelligence, used figuratively, in various contexts, far from the meaning of human intelligence, is overused in all texts about the IoT. One would have to constantly use adjectives, AI, neural, computational, component and device, machine, virtual, cloud, fog, edge, and central, deep and emotional. In addition, it would be necessary to add to this date the recently developed 23 noble and seemingly very important AI Rules of Asilomar, fundamentally affecting the development of IoT and robotics, promoted by the Future of Life Institute. Exaggerated emphasis of the role of IoT in the future is perhaps justified by the current widespread interest in science in this subject, including social media but not excluded that also fashion. There are undertaken big science and industry initiatives and projects, with billions on the financial scale, concerning artificial intelligence in the IoT and digitization of the economy, such as the IIC Industry Consortium, Industry 4.0, Open Fog Computing, SMAC, and many other. The description of some of the existing and potential IoT attributes are often repeated in different contexts to show the diversity of the development of this new civilization phenomenon. Despite the considerable technical resources needed to build the IoT system, efficiently and functionally linked to the civilization infrastructure, the importance of the technical part of the IoT will decline in the face of a very strong economic, social and cultural impact. In the future, the IoT, which is likely to be called then differently, will be more of a social and civilization phenomenon than a technical one. Today, however, the Internet of Things is born in our eyes, built from a variety of technical bricks, in interdisciplinary scientific teams, inspired by dreams but also the fears of scientists and users. How many of these research and laboratory dreams will be accepted, we do not know. Probably it is not going to be quite a lot. For the time being, we have not yet witnessed a major, truly fundamental breakthrough in passing the power to the IoT. Or maybe it is a slower, much more evolutionary change. It is therefore that to some of the dreams and worries presented here, one has to come up with a reserve. The IoT, in conjunction with future artificial intelligence, advanced robotics and ICT technology, builds a reality, a digital civilization infrastructure, and an analogue person, a digital person, and a society.

IV. IoT Future

We ask more questions than we answer. But if we are able to ask some of these questions today, even if they sound absurd, even if they do not currently have any technological prescription, it still means that it is probably a non-trivial cause. Transhumanism and the intellectual superiority of machines are of great concern, and these are the likely attributes of the future IoT, especially if out of control, or under absolute power of money and science without conscience. We do not ask questions in certain areas without realizing that they there are, and there is no doubt that they exist. Some of these areas, including the IoT, are financed by billionaires 'philanthropists' who can do more in science in the world today than entire countries. We are here to signal many large, fundamental areas of IoT, but not in any of them too deep. The exception will be some detailed examples and curiosities that characterize certain directions of development. Nearly in every one of these large areas, such as the smart city or cyber security, the IoT is today a subject of rapid development and deeper analysis, often very publicly available in the form of broad social studies. Such studies are also available in popular editions. In that way everyone knows immediately from the Internet nearly everything. The situation shown during the largest computer fair in the world, the 30-year-old Hanover CeBIT, is a clear proof of the profound and irreversible penetration of ICT and IoT into social life, markets, commerce, and marketing. Market giants are presenting their news increasingly frequently in social media. The CES Consumer Technology Association in Las Vegas, which is a fifty-year exhibition and conference is still showing some of the consumer innovations, including now largely IoT.

IoT technical development, its quantitative changes in rich and varied quality, and IoT technology coupling with infrastructure and social space, with new services, open up the debate on human freedom. Between the two polarities clearly present in this discussion, that IoT will greatly reduce and greatly expand freedom extends the enormous field of new science. Somehow trivializing, we have to answer many questions, for example, whether we are ready to cast some of our decision-making power over the nutrition to our 'smart' refrigerator, which after some time will not only learn our habits but may fall into a monopolistic dependence on some, even more intelligent supplier. In spite of these uncertainties regarding the acceptance of our freedom of choice, or perhaps the transfer of this freedom to another level, the most intensive (apart from defence) research goes on the development of IoT sector specializing in direct and indirect human service.

The IoT is supposed to become 'caring' towards the human being. The most active creators and IoT users will say their expectations bravely. Not the bravest of the opinions predicts close coupling of man to the IoT, both in physical, trans humanistic and now virtual terms, by means of his/her digital twin, my busy IoT bot, finally my virtual Bionic Guardian Angel.

Several question have to be answered in different ways. What is really IoT from a technical point of view? What are its elemental components? How science in collaboration with industry transforms a specific type of research IoT, called RIoT, into a service SIoT, commercial CoIT, industrial IIoT. And all these IoT types should have the cognitive attribute IoTC. IoT components are virtual reality, large data sets - big data, artificial intelligence distributed, but also individualized machine and robotic intelligence with some anthropomorphic features, data processing systems - fog and cloud, cognitive networks - proximal, access and transport, almost unlimited mobility, next generations 5G mobile networks, sensors, transducers and effectors, robots, intelligent objects, autonomous machines, computer techniques, communication and ICT technologies, inter-machine M2M communication and between D2D devices, security, and interfaces between system components and with man. Sensors are equipped with individual IoT devices, or sensor networks are developed that utilize cost-effective local communication protocols such as ZigBee, 6LoWPAN, BLE - Bluetooth Low Energy and many more. At present the functional, practical, very practical IoT is built massively and spontaneously also completely outside the field of science. Science has developed a theoretical, hardware, programming, as well as system and infrastructure foundations for the IoT. Available commercially, cheap, easy to use, ready-made IoT components allow you to build your own advanced hardware and software solutions even in relatively not advanced ICT business environments. Components of IoT functional systems are also available for home and amateur. Some of us at home or office have a great set of Raspberry Pi, or similar to Arduino and Industruino, transforming ordinary items into completely different, "intelligent", cross-linked, responsive to our commands, or system commands that rationalize and optimize their use. Personalization and optimization of larger business solutions requires a deeper knowledge of hardware and software. Many multimedia courses are available on-line at all levels. These and similar courses, tutorials and promotional materials, virtual examples of use, increasingly available in expanded reality format, become standard for popular and professional education, as well as a new way to contact service companies and commercial customers. Science has been building virtual institutions, laboratories, experiments, efficient inter-machine communication, device and data state visualization, remote hardware and software diagnostics, virtual human interfaces for a long time. In these scientific solutions, we sought almost exclusively raw, unpretentious functionality. We did not look for these features of commercial order, incentive, promotion, and graphic design that we place on the functionality of packaging for market products. Now these bricks are assembled from the scratch, massively, for the rapidly expanding IoT market. In principle, all components for the construction of a very advanced IoT are readily available today.

IoT is a scientific and technical field but also an economic and social one. It also becomes a new cultural layer of our society. In the future, the socio-cultural role of IoT will deepen. For a purely utilitarian role, the basic functional IoT will get used up quickly and we will stop seeing it. In the science and technology layer, the current practical IoT development is focused on the most application and innovative areas. This development is mainly in industrial laboratories, which eventually offer almost finished market products. IoT transfer generally in the area of science - innovation - industry also means a need to reach a bit into the future. Science in this general case also includes universities, national institutes and research laboratories, very powerful science laboratories of large industrial corporations, and thousands of small local

development laboratories of smaller innovation companies. Each of these laboratories works slightly differently for the IoT. The distance between science and industry in today's rapidly evolving IoT is not so great because adequate scientific research is highly fragmented, in many cases is not very costly, it is mass, application and implementation oriented, and rather not basic today. Fundamental research in such areas as new material technology, factory food production, fusion energy, quantum computers, artificial intelligence, smart environment, cognitive new generation telecommunication networks that are conscious of transported data, large data sets containing knowledge, and the generation of new knowledge, will undoubtedly contribute to the further development of the IoT, but not yet tomorrow. Today's dynamic development of IoT is based on studies done some time in the past.

This time gap between science and industry is much shorter than many decades ago, squeezed to a few years, at most for a decade now. Over the course of a decade, not more than two, it is expected to implement many of the technologies mentioned above in the IoT, which are capable of achieving a qualitative technological breakthrough, and change of this civilization. Why this process will last even two decades? For the transformation is the whole industry, which mostly work in analogue way, or digital but not yet fully networked. There are billions and even trillions of sensors connected to local networks and add intelligence to the machines, giving them the necessary functionalities. Significant further improvements are artificial intelligence, which is the only potential solution capable of managing so many sources and large amounts of data. Virtual reality is to be tamed, to which we either get used, or accept or not. For a possible and accelerated evolutionary acceptance by us there is a completely different world that we create ourselves. Many industrial areas should be subject to fundamental change from the conservative approach to the IoT. These processes have to last some time since have the roots embedded in the conservative human psychology. And yet it is going to be incomparably shorter when compared to the previous transformations of the "technical revolution", whose effects we are experiencing all the time.

V. IoT SOURCES

Today the major sources for the IoT is in the global network: (iot.ieee.org), (theinternetofthings.eu), (thethings.io), primary (resiot.io) and secondary (iotjournal.com), professional (aws.amazon.com/iot), (evrythng.com) and popular (iotworldnews.com). It is a proof of gigantic interest in the IoT by science, development, technology, industry, economy, different communities and the society. The Internet sources on the IoT have different weight and global or regional extent: (internet-of-things-research.eu), (iotweekslynews.com), (iottedchnews.com), (iotnewsnetwork.com), (iotbusinessnews), (iot-today.com), (iot-now.com), community and association sources (Prpl 2016), (iofthings.org), (iotcentral.io), (internetofthingsagenda.techtarget.com), popular and professional books, technical reports(Eclipse 2016), (IIConsortium 2016), application notes by market associations and vendors (Cisco, IBM, Intel, Amazon), IoT emerging standards (IIConsortium 2015), conference proceedings, etc. These sources count today in thousands, tens of thousands, and grow every day.

Using IoT abbreviations one has to be careful enough because they can have different meanings. These abbreviations are stabilizing themselves with the development of particular IoT sectors. CIoT abbreviation or IoTC is used in reference to the future Cognitive IoT, but also to closer Collaborative IoT and Cloud IoT.

Technical issues of IoT are, by nature, written in a specialized language for a given field of science, are therefore quite hermetic in the world literature dispersed in many scientific journals on artificial intelligence, automation and robotics, telecommunications, sensing systems, and emerging journals dedicated exclusively to this subject. The IEEE IoT Journal, is linking Societies for Technology Effectiveness, Reliability, Telecommunications, Computer Engineering, Consumer Electronics, Industrial Applications, Sensors and Signal Processing (iot-journal.weebly.com). In the fast-growing field of the IoT the books are published with some delay comparing to the content of articles published in scientific journals especially in fast online journals, despite the rapid rise in popularity of the e-books. The books on IoT concern different development and application aspects of this sector like: general business with IoT, change of business models and trust, business analytics, finances and economy in the IoT industry and business, psychology, artificial intelligence in IoT, superintelligence, health, future of man and digital generation of men, cybersecurity, privacy, architectures, protocols and algorithms, industrial and cognitive IoT, networks and virtualization, finances and economy of IoT based enterprises, didactics and education, permanent training, open universities, intelligent cities, transportation and municipal systems, intelligent house, fog and cloud computations, edge-cloud links, interoperation ability, IoT sensors and actuators, 5G networks, big-data systems, IoT-M2M transformations, IoT microprocessors and microsystems, IoT resource management, potential conflicts IoT-humans, intelligent garment, IoT service conversions, and numerable application examples.

Another source are the IoT technical standards prepared by large teams of experts. They concern IoT architecture and specific issues for applications in the world economy. They generally are maturing for several years and partial solutions are published for open consultations by the industry and community users. Numerous in-depth business analyses of IoT sectors such as the IoT ecosystem, low-resource WAN for IoT, IoT edge information processing, etc. are also available. Many business sectors are available from commercial analytic firms. The language of technical notes and standards, especially for the IIoT, is the most hermetic.

This concerns, for example, optimized and standardized highly reliable protocols for information-intensive edge-to-edge IIoT, as well as application-oriented topology of mini proximal networks, minimally latent, economically critical, such as systems with optimal energy usage. In the business IoT and IIoT's optimized solutions, the standards concern, for example, the impact of aggressiveness and assertiveness on the economic efficiency of the corporate environment. A very useful source of the current conditions of technical, economic and social development of the IoT are many news journals and magazines devoted to IoT and associated subjects like (iottechnews.com).

VI. IoT STANDARDIZATION

The contact area between the company and the customer, the company and the market is now very strongly subject to IoT transformation. This area is equally subject to standardization for technical reasons, for obvious economic reasons and ease of use, facilitating usage of the omnipresent Android. The technical background of IoT, which has to be not directly visible to the user, must remain the responsibility of engineers and IT professionals. The users evaluate and possibly accept or not the functionality of the application. Such feedback between the users and the IoT deigners works usually pretty well and thus the norms are constantly evolving. That is, they are frozen for some time, allowing the industry to produce IoT hardware and software, and then are changed to the next version, potentially but not always, with the backward compatibility. The rapid technical development that we observe in IoT and, therefore, the accelerated pace of industrial standards developed, this compatibility is not in principle guaranteed today. To use the latest generation of IoT hardware and software solutions, we need to continue to invest individually or in a company premises. IoT is an expensive area for large industry, but potentially very attractive. There is not much to talk about, the IoT is becoming a standard for the industry, and it becomes even a new universal multi-layered platform, a new operating environment and a common universal language of agreement for the business. If the issue of development and wide penetration by the IoT of our civilization is so complicated and important, then let's try first to fully understand the question of what exactly is the IoT from a technical and business point of view. IoT standards proliferation, and cost lowering of IoT equipment will ease to answer this question.

VII. CONCLUSIONS

The future of work is discussed by politicians, financiers, economists, sociologists, psychologists, who notice a real possibility that the IoT may completely change the work markets for humans. It is predicted that numerable professions will disappear forever. Fortunately new professions may appear. However, a lot of work will be taken off by the intelligent IoT environment, real and virtual alike, including strong robotics sector and anthropocentric network. Technical layers of these processes will play soon only auxiliary role, indicating the pace of transformations from passive infrastructure to very active and intelligent environment. Some expert call it technological catastrophe. Solutions are searched intensely by humanistic and economic professions, which today leads to very animated discussions and analytical actions around the IoT. There are no simple solutions to these not so distant futuristic issues. On one hand there is no option to stop development is information sciences, electronics, mechatronics, communication, biophysics, artificial intelligence, virtual reality, applied virtual cognitivism, etc. Artificial intelligence turns to a constant component of business strategies in bigger firms. It can be easily seen in the web portals of such firms like Intel, IBM, Coca-Cola, eBay, Airbnb, NYT and many more. A lot of web resources are available on how to increase ROI by application of artificial intelligence and eliminating humans from certain processes. A critical moment in these economic and business, but also service transformations is noted when the operational efficiency of the IoT ecosystem overcomes irreversibly any individual or common effort by humans. Are we then lost totally and forever, and no work is available for the weaker. We are just witnessing this transformation done as a common, mutual effort of university, development, business, industrial and market laboratories and institutions.

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