

**Developing Information and Communications Technologies with More Artificial
Intelligence, Using Artificial Intelligence,
When Internet of Things is “*Intelligence Everywhere*”**

-Part2-



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Abstract

The paper presents an analysis of the emergency of advanced artificial intelligence (AI) devices/systems/services and Internet of Things (IoT), in the context of Information and Communications Technologies (ICT) exponential evolution - as main driving factor of the progress of the Information society (IS) toward Knowledge Based Society (KBS).

In the paper analysis, some trends and challenges of AI/IoT/ICT development, evolution and implementation issues are pointed, versus the benefits and consequences these issues could bring for humankind and Earth, in the IS/KBS context.

The analysis premises include the impressive perspective of IoT, that would encode trillions of objects, covering, among others, smart home/cities, e-health, environment monitoring, smart grid, smart transportation, industrial applications, but besides others important fields where intelligence penetration is growing, including robots, smart communication networks, defense/security, social media, business intelligence etc.

As expression of the IoT proliferation, the paper also presented the family of terms used for different areas of IoT applications, which are extending too, including a lot of important areas of humankind activity and also new fields and concepts, like Crowdsensing, TaaS, M2M, V2V, BAN, IoE etc.

Despite the explosive evolution of IoT, which is an incontestable reality, the figures largely promoted in the last years, about the IoT forecasts, tend to be corrected and in the paper some reasons which led to these corrections have been identified, as it seems that the reasonable doubts are based on the counting models which led to the initial figures, but globally the correction factors include security, powering or e-waste for billions of sensors/devices.

Because the ICT specialists world is hardly working to find the best solutions for a sustainable development of ICT/IoT/AI, considering the high complexity, performance and efficiency already reached today, the paper also presents some important examples of new technological advances intended to fight the mentioned corrected factors, including fog computing and nanorobots.

After analysing the “line between AI and wisdom”, it resulted that AI must be conceived and then implemented by an intelligent design, in order to lead toward sustainable development – depending on wisdom involved when using the „double sharpened” power of Technology, i.e. without forcing its complex potential as wisdom is more and more difficult to obtain when complexity is increasing.

Consequently, for AI/IoT/ICT development, in the future IS toward KBS, it will be very difficult to define and reach wisdom as complexity and other challenges generated by an exponential powerful development are also increasing.

The analysis of some literature references confirmed that the preoccupation for the ICT exponential pace development, with complex challenges and difficult to forecast consequences, is largely spread and argued.

Also, another concrete conclusion, confirmed in references, is that this development could become „unknowably” complex, because technologists could overdo in creating complex systems.

Based on the these conclusions, it became obvious that their link with the AI growing evolution is just the essence of our paper point, because arriving in the situation to be more and more dependent of ICT/AI devices/systems that are „unknowably” complex, i.e. difficult to manage, is a real challenge for humankind and Earth survival!

As support of this last (general) conclusion, the paper also analysed some actual examples, including emergent robo-taxis and fly robots, which could be relevant cases of AI amazing complexity, performance and proliferation, where there is a human - AI competition in making-decision vital processes and the specialists have hesitations when they have to give in the main decision attributes to robots/machines.

Keywords: advanced artificial intelligence, Internet of Things, information society, knowledge based society, robo-taxi, fly robots, nano-robots, crowdsensing, fog computing.

JEL Classification: L63; L86; M15; O31; O33

1. Building ICT/IoT with intelligence everywhere

One of the most impressive features of ICT development is their multiplying power over everything they “touch” and if this is not sufficient, it is happening ... **everywhere** on Earth and ... beyond.

With other words, here again we may quote Sun Tzu who admirably observed, thousands of years ago, that “**opportunities multiply as they are seized**” [22].

For an accurate picture we also have to observe that, excepting the “species evolution“, probably nothing else proved so efficient multiplying consequences on Earth scale, like ICT!

By multiplicity factor here we understand not only the obvious spreading effects in all fields of humankind activity, but the intrinsic feature of **digital technology** to easy/efficiently multiply/combine its hardware modules and processing functions, in order to obtain new structures and functions.

More than these, we already presented [13] the crucial importance of the ICT digital operating and developing **models**, which are applied in many other activity fields, just due to their proved efficiency.

As a consequence for IS/KBS, ICT could enable people to more efficiently work and innovate and this way the ICT development must be a continuous *human centric innovation*.

This way it is not a surprise that every day we can observe these ICT development overwhelmingly spreading models, products, services and consequences, **everywhere**!

On the other hand, the same ICT could generate, in unsustainable development scenarios, negative influence to human evolution and potential.

As we have already pointed [2][10], the essential issue of this development, we have to carefully analyse, is to be sure that it is sustainable, as general consequences for humankind and Earth!

The actual phase of this issue is mainly characterized by the complexity induced through the exponential ICT developing pace and the huge processes which ICT generate, as progress prominent factors in IS toward KBS.

Now we just could point the revolutionary transformation IoT and AI tend to generate over the general above picture of ICT development and consequences.

Because “the picture” is in fact such an immense ”movie” (i.e. a lot of **changing** pictures), we can only try to analyse some prominent ”frames” and eventually try to see if they prove **intelligent design** or only contain a level of **intelligence** capacity.

First of all, about the ”immense” dimension, it is interesting to recall a projected image of IoT [14]:

“The Internet of objects would encode 50 to 100 trillion objects, and be able to follow the movement of those objects. Human beings in surveyed urban environments are each surrounded by 1000 to 5000 trackable objects”

Of course, even in our days, IoT is a prominent part of the above mentioned picture, covering, among others, smart home/cities, e-health, environment monitoring, smart grid, smart transportation, industrial applications, but besides others important fields where intelligence penetration is growing, including robots, smart communication networks, defense/security, social media, business intelligence etc.

These premises express the complexity and the overwhelming importance of the emergent processes where „intelligence” is more and more present.

Our above mentioned „picture/movie”, even shorted, could not be completed outside the IoT, as the main frame where the future ICT/AI devices, systems and services will be deployed, under the large cover of Cloud [20][14][6].

As a concrete expression of the IoT proliferation, the family of terms used for different areas of applications are extending too, including a lot of important areas of humankind activity and also new fields and concepts [4].

Probably the most dynamic and largely implemented family consists of sensors networks, where every pair of (transceiver + sensor) is now usually called “*mote*” (remote).

Also very promising is the vehicular IoT family, which will include both vehicle-to-vehicle (**V2V**) and vehicle-to-person (**V2P**) applications, all these representing in the future the big family of Internet of Vehicles (**IoV**).

Extending the above concepts to general/industrial applications, we will be surrounded or even integrated in large combinations of machine-to-machine (**M2M**) or machine-to-person (**M2P**).

In [21] we have mentioned the important and spectacular applications of IoT in the e-Health areas, implemented for the human benefit inside the body, thus leading to body area networks (**BAN**), a field with dramatic benefic results for our health, but also supposing an incredible level of difficulty, complexity and performance.

It is here the place to notice that ***BAN should be perhaps one of the most important, as priority for humankind, areas of IoT to be sustainably developed***, as body monitoring is implemented along with all revolutionary e-Health involved technologies.

Without entering details, one of the primary and largely implemented areas of applications, assigned as domestic informatics, is called ***Domotics***. Here the diversity of smart home applications will be deployed, all being connected and integrated in management and optimization processes by IoT sub-networks.

Social networks, as prominent fields of ICT/IS/KBS, will generate, through mobile communications networks as social-aware component of IoT, what is going to be called Social Web of Things (**SWoT**) [4].

Extending these awareness features by the context aware communications and IT, we have already presented [13], the environment data will lead do to the general concept/feature of ***Crowdsensing***, which can enable a huge amount of applications for the optimizations of all humankind activities and Earth environment.

Actually, the most general term that is going to cover the huge expansion of IoT tends to be naturally called Internet of Everything (**IoE**).

Of course, specialists and generally literature could use a lot of relevant words, assigned to IoT areas, but, technically speaking, an emergent prominent reality, as IoT main support, needs also to have a name.

The most extended support for IoT data processing and services management is going to be the “*Cloud*”, this leading to Things as a Service (**TaaS**), not only because ***TaaS*** seems to be the highest, although an apparently abstract, concept, but because it covers the essential trend of ICT, which could not be missed by IoT.

As we repeatedly presented [6][21], in spite of the overwhelming diversity of ICT devices and systems, all over the Earth for humankind in IS/KBS, ***the most dynamic and innovative ICT developing direction is to offer new services – this trend being more and more manifest also as business/commercial model in the digital age*** we live.

In fact, if we link **Crowdsensing** and **TaaS** the result is a planetary frame to monitor and then optimize everything (by **IoE**).

If these “iceberg tips”, we have already approached as metaphor [10], could create the impression of a symbolic “sea of fictions”, against a World of concrete and dramatic changing realities, recent events could be relevant.

Unfortunately, recently we have been shocked by a series of terrorist attacks, last at London Westminster/Parliament.

Perhaps many security specialists work on the means to implement new preventive ways against this “**asymmetric war**”, where **imagination sets the limits**.

Linking this fundamental need with **Crowdsensing** and **TaaS**, we may imagine how much help we could get monitoring (eventually, if necessary, **controlling**) relevant **data and actions** scenarios with **appropriate devices**, applied on EVERYTHING could generate risks for people’s lives (for example: vehicles).

Still, some opinions converge toward to doubting the realism and sustainability of certain ICT trends, when observing the above mentioned impressive diversity of applications (terms), as the authors of [4] asked:

“Just because you can, does it means You should?”

This doubt, we also approached before [10][6], is arising more and more as IoT/ICT new devices/systems/applications “explode” with an exponential pace and unpredictable consequences everywhere on Earth.

Although the explosive evolution of IoT is an incontestable reality, the figures largely promoted in the last years, about the IoT forecasts, tend to be corrected [8].

For example, the largely spread estimation of connected IoT devices, for (30-50) billion by 2020, began to be reconsidered and corrected, as the last estimations for 2020 do not exceed (20-25) billion.

The most important fact is to identify some reasons which led to these (benefic if argued) corrections.

It seems that the reasonable doubts are based on the counting models which led to the initial figures, but globally the correction factors include security, powering or e-waste for billions of sensors/devices.

Our opinion, already expressed when speaking about Earth resource fading [2], is that **first to produce these billions of devices could be a challenge and then come recycling, ethics and legal conformity** etc.

These corrections finally prove that the doubts about the too fast pace of ICT/IoT/AI development are eventually sustained by the industry/market and specialists – and we consider this **a long expected wisdom sign**.

Naturally, beyond such welcomed signs, the ICT specialists world is hardly working to find the best solutions for a sustainable development of ICT/IoT, considering the high complexity, performance and efficiency already reached today.

As we have mentioned above, the tens of billions of IoT devices will need huge (material) resources, but there will be included the communications and computing resources necessary to handle the exponentially growing amount of data.

This way, one of the promising solutions is **fog computing** (FC) [7]:

“The fog computing paradigm aims to address these problems by extending cloud computing toward the edge of the network ... a novel FC-IoT paradigm designed to move computing, storage, and applications/services close to IoT objects so as to reduce communication bandwidth and energy consumption as well as decision making latency. The proposed IoT-based solution has been designed to have intelligent and autonomous IoT objects that are integrated with an FC and fog networking approach. The distinguishing features of the intelligent FC-IoT platform are low latency, self-adaptation, low energy consumption, and spectrum efficiency”

A similar new approach is pointing energy consumption of ICT/IoT networks, another basic resource and in the same time involving AI in “green ICT” optimization [18]:

“The need to manage the energy consumption of network infrastructure has been addressed by a significant body of work in recent years. In general, energy management capabilities were developed independently and optimized for particular network layers and node features. The interaction between multiple such green capabilities when deployed simultaneously, as well as potential interactions with other existing functionality such as quality of service functions, need to be managed transparently by the operators. We developed SLIM, the SustainabiLity Information Model for Energy Efficiency Policies...to allow unifying the management of green capabilities throughout the network”

Such solutions could cover in the future the increasing need for standardized automated coordination management systems of the network of networks IoT will represent, in order to transparently optimize both energy consumption and service quality requirements.

An other confirmation of our already presented essential trends of ICT developing, when getting physical and innovation limits [16], is represented by the actual approaches of bio-inspired promising new technologies [11]:

“Recent progress in bio-nanomachines have motivated the research on bio-inspired, biocompatible, and biodegradable nanorobots such as flagellated magnetotactic bacteria (MTB) with nanometer-sized magnetosomes. These bacteria can be utilized as efficient carriers of nanoloads, and thus can serve as diagnostic and therapeutic agents for tumor targeting applications”

With such premises, the future technologies could leverage not only the **e-Health** fields, but step by step inspire other ICT/IoT/AI technologies and applications, due to the **“wisdom”** mother nature inserted in the living world, in millions years of **“research”** (evolution).

Speaking about AI and wisdom, it is worth to further analyse how the **AI/IoT/ICT evolution should be oriented to implement more wisdom in their intelligent devices, systems and services, for a sustainable humankind progress on Earth in IS/KBS.**

2. The line between AI and wisdom

In order to have a clear reference for this section, a quote of Thomas Jefferson [23] could be very relevant for the actual challenges of Ai/ICT:

“I hope our wisdom will grow with our power, and teach us, that the less we use our power the greater it will be”

Starting from this quote, our opinion, already generally approached in the first lines of the paper, now could be further developed/confirmed, as in the AI/ICT evolution **AI must be conceived and then implemented by an intelligent design, in order to lead toward sustainable development – depending on wisdom involved when using the „double sharpened” power of technology.**

With other words, applying T.Jefferson advice for the ICT (incredible) power in our days and beyond, means that it must be used very carefully, i.e. without forcing its complex potential, **observing that wisdom is more and more difficult to obtain when complexity is increasing.**

Consequently, we consider that **for AI/IoT/ICT development, in the future IS toward KBS, it will be very difficult to define and reach wisdom as complexity and other challenges generated by an exponential powerful development are also increasing.**

Perhaps one of the most complicate issues of the analysis we have started is quite inside the word „**intelligence**”, we have generally approached in [2], but this time the emphasis is most on the technical side.

It would be easy to consider that almost all electronics are intelligent, or, with the well known pace established by the Moore Law, **became more and more intelligent.**

But speaking only about AI, the context is much complicated, including the term definition or interpretation.

As an evidence that this approach is not singular, we can quote [5], which presented a documented and interesting analysis on AI, pointing:

<<The concept of what constitutes AI has evolved as technology has evolved. A colleague of mine has said, “It’s artificial intelligence until you know how it works.” An interesting perspective indeed. I found support for this in material from an MIT AI course ...

For instance, compilers used to be considered AI, because [...] statements [were in a] highlevel language; and how could a computer possibly understand? [The] work to make a computer understand [...] was taken to be AI. Now [...] we understand compilers, and there’s a theory of how to build compilers [...] well, it’s not AI anymore. [...] When they finally get something working, it gets co-opted by some other part of the field. So, by definition, no AI ever works; if it works, it’s not AI>>.

Without agreeing with all the above assertions, we rather conclude that **developing standalone or embedded AI devices, systems and services represents a very complex, complicated, challenging and important direction of ICT in IS/KBS, which is worth to be designed with maximum responsibility, due to its dramatic consequences for humankind at Earth scale.**

Coming back to our analysis, we may also observe, by some relevant examples, how AI is evolving following the ICT general exponential evolution, but presenting complicated issues because of their increasing complexity and performance.

On the other hand, we have to notice that, naturally, these special issues, including ethics, come mostly from those fields where AI tends to compete with sensible human activities, like creation and decision making.

A relevant confirmation of this approach is given by [9]:

*“I enjoyed Samuel Arbesman's first book, **The Half-Life of Facts**, which was a discussion of the exponential pace of change, as exemplified by Moore's Law, among other things. When I saw the title of his new book, **Overcomplicated**, I assumed that it would be a warning that we technologists had gone too far in creating complex systems. It would advocate moving to simpler systems, just as a doctor might advise an overweight person to go on a diet. I was prepared to argue against such a conclusion, but as I discovered upon reading the book, Arbesman does not say that complexity is necessarily bad or that we should seek simplicity. Instead, he maintains that systems are now unknowably complex, that they will become even more so, and we should...just get over it. Much of the book is spent in discussing the reasons why complexity is inevitably increasing. “*

We can notice that our preoccupation for the ICT exponential pace development, with complex challenges and difficult to forecast consequences, is largely spread and argued [15].

An other concrete conclusion, we generally share, is that this development is **unknowably complex**, because **technologists had gone too far (they could overdo) in creating complex systems**.

Of course, **it is not sure that things have been pushed „too far”**, but the fact that they (ICT) could become **unknowably complex** is a **scaring scenario we can not neglect!**

More than this, the link with the AI growing evolution is just **the essence of our paper point**, because **arriving in the situation to be more and more dependent of ICT/AI devices/systems that are unknowably complex, i.e. difficult to manage, is a real challenge for humankind and Earth survival!**

As actual examples, the emergent robo-taxis, buses or even fly robots could be relevant cases of AI amazing complexity, performance and proliferation [1][12].

Robo-taxis (and buses) are the actual trials we have to face and the above mentioned challenges are clearly confirmed by [1] starting from the emergent trend of advanced AI called **deep learning**:

<<A deep-learning system's ability to recognize patterns is a powerful tool, but because this pattern recognition occurs as part of algorithms running on neural networks, a major concern is that the system is a “black box.” Once the system is trained, data can be fed to it and a useful interpretation of those data will come out. But the actual decision-making process that goes on between the input and output stages is not necessarily something that a human can intuitively understand. This is why many companies working on vehicle autonomy are more comfortable with using traditional robotics approaches for decision making, and restrict deep learning to perception>>

If on ground we face some worries, how we will feel „in the air”, where soon we could be guests of a **fly robot**?

Some answers are given by aviation specialists [3], when analysing the perspectives of taxi-drones or fly robots:

<<In the future, the joke goes, airliners will each have a pilot and a dog. The dog will be there to bite the pilot if he touches the controls, and the pilot will be there to feed the dog. It's no joke, though, when NASA scientists begin entertaining the idea of replacing the copilot with a wideband connection to a ground controller. Who will take over the plane should the

pilot become incapacitated? Nor is it a joke to carry the argument to its logical conclusion and do away with the pilot altogether>>

Besides these positive premises, the main question, again on target of our paper but also approached in [3], rises:

<<“It can be done-we could be flying around in pilotless planes, just as we could be living on cities on Mars-but is it worth the cost and the effort?” asks Patrick Smith...

“I fly airplanes for a living, and my jaw drops when I hear people say that flying is already mostly automated. Even the most ‘automated’ flight is still subject to so much human input and subjective decisions”...>>

With other words, it appears the same already presented issue [2][19][17] of the human - AI competition in making-decision vital processes.

Perhaps that is why the specialists have the same hesitation when they have to give in the main decision attributes to robots/machines [3]:

<<And should one of these outfits ever offer seats to the paying public, would you entrust your life to a robotic pilot? “People want a pilot in the cockpit, to know there's someone in charge who shares their fate,” says Missy Cummings, a former U.S. Navy fighter pilot, now a professor of mechanical engineering and materials science at Duke University. “I don't think we'll ever have a passenger airliner be a drone-there will always be some version of a Captain James T. Kirk on board.” But, she adds, things are different for hops of, say, 50 miles (80 kilometers), where for some people, at least, convenience might outweigh fear.>>

The AI-responsibility dilemma we meet today, as AI is the result of summing the past data/experiences, was foreseen by inspired minds, as George Bernard Shaw [23]:

“We are made wise not by the recollection of our past, but by the responsibility for our future”

Here our opinion is that all actual facts and serious analyses should lead us all to **more wisdom and responsibility about developing complex but difficult to completely understand, as consequences, AI/IoT/ICT devices, systems and services, in order to increase chances for a sustainable progress for humankind on Earth, in the future IS/KBS.**

Obviously, such great and complex objectives needs further analyses and evaluations, as time changes **everything**... so fast!

3. Conclusions

Through the paper analysis, some trends and challenges of AI/IoT/ICT development, evolution and implementation issues are pointed, versus the benefits and consequences these issues could bring for humankind and Earth, in the IS toward KBS context.

As premises, we have considered the impressive perspective of IoT that *would encode trillions of objects*, covering, among others, smart home/cities, e-health, environment monitoring, smart grid, smart transportation, industrial applications, but besides other important fields where intelligence penetration is growing, including robots, smart communication networks, defense/security, social media, business intelligence etc.

As a concrete expression of the IoT proliferation, the paper also presented the family of terms used for different areas of IoT applications, which are extending too, including a lot of important areas of humankind activity and also new fields and concepts, like **Crowdsensing, TaaS, M2M, V2V, BAN, IoE** etc.

In spite of the explosive evolution of IoT, which is an incontestable reality, the figures largely promoted in the last years, about the IoT forecasts, tend to be corrected and in the paper some reasons which led to these (benefic if argued) corrections have been identified, as it seems that the reasonable doubts are based on the counting models which led to the initial figures, but globally the correction factors include security, powering or e-waste for billions of sensors/devices.

As beyond such welcomed signs the ICT specialists world is hardly working to find the best solutions for a sustainable development of ICT/IoT, considering the high complexity, performance and efficiency already reached today, the paper also presents some important examples of new technological advances intended to fight the mentioned corrected factors, including **fog computing** and **nanorobots**.

Analysing the “**line between AI and wisdom**”, we may conclude that **AI must be conceived and then implemented by an intelligent design, in order to lead toward sustainable development – depending on wisdom involved when using the „double sharpened” power of technology, i.e. without forcing its complex potential as wisdom is more and more difficult to obtain when complexity is increasing.**

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After analysing some literature references it has resulted that our preoccupation for the ICT exponential pace development, with complex challenges and difficult to forecast consequences, is largely spread and argued.

An other concrete conclusion, we generally share, is that this development could become „*unknowably*” complex, because *technologists could overdo in creating complex systems*.

Based on the these conclusions, it became obvious that their link with the AI growing evolution is just **the essence of our paper point**, because **arriving in the situation to be more and more dependent of ICT/AI devices/systems that are *unknowably complex*, i.e. difficult to manage, is a real challenge for humankind and Earth survival!**

This last (general) conclusion was also confirmed in the paper by analysing some actual examples, including ***emergent robo-taxis and fly robots***, which could be relevant cases of AI amazing complexity, performance and proliferation, **where there is a human-AI competition in making-decision vital processes and the specialists have some hesitations when they have to give in the main decision attributes to robots/machines.**

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