

INFORMATION AND COMMUNICATIONS TECHNOLOGIES GO GREENER BEYOND IOT- BEHIND IS ALL THE EARTH

- Part1 -



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Abstract

The paper is approaching the systemic analysis of the context of Information and Communications Technologies (ICT) exponential evolution, as driving power of the transformation of the Information society (IS) toward Knowledge Based Society (KBS), foccusing on a smart management of ICT/IS/KBS evolution, where the essential is to deeply analyze, update the solutions, refine knowledge and responsibly react to challenges/implications, in order to correct the negative consequences of such complex and mass processes at Earth scale.

The analysis approached the actual point of ICT development, dominated by Cloud Computing, Big Data and Internet of Things (IoT), starting from the premises created by “COPs21” Paris Conference context including ICT latest figures on carbon footprint and IoT emergent expansion – which show that Internet traffic is increasing with 40% / year, which would lead, without corrections, as ICT could consume in 10 years 60 percent of the Earth’s energy production.

The author opinion is that the actual “machine” trend, focussed on striving for performance, must be balanced by a greener approach aiming power efficiency and carbon footprint reduction, including a concrete approach based on relevant issues as: Identifying incertitude/risk complex and complicated mechanisms, generated by the exponential speed of ICT development in IS/KBS and generally on Earth ecosystem; Developing greener ICT capable to induce greener solutions in all fields of activity; Designing new integrated models, algorithms and technologies for information analysis to cope with all consequences of IoT, Cloud computing, Big Data.

The paper main conclusions include the priority to fight the main difficulties generated by the extreme speed of changes induced by ICT exponential pace of development, which create such complex consequences but does not allow humankind the necessary time to real time react, with the immediate approach of this “impossible” mission as being twofold: rethink and adapt (slow) the ICT pace and on the other hand create the instruments to help us find the balance between the designed ICT pace and the capacity to cope with it!

Keywords: *green communications and information technologies, carbon footprint, Internet of things, Big Data, climate changes, information society, knowledge based society, innovation.*

Jel Classification: L63; L86; M15; O13; O31; O33

1. Wherever ICT are going beyond IoT, the “road” must be greener and smarter than “machine”

Always people have tried to predict the future, like, for example, Nostradamus did, but naturally this is not an easy or clear issue.

Still, the human nature is pushing us to analyze and estimate the evolution of processes, but ***this approach becomes a responsibility when the technologies give us performant (sometimes never imagined) instruments and on the other hand the complexity of processes and their changes are increasing with the actual unprecedented pace.***

As we have already presented [5], this complexity is generated by the context of Information and Communications Technologies (ICT) exponential evolution, which is the driving power of the evolution of the Information society (IS) toward Knowledge Based Society (KBS).

Coming back to our responsibility, this is also increasing as we are facing a spectacular transformation of the humankind life and generally dramatic changes of the Earth environment, where climate changes are only the most important consequences among other, including Earth resources fading. On this line, we expressed the dual image of humankind and Earth as apogee or decline [8].

For the accurate actual picture of ICT in IS/KBS, we also analyzed [3] the importance and the complicate challenges of the emergent expansion of IoT at Earth scale, but the dynamic of such huge processes, starting from the above mentioned context, needs step by step analyses and estimations.

Now we have just arrived to the point of necessity to estimate the evolution of these processes and their most important consequences, either good or bad.

Still, we have to mention that the main goal of this paper is not to predict, but to analyze some actual trends and challenges of ICT along with the corresponding efficient corrections solutions.

In fact, our opinion, considering the above issues, is that specialists have the responsibility to carefully and continuously evaluate all the consequences of ICT/IS development, in spite of the amazing speed of changes, but specially to find, in real time, the appropriate solutions to correct the negative implications of such complex and mass processes at Earth scale.

In simpler words, we called this approach ***a smart management of ICT/IS/KBS evolution, where the essential is to deeply analyze, update the solutions, refine knowledge and responsibly react to challenges/implications*** [11].

We consider that this “open design” approach could be actually expressed as ***“the best way to predict the future is to ... design it”***- paying tribute to the brilliant quote of the prominent American computer scientist Alan Curtis Kay:

“The best way to predict the future is to invent it”

Applying these conclusions to the actual point of ICT development, dominated by Cloud Computing, Big Data and ... Internet of Things (IoT), it is quite normally to try to use the available performance level of technology in order to transform “prediction” in “design”, this way timely reducing the costs/consequences.

Perhaps the next question to be answered is: What Cloud Computing, Big Data and IoT have in common?

Apparently the answer is simple, as these 3 main “technologies” represent a huge wave of actual ICT systems or applications, with unprecedented proliferation at Earth scale.

We have already analyzed them [3] [16], obviously not exhaustively, but the paper point is to emphasize “the road” where these 3 ICT “peaks” actually are and especially to what extent their complex development processes create consequences to be corrected.

Here we have only to add that the necessity to have a “green ICT” is not a new issue, but the **“IoT époque” demands a “greener ICT road” and ... more!**

Although the need for a greener road of ICT is obvious, this is only one of the above mentioned consequences to be faced.

A systemic approach must consider the whole complicate process of IS/KBS [16], but the need for refined knowledge demands to take into account the actual dimension and dynamic of the exponential development of ICT products and services, influencing all humankind activities and eventually **life on Earth**.

The deep significance of the link between ICT “road” and ICT “machine” must be further described, as the necessity of a “smarter” road is not very clear in the above context.

As a matter of fact we intend to further and deeply analyze [3] the complex and complicate processes where the humankind and “the machine” is a metaphor for the actual interaction “man-machine”, which is today too simple called M2M.

It is interesting to point that inherently “the machine” is a syntagm with many “faces”, but here we want to notice the actual project of HP Company [12].

Expected this year, “The machine” project is intended to be a prominent step on the ITC computing “road”, as HP Company intends to achieve a revolutionary supercomputer with 2500 cores using MEMRISTORS (the revolutionary technology for the next generation memory), capable of handling 160 petabytes (i.e. 5 times the Large Hadron Collider generates in one year).

We cited this project just as a symbol of the ICT actual evolution, striving to keep Moore’s Law and provide energy-efficient memory.

Consequently, we have used this actual symbol in order to suggest that in fact the designers of the ICT must conceive a new “road”(approach) which must be “greener” and “smarter” than the actual trend of thinking (machine like!), where the machines take, step by step, the place of human, including “intelligent” activities (like design!).

Here our essential opinion is that, **when conceiving new ICT, the actual “machine” trend, focussed on striving for performance, must be balanced by a greener approach aiming power efficiency and carbon footprint reduction.**

Well, someone could ask: And what is the news?

The answer pillar is the two-fold we will further present: “COPs21” Paris Conference context including ICT latest figures on carbon footprint and **IoT ... aisberg!**

It is possible that COPs21 to **become** an historical milestone [1], as, *“under the frame of the United Nations Framework Convention on Climate Change (UNFCCC) and the Conferences of the Parties (COPs), ... after solid and united global efforts, from 30 November to 12 December 2015, COP 21 was held in Paris, France, when, in a historical breakthrough and milestone toward securing the future Earth, a global agreement on the reduction of climate change was agreed upon by representatives of more than 193 countries in attendance. According to the COP21 Organizing Committee, the agreement was to limit global warming to well below 2°C compared to pre-industrial levels...The agreement in COP21 greatly encouraged and promoted green information and communications technologies ... A parallel trend to the newer generation global green revolution is the global challenges in big data issues, and there are recent studies discovering the relations between the two trends”*.

On the other side [1], in 2014, the IEEE Technical Committee on Green Communications and Computing (TCGCC), later jointly with the IEEE Technical Sub-Committee on Big Data (TSCBD), started an IEEE Access Special Section on Big Data for Green Communications and Computing.

These premises, provided by COPs21 and IEEE, represent, in our opinion, a serious factor for progress of green ICT, considering also the newest figures on ICT carbon footprint.

Recent estimations [4] show that *“projections show that by 2020 the global greenhouse gas emissions from ICT will double from today’s 2 percent to 4 percent”*

An other point of view [2], is almost “shocking”, as starting from the fact that ICT 2% carbon footprint is the same with the aviation industry case, but(citing Jaafar Elmirghani)

*“ICT is growing much faster than the aviation industry. Internet traffic is increasing 30 percent to 40 percent each year, Elmirghani points out, adding, **“If this rate continues and nothing is done, ICT in 10 years could consume about 60 percent of the world’s energy resources...** People are unaware that the carbon footprint of ICT is so large,” says IEEE Senior Member Jaafar Elmirghani (co-chair of the IEEE Green ICT initiative).*

Now it is more than clear that a greener ICT is a “zero degree” emergency, but what can be done is not a simple question.

As we concluded above, the essential is to start with a new approach of the ICT design policies and this opinion is confirmed by [4]:

“What’s needed is a complete rethinking of how to design, build, and use ICT. That’s the mission of the IEEE Green Information and Communication Technology initiative, launched in January 2015 by the IEEE Future Directions Committee”.

IEEE Communications Society has a leading role in the initiative, because its technical committees have been active in green ICT and it is collaborating with other 16 IEEE societies and with organizations including Bell Labs/Alcatel-Lucent (now part of Nokia), British Telecom, Ericsson Research, the University of Arizona, the University of Leeds and the University of Melbourne.

An **optimistic** point of view comes also from Jaafar Elmirghani[4]:

“With 40 percent annual traffic growth, if we are able to improve the energy efficiency of today’s networks by a factor of 1,000, then in 20 years they would consume the same amount of energy used today”.

Still, the initiative coordinated by Jaafar Elmirghani[2] proposed some concrete directions toward a greener ITC, as:

*„Identifying ways to help the telecom industry become more energy efficient.
Promoting uses of ICT that can make other industrial sectors greener, including manufacturing and transportation.
Working with ICT companies to develop standards for green technologies and for assessing the full environmental impact of their technologies during their life cycles”.*

Perhaps here is the point our section title is completely explained, as the “**road**” must be greener and smarter than “**machine**”, but we have to add the **pillar of ... IoT (aisberg)**.

In the above presented context, the IoT (aisberg) pillar is still simpler to explain, because its Earth scale proliferation, but not only!

To be more concrete, we have to observe that among the mentioned 3 main “technologies” (Cloud Computing, Big Data and IoT) IoT has a prominent position [7][10][13][19][15][14].

First of all and most important, IoT has a dramatic influence on both Big Data and Cloud Computing because as IoT is extending more and more, then more and more amount of data will be produced and ... processed!

We recall[3] that IoT will represent a huge “explosion” in all “directions” [6]: *as cows, water pipes, people, and even shoes, trees, and animals become connected to IoT, the world has the potential to become a better place ...With a trillion sensors embedded in the environment—all connected by computing systems, software, and services—it will be possible*

to hear the heartbeat of the Earth, impacting human interaction with the globe as profoundly as the Internet has revolutionized communication.”

A realistic picture of the impact over Earth carbon footprint, energy and resources could be estimated if we also recall that not later than in 2020 more than 30-50 billions (estimations varying) of connected (IoT) devices, with over 200 billion with intermittent connections, will be in use [9].

Finally we may now at least have a rough idea about what ICT could produce “**beyond**” IoT, but what we could expect to be left “**behind**” on Earth must be further analyzed.

2. Whatever humankind are innovating by ICT, behind every step there is a big “footprint” on Earth

Apparently the main idea of the first section, a greener development of ICT, is the essence of what we have to correct when rethinking the design of ICT products and services.

In fact, a stronger greener trend is only the first emergency of “drivers” on the ICT “philosophy” road.

For an accurate evaluation of the main factors influencing ICT and IS toward KBS we have repeatedly analyzed them [5][8], but a refined update is necessary, especially in the above presented complex context and emergency.

When we above have mentioned refined knowledge processes, it was the main idea of a more complex approach we already have presented [16] as mechanism of optimization of ITC/IS/KBS, but every new iteration must be carefully analyzed and ... refined.

Now we are facing such new iteration, generated by the accumulated challenges/emergencies, where climate changes are the most dramatic.

Optimizing a complex process needs a multi-criteria approach, so in this case we have to also consider Earth resources fading, the social unbalances, humankind life/work changing conditions and so on.

Our opinion, also repeatedly presented [3], is that ***the main source of incertitude and risk, complex and complicated mechanisms, is generated by the exponential speed of ICT development***. This opinion is largely confirmed [4][21][17][18], as “***annual growth in traffic doubles every two years***”.

The dramatic pace of changes ICT induce to all fields of activity in IS/KBS could determine unpredictable, or at least impossible to completely control, consequences for humankind life and Earth ecosystem.

The complexity and difficulty of the mentioned optimization, for the considered actual epoche of IoT, is well reflected and confirm our approach, if starting from [6] analysis:

“Individual data by itself is not very useful, but volumes of it can identify trends and patterns. This and other sources of information come together to form knowledge. In the simplest sense, knowledge is information of which someone is aware. Wisdom is then born from knowledge plus experience. While knowledge changes over time, wisdom is timeless, and it all begins with the acquisition of data. It is also important to note there is a direct correlation between the input (data) and output (wisdom). The more data that is created, the more knowledge and wisdom people can obtain. IoT dramatically increases the amount of data available for us to process. This, coupled with the Internet’s ability to communicate this data, will enable people to advance even further”.

Although apparently this opinions could simply mean that [6]“*Humans Turn Data into Wisdom*”, we want to suggest that behind the **optimistic** and positive conclusions we must notice 2 messages.

The positive one is that [6] confirms the essential role of knowledge for IS/KBS progress, although, for being realistic, at “*Wisdom is then born from knowledge plus experience*” we must add refined knowledge in order to accurately reveal the iterative (continuous) feature of the process which could offer updated solutions in ICT/IS/KBS dramatically changing processes at Earth scale.

On the other hand, we have to recall (because here is the place to be again partially relevant) the above quote [4] “*if we are able to improve the energy efficiency of today’s networks by a factor of 1,000, then in 20 years they would consume the same amount of energy used today*”. Then, remark the same lack of realism when in [6] we must suppose the “hope” that “*Individual data by itself is not very useful, **but volumes of it can identify trends and patterns**. This and other sources of information come together to form knowledge*”.

In fact we may consider this second message to be also positive, in part, because it points (unintentionally) where the problem is.

In a more concrete manner we must observe that, unfortunately, for instance it is not clear how to *improve the energy efficiency of today’s networks by a factor of 1,000* or how to **identify trends and patterns** if “Big Data” means that 90% of digital information is generated in the last 2 years (generated data is doubling every 2 years!).

Maybe the real dimension of the problem is more clear if we add other actual largely agreed figures: **90% of actual stored data are unstructured and the estimation for the amount of generated data in 2020 is of 44 zetta B!**

About the 90% unstructured of actual stored data, at recent “Dell (&Intel-Microsoft) Be / Future Ready / ’16 Bucharest Conference we have raised the issue of evaluating the expectations for technical solutions to reduce a part of 90% unstructured data, but beyond Business Intelligence commercial packages other performant and Big Data oriented new integrated models, algorithms and instruments are not visible yet.

With such premises we have to emphasize that these are only some aspects of the above mentioned IoT “aisberg”, but the scope is not to enlarge the analysis we already made on IoT issues [3].

We only want to point out that the long, complicate and difficult processes of developing IoT is a milestone for ICT/IS/KBS (called a new phase of Internet, 4-th industrial revolution etc.), where starting with the emergency of “greener ICT” we have to rethink all ICT design processes. Without approaching political issues, this moment of “greener ITC” and IoT building seems to be similar in significance with the recent BREXIT moment for EU strategies.

A concret, but simple approach of actual ITC priority/emergency is also expressed [4] as:

“Whatever is designed—whether it’s a communication system, a cloud system, a computer system, or if there’s an electron device, photonic device, or an antenna propagation project-it needs to be done with the environment in mind.”

Of course it is not simple to express what should be a not “simple” approach, but it is clear that the new “road” must be not only “greener”, but generally “smarter”, considering a larger set of criteria for optimization and above all more elaborated ICT development policies, in order to include refined knowledge from new relevant information (data).

Capitalizing the last analysis elements, the set of mentioned main criteria should include, by our opinion, relevant issues as:

- a. **Identifying incertitude/risk complex and complicated mechanisms, generated by the exponential speed of ICT development in IS/KBS and generally on Earth ecosystem;**
- b. **Developing greener ICT capable to induce greener solutions in all fields of activity;**

c. Designing new integrated models, algorithms and technologies for information analysis to cope with all consequences of IoT, Cloud computing, Big Data.

Although the associated order (a, b, c) is not random, the issues are not independent and the list is far to be complete, we only intended to suggest a systemic approach, considering the design and readiness order.

As a matter of fact, our main paper them, ***“beyond IoT”***, is a “cloud” of incertitude (i.e. difficult to predict) we have to ***“smarter”*** design, going through the main steps above suggested (a, b, c) - in the succession of iterations on “road” where every step must be carefully analyzed in advance aiming a minimal of consequences (***“behind”***) on its “footprint” on Earth.

Obviously, such analysis and evaluation processes are very difficult and complex (see point “a”) and (in a vicious circle) are depending on available instruments (see point “c”), but most of all are dramatically influenced also by ***humankind capacity and will to wisely ... innovate.***

Last, but not least, ***again and again we have to fight the main difficulties generated by the extreme speed of changes induced by ICT exponential pace of development, which create such complex consequences but does not allow humankind the necessary time to real time react.***

By our opinion, ***the immediate approach of this “impossible” mission should be twofold: rethink and adapt (slow) the ICT pace and on the other hand create the instruments (see point “c”) to help us find the balance between the designed ICT pace and the capacity to cope with it!***

These premises and ... other ***arguments are leading us to learn how to redesign our lives, ICT and ... Earth ecosystem, i.e. for this paper ... to be continued!***

3. Conclusions

The paper is approaching the systemic analysis of **a smart management of ICT/IS/KBS evolution, where the essential is to deeply analyze, update the solutions, refine knowledge and responsibly react to challenges/implications**, in order to correct the negative consequences of such complex and mass processes at Earth scale.

The analysis started from the actual stage of ICT development, dominated by Cloud Computing, Big Data and Internet of Things (IoT), considering the premises created by “COPs21” Paris Conference context including ICT latest figures on carbon footprint and IoT emergent expansion – which show that Internet traffic is increasing with 40% / year, which would lead, without appropriate measures, to the fact that ICT could consume in 10 years 60 percent of the Earth’s energy resources.

Facing these dramatic realities, our opinion is that **the actual “machine” trend, focussed on striving for performance, must be balanced by a greener approach aiming power efficiency and carbon footprint reduction.**

As consequence, **we have proposed a concrete approach based on 3 relevant issues as: Identifying incertitude/risk complex and complicated mechanisms, generated by the exponential speed of ICT development in IS/KBS and generally on Earth ecosystem; Developing greener ICT capable to induce greener solutions in all fields of activity; Designing new integrated models, algorithms and technologies for information analysis to cope with all consequences of IoT, Cloud computing, Big Data.**

Last but not least, **we consider a priority to fight the main difficulties generated by the extreme speed of changes induced by ICT exponential pace of development, which create such complex consequences but does not allow humankind the necessary time to**

real time react, with the immediate approach of this “impossible” mission as being twofold: rethink and adapt (slow) the ICT pace and on the other hand create the instruments to help us find the balance between the designed ICT pace and the capacity to cope with it!

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