

# Improving Information and Communication Technology to Innovate the Paradigms of World Progress

## -Part 3-



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### **Abstract**

The paper analyses the evolutions and the role of information and communication technology (ICT), as the most powerful instrument of spreading information/knowledge across the Earth, crucial in refining knowledge, in the actual World crises context. **Our opinion and intention are to leverage the perception of the continuously increasing importance and complexity, of using, or not, the right meanings of the fast changes of World, in order to determine, by individual and collective understanding, the new data/information potential implications, along with the necessary actions which could bring benefic results every day, providing the sustainable progress and eventually saving the life on Earth.**

One of the most relevant examples of the ICT mentioned potential is actually given by its implementation in the evolution of 5G mobile communication systems [1], apparently just mobile telephony, but now offering a plethora of services which globally also spread knowledge. Among 5G new challenges, some issues remain to be approached and solved, with direct impact on security issues, where we notice the vulnerabilities in software components and virtualized network functions, along with user privacy, environmental sustainability, interoperability or cyber threats. To address these challenges and more, the technical solutions should include some complicate innovations and processes (like energy optimization, scalability and flexibility, single-channel utilization for both uplink and downlink, handling interference, environmental sustainability, low latency, high reliability, network performance optimization, economic impacts, high mobility, handover, and self-healing infrastructures). In this new World context, telco could use the last advances of AI to mitigate, at least some of the emergent operational challenges, as confirmed in another analysed example from [2]. A more detailed analysis of sustainably using AI for telcos actual innovations/development challenges, based on the relevant example from [4], showed that these should be approached by scaling AI implementation in a step-by-step process.

In the Data Deluge we live in, **we consider that its holistic approach is also mandatory**, as it is already confirmed by [5], where we meet the fourth paradigm of science, i.e., **the actual reality we have to understand and promote, if we want to globally and plenty benefit from the huge potential the humankind history achieved, especially recently.** Analysing the safety and sustainability of ICT innovations/development, we approached autonomous systems (ASs), along with AI/ICT and HI synergy, as it is also presented, in details by [7]. We concluded that AS analysis has to be considered in the World larger context (beyond cars etc), as, by the new safety-related systems we have to eventually see in both space and time, what our **Earth will become, a place crowded by (automated) critical infrastructures, systems and devices, ruled by ICT, where individuals lives and Planet future are more and more depended of reliability and hazard.** For these AS crucial decision processes where ICT advances are deeply implied and ask knowledge refining, the above aspects and premises are just

*the entry levels or tips of the iceberg which we should consider for innovation and sustainable World progress and consequently need further and timely analyses, on diverse planes and criteria.*

**Keywords:** 5G networks, fourth paradigm of science, telco, safety of autonomous systems, safety-related systems, data science, artificial intelligence, knowledge refining

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

*“Intelligence sees things as they are; wisdom sees things as they should be”  
- Matshona Dhliwayo*

## **1. Telecommunications will still advance, but they have to continuously innovate**

Observing the continuous changes of World everywhere, sometimes we could ask if it is better to ignore what we see around, as being “blind” we lose not only what we miss to see, but mainly what this could change in our lives.

Of course, from here to our repeatedly mentioned necessity of knowledge refining is an interesting road we have to travel every day, but the actual Earth dramatic realities show undoubtedly that these daily roads are more and more complex and difficult to find their right tracks [11][14].

From the beginning, it is crucial to point that the complexity and importance of knowledge refining, at individual and community/organization levels, are not given only by the actual World crises context, where we should include at least main combined sources of crises, considering first the global warming (climate changes), Earth resources fading, geopolitical conflicts or social unbalances, but also by **the logical necessity to use every time updated data/information, after a refining analysis of the contain and time sensitive implications.**

In fact, the whole history and evolution of humankind is linked with learning and using knowledge for sooner or later progress and that is why a more comprehensive analysis of knowledge refining concept should be further/eventually re-opened, along with relevant references which could distinguish the artificial intelligence (AI), machine learning (ML) and technological issues of refining knowledge from large sets of data, versus the human level of refining knowledge we usually proposed [3].

**Still, our opinion and intention are to leverage the perception of the continuously increasing importance and complexity, with dramatical consequences, of using, or not, the right and practical meanings of the fast changes of our World, in order to determine, by individual and collective understanding, new data/information potential implications, along with the necessary actions which could bring benefic results every day, providing the sustainable progress and eventually saving the life on Earth.**

In this context, naturally, we often emphasised the huge role of information and communication technology (ICT) for Information Society (IS) on the way towards the Knowledge Based Society (KBS), due to its systemic influence at Earth scale, based on the unprecedented fast proliferation of its products, applications and services [10] [12] [15] [20] [22].

In addition, also by communications means or IT applications, ICT became obviously the most powerful instrument of spreading information/knowledge across the World, but their importance in refining knowledge, in this fast-changing context, is now more than a leveraging factor, as the combination of AI and human intelligence is one of the essential keys for ICT and World sustainable progress, as we have already presented [9] [19] [23] [6] [25].

Perhaps, one of the most relevant examples of the ICT mentioned potential is actually given by its implementation in the evolution of mobile communication systems, which

apparently started by aiming the mobile telephony, but now it is offering a plethora of services which globally also spread knowledge [28].

This way, the mobile communications challenges and innovations/solutions continue to provide useful models for World progress, even in these fast and unpredictable changes of Earth environment, as in the next relevant example is detailed presented [1]:

*“Key findings highlight 5G's transformative capacities, spanning unparalleled data transfer speeds, low-latency communication, and applications like IoT, augmented reality, and autonomous vehicles. The study underscores 5G's far-reaching impact across various sectors. Serving as both a retrospective analysis and a valuable resource, the survey guides researchers, industry professionals, and policymakers through the intricate landscape of 5G technology. Addressing the imperative of accommodating increasing mobile data traffic, the 5G network strives for improved spectrum utilization, energy efficiency, and QoS parameters. Notable innovations include Massive MIMO, promising high spectral efficiency. The focus on efficacy, accuracy, and channel estimation techniques is evident.”*

Along with the high aims of unprecedented capacities and speeds, 5G also realized amazing advances in energy efficiency and spectrum use, i.e., some of the most wanted resources, providing this way benefic premises for other ICT areas and also for the future networks, beyond 5G (B5G):

*“The advent of 5G emerges as a pivotal solution, aiming for a 1000-fold capacity gain and assuring quality-of-service, higher spectral efficiency, ultra-reliable communication, and facilitating massive machine-type communication. Challenges in traffic load and resource consumption necessitate innovative approaches. The research reviews emerging wireless technologies, including an analysis of Massive MIMO as an efficient solution, ... a valuable resource, contributing to the seamless development of state-of-the-art 5G and B5G networks, recognizing the importance of continued research and innovation in the dynamic landscape of mobile communication technologies. “*

Still, irrespective the highest achievements, old and especially new challenges, given by World mentioned crises, remain to be approached and solved, as one of the increasing complexity and versatility consequences, with direct impact on security issues:

*“The deployment of 5G technology heralds a new era of connectivity and innovation, yet it is not without its challenges and concerns. This exploration delves into the potential obstacles associated with the widespread adoption of 5G, with a focus on security, privacy, and infrastructure considerations...The complexity of 5G network architecture introduces cybersecurity risks, given the increased number of connected devices and integration of IoT. The expanded attack surface necessitates fortified security measures against potential cyber threats. Vulnerabilities in software components and virtualized network functions pose additional risks, demanding the critical maintenance of their integrity. The global nature of the 5G supply chain raises concerns about the security of equipment and infrastructure, emphasizing the need to address compromised hardware or software components.”*

Democratic rights could also be affected, when connectivity and ubiquitous access to data generated all over the Earth have now opportunities and communications means to be used by billions of individuals with unprecedented speeds on diverse mobile or fixed devices:

*“The proliferation of connected devices generates vast amounts of data in a 5G ecosystem, raising concerns about data collection and potential misuse. Striking a balance between utilizing data for network optimization and safeguarding user privacy becomes a critical challenge. Seamless connectivity and device mobility raise worries about user tracking, necessitating robust privacy policies and regulations to protect individuals from unwarranted surveillance...The deployment of 5G infrastructure, including small cell installation and existing network upgrades, comes with significant costs. Service providers and governments grapple with the challenge of funding and managing the financial burden associated with the*

*extensive rollout of 5G networks. Regulatory hurdles, encompassing various requirements, zoning regulations, and environmental considerations, add complexity to the deployment process, requiring navigation through a multifaceted regulatory landscape.”*

Proliferation of mobile connectivity, anywhere over the Earth, naturally could not be supported without an increased international collaboration, provided mainly by the more complex processes of standardization:

*“Ensuring interoperability between different 5G networks and technologies is crucial for global connectivity. The absence of standardized protocols and collaboration among countries and telecommunications companies can lead to interoperability challenges, hindering the seamless integration of 5G services globally...To address these challenges, robust cybersecurity measures are essential, including encryption, secure authentication, and continuous monitoring. Privacy considerations should be integrated into the development of 5G networks from the outset, employing anonymization techniques and providing users with transparent control over their data. Continued investment in research and development is necessary to overcome infrastructure challenges, explore innovative funding models, and streamline.”*

Finally, to address these challenges and more, the technical innovations and processes should include some complicate issues, which sometimes suppose improvement on old networks or systems, but inherent new requirements should be also fulfilled:

*“Achieving the vision of 5G networks poses several challenges. These include the expansion of data rates and network capacity with energy optimization, scalability and flexibility, single-channel utilization for both uplink and downlink, handling interference, environmental sustainability, low latency, high reliability, network performance optimization, economic impacts, high mobility, handover, and self-healing infrastructures. In conclusion, while the deployment of 5G promises a revolution in communication and connectivity, it is essential to address and mitigate the challenges associated with its implementation. Proactive measures in cybersecurity, privacy, infrastructure, and international collaboration can pave the way for a secure, efficient, and globally interconnected 5G ecosystem.”*

It is clear that the amazing benefits of 5G will come with inherent challenges, confirming a prominent feature of ICT general development, we also emphasised [21], i.e., its progress becomes more complex and difficult as the reached performances become higher.

This way, the necessity of innovation is also a perpetual feature of ICT, but in this context, telco could use the last advances of AI to mitigate, at least some of the mentioned or emergent operational challenges, as confirmed in [2]:

*“Solutions that enable advanced retail experiences, smarter scheduling, self-healing and better coaching can reduce complexity, lower costs, and make both customers and employees happier...Field and service operations account for 60 to 70 percent of most telcos’ operating budgets, so applying AI can offer real and rapid benefits. The industry has already faced a decade-plus of increasing cost pressure, and the returns on necessary infrastructure investments are barely outpacing the cost of capital.”*

Here we have to notice that not only the actual World crises are relevant, but, as we already presented, [9][11], the causes and solutions for the actual challenges should be analysed considering also their past evolutions (a decade-plus), where the problems have been sometimes accumulated and now, they require consistent actions:

*“Telcos that are just getting started with AI to support their service operations or are thinking about doing so would benefit from considering some best practices already battle-tested by the front-runners, including the following actions:*

*Identify the top use cases for AI for each business unit and its relevant service operations journeys—call centers, retail, and in-store uses, or field operations, for example—based on the most critical gaps or pain points.*

*Then run a prioritization exercise to rank the opportunities and use cases according to feasibility, impact, and ease of implementation.*

*Determine the availability of data for each use case being considered and create a road map for the data asset build that will be needed to enable it.”*

Although, in this case, it is not intended to enter technical details, perhaps naturally when operational issues are prominent, the focus is on efficiently approaching the AI implementation for such areas of use, in order to provide all the necessary data, *prioritization* being important for maximizing the improvement impact, considering the appropriate conditions for AI/ML and the collaboration AI and human intelligence (HI):

*„Building minimum viable products through dedicated sprints and scaling up based on a continuous learning approach will help ensure strong outcomes. Set up teams in AI pods that incorporate both technical talent as well as business leads and subject-matter experts, depending on the use case. Working jointly, these cross-functional experts develop and test the AI use cases and solutions...Although telco operators continue to face formidable headwinds, artificial intelligence can help mitigate them, with service ops a particularly ripe opportunity. The ubiquity of technology and the growing application of AI and ML in particular are enabling a new wave of growth and disruption. Telcos that take this opportunity to continue to innovate on this path are more likely to emerge as the undisputed leaders in the long run.”*

A more detailed approach of sustainably using AI for telcos actual innovations/development challenges, in the dynamic and adversarial context of World crises (turbulent times), is also presented by a relevant example, in [4]:

*“Given the numerous challenges the telecom industry has faced in recent years, such as flagging revenues and ROIC, one might expect the industry would have already adopted a full transition to this technology. Yet, based on our experience with operators across the world, telcos have yet to fully embrace AI and an AI-focused mindset. Instead, models are developed once and not enhanced as the business context evolves. Machine learning (ML) is in name only, limiting the ability of the system to improve from experience. Most regrettably, AI investments are often not aligned with top-level management priorities; lacking that sponsorship, AI deployments stall, investment in technical talent withers, and the technology remains immature.”*

Pointing also the AI investment efficiency, a further approach is detailed on *scaling AI* implementation in a step-by-step process, measuring the impact of technology use and then act:

*“Here, AI is viewed as a core competency that powers decision making across all departments and organization layers...Reaching this state of AI maturity is no easy task, but it is certainly within the reach of telcos. Indeed, with all the pressures they face, embracing largescale deployment of AI and transitioning to being AI-native organizations could be key to driving growth and renewal. Telcos that are starting to recognize this is non negotiable are scaling AI investments as the business impact generated by the technology materializes.”*

As a concrete support for AI business embrace, its increasing accessibility is illustrated by factors to reduce the cost and ease the transition to a large use in telcos, where dropping costs of data processing and storage and of *Application Programming Interfaces (API)* are prominent priorities:

*“Some prominent factors could support the transition of AI potential to real, sustainable, at-scale success, are further considered - Increasing accessibility of leading AI technology: AI-native organizations like Meta continue to grow the open-source ecosystem by making new programming languages, data sets, and algorithms widely available. In parallel, cloud providers have developed multiple quick-to deploy machine-learning APIs like Google Cloud’s Natural Language API. Generative AI solutions, such as ChatGPT, that are capable of creating engaging responses to human queries are also accessible through API. These two*

*factors, coupled with dropping costs of data processing and storage, make AI increasingly easier for organizations to leverage.”*

As AI is far from being the universal solution or source of innovation, **the telco struggle for sustainable progress, to fulfill its crucial role in the IS/KBS and along with World unprecedented crises, is a continuous race and the solutions have to include changes of approach or even paradigms, using, along with AI and other ICT advances, the unlimited potential of creation/imagination of humans.**

## **2. Using ICT advances for building the future World with more safety and sustainability**

One of the conclusions of the above analysis is that the complexity and difficulty of finding solutions for the World crises emergent context eventually lead to new approaches and paradigms.

As data science is obviously a necessity, in the Data Deluge we live in, **we consider that its holistic approach is also mandatory**, as it is already confirmed by [5], where we meet *the fourth paradigm* of science, i.e., **the actual reality we have to understand and promote, if we want to globally and plenty benefit from the huge potential the humankind history achieved, especially recently:**

“Science Paradigms

- Thousand years ago: science was empirical describing natural phenomena
- Last few hundred years: theoretical branch using models, generalizations
- Last few decades: a computational branch simulating complex phenomena
- Today: data exploration (eScience) unifying theory, experiment and simulation
  - Data captured by instruments or generated by simulator
  - Processed by software
  - Information/knowledge stored in computer
  - Scientist analyses database/files using data management and statistics

After the long phases of experiments and theories for scientific explorations, we witnessed, in only decades, a revolutionary evolution of science, based on ICT fast advances, where humans’ activities and “machines”, supported by computers, communications and sensors, provide huge data volumes:

<<...simulations are generating a whole lot of data, along with a huge increase in data from the experimental sciences. People now do not actually look through telescopes. Instead, they are “looking” through large-scale, complex instruments which relay data to datacenters, and only then do they look at the information on their computers.>>

Exploiting the potential of the preceding phases, the actual era of science met the dimensions and complexity of a new model and dynamic process, naturally called *the fourth paradigm for scientific exploration*:

*“The world of science has changed, and there is no question about this. The new model is for the data to be captured by instruments or generated by simulations before being processed by software and for the resulting information or knowledge to be stored in computers. Scientists only get to look at their data fairly late in this pipeline. The techniques and technologies for such data-intensive science are so different that it is worth distinguishing data-intensive science from computational science as a new, fourth paradigm for scientific exploration [1].”*

The relevance of *the fourth paradigm for scientific exploration*, for the analysed ICT/World context, is given by its huge potential to optimize the complex, complicate and extremely difficult problems of Earth and humankind, in reasonable time, implying/leveraging

both AI and human intelligence (HI), across the entire ensemble of scientific disciplines and technologies:

*“... helping to refine an understanding of this new paradigm from a variety of disciplinary perspectives. In many instances, science is lagging behind the commercial world in the ability to infer meaning from data and take action based on that meaning. However, commerce is comparatively simple: things that can be described by a few numbers or a name are manufactured and then bought and sold. Scientific disciplines cannot easily be encapsulated in a few understandable numbers and names, and most scientific data does not have a high enough economic value to fuel more rapid development of scientific discovery.”*

**It is important to observe, here too, the essential role and meaning of refining (knowledge), we have pointed many times as mandatory approach and action, wide World, in order to maximize the chances of finding sustainable solutions for the Earth and humankind unprecedented challenges/crises.**

In the actual World context, ICT has to leverage, among other areas of processes, the necessary **refining of knowledge**, where individuals and organizations are implied, in order to optimize the transition to new technologies and businesses generated by development or crises. Among these, the people's safety/privacy or Earth environment protection are very relevant.

From a practical point of view, the safety and sustainability of ICT innovations/development could be examples of particular approach, although they have to be ubiquitous just like ICT products and services, along with AI/ICT and HI synergy, as it is also presented, in details, by [7]:

*“Autonomy does not subvert existing safety processes, but they must be supplemented with methods that address autonomy's challenges, especially where perception and decision-making tasks are implemented with machine learning. We present an approach to address the safety of autonomous systems, building on and complementing established safety engineering methods. Traditionally, safety-related systems, like aircraft, cars, and factory robots, have operated under human control or supervision. With autonomous systems (ASs), the role of the human is lessened—perhaps just to the extent of initiating autonomous operation: An AS can operate independently of human control.”*

It is important to note that AS analysis has to be considered in the World larger context (beyond cars...), as, by the new safety-related systems we have to eventually see in both space and time, what our Earth will become, a place crowded by (automated) critical infrastructures, systems and devices, ruled by ICT, where individuals lives and Planet future are more and more depended of reliability and hazard, compared with the past:

*“Although safety-critical, such systems operate within well-defined and, to an extent, controlled environments; for example, there are physical controls on human access to the tracks, and traffic movement is controlled through a signalling system. The introduction of such ASs has been successful, and they have good safety records. By contrast, emerging ASs, such as autonomous vehicles (AVs) on the roads or collaborative robots (called cobots) in factories, operate in significantly more challenging environments.”*

What we have here is to observe that, along with known safety-critical systems, we have to consider the harder challenges/concerns about the new technology advances, which rise higher risks just because they are more complex and independent/autonomous of human decisions:

*<<Humans are generally good at dealing with open-domain and partially defined goals, such as driving from York to London, and will “fill in” the necessary details on the way. In developing an AS, decisions on such details are being transferred from human to machine: computers are used to realize capabilities that humans have undertaken hitherto. Thus, from a safety perspective, the most fundamental challenge in assessing and assuring ASs is dealing*

*with decision making by a machine that does not have the contextual and semantic “understanding” of the world that humans have (both taught and learned as we grow up).>>*

It is worth to notice that, before going further to concrete solutions, we have to keep in mind the systemic aspects, we also presented [27], concerning the importance of synergy between AI and HI, including the appropriate/dynamic levels of knowledge refining and semantic issues [8][18][24][26].

**As a conclusion, for these crucial decision processes where ICT advances are deeply implied and ask knowledge refining, the above aspects and premises are just the entry levels or tips of the iceberg which we should consider for innovation and sustainable World progress and consequently need further and timely analyses, on diverse planes and criteria.**

### 3. Conclusions

The necessity of knowledge refining is determined by the actual Earth dramatic realities and challenges, which are more and more complex and difficult to approach, but it is crucial to point that the complexity and importance of knowledge refining, at individual and community/organization levels, are not given only by the actual World crises context, where we should include at least main combined causes of crises, considering first the global warming (climate changes), Earth resources fading, geopolitical conflicts or social unbalances, but also by **the logical necessity to use every time updated data/information, after a refining analysis of the contain and time sensitive implications.**

In fact, the whole history and evolution of humankind is linked with learning and using knowledge for sooner or later progress and that is why a more comprehensive analysis of knowledge refining concept should be further/eventually re-opened, along with relevant references which could distinguish the artificial intelligence (AI), machine learning (ML) and technological issues of refining knowledge from large sets of data, versus the human level of refining knowledge we usually proposed [3]. Consequently, **our opinion and intention are to leverage the perception of the continuously increasing importance and complexity, with dramatical consequences, of using, or not, the right and practical meanings of the fast changes of our World, in order to determine, by individual and collective understanding, the new data/information potential implications, along with the necessary actions which could bring benefic results every day, providing the sustainable progress and eventually saving the life on Earth.** We also emphasised the huge role of information and communication technology (ICT) for Information Society (IS) on the way towards the Knowledge Based Society (KBS), due to its systemic influence at Earth scale, based on the unprecedented fast proliferation of its products, applications and services [10] [12] [15] [20] [22].

By communications means or IT applications, ICT became the most powerful instrument of spreading information/knowledge across the World, but their importance in refining knowledge, in this fast-changing context, is now more than a leveraging factor, as the combination of AI and human intelligence is one of the essential keys for ICT and World sustainable progress, as we have already presented [9][19][23][6][25]. One of the most relevant examples of the ICT mentioned potential is actually given by its implementation in the evolution of mobile communication systems, which apparently started by aiming the mobile telephony, but now it is offering a plethora of services which globally also spread knowledge [28].

As the mobile communications challenges and innovations/solutions continue to provide useful models for World progress, even in these fast and unpredictable changes of Earth environment, we have analysed the relevant example of 5G [1], where, along with the high aims of unprecedented capacities and speeds, the 5G project/standard also realized

amazing advances in energy efficiency and spectrum use, i.e., some of the most wanted resources, providing this way benefic premises for other ICT areas and also for the future networks, beyond 5G (B5G). Among the new challenges, partially given by World mentioned crises, some issues remain to be approached and solved, as part of the increasing complexity and versatility consequences, with direct impact on security issues, where we notice the *vulnerabilities in software components and virtualized network functions, along with user privacy, environmental sustainability, interoperability or cyber threats*. To address these challenges and more, the technical solutions should include some complicate innovations and processes (like *energy optimization, scalability and flexibility, single-channel utilization for both uplink and downlink, handling interference, environmental sustainability, low latency, high reliability, network performance optimization, economic impacts, high mobility, handover, and self-healing infrastructures*), which sometimes suppose improvement on old networks or systems, but inherent new requirements should be also fulfilled.

As the necessity of innovation is also a perpetual feature of ICT, in this new World context, telco could use the last advances of AI to mitigate, at least some of the mentioned or emergent operational challenges, as confirmed in another analysed example from [2]. Here we conclude that not only the actual World crises are relevant, but, as we already presented [9][11], the causes and solutions for the actual challenges should be analysed considering also their past evolutions (*a decade-plus*), where the problems have been sometimes accumulated and now, they require consistent actions. The focus is on efficiently approaching the AI implementation for such areas of use, in order to provide all the necessary data, *prioritization* being important for maximizing the improvement impact, considering the appropriate conditions for AI/ML and the collaboration AI and human intelligence (HI).

A more detailed analysis of sustainably using AI for telcos actual innovations/development challenges, in the dynamic and adversarial context of World crises (*turbulent times*), based on the relevant example from [4], showed that, for the AI investment efficiency, a further solution could be approached by *scaling AI* implementation in a step by step process, measuring the impact of technology use and then act, where dropping costs of data processing and storage and of *Application Programming Interfaces* (API) are prominent priorities.

As AI is far from being the universal solution or source of innovation, **the telco struggle for sustainable progress, to fulfill its crucial role in the IS/KBS and along with World unprecedented crises, is a continuous race and the solutions have to include changes of approach or even paradigms, using, along with AI and other ICT advances, the unlimited potential of creation/imagination of humans.**

Because data science is obviously a necessity, in the Data Deluge we live in, **we consider that its holistic approach is also mandatory**, as it is already confirmed by [5], where we meet the *fourth paradigm* of science, i.e., **the actual reality we have to understand and promote, if we want to globally and plenty benefit from the huge potential the humankind history achieved, especially recently**. After the long phases of experiments and theories for scientific explorations, we witnessed, in only decades, a revolutionary evolution of science, based on ICT fast advances, where humans' activities and "machines", supported by computers, communications and sensors, provide huge data volumes, as the actual era of science met the dimensions and complexity of a new model and dynamic process, naturally called *the fourth paradigm for scientific exploration*.

The relevance of *the fourth paradigm for scientific exploration*, for the analysed ICT/World context, is given by its huge potential to optimize the complex, complicate and extremely difficult problems of Earth and humankind, in reasonable time, implying/leveraging both AI and human intelligence (HI), across the entire ensemble of scientific disciplines and technologies. **It is important to observe, here too, the essential role and meaning of refining**

(knowledge), we have pointed many times as mandatory approach and action, wide World, in order to maximize the chances of finding sustainable solutions for the Earth and humankind unprecedented challenges/crises. In the actual World context, ICT has to leverage, among other areas of processes, the necessary *refining of knowledge*, where individuals and organizations are implied, in order to optimize the transition to new technologies and businesses generated by development or crises. Among these, the people's safety/privacy or Earth environment protection are very relevant.

Analysing the safety and sustainability of ICT innovations/development, we approached *autonomous systems (ASs)*, along with AI/ICT and HI synergy, as it is also presented, in details, by [7]. We conclude that AS analysis has to be considered in the World larger context (beyond *cars...*), as, by the new *safety-related systems* we have to eventually see in both space and time, what our Earth will become, a place crowded by (automated) critical infrastructures, systems and devices, ruled by ICT, where individuals lives and Planet future are more and more depended of reliability and hazard, compared with the past. We noticed that, before going further to concrete solutions, we have to keep in mind the systemic aspects, we also presented [27], concerning the importance of synergy between AI and HI, including the appropriate/dynamic levels of knowledge refining and semantic issues [8][18][24][26].

**As a final conclusion, for these AS crucial decision processes where ICT advances are deeply implied and ask knowledge refining, the above aspects and premises are just the entry levels or tips of the iceberg which we should consider for innovation and sustainable World progress and consequently need further and timely analyses, on diverse planes and criteria.**

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