Internet of the Future Non-Engineering Challenges

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***Abstract*—The Internet of the Future is a fascinating theme from the point of view of both engineering and education as well. Terms like pervasive, ubiquitous have become known for a growing number of digital *netizens* due to the presence of Internet in our daily lives. Quality of Service (QoS) and Quality of Experience (QoE) have become the buzzwords in the network engineering community. However, we dare to say that the engineering challenges faced by the Internet of the Future are *easy*. They are easy by the single reason that we know what is at stake. So, in this paper we address the challenges of the Internet of the Future from the perspective of the Systems Engineering analyzing it as a socio-technical complex and from the perspective of the Iconomics considering the beings, things and icons vertices.**

I. Introduction

The Internet of the Future is a fascinating theme from the point of view of both engineering and education as well. Terms like pervasive, ubiquitous have become known for a growing number of digital *netizens* due to the presence of Internet in our daily lives. Quality of Service (QoS) and Quality of Experience (QoE) have become the buzzwords in the network engineering community. However, we dare to say that the engineering challenges faced by the Internet of the Future are *easy*. They are easy by the single reason that we know what is at stake.

The Internet of the Future engineering challenges may be summarized in obtaining the best transmission quality between any set of end-users. This problem may be *easily* solved by laying a *perfect* wire between any pair of communicating users. *Perfect* is to be understood as a transmission mean where:

i) the delay would be zero;
ii) the signal attenuation would be zero;
iii) the noise influence would be zero;
iv) the signal distortion would be zero.

Despite of knowing that there is no solution for such problem, first of all because the speed of light, thanks to Einstein, is limited to $c = 300,000 \, \frac{km}{s}$, second, it does not exist such *perfect* wire and, last but not least, it is not neither economically nor environmentally feasible to lay a wire between any pair of communicating users, on the other hand, assuming such hypothetical solution we know what is the best quality that could be achieved and this is the direction that the engineering efforts should follow, trying to get closer to this ideal level of performance. In short, *engineering knows where to go*.

However, does anyone know, in what is Internet related:

- what is its economic value?
- what should be the rules governing access, exploitation, intellectual property rights, content distribution?
- how do people represent and communicate values and expectations associated to Internet related actions, projects and technologies?

Conceptually, the challenges of network design and implementation (“social weaving”, so to speak, as in assemblages and re-assemblages of actor-networks) are compounded by the simultaneous interaction of space, time and symbol - the playful evolution of this human e-infrastructure corresponds with values, projects and icons for the audiovisual e-superstructural grids.

The contribution of this paper consists on analyzing the challenges of the Internet of the Future from the perspective of the Systems Engineering looking at it as a socio-technical complex and from the perspective of *Iconomics*.

Iconomics relies on the triad: icons, things and beings, meaning that the actors will benefit from this new era if they are able to make appropriations in all three dimensions.

Iconomic appropriation depends on the symbolization process that, in the present context, has to be performed in the realm of groups and networks.

After this brief Introduction, in Section II we present a review of recently published conclusions about the non-engineering challenges of the Future Internet. In Section III we discuss the Internet of the Future from the perspective of the System Engineering and in Section IV from the perspective of *Iconomics*. Section V summarizes our conclusions and indicates some future work.

II. A review of the recognized non-engineering challenges of the Future Internet

This section presents a brief review of recognized non-engineering challenges of the Future Internet based, mainly, on three recent publications: [1], [2] and [3].

A. Future Internet Socio-Economics - Challenges and Perspectives

According to [1], socio-economics aims to understand the interplay between the society, economy, markets, institutions, self-interest, and moral commitments. It is a multi-disciplinary field using methods from economics, psychology, sociology, history, and even anthropology. Socio-economics of networks have been studied for over 30 years, but mostly in the context of social networks instead of the underlying communication networks.

Over the past decades, the Internet has grown and evolved to unprecedented size. However, its architecture is still based on the original design principles for an academic network in a “friendly” environment. In addition to the academic usage, the Internet is now used as a business platform and has become a central part of social life.

The overall socio-economic context is an important one, as it can significantly boost or hamper the success of an innovation - issues include the "degree of mobility" in the life-style, the balance of "privacy vs. sharing", the need for security, the importance ascribed to health, and the distribution of wealth. Important socio-economic aspects include markets of Internet Service Providers (ISPs) and Telecommunication Providers, ISP peering agreements and/or transit contracts, as well as customer usage behaviors and selections of content. A study of all these aspects has to include investigations of regulations for the e-services market and security regulations, as well as the physical environment of e-services in terms of availability - world-wide vs. highly focused (cities) - and dependability for commercial services. This approach will enable to determine (if possible) the economic growth, providers' revenue maximization, and customers' benefits.

Socio-economics challenges can be identified in all domains of the Future Internet including the areas of networks, services, and content. As far as the economic challenge faced by all three areas it is worth mentioning that the rules applied for sharing are extremely vital for the healthy operation of the Internet ecosystem and directly affect the value of the network to its users. Such challenges can only be addressed by merging the disciplines of computer science and economics. The key question is: what is wrong with today's Internet sharing technologies? Are these consistent with economics? More specifically, since TCP is the dominant sharing technology, is TCP sensible from an economic point of view? Is deep packet inspection (DPI) technology good or bad for the Internet community? Which network sharing technologies justify the end-to-end (E2E) paradigm from an economics perspective? What is required to make peer-to-peer (P2P) a blessing instead of a curse? Are there bad applications or just inefficient combinations of sharing technologies and pricing schemes? [1]

Besides the economic dimension, the Internet faces an important social challenge. The current Internet penetration has reached 20% worldwide and should reach 30% by 2015 and 50% by 2020. The Future Internet shall be able to support daily life in developed countries as well as within developing countries. Telecommunication infrastructures must be conceived to guarantee access to the Future Internet also where currently it is poor. As mobile, wireless, optical, and broadband communication infrastructures become even bigger and more interdependent, the number of Web services is expected to grow exponentially in the years to come. These trends lead to a future Internet of billions of services in a network of equals - large enterprises, small and medium enterprises (SMEs), and citizens - in which these services will be indistinctly produced or consumed by "prosumers".

In this new context *trust* will become a major issue and Web 2.0 technologies are already starting to support trust and reputation within and between computers and humans.

A critical issue in the Future Internet research is the current proliferation of separate efforts due to the various initiatives world-wide. This may on one hand be good for innovation, as it can produce more ideas. However, if initiatives remain separate throughout the development of the Future Internet, many technologically incompatible Internets could emerge. In contrast to the current global Internet, these separate Internets could cause market fragmentation and even social seclusion. To avoid such adverse possibilities, design and implementation of the global Future Internet should proceed with a growing degree of cooperation between initiatives. The mere separation of Future Internet initiatives, if left unchecked, could become a schism leading to many incompatible Future Internets.

B. Challenges of Internet Evolution: Attitude and Technology

Another dimension can be added to the challenges of Internet evolution. This new dimension is the *attitude* towards new technologies. In [2], the author states that according to economic theory, in a competitive environment with limited resources, rational species' behaviors change so that individuals can maximize a utility function that depends on these resources and on the satisfaction of their needs. The behaviors of rational individuals are constrained by their attitudes. *Attitude* is understood as the disposition, tendency or orientation of mind with regard to a thing, particularly with regard to technology. These attitudes determine the range of behaviors that are valid according to mental disposition. To let a wider range of behaviors be assessed by a rational individual, a change in attitude towards the elements of reality involved in the satisfaction of their needs is needed. There is a limit at which better behaviors cannot be enabled by any new technology, because they cannot be conceived according to existing attitudes. At this limit, the only way to achieve better performance in a competitive environment is a change in attitudes. When the attitudes involved in the satisfaction of needs evolve, new behaviors are considered and consequently new technologies that enable these new behaviors can be developed.

The foundations of this simple co-evolution model are that attitudes demand new technologies to improve the satisfaction of needs and, reciprocally, the new technologies enable the improvements allowed by new attitudes.

Internet is a tool involving technologies that is used by users to satisfy their needs according to their attitudes. This tool has another two characteristics that determine the need to complete this model with two more requirements. These characteristics are: (1) Internet locates at multiple locations both geographically and within society and (2) Internet has no single ownership. According to the two Internet characteristics, two requirements [4] exist for changes on attitudes and technologies to be adopted by Internet. (1) Universality: new technology can be used and new attitudes can be adopted by any user anywhere; and (2) Independency: new technology can be used and new attitudes can be adopted by some users even if others do not use or adopt them, i.e., there is no need to orchestrate change.

The Internet evolution model is completed by two fundamental characteristics: creativity and economic feasibility. The first one must be present whenever a change occurs intentionally. Unless it is a hazardous change, creative minds conceive changes out of their knowledge and experience. The second one is necessary so that evolution is possible, according to economy, in a context of competition for scarce resources, i.e., so that the underlying agents of evolution have the economic capabilities to invest on new technologies and adopt new attitudes obtaining a benefit out of them. Therefore, creativity, economic feasibility, universality and independency are necessary requirements for the co-evolution explained before to be realized. They ensure that changes will occur, that they will be financed, that they will not be reduced to a specific community and that they have the potential to be virally spread through the Internet.

In terms of goals, there are two interests using the Internet: interests of individuals and interests of organizations. Both individuals and organizations use the Internet to satisfy their needs. But in recent times, and particularly during the evolution of the web towards the web 2.0 [5], individuals prove to obtain far more benefits than organizations do. Blogs, wikis, social networks, file sharing, podcasts, online applications and other Internet progresses help individuals to innovate in satisfying their needs more efficiently; accordingly, the success of these new technologies and behaviors coalesces into their increasing number of users [6]. Furthermore, it is widely admitted that these new technologies have co-evolved together with attitudes [5]. Among others, the main components of this shift in the attitude of individuals are: participation, collaboration, confidence and sharing.

This success does not seem to spread likewise through enterprises. Although companies are introduced to web 2.0, not all of them manage to find its benefits. Sometimes, they even abandon these incipient tools, because they do not always turn out to be representing a greater value for their businesses. It is recognized that certain organizations are undeniably profitable thanks to new Internet technologies, but this benefit tends to focus on the tertiary technological sector, rather than pervasively spread through every sector of economy including the primary and secondary sectors. The problem is that societal evolution of new economic sectors fundamentally relies on higher productivity rates in the primary and secondary sectors. As the performance and competitiveness of these organizations are not strongly favored by current Internet trends, thus, the economic capabilities required to ensure the economic feasibility of investments in new Internet technologies and attitudes are limited.

It seems reasonable that a solution consists of promoting innovative paradigm shifts on the attitudes of organizations towards Internet, i. e., to incorporate collaboration, confidence, participation and sharing. However, this paradigm shift does not consist of applying, on an "as is" basis, patterns existing in communities of individuals to enterprises. Competition in business is much fiercer. Collaboration, confidence, participation and sharing must be reconciled with competitiveness. New behaviors have to assess how to create value out of confidence, sharing, participation and collaboration.

If a paradigm shift pervades organizations, performance of every sector of economy can be rewarded by new Internet technologies and can pull Internet technology evolution. Other businesses may appear out of new attitudes and new value can be created for economy with these new attitudes. Unexplored, unexploited and unmerged information might be the clue to follow so that companies can capitalize on new information technologies and gain competitive advantage.

C. Roadmap for Real World Internet Applications - Socio-economic scenarios and design recommendations

In [3], the authors' vision is to realize ambient intelligence in a future network and service environment, and to integrate Wireless Sensor and Actuator Networks (WSAN) efficiently into the Future Internet. Three scenarios are analysed to roadmap some Real World Internet applications. The three phases involve different levels of societal changes, business innovation and technical feasibility. They are not discreet but show a continuous timeline which depends on the context of the actual end use.

1) The first phase - Now - is *evolutionary* from a societal point of view and incremental from technological angle since it is the least integrated: the infrastructure of a mall is used for applications dedicated to the stakeholders of this place.
2) The second phase - New - is more *futuristic* from the socio-economics point of view and innovative from the technology side since it implies the deployment of connections between different and separate areas in the city and it starts to integrate different entities in extension to the shopping mall, e.g. private residential WSAN infrastructures.
3) The third phase - Next - is the most *revolutionary* one from the society point of view because it involves holistic applications of RWI. It proposes a fully horizontal vision of RWI applications with integration of all types of WSAN infrastructures in the city for the provision of an unlimited scope of applications. This is a disruptive vision compared to the existing Internet technology.

A RWI system has to challenge to provide benefits to the user and society through FI applications in key domains such as environment, mobility, safety, professional and industrial activities, citizenship, and ethics.

Today's Internet will change from the distinct network, providing specific services accessible through dedicated terminals, to an Internet dissolved in the artifacts of the physical world accessible via heterogeneous networks enabling users to browse the world as they browse the Internet. The RWI framework should support *horizontal* use and reuse of common WSAN infrastructures to develop a variety of applications. It should not therefore require as many WSANs as applications. RWI system architecture should be *scalable* to enable its functions to evolve in order to meet the future requirements of technology changes and growth. The RWI system must ensure the *continuity* of the services that the user needs with an adequate quality despite the user?s mobility. The RWI framework should *reduce complexity* to enable an easy access of user applications to the sensing and actuation services that are available everywhere. The RWI framework should provide mobile users with a good level of *security and privacy* protection. RWI applications will improve the users? safety in various activities, in particular in the transport, built environment, crisis management and healthcare domains. RWI applications are expected to increase the sense of the community by making perceptible the side effects of individuals? behavior. RWI will support professional and industrial activities. These benefits will be perceptible at short term as shown in the *Now* scenario. RWI system must support new business opportunities and new industrial partnerships by optimizing the integration of sensed and controlled physical phenomena to the Internet. With the integration of a real world dimension to the Internet, privacy and related ethical issues will increase. Even if RWI technology integrate the appropriate mechanisms, privacy and ethics can persist as critical issues and mistrust may slow the adoption despite it enabling an open and secure market space for context-awareness and real world interaction.

D. Concluding Remarks

The three reviewed papers do provide an in-depth view of the non-engineering challenges faced by the Future Internet. However, this discussion is far from being concluded. It seems that a more integrated assessment of such challenges are required and, at the same time, emphasizing the human aspects. Additionally, new dimensions remain to be included in the analysis. The first issue will be addressed in Section III that employs the concepts of the System Engineering, while the second issue will be addressed in Section IV that introduces the *Iconomics* vertices of beings, things and icons.

III. The Future Internet: a system engineering perspective

One of the main difficulties to understand the challenges of the Future Internet is its complexity. The System Engineering perspective provides a means to harmonize the different dimensions that compound the Internet. In this section we show how the System Engineering perspective helps to have a whole view of a such complex problem providing the human being with a protagonist role.

A. Engineering Problems Solving

Descartes's dictum that every problem should be broken down into as many separate simple parts as possible - reductive analysis - is the most successful technique that has ever been used in science. Engineering, as a constructive problem solving science, uses this principle to reduce the problems into as small as possible parts to get to the disciplines assigned to each smaller problem and, based on fundamental phenomena and materials, to cope with the necessary or possible solution. This is the main method to engineering solutions to systems construction.

B. System Engineering

The word system has a subjective nature. It is used to refer to organization forms that are associated to the way that men recognize them; the constructivist view of reality determines that a system does not exist in real world regardless human mind [7].

Systems engineering, differently from others traditional engineering disciplines, does not follow a fundamental phenomenon?s set based on physical properties and relations. Instead, it deals with the necessary knowledge to manage these phenomena, dealing with the system emergent properties, looking for a way to get control about the system entropy [7], [8].

The reductive analysis and the relatively simple construction from the parts became more difficult to deal with as the systems became bigger and bigger.

C. Complexity

The new main problem in the big systems engineering came to be the complexity. Complexity arises when there is a set of characteristics of the system that are not present in any of its parts alone. They are characteristics of the whole or of the co-existence of the parts working together. They are called emerging properties: perhaps the most simple example could be the human body. Life is an emerging property that does not exist in any part aside of the body.

Internet is complex; it is based on a huge amount of subsystems working together that is usually collectively called e-infrastructure. Many layers, not only technical ones, are interacting to fulfill the tasks assigned to them.

D. Socio-technical systems

Information systems are made considering stakeholders (man and social institutions) and technology. It is a socio-technical system, a system in which there is a social infrastructure (man and social institutions) and a technology infrastructure. The consideration of these two infrastructures is crucial in order to identify the correct factors for the quality of services and to identify which are the stakeholders? expectations, to give them the experience that they expect, surprising them whenever it is possible [8], [9], [10].

Considering an e-infrastructure alone, a computer grid, for example, it is only a technological artifact. It has a purpose, a meaning, only when one or more people use it to accomplish some task, as information search or data process to solve problems.

The technological, human and social components of an e-infrastructure system cannot be seen only as the sum of its components. There is a complex interaction among them, with emergent properties.

Another issue that contributes to e-infrastructure system complexity is that many of the systems used today were not developed in an integrated way. They were put together in a gradual way, resulting in a kind of patchwork, with new and old technologies, people and social institutions. New designs must respect this scenario, considering the new, and the old, technologies and several actors (as user, consumers and social institutions). These actors want to optimize their decisions, thinking about their own subsystems, proposes and interests [11].

Big systems engineering had very good answers before and during the WWII but, as the war ended, another new set of problems arose. These new problems came from the dawn of a completely new player in the game: the consumer. What does the consumer wants? In other words: for what is he willing to pay for? What are the requirements?

E. Requirements Engineering

Requirements engineering is engineering discipline alone, crucial in the development of any product or service. This engineering has a life cycle that leads the systems engineer in the process of requirements elicitation, negotiation, documentation and validation of the systems to be developed. The system engineer makes use of this process to execute a task that Kossiakoff and Sweet [12] call concept definition phase, and INCOSE [13] calls concept stage. Both refer to the initial phase of various life cycle models placed by the engineering statements to system information development.

In the requirement process, the elicitation phase concerns itself with people. This requirement gathering process needs to draw upon the knowledge and experience of the organization directors, managers, employees, etc., that are demanding the system. The system engineer needs to talk with people that are demanding the new systems and to the people that will be affected, positively or not, by the system. Usually all these stakeholders are organized in groups, formals or not, with different purposes; such that the whole has no clear purpose and the groups pull in different and often conflicting directions. The elicitation phase is essentially a human activity system that can bring some degree of order to the situation of multiple demands, purposes, issues and problems.

Using appropriate methods to progressively increase order to the requirements gathering process, and achieve a point where specific designs and solutions can be manifested, the system engineering has an approach to achieve the three requirements types that Kano [14], [15], [16] states that must be present on a product or service. This requirements allows the engineering to understand how meeting or exceeding the stakeholders expectation affects satisfaction in the relationship with the system. These requirements types are:

- Normal requirements: these are the requirements that are explicitly required.
- Expected requirements: these requirements are so basic that sometimes the stakeholders may fail to mention them, because they think that it was unnecessary request them explicitly. A system without these requirements is very dissatisfying, but meeting these requirements often goes unnoticed by most stakeholders.
- Exciting requirements: these requirements are the ones that if not present in the system, their absence will not be perceived, will not dissatisfy the stakeholder. As these requirements are not formalized by the stakeholders, i.e., the stakeholders are not apt to voice them, it is the engineer responsibility to explore the problem and opportunities to uncover such unspoken items. For example, as the engineer increases his knowledge about stakeholders needs, he can use his experience to propose features that were not requested but that can improve the system efficiency and effectiveness.

F. Final considerations

Man has personality, hopes, fears, dreams, values and intentions. Do not consider these human dimensions to build systems ultimately dehumanize human-system interaction, and is costly!

IV. The Future Internet: an iconomics perspective

"Iconomics", from a very broad perspective, results from a critical review of the political economy and the macroeconomics of technology transfers and market design aligned with the Center-Periphery system. The evolving actor-network develops and unfolds in the twenty-first century, generating new tools for the creation, management and critique of the information economy as a relatively open and simultaneously global and local network.

Existing technological and economic gaps are compounded by social and cultural differences which are immaterial or intangible, and which are related more closely to the realm of icons than to the requirements of things (hardware, software) and beings (evolving social networks). The iconicity of this evolutionary development is also an index of new metrics for consumption and audiovisual knowledge creation chains. The intangible assets thus produced (real, digital or virtual) are differentially appropriated by individuals, groups and property rights owners (in all classes of assets). The recovery of the world economy depends on this new accountability as much as on the survival of this bank or that company.

However, a precarious regulatory ecology coexists with the global Internet where no one is totally sure with respect to

- what is its economic value?
- what should be the rules governing access, exploitation, intellectual property rights, content distribution?
- how do people represent and communicate values and expectations associated to Internet related actions, projects and technologies?

Conceptually, the challenges of network design and implementation ("social weaving", so to speak, as in assemblages and re-assemblages of actor-networks) are compounded by the simultaneous interaction of space, time and symbol - the playful evolution of this human e-infrastructure corresponds with values, projects and icons for the audiovisual e-superstructural grids.

The emergence of mobile and immersive (audiovisual, virtual and real) applications and infrastructures will expand significantly the uses of the available grids, on the other hand the skills and knowledge required for the adequate creation, production, management, funding and distribution of information-rich devices will be lagging behind at a more than proportionate rate.

The management of audiovisual tools for human and local development engages the storyteller as well as the surveillance manager in the same local neighborhood. Privacy, intimacy, governance and intellectual property issues are at stake. On the other hand, access and use must be weighed by the skills to sustain a balance between supply and demand for information in the long run. However, the regulation of information asymmetries is not only an economic issue as such, it involves control of strategic energetic and telecom infrastructures as well as interference with content production and consumption streams, environmental effects and national identity (iconic) issues.

A. The brazilian case

The Brazilian iconomy has evolved through three stages of digital inclusion frameworks as designed by federal and state level agencies: access, open source and audiovisual, with a growing number of public funding mechanisms as well as articulation with other public policies in areas such as education, science, technology and innovation, culture and telecommunications. But without an overall ICT for development policy, which may be among the explanations for the decline in relative position of Brazil in the ICT Development Index.

A second, more political and institutional issue comes to the fore, given the emphasis on public funding of local content production and recent attempts at reconstruction of State-led broadcasting, social control of communication and regulation of digital TV in Brazil. Scenarios for future audiovisual policies and their impact on local development strategies must be thoroughly discussed, taking into account the limited impact of current policies on income generation and distribution as well as on the creation of sustainable markets for local audiovisual production.

B. Final considerations

Maybe the ideal scenario is that of an emerging "mediapolis", as in Livingstone, where it is "the mediated space where we can communicate, learn about others and take responsibility for one another". As a space where multiple mediated voices talk about the media and its centrality in everyday life. A space where the media and its work in culture, politics, economics, and ethics is critically discussed. A space where scholars, students, producers, and consumers speak the unspeakable and engage with the challenges of a multiply mediated society. A space where the presence of multiple voices in a single discourse is acknowledged and respected. A space where criticism is practiced with the spirit of plurality and hospitality [17].

Silverstone draws on Hannah Arendt and "her deliberations on the notion of republican democracy in the face of totalitarianism, imperialism and of course the threat of mass society. Often unjustly dismissed as a conservative critic, Silverstone seeks to rediscover through Arendt the public art of being with others. In particular Arendt stresses the role of public judgement, responsibility and perhaps above all the human capacity to think as the best shield against political catastrophe. A new global political culture then is not brought about through a McLuhanite technological transformation, but depends upon our shared moral and intellectual capacities. In particular the media?s ability to be able to stretch relations of time and space poses questions related to our civic imagination" [18].

This mediated space or mediapolis is a public sphere open to language patterns such as digital emancipation and other creative expressions of civic intelligence [19].

V. Conclusions and future work

In this paper we focus on the non-engineering challenges of the Future Internet as the most difficult issues to be addressed. After reviewing some recent publications concerning the socio-economic dimensions to be considered in the development of the Future Internet we postulate that the discussion is not over. We extend such discussion by presenting the systems engineering perspective that provides a more integrated approach and puts the human dimension in the center of process. Moreover, we present the *iconomics* perspective that shows that digital inclusion and appropriation of the digital technology by "prosumers" depend on considering a complete new set of values.

As future work we intend to perform an exhaustive study of the Future Internet, to develop a model that includes technological, societal and economical dimensions to produce integrated roadmaps for different technologies, applications, services and businesses.

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Foreword

Engineering activities are based on the development of new Knowledge *(Scientia)*, new 'made things' *(Techné)*, and/or new ways of working and doing *(Praxis)*. *Scientia*, *Techné*, and *Praxis* are three important dimensions of a comprehensive conception of Engineering as a whole. Engineering, as *Scientia*, is mostly developed in academia; as *Techné*, is practiced in industry generating technological innovations; and as *Praxis*, is carried out in technical and non-technical organizations, supporting managerial activities and technical procedures, via methodical and methodological design and implementation. This is why Engineering provides one of the most solid academic and professional substrata for bridging among universities, industries and governments.

Publications and conferences related to Engineering are usually oriented to one of its three dimensions. While this is an adequate thing to do when disciplinary focus is sought, it does not represent Engineering as a whole and it misses the very important synergic relationships among the three kinds of engineering activities mentioned above. This is why a group of scholars, professionals, and consultants, in the field of engineering, considered the possibility of organizing a conference where presentations would not be reduced to one specific Engineering dimension, but would foster the participation of academics, practitioners, and managers in the three dimensions of Engineering, in the same conference, so they can synergistically interact with each other. A consequence of this purpose is the organization of IMETI 2010, where submissions were accepted for the presentation of:

- **New knowledge** (Engineering as *scientia*);
- **New products and services**, i.e. technological innovations (Engineering as *techné*);
- **New technical and managerial methods and methodologies** (Engineering as *praxis*);
- **New meta-engineering** (Engineering of Engineering activities) knowledge, innovations, and methodologies.

The 7th International Conference on Cybernetics and Information Technologies, Systems and Applications (CITSA 2010) and The 8th International Conference on Computing, Communications and Control Technologies (CCCT 2010) have been organized in the context of IMETI 2010, because both are mainly oriented to Engineering and Technology. Both of them are International Multi-Conferences organized with the purpose of providing a communicational forum to researchers, engineers, practitioners, developers, consultants, and end-users of computerized, communications, and/or control systems and technologies in the private and the public sectors. This multi-disciplinary forum provides the opportunity to share experience and knowledge by facilitating discussions on current and future research and innovation. Participants can explore the implications of relationships between new developments and their applications to organizations and society at-large.

One of the primary objectives of CITSA 2010, CCCT 2010 and, in general, IMETI 2010 is to promote and encourage interdisciplinary cross-fertilization and knowledge communication. They encourage systemic thinking and practice, including the analogical thinking that characterizes the Systems Approach, which is, in most cases, the required path to logical thinking, scientific hypothesis formulation, and new design and innovation in engineering.

CITSA 2010 and CCCT 2010 are spin-offs from the International Conference on

IMETI 2010

International Conference on Engineering and Technological Innovation

CITSA 2010

International Conference on Cybernetics and Information Technologies, Systems and Applications

EEEP 2010

International Symposium on Energy Engineering, Economics, and Policy

EEET 2010

International Symposium on Engineering Education and Educational Technologies

OEPT 2010

International Symposium on Optical Engineering and Photonic Technologies

CCCT SUMMER 2010

International Conference on Computing, Communications and Control Tecnologies

SICT 2010

International Symposium on Security and Information/Communication Technologies

Information Systems, Analysis and Synthesis (ISAS), and the World Multi-Conference on Systemics, Cybernetics and Informatics (WMSCI) which are yearly events that have been held in the last 15 years as a forum for Information Systems researchers, practitioners, consultants, and users who have been interchanging ideas, research results, and innovations in the area of Information Systems. Analytical as well as synthetical thinking represent the conceptual and methodological infrastructures that support the papers presented in ISAS conferences. Synthetical thinking supported papers in the Information Systems area, as well as in its relationships (analogies, "epistemic things", "technical synthetical objects", hybrid systems, cross-fertilization, etc.) with other areas. The Organizing Committees of IMETI/CITSA/CCCT 2010 invited authors to submit original works, analogy-based hypothesis, innovations, experience-based reflections and concepts, specific problems requiring solutions, case studies, and position papers that explore the relationships among the disciplines of computers, communications and control, and the social and industrial applications within these fields.

On behalf of the Organizing Committee, I extend our heartfelt thanks to:

1. the 625 members of the Program Committee from 63 countries;
2. the 673 additional reviewers, from 80 countries, for their **double-blind peer reviews;**
3. the 451 reviewers, from 58 countries, for their efforts in making the **non-blind peer reviews**. (Some reviewers supported both: non-blind and double-blind reviewing for different submissions)

A total of 2480 reviews made by 1124 reviewers (who made at least one review) contributed to the quality achieved in IMETI 2010. This means an average of 5.84 reviews per submission (425 submissions were received). Each registered author could get information about: 1) the average of the reviewers' evaluations according to 8 criteria, and the average of a global evaluation of his/her submission; and 2) the comments and constructive feedback made by the reviewers, who recommended the acceptance of his/her submission, so the author would be able to improve the final version of the paper. In the organizational process of IMETI 2010, including CITSA 2010 and CCCT 2010, about 425 papers/abstracts were submitted. These pre-conference proceedings include about 126 papers, from 36 countries, that were accepted for presentation,. We extend our thanks to the invited sessions organizers for collecting, reviewing, and selecting the papers that will be presented in their respective sessions. The submissions were reviewed as carefully as time permitted; it is expected that most of them will probably appear in a more polished and complete form in scientific journals.

This information about IMETI 2010 is summarized in the following table, along with the other collocated conferences:

Conference	# of submissions received	# of reviewers that made at least one review	# of reviews made	Average of reviews per reviewer	Average of reviews per submission	# of papers included in the proceedings	% of submissions included in the proceedings
WMSCI 2010	711	1841	3586	1.95	5.04	211	**29.68%**
IMETI 2010	425	1124	2480	2.21	5.84	126	**29.65%**
IMSCI 2010	321	720	1751	2.43	5.45	121	**37.69%**
CISCI 2010	622	1174	3321	2.83	5.34	194	**31.19%**
TOTAL	**2079**	**4859**	**11138**	**2.29**	**5.36**	**652**	**31.36%**

We are also grateful to the co-editors of these proceedings for the hard work, energy, and eagerness they displayed preparing their respective sessions. We express our intense gratitude to Professor William Lesso for his wise and opportune tutoring, for his eternal energy, integrity, and continuous support and advice as Honorary President of WMSCI 2010 and its collocated conferences, as well as for being a very caring old friend and intellectual father to many of us. We also extend our gratitude to Professor Belkis Sanchez, who brilliantly managed the organizing process. Special thanks to Dr. C. Dale Zinn for chairing CCCT 2010 Program Committee (PC) and for co-chairing IMETI 2010 PC, to Professor Hsing-Wei Chu for co-chairing the IMETI 2010 PC and being General Co-Chair of CCCT 2010; to Professor Michael Savoie for being Co-General Chair of CCCT 2010 and CITSA 2010; to Professor José Ferrer for chairing the CITSA 2010 Organizing Committee; to professors Andrés Tremante and Belkis Sánchez for co-chairing the IMETI 2010 Organizing committee.

We also extend our gratitude to Drs. W. Curtiss Priest, Louis H. Kauffman, Leonid Perlovsky, Stuart A. Umpleby, Eric Dent, Thomas Marlowe, Ranulph Glanville, Karl H. Müller, and Shigehiro Hashimoto, for accepting to address the audience of the General Joint Plenary Sessions with keynote conferences, as well as to Drs. Sam Chung, Dr.

IMSCI 2010

International Multi-Conference on Society, Cybernetics and Informatics

EISTA 2010

International Conference on Education and Information Systems, Technologies and Applications

PISTA 2010

International Conference on Politics and Information Systems, Technologies and Applications

SOIC 2010

International Conference on Social and Organizational Informatics and Cybernetics

WMSCI 2010

World Multi-Conference on Systemics, Cybernetics and Informatics

RMCI 2010

Symposium on Risk Management and Cyber-Informatics

MEI 2010

International Symposium on Management, Engineering and Informatics

KGCM SUMMER 2010

International Conference on Knowledge Generation Communication and Management

BMIC 2010

Susu Nousala, Robert Lingard for accepting our invitation as Keynote Speakers at the Plenary Session of IMETI 2010.

Many thanks to Professors Friedrich Welsch, Thierry Lefevre, José Vicente Carrasquero, Angel Oropeza, and Freddy Malpica for chairing and supporting the organization of the focus symposia and conferences in the context of, or collocated with, IMETI 2010. We also wish to thank all the authors for the quality of their papers.

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Professor Nagib C. Callaos,
IMETI 2010 General Chair

BMIC 2010
International Symposium on Bio-Medical Informatics and Cybernetics

AG 2010

International Symposium on Academic Globalization

ISPR 2010

International Symposium on Peer Review

DRANS 2010

International Symposium on Design and Research in Artificial and Natural Sciences

S2ES 2010

International Symposium on Science 2.0 and Expansion of Science

CISCI 2010

Conferencia Iberoamericana en Sistemas, Cibernética e Informática

SIECI 2010

Simposium Iberoamericano de Educación, Cibernética e Informática

SVD 2010

Simposio Latinoamericano en Visualización Digital

GCGC 2010

Conferencia Iberoamericana en Generación, Comunicación y Gerencia del Conocimiento

CIIIT 2010

Conferencia Iberoamericana en Ingeniería e Innovación Tecnológica