INTERDISCIPLINARITY AND UBIQUITOUS INTERNET TECHNOLOGIES IN SUPPORT OF AUTOMATION

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ABSTRACT:

The Telecommunications and Internet Technologies have evolved dramatically during the last decade, laying solid foundation for the future generation of the Ubiquitous Internet access, omnipresent web technologies and ultimate automated information cyberspace. Recent technological advancements in the areas of global mobility, wireless technologies and miniaturization are driven by the economic and social prosperity. The current state of the art in Differentiated Networks, Health Informatics, Advanced Television, Sensor Networks, MIMO Systems, and recent experiments conducted in the Quantum and Bio Computing open a new horizon for the Future Technologies.

As a result, the current efforts in the research and development in the areas of Next Generation of Internet and Telecommunications Technologies promotes formation of inter-disciplinary international teams of experts, scientists, researchers and engineers to create a new generation of applications and technologies that will facilitate the fully-automated information cyberspace systems, such as Future House 2015. The speed and omnipresent accessibility to Internet providing any information at any time from anywhere will create global very complex communications infrastructures. The increased number of Internet sites worldwide will ultimately generate large number of performance bottlenecks and technical faults that may put in danger essential resources for societies world-wide such as energy supplies, national security, financial integrity, transportation logistics and ultimately human safety.

The author discusses the current state of the art in the world of Telecommunications and Internet Technologies, new technological trends directions in the Internet and Automation Industries, as well as the concept of the Fully-automated Future House 2015. The paper presents a survey of current developments and future directions in Telecommunications Industry and Automation while promoting research and development in the inter-disciplinary projects conducting by multinational teams world-wide.

KEYWORDS

AUTOMATION, CYBERSPACE, SMART HOUSE, UBIQUITOUS, INTERNET, CONVERGENCE.

1. *INTRODUCTION*

The past 20th century left us with legacy of the global Internet, final flight of Concord Air, CISCO monopoly in computer networking, etc., while large, medium and small corporations alike have discovered the need to adapt to the new technologies, or sink in the emerging global knowledge economy. There is no facet of life in the industrialized world that has not undergone some form of shift. The resultant new information economy has brought with it different approaches to work. The current 21st century is perhaps one of the most interesting times in history to be alive. We are witnessing a phenomenal abundance of change in societies around the world in a very short period. The source of most of this change is new technologies and the Internet. In the past decade we have seen every aspect of the lives of individuals and organizations go through many evolutions and uncertainties [1]. There are plenty of publications on the subject of futuristic and ubiquitous computing for the 21st century presenting excellent discussion and possible

scenarios in the subject area. [2, 3, 4, 5, 6]. History proved that one must look forward and accept the futuristic vision as possible scenarios of tomorrow's reality. Nowadays, technologies such as TV, Internet, Mobile Phone, Traffic lights, cameras are essential part of daily life. However, if one would suggest hundred years ago what would be the reality of 2005, surely he or she would be considered "with great caution" [Stajano 2002, Weiser 1996]. Past 20th century gave rise to new technologies that have become a reality for us all. Today, we are yet again at the very beginning of evolution of even more advanced and sophisticated technologies. Current industries, governments, business, academic and research institutions are all computerised and interconnected via Internet.

2. *PERVASIVE COMPUTING*

Research and development trends in the filed of computing industry promote a vision of smart spaces, smart devices, clothing, fully automated houses etc., which creates an environment where computers are everywhere and provide ultimate access to Internet. Pervasive computing environments, such as the ones studied in CMU's Aura project [Garlan 2002], provide many kinds of information. Some of this information should be accessible only by a limited set of people. For example, a person's location is a sensitive piece of information, and releasing it to unauthorized entities might pose security and privacy risks. For instance, when walking home at night, a person will want to limit the risk of being robbed, and only people trusted by the person should be able to learn about her current location. The access control requirements of information available in a pervasive computing environment have not been thoroughly studied. This information is inherently different from information such as files stored in a file system or objects stored in a database, whose access control requirements have been widely studied. The market is evolving from wired computing to pervasive computing, mobile and wireless, anytime at anyplace. Many types of information available in a pervasive computing environment, such as people location information, should be accessible only by a limited set of people. Some properties of the information raise unique challenges for the design of an access control mechanism: Information can emanate from more than one source, it might change its nature or granularity before reaching its final receiver and it can flow through nodes administrated by different entities [Hengartner 2003]. New developments in telecommunications industry gave rise to embedded systems working as networks. Many embedded systems today may be characterized as computing network, while chip architectures will follow the Network-on-chip Paradigm. Devices such as mobile terminals will have a distributed communication centric architecture, while Hardware and Software development for such systems will be communications centric. This will be a paradigm shift and a major challenge for the engineering community especially for SW developers, since traditional SW programming methods do not work well for distributed highly concurrent platforms.

3. CURRENT MARKET EVOLUTION OF E-M-U COMMERCE TECHNOLOGIES AND NETWORK CONVERGENCE.

Current research efforts in Automation industry are inspired by manufacturing evolution which went from heavy engineering plants in UK on 19th century to 20th century modern manufacturing concepts, while entering completely new dimension in the world of Internet and electronic information interchange world-wide. The manufacturing and automation technologies have cross the frontiers from nanotechnology to Giga Networks Infrastructures that are essential in enabling the information flow between robots, powerful computing centres and man controlled stations. The current merger of current Computer Integrated Manufacturing Technologies and Data-Telecommunications Technologies present a new challenge to community of engineers and scientists in the manufacturing sector as well as, mathematics and computing science and engineering sector [Babulak 2004, 2005]. The economic prospects for 2005/10 remain particularly hard to predict. Whilst the markets for Control and Power industry proved to be challenge for the companies, the Software and Automation industry have grown, particularly those businesses serving the oil, gas, power generation and auto markets [Shade 2001]. What gives rise to pressures in the market place are company drivers in conjunction with the industry drives. Globalization of the market with accelerating technological changes such as digital

revolution and mobile technologies in conjunction with the customer demands represent main industrial drivers [Wohlwend 2001]. On the company site it is the cost efficiency combined with the new lines of products that give rise to business complexity. The major forces in industry today are e-commerce and e-manufacturing [7]. E-manufacturing has been well adopted in industry overseas and the next wave of the e-manufacturing is driven by customers utilizing full capacity of e-commerce [8]. Toyota is one of many examples where e-manufacturing has become a major force for their productivity and business success. Future technological advancements open a new avenue for multidisciplinary development and research teams consisting of IT professionals such program developers, telecommunications engineers, production engineers and business managers to work closely with academics and industrial research teams on new e-manufacturing solutions. Sales marketing forces combined with the manufacturing and operation teams work together to plan the dynamics for future vision and the current reality, while facilitating supply chain of products in respond to customer chaotic orders. As a result, real-time planning and execution must be well balanced with the plant chaos. Both processes of making order and forecast are reflected well in the domain of vision and the reality while main facilitator for the customer remains to be Internet world-wide. Customers order behavior with mobility represents very complex, dynamic and non-linear systems [9]. A firm's ability to serve its customers needs determines its success. Initially, firms needed to meet face-to- face to meet most of their customer's needs; however, with the development of information technology, the requirement for face-to-face interaction has gradually declined. The Internet opened up a new channel for firm-customer interaction that has significantly changed the customer relationship equation. Now, cell phone networks are enabling m-commerce and further change in the firm-customer dynamics [Watson 2004]. Traditionally, business has been biased by geography and located near rivers, roads, and other transport services so that the cost of being reached by customer or reaching customers is lowered. Now, business is increasingly using electronic networks (e.g., the Internet and mobile phone networks) to interact with customers. Thus in the next few years, it is likely that we will see the emergence of u-commerce, where u stands for ubiquitous, universal, unique, and unison. U-Commerce is the use of ubiquitous networks to support personalized and uninterrupted communications and transactions between a firm and its various stakeholders to provide a level of value over, above, and beyond traditional commerce. U-Commerce represents the use of ubiquitous networks to support personalized and uninterrupted communications and transactions between a firm and its various stakeholders to provide a level of value over, above, and beyond traditional commerce. Ubiquitous represents concept of having [Watson 2004]:

- Networks everywhere;
- All consumer durable devices are on a network;
- Intelligence and information are widely dispersed and always accessible;
- Smart entities :
- Appliances ;
    - Buildings;
    - Signs
    - Street smart communities.

The main focus is to enable one global network that would be available 24 hours a day, seven days a week, whole year round and will provide best quality of services to anyone, anywhere and anytime. World's telecommunications providers are looking for the ways to merge together all digital and analogue services (voice, video, data) on one common network, which would provide users with unlimited access to online information, business, entertainment, etc. Convergence's goal is to provide corporations with a highly secure and controllable solution that supports real-time collaborative applications [10].

4. *SMART HOUSE 2005" SCENARIO OF FULLY AUTOMATED ENVIRONMENT VIA INFORMATION CYBERSPACE.*

In last decade, number of researcher articles presented vision and illustrated the scenarios of futuristic computing systems in the year 2005 [Babulak 2005-a]. Today, we are in the 2005 and much of the foreseen technology is already implemented and fully integrated in industry, military, businesses, education and home. Mark Weiser in his article written in 1996 wrote about futuristic computer technologies applied in "Smart House in the year 2005" [Weiser 1996].

Mark Weiser's vision did indeed materialised and some of his concepts are currently ongoing research and implementation projects. Ultimately the ubiquitous computer and Internet technologies should make living more comfortable for all. Looking back at my own graduation in London in 1991, I remember a statement made by the Distinguish Professor of Computer Science who was awarded the Doctor of Science degree. He said: "Computer technology today has influenced almost every aspect of our lives, industry, business, education. However, most unfortunately computer technology have mechanised the relationship between people due to e-mail and Internet technologies. It is important that the research, academic and industrial community work together to reverse that equation, whereby computer technology will be a tool that will improve human lives and mutual interaction." Author encourages reader to reflect on that statement. Let us imagine scenario where you and I will live in the "Smart House 2015". Early morning, just before the sunrise the fridge will send a message to local milkman, baker and fruit–vegetable market to make sure that breakfast will be served as usual with five star quality. While fridge completes its duties for the rest of the day and order all fresh food necessary for the day, the "Local Information House Center" will make sure that dining room is ready (i.e., silent vacuum cleaner and window washer completed it's job just before the sunrise. Garden is tendered everyday, garage is looking after car, making sure that batteries are fully recharged and that heat fits with the local weather forecast. Chairs, table, all kitchen appliances are ready and in place. Son after breakfast they will proceed with self cleaning, self storage. The "Local Information Health Centre" will examine the hygiene in the house and diagnose all possible viruses that are in the area and in the work place. All necessary vitamins and medications will be administered automatically and painlessly. For those who are overweigh if agreed to in-house regime policies, food chain calories will be carefully supervised and monitored by fully automated cook and service appliances. Every member of the family will have automatically prescribed the educational and entertainment programs according to their position (i.e., pupil, student, engineer, academic, worker, etc.) In addition, the Local Heath Centre will monitor house members' state of health per 24 hours, every day, consult the "Medical Database" and automatically alert the house member and local doctor in case of urgency. Naturally, there are issues related to the "House Automatic Positioning Systems" and "Security Systems", which will be carefully monitored and controlled remotely by the house owner or if necessary by the "Local Weather Centre". In case of natural disasters these systems will protect the house and its members while switching to contingency plan B. Well, all we need is to wait until 2015 and see if this vision will materialise. Fully automated environment requires sophisticated MIMO antenna systems and small smart devices that will be able to communicate within themselves all the time. These devices will have self healing capabilities to make sure that they are recharged regularly and will be operational without any interruption. Similar to us humans we have breakfast, lunch, dinner and snack on accession to make sure that we are able to do our job, and yet we sleep anywhere from 6 to 14 hours each day. Device creating the fully automated space can not sleep, perhaps they may wait or be on pause mode, but as soldiers they must be in full operational readiness at any time and anywhere. The advancement of current technologies in the fields such as data and telecommunications, ubiquitous Internet access and sensor technologies combined with the new revolutionary explorations and concepts in biotechnology and nano-technology, computer human interface-interaction, etc., present a great challenge for the research community not only as a result of mathematical complexity, but most of all by the user's perception [Babulak]. It is essential to remember that technology is only a tool an utility resource that is available to us all. Did we find the answer to simple question such as:

1) "Why it is that if little spider falls from the table down on the kitchen floor, it never breaks its tiny legs?"
2) "Did we really make progress in Automation and if yes to what extend?"
3) "What is the ultimate Internet access?"
4) "What is the truly Intelligent Fully-Automated Cyberspace?"

5. *CONCLUSION*

Automation did inspire number of outstanding scientists and engineers in the past centuries to find new solution to ease lives for all mankind. The emergence and accessibility of advanced data and telecommunications technologies combined with convergence of industry standards, as well as the convergence of data and telecommunications industries contribute towards the ubiquitous access to information resources via Internet [11, 12]. The automated environment and cyberspace systems for the 21st century entered a new era of innovation and technological advancements. World's industry and commerce are becoming more and more computerised having a global vision for the future. With increased benefits and improvements in overall information technology, the benefit-to-cost ratio has never been higher. It is essential to continue in the developments of industry standards and application of information technologies in order to increase the automation and ultimate success of modern logistics, the E-M-U-Commerce and E-manufacturing industries.

In this paper, author presents new directions in the research areas of ubiquitous computing and applied automation, while presenting visions shared by researcher worldwide. The automated environment and cyberspace systems for the 21st century entered a new era of innovation and technological advancements. World's industry and commerce are becoming more and more computerized having a global vision for the future. With increased benefits and improvements in overall information technology, the benefit-to-cost ratio has never been higher. It is essential to continue in the developments of industry standards and application of information technologies in order to increase the automation and ultimate success of modern logistics, the E-M-U-Commerce and E-manufacturing industries.

Paper further discuss the concept of pervasive computing, the current evolution of E-M-U Commerce technologies, Network Convergence, which will serve a foundation for the future developments in pervasive computing environments. Paper identified several challenges, and presented basic principles for smart devices intercommunication via cyberspace.

Author presents his own vision on future automated environment via information cyberspace for the year 2015. Paper suggests the integration of automated environments and intelligent cyberspaces in light of applied robotics, logistics, smart devices, smart antennas and intelligent systems. Author hopes that this paper will encourage the research and industrial community to invest their efforts in implementing fully automated environments via intelligent cyberspaces. Future efforts should be focused on designing a communication language and transmission media that will allow for instantaneous communication transfer and control between smart devices and humans. This paper promotes further research in the area of automation, ubiquitous computing and artificial intelligence.

Current research and development efforts in the areas of industrial automation, Robotics and Internet bring together large team of researcher and experts worldwide. Telecommunications and data networks infrastructures are the essential platform for industrial automation and Internet.

The promotion of interdisciplinary activities in the areas of Informatics, Engineering, Mathematics, as well as, Aesthetics and Business is quickly becoming one the most exiting fields of academic and industrial research. However, it is essential to invests in creating advanced academic, research and new technology parks. Successful future will belong to those who dare to go forward despite of challenges and setbacks caused by temporary lack of resources and motivation.

REFERENCES

[Babulak] Babulak Eduard: "Next Generation of Internet & Telecommunications Technologies for Fully Automated Cyberspace", Keynote Speech at the 7th International Conference on New Trends in Technology System Operation, held in Presov, Slovakia, October 2005.

[Babulak 2005-a] Babulak Eduard: "Automated Environment via Cyberspace", International Conference on Applied Computing (IADIS) 2005, February, 2005 in Algarve, Portugal.

[Babulak 2005] Babulak Eduard, "Quality of Service Provision Assessment in the Healthcare Information and Telecommunications Infrastructures", selected for publication in the *International Journal of Medical Informatics*, Elsevier Ireland Ltd, 2005.

[Babulak 2004] Babulak Eduard, Manufacturing for the 21st Century, *1st International Conference on Manufacturing Management*, Presov, Slovakia, November 2004.

[Garlan 2002] Garlan, D, Siewiorek, D, Smailagic, A, and Steenkiste, P, 2002, Project Aura: Towards Distraction-Free Pervasive Computing. *IEEE Pervasive Computing*, 1(2):22–31, April- June.

[Hengartner 2003] Hengartner, U and Steenkiste, P, 2003, Protecting Access to People Location Information, *Proceedings of International Conference on Security in Pervasive Computing (SPC 2003)*, March.

[Kropft 2002] Kropft, P: "What is Pervasive Computing, Series of Lecture notes 2002.
Shade, B., 2001, *Increased Productivity Through E-Manufacturing*, by Cahners Business Information

[Stajano 2002] Stajano F: "*Security for Ubiquitous Computing*, Wiley press, 2002.

[Watson 2004] Watson R.T: "Data management: *Databases and Organizations*" 4th edition, Willey press, 2004.

[Wolhlwend 2001] Wohlwend, H: "An E-Factory Vision" 2nd European Advanced Equipment Control/AdvanceProcess Control Conf., April 18-20, 2001.

[Weisser 1996] Weiser, M: "Open House", *Web magazine of the Interactive Telecommunications Program of New York University*. Appeared in March, 1996 ITP, Review 2.0.
http://www.itp.tsoa.nyu.edu/~review/

Web resource:

1) Government Canada: http://www.atirtf-geai.gc.ca/submissions/riley2001-05-30-f.html
2) Security for Ubiquitous Computing: http://www-lce.eng.cam.ac.uk/~fms27/secubicomp/index.html
3) Ubiquitous Computing: http://www.ubiq.com
4) Ubiquitous Computing: http://www.cs.albany.edu/~maniatty/teaching/ubicomp/index.html
5) Ubiquitous Computing: http://www.ubiq.com/hypertext/weiser/SciAmDraft3.html
6) Bleutooth: http://www.bluetooth.com
7) Advanced manufacturing Research: http://www.amrresearch.com/
8) Toyota: http://www.toyota.com/
9) Agile Manufacturing Concepts: http://www.darpa.mil/mto/solicitations/CBD/cbd_9431A.html
10) Convergence : http://www.covergence.com/contact.html
11) IEEE Pervasive Computing : http://www.computer.org/pervasive
12) Distributed Computing: http://dsonline.computer.org/portal/site/dsonline/index.jsp

Professor, Eur.Ing., Eduard Babulak Ph.D., P.Eng., C.Eng., C.ITP., worked as a University Professor, Senior Lecturer and Researcher in Mathematics, Electrical, Computer Engineering and Computing Science in Canada, USA and United Kingdom. Professor Babulak speaks 14 languages and was nominated Fellow of the British Computer Society (BCS) and Fellow of Association of Computer Machinery (ACM). He is a Senior Member of IEEE, a Corporate Member of IEE, a Professional Member of BCS, a Professional Member of ACM, a Member of American Society for Engineering Education (ASEE), American Mathematical Association (AMA) and Member of the Mathematical Society of America (AMS). Professor Babulak is an international scholar, researcher, consultant, educator, professional engineer and polyglot with more that twenty two years of teaching experience and industrial experience as a professional engineer in USA, Canada, UK, Germany, Austria, and Czech Republic and Slovakia. Professor Babulak's biography was selected for citation in the Cambridge Blue Book 2005, the Cambridge Index of Biographies 2004-2005, the Dictionary of International Biography 2004, published by the Cambridge Center of International Biographies, Who's Who in the Science and Engineering 2003, 200-2006, Who's is Who in the Industry and Finance 2004-2005 and in the Who's, et Who in the World 2003, 2004. Professor Babulak academic and engineering work was recognized internationally by the Engineering Council in UK and European Federation of Engineers. His academic qualifications have been recognized and credited by the Association of Professional Engineers of Canada in Toronto. Professor Babulak's research interest is in Ubiquitous Computing, E-Manufacturing, QoS provision for Computer and Telecommunications Communications Infrastructures, Differentiated Networks, Health Informatics, Electronic Health Record, Sensor Networks, Automation and Applied Mathematics.