IEEE Standards Education e-Magazine

The IEEE Standards Education e-Magazine: A publication for those who learn, teach, use, deploy, develop and enjoy Standards! Sponsored by the Standards Education Committee IEEE is committed to: promoting the importance of standards in meeting technical, economic, environmental, and societal challenges; disseminating learning materials on the application of standards in the design and development aspects of educational programs; actively promoting the integration of standards into academic programs; providing short courses about standards needed in the design and development phases of professional practice. Serving the community of students, educators, practitioners, developers and standards users, we are building a community of standards education for the benefit of humanity. Join us as we explore the three fundamental dynamics of standards--technology, economics and politics, and enjoy our feature articles about the use, deployment, implementation and creation of technical standards.

The IEEE Standards Education e-Magazine
1st Quarter 2013, Vol. 3, No. 1

Table of Contents

Welcome to the IEEE Standards Education e-Magazine

A publication for those who learn, teach, use, deploy, develop and enjoy Standards!

Technical standards are formal documents that establish uniform engineering or technical criteria, methods, processes and practices developed through an accredited consensus process.

Standards are:

- developed based on guiding principles of openness, balance, consensus, and due process;
- established in order to meet technical, safety, regulatory, societal and market needs;
- catalysts for technological innovation and global market competition.
- Knowledge of standards can help facilitate the transition from classroom to professional practice by aligning educational concepts with real-world applications.

IEEE is committed to:

- promoting the importance of standards in meeting technical, economic, environmental, and societal challenges;
- disseminating learning materials on the application of standards in the design and development aspects of educational programs;
- actively promoting the integration of standards into academic programs;
- providing short courses about standards needed in the design and development phases of professional practice.

Serving the community of students, educators, practitioners, developers and standards users, we are building a community of standards education for the benefit of humanity.
Join us as we explore the dynamic world of standards!

Return to Table of Contents

Letter from the Editor-in-Chief

Yatin Trivedi

1st Quarter 2013

Collaboration at the Heart of a Competition

Collaboration is a quintessential aspect of all successful standards. Many engineers (and non-engineers, often) collaborate to develop and deploy engineering standards. So it is no surprise that collaboration is inherently in the blood of standards development organizations (SDOs) such as IEEE and IEC. The two organizations have collaborated since 2002 to bring many "dual-logo" standards to the engineering community. I am quite familiar with the Design Automation standards that have attained true global adoption as a result of such dual-logo collaboration between the two organizations.

Both organizations, with their profound interest in a better understanding of the economic and social impact of the electro-technical standards around the world on humanity, decided to collaborate on a new level. They launched a competition in October 2011 called the IEC-IEEE Challenge 2012. The global academic community was invited to analyze and debate the impact of electro-technology on the economic, social and environmental development of nations and regions, including how accepted standards affect this process. The competition was open for 8 months, and elite members of the standards community reviewed the submissions. I was fortunate to read some of the submissions as a member of the team that made recommendations to IEEE Past President Moshe Kam, and the other judges on the Executive Review Council of the IEC-IEEE Challenge. It is fascinating to read the about the models developed by the academic community for better understanding and research in this field. The three winners, no doubt, represent not only the best researchers among the submissions, but also some of the best researchers and educators in standards field.

There is a lot more to be done. We hope the collaboration between IEEE and IEC can create such competitions in the future while expanding to invite industry to the competition as well. We hope that academia will encourage faculty, students and researchers to actively pursue the structured study of the impact of electro-technical standards in all aspects of our lives. We certainly hope to cover such future competitions in greater details in this eZine and perhaps with some fanfare!
In the meantime, we bring you an abridged version of the three prize winning entries, in their own words. Read, learn, and spread the good word about how standards are affecting your world.

Yatin Trivedi
Editor-in-Chief

Note: Regular readers expected an issue in November. It is now end of January and only now you are getting this issue of SEC eZine. Why so late? Because Sandy, the hurricane, happened. When the warning came, we thought it was a big rain storm. Then, perhaps a couple of hours of electricity disruption, or may be a day of office closure. Most of us did not expect complete shutdown of our offices or closure of all operations for a couple of weeks. But there was much more than work that was interrupted. Homes, neighborhoods and communities were destroyed and families were displaced.

In that context, we made a conscious decision to skip one issue of the eZine and focus our attention on more important things in life – to get everyone back on their feet as quickly as possible. With winter setting in and year-end holidays upon us, this was the least inconvenience we were going to cause anyone. We hope our readers from across the globe understand the plight and the effort to restore the disruption back to order. Thank you for your continued support, readership and contributed articles and comments.

The IEEE Standards Education eZine Editorial Board welcomes your comments and suggestions. Please write to us at: ezine-eb@listserv.ieee.org.

About the Editor-in-Chief

Yatin Trivedi, Editor-in-Chief, is Director of Standards and Interoperability Programs at Synopsys. He is a member of the IEEE Standards Association Standards Board (SASB), Standards Education Committee (SEC), Corporate Advisory Group (CAG), New Standards Committee (NesCom), Audit Committee (AudCom) and serves as vice-chair for Design Automation Standards Committee (DASC). For 2012, Yatin was appointed as the Standards Board representative to IEEE Education Activities Board (EAB). He represents Synopsys on the Board of Directors of the IEEE-ISTO and on the Board of Directors of Accellera. He represents Synopsys on several standards committees (working groups) and manages interoperability initiatives under the corporate strategic marketing group. He also works closely with the Synopsys University program.

In 1992, Yatin co-founded Seva Technologies as one of the early Design Services companies in Silicon Valley. He co-authored the first book on Verilog HDL in 1990 and was the Editor of IEEE Std 1364-1995™ and IEEE Std 1364-2001™. He also started, managed and taught courses in VLSI Design Engineering curriculum at UC Santa Cruz extension (1990-2001). Yatin started his career at AMD and also worked at Sun Microsystems.

Yatin received his B.E. (Hons) EEE from BITS, Pilani and the M.S. Computer Engineering from Case Western Reserve University, Cleveland. He is a Senior Member of the IEEE.

Return to Table of Contents

Video Series: Discussions about the Importance of Standards and Standards Education

---

In part two of a three part series, President of the IEEE Standards Association, Karen Bartleson talks about how standards education can benefit industry. (2:41)

Part one in three part series (2:48)

Previous Video Series

IEEE Standards Association Past President Steve Mills and our Editor-in-Chief Yatin Trivedi discuss three fundamental dynamics of standards--technology, economics and politics, and address the importance of having a strong foundation in understanding standards and their impact on innovation.

Part three in the three-part series (5:44)

Part two in the three-part series (4:59)

Part one in the three-part series (5:53)

Videos will launch in You Tube.

Return to Table of Contents

Feature Articles

Return to Table of Contents

The IEC-IEEE Challenge 2012: How Does Electrotechnology Impact Economic, Social, and Environmental Development?

By Susan Tatiner, IEEE Standards Association, Director, Government Relations & Standards Education

First Quarter 2013

In the early years of our century, buffeted by financial crises, geopolitical shifts, and unprecedented technical advances, people everywhere seek a better understanding of economic, social, and environmental development. What can we do to protect and perhaps nurture development? What direction will it take? What forces affect it?

In October 2011, the IEEE and the IEC joined together to issue a call to academics around the world to engage in a paper competition focused on a very specific question in this arena …How does Electrotechnology Impact Economic, Social, and Environmental Development? Participants were asked to address how innovation and technological advancement shape the economic and political landscape of countries all around the world and remain important in providing new growth and job opportunities. The IEC and the IEEE hoped to stimulate academic debate on how electrotechnology can be used to solve some of the world's greatest problems.

Papers submitted in answer to the IEC-IEEE Challenge were submitted from continents, countries, and universities around the globe. Papers were reviewed thoroughly by IEEE and IEC teams, and finally by a distinguished panel of judges: IEC Immediate Past President Jacques Régis, former CEO of Hydro Quebec, Montréal; Dr. Moshe Kam, 2011 IEEE President, and Department Head, Electrical and Computer Engineering, Drexel University; and Paul Markillie, Innovation Editor at The Economist.

Pictured from left to right: IEEE Standards Association Past President Ben Johnson, Axel Mangelsdorf from BAM Federal Institute of Materials Research & Testing, Ken Krechmer from University of Colorado, Joyce van de Vegte from Camosun College, and IEC Immediate Past Present Jacques Régis

The IEEE provided the information below on the prize winners:

> The IEC-IEEE Challenge first prize and USD 20 000 was awarded to Ken Krechmer from the University of Colorado, Boulder, USA, for his paper: Cloud computing standardization. His paper addressed how cloud computing promises to dramatically simplify the development and deployment of new economic, social and environmental applications. Such applications represent very large commercial opportunities. Standardization of the cloud computing building blocks and interfaces is vital to establishing multi-national markets and to balance the vendor's desire for commercial gain with the public's desire for open interfaces. Commercial gain and open interfaces need not be opposing goals and Krechmer's paper develops how the standards for these building blocks and interfaces may be designed to maximize both goals.
>
> The second prize and USD15 000 was awarded to Axel Mangelsdorf from the BAM Federal Institute of Materials Research and Testing, Berlin, Germany, for his paper: The benefits of standards and standardization in the German electrical and electronic industry. Knut Blind2, Chair of Innovation Economics, Technical University Berlin, Germany, is co-author of this paper. A summary is as follows:
>
> > Economic and innovation policies directly rely on standardization. Standards support technological change, impact safety and the environment, and facilitate access to global markets for new products

and services. Interoperability standards allow devices from different manufacturers to connect and thereby stimulate economic development. This publication presents a study conducted with 170 companies in Germany. It explores, among other things, how active participation in the standard setting process changes the perception of the strategic value of standards and the real benefits for companies. Based on this research, Mangelsdorf and Blind recommend implementation of a high-capacity, web-based portal to increase companies' participation in standardization processes and to encourage wider standards dissemination.

The third prize and USD 10 000 was awarded to Joyce van de Vegte from Camosun College, British Columbia, Canada, for her paper: Bridging the divide with a three-way handshake. The paper discusses how historical differences in the access to personal computers triggered a "digital divide" between those who benefit from the Internet and those who do not. The divide encompasses many dimensions – economy, education, health, information – and has tangible effects on human development. The adoption of global Internet standards based on TCP/IP helped narrow the digital divide, and the author demonstrates how Internet standards help bridge other divides as well, improving equity in the economy, education, health, and communication. Van de Vegte states that the benefits of the Internet are still unavailable to many due to language barriers, and that translation will be the next frontier. Robust standards for translations between pairs of languages could produce a seamlessly international Internet, preserving diverse cultural content while offering an increasingly level playing field to all.

An Awards Ceremony was held in Oslo, Norway, on 5 October, during the IEC General Meeting. Jacques Regis and IEEE-SA Past President Ben Johnson were on hand to present the prize winners with their awards. Coming from diverse backgrounds, all the winners share a common vision of the power of technological change to create a better future for society and the importance of empowering the technologists of today and tomorrow to make that happen.

Susan K. Tatiner is with the IEEE Standards Association as Director, Government Relations & Standards Education. She is responsible for strategic planning, maintenance and growth of internal and external business relationships, and oversight and implementation of all activities in the areas of Government Relations and Standards Education for the IEEE Standards Association.

Ms. Tatiner is a member of the Council of Engineering and Scientific Society Executives (CESSE) and of the American Society of Association Executives (ASAE). She is a member of the ANSI Committee on Education, and has served on the ANSI National Policy Committee and Organizational Membership Council. She has been a Certified Association Executive (CAE) since 2008.

Ms. Tatiner holds a B.A. from Queens College, of the City University of New York, and an M.A. from New York University.

Return to Table of Contents

Introducing the IEC-IEEE Challenge Prize Winners

By Susan Tatiner, IEEE Standards Association, Director, Government Relations & Standards Education

First Quarter 2013

Dig a little deeper as we explore standards and standardization with the IEC-IEEE Challenge prize winners. We checked in with Ken Krechmer, Axel Mangelsdorf, and Joyce van de Vegte and asked about their background, their experience in standards, their take on standards education, the direction their work is taking next, and more.

From Ken Krechmer …

My paper, "Cloud computing standardization," addresses how cloud computing promises to dramatically simplify the development and deployment of new economic, social and environmental applications. Such applications represent very large commercial opportunities. Standardization of the cloud computing building blocks and interfaces is vital to establishing multinational markets and to balancing the vendor's desire for commercial gain with the public's desire for open interfaces. Commercial gain and open interfaces need not be opposing goals, and my paper develops how the standards for these building blocks and interfaces may be designed to maximize both goals.

I am a lecturer at the University of Colorado, Boulder, Colorado, USA, where I have taught a three-credit-unit graduate engineering course on the theory of standards - Isology. I was Program Chair of the Standards and Innovation in Information Technology (SIIT) conference in 2001 (Boulder), 2003 (Delft, Netherlands) and 2007 (Calgary, Canada) and co-Program Chair of SIIT 2009 (Tokyo, Japan) and 2011 (Berlin, Germany).

From 1990 to 2002, I was the founding technical editor of Communications Standards Review, a journal reporting on standards work-in-progress in the Telecommunications Industry Association (TIA), the International Telecommunications Union (ITU) and the European Telecommunications Standards Institute (ETSI). I have been secretary of TIA TR-29 (facsimile standards) 1990-1995 and a US delegate to ITU-T Study Group 8 (fax), 14 (previous modem standards), 15 (xDSL) and 16 (modem, video, conferencing) meetings.

I teach (when I can) Isology, the science of standards and standardization. See "Teaching Standards to Engineers"-- http://www.csrstds.com/pdf/teachengr.pdf-- for a detailed explanation of my views on this.

In order to show a mathematical basis for isology, I have been working for several years on a paper, "Unified measurement theory," which develops and proves there is a single measurement equation that applies to quantum, classical and relativistic systems. This paper describes how a reference frame is used to create a measurement result or calculation. A standard is a committee's agreement on a reference frame. I am hopeful that this paper will be ready for publication in the next year.

The next paper will apply the concepts from the above paper to layered standards using information theory. Isology is very new. There is a great amount of work necessary to establish its theoretical underpinnings as well as to show how isology applies to new applications - like the Cloud computing standardization paper.

Although I have no survey data, I suspect that standards and standardization is the largest single employment category of first world engineers. Most first world engineers do not work full time in isology, but many would indicate that they devote 10 to 40% of their time to such activities. It is unfortunate that there are almost no technical courses in the field of isology. Particularly for experienced engineers, who might be expected to participate in standardization work.

From Axel Mangelsdorf ...

For our paper, **"The benefits of standards and standardization in the German electrical and electronic industry,"** Knut Blind and I used a company survey to show how standards and participation in standardization committees benefits companies in the electrical and electronic industry. Our results show that companies use standards to enhance product quality and safety. Standards also help companies to increase their competitiveness and market share and are a valuable source of new technical knowledge helping companies to become more innovative. We also show that companies participating in standards setting benefit more from standards compared to non-participating companies. Participation in standards setting influences the way companies perceive the strategic advantages of standards.

I have been involved in economic research about standards since I joined Knut Blind's Chair of Innovation Economics at the Berlin Institute of Technology back in 2006. I received a scholarship from the HARTING Technology Group to write my

PhD in 2008 and finished my thesis in 2010. As a consultant, I also worked on standards-related issues for the World Trade Organization and the World Bank.

I have not participated in standardization activities at the IEEE but as a researcher I use the IEEE Journals and Magazines to publish our work. One of my papers I wrote together with Knut Blind is published in the IEEE Transactions on Engineering Management (IEEE-TEM). I also attend IEEE conferences. I went to the IEEE International Technology Management Conference in Dallas this year.

I think standards education is absolutely essential. It is not only interesting for students but also a good preparation for their future work. I am part of a team of lecturers for the course "Strategic Standardization" at the Berlin Institute of Technology. I also supervise students' Bachelor or Master Thesis work on standards and standardization.

All my students have loved the topic of standards because it has a tremendous impact on the economy. The study of technical standards has many dimensions: for example, company strategies, innovation performance, and impact on international trade.

I will continue my research and teaching activities in the field of standards. In addition to standards, my field of research now includes the so-called National Quality Infrastructure, which comprises standards, certification, and accreditation, as well as metrology.

From Joyce van de Vegte …

My paper, **"Bridging the divide with a three-way handshake,"** looks at the digital divide and the ways in which standards, Internet standards in particular, influence its closing. Historically the success of TCP/IP led to the first truly global Internet. More recently, standards for wireless and fiber optics have contributed to greater infrastructure availability. But access does not guarantee benefit. Language encoding and translation standards will promote the production of content commensurate with the languages of Internet use. If the digital divide can be closed, perhaps greater progress in the closing of education, health, and economic divides will follow.

I have been teaching electronics and computer engineering for nearly two decades. My teaching areas include digital signal processing, system dynamics, and renewable energies. I had not previously been involved in standards activities.

Rather, it is my particular interest in engineering contributions to international development that first sparked my interest in the IEC-IEEE Challenge question.

My lack of expertise in standards meant that my research was a process of discovery. The more I read and learned, the more excited I became about the fundamental and very specific ways in which standards can contribute to the important goal of closing the global digital divide. I can report that I am now absolutely a convert!

Following my own traditional electrical engineering background, I have not previously taught standards in my courses. Luckily an extremely informative renewable energy panel session immediately followed the awards ceremony in Oslo, and I now have some fantastic IEC white papers that I will be using in my renewable energy courses.

I believe the most effective way to ensure that standards education becomes integral to engineering and technology education is to seek to include standards competencies among accreditation criteria demanded by national accrediting bodies. Online standardization teaching materials will be a boon to faculty in support of this goal.

****Please note that the winning papers will be published in their entirety in booklet form and on the web in the near future. When they are available, the IEEE Standards Education eZine will make a link available to our readers.

Return to Table of Contents

Abstract: Cloud Computing Standardization

By Ken Krechmer, University of Colorado, Boulder, USA

Winner of First Prize, IEC-IEEE Challenge 2012

Cloud computing is a service, like a utility, that allows software, platforms and infrastructure to be available as needed to mobile and stationary users over the Internet. Cloud computing is desirable for distributed applications such as: financial exchange, international trade, social networks, epidemic monitoring, health care informatics, emergency services, smart power grids, and environmental monitoring and management. These vital new services suggest significant commercial cloud computing opportunities.

The cloud computing SDOs' challenge is getting each competing commercial implementer to agree to negotiate their proprietary interfaces and services (compatibility specifications) as a part of a meta standard that only negotiates (without data transfer or control functions) which APIs, protocols, formats, converters, gateways, and specifications to utilize. When the meta standard defines a single logical tree structure where the only changes allowed (in one revision level) are additions, backward compatibility is always maintained. Such meta standards are termed adaptability standards.

Considerable cloud computing standardization activity is underway. A reference architecture and use cases for cloud computing have been created, and work on compatibility standards is underway (e.g., IEEE draft P2302). But cloud computing today has few standardized APIs, and different proprietary services support incompatible protocols and formats. The technical problems of achieving and maintaining compatibility between different precursor products and systems in the cloud computing environment are considerable. Adaptability standards can negotiate which interfaces to use or which converters to apply.

When an adaptability standard defines how to negotiate all capabilities, a desirable feature for implementers emerges. Each adaptable end sends to the other a menu of all available capabilities. The classes of capabilities that are proprietary are identified and each proprietary option (if supported) is also identified by a representation of a trademarked name. The trademarked name must be received at each end to invoke any proprietary option. If an unlicensed implementer sends someone else's trademarked name, it is a case of illegal use of trademark, not a complex intellectual property litigation.

If a proprietary cloud computing service becomes successful, other commercial implementers, hoping to capitalize on its success, may reverse engineer key interfaces to compete with the original implementer. The trademark exchange proposed via adaptability standards offers a means for innovative cloud computing implementers to control their proprietary options similar to how a patent gives control of similar products to the inventor. When the value of trademark negotiation is understood by proprietary cloud computing implementers, they will have a reason to participate in cloud computing standardization.

****Please note that the winning papers will be published in their entirety in booklet form and on the web in the near future. When they are available, the IEEE Standards Education eZine will make a link available to our readers.

Return to Table of Contents

Abstract: The Benefits of Standards and Standardization in the German Electrical and Electronic Industry

By Axel Mangelsdorf, BAM Federal Institute of Materials Research and Testing, Berlin, Germany, and Knut Blind, Chair of Innovation Economics, Technical University, Berlin, Germany

Winner of Second Prize, IEC-IEEE Challenge 2012

Standardization and standards are recognized as important instruments in economic and innovation policy. Standards support technological change and enable new products and services to access global markets.

With this focus on mind, we want to know how standards and participation in standardization committees benefits companies in the electrical and electronic industry. In 2008, the Chair for Innovation Economics of the Technical University in Berlin in cooperation the German Electrical and Electronic Manufacturers' Association (ZVEI) conducted a company survey to examine this question. About 170 companies filled out our questionnaire. The survey includes questions on how companies participate in standards setting bodies, how information on standards is provided and how standards are implemented in companies.

Obviously, involvement in standards setting bodies is an important task for companies in the electrotechnical industry. About 75percent participate in DKE -- the German Electrotechnical Commission -- and about half of the companies participate in CENELEC and IEC respectively.

Regarding information sources of standards the results show that the national trade association and the national standards body – DKE the German Electro-technical Commission – are in important providers for information on standards and standardization work. Standards application does not come for free. Companies face different costs, ranging from translation of foreign standards to identifying the

correct standard and proper implementation. In addition, smaller companies find it difficult to identify relevant standards and deal with their complexity.

Of course, standards deliver lots of benefits to businesses. Enhanced product safety and quality are the most important ones. Other advantages are directly related to business performance. The companies answered that standards help to increase their competitiveness and increase their market. New product development is essential for every business and standards -- as majority of the companies in our survey told us -- are important information sources for new technical knowledge. Interestingly, the advantages of standards application are evaluated differently by companies who participated in standardization. For participants, standards application is much more important to increase their competitiveness and market area compared to non-participants. Obviously, participation in standards setting committees influences the way companies perceive the strategic advantages of standards. Therefore, we recommend in our paper -- among others -- that standards setting bodies need to support participation in order to increase companies' awareness regarding strategic potentials of standards.

****Please note that the winning papers will be published in their entirety in booklet form and on the web in the near future. When they are available, the IEEE Standards Education eZine will make a link available to our readers.

Return to Table of Contents

Abstract: Bridging the Divide with a Three-Way Handshake

By Joyce van de Vegte, Camosun College, Victoria, British Columbia, Canada

Winner of Third Prize, IEC-IEEE Challenge 2012

Standardization of the Internet's network protocols through worldwide adoption greatly narrowed the gap in Internet use in the years following 1994. This was a tremendous accomplishment and dramatically broadened the access to the potential benefits the Internet could bring in economic, education, health and information domains. It is the presence of such benefits that makes a gap in Internet use that might be of academic interest only into a digital divide whose closing brings hope for development equity across other, more important, divides.

The digital divide is important precisely because one group of countries benefits preferentially in comparison to another, an echo of Kofi Annan's message in 2005, that "for far too many people, the gains remain out of reach." The inaccessibility of these gains is the most important pragmatic manifestation of the digital divide. The gains are out of reach not only because network infrastructure is lacking or because cost of access is prohibitive, although both of these are important factors. They are out of reach as well for reasons of language and content. Many users are unable to find relevant content – because it does not exist, because it does not exist in their language, or because they cannot read.

The Internet has the power to transmit benefits of many kinds to its users, benefits that are still unavailable to many. Internet protocols, beginning with TCP/IP and continuing with standards for wireless, fiber optic and satellite networks, as well as for language encoding and presentation, are speeding the demise of this "digital divide." Translation will be the next frontier. Robust standards for translations between pairs of languages will produce a seamlessly international Internet that can help preserve the world's rich cultural heterogeneity while also offering a powerful vehicle for communication, development and peace. To what degree will economic,

education and health divides be diminished when the digital divide is finally closed? Only time will tell. Or, even better, as Babel Fish reports after a translation of this phrase from English to Chinese and back to English, “In the course of time will only see the will of the people.”

****Please note that the winning papers will be published in their entirety in booklet form and on the web in the near future. When they are available, the IEEE Standards Education eZine will make a link available to our readers.

Return to Table of Contents

IEEE's Cloud Computing Initiative Has Taken Off...

By Mary Lynne Nielsen, Director of Corporate Programs, IEEE Standards Association

First Quarter 2013

Working in the cloud is something that more and more people are aware of. As tablets become more popular, as more people begin to use cloud-based mail systems, consumers are reminded that the cloud is moving into our daily lives in an astounding way. The IEEE has responded to this paradigm shift through its Cloud Computing Initiative (CCI). Launched in April 2011 and supported by the IEEE New Initiative Committee, this initiative is the first broad-based collaborative project for the cloud to be introduced by a global professional association.

Covering all aspects of IEEE interests, the CCI is working to coordinate and promote IEEE's activities related to the cloud. And there is a lot of activity to report! The IEEE runs approximately a dozen conferences and seminars related to the cloud each year, ranging from one-day workshops to weeklong conferences, all around the world. This year included events in Bangalore, India; Shenzhen, China; Porto Alegre, Brazil; Paris, France; Anaheim, California, USA; and Taipei, Taiwan, bringing together thought leaders, users, vendors, and interest groups. Plans are under way for an IEEE Cloud World Forum for high-level innovators in late 2013 or early 2014.

IEEE has produced thousands of articles addressing aspects of cloud computing in its many publications. But now IEEE plans to offer practical and theoretical articles about cloud computing through new publications. Work is underway to establish a cloud-specific, online only cloud journal in 2013 and a magazine in early 2014.

IEEE Standards is contributing to this through the development of two new standards projects. IEEE P2301 is developing cloud portability and interoperability profiles to aid cloud vendors, service providers, and users about their options in areas such as application interfaces, portability interfaces, management interfaces,

interoperability interfaces, file formats, and operation conventions. The guide will group these choices into multiple logical profiles, which are organized to address different cloud personalities. This will assist cloud computing vendors and users in developing, building, and using standards-based cloud computing products and services.

Further along in development is IEEE P2302. Since cloud computing is a new design pattern for large, distributed data centers, it offers end consumers a "pay as you go" model. This is a powerful shift for computing towards a utility model like the electricity system, the telephone system, or more recently the Internet. However, unlike those utilities, clouds cannot yet federate and interoperate. And that's what the Intercloud will create. This standard will develop the protocols needed for the Intercloud, including topology, functions, and governance for cloud-to-cloud interoperability and federation. The concept of a cloud operated by one service provider or enterprise interoperating with a cloud operated by another provider is a powerful means of increasing the value of cloud computing to industry and users.

This active working group is currently developing its draft specification. If you're interested in this work, go to http://grouper.ieee.org/groups/2302/ to sign up.

Another major activity for IEEE is the development of an Intercloud Testbed. This testbed, an IEEE-SA Industry Connections program, will be a global lab to prove and improve the Intercloud. Participating bodies will code, test, re-engineer, and contribute to an open-source implementation of the Intercloud protocol suite to experiment with cloud federation, further develop protocols and ontologies, and explore topology issues for scalability. Then they'll connect to the IEEE's Reference Intercloud Root and Exchange to feed results to IEEE P2302.

Once this testbed is fully functional, further opportunities will be explored. Of particular interest to educational bodies could be the use of this testbed for certification testing for cloud engineers. This would be just one of many educational programs that are currently under way at IEEE. These include continuing education, eLearning modules, and videos of conference presentations and IEEE Section and Chapter talks. The goal of these cloud educational programs is to provide a rich and varied curriculum of courses on cloud computing through IEEE.

A new area of development for 2014 is to look at the relationship between cloud and big data. One of the major benefits of cloud computing is that it offers the chance to access large bodies of data and use them in new and varied ways. The IEEE will be looking at how it can assist in this burgeoning area of interest for the cloud, perhaps tied to its publications or standards.

A coordinated web portal is up and running. This resource includes news about the CCI's activities, articles from the IEEE Xplore digital library, conferences sponsored by IEEE and other organizations, standards, educational materials, interviews from

experts, and other relevant information. Check it out at http://cloudcomputing.ieee.org/.

Mary Lynne Nielsen has worked in the standards field for over 20 years, supporting the creation of industry consensus at the IEEE Standards Association (IEEE-SA). Currently, she is the Director of Corporate Programs for the IEEE-SA, overseeing its corporate standards development and outreach programs as well as its emerging technologies program. Mary Lynne is responsible for the development of emerging technology standards strategies for the IEEE-SA. A graduate of Indiana University, Mary Lynne has also completed executive education at Cornell University. She is the recipient of an IEEE Computer Society Certificate of Appreciation as well as an Appreciation Award from the IEEE-SA Standards Board.

Return to Table of Contents

Access to IEEE Standards for Educators & Students

By Jennifer McClain, Program Manager, IEEE Standards Education

First Quarter 2013

IEEE encourages the introduction and use of standards in engineering curricula. A common request from educators is that standards be made more easily available to students and faculty at little to no cost.

Accessing standards through your university's library system

One easy way to access standards for hundreds of colleges and universities is through their own institutions' existing subscription to the IEEE Xplore Digital Library. These subscriptions include access to IEEE Standards, journals, transactions, letters, magazines and conference proceedings, IEEE educational courses and more. If your institution appears on our list, contact your school's librarian to obtain your subscription access and for more information. You can then log in to IEEE Xplore® to search for standards in your interest area.

Standards available for no-cost

Another way to access standards is through the IEEE Standards Association's "IEEE Get Program." This program grants public access to view and download current individual standards at no charge. There are many standards in this program, including the IEEE 802® Standards, which are available 6 months after publication.

Additional standards available include:

- IEEE C95™ standards: Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields
- IEEE 2600™ standards: Hardcopy Device and System Security
- IEEE 1622™ standards: Electronic Distribution of Blank Ballots for Voting Systems
- IEEE 1666™ standards: Open System C Language Reference Manual
- AND MORE!

Making use of your institution's subscription to the IEEE's digital library or accessing no-cost standards are great ways to expose students to standards in the classroom, and perhaps even use them for student design projects.

Jennifer McClain has been with the IEEE for fifteen years. She spent eight years with the IEEE Standards Association aiding working groups with the standards development process, editing standards, and as the Managing Editor of the Standards Information Network, publishing handbooks and guides to help with the implementation and understanding of standards. She is currently the Program Manager for IEEE Standards Education. Ms. McClain holds a B.A. in History and English from Western Michigan University, Kalamazoo, MI.

Return to Table of Contents

In each issue we will publish selected examples of final application papers from students who received IEEE Standards Education Grants to help with projects that include technical standards.

Introduction to Student Application Paper, "A Study to the Downlink Transmission of the 3GPP LTE-A System with respect to Different Antenna Array Polarization: Evaluation and Enhancement"

By Ashraf Tahat, Department of Communications Engineering, Princess Sumaya University for Technology, Amman, Jordan

---

Teaching undergraduate students about advanced and state-of-the-art concepts in signal processing and communications requires continuous update and additions to existing curricula. But as Knut Blind points out in his article "Best Practice on Education about Standardization: The Success Story at the Technical University of Berlins', in general, it is difficult to integrate new content in existing curricula of university degree. In order to be successful, these new contents should be driven both by the supply of new content generated by research and the demand side. Where he meant by 'demand side' the requirements by the employers. Here, I would like to approach this issue of integrating new content into existing curricula of university degree (and ensuring its well-acceptance) from a different perspective, the student perspective. My personal experience of developing and teaching a new course about the 3GPP LTE wireless standard (which is relatively advanced for undergraduate-level students) was very successful. It demonstrates how the desire to learn about a new and popular wireless communications standards was utilized to generate interest into advanced theoretical topics that would normally repel (or intimidate) the average undergraduate-level student. Although, in the beginning, the driving-force to the student was the desire to learn and understand the telecom-standard, because it is an added skill to facilitate landing a related telecomm job, but the end-results were learning the underlying engineering and science theories and the generated appreciation for their concepts and application. In this course in particular, my teaching approach was reversed when compared to the common (or traditional) approach (I) used in core engineering courses. Where in those courses, it was better to focus on teaching the theoretical rules that underlie standards and use specific standardization examples for demonstration that the rules function as proposed and put into everyday valuable applications [1].

The evolution of the 3GPP family of technologies has evolved incrementally through its different releases to the Long-Term Evolution (LTE) technology in its Release 8. In its Release 10, LTE Advanced (LTE-A) have satisfied the IMT-Advanced

requirements to be considered a 4G standard (and the more popular). In order for it to satisfy the high data rate requirement (1 Gbps and above) and others, such as spectral efficiency and latency, multi-antenna systems had to be an integral part of LTE-A operational modes in addition to carrier aggregation. The work reported in Sarah Al-Khokhon's application paper 'A study to the Downlink Transmission of the 3GPP LTE-A System with respect to Different Antenna Array Polarization: Evaluation and Enhancement' is a good example of the generated interest in the underlying theory and its practical application as a result of standards education and the desire to learn about the LTE standard as was described. LTE-A supports MIMO that uses multiple antennas arrays at the transmitter and receiver (in some modes of operation) along with advanced digital signal processing to improve link quality and capacity. This paper used a realistic LTE-A link-level simulator and WINNER channel models to analyze the performance of two LTE-A base station antenna configurations. As a final conclusion in our simulation and selected parameters, to provide higher downlink data rate, in case of small impact devices and deployment scenarios, where large implementation space is not permitted, cross polarized antenna arrays are to be used. Whereas for deployment scenarios where large implementation space is available, both antenna array configurations can be used, since both provide comparable downlink throughput.

[1] Krechmer, K., "Teaching Standards to Engineers," International Journal of IT Standards and Standardization Research, Vol. 5 No. 2, July - December 2007.

Dr. Ashraf Tahat received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from the Illinois Institute of Technology (IIT), Chicago, Illinois, USA, in 1992, 1993, and 2002, respectively. He is an Associate Professor with the Department of Communications Engineering at PSUT in Amman, Jordan since 2004 where he was the Department Chairman. He is currently a Visiting Professor in the Department of Electrical and Computer Engineering (ECE) at McGill University in Montreal, Quebec, Canada, working on digital signal processing for modern communications systems such as LTE-A. In 2002, he worked at the ECE Department, IIT, as a Post-Doctoral Fellow. From 1998 to 2000, he was with 3Com Corporation (and US Robotics) working on voice-band PC modems. In 1997, he joined Lucent Technologies, Inc. (currently Alcatel-Lucent) as a consultant Research Engineer to assist in the development of DSP-based ADSL modems. Dr. Tahat is a senior member of IEEE. (e-mail:aat@ieee.org).

Return to Table of Contents

In each issue we will publish selected examples of final application papers from students who received IEEE Standards Education Grants to help with projects that include technical standards.

The following paper is an example of a successful project with good applications and a well-written final report.

Enhancing 3GPP LTE Downlink Transmission: A Study to the downlink transmission of an LTE system with respect to different antenna array polarization

By Sara O. Al-Kokhon

Faculty Advisor: Dr. Ashraf A. Tahat

Communications Engineering Department, Princess Sumaya University for Technology, Amman, Jordan

---

Abstract - Long Term Evolution (LTE) is developed by the 3GPP as a long term perspective for the UMTS/3G standard by providing higher peak data rates, reduced round trip latency and improved system capacity. Since success of UMTS is based on the uptake of mobile data services and the demand for such services is increasing exponentially, enhancements such as improved data rates and latency are to be considered. This paper aims to investigate performance of the 3GPP LTE downlink transmission with respect to different antenna array polarization for the purpose of enhancing achievable downlink throughput. In this paper, performance of Open Loop Spatial Multiplexing (OLSM) and Closed Loop Spatial Multiplexing (CLSM); two different LTE downlink Multiple Input Multiple Output (MIMO) transmission modes, are tested using Uniform Linear Antenna Arrays (ULA) and Cross Polarized Antenna Arrays (XPA) with respect to two different transmit antenna element spacing. This investigation is supported by performance analysis based on simulation results. With reference to the simulation results, it is shown that the use of cross polarized antenna arrays provides better performance in terms of achieving higher downlink throughput for small transmit antenna element spacing.

Keywords - Long term evolution (LTE); multiple input multiple output (MIMO);open loop spatial multiplexing (OLSM); closed loop spatial multiplexing (CLSM); uniform linear antenna array (ULA); cross polarized antenna Array (XPA)

I. INTRODUCTION

Long-Term Evolution (LTE) was introduced by the Third Generation Partnership Project (3GPP) to ensure competitiveness of the 3GPP UMTS for a longer time frame. Hence, some requirements were set by the 3GPP for this new technology. These requirements included a peak data rate of 100 Mbps (5 bps/Hz) to be achieved in the downlink; assuming two receive antennas, and 50 Mbps (2.5 bps/Hz) to be achieved in the uplink; assuming one transmit antenna at the mobile terminal, for 20 MHz spectrum allocation [1]. By the use of multiple-input multiple-output (MIMO) technology, LTE did not only meet these requirements but also surpassed them. Therefore, MIMO can be viewed as an important factor in data rate enhancements.

MIMO as a technology supports a number of transmission modes. In LTE, seven different downlink transmission modes are supported [2]. Each transmission mode is used to provide different means of system improvement, e.g., transmission mode three, i.e., open-loop spatial multiplexing (OLSM), and transmission mode four, i.e., closed-loop spatial-multiplexing (CLSM), are used to achieve higher peak downlink data rate in contrast to other transmission modes that are used to improve system capacity and coverage. In addition to the individual system enhancement provided by these modes, each mode requires certain antenna configuration for specific environment settings and certain channel conditions. Therefore, to achieve optimum performance and further downlink data rate enhancement, this paper investigates the performance of the OLSM and CLSM with respect to different antenna array polarization and antenna element spacing.

In this paper, performance in terms of downlink throughput of a 4×4 OLSM and CLSM is tested using uniform linear antenna array (ULA), i.e., four vertical polarized spatially spaced antenna elements, and cross-polarized antenna array (XPA), i.e., two spatially spaced pairs of dual-polarized antennas, at both, the transmitter and receiver sides. This is performed to exploit the advantages of spatial and polarization diversity on the performance of spatial multiplexing. This study is based on simulation results that are carried out using the “LTE-A Link Level MATLAB Simulator” [5].

This paper proceeds as follow; Section 2 provides a brief review of the two LTE MIMO modes, i.e., OLSM and CLSM. Section 3 provides an overview of the LTE downlink signal generation chain, with a focus drawn on the main MIMO processing components, i.e., Layer mapping and precoding, at which CLSM or OLSM is achieved. In Section 4, simulations of the two MIMO modes at certain antenna configurations are presented and comparison of the different configurations is stated. Finally, in Section 5, conclusions drawn from this paper are previewed.

II. LTE MIMO - OLSM AND CLSM

In LTE, OLSM and CLSM are used to achieve higher downlink data rates by dividing the data into different streams (layers) that are transmitted over the same radio resources, i.e., using the same resource blocks but different transmit antenna elements. For these MIMO modes, the use of multiple antennas at the transmitter side and at the receiver side is mandatory, which leads to a 2×2 base line antenna configuration, i.e., two antennas at the eNodeB and two antennas at the terminal are to be supported in the first LTE release system with a maximum of up to four transmit (Tx) and receive (Rx) antennas.

These modes are used in a known, good quality channel condition, i.e., when the channel quality is known at the eNodeB and a high SINR is achieved [9]. They also require low correlated antenna elements to exploit multipath or diversity gains [8]. This low correlation can either be achieved by employing spatial or polarization diversity. Although both MIMO modes are used for the same purpose and require same antenna configuration, each can be used only under specific conditions and provides different level of throughput enhancement.

For both MIMO modes, the eNodeB requires some feedback information from the user equipment (UE) regarding the channel quality. In brief, the UE measures the downlink reference signals transmitted by the eNodeB on different antenna ports and transmits a Channel Quality Indicator (CQI), which represents the channel quality for the current transmission mode, and a Rank Indicator (RI), which represents the transmission rank, i.e., the number of useful layers that can be supported under the current channel conditions and modulation scheme. In addition to this feedback information, in the case of CLSM, the UE reports the precoding matrix that provides optimum performance in terms of achieving the maximum SINR under the current channel conditions by transmitting a Precoding Matrix Indicator (PMI). With reference to the UE's Channel State Information (CSI): CQI, RI and PMI, the eNodeB allocates the radio resources and assigns a transmission scheme to each UE every single Transmission Time Interval (TTI). In the case of missing channel information or rapid changing channel due to a fast moving UE, OLSM is to be used [9]. On the other hand, in the case of low mobility scenarios where the UE reports detailed channel feedback information that closely matches the existing channel conditions, CLSM achieves better performance and hence is the choice to be made by the eNodeB [9].

When comparing between the performance of CLSM and OLSM, CLSM is said to provide better performance in terms of achieving the maximal system throughput, since it closely relates things to the real channel situation enabling the eNodeB to make the right decisions. But it can only be used when the channel conditions and the UE capabilities allow for it.

III. LTE- DOWNLINK MIMO SIGNAL GENERATION CHAIN (PRECODING AND LAYER MAPPING)

Fig. 1 shows the LTE physical downlink signal generation chain for multiple transmit/receive antenna element system. Note that, this is a general structure of the LTE baseband signal processing that is not applicable to all of the downlink physical channels. In this paper, we refer to the Physical Downlink Shared Channel (PDSCH) [3]. As shown in Fig. 1, each codeword, which corresponds to a coded transport block, is first scrambled using a cell-specific sequence based on the UE's C-RNTI (Cell Radio Network Temporary Identifier) and the cell's Physical Cell Identity (PCI) for the purpose of intercell interference rejection [3]. These scrambled bits are then grouped and converted into complex-valued modulation symbols using QPSK, 16 QAM or 64 QAM. After that, the resulting modulation symbols are input into a layer mapper followed by a precoder. We will look closely at these two components since they are defined independently for the different MIMO modes.

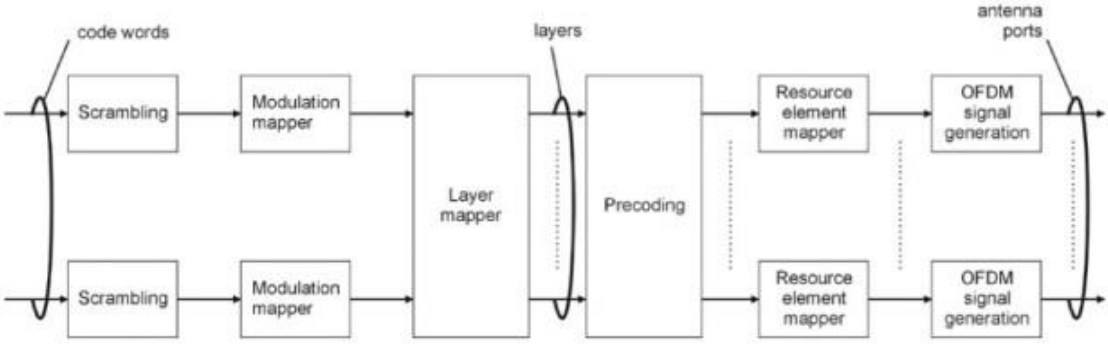


Figure 1: LTE-Physical Downlink Signal Generation Chain [3]

A. Layer Mapping

In this stage, the complex-valued modulation symbols are mapped into one or several transmission layers, i.e., the data is split into a number of layers. In LTE, layer mapping is defined for three different transmission schemes; transmission on a single antenna port, transmit diversity, and spatial multiplexing [3]. For spatial multiplexing (SM), the complex-valued modulation symbols are mapped in a round robin fashion into one, two, three or four layers. Table 1 shows the available layer mapping configurations for spatial multiplexing where; d(q)(i) represents the modulation symbol (i) per codeword (q), x(v)(i) represents the modulation symbol (i) per layer (v), and M layer/symb represents the number of modulation symbols per layer, which is equal for all layers in all configurations [3].

In the case of SM, the transmission rank is less than or equal to the number of antenna ports (P) and the maximum number of layers that can be supported, known as the channel rank, is equal to the minimum number of transmit and receive antennas. Note that the transmission rank reported by the UE can be less than the

channel rank, e.g. in case of four transmit antennas and two receive antennas the channel rank is equal to two and the transmission rank can be one or two. In addition to this, a maximum of two codewords can be assigned for UE transmission per TTI [8]. In the case of one codeword assignment, the transmission mode serves to enhance the transmission robustness instead of enhancing the downlink data rates.

Therefore, in LTE transmission mode three and four; OLSM and CLSM, two codewords are mapped to two layers that are precoded and transmitted over two antenna elements in case of 2×2 MIMO. And in case of 4×4 MIMO, the two codewords are mapped to two, three or four layers that are precoded and transmitted over four antenna elements. The number of layers used for transmission is defined by the transmission rank that depends on the channel quality.

Table 1: Spatial Multiplexing Layer Mapping [3]

Number of Layers (v)	Number of codewords (q)	Codeword-to-layer mapping $i=0,1,\ldots,M_{symb}^{layer}-1$
1	1	$x^{(0)}(i)=d^{(0)}(i)$
2	2	$x^{(0)}(i)=d^{(0)}(i)$ $x^{(1)}(i)=d^{(1)}(i)$
2	1	$x^{(0)}(i)=d^{(0)}(2i)$ $x^{(1)}(i)=d^{(0)}(2i+1)$
3	2	$x^{(0)}(i)=d^{(0)}(i)$ $x^{(1)}(i)=d^{(1)}(2i)$ $x^{(2)}(i)=d^{(1)}(2i+1)$
4	2	$x^{(0)}(i)=d^{(0)}(2i)$ $x^{(1)}(i)=d^{(0)}(2i+1)$ $x^{(2)}(i)=d^{(1)}(2i)$ $x^{(3)}(i)=d^{(1)}(2i+1)$

B. Precoding

In the precoding stage, the layers are multiplexed before they are mapped to the radio resources for transmission on different antenna ports, P, to normalize the signal transmission across the different antenna elements to get the optimal signal reception with respect to the radio channel condition. As for layer mapping, precoding is defined for three different transmission schemes; Transmission on a single antenna port, transmit diversity and spatial multiplexing [3]. For spatial multiplexing, two precoding schemes are defined; precoding with large delay cyclic

delay diversity (CDD), defined for OLSM and precoding without CDD, defined for CLSM [3]. Both precoding schemes are defined for a 2×2 and 4×4 antenna configuration.

For CLSM (precoding without CDD), the different number of layers, v, are multiplexed to a number of output signals that are equal to the number of antenna ports used for transmission, P, according to Equation (1) [3];

$$\begin{bmatrix} y^{(0)}(i) \\ \vdots \\ y^{(P-1)}(i) \end{bmatrix} = W(i) \begin{bmatrix} x^{(0)}(i) \\ \vdots \\ x^{(\upsilon-1)}(i) \end{bmatrix}$$

(1)

where x(v)(i) represents the modulation symbol per layer v, y(p)(i) represents the modulation symbol per port P and W(i) represents the precoding matrix (P×v) selected from a predefined codebook configured at both the eNodeB and the UE. The codebook is defined for transmission on two antenna ports and four antenna ports [3]. For two antenna ports, the codebook contains four precoding matrices defined for one and two layer transmission, whereas for four antenna ports, the codebook contains sixteen precoding matrices defined for one, two, three and four layer transmission [3]. For CLSM, the precoding matrix is selected with respect to the UE's feedback and from a defined set [2], i.e., not all precoding matrices are a valid choice for CLSM, for the purpose of minimizing signaling overhead and feedback delay.

For OLSM (precoding with large CDD), a CDD is applied in addition to the precoding matrix to improve robustness of system's performance by introducing artificial multipath that increases the diversity in the channel. Equation (2) represents the precoding for OLSM, where x(v)(i) represents the modulation symbol per layer v, y(p)(i) represents modulation symbol per port P, W(i) represents the precoding matrix (P×v) selected from the predefined codebook configured at both the eNodeB and the UE, and the combination of D(i) (v×v matrix) and U (diagonal v×v matrix) represents the cyclic delay diversity that is defined for two, three and four layer transmission [3]. Note that, matrix U and matrix D(i) are applied first, then precoding W(i). In OLSM, the precoding matrix is not based on UE feedback, instead is predetermined and is set by the eNodeB [2].

$$\begin{bmatrix} y^{(0)}(i) \\ \vdots \\ y^{(P-1)}(i) \end{bmatrix} = W(i)D(i)U \begin{bmatrix} x^{(0)}(i) \\ \vdots \\ x^{(\upsilon-1)}(i) \end{bmatrix}$$

(2)

C. Antenna mapping

After the layers have been precoded, the output signals are mapped to resource blocks assigned for their transmission on different antenna ports. Note that in LTE, we refer to antenna ports and not physical antennas. An antenna port is defined by the presence of antenna port specific reference signals that are distributed within a resource block. There are six antenna ports defined in LTE release 8 [3]. These antenna ports are mapped to one, two or four physical antennas. For both OLSM and CLSM, antenna ports{0,1} are mapped to two transmit antenna elements in case of 2×2 MIMO, and antenna ports{0,1,2,3} are mapped to four transmit antenna elements in case of 4×4 MIMO [3].

IV. SIMULATION- OLSM and CLSM Physical Antenna Configuration

This section studies performance of 4×4 OLSM, LTE transmission mode three, and CLSM, LTE transmission mode four, with respect to different antenna array polarization at two different transmit antenna element spacing. In this paper, two testing scenarios are considered. In the first scenario, uniform linear antenna array 'ULA', consisting of four vertically polarized, horizontally spaced, isotropic antenna elements is employed at both; the eNodeB and the UE sides. In the other scenario, uniform cross polarized antenna array 'XPA', consisting of two, horizontally spaced, pairs of dual-polarized (cross-polarized) antennas is employed at both the eNodeB and the UE sides. In the XPA, each pair consists of ±45° slanted isotropic antenna elements. These scenarios are simulated with respect to two different transmit inter-antenna distances; 0.5λ and 4λ, with the UE inter-antenna distance set to 0.5λ. Note that in the case of XPA, inter-antenna distance refers to the distance between the two antenna pairs and not the antenna elements. Fig. 2 shows the antenna configuration for the 'XPA' and 'ULA'.

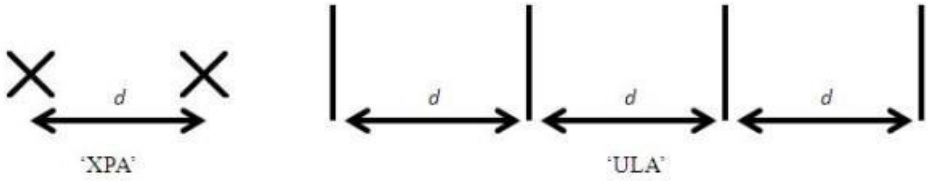


Figure 2: 'XPA' and 'ULA'

The simulation of the two testing scenarios is carried out using the "LTE-A Link Level (v1.1)" MATLAB simulator [5], with the use of the WINNER Phase II channel Model [6]. The WINNER Phase II channel Model is used to generate the radio channel realization for the link level simulator, and for the antenna array creation. Table 2 shows the common set of configured parameters for both scenarios.

Table 2: Simulation Parameters

Parameter	Value
Propagation Condition	Typical Urban macro-cell, NLOS
Center Frequency	2.6 GHz
Channel Bandwidth	1.4 MHz
Number of UEs	1
User Speed	0 m/s
Receiver Type	Zero Forcing

In this simulation, a typical urban macro-cell with a non-line of sight condition is considered, where the eNodeB is mounted on rooftop and the UE is located at street level [7]. Due to this configuration the angular spread at the eNodeB is considered to be quite low and at the UE quite high. Therefore, an inter-antenna distance of 0.5λ is considered to be large at the UE and small at the eNodeB. In contrast, an inter-antenna distance of 4λ is considered to be large at the eNodeB.

Fig. 3 and Fig. 4 show simulation results for testing scenario 1 and scenario 2, using small transmit inter-antenna distance (0.5λ). Where Fig. 5 and Fig. 6 show the simulation results for both scenarios but using large transmit inter-antenna distance (4λ). It can be observed that, by the use of OLSM or CLSM, LTE surpasses the required downlink throughput (7Mbps for 1.4MHz).

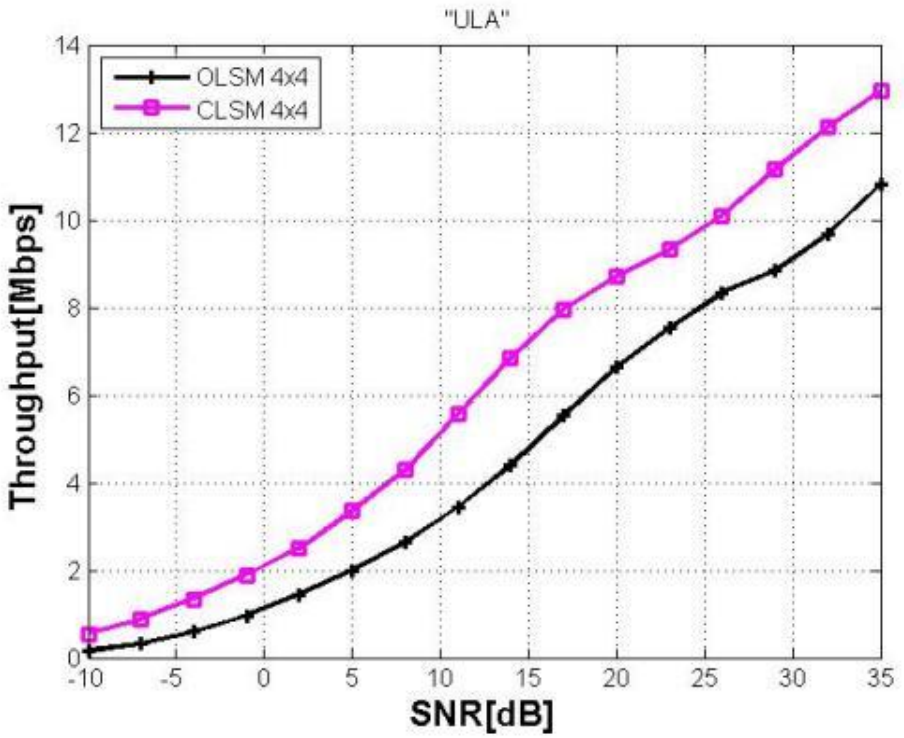


Figure 3: 'ULA' with 0.5λ transmit inter-antenna distance

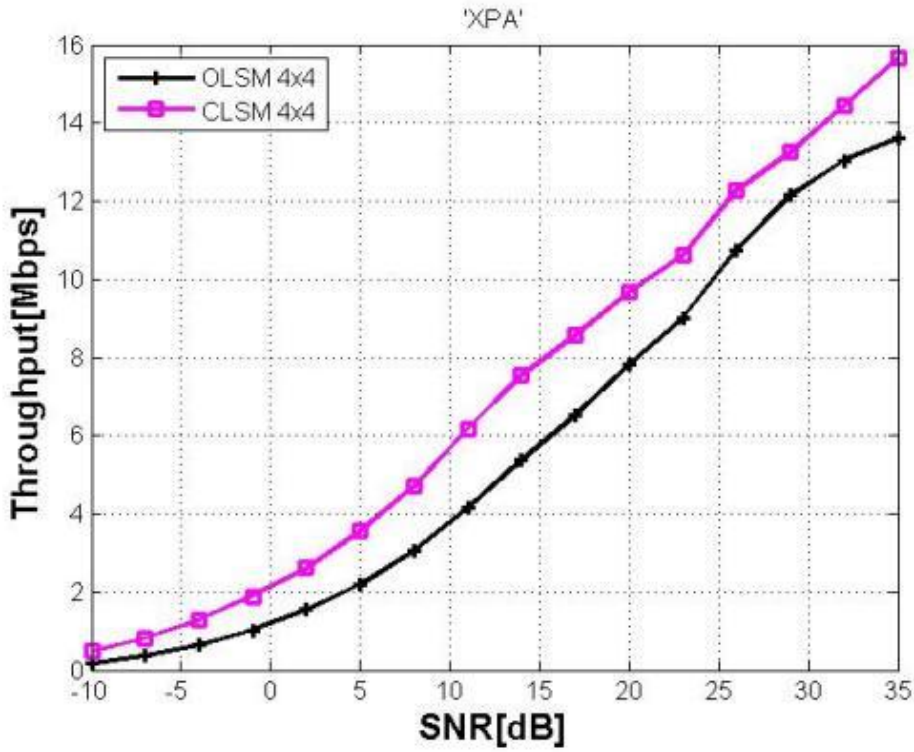


Figure 4: 'XPA' with 0.5λ transmit inter-antenna distance

It can be noted that CLSM provides better performance when compared to OLSM in all scenarios. It can also be noted that the performance of CLSM is more sensitive to antenna array polarization and inter-antenna distance when compared to OLSM. In addition, it can be observed that for both antenna configurations, performance of both transmission modes improves as the inter-antenna distance at the transmitter side increase.

For transmit inter-antenna distance of 0.5λ, it is observed that by using 'XPA' at both the transmitter and the receiver sides, OLSM and CLSM achieve higher downlink data rates. This leads to the conclusion that for small inter-antenna distance, exploiting polarization diversity provides better performance than exploiting the spatial diversity.

For transmit-antenna distance of 4λ, it is observed that OLSM provides the same downlink data rate for both antenna arrays, while CLSM performs slightly better for 'ULA'. This leads to the conclusion that, in the case where large inter-antenna distance is possible and according to our testing scenarios, exploiting spatial or polarization diversity doesn't result in a comparable performance with a priority given to exploit spatial diversity by employing 'ULA' for the slight better performance it provides.

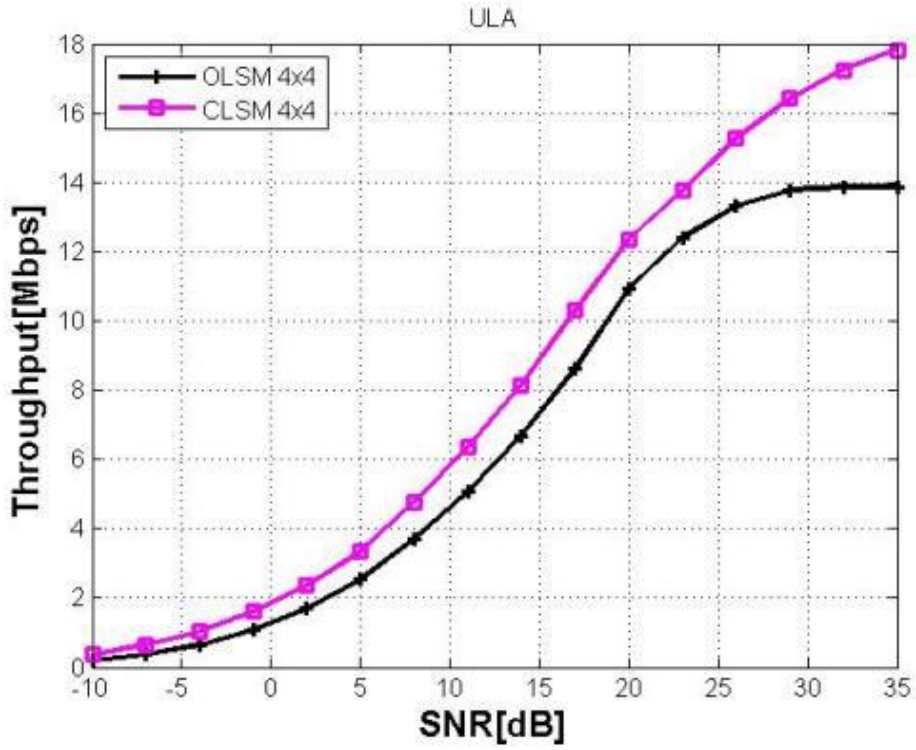


Figure 5: 'ULA' with 4λ transmit inter-antenna distance

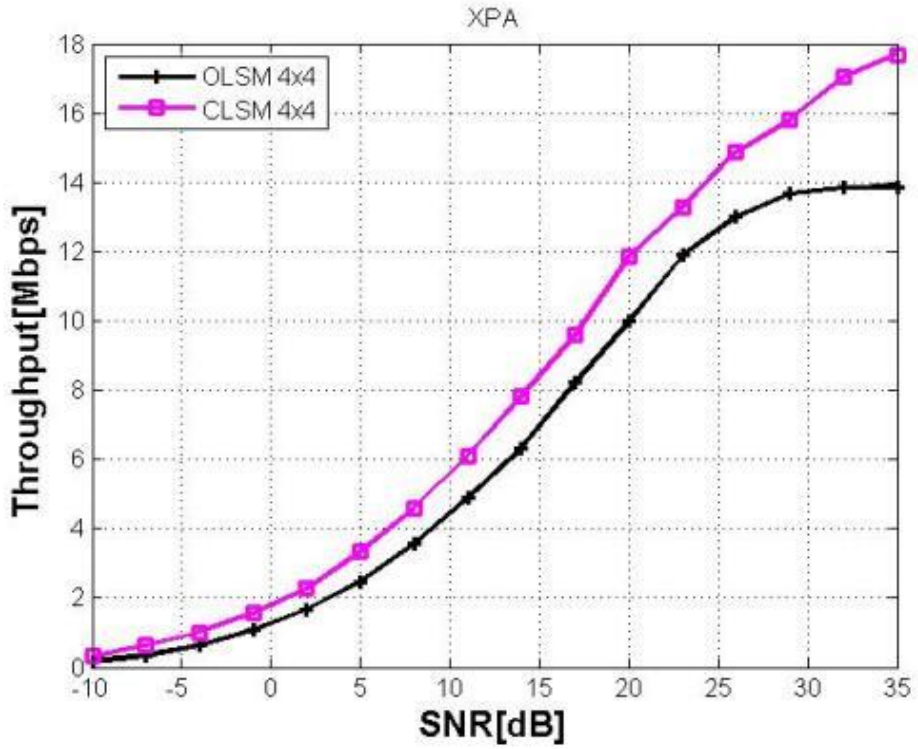


Figure 6: 'XPA' with 4λ transmit inter-antenna distance

V. Conclusion

In this paper, it is shown that with use of CLSM and OLSM, LTE is able to surpass the downlink requirements set by the 3GPP. It is also shown, through signal processing and simulation, that CLSM outperforms OLSM in terms of providing higher downlink throughput for all antenna configurations. It is also shown, through simulation, that performance of the OLSM, and CLSM, in terms of throughput, is dependent on antenna polarization and inter-antenna distance at the transmitter side. From simulation results, it is concluded that, for both OLSM and CLSM, exploiting polarization diversity at small transmit inter-antenna distance provides better throughput when compared to exploiting spatial diversity.

Therefore, as a final conclusion, to provide higher downlink data rate, in case of small impact devices and deployment scenarios where large implementation space is not permitted, cross polarized antenna arrays are to be used, whereas for deployment scenarios where large implementation space is available, both antenna array configurations can be used, since both provide almost the same downlink throughput.

References

[1] 3GPP TR 25.913 V8.0.0 (2008-12): “Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN) (Release 8).”

[2] 3GPP TS 36.213 V8.8.0 (2009-09): Physical layer procedures (Release 8).”

[3] 3GPP TS 36.211 V8.9.0 (2009-12): “Physical Channels and Modulation (Release 8).”

[4] 3GPP TR 21.905 V11.0.1 (2011-12): “Vocabulary for 3GPP Specifications (Release 11).”

[5] Vienna LTE Simulators: “LTE-A Link Level Simulator, v1.1” http://www.nt.tuwien.ac.at/ltesimulator.

[6] WINNER Phase II Channel Models ver1.1: http://www.ist-winner.org/phase_2_model.html.

[7] WINNER Phase II Channel Models “D1.1.2” V1.2: http://www.cept.org/files/1050/documents/winner2 - final report.pdf.

[8] Telesystem Innovation (TSI), white paper : “The Seven Modes of MIMO in LTE.”

[9] 3G americas, “MIMO and Smart Antennas for 3G and 4G Wireless Systems” Available: http://www.3gamericas.org/documents/mimo_and_smart_antennas_for_3g_and_4g_wireless_systems_May 2010 Final.pdf.

Return to Table of Contents

IEEE Standards Education Grants and Student Application Papers

by David Law

Knowledge of industry standards helps facilitate the transition from classroom to workplace by aligning educational concepts with real-world applications and market constraints. IEEE encourages the introduction and use of technical standards in the classroom.

In support of the IEEE Standards Education Committee's (SEC) mission, in particular to actively promote the integration of standards into academic programs, the IEEE SEC is offering grants to both students (500 USD) and faculty mentors (300 USD) to promote the use of industry standards in projects.

These grants are offered to students in all stages of their study (e.g., undergraduate, post graduate, doctoral) and for all types of projects (e.g., design, development, research). The grant requires submission of a paper on completion of the project describing the design choices driven by, and the application of, industry standards in meeting the project goal. This provides the applicant(s) the additional opportunity of having a paper published by the IEEE.

The application process is reasonably lightweight and so far the success rate of application has been high, with the main reason for rejection being meeting the requirement to use industry standards in projects. The key to a successful application is to have a project that is based on the investigation or application of industry standards.

Simply using components that conform to a particular standard, for example using an IEEE 802.11™ WiFi Router to communicate a WiFi connected laptop as part of the project, is not sufficient. What we wish to see is a paper that highlights specific design choices in the project driven by an understanding, and application, of the industry standard(s) used.

To learn more and to apply for a grant visit http://standardseducation.org/applications/. Also, don't miss our FAQ section in this eZine, which is quite helpful.

The SEC reviews each final paper carefully and the accepted final papers are published to our Student Application Papers website. Please take some time to read through the successful papers for some inspiration.

David Law is a Distinguished Engineer at Hewlett-Packard Networking and has worked on the specification and development of Ethernet products since 1989. Throughout that time he has been a member of the IEEE 802.3 Ethernet Working Group where he has held a number of leadership positions. He served as the Vice-Chair of IEEE 802.3 from 1996 to 2008 and in 2008 was elected to Chair of IEEE 802.3. David has been a member of the IEEE-SA Standards Board since 2005, has served as the Chair of IEEE-SA Standards Board Review Committee (RevCom) since 2008, and is currently serving as the Vice-Chair of the IEEE Standards Education Committee. In 2000 he received the IEEE-SA Standards Medallion for 'leadership and technical contributions to Ethernet networking standards' and in 2009 he received the IEEE Standards Association Standards Board Distinguished Service award 'For long term service to improve the operation and integrity of IEEE-SA governance'. David has a BEng (hons) in Electrical and Electronic Engineering from Strathclyde University, Glasgow, Scotland.

Return to Table of Contents

Applying for IEEE Standards Education Grants

First Quarter 2013

The IEEE Standards Education Committee (SEC) offers grants of US $500 for students (per project) and US $300 for faculty mentors to help complete senior, undergraduate or graduate projects. Projects may be for design, capstone, development or research in which an industry technical standard(s) was applied to complete the project. Students report on the results of these projects by writing and submitting a Student Application Paper. The papers detail which industry technical standard(s) was applied (analyzed and implemented). Each paper highlights specific design choices in the application of various technical standards and describes the resulting product, process, or service. Final papers accepted by the SEC are published to our Student Application Papers website.

Applications for the grants may be submitted at any time throughout the year, however the next upcoming deadlines are 15 March, 15 June, 15 October.

Frequently asked questions about the IEEE grants

1. **What are the grants for?** The grants are to help support students at colleges and universities worldwide with their design projects. The funds are generally used to purchase much needed materials to help students' projects succeed. The one absolute requirement is the projects include the application of industry standards.

2. **Who can apply?** Any college-level student planning to incorporate industry standards or specifications into their projects, and are in need of additional financial support. Keep in mind that students must produce a final paper, a Student Application Paper, that will be submitted to the Standards Education Committee (SEC) for review. If the SEC accepts the paper, it is published to the IEEE's website.

3. **Do I need to be an IEEE member and do the standards we use have to be IEEE standards?** The answer to both of these questions is no. The standards education grants are for all students worldwide, and as long as your project is using the appropriate technical standards for your project, the SEC requirements have been met.

4. **How are the grant applications evaluated?** The SEC carefully evaluates each application package and according to the following criteria: (a) completeness of

submission package; (b) quality of student abstract; (c) quality of faculty endorsement; (d) whether the project meets the intent of the Standards Education Grant.

5. **How do I apply?** Visit our Student Application Papers website: http://standardseducation.org/applications/ for more information. The application and instructions are also linked below.

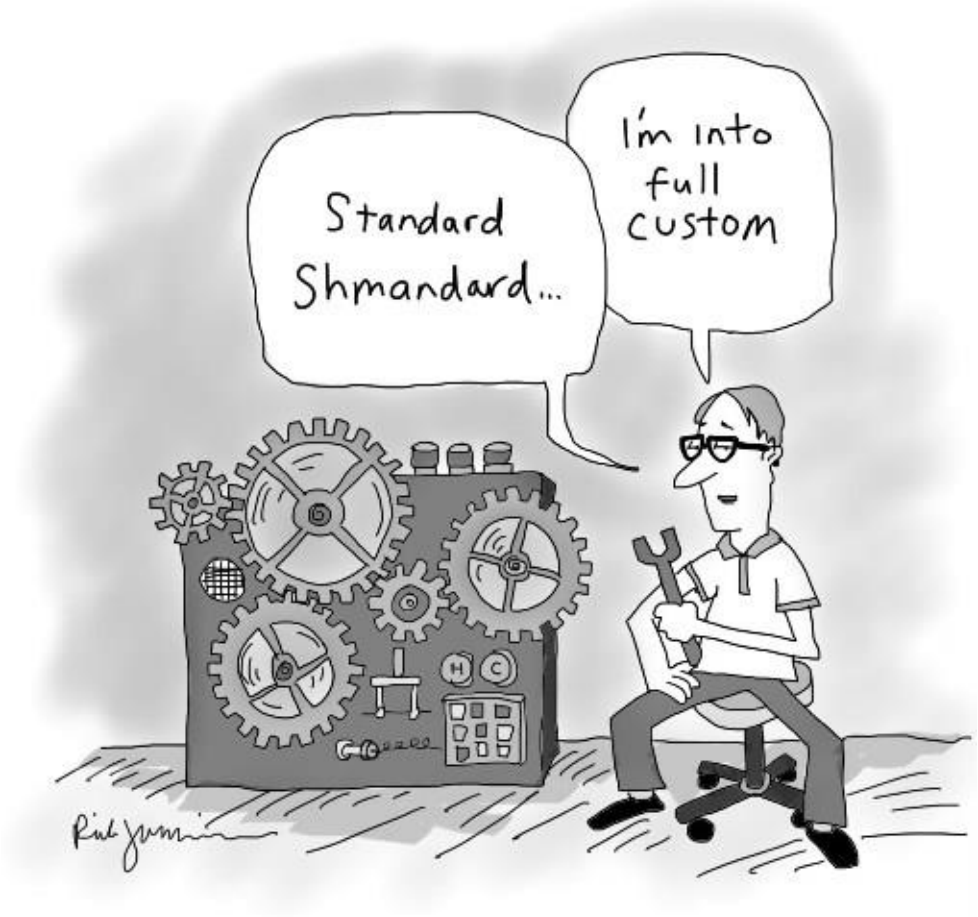
Application and Instructions (DOC, 82 KB)

The next upcoming deadline for applications is 15 March 2013.

Read successful final Student Application Papers.

Return to Table of Contents

IEEE Standards Education Funny Pages...



This cartoon appears in the book "Ten Commandments of Effective Standards" by Karen Bartleson. Reproduced with permission from Rick Jamison. © Rick Jamison.

Contributions

Have something amusing (cartoon, video) related to standards you'd like to share? Contact our IEEE eZine staff editor Jennifer McClain at j.mcclain@ieee.org.

Return to Table of Contents

Upcoming Standards Education Opportunities for Students & New Professionals

---

Students & Faculty Members are invited to the IEEE 802 Plenary Meeting on 19 March 2013 at the Caribe Royale Convention Center, Orlando Florida

---

Cost: $25.00 US

Knowledge of industry standards helps facilitate the transition from classroom to workplace by aligning educational concepts with real-world applications and market constraints.

Now is the chance to see for yourself how the accomplished IEEE 802 working groups develop standards. By attending this one-day event you will expand your knowledge of the standards development process while learning the significance of standards within engineering technology. You might even consider future participation in standards development.

The IEEE 802 LAN/MAN Standards Committee develops local and metropolitan area network standards. The most widely used standards are for Ethernet LANs, Wireless LANs, Wireless PANs, Wireless MANs, and Bridging and Virtual Bridged LANs.

Come and participate in this unique University Outreach Program.
Seats are limited. Register Today!
Visit http://802world.org/plenary/university-outreach/

Additional Information.

ANSI 2013 Student Paper Competition

As part of its continuing efforts to raise awareness of the strategic significance of standards and conformance among postsecondary students, the American National Standards Institute (ANSI), in conjunction with its Committee on Education (CoE), is pleased to announce its second annual student paper competition. Entries in the competition are due by 5 p.m. EST on Monday, **April 15, 2013**, and must be written and submitted by an enrolled college or university student(s) at the associate, undergraduate, or graduate level in a U.S. academic institute of higher learning. It is open to students of all disciplines.

The theme of the 2013 ANSI Student Paper Competition is Standards and Emerging Technology Decisions – What Role Do Standards Play in Disaster Recovery and Business Recovery? As we all know, in 2012 the Northeast experienced the devastation of Hurricane Sandy and Standards played a critical role across various industries, especially in regards to public safety and welfare. With a destructive Hurricane such as this, Standards were important across various areas including health, medical, water and food safety, environment and climate, power (Smart Grid) and utilities, evacuation and emergency response, transportation, communications (e.g., cell towers), financial (e.g., national mortgage standards), fuel delivery, business continuity, product safety, energy efficiency, waste treatment, building (for disasters such as hurricane) and others.

Submitted papers should examine the role standards play in disaster recovery and business continuity, providing specific examples of where, how and which standards were or could have been invoked in an emergency situation; papers may also identify areas where existing standards could be improved and new standards could be developed and introduced for emergency management.

Entries must not exceed 2,000 words and must be formatted in accordance with the submission criteria in the paper competition flyer linked below. Submissions will be screened by members of the ANSI CoE to ensure they meet specified criteria and finalists will be recommended to ANSI for consideration. ANSI reserves the right to award no prizes based on the determination of the judges.

The winning entry will be awarded $2,500, while the second place and third place entries will receive $1,000 and $500, respectively. The three winning papers will be announced in May 2013 and presented at a later ANSI event; however, ANSI reserves the right to award no prizes based on the determination of the judges.

For full submission criteria, view the ANSI 2013 Student Paper Competition flyer here. To enter the contest, email entries by Monday, April 15, 2013, to lrajchel@ansi.org.

Young U.S. Electrotechnology Professionals Sought for Prominent International Standardization Program

Program aims to strengthen the future of technology transfer and encourage the participation of young professionals in shaping the future of standardization and conformance

The U.S. National Committee (USNC) of the International Electrotechnical Commission (IEC) is seeking nominations for young professionals at the start of their electrotechnology careers to participate in the Young Professionals 2013

Workshop, to be held in conjunction with the 77th IEC General Meeting (GM) in New Delhi, India, on October 21-25, 2013.

The Young Professionals Workshop brings together international candidates selected from IEC National Committees around the globe who are at the start of their careers in electrotechnical standardization and conformity assessment. The program aims to cultivate long-term national involvement in the international arena, strengthen the future of technology transfer, and encourage the participation of young professionals in shaping the future of standardization and conformance. Alongside recipients from other nations, the three young professionals selected to represent the U.S. at the IEC 2013 General Meeting in New Delhi will attend a dedicated workshop where they will learn more about the IEC, standardization strategies, and conformity assessment. They will also have the opportunity to attend technical meetings where standards are developed, observe meetings of the IEC Standardization Management Board (SMB) and the IEC Conformity Assessment Board (CAB), and benefit from extensive networking opportunities in an international setting. Recipients will be financially supported for their travel and up to three nights of accommodation.

Nominations must be submitted electronically to Charlie Zegers, general secretary of the USNC (czegers@ansi.org) by Tuesday, April 30, 2013. Letters of support from members of the standardization community attesting to the nominee's outstanding achievements and appropriateness for receipt of the award are strongly encouraged.

For more information and to download the nomination form, visit the ANSI website.

If you would like to share information or announcements about any recent or upcoming events related to Standards Education, please contact our IEEE eZine staff editor Jennifer McClain at j.mcclain@ieee.org.

Return to Table of Contents

New Online Standards Education Courses

IEEE Educational Activities and and the IEEE Standards Education Committee have collaborated with IP Shield to extend this offering of high-quality educational tutorials at a discount to visitors from the IEEE.

The Standards Aware Series is similar to taking a Standards 101 course at the university level. To learn more about the courses, watch a brief video.

Courses in the series:

- What are Standards?
- Why are Standards Used?
- Standards Development Organizations
- Standards Development Process
- Standards and Trade
- Conformity Assessment
- Strategic Standardization
- Finding Standards
- Copyright Aware

More information and pricing.

Return to Table of Contents

Call for IEEE Standards Education eZine Contributions

The IEEE Standards Education eZine Editorial Board invites contributions from industry practitioners, educators and students on topics related to education about technical standards.
Interested parties may submit an inquiry or article abstract for consideration to the Editorial Board at any time throughout the year via email to: ezine-eb@listserv.ieee.org.

Abstracts should be no longer than 500 words and final articles should be no more than 2,000 words.

Particular areas of interest include, but are not limited to:

- standardization activities in technical areas such as Networking Standards;
- impact and development of standards in various regions of the world;
- best practices and ideas for incorporating standards into the classroom and curricula.

Final contributions should include a 100 word biography of the author(s) and a high-resolution (JPEG) picture. All illustrations must be provided in a high-resolution (JPEG) format. References to all copyrighted material must be properly cited.

Return to Table of Contents

Subscribe to the IEEE Standards Education eZine

Subscribe to the eZine and we'll notify you when a new issue is available.

Return to Table of Contents

IEEE Standards Education eZine Editorial Board

Yatin Trivedi, Editor-in-Chief, is Director of Standards and Interoperability Programs at Synopsys. He is a member of the IEEE Standards Association Standards Board (SASB), Standards Education Committee (SEC), Corporate Advisory Group (CAG), New Standards Committee (NesCom), Audit Committee (AudCom) and serves as vice-chair for Design Automation Standards Committee (DASC). For 2012, Yatin was appointed as the Standards Board representative to IEEE Education Activities Board (EAB). He represents Synopsys on the Board of Directors of the IEEE-ISTO and on the Board of Directors of Accellera. He represents Synopsys on several standards committees (working groups) and manages interoperability initiatives under the corporate strategic marketing group. He also works closely with the Synopsys University program.

In 1992, Yatin co-founded Seva Technologies as one of the early Design Services companies in Silicon Valley. He co-authored the first book on Verilog HDL in 1990 and was the Editor of IEEE Std 1364-1995™ and IEEE Std 1364-2001™. He also started, managed and taught courses in VLSI Design Engineering curriculum at UC Santa Cruz extension (1990-2001). Yatin started his career at AMD and also worked at Sun Microsystems.

Yatin received his B.E. (Hons) EEE from BITS, Pilani and the M.S. Computer Engineering from Case Western Reserve University, Cleveland. He is a Senior Member of the IEEE.

Amin Karim is a visiting professor at the college of engineering and information science at DeVry University. Prior to this position, he served as the national Dean of the College of Technology at DeVry. He is a past Chair of the Electronics and Computer Engineering Technology Department Heads Association of the American Society for Engineering Education and served as a TAC of ABET evaluator for engineering technology programs. He is a member of the IEEE Standards Education Committee.

Wael William Diab serves as Senior Technical Director in the Office of the CTO at Broadcom Corporation. In this role, Diab is responsible for defining the technical strategy for the Infrastructure & Networking Group (ING). Prior to Broadcom, Diab served at Cisco in various technical, architectural, and business leadership roles, focused on next-generation networking products and technologies. Diab holds BS and MS degrees in Electrical Engineering from

Stanford University, a BA degree in Economics from Stanford, and an MBA with honors from the Wharton School of Business. He has developed over 300 patents and patents-pending in the networking space, with over 75 issued patents in the United States.

Diab also is a Senior Member of the IEEE and was unanimously elected and reelected as the Vice-Chair of the IEEE 802.3 Ethernet Working Group, serving in that position since 2008. Diab is a member of the IEEE-SA Standards Board, a member of the IEEE Standards Education Committee (SEC), was elected to the IEEE-SA Corporate Advisory Group (CAG) in 2010 and has served as its Vice-Chair since March 2012. He also serves as the IEEE-MGA liaison to the IEEE-SA and participated on a number of efforts on the IEEE-SA Board of Governors (BoG) sub-committees.

Named winner of the 2011 TechAmerica Innovator Awards for his leadership in Green Technology, Diab was recognized by the David Packard Medal of Achievement and Innovator Awards for his leadership in the development of Broadcom's Energy Efficient Networking solutions.

Bruce Harding is professor of mechanical engineering technology and coordinator of professional practice at Purdue University.

Professor Harding's scholarship and engagement activities revolve around the development and application of American National and ISO standards dealing with Technical Product Documentation (TPD) as it broadly relates to product realization, green manufacturing and other technical aspects of product lifecycle management (PLM).

He is active on a number of American National standards developing committees, and chairs the US Technical Activities Group (TAG) to ISO. He is ASME vice-president for Standardization and Testing, overseeing development of American National Standards for fasteners, geometric dimensioning and tolerancing, metrology, tools, pallets, threads, gaging, plumbing fixtures, metal mill products, chemical pumps, instrumentation, performance test codes and others.

Internationally, he has served as a US Delegate to APEC and has served as the Head of Delegation to ISO Technical Committee meetings in North America, Asia, Oceania, and Europe. Currently he chairs the 62-country ISO/TC10 committee on Technical Product Documentation, whose Secretariat is based in Sweden. The committee writes worldwide standards for technical product documentation for PLM.

Dr. James Irvine is a Reader in the EEE Department at Strathclyde University in Glasgow. His research interests include resource management and security for wireless systems, and he works as Academic Co-ordinator within the Mobile VCE programme. Prior to this he worked on the ACTS MOSTRAIN project providing communication services to high speed trains. He holds four patents, with three more being pursued, and has authored two books. Technical Programme Chair of VTC2004-Spring in Milan, Dr Irvine was elected in 2002 to the Board of the IEEE VTS, where he is chair of the VTS Technical Advisory Committee, and President for 2008-9.

Editorial Board Corresponding Members:

David Law is a Distinguished Engineer at Hewlett-Packard Networking and has worked on the specification and development of Ethernet products since 1989. Throughout that time he has been a member of the IEEE 802.3 Ethernet Working Group where he has held a number of leadership positions. He served as the Vice-Chair of IEEE 802.3 from 1996 to 2008 and in 2008 was elected to Chair of IEEE 802.3. David has been a member of the IEEE-SA Standards Board since 2005, has served as the Chair of IEEE-SA Standards Board Review Committee (RevCom) since 2008, and is currently serving as the Vice-Chair of the IEEE Standards Education Committee. In 2000 he received the IEEE-SA Standards Medallion for 'leadership and technical contributions to Ethernet networking standards' and in 2009 he received the IEEE Standards Association Standards Board Distinguished Service award 'For long term service to improve the operation and integrity of IEEE-SA governance'. David has a BEng (hons) in Electrical and Electronic Engineering from Strathclyde University, Glasgow, Scotland.

Donald Heirman is president of Don HEIRMAN Consultants which is a training, standards, and educational electromagnetic compatibility (EMC) consultation corporation. Previously he was with Bell Laboratories for over 30 years in many EMC roles including Manager of Lucent Technologies (Bell Labs) Global Product Compliance Laboratory, which he founded, and where he was in charge of the Corporation’s major EMC and regulatory test facility and its participation in ANSI accredited standards and international EMC standardization committees.

He chairs, or is a principal technical contributor to, US and international EMC standards organizations including ANSI ASC C63® (immediate past chairman), the Institute of Electrical and Electronics Engineers (IEEE), and the International

Electrotechnical Commission's (IEC) International Special Committee on Radio Interference (CISPR). He was named chairman of CISPR in October 2007. He is a member of the IEC's Advisory Committee on EMC (ACEC) and the Technical Management Committee of the US National Committee of the IEC.

In November 2008 he was presented with the prestigious IEC Lord Kelvin award at the IEC General Meeting in Sao Paulo, Brazil. This is the highest award in the IEC and recognizes Don's many contributions to global electrotechnical standardization in the field of EMC. He is a life Fellow of the IEEE and an honored life member of the IEEE EMC Society (EMCS) and member of its Board of Directors, chair of its technical committees on EMC measurements and Smart Grid, vice president for standards, past EMCS president, and past chair of its standards development committee. He is also past president of the IEEE Standards Association (SA), past member of the SA Board of Governors and past member of the IEEE's Board of Directors and Executive Committee. He is also the Associate Director for Wireless EMC at the University of Oklahoma Center for the Study of Wireless EMC. Currently he is a voting member of the Smart Grid Interoperability Panel and its Testing and Certification Committee. In addition he is a focus leader on the NIST Electromagnetic Interoperability Issues Working Group which is providing EMC recommendations for Smart Grid equipment and systems.

IEEE Standards Education eZine Editor: Jennifer McClain

IEEE Standards Education Committee

Return to Table of Contents
