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

4th Quarter 2014, Vol. 4, No. 2

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Letter from the Editor-in-Chief

Yatin Trivedi

4th Quarter 2014

As we reach the end of another year, I am reminded, and amazed at, how far we have come – not just with this Standards Education eZine, but with adoption of technology and how it impacts our daily lives. Standards continue to play a very important role in this accelerated deployment of technology. Therefore, the more we all are educated about it the better. Many of us, old and young, learn about the existence of standards from the products we use; for example, we know about Wi-Fi and Ethernet because our use of mobile devices and computers depend on them. Many engineering students learn about standards in their classes and through their projects. So what can a History Professor tell us about standards? You would be surprised to learn how the standards have shaped our world for centuries, and telecom standards in the more recent times. Read Prof. Andrew Russell's article *Lessons and Cautionary Tales from the History of Standardization.* Better still, visit the IEEE History Center at Stevens Institute of Technology, Hoboken, NJ, USA to see how far we have come.

OK, so having learned a lesson or two about the importance of standards from the history, how do you gain experience in developing consensus based standards? Dr. James Irvine, Chair of the IEEE Standards Education Committee, explains how consensus is built in standards committees in *"Coals to Newcastle": Delivering the Standards Consensus Building Workshop to IEEE Staff.* It's a wonderful recap of a day-long workshop where participants go through quite a realistic, albeit accelerated and compressed, process of building electric vehicle standards for colonizing Mars. Was there any proof that this was effective? You bet! He tried it live on the IEEE Standards Association and Educational Activities staff members and they all liked it. You should consider hosting one at your university or workplace. Continuing our journey down that road, one must be prepared to deal with standards for some of the new and emerging technologies such as Nanotech. Prof. Ahmed Khan and Dr. Amin Karim from DeVry University get us started on the right foot in their article *In Quest of Universal Nanotechnology Standards.* It should serve as a handy reference to those dealing with applications of Nanotechnology, especially the regulatory aspects.

Our regular columns of student projects, new grants, book reviews, and my favorite cartoons are as interesting as ever.

I hope to hear back from you with comments on the articles from our contributors, and what topics you'd like to read about in future issues.

From the entire eZine Editorial Board, Happy Holidays and Warm Wishes to all of you for 2015!

Yatin Trivedi
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), Industry Connections Committee (ICCom) and serves as vice-chair for Design Automation Standards Committee (DASC). Since 2012 Yatin has served 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 and a member of IEEE-HKN Honor Society.

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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!

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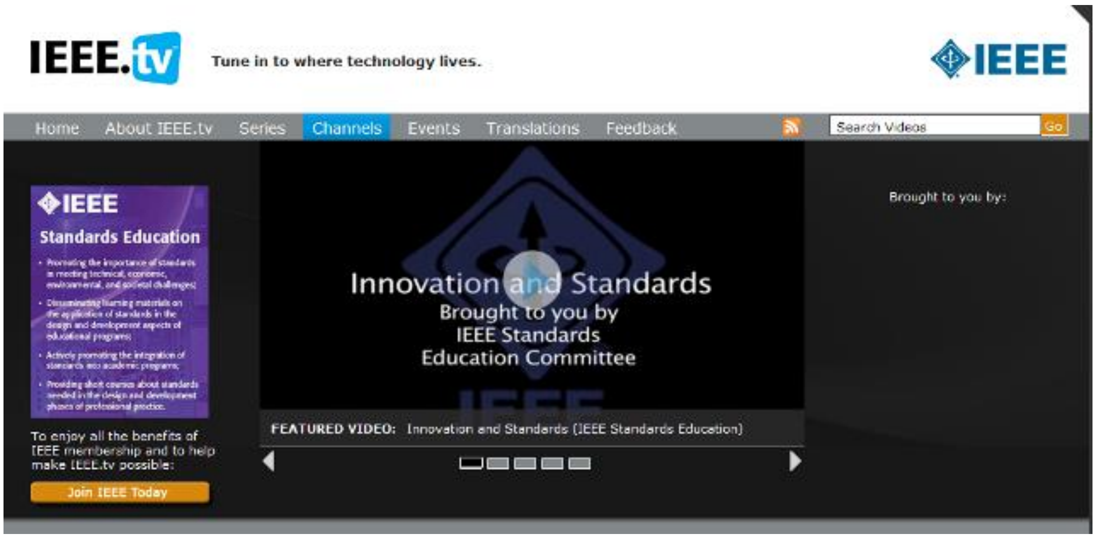
New IEEE Standards Education channel available on IEEE.tv

The IEEE Standards Education Committee is pleased to announce the launch of the new IEEE Standards Education Video Channel on IEEE.tv.



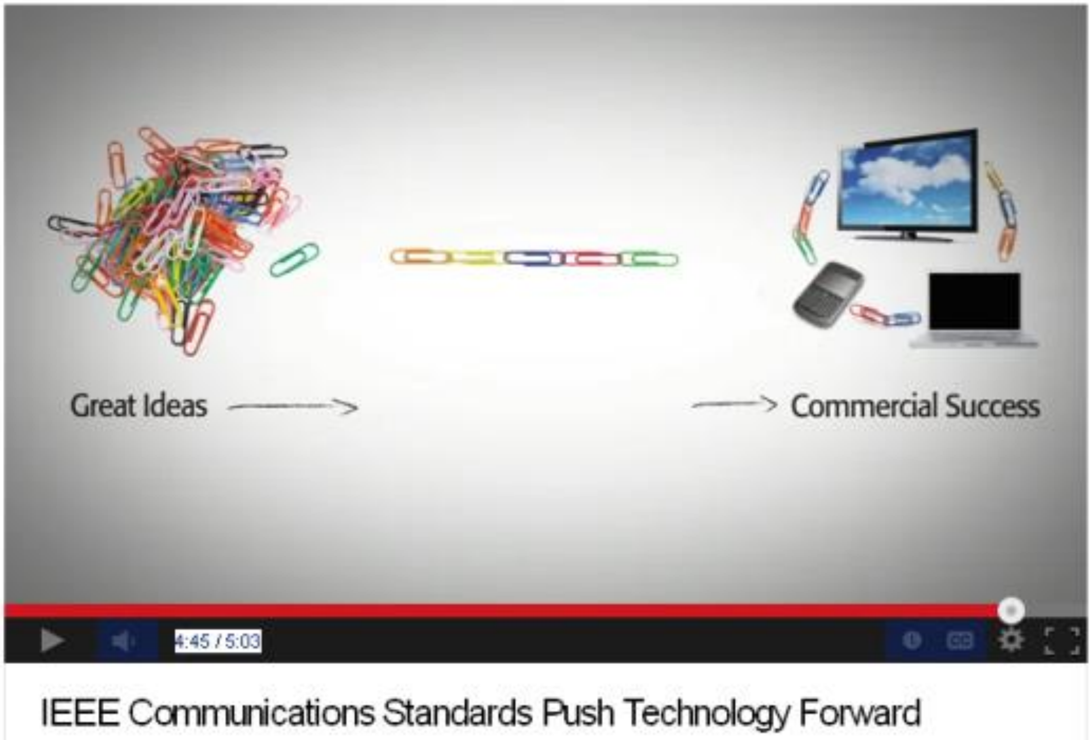
The short videos present information related to Innovation and Standards, the Value and Global Impact of Standards, as well as topics related to standards development and the importance of standards as part of an engineering education. There is also a Case Study presented on IEEE Standards 515 (electrical trace heating), with a version translated into Mandarin.

Look for more videos in the first quarter of 2015 related to IEEE 802 Standards.

More Videos

Learn about the broad range and impact of standards developed under the IEEE Standards Association umbrella. (6:17)

IEEE Standards...Pushing Technology Forward



[Learn the value of openly developed interoperable standards (5:04)]

In part three of three, President of the IEEE Standards Association, Karen Bartleson talks with eZine Editor-in-Chief Yatin Trivedi about Global Collaboration and Standards Education (2:57).

Part one in three part series (2:48)
Part two in three part series (2:41)
Part three in the three part series (2:57)

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 one in the three-part series (5:53)
Part two in the three-part series (4:59)
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Videos will launch in You Tube.

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Lessons and Cautionary Tales from the History of Standardization

By Andrew L. Russell, Ph.D.
Stevens Institute of Technology, Hoboken, NJ USA

4th Quarter 2014

Does the history of standardization hold lessons for standards professionals of the 21st century? This can be a dangerous question for historians, since we are at our best when we resist the urge to reduce past experience into simple lessons for the present. (After all, we're trained to say "it depends" and "well, it's more complicated than that…") The past does not provide formulas that we should apply under all conditions, but it does suggest some general patterns and tendencies that are worthy of careful consideration by standards professionals, educators, and students alike.

My recent book, *Open Standards and the Digital Age: History, Ideology, and Networks* (Cambridge University Press, 2014), is a history of standardization in telecommunication and computer networks from the telegraph to the Internet. Within this history, I found relatively few cases where government regulators set technical standards and backed them with the force of law. In many more cases, firms such as Western Union, AT&T, and IBM set standards through the force of their dominant industry position. And in other, increasingly important cases, standards emerged from an "open" and consensus-driven process in organizations such as the IEEE, the Internet Engineering Task Force, and the World Wide Web Consortium. The organizations active in this third form of "consensus" standard setting are loosely coordinated, often overlapping, and sometimes competing – in short, they are fascinating examples of human capacities for cooperation and collaboration. In what follows I will discuss three areas of unresolved tension within the broader quest to create standards for our industrial economy.

First, we need to come to grips with a fundamental paradox: the purpose of a standard is to create stability, but the process of standardization is unstable and ever changing. There is not and never has been a standard way to make standards, nor is there any overarching national or international authority in the field. Instead, there is an endless cycle of cooperation and competition within and between standards setting organizations.

This paradox arose alongside the core technologies of industrial capitalism. In the late 19th century, engineers working with steel, electric power, and telephones created standards to simplify, streamline, and reduce technological diversity. Their success can be measured by any number of massive technological systems, such as the world-class telephone network that AT&T engineers built in the early 20th century. But the successful creation of standards also bred suspicion, and critics alleged that the proliferation of standards served only to concentrate power in the hands of the powerful. Competitors complained that AT&T abused its market power, and regulators suspected that AT&T was stifling technological innovation and inflating the rates it charged customers. In the view of AT&T's

critics, standardization was an ally of monopoly and centralized control; it was the antithesis of progress.

To push back against these types of criticisms, the leaders of the American Standards Association (ASA) – the forerunner of today's American National Standards Institute (ANSI) – developed a sophisticated defense of the social process of standardization. In 1924, ASA President and safety advocate Albert Whitney defended the creative power of standardization, which he named as "the liberator that relegates the problems that have already been solved to their proper place, namely to the field of routine." The power of standardization, Whitney continued, was that it "leaves the creative faculties free for the problems that are still unsolved." ASA Secretary Paul Gough Agnew likewise presented standards as vital indicators of societal progress: "Standardization is dynamic, not static; it means not to stand still, but to move forward together."

Second, we should maintain a healthy skepticism toward the calm and inclusive rhetoric of openness and consensus. Beneath such rhetoric lies an underlying reality of conflict and dissent – as any observer of "standards wars" can attest. The latter chapters in Open Standards and the Digital Age follow the history of computer networking and internetworking standards, from their origins in the 1960s to the global adoption of Internet standards in the 1990s. My account provides a corrective to the journalists who have been tricked into thinking that Internet standards emerged from open and collegial gatherings of hippie graduate students and kind, grey-bearded computer scientists. While it is true that a several graduate students and even a few hippies were involved, the Internet's funding and political support came from government bureaucrats, military officials, and ambitious executives who sensed a multi-billion dollar market ready for the taking. The engineers who made Internet standards argued a lot, and their arguments often got nasty (and still do!). By custom they try to keep evidence of internal disputes from official documents, but their publicly archived mailing lists display the depths of their raw emotions and bitter feelings. By definition, "consensus" is not unanimity, and the making of a consensus always requires compromise and exclusion.

Third, diplomatic skills and administrative processes often matter more than technical details. Of the dozens of standards-setters that readers encounter in Open Standards and the Digital Age, the most successful were those who found ways to use or reform the standardization process to bring diverging ambitions into alignment. A good example comes from the 1920s, when AT&T clashed with electric power and lighting companies over interference that electric cables were introducing into telephone calls. AT&T's engineers knew that so-called "inductive interference" occurred when transmission lines were in close proximity, but they did not dare to remove the interfering lines owned by the electric companies. AT&T's lawyers believed that they should assert their property rights and resolve the problem in court, but AT&T Chief Engineer Bancroft Gherardi suggested that a cooperative approach would be less costly and more prudent. Throughout the mid 1920s, Gherardi worked closely with representatives from the electrical industry to find solutions that could avoid costly lawsuits. They never did solve the underlying scientific problems of inductive interference; but by the late 1920s they agreed to adopt a simple standard that defined the minimum distance between different types of electrical wires on utility poles. At a national meeting of electrical engineers, Gherardi celebrated the ability of his peers to work together: “We came to the conclusion that 10 per cent of our problem was technical and 90 per cent was to bring about between the people on both sides of the question, a friendly and cooperative approach.”

In conclusion: as I see it, the history of standardization does not yield precise lessons or nuggets of wisdom. Instead, it is a landscape of cautionary tales, delightful characters, and unresolved tensions. One can only hope that the next generation of standard bearers will study the past, draw their own conclusions, and proceed with caution!

Andrew L. Russell is an Associate Professor in History and Director of the Program in Science & Technology Studies in the College of Arts & Letters at Stevens Institute of Technology in Hoboken, New Jersey. He is the author of Open Standards and the Digital Age: History, Ideology, and Networks (Cambridge University Press, 2014) and he has published over a dozen articles and book chapters on standardization in the Bell System, the Internet-OSI standards war, and the theory and practice of modular design. He is a graduate of Vassar College (B.A. History, 1996), the University of Colorado at Boulder (M.A. History, 2003), and the Johns Hopkins University (Ph.D. History of Science and Technology, 2007), and worked in the Harvard Information Infrastructure Project in Harvard University’s Kennedy School of Government from 1997 to 1999. Currently he serves as the Reviews Editor for IEEE Annals of the History of Computing, a member of the IEEE Computer Society History Committee, and Chair of SIGCIS, an international collective of computing historians.

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"Coals to Newcastle": Delivering the Standards Consensus Building Workshop to IEEE Professional Staff

By Dr. James Irvine
Chair, IEEE Standards Education Committee

4th Quarter 2014

The Standards Education Committee (SEC) has developed a consensus building workshop which is designed to introduce students and professional engineers to how standards are agreed. It does this through a simulated standards process, giving participants an insight into what goes on at standards meetings. The day-long event starts with introductions to the IEEE and the value of standards to the community, before going into detail on the history of some example standards and proceeding to the standards simulation itself, followed by a debrief. The workshop has been run successful two or three times each year for the past three years, and feedback from those attending has been very positive.
Late in 2014 an opportunity presented itself to run the workshop at IEEE Headquarters. Staff from both the Standards Association (SA) and Educational Activities (EA) Department were invited, the idea being that while IEEE SA staff are experts in standards, they may not have experienced standards meetings from the point of view of a practicing engineer: the workshop would give them a useful counterpoint to their normal IEEE working experience. The whole workshop process was also being documented and evaluated with the aim of making it available more widely within the IEEE.

Five brave souls from EA joined the thirty or so SA staff who took part. The scale of the challenge they faced can be seen from the fact that the SA staff had, on average, over 13 years experience in the standards process apiece: the most experienced being a 38 year veteran. In fact, your correspondent, who serves on SEC as an EA delegate, was left seriously intimidated by the amount of standards experience in the room.

The introduction to the IEEE and the importance of standards being somewhat redundant given the audience, the event started with Yatin Trivedi, SA Board member and past chair of SEC, discussing the role of standards in enabling chip design, followed by Steve Carlson, Executive Secretary of 802.3, discussing Ethernet. Steve, author of the case study used in the workshop, introduced the problem: humanity was colonizing Mars, and those present had to come up with standards for the electric vehicles to be used. This involved three areas: the side of the road to drive on, the battery charging technology to be used, and the connector technology. To make things more interesting, each member of the working groups attendees were divided in to was given a role which they had to perform. These ranged from the benign ‘perfect attendee’, who would listen to the arguments and make up his or her mind based solely on the discussion, to the ‘timewaster’, tasked to do whatever was necessary to delay proceedings. Others had more specific roles – to support a particular technology options on behalf of their company, or to advocate regulator, consumer or environment issues. I should note that Steve and his colleagues had much amusement in drafting these roles, often modeled on real standards group members who shall, of course, remain nameless.

The first task each group had was to elect a chair, a task slightly complicated by the fact that in some cases one of the roles was explicitly to try to become chair, while others felt that they would be best placed to achieve their role's objective if they were to be chair. For previous iterations of the workshop, the chair election took the form of attendees sticking their hands up, and the person with the most votes being successful. The first indication that this time things might be different was the group who undertook four rounds of voting, on each round eliminating the candidate with the fewest votes until only a single candidate remained. Suffice to say, that took until lunchtime.

The next problem to present itself was the IP declaration. Obviously, it is essential in the standards development process that participants make clear where they have patents or other protected IP in a particular technology, but this isn't a question previous course attendees have known to ask. Some attendees recognized that achieving their objectives would be assisted by a rather strict reading of how required the requirement to declare IP actually was, something which is not totally unknown in real standards meetings!

The first question – which side of the road to drive on – was disposed of quickly by a couple of the groups on the basis that only those strange Brits drive on the left. If you live in India or other parts of the 35% of the world that drives on the left, I can only apologize!
The remaining questions caused much more debate, not least because different attendees had been told to promote different technologies. Over a working lunch, things were mixed up again by the organizers as some 'companies' were taken over, changing the negotiating positions of their respective delegates. A number of votes were required, prompting one delegate to note that in real standards meetings a much higher requirement for consensus was used than the theoretical 75% minimum. However, such meetings also include several more opportunities for consensus building while imbibing alcoholic beverages, which can often ease the decision making process.

All of the groups did manage to come up with some decisions for all the questions. The last part of the day was the debrief, looking at which options the different groups chose. Implicit in this debrief was revealing which roles each attendee had been assigned, and as a result how successful they had been at keeping them secret. A few would have found their employment in peril, having not succeeded in any of their aims, but most did manage to meet at least some of their goals.

Overall, the event proved very valuable. The attendees found they had a new insight to the complexities of the standardization process, and how the various procedural rules work to keep things on track. The organizers also found the day very stimulating, having had one of their most challenging groups of 'students'. Future workshops will reap the benefits.
If you are interested in running the SEC workshop within your organization, please contact Jennifer McClain (j.mcclain@ieee.org)

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 Coordinator 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.

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Use of Standards in Student Project in Optical Networks: Case Study of XGPON and GPON Coexistence

By Dr. Frederic Surre
City University, London, UK

4th Quarter 2014

This article focus on the outline of a student project based on optical network design and including the use of Technical Standards (here ITU Recommendations) as a core learning outcome.

The proposed outline does not aim to be exhaustive and ready to be use, but proposes ways to include Technical Standards. It is, however, possible to modify some of the aspects of the project and to go deeper in some other aspects.

Preamble: Passive Optical Networks (PON) is an important technology for fibre-to-the-x (FTTx) applications. Different versions of PON exist, the one of interest here is Gigabit -PON (GPON).

Passive Optical Network corresponds to a network where, after the light is launched, no active device is used. However, over the years, the expression PON has been used for a wider range of networks, sometimes including active devices. In this article, the original meaning is used, i.e. a point-to-multipoint optical network using only passive devices.
A typical GPON has a capacity of 2.488 Gbit/s in downstream (DS) and 1.244 Gbit/s in upstream (US). However, the need for higher bandwidth leads to the development of Standards for the Next Generation of PON (NGPON). To facilitate the transition from current GPON to XGPON2 (XGPON stands for 10-gigabit-capable PON), XGPON1 is developed to handle the coexistence of GPON and NGPON.

The design exercise proposed here focuses on XGPON1. To perform this design project, students will need access to an optical network simulator. Two main players are available on the market.

Design Exercise: The point of the project is to design the optical link of a XGPON1 based on ITU Recommendation family G987, which focus on the characteristics of the network to coexist with a GPON optical link. Figure 1 shows the structure of the network to design. It consists of an Optical Line Termination (OLT) and several Optical Network Units (ONU) – for now let’s say 4.

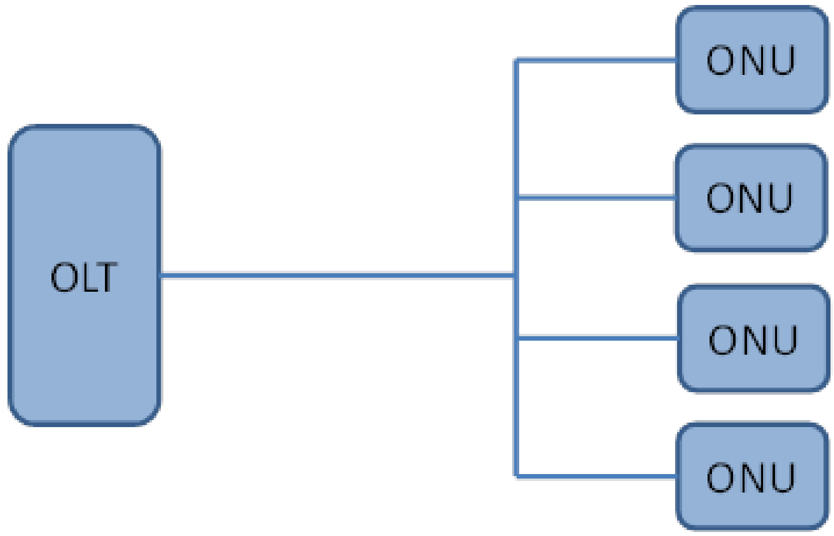


Figure 1: Network to design comprising an Optical Line Terminal (OLT) and four Optical Network Units (ONU).

The distance between the OLT and the ONUs can be specified and different scenarios are possible. The easiest is to have all the lengths equal as it should give similar performances for each ONU. However, from a design point of view, it is more interesting and realistic to have different lengths.

Section 1: Design of the OLT and ONU

The first part of the student's work consists of designing the OLT and ONU in accordance with the ITU recommendations.

The OLT contains a transmitter and a receiver. Using the ITU recommendations and the optical network simulator, students have to elect devices by monitoring the following parameters (in bracket are some elements of answer for each parameter):

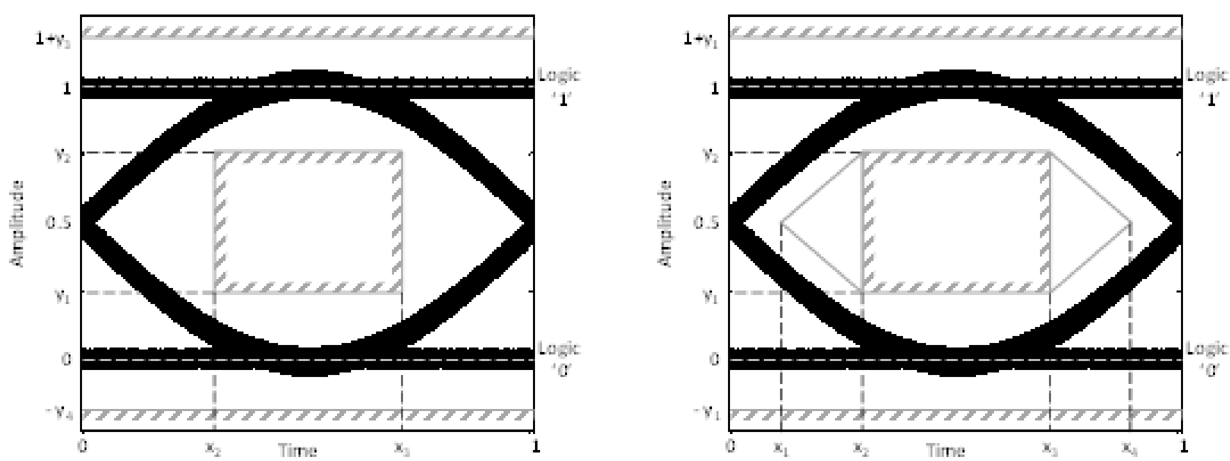
- The wavelengths for both the transmitter (DS) and receiver (US) [DS wavelength range is 1575-1580nm and the US one is 1260-1280nm];
- Nominal bit-rates [9.95328 Gb/s for DS- this is related to the speed of the modulator in the transceiver];
- An average launch power that satisfies the ITU recommendation [Average launch power in the recommendations depend on the class of the optical distribution network (ODN). For an ODN class N1 the launch power is between +2 and +6dBm];
- Light source linewidth [Recommendations requires a maximum linewidth of 1nm];
- Extinction ratio [Recommendations requires a ER of at least 8.2];
- Maximum sensitivity of the receiver [For an ODN class N1, minimum sensitivity is -27.5dBm];
- Maximum overload [For an ODN class N1, maximum overload is -7dBm].

For the ONU, similar work is necessary. It has also a transmitter (for US) and receiver (for DS). Again, specific devices have to be selected after simulations in order to guarantee that the ONU is in accordance with the recommendations (i.e. extinction ratio and laser linewidth are identical to the OLT transceiver):

- Transmitter (US) wavelength between 1260 and 1280nm and Receiver (DS) wavelength between 1575 and 1580nm;
- Nominal data rate for the transceiver of 2.48832GB/s;
- An average launch power comprised between +2 and +7dBm for an ODN Class N1;
- Maximum sensitivity of detector: -28dBm (Class N1)
- Maximum overload: -8dBm (Class N1)

Other parameter can be included, such as Side Mode Suppression Ratio, Jitter tolerance, etc. Also, the devices can be selected from a list given to the students or the students can be allowed to roam the internet in search of devices that will satisfy the performance requirements.

Section 2: Eye diagram of the transmitters
After the selection of the light source and modulators, the next design stage is, for the students, to check the quality of the light pulses generated. For that purpose, using the optical network simulator, and following the recommendation G987.2, students should simulate the pulse emitted by the transmitter for a pseudo-random bit sequence. The conversion from optical to electrical uses an OE conversion with a 4th-order Thompson filter (cutoff frequency is 0.75 times the output nominal data rate). The eye diagram obtained for OLT and ONU transmitters should satisfy the eye diagram mask on fig 2 with parameters given in Table 1.



(a) **(b)**

Figure 2: Eye diagram masks for OLT transmitter (a) and ONU transmitter (b)
(figure from ITU G987-2)

Table 1: Parameters for eye diagram masks in Figure 2

Parameters	OLT Transmitter	ONU Transmitter
x3 – x2	0.2	0.2
y1	0.25	0.25
y2	0.75	0.75
y3	0.25	
y4	0.25	

Section 3: Design of the XGPON1 link

After the OLT and ONUs are specified, the third step is to design the optical link. In order for students to design and evaluate the performance of the link, the distance between OLT and ONUs should be given. For the scenario considered here, the four lengths are chosen to be different to each other, but shorter than the maximum distance allowed in the recommendations.

Students will have, first, to choose how to split the DS signal from the OLT to the 4 ONUs. In GPON, optical splitter have 16, 32 or 64 outputs. This should guide students to select a standard 16 outputs splitter. When a commercially available splitter is selected, its characteristics can be inputted in the simulator and the performance of the DS link can be tested. The performance should be compared with the recommendations, i.e.:

- Q factor of at least 6;
- BER of less than 10-12;

The US link simulation should return a link with the same Q factor and BER as the DS. When these performances have been obtained in simulation, the XGPON1 is designed to the ITU recommendations. It is, furthermore, possible to include tests on different commercially available fibre and to estimate the designed network tolerances to fibre damages (or other devices performance deterioration).

Option 1: Increase of the distance between OLT and one ONU

If the distance between the OLT and one ONU is increased and becomes larger than the maximum allowable distance, the received signal will not satisfy the recommendations anymore. In that case, students will have to include a Reach Extender (RE) in their design. After finding a suitable RE, simulations should check that the updated design satisfy the recommendation for all ONUs.

Option 2: Design of a GPON network to coexist with the XGPON1

The XGPON design in this project is based on ITU recommendations for XGPON1 which, by definition, can coexist with GPON. Thus, it can be simulated without considering the GPON network. However, a preliminary section can be included on the design of a GPON network between the OLT and some of the ONUs. Then, in a separate part of the project, the XGPON1 network is designed and both are simulated together to estimate the performances of the two coexisting networks.

Frederic Surre is a lecturer in the Electrical and Electronic Engineering Department at City University London. His research interests are centered on the design of optical systems for sensing and communications, with a particular interest in the modeling, design and characterization of active device for Infra-red and terahertz waves.

Frederic received the French Engineering Degree in Electronic Engineering, Msc in Microwave and Optical Communications and PhD in Computational Electromagnetics from INPT-ENSEEIHT, Toulouse, France in 1998, 1998 and 2003 respectively. Following his PhD he worked at Queen Mary University of London, UK, Trinity College Dublin and Dublin City University, both in Ireland.

He was chair of the topic "Advances in Terahertz Devices and Applications" in IEEE Photonics Winter Topicals Meeting 2010 and organized a Special Session on "Optical Metrology for Structural Health Monitoring" during IEEE Sensors Conference in 2011. He is a member of the IEEE Standards Education Committee and the Counsellor of the City University London IEEE Student Branch.

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In Quest of Universal Nanotechnology Standards

By Ahmed S. Khan and Amin Karim
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4th Quarter 2014

Advances in nanotechnology are transforming the ways of creating materials and products. It is estimated that by 2020 nanotechnology will be a $3 trillion-a-year global industry. In 1997 the investment in nanotechnology stood at $430 million, rising to more than $9 billion in 2004. The U.S. share of this is estimated at $ 1 trillion, which would correspond to about 5% of gross domestic product (GDP), compared to 0.8% of GDP in 2010. Presently more than 800 products have been developed using nanotechnology. Significant R & D investments were made by Brazil, India, Russia and other countries after the second generation of active nanotechnology products came to market in 2006. [1, 2]

Nanotechnology is remaking the world at an alarmingly fast pace, but presently nanoproducts are being developed in an environment of regulatory vacuum at national and international levels. The biggest question is how to deal with uncertainty and risk assessment? All new and emerging technologies pose new challenges and uncertainties; in the domains of science and technology these can be dealt with additional research, but in the realm of law and regulation, immediate answers are sought. Because uncertainty must be dealt with in regulation, and in the absence of straightforward regulations, methodologies are used to address uncertainty. One such methodology used for dealing with uncertainty in regulation is risk assessment.[3]

The primary objective of this short narrative is to provide readers with a list of international standards development organizations as well as regulatory bodies in the USA. The table (State and Status of Nanotechnology Standards and Recommendations), although not comprehensive, lists a number of U.S., and international organizations that have developed guidelines and recommended practices for working with manmade nanostructures. But there is an urgent need to develop specific universal standards to ensure safety for researchers working with nanomaterials and nanostructures and for consumers using nanotechnology based products. These standards would eventually be incorporated into research and manufacturing procedures as the countries around the globe develop their own regulations.

To develop universal standards, the following questions need to be answered by the all stakeholders – consumers, businesses, industries, and national and international regulatory bodies--- of nanotechnology:

- How should we manage exposure to nanowaste by humans and environment?
- How can we develop effective risk management strategies dealing with the uncertainties of nanotechnologies?

- How should people be educated about the potential benefits and risks of nanotechnology?
- How can schools and universities promote best practices in lab safety protocols?
- What are some design factors that must be considered in building laboratories that will provide safe environment for researchers?

Development of universal Nanotechnology standards, and stakeholder education, are the pivotal factors in effectively dealing with the potential short-term and long-term benefits (intended consequences) of nanotechnology together with the limitations and risks (unintended consequences).

Table: State and Status of Nanotechnology Standards and Recommendations

Organization	**Guideline/Recommendation/ Standards Publication**	**Comments**
ASTM http://www.astm.org/Standards/nanotechnology-standards.html	Provides guidance for nanotechnology and nanomaterials	Focuses on informatics and terminologies, physical and chemical characterization of nanomaterials, and environmental health and safety
NIOSH/CDC Department of Health and Human Services Centers for Disease Control and Prevention National Institute for Occupational Safety and Health	Approaches to Safe Nanotechnology Managing the Health and Safety Concerns Associated with Engineered Nanomaterials	This document provides guidelines for managing the Health and Safety Concerns Associated with Engineered Nanomaterials
	General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories	This document provides guidelines for General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories.
Institute of Environmental Sciences and Technology http://www.iest.org	EST-RP-NANO200.1: Planning of Nanoscale Science and Technology Facilities; Guidelines for Design, Construction, and Start-Up.	This Recommended Practice (RP), IEST-RP-NANO200.1, provides an overview of factors involved in the design, start-up, and operation of facilities in the field of nanotechnology. The overview focuses on the unique

		considerations related to planning, design, construction, and start-up that typically confront owners, designers, and users of the advanced-technology facilities supporting research or production at the nanometer scale.
	Nanotechnology Safety: Applying Prevention through Design Principles to Nanotechnology Facilities	This Recommended Practice (RP), IEST-RP-CC205, will cover all aspects of facility safety, targeted at interdisciplinary research and manufacturing facilities. The document will provide a compendium of existing information on facility safety coupled with emerging information and its impact on facilities.
U.S. Food and Drug Administration http://www.fda.gov	1. Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology. 2. Safety of Nanomaterials in Cosmetic Products. 3. Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies	The guidance describes FDA's current thinking on determining whether FDA-regulated products involve the application of nanotechnology. This guidance is intended for manufacturers, suppliers, importers, and other stakeholders. This document provides guidance to industry and other stakeholders (e.g., academia, other regulatory groups) on FDA's current thinking on the safety assessment of nanomaterials in cosmetic products. The guidance document is intended to assist industry and other stakeholders in identifying the potential safety issues of nanomaterials in cosmetic

		products and developing a framework for evaluating them. Final Guidance for Industry: Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies, on the Safety and Regulatory Status of Food Ingredients and Food Contact Substances, Including Food Ingredients that Are Color Additives
IEEE Nanotechnology Standards Working Group http://grouper.ieee.org/groups/1650/	IEEE Standard 1650™-2005 IEEE Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes	This standard describes methods for the electrical characterization of carbon nanotubes. The methods are independent of processing routes used to fabricate the carbon nanotubes.

References
1. Khan, Ahmed S. 2012 Nanotechnology: Social and Ethical Implications, CRC Press, p.2.
2. Roco, Mihail C. (2011) Nanotechnology: From Discovery to Innovation and Socioeconomic Projects, CEP May 2011, pp. 21-27, Available online, retrieved, December 14, 2014. http://www.aiche.org/cep
3. Sutton, Victoria (2011). Nano technology law and policy, Carolina Academic Press, Durham, North Carolina), p. 38.

Dr. Ahmed S. Khan is a Professor of Electronics and Electrical Engineering in the College of Engineering and Information Sciences at DeVry University, Addison, Illinois. Dr. Khan has thirty-two years of experience in research, instruction, curricula design, development, evaluation, implementation and program accreditation, management and supervision. Dr. Khan received an MSEE from Michigan Technological University, an MBA from Keller Graduate School of Management., and his Ph.D. from Colorado State University. His research interests are in the areas of Nanotechnology, and Social and Ethical Implications of Technology. He teaches Wireless Engineering, Network Engineering, Fiber Optic Communications, Science Technology and Society (STS), and Project Management. He also advises students on their senior design projects. He is the author of many educational papers and presentations. He has authored/coauthored many books, including the most recent "Nanotechnology: Ethical and Social Implications," CRC Press (2012).

Dr. Khan is a senior member of the Institute of Electrical and Electronics Engineering (IEEE), and a member of American Society of Engineering Education (ASEE), and has been listed in Who's Who among America's Teachers. Dr. Khan has been serving as the faculty adviser to the student chapter of IEEE at DeVry-Addison since its inception in 1986. Dr. Khan also serves as a program evaluator for the Accreditation Board for Engineering and Technology (ABET).

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.

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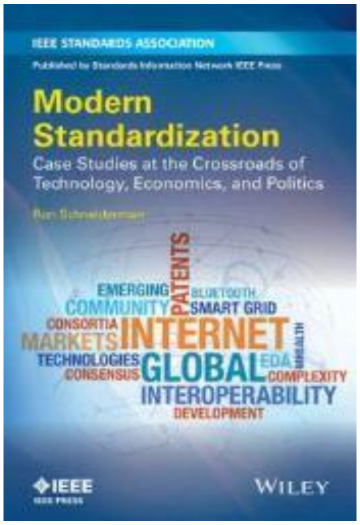
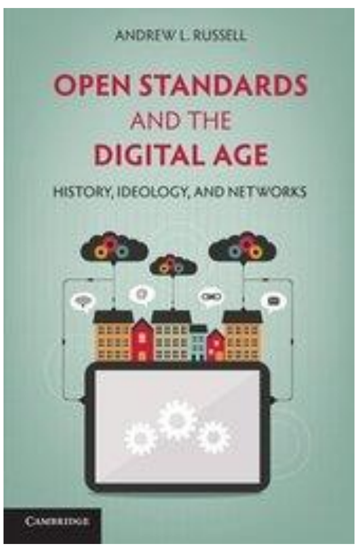
New Books about Standards....



[Modern Standardization: Case Studies at the Crossroads of Technology, Economics, and Politics]
by Ron Schneiderman will be available in March 2015.

This book is a collection of IEEE Standards-specific case studies. The case studies offer educators and students real-world insight into the technical, political, and economic arenas of engineering.

Get 25% off!



Open Standards and the Digital Age: History, Ideology, and Networks
by Andrew L. Russell

How did openness become a foundational value for the networks of the twenty-first century? Open Standards and the Digital Age answers this question through an interdisciplinary history of information networks that pays close attention to the politics of standardization.

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New Books about Standards....

Smart Energy Industry Innovation and Practice: IEEE Std 1888

By Wang Zhongmin
President, STCE (China Standardization and Technical Consortium for Energy Conservation and Emission Reduction)
Vice President, China Energy Conservation Association

4th Quarter 2014

《智慧能源—产业创新与实践》简介
当今，环境问题、能源问题已成为制约全球经济社会可持续发展的重大问题。为应对这些问题，世界各国都在制定各自的“能源战略”。由天地互连主导，同时整合学术界及产业界各方面的资源创制的 IEEE 1888 国际标准，以绿色节能为宗旨，将 ICT 技术、互联网技术与传统行业深入融合，为提高能源利用效率、加强能源管理开辟了一条新的道路，带领我们迈向“智慧能源时代”。
可以说，作为智慧能源的关键技术标准之一，IEEE 1888 已经在世界范围内得到广泛关注。在日本，IEEE 1888 标准在东京大学江崎浩（Hiroshi Esaki）教授团队的推动下，已经取得了众多成功应用；在中国，浙江大学的沈新荣教授领导的哲达公司以及中国其他许多企业都是 IEEE 1888 标准成功的实践者。全国节能减排标准化技术联盟（STCE）以及智慧能源产业技术创新战略联盟（SASE）也在全国范围内推广这些成功经验，进一步丰富和完善基于 IEEE 1888 标准的智慧能源产业链。
为了能使业界和读者进一步了解智慧能源理论知识与产业实践，理解 IEEE 1888 与智慧能源的关系，全国节能减排标准化技术联盟理事长王忠敏以及天地互连总裁刘东共同撰写了《智慧能源—产业创新与实践》一书。本书从能源的特点、性质、节约能源的历史责任、气候变化与节能减排、节能措施、终端能源消费、终端能效管理的角度，阐述了中国在能源使用和能效管理问题上面临的国际形势、国家政策以及相关产业现状，研究了智慧能源从概念到实践的发展过程，分析了互联网与能源管理工作的关系以及 IEEE 1888 标准在智慧能源产业发展中的关键作用。此外，本书还介绍了国内外的智慧能源发展应用情况，并以天地互连、哲达科技、中国电信、海尔等企业为例，介绍了智慧能源以及 IEEE 1888 标准在各领域的具体实践。
通过大量的理论研究与实践总结，本书指出：
1）智慧能源必须是应用互联网和现代通讯技术对能源的生产、使用、调度和效率状况进行实时监控、分析，并在大数据、云计算的基础上进行实时检测、报告和优化处理，以达到最佳状态的开放的、透明的、去中心化和广泛自愿参与的综合管理系统。
2）IEEE 1888 标准是连接智慧能源是连结能源与信息两大关键技术桥梁和纽带，是建立互联网条件下的能源综合管理系统的前提条件。IEEE 1888 标准针对城市中的能耗环节，实现泛在网络设备和基础设施在互联网范围内的智能互联、协同服务、远程控制和统一管理，为政府部门、社区管理者、消费者和公共服务运营商提供合适的远程和协同管理解决方案，协助建立公共环境监督管理机制，并促进相关产业升级。

3）智慧能源综合管理系统将具有高度的兼容性、民主性、自愿性，不接受任何长官意志、行政命令和垄断行为，而且还需打破一个个自我封闭的信息孤岛，使所有相关能源的生产和使用行为相互连通起来，实现自调节、自组织和自平衡，以获得科学合理的能源利用形式，解决能源、资源以及环境困境，实现生态文明及可持续发展。

目前，许多企业及政府主管部门纷纷建立能源监测管控平台，传统的能源技术正逐渐向自动化、信息化不断靠拢。随着 IEEE 1888 的推广应用，能源技术与信息技术将进一步融合，能源利用效率将不断提高，能源的开发利用也将越来越变得越智慧。

Summary of Smart Energy——Industrial Innovation and Practice

Nowadays, environment and energy-related issues have become the grave problems that impede the sustainable development of economy and society in the world. Countries worldwide are developing their own "energy strategy" to deal with these problems. The IEEE 1888 international standards, led by BII Group, with the resources from academia and industries, aim at green energy, and integrate ICT and Internet technologies with conventional industries, which open up a new path to improve energy efficiency and enhance energy management. It will lead us to the era of smart energy.

As one of the key technical standards of smart energy, IEEE 1888 has been concerned and researched in worldwide. In Japan, IEEE 1888 has been widely applied, promoted by the team led by Professor Hiroshi Esaki of the University of Tokyo. In China, Zeta, led by Professor Shen Xinrong of Zhejiang University and many other companies are the ones that successfully practice IEEE 1888 standards. China Standardization and Technical Consortium for Energy Conservation and Emission Reduction (STCE) and Strategic Alliance of Technology and Innovation in Smart Energy Industry (SASE) will promote their experience of success nationwide, to further enrich and complete the industrial chain of smart energy based on IEEE 1888.

In order to make the reader a better understanding of the theory and practice of smart energy, and to understand the relationship between IEEE 1888 and smart energy, the book of Smart Energy——Industrial Innovation and Practice, is written by STCE president Wang Zhongmin and BII president Liu Dong. The book describes the international situation, national policy and current situation of the energy utilization, and researches the development process from concept to practice, from the perspective of energy characteristics, historical responsibility of energy conservation, climate change and energy conservation, energy conservation measures, final energy consumption and end-use energy efficiency management. The book also analyzes the relationship between the Internet and energy management and the key role of IEEE 1888 standard in the smart energy industry. In addition, the book also introduces the application of smart energy at home and abroad, and takes BII, Zeta, China Telecom , Haier and other enterprises for examples, to describe the practices of smart energy and IEEE 1888 in various fields.

Through numerous theory research and practice summary, the book points out that:
1) Smart energy must be the open, transparent, decentralized and extensive voluntary participated Energy Integrated Management System, which apply the Internet and modern communication technology to the monitoring and analysis of the energy production, utilization, scheduling and efficiency on the basis of big data and cloud computing, so as to achieve the real-time detection, reporting and optimization.

2) IEEE 1888 is the link between the two key technologies (energy technology and information technology) of smart energy, and also is the prerequisite to build an Energy Integrated Management System. Aim to the city energy consumption, IEEE 1888 achieves the intelligent connectivity, collaboration services, remote control and unified management between ubiquitous network equipment and infrastructure within the scope of the Internet, so as to provides appropriate, remote and collaborative management solutions for the government departments, community managers, consumers and public service operators to build public environmental supervision and management mechanism, and to promote the industrial upgrading.

3) The Integrated Management System of smart energy will have a high degree of compatibility, democracy and voluntary, and will not accept any executive order and monopolistic behavior. The system also needs to break the self-enclosed information silos, and connected all the behaviors of energy production and utilization to achieve self-adjusting, self-organization and self-balancing. So the scientific and rational energy utilization will be gained so as to solve the energy, resource and environmental predicament and to realize the ecological civilization and sustainable development.
At present, many companies and government departments have established energy monitoring and control platform. Traditional energy technologies are gradually moving closer to the automation and information. With the popularization and application of IEEE 1888, energy technology and information technology will be further integration. Energy efficiency will continue to be improved, and the development and utilization of energy will become smarter and more intelligent.

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Standards Education Grants for Student Projects: Updated Instructions for Applications & Final Student Papers

By David Law, Vice-Chair, IEEE Standards Education Committee

4th Quarter 2014

In each issue of the IEEE Standards Education eZine, we provide information related to our Standards Education Grants Program. I am pleased to provide an end-of-year 2014 update on the awards given this year.

The Standards Education Committee (SEC) received 22 grant applications in 2014 and approved 18 of them. Between 2009 and 2014, the SEC approved 137 out of 227 grant applications.

IEEE Standards Education Grants were given to students at the following institutions in 2014:

- Amrita School of Engineering, India (2 grants)
- County College of Morris, NJ, USA
- DEI-Politecnico di Bari, Mofetta, Italy
- DeVry University, Ohio
- GIK Institute, Pakistan
- Institute of Electrodynamics of National Academy of Science of Ukraine
- Jamia Millia Islamia, New Delhi, India
- London Metropolitan University, UK
- Karunya University, India (2 grants)
- Texas A&M, College Station, TX, USA
- Peking University, China
- University of Alabama at Birmingham, USA
- University of Central Florida, Orlando, FL, USA
- University of Engineering & Technology, Pakistan
- University of New Mexico, Albuquerque, NM, USA
- University of Pennsylvania, Philadelphia, PA, USA

About the IEEE Standards Education Grants

The IEEE Standards Education Committee (SEC) will continue in 2015 to 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. For students participating in the grant program, it is an excellent way to receive extra funding for student projects, to learn about technical standards necessary for their career development, and to have their final papers peer-reviewed by an IEEE committee.

The purpose of the grants is to facilitate students studying, analysing and/or implementing standards in projects. This can be achieved by implementing an existing standard in hardware and/or software, analyzing the performance of a standard in a particular situation, testing compliance with, or alternatively adapting or extending a standard to fit a new scenario. Projects are expected to include a significant component working on the standard: projects that simply make use of standards through modules or libraries without significant design input will not be eligible for an award.

Updated Standards Education Grant Instructions

The IEEE Standards Education Committee has updated some of the criteria in the grant application in an effort to clarify for students the information needed in order to help them become successful grant recipients. Many times students have difficulty in completing Section 2 of the application where they are asked about the standards they plan to analyze or use in their projects.

Instructions in this section now include the following language.

- Provide a list of technical industry standards being analyzed and how they will be implemented to achieve your project goal. If you will be comparing two or more standards, please illustrate.
- Description or plan of how the project will proceed from beginning to end, including:
    - where in the project you will be choosing/considering the standards;
    - an explanation of how and when you will apply the standard(s) in the project.

As always, the following **NOTE** is included which contains the **key provision** for receiving an IEEE Standards Education Grant:

*****NOTE that using off-the-shelf modules, products or components built to industry standards does not satisfy this requirement. SEE FAQ's for more details and examples.**

So what does this mean, "off-the-shelf" modules?

If you propose to use a router with an integrated IEEE Std 802.11TM (WiFi®) access point to connect a laptop using WiFi to the internet as part of the project, this does not meet the criteria for receiving a grant. The router and the laptop have already implemented the requirements of IEEE 802.11 standard necessary to support the connection, so there really is nothing to do except connect the laptop to the access point. Hence while the IEEE 802.11 standard is being used, it has not been implemented, analysed, tested, adapted or extended by the project. The goal of gaining an understanding of the standard as part of the project would therefore not have been achieved. If on the other hand as part of the project, you propose to design and build part of an IEEE Std 802.11 (WiFi) access point, for example the Radio Frequency (RF) front end, this is an implementation of the standard and therefore would eligible for consideration for a grant.

Final Student Application Papers

Students who receive the IEEE Standards Education Grants must submit a final paper called a Student Application Paper. The final papers detail which industry technical standard(s) were 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.

New criteria for the final student application papers includes a mandatory section called, "Standards Applied." In this section, students must clearly state which standards were used, how they were applied, and explain what they learned. The paper must also include a Reference section that includes all of the standards applied in the project.

More Information

The IEEE Standards Education Grants will continue to be available through 2015. Applications may be submitted at any time during the year.

For more information about the IEEE Standards Education Grants and how to apply, please visit the IEEE Standards Education website, and be sure to read all of the application instructions and FAQ section.

All successfully accepted final papers are posted to the IEEE Student Application Papers website.

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 is a member of the IEEE-SA Standards Board, Chair of the IEEE-SA Standards Board Patent Committee (PatCom) and Vice-Chair of 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. He is a senior member of the IEEE.

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Introduction to Student Application Paper

With the rapid development of intelligent transportation systems (ITS), there is an increasing need for more efficient and reliable vehicle-to-vehicle (V2V) communications. V2V is critical in supporting both safety-centric ITS functions and the ever growing infotainment ITS applications. However, design and optimization of V2V are very challenging due to the extremely challenging channel conditions encountering fast time variation as well as noticeable multipath propagation.

The paper, IEEE 802.11p for V2V Communications, investigates the channel information acquisition problem in vehicular environments, and presents a novel channel estimator named constructed data pilot (CDP) estimator particularly designed for the IEEE 802.11p standard. In particular, unlike existing alternatives, this approach does not impose any modification on the current standard frame structure, thus ensuring maximal compatibility with existing IEEE 802.11p receivers. At the same time, the devised approach exhibits significant performance improvement in comprehensive simulated tests.

About the Use of the Standard

IEEE 802.11p standard is by far the most widely adopted standard in V2V communications. However, due to the wide variety of vehicular environments, its successful application is often impaired by insufficient treatment of the channel variation. This paper nicely compliments this prevalent standard, and has the potential of help promoting the application of IEEE 802.11p in a broader variety of more challenging vehicular environments.

Xiang Cheng, PhD, Senior Member IEEE,
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Modern Communications Research Institute
School of Electronics Engineering and Computing Sciences
Peking University, Beijing, P. R. China

Xiang Cheng (S'05-M'10-SM'13) received the PhD degree from Heriot-Watt University and the University of Edinburgh, Edinburgh, U.K., in 2009, where he received the Postgraduate Research Thesis Prize. He has been with Peking University, Bejing, China, since 2010, first as a Lecturer, and then as an Associate Professor since 2012. His current research interests include mobile propagation channel modeling and simulation, next generation mobile cellular systems, intelligent transportation systems, and hardware prototype development.

He has published more than 100 research papers in journals and conference proceedings. He received several best paper awards, including the IEEE International Conference on ITS Telecommunications (ITST 2012), the IEEE International Conference on Communications in China (ICCC 2013), and the 17th International IEEE Conference on Intelligent

Transportation Systems (ITSC 2014). Dr. Cheng received the "2009 Chinese National Award for Outstanding Overseas PhD Student" for his academic excellence and outstanding performance. He has served as Symposium Leading-Chair, Co-Chair, and a Member of the Technical Program Committee for several international conferences. He is now an Associate Editor for IEEE Transactions on Intelligent Transportation Systems.

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BEST OF STUDENT APPLICATION PAPERS

In each issue we publish selected "Best of Student Application Papers." These papers are written by students who have received IEEE Standards Education Grants to help with projects that include the use and implementation of technical standards.

IEEE 802.11p for Vehicle-to-Vehicle (V2V) Communications

By Zijun Zhao and Xiang Cheng

School of Electronics Engineering and Computer Science, Peking University, Beijing, P. R. China.

Abstract—This report focuses on the channel estimation problem in IEEE 802.11p based vehicle-to-vehicle (V2V) communications, which is very challenging in view of the extremely time-varying characteristics of mobile channels. Specifically, we propose a novel channel estimator named constructed data pilot (CDP) estimator for the current communication standards, by fully exploiting the channel correlation characteristics across two concatenated symbols. On the basis of the CDP estimator, we further resort to two efficient techniques to improve its performance over the entire signal-to-noise ratio (SNR) region. For the first technique, the time-variant mobile channel is modeled as a first-order Markov process so that the exact autocorrelation value of the two adjacent symbols can be derived. For the second technique, the SNR is estimated and serves as a priori information. Simulation results reveal that our proposed channel estimators outperform existing alternatives with lower computational complexity.

Index Terms—Orthogonal frequency division multiplexing (OFDM), IEEE 802.11p, vehicle-to-vehicle (V2V) communications, channel estimation, constructed data pilot (CDP).

I. INTRODUCTION

In the recent years, traffic accidents have become one of the leading causes for death all over the world, hence road safety has been greatly concerned. At the same time, we are facing the pressing needs for convenience and commercial oriented applications onboard. Vehicle-to-vehicle (V2V) communication, as a promising technique of intelligent transportation system, has been proposed to meet these needs. Over the past decade, V2V communications have attracted a lot of attention and various applications have been developed, such as the cooperative forward collision warning, traffic light optimal speed advisory, remote wireless diagnosis, etc. In 2010, after a few years test run, IEEE 802.11p standard, which is also referred to as dedicated short range communications standard, has been officially implemented.

Channel estimation technique plays an important role for the design of any communication systems. As far as we know, a precisely estimated channel response (CR) is critical for the follow-up equalization, demodulation, and decoding. Therefore, generally speaking, the accuracy of the channel estimation decides system performance. However, the maximum Doppler frequency in V2V communications can be four times higher than that in cellular scenarios with the same velocity. As a consequence, the time-varying characteristics of vehicular environments are extremely prominent which make the channel estimation very challenging.

For V2V communication systems, the design of channel estimation technique is much more difficult and significant than any other wireless systems. However, the IEEE 802.11p is originally derived from the well-known standard IEEE 802.11a, which was initially designed for relatively stationary indoor environments, without considering the impact of high mobility. This results in the current IEEE 802.11p standard having several deficiencies to properly suit high dynamic property of V2V channels. This report focuses on one of the most important challenge among these deficiencies: how to properly design the channel estimation module for IEEE 802.11p standard. In general, there are two basic manners. The first one needs the modification of the structure of the IEEE 802.11p, while the other one adheres to the structure of the IEEE 802.11p standard.

Obviously, modifying the standard frame structure is a shortcut to obtain satisfactory performance improvement as well as simplifying the estimation. However, the compatibility with other standard IEEE 802.11p receivers is severely impaired. Therefore, the majority of the current channel estimation schemes adopt the aforementioned second approach, i.e., keep the standard structure unchanged. Through comprehensive analysis, we observe that these existing schemes which belong to the second category exhibit some critical limitations. For example, most existing schemes require the receiver to have strong computational capability and some schemes rely on a priori channel statistics beforehand for estimating CRs. These limitations motivate us to design a new type of channel estimator. Our contributions in this report are summarized as follows.
1) Focusing on the limitations of existing channel estimation schemes, we propose a novel estimator named constructed data pilot (CDP), by exploiting the channel correlation characteristics of data symbols without any necessitation of a priori channel statistics.

2) We model the vehicular channel as a first-order Markov process. Thus, more accurate correlation values can be easily derived by means of the pilots inserted between data symbols, no matter which type of pilot pattern the standard follows.

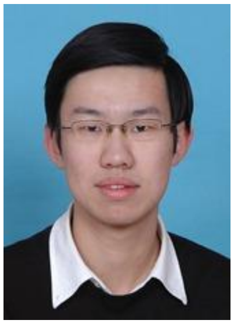
3) By implementing minor modifications, the proposed estimators can be extended for most of the current orthogonal frequency division multiplexing (OFDM) based communication standards under vehicular time-variant channels.

The rest of this report is organized as follows. In Section II, we introduce the IEEE 802.11p standard and the channel model we use as system model. Section III gives a brief overview of two existing channel estimation schemes, namely least square (LS) and spectral temporal averaging (STA). The proposed CDP estimator along with its two modifications are elaborated in Section IV. Then, comparisons of bit error rate (BER) and frame error rate

(FER) simulations, as well as computational complexity with the proposed estimators are presented in Section V. Finally, Section VI concludes this report.

Read the full paper.

Visit the IEEE Student Application Papers site to read more final student papers.



Zijun Zhao received the B. Eng. degree in optoelectronic information engineering from Beihang University (Beijing University of Aeronautics and Astronautics), Beijing, China, in 2011. He is currently working toward the Ph. D. degree at Peking University, Beijing, China. He received the Best Paper Award from IEEE International Conference on ITS Telecommunications (ITST 2012). His research interests include vehicle-to-vehicle communication and channel modeling.

Xiang Cheng (S'05-M'10-SM'13) received the PhD degree from Heriot-Watt University and the University of Edinburgh, Edinburgh, U.K., in 2009, where he received the Postgraduate Research Thesis Prize. He has been with Peking University, Bejing, China, since 2010, first as a Lecturer, and then as an Associate Professor since 2012. His current research interests include mobile propagation channel modeling and simulation, next generation mobile cellular systems, intelligent transportation systems, and hardware prototype development.

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Application of IEEE 802.15.4 Security Procedures in OpenWSN Protocol Stack

By Savio Sciancalepore, Student Member, IEEE, Giuseppe Piro, Member, IEEE, Gennaro Boggia, Senior Member, IEEE and Luigi Alfredo Grieco, Senior Member, IEEE

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Abstract—With the diffusion of the Internet of Things paradigm, even more researchers and industries worldwide are focusing their attention on the definition of optimized protocol architectures, able to offer a wide range of services in Lowpower and Lossy Networks. In this context, the OpenWSN project emerges as one of the most promising open-source protocol stack for IoT devices; it is based on the IEEE 802.15.4 radio and is particularly suitable for constrained devices. Unfortunately, at the time of this writing, it does not support security features defined by IEEE 802.15.4 specifications for the MAC layer. To bridge this gap, we present in this contribution a freeware and opensource implementation of security procedures for the OpenWSN protocol suite, which embraces security attributes stored into the MAC entity, security functions operating at the MAC layer, and cryptographic techniques used to execute encryption and decryption functionalities. To provide a further insight, we also evaluated, through real experiments conducted with the TelosB hardware platform, the impact that the adoption of security features has on both computational load and communication latencies. Our findings demonstrate that computational capabilities of constrained motes drastically influence the network operation, thus requiring the design of optimized and enhanced security services. We believe that the open source nature of the developed module could widely support all people involved in this research area.

I. INTRODUCTION

The emerging Internet of Things (IoT) paradigm introduces the possibility to create a capillary networking infrastructure, able to provide several ICT services, spanning several different contexts like transportation, logistics, healthcare, smart environment (home, office, plant), and personal/social domains [1]. This idea leads to the definition of a Low Power and Lossy Network (LLN), which is mainly composed by a large number of lowpower nodes that can establish short-range wireless connections among them and that can be connected to the Internet through gateway servers [2]. Such devices have several constraints in terms of computational capabilities, energy consumptions, and storage resources. As a consequence, the definition of suitable protocol stacks (that cover all aspects, from the application layer to the physical interface) is a key topic, which is currently attracting the attention of researchers, industries, and standardization bodies worldwide [3], [4], [5].

In this context, the IEEE 802.15.4 standard emerges as the leading enabling technology for short range low rate wireless communications [6]. In fact, it defines (i) physical and the Medium Access Control (MAC) layers for LLNs, (ii) two types of network nodes, i.e., Fully Function Device (FFD) and Reduced Function Device (RFD), that can build peer-to-peer or star networks, and (iii) advanced security features at the MAC layer. More recently, instead, the IEEE 802.15.4e specification has been published for introducing some amendments to the IEEE 802.15.4 standard [7]. Among its key features, the Time Synchronized Channel Hopping (TSCH) emerges as a novel MAC protocol, which better supports multi-hop communications in industrial applications.

To actualize the IoT vision and easy plug and play operations of smart devices in IPv6 networks, the ZigBee alliance and the Internet Engineering Task Force (IETF) have recently proposed and standardized novel solutions, based on the aforementioned IEEE 802.15.4 radio, at different layers of the protocol stack. At the same time, researchers and industries are looking at designing and developing innovative algorithms and approaches that optimize and/or extend what have been conceived within standardization efforts. In this context, the availability of sophisticated research instruments, which model and implement in real devices LLN-related protocols, can be very useful for better supporting research activities aiming at evaluating pros and cons of existing and novel solutions.

At the time of this writing, one of the most promising freeware and open-source implementation of IoT-compliant protocol stack for constrained devices has been developed within the OpenWSN project [8]. Nevertheless, despite it already offers a large number of protocols, including PHY and MAC layers defined in IEEE 802.15.4 and IEEE 802.15.4e specifications, as well as other high level protocols devised by the IETF, i.e., IPv6 over Low Power and Lossy Networks (6LoWPAN), Routing Protocol for Low Power and Lossy Network (RPL), and Constrained Application Protocol (CoAP), some important features are still not fully available. Among them, one of the most important lacks is the unavailability of security procedures and services defined by the IEEE 802.15.4 standard for the MAC layer.

The present contribution intends to overcome this weakness by proposing an open source implementation of IEEE 802.15.4 security features within the OpenWSN project. To this end, we properly extended the OpenWSN protocol stack by developing:

- MAC PIB attributes related to security aspects, i.e., tables and variables storing all the information needed to provide security services (including keys, devices' authorization, security levels, and so on);
- functions operating at the MAC-high layer, handling the inserting and the retrieving of security-related parameters and attributes introduced at the previous point;

- cryptographic techniques used to execute encryption and decryption functionalities, based on the Advanced Encryption Standard (AES) scheme.

We remark that the developed code is fully compliant with IEEE 802.15.4 specifications and it is integrated with the entire OpenWSN protocol stack (and, hence, it could be used for managing security services at the MAC layer independently from the set of configured upper layers). Moreover, the code is freely available at: http://telematics.poliba.it/openwsn_ieee802154_security.

To provide a further insight, we also evaluated, through real experiments, the impact that the provisioning of security features has on communication latencies. In particular, we set up a simple testbed composed by a couple of TelosB motes [9], that exchange a number of packets, which are protected at the MAC layer according to IEEE 802.15.4 specifications. Obtained results clearly show that the enabling of security features in constrained nodes requires additional computational efforts, which involves a not negligible growth of communication latencies.

The rest of the paper is organized as follows: Sec. II describes the IEEE 802.15.4 standard and focuses on security mechanisms it proposes; the description of the implemented security module within the OpenWSN project is provided in Sec. III; Sec. IV shows experimental results; finally, Sec. V draws conclusions and future works.

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Savio Sciancalepore was born in Molfetta (BA) on 14th of June, 1989. He studied at Politecnico di Bari (Italy), obtaining his bachelor degree in in 2011 and his master degree in 2013, both in Telecommunications Engineering. In 2013 he obtained the Cisco Certification "Cisco Certified Network Assistant" (CCNA). Since January 2014 he is a Ph.D. Student in Telecommunications Engineering at the Department of Electrical and Informational Engineeering (DEI), Politecnico di Bari. He is IEEE Student Member (#93120773) since August 2014. His major research interests are: security issues in Wireless Sensor Networks (WSN) and Internet of Things (IoT) and Machine-to-Machine (M2M) and IoT architectures and protocols.

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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

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