IEEE Standards Association (IEEE-SA)
Information & Opportunities for Global & Local Industry and Academia

INDICON 2011
Hyderabad, India
16 December 2011
Outline

Introductory Material
Jennie Steinhagen will provide an overview of the IEEE Standards Association.
John Walz will discuss the standards development process in IEEE Technical Societies.

Standards Education
Satish Aggarwal will begin with some information about Nuclear Power Engineering Standards and then move to a discussion of Standards Education efforts at IEEE.

Industry
Srikanth Chandrasekaran will discuss the India Standards Interest Group and the IEEE India Office.
Rahul Sinha will discuss the value of standards to industry.
Overview: IEEE and IEEE Standards Association

Jennie Steinhagen,
Global Strategy Manager, IEEE-SA
IEEE: Advancing Technology for Humanity

- 400,000+ members in 160+ countries; 45% outside the US
- 100,000+ student members; 1,855 student branches at colleges and universities in 80 countries
- 333 sections in 10 geographic regions worldwide
- 38 societies and 7 technical councils representing the wide range of IEEE technical interests
- 3 million documents in the IEEE Xplore Digital Library with more than 7 million downloads each month
- 1,300 standards and projects under development
- Publishes more than 150 transactions, journals and magazines
- 1,200 conferences in 78 countries
IEEE-SA Today

- Developer of globally recognized standards
- 1,300+ active standards
- Agreements with ISO and IEC (Dual Logo)
- 7,000 individual members; 200 corporate members
- Over 20,000 standards developers worldwide

IEEE Global Offices

Consensus ⇔ Collaboration ⇔ Solutions

Consensus  Due Process  Openness  Right of Appeal  Balance
IEEE and IEEE-SA Individual Membership = Reduced Dues Available

- 2012 IEEE reduced e-membership
  - $55 (USD) (2,872 INR)
  - $27 (USD) (1,410 INR) Students

- 2012 IEEE-SA reduced dues offer is $26 (1,358 INR) (instead of $49 full price)

- Discount offer for current and prospective IEEE Members and Society Affiliates who are:
  - Joining IEEE-SA for the first time
  - Higher-grade members only (students not eligible for offer)

- 2013 goal is to provide reduced dues offer through:
  - Online directly, not through a promotion code
  - More automated approach - which will also support the join IEEE-SA and renew IEEE-SA scenarios
Ways for Indian Engineers to Participate in IEEE Standards Development

1. **Start at the IEEE Standards Association home page**

2. **Find a project you are interested in**
   
   Search for PROJECTS by topic
   - [http://standards.ieee.org/develop/project/](http://standards.ieee.org/develop/project/)

   Search for WORKING GROUPS by topic:

   Search by SPONSOR (usually IEEE Societies):
   - [http://grouper.ieee.org/groups/detailed_index.html](http://grouper.ieee.org/groups/detailed_index.html)
   - The link says “Contact a Staff Liaison”

3. **Contact the Staff Liaison to join the working group**
Technical Society Standard Development Process

John Walz,
2012 President, IEEE Computer Society
IEEE Technical Societies/Councils

- Aerospace & Electronic Systems
- Antennas & Propagation
- Broadcast Technology
- Circuits & Systems
- Communications
- Components, Packaging, & Manufacturing Technology
- **Computer**
  - Computational Intelligence
  - Consumer Electronics
  - Control Systems
  - Council on Electronic Design Automation
  - Council on Superconductivity
  - Dielectrics & Electrical Insulation
  - Education
  - Electromagnetic Compatibility
  - Electron Devices
  - Engineering in Medicine & Biology
  - Geosciences & Remote Sensing
  - Industrial Electronics
  - Industry Applications
  - Information Theory
  - Intelligent Transportation Systems
- Instrumentation & Measurement
- Lasers & Electro-Optics
- Magnetics
- Microwave Theory & Techniques
- Nanotechnology Council
- Nuclear & Plasma Sciences
- Oceanic Engineering
- Power Electronics
- Power & Energy
- Product Safety Engineering
- Professional Communication
- Reliability
- Robotics & Automation
- Sensors Council
- Signal Processing
- Social Implications of Technology
- Solid-State Circuits
- Systems Council
- Systems, Man, & Cybernetics
- Technology Management Council
- Ultrasonics, Ferroelectrics, & Frequency Control
- Vehicular Technology
IEEE Standards Development Process

- **Idea!**
  - Maximum of 4 years

- **Project approval**
- **Develop draft standard**
- **Sponsor ballot**
- **Standards Board approval**
- **Publish standard**

- **Reaffirm, revise, or withdraw standard**
  - Maximum of 5 years

Process overseen by **sponsoring technical committee** and **IEEE-SA Standards Board**
Technical Support of Standards Development Process

Major value proposition of the IEEE sponsor society is based on its access to a global technical expertise pool.

Standards Working Group (WG)
Individual or entity-based

Society Technical Committee
- WG Liaison
- Expert Review
- Expert Advise
- Ad-Hoc Research Task Groups

Society Products & Services
- Conferences
- Publications
- Ancillary Products

Thanks to
Gelman, ComSoc
IEEE Products and Services Relevant to Standards

IEEE-CS Products:
Publications - Magazines & Journals, White Papers
Podcasts
Webinars
Videos
Tutorials, Workshops
eBooks (ReadyNotes)
Books

IEEE-CS Services:
Meetings and Conferences
User Groups
Engineering Certification
Standards Sponsorship

IEEE-SA Products:
■ Published standards

IEEE-SA Services:
■ Standards development Support
■ Publicity of standards

IEEE-SA ISTO Services
■ Compliance / Interoperability
■ Testing / certification
■ Corporation support

IEEE-USA Services
■ Publicity of standards

IEEE-EA Services
■ Education in Standardization
Big Tent for Standards Volunteers
Call for Volunteers on IEEE Standards

**Study** Groups
- Determine future standard need

**Working** Groups
- Contributors
- Reviewers

**Balloting** Groups
- Formal Reviewers

**User** Groups
- Q&A
- Deployments
- Best practices
- Helpful sources
Engagement Ladder of Interested Volunteers

Readers of listserv emails news
User Group members
SA Balloters
Study Group members
Working Group members / contributors
Volunteer Leaders
S2ES Committee at large members
S2ES Management Board
S2ES Committee members

Increased responsibility
Standards Working Group Roles

- **WG leadership team:**
  - Chair
  - Secretary
  - Editor
  - Web master, Archiver
  - Taxonomy, Vocabulary
  - Blog editors
  - Forum Moderators
  - News gathers / reporters
  - Industry sectors
  - Consultants
  - Education, researcher
Standards User Groups Can:

- Publicize our published standard
- Explain the intent of our standard
- Help to deploy /implementation our standard
- Explain standard usage with other standards
- Network professionals with common interests
- Champion cases studies, best practices
- Alert new resources, e.g. training events, tools
- Allow our standards volunteers to author supporting IP in the form of Podcasts, Webinars, Tutorials, eBooks, & Books
- Gather community feedback on the relevance and accuracy of our published standards
- Collect change requests for next version
- Recruit contributors to join the next WG
Call for Volunteers from India

- Anyone with a vested interest in the specific topic of the standard may join the standard development working group.
- Use [http://standards.ieee.org](http://standards.ieee.org) to signup as a working group member by typing your topic in “Find a Project or Group”.
- You can participate in person or via comments through email with the working group and working group chair.
- As long as your contributions are meaningful and add substance (not just questions) to the development of the standard, you will be listed as a working group member in the published standard.
  - This begins to establish you as an knowledgeable individual to potential employers and fellow colleagues.
  - Must join IEEE and IEEE-SA to ballot on a standard.
- You can cite the participation in standards on your resume.
- Potential to move into higher positions of volunteer responsibility within the Standards Committee and the sponsoring IEEE Society.
Nuclear Power Engineering Standards

Satish Aggarwal,
Chair, IEEE Nuclear Power Engineering Committee
IEEE Nuclear Power Engineering Committee (NPEC)

- NPEC is one of the Technical Committees of the IEEE Power & Energy Society (PES).
- NPEC scope covers all nuclear power related technical and standards writing activities within the IEEE.
- NPEC's principal subcommittees cover
  - Equipment Qualification
  - Seismic Qualification, Operating, Aging, Maintenance, Testing and Reliability
  - PRAs
  - Auxiliary Power
  - Human Factors and Control Facilities
  - Plant Security, Cyber Security
NPEC Responsibilities

1. Participating in and supporting goals and activities of IEEE.
2. Sponsorship of IEEE nuclear power plant standards.
3. Preparation of IEEE-coordinated responses to regulatory documents, e.g., draft regulatory guides, rule-making documents, and other documents released for public comment.
4. Liaison between IEEE and ANSI, ASME, ANS, ASTM and ISA and other international organizations (e.g., IEC, ISO, IAEA) in all nuclear power plant matters.
5. Management responsibility for all equipment qualification standards (by ANSI direction).
6. Management responsibility for national consensus on all nuclear power plant standards in electrical and electronic areas.
7. Responsibility for human factors standards within nuclear power industry.
NPEC Policy

- NPEC's established policy is to:
  - Improve, clarify, update and provide application guidance on the standards already produced,
  - Reflect lessons learned from the operating nuclear power plants world-wide, and
  - When appropriate, to produce new standards.

- In order to avoid conflicts, overlapping efforts and inefficient use of resources, NPEC has established liaison efforts with:
  - Outside of IEEE, there are liaisons established with ANS, IEC, IAEA, ASME, ISA, HFES, EPRI, INPO, NEI, NIRMA, DOE, Department of Commerce, and NRC.
  - Within IEEE, there are liaisons established with the Computer Society, the Nuclear Plasma Sciences Society, and the Reliability Society. Within the PES, there are liaisons established with other Technical Committees.
NPEC Subcommittees

Subcommittee 2 (SC2). Qualifications of safety-related systems and equipment in nuclear power generating stations.

Subcommittee 3 (SC3). Operation, surveillance, maintenance, and testing of safety-related systems and equipment in nuclear power generating stations, and the treatment of all matters relating to the analysis of the reliability of safety-related systems for nuclear facilities.

Subcommittee 4 (SC4). Electric systems which provide power to the safety-related equipment and systems in nuclear power generating stations.

Subcommittee 5 (SC5). Analysis of the human performance aspects of systems and equipment, the development of control facilities criteria, and the treatment of all matters relating to the analysis of the reliability of safety-related systems for nuclear facilities.

Subcommittee 6 (SC6). Safety-related systems engineering of the plant protection system, protective action system, reactor trip system, reactor protection system, engineering safety features, auxiliary supporting features, safety systems, post-accident monitoring display instrumentation, safe shutdown systems, and preventative interlocks. Included is the development of criteria, functional and design requirements from the systems aspect in standards for nuclear power generating stations.
NPEC Goals 2011-2012

1. Concentrate efforts in revising and updating all NPEC standards.

2. Develop new standards in the instrumentation & control area, including digital.

3. Publish a minimum of eight joint-logo International Electrotechnical Commission/Institute of Electrical and Electronic Engineers standards. Continue efforts in harmonizing nuclear safety standards, including close coordination with the International Atomic Energy Agency on safety guides.

4. Solicit participation by technical experts in working groups and subcommittees from those with nuclear expertise outside the U.S. to make NPEC a truly international technical committee.

5. Solicit participation from young engineers in working groups and/or subcommittees.
My Legacy

NPEC goals reflect that IEEE is clearly engaged in the revitalization of nuclear power. We are ready and willing to meet the emerging needs in the area of nuclear safety standards.

My mission is: “One Standard One Test Accepted Everywhere.”

I will aggressively work with IEC, IAEA (and many countries with nuclear power) to harmonize nuclear safety standards.

The Fukushima Factor: Applying Lessons Learned to the Nuclear Safety Stds.

I will continue to play an active role in ensuring safety of nuclear power plants by making IEEE nuclear safety standards stronger. I am committed to continually making nuclear power plants safer by incorporating lessons learned from reactor operations around the world, in IEEE nuclear standards.
Standards Education at IEEE

Satish Aggarwal,
Chair, IEEE Nuclear Power Engineering Committee
IEEE Board of Directors

Standards Education within IEEE Board Structure

Educational Activities

Standards Association

Member & Geographic Activities

IEEE-USA

Technical Activities

Publication Activities

Standards Education Committee
Why Standards Education Is Important to IEEE

Standards education recognizes the key role standards play within the engineering, technology and computing fields.

Knowledge of standards can help facilitate the transition from classroom to professional practice by aligning educational concepts with real-world applications.

Incorporating standards into the curriculum ...

- Benefits students and faculty mentors as they face challenging design processes
- Provides tools for use in learning about standards and their impact on design and development
IEEE Standards Education Offerings

**Present**
- Standards Education eZine
- Student Application Papers
- Workshops and Symposia
- Standards Education Speakers Bureau
- Case illustrations
- Tutorials
- Dictionary
- Glossary
- Announcements

**Future**
- Everything from “Present” list, plus ...
- TryStandards Portal
- Case studies
- Training Certificate program
- Standards videos
- Distributed content in coursework
- Faculty Lounge
IEEE Standards Education on the Web


Focal point for delivery of information on education about standards

Content is available at no charge.
IEEE Standards Education eZine

Launched in September 2011

Standards education electronic magazine, available at no charge.

Each issue has a theme—technical, regional.

   Next issue’s theme will be “Smart Grid,” Jan 2012

http://standardsmagazine.ieee-elearning.org

Worldwide audience of educators, students, practitioners

Working on a plan to translate eZine into Mandarin

Contributions to the eZine are in the form of refereed papers, feature articles, interviews, “Funny Pages”, etc.

We WELCOME contributions and ideas!
IEEE Student Application Paper Grants

SEC offers Grants to students and faculty mentors
Help with graduate and undergraduate last-year design projects that contain an industry standards component

- US $500 grants for students
- US $300 grants for faculty advisors

Projects must illustrate how specific standards were applied to a task in the classroom and describe how standards impacted the design process

Results are published as **Student Application Papers**
http://standardseducation.org/applications

Microsoft sponsors this program in sub-Saharan Africa
- SEC actively looking for a corporate sponsor in India
IEEE Standards Education Conference Activity

- Standards education at 2008 and 2010 IEEE Region 8 GOLD and Student Branch Congress in the U.K. and Belgium
- Standards workshop for the South Africa section in 2009
- Standards education tutorial at IEEE 802 plenary in U.S in 2009
- Standards track at IEEE MELECON (Mediterranean Electrotechnical Conference) 2010 in Malta
- Standards education speaker at Electronic Design & Solution (EDS) Fair in Japan 2010
- **Seminar at Indian Institute of Science during visit of IEEE-SA Corporate Advisory Group in 2010**
- Joint CNIS/IEEE Standards Education Workshop, Beijing, China, 2010
- Standards track at IEEE AFRICON 2011 in Zambia
- University of Strathclyde, Glasgow, Scotland, 2011
- **Series of workshops in India in Feb 2011 in Delhi, Bangalore, and Mumbai**
Example of a Popular Workshop Topic

Demystifying 802 Standards

A full day of immersion into the world of IEEE 802® Standards that covers each of the working groups developing standards in both the wired and wireless areas.
IEEE Standards Education Speakers Bureau

Supports our conference and university group meeting activities.

Sends speakers around the world to speak on the subject of Standards Education.

Seven speaking engagements in 2011
  – Including this one!

Contact us ...
  – If you are interested in becoming a speaker
  – If you know about a worthwhile event where a Standards Education speaker would be useful

Website for the program coming in 2012
IEEE Standards Education Case Illustrations and Tutorials

On the IEEE Standards Education website, there are two interactive case illustrations. Via the website, the SEC seeks more case illustrations and makes honoraria available.

- “Wireless Router Case Illustration.”
- “Multimode Mobile Phone Case Illustration.”

There are four interactive tutorials. Via the website, the SEC seeks more and makes honoraria available.

- “The Role of Standards in Engineering and Technology.”
- “The Role of Standards in Cellular Telephony.”
- “The Role of Standards in Electrical Power Systems.”
- “SystemVerilog.”
Snapshot of Tutorial

THE ROLE OF STANDARDS
in engineering and technology

This tutorial addresses the subject of technical standards. The standards discussed in this tutorial deal with subjects ranging from architecture and operations to physical, environmental and electrical aspects of a product or service. In the body of this tutorial the term "standards" is to be taken as "technical standards," as opposed to standards, such as ethical and business, which are also important but are not covered by this tutorial.

This core publication of 'The Role of Standards in Engineering and Technology' presents introductory material that is applicable to most classes of standards. It then makes use of existing standards from the telecommunications and information technology fields to provide direct examples on how standards and technical developments interact.

Each section in this module is navigated by a toolbar at the top of the page. This toolbar has five choices:

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<tr>
<th>TABLE OF CONTENTS</th>
<th>GLOSSARY</th>
<th>FURTHER READING</th>
<th>INDEX</th>
<th>GO TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Table of Contents listing all the sections in the module.</td>
<td>A list of all terms in the module with their definitions and links to further material, as appropriate.</td>
<td>A reading list for the module, linked to additional material as appropriate.</td>
<td>A full index of content in the module, linked as appropriate.</td>
<td>A menu to jump to different parts of the SETF site.</td>
</tr>
</tbody>
</table>

http://www.ieee.org/web/education/standards/tutorials.html
TO COME:

TryStandards: Global Standards Education and Standards Search

This portal would allow search for all available resources on standards education.

The portal would allow for search for all publicly available standards in IEEE Technical Fields of Interest.

Search by key words, topics, and standard numbers/titles
   For all available educational material
   For all available standards

User may be able to proceed from the landing page to purchase educational material or standards.

Not limited to English or English sites, though mostly in English

Timeline: Currently under development, with beta launch planned for January 2012.
IEEE Case Studies

SEC endorsed the development of a series of case studies on standards development, showing the intersection of technology, economics, and politics.

This idea was a popular suggestion from professors for post-graduate students.

In addition, ancillary material to help professors use case studies will be developed.

Timeline: First case study will be ready by year-end 2011. More planned in 2012. Full initial series by 2013.
TO COME:
Training Certificate Program

Professional Certificates in Standardization Topics

IEEE-developed and -branded multi-day workshops leading to professional certificates in focused standardization topics for practicing engineers.

Many topics possible: IP in standards, Nuclear Engineering, Cloud Computing, Sustainability, e.g.

“Training certificate” program, not “certification”

Timeline: 2012-2014 for development and rollout.
TO COME:

IEEE Standards Videos

Series of 20-minute lectures on standards basics to be developed and made available on the website at no charge.

- Standards professionals “visiting” the classroom
- Professors teaching undergrads asked us for this

Video interviews of technology experts working in standards development.

Interviews with people who have made a difference in the world through standards, conducted by professional interviewers.

Encourages real-world view and critical thinking for undergrad and postgrad students.

Timeline: Two videos on standards basics will be developed in 2012.
TO COME:

Distributed Content in Coursework

The “distributed model” for Standards Education is key to including standards in the engineering curriculum.

There are many ways to do this ...

- Developing standards chapters for existing popular engineering texts
- Creating ancillary materials for professors
- Promoting online materials such as case illustrations, tutorials, videos, IEEE eLearning Library

Timeline: Development of a strong body of coursework material will take place over the next 3-5 years. Organization of existing materials in the Faculty Lounge will occur in 2012.
TO COME: Faculty Lounge

A new web “room” on the Standards Education web site will be developed as a home for university-level products and services.

It will be featured in, and linked from, the Standards Education eZine

Designed to aid one of our most important resources in university-level Standards Education

Timeline: Faculty Lounge will be developed in 2012.
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IEEE-SA Standards Interest Group and IEEE India Office

Srikanth Chandrasekaran,
Chair, IEEE India Standards Interest Group
IEEE India Standards Interest Group

- Discussions initiated as part of IEEE-SA outreach sessions in India in April 2010
- Initiative from IEEE Bangalore Section
  - Driven by Bangalore ExeCom with support from IEEE-SA
  - Though this effort is incubated under the IEEE Bangalore Chapter, the SIG focus is India-wide with involvement from members from other IEEE Sections within India
- IEEE-SA setup a blog website to seek feedback from members
  - Blog sought input related to areas of interest, experience with standards development
  - Instrumental in creating the core focus areas within SIG
- Excellent platform to bring together volunteers from the community
  - Work on focused activities which are of key importance to the engineering community
  - Enable & drive standardization
SIG Focus Areas and Core Team

- The SIG activities, charter, & KPIs are driven by volunteers
  - Each focus area decides on projects and activities to be driven in that area
  - The IEEE-SA & IEEE Sections help the SIG connect with the right community/society to drive SIG efforts

- Identified key focus areas for SIG:
  - Software/IT focus area
  - Telecom/Computer Networking
  - Standards in Education
  - Cloud Computing Initiative
  - Smart Grid, Energy Efficiency
  - VLSI, EDA focus area

- IEEE-SA also helped with IEEE Mentor web site for the SIG
  - [https://mentor.ieee.org/standards-india/bp/StartPage](https://mentor.ieee.org/standards-india/bp/StartPage)
  - Email list servers have also been setup for each focus area
SIG Mission and Charter

- Increase participation & contribution from Indian community to existing & new standards
  - Opportunities to take leadership role in standards development

- India is growing with a lot of R&D being done; Indian companies are operating in global markets
  - Need to adhere to standards to compete in global markets

- Discuss areas that need to be explored from an Indian context and drive standards initiatives
INDIC 1908.1 Mobile Computing Standard

- Driven as part of the Software/IT focus area within SIG
- Proposal for standard for Indic Virtual Keyboard targeted towards mobile phones and tablets with touch interface
  - Currently no defined, independent standard for virtual keypads for Indian languages
  - Study group led by Arjuna Chavala (technical chair) with participation from Nokia, Samsung, DIT, and Brahmi Computing
  - CSSB (Communication Society Standards Board) has approved the draft PAR (Project Authorization Request) proposal: Oct ‘11
  - Next step is for the PAR approval process at the NESCOM (New Standards Committee) meeting
- Standard would include prototype reference implementation of device driver and software
- Proposed as Individual Standard
Smart Grid Initiative

- Discussions of IEEE-SA standards development & initiatives in the area of smart grids
- IEEE 2030, 1457, 1701.x standards
- Broad range of topics with involvement from different members/corporations: generation, storage, deployment, distribution, smart metering, IT
- Working with IEEE-ISTO & labs in India to driving testing/deployment of Smart Grid initiatives in India
- First Face-2-Face meeting in Sept 2011; Second Face-2-Face meeting in Dec 2011
- Plan for workshop in collaboration with IEEE PES; Special sessions on SG Standards at key conferences in 2011/2012

VLSI Community

- DASC (Design Automation Standards Committee) hosted a webinar on VLSI/EDA (Electronic Design Automation) related Standards activities within IEEE-SA
- Webinar was held in Sept 2011 with participation from the semiconductor engineers including technology developers, researchers and users across India
- Stan Krolikoski, Chair, DASC presented on the standards developed by IEEE DASC followed by presentations from Harish Mysore, Director, IEEE India and Sri Chandra, Chair IEEE SIG on IEEE India related activities
- Presentations and recorded audio will be made available on the IEEE-SA website
SIG Activities

- **Cloud Computing Initiative**
  - Working on identifying current standards participation in this area within India (ITU Cloud standards, DMTF, etc.)
  - Presentation from David Bernstein, WG chair for P2301 & 2302 (portability, Cloud/Intercloud interoperability)
  - Various industry alliances have been formed to address security, interoperability aspects in cloud computing

- **Wireless/Computer Networking**
  - New contributions under discussion for emergency warning system
  - Currently scoping out purpose & need for a project (PAR)
IEEE Membership in India

IEEE Members

- India Council with 11 Sections
  - Bangalore Section
  - Bombay Section
  - Calcutta Section
  - Delhi Section
  - Gujarat Section
  - Hyderabad Section
  - Kerala Section
  - Kharagpur Section
  - Madras Section
  - Pune Section
  - Uttar Pradesh Section

IEEE Members

= 37,207 (year-end 2010)

IEEE-SA Members

Individual = 72 (year-end 2010)
Corporate = 3
- Asian Institute of Management & Technology
- K7 Computing
- Net-O2 Technologies
IEEE India Office

IEEE office started functioning 1 June 2011.
Currently staffed by director and additional staff to be hired.

- Immense opportunity to grow membership and introduce member benefits program in India
- Digital Library penetration in Education, corporate sector and public sectors
- Bring international conferences to India. There is real demand for quality technical conferences in India.
- Humanitarian initiatives
- Standards initiatives
- Education programs
- Improve Section's and Chapter activities
The Value of Standards to Industry

Rahul Sinha,
Chair, Standards Education Subgroup
of IEEE India Standards Interest Group
Agenda

- Architecting Systems
- Standards and Systems Engineering
- Standards and Interoperability
- Wireless Standards
- Interfacing Academic Research and Standards
Architecting Systems

- Algorithms
- Architecture
- Feedback
- Data flow
- Control flow
- Interfaces

Feedback:
- Unstable systems can be stabilized
- Systems can be made responsive
- Drifting operating points of systems can be held constant
Systems Engineering

Requirements analysis

Define operational scenarios

Define system boundaries
Define Interfaces
Define utilization environments

Define functional requirements
Define performance requirements

Define modes Of operation
Define technical performance measures
Define design characteristics
ARCHITECTING SYSTEMS-INTERFACES

Module A
Module B
Module C

Module to module Interface standards
Data flow
Control flow

Common Infrastructure

Module to bus interface standards
Data flow
Control flow
INTERFACES

Describes the message and its contents

Describes how the messages are passed (protocols)

Describes how physical components fit together
**INTERFACE REQUIREMENTS**

- **System**
- **Modem interface**
- **Modem module**
- **RF Interface**
- **RF module**

- It can be logically expanded while maintaining capability
- It must address resource management
- It must address timing requirements
- It will identify and support capability exchange
Standards and Interoperability
Standards Compliance

Typical tests for checking Interoperability:
- Ability to connect in a timely manner.
- Ability to achieve a minimum data rate consistently.
- Ability to maintain a pre-defined quality of service.
- Ability to recover from interference and errors.
WiMax working groups

- Technical Steering Committee
- Service Provider Working group
  - Network WG
    - Technical WG
      - Certification WG
      - Regulatory WG
        - Global roaming WG

Air-interface, Network requirements

Network architecture, Protocols

Technical conformance specs, system profiles, certification test suites

Spectrum policy, Interoperability

Needs Standards development Test, Certification

Requirements Architecture +System Protocols Interoperability
LTE Technical Specification Groups (TSG)

TSG Radio Access Network
- Physical layer specs
- Radio interface architecture, and Protocols
- Radio resource management
- Technical conformance specs, and certification test suites

TSG Service and Systems
- Network architecture
- Network management
- Network requirements

TSG Core Networks and Terminals
- Call control,
- Session management
- Mobility management
- Internetworking
LTE-Network Architecture and Interfaces

- **Internet**
- **Packet Data Network gateway**
- **Mobility Management Entity**
- **Serving gateway**

- **X2 Interface between Base stations**
- **S1 Interface between the BS and the Core Network**

- **Radio interface**
LTE Radio Sub-system Protocol model

- Radio Resource Control
  - Mobility management
- Link access control layer
- Medium access control layer
- Physical layer

Control/measurements

Data Flow interfaces

Logical channels

Transport channels

Control flow interface
# Protocol Standards

A communication protocol defines the exchange of information between a number of communicating entities. The following elements need to be specified:

- **Protocol messages** that carry the information
- **Structure of protocol messages**
  (data elements carried by each message)
- **Message sequencing** for both normal behaviour and error cases.
- **Actions related to message exchange**
  both at the sending and the receiving end.
Interfacing Academic Research and Standards-Advantages

- IPR developed through academic research
- Introduce students to Standards and their effect on Technology and Trade
- Access to system level design guidelines in Standardization
- Develop international research co-operation (Academics, Industry, Standards bodies)
- Raise profile and reputation of scholars and university, among peers
Questions to consider before interfacing with a standards body

Research output

Useful to companies for new/existing products

Can be used by companies to create compatible technologies

Results map to the technology road-map of an identified technology

Integrates different Standards into a Platform framework/Architecture
### Interfacing Research and Standards

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<th>Consensus on requirements</th>
<th>Technical work</th>
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#### Timing
- Plan interfacing at the beginning of the project
- Ensure consortium partners can complete Standards work initiated by the project

#### Mechanisms to enable Interaction
- Participate in standardization processes as a project or a project partner
- Formal Submission preparation
- Consensus building
- Conflict resolution
Issues to consider when Integrating Research Projects and Standards

- Find the right Standards organization to interface with
- Align a project’s lifespan with the standardization lifecycle
- Identify commercial, confidentiality and IPR arrangements
- Define concrete action steps for preparing:
  - Tech specifications
  - Tech reports
  - Best practice guidelines
  - Reference implementations
REFERENCES


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