



Nano-Standards Activities

An Overview:

Where we've been
Where we are today
Where we're headed

Jonathan Tucker

Evelyn Hirt

IEEE Nanotechnology Council (NTC) – Standards
Committee

28 February 2008

IEEE Today

- **World's largest professional society dedicated to the advancement of technology**
 - Over 370,000 members in over 160 countries
 - Sponsors/'Cosponsors more than 450 conferences worldwide
 - Publishes over 30% of the world's literature in electrical and electronics engineering and computing
- **IEEE is grouped into geographic areas reflecting where we live and work ...**
 - 10 Geographic Regions
 - i. 324 Regional Sections
 - ii. 1, 616 Student Branches (>80,000 Student Members)
- **...and technical areas based on our fields and interests.**
 - 38 Societies and 6 Technical Councils (including the IEEE Nanotechnology Council)

IEEE's Role in Standards

- **The IEEE is a leading global developer of standards that underpin many of today's essential technologies.**
 - **IEEE is a central source of standardization in both traditional (e.g., power and energy, information technology, telecommunications, transportation, medical and healthcare, etc.) and emerging fields (e.g., nanotechnology and information assurance).**
 - **Standards are developed in a unique environment that builds consensus in an open process based on input from all interested parties.**
 - **Nearly 1,300 standards either completed or under development**
- **The IEEE Standards Association (IEEE-SA) leads IEEE's standards activities.**
 - **Draws on the expertise of the IEEE's 41 societies and technical councils.**
 - **The IEEE-SA itself contains nearly 20,000 individual and corporate participants who participate in standards activities.**

IEEE and Nanotechnology

- The IEEE Nanotechnology Council (NTC) was formed as a multidisciplinary group to advance and coordinate the many nanotechnology scientific, literary and educational endeavors within the IEEE.
- NTC has become a focal point in the field and is helping to unite the global nanotechnology community.
- The IEEE through the NTC has taken the lead in developing nanotechnology-based electronics standards.
 - Key drivers are:
 - i. The need for reproducibility of results
 - ii. International collaboration
 - iii. Common means for communicating across traditional scientific disciplines.

IEEE Nanotechnology Council Standards Committee (NTC-SC)

- Chair and NTC Liaison to IEEE Standards Association (IEEE-SA), Daniel Gamota
- Committee Members:
 - IEEE-SA Nanoelectronics Standards Roadmap (NESR) Initiative Co-Chairs, Jonathan Tucker and Evelyn Hirt
 - IEEE P1690™ Chair, Krishna Kalyanasundaram
 - IEEE P1620.2™ Chair, Paul Brazis
 - Ex-officio, Non-voting members:
 - i. IEEE NTC Staff Liaison, Soo Kim
 - ii. IEEE-SA primary member of the US Technical Advisory Group (TAG) to ISO TC229 (i.e., International Organization for Standardization technical committee on nanotechnologies), Cherry Tom
- Nano-Standards Linkages to 10 IEEE NTC Technical Committees (TCs)

IEEE Linkages to Other Standards Bodies

- **IEEE-SA provides representation and expertise to the international IEC TC113 WG3**
- **IEEE-SA is a member of the US TAG to ISO TC229 and the US TAG to IEC TC113.**
- **IEEE Agreement with IEC**
 - **IEC/IEEE Dual Logo Agreement**

IEC/IEEE Dual Logo Agreement

- Aimed at identifying suitable IEEE standards and draft standards as candidates for processing through the IEC full-consensus procedure at the country level.
- If the document is approved by the IEC, the logos of both organizations will appear on the document.

INTERNATIONAL
STANDARD

IEC
60488-2

First edition
2004-05

IEEE 488.2

Standard digital interface for programmable
instrumentation –

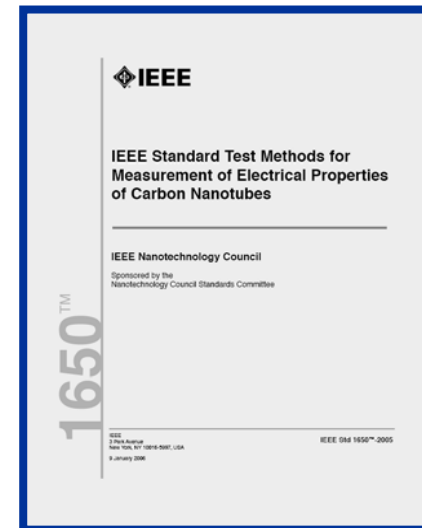
Part 2:
Codes, formats, protocols
and common commands



Reference number
IEC 60488-2(C):2004
IEEE Std. 488.2(C)-1992

Where we've been

- 2003 workshop at NIST for initial identification of key areas for standards
- IEEE 1650™-2005 Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes
 - Released January 2006




Where we are at today

- NTC-SC is overseeing the development of IEEE P1690™, *Standard Methods for the Characterization of Carbon Nanotubes Used as Additives in Bulk Materials.*
- NTC-SC is overseeing the development of IEEE P1620.2™, *Standard Methods for the Characterization of Printed and Organic Diode Bridges Structures for RF Devices.*
- NTC-SC is supporting the IEEE Nanoelectronics Standards Roadmap (NESR) initiative.

Nanoelectronics Standards Roadmap (NESR)

- Created as a framework through which the IEEE Standards Association (IEEE-SA) and the Nanoelectronics community may collaborate to define a roadmap for Nanoelectronics standards.
- Designed to facilitate the movement of nanotechnology innovations from a research to a market environment.
- Identify nanoelectronic technologies likely to generate products and services having high commercial and/or societal value
- Areas where new standards can aid rapid commercialization, technology transfer and diffusion into the market
- To Date: 700+ downloads, from 60+ countries



IEEE Nanotechnology Standards Roadmap Initiative
14 April 2007

Nanoelectronics Standards Roadmap

VERSION 1.0 - FOR PUBLIC COMMENT
(Please provide comments, mailto:nesr-comments@ieee.org)

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IEEE Standards Association (IEEE-SA)
New Technical Programs

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Where we're headed

- NTC-SC is overseeing the development of the first NESR working group for: *Nanomaterials Characterization and Use in Large Scale Electronics Manufacturing*.
 - IEEE-SA Study Groups to complete initial IEEE PARs (Project Authorization Requests)
- NTC-SC is supporting IEEE-SA efforts to promote IEEE P1650™, *IEEE Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes*, becoming a dual-logo standard with IEC.
- Evelyn Hirt and Jonathan Tucker are co-chairing a Nano-Standards Track at IEEE-NANO 2008, IEEE's premier Nanoscience conference, 18th-21st August 2008 in Arlington, Texas.

Where we're headed

- IEEE-SA is exploring support for adoption of its nanotechnology standards in these international bodies.
- The IEEE-SA, in collaboration with the NTC-SC, is pursuing IEEE becoming a Category D Liaison to IEC TC 113 WG3.
 - The liaison was approved at the TC 113 plenary in Singapore but it still has to go through a higher level of approval by IEC SMB

Priorities for Nano-Standards

Technology maturity

- **Well-enough understood to standardize**

Clear near-term applications

- **Standard eliminates near-term roadblocks – rapid payback**

High business value

- **Multiple device-circuit-application “threads”**

Fits IEEE role - Nanoelectronics

- **Does the definition of electronics stretch a bit at the nanoscale level?**

Continuing Challenges

- Prioritizing the best choice of standards to be developed.
- People, People, People!
 - Getting real people to work on these projects.
- Do we really know the best measurement and characterization processes?
 - What are the best practices?
- Are the latest measurement tools the right tools?
- International acceptance
- Environment, Health, Safety

Summary

- IEEE-SA global outreach to measurement experts and scientists to participate in standards development.
- IEEE-SA desires collaboration / cooperation with other organizations – especially for comment and input for NESR
- Desire to incorporate emerging science
 - New and disruptive materials & behaviors
- Achieve consistency in definitions/terms
- Balance between standardization vs innovation
- Gain consensus on standards priorities
 - Vertical vs horizontal vs end-to-end (integration)
 - Process vs product standards
 - Top-down strategic standards development vs incremental, spontaneous



**Fostering Technological Innovation And Excellence
For The Benefit Of Humanity**

Thank You

Appendix

IEEE Mission

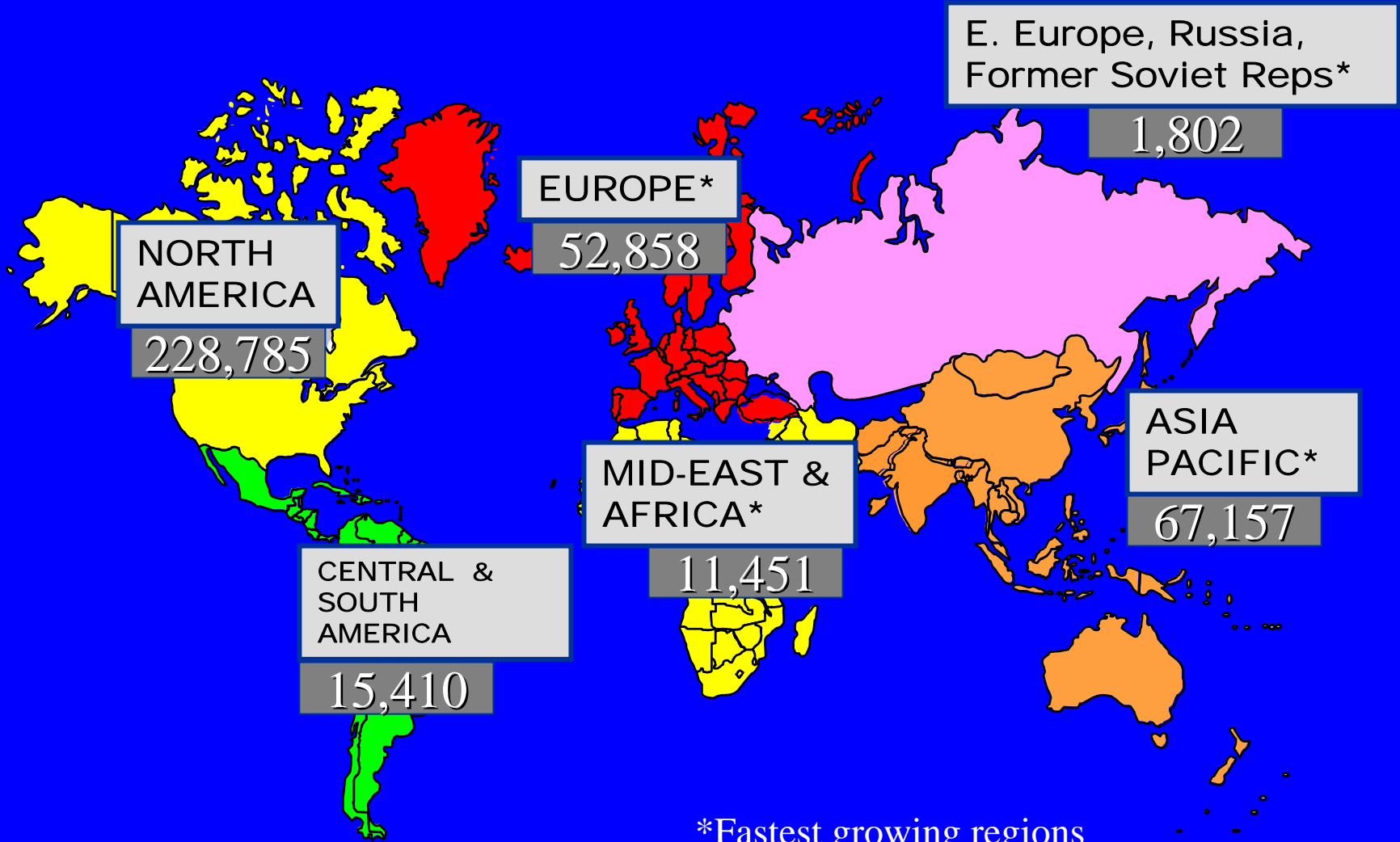
... Foster Technological Innovation And Excellence For The Benefit Of Humanity

● Core Values

- **Service to humanity:** leveraging technology and engineering to benefit human welfare; promoting public awareness and understanding of the engineering profession.
- **Global focus:** supporting and embracing the global nature of and need for technical work and engineering solutions.
- **Trust and respect:** promoting a culture where contributions at all levels are valued; encouraging member driven, volunteer-led, knowledge-based projects; building effective volunteer/staff partnerships.

IEEE Membership

2007 total membership = 376,328



Nano-Standards Linkages to IEEE NTC Technical Committees (TCs)

- TC-1, Nanorobotics and Nanomanufacturing
- TC-2, Nanobiomedicine
- TC-3, Nanofabrication
- TC-4, Nano-optics, Nano-optoelectronics and Nano-photonics
- TC-5, Spintronics and Nanomagnetism
- TC-6, Nanoelectronics
- TC-7, Nanosensors and Nanoactuators
- TC-8, Nanomaterials
- TC-9, Nanometrology and Nanocharacterization
- TC-10, Simulation and Modeling

Nanoelectronics Standards Roadmap (NESR) Accomplishments

- 2005: Generated input from groups of experts and variety of source documents into Decision Driven® Database by technical editor
- Jan 2006: Published initial draft of roadmap
- May & Oct 2006: Held workshops in NYC and San Jose, CA for prioritization and scoping of key standards in the materials and devices areas
 - Received support from SEMI for collaboration
- April 2007: Published NESR v1.0 for public review and comment.
- May 2007: Convened the IEEE NESR Town Hall meeting at NSTI Nanotech 2007, Santa Clara, CA to solicit support directly from the nanoscience community.
 - Received support from ITRS for collaboration
- To Date: 700+ downloads, from 60+ countries

IEEE Websites of Interest

- **IEEE-SA**
 - <http://standards.ieee.org/>
- **List of Formal Liaisons between IEEE committees and other Standards Developers**
 - http://standards.ieee.org/intl/cp_formal_liason.html
- **NESR v1.0 available at:**
http://standards.ieee.org/getieee/nano/nanoelectronics_roadmap_v1.pdf
- **Procedure for Submitting IEEE Standards as IEC/IEEE Dual Logo Documents is available at:**
 - <http://standards.ieee.org/intl/iec-submittal-proc.pdf>
- **IEC-IEEE Dual Logo Maintenance Procedure is available at:**
 - <http://standards.ieee.org/intl/maint-proc-written.pdf>
- **List of IEEE Documents Adopted as IEC/IEEE Dual Logo Documents at**
 - http://standards.ieee.org/intl/dual_logo.html