Annual Conference of the Prognostics and Health Management Society 2015
Oct 18 – 24, 2015, Diego, CA

IEEE PHM Standard Framework for Prognostics and Health Management of Electronic Systems

Sony Mathew

Schlumberger

Standards

- Simplify product development
- Speed time-to-market
- Help in development and implementation of new technologies
- Ensure consistent protocols that can be universally understood and adopted
- Ensure product functionality and reliability
- Ensure compatibility and interoperability
- Make it easier to understand and compare competing products
- Help verify the credibility of new products
- Support consumer safety and public health

Need for a Standard on PHM

- No standardized definition of terms used in PHM.
- Researchers have developed a variety of approaches, methods, and tools that are useful for PHM.
  - There is a lack of real visibility into these tools.
  - Lack of uniformity in application of these tools.
  - Lack of consistency in their demonstrated results.
- No clear compatibility and interoperability of PHM technology .
- Not easy to understand and compare different methodologies, algorithms and products related to PHM.
- There is a need for documented guidance that will encourage practitioners to invest the resources necessary to develop and put PHM techniques into practice.

IEEE Standard for PHM

- **IEEE Std. No.:** P1856
- **Title:** Standard Framework for Prognostics and Health Management of Electronic Systems
- **Type of Document:** Standard
- **Life Cycle:** Full Use
- **Working Group Chair:** Michael Pecht
- **Sponsoring Society and Committee:** IEEE Reliability Society/IEEE Reliability (RS/SC)
- **Working Group:** Prognostics and Health Management of Electronic Systems (RS/SC/PHM).

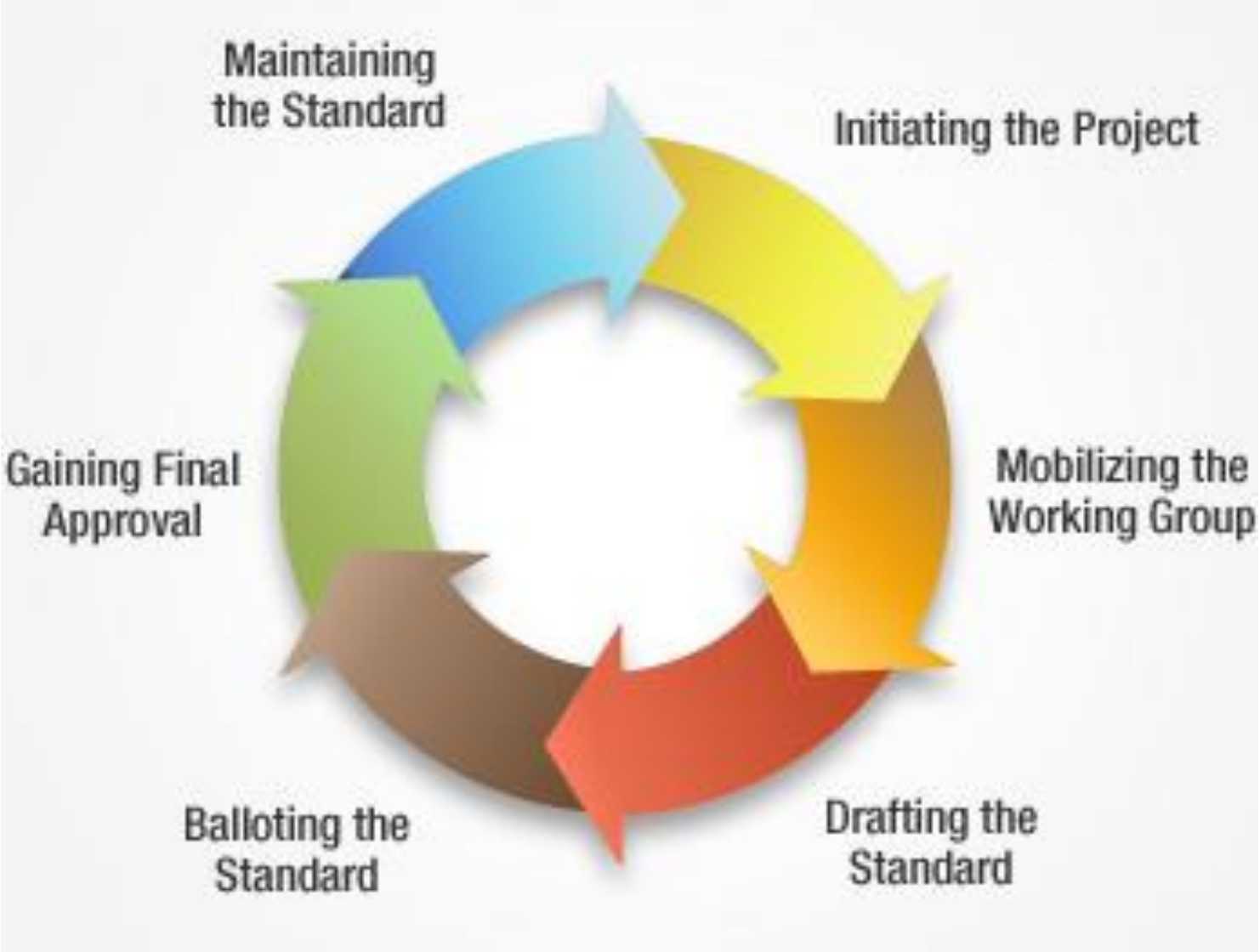
Scope and Purpose

- This standard describes a **normative** framework for classifying PHM capability and for planning the development of PHM for a system or product.
- This standard provides **information** to aid practitioners in the selection of PHM strategies and approaches to meet their needs.
- The purpose of this standard is to **classify and define** the concepts involved in PHM of electronic systems, and to provide a standard framework to **guide** practitioners to implement PHM for complex electronic components and systems.
- **Note:-** it is possible to extend the core principles described in this document to other application domains, such as systems comprising electro-mechanical, mechanical, and structural elements.

IEEE Standards Association

- IEEE is the world's largest professional association for the advancement of technology.
- Today, IEEE is one of the world's leading global standards development organizations.
- The IEEE Standards Association (IEEE-SA) oversees the IEEE standards development process.
- The IEEE-SA is governed by the Board of Governors (BOG) who are elected by IEEE-SA Members.
- The IEEE-SA Standards Board provides guidelines and oversees the process and policies that support standards development.

IEEE Standards Development Lifecycle



Basic Principles of Standard Development

- Due process: having highly visible procedures for standards creation and following them
- Openness: ensures all interested parties can participate actively in the standards development process
- Consensus: a clearly defined percentage of those in a balloting group vote to approve a draft of a standard
- Balance: balloting groups include all interested parties and avoid an overwhelming influence by any one party
- Right of appeal: anyone to appeal a standards development decision at any point, before or after a standard has been approved

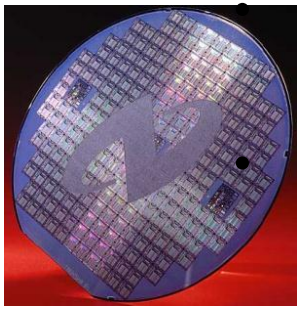
Our WG Members and Meeting

- WG Members:
  - More than 120 experts in the field of PHM, reliability, maintenance, CBM, Control systems, Systems Engineering.
  - 18 countries
  - More than 80 organizations including consumer electronics, aerospace, nuclear energy, oil & gas, medical electronics, defense industry, military, research and academia.
- Working Group Telecons:
  - 1st Wednesday of every month
  - Time - 10 am Eastern Time, USA
- In Person Meeting of Working Group - IEEE PHM Conference.

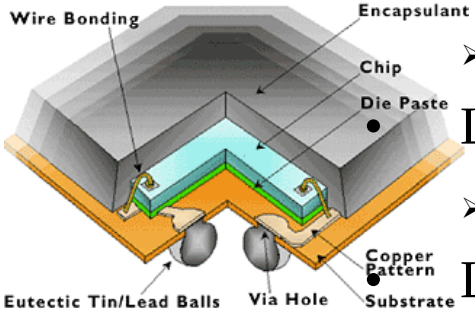
Challenges for Electronics Industry

- Shorter time to market
- Higher density of components than mechanical devices
- Constant upgrades / faster obsolescence
- Imperfect screening and qualification standards
- Significant numbers of field failures turn out to be no trouble found (NTF)
- Improve customer satisfaction but reduce price.
- Life cycle management
  - WEEE and RoHS legislations
  - Repair or replace
  - Logistics

Levels for Electronics



- Level 0: on–chip (Device Level)
  - die and metallization
- Level 1: the part and package (Component)
  - resistor, capacitor, wirebond, lead frame and encapsulant



- Level 2: the circuit card assembly (Board)
  - circuit boards and solder joints
- Level 3: the box, chassis (Syb-system)
  - hard drive, Line Replaceable Unit box
- Level 4: electronic product, system (System)
  - notebook computer, field communications unit

- Level 5: Multi electronic systems (System of Systems)
  - Aircraft communication, navigation and identification (CNI) systems, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

Challenges in PHM for Electronics (1/2)

- Electronic systems are complex.
- Relatively few fielded prognostic systems.
- PHM not part of the conceptual design of the system.
- Inadequate physics based models.
- Identification and selection of precursor parameters to monitor.
- Sensors for PHM. Availability and selection criteria.
- Algorithms for prediction. (Which algorithm is the best? What about uncertainties in the initial modeling of the system).
- Accounting for aging of systems. (Shift in normal behavior over a period of time/ usage).
- Intermittent Failures.

Challenges in PHM for Electronics (2/2)

- Integration of canary devices on host systems.
- Software-hardware interactions. How do you account for hardware failures caused by software glitches and vice-versa?
- Data fusion and fault isolation at the system-of-systems level.
- Implementation at enterprise level.
- Changing the maintenance culture.
- Education: lack of trained professionals in PHM.
- Business Case: quantifying the cost of implementation of PHM vs maintenance savings.
- Regulatory issues.
- Lack of standards for PHM.

Adaptability

- How can standards evolve to address adaptive and reconfigurable PHM implementations across the supply chain over the life cycle?
- Standard:- PHM system performance shall be tracked over time to determine if a need exists to either update the PHM system (e.g. models, instrumentation, algorithms, rules, etc.) or performance measurement methods and metrics.
- Development of IEEE Standard/Guide on PHM Metrics as addendum to existing standard.

Thank You