



High Reliability Electronics Virtual (HiREV) Center Overview

NASA NEPP ETW

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Outline

- HiREV Mission & Strategy
- HiREV Team
- HiREV Status
- Technology Forecasting
- Reliability Science
- Prequalification
- Interaction with Community of Practice
- Summary

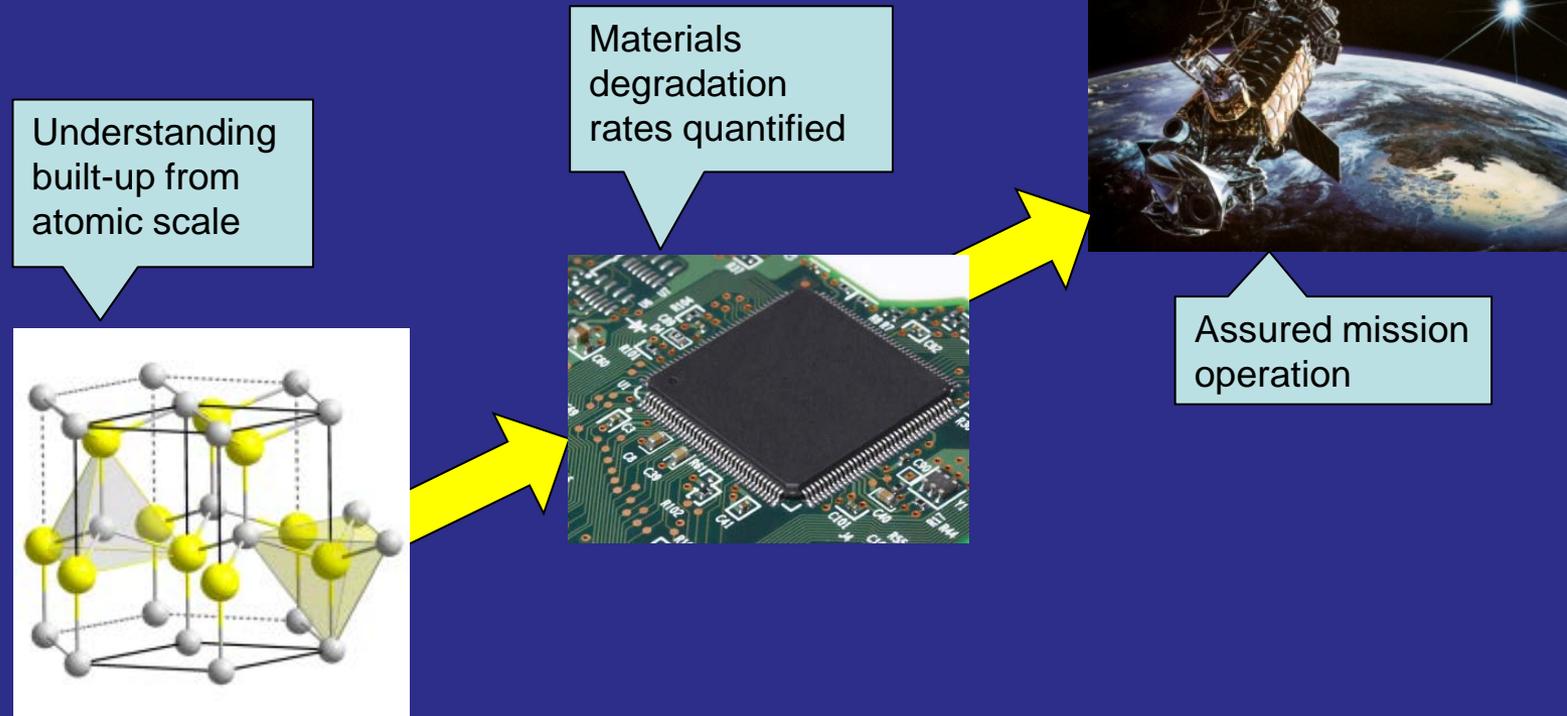
HiREV Mission



The mission of HiREV is to **ensure the timely delivery of independent, high-fidelity lifetime estimates for electronic device technologies** and their corresponding **underlying physics and chemistry of degradation and failure** to enable their qualification for critical DoD and NSS applications. HiREV will identify and respond to community needs by:

- Creating and maintaining partnerships and capabilities with government, industry and academia through a virtual center concept
- Assessing current qualification practices - identify and address shortfalls
- Forecasting emerging electronics technologies and opportunities; assessing needs; advocating and performing prequalification studies

High Level Team Strategy



Preserve knowledge in updated lifetime models, standards, practices, processes and techniques for industry – encourage and sponsor industry participation

HiREV Leadership Team



Systems Engineering

Tom Burns
Byron Knight



Space Vehicles

Andy Motes

Materials and Manufacturing

Don Dorsey

Sensors

Chris Bozada



National Systems Group

Rich Haas

Physical Sciences Laboratories

Jon Osborn

Electronics and Sensors Division

Larry Harzstark



Space and Missile Command

Dave Davis



Defense Microelectronics Activity

Dan Marrujo

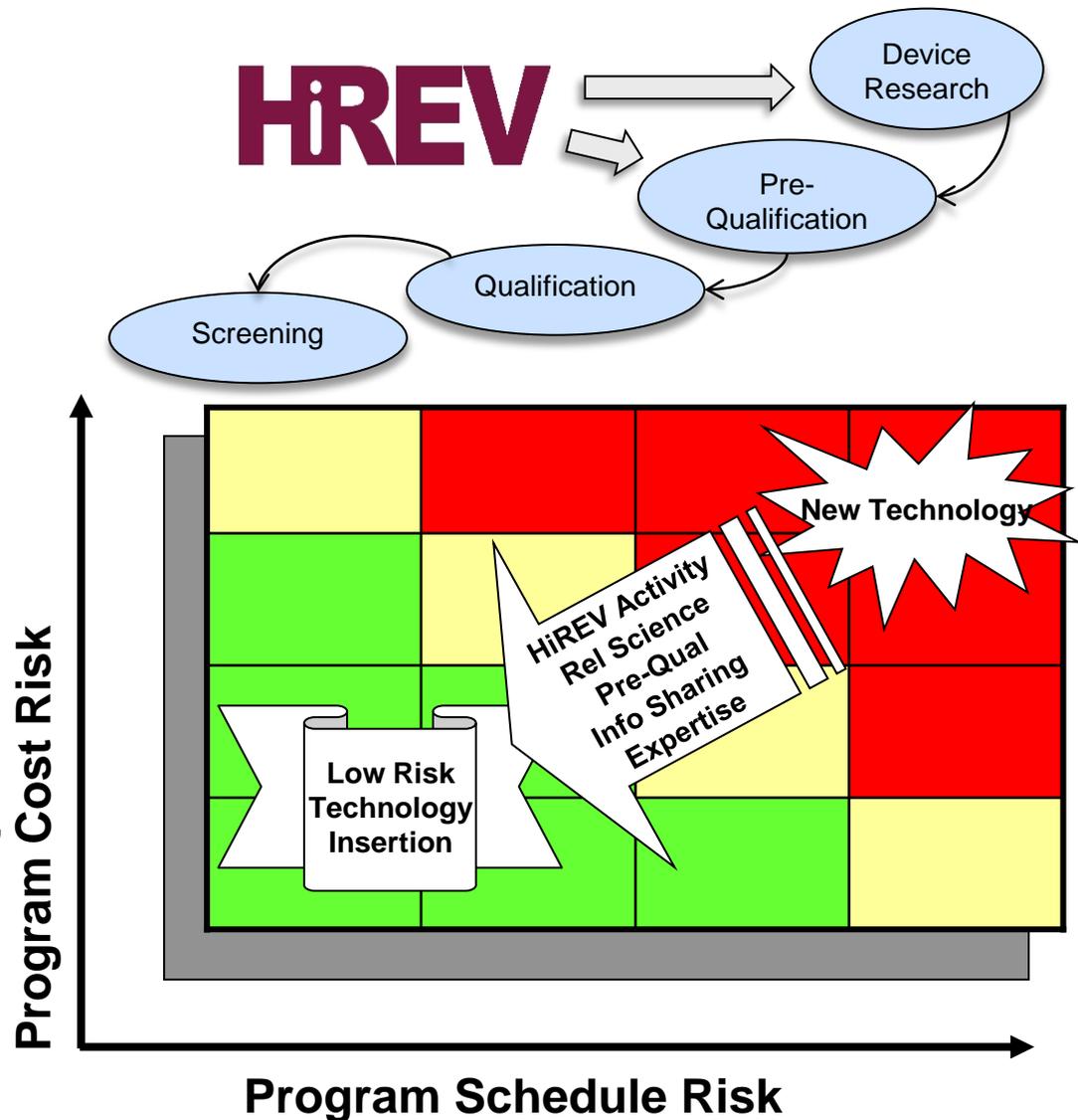


NASA

Ken Label

Refined ConOps

- **Technology Forecast**
Poll acquisition, prime and manufacturer communities
- **Reliability Science**
Physics and chemistry based models, tools and techniques
- **Prequalification**
Lit Reviews, test chip design and fab, testing, analysis, etc
- **Information Sharing**
Data, measurements, techniques, models, standards, guidelines, etc



Technology Forecasting



- **Goal - Anticipate the needs of the NSS acquisition community**
 - **Prequalify to verify that a technology is ready for qualification and insertion**
 - **Don't duplicate what is being done or already has been done**
 - **Identify knowledge gaps**
- **Approach**
 - **Develop a comprehensive electronics parts list for one relevant system in each domain of interest (Space/Air/Ground)**
 - **Develop a comprehensive list of electronic components by device technology effort/foundry, e.g. 9LP, 9SF, etc.**
 - **Gather available information from the community on the electronic device technologies including test results, projections, roadmaps and schedules**

Prioritize Forecasting Effort

Technology Roadmap



	Near Term 2012	Mid Term 2012-2014	Longer Term > 2015
Digital	<ul style="list-style-type: none"> ▪ CMOS (150, 90, 65nm) ▪ Xilinx V-4 FPGA (90nm) ▪ HNY HX5000 (150nm) ▪ NG SONOS EEPROM 	<ul style="list-style-type: none"> ▪ CMOS (90, 65, 45nm) ▪ Xilinx V-5 FPGA (65nm) ▪ MRAM (HNY, Aeroflex) 	<ul style="list-style-type: none"> ▪ CMOS (32, 28, 22nm) ▪ Xilinx V-7 FPGA (28nm) ▪ BAE/Achronix (150nm) ▪ CNTs ▪ Freescale 45nm SOI
Analog/ Mixed Signal	<ul style="list-style-type: none"> ▪ SERDES (HNY/BAE 150nm) 	<ul style="list-style-type: none"> ▪ CMOS (90, 65, 45nm) ▪ SiGe BiCMOS (130, 90nm) 	<ul style="list-style-type: none"> ▪ CMOS (32nm) ▪ InP HBT
Power		<ul style="list-style-type: none"> ▪ GaN ▪ SiC 	<ul style="list-style-type: none"> ▪ GaN ▪ SiC

*Packaging for all new technologies

HiREV Reliability Science Focus



- Improved Models of Device Operation and Degradation
 - Get the stressor distribution right
 - Both **External** (T_{BP} , V_D , etc.) and resulting **Internal** (T_{CH} , T_e , E field, etc.)
 - Probe, understand, model the complex physical and chemical interactions
 - Predict behavior in areas inaccessible to measurements
 - Interpret stress test and characterization results
 - Develop multi-stressor degradation models
 - Add fidelity to interpretation of existing stress tests
 - Example: *What if* the R_{TH} was wrong?
 - Example: Alternate statistical interpretations of data
- Improved Characterization Techniques
 - Improve sample preparation (spatial specificity and sample quality)
 - Drive spatial resolution to the atomic level
 - Track evolution of chemistry, structure, charge/defect populations
 - Improve understanding of thermal, electrical, chemical and mechanical behavior

HiREV Reliability Science

University Activities



HiREV University Tasks:

- Arizona State University – Electron Microscopy, Modeling
- Georgia Institute of Technology – Thermometry, Strain Behavior, Modeling
- Iowa State University – Reliability Statistics
- Miami University – Thermodynamics and Diffusion
- Naval Postgraduate School – GaN HEMT Modeling (Transient Behavior)
- Purdue University – Multi-Scale Device Modeling; Hot Electron Spectroscopy
- SUNY Albany – End of Life Modeling Analysis
- UC Santa Cruz – Transient Device Thermography
- Vanderbilt University – Modeling/Radiation Effects

Reliability MURIs (Close Interaction):

- AFOSR – University of Florida
- ONR – University of California-Santa Barbara led (MIT, CMU, OSU, NCSU, UM, Bristol and Vanderbilt)



Prequalification



- **Goal - Determine whether or not a specific device technology is “qualifiable” for specific missions**
- **Approach**
 - **Develop quantitative analysis techniques to evaluate current practices – cost/benefits/risks**
 - **Currently evaluating JEP 118 (GaAs FETs and Mil Perf 38535 Appendix H)**
 - **Next on list is Mil Handbook 217**
 - **Develop and refine prequalification checklist – Initial checklist complete**
 - **Use checklist to survey existing knowledge**
 - **Develop cost and schedule to validate knowledge and gather missing knowledge**
 - **Perform prequalification studies on customer demand**
 - **Efforts are similar to Root Cause Investigations**
 - **Provide capability to perform multiple studies simultaneously**
 - **Support DARPA Integrity and Reliability of Integrated Circuits (IRIS)**

DoD has High Interest in IRIS



- DoD lacks perceptivity and oversight in:
 - Synthesis algorithms
 - Third party IP
 - Foreign suppliers
 - Foundry processes
- IRIS success provides affordable, timely and independent assessment of critical part lifetime (to specific lot and wafer, if known) - verification of actual reliability versus expected lifetime

IRIS Minimizes Dependence on Supply Chain Trust

IRIS Reliability Specific Goals

(From DARPA-BAA-10-33)



“... ICs of interest include all newly developed Complementary Metal-Oxide-Semiconductor (CMOS)-based ICs especially those acquired ICs in which there is not full visibility into the design and/or fabrication sequences...”

“...to derive the functionality of an IC to determine unambiguously if malicious modifications have been made to that IC and to accurately determine the ICs useful lifespan ...”

“... to develop innovative test technologies and processes that can determine an ICs useful lifespan based on a significantly reduced number of samples...”



Interaction with Community of Practice



- **Goal – Be part of the existing community**
- **Approach**
 - **Work with sponsors to align mission, effort, culture to existing community**
 - **Provide information sharing infrastructure**
 - **Partner with Aerospace Corporation's MRQW (early Dec) and NASA's NEPP ETW (June) yearly to share information**

Quid Pro Quo



- “Something given or done in exchange for something else”
- No single entity can afford or perform the evaluation of all semiconductor materials for reliability assessment
- Accelerate advancements of semiconductor reliability science
- Allows for quick turnaround tests
- Information sharing capability
- Government organizations reliability portfolio can leverage overall HiREV programs capabilities

Current Paths for Collaboration



Government



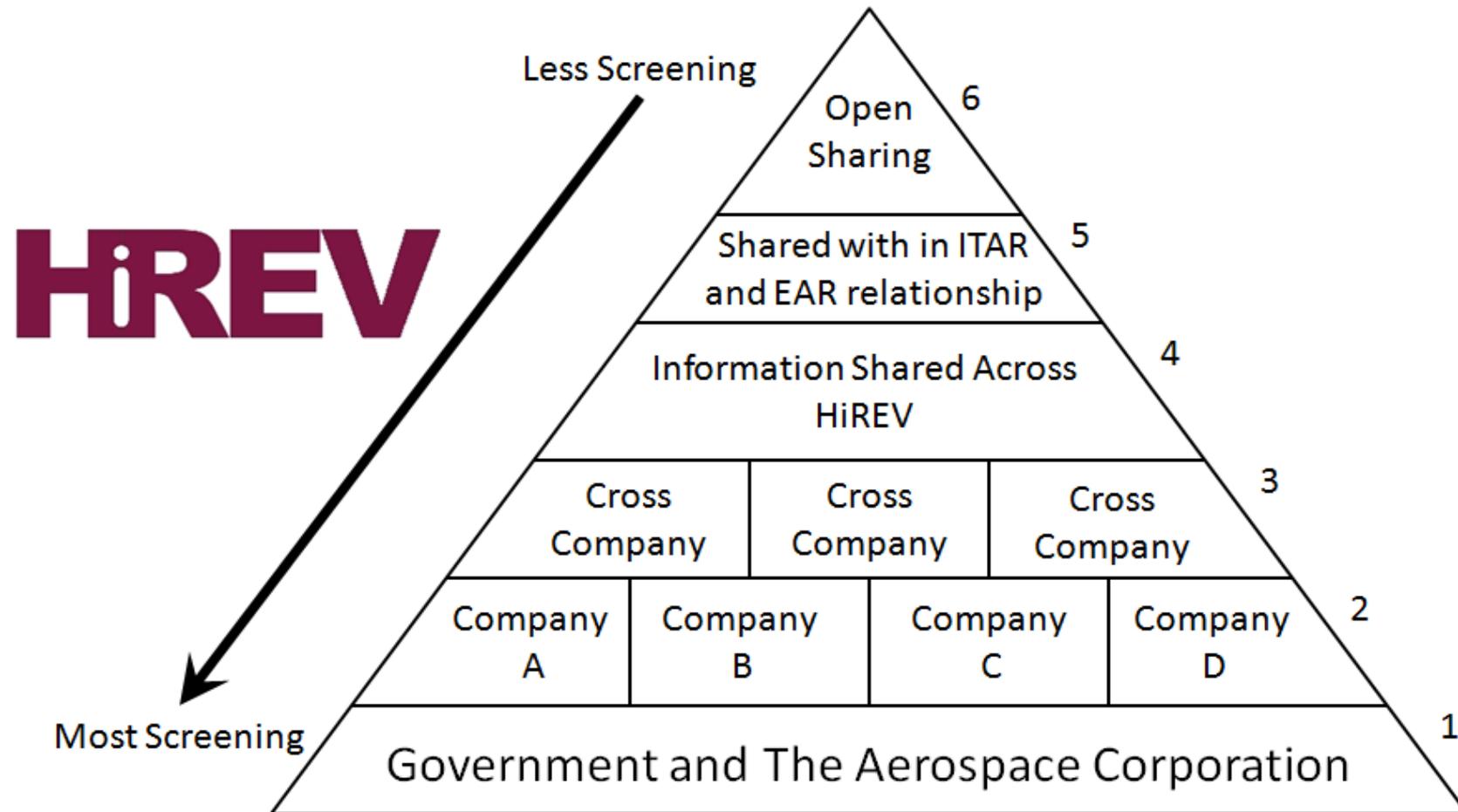
Industry



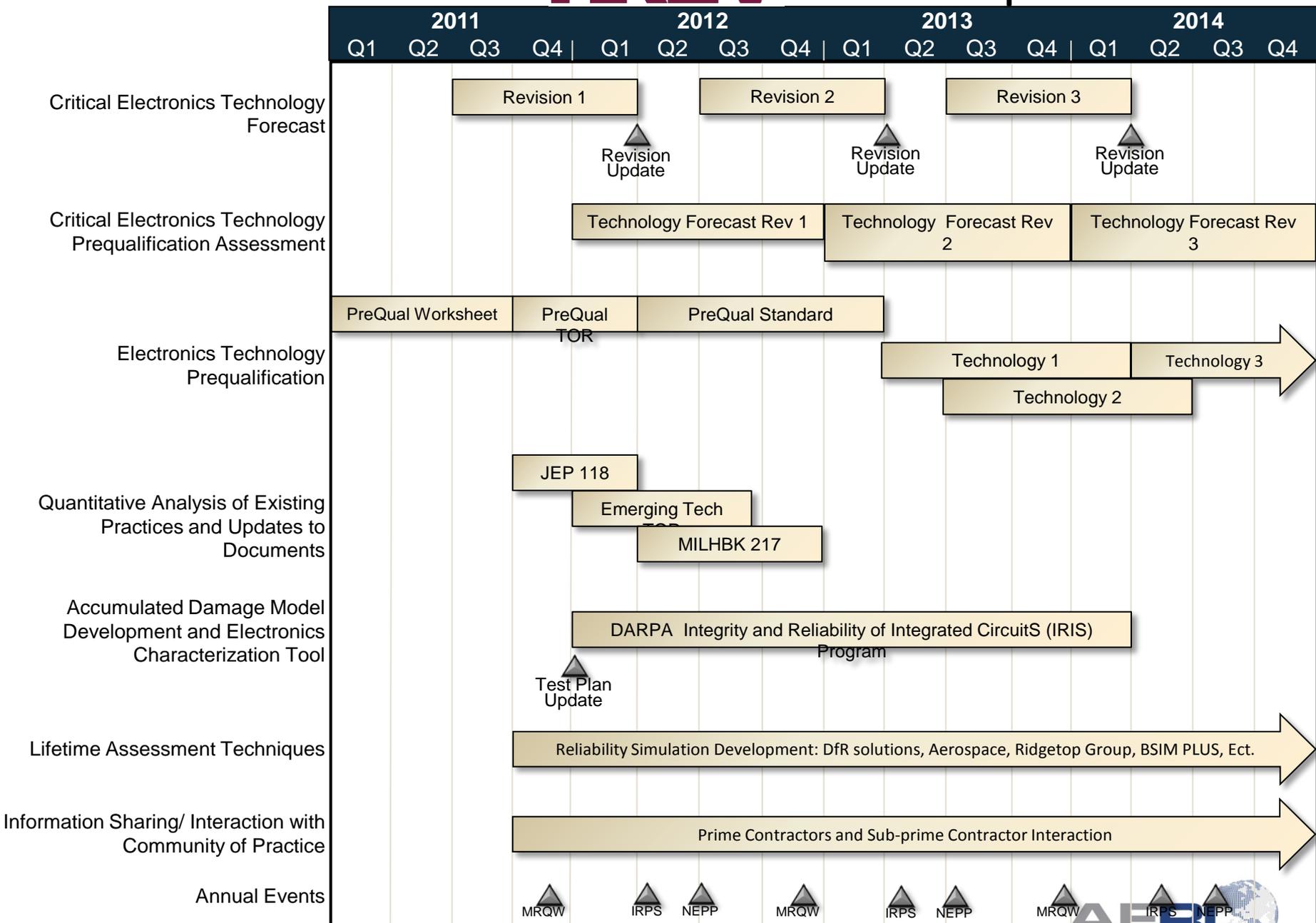
HiREV Information Architecture



HiREV Information Architecture (HIA)



HiREV Roadmap



Summary



- HiREV Center has expanded the core team and continues to make contributions
- Progress in multiple areas:
 - Information Sharing – Lessons Learned
 - Prequalification approach refined
 - Preliminary Technology Forecast Completed
 - Multiple Reliability Science Advances
- DARPA IRIS (**I**ntegrity and **R**eliability of **I**ntegrated **C**ircuit**S**)