Office of the Secretary of Defense

Defense Microelectronics Activity (DMEA)

RoHS/Pb-free electronics for DoD?

Managing the Pb-free electronics transition

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Outline

- Background
- Risks and Impacts
- Pb-free Guidance Efforts
- PERM
- Pb-free Electronics Risk Reduction Project
- DoD Technology Focus Team
- Summary

Background

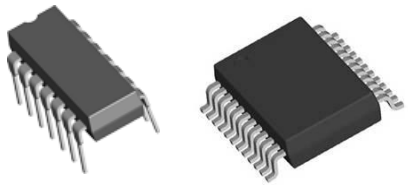
There is a global transition to Lead-free

- **Reduction of Hazardous Substances (RoHS)**
  - EU Directive banning "placing on market" new electronic equipment containing specific levels of the following after July 1, 2006
    - **Lead**, Cadmium, Mercury, hexavalent chromium, polybrominated biphenyl (PBB), polybrominated diphenyl ether (PBDE) flame retardants
- **Waste Electrical and Electronic Equipment Directive (WEEE)**
  - EU directive aims to minimize the impact of electronic waste
  - Encourages and sets criteria for collection, treatment, recycling
  - Makes the *producer responsible*
- Related/updated legislation in place or underway in China, Japan, Korea, California, EU, and others

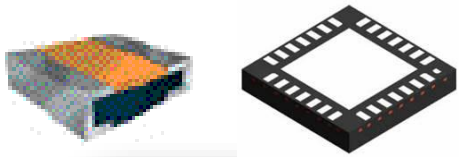
Lead-free brings new and re-emerging failure modes in electronics

How Products are Affected

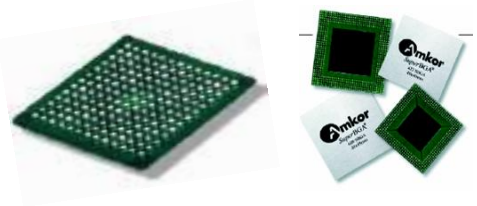
Leadframe Finish



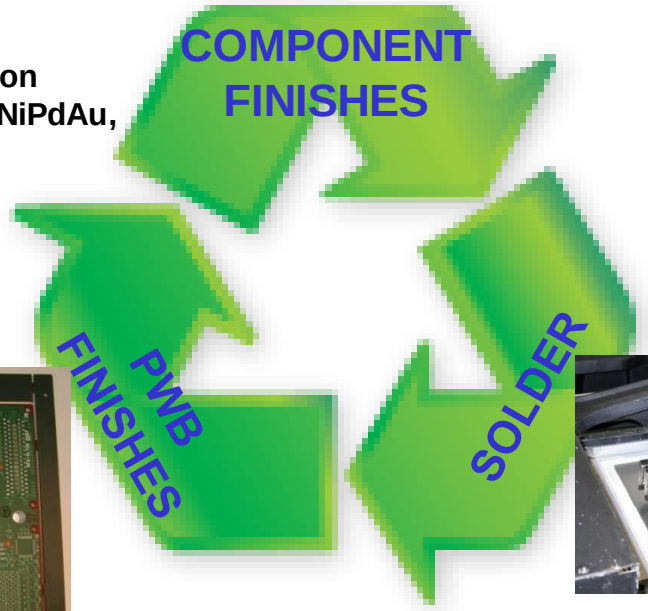
Leadless Termination Finish

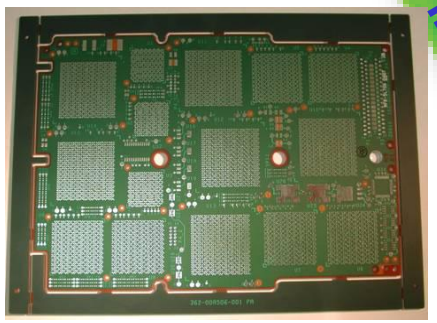


BGA Solder Balls



Common Lead-free finishes on current products: matte tin, NiPdAu, SnAgCu





Today: Tin-Lead HASL
Tin-Lead plate and fused

Wave

Paste

Today: SnPb solders

Wire

Also mechanical parts: connectors, lugs, cardguides, packages, lids, etc.

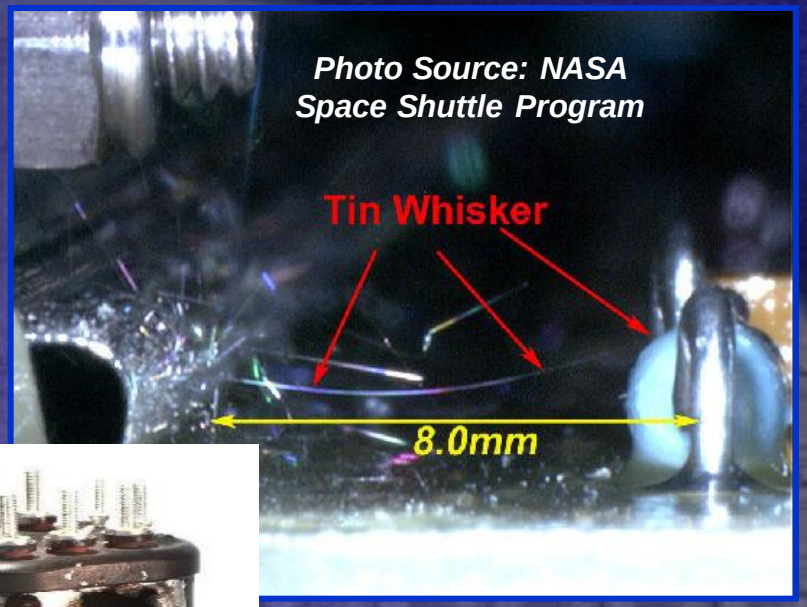
Why are Lead-Free Electronics a challenge ?

- DoD (and Aerospace/High Performance) systems have unique requirements:
  - High reliability and critical systems
  - Very long service life
  - Extreme operating environments
  - Repairable systems
- Pb-free alloys present a completely new material set
  - Vastly different metallurgical properties
  - Little test and qualification data
  - Material set is still changing

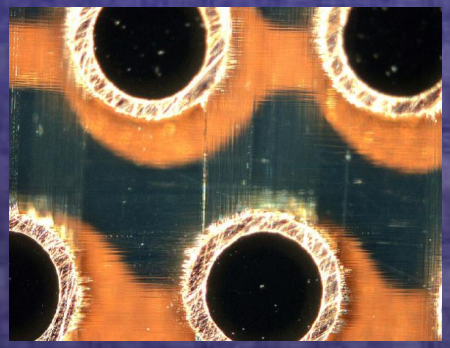
DoD acquisition programs are increasingly dependent on ***commercial*** electronic parts and assemblies (COTS)

Pb-free Electronics Risks

- **"Tin Whisker" Short Circuits**
  - Electrically conductive
  - Can metal vapor arc
- **Pb-free Solder Issues**
  - Fractures in high shock & vibration environments
  - Has higher melting temps
  - Incompatibilities with SnPb Solder
  - Conductive Anodic Filament (CAF) problem is re-emerging
  - Less repairable assemblies
- **Configuration Control**
  - Unidentified component alloys
  - Mixed Pb & Pb-free inventory




Relay
Vapor Arc Damage




Pb-Free Solder Joint

Pb-free Electronics Technical Impact on Defense & Aerospace

- No universally acceptable technical solutions in sight to replace SnPb in defense applications
  - Conformal coatings only mitigate tin whiskers
  - Pb-free solder joint reliability decreased for shock
  - SAC305 solder dissolves copper, impacting rework and repair
  - Conductive Anodic Filament (CAF) problem is re-emerging due to higher CCA processing temperatures using Pb-free solders
- Current technical approaches are all still “mitigations” and not “elimination” of the Pb-free electronics issues

Pb-free Guidance Efforts

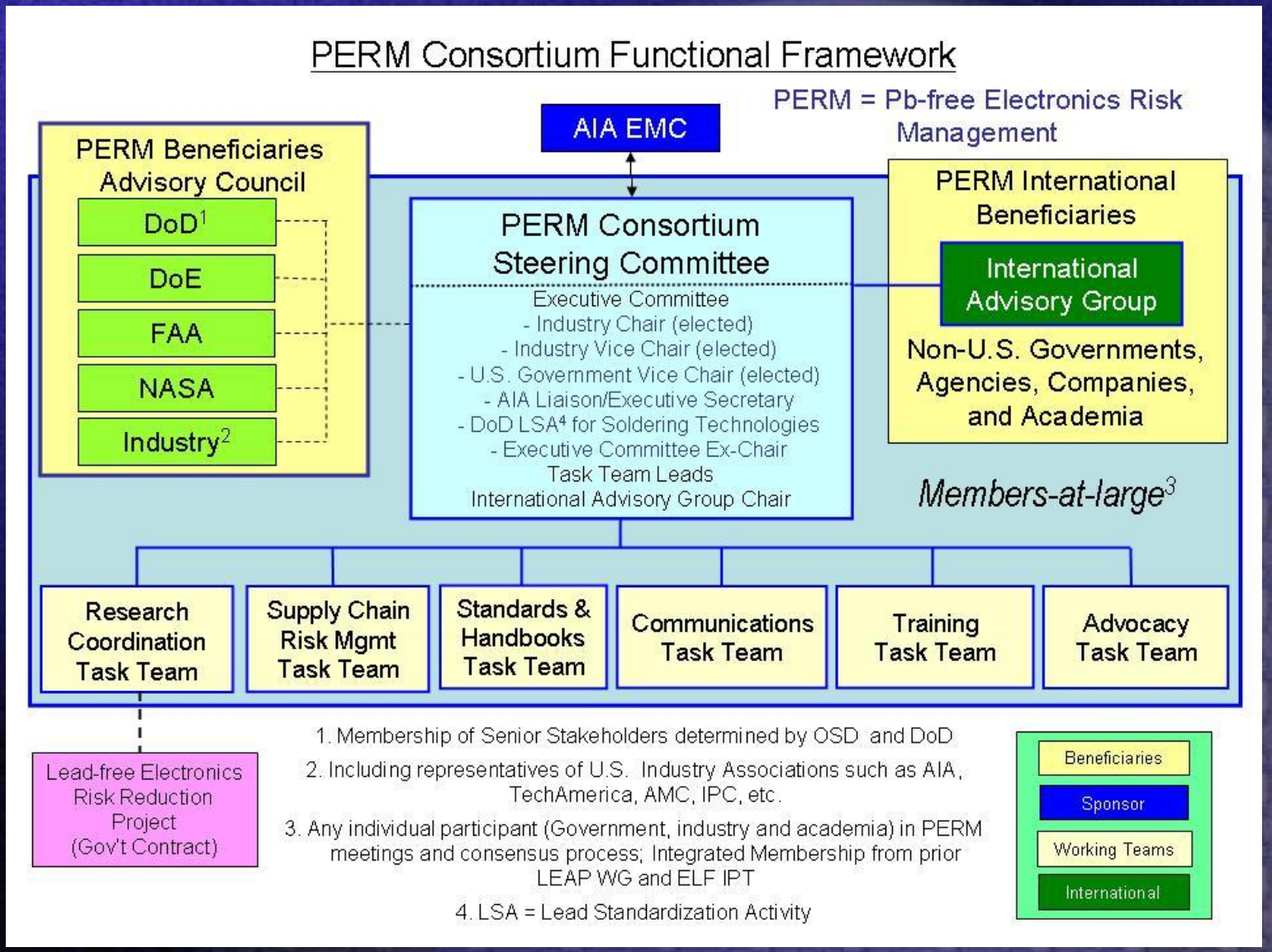
- AIA-AMC-GEIA Lead-free Electronics in Aerospace Project Working Group (LEAP WG) 2004-2009
- Executive Lead-Free Integrated Process Team (ELF IPT) 2004-2009
- LSA, STWG, LFET

- Aerospace industry research
- JG-PP, NASA/DoD, CALCE

- Produced 7 Standards and Handbooks
  - **GEIA-STD-0005-1** Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
  - Available from TechAmerica

AIA = Aerospace Industries Association
GEIA = Government Electronics & Information Technology Association
AMC = Avionics Maintenance Conference

Pb-free Electronics Risk Management
PERM
Consortuim



Pb-free Electronics Risk Reduction Project Concept

- **Who:**
  - 17 recognized deep subject matter experts assembled to work as a single, fully-funded team
  - Strong team leader with requisite management and technical skills
  - Government Funding Champion at highest possible level
- **What:** "Find acceptable replacements for Pb in electronics for use in aerospace and defense environments" (Dual Use)
- **When:** Begin ASAP with a 3-year commitment and hope for shorter
- **Where:** National Lab or Research Center
- **How:** $105M Dedicated "Pocket change funding" compared to the scope of the problem
- **Why:** Given time, the "Business Case" will become self-evident based on events, even to the most strident "nay sayers"

Pb-free Electronics Risk Reduction Project

"Manhattan" Project — **Pb-free Electronics Risk Reduction Project**

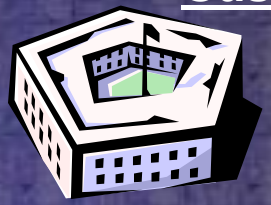
ONR Funded

Phase 1: Best Practice Baseline

JDMTP Funded

Phase 2: Technology Roadmap

Customers



DoD plus…

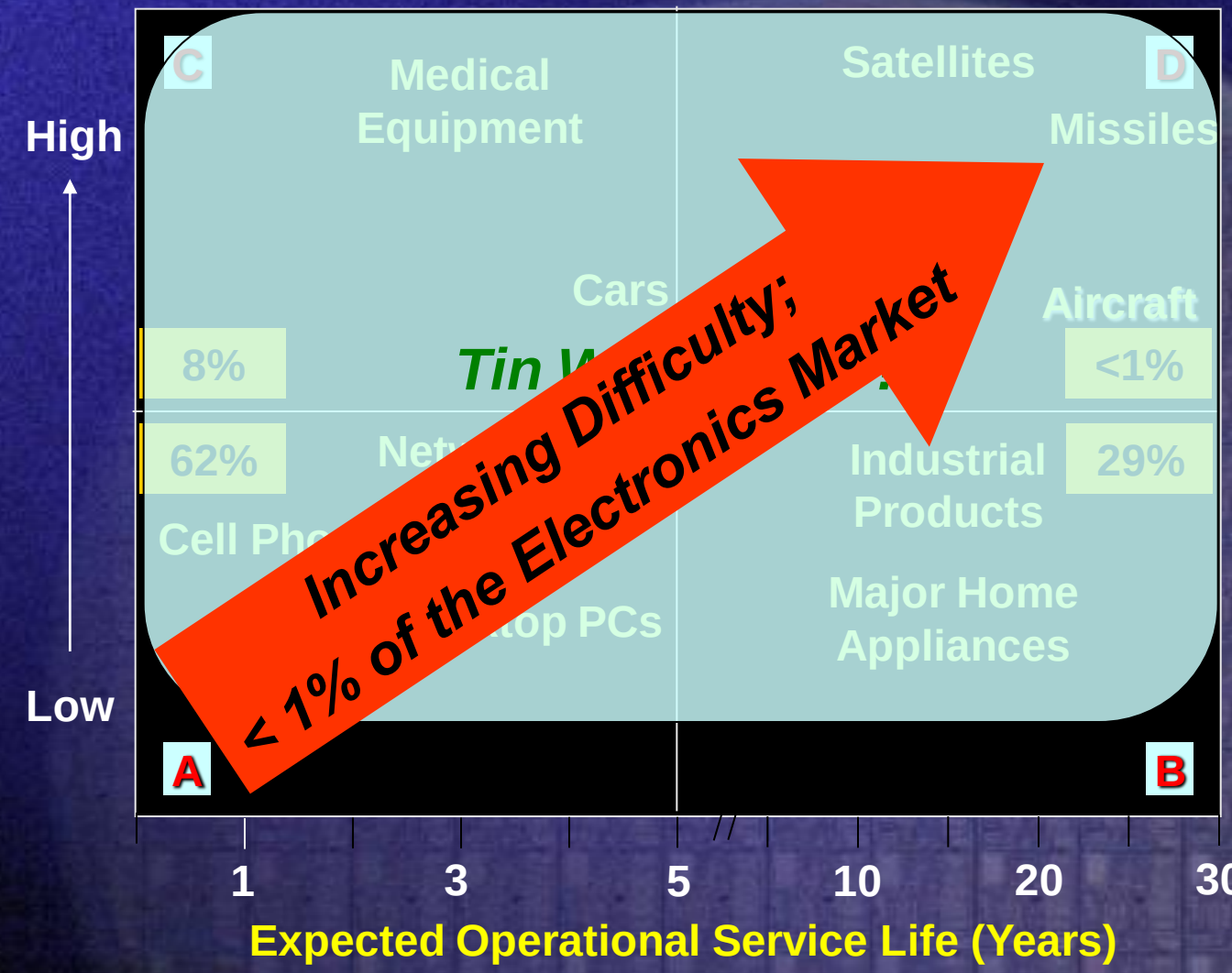
Phase 3 – Integrated Risk Reduction Projects

- Tin Whiskers
- Electronics Assembly
- Solder Joints
- Electronic Component
- Printed Circuit Boards

2009

2010-2013----

Pb-free Electronics Operating Environment vs. Operational Life-time



DoD Lead-free Electronics Technology Focus Team

- Directed by Defense Research & Engineering
- Chartered to engage all stakeholders in Government and industry
- Advise DDR&E
  - Defense industrial base
  - Policy
  - Technology gaps
  - Standards
  - R&D investments

Summary
DoD Response to Lead-Free

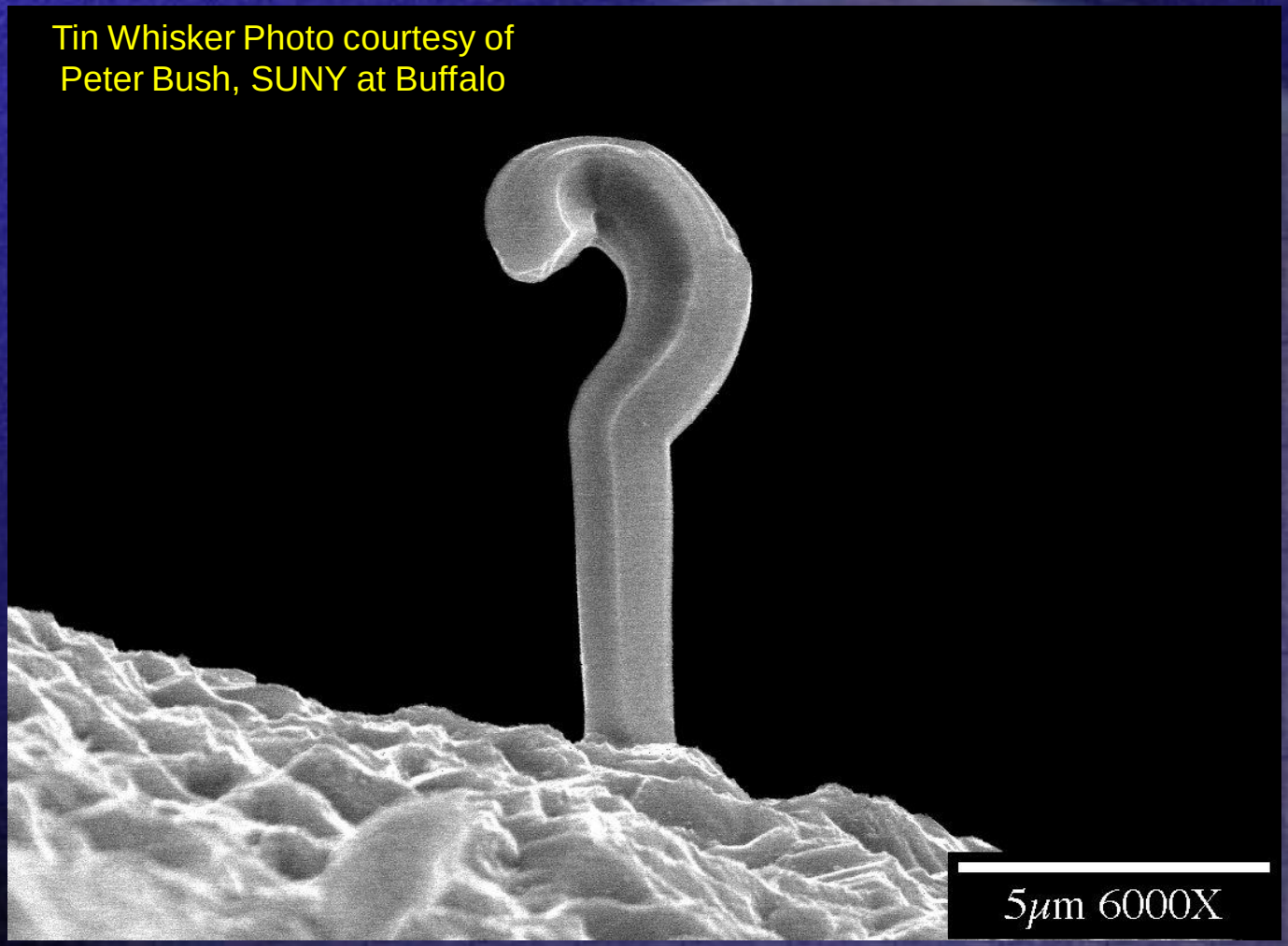
- There is a global transition to lead-free
  - Lead-free solder issues
  - Tin whisker risks
  - Availability of leaded solder and components
  - New repair processes
  - Configuration control challenges

- Programs must assess risks and manage the transition

- Challenges
  - Pb-free policy at DoD, Service and Program levels
  - Guidance and awareness
  - R&D investments - $$$

*The DoD must **continue** to field reliable and supportable systems to meet mission requirements*

Questions


Tin Whisker Photo courtesy of
Peter Bush, SUNY at Buffalo
5μm 6000X