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National Aeronautics and Space Administration

Current and Future Parts Management at NASA

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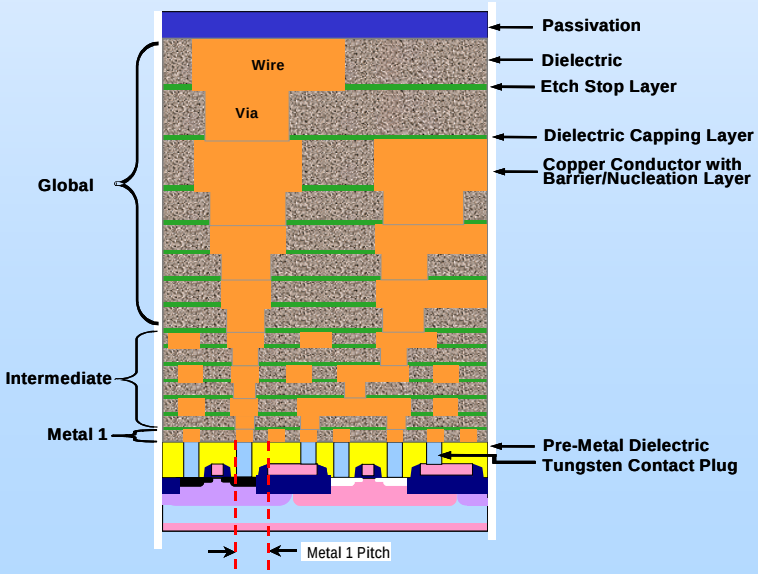
Overview

- **NASA Today – The Backdrop**
- **Current Parts Management at NASA**
- **NASA Parts Policy, NPD 8730.2**
- **Center Implementation of 8730.2**
- **The "Universal" Parts Management Process**
- **NASA Center Missions**
- **Examples of Parts Management Implementation**
- **Immediate Challenges:**
  - Advanced packaging – Class Y
  - Obsolescence and Counterfeit
  - Global Supply Chain
  - Parts Management for COTS "boxes"
  - Commercial Crew
- **Future Challenges**

This Presentation Does Not Discuss Radiation Hardness Assurance


Spiral galaxy M81, located approximately 12 million light-years from Earth, as seen by the Spitzer Space telescope.



NASA Today – The Backdrop

- NASA is at a major crossroads
- The Shuttles will soon be retired
- NASA launch systems (crewed) to be replaced with commercial ones for transport to the International Space Station – “Commercial Crew”
- There will be a gap in NASA-launched, human space flight
- Increasing budget pressure in these tough economic times (affordability)
- NASA will manage a new Space Launch System (SLS) for heavy lift and exploration
- Exploration focus is Mars, asteroid, moon? TBD
- New Vision Statement: "*To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind.*“

This Presentation Does Not
Radiation Hardness Assurance

Current Parts Management at NASA

- NASA Parts Policy NPD 8730.2 applies to all NASA flight projects and critical ground support equipment but it is high level and allows considerable flexibility of implementation
- Each NASA Center has similar goals and processes are similar but the tools are different between Centers
- The differences reflect the different missions, histories and cultures of the 8 flight Centers
- Parts management/control functions may be in different managerial chains, engineering, mission assurance or both
- NASA has no standard or preferred parts list, preferred or qualified vendor list or parts database
- The NASA Parts Selection List (NPSL) is an optional on-line tool that mainly captures lessons learned
  - It does not cover radiation effects

NPD 8730.2

- **NASA Policy Directive NPD 8730.2, NASA Parts Policy, applies to materials and mechanical parts such as fasteners as well as electronic packaging and parts**
- **Overall Requirements:**
  - Parts and Materials Management Plans
  - Reporting of non-conformances via NASA Alert Policy NPR 8735.1
  - Parts management and assurance actions such as audits
- **Electronic Parts Requirements**
  - Selection to meet mission requirements
  - Maintenance of the NASA Parts Selection List (NPSL)
  - Participation in the US Military Standardization Program
  - Parts qualification and screening
  - Derating
  - Lead-free Control Plans (LFCP), GEIA 0005 standards or equivalent
  - Counterfeit Parts Control Plans (CPCP) SAE AS5553 or equivalent

NPD 8730.2
NASA Parts Policy

NASA EEE-INST-002, Instructions for EEE Parts Selection, Screening, Qualification, and Derating

Maintained by GSFC

ARC

APR 8730.2, Ames EEE Parts Control Requirements, NPSL

GRC

Space Assurance Requirements NPSL, EEE-INST-002

GSFC

Mission Assurance Requirements (MAR), EEE-INST-002, NPSL

JPL

JPL Rules Doc 57732, Institutional Parts Program Requirements (IPPR)

NASA Parts Selection List (NPSL)

http://nepp.nasa.gov/npsl/

Maintained by NASA Electronic Parts and Packaging (NEPP) Program

JSC

SSP 30312, EEE Parts Management and Implementation Plan for the Space Station Program

KSC

ISS and Shuttle Servicing Requirements

LaRC

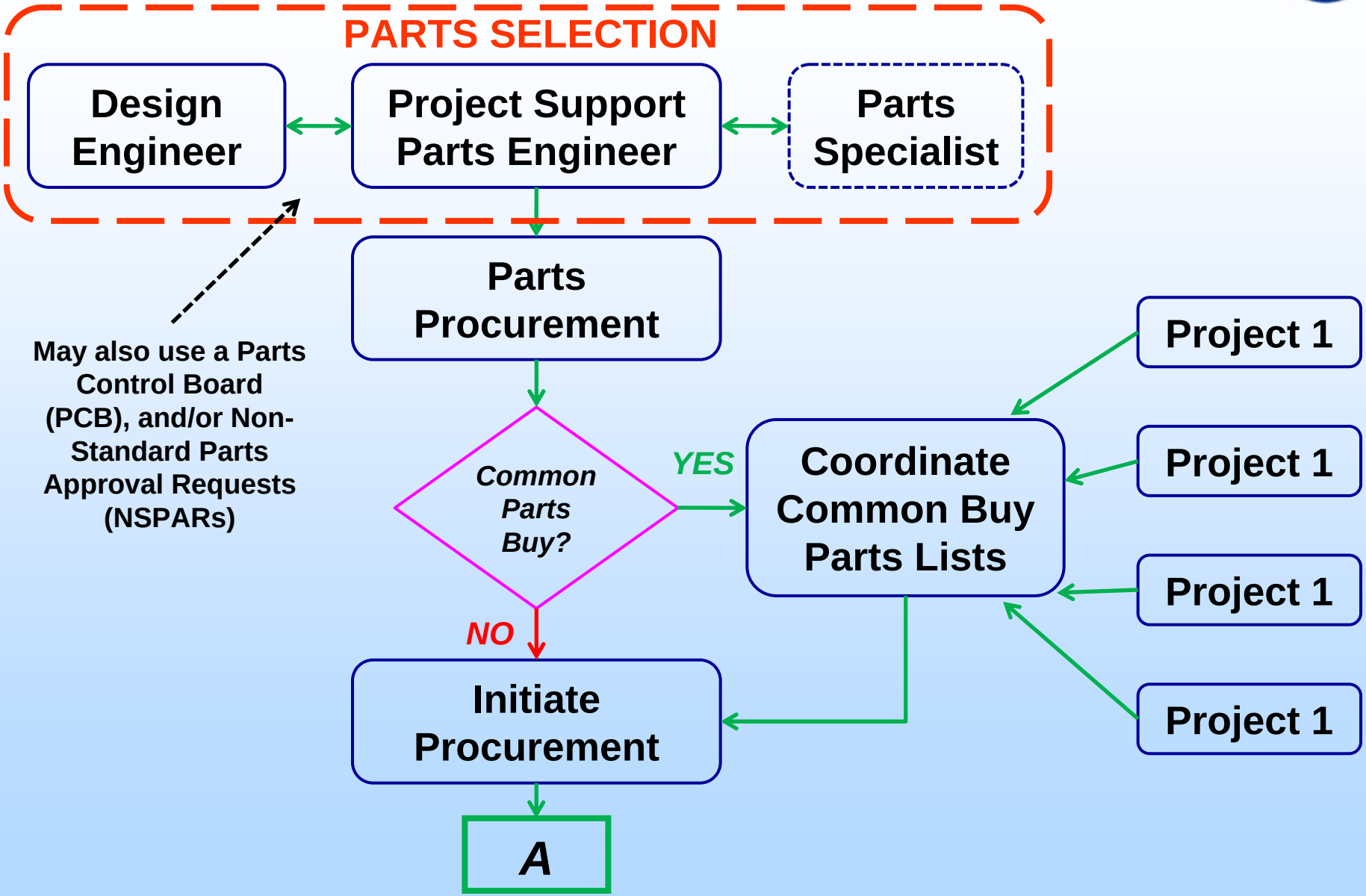
NPSL, EEE-INST-002

MSFC

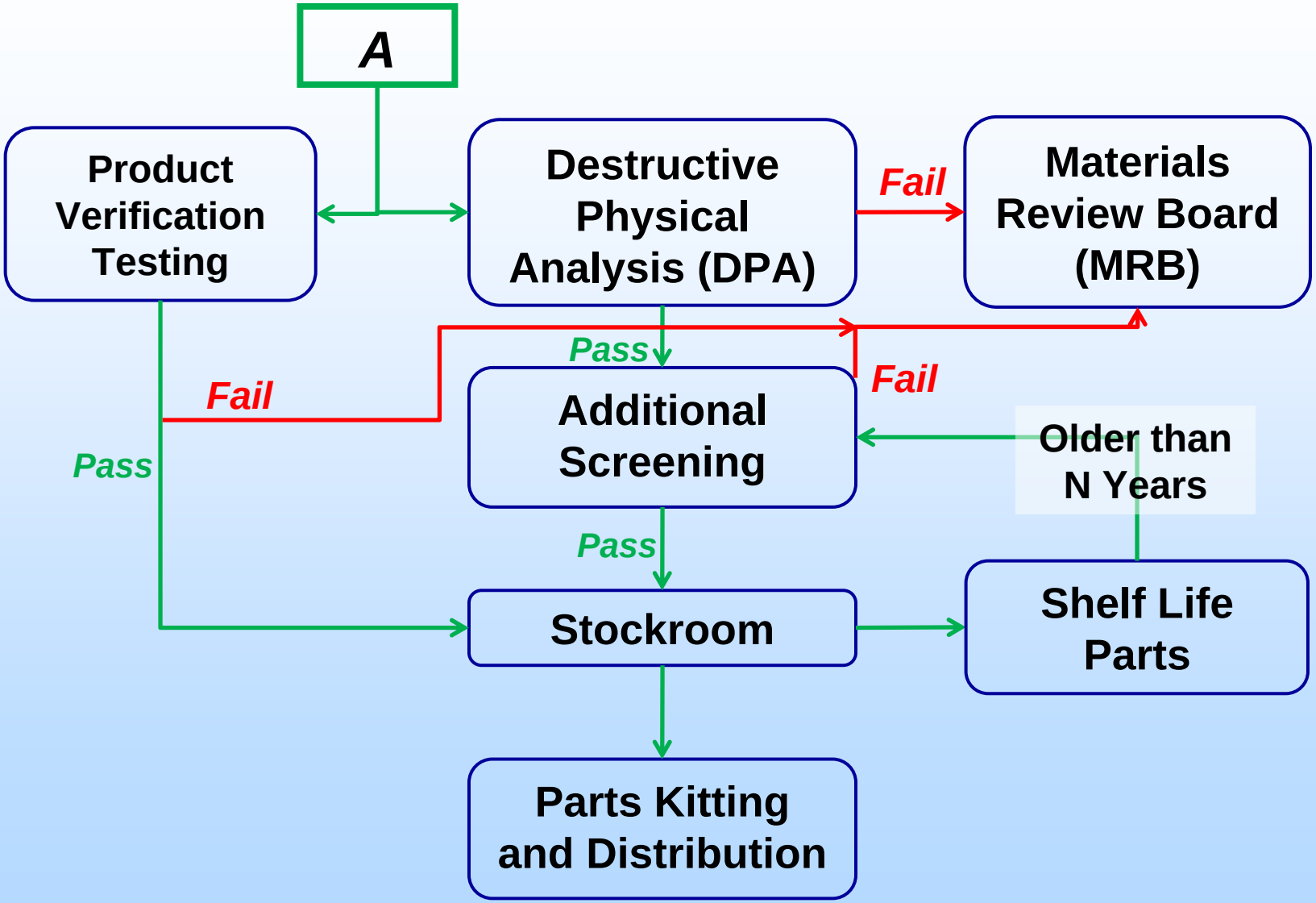
MSFC-STD-3012

EEE Parts Management and Control for MSFC Space Flight Hardware

Typical EEE Parts Management Flow



Parts Management Flow Continued



NASA Centers - Mission Focus

Center	Primary	Other
Ames Research Center (ARC)	Mini and Microsats, Lunar Science	C & D Missions, Aeronautics, Astrobiology
Glenn Research Center (GRC)	Rocket Propulsion, Aeronautics	Power Systems, Communications
Goddard Space Flight Center (GSFC)	Earth and Interplanetary, Science, Satellites and Instruments	Sounding Rockets and Balloons
Jet Propulsion Laboratory (JPL)	Interplanetary Exploration Satellites and Instruments	Earth Science Satellites and Instruments
Johnson Space Center (JSC)	Human Spaceflight, ISS, Shuttle Program	Crew Vehicle Development
Kennedy Space Center (KSC)	Launch Services and Commercial Crew	Ground Systems Development
Langley Research Center (LaRC)	Earth and Space, Science, Satellites and Instruments	Aeronautics and Advanced Technologies
Marshall Space Flight Center (MSFC)	Space Transportation and Rocket Propulsion	Low Earth Orbit Science Satellites and Instruments

Inter-Center partnerships and roles are dynamic. This is a snapshot

Examples of NASA Center Variation

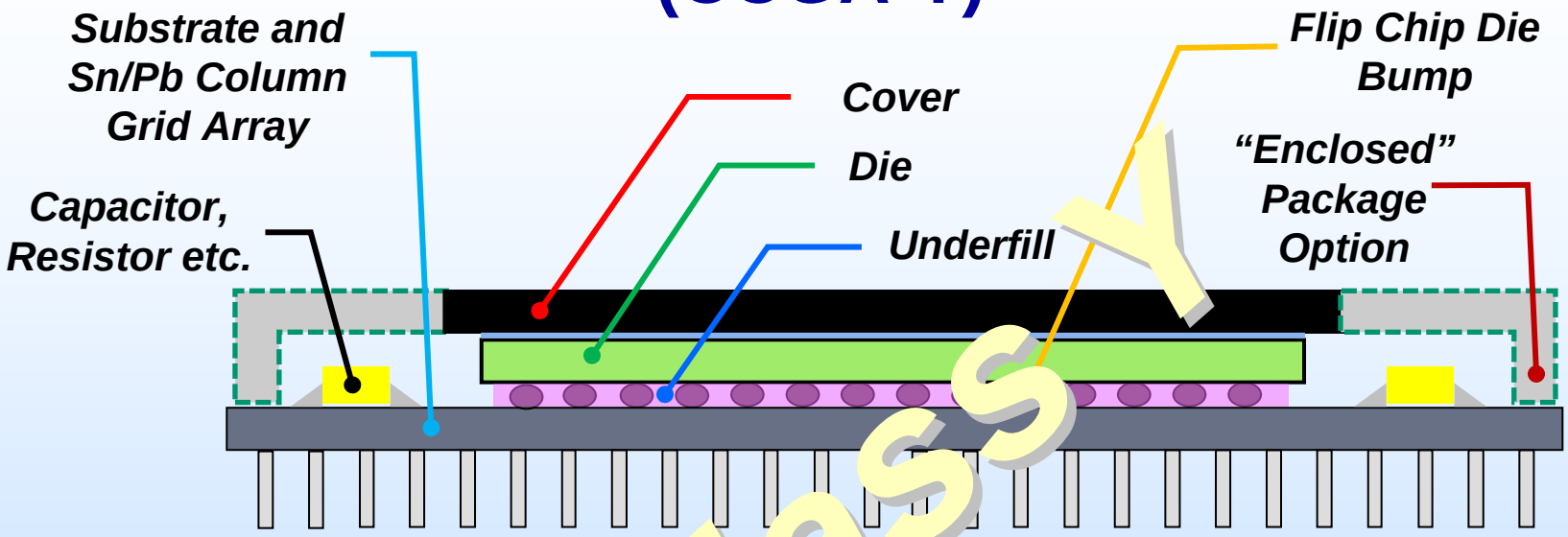
	ARC	GRC	GSFC	JPL	JSC	KSC	LaRC	MSFC
Center Level Controlling Std	APR 8730.2	SAR	None	None	None	KNPR 8720.2	None	None
Electronic Parts Standard	APR 8730.2	SAR, EEE-INST-002	EEE-INST-002	IPPR, Parts Eng. Tech Std (PETS)	SSP 30312, OPPR	KNPR 8720.2	None	MSFC-STD-3012
Project Requirements	APR 8730.2	SAR	MAR	PPPR	JPD 5320.6	KNPR 8720.2	Flexible	Project Parts Plan
Project-specific Parts Mgt. Plan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selection	Flexible	Flexible	MAR, EEE-INST-002	PPPR, IPPR	Program Specific	Flexible	Flexible	MSFC-STD-3012
Derating	No	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	MSFC-STD-3012
Screening	Flexible	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	MSFC-STD-3012
Qualification	Flexible	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	MSFC-STD-3012
Classification Levels (Grades)	Flexible	1, 2, 3, COTS	1, 2 or 3	1,2,3 or 4	Program Specific	Flexible	Flexible	1, 2, 3, or 4
EEE Parts Database	NO	No	Yes	Yes	Program Specific	No	Flexible	Yes
NSPAR or PCB?	PCB + NSPAR	Flexible	PCB	Parts Specialists	PCB and NSPAR	Flexible	Flexible	PCB and NSPAR
Parts Responsibility	Engring	Engring	Engring + S&MA	Engring + S&MA	Engring + S&MA	Engring	Engring	Engring

Immediate Challenges

- **Complex non-hermetic packages for space**
  - The “Class Y” concept
- **Counterfeits and Obsolescence**
  - A challenge for obsolescence management
  - An increasing challenge, even for one-off science birds
- **Global supply chain, global challenges:**
  - Security restrictions, secrecy
  - Limited sources
  - International politics and unrest
- **Parts management for COTS “boxes”**
  - Am I crazy?
  - Faith, or is assurance possible with no parts list?
- **Commercial Crew**
  - Balancing risk with heritage and precedence

Lunar Reconnaissance Orbiter (LRO), Built at GSFC, Launched with LCROSS, June 18,2009

Non-hermetic Package, With ”Space” Features (CCGA*?)



Space Challenge	Some Defenses
Vacuum	Low out/off-gassing materials. Ceramics vs polymers.
Shock and vibration	Compliant / robust interconnects - wire bonds, solder balls, columns, conductive polymer
Thermal cycling	Compliant/robust interconnects, matched thermal expansion coefficients
Thermal management	Heat spreader in the lid and/or substrate, thermally conductive materials
Thousands of interconnects	Process control, planarity, solderability, substrate design
Low volume assembly	Remains a challenge
Long life	Good design, materials, parts and process control
Novel hardware	Test, test, test
Rigorous test and inspection	Testability and inspectability will always be challenges

Class Y

* Ceramic Column Grid Array

MIL-PRF-38535, Class Y

- **“Y Not” Non-hermetic for Space? We have no choice**
- **Proposed new class for MIL-PRF-38535, monolithic microcircuits**
- **Class Y will be for Space level non-hermetic**
- **Class V will be defined as hermetic only**
- **Addition to Appendix B, “Space Application”**
- **Package-specific “integrity” test requirements proposed by manufacturer, approved by DLA* and government space**
- **The Package Integrity Test Plan must address:**
  - Potential materials degradation
  - Interconnect reliability
  - Thermal management
  - Resistance to processing stresses
  - Thermo-mechanical stresses

- **G12 Task Group established 01/13/10**

* MIL spec qualifying activity Defense Logistics Agency, Land and Maritime

Obsolescence and Counterfeit

- **For space systems, greatest risk for encountering counterfeit electronic parts is obsolescence**
  - Cost and schedule are also risks if oversight is poor
  - Ignorance is always a factor
- **Increasing pace of technology turnover combined with increased use of COTS for space and the decreasing supplier base means the obsolescence issue will continue to grow**
  - Even for “one off” science missions
- **Counterfeits evolve as our detection gets better**
- **Obsolescence control plans, counterfeit avoidance plans and training are *essential***

Global Supply Chain, Global Challenges

- **Recent events have highlighted the risks to electronic parts supply from the global market**
- **Source reduction is continuous and rapid: mergers, acquisitions and facility consolidations**
  - Many single source situations for combinations of quality levels, package styles and specific performance
- **Political and social unrest in the source country can introduce “new” challenges:**
  - Monitoring/auditing may be considered too dangerous
  - Supply may be impaired by collapse of infrastructure
- **Time changes, language barriers, laws and customs issues are always with us**
- **Success requires resources dedicated to maintenance of the global supply chain**

Parts Management for COTS “Boxes”

- **Growth in “commercial space” is making more Commercial-Off-The-Shelf (COTS) systems (boxes) available**
  - Star trackers, single-board computers, gyros, wheels
- **Available from world-wide sources**
- **Flight history claims require study**
- **Parts lists are guarded secrets**
- **Apparent “affordability” of these systems will increase their selection for government space**
- **How do we assure these systems will meet our needs?**
- **Perhaps they should be treated as “parts”, super hybrids maybe?**

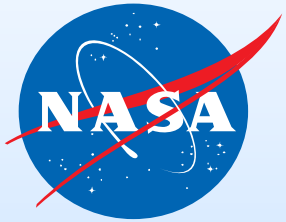
Commercial Crew

- **Commercial launch vehicles and crew capsules to put NASA and NASA-sponsored crews in orbit**
- **A "sea change" for NASA – breaking with 50 years of culture, painful lessons learned and corrective actions**
- **What constitutes "human rated"?**
- **Expectation is that commercial systems will be more affordable than NASA ones**
- **Dilemma:**
  - Will commercial still be more affordable if it has to meet current NASA requirements for human rating?
  - But if we relax them for commercial crew aren't we saying the requirements can be relaxed for NASA too?
  - Can we do that given our risk aversion based on our experiences from a long history of success and failure?
  - This precedent **will** encompass electronic parts selection and qualification AND if it's good enough for humans, then why not unmanned AND if NASA can do it, why not ESA?

Future Challenges

- **Who knows? BUT it will be:**
  - Smaller and lighter
  - More efficient
  - Faster
  - Changing continuously
  - Desirable BUT perhaps not space-worthy
  - And someone always expects it to be more affordable
- **And we need to be:**
  - Flexible and innovative
  - Open-minded
  - Willing to expand the definition of “part” as integration puts more system levels on a chip or in a package

Business as Usual – JUST EVEN MORE COMPLEX



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