Current and Future Parts Management at NASA

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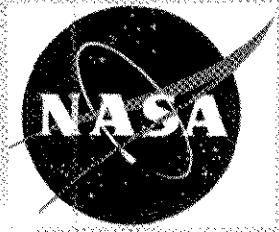
This presentation provides a high level view of current and future electronic parts management at NASA. It describes a current perspective of the new human space flight direction that NASA is beginning to take and how that could influence parts management in the future. It provides an overview of current NASA electronic parts policy and how that is implemented at the NASA flight Centers. It also describes some of the technical challenges that lie ahead and suggests approaches for their mitigation. These challenges include: advanced packaging, obsolescence and counterfeits, the global supply chain and Commercial Crew, a new direction by which NASA will utilize commercial launch vehicles to get astronauts to the International Space Station.

European Space Components Conference (ESCCON) 2011

National Aeronautics and Space Administration



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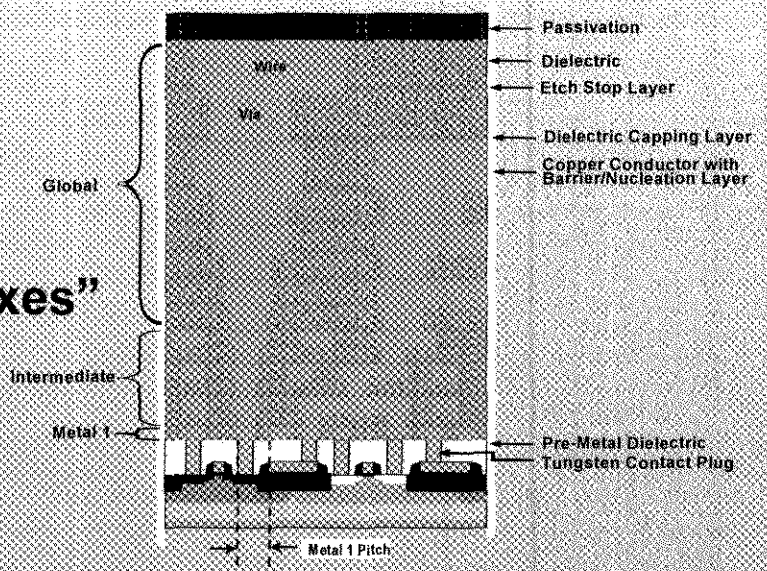
Overview

- 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



NASA Today – The Backdrop

- NASA is at a major crossroads point
- The Shuttles will soon be retired
- NASA launch systems (crewed) to be replaced with commercial ones for transport to the International Space Station – called "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.*"

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 Document 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

NASA Parts Selection List (NPSL)
http://nepp.nasa.gov/npsl/
Maintained by NASA Electronic Parts and Packaging (NEPP) Program

ARC
ARP 8730.2, Ames EEE Parts Control Requirements, NPSL

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

GRC
Space Assurance Requirements NPSL, EEE-INST-002

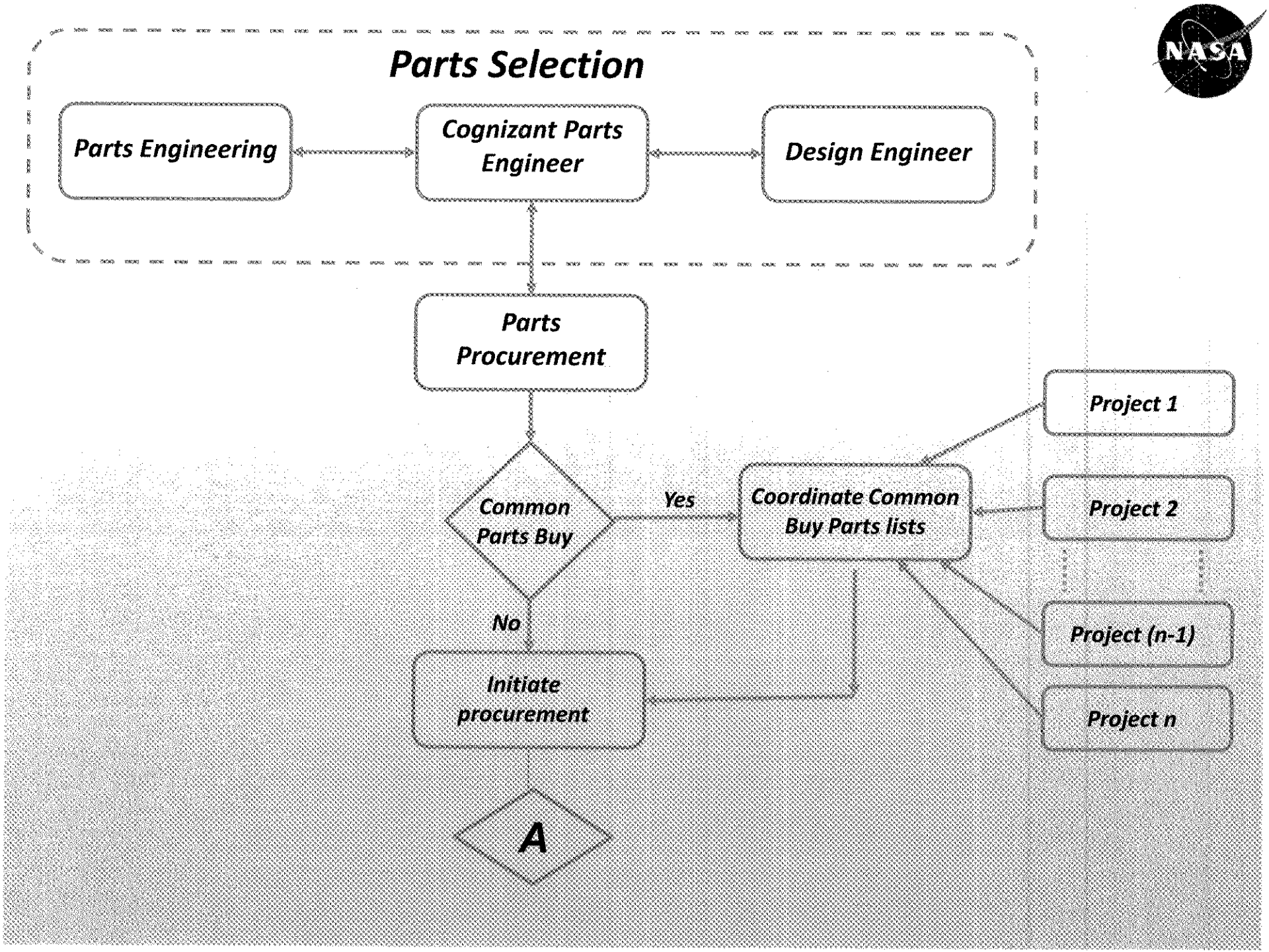
KSC
ISS and Shuttle Servicing Requirements

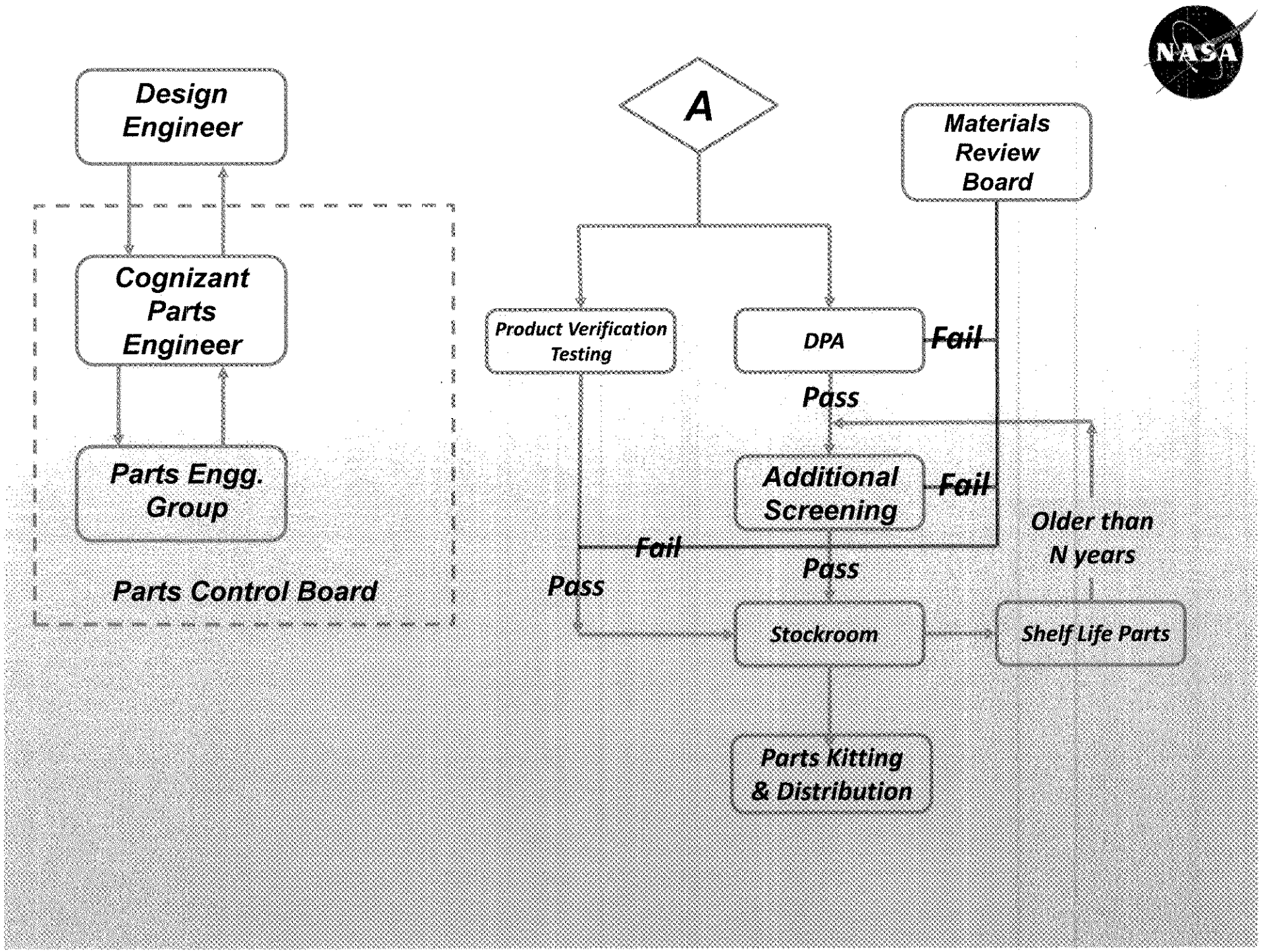
GSFC
Mission Assurance Requirements (MAR), EEE-INST-002, NPSL

LaRC
NPSL, EEE-INST-002

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

MSFC
MSFC-STD-3012
EEE Parts Management and Control for MSFC Space Flight Hardware


Parts Selection
Parts Engineering
Cognizant Parts Engineer
Design Engineer
Parts Procurement
Common Parts Buy
Yes
Coordinate Common Buy Parts lists
Project 1
Project 2
Project (n-1)
Project n
No
Initiate procurement
A


Design Engineer
Cognizant Parts Engineer
Parts Engg. Group
Parts Control Board
A
Materials Review Board
Product Verification Testing
DPA
Fail
Pass
Additional Screening
Fail
Older than N years
Fail
Pass
Pass
Stockroom
Shelf Life Parts
Parts Kitting & Distribution

NASA Centers - Mission Focus

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

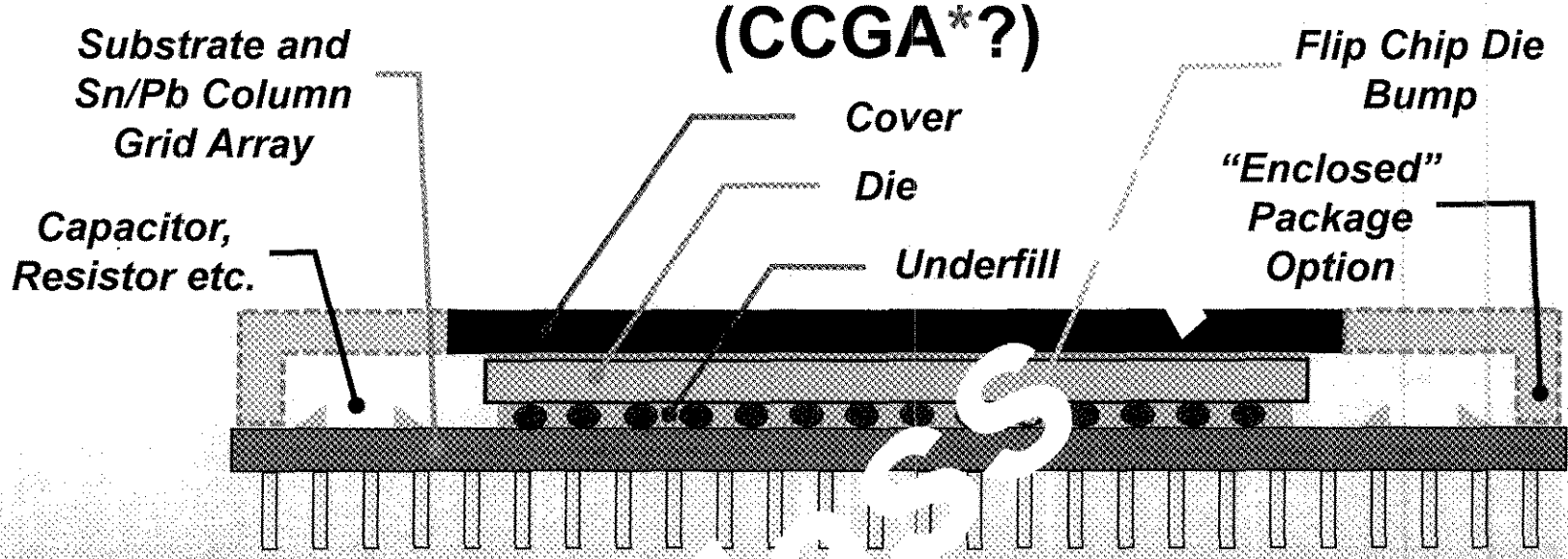
Examples of NASA Center Variation

	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
Selection	Flexible	Flexible	MAR, EEE-INST-002	PPPR, IPPR	Program Specific	Flexible	Flexible	Per MSFC-STD-3012
Derating	No	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	Per MSFC-STD-3012
Screening	Flexible	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	Per MSFC-STD-3012
Qualification	Flexible	Flexible	EEE-INST-002	IPPR	Program Specific	Flexible	Flexible	Per MSFC-STD-3012
Classification Levels	Flexible	1, 2, 3, COTS	1, 2 or 3	1,2,3 and 4	Program Specific	Flexible	Flexible	Grades 1, 2, 3, or 4
EEE Parts Database	NO	No	Yes	Yes	Program Specific	No	Flexible	Yes
NSPAR or PCB?	PCB + NSPAR	Flexible	PCB	NSPAR	PCB and NSPAR	Flexible	Flexible	PCB and NSPAR
Parts managed by	Engring	Engring	Engring and S&MA	Engring and S&MA	Engring and 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

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

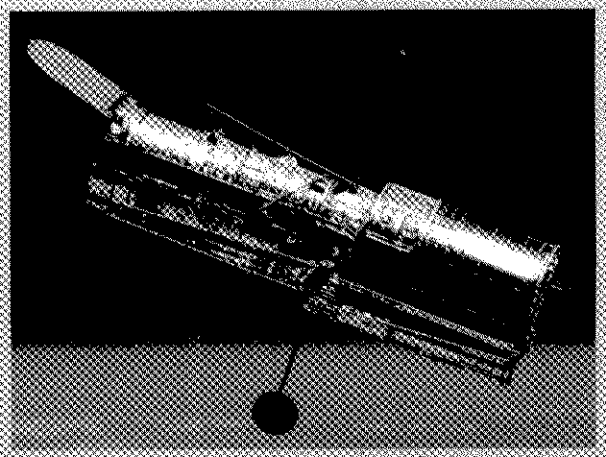


Space Challenge	Some Defenses
Vacuum	Low out/off-gassin materia Ceramics vs polymers.
Shock and vibration	Compliant / robust terco nects - wire bonds, solder balls, columns, conductive polymer
Thermal cycling	Compliant/robust in nects, matched thermal expansion coefficients
Thermal management	Heat spreader 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

* Ceramic Column Grid Array

MIL-PRF-38535, Class Y

- "Y Not" Non-hermetic for Space? We have no choice
- Proposed new class for M38535, 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

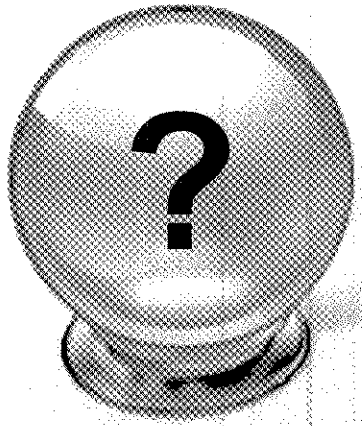
Parts Management for COTS "Boxes"

- 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

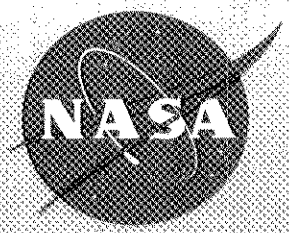


- **Who knows? BUT it will be:**
  - Smaller and lighter
  - More efficient
  - Faster
  - Changing continuously
  - Desirable BUT perhaps not space-worthy
  - And someone always expects it to be more affordable
- **And we need to be:**
  - Flexible and innovative
  - Open-minded
  - Willing to expand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

Business as Usual – JUST EVEN MORE COMPLEX

AND …

- **AFFORDABLE, AFFORDABLE, AFFORDABLE.**
- **We no longer talk of faster, better, cheaper**
- **Are we only left with *CHEAPER*?**



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