



# **CLASS Y STATUS OVERVIEW**

## **(Infusion of New Technology into DoD Standards)**

### **NASA Electronic Parts & Packaging Program (NEPP)**

### **Electronics Technology Workshop (ETW)**

**GSFC, Greenbelt, Maryland**  
**June 11-12, 2013**

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Artists conception Mars Science Laboratory Curiosity ChemCam instrument firing a laser to identify chemical elements in target rocks.

(Note: the red beam is for illustration; the actual infrared beam is invisible to human eyes.)

# Agenda

- Introduction
- Infusion of New Technology into the QML System, the “Class Y” Initiative
  - What is it
  - Why Class Y
  - Creation of a Task Group
  - The effort at a glance
  - Issues, Team, current status
- Looking beyond Class Y
  - The next generation of (Nano) devices
- Moving forward

# Introduction

**Purpose:** This talk is about an **EXPERIMENT** in adopting new technology for military and space.

**Fact:** Advancements in packaging technology, increasing functional density, and increasing operating frequency have resulted in single-die system-on-a-chip (SoC), some with non-hermetic flip-chip construction, in high-pin-count ceramic column grid array packages. The next generation of nanodevices will be built on 450-mm wafers in a 28-nm process. This will increase device complexity even more.

**Question:** Do we want to stay current with developments in technology? If so, how can we bring such devices into the military/space standardization system?

**Approach:** Perform reliability and radiation evaluations. If the results are acceptable to the user community, commence making it a QML product. This will create a path for review and possible infusion of other new technologies as they evolve.

## What Is the Class Y Initiative?

- Advances in packaging and device technology are happening rapidly.
- How do we enable space flight projects to benefit from the newly developed devices?
- NASA is leading a G12 initiative, called Class Y, for infusing this new type of complex devices into military/space standards. Class Y is envisioned as a new category of ceramic-based non-hermetic microcircuits, such as the Virtex-4 and Virtex-5 field programmable gate arrays (FPGAs) offered by Xilinx Corporation.
- Creation of a new class of microcircuits (such as Class Y) requires considerable effort. It must be coordinated with manufacturers, government agencies, prime contractors, and other interested entities (e.g., academia). Also, we need to ensure that all aspects of packaging configuration are adequately covered by the military documents, such as MIL-PRF-38535 and MIL-STD-883. These packaging aspects include flip-chips, underfills, adhesives, column attaches, and others
- New test methods must be created and the existing standards updated as necessary.

## Why “Class Y”?

- The goal of this effort is to bring advancements in packaging technology into the QML system.
- Advancements in packaging technology, increasing functional density, and increasing operating frequency have resulted in single-die SoCs with non-hermetic flip-chip construction, in high-pin-count ceramic column grid array packages
  - “Poster Child” example: Virtex-4 (V-4) FPGAs from Xilinx
  - Such products were evaluated for radiation and reliability and have drawn the attention of the space user community
- Question: How do we bring V-4 and similar microcircuits into the QML system as space products?
  - It can’t be Class V because those are hermetic devices
  - Our intent is to put V-4 like products for space users in a new category: “Class Y”.
  - In Jan. 2010, G-12 opened a Task Group to develop Class Y
- What if we dropped the Class Y effort?
  - It would be a major loss for the space community and the QML program at large because the industry would be limited to ordering via Source Control Drawings (SCDs), which is counterproductive to Mission Assurance, prevents standardization, and is expensive.

## Creation of Class Y Task Group

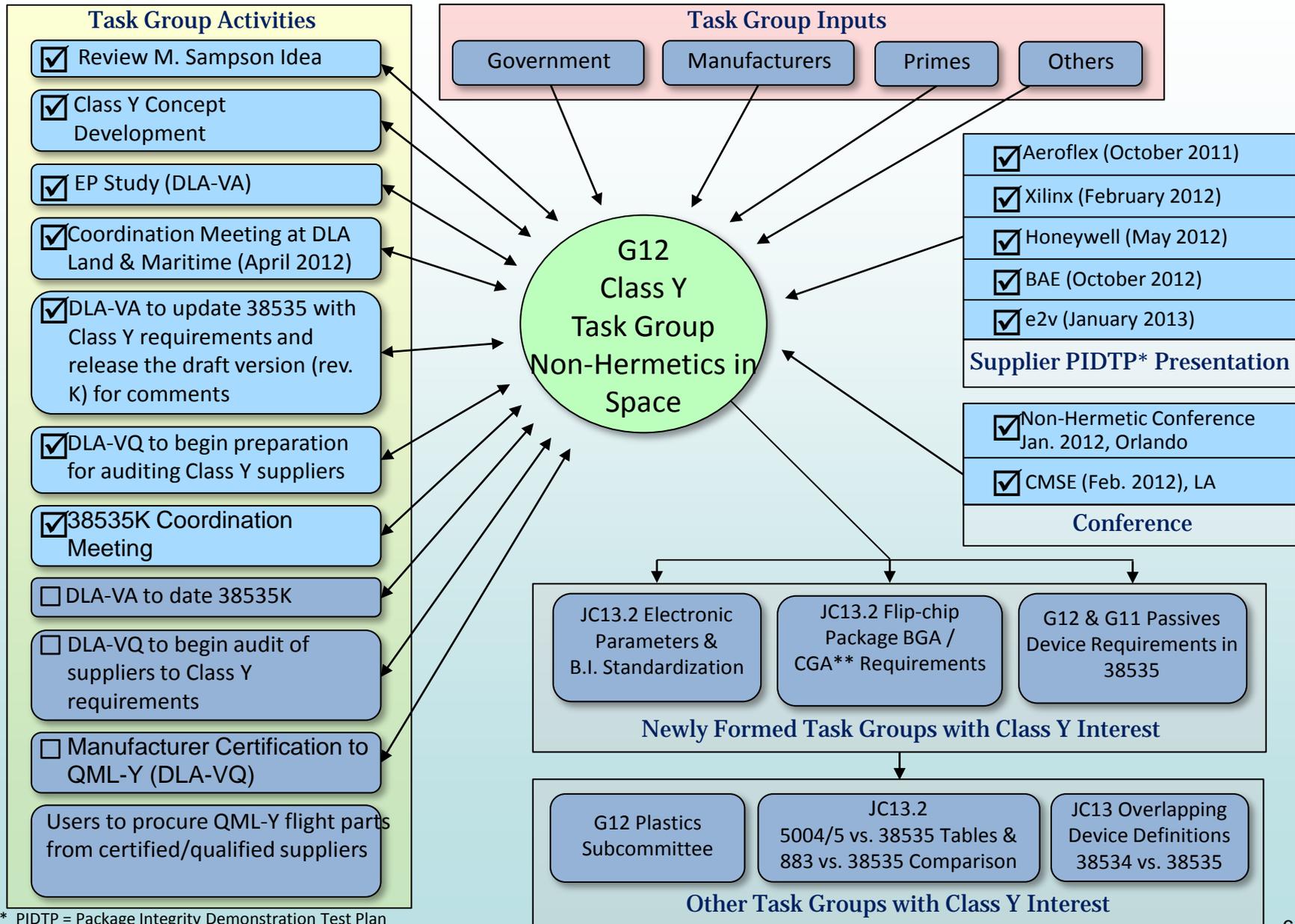
A new G-12 Task Group, TG 2010-01, was formed in early 2010 to address non-hermetic devices for space. Shri Agarwal was asked to lead the effort.

This task was challenging because it:

- Was far more involved than typical G12 tasks,
- Required development of a brand new concept,
- Used system-on-a-chip (SoC) — one of the most complicated devices,
- Needed to be simple and easily understood,
- Possessed sketchy testing and board assembly boundaries, and
- Was needed to procure a standard QML product as quickly as possible.

# Infusion of New Technology into the QML System

## G12 Class Y Effort at a Glance



\* PIDTP = Package Integrity Demonstration Test Plan

\*\* BGA / CGA = ball-grid array / column-grid array

# Infusion of New Technology into Mil Standards, Class Y

- **MIL-PRF-38535, Revision K**
  - Has Class Y requirements added
- **Coordination meeting hosted by DLA-VA**
  - Held April 9-10, 2013
  - Attended by all stake holders
- **Final Draft of 38535K**
  - Available now, see DLA-VA letter on next page
- **Acknowledgements**
  - Special thanks to DLA-VA
  - Thanks to everyone including task group (TG) members and advisors
- **Class Y Status**
  - See previous sheet

# Infusion of New Technology into Mil Standards, Class Y

- **DLA-VA email dated May 8, 2013**

Please find attached file of 2nd initial draft of MIL-PRF-38535 revision K for your review and comments. The 2nd initial draft has been updated (see highlighted tables and paragraphs) based on received comments and recommendations/suggestions of MIL-PRF-38535 revision K coordination meeting which was held on April 9 and 10, 2013 at DLA Land and Maritime, Columbus, Ohio.

Concurrence or comments on updated highlighted paragraphs are due at this Center within 45 days from the date of this letter (e.g., comments are due by June 24, 2013). Any new comments received by the DLA Land and Maritime-VAC will be considered for the next revision of this document.

The point of contact for this document is Mr. Muhammad Akbar, DLA Land and Maritime-VAC, Post Office Box 3990, Columbus, OH 43218-3990. Mr. Akbar can also be reached at 614-692-8108, DSN: 850-8108, or by facsimile 614-692-6939, or by e-mail to: [Muhammad.akbar@dla.mil](mailto:Muhammad.akbar@dla.mil)

## Progress Status

- DLA-VA hosted a coordination meeting April 9-10, 2013. The purpose of this meeting was to review and disposition comments received on the initial draft of MIL-PRF-38535, Revision K.
- DLA-VA sent the updated draft of 38535K on May 8, 2013. Comments are due by June 24, 2013.

# Infusion of New Technology into the QML system

## Roadmap to QML-Y Flight Parts Procurement

- Major Milestones:
  - ☑ G12 approval of TG charter
  - ☑ G-12 Class Y Task Group to develop requirements
  - ☑ G12 approval for DLA-VA to commence EP study
  - ☑ DLA-VA to conduct EP study
  - ☑ DLA-VA to release “final” report
  - ☑ Coordination meeting at DLA Land and Maritime (April 2012)
  - ☑ DLA-VA to update 38535 with Class Y requirements and release the draft version (rev. K) for comments
  - ☑ DLA-VQ to begin preparation for auditing Class Y suppliers
  - ☑ 38535, rev. K Coordination meeting

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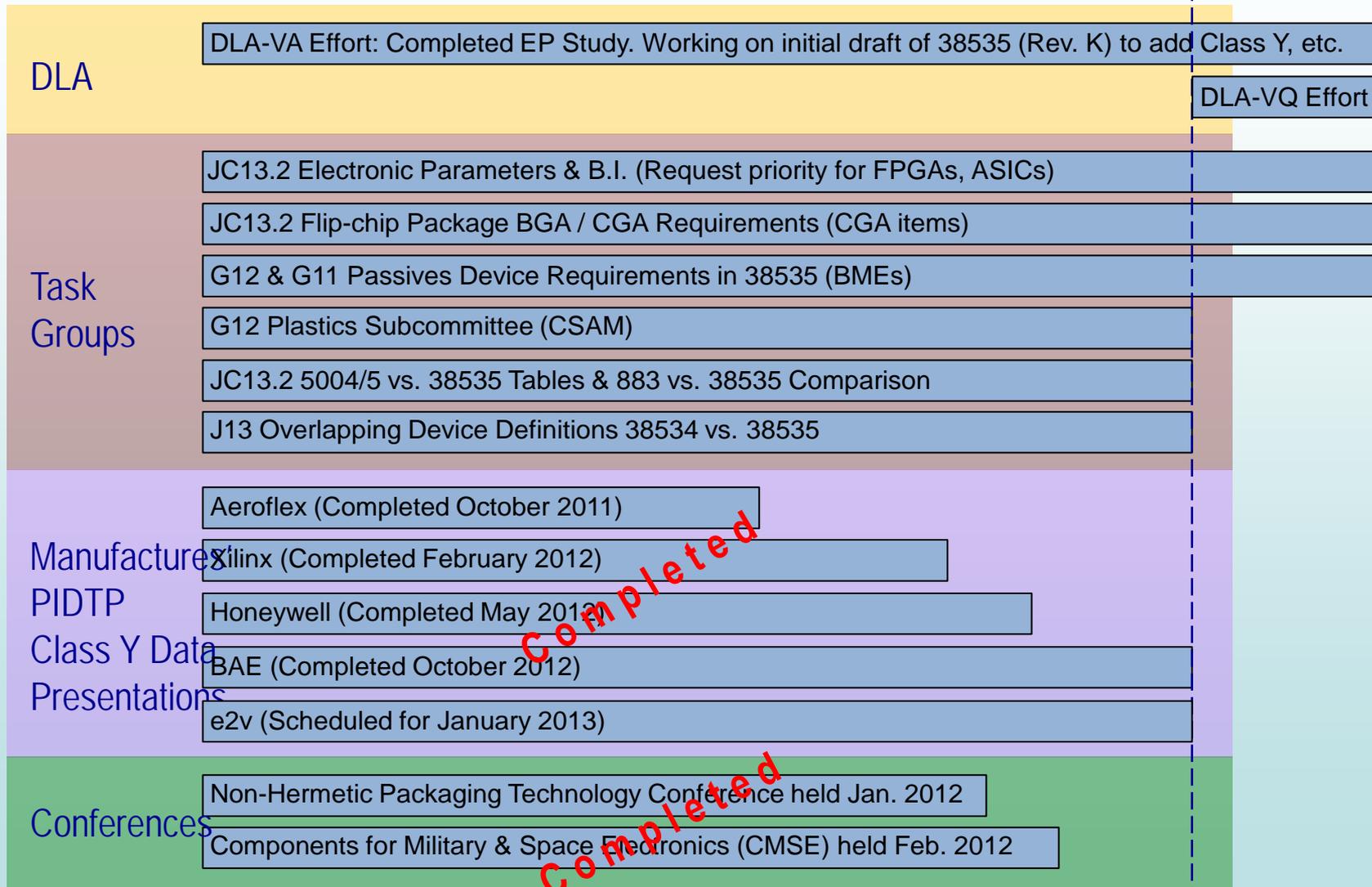
  - ☐ DLA-VA to date 38535, rev. K
  - ☐ DLA-VQ to commence audit of suppliers to Class Y requirements
- After milestones completed,  
Users to procure QML-Y flight parts from certified/qualified suppliers

# CLASS Y - Package Integrity Demonstration Test Plan (Class Y - PIDTP) Data Sharing with the Space Community

- Presentations by Major Suppliers:
  - ☑ Aeroflex (Presented at the Class Y TG meeting in October 2011)
  - ☑ Xilinx (Presented at the TG meeting in February 2012)
  - ☑ Honeywell (Presented at the TG meeting in May 2012)
  - ☑ BAE (Presented at the TG meeting in October 2012)
  - ☑ e2v (Presented at the TG meeting in January 2013)
  - ☐ TBD

# Closure of QML-Y (and related) Activities

Time T  
(May 2013)



# The Team

The **Team members** are:

- Muhammad Akbar, DLA-VA
- Larry Harzstark, Aerospace
- David Sunderland, Boeing
- Shri Agarwal, NASA/JPL
- Roger Carlson, NASA/JPL

**Team resources** include:

- Mike Sampson, NASA/GSFC
- Mark Porter, G12
- Brent Rhoton, JC13
- Anduin Touw, G12
- Mike Adams, DLA-VQ
- Rob Heber, DLA-VA
- Tom Hess, DLA-VA
- Charles Saffle, DLA-VA

# G12 Class Y Task Group (TG) Summary

- G12 Task Group formed in Jan. 2010 to develop screening/qualification requirements for non-hermetics for Space (TG2010-01).
- The TG's work so far may be summarized as follows:
  - Had 10 meetings so far. Well attended.
  - As soon as the TG was formed, users were enthusiastic and eager to know when they could procure QML-Y flight parts.
  - A questionnaire was sent to a targeted group of users, manufacturers, and others (There are about 150 names on the Class Y distribution list). The major inputs were:
    - Class Y should cover those items that are ceramic based. The broader issue of organic-based substrates would be addressed in the next phase.
    - Some respondents asked why the space community should even allow use of non-hermetic parts. (There are concerns with cost, sealing process, board level, etc. There are no current development programs as there is no user interest.)
    - Add the word “hermetic” to the definitions of QML-Q and QML-V classes.
    - NASA and DLA do not endorse attaching the description “near hermetic” to Class Y.

# G12 Class Y Task Group Summary (Contd.)

- TG meetings summary (cont'd):
  - Boeing proposed “simplified approach” was adopted:
    - **Add paragraph to existing 38535 Appendix B stating differences for class Y** (most remains same as Class V). One key element is for the manufacturers to submit a **Package Integrity Demonstration Test Plan (PIDTP)** to QA for approval. This plan must address issues unique to non-hermetic construction and materials, such as potential materials degradation, interconnect reliability, thermal management, resistance to processing stresses, thermo-mechanical stresses, & shelf life. The PIDTP plan shall be approved by QA after consultation with the space community.
    - Separate issues related to non-hermeticity from those for solder terminations.
    - Provide markups to other affected documents.
  - 10 manufacturers so far have expressed interest in offering Class Y products (Xilinx, Actel, Intersil, Aeroflex, BAE, Honeywell, TI, e2v, 3D Plus, & Cypress).
  - Comment from G12 management: The group may be surprised at how quickly this is moving. Usually, documents take longer than a year to get a full draft. You are far ahead of schedule. People just may not realize that Class Y is out of the conceptual stage and into the writing stage.

## G12 Class Y Task Group Summary (Contd.)

- Clarification needed on burn-in, electricals, and delta requirements. This is a major issue for all microcircuits and would apply to Class Y products as well. At the request of L. Harzstark and S. Agarwal, a JC13 Task Group was formed to clarify/update requirements in MIL-STD-883, Method 5004.
- Solder-terminated parts (could be hermetic or non-hermetic) need attention. The JC-13.2 Task Group on solder terminations was formed. The broad issues are: solderability, storage and shelf life, electrical testing, reworks, pull test, termination definition (tin–lead solder based?), etc. What boundaries separate JEDEC from IPC?
- The screening/qual requirements for BME capacitors should be clearly stated (ref. MIL-PRF-38535, Paragraphs 3.15). What is the attached method of the BME capacitors used in designs (epoxy, silver-glass or solder)? A JC13 Task Group was formed to address these issues.
- What is a space flight part?
  - Land Grid Array, LGA, configuration (yes)
  - Column Grid Array, CGA, configuration (debatable)
- Will the set of 38535 classes, with Class Y added, cover microcircuits for the next several years? (yes, per the poll taken of major manufacturers)

## G12 Class Y Task Group Summary (Contd)

- The Team requested G12 approval for DLA-VA to conduct an Engineering Practice (EP) study using the detailed requirement input the Task Group has developed. This request was approved by G12.
- The Team's request for clear approval of the Task Group charter was also approved by G12. The charter statement reads:

"This task group will develop requirements, including qualification and screening standards, for non-hermetic, ceramic-based microcircuits suitable for space applications. Initial effort will be focused on support for devices using flip-chip ceramic column grid array packaging, with resulting requirements to be submitted as a proposal for consideration to DLA Land and Maritime."

--At the October 2012 TG meeting held in Columbus, Ohio, the group voted (20-6) to go with option 1 recommendation which was:

DLA-VA to update 38535 with Class Y requirements and release it (keeping the requirements for common issues the same as they exist today for QMLV). DLA-VQ to prepare auditing Class Y suppliers.

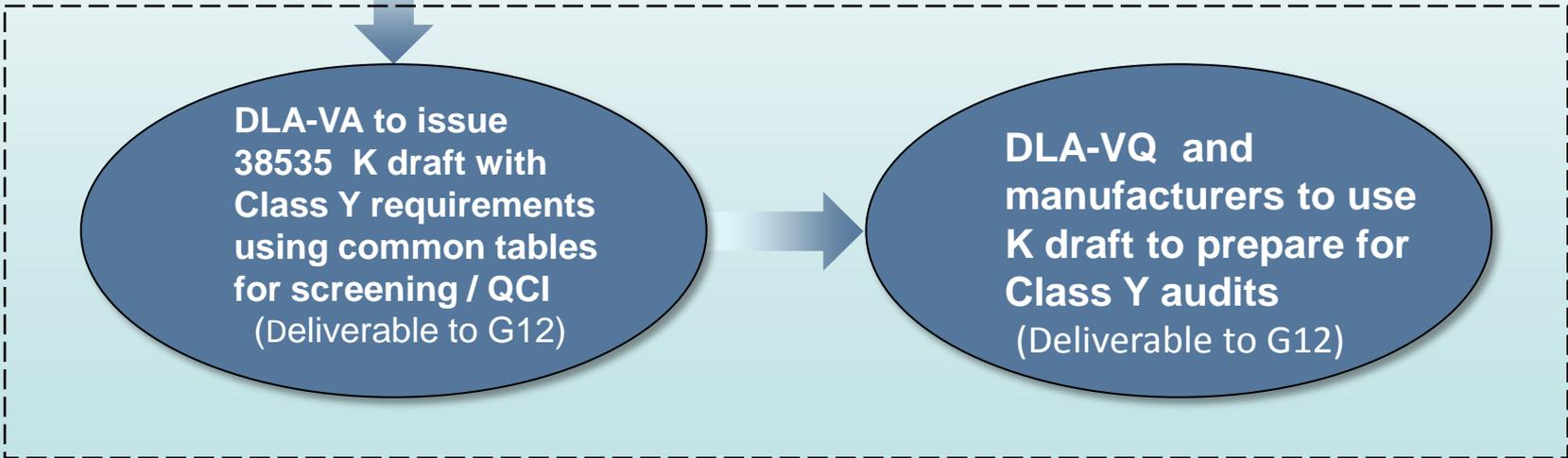
Keep working the common issues as quickly as possible. Continue to update the MIL documents as conclusions are reached on these issues.

# Class Y—Infusion of New Technology into QML System Picked

## Option 1 at Oct. 1, 2012 meeting

**Class Y Current status:**  
DLA-VA EP study—done  
(G12 deliverable)  
DLA-VA coordination meeting—done  
(Add'l deliverable to G12)

Common Issues  
**Base Metal Electrodes**  
**Column Grid Array**  
**Flip-Chip**  
**Burn-in**



**Option 1:** Begin two parallel activities to save time.

**Option 2:** Stop any further activity until common issues are resolved.

# 38535 QML Space – Current Status

		Class V (Existing)	Class Y (In Development)	Comment
<b>QML</b>	Need class specific PIDTP	No	Yes	
<b>CGA**</b>	Offered as QML	Yes	Yes	
<b>CGA*</b>	CGA specific PIDTP	Yes	Yes	same for both classes
<b>Flip-chip*</b>	Flip-chip specific PIDTP	Yes	Yes	same for both classes
<b>Passives*</b>	38535 Para 3.15	applies	applies	same for both classes
<b>Passives*</b>	Any updates for BME	would apply	would apply	same for both classes

- **Observations**

- \* represents an issue which is common to both classes (V and Y)
- \*\* highlights the fact that CGA devices are currently offered as QMLV.
- Despite limited resources in working this task, a meaningful QML Y product must be delivered to the flight projects in a timely manner. While the common issues are being worked, we should be able to update MIL-PRF-38535 to include Class Y requirements. This would enable the manufacturers and DLA-VQ to gear up for Class Y audits, an activity that can start now and continue in parallel with resolution of common issues, thus saving time.

- **Recommendations**

- DLA-VA to update 38535 with Class Y requirements and release it (keeping the requirements for common issues the same as they exist today for QMLV). DLA-VQ to begin preparation for auditing Class Y suppliers.
- Keep working the common issues as quickly as possible. Continue to update the MIL documents as conclusions are reached on these issues.

PIDTP = Package Integrity Demonstration Test Plan  
CGA = column-grid array BME = base metal electrode

## Evaluating the next generation of (Nano) Devices

- The next generation of nanodevices will be built on 450-mm wafers in a 28-nm process. This will increase device complexity tremendously.
- As the next-generation nano devices are developed, the candidates for infusion into the military standards should be identified and evaluated.
- The evaluation for reliability would follow the requirements as given in MIL-PRF-38535, Appendix H.
- The radiation hardness evaluation requirements are given in MIL-PRF-38535.
- It is anticipated that most of the new devices would be microcircuits. Such devices should be classified in one of the quality assurance levels as defined in MIL-PRF-38535.
- In case any of the devices is a hybrid circuit, the classifications for those devices should be per the quality assurance levels as defined in MIL-PRF-38534.
- Ref: S. Agarwal, "Infusion of Next-Generation Nano Devices into Military/Space Standards," Advanced Technology Workshop on Packaging Next Generation of Nano Devices, Albany, NY, April 30-May 1, 2013.

## Moving Forward

- The Class Y experiment has shown that it takes a considerable amount of time and effort to infuse new technology into the QML system.
- The next step for Class Y would be the release of MIL-PRF-38535, Rev. K.
- As the next generation nano devices are developed, the candidates for infusion into the military standards should be identified and evaluation of those candidates should be started as early as possible.
- The military standards should be reviewed on a periodic basis and updated to accommodate the unique features of the new devices.

- NASA Electronic Parts Assurance Group (NEPAG)



# <http://nepp.nasa.gov>



## **ACKNOWLEDGMENTS**

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