



NASA EXPLORES

Technology Assurance for Space Systems in an Age of Rapid Diversification

Jonathan Pellish

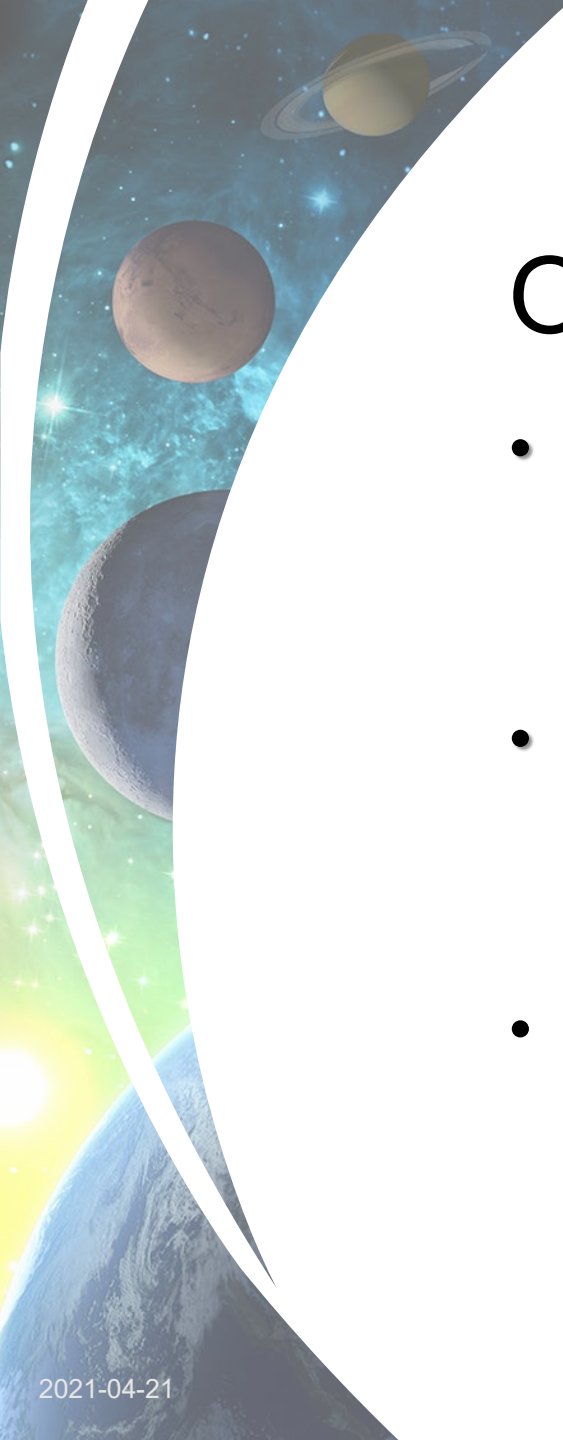
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21 April 2021

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To be presented by J. Pellish at the 2021 Components for Military &
Space Electronics (CMSE) Virtual Conference on 21-Apr-2021.



Outline

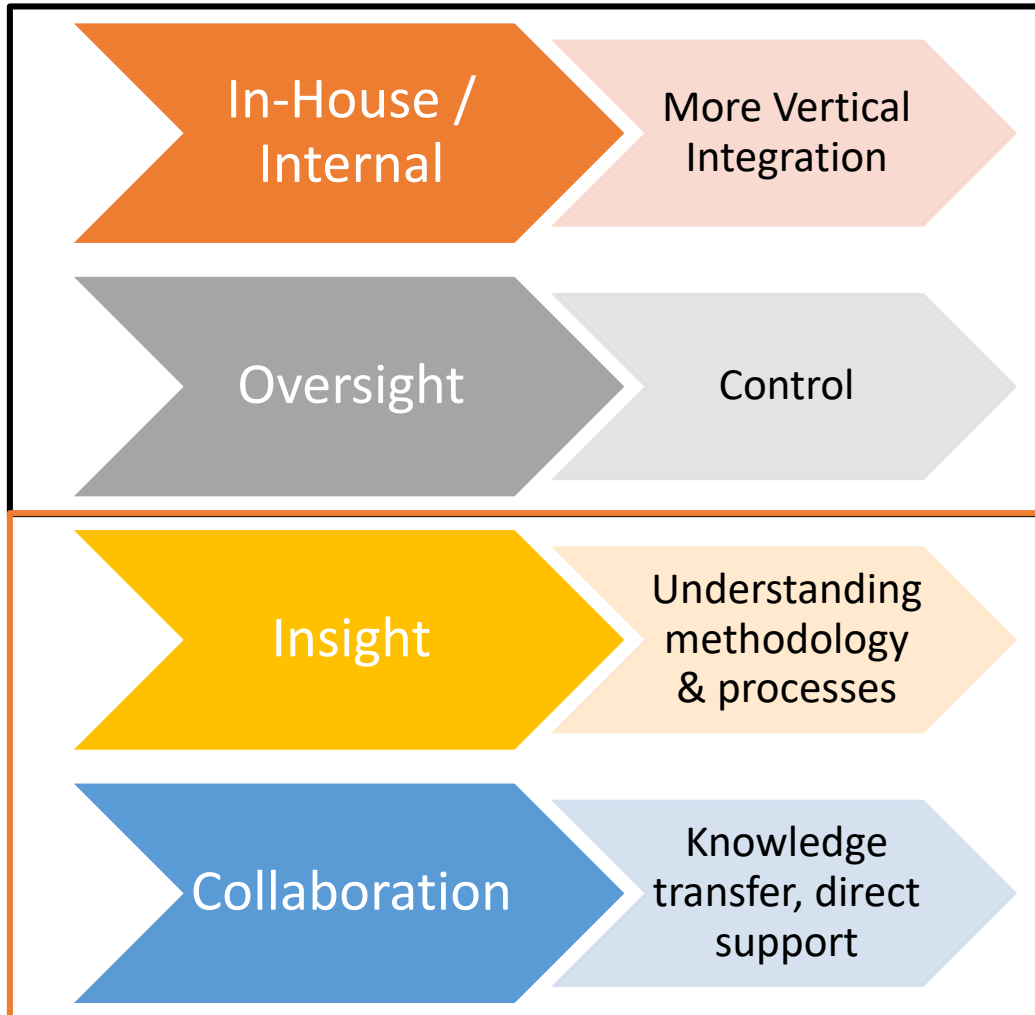
- Increasing exploration & science mission throughput is forcing traditional assurance roles to evolve – also driven by supply chain management & acquisition policy changes
- Digital transformation of assurance processes is accelerating and will also affect the way we think about best practices / guidelines & standards
- Cross-cutting needs like (heavy ion single-event effects) test facility capacity / capability and (parts & radiation assurance) workforce development require long-term focus

The background of the slide is a cosmic scene featuring a dark blue and black space filled with numerous stars of varying brightness. In the upper right, there is a bright blue nebula with wispy, ethereal structures. The lower half of the slide transitions into a lighter, more vibrant background with a mix of orange, yellow, and green hues, suggesting a different celestial region or a stylized gradient. The title text is centered in a large, black, sans-serif font.

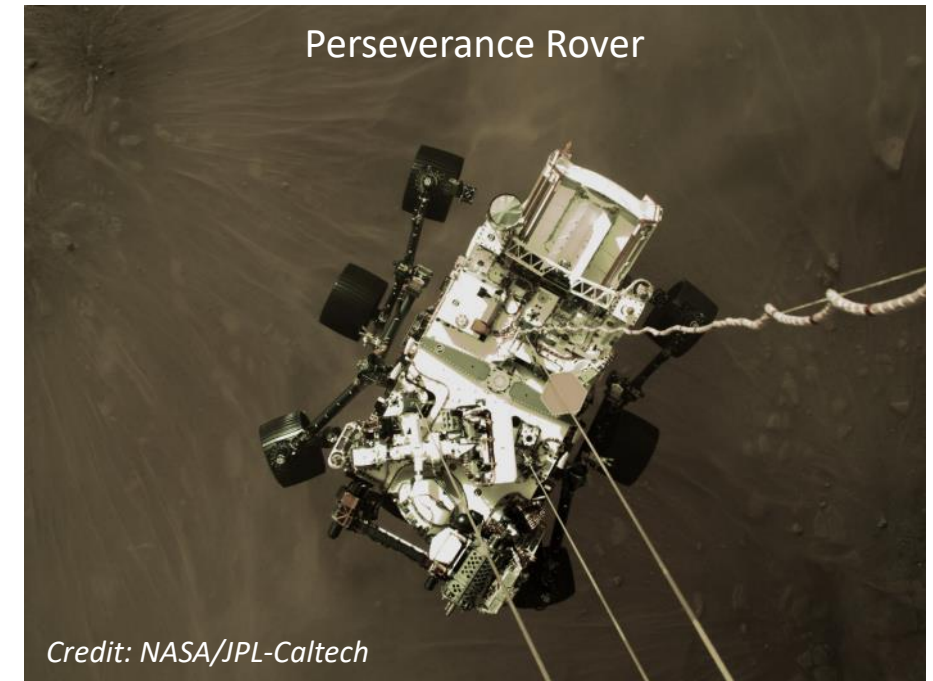
Assurance Roles Evolution & Growing Impacts of Supply Chain Management

Assurance Role Evolution

Example Scenarios for Parts & Radiation Assurance



Traditional

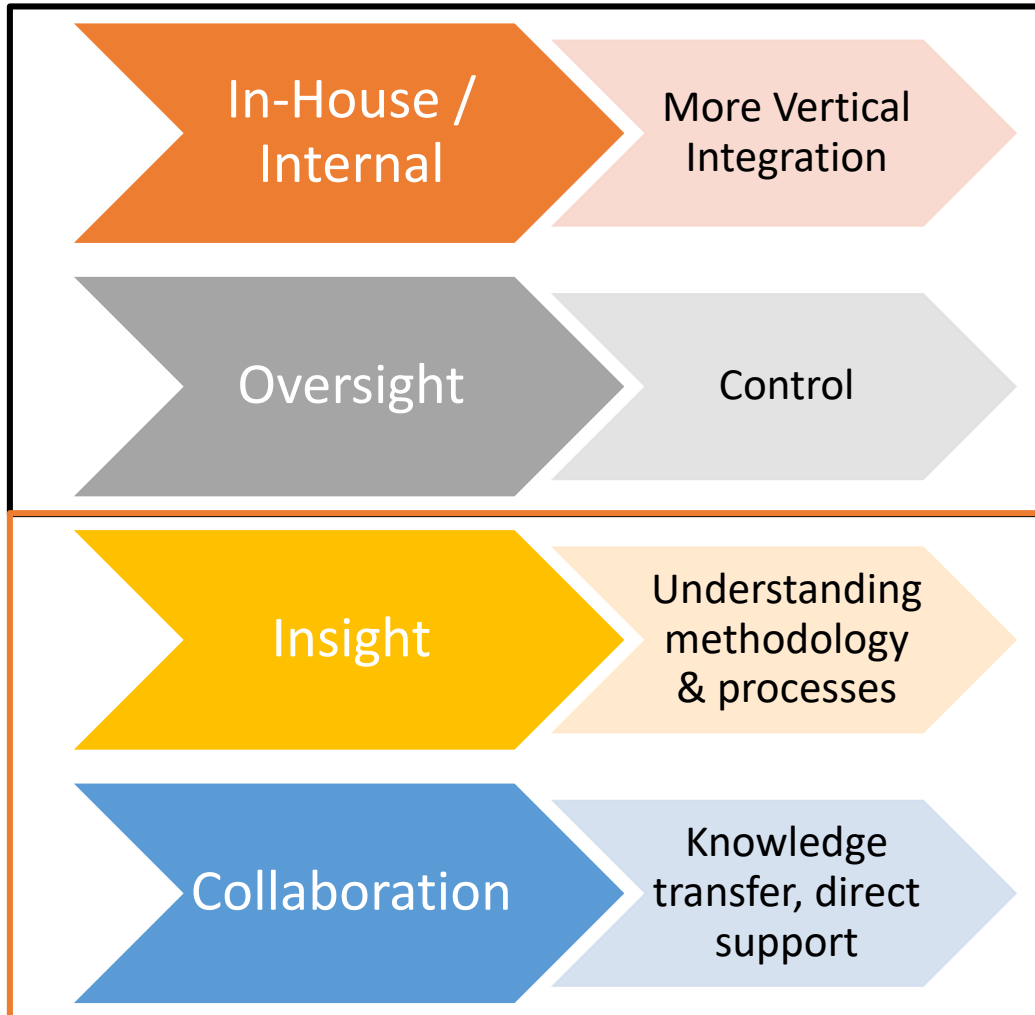


Evolved



Assurance Role Evolution

Example Scenarios for Parts & Radiation Assurance

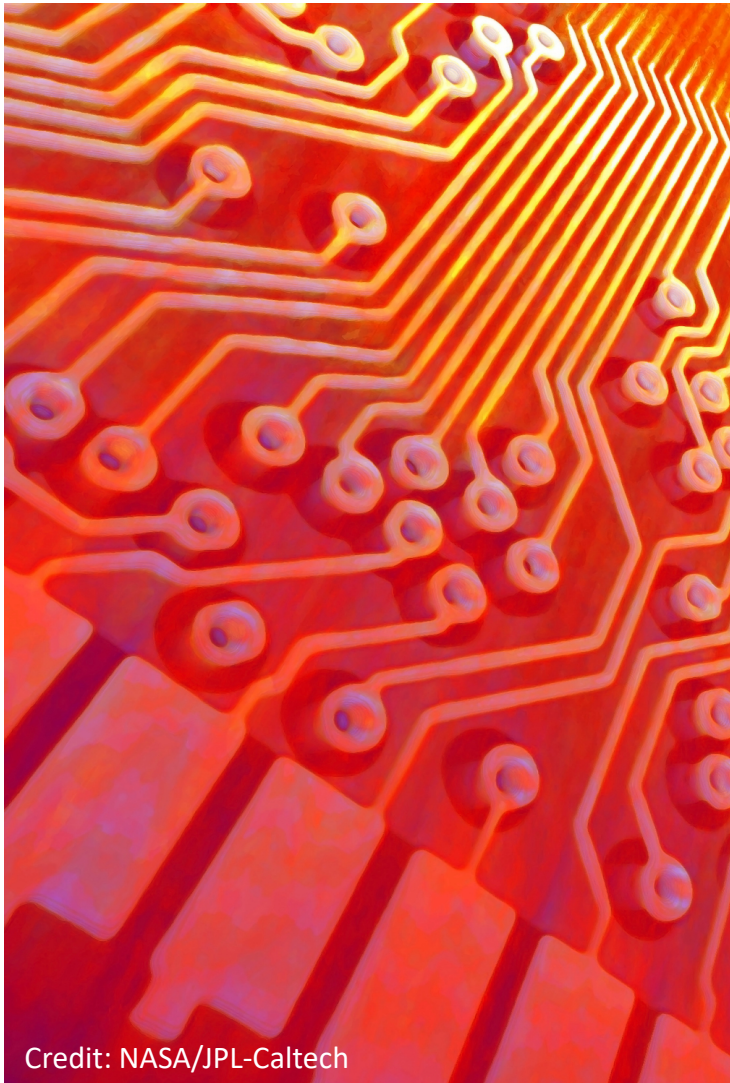


Traditional

Evolved

- Do we have the right requirements to flow down?
- How can we be sure that we understand our partners' methodologies & processes? Do they meet our requirements?
- Do we understand what our partners need & expect?
- Complexity and risk trades increase rapidly with the necessary infusion of advanced technologies

Ever-Growing Focus on Supply Chain (*Risk*) Management



Credit: NASA/JPL-Caltech

- Supply chain management has many pieces that often require coverage from several disciplines and units within an organization
- Despite significant focus on information and communications technology (ICT), including electronic piece parts and components, other important aspects exist in parallel:
 - Design practices,
 - Industrial base policy,
 - Quality assurance (technical & contractual),
 - Etc.

Ever-Growing Focus on Supply Chain (*Risk*) Management

AUTHENTICATED
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INFORMATION
GPO

34597

Federal Register **Presidential Documents**
Vol. 82, No. 142
Wednesday, July 26, 2017

Title 3— **Executive Order 13806 of July 21, 2017**
The President **Assessing and Strengthening the Manufacturing and Defense
Industrial Base and Supply Chain Resiliency of the United
States**

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

11849

Federal Register / Vol. 86, No. 38 / Monday, March 1, 2021 / Presidential Documents

Presidential Documents

Executive Order 14017 of February 24, 2021
America's Supply Chains

Industrial base actions are just part of the story

Public Law No. 116-283
FY2021 National Defense Authorization Act

**One Hundred Sixteenth Congress
of the
United States of America**

AT THE SECOND SESSION

*Begun and held at the City of Washington on Friday,
the third day of January, two thousand and twenty*

An Act

To authorize appropriations for fiscal year 2021 for military activities of the Department of Defense, for military construction, and for defense activities of the Department of Energy, to prescribe military personnel strengths for such fiscal year, and for other purposes.

*Be it enacted by the Senate and House of Representatives of
the United States of America in Congress assembled,*

SECTION 1. SHORT TITLE.

This Act may be cited as the “William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021”.

Ex: TITLE XCIX—Creating Helpful
Incentives to Produce Semiconductors
(CHIPS) for America

Ever-Growing Focus on Supply Chain (*Risk*) Management

Federal Driver Examples – Not Exhaustive

John S. McCain
National Defense
Authorization Act for
Fiscal Year 2019
Public Law No. 115-232

Established Sec. 889
prohibitions on certain
telecommunications
and video equipment

SECURE Technology Act
Public Law No. 115-390

Created the Federal
Acquisition Security
Council (FASC)

Established term
“covered article”

Granted additional
authorities and
responsibilities

Executive Order 13873
May 15, 2019

Securing the
Information and
Communications
Technology and Services
Supply Chain

Other Documents

Federal Acquisition
Regulation and
Supplements

NASA Procedural
Requirements and
Procurement Class
Deviations

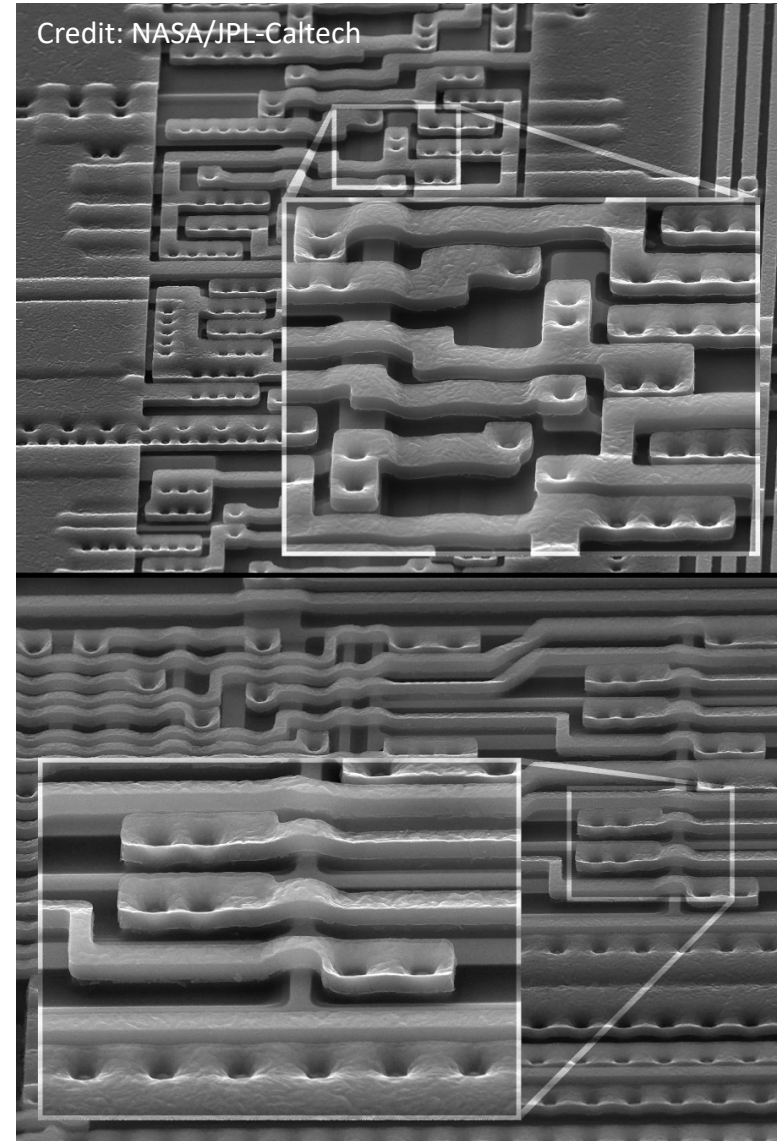
NIST Special
Publications

- Practical implications for both end users and vendors of electrical, electronic, electromechanical, and electro-optical (EEME) parts and components

Ever-Growing Focus on Supply Chain (*Risk*) Management

- Helping propel many other related topics related to electronic parts:
 - Best practices, guidelines, and standards;
 - Digital transformation;
 - Procurement regulations;
 - Test facility capacity and capabilities; and
 - Workforce stewardship and development
- Exerting influence on how we manage risk for parts and components

Continuing pushes for interagency cooperation and reciprocity



The background of the slide is a cosmic scene featuring a dark blue and black space filled with numerous stars of varying brightness. In the upper right, there is a bright blue nebula with wispy, ethereal structures. The lower half of the image transitions into a warm, golden-yellow glow, suggesting a distant star or a nebula's edge, with many small, bright stars scattered throughout.

Digital Transformation & Best Practices / Guidelines, and Standards

Digital Transformation of Technology Assurance

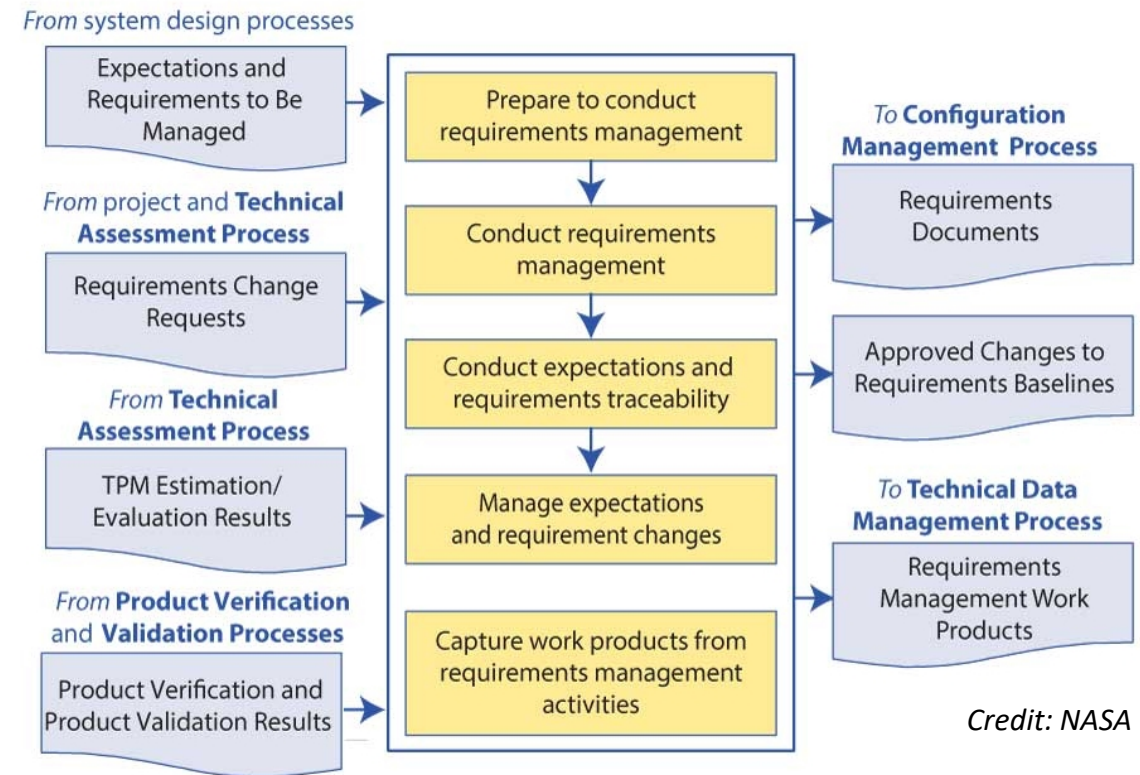


Credit: NASA

- Digitalization, the process of moving toward digital business, is occurring everywhere and remains an ongoing process for technology assurance
 - Digital transformation can lead to more informed decisions, increased operational efficiency, and streamlined processes
 - Increasingly important in age of diversification
- Model-based mission assurance (MBMA) and systems engineering (MBSE) are just two manifestations of digital transformation
 - Can also include things like digital twins (virtual representation in virtual space of a physical structure in real space and the information flow that keeps them synchronized) and other model-based constructs

Digital Transformation of Technology Assurance

- With increasing exploration & science mission throughput and rapid technology infusion, need to consider how we think about requirements and standards
- Digital transformation approaches can be used here too
- Systems for model-based requirements and standards can be more agile, efficient, understandable, and easier to maintain – *key may be self-consistent agility*

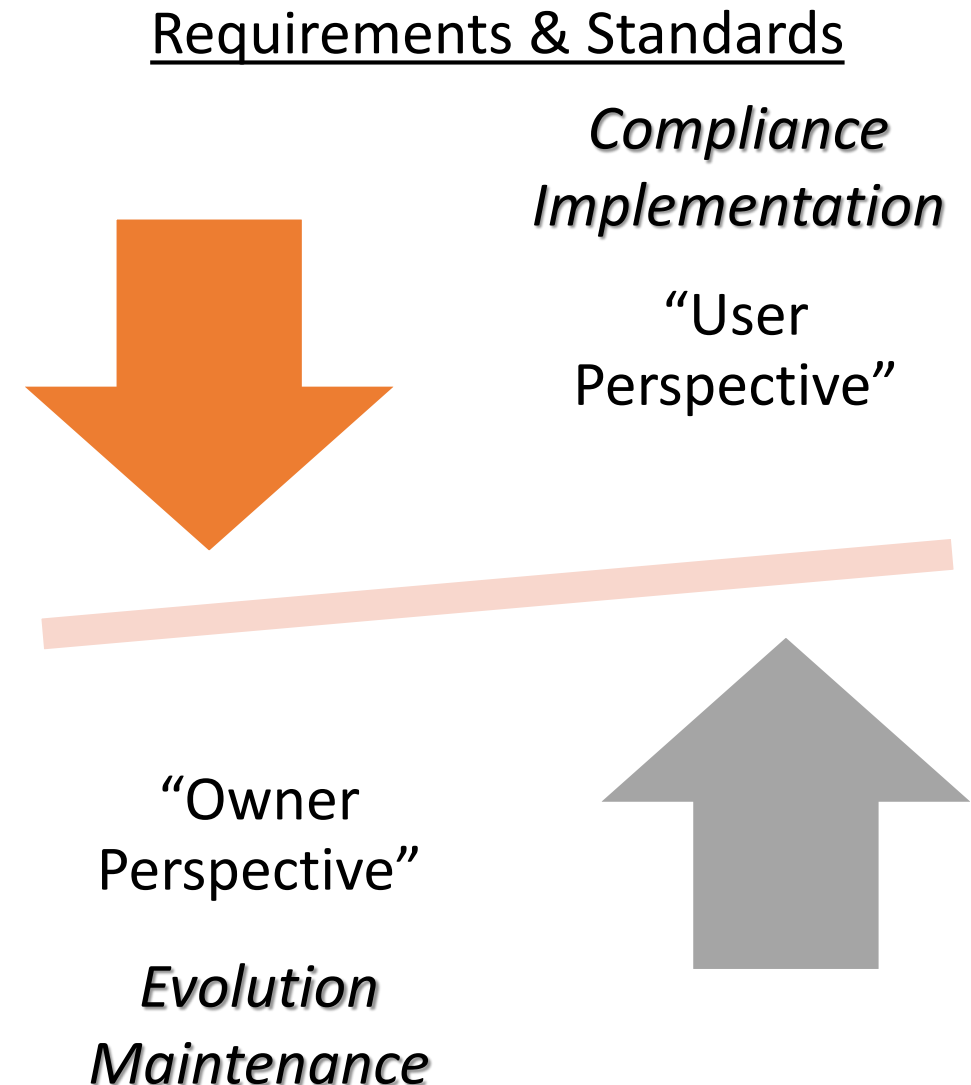


Example requirements management process

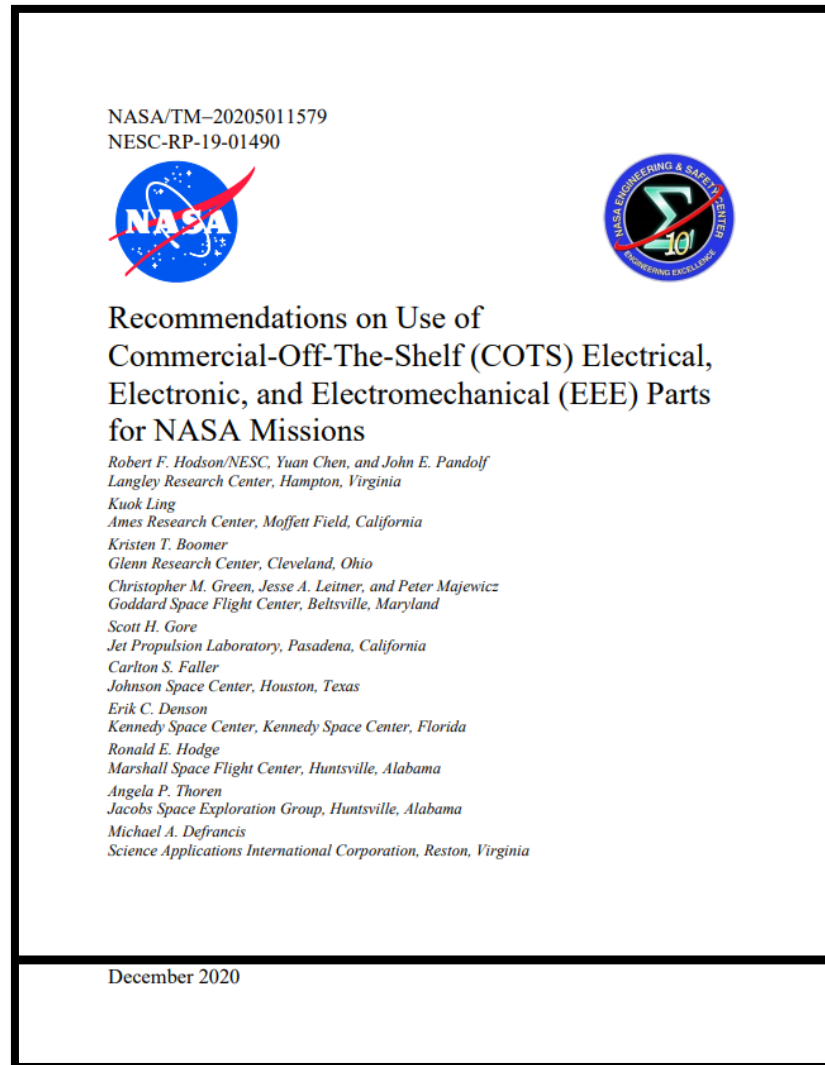
TPM = technical performance measure

Digital Transformation of Technology Assurance

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Best Practices, Guidelines, and Standards

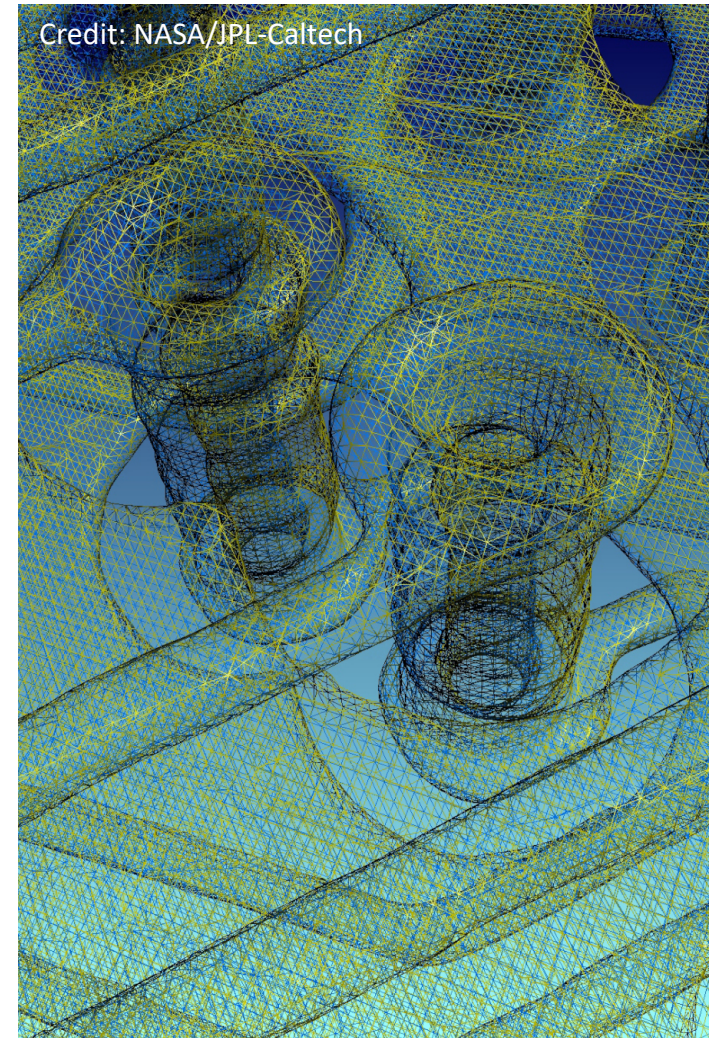


<https://ntrs.nasa.gov/citations/20205011579>

- NASA Engineering and Safety Center (NESC)
 - COTS parts recommendations
 - Delivered Phase I report; Phase II ongoing now
 - Avionics radiation hardness assurance (RHA) best practices / guidelines
 - Limited distribution report complete, working on public technical memorandum
 - Recommends creation of Agency RHA standard
- NASA Electronic Parts and Packaging (NEPP) Program
 - Developing an Agency standard for EEEE parts selection, testing, and derating
 - Will be publicly available when approved
 - Supporting related NESC activities
- Many other ongoing activities within the JEDEC and SAE communities (e.g., advanced technology microcircuits, alternate grade parts, QML-P, etc.)

Commercial Off The Shelf Electronics

- Understanding and effectively managing COTS electronics risk should use a holistic approach – accounting for mission, environment, application, and lifetime (“MEAL”)
 - MEAL guidelines: <https://ntrs.nasa.gov/citations/20180007514>
- Identifying and managing COTS electronics risk tends to hinge on how a program/project copes with lack of control and insight (relative to MIL-SPEC parts)
- Mitigating residual technical gaps (e.g., space radiation, temperature, etc.) will always create trades
- Can COTS be used directly, without further effort at the part level? How can we effectively / efficiently leverage what we buy?



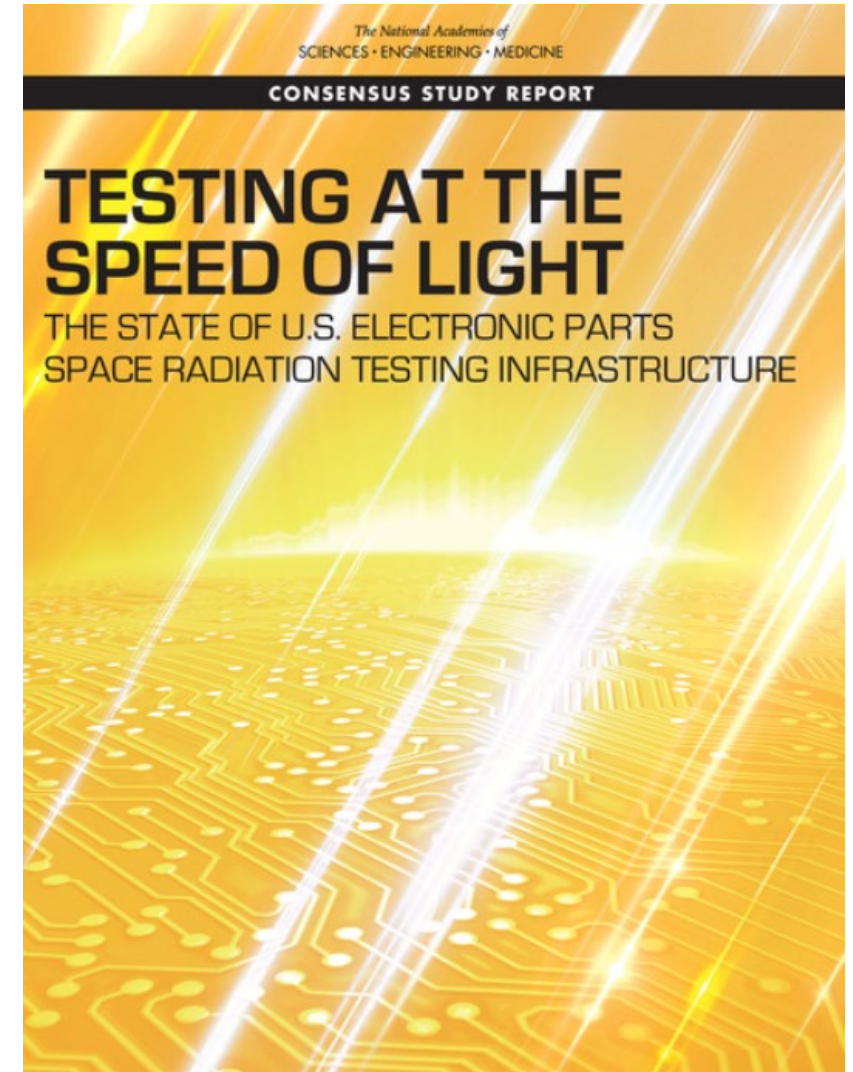


Radiation Test Facilities' Capacity & Capability

An industrial base issue, not just facility users...

Test Facility Capacity and Capabilities

- *Heavy ion single-event effects* (SEE) test facility capacity and capability issues were documented in the 2010s – but impacts not immediately apparent
- Organizations recognized the need to act – e.g., 2018 National Academies consensus study report, etc.
- Recommendations have taken time to implement, which has increased risk to facility users and their programs – exacerbated by COVID-19

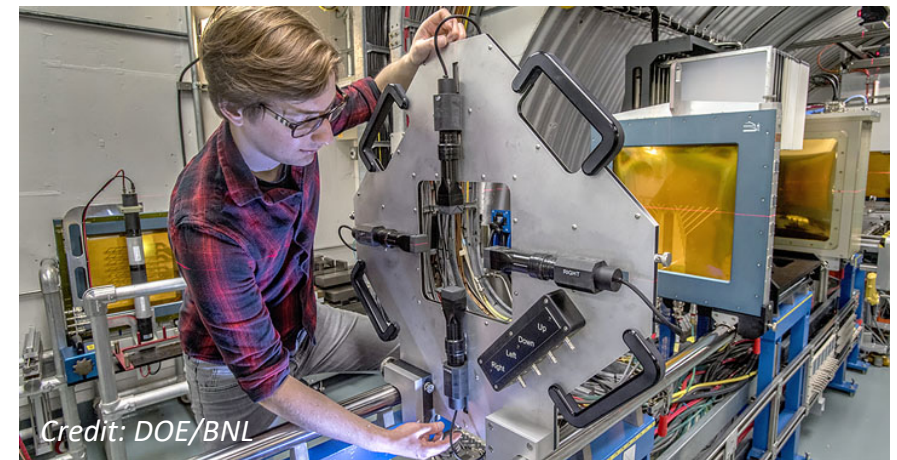
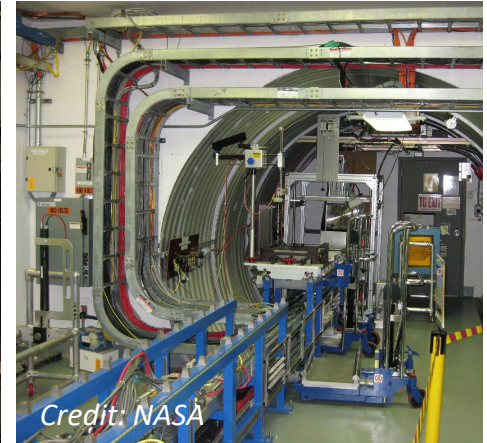
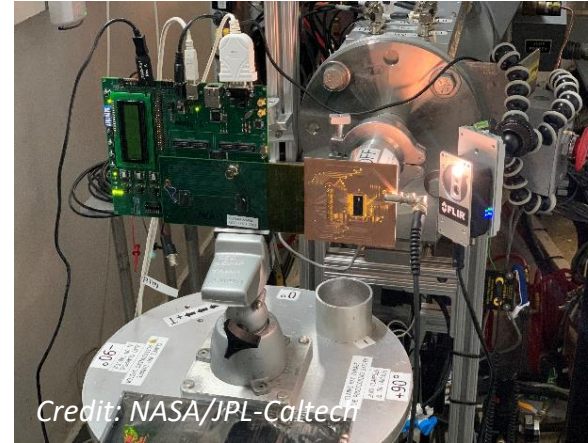


<https://doi.org/10.17226/24993>

Test Facility Capacity and Capabilities

U.S.-based perspective – but appears to have broad consensus

- Existing heavy ion SEE test facilities cannot meet current or future demands
- Government and commercial space are driving significant increases in SEE testing demand
- Current heavy ion accelerators for SEE testing at Department of Energy laboratories and U.S. universities have limited capacity and capability
- More complex electronics and systems require more testing hours
- Advanced electronics and packaging require higher ion energies



Summary points based on publicly-disclosed work conducted by the Strategic Radiation-Hardened Electronics Council

Test Facility Capacity and Capabilities

*Possible heavy ion SEE test facility
investment strategies*

Focus on building low-energy testing capacity

Understand high-energy testing needs

Invest in high-energy capabilities as applicable

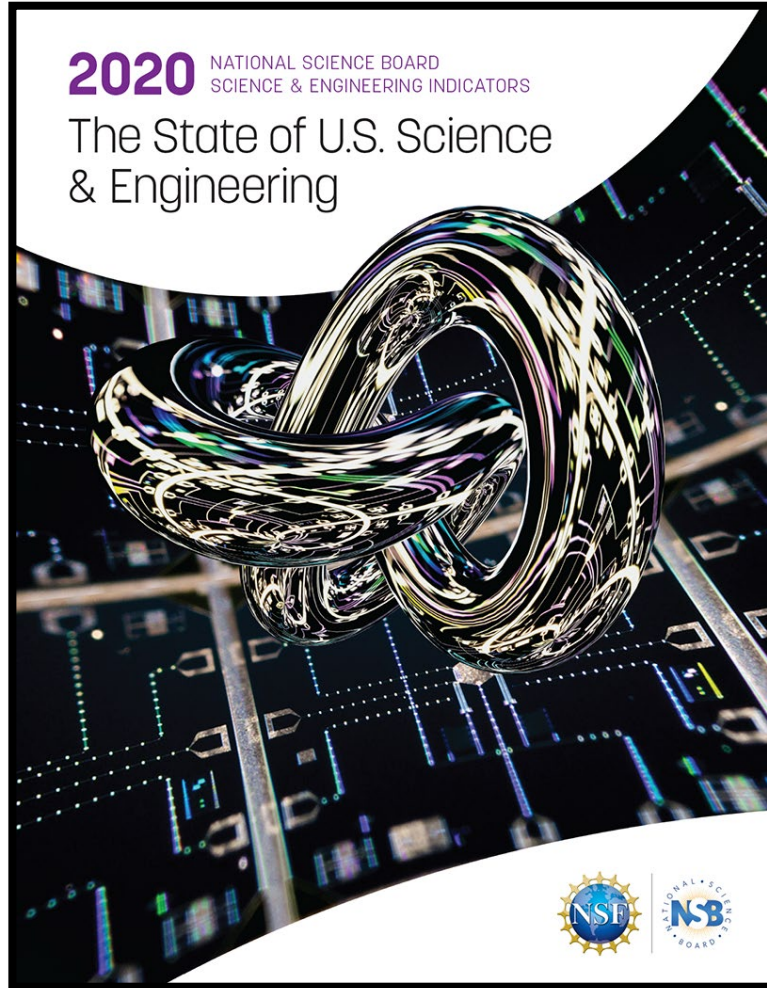
- Conducting efforts in a delicate ecosystem – need to avoid unintended consequences that undermine current capacity and capabilities
- Understanding future testing demands and needs is not trivial – users are accustomed to parasitic operation and limited supply, which affects test planning & methodologies

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Workforce Stewardship & Development

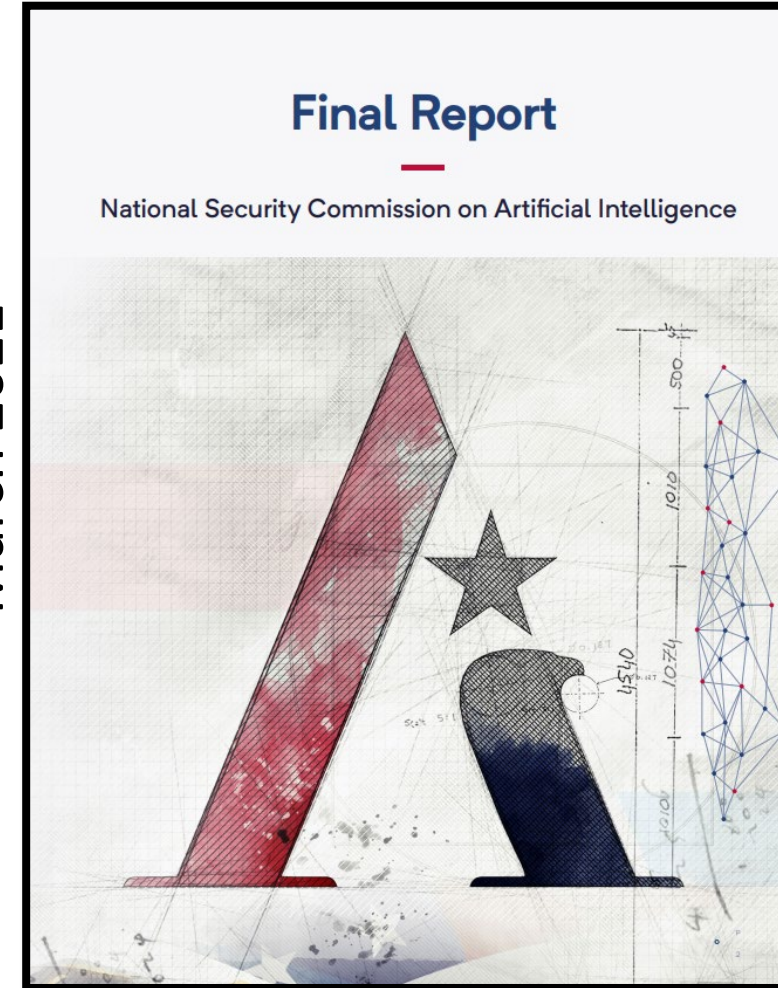
Workforce Stewardship & Development are More Important Than Ever

January 2020 (“Indicators” is biennial)



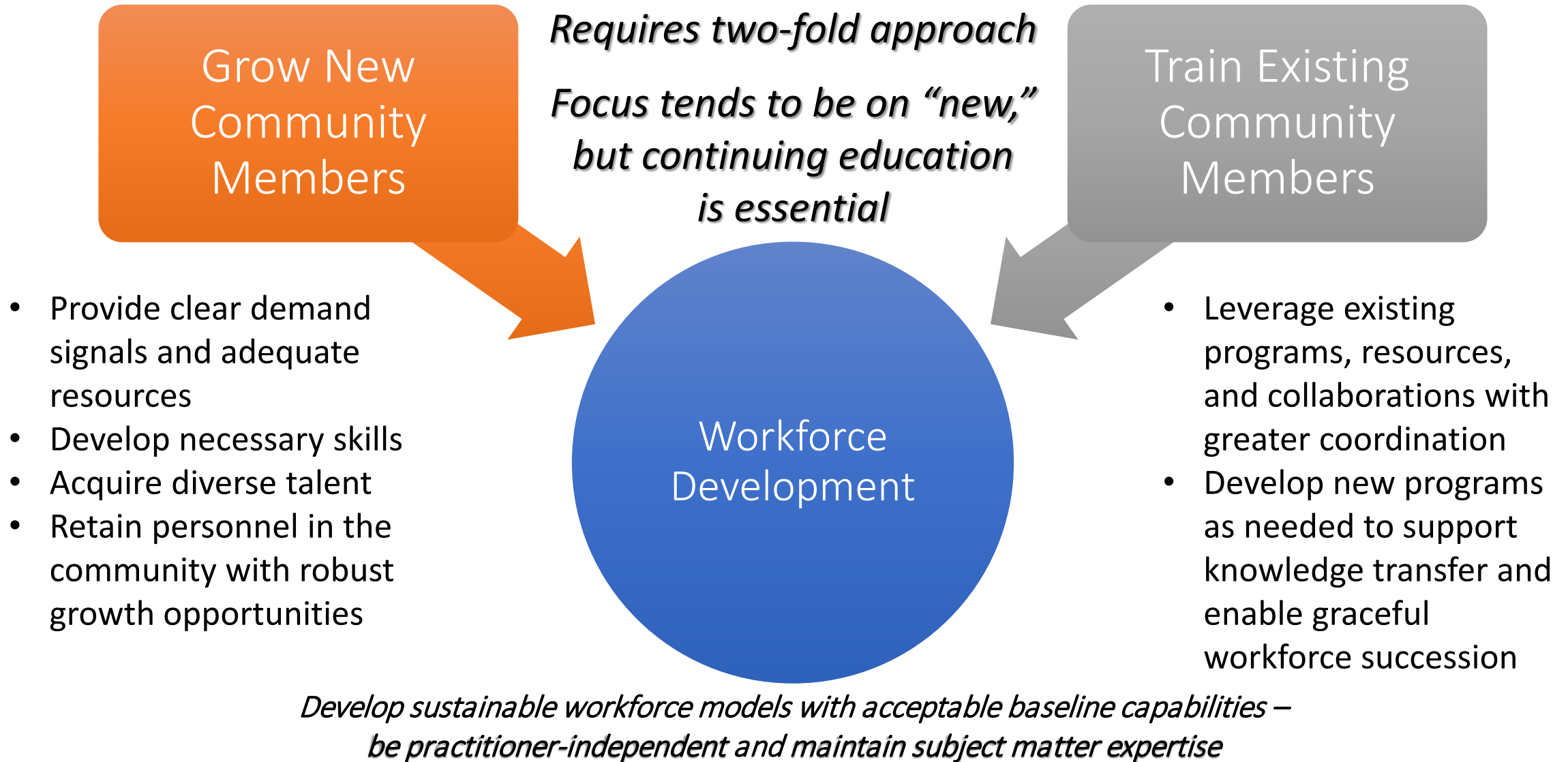
<https://ncses.nsf.gov/pubs/nsb20201>

March 2021



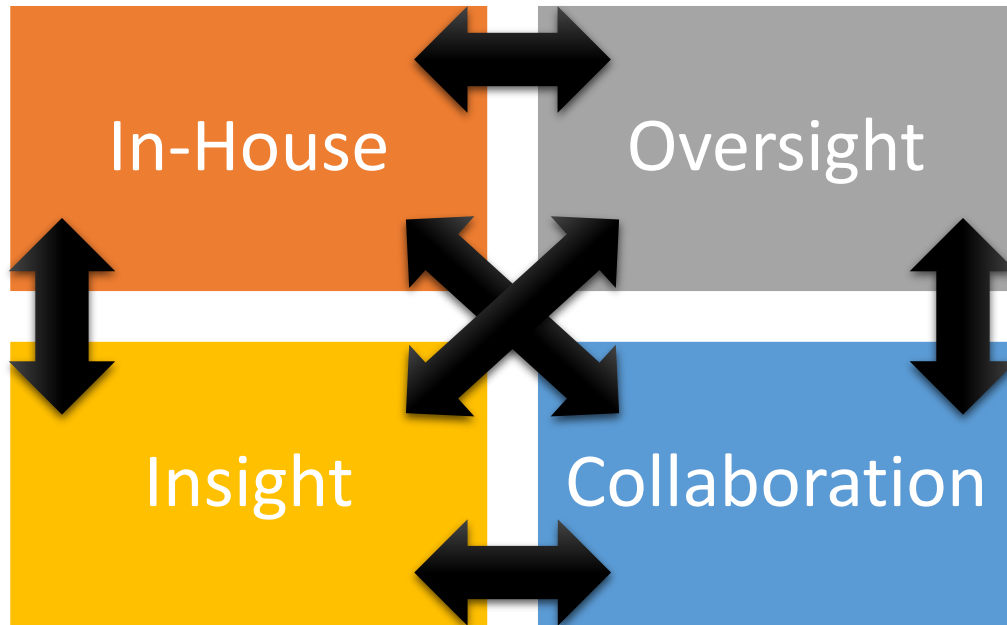
<https://www.nscai.gov/>

Workforce Development Strategies



Workforce Development Strategies

Assurance Scenarios & Skills



- Workforce skill mix needs are not necessarily the same across assurance scenarios
 - In-house $\approx$ Collaboration (maybe...)
 - Oversight $\neq$ Insight
- Many workforce development efforts to-date have focused on radiation effects, radiation hardness assurance, etc. – rightly so...but...
 - Need to balance with electronics reliability and piece part commodity expertise
 - Can be harder to pursue / maintain, not as well-defined – early-career motivation?

Summary

- Mission throughput and diversification, combined with growing focus on supply chain management, have had strong effects on technology assurance roles and responsibilities
 - Can impact workforce development requirements too
- Digital transformation of assurance practices as well as requirements and standards management will be increasingly important
- Heavy ion SEE test facility capacity and capability issues are likely to drive programmatic / technical risks for the next several years – at least until current investment plans *start* to mature in the mid-2020s
- Growing, training, and retaining qualified assurance professionals requires a combination of patience and foresight to ensure necessary skill mixes are developed and retained *within the community* – increase pipelines and accessible training opportunities to mitigate inter- and intra-organization competitions

The background of the slide is a composite of two cosmic images. The top half features a dark blue and black space scene with a bright, glowing blue nebula on the right side and several sharp, bright stars. The bottom half shows a vibrant orange and yellow nebula on the left, transitioning into a green and blue nebula on the right, with numerous stars scattered throughout.

Thank you for your attention!

Acronyms

Abbreviation	Definition
BNL	Brookhaven National Laboratory
CHIPS	Creating Helpful Incentives to Produce Semiconductors
CMSE	Components for Military & Space Electronics
COTS	Commercial Off The Shelf
COVID-19	Coronavirus Disease 2019
DOE	Department of Energy
EEE	Electrical, Electronic, and Electromechanical
EEEE	Electrical, Electronic, Electromechanical, and Electro-Optical
FASC	Federal Acquisition Security Council
FY	Fiscal Year
ICT	Information and Communications Technology
JEDEC	JEDEC is a proper noun
JPL	Jet Propulsion Laboratory
MBMA	Model-Based Mission Assurance
MBSE	Model-Based Systems Engineering
MEAL	Mission, Environment, Application, and Lifetime
NASA	National Aeronautics and Space Administration
NEPP	NASA Electronic Parts and Packaging (Program)
NESC	NASA Engineering and Safety Center
NIST	National Institute of Standards and Technology
QML	Qualified Manufacturers List
RHA	Radiation Hardness Assurance
SAE	SAE is a proper noun
SECURE	Strengthening and Enhancing Cyber-capabilities by Utilizing Risk Exposure (Technology Act)
SEE	Single-Event Effects
TPM	Technical Performance Measure
U.S.	United States (of America)