NDIA #19694: Software Development Practices in HPCMP-CREATE™ (A Family of Large-scale, Physics-based, System-of-Systems, Software Development Projects)

An Application of Risk-based Software Development Practices

DOD HPC MODERNIZATION PROGRAM

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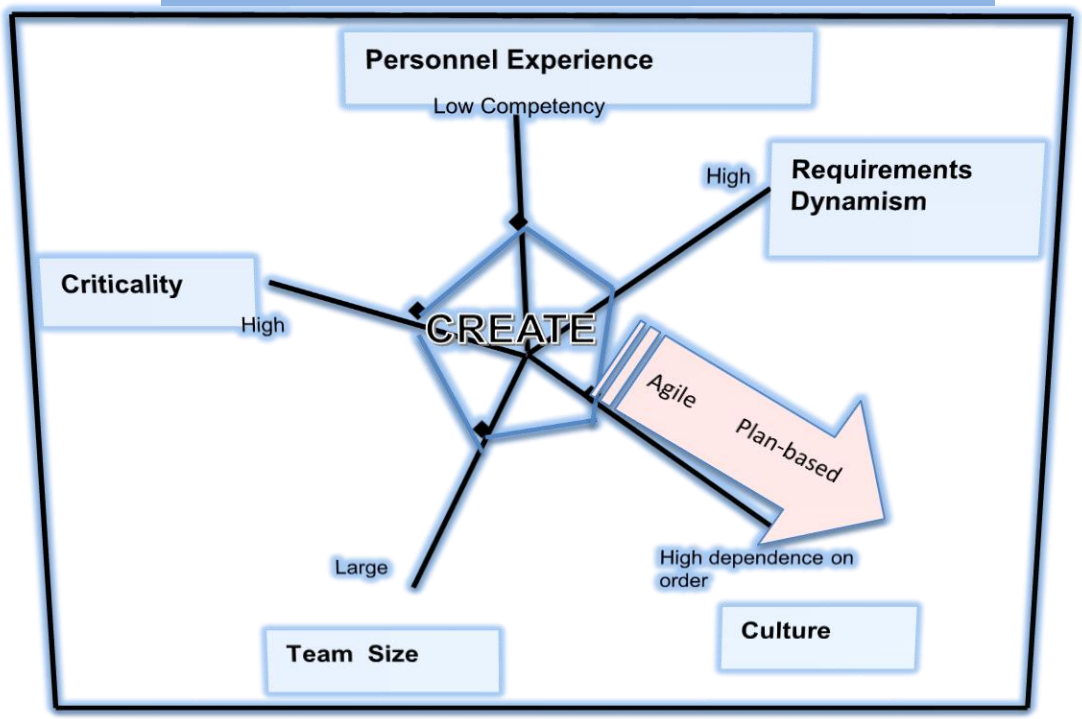
Risk-based Software Development Practices in CREATE

CREATE Core Software Development Risks

1. Misaligned requirements management
2. Workflow management for distributed teams across the Services
3. Team communications across different security enclaves
4. Testing
5. Product support with limited resources

Software Development Practice Drivers

Development Environment Indicators



Notional Home Ground Chart for CREATE

after Boehm, Using Risk to Balance Agile and Plan Driven Methods, IEEE Computer Society, 2003

The attributes of CREATE teams favor an Agile Development approach

Risk 1: Misaligned Requirements Management

Mitigating Practice. *Express requirements as use-cases in language that customers and developers share.*

CREATE-Capstone Foundational[1] Required Capabilities

ID	Description
MG-00	Import Externally Generated Geometry (C
MG-01	Create Parameterized Geometry
MG-02	Support Dependency-Based Associative I
MG-03	Repair Externally Generated (eg CAD) Ge
MG-04	Support De-featuring and Idealization of C
MG-05	Provide Robust Surface Meshing Algorithm
MG-06	Provide Robust Volume Meshing Algorithm
MG-07	Provide Geometry-based Mesh Generatio
MG-08	Support Multi-scale Models
MG-09	Support Legacy Component Integration
MG-10	Support Analysis Model Attribution
MG-11	Provide Accurate and Scalable Runtime C
MG-12	Core Framework (Internal requirements to above)

MG-06 Use-Cases

MG-06-UC-01	Unstructured all-tetrahedral volume meshing
MG-06-UC-02	Unstructured hexahedral-dominated hybrid meshing
MG-06-UC-03	Boundary Layer meshing with triangular wedge elements in the viscous region transitioning to tet. No interference from other BL
MG-06-UC-04	MG07-UC04 with complex geometries and multiple intersecting boundary-layers
MG-06-UC-05	Boundary layer meshing with hex,prism in the viscous regin transitioning to hex/tet
MG-06-UC-06	MG06-UC05 with complex geometries & multiple intersections
MG-06-UC-07	Volume mesh handing for high order element (first approach)
MG-06-UC-08	Matching volume meshes for periodic boundary condition
	en truncation boundary
	with sources
MG-06-UC-11	Modeling and meshing for sliding planes for moving parts
MG-06-UC-12	Support for 'strand-meshing' paradigm

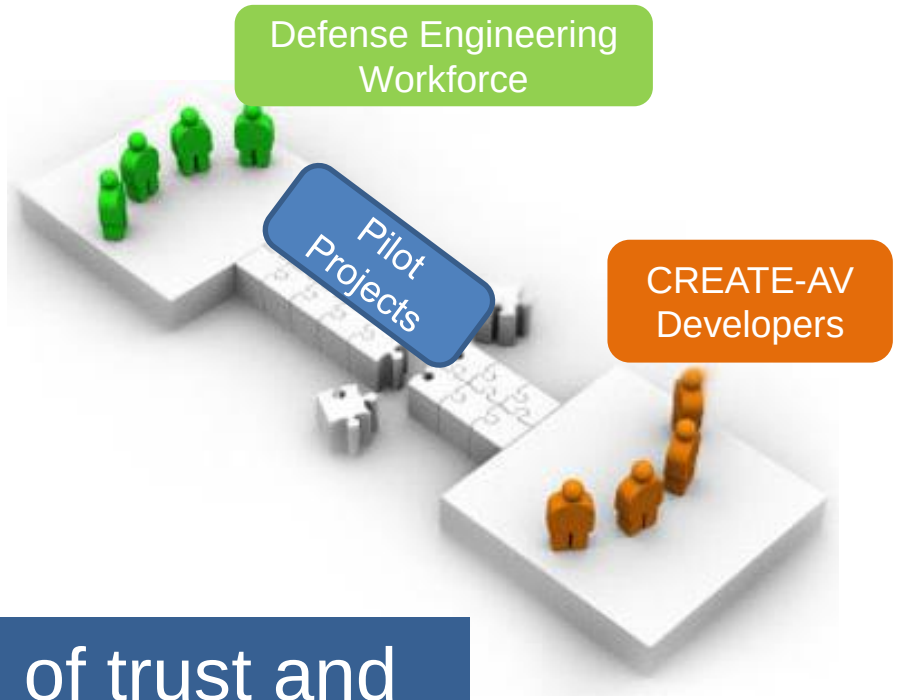
Use-Cases promote a shared view of requirements

[1] Established in 2008

Risk 1. Misaligned Requirements Management

Mitigating Practice: Pursue Pilot Projects

Annually execute between 4 and 6 Pilot Projects to "shadow" acquisition programs engineering workflows– 60+ Pilots since 2008!

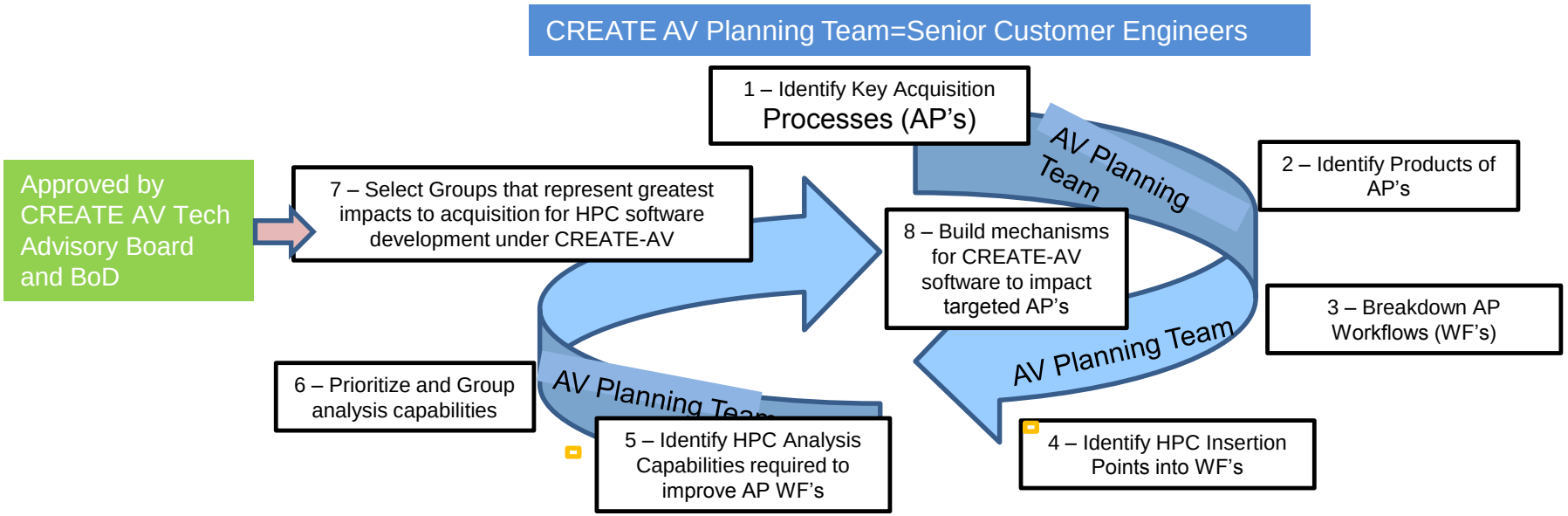


Pilots build bridges of trust and go deeper than product demos

Risk 1. Misaligned Requirements Management

- **Mitigating Practice: *Bring Senior Customer Engineers into the planning cycle for new processes/workflows***

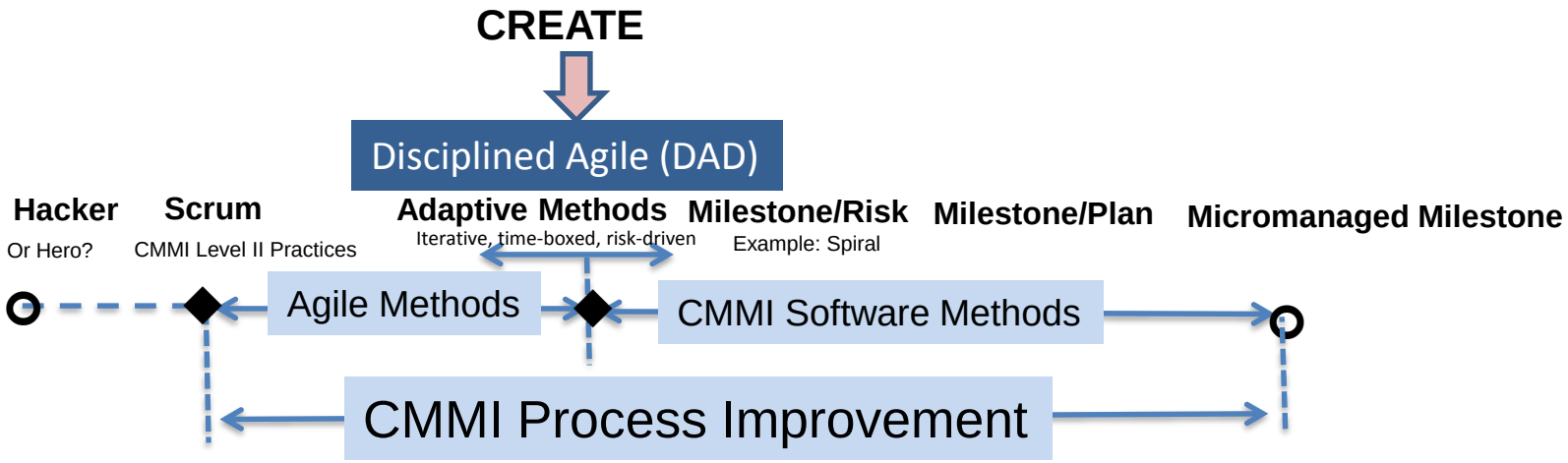
Example: CREATE-AV Planning Process for new Stakeholder Processes/workflows



This demonstrates that the product solves the customer's problem and that it can be used in the customer's workflow

Risk 2. Software Development Workflow for Distributed Teams

- **Mitigating Practice:** ***Balance flexible planning with milestone-based accountability.***

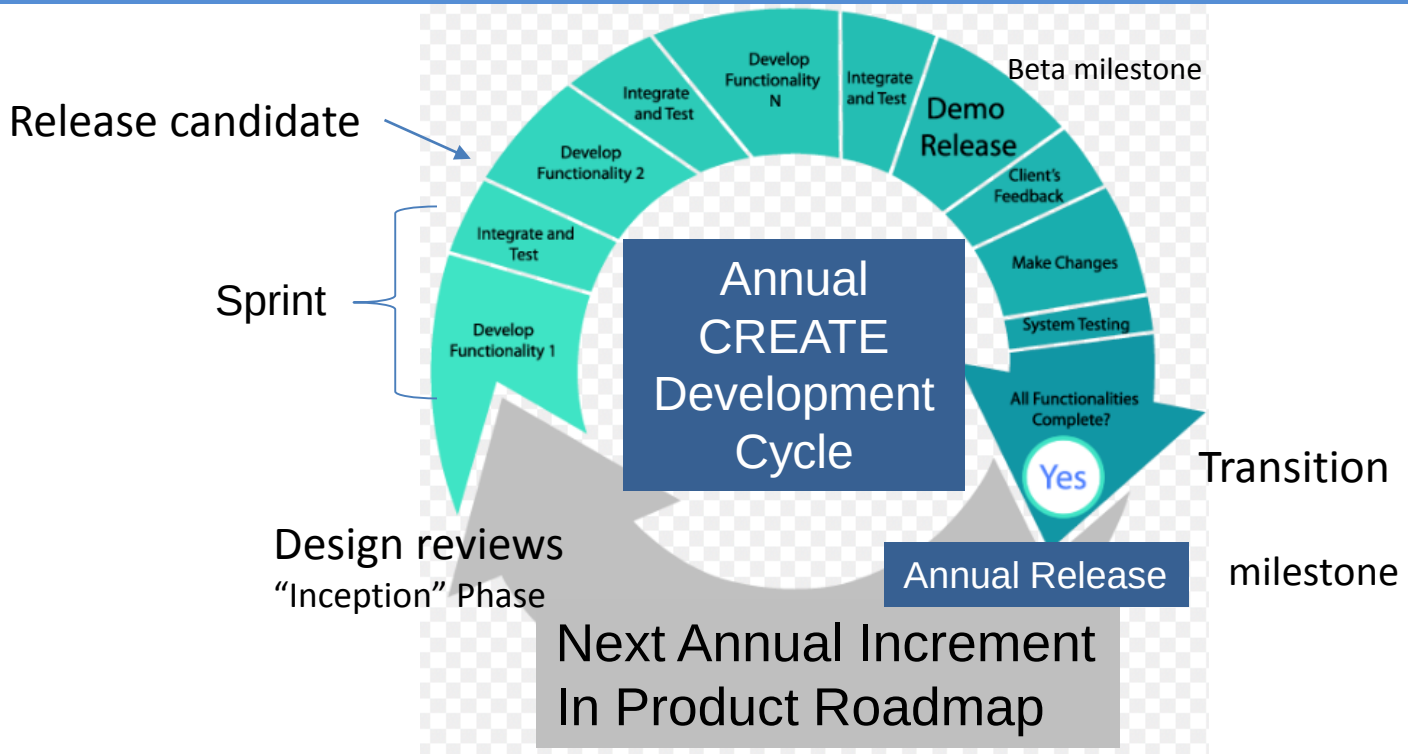


after Boehm, "Getting Ready for Agile Methods with Care," IEEE Software, 2002

CREATE: An disciplined agile approach with the features of Milestone/Risk and Agile Workflow Management

Risk 2. Software Development Workflow for Distributed Teams

The CREATE Approach—Disciplines Agile Development based on Scrum with Risk-based Milestones

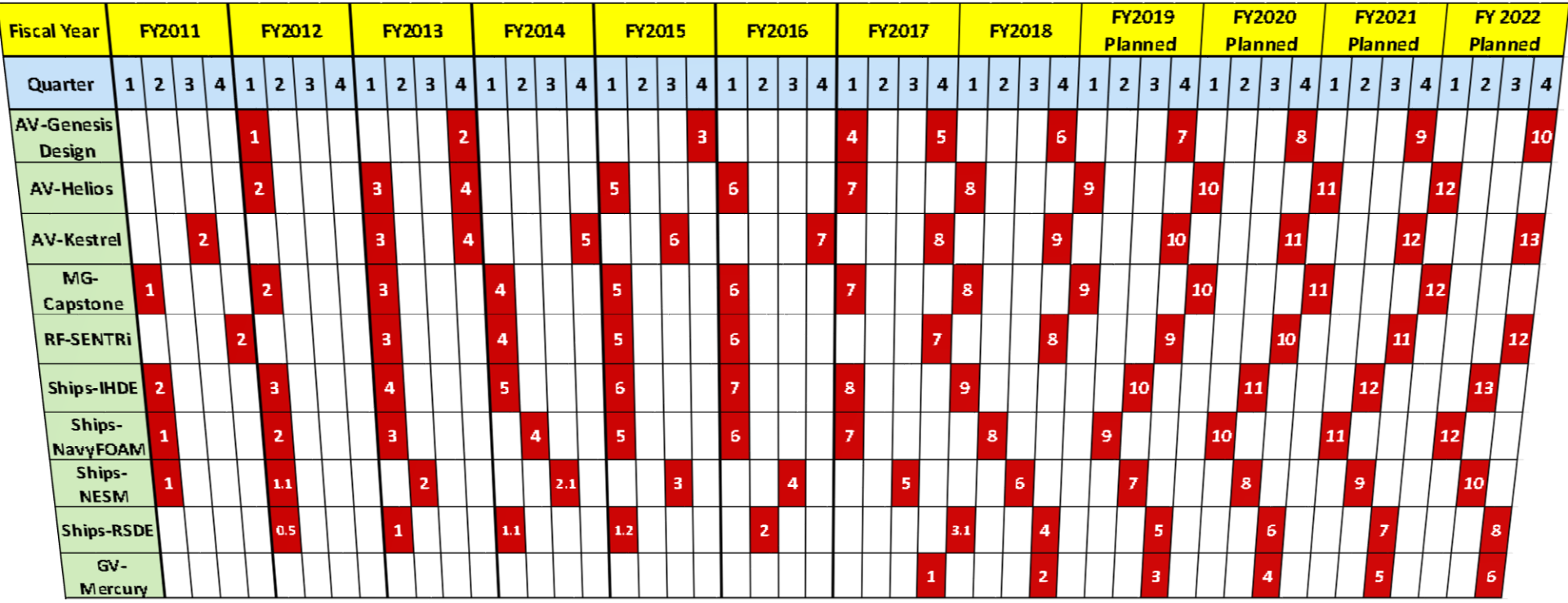


Our approach couples flexibility with accountability

Figure after info@matrix-soft.org

Risk 2. Workflow Management for Distributed Teams

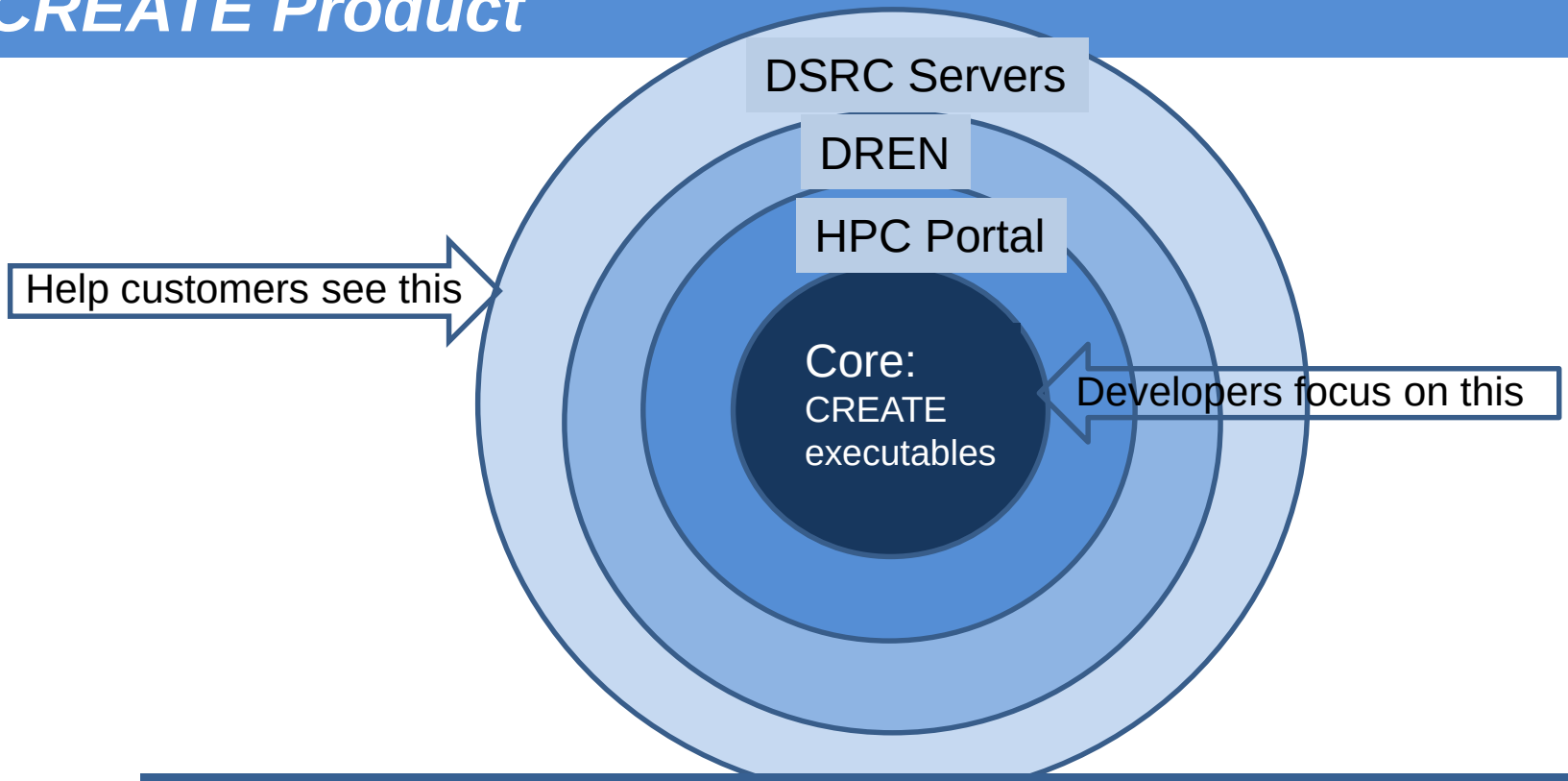
- **Mitigating Practice:** ***Require at least one new "version" every year***



Annual releases guarantee meaningful progress during the fiscal year

Risk 3. Communications across different Security Enclaves

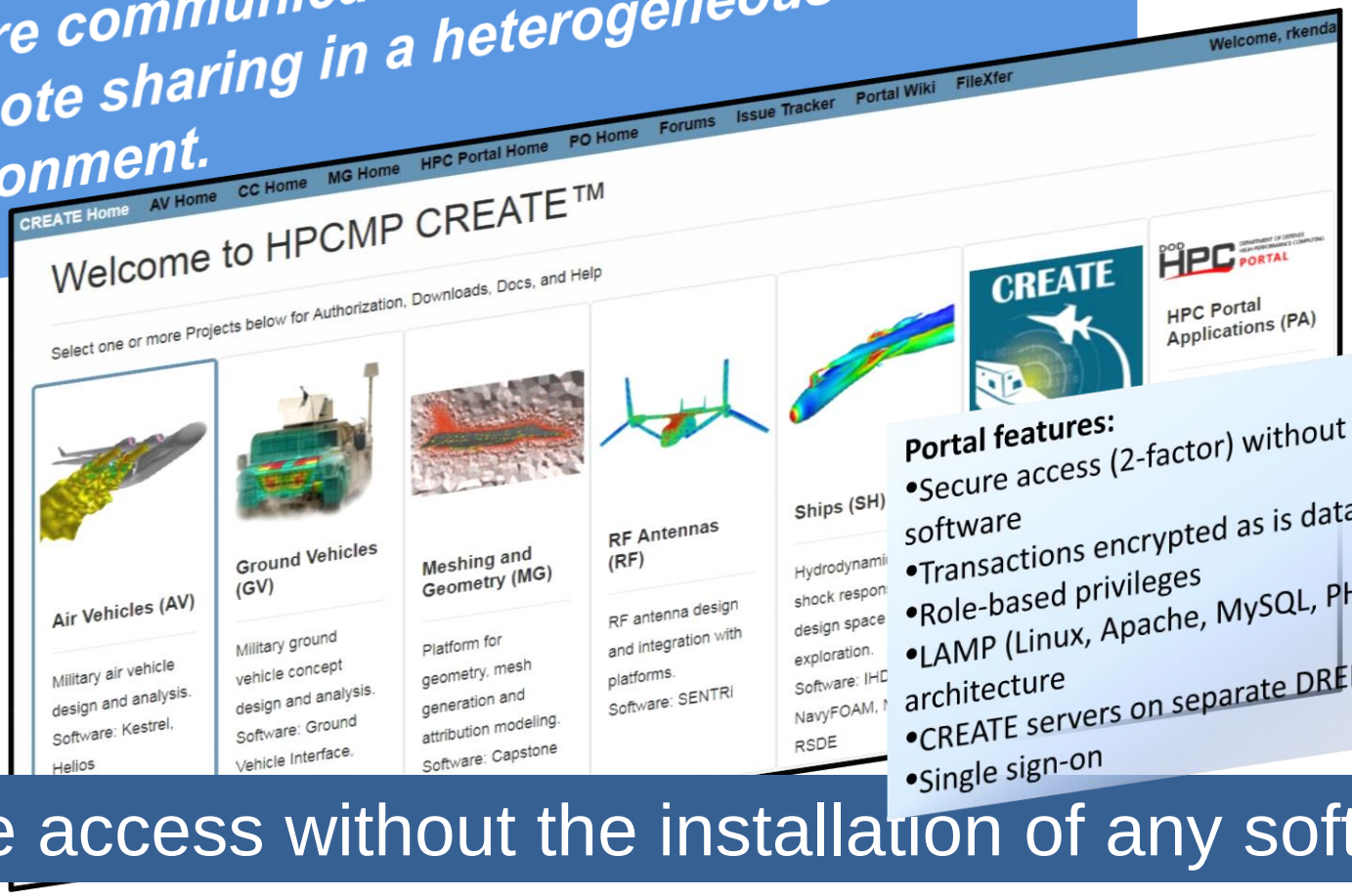
Mitigating Practice: *Start with an extended view of the CREATE Product*



Ensure that Customers see the “whole” product

Risk 3. Communications across different Security Enclaves

Mitigating Practice: ***Make maximum use of secure communication technologies that promote sharing in a heterogeneous security environment.***



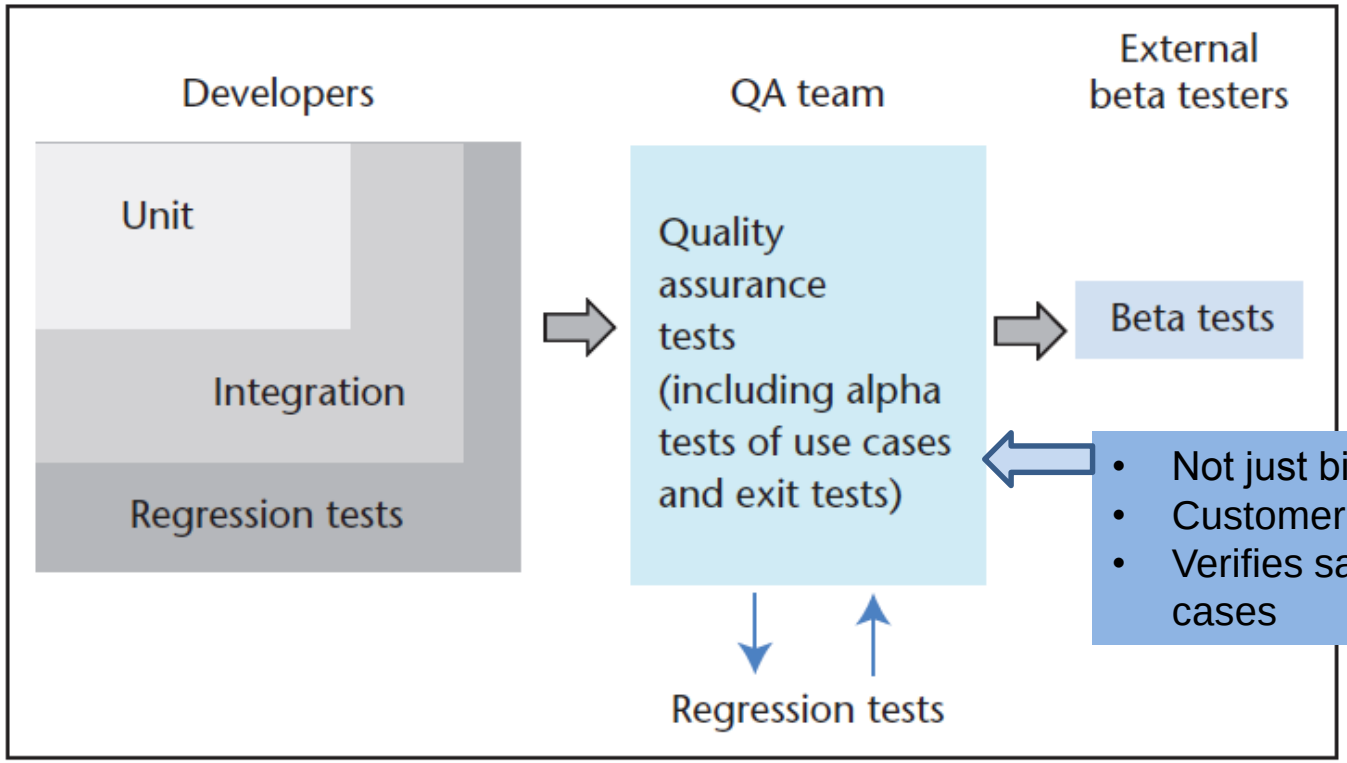
Portal features:

- Secure access (2-factor) without installation of any software
- Transactions encrypted as is data at rest
- Role-based privileges
- LAMP (Linux, Apache, MySQL, PHP/Perl) architecture
- CREATE servers on separate DREN network
- Single sign-on

Secure access without the installation of any software

Risk 4: Software testing

Mitigating Practice: *Implement a testing program compliant with National Research Council guidelines*

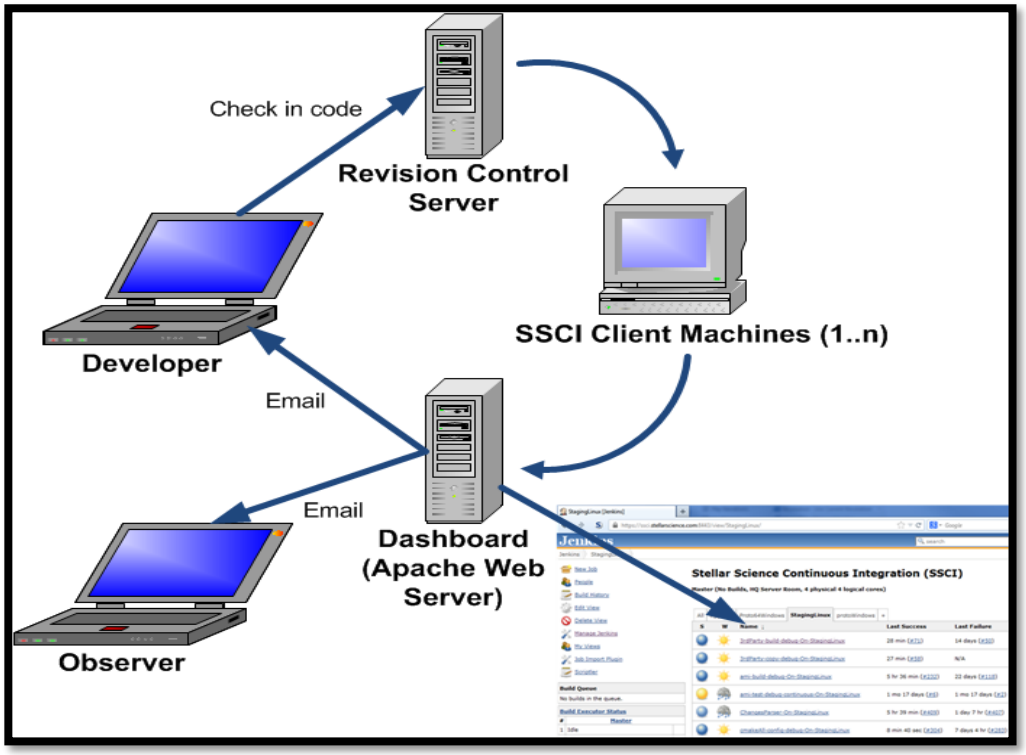


- Not just binary “yes” or “no”
- Customer view of testing
- Verifies satisfaction of use-cases

6 levels of testing in CREATE -AV!

Risk 4: Software Testing

Mitigating Practice: *Strive for continuous integration with automated regression tests for each commit*



CREATE-RF Continuous Integration Platform

Discover problems before they are hard to fix

Risk 5. Inadequate Product Support

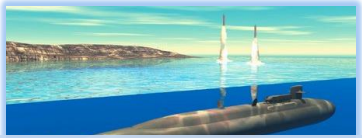
Mitigating Practice: *Maximize the use of self-help and user forums in the support model.*

Self-help scales as the user base grows

How Well Has this Worked?

- Over 1600 current user licenses
- Over 180 organizations across DoD/Gov't, Industry, and Academia
- User organizations are split roughly 40% DoD/Gov't, 50% Industry, 10% Academia
- Impacting ~70 DoD programs of record and major S&T, T&E, and R&D efforts across the major warfare domains of Air, Sea, Land, and EM spectrum throughout the acquisition cycle
- Constant positive growth of user licenses since (~7% growth in the past 6 months)

NAVSEA



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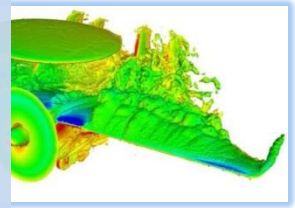
NAVAIR

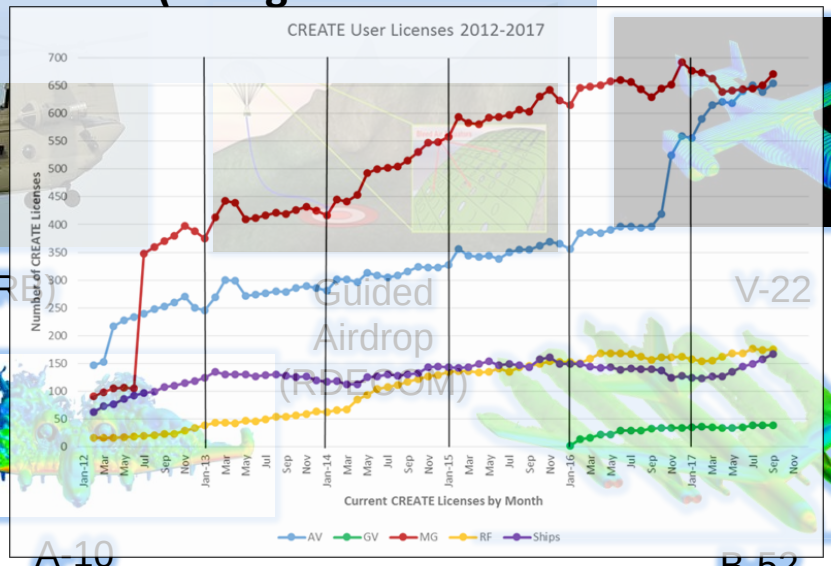


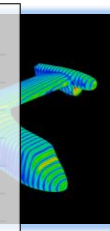
E-2D

ARMY/USMC

UH-60

CH-47 (ACR





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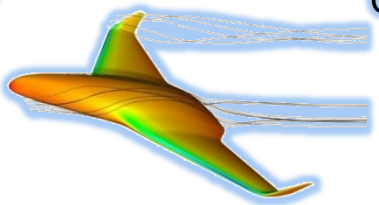
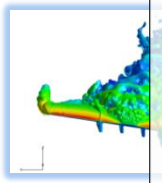


Strategic Airlift CP&A



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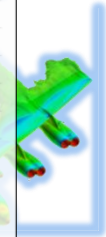
Guided Airdrop (REFORM)

V-22



B-52

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