NDIA 21320: HPCMP CREATE™ as an Early Example of a DoD "Software Factory"

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This Presentation will address:

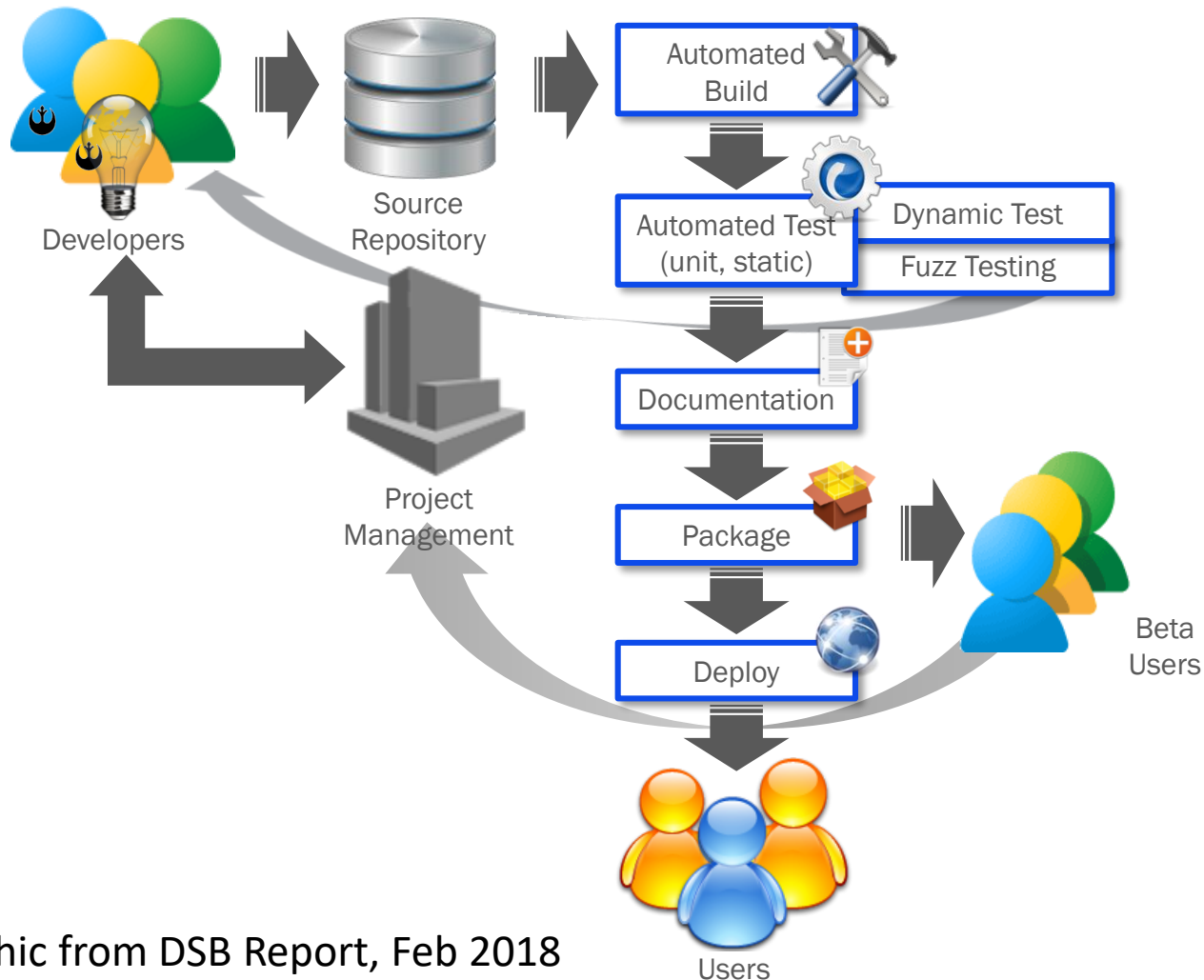**CREATE as an early example of of the DoD "Software Factory" Concept:**

o **What is a "Software Factory?"**
o **Why is it important?**
o **The early CREATE Example**

Software Factories

The Defense Science Board(DSB) defines a "Software Factory" as:

- A small software development team (5-15 members)
- Supported by an *highly automated* development infrastructure (development tools, computers, networks, storage devices, etc.)
- Focused on *continuous, iterative* product development using **Agile development practices**

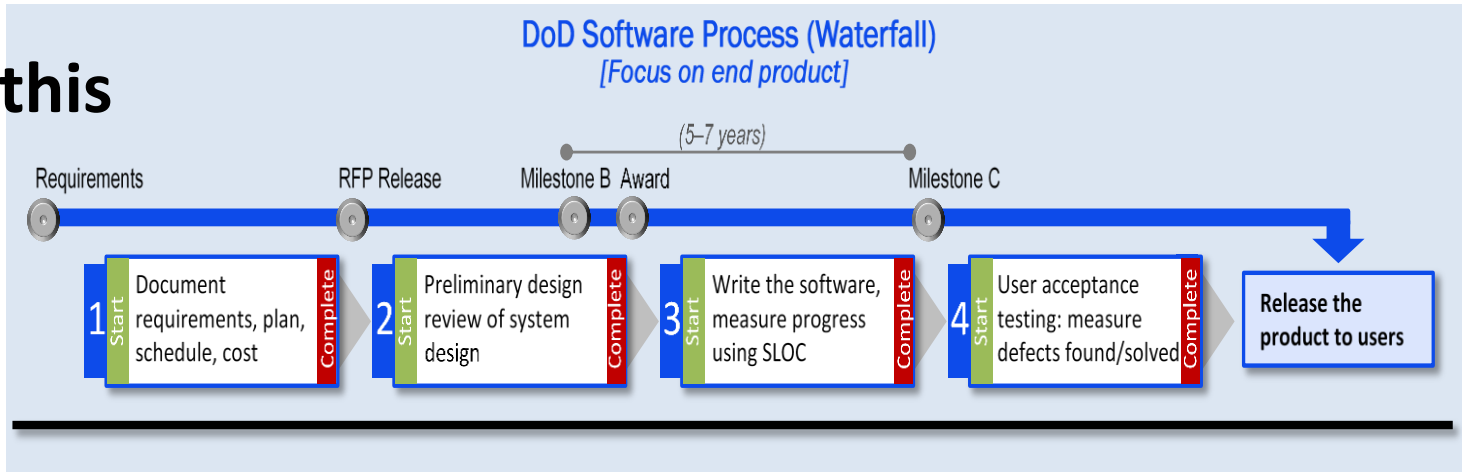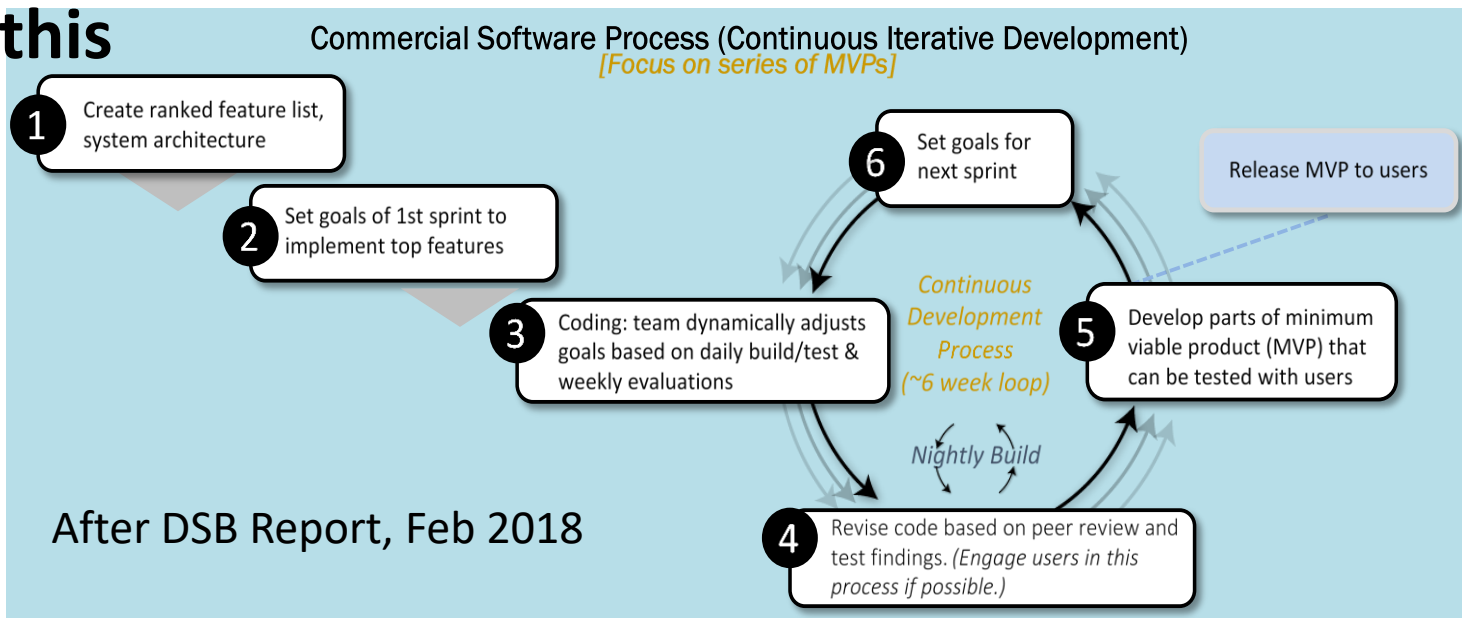# Commercial Software Factory*

Developers

Source Repository

Automated Build

Automated Test (unit, static)

Dynamic Test

Fuzz Testing

Documentation

Project Management

Package

Deploy

Beta Users

Users

* Graphic from DSB Report, Feb 2018

Continuous, Iterative Software Development

Not this

DoD Software Process (Waterfall)
[Focus on end product]

(5–7 years)

Requirements — RFP Release — Milestone B — Award — Milestone C

| 1 | Start | Document requirements, plan, schedule, cost | Complete |

| 2 | Start | Preliminary design review of system design | Complete |

| 3 | Start | Write the software, measure progress using SLOC | Complete |

| 4 | Start | User acceptance testing: measure defects found/solved | Complete |

Release the product to users

But this

Commercial Software Process (Continuous Iterative Development)
[Focus on series of MVPs]

1. Create ranked feature list, system architecture

2. Set goals of 1st sprint to implement top features

3. Coding: team dynamically adjusts goals based on daily build/test & weekly evaluations

4. Revise code based on peer review and test findings. *(Engage users in this process if possible.)*

5. Develop parts of minimum viable product (MVP) that can be tested with users

6. Set goals for next sprint

Continuous Development Process (~6 week loop)

Nightly Build
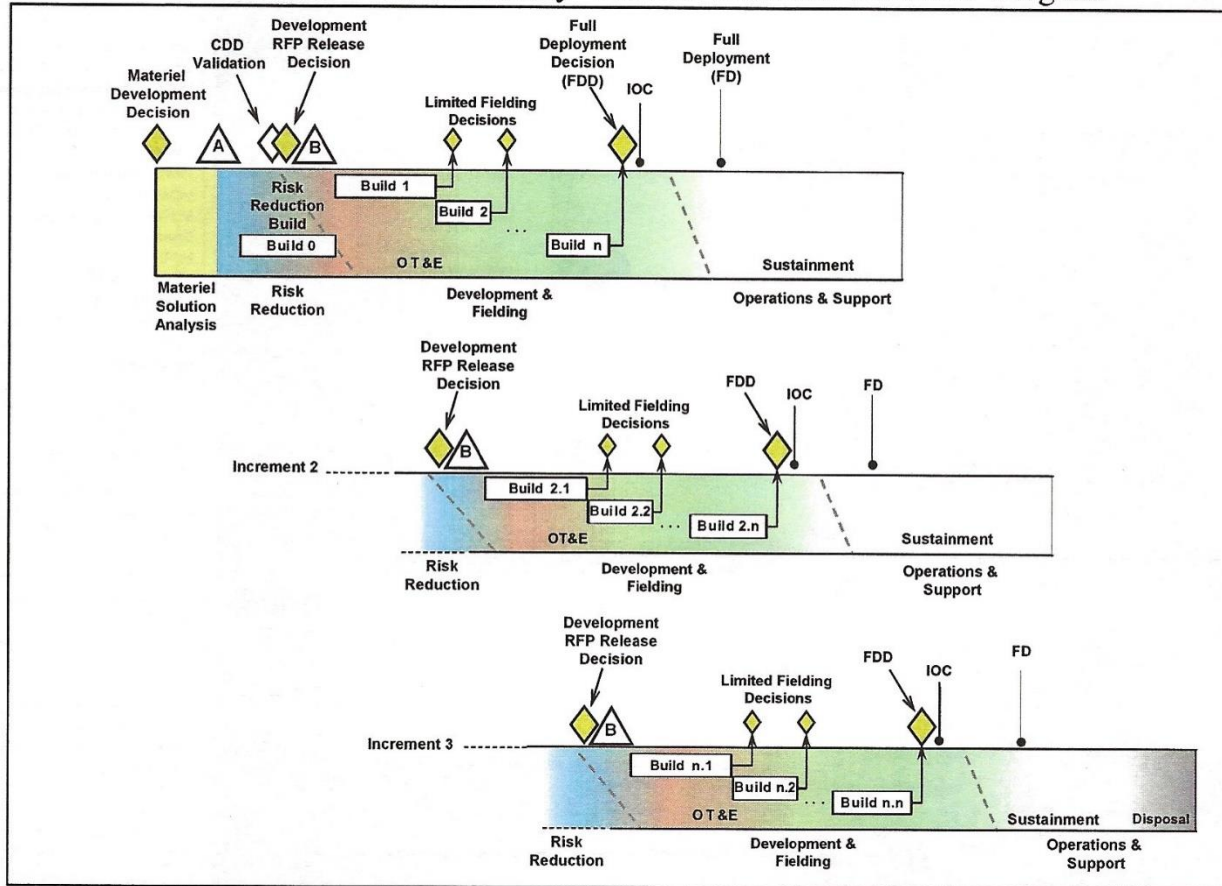
Release MVP to users

After DSB Report, Feb 2018
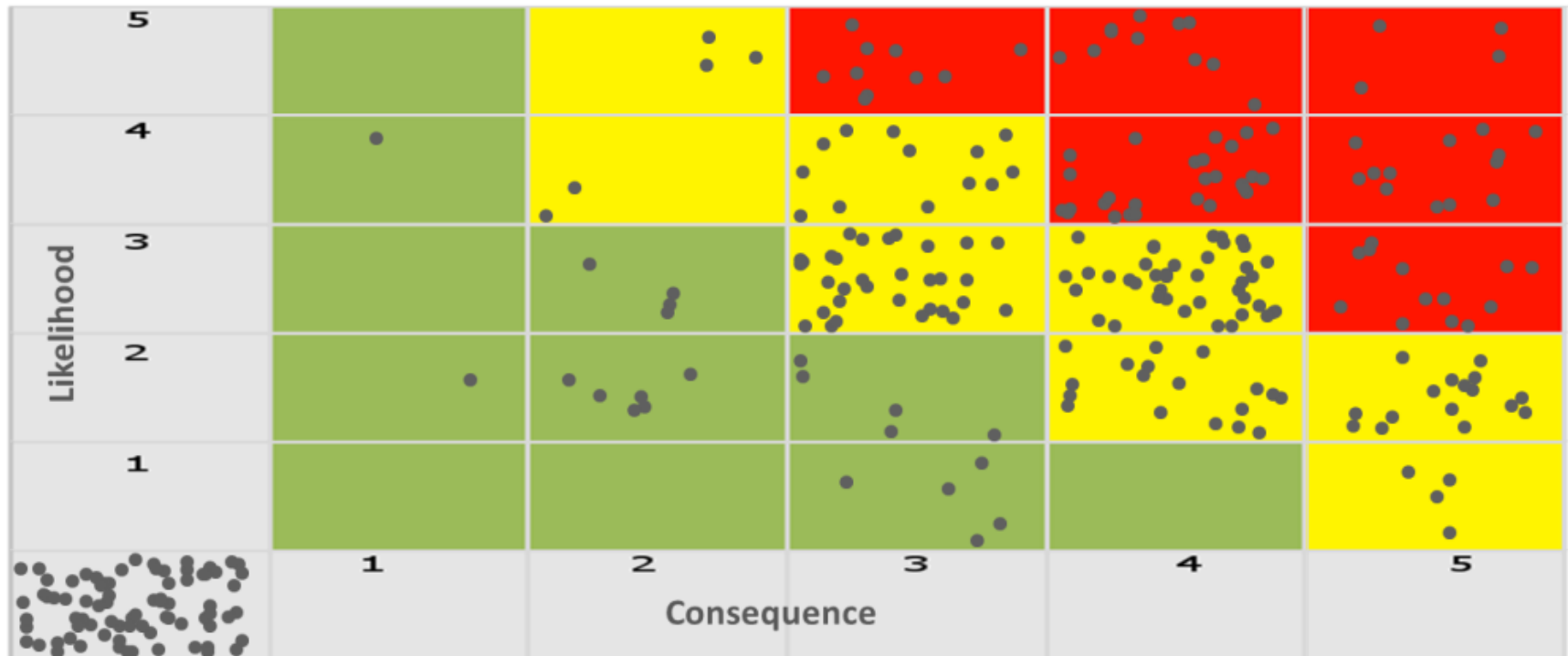
Defense Acquisition Lifecycle Model 3

Model 3: Incrementally Fielded Software Intensive Program

Why is this Important?

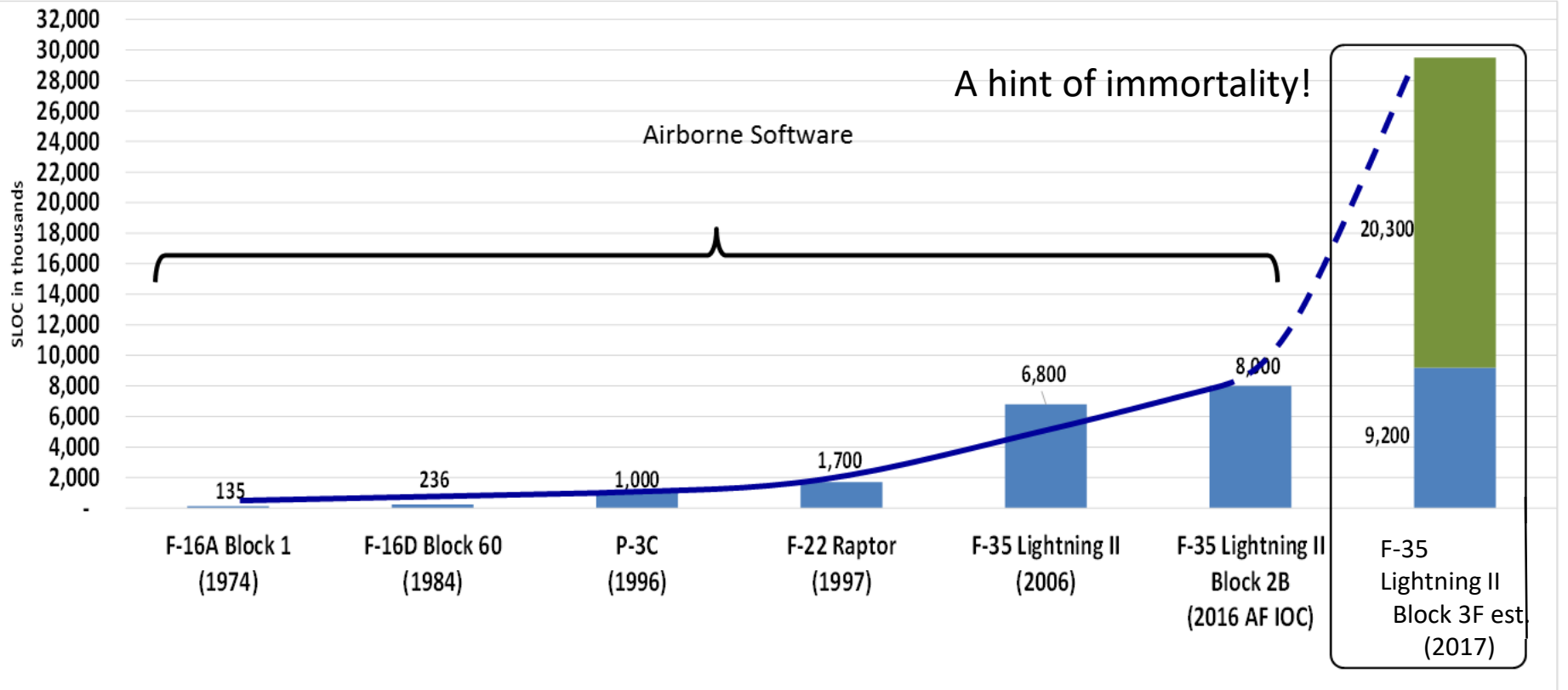**Software Drives ~60% DoD Program Risk (after DSB report)**

FY14 - FY16

Software not in top program risks

* Graphic from DSB Report, Feb 2018

Change Driver: Explosive Growth in Source Code for Defense Systems-- Avionics

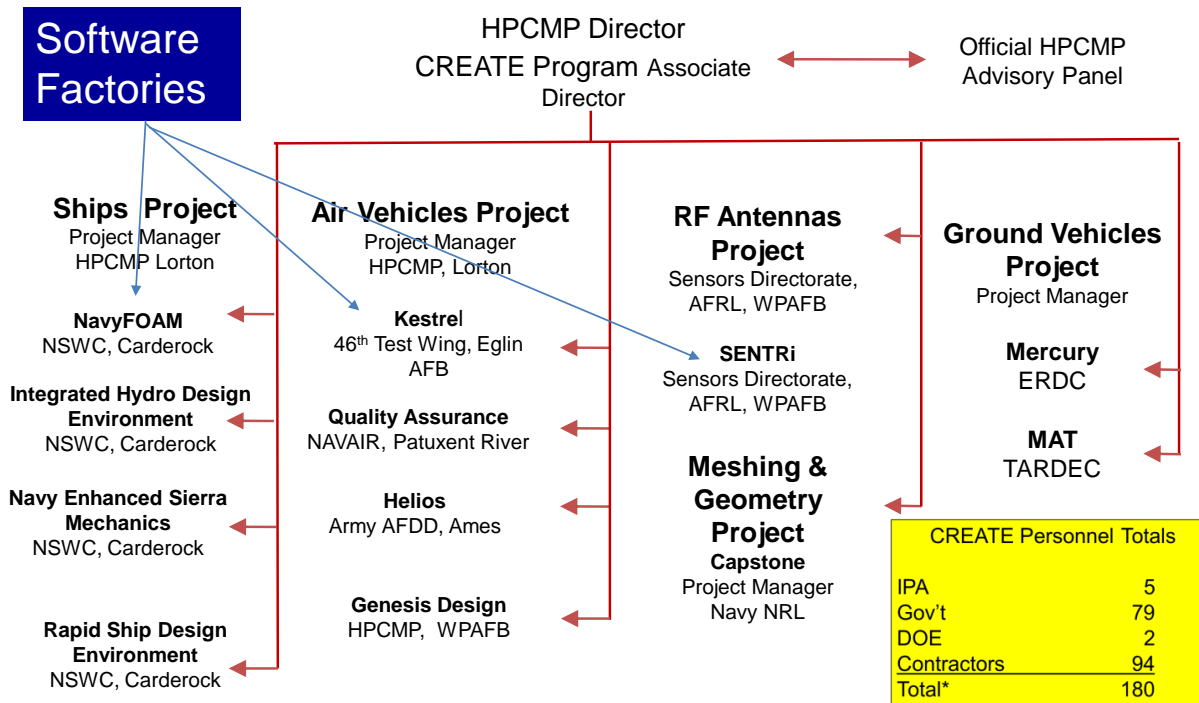# The Commercial Case for Agile Development

A meta-survey* of 29 studies (of 300 analyzed) concluded the following return on investment:

- 29% lower cost
- 91% better schedule
- 50% better quality
- 400% better job satisfaction

* David Rico, "What is the ROI of Agile vs. Traditional Methods"

CREATE Software Factories

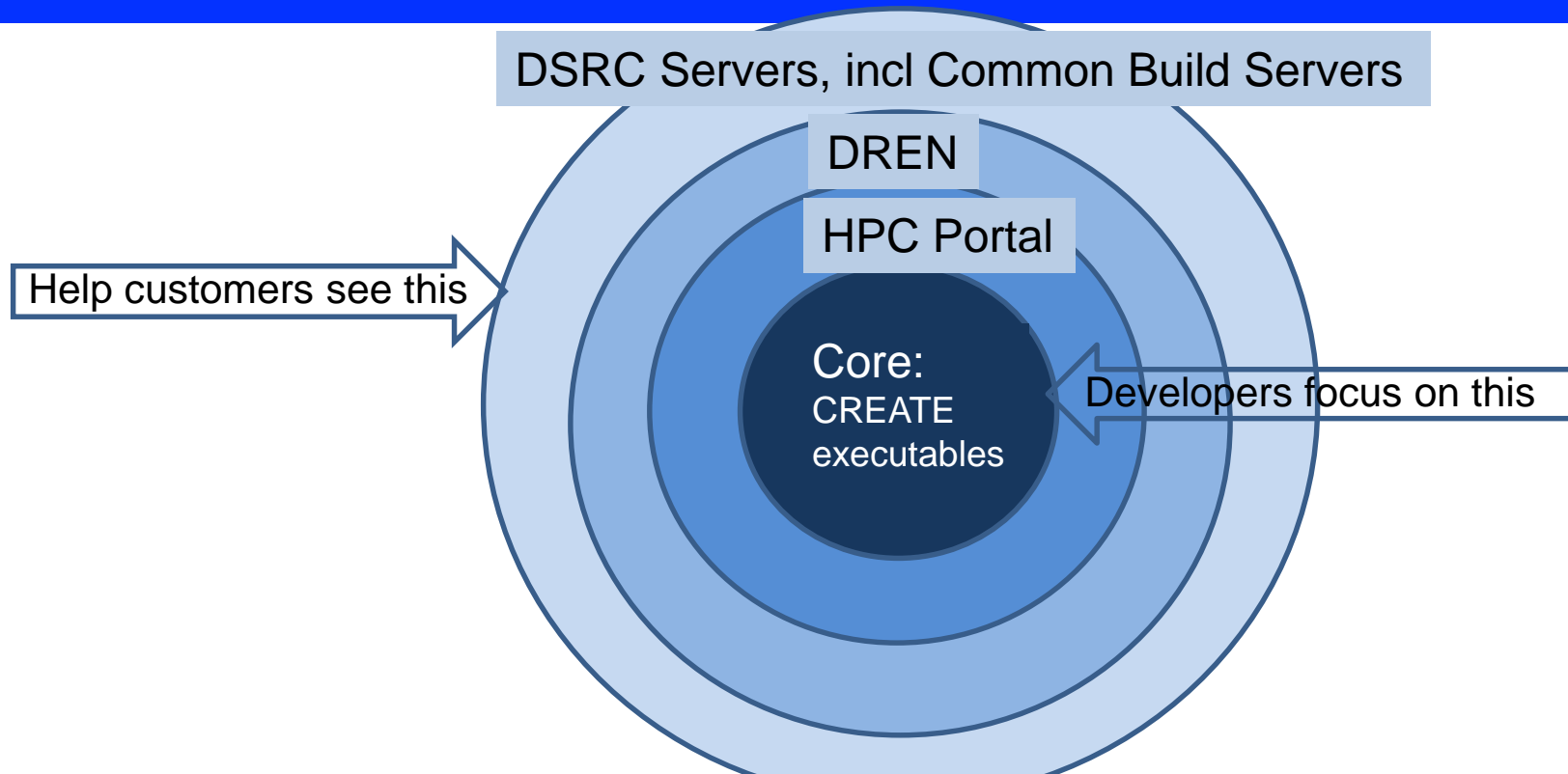CREATE began to establish "Software Factories" in 2008

Software Factories

HPCMP Director
CREATE Program Associate Director

Official HPCMP Advisory Panel

Ships Project
Project Manager
HPCMP Lorton

NavyFOAM
NSWC, Carderock

Integrated Hydro Design Environment
NSWC, Carderock

Navy Enhanced Sierra Mechanics
NSWC, Carderock

Rapid Ship Design Environment
NSWC, Carderock

Air Vehicles Project
Project Manager
HPCMP, Lorton

Kestrel
46th Test Wing, Eglin AFB

Quality Assurance
NAVAIR, Patuxent River

Helios
Army AFDD, Ames

Genesis Design
HPCMP, WPAFB

RF Antennas Project
Sensors Directorate, AFRL, WPAFB

SENTRi
Sensors Directorate, AFRL, WPAFB

Meshing & Geometry Project
Capstone
Project Manager
Navy NRL

Ground Vehicles Project
Project Manager

Mercury
ERDC

MAT
TARDEC

CREATE Personnel Totals	
IPA	5
Gov't	79
DOE	2
Contractors	94
Total*	180

A Multi-Institutional, Multi-Organizational, Distributed Program

The CREATE Infrastructure

From the beginning CREATE embraced an extended view of the CREATE Product

DSRC Servers, incl Common Build Servers

DREN

HPC Portal

Help customers see this

Core: CREATE executables

Developers focus on this

Ensure that Customers see the "whole" product

The CREATE Approach to Agile Development
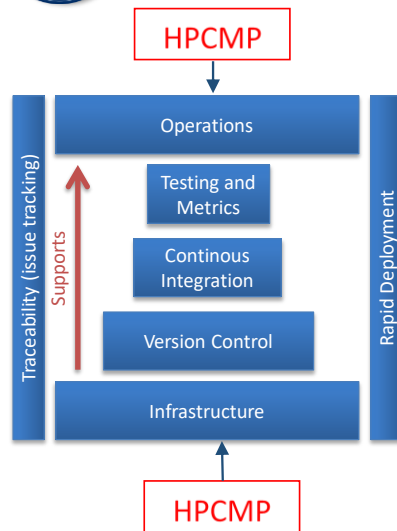
The CREATE Approach—"Disciplined Agile" based on Scrum

Potential release candidate

Sprint

Design reviews

Next Annual Increment In Product Roadmap

Develop Functionality N

Integrate and Test

Develop Functionality 2

Integrate and Test

Develop Functionality 1

Integrate and Test

Demo Release

Beta milestone for Annual Release

Client's Feedback

Make Changes

System Testing

All Functionalities Complete?

Yes

Annual CREATE Development Cycle

Annual Release= milestone

Our approach couples flexibility with accountability

Figure after info@matrix-soft.org

Software Factory Software Infrastructure*

Software Factory Source Selection Criteria Suggestions

HPCMP

Operations

Testing and Metrics

Continous Integration

Version Control

Infrastructure

Traceability (issue tracking)

Supports

Rapid Deployment

HPCMP

- Configuration management software (e.g., Puppet, Chef, Ansible) Git, SVN
- Continuous Integration (build and test) Systems (e.g., Travis CI for hosted service, Jenkins for open source application) Jenkins
- Scripts and code used to release software (e.g., Python scripts) Python, PERL,…
- Servers, network or other infrastructure that support release tools CREATE Server, Portal, and Continuous Build Server
- Software and tools to support developer self-service operations (NewRelic for application performance over time, diagnostic tools, monitoring) TotalView, Tau, Valgrind,…
- External test frameworks (e.g., Jersey Test Framework, Testplant/Eggplant) SCCI (Jenkins add-on), and Home Grown Tools
- External operational monitoring and log mining tools (e.g., Splunk, Elasticsearch + Logstash + Kibana (ELK) Stack)SIDPACK,…
- Source code repositories (e.g., Github for hosted service, GitLab for open source application) Github, Redmine, SVN,…
- Issue tracking systems (e.g., JIRA, Trello, GitHub) JIRA, Github
- Container driven tools (e.g., Docker, Elastic Container Service (Amazon Web Services (AWS)), Kubernetes) CREATE Server
- Requirements management (e.g., Doors, Blueprint) JIRA, Agile
- Infrastructure and cloud providers (e.g., AWS, Rackspace, Azure, RedHat OpenShift, Pivotal Cloud Foundry DoD HPCMP provides cloud-like services—5 HPC computer
- IDEs integrated DevOps process centers with 11 High Performance MS Visual Studio, Xcode, Eclipse Computers linked by a high speed network

Comparison of DSB Software Factory with HPCMP/CREATE Version of Software Factory

HPCMP/CREATE operating capabilities are highlighted in red

DSB Task Force on Design and Acquisition of Software for Defense Systems

UNCLASSIFIED

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*From DSB Report, Feb 2018, based on SEI DevOps

CREATE Software Quality Control

A Software Factory Requires Quality Control
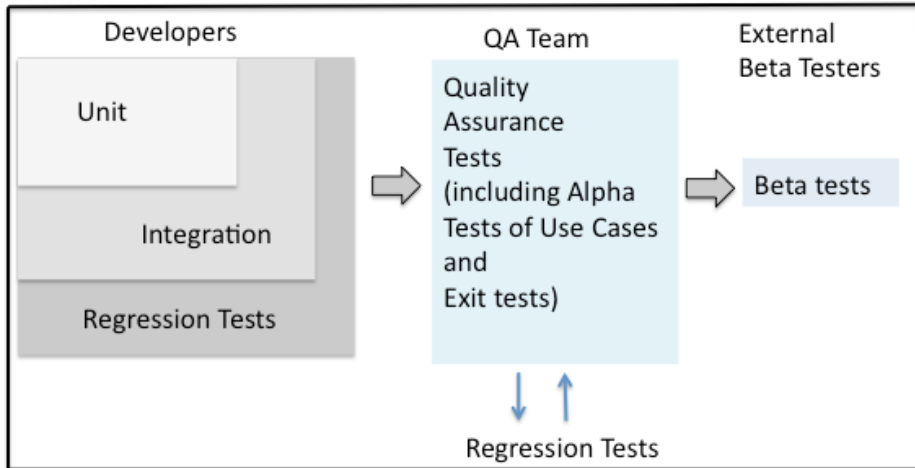
- **Annual Releases**
- **Hierarchal Testing**
- **External, Knowledgeable Testing Group**
- **User Testing (Beta)**

Distribution A: Approved for Public release; distribution is unlimited

The Practical Aspects of Computational Science and Engineering
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Based on HPCMP CREATE-AV testing practices

The CREATE Goal for Iterative Development:

At *least one new "version" every year*

Fiscal Year	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019 Planned	FY2020 Planned	FY2021 Planned	FY2022 Planned
AV-Genesis Design		1	2		3	4	5	6	7	8	9	10
AV-Helios		2	3, 4		5	6	7	8	9	10	11	12
AV-Kestrel	2		3, 4		5	6	7	8	9	10	11, 12	13
MG-Capstone	1	2	3	4	5	6	7	8	9	10	11	12
RF-SENTRi	2		3	4	5	6	7	8	9	10	11	12
Ships-IHDE	2	3	4	5	6		7	8	9	10	11, 12	13
Ships-NavyFOAM	1	2	3	4	5	6	7	8	9	10	11	12
Ships-NESM	1	1.1	2	2.1	3	4	5	6	7	8	9	10
Ships-RSDE		0.5	1	1.1	1.2	2		3.1	4	5	6	7, 8
GV-Mercury							1		2	3	4	5, 6

Annual releases demonstrate meaningful progress

CREATE Tools Impacting DoD Programs

NAVSEA

DDG-1000

CVN-78 Class

So-Called "Valley of De...
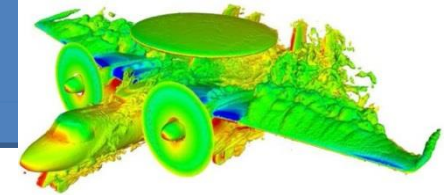
Ohio SSBN Replacement

LX(R)

NAVAIR
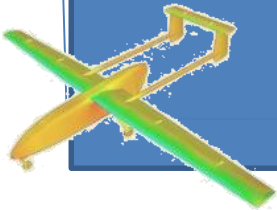
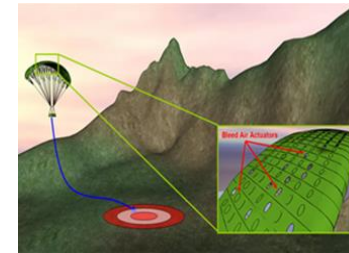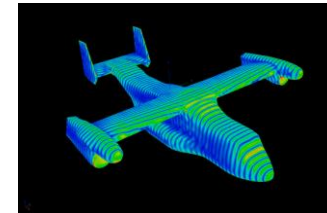Aerostar & Raven UAVs

F/A-18 E/F/G

E-2D

ARMY/USMC

UH-60
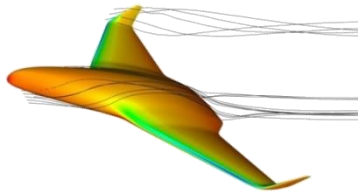
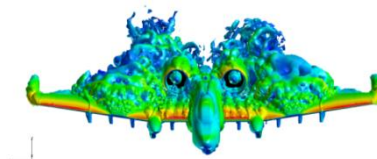CH-47 (ACRB)

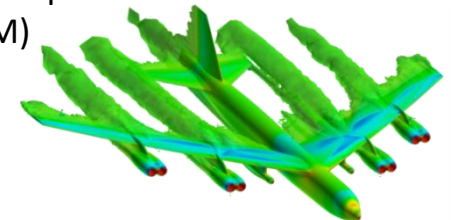Guided Airdrop (RDECOM)

V-22

AFLCMC

F-15 SA/DB-110

Strategic Airlift CP&A

A-10

B-52

Thank You!

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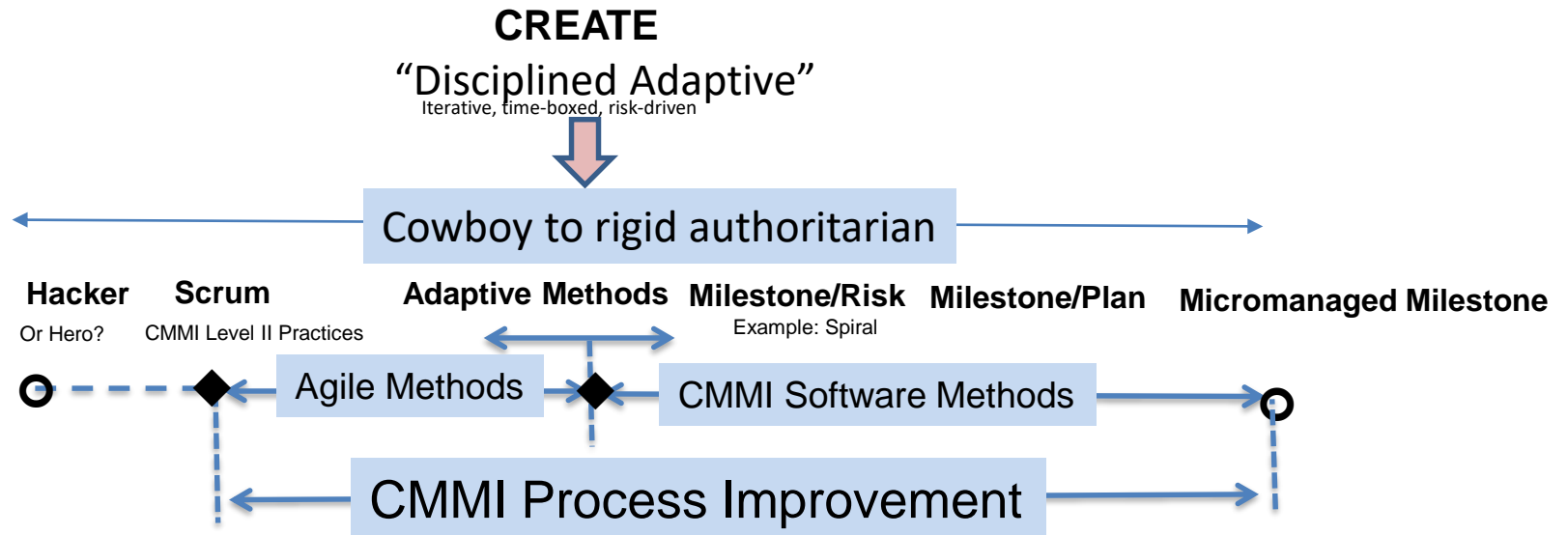**richard.p.kendall4.ctr@mail.mil**
(505) 660 0976

Back-up slides

CREATE Software Development Workflow for Distributed Teams

- **Balance flexible planning with milestone-based accountability.**

CREATE

"Disciplined Adaptive"

Iterative, time-boxed, risk-driven

Cowboy to rigid authoritarian

Hacker	**Scrum**	**Adaptive Methods**	**Milestone/Risk**	**Milestone/Plan**	**Micromanaged Milestone**
Or Hero?	CMMI Level II Practices		Example: Spiral		

Agile Methods

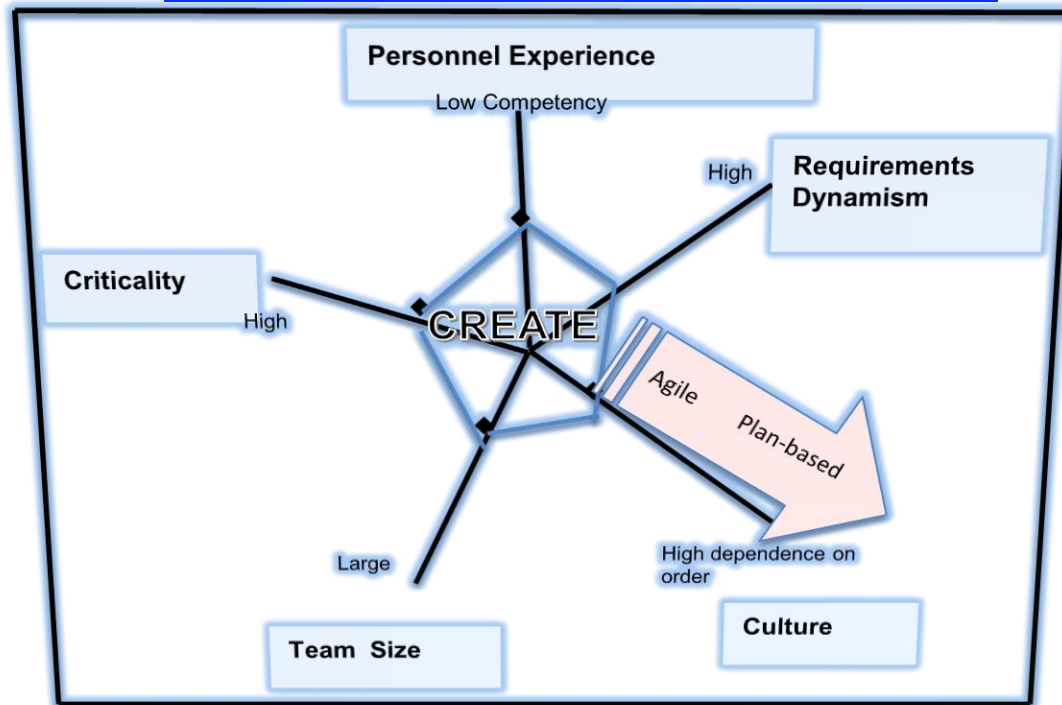CMMI Software Methods

CMMI Process Improvement

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

CREATE: Disciplined Adaptive Workflow Management based on Scrum (balance risk and value)

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 environment favor an Agile Development approach

Example: Kestrel Software Architecture