



# *Infinite Dimensions, Inc (IDI) & Tucson Embedded Systems (TES)*

## *BITS BALSА Event 2018*

### **Air Force's Continuous Integration and Continuous Development with the FACE Technical Standard**

*Presented to*  
FACE BITS BALSА

12 December 2018

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- Resilient EGI (R-EGI) addresses aircraft GPS jamming and spoofing
  - Multiple inputs improve positioning information and increases resilience
- R-EGI is an Open Systems Architecture (OSA) design
  - Currently aligned with FACE v2.1.x
  - Next steps, likely OMS, and maybe FACE v3.x
- Well-formed cross-organizational development Environment
  - Well-formed processes, support cross-organizational contributions
  - Complete Lifecycle - Satisfies 61% (or 44 of 72) DO-178 software lifecycle objectives, processes which are support Air Force, Navy, and Army LC processes
  - Described/Published: AF CI/CD – FACE TIM Paper, September 2018
- (Resulting in) Speeds capability development & integration efforts (dev./test/fix agile development), and improves product quality



# R-EGI Program OV-1

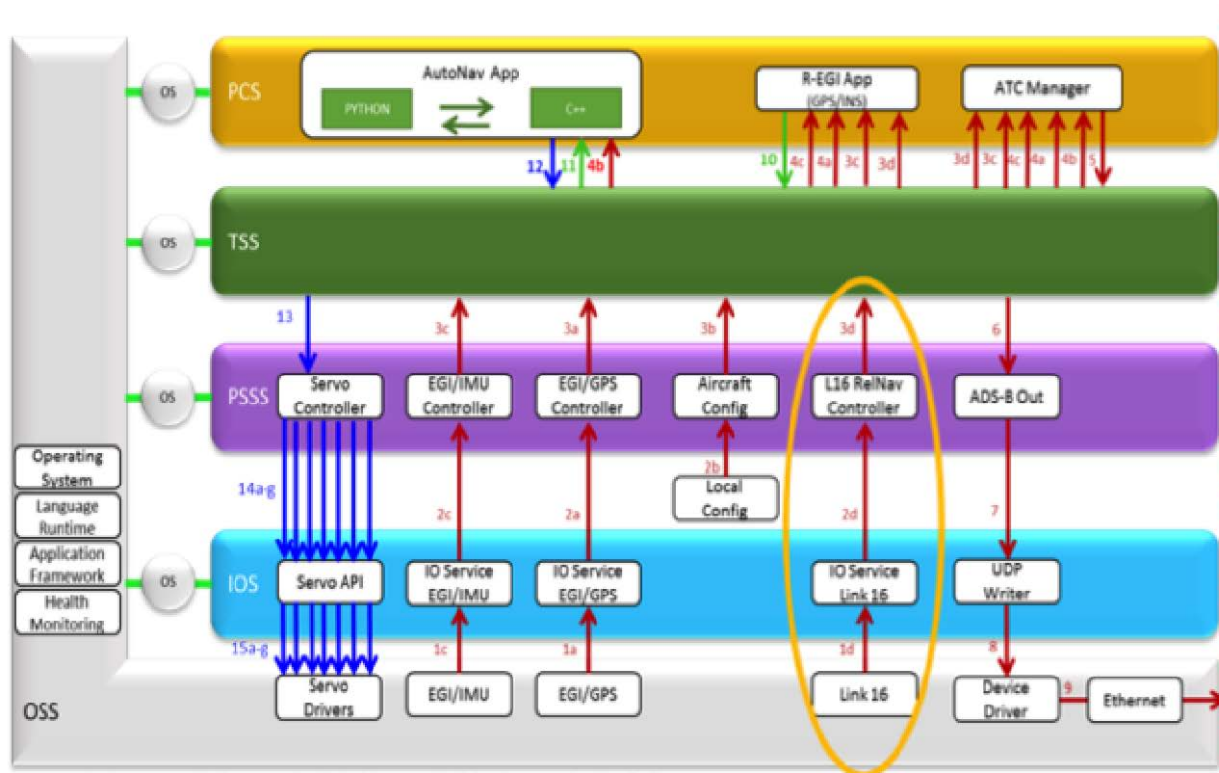
- Resilient EGI (R-EGI) addresses aircraft GPS jamming and spoofing
  - Multiple inputs improve positioning information and increases resilience





# R-EGI OSA Designed

- R-EGI is an Open Systems Architecture (OSA) design
  - Currently aligned with FACE v2.1.x, *multiple FACE UoCs*
  - Next steps, likely OMS, and maybe FACE v3.x



N.B. Servos: 14a, 15a Elevator; 14b, 15b Rudder; 14c, 15c Right Aileron; 14d, 15d; Left Aileron; 14e, 15e Right Flap; 14f, 15f Left Flap; 14g, 15g Electronic Speed Control (Throttle)



- Air Force’s Continuous Integration and Continuous Development with the FACE Technical Standard, FACE VV&A on Hanscom MilCloud–FACE TIM Paper, September 2018
  - Well-formed processes, support cross-organizational contributions

**Consortium through OTA  
with Government & Industry  
(small & large businesses)**

The consortium includes logos for:

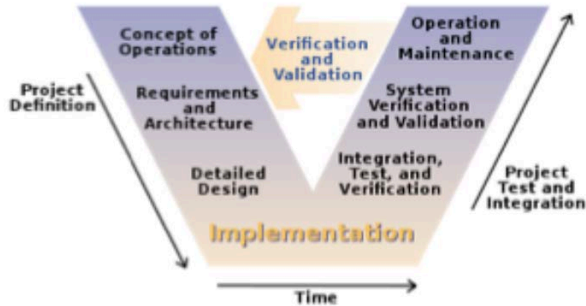
- Air Force (two logos)
- MITRE
- WBB
- DORNERWORKS
- Infinite Dimensions
- NORTHROP GRUMMAN
- Honeywell
- Raytheon
- Georgia Tech
- Rockwell Collins
- Green Hills SOFTWARE
- jackpine technologies
- SwRI
- DDC-I
- Safety Critical Software Solutions for Mission Critical Systems
- Kearfott
- QUANTUM DIMENSION
- GENERAL DYNAMICS Mission Systems
- rti
- Tucson Embedded Systems
- SAVi AWESUM



# CI/CD Well-Formed Lifecycle Processes

72 DO-178C objectives

- DO-178 process objectives described by life cycle processes



### R-EGI

			A4.1						
			A4.2						
			A4.3						
			A4.4						
			A4.5	A5.1		A7.1			
			A4.6	A5.2		A7.2			
A1.1	A2.1	A3.1	A4.7	A5.3		A7.3			
A1.2	A2.2	A3.2	A4.8	A5.4		A7.4	A8.1		
A1.3	A2.3	A3.3	A4.9	A5.5	A6.1	A7.5	A8.2	A9.1	
A1.4	A2.4	A3.4	A4.10	A5.6	A6.2	A7.6	A8.3	A9.2	
A1.5	A2.5	A3.5	A4.11	A5.7	A6.3	A7.7	A8.4	A9.3	A10.1
A1.6	A2.6	A3.6	A4.12	A5.8	A6.4	A7.8	A8.5	A9.4	A10.2
A1.7	A2.7	A3.7	A4.13	A5.9	A6.5	A7.9	A8.6	A9.5	A10.3

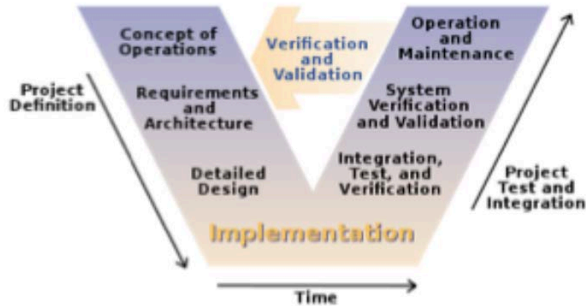
- A-1 – Software **Planning** Process
- A-2 – Software **Development** Processes
- A-3 – Verification of Outputs of Software **Requirements** Process
- A-4 – Verification of Outputs of Software **Design** Process
- A-5 – Verification of Outputs of Software **Coding and Integration** Processes
- A-6 – **Testing** of Outputs of **Integration** Process
- A-7 – **Verification of Verification Process** Results
- A-8 – Software **Configuration Management** Process
- A-9 – Software **Quality Assurance** Process
- A-10 – **Certification Liaison** Process



# CI/CD Well-Formed Lifecycle Processes

72 DO-178C objectives  
 R-EGI CI/CD - addresses: 61%

- DO-178 process objectives described by life cycle processes



**R-EGI**

71% 29% 86% 67% 67% 40% 22% 83% 100% 100%

			A4.1							
			A4.2							
			A4.3							
			A4.4							
			A4.5	A5.1			A7.1			
			A4.6	A5.2			A7.2			
A1.1	A2.1	A3.1	A4.7	A5.3			A7.3			
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A1.5	A2.5	A3.5	A4.11	A5.7	A6.3		A7.7	A8.4	A9.3	A10.1
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# **R-EGI Test Architecture**

**Air Force's Continuous Integration and  
Continuous Development  
with the FACE Technical Standard**





# R-EGI Test bed Architecture

Status as of 10 Dec. 2018

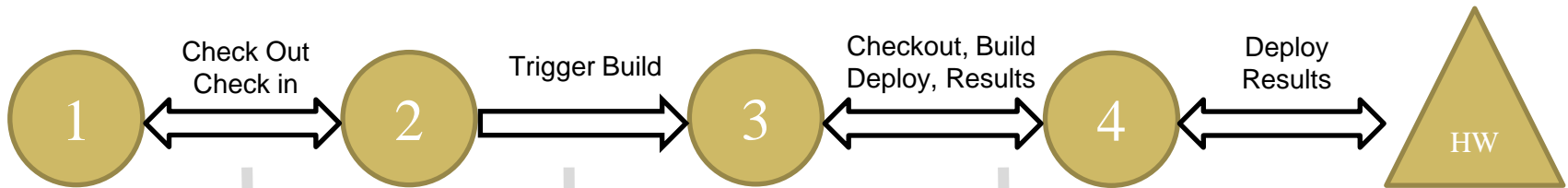
## Various Virtual Machines (1 to 4) on Hanscom MilCloud (with roles)

Developer Role

CM/Version Control Role

VV&A Roles (HW agnostic)

Target Implementation Testing



**1**  
**USER VM**  
 dr84736  
 192.168.10.117

**2**  
**GITLAB VM**  
 dr84018  
 192.168.10.111

**3**  
**JENKINS VM**  
 dr78364  
 192.168.10.113

**4**  
**TARGET BUILD VM**  
 dr84379  
 192.168.10.116

**HW**  
**TARGET HW**  
 Raspberry Pi

- 1. Check out
- 2. Modify code
- 3. Check-in

- 1. Version Control
- 2. Signals Jenkins on check-in

- 1. Initiate CI/CD Scripts
  - a. Check out
  - b. Build
  - c. FACE v2.1.1 CTS
  - d. BALSAArch Supt Tests
  - e. Data Analytic Tests
  - f. Build/Deploy on HW
- 2. Reports any Failures

- 1. Check out Code
- 2. Build for HW
- 3. Deploy to HW
- 4. Execute on HW
- 5. Receive Results
- 6. Report Results

Scope: 3 of 4 Phase 1  
 FACE UoPs;  
 3 DM pass, 1 UoC in Dev.

**LEGEND**

- Testbed Developed
- R-EGI Application Development, *in-progress*
- Both Complete, *no problems*



FACE Conformance Test ... x +

file:///home/va/share/ConformanceReport.html

**FACE Conformance Test Results** Expand All Collapse All

+ Test Configuration

—Data Model Tests → PASSED

- + Test: FACE Meta Model Validation (Link16\_FACE\_Integration\_DM.f
- + Test: OCL Constraints Check (Link16\_FACE\_Integration\_DM.face)
- + Test: Shared Data Model Conformance (Link16\_FACE\_Integration

FACE Conformance Test ... x +

file:///home/va/share/ConformanceReport.html

**FACE Conformance Test Results** Expand All Collapse All

+ Test Configuration

—Data Model Tests → PASSED

- + Test: FACE Meta Model Validation (IMU\_Controller\_FACE\_Integration\_DM.face) → PASSED
- + Test: OCL Constraints Check (IMU\_Controller\_FACE\_Integration\_DM.face) → PASSED
- + Test: Shared Data Model Conformance (IMU\_Controller\_FACE\_Integration\_DM.face) → PASSED

FACE Conformance Test ... x +

file:///home/va/share/ConformanceReport.html

**FACE Conformance Test Results** Expand All Collapse All

+ Test Configuration

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- + Test: FACE Meta Model Validation (Link16\_App\_FACE\_Integration\_DM.face) → PASSED
- + Test: OCL Constraints Check (Link16\_App\_FACE\_Integration\_DM.face) → PASSED
- + Test: Shared Data Model Conformance (Link16\_App\_FACE\_Integration\_DM.face) → PASSED

Scope: 3 of 4 Phase 1 FACE UoPs;  
 3 DM pass CTS

- Link-16
- Link-16 App
- IMU

1 UoC in Dev. GPS Controller



# R-EGI Test Architecture **Live Demonstration**

Air Force's Continuous Integration and  
Continuous Development  
with the FACE Technical Standard



# Summary - R-EGI Program Significance

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  - Multiple inputs improve positioning information and increases resilience
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  - Currently aligned with FACE v2.1.x
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- Well-formed cross-organization development
  - AF CI/CD – FACE TIM Paper, September 2018
  - Well-formed processes, support cross-organizational contributions
  - Complete Lifecycle - Satisfies 61% (or 44 of 72) DO-178 software lifecycle objectives, processes which are support Air Force, Navy, and Army LC processes
- **Bottom-Line:** (Resulting in)
  - Speeds cross-organizational capability development & integration efforts (dev./test/fix agile development),
  - Improves product quality,
  - Aligns with DoD MOSA directive, mandated for 2020





# Questions / Discussion

