



Tucson Embedded Systems

IMPACT in Action

Conducting multiple FACE™ development efforts aligned to DO-178C, DO-331, AC 20-148, and AR 70-62 for U.S. Army Airworthiness



Presented to
The Open Group
FACE™ and SOSA™ TIM
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Presentation Outline

- ***IMPACT*** – Improvements and Modernizations of Programs Affecting Capabilities and Technologies
- ***Two Current FACE Development Programs*** – multiple FACE™ development efforts aligned to DO-178C, DO-331, AC 20-148, and AR 70-62 for U.S. Army Airworthiness
- ***TES' MBOSA Proven Process*** – with additional benefits of AWESUM® MBOSA
- ***Summary with Next Steps***



IMPACT – Improvements and Modernizations of Programs Affecting Capabilities and Technologies

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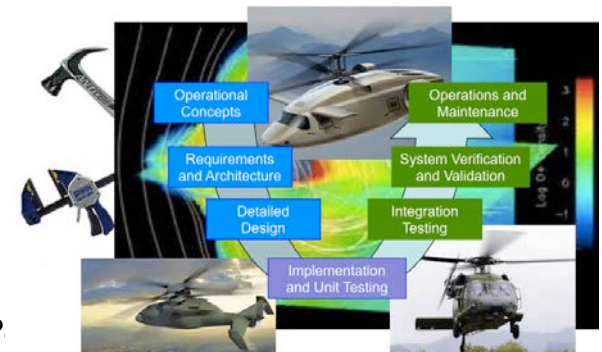
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- IMPACT

- Important funded research and development (R&D) efforts conducted within the U.S. Army's Aviation Directorate (ADD) conducted in the 2014 to 2015 timeframe, was one of a series of Science and Technology (S&T) research studies
- Objective and intent of IMPACT were to prepare the U.S. military aviation community for using improved tools and processes to modernize the design and development capabilities for applications on its fleet of modern aircraft (Vision) [ref.: 7 – Vision]
- The development processes for these next-generation aircraft must be prepared for the advanced capabilities that will be required to address tomorrow's complex battlespace environments. The battlespace requires both manned and unmanned teams (MuM-T) of aircraft operating within a dynamic mix of complex operational challenges (*e.g.*, day/night, all weather, complex hostile terrain, over land, sea, *etc.*).
- All of this will ensure that the U.S. military will “*own the environment*” through a collection of highly integrated advanced aircraft operating collectively with a set of interoperable advanced capabilities that is a system of airborne systems-of-systems [ref.: 8 – SA Net Centric Ops].

IMPACT – A Report on the Gaps in Tools and Processes
needed for the development of
US Army Next-Generation Advanced Aircraft





Two current FACE Development Programs – multiple FACE™ development efforts aligned to DO-178C, DO-331, AC 20-148, and AR 70-62 for U.S. Army Airworthiness

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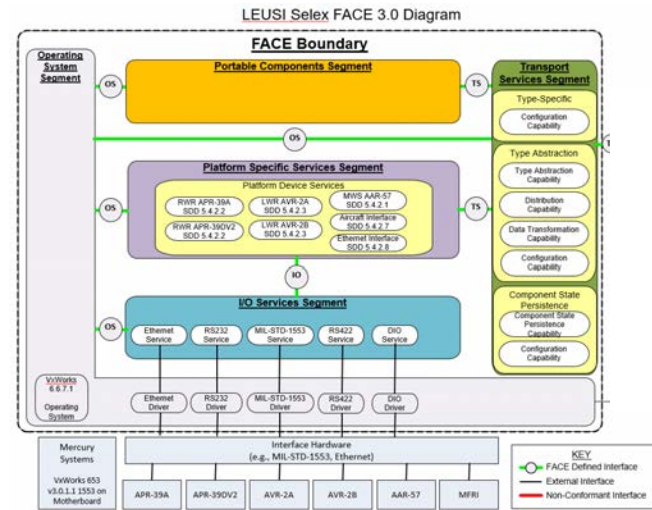
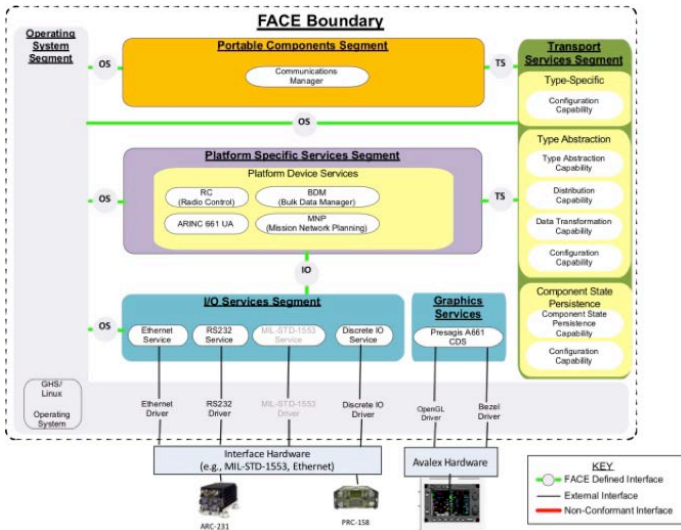
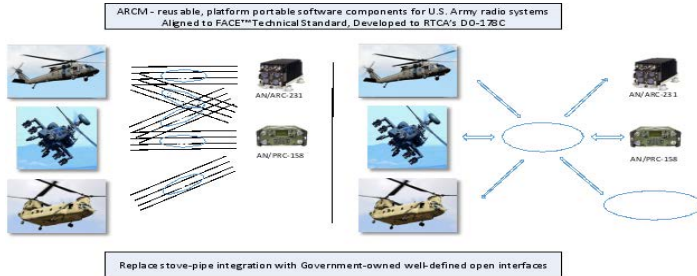
Two current FACE Development Programs

U.S. Army Programs aligned to MOSA (i.e., FACE™)

ARCM

&

AGx EIS



FACE™ edition 3.1, DO-178C DAL-C



Two current FACE Development Programs (continued)



U.S. Army Programs aligned to MOSA (*i.e.*, FACE™)

ARCM Army Communications & AGx EIS Apache Aircraft Survivability

- **5 FACE Units of Conformance (UoCs)**
 - Radio Control (RC) Platform Device Services (PCS)
 - CM - Communications Manager is a FACE Component that provides a focal point and management of all communications through the Radio Control PCS. The CM also provides a central point of ARCM system status and provides this status to other components.
 - MNP – Mission and Network Planning is a FACE component used to provide Unit Task Organization (UTO) and RMDS configuration data to other components.
 - BDM – Bulk Data Manager is a FACE component that provides files such as UTO and RMDS through a FACE IOS interface to other components
 - **Shall be Verified to be FACE Conformant and Army Airworthiness Qualified**
 - U.S. Army FACE VA
 - Combat Capability Development Command-Aviation/Missile Command System Readiness Directorate – Airworthiness (CCDC-AvMC SRD-AW)
- **7 FACE UoCs**
 - APR-39A Radar Warning Receiver
 - APR-39DV2 Radar Warning Receiver
 - AN/APR-48B MRFI (Modernized Radar Frequency Interferometer)
 - AAR-57 Common Missile Warning System (including Improved Countermeasure Dispensers) and CIRCM
 - AVR-2A Laser Detecting Set
 - AVR-2B Laser Detecting Set
 - ALQ-144A Infrared Jammer (note this is a LEI development activity)
 - ALQ-136 Radio Frequency Jammer (note this is a LEI development activity)
 - **Shall be Verified to be FACE Conformant and Army Airworthiness Qualified**
 - TES-SAVi FACE VA
 - Mission Equipment Development & AH-64E Modifications Apache Airworthiness Division Systems Readiness Directorate-Airworthiness



Two current FACE Development Programs (continued)



U.S. Army Programs aligned to MOSA (i.e., FACE™)

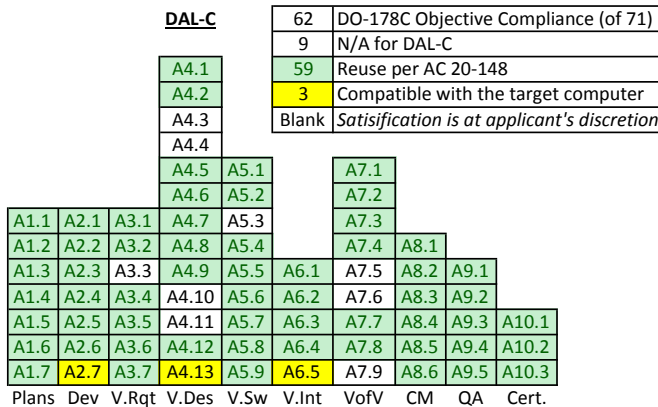
ARCM Army Communications

AGx EIS Apache Aircraft Survivability

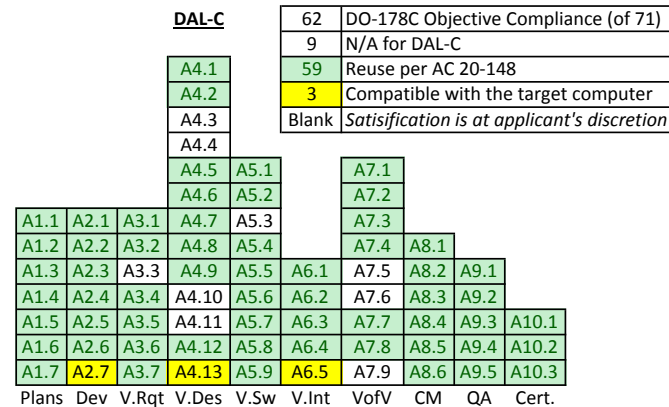
- **5 FACE UoCs**
- Designed to align with FACE edition 3.1 & DO-178C DAL-C with 11.1, ..., 11.22 Lifecycle Design Artifacts

- **7 FACE UoCs**
- Designed to align with FACE edition 3.1 & DO-178C DAL-C with 11.1,..., 11.22 Lifecycle Design Artifacts

LOE - Level of Effort
LOE from DO-178C DAL 'C' perspective (ref. RTCA, DO-178C, 2011)



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DO-178C DAL-C Dashboard – 62 Compliance Objectives

- Shall be Verified to be FACE Conformant and **Army Airworthiness Qualified**
 - U.S. Army FACE VA
 - **Combat Capability Development Command-Aviation/Missile Command System Readiness Directorate – Airworthiness (CCDC-AvMC SRD-AW)**

- Shall be Verified to be FACE Conformant and **Army Airworthiness Qualified**
 - TES-SAVi FACE VA
 - **Mission Equipment Development & AH-64E Modifications Apache Airworthiness Division Systems Readiness Directorate-Airworthiness**



TES' MBOSA Proven Process – with additional benefits of AWESUM® MBOSA

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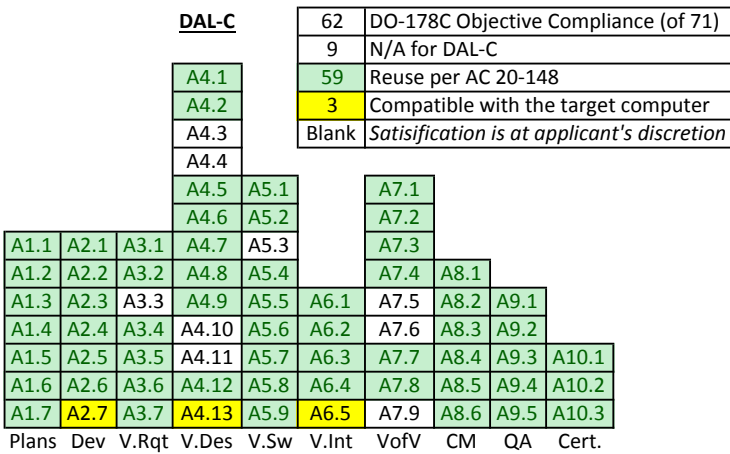
DO-178C's DO-331 Model-based Approach Benefits



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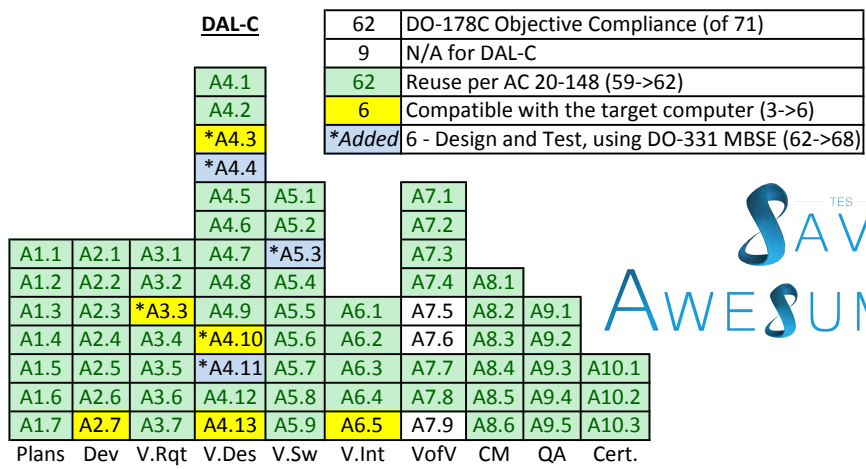
- “Sufficiently” described (*i.e.*, AWESUM® Capability) models allow for the auto-generation of FACE™ and DO-178C Artifacts (*i.e.*, embedded code, FACE data models, test cases and procedures, test results with tracing, and lifecycle design documentation) for FACE Verification, FACE Conformance and Army Airworthiness efforts (AR 70-62 using AC 20-148 guidance for software reuse)
- MBOSA using TES-SAVi AWESUM® allows for development, test, integration of (6) **additional** Compliance Objectives with little additional level-of-effort (LOE) (~more for same LOE)
 - DO-331 Model-based Process embedded within TES-SAVi AWESUM® modeling process produces DAL-B-like for cost of DAL-C

LOE - Level of Effort
 LOE from DO-178C DAL 'C' perspective (ref. RTCA, DO-178C, 2011)



DO-178C DAL-C Dashboard – 62 -> 68
 Objectives, achieve DAL-B like using MBOSA

LOE - Level of Effort
 ** Upscope benefit using TES' MBSE DO-331- LOE becomes DO-178C DAL 'B-like'



6 additional Compliance Objectives using TES' DO-331 mbse approach

- A3.3 High-level requirements are compatible with the target computer
- A4.3 Low-level requirements are compatible with the target computer
- A4.4 Low-level requirements are verifiable
- A4.10 Software architecture is compatible with target computer
- A4.11 Software architecture is verifiable
- A5.3 Source Code complies is verifiable





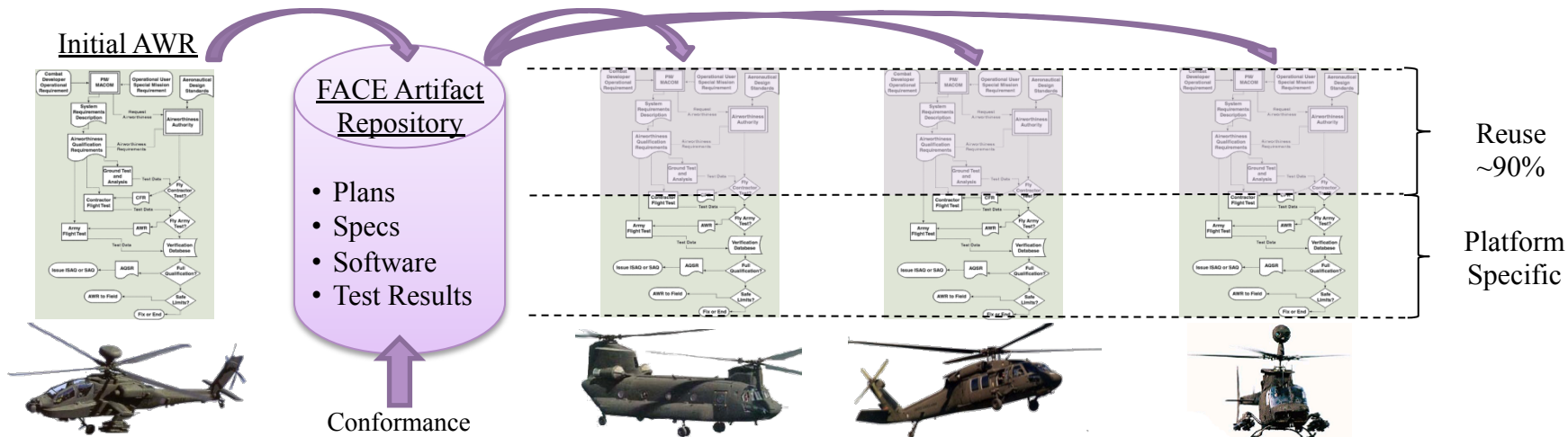
MBOSA Reuse Benefits



- MBOSA using TES-SAVi AWESUM® allows for reuse benefits
 - 90% reuse – all Compliance Objectives identified in Green can be reused per AC 20-148 guidance
 - 10% - Yellow – “Compatible with the Target Computer”. RSC FACE software needs to be ported to Target RTOS and processor and auto-generated Testing Artifacts can be re-executed on Targets to support Yellow Compliance Objectives
 - Re-Execute Formal Qualification Tests(ing) of RSC within each Platform SIL
 - Therefore, we can to achieve the goal of the FACE Approach
 - Rapid Acquisition (Development, Qualification, and cross-platform Integration) of reusable Aviation Capabilities of cyber-physical systems on complex SoS aircraft
 - Regain ownership (control) of aircraft interfaces – promote aviation plug-n-play
 - Procure reusable portable capabilities (applications) and field them

LOE - Level of Effort
 ** Upscope benefit using TES' MBSE DO-331- LOE becomes DO-178C DAL 'B-like'

DAL-C		63	DO-178C Objective Compliance						
		8	N/A for DAL-C						
A4.1		60	Reuse per AC 20-148						
A4.2		4	Compatible with the target computer						
A4.3		Added Design and Test, using DO-331 MBSE							
A4.4									
A4.5	A5.1			A7.1					
A4.6	A5.2			A7.2					
A4.7	A5.3			A7.3					
A1.1	A2.1	A3.1	A4.7	A5.3					
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
Plans	Dev	V.Rqt	V.Des	V.Sw	V.Int	VofV	CM	QA	Cert.





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Summary with Next Steps of MBOSA tooling applied to the FACE Eco-system



- TES-SAVi's AWESUM® is a commercially available product
 - [<https://tes-savi.com/awesum-products/>]
- TES' Military and Aerospace Solutions (MAS) division members actively participate in the FACE Consortium, serve as leads on several FACE working groups, and provide FACE development engineering services [<https://tes-savi.com/services/>]
- TES-SAVi FACE VA is a sanctioned FACE Verification Authority [<https://tes-savi.com/services/>]
- Lessons Learned from using FACE Ecosystem (hybrid) tool within cross-organizational team environment provided insight into how complex systems-of-systems *e.g.*, Future Vertical Lift (FVL) will be developed in our near future
- TES is on schedule to develop FACE conformant software, which is scheduled for US Army aircraft (AH-64D & E models, and the UH-60M & V models) in 2021. The software will be verified by TES-SAVI's FACE VA (for the AGx EIS) and US Army's FACE VA (for the ARCM). ARCM will be submitted to the U.S. Army Airworthy authorities for flight qualification efforts. As noted the software shall be designed with considerations for reuse per AC 20-148 RSC guidance.
- Next Steps include additional direct and indirect development support for the FVL FoS' that await the military community. The initial aircraft include both the Future Attack Reconnaissance Aircraft (FARA) and the Future Long Range Assault Aircraft (FLRAA). TES will continue to support JMR developments including the JMR AV/MSA IDD and the FVL Architectural Framework (FAF)

MBOSA is the preferred choice when planning to manage the complexity of next-generation systems-of-systems developments, integration, testing, qualification, and sustainment



Questions / Discussion



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