



Presented to:
FACE Consortium

***Rapid Integration
Framework
Demonstration
Presentation***



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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

September 2018

Presented by:

Chris Edwards

**U.S. Army Aviation and Missile Research,
Development, and Engineering Center**

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AMRDEC Mission



Deliver collaborative and innovative aviation and missile capabilities for responsive and cost-effective research, development and life cycle engineering solutions.

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Who is AMRDEC?



~9,211

FY17 Strength



2,945

Civilian

16

Military

6,250

Contractor

907 / 5343

SETA Non-SETA

Core Competencies

- Life Cycle Engineering
- Research, Technology Development and Demonstration
- Design and Modification
- Software Engineering
- Systems Integration
- Test and Evaluation
- Qualification
- Aerodynamics/ Aeromechanics
- Structures
- Propulsion
- Guidance/Navigation
- Autonomy and Teaming
- Radio Frequency (RF) Technology
- Fire Control Radar Technology
- Image Processing
- Models and Simulation
- Cyber Security

FY17
\$2,904M

6%

Aviation S&T

7%

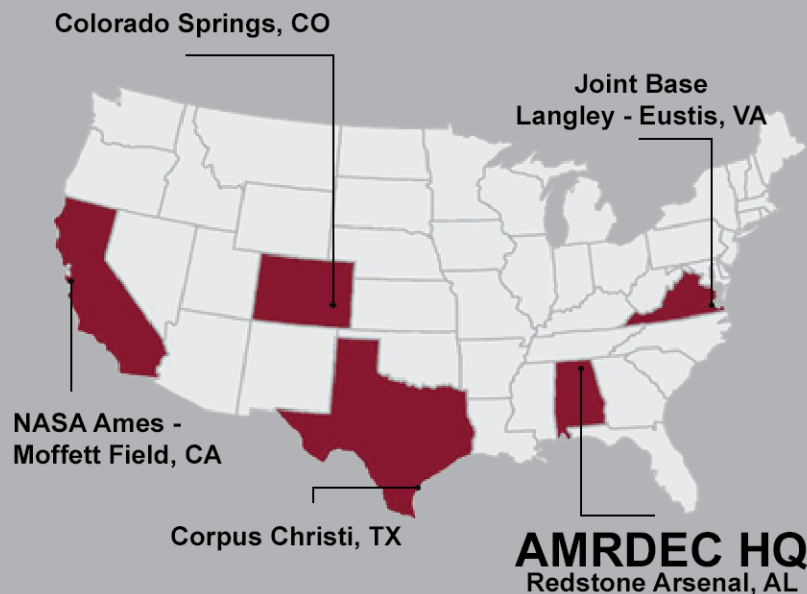
Missile S&T

63%

Army

24%

Other



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AMRDEC Priorities



#1: Readiness

Provide aviation and missile systems solutions to ensure victory on the battlefield today.



#2: Future Force

Develop and mature Science and Technology to provide technical capability to our Army's (and nation's) aviation and missile systems.

#3: Soldiers and People

Develop the engineering talent to support both Science and Technology and the aviation and missile materiel enterprise



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Rapid Integration Framework Demonstrations



- **What is the Rapid Integration Framework**
 - Why is it important
 - Origins in FACE and CMS
 - Relationship to a Comprehensive Architecture Strategy
- **What are we demonstrating**
 - CMS and four alternative platforms
 - Alternative hardware and Software, Rehosting, New Capabilities, Interoperability,
 - Integration without recompile
- **What have we learned**
 - Lessons learned on the SDK
 - Rapid development
 - Positive feedback



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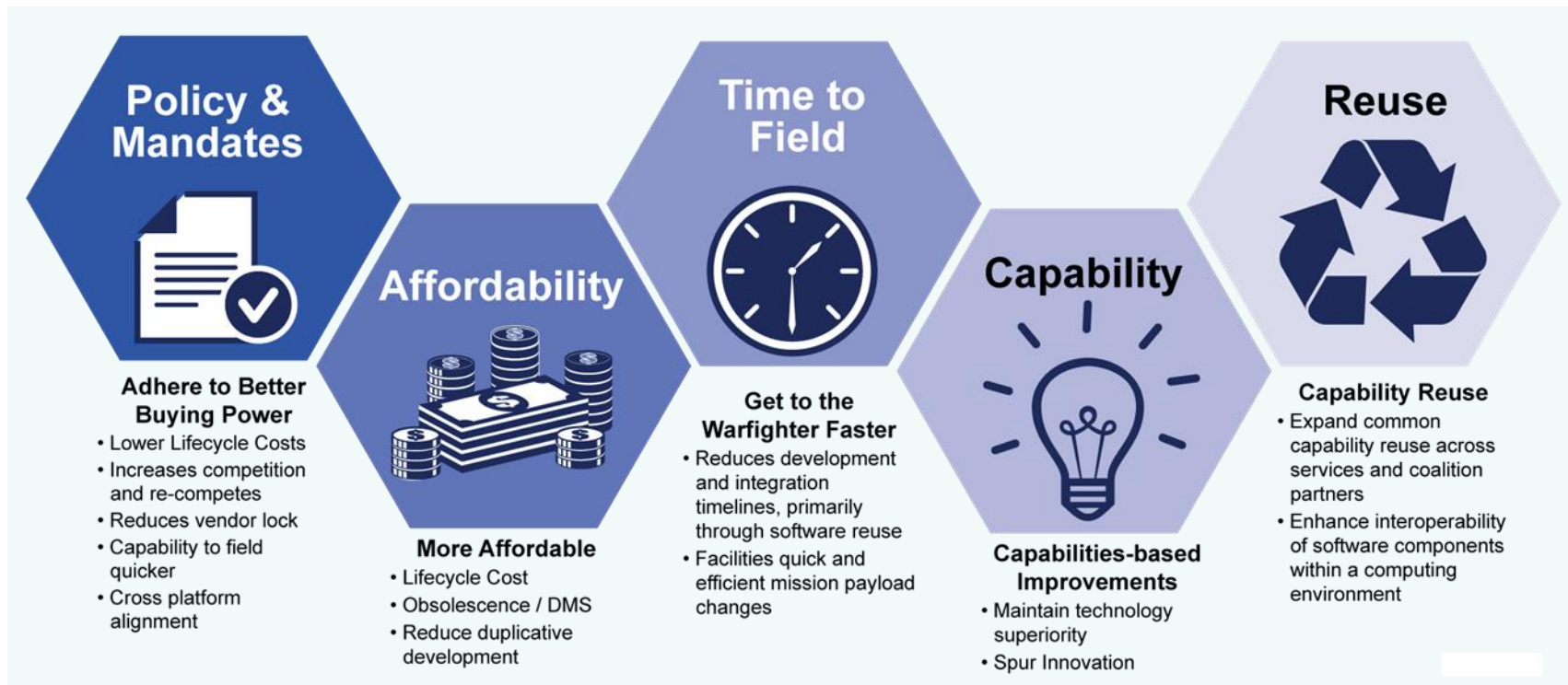
History



- A DoD wide Need for Open Systems Architecture
- FACE Consortium
- CMS
- Multiple Platform/Multiple Use Interests

FACE 101 Government Business Drivers

The Technical and Business Drivers for FACE are closely aligned to these goals.





- Support PEO AVN Strategic Goal of Achieving an Interoperable Combat Aviation Brigade through Open Systems Architecture



- Provide a Government Controlled Open Systems Architecture



- Provide a common objective architecture for use across multiple programs



- Enable faster fielding to the Warfighter



- Decrease cost and complexity



- Break vendor lock and increase competition



- Address obsolescence issues by decreasing downtime and cost



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Crew Mission Station (CMS)



The Crew Mission Station (CMS) was initiated by the UH-60 PO to:

- **Add SA for the Crew Chief on the UH-60 Blackhawk**
- **Provide a means to deploy new capabilities as rapidly as possible**
- **Produce a government owned open systems architecture**
- **Promote independence for the system integrator**

The successes of the CMS lead to:

- **Placement of CMS into a Limited User Evaluation (LUE)**
- **Continued funding to assess a production version**
- **Projects for variations of CMS while maintaining a common code base**
- **Use of CMS as an integration platform for testing**

For each use of CMS there are different goals, these goals can manifest in variations in capabilities, hardware selection, and interfaces.

The CMS Objective Architecture can:

- **Provide a repository of common architecture and system elements**
- **Evolve to cover variations in the resulting system**



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Evolution to a Rapid Integration Framework

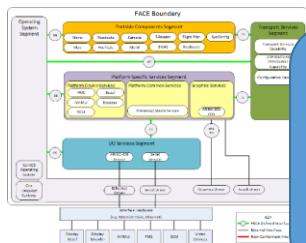


The Rapid Integration Framework:

- Based on the Objective Architecture for CMS
- Defines an Open Systems Architecture for a Core System
- Includes Hosted Capability definitions as extensions to the architecture

A Rapid Integration Platform:

- Includes the Systems Architecture as well as the resulting system for a specific implementation of the RIF
- CMS is a Rapid Integration Platform



Reference Architecture

- U.S. Army Common Operating Environment
- DoD and Army Regulations
 - MOSA
 - FACE
 - BBP

Army Aviation

- PEO AVN
- PM Utility
- TCM Lift
- PMO FVL

Objective Architecture

Rapid Integration Framework

- Business and technical objectives of the RIF
- Core Assets of a Product Line
- Technology Independent Architecture

Community of Interest

RIF COI

RIF Architecture Control Working Group

- Develops the Rapid Integration Framework Requirements
- Works to identify and document common needs (commodities) for each product line

RIF Repository

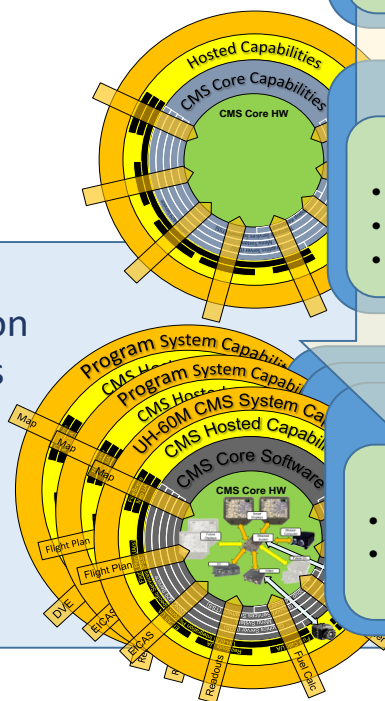
- Maintains the Product Lines (HW/SW) supporting the RIF
- Provides common components for RIFs

System Architecture

Rapid Integration Platform

- Extending the OA to meet system objectives
- Technological decisions needed to procure components

Rapid Integration Platforms





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Demonstration Objectives



- **Demonstration Objectives**
 - **Rapidly integrate new hardware and software to support technology refresh, i.e. replace suppliers' products**
 - **Provide government managed architecture for Industry to extend and show integration and interoperability of new/innovative capabilities**
 - **Enable Industry to port and reuse software and artifacts across platforms**
 - **Enable learning and outreach for PEO AVN**

“The Rapid Integration Framework provides a path for rapid integration of new capabilities.”

- Envisioned 6 months ago
- Kicked off 3 months ago
- New products rapidly integrated following the framework architecture

“The architecture is flexible to meet the needs of a variety of platforms.”

- Hardware Variations
- I/O Variations
- Integration variations
- Software ported to multiple target hardware and operating systems

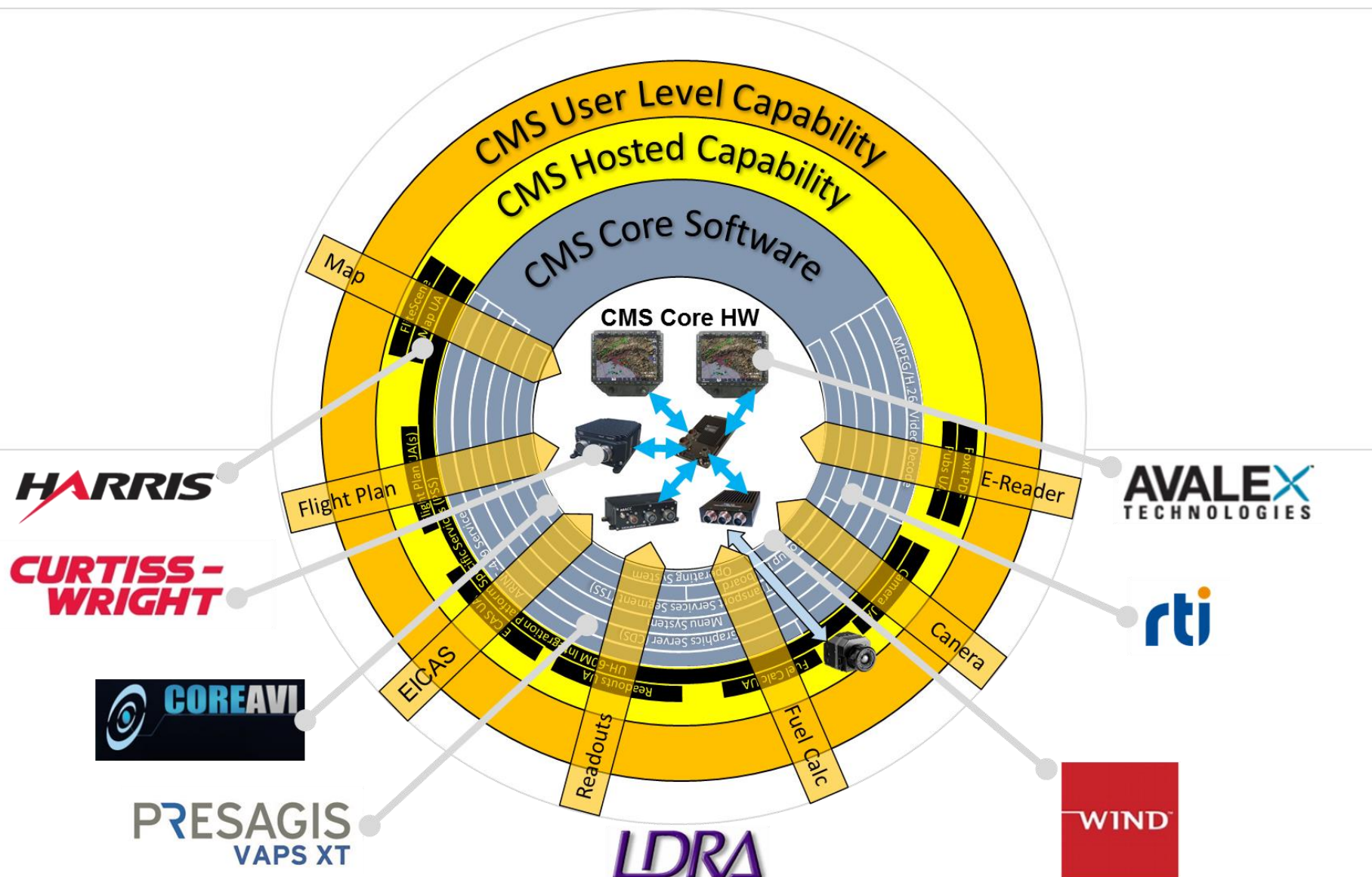
“This architecture and these components are not bound to any single vendor or product”

- 19 participating suppliers
- All core components procured for CMS are demonstrated with alternative Hardware and Software

The Demonstrations

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- **CMS**
 - CMS LUE Version
 - Government Owned Architecture
 - Designed for Rapid Deployment of New Capabilities
 - Utilizes the FACE Technical Standard to provide access to FACE Conformant software developed for other platforms
 - Logically Separates the Core System from the Hosted Capabilities
 - Features Smart Displays for expandability to additional stations
 - Features I/O distributed through Ethernet to reduce wiring and equipment costs

- **LDRA**
 - Guide, and manage adherence to the FACE Technical Standard
 - Manage artifacts across a distributed set of suppliers



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White Layout



Partitioned for fielding Safety of Flight applications while providing a lower DAL area for rapid fielding

VxWorks 653 MultiCore Operating System with a VxWorks 7 Guest OS and a CentOS Guest OS

Avaalex 3105



Guide, and manage adherence to the FACE Technical Standards across a distributed set of suppliers with the LDRA tool suite

TBmanager
TBvision



LDRA



The Army booth contains the equipment and software that will be deployed to active duty personnel as part of a limited user evaluation..

Avaalex 3105



MILTECH 912



Ethernet

Excalibur MACC



Delta Digital



Parvus DUA-COR



Avaalex 3105



CoreAVI's ArgusCore™
OpenGL® SC 1.0.1

EGL_EXT_Compositor
for compositing
graphics to FACE
Technical Standard 3.0

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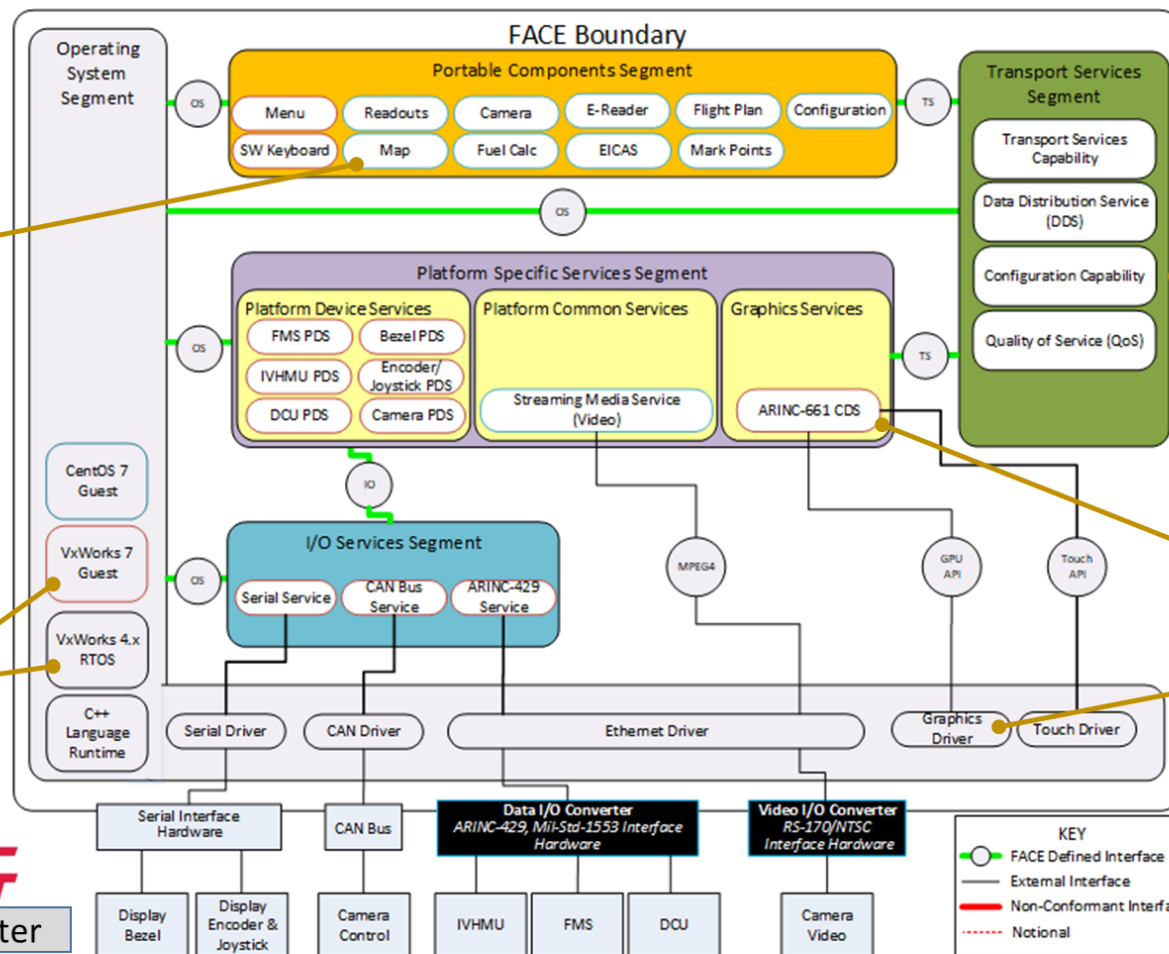
White FACE View

HARRIS

WIND

**CURTISS -
WRIGHT**

Mission Computer



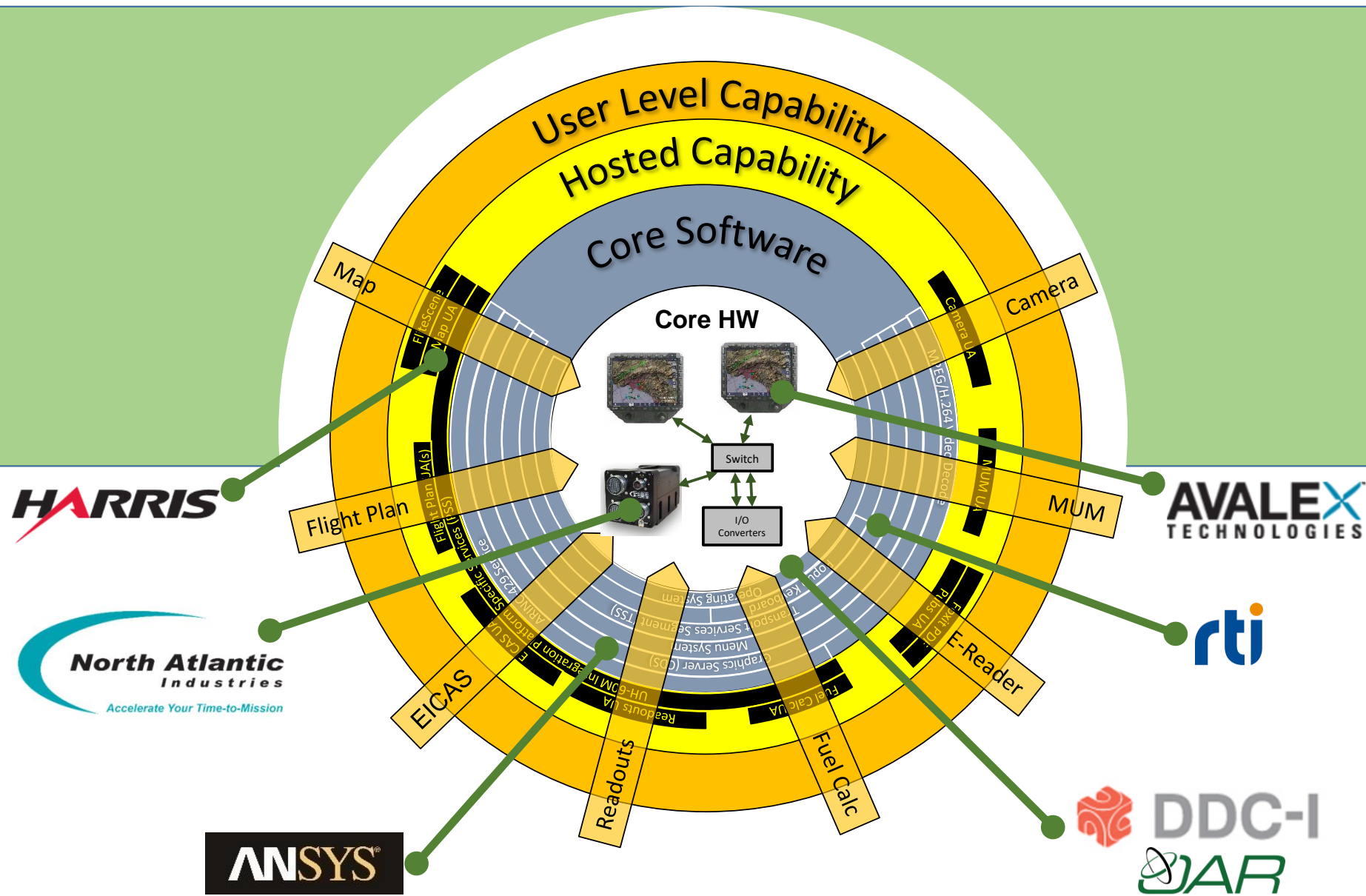
LDRA
tool suite

rti

PRESAGIS
VAPS XT

COREAVI

AVALEX
TECHNOLOGIES
Displays





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Green Platform Description



- Features an enhancement to the map showcasing a 3D virtualization along with other features not selected for the initial LUE (includes planned additions to CMS).
- ANSYS SCADE Replacement CDS Graphics Server replaces one of the core software components
- Features a mission computer from NAI that integrates I/O functions to reduce SWaP.
- PSSS Device Services run in the mission computer, with the I/O processing to reduce redundant processing.
- DDC-I's Deos RTOS with ARINC 653 and POSIX (provided by RTEMS) APIs shows redeployment of components on another Operating System.
- Use of Synchro demonstrates ease of expanding the platform to accommodate new sensors/effectors without impacting other components

Green Booth Layout

The Harris FliteScene map was an initial requirement for the CMS map capability and is used by pilots on UH-60M as well as other Army aircraft.. It is shown in most of the platforms demonstrated today.

Map UA based on the
FACE Conformant
Harris FliteScene

Avalex 3105



**ANSYS SCADE CDS
Graphics Server:**

- Model-Based,
- Certifiable,
- Extensible,
- Platform-Portable
ARINC 661 Solution

Avalex 3105



Ethernet

Switch



DDC-I's Deos RTOS: DO-178C DAL A certifiable real time operating system (RTOS)

FACE Aligned (safety base) Deos+RTEMS supports ARINC653 and POSIX APIS.

Scalable, Reconfigurable LRU supporting I/O and application processing.

Quad Core T2080
With Integrated I/O

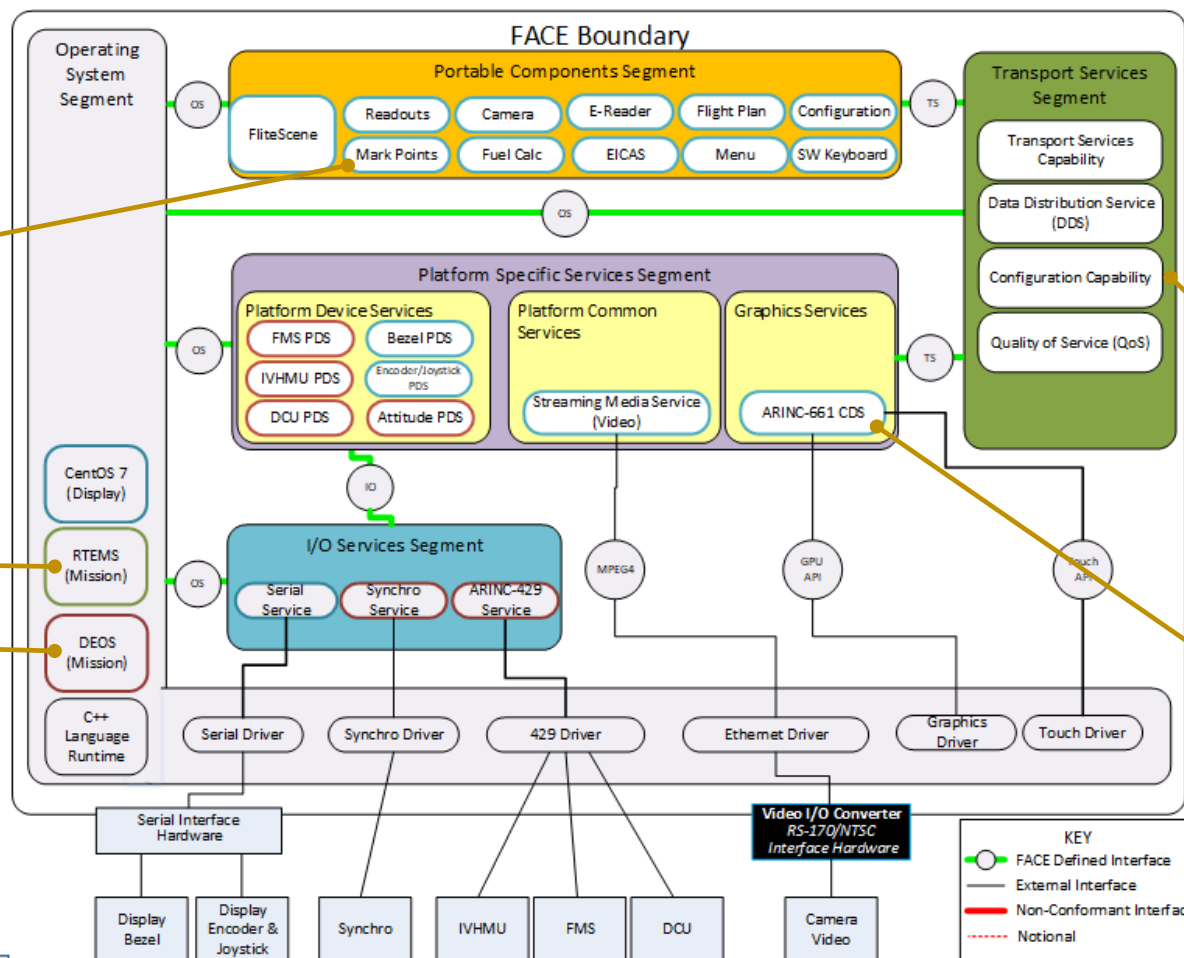
COTS standards,
MIL qualified,
DO-254 & DO-178

NAI SIU33



ARINC 429
Synchro





HARRIS

JAR
AN INTREPID COMPANY

DDC-I

North Atlantic Industries
Accelerate Your Time-to-Mission

I/O and Mission

rti

ANSYS

AVALEX TECHNOLOGIES

Displays

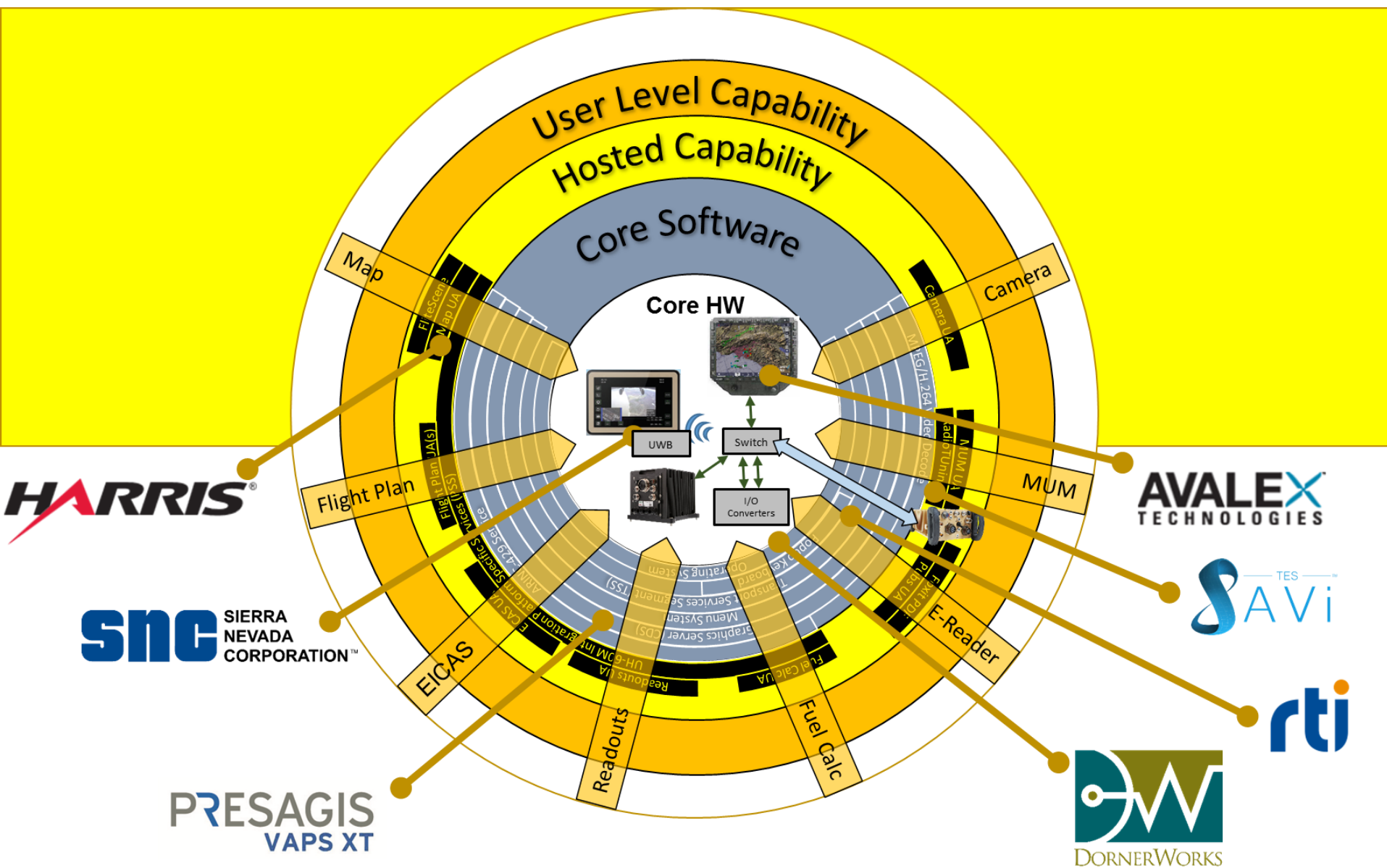


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Yellow Platform

Wireless, Tablet Displays, MUM, FACE 3.0





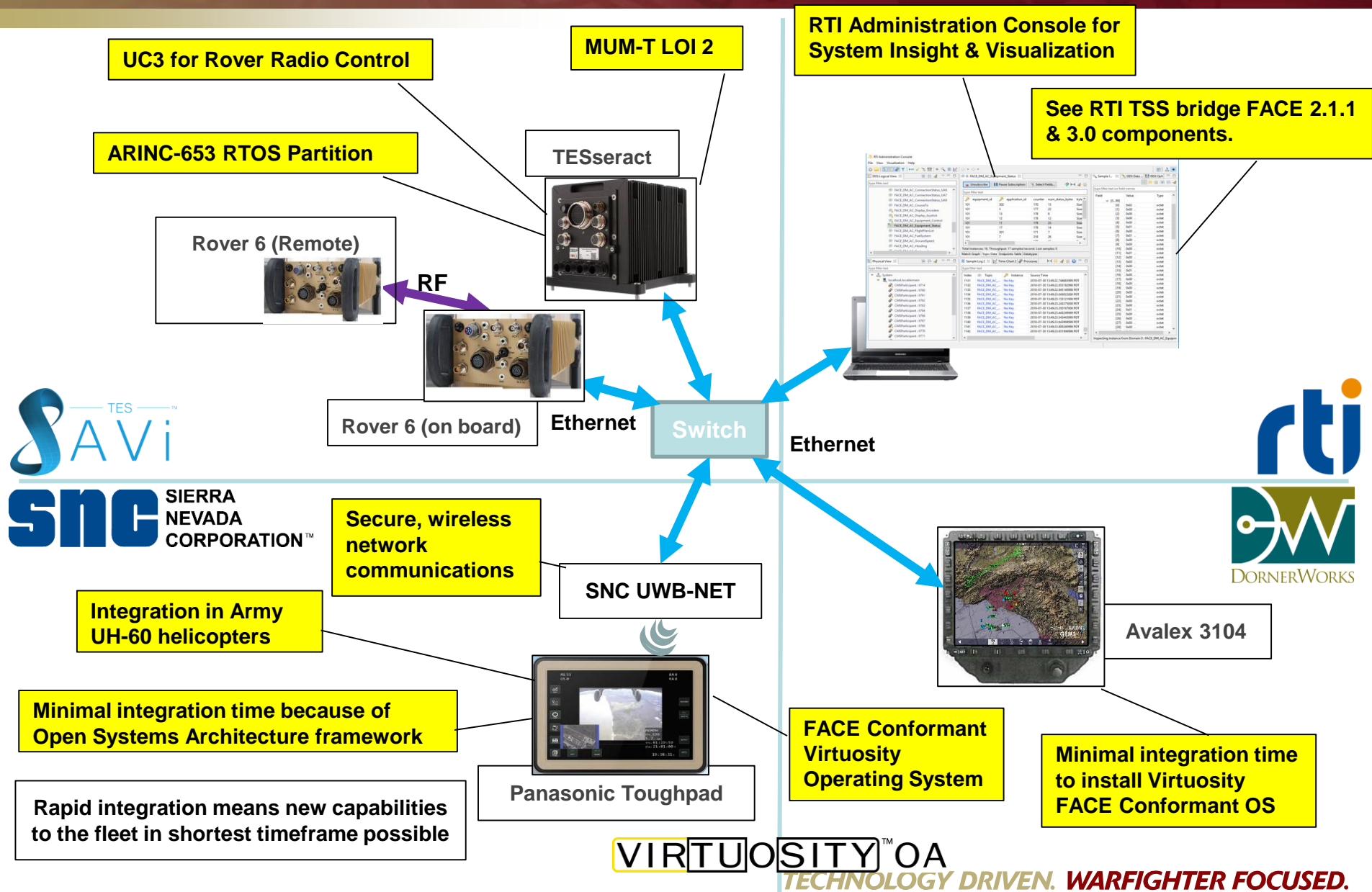
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Yellow Platform Description



- Features applications running on a Panasonic Toughpad as an alternative display.
- Utilizes an Ultra-Wideband wireless network capability provided by SNC to reduce the need for wires within the cabin
- Shows the applications running on the DornerWorks Virtuosity FACE Conformant OS.
- Shows an implementation of MUM-T LOI2 through a Rover6 radio.
- Shows an integration with components developed to the FACE 3.0 Technical Standard interoperating with components developed to the 2.1 Technical Standard. This is achieved through a common TSS provided by RTI.
- Shows an integration of CMS and BALSA.

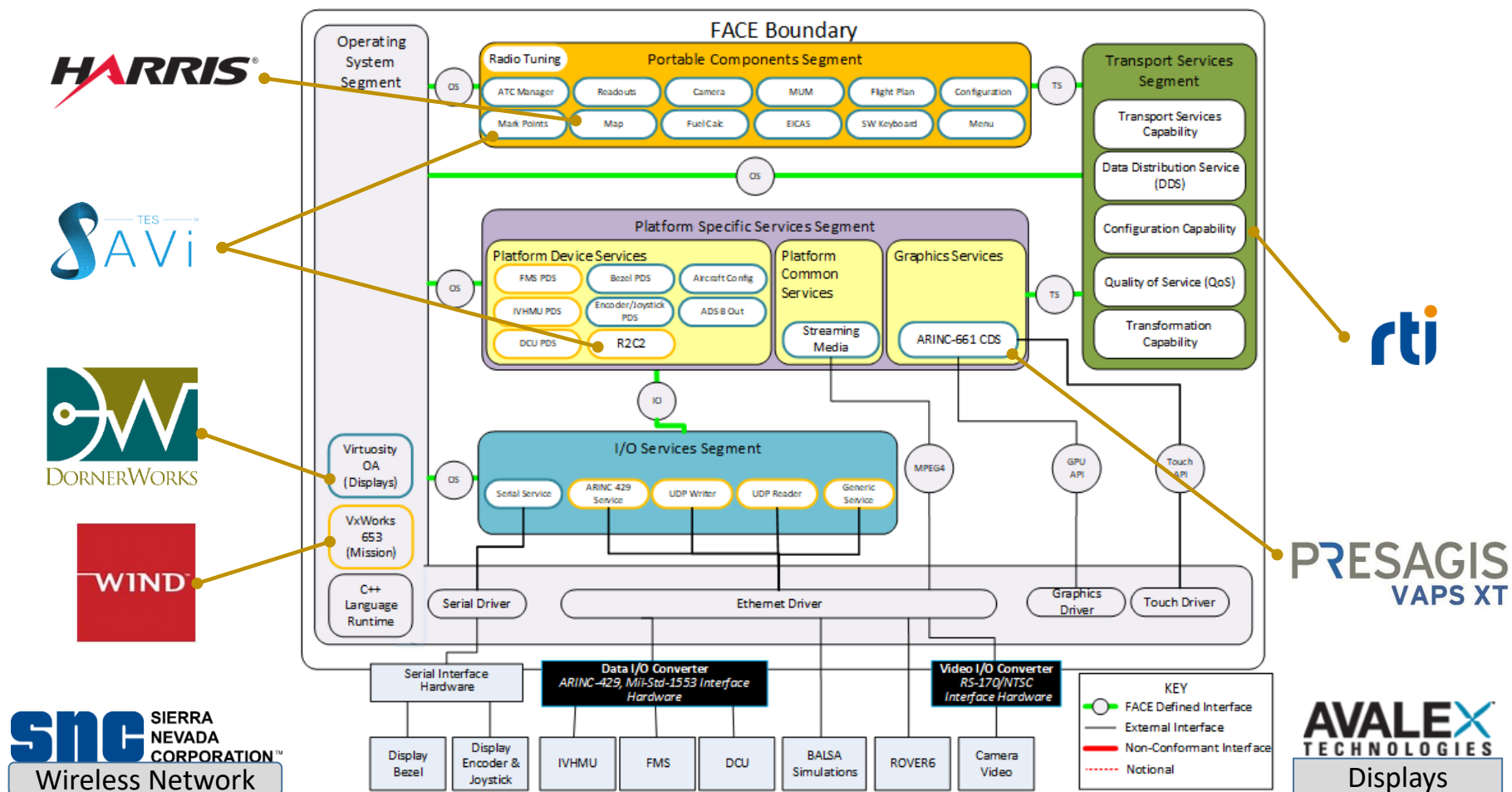
Yellow Booth Layout



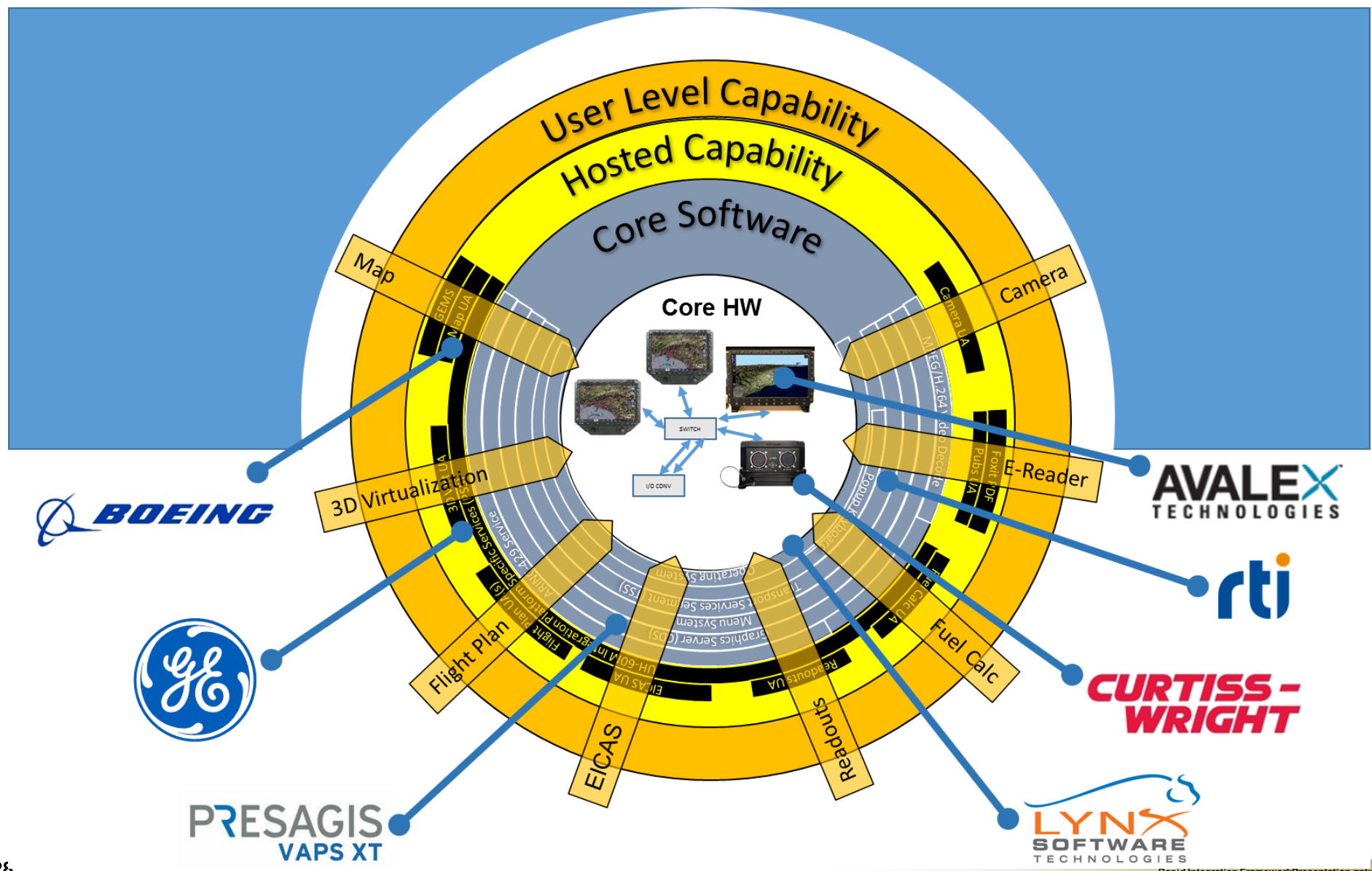


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Yellow FACE View



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Blue Platform Description



- Features an alternative map in the GEMS product from Boeing.
- Features a new capability in OpenMap from GE Aviation.
- Shows an additional display in a larger format for a crew member serving in a mission specialist role
- Processing for this larger display is performed on the mission computer in a separate CentOS guest showing further flexibility in display solutions.
- Alternative Mission Computer with a next generation processor from the one used in CMS.
- The Mission Computer is running LynxSecure, a multicore separation kernel / hypervisor.
- A LynxOS 178 RTOS guest on the mission computer runs the PSSS components, including the IVHMu, the FMS, and the DCU.



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Blue Booth Layout



VAPS XT 661, model-based
development tool

The PRESAGIS CDS has
been an integral part of the
CMS project from the start
and is being demonstrated
in most of the other display
platforms.

PRESAGIS
VAPS XT

Avaalex 3105



Ethernet

Ethernet



Boeing GEMS Map

Avaalex 3105

BOEING **AVIONX**
GEMS

Avaalex AVM4178



Integration with a "Standard" Display

GE Aviation's OpenMap provides
a 3D virtualization

Relevant future applications:

- DVE & Synthetic Vision
- Interactive route planning
- Tactical mission displays



Video

RS-232

Mission Computer
provides processing
for 3rd display

Ethernet



Parvus DuraCor 8042

5th generation i7
processor

LynxSecure separation
kernel Lynx Software that
allows dedicated hardware
resources to be assigned to
various guests OS's

LynxOS-178 RTOS for
Higher DAL applications

CentOS Guest for rapid
deployment of lower DAL
capabilities

LynxOS-178
FROM LYNX SOFTWARE TECHNOLOGIES

LYNXSECURE
TECHNOLOGY DRIVEN.

WARFIGHTER FOCUSED.



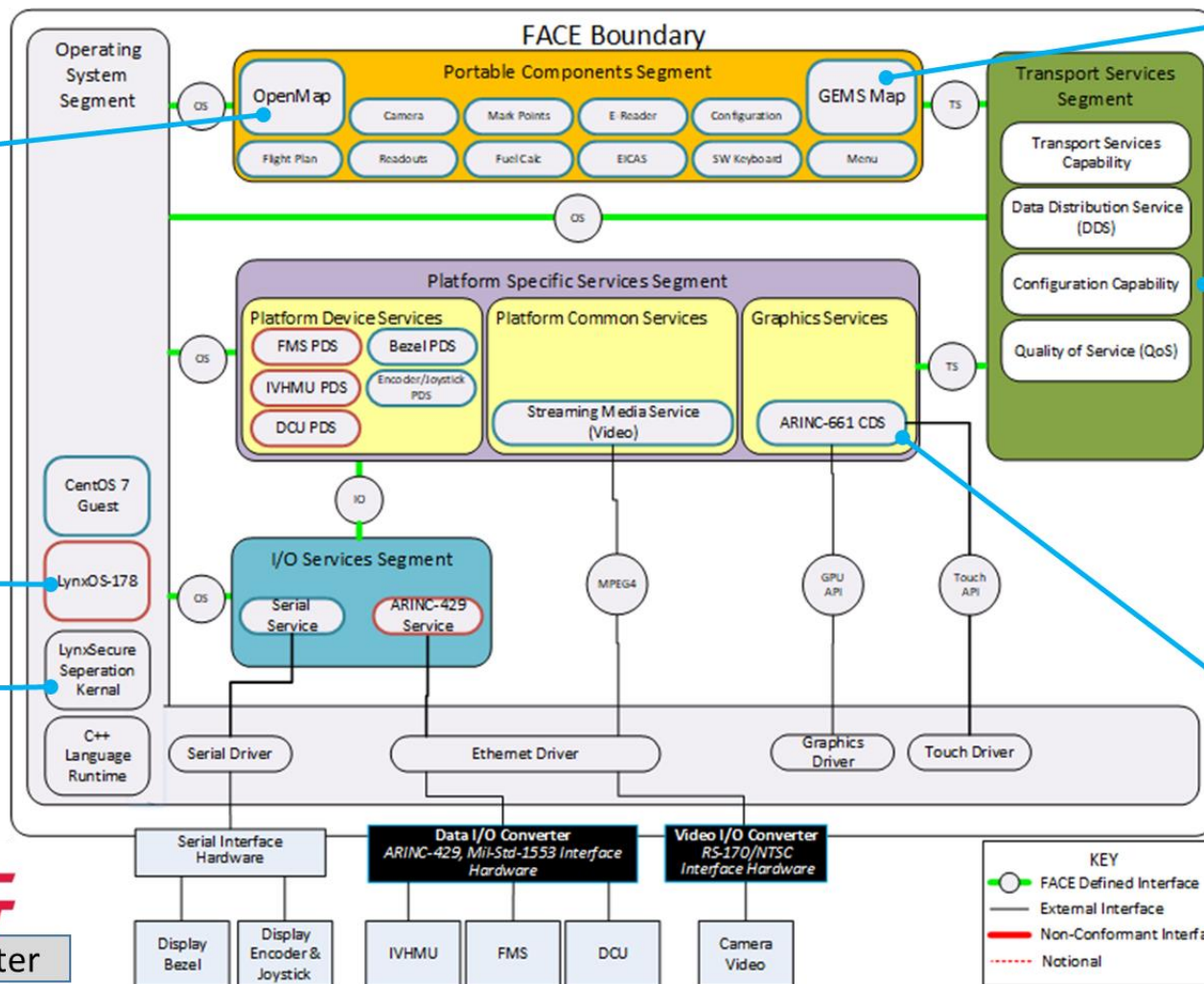
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Blue FACE View



PRESAGIS
VAPS XT

AVALEX
TECHNOLOGIES
Displays



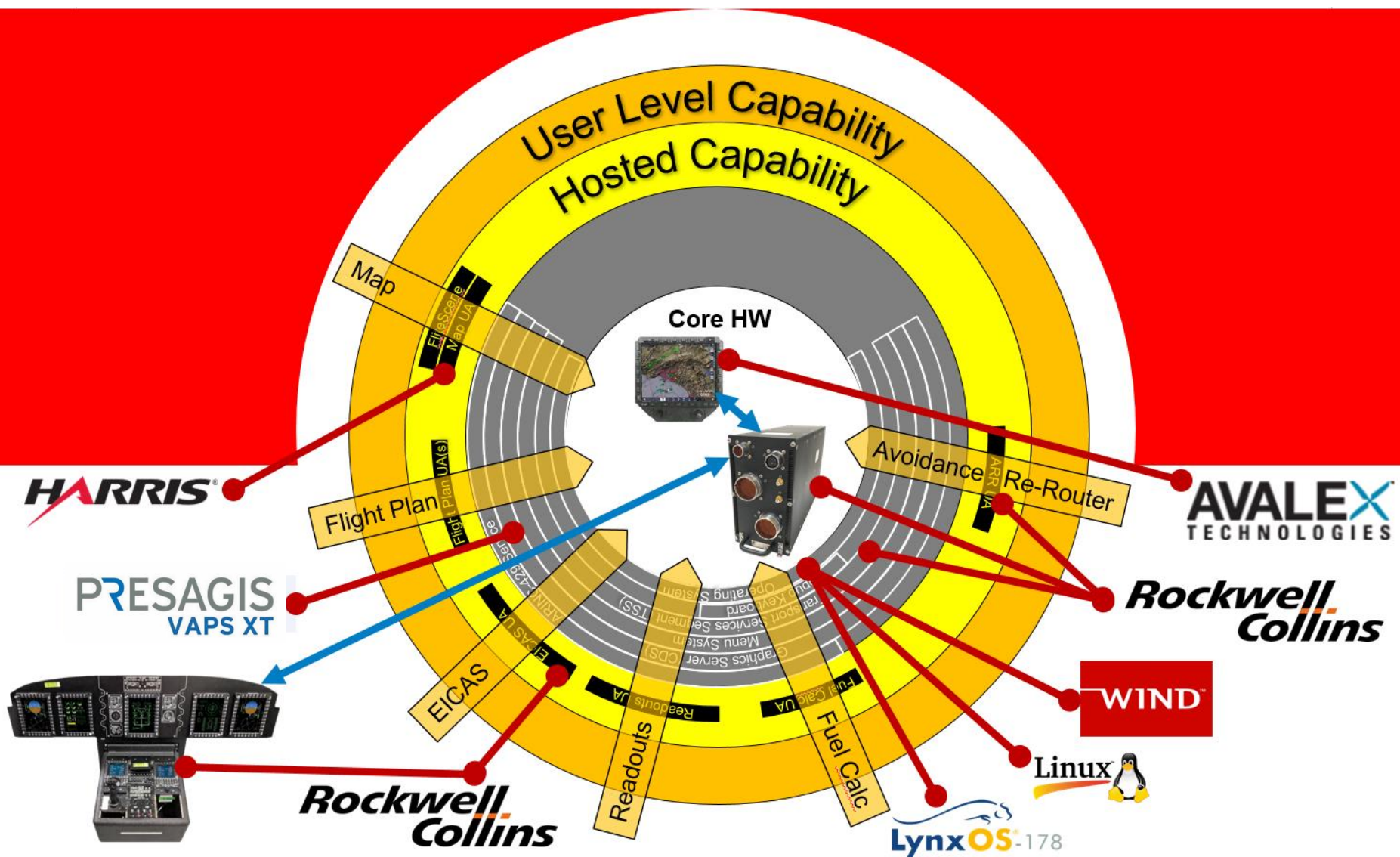
**CURTISS -
WRIGHT**
Mission Computer

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Red Platform
Tighter Integration, Chinook Variations





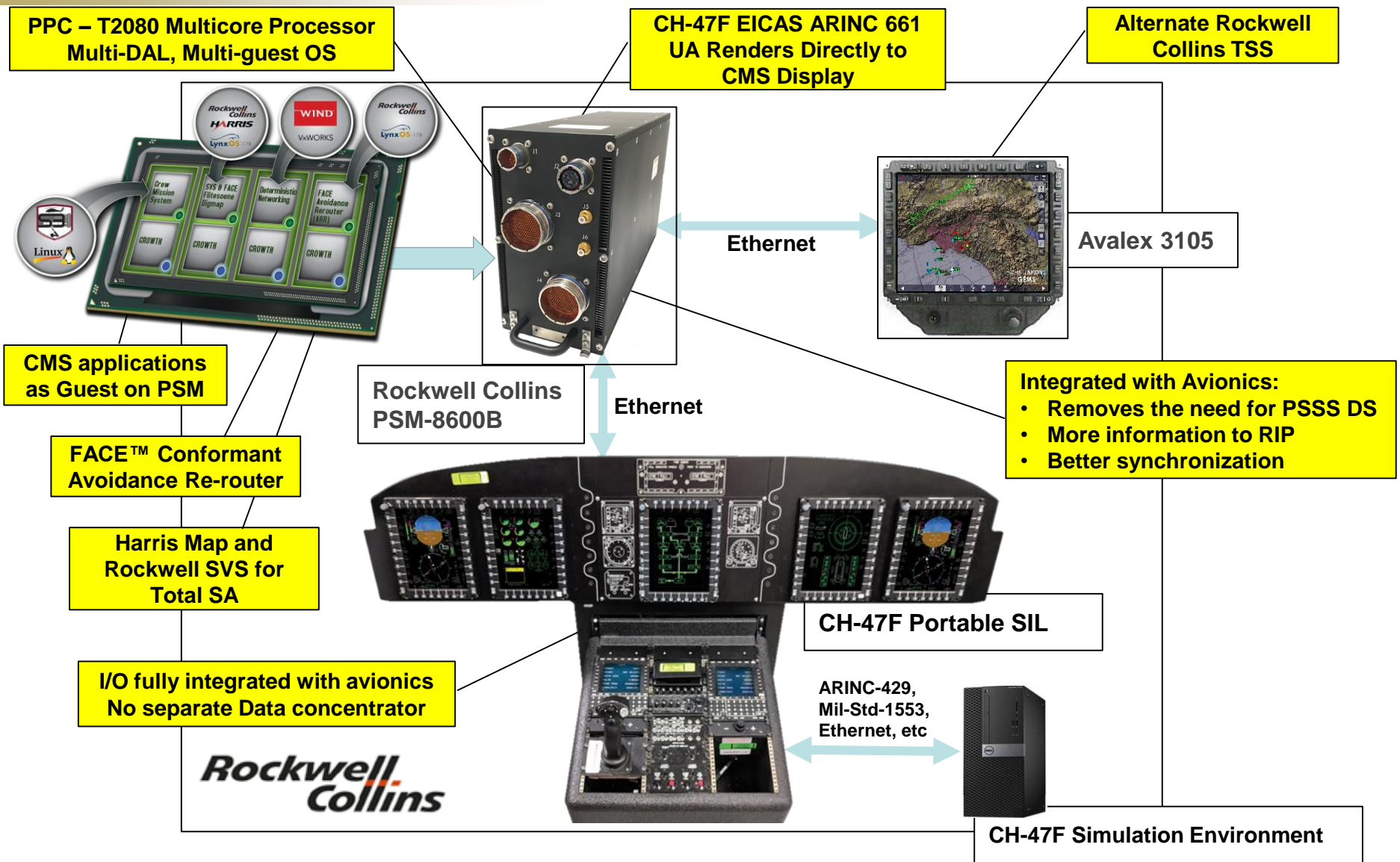
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Red Platform Description



- **Features an Army led CMS integration effort onto a civil certifiable multicore mission computer that provides more computing with less SWAP**
- **Mission computer shows separation of safety critical and mission processing for hosting applications at different DAL levels lowering the recertification impact of incremental software upgrades**
- **Demonstrates integration with a Chinook system and access to the avionics LAN to increase connectivity between FACE™ applications**
- **The system utilizes an alternative to the TSS used on CMS, giving additional proof of RIF open architecture portability**
- **Shows graphical applications running on the Mission Computer to reduce processing needs on the individual displays**
- **Shows use of CH-47F native ARINC 661 user applications to remotely render graphics on CMS displays without the need to recode**

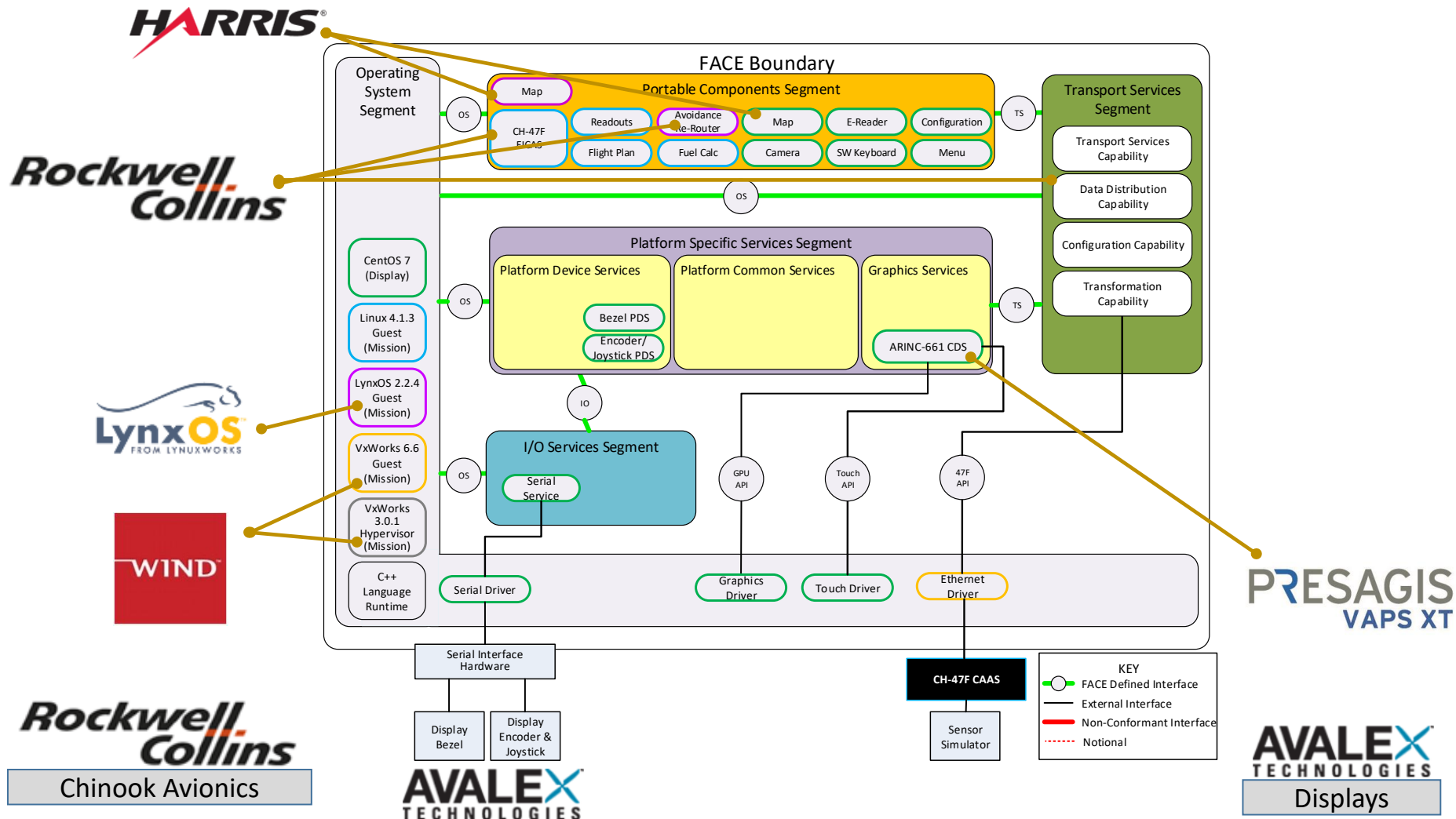
Red Booth Layout





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Red FACE View



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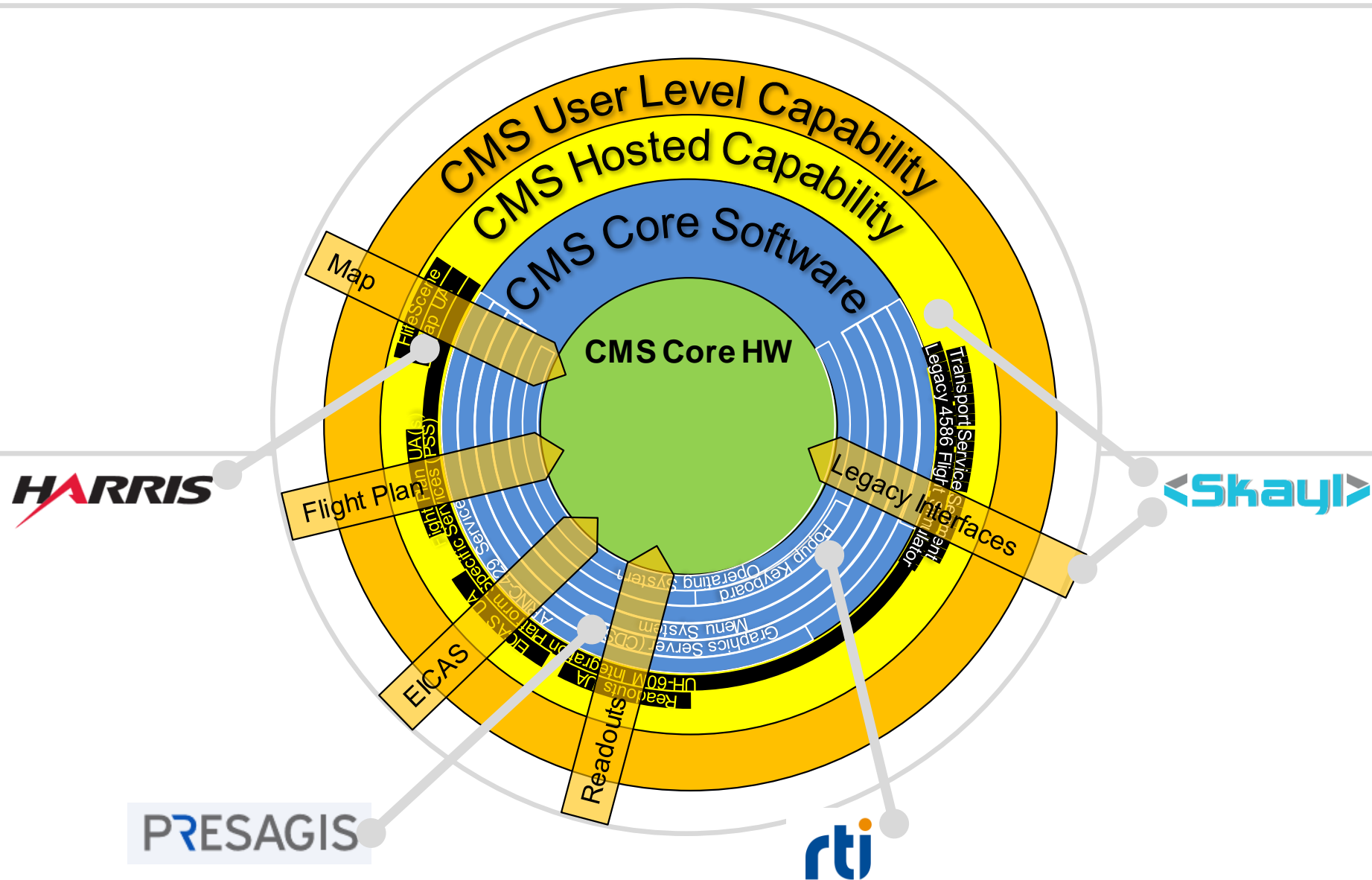
Rapid Integration FrameworkPresentation.pptx



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SKAYL

TSS/Modeling Tooling for Rapid Integration





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Skayl Demonstration



- Performs rapid integration of legacy application with CMS utilizing model-based engineering and semantic data model merging
- Integrates legacy STANAG 4586 vehicle simulator with RIF SDK without modification to existing source code
- Performs *on-demand, live integration* of exemplar user application into RIF through model content updates
- Automatically generates executable PCS application and TSS mediation code to bridge between transport services.

Skayl Booth

- Features Skayl's PHENOM™
- Includes Certified DSDM, including traceability to FACE™ SDMs
- Enables multi-model import, merge, manipulation, and maintenance
- Facilitates alignment of interfaces between data models and systems
- Automatically generates executable integration code - no need for hand-coding

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The Results



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Schedule



- Envisioned at the February FACE-to-FACE meeting (6 months ago)
- Kicked off at the July FACE-to-FACE meeting (3 months ago)
- First draft of the SDK provided July 30th
- Most of the engineering/integration work completed in 6 weeks

- **Early and often iterations of the SDK enable participants to get started sooner and flush out challenges quicker**
- **Need better Transport/Integration documentation**
 - **Earlier understanding/establishment of supporting project tools & infrastructure capabilities & limitations (for example, Webex).**
 - **Include Connex DDS Micro in the SDK to enable use of TSS for non-standard Connex DDS Pro platforms.**
 - **Reach out for TSS integration early to help address issues (i.e not every platform supports multicast)**
- **The preliminary nature of the SDK and source code comments mean the code is virtually undocumented.**
 - **Having functional descriptions of major classes would be nice.**
 - **It would also be nice to have an understand of the control flow of the software.**
- **Included files are not modular enough.**

Rapid Integration Framework Demonstrations

Completed all efforts in less than 3 months with 19 vendors and multiple government organizations

Vendors completed project in less than 280 hours on average

Once CMS/sample application was setup and running, integration for our map to render to the display took < 2 days!

The configurability of the CDS made integration with new display hardware/drivers a breeze.

Early and often iteration of SDK enabled rapid resolution of challenges

Identified valuable lessons learned for future RIF enhancements



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