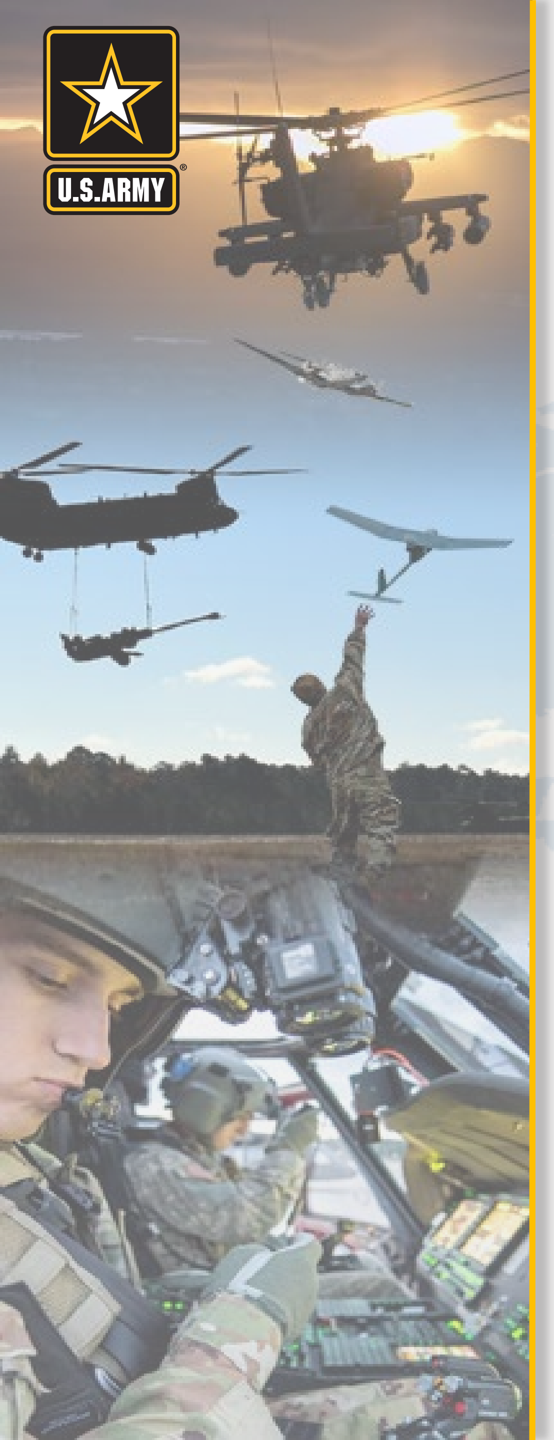


PEO AVN Open Systems Demo

Task Allocations and Overall Tracking

Christopher Edwards

29 June 2021

Distribution Statement A -
Approved for Public Release
- Distribution Unlimited

MOSA TO -- Technical Goals

Goal		Demonstration	Documentation
MOSA Conformance Capability	Reflect the business goal in technical results	• TES Demonstration of HOST Testing • Use of FACE Conformant Software • Use of FACE Transports for integration	• MOSA News Letter • MOSA D.Handout – MOSA TO • MOSA D.Handout – MOSA Conformance • Demo D.Handout – FACE Statements • MOSA Video
Exercise AMCE Concepts & Assumptions	Open Graphical Interfaces Open transports Configurable Processing	• Multiple CDS implementations showing mixed criticality • Multiple TSS Implementations across multiple FACE Technical Standard Editions • Multiple Mission Computer representations • Use of modular hardware approaches	• White Paper – Configurable UA • White Paper – Mixed Criticality in A661 • White Paper – Multiple TSS • Demo D.Handout – Relate to the white papers • Demo D.Handout – Lessons Learned from TSS integrations
FACE / SOSA Interoperability	Containers Exploration, Enabling Rapid Portability for the Future Standards Alignment and Interoperability (CMOSS, etc.)	• Containers in Stellar Relay • Guest Operating Systems • Separation of DAL through multiple processing cards	• Demo D.Handout – FACE Statements • Demo D.Handout – Demonstration Open Standards List
Integration of Apps across Multiple Platforms		• Integration of enduring aircraft system software into a FACE Architecture • Includes - PM UH, PM FW, PM EUAS, PM AMSA, PM CARGO	• Demo D.Handout – Demonstration Participating PM List • Demo Video
Model the Demo'd Systems	• Capturing Key Interfaces • Considerations for Integration	• Models include physical/logical system models and use of integration models to generate TSS configurations • Mappings to KILA	• Models D.Handout – Models ADDish • Demo Video
Feedback/Q&A Related to Technical Goals	• MOSA Conformance • Easiest through FACE, SOSA. and others are harder without some	• Participant Q&A based on integration efforts	• Demo D.Handout – Participant Q&A

PEO Aviation Open Systems Demo

- Open Systems Demo Logo will be prominent in the Army Booth.

OPEN SYSTEMS DEMONSTRATION HANDOUT INFORMATION

FACE TIM Message

- **The Army continues its over 10-year commitment to requiring the use of the FACE Approach**
  - Multiple projects utilizing the FACE Technical Standard were brought together in this demonstration
  - These products come from many Program Offices within the Army and the Navy
- **PEO Aviation has stepped up its commitment to Open Standards like FACE, SOSA, HOST, CMOSS with the forming of the MOSA Transformation Office**
  - Conformance to the FACE and SOSA Technical Standards are key among these standards
- **Use of the FACE Approach and the FACE Reference Architecture make this demonstration possible.**
  - Use of the common reference architecture provided by the FACE Technical Standard by multiple program offices has provided readily available components
  - New features of the FACE Tech Standard 3.0 provide extremely effective ways to blend transports without recompiling software.
  - The FACE Approach includes guidance on how to bring the FACE Technical Standard to Legacy systems, allowing the inclusion of software packages that are not aligned to FACE into future systems through FACE wrappers.

Participants and Products

Participants (20)
AdaCore
Ansys
Avalex
BAE
Bell
Boeing
Collins
DDC-I
General Atomics
L3/Harris
Lockheed Martin
Lynx
Mercury Mission Systems
NAI
Northrop Grumman
OAR
Parry Labs
RTI
Skayl
TES
Wind River

DoD Organizations (9)
DEVCOM/ASIF
DEVCOM AvMc/TDD-A
DEVCOM/CAPT
PEO Aviation
PM AMSA
PM UAS
PM UH
PM CARGO
PM FW
PMA 209 (Navy)

Operating Systems (5)	Company
CentOS 7	Red Hat (Open Source)
DDC-I DEOS with RTEMS	DDC-I + OAR
LynxOS 178	Lynx
RedHat 8	Red Hat
VxWorks	Wind River

TSS Products (8)	Company
FACE 3.1 COE TSS	TES
CinC	DEVCOM AvMC/TDD-A, Skayl
Collins	Collins
Connext	RTI
EUAS TSS (Kafka)	PM EUAS, Parry Labs
L3Harris TSS	L3Harris
NG TSS	PM UH, Northrup Grumman
RRADE	PEO Aviation, OAR

Hardware Products (7)	Company
4178 Display	Avalex
4105 Display	Avalex
AMCS Prototype	Mercury Mission Systems
PSM 8600B	Collins
TRMC	Northrop Grumman
Stellar Relay	Parry Labs
SIU	NAI

Software Products (29)	Company
ANSYS CDS	Ansys
Bell ITEP Engine PSSS	Bell, TES
PFD	Boeing
ARR	Collins
MFMS	Collins
Alerts UA	DEVCOM/ASIF
CommonUA	DEVCOM/ASIF
MAP UA	DEVCOM/ASIF
Menu System	DEVCOM/ASIF
RIF CDS	DEVCOM/ASIF, Preasgis
RIF PSSS	DEVCOM/ASIF
Downlink	General Atomics
Flight C2	General Atomics
Handover Manager	General Atomics
MEM	General Atomics
Passive Sensor C2	General Atomics
Uplink	General Atomics
Air Traffic Manager (ADS-B)	Lockheed Martin
eTAWS	LM/Army/Navy
IFF Reduced Size Transponder ADS-B Device Manager	Lockheed Martin
60v FliteScene	PM UH, NGC, L3H
TRMC BFT	PM UH, NGC
TRMC Flight Display	PM UH, NGC
Correlator	BAE
Arke Broker	PEO Aviation
Arke Collector	PEO Aviation
IDM Software	PM AMSA
ARCM	TES

MOSA TO and the 5 Principles of MOSA

MOSA is defined by 10 U.S. Code 2446a as an integrated business and technical strategy that

- Employs a modular design that uses modular system interfaces
- Is subjected to verification to ensure relevant modular systems interfaces
- Uses a system architecture that allows severability
- Complies with technical data rights guidance (10 U.S. Code 2320) prescribed in the FAR

Establish an Enabling Environment

- Provide organization and structure for continued discussion between program offices on common elements within Arny Aviation
- Direct program offices to utilize common approaches via a Reference Architecture Description Document (RADD)

Employ Modular Design

- Develop the Enterprise Architecture Framework (EAF) that defines Major System Components as modular elements
- Require the use of the EAF and clarification of rationale in an Architecture Description (derived from the RADD)

Designate Key Interfaces

- Review Key Interface input from Industry through the ACWG
- Develop Key Interfaces as part of the EAF

Use Open Standards

- Use Open Standards in the EAF, apply standards to Key Interfaces
- Refine program guidance for how to apply standards through Implementation Guide and RADD

Certify Conformance

- Develop a MOSA Conformance Capability to evaluate solutions against the EAF and MOSA TO direction
- Provide program support through multiple milestone reviews & ITRA assessments

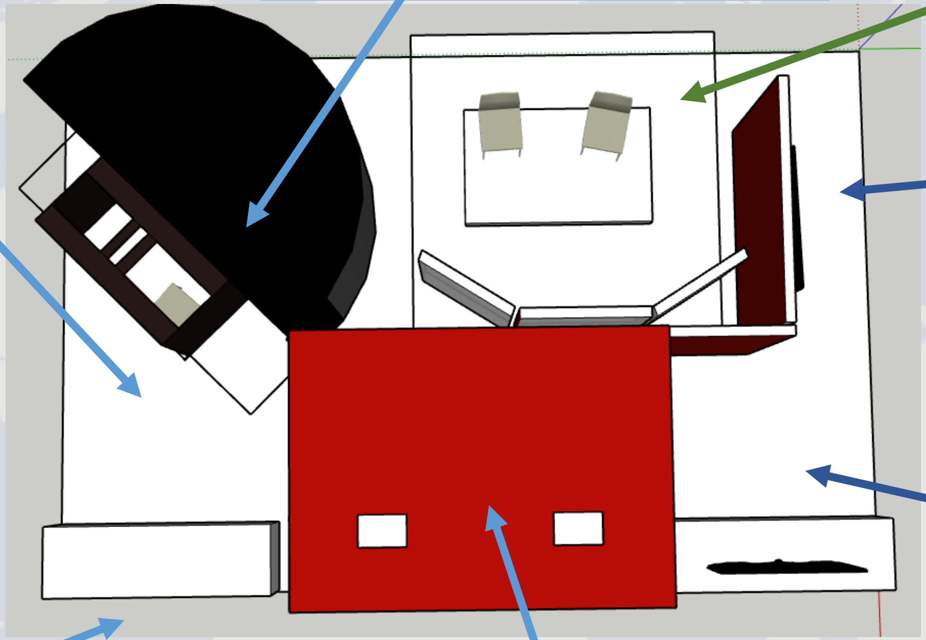
Discussion Locations

<u>OSD: Pilot</u>
Staffed by: Nick
Scope:
- Fly the Simulation
- Instruct on aircraft functions

<u>60V Cockpit, Tri-Services Demo</u>
Staffed by: GTRI Team
Scope:
Tri-Service Demo

<u>OSD: Aircraft Demonstration</u>
Staffed by: S3I Team
Scope:
Instruction on using integrated functions
- Teaming Display
- ATAK

Operating the Demo
- Run the CAPTE
- Manage Flight Plan
- Manage Tactical Symbols



<u>Flying FACE Demo, Other PEO Aviation Activities</u>
Staffed by: PEO Aviation

Scope:
- Flying FACE Demo
- BALSA, Arke, RRADE
- FACE, SOSA Participation

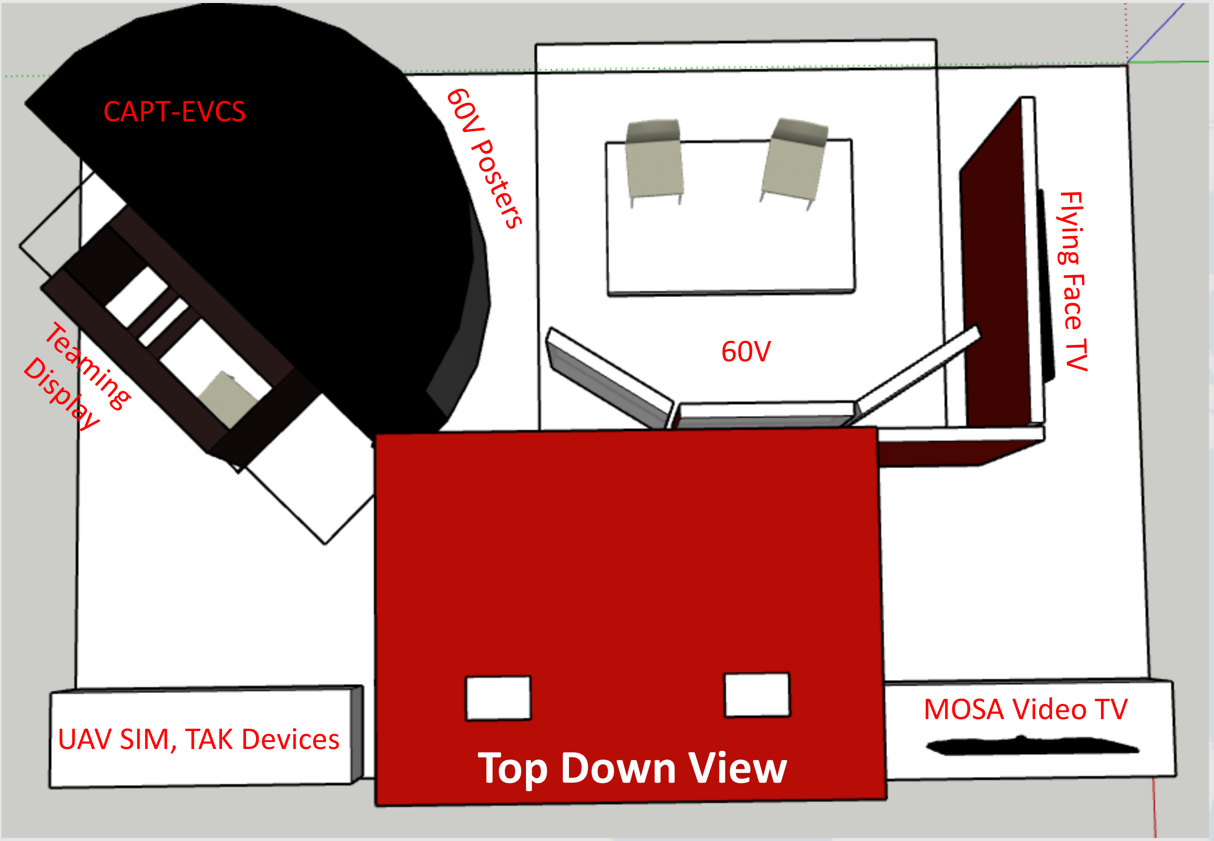
<u>OSD: UAV and ATAK Demonstration</u>
Staffed by: S3I Team
Scope:
Instruction on Using Functions
- ATAK

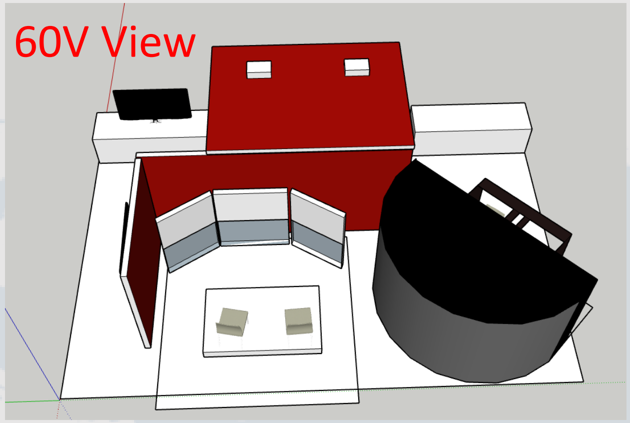
Operating the Demo
- ATAK Ground Device
- UAV Simulation

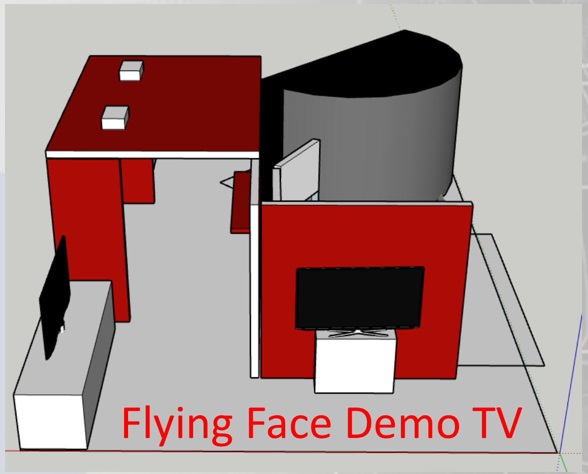
<u>MOSA Transformation Office/MOSA Conformance</u>
Staffed by: MOSA TO
Scope:
- What is MOSA TO
- What is MOSA Conformance
- Direct people to Meeting Room 1

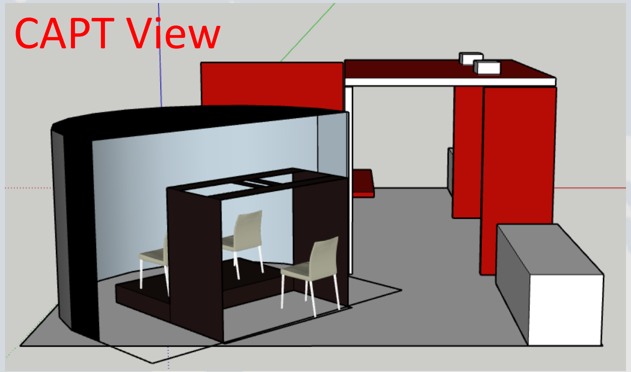
<u>OSD: Modeling and Integration</u>
Staffed by: S3I Team
Scope:
- Description of the integrations
- Functional flows, Integration groups
- FACE/SOSA Approach
- FACE Lessons Learned

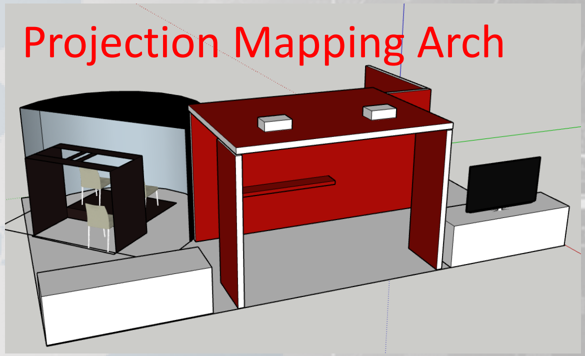
Booth Layout



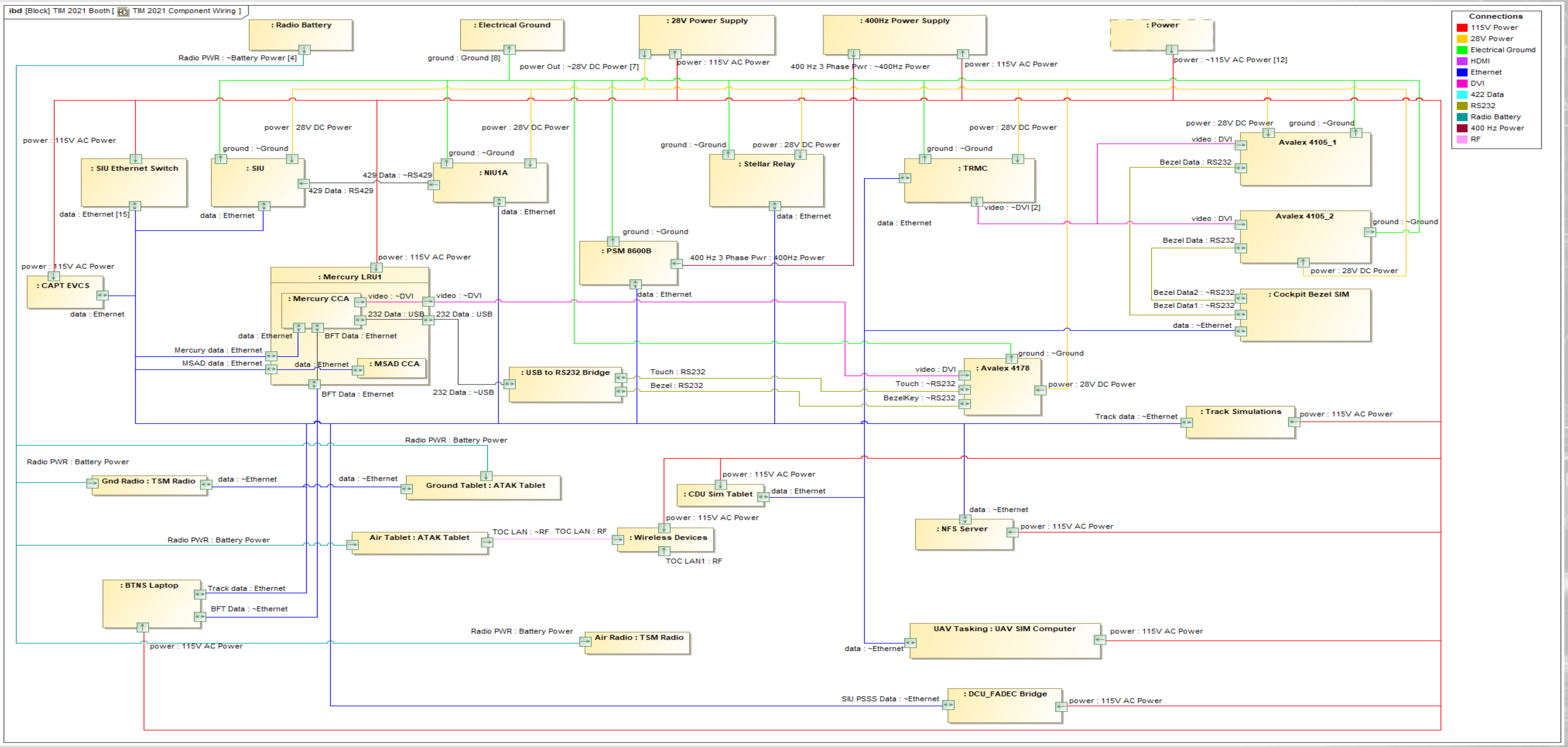




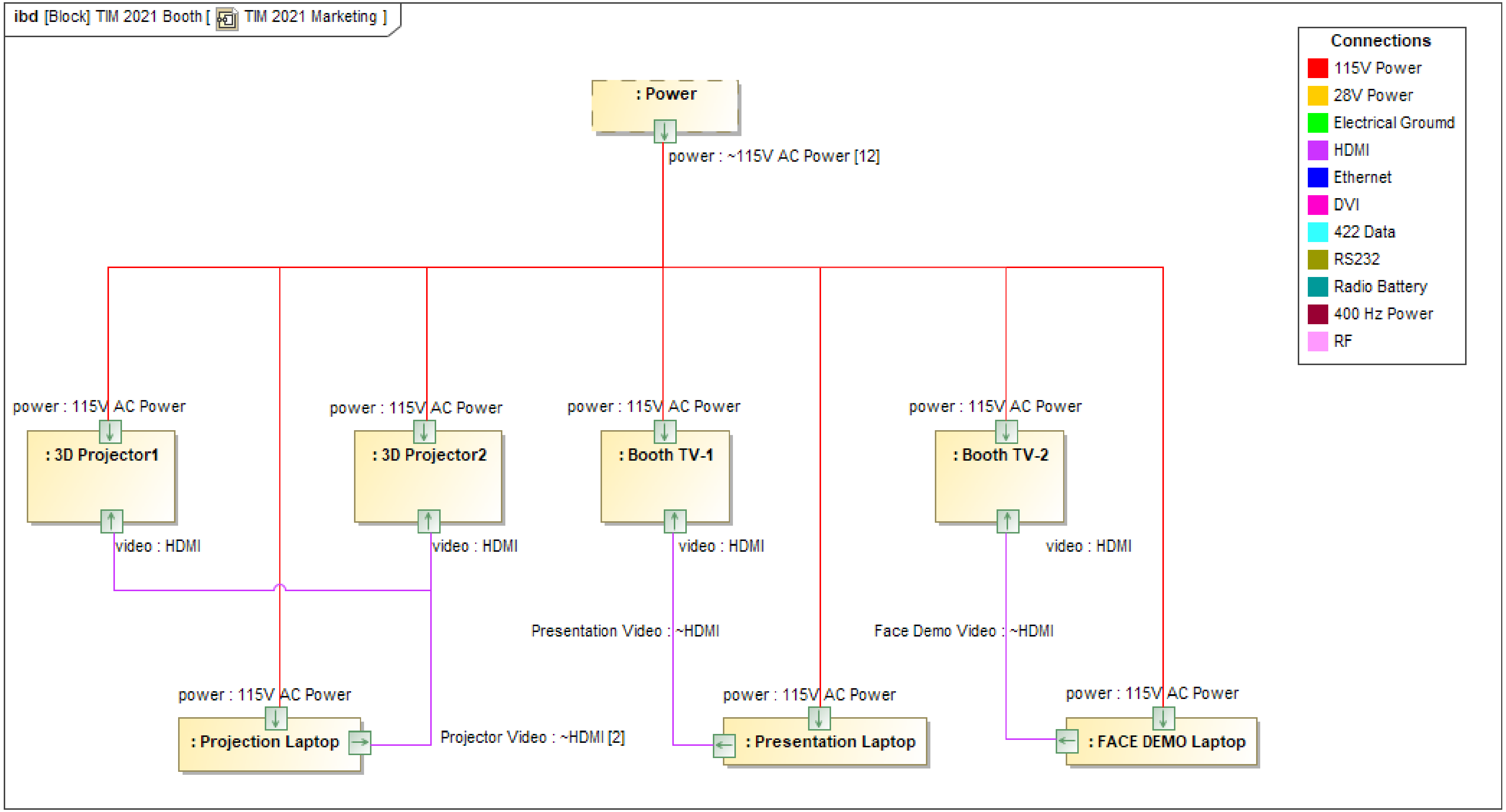




Wiring Diagram



Marketing Wiring Diagram



PROJECTION MAPPING STORYBOARD and Related TALKING POINTS

Flight Display Functions

- To demonstrate integration with an enduring platform, we have brought the UH-60V flight deck software hosted on a TRMC.
- We have integrated the Ansys ARINC-661 CDS to demonstrate how an enduring fleet cockpit can support new capabilities developed to this key interface.
- We have also replaced the 60V displayed with an alternative Avalex display, using a PSSS to convert the Avalex bezel inputs to the 60V Transport.
- Displayed on the ARINC 661 CDS are some indicators driven from eTAWS (an application developed by PMA 209) as well as a systems status and logging application, Arke, developed by PEO Aviation.
- 661 is one of the primary focuses for Open Graphical Interfaces. It enables 3rd parties to write to the displays in a safety sensitive manner. Critical to 3rd party future ecosystem.

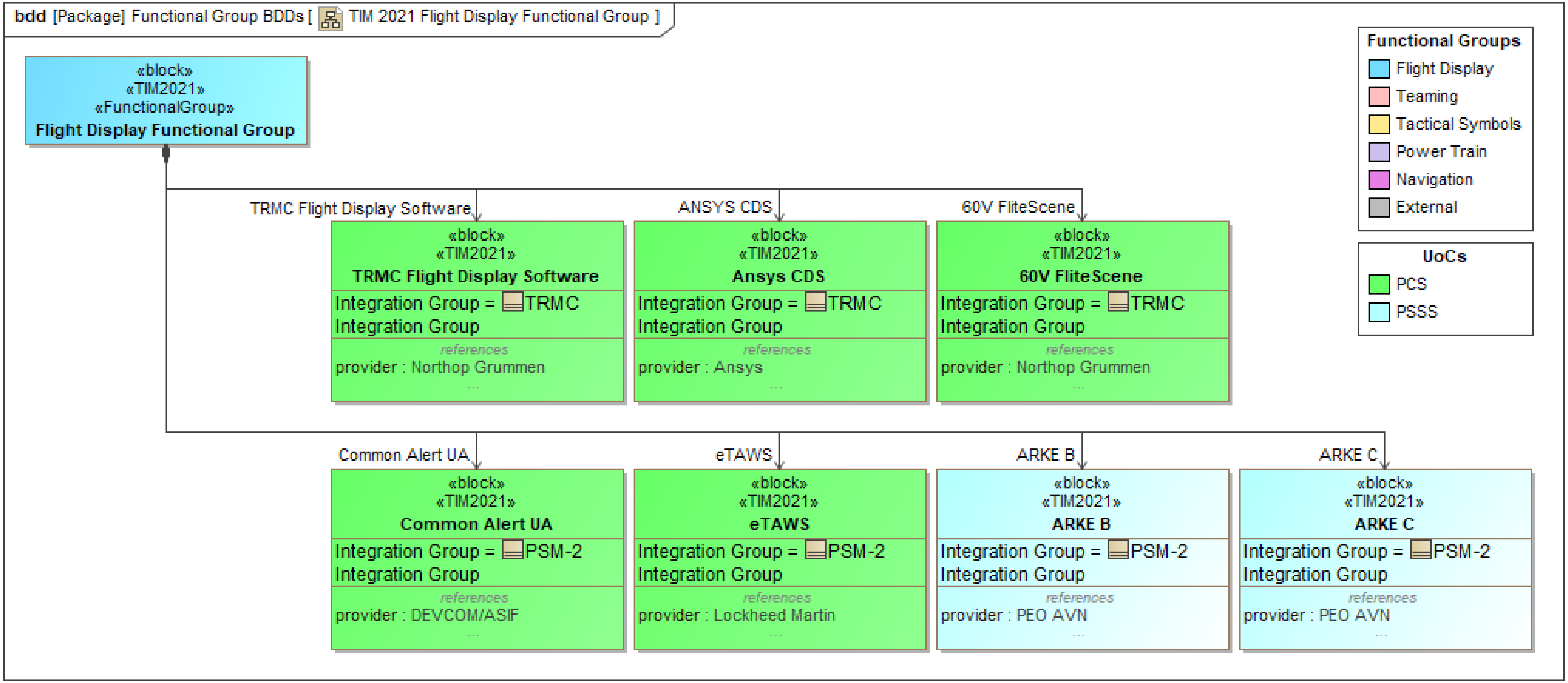
Flight Integration

- Integration of the 60V software with the Ansys CDS had been underway when the Open Systems Demo was initiated.
- The TSS used on the TRMC is the same TSS used in the 60V, other TSS data is transformed in other devices and sent to interface software in the TRMC
- The interface software was written by NGC and provides inputs to the remaining TRMC software that is not provided by this demonstration.

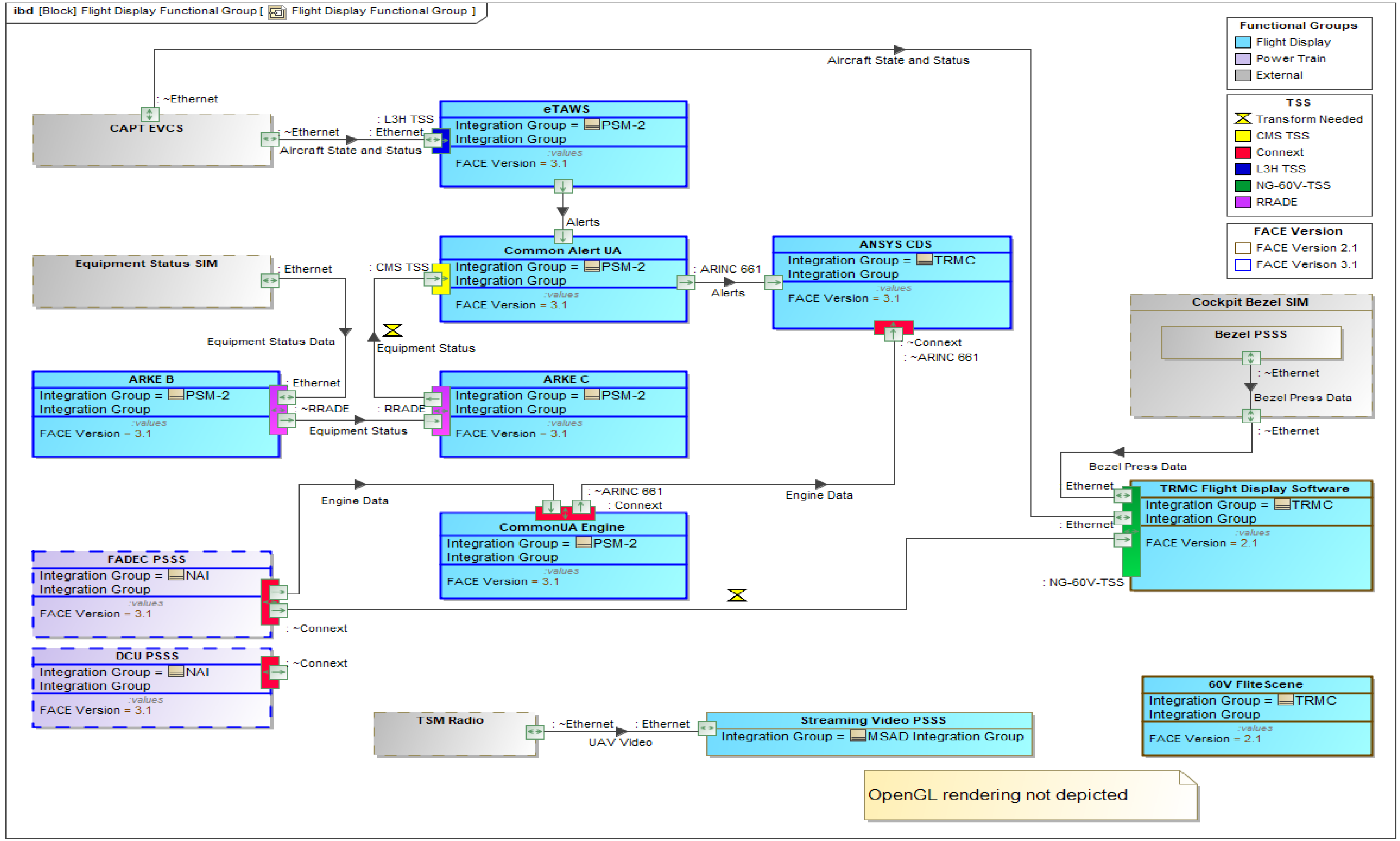
Flight Display Status

- The integration of the 60V flight deck software is assisted by a CDU Simulation. This simulation provides CDU functions according to the 60V software interfaces. Development of a common interface between the CAPT Software and the flight deck software could have avoided this workaround. As it is, this is a good representation of how multiple test utilities (CAPT and the CDU SIM) can be brought together to demonstrate functionality.
- The integration of the bezel inputs from the new Avalex display was performed in a separate computer than the TRMC. This was completed out of expediency.

Flight Display Functions



Flight Display Data Flow



Power Train Functions

- Also displayed on the ARINC 661 CDS is a display of Engine Data presented by a configurable User Application as proposed in one of the white papers presented by the DEVCOM team at this TIM.
- To exercise the abilities of a separate mission computer interfacing to a data bus, the CAPT-E simulation data was routed to an ARINC 429 bus. This bus simulates the traditional 60V fuel and power train data, as well as data from an ITEP engine.
- The ITEP Engine data is transformed into data for display by the 60V flight deck software, as well as being displayed on the configurable UA using ARINC-661.

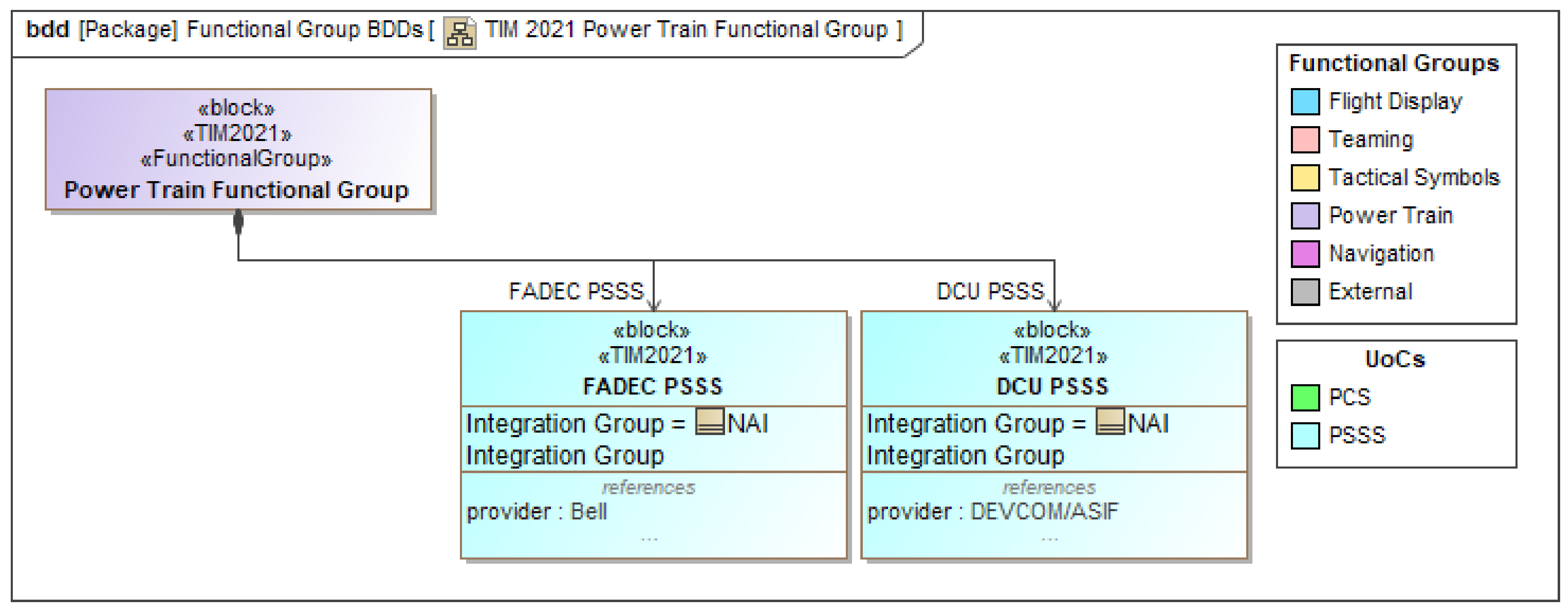
Power Train Integration

- The integration of DCU and ITEP engine functions is demonstrated in the TES, RTI and NAI booths as part of another integration on a different processor (PPC instead of ARM).
- In this integration, the TSS was replaced by the RTI DDS and was bridged over to the 60V transport through an adapter running in the MSAD platform.
- This TSS Conversion represents one way of supporting multiple TSS implementations and is necessary when two platforms do not have native support of the other transport.
- NOTE: in this instance we could have had either TSS run on the other device, but chose to use this method out of expediency and to demonstrate the capability.

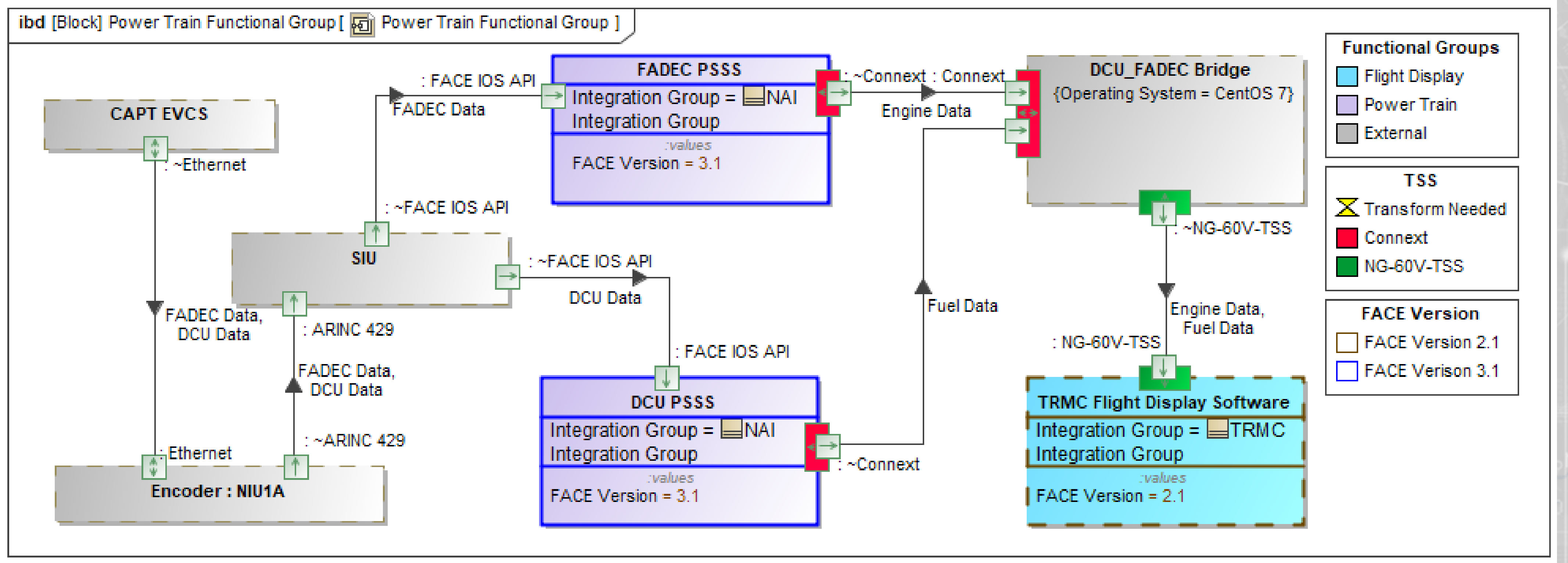
Power Train Status

- The ITEP Engine PSSS is currently only representing one ITEP engine, so that data is duplicated to represent to engines to the flight deck.
- The ITEP Component is currently sending a small portion of the data that could be presented.
- The display of the ITEP Data was built to represent the component and has not been developed to a proper PVI for this type of engine.

Power Train Functions



Power Train Data Flow



Navigation Functions

- The Flight Plan is demonstrated with an integration of the Collins MFMS FACE Conformant UoC.
- The Collins Avoidance Re-Router FACE Conformant UoC is also included, integrated with a threat filter application that listens to the Track Correlator
- The Collins ARR and MFMS software UoCs are both conformant to the FACE Technical Standard 2.1.

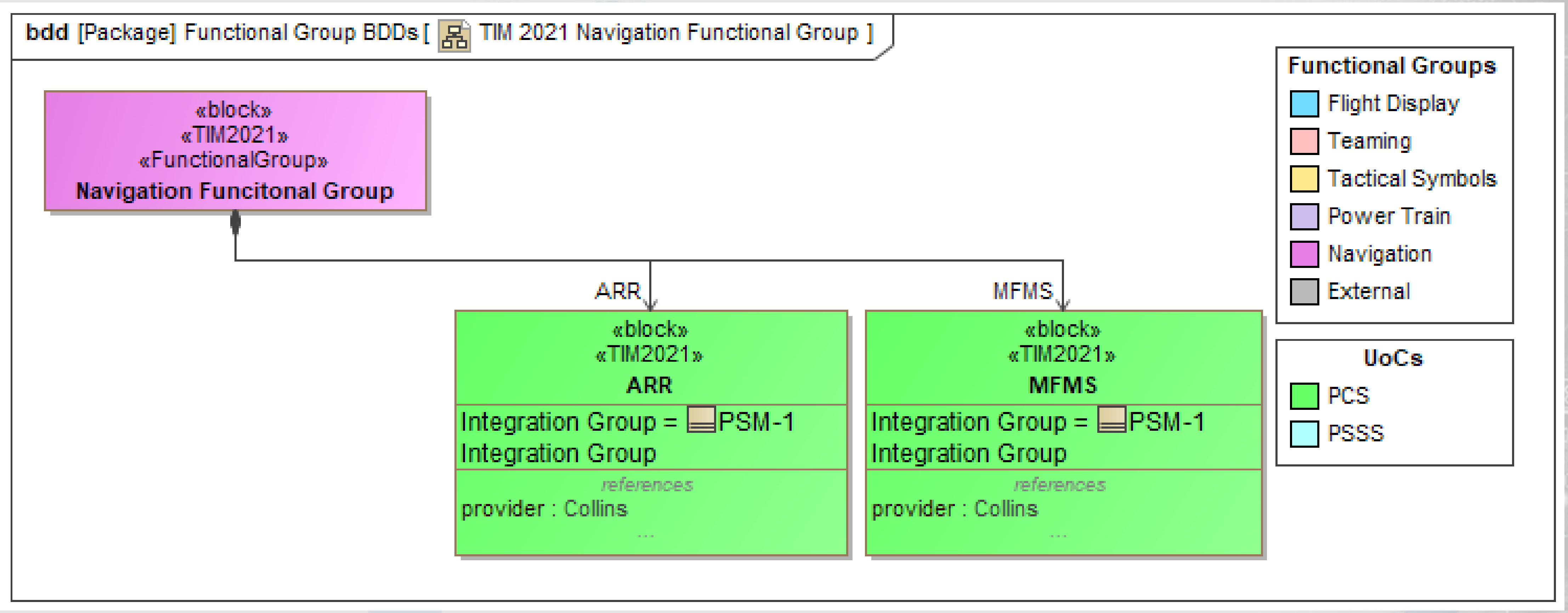
Navigation Integration

- A plan to replace the TSS with another TSS in the demonstration was changed to reduce the work in completing the integration. Like the TRMC software, a large number of connections would make the integration difficult without a well developed system model that could feed a TSS code and configuration generator.
- The conversion of Flight Plan data into the TRMC software was the most complex conversion performed in this demonstration. Both Collins and NGC put in effort to get the conversion implemented.
- A Threat Filter TSS transform was developed as an application that runs on the Stellar Relay hardware. This transform listens to the Corrlated Track Data and looks for enemy units, identifies them as threats, and sends threat messages to the ARR.

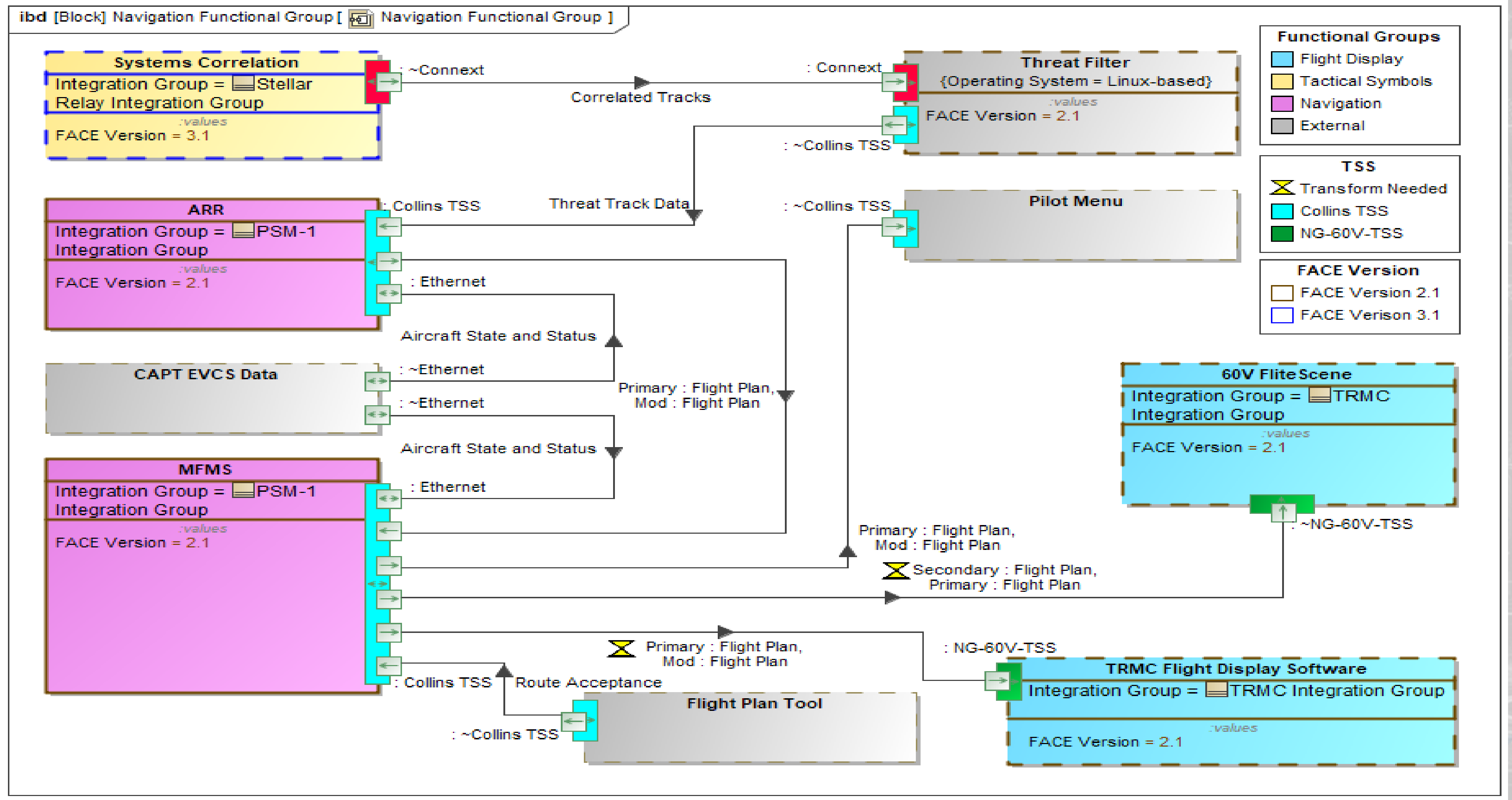
Navigation Status

- The MFMS Interfaces are not all connected to the Flight Display software. The integration is rather complex and the approach was to experiment and document how this could be completed.
- Entry of Flight Plans and acceptance of a change are completed on a tablet, rather than through the CDU interface.
- Note: Even with two applications supporting the same high level key interface (Flight Plan) there can be significant effort to integrate without alignment to further details within that interface.

Navigation Functions



Navigation Data Flow



Teaming Functions

- To represent the aircraft interfacing with a UAV at LOI 4, software developed by PM EUAS was combined with software developed by UH PO as part of the CMS program.
- This Teaming Display represents several aspects of a Common Operating Picture developed as a set of configurable UoCs using data modeled interfaces.

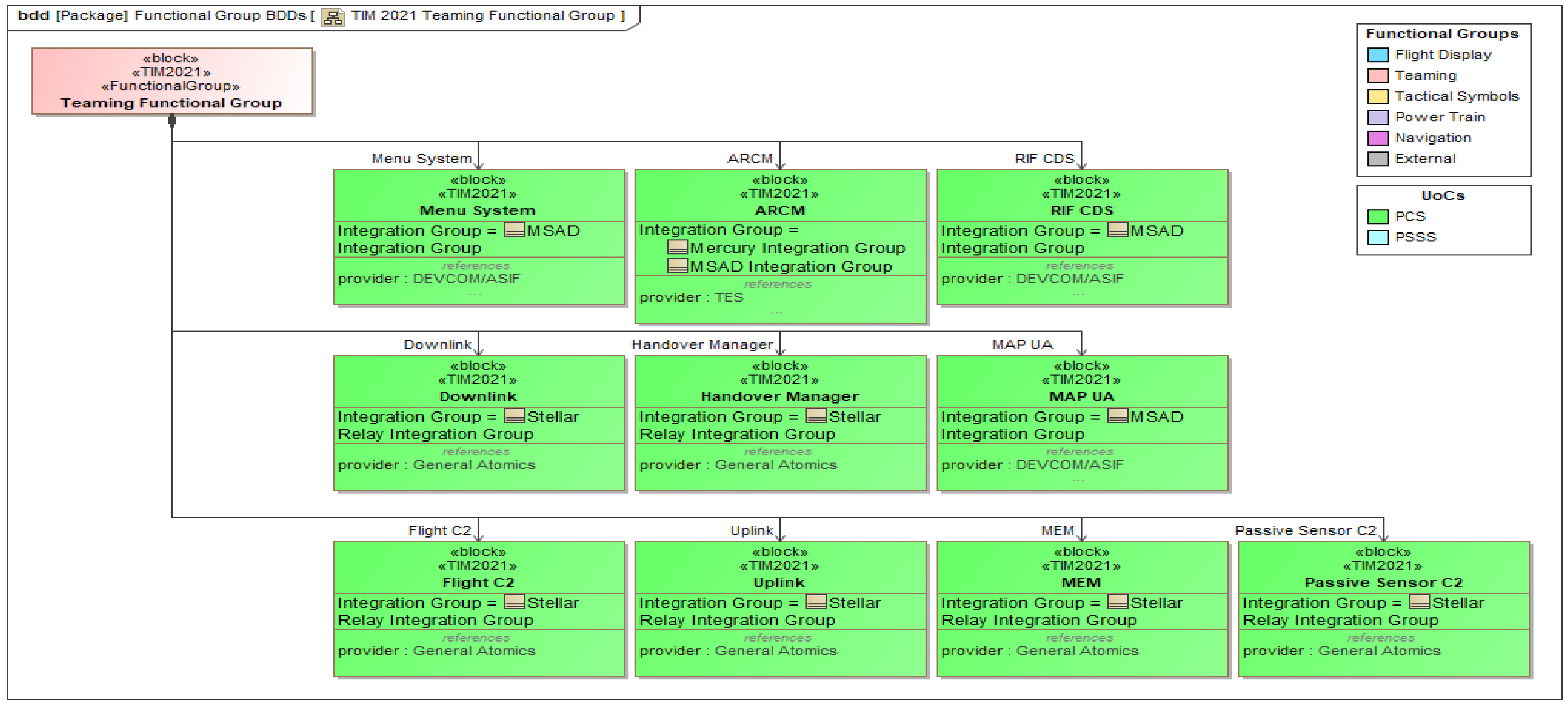
Teaming Integration

- The Teaming Management functions provided by General Atomics are integrated using the multiple TSS Proxy approach presented by the DEVCOM team in this TIM. This proxy was developed by Skayl.
- The CMS/RIF applications are presented in a mix of FACE Technical Standard editions. Both edition 2.1 and edition 3.0 are represented here with edition transforms occurring seamlessly in the TSS implementation.
- The Sensor Slewing operation is provided by a separate TSS Transform that accepts the geo-refenced event messages from the Menu System (using the RTI TSS) and converts that into a Sensor Command message (using the EUAS TSS). Additional commands can be built using the same transform and further modification of the Menu System configuration.

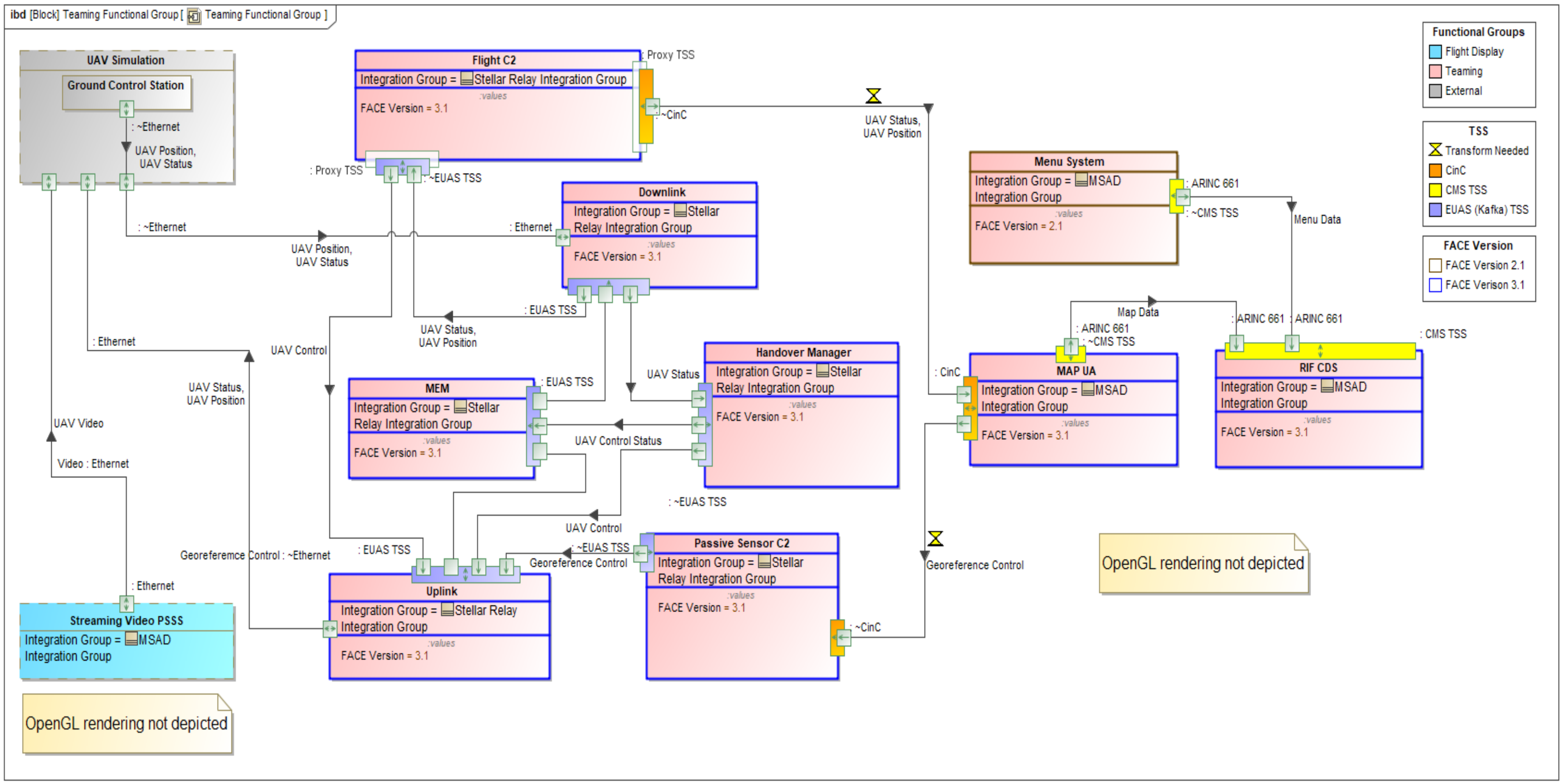
Teaming Status

- Limited LOI 4 functions are integrated. Additional functions can be rapidly added.
- User interface for some of the advanced functions may require integration of planned features to the configurable menu system.

Teaming Functions



Teaming Data Flow



Tactical Functions

- Aircraft connectivity to multiple networks and correlation of track data into a coherent display is an important part of providing a common operating picture in the current and future battlespace.
- ADS-B software from LMCO is combined with the IDM software into a correlator provided by BAE. Additional messages for the ATAK devices and Link-16 are brought into the correlator, which presents correlated symbols to the Maps.
- The IDM Software Application was ported to the Intel i7 processor and implemented on a reorientation of the AMCS.
- Included in this demonstration is an ATAK device using a wireless on-board network to represent passengers and a second ATAK coupled with a TSM radio representing a ground soldier.

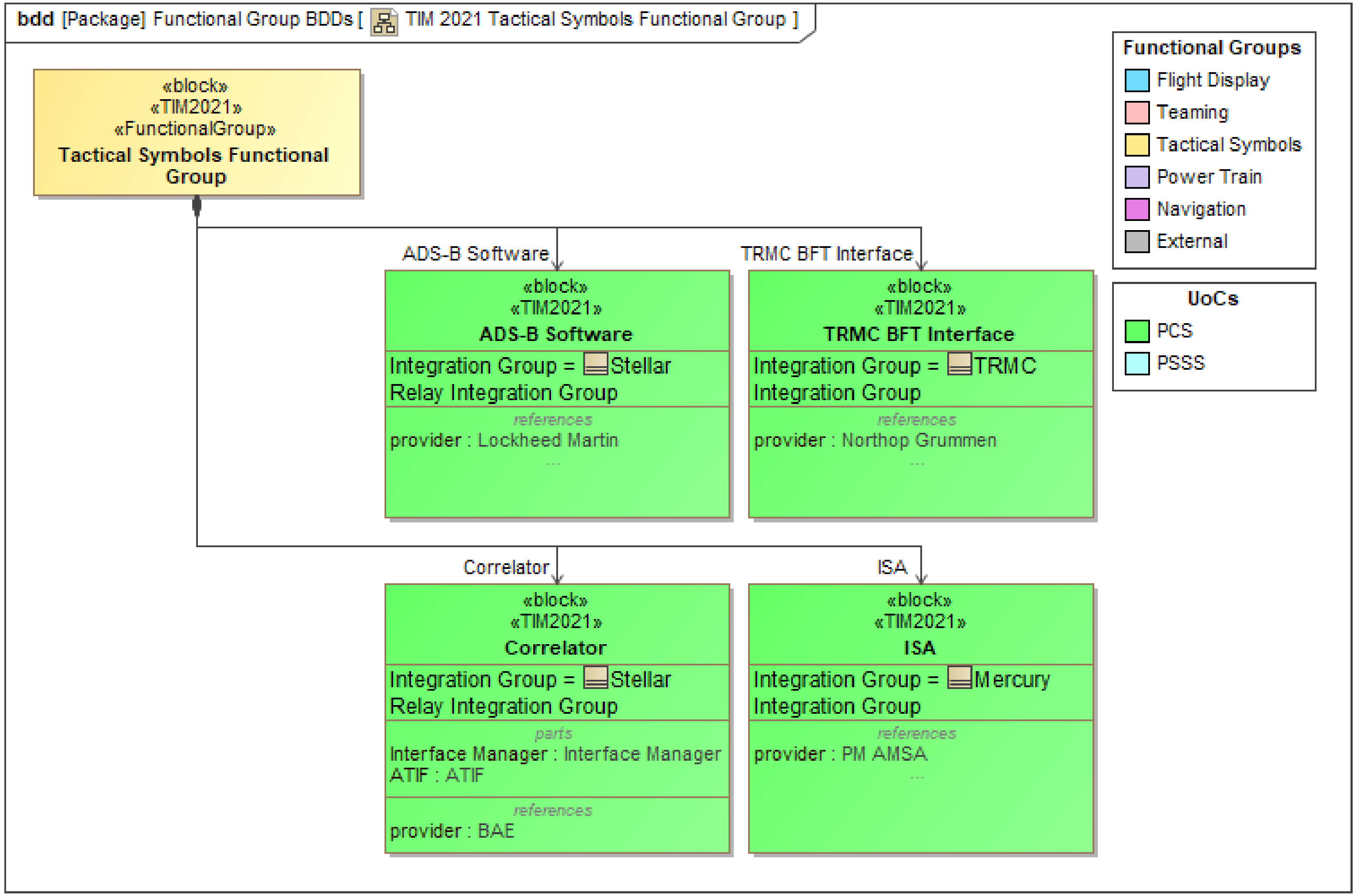
Tactical Integration

- The BAE Correlator and LMCO ADS-B software was developed to use a FACE Technical Standard edition 2.1 interface. In this integration we show that a FACE technical Standard edition 3.x transport can link to these applications and support multiple TSS connections.
- The Correlator receives messages on one TSS, and sends messages on two others. One of the TSS implementations typically uses a FACE 2.1 interface.
- The Correlator also receives messages from Link-16, VMF, and CoT using the native radio format. The code was not modified to utilize the FACE IO API, and is shown as a method for integration of legacy software into a FACE Computing Environment.
- The VMF data is suppled by the IDM Software Application running on the Mercury Mission Systems device. This software supports the same CORBA interface to the 60V Flight Deck software, as well as providing a TOC LAN connection to the ATAK devices and the correlator.

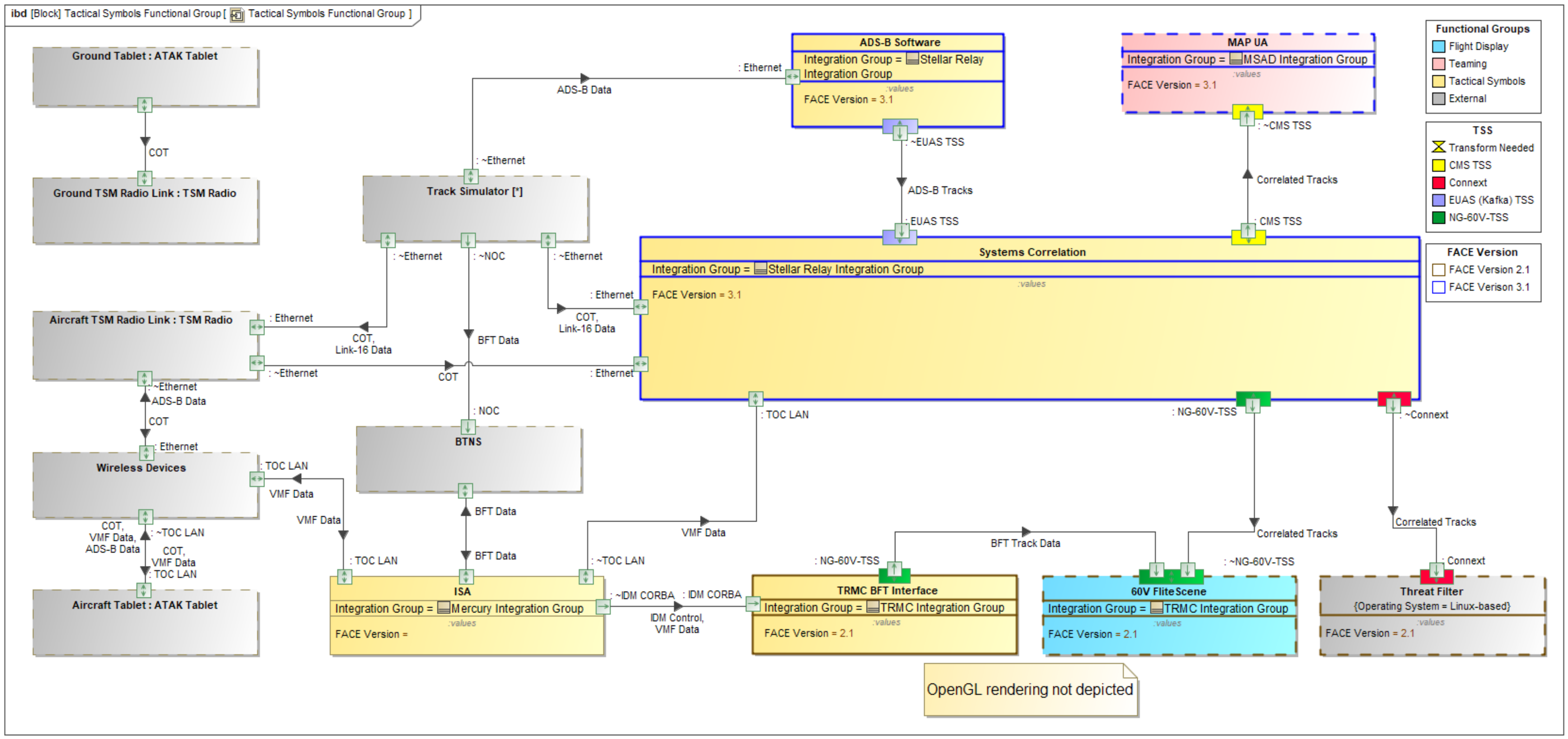
Tactical Status

- A realistic extension of this demonstration is the inclusion of actual BFT, Link-16, and IFF radios.
- The current state of the 60V software currently results in duplicate VMF tracks displayed on the cockpit displays. A modification to the data flows in the 60V software can eliminate these duplicate symbols if this integration were to be brought to the enduring aircraft.

Tactical Symbols Functions



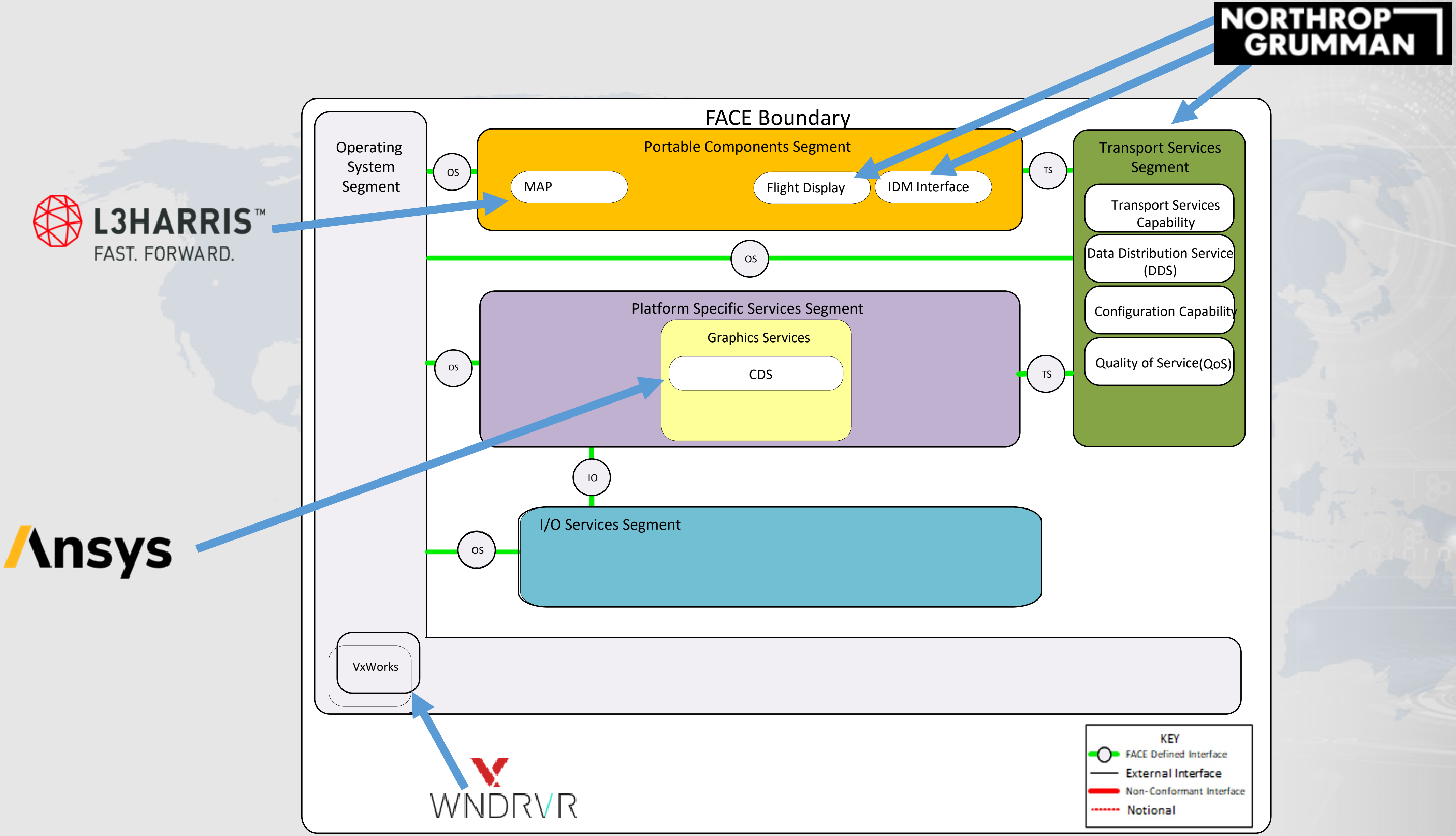
Tactical Data Flow



TRMC Integration

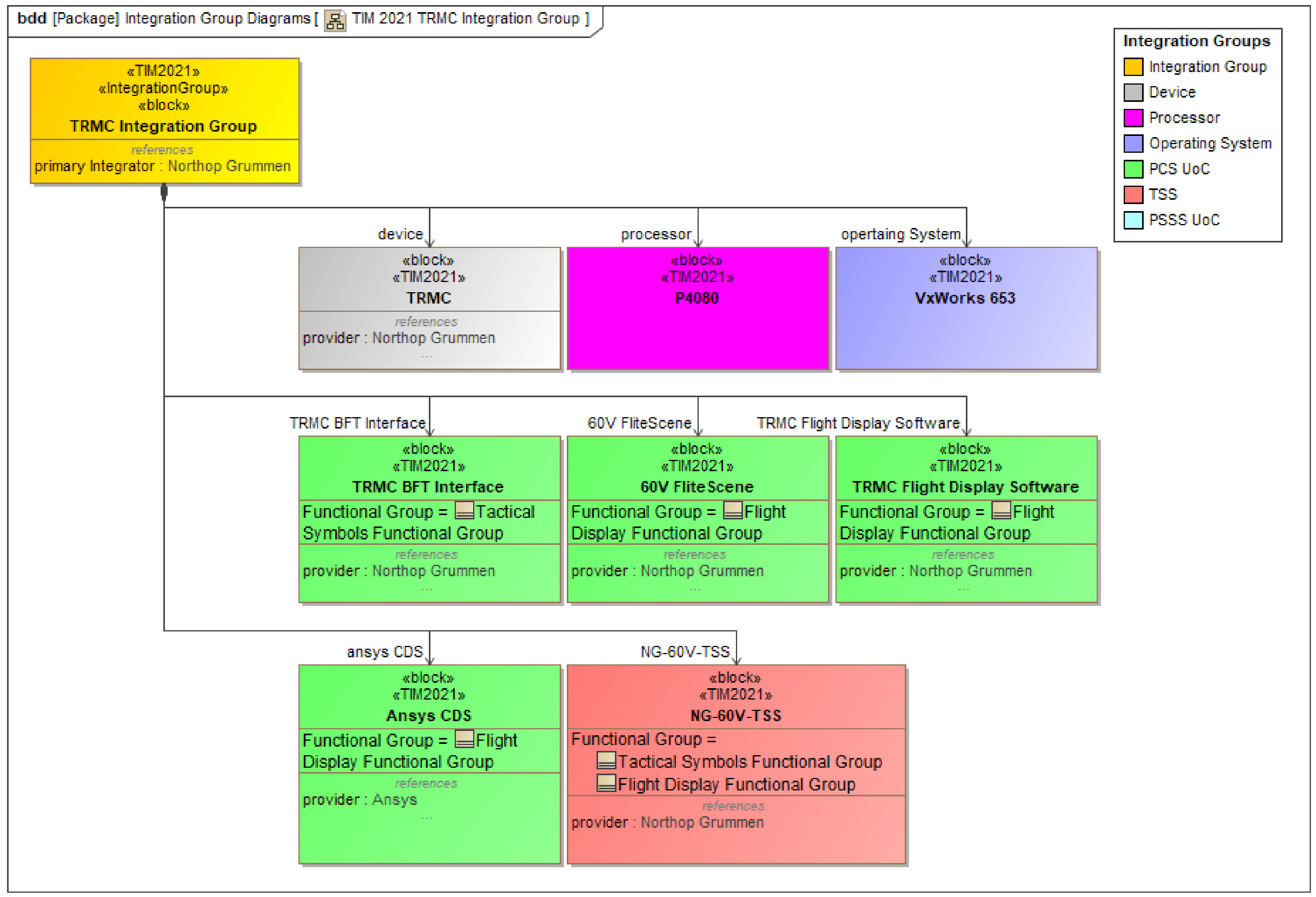
- The TRMC was developed as a reusable mission computer prior to the development of the HOST, SOSA, and other recent hardware MOSA standards.
- TRMCs have been used by the Nave and Army on multiple aircraft.
- In this demonstration, the integration on the TRMC was performed by NGC and represents the current 60V software load with the addition of the Ansys CDS for display of ARINC-661 capabilities.
- The TRMC uses a T4080 processor and runs the VX Works Operating system.

TRMC Face Diagram



TRMC Integration

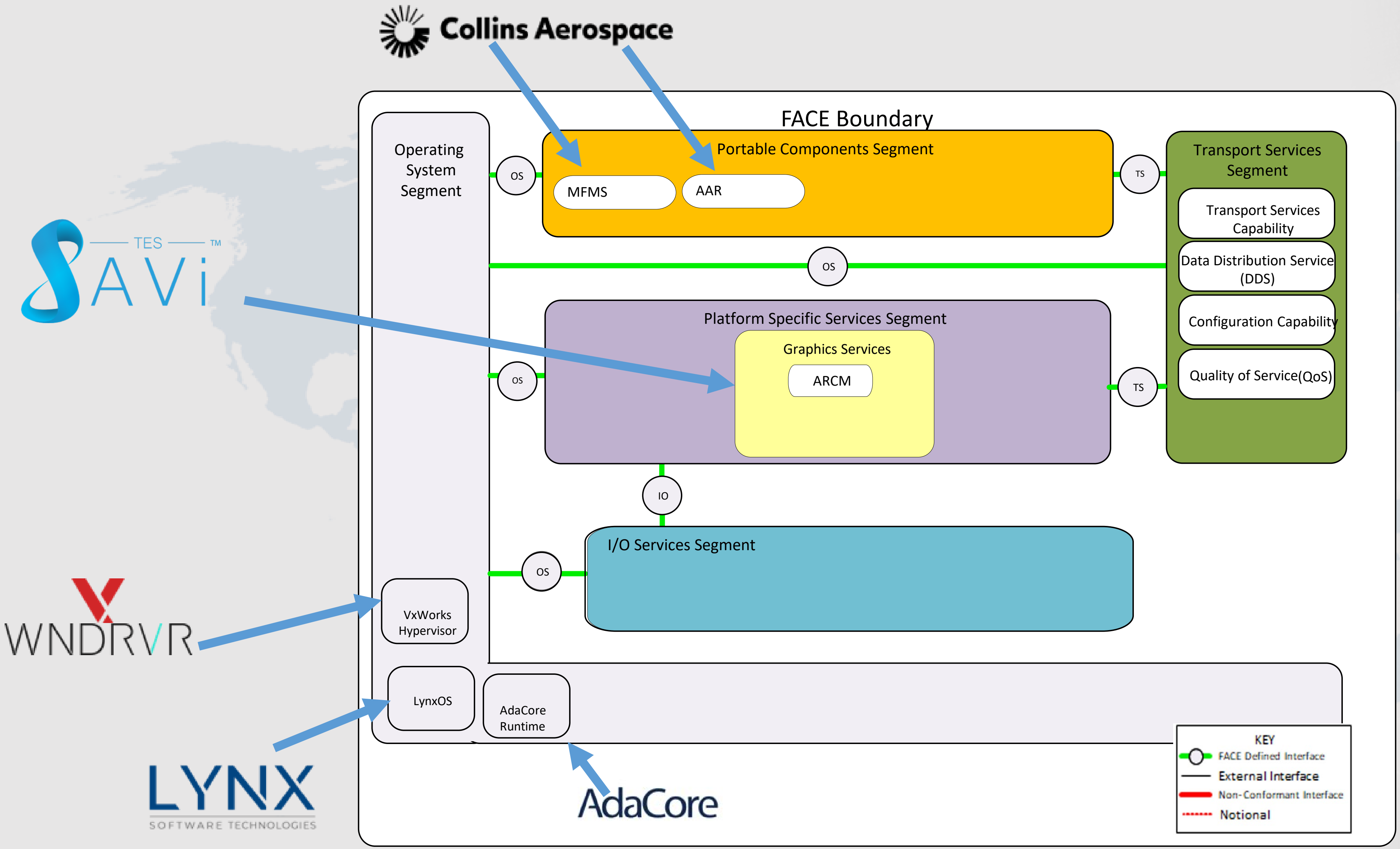
Weekly Meeting: TRMC/NG Meeting, Thursday @10:00 Central



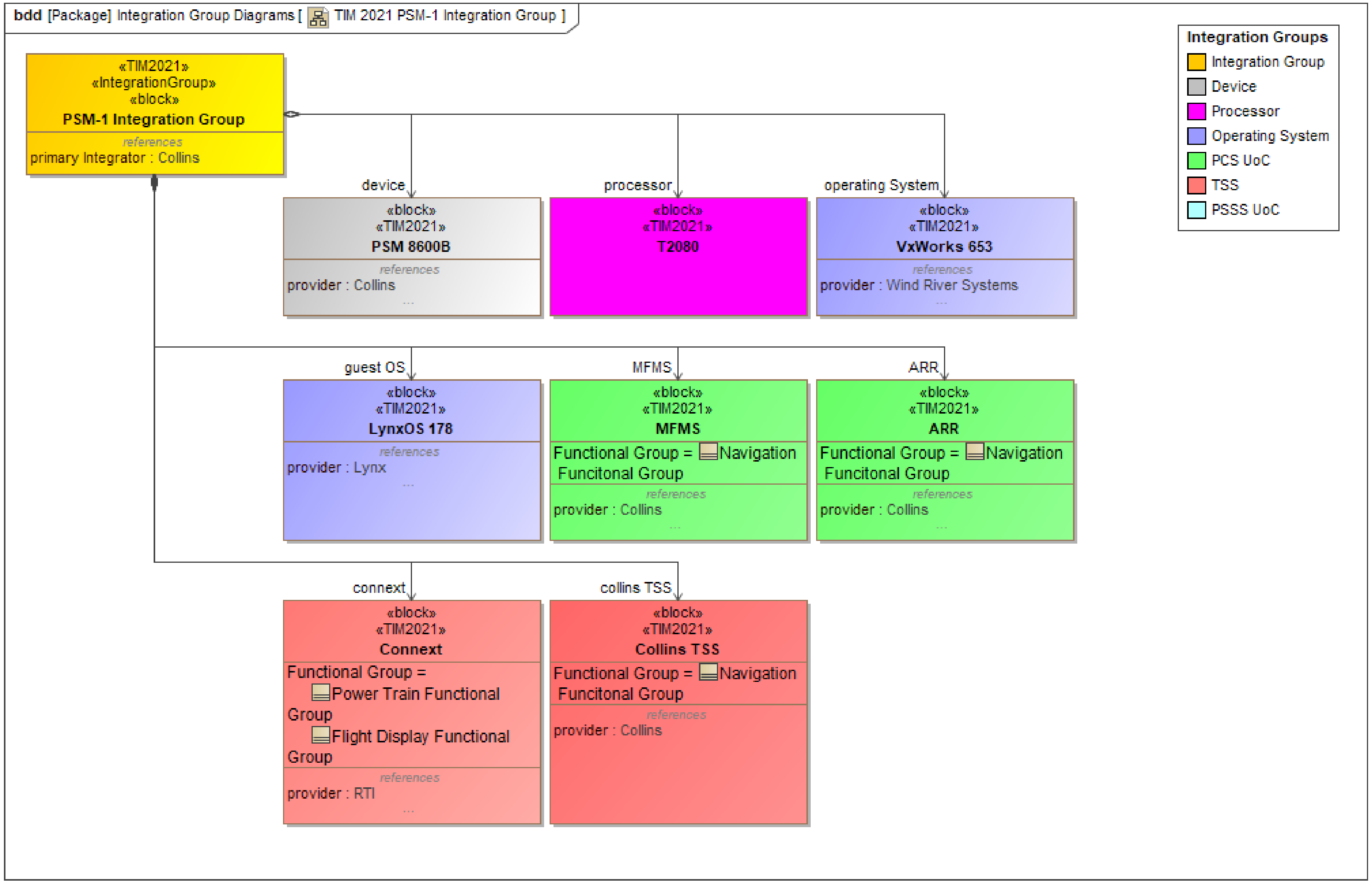
PSM Integration

- The PSM presented in this demonstration represents an upgrade to the switch module used on the CH-47F. This version of the PSM was a major compoent of the 2018 TIM. During that TIM several functions were demonstrated in multiple partitions, showcasing the capability of this hardware.
- The PSM uses a P2080 processor and runs the VX Works as a hypervisor. In this demonstration, one LynxOS guests OS is using two cores while anoter two cores are available for other guests.
- This PSM could serve as the switch in this demonstration, as well as provide more processing power than we are demonstrating.

PSM Face Diagram



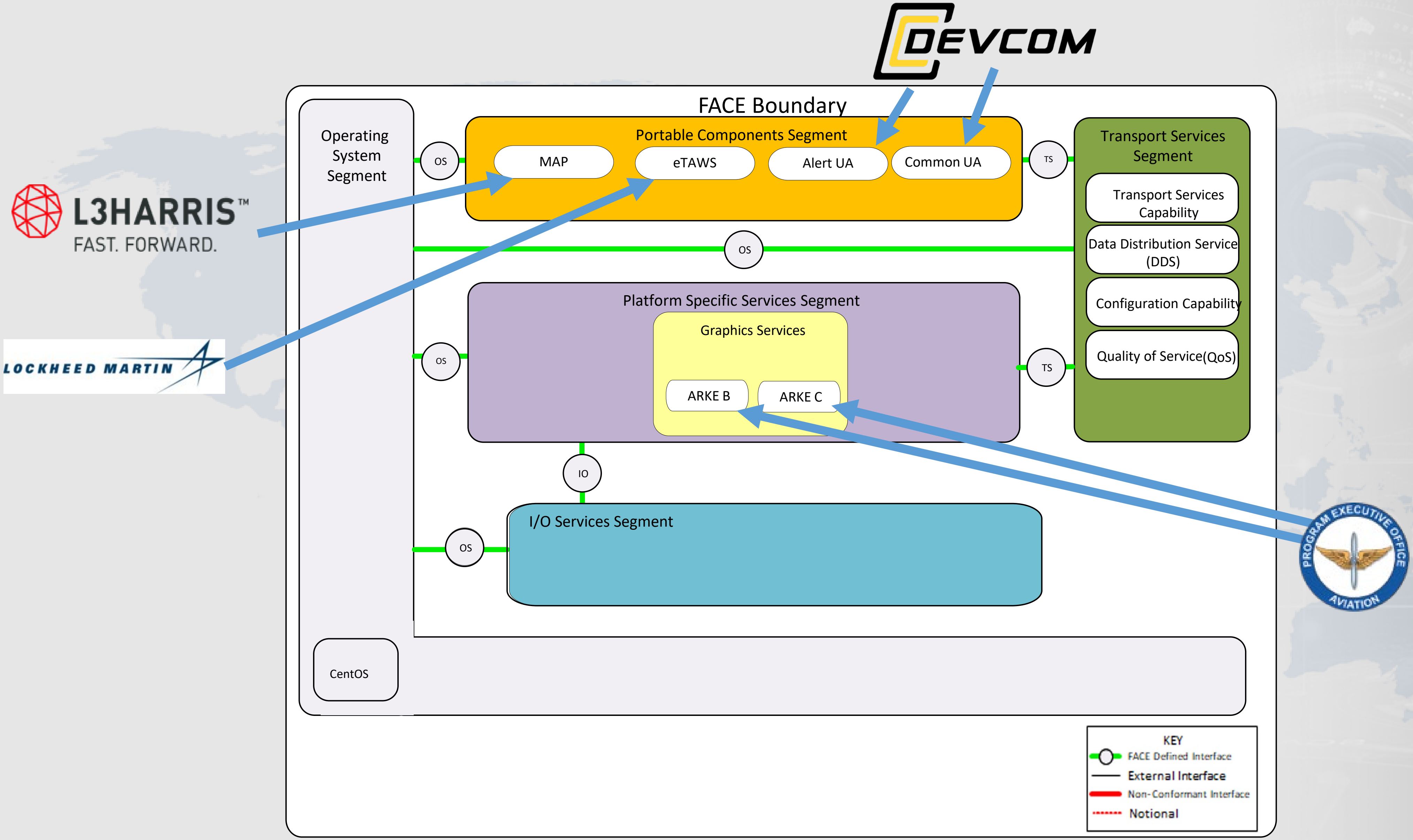
PSM-1 Integration



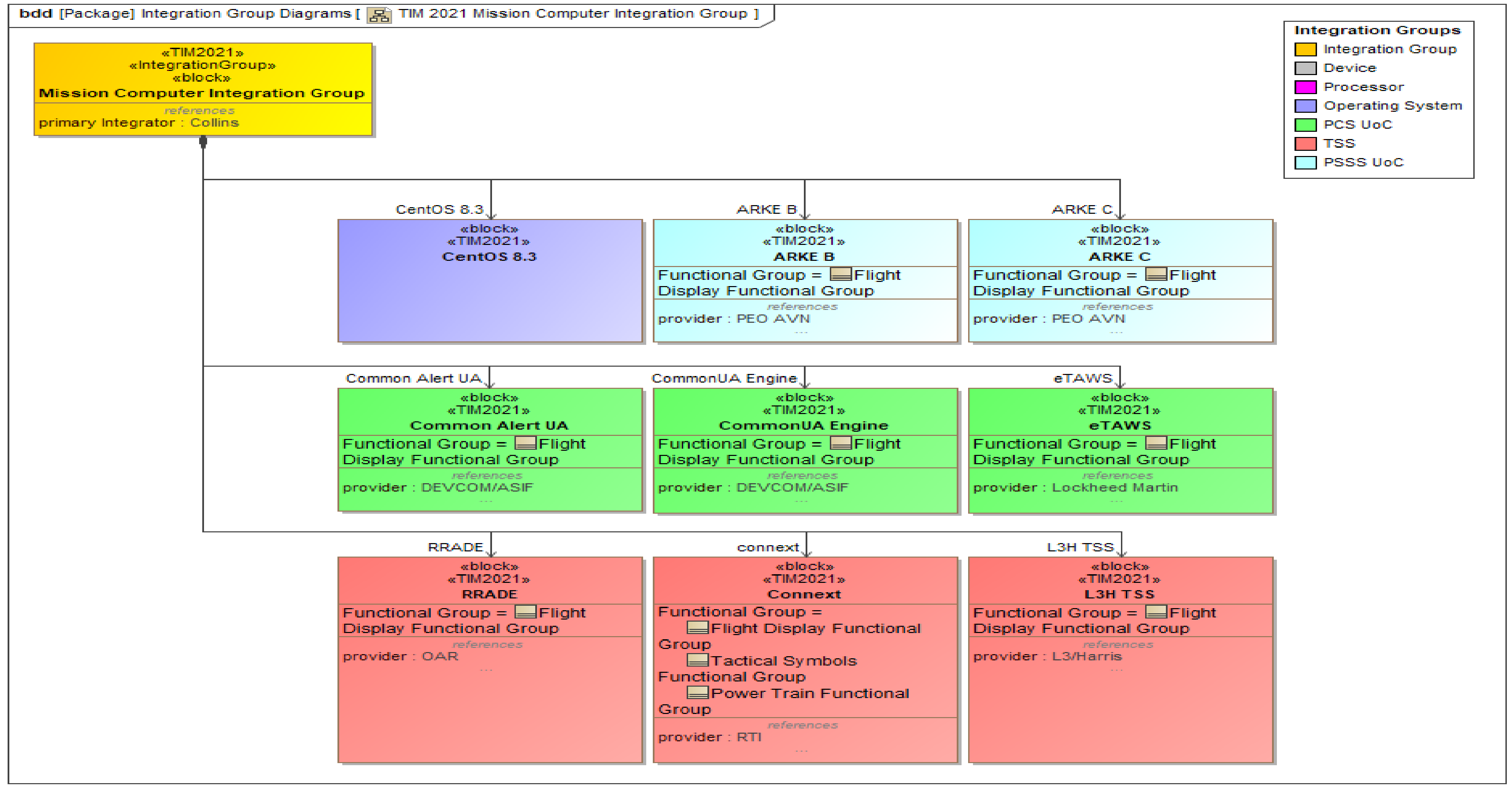
Mission Computer Integration

- The collection of software in the Mission Computer Integration was targeted for a second guest in the PSM.
- The software development and port to LynxOS was delayed to a point where a delivery on CentOS was implemented as a mitigation effort.
- These components are now running on the MSAD card in the Mercury Mission Systems device.
- As a lesson learned, development for multiple distributed vendors to one piece of hardware requires more advanced planning and aggressive procurement of developmental licenses. Remote development tools can provide a solution and should be pursued for future integration events.

Mission Computer Diagram Face Diagram



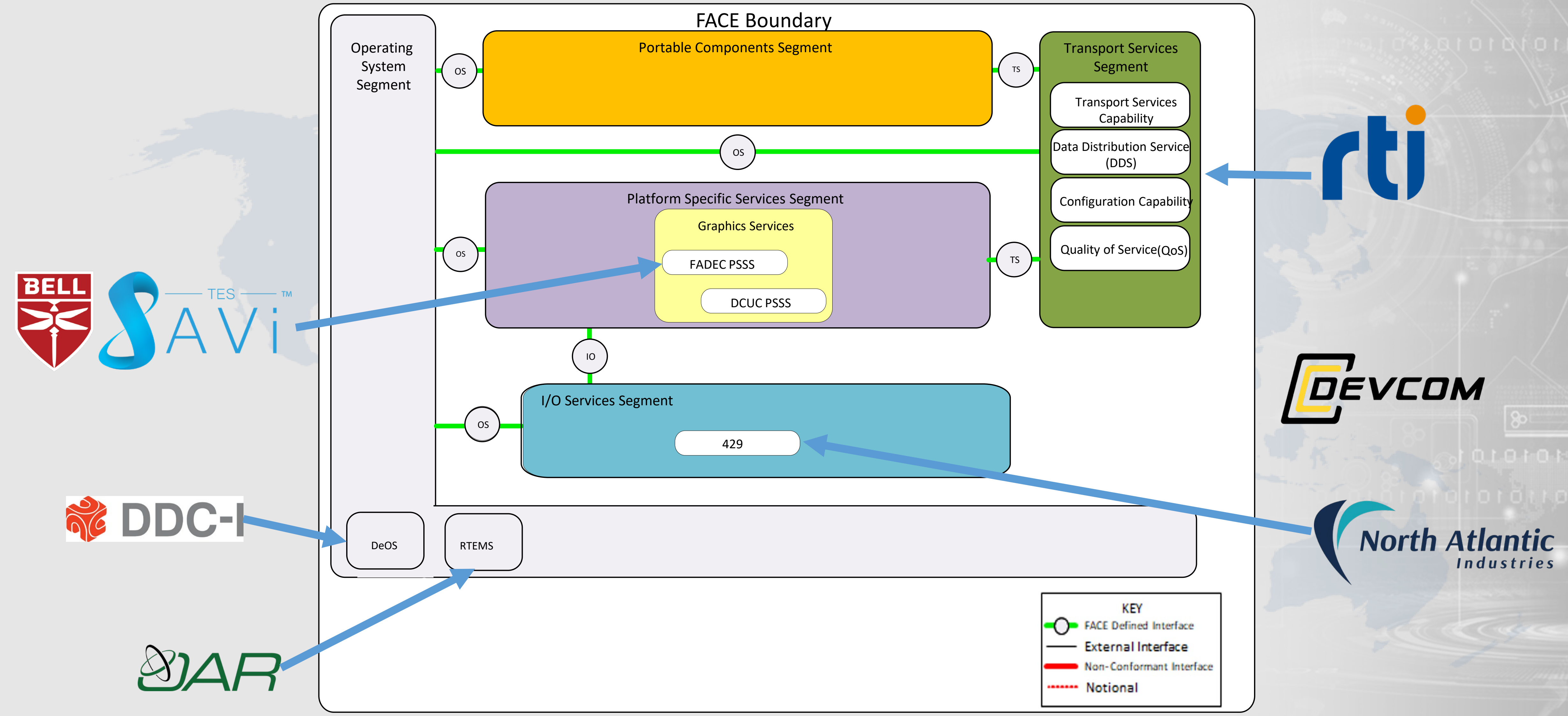
Mission Computer Integration



SIU Integration

- The SIU provided by NAI represents an up-to-date take on the HOST/SOSA approach to hardware solutions.
- This version is using a quad core ARM processor using the FACE Conformant DEOS and RTEMS operating system. Other processing cards are available, and this processing card is also supported by VxWorks.
- After this device was selected for the TIM, a Switch card and cable was sent to add the Switch capabilities to this device. This demonstrates the capabilities available with these MOSA devices.

SIU FACE Diagram

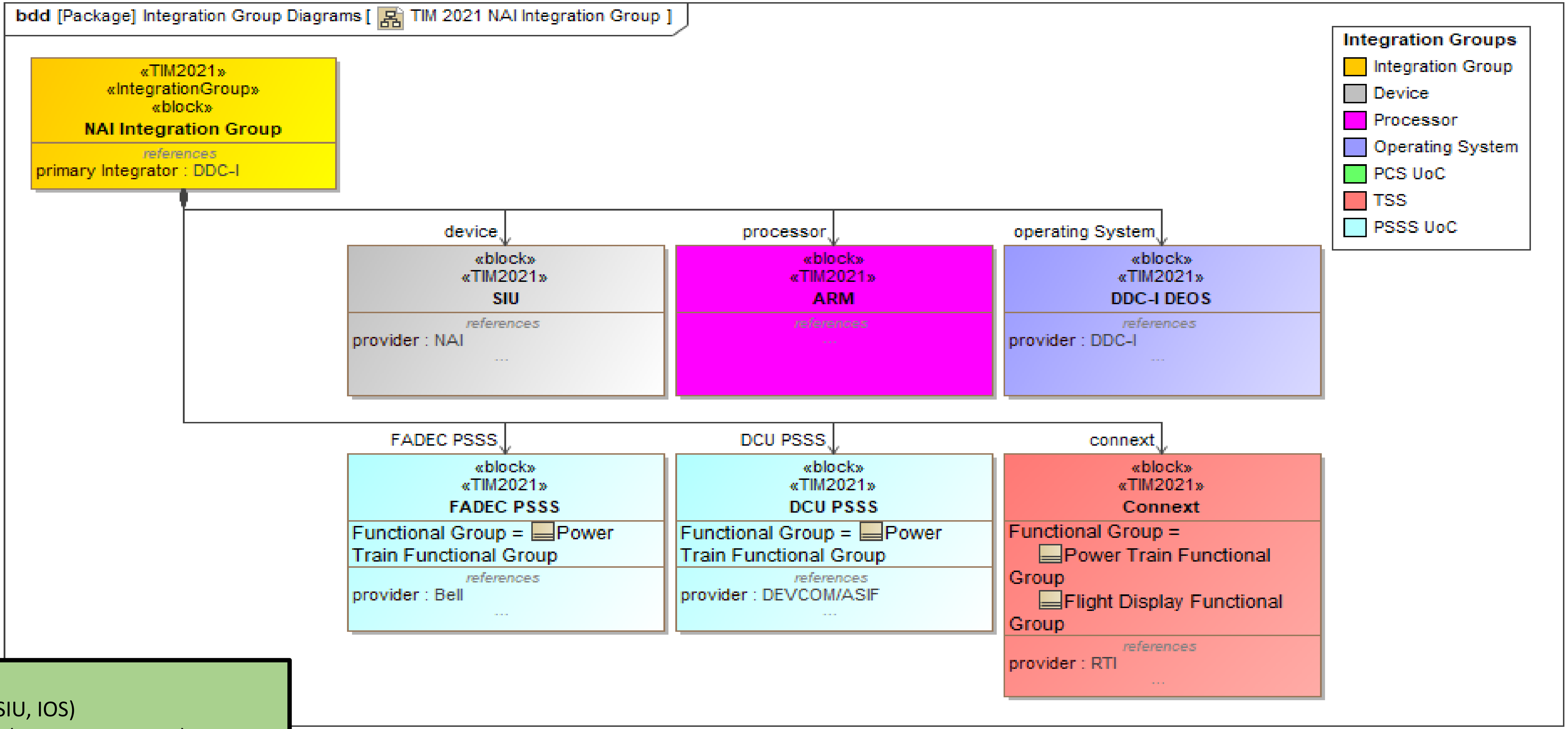


U.S. ARMY

SIU Integration

Weekly Meeting: NAI Meeting, Thursday @ 3:30 Central

PROGRAM EXECUTIVE OFFICE AVIATION



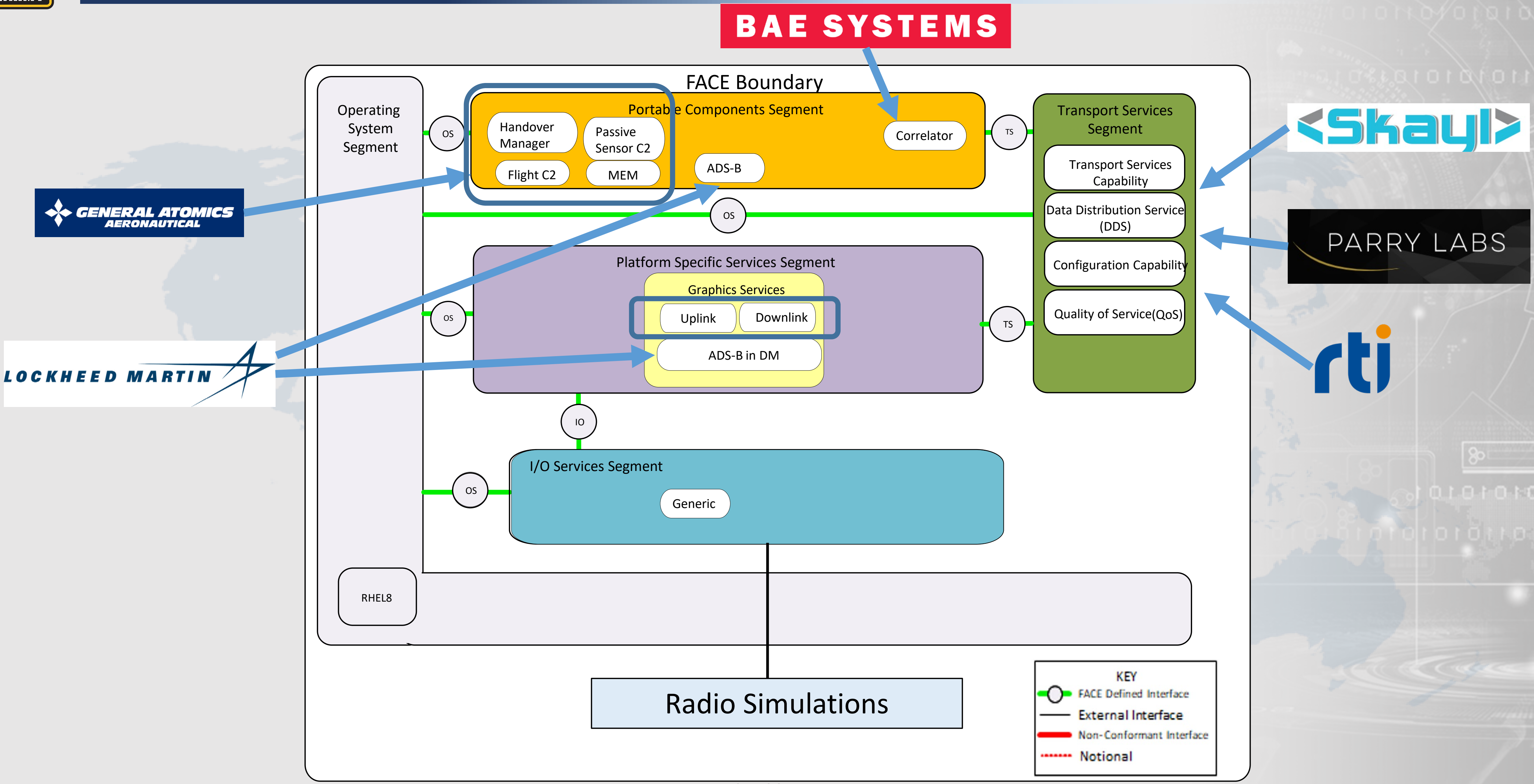
Entities:

- NAI (SIU, IOS)
- DDC-I (DEOS, Integration)
- RTI (Connext TSS)
- BellFlight (FADEC PSSS)
- S3I ASIF (DCU PSSS)

Stellar Relay Integration

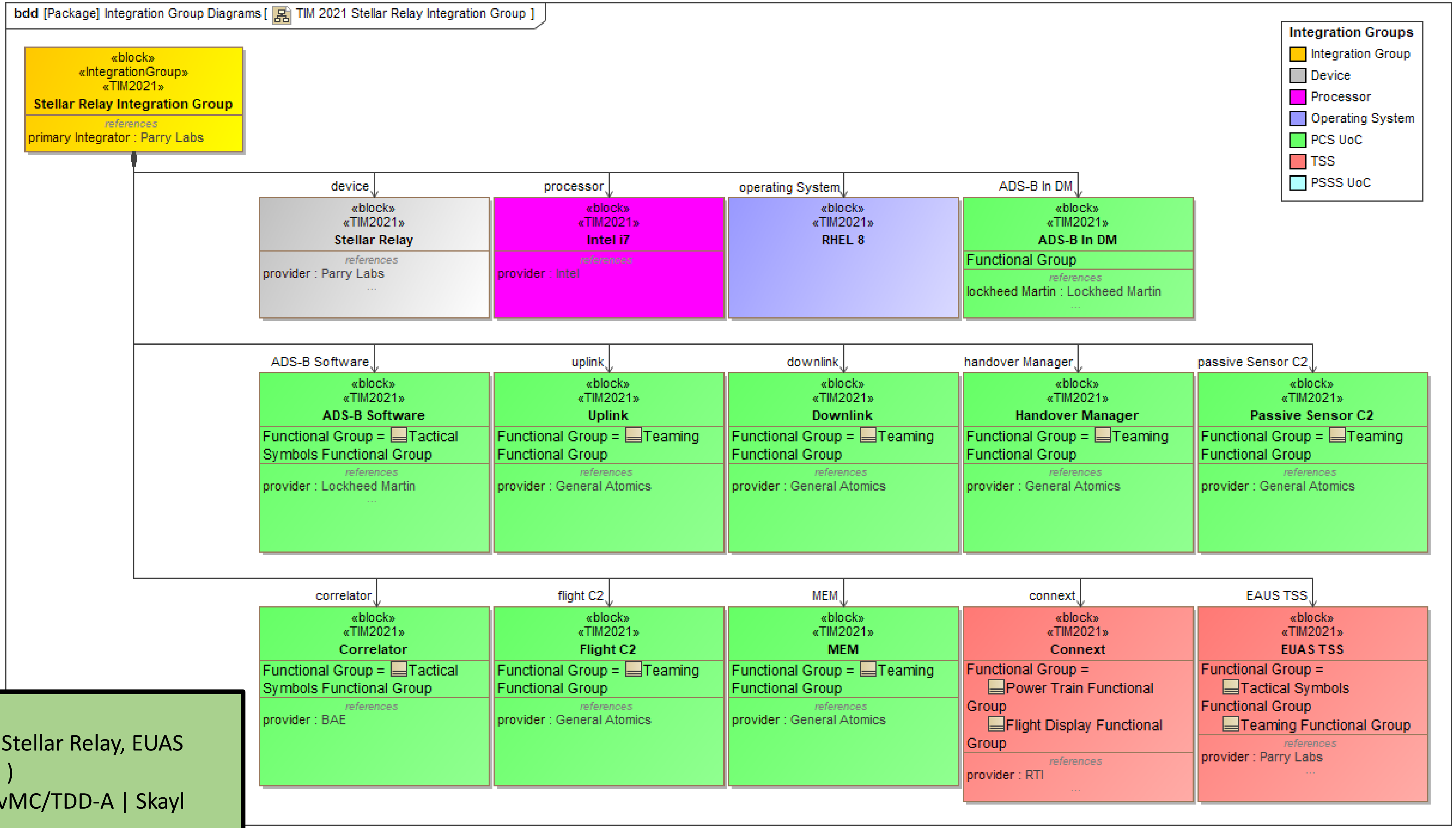
- This Stellar Relay CCM is the same mission computing capability used on the Grey Eagle for PM EUAS. It represents a lighter computing environment capable of processing low criticality functions.
- It is using a recent generation of the Intel i7 processor and runs the Red Hat Linux operating system using Docker Containers for software separation and portability.
- Containers are a recent addition in the open source world and provide advantages when developing software for deployment to other devices and operating systems.
- Container use in avionics systems still has a ways to go. Current implementations utilize code that cannot achieve flight critical airworthiness. The FACE consortium should consider providing container guidance and potential requirements for future FACE Technical Standard editions. This can provide a path to Container functionality in flight critical software.

Stellar Relay FACE Diagram



Stellar Relay Integration

Weekly Meeting: Teaming and Tactical Meetings, Friday at 1:00 and 2:00 central

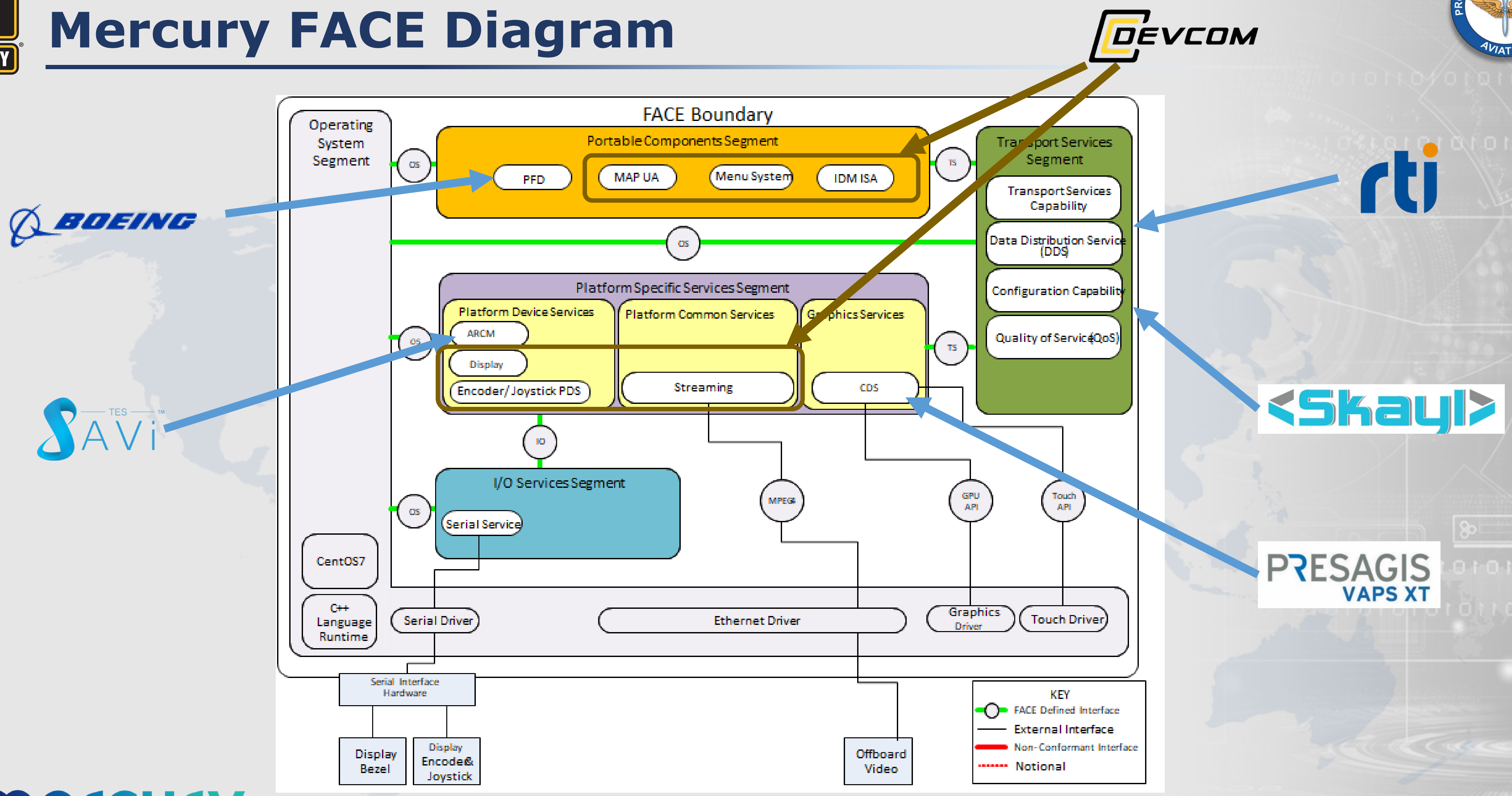


Entities:
- Parry Labs (Stellar Relay, EUAS TSS (Kafka))
- DEVCOM AvMC/TDD-A | Skayl (CiNC TSS)
- RTI (Connext TSS)
- LMCO (ADS-B)
- General Automics (UAV Control)

Mercury Integration

- The Mercury Mission Systems developmental unit presented here represents an early version of the AMCS. It is shown here with two Intel i7 cards in an open frame. The cards are both currently running the CentOS 7.
- This two card approach can show how a single device can easily support a mixed DAL implementation. Once card can run an RTOS while the other could continue to support low criticality applications through Red Hat Linux, possibly using a Container approach.
- During development of this system, the two cards we placed in separate frames to develop the separate component sets. The two cards were then combined to show the flexibility of the standards used by SOSA.

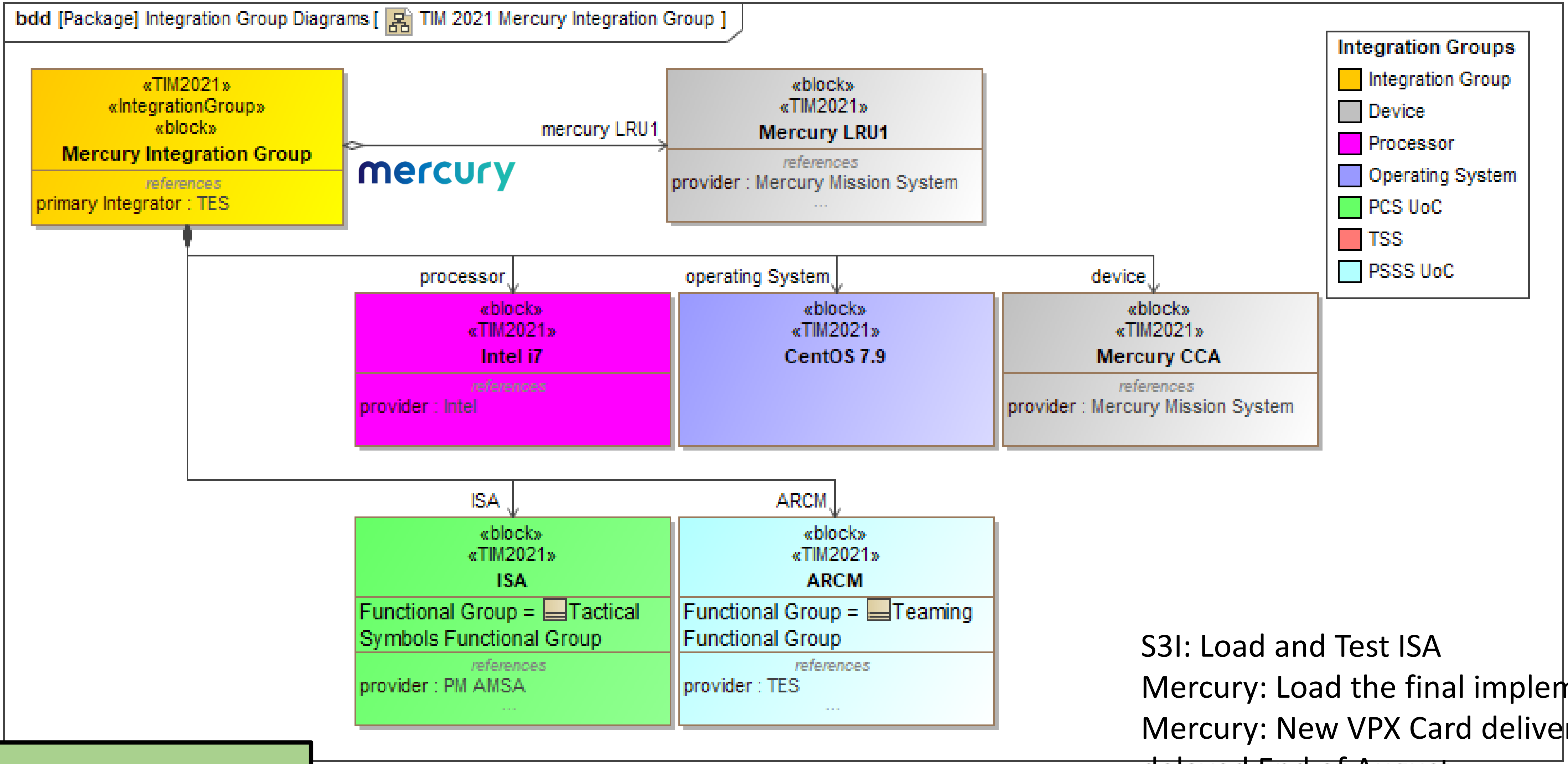
Mercury FACE Diagram



mercury

Mercury Integration

Weekly Meeting: AMCS/Mercury Meeting, Thursday @11:00 Central



S3I: Load and Test ISA

Mercury: Load the final implementation

Mercury: New VPX Card delivery delayed End of August

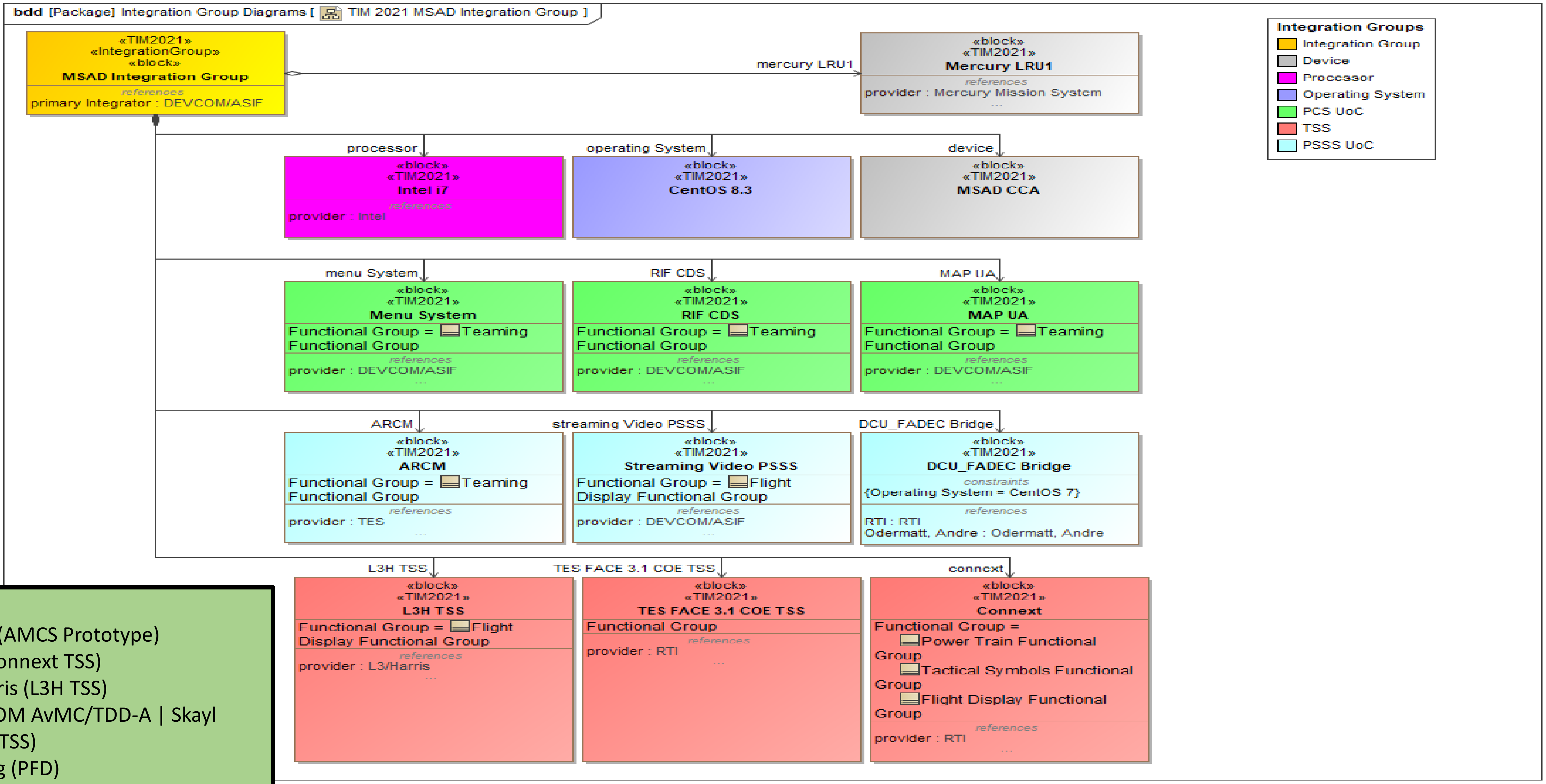
Mercury: Identify USB/Video

Entities:

- MMS (AMCS Prototype)
- S3I (ISA Port)

Display Integration

Weekly Meeting: Internal RIF/SDK Meeting, Monday @9:00 Central



Entities:

- MMS (AMCS Prototype)
- RTI (Connext TSS)
- L3Harris (L3H TSS)
- DEVCOM AvMC/TDD-A | Skayl (CiNC TSS)
- Boeing (PFD)
- TES (ARCM)
- S3I ASIF (RIF Components)