



Presented to:

AADL Standards Committee

AADL and FACE



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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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for the

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

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BLUF



- **Adventium is producing a FACE™ annex for the AADL AS 5506 Standard**
- **FACE and AADL are *complementary* standards.**
 - FACE technical standard provides data-driven interoperability and conformance to a data model.
 - AADL provides portable semantically precise architectural modeling for integrated, software reliant real time systems.
 - However, translation between FACE and AADL models requires careful semantics
- **Software implemented using the FACE technical standard presents an opportunity to leverage AADL style model based analysis, code generation, and formal methods.**

Technical Standard for the Future Airborne Capability Environment (FACE™), Edition 2.0, © 2013 The Open Group. FACE™ is a trademark of The Open Group in the United States and other countries.

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Outline



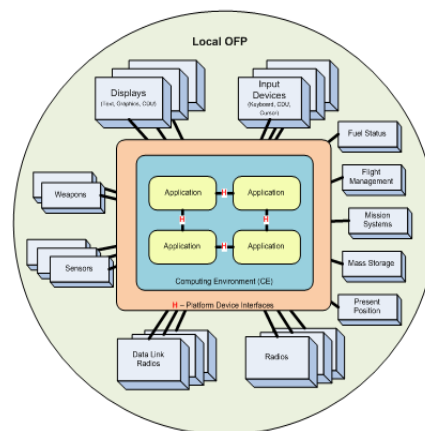
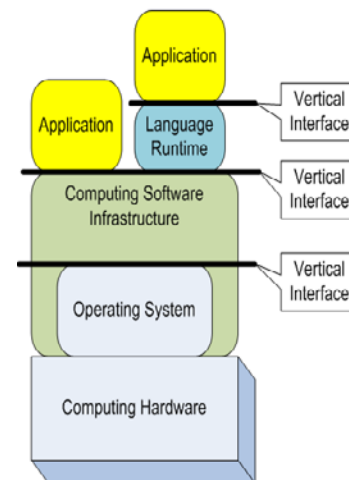
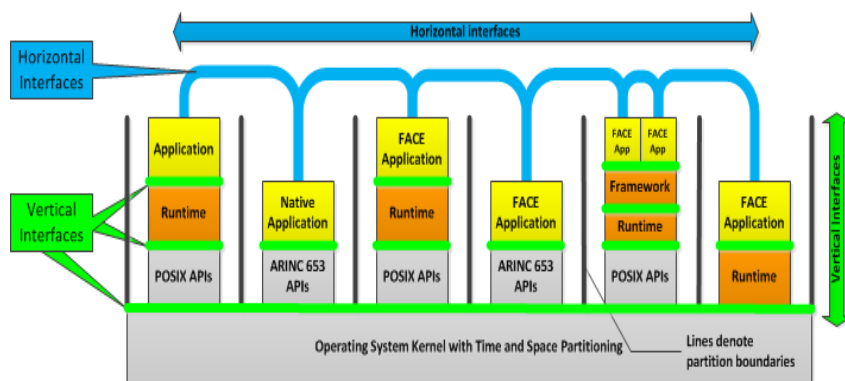
- **What is FACE**
 - Overview
 - Architecture, and Data Model
- **FACE and AADL**
 - Comparison
 - Overlap and Mapping
- **BALSA**
 - Overview
 - AADL translation
 - Gaps and opportunities

- **FACE technical standard focuses on the data model of a system and does not describe physical properties of a system**
 - Focuses on verifiable interoperability
 - Provides semantic consistency independent of operating environment (e.g., processor type)
- **FACE technical standard is independent of timing properties and internal states.**
 - Reusable software components are called Units of Portability (UoP)
 - The LifeCycle Management Services (3.13) provide some capability for describing the state of a UoP, but internal state of UoPs is left as a black box

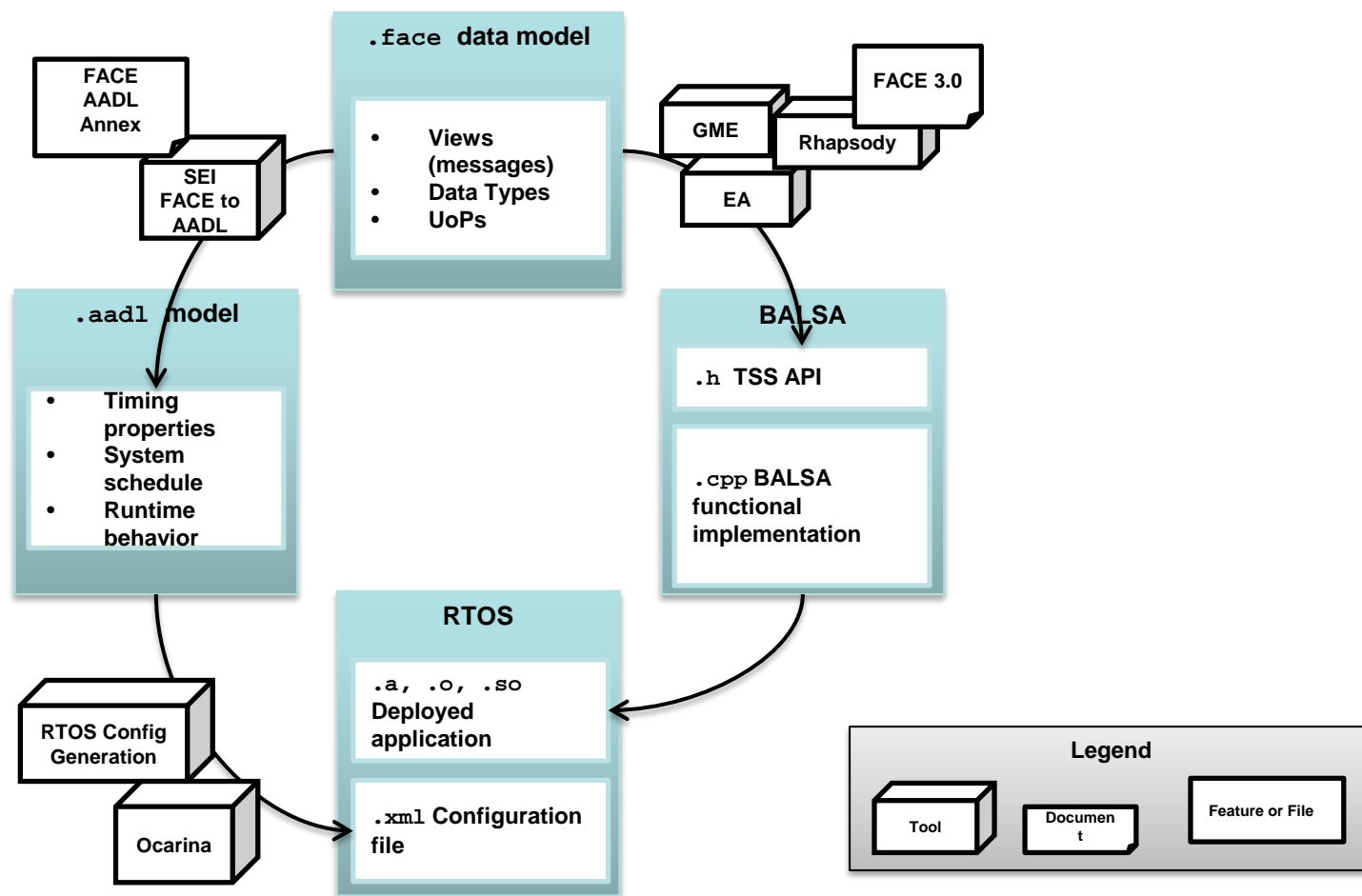


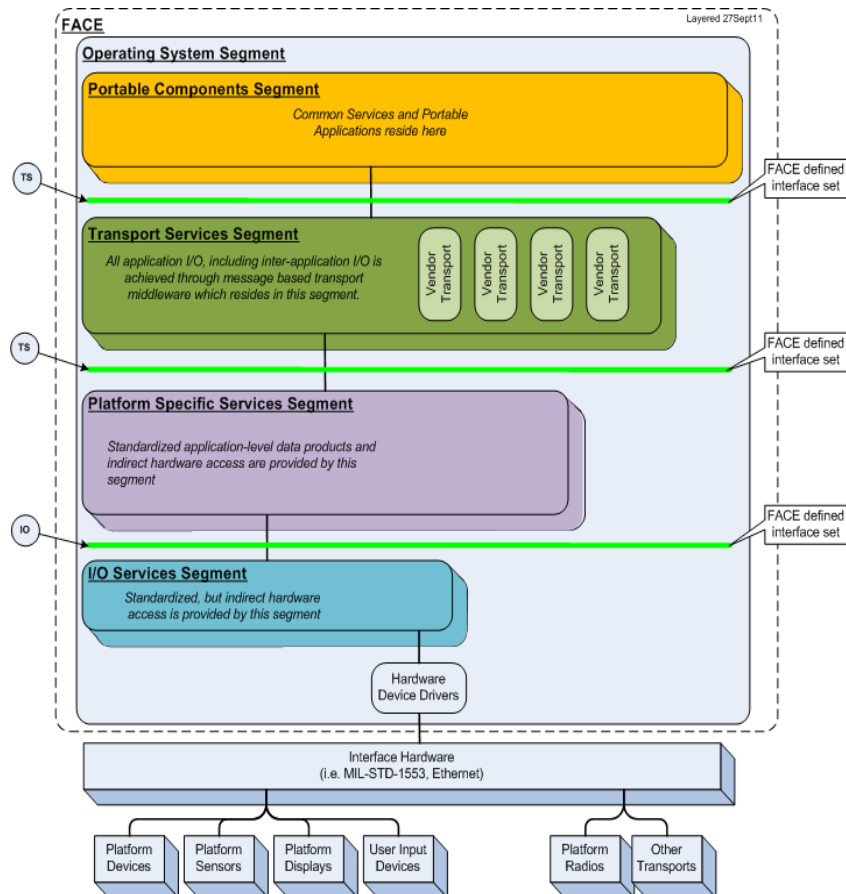
What is the FACE Architecture?

- A software computing environment to enable product lines for military aviation
- The FACE architecture is comprised of a set of “places” where variance occurs
 - Points of variance are called “Segments”
 - The structure created by connecting these segments together is the beginning of the FACE architecture
- Horizontal and vertical interfaces defined as part of FACE architecture
- Integration model in FACE 3.0 allows for code generation



From James 'Bubba' Davis,
Ph.D. CRL Technologies, Inc.





- **FACE Portable Components Segment**
 - Portable Applications
 - Portable Common Services
- **Transport Services Segment**
- **Platform Specific Services Segment**
 - Platform Device Services
 - Platform Common Services
 - Graphics Services
- **I/O Services Segment**
- **Drivers**
- **Operating System Segment**

From the FACE Standard. (ref., <http://www.opengroup.org/face/>)

FACE AND AADL



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Comparison of FACE and AADL



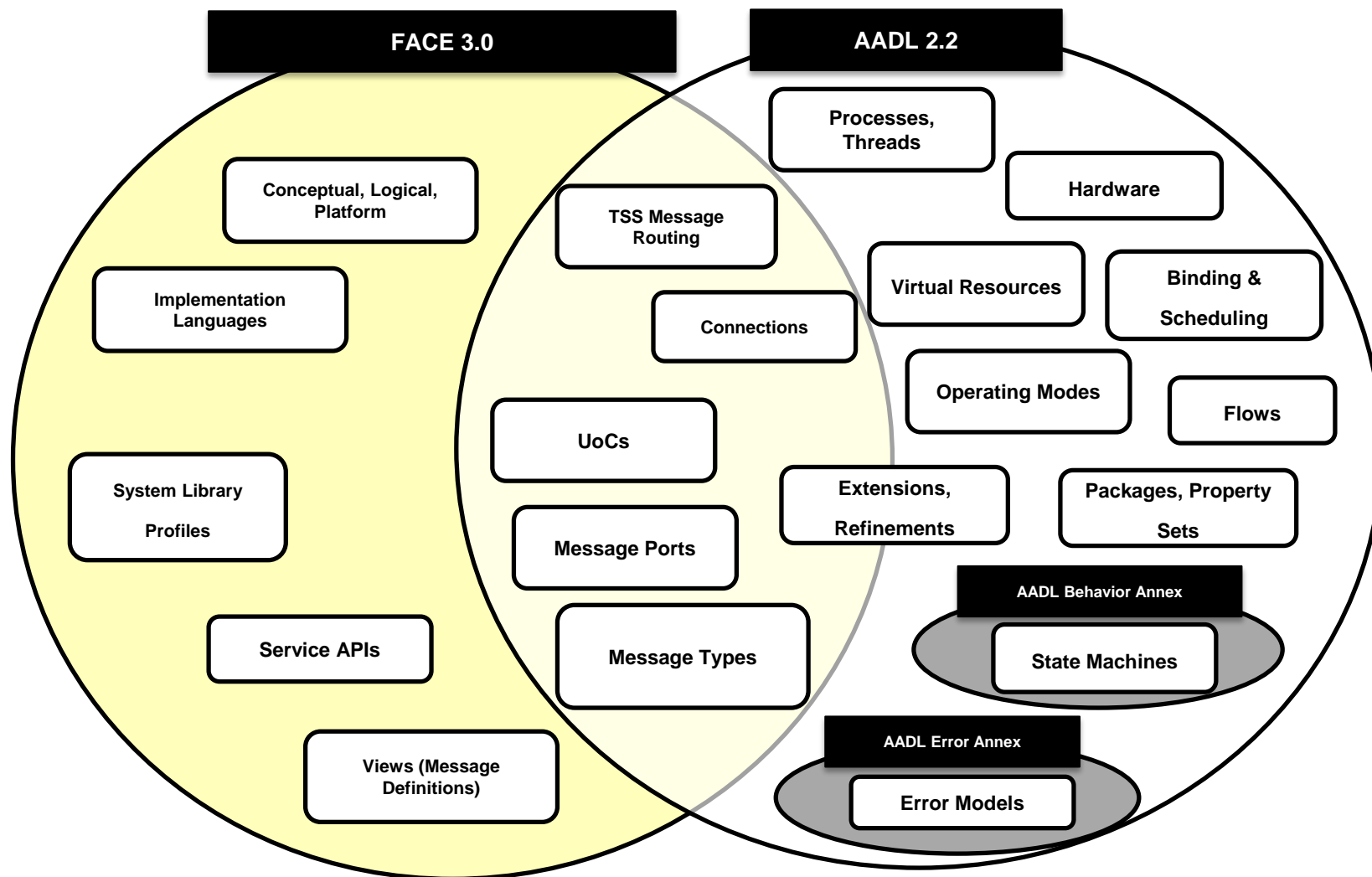
FACE: Data model of a system without physical properties of a system

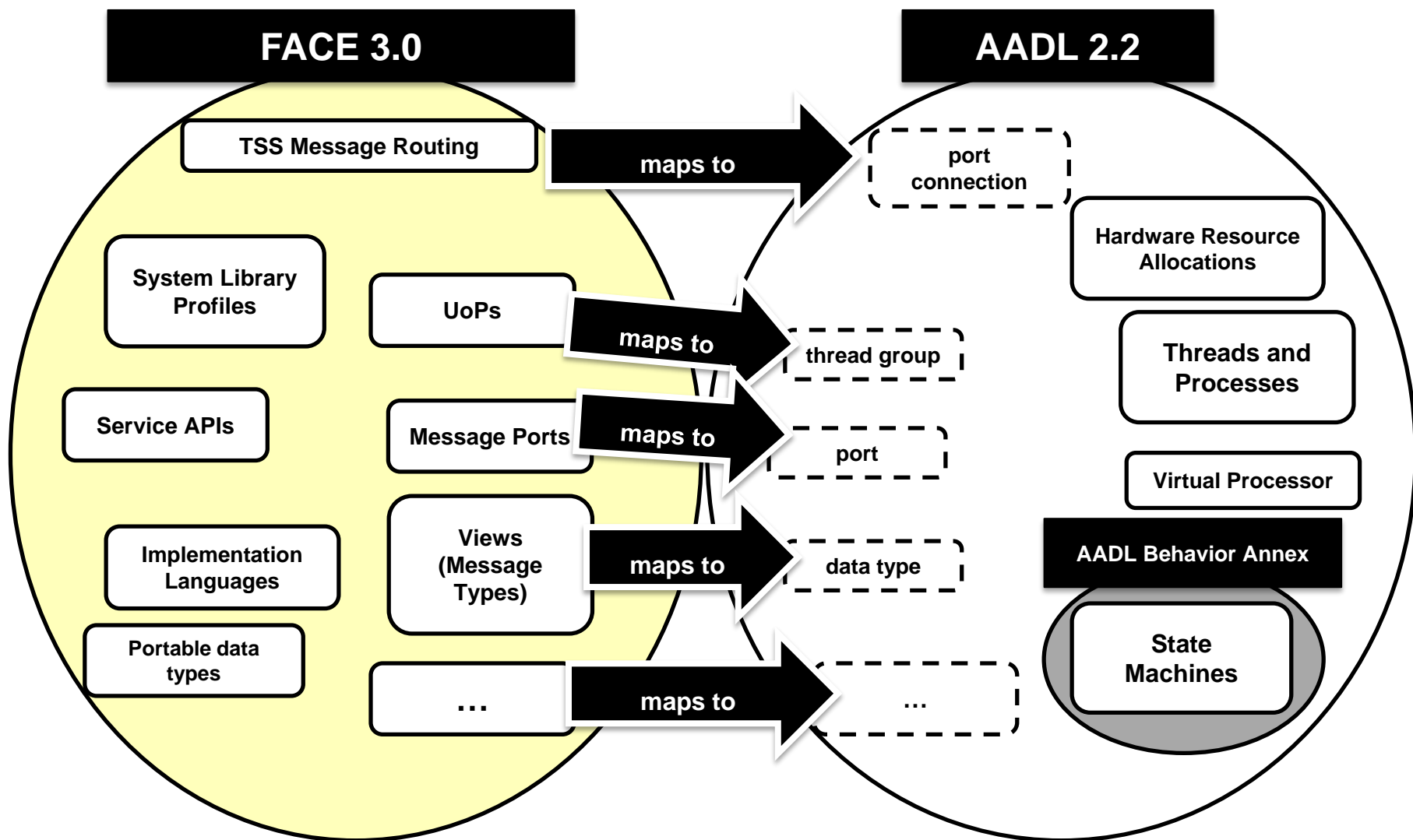
- **Focuses on APIs and data for communication**
- **Focuses on data modeling for reusable interoperable software components**
 - **API**
 - **Data types, direct connections**

AADL: Formal methods and model based analysis of cyber-physical systems

- **AADL models an architecture that is an integration of components.**
- **Focuses on binding, interaction, behavior, data flows, and performance.**

FACE and AADL together allow you to do model-based analysis of interoperable data driven software in cyber-physical systems





property set FACE is

Profile: type enumeration (security, safety_extended, safety, general);

Tier: type enumeration (conceptual, logical, platform);

UUID: aadlstring applies to (all);

Realization_Tier: FACE::Tier applies to (all);

segment: type enumeration (PSSS, PCS, IOSS, IOS, TSS);

FaceSegment: FACE::segment applies to (all);

end FACE;

- Key components of FACE can be translated to AADL with a custom property set, similar to ARINC653 approach
- The UUID need not be FACE specific



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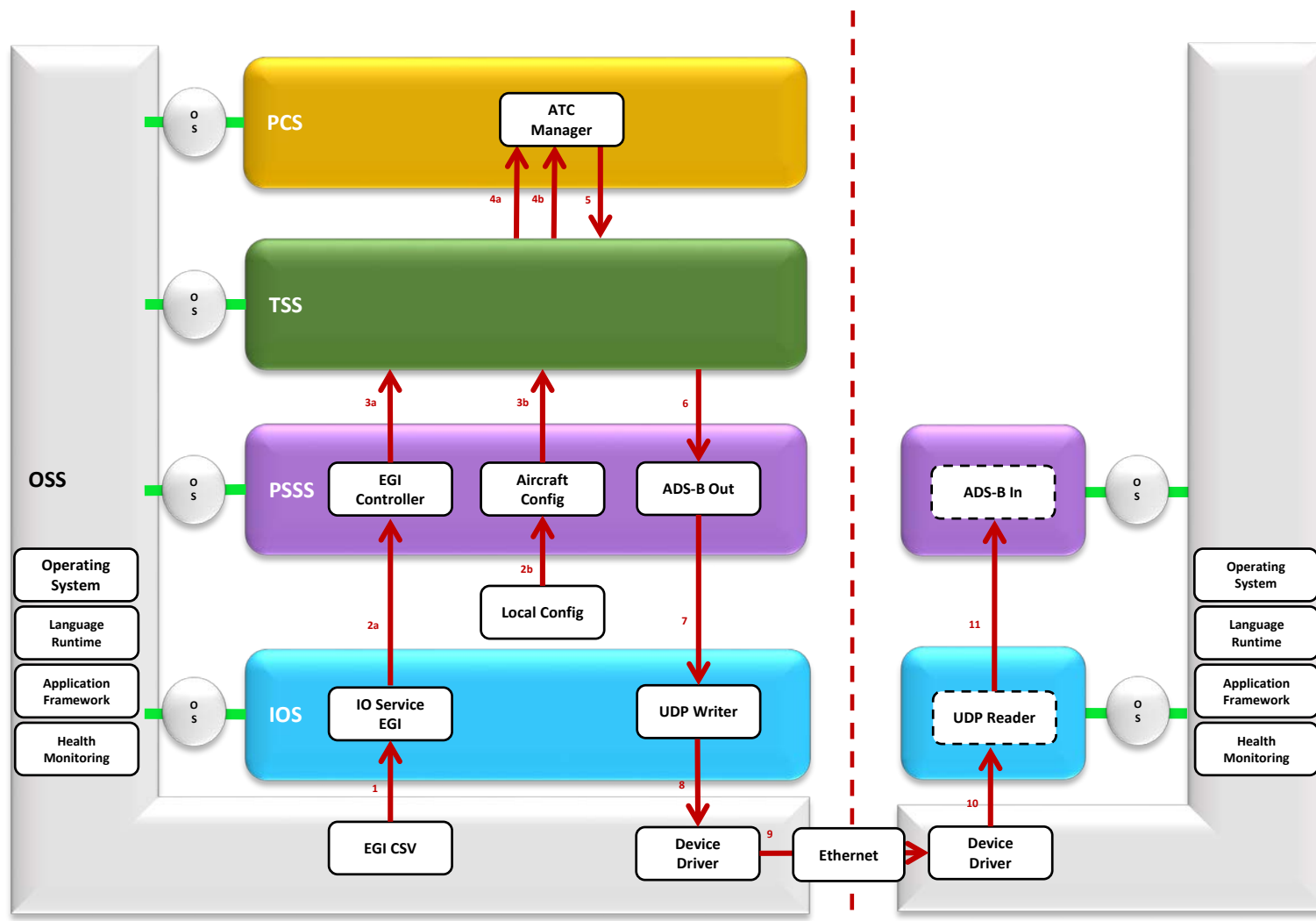


Basic ADS-B Lightweight Source Archetype (BALSA) Exemplar

- **Written in C++**
 - **BALSA runs on a desktop computer (e.g., Ubuntu)**
 - **Contains 5 UoPs split between PCSS and PSSS and a complete data model**
- **BALSA provides a sharable, easy-to-execute example of a working FACE implementation**
 - **BALSA is simple enough to understand but has enough complexity that an AADL model of BALSA could be used to demonstrate AADL analyses**

Name	Description
egi	Embedded Global Positioning System (GPS) / Inertial Navigation System (INS))
aircfg	Aircraft config data, identifier and tail number
Ads B	Identifier (aircfg and egi of a specific aircraft for airtraffic system)
UDP	ADS B data wrapped in a UDP data packet
ATC Manager	Air Traffic Data manager

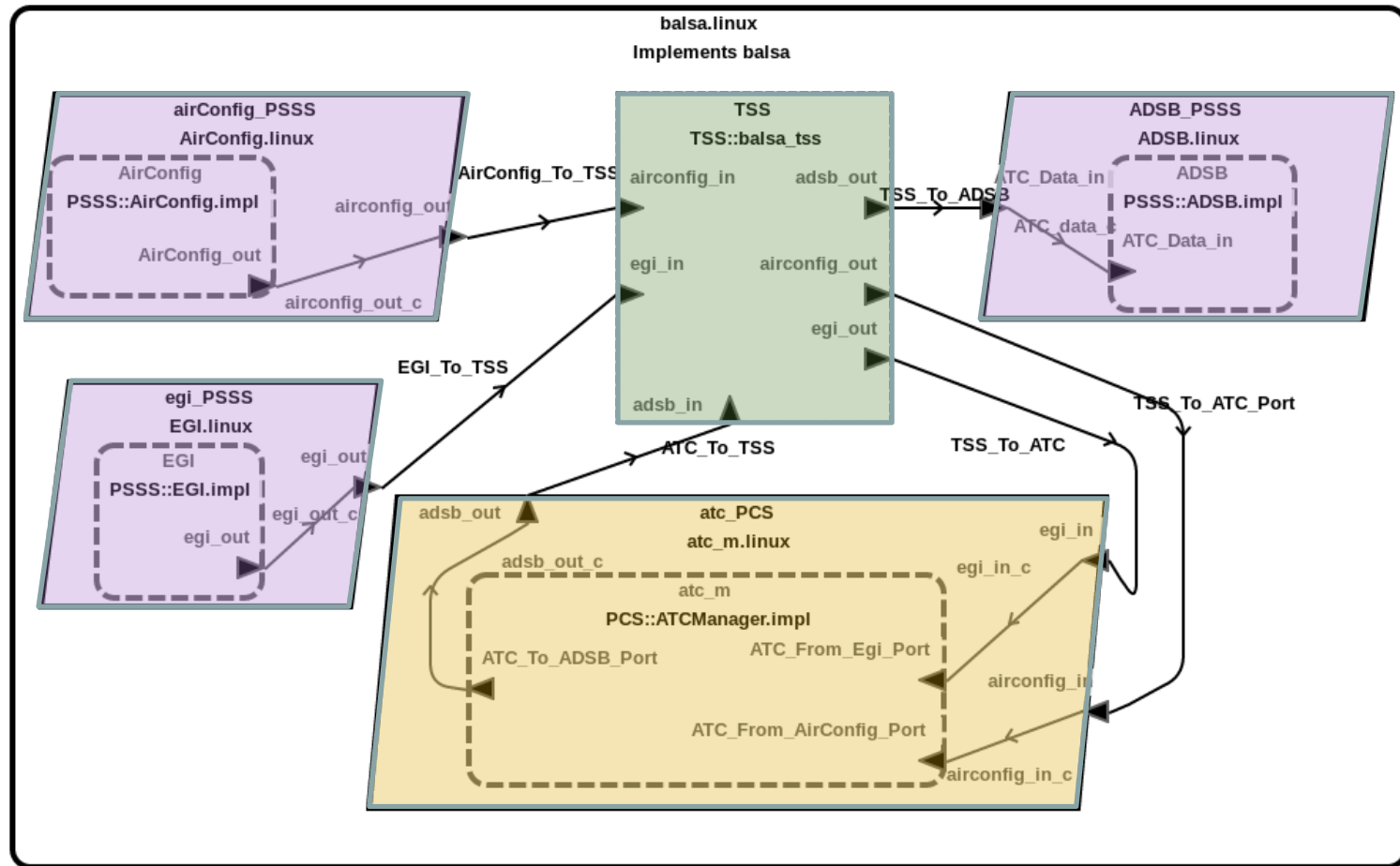
BALSA Elements within the FACE Layered Model



- Import FACE data types and views as data and
- UoPs are imported as thread groups
- Data connections
- Have added platform specifics
 - Create processor, memory architecture
 - Memory partitions, UoPs (thread groups)

There are architectural decisions made in translating BALSA into AADL.

BALSA Representation in AADL



- **TSS is key to FACE**
- **Connections routed through the TSS, but the particular TSS implementation is opaque to component developers**
- **Connections are generated at runtime, but assumed to be known in advance**
- **Model as an abstract to make use of extension/refinement**

```
FACE::TS::Create_Connection (
    TSS_ADSB_conn_name, // connection name
    FACE::SERVER,       // messaging pattern
    TSS_ADSB_conn_id,   // connection ID
    conn_direction,     // connection direction
    ADSB_msg_size,      // message size
    0,                  // timeout
    status               // return code
);
```

```
FACE::TS::Receive_Message (
    TSS_EGI_conn_id,    // connection ID
    FACE::INF_TIME_VALUE, // timeout
    transaction_id,     // transaction ID
    position_time,      // message
    EGI_msg_size,       // message size
    status              // return code
);
```

Sample UoC/TSS interactions

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CONCLUSION

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Benefits



- **FACE technical standard allows independent but aligned data modeling for multiple vendors to develop related tools and have assurances that the tools will work together**
 - **Institutions for verifying conformance**
 - **Exactly one way to generate code for a given entity**
 - **Portability**
- **Interoperable guarantees to allow vendors to work together**
- **Ready and sympathetic user base in FACE members**
- **Translation can be largely automated**



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Questions to the AADL community



- What are the imported constructs required to support formal methods
 - What about code generation?
- What are model constructs we should use for parsimonious modeling?
TSS model?
- UUID => Can we promote to a AADL primitive data type



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BACKUP





Where do you go from here



- <https://www.youtube.com/watch?v=K mLJcewvHis>
- **FACE consortium**
 - **Standard**



FACE Consortium Members



Sponsor Level Member Organizations

- Air Force Research Laboratory
- Boeing
- Lockheed Martin
- Rockwell Collins
- US Army PEO Aviation
- US Navy NAVAIR

The FACE Consortium was formed in 2010 by The Open Group

Principal Level Member Organizations

- AeroVironment, Inc.
- BAE Systems
- BELCAN
- Booz Allen Hamilton
- DRS Training & Control Systems
- Elbit Systems of America
- GE Aviation Systems
- General Dynamics
- Green Hills Software
- Harris Corporation
- Honeywell Aerospace
- IBM
- Northrop Grumman
- Raytheon
- Sierra Nevada Corp.
- Sikorsky Aircraft
- Textron Systems
- US Army AMRDEC
- Wind River

Associate Level Member Organizations

- Abaco Systems
- AdaCore
- Arizona State University
- ARTEMIS, Inc.
- Astronautics Corporation of America
- Avalex Technologies
- Avionics Interface Technologies
- Brockwell Technologies
- Carnegie Mellon Univ. – Software Engineering Institute
- CERTON Software, Inc.
- CMC Electronics
- Cobham Aerospace Communications
- Core Avionics & Industrial Inc.
- Creative Electronic Systems North America
- Crossfield Technology LLC
- CS Communication & System, Inc.
- CTSi
- Curtiss-Wright Defense Solutions
- Delta Information Systems, Inc.
- DDC-I
- DornierWorks
- Draper Laboratory
- Elma Electronic Inc.
- Enea Software & Services
- ENSCO Avionics
- Esterel Technologies
- Esterline AVISTA
- EuroAvionics USA LLC
- Garmin International, Inc.
- GECO Inc.
- General Atomics Aeronautical Systems, Inc.
- IEE
- Infinite Dimensions
- Inter-Coastal Electronics, Inc.
- Johns Hopkins Univ. - APL
- Joint Tactical Networking Center
- Kaman Precision Products
- KEYW Corp.
- KIHOMAC
- L-3 Communications
- LDRA Technology
- Leidos Inc.
- Lynx Software Technologies
- Mercury Systems
- OAR Corporation
- North American Industries, Inc.
- Performance Software
- Physical Optics Corp.
- Presagis USA, Inc.
- PrismTech Corp.
- Pyrrhus Software
- Rapid Imaging Software
- Real-Time Innovations
- Riverside Research
- Rogerson Kratos
- SAIC
- Selex Galileo Inc.
- Skylt LLC.
- SimVentions
- SwRI
- StackFrame, LLC.
- Technology Service Corp.
- TES-SAVI
- Terma North America
- Thales USA, Inc.
- Thomas Production Company
- Trideum
- TTTech North America, Inc.
- University of Dayton Research Institute
- Vector Software, Inc.
- Verocel
- VTS, Inc.
- Zodiac Data Systems

<http://www.opengroup.org/face/member-list>

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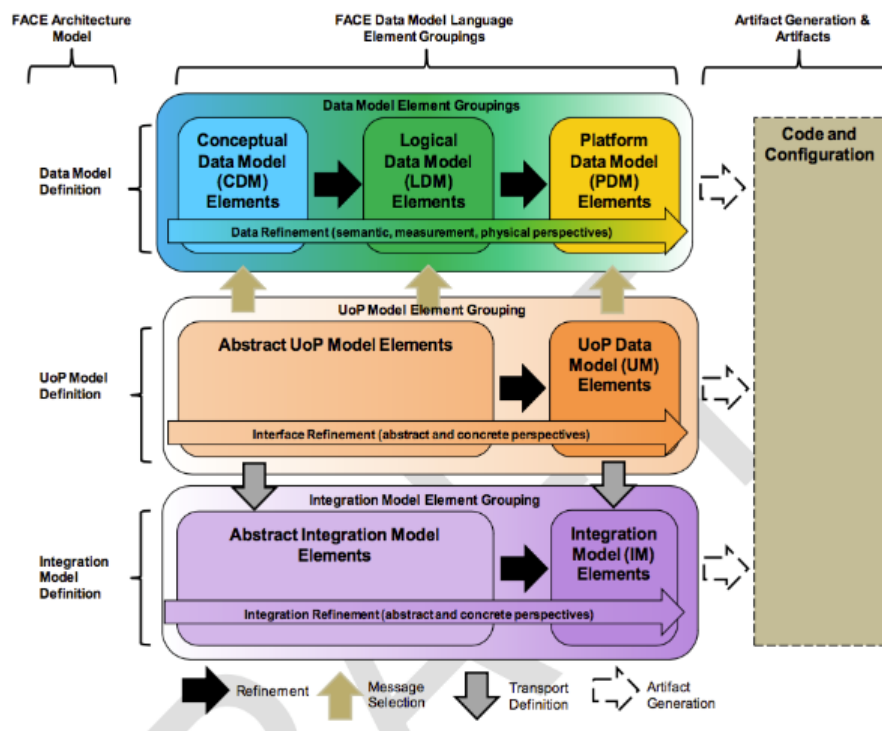
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- Divides the system into segments
- Shared Data Model
- Data Architecture
- New in FACE 3.0 (released 2017-11)
 - Integration Model



From the FACE 3.0
Draft Standard



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Example



- Based on BALSA, imagine you are acme GPS vendor and want to integrate your GPS into BALSA
 - You write some UoCs, check them with a VA
 - Provide them to an integrator
 - Lower costs for the integrator
 - And more platforms for you to target
 - And MAGIC



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Tradeoffs



- **TSS modeling**
 - System
 - Virtual Bus
- **External Elements (other systems)**
 - Included Them
 - Ignore them
- **FACE Segments**
 - Flat model (with FACE properties)
 - Segments => Systems



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FACE tools



- **GME, Enterprise Architect**
- **Minimum: pointer to standard**
 - **YouTube videos**
 - **Specific tools**
- **In development eclipse based tool, jives nicely with OSATE.**
- **Links or something else?**