



A Time & Space Partitioned DO-178 Level A Certifiable RTOS

- Designed to Lower Costs from Initial Design through Aircraft Certification
- Field Proven on Tens of Thousands of Aircraft with Millions of Flight Hours
- Enforced Time and Space Partitioning
- Patented Technology that Enables Maximum Processor Utilization
- Innovative SafeMC™ Technology for Multicore Processors Unmatched in the Industry
- Support for popular avionics standards, ARINC-653, POSIX
- Certified as FACE™ Conformant
- DO-178C DAL A Verification Evidence is Available

Deos™ is a time & space partitioned safety critical RTOS, which has been certified to DO-178 Design Assurance Level A (DAL A) since 1998. Built from day one using DAL A certifiable plans and procedures, Deos features bounded and deterministic response, superior multicore technology, industry standard interfaces, and shared resource partitioning to deliver the highest performance when compared to other certifiable safety-critical COTS RTOS.

For increased software portability, Deos users have the ability to add optional ARINC-653 & POSIX personality modules.

- Deos supports the full ARINC Specification 653 Part 1, which is designed to enhance software portability to avionics operating systems. Applications needing to utilize this full spec can choose this Deos personality module which delivers standards conformance combined with patented Deos technology.
- Deos also supports the lightweight version, ARINC Specification 653 Part 4. This module is the right choice for less complex applications such as the majority of Line Replaceable Units. Deos is the only COTS RTOS vendor supporting this strict subset, delivering the value added features of Deos, and the portability of the popular avionics standards.
- Deos targets the Future Airborne Capability Environment (FACE) Safety Extended and Safety Base Profiles by integrating RTEMS, the open source POSIX RTOS, in a Deos time and space partition to deliver maximum application portability.



Safety Critical Software Solutions
for Mission Critical Systems

Robust, Reliable Technology

Designed to Increase Performance & Lower Costs

Key Features & Benefits

Superior Multicore Technology ...

SafeMC technology delivers maximum safety critical performance across multiple cores.

OS Binary Modularity ...

Deos components are delivered as binary runtime linkable modules, each with their own certification artifacts.

Run-time Linkable Libraries ...

Saves valuable space, increases modularity, and can enable customer binary software & artifact reuse.

Factoring ... Configuration parameters for Deos are contained outside of the Deos kernel in an XML configuration file. This design isolates the impact of configuration changes on the verification evidence and allows easy adaptation for different applications.

Unlimited Processes and Threads ...

No artificial limits on the number of processes and threads allows great flexibility in the design of an application.

Slack Scheduling ... Allows for full processor utilization without jeopardizing hard deadlines.

Object Code Structural Coverage

Tool ... Eliminates the need for expensive source to object code traceability analysis; creates better and safer software.

Harmonic Rate Monotonic Scheduling and Optional ARINC

and POSIX Scheduling ... Delivering versatility of scheduling options to avionics systems developers!

Industry Standard Interfaces ...

- **ARINC Specification 653 Part 1 (Optional Module) ...** Delivers the standard avionics interfaces for enhanced portability, and allows designers to take advantage of the advanced features of Deos.
 - **ARINC specification 653 Part 4 (Optional Module) ...** Delivers a streamlined subset of the standard avionics interfaces for less complex systems and the value added features of Deos.
 - **POSIX 1003.1 Subset (Optional Module)...** Targeting the FACE Safety Extended and Safety Base Profiles to deliver enhanced portability and reuse.
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SafeMC Technology for Deos

Efficiently Utilizes Processing Resources & Maximizes Software Design Flexibility

SafeMC™ Technology from DDC-I provides the resource and scheduling mechanisms that enable developers to bound and control the interference patterns which occur whenever processor cores share resources (e.g., cache, memory, or I/O). These patented capabilities enable Deos developers to have full utilization of all cores for safety critical operation, as opposed to artificially forcing the user to designate a single core for safety critical tasks.

Safe Scheduling includes patented technology for the bounding and control of interference patterns created by the shared resources within multi-core processors. Safe Scheduling offers a configurable approach of a single RTOS instance managing all the cores and provides user control over the co-scheduling of tasks among the cores. As shown in Figure 1, this scheduling environment allows high-DAL applications to run simultaneously across all cores by enabling the system integrator to configure the system such that resource contentions are minimized (and bounded) between processor cores. For example one could place a memory intensive application on one core and compute bound applications on other cores (which then limits, and bounds, memory resource contention).

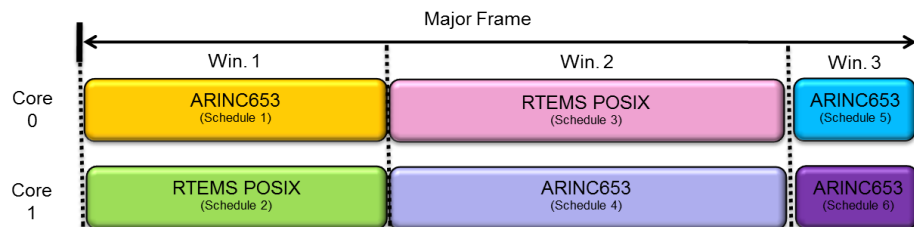
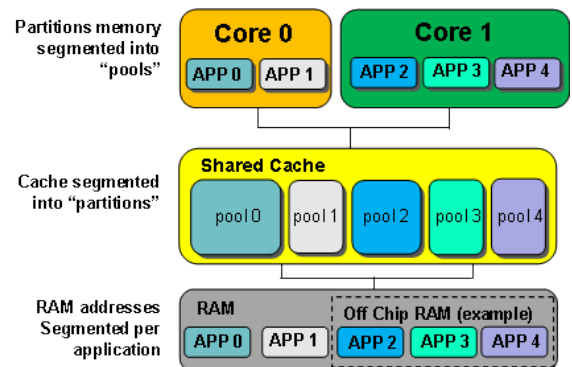


Figure 1 - Safe Scheduling

Memory Pooling and Cache Partitioning is a configurable cache partitioning capability that enables developers to isolate cache at the application or partition level (not just at the core level) via XML based configuration files (not based on hardware features). This patented Deos feature substantially reduces one of the major sources of resource contention, namely access to cache and system memory.



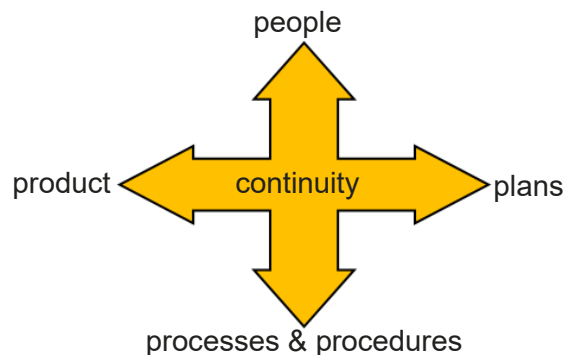
Fine Grain Locking on Kernel Interface Objects - Deos is designed to not have any cross core couplings (e.g., contention) by using multiple schedulers and employing fine grain locking on kernel interface objects. Since kernel resources are not shared across cores, there is no cross core locking or the associated impacts on performance.

Safety Nets (Memory Throttling) - A safety net is required according to CAST-32A to contain unintended functionality. Deos implements a method of contention throttling that uses the resources available on the hardware platform designed to monitor hardware behavior.

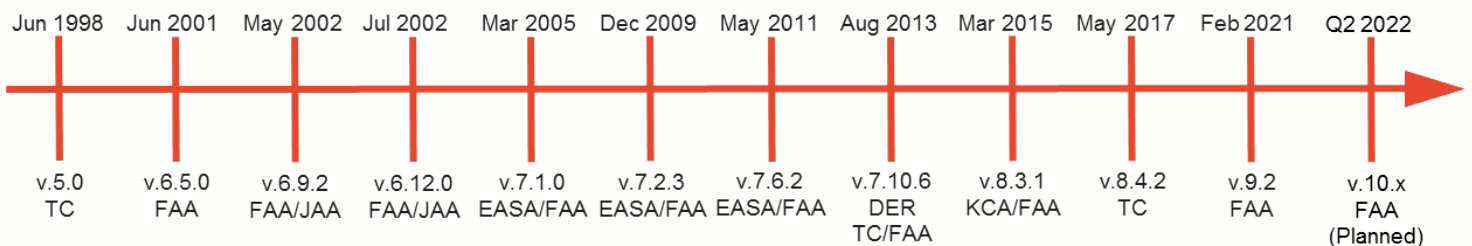
RTOS Pedigree

Deos from DDC-I is a DO-178 Level A certifiable embedded RTOS that has been used in hundreds of safety critical avionics applications on commercial and military aircraft, with continuity of people, product, plans, processes & procedures since its inception.

- ✓ 20 year certification history with millions of flight hours of use in certified applications
- ✓ The only certifiable COTS RTOS created using DO-178 Level A plans and procedures from the very first day of its development
- ✓ Field proven on hundreds of aircraft, in a multitude of avionics functions
- ✓ Well known in the avionics certification community
- ✓ Certified as FACE™ Conformant



Deos Certification Baselines (DAL A) A Single Line of On-Going Development!



Proven Reliable

In the Most Stringent Safety Critical Applications

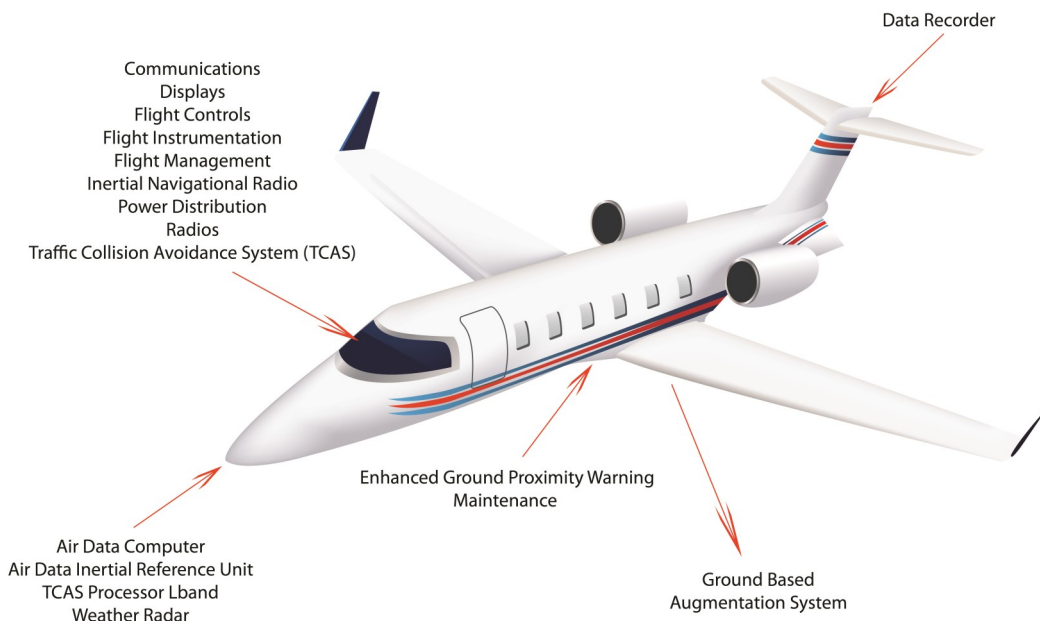
Deos is certified and flying on tens of thousands of aircraft, with tens (if not hundreds) of millions of hours in service.

Examples of aircraft using Deos include:

- Agusta AB-139
- Airbus A320, A320Neo, A330, A340, A350, A380, A400M
- Bell-Boeing V-22
- Boeing 737Max, 757, 777, 777X, 787, F-18
- Bombardier CSeries, Global Express
- Cessna Citation V, Sovereign
- Comac ARJ21, C919
- Dassault F7X, F900, F2000
- Embraer ERJ-170, ERJ-175, ERJ-190, ERJ-195
- Gulfstream GIV-X, GV, G150, G200, G350, G450, G500, G550, G650
- Hafei Y-12
- Hindustan Aeronautics Limited LUH, ALH
- Hawker Horizon, 450
- Lockheed C-5, C-130J, C-141
- Pilatus PC-12NG
- Spectrum S-40
- Viking Twin Otter

Avionics applications include:

- Air Data Computer
- Air Data Inertial Reference Unit
- Cockpit Video
- Communications & Radios
- Data Recorders
- De-Icing
- Displays
- Electronic Flight Bag
- Enhanced Ground Proximity Warning
- FADEC
- Flight Controls
- Flight Instrumentation
- Flight Management
- Health Management
- Maintenance
- Power Distribution
- Traffic Collision Avoidance System
- Weather Radar

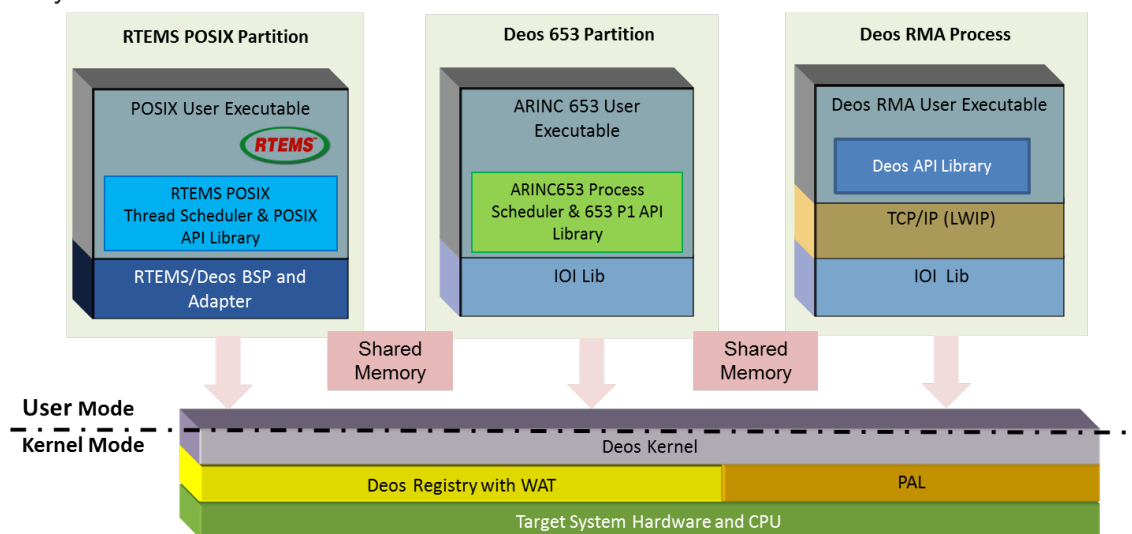


Deos Optional Components

Deos supports popular avionics standards and other features allowing users to customize their Deos environment by choosing from a variety of optional modules:

- ARINC Specification 653 Part 1
- ARINC Specification 653 Part 4
- POSIX 1003.1 subset targeted at FACE Safety Extended and Safety Base Profiles
- CFFS (Certifiable Fast File System)
- ARINC-615 Target Data Loader
- ARINC-664 Data Bus
- AFDX

These optional API and scheduling components allow Deos to schedule ARINC-653 applications, POSIX applications in RTEMS partitions, and native Deos threads scheduled according to the rate monotonic algorithm (RMA) all on the same system. The figure below depicts this partitioning and the placement of the user-kernel boundary in the combined system.



ARINC-653 - Deos optionally supports the ability to run applications written to conform to the ARINC 653 Standard. ARINC 653 is an Avionics Application Standard Software Interface specification for space and time partitioning in safety-critical avionics that defines an API called APplication EXecutive (APEX). It allows the hosting of multiple applications of different software levels on the same hardware in the context of an Integrated Modular Avionics architecture. As shown in the figure above ARINC 653 applications can coexist with both Deos RMA processes and POSIX Processes as the ARINC 653 Partitions and Tasks are mapped within a Deos Partition. Deos's optional ARINC 653 package supports: the complete Part 1 Supplement 3; the File System, Memory Blocks, and Sampling Port Extensions of the optional services defined in Part 2 ; the complete Part 4 specification. DDC-I also offers certification artifacts to DO-178C DAL A for this optional package.

Deos Optional Components (continued)

FACE™ Interfaces - The Open Group Future Airborne Capability Environment (FACE) Consortium has developed a reference architecture and standard for real-time embedded avionics systems. The FACE Technical Standard defines required capabilities for real-time operating systems (RTOS), I/O services, transport services, and a shared data model. RTOS requirements specified by the FACE Operating System Segment are based on ARINC 653 and POSIX 1003.1b subset tailored to address the needs of avionics systems.

POSIX interfaces for FACE, DDC-I para-virtualized RTEMS (an open source POSIX RTOS) to leverage its strengths in functionality and pedigree. RTEMS was originally released in 1990 as a deterministic real-time environment and is employed in military, space, and some industrial applications. Integrating a para-virtualized RTEMS with Deos combines the strengths of both OSs and provides a path to conformance with the FACE Technical Standard Safety Extended and Safety Base operating system profiles and maximum portability of standards based applications software.

RTEMS on Deos delivers efficient execution within a Deos partition, which provides the required operating system services to RTEMS. This allows RTEMS to execute in user space with its normal critical sections, proper memory layout, and only interfaces with the Deos kernel for timing and I/O. POSIX applications on RTEMS therefore will be partitioned and will be provided the I/O services needed by the Deos kernel.

Certifiable Fast File System (CFFS) - Deos contains a DO-178 DAL-A kernel file system, which is read-only in -flight use. The optional CFFS provides a rich feature set that permits read/write capability in-flight. Further, while CFFS can be employed in systems with large data storage needs, CFFS is also well suited for applications requiring low latency and very high transfer rates. Typical CFFS applications include Logging Aircraft Monitoring Data or Displays for Image and Graphic Data. DDC-I also offers certification artifacts to DO-178C DAL A for this optional package.

CFFS was built from the ground up as a DO-178 high Design Assurance Level (DAL A) module. Designed with the goal of reuse of certification artifacts, CFFS is a user space application that's adaptable through XML configuration files to isolate change impact on the application during reuse. Additionally, the CFFS server is hardware agnostic via abstraction through its Media Abstraction Layer (MAL), which is independently used and/or modified for customer specific storage media.

ARINC-615A Target Data Loader - Avionics systems require the ability to transfer the initial software load to the hardware as well as update this software load in the field. The ability to transfer this software or data with an avionics device running Deos™ may be carried out through the optional Deos Target Data Loader (TDL) software package that supports the ARINC 615A standard. The ARINC 615A protocol is referred to as the Data Load Protocol (DLP) and it specifies the communications between an ARINC 615A Data Loader, which can be any computer with a network interface such as Ethernet/AFDX/ARINC 664 and the avionics target device (in this case an avionics device running Deos and the TDL software package). DO-178 certification artifacts to DAL A are available for the TDL integrity library.

ARINC-664/AFDX Driver Library - Deos includes an industry standard lightweight TCP/IP stack (LwIP) with a DAL-A sockets library so it can provide data transport during in flight or on ground as part of its standard package. While it may have high data integrity (e.g., through CRC or other such mechanisms), TCP/IP over Ethernet is a non-deterministic protocol. As such, it is not suitable for some avionics applications. In contrast, ARINC-664/ADFX is a redundant and deterministic data network designed for aircraft data network applications and based on switched Ethernet technologies. These features enable ARINC-664/AFDX to be used in aircraft control and other applications where both integrity and availability are essential. Since ARINC-664/ADFX is often employed as a data bus backbone for an aircraft, it's also a common interface for modern aircraft monitoring and recording systems. AFDX is an ARINC 664 data network, patented by Airbus, that is a specific implementation of ARINC 664 Part 7. DDC-I also offers certification artifacts to DO-178C DAL A for this optional package.

The DDC-I Advantage

With over 30 years of experience supplying complex COTS and custom embedded solutions, DDC-I provides long-term, strategic advantages to an ever changing safety critical industry. Boasting founding and committed management, our staff offers a level of experience and service that is unmatched in the industry. Our customers have direct access to DDC-I's highly experienced engineers, which ensures the success of our customer's development efforts.

For additional information about DDC-I's experienced, industry leading, safety critical development systems and solutions please contact:



Safety Critical Software Solutions
for Mission Critical Systems