



PEARLsoft

Pico-satellite Exo-Atmospheric Research Laboratory Flight Software

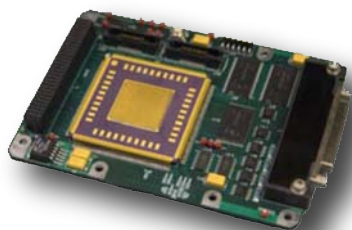
PEARLsoft is the software solution that the Space Dynamics Laboratory (SDL) provides for the PEARL CubeSat platform and the Modular Avionics System (MODAS). PEARLsoft operates on the MODAS Bus Interface Controller (BIC) single board computer (SBC). The MODAS BIC is designed around the radiation tolerant LEON3-FT SPARC V8e microprocessor and provides a configurable 11-66 MIPS processor with a floating point math processor on a PCI-104 backplane. PEARLsoft operates in the UNIX environment using the POSIX libraries. Support is currently provided for Wind Rivers Systems' VxWorks operating system, with future support planned for real-time Linux operating systems.

PEARLsoft uses a multi-threaded architecture to provide design modularity. The modularity enables a high level of reuse and adaptability to meet a broad range of satellite mission requirements and to accommodate SDL's evolving miniaturized subsystem technologies. Separate threads for communications, attitude control, and payload management allow developers to modify or replace PEARLsoft threads without extensive retesting of the satellite system.

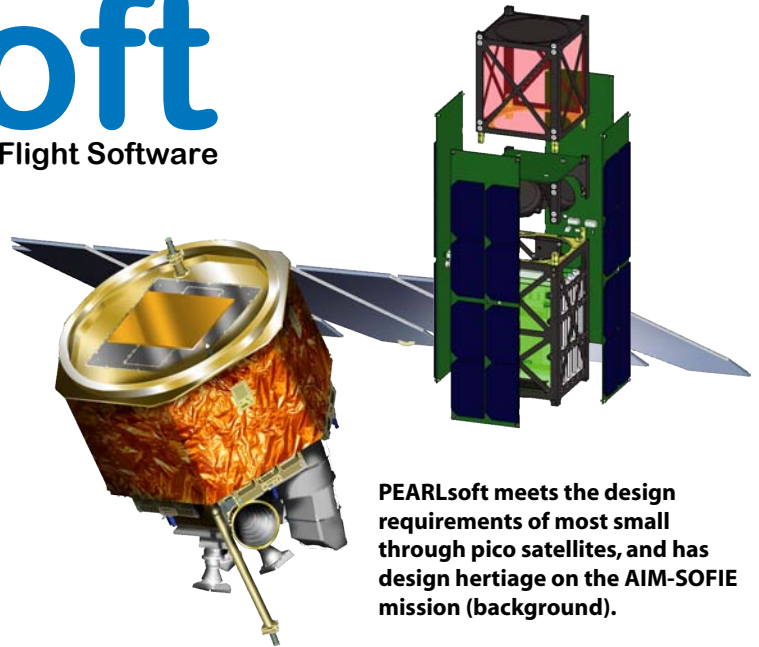
The payload manager of the PEARLsoft software enables companies to develop their own custom payload interface with few modifications to the executor and the telemetry processor (see diagram on reverse).

SDL developed the PEARLsoft software suite in compliance with its ISO-9001 registered software development procedures. These processes include a documented method to control and verify the software development to ensure that the finished product meets specified requirements within schedule and budget constraints. This is accomplished through measurable benchmarks and traceability using statistical and quantitative techniques such as feature-driven status matrixes, formal inspections and peer reviews, formal validation and acceptance tests, managed configuration control and change processes, and deficiency tracking and reporting.

PEARLsoft draws its flight heritage from the NASA Aeronomy of Ice in the Mesosphere (AIM) mission, Solar Occultation for Ice Experiment (SOFIE) experiment, which SDL designed, developed, and integrated. The SOFIE software has operated successfully on-orbit since April 2007 with no problems.



PEARLsoft operates on SDL's Modular Avionics System (MODAS) under VxWorks and POSIX UNIX operating systems.



PEARLsoft meets the design requirements of most small through pico satellites, and has design heritage on the AIM-SOFIE mission (background).

PEARLsoft Characteristics

- Operates on SDL's MODAS 66 MIPS single board computer.
- Supported by VxWorks and other POSIX/UNIX operating systems.
- Rapid design and development through modular design.

PEARLsoft Threads

- System Monitor — state of health monitoring and fault response
- Communications Handler — supports OSI Link Layer communications (AX.25 currently; CCSDS AOS Space Data Link Protocol future)
- Network Manager — supports OSI Network Layer communications (CCSDS Space Packet Protocol)
- Code Updater — facilitates reprogramming of code images on-orbit
- Command Handler — command validation, script management, and timed command scheduling
- Executor — implements system control and manages command execution and response
- Attitude Resolver — high-order Kalman filter for determining spacecraft attitude from the sensor suite (GPS, magnetometer, sun sensor)
- Attitude Controller — control law resolution of attitude dynamics control utilizing magnetic torque coils and SDL's reaction wheels (future).
- Telemetry Processor — prioritizes and organizes data for real-time and store-and-forward downlinks
- Payload Manager — primary payload software interface to the executor thread and on-board data storage

MODAS Bus Interface Controller

- Radiation tolerant LEON3-FT SPARC V8e processor
- 11-66 MIPS (configurable)
- 128 Mbytes on-board memory
- Floating point math processor
- PCI-104 bus
- Ethernet development interface

Attitude Determination & Control
 Telemetry, Tracking, and Command
 Command & Data Handling
 Power
 Thermal
 Structures & Mechanisms
 Guidance & Navigation
 Payload

Subsystem		Thread	Current Development	Future Development	
	● ●		System Monitor	In-flight configurable error detection and fault response	Autonomous reconfiguration
●			Communications Handler	OSI Link Layer: AX.25 Protocol	OSI Link Layer: CCSDS AOS Space Data Link Protocol
	●		Network Manager	OSI Network Layer: CCSDS Space Packet Protocol	Satellite cross-link networking
●			Code Updater	Flash memory manager	Flash file system
●			Command Handler	Command script management and 1 sec command execution fidelity	-
		● ● ●	Executor	Deployable structures, thermal monitoring, power switching, 1 msec time stamp accuracy	Actuated structures, active thermal control
●			Attitude Resolver	Magnetometer, sun sensor, MEMS gyros, GPS, 1-5° knowledge	Horizon crossing indicator, star camera, 1 arcminute knowledge
●			Attitude Controller	Torque coils, passive gravity gradient, 1-5° control	3-axis stabilization, spin stabilization, 1 arcminute control
● ●			Telemetry Processor	Real-time and store & forward communications	Data delivery assurance
		●	Payload Manager	RS-232, SPI, I ² C interfaces	Spacewire, CAN2.0 interfaces

