Software support for X2000 Hardware

Blair Lewis / Len Day
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Europa Orbiter/X2000 Avionics
Industry Briefing

Agenda

• Charter
• Software overview
• Abstract Device Model
• Device drivers
• 1394 Hardware Abstraction Layer (HAL)
• Test tools
• CPU Performance measurement
• Development status

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Software support for X2000 Hardware
Charter

- Among other things the Europa Orbiter Operating System and Avionics Support team is chartered to:
  - Provide flight device drivers for all X2000 hardware
  - Use these drivers to support the X2000 hardware integration and test
  - Provide test tool support for testing / exercising the X2000 hardware
Software Overview

- To achieve these ends the following have been developed:
  - Abstract Device Model (ADM)
    - An object oriented framework containing the common code for implementing drivers such as I/O queuing, I/O completion notification, event reporting
  - Concrete instantiations of the ADM for each of the X2000 devices
  - A complimentary implementation called "Command Lists" which enables repetitive execution and allows commands for various devices to be executed with specified temporal relationships
  - A test tool called LLE (Low Level Exerciser) useful for both software and hardware test
Software overview cont

- Portability
  - Primary target is VxWorks, nevertheless we are maintaining portability
  - Minor portions of the code such as hooking interrupts are necessarily OS-dependent
  - All other OS interaction is done using a wrapper called ACE (Adaptive Computing Environment) from the University of Washington
    - ACE is ported to many environments
  - We currently do much of our software testing under Solaris using simple software simulators instead of hardware
  - Full bit-level simulator hooks in place, simulators to be developed in the future.
  - All drivers in C++
Abstract Device Model

• General goals:
  – Provide a uniform functional interface across a set of device drivers
  – Provide general-purpose methods to handle sets of related I/O operations
  – Provide a flexible framework for device driver implementation
Abstract Device Model

- Use objects to represent actions
  - Command objects represent I/O operations.
  - Action objects represent how a user is to be notified of an asynchronous operation’s completion.

- Use a Command/Handler model
  - Users (clients) send Commands with attached Action objects to a Handler that executes the command and uses the Action objects to perform the notification of completion.
  - Actions can set semaphores, do callbacks, set bits, virtually anything
Abstract device model

Operation Description

ACE Event

Cmd Actn

Cmd Actn

TRIO Handler

I2C Handler

I2C Handler

I2C Handler

1394 Handler

Other Handler

CommandList

Start Time

Cycle Time

Phase Handler Cmd Actn

Phase Handler Cmd Actn

Phase Actn

User Func

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Device drivers

- DIO
  - 4 separate drivers, 1394, I2C, UART and “Custom logic” (timers, discretes)

- SIA
  - Incorporates instrument and telecom interfaces

- NVM
  - There is a filesystem layer planned in addition to the driver

- TRIO

- PSS

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1394 Hardware Abstraction Layer (HAL)

- Provides access to all 1394 hardware features
- Implemented mostly in C
  - C++ parts can be replaced by C code
- Less abstract than the ADM interface
  - ADM interface is implemented on top of the HAL
  - ADM Interface a higher-level view of the isochronous and asynchronous operations and contains address space management.
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Test tools

Low Level Exerciser (LLE)

Solaris

LLE GUI

Scripts

Logs

Cooperating App

Solaris, Windows

VxWorks, etc

VxWorks Target

LLE Interface

TCL

ADM Device Drivers

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Test Tools

• LLE GUI implemented in TCL/TK
  – Provides command input, script input, timestamped logging to file and the screen
  – Provides interfaces to two external applications for transfer of commands and output
  – Can interleave commands / output from both
  – Not actually dependent on ADM or other programs, could be used with any application that can send and receive via a socket
Test tools

- On the target we run a TCL interpreter (V8.0)
- ADM drivers register TCL commands to exercise I/O operations, build and maintain command lists, verify data and I/O status, etc.
- TCL commands / scripts can be loaded including complex procedure definitions
- Scripts have access to the full TCL language as well as the additional commands created by the drivers
- Not specifically dependent on the LLE GUI, can be operated by any TCP/IP-aware application (sometimes we use telnet for software test).
Test Tools

- Support by the LLE GUI for an additional application
- Allows another application to participate in the test
- In our application for the PSS the application is a logic analyzer interface program
- Can be any application which can take input and display output via a socket
- This implementation is currently in progress
CPU Performance measurement

- We have developed a VxWorks-specific package to monitor performance
- Uses the PPC 750 performance monitoring registers
- Collects statistics on a per-task basis
- Reports CPU time, # of instructions, L1 cache rate, memory use (malloc / free)
- Currently being enhanced to report 1394, I2C and SIA bus traffic
- Summarizes output
- Reports to screen or file
- Intended for eventual flight use
Development status

- All device drivers are nearing completion
  - All of them run on the X2000 hardware, being debugged in parallel with the hardware debug
- LLE is operational and being used extensively for hardware and software test
  - Currently adding additional interface
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Low Level Exerciser (LLE)

- Cooperating App: Solaris, Windows, VxWorks, etc.
- TCP/IP
- LLE GUI
- Solaris
- Scripts
- Logs

VxWorks Target

- LLE Interface
- TCL
- ADM Device Drivers
- X2000 Hardware

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