eCos in commercial use - the Sinar eMotion

Outline

- Introduction
- Sinar eMotion
- Overview Operating Systems
- Application Design
- eCos
- Development Environment
- Roundup

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Jenoptik Laser, Optik, Systeme GmbH
Jenoptik LOS GmbH / Sensor Systems

- located in Jena, Germany, „Saalecon Valley“
- 500 employees
- highly specialized products
- digital cameras, thermography cameras, optical modulators and more
Sinar eMotion characteristics

eCos in the Sinar eMotion

- Digital back for medium format cameras
- 22 and 33 megapixel 14 bit CCD sensors
- Up to 50 images/minute
- 6 GB internal flash for up to 120 raw image files
- CF card, Firewire
- Compatible to Hasselblad H1, Sinar m, generic X contact, Mamiya 645 AFD, Contax 645
A typical microscopy camera - ProgRes

eCos in the Sinar eMotion

tethered operation only
MS Windows, Mac OS X, Linux
high quality raw images
high frame rates
GPIO interfacing
C Compiler, no OS

CCD sensor
FPGA
Firewire

16bit uC

<< 1 MB RAM
<< 1 MB Flash
Hardware concept and requirements

eCos in the Sinar eMotion

- fast startup, < 5 s
- fast interrupt response, < 125 us
- Firewire, CF + FAT16/32 driver
- high data throughput
- simple GUI, i18n
- optimized image processing
- safe update mechanism
- high quality raw images
**Roll-your-own**
- high effort, 1 developer, untested -> buggy, no support, no drivers, no docs, ...

**QNX, VxWorks**
- high initial costs, no previous experience
- commercial RTOS, “high end”, some drivers/software available
- local commercial support

**RTEMS**
- open source RTOS, some drivers/software available
- no experience/contacts, no local commercial support
Embedded Operating Systems (2)

**eCos in the Sinar eMotion**

**Linux**
- long startup time (5..10s), very complex, no RTOS, separation kernel/userspace
- (only) some experience, firewire driver?
- community and local commercial support, many drivers/software available

**Windows CE**
- only up to 32 MB per process, separation kernel/userspace, royalties
- no experience, commercial RTOS, medium costs, firewire driver?
- local commercial support, many drivers/software available

**eCos**
- not too many users/developers
- open source RTOS, some drivers/software available
- low cost, Linux synthetic target, fast startup, direct hardware access, easy firewire driver porting, community and local commercial support
eCos – the embedded Configurable operating system

- started by Cygnus, then RedHat, now eCosCentric Inc.
- one static application image, runnable in RAM and ROM („XIP“)
- multithreaded RT kernel, single user, single process
- GNU toolchain: reliable and standard conformant C/C++ compiler
- highly portable: x86, ARM, MIPS, PowerPC, Sparc and more
- small footprint, e.g. ARM7 40 Mhz with 32 KB RAM, 64 KB ROM
- development platforms Linux and Windows/cygwin
- C library: input/output, math, etc., parts of POSIX
- FreeBSD TCP/IP stack
- highly configurable
Application architecture

eCos in the Sinar eMotion

eCos with C++ app

Messagebus

Hardware

Camera Interface

Acquisition Control

CFStorage

FirewireControl

GUIControl

FPGA Register

FPGA DSR

CF/FAT driver

Firewire driver

GUI Library

Hasselblad

Sinar

Mamiya

FPGA ISR
Usage of eCos in the eMotion (1)
eCos in the Sinar eMotion

Timeline
- Linux synthetic target + Qvfb -> develop without hardware
- Bootloader „Redboot“ running after two weeks

Realtime issues
- eCos enables realtime applications
- deterministic scheduler, highest priority thread runs
- sync. primitives: mutex, semaphore, message queue, condition and more
- multi-stage interrupt handling: ISR -> DSR (Deferred service routine) -> thread
- avg. interrupt response time: 5 us (PXA 255, 200 Mhz)
- no dynamic memory allocation in the kernel (neither in the application)

Licensing
- GPL + exception: allows closed source application and 3rd party software
- no GPL (or LGPL) software usable with closed source application
Usage of eCos in the eMotion (2)
eCos in the Sinar eMotion

GUI
- simple custom GUI with i18n
- Alternatives:
  - SwellSoftware PEG (Portable Embedded GUI), commercial
  - MiniGUI (Beijing Feynman Software Inc.), GPL/commercial
  - MicroWindows, free (Mozilla Public License)
    drawing primitives, X API, e.g. FLTK, Win32 API
  - not appropriate: PicoGUI (dead), Qt/E (quite big)

Drivers
- custom drivers for SPI, I2C, FPGA, display, keys
- since 2005/2006: SPI and I2C framework in eCos
- Firewire: Jenoptik driver ported
- CF + FAT16/32: commercial 3rd party driver
- CF/MMC driver with FAT16/32 in eCos
Development environment

eCos in the Sinar eMotion

- **Linux**: KDevelop, CuteCom
- **Windows**: cygwin, Eclipse/Programmers Notepad, Insight, Terminal Bray++
- **CMake** buildsystem
  - **Linux**: Makefiles and KDevelop projects
  - **Windows**: cygwin and nmake Makefiles
- **eCos from cvs**
Debugging eCos in the Sinar eMotion

- `CYG_TRACE(bool, <format str>, args); CYG_ASSERT(bool, <format str>);`
- Debugging via gdb: serial line, ethernet
- Windows: Insight, Eclipse
- Linux: Insight, Eclipse, KDevelop, ddd, kdbg
- JTAG debuggers: Abatron BDI2000, Ronetix PEEDI: gdb compatible
Software quality measures

**eCos in the Sinar eMotion**

- Source control system: `cvs`
- Bug and issue tracking: `Trac` ([http://trac.edgewall.org](http://trac.edgewall.org))
- `CMake` -> easy integration with Dart2 ([http://www.cmake.org](http://www.cmake.org))
  - continuous and nightly builds including unit tests

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**4 Files Changed** by 2 Authors as of 2007-02-10 01:00 GMT

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Roundup
eCos in the Sinar eMotion

- eMotion shipping since 2005, more projects in work
- core components stable and basically bug free
- instant startup (<< 1 s, application dependent)
- community and commercial support available
- low system complexity - easy transition from non OS projects
- suited for single purpose devices
- configurability – partly *many* preprocessor directives
- GPL+exception: good for the companies, bad for contributing back
- thorough patch review – eCos cvs always stable, but slow progress
- Contributions: some bug fixes, failsafe update mechanism, USB 2.0 support pending