



Milkymist System-on-Chip

The architecture for the FLOSS world

Sébastien Bourdeauducq

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Open Hardware?

- ▶ Open source software is already well known...
- ▶ Among many hackers and artists: trend for “open source hardware”
- ▶ What is it, exactly?

Some (bad) examples

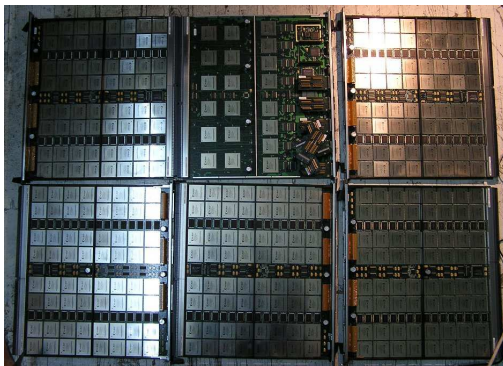
- ▶ Arduino and Beagleboard projects
- ▶ What is “open”?
 - ▶ Freely modifiable/redistributable/manufacturable/...
schematics and circuit board
 - ▶ Ahah, come on! every chip manufacturer has been giving them away for decades!
 - ▶ By the way, did you know Beagleboard was run by Texas Instruments?
 - ▶ Big community of tinkerers, open source tools, community support
 - ▶ But is the hardware itself open?
- ▶ The real technical magic is inside the chip (Atmel's AVR or Texas Instruments's OMAP)
- ▶ And it could not be more closed and proprietary!

Let's make our own open chip then!

- ▶ But isn't manufacturing a chip horribly expensive?
 - ▶ Hell, it is...
 - ▶ The cost of setting up the foundry for a complex chip reaches millions of euros
 - ▶ Fablabs/Hacker-run foundry anyone? (let's be ambitious!)
 - ▶ But, seriously...?
- ▶ Use reconfigurable logic!
 - ▶ FPGAs can "emulate" any digital circuit
 - ▶ Okay, FPGA design tools are proprietary...
 - ▶ but the circuit itself can be free and portable
 - ▶ Reverse engineering anyone? (hard but easier than the aforementioned foundry)

I was told that...

- ▶ Aren't FPGAs still expensive (high per-unit cost), plus low-density, slow and bulky?
- ▶ That was the case 10 years ago...



Debunking the myth

- ▶ FPGA per-unit cost is falling, and their density and speed are increasing
- ▶ Careful system design runs fast...
- ▶ and uses FPGA resources with a fair efficiency.
 - ▶ Even though “hard” chip:
 - ▶ faster, fewer transistors than the equivalent FPGA
 - ▶ but NRE cost is today a show-stopper
- ▶ “Large Scale Integration” absorbs the cost of the FPGA by reducing the number of chips on the board.

The architecture for the FLOSS world

- ▶ Milkymist features a custom, free System-on-Chip design
 - ▶ which also brings about technical advantages
 - ▶ large scale integration
 - ▶ performance
 - ▶ size
- ▶ Works like AVR (Arduino) or OMAP (Beagleboard)
- ▶ Works on FPGAs – reconfigurable silicon
 - ▶ enables everyone to modify and test the design
- ▶ Portable code – small effort to port to all FPGA vendors, even to make a fully “hard” chip
- ▶ Most of the code (which directly generates the electronic circuit) is GNU GPL v3 licensed

What makes it specific?

- ▶ The MilkyMist System-on-Chip (SoC) contains a general-purpose Linux-capable computer.
 - ▶ Embedded computer: like the AVR microcontroller
 - ▶ Difference between “microcontroller” and “SoC”: only about performance and complexity
 - ▶ Fuzzy border



VJ-friendly built-in features

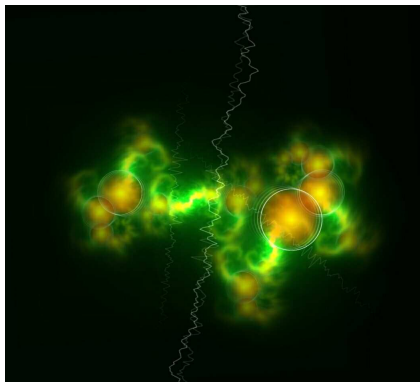
- ▶ Video output (VGA)
- ▶ Video input (PAL/NTSC)
- ▶ AC'97 audio
- ▶ Control interfaces
 - ▶ Ethernet (OpenSoundControl) + MIDI
 - ▶ DMX512
 - ▶ USB
 - ▶ IR remote control
 - ▶ Generic I/O
- ▶ Hardware graphics acceleration
 - ▶ PFP (similar to a vertex shader)
 - ▶ Texture Mapping Unit
- ▶ **All this with a minimal number of additional chips, and with a truly open design**

Development tools

- ▶ The System-on-Chip is very flexible (software controlled)
- ▶ Like most computer systems, you can program it in C/C++
- ▶ Linux operating system is optional
- ▶ GCC is capable of compiling programs for the Milkymist SoC
 - ▶ currently requires a patch
 - ▶ the upcoming GCC 4.5 will have built-in support for compiling Milkymist software
- ▶ Interpreted languages (Python, Ruby, ...) can probably be easily ported

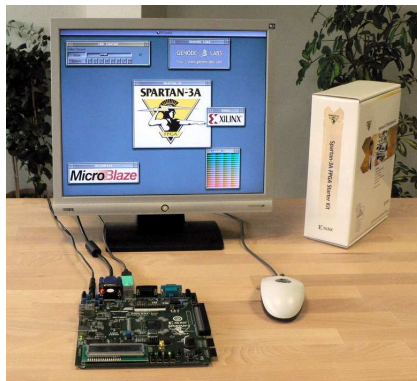
Intended application

- ▶ The intended use is to implement a VJ application
- ▶ Inspired by the popular MilkDrop program for PCs



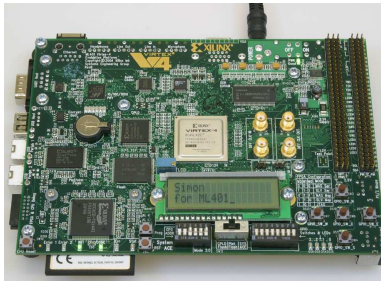
Genode FX GUI toolkit

- ▶ <http://www.genode-labs.com>



Generic FPGA development boards

- ▶ Works on development boards from FPGA vendors
- ▶ Xilinx ML401
- ▶ Not all interfaces are supported



Custom board

- ▶ A custom board is being developed
- ▶ All interfaces will be there!
- ▶ PCB prototypes should be ready in a couple of months
 - ▶ completing all FPGA and software development will take more
 - ▶ stay tuned...

Thank you for your attention

- ▶ Web: <http://www.milkymist.org>
 - ▶ documented source code (GPLv3 licensing)
 - ▶ binary kits (to get started fast on a generic FPGA board)
 - ▶ mailing list
 - ▶ wiki (with suggested contributions)
 - ▶ blog
 - ▶ these slides are online
- ▶ Mail: [sebastien.bourdeauducq \[AT\] lekernel DOT net](mailto:sebastien.bourdeauducq@lekernel.net)

Questions?