OpenHW design trend: A survey

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Abstract

The last few years witnessed very good improvements in the software industry and protocols. This was achieved by many programmers who made the source code of their SW available for everyone. HW designers are now trying to follow the same model to prevent companies from monopolizing the technologies. This led to the introduction of open free HW designs. The ***OpenHW*** designs will improve the overall design methodologies and reusability through the intensive verifications and reviews. It will also open new markets and business models.

1 Introduction

Hi-tech industry becomes more and more important in our life by the daily introduction of new technologies. This puts more pressure on the designers to produce bug free designs in less time. Which in turns, need more time to do the verifications and design checking that is almost impossible for the short time to market. Designers start looking for new concepts that may help them. The best design model is the Linux OS programming which provides the source files for free that can be tested and fixed by anyone. This concept can be adopted to get the ***OpenHW*** design methodology.

2 ***OpenHW*** definition

There are many points to be followed to define the hardware as ***OpenHW*** and ***OpenHW*** design.[5]

- **Information on using the hardware and software interfaces must be available:**
  It means all information needed to interface the design from all points

of view should be documented and available for everyone. Some of these information are the registers, the programming information "drivers" of the system, the sockets, connectors and its pin assignments, FPGAs bit streams[1], CPUs' instructions and software tools[2] etc. This is to enable everyone to produce highly optimized designs and to prevent the monopoly on the interfaces.
The Open Hardware Certification Program[4] says:

"... is a self-certification program for hardware manufacturers. By certifying a hardware device as Open, the manufacturer makes a set of promises about the availability of documentation for programming the device-driver interface of a specific hardware device.... sufficient documentation for the device must be available for a competent system programmer to write a device-driver."

- **The availability of the hardware design.**
  The hardware designs should be available for free, where all EDA design files, HDLs, block diagrams or any kind of hardware design description files or documents are made free. This is the same as the open software where all source files are published and made available for free. Some companies and organizations have started to follow this approach like Sun that published the source of picoJava processor.[8]

3 Needs and advantages of *OpenHW* designs

OpenHW designs trend become more popular to satisfy the technology and market progress. It comes to solve many problems of current design and marketing methodologies. It allows the competition between the designs themselves rather than the companies. The main advantages and facilities ***OpenHW*** can offer are:

1. The development time and cost of new systems can be reduced by using reusable verified open design cores where the debugging process is shared between many designers.

2. Through Open designs, people start cooperating to produce extreme good designs rather than competing. The low resources available for them will lead also to high optimized designs

[1] Xilinx old XC6200 family is the only family that has a documented bit stream format
[2] Xilinx CPLDs can be implemented using the webfitter or web pack and Altera has a software version of its tools for some CPLDs

3. Open designs will help people to debug their systems and to fix them easily which increase system reliability and will lead to easily repaired appliances. This gives the devices the best support and very wide distribution.

4. Open designs will use the extra power of retired, work-less, enthusiastic people who has some free time. Students can show and prove their ideas through ***OpenHW*** . These designs can be tested and studied by many people and give their comments to improve the design.

5. ***OpenHW*** can solve some bugs caused by bad management ideas followed by companies. Like the paranoia which makes companies divide designs between teams and stop information sharing between them and the public. This, in turns, prevents the design recreation by the designers. [6]

6. There are many advantages for open Hardware design in business. For more detailed description refer to the Business case section.

7. Open designs will live almost forever. When the design becomes open, anyone can improve it and adopt it for his needs. This will lead to the intensive use and continuous development of the design for ever even if it is not exactly like the original design.

8. The designs can be used for educational purposes that will lead to design improvement.

To summarize,***OpenHW*** design methodology will lead to improve the overall technology by allowing rapid prototyping, testing and lot of feedbacks from the designers.

4 Problems and solutions of *OpenHW*

There are many problems facing designers and prevent them from following the ***OpenHW*** methodology.

1. **Cost of EDA tools:** individuals can not afford commercial EDA tools. This makes OpenSW developers start developing free EDA tools such as gEDA[9] and Alliance[10] which enables ***OpenHW*** designers to work at home.

2. **Cost of manufacture:** HW manufacturing is relatively expensive, so ***OpenHW*** designers can use simulation or programmable logic devices to check their designs.

3. **Design protection:** no one in the world likes to give his ideas and work for free, unless there is some kind of control and protection over his work. Currently there are some groups on the net who try to define some kind of protection. One of these groups, is the OpenIPCore Project [3] which has several suggestion like "openNDA, GNU like license, OpenPatents ... etc".

5 Business case of *OpenHW*

OpenHW designs can be very important in the business field because of many advantages described earlier. ***OpenHW*** can be closer to the customers' requirements because they themselves can help in the definition of the design specifications. The SoC industry will get the advantages of the re-usability of openIP cores resulted from many bug fixes and design reviews. ***OpenHW*** designs reduce the paranoia of companies that care about design and IP security.

6 *OpenHW* business models

The ***OpenHW*** concept will lead to the emergence of new business models that depend on:

1. **Design distribution** where companies can pack set of designs and sell the distribution.

2. **Design support** experts can give support for ***OpenHW*** designs.

3. **Design implementation** companies can implement the designs and sell them.

4. **Programmable logic** devices and boards can increase their market.

7 *OpenHW* The road map

The ***OpenHW*** road map can be divided into three main stages. If we can follow these stages we will have new industrial and technological revolution.

1. **Simple prototyping boards:** A set of small generic prototyping boards can be designed to test small IP cores. The designers will use the available free tools which give lot of feedback to the EDA developers.

2. **Advanced boards and IP Cores:** Designers will publish ***OpenHW*** cores and ***OpenSource*** software for the boards. The boards will be much advanced in this stage and new companies will emerge that depend on selling the fabrication of the ***OpenHW*** boards. So anyone can download the design files from the Internet and implement it on one of the prototyping boards. At the end of this stage FPGA and CPLD companies will publish the programming technique or provide free tools for their devices.

3. **Run time Configurable logic systems:** will be more popular in this stage where relation between the software and hardware will change. The user will not feel if the program he is running is executing instructions of the host PC or if new hardware is being created on the board. The use of this idea will produce new free software-hardware compilers and new design methodologies.

8 Methodology

Release early, Release often, and listen to the customers.
The previous statement is the best one that can describe the open hardware design methodology. It means that ***OpenHW*** designs should be published as soon as possible even if they are not fully debugged, not fully conform with the standards or not have all of the final features or marketing requirements. This has many advantages because the design reaches the customers in very short time and then lots of feedback will be given by the customer. These comments will be included in the next version very soon which make the customer "end user" define what he/she wants from the hardware. This approach also reduces the costs of intensive debugging and R&D.
This approach is used very much in the Open software industry where programmers produce monthly versions if not daily and give them very good performance and standardization.[7]

9 Conclusion

The ***OpenHW*** concept is not only a design methodology, it is also a management scheme and business trend. ***OpenHW*** yields highly optimized and reliable designs. They will be reusable designs and the source for all future designs and technology information. ***OpenHW*** will be very close to customers' needs and give them the fastest design updates.

10 Examples of *OpenHW* designs

- *F-CPU project* The Freedom CPU. The first open processor that is designed over the Internet.[6]
- *Sun processors.* It provided the verilog source of the picoJava and sparce processor.[8]
- *OpenCores Projects* Develops several IP Cores and board designs.[11]
- *Free-IP Cores project*s Develops several IP Cores.[12]
- *OpenPPC Project* The aim of this project is to develop a free PowerPC board design.[13]
- *Leon-2 processor* Full VHDL design of a Sparc processor under GNU License.[14]

References

[1] Industry Analysis Paper "http://pages.nyu.edu/ gmp216/papers/bmfosh-1.0.htm"

[2] Business Models for Open Source Hardware Design. "http://pages.nyu.edu/ gmp216/papers/bmfosh-1.0.htm"

[3] OpenIPCore Project site "http://www.openip.org/oc/"

[4] The Open Hardware Certification Program. Sponsored by the FSF, Debian, and FreeBSD. "http://www.debian.org/OpenHardwre"

[5] OpenCollector site "http://collector.hscs.wmin.ac.uk"

[6] F-CPU manual. "http://f-cpu.tux.org"

[7] Linux Operating system "http://www.linux.org"

[8] Sun Microsystems "http://www.sun.com"

[9] gEDA site "http://www.geda.seul.org"

[10] Alliance site "http://www-asim.lip6.fr/alliance"

[11] OpenCores site. "http://www.opencores.org"

[12] Free IP site. "http://www.free-ip.com"

[13] OpenPPC mother board site "http://www.openppc.org"

[14] Leon-2 processor site. "http://www.estec.esa.nl/wsmwww/leon"