AUDIOBULLDOG

(Almost) Free Development System for Professional Audio

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Abstract

In this paper authors describe reasons why various audio hardware design and business concepts failed and even furthermore slowed down development of professional audio hardware. Various marketing approaches accompanied with a lack of technical standards as well as technical and legal rules that will foster manufacturers to obey rigorous technical standards led a vast majority of audio industry to stagnation and loss of quality strategy towards increase of quality, improvements of technical specifications and finding better price/value relationship. Authors create development system that may be helpful in design of free audio hardware that would be used in professional audio applications as well as in related disciplines. Authors use free software (see content of GPL, LGPL and BSD licenses) as well as software packages that are free of charge in hardware design that is aimed to be freely distributable among potential users, scholars, scientists, music enthusiasts and those who might be interested in audio hardware design and implementation.

Introduction

Despite the fact that authors of this text are people from various disciplines with various approaches to audio and audio hardware, they have many things in common when reconsidering future of relationship between manufacturer and capabilities of end user. Their experience, scientific and artistic rigor led them to detection of many problems related with audio hardware design and conclusion that some radical changes in approaching hardware design and implementation of audio hardware are needed.

Technical inconsistencies

Understanding of documentation for audio hardware whether it is owner's manual, block diagram, service manual or electronic circuit schematics led us to conclusion that various manufacturers do not obey some very basic hardware

design rules, technical specifications are written according to marketing department requests rather than to correct mathematical calculations and scientific findings. Even more, packing of such devices is arranged with phrases, hidden messages and misleading call-outs for customers, salesmen and those who do not have technical academic background. Such a misconduct and negligence is even present in hardware design of products that are labeled as "professional" or "for studio use".

Actually, we understood that culmination of such a practice is result of continuous negligence by manufacturers, reviewers, technical and university communities as well as agencies that may be responsible for regulation and development of technical standards and legal protection of customers.

Economy as manufacturers understand it is field on which they compete with closed and attractive entities called products. Thus, market became *bellum omnium contra omnes* that is usually consequence of co-existence of closed entities. Consequently, those who survived are those who are more durable. Consumerist approach determined market as a field on which commodities are used, consumed, thrown away and purchased again. Quality turned out to be measured by financial and marketing criteria that according to such business policy is rather oriented towards durability of manufacturer than to criteria that ensure customers that usage of such devices will help them to increase their efficiency in performing their tasks. Closedness is characterized by proprietary elements that consist closed entity called product. Since research and development are often expensive, manufacturers gradually dropped out some very important elements of quality management based on testing, system integration, evaluation and correct consulting and communication with technically educated community and users themselves. In some cases, certain problems i.e. jitter have been analyzed, but hardware design solutions have not been proposed accordingly. Possible solutions were rarely freely discussed thus resulting in quasi – mystical atmosphere around some technical solutions. Consequently, slower development of high quality products is a necessity. On the other side, we are witnessing overwhelming tendency of massive distribution of products without respect of customers right to use and adjust products towards user's needs.

Exchange of knowledge and development

Since genuine development is possible only in atmosphere of free exchange of knowledge we decided to go back to the roots of development – free exchange of knowledge. Hence, ideas of free software and free hardware are our ground on which we base our approach.

Members of our team do have experience in GNU/Linux, BSD, RTEMS; GNU tool chain, VHDL programming, embedded hardware design, FPGA based digital hardware design, use of professional audio equipment and studio equipment in artistic work. Our consensus and decision to undertake alternative

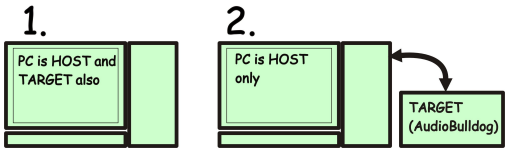
approach resulted in project AudioBulldog. AudioBulldog is project based on careful analysis of pitfalls and mistakes by various manufacturers including their pitfalls of product conception, hardware design, marketing strategy and technical inconsistencies.

First of all, our basic premises are:

- Hardware should be designed according to high quality technical standards
- Hardware should be made of the best available components available on the market
- Hardware should be fully programmable and controllable so the user or any skilled person may adjust it towards user's needs
- Hardware should be designed in a way that it can be fully controllable and upgradeable by free software developed for various purposes
- Hardware should be upgradeable and usable even after period of its production
- The basic precondition for development and upgrade of existing free hardware and development of future free hardware is free exchange of knowledge through various telecommunication means as well as on the seminars, conferences, symposia and other ways of gathering of people that are interested in free hardware design
- Each person or company who do have intention to manufacture such a hardware should obey GPL, LGPL or BSD license depending which license is used by author in order to define license regulation of certain hardware design
- Free hardware design must be based on free documentation that is consisted on detailed and precise instructions to build, manufacture, use and service certain piece of hardware
- Free hardware should be designed in a way that its manufacture, upgrade and servicing does not require technology which is extremely hard and expensive to realize
- Free hardware should be whenever needed and possible (re)configurable

Difference and similarities between free software and free hardware

We are aware that our work is pioneering one and that it is before all, necessary to create fundamental basis for the development of free hardware. Thus, we decided to create a development system that we call AudioBulldog. Comparably to software which needs compiler, debugger, editor and hardware on which it will try to run (as far as free software is concerned it is usually personal computer on which we develop such a free software), free hardware design needs free (cross)tools, fully programmable processing and controlling components, free hardware platform on which it will be tested, free applications and personal computer on which we develop software and full design of free hardware.



Picture 1. – *Difference between free software and free hardware approach*

Free hardware platform should be consisted of elements that are necessary for functionality of any target system.

Case Study: AudioBulldog

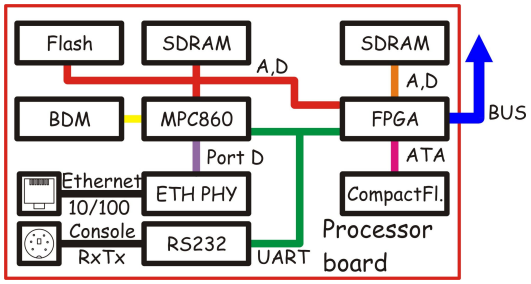
In our case we speak about audio system and therefore AudioBulldog is consisted of processor board, audio board, simple user interface board, microphone preamplifier, headphone amplifier and monitoring system. Since AudioBulldog is aimed for the development of free audio hardware that will be relatively easy to manufacture, (re)configure, upgrade and service, we used the highest quality components that are available on a regular market of chips. We used analog design where it was needed, but also we used digital design when functionality of a part of audio system requires digital design. Our idea is to avoid design methods that are extremely expensive and very hard to realize, hard or impossible to (re)configure and control by the user. Though there are some widely known designs of analog audio components, our criteria for digital domain is that all preconditions for design should be based on the fact that such a digital design should have all necessary functional parts as much as possible free.

For that matter, our processor board is based on MPC860 (PowerPC based) because of manifold reasons. This processor is very powerful 32bit integrated communication controller that meets the following criteria:

- Availability of GNU/LINUX port for MPC860
- Availability of RTEMS RTOS port for MPC860
- Availability of GNU cross – tool chains
- Freely available In Circuit Emulator (ICE is very important

since it provides full control of processor even if it is blocked. This is very important for debugging and developing purposes.)

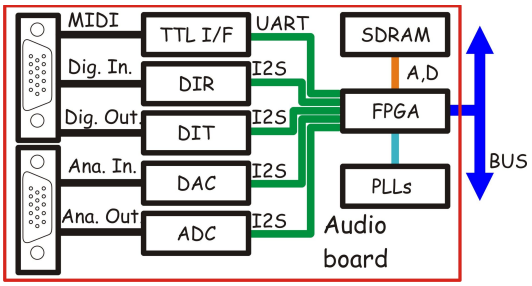
- BDM functionality (Background Debugging Mode), which is very important since it, enables designer/user to fully control processor through ICE adapter/cable. It is important to note that personal computers that we use in everyday work do not have such controllability as this processor and even in the case that something is wrong with PC it is not possible to control it via serial port, since serial port in that case is out of operation too.
- MPC860 is rich with communication interfaces (Ethernet, I2C, IrDA, MII, UART, HDLC, SPI, TDM, etc.) included in chip. In the case of AudioBulldog, ports of MPC860 are connected to FPGA thus; enabling user to control and (re)configure all unused MPC860 ports through/with FPGA. MPC860 does have one port that is dedicated to 10/100 Ethernet, which enabled us to control processor board via Ethernet.



Picture 2. – *AudioBulldog processor board block schematic*

Processor board and its functionality should be managed and controlled by FPGA also, but they can share their controls. Compact flash connector is connected to FPGA on processor board (ATA interface).

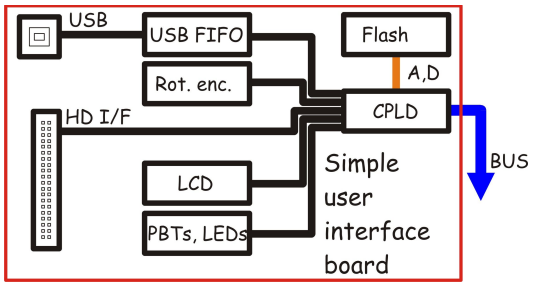
Processor board is connected via expansion connector with audio board that is also fully controllable via another FPGA, which will perform DSP algorithms. Audio board does have on it important audio interfaces including analog I/O (with ADC and DAC chips), digital I/O (with DIR and DIT chips) and MIDI.



Picture 3. – *AudioBulldog audio board block schematic*

Simple user interface board, which is consisted of:

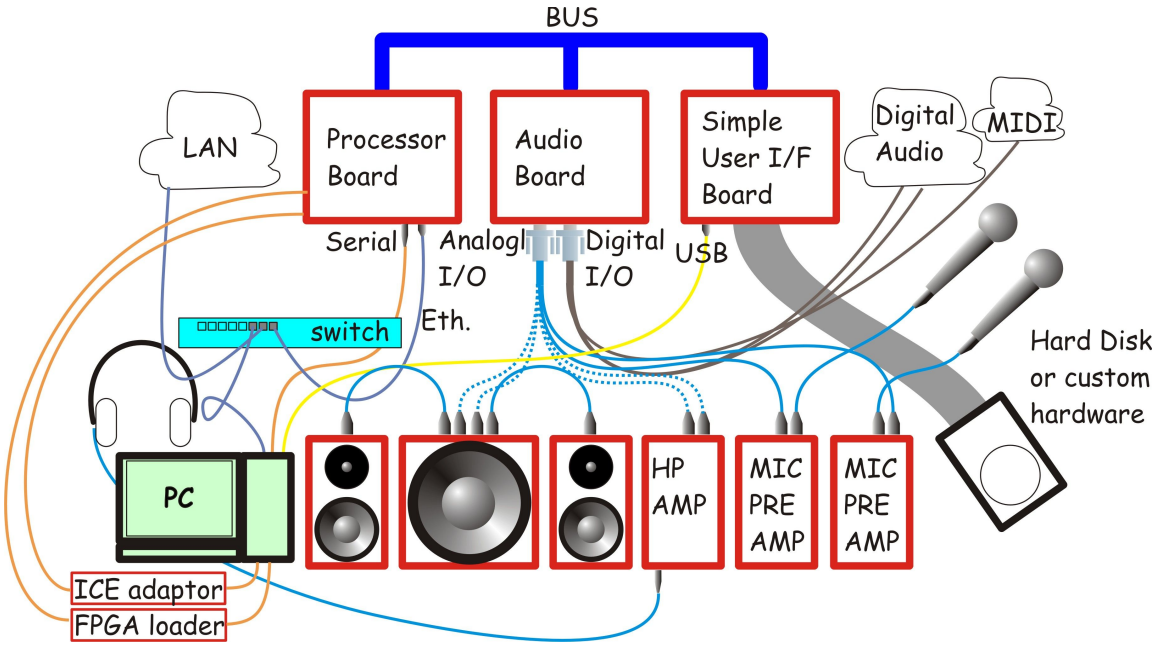
LCD display, programmable push buttons, LEDs, rotary encoder, USB and hard disk 40-pin connector. Its main purpose is to control processor board and audio board. Hard disk connector enables connecting a standard hard disk or any custom hardware board (pins on the connector are not dedicated to hard disk only). Signal throughput, which flows through expansion bus, is controlled by CPLD chip, which is fully programmable.



Picture 4. – *AudioBulldog simple user interface board block schematic*

Processor board, audio board and simple user interface board communicate with each other via expansion bus.

Highly professional grade quality microphone preamplifier and headphone amplifier are developed also, and should be connected to audio board. They are based on high quality analog design and they can operate as stand alone devices too. Although active loudspeakers are still in planning stage we will complete our development system by building free hardware active monitors that may be built by high quality components that are available on the market.



Picture 5. – *AudioBulldog connection example*

Conclusion

Our case study showed that it is possible to design free audio development platform that can meet basic criteria of free hardware and that may pass very rigorous professional testing and technical consistency tests in terms of design, usability, reliability and respect for user's needs. We hope that such an approach will find its place in wider engineering and developer's communities that will be open for communication with users themselves.