Q-STAR TEST
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REPORT

TITLE:

Exploiting System Re-configurability to Minimize HW/SW Co-Design Risk

AUTHOURS: Stefaan Kerckenaere
Hans Manhaeve

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L.Bauwensstraat 20, B-8200 Brugge, Belgium, Tel.: +32 50 319273, Fax: +32 50 312350, http://www.Qstar.be

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1 Abstract

Consider a system that consists of a hardware and a software layer and whereby the HW layer makes use of programmable building blocks. The objective of the approach documented is to exploit the re-configurability of a programmable part being present in the system to verify/debug/optimize as much as possible the HW part of the system without the need for the final (embedded) SW part to be ready. To do so the basic functionality of the system that will be exploited by the embedded SW, to be developed by the SW team, is identified. Firmware is developed that mimics the functionality identified and placed in an easy to manage smaller microcontroller developed by the HW team. As such all the bugs present in the HW part (analog as well as digital) can be fully debugged by the time the advanced SW part needs to be introduced and tested. This approach reduces the co-design risk as a clear and uniform rendezvous point is defined between both domains in the form of transferring/copying identical communication functionality from one domain to the other. It also shortens time to market as both the HW and SW teams can work concurrently. By the time the SW is ready for debugging, the HW can be fully debugged decreasing the complexity of inter-domain system bugs. This approach has been successfully implemented and the system specification characterization was fully done by the time the first software shakedown occurred. This enabled also an early datasheet hardware specification section completion as well.

2 Background

A high level block schematic of the application in which this approach is used is shown in figure 1. Three major blocks are identified: an ARM processor, an AVR microcontroller and essential analog parts and AD and DA convertors. The whole application communicates to a PC via an I2C communication interface. The embedded software that runs on the ARM processor is designed by the SW team. The HW and the microcontroller firmware are designed by the HW team. In this case a microcontroller is used, but the same approach can be deployed if the programmable part of the HW is a CPLD or a FPGA. Figure 2 illustrates the application diagram on functional level. The SW team is responsible for high level functions (green block), PC communication functions (yellow block), Advanced HW functions (purple block) and MCU glue functions (blue block). The HW team is responsible for the processor glue functions (blue block) and the basic HW functions (gray block) on the level of the MCU and the basic and advanced functions in the discrete HW section.

The case on which this approach has been validated is a joint product development based on HW/SW co-design. The HW & SW teams are from different companies. The HW related developments are done by Q-Star Test, whereby the development of the embedded SW running on the ARM processor is the responsibility of the Q-Star Test customer. Parts of the HW functions are controlled by the SW.

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Hence, debugging of the HW is strongly dependent on the on the availability of the SW components. Also SW issues/bugs can complicate the HW debug operation.

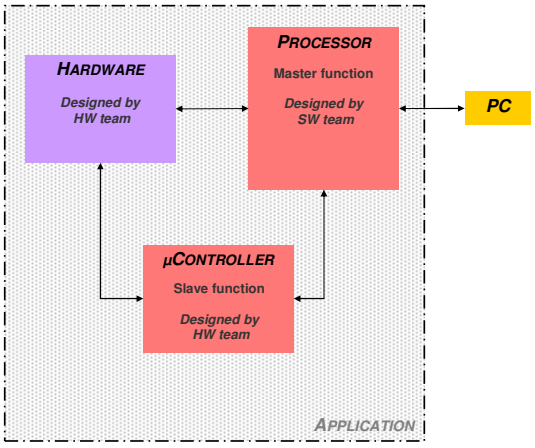

Figure 1 Engineering team level application block schematic

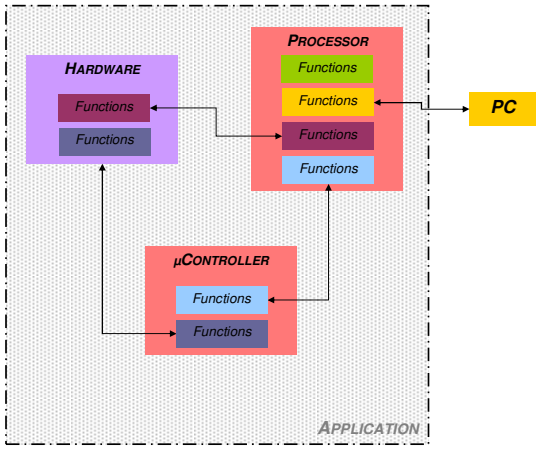

Figure 2 Function level application block schematic

3 Work plan

To introduce an independency in the debugging of both the HW and SW part, the reconfiguration options of the microcontroller are being exploited. The focus lies on the reuse of logic control circuitry to implement test functions, allowing to test most of the HW part without SW but without changing the system functionality. To do so only elementary functionality that is copied from the main SW specifications (the SW is to be developed by the software team) and placed in an easy to manage smaller microcontroller developed by the HW team. As such all the bugs present in the HW part (analog as well as digital) can be fully debugged by the time the advanced SW part needs to be introduced and tested.

After debugging the HW, the MCU content is reverted to its original content making the system ready for the SW debugging phase.

4 Results

Figure 3 shows the application diagram in which the ARM processor is bypassed. The PC communication functions (yellow block) and advanced HW functions (purple block) are duplicated. As such the HW team can fully control the HW section and perform the necessary debugging and characterization test.

This approach has been successfully implemented. By the time the SW was ready for debugging, the HW was fully debugged. No serious inter-domain system bugs occurred. The system specification characterization was fully done by the time the first software shakedown occurred. This enabled also an early datasheet hardware specification section completion as well.

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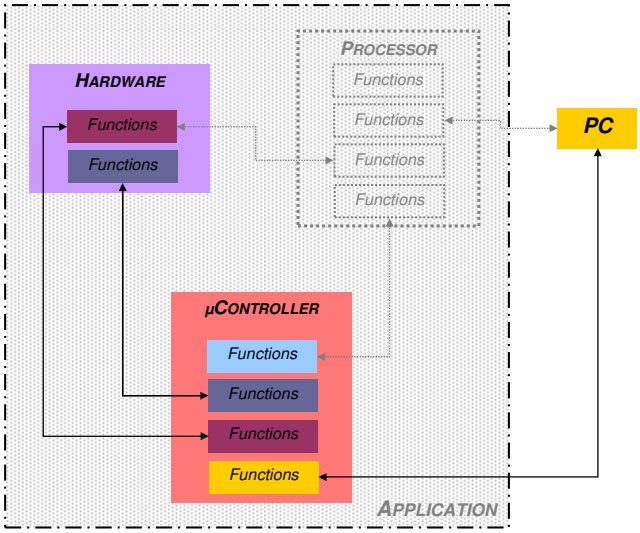

Figure 3 Bypassed processor application block schematic

5 Conclusions

The objective of the approach documented was to exploit the re-configurability of a programmable part being present in the system to verify/debug/optimize as much as possible the HW part of the system without the need for the final (embedded) SW part to be ready.

To encompass this, firmware is developed that mimics the basic functionality and placed in an easy to manage smaller microcontroller developed by the HW team. Using this approach enabled the HW team to debug/test/characterize the HW part (analog as well as digital) independently from the SW team.

By the time the advanced SW, developed by the SW team, is ready for debugging, the HW was be fully debugged decreasing the complexity of inter-domain system bugs. This approach has been successfully implemented and the system specification characterization was fully done by the time the first software shakedown occurred. This enabled also an early datasheet hardware specification section completion as well.

This approach reduces the co-design risk as a clear and uniform rendez-vous point is defined between both domains in the form of transferring/copying identical communication functionality from one domain to the other. It also shortens time to market as both the HW and SW teams can work concurrently.

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