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FPGA based Sensor Systems

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ABSTRACT

In this paper, we present FPGA sensor system designs and implementations based on standalone platforms or also on combination of microcontroller. Modern FPGAs are having many challenges, for that several types of algorithms are proposed in terms of speed and power consumption compared to micro controller. FPGA plays key role in sensor networks. Different capabilities in FPGAs are Cryptography, self testing and data compression.

Keywords: FPGA (Field Programmable Gate Array), sensor Networks, Cryptography, Data Compression.

I. INTRODUCTION

In Previous days, wireless sensor networks are used in military applications based on identification, classification and tracking objects, images in the battle field. It is also used in agriculture, medicine, industrial control etc in environmental monitoring applications.

FPGA configuration is specified using Hardware Description Language (HDL) just like used in Application Specific integrated circuit (ASIC). Some of the industry's foundational concepts and technologies for programmable logic arrays gates and logic blocks.

Here we go in detail with the current capacities of FPGAs of 3 main vendors Altera, Xilinx and Actel.

Altera and Xilinx are continued unchallenged and it is quickly grew from 1985 to mid 1990. After 1993 Actel was serving about 18% of the market.

fig: Xilinx

Xilinx changing the ASIC / FPGA paradigm to several market and technology dynamics, those are:

- Development time is more in ASIC based on its complexity.
- Development cost is increasing in Integrated Circuits.
- Decreasing the R& D resources
- Revenue losses for slow time to market are increasing.
- Financial constraints are having poor economy, which are driving low cost technologies.

fig: Altera

II. DIFFERENT CAPABILITIES OF MODERN FPGA.

2.1: FPGA vs ASIC

FPGAs are made up of collection of logic blocks in the form of bidimensional array. Logical blocks have look up tables (LUTs). It is constructed over simple memories, store boolean functions. LUT have a fixed number of inputs and it is combined with multiplex and flip flop, used to build sequential circuits in order to implement complex functions.

We used an Application-specific integrated circuit (ASIC) in a number of products where a microcontroller used too much power. It was a fairly simple device, a couple of hundreds gates, and had to consume less than 100 nA static, which for microcontrollers at the time was not possible. Price was comparable to a microcontroller due to high quantities.

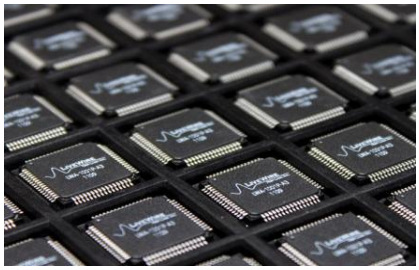

Fig: ASIC chips

III. CHALLENGES AND TRENDS IN WIRELESS SENSOR NODES

It has several limitations in use of FPGAs in sensor nodes architecture. It claims the power consumption of FPGA is made not suited to be part of sensor nodes. It is also concentrated on, HDLs and VHDLs. Those are not properly described the complexity of the sensor node.

3.1: Strong Cryptography for Sensor Nodes

It provides strong authentication, replay protection primitives, confidentiality.

To implement this software, ASIC have some limitations like use microcontroller in commercial nodes. They work at low frequency to reduce the energy consumption.

So applications are considered when data must be authenticated, encrypted or decrypted. So that battery can be depleted. Another one is giving security protocols and algorithms, which are relatively high frequency. Some software's are rapidly outdated.

FPGA have two main **advantages**:

One is the embedded resources of FPGA such as block RAM and DSP slices are used to for instance, accelerate arithmetic operations, reductions in Galois Field (GF).

Second one is Dynamic reconfiguration, it plays key role into reducing the obsolescence of cryptographic primitives. Partial reconfigurations are used in order to change, for instance, the curve parameters of ECC implementations in hardware.

3.2 Heterogeneous Sensor Networks

These are supporting many physical layers. System for the Vigilance of the Amazon is based on different types of sensors such as environmental sensors, radars and imaging systems. Such networks, miscellaneous sensors and data sources called heterogeneous sensor networks. Which consists of high speed links like low speed measurements like ground sensors and high speed links.

These are used to reduce network bandwidth, energy consumption nodes with many network interfaces.

IV. SUMMARY

4.1 Commercial Sensor Nodes

These are allowing better understanding of FPGA based nodes or sensor nodes to improve and impact on it, connected with coprocessors of FPGA.

4.2 FPGA Standalone Sensor Nodes

These are high power consumption (221mW, 2850 mW, 700mW). At that time, FPGA can deplete the battery in very low time. We can't give possibility to switching the board in sleep mode when it is not working.

The proposed standalone sensor nodes are used for obtaining an estimation of the power consumption. Research on the static power consumption of the platforms can be done via XPE and EPE tools with no configuration. But these are not suited for sensor node construction.

V. CONCLUSION

In this paper, FPGA are used to delete the difference between commercial nodes and research nodes using extended processing capabilities.

There are 3 groups of sensor nodes: FPGA coprocessors for experimental nodes and combinations of microcontrollers and FPGAs.

It supports for the strong cryptography and multiple interfaces implementations.

In future, FPGA plays key role on construction of sensor nodes. So that power consumption and cost are reduced.

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