

# 1. A fast and accurate network-on-chip timing simulator with a flit propagation model

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7059108&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7059108&queryText=noc&sortType=desc_p_Publication_Year&searchField=Search_All)

## Abstract:

Network-on-chip (NoC) can be a simulation bottleneck in a many-core system. Traditional cycle-accurate NoC simulators need a long simulation time, as they synchronize all components (routers and FIFOs) every cycle to guarantee the exact behaviors. Also, a NoC simulation does not benefit from transaction-level modeling (TLM) in speed without any accuracy loss, because the transaction timings of a simulated packet depend on other packets due to wormhole switching. In this paper, we propose a novel NoC simulation method which can calculate cycle-accurate timings with wormhole switching. Instead of updating states of routers and FIFOs cycle-by-cycle, we use a pre-built model to calculate a flit's exact times at ports of routers in a NoC. The results of the proposed simulator are verified with NoC implementations (cycle-accurate at RTL) created by a commercial NoC compiler. All timing results match perfectly with packet waveforms generated by above NoCs (with 40-325 times speed up). As another comparison, the speed of the simulator is similar or faster (0.5-23X) than a TG2 NoC model, which is a SystemC and transaction-level model without timing accuracy (due to ignoring wormhole traffics).

# 2. A Methodology for Cognitive NoC Design

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7128666&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7128666&queryText=noc&sortType=desc_p_Publication_Year&searchField=Search_All)

## Abstract:

The number of cores in a multicore chip design has been increasing in the past two decades. The rate of increase will continue for the foreseeable future. With a large number

of cores, the on-chip communication has become a very important design consideration. The increasing number of cores will push the communication complexity level to a point where managing such highly complex systems requires much more than what designers can anticipate for. We propose a new design methodology for implementing a cognitive network-on-chip that has the ability to recognize changes in the environment and to learn new ways to adapt to the changes. This learning capability provides a way for the network to manage itself. Individual network nodes work autonomously to achieve global system goals, e.g., low network latency, higher reliability, power efficiency, adaptability, etc. We use fault-tolerant routing as a case study. Simulation results show that the cognitive design has the potential to outperform the conventional design for large applications. With the great inherent flexibility to adopt different algorithms, the cognitive design can be applied to many applications.

### 3. A packet-switched interconnect for many-core systems with BE and RT service

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092531&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092531&queryText=noc&sortType=desc_p_Publication_Year&searchField=Search_All)

**Abstract:**

A packet-switched interconnect design which supports real-time and best-effort services is proposed. This interconnect is different from traditional NoCs in that we use direction channels to replace the large input buffers and use less resource to realize the network transfer. The connection between our interconnect design and IP core is an on-chip memory management block named DME. The real-time service implies preferential transfer channel allocation, maximum delay bound and time stamping of every real-time packet. The solution is geared towards many-core systems, such as complex industrial control systems and communication devices, which require these features to facilitate efficient SW and application development.

### 4. FPGA based design of low power reconfigurable router for Network on Chip (NoC)

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092531&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092531&queryText=noc&sortType=desc_p_Publication_Year&searchField=Search_All)

**Abstract:**

FPGA based design of reconfigurable router for NoC applications is proposed in the present work. Design entry of the proposed router is done using Verilog Hardware Description Language (Verilog HDL). The router designed in the present work has four channels (namely, east, west, north and south) and a crossbar switch. Each channel consists of First in First out (FIFO) buffers and multiplexers. FIFO buffers are used to store the data and the input and output of the data are controlled using multiplexers. Firstly, south channel is designed which includes the design of FIFO and multiplexers. After that, the crossbar switch and other three channels are designed. All these designed channels, FIFO buffers, multiplexers and crossbar switches are integrated to form the complete router architecture. The proposed design is simulated using Modelsim and the RTL view is obtained using Xilinx ISE 13.4. Xilinx SPARTAN-6 FPGAs are used for synthesis of proposed design. Power dissipation of the proposed reconfigurable router is reduced using Power gating technique. Total power is calculated by the use of XPower Analyzer tool. Obtained results show that the proposed design consumes less power compared to the previously designed reconfigurable routers.

## 5. Reliable router architecture with elastic buffer for NoC architecture

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7050463&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=5&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7050463&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=5&searchField=Search_All)

**Abstract:**

Router is the basic building block of the interconnection network. In this paper, new router architecture with elastic buffer is proposed which is reliable and also has less area and power consumption. The proposed router architecture is based on new error detection mechanisms appropriate for dynamic NoC architectures. It considers data packet error detection, correction and also routing errors. The uniqueness of the reliable router architecture is to focus on finding error sources accurately. This technique differentiates permanent and transient errors and also protects diagonal availabilities. Input and output buffers in router architectures are replaced by elastic buffers. Routers spend considerable area and power for router buffer. In this paper the proposed router architecture replaces FIFO buffers with the elastic buffers in order to reduce area, and power consumption and also to have better

## 6. Design and analysis of 10 port router for network on chip (NoC)

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7087013&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=5&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7087013&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=5&searchField=Search_All)

### Abstract:

Network on chip is an emerging technology which provides data reliability and high speed with less power consumption. With the technological advancements a large number of devices can be integrated into a single chip. So the communication between these devices becomes vital. The network on chip (NoC) router is used for such communication. This paper focuses on the design analysis of 10 port router. The delay (2.571ns) and power (80.98mW) is minimized by using crossbar switch. The proposed architecture of 10 port router is simulated and synthesized in Xilinx ISE 14.4 software.

## 7. Concentration and Its Impact on Mesh and Torus-Based NoC Performance

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092745&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=2&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7092745&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=2&searchField=Search_All)

### Abstract:

This paper investigates the effects of concentration on the performance of k-ary n-cubes. Simulation results indicate that only large ratios of packet length-to-average hop-count are in favor of concentrated mesh and torus. The Cmesh takes full advantage of its high channel bandwidth to outperform Ctorus. Moreover, non-local traffic suffers more from performance bottleneck than local traffic at routers. Providing dedicated input ports, one for each IP, at routers, reduces the average packet latency compared to a configuration with a single input port shared by all IP cores of the cluster.

## 8. Effect of core ordering on application mapping onto mesh based network-on-chip design

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7100274&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=2&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7100274&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=2&searchField=Search_All)

### Abstract:

This paper presents a mapping strategy onto mesh based Network-on-Chip (NoC) architecture by using combined techniques such as Particle Swarm Optimization (PSO) and constructive heuristic. To arrive at a better solution, the basic PSO has been augmented further. That is, it runs the PSOs multiple times. The mapping result has been compared, in terms of communication cost, with an exact method such as Integer Linear Programming (ILP) and other methods. Experiment results show improvement with other approaches.

## 9. Merged switch allocation and transversal with dual layer adaptive error control for Network-on-Chip switches

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7050468&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=2&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7050468&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=2&searchField=Search_All)

### Abstract:

In this paper, we propose a Network on Chip router architecture with increased reliability, energy efficiency and with reduced area overhead. The proposed router architecture model adjusts dynamically to the error control strengths of the layers of NoC. In this paper, we target to optimize the combined operations of arbiter and multiplexer by using a Merged Arbiter Multiplexer (MARX) along with a dual layer cooperative error control protocol. By doing so, the number of pipe line stages, area and power consumed is reduced. We use XY Routing algorithm to send data from one router to the other when these routers are placed in network architecture. The proposed model outperforms the dual layer error control model without MARX unit. The router architecture with MARX unit has 22.7% less area and 2.4% less energy consumption than router architecture without MARX unit but has moderate increase in the delay.

## 10. Argo: A Real-Time Network-on-Chip Architecture With an Efficient GALS Implementation

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7064728&queryText=noc&sortType=desc\\_p\\_Publication\\_Year&pageNumber=3&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7064728&queryText=noc&sortType=desc_p_Publication_Year&pageNumber=3&searchField=Search_All)

### Abstract:

In this paper, we present an area-efficient, globally asynchronous, locally synchronous network-on-chip (NoC) architecture for a hard real-time multiprocessor platform. The NoC implements message-passing communication between processor cores. It uses statically scheduled time-division multiplexing (TDM) to control the communication over a structure of routers, links, and network interfaces (NIs) to offer real-time guarantees. The area-efficient design is a result of two contributions: 1) asynchronous routers combined with TDM scheduling and 2) a novel NI microarchitecture. Together they result in a design in which data are transferred in a pipelined fashion, from the local memory of the sending core to the local memory of the receiving core, without any dynamic arbitration, buffering, and clock synchronization. The routers use two-phase bundled-data handshake latches based on the Mousetrap latch controller and are extended with a clock gating mechanism to reduce the energy consumption. The NIs integrate the direct memory access functionality and the TDM schedule, and use dual-ported local memories to avoid buffering, flow-control, and synchronization. To verify the design, we have implemented a 4 x 4 bitorus NoC in 65-nm CMOS technology and we present results on area, speed, and energy consumption for the router, NI, NoC, and postlayout.

## 11. High Speed Modified Booth Encoder Multiplier for Signed and Unsigned Numbers

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6205523&queryText=multiplicier&newsearch=true&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6205523&queryText=multiplicier&newsearch=true&searchField=Search_All)

**Abstract:**

This paper presents the design and implementation of signed-unsigned Modified Booth Encoding (SUMBE) multiplier. The present Modified Booth Encoding (MBE) multiplier and the Baugh-Wooley multiplier perform multiplication operation on signed numbers only. The array multiplier and Braun array multipliers perform multiplication operation on unsigned numbers only. Thus, the requirement of the modern computer system is a dedicated and very high speed unique multiplier unit for signed and unsigned numbers. Therefore, this paper presents the design and implementation of SUMBE multiplier. The modified Booth Encoder circuit generates half the partial products in parallel. By extending sign bit of the operands and generating an additional partial product the SUMBE multiplier is obtained. The Carry Save Adder (CSA) tree and the final Carry Look ahead (CLA) adder used to speed up the multiplier operation. Since signed and unsigned multiplication operation is performed by the same multiplier unit the required hardware and the chip area reduces and this in turn reduces power dissipation and cost of a system.

## 12. Design and implementation of $16 \times 16$ multiplier using Vedic mathematics

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7150925&queryText=multiplic&sortType=desc\\_p\\_Publication\\_Year&pageNumber=2&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7150925&queryText=multiplic&sortType=desc_p_Publication_Year&pageNumber=2&searchField=Search_All)

**Abstract:**

This paper briefly describes the Urdhva-Tiryagbhyam Sutra of vedic mathematics and we have designed multiplier based on the sutra. Vedic Mathematics is the ancient system of mathematics which has a unique technique of calculations based on 16 Sutras which are discovered by Sri Bharti Krishna Tirthaji. In this era of digitalization, it is required to increase the speed of the digital circuits while reducing the on chip area and memory consumption. In various applications of digital signal processing, multiplication is one of the key component. Vedic technique eliminates the unwanted multiplication steps thus reducing the propagation delay in processor and hence reducing the hardware complexity in terms of area and memory requirement. We implement the basic building block:  $16 \times 16$  Vedic multiplier based on Urdhva-Tiryagbhyam Sutra. This Vedic multiplier is coded in VHDL and synthesized and simulated by using Xilinx ISE 10.1. Further the design of

array **multiplier** in VHDL is compared with proposed **multiplier** in terms of speed and memory.

## 13. Low power multiplier architectures using vedic mathematics in 45nm technology for high speed computing

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7045662&queryText=multiplier&sortType=desc\\_p\\_Publication\\_Year&pageNumber=4&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7045662&queryText=multiplier&sortType=desc_p_Publication_Year&pageNumber=4&searchField=Search_All)

### Abstract:

Speed and the overall performance of any digital signal processor are largely determined by the efficiency of the **multiplier** units present within. The use of Vedic mathematics has resulted in significant improvement in the performance of **multiplier** architectures used for high speed computing. This paper proposes 4-bit and 8-bit **multiplier** architectures based on Urdhva Tiryakbhyam sutra. These low power designs are realized in 45 nm CMOS Process technology using Cadence EDA tool.

## 14. Design of area and power aware reduced Complexity Wallace Tree multiplier

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7087207&queryText=multiplier&sortType=desc\\_p\\_Publication\\_Year&pageNumber=4&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7087207&queryText=multiplier&sortType=desc_p_Publication_Year&pageNumber=4&searchField=Search_All)

### Abstract:

**Multiplier** is a vital block in high speed Digital Signal Processing Applications. With the more advance techniques in wireless communication and high-speed ULSI techniques in recent era, the more stress in modern ULSI design under which main constraints are Power, Silicon area and delay. In all the high-speed application to Very Large Scale Integration fields, fast speed and less area is required. There are two approaches to improve the speed of **multipliers** namely booth algorithm and other is Wallace tree algorithm.

Generally, **multipliers** require high latency during the partial products addition and conventional **multipliers** have more stages so delay is more. However, in this paper, the work has been done to reduce the area by using energy efficient CMOS Full Adder. To implement the high-speed **multiplier**, Wallace tree **multiplier** is designed and it is a three-



stage operation, which again leads to lesser number of stages and subsequently less number of transistors. Moreover the gate count is significantly reduced. **Multipliers** and their associated circuits like half adders, full adders and accumulators consume a significant portion of most high-speed applications. Therefore, it is necessary to increase their performance as well as size efficiency by customization. In order to reduce the hardware complexity which ultimately reduces an area and power, Energy Efficient full adders plays a vital role in Wallace tree **multiplier**. Reduced Complexity Wallace **multiplier** (RCWM) will have fewer adders than Standard Wallace **multiplier** (SWM). The Reduced complexity reduction method greatly reduces the number of half adders with 65-75 % reduction in an area of half adders than standard Wallace **multipliers**.

## 15. FPGA implementation of vedic floating point multiplier

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7091534&queryText=multiplicier&sortType=desc\\_p\\_Publication\\_Year&pageNumber=4&searchField=Search\\_All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7091534&queryText=multiplicier&sortType=desc_p_Publication_Year&pageNumber=4&searchField=Search_All)

### Abstract:

Most of the scientific operation involve floating point computations. It is necessary to implement faster **multipliers** occupying less area and consuming less power. **Multipliers** play a critical role in any digital design. Even though various multiplication algorithms have been in use, the performance of Vedic **multipliers** has not drawn a wider attention. Vedic mathematics involves application of 16 sutras or algorithms. One among these, the Urdhva tiryakbhyam sutra for multiplication has been considered in this work. An IEEE-754 based Vedic **multiplier** has been developed to carry out both single precision and double precision format floating point operations and its performance has been compared with Booth and Karatsuba based floating point **multipliers**. Xilinx FPGA has been made use of while implementing these algorithms and a resource utilization and timing performance based comparison has also been made.

## 16. FPGA based design of low power reconfigurable router for Network on Chip (NoC)

IEEE 2015

[http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7148581&queryText=router&sortType=desc\\_p+Publication+Year&pageNumber=3&searchField=Search+All](http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7148581&queryText=router&sortType=desc_p+Publication+Year&pageNumber=3&searchField=Search+All)

**Abstract:**

FPGA based design of reconfigurable **router** for NoC applications is proposed in the present work. Design entry of the proposed **router** is done using Verilog Hardware Description Language (Verilog HDL). The **router** designed in the present work has four channels (namely, east, west, north and south) and a crossbar switch. Each channel consists of First in First out (FIFO) buffers and multiplexers. FIFO buffers are used to store the data and the input and output of the data are controlled using multiplexers. Firstly, south channel is designed which includes the design of FIFO and multiplexers. After that, the crossbar switch and other three channels are designed. All these designed channels, FIFO buffers, multiplexers and crossbar switches are integrated to form the complete **router** architecture. The proposed design is simulated using Modelsim and the RTL view is obtained using Xilinx ISE 13.4. Xilinx SPARTAN-6 FPGAs are used for synthesis of proposed design. Power dissipation of the proposed reconfigurable **router** is reduced using Power gating technique. Total power is calculated by the use of XPower Analyzer tool. Obtained results show that the proposed design consumes less power compared to the previously designed reconfigurable **routers**.

## 17. VHDL Implementation of Genetic Algorithm for 2-bit Adder

**Abstract:**

Future planetary and deep space exploration demands that the space vehicles should have robust system architectures and be reconfigurable in unpredictable environment. The Evolutionary design of electronic circuits, or Evolvable hardware (EHW), is a discipline that allows the user to automatically obtain the desired circuit design. The circuit configuration is under control of Evolutionary algorithms. The most commonly used evolutionary algorithm is Genetic Algorithm. The paper discusses on Cartesian Genetic Programming for evolving gate level designs and proposes Evolvable unit for 2-bit adder based on Genetic Algorithm

## 18. An Area- and Energy-Efficient FIFO Design Using Error-Reduced Data Compression and Near-Threshold Operation for Image/Video Applications

IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS

**Abstract:**

Many image/video processing algorithms require FIFO for filtering. The FIFO size is proportional to the length of the filters and input data width, causing large area and power consumption. We have proposed an energy- and area-efficient FIFO design for image/video applications through FIFO with error-reduced data compression (FERDC) and near-threshold operation. On architecture level, FERDC technique is proposed to reduce the size and power consumption of the FIFO by utilizing the spatial correlation between neighboring pixels and performing error-reduced data compression together with quantization to minimize the mean square error (MSE). On circuit level, nearthreshold operation is adopted to achieve further power reduction while maintaining the required performance. To demonstrate the proposed FIFO, it has been implemented using a 0.18- $\mu\text{m}$  CMOS process technology. The implementation covers different FIFO length, including 128, 256, 512, and 1024. The experimental results show that the proposed FIFO operating at 0.5 V and 28.57 MHz achieves up to 99%, 65%, and 34.91% reduction in dynamic power, leakage power, and area, respectively, with a small MSE of 2.76, compared with the conventional FIFO design. The proposed FIFO can be applied to a wide range of image/video signal processing applications to achieve high area and energy efficiency.

## 19. An Area- and Power-Efficient FIFO with Error-Reduced Data Compression for Image/Video Processing

IEEE 2014

**Abstract:**

Filtering is a key component of many digital image/video processing algorithms. It often requires FIFO to temporarily buffer the pixels data for later usage. The FIFO size is proportional to the length of the filters and input data width, causing large area and power consumption. This paper presents a technique named FIFO with error-reduced data compression (FERDC) to reduce the FIFO size for various filters. The proposed FERDC significantly reduces the area and power consumption while keeping the error metrics such as mean square error (MSE) and peak signal to noise ratio (PSNR) in the acceptable range. Simulation results of a two dimensional wavelet filter shows that the proposed FERDC technique achieves the FIFO size reduction of up to 44.44% with PSNR values larger than 39 dB, which leads to the reduction of at least 31.6% in the dynamic power and 44.44% in the leakage power.

## 20. DESIGN AND ANALYSIS OF FIVE PORT ROUTER FOR NETWORK ON CHIP

**Abstract:**

With the technological advancements a large number of devices can be integrated into a single chip. So the communication between these devices becomes vital. The network

on chip (NoC) is a technology used for such communication. A router is the fundamental component of a NoC. This paper focuses on the implementation and the verification of a five port router. The building blocks of the router are buffering registers, demultiplexer, First In First Out registers, and schedulers. The scheduler uses the round robin algorithm. The proposed architecture of five port router is simulated in Xilinx ISE 10.1 software. The source code is written in VHDL.

## 21. Design and verification of five port router for network on chip

IEEE 2014

### Abstract:

Traditional system on chip (SOC) designs offer integrated solutions to exigent design tribulations in areas which necessitate outsized computation and restriction in certain area. Because of the common bus architecture in SOC system, performance becomes sluggish which limits the processing speed. The network on chip (NOC), due to their characteristics such as scalability, flexibility, high bandwidth have been proposed as a valid approach to meet communication requirements in SoC, where common bus architecture replaced by network. The communication on network on chip is carried out by means of router, so for implementing better NOC, the router should be efficiently design. In this paper we present the design and verification of router for Mesh topology using Verilog HDL which supports five parallel connections at the same time. It uses store and forward type of flow control and FSM controller deterministic routing which improves the performance of router. Design unit is targeted to Spartan 3E xc3s500e-4fg320 FPGA device and simulated in XILINX 13.1 Software.

## 22. Hummingbird: Ultra-Lightweight Cryptography

### for Resource-Constrained Devices

### Abstract:

Due to the tight cost and constrained resources of high volume consumer devices such as RFID tags, smart cards and wireless sensor nodes, it is desirable to employ lightweight and specialized cryptographic primitives for many security applications. Motivated by the design of the well-known Enigma machine, we present a novel ultralightweight cryptographic algorithm, referred to as Hummingbird, for resource-constrained devices in this paper. Hummingbird can provide the designed security with small block size and is resistant to the most common attacks such as linear and differential cryptanalysis. Furthermore, we also present efficient software implementation of Hummingbird on the

8-bit microcontroller ATmega128L from Atmel and the 16-bit microcontroller MSP430 from Texas Instruments, respectively. Our experimental results show that after a system initialization phase Hummingbird can achieve up to 147 and 4:7 times faster throughput for a size-optimized and a speed-optimized implementations, respectively, when compared to the state-of-the-art ultra-lightweight block cipher PRESENT [10] on the similar platforms.

## 23. Enhanced FPGA Implementation of the Hummingbird Cryptographic Algorithm

### **Abstract:**

Hummingbird is a novel ultra-lightweight cryptographic algorithm aiming at resource-constrained devices. In this work, an enhanced hardware implementation of the Hummingbird cryptographic algorithm for low-cost Spartan-3 FPGA family is described. The enhancement is due to the introduction of the coprocessor approach. Note that all Virtex and Spartan FPGAs consist of many embedded memory blocks and this work explores the use of these functional blocks. The intrinsic serialism of the algorithm is exploited so that each step performs just one operation on the data. We compare our performance results with other reported FPGA implementations of the lightweight cryptographic algorithms. As far as author's knowledge, this work presents the smallest and the most efficient FPGA implementation of the Hummingbird cryptographic algorithm.

## 24. FPGA-based High-Throughput and Area-Efficient Architectures of the Hummingbird Cryptography

### **Abstract:**

Hummingbird is an ultra-lightweight cryptography targeted for resource-constrained devices such as RFID tags, smart cards and sensor nodes. It has been implemented across different target platforms. In this paper, we present two different FPGA-based implementations for both throughput-oriented (TO) and area-oriented (AO) Hummingbird Cryptography (HC). The throughput-oriented design is optimized for operation speed while the area-oriented design consumes smaller area resource usage. Both proposed designs have been implemented on a Xilinx low-cost Spartan-3 XC3S200 FPGA. When compared with existed methods, the results from the proposed designs show that our designs cost less FPGA slices while the same throughput can be obtained. The proposed architectures are designed to best suit for adding customizable security to embedded control systems

## 25. Remediating the Hummingbird Cryptographic Algorithm

### **Abstract:**

Hummingbird is a recently proposed lightweight cryptographic algorithm for securing RFID systems. In 2011, Saarinen reported a chosen-IV, chosen-message attack on Hummingbird in FSE'11. In this paper, we propose a lightweight remedial scheme in response to the Saarinen's attack. The scheme is quite efficient both in software and hardware since only two cyclic shifts are involved. Using this simple tweak, we can keep the compact design of Hummingbird as well as enhance the security of Hummingbird. Readers are welcome to attack the remedial Hummingbird.

## 26. Low Power Implementation of Hummingbird Cryptographic Algorithm for RFID tag

### **Abstract:**

Hummingbird algorithm is a newly proposed lightweight cryptographic algorithm targeted for low-cost RFID tag. In this paper, we present a hardware implementation of this algorithm using SMIC0.13\_μm CMOS process. Methods are used to reduce the unnecessary clock toggling and data toggling to reduce dynamic power. Simulation results show that the total area of our design is 14,735\_μm<sup>2</sup>. It requires 16 clock cycles to encrypt 16-bit data (an additional 69 clock cycles for initialization is needed), and consumes 1.08\_μw power for 1.2 V power supply at 100 KHz.

## 27. Merged Switch Allocation and Traversal in Network-on-Chip Switches

### **Abstract:**

Large systems-on-chip (SoCs) and chip multiprocessors (CMPs), incorporating tens to hundreds of cores, create a significant integration challenge. Interconnecting a huge amount of architectural modules in an efficient manner, calls for scalable solutions that would offer both high throughput and low-latency communication. The switches are the basic building blocks of such interconnection networks and their design critically affects the performance of the whole system. So far, innovation in switch design relied mostly to architecture-level solutions that took for granted the characteristics of the main building blocks of the switch, such as the buffers, the routing logic, the arbiters, the crossbar's multiplexers, and without any further modifications, tried to reorganize them in a more efficient way. Although such pure high-level design has produced highly efficient switches, the question of how much better the switch would be if better building blocks were available

remains to be investigated. In this paper, we try to partially answer this question by explicitly targeting the design from scratch of new soft macros that can handle concurrently arbitration and multiplexing and can be parameterized with the number of inputs, the data width, and the priority selection policy. With the proposed macros, switch allocation, which employs either standard round robin or more sophisticated arbitration policies with significant network-throughput benefits, and switch traversal, can be performed simultaneously in the same cycle, while still offering energy-delay efficient implementations.

## 28. MIHST: A Hardware Technique for Embedded Microprocessor Functional On-Line Self-Test

### **Abstract:**

Testing processor cores embedded in systems-on-chip (SoCs) is a major concern for industry nowadays. In this paper, we describe a novel solution which merges the SBST and BIST principles. The technique we propose forces the processor to execute a compact SBST-like test sequence by using a hardware module called Microprocessor Hardware Self-Test (MIHST) unit, which is intended to be connected to the system bus like a normal memory core, requesting no modification of the processor core internal structure. The benefit of using the MIHST approach is manifold: while guaranteeing the same or higher defect coverage of the traditional SBST approach, it reduces the time for test execution, better preserves the processor core Intellectual Property (IP), does not require the system memory to store the test program nor the test data, and can be easily adopted for non-concurrent on-line testing, since it minimizes the required system resources. The feasibility and effectiveness of the approach were evaluated on a couple of pipelined processors.

## 29. A Practical NoC Design for Parallel DES Computation

### **Abstract:**

The Network-on-Chip (NoC) is considered to be a new SoC paradigm for the next generation to support a large number of processing cores. The idea to combine NoC with homogeneous processors constructing a Multi-Core NoC (MCNoC) is one way to achieve high computational throughput for specific purpose like cryptography. Many researches use cryptography standards for performance demonstration but rarely discuss a suitable NoC for such standard. The goal of this paper is to present a practical methodology without complicated virtual channel or pipeline technologies to provide high throughput Data Encryption Standard (DES) computation on FPGA. The results point out that a mesh-based NoC with packet and Processing Element (PE) design according to DES specification can achieve great performance over previous works. Moreover, the deterministic XY routing algorithm shows its competitiveness in high throughput NoC and

the West-First routing offers the best performance among Turn-Model routings, representatives of adaptive routing.

## 30. Design of a High Speed FPGA-Based Classifier for Efficient Packet Classification

### **Abstract:**

Packet classification is a vital and complicated task as the processing of packets should be done at a specified line speed. In order to classify a packet as belonging to a particular flow or set of flows, network nodes must perform a search over a set of filters using multiple fields of the packet as the search key. Hence the matching of packets should be much faster and simpler for quick processing and classification. A hardware accelerator or a classifier has been proposed here using a modified version of the HyperCuts packet classification algorithm. A new pre-cutting process has been implemented to reduce the memory size to fit in an FPGA. This classifier can classify packets with high speed and with a power consumption factor of less than 3W. This methodology removes the need for floating point division to be performed by replacing the region compaction scheme of HyperCuts by pre-cutting, while classifying the packets and concentrates on classifying the packets at the core of the network.

## 31. Ultra-High Throughput Low-Power Packet Classification

### **Abstract:**

Packet classification is used by networking equipment to sort packets into flows by comparing their headers to a list of rules, with packets placed in the flow determined by the matched rule. A flow is used to decide a packet's priority and the manner in which it is processed. Packet classification is a difficult task due to the fact that all packets must be processed at wire speed and rulesets can contain tens of thousands of rules. The contribution of this paper is a hardware accelerator that can classify up to 433 million packets per second when using rulesets containing tens of thousands of rules with a peak power consumption of only 9.03 W when using a Stratix III fieldprogrammable gate array (FPGA). The hardware accelerator uses a modified version of the HyperCuts packet classification algorithm, with a new pre-cutting process used to reduce the amount of memory needed to save the search structure for large rulesets so that it is small enough to fit in the on-chip memory of an FPGA. The modified algorithm also removes the need for floating point division to be performed when classifying a packet, allowing higher clock speeds and thus obtaining higher throughputs.

## 32. A STUDY & VHDL IMPLEMENTATION OF REEDSOLOMON ERROR CORRECTING CODES



**Abstract:**

In the present world, communication system which includes wireless, satellite and space communication, reducing error is being critical. During message transferring the data might get corrupted, so high bit error rate of the wireless communication system requires employing to various coding methods for transferring the data. Channel coding for detection and correction of error helps the communication systems design to reduce the noise effect during transmission [1]. In this paper, Reed Solomon (RS) Encoder and Decoder and their VHDL implementation using ModelSim tool is analyzed. RS codes are non- binary cyclic error correcting block codes. Here redundant symbols are generated in the encoder using a generator polynomial  $g(x)$  and added to the very end of the message symbols. Then RS Decoder determines the locations and magnitudes of errors in the received polynomial. The paper covers the RS encoding and decoding algorithm, simulation results.

### 33. Design and Implementation of Reed Solomon Encoder on FPGA

**Abstract:**

Error correcting codes are used for detection and correction of errors in digital communication system. Error correcting coding is based on appending of redundancy to the information message according to a prescribed algorithm. Reed Solomon codes are part of channel coding and withstand the effect of noise, interference and fading. Galois field arithmetic is used for encoding and decoding reed Solomon codes. Galois field multipliers and linear feedback shift registers are used for encoding the information data block. The design of Reed Solomon encoder is complex because of use of LFSR and Galois field arithmetic. The purpose of this paper is to design and implement Reed Solomon (255, 239) encoder with optimized and lesser number of Galois Field multipliers. Symmetric generator polynomial is used to reduce the number of GF multipliers. To increase the capability toward error correction, convolution interleaving will be used with RS encoder. The Design will be implemented on Xilinx FPGA Spartan II.

### 34. Instruction-based high-efficient synchronization in a many-core Network-on-Chip processor

IEEE 2014

**Abstract:**

Parallelized applications running on many-core Network-on-Chip (NoC) processors may consume a great part of execution time to synchronize threads mapped on multiple NoC nodes, if synchronization for NoC processors is not carefully designed. In this paper, we propose an instruction-based synchronization solution applied in a packet-switched many-core NoC processor with 2D mesh grid topology. Return links are added into the on-chip network to transmit acknowledgements of read requests, while a specific instruction SET is designed as instruction set extension to the original pipeline to perform atomic read-modify-write operations. To support various synchronization schemes, a hardware unit SYNC containing globally addressable registers as shared variables is adopted to handle synchronization requests from both local and remote NoC nodes. Additionally, a FIFO located in the SYNC unit can store these synchronization requests to poll on shared variables locally. Thus, network contention due to busy-wait synchronization algorithms is greatly reduced. Synchronization schemes including spinlock, barrier, FIFO spinlock and semaphore are implemented as inline assembly functions. Synthesis results under 55nm process suggest low area and power overhead of the hardware design. Performance of synchronization schemes are evaluated and are compared to results of conventional methods and prior works, showing the proposed solution is of higher efficiency.

## 35. Argo: A Time-Elastic Time-Division-Multiplexed NOC Using Asynchronous Routers

IEEE 2014

### Abstract:

In this paper we explore the use of asynchronous routers in a time-division-multiplexed (TDM) network-on-chip (NOC), Argo, that is being developed for a multi-processor platform for hard real-time systems. TDM inherently requires a common time reference, and existing TDM-based NOC designs are either synchronous or mesochronous. We use asynchronous routers to achieve a simpler, smaller and more robust, self-timed design. Our design exploits the fact that pipelined asynchronous circuits also behave as ripple FIFOs. Thus, it avoids the need for explicit synchronization FIFOs between the routers. Argo has interesting elastic timing properties that allow it to tolerate skew between the network interfaces (NIs). The paper presents Argo NOC-architecture and provides a quantitative analysis of its ability of absorb skew between the NIs. Using a signal transition graph model and realistic component delays derived from a 65 nm CMOS implementation, a worst-case analysis shows that a typical design can tolerate a skew of 1-5 cycles (depending on FIFO depths and NI clock frequency). Simulation results of a  $2 \times 2$  NOC confirm this.

## 36. Efficient round-robin multicast scheduling for input-queued switches

IEEE2014

### Abstract:

The input-queued (IQ) switch architecture is favoured for designing multicast high-speed switches because of its scalability and low implementation complexity. However, using the first-in-first-out (FIFO) queueing discipline at each input of the switch may cause the head-of-line (HOL) blocking problem. Using a separate queue for each output port at an input to reduce the HOL blocking, that is, the virtual output queuing discipline, increases the implementation complexity, which limits the scalability. Given the increasing link speed and network capacity, a low-complexity yet efficient multicast scheduling algorithm is required for next generation high-speed networks. This study proposes the novel efficient round-robin multicast scheduling algorithm for IQ architectures and demonstrates how this algorithm can be implemented as a hardware solution, which alleviates the multicast HOL blocking issue by means of queue look-ahead. Simulation results demonstrate that this FIFO-based IQ multicast architecture is able to achieve significant improvements in terms of multicast latency requirements by searching through a small number of cells beyond the HOL cells in the input queues. Furthermore, hardware synthesis results show that the proposed algorithm can be very efficiently implemented in hardware to perform multicast scheduling at very high speeds with only modest resource requirements.

## 37. An area- and power-efficient FIFO with error-reduced data compression for image/video processing

IEEE 2014

### Abstract:

Filtering is a key component of many digital image/video processing algorithms. It often requires FIFO to temporarily buffer the pixels data for later usage. The FIFO size is proportional to the length of the filters and input data width, causing large area and power consumption. This paper presents a technique named FIFO with error-reduced data compression (FERDC) to reduce the FIFO size for various filters. The proposed FERDC significantly reduces the area and power consumption while keeping the error metrics such as mean square error (MSE) and peak signal to noise ratio (PSNR) in the acceptable range.

Simulation results of a two dimensional wavelet filter shows that the proposed FERDC technique achieves the FIFO size reduction of up to 44.44% with PSNR values larger than 39 dB, which leads to the reduction of at least 31.6% in the dynamic power and 44.44% in the leakage power.

## 38. An Area- and Energy-Efficient FIFO Design Using Error-Reduced Data Compression and Near-Threshold Operation for Image/Video Applications

IEEE 2014

### Abstract:

Many image/video processing algorithms require FIFO for filtering. The FIFO size is proportional to the length of the filters and input data width, causing large area and power consumption. We have proposed an energy- and area-efficient FIFO design for image/video applications through FIFO with error-reduced data compression (FERDC) and near-threshold operation. On architecture level, FERDC technique is proposed to reduce the size and power consumption of the FIFO by utilizing the spatial correlation between neighboring pixels and performing error-reduced data compression together with quantization to minimize the mean square error (MSE). On circuit level, near-threshold operation is adopted to achieve further power reduction while maintaining the required performance. To demonstrate the proposed FIFO, it has been implemented using a 0.18- $\mu\text{m}$  CMOS process technology. The implementation covers different FIFO length, including 128, 256, 512, and 1024. The experimental results show that the proposed FIFO operating at 0.5 V and 28.57 MHz achieves up to 99%, 65%, and 34.91% reduction in dynamic power, leakage power, and area, respectively, with a small MSE of 2.76, compared with the conventional FIFO design. The proposed FIFO can be applied to a wide range of image/video signal processing applications to achieve high area and energy efficiency.

## 39. Design and Implementation of an On-Chip Permutation Network for Multiprocessor System-On-Chip

IEEE 2013

<http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6133316&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F92%2F6387661%2F06133316.pdf%3Farnumber%3D6133316>

**Abstract :**

This paper presents the silicon-proven design of a novel on-chip network to support guaranteed traffic permutation in multiprocessor system-on-chip applications. The proposed network employs a Pipelined circuit-switching approach combined with a dynamic path-setup scheme under a multistage network topology. The dynamic path-setup scheme enables runtime path arrangement for arbitrary traffic permutations. The circuit-switching approach offers a guarantee of permuted data and its compact overhead enables the benefit of stacking multiple networks. A 0.13-  $\mu$ m CMOS test-chip validates the feasibility and efficiency of the proposed design. Experimental results show that the proposed on-chip network

## 40. UnSync: A Soft Error Resilient Redundant Multicore Architecture

IEEE 2013

**Abstract :**

Reducing device dimensions, increasing transistor densities, and smaller timing windows, expose the vulnerability of processors to soft errors induced by charge carrying particles. Since these factors are only consequences of the inevitable advancement in processor technology, the industry has been forced to improve reliability on general purpose Chip Multiprocessors (CMPs). With the availability of increased hardware resources, redundancy based techniques are the most promising methods to eradicate soft error failures in CMP systems. In this work, we propose a novel customizable and redundant CMP architecture (UnSync) that utilizes hardware based detection mechanisms (most of which are readily available in the processor), to reduce overheads during error free executions. In the presence of errors

(which are infrequent), the always forward execution enabled recovery mechanism provides for resilience in the system. The inherent nature of our architecture framework supports customization of the redundancy, and thereby provides means to achieve possible performance-reliability trade-offs in many-core systems. We provide a redundancy based soft error resilient CMP architecture for both write-through and write-back cache configurations. We design a detailed RTL model of our UnSync architecture and perform hardware synthesis to compare the hardware (power/area) overheads incurred. We compare the same with those of the Reunion technique, a state-of-the-art redundant multi-core architecture. We also perform cycle-accurate simulations over a wide range of SPEC2000, and MiBench benchmarks to evaluate the performance efficiency achieved over that of the Reunion architecture. Experimental results show that, our UnSync architecture reduces power consumption by 34.5% and improves performance by up to 20% with 13.3% less area overhead, when compared to Reunion architecture for the same level of reliability achieved.

## **41. FPGA based asynchronous pipelined multiplier with intelligent delay controller**

**IEEE 2008**

### **Abstract:**

In this paper, a novel scheme is proposed for the implementation of FPGA based digital systems using asynchronous pipelining technique. To control the asynchronous data flow between stages, an intelligent controller is designed which decides the delay of each stage depending upon the magnitude of the input data (Data Dependent Delay). The intelligent controller has been designed using NIOS II soft core embedded processor in ALTERA EP2C20F484C7 device. But, in this approach, the maximum operating frequency is limited by the excess of logical elements consumed by the microcontroller and the sequential execution of the C code. Hence, the function of NIOS processor to control asynchronous data flow alone has been chosen and is implemented as an equivalent hardware INTASYCON (INTelligent ASYnchronous CONtroller) using hardware description language and the speed of the circuit was evaluated. To verify the efficacy of the proposed approach, 8times8 Braun array multiplier is implemented as external logic to the INTASYCON. The INTASYCON processor calculates the completion time of each stage (based on the logic depth) and accordingly activates the respective dual edge triggered flipflops to transfer data from one stage to next stage. This approach consumes lower power and also avoids the need for global clock signals and their consequences like skew problems.

## **42. VLSI implementation of visible watermarking for secure digital still camera design**

<http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=1261070&queryText%3Dwatermarking+vlsi>

**Abstract:**

Synopsis: Watermarking is the process that embeds data called a watermark into a multimedia object for its copyright protection. The digital watermarks can be visible to a viewer on careful inspection or completely invisible and cannot be easily recovered without an appropriate decoding mechanism. Digital image watermarking is a computationally intensive task and can be speeded up significantly by implementing in hardware. In this work, we describe a new VLSI architecture for implementing two different visible watermarking schemes for images. The proposed hardware can insert on-the-fly either one or both watermarks into an image depending on the application requirement. The proposed circuit can be integrated into any existing digital still camera framework. First, separate architectures are derived for the two watermarking schemes and then integrated into a unified architecture. A prototype CMOS VLSI chip was designed and verified implementing the proposed architecture and reported in this paper. To our knowledge, this is the first VLSI architecture for implementing visible watermarking schemes.

### **43. Analysis and FPGA implementation of image restoration under resource constraints**

<http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1183952>

**Abstract:**

Programmable logic is emerging as an attractive solution for many digital signal processing applications. In this work, we have investigated issues arising due to the resource constraints of FPGA-based systems. Using an iterative image restoration algorithm as an example we have shown how to manipulate the original algorithm to suit it to an FPGA implementation. Consequences of such manipulations have been estimated, such as loss of quality in the output image. We also present performance results from an actual implementation on a Xilinx FPGA. Our experiments demonstrate that, for different criteria, such as result quality or speed, the best implementation is different as well.

### **44. Design of high speed low power Viterbi decoder for TCM system**

## IEEE 2013

### **Abstract :**

High-speed, low-power design of Viterbi decoders for trellis coded modulation (TCM) systems is presented in this paper. It is well known that the Viterbi decoder (VD) is the dominant module determining the overall power consumption of TCM decoders. We propose a pre-computation architecture incorporated with  $\gamma$ -algorithm for VD, which can effectively reduce the power consumption without degrading the decoding speed much. A general solution to derive the optimal pre-computation steps is also given in the paper. Implementation result of a VD for a rate-3/4 convolution code used in a TCM system shows that compared with the full trellis VD, the precomputation architecture reduces the power consumption by as much as 70% without performance loss, while the degradation in clock speed is negligible.

## 45. CORDIC Designs for Fixed Angle of Rotation

### IEEE 2013

#### **Abstract:**

Rotation of vectors through fixed and known angles has wide applications in robotics, digital signal processing, graphics, games, and animation. But, we do not find any optimized coordinate rotation digital computer (CORDIC) design for vector-rotation through specific angles. Therefore, in this paper, we present optimization schemes and CORDIC circuits for fixed and known rotations with different levels of accuracy. For reducing the area- and time-complexities, we have proposed a hardwired pre-shifting scheme in barrel-shifters of the proposed circuits. Two dedicated CORDIC cells are proposed for the fixed-angle rotations. In one of those cells, micro-rotations and scaling are interleaved, and in the other they are implemented in two separate stages. Pipelined schemes are suggested further for cascading dedicated single-rotation units and bi-rotation CORDIC units for

high-throughput and reduced latency implementations. We have obtained the optimized set of micro-rotations for fixed and known angles. The optimized scale-factors are also derived and dedicated shift-add circuits are designed to implement the scaling. The fixed-point mean-squared-error of the proposed CORDIC circuit is analyzed statistically, and strategies for reducing the error

are given. We have synthesized the proposed CORDIC cells by Synopsys Design Compiler using TSMC 90-nm library, and shown that the proposed designs offer higher throughput, less latency and less area-delay product than the reference CORDIC design for fixed and known angles of rotation. We find similar results of synthesis for different Xilinx field-programmable gate-array platforms.

## 46. A 1.1 GHz 8B/10B encoder and decoder design



**IEEE 2010**

[http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5604943&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxppls%2Fabs\\_all.jsp%3Farnumber%3D5604943](http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5604943&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxppls%2Fabs_all.jsp%3Farnumber%3D5604943)

**Abstract:**

This paper presents a design of 8B/10B encoder and decoder with a new architecture. The proposed 8B/10B encoder and decoder are implemented based on pipeline and parallel processing. The decoder implements an error-undiffusing function. This 8B/10B encoder and decoder can be used in the high-speed interconnection between chips. After being synthesized using CMOS 90nm process, the proposed encoder and decoder achieves the operating frequency over 1.1GHz and occupies the chip area of 1798 $\mu\text{m}^2$  and 1261 $\mu\text{m}^2$ . They each consume 1.8mW and 1.12mW power.

## 47. An 8B/10B encoder with a modified coding table

[http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4746322&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxppls%2Fabs\\_all.jsp%3Farnumber%3D4746322](http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4746322&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxppls%2Fabs_all.jsp%3Farnumber%3D4746322)

**IEEE 2009**

**Abstract:**

This paper presents a design of 8B/10B encoder with a modified coding table. The proposed encoder has been designed based on a reduced coding table with a modified disparity control block. After being synthesized using CMOS 0.18  $\mu\text{m}$  process, the proposed encoder shows the operating frequency of 343 MHz and occupies the chip area of 1886  $\mu\text{m}^2$  with 189 logic gates. It consumes 2.74 mW power. Compared to conventional approaches, the operating frequency is improved by 25.6% and chip area is decreased to 43%.

## 48. Configurable Pipelined Gabor Filter implementation for fingerprint image enhancement

## IEEE 2010

### Abstract:

In this paper a novel Gabor filter hardware scheme for the fingerprint image enhancement is presented. For each pixel of the image, we use accurate local frequency and orientation to generate the corresponding convolution kernel and thus achieve a better enhancement effect. And Compared to the previous works, our design yields a higher throughput which is due to the pipeline techniques. Moreover the proposed design can be reconfigured to fulfill the different requirements. Evaluation results demonstrate that, when convolution kernel size is 11h11, our design can achieve 2MPixels/s @ 250MHz, and equivalent gate count is 63.8k at SMIC 0.13um worst process corner. Indeed, it's very suitable for the embedded fingerprint recognition system.

## 49. Fingerprint Verification Using Gabor Co-occurrence Features

IEEE2010

### Abstract:

The biometric techniques based on face, iris and fingerprints are used in order to provide strong security. Out of which, Fingerprint identification effects far more positive identifications of persons worldwide than any other human identification procedure. The most widely used minutia based techniques find difficulty in matching the two finger prints with unregistered minutia points and also it is difficult to extract complete ridge structures in finger prints automatically. This paper presents an efficient Gabor Wavelet Transform (GWT) based algorithm for finger print verification for personal identification. This GWT based method provides the local and global information in fixed length fingercode. The finger print matching is done by means of finding the Euclidean distance between the two corresponding Finger codes and hence matching is extremely fast. Key words: Biometrics, FingerCode, fingerprint classification, Gabor filters

## 50. Finger-knuckle-print: A new biometric identifier

IEEE 2009

### Abstract:

This paper presents a new biometric identifier, namely finger-knuckle-print (FKP), for personal identity authentication. First a specific data acquisition device is constructed to capture the FKP images, and then an efficient FKP recognition algorithm is presented to process the acquired

data. The local convex direction map of the FKP image is extracted, based on which a coordinate system is defined to align the images and a region of interest (ROI) is cropped for feature extraction. A competitive coding scheme, which uses 2D Gabor filters to extract the image local orientation information, is employed to extract and represent the FKP features. When matching, the angular distance is used to measure the similarity between two competitive code maps. An FKP database was established to examine the performance of the proposed system, and the experimental results demonstrated the efficiency and effectiveness of this new biometric characteristic

## 51. MIHST: A Hardware Technique for Embedded Microprocessor Functional On-Line Self-Test

IEEE 2013

### Abstract

Testing processor cores embedded in Systems-onChip (SoCs) is a major concern for industry nowadays. In this paper, we describe a novel solution which merges the SBST and BIST principles. The technique we propose forces the processor to execute a compact SBST-like test sequence by

using a hardware module called Microprocessor Hardware SelfTest(MIHST) unit, which is intended to be connected to the system bus like a normal memory core, requesting no modification of the processor core internal structure. The benefit of using the MIHST approach is manifold: while

guaranteeing the same or higher defect coverage of the traditional SBST approach, it reduces the time for test execution, better preserves the processor core Intellectual Property (IP), does not require the system memory to store the test program nor the test data, and can be easily adopted for non-concurrent on-line testing, since it minimizes the required system resources. The feasibility and effectiveness of the approach were evaluated on a couple of pipelined processors.

## 52. Area and time efficient hardwired pre - shifted bi-rotation CORDIC design

IEEE 2014

### Abstract:

This paper deals with an optimization schemes and CORDIC circuit for fixed and known rotations different level of accuracy. For reducing area and time complexity. This paper proposed hard wired, pre-shifting technique for barrel-shifter of proposed circuit. Here two proposed CORDIC cells are used to the fixed angle rotations. This cells going to implement the micro rotations and scaling interleaved, it's implemented the two stages. The cascade proposed the bi-rotation CORDIC for higher throughput and reduced latency implementation. This method proposed optimized set of micro rotations for fixed and known angles. Shift and add circuits are used to implement the scaling factor. Fixed means square error used for analysis and reduced the error in this method. Synthesized the proposed CORDIC cells by Synopsys Design Compiler using TSMC 90-NM library, and shown that the proposed designs offer higher throughput, less latency and less area-delay product than the reference CORDIC design for fixed and known angles of rotation. We find similar results of synthesis of different Xilinx field-programmable gate-array platforms.

## **53. Fixed-Point Analysis and Parameter Selections of MSR-CORDIC With Applications to FFT Designs**

IEEE 2012

### **Abstract:**

Mixed-scaling-rotation (MSR) coordinate rotation digital computer (CORDIC) is an attractive approach to synthesizing complex rotators. This paper presents the fixed-point error analysis and parameter selections of MSR-CORDIC with applications to the fast Fourier transform (FFT). First, the fixed-point mean squared error of the MSR-CORDIC is analyzed by considering both the angle approximation error and signal round-off error incurred in the finite precision arithmetic. The signal to quantization noise ratio (SQNR) of the output of the FFT synthesized using MSR-CORDIC is thereafter estimated. Based on these analyses, two different parameter selection algorithms of MSR-CORDIC are proposed for general and dedicated MSR-CORDIC structures. The proposed algorithms minimize the number of adders and word-length when the SQNR of the FFT output is constrained. Design examples show that the FFT designed by the proposed method exhibits a lower hardware complexity than existing methods.

## **54. Scalable pipelined CORDIC architecture design and implementation in FPGA**

IEEE 2009

### **Abstract:**

In Digital Signal Processing, trigonometry and complex multiplications are used in many signal equations, such as synchronization and equalization. Therefore, a fast and an efficient method to calculate trigonometry and complex multiplications are required. Coordinate Rotation Digital Computer (CORDIC) is trigonometric algorithm that is used to transforming data from rectangular to polar and vice versa. CORDIC also can be used other to compute several trigonometry functions,

either directly or indirectly. The proposed CORDIC design is based on Pipeline datapath Architecture. By using pipeline architecture, the design is able to calculate continuous input, has high throughput, and doesn't need ROM or registers to save constant angle iteration of CORDIC. The design process is started by modelling CORDIC function, design datapath and control unit, coding to hardware description language using Verilog HDL, synthesized using Quartus II Version 7.2 and implemented on ALTERA Cyclone II DE2 EP2C35F672C6N FPGA. Synthesis result shows that the design is able to work at 81.31 MHz.

## 55. Design and evaluation of a floating-point division operator based on CORDIC algorithm

IEEE 2012

### Abstract:

Design and evaluation of a CORDIC (COordinate Rotation Digital Computer) algorithm for a floating-point division operation is presented in this paper. In general, division operation based on CORDIC algorithm has a limitation in term of the range of inputs that can be processed by the CORDIC machine to give proper convergence and precise division operation result. A hardware architecture of CORDIC algorithm capable of processing broader input ranges is implemented and presented in this paper by using a pre-processing and a post-processing stage. The performance as well as the calculation error statistics over exhaustive sets of input tests are evaluated. The results show that the CORDIC algorithm can be well-convergence and gives precise division operation results with broader input ranges. The proposed hardware architecture is modeled in VHDL and synthesized on a CMOS standard-cell technology and a FPGA device, resulting 1 GFlops on the CMOS and 210.812 MFlops on the FPGA device.

## 56. *C!!-!!Lock* : Energy Efficient Synchronization for Embedded Multicore Systems

IEEE 2013

### Abstract:

Data synchronization among multiple cores has been one of the critical issues which must be resolved in order to optimize the parallelism of multicore architectures. Data synchronization schemes can be classified as lock-based methods ("pessimistic") and lock-free methods ("optimistic"). However, none of these methods consider the nature of embedded systems which have demanding and sometimes conflicting requirements not only for high performance but also for low power consumption. As an answer to these problems, we propose C-Lock, an energy- and performance-efficient data

synchronization method for multicore embedded systems. C-Lock achieves balanced energy- and performance-efficiency by combining the advantages of lock-based methods and transactional memory (TM) approaches; in C-Lock, the core is blocked only when true conflicts exist (advantage of TM), while avoiding roll-back operations which can cause huge overhead with regard to both performance and energy (this is an advantage of locks). Also, in order to save more energy, C-Lock disables the clocks of the cores which are blocked for the access to the shared data until the shared data become available. We compared our C-Lock approach against traditional locks and transactional memory systems, and found that C-Lock can reduce the energy-delay product by up to 1.94 times and 13.78 times compared to the baseline and TM, respectively.

## 57. ViChaR: A Dynamic Virtual Channel Regulator for Network-on-Chip Routers

IEEE 2009

**Abstract:**

The advent of deep sub-micron technology has recently highlighted the criticality of the on-chip interconnects. As diminishing feature sizes have led to increases in global wiring delays, network-on-chip (NoC) architectures are viewed as a possible solution to the wiring challenge and have recently crystallized into a significant research thrust. Both NoC performance and energy budget depend heavily on the routers' buffer resources. This paper introduces a novel unified buffer structure, called the dynamic virtual channel regulator (ViChaR), which dynamically allocates virtual channels (VC) and buffer resources according to network traffic conditions. ViChaR maximizes throughput by dispensing a variable number of VCs on demand. Simulation results using a cycle-accurate simulator show a performance increase of 25% on average over an equal-size generic router buffer, or similar performance using a 50% smaller buffer. ViChaR's ability to provide similar performance with half the buffer size of a generic router is of paramount importance, since this can yield total area and power savings of 30% and 34%, respectively, based on synthesized designs in 90 nm technology.

## 58. Virtualizing Virtual Channels for Increased Network-on-Chip Robustness and Upgradeability

IEEE 2012

**Abstract:**

The Network-on-Chip (NoC) router buffers are instrumental in the overall operation of Chip Multi-Processors (CMP), because they facilitate the creation of Virtual Channels (VC). Both the NoC routing

algorithm and the CMP's cache coherence protocol rely on the presence of VCs within the NoC for correct functionality. In this article, we introduce a novel concept that completely decouples the number of supported VCs from the number of VC buffers physically present in the design. Virtual Channel Renaming enables the virtualization of existing virtual channels, in order to support an arbitrarily large number of VCs. Hence, the CMP can (a) withstand the presence of faulty VCs, and (b) accommodate routing algorithms and/or coherence protocols with disparate VC requirements. The proposed VC Renamer architecture incurs minimal hardware overhead to existing NoC designs and is shown to exhibit excellent performance without affecting the router's critical path.

## 59. Low-Cost Self-Test Techniques for Small RAMs in SOCs Using Enhanced IEEE 1500 Test Wrappers

**IEEE 2012**

**Abstract :**

This paper proposes an enhanced IEEE 1500 test wrapper to support the testing and diagnosis of the single-port or multi-port RAM core attached to the enhanced IEEE 1500 test wrapper without incurring large area overhead to small memories. Effective test time reduction techniques for the proposed test scheme are also proposed. Simulation results show that the additional area cost for implementing the enhanced IEEE 1500 test wrapper is only about 0.58% for a 64 K-bit single-port RAM and only 0.57% for a 64 K-bit two-port RAM

## 60. Application-Aware Topology Reconfiguration for On-Chip Networks

**IEEE 2010**

**Abstract:**

In this paper, we present a reconfigurable architecture for networks-on-chip (NoC) on which arbitrary application-specific topologies can be implemented. When a new application starts, the proposed NoC tailors its topology to the application traffic pattern by changing the inter-router connections to some predefined configuration corresponding to the application. It addresses one of the main drawbacks of the existing application-specific NoC optimization methods, i.e., optimization of NoCs based on the traffic pattern of a single application. Supporting multiple applications is a critical feature of an NoC when several different applications are integrated into a single modern and complex multicore system-

on-chip or chip multiprocessor. The proposed reconfigurable NoC architecture supports multiple applications by appropriately configuring itself to a topology that matches the traffic pattern of the currently running application. This paper first introduces the proposed reconfigurable topology and then addresses the problems of core to network mapping and topology exploration. Further on, we evaluate the impact of different architectural attributes on the performance of the proposed NoC. Evaluations consider network latency, power consumption, and area complexity.

## 61. Smart Reliable Network-on-Chip

**IEEE 2014**

**Abstract :**

In this paper, we present a new network-on-chip (NoC) that handles accurate localizations of the faulty parts of the NoC. The proposed NoC is based on new error detection mechanisms suitable for dynamic NoCs, where the number and position of processor elements or faulty blocks vary during runtime. Indeed, we propose online detection of data packet and adaptive routing algorithm errors. Both presented mechanisms are able to distinguish permanent and transient errors and localize accurately the position of the faulty blocks (data bus, input port, output port) in the NoC routers, while preserving the throughput, the network load, and the data packet latency. We provide localization capacity analysis of the presented mechanisms, NoC performance evaluations, and field-programmable gate array synthesis

## 62. Headfirst sliding routing: A time-based routing scheme for bus-NoC hybrid 3-D architecture

**IEEE 2013**

**Abstract :**

A contact-less approach that connects chips in vertical dimension has a great potential to customize components in 3-D chip multiprocessors (CMPs), assuming card-style components inserted to a single cartridge communicate each other wirelessly using inductive-coupling technology. To simplify the vertical communication interfaces, static Time Division Multiple Access (TDMA) is used for the vertical broadcast buses, while arbitrary or customized topologies can be used for intra-chip networks. In this paper, we propose the Headfirst sliding routing scheme to overcome the simple static TDMA-based vertical buses. Each vertical bus grants a communication time-slot for different chips at the same time periodically, which means these buses work with different phases. Depending on the current time, packets are routed toward the best vertical bus (elevator) just before the elevator acquires its communication time-slot.



## 63. An Area Effective Parity-Based Fault Detection Technique for FPGAs

**IEEE 2013**

**Abstract:**

Field programmable gate arrays (FPGAs) are highly successful platforms in a variety of niches, such as telecommunications and automotive applications. Their usage in critical systems for radiation environments, however, still depends on techniques able to provide increased reliability, since such devices are susceptible to single event upsets that may alter the specified functionality. Classical approaches such as duplication with comparison and triple modular redundancy are powerful in terms of fault detection and/or correction capabilities, and can be easily applied to a variety of circuits, but come with heavy area overheads. In this work we propose a parity-based concurrent error detection technique able to provide single error detection for combinational logic in FPGAs with reduced area when compared to the classical approaches. The proposed technique is automatically applied to a set of benchmark circuits and presents an average area reduction of 24.4% when compared to duplication with comparison, with no performance overhead.

## 64. Vendor agnostic, high performance, double precision Floating Point division for FPGAs

**IEEE 2013**

**Abstract:**

Double precision Floating Point (FP) arithmetic operations are widely used in many applications such as image and signal processing and scientific computing. Field Programmable Gate Arrays (FPGAs) are a popular platform for accelerating such applications due to their relative high performance, flexibility and low power consumption compared to general purpose processors and GPUs. Increasingly scientists are interested in double precision FP operations implemented on FPGAs. FP division and square root are much more difficult to implement than addition and multiplication. In this paper we focus on a fast divider design for double precision floating point that makes efficient use of FPGA resources including embedded multipliers. The design is table based; we compare it to iterative and digit recurrence implementations. Our division implementation targets performance with balanced latency and high clock frequency. Our design has been implemented on both Xilinx and Altera FPGAs. The table based double precision floating point divider provides a good tradeoff between area and performance and produces good results when targeting both Xilinx and Altera FPGAs

## 65. Floating-Point Divider Design for FPGAs

## IEEE 2007

### Abstract:

Growth in floating-point applications for field-programmable gate arrays (FPGAs) has made it critical to optimize floating-point units for FPGA technology. The divider is of particular interest because the design space is large and divider usage in applications varies widely. Obtaining the right balance between clock speed, latency, throughput, and area in FPGAs can be challenging. The designs presented here cover a range of performance, throughput, and area constraints. On a Xilinx Virtex4-11FPGA, the range includes 250-MHz IEEE compliant double precision dividers that are fully pipelined to 187-MHz iterative cores. Similarly, area requirements range from 4100 slices down to a mere 334 slices

## 66. Split-Path Fused Floating Point Multiply Accumulate (FPMAC)

## IEEE 2007

### Abstract:

Floating point multiply-accumulate (FPMAC) unit is the backbone of modern processors and is a key circuit determining the frequency, power and area of microprocessors. FPMAC unit is used extensively in contemporary client microprocessors, further proliferated with ISA support for instructions like AVX and SSE and also extensively used in server processors employed for engineering and scientific applications. Consequently design of FPMAC is of vital consideration since it dominates the power and performance tradeoff decisions in such systems. In this work we demonstrate a novel FPMAC design which focuses on optimal computations in the critical path and therefore making it the fastest FPMAC design as of today in literature. The design is based on the premise of isolating and optimizing the critical path computation in FPMAC operation. In this work we have three key innovations to create a novel double precision FPMAC with least ever gate stages in the timing critical path: a) Splitting near and far paths based on the exponent difference ( $d = E_x - E_z = \{-2, -1, 0, 1\}$  is near path and the rest is far path), b) Early injection of the accumulate add for near path into the Wallace tree for eliminating a 3:2 compressor from near path critical logic, exploiting the small alignment shifts in near path and sparse Wallace tree for 53 bit mantissa multiplication, c) Combined round and accumulate add for eliminating the completion adder from multiplier giving both timing and power benefits. Our design by premise of splitting consumes lesser power for each operation where only the required logic for each case is switching. Splitting the paths also provides tremendous opportunities for clock or power gating the unused portion (nearly 15-20%) of the logic gates purely based on the exponent difference signals. We also demonstrate the support for all rounding modes to adhere to IEEE standard for double precision FPMAC which is critical for employment of this design in contemporary process- r families. The demonstrated design outperforms the best known silicon implementation of IBM Power6 [6] by 14% in timing while having similar area and giving additional power benefits due to split handling. The design is also compared to best known timing design from Lang et al. [5] and outperforms it by 7% while being 30% smaller in area than it.

## 67. FPGA Based High Performance Double-Precision Matrix Multiplication

**IEEE 2009**

**Abstract:**

We present two designs (I and II) for IEEE 754 double precision floating point matrix multiplication, an important kernel in many tile-based BLAS algorithms, optimized for implementation on high-end FPGAs. The designs, both based on the rank-1 update scheme, can handle arbitrary matrix sizes, and are able to sustain their peak performance except during an initial latency period. Through these designs, the trade-offs involved in terms of local-memory and bandwidth for an FPGA implementation are demonstrated and an analysis is presented for the optimal choice of design parameters. The designs, implemented on a Virtex-5 SX240T FPGA, scale gracefully from 1 to 40 processing elements (PEs) with a less than 1% degradation in the design frequency of 373 MHz. With 40 PEs and a design speed of 373 MHz, a sustained performance of 29.8 GFLOPS is possible with a bandwidth requirement of 750 MB/s for design-II and 5.9 GB/s for design-I.

## 68. An FPGA Implementation of a Fully Verified Double Precision IEEE Floating-Point Adder

**IEEE 2007**

**Abstract:**

We report on the full gate-level verification and FPGA implementation of a highly optimized doubleprecision IEEE floating-point adder. The proposed adder design incorporates many optimizations like a nonstandard separation into two paths, a simple rounding algorithm, unification of rounding cases for addition and subtraction, sign-magnitude computation of a difference based on one's complement subtraction, compound adders, and fast circuits for approximate counting of leading zeros from borrow-save representation. We formally verify a gate-level specification of the algorithm using theorem proving techniques in PVS. The PVS specification was then used to automatically generate a gate-level implementation that was synthesized using Altera Quartus II. The resulting implementation has a total latency of 13.6 ns on an Altera Stratix II device. We have partitioned the design into a 2 stage pipeline running at a frequency of 147 Mhz.

## 69. Low-power radix-8 divider

**IEEE 2008**

**Abstract:**

This work describes the design of a double-precision radix-8 divider. Low-power techniques are applied in the design of the unit, and energy-delay tradeoffs considered. The energy dissipation in the divider can be reduced by up to 70% with respect to a standard implementation not optimized for energy, without penalizing the latency. The radix-8 divider is compared with the one obtained by overlapping three radix-2 stages and with a radix-4 divider. Results show that the latency of our divider is similar to that of the divider with overlapped stages, but the area is smaller. The speed-up of the radix-8 over the radix-4 is about 20% and the energy dissipated to complete a division is almost the same, although the area of the radix-8 is 50% larger

## 70. Design and evaluation of a floating-point division operator based on CORDIC algorithm

**IEEE 2008**

### **Abstract:**

Design and evaluation of a CORDIC (COordinate Rotation Digital Computer) algorithm for a floating-point division operation is presented in this paper. In general, division operation based on CORDIC algorithm has a limitation in term of the range of inputs that can be processed by the CORDIC machine to give proper convergence and precise division operation result. A hardware architecture of CORDIC algorithm capable of processing broader input ranges is implemented and presented in this paper by using a pre-processing and a post-processing stage. The performance as well as the calculation error statistics over exhaustive sets of input tests are evaluated. The results show that the CORDIC algorithm can be well-convergence and gives precise division operation results with broader input ranges. The proposed hardware architecture is modeled in VHDL and synthesized on a CMOS standard-cell technology and a FPGA device, resulting 1 GFlops on the CMOS and 210.812 MFlops on the FPGA device.

## 71. Method of modeling analog circuits in verilog for mixed-signal design simulations

**IEEE 2013**

### **Abstract :**

Simulating mixed-signal circuit designs needs to bridge between the analog and digital circuit domains. Preserving the behavior and structure of the analog and digital parts of the circuit is possible with Hardware Description Languages (HDLs), such as Verilog-AMS. However, the analog and digital parts of the design are typically developed in simulation environments tailored to either the analog or digital design flow requirements. For digital circuit development, Verilog is a popular choice of HDL. Including the analog part of the mixed-signal circuit in the Verilog description without the AMS extension requires

a modeling strategy that can preserve fundamental analog behavior. In this contribution we describe a method of modeling analog sub-circuits in Verilog. The higher-level analog circuit is modeled by netlisting the connectivity of sub-circuits based on a schematic. This method of modeling and hierarchical netlisting is scalable and demonstrated for the example of an Analog-to-Digital Converter (ADC). We can simulate the digital design interacting with the analog circuit on any standard Verilog simulator, thus, (proprietary) language extensions are not required.

## 72. A Behavior Model Based on Verilog-A for 14 Bits 200MHz Current-Steering DAC

IEEE 2012

**Abstract :**

In this paper a behavioral based on Verilog-A for segmented current-steering DAC is presented. Much attention was paid to the main circuits such as bandgap reference, current cells, switch array and other relative digital circuits. In this model, non-ideal factors including mismatch of current source transistors and switch glitch are considered, and it aims to model the DAC as accurate as possible. At last the simulation data is analyzed by 8192 points FFT.

## 73. A 0.18 $\mu\text{m}$ pipelined 8B10B encoder for a high-speed SerDes

IEEE 2010

**Abstract :**

This paper presented a pipelined 8B10B encoder for a high speed SerDes. To overcome the drawback of the speed limitation due to the conventional architecture, a pipelined encoding architecture is proposed. By splitting the longer path into two shorter paths with registers, the delay of the critical path is shortened greatly. Based on the pipelined architecture, a high-speed 8B10B encoder is implemented using 0.18  $\mu\text{m}$  CMOS technology and standard cell library. Post-simulation results show that the encoder can work up to the rate of 7Gbps with a core area of 76.86  $\mu\text{m} \times 76.86 \mu\text{m}$  and the power consumption is 5.0317 mW under a 1.8V power supply voltage.

## 74. An 8B/10B encoder with a modified coding table

**IEEE 2008**

**Abstract :**

This paper presents a design of 8B/10B encoder with a modified coding table. The proposed encoder has been designed based on a reduced coding table with a modified disparity control block. After being synthesized using CMOS 0.18  $\mu\text{m}$  process, the proposed encoder shows the operating frequency of 343 MHz and occupies the chip area of 1886  $\mu\text{m}^2$  with 189 logic gates. It consumes 2.74 mW power. Compared to conventional approaches, the operating frequency is improved by 25.6% and chip area is decreased to 43%.

## 75. An Area- and Energy-Efficient FIFO Design Using Error-Reduced Data Compression and Near-Threshold Operation for Image/Video Applications

**IEEE2010**

**Abstract:**

Many image/video processing algorithms require FIFO for filtering. The FIFO size is proportional to the length of the filters and input data width, causing large area and power consumption. We have proposed an energy- and area-efficient FIFO design for image/video applications through FIFO with error-reduced data compression (FERDC) and near-threshold operation. On architecture level, FERDC technique is proposed to reduce the size and power consumption of the FIFO by utilizing the spatial correlation between neighboring pixels and performing error-reduced data compression together with quantization to minimize the mean square error (MSE). On circuit level, near-threshold operation is adopted to achieve further power reduction while maintaining the required performance. To demonstrate the proposed FIFO, it has been implemented using a 0.18- $\mu\text{m}$  CMOS process technology. The implementation covers different FIFO length, including 128, 256, 512, and 1024. The experimental results show that the proposed FIFO operating at 0.5 V and 28.57 MHz achieves up to 99%, 65%, and 34.91% reduction in dynamic power, leakage power, and area, respectively, with a small MSE of 2.76, compared with the conventional FIFO design.

The proposed FIFO can be applied to a wide range of image/video signal processing applications to achieve high area and energy efficiency.

## 76. Optimum packet size of voice packet in the FIFO adversarial queuing model

IEEE 2007

**Abstract:**

First-in-First-out (FIFO) is one of the simplest queuing policies used to provide best effort services in packet-switched network. However, the performance of FIFO is really crucial when it related to stability i.e. question of whether there is a bound on the total size of packets in the network at all times. In this study, our main objective is to find the optimum packet size of voice packet when using FIFO scheduling policy. Our approach is based on adversarial generation of packets so that positive results are more robust in that they do not depend on particular probabilistic assumptions about the input sequences. In this paper, we proposed the FIFO scheduling technique that uses adversarial queuing model to find the optimum packet size of voice packet in FIFO network. Although the simulation results show that the average packet loss is increase when the arrival packet is increased, the average packet delay is improved as compared to FIFO M/M/1 technique, studied by (Phalgun, 2003). This algorithm can be utilized for transmitting voice packet over IP.

## 77. A dynamic priority arbiter for Network-on-Chip

IEEE 2009

**Abstract:**

For some customized network-on-chip, the communication requirements among IP cores are usually non-uniform, which make the loads of input ports in one router are not balance. In order to improve the performance of network-on-chip, we proposed a dynamic priority arbiter. The arbiter detect the loads of input ports in every clock cycle and adjust the priority of each

input port dynamically, then authorize one input ports to transfer data based on lottery mechanism. Under the uniform traffic mode in network-on-chip and non-uniform traffic mode such as an application of MPEG4 decoder in network-on-chip, we compared the performance between network-on-chip based on round-robin arbiter and network-on-chip based on dynamic priority arbiter proposed in this paper. The result shows: under non-uniform traffic mode, the dynamic priority arbiter can improve the communication performance of network-on-chip and reduce the requirement of buffer resource in network interface.

## 78. Low-power network-on-chip for high-performance SoC design

**IEEE 2009**

**Abstract:**

An energy-efficient network-on-chip (NoC) is presented for possible application to high-performance system-on-chip (SoC) design. It incorporates heterogeneous intellectual properties (IPs) such as multiple RISCs and SRAMs, a reconfigurable logic array, an off-chip gateway, and a 1.6-GHz phase-locked loop (PLL). Its hierarchically-star-connected on-chip network provides the integrated IPs, which operate at different clock frequencies, with packet-switched serial-communication infrastructure. Various low-power techniques such as low-swing signaling, partially activated crossbar, serial link coding, and clock frequency scaling are devised, and applied to achieve the power-efficient on-chip communications. The 5 /spl times/5 mm/sup 2/ chip containing all the above features is fabricated by 0.18-/spl mu/m CMOS process and successfully measured and demonstrated on a system evaluation board where multimedia applications run. The fabricated chip can deliver 11.2-GB/s aggregated bandwidth at 1.6-GHz signaling frequency. The chip consumes 160 mW and the on-chip network dissipates less than 51 mW.

## 79. A new mode of operation for arbiter PUF to improve uniqueness on FPGA

**IEEE 2014**

**Abstract:**



Arbiter-based Physically Unclonable Function (PUF) is one kind of the delay-based PUFs that use the time difference of two delay-line signals. One of the previous work suggests that Arbiter PUFs implemented on Xilinx Virtex-5 FPGAs generate responses with almost no difference, i.e. with low uniqueness. In order to overcome this problem, Double Arbiter PUF was proposed, which is based on a novel technique for generating responses with high uniqueness from duplicated Arbiter PUFs on FPGAs. It needs the same costs as 2-XOR Arbiter PUF that XORs outputs of two Arbiter PUFs. Double Arbiter PUF is different from 2-XOR Arbiter PUF in terms of mode of operation for Arbiter PUF: the wire assignment between an arbiter and output signals from the final selectors located just before the arbiter. In this paper, we evaluate these PUFs as for uniqueness, randomness, and steadiness. We consider finding a new mode of operation for Arbiter PUF that can be realized on FPGA. In order to improve the uniqueness of responses, we propose 3-1 Double Arbiter PUF that has another duplicated Arbiter PUF, i.e. having 3 Arbiter PUFs and output 1-bit response. We compare 3-1 Double Arbiter PUF to 3-XOR Arbiter PUF according to the uniqueness, randomness, and steadiness, and show the difference between these PUFs by considering the mode of operation for Arbiter PUF. From our experimental results, the uniqueness of responses from 3-1 Double Arbiter PUF is approximately 50%, which is better than that from 3-XOR Arbiter PUF. We show that we can improve the uniqueness by using a new mode of operation for Arbiter PUF.

## 80. The design and implementation of arbiters for Network-on-chips

**IEEE 2010**

**Abstract:**

Round robin arbiter and matrix arbiter mechanism are widely used in Network-on-chips. These two mechanisms are implemented in this paper. The performances in 2D-mesh topology are tested in a FPGA platform. The resource consumption and throughput between Round-robin arbiter and Matrix-arbiter are compared. Through the experiment result, we found that the Matrix-arbiter has higher throughput than the Round-robin arbiter. However the Round-robin arbiter can save much more resources than Matrix arbiter. Thus a tradeoff between the two mechanisms should be considered when design networks-on-chip arbiters.

## 81. Round-robin Arbiter Design and Generation

**IEEE2009**

**Abstract:**

For some customized network-on-chip, the communication requirements among IP cores are usually non-uniform, which make the loads of input ports in one router are not balance. In order to improve the performance of network-on-chip, we proposed a dynamic priority arbiter. The arbiter detect the loads of input ports in every clock cycle and adjust the priority of each input port dynamically, then authorize one input ports to transfer data based on lottery mechanism. Under the uniform traffic mode in network-on-chip and non-uniform traffic mode such as an application of MPEG4 decoder in network-on-chip, we compared the performance between network-on-chip based on round-robin arbiter and network-on-chip based on dynamic priority arbiter proposed in this paper. The result shows: under non-uniform traffic mode, the dynamic priority arbiter can improve the communication performance of network-on-chip and reduce the requirement of buffer resource in network interface.

## 82. ElastiStore: An elastic buffer architecture for Network-on-Chip routers

IEEE 2014

### **Abstract:**

The design of scalable Network-on-Chip (NoC) architectures calls for new implementations that achieve high-throughput and low-latency operation, without exceeding the stringent area-energy constraints of modern Systems-on-Chip (SoC). The router's buffer architecture is a critical design aspect that affects both network-wide performance and implementation characteristics. In this paper, we extend Elastic Buffer (EB) architectures to support multiple Virtual Channels (VC) and we derive ElastiStore, a novel lightweight elastic buffer architecture that minimizes buffering requirements, without sacrificing performance. The integration of the proposed elastic buffering scheme in the NoC router enables the design of new router architectures - both single-cycle and two-stage pipelined - which offer the same performance as baseline VC-based routers, albeit at a significantly lower area/power cost

