

# Data Correlation Aware Serial Encoding for Low Switching Power On-Chip Communication

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## Introduction

- ❖ Tremendous growth of VLSI technology has enabled designers to realize the complex applications as the system-on-a-chip (SoC).
- ❖ To adequate with the nanoscale technologies and multicore architecture, the network on chip (NoC) architectures have been developed which are scalable and highly utilized.
- ❖ In nanoscale domain, NoC links account for most of the power dissipation.
- ❖ For today's ULSI design the most important design metric is power dissipation, concerning the lifetime of battery driven portable devices.
- ❖ However, the existing research is primarily for parallel communication links and there is lack of research for serial communication links in NoC.
- ❖ To address this existing deficiencies, we propose an on-chip data serialization technique with encoding for serial links that
  - reduces the number of transitions significantly
  - guarantees a low-power dissipation independent of data types and their correlations.

## Motivation and Background

- ❖ Most of the energy in the traditional SoCs are dissipated in the data buses and long interconnects due to dynamic power dissipation.
- ❖ The parallel communication in NoC suffers from many a disadvantages viz.
  - larger chip area
  - routing difficulties,
  - considerable leakage power due to large driver/receiver,
  - inter-wire spacing,
  - shielding to avoid crosstalk noises,
  - presence of repeaters to communicate along long distance.
- ❖ Serial links for the NoC leads to
  - the savings in the wire area and power dissipation
  - reduction of noise and crosstalk
  - simpler layout and timing verification
  - controlled throughput by adjusting the frequency of the serializer
  - eliminates the requirements of the multiple line drivers and buffers.
- ❖ The conventional parallel bus coding techniques cannot be used for the serial bus. The serialized Low energy transmission coding technique minimizes the transmission energy on the serial interconnect by using the data correlation properties. Such serial coding technique is data dependent
- ❖ Moreover, the switching activity factor in serial links may grow significantly due to the serialization. Hence for serial links, it is more crucial to reduce the number of transitions independent of data types.

## Major Contributions

- ❖ Proposed on-chip bus serialization method
  - reduces the number of transitions on a serial link significantly
  - guarantees a non-increasing power consumption
  - independent of data types.
- ❖ The encoder and decoder parts are implemented using Synopsis Design Vision tool mapped into UMC 90 nm technology node.
- ❖ Extensive experimental studies on the proposed system architecture have been done with different types and sizes of data-stream (JPG,PNG,PDF,TEXT,DOC,HTML,MP3) and result shows the power reduction within the range from 20 to 27%.

## Methodology

Step 1

- Encoder checks every consecutive strings of length three of each byte of the serial data-stream.

Step 2

- If it contains two consecutive transitions like 0 1 0 or like 1 0 1 then the last two bits are swapped. Other bits remain unchanged.  
For example , 010 001  
101 110

Step 3

- For each byte, (a0,a1,...a7) two additional lines L1 and L2 are introduced to keep track of the changes in bits by encoding.

Step 4

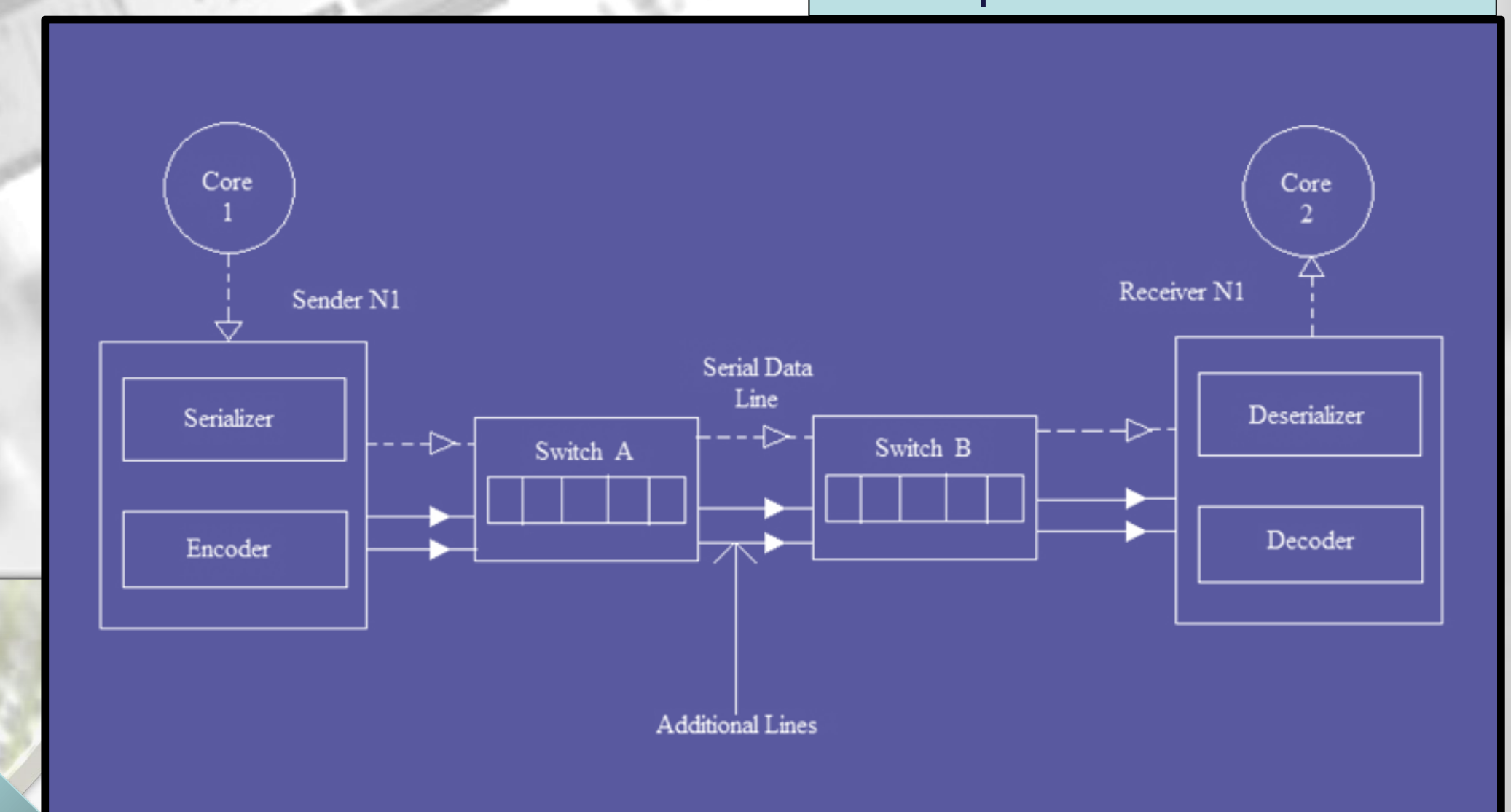
- If major part of the three-bit string changed lies within (a0,a1,a2,a3,a4), (or in (a3,a4,a5,a6,a7)) then L2 = 1 and L1 = 0 (or L2 = 0 and L1 = 1) respectively. For no change L1 = L2 = 0, and similarly for changes in both halves L1 = L2 = 1.

## Algorithm

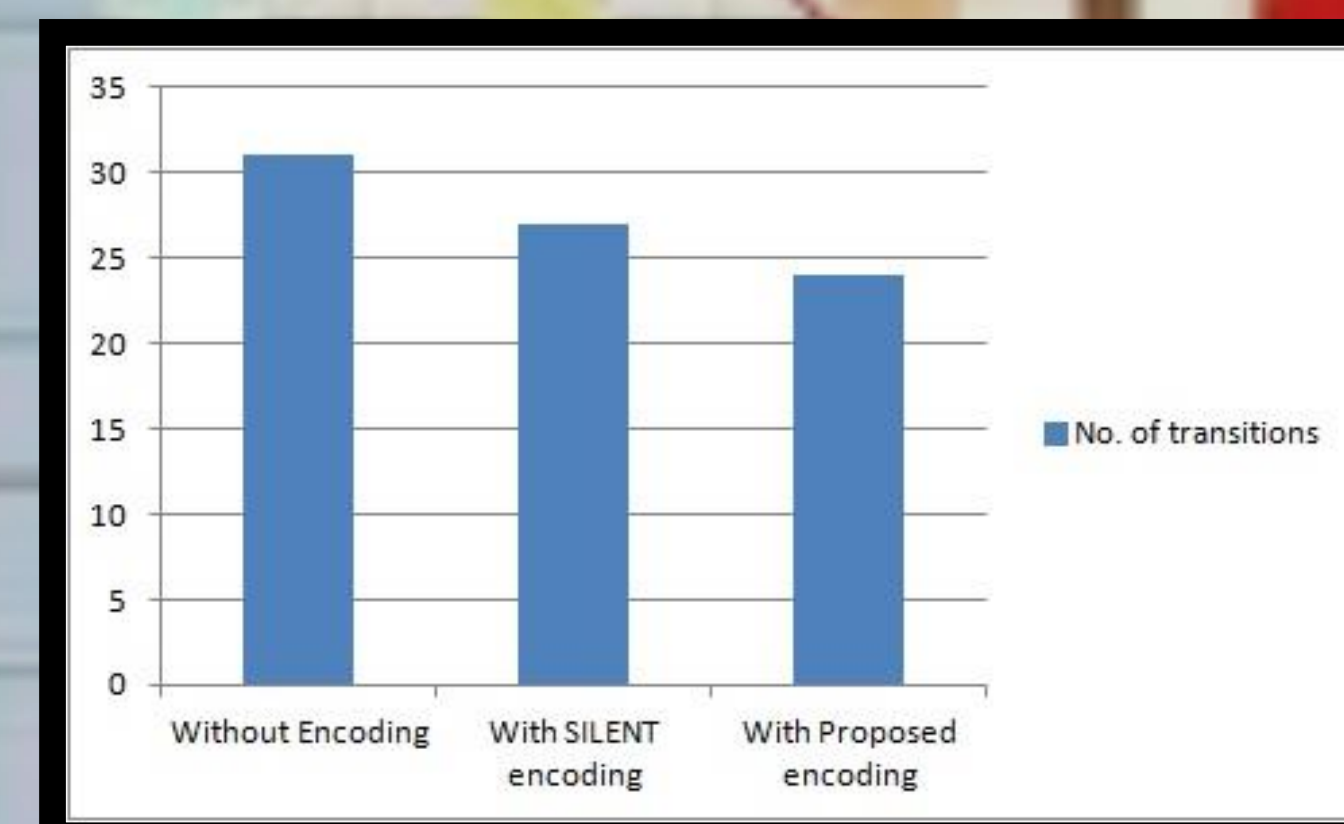
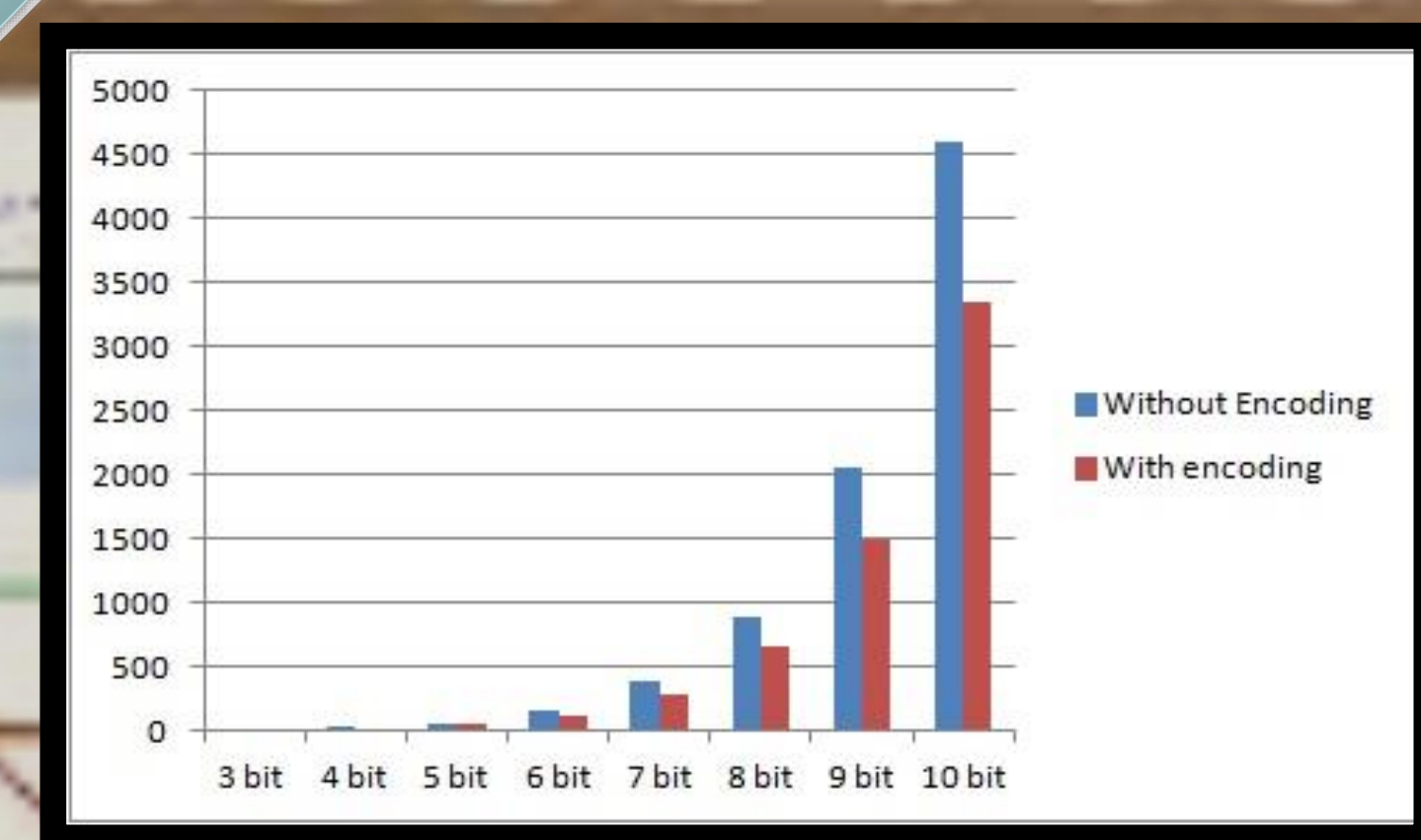
INPUT : DATASET (A = A0; A1; A2; A3; A4; A5; A6; A7)  
OUTPUT : ENCODED DATASET((B = B0; B1; B2; B3; B4; B5; B6; B7), L1, L2)

```
BEGIN
    LENGTH = LENGTH(A);
    I = 0;
    L1 = 0;
    L2 = 0;
    B = A;
    FOR I <= LENGTH - 3 DO
        IF AI = AI+2 ≠ AI+1 THEN
            BI+2 = AI+1;
            BI+1 = AI+2;
            IF I < 3 THEN
                L2 = 1;
            ELSE
                L1 = 1;
            END
        END
        I = I + 2;
    END
END
```

Proposed Architecture

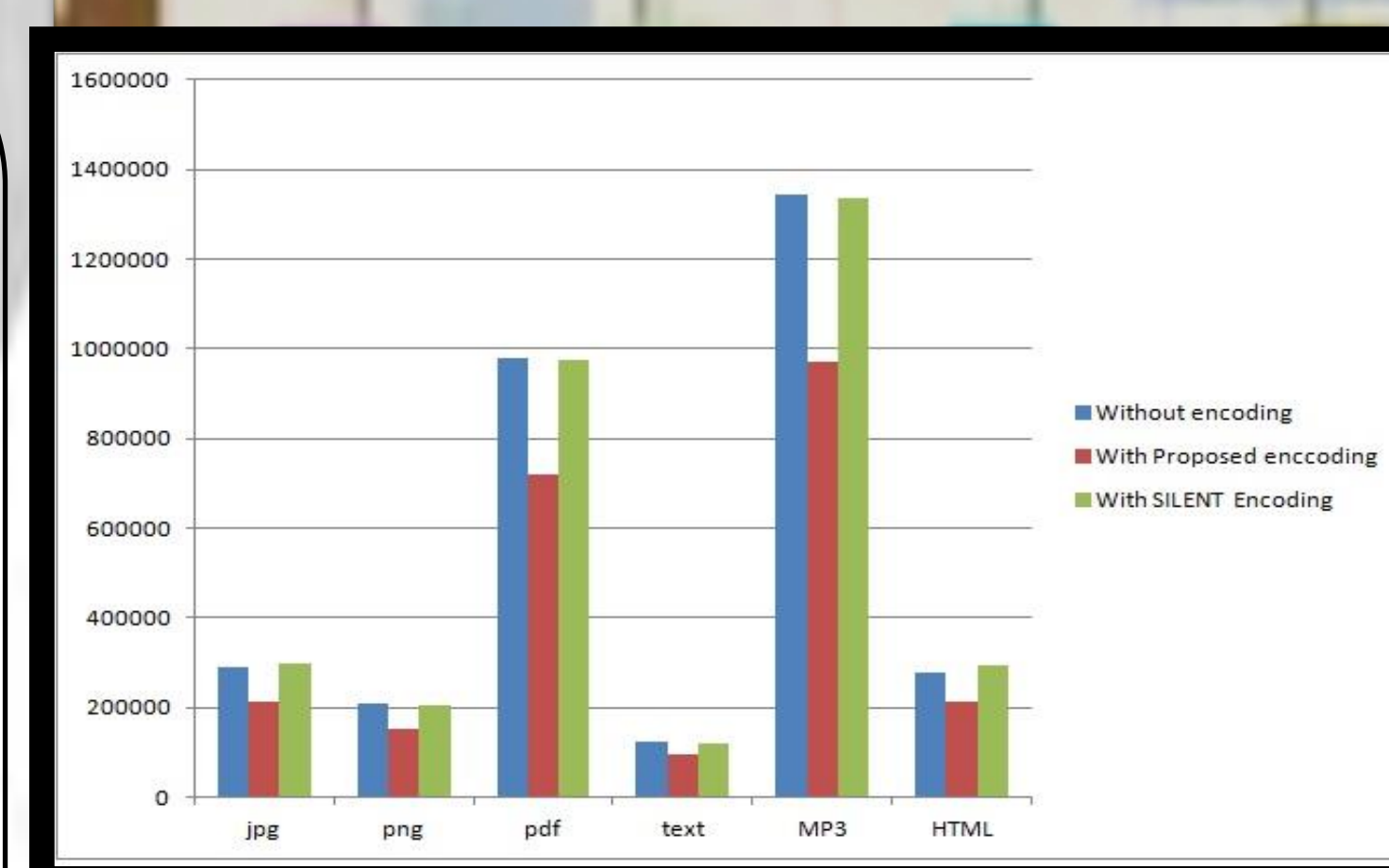


## Results



Total no. of transitions for different Bus widths with and without proposed Encoding

- ❖ Reduction of transitions for an arbitrary data-stream:
  - 12.9% by SILENT Encoding technique
  - 22.58% by proposed Encoding technique



Reduction of transitions for different data-stream:

- 26.39% for JPG file
- 26.40% for PNG file
- 25.36% for PDF file
- 21.95% for TEXT file
- 27.56% for MP3 file
- 23.27% for HTML file

## Conclusions

- This novel encoding technique can minimize the number of transitions as well as dynamic power consumption in the serial link of the NoC.
- The proposed method has been compared with SILENT encoding technique and it always leads to significant reduction in the switching activity.
- The proposed framework was tested for different types of data streams and Average reduction is near about 25%.

## Future Work

- ❖ Future works should be towards making it more flexible and fault tolerant method so that its effectiveness increases for all routing architectures.
- ❖ The ISI effect of the adjacent bits and the other factors affecting the dynamic power dissipation should be considered along with the self switching activity.