FinFET based Novel Physical Unclonable Functions for Efficient Security in the IoT

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Introduction

- The Internet of Things is a futuristic area where all devices can communicate with each other.
- In such an IoT environment, if any security feature is compromised, the entire environment will be in chaos.
- Hence to encrypt that environment, PUFs can be used.
- Physical Unclonable Function uses process variation in devices to generate different encryption keys.
- A PUF key is never stored in memory. For each communication, hardware encryption is performed.
- Hacking into such environment without being present at the hardware location is very difficult.
- Two designs are presented: Speed Optimized design for high speed devices like network switches and Power Optimized design for hand-held devices like smartphones.

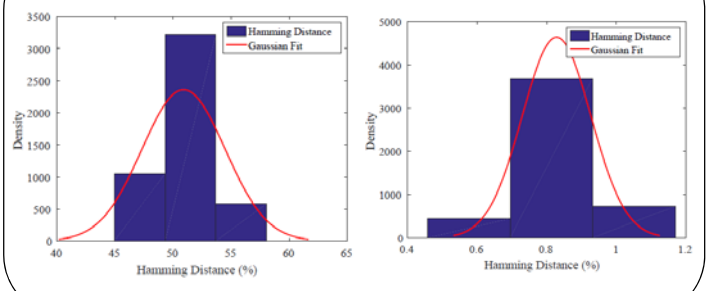
PUF Designs

- In both designs, Ring Oscillators (ROs) generate the oscillations.
- Due to process variation, there will be change in the frequencies generated.
- Hence the D-input and the clock signal will vary at any given point of time.
- Multiplexers in the Power Optimized design select a pair of ROs and give signals to D-Flipflop which consumes time but with low power consumption.
- Speed Optimized design does not have multiplexers but each pair of RO has its own flipflop which saves time in key generation.

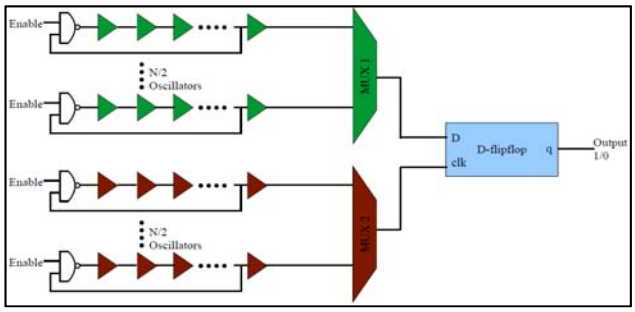
Figures of Merit

- Uniqueness: The same key should not be used in any other PUF design. Uniqueness is calculated using Hamming Distance.
- Reliability: The PUF module should give the same key. Even environmental effects should not change the key.
- Security: The module should be resistant to different attacks on the circuit.
- Each of these results are presented below.

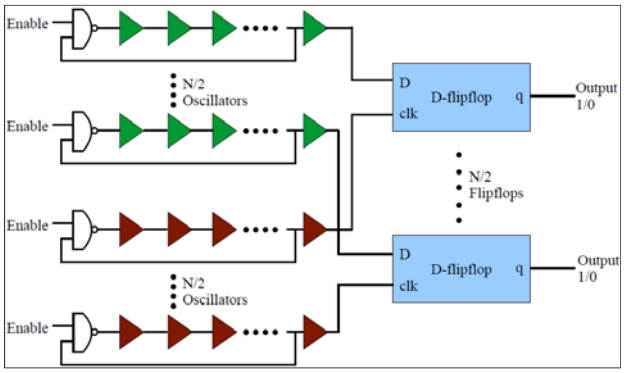
Experimental Results



Proposed PUF Topologies



Power Optimized Hybrid Oscillator Arbiter PUF



Speed Optimized Hybrid Oscillator Arbiter PUF

Experimental Results

- A comparison with traditional RO PUF is presented.
- Ideal Hamming distance is 50%.
- Power consumption is also presented for a better understanding of implementation in IoT.
- Time to generate key is a novel FoM in this presentation.

Parameter	Value
Traditional Ring Oscillator PUF	
Average Power	310.8 µW
Hamming Distance	50 %
Average Time to Generate Key	150 ns
Speed Optimized Hybrid Oscillator Arbiter PUF	
Average Power	320 µW
Hamming Distance	52 %
Average Time to Generate Key	50 ns
Power Optimized Hybrid Oscillator Arbiter PUF	
Average Power	285.5 µW
Hamming Distance	50.9 %
Average Time to Generate Key	150 ns

Conclusions

- Two designs of PUFs are presented which can be deployed in an IoT environment.
- In future, Ultra Low power designs of the same circuits can be designed.
- More robust designs can be implemented to increase the whole security of the circuit.

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