Hardware Security

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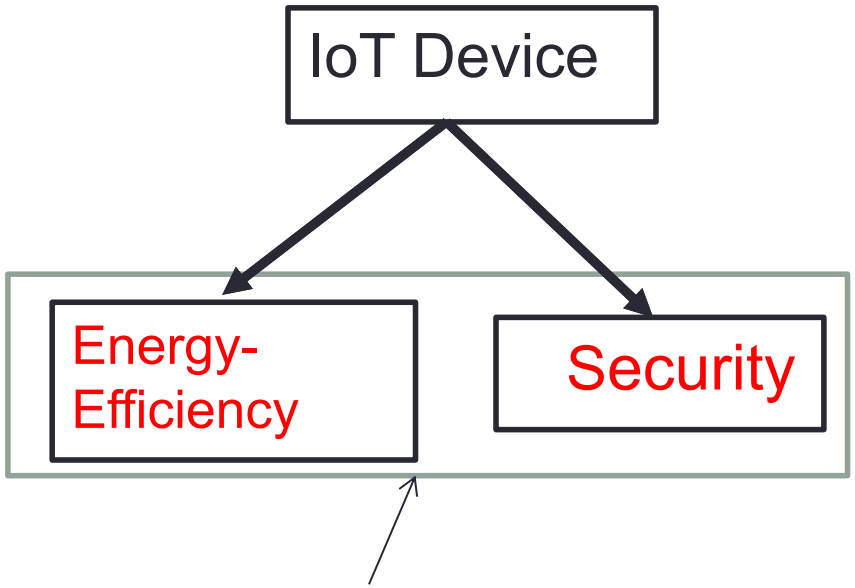
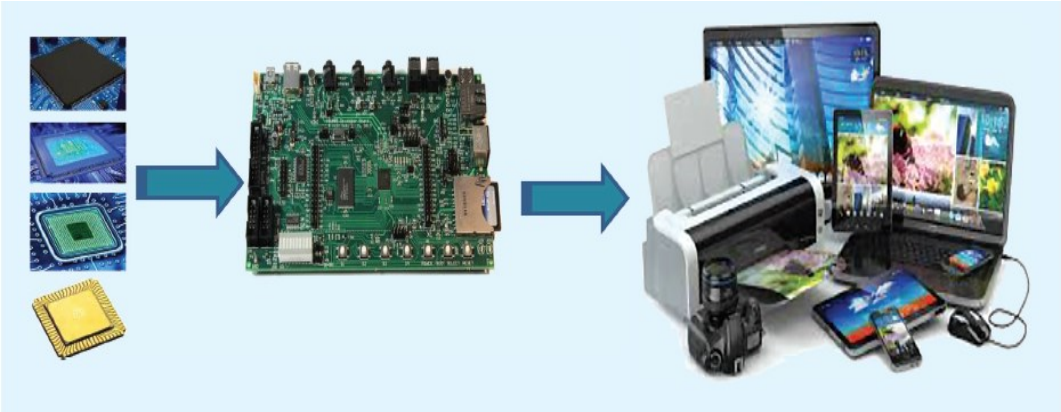
Challenges in Embedded and IoT Devices

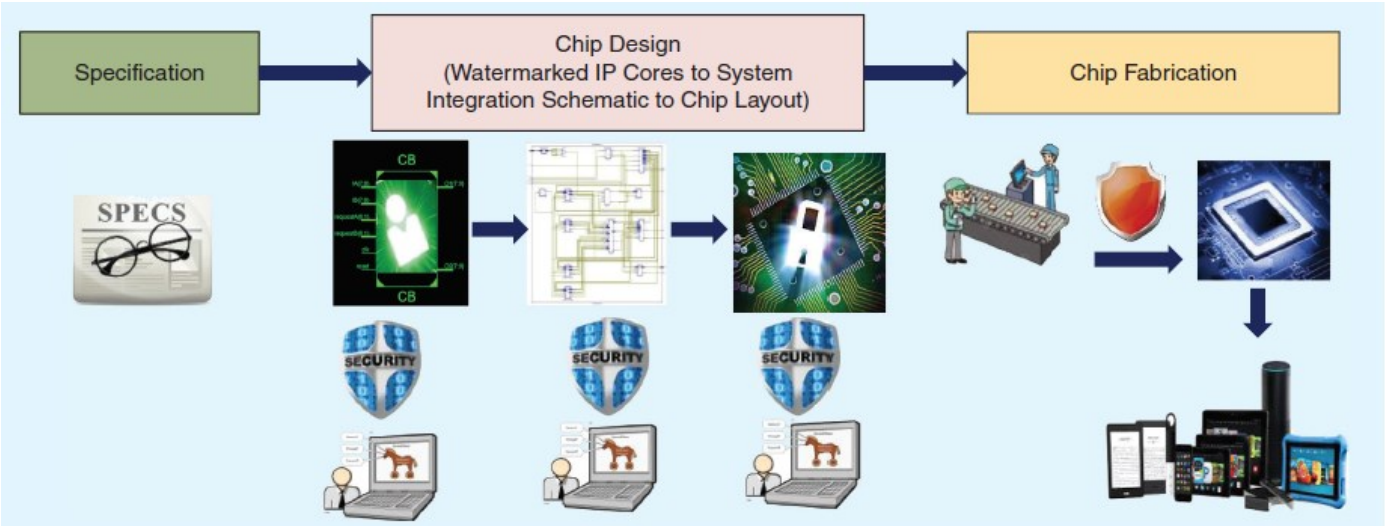


- Typically battery operated
  - Energy-efficient design
- Vulnerable to hardware/malware attacks
  - Power analysis attacks
  - IC piracy, IC counterfeiting, Hardware trojan

Cyberattacks are threat to reliability, safety, consumer's personal information and piracy or cloning of intellectual property (IP) core.

Consumer Electronics (CE) Device Vulnerabilities





Anirban Sengupta et. al "IP Core Protection and Hardware-Assisted Security for Consumer Electronics", **The Institute of Engineering and Technology (IET)**, 2019, Book ISBN: 978-1-78561-799-7, e-ISBN: 978-1-78561-800-0

INTRODUCTION

- Hardware Security and Intellectual Property (IP) Core protection is an emerging area of research for semiconductor community that focusses on protecting designs against standard threats such as reverse engineering, counterfeit, forgery, malicious hardware modification etc.

- Hardware security is broadly classified into two types: (a) authentication based approaches (b) obfuscation based approaches.

- The second type of hardware security approach i.e. obfuscation can again be further sub-divided into two types: (i) structural obfuscation (ii) functional obfuscation. Structural obfuscation transforms a design into one that is functionally equivalent to the original but is significantly more difficult to reverse engineer (RE), while the second one is active protection type that locks the design through a secret key.

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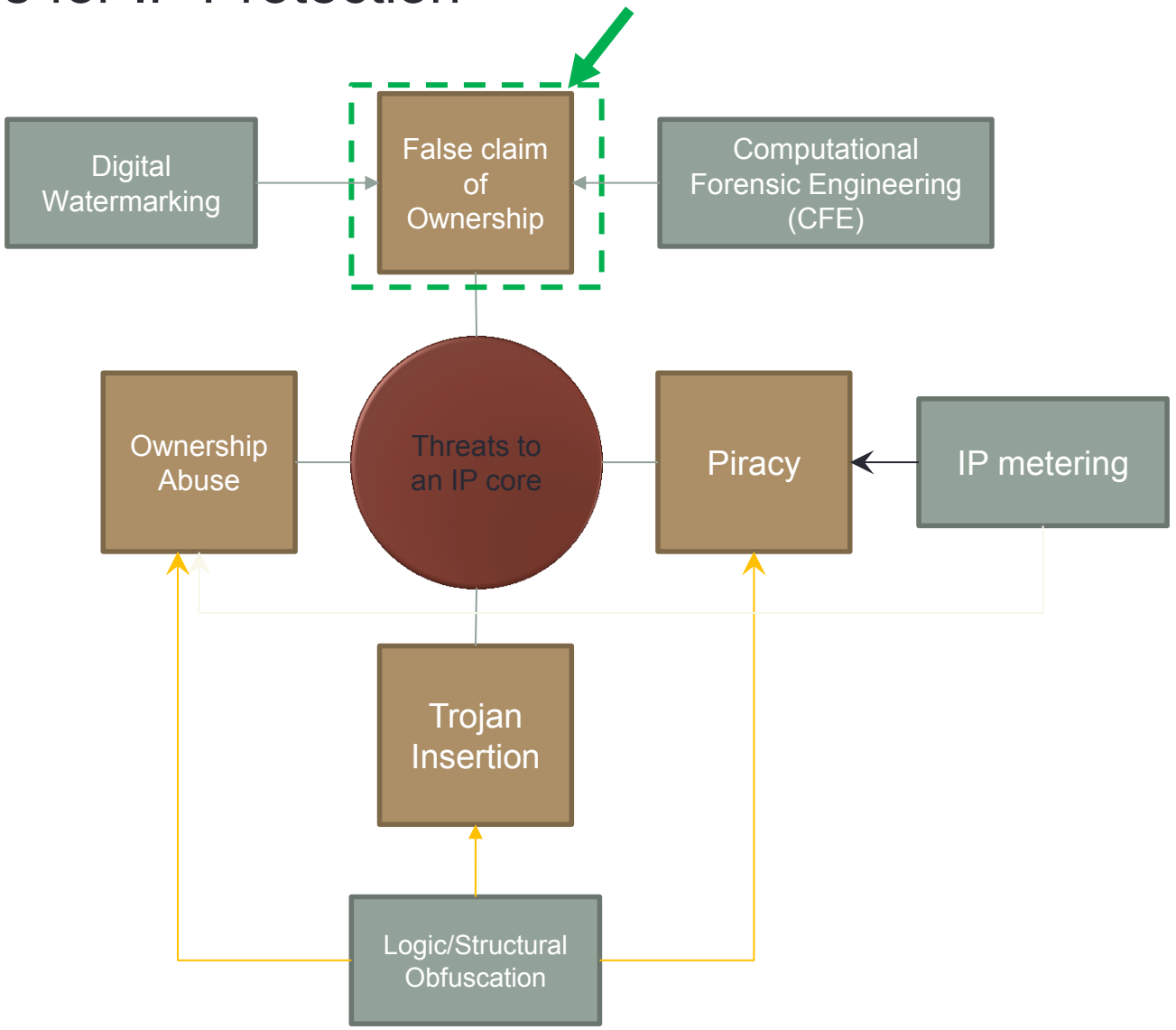
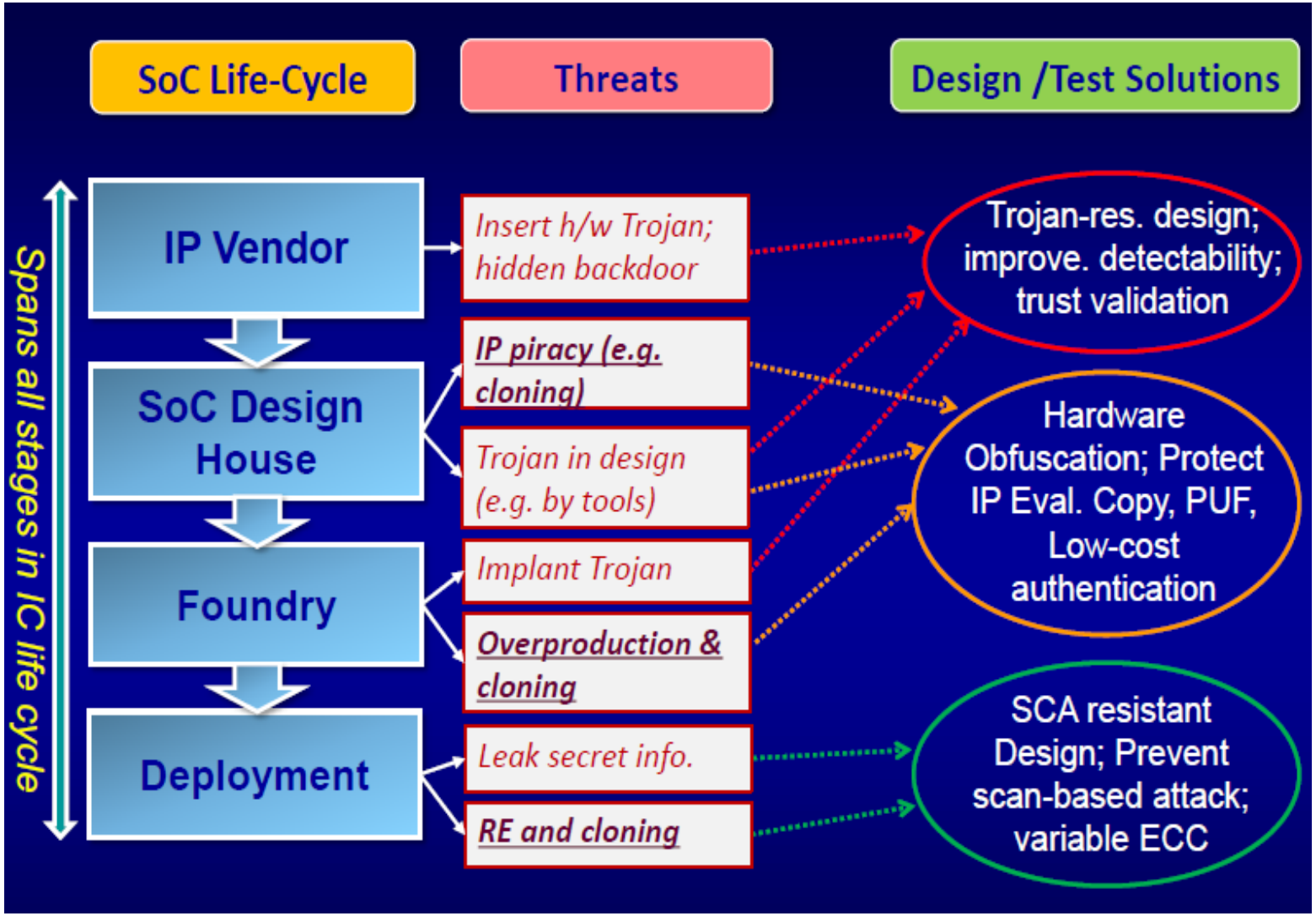
Approaches for IP Protection

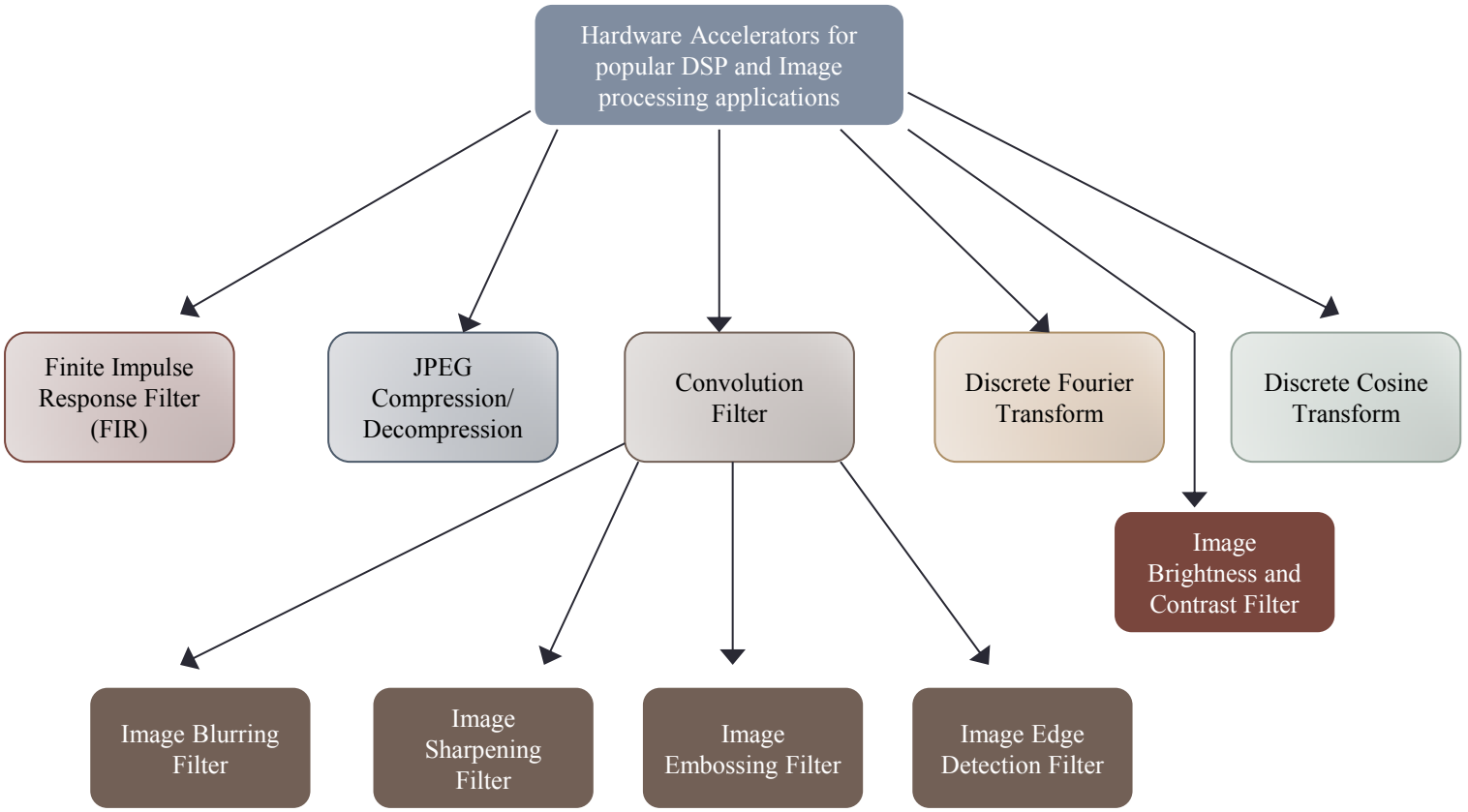


Anirban Sengupta, Dipanjan Roy, Saraju Mohanty, Peter Corcoran "DSP Design Protection in CE through Algorithmic Transformation Based Structural Obfuscation", **IEEE Transactions on Consumer Electronics**, Volume 63, Issue 4, November 2017, pp: 467 - 476

IP Core Protection and Hardware Security



Real World Applications



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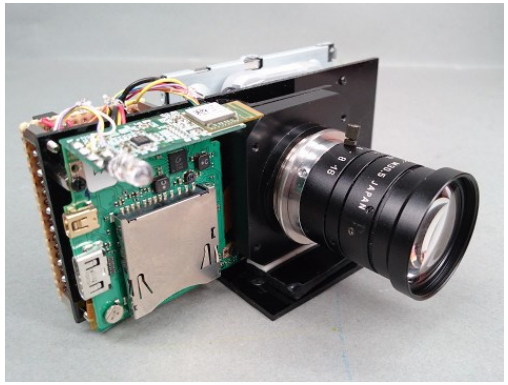
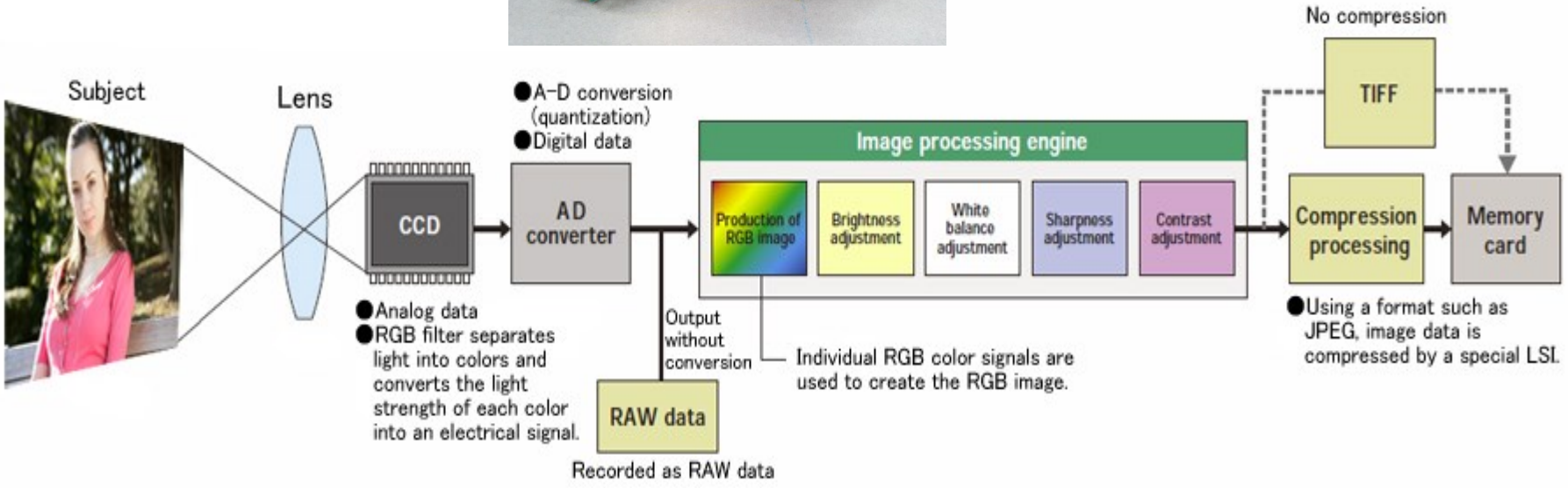
Example of CE Device : Digital Camera

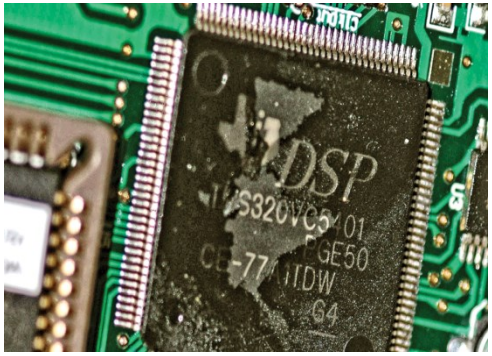
- ✓ Simply converting an analog image that is captured by the CCD into digital data does not create a digital image.
- ✓ Only after the image processing engine and CODEC engine performs a variety of calculations on a huge amount of digital image data can we see a completed color/grayscale image.





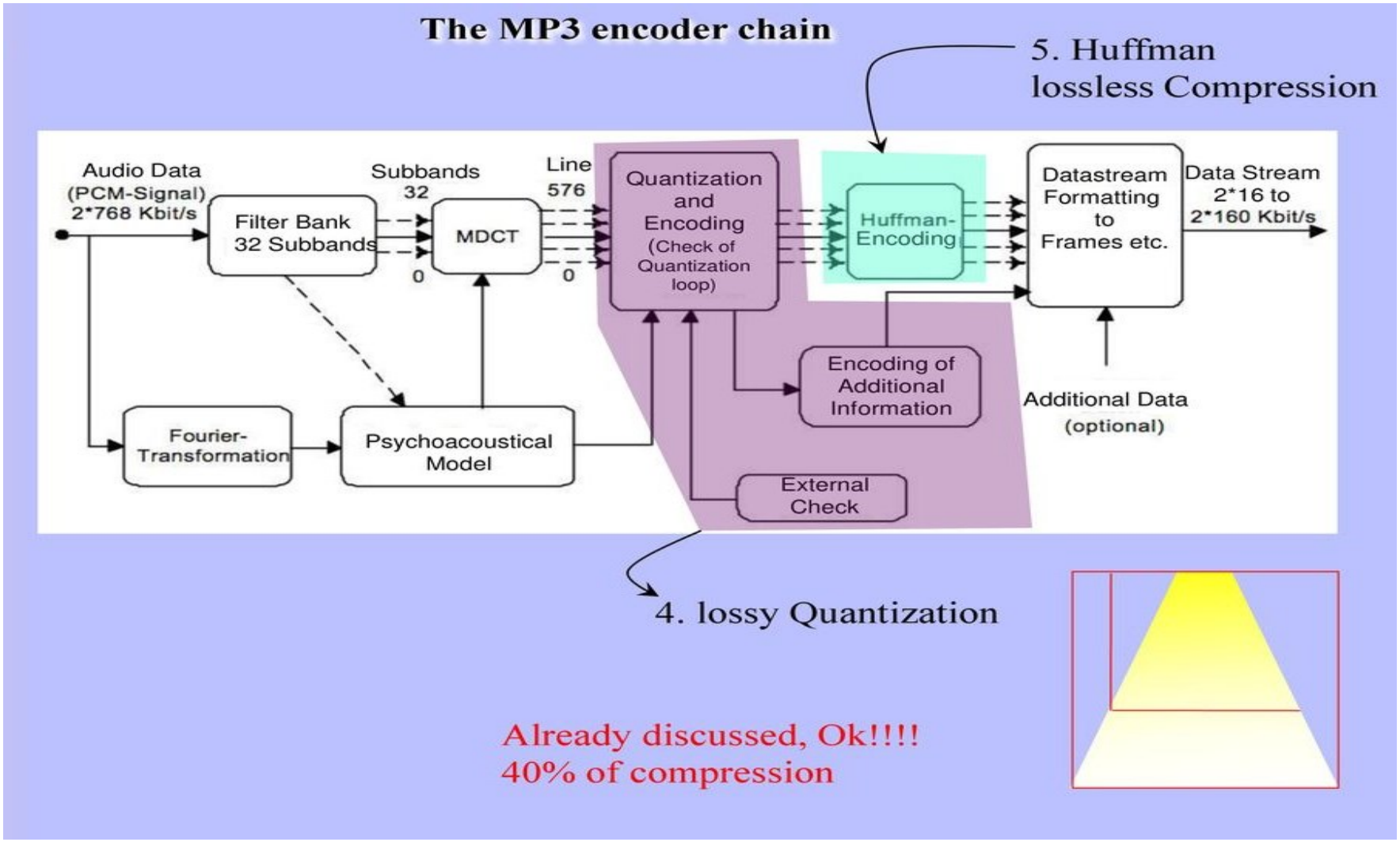
Example of DSP Core in Digital Camera

- ✓ But when you're recording video, if the videos are not processed fast, then you start missing frames.
- ✓ This is why digital video cameras almost always have a second microprocessor built-in, dedicated to video calculations. This is a Digital Signal Processor or DSP — the job of which is to perform repetitive mathematical tasks in real time.
- ✓ So, while your iphone's main microprocessor is checking to see if you have an incoming call, running your email in the background and managing your Wi-Fi signal, when video is coming through the lens, those calculations are handed off to a second microprocessor.

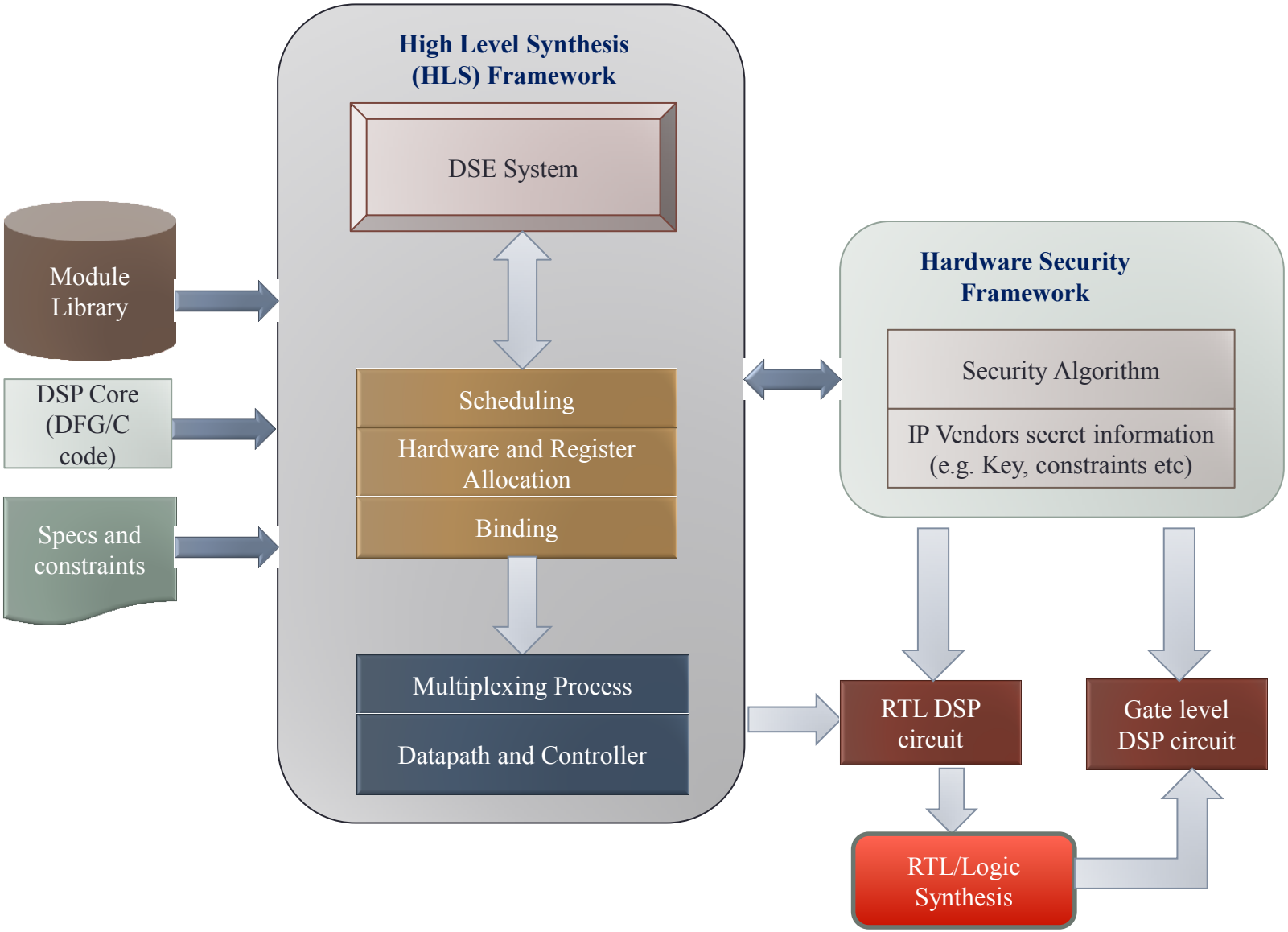


Nikon EXPEED, a system on a chip including an image processor, video processor, digital signal processor (DSP) and a 32-bit microcontroller controlling the chip

Another example of DSP in CE



Hardware Security Algorithms integrated with HLS and Logic Synthesis phases



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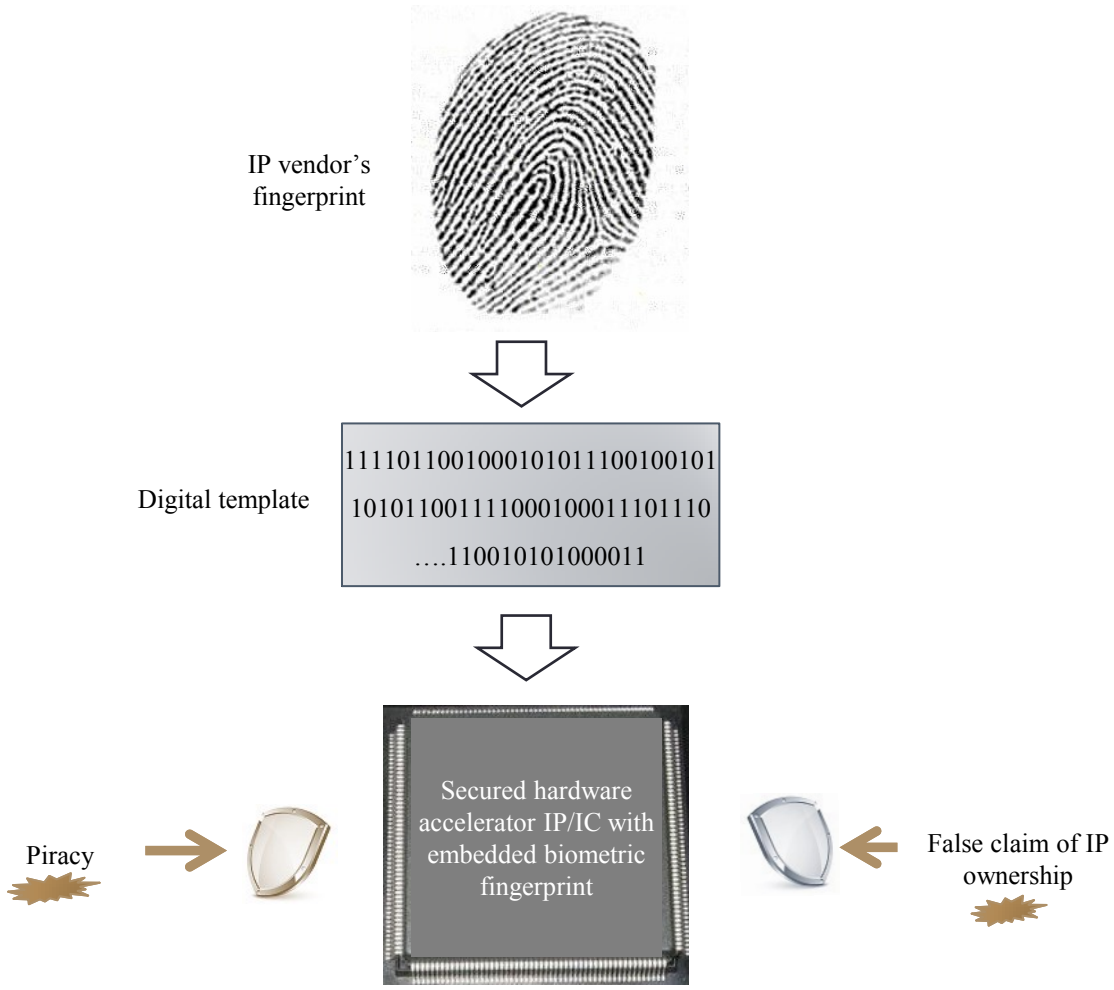
Securing hardware accelerators using biometric fingerprinting: Forensics



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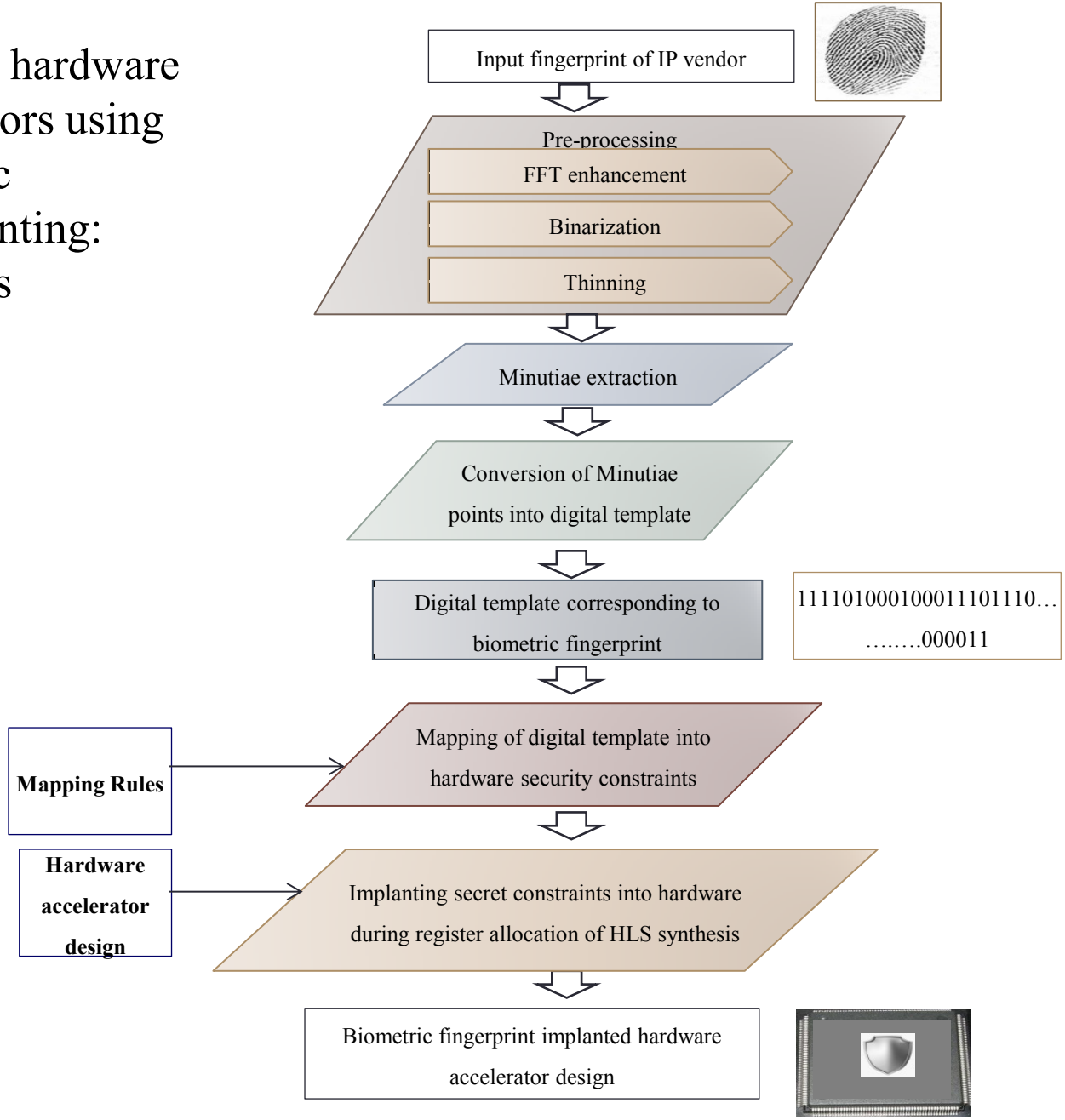

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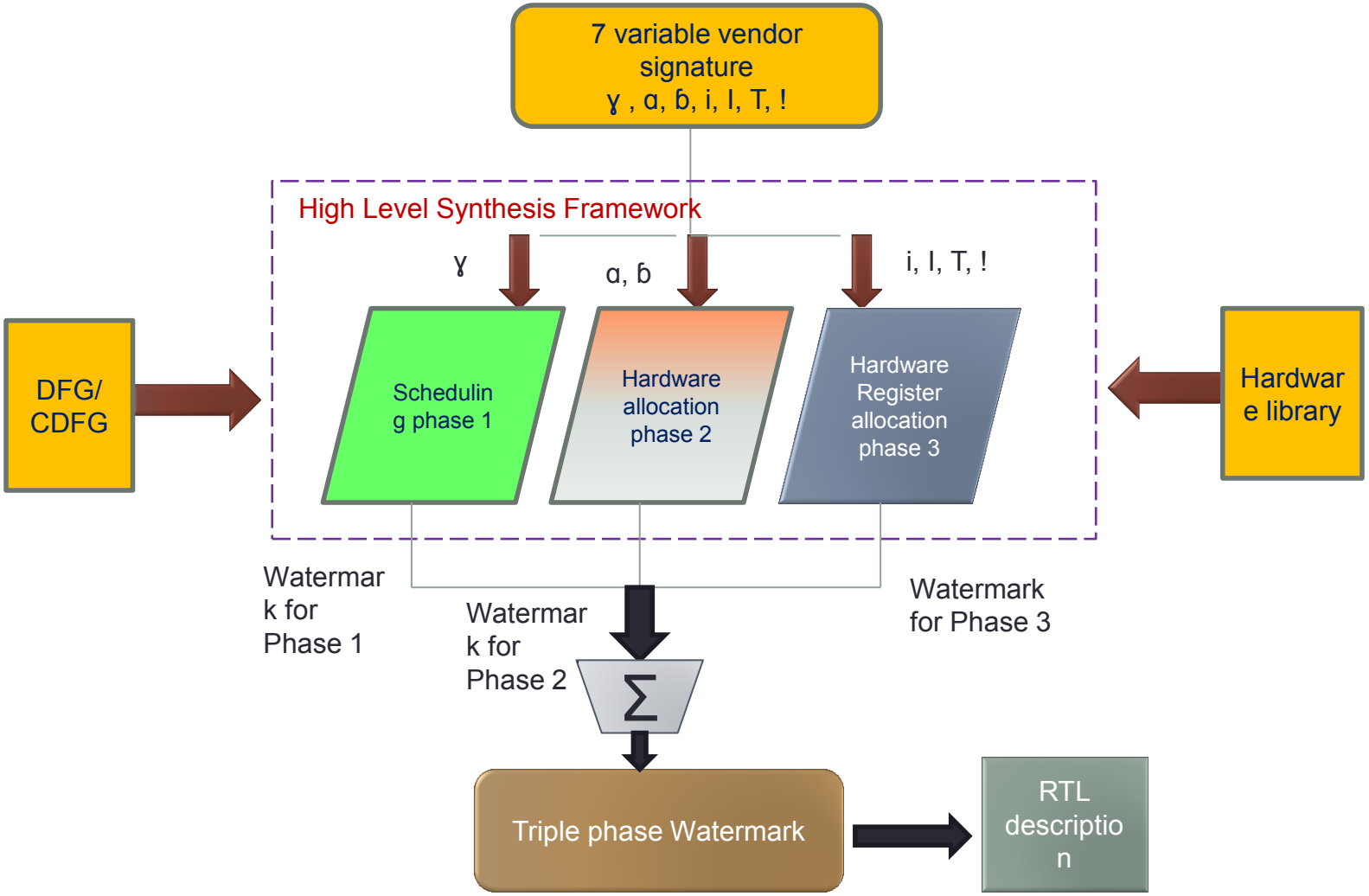
High level overview of triple phase watermarking



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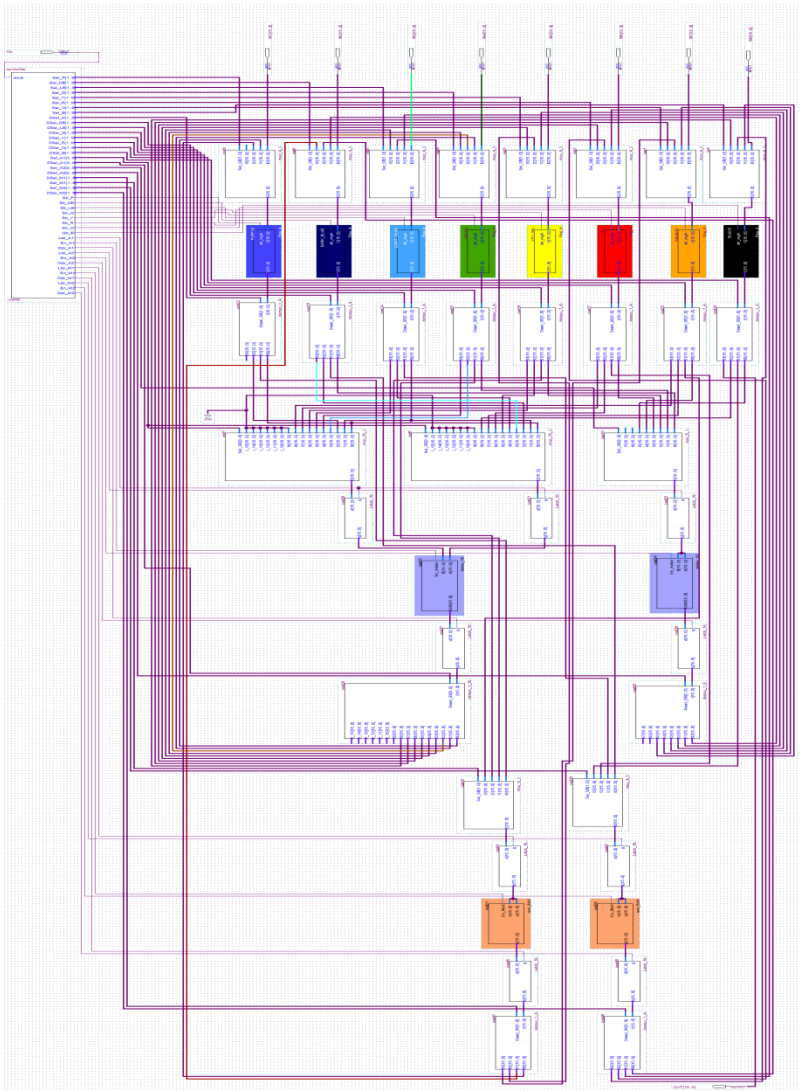
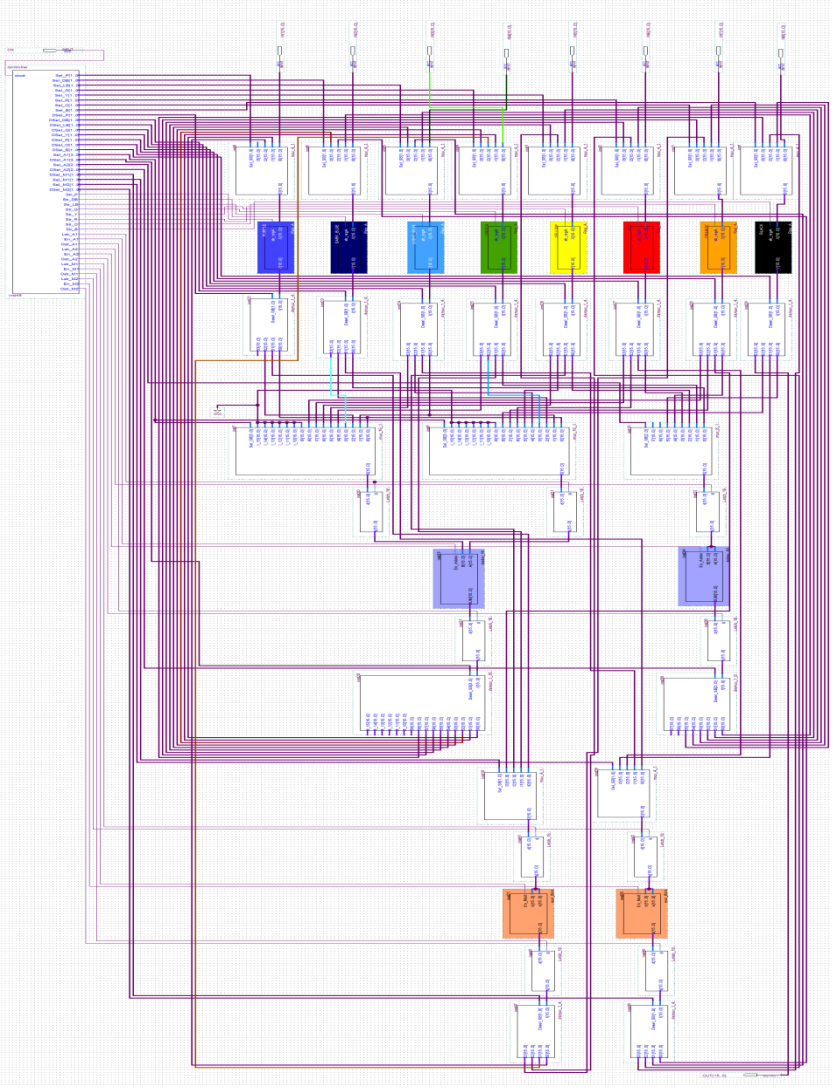
Watermarked FIR Vs Non-Watermarked FIR at RTL





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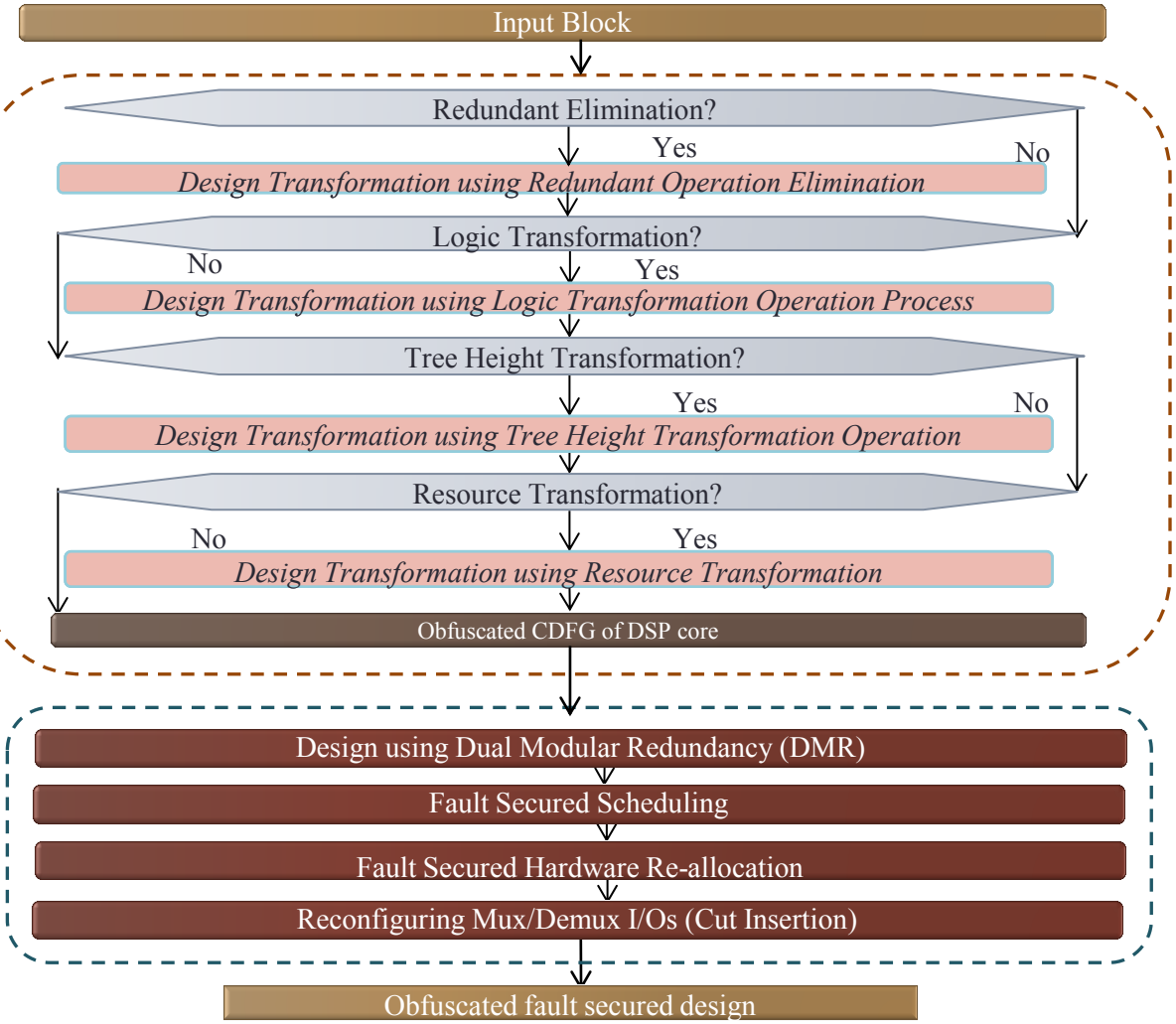
GENERIC DESIGN FLOW OF THE OBFUSCATION PROCESS



Obfuscation for fault Secured IP Designs

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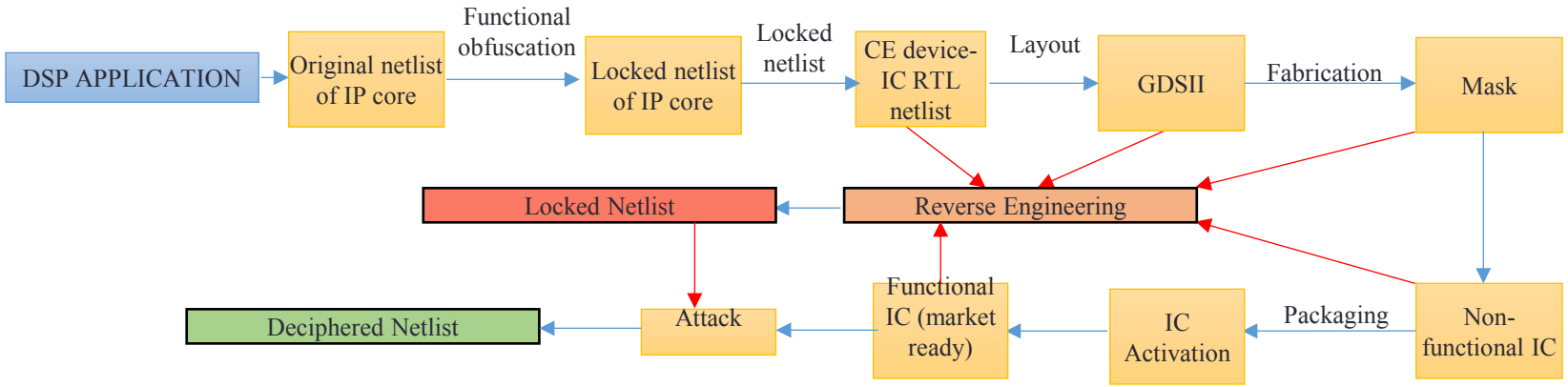
How Hardware of a CE device can be compromised ?



- Reverse engineering (RE) of a DSP core is a process of gaining the complete understanding of its **functionality**, **design** and **structure**.
- However, RE can be used for dishonest intention such as **overbuilding**, **piracy**, or **counterfeiting** a DSP core or inserting a **hardware Trojan**.

Anirban Sengupta, Deepak Kachave, Dipanjan Roy "Low Cost Functional Obfuscation of Reusable IP Cores used in CE Hardware through Robust Locking", **IEEE Transactions on Computer Aided Design of Integrated Circuits & Systems (TCAD),** 2019

Conclusion

The future of CE system / IoT design / CPS design / Autonomous vehicle design is Energy-Security Tradeoff !

References

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Thank You