SALWARE: Salutary Hardware to design Trusted IC.
Lilian Bossuet, David Hely

To cite this version:
Lilian Bossuet, David Hely. SALWARE: Salutary Hardware to design Trusted IC.. Workshop on Trustworthy Manufacturing and Utilization of Secure Devices, TRUDEVICE 2013, May 2013, Avignon, France. ujm-00833871

HAL Id: ujm-00833871
https://ujm.hal.science/ujm-00833871
Submitted on 13 Jun 2013

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
SALWARE: Salutary Hardware to design Trusted IC

Lilian Bossuet¹, David Hely²

¹ Laboratoire Hubert Curien, UMR CNRS 5516
University of Lyon, Saint-Etienne, France
Lilian.bossuet@univ-st-etienne.fr

² Laboratoire de Conception et d’Intégration des
Systèmes, Grenoble Institute of Technology
F-26902, Valence cedex 9, France

Abstract—Fabless semiconductor industries are facing the rise of
design costs of integrated circuits. This rise is due to the
technology change and the complexity increasing. It follows that
integrated circuits have become targets of counterfeiting and
theft. The SALWARE project aims to study (theoretically and
experimentally) salutary hardware design in order to fight
to theft, illegal cloning and counterfeiting of integrated
circuits. Salutary hardware means an embedded hardware
system, hardly detectable / circumvented, inserted in an
integrated circuit or a virtual component (Intellectual Property),
used to provide intellectual property information (eg
watermarking or hardware license) and/or to remotely activate
the circuit or IP after manufacture and during use.

Index Terms—salutary hardware, IP protection, IC
counterfeiting, IP watermarking.

I. INTRODUCTION

The microelectronics industry is facing increased costs of
production of integrated circuits. This increase is due to the
decline in technology and the increasing complexity of
systems (e.g., the transition from 32nm to 28nm technology is
accompanied by a 40% increase in manufacturing costs with
300 mm wafers in diameter and a 30% increase in
manufacturing costs with 450 mm wafers). For several years,
this has led to a sharp increase in the number of companies
with no means of production (fabless companies) and the
relocation of production. In addition, integrated circuits
manufactured today are produced with high added value in
a highly competitive industry. Moreover, their time-to-market is
increasingly tight. This makes them the targets of
counterfeiting and theft.

In recent years, the issue of counterfeiting of integrated
circuits has increased considerably. For example, the number
of counterfeit electronic circuits collected by U.S. Customs
from 2001 to 2011 has increased by around 700 [1]. Between
2007 and 2010, U.S. Customs collected 5.6 million counterfeit
electronic products [2]. Overall, the estimation of
counterfeiting is about 7% of the semiconductor market [3]
which represents a loss of about $10 billion per year for the
legal industry. It is therefore crucial and strategic to implement
research projects to protect the intellectual property of IC
designers.

To summarize the threat model of IC during manufacturing
and life, Fig. 1 shows a simplified life cycle of an IC from a
fabless designer to recycling. This cycle includes many threats
to intellectual property from the designer: netlist theft, IP theft,
mask theft, chip over-production (overbuilding), untested
device theft, discarded device, reverse engineering, device
counterfeiting, cloning, relabeled-repackaged-falsified “like
new device”.

We propose to fight against theft, illegal cloning and
counterfeiting of integrated circuit by designing salutary
hardware (salware). Salware is from the opposite of malware
(malicious hardware) but can use the same technique, strategy
and means. Salware means an embedded hardware system,
hardly detectable, hardly circumvented, inserted in an
integrated circuit or an IP, used to provide intellectual property
information and/or to remotely activate the circuit or IP after
manufacture and during use. IP Watermarking. PUF for IC
authentication, remote activation, logic encryption, FSM
encryption, memory encryption, bus encryption, hardware
metering. VHDL obfuscation, bitstream encryption (FPGA),
are some on the well-know salwares. In this short paper, we
do n’t want to give a state of the art of these usual salwares. We
want to discuss a new strategy to design salware by studying
malware. Following section present some ideas that we want to
investigate in order to find new efficient salwares.

![Diagram](image_url)

Fig. 1 - simplified life cycle of an IC from a fabless designer to recycling with threat model
II. NEW STRATEGIES FOR SALWARE DESIGN

In the area of security, a means of attack can also be a means of protection. The techniques used to attack and to defend have always been very close. Investigating ways of attacks and malicious hardware is the strategy that we propose to develop new efficient salware. At a first glance, three options can be considered: hardware trojans, backdoors and side channels. Other means of attack / malware can be also investigated.

A. Hardware Trojan Spirit

Small, hardly detectable, hardware Trojans are able to disable a part of a device or to allow information leakage without degradation of the system performance. According to our proposed definition, such characteristics are required to design efficient salware. Embedding a Trojan inside an IP in order to protect it during evaluation was recently proposed [4]. This work proposes to modify the IP finite state machine in order to disturb the normal functional behavior of the IP. With such salware it is possible to put an “expiry date” on the FSM control and to sell evaluation IP (temporary license). It is a time-based activation mechanism of Trojan [5], [6]. Others activation mechanism can be used to disturb the IP in case of illegal use such as expired hardware license or illegal copy. For example, a salware based on Trojan principles can use a PUF response to disturb or not an IP. Such physical-condition-based activation can permit to link an IP to a hardware implementation (hardware license).

As we have previously said, hardware Trojan can be designed to change the functionality of the infected device but also to silently leak information. Designing salware with a Trojan spirit could be a new opportunity to design IP watermarking. Watermarking techniques to fight against illegal IP copy and to allow IP traceability are already well studied. Recent study has shown that inserting watermarking during synthesis of IP netlist allows obtaining best results [7]. Embedding Trojan during the synthesis process is also an efficient way to design powerful and optimized Trojans. To conclude watermarking techniques could be efficiently improve by using Trojan mechanism to silently leak intellectual property information (mark).

Last but not least, hardware Trojan can be inserted in all location on the device: processor, hardware accelerator, memory, bus, i/o, NoC, power supply, analog part. That is really interesting to extend current works on salware which are often limited to logical gate, FSM, data-path and bus.

B. Official Backdoors

A recent work claimed that a backdoor was inserted into an FPGA [8]. This paper whipped up a storm on web before publication. Incriminated firm claimed that the inserted hardware was not malicious but salutary! This short story shown that malicious and salutary hardware are really close. Sometimes it is hard to distinguish them. Designers have to keep in mind that embedded salutary hardware could be misconstrued.

C. Side Channel Emission

The side channel attacks are well-known attacks in the field of cryptographic engineering. Most of the dynamic characteristics of both hardware and software implementation of cipher can be used for side channel analysis: the computation time, power consumption, electromagnetic radiation, optical radiation and even the produced sound during computation. The above descriptions are mainly oriented for side channel analysis. Such attack techniques can be used to read intellectual property information from the device to the verification process (watermarking checking).

Some published works proposed to use side channel as a communication channel to extract intellectual property. Thermal channel was used in [9] to allow a communication from an embedded tag to a remote receiver. Power consumption was used in [10]. Other side channel information can be efficiently used to transmit information about the IP. From example, like thermal channel, electromagnetic channel allows contactless checking. To conclude, side channels have to be used to design salware with discreet communication means.

VI. CONCLUSION

Investigating malicious hardware design and behavior is an opportunity to improve salutary hardware. Salware project aims at to design efficient intellectual property protection by follow this strategy. We hope to find new ways of protection, more efficient, more useful, more secure and low cost than state of the art existing protections.

REFERENCES