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Forensic Reverse Engineering of Silicon chips - Advanced digital investigation to tackle cybercrime of electronic devices

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## Factsheet 1: FinFET Technology

FinFET (Fin Field-Effect Transistor) technology has emerged as a groundbreaking innovation in semiconductor manufacturing, revolutionizing the performance and efficiency of modern electronic devices. The main objective of ForRES is to develop all necessary tools and methods to reverse engineer functionality, extract ROM content, and perform fully invasive attacks on leading-edge semiconductor devices, focusing mainly on sub 28 nm technology and FinFET integrated circuits. This fact sheet aims to provide a comprehensive overview of FinFET technology, covering its key features, advantages and what role it plays in ForRES.

### What is FinFET Technology?

FinFET is an advanced transistor design used in semiconductor manufacturing processes, primarily for integrated circuits (ICs) such as CPUs (Central Processing Unit), GPUs (Graphics Processing Unit), and SoCs (System-on-Chips). Unlike traditional planar transistors, FinFETs feature a three-dimensional structure where the conducting channel is wrapped around a thin silicon "fin," providing enhanced control over current flow.

#### Key Features and advantages

- Three-Dimensional Structure: Unlike planar transistors, which have a two-dimensional structure, FinFET transistors are three-dimensional. They feature a raised "fin" structure that protrudes from the silicon substrate, providing better control over the flow of electrical current.
- Improved Electrostatic Control: The fin structure allows for better electrostatic control of the transistor channel. This results in reduced leakage current and improved transistor switching characteristics, leading to higher performance and lower power consumption.
- Scaling Benefits: FinFET technology enables continued scaling of transistor dimensions, allowing manufacturers to pack more transistors into a given chip area. This scalability is essential for meeting the increasing demands for higher performance and energy efficiency in modern electronic devices.
- Enhanced Performance: FinFET transistors offer improved performance metrics such as higher drive current and faster switching speeds compared to their planar counterparts. This makes them particularly suitable for applications requiring highspeed computing and data processing.

#### **FinFET in ForRES**

In the context of ForRES, FinFET technology plays a critical role in the challenges and objectives associated with reverse engineering and security analysis. ForRES aims to develop tools and methods to reverse engineer the functionality of semiconductor devices, extract ROM content, and perform fully invasive attacks on advanced semiconductor technologies, particularly those at sub-28 nm nodes, which predominantly use FinFET technology. Here are the key roles FinFET technology plays in ForRES:

- 1. Increased Complexity: FinFETs introduce a three-dimensional structure, which adds complexity to the reverse engineering process. Traditional planar transistors are easier to analyze because of their simpler, two-dimensional layout. The added dimension of FinFETs requires more advanced imaging and analysis techniques to accurately understand the device's structure and functionality.
- 2. Advanced Imaging and Analysis Tools: To reverse engineer FinFET-based devices, ForRES has to develop and utilize cutting-edge imaging techniques like Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) with high resolution to accurately capture the three-dimensional architecture of FinFET transistors.
- 3. Extraction of ROM Content: Extracting ROM content from FinFET-based devices is more challenging due to the denser and more complex layout. Advanced techniques are required to precisely locate and read the ROM cells without damaging the surrounding structures.



Cross-section of a 14nm FinFET-based integrated circuit (upside down). FinFETs can be observed on top of the image.



Close view of a cross-section of 14nm FinFETs

In summary, FinFET technology significantly influences the scope and methodology of ForRES by introducing new complexities and challenges in the reverse engineering process. The project's success hinges on developing innovative tools and techniques to address these challenges, ensuring that the forensic analysis and security evaluations of advanced semiconductor devices remain effective and accurate.

