Accepted Manuscript

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PII: S1742-2876(18)30111-7
DOI: 10.1016/j.diin.2018.05.005
Reference: DIIN 782

To appear in: *Digital Investigation*

Received Date: 10 March 2018
Revised Date: 24 May 2018
Accepted Date: 28 May 2018

Please cite this article as: Heckmann T, Markantonakis K, Naccache D, Souvignet T, Forensic smartphone analysis using adhesives: Transplantation of Package on Package components, *Digital Investigation* (2018), doi: 10.1016/j.diin.2018.05.005.

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Digital Investigation 00 (2018) 1–10

Digital Investigation

Forensic Smartphone Analysis Using Adhesives: Transplantation of Package on Package Components

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Abstract

Investigators routinely recover data from mobile devices. In many cases the target device is severely damaged. Events such as airplane crashes, accidents, terrorism or long submersion may bend or crack the device's main board and hence prevent using standard forensic tools. This paper shows how to salvage forensic information when NAND memory, SoC or cryptographic chips are still intact. We do not make any assumptions on the state of the other components. In usual forensic investigations, damaged phone components are analysed using a process called "forensic transplantation". This procedure consists of unsoldering (or lapping) chips, re-soldering them on a functionnal donor board and rebooting.

Package on Package (PoP) component packaging is a new technique allowing manufacturers to stack two silicon chips, e.g. memory, CPU or cryptographic processors. Currently, PoP is widely used by most device manufacturers and in particular by leading brands such as Apple, BlackBerry, Samsung, HTC and Huawei. Unfortunately, forensic transplantation destroys PoP components.

This work overcomes this difficulty by introducing a new chip-off analysis method based on High Temperature Thixotropic Thermal Conductive Adhesive (HTTTCA) for gluing the PoP packages to prevent misalignment during the transplantation process. The HTTTCA process allows the investigator to safely unsolder PoP components, which is a crucial step for transplantation. To demonstrate feasibility, we describe in detail an experimental forensic transplantation of a secure mobile phone PoP CPU.

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Keywords: Forensic Rework, Hardware Forensics, Adhesives Properties, Forensic Transplantation.

Introduction

Forensic investigators must frequently bypass the protections of embedded systems to access digital evidence. Terrorism and mass accidents[1] are on the increase and the analysis of mobile devices is necessary to address various needs: legal (proof in court), technical (understanding the disaster) and ethical (mourning of the victims' families).

This paper concerns the recovery of data from damaged smartphones. The damage levels considered in our setting can be severe: we assume that the main boards might be broken or severely bent, but that the NAND, SoC or cryptographic chips remain intact. As of today, the mobile phone industry largely uses a new packaging technology called Package on Package (PoP). Miniaturisation and the race for performance and security make PoP omnipresent. Indeed, PoP is deployed in the latest smartphone generations: iPhone X, iPhone 8, iPhone 8 Plus (A11 Bionic PoP), iPhone 7, iPhone 7 Plus (A10 Fusion processor APL1W24 PoP), iPhone 6S Plus (A9 processor PoP), BlackBerry 9900 (Qualcomm 8655 PoP processor), BlackBerry Z10 (Qualcomm Snapdragon S4 Plus processor PoP), Samsung Galaxy S7 edge (Qualcomm 820 Snapdragon or Samsung Exynos 8890), HTC 10 (Snapdragon 820), Huawei Mate 8 (Kirin 950), etc. Unfortunately, unsoldering PoP components for transplantation is extremely difficult using traditional techniques.

This paper shows how specific adhesives (thermally conductive and electrically insulating epoxy) can allow the investigator to unsolder PoP components without destroying them including cases when the PoP stack solder balls have the same or

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[1]e.g. the attacks in Paris [1], Nice [2], the Germanwings crash [3] and the Puisseguin bus accident [4].

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