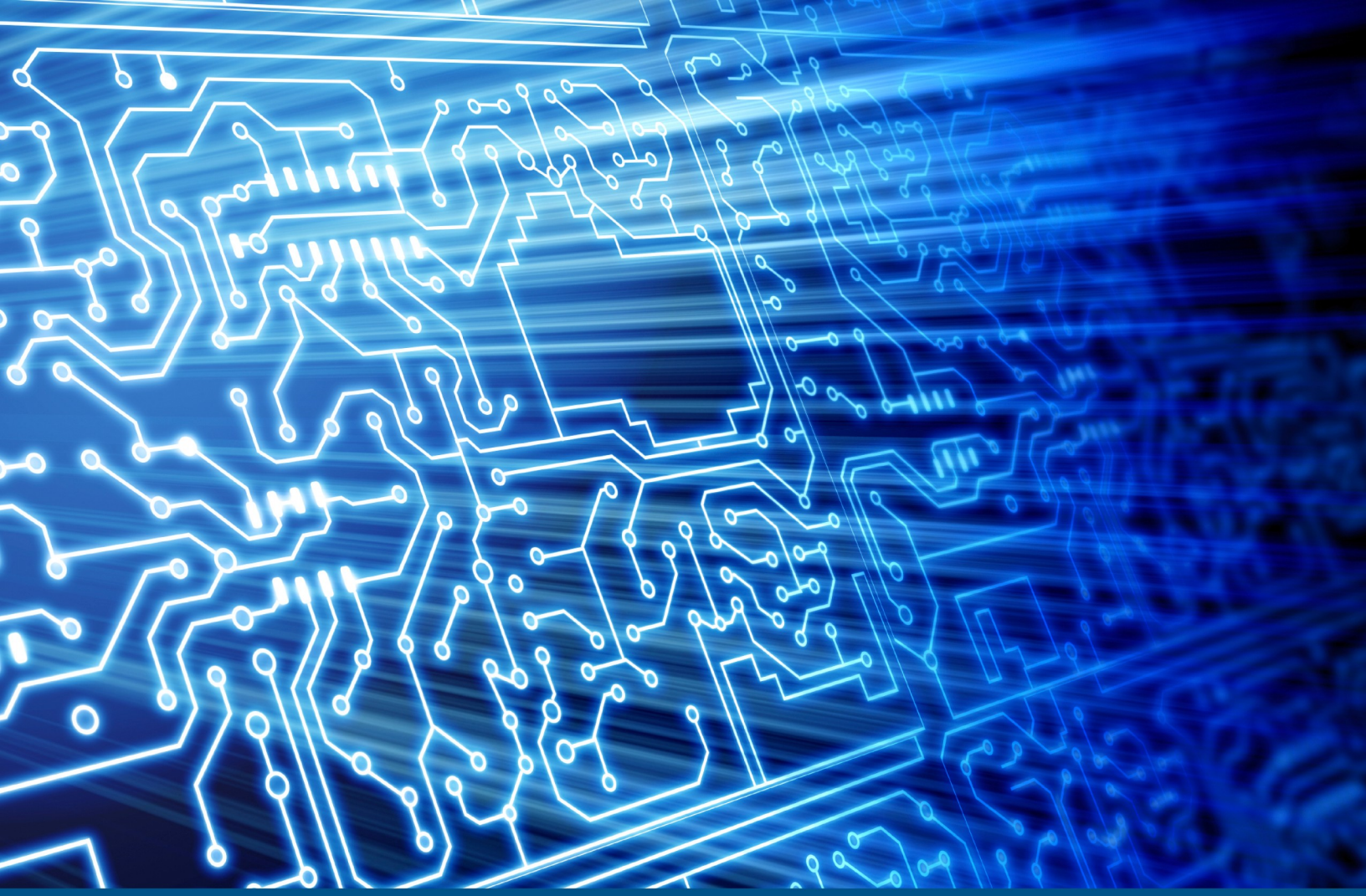

Test Results for Binary Image (JTAG, Chip-Off) Decoding and Analysis Tool
X-Ways v19.8 SR-7

February 2020

Homeland Security

Science and Technology

This report was prepared for the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) by the Office of Law Enforcement Standards of the National Institute of Standards and Technology.

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February 2020

Test Results for Binary Image (Joint Test Action Group (JTAG), Chip-Off) Decoding and Analysis Tool: X-Ways Forensics_v19.8 SR-7

Contents

Introduction

The Computer Forensics Tool Testing (CFTT) program is a joint project of the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), the National Institute of Justice, and the National Institute of Standards and Technology Special Program Office and Information Technology Laboratory. CFTT is supported by other organizations, including the Federal Bureau of Investigation, the U.S. Department of Defense Cyber Crime Center, U.S. Internal Revenue Service Criminal Investigation Division Electronic Crimes Program, U.S. Immigration and Customs Enforcement, U.S. Customs and Border Protection and U.S. Secret Service. The objective of the CFTT program is to provide measurable assurance to practitioners, researchers, and other applicable users that the tools used in computer forensics investigations provide accurate results. Accomplishing this requires the development of specifications and test methods for computer forensics tools and subsequent testing of specific tools against those specifications.

Test results provide the information necessary for developers to improve tools, users to make informed choices, and the legal community and others to understand the tools' capabilities. The CFTT approach to testing computer forensics tools is based on well-recognized methodologies for conformance and quality testing. Interested parties in the computer forensics community can review and comment on the specifications and test methods posted on the CFTT website (https://www.cftt.nist.gov/).

This document reports the results from testing X-Ways Forensics v19.8 SR-7 decoding and analysis of mobile devices JTAG and Chip-Off binaries.

Test results from other tools can be found on the DHS S&T-sponsored digital forensics webpage, https://www.dhs.gov/science-and-technology/nist-cftt-reports.

Thanks and appreciation to Rex Kiser and his team from the Fort Worth Police Department – Digital Forensics Lab and Steve Watson and his team from VTO Labs for their assistance on performing Chip-Off data extractions.

How to Read This Report

This report is divided into four sections. Section 1 identifies and provides a summary of any significant anomalies observed in the test runs. This section is sufficient for most readers to assess the suitability of the tool for the intended use. Section 2 identifies the mobile devices used for testing. Section 3 lists testing environment and the internal memory data objects used to populate the mobile devices. Section 4 provides an overview of the test case results reported by the tool.

Test Results for Binary Image (JTAG, Chip-Off) Decoding and Analysis Tool

Tool Tested:	X-Ways Forensics
Software Version:	v19.8 SR-7
Supplier:	X-Ways AG
Address:	PO box 62 02 08 50695 Cologne Germany
Fax:	+49 3212-123 2029
Website:	https://www.x-ways.net

1 Results Summary

X-Ways Forensics is an advanced work environment for computer forensic examiners that operates under Windows XP/2003/Vista/2008/7/8/8.1/2012/10*, 32 Bit/64 Bit, standard/PE/FE.

X-Ways was tested for its ability to decode and analyze binary images created by performing Chip-Off and JTAG data extractions from supported mobile devices. Except for the following anomalies, the tool was able to decode and report all supported data objects completely and accurately for all mobile devices tested.

Stand-Alone Files:

- Stand-alone files (i.e., audio, documents, graphics, video) are not reported. (Device: *HTC One Mini-_Chip-Off*)

Social Media Data:

- Social media related data (i.e., Twitter) is partially reported. (Devices: *LG K7_Chip-Off, ZTE 970_Chip-Off,)*
- Social media related data (i.e., Facebook) is partially reported. (Devices: *HTC One XL-.- Chip-Off, HTC Desire S-.-. Chip-Off, HTC One XL_JTAG, HTC Desire S-_JTAG*)

GPS Related Data:

- GPS related data (i.e., longitude, latitude coordinates, routes, addresses, etc.) was not reported. (Device: *HTC One Mini-.- Chip-Off*)

NOTE:

The Chip-Off and JTAG binary file analysis was performed by searching through individual files and databases contained within a partition. To view these files an association was created within X-Ways with a viewer capable of presenting a specific type of data artifact. Mobile data artifacts were extracted from. The Chip-Off and JTAG binaries were not normalized, i.e., categorized based upon data type (contacts, calendar, notes, call logs, SMS, multimedia messaging service [MMS], etc.).

For more test result details see section 4.

2 Mobile Device Binary Images

The following table lists the mobile device binaries used for testing X-Ways v19.8 SR-7.

Make	Model	OS Version	Data Extraction
HTC	Desire 626	Android 5.1 Lollipop	Chip-Off
LG	K7	Android 5.1 Lollipop	Chip-Off
Samsung	S4	Android 4.2 Jelly Bean	Chip-Off, JTAG
ZTE	Z970	Android 4.4 KitKat	Chip-Off
HTC	Desire S	Android 2.3 Gingerbread	Chip-Off, JTAG
HTC	One XL	Android 4.0 Ice Cream Sandwich	Chip-Off, JTAG
HTC	One Mini	Android 4.2 Jelly Bean	Chip-Off, JTAG
Samsung	S2	Android v2.3 Gingerbread	Chip-Off

Table 1: Mobile Device Binary Images

3 Testing Environment

The tests were run in the NIST CFTT lab. This section describes the selected test execution environment, and the data objects populated onto the internal memory of mobile devices.

3.1 Execution Environment

X-Ways v19.8 SR-7 was installed on Windows 10 Pro version 10.0.14393.

3.2 Internal Memory Data Objects

X-Ways v19.8 SR-7 was measured by analyzing acquired data from the internal memory of pre-populated mobile devices. Table 2 defines the data objects and elements used for populating mobile devices, provided the mobile device supports the data element.

Data Objects	Data Elements
Address Book Entries	*Regular Length*
	Maximum Length
	Special Character
	Blank Name
	Regular Length, Email
	Regular Length, Graphic
	Regular Length, Address
	Deleted Entry
	Non-Latin Entry
	Contact Groups
Personal Information Manager (PIM) Data: Datebook/Calendar; Memos	*Regular Length*
	Maximum Length
	Deleted Entry
	Special Character
	Blank Entry
Call Logs	*Incoming*
	Outgoing
	Missed
	Incoming – Deleted
	Outgoing – Deleted
	Missed - Deleted
Text Messages	*Incoming Short Message Service (SMS) – Read*
	Incoming SMS – Unread
	Outgoing SMS
	Incoming Enhanced Message Service (EMS) – Read
	Incoming EMS – Unread
	Outgoing EMS
	Incoming SMS – Deleted
	Outgoing SMS – Deleted
	Incoming EMS – Deleted
	Outgoing EMS – Deleted
	Non-Latin SMS/EMS
Multimedia Messaging Service (MMS) Messages	*Incoming Audio*
	Incoming Graphic
	Incoming Video
	Outgoing Audio
	Outgoing Graphic
	Outgoing Video

Table 2: Internal Memory Data Objects

Data Objects	Data Elements
Application Data	*Device Specific App Data*
Stand-alone data files	*Audio*
	Graphic
	Video
	Audio – Deleted
	Graphic - Deleted
	Video - Deleted
Internet Data	*Visited Sites*
	Bookmarks
	E-mail
Location Data	*GPS Coordinates*
	Geo-Tagged Data
Social Media Data	*Facebook*
	Twitter
	LinkedIn
	Instagram
	Pinterest
	Snapchat
	WhatsApp

Table 2: Internal Memory Data Objects (Continued)

4 Test Results

This section provides the test case results reported by the tool. Sections 4.1 and 4.2 identify the make and model of the mobile device used for creating the binary image and data extraction technique employed, i.e., Chip-Off, JTAG.

The *Test Cases* column in sections 4.1 and 4.2 are comprised of two sub-columns that define a particular test category and individual sub-categories that are verified when decoding and analyzing the associated binary image. The results are as follows:

As Expected: The mobile forensic application returned expected test results – the tool acquired and reported data from the mobile device/UICC successfully.

Partial: The mobile forensic application returned some of the data from the mobile device/UICC.

Not As Expected: The mobile forensic application failed to return expected test results – the tool did not acquire or report supported data from the mobile device/UICC successfully.

NA (Not Applicable): The mobile forensic application is unable to perform the test, or the tool does not provide support for the acquisition of a particular data element.

4.1 Chip-Off Data Extractions

The internal memory contents for Chip-Off binary images were decoded and analyzed with X-Ways v19.8 SR-7.

All test cases pertaining to the acquisition of supported Android devices were successful, with the exception of the following.

- Stand-alone files (i.e., audio, documents, graphics, video) were not reported for the HTC One Mini.
- Twitter social media data was partially reported, i.e., account- related information for the LG K7 and ZTE 970.
- Facebook social media data was partially reported, i.e., account-related information for the HTC One XL and HTC Desire S.
- GPS-related data (e.g., waypoints, longitude, latitude, routes) were not reported for the HTC One Mini.

Notes:
-Devices defined in the table below with an '', e.g., HTC One XL*, both Chip-Off and JTAG data extractions were performed.*

-When performing the Chip-Off data extraction, it appeared the HTC One Mini had suffered water damage, which may lead to differences in the data reported for the JTAG compared t Chip-Off.

- Deleted Contacts, Calendar, Memo/Note entries were recovered for the HTC Desire 626, ZTE 970, Samsung S2, HTC One XL and Samsung S4.
- Deleted Contacts and Calendar entries were recovered for the LG K7 and HTC Desire S.
- Deleted Contacts and Memo entries were recovered for the HTC One Mini.
- Deleted Call logs were recovered for the LG K7, Samsung S2, Samsung S4 and HTC Desire S.
- Deleted SMS entries were recovered for the HTC Desire 626, LG K7, ZTE 970, Samsung S2, HTC One XL, Samsung S4, HTC One Mini and HTC Desire S.
- Deleted bookmark entries were recovered for the HTC Desire 626, ZTE 970, Samsung S2, HTC One XL and HTC Desire S.

See Table 3 below for more details.

X-Ways v19.8 SR-7									
Test Cases – Chip- Off Binary Decoding and Analysis		*Mobile Device Binary Images: Chip-Off*							
		HTC Desire 626	LG K7	ZTE 970	Samsung S2	HTC One XL*	Samsung S4*	HTC One Mini*	HTC Desire S*
Equipment/ User Data	International Mobile Equipment Identity (IMEI)	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Mobile Equipment Identity (MEID)/Electronic Serial Number (ESN)	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
	Mobile Subscriber International Directory Number (MSISDN)	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
PIM Data	Contacts	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Calendar	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Memos/ Notes	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Call Logs	Incoming	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Outgoing	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Missed	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
SMS Messages	Incoming	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Outgoing	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*

Table 3: Chip-Off Data Extractions

X-Ways v19.8 SR-7									
Test Cases – Chip- Off Binary Decoding and Analysis		*Mobile Device Binary Images: Chip-Off*							
		HTC Desire 626	LG K7	ZTE 970	Samsung S2	HTC One XL*	Samsung S4*	HTC One Mini*	HTC Desire S*
MMS Messages	Graphic	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Audio	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Video	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Stand-Alone Files	Graphic	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*Not As Expected*	*As Expected*
	Audio	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Video	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*Not As Expected*	*As Expected*
Application Data	Documents (txt, pdf files)	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*Not As Expected*	*As Expected*
Social Media Data	Facebook	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*Partial*	*As Expected*	*As Expected*	*Partial*
	Twitter	*As Expected*	*Partial*	*Partial*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	LinkedIn	*As Expected*	*As Expected*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
	Instagram	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*NA*	*As Expected*	*NA*	*NA*
	Pinterest	*NA*	*As Expected*	*As Expected*	*NA*	*NA*	*As Expected*	*NA*	*NA*
	Snapchat	*NA*	*As Expected*	*As Expected*	*NA*	*NA*	*As Expected*	*NA*	*NA*
	WhatsApp	*NA*	*As Expected*	*As Expected*	*NA*	*NA*	*NA*	*NA*	*NA*
Internet Data	Bookmarks	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	History	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Email	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*

Table 3: Chip-Off Data Extractions (Continued)

X-Ways v19.8 SR-7									
Test Cases – Chip- Off Binary Decoding and Analysis		*Mobile Device Binary Images: Chip-Off*							
		HTC Desire 626	LG K7	ZTE 970	Samsung S2	HTC One XL*	Samsung S4*	HTC One Mini*	HTC Desire S*
GPS Data	Coordinates/Geo-tagged	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*Not As Expected*	*As Expected*
Non-Latin Character	Reported in native format	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Hashing	Case File/ Individual Files	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Case File Data Protection	Modify Case Data	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*	*As Expected*

Table 3: Chip-Off Data Extractions (Continued)

4.2 JTAG Data Extractions

The internal memory contents for JTAG binary images were decoded and analyzed with X-Ways v19.8 SR-7.

All test cases pertaining to the acquisition of supported Android devices were successful except the following:

- Facebook social media data was partially reported (i.e., account information) for the HTC Desire S and HTC One XL.

Notes:
-Devices defined in the table below with an '', e.g., HTC One Mini*, both Chip-Off and JTAG data extractions were performed.*

- Deleted Contacts and Calendar entries were recovered for the HTC Desire S.
- Deleted Contacts and Memo/Note entries were recovered for the HTC One Mini.
- Deleted Contacts, Calendar and Memo/Note entries were recovered for the HTC One XL and Samsung S4.
- Deleted Call Logs were recovered for the HTC Desire S and Samsung S4.
- Deleted SMS entries were recovered for the HTC Desire S, HTC One Mini, HTC One XL and Samsung S4.
- Deleted bookmark entries were recovered for the HTC Desire S, HTC One XL and Samsung S4.

See Table 4 below for more details.

X-Ways v19.8 SR-7					
Test Cases – JTAG Binary Decoding and Analysis		*Mobile Device Binary Images: JTAG*			
		HTC Desire S*	HTC One Mini*	HTC One XL*	Samsung S4*
Equipment/ User Data	IMEI	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	MEID/ESN	*NA*	*NA*	*NA*	*NA*
	MSISDN	*As Expected*	*As Expected*	*As Expected*	*As Expected*
PIM Data	Contacts	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Calendar	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Memos/Notes	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Call Logs	Incoming	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Outgoing	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Missed	*As Expected*	*As Expected*	*As Expected*	*As Expected*
SMS Messages	Incoming	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Outgoing	*As Expected*	*As Expected*	*As Expected*	*As Expected*
MMS Messages	Graphic	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Audio	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Video	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Stand-alone Files	Graphic	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Audio	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Video	*As Expected*	*As Expected*	*As Expected*	*As Expected*

Table 4: JTAG Data Extractions

X-Ways v19.8 SR-7					
Test Cases – JTAG Binary Decoding and Analysis		*Mobile Device Binary Images: JTAG*			
		HTC Desire S*	HTC One Mini*	HTC One XL*	Samsung S4*
Application Data	Documents (txt, pdf files)	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Social Media Data	Facebook	*Partial*	*As Expected*	*Partial*	*As Expected*
	Twitter	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	LinkedIn	*NA*	*NA*	*NA*	*NA*
	Instagram	*NA*	*NA*	*NA*	*As Expected*
	Pinterest	*NA*	*NA*	*NA*	*As Expected*
	Snapchat	*NA*	*NA*	*NA*	*As Expected*
	WhatsApp	*NA*	*NA*	*NA*	*NA*
Internet Data	Bookmarks	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	History	*As Expected*	*As Expected*	*As Expected*	*As Expected*
	Email	*As Expected*	*As Expected*	*As Expected*	*As Expected*
GPS Data	Coordinates/ Geo-tagged	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Non-Latin Character	Reported in native format	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Hashing	Case File/ Individual Files	*As Expected*	*As Expected*	*As Expected*	*As Expected*
Case File Data Protection	Modify Case Data	*As Expected*	*As Expected*	*As Expected*	*As Expected*

Table 4: JTAG Data Extraction (Continued)