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XBOX ONE FILE SYSTEM DATA STORAGE: A FORENSIC ANALYSIS

For the degree of Master of Science

Is approved by the final examining committee:

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XBOX ONE FILE SYSTEM DATA STORAGE: A FORENSIC ANALYSIS

A Thesis

Submitted to the Faculty

of

Purdue University

by

Caitlin Elizabeth Gravel

In Partial Fulfilment of the

Requirements for the Degree

of

Masters of Science

May 2015

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West Lafayette, Indiana

To my parents, Liz and Mark, for always supporting and believing in me. To my brothers, Patrick and Sammy, for being there for me. To Katja for never letting me give up and always making me smile when I needed it.

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LIST OF ABBREVIATIONS

BIOS	Basic Input/Output System
FAT	File Allocation Table
FTK	Forensic Took Kit
GPT	GUID Partition Table
GUID	Global Unique Identifier
HDD	Hard drive
LBA	Logical Block Address
MBR	Master Boot Record
MD5	Message Digest 5
MFT	Master File Table
MSDOS	Microsoft Disk Operating System
NIST	National Institute of Standards and Technology
NTFS	New Technology File System
OS	Operating System
PC	Personal Computer
PS#	PlayStation #
PFS	PlayStation File System

RAM	Random Access Memory
ReFS	Resilient File System
SATA	Serial ATA
SHA1	Secure Hash Algorithm 1
TC1	Test Case One
TC2	Test Case Two
TC3	Test Case Three
TD1	Test Drive One
UEFI	Unified Extensible Firmware Interface
USB	Universal Serial Bus

GLOSSARY

Data – "A subset of information in an electronic format that allows it to be retrieved or transmitted" (NIST, 2013 p.83).

Data Integrity – "The property that data has not been altered in an unauthorized manner. Data integrity covers data in storage, during processing, and while in transit" (NIST, 2013 p. 59).

Decryption – "The process of transforming ciphertext into plain text" (NIST, 2013 p.60).

Digital Evidence – "a digital object that contains reliable information that supports or refutes a hypothesis" (Carrier, 2005).

Digital Forensics – "the use of an expert to preserve, analyze, and produce data from volatile and non-volatile media storage" (Meyers, 2004).

Digital Investigation – "a process where we develop and test hypothesis that answer questions about digital events" (Carrier, 2005 p.12).

Encryption – "Conversion of plaintext to ciphertext through the use of a cryptographic algorithm" (NIST, 2013 p.69).

File Sytem – Computers method for the long-term storage and retreival of data. File systems provide a mechanism for users to store data in a hierarchy of files and directories. A flie system consists of structural and user data that are organized such that the computer knows where to find them" (Carrier, 2005).

Firmware – "The programs and data components of a crytographic module that are stored in hardware within the cryptographic boundry and cannot be dynamically written or modified during execution" (NIST, 2013 p.79).

Forensically Sound – "The application of a transparent digital forensic process that preserves the original meaning of the data for production in a court of law" (McKemmish, 2008 p. 3).

Game Console – "Computer devices dedicated to (or primarily used for) playing video games" (Henderson, 2009 p. 205).

Hard Drive/Hard Disk (magnetic) (aka HDD) – "The primary means of fast data storage and retrieval in computer systems of all sizes. The disk itself consists of a rigid aluminum alloy platter coated with a magnetic oxide material. The platter can be rotated at speeds of more than 10,000 rpm. A typical drive consists of a stack of such platters mounted on a rotaating spindle, with a read/write head mounted above each platter" (Henderson, 2009 p.222).

Hardware – "The physical components of an information system" (NIST, 2013 p.84).

Hash Function – "A function that maps a bit string of arbitrary length to a fixed length bit string. Approved hash functions are specific in FIPS 180 and are designed to satisfy the following properties: 1) (One-way) It is computationally infeasible to find any input that maps to any new prespecified output, and 2) (Collision resistant) It is computationally infeasible to find any two distinct inputs that map to the same output" (NIST, 2013 p.84).

Hash Total – "Value computed on data to detect error or manipulation" (NIST, 2013 p.84).

Hashing – "The process of using a mathematical algorithm against data to produce a numeric value that is representative of that data" (NIST, 2013 p.85).

Hypervisor – "A layer of software that sits between the hardware and one or more operating systems. Its primary job is to provide isolated execution environments called partitions." (Microsoft, 2014).

Operating System (OS) – "An overreaching program that manages the resources of the computer. It runs programs and provices them with access to memory (RAM), input/output devices, a file system, and other services. It provides application programmers with a way to invoke system services, and gives users a way to control programs and organize files" (Henderson, 2009 p.352-353).

Software – "Computer programs and associated data that may be dynamically written or modified during execution" (NIST, 2013 p.185).

Virtual Machine – "Software that allows a single host to run one or more guest operating systems" (NIST, 2013 p. 211).

Write-Blocker – "A device that allows investigators to examine media while preventing data writes from occurring on the subject media" (NIST, 2013 p. 215).

ABSTRACT

Gravel, Caitlin Elizabeth, M.S., Purdue University, May 2015. Xbox One File System Data Storage: A Forensic Analysis. Major Professor: Marcus K. Rogers.

The purpose of this research was to answer the question, how does the file system of the Xbox One store data on its hard disk? This question is the main focus of the exploratory research and results sought. The research is focused on digital forensic investigators and experts. An out of the box Xbox One gaming console was used in the research. Three test cases were created as viable scenarios an investigator could come across in a search and seizure of evidence. The three test cases were then analyzed individually and cross analyzed with each other for differing digital artifacts. It was found that the Xbox One works off of a UEFI/GPT system with NTFS within each of the five partitions. MD5 and SHA1 hash checksums were used as to view altered, added, and removed files for both integrity checking and test case comparison.

CHAPTER 1. INTRODUCTION

Technology is constantly evolving in the world. Digital forensic investigators have to overcome the challenge of researching brand new devices every year. Microsoft's Xbox One is among these new devices and was released on November 22nd, 2013 (Microsoft, 2014). To help forensic investigators understand the Xbox One system the following research explored the gaming consoles file system.

The Xbox One console has many new features than simply allowing users to play video games, including allowing users to download music, pictures, and videos, browse the internet, Skype, backup data in the cloud, sign on to the Xbox Live network, voice command, Kinect camera motion tracking, SmartGlass, cloud storage, ability to run cable box through console, and of course play video games. With these new features users have the ability to do innocent and devious behavior with the Xbox One. It is up to forensic investigators to conclude which is which. This research allows the forensic investigators to know more about the gaming console so they can make their conclusion an accurate one.

The default specifications of the Xbox One are: an eight core processor, eight gigabytes of RAM, one 500GB magnetic hard drive, Blu-ray/DVD optical drive, Wi-Fi, and Ethernet capabilities (Microsoft, 2014).

The Xbox One has three operating systems working together for the overall end user experience (Rubin, 2013). The operating systems are listed as the Xbox OS, an OS based on Windows 8 and RT, and a Hyper-V like operating system to talk between the other two operating systems (Sakr, 2013). The Xbox OS is used as the main gaming engine for video gaming. The stripped down Windows OS is based off of the Windows kernel and is primarily used for the apps to be used on the system (Sakr, 2013).

These operating systems, working together simultaneously, allow the ability of Microsoft's SmartGlass to work where the end-user can see two different screens at the same time. Examples of these features include, but are not limited to, playing a video game while Skyping with friends and family, or watching a movie and browsing the internet or downloading more games.

The forensic significance of researching the Xbox One is that the console can be used to commit illegal crimes. An Xbox One can be used either as a target, tool, or data storage unit for malicious intent. The Xbox One has the potential to be included in crimes such as computer fraud, child abuse and pornography, network intrusion, homicide, domestic violence, financial fraud and counterfeiting, e-mail threats, harassment and stalking, narcotics, software privacy, telecommunications fraud, and identity theft (USA DHS, 2007, p. 13).

By researching the Xbox One investigators have the ability to better know how the console works to get to the data they need to better help liberate or incarcerate a suspect. Each digital device is customized to its owner's specifications and can be modified further to enable illegal acts. If investigators have a better grasp on the ways in

which owners can modify their Xbox One then they have the ability to enter the digital investigation with proper knowledge and understanding of the Xbox One's full capabilities. Just like behavioral profiling of a suspect, an investigator can profile a digital device.

1.1 Statement of the Problem

This research is important for forensic investigators due to the challenge of technologies being pushed into the market at high speeds while digital forensic tools and investigators struggle to play catch-up. This research acts as a stepping stone for investigators to understand further how the Xbox One file system(s) structure stores data.

Digital forensic investigators are strongly encouraged to understand how the technology that they are investigating works down to the most technical level so they are aware of errors, the potential for anti-forensics, and the ability to prove their competence (Wedge, 2013). There is little published work on how the Xbox One interacts with its file system. This research is able to provide some of the answers for current investigators and provide direction for later research.

The investigators, researchers, and those in charge of creating, modifying, and replacing standards in the digital forensic field are all stakeholders in this research. The Xbox One is but a single device to be examined but with the number of features, the Xbox One has the ability to execute, makes it very personalized to its owner and could contain valuable digital evidence.

1.2 Research Question

The question to be answered is: How do the file system(s) of the Xbox One store data on its hard disk?

1.3 Statement of Purpose

Research on the newest devices allows current and future digital forensic investigators to understand how the system works. Carrier (2005) states that by understanding how a system works the examiner has the ability to know the full potential of the device leading to quicker and smarter investigations. This also allows digital forensic investigators to save time, money, and resources because the foundational research is already done. They can then allocate these resources to other priorities. By understanding how the Xbox One stores data on its hard disk investigators are closer to understand the device's potential for anti-forensics and also have the ability to prove competence and understanding of the Xbox One.

1.4 Assumptions

The assumptions inherit to this project include:

- The Xbox One chosen for this research has not been altered in any way before unboxing.
- The Xbox One is working within tolerable error in the way Microsoft meant it to.

- The Xbox One has three operating systems which meant there was a possibility it had multiple file systems.

1.5 Limitations

The limitations inherit to this project include:

- The research conducted was by interacting with the Xbox One gaming console following the methodology taken from NIST General Test Methodology for Computer Forensic Tools
- The hardware that was forensically imaged in this research was the hard drive.
- Tested the tools with a different internal hard drive. Being a different hard drive from the Xbox One's drive for these tests is a low risk understood by the researcher.

1.6 Delimitations

The delimitations inherit to this project include:

- The embedded memory was not looked at in this research.
- Interaction with Microsoft's SkyDrive, or cloud, was not be looked at in this research.
- Error rate was not examined.
- The encrypted blocks on the hard drive were not decrypted.

CHAPTER 2. REVIEW OF LITERATURE

2.1 The PlayStation 2

The PlayStation 2 (PS2) is a gaming console created by Sony and released on March 4th, 2000 (Tyson, 2012). The PS2 has the option to have an external 40GB hard drive attached and the option to connect to the internet via Ethernet. Sony used the PlayStation File System (PFS) for the PS2 hard disk (Wiki, 2014). This file system is a proprietary file system created and used by Sony. It was also found that the file system of the memory cards used for the PS2 closely resemble MSDOS FAT (Ridge, 2000).

2.2 The PlayStation 3

The PlayStation 3 (PS3) was the third generation of the PlayStation systems, which was released in November 2006 (Conrad, 2010). The PS3 was used in a crime involving Anthony Scott Oshea, 24 years old, who was storing pictures of child pornography on his PS3 gaming console (Conrad, 2010). Investigators were able to identify the girl in the photos as "an 11-year-old from Houston, Texas" (Conrad, 2010 p.1). Oshea was able to convince the girl to send him the nude photos of herself over the PlayStation Network via email from her PS3 to his PS3 and then also sent the illegal photos to "people in at least 5 other states" (Potter, 2009).

The Xbox systems and the PlayStation systems are very different in their software technologies as Sony and Microsoft have been avid competitors in the gaming realm for years. Nintendo was also in that race but has been taking more of a back seat in the dueling company wars. As for the actual capabilities of the PS3, Sony allows its users on the PS3 to partition the hard drive themselves, which allows users to add their own operating systems as well as potentially hiding partitions and other questionable and illegal materials (Conrad, 2010).

The PS3 has a single operating system, an internal magnetic hard disk storage, and internet accessibility through Ethernet cable and Wi-Fi. The file system of the PS3 is difficult to identify like its predecessor the PS2. The research found discusses the file system of the PS3 as FAT32 but studies show that the FAT32 file system is just a file system that the PS3 supports, not necessarily one of which it runs. The actual file system of the PS3 is actually a proprietary file system that can cause issues for investigators as Sony has not been the most forthcoming with information on its set up (PS3FAQ, 2013).

2.3 The Xbox

The Xbox was released November 15th, 2001 and "largely relies on stock PC hardware modified for use as a game console" (Burke, 2007 p.2). Having simply been modified from stock hardware from PC's, the Xbox was a popular gaming console to be altered by its users for non-gaming uses and projects. The file system Microsoft used for the hard drive of the Xbox was an altered version of FAT32, which they began to call

FATX. Forensic tools that could read FAT32 had difficulties reading anything in FATX after this change until research was done and updates were pushed out (Burke, 2007 p.2).

Burke and Craiger (2007) conducted research to explore the Xbox for forensic investigators. They found that the hard drive of the Xbox was difficult to image as errors would occur if Windows or Linux programs attempted to access the stored data. The data on the hard drive locks unless the hard drive gets a 32-byte password generated from the Xbox's ROM, serial number, and model number (p.2). Burke and Craiger (2007) created a work around this problem by connecting to the Xbox as root through SSH and imaging each partition (p.5).

Rabaiotti and Hargreaves (2010) also showed alternative ways to image data stored on the Xbox. The storage being imaged was the Xbox's RAM by using a buffer overflow exploit to push out any data being stored creating a raw image (p.97).

2.4 The Xbox 360

The Xbox 360 was released on November 22nd, 2005. This console has one operating system and a custom volume handler working together to better handle data stored on its hard disk (Nelson, 2014 p. S49). The Xbox 360's hard disk file system is XTAF, which is said to be similar to FAT by Alex J. Nelson, Erik Q. Steggall, and Darrell D. E. Long (2014):

> File allocations are still handled with block chains in a File Allocation Table. Directory entries and inodes are a single, conflated concept. The superblock is also a simple structure… The most significant changes in interpreting the directory entry data are how timestamps and names are handled. Timestamps use one format for modification, access, and creation times, with a granularity of two seconds. Names are a single 42-byte field, that are only designed to store ASCII characters (p. S49).

These differences between FAT and XTAF allow forensic investigators to get a better idea on what they are looking at. Without the knowledge of what file system they were looking at on an Xbox 360, the investigators could potentially interpret data improperly (such as the file system header and modified/created/accessed times), which would then alter the timeline they were attempting to create or even cause the investigator to not understand what they were really looking at inevitably allowing data to fall through the cracks (Nelson, 2014 p. S49). One can also see that XTAF is FATX backwards which should be a huge indicator to the relationship between the two file systems.

According to Bolt (2011), was called an "application-specific computer… the machine is designed to run one specific type of application: video games" (p.12). The Xbox 360 was designed simply to run games at the beginning of its creation but had the additional feature of network connectivity to include chatting and interaction with multiplayer and Xbox Live friendly games. This allowed for chat sessions between people over the internet and offered a whole new type of communication for crime to take part in under law enforcement's nose, but not for long. According to Bolt (2011) the

Xbox 360, along with the PS3 and Wii, were examined for forensic evidence in various criminal and civil cases and then the view on digital evidence identification began to focus in on gaming consoles of all types (p.4).

In 2006 a Ronnie Brendan Watts, 26, met a 14-year-old boy through the Xbox Live network (LiveJournal, 2006). Watts persuaded the boy to meet with him in a Santa Rosa park after talking and Watts sending multiple e-mails and pornographic videos. Watts molested the boy at the meeting point (LiveJournal, 2006). There have been similar cases like this across the country. In response to happenings like this, in 2012 the state of New York banned around 3,580 known sex offenders from online gaming due to the potential for them to use the anonymity of certain games (Good, 2012).

2.5 The PlayStation 4

The PlayStation 4 (PS4) was released November 15th, 2013 as the Xbox One's competition. In hardware they are almost identical. The biggest differences between the two consoles are the file system and the operating system. The PS4 uses a single operating system named Orbis OS, which is a modified version of FreeBSD 9.0 (Humphries, 2014). The file system of the PS4 has not been identified in publications, which leads some to believe that Sony stuck with or modified their PS3 proprietary file system for the PS4 but this is just an assumption based on Sony's previous pattern with the PS3 and PS2.At the time of this research there were no articles to be found currently on digital forensic analysis of the PS4, which is not surprising as the file system is also

still unknown. It is still worth noting though in this literature review as this is the Xbox One's main competitor in the gaming console realm.

2.6 The Xbox One

2.6.1 Previous Studies

In the summer of 2014 Digital Investigation published an article titled *Preliminary Forensic Analysis of the Xbox One*. The researchers looked at an Xbox One to create a preliminary forensic analysis by answering the questions: what is the file structure of the Xbox One console system, and what forensically valuable information is available on the console, and where is that information located? The researchers were able to get some of these answers through three different phases in their research(Moore, 2014). Each of these phases had forensically sound images produced and each image was then analyzed and compared to each other. In phase 1 their Xbox One was reset to factory settings and imaged while using a write blocker. Phase 2 was to get the hard drive reinstalled in the console, install various games, importing data for the examination, connecting the console to a cable box, signing in with facial recognition and without, and viewing friend's gameplay. Phase 3 included connecting the console to the internet and visiting various applications and playing games using the Xbox Live network(Moore, 2014).

The researchers also were able to gain network packet captures to view what kind of information the Xbox One uses to communicate over the Xbox Live network. Through

this research they were able to determine that the Xbox One has five partitions: Temp Content, User Content, System Support, System Update, and System Update 2. The researchers also found what areas of the hard drive were being kept encrypted, different file types the Xbox One comes with, changes in time zone and time stamp records, what changes on the system when the console connects to the Xbox Live network, and entropy scores completed for all files. The research team also released the images taken along with obtainable data for the public to view and analyze (Moore, 2014).

2.6.2 Xbox One Technical Specifications

The console's internal hardware consists of an 8-core x86 AMD Jaguar CPU combined with an AMD Radeon graphics GPU, 8GB of DDR3 SDRAM, 8GB SK Hynix H2M42003GMR eMMC NAND flash memory, and a 500GB hard drive (via SATA connection) (iFixit, 2014). The input/output methods of the console are: a power connection, HDMI out, HDMI in, digital optical audio out, three USB 3.0 ports, one Kinect port, infrared output, one Ethernet port, one Blu-ray/DVD/CD drive (via SATA connection), and a touch activated power sensor, Wi-Fi 802.11ac, NFC (iFixit, 2014).

The 8-core processor allows the user to switch in-between their game and the applications used on the system, including web browsing(Microsoft, 2014). The user is also able to use certain apps at the same time as playing a game or watching TV with the use of Microsoft's application SmartGlass. The Xbox has an HDMI pass-through as well, to allow the user to pass the Xbox One through their TV to ease switching inputs of devices connected to the TV. The Xbox One has the option to be purchased with a Kinect

2.0 sensor bar. This additional accessory allows the Xbox One to view gesture controls, hear voice commands, and automatically log a known user into their Xbox Live account based on facial recognition software (Microsoft, 2014).

Two other interesting features of the Xbox One is its Game DVR and voice command. The Game DVR feature allows users to have "a continuously recording backlog of the last 5 minutes (of game play)" (Stein, 2013). This could prove to be interesting for forensic investigators to assist in creating a timeline of events. The voice command feature is another feature to should stand out for forensic investigators. If the Xbox One is off and so is the TV the user can walk into a room and say "Xbox On" and the system turns on as well as turns on the TV. In order for this to happen that means that the Xbox One is always on, even if just in a lower power state, in order to hear and react to the voice commands (Stein, 2013).

The site iFixit.com proves to be useful, as they have videos, pictures, and descriptions as how best to extract the hard drive disk of the Xbox One safely without causing harm to the console itself (iFixit, 2014). According to iFixit's Xbox One teardown, when connecting the Xbox One's hard drive disk to their test computer they found five New Technology File System (NTFS) partitions (iFixit, 2014).

Due to the research done by Moore, Baggili, Marrington, and Rodrigues the partitions have been identified to have the file system as some form of NTFS. This is important to know as the researcher knows now that there is some element in the Xbox One that is signaling to other tools that it is NTFS. By identifying certain elements of the operating system and how it interacts with an NT file system, there are certain flags used

with file structures and metadata structures that showed what is happening which allowed the researcher to answer the research question.

Carrier (2005) states by knowing how a file system works on a device, the investigator can conduct a smarter investigation which in turn "reduces the time needed to conduct an investigation" (p.12). The investigator also is more aware of how the tools they are using work when they understand file system structures According to Carrier (2005):

> An NTFS file system does not have a specific layout like other file systems do. The entire file system is considered a data area, and any sector can be allocated to a file. The only consistent layout is that the first sector of the volume contain the boot sector and boot code (p.199).

Carrier (2005) also points out that the Master File Table (MFT) is a huge give away for NTFS because it is what keeps track of all the files in the file system. The MFT stores meta-data on every file within the file system and because everything within NTFS is a file that means the MFT is a gold mine of data for investigators (p.199).The Xbox One has three different operating systems working simultaneously so the researcher is curious to know if the console is using a true NTFS, hybrid version, or an updated version and if so what are the changes it has done to data storage on the hard disk to answer the main research question.

Mentioned as well in a publication testing metadata verification on the Xbox 360, Nelson mentions how the Xbox 360's file system is XTAF but that file system seems to be abandoned by the Xbox team and they have been integrating NTFS within the Xbox

One (Nelson, 2014). Microsoft has also been dealing with the creation of Resilient File System (ReFS) for Windows Server 2012 but there has not been any mention of possible overlap between changes in the Xbox One NTFS version and ReFS (Microsoft, 2013).Since the Xbox One has been released to the public there have been 11 updates to the operating system of the Xbox One. The update "6.2.11511.0 (xb_rel_1409.140829-1829) fre" (Xbox Support, 2014) is the most recent update released September 2nd, 2014 by Xbox Support.

CHAPTER 3. METHODOLOGY

The researcher analyzed the Xbox One with a methodology that was adapted from the National Institute of Standards and Technology (NIST). This NIST methodology has been used and adapted in the past for similar research by Leshney (2008) and Gillam (2007). The methodology has been reviewed directly from NIST and adapted to meet the demands and stay within the scope of the research conducted.

The researcher used a write-blocker and hash functions to check the integrity of the data stored on the Xbox One's hard disk as well as each individual file. The researcher used a hardware write blocker to keep the original device's data from being altered by disabling the hard drives write ability when being forensically imaged.

Kit #4 contains the Digital Intelligence UltraKit. The Tableau Firewire 800 + USB 2.0 SATA Bridge (firmware v5.20) was used for write blocking to connect the test hard drive (TD1) and Xbox One hard drive (TC1, TC2, TC3) to the computer when imaging. The write blocker is crucial in the imaging process as it blocks the possibility of the computer and imaging program from writing data on the test case hard drive. If the program were allowed to write data, on the hard drive being investigated, then it has the potential to alter results making the research flawed. A hash function was used to show that the data from each forensic image has not been altered in any way shape or form upon analysis. The hash functions used were the MD5 and SHA1 hash functions. Each

image hash check sum was compared with the hard drive hash check sum value after the image is first created and after the analysis of that image is completed as to show that no data was altered before, during, or after imaging and analysis.

3.1 Method

The method used is from NIST's General Test Methodology for Computer Forensic Tools are under the approach section which asks for the following (NIST, 2001):

1. Develop test assertions based on requirements
2. Identify relevant test cases
3. Develop testing procedures and method
4. Report test results

3.1.1 Test Assertions

Within the research conducted "develop test assertions based on requirements" (NIST, 2001)is the first step in the methodology. This beginning step allows the researcher to stay on track and within the scope of the research. The test assertions developed within the scope of the proposed research are shown in Table 3.1.

Table 3.1 Test Assertions to Test Cases

Test Assertions		Test Cases
Unboxed Data	→	Case #1
Updated System Data	→	Case #2
User Data Interaction	→	Case #3

These test assertions work in relation to the test cases developed. Within each test case the test assertions are imposed as the defining data variable when the researcher interacts with the Xbox One. This is the first step in changing data between the test cases.

3.1.2 Test Cases

The second step in the researcher's methodology is to "identify relevant test cases" (NIST, 2001). Three test cases are created based upon states that the gaming console's hard disk could be under in a search and seizure event, as shown in Table 3.2. The test cases were compared with each other to determine any major changes in data storage such as file slack, deleted files, and orphan folders.

Table 3.2 Xbox One Test Cases

Test Case	Test Assertion	Data Change
TC1	Unboxed Data	Out of the box Xbox One. Acts as base line test case.
TC2	Updated System Data	Xbox One updated to v6.2.12130.0 (xb_rel_1502.150209-1738) fre
TC3	User Data Interaction	Top 25 most popular applications installed& accesses, 2 games installed and accessed, & user profile created.

3.1.2.1 Test Case #1

The first test case is to look at an Xbox One's hard disk after the gaming system has been first taken out of the box. This test case acted as the state of the Xbox One as if it has not been played on or touched by a user. This was used as a control test case for the research, as no test data has been created on the hard disk. Refer to Appendix A for the Test Case Creation Procedure for details.

3.1.2.2 Test Case #2

The second test case looks at the TC1 hard disk after it was updated to OS version.2.12130.0 (xb_rel_1502.150209-1738) fre (Xbox Support, 2014). Hard drive retrieval and imaging follows the same procedures as TC1. Refer to the Appendix A for the Test Case Creation Procedure for details.

3.1.2.3 Test Case #3

The third test case looked at the TC2 hard disk after it had been altered with user data generated by the researcher thus creating TC3. The top 25 most popular applications were downloaded and installed on the Xbox One as well as two games. The applications were chosen because they are currently the most popular downloaded apps listed in the Xbox Store. The games were chosen as they were launch titles for the Xbox One when it was first released. These games help showcase the features of the Xbox One. To gauge a baseline of how the Xbox One saves popular file types on its hard disk a variety of data files were attempted to be copied onto the Xbox One's hard disk. Refer to the Appendix

A for the Test Case Creation Procedures and Data Files List for details. The files were taken from NIST resources of test files (CFReDS, 2013).

Once the Xbox One had application and game play data generated, the TC3 hard drive was imaged in the same way TC1 and TC2 were. The images taken from TC3 was compared to the images taken from TC1 and TC2 to look for any changes in the way the Xbox One's file system has been saving data.

3.1.3 Procedures and Methods

The third step in the researcher's methodology is to "develop testing procedures and method" (NIST, 2001). The procedures identified are, to create a bit-copy of an Xbox One's hard drive for each test case with the use of a hardware write blocker, MD5 & SHA1 hash functions, and FTK Imager 3.1.4.6 (or newest version). Duplicates of the bit-copy images were stored as a back-up; one as a working copy and one as a library backup. By the use of the tools FTK Imager 3.1.4.6, and Autopsy 3.1.1were used to analyze the bit-copy image to determine how the file system of the Xbox One stores data by interpreting the hex within the copies.

Each test case involves the researcher to ground self, apply the test case changes to the Xbox One, removal of the Xbox One's hard disk from the console, imaging, relocating the hard disk to the Xbox One, and analysis of the bit-copy image. A final comparison was done as to note the changes occurring with the data between each imaging process. Refer to the Appendix A for Steps of the Process for handling the Xbox

One hard disk and images. If at any point the researcher feels the need to reimage the Xbox One hard disk, these steps were followed starting from the Test Stage.

3.1.4 Results

The fourth and final step in the researcher's methodology is to "report test results" (NIST, 2001). After the analysis stage is complete, within the steps of the process, the researcher began to report results found.

3.2 Validity

The research is exploratory by nature. Validity is met within this research when the research question is answered by explaining what was found within the Xbox One's file system. The researcher is following a similar methodology that was followed by Leshney (2008). Leshney borrowed methodology steps from NIST's General Test Methodology for Computer Forensic Tools in their study which was also exploratory (Leshney, 2008). The details to each step within this research are different because they are tailored to help answer a different research question.

CHAPTER 4. RESULTS

TC1, TC2, and TC3 were compared to each other. The test cases were used to determine any major changes in data storage on the Xbox One; such as deleted, changed, or added files and folders. The test cases are three possible states an unmodified Xbox One could be in if an investigator had to forensically investigate the gaming console. The Xbox One underwent various updates and data changes and because of this the researcher needed the three test cases to make sure that the file system would not change. It is not normal for the file system to change under an update but because the system uses three OS's simultaneously, which within itself is new to gaming systems, the researcher had to be sure of what was happening to the file system during these test case changes. Reference Appendix A for the test case creation procedures.

Note that throughout the results there is a directory listed as "[orphan]" parallel to the root directory. This does not reside on the Xbox One's hard drive this is simply a directory that one of the tools, FTK Imager 3.1.4.6, adds into the evidence tree to display items that no longer have a parent directory.

4.1 Test Case #1

Reference Appendix C-D for the TC1 imaging and analysis process. The first thing noticed was the Xbox One has 5 partitions with unpartitioned space as seen in Table 4.1.

Table 4.1 Xbox One Partitions

#	Name	Size	Reported File System
1	Temp Content	41984MB	NTFS
2	User Content	373760MB	NTFS
3	System Support	40960MB	NTFS
4	System Update	12288MB	NTFS
5	System Update 2	7168MB	NTFS
-	Unpartitioned Space	-	GPT

The tools (FTK Imager and Autopsy) reported NTFS as the file system. To double check if this is actually true the researcher went to the MBR to check the partition table. Instead of a traditional MBR there was a Protected MBR located at Logical Block Address (LBA) 0. Figure 4.1 shows a screen shot of the Xbox One Protected MBR.

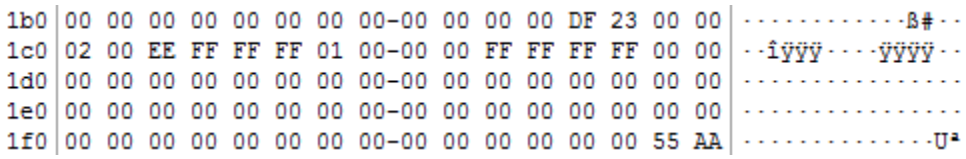


Figure 4.1 Protected MBR

Understanding the partition table of the Xbox One allows the investigator to know how the partitions are broken up on the hard disk of the console which also allows for better knowledge on what file system and probability of the file system version. The type of file system and its version gives the researcher a structural understanding of how data

is stored on the Xbox One. The researcher was able to identify this MBR as a Protected MBR which is different from a legacy MBR.

The legacy MBR would have a partition table beginning at offset “1ce” but there are no entries for active partitions here because this is a Protected MBR. This is causing the entire disk to be protected by legacy OS’s so the GUID Partition Table (GPT) layout can reside on the entire disk (UEFI Inc, 2014, p. 163). This means that the whole hard drive of the Xbox One uses GPT with a set file system within each partition. The Protected MBR is acting as a way for legacy systems to be used with the Xbox One’s system as well as protecting the MBR as not to disrupt the newer system that has been implemented on the gaming console. This is why in Table 4.1 it shows GPT as the reported file system in the unpartitioned space.

This Protected MBR looks standard and follows the UEFI Inc. standards (UEFI Inc, 2014, p. 163). This Protected MBR is showing that it is unbootable, the partitions begin at C0, H0, S2 which is where the Primary Partition Entry Array is located, and that there is one sector before the partitions. The only item that was not represented was at offset 0x1c3 and 0x1ca. According to UEFI Inc. (2014), these values can be 0xFFFFFF and 0xFFFFFFFF if the values are too large to represent. This is slightly odd because the Xbox One’s hard drive is only 500GB which is under the UEFI/GPT limit. This is discussed further in section 5.3 Future Research. Table 4.2 gives the meaning of each hex entry within the Xbox One Protected MBR.

Table 4.2 Xbox One Protected MBR Hex Meanings

Hex	Offset	Meaning
00 00 00 00	1b8	Unique MBR Disk Signature (Unused by UEFI and set blank here)
DF 23	1bc	Unknown (unused by UEFI)
00	1be	BootIndicator: Stating not bootable
00 02 00	1bf	Starting CHS: Stating that the partitions begin at Cylinder 0, Head 0, Sector 2
EE	1c2	OSType: Stating the partition type is GPT partitioned disk.
FF FFFF	1c3	EndingCHS: Is set to 0xFFFFFF because it was not possible to represent the value.
01 00 00 00	1c6	StartingLBA: Stating that there is 1 sector preceding the partitions, which is the MBR here.
FF FFFFFF	1ca	SizeInLBA: Normally "set to the size of the disk minus one" (UEFI Inc, 2014, p. 104) but is 0xFFFFFFFF because the disk was too large to be represented.
55 AA	1fe	End Signature

Note. Adapted from *Unified Extensible Firmware Interface Specification v2.4 Errata B, p.103.* By Unified EFI, Inc 2014.

Since the Xbox One is using GPT, it was assumed that it is also working off of a Unified Extensible Firmware Interface (UEFI) at this point (Nikkel, 2009). This assumption was checked by viewing LBA 1 to find the GPT Header. The GPT Header had information about the Xbox One system including where the partition table is, the

version of GPT header, and the Disk Globally Unique Identifier (GUID or UUID). See Figure 4.2 for a screen shot of the Xbox One GPT Header.

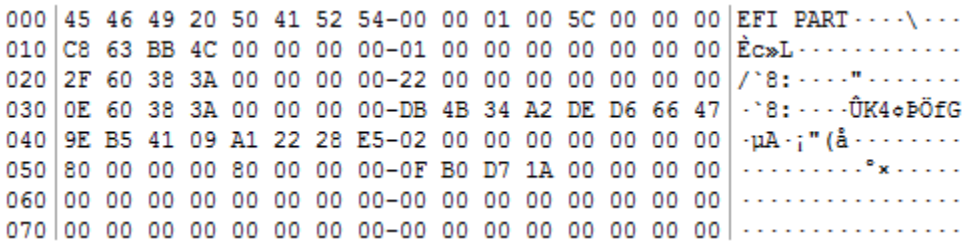


Figure 4.2 Xbox One GPT Header

From Figure 4.2, the Xbox One reveals itself as a UEFI/GPT system. This is different from the legacy BIOS/MBR system found on legacy Microsoft systems. The UEFI/GPT system was created for larger systems so they could handle more data and features. A difference is that the MBR was limited to 32 bits wide, 3 primary partitions and an extra partition entry for logical partitions. This limits the maximum disk size that the BIOS/MBR can handle to 2 Terabyte. The UEFI/GPT system can have 128 partitions with 64 bit wide which means it can handle disk sizes up to 8 Zettabytes (which is 8,000,000,000TB) (Nikkel, 2009).

The GPT header also contains a Cyclic Redundancy Check (CRC) to check the integrity of the GPT Header (Microsoft, 2015). The GPT Header has a CRC32. This checksum acts as an error check function and is only for GPT Header errors. Table 4.3 describes the meanings of the Xbox One GPT Header hex.

Table 4.3 Xbox One GPT Header Hex Meanings

Hex	Offset	Meaning
45 46 49 20 50 41 52 54	000	"EFI PART"
00 00 01 00	008	GPT Header version 1.00
5C 00 00 00	00C	Each logical block is 92 bytes
C8 63 BB 4C	010	CRC32 of the GPT Header checksum is "4CBB635C"
00 00 00 00	014	Reserved space (blank)
01 00 00 00 00 00 00 00	018	"LBA location of the GPT Header" at 0x0000000000000001.
2F 60 38 3A 00 00 00 00	020	LBA address of the backup copy GPT Header which is at sector 976773167
22 00 00 00 00 00 00 00	028	"First usable LBA sector for any partition" which is at sector 34.
0E 60 38 3A 00 00 00 00	030	"Last usable LBA sector for any partition" which is at sector 976773134.
DB 4B 34 A2 DE D6 66 47 9E B5 41 09 A1 22 28 E5	038	This is the Disk Globally Unique Identifier (UUID) which is 0xE52822A10941B59E4766D6DEA2344BDB
02 00 00 00 00 00 00 00	048	Sector 2 is the starting LBA of the GPT array.
80 00 00 00	050	"Stating the number of partition entries" which is 128 here.
80 00 00 00	054	Each partition entry size which is 128 bytes here.
0F B0 D7 1A	058	Partition Entry Array CRC32. Number of partition entries * size of the partition entries = 0x1AD7B00F.
00...	060	Reserved

By following the GPT Header we see that the Primary Partition Entry Array is at LBA 2. The Primary Partition Entry Array is the GPT version of the legacy MBR partition table. There is more data as well as data integrity checking within a Primary Partition Entry Array. Figure 4.3 shows a screen shot of the Primary Partition Entry Array.

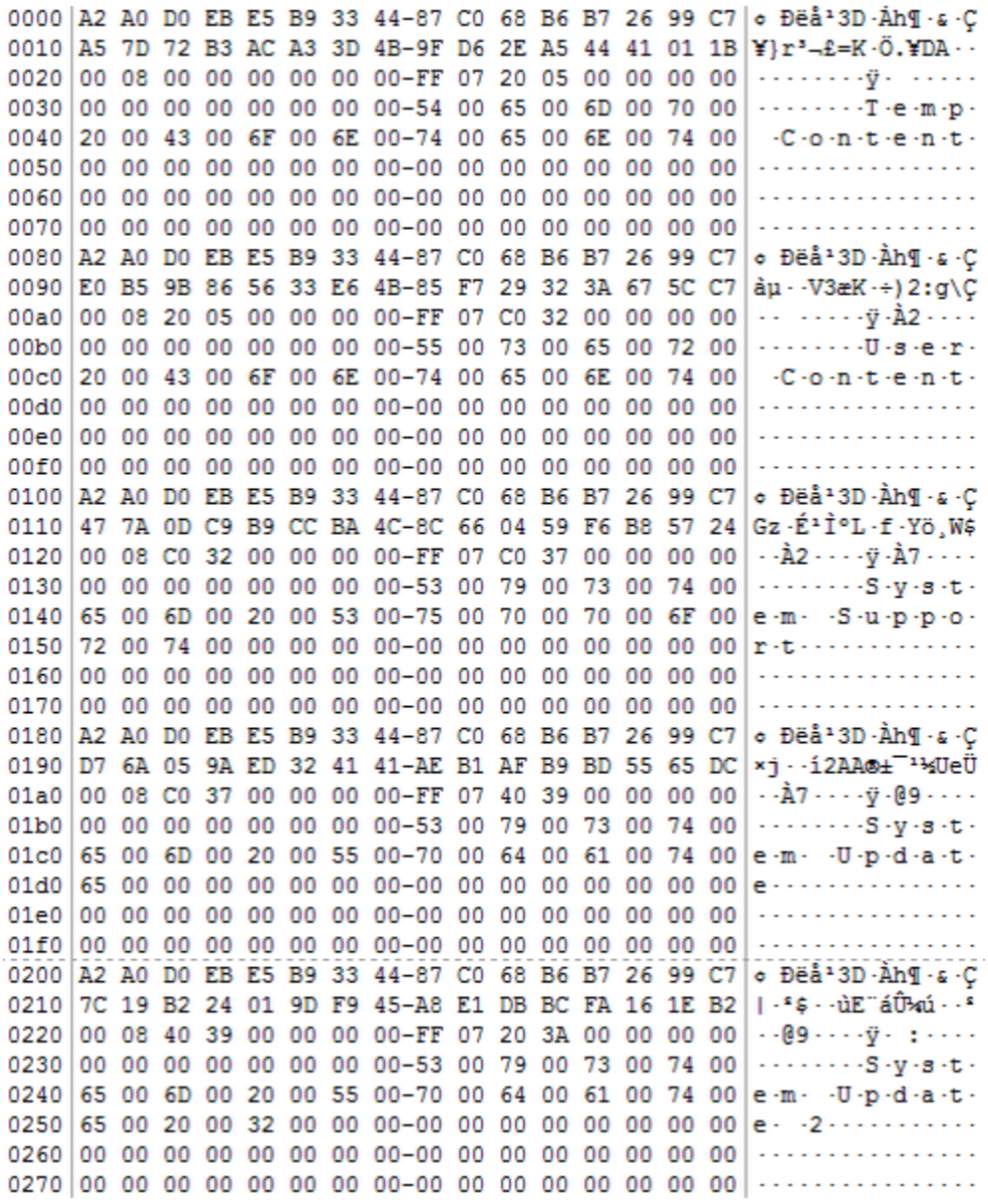


Figure 4.3 Xbox One Primary Partition Entry Array

The Primary Partition Entry Array shows similar information that would be saved in a regular MBR partition table but the GPT partition table holds more information such as a partition GUID, the partition type GUID, and each partition's full name which is limited to a 36 character Unicode string (Nikkel, 2009). Table 4.4 shows the hex meanings for the Primary Partition Entry Array.

Table 4.4 Xbox One Primary Partition Entry Array

Hex	Offset	Meaning
A2 A0 D0 EB E5 B9 33 44 87 C0 68 B6 B7 26 99 C7	000	Partition Type GUID: (Windows basic data partition) EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
A5 7D 72 B3 AC A3 3D 4B 9F D6 2E A5 44 41 01 1B	010	Partition GUID: B3727DA5-A3AC-4B3D-9FD6-2EA54441011B
00 08 00 00 00 00 00 00	020	Partition starting LBA: sector 2048
FF 07 20 05 00 00 00 00	0028	Partition ending LBA: 85985279
00 00 00 00 00 00 00 00	0030	Partition attributes: empty
54 00 65 00 6D 00 70 00 20 00 43 00 6F 00 6E 00 74 00 65 00 6E 00 74 00	0038	Partition Name: T.e.m.p. .C.o.n.t.e.n.t.
A2 A0 D0 EB E5 B9 33 44 87 C0 68 B6 B7 26 99 C7	0080	Partition Type GUID: (Windows basic data partition) EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
E0 B5 9B 86 56 33 E6 4B 85 F7 29 32 3A 67 5C C7	0090	Partition GUID: 869BB5E0-3356-4BE6-85F7-29323A675CC7

Table 4.4 (Continued)

Hex	Offset	Meaning
00 08 20 05 00 00 00 00	00a0	Partition starting LBA: 85985280
FF 07 C0 32 00 00 00 00	00a8	Partition ending LBA: 851445759
00 00 00 00 00 00 00 00	00b0	Partition attributes: empty
55 00 73 00 65 00 72 00 20 00 43 00 6F 00 6E 00 74 00 65 00 6E 00 74 00	00b8	Partition Name: U.s.e.r. .C.o.n.t.e.n.t.
A2 A0 D0 EB E5 B9 33 44 87 C0 68 B6 B7 26 99 C7	0100	Partition Type GUID: (Windows basic data partition) EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
47 7A 0D C9 B9 CC BA 4C 8C 66 04 59 F6 B8 57 24	0110	Partition GUID: C90D7A47-CCB9-4cBA-8C66-0459F6B85724
00 08 C0 32 00 00 00 00	0120	Partition starting LBA: 851445760
FF 07 C0 37 00 00 00 00	0128	Partition ending LBA: 935331839
00 00 00 00 00 00 00 00	0130	Partition attributes: empty
53 00 79 00 73 00 74 00 65 00 6D 00 20 00 53 00 75 00 70 00 70 00 6F 00 72 00 74	0138	Partition Name: S.y.s.t.e.m. .S.u.p.p.o.r.t.
A2 A0 D0 EB E5 B9 33 44 87 C0 68 B6 B7 26 99 C7	0180	Partition Type GUID: (Windows basic data partition) EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
D7 6A 05 9A ED 32 41 41 AE B1 AF B9 BD 55 65 DC	0190	Partition GUID: 9A056AD7-32ED-4141-AEB1-AFB9BD5565DC

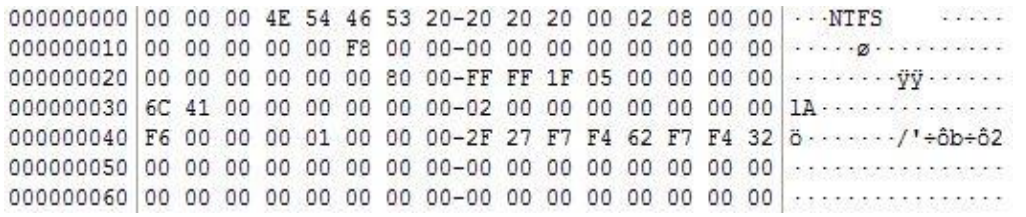
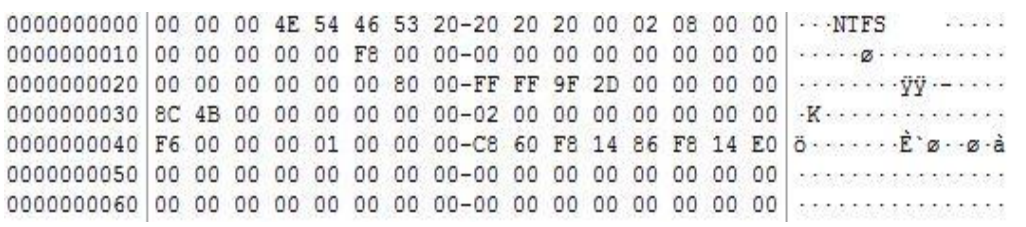
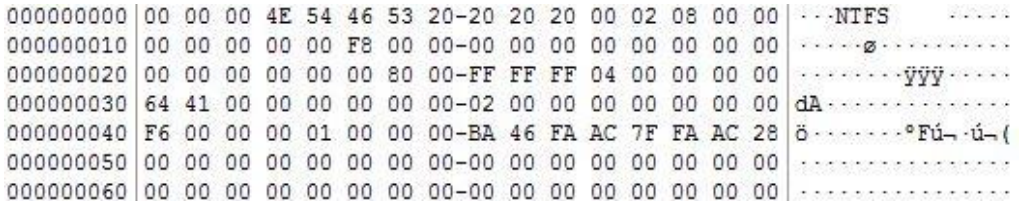
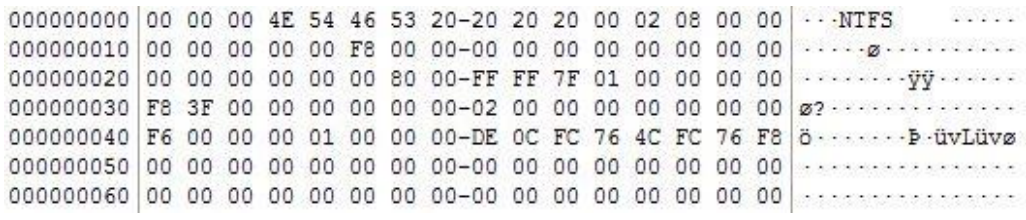
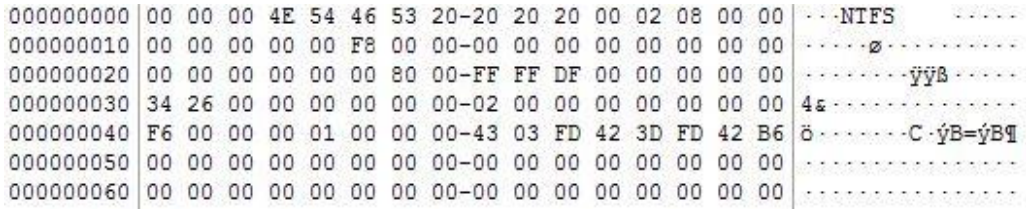
Table 4.4 (Continued)

Hex	Offset	Meaning
00 08 C0 37 00 00 00 00	01a0	Partition starting LBA: 935331840
FF 07 40 39 00 00 00 00	01a8	Partition ending LBA: 960497663
00 00 00 00 00 00 00 00	01b0	Partition attributes: empty
53 00 79 00 73 00 74 00 65 00 6D 00 20 00 55 00 70 00 64 00 61 00 74 00 65 00	01b8	Partition Name: S.y.s.t.e.m. .U.p.d.a.t.e.
A2 A0 D0 EB E5 B9 33 44 87 C0 68 B6 B7 26 99 C7	0200	Partition Type GUID: (Windows basic data partition) EBD0A0A2-B9E5-4433-87C0-68B6B72699C7
7C 19 B2 24 01 9D F9 45 A8 E1 DB BC FA 16 1E B2	0210	Partition GUID: 24B2197C-9D01-45F9-A8E1-DBBCFA161EB2
00 08 40 39 00 00 00 00	0220	Partition starting LBA: 960497664
FF 07 20 3A 00 00 00 00	0228	Partition ending LBA: 975177727
00 00 00 00 00 00 00 00	0230	Partition attributes: empty
53 00 79 00 73 00 74 00 65 00 6D 00 20 00 55 00 70 00 64 00 61 00 74 00 65 00 20 00 32 00	0238	Partition Name: S.y.s.t.e.m. .U.p.d.a.t.e. .2

Here the Primary Partition Entry Array shows the partition type for each section as a basic data partition. According to Microsoft their UEFI/GPT systems must have an NTFS file system. Some differences between MBR partition tables to a GPT partition

table is that an MBR partition table has beginning and ending H/C/S where the GPT has beginning and ending sectors. By taking this information one can go to the beginning of each partition to check what file system is listed for each. Table 4.5 shows a screen shot of each of the Xbox One's partition headers, also known as the boot sector ($Boot).

Table 4.5 Xbox One Partition Boot Sectors

Partition	Boot Sector Screen Shot
Temp Content	
User Content	
System Support	
System Update	
System Update 2	

Throughout each test case each partition's boot sector stayed the same. Notice in Table 4.5 that from offset 0x00 to 0x29 everything is the same, then the hex values begin to change beginning at offset 0x2a. Table 4.6 shows the boot sector hex meanings for each partition. Note that the table is sectioned off to have different partition entries after offset 0x28 so show the different hex meanings.

Table 4.6 Xbox One Partition Boot Sector Hex Meaning

Partition	Hex	Offset	Meaning
1-5	00 00 00	000	Jump Instruction: (none here)
1-5	4E 54 46 53 20 20 20	003	OEM ID: NTFS (no version listed)
1-5	00 02	00b	Bytes per sector: 512
1-5	08	00d	Sectors per cluster: 8
1-5	00 00	00e	Reserved sectors (must be zero by Microsoft specifications)
1-5	00 00 00 00	010	Unused
1-5	F8	015	Media descriptor: Hard disk
1-5	00 00	016	Unused (must be 0)
1-5	00 00 00 00 00 00 00 00	018	Unused (must not be checked)
1-5	00 00 00 00	020	Unused (must be 0)
1-5	00 00 80 00	024	Unused (must not be checked): is checked
1	FF FF 1F 05 00 00 00 00	028	Total sectors in file system: 85,983,231

Table 4.6 (Continued)

Partition	Hex	Offset	Meaning
1	6C 41 00 00 00 00 00 00	030	Starting cluster address of MFT: 16748
1	02 00 00 00 00 00 00 00	038	Starting cluster address of MFT Mirror $DATA attribute: 2
1	F6	040	Size of MFT entry: 246 sectors
1	00 00 00	041	Unused
1	01	044	Size of index record: 1 sector
1	00 00 00	045	Unused
1	2F 27 F7 F4 62 F7 F4 32	048	Serial number
2	FF FF 9F 2D 00 00 00 00	028	Total sectors in file system: 765,460,479
2	8C 4B 00 00 00 00 00 00	030	Starting cluster address of MFT: 19340
2	02 00 00 00 00 00 00 00	038	Starting cluster address of MFT Mirror $DATA attribute: 2
2	F6	040	Size of MFT entry: 246 sectors
2	00 00 00	041	Unused
2	01	044	Size of index record: 1 sector
2	00 00 00	045	Unused
2	C8 60 F8 14 86 F8 14 E0	048	Serial number
3	FF FFFF 04 00 00 00 00	028	Total sectors in file system: 83,886,079
3	64 41 00 00 00 00 00 00	030	Starting cluster address of MFT: 16740

Table 4.6 (Continued)

Partition	Hex	Offset	Meaning
3	02 00 00 00 00 00 00 00	038	Starting cluster address of MFT Mirror $DATA attribute: 2
3	F6	040	Size of MFT entry: 246 sectors
3	00 00 00	041	Unused
3	01	044	Size of index record: 1 sector
3	00 00 00	045	Unused
3	BA 46 FA AC 7F FA AC 28	048	Serial number
4	FF FF 7F 01 00 00 00 00	028	Total sectors in file system: 25,165,823
4	F8 3F 00 00 00 00 00 00	030	Starting cluster address of MFT: 16376
4	02 00 00 00 00 00 00 00	038	Starting cluster address of MFT Mirror $DATA attribute: 2
4	F6	040	Size of MFT entry: 246 sectors
4	00 00 00	041	Unused
4	01	044	Size of index record: 1 sector
4	00 00 00	045	Unused
4	DE 0C FC 76 4C FC 76 F8	048	Serial number
5	FF FF DF 00 00 00 00 00	028	Total sectors in file system: 14,680,063
5	34 26 00 00 00 00 00 00	030	Starting cluster address of MFT: 9780
5	02 00 00 00 00 00 00 00	038	Starting cluster address of MFT Mirror $DATA attribute: 2

Table 4.6 (Continued)

Partition	Hex	Offset	Meaning
5	F6	040	Size of MFT entry: 246 sectors
5	00 00 00	041	Unused
5	01	044	Size of index record: 1 sector
5	00 00 00	045	Unused
5	43 03 FD 42 3D FD 42 B6	048	Serial number

TC1 had 4693 total files throughout the entire image. Out of those 4693 files there were only 154 total unique hashes. Reference Table D.1 in Appendix D for TC1 Hash List. This test case is only specific for an Xbox One that is out of the box and has no unique user data on it but it is still good information to know because it is a baseline for what the Xbox One has on its system already.

4.2 Test Case #2

Reference Appendix E-G for creation, imaging, and comparison from TC2. From TC1 to TC2 it was found that the Protected MBR, GPT Header, the Primary Partition Entry Array, and Partition Boot Sectors had not changed at all.

What had changed between TC1 and TC2 was there were 4,679 total items (14 less than TC1), and 164 total unique hashes (10 more than TC1). Of the items from TC1 to TC2, 2 had been removed, 12 had been added, and 26 had been altered. The researcher is stating the changes as ‘items’ because there was a mix of file types, clusters, and meaningful sectors that were looked at for alterations, additions, and removals. There

were a plethora of clusters that had been added /removed/altered to and from the unpartitioned space within each partition including the unallocated space. This is discussed further in section 5.3 Future Research. Reference Table G.2, G.3, and G.4 within Appendix G for the full list of altered, added, and removed items.

The majority of altered files were within Temp Content. The majority of added files were within System Update, which is not surprising as this is the updating test case. For a forensic investigator this test case is good to know what it would look like because it shows that the user has not really done a whole lot with the system yet and so there may not be much forensic value in exploring further unless with probable cause to do so.

4.3 Test Case #3

Reference Appendix H-J for creation, imaging, and comparison from TC3. Like TC2 it was found that the Protected MBR, GPT Header, the Primary Partition Entry Array, and Partition Boot Sectors had not changed at all from TC2 to TC3. This is great information to know because it means that from out of the box to user generated data the file system and boot sequence of the Xbox One stays the same. This is important for a forensic investigator to be aware of because it lets them know if the Xbox One has been modified by the user if these items are not the same as Microsoft's specifications.

TC3 had 3,869 total items (810 less than TC2), and 185 unique hashes (19 more than TC2). Of the items from TC2 to TC3, 49 had been removed, 79 had been added, and 25 had been altered. Just like TC2, there were a plethora of clusters that had been added /removed/altered to and from the unpartitioned space within each partition including the

unallocated space. This is discussed further in section 5.3 Future Research. Reference Table J.2, J.3, and J.4 within Appendix J for the altered, added, and removed items.

A very important issue for forensic investigators found within TC3 is that within the partition User Content, there are huge blocks of data that are encrypted. The file names are in the form of GUIDs and the research assumes that these files are the applications and game data created by in the test case creation.

CHAPTER 5.CONCLUSIONS AND DISCUSSION

The research question to answer was how do the file system(s) of the Xbox One store data on its hard disk? To answer this question the researcher also asked: is the console is using a true NTFS/hybrid version/an updated version, and what changes are there to data storage on the hard disk? The answer to these questions is that the Xbox One uses UEFI/GPT for its partitions and uses the file system NTFS for data storage.

5.1 Conclusions

The researcher was able to determine that the Xbox One works off of a basic disk utilizing UEFI/GPT. From Microsoft's specifications this system must have an NTFS file system, can have up to 128 partitions, has no need for extended or logical partitions, each partition can be larger than 2TB (if given a single large enough disk), the ability to support other operating systems, other partition types, and independent software vendors (Microsoft, 2015).

One of the fundamental elements of the UEFI design is the system partition which allows cross partition sharing to maximize the value of the platform "without significantly growing the need for nonvolatile platform memory" (UEFI Inc, 2014, p. 8). This could be how all three operating systems of the Xbox One are able to optimize the system while interacting with each other in addition to the Hyper-V ability.

The file system is confirmed as NTFS as well and the hierarchy of the system is simplified within the partitions as they each hold similar structures. Reference Figure M.1 in Appendix M.

5.2 Issues encountered

The first real issue encountered was within TC3 when data creation was happening. There were some applications that needed a credit card to be created. Due to the fact that the Xbox One was connected to an open network on a University Campus the network wasn't fully secure to use that sort of information. Upon finding that this type of data is encrypted when stored on the hard drive this issue was a moot point for the researcher.

The other issue encountered was when the data files, taken from NIST and listed in Table A.1 within Appendix A, to be placed on the hard drive were not being allowed to be copy and pasted. The researcher would need to create another test case that could alter the Xbox One system in order to force these files to reside on the hard disk for analysis. This was outside of the scope of the research and forfeited this task.

5.3 Future Research

The Xbox One offers a plethora of features that could assist forensic investigators with an investigation. Other areas of research to be explored include but are not limited to testing the full extent of the potential for anti-forensics, Kinect facial recognition error rate (including logon differences such as manual logon, facial recognition logon, or

automatic logon), in-depth network forensics, and user gesture profiles for behavioral analysis. All of these topics could assist investigators to better understand the workings of the Xbox One along with assisting in profiling their suspect based on their behaviors on this gaming system.

An unanswered question is why were the EndingCHS and SizeInLBA set to unknown values (0xFFFFFF and 0xFFFFFFFF) when the disk size was under the UEFI/GPT disk size limit? These values could be set to unknown values if the operating systems were booted from virtual machines. This also would allow for all three operating systems to work simultaneously. This was a speculation so this would be another area for future research as testing these hypothesis were outside the scope of this research.

One last item was that within the Xbox One's unpartitioned space of each partition, including the unallocated space, both FTK Imager and Autopsy were listing a plethora of clusters. Each time the test case changes these clusters would get new names. Each cluster name was the cluster ID. Most of the clusters had no data and a few had data within them. There was uncertainty as to what the clusters within the unallocated space of each partition represented. This would be another area for future research as testing this was once again outside the scope of this research.

In closing, this research provides test cases for scientists to see the technological advancements companies are using within their digital systems within the last year. Understanding what the file system is for the Xbox One allows digital forensic investigators to enter an investigation on this device without a blind fold that would force them to create similar redundant research that would cost them money and time that they

cannot spare. The researcher also welcomes any other researcher to recreate these test cases and see if they find differing results or further answers. Digital forensics is a growing field that relies on collaborative research to flourish. Never stop hunting for the right answers.

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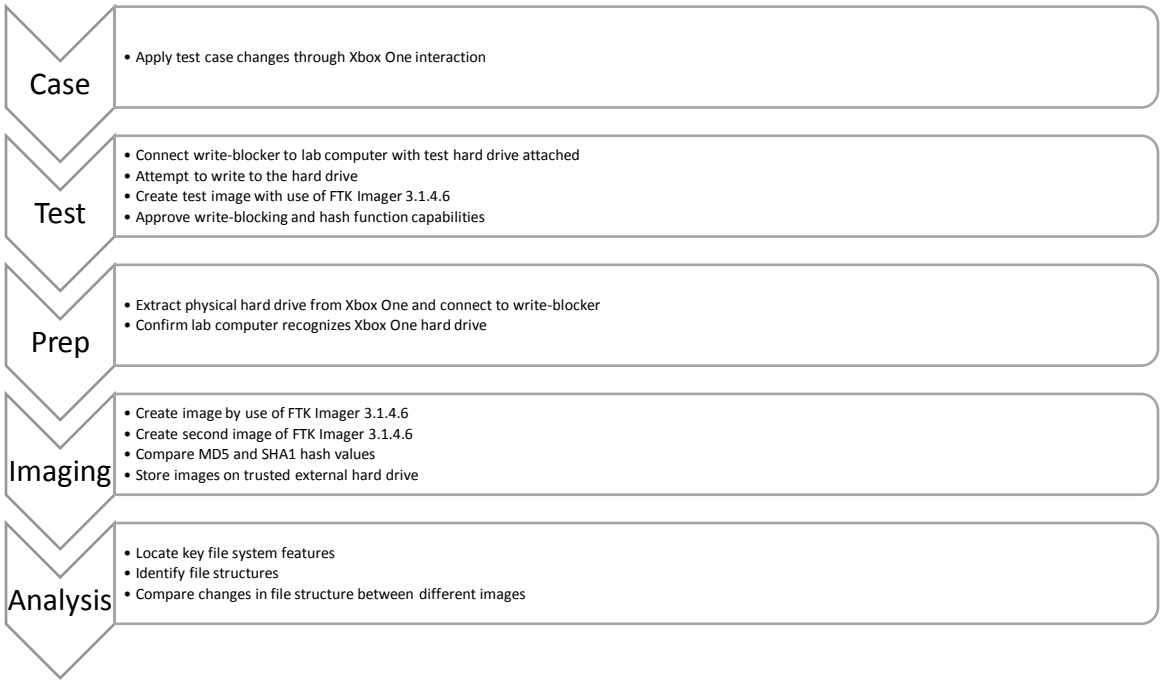
APPENDICES

Appendix A. Test Case Creation Procedures

Figure 0.1 Test Case Procedures



TC1 Steps of the Process

1. The Xbox One taken apart safely
2. Test case one hard disk (TC1) safely removed
3. TC1 connected to the SATA hardware write blocker
4. TC1 imaged (bit-copy image) using Access Data's Forensic Tool Kit (FTK) 3.1.4.6.
5. TC1_(date) .001 saved.
6. TC1 reconnected to the Xbox One

TC2Steps of the Process

1. The Xbox One connected to an Ethernet cable and turned on.
2. Create a test account through the Xbox Live network.
3. Begin the update and wait for the most recent update to complete.
4. Turned Xbox One off.
7. Once the Xbox One has been updated Xbox One taken apart safely.
8. Test case one hard disk (TC2) safely removed.
9. TC2 connected to the SATA hardware write blocker.
10. TC2 imaged (bit-copy image) using Access Data's Forensic Tool Kit (FTK) 3.1.4.6.
11. TC2_(date) .001 saved.
12. TC2 reconnected to the Xbox One.

TC3 Steps of the Process

1. Xbox One turned on and connected to an Ethernet cable to access the Xbox Live network and log in.
2. Install applications .
    a. Netflix, YouTube, Blu-ray Disc, Twitch, Xbox Video, Hulu Plus, Skype, Media Player, Amazon Instant Video, Pandora, Xbox Music, HBO Go, Upload Studio, Uplay, WWE Network, Halo Channel, EA Access Hub, Forza Hub, Crunchyroll, VUDU Movies & TV, ESPN, Plex, MLG, Audio CD Player, and Crackle.
3. Interaction with each application.
4. Data transfer from EX2 USB. Table A1 shows files and hashes.
5. Install games.
    a. Ryse: Sons of Rome&Forza Motorsport 5
6. Interact with game for 30 minutes each.
7. Turn off Xbox One
8. The Xbox One taken apart safely
9. Test case one hard disk (TC3) safely removed
10. TC3 connected to the SATA hardware write blocker
13. TC1 imaged (bit-copy image) using Access Data's Forensic Tool Kit (FTK) 3.1.4.6.
14. TC3_(date) .001 saved.
15. TC3 reconnected to the Xbox One

Table 0.1 Files for Transfer to Xbox One

File Name	File Type	Use	Size KB	MD5	SHA1
000_0021	.png	Graphic	12663	b1bdd6f22c1a622b6acf68ba95d6ad64	8f244b50a7ac8129f455b1e9c6ca74cf06a23640
100_0018	.tiff	Graphic	14619	70ea373e3b686f6ef295fd9a49fe1a13	1c4402f777440f15d8f5896156ddb647f8747208
100_0183	.gif	Graphic	130	0b910d6c21828e0b8be06322168fbd60	eefd2bb644efb6d0ee57814992f8108834f8c0b2
100_0304crop	.bmp	Graphic	4993	a4f1f6095d8117aa00737f4b7f79c094	98b43081a49c83ca4e00e36e3e08bcab071ff01b
02010025	.pcx	Graphic	788	1e846d0506d21dd8a08a0cd784ce4f19	76f8ad6854448c76c2b127cb5a1a5486ee3ba5b3
02010026	.jpg	Graphic	60	20f34a3f571d394ab9342ac21588e96e	57cc6a1d54280f77674388ec31c1710bb8836ba3
09260002	.jpg	Graphic	60	bb1e236cf935815e5bb714760b23f549	395e50118bc92973049709 56c2241059eabe7f8d
arc1	.7z	Archive	1104	d1051cae37c82c24a019d03902c2d0c2	32f913fe68601e999baf77b92fe7ba934db99c83
arc2	.bz2	Archive	552	7e50af1887d7b39c3a900d99924ae521	4161f3045fc93bdfd22c34bf8aa0ea41967ab776
arc3	.gz	Archive	50	2b2ac3fd281e2f1ff94257f47780ad9a	bf6ae4537bf5bf11f14f57d41812bda52637f86c
arc4	.tar	Archive	1185	c52408fbba699fff0f6ea62ba86ab33d	e2f0d19d235d42ba34e8b5e643930f10ae12f21f
arc5	.wim	Archive	920	3fb5f789ab0d9693a9e11333fac463ef	c0934bb2668fe45d79c5606f033d749f8343c5c6
arc6	.rar	Archive	849	15ccca7548228668d1fe8eead2ff10fc	ac892b4584fefd06712e9a530147f7ca8ac447dc
arc7	.zip	Archive	629	4c514453204a0eca1d8e46765ecaa4ce	7b0ac44b60adabc3cfabb6929042e50c7e954529
audio1	.mp3	Audio	1029	4906f2b94eb7a95591396dca7fb9ef67	7f80f691ba21efdaf99df0e7381a5de7a16db3f6
audio2	.wav	Audio	4505	5124c9db0a4c3269e8562b8ed2e85f66	ddc5e2b60a59f2d3ef47340f4b224588a8ed628d
audio3	.au	Audio	9028	ad0c2d9fd8ef051e6b3bfecfee780a44	cac33b6d61c4b59252149f5a28e0abcb86a31340
audio4	wma	Audio	1050	1e1eaa07418813407a3e12e685008570	7f2301958fb8024b702df1ed7a55bc26bdc299b4
D1	.pdf	Document	3102	624eb29686b0b13974a804d66a6779d8	ed7cfb2161941c474bf4beba65abb735bcbcddb7
D2	.pdf	Document	2467	d8b3bd66e9c38ce0af69658df3de8c78	ca9b313594c4ab7986f1c75f42ac5505bdcf1777
D3	.xlsx	Document	23	21f5ae676b06893a1ad7e7fc9da8a141	a8798e9fa76f22e87c1602afebad5bb1e1f98682
D4	.xlsx	Document	14	d5a11e93b5bd2a6e7735fee921c0a6ea	da1b444a230350dc13cc46a72ccf96b77131e116
D5	.docx	Document	5	038bc8f9138cc281ee9def3edadec4bd	aa97a1d5ee7befb60e370565c74e075a7125440a
D6	.docx	Document	4	00a289fca326a78e40420f33dfe77eac	08f62b9f5bdaaecc48c4cc8fc8fbd981d3ef4223
D7	.pptx	Document	882	3bb602b8f96c56a10bbc97a5e210678d	b7780bec19f40d2b06690b9e860dc801a4f0be14
vid1	.mp4	Video	1110	d3bf39fa2f30b5acf644523d1a92ac82	49a35bb85084da324d393b1916559cbca5d4dd7b
vid2	.avi	Video	1436	20ca4356a2f152bae77c30f98f7e381f	e7cb37ede3bfc1c9594f07a0dcdeb391a7aa3eb6
vid3	.mov	Video	486	074ce15293e30b338d5a0c5fe8cf5d88	a961343baf828c5363e99907bed97c5b033e947a
vid4	.flv	Video	3627	c57611b8e3052bd853d79e2de932aa3d	7ba95033fd83d8013fc5cb3fba6834c0eb635677
vid5	.mpg	Video	22050	57586384eb1f286ef9c2325b521dca4c	ed12faaa09ffffbca7682529c44b013c7bfb4f4b
vid6	.wmv	Video	2404	abb8ca304b17d645aee1c46786361fe0	8e3cf8a8f0fe65e5d598b9e012f8a0291e72084e

Appendix B. Tool Test

Date: Wednesday February 11th, 2015 beginning at 12:04 pm
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228
Computer: CFLWIN15

- Windows 7 sp1 64-bit
- 8GB RAM
- Intel Core i5-2400S CPU @ 2.50GHz
- domain cit.lcl
- Time Zone Set:(UTS-05:00) Indiana (East) date set to Wednesday February 11th, 2015

Test Hard Drive: (TD1)

- Manufacturer: Toshiba
- Model: mq01abd050
- S/N: Y4CQTIBHTSB1
- P/N: PH2050U-1|54 593851-A0
- Size: 500GB 5400APM 8MB Cashe
- Physical: 2.5 SATA 3Gb/s
- Cylinders: 16,383
- Heads: 16
- Sectors: 63
- LBA: 976,773,168

External Hard Drive: (EX1)

- Manufacturer: Western Digital
- Model: N3565A
- S/N: WXF1A7221875
- P/N: WDBY8L0020BBK-01
- Size: 2TB

Tools:

- Disk Manager (Logical Disk Manager)
- FTK Imager 3.1.4.6
- Tableau Firewire 800 + USB 2.0 SATA Bridge

Steps of the Process:

1. Took SATA bridge and connected power cord, USB cord, SATA data, and SATA power to power cable. Connected USB to Computer, and connected TD1 to bridge. Turned on at 12:03:00. Computer detected hard drive as “USB Mass Storage Device” and “TOSHIBA MQ01ABD050 USB Device”.
2. Accessed disk management and found TD1 as “Disk 3 Unknown 465.76GB”. Prompted to “initialize a disk before Logical Disk Manager can access it”. Clicked OK. Got a message stating that the device was write protected.
3. Opened FTK Imager 3.1.4.6
    a. Create Disk Image
    b. Physical Drive
    c. \\PHYSICALDRIVE3 - TOSHIBA MQ01ABD050 USB DEVICE [500GB USB] → Finish → Add
    d. Raw (dd)
    e. Skipped case info entry
    f. Named image “TD1_2-11-15.001” and saved it on external hard drive EX1. Also changed Image Fragment Size to 0 so the image would not be broken up.
    g. Began imaging at 12:04 pm.
    h. Forced stop at 1:37pm. Tools proved to be imaging fine and write blocking. Turned off tools and disconnected TD1.

Appendix C. Test Case 1 (TC1) Imaging

Date: Wednesday February 11th, 2015 beginning at 13:40
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228
Computer: CFLWIN15

- Windows 7 sp1 64-bit
- 8GB RAM
- Intel Core i5-2400S CPU @ 2.50GHz
- domain cit.lcl
- Time Zone Set:(UTS-05:00) Indiana (East) date set to Wednesday February 11th, 2015

Xbox One TC1 Hard Drive: (TC1)

- Manufacturer: Seagate
- Model: ST500VT000
- S/N: W3PA4MEL
- P/N: 1DK142-120
- FW: 0001MBC1
- Size: 500GB
- Physical: SATA 2.5”
- CHS and LBA not listed

External Hard Drive: (EX1)

- Manufacturer: Western Digital
- Model: N3565A
- S/N: WXF1A7221875
- P/N: WDBY8L0020BBK-01
- Size: 2TB

Tools:

- Windows Explorer
- Disk Manager (Logical Disk Manager)
- FTK Imager 3.1.4.6
- Tableau Firewire 800 + USB 2.0 SATA Bridge

Steps of the Process:

1. Tested tools again on TD1. Reference Appendix B for tool testing steps of the procedure.
2. Grounded self.
3. Took Xbox One from its box and unwrapped. Took tools and followed instructions from iFixit opened Xbox One to get access to the hard drive.
    a. There were no screws to take the outer casing off, just plastic clips along the inner sides of the Xbox One. Start on the back left corner using pressure points to lift the top off. Note that there is a ribbon attached to the front of the case to the inner hardware, removed with caution. Top section of case successfully removed.
    b. There were 8 64mm Torx screws to get out to release the top inner protective covering. All but one screw was showing. C3 was under the Wi-Fi board. Carefully removed Wi-Fi board as it was attached to a connector with an 11 pin connection.
4. Found hard drive, TC1. Grounded self again before touching.
5. Disconnected TC1 from Xbox One (4 Torx9 screws connected to supports). Placed TC1 on antistatic pad.
6. Connected TC1 to Tableau Firewire 800 + USB 2.0 SATA Bridge and turned on at 13:40.
    a. NOTE: when TC1 was turned on 5 windows opened titled “System Support (I:)”, “Temp Content (J:)”, “User Content (K:)”, “System Update (L:)”, and “System Update 2 (M:)”. Did not engage with pop-ups and closed them.
7. Attempted to write on each partition by creating a text document named “TxtTest1.txt” with “TxtTest” written in the document through Windows Explorer. All partitions showed that the device was write protected and could not create the text document.
8. Accessed disk management and found TC1 listed as “Disk 3 Basic 465.76GB Read Only” with 5 partitions in use and unallocated space:

Table 0.1 TC1 Partitions

Name	Size	Partition Type	Reported File System
Temp Content	41GB	Primary	NTFS
User Content	365GB	Primary	NTFS
System Support	40GB	Primary	NTFS
System Update	12GB	Primary	NTFS
System Update 2	7GB	Primary	NTFS
Unallocated	779MB	-	-

7. Proceeded to create the TC1 image.
8. Opened FTK Imager 3.1.4.6
    a. Create Disk Image
    b. Physical Drive
    c. \\.\PHYSICALDRIVE3 - ST500VT0 00-1DK142 USB Device [500GB USB] → Finish → Add
    d. Raw (dd)
    e. Skipped case info entry
    f. Named image "TC1_2-11-15
    g. 5.001" and saved it on external hard drive EX1. Also changed Image Fragment Size to 0 so the image would not be broken up.
    h. Began imaging at 14:01:18, ended at 21:48:44.
        i. MD5 checksum: f6518a28cd6d9325a1c9e1153d54d5ef
        ii. SHA1 checksum: f675c832b865158760b2cf7ef11dee546a01cbd3
        iii. Sector Count: 976773168
        iv. Source data size: 476940 MB
        v. Cylinders: 60,801
        vi. Tracks per Cylinder: 255
        vii. Sectors per Track: 63
        viii. Bytes per Sector: 512
9. Disconnected TC1 and reconnected to Xbox One. Put all equipment back where found and left lab.

Appendix D. Test Case 1 (TC1) Analysis

Image File: TC1_2-11-15.001

MD5 checksum: f6518a28cd6d9325a1c9e1153d54d5ef
SHA1 checksum: f675c832b865158760b2cf7ef11dee546a01cbd3
Cylinders: 60,801
Tracks per Cylinder: 255
Sectors per Track: 63
Bytes per Sector: 512
Source data size: 476940 MB
Sector Count: 976,773,168
Drive Model: ST500VT0 00-1DK142 USB Device
Drive Serial Number: W3PA4MEL

Software:

Windows Explorer
FTK Imager 3.1.4.6
Autopsy 3.1.1

Total file count: 4693
154 total unique hashes

Table 0.1 TC1 Unique File Hash List and Amounts

MD5	SHA1	Amt.
00c1c00a63e5b5b661520bfa8c49d137	6f2a3ce1078214d921ca4ee2fdb482163d3af3cb	1
046ab916388bcb86384203d19e244324	5414390643ea5e6e1b4724107e25911f0e9340d7	1
04a3207844460ceb816475f4fce40993	8bf96ea97b3946252ec45d5c1866baec9f140f10	1
0546597403c3844850c60ae78cd5edb4	20b2955bffc2c19c1ec3afe82aa3d76c43c9d306	1
063c648b6dac91ff704e1e2f0b6341d2	002365d3c2ab3cce12da3024a27f7d560b08ef5b	1
09ed73e70b3d012fd44c2e5131e8f2dc	022b57f89f30e73b174e9035419312a03c75bfcd	1
0c6dd58f92ba24f89de8035f124c81ce	af62999cd86dd361600c8583af6da13319e2803b	1
0e8182d48fa55d3826e8326baa896069	ca6219651ff48945ec5e8d57cd7f6713490b9290	1
111a4fc1939438e30f1703f139f86a65	5c09403e69aa821fe79a15f63225aa41e6556ee2	1
122dd294e44b50559f1769a877c8e753	d35553f49273d92e28fef92988de61d53f8ea2b7	1
128d96428f6a38fde18795e41b1e5484	0bfcc909783c63ef45fb5d7db9eb83d324f740ea	1
141bface6cf6fa22ee616eb8ebbcc2ec	cdad43ff107fffa8c0858f9bffc6279c124e3ff6	1
167913465360d336cf2c0bc7efb2b61d	c1f978cef7de559c231bb5ae8d99a898f89529bd	1

Table D.1 (Continued)

MD5	SHA1	Amt.
18f40283e94415cae928d4216654f653	ddfbf2c59cc1c1a559f1156c749fac0c4b5ae23e	1
19366f3ebb206606cc3f8d073eb7c2b7	4b71522ada21d131764338ecd0230f55ce109123	1
19af014284d561a89087252bb17a8812	bfbdccfe11b7d634fb853fe0843d6e635ed842e6	1
1ab7adc6e6e6ee7e339bc3ea49cf2198	2bc3013440673173841eff04eff3875b0f0ea348	1
1b5d03ae790f7f7af1dc172574033c35	044c0c253e60d625cc585a0edb1811deb1c357eb	1
1cc4c3f7d02459aed30512ada20f8cfa	8020692270b4dfad9ef6cc047e904de24b436cc6	1
1d748d6235553d44a2c2903812abdc06	f222502bf4d54cfb1019fe45f343582478b0aa4b	1
1f53d222546c48bceb8b81585e475500	1159a288756247dfb9f1f5980e2cfb4fb1ea7a98	1
1f7f61d2bd3456aaee7e56193bdf8a7f	93248290392c2e5f99f75e49a66d900f713d92dd	1
1ff5e07de590894222c3622492d1f874	7468c2ae22674764b1f293b351ed65b9ba63e659	1
209c81a16cccb6936901ea78ee530571	e9b0d7d775be88ef07eef03aa520a063652d2d4a	1
20b38aa5c071c0a36f67c8c127af4106	d2aa44e759db5639ead6f1e4bdd640eab5ecde2e	1
22ffb13a63dbb2a0f583664f8ea5ae7c	363a5c888349b471b0391b88ccec3e85e9f4e575	1
23b5793757b5db5d26744a56ffa1e3f1	6034b085137733020818a543819567d5c10a71ed	1
24b7f3c819fab262a83a9e683a402be3	0f86db156cfd0d06745720d08455d5a5ed41336b	1
2b51a57a938b93b203f74ca6fdbe2d0b	f10bcda35f6a8131e15dc5ec4ca56c581f4eb522	1
2bc496adfeb69f722f3de20693a22fd0	6f9f4c44b13550c0575848749b39568438d50f15	1
2d0a8a3d8447bc8154c3e2dc1f3db9ac	43803812cbf81f22b7bba4ef576093d84b178bb3	1
2f282b84e7e608d5852449ed940bfc51	2c2ceccb5ec5574f791d45b63c940cff20550f9a	4159
2f550fa2e03eccfed53223fe5ce2f3b6	952a0bb80cc6cf0140839c97c599d87ff32fa757	1
30f3fb693759b623bd468523068db4b5	ef75b37d170403700369ac0afee53ea4ab442dd1	1
35843e6d7ff00fecb23c7dc36eafabe1	aaf3d72e47b345a42cac7cfcf47c399563e3dfff	2
358afb2be5387086a1be7da04a6150db	2374bff0efa8fbe322c5e0e29f657848704e1665	2
35d8d747df8bedc2e2c9ac404a85b671	f0db40f7a03c27f8e085aa29481c49e438fad3b0	1
366db0e7c30f245721d116a1aad6bfa5	e425547a0d4adf4983d32c04076447e0a51483da	1
36d7c154f7bcd854cfdc26174406b848	9e8710c92f79e64fe0535db1af7bdfcbf6e44384	2
3766dd2e8b80f5a9f3c75cde67e042bc	200c8eac9b8c29562fec4d548c21ffb043480bd6	1
397e01f35a5c162a600b16b6cb8f25b8	cae2d2eea396f3137bb209f31adabf2e7a65276c	1
3c8197cf20e7f199f9a24a6b785c1604	231b46bb6b9fa81cff0fc94ef06e5d04854cbbcd	1
3dae037a4cdcb10684501b6d31d65a20	106aa5f2158c5f50f80b9e52639755dca3d74606	1
3e7bf0de7afe72ff80be10cb4f86fd9a	a47f8f20b99976c835ce7589923af2729ea56397	1
3f35779fca79720f75f00b9f5b6bde03	e1f210de9519ccd71fcd276f48fce7ace88c43e4	1
3f7c39e0e2e3b7248e7d219cd6988572	c2d5ab34e58cdd2f7ea4c59e88f50a0b602dc9b6	1
401797918103f25aacd7bf703e26912b	67db4accd91426953a54becf1fb44dc5a0cd6ded	1
438fa532fbde3200d7eb7639a6ae034c	855827d861f3576a4774761cc59b7d4a5c623217	1
44eca22626fa607c99d9f94bd9b6c0d8	0dfd75954d661dead1a78959caca1650224448d1	1
45b9ceebfe8cf0d8fdca816c4d438787	0f259f90da24c5e827ce1a92802198b5cffe40f2	1
464379cc355b512c78788d323b87ff25	62f7398b85d58478548f981b64eb4cb486e8de10	1
474e0085d3b2e9916d35fd47ca18ee38	ca7fc995ba2d3ed5d084e258ae486ebeba94a73b	1
4781df8adc61e16eb4adcb0301749613	db4d5476c3b2d2aadd0b0d6e3296c547f1653c03	1
489606cb5c87f29ce4541a3b0262b88f	56d34531d73304bbf2ac24a606c4e0c6fc0663e9	1
49caba25f2de87b7917392b8c63aec4c	edfa5c8dd12148ef633fd43626542e2ab97974ad	1
515c0d931d58160810db9f1a583e8d34	984aa74038a19d0c5e0812981e3a5c24769ebbd3	1
51f03672d2152c11f0ff3f399e272922	abb5dcb132358e0df5add93887379562af7e44a9	10
521a6ebf3468eff686f388e4eb405bd5	f8f0982d594c267a5ea26c5decdecbf0befbd7d1	1
52693c359c8a13f8817c3931d2d8a8a2	555e6405a5ffd95ce2b303abeb119566a0a740c8	1

Table D.1 (Continued)

MD5	SHA1	Amt.
5a48c2eb9fbd45d420b5a794c5672de5	e48bad554ae6ff5f07b644f36143334cf593705b	2
5abd611446f9e8e9c2fe6baab91e3df2	cb7aca18264b724f8a9490460f29ae6c3635387f	1
5d0ff95229281d3c3b0596746538c445	c9b699eba930c46eed95aa8378036e9f76a249aa	1
60677a6bd61fa68beb18aa91153ed2ae	682d44df56b82dc00158769e63c383fa05b44a74	1
60c0688147f715a7ab0940286e7dc927	32fdf5d888d2d32883282063354bab77e11c5813	1
6404c73e103c4c90eb1b3e8317d0e44c	40f2daa9b39a260852f97da16d9e04d3d6f99c4d	1
6c768abe7517044afcd418e6c8a18a33	eef231ee80882665317ecbd819703425ca03d3ca	5
6dff3a49046b0f8c2949e7661cb53753	4dad28cc5bcf4af4b0d5a3bc5750594d1860d61a	1
710a811fb3679f5701a8494b00729106	76f211ba32c2c035d34630d651e0750fd3c233e2	1
7165d94359886c0cb0f29504f5c11467	9a8070d17c81d629a3a00a0f3b6cff84204ff944	2
72161653662ff0afdc29bb4458004618	96809fb60612c5169da8ffa38e8e38c9d9b806b6	1
72678dd19efebfdd1fe989ba5048f6c4	c53bb67862d14155d566c4985bd8f0b71fdee2f8	1
78df7d13538aa76aca97b8866347ed84	e91e524a5fe21cad756cfc89546a87e87bfa4cfa	2
790742fa73920dbf2f7bcb8a171243a8	5bf7219a9074a2429cb28fed8a746906b74d44c9	1
79de6e5cbb286c47048761bf01a387ef	895cacb945011b3c4bf0809bcba087aaaafd2ca2	1
7c1ec3cf185afb99bbc70925748fae72	d148e882f73707fee834226a09e4e7d191d3403f	1
7df03c94e79e4dda462dd276eea6fc44	3978be682abd094e8b6e8ffb81f3e5f5a6dd75c0	1
7ff498a44e45e77374cc7c962b1b92f2	5161a18e27b9ca9f5d04f2154576bf1ffb1121e8	5
800cd991ba91f9d14fc70aefe870e48d	6a676fd61c469d3d897acce68a3a12928e2ab2ae	1
8010d4683006b5dd7ac2b5ac27ad050d	b0cde380832992aae356a0db713a391dcab6af5d	1
8274dc8683724b52651766b2dd089b42	2bb0be460de913213dd2d4668f94917864ccc5a6	1
82ae862e8b7d3e883d054d951a51c993	5906fb34e435d35c9f8efdc11a0f7c8f48a92bb7	1
856e334ad8b7835c41bd91ee305f83d4	b6f737a8d59a42a2858e325b39e55715d04a7982	1
8b7bdf67970ed38a7bff8d58ef435936	9b2efab8d9471a4b0760f5080c1da448098099ff	1
8bb09d218c62d77d23c5fafce3649d3f	691ca96d12f11db6ecc00f5aef2a7c267bc1e555	1
8bb91cc072005f033bdb37e1eb77d0d5	251ce0775e2cff87380252fcda16ffb72713efef	1
8e90f3f16cc1fd4ba3f5a4d918181f7b	cab36f1deb571fbc50b3ff939a1f11e1cf158311	2
9127d4b76ccd3ef715576cb478e7d630	7619b5e9095d9edeb627a4d0083df066330a9284	1
916d600863fc424010372e2c031737f6	f6e57e756b64041690ccb4794bb116c5925a82a2	2
92f409f797b858544a1ce6f795f2eb1e	ef8b56ff4d8737c0023bf3df6f3a1faf48408df7	1
95fe8cf0ea7a88154e1523a60280488b	df737753bcd2abf701dd916424eae9294a567d9f	1
9608501875f7e7c9ef9459fa0439b714	2bc765cce8c5339cd7f16e21130e1c3cf65c84bd	1
97dc490ac9723fd995d68f514dd458d2	23d72f7774037e9ad32b6802889616ebae3a89fd	1
9948d222b8ddd10eea5fd27e43c96a7a	cfafe8def0bad81e99da11592240fefff09d4a52	1
99e462d40c3bb1fb0736ec75fc7f0164	984a17257a606225860de5ad8730903d9ae73a41	1
9cdbab9bba51624d6309daad3e817011	38474cfba7c623b8bcbc07d9648f7c7857bd0d1f	1
9d8bb6cb1247ee8c254cbcfccc016f1a	3dcedd819a91b7380f2567c9c97dce382d624238	1
9f0a88928e5d5c0736737e032b3fbbdb	540e3cd6a5df4aaf2613072d19206b67c43a34f8	1
a0923df212bf9a4189cb2a15dc4626af	b04d94dd04f2415edaee5547b1210b7190d0a1aa	1
a0b1512cea6286fdb5db65018849489e	4ace8815abad5d9ef6d840c8beb7d95895d838bf	1
a6dcb8041f7a2e9d236527994ff0f3e2	809fafd115128f7126a4c34d80dc5e0214379024	1
a75c836e8ed090d6065c2e0043c5fba4	d0c8bffe35cb031f282b8517fd95d19f397cdf4b	1
a9b4ea855f46fa7da9d975173078ffd6	fd9c344c2205d39fab1b174e44ed23ee6d096fa2	1
aab9a8c0d3ba44ddd0b069b74d72c638	da799991f31b9b8fdda33e41aef8f7d9ab8133cf	1
ab981967d9f545695c396db3787f8a49	2497adcb05fe54ad8a55c8fd2c145951ea039237	5
ad617ac3906958de35eacc3d90d31043	b49d7f48300701235231f6b6fc3d92a5630f9e70	5

Table D.1 (Continued)

MD5	SHA1	Amt.
af9648fb762b69314cbf19cb1e37e976	0092a991194babb338d156eaabf041ab7229df51	1
b29f58cfde2c25d89c47abc1dd0029ab	4677fb679acb30b3ec9833353e4e219a79c15a77	1
b31ff39de9cacf82e654a8d1a374fe07	df9384ba90f3b7e51717d5979f501b51c5246065	1
b4202f7fe985b9648b4676e6f70832bd	d37c2b3927946ed617455b3c5913fcab0bc1af52	5
b4f0f0aa21e50f6d4d704d734b8d4d34	a6dbb19a063be57fd63b3ffeeaaa9378e77b92e5	1
b501432bddf91ae5d7ed16b496f298ff	9ac41b155deda4dc8cb5dcceca27e85da82406a6	1
b64d1ea9751245ffd169b598aa0dd60d	7cf09ade47e16babb369262d2308bbeb74095c8d	1
b836143231c4eda0e4fd4765a741ec18	466bb52a38153071e22ae0c42c426cd6b8846e7c	1
bc6ee59591d5007c78f1b64c25f0404c	96d671198b381a39b57cdebd94db89bd8b33856c	1
bed6ab23b0e4a4f2f903a87afbec4b3b	53f475644e4ca0daeba0c59a18df804da1233310	1
c0a01e9c9296748e2761bf6b1d6d202a	9a9a348c0136385572f6d46646541190b91649cc	1
c2115c88466fd2148bfbb4f9b7a6aaca	2043af89dbec10180005f1e1a721b342de526aea	1
c30b4d73be49df3d5950ba49e3ebe0ee	e821ef789b6fb72a4eba0ef205e52c42cc04ba2f	1
c37b911194bf81da064cbb49d767d308	3fc3a3970b1a78848656ac7743ce0fa303482c8f	1
c93a7fdc2ecba8b65c4c5ee5e7dcd1a1	b71f43c05952e4f5debe6cd12f600534e3d1f509	1
ccc7677b0a8d066efb0026d05fc2d8ce	014311aed6137cb46edeec2da597c9e9fb51c0fb	1
d2389a74d9784cc5aeaca86f6ce50993	623c0330e86dd7ce07dc20665d6e225cc514f362	1
d3c35273db55dcda916db3b3f3a998d9	8fe086fd8fc2bda28b304cc38ccddfa55819e98d	1
d41d8cd98f00b204e9800998ecf8427e	da39a3ee5e6b4b0d3255bfef95601890afd80709	20
d4213280274d39a03eba7b5cd99c8e9f	88a395ac835da687cc806988590471227cd45191	1
d6fdfa460e2538caef7bf574453d7894	2d24c6762d6ec8575fc70f17f88a4f599043931f	1
d887a17cc43887d799fca62319d051db	cf6e8e0e96636477f1746bf8aa0ca9c3f5fa4c9f	1
d892d0820768c96bc521c1318efcfa9d	b830e94e6a37e6c95859a2279976ee780f713e8f	1
db511d02c1be9792fbdf4bea7c5fd3ca	43a98d5a2e7aa411d0ca184d8382572e323f3165	1
dc2784e32e79706ac09df198ec8835ed	52b6a6caf32bfbb061436b7e710a5cc4625e5d9a	1
deb5c30cf4e8a2bfab38992264b1756c	51106b2af57081242ab2c27dcc547e3c9b378630	4
df97e5cfdb6a5e84b230d61536d9ac3e	e354da81e30913cda2f8ee813742631a091884f5	1
e0777a146f0eeaaa587c283faaa19bf3	39c683ea038a60740c518645a386228f64576019	1
e0b1a957b1a0efc909fb2e64960968ac	bac35ed86cd09ce1c64770b565ce4a6ffe17c1ef	1
e2da72071b15025127156f3ce6e5cca7	b47ae4e38370d4d0a40ce73cfb507168344c5f23	1
e7301356d96583bbd713667c56ca6f82	1559df29b3625ac3c687f5160e57874f8125fd12	1
e81ecc08fd743d071619f226cb9715c8	3a7df03a12853503a0212379cc4e1f17c87c978c	4
e94f97f8f0d4dfbc11c487c98b88f58d	4c17d3a67e6c384f8d7259b7562d2687f8e2db0f	1
ea5ba8a90735e40978eac5e9da75a94a	f100f255996de20aadcf708047ca4f734065e674	1
eb349055b5eac7c0503ecf711f6fbca3	fd04c3376f10a1a0b628d9ad163b9d263e014a3e	1
ecb6749289cd3277e5cdb970a36ae18d	d4f794dc10a472355c50727ba4cede94e4f92955	1
edc4c3de71636089cd395e4773c79e19	1dcc88152fc1492520b3e26f54a98a5abdfa6c58	1
edcd503951b8676ec401a3df89ee4df0	606fcae96a65dd92ee44e32aeb0090f8174a230e	1
f4152b0992dbb28a19e4447ef6a7b195	67dffc8090b19b96e86c6486402b3f8a38792c18	1
f4d2127084a2277d9b0911714111849c	e745a76dedd998715f7197f697afca681de8a8d6	1
f77eb69c26e1f279329bf19c735d116c	872517d323ea780c61153239bea1c35caefc756c	1
fa1daa970ba3560c1314dff313653157	47eaa934af5497fd010f941edb04c30bf7ac6788	1
fb4a1dad2dcf9a38e84a0c38c642357a	bae9f94196b7d2d539dbf3351e10b20dbc3b6069	1
fbb7abadb02632161176e7cefdb874d5	0cb9b4bb73c4bdd0c4286e8b0777a27337c52905	1
fc0567da64a9842ca71e73dfebda99fd	f38a9f6bfd411dd7d87055e65e92c290cd9e72de	1
fc3e8322d0bb5d1dc5f643dea86ab359	e0c0134b207dce519bbe5213fea176d90dae898a	5

Table D.1 (Continued)

MD5	SHA1	Amt.
fece24feb630ae23b9171380c3116685	ac0625c334905c8a543f3b4e0aa31438a1c22f04	1
ff2339aaf556aa414f8f241726b1d3b4	fcf786eccdfd566ac1a952d9c30237fa5affc5f4	1
ff63cd5358364dfacc3cd95d5ebb01af	a93d6a93f12f8bc78f1f6bf2ba984277258fc59c	1

Appendix E. Test Case 2 (TC2) Creation

Date: Monday February 16th, 2015 beginning at 6:00 am
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228

Steps of the process:

1. Took Xbox One (reassembled since TC1 Imaging) and connected it to a TV in the lab via HDMI connection. Note at this time the researcher had acquired a Kinect and also connected that to the Xbox One for TC2 creation.
2. Connected Ethernet cable to Xbox One.
3. Turned on the TV.
4. Turned on the Xbox One with the controller it came with at 6:08 am.
5. Pressed Continue at 6:11:20.
6. Chose English as main language.
7. Xbox One asked if 1080p or 740p would work for the TV resolution but neither worked. Chose option "None of these work" and continued through to a screen saying the resolution was at 640 x 480 and continued through.
8. The Xbox One stated that it was connected to the internet at 6:13:35 am.
9. Chose United States as location country and continued through.
10. Stated the Xbox One needed an update. Began update at 6:14:15. An automatic reboot happened at 6:17:53, then booted back up again at 6:18:26. Update completely finished at 6:21:20. Continued through.
    a. NOTE: At this time the update should be 6.2.12130.0 (xb_rel_1502.150209-1738) fre which was released 2-13-15 (Xbox Support, 2015).
11. Set time zone to (UTC -05:00) Indiana. Kept the option checked to automatically update for daylight savings time and continued through at 6:22:40.
12. Began Kinect sensor set up. The Kinect could see me, and then checked audio. The volume was at 45 for the check (louder than normal as prompted). Continued through.
13. Created a Microsoft account on Xbox One. Account is FrankOX@outlook.com (Frank OX) at 6:30:05-6:31:50. Password is "Digital!" which was entered at 6:33:00-6:33:20. Birthday was set for May 17th, 1987. The external email was set to FrankieXman@yahoo.com at 6:40:40. This email was created by the researcher.
    a. Yahoo account: Frank OX. Fake Phone: (765) 223-1828. Birthday: 05-17-1987. Password: Digital!
14. Accepted Terms of Use.
15. Chose the privacy control to be "Make it Fast, Make it Magic". This option states "Step in front of Kinect and you're signed in, ready to play. On this Xbox, people

can sign you in, change your settings, and buy things without extra steps." Continued through and the Kinect found my face again. Stated that was me and continued through again.

16. Chose the light blue color for the profile and continued through.
17. Chose "No Thanks" to signing up for Xbox Live for now as this is a part of creating TC3. Continued through to the Xbox One Home screen. Turned off by holding the X button on controller and selecting "Turn of Console" at 6:45:30.
18. Turned off TV and disconnected Xbox One from TV. Put all power cables to TV where found.
19. Took Xbox One to imaging workstation to begin imaging process.

Appendix F. Test Case 2 (TC2) Imaging

Date: Monday February 16th, 2015 beginning at 7:00 am
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228
Computer: CFLWIN15

- Windows 7 sp1 64-bit
- 8GB RAM
- Intel Core i5-2400S CPU @ 2.50GHz
- domain cit.lcl
- Time Zone Set:(UTS-05:00) Indiana (East) date set to Wednesday February 16th, 2015

Xbox One TC2 Hard Drive: (TC2)

- Manufacturer: Seagate
- Model: ST500VT000
- S/N: W3PA4MEL
- P/N: 1DK142-120
- FW: 0001MBC1
- Size: 500GB
- Physical: SATA 2.5”
- CHS and LBA not listed

External Hard Drive: (EX1)

- Manufacturer: Western Digital
- Model: N3565A
- S/N: WXF1A7221875
- P/N: WDBY8L0020BBK-01
- Size: 2TB

Tools:

- Windows Explorer
- Disk Manager (Logical Disk Manager)
- FTK Imager 3.1.4.6
- Tableau Firewire 800 + USB 2.0 SATA Bridge

Steps of the Process:

1. Took Xbox One apart to access the hard drive just as when accessing TC1.
2. Connected TC2 drive to tools and turned on at 7:10 am. Note when the write blocker was turned on messages popped up for all 5 partitions: "You need to format the disk in drive (I:, J:, K:, L:, M:) before you can use it." Canceled format to all.
3. Attempted to write on each of the volumes but Windows Explorer would not even let me access the partitions to TC2 stating "(I:, J:, K:, L:, M:) is not accessible. The media is write protected".
4. Accessed disk management and found TC2 listed as "Disk 3 Basic 465.76GB Read Only" with 5 partitions in use and unallocated space only the partitions did not have any names this time and the reported file system was listed as "RAW":

Table 0.1 TC2 Partitions

Name	Size	Partition Type	Reported File System
(K:)	41GB	Primary	RAW
(J:)	365GB	Primary	RAW
(I:)	40GB	Primary	RAW
(L:)	12GB	Primary	RAW
(M:)	7GB	Primary	RAW
-	779MB	-	-

5. Proceeded to create the TC2 image.
6. Opened FTK Imager 3.1.4.6
    a. Create Disk Image
    b. Physical Drive
    c. \\.\PHYSICALDRIVE3 - ST500VT0 00-1DK142 USB Device [500GB USB] → Finish → Add
    d. Raw (dd)
    e. Skipped case info entry
    f. Named image "TC2_2-16-15.001" and saved it on external hard drive EX1. Also changed Image Fragment Size to 0 so the image would not be broken up.
    g. Left "Verify images after they are created checked".
    h. Began imaging at 7:27:10, ended at 15:42:57
        i. MD5 checksum: e5ba73896e6698fcfe90e2f29b35d01f
        ii. SHA1 checksum: 9daf045689c847e6f4f432571b8f238628946945
        iii. Sector Count: 976773168
        iv. Source data size: 476940 MB
        v. Cylinders: 60,801
        vi. Tracks per Cylinder: 255

vii. Sectors per Track: 63
viii. Bytes per Sector: 512

7. Disconnected TC2 and reconnected to Xbox One. Put all equipment back where found and left lab.

Appendix G. Test Case 2 (TC2) Analysis

Image File: TC2_2-16-15.001

- MD5 checksum: e5ba73896e6698fcfe90e2f29b35d01f
- SHA1 checksum: 9daf045689c847e6f4f432571b8f238628946945
- Cylinders: 60,801
- Tracks per Cylinder: 255
- Sectors per Track: 63
- Bytes per Sector: 512
- Sector Count: 976,773,168
- Drive Model: ST500VT0 00-1DK142 USB Device
- Drive Serial Number: W3PA4MEL

Software:

- Windows Explorer
- FTK Imager 3.1.4.6
- Autopsy 3.1.1

Total file count: 4679 (14 less than TC1)

164 total unique hashes

Table 0.1 TC2 Unique Hash List

MD5	SHA1	Amt.
0546597403c3844850c60ae78cd5edb4	20b2955bffc2c19c1ec3afe82aa3d76c43c9d306	1
09ed73e70b3d012fd44c2e5131e8f2dc	022b57f89f30e73b174e9035419312a03c75bfcd	1
0bb15da434440c0572eac837ad847f9a	3676fa9cce3b3aee499fdf9dab1ff5325b16415e	1
0cb1099ee088093a5cbb4c8cc0fd1556	95693181a5792da022a4f151ca40d3399a03cfd9	1
0e7a8b19c7c02ed2e0161ffe81071673	d851fe0993baecda42cd71ce29be0a8d144db75f	1
111a4fc1939438e30f1703f139f86a65	5c09403e69aa821fe79a15f63225aa41e6556ee2	1
122dd294e44b50559f1769a877c8e753	d35553f49273d92e28fef92988de61d53f8ea2b7	1
128d96428f6a38fde18795e41b1e5484	0bfcc909783c63ef45fb5d7db9eb83d324f740ea	1
167913465360d336cf2c0bc7efb2b61d	c1f978cef7de559c231bb5ae8d99a898f89529bd	1
18f40283e94415cae928d4216654f653	ddfbf2c59cc1c1a559f1156c749fac0c4b5ae23e	1
19af014284d561a89087252bb17a8812	bfbdccfe11b7d634fb853fe0843d6e635ed842e6	1
1ab7adc6e6e6ee7e339bc3ea49cf2198	2bc3013440673173841eff04eff3875b0f0ea348	1
1d748d6235553d44a2c2903812abdc06	f222502bf4d54cfb1019fe45f343582478b0aa4b	1
1f53d222546c48bceb8b81585e475500	1159a288756247dfb9f1f5980e2cfb4fb1ea7a98	1
209c81a16cccb6936901ea78ee530571	e9b0d7d775be88ef07eef03aa520a063652d2d4a	1

Table G.1 (Continued)

MD5	SHA1	Amt.
20b38aa5c071c0a36f67c8c127af4106	d2aa44e759db5639ead6f1e4bdd640eab5ecde2e	1
22ffb13a63dbb2a0f583664f8ea5ae7c	363a5c888349b471b0391b88ccec3e85e9f4e575	1
23b5793757b5db5d26744a56ffa1e3f1	6034b085137733020818a543819567d5c10a71ed	1
296e94da77b6b827a885a3572d1db539	c9bfa2e235f5f4d576ebda41b0d09256752333f0	1
2a5a0f9c27aab78550042c6e2d35a49f	4b2ea7cbb857732420a02a2006cf166f46e9df8a	1
2b51a57a938b93b203f74ca6fdbe2d0b	f10bcda35f6a8131e15dc5ec4ca56c581f4eb522	1
2b76f46a6c00947779ac55f0a5b98068	ec42e6a4027c0590c378ddda2c4708c0d4c39527	1
2bc496adfeb69f722f3de20693a22fd0	6f9f4c44b13550c0575848749b39568438d50f15	1
2e1459c0273ade852dbf7369172b1dd8	158af0658367584c4bd64e5fa4c933fa92fef472	1
2f282b84e7e608d5852449ed940bfc51	2c2ceccb5ec5574f791d45b63c940cff20550f9a	4416
2f550fa2e03eccfed53223fe5ce2f3b6	952a0bb80cc6cf0140839c97c599d87ff32fa757	1
2f8b78c0afa0dd910042ce51ddfc27fd	4d9c0089b59ce4087d223b99f5c33a168064e230	1
30f3fb693759b623bd468523068db4b5	ef75b37d170403700369ac0afee53ea4ab442dd1	1
32f887d5b2a059839397ff7f9a34b9a6	eaf86283eb470a2a37c3420ed505b4d82434b544	1
358afb2be5387086a1be7da04a6150db	2374bff0efa8fbe322c5e0e29f657848704e1665	2
36d7c154f7bcd854cfdc26174406b848	9e8710c92f79e64fe0535db1af7bdfcbf6e44384	2
397e01f35a5c162a600b16b6cb8f25b8	cae2d2eea396f3137bb209f31adabf2e7a65276c	1
3996bf6b970dda7688c1c2373f6d5406	984b84258bbc01a09d695a9df9bb354cd7990933	1
3c8197cf20e7f199f9a24a6b785c1604	231b46bb6b9fa81cff0fc94ef06e5d04854cbbcd	1
3d62dd60999d5e06ddb2f00ea523ffe6	da6fdb58a93df3a57562b47d62cf1472dd50b191	1
3dae037a4cdcb10684501b6d31d65a20	106aa5f2158c5f50f80b9e52639755dca3d74606	1
3e7bf0de7afe72ff80be10cb4f86fd9a	a47f8f20b99976c835ce7589923af2729ea56397	1
3f35779fca79720f75f00b9f5b6bde03	e1f210de9519ccd71fcd276f48fce7ace88c43e4	1
410f2d06fb03b594a17c5a067711648c	90afa71a0e397f526dea055c7c438685a26f2f62	1
438fa532fbde3200d7eb7639a6ae034c	855827d861f3576a4774761cc59b7d4a5c623217	1
44b65b6e3ce4169ea99365a1413e04b4	94b729497d653086764c1f54dd9f8eeb330d5708	1
464379cc355b512c78788d323b87ff25	62f7398b85d58478548f981b64eb4cb486e8de10	1
4781df8adc61e16eb4adcb0301749613	db4d5476c3b2d2aadd0b0d6e3296c547f1653c03	1
489606cb5c87f29ce4541a3b0262b88f	56d34531d73304bbf2ac24a606c4e0c6fc0663e9	1
49caba25f2de87b7917392b8c63aec4c	edfa5c8dd12148ef633fd43626542e2ab97974ad	1
4b33951b65ba1451ed8a16bebad154f3	206d35d2248dda8c4bd1584ad8790ba28f773dbf	1
4d8f577de833ccf4713fd85e60b7167a	6782f051e208e541f1e214376829a55a6a0f8aee	1
4e1159971f10b57ec7de45bf14e2ae34	4f1af59708e791ee208d356da708a3bffbb761da	1
4f3c847cabe9542dc748a7ff08021496	6710dd9626cc4a2a71ffc670ffd929459dbf3f26	1
51f03672d2152c11f0ff3f399e272922	abb5dcb132358e0df5add93887379562af7e44a9	10
521a6ebf3468eff686f388e4eb405bd5	f8f0982d594c267a5ea26c5decdecbf0befbd7d1	1
523565888e1178c984ad673cda163b9d	595c55f5b3b6a2151ff828548e5b3f8385dc8ce3	1
57c156ada7dcb2105e212e9c081f27ec	60995d6b003dc718a8c727d661e19f8763fafb3b	1
5a48c2eb9fbd45d420b5a794c5672de5	e48bad554ae6ff5f07b644f36143334cf593705b	2
5abd611446f9e8e9c2fe6baab91e3df2	cb7aca18264b724f8a9490460f29ae6c3635387f	1
5e58d6d766454f2e7aa304f26bcda97e	89065f45d646f24accc77dc707f75b2cc4bf2ff5	1
60c0688147f715a7ab0940286e7dc927	32fdf5d888d2d32883282063354bab77e11c5813	1
62244af3c96842f764ecc9cbbfed5417	490c5f83df1eb0372f8f1bc4275a38282e482c55	1
6404c73e103c4c90eb1b3e8317d0e44c	40f2daa9b39a260852f97da16d9e04d3d6f99c4d	1
687985620e9bcea4865953c79eed183b	5f9e7f0675605a5d58751d960c2f541354eb4e14	1
6c768abe7517044afcd418e6c8a18a33	eef231ee80882665317ecbd819703425ca03d3ca	5

Table G.1 (Continued)

MD5	SHA1	Amt.
6cf4216366dfead41858352db690cbd1	82f96583af5f8df4a84dc4ee1fad64161c81634a	1
6d1340e58f7bf2f2db660f1dc7d1da43	d55c36f8276aa69c658f665b6823f858c02f6989	1
710a811fb3679f5701a8494b00729106	76f211ba32c2c035d34630d651e0750fd3c233e2	2
7147a7f3dbeee702202e0a74f88f1530	14e5ee5ca6e574077d0ecffcda8597f14e3a3956	1
7165d94359886c0cb0f29504f5c11467	9a8070d17c81d629a3a00a0f3b6cff84204ff944	1
77457113512eeb29b981a0fc6b94e336	f8781ca90285e81f445bf6bee45ea1dc536c39c2	1
78df7d13538aa76aca97b8866347ed84	e91e524a5fe21cad756cfc89546a87e87bfa4cfa	2
790742fa73920dbf2f7bcb8a171243a8	5bf7219a9074a2429cb28fed8a746906b74d44c9	1
796f01508b47a95ac217e3ce8021f442	8599485f5df223fd050aa3d869ee069bdf329a30	1
79bc93165b22865dab0799f55f83eab3	6b44ce69f3ac4ae9160a5c690d6f28a31849096b	1
7b400915c05deeb86a175af6a8f20400	4401f8d259bf599c28dd62e7c17a930af7687430	1
7b802e9d49c916b0f9bc8400ad1436f3	6f8f70ae08a6800278e2c483d585d9e200f53141	1
7c1ec3cf185afb99bbc70925748fae72	d148e882f73707fee834226a09e4e7d191d3403f	2
7df03c94e79e4dda462dd276eea6fc44	3978be682abd094e8b6e8ffb81f3e5f5a6dd75c0	1
7e85c536816811126fc8f0512561c19e	5ba19850e6505aa6692b1e2c6a3f3b838338b7ea	1
7ff498a44e45e77374cc7c962b1b92f2	5161a18e27b9ca9f5d04f2154576bf1ffb1121e8	5
8010d4683006b5dd7ac2b5ac27ad050d	b0cde380832992aae356a0db713a391dcab6af5d	1
8215b3d8187e427a16628505de16c298	bb1711f203dedbcf0c36595e2bb46f66af82cfd7	1
8274dc8683724b52651766b2dd089b42	2bb0be460de913213dd2d4668f94917864ccc5a6	1
82ae862e8b7d3e883d054d951a51c993	5906fb34e435d35c9f8efdc11a0f7c8f48a92bb7	1
868578814c1d61a3f84fd546a1e064a8	877c69b83aa60491e0e7bc7b6ab396b6e02c5f42	1
892a474648e191a875ca4fb6c9a74a8c	d92cf32e5ea100dd99ca7713ce32b7831948af87	1
8b7bdf67970ed38a7bff8d58ef435936	9b2efab8d9471a4b0760f5080c1da448098099ff	1
8e90f3f16cc1fd4ba3f5a4d918181f7b	cab36f1deb571fbc50b3ff939a1f11e1cf158311	2
9127d4b76ccd3ef715576cb478e7d630	7619b5e9095d9edeb627a4d0083df066330a9284	1
916d600863fc424010372e2c031737f6	f6e57e756b64041690ccb4794bb116c5925a82a2	2
92f409f797b858544a1ce6f795f2eb1e	ef8b56ff4d8737c0023bf3df6f3a1faf48408df7	1
95fe8cf0ea7a88154e1523a60280488b	df737753bcd2abf701dd916424eae9294a567d9f	1
9608501875f7e7c9ef9459fa0439b714	2bc765cce8c5339cd7f16e21130e1c3cf65c84bd	1
97f9ef13a1aa24f4e5dd226057249ed1	d17a20dd25fc238bbe5547f1c06abd9303d3d60b	1
9948d222b8ddd10eea5fd27e43c96a7a	cfafe8def0bad81e99da11592240fefff09d4a52	1
9cdbab9bba51624d6309daad3e817011	38474cfba7c623b8bcbc07d9648f7c7857bd0d1f	1
9d8bb6cb1247ee8c254cbcfccc016f1a	3dcedd819a91b7380f2567c9c97dce382d624238	1
9dce8f75aee0d59aea168b98598844d1	6dda93f60858c3ffdb17a81e99b99606b543ab57	1
9eda4e5252c089fe9390eb4879a183f1	249fd4e8a153860170eb36d8e59590aead188a84	1
9f0a88928e5d5c0736737e032b3fbbdb	540e3cd6a5df4aaf2613072d19206b67c43a34f8	1
a04e45f8538613c10372faa3179552e0	bea0067fa554dda7ddf129d0bccafed1372e6d79	1
a0923df212bf9a4189cb2a15dc4626af	b04d94dd04f2415edaee5547b1210b7190d0a1aa	1
a0b1512cea6286fdb5db65018849489e	4ace8815abad5d9ef6d840c8beb7d95895d838bf	1
a220e732919d636f1bf269c8ffa794e1	69c3945d071da28e3639271c0eb98cf7a096607c	1
a6dcb8041f7a2e9d236527994ff0f3e2	809fafd115128f7126a4c34d80dc5e0214379024	1
a75c836e8ed090d6065c2e0043c5fba4	d0c8bffe35cb031f282b8517fd95d19f397cdf4b	1
a835df07c953fd918606e4aaa11367ea	526ae7867a9fd64c4be0a54b81cea0fd5c88b99d	1
ab981967d9f545695c396db3787f8a49	2497adcb05fe54ad8a55c8fd2c145951ea039237	5
acf026ca14cce268fe40621c1fd787ad	b1558802b2f4334734b2dbfd9cd9a3ace4c49b9e	1
ad617ac3906958de35eacc3d90d31043	b49d7f48300701235231f6b6fc3d92a5630f9e70	5

Table G.1 (Continued)

MD5	SHA1	Amt.
ae53ce28325bfc0482ca90d005d1bab5	f3c711d17c34c4b0a28a61c2e523952fbf5c4f5b	1
af9648fb762b69314cbf19cb1e37e976	0092a991194babb338d156eaabf041ab7229df51	1
b3bc476292e8056db03d87b88a7e82c7	44a1d8e05f52300da748ea18edc00f5b1e2274c6	1
b4202f7fe985b9648b4676e6f70832bd	d37c2b3927946ed617455b3c5913fcab0bc1af52	5
b4f0f0aa21e50f6d4d704d734b8d4d34	a6dbb19a063be57fd63b3ffeeaaa9378e77b92e5	1
b501432bddf91ae5d7ed16b496f298ff	9ac41b155deda4dc8cb5dcceca27e85da82406a6	1
b5f13a73f7f681be6e8f2e6310387bd6	16e8cfa23688f441a5ac548091207e49a56bd1fa	1
b64d1ea9751245ffd169b598aa0dd60d	7cf09ade47e16babb369262d2308bbeb74095c8d	1
ba4fa6f08f8431c94115b55bc589123b	d3e3121c8677140b5bbd3bf1fa861846a038ed31	1
bed6ab23b0e4a4f2f903a87afbec4b3b	53f475644e4ca0daeba0c59a18df804da1233310	1
c0a01e9c9296748e2761bf6b1d6d202a	9a9a348c0136385572f6d46646541190b91649cc	1
c1915798b2c80eeee4e10ff7ddc40bcd	d030e154b71d07681fb7c358cdac089bbf53772b	1
c2115c88466fd2148bfbb4f9b7a6aaca	2043af89dbec10180005f1e1a721b342de526aea	1
c30b4d73be49df3d5950ba49e3ebe0ee	e821ef789b6fb72a4eba0ef205e52c42cc04ba2f	1
c37b911194bf81da064cbb49d767d308	3fc3a3970b1a78848656ac7743ce0fa303482c8f	1
c81601b97f1a4095366b51fa8d0620ab	67751b58b290f6bcd5ec054d02ca9b98c229990d	1
c8505390f82e20e2a623d1205b1e3ea8	b6fa4e367eaa23dd3e8eeff8f3972cb2c153967e	1
c93a7fdc2ecba8b65c4c5ee5e7dcd1a1	b71f43c05952e4f5debe6cd12f600534e3d1f509	1
ccc7677b0a8d066efb0026d05fc2d8ce	014311aed6137cb46edeec2da597c9e9fb51c0fb	1
cfcd208495d565ef66e7dff9f98764da	b6589fc6ab0dc82cf12099d1c2d40ab994e8410c	1
d2389a74d9784cc5aeaca86f6ce50993	623c0330e86dd7ce07dc20665d6e225cc514f362	1
d308cbaf2024821a8c08a68fe790fb7a	3f01db556e043ad37a5bb602b485781b5199baca	1
d3656d96011f4604a8e9d8a32af4f500	0b367314ae8ecc42fceea20b7d98b9361789f2d9	1
d3c35273db55dcda916db3b3f3a998d9	8fe086fd8fc2bda28b304cc38ccddfa55819e98d	1
d41d8cd98f00b204e9800998ecf8427e	da39a3ee5e6b4b0d3255bfef95601890afd80709	20
d46ca434e2518cd2ae05068f8579821c	00c43af3a98dbd48248e4530375ab67f8b9c7a29	1
d6fdfa460e2538caef7bf574453d7894	2d24c6762d6ec8575fc70f17f88a4f599043931f	1
d73ddac86b5f91f06043a66cd16fa35f	91f8d883d7fd1d6678be04693f182fc5c1c68113	1
d887a17cc43887d799fca62319d051db	cf6e8e0e96636477f1746bf8aa0ca9c3f5fa4c9f	1
d9df5b2e2927a94735c6c1c3112a9a5d	0fe35373c0020995623ed3f7372d15d4d7d2eb86	1
db511d02c1be9792fbdf4bea7c5fd3ca	43a98d5a2e7aa411d0ca184d8382572e323f3165	1
dc2784e32e79706ac09df198ec8835ed	52b6a6caf32bfbb061436b7e710a5cc4625e5d9a	1
dc7acf30aacc4e0fcd40a903827f004b	a9bb13387a1e856f1b29c62a84bbdb0d3109781d	1
deb5c30cf4e8a2bfab38992264b1756c	51106b2af57081242ab2c27dcc547e3c9b378630	4
df97e5cfdb6a5e84b230d61536d9ac3e	e354da81e30913cda2f8ee813742631a091884f5	1
e2da72071b15025127156f3ce6e5cca7	b47ae4e38370d4d0a40ce73cfb507168344c5f23	1
e7301356d96583bbd713667c56ca6f82	1559df29b3625ac3c687f5160e57874f8125fd12	1
e81ecc08fd743d071619f226cb9715c8	3a7df03a12853503a0212379cc4e1f17c87c978c	4
e86ad85283c81dfa99acf8e7e47c0a0c	0361e246ea05cefd4b0ae4bd8c1dfa6db82ae4b7	1
e94f97f8f0d4dfbc11c487c98b88f58d	4c17d3a67e6c384f8d7259b7562d2687f8e2db0f	1
eb349055b5eac7c0503ecf711f6fbca3	fd04c3376f10a1a0b628d9ad163b9d263e014a3e	1
ecb6749289cd3277e5cdb970a36ae18d	d4f794dc10a472355c50727ba4cede94e4f92955	1
edcd503951b8676ec401a3df89ee4df0	606fcae96a65dd92ee44e32aeb0090f8174a230e	1
f2b16423939a53598ac2ddd44a8cbf93	d095bb8a1bca8c222ec81b5f8ee21535b692805e	1
f4152b0992dbb28a19e4447ef6a7b195	67dffc8090b19b96e86c6486402b3f8a38792c18	1
f4d2127084a2277d9b0911714111849c	e745a76dedd998715f7197f697afca681de8a8d6	1

Table G.1 (Continued)

MD5	SHA1	Amt.
f67552881bc13163f2b3abe2c9efb283	7ca1a295eebf4704ae6be060985bafc6d059fa05	1
f77eb69c26e1f279329bf19c735d116c	872517d323ea780c61153239bea1c35caefc756c	1
f8ff33c019580b3e4c8437d3ddaabfd7	edd6b21f0dfb25146ea9e8db90a349ea1680e750	1
fa70b0482ca9f558affc52d8576cd62e	7efb058f0a9ce9a52e71869a2dc78dbd68230061	1
fb4a1dad2dcf9a38e84a0c38c642357a	bae9f94196b7d2d539dbf3351e10b20dbc3b6069	1
fbb7abadb02632161176e7cefdb874d5	0cb9b4bb73c4bdd0c4286e8b0777a27337c52905	1
fc0567da64a9842ca71e73dfebda99fd	f38a9f6bfd411dd7d87055e65e92c290cd9e72de	1
fc3e8322d0bb5d1dc5f643dea86ab359	e0c0134b207dce519bbe5213fea176d90dae898a	5
fece24feb630ae23b9171380c3116685	ac0625c334905c8a543f3b4e0aa31438a1c22f04	1
ff2339aaf556aa414f8f241726b1d3b4	fcf786eccdfd566ac1a952d9c30237fa5affc5f4	1
ffaaa451dd79de906024098fd4cf3614	7641ee9c335df770fea00aebf03af88778e2f1bf	1

Compared TC1 hash lists to TC2 hash lists. NOTE: No changes to the Protected MBR, Primary GPT Header, or the Primary Partition Entry Array.

Table 0.2 TC2 Changed Items

#	Changed Location
1	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$Bitmap
2	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$I30
3	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$LogFile
4	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$MFT
5	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$sosrst.xvd
6	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\appswapfile.xvd
7	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\AppTempStorage
8	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\AppUserStorage
9	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\ConnectedStorage-retail
10	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\GDVRIndex.xvd
11	User Content (2) [373760MB]\User Content [NTFS]\[root]\$I30
12	User Content (2) [373760MB]\User Content [NTFS]\[root]\$LogFile
13	User Content (2) [373760MB]\User Content [NTFS]\[root]\$MFT
14	System Support (3) [40960MB]\System Support [NTFS]\[root]\$Bitmap
15	System Support (3) [40960MB]\System Support [NTFS]\[root]\$I30
16	System Support (3) [40960MB]\System Support [NTFS]\[root]\$LogFile
17	System Support (3) [40960MB]\System Support [NTFS]\[root]\$MFT
18	System Support (3) [40960MB]\System Support [NTFS]\[root]\cms.xvd
19	System Support (3) [40960MB]\System Support [NTFS]\[root]\controllers\cache0.cfg
20	System Support (3) [40960MB]\System Support [NTFS]\[root]\DataCollectionUploader_0
21	System Update (4) [12288MB]\System Update [NTFS]\[root]\$Bitmap
22	System Update (4) [12288MB]\System Update [NTFS]\[root]\$I30
23	System Update (4) [12288MB]\System Update [NTFS]\[root]\$LogFile
24	System Update (4) [12288MB]\System Update [NTFS]\[root]\$MFT
25	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$I30
26	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$LogFile

Table 0.3 TC2 Added Locations

#	Added Location
1	User Content (2)\User Content [NTFS]\[root]\PLS\
2	System Support (3)\System Support [NTFS]\[root]\oddfwupd\
3	System Support (3)\System Support [NTFS]\[root]\SharedStorage\
4	System Support (3)\System Support [NTFS]\[root]\oddfwupd\0.log
5	System Support (3)\System Support [NTFS]\[root]\oddfwupd\sequence.txt
6	System Update (4)\System Update [NTFS]\[root]\updater.xvd
7	System Update (4)\System Update [NTFS]\[root]\A\systemaux.xvd
8	System Update (4)\System Update [NTFS]\[root]\A\system.xvd
9	System Update (4)\System Update [NTFS]\[root]\A\deltas.xvd
10	System Update (4)\System Update [NTFS]\[root]\A\sosinit.xvd
11	System Update (4)\System Update [NTFS]\[root]\A\SettingsTemplate.xvd
12	System Update (4)\System Update [NTFS]\[root]\A\sostmpl.xvd
+	Overabundance of numbered clusters in Unpartitioned Space

Table 0.4 TC2 Removed Location

#	Removed Location
1	User Content (2)\User Content [NTFS]\[root]\246d3k
2	System Update (4)\System Update [NTFS]\[root]\2x42ir
+	Overabundance of numbered clusters in Unpartitioned Space

Appendix H. Test Case 3 (TC3) Creation

Date: Wednesday February 18th, 2015 beginning at 14:00
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228

Steps of the Process:

1. Connected Xbox One to TV.
2. Powered on Xbox One at 14:02
3. Signed in without network connection to Frank. NOTE: gamer tag had not been created yet but showed a gamer tag named "MoltenRhombus35" for Frank. Double checked to make sure this was the correct account and it was. Logged out.
4. Connected Ethernet to Xbox One and signed on with network connection as Frank. NOTE: gamer tag still showed as "MoltenRhombus35". Found out that Xbox Live automatically assigns a gamer tag when user first signs up profile. The user can change this tag once for free.
5. Changed gamer tag to FrankieXman at 14:29.
6. Created custom avatar for Frank at 14:33.
7. Made Avatar the gamer pic at 14:44.
8. Created Xbox Live Account at 14:49:40. Xbox Live Membership entered "R3D3Y-KBFBX-XF3K4-PP4J6-HP3BD".
9. Went to Microsoft Store/apps and began downloading top 25 most popular applications at 14:50. Ended downloads at 14:59.
10. Accessed Internet Explorer (IE) between 15:00-15:02.
    a. Opened
    b. Accepted default privacy settings
    c. Closed before entering any information
11. Accessed Netflix between 15:07-15:18.
. Signed-in
    a. Accepted new terms of service
    b. Watched the first thing that came up which was "Mr. Peabody & Sherman" for 5 minutes.
12. Accessed YouTube between 15:23-15:42.
    a. Opened
    b. Dismissed the guide
    c. Searched and typed "epic" then selected the auto finish option "Epic Rap Battles of History"
    d. Selected option "ERB"
    e. Played "Romeo and Juliet vs. Bonnie and Clyde Epic Rap Battles of-"
    f. Let ad load and play
    g. Watched video then went back by pressing "O"
    h. Played "Artist vs. TMNT Epic Rap Battles of History Season 3"

i. Went back with O to the search option.
j. Searched “game grumps” and selected “Best of Game Grumps – Jan. 2015”
k. Watched video for 5 minutes.
l. Exited YouTube

13. Accessed Blu-Ray Disk between 3:43-3:43
    a. Opened
    b. Forgot my blue-ray disk. Got an error message reading “We’re having trouble reading this. Make sure it’s a Blu-ray or DVD. If it’s a game, launch it from your games & apps instead. (0x91d70000)”
    c. Exited.
14. Accessed Twitch between 15:45-16:09
    a. Opened
    b. Selected Log-In
    c. Stated to “1) head to http://twitch.tv/activate on a mobile device or computer. 2) On the website, enter the 6-digit code to start broadcasting for free!” 6-digit code is “ECD5D9”.
    d. Went to IE on the Xbox One and followed site
    e. Selected sign-up
    f. Entered “FrankieXman” as user name, “diggs23” as password, 05-17-1987 as birthday, and FrankieXman@yahoo.com for email
    g. Signed up
    h. Entered code
    i. Went back to Twitch and selected “Channels”
    j. Selected “Captain5parklez”
    k. Followed Captain5parklez
    l. Entered chat option for channel and entered “lol”
    m. Exited Channel
    n. Entered channel FACEITTV
    o. Followed FACEITTV
    p. Entered chat option for channel and entered “pizza time”
    q. Exited channel and exited Twitch.
15. Plugged EX1 into Xbox One.
    a. Found at Settings\System\Manage Storage\External 3.7GB
    b. Could not access items on EX1
16. Accessed Xbox Video between 17:28-17:45
    a. Opened
    b. Browsed movies
    c. Added the following to my wish list:
    d. Guardians of the Galaxy
    e. Big Hero 6
    f. Birdman
    g. Dumb and Dumber to
    h. John Wick

i. Warren Miller's Playground
j. Ride: World Elements
k. Lucy
l. The Interview
m. Let's be cops
n. Game of Thrones
o. Inuyasha Season 7
p. Played the movie "Atari: Game Over" for 5 minutes.
q. Exited

17. Accessed Hulu Plus between 17:46-17:55
    a. Opened
    b. Start Your Free Trial
    c. "Please visit www.huluplus.com/xboxone on your computer and sign up with this code to start your 1 week free trial: GDX3M5J".
    d. Went to IE on the Xbox and followed the link.
    e. Pinned IE to home and opened
    f. Start your free week trial
    g. Entered: Frank OX 05-17-1987 frankiexman@yahoo.com diggs23 and continued
    h. Asked for credit card information. Due to not being on fully secure network the researcher decided to skip this and end the interaction with Hulu plus.
    i. Exited IE and Hulu Plus.
18. Accessed Skype between 17:55-19:15
    a. Opened
    b. Join
    c. Agreed to terms and conditions. Skype detected my Xbox profile and created an account with the information I already had attached to the account.
    d. Saw that the account was with frankox2015@outlook.com and the name that pops up for this account is FrankOX.
    e. Added account photo by taking a photo with the Kinect.
    f. Allowed Skype to send notifications to user,
    g. Got started and made a skype call to a bogus created account to Ted Lolly, password: lollieteddy85.
    h. Exited skype.
19. Accessed Media Player
    a. Accidentally accessed when attempting to get USB to work.
    b. Connected EX2 to Xbox One.
    c. Media Player open
    d. Found USB: EX2
    e. No access to this location.
    f. Went to settings/system/manage storage
    g. Did not see EX2.

h. Disconnected EX2, connected to lab computer and put DataSets on EX2 then reconnected to Xbox One.
i. Xbox One could now see EX2 in Media Player.
j. Opened Data Sets and played what Xbox One recognized as music. Files audio1, audio2, and "." played.
k. Went back and hit play all for videos and photos. 6 photo's played (rose, pizzeria, Idaho, bamboo, sunflower, & Stonehenge), 5 videos played (vid1.mp4, vid2.avi, vid3.mov, vid5.mpg, vid6.wmv).
l. When viewing the following items are the only that show in Media Player:
    i. 000_0021
    ii. 09260002
    iii. 100_0183
    iv. 02010026
    v. 100_0018
    vi. 100_0304crop
    vii. Audio1
    viii. Audio2
    ix. Audio4
    x. Vid1
    xi. Vid2
    xii. Vid3
    xiii. Vid5
    xiv. Vid6
m. Media is not giving an option to copy and paste items to Xbox One's hard drive (TC3) or transfer directories. Will have to force data on hard drive when outside the Xbox One. This is outside the scope of this research.
n. Exit.

20. Accessed Amazon Instant Video between 19:16-19:26.
    a. Opened
    b. No thanks, start browsing (not signed in and browsing, did not attempt to make an account)
    c. Watched trailer for Jack Ryan: Shadow Recruit
    d. Watched trailer for The Captive
    e. Watched trailer for Snatch
    f. Exited
21. Accessed Pandora between 19:26-19:37.
    a. Opened
    b. I am new to Pandora
    c. FrankieXman@yahoo.com, diggs23, 1987, 47906
    d. Searched for artist "Childish Gambino" and selected that artist to play.
    e. Liked the song Lights Turned On by Childish Gambino
    f. Went back and searched the artist "Kend" and selected "Kendrick Lemar".
    g. Liked the song Swimming Pool (Drank) (Extended Version) by Kendrick Lemar.

h. Searched for the artist “Girl Talk” and chose that option.
i. Disliked the song “Too Deep” and “Non-Stop Party Now” by Girl Talk
j. Went back and Exited
k. Xbox Music:
l. Opened
m. Selected Playlists
n. Created a new playlist named “This is it”
o. Went to add songs to the playlist by browsing the catalog
p. Played the album “If you’re reading this it’s too late” by Drake. Only played the first song “Legend”
q. Played the album “Birdman (Original Motion Picture Soundtrack)”. Only played the first song Get Ready.
r. Played the album “In the lonely hour” by Sam Smith. Only played the first song Money on My Mind.
s. Played the album “Hail to the King: Deathbat” by Avenged Sevenfold. Only played the first song “AndronikosTheme”
t. Exited.

22. Accessed HBO Go between 19:45-21:17.
    a. Opened
    b. Went to Collections
    c. Selected Kids
    d. Played Scooby Doo the movie but was prompted to activate an account by going to www.hbogo.com/activate and enter the code below: TP927K.
    e. Opened IE and followed site
    f. Activate Device: Xbox One
    g. Signed in
    h. Pin TP927K
    i. Went back to HBO Go and started Scooby Doo The Movie for 5 minutes.
    j. Exited
23. Accessed Uplay between 21:17-21:25.
    a. Opened
    b. Created account with autofill Frank’s info
    c. Selected an avatar for Frank
    d. Accepted terms and policy
    e. Went to games
    f. Selected Child of Light
    g. Went to video’s and played “Child of Light”
    h. Exited Uplay as games have not been played yet
24. Accessed WWE Network between 21:25-21:32.
    a. Opened
    b. Prompted to sign up at wwe.com and create an account but wanted credit card info. Researcher decided not to as it was on an unsecure network.
    c. Exited

25. Accessed Upload Studio between 21:32-21:35.
    a. Opened
    b. Selected to add a new clip
    c. Showed nothing in my box
    d. Need to play games to access more in this. Will return.
    e. Exited.
26. Accessed Halo Channel between 21:36-21:49.
    a. Opened
    b. Selected featured
    c. Selected view episodes
    d. Selected add to queue
    e. Played the first episode "Second Story Seed of Honor".
    f. Added Red vs. Blue Season 12 to Queue and played first episode.
    g. Exited.
27. Accessed EA Access Hub between 21:49-21:59
    a. Opened
    b. Connected to server
    c. Auto completed with Frank's profile info and had me create a password for the account: Digital!3. User name FrankieXman. Favorite pet: bird
    d. All items in this app require purchase, exited.
28. Accessed Crunchyroll between 22:00-22:15.
    a. Opened
    b. Played first video option to come up with Ads (no trial): Episode 1 Testimiate of sister new devil.
    c. Played 5 minutes of Yona of the Dawn.
    d. Exited.
29. Accessed Vudu Movies & TV between 22:16-22:18.
    a. Opened
    b. Chose to create account
    c. Entered email address
    d. Accepted terms
    e. Signed in.
    f. Browsed Most Watched
    g. Everything required purchase. Exited
30. Accessed Forza Hub between 22:19-22:27.
    a. Opened
    b. Selected News
    c. Selected Weekly Summary
    d. Watched video "My New Ferrari" and "Dubai Police Fleet"
    e. Exited
31. Accessed ESPN between 22:27-22:35.
    a. When opening ESPN app got the Achievement "Off the Bench"
    b. Went to most recent news and went to NHL
    c. Watched the video "Predators Rout Sharks"

    d. Watched the video “Panthers Edge Maple Leafs”
    e. Exited
32. Accessed MLG TV between 22:35-22:43.
    a. Opened
    b. Watched live video from “KYRSP33DY” for 2 minutes.
    c. Watched live video from “jahova” for 2 minutes.
    d. Exited
33. Accessed Plex between 22:43-22:47.
    a. Opened
    b. Prompted to sign in
    c. Signed in with FrankieXman, Digital!
    d. Need to purchase Plex Pass.
    e. Exited.
34. Accessed Audio CD Player 22:47-22:47.
    a. Opened
    b. Exited
35. Accessed Crackle between 22:48-22:59.
    a. Opened
    b. Went to featured
    c. Pinned The Throwaways to home and attempted to play but image would not come through, only audio.
    d. Pinned Hot Fuzz to home and watched 5 minutes of movie.
    e. Exited
36. Accidentally turned off system at 23:00, immediately turned back on.
    a. Turned off system again at 23:01.
    b. Turned back on at 23:11.
37. Put in Inglorious Bastards DVD and played for 10 minutes.
    a. Tried manual cd eject but wouldn’t work
    b. Put Xbox One’s case top back on and attached ribbon. Got DVD out with touch eject button.
38. Put in Ryze and started install and update
39. Started game with 11% done at 23:42.
    a. Started a new timeline as a recruit
    b. Started another install
    c. Stopped Ryze at 24:34am
40. Started Forza at 24:35am
    a. Started a new game as a single player.
    b. Played through introduction race.
    c. Selected local multiplayer (not networked multiplayer) and raced two courses.
    d. Stopped Forza.
41. Turned off Xbox One.

Appendix I. Test Case 3 (TC3) Imaging

Date: Monday February 19th, 2015 beginning at 1:50 am
Examiner: Caitlin Gravel
Location: Purdue University Knoy Lab 228
Computer: CFLWIN15

- Windows 7 sp1 64-bit
- 8GB RAM
- Intel Core i5-2400S CPU @ 2.50GHz
- domain cit.lcl
- Time Zone Set: (UTS-05:00) Indiana (East) date set to Wednesday February 19th, 2015

Xbox One TC3 Hard Drive: (TC3)

- Manufacturer: Seagate
- Model: ST500VT000
- S/N: W3PA4MEL
- P/N: 1DK142-120
- FW: 0001MBC1
- Size: 500GB
- Physical: SATA 2.5”
- CHS and LBA not listed

External Hard Drive: (EX1)

- Manufacturer: Western Digital
- Model: N3565A
- S/N: WXF1A7221875
- P/N: WDBY8L0020BBK-01
- Size: 2TB

Tools:

- Windows Explorer
- Disk Manager (Logical Disk Manager)
- FTK Imager 3.1.4.6
- Tableau Firewire 800 + USB 2.0 SATA Bridge

Steps of the Process:

1. Took Xbox One apart to access the hard drive just as when accessing TC1 & TC2.
2. Connected TC3 drive to tools and turned on at 1:50 am. Note once again when the write blocker was turned on messages popped up for all 5 partitions: "You need to format the disk in drive (I:, J:, K:, L:, M:) before you can use it." Canceled format to all.
3. Once again attempted to write on each of the volumes but Windows Explorer would not even let me access the partitions to TC3 stating "(I:, J:, K:, L:, M:) is not accessible. The media is write protected".
4. Accessed disk management and again found TC3 listed as "Disk 3 Basic 465.76GB Read Only" with 5 partitions in use and unallocated space, the partitions did not have any names, and the reported file system was still listed as "RAW":

Table 0.1 TC3 Partitions

Name	Size	Partition Type	Reported File System
(J:)	41GB	Primary	RAW
(I:)	365GB	Primary	RAW
(K:)	40GB	Primary	RAW
(L:)	12GB	Primary	RAW
(M:)	7GB	Primary	RAW
-	779MB	-	-

5. Proceeded to create the TC3 image.
6. Opened FTK Imager 3.1.4.6
    a. Create Disk Image
    b. Physical Drive
    c. \\.\PHYSICALDRIVE3 - ST500VT0 00-1DK142 USB Device [500GB USB] → Finish → Add
    d. Raw (dd)
    e. Skipped case info entry
    f. Named image "TC3_2-19-15.001" and saved it on external hard drive EX1. Also changed Image Fragment Size to 0 so the image would not be broken up.
    g. Left "Verify images after they are created checked".
    h. Began imaging at 1:54:24 am, ended at 10:16:40
        i. MD5 checksum: e5ba73896e6698fcfe90e2f29b35d01f
        ii. SHA1 checksum: 9daf045689c847e6f4f432571b8f238628946945
        iii. Sector Count: 976773168
        iv. Source data size: 476940 MB
        v. Cylinders: 60,801
        vi. Tracks per Cylinder: 255
        vii. Sectors per Track: 63

viii. Bytes per Sector: 512

7. Disconnected TC3 and reconnected to Xbox One. Put all equipment back where found and left lab.

Appendix J. Test Case 3 (TC3) Analysis

Image File: TC3_2-19-15.001

MD5 checksum: d77a90737303fccaf9ca2acb8143351e

SHA1 checksum: 55cdba10adc62b20941136f011043c33e55a5afe

Cylinders: 60,801

Tracks per Cylinder: 255

Sectors per Track: 63

Bytes per Sector: 512

Sector Count: 976,773,168

Drive Model: ST500VT0 00-1DK142 USB Device

Drive Serial Number: W3PA4MEL

Software:

Windows Explorer

FTK Imager 3.1.4.6

Autopsy 3.1.1

Total file count: 3869 (810 less than TC2)

185 total unique file hashes

Table 0.1 TC3 Unique Hash List

MD5	SHA1	Amt.
0546597403c3844850c60ae78cd5edb4	20b2955bffc2c19c1ec3afe82aa3d76c43c9d306	1
06319cc3693aa9b16d94dd60e0b4e168	f73121ca022fc7cf72e56ae4f4fc822f06c99a03	1
0796567f38c0d7fa2d402ed9ac575b10	09a54e30f4f850d4765c6e08e4ce20e6fe552148	1
080386bcb0c58c0bf1618d2d7ffc7525	35b398213c6b4bd9550594b6f6e18ccc463fe992	1
0805bc6281e0c28ae12b37bad0cbb627	ec1e1d62f25e8b410c4d47008ee9ff400e8e704b	2
0cb1099ee088093a5cbb4c8cc0fd1556	95693181a5792da022a4f151ca40d3399a03cfd9	1
122dd294e44b50559f1769a877c8e753	d35553f49273d92e28fef92988de61d53f8ea2b7	1
136684549d26b21ccf81729d43e897d1	9e12f64d5c4fbac507729570275c6b52a2c2efac	1
166fc4b9722b8047b707e7c646c76a75	49101f0816a6c17fd5863e77c9bdcbe2fa77cd02	1
183fd4099b5aa63e9bbccbcc3bcfb303	8391f29df80eaf3c0fcce8b4ce8a73e8d904f646	1
18f40283e94415cae928d4216654f653	ddfbf2c59cc1c1a559f1156c749fac0c4b5ae23e	1
1cdaefd37fc83464b29aafbc7f754916	c0eb1fea4495c8c49647c582c9ba65ab4d7e0908	1
1ce79b10ed92aa06c8fbd605f8b83ecc	506d6e02dec736fbefbe5707c8a1df0edf8d3e0b	1
1d748d6235553d44a2c2903812abdc06	f222502bf4d54cfb1019fe45f343582478b0aa4b	1

Table J.1 (Continued)

MD5	SHA1	Amt.
1e361430258da7f9d2553293e3ac723b	78445fc491d8e23b3812f3d6a26f7af986abbde4	1
1fa02b90bcb02ce56e22a0805ec9fd2a	c96b8167d3ce937aa5ba47b077f16df96a40f0dd	1
1ffb17510d3c389d8963bb3fbcae740f	68d9121caa09e9f314f1f1630e128a6e5ba9794f	1
209c81a16cccb6936901ea78ee530571	e9b0d7d775be88ef07eef03aa520a063652d2d4a	1
20d718307730690062ee6b7281ae5742	263d69259efd2b5cbf9b48b12b3515a8781378da	1
23b5793757b5db5d26744a56ffa1e3f1	6034b085137733020818a543819567d5c10a71ed	1
2b65b29b4133274492e247726071b35b	392088180a0337da6dace7a093558f25e4e2baee	1
2cfcac52c1bab63906b5fe86d94861f7	dae30fc275ea3c835d97b5e992e627b7cddad993	1
2e1459c0273ade852dbf7369172b1dd8	158af0658367584c4bd64e5fa4c933fa92fef472	1
2f282b84e7e608d5852449ed940bfc51	2c2ceccb5ec5574f791d45b63c940cff20550f9a	3587
2f550fa2e03eccfed53223fe5ce2f3b6	952a0bb80cc6cf0140839c97c599d87ff32fa757	1
2f8b78c0afa0dd910042ce51ddfc27fd	4d9c0089b59ce4087d223b99f5c33a168064e230	1
30f3fb693759b623bd468523068db4b5	ef75b37d170403700369ac0afee53ea4ab442dd1	1
314e60c4b98c4a0f95caaec6685fdd59	62af8cae07a27699888dbd533eb4ded5a741cd8a	1
352340aaa26350f176f67ebed22e9468	7f6c65c3912ef60ce211f631c83d9f08c8358821	1
358afb2be5387086a1be7da04a6150db	2374bff0efa8fbe322c5e0e29f657848704e1665	1
36d7c154f7bcd854cfdc26174406b848	9e8710c92f79e64fe0535db1af7bdfcbf6e44384	2
397e01f35a5c162a600b16b6cb8f25b8	cae2d2eea396f3137bb209f31adabf2e7a65276c	1
3b9d715e82946b3f6545dc9ce8bbe517	8081c1e6cf361d07f8bb28fa5a7dd1cc785d1928	1
3c8197cf20e7f199f9a24a6b785c1604	231b46bb6b9fa81cff0fc94ef06e5d04854cbbcd	1
3dae037a4cdcb10684501b6d31d65a20	106aa5f2158c5f50f80b9e52639755dca3d74606	1
3f35779fca79720f75f00b9f5b6bde03	e1f210de9519ccd71fcd276f48fce7ace88c43e4	1
3f8d746a91e101f887a8e2984026e2aa	72fd9d960ff0eeb834c370d18b38db092de67f8d	1
41d1de316a765c3804e63b0d82ddfb2d	4d29dfd1b2051af06bffec4eaf5f78d50bfb0123	1
464379cc355b512c78788d323b87ff25	62f7398b85d58478548f981b64eb4cb486e8de10	1
4721c82200624f82a4ae426e092454f6	bad8eefbabeb355161c1590a7346a2a9a45b8a1e	1
4781df8adc61e16eb4adcb0301749613	db4d5476c3b2d2aadd0b0d6e3296c547f1653c03	1
48784b65e7c932baff5b5693d84466cd	6c76c02acfc449a5b3f439fc9e1d5939dc1cc62a	1
4942faa946adef562b39d12b1534c9c3	9adb291f7c039284fb376687d3e47166d08b9cf8	1
49caba25f2de87b7917392b8c63aec4c	edfa5c8dd12148ef633fd43626542e2ab97974ad	1
4af824a16fee99ab67b1b47f94353aa2	10d7d4ce1949371201d2e6ad52b5fc1af4ea2c47	1
4d1b61ea5d69d4bfdd53b814820c2fca	02ea96b7fa6e871e8bbf9e14afa178a335daef47	1
4d390d4862e880154aed02df9432d80f	152666e40fe49c73a9fb0cfefffe0b9890426688	1
4eb7f4984baa00a80d0123b181822a1b	1bf1049727ff1e52bba9aafb104231198c9dd05c	1
5191ab5a6ddf692f24e137ccd2634328	6aa5dc83d799f863b5477ebfa1fb22805ba5cd05	1
51f03672d2152c11f0ff3f399e272922	abb5dcb132358e0df5add93887379562af7e44a9	10
5315235fc500ab10521f0d92610ee4d5	e7d97834ba9210dba17de4886d857be22d6e4adf	1
586ad722b35e66ec9508cbdd054d82c9	43b7dc9f0c1fe1db9aea932e3133a1b5b962e06e	1
5a48c2eb9fbd45d420b5a794c5672de5	e48bad554ae6ff5f07b644f36143334cf593705b	2
5abd611446f9e8e9c2fe6baab91e3df2	cb7aca18264b724f8a9490460f29ae6c3635387f	1
5c5d38f6d2a7d5af20d6cbaa3acf3060	9afc1b7acc9053d7a28ee1c62fe34388925eada7	1
5e58d6d766454f2e7aa304f26bcda97e	89065f45d646f24accc77dc707f75b2cc4bf2ff5	1
62244af3c96842f764ecc9cbbfed5417	490c5f83df1eb0372f8f1bc4275a38282e482c55	1
656d004649be5160508a3f9eb78386ec	75cc5015cff3bb930fdc0d5b8061ed750e7db5ac	1
675055b71fead63af48c389190eed3d6	4d6e3e14315a80a241a1a309104376d3385346c3	1
687985620e9bcea4865953c79eed183b	5f9e7f0675605a5d58751d960c2f541354eb4e14	1

Table J.1 (Continued)

MD5	SHA1	Amt.
68fec310b994f254701a4d6b26537ee6	56581b457040db04171b53183075b09e3bfaa1c2	1
693bd78f0b3f7ab6806cd39d49f1e148	06460da63d4ab717686eaf3ea2e07c70a5c0e004	1
6947a1ff3354a1b6aafe118924abc6ac	a69c5e8878d3a2cdc22e3951363513a2303ce3a2	1
69767357bd3136222ad1f274954d7a82	b5309b623ab288157585a530a77d71537af94b87	1
6b66429e970f481027e84fcbef88e38d	ce12bc48154869f192bbf69fc85807a1e7ef5900	1
6bb149afa324ce2b2aabcb2c3a70f6a9	1a888029ca94b4ead7ada483b60bcdb41105c4a7	1
6c20f7343d677aab0e8764d002765c01	5615e0bfd40a2a8c81c4d0073d83b73a9cfaac9b	1
6c768abe7517044afcd418e6c8a18a33	eef231ee80882665317ecbd819703425ca03d3ca	5
6cda3ab3e6c5fa5cd606f07fddfdbeec	046f017bc290a78fde66b6d0f07d53e500f20f92	1
6df25890719229603a4ee00c21adaf07	bc1c7d9fcb5316fab4895456f169c12d0d1e9aaf	1
710a811fb3679f5701a8494b00729106	76f211ba32c2c035d34630d651e0750fd3c233e2	1
7147a7f3dbeee702202e0a74f88f1530	14e5ee5ca6e574077d0ecffcda8597f14e3a3956	1
7165d94359886c0cb0f29504f5c11467	9a8070d17c81d629a3a00a0f3b6cff84204ff944	1
727294268d73a090a3ba58ae2ab672cb	bbf52e9282bf9c8c23a58c8a6bf872f2b76308a9	1
727694f0465e86f739d1b83235c31548	8a41c1d5f5939fcc19331a63556eecd5864b7333	1
73c2bd65ac0e1e73e435937eb181cf60	c35573f2dbd0cd284d2fd5bac26b74309397b66b	1
73d8bd2371cec53d2faf4f036fc65e22	e29b0e7ae8d9ef6e2b2dbe482eb21caadab39929	1
766c36a65e48b9b83a4052210388184c	23c82069eecc5fde6df5da69325408504565792d	1
78df7d13538aa76aca97b8866347ed84	e91e524a5fe21cad756cfc89546a87e87bfa4cfa	2
790742fa73920dbf2f7bcb8a171243a8	5bf7219a9074a2429cb28fed8a746906b74d44c9	1
7c1ec3cf185afb99bbc70925748fae72	d148e882f73707fee834226a09e4e7d191d3403f	1
7cb729cf9ada1fc358b37c0b8b5b7ce7	532aa868f19043ebecf8c9a10899bfa3147e32f9	1
7d68e5880964810a63e0913f0489bbf0	8911ee35b48e176de0cc43bab640f9707f07cc1a	1
7df03c94e79e4dda462dd276eea6fc44	3978be682abd094e8b6e8ffb81f3e5f5a6dd75c0	1
7e85c536816811126fc8f0512561c19e	5ba19850e6505aa6692b1e2c6a3f3b838338b7ea	1
7ff498a44e45e77374cc7c962b1b92f2	5161a18e27b9ca9f5d04f2154576bf1ffb1121e8	5
8010d4683006b5dd7ac2b5ac27ad050d	b0cde380832992aae356a0db713a391dcab6af5d	1
8265922f61653dc1892ccb4d8f701a8e	601f932e417e130edd99b6285196e9bc886ca031	1
8274dc8683724b52651766b2dd089b42	2bb0be460de913213dd2d4668f94917864ccc5a6	1
83a34aa0a3b783fc229b78bd6d48d254	b23f42c5a2ce3ebd396daa1f8416ec502f5c7edf	1
846dd3c05b166896a5af3ea74b3ad680	c0620f2c514dae5433324c4cdbb7b1216f2dfdcd	1
89a87953c8cec4193274f83b92feec44	ca161f0d88cba1a340fb4fc90d6091b9897d9ac5	1
8a31d95f63af54967d42a3b9b5f9a408	1ba3a832bd111adbb48208a86098e00755ea88ea	1
8a7a85db98e91004b149fdcdeed5f054	54218ef7f1b88d6a4996be04037c9ef4b4ff5eb5	1
8ce20ce49936eb3879328968f729e880	3066118919777fdc4f5354618192997c74b0cd43	1
8dff116fa589af347cd0c206cdc2ef27	3aa2a0fdef25ad857501a8a370f0939dc3d49406	1
8e90f3f16cc1fd4ba3f5a4d918181f7b	cab36f1deb571fbc50b3ff939a1f11e1cf158311	1
9127d4b76ccd3ef715576cb478e7d630	7619b5e9095d9edeb627a4d0083df066330a9284	1
91d68cfd6ffeb894d70acb4d211d9dfa	d61087632564b3529e7b841bd98ba23535b4525b	1
95fe8cf0ea7a88154e1523a60280488b	df737753bcd2abf701dd916424eae9294a567d9f	1
9699fdc561f554ac9c0f022834a4dcea	535a22cfcd512fe2eda9e4d9c1d5067bb8fa017d	1
97f9ef13a1aa24f4e5dd226057249ed1	d17a20dd25fc238bbe5547f1c06abd9303d3d60b	1
9a907739909f1e8e9927d1def1231689	794d8725f6d0688f09892aee235fb955f09d6070	1
9e1be64a753cf001a4bc5ce74752346f	1319fcf802798d26b7071ae88716c07207eea150	1
a0923df212bf9a4189cb2a15dc4626af	b04d94dd04f2415edaee5547b1210b7190d0a1aa	1
a0b1512cea6286fdb5db65018849489e	4ace8815abad5d9ef6d840c8beb7d95895d838bf	1

Table J.1 (Continued)

MD5	SHA1	Amt.
a120cf12517ffa1fdbe292ee506d3bed	6aea1ce93700d894c83ca5e6e870baf5c5712e7f	1
a3465c3ba79bd2631da72df1c2a40898	5baa321db97bb9806b7dd2a39dc525b5087d5fc0	1
a42dd0428bc3dd190dd50df6b2a81700	a4ddf8f5854fa5fe1d11a883c0338175c6d9c178	1
a6dcb8041f7a2e9d236527994ff0f3e2	809fafd115128f7126a4c34d80dc5e0214379024	1
a8c6767f5a450c9b49899f287452eefa	c50f8b22094be95fa2fa2ba1887160dfbfe92c5e	1
aa0858eea994d6b99affd94304ac635d	17b9433b504eea95de619a1abcc380d570b90d14	1
ab981967d9f545695c396db3787f8a49	2497adcb05fe54ad8a55c8fd2c145951ea039237	5
acfe8314fd109f0be892bd3fab51e2ed	ebc414d490df3b1ff2c59b57e6ae4daecd5dba27	1
ad617ac3906958de35eacc3d90d31043	b49d7f48300701235231f6b6fc3d92a5630f9e70	5
aee4247a1fe04cd6f7e1501f919e42b4	1bc3d127d5f35fdca4b253699e616ea56035410c	1
af164022602e83c7586afd92c802b2f8	ac5da3f770c5eba43bfdd9f78004f4bb5201c7d0	1
b0d06d53d7d5491acf6a7cda1579b224	c6fc579929187826e4f8896b1a2d4e92b7029f88	1
b4202f7fe985b9648b4676e6f70832bd	d37c2b3927946ed617455b3c5913fcab0bc1af52	5
b48aab0739c6786030ad3b39f4f090e4	4d6ce185f5da7b2456de6e0729c604a32f26fff4	1
bc8617576815910180d1eb604a0bcdd9	474c039e27345412b0d8c871669263e2963592ba	1
bed6ab23b0e4a4f2f903a87afbec4b3b	53f475644e4ca0daeba0c59a18df804da1233310	1
c0d7cca8dfe3966a3023c30ce3cfebda	e2752ae08e2019212def6763ea138bc636466dec	1
c2c244b10d9fc7f6f48ed1ea5cc4999e	1fd09283c4a4681930778b95ce85706eeb7106b9	1
c44f26b77ce61a95a487765916c95a4a	427d4f6596c29338c458b8b03b36032461a39ac6	1
c54d16984503f206bf56f5fa5731f581	4155c198ff821b2dcd026fc4dfd023961fbcccae	1
c62367558e59b7e1249ae427369d102a	ded4c083c88245a37e3b38395ae0f0814fcc7ece	1
c6f32cdb0612efaa422911f3be9dca6a	4e07f85ed718a42a4f02dce5cc714782b88085fc	1
c8c158b10df60d2a147053985127e766	8f9fc5bc71c58a71ecc3de28876c9d7746dbfa00	1
c9616c056c5247a7f4a821fd2a255ae6	730e6ab9859af48b7619c6f57d1d558329eeacbd	1
cfcd208495d565ef66e7dff9f98764da	b6589fc6ab0dc82cf12099d1c2d40ab994e8410c	1
d0a8194a9b11f8d89d073016c06e76d3	ee9b733edb8928458ebe97becdacbec48f5c2a24	1
d0d75577042a8848c13860450e0adbeb	a240a99aa21a2ad44f0ffc01a2e8532db2fd50eb	1
d0e8abd769fa4d66b7a622e8d0c0fb49	4aa0bfa399fdd31d09731ba3f534b4e382f16246	1
d2389a74d9784cc5aeaca86f6ce50993	623c0330e86dd7ce07dc20665d6e225cc514f362	1
d3c35273db55dcda916db3b3f3a998d9	8fe086fd8fc2bda28b304cc38ccddfa55819e98d	1
d3de3450bf82a8fd46074c0e07ae381b	662c0e8b7e38d81aea51f4fdbb564cb0a54c02af	1
d41d8cd98f00b204e9800998ecf8427e	da39a3ee5e6b4b0d3255bfef95601890afd80709	20
d44cac632ed017fd40c4e89695c5d325	7a8373fd2f4eebae30fbbf12d01d2a0024f97690	1
d5e4ed7d12bd084e0bf64c8fc7dac6eb	1f6c528e66b5b5ba4bb6be01489e0e5959b6b55d	1
d730c03e674f79d3d5aef7a344c26a8e	fdb8a6b397bb6369d8eb3c7dac47c7cebb67b2a3	1
d7c438a0f84fe20d98c289909f7178b8	3501313d66cc7f58567c0f8e4122104e33cd00c8	1
d9df5b2e2927a94735c6c1c3112a9a5d	0fe35373c0020995623ed3f7372d15d4d7d2eb86	1
da9c64d014ca514e7d8c68eadd9bda99	02551c45074e8453453ea9d707d4e97beedae6d2	1
dbbe162825e7b9e58e37c8c46ebb7052	8b6e8619958d19f97051c05bdcd5231b176df283	1
dc2784e32e79706ac09df198ec8835ed	52b6a6caf32bfbb061436b7e710a5cc4625e5d9a	1
dcce2ae90ee1b34b167bb065e4a108b5	912e524cdaa8e8f5caad76cbb76e8044b1587583	1
deb5c30cf4e8a2bfab38992264b1756c	51106b2af57081242ab2c27dcc547e3c9b378630	4
e17053b5f91c937302cde3cc045be980	088f06ae0d12fa6b6217d34b5286a1a89a3e9814	1
e2da72071b15025127156f3ce6e5cca7	b47ae4e38370d4d0a40ce73cfb507168344c5f23	1
e2fbc3860bc16fbf97ab6ae86b9ae8b4	aed9ea7953f2a5b1a20d8404b81a3ab8c179f502	1
e483b2c4ea0785e6fa71d13ba94a355c	538f135525d166ff160804bf87d3eed6f2784e17	1

Table J.1 (Continued)

MD5	SHA1	Amt.
e52b61ca908384e86c52a40085ef55fa	53e6337a086a96fb37f11be84ada1c39e0807e67	1
e7301356d96583bbd713667c56ca6f82	1559df29b3625ac3c687f5160e57874f8125fd12	1
e81ecc08fd743d071619f226cb9715c8	3a7df03a12853503a0212379cc4e1f17c87c978c	4
e86ad85283c81dfa99acf8e7e47c0a0c	0361e246ea05cefd4b0ae4bd8c1dfa6db82ae4b7	1
e94f97f8f0d4dfbc11c487c98b88f58d	4c17d3a67e6c384f8d7259b7562d2687f8e2db0f	1
ea2204d97754ecb4c29af5d7bfab61aa	142b9773b70b27a692c75022c79aad8659cebee8	1
eb349055b5eac7c0503ecf711f6fbca3	fd04c3376f10a1a0b628d9ad163b9d263e014a3e	1
eb8cbf7032a6ab9c73afb496fda8747a	3f89cbf9bfcfd0c6315f58553aeb28816453df16	1
ec7af7386bc25fda768a7853aa6dcd3f	f2ccba3fc871d710037d9ec3262a6896052d230e	1
edcd503951b8676ec401a3df89ee4df0	606fcae96a65dd92ee44e32aeb0090f8174a230e	1
f03a632623bfcec005f1ba26d3375937	88aa3948648bca5765d208d4c604d3e604f3e851	1
f086fd72ba16681a0c620eb80b133ee0	decd0cf818111492a29bd96ddd4f2a9c6eb2c1b6	1
f0a55a130ea18ec612878aba617efe84	f948b56ea7d60cec4873baa03a26ec69c5014970	1
f21164d554d650a831f01018068e7897	d9373f41e92744f409db8bda525f4b803a70773c	1
f4152b0992dbb28a19e4447ef6a7b195	67dffc8090b19b96e86c6486402b3f8a38792c18	1
f43ff879d89093f96dde472cf0b1f426	336a3c9b4d2de88d6d6e17f7b9674c282b98417b	1
f4d2127084a2277d9b0911714111849c	e745a76dedd998715f7197f697afca681de8a8d6	1
f572a951486b04ee032d32955b8f8cda	75874124d575bf0e4fedafd8b566580efae4c5ed	1
f6a1dc7578a99f4bffd97861d2b35889	b7da46b3cf71e7c35bf55915a8ed34dcb9311c4f	1
f77eb69c26e1f279329bf19c735d116c	872517d323ea780c61153239bea1c35caefc756c	1
f9228f09ce436260fc4f282025c88502	03391334922e38eeb3e53b439bde34582669b412	1
fa70b0482ca9f558affc52d8576cd62e	7efb058f0a9ce9a52e71869a2dc78dbd68230061	1
fa9cdbd6c7bb38a9b8c1c7112447509e	c7ee21b6d8b7107c8d69edfd021c3258d162bd4f	1
fb4a1dad2dcf9a38e84a0c38c642357a	bae9f94196b7d2d539dbf3351e10b20dbc3b6069	1
fbbf311ade5c8fbffbf83c7e5d4cc0b1	3ad5e14379a8ec6a75b1e4e0151626c81deeaf27	1
fc061ed3c383dbf3ca9e765df335583b	077de28c9df4d71933d201421dcf25db641b2a88	1
fc3e8322d0bb5d1dc5f643dea86ab359	e0c0134b207dce519bbe5213fea176d90dae898a	5
fc3f8cfe7e7ad49317311d4aed65b921	ad0bb72a68d29f9e8844f4d77008f9137aef6c08	1
fde1cd7e515b4ac2aca92db1e930505a	750b7f20784406f841902adae144c935224fa223	1
fe21fcce87647dc359f6576442baa1ee	f13cb031619967aed398e53c9bbb7300f0717a6f	1
fe8fc85a9efbcede081436cf65efcd6c	61ba65ee69f765507f9339b5bafd8de5e52e358e	1
fece24feb630ae23b9171380c3116685	ac0625c334905c8a543f3b4e0aa31438a1c22f04	1
ffb14422313e7ad74aad8a79cb239191	9f95284746d2fa7c79793a8166455edd793e753b	1

Compared TC2 hash lists to TC3 hash lists. NOTE: No changes to the Protected MBR, Primary GPT Header, or the Primary Partition Entry Array.

Table 0.2 TC3 Changed Locations

#	Changed Location
1	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$Bitmap
2	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$I30
3	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$LogFile
4	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$MFT
5	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\$sosrst.xvd
6	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\appswapfile.xvd
7	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\AppTempStorage
8	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\AppUserStorage
9	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\ConnectedStorage-retail
10	Temp Content (1) [41984MB]\Temp Content [NTFS]\[root]\GDVRIndex.xvd
11	User Content (2) [373760MB]\User Content [NTFS]\[root]\$Bitmap
12	User Content (2) [373760MB]\User Content [NTFS]\[root]\$I30
13	User Content (2) [373760MB]\User Content [NTFS]\[root]\$LogFile
14	User Content (2) [373760MB]\User Content [NTFS]\[root]\$MFT
15	System Support (3) [40960MB]\System Support [NTFS]\[root]\$Bitmap
16	System Support (3) [40960MB]\System Support [NTFS]\[root]\$I30
17	System Support (3) [40960MB]\System Support [NTFS]\[root]\$LogFile
18	System Support (3) [40960MB]\System Support [NTFS]\[root]\$MFT
19	System Support (3) [40960MB]\System Support [NTFS]\[root]\cms.xvd
20	System Support (3) [40960MB]\System Support [NTFS]\[root]\controllers\cache0.cfg
21	System Support (3) [40960MB]\System Support [NTFS]\[root]\DataCollectionUploader_0
22	System Update (4) [12288MB]\System Update [NTFS]\[root]\$I30
23	System Update (4) [12288MB]\System Update [NTFS]\[root]\$LogFile
24	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$I30
25	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$LogFile

Table 0.3 TC3 Added Locations

#	Added Location
1	Temp Content (1)\Temp Content [NTFS]\[root]\temp01
2	Temp Content (1)\Temp Content [NTFS]\[root]\temp00
3	User Content (2)\User Content [NTFS]\[root]\F706F390-A956-4C2C-8D4B-67196C3A2C92
4	User Content (2)\User Content [NTFS]\[root]\F3DBA358-AC97-4882-8E4E-8219FAE8FF1B
5	User Content (2)\User Content [NTFS]\[root]\478C0B29-148A-4814-AA63-3D759ED4A459
6	User Content (2)\User Content [NTFS]\[root]\F1C16E8E-594A-4282-B5B4-4E3EF93AC8F4
7	User Content (2)\User Content [NTFS]\[root]\5516852A-9F51-453C-84AC-A2B02F5023A2
8	User Content (2)\User Content [NTFS]\[root]\7F1327EB-FA14-4A27-B72A-FDF3393DBB5E
9	User Content (2)\User Content [NTFS]\[root]\466E2035-64EF-47D8-A7B7-DC8EE810DB64
10	User Content (2)\User Content [NTFS]\[root]\79BB07B5-F533-4E6E-AC74-94595DB47CF9
11	User Content (2)\User Content [NTFS]\[root]\116AE68B-3CEE-462C-AF8A-57D5525AA40E
12	User Content (2)\User Content [NTFS]\[root]\E07277CC-7AFF-4F81-9990-5EDF0F7B073D
13	User Content (2)\User Content [NTFS]\[root]\F5022706-83BB-4AC2-B425-4FBA4D78D82D
14	User Content (2)\User Content [NTFS]\[root]\12F8A6D0-CB0B-4860-981B-D546278985F2
15	User Content (2)\User Content [NTFS]\[root]\265C6BAD-C47C-4A63-A192-5818037FAC97
16	User Content (2)\User Content [NTFS]\[root]\47EDE6D3-AF95-4B45-904A-228E39EEAB3D
17	User Content (2)\User Content [NTFS]\[root]\068D245A-11BC-479B-8769-033BEB60208D
18	User Content (2)\User Content [NTFS]\[root]\4431298F-71B0-4FA0-9566-A981A2B6AE45
19	User Content (2)\User Content [NTFS]\[root]\B72D5AA7-6941-472A-8A5C-8BACE4D0B6DF
20	User Content (2)\User Content [NTFS]\[root]\F33D08D8-73E9-4897-9BBF-8736A32E34D9
21	User Content (2)\User Content [NTFS]\[root]\02BBDA9B-E4D2-400A-BA6E-84E7DEA4F2BE

Table J.3 (Continued)

#	Added Location
22	User Content (2)\User Content [NTFS]\[root]\05D64F3E-9E29-47CE-A23C-4E86F2AFB09A
23	User Content (2)\User Content [NTFS]\[root]\242BF9CE-DA7C-4872-805E-E873ADB32C07
24	User Content (2)\User Content [NTFS]\[root]\0EE0F048-4608-4CB4-AC16-BD285CB6A3B0
25	User Content (2)\User Content [NTFS]\[root]\B0655109-C128-4519-9E36-0D370809CD0E
26	User Content (2)\User Content [NTFS]\[root]\D0134385-33C0-4382-BE31-58C4CF4F453E
27	User Content (2)\User Content [NTFS]\[root]\AppSpecificStorageXvd1
28	User Content (2)\User Content [NTFS]\[root]\72354F8E-9A35-4148-811D-0E36CA95C64C
29	User Content (2)\User Content [NTFS]\[root]\13096BD0-8237-47FA-80BE-29A3563CF0BF
30	User Content (2)\User Content [NTFS]\[root]\FB4C8FF5-ED19-48FE-A462-851A076663C0
31	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00687733
32	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00713333
33	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00738933
34	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00763133
35	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00788733
36	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00882170
37	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00907770
38	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00923541
39	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00924068
40	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00926186
41	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\02032935
42	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\02111483

Table J.3 (Continued)

#	Added Location
43	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\03831553
44	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\09699303
45	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\47840587
46	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\95662081
47	System Support (3)\System Support [NTFS]\[root]\F706F390-A956-4C2C-8D4B-67196C3A2C92.xvi
48	System Support (3)\System Support [NTFS]\[root]\esram.bin
49	System Support (3)\System Support [NTFS]\[root]\F3DBA358-AC97-4882-8E4E-8219FAE8FF1B.xvi
50	System Support (3)\System Support [NTFS]\[root]\478C0B29-148A-4814-AA63-3D759ED4A459.xvi
51	System Support (3)\System Support [NTFS]\[root]\F1C16E8E-594A-4282-B5B4-4E3EF93AC8F4.xvi
52	System Support (3)\System Support [NTFS]\[root]\5516852A-9F51-453C-84AC-A2B02F5023A2.xvi
53	System Support (3)\System Support [NTFS]\[root]\7F1327EB-FA14-4A27-B72A-FDF3393DBB5E.xvi
54	System Support (3)\System Support [NTFS]\[root]\466E2035-64EF-47D8-A7B7-DC8EE810DB64.xvi
55	System Support (3)\System Support [NTFS]\[root]\79BB07B5-F533-4E6E-AC74-94595DB47CF9.xvi
56	System Support (3)\System Support [NTFS]\[root]\116AE68B-3CEE-462C-AF8A-57D5525AA40E.xvi
57	System Support (3)\System Support [NTFS]\[root]\E07277CC-7AFF-4F81-9990-5EDF0F7B073D.xvi
58	System Support (3)\System Support [NTFS]\[root]\F5022706-83BB-4AC2-B425-4FBA4D78D82D.xvi
59	System Support (3)\System Support [NTFS]\[root]\12F8A6D0-CB0B-4860-981B-D546278985F2.xvi
60	System Support (3)\System Support [NTFS]\[root]\265C6BAD-C47C-4A63-A192-5818037FAC97.xvi
61	System Support (3)\System Support [NTFS]\[root]\47EDE6D3-AF95-4B45-904A-228E39EEAB3D.xvi
62	System Support (3)\System Support [NTFS]\[root]\068D245A-11BC-479B-8769-033BEB60208D.xvi
63	System Support (3)\System Support [NTFS]\[root]\4431298F-71B0-4FA0-9566-A981A2B6AE45.xvi

Table J.3 (Continued)

#	Added Location
64	System Support (3)\System Support [NTFS]\[root]\B72D5AA7-6941-472A-8A5C-8BACE4D0B6DF.xvi
65	System Support (3)\System Support [NTFS]\[root]\F33D08D8-73E9-4897-9BBF-8736A32E34D9.xvi
66	System Support (3)\System Support [NTFS]\[root]\02BBDA9B-E4D2-400A-BA6E-84E7DEA4F2BE.xvi
67	System Support (3)\System Support [NTFS]\[root]\05D64F3E-9E29-47CE-A23C-4E86F2AFB09A.xvi
68	System Support (3)\System Support [NTFS]\[root]\242BF9CE-DA7C-4872-805E-E873ADB32C07.xvi
69	System Support (3)\System Support [NTFS]\[root]\0EE0F048-4608-4CB4-AC16-BD285CB6A3B0.xvi
70	System Support (3)\System Support [NTFS]\[root]\B0655109-C128-4519-9E36-0D370809CD0E.xvi
71	System Support (3)\System Support [NTFS]\[root]\D0134385-33C0-4382-BE31-58C4CF4F453E.xvi
72	System Support (3)\System Support [NTFS]\[root]\72354F8E-9A35-4148-811D-0E36CA95C64C.xvi
73	System Support (3)\System Support [NTFS]\[root]\13096BD0-8237-47FA-80BE-29A3563CF0BF.xvi
74	System Support (3)\System Support [NTFS]\[root]\FB4C8FF5-ED19-48FE-A462-851A076663C0.xvi
75	System Support (3)\System Support [NTFS]\[root]\controllers\cache1.cfg
76	System Update (4) [12288MB]\System Update [NTFS]\[root]\$I30
77	System Update (4) [12288MB]\System Update [NTFS]\[root]\$LogFile
78	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$I30
79	System Update 2 (5) [7168MB]\System Update 2 [NTFS]\[root]\$LogFile
+	Overabundance of numbered clusters in Unpartitioned Space

Table 0.4 TC3 Removed Locations

#	Removed Location
1	Temp Content (1)\Temp Content [NTFS]\[root]\qzfwSy
2	User Content (2)\User Content [NTFS]\[orphan]\
3	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\1smcbl_gb_dev.bin
4	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\1smcbl_gb_rtlA.bin
5	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\1smcbl_gb_rtlB.bin
6	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootanim.dat
7	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootkbe.green.bin
8	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootkbmse.green.bin
9	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootkbsse.green.bin
10	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootmbe.green.bin
11	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootmbmse.green.bin
12	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\bootmbsse.green.bin
13	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\ExtHost.green.xvd
14	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\Header_a.bin
15	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\Header_b.bin
16	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_113_dev.mng
17	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_113_rtlA.mng
18	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_113_rtlB.mng
19	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_123_dev.mng
20	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_124_dev.mng
21	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\smcfw_124_rtlB.mng
22	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\SystemAux.green.xvd
23	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\SystemExt.green.xvd
24	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\Template.green.xvd
25	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\Template2.green.xvd
26	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\update.ini
27	User Content (2) [373760MB]\User Content [NTFS]\[orphan]\XosInitExt.green.xvd
28	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00079843
29	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00105443
30	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00131043
31	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00156643
32	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00182243
33	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00207843
34	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00233443
35	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00259043
36	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00284643
37	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00310243
38	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00335843
39	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00361443
40	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00387043
41	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00412643
42	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00438243
43	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00463843
44	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00489443

Table J.4 (Continued)

#	Removed Location
45	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00515043
46	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00540643
47	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\00566243
48	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\47823843
49	User Content (2) [373760MB]\User Content [NTFS]\[unallocated space]\95662080
+	Overabundance of numbered clusters in Unpartitioned Space

Appendix K. Digital Storage Devices Used

Xbox One Hard Drive:
- Manufacturer: Seagate
- Model: ST500VT000
- S/N: W3PA4MEL
- P/N: 1DK142-120
- FW: 0001MBC1
- Size: 500GB
- Physical: SATA 2.5”
- CHS and LBA not listed

Image Storage:
- EX1:
  - Manufacturer: Western Digital
  - Model: 1213B
  - S/N: WXF1A7221875
  - P/N: WDBY8L0020BBK-01
  - Size: 2TB
- EXLibrary:
  - Manufacturer: Western Digital
  - Model: 2515B
  - S/N: WX41AB415L4A
  - P/N: WDBMWV0020BBK-04
  - Size: 2TB

File Transfer:
- EX2:
  - Manufacturer: SanDisk
  - Model: Cruzer
  - S/N: NG04G2308005789DMI
  - Size: 4GB
- EX3:
  - Manufacturer: Western Digital
  - Model: 0515B
  - S/N: WX21e54mz410
  - P/N: WDBZFP0010BBK-94
  - Size: 1TB

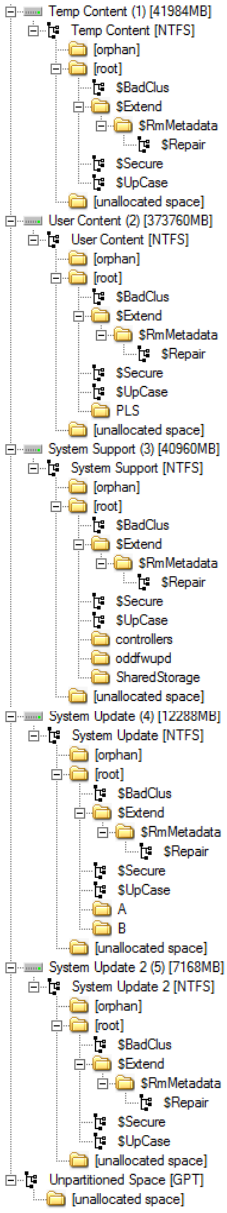
Appendix L. Test Case Image Hashes

Table 0.1 Test Case Image Hashes

Test Case	MD5	SHA1
TC1	f6518a28cd6d9325a1c9e1153d54d5ef	f675c832b865158760b2cf7ef11dee546a01cbd3
TC2	e5ba73896e6698fcfe90e2f29b35d01f	9daf045689c847e6f4f432571b8f238628946945
TC3	d77a90737303fccaf9ca2acb8143351e	55cdba10adc62b20941136f011043c33e55a5afe

Appendix M. Xbox One Directory Tree

Figure 0.1 Xbox One Directory Tree.



NOTE: The "[orphan]" folder in each partition is not an actual folder located within the Xbox One directory, FTK Imager creates the folder as to show items that have no parent directory.