

Lecture 30: Mounting Targeted Attacks for Cyber Espionage with Trojans and Social Engineering

Lecture Notes on “Computer and Network Security”

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10:13pm

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Goals:

- Phishing and spear phishing attacks
- Can a well-engineered network be broken into?
- Socially engineered email lures
- Trojans and surveillance software tools (R.A.T, R.C.S, etc.)
- Cyber espionage
- Exploiting browser vulnerabilities

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30.1 SPEAR PHISHING ATTACKS THROUGH EMAIL

- As was mentioned previously in Section 17.10 of Lecture 17, the goal of a general phishing attack is to steal sensitive personal information (such as credit-card and banking information) from computers. Such attacks are also aimed at getting people to reveal their usernames and passwords.
- Spam email is a commonly used medium for launching general phishing attacks. Examples of such spam include messages that *appear* to be from your bank, from an e-commerce site, from your email service provider, etc. **These messages look deceptively real — including what *you see* for the URLs in the body of the messages.** However, under the hood, these URLs point to malicious websites that are frequently located in countries with questionable law enforcement.
- As **an example of phishing** that we commonly see at Purdue, the students and staff at Purdue frequently receive email [**If you are at Purdue and not seeing such email, it is probably because ITaP's spam filter has successfully filtered it out from your email stream.**] that appears to come from a sysadmin and that informs you that your mailbox is full and cannot receive any further messages. It then asks you to log into

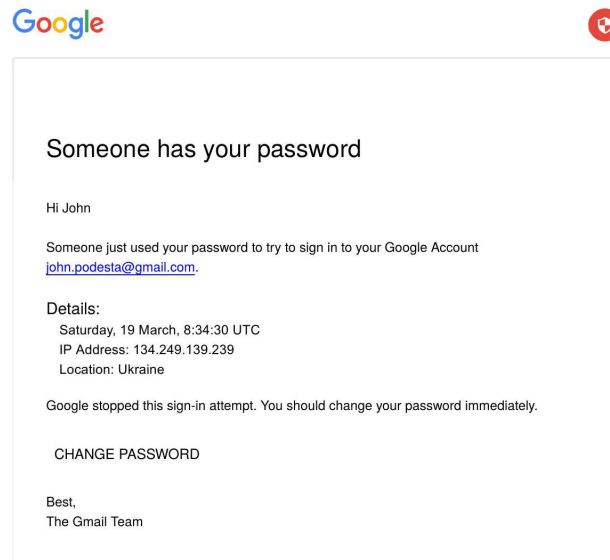
a website to add to the storage allocated to your mailbox.

- When phishing is directed at a specific individual, it is known as **spear phishing**. Spear phishing is a prime example of a social-engineering based attack since it frequently requires careful research by the bad guys into what it would take **to get the targeted individual to do their bidding, which in most cases amounts to getting the victim to either download an attachment or to click a link**. The attachment, which is often a Microsoft Word or PowerPoint document, when executed results in the victim's machine creating a backdoor for downloading additional malware. **And the link, when clicked, takes the victim to an authentic looking website where the victim is asked to enter his/her username and password and other such personal information.**
- As you can imagine, once the bad guys have a victim's username and the password, any email generated by the bad guys *under the guise of the victim* will be trusted by the victim's colleagues and friends. **And that trust can be taken advantage of to break into the computers of these other individuals for the installation of trojans and other malware.** In this manner, an entire organization can be infected through and through, resulting in a massive stealing of proprietary information by the adversaries. For obvious reasons, such wide-scale infection makes it that much more difficult to carry out an organization-wide cleansing of the malware after the

intrusion is discovered.

- When spear phishing attacks involve getting a victim to visit what is a fake website that looks exactly like the real thing, the fake website is typically supported on machines in countries with lax law enforcement.
- **As an example of a highly successful spear phishing attack in a high-stakes presidential contest in the US, you have surely already heard of how John Podesta, Chairman of the Hillary Clinton's presidential campaign, fell prey to such an attack.** In an email message that looked completely authentic, he was told that he needed to change his password and he was asked to click on a link for the purpose. The link led to a web page that also looked totally authentic — except that it was not. No sooner had he entered his new password that it was scooped up by the bad guys who immediately gained access to his accumulated trove of 60,000 messages. The web page in which he entered his new password was hosted on servers with a domain address assigned to a cluster of atolls in the South Pacific.
- There is an excellent description of the specifics of the spear phishing attack on John Podesta in a June 1, 2016 NYT article titled *“Was It a 400-pound, 14-year Old Hacker, or Russia? Here's Some of the Evidence,”* by Jeremy Ashkenas. As described in this article, John Podesta received an email sent to

his Gmail account that in his email client must have looked like:



You received this mandatory email service announcement to update you about important changes to your Google product or account.

Source: wikileaks.org

in which the words “CHANGE PASSWORD” that you see at the bottom were linked to the Bitly link “<https://bit.ly/1PibSU0>”. [As the article mentions: “Bitly is a public link shortening service popular for turning long, awkward web addresses into short links that can be easily typed into a phone, or shared on social media. In this case, the Bitly link served as a mask, hiding the real destination of the address from careful scrutiny, and potentially from Google’s automatic anti-phishing defenses.”] This short link from Bitly expanded into the following URL (meant to be in a single line):

```
http:// myaccount.google.com-securitysettingpage.tk/security/signinoptions/password
?e=am9obi5wb2Rlc3RhQGdtYW1sLmNvbQ==&fn=Sm9obiBQb2Rlc3Rh&n=Sm9obg== ...
```

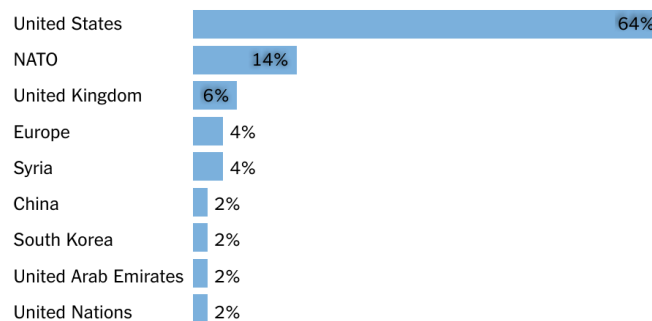
in which the values in the key/value pairs in the parameter section of the URL [This is the section that begins with the character “?”. The key/value

pairs are separated by the character "&".] are in Base64 encoded form. If you enter the value "Sm9obiBQb2Rlc3Rh" for the "fn" parameter in an on-line Base64 decoder, you'll see that it stands for "John Podesta". Therefore, the value of the parameter "fn" is "John Podesta".

- The important thing to note in the URL shown above is that its top-level domain is `com-securitysettingpage.tk`. This would be a server that is assigned to the country-code suffix ".tk" that is reserved for a tiny island nation called "Tokelau" in the southern Pacific ocean. [According to Wikipedia, the combined land area of the islands is around 4 square miles and the population is 1,400.]
- Another important thing to note in the expansion of the Bitly URL is that, after you have Base64 decoded the key/value pairs in the parameter portion of the URL, it tells us directly who the target of the spear phishing attack is. So if you could somehow figure out from the Bitly website the expanded versions of the abbreviated URLs being registered there, you would be able to get a good sense of the range of the individuals/organizations being subject to spear phishing attacks through Bitly URLs. According to the NYT article by Jeremy Ashkenas, this is exactly what you could do at the Bitly website until May of 2016. Until then, that website provided a function that allowed people to see all of the abbreviated URLs (and their expanded forms) being registered by any given account name.

- A well-known information security company named SecureWorks examined the newly created Bitly short links on a daily basis from mid-2015 until March 2016 and compiled a list of 5000 Google accounts being subject spear phishing attacks. Of these accounts those that SecureWorks could create a user profile for, shown below is their geographic distribution:

Nation or organization of government and military targets



Source: SecureWorks Counter Threat Unit

- Another wonderfully written NYT article related to the spear phishing attack on John Podesta's Gmail account is by Mattathias Schwartz. It appeared on Jan. 4, 2017 in the NYT Sunday Magazine and its title is "*Cyberwar for Sale*". Here is a quote from that article:

“On average, an American office worker sends and receives roughly 120 emails per day, a number that grows with each passing year. The ubiquity and utility of email has turned it into a fine-grained record of our day-to-day lives, rich with mundane and potentially embarrassing details, stored in a perpetual archive, accessible from anywhere on earth and protected, in some cases, by nothing more than a single password. In the case of Violeta Lagunes, her email login represented a point of vulnerability, a seam where the digital walls protecting her campaign were at the mercy of her human judgment — specifically, whether she could determine if a message from an apparently reputable source was real or fake.

Nearly two years later, John Podesta, chairman of Hillary Clinton's campaign, was faced

with a similar judgment call. An email warned him that someone in Ukraine had tried to access his Gmail account and asked him to click on a button and reset his password. His senior adviser forwarded the email to one of the campaign's technology experts. 'This is a legitimate email,' he replied, in what the expert later would clarify was a simple typing error on his part; he meant to say it was not legitimate. 'The gmail one is REAL,' the senior adviser wrote to Podesta and another aide."

"And so, like Lagunes, Podesta fell into a trap. The button appeared to lead to an official Google page, but it was in fact a meticulously personalized fake, with a domain address linked to a remote cluster of atolls in the South Pacific. **The details were designed to trick Podesta into entering his password. This technique is known as 'spear phishing.'** It is an especially potent weapon against companies and political organizations because it needs to succeed only one time, against one target. After that, attackers can use the trusted identity of the first compromised account to more easily lure colleagues into opening infected attachments or clicking on malicious links. Not only will a working email password yield years of intraoffice chatter, invoices, credit-card bills and confidential memos; it can often be leveraged into control of other personal accounts — Twitter, Facebook, Amazon — and even access to company servers and internet domains."

- The color highlighting is mine in the quote shown above.

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30.1.1 An April/May 2020 Account of a Large-Scale Email-Based Phishing Campaign

- As you would expect, the bad actors are always ready to exploit anxieties and tensions in the communities of people in pursuing their goals. **When people are tense and apprehensive, they are more likely to let their guard down when receiving a cleverly phrased email messages with dangerous attachments.**
- In April/May 2020, as the new coronavirus was raging across the United States, Microsoft discovered a phishing campaign based on the spreading pandemic.
- The main body in these email messages, which ostensibly came from “John Hopkins Center”, told the recipient that the attached Excel document had updates on the number of coronavirus related deaths in the US. When the recipient opened the attachment, they were asked to click on a popup that said “Enable Content”. Clicking on that executed the malware macros in the Excel sheet that downloaded and installed the NetManager RAT in the recipients machine that basically gave the control of the victim’s machine to the bad guys. The acronym RAT, as you will see later in this lecture, stands for “Remote Administration Tool”. A RAT installed in

your machine would allow the bad guys to record your keystrokes, to turn on your camera, your microphone, etc., not to speak of access to any and all of the sensitive information stored in your machine.

- In a news release in early April 2020, Ann Johnson, Corporate Vice-President for Cybersecurity Solutions Group at Microsoft, said Microsoft was blocking on a daily basis roughly 24,000 phishing attempts of the sort mentioned above.
- In a variant of the phishing attack mentioned above, the recipients were offered Covid financial compensation. As you will recall, the US government had approved a large financial package to help the individuals and the small businesses weather the lockdown during that time.

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30.2 IS IT POSSIBLE TO BREAK INTO A WELL-ENGINEERED NETWORK?

- Consider an agent **X** who is determined to break into a network with the intention of stealing valuable documents belonging to an organization and for the purpose of conducting general espionage on the activities of the organization.
- Assume that the targeted organization is vigilant about keeping up to date with the patches and with anti-virus software updates ([Lecture 22](#)). We also assume that the organization's network operates behind a well-designed firewall ([Lectures 18 and 19](#)). Additionally, we assume that the organization hires a security company to periodically carry out vulnerability scans and for penetration testing of all its computers ([Lecture 23](#)).
- We further assume that the computers in the targeted organization's network are not vulnerable to either the dictionary or the rainbow-table attacks ([Lecture 24](#)).
- In addition, we assume that **X** is physically based in a different country, which is not the same country where the organization's network is. Therefore, it is not possible for **X** to gain a James

Bond like physical entry into the organization's premises and install a packet sniffer in its LAN.

- **Given the assumptions listed above, it would seem that the organization's network cannot be broken into. But that turns out not to be the case. Any network, no matter how secure it is from a purely engineering perspective, can be compromised through what is now commonly referred to as "social engineering."**
- Here is a commonly used exploit to compromise an otherwise secure network through social engineering:
 - Let's say there is an organization **A** in the US that manufactures night-vision goggles for the military. Assume that an individual named **Bob Clueless** is a high official in this organization. Pretend that there is a country **C** out there that is barred from importing military hardware, including night-vision goggles, from the US. So this country decides to steal the design documents stored in the computers of the organization **A**. Since this country does not want to become implicated in cross-border theft, **it outsources the job to a local hacker** named **X**, who is obviously promised a handsome reward by a quasi-government organization in **C**. **C** supplies **X** with all kinds of information (generated by its embassy in the US)

regarding **A**, its suppliers base, the cost structure of its products, and so on. On the basis of all this information, **X** sends the following email to **Bob Clueless**:

To: Bob Clueless
From: Joe Smoothtalker
Subject: Lower cost light amplifier units

Dear Bob,

We are a low-cost manufacturer of light-amplifier units. Our costs are low because we pay next to nothing to our workers. (Our workers do not seem to mind --- but that's another story.)

The reason for writing to you is to explore the possibility of us becoming your main supplier for the light amplification unit.

The attached document shows the pricing for the different types of light-amplification units we make.

Please let me know soon if you would be interested in our light amplifier units.

Attachment: light-amplifiers.doc

-
- When Bob Clueless received the above email, he was already under a great deal of stress because his company had recently lost significant market share in night-vision goggles to a competing firm. Therefore, no sooner did Bob receive

the above email than he clicked on the attachment. What Bob did not realize was that his clicking on the attachment caused the execution of a small binary file that was embedded in the attachment. This resulted in Bob's computer downloading the client `gh0st` that is a part of the `gh0stRAT` trojan.

- Subsequently, **X** had full access to the computer owned by Bob Clueless.

[As is now told, **X** used Bob's computer to infiltrate into the rest of the network belonging to the organization — this was the easiest part of the exploit since the other computers trusted Bob's computer. It is further told that, for cheap laughs, **X** would occasionally turn on the camera and the microphone in Bob's laptop and catch Bob picking his nose and making other bodily sounds in the privacy of his office.]

- I would now like to present a summary of the different steps/facets of a classic social engineering attack. This listing is taken from

<http://www.f-secure.com/weblog/archives/00001638.html>:

1. You receive a spoofed e-mail with an attachment
2. The e-mail appears to come from someone you know
3. The contents make sense and talk about real things (and in your language)
4. The attachment is a PDF, DOC, PPT or XLS

5. When you open up the attachment, you get a document on your screen that makes sense, but you also get exploited at the same time
6. The exploit drops a hidden remote access trojan, typically a Poison Ivy or Gh0st Rat variant
7. You are the only one in your organization who receives such an email
8. You work for a government, a defense contractor or an NGO

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30.3 TROJANS – SOME GENERAL COMMENTS

- From the standpoint of the programming involved, there is not a whole lot of difference between a bot and a trojan. We talked about bots in Lecture 29. [The word “trojan” that you see here is all lowercase. However, in the literature, you are more likely to see the word as “Trojan” or “Trojan Horse” — after the Trojan Horse from the Greek epic “The Aeneid.” But as this word is acquiring a currency of its own in computer security circles, I think, sooner or later, it will become a more generic noun and that the security folks will refer to the malware simply as a “trojan.”]
- The main difference between a trojan and a bot relates to how they are packaged for delivery to an unsuspecting computer. There could be a certain randomness to how a bot hops from machine to machine in a network. [For example, as you saw with the `AbraWorm.pl` and `AbraWork.py` worms in Lecture 22, a bot may simply choose to scan a random set of IP addresses each day and, when it finds a machine with a certain vulnerability, it may install a copy of itself on that machine.]
- On the other hand, a trojan is intended for a more targeted attempt at breaking into a specific machine or a specific set of machines in a network.

- Also, a trojan may be embedded in a piece of code that actually does something useful, but that, at the same time, also does things that are malicious. So an unsuspecting person may never realize that every time he/she is clicking on an application, in addition to producing the desired results, his/her computer may also be engaged in harmful activities.
- As to the purpose of the malware packed into a trojan, it may be intended, say, to get a victim to execute an innocent looking attachment. That action by the victim could create a communication link with the human handler of the trojan. Such a communication link, known as a [backdoor](#), may pull in additional malware and/or may be used for exfiltrating sensitive information from the victim's machine.
- What makes trojans deadly is that they frequently come with surveillance software that can send back to the their human controllers the victim's screen on a continuous basis, as also the victim's keystrokes. So any confidential information entered by the victim in his/her computer becomes instantly available to the human controller before it can be encrypted. This surveillance software can also turn on and off the camera and the microphone on the victim's machine.
- It is sobering to realize that email attachments and other applications (that one typically finds on the desktop of a

run-of-the-mill computer today) are **not** the only hosts for trojans. As we describe below, trojans may also come buried in what is downloaded for the updating of the more system-oriented software in your computer.

- The CERT advisory, whose first page is shown on page 12, mentions a version of the `util-linux` package of essential linux utilities that had a trojan embedded in it; this corrupted package was inserted into the archive `util-linux-2.9g.tar.gz`. The archive was placed on at least one official FTP server for Linux distribution at some point between January 22 and 24, 1999. It is possible that this corrupted archive was distributed to other mirror sites dedicated to the distribution of the Linux operating system. [As the CERT advisory mentions, this specific trojan consisted of a modification to the `/bin/login` file that is used for logging in users. The trojan code would send email to, presumably, the intruders, providing them with information related to the user logging in, etc.] The full text of the advisory is available at <http://www.cert.org/advisories/CA-1999-02.html>.

- The same CERT advisory also talks about messages of the following sort that were emailed to a large group of recipients in January 1999:

```
Date: ....
From: "Microsoft Internet Explorer Support" IESupport@microsoft.com
To: ....
Subject: Please upgrade your Internet Explorer
```

Microsoft Corporation
1 Microsoft Way
Redmond, WA 98052


As a user of the Microsoft Internet Explorer, Microsoft Corporation provides you with this upgrade for your web browser. It will fix some bugs found in your Internet Explorer. To install the upgrade, please save the attached file `ie0199.exe` in some folder and run it.

For more information, please visit our web site at www.microsoft.com/ie/

As you can see, this spam message is written to look like it came directly from Microsoft to your computer. As you would infer on the basis of what was presented in the previous section, **this email is a classic example of using social engineering to break into a machine.** According to the information posted at <http://www.f-secure.com/v-descs/antibtc.shtml>, when the trojan `ie0199.exe` that came with the email messages was run, it extracted two files from its body: `mprexe.dll` and `sndvol.exe`. The trojan then registered the dll with the Windows registry so that it would be run at every reboot of the machine. When the dll was run, it executed the `sndvol.exe` file, which caused the infected machine to contact one of the following Bulgarian web sites: <http://www.btc.bg>, <http://www.infotel.bg>, and <http://ns.infotel.bg>.

- The lessons to be learned from the above CERT are:
 - Unless you are using a respected package manager such as the Synaptic Package Manager to install software updates,

CERT Advisory CA-1999-02 Trojan Horses

<http://www.cert.org/advisories/CA-1999-02.html>

search

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Software Assurance Secure Systems Organizational Security Coordinated Response Training

CERT[®] Advisory CA-1999-02 Trojan Horses

Original issue date: February 5, 1999
Last revised: March 8, 1999
Minor typographical corrections

A complete revision history is at the end of this file.

Systems Affected

Any system can be affected by Trojan horses.

Overview

Over the past few weeks, we have received an increase in the number of incident reports related to Trojan horses. This advisory includes descriptions of some of those incidents ([Section II](#)), some general information about Trojan horses ([Sections I and V](#)), and advice for system and network administrators, end users, software developers, and distributors ([Section III](#)).

Few software developers and distributors provide a strong means of authentication for software products. We encourage all software developers and distributors to do so. This means that until strong authentication of software is widely available, the problem of Trojan horses will persist. In the meantime, users and administrators are strongly encouraged to be aware of the risks as described in this document.

I. Description

A Trojan horse is an "apparently useful program containing hidden functions that can exploit the privileges of the user [running the program], with a resulting security threat. A Trojan horse does things that the program user did not intend" [[Summers](#)].

Trojan horses rely on users to install them, or they can be installed by intruders who have gained unauthorized access by other means. Then, an intruder attempting to subvert a system using a Trojan horse relies on other users running the Trojan horse to be successful.

II. Recent Incidents

Incidents involving Trojan horses include the following:

False Upgrade to Internet Explorer

Recent reports indicate wide distribution of an email message which claims to be a free upgrade to the Microsoft Internet Explorer web browser. However, we have confirmed with Microsoft that they do not provide patches or upgrades via electronic mail, although they do distribute security bulletins by electronic mail.

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[Courses](#)

US-CERT
www.us-cert.gov

Carnegie Mellon
CyLab

make sure that you are downloading the software from a trusted source, that it has a digital signature obtained through a cryptographically secure algorithm, and that you can verify the digital signature of the software you are downloading. *When trojans are embedded in system files, the file size is often left unchanged so as to not arouse suspicion. So the only way to verify that a file was not tampered with is through its digital signature.*

- Validating the digital signature should involve also validating the public key of the signer.
- **Never, never click on an email attachment if you are not absolutely sure that the message is authentic** — **even if it looks authentic**. If you were not expecting the sort of message you are looking at (even if it appears to be from someone you know), it is best to not open the attachment without establishing the provenance of the message. In most of our day-to-day interactions, this is not a problem since the context of our interaction with the others immediately establishes the authenticity of the email.
- To further underscore the role played by socially engineered email (especially those emails that include attachments containing malware) in infiltrating networks, here is a quote from the abstract of a recent report by Nagaraja and Anderson from the University of Cambridge (a detailed reference to this report is given in Section 30.4):

“This combination of well-written malware with **well-designed email lures**, which we call social malware, **is devastatingly effective**. The traditional defense against social malware in government agencies involves expensive and intrusive measures that range from mandatory access controls to tiresome operational security procedures. **These will not be sustainable in the economy as a whole**. Evolving practical low-cost defenses against social-malware attacks will be a real challenge.”

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30.4 SURVEILLANCE SOFTWARE FOR ESPIONAGE— R.A.T, R.C.S, ETC.

- As mentioned in the previous section, trojans frequently incorporate surveillance software that allows them to snoop on the activities of the victims, control the camera and the microphone on the victim’s computer, capture keystrokes, etc.
- What is interesting is that surveillance software of the sort mentioned above has become a multi-billion dollar business around the world. **I am talking about surveillance software that exists — for at least “official” purposes — outside the trojans used by the bad guys.** Some of the companies in this business include [Hacking Team](#) in Italy, [FinFisher](#) in Germany, [Trovicor](#) in Israel, and several others.
- As to the claimed legal reasons for selling such software, the companies say that the software is needed by law enforcement agencies to monitor criminal networks. The main point they make in their defense is that their surveillance software is just the modern version of the phone wiretapping tools that have been used by law enforcement for a long time.

- However, it is now well documented that some of these companies do sell their software to repressive regimes and other organizations to enable them to spy on whomsoever they consider to be their adversaries — political dissidents, journalists, etc. The NYT article by Mattathias Schwartz that I cited in the previous section is about the role played by Hacking Team’s surveillance software in an election contest for governorship in the state of Puebla in Mexico.
- Hacking Team refers to their surveillance software as **Remote Control System** with the acronym R.C.S or just RCS. More generally, though, such software is called **Remote Administration Tool** with the acronym R.A.T or just RAT.
- As to the power of Hacking Team’s RCS, it is best described by the following quote from Mattathias Schwartz’s story in NYT:

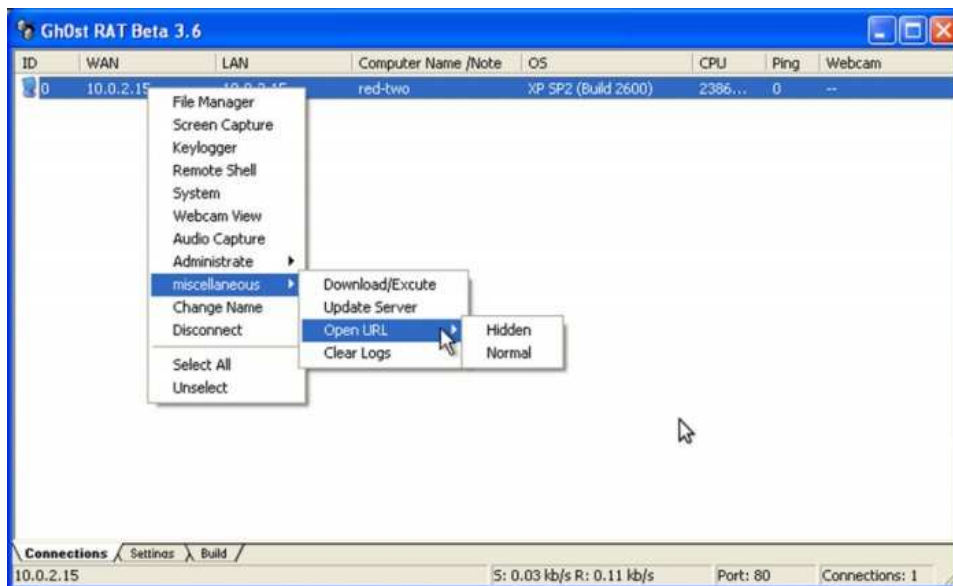
“A couple of months later, I went to Milan to visit Hacking Team’s headquarters, a stately gray apartment building with boxes of limp flowers adorning a few of its sooty sills. Waiting to demonstrate the company’s software were Rabe; Philippe Vinci, a company vice president; and Alessandro Scarafile, a young engineer. Scarafile had gathered a Dell desktop computer and three smartphones: iPhone, BlackBerry and Android. **The screen from his own laptop, which represented the console of a client intelligence agency, was projected on the wall. Several icons represented the various streams of data that could potentially be acquired by gaining control of the target’s computer: images from built-in cameras, sound from built-in mikes, screenshots, detailed records of applications opened and bitcoins transferred, a continuous log of location with latitude and longitude, and logs of address books, calendars, phone calls, Skype calls and passwords, as well as websites visited. A key logger recorded every key that was pressed. It was a lot to keep track of. Two other views, called “line of events” and “line of actions,” assembled the information into chronological order.”**

The text coloring in the above quote is mine. As you can tell from the blue colored text, RCS has complete control over the victim's computer or smartphone. Using RCS, the human controllers of the victim's machine can send email and text messages to the victim's contacts. When needed, such messages may come with an ordinary looking attachment, such as a Microsoft Word or a PowerPoint file, that when clicked on would cause the recipients to download their own copy of RCS.

- What is truly ironic is that Hacking Team itself was hacked in July 2015 and **all** of its source code along with all of the company emails and other files — **all in all 420 Gigabytes of material** — were stolen and made publicly available through WikiLeaks and GitHub. It is an incredibly rich trove of source code for learning about how deadly effective surveillance software is written. [**The company emails and other files that are now publicly available name the organizations and the regimes around the world that used the Hacking Team's surveillance software to spy on their adversaries.**] Despite this stunning loss, looks like Hacking Team is back in business — supposedly with an “upgraded” version of its surveillance software.
- If you are curious as to how Hacking Team itself got hacked, here is a link to the document you will enjoy reading “*The 'HackBack' – How Hacking Team became 'Hacked Team'*” by Brad Green:

<https://ntxissa.org/wp-content/uploads/The-Hack-Back-Dallas-ISSA.pdf>

- In addition to the Hacking Teams RCS that you can now study and analyze because of its publicly available source code, another surveillance tool whose source code is also now publicly available is by FinFisher.
- I am going to devote the rest of this section to the **gh0stRAT** surveillance tool that supposedly was used extensively by some Chinese state agencies to spy on organizations tied to Dalai Lama. The suffix “RAT” in **gh0stRAT** again refers to Remote Administration Tool.
- Shown on the next page is an example of the GUI of the R.A.T management tool that comes with the **gh0stRAT** trojan. As the reader can see, the drop-down menu displayed includes buttons for controlling the camera, the microphone, etc., on the infected machine.
- Variants of this trojan allow the attackers to plug in their own additional features for further customizing its behavior.
- Since the **gh0stRAT** trojan was written originally by the hackers in China, the original code has its comments and other embedded documentation (which are important to understanding code) mostly in Chinese. But now some



open-source folks claim to have translated it into English — meaning that they claim to have translated the comment lines and the other documentation into English. [However, you will notice that that is not entirely the case. Much of the documentation that is included in the files is still in Chinese.] You can download the latest “English version” as an archive called `gh0st3.6_src.zip` from the URL

<http://www.opensc.ws/c-c/3462-gh0st-rat-3-6-source-code.html>

One of the coders at this web site says that *“ This is very poorly coded and most of it looks ripped. Anyhow, I tested it out on Vista and it compiled fine using MSVC++ with the Platform SDK. It has minor warnings but all functions still work properly.”*

- Just to give the reader a sense of the scope of `gh0stRAT`, shown on the next four pages is an indented listing of the subdirectories and the files in the source code directory for

gh0st3.6. [At some point in the future, I plan to add to my description of the functionality of some of the more significant files in the directory tree — assuming it can be done at all.]

- The brief comments that follow the file names in the directory listing on the next several pages are just pure guesses on my part at this time — not at all to be taken too seriously. I hope to refine my understanding of the code at some point in the near future.
- A compilation of this source code will give you a **Server** that an attacker can use to monitor the trojan on an infected machine. The trojan itself is compiled as the executable **gh0st**.
- Here is a listing of the files:

```

gh0st3.6_src/
  gh0st.dsw
  gh0st.ncb
  gh0st.opt

  Server/
    install/
      ReadMe.txt
      install.aps
      install.rc
      install.plg
      install.dsp
      acl.h
      RegEditEx.h
      resource.h
      StdAfx.h
      decode.h
      install.cpp
      StdAfx.cpp      => for including the precompiled header stdafx.h
      res/
        svchost.dll  => a well-known trojan module for remote access
                       (Note that this is not the same as svchost.exe
                        that is so basic to the operation of the Windows
                        platform. See Lecture 22.)

    svchost/

```

```

ReadMe.txt
svchost.plg
svchost.aps
svchost.rc
svchost.dsp
resource.h
ClientSocket.h
hidelibrary.h
ClientSocket.cpp
StdAfx.cpp
svchost.cpp
common/
    filemanager.h      => for file ops such saving, loading, moving, etc.
    KeyboardManager.h => for storing keystrokes, etc.
    AudioManager.h    => for recording microphone inputs from the trojan
    hidelibrary.h     => for making folders invisible to a user
    login.h
    ScreenManager.h   => header needed for the control GUI
    until.h
    inject.h
    loop.h
    Buffer.h
    ScreenSpy.h       => for monitoring the screen of an infected machine
    VideoCap.h        => for capturing camera config and for remote video capture
    decode.h
    install.h
    Manager.h
    ShellManager.h
    VideoManager.h   => for capturing camera config and for remote video capture
    Dialupass.h
    KernelManager.h
    RegEditEx.h      => sets and reads registry permissions (header)
    resetsstd.h
    SystemManager.h
    AudioManager.cpp => for recording microphone inputs from the trojan
    ScreenManager.cpp => needed for the control GUI
    until.cpp
    Buffer.cpp
    ScreenSpy.cpp
    VideoCap.cpp     => for capturing video remotely
    install.cpp
    Manager.cpp
    ShellManager.cpp
    VideoManager.cpp => for capturing video remotely
    Dialupass.cpp    => for viewing passwords used for dialup
    KernelManager.cpp => makes calls to cKernelManager for multithreading
    SystemManager.cpp
    RegEditEx.cpp    => sets and reads registry permissions
    FileManager.cpp
    KeyboardManager.cpp
sys/
    makefile
    RESSDT.c
    RESSDT.sys
    sources

gh0st/
    ReadMe.txt
    gh0st.clw        => contains info for the MFC class wizard
    gh0st.plg        => compilation build log file
    removejunk.bat
    gh0st.rc
    gh0st.aps

```

```

BuildView.h
KeyboardDlg.h          => header for capturing keystrokes
StdAfx.h
AudioDlg.h            => for recording microphone inputs
MainFrm.h
SystemDlg.h
BmpToAvi.h
ghOstDoc.h
TabSDIFrameWnd.h
Resource.h
ThemeUtil.h
ghOst.h
Tmschema.h
ScreenSpyDlg.h        => header for screen capture
CustomTabCtrl.h
ghOstView.h
TrayIcon.h
encode.h
SettingsView.h
TrueColorToolBar.h
FileManagerDlg.h      => header for file operations
IniFile.h
SEU_QQwry.h
WebCamDlg.h           => header for camera image capture
FileTransferModeDlg.h
InputDlg.h
ShellDlg.h
AudioDlg.cpp          => for microphone capture
ghOst.cpp
MainFrm.cpp
SystemDlg.cpp
BmpToAvi.cpp          => for format conversion
ghOstDoc.cpp
TrueColorToolBar.cpp
TabSDIFrameWnd.cpp
BuildView.cpp
ghOst.dsp
ThemeUtil.cpp
IniFile.cpp
FileManagerDlg.cpp    => for file ops such as saving, moving, etc.
ScreenSpyDlg.cpp     => for screen capture
CustomTabCtrl.cpp
ghOstView.cpp
TrayIcon.cpp
SettingsView.cpp
WebCamDlg.cpp         => for camera capture
SEU_QQwry.cpp
FileTransferModeDlg.cpp
InputDlg.cpp
ShellDlg.cpp
KeyboardDlg.cpp       => header for capturing keystrokes
StdAfx.cpp            => for including precompiled Windows headers
include/
    Buffer.h
    CpuUsage.h
    IOCPServer.h
    Mapper.h
    Buffer.cpp
    CpuUsage.cpp
    IOCPServer.cpp
control/
    BtnST.h
    HoverEdit.h
    WinXPButtonST.h

```

```

    BtnST.cpp
    HoverEdit.cpp
    WinXPButtonST.cpp
res/
    1.cur           => cur is an ico like format for cursors
    2.cur
    3.cur
    4.cur
    dot.cur
    Bitmap_4.bmp   => bitmapped image files
    Bitmap_5.bmp
    toolbar1.bmp
    toolbar2.bmp
    audio.ico
    gh0st.ico
    cmdshell.ico  => ico is a format for icons
    keyboard.ico
    system.ico
    webcam.ico
    gh0st.rc2
    install.exe
CJ60Lib/
    overview.gif
    Readme.htm
CJ60Lib/           => graphics extension library, originally by Code Jockey
    readme.txt
    CJ60lib.def
    resource.h
    Globals.h
    stdafx.h
    CJ60Lib.clw
    CJ60Lib.dsw
    CJ60Lib.ncb
    CJ60Lib.opt
    CJ60Lib.positions
    CJ60Lib.rc
    CJ60StaticLib.dsp
    CJCaption.cpp
    CJListCtrl.cpp
    CJToolBar.cpp
    CJ60lib.cpp
    CJControlBar.cpp
    CJListView.cpp
    CoolBar.cpp
    CJDockBar.cpp
    CJMDIFrameWnd.cpp
    CoolMenu.cpp
    CJ60Lib.dsp
    CJDockContext.cpp
    CJMiniDockFrameWnd.cpp
    FixTB.cpp
    ShellPidl.cpp
    CJExplorerBar.cpp
    CJOutlookBar.cpp
    FlatBar.cpp
    ShellTree.cpp
    CJFlatButton.cpp
    CJPagerCtrl.cpp
    Globals.cpp
    SHFileInfo.cpp
    CJFlatComboBox.cpp
    CJSearchEdit.cpp
    stdafx.cpp
    CJFlatButtonCtrl.cpp

```



```
CJSizeDockBar.cpp
hyperlink.cpp
CJFrameInfo.cpp
CJTabctrlBar.cpp
MenuBar.cpp
Subclass.cpp
CJFrameWnd.cpp
res/
  btn_arro.bmp
  button_images.bmp
  btn_explorer.bmp
  cj_logo.bmp
  vsplitba.cur
  hsplitba.cur
  cj60lib.rc2
Include/
  CJ60Lib.h
  CJFlatComboBox.h
  CJMiniDockFrameWnd.h
  CJToolBar.h
  ModulVer.h
  CJCaption.h
  CJFlatHeaderCtrl.h
  CJOutlookBar.h
  CoolBar.h
  ShellPidl.h
  CJControlBar.h
  CJFrameInfo.h
  CJPagerCtrl.h
  CoolMenu.h
  ShellTree.h
  CJDockBar.h
  CJFrameWnd.h
  CJSearchEdit.h
  FixTB.h
  SHFileInfo.h
  CJDockContext.h
  CJListCtrl.h
  CJSizeDockBar.h
  FlatBar.h
  Subclass.h
  CJExplorerBar.h
  CJListView.h
  CJTabCtrlBar.h
  hyperlink.h
  CJFlatButton.h
  CJMDIFrameWnd.h
  CJTabView.h
  MenuBar.h
Lib/
  CJ60StaticLib.lib

common/
  Audio.h
  CursorInfo.h
  macros.h
  VideoCodec.h
  Audio.cpp
  zlib/
    zconf.h
    zlib.h
    zlib.lib
```

- You will find several other RATs at the following URL:
<http://www.opensc.ws/trojan-malware-samples/>.

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30.5 CYBER ESPIONAGE

- Much of the current focus on “Cyber Espionage” started with the seminal work that has come out of a collaboration between the Citizens Lab, Munk Center for International Studies, University of Toronto, and the SecDev Group, a Canada-based consultancy house. This collaboration has produced the first two reports listed below. These reports make for a remarkable reading of the spy-thriller sort:

- [“Tracking GhostNet: Investigating a Cyber Espionage Network,”](#)

<http://www.scribd.com/doc/13731776/Tracking-GhostNet-Investigating-a-Cyber-Espionage-Network>

- [“Shadows in the Cloud: Investigating Cyber Espionage 2.0,”](#)

<http://www.infowar-monitor.net/2010/04/shadows-in-the-cloud-an-investigation-into-cyber-espionage-2-0>

- [“The Snooping Dragon: Social-Malware Surveillance of the Tibetan movement,”](#)

<http://www.cl.cam.ac.uk/techreports/UCAM-CL-TR-746.html>

The third report mentioned above is from the University of Cambridge by two researchers, Shishir Nagaraja and Ross Anderson, who also collaborated with the folks at the University of Toronto and the SecDev Group.

- If you do look through the reports listed above, seek answers to the following questions:
 1. At the lowest levels of data gathering, what information did the investigators collect and what tool(s) did they use for that purpose?
 2. How did they identify the malware (the trojan) present in the infected computers?
 3. How did the investigators track down the control and the command computers that the infected machines sent their information to?
 4. What was the capability of the specific trojan that played a large role in stealing information from the infected computers? How did this trojan allow the humans to control in real-time the infected machines?
 5. How did the investigators manage to spy on the spies?
 6. What can you infer from the source code for the trojan?
- The “Tracking Ghostnet” report, which came out in March 2009, describes an espionage network that had infected at least 1295 computers in 103 countries, mostly for the purpose of spying on the various Tibetan organizations, especially the offices of the Dalai Lama in Dharamsala, India. **The espionage**

network unearthed through the investigative work presented in this report is referred to as the “Ghostnet.”

- The “Shadows in the Cloud” report, released in April 2010, documents an extensive espionage network that successfully stole documents marked “SECRET,” “RESTRICTED,” and “CONFIDENTIAL” from various high offices of the Government of India, the Office of the Dalai Lama, the United Nations, etc. The espionage network unearthed through the investigative work presented in this report is referred to as the “Shadow.” The Shadow network is considered to be more sinister than the older Ghostnet network.
- The “Snooping Dragon” report is about the same attacks that are described in the “Tracking Ghostnet” report, but its overall conclusions are somewhat different. The “Snooping Dragon” report is more categorical about the origin of the attacks and who sponsored them.
- The primary mechanism for spreading malware in both Ghostnet and Shadow was targeted and socially-engineered email containing infected Word or PDF attachments.
- The attackers designated some of their own machines that were used to facilitate their exploits as “Control Servers” and some others as “Command Servers.” The trojan server we talked

about in the previous section ran on the Control Servers. Such servers provided the attackers with GUI-based facilities — an example of which was shown earlier on page 15 — to watch and control the infected machines. The Command Servers, on the other hand, served mostly as repositories of malicious code. A human monitoring the trojan-server GUI on a Control Server could ask the trojan client on an infected machine to download a newer version of the malware from one of the Command Servers.

- The espionage attacks in both Ghostnet and Shadow used the `gh0stRAT` trojan as the main malware for spying. The trojan client in the Shadow network appears to have greater communication capabilities. In addition to communicating with the trojan servers running on the Control Servers, the Shadow trojan client could also receive commands directly through email and through certain social media.
- The trojan clients running on the infected machines communicated with their server counterparts running on the Control Servers using the HTTP protocol and using the standard HTTP port. This was done to disguise the trojan communications as ordinary HTTP web traffic. When a trojan client on an infected machine wanted to upload a document to a Control Server, it used the HTTP POST command. [Your web browser typically makes an HTTP GET request when it wants to download a page from a web server. On the other hand, when your browser wants to upload to the web server a web form you may have filled out with, say, your credit card information, it

sends to the server an HTTP POST ‘request’ that contains the information you entered in the form.]

- The HTTP requests sent by the trojan clients running on infected machines were typically for what seemed like JPEG image files. In actuality, these files contained further instructions for the trojans. That is, the trojan on an infected machine would send an HTTP GET request to a Control Server for a certain JPEG image file; in return, the Control Server would send back to the trojan the instructions regarding which Command Server to contact for possibly additional or newer malware.
- For the investigation reported in “Shadows in the Cloud,” the University of Toronto investigators used **DNS sinkholes** to good effect. A sinkhole is formed by re-registering a now-expired domain name that was programmed into an earlier version of a trojan as the destination to which the trojan should send its communications. Since the older versions of the trojans still lodged in the infected machines are likely to continue communicating with these now expired domain names, by re-registering such domains with new IP addresses, the investigators could pull to their own sites the HTTP traffic emanating from the older trojans. **What a cool trick!** If my understanding is correct, this is how the U. of Toronto folks got hold of the highly-classified documents that were exfiltrated by some of the trojans during the course of the investigation

reported in “Shadows in the Cloud.”

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30.6 CYBER ESPIONAGE THROUGH BROWSER VULNERABILITIES

- The beginning of 2010 witnessed Google announcing that its computers had been compromised. Some news reports mentioned that Google's password/login system Gaia was targeted in these attacks. Supposedly, some or all of the source code was stolen. Again according to news accounts, some Gmail accounts were also compromised.
- It is believed that social engineering played a large role in how this attack was carried out. According to a report by John Markoff in the New York Times (April 19, 2010), the attack started with an instant message sent to a Google employee in China who was using Microsoft's Messenger program. By clicking on a link in the message, the Google employee's browser (Internet Explorer) connected with a malicious web site. This connection caused the Google employee's browser to download the Hydraq trojan (also referred to as the Aurora trojan) from the web site. That gave the intruders complete control over the Google employee's computer. The rest is history, as they say.
[The backdoor to the attacked computer created by Hydraq is similar to what is achieved by the gh0stRAT trojan. However, the former is probably not as powerful with regard to its remote administration capabilities as the latter. An interesting difference between Hydraq and gh0stRAT is

that the former uses port 443 to make connections with its command and control computers. As you may recall from Lecture 19, this port is used for the secure SSL-based HTTPS service for the delivery of web pages. However, the encryption algorithms used by Hydraq are not based on the SSL protocol; they are custom designed. We will not go any further into the Hydraq (or Aurora) trojan.]

- Context-relevant messages and email as lures to get users to click on malware-bearing attachments and URLs are probably the most common attack vectors used today that cause computers to download viruses, worms, and trojans. In addition to those attack vectors for delivering the Hydraq trojan, it is believed that the attack on Google also utilized a more specialized attack vector — a vulnerability in the older and unpatched versions of the Microsoft’s Internet Explorer web browser. This vulnerability, **presented earlier in Section 28.4 of Lecture 28**, has to do with the allocation and deallocation of memory for HTML objects by JavaScript and the fact that JavaScript, like scripting languages in general, is not a strongly typed language.

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30.7 OTHER FORMS OF SOCIAL ENGINEERING BASED ATTACKS: FAKE NEWS AND RANSOMWARE

- When collaborative actions by a network of users spread and seemingly reify what in retrospect turns out to be planted information, we have a social-engineering based attack on our information systems.
- The recent phenomenon of fake news is driven by the fact that the news recommendation algorithms used by social networks like Facebook give greater weight to how the friends of a user have *reacted* to and *rated* the news items than to the provenance and the authorship of the news items.
- An algorithm cannot be expected to recognize the basic fact that in any contest we enjoy seeing a piece of information if it goes along with what we *want* to believe. We are likely to rate such items higher than a piece of information that we *do not want* to believe. Our emotionality plays a large role in our wants and needs. Logic and rationality that algorithms are based on are orthogonal to that emotionality.

- The higher the stakes in a contest, the greater the emotional hunger to see and read material that projects our own points of view and the greater the tendency that we would give such material a higher rating.
- Just imagine the cascading effect of an ever expanding circle of friends and friends of those friends giving emotionally based ratings to a piece of information. You might associate an “avalanche effect” with the propagation of these ratings that makes the information appear more and more significant the larger the number of people who like it. Ultimately, in the minds of many, it acquires a reality of its own.
- How is it that the developers of the news recommendation algorithms at our social networks did not see the phenomenon of fake news coming? That’s really the main surprising thing here.
- Let’s now talk about the second topic in this section: **Ransomware**. To the extent that ransomware can be used to coerce individuals into yielding results desired by the bad guys, we can talk about ransomware attacks as a form of social-engineering based attacks on computer networks.
- Two particular variants of ransomware that have been much in the news lately are known as HDDCryptor and RaaS (Ransomware As A Service).

- To give the reader a sense of how ransomware works, in the rest of this section I'll present some of the main points in a September 18, 2016 article entitled "*HDDCryptor Ransomware Overwrites Your MBR Using Open Source Tools*" by Lawrence Abrams that you can download from:

<https://www.bleepingcomputer.com/news/security/hddcryptor-ransomware-overwrites-your-mbr-using-open-source-tools/>

- Lawrence Abrams makes the following points:
 - HDDCryptor overwrites the PC's master boot records (MBR) in the storage used by a PC. An MBR tells the system how its disk drive is partitioned and how each partition is organized with regard to the files it contains. An MBR also contains a piece of code known as the *boot loader* for accessing and reading those files. [On account of the limitations on the size of the disk space that can be handled by MBR, the more modern PCs use what is known as GPT (GUID Partition Table). The acronym "GUID" stands for "globally unique identifiers". For backward compatibility, both MBR and GPT may co-exist in a PC.]
 - Users typically acquire this malware in their computers when they download files from malicious websites. [Let's say your PC lacks a reader for PDF files and you do what most people would in such a case: you go to Google and enter "PDF reader download" as a search string. Chances are high that unless you go to the official Adobe website for the reader you want, you could end up downloading it from a malicious website. The same thing can happen when you are looking to download songs, lyrics, movies, etc., from unofficial websites.]
 - The malware binary that your computer acquires is given a random 3-digit name, such as 123.exe. When this file is executed — probably by the action of you installing the file you were trying to download in the first place — it deposits the following files in the System folder of your PC:

dcapi.dll

dccon.exe (used to encrypt the disk drive)

dcrypt.exe

dcrypt.sys

log_file.txt (log of the malware's activities)

Mount.exe (scans mapped drives and encrypts files stored on them)

netpass.exe (used to scan for previously accessed network folders)

netuse.txt (used to store information about mapped network drives)

netpass.txt (used to store user passwords)

- Of these files, `Netpass.exe` is a legitimate password recovery tool provided by <http://www.nirsoft.net>. When connecting to a network share in a LAN, Windows allows you to save your password in order to use it automatically each time you connect with the remote server. `Netpass.exe` is for recovering the passwords thus saved. The ransomware uses `Netpass.exe` to extract login credentials from the different network folders in order to later encrypt the mapped drives in addition to the user's disk drive.
- Along the same lines, `dcrypt.exe` is the executable for another legitimately used tool, `DiskCryptor`, which is an open-source disk encryption utility. The ransomware uses this utility to encrypt the user's disk drive. Any mapped drives are encrypted with the utility `Mount.exe`.
- Lawrence Abrams says that “to gain boot persistence, `HDDCryptor` creates a new user called 'mythbusters' with password '123456,' and also adds a new service called 'DefragmentService,' that runs at

every boot. This service calls the ransomware's original binary (the three-digit exe file).”

- After the encryption ends, the ransomware rewrites all the MBRs for the disk partitions with a custom boot loader. Subsequently, it reboots the machine and displays a ransom message on the user's screen. This message demands that the user pay a certain number of bitcoins in order to get hold of the decryption key.