

Ransomware: Is human error the primary reason for the surge in this increasingly popular malware?

Craig Heptinstall Crh13- 110005643

Institute of Computer Science - Aberystwyth University

Abstract—As computers and other machines become more and more an integral part of a person's life, the risk of a computer infection increases. The amount of platforms available to the common user today allows malicious attackers a variety of ways to access user's personal data (from contact details to banking details.) A class of malware (malicious software) that has been reported more than others in recent years known as Ransomware has been taking advantage of user's fears and errors. Because most Ransomware requires users to physically click a link or download a file to instigate this malware, human error can be perceived to one of the biggest causes of the rise of attacks.

Index Terms—Computer Crime, Computing, Human Error, Malicious, Malware, Ransomware, Users, Virus

I. INTRODUCTION

IN recent years, the amount of news reports on cases of this form of malware has been increasing, showing both the rise of cases, and the sophistication of attacks. The most recent of these includes an article from the BBC [1], where a Ransomware software known as Maktub emails a user not only a malicious link to the software, but the user's postcode to make it more convincing. With more and more intricate ways of persuading the users to access the malware, it is the upmost importance that user's should know when a link, email or web address is genuine. This paper looks into the idea that although all viruses benefit from user errors or mistakes, Ransomware is benefitting the most, and would be most affected by a change in user interaction.

A. Ransomware

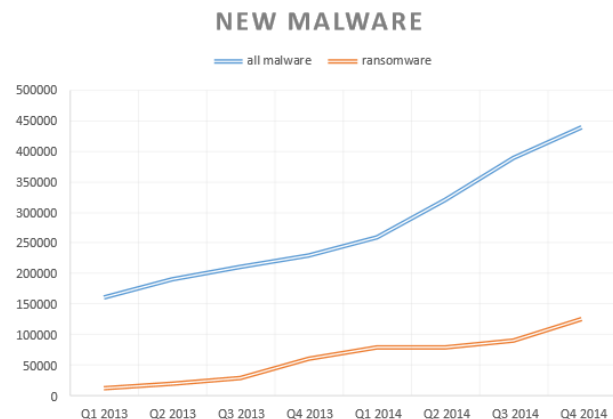
In order to look closely at some of the human errors that are causing the rise of Ransomware, the malicious software should be examined, and reasons why this form of software is so effective in current times.

In a paper by A. Kharraz (A look under the hood of Ransomware attacks) [2], the authors give an insight into how attacks take place, and how a range of different encryption algorithms are used by several of the most common Ransomware. Ransomware belongs to a class of malware identified by the author as 'scareware', which takes advantage of a users' fear of losing their private information or having their data exposed to others.

In addition to the basic introduction of what the author introduces Ransomware as, is the startling statistics on this kind of malware. In 2013, the author reported an increase of over 500% (as shown in Figure 1.) on the amount of attacks compared to 2012. Because of this statistic, the author claims

that Ransomware is one of the most threatening viruses at the time the paper was published. In conducting research about the inner-workings of Ransomware the author uses 1359 real-life reported cases of Ransomware attacks in order to get consensus of how attacks are generally performed.

Fig. 1. Increase in Ransomware attacks on all platforms, presented next to all malware attacks. Y axis represents number of reported attacks.



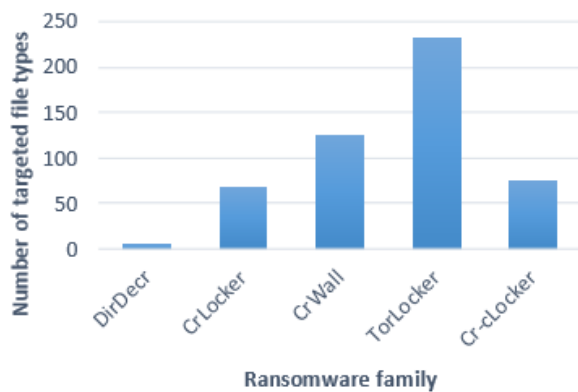
They found most prominently:

- There are two main Ransomware families (specific pieces of software which have developed over the years). Both with highlighted traits, these are:
 - 1) TorrentLocker - A Ransomware exclusively distributed by email, and uses the infected user's email address list to distribute further.
 - 2) CryptoWall - Communicates back to the attackers using the Tor network, to remain anonymous.
- There are a further 97 variants, most of which are related. Some are direct copies however.
- 35.6% of the attacks were made by Ransomware that do not perform encryption, but simply delete users files if they do not pay the ransom.
- CryptoWall infected 250,000 computers worldwide in the year of publishing (2015).

Both of the described Ransomware families above are particularly sophisticated according to the author's findings, stating that they both use AES (Advanced Encryption Standard) to encrypt user data. This happens once a user is infected, and because of the high level of security AES was designed for (this method is used by the U.S. government to encrypt classified information for instance [3]), it makes any attempt at decrypting user data without paying extremely difficult.

Although other Ransomware use less sophisticated locking mechanisms such as standard Windows functions as described in the paper, a common user would still not be able to unencrypt the data without the help of good decryption software or with guidance from professionals. The paper noted that it in fact most Ransomware were not concentrating on the strength of the encryption, as long as it took away the ability for users to access files, then they could begin holding such users at ransom. In a whitepaper published by Bromium Security [4], file type targeting is something that can increase the efficiency and speed at which more vital files are encrypted. By only encrypting recently modified, new and common file-type files (as shown in Figure 2.), a Ransomware can cut its footprint and avoid anti-virus systems detecting major file system changes.

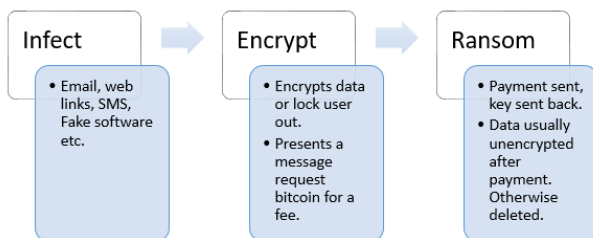
Fig. 2. The number of file types encrypted by numerous Ransomware.



The final aspect, and most important part to the process of an attackers infecting a user with the malware is the payment or ransom. In order to remain anonymous, and so that attackers cannot be traced, Bromium noted that nearly all Ransomware used BitCoins as payment. This secure and anonymous payment system allows anyone to send virtual cash through unique Bitcoin addresses which can later be traded for cash.

Figure 3 shows the most common found way that Ransomware attacks happen. Though with nearly 40% attacks now affecting multiple platforms, there is a constant shift in means of attacking.

Fig. 3. An example flow of a Ransomware attack.



B. Transmission of malware

Although the paper mentioned earlier (A look under the hood) goes into great detail of how Ransomware functions, and the statistics around them, the means at which users

receive the malware is very brief in Kharraz's paper. In order to understand how Ransomware is transported, and how this relates to user responsibilities, other papers gave good insight. The Bromium whitepaper listed findings for most common Ransomware attacks:

- Spam or social engineering
- Direct or indirect user download
- Malware installation tools and botnets

Where these means of infection relate to the topic of this paper is in the fact that all three contain some user involvement. Without the user clicking on a suspicious link, downloading faulty software, or installing software with unwanted additional add-ons, it could be claimed that malware would not exist or exist in a different manner, as told by K. Wyk [5]. Because Ransomware realises heavily on user interaction, this is where this form of malware is required to look more professional than traditional viruses or spamming software.

The Bromium report highlights the professionalism that is shown from some of the Ransomware seen, and the increase is overall sophistication, making it more believable to be safe software of any kind. As mentioned in the abstract, emails produced to bring users to download the malware has been found to be increasing in sophistication too, with the use of correct user postcodes sent out. Because of this professionalism in the malware produced, software can almost seem to be on the side of the user when trapping them into a ransom.

C. "al Ransomware victims

Because the main objective of Ransomware attacks being money, attackers of this type of malware usually aim for high profile, wealthy victims. The Bromium report highlights this, saying that attacks will usually perform some research into potential victims, and accustom emails or phishing materials towards them specifically.

Although wealthier victims are attractive to attackers due to the better chance that they would be willing to pay ransoms, some reports suggest that a lot of attacks are performed on high profile individuals and organisations too. A report by ITProPortal [6] argues that high profile organisations are becoming more attractive potential victims to attackers, and provides the example of a police department in Maine who were attacked and actually payed the ransom. It was reported that the attack invoked embarrassment of losing data, therefore forcing the organisation to pay.

By attacking large organisations, it goes back to the idea that with more money, they would be more willing to pay. It was found that 60% of all Ransomware attacks were on companies. On the other hand, some Ransomware (such as cryptolocker) attacks individuals more often, and aims to spread further, requesting smaller amounts of ransom from users. By doing this more often than to larger, less cost sensitive victims, the attackers can still achieve great amounts from attacks. Although the success rate may go down by applying phishing emails to a wide group of users (though as mentioned, recent developments have allowed attackers to get basic user details like postcodes), the range of user skills can cover more,

meaning basic users who would be more inclined to pay would be found by the Ransomware.

D. The psychology of a Ransomware victim

A quote made by James Scott from the Institute for Critical Infrastructure Technology said that "Ransomware is more about manipulating vulnerabilities in human psychology than the adversary's technological sophistication". Although the user may be at ransom with their data, the way in which attackers attempt to convince users to pay is by gaining the trust of a user. To do this various insightful ways have been produced over recent years, such as CryptoWall's method of giving a user one free decryption key in order to make it believable that the attackers actually have the ability to unlock the user's files [2].

Images of various Ransomware shown in the Bromium report actually show clear and helpful instructions on how to make payment, and how to decrypt files, again instilling trust with the user. By providing trust, a user will be more inclined to pay, which sets this type of malware apart from any others. Having a user wanting to pay the attackers rather than the attackers having to attempt to steal financial data using more aggressive software makes the work of an attacker in this situation much easier, and more profitable if the attacker can reach the Ransomware to many users.

II. HUMAN ERRORS

Because humans build and use machines, a mistake by a machine can usually be related back to an error by the human who built it. Therefore, the weakest part of any system appears to be the users, as stated by A Sharaki (Human errors in computer related abuses) [7]. The paper points out a number of ways a person can affect the usage and vulnerability of the system, which are not limited to:

- Fooled, distracted or persuaded
- Blackmailed- heavily related to Ransomware
- Be affected by human characteristics such as being tired, idle or apathetic

Any of the above can benefit viruses of any kind, making it easier for them to infiltrate computer and networks. Human errors are said to be distinguishable into two types, slips and lapses. Slips could be something such as attaching a wrong file in an email, whilst a lapse would be leaving systems open or unlocked. These two definitions were coined by James Reson (1990) [8], who compared mistakes to errors, stating that the mistake in the two cases mentioned previously was in not having an adequate plan for checking emails are from reliable sources. A mistake is therefore something that can heavily impact the possibilities of human error. By eradicating mistakes and being more prepared for human error, computer related abuses would be less frequent.

In addition to this, the paper by Sharaki noted that human error is part of a human behaviour and that because of many preceding events (or mistakes as mentioned), it may not be the fault of the human.

Designers and developers should be aware of the human errors issue, and therefore build mechanisms for dealing with

possible errors according to Sharaki. Even if a developer was to create a perfect system with no bugs, or a system that did exactly what it was supposed to do, they should always be designed with any possible misuse in mind. For instance, without blocking every email that comes into a user's system, there will always be a finite number of suspicious emails that will come through the spam filter, and at that point the security lies with the user. In the case of Ransomware, because of the growing advancement of email authenticity this is one example of a hard to avoid mistake without further user training.

In addition to the developers, Sharaki also asks for ISPs (Internet Service Providers to protect against spyware and viruses by actively stopping suspicious network activity, which take yet more room for error out of the hands of users.)

As stated already, even with many precautions in place, unintentional threat still remains an increasing problem for many organisations or stand-alone users. Alphonso Price (Human factors in information security, 2015) [9] gathered some statistics on mistakes made by users resulting in issues for their respective organisations, and found that 57% of employees believed that breaches in security caused by accidental or careless users are more damaging as breaches caused by intentionally malicious users. The author believed the reasoning for this lied with the fact that it is easier to predict the subject of attack when done purposely, but unintentional mistakes from other users are unpredictable and harder to foresee.

A. Human errors as a factor in attacks

By combining the proceeding examples of human errors in computing with how Ransomware attacks generally flow, some correlation can be seen. Several statistical reports on the web have begun to identify this, such as an article from the Visual media alliance [10] who have combined the increase in Ransomware attack numbers with the increase in users and amount of errors resulting. One concerning statistic given is that there is an 11% chance of an employee clicking on a phishing link (Ransomware or other phishing software), and letting the program entry into the system or company wide database.

Another frightening statistic provided by the report highlights the amount of time taken for attacks to take place. With most emails (including phishing emails) opened within one minute, it makes controlling the human factor of attacks much more difficult, and gives less time to prevent code reaching a system. For Ransomware, this is especially concerning due to the quick nature of the malware. As shown in previously in this paper, Ransomware is becoming more and more adept at picking efficient ways of attacking a file system when encrypting, by targeting less, but more important files. Because phishing emails are opened so quickly, Ransomware is given an ideal amount of time to attack and lock out a user.

Because Ransomware leaves less of a trail on a system when encrypting or locking out a user, the security of an organisation or user may not be enough, and relying on them may not be enough. The paper identifies this, and it is down to user skill or knowledge to help reduce threat levels. Reinforcing the idea of attacks being strongly correlated to

human error, Verizon's director of global security services stated that "Despite advances in information security research, we continue to see many of the same errors we've known for more than a decade now". This was said alongside the claim that 95% of cybersecurity incidents were due to human error [11].

III. LEGAL AND ETHICAL CONSEQUENCES OF RANSOMWARE

It is clear that the exposure of Ransomware is not only breaking laws, but is unethical. Although it is easy to see which laws are being broken from writing and releasing Ransomware software, there is also the implications for users or organisations that are allowing this malware to effect other users. This section looks at laws and ethical situations from the writing of Ransomware through to the exposure of it.

The Computer Misuse Act 1995 is designed to deal with hackers and viruses, and is one law that Ransomware breaks. Buy writing the malicious code designing to access computer material with intent to commit further offences (in this case, commit fraud) is one of the offences for which this law covers. In addition, it is generally thought of as extremely unethical by society to take advantage of a user's trust in order to receive payment from them. Because the software is essentially a scam, it is easy to pin several UK and international laws on any found attackers, but due to the anonymous protection (communicating through Tor, and payments through BitCoin) that attackers use, cases of Ransomware have very rarely resulted in charges.

On the other hand, organisations or internet services providers who do not provide sufficient protection against attacks may be breaking the Data Protection Act 1998. The act, which requires anyone holding another users' data, should make it as secure as possible. Although in some cases the law does not apply (such as individuals holding their own data), an ethical standpoint has been used in past Ransomware attacks where employees of attacked companies have accused their organisation of having too weak a security, and placing too much risk in the hands of themselves.

IV. PREVENTION FINDINGS

A. *Human error prevention*

B. *Ransomware prevention*

V. CONCLUSION

The conclusion goes here.

APPENDIX A

Appendix two text goes here.

ACKNOWLEDGMENT

The author would like to thank...

REFERENCES

- [1] BBC Technology News, *The Ransomware that knows where you live*, <http://www.bbc.co.uk/news/technology-35996408> BBC. 2016.
- [2] A. Kharraz et.al, *Cutting the Gordian Knot: A Look Under the Hood of Ransomware Attacks*, Northeastern University, Boston, USA. 2015.
- [3] Tech Target, *Advanced Encryption Standard (AES)*, <http://searchsecurity.techtarget.com/definition/Advanced-Encryption-Standard>. 2014.
- [4] V. Kotov and M. Rajpal, *Understanding Crypto-Ransomware*, Bromium Inc, 2015.
- [5] K. van Wyk, *Blaming Users for Virus Chaos?*, 3rd ed. <http://www.esecurityplanet.com/views/article.php/3377201/Blaming-Users-for-Virus-Chaos.htm>, 2004.
- [6] D. Balaban, *High profile ransomware victims: No one is safe - You could be next*, <http://www.esecurityplanet.com/views/article.php/3377201/Blaming-Users-for-Virus-Chaos.htm>, 2016.
- [7] A. Sharaki and M. Nikaram, *Human Errors in Computer Related Abuses*, Journal of Theoretical and Applied Information Technology Vol 47 No 1. 2013.
- [8] J. Reason, *Human Error*, Cambridge University Press. 1990.
- [9] A. Price and Y. Choi, *Human Factors in Information Security*, International Journal of Computer and Information Technology, Vol 04 Issue 05. 2015.
- [10] Visual Media Alliance, *Cyber Threat Mounts with Human Error and Ransomware*, <http://main.vma.bz/insurance/cyber-threat-mounts-with-human-error-and-ransomware>, 2013.
- [11] E. Mitchell, *Combating human error in cybersecurity*, <https://www.helpnetsecurity.com/2015/08/24/combating-human-error-in-cybersecurity/>, 2015.