

POLYTECHNIQUE MONTRÉAL

WORLD-CLASS ENGINEERING

COMPUTER SECURITY CLINICAL TRIALS
Lessons learned from a 4-month pilot study

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1 / Introduction
2 / Computer security clinical trials
3 / Lessons learned and Recommandations
4 / Conclusion and Future Work



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INTRODUCTION

- Security products are an important line of defence against current threats
- The success of malware depends upon both technical and human factors
- Users are involved in both the infection and protection process
- Security products should be tested:
  - With actual users that interact with the product
  - In a realistic environment
  - Over an extended period of time



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COMPUTER SECURITY CLINICAL TRIALS

- Security solutions would be installed and monitored on systems in regular use by regular users

- Data would be gathered on:
  - The performance of the security product in protecting the system
  - How the user interact with the system during this time period

- We performed a 4-month pilot study that involved 50 subjets in order to:
  - Develop and test the validity and viability of the methodology
  - Determine how malware infects computer systems and characterize sources of malware infections
  - Determine how factors such as the configuration of the system, the environment in which the system is used, and user behavior affect the probability of infection of a system



COMPUTER SECURITY CLINICAL TRIALS

- Protocol certification and approval
  - Computer security risks evaluation committee
  - Reseach ethics review committee

- Computer risk
  - Guarantee that subjects were not going to be significantly more at risk than the average home computer user who had installed an up-to-date reputable antivirus
  - Protect the university's IT infrastructure as the experiment implied manipulation of malware files

- Ethics and privacy considerations
  - Guarantee the anonymity of the participants
  - Guarantee confidentiality of the data collected



COMPUTER SECURITY CLINICAL TRIALS

- Equipment:
  - We provided the same laptop to the subjects
  - All laptops had an identical configurations (OS, tools, AV product, etc)

- Data collected with scripts:
  - List of applications installed and applications for which updates are available
  - Number of Web sites visited and type of Web sites visited
  - Number and types of files downloaded
  - The list of different locations from which the laptop establish connected to the Internet
  - The list of plug-ins installed
  - Number of different hosts to which to laptop communicated
  - Number of hours per day the laptop is connected to the Internet
  - Number of hours per day the laptop is on



COMPUTER SECURITY CLINICAL TRIALS

- Subject recruiting by advertising the experiment on the University campus

- Users were required to attend 5 in-person sessions

  Initial session:
  - Obtain informed consent from users
  - Provide laptop to users
  - Invite users to complete initial questionnaire (gender, age, status, field of activity, etc.)

  Monthly sessions:
  - Invite users to answer on-line questionnaire to:
    - Assess experience and opinion of the AV product
    - Gain insights about how the computer was used
    - Determine users' level of security awareness and measure of due diligence they exert to secure their computer
  - Collection of statistical data



COMPUTER SECURITY CLINICAL TRIALS

Monthly sessions:

- Analysis of the computer to find malware missed by the AV product
  - Tools: HijackThis, ProcessExplorer, Sigcheck, Autoruns, SpyBHORemover, SpyDLLRemover, Whatchanged, Winprefectview
  - Elements were classified using external online ressources: *www.systemlookup.com*, *www.processlibrary.com*, VirusTotal, Anubis, etc.
  - Files identified as suspicious or dangerous were subject to an in-depth investigation

- If a malicous file is identified by the AV product or our protocol:
  - User is asked to answer a questionnaire to collect more information regarding the potential means and sources of the infection, and any behavioural changes obserbed on the computer
  - Additional consent is requested from user to collect specific data, such as the browser history, the tshark log files, and the suspected file(s)



COMPUTER SECURITY CLINICAL TRIALS

Final session:

- Similar to the other monthly sessions
- Users had to answer a post-experiment questionnaire to:
  - Assess their overall experience in the study
  - Help us ide
- Users were asked to keep the collected data for an additional period of 3 months in the event me might need to perform more in-depth analysis on the computer
- We provided users procedures to:
  - Stop the automatic collection of the data
  - Delete the data and tools we installed
  - Reinstall the operating system, if they wanted to do so



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LESSONS LEARNED AND RECOMMANDATIONS

Estimate the required population size before the study

- The required population size is based on many factors:
  - Form of the experiment
  - Hypotheses to be tested
  - Desired power of experiment results
  - Budget available

- Power analysis can help estimate the number of subjects based on:
  - The desired power (indicator of how statistically significant the results may be)
  - The desired statistical level of significance
  - The effect to be measured (estimated based on prior studies, literature review, logical assertation and conjecture)



LESSONS LEARNED AND RECOMMANDATIONS

Select users on a scientific and ethical basis

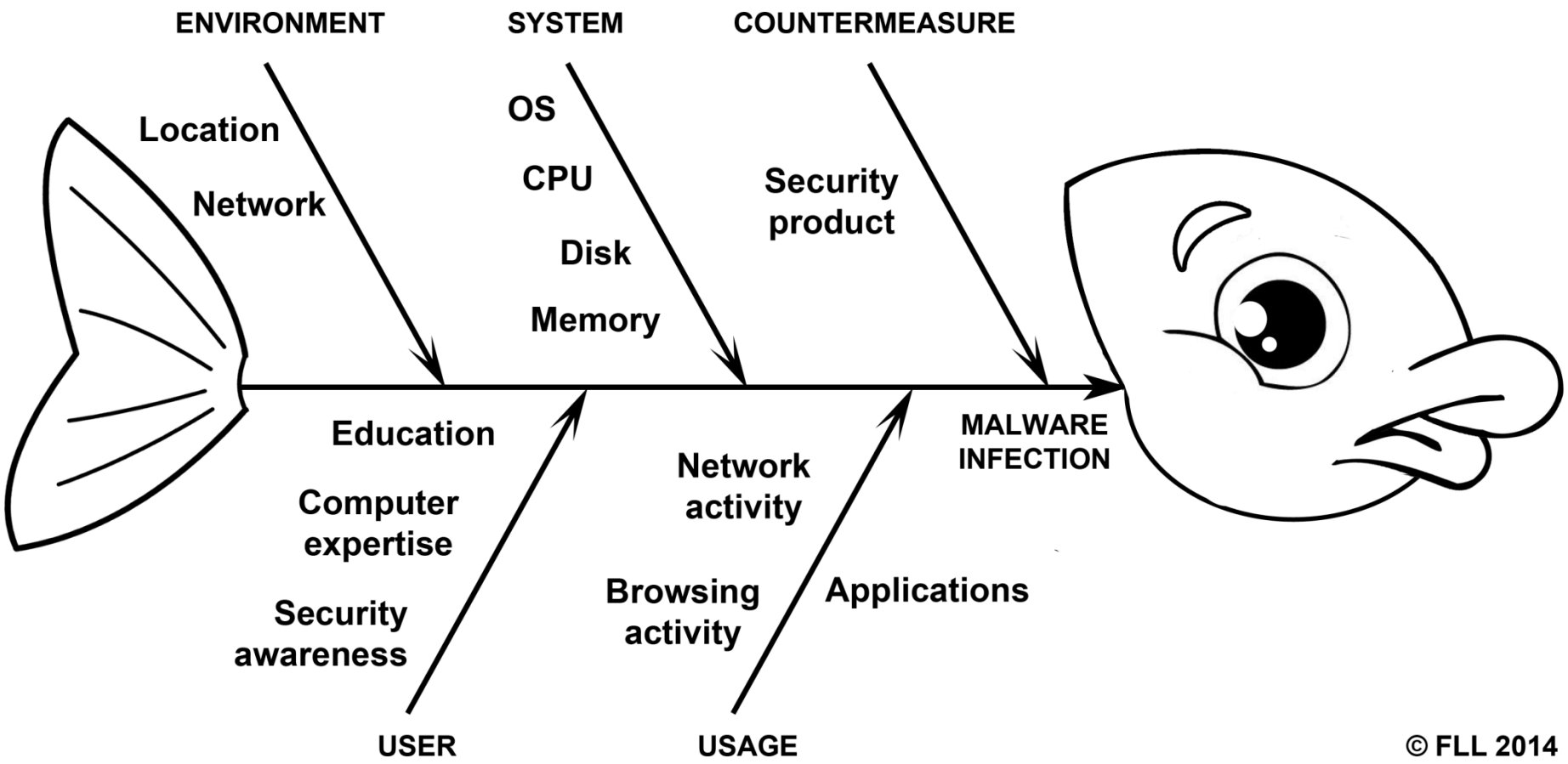
- Specify the target population using appropriate inclusion and exclusion criteria
- Recruit users based on their characteristics depending on the hypotheses to be tested

LESSONS LEARNED AND RECOMMANDATIONS

Identify relevant independant variables

- Choose the data to be collected based on the research questions
- Identifiy appropriate independant variables that may affect the dependent variable
- How ? Produce an Ishikawa diagram (aka fishbone diagram or cause-and-effect diagram) to identify potential factors

LESSONS LEARNED AND RECOMMANDATIONS



LESSONS LEARNED AND RECOMMANDATIONS

Select the appropriate data collection method

- The collection method should depend on:
  - The data you want to collect
  - The research questions you want to address
  - The type of data analysis you want to perform

- Example: We collected the number of applications installed thought surveys and scripts
  - Average number of applications installed from surveys = 19.02
  - Average number of applications installed from real data = 67.78
  - Recommandation: survey results should be cross-checked with another collection source before analysis



LESSONS LEARNED AND RECOMMANDATIONS

Understand the data before the analysis

- Collected data should be subject to an in-depth investigation to detect and understand any anomalies such as:
  - Missing data
  - Outliers (residual analysis)

- Example: One user had more than 100 detections from the AV product when all others had less than 30 detections
  - Cause: An infected file that the AV was not able to remove, which resulted in multiple detections
  - User has been considered as an outlier and was removed for the analysis



LESSONS LEARNED AND RECOMMANDATIONS

Ground truthing and in-depth analysis

- Number of malware encounters: provided by the AV
- Number of malware infections: based on our protocol
  - Could have been underestimated
- Type of malware
  - Malware classification is inconsistent from one AV vendor to another
  - The problem is even worse with unwanted software (adware, spyware, etc.)
  - Solution: in-depth forensics analysis based on the collected data



LESSONS LEARNED AND RECOMMANDATIONS

Evaluate potential bias before the study

- Controlling factors can reduce experimental bias, but they can also reduce the ecological validity of the results

- We had to control system configuration variables that could affect AV performance in protecting the system
  - Users had the same laptop, same OS, same AV, same tools, etc.
  - They not allowed to install another AV, uninstall or disactivate the AV being evaluated

- We decided to evaluate the bias related to user behavior and environment, rather than control it
  - Users share their computer, use VM, use a private navigation mode, etc.
  - We asked the users at the end of the experiment how they may have changed their behavior knowing that they were participating in the study



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CONCLUSION AND FUTURE WORK

- We showed that computer security clinical trials are a viable and complementary alternative to traditional testing
- Designing and conducting such studies presents many scientific, technical and ethical challenges
- Computer security clinical trials could:
  - Help AV vendors to improve their products and understand how users adopt security solutions and react the security threats
  - Be applied to evaluate the effectiveness of training and education on users
  - Help key deciders in IT to make better evidence-based decisions



QUESTIONS

Results were presented in :

- « A clinical study of risk factors related to malware infections » , ACM CCS 2013

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