Executive Summary

Spurred by the prevalence of always-on, high-speed connections, the Internet has become a powerful tool for enhancing innovation and productivity. The increasing dependence on the Internet and other communication networks, however, means the Internet has also become a popular and efficient way to distribute computer viruses and other types of malicious software.

"Viruses", "worms" and "zombies" might sound like science fiction, but they are in fact the reality presented by the spread of malware. The power and threat of malware are that it can infiltrate, manipulate or damage individual computers, as well as entire electronic information networks, without the users' knowing anything is amiss.

All of this has brought the electronic world to an important juncture. The onslaught of malware attacks is increasing, both in frequency and sophistication, thus posing a serious threat to the Internet economy and to national security. At the same time, current efforts to fight malware are not up to the task of addressing this growing global threat; malware response and mitigation efforts are essentially fragmented, local and mainly reactive.

This report is a first step toward addressing the threat of malware in a comprehensive, global manner. As such, the report has three major aims: (1) to inform policy makers about malware – its growth, evolution and countermeasures to combat it; (2) to present new research into the economic incentives driving cyber-security decisions; and (3) to make specific suggestions on how the international community can better work together to address the problem.

The need for a consistent approach to a global problem is not new, but malware presents particular challenges owing to the wide variety of actors working on the problem: governments, businesses, end users and the technical community. These different actors need to improve their understanding of the challenges each of them faces and to co-operate, within their communities and across communities. Furthermore, this co-operation must occur at the global level. It is not enough for one country or one community to effectively self-organise if others do not do so as well.

In light of the need for a holistic and comprehensive approach to malware, a common point of departure is needed from which to build co-operation and collective action. This report calls for the creation of a global "Anti-Malware Partnership" involving governments, the private sector, the technical community and civil society.

The rise of malware

No longer limited to the realm of computer hackers and tech researchers, malware in the 2000s has become a serious business and a multi-million-dollar criminal industry. The major drivers can be summarised as follows:

Malware is widely available. Virtually anyone can buy it online at a nominal cost, as well as from underground markets. And malware is user-friendly, meaning it provides attackers with the capability to launch prolonged, sophisticated attacks beyond their skill level.

Malware can infect all sorts of devices. Since it is nothing more than a piece of software, malware can infect not only personal computers but also the backbone of the Internet – the servers and routers that move data worldwide. While malware often propagates through the Internet, it is important to note it can also be introduced into computer systems not connected to the Internet.

Malware is profitable. Together with other cyber tools and techniques, malware is a low-cost, reusable way to carry out highly lucrative forms of cybercrime. Two prime examples are the capture of credit card and bank account data via "spyware" and the launch of "denial-of-service" attacks used to extort money or concessions.

The costs

Malware can harm critical information infrastructures, cause major financial losses and, perhaps worst of all, undermine trust and confidence in the Internet economy. Therefore, malware is increasingly a shared concern for all Internet market participants: governments, businesses and individuals in both OECD countries and Asia Pacific Economic Co-operation (APEC) economies.

Governments, for one, are increasingly dependent on the Internet for providing services, making them and their citizens vulnerable to malware. In addition to the complex and expensive task of securing their own systems, governments are being called upon to protect the general public from online ID theft and other Internet crimes.

Malware is also taking a toll on the private sector. With few exceptions, many private Internet market participants – from Internet Service Providers

to e-commerce companies to software vendors – have had to increase security-related investments in order to expand their online business.

The key Internet market participants interviewed for this book (please see Part II) were devoting an estimated 6% to 10% of their technology budgets to protect against malware. Combined with indirect costs (such as funding watchdog organisations, public education campaigns and law enforcement efforts) the total costs of malware for key Internet market participants may well be above 10% of technology spending.

Problematic trends

As explained in Part I, the deployment of malware is becoming ever-more sophisticated and targeted, presenting a great challenge to those attempting to measure and combat the problem. Key findings include:

- Self-sustaining cyber attacks increasingly depend on "botnets", or groups of malware-infected computers (also called "zombies") that can be used to remotely carry out attacks against other computer systems.
- Many malware attacks are smaller and deliberately limited in scope, in an attempt to stay "below the radar" of the security and law enforcement communities.
- Spam has evolved from a nuisance, to a vehicle for fraud, to a vector for distributing malware.
- The overall malware problem is difficult to quantify: no single entity has a global understanding of the scope, trends, development and consequences of malware.
- Data on malware are not consistent, and terminology for cataloguing and measuring the occurrence of malware is not harmonised.
- The effectiveness of current approaches in combating malware is constantly challenged by both ongoing technological changes and faster exploitation of software vulnerabilities.

The role of economic incentives

To a great extent, cyber security is affected by the behaviour of the key Internet market participants: Internet Service Providers; e-commerce companies; domain name registrars; software vendors; and end users. Part II of this book presents new field research on how these Internet market participants make their information-security decisions.

During 2007, 41 in-depth interviews were conducted with organisations confronted with malware. In each instance, the following questions were asked: how the organisation is confronted with malware; what its responses

are; what trade-offs are associated with these responses; and how the organisation is affected by the security actions of other market participants. Some key findings were:

- How key market participants address malware is greatly influenced by the specific incentives they face: greater online traffic vs. higher security costs, for example. Some of these incentives work to enhance online security while others work to reduce it.
- In many instances, market participants make decisions that pass on the costs of malware to others in the network (thus "externalizing" them), such as when end users opt not to protect their computers against viruses.
- Owing to existing feedback loops, which should be strengthened and expanded, the extent of passed-on costs and benefits is probably smaller than had been previously assumed. On the other hand, many of these passed-on costs remain unaddressed.

A global approach

While this work details many of the problems presented by malware, it is only a first step towards a solution. To prevent malware from becoming a serious threat to the Internet economy and to national security, a global partnership against malware is needed.

A wide range of communities and actors – from policy makers to Internet Service Providers to end users – all play a role in combating malware. But there is still limited knowledge, understanding, organisation and delineation of the roles and responsibilities of each of these actors.

Therefore, a global "Anti-Malware Partnership" should involve not only governments, but also the private sector, the technical community and civil society. Such an inclusive, co-ordinated effort would be more likely to produce co-ordinated policy guidance to fight malware on all fronts – from educational to technical to legal and economic.

This type of international co-operation should be supported and enhanced by accurate measurement of the problem and analysis of the underlying economics at play. Also, the limitations of current actions against malware should be addressed, and the question of how to strengthen anti-malware incentives for market participants should be further explored.

Improvements can be made in many areas, and international co-operation would benefit greatly in areas such as: proactive prevention (education, guidelines and standards, research and development); improved legal frameworks; stronger law enforcement; improved tech industry practices; and better alignment of economic incentives with societal benefits.

Background

The Organisation for Economic Co-operation and Development (OECD) Working Party on Information Security and Privacy (WPISP) and the Asia Pacific Economic Co-operation Telecommunication and Information Working Group (APEC TEL) Security and Prosperity Steering Group (SPSG) have both experience and expertise in the development of policy guidance for the security of information systems and networks.

In 2002, the OECD adopted the *Guidelines for the Security of Information Systems and Networks* ("the *Security Guidelines*") which provide a clear framework of principles at the policy and operational levels to foster consistent domestic approaches to addressing information security risks in a globally interconnected society. More broadly, the *Security Guidelines* reflect a shared ambition to develop a culture of security across society, so that security becomes an integral part of the daily routine of individuals, businesses and governments in their use of Information and Communication Technologies (ICTs) and in conducting online activities.[1] In 2003 and 2005, the OECD monitored efforts by governments to implement national policy frameworks consistent with the *Security Guidelines*, including measures to combat cybercrime, develop Computer Security Incident Response Teams (CSIRTs), raise awareness, and foster education as well as other topics (OECD, 2005a). In 2006 and 2007, the OECD focused on the development of policies to protect critical information infrastructures (OECD, 2007c and 2008).

Likewise, in 2002, APEC issued the APEC Cybersecurity Strategy outlining six areas for co-operation among member economies including legal developments, information sharing and co-operation, security and technical guidelines, public awareness, and training and education. To supplement the APEC Cybersecurity Strategy, in 2005 the APEC TEL adopted the Strategy to Ensure a Trusted, Secure, and Sustainable Online Environment to encourage APEC economies to take action for the security of information systems and networks.

Shared OECD and APEC objectives

In 2005, the APEC and OECD co-organised a workshop to share information on evolving information security risks and to explore areas for further co-operation between the organisations to better tackle the international dimension of information security risks. In 2006, both organisations agreed that the need to encourage a safer and more secure online environment was more pressing than ever due to the continued growth of economic and social activities conducted over the Internet and the increased severity and sophistication of online malicious activity. Subsequently, they decided to organise a workshop[2] and develop an analytical report to examine the issues of malicious software, commonly known as "malware", with a view to:

- Informing national policy makers on the impacts of malware.
- Cataloguing trends in malware growth and evolution.
- Examining the economics of malware and the business models behind malicious activity involving malware.
- Evaluating existing technical and non-technical countermeasures to combat malware and identify gaps; and,
- Outlining key areas for action and future work.

Prepared by the OECD Secretariat in close collaboration with volunteer government experts from OECD and APEC as well as the private sector, this report does not discuss every aspect of malware, all types of malware, or all propagation vectors. Rather, it focuses on issues of significant concern and areas which may pose problems in the future. Similarly, the report does not examine all possible strategies associated with preventing, detecting and responding to malware but rather focuses on elements of relevance to OECD member countries, APEC economies, and other governments and organisations more broadly. Finally, the report refers to forms of cybercrime, such as spam and phishing[3] that may not *directly* involve the use of malware but nevertheless demonstrate how malware can also be used *indirectly* to facilitate cybercrime.

Notes

1. The United Nations, the Council of the European Union, the Asia Pacific Economic Co-operation (APEC) and the Asia-Europe Meeting (ASEM) all recognised and used the Guidelines in their work.

2. Information on the joint APEC-OECD Malware Workshop is available at: *www.oecd.org/document/34/0,3343,en_2649_34255_38293474_1_1_1_1,00.html*.

3. Phishing refers to a social engineering attack, where an attacker manipulates a user to disclose their online account access credentials or other personal information (typically) to a website in the control of an attacker. According to this definition phishing may not *directly* involve malware. However, when the term is used to, for example, also refer to certain types of Trojan attacks, malware is implicated.

Glossary of Malware Terms

Authentication factors: Used to obtain access; something the user knows (such as a password); something the user has (such as a credit card or token); or something the user is (a photograph or thumbprint).

Authentication/Authenticity: Being able to prove or verify a person's or entity's identity with a certain level of assurance. Authentication mechanisms are used to provide access control to information systems.

Availability: Ensuring that digital data within an information system and the system itself are available to authorised users.

Backdoors[1]: A backdoor is malicious code that allows unauthorised access to a computer system or network by accepting remote commands from an attacker elsewhere on the Internet.

Bluejacking: Sending unsolicited messages to Bluetooth connected devices.

Bluesnarfing enables unauthorised access to information from a wireless device through a Bluetooth connection.

Bot programme: A type of 'backdoor' programme that allows attackers to remotely control many compromised information systems (often thousands) simultaneously (or individually).

Botnet(s): Group of malware infected computers that can be used to remotely carry out attacks against other computer systems.

Confidentiality: Being able to protect information and data from unauthorised access.

CERTs: Computer emergency response teams.

CSIRTs: Computer security incident response teams.

DDoS: Distributed denial of service attacks.

1. NIST (2005), pp. 2-12.

Digital certificate: A means of authenticating an identity for an entity when doing business or other transactions on the web or on line. Digital certificates exist as part of public key infrastructures (PKI).

Domain name: The identifier or address of any entity on the Internet. Domain Name System (DNS): The way Internet domain names are located and translated into an Internet Protocol, or IP, address. For example, the domain name www.oecd.org is a more user friendly and memorable alternative to the IP address 193.51.65.71.

Honeynet: Two or more honeypots on a network form a honeynet.

Honeypot is a trap set to detect, deflect or in some manner counteract attempts at unauthorised use of information systems. Generally it consists of a computer, data or a network site that appears to be part of a network but which is actually isolated, (un)protected and monitored, and which seems to contain information or a resource that would be of value to attackers.

Integrity: A primary security goal of information systems which seeks to ensure that the system as a whole (people, data, software) have not been compromised and can continue to be trusted. Internet Protocol The native language of programmatic communication on the Internet.

Keystroke loggers[2] *:* A hidden programme that records and "logs" each key that's pressed on the compromised system's keyboard, as the legitimate user of the system is typing.

Malware payload: The primary function of a piece of malware.

Non-repudiation: A security goal which seeks to prevent a person from denying they undertook an electronic transaction when they did.

Operating system: A computer program that manages the hardware and software on a computer.

Packet: The minimum autonomously-routable quantum of data which can be transmitted across a modern digital "packet switched" network.

Patch/Workaround: A small piece of software code designed to correct or rectify an existing bug or flaw in an operating system or application programme. A work-around is a set of actions that network security managers can take to reduce their exposure to a known software vulnerability.

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2. Ibid.

Payload: The essential data that is being carried within a packet or other transmission unit. The payload does not include the "overhead" data required to get the packet to its destination.

Rootkit: A set of programmes designed to conceal the compromise of a computer at the most privileged "root" level, by modifying operating system files or inserting code into the memory of running processes.

Social engineering: Techniques designed to fool human beings into providing information or taking an action that leads to a subsequent breach in information systems security.

Spam: Commonly understood to mean bulk, unsolicited, unwanted and potentially harmful electronic messages.[3]

Spoofing is a technique designed to deceive an uninformed person about the origin of, typically, an e-mail or a website.

Spyware: A form of malware that is capable of capturing a range of data from user input (keyboards, mice) and output (screens) and other storage (memory, hard drive etc.) and sending this information to the attacker without the user's permission or knowledge.

Transaction signing: The process of calculating a keyed hash function to generate a unique string that can be used to verify both the authenticity and integrity of an online transaction.

Trojan horses: A computer program that appears legitimate but actually has hidden functionality used to circumvent security measures and carry out attacks.

Virus: Directly analogous to its biological namesake, a virus is hidden code that spreads by infecting another program and inserting a copy of itself into that program.

Vulnerability: A flaw or weakness in a system's design, implementation, or operation and management of software that could be exploited.

Worm: A type of malware that self replicates without the need for a host programme or human interaction.

3. OECD (2006).

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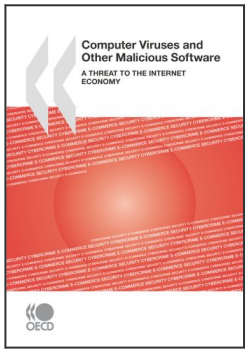

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