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Defending against Zero-Day attacks

Bob Mahoney

Zanshin Security, LLC

MIT Security Camp August 15-16, 2006

Presentation focuses on the Incident Response relevance of a research project Zanshin did for Verdasys, Inc. (http://verdasys.com) earlier this year.

Project considered the role their “Digital Guardian” product might play in a Defense-in-Depth strategy, and gauging the effectiveness against Zero-Day attacks.

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Somewhere, an intellectual property lawyer just got his wings.

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Digital Guardian and Defense-in-Depth

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Yes, this is a commercial product.

But like the other tips and techniques we share at Camp, the content or ideas might be useful to some people.

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Malware is a general term for “malicious software”. Everyone agrees a virus is malware, but near the edges live things like “beneficial” worms and DRM mechanisms such as the now famous “Sony rootkit”.

Zero-day exploits are released on the same day the vulnerability becomes known to the public. The term derives from the number of days between a public advisory and the release of an exploit. The term 'zero-day exploits' is sometimes used to indicate publicly known exploits for which patches have not yet been made available.

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Digital Guardian

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Central server manages intelligent agents

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Agents enforce compliance with policy

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Server provides alert and audit functions

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Server provides alert and audit functions

System functions as a “Reference Monitor”

The Reference Monitor model:

Provides mandatory enforcement of security policies regarding all *user*, *program*, or *data* transactions.

"The Reference Monitor watches what other processes do and, where necessary, intervenes; otherwise it is, like the very best security products, entirely invisible and entirely inescapable. A good conscience is like that, too; just as no one wants to live with people who do not have a conscience it is now time to say that no computer that has its hands on valuable bits should not have a reference monitor."

From a Verdasys Whitepaper, "Defending in Depth" http://verdasys.com/pdf/did.pdf

http://www.craigchamberlain.com/ has a link to a paper by Craig Chamberlain, Donato Bucella, Daniel Geer, Sc.D. Presented at DHS Science & Technology 2005:

"A Host Reference Monitor Approach to the Problem of Human and Programmatic Insider Threat to Computer Information Systems"

The Reference Monitor model:

Put another way, the system functions much as a conscience would in an honest person.

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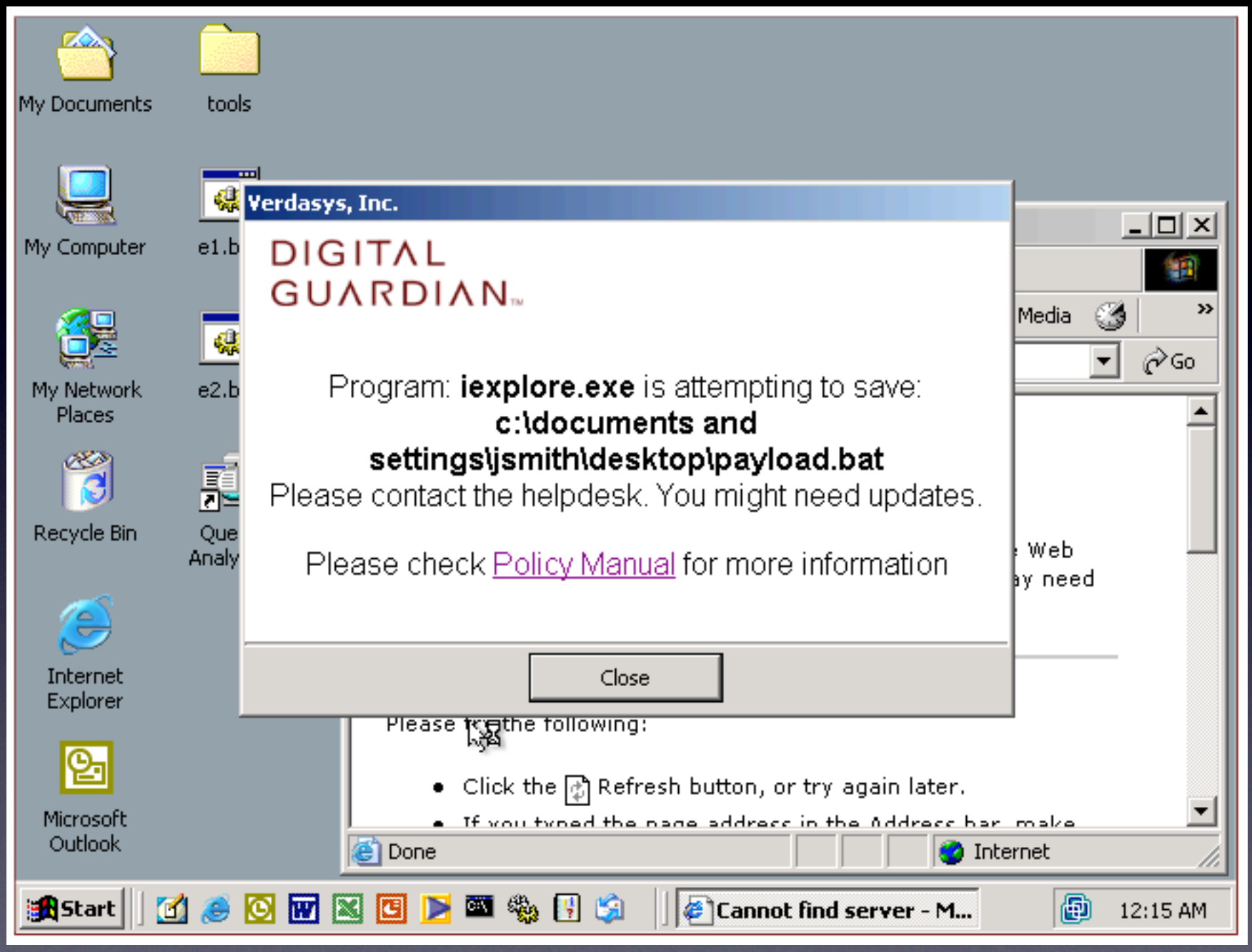
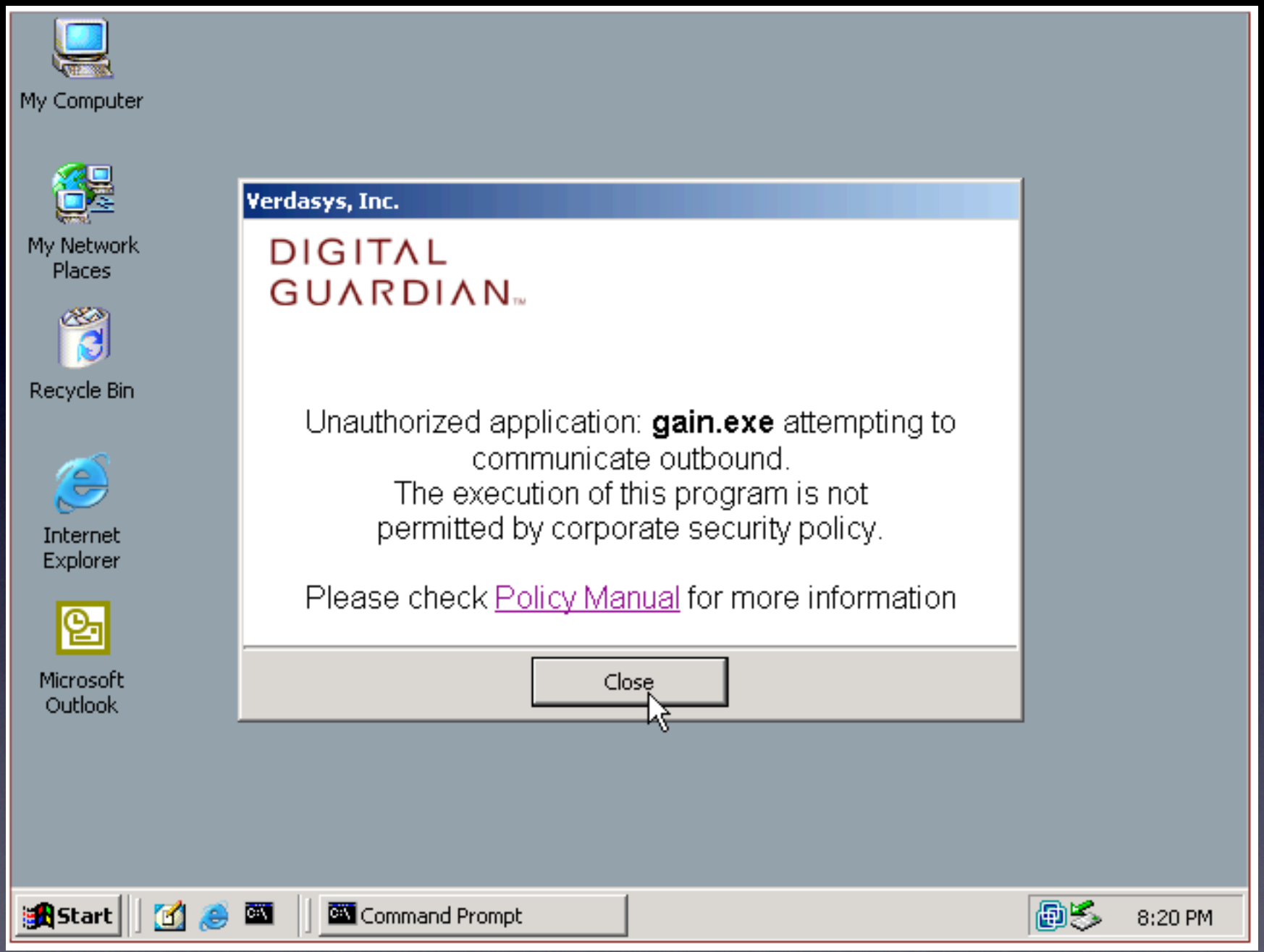


Screen shots grabbed from this Flash demo: http://verdasys.com/demos/def_in_depth



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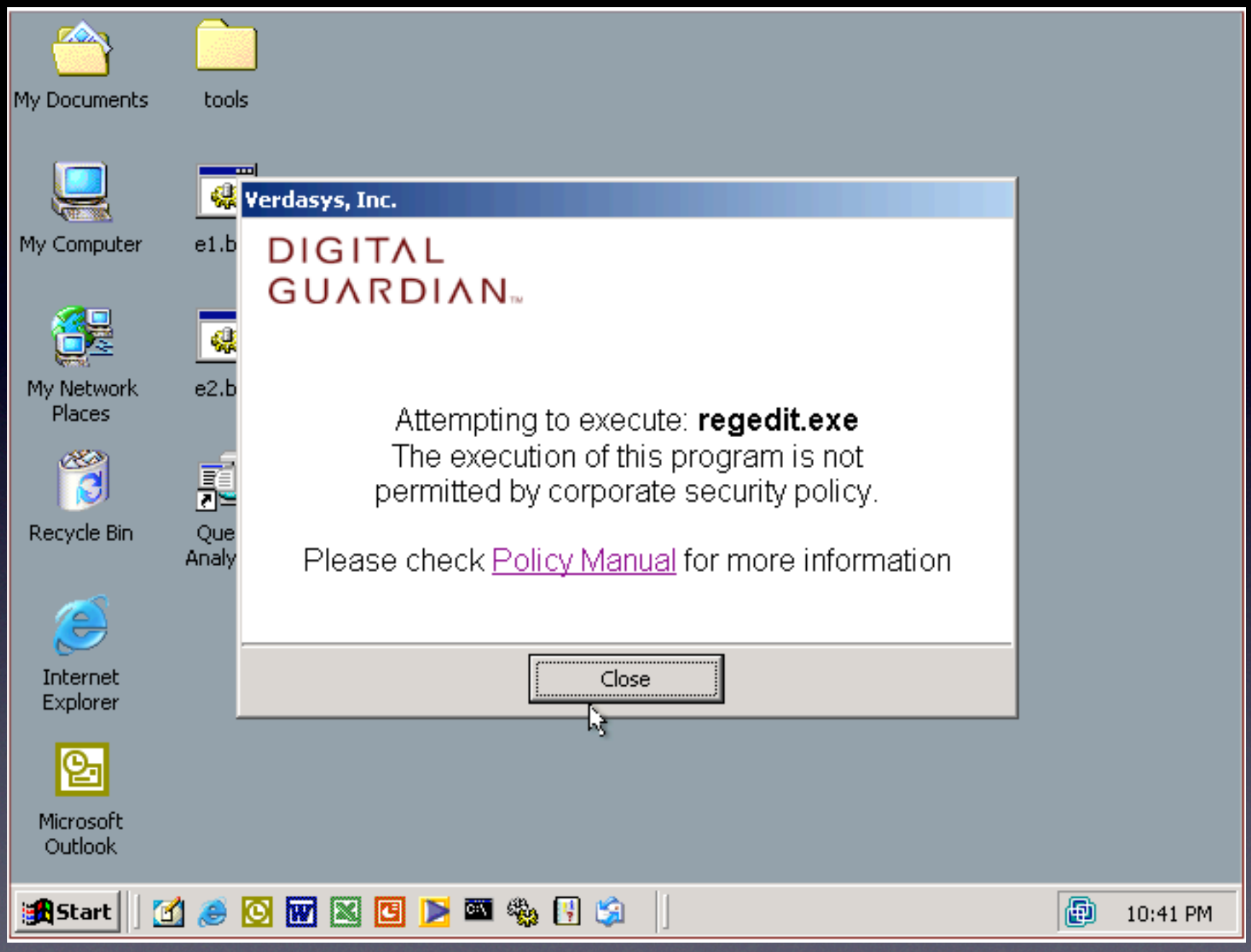

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Our Mission:

A primary goal of an organization's IT security function is to make sure that the IT assets are available for their intended use, and can be relied upon. Other goals such as preventing fraud, intrusion, or other misuse are critical, of course, but IT assets are a tool, and the tool has to function as intended for their to be any basic value.

We need to protect corporate financial records, but the primary role of these systems is to manage and support the financial operations of the organization.

When security appears to trump functionality, it's likely that the real function of the asset is security-related. (military, life-safety, etc)

Our Mission:

Maintain the integrity, availability, and security of organizational IT assets.

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Functionality *always* trumps security

Incident response takes place in the presence of *high uncertainty*

High Uncertainty means we might not have seen this coming, at least not as a specific event in time. We may not be sure at first what is happening. Things we do with the best intentions might make things worse, or obscure the actual causes.

At the user/organizational level, Functionality is demanded. The security of systems and processes is often merely *assumed*. (“Life is not fair”)

Incident Response can be hard: The kitchen is hot, everything is sharp, and the lights keep going out. (see “Life”, above)

Challenges

People, of course, are the biggest challenge.

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Fear and Uncertainty
cause delay and *confusion*

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Fear and Uncertainty
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Time and Trust Pressures
make achieving consensus
on incident response *hard*

People, of course, are the biggest challenge.

Incident Management

With luck, you have smart security people, and you've done your homework.

Early notice of problems via trusted channels, if you're lucky.

Determine what your exposure is

Figure out what you'll do about it

Communicate to user community, and take steps to prevent problems

Incident Management

Border Protections

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Host-based protections

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Incident Management

Policy Implementation
Organizational
Technological

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Incident Management

User Education and Awareness

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Getting this right is hard

Security Response is hard, and sometimes, the other kids don’t much like us…

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Most actions have side effects

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Most side effects represent costs

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Most actions have side effects

Most side effects represent costs

New costs will meet resistance

Security Response is hard, and sometimes, the other kids don’t much like us…

Image stolen under the assumption that “Anarchy, Inc.” probably doesn’t have a lot of intellectual property attorneys.

University networks are rather more subject to individual freedom and choice than in most organizations...

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Patches are hard.

Patches are hard. They must be written under pressure, usually by the group “responsible” for the problem at hand

Patches must be tested thoroughly, because damage to systems, not to mention further damage to vendor reputation, is at stake

> “Pick One...”

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Complete?

Safe?

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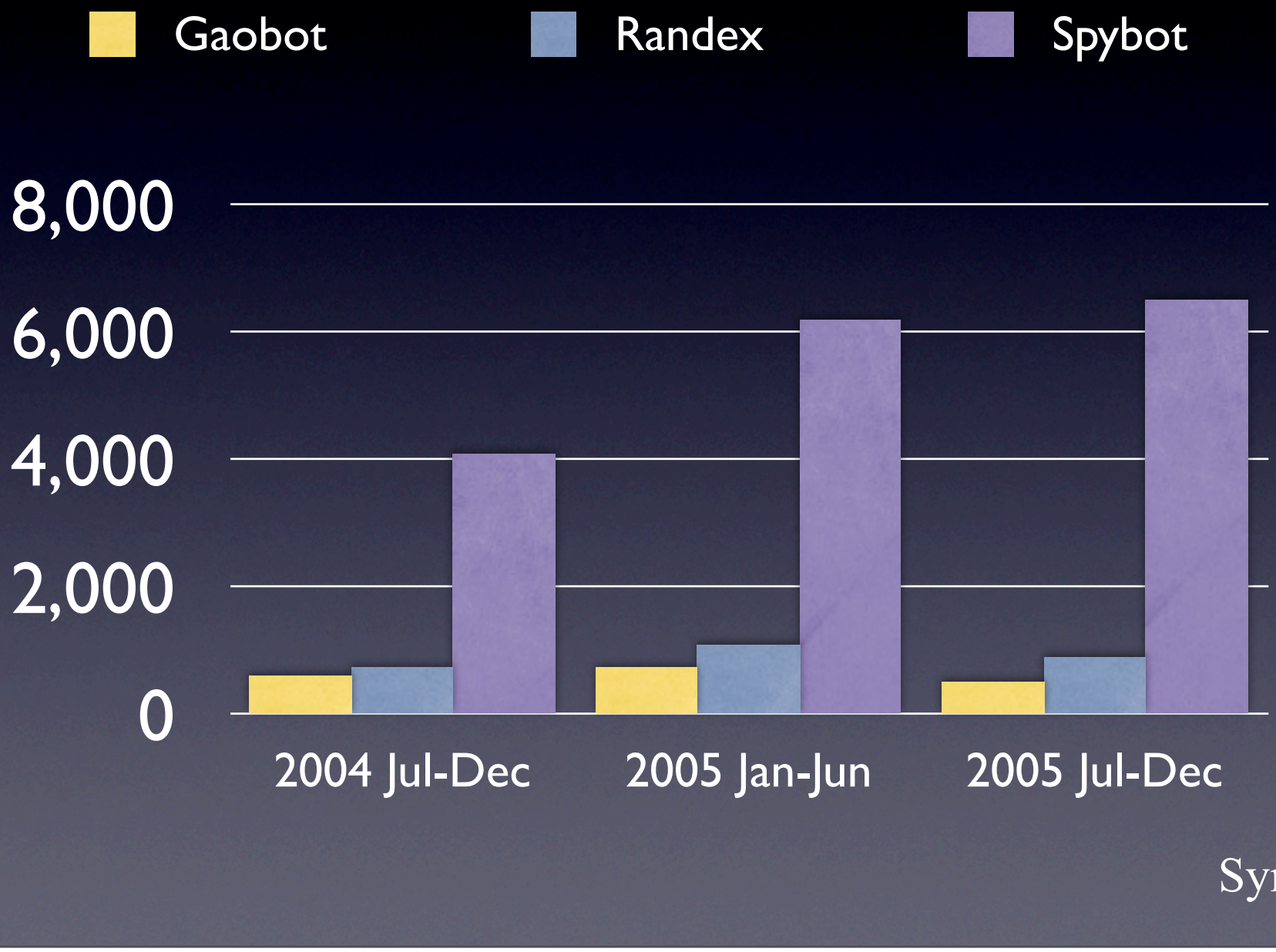
“Pick One...”

Trends

This section on threat “trends” is based on analysis of recent reports and publications done by Dan Geer, who who generously shared his work with me for use in this talk. Sources include the CSI/FBI Report, the Symantec Threat Report, the Anti-Phishing Working Group, Webroot Software, and the Counterpane Attack Trends Report.

My thanks to him for sharing his work and insights, and for taking all those statistics courses... (I wasn’t going to pass anyway)

Top 3 new Bot variants



Note that for Spybot, this is 1.5 new variants Every Hour

Dan: “One can almost consider variation rates like this to be denial of service (DoS) attacks on the computer immune system.”

Data Source: Symantec Threat Report

Phishing

From Anti-Phishing WG data

Phishing

Phishing email reports are up 35%

From Anti-Phishing WG data

Phishing

Phishing email reports are up 35%

Number of URLs used is up 250%

From Anti-Phishing WG data

Phishing & Malware

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Over the past year:

From Anti-Phishing WG data

Phishing & Malware

Over the past year:

172% increase in malware variants

From Anti-Phishing WG data

Phishing & Malware

Over the past year:

172% increase in malware variants

324% increase in urls used

From Anti-Phishing WG data

Phishing & Malware

There are over 200 new variants of ride-along malware each month

From Anti-Phishing WG data

Us *vs.* Them

We (defenders) need to work harder as the number of attacks increases.

They (attackers) need to work only hard enough to make the next variant.

“As [creating new variants] is now automated, the arms race between attacker and defender can be manipulated by the attacker to bankrupt the defender.”

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Malware variants increased by 28X

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"As [creating new variants] is now automated, the arms race between attacker and defender can be manipulated by the attacker to bankrupt the defender."

"When you are dealing with rootkits and some advanced spyware programs, the only solution is to rebuild from scratch. In some cases, there really is no way to recover without nuking the systems from orbit."

Mike Danseglio, Program Manager, Security Solutions Group, Microsoft, April 3, 2006.

"Reality Bites"

Microsoft's *Antivirus Defense-in-Depth Guide*

"...viruses, worms, and Trojan horses continue to infect computer systems around the world.

There is no single reason for this apparent contradiction, but the current situation indicates that the standard approach of deploying antivirus software on each computer in your environment may not be sufficient."

http://www.microsoft.com/technet/security/topics/serversecurity/avdind_0.mspx

Zero-Day Project Goals:

Project Summary: “We would like you to dip our product in a variety of poisons and hot oils, and see what happens.”

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Investigate DG's ability to provide protection against Zero-Day attacks

Project Summary: "We would like you to dip our product in a variety of poisons and hot oils, and see what happens."

Approach

Simply put, if we can do this, we win.

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Protect User Data

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Protect Local Applications

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Zanshin Malware Lab

Zanshin Security assembled a library of malware from existing collections (including the Nepenthes library as of February 2006) and private efforts. At the time of this project, Our malware library included some 3260 unique worm samples (of which 2552 were Korgo/Padobot variants).

We selected 24 worms to serve as a representative sample, covering 93% of our library. Our samples included one of each uniquely-identified variant from each worm type/family. Identification was performed using ClamAV.

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Manually

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Malware
Strategy & Tactics

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Infection mechanisms and targets

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Propagation

Malware
Strategy & Tactics

Infection mechanisms and targets

Propagation

Self-Preservation

Targets

Targets

Executable files

Targets

Executable files

Documents and data files

Propagation

Propagation

Removable storage

Propagation

Removable storage

Email and other network downloads

Self-preservation

Stealth by Design Malware doesn’t rely on conventional rootkit technology to hide itself, instead makes stealth a core design goal.

See http://invisiblethings.org

Polymorphic code is code that mutates while keeping the original algorithm intact.

Metamorphic code is code that can reprogram itself. Often, it does this by translating its own code into a temporary representation, and then back to normal code again. This is used by some viruses when they are about to infect new files, and the result is that their "children" will never look like themselves.

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Malware propagation mechanisms often use network ports that are needed by relatively few, well-known, legitimate system programs.

Although malware does often write to the registry, it is uncommon for registry changes alone to be sufficient for the malware's viability, and it is rare for the registry changes to have an independent impact on the integrity or usability of the system.

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In the actual tests performed, we found that 30% of network worms were completely blocked, and the remaining 70% were ineffective but left some artifacts on the system.

In one of these cases, the vulnerability was not exploited successfully, causing LSASS.EXE to crash and the system to reboot 60 seconds later (the expected result under these conditions).

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Digital Guardian & Incident Response

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Digital Guardian & Incident Response

We can push out rules to block a specific activity

We have the agility to rapidly refine the rule as new information warrants

The background for the sort of IR events we're considering was discussed in more detail in our paper on incident response and large event management:

http://www.zanshinsecurity.com/archive/zanshin-incidentresponse.pdf

Digital Guardian & Incident Response

We can push out rules to block a specific activity

We have the agility to rapidly refine the rule as new information warrants

This capability can be built into security policies and procedures ahead of time

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Traditional Approaches

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Emergency update of virus definitions?

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Emergency update of virus definitions?

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- Not all hardware, not all network topologies

Patch and reboot every machine?

Labor-intensive and time-consuming, not possible in the case of 0day events

How can Digital Guardian help?

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All of this is done on the organization's schedule, and focused on their priorities

Example DG Response

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IT Staff sees increased port 135 traffic

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Action: Deploy ruleset blocking port 135

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Result?

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We've bought ourselves analysis time

Response Continues

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Tentative conclusions:

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- Port 135 traffic was a worm

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Action:

- *Protect servers & Domain Controllers*

Response Continues

Tentative conclusions:

- Port 135 traffic was a worm
- Some port 135 traffic is important

Action:

- *Protect servers & Domain Controllers*
- *Refine ruleset to include exceptions for Server and Domain Controller addresses*

Analysis?

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We have stopped spread of the worm

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We now have time to patch and clean up

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What if it had been a port 80 worm?

Main points

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- Digital Guardian offers a powerful and flexible new tool against observed or predictable malicious activity

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- Digital Guardian offers a powerful and flexible new tool against observed or predictable malicious activity
- Digital Guardian presents a very attractive ad-hoc response capability in emergent situations
- This capability empowers organizations to respond to threats effectively, and with local priorities in mind

Q?

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Very Special thanks to our malware project staff, Alejandro Sedeno and Matt Power. You folks do *cool* work...

Some Other References

The Metasploit Project
OSVDB: The Open Source Vulnerability Database
CVE - Common Vulnerabilities and Exposures
Common Malware Enumeration (CME)
mwcollect.org
Mal-Aware.org

Q?

"Hey, hey, hey- Don't be mean."

-Buckaroo Banzai

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