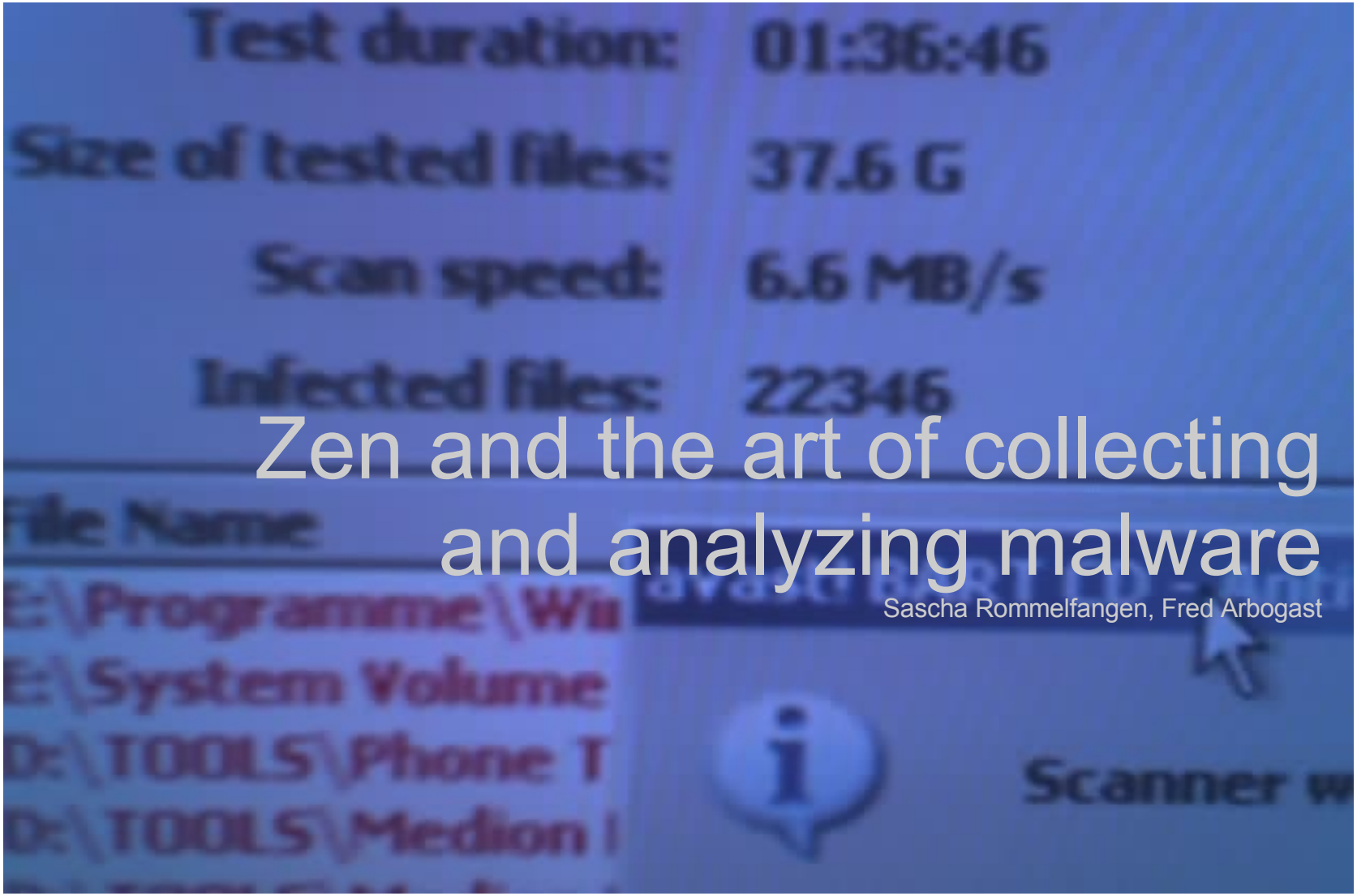
CanSecWest/core06



Zen and the art of collecting and analyzing malware

Sascha Rommelfangen, Fred Arbogast

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Computer Security Research & Response Team

CSRRT-LU

Outline

- Introduction
- Setup to collect malware
- Statistics
- Analysis
- Live Demo
- Future development
  - early warning/reacting system approaches
  - interactive malware database
- Conclusion

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Definition of malware

- Umbrella term for malicious software
- Not to be confused with *defective software*
- Designed to infiltrate, damage, control or abuse computer systems without owner's consent
- Legal vocabulary: computer contaminant
- Also used: scumware
- Worms, virii, root kits, spyware, adware

The tools used

- mwcollect by Georg Wicherski
  - (http://www.mwcollect.org)
- Nepenthes by nepenthes team
  - (http://nepenthes.sourceforge.net)
- Focus on nepenthes as mwcollect has merged with nepenthes
- Joint effort will result in a more powerful tool

Things both tools have in common

- “Low interaction” honeypots
- passive
- catching autonomously spreading malware
- Running in non-native environments
- simulating network services
  - mwcollect: vulnerable built-in services
  - nepenthes: additionally 'pre-infected' services
- acting upon exploitation attempts
  - Downloading malware
- Both tools are Free and Open Source software

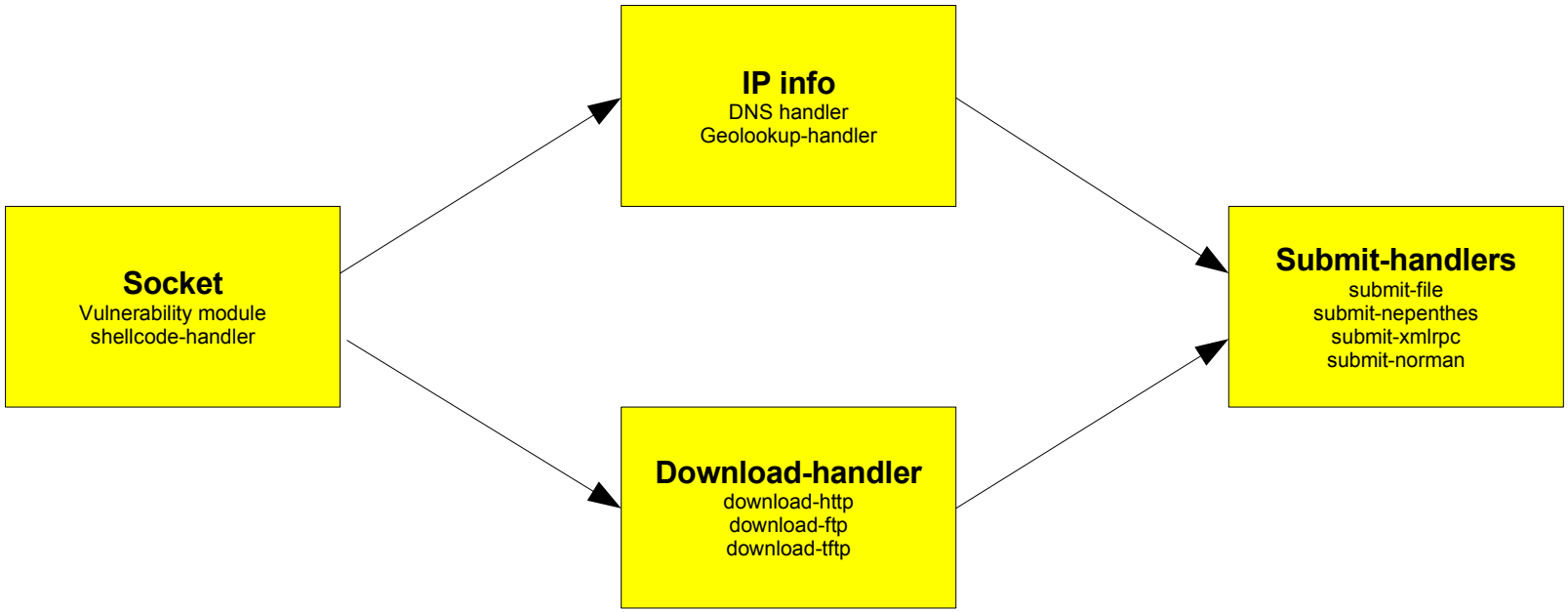
Tools - nepenthes

- Emulates native and non-native vulnerabilities
- Modular
  - Know a new exploit, add it as a module
- Support for geolocation information
- Support for submitting malware and additional information
  - Other instances of nepenthes (distributed installation)
  - XML-RPC

Vulnerabilities

- 'native' vulnerabilities:
  - RPC-DCOM (135, 139, 445, 593)
  - LSASS (445)
  - WINS (42)
  - MSSQL (1434)
  - ASN.1 library in IIS, SMB (80 and 445)
  - IIS (443)
  - NetDDE (139)
  - Message queueing (2103, 2105, 2107)
  - UPNP (5000)
- 3rd party vulnerabilities:
  - Kuang2 (17300)
  - Mydoom (3127)
  - Bagle (2745)
  - sasser_ftp (5554, 1023)
  - Sub7 (27374)

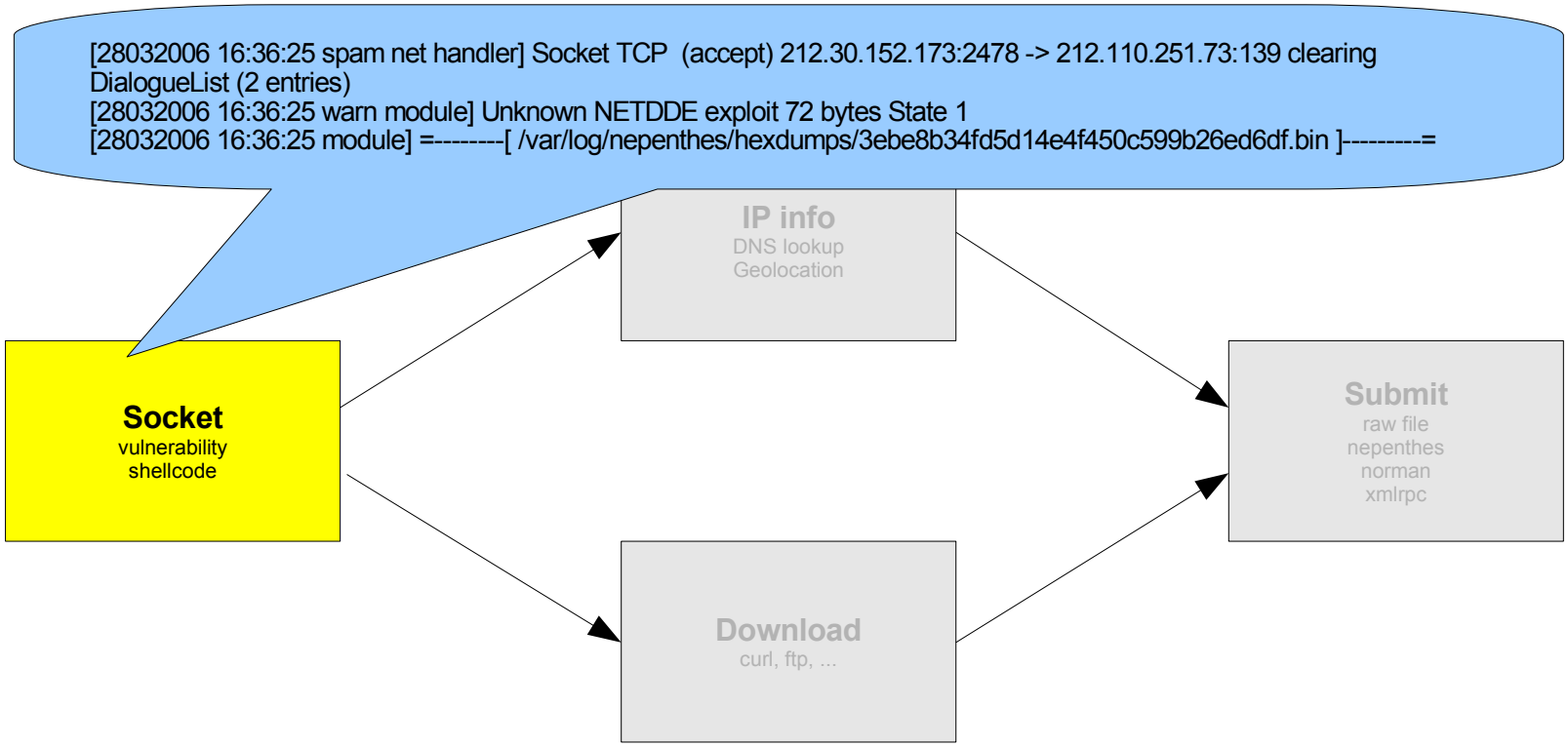
Nepenthes information flow - modules/handlers



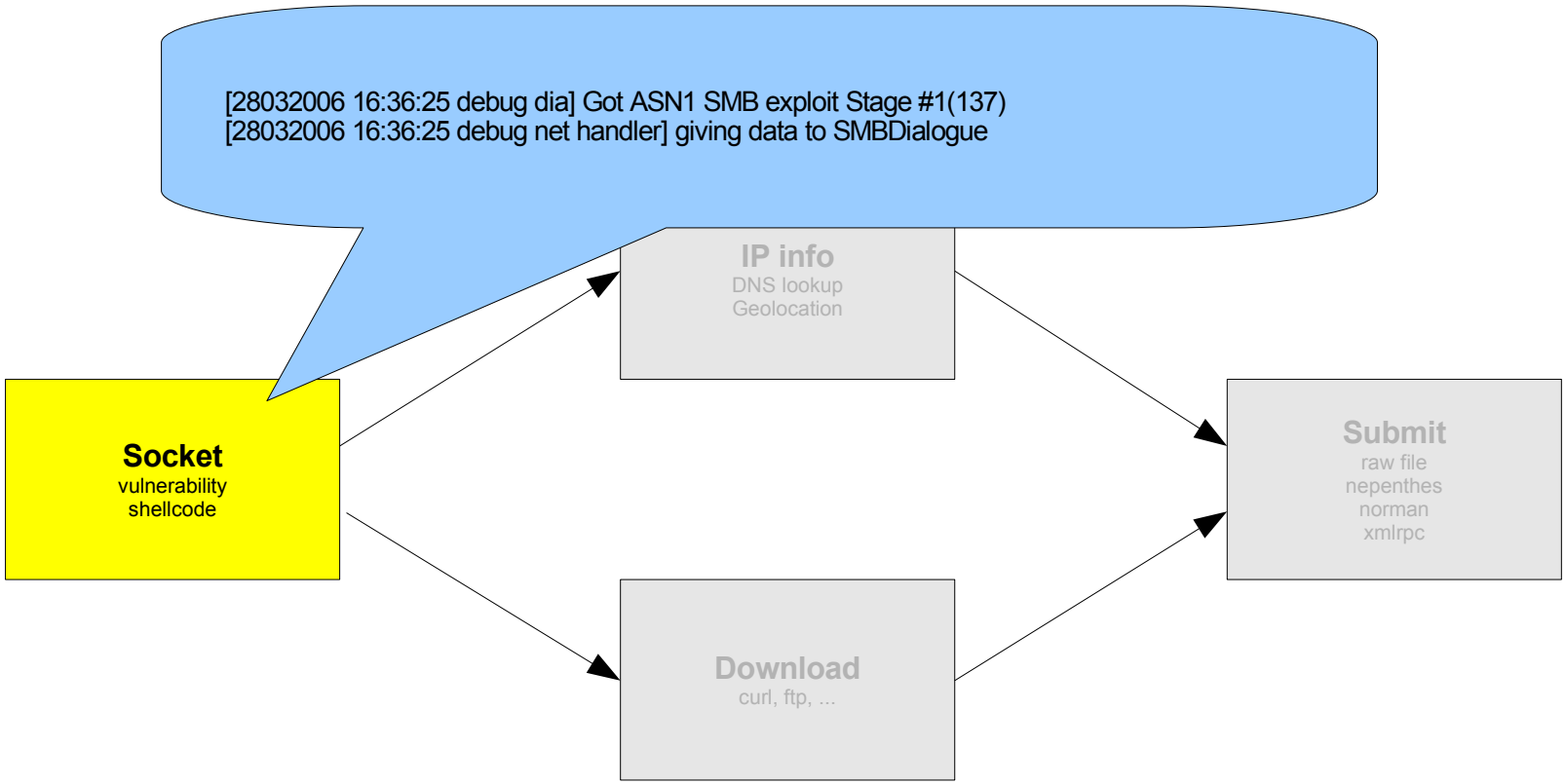
Categories of modules/handlers (1)

- Vulnerability module
  - Different modules for simulating the vulnerabilities
- Shellcode-handler
  - Per shellcode one module
  - Common Shellcode Naming Initiative

Nepenthes information flow



Nepenthes information flow



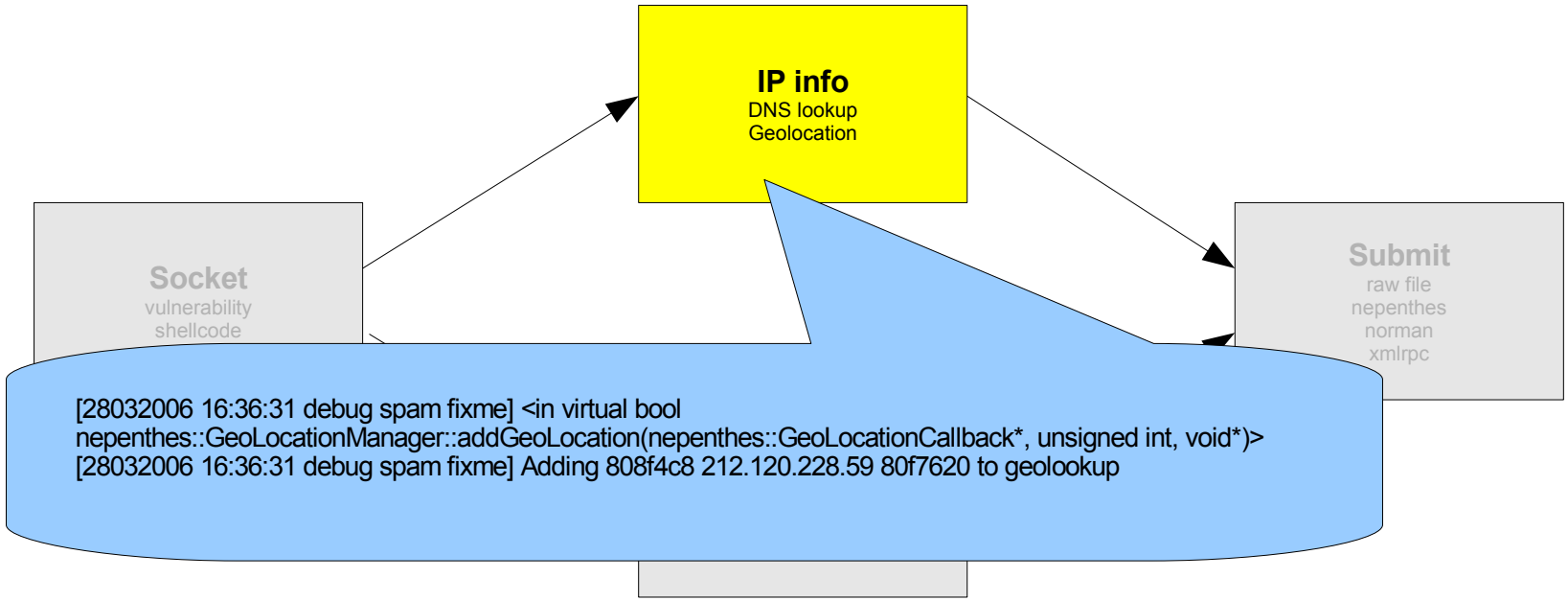
Categories of modules/handlers (2)

- Geolocation-handler (some alternatives)
  - Resolves IP address to location information
- DNS-handler
  - Delivers resolved domain name
- Download-handler
  - Downloads through curl
    - Provides http and ftp protocol
  - Download ftp
    - Needed as curl is not the same than the messy M$ client
    - Netcat is doing the job

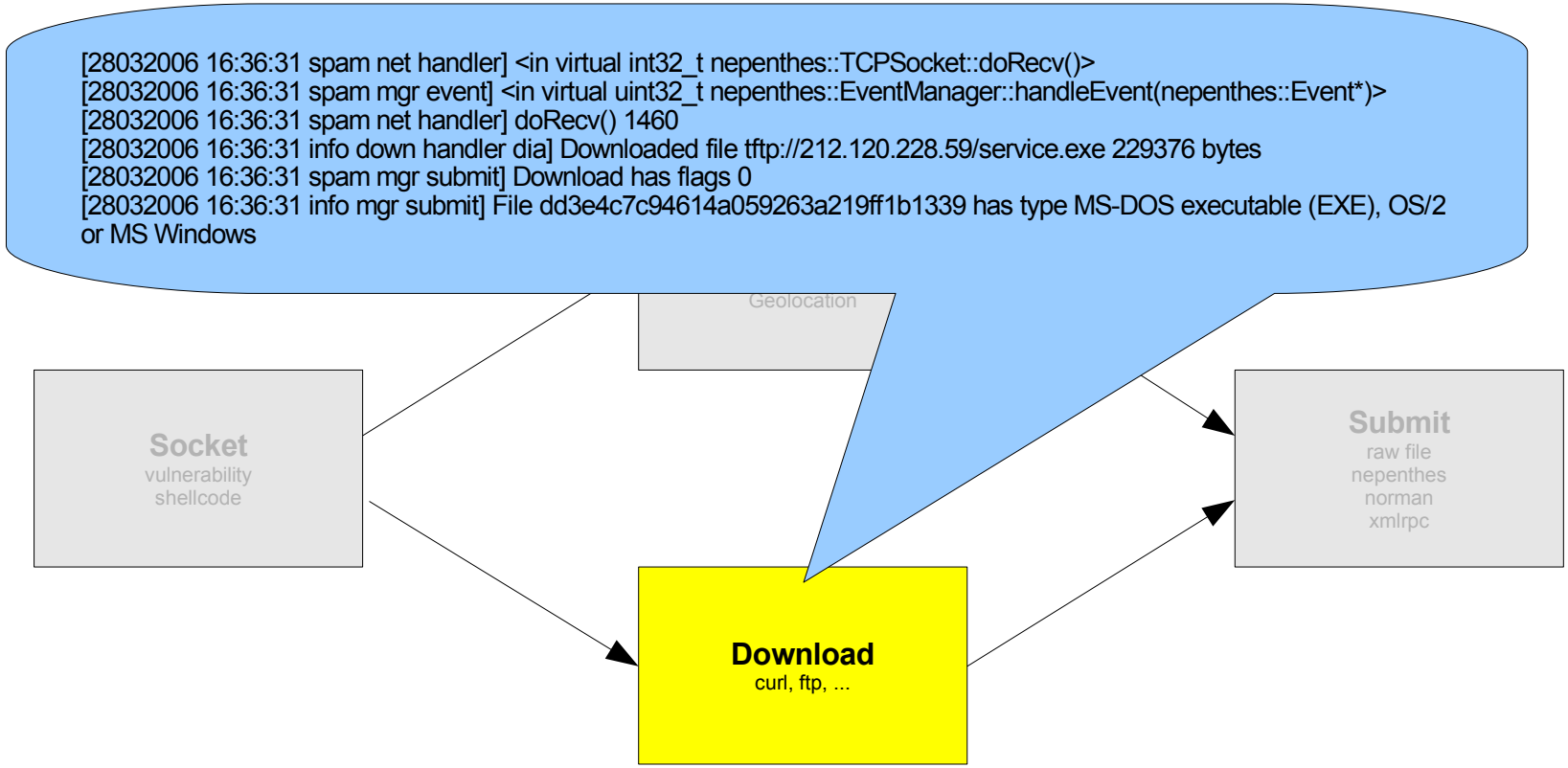
Categories of modules/handlers (3)

- Download-handler cont'd
  - Download tftp
    - Support for tftp protocol
    - Max filesize 4MB
    - Can not handle DNS for the moment
  - Download nepenthes
    - Listens for file transfers from other nepenthes agents
    - Port can be set in the config file
    - transfer is simple and bandwidth optimised

Nepenthes information flow



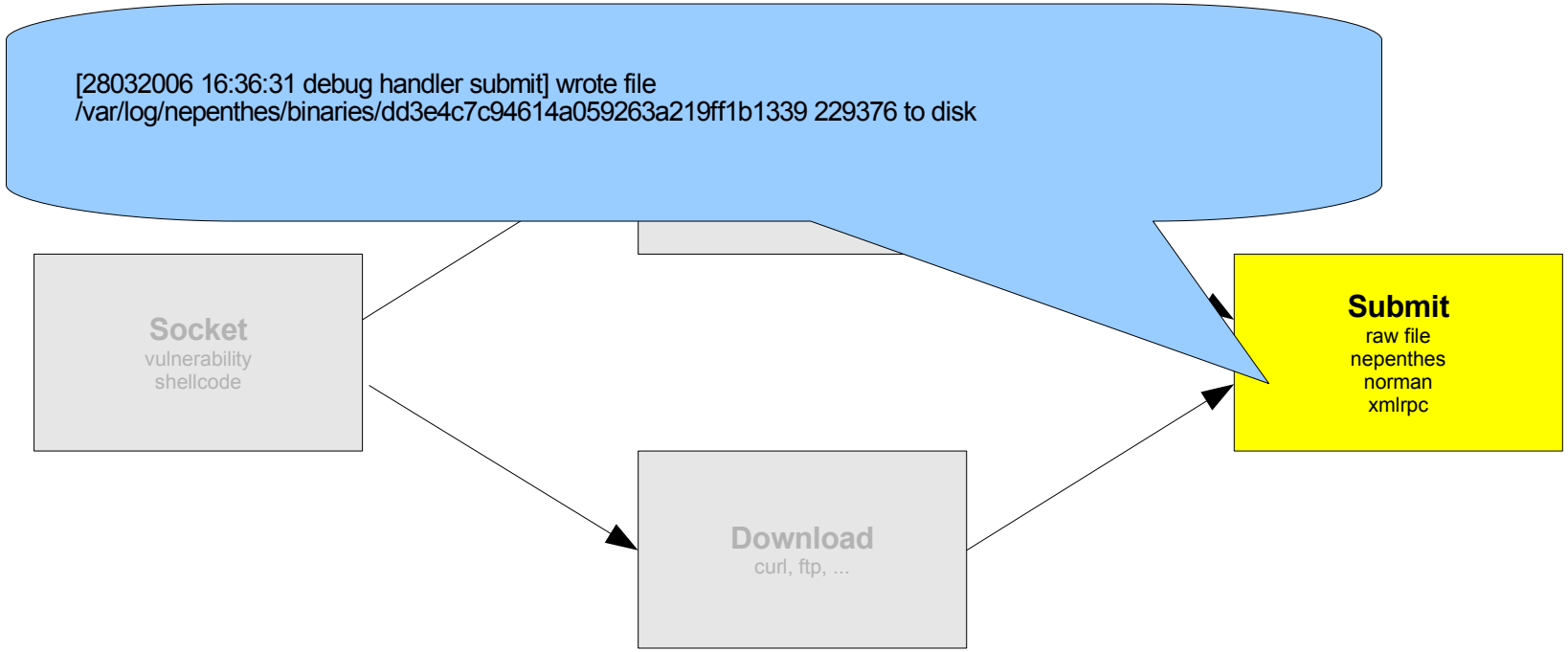
Nepenthes information flow



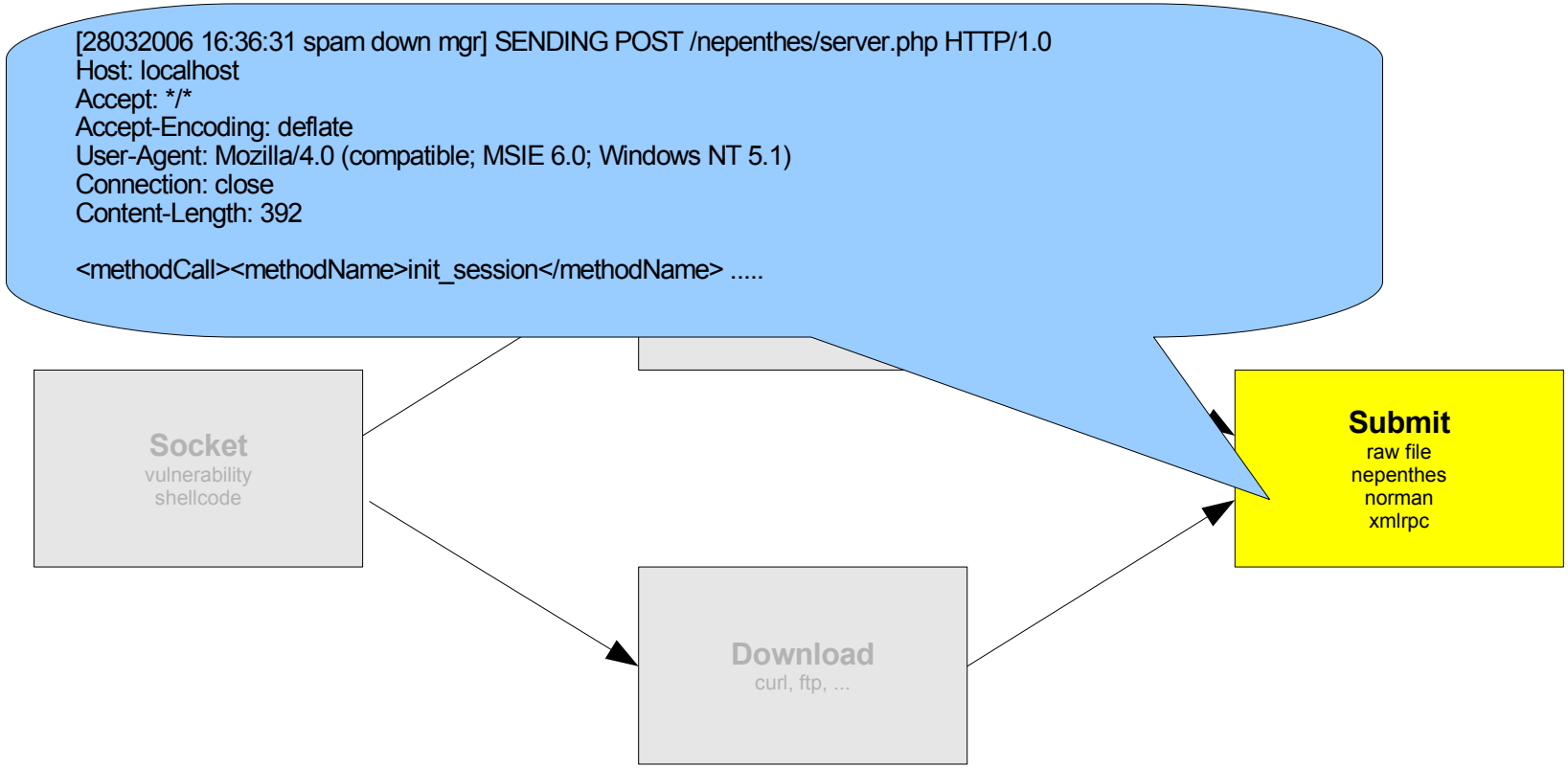
Categories of modules/handlers (4)

- Submit-handlers
  - Submit-file
    - Dumps to a file on HDD
  - submit-nepenthes
    - Submits information to a central server
    - Currently receiving from Telecom Italia Early Warning Team
  - Submit-norman
    - Submits file to norman sandbox
  - Submit XML-RPC
    - Submits information to applications outside nepenthes

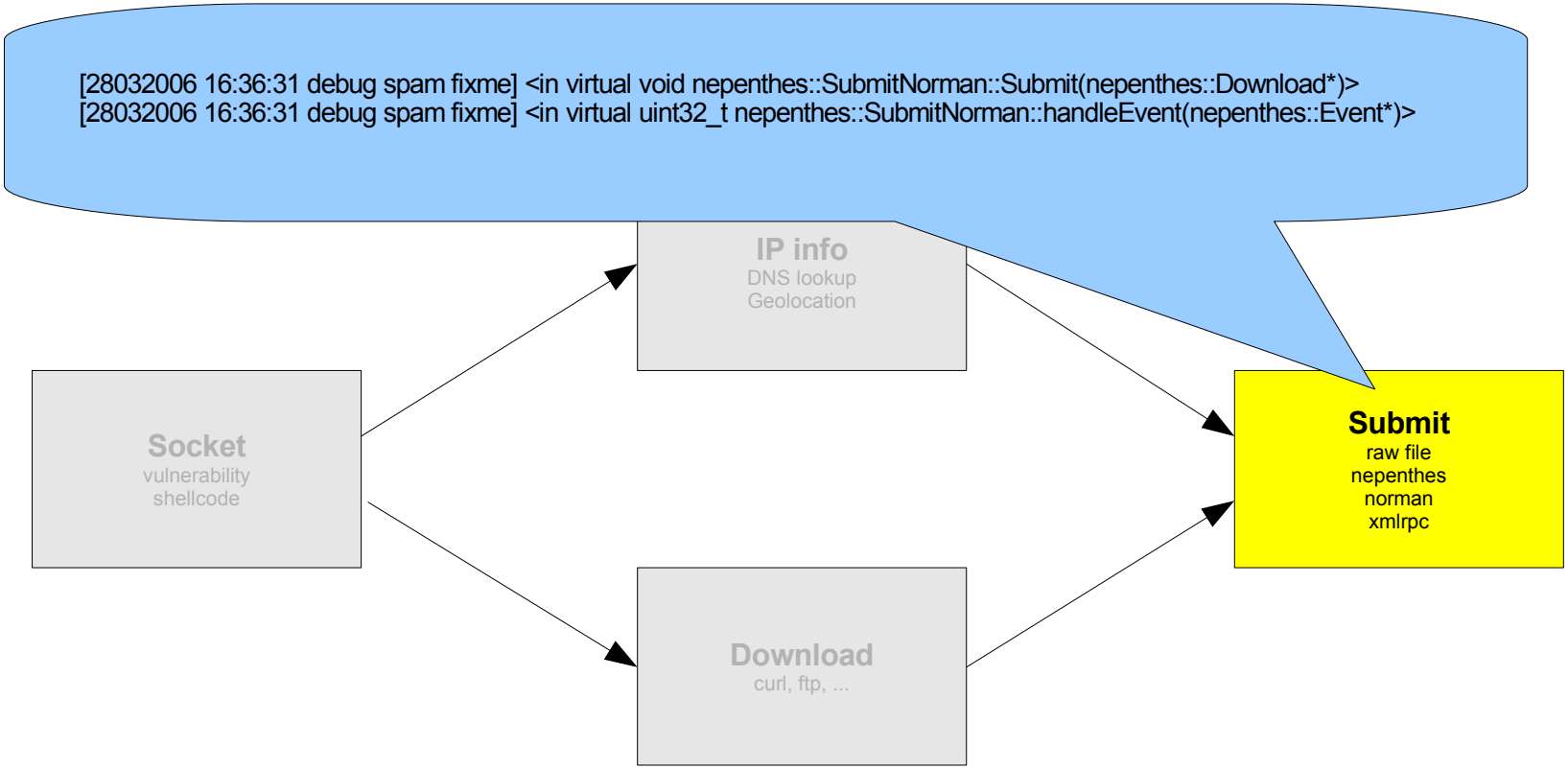
Nepenthes information flow



Nepenthes information flow



Nepenthes information flow



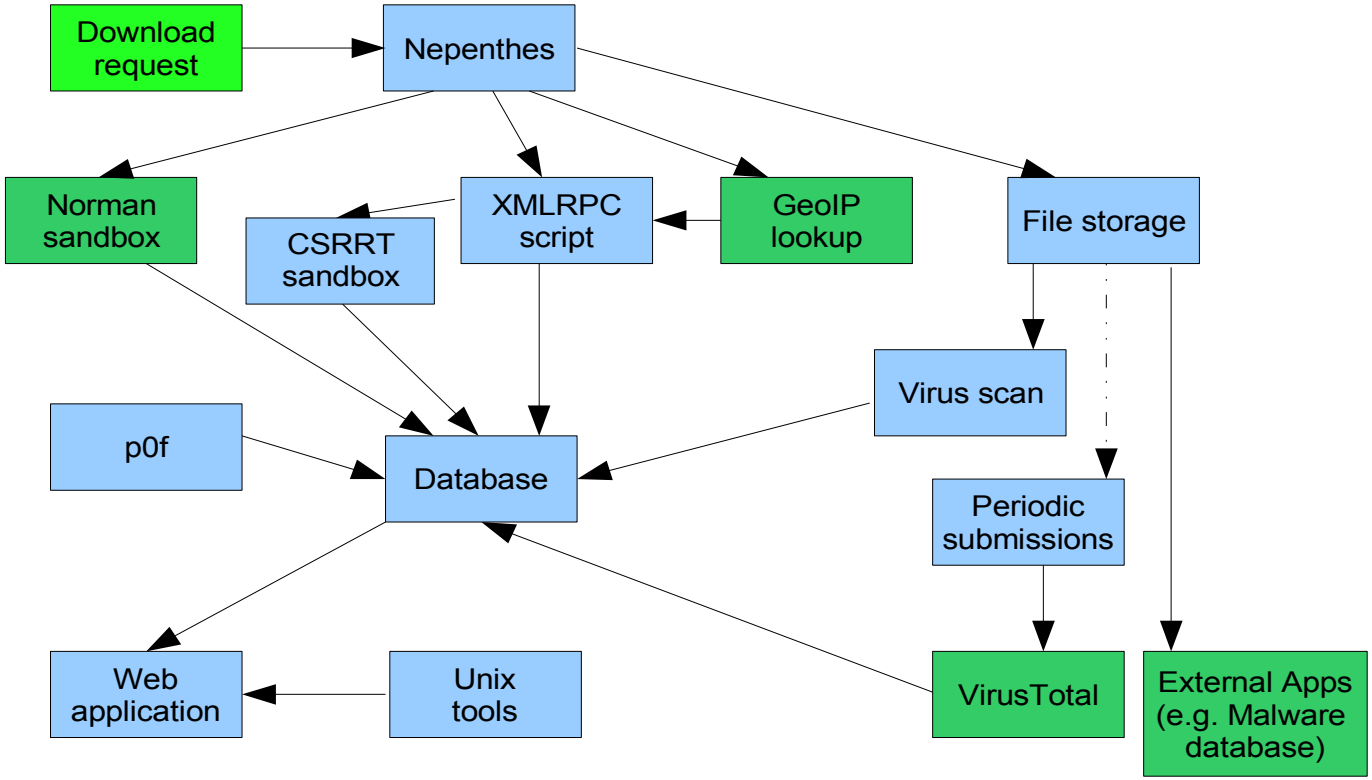
Additional information collected

- Extension to nepenthes - stored in database
  - Platform information (p0f-sql)
    - P0f hack to submit information into DB
  - 4 AV product results from local machine
    - Extendable
    - Signatures hourly updated
  - 24 AV results from VirusTotal (added later)
  - 2 sandbox results
    - Submitted to http://sandbox.norman.no
    - Submitted to our own POC sandbox (added later)

Full information set collected

- Various static analysis
  - file, upx, hexdump, strings, objdump
- Number of hits
- First/last seen
- Number/names of recognized virii
- Sandbox results
- Hex-dump of file (browseable)
- IP/URL from where fetched
- System
- Latitude, Longitude, Country, City

Setup to collect malware – flow



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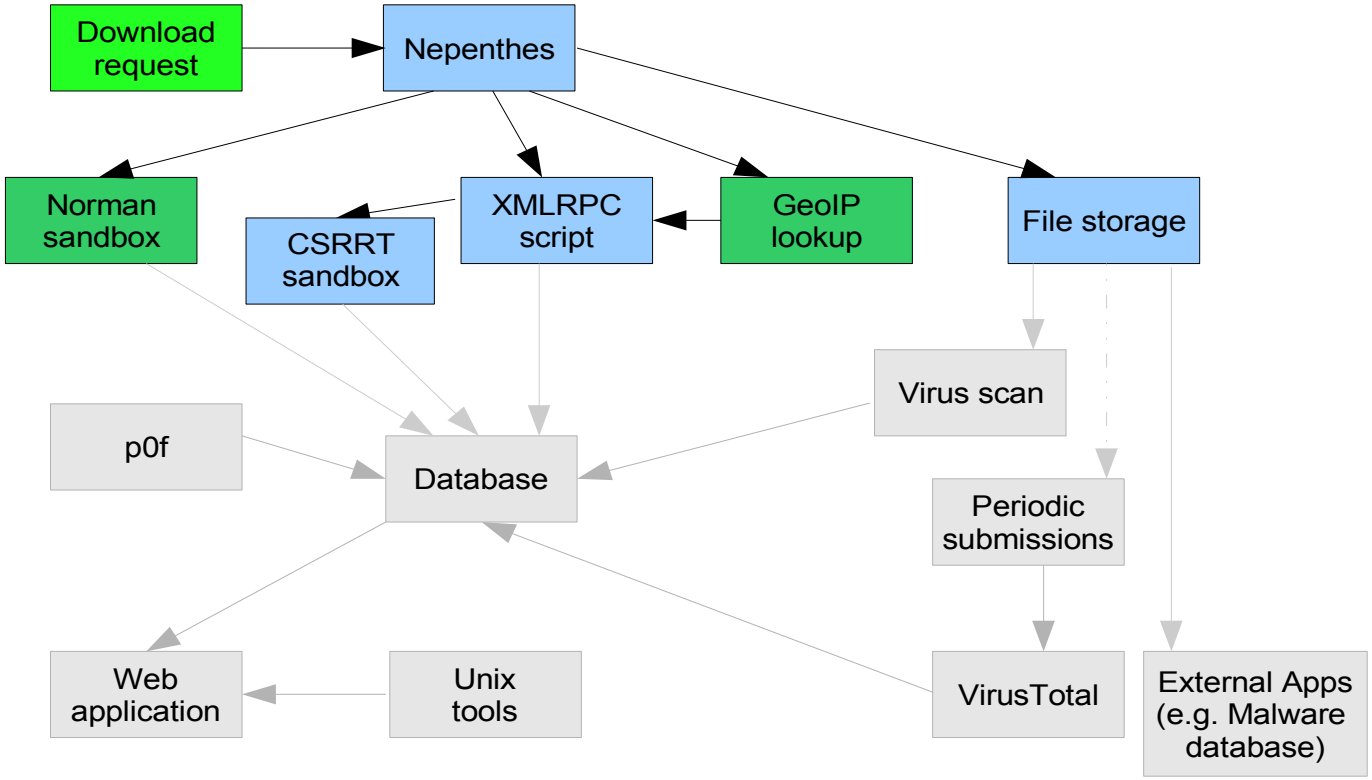
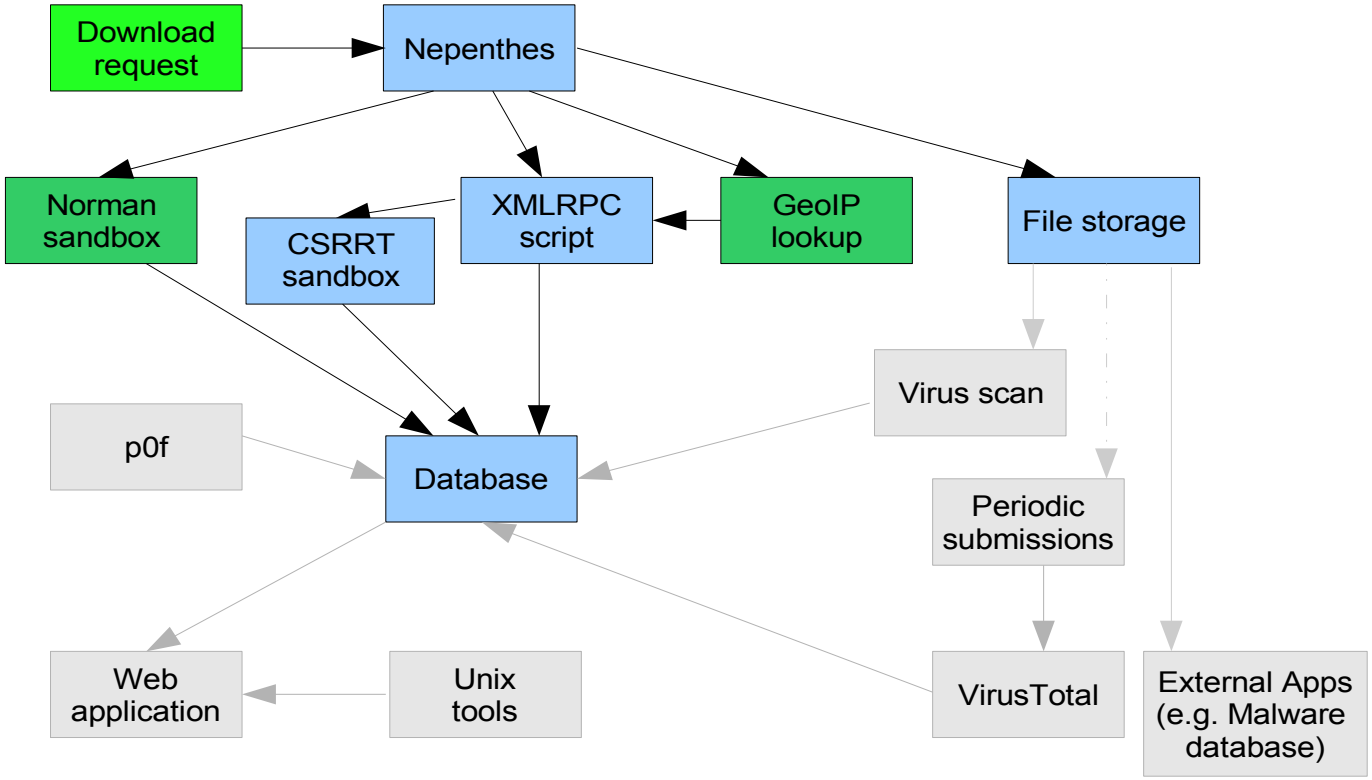
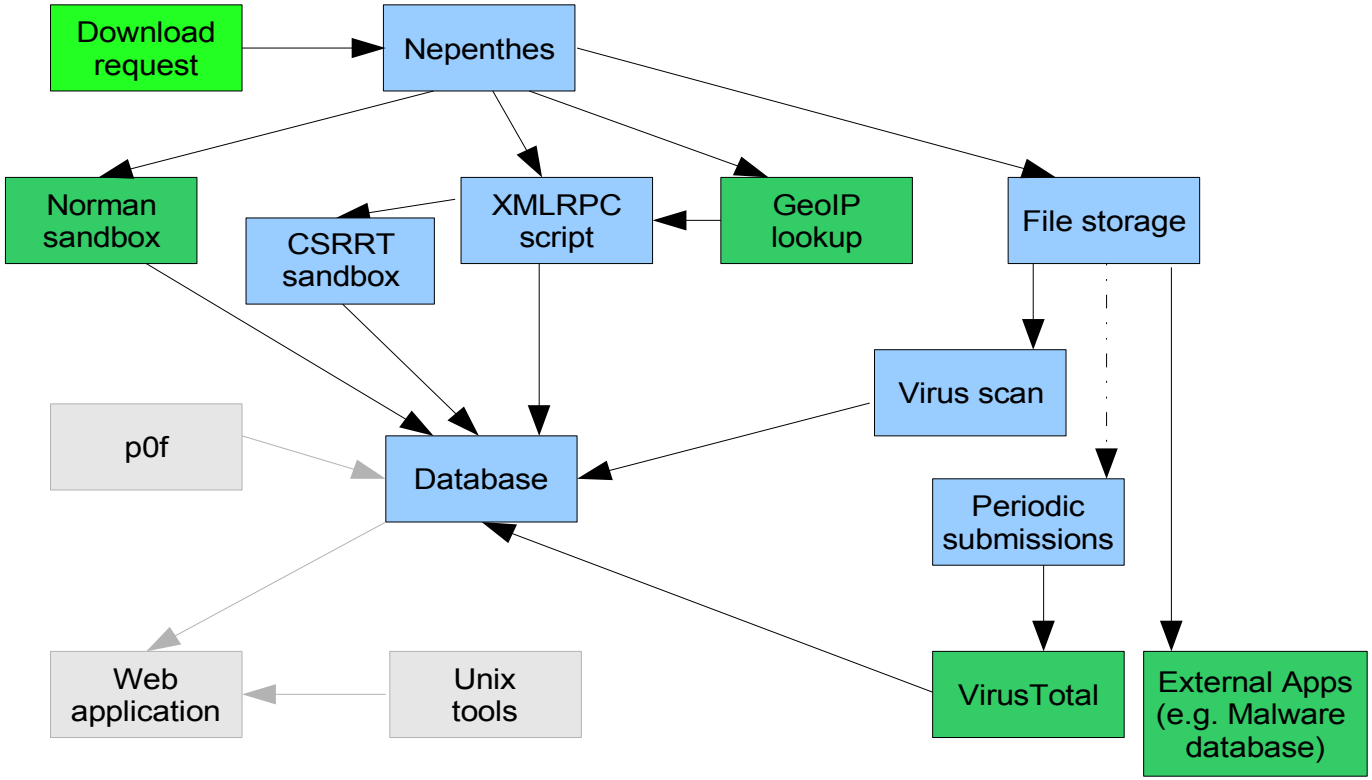


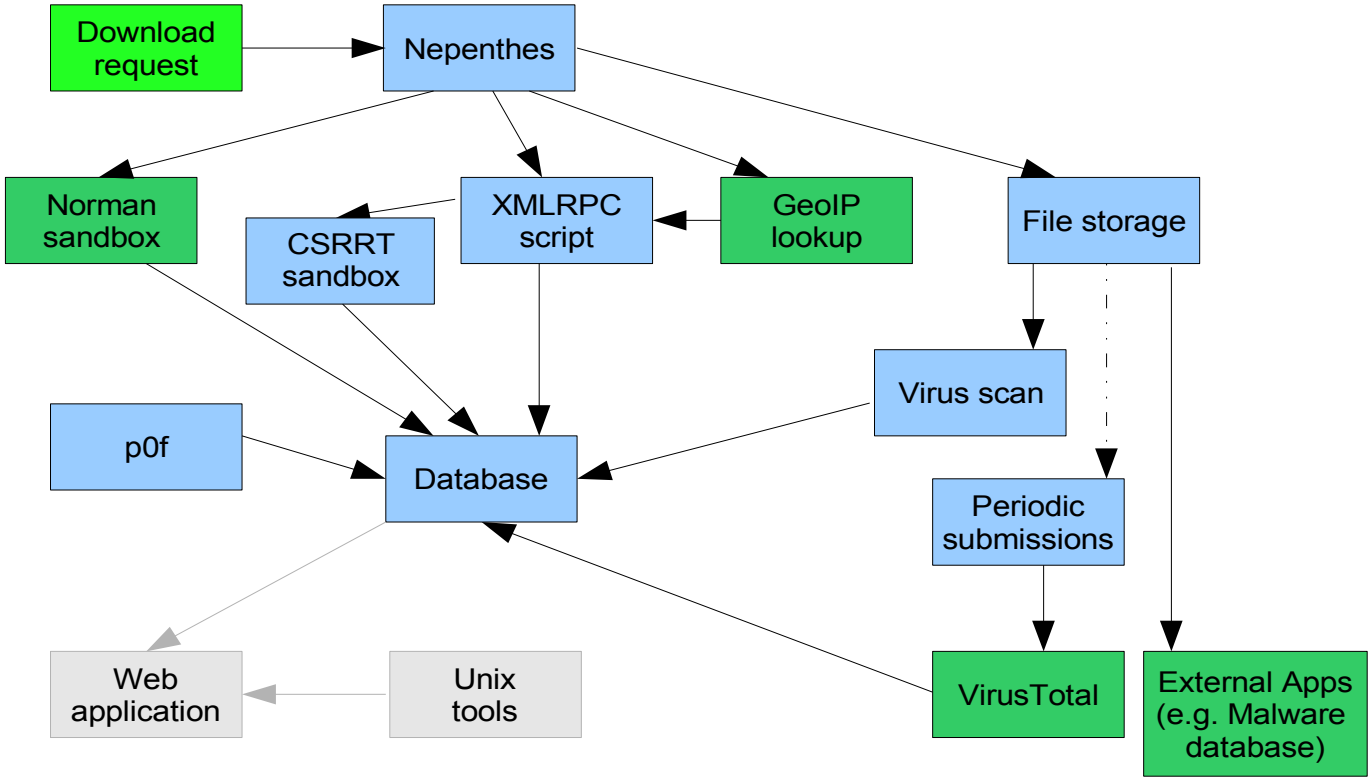
Setup to collect malware – flow



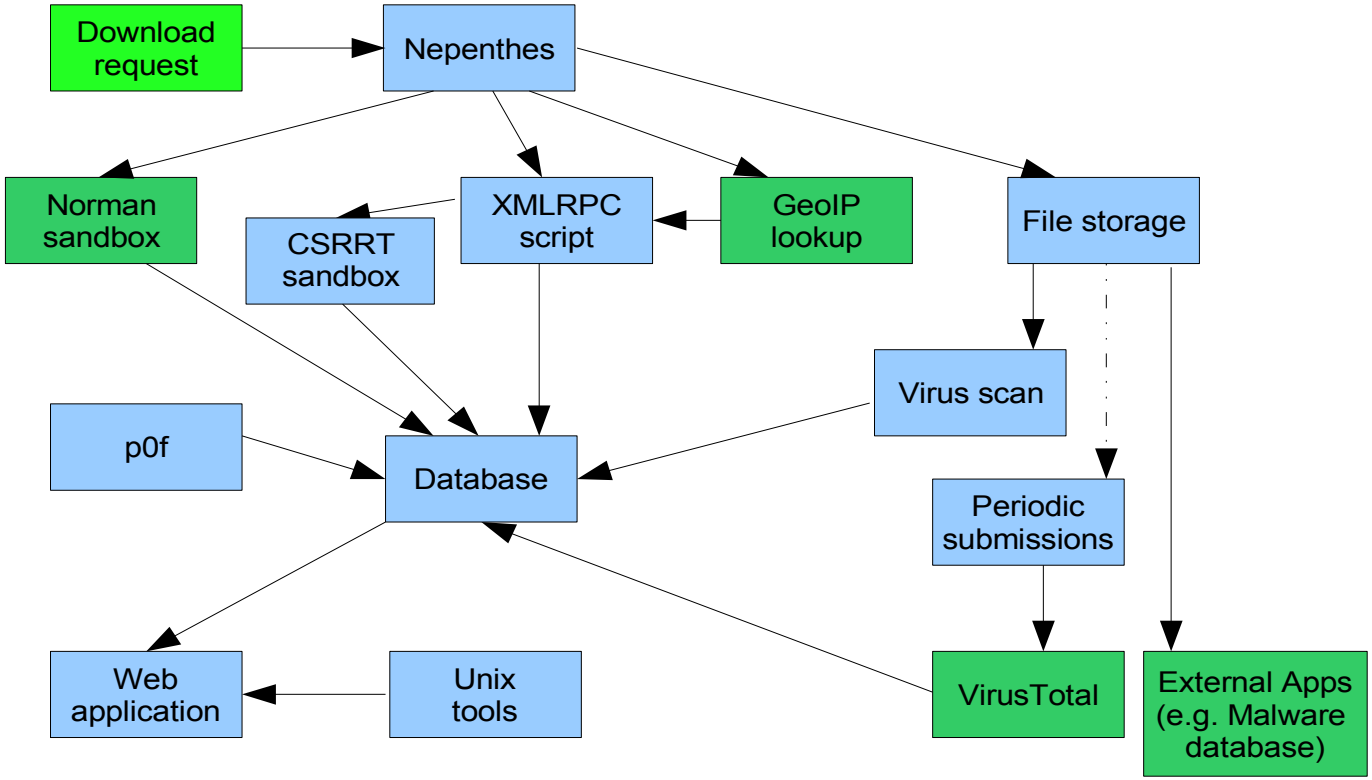
Setup to collect malware – flow



Setup to collect malware – flow



Setup to collect malware – flow



Statistics

- There are three kinds of lies: lies, damned lies, and statistics. Benjamin Disraeli (1804 - 1881)
- 1st set, collected with mwcollect:
  - Approx 600,000 files (9.2 GB)
  - 542 unique (80 MB)
  - 529 executables
  - File length: 100 to 1,145,856 Bytes
  - Time frame: 6 weeks (April - June 2005)
  - 503 MS-Windows executables
  - 26 MS DOS executables

Statistics

- 1st set continued
  - 52% of the files were detected by all 4 virus scanners
  - 17% of the files were detected only by 3 virus scanners
  - 25% of the files were detected only by 2 virus scanners
  - 3% of the files were detected only by 1 virus scanner
  - 2% were defective
- When scanning files later -> some files detected as Zotob
  - During collecting time there was no Zotob signature!
    - false positive?
    - test-run?

Statistics

- 2nd set, collected with nepenthes:
  - 2,079 unique files
  - 209,327 malware downloads complete
  - 13% using anti debug/emulation techniques
  - 1,852 MS-Windows executables
  - 227 MS-DOS executables
  - File length: 1,024 – 1,323,222 (1.3MB) bytes
  - Time frame: December 2005 – March 2006

Statistics

- Result of immediate scan:
  - Results of virus scan, directly after reception with up-to-date signatures:
    - 69.5% Norman Sandbox
    - 68.5% Bitdefender
    - 58.0% Antivir
    - 49.5% F-Prot
    - 31.8% ClamAV
  - Are signature based systems really future-proof?

Statistics

- Results of re-scan:
  - 96.1% Panda
  - 91.2% Norman
  - 85.9% Antivir
  - 85.9% Avira
  - 85.1% Kaspersky
  - 84.7% DrWeb
  - 84.5% Fortinet
  - 83.9% McAfee
  - 83.8% BitDefender
  - 80.4% VBA32
  - 80.1% CAT-QuickHeal
  - 79.8% NOD32v2
  - 78.9% UNA
  - 77.2% AVG
  - 76.3% Symantec
  - 75.7% Ewido
  - 72.4% F-Prot
  - 65.9% Sophos
  - 65.1% TheHacker
  - 64.1% Ikarus
  - 57.2% eTrust-Inoculate
  - 54.3% Avast
  - 50.7% ClamAV

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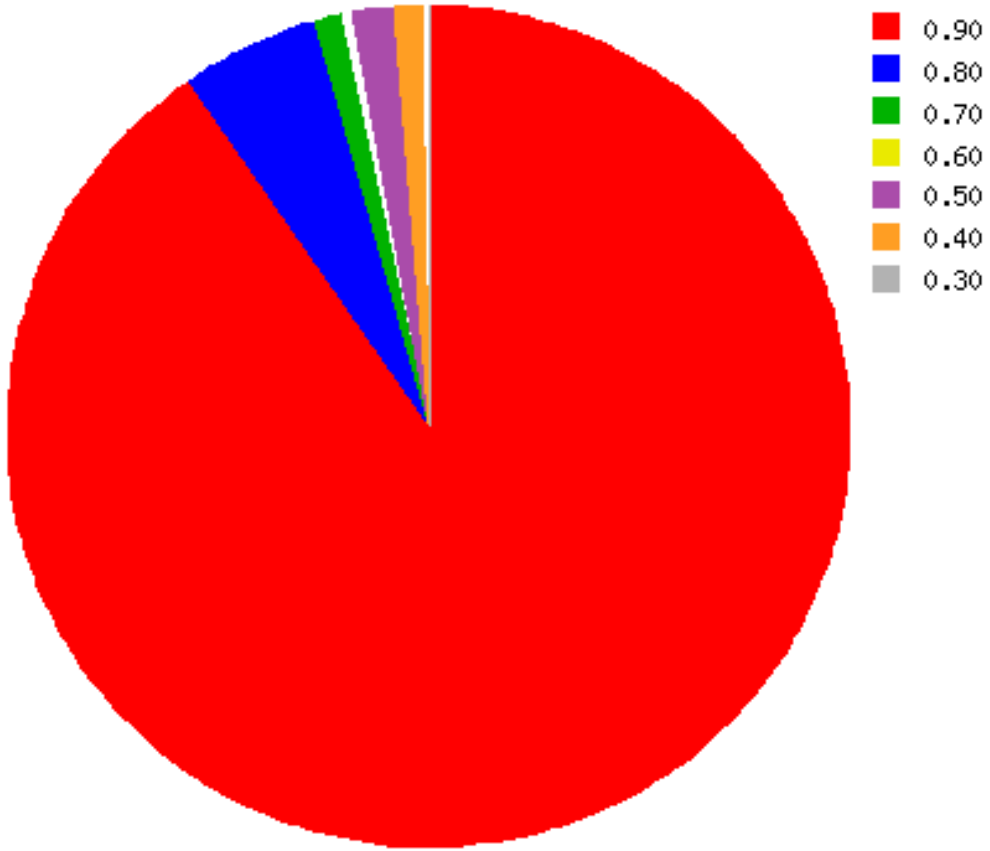
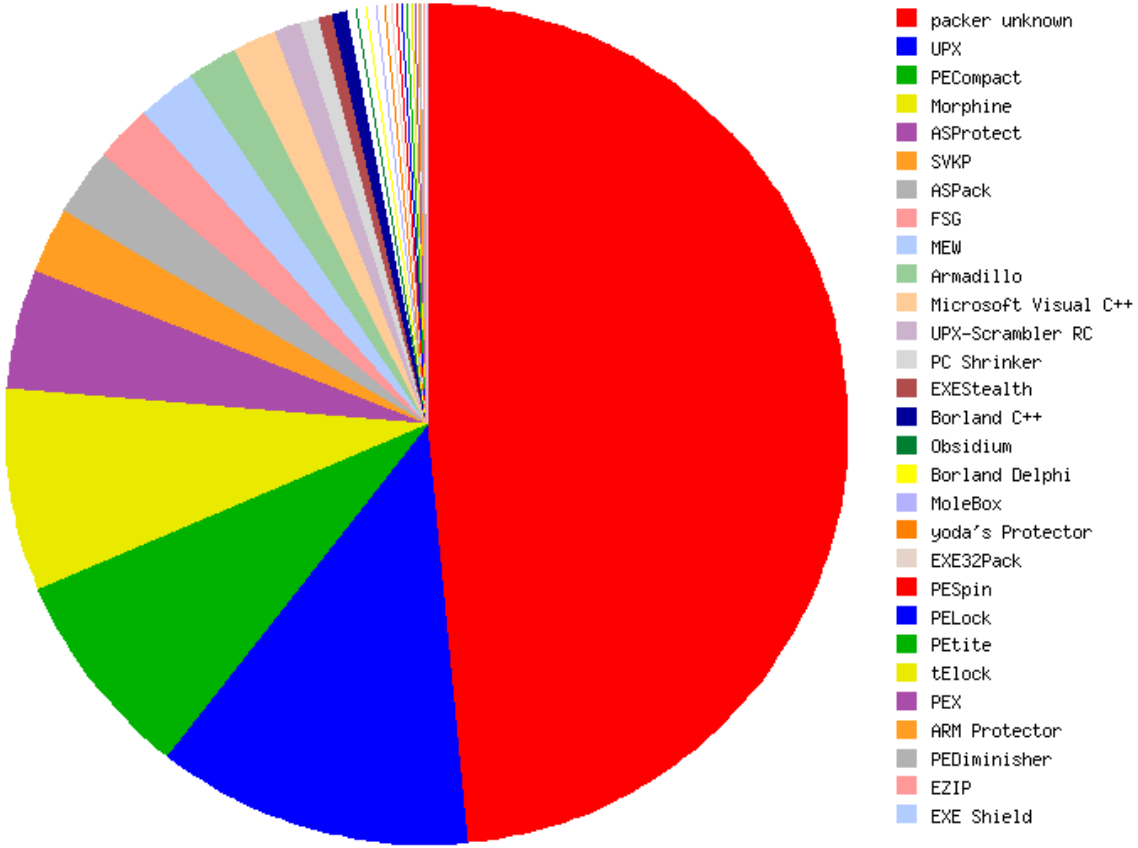
Statistics

- Packing/Encrypting statistics using bzip2



Statistics

- Packing/Encrypting statistics:



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Analyzing Malware - Side-effects

- Malware hides from the analyzer and obfuscates its techniques
- Automated processes not 100% reliable
  - Anti-virus products, current sandbox techniques
- Last resort: manual investigation
  - Disassembler, Debugger, file monitors, registry monitors, Virtual Machines
  - Very time consuming and/or requires high skills

Ways to fool the analyzer

- Modified binary
  - (multiple) Packing
  - Encrypting
  - Header crippling
- Test presence of Debugger/Disassembler
  - SoftICE, OllyDbg, Breakpoints, Vmware, ...
  - http://www.honeynet.org/papers/bots/botnet-code.html
- Usage of file droppers
  - Dropper downloads malware and executes it
  - Malware makes usage of other malware already downloaded (e.g. browser hijacker vmmon32.exe)

Automated analysis

- Virus Total:
  - Free service scanning files with 24 AV products
  - Submits by default samples to AV vendors
  - Automated submission through extensions
  - Virus Total sends back mail with report
  - Most of the time at least one AV product finds malware
  - Cooperativeness to extend results (e.g. XML, more details, ...)
  - Negative point:
    - Slow – agreed on a 60s interval when sending all files (adding more resources in the future)

Automated analysis

- Norman sandbox:
  - APIs simulating a Windows Computer
  - Some of the APIs simulate the Network/Internet connectivity
  - Automated submission through nepenthes
  - Sandbox sends back mail with report
  - Negative points:
    - often not working because of filled up mail queue
      - Necessity to resubmit
    - Often trapped into anti-debug code
  - Have to trust the output!

Norman Output

Googlesetup.exe : [SANDBOX] contains a security risk - W32/Spybot.gen3 (Signature: W32/Spybot.AHWZ)
[General information]
* **Locates window "NULL [class mIRC]" on desktop.
* File length: 133120 bytes.
* MD5 hash: df2eaaf757053a4a0209c4668efd8d1c.

[Changes to filesystem]
* Creates file C:\WINDOWS\SYSTEM32\Googlesetup.exe.
* Deletes file 1.

[Changes to registry]
* Creates value "Google service"="Googlesetup.exe" in key "HKLM\Software\Microsoft\Windows\CurrentVersion\Run".
[...]

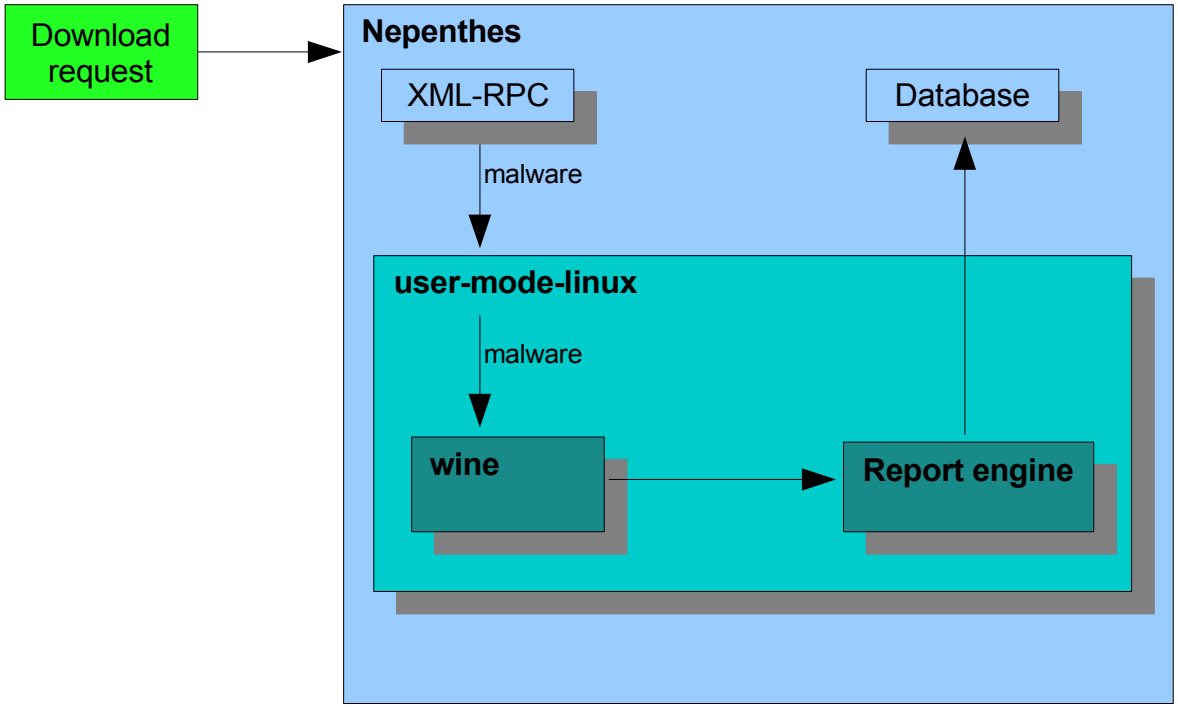
[Network services]
* Looks for an Internet connection.
* Connects to "der.ifconfig.us" on port 7000 (TCP).
* Connects to IRC Server.

[Signature Scanning]
* C:\WINDOWS\SYSTEM32\Googlesetup.exe (133120 bytes) : W32/Spybot.AHWZ.

Automated analysis using wine (1)

- wine as a (cheap) sandbox approach
  - Why?
    - Signatures suck
    - wine executed 72% out of 2199 malware files
  - How?
    - Compare .wine directory with an unmodified one
    - Use debug and trace messages from wine
    - Create report from what is known (~signature)
  - Security?
    - Outbreak is possible - include an assembler program that executes linux system calls via int 80h in the .text section of the windows executable
    - we're using user-mode-linux

Automated analysis using wine (2)



Live Demonstration

- http://nepenthes.csrrt.org:10080/nepenthes/

Developments and future steps (1)

- Early warning / reacting system (so far implemented)
  - Monitoring and visualization of outbreak waves
  - Live export of most common attacker IP list
    - To be imported into Firewalls, IDS, ...
  - Live export of most common download locations
    - To be imported into Proxies, Firewalls, IDS
  - Company-wide hash-scan with Encase
- Better virus scanner comparison
  - Automatic re-scan of malware files with each signature update (partly implemented)

Developments and future steps (2)

- Automated analysis:
  - Enhance wine sandbox results
  - rewriting DLLs to log even more
  - Also very interesting:
    - Diploma Project about automated behavior analysis
    - http://pi1.informatik.uni-mannheim.de/diplomas/show/59
    - Extensive API-hooking approach
- MalwareDB
  - A research database for preserving malicious computer programs

Introduction to Malware DB

- ”Fred, where is the DVD with the malware collected in January?”
- ”Somewhere on my desk? ... I was sure that it was laying on my desk...”
- ”I really need that to test something...”

- MalwareDB Scope
  - Simple storage mechanism to archive malware
  - Easy way to tag and classify the malware
  - Multiple interfaces to query and get the malware
  - Not a signature database
  - Not exhaustive

MalwareDB data store (v1)

- MalwareDB only contains metadata for each malware
- Files are stored on the filesystem
- Malware is identified by SHA-2 (256bits)
- For managing collisions (if any), MalwareDB keeps track of:
  - the original filename
  - information about file (like magic code, mime/type...)
- Source is a unique field to identify the origin of the malware
  - who or what is submitting the malware
- MalwareDB supports free tagging for classification, excluded are some reserved prefixes like RFC, CVE, OSVDB,..

Query the MalwareDB

- Using the web interface : http://www.csrrt.org/maldb/index.pl
- Using the RSS feed : http://www.csrrt.org/ml/rss/latest.xml
- Using the DNS interface to check the existence of a malware from its fingerprint:
  - dig -t TXT 3d5a9097cda0565ccc4a0e8aaa703b8543.187 \ 31eb80bce12e8d9958f115fa468.sha1.maldb.csrrt.org
  - 63 bytes have to be separated by a dot to split into “subdomains”, server reassembles accordingly
  - You could use the DNS interface as an RBL-like interface for early detection/warning but don’t forget that the database is not exhaustive.

Conclusion about the MalwareDB

- First try for a malware database (far from being perfect)
- Legal implication (copyright, computer security,...)
- Could be used by attackers as a repository
  (measure must be taken to avoid that)

Conclusions

- Nepenthes provides a nice way to collect malware
- It can also be used to block intruders/malicious URLs
- Early reaction is possible for the attacking vectors implemented in nepenthes
- Signature based systems definitely not fulfilling requirements
- Signature based plus behavioral analysis is definitely a way to pursue
- Automated analysis is a need, especially when receiving large feeds
- Hopefully increased joint-effort for sandbox-alike tools in the future

Thanks to

- mwcollect.org
  - Thorsten Holz, Markus Kötter
  - Paul Baecher, Georg Wicherski
- CSRRT-LU
  - Alexandre Dulaunoy
  - Gerard Wagener
- Hispasec Sistemas (VirusTotal)
  - Julio Canto
- Telecom Italia (Early Warning Team)
  - Gaetano Zappulla

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Questions?

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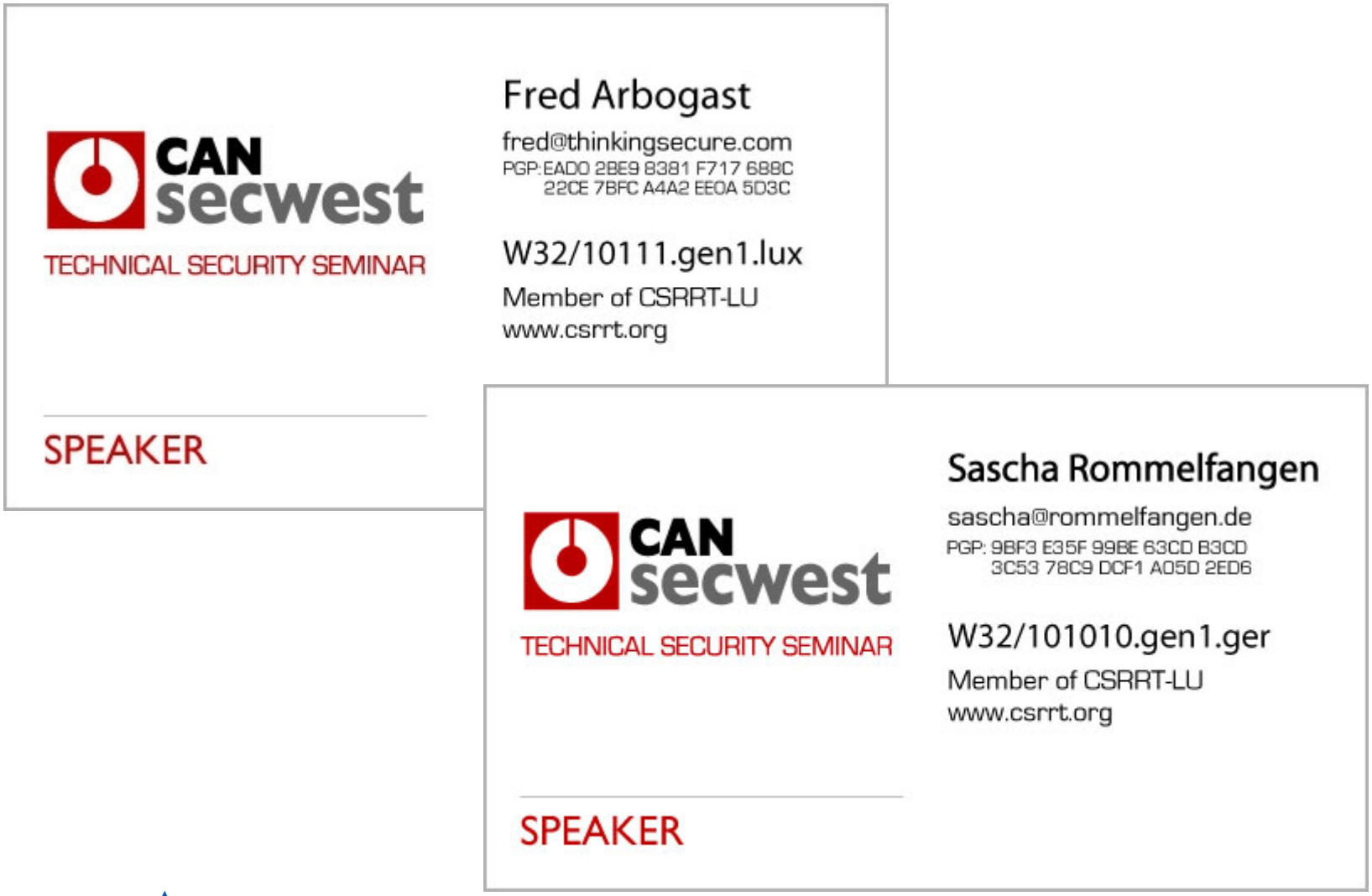
Thank you



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