Malware analysis from the trenches

Marcos Orallo

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Intro

Who

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- Telecommunications Engineer
- 8 years working in public and private CERTs.
- GREM, GCFA, CISSP, CISA
- NOT a malware reverser

Where

Airbus Group CERT

- Private, non-commercial CERT
- Constituency[1]: Airbus Group divisions and other subsidiaries.
- Missions:
  - Coordinate incident response and write report
  - Center for technical expertise
  - Internal and external focal point of contact

[1] the organization (or group of organisations) and/or people whose incidents we handle (or co-ordinate).

Why

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E.g. show you how lame we are, so you can help us.

CERT

Computer Emergency Response Team®

a.k.a. CSIRT (Computer Security Incident Response Team)

> *"A CSIRT is a team that responds to* **computer security incidents** *by providing* **all necessary services** *to solve the problem(s) or to support the resolution of them.*

[2] Source: ENISA

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"A CSIRT is a team that responds to **computer security incidents** *by providing* **all necessary services** *to solve the problem(s) or to support the resolution of them.*

In order to mitigate risks and minimize the number of required responses, most CSIRTs also provide **preventative and educational services** *for their constituency. They issue* **advisories** *on vulnerabilities and viruses in the soft- and hardware running on their constituent's systems."* [2]

[2] Source: ENISA

Incident Response: the theory

- We are firefighters.
- We **don't check** if fire prevention measures are in place.
- We **don't maintain** the smoke detectors and fire extinguishers.
- We **don't test** if the materials are flammable.
- We **don't rebuild** after the fire.

- We **contain** and **take out** the fire.
- We **give advice** to people on how to prevent the fire.
- We **investigate** how the fire started.

Incident qualification & threat assessment

- *"There is a match for one of the markers provided in advisory X"*
- *"We have a malware alert!"*
- *"They have defaced one of our web sites!"*
- *"This pastebin says someone has pwned us"*

Digital forensics and investigation

- Evidence acquisition
- Host forensics
- Network forensics
- e-Discovery

The reality

In a normal business day, a CERT does a little bit of everything

Intelligence collection and sharing

- *"What do you know about this IP/domain?"*
- *"Are you aware of the new $fancy_backronym vulnerability?"*
- *"Have you seen the new report about $scary_animal_name APT group?"*

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This means...

- Staying up to date (RSS feeds, twitter, conference papers, reports from infosec companies)
- Keeping record of malicious activities
- Writing advisories and communications

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Security Operations Center

- Manage prevention and detection controls
- Watch for alerts and triage
- Heavily procedured

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- SOC operator:

  "Is this IDS alert a false positive?"

  "We received this malware that our systems don't detect. Can you analyze it?"

- User:

  "Is this e-mail legit? Can I open this attachment?"

Security officer and consultant

- *"Should we allow this URL in the proxy?"*
- *"Can we publish our Exchange server?"*
- Policies and procedures

Vulnerability/Abuse report handling

- *"Your corporate website is vulnerable"*
- *"One of your IPs is sending spam"*

Awareness raising

- Training
- User awareness

Internal sysadmin

- Who wants to deal with the IT department?
- Let's deploy our own infrastructure!

Provider management

- Technical specification
- Request for proposals
- Project management

Miscellanea

"If you could do. . .

- Data recovery
- Pentesting
- Take down offending/illegal content

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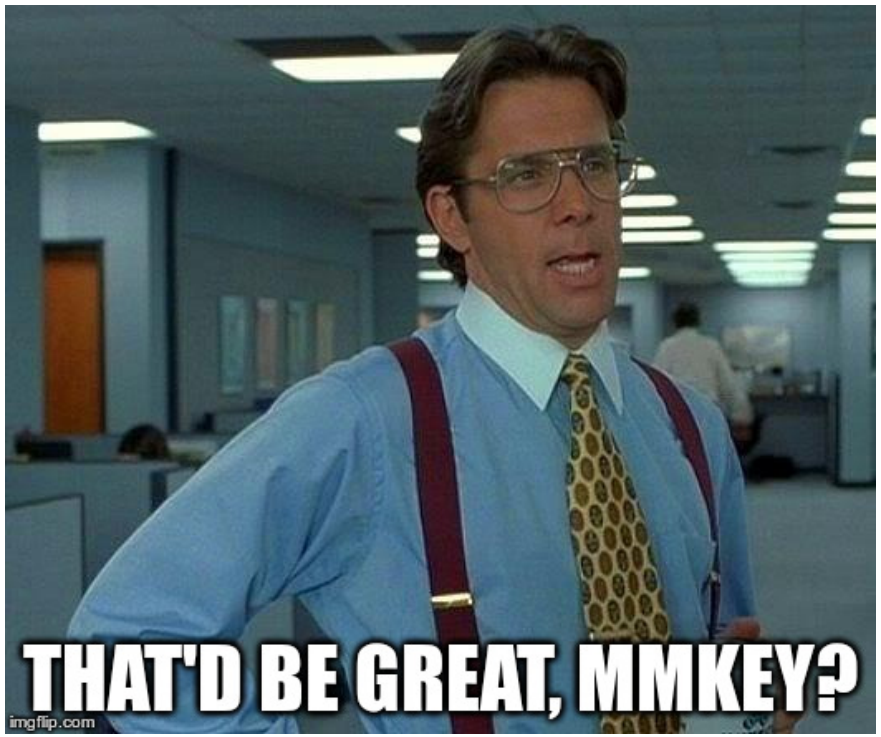

Lack of manpower

Common pattern in CERTs

Lack of manpower

leads to...

- Multitasking (actually context switching)
- Need for processes
- Industrialization whenever possible

Malware analysis in a CERT

What is “malware”?

Any code that makes your computer do what the malware writer wants, and not what YOU want.

- Trojans, Remote Access Tools, “Implants”
- Password stealers, keyloggers, bankers
- Malicious documents and web sites, downloaders, droppers
- Ransomware
- Worms

Advanced Persistent Threat

vs.

Basic Opportunistic Annoyance

BOA: Conficker

- First detected in 2008
- Botherders arrested in 2011
- Yes, you still get detections in 2015

BOA: Dridex

"Banker"[3] delivered by spam e-mails

1. Attached Word/Excel file with macro that downloads binary

[3] Online banking password stealer

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6. .lnk attachments

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APT: PlugX

RAT used by multiple attacking groups[4]

- Legitimate signed executable
- Malicious DLL (side loading)
- Encrypted custom configuration

[4] https://www.blackhat.com/docs/asia-14/materials/Haruyama/Asia-14-Haruyama-I-Know-You-Want-Me-Unplugging-PlugX.pdf

APT: PoisonIvy

- It's been around since 2005
- Still evolving
- "The AK-47 of RATs"

APT Wars: Episode I

The Phishing Menace

- A VIP user receives a spear phishing[5] e-mail with a malicious attachment

[5] A malicious e-mail customized for a specific target

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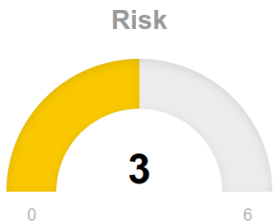

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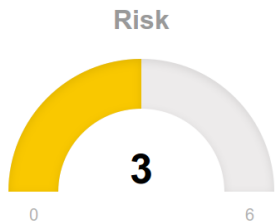

  - *"The antivirus didn't block it, so I guess I can open it"*

[5] A malicious e-mail customized for a specific target

APT Wars: Episode II

The SOC Strikes Back

- A SOC operator sees an alert about an EXE running from `%TEMP%` folder
- Some unusual network activity is identified from the same machine.

APT Wars: Episode II

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- Some unusual network activity is identified from the same machine.

    - *"Is this malware sample well known?"*
    - *"How bad is it?"*
    - *"Are we protected?"*
    - *"Is it similar to a previously known threat?"*
    - *"Has it been detected before? When, where, how many times?"*

User and SOC needs

- High number of analyses
- Both benign and malicious samples
- Many different types of files to analyze

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requires...

- Performance
- Effectiveness in detection
- Accept multiple types of input

APT Wars: Episode III

The CERT Awakens

- The SOC escalates the incident as the user has access to critical information.
- The CERT takes a memory dump of the machine for triage, finds an unknown DLL loaded into the explorer.exe process.

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The CERT Awakens

- The SOC escalates the incident as the user has access to critical information.
- The CERT takes a memory dump of the machine for triage, finds an unknown DLL loaded into the explorer.exe process.
    - Is it tailor made or off-the-shelf?
    - What's its purpose? (a banker? a RAT? password dumper?)
    - How does it spread?
    - What does it use for persistence?
    - Where does it come from?
    - How can I detect it in my constituency?

Indicators of Compromise

- Filename
- Path
- Hash
- Mutex
- Named pipe
- Registry key/value
- Service name

- IP
- Domain
- URL pattern
- User-Agent
- E-mail
  - sender
  - recipient
  - subject
  - attachment name

... and anything that is **actionable**!

Malware analysis for Incident Response

- The malware has already infected one (or more) machines.
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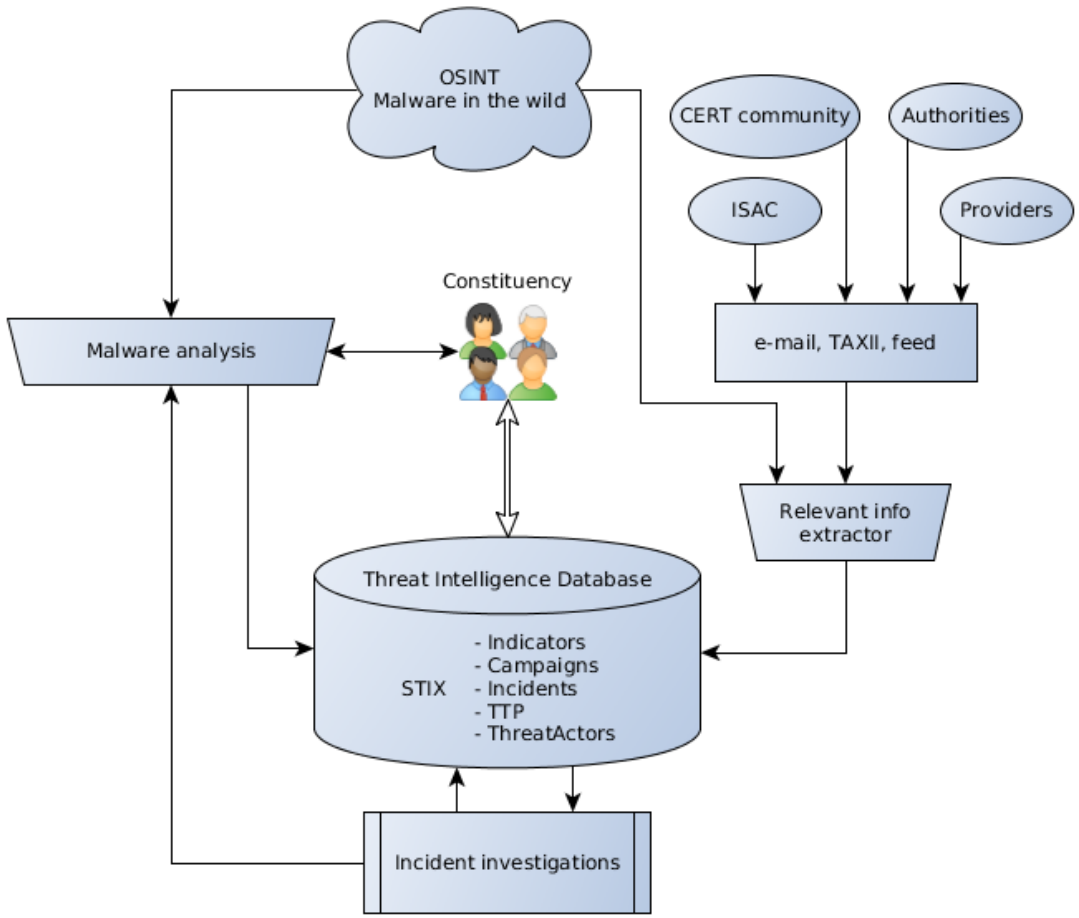
this means. . .

- Performance requirement is not as high
- Comprehensiveness
- **Actionable results**

Acting on the results

- Search host/network logs
- Check hosts for IOCs
- Monitor/blocking lists in proxies, firewalls.
- Find links

Threat Intelligence Database



Standard formats

Challenges

- Volume of samples
- Malware zoology
- Multi-stage malware toolkits
- Registry based and memory-only malware
- Lowest level implants (malicious firmware analysis)
- Malware writers learn

TL;DR;

- We need to identify malware, **quickly**.

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- We need to identify malware, **quickly**.
  - Automation
  - Scalability
- We want **actionable** information
  - Comprehensive analysis
  - IOCs

Static analysis of malware

Red vs Blue

- Red team finds and exploits vulnerabilities
  - High level code available
  - Well-behaving targets
- Blue team analyzes exploits and malicious programs
  - Low level code analysis is often the only option
  - The program is your enemy.

Static vs. Dynamic

Pros

- Fast (compared to a sandbox)
- Scalable
- Harder to thwart by the sample

Cons

- Packers
- Complexity

What do we use static analysis for?

- File type identification
- Sample identification and classification
- Triage (malicious pattern detection)
- Packer detection (signatures, entropy)
- Full reversing

What is "static analysis"

(for an Incident Responder)

- ASCII/unicode strings
- Antivirus engines (signatures and "heuristics")
- Hash (classic, fuzzy, imphash...)
- Byte patterns (YARA rules!)
- Entropy analysis
- PE[6] properties
  - Metadata
  - Import/Export table
  - Sections
  - Resources
- Manual dissassembly (but remember the time constraints)

[6] Portable Executable, the most common format for Windows binaries

Tools

- strings
- PeID
- PeStudio
- pescanner
- ExifTool
- YARA

- IRMA (antivirus)
- signsrch
- oledump.py
- IDA Pro
- ...

Ideas & Wishlist

“Big data” static analysis

- Imagine collecting every binary that is seen on an enterprise.
- What could you do with such a corpus?

Script based malware

For once, we have the source code :-)

But it is obfuscated in most cases.

- Office Macros (VBScript)
- PDF javascript
- Malicious web javascript
- Powershell
- Python

```
<body><script type="text/javascript">$=~[];$={___:++$,$$$$:(![]+"")[$],__$:++$,$_$_:(![]+"")[$],_$_:++$,$_$$:({}+"")[
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_$+$.$_$+$.__$+"\\"+$.__$+$.$$_+$.$$_+">');"+"\"")()();
</script>
```

Think outside the (static) box

- Can dynamic analysis give useful information?
- Can you provide useful info for dynamic analysis?
  - What checks/conditions would prevent the execution of a big portion of the program?
  - What kind of properties of the environment trigger certain API calls?
  - Are there "time-bombs" that would make the execution too long or the logs too big?

Help with obfuscation

- Can you reach an unpacked stage without actually running the malware?
- What can you do to fix imports of a dumped process?
- Can you determine what's the real list of imported functions?
- Can you extract dynamically constructed or obfuscated strings?

How to be ~~awesome~~ useful

1. Embrace the Suck
2. Do It in Public
3. Pick Stuff That Matters

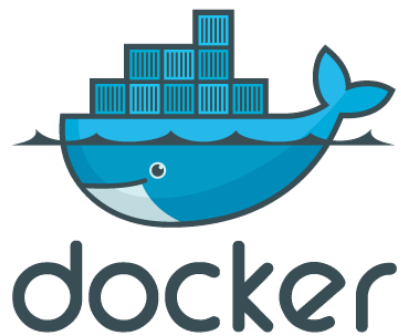
(by Jeff Attwood - the Stack Overflow and Coding Horror guy)[7]

[7] http://blog.codinghorror.com/how-to-stop-sucking-and-be-awesome-instead/

Release code!

Try the github experience. Bitbucket is ok too :-)

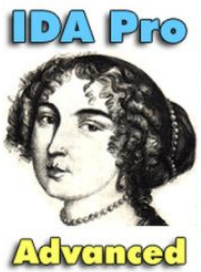
- README and examples
- Make a docker image
- Integrate into REMnux



Make it easy to adopt

Integrate into existing frameworks and workflows

- Develop a Rebus[8] agent
- Implement a Volatility plugin
- Create a YARA module
- Make an IRMA probe
- Code an IDA or OllyDbg plugin



[8] https://bitbucket.org/iwseclabs/rebus

Thanks for your attention! Now...

KEEP
CALM
AND
ASK
QUESTIONS

References

Slides 8,10: Backdraft (movie,1991)
Slide 17: Halt and Catch Fire (tv show, 2014)
Slide 18: Watchmen (comic). Image from dropthecow.com
Slide 19: The IT Crowd (tv show, 2006)
Slide 21: Office Space (movie, 1999)
Slides 11,72: Mr. Robot (tv show, 2015)

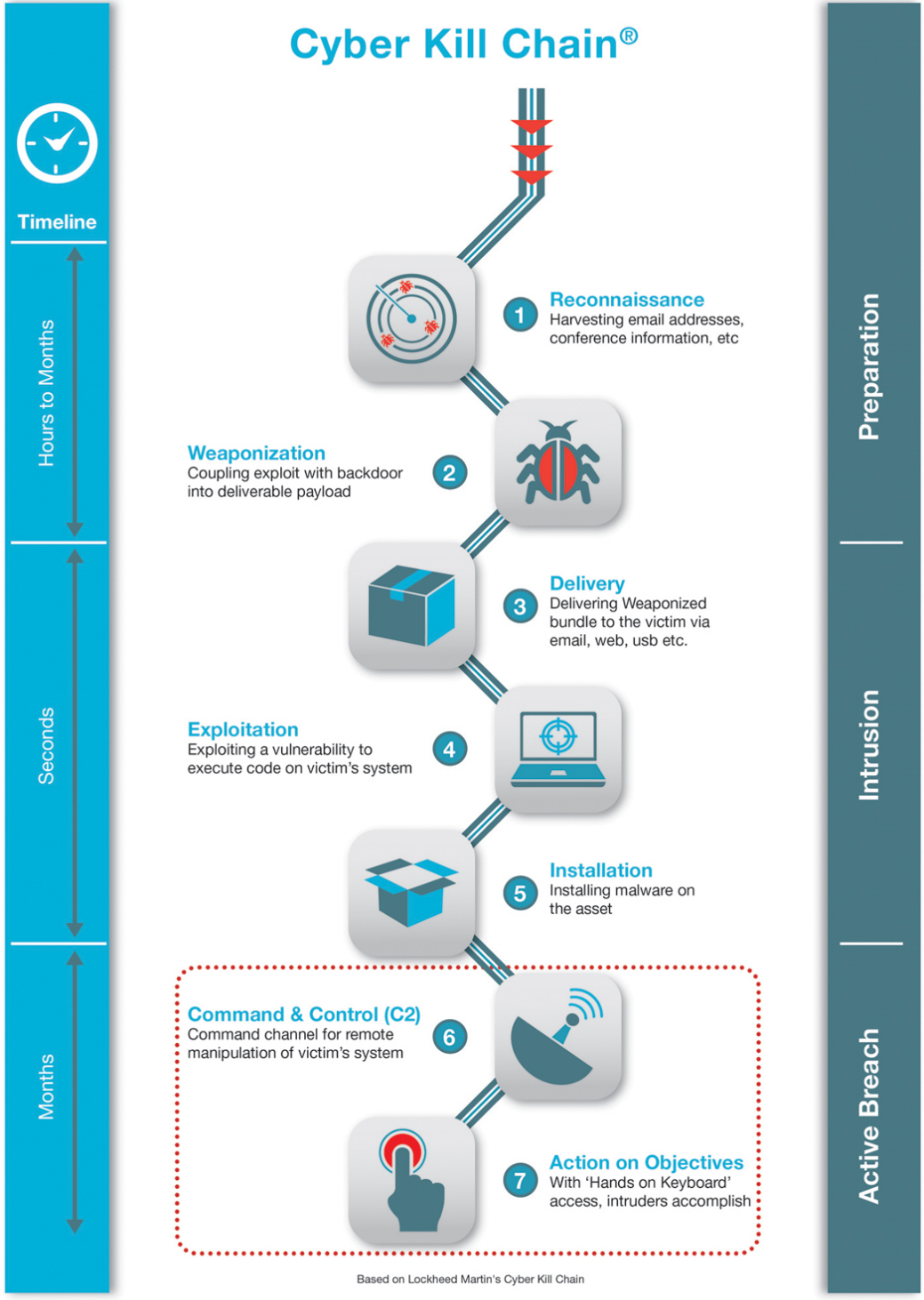
Slide 12: Image by Mila Atkovska (Shutterstock)
Slide 13: Victorinox SwissChamp knife. Image from zombie.wikia.com
Slide 23: Image by Jameson Gagnepain in flickr.com (CC BY-NC-SA 2.0)
Slide 29: Unknown author. Image from imgneed.com.
Slide 31: Unknown author. Image from pinterest.com

Backup slides

Malware sample sources

- VirusTotal Intelligence ($$$)
- Mailing lists
- Spam traps, honeypots, honeyclients
- Web repositories[9]
  - Malwr.com
  - ContagioDump (http://contagiodump.blogspot.com)
  - VXvault.net
  - Virusshare.com

[9] https://zeltser.com/malware-sample-sources/


Cyber Kill Chain®
Timeline
Hours to Months
Seconds
Months
Preparation
Intrusion
Active Breach
1 Reconnaissance
Harvesting email addresses, conference information, etc
2 Weaponization
Coupling exploit with backdoor into deliverable payload
3 Delivery
Delivering Weaponized bundle to the victim via email, web, usb etc.
4 Exploitation
Exploiting a vulnerability to execute code on victim's system
5 Installation
Installing malware on the asset
6 Command & Control (C2)
Command channel for remote manipulation of victim's system
7 Action on Objectives
With 'Hands on Keyboard' access, intruders accomplish
Based on Lockheed Martin's Cyber Kill Chain