Session 5: Information Security

PRIVACYCON

Northeastern University

International Secure Systems Lab

A Large-Scale, Automated Approach to Detecting Ransomware

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Disclosure: This research was funded by National Science Foundation and Secure Business Austria

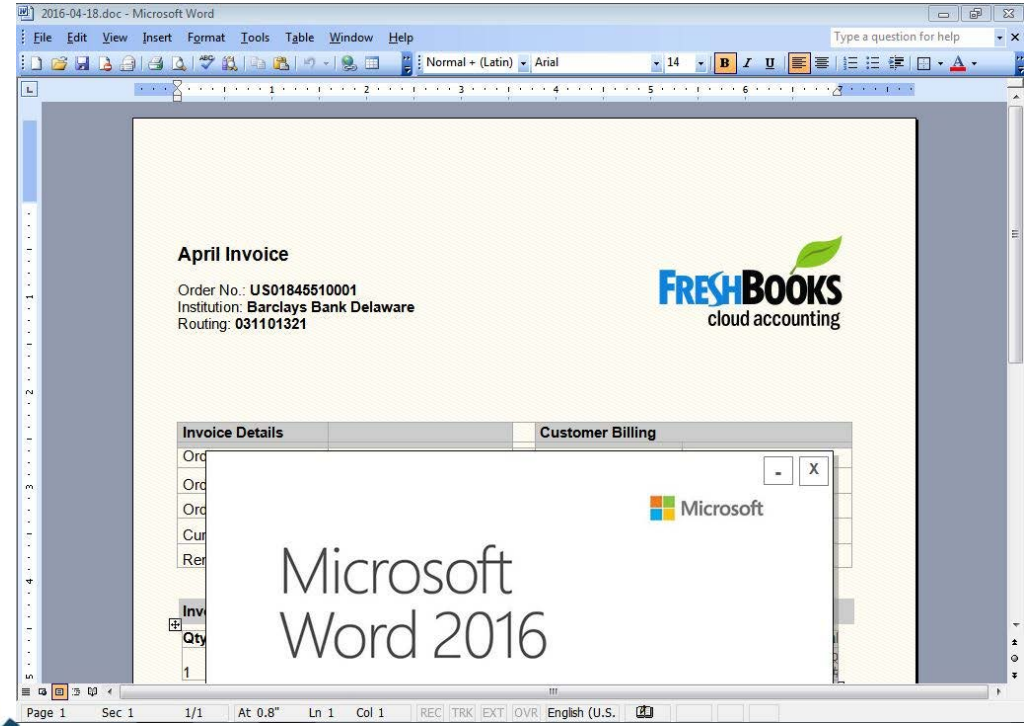
Infecting Victim's Machine

Attachments

Drive-by Downloads

Malicious binaries

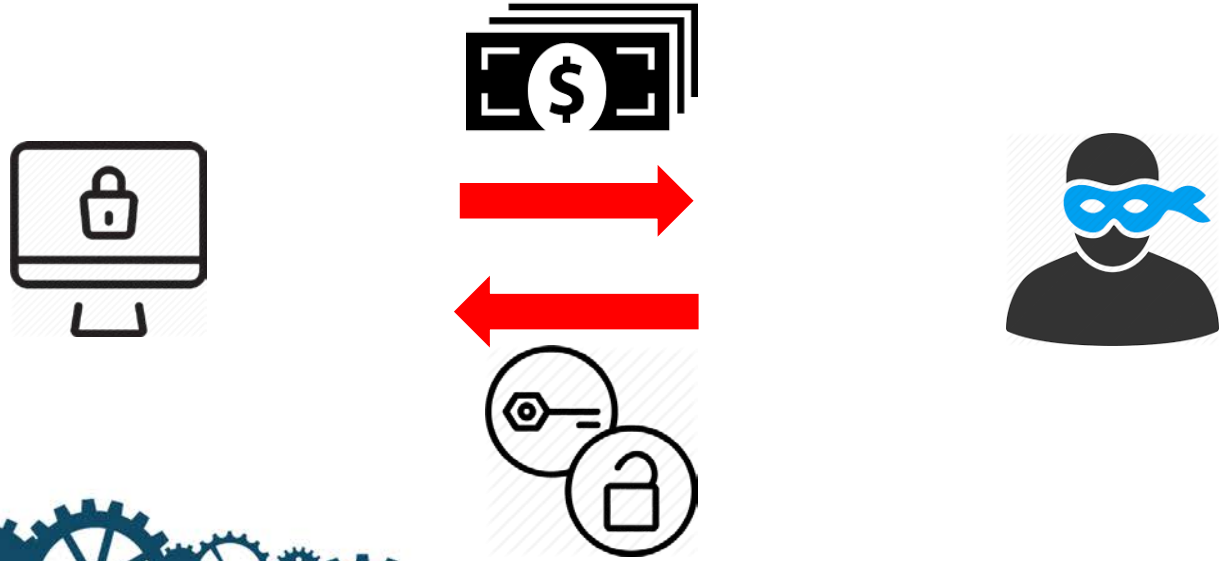
Macro Viruses: An Innocent Looking Word File



By opening the file you might get infected

What is a ransomware attack?

1. **Paying the ransom fee**
2. **Receiving the decryption key**



Privacy & Security

Ransomware attackers collect ransom from Kansas hospital, don't unlock all the data, then demand more money

Kansas Heart Hospital declined to pay the second ransom, saying that would not be wise. Security experts, meanwhile, are warning that ransomware attacks will only get worse.

By Bill Siwicki | May 23, 2016 | 02:58 PM

Kansas Heart Hospital in Wichita paid the initial ransom but decided against paying the second request even though some of its data appears to still be locked.

Kansas Heart Hospital was the victim of a ransomware attack and after it paid the first one, attackers boldly demanded a second ransom to decrypt data.

Kansas Heart Hospital president Greg Duick, MD told local media that patient

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University Pays $16,000 to Stop Ransomware Attack JUNE 8, 2016

Michael Phelps Picks Up His 20th Gold in 200-Meter Butterfly 10:37 PM EDT

USA's Katie Ledecky Clinches the Gold Again in 200m Freestyle 10:17 PM EDT

Two Years After Ferguson, What Has Changed? 8:00 PM EDT

Wild and Weird, Drone Racing May be the Sport of the Future 7:57 PM EDT

Elon Musk Says SolarCity Will Sell a Roof Integrated With Solar Panels 7:56 PM EDT

Disney Hedges Its Bets on TV With BAMTech Stake and ESPN Streaming 7:36 PM EDT

TECH CHANGING FACE OF SECURITY

University Pays $16,000 to Stop Ransomware Attack

by Jeff John Roberts @jeffjohnroberts JUNE 8, 2016, 1:29 PM EDT

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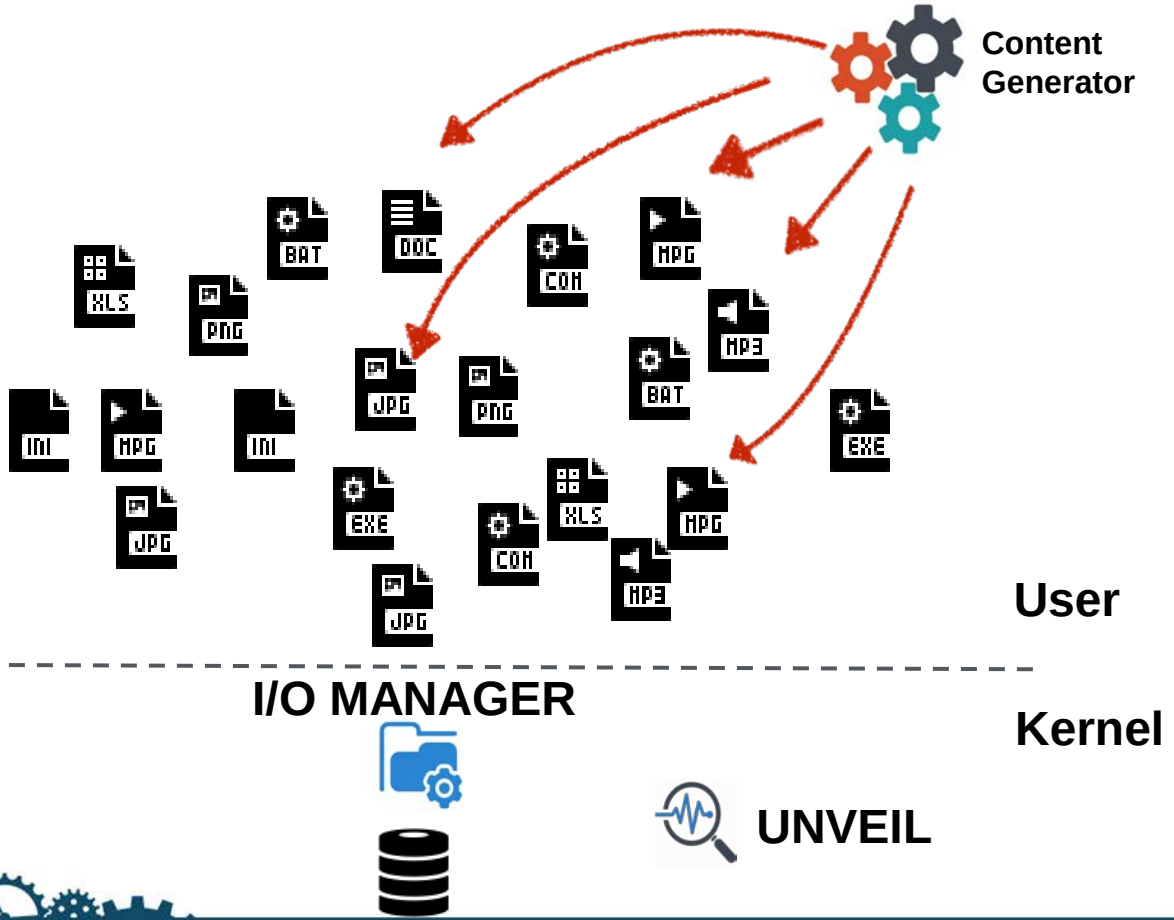
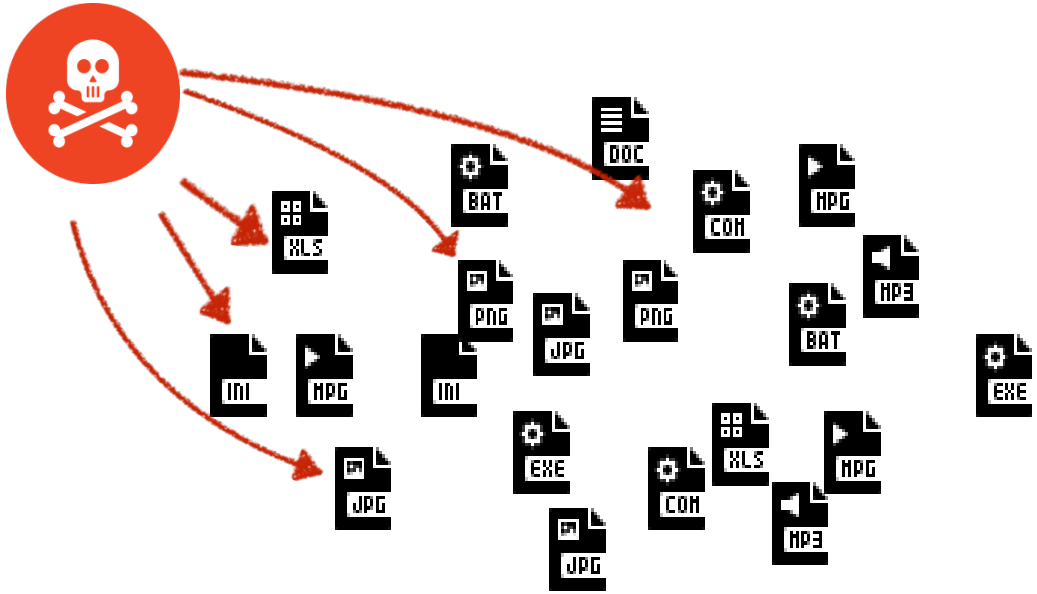
Achilles' Heel of Ransomware

- Ransomware *has to inform* victim that attack has taken place

- Ransomware has certain behaviors that are predictable
  - e.g., entropy changes, modal dialogs and background activity, accessing user files
- A good sandbox that looks for some of these signs helps here…


Content
Generator
XLS
BAT
DOC
COM
MPG
PNG
MP3
INI
JPG
EXE
User
I/O MANAGER
Kernel
UNVEIL



User

Kernel

I/O MANAGER

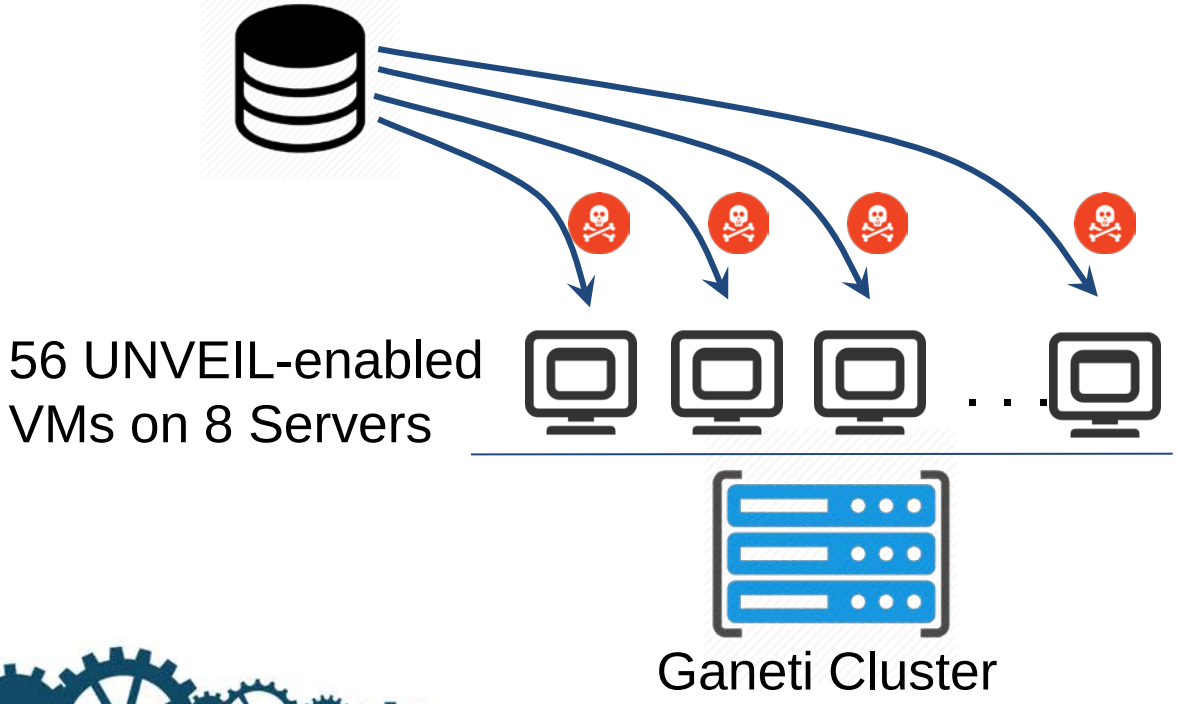
UNVEIL

Iteration over files during a CryptoWall attack

File	Operation	Process	Entropy
midterm_paper.docx	IRP_MJ_CREATE	svchost.exe	—
midterm_paper.docx	IRP_MJ_READ	svchost.exe	4.01
midterm_paper.docx	IRP_MJ_WRITE	svchost.exe	7.28
	...		
midterm_paper.docx	IRP_MJ_CLEANUP	svchost.exe	—
midterm_paper.docx	IRP_MJ_CLOSE	svchost.exe	—
myweddingparty.mpeg	IRP_MJ_CREATE	svchost.exe	—
myweddingparty.mpeg	IRP_MJ_READ	svchost.exe	5.14
myweddingparty.mpeg	IRP_MJ_WRITE	svchost.exe	7.24
	...		
myweddingparty.mpeg	IRP_MJ_CLEANUP	svchost.exe	—
myweddingparty.mpeg	IRP_MJ_CLOSE	svchost.exe	—

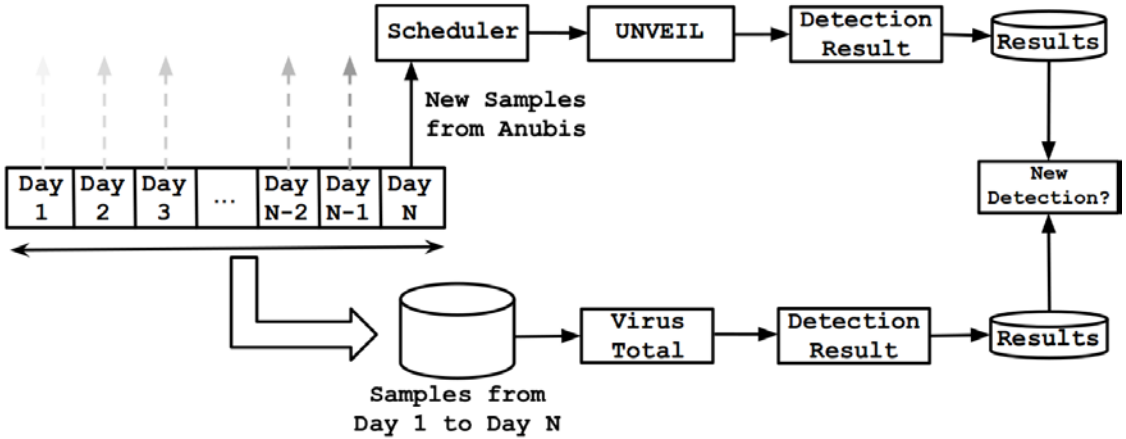
Evaluation UNVEIL with unknown samples

~ 1200 malware samples per day



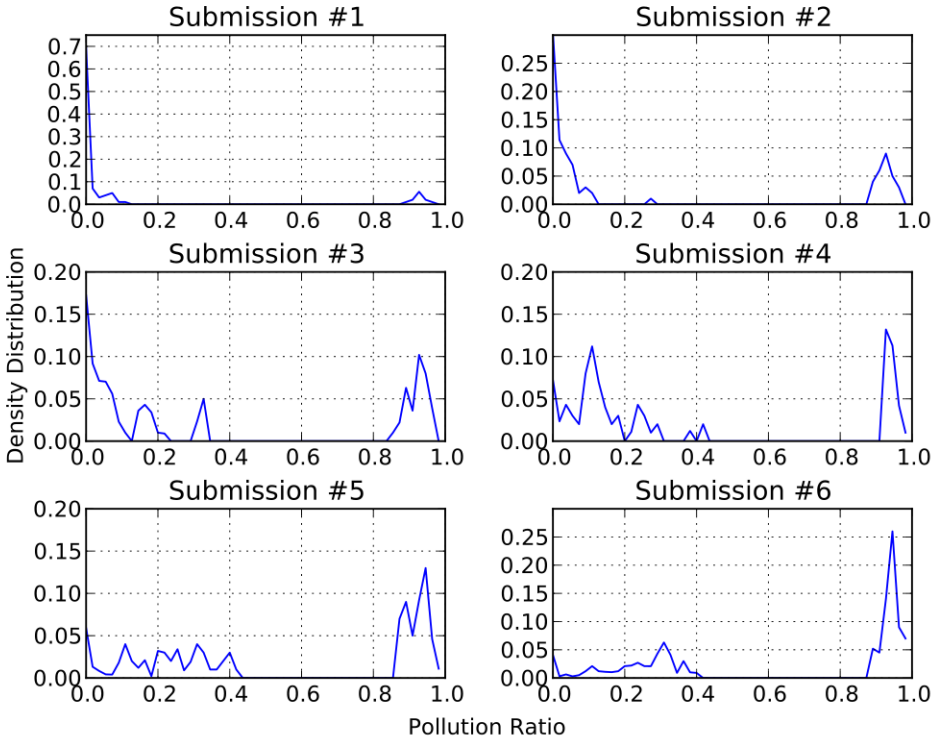
Evaluation UNVEIL with unknown samples

- The incoming samples were acquired from the daily malware feed provided by Anubis from March 18 to February 12, 2016.
- The dataset contained 148,223 distinct samples.

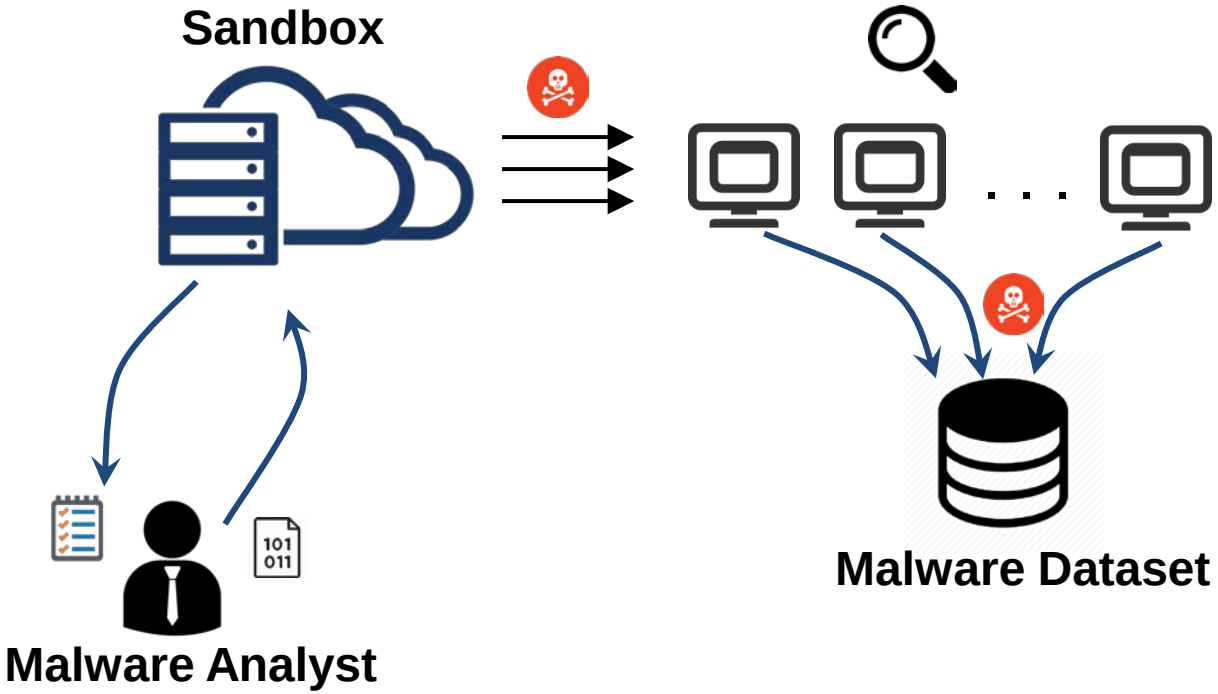


Cross-checking with VirusTotal

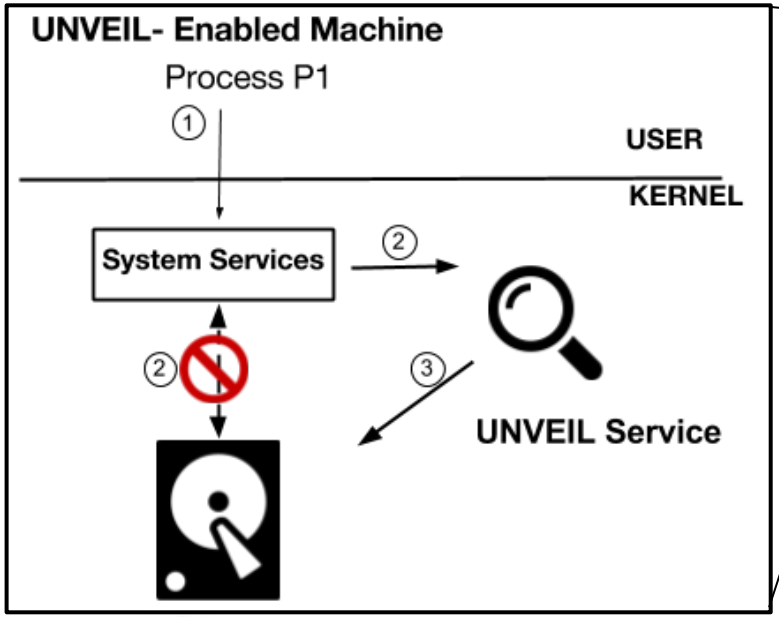
- The results are concentrated either towards small or very large detection ratios.
- A sample is either detected by a relatively small number, or almost all of the scanners.



Deployment Scenario (Malware Research)



Deployment Scenario (End-point Solution)



- Running UNVEIL as an augmented service
- UNVEIL supports legacy platforms
- Incurs modest overhead, averaging 2.6% for realistic work loads

Conclusion

- Ransomware is a challenging problem
  - But it has predictable behaviors compared to other malware
- UNVEIL introduces concrete models to detect those behaviors
  - We've shown that our detection model is useful in practice
- There is definitely room for improvement
  - We can extend our dynamic systems with functionality tuned towards detecting ransomware

Thank You

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INVESTIGATING COMMERCIAL PAY-PER-INSTALL

Kurt Thomas, Juan A. Elices Crespo, Ryan Rasti, Jean-Michel Picod, Cait Phillips, Marc-André Decoste, Chris Sharp, Fabio Tirelo, Ali Tofigh, Marc-Antoine Courteau, Lucas Ballard, Robert Shield, Nav Jagpal, Moheeb Abu Rajab, Panos Mavrommatis, Niels Provos, Elie Bursztein, **Damon McCoy**

This research was funded by the National Science Foundation and Gifts from Google

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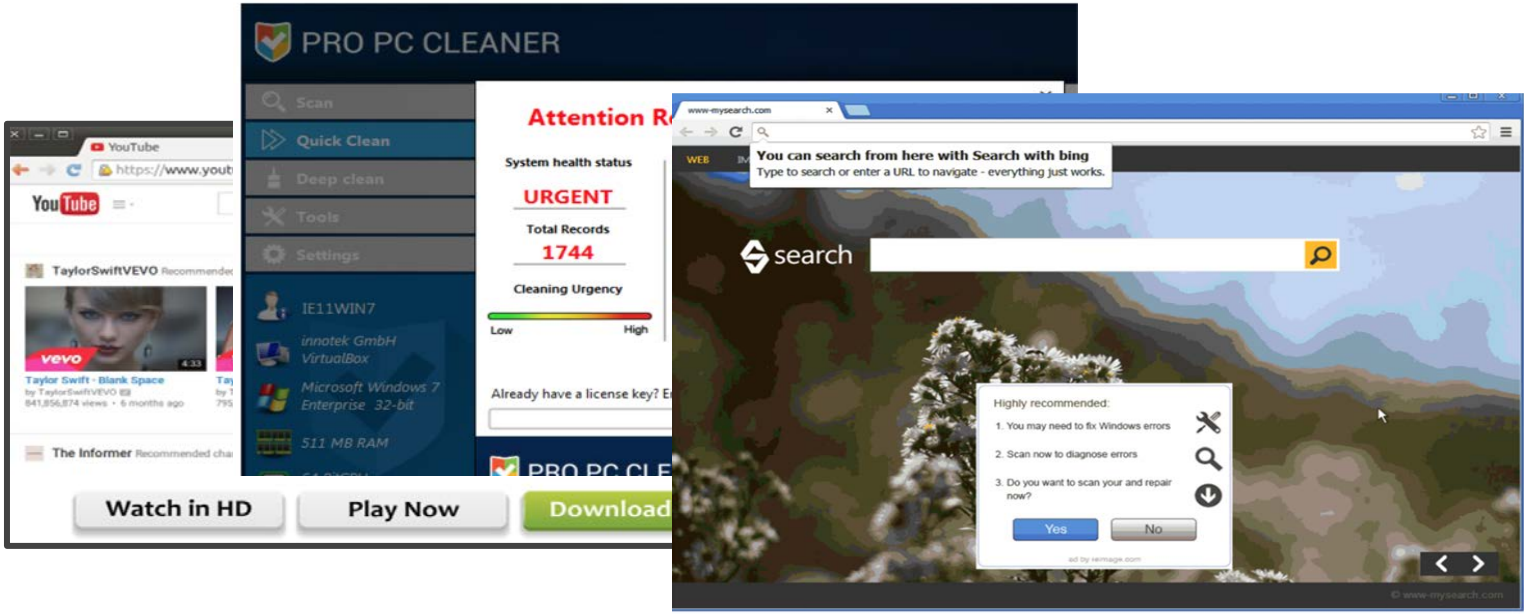
Unwanted software



Millions of users with symptoms of unwanted software. How was it installed?

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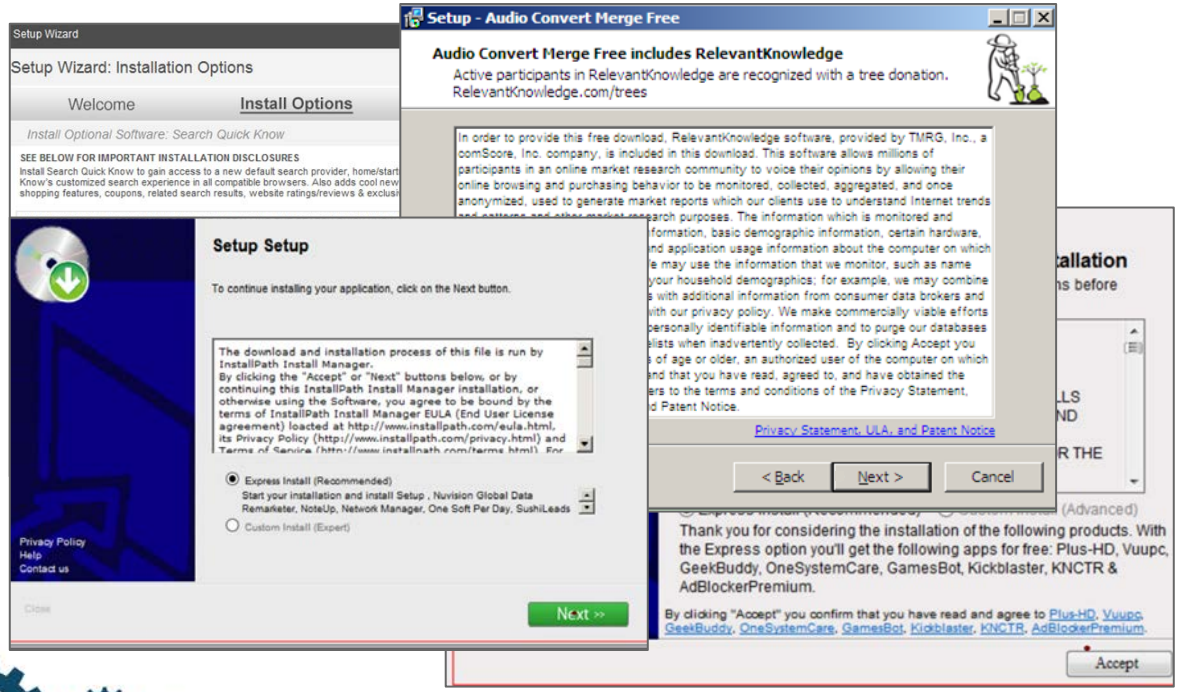
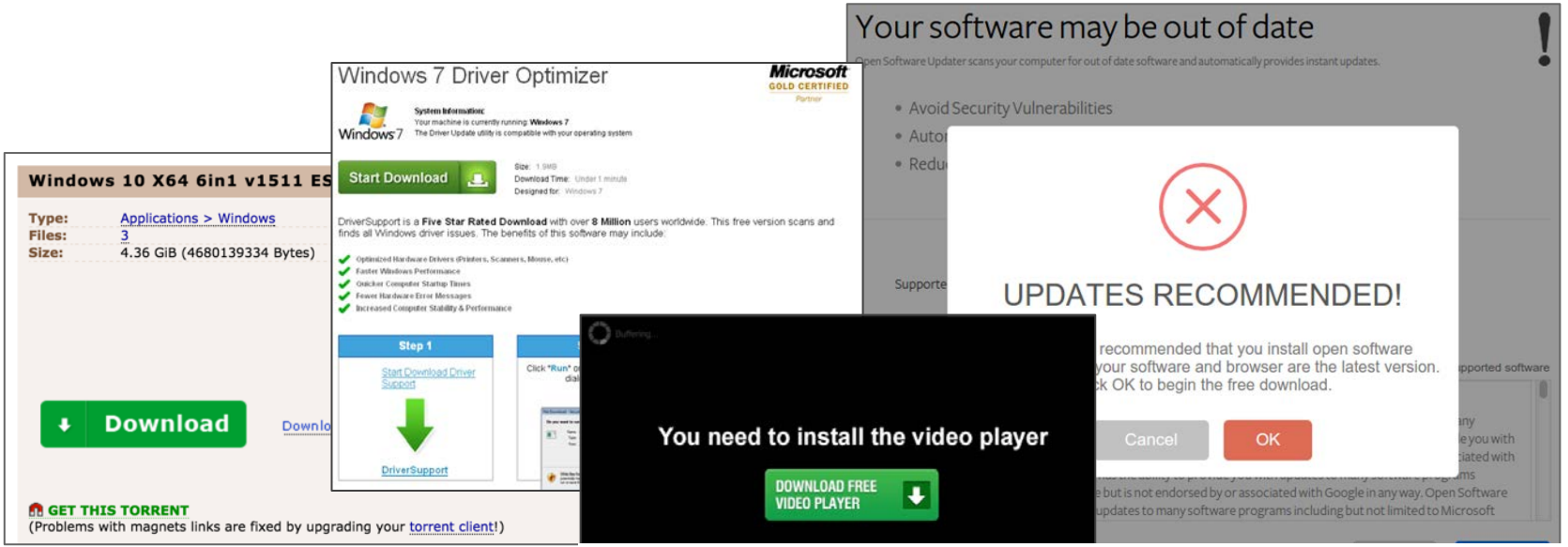
Commercial pay-per-install

Practice of bundling several additional applications.



Deceptive promotions



Users deceived into unintentionally installing unrelated software.

Our work

Year-long investigation into the marketplace of bundling:

- Relationships with unwanted software
- Deceptive promotional tools
- Negative impact on users

Get the community on board to tackle unwanted software

1

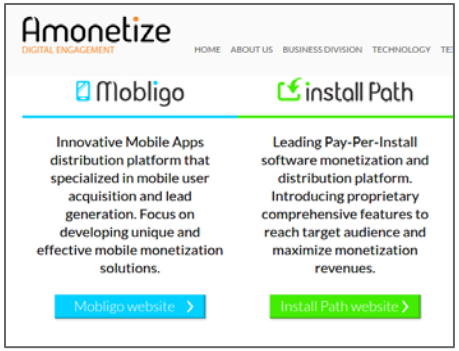
BEHIND THE SCENES

Pay-per-install affiliate model

Advertisers: software developers willing to buy installs.

Pay-per-install affiliate model

$$$



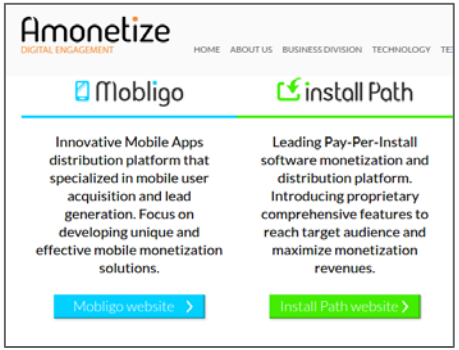
Advertisers *PPI Network*

PPI affiliate network: middle-man that create download manager.

Pay-per-install affiliate model

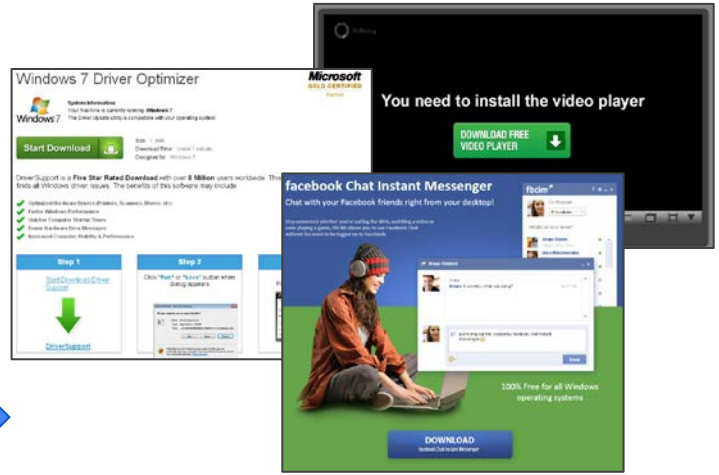
Advertisers

$$$



PPI Network

$$



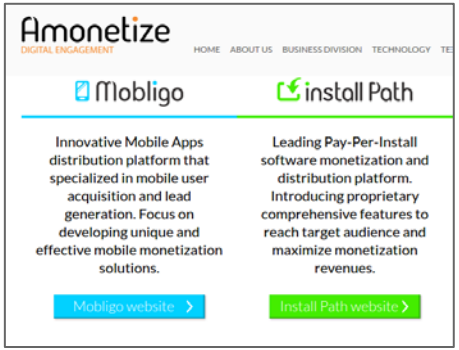
Publishers

Publishers: popular software developers or websites that distribute bundles for a fee.

Pay-per-install affiliate model

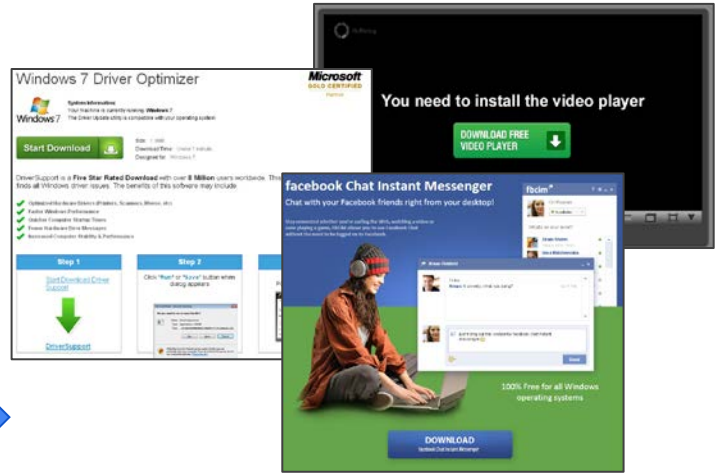
Advertisers

$$$



PPI Network

$$



Publishers

Decentralized distribution can lend itself to abuse.

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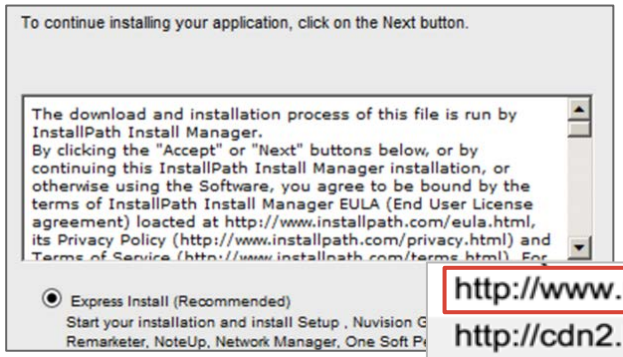
2

MONITORING PPI NETWORKS

Upon launching a PPI bundle...



C&C domain

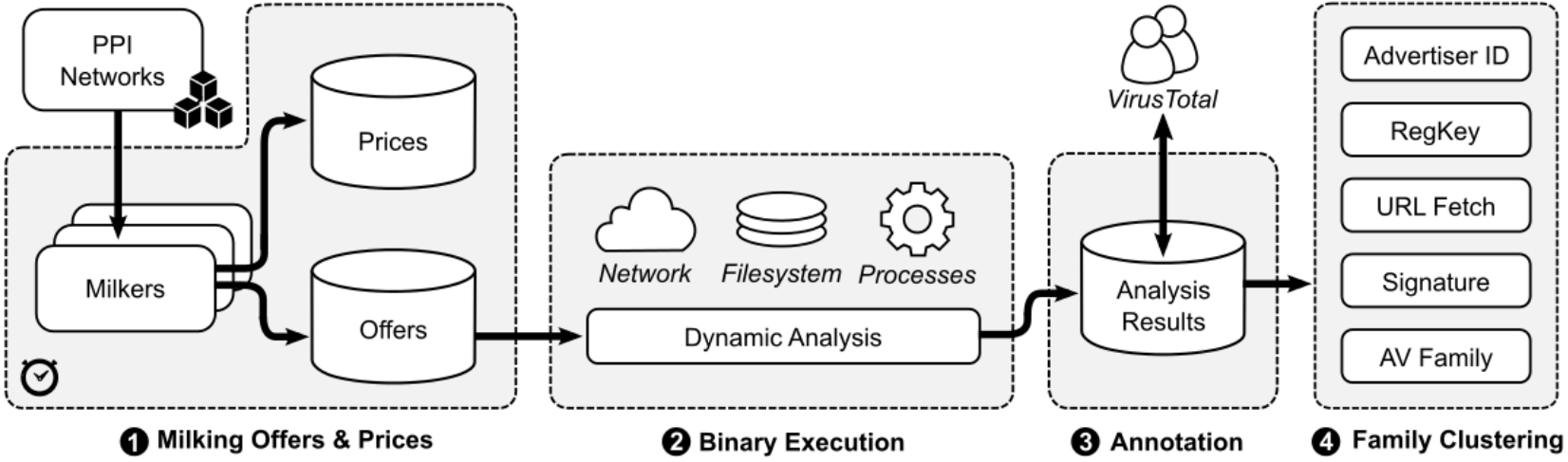
http://www.myflowerdownload.com/index.php
http://cdn2.lawfuldownload.com/9ee1efd2-b9b2-403
http://cdn2.lawfuldownload.com/9ee1efd2-b9b2-403
http://www.myflowerdownload.com/finalize.php
http://cdn2.lawfuldownload.com/9ee1efd2-b9b2-403
http://cdn2.lawfuldownload.com/9ee1efd2-b9b2-403
http://www.myflowerdownload.com/thankyou.php

Fingerprint system & request offers

Report successful installs

Optional splash screen post-install

Analysis pipeline



Dataset

PPI Network	Milking Period	Offers	Unique
Outbrowse	Jan 8, 2015 -- Jan, 7, 2016	107,595	584
Amonetize	Jan 8, 2015 -- Jan, 7, 2016	231,327	356
InstallMonetizer	Jan 11, 2015 -- Jan, 7, 2016	30,349	137
OpenCandy	Jan 9, 2015 -- Jan, 7, 2016	77,581	134
Total	Jan 8, 2015 -- Jan, 7, 2016	446,852	1,211

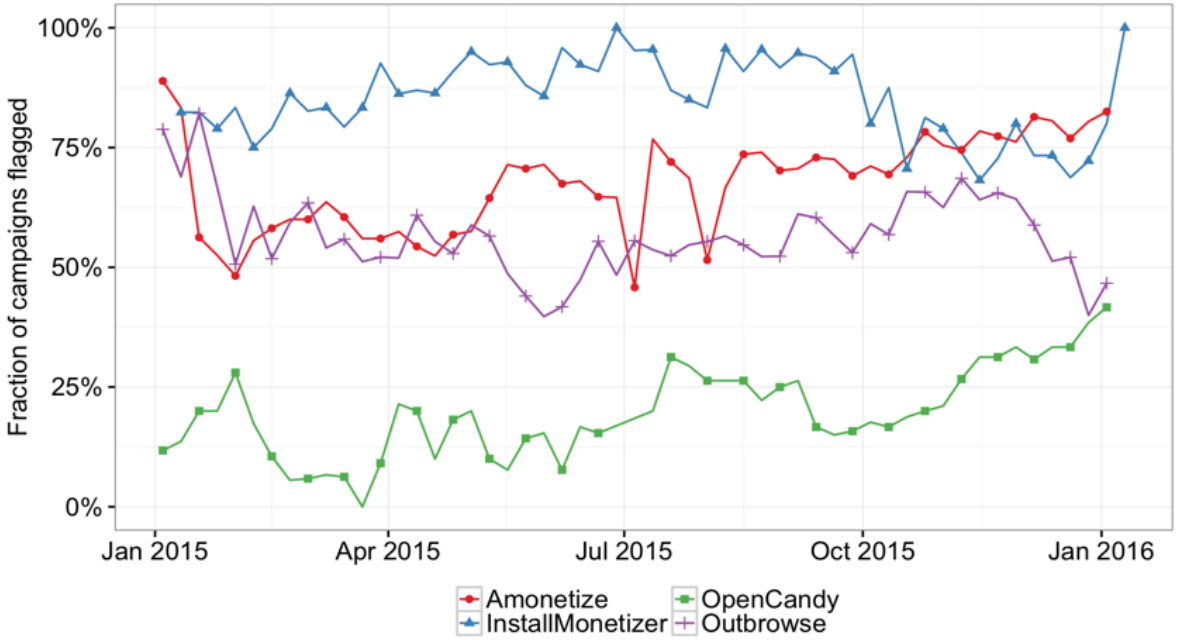
3

ANALYSIS

Most frequent advertisers

	Brand	PPI Networks	Days Active
Ad Injectors	*Wajam*	4	365
	Vopackage	3	365
	Youtube Dwnldr	3	365
	Eorezo	2	365
Browser Settings Hijackers	*Browsefox*	4	363
	Conduit	3	327
	CouponMarvel	1	300
	Smartbar	3	294
Cleanup Utilities	*Speedchecker*	2	365
	Uniblue	4	327
	OptimizerPro	4	302
	Systweak	3	249

VirusTotal labels



59% of weekly offers flagged by at least 1 AV

Anti-virus detection

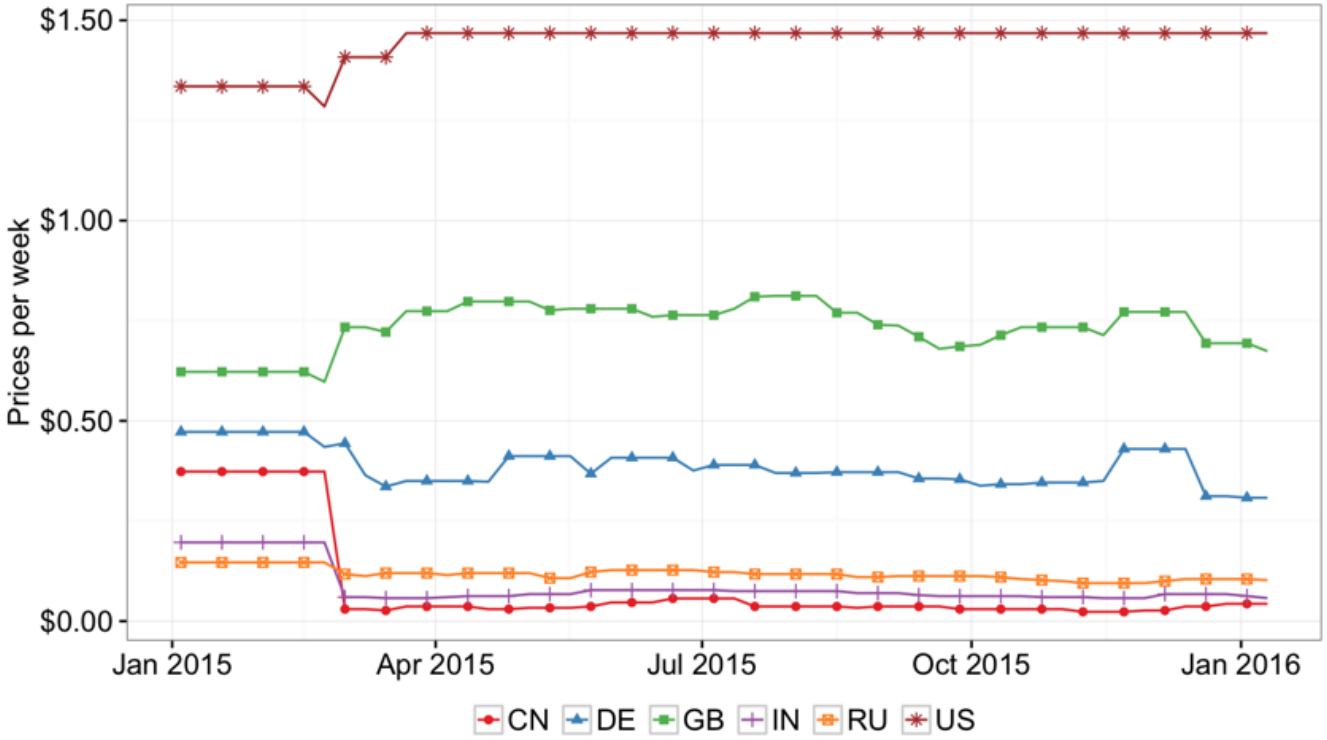
Advertiser-specified installation criteria avoids hostile AV:

```
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\Avast')!=0)
(g_ami.CheckRegKey(g_hkcu, 'SOFTWARE\\\\Avast')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'Software\\\\AVAST Software')!=0)
(g_ami.CheckRegKey(g_hkcu, 'Software\\\\AVAST Software')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\Avira')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\Classes\\\\avast')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\ESET')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'AppEvents\\\\Schemes\\\\Apps\\\\Avast')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SYSTEM\\\\CurrentControlSet\\\\Services\\\\avast! Antivirus ')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\Microsoft\\\\Windows\\\\CurrentVersion\\\\Uninstall\\\\Avast')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\{C1856559-BA5C-41B7-961C-677E89A2C490}')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\{0D40F91C-41DE-4E06-8B14-ABCCF7A51495}')!=0)
(g_ami.CheckRegKey(g_hklmg_hk64, 'SOFTWARE\\\\{8B261394-6C7D-4CFC-A767-E02F34A60D8B}')!=0)
```

```
HKEY_LOCAL_MACHINE SOFTWARE\\\\OpenVPN
HKEY_LOCAL_MACHINE SOFTWARE\\\\VMware,*Inc.
HKEY_LOCAL_MACHINE SOFTWARE\\\\Oracle\\\\VirtualBox
```

20% of advertisers use some AV/VM detection

Price per install

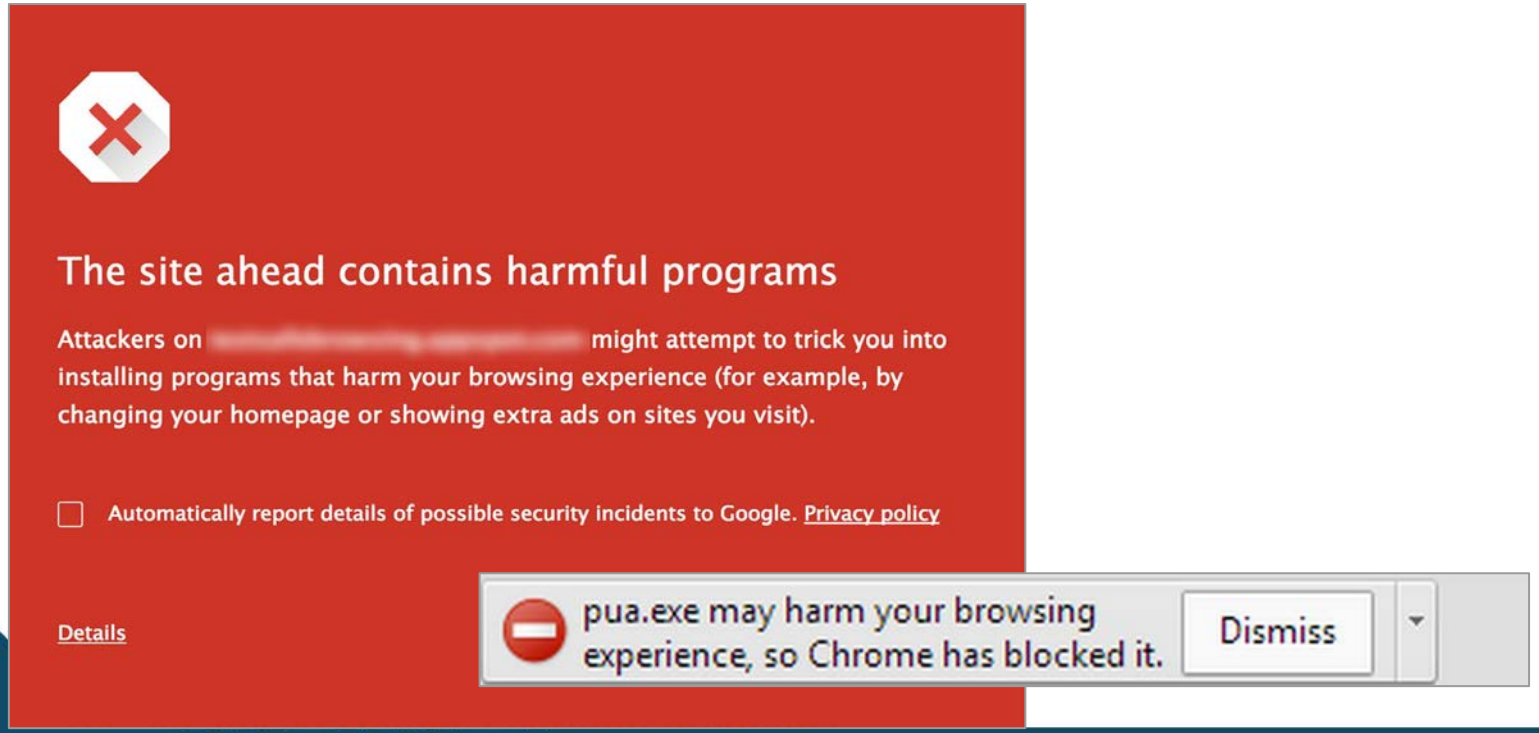


Price ranges
$0.10–$1.50

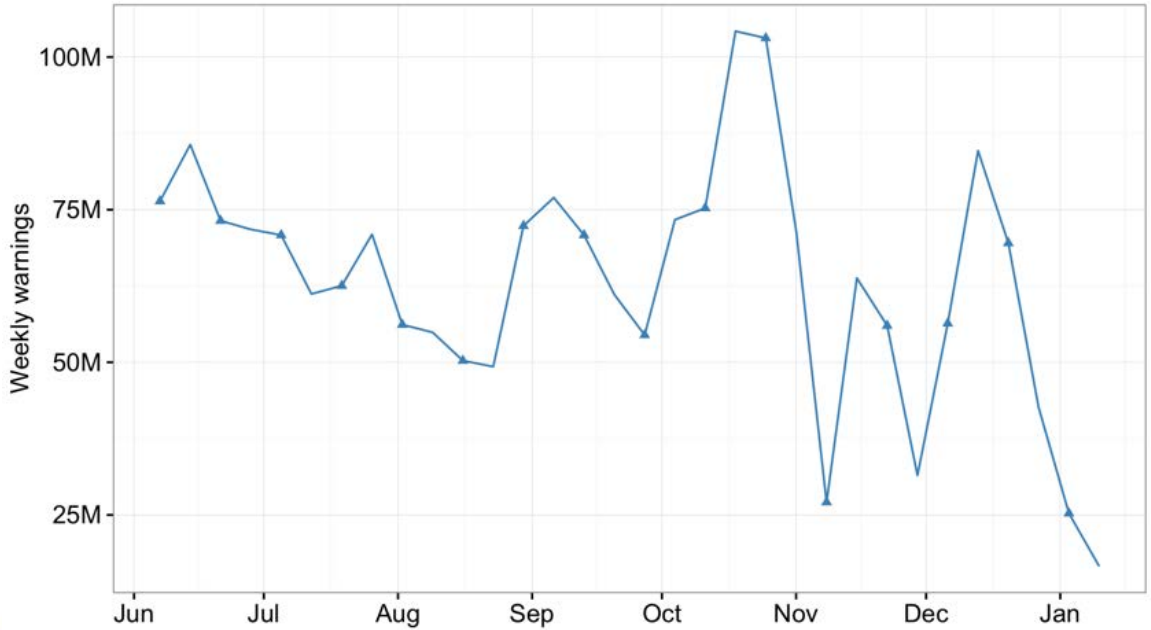
4

USER IMPACT

Unwanted software warnings



Weekly user warnings



60M warnings every week

5

DECEPTIVE DISTRIBUTION

Promotional tools

PERINSTALLCASH

NEWS STATISTICS MANAGE PROMOTOOLS PAYMENTS HELP LOG OUT

Home / Promo tools

Promo tools

Promo tools

Attention! Never save any exe-files to your server! Outdated distributives may cause

Show All | Movie traffic | Download traffic | Youtube traffic | MP3 traffic | Sc

NEW! Basic direct download link for common cases. Place it on your site and see how profit grows.

» How to setup

Lock any URL with our Link Locker and get paid when user installs the software to access the link.

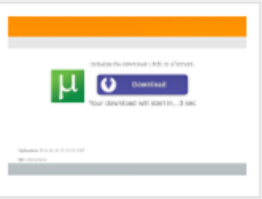
» How to setup

uTorrent Download #2 (add parameters fn=File_to_download.zip size=sizeinMB)

Copy this link and use on your website:

http://ncradserver.com/go.php?aff=2474&offer=9&lp=16 preview

View banners (4)



Java Update Download (add parametr auto=1 for auto download exe)

Copy this link and use on your website:

http://ncradserver.com/go.php?aff=2474&offer=9&lp=17 preview

Java Update Error (add parametr auto=1 for auto download exe)

Copy this link and use on your website:

http://ncradserver.com/go.php?aff=2474&offer=9&lp=18 preview

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Domain cycling

07 Jan

New domains New

IMPORTANT!!!

We replaced some blocked promo domains with new ones. Please change it at your side as soon as possible, using of old domains can lead to profit loss.

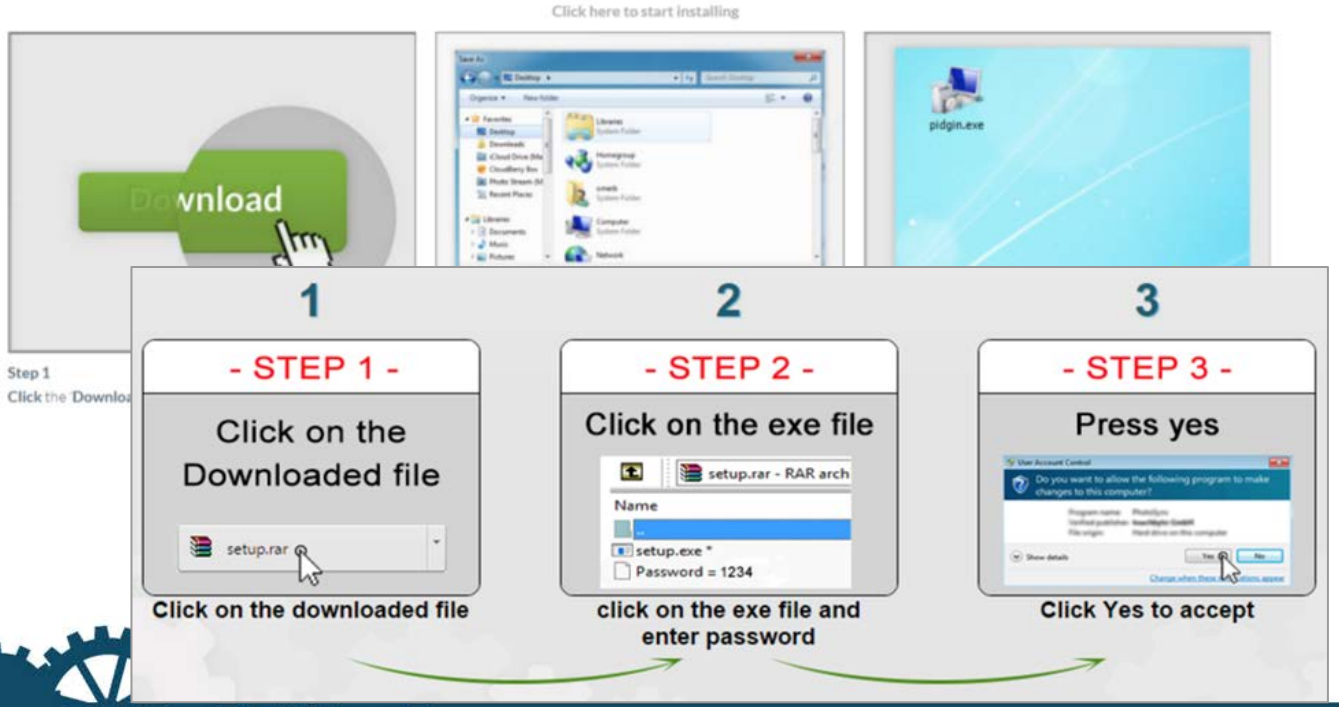
Old domain => New domain:

letshareus.com => letshare.club
downloadsoundcloud.net => downloadsoundcloud.xyz
fbmessenger.net => fbchat.xyz
mp3gino.com => ginoplayer.xyz (also dynamic banners are now on blocks.ginoplayer.xyz)
loadvids.net => loadvids.xyz
saveclip.net => saveclip.xyz
wallpapermanager.net => wallpaperman.xyz

Also, note that our main direct download domain now is download5-cdn.com, so if you still use download4-cdn.com or download3-cdn.com - replace it as soon as possible.

Distribution sites cycle every 1-7 hours

Safe Browsing evasion



Takeaways

Unwanted software massive commercial ecosystem:

- **Tens of millions of users affected**
- **Pay-per-install primary distribution vector**
- **Misaligned incentives for advertisers, publishers**

Killed by Proxy: Analyzing Client-end TLS Interception Software

Xavier de Carné de Carnavalet and Mohammad Mannan
Concordia University, Canada

Funding support: **Vanier CGS, NSERC, and OPC**
Original publication: **NDSS 2016**

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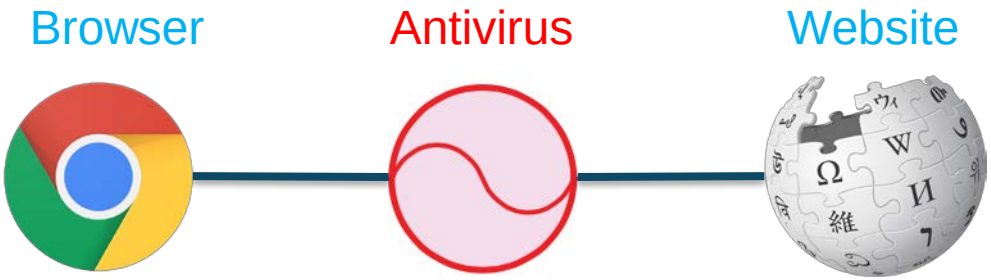
HTTPS usage

- Secures client-server connection
- > half the websites now support HTTPS

Antivirus vs. HTTPS

- Both help secure your data/online experience
- AVs also want to guard against web malware
- But malware may come via HTTPS



Client-end TLS interception

1. Ad-related products (SuperFish/PrivDog/Komodia)
   - inject/replace ads
2. Antivirus products
   - eliminate drive-by downloads, malicious scripts
3. Parental control applications
   - block access to unwanted websites, hide swear words

Wanted vs. unwanted interception

- Unwanted adware can/should be removed

- But AVs and parental control apps are
  - “wanted”
  - “strongly recommended” or “required”

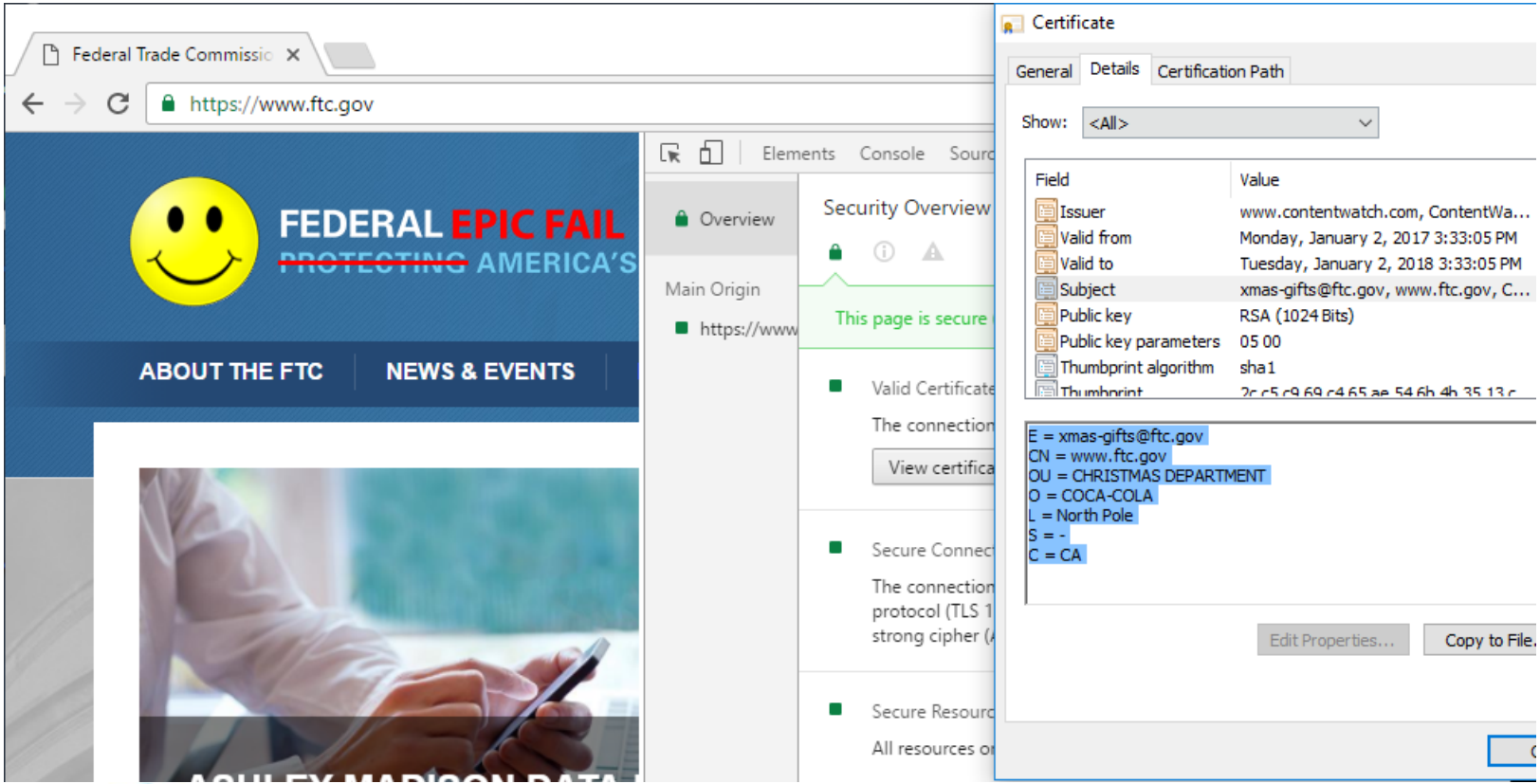
Our targets

- 14 security products in Windows
  - March and August 2015
- All but one significantly downgrade TLS security

Implications

- Attacker must be an active Man-in-the-Middle
  - Anywhere between a user and website
  - Target all users of a product vs. selective users
  - No admin privilege is needed

- Can impersonate a server
- Can extract secrets e.g., authentication cookies
- Design flaws – not software bugs


Federal Trade Commissio
https://www.ftc.gov
FEDERAL EPIC FAIL
PROTECTING AMERICA'S
ABOUT THE FTC
NEWS & EVENTS
Elements
Console
Overview
Security Overview
Main Origin
This page is secure
Valid Certificate
The connection
View certifica
Secure Connec
The connection
protocol (TLS 1
strong cipher (
Secure Resourc
All resources o
Certificate
General
Details
Certification Path
Show:
<All>
Field
Value
Issuer
www.contentwatch.com, ContentWa...
Valid from
Monday, January 2, 2017 3:33:05 PM
Valid to
Tuesday, January 2, 2018 3:33:05 PM
Subject
xmas-gifts@ftc.gov, www.ftc.gov, C...
Public key
RSA (1024 Bits)
Public key parameters
05 00
Thumbprint algorithm
sha1
E = xmas-gifts@ftc.gov
CN = www.ftc.gov
OU = CHRISTMAS DEPARTMENT
O = COCA-COLA
L = North Pole
S = -
C = CA
Edit Properties...
Copy to File...

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Our test framework

Hybrid test framework: adapt existing + custom tests

1. Private key protection
2. Certificate validation
3. Cipher suites & protocols
4. Transparency

Root certificate and private key

- Pre-generated certificates (2/14)
- Proxies accept own certificates (12*/12)
- User-readable private keys (9/14)
- Root cert. not removed after uninstallation (8/14)
- Certificates are valid, on average, for 10 years

Site certificate validation

- No validation (3/12)
- Improper signature verification (1/12)
- Accept weak primitives: MD5 (9/12), RSA 512 (7/12)
- No revocation check (9/12)
- Custom CA store (3/12): DigiNotar+CNNIC; Mozilla Trusted CAs from 2009; One RSA 512 root CA

Protocol, cipher suites and attacks

- SSL 3.0 support (6/12), no support for TLS 1.1+ (6/12)
- Weak cipher suites: RC4 and MD5 (10/12)
- Proxies vulnerable to known attacks: Insecure Renegotiation (1), BEAST (7), CRIME (1), FREAK (5), Logjam (3)

Proxy transparency

- Virtual upgrade of TLS version as seen by the client (7/12)
  - SSL 3.0 → TLS 1.0 or 1.2
  - TLS 1.0 → TLS 1.2
- Cipher-suites are never transparent, client's choice ignored
- EV certificates filtered, replaced by DV (11/12)

Summary results

	Certificate generation time	Reject own root certificate	Removal during uninstallation	Validity (years)	Key protection	Access right
Avast	Installation	×	✓	10	OS API	Admin
AVG	Installation	✓*	✓	10	Obfuscation	Unknown
BitDefender	Installation	×	✓	10	Hardcoded pwd	User
BullGuard AV	Installation	—	×	10	Hardcoded pwd	User
BullGuard IS	Installation	✓	×	10	Hardcoded pwd	User
CYBERsitter	Pre-generated*	×	×	20	Plaintext	User
Dr. Web	Installation	×	×	1	OS API	Admin
ESET	Installation*	×	×	10	OS API	Admin
G DATA	Installation	×	✓	10	Obf. encryption	User
Kaspersky	Installation	×	×	10	Plaintext	User
KinderGate	Installation	×	×	5	Plaintext	User
Net Nanny	Installation	×	✓	10	Modified SQLCipher	User
PC Pandora	Pre-generated	×	✓	10	OS API	Admin
ZoneAlarm	Installation	—	×	10	Plaintext	User

Recommendations

- Use TLS "key-logging"
- Private keys: Use OS-provided storage APIs
- Certificate validation: Rely on an updated TLS library, communicate errors to users
- Transparency: Respect client's choice
- Browsers/servers: More pro-active, warn users when proxied

Takeaways…

1. “More security” (software) may be bad users
   - increased attack surface
2. How to hold AVs responsible?
3. Periodic monitoring – needs regulatory help?

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Discussion of Session 5

Presenters:

- **Amin Kharraz**, Northeastern University
- **Damon McCoy**, New York University
- **Mohammad Mannan**, Concordia University, Canada

Moderator:

- **Mark Eichorn,** Federal Trade Commission

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Wrap-Up Panel

Panelists:

- **Howard Beales**, George Washington University
- **Deirdre Mulligan**, University of California, Berkeley
- **Andrew Stivers**, Federal Trade Commission

Moderator:

- **Jessica L. Rich,** Federal Trade Commission

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THANKS!

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