How to Steal a Botnet and What Can Happen When You Do

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Botnet Terminology

- Bot
  - an application that performs some action or set of actions on behalf of a remote controller
  - installed on a victim machine (zombie)
  - modular (plug in your functionality/exploit/payload)
- Botnet
  - network of infected machines controlled by a malicious entity
- Control channel
  - required to send commands to bots and obtain results and status messages
  - usually via IRC, HTTP, HTTPs, or Peer-to-Peer
- Bot Herder
  - aka botmaster or controller
  - owns control channel, sends commands to botnet army
  - motivations are usually power or money

Torpig

- Trojan horse
  - distributed via the Mebroot “malware platform”
  - injects itself into 29 different applications as DLL
  - steals sensitive information (passwords, HTTP POST data)
  - HTTP injection for phishing
  - uses “encrypted” HTTP as C&C protocol
  - uses *domain flux* to locate C&C server
- Mebroot
  - spreads via drive-by downloads
  - sophisticated rootkit (overwrites master boot record)

Torpig: Behind the scenes

"Hacked" web servers

Mebroot C&C

Commands + torpig

Innocent victim

STOLEN DATA

Torpig C&C

Mebroot download

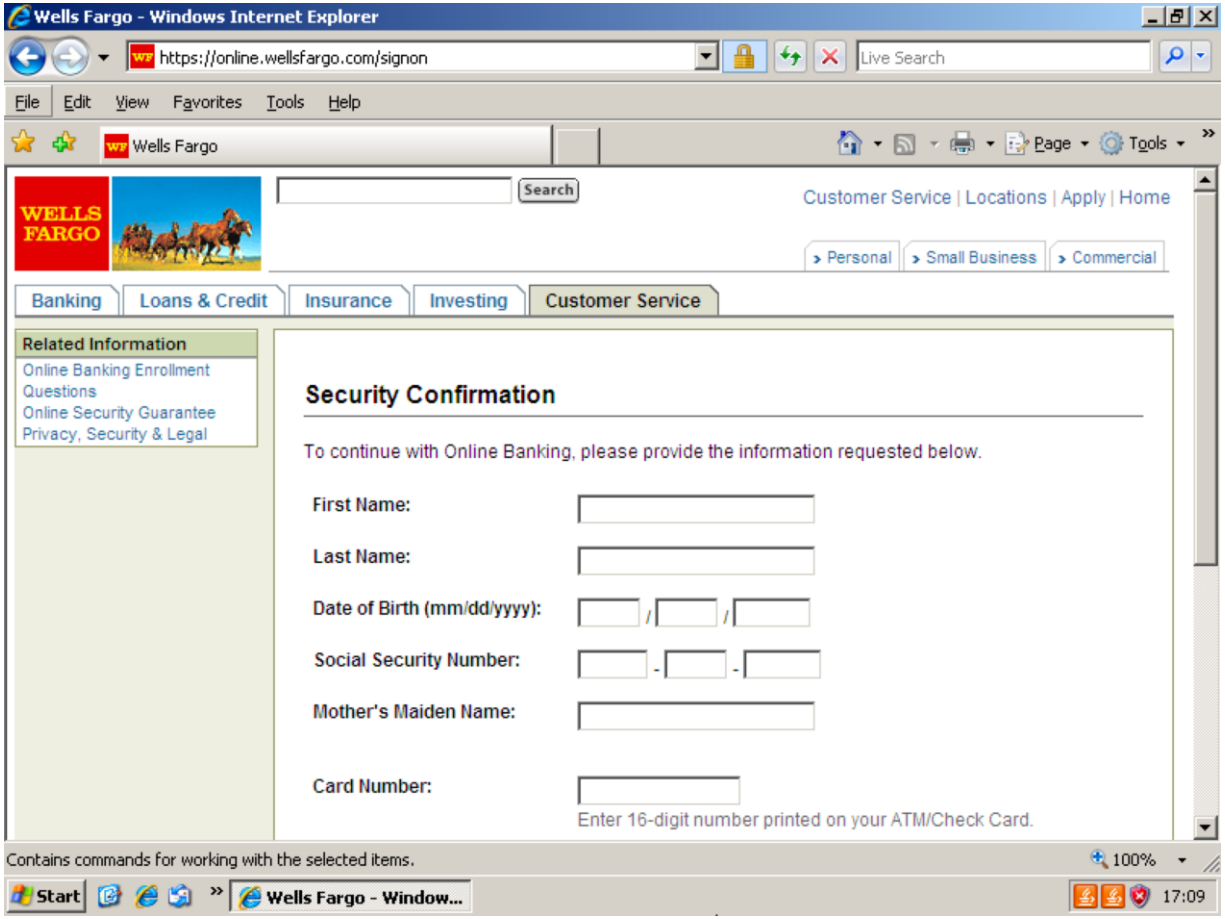
"Drive-By Download" server

Injection server

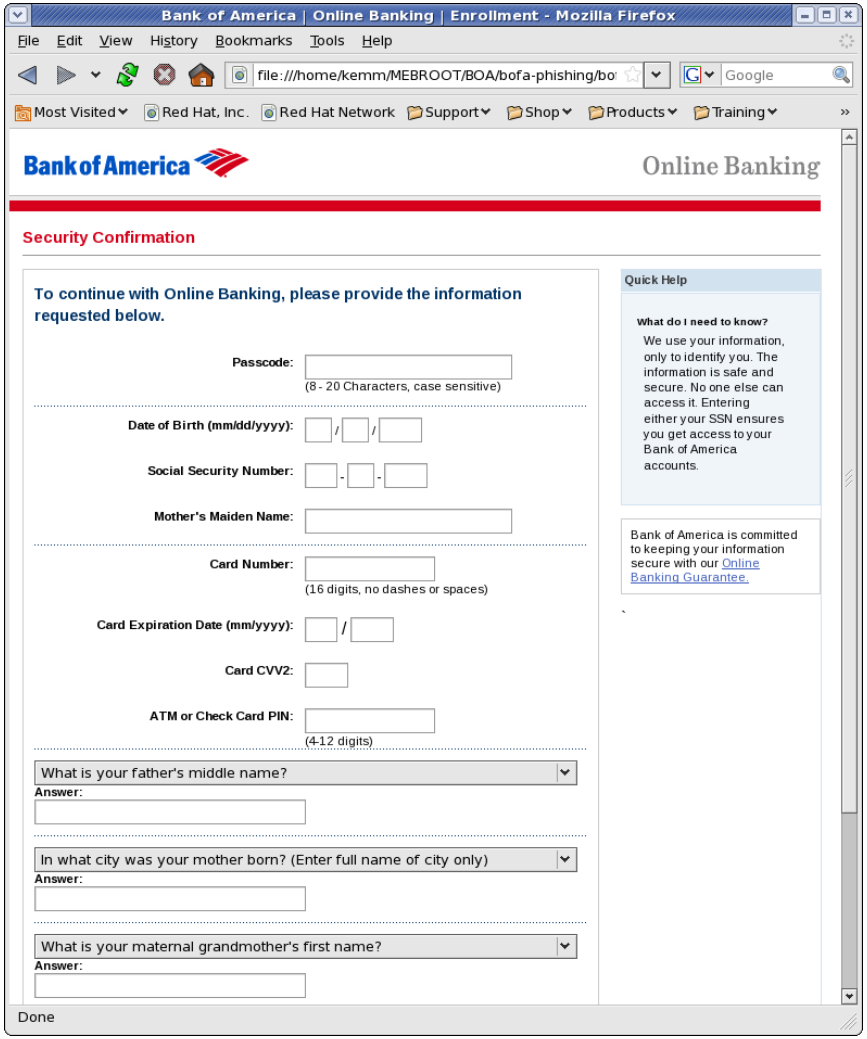
Torpig HTML Injection

- Domains of interest (~300) stored in configuration file
- When domain of interest visited
  - Torpig issues request to injection server
  - server specifies a *trigger page* on target domain and a URL on injection server to be visited when user visits trigger page
- When user visits the trigger page
  - Torpig requests injection URL from injection server
  - Torpig injects the returned content into the user's browser
- Content is usually html phishing form that asks for sensitive data
  - reproduces look and style of target web site

Example Phishing Page



Example Phishing Page



Domain Flux

- Taking down a single bot has little effect on botmaster
- C&C servers are vulnerable to take down
  - if you use a static IP address, people will block or remove host
  - if you use a DNS name, people will block or remove domain name
- Domain flux
  - idea is to have bots periodically generate new C&C domain names
  - often, use local date (system time) as input
  - botmaster needs to register one of these domains

  and respond properly so that bots recognize valid C&C server
  - defenders must register all domains to take down botnet

Torpig Domain Flux

- Each bot has
  - same domain generation algorithm (DGA)
  - three fixed domains to be used if all else fails
- DGA generates
  - weekly domain name (wd)
  - daily domain name (dd)
- Every 20 minutes bot attempts to connect (in order) to
  - wd.com, wd.net, wd.biz
  - if all three fail, then dd.com, dd.net, dd.biz
  - if they also fail, then the three fixed domains
- Criminals normally registered wd.com (and wd.net)

Sinkholing Torpig C&C Overview

- Reverse engineered name generation algorithm and C&C protocol
- Observed domains for 01/25 – 02/15 unregistered
- Registered these domains ourselves
- Unfortunately, Mebroot pushed new Torpig binary on 02/04
- We controlled the botnet for ~10 days
- Data
  - 8.7 GB Apache logs
  - 69 GB pcap data (contains stolen information)

Sinkholing Torpig C&C

- Purchased hosting from two different hosting providers known to be unresponsive to complaints
- Registered wd.com and wd.net with two different registrars
  - One was suspended 01/31 due to abuse complaint
- Set up Apache web servers to receive bot requests
- Recorded all network traffic
- Automatically downloaded and removed data from our hosting providers
- Enabled hosts a week early
  - immediately received data from 359 infected machines

Data Collection Principles

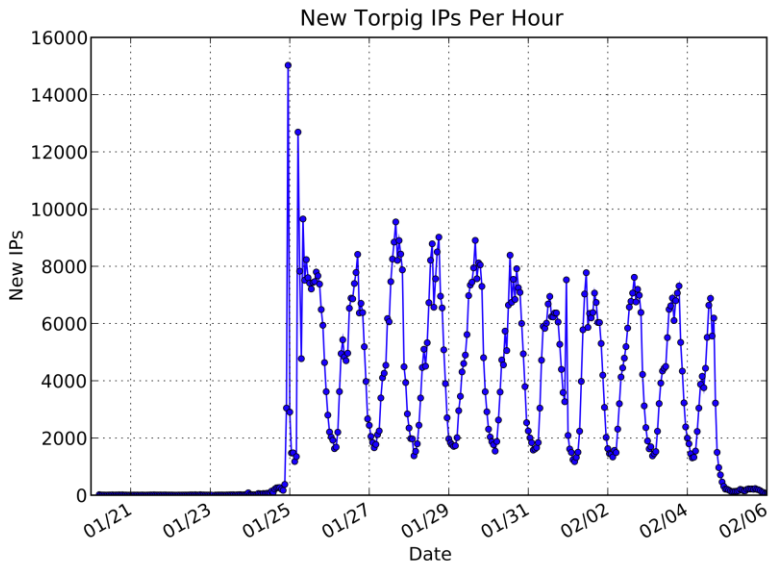
- Principle 1: the sinkholed botnet should be operated so that any harm and/or damage to victims and targets of attacks would be minimized
  - always responded with okn message
  - never sent new/blank configuration file
  - removed data from servers regularly
  - stored data offline in encrypted form
- Principle 2: the sinkholed botnet should collect enough information to enable notification and remediation of affected parties
  - worked with law enforcement (FBI and DoD Cybercrime units)
  - worked with bank security officers
  - worked with ISPs

Data Collection

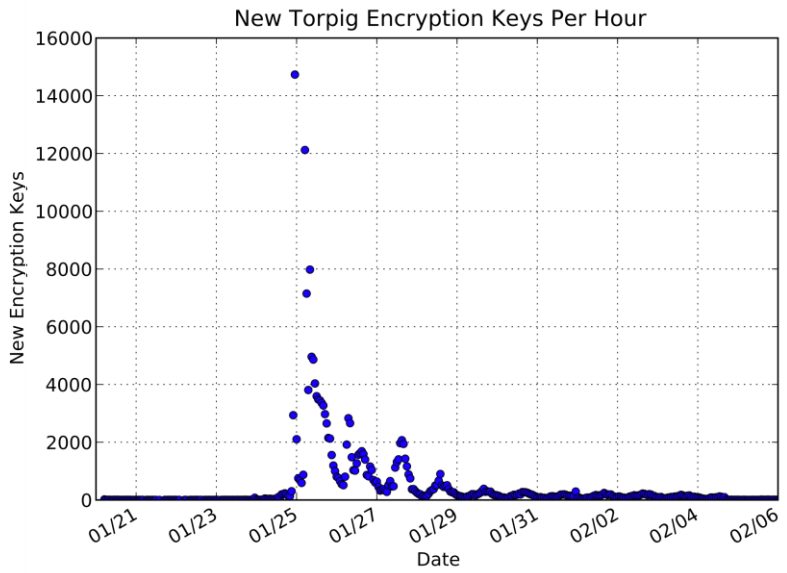
- Bot connects to Torpig C&C every 20 minutes via HTTP POST
- Sends a header
  - timestamp, IP address, proxy ports, OS version, locale, nid, Torpig build and version number
- nid
  - 8 byte value, used for encrypting header and data
  - derived from hard disk information or volume serial number
  - serves as a convenient, unique identifier
  - allows one to detect VMware machines
- Optional body data
  - stolen information (accounts, browser data, …)

Size Estimation

- Count number of infections
  - usually based on unique IP addresses
  - problematic: DHCP and NAT effects (we saw 1.2M unique IPs)
  - our count based on header information: ~180K hosts (nids) seen



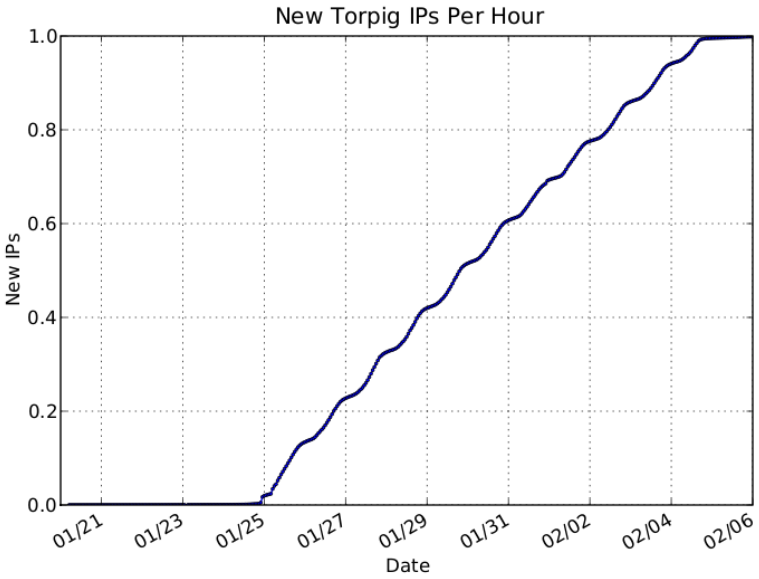
Average 4,690 new IPs

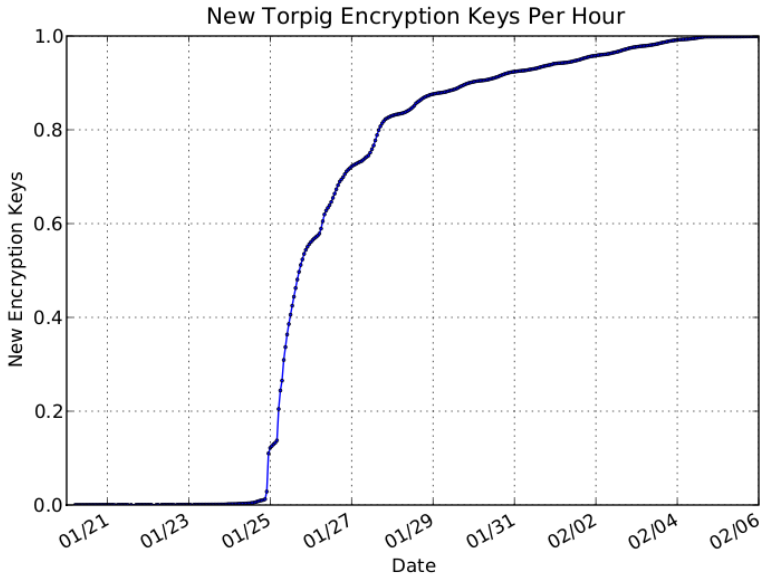


Average 705 new nids

Size Estimation

- Cummulative number of infections
  - linear for unique IP addresses
  - decayed quickly for unique nids
  - more than 75% of unique nids were observed in first 48 hours





Threats

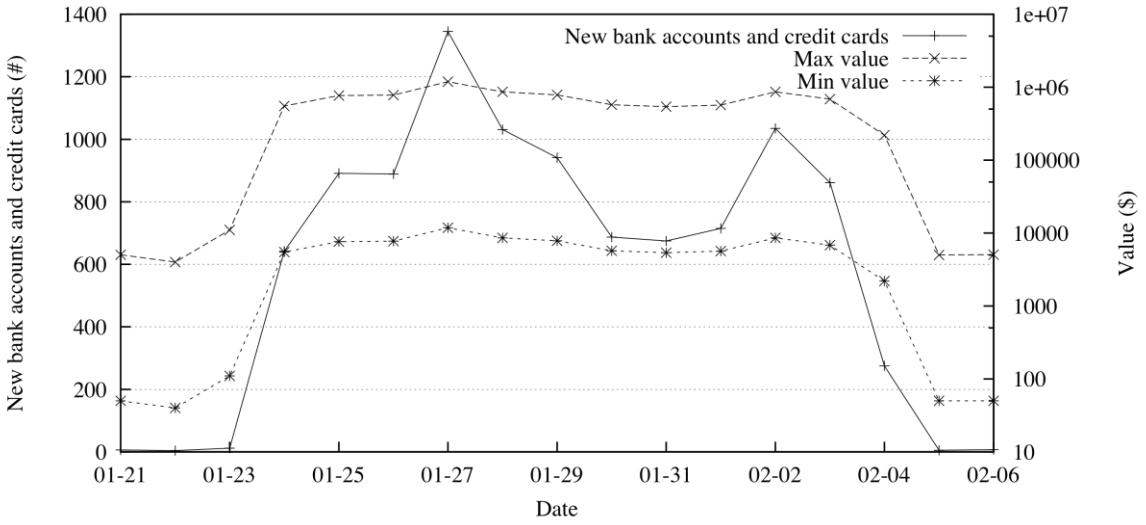
- Theft of financial data
- Denial of service
- Proxy servers
- Privacy threats

Threats: Theft of Financial Information

- 8,310 unique accounts from 410 financial institutions
  - Top 5: PayPal (1,770), Poste Italiane, Capital One, E*Trade, Chase
  - 38% of credentials stolen from browser's password manager
- 1,660 credit cards
  - Top 5: Visa (1,056), Mastercard, American Express, Maestro, Discover
  - US (49%), Italy (12%), Spain (8%)
  - typically, one CC per victim, but there are exceptions …

Value of the Financial Information

- Symantec [2008] estimates
  - Credit card value at $.10 to $25.00
  - Bank account at $10.00 to $1,000.00
- Using Symantec estimates,10 days of Torpig data valued at $83K to $8.3M



Threats: Denial of Service

- More than 60,000 active hosts at any given time
- Determine network speed from ip2location DB
  - cable and DSL make up 65% of infected hosts
  - used 435 kbps conservative upstream bandwidth
  - yields greater than 17 Gbps just from DSL/cable
  - corporate networks make up 22% of infected hosts
- Potential for a massive DDOS attack

Threats: Proxy Servers

- Torpig opens SOCKS and HTTP proxy
- 20% of infected machines are publicly reachable
- Only 2.45% of those marked by Spamhaus blacklist
- Could be abused for spamming

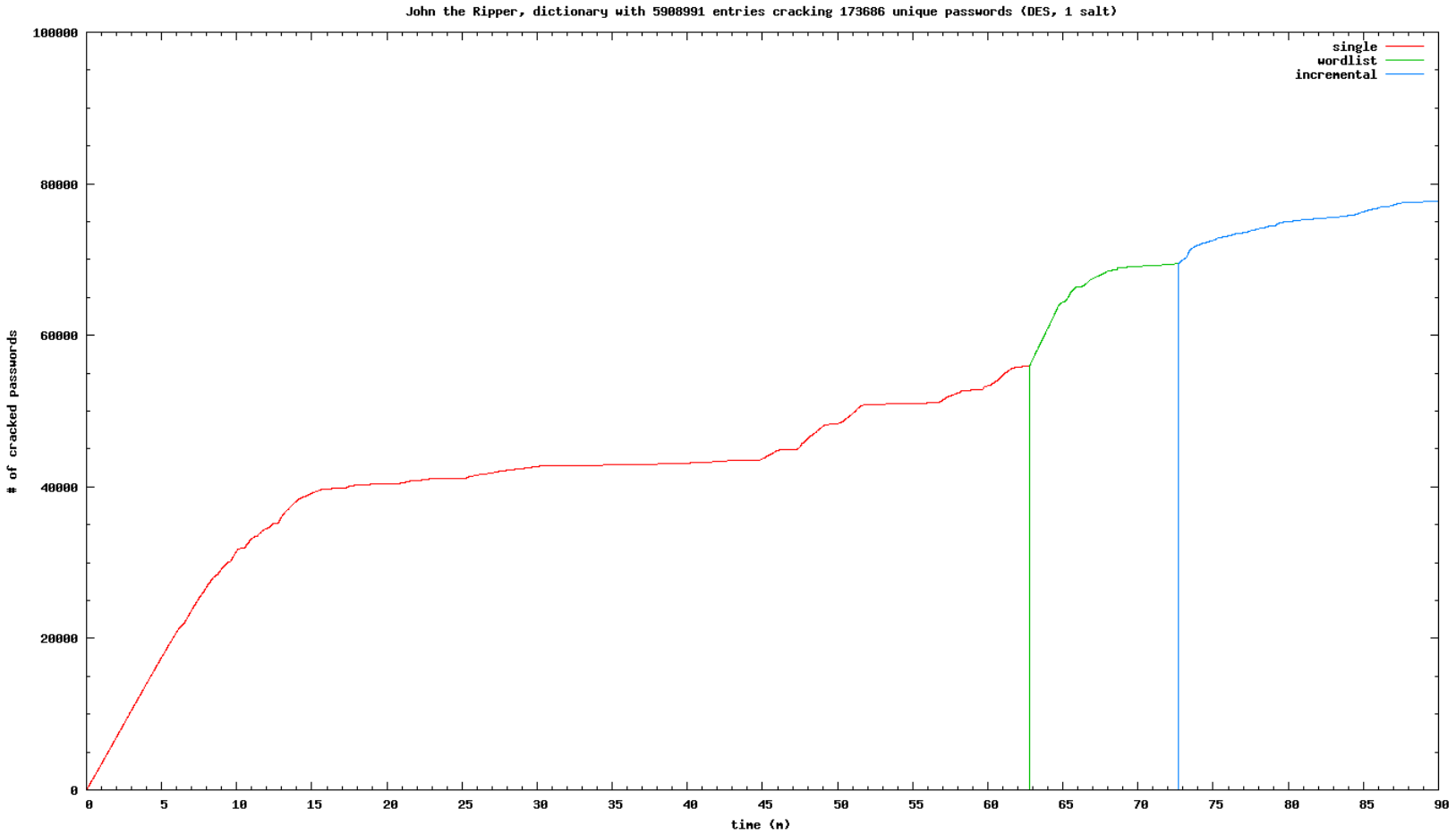
Threats: Privacy

- Web mail, web chat, and forum messages
- Focused on 6,542 messages in English that were 250 characters or longer
- Zeitgeist of the Torpig network
  - 14% are about jobs/resumes
  - 7% discuss money
  - 6% are sports fans
  - 5% prepare for exams and worry about grades
  - 4% partners/sex online
- Online security is a concern, but think they are clean
  - 10% specifically mention security/malware

Password Analysis

- 297,962 unique credentials used on 368,501 web sites (domains)
  - mostly web mail (Google, live, Yahoo) and social networking sites (Facebook, MySpace, netlog.com)
  - 28% of the victims reused their password on multiple domains
- Used John the Ripper to assess the strength of the passwords
  - 173,686 unique passwords
  - 56,000 in < 65 minutes using permutation, substitution, etc.
  - 14,000 in next 10 minutes using large wordlist
    (i.e., 40% cracked in less than 75 minutes)
  - another 30,000 in next 24 hours

Password Analysis



What about?

- Criminal retribution
- Law enforcement
- Repatriating the data
- Ethics, IRB, etc.

Criminal Retribution

- Big concern on January 25
  – are the criminals going to come to get us?
- More realistically - when will they DDOS our servers?
- Biggest question – why did it take them 10 days to download a new DGA?

Law Enforcement

- We needed to inform law enforcement about this
  - who do we notify?
  - need someone knowledgeable so they don't shut us down
- How do we get a hold of law enforcement?
  - US CERT gives you a form to fill out
  - contacted David Dagon at Ga Tech and got FBI contact
  - contacted FBI cybercrime unit
  - also contacted DoD defense criminal investigative services
- FBI was very good to work with and gave us lots of contacts for repatriation

Repatriating the Data

- 8,310 accounts from 410 financial institutions
- 1,660 credit cards from various financial institutions
- Need to mine the information from the raw data files
- Cannot just cold call a bank and say I have information that you might want, send me your BINs
- Need introductions from trusted individuals or groups
- FBI and National Cyber-Forensics and Training Alliance (NCFTA) were very helpful
  - leads to individuals who could handle an entire country

Ethics

- Recall Principle 1: *the sinkholed botnet should be operated so that any harm and/or damage to victims and targets of attacks would be minimized*

- Collected sensitive data that potentially could threaten the privacy of victims
- Should emails be viewed at all?
- What about IRB approval?
  - not working with human subjects, why would we need it?
  - we didn't plan on getting this kind of data
  - any data that can be used to identify an individual needs IRB

Conclusions

- Unique opportunity to understand
  - potential for profit and malicious activity of botnet's creators
  - characteristics of botnet victims
- Previous evaluations of botnet sizes based on distinct IPs may be grossly overestimated
- Botnet victims are users with poorly maintained machines and choose easily guessable passwords to protect sensitive data
- Interacting with registrars, hosting facilities, victim institutions, and law enforcement can be a complicated process

Credits

- Brett Stone-Gross
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- Richard Kemmerer
- Chris Kruegel
- Giovanni Vigna

Questions?