Blackworm: Analyzing the Spread of a Worm from Poisoned IP Data

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About Blackworm

- Began to spread January 15, 2006
- 95k Visual Basic executable email attachment run by users
- Also spread to attached network shares
- Malicious: on the 3rd day of every month:
  - searches for files with 12 common file extensions (.doc, .xls, .mdb, .mde, .ppt, .pps, .zip, .rar, .pdf, .psd, and .dmp)
  - replaces those files with the text string "DATA Error [47 0F 94 93 F4 K5]"

So who cares?

- Blackworm is not particularly different from many, many other email viruses, except…
- Every infected computer automatically generates an http request for a web page that displayed a hit count graph (self-documenting code?)
- Logs for the website were available before the first date of payload destruction
- **Some victims could be notified before they lost data**

Log Analysis

- Simple! Just take the logs and look at who connected and you'll have the infected IP addresses!
- Except that the url was publicized…
- Many folks looked at the page to observe the spread of the virus
- Denial-of-service attacks added a large volume of spurious traffic

Log Filtering

- Why not just count IP addresses that were logged once?
- Web traffic aggregators (NAT, proxy servers) obscure victim IP addresses; multiple probes can represent mulitple infections
- DHCP use allows two different computers to have the same IP at the time that they become infected

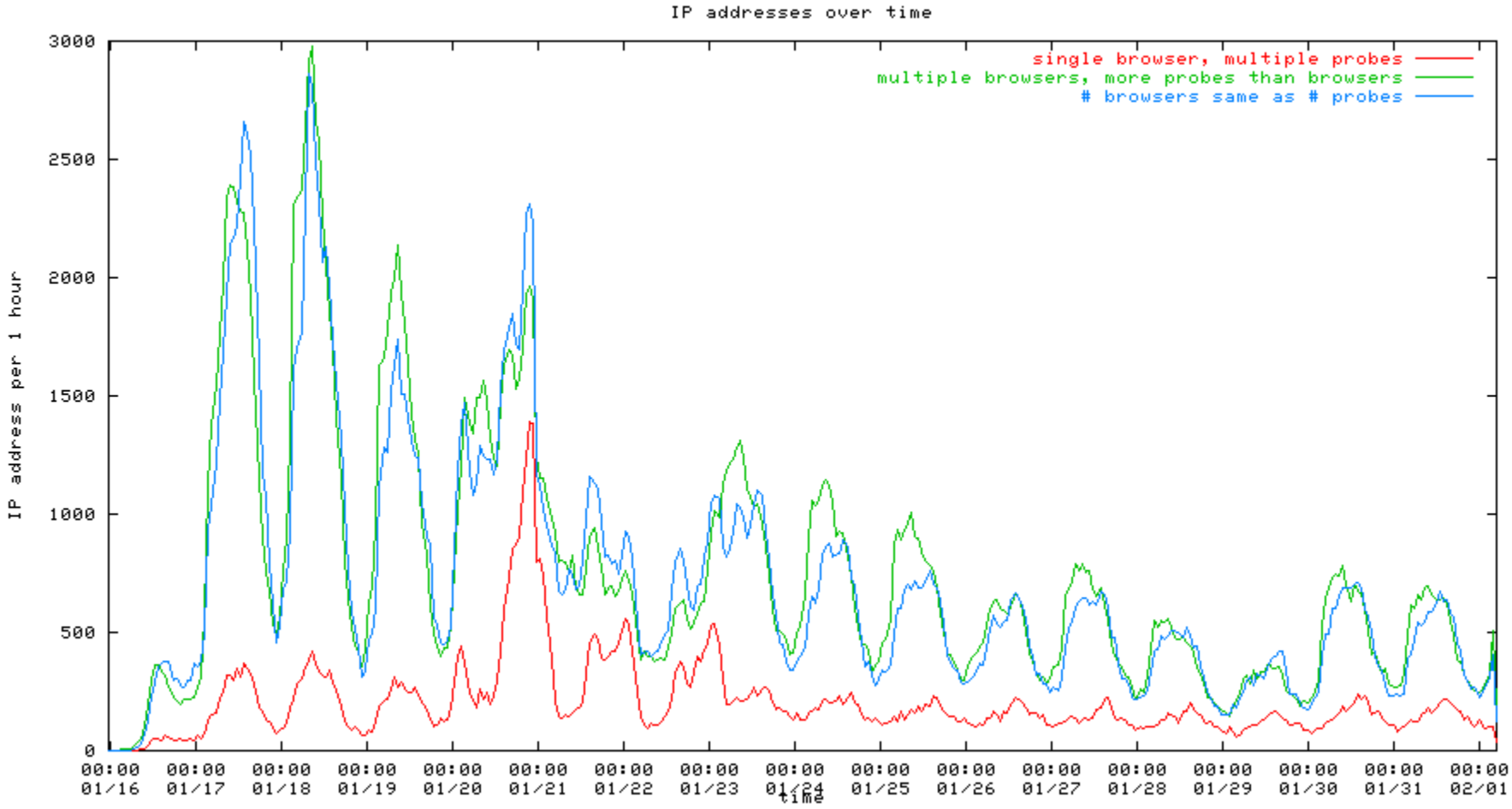
Log Filtering: DoS Attacks

- Many denial-of-service attacks use one tool deployed across many compromised computers
- Attack connections share common features: browser type, referer strings
- Those features combined with sharp onset and cessation identify DoS attacks in the log data

Log Filtering Process

- Remove referer/browser strings set by common DDoS tools (91.1% of all hits)
- Remove requests for pages different from the one accessed by the virus (0.2%)
- Remove any request with a referer string (virus did not use one in its probes) (0.8%)
- Remove requests from invulnerable Operating Systems: MacOS, Unix, cell phone, and PDA devices (0.03%)

Sanity Check



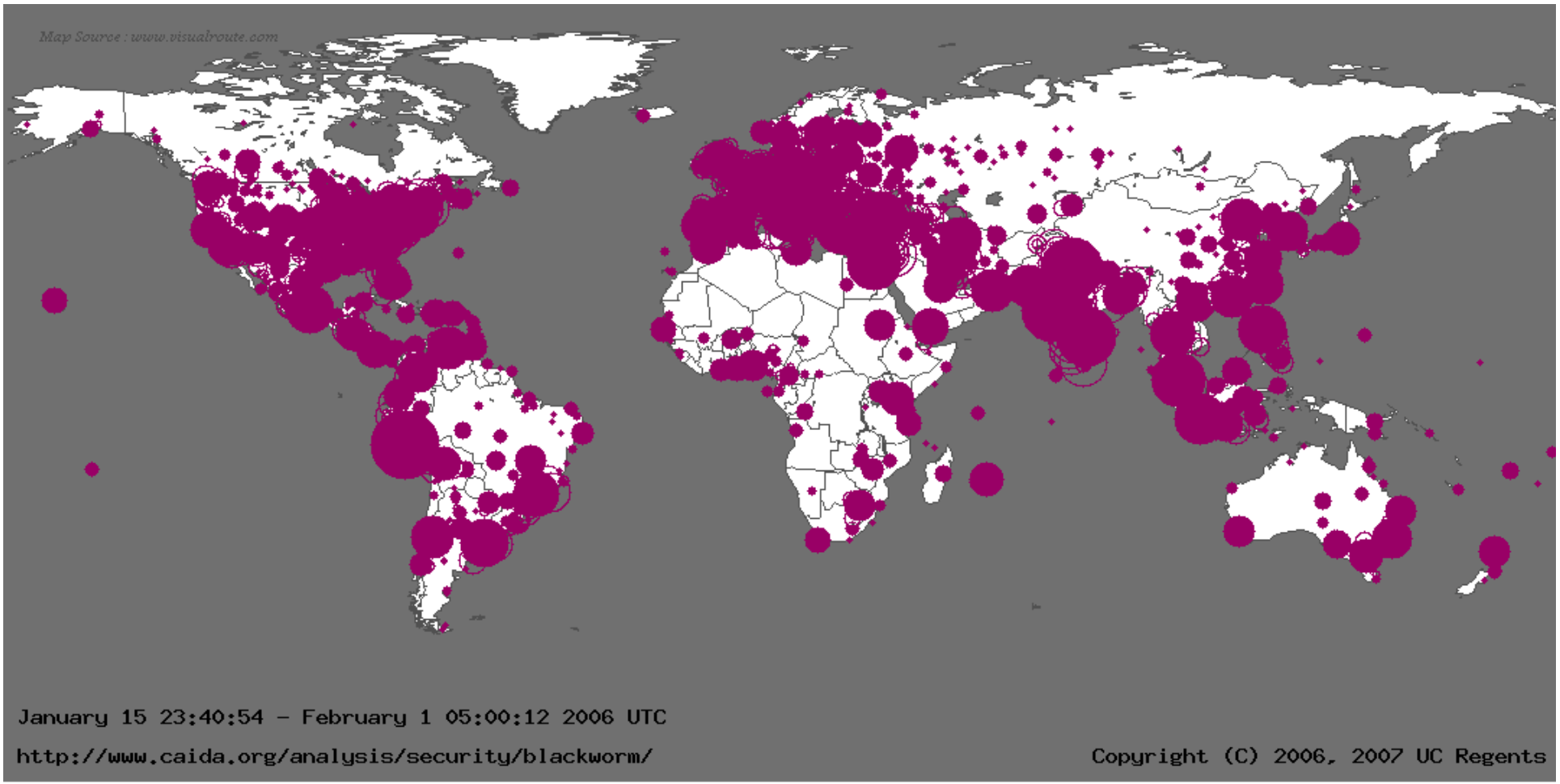
Sources of Error and Uncertainty

- Infected computers that failed to send the probe
- Network firewalls or outages that prevented victims from reaching the web page
- Denial-of-Service attacks preventing infected computers from reaching the web page
- People who viewed the counter only once using a vulnerable browser, but were not infected

Estimating a Victim Count

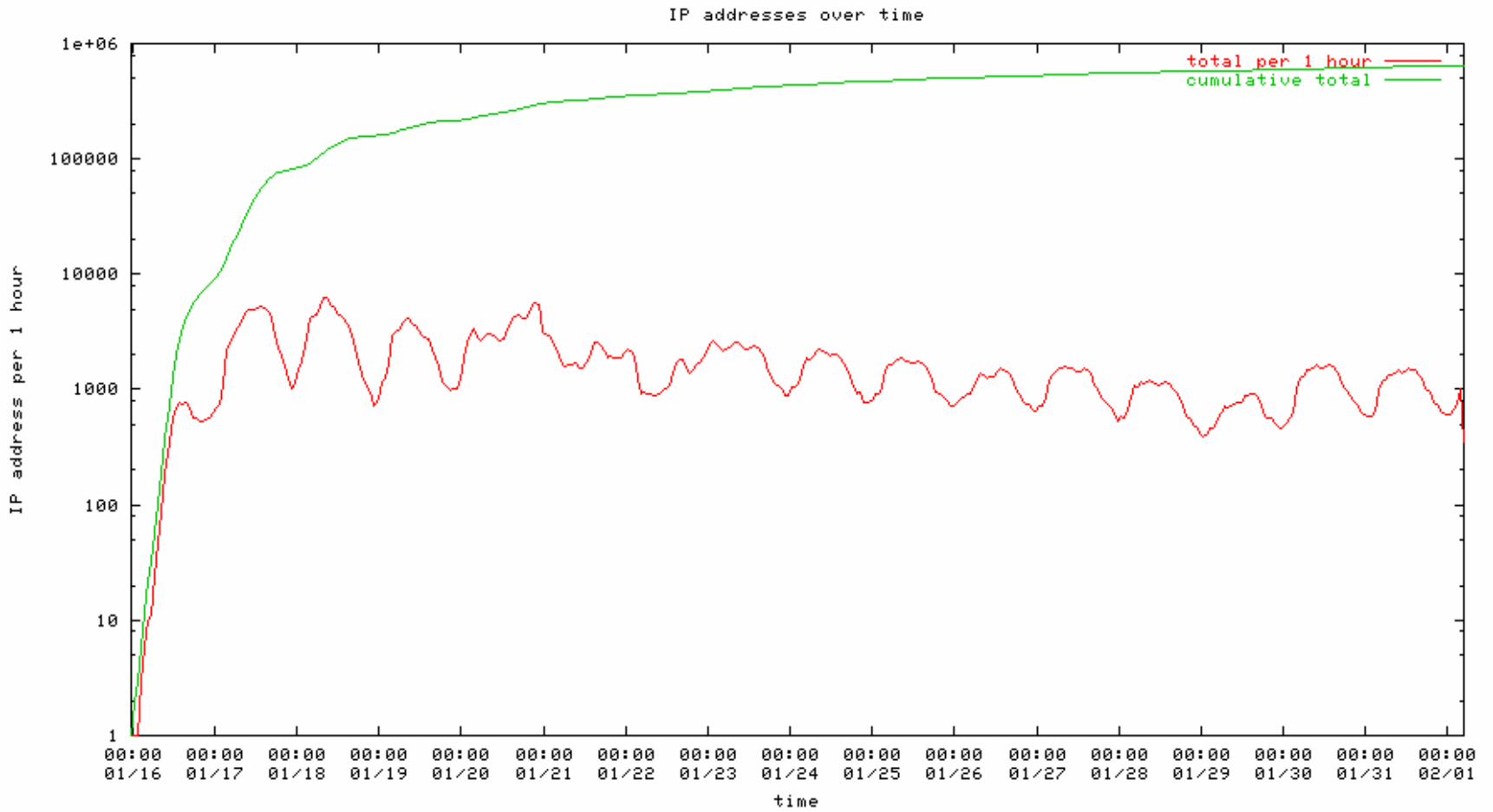
- Lower bound: for each IP address, the number of unique, vulnerable browser types received from that IP address

- Upper bound: for each IP address, the total number of probes received from that IP address

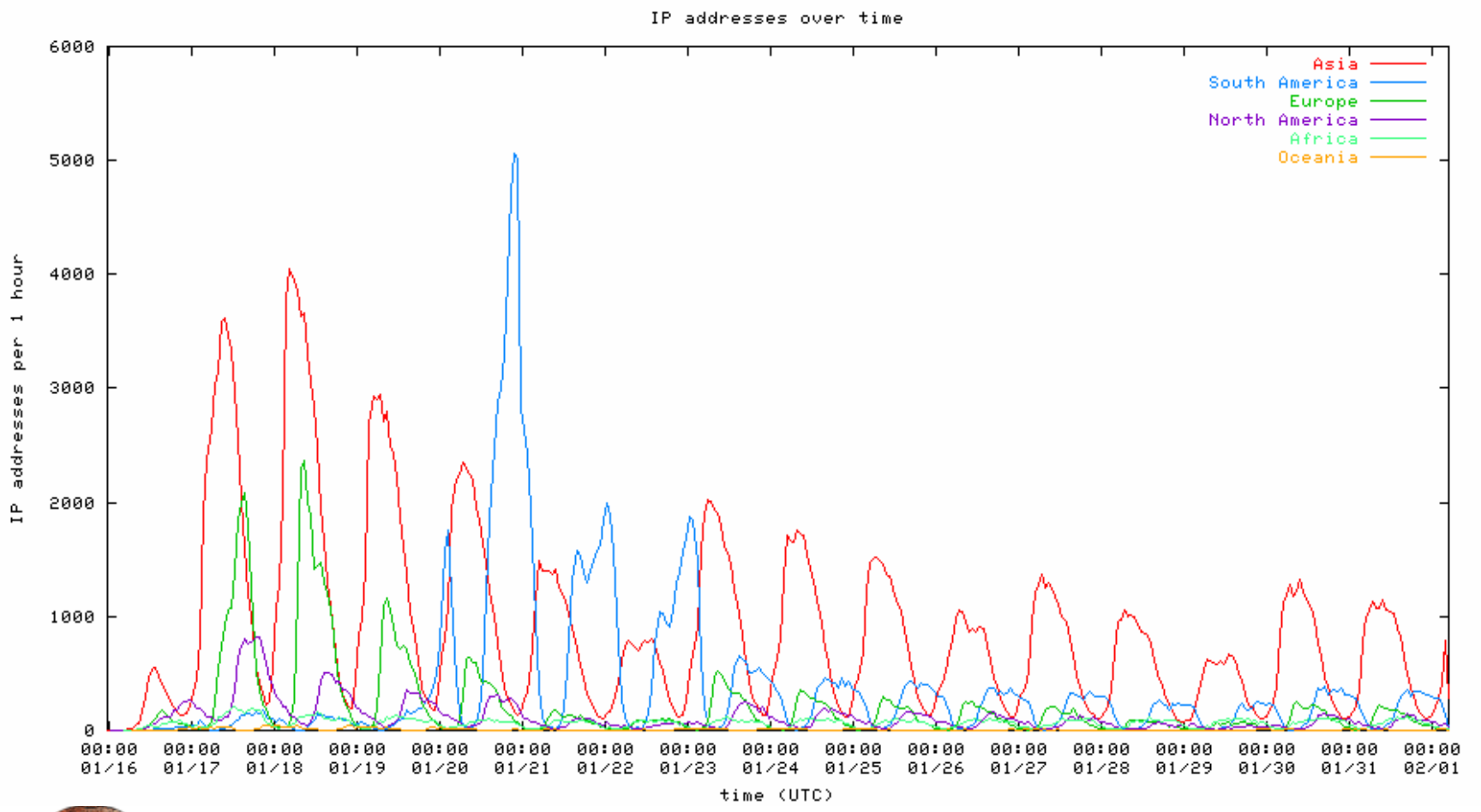


- Blackworm victim estimate: between 469,507 and 946,835 (3.2%-6.4% of original log entries)

Blackworm Overall



Blackworm by Continent



Blackworm by Country (>2%)

Country	Min. Count	Min %	Max Count	Max %
India	151341	32	273013	29
Peru	87599	19	150785	16
Italy	38216	8	58002	6
Turkey	28264	6	43437	5
USA	26315	6	58791	6
Egypt	12201	3	25104	3
Malaysia	11160	2	19942	2

Blackworm by TLD (>1%)

TLD	Min. Count	Min %	Max Count	Max %
Unknown	173510	37	367750	39
net	77706	17	141308	15
pe	71881	15	123960	13
it	31367	7	45923	5
in	25127	5	52818	6
com	18516	4	39283	4
tr	16162	3	24204	3

Concurrent Infections

- 45,401 Blackworm victims (10%) had concurrent spyware and/or botnet infections advertised in their browser string
  - `Mozilla/4.0 (compatible; MSIE 5.5; Windows 98; Sgrunt|V109|29|S493689067|dial; FunWebProducts; XBE|29|S0406967952114 3#398|isdn; snprtz|S04138822910124)`

Cuttlefish Animation…

- See http://www.caida.org/analysis/security/blackworm/#Animations

Conclusions

- Log analysis allows insight into email virus spread given sufficient data mining
- Email viruses spread in a slower and steadier pattern than Internet worms, which infect the vast majority of their victims in the first day
- Diurnal patterns are strongly apparent in spread data (people read their email when they are awake)

Conclusions (2)

- Country distribution of victims does not correlate with web infrastructure development
- Spread strongly influenced by geographic location (based on social and linguistic similarity)
- TLD distribution reflects geographic distribution rather than # of vulnerable hosts/TLD
- 10% of victims had concurrent botnet or spyware infection

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Internet Measurement Data Catalog

http://imdc.datcat.org