Anonym activities: white- and blackhat applications

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The need for hiding

- blackhat
  - avoid the detection of criminal activity
  - hide crucial infrastructure such as “mothership” servers, monitoring and control servers, etc
- whitehat
  - protect privacy
  - fight censorship

Example systems

- BotNets
  - networks of compromised PCs
  - initially IRC-based; now increasingly P2P
  - main servers and operator wants to stay anonym
- Anonym networks
  - Dedicated (closed or open) networks
  - some variation of “mixing” communication so that participants cannot be traced back
  - remailer networks, low latency networks, friends-networks

Outline

- The Storm botnet
  - storm protocols and operation
  - fast-flux dns techniques
- Tor
  - basic idea of onion routing
  - current status and some problems

Storm Botnet

- appeared in 2007 January
- primarily for sending spam
- advanced P2P technology
- size estimated between 500,000 and 50 million
- aggressive measures for protection
  - regular download of updates to prevent reverse engineering
  - DDoS attack against external hosts that attempt to probe its operations

Storm Botnet Technology

- uses overnet protocol, based on the kademlia DHT
  - key space is 128 bit binary (usual DHT design)
  - routing is based on XOR distance
    - **eg $d(001,110)=001\oplus110=111$**
  - for 0<=i<=128 there is a “bucket” of k(=20) addresses that are at distance from $[2^i,2^{i+1})$
  - these buckets are kept fresh from observing traffic (preferring oldest, but live nodes), and proactive lookup if needed
  - lookup uses the 3 closest nodes in parallel

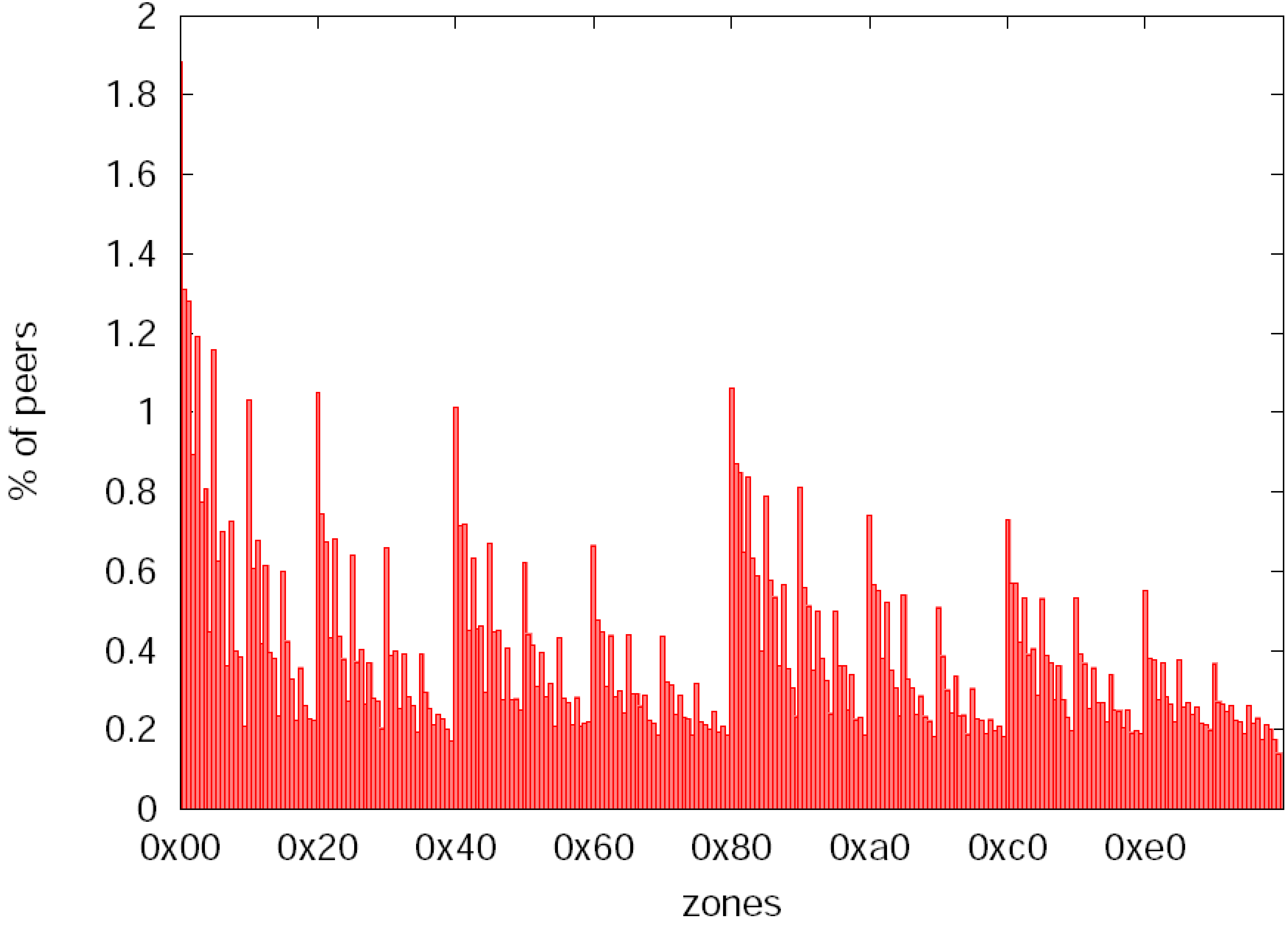
Storm Botnet Technology

- Storm bots periodically search for a given key
  - key is generated using the current date and a random number from [0,31]
  - value of that key contains an encrypted URL
  - which in turn contains new binary updates and other files to download
- for some reason
  - if this lookup fails, bots rejoin the network with new ID and repeat the search
- file sharing networks such as eDonkey can be used to store these keys! (same protocol)

Measurements

- Crawler: kademlia client that
  - performs queries for random keys
  - records node ID, IP and port that is returned
- seed list
  - 400 hard-wired IP-s in the Storm bot binary
  - storm bot run in a honeypot for 5 hours: 4000 peers
- full crawls (entire 128 bit space)
- zone crawl (space with a fixed prefix)
- estimated size: around 500,000

Uneven distribution of storm bot IDs

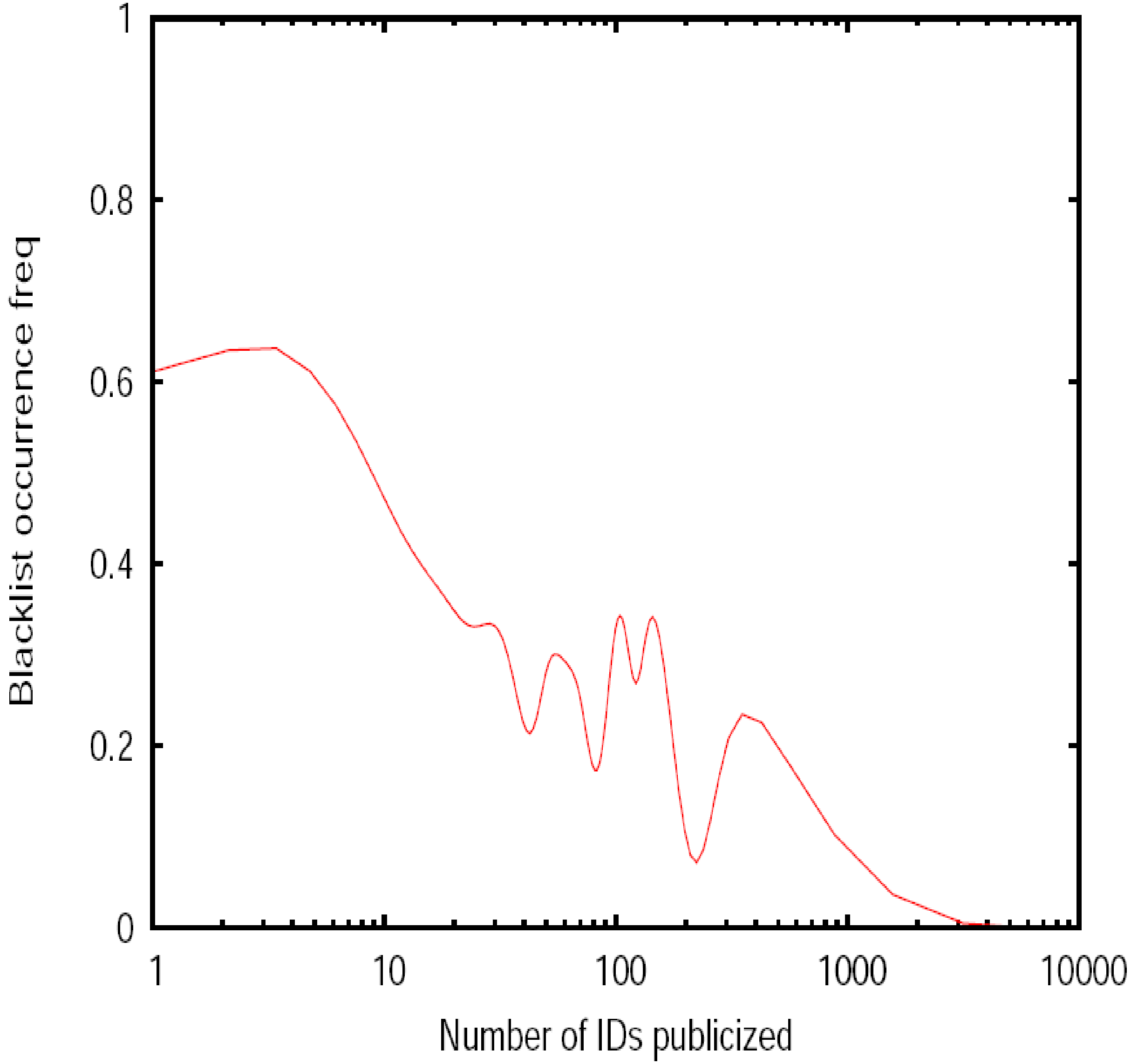


Explanation of uneven distribution: war against the Storm?

- Around 1% of returned IP addresses bogous
- But 45% of unique Ids have one of these addresses
- These IDs are responsible for the non-uniformity of the ID distribution as well
- possible explanation
  - index poisoning
  - we are witnessing efforts to fight the Storm Botnet

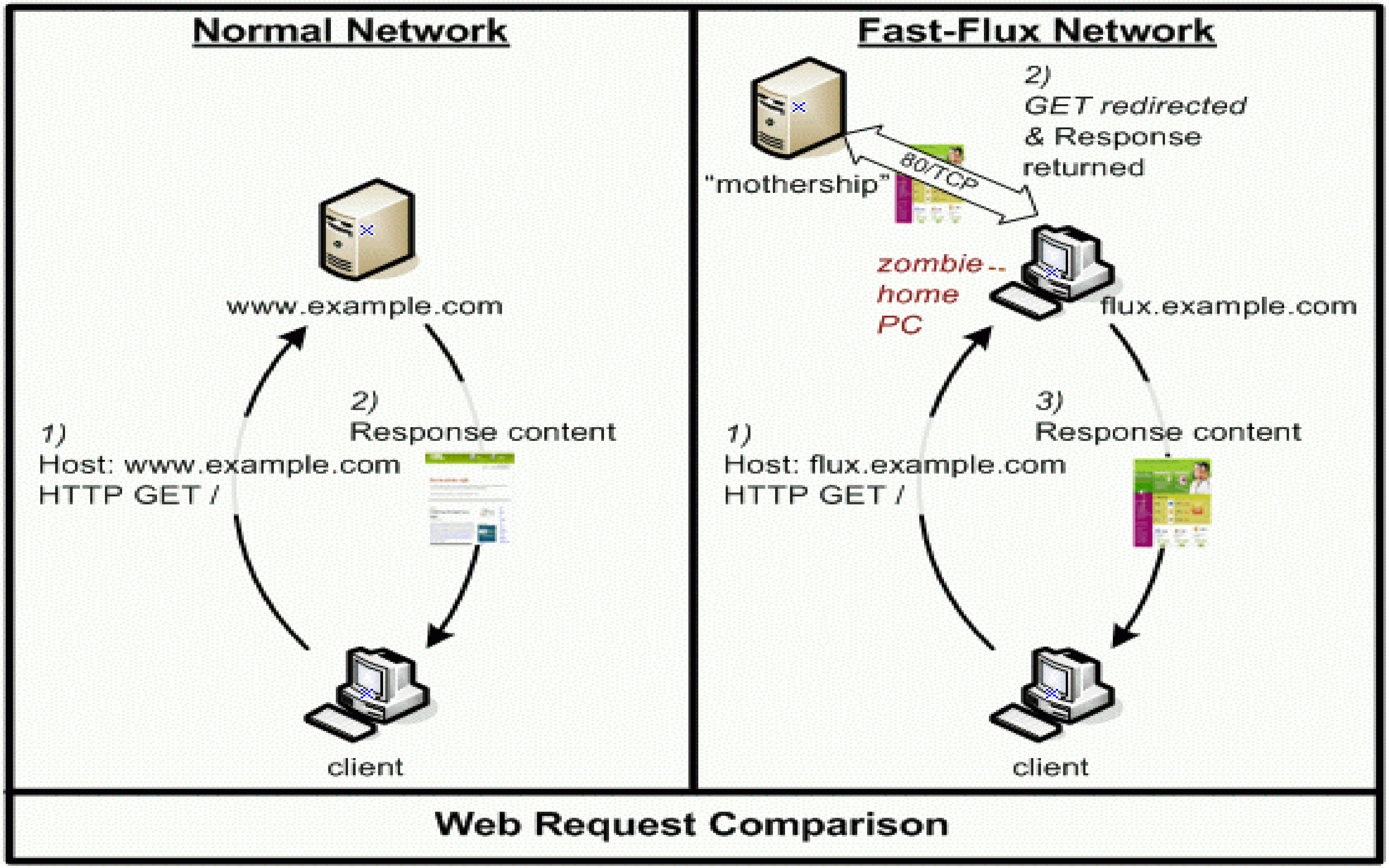
More observations of the war?

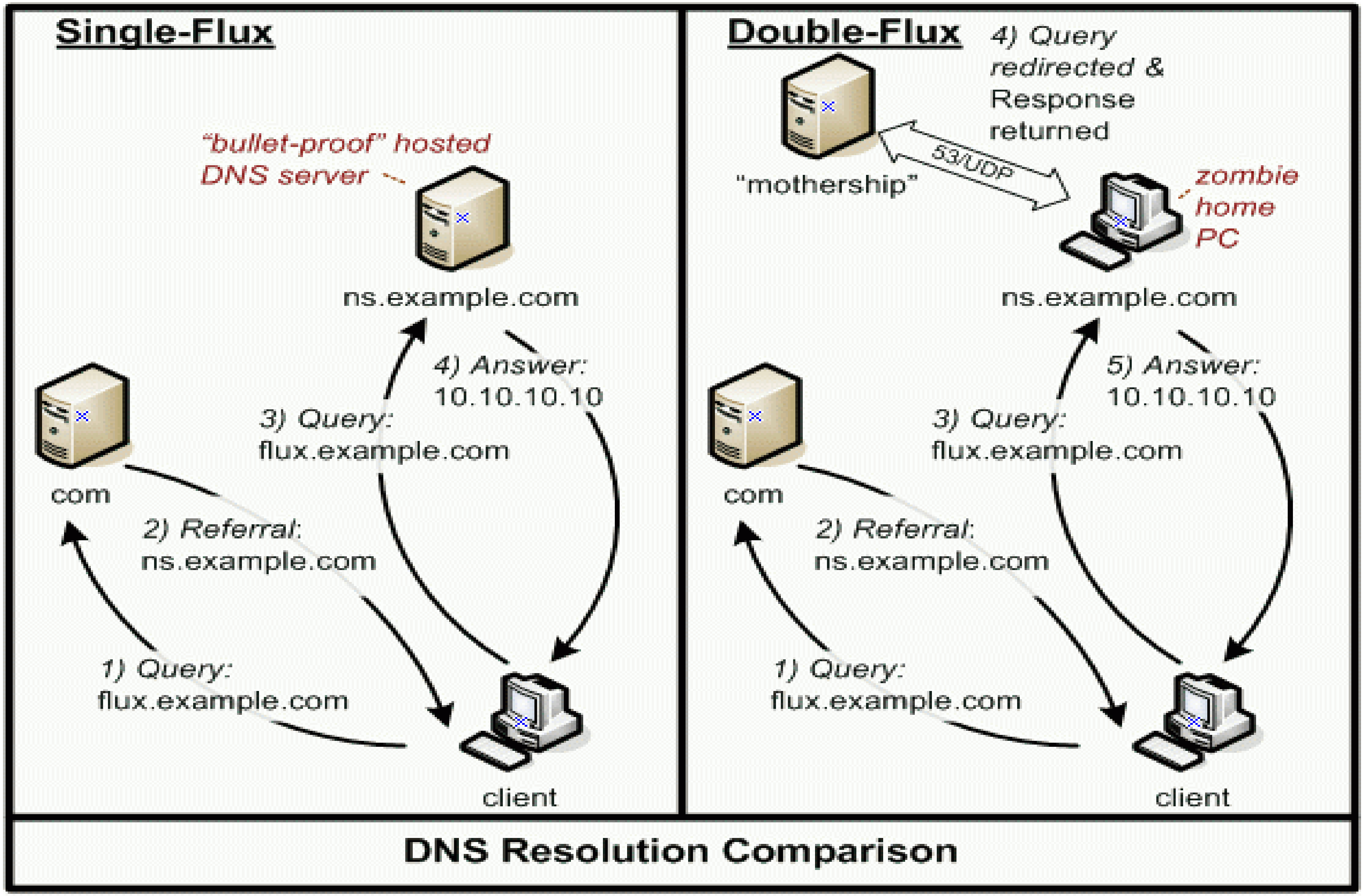
- interestingly: some non-bogous IP addresses are associated with many IDs
- these tend to be those that are not on spam blacklists...



Fast-flux service technology

- Storm was observed to use it since 2007 June
- another step to use the BotNet as a supercomputer!
- basic idea is to very quickly change the DNS record for a given hostname so that each time a different bot serves it
  - this website can host the content the spam messages point to: scam, phishing, illegal content, etc
  - remotely similar to round robin DNS, but emphasis is obfuscation not only load balancing, and actual content is often served by a single “mothership” where bots forward to


Normal Network
www.example.com
1)
Host: www.example.com
HTTP GET /
2)
Response content
client
Fast-Flux Network
"mothership"
2)
GET redirected
& Response
returned
80/TCP
zombie -- home PC
flux.example.com
1)
Host: flux.example.com
HTTP GET /
3)
Response content
client
Web Request Comparison


Single-Flux
"bullet-proof" hosted DNS server
ns.example.com
com
4) Answer: 10.10.10.10
3) Query: flux.example.com
2) Referral: ns.example.com
1) Query: flux.example.com
client
Double-Flux
4) Query redirected & Response returned
"mothership"
53/UDP
zombie home PC
ns.example.com
com
5) Answer: 10.10.10.10
3) Query: flux.example.com
2) Referral: ns.example.com
1) Query: flux.example.com
client
DNS Resolution Comparison

Use cases of fast flux

- Point is to hide the mothership behind a disposable redirection layer of compromised home PCs
- Mothership takes much longer to detect and shut down
- fast flux combined with P2P technologies are very powerful
  - need active and proactive collaboration with ISP-s: traffic filtering, sending and detecting probe packets with an intrusion detection system (IDS)

Tor

- Can provide anonymity for both clients and servers (the latter using the ".onion" domain)
- So called "onion" routing
- Originally funded by US Naval Research Lab
  - To provide protection for negotiators, agents, etc
  - but if only the Navy uses it, everyone knows it's the Navy: so it went public...
- Later taken over by Electronic Frontier Foundation (EFF)
- Currently a few thousand nodes

Tor Technology

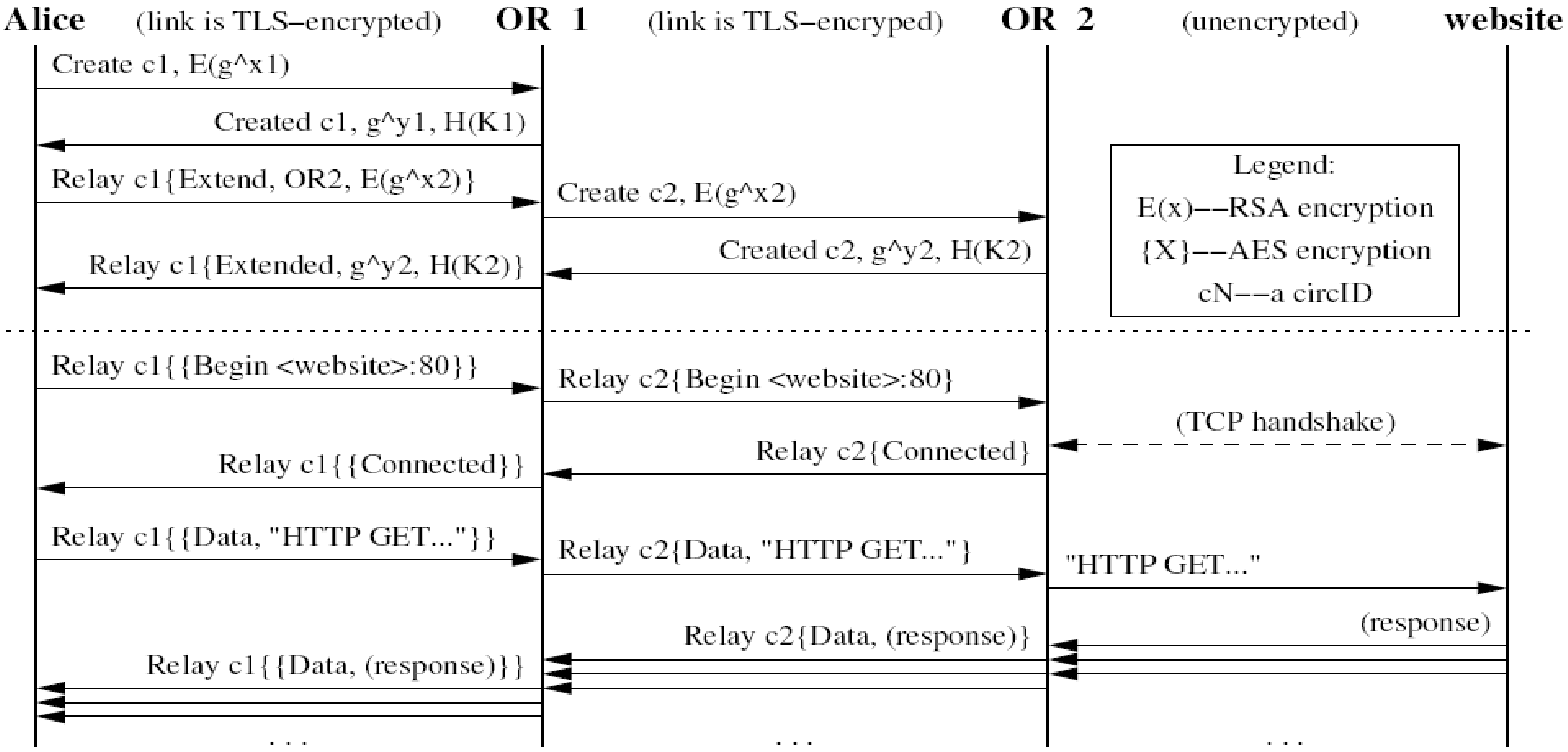
- mix based technology
  - messages are relayed by nodes while each use layers of public-key cryptography
- two kinds of mixing approaches
  - high latency: resilient to global traffic analysis but not interactive (no browsing or shell)
  - low latency: good for interactive applications but vulnerable to traffic correlation analysis (between entry points and exit points)
  - Tor is low latency

Tor Technology

- Tor is TCP level approach
  - can support any application over TCP without modifying the application client or server
  - uses IP without modification as well
- Application layer often reveals the client (eg http get, cookies, etc)
  - use Tor along with application filters such as Privoxy (privacy proxy for browsing)

Tor technology

- fully connected overlay network: TLS (SSL) connection to all other routers
- on the client end:
  - the client is talking to the Tor proxy that implements the SOCKS interface
  - the Tor exit builds an unencrypted TCP connection to the server
  - between the Tor proxy and exit onion routing



Alice (link is TLS–encrypted) **OR 1** (link is TLS–encryped) **OR 2** (unencrypted) **website**

Create c1, E(g^x1)

Created c1, g^y1, H(K1)

Relay c1{Extend, OR2, E(g^x2)}

Create c2, E(g^x2)

Created c2, g^y2, H(K2)

Relay c1{Extended, g^y2, H(K2)}

Legend:
E(x)––RSA encryption
{X}––AES encryption
cN––a circID

Relay c1{{Begin <website>:80}}

Relay c2{Begin <website>:80}

(TCP handshake)

Relay c2{Connected}

Relay c1{{Connected}}

Relay c1{{Data, "HTTP GET..."}}

Relay c2{Data, "HTTP GET..."}

"HTTP GET..."

(response)

Relay c2{Data, (response)}

Relay c1{{Data, (response)}}

. . . .

- the client never uses its public key
- onion: layers of AES encryption (a symmetric key encryption) based on secret key negotiated with Diffie Hellman during the circuit building

Problems: last step

- link between Tor exit and service is unencrypted
  - people hosting Tor exits can see all traffic (but not the origin)
- Dan Egerstad: collected high value corporate and government email addresses
  - arrested in October 2007!
  - Egerstad says
    - **traffic to these email accounts probably originated from spies and not original owners**
    - **web traffic is mostly porn...**

Other problems

- DNS leak
  - resolving DNS requests is still direct
  - latest version includes DNS resolver (understands .onion domain as well)
- traffic analysis
  - techniques exist that capture correlated traffic without global knowledge
- misuse
  - bittorrent clients often support Tor: huge traffic
  - criminals wanting to avoid detection

Some refs

- Papers this presentation used material from

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Roger Dingledine, Nick Mathewson, and Paul Syverson.
Tor: the second-generation onion router. In Proceedings of the 13th USENIX Security Symposium (SSYM'04), pages 21–21, Berkeley, CA, USA, 2004. USENIX Association.

- The course website
  - http://www.inf.u-szeged.hu/~jelasity/p2p/