CIPHERSPACES/DARKNETS: AN OVERVIEW OF ATTACK STRATEGIES

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About Adrian

- I run Irongeek.com
- I have an interest in InfoSec education
- I don't know everything - I'm just a geek with time on my hands
- (ir)Regular on the ISDPodcast http://www.isdpodcast.com
- Researcher for Tenacity Institute http://www.tenacitysolutions.com

A little background…

- Darknets: There are many definitions, but the one I'm working from is "anonymizing networks"
- Use of encryption and proxies (some times other peers) to obfuscate who is communicating to whom
- Sometimes referred to as Cipherspace (love that term)
- Tor and I2P will be my reference examples, but there are others

…and some notes

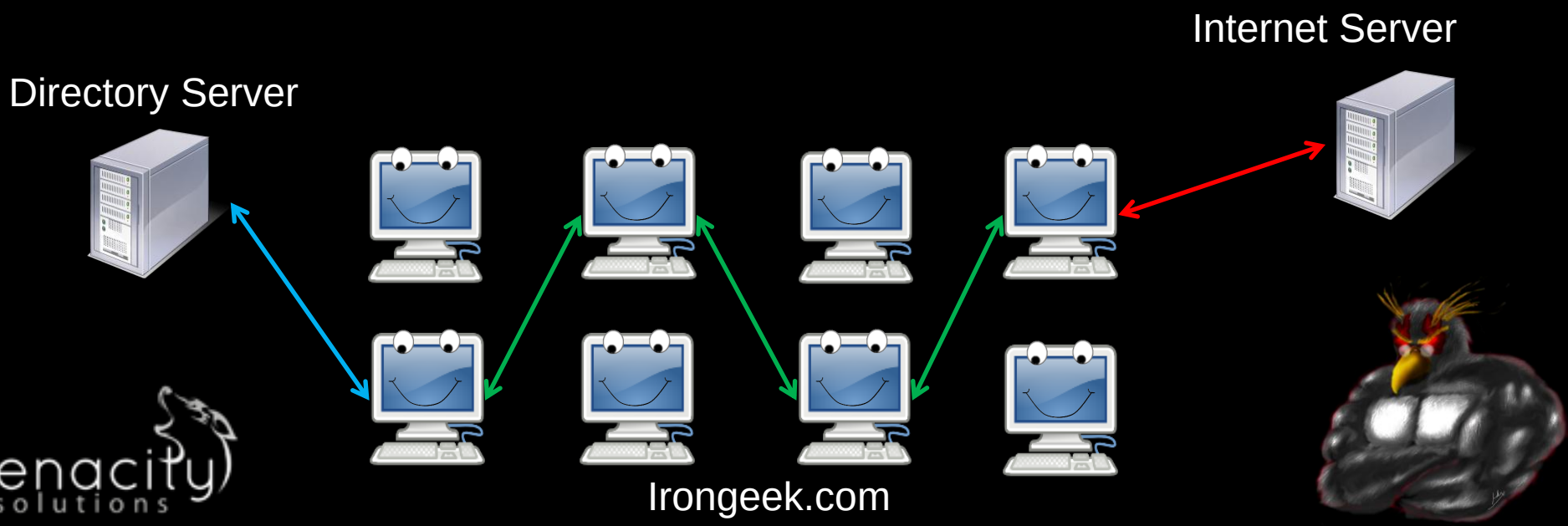
- Things get subtle
- Terms vary from researcher to researcher
- Many weaknesses are interrelated
- Other anonymizing networks: Morphmix/Tarzan/Mixminion/Mixmaster/JAP/MUTE/AntsP2P/Haystack
- Focus on Tor and I2P for illustrations when needed
- Academic vs. real world

Threat Model and Adversaries matter

- Threat Model: You can't protect against everything!
  - Some protocols may be lost causes
  - Users may do something to reveal themselves
  - Does an attack reveal the Client/Host or just reduces the anonymity set?
- Active vs. Passive attackers
- Location, Location, Location:
  - Internal vs. External
- Adversaries: Vary by power and interest
  - Nation States
    - Western Democracies vs. Others
  - Government agency with limited resources
  - ISP/Someone with a lot of nodes on the network
  - Private interests groups (RIAA/MPAA)
  - Adrian (AKA: Some shmuck with time on his hands)

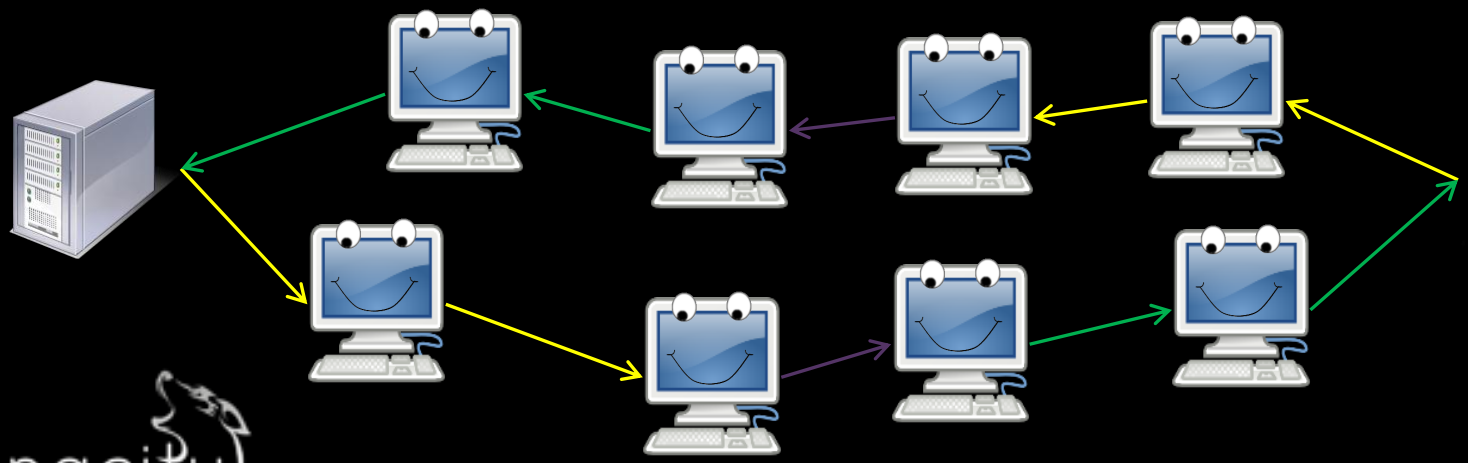
Tor: The Onion Router

- Layered encryption
- Bi-directional tunnels
- Has directory servers
- Mostly focused on out proxying to the Internet
- More info at https://www.torproject.org



I2P

- Unidirectional connections: In tunnels and out tunnels
- Information about network distributed via distributed hash table (netDB)
- Layered encryption
- Mostly focused on anonymous services
- More info at http://www.i2p2.de/



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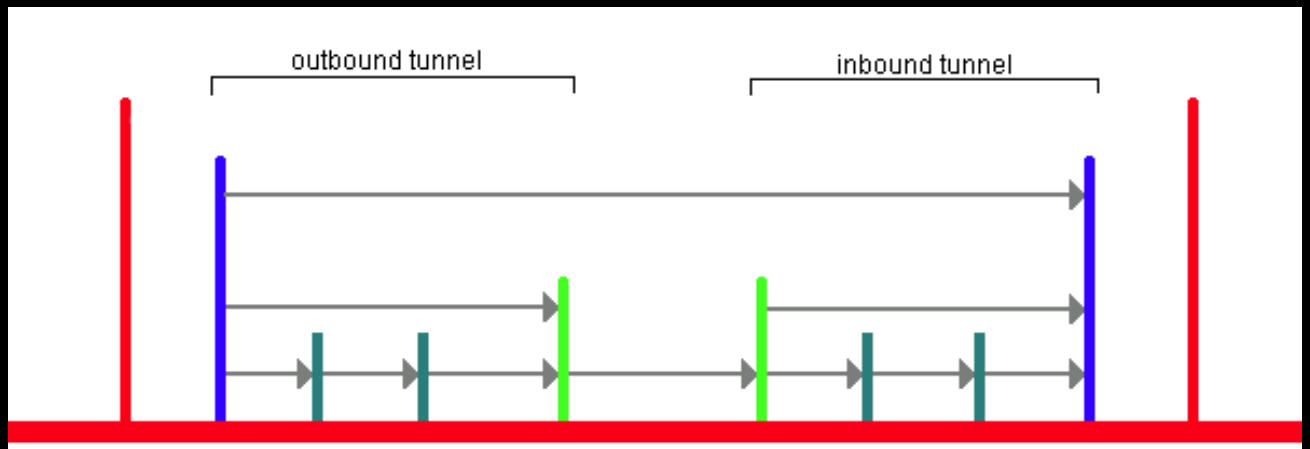
I2P Encryption Layers

- EIGamal/SessionTag+AES from A to H
- Private Key AES from A to D and E to H
- Diffie–Hellman/Station-To-Station protocol + AES



		tunnel encryption (private key AES)	a to d, e to h
garlic encryption (ElGamal/SessionTag+AES)	a to h	transport encryption (DH/STS+AES, etc)	a to b, b to c, c to d, d to e, e to f, f to g, g to h

Image from http://www.i2p2.de/

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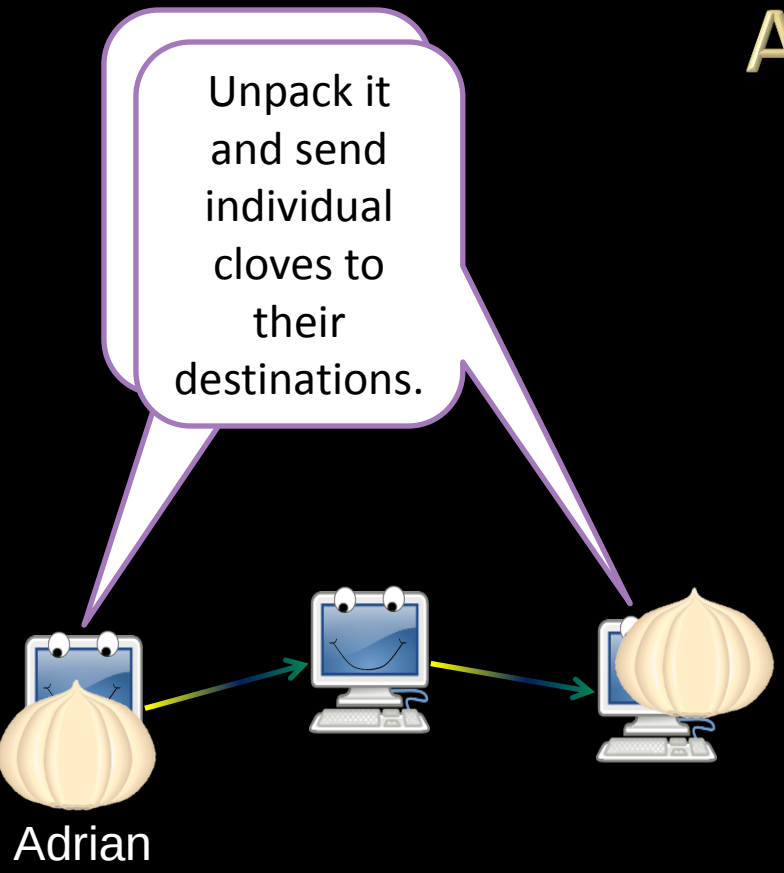
Silly Garlic Routing Animation



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UN-TRUSTED EXIT POINTS

You are only as anonymous as the data you send!

Overview

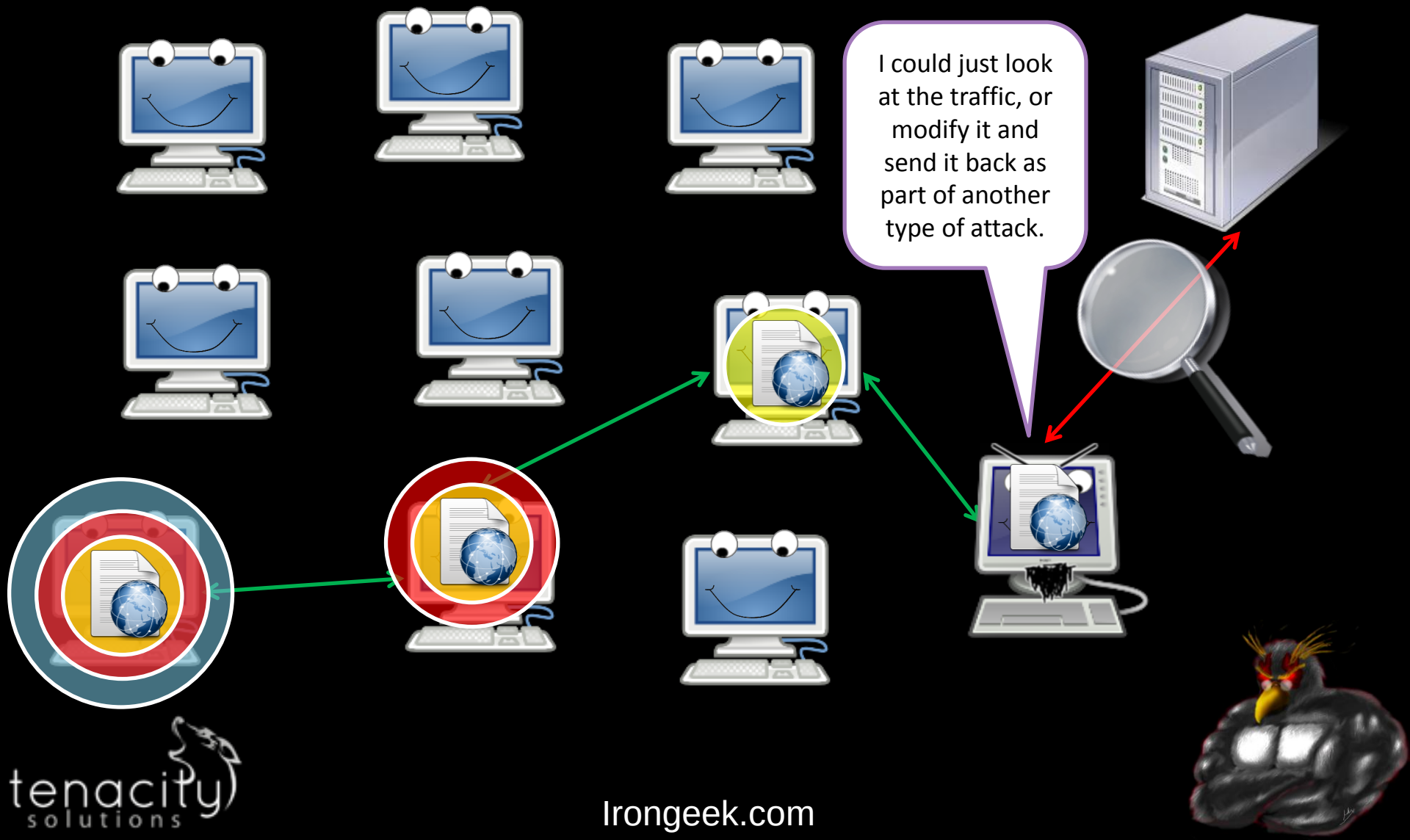
Mostly Tor centric:

- Is the exit point for traffic looking at the data?
- Traffic may be encrypted inside the network, but not once it is outbound!

Incidents

- Dan Egerstad and the “Embassy Hack” http://www.wired.com/politics/security/news/2007/09/embassy_hacks
- Tons of passwords sent via plain text protocols (POP3/SMTP/HTTP Basic/Etc)
- Moxie Marlinspike did something similar with SSLStrip http://intrepidusgroup.com/insight/2009/02/moxie-marlinspike-un-masks-tor-users/

Do you trust your exit node?



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Mitigation

- Tor is for anonymity, not necessarily security
- Use end-to-end encryption/Don't use plain-text protocols
- Plain text protocols that send usernames/email addresses in the clear are not very anonymous now are they?

DNS LEAKS, OTHER PROTOCOL LEAKS AND APPLICATION LAYER PROBLEMS

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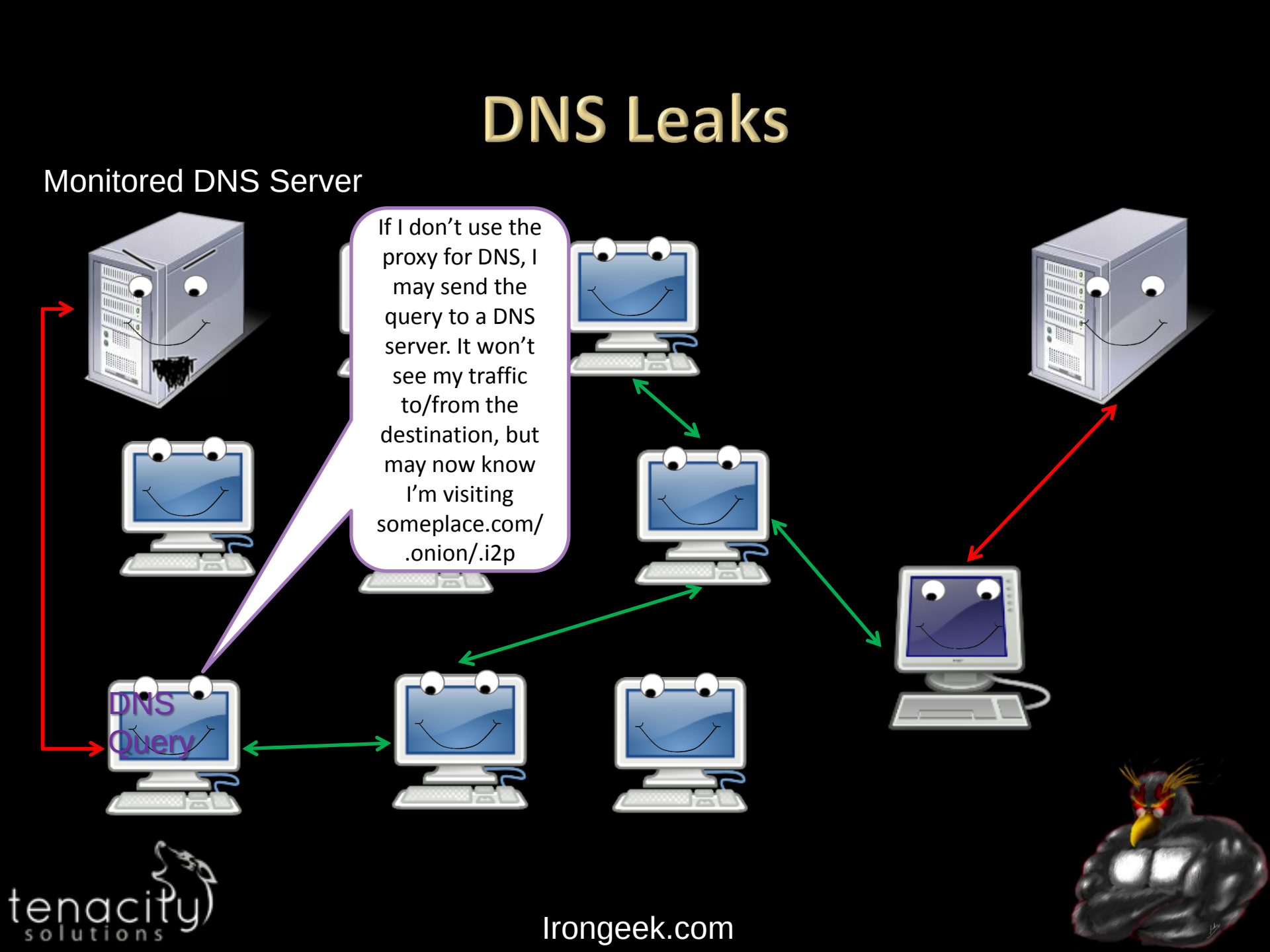
Overview

- Does all traffic go though the proxy?
- DNS Leaks are a classic example
- Badly configured proxy setting could lead some types of traffic to go elsewhere (outside of cipherspace)
- Snooper can use web bugs to figure out your location
  http://www.irongeek.com/i.php?page=security/webbugs
- HTTPS is a good example, but plugins can also be an issue
- Application level stuff in general is a problem
- Javascript is just hosed as far as reducing you anonymity set
  See: Gregory Fleischer, DEFCON 17: Attacking Tor at the Application Layer

DNS Leaks



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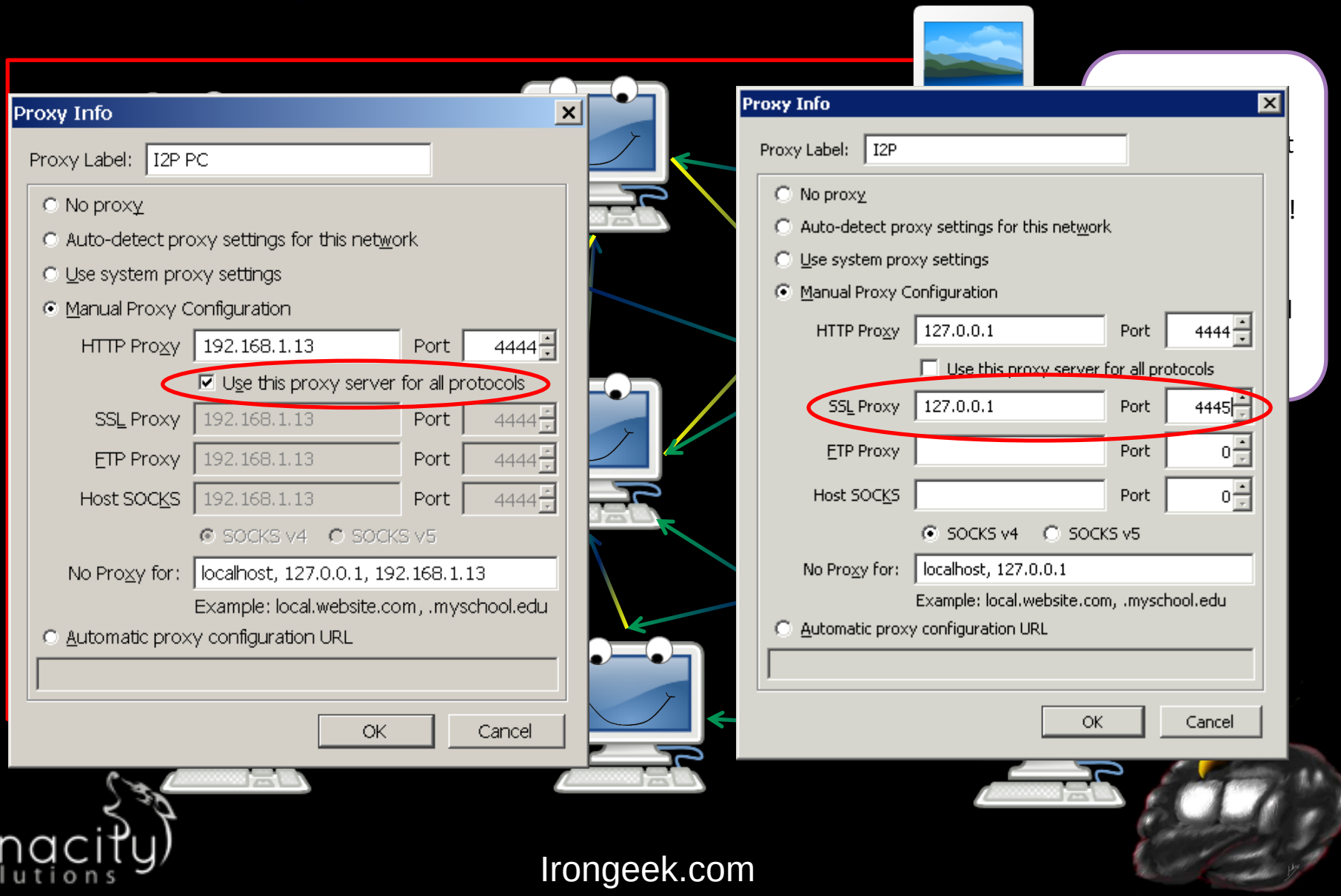
Mitigating DNS Leaks

- Sniff for traffic leaving your box on port 53. The libPcap capture filter:
  port 53
  should work in most cases.
- In Firefox, under about:config set network.proxy.socks_remote_dns to true
- Torbutton should help
- Other applications vary
- May have to firewall off 53 in some cases
- May want to edit torrc, and add:
  DNSPort 53
  AutomapHostsOnResolve 1
  Then set your box's DNS to point to 127.0.0.1

Grabbing content outside of the Darknet



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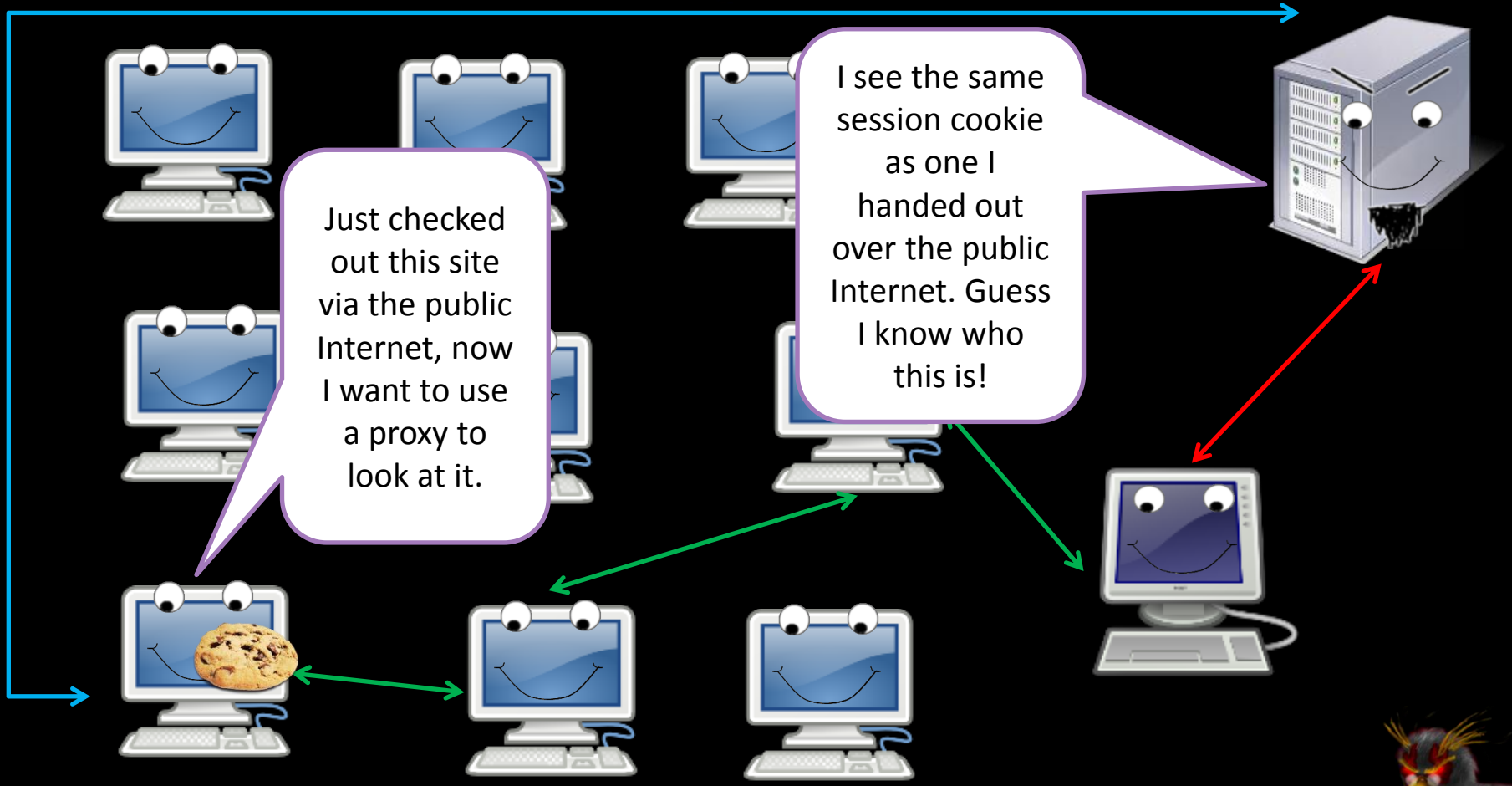
Slightly Related: Cookies/Supercookies/Etc



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Cookie image from brainloc on sxc.hu via Wikipedia

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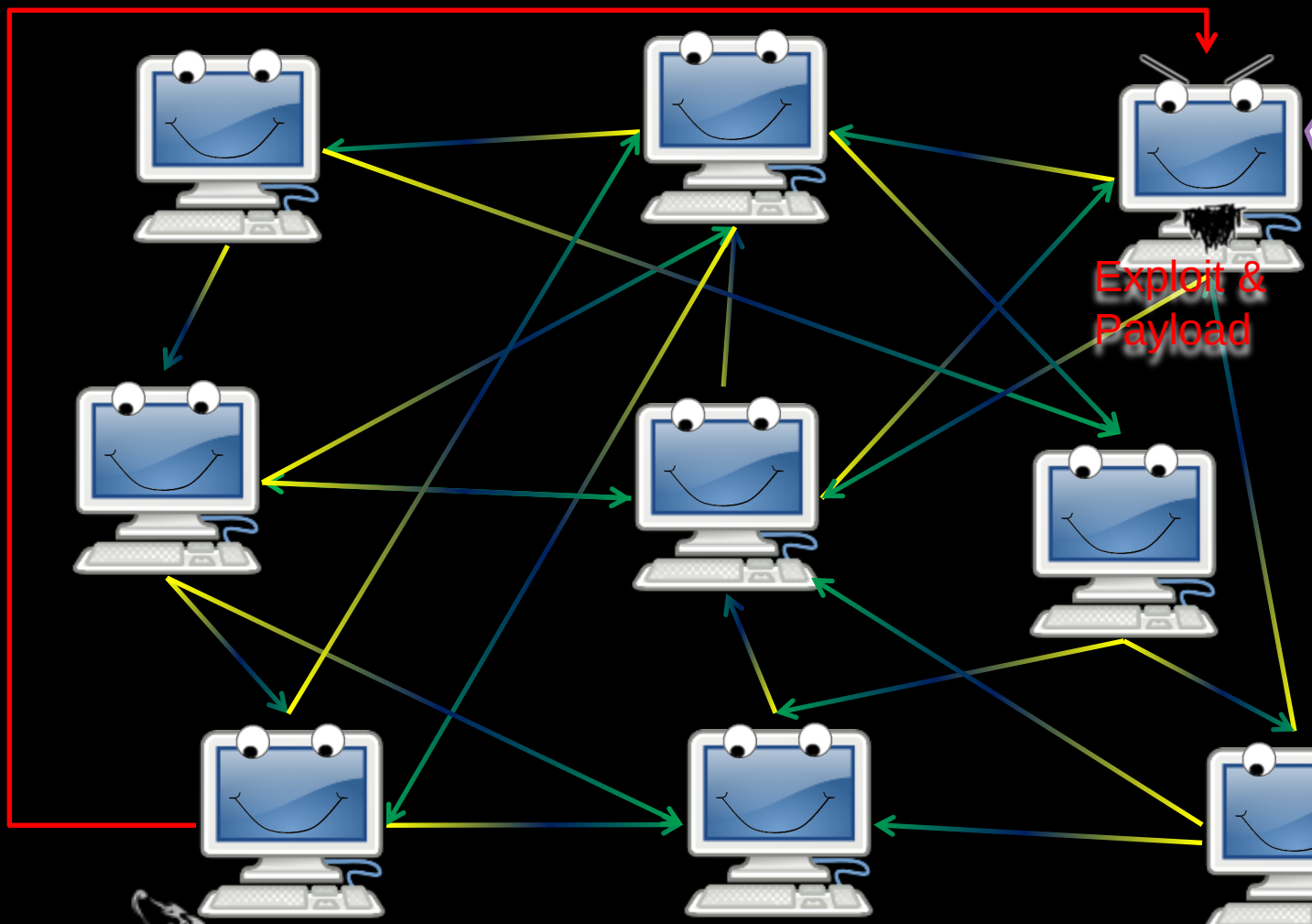
Make hidden server contact you over public Internet



Let's see if the hidden server app is vulnerable to an exploit (buffer overflow/web app shell exec/etc).

Send a payload that contacts an IP I monitor.

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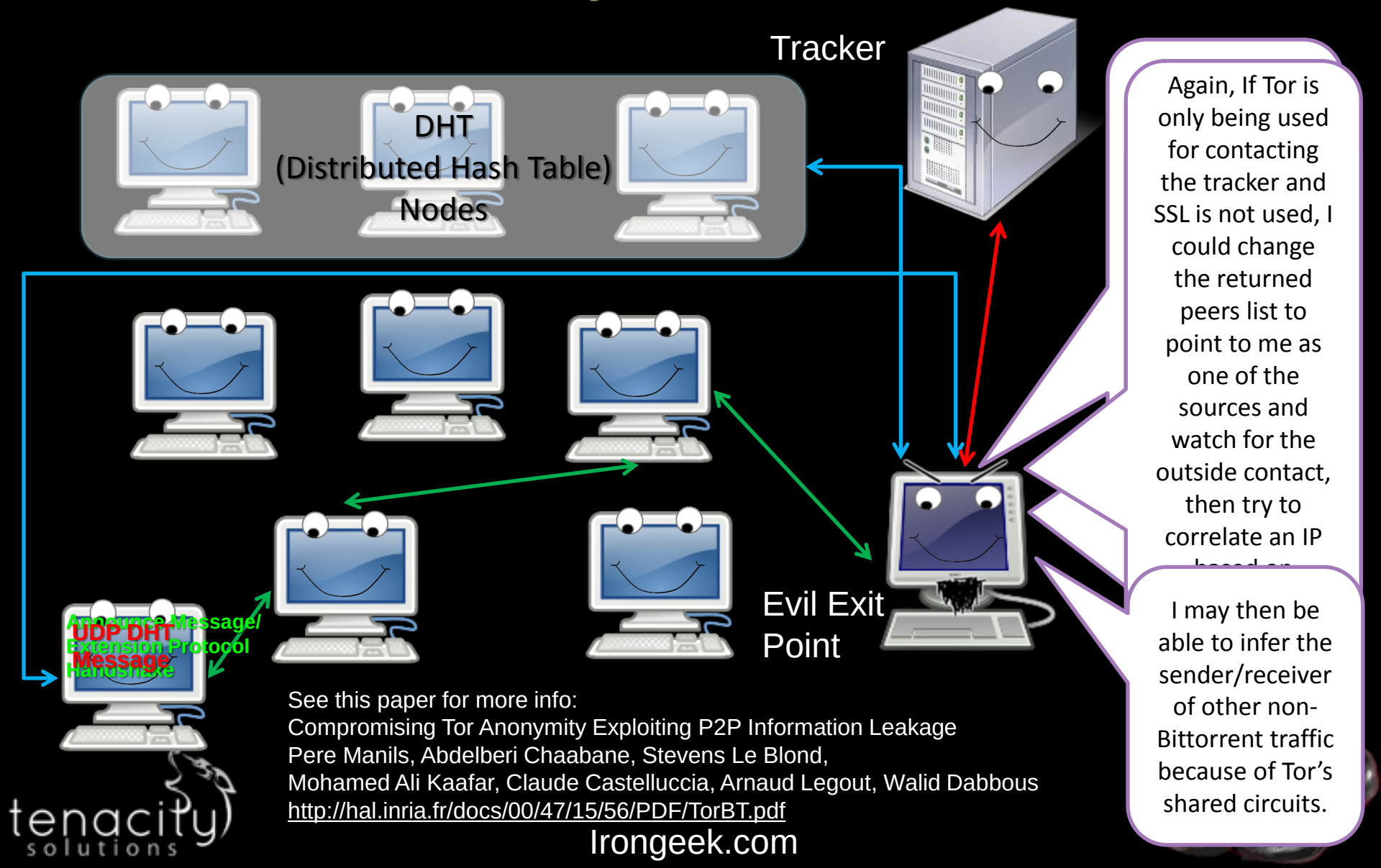
Another example, Bittorrent Issues



See this paper for more info:
Compromising Tor Anonymity Exploiting P2P Information Leakage
Pere Manils, Abdelberi Chaabane, Stevens Le Blond,
Mohamed Ali Kaafar, Claude Castelluccia, Arnaud Legout, Walid Dabbous
http://hal.inria.fr/docs/00/47/15/56/PDF/TorBT.pdf

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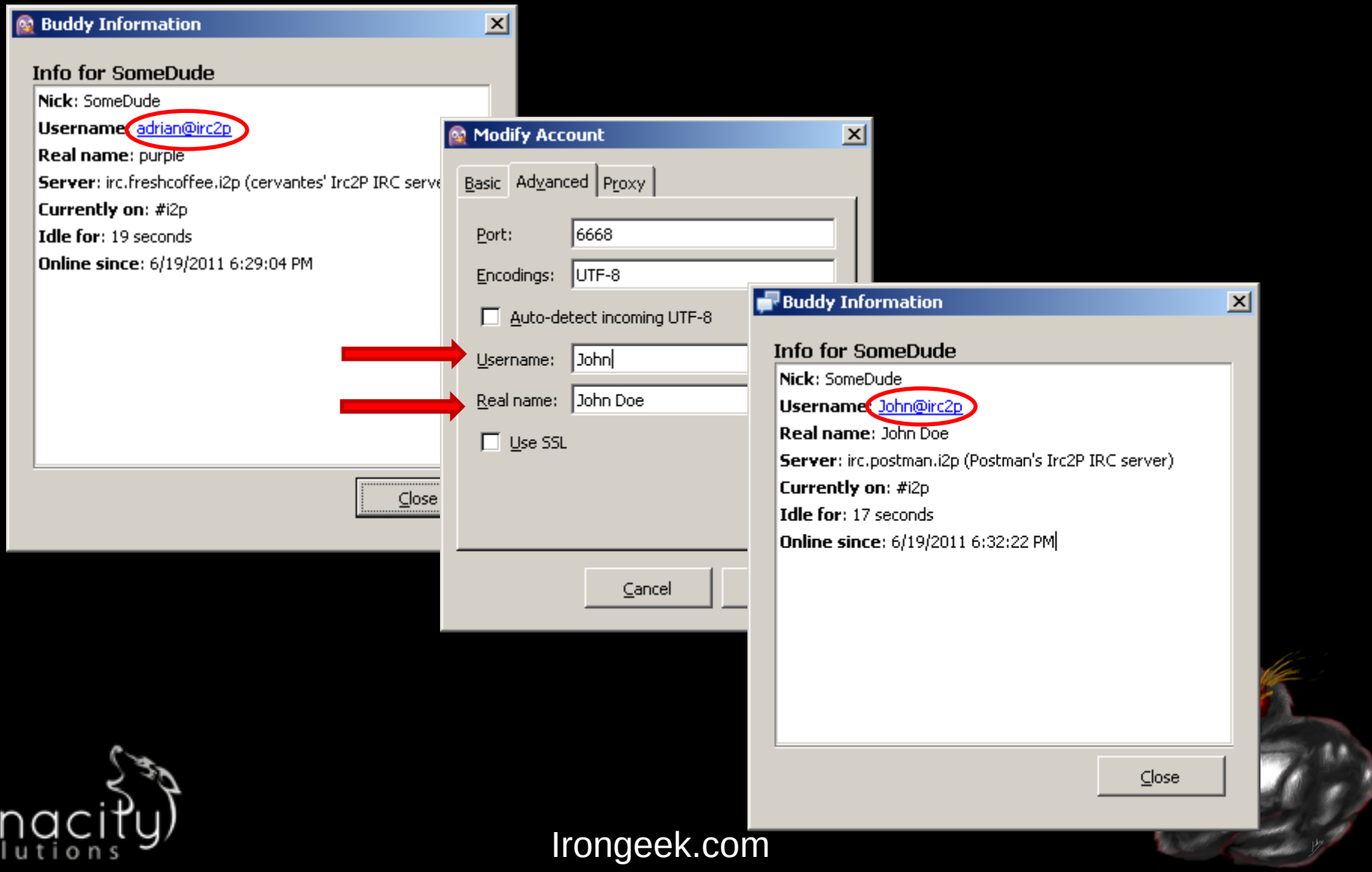
Yet Another Example: IRC Ident



General Mitigations

Client wise:

- Make sure your browser is set to send all traffic though the darknet, or none at all
- Look into firewall rules
- Limit plugins used
- Use a separate browser
- Check against:
  http://decloak.net/
  http://panopticlick.eff.org/

Hidden server wise:

- Patch your stuff
- Don’t run on a box that routes to the Internet

ATTACKS ON CENTRALIZED RESOURCES/INFRASTRUCTURE ATTACKS/DoS ATTACKS

Overview

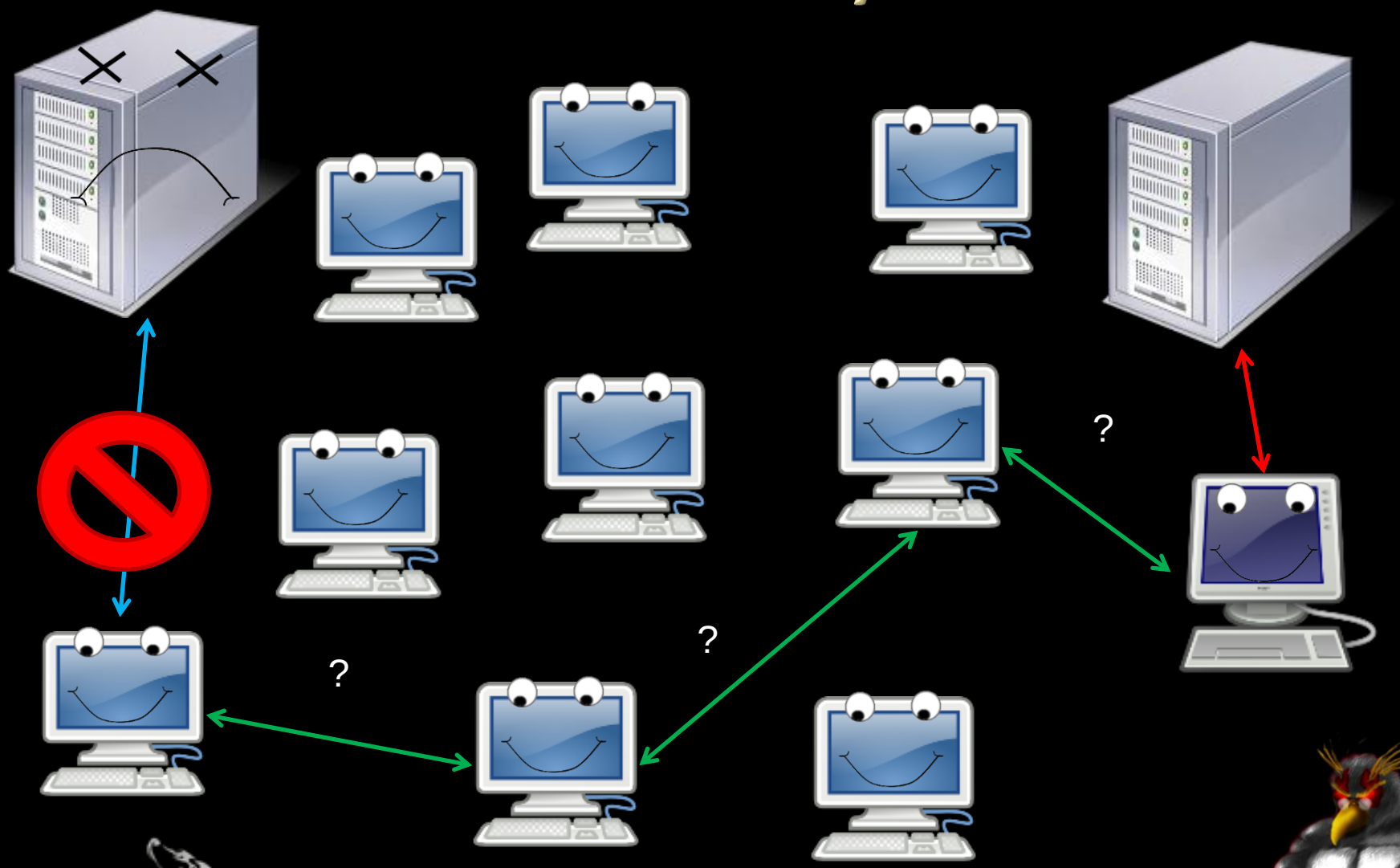
- Not so much against individual nodes, but the network in general
- Whole bunch of categories, not comprehensive:
  - Starvation attacks
  - Partition attacks
  - Flooding
- Standard DDoS attacks against resources inside and outside of the network (if going though the network) are likely to be soaked by other peers
- Shared known infrastructure can be a problem
- Total (or at least severe) blocking of the Internet

Incidents

- China blocked access to the core directory servers of Tor on September 25th 2009 https://blog.torproject.org/blog/tor-partially-blocked-china
- Other blocking of Internet access. (Egypt, Libya, Iran)

Tor Directory Server

DoS of directory servers



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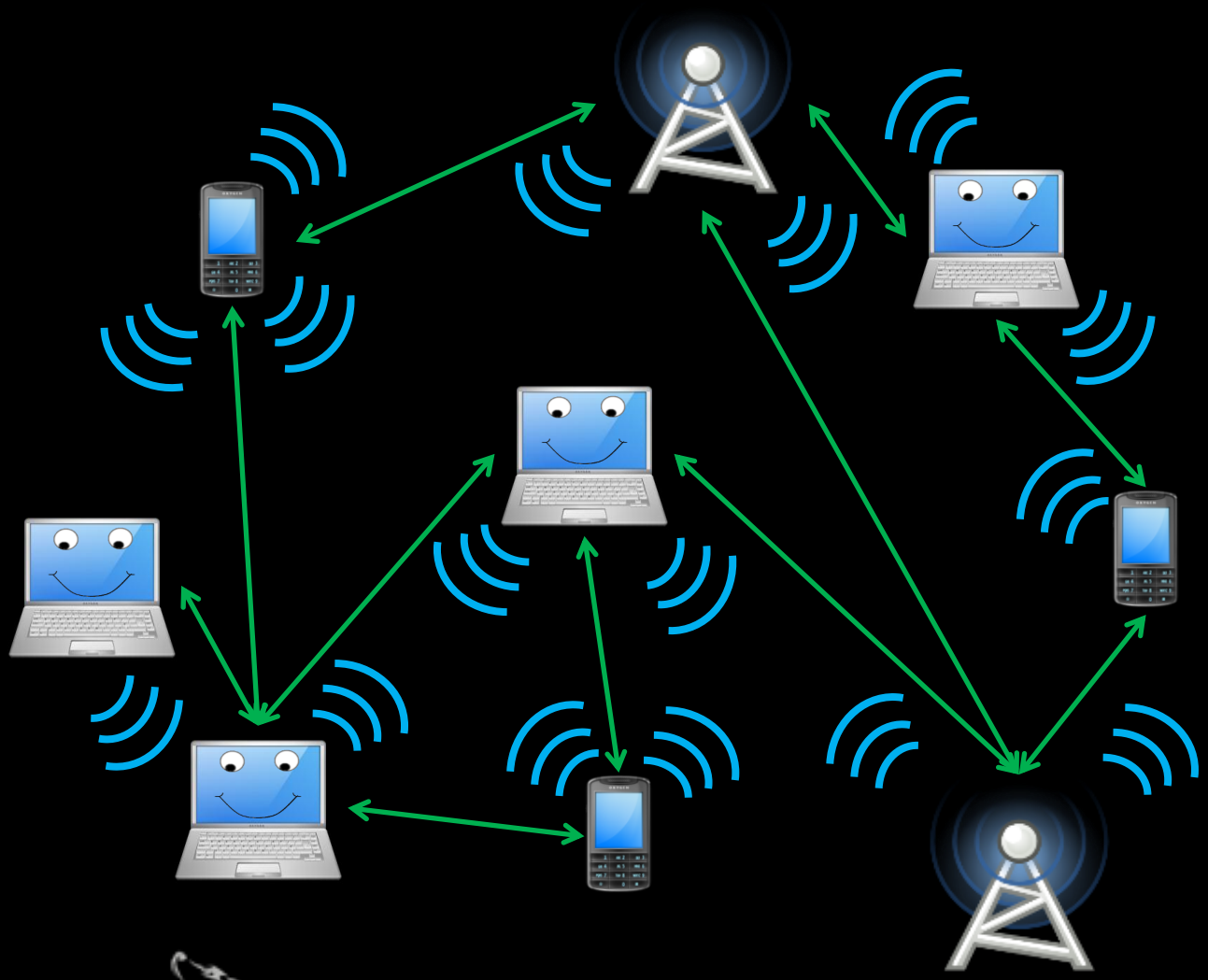
Mitigation

- Bridge nodes (Tor)
- Distributed infrastructure (I2P)
  - Taking out dev site would still be an issue
- Distributed Hash Table
- Protocol obfuscation
- Total/Severe blocking will take a bit more:
  (see next slide)

Mesh/Store and forward



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For more info on mesh networks

- Needs a clear front runner for setting up such a system
- Wikipedia if nothing else
  http://en.wikipedia.org/wiki/Wireless_mesh_network
- Village Infrastructure in a Kit-Alpha (VIKA) Project
  http://www.cuwin.net/node/325
- U.S. Underwrites Internet Detour Around Censors
  http://www.nytimes.com/2011/06/12/world/12internet.html?_r=2&pagewanted=all

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CLOCK BASED ATTACKS

Overview

- Some protocols allow you to check the remote system's clock
- Clock difference could be an issue
- Minor clock issues may need statistical analysis

Incidents

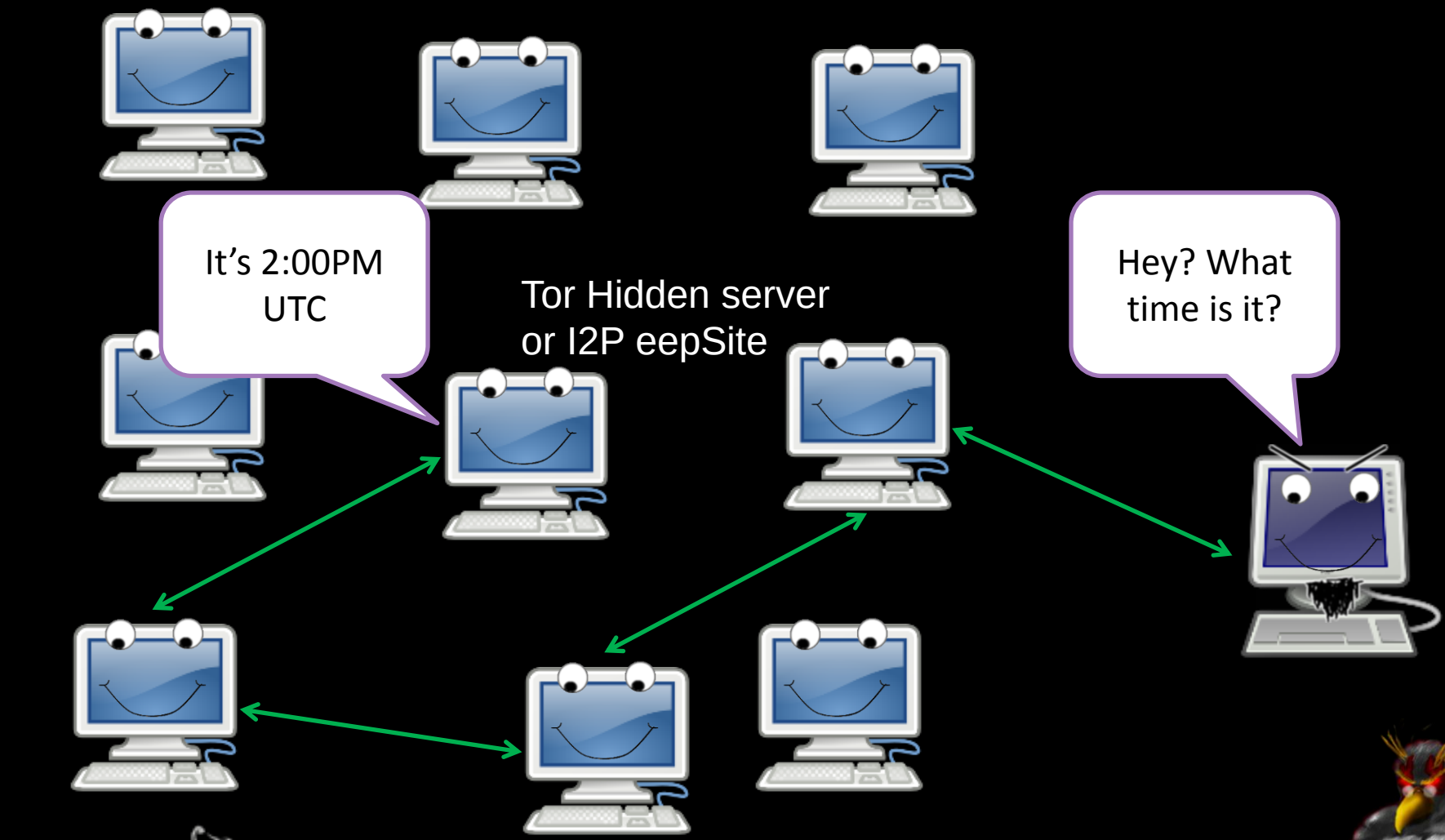
- For skew, see:
  Steven J. Murdoch, "Hot or Not: Revealing Hidden Services by their Clock Skew"
  University of Cambridge, Cambridge, 2006
  http://www.freehaven.net/anonbib/cache/HotOrNot.pdf

- I2P Clock differences in I2P
  http://www.irongeek.com/i.php?page=security/darknets-i2p-identifying-hidden-servers

Clock Differences

Time Difference	Retrieval Time	Host	Header
40.417	0.436	89.31.112.91	Apache/2.2.13 (Linux/SUSE)
50.294	10.549	medosbor.i2p	Apache/2.2.13 (Linux/SUSE)
3.418	0.35	85.229.85.244	Apache/2.2.15 (Debian)
4.325	5.059	jonatan.walck.i2p	Apache/2.2.15 (Debian)
-4325.58	0.353	84.55.73.228	Apache/2.2.3 (CentOS)
-4321.66	8.946	ipredia.i2p	Apache/2.2.3 (CentOS)
4488.434	0.702	130.241.45.216	Apache/2.2.9 (Debian) PHP/5.2.6-1+lenny8 with Suhosin-Patch
4490.365	4.894	error.i2p	Apache/2.2.9 (Debian) PHP/5.2.6-1+lenny8 with Suhosin-Patch
2.407	4.89	bolobomb.i2p	Apache/2.2.9 (Debian) PHP/5.2.6-1+lenny9 with Suhosin-Patch mod_ssl/2.2.9 OpenSSL/0.9.8g
2.421	0.091	83.222.124.19	Apache/2.2.9 (Debian) PHP/5.2.6-1+lenny9 with Suhosin-Patch mod_ssl/2.2.9 OpenSSL/0.9.8g
3.43	0.282	188.40.181.33	lighttpd/1.4.22
5.366	2.901	docs.i2p2.i2p	lighttpd/1.4.22
6.274	3.673	zzz.i2p	lighttpd/1.4.22
53.415	0.26	93.174.93.93	Microsoft-IIS/6.0
54.404	3.92	colombo-bt.i2p	Microsoft-IIS/6.0
3.287	0.531	www.i2p2.i2p	nginx/0.6.32
3.429	0.285	46.4.248.202	nginx/0.6.32
11.323	8.989	lurker.i2p	nginx/0.7.65
12.433	8.882	178.63.47.16	nginx/0.7.65

Clock Issues



Mitigation

- Attack can be hard to pull off because of network jitter
- Set clocks with a reliably and often used NTP server
- Some mitigation may take place in the darknet protocol itself

METADATA IN FILES

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Overview

- Matadata is data about data
- Just a few files types that contain metadata
  - JPG
    EXIF (Exchangeable image file format)
    IPTC (International Press Telecommunications Council)
  - PDF
  - DOC
  - DOCX
  - EXE
  - XLS
  - XLSX
  - PNG
  - Too many to name them all
- Things stored: User names, edits, GPS info, network paths, MAC addresses in odd cases. It all depends on the file format.

Incidents: Pwned by Metadata

Cat Schwartz
Is that an unintended thumbnail in your EXIF data, or are you just happy to see me?

Dennis Rader (BTK Killer)
Metadata in a Word DOC he sent to police had the name of his church, and last modified by “Dennis” in it.

Darkanaku/Nephew chan
A user on 4chan posts a pic of his semi-nude aunt taken with an iPhone, Anonymous pulls the EXIF GPS info from the file and hilarity ensues.
More details can be on the following VNSFW site:
~~http://encyclopediadramatica.com/User:Darkanaku/Nephew_chan~~
http://web.archive.org/web/20090608214029/http://encyclopediadramatica.com/User:Darkanaku/Nephew_chan

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Mitigation

- Well, clean out the metadata, duh!
- Apps vary on how to do it

LOCAL ATTACKS

(at this point, it is already probably a lost cause)

Overview

- If they have access to the local box, your hosed
- Comes down to mostly traditional forensics
  - Data on hard drive
  - Cached data and URLs
  - Memory Forensics

Mitigations

- Anti-forensics http://www.irongeek.com/i.php?page=videos/anti-forensics-occult-computing
- Live CD/USB, but see Andrey Case's work: https://media.blackhat.com/bh-dc-11/Case/BlackHat_DC_2011_Case_De-Anonymizing_Live_CDs-wp.pdf
- Full hard drive encryption

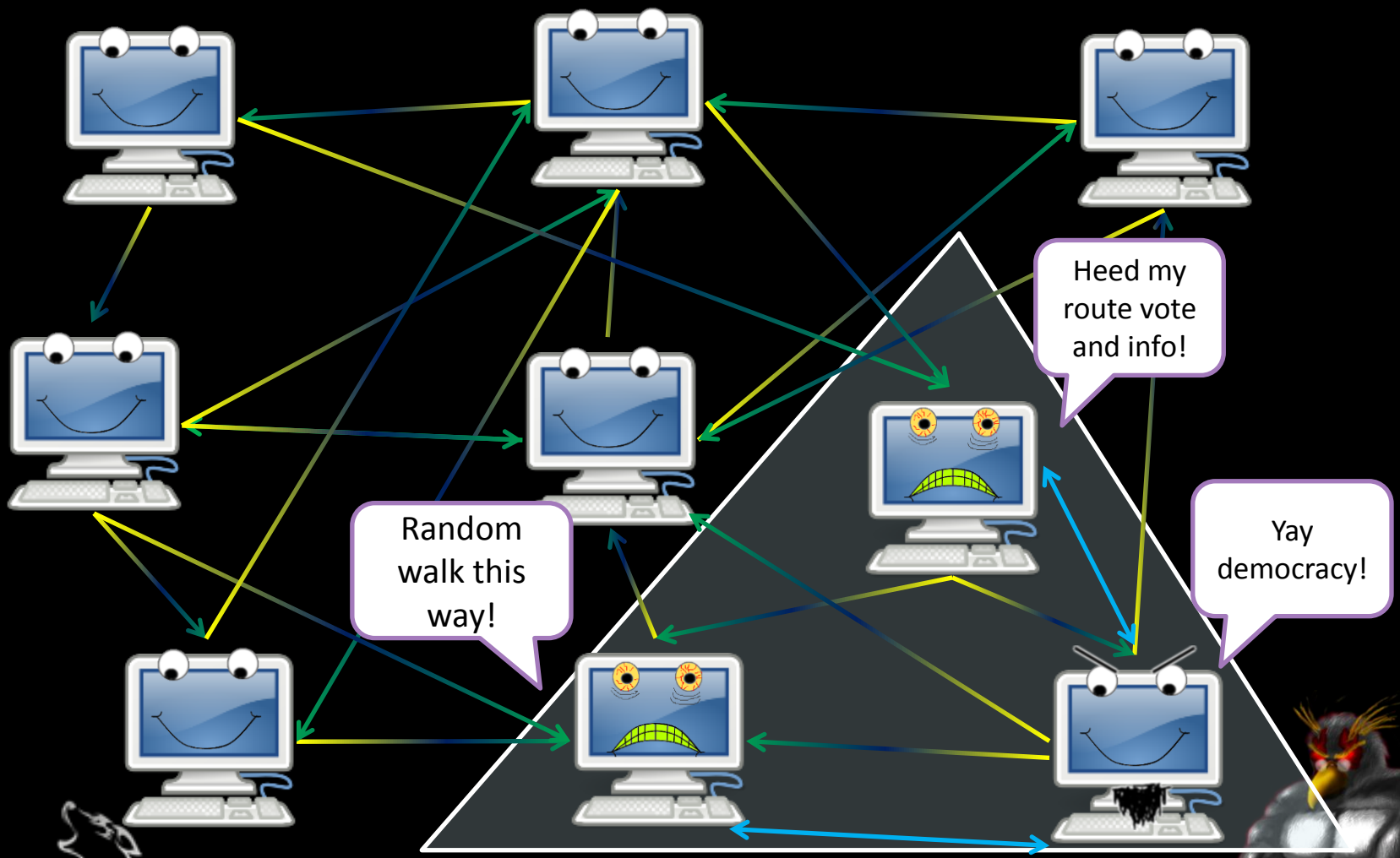
SYBIL ATTACKS

Sock puppetry

Overview

- Ever heard of Sybil attacks?
- Think sock puppet, one entity acting as many
- May allow for control of routing, elections, etc.
- Makes many of the other attacks easier

Sock puppetry/Sybil



Mitigation

No absolute fixes

- Make it cost more to have nodes (hashcash)
- IP restrictions:
  Both Tor and I2P restrict peering between IPs on the same /16
- Central infrastructure may be more resilient against Sybil attacks (but has other issues)
- Peering strategies
- SybilLimit/SybilGuard/SybilInfer

TRAFFIC ANALYSIS ATTACKS

First/Last in chain attacks

Tagging attacks

Timing attacks

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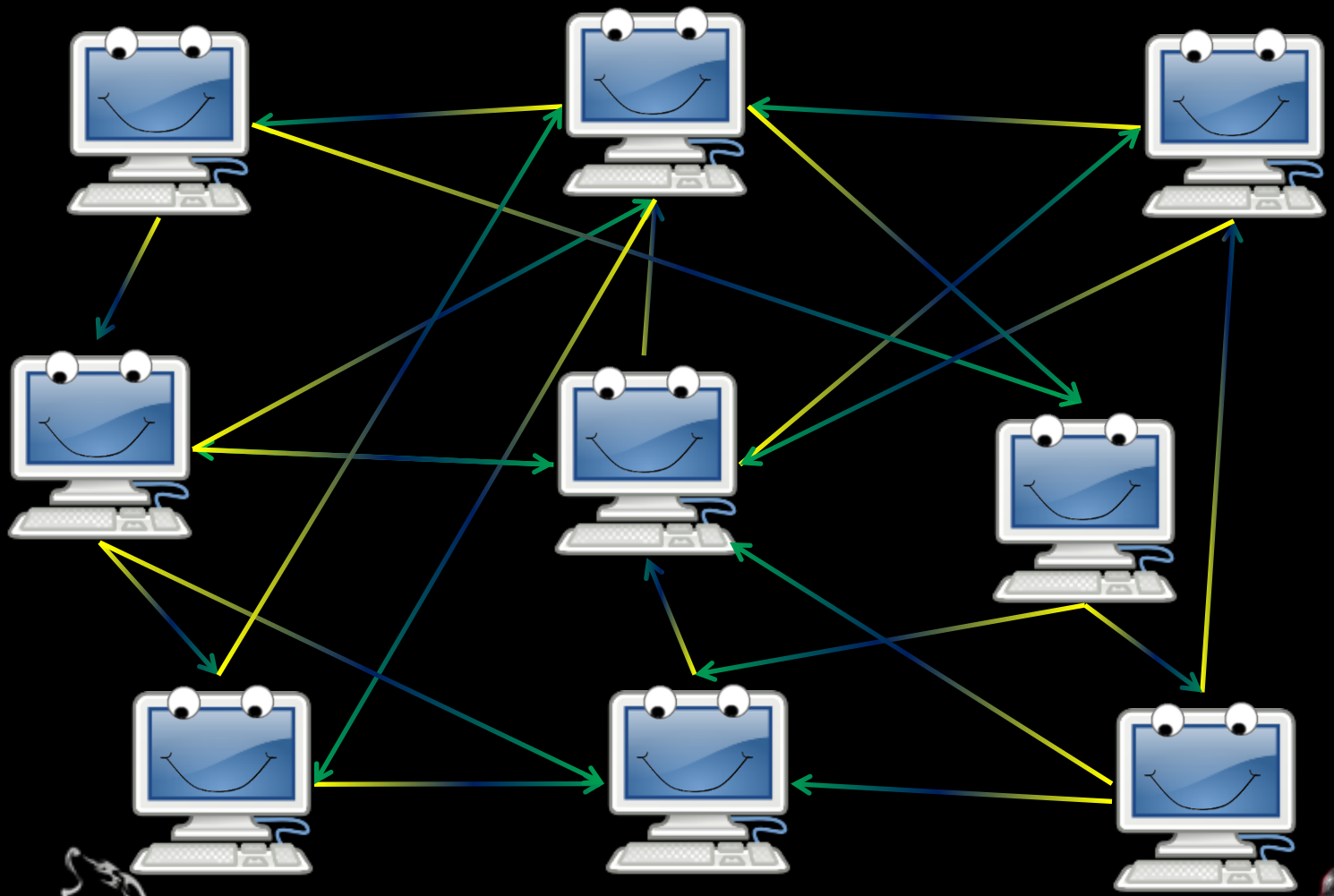
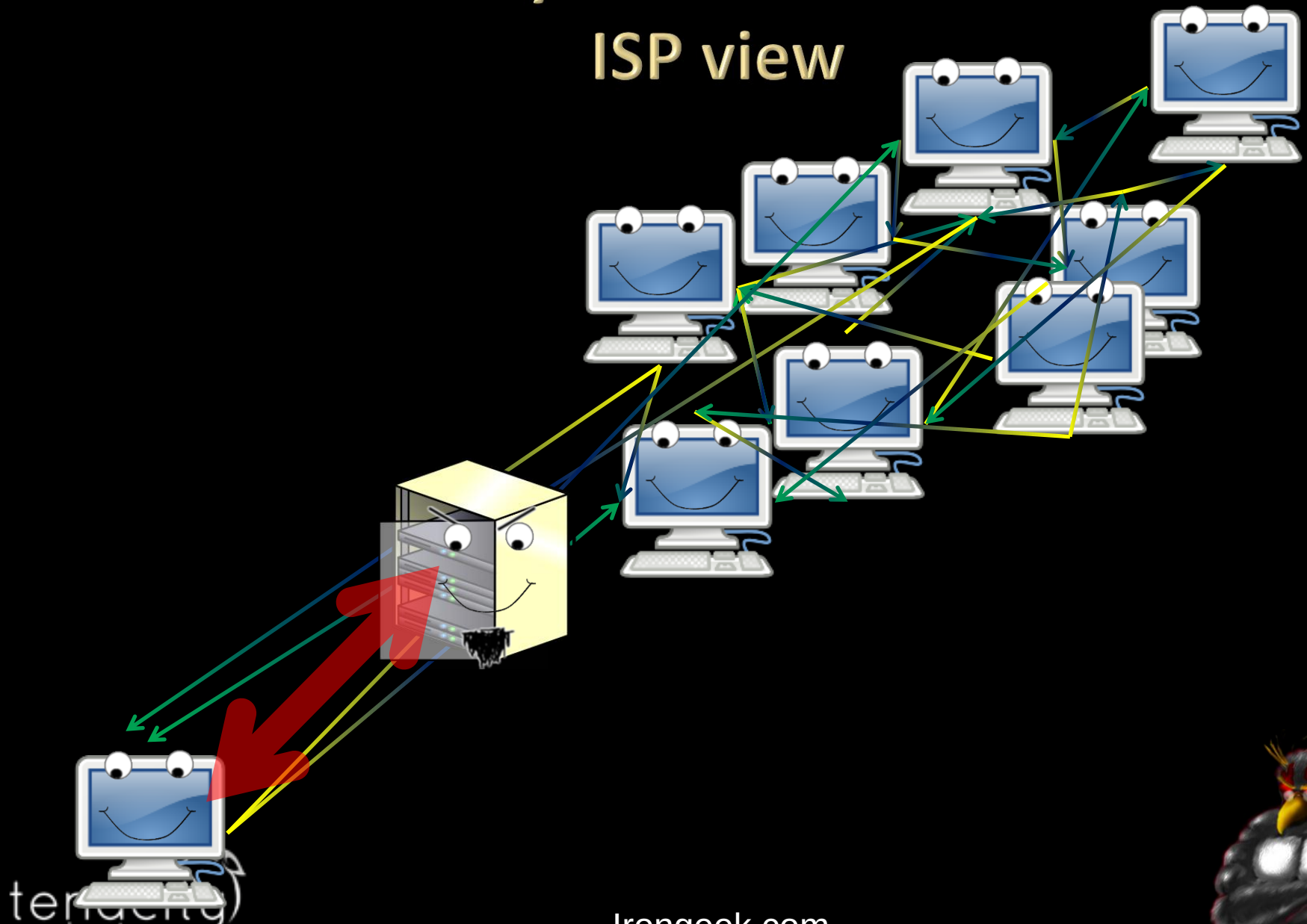
Overview

- There's much focus on this in academia, but I imagine application layer flaws are more likely to snag someone
- So many subtle variation on profiling traffic
- Could be:
  - Timing of data exchanges
  - Amount of traffic
  - Tagging of traffic by colluding peers
- Generally takes a powerful adversary
- Hard to defeat in "low latency" networks

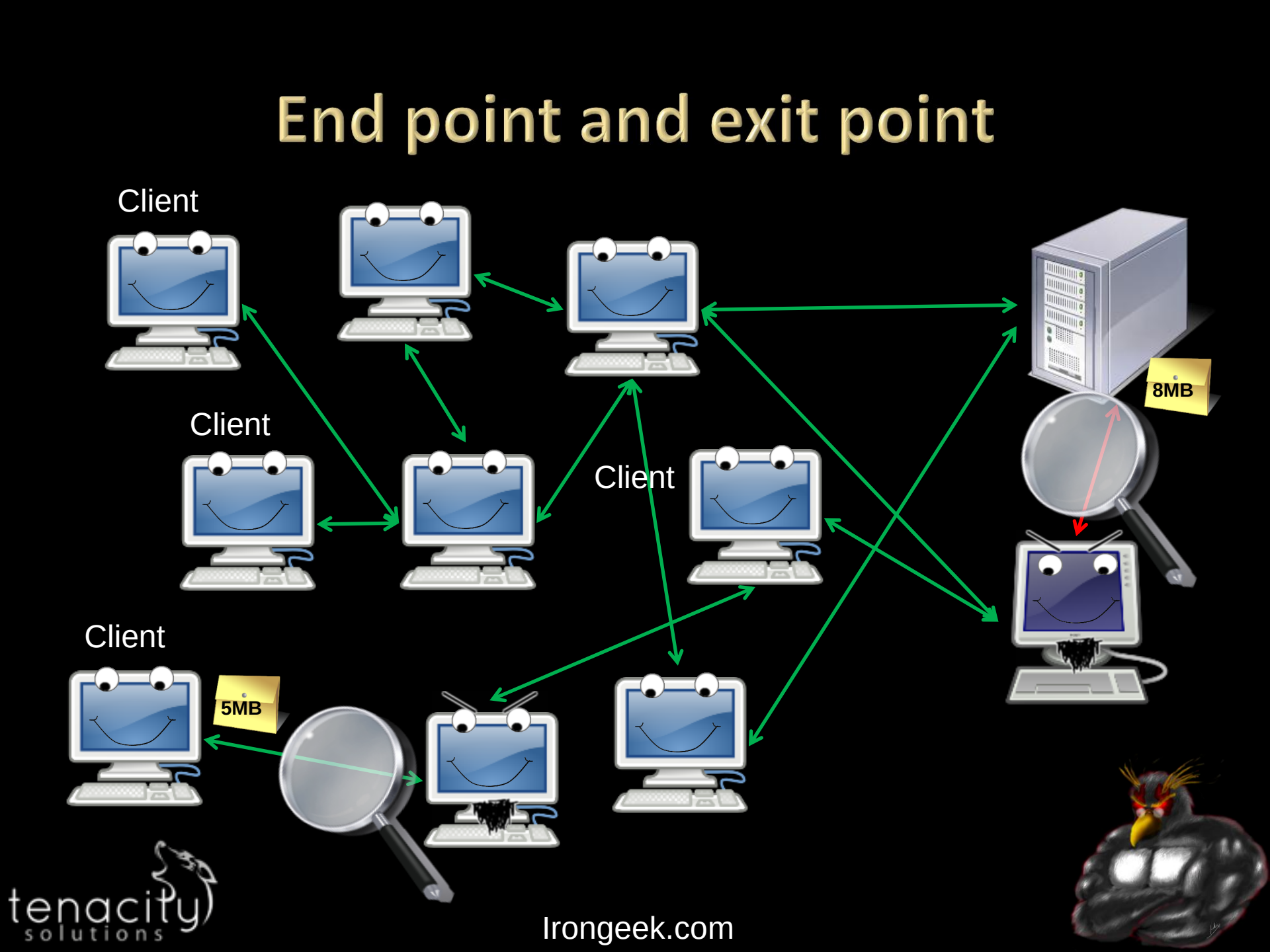
I2P one-way tunnel mesh network: Logical view



I2P one-way tunnel mesh network: ISP view



End point and exit point



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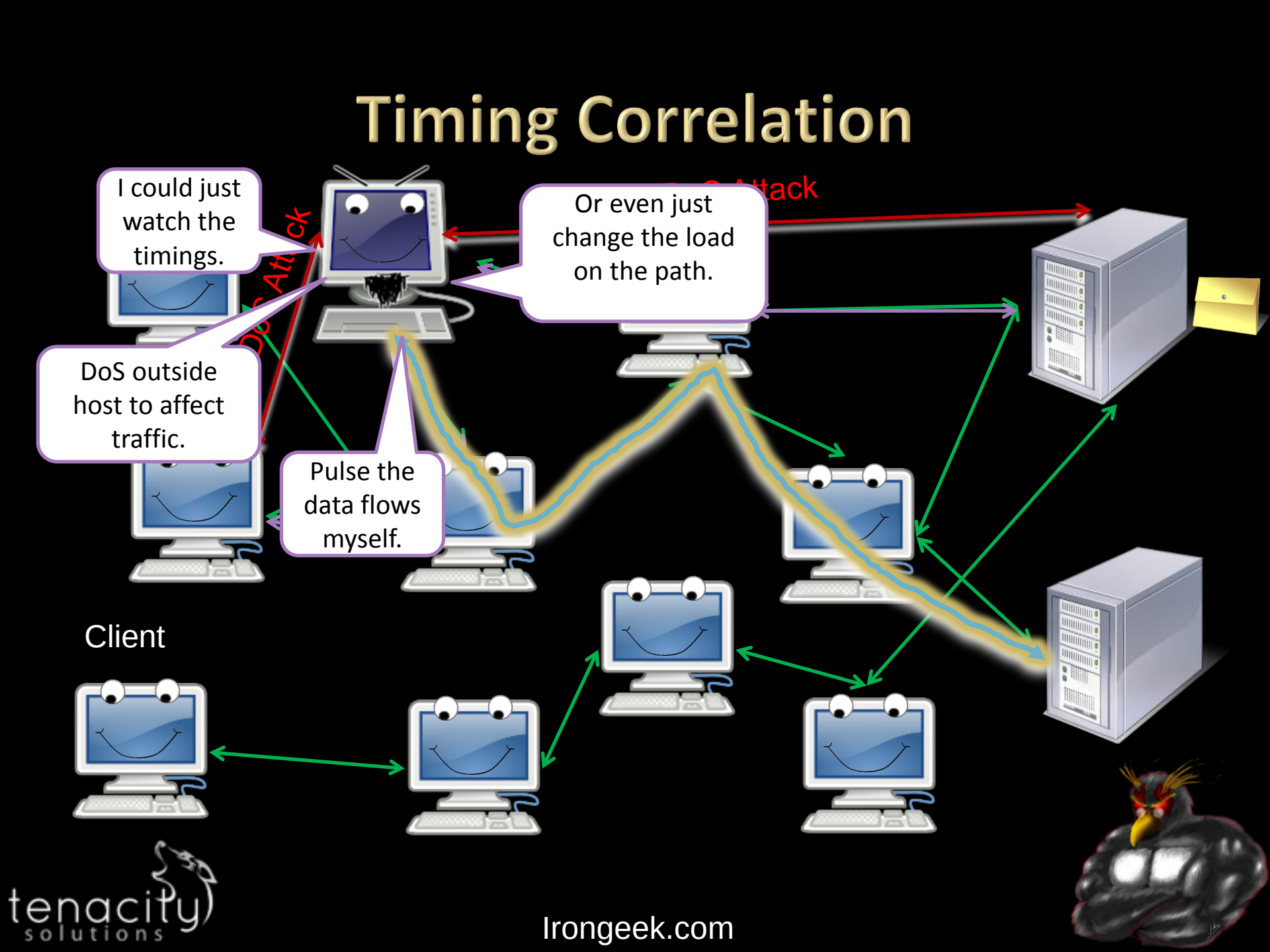
Timing Correlation



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Mitigation

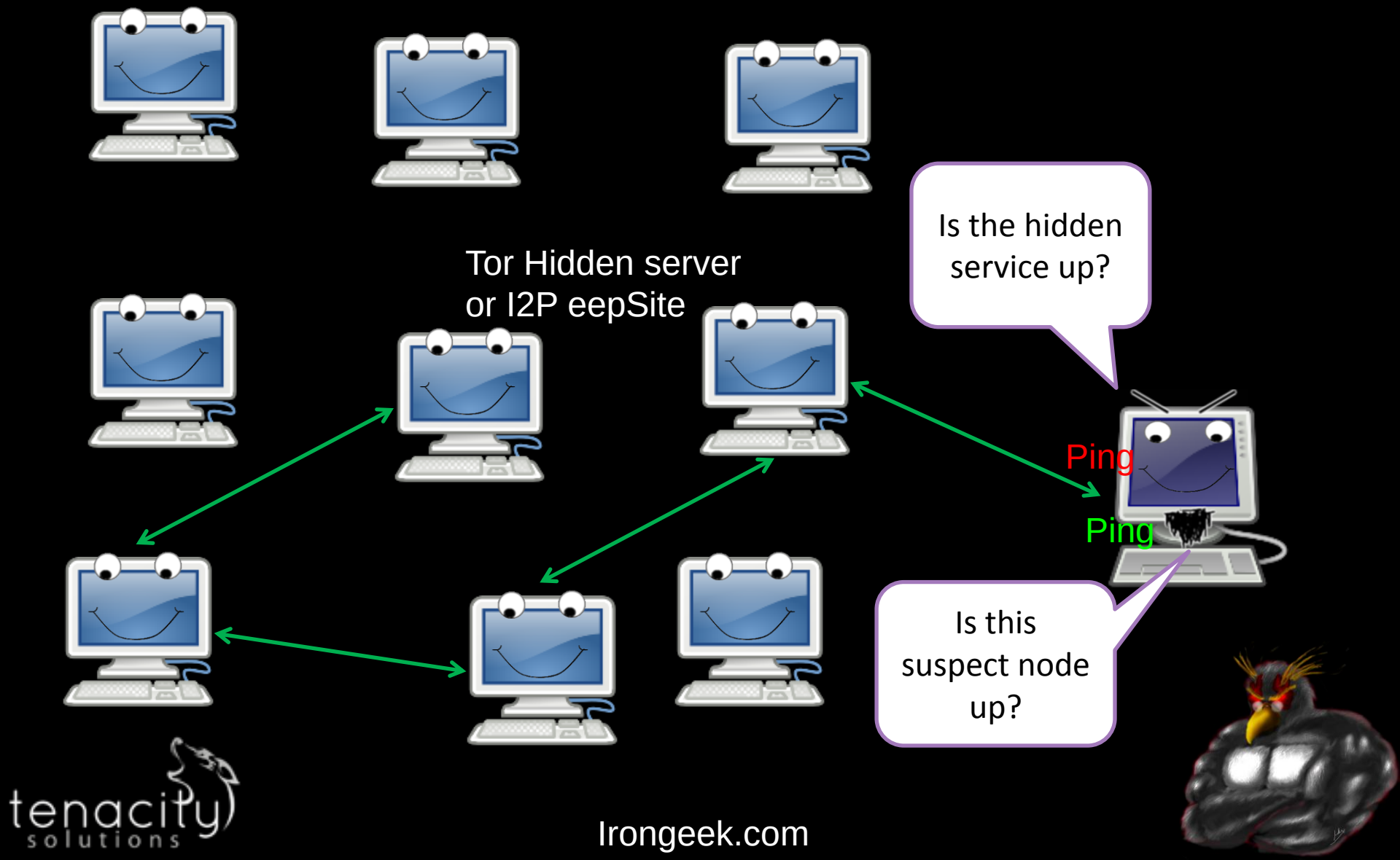
- More routers
- More cover traffic
  (smaller needle in a larger haystack)
- Entry Guards for first hop
- One way tunnels
- Short lived tunnels may help, ends of tunnels act as rendezvous points
- Better peer profiling
- Signing of the data
- Fixed speeds
- Padding and Chaff
- Non-trivial delays and Batching

INTERSECTION/CORRELATION ATTACKS

Overview

- Could be as simple as knowing who is up when a hidden service can be accessed
- Techniques can be used to reduce the search set
- Application flaws and information leaks can narrow the anonymity set
- Harvesting attacks

Correlation



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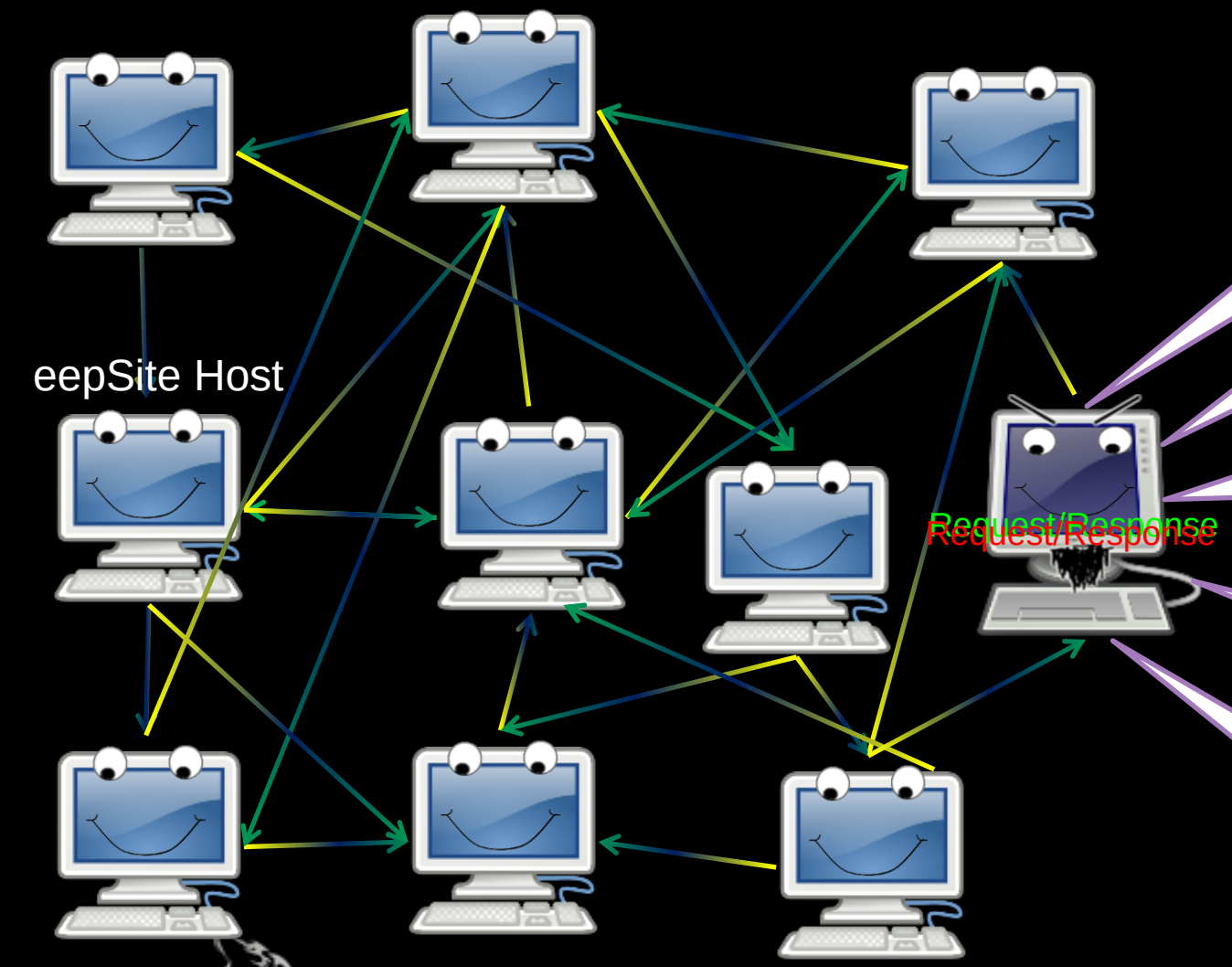
Cut down needed checks



1. What server software are you running an eepSite on?

2. Harvest as many peer IPs as I can.

3. Is there a web service on the public facing IP using the same daemon?

4. Does it respond to the same Vhost request?

5. If so, yippy! Found you!

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Mitigation

- More nodes
- Give less data that could be used to reduce the anonymity set
- Make harvesting/scrapping attacks harder
- Checkout “De-anonymizing I2P” paper and talk I’ll link to later

Links

- Selected Papers in Anonymity
  http://www.freehaven.net/anonbib/
- I2P's Threat Model Page
  http://www.i2p2.de/how_threatmodel.html
- General Darknets Talk
  http://www.irongeek.com/i.php?page=videos/aide-winter-2011#Cipherspace/Darknets:_anonymizing_private_networks
- De-anonymizing I2P
  http://www.irongeek.com/i.php?page=security/darknets-i2p-identifying-hidden-servers
  http://www.irongeek.com/i.php?page=videos/identifying-the-true-ip-network-identity-of-i2p-service-hosts-talk-adrian-crenshaw-blackhat-dc-2011

Thanks

- Conference organizers for having me
- Tenacity for helping get me to Defcon
- By buddies from Derbycon and the ISDPodcast
- Open Icon Library for some of my images http://openiconlibrary.sourceforge.net

Events

- DerbyCon 2011, Louisville Ky
  Sept 30 - Oct 2
  http://derbycon.com
- Louisville Infosec
  http://www.louisvilleinfosec.com
- Other Cons:
  http://skydogcon.com
  http://dojocon.org
  http://hack3rcon.org
  http://phreaknic.info
  http://notacon.org
  http://outerz0ne.org

QUESTIONS?

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