The Zombie Roundup:

Understanding Detecting, and Disrupting Botnets

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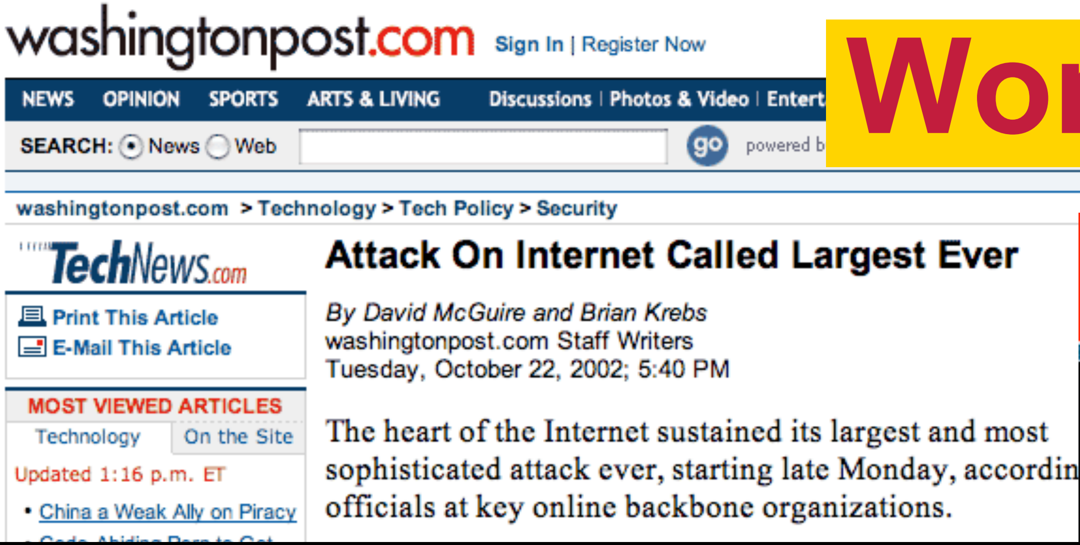
SRUTI Workshop 2005
July 7, 2005

The Old Days…



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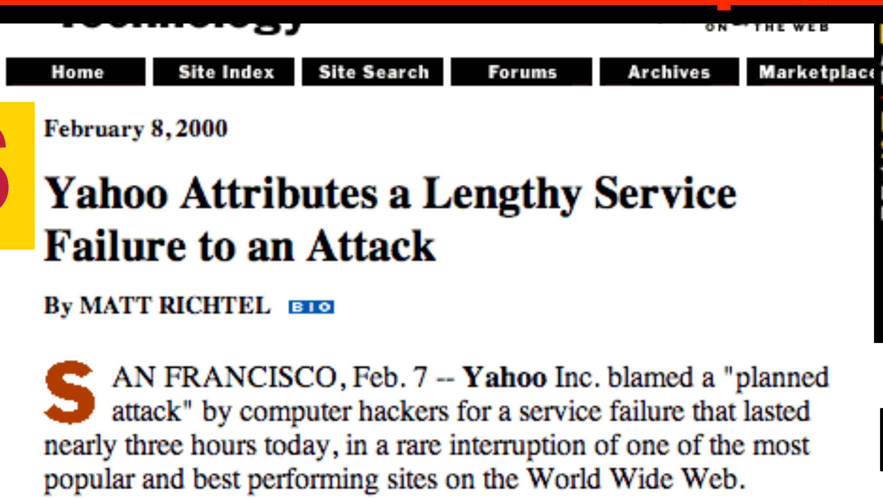
Attack On Internet Called Largest Ever

By David McGuire and Brian Krebs
washingtonpost.com Staff Writers
Tuesday, October 22, 2002; 5:40 PM

The heart of the Internet sustained its largest and most sophisticated attack ever, starting late Monday, accordin officials at key online backbone organizations.

Worms

These attacks disrupt infrastructure



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February 8, 2000

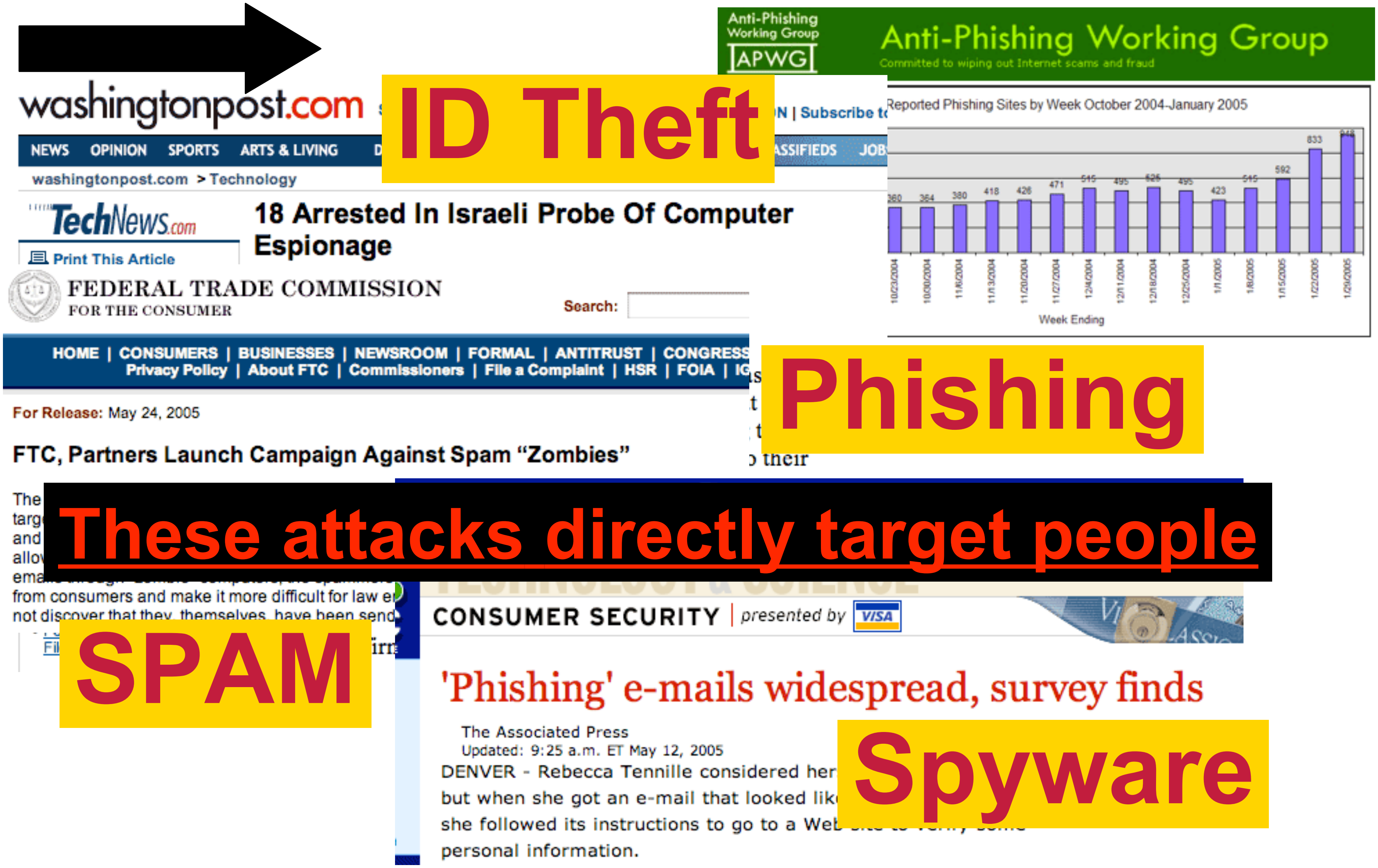
Yahoo Attributes a Lengthy Service Failure to an Attack

By MATT RICHTEL BIO

SAN FRANCISCO, Feb. 7 -- **Yahoo** Inc. blamed a "planned attack" by computer hackers for a service failure that lasted nearly three hours today, in a rare interruption of one of the most popular and best performing sites on the World Wide Web.

DoS

A Dramatic Escalation/Transformation



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18 Arrested In Israeli Probe Of Computer Espionage

ID Theft

Anti-Phishing Working Group APWG

Anti-Phishing Working Group

Committed to wiping out Internet scams and fraud

Reported Phishing Sites by Week October 2004-January 2005

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Phishing

For Release: May 24, 2005

FTC, Partners Launch Campaign Against Spam "Zombies"

The … targ… and … allo… ema… from consumers and make it more difficult for law e… not discover that they, themselves, have been send…

These attacks directly target people

SPAM

CONSUMER SECURITY | presented by VISA

'Phishing' e-mails widespread, survey finds

The Associated Press
Updated: 9:25 a.m. ET May 12, 2005

DENVER - Rebecca Tennille considered her … but when she got an e-mail that looked lik… she followed its instructions to go to a Web … personal information.

Spyware

Rise of the Zombies

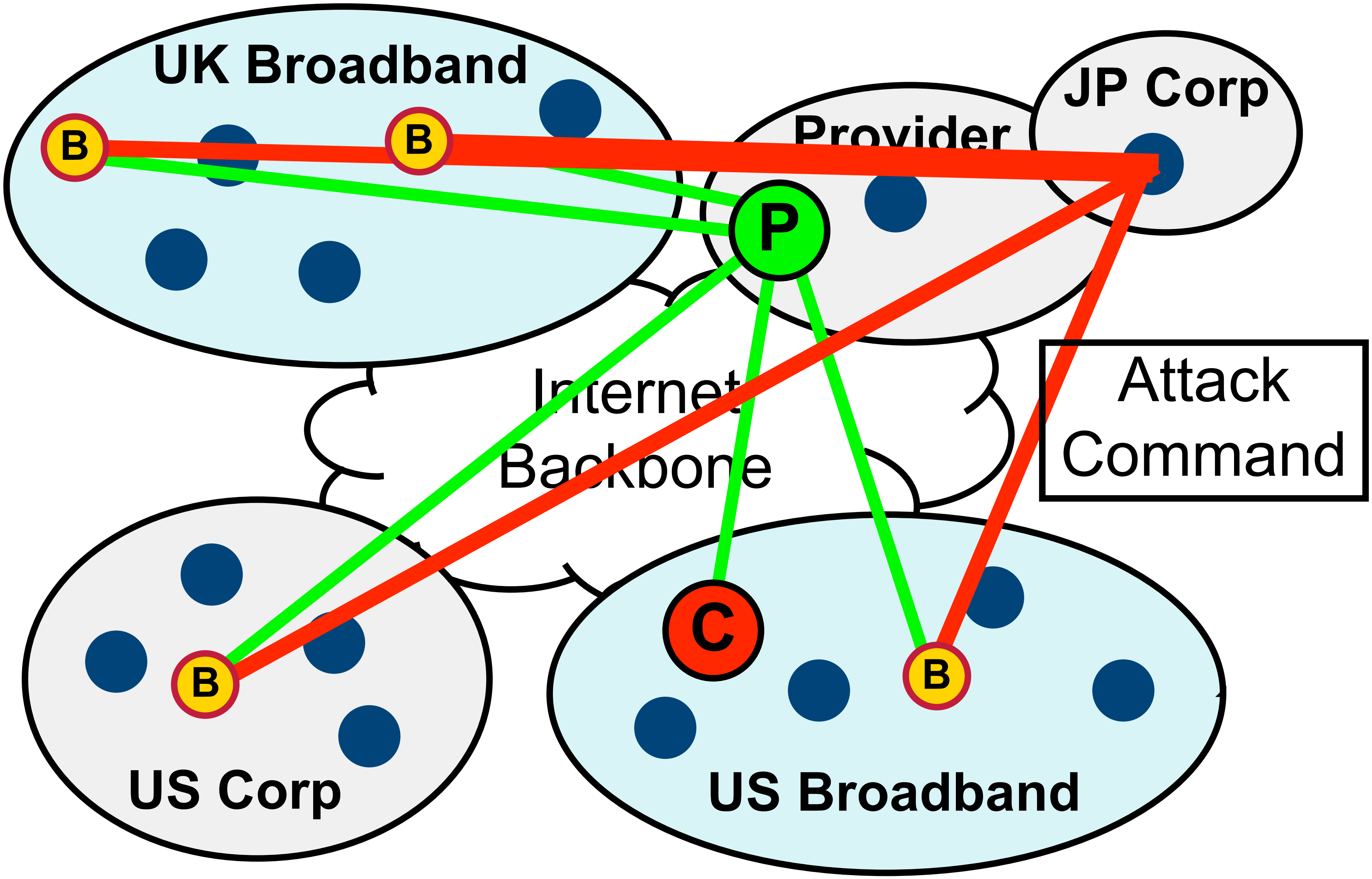
- New ***personal*** attacks often rely on an another resource (e.g. phishing site, SPAM relay)
- Anonymous use of resource highly desirable

  => attackers use another compromised system as a proxy!

  Attackers have learned a compromised system is more useful alive than dead!

This talk is about detecting and disrupting access to the anonymous infrastructure used in these attacks

The Botnet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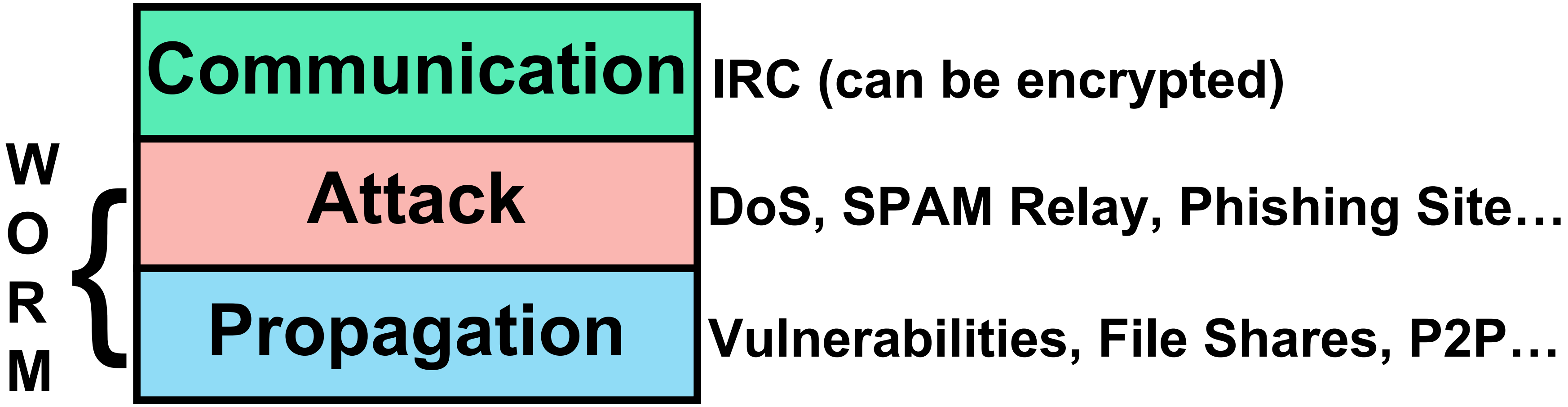
B
B
Provider
JP Corp
P
Internet
Backbone
Attack
Command
C
B
B
US Corp
US Broadband

Bot History and Structure

- Not New: An original use, help Internet Relay Chat (IRC) Operators (*Eggdrop/1993*)
- Nefarious attack bots soon emerged (*DDoS*)
- Developed Sophisticated Hiding and Attack Capabilities (*SubSeven, Bot/Bionet Bot*)
- Modern Bots: (***AgoBot****[PhatBot],****GTBot****[rBot]*)



Communication — **IRC (can be encrypted)**

Attack — **DoS, SPAM Relay, Phishing Site…**

Propagation — **Vulnerabilities, File Shares, P2P…**

Big Bad Bots

- Total infected bot hosts **800,000 - 900,000** [CERT CA-2003-08]

  > **100,000 nodes/botnet**
- **1000's of new bots** each day [Symantec 2005]
- Many articles/press citing thousands of infected hosts [IEEE S&P, Register]
- Difficult to measure:

  => Population likely *much much* larger!

Bot/Botnet Measurements - Operators

- Very little hard data on botnets!
- We asked operators (five Tier-1 & Tier-2 ops):
  - They are actively fighting the problem
  - # of Botnets - *increasing*
  - Bots per Botnet - *decreasing*

    Used to be 80k-140k, now 1000s (evasion/economics?)
  - More firepower:

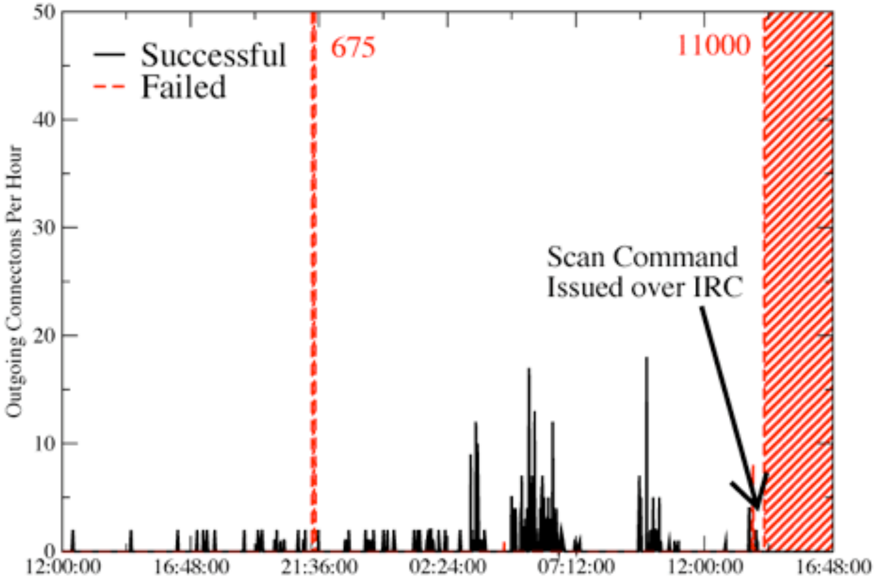
    Broadband (1Mbps Up) x 100s == OC3!!!
  - Custom botnets (all .edu, .gov/.mil) - economics?

Bot/Botnet Measurements - Honeypot

- Windows 2000/XP Honeypot
- Placed behind proxy:
  1. Rate limit traffic 12KB/s
  2. Disallow local network
  3. Log all traffic
- 12 experimental runs over a month:
  - 12-72 hour traces > 100MBs
  - Recruited into least **15 unique botnets**
  - Bots used DCOM/RPC, LSASS

=> Bots are extremely prevalent

Successful and failed outgoing connections from bot infected honeypot



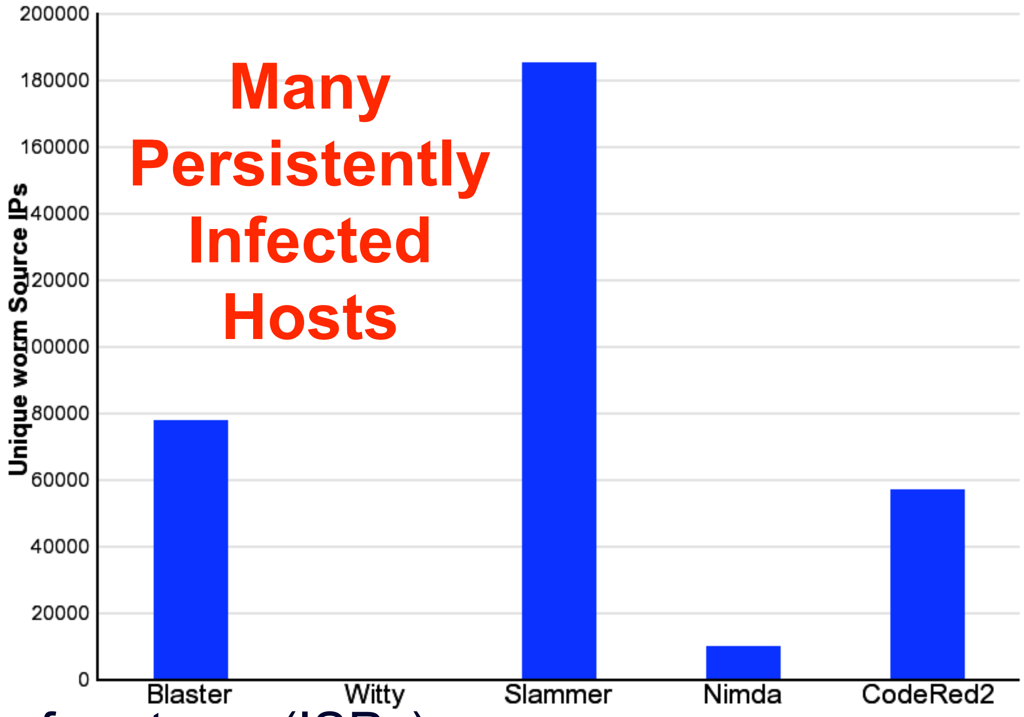
Just 2 worm infections during the experiment!

Detecting and Stopping Bots

1. Prevent systems from getting infected
2. Directly detect *bot* communications between *bots* and between *bots* and *bot controllers*
3. Detect the secondary features of a *bot* infection like propagation or attacks

Prevent Infection

- Well developed methods:
  - Anti-virus
  - Firewalls
  - Patching

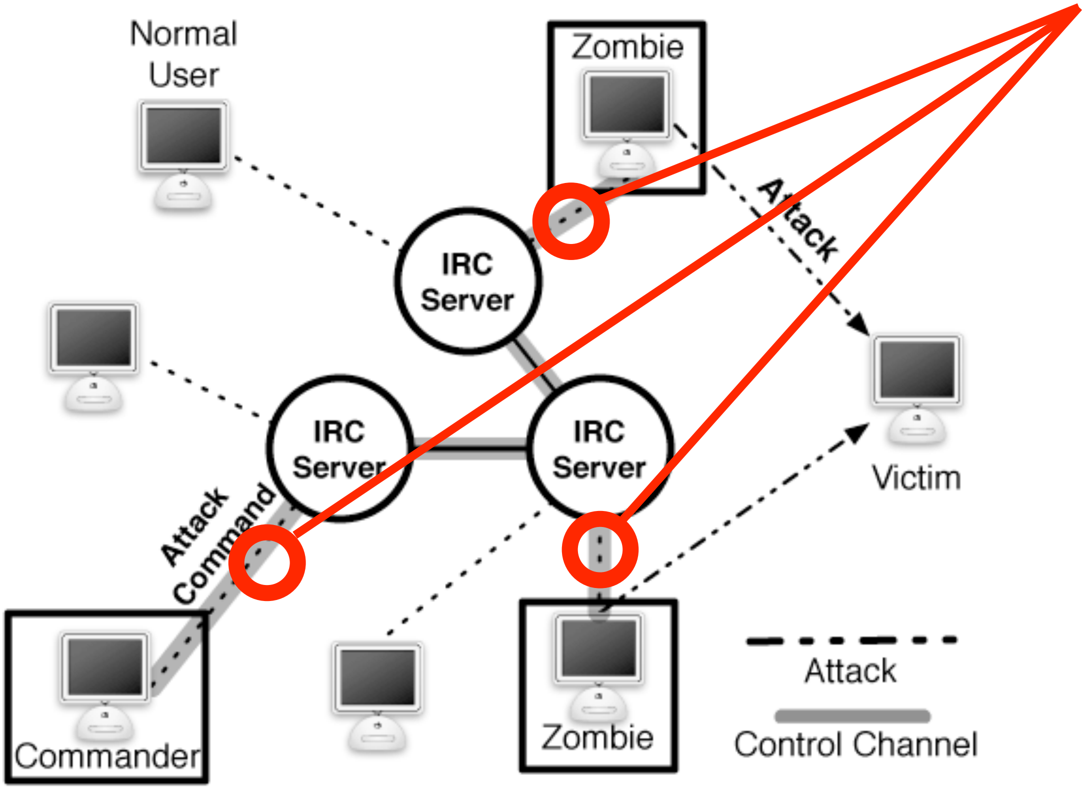


Many Persistently Infected Hosts

- But:
  - Might not directly control of systems (ISPs)
  - Can’t upgrade certain systems (Win98 DAQ)
  - Complex infection vectors: App-level (javascript, AIM)
  - Custom threat (Israeli trojan)
- Naïve to assume 100% protected

Detect Bot Communication

- Many bots use IRC for Command and Control



Detect IRC Bot Commands

- Offramp TCP port 6667
- Inspect Payloads (*advscan*…) [honeynet05]
- IRC Behavior [Racine04]

Detecting Bot Communication…

Less knowledge of peers per Bot

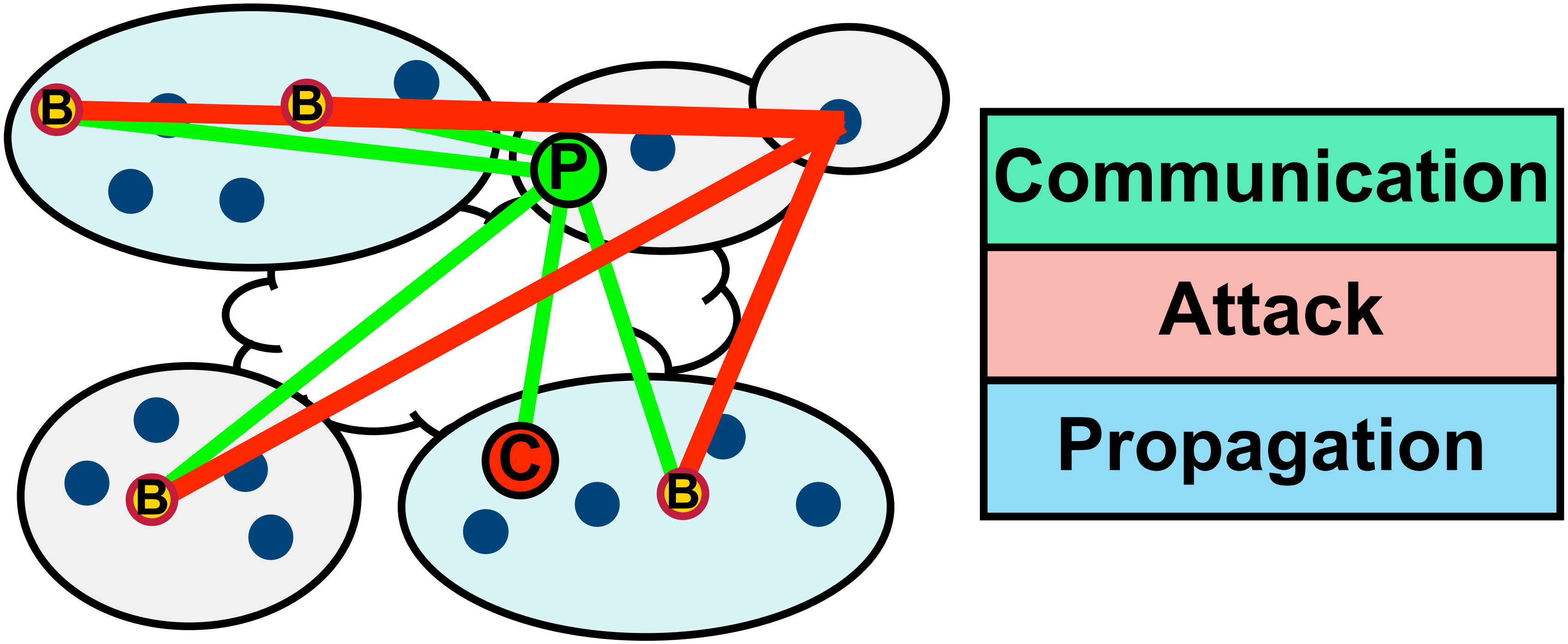
Topology	**Design Complexity**	**Detectablity**	**Message Latency**	**Survivability**
Centralized	*Low*	*Medium*	*Low*	*Low*
Peer-to-Peer	*Medium*	*Low*	*Medium*	*Medium*
Random	*Low*	*High*	*High*	*High*

Taxonomy of Bot Communication Topologies

- Reliance on detecting *Bot Communication* degenerates into **arms race** between bot authors and defenders
- Communication is very flexible
    - Easy to Encrypt/Obfuscate

Advanced Botnet Detection

- Relying on detecting bot communication is *not* viable in the long term
- Leverage *all* available bot characteristics
- Build detectors for each bot behavior



🟩 Communication

🟥 Attack

🟦 Propagation

Behavioral Bot Detection

- Preliminary evidence very promising:
- Strong correlation between bot ***communication*** and bot ***propagation***

Correlating data sources from a large live network (payloads & IMS dark IP sensors):

Bot Command Detected	Δ IMS Detection Time	Scan Type
ipscan r.r.r.r dcom2	*11 secs*	*Global Random*
ipscan s.s.s.s dcom2	*0 secs*	*Global Seq.*
ipscan 24.s.s.s dcom2	-	*Local 24/8 Seq.*
ipscan 69.27.s.s dcom2	-	*Local 69.27/16 Seq.*
ipscan s.s.s lsass	*0 secs*	*Local /8 Seq.*
ipscan s.s webdav3	*0 secs*	*Local /16 Seq.*

Conclusions

- Bots provide support infrastructure for a large range of devastating Internet attacks
- IRC-based botnet detection may be effective tool today
- Tomorrow must focus on holistic view of bot behavior
- Interesting questions:
  - How do we measure bots?
  - Who is responsible for cleanup? (Organizations/ISPs/Law Enforcement)
  - Global enforcement => bots in US attack China?

Questions

- Questions?

Many thanks to Michael Bailey, Jose Nazario, Chris Morrow, Tim Battles, Nicolas Fischbach, and Rob Thomas for helpful comments and feedback.

http://ims.eecs.umich.edu ims@umich.edu

Botnet Disruption

- Once you detect a bot how to shut it down?
- Two goals

  1. Take down the bot
  2. Take down the botnet

- Problem is similar to infiltrating a gang: monitoring the bot => provide info on botnet (i.e. a “narc”)
- Problem is complicated because many botnets span many countries