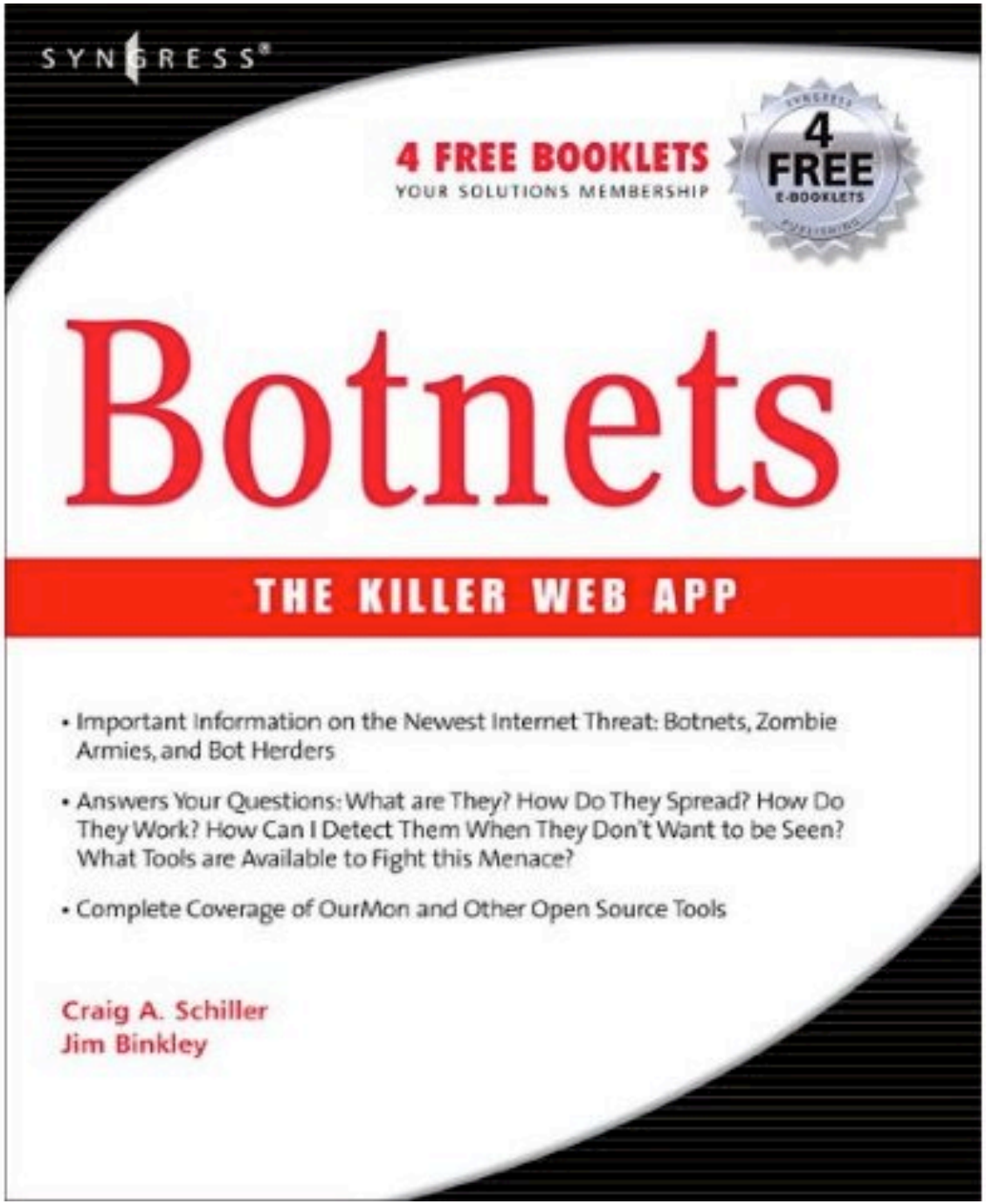
botnets

Jim Binkley
PSU CS

outline

- intro – the problem
- how a botnet works
- tools and techniques for combat
- ourmon
- summary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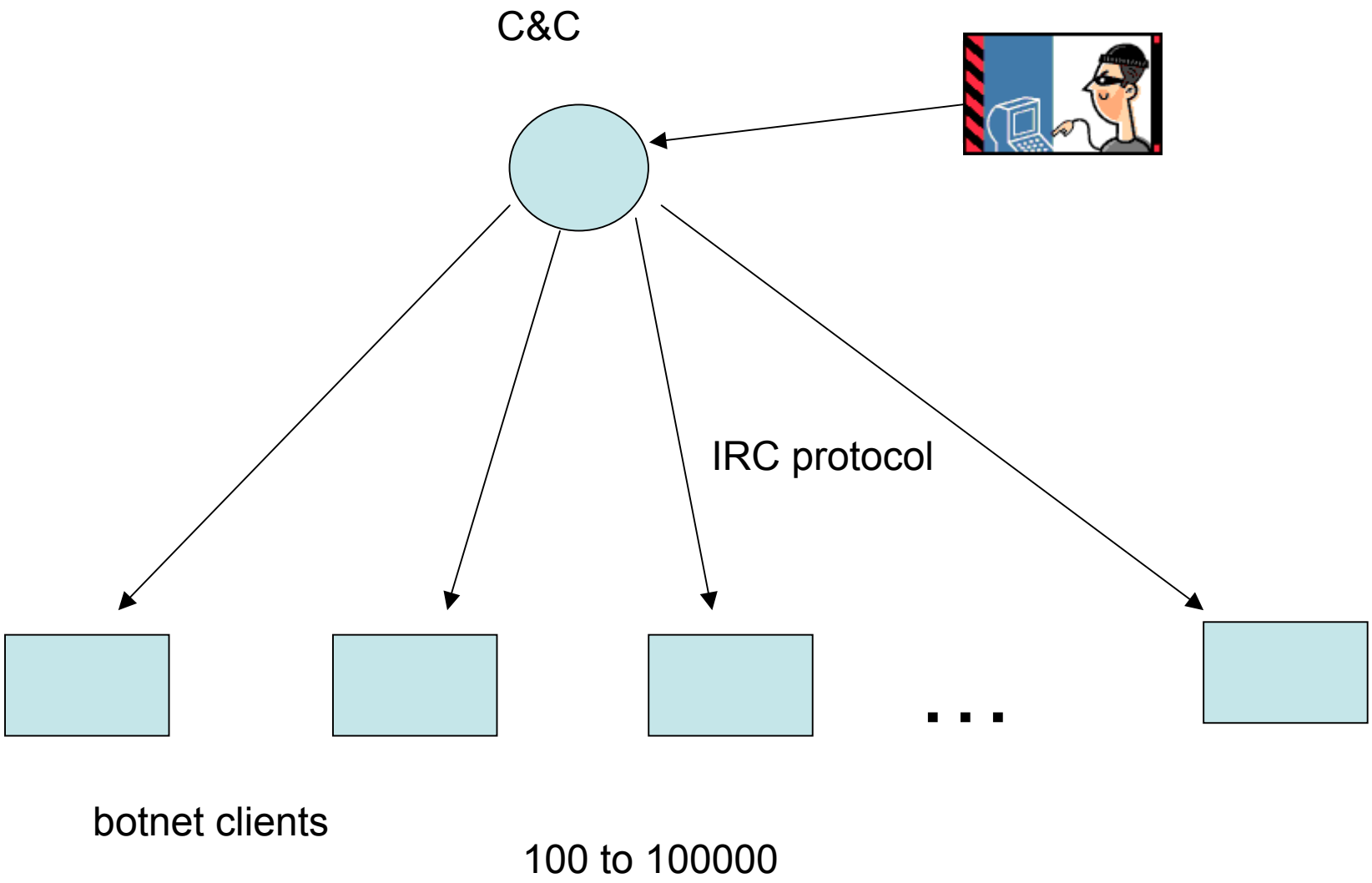
Botnets
THE KILLER WEB APP
• Important Information on the Newest Internet Threat: Botnets, Zombie Armies, and Bot Herders
• Answers Your Questions: What are They? How Do They Spread? How Do They Work? How Can I Detect Them When They Don't Want to be Seen? What Tools are Available to Fight this Menace?
• Complete Coverage of OurMon and Other Open Source Tools
Craig A. Schiller
Jim Binkley

intro

- botnet definition
  - a distributed network of exploited clients
    - aka zombies
  - traditionally run from 1-N IRC servers
    - aka C&C or C-squared
    - DNS involved in interesting ways (fastflux)
  - run by individual known as botherder
  - may speak of botnet client or botnet server mesh


C&C
IRC protocol
botnet clients
100 to 100000

what's it for?

- to make money e.g.,
- botnet clients send SPAM
  - drugs meaning pharmaceuticals
  - and other stuff
- botnet clients steal IDENTITY
  - phishing attacks
  - pharming attacks
  - key logging attacks
- extortion
  - we encrypted your files – want them back?
  - pay up or we DOS you

how is this different from before?

- evolution in hackery is true BUT
- hackery used to be immature male problem
- now it's immature males working as a criminal enterprise
  - or working for a criminal enterprise
- often more international than before
  - which makes law enforcement very difficult

previous attacks

- not as well coordinated
- disruption was the motive – not profit
- Internet used more now for business
  - THEREFORE more business-related crime
- certain sacrosanct Internet protocols
  - infrastructure like DNS
  - DNS is now under attack – misuse is more and more common

one recent paradigm called “clicks for hire”

- google and others may pay money if advertising on web sites is “visited”
- therefore a botnet of 100000 computers may auto click on websites
- therefore a particular well connected host may become a server
  - with porn, viagra, loan web links on it
- google on: phpbb site:yoursite.com

how does it work

- how does a computer get infected?
  - you don't run windows update
  - you practice poor password hygiene
  - you download something off of the Internet
    - via email
    - via the web
    - via a side effect of using the Web (IE)
    - Microsoft may not keep up the patches to the level necessary (see the 1st item above)

what happens to your computer

- you are now running a very complex app
  - agobot
  - sdbot
  - rbot
  - mytob
  - conficker, stormworm, zbot
- this may include a rootkit
- a backdoor (call it telnet but it might be ftp, tftp, dameware, etc)
- the new software tries to kill off AV software
- AV software may not be able to eradicate it

the new zombie

- “rallies” to the C&C
- contacts it via IRC
  - and/or an http GET
  - and/or possible newish P2P like protocols
- note that a zombie is just software
- you (the zombie) may be instructed to participate in a fan-out attack

typical bots

- contain some set of exploits
  - e.g., aimed at Microsoft file share exploits
  - SYN attacks at ports 445, 139 common
  - may be ordered to scan with TCP syns
- may make password attacks on local computers (user/password guesses)
- may take part in a DDOS attack
  - against microsoft
  - against an air force installation
  - against the White House
  - against Ma and Pa smallbiz.biz for extortion

what do the white hats do?

- they try to stomp out the C&C for the most part
- and if possible fix the infected ZOMBIE but
- many many zombies are to be found in broadband land
  - this is a serious problem

clear direction in black-hat land

- make c&c mechanism more better in terms of redundancy
- oddly paralleling making DNS itself more redundant (at least for roots)

what do the blackhats do to protect the C&C

- clients are programmed with DNS name/s not IP addresses for C&C
- multi-homed DNS
  - lsass.exploited.org is actually 3 IPs 1,2,3
- short DNS TTLs for clients
  - remap DNS often, check at boot
- dynamic DNS used thru commercial site
  - so change IP address

IRC – the protocol

- user logins to channel (chatroom name)
  - with optional password at a server on a port (TCP port 6667 but any port can work)
- server makes sure channel messages forwarded to all clients interested in channel
- IRC basic messages
  - join/nick/ping/pong/privmsg

IRC bot

- originally simply something automated that uses IRC
  - file xfer (so-called warez transfer)
  - might be benign like setup a scheduler “irc as meeting-maker”)
  - might be a game
  - might try to fool user into a “real” conversation with a computer robot (turing test)
  - might be agobot (not benign)

agobot and other bots overload

- IRC privmsg to simply include commands like
  - ddos this ip
  - scan these ip nets at this port with attack N
  - talk back if a scan succeeds
  - send spam
  - take new spam template as output
  - … it’s just software …

modern bots may not use IRC

- 1. may use p2p (a la emule/edonkey as does stormworm)
  - stormworm seems to use email (greeting card)
  - send email as spambot
- 2. may use http GET or POST for client to talk to server infrastructure
  - port 80 traffic may be “harder to spot”

zbot/zeus/wsnpoem

- POST http://iamhacked.com/up/s.php
- http periodic update from client to server
- See for more info: https://zeustracker.abuse.ch/monitor.php
- http://www.trustdefender.com/blog/2009/01/20/banking-malware-at-its-best-a-detailed-look-at-a-new-zeuswsnpoem-zbot-variant/

fast-flux DNS

- 1. given a bot server DNS name hardwired in the bot client,
  - the advisory makes the IP addresses change
  - to protect against one IP address being lost
  - mybot.info -> 10.0.0.1, 192.168.1.2, etc.
- 2. DNS servers themselves may be compromised and available for hire
  - therefore viagra1.info, viagra2.info may appear in spam as valid DNS addresses for a short period of time (long enough to be verified as real)
- “we control the horizontal and the vertical”

ddos attacks

- tcp syns of course
- udp small packets
- DNS reflection attacks
  - open dns server - ns1.bar.com
    - resolves fooledyou.com for 3rd party
    - amplication attack if small query causes large response
    - sent to innocent 3rd party due to faked ip
    - modern version of “smurf”
    - fair number of DNS servers are open resolvers

tools and techniques

- are they distributed, network-wide, or per-host
- network tools and techniques
- per host tools and techniques
- intrusion detection
- anomaly detection
- “signature” detection
- preventative measures

some examples

- network-based
  - graphics to watch for anomalies
  - cricket and ourmon
  - signature-based IDS to watch for known attacks (like snort)
  - firewalls can keep them out
- honeypots and darknets
  - darknets can see scanning
  - honeypots can capture a bot and take it apart to see how it ticks (see nepenthes.mwcollect.org)

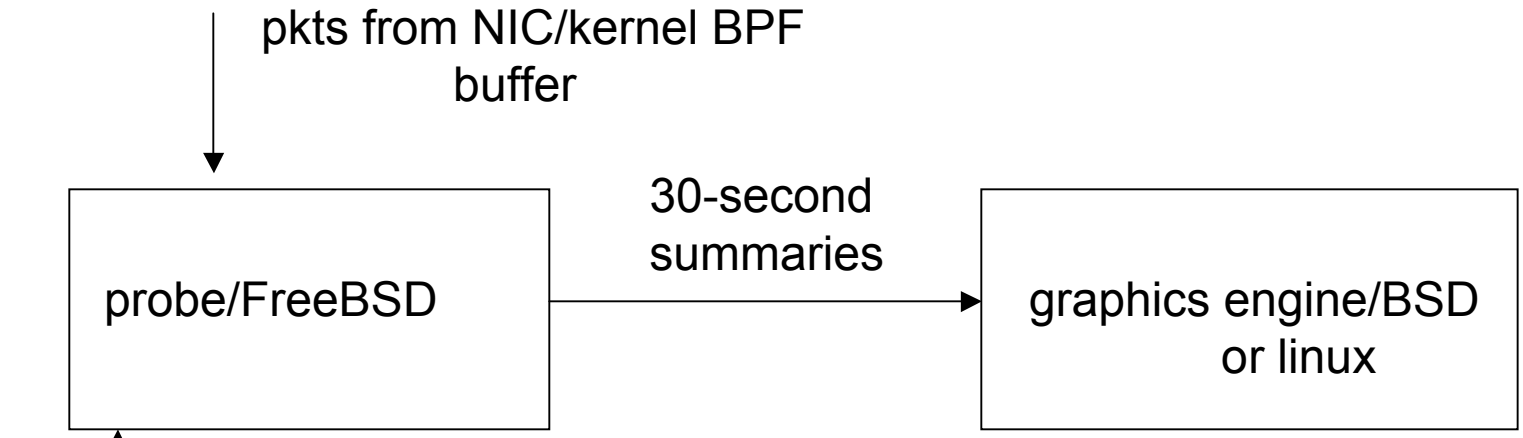
ourmon outline

- background
- experimental flow tuples
- botnet server mesh detection
- botnet client mesh detection
- conclusions

PSU's network

- 26k students/faculty/staff
- 100s Ethernet switches, 10k lit ethernet ports
- wide-spread wireless "pubnet", 802.11b/g
- typical daily traffic
  - 60k pps at peak periods
  - 200-300 mbits total, more to Internet, than from Inet
  - see next bullet item
- **we have dorms** (resnet) – easily infected – not centrally managed
  - massive p2p bittorrent/gnutella traffic

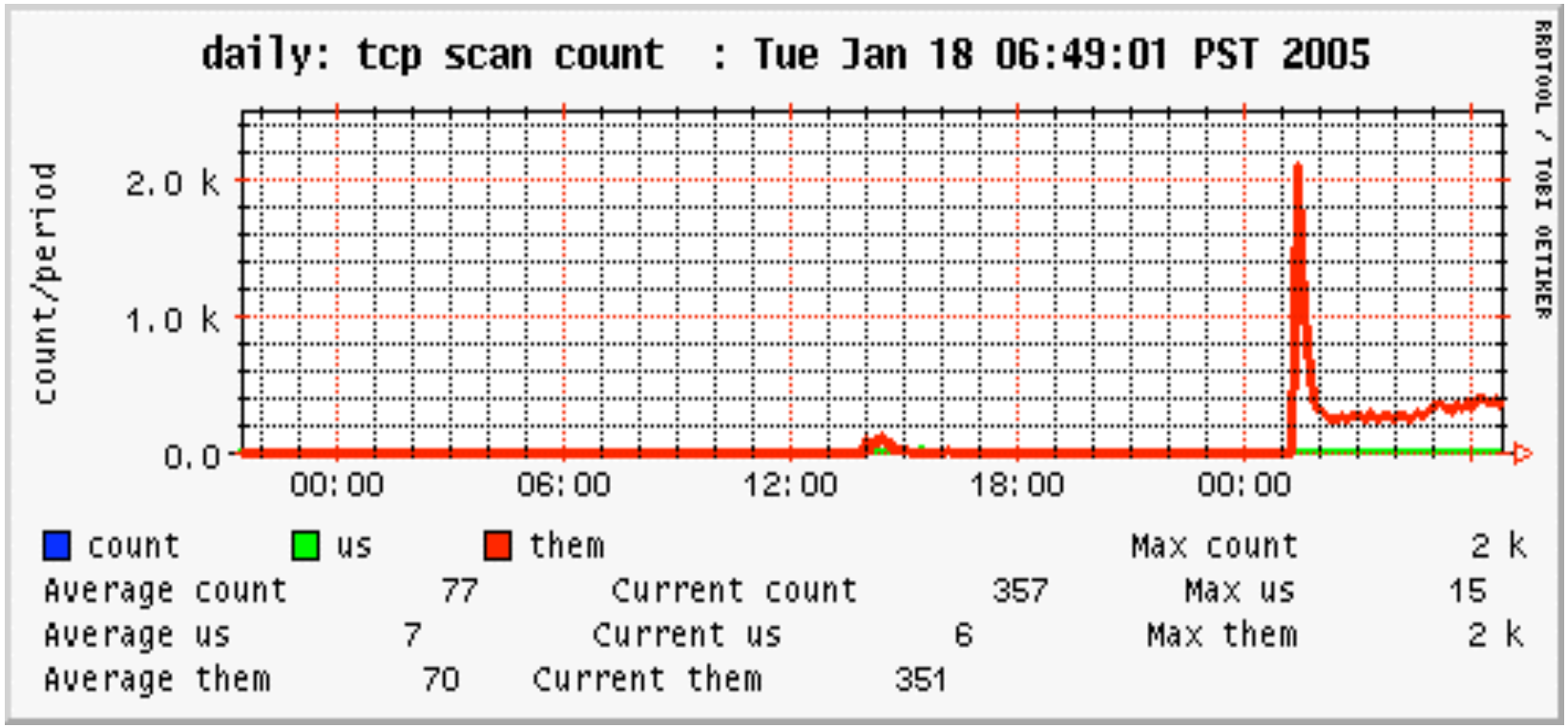
ourmon architectural breakdown



runtime:
1. N BPF expressions
2. + topn (hash table) of flows and other things (**tuples or lists**)
3. some hardwired C filters (scalars of interest)
4. PCRE tags for large-scale traffic analysis

outputs:
1. **RRDTOOL strip charts**
2. histogram graphs
3. **various ASCII reports, hourly summaries** or report period

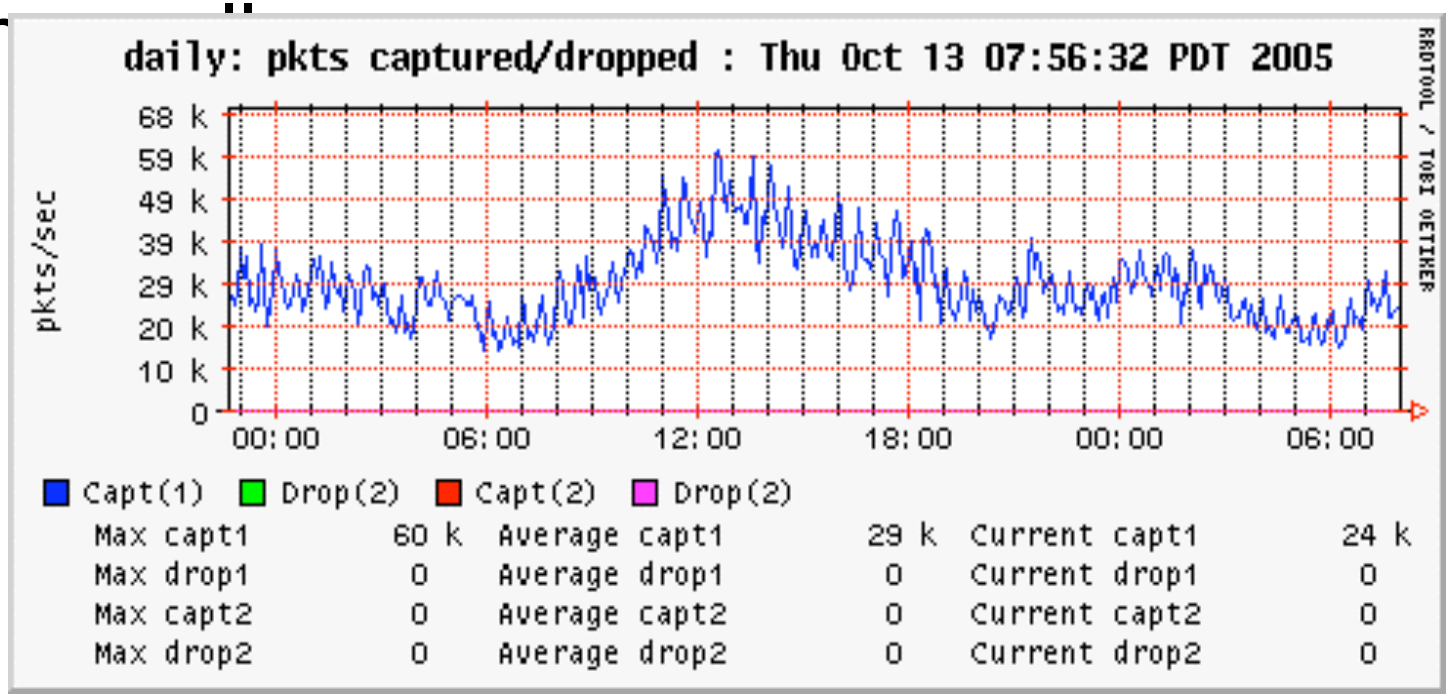
scan count graph (worm count) in Jan. 2005



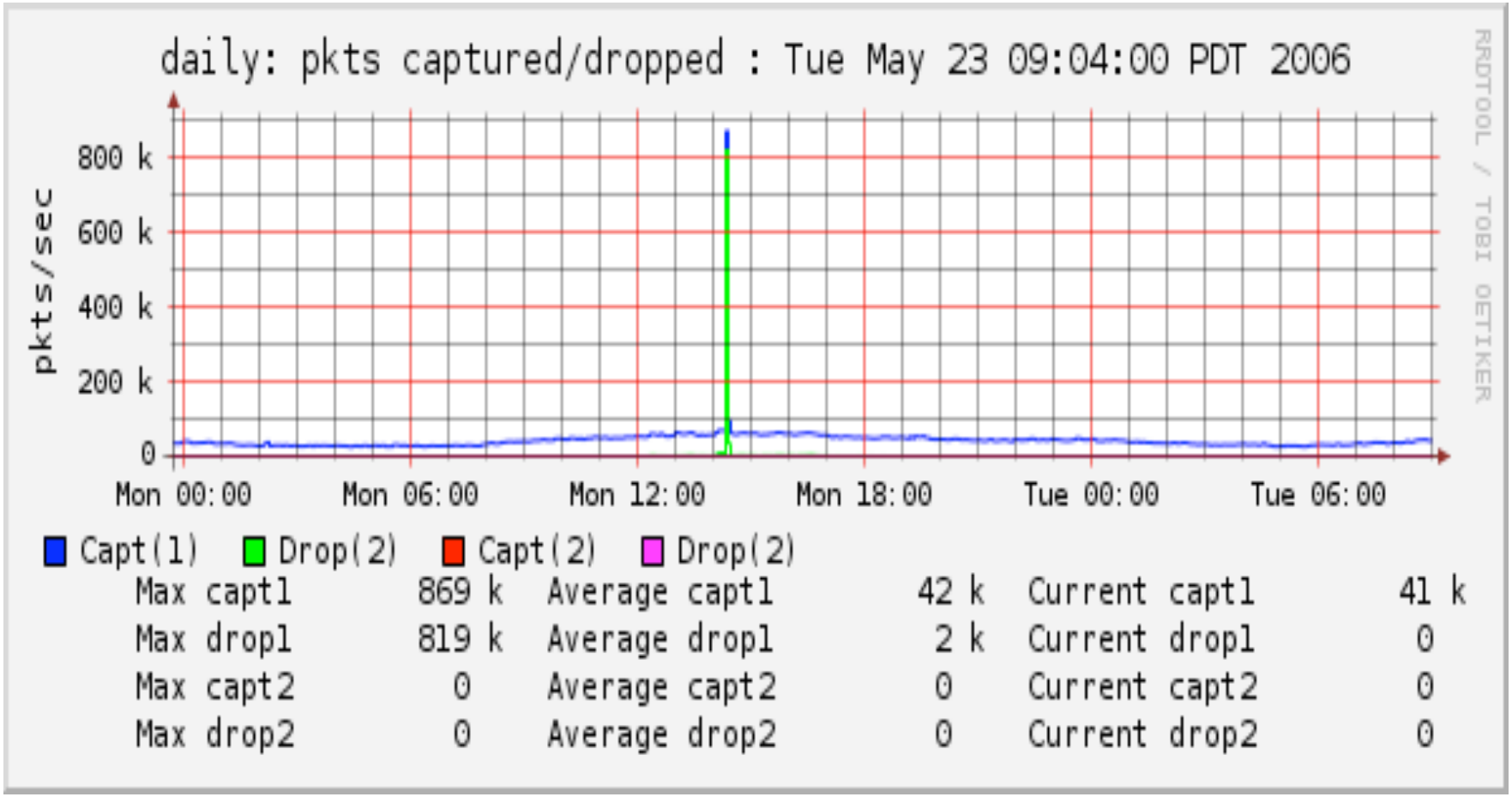
2k external host attack (DDOS) on infected host running IRC

recent large ddos attack

- fundamental pkts graph looks like this r



ouch ouch ouch



that's 869k pps – we have physical gE connection to Inet …

botnet situation

- over the last few years emerging picture
  - large percentage of our infections botnet related
- collateral damage common:
  - Jan 06/wireless subnet knocked off air due to DDOS attack
  - large and vicious DDOS attacks have occurred in OUS systems (previous pic)
- large amounts of TCP-based scanning aimed at ports 139/445
- decided to create IRC mesh detection module in ourmon to look for IRC-related malware
- goal: basic IRC statistics plus coupling of IRC to scanning module elsewhere in ourmon

infrastructure – 3 tuples in ourmon (irc new, tcp syn old)

- every thirty seconds extract 3 experimental flow tuples:
- **irc channel tuple:**
- **irc host tuple:**
- **tcp syn tuple**
  - coupled with scan detection attribute called
  - **tcp work weight**
- **IRC: we look at layer 7 IRC data, and use a snap size of 256 bytes.**

irc tuples and stats

- we extract these 4 IRC messages:
  - JOIN, PRIVMSG channel-name
  - PING, PONG for client/server connectivity
- we want: IP addresses in channel names
- also client/server information taken from directionality of IRC messages
- per host and channel stats counters
- also per network stats counters, total message kinds of all 4 kinds – graphed with RRDTOOL

irc measures

- irc channel tuples:
  channel name, message counts, list of IPs

- irc node tuples:
  ip address, message counts, weak tcp ww, client/server flag

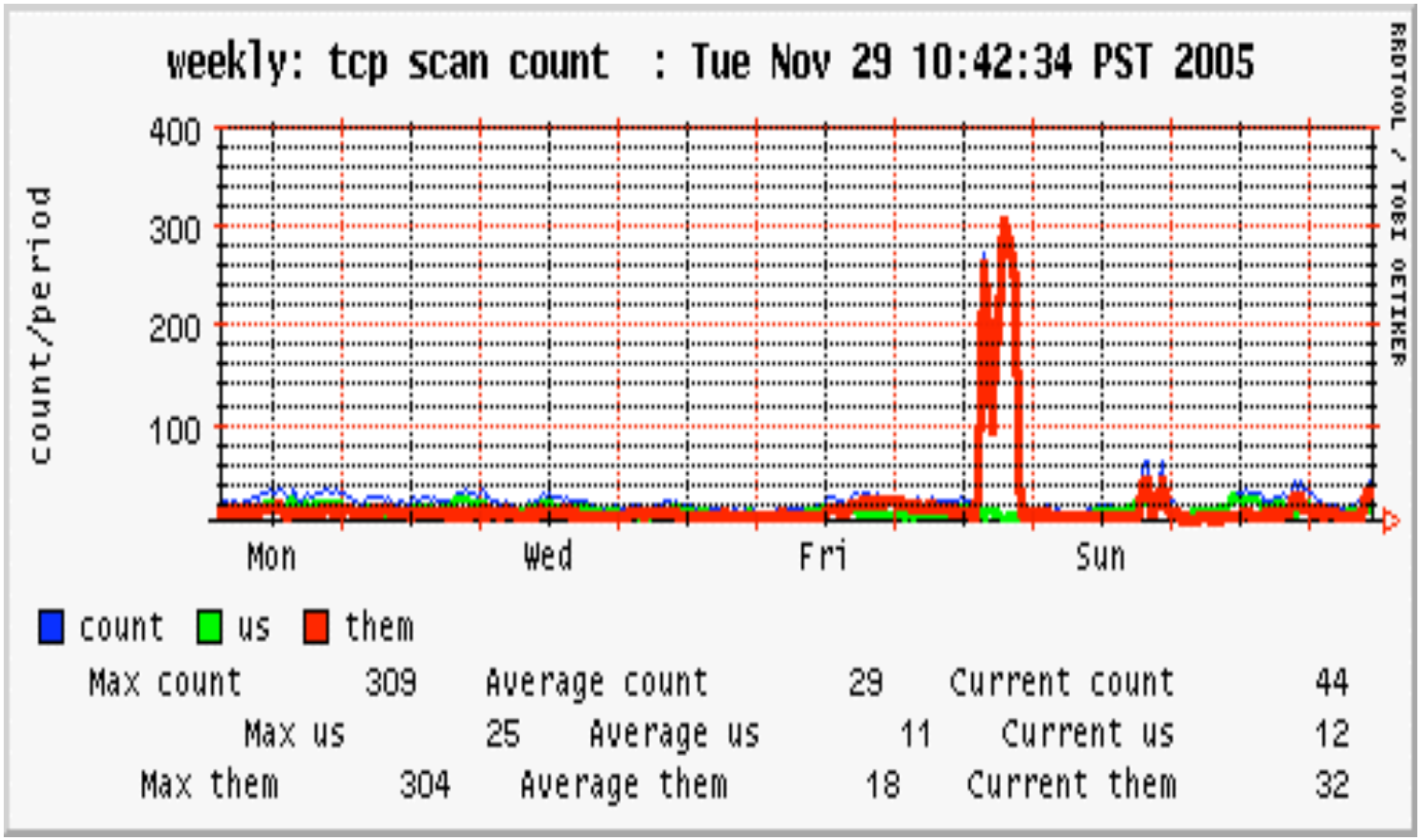
- TCP work weight: (comes from syn tuple)
  per IP ww = (Syns sent + Fins sent + Resets returned)/total pkts

  view this as a **rude efficiency measurement**:
  100% means you are sending control packets.

TCP ww

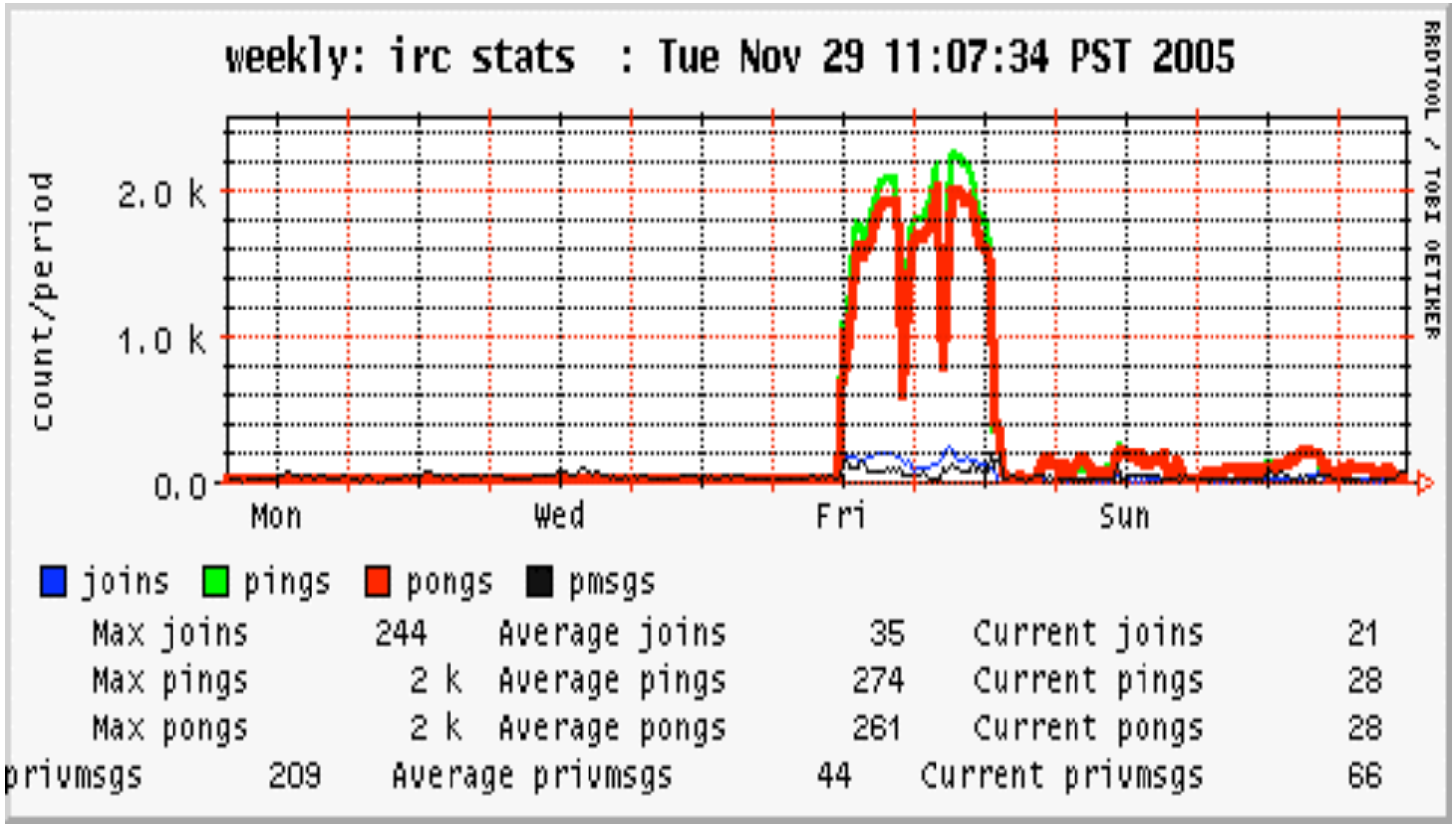
- we have years of experience with it
- < 50% is normal over some number of minutes
- not only attribute used for scan detection:
  - strength: typically use 1 syn/second at least
  - 2-wayness of data: typically look at this as additional attribute in 30-second scan determination
  - counts of L3 and L4 unique destinations
- strength and 2-wayness not used here:
  - IRC version of TCP work weight is weaker
- ww often affected by P2P lack of connectivity – especially with gnutella

high abnormal scanner count – ironically was the real alert



some kinda distributed tcp syn scan right?, wait … let's look at the IRC data

bot server detection: uh-oh, irc RRD has ping/pong way UP!



hourly irc summary stats like so:

- channel msgs ips scanners evil
- f 157k 36k 1700 you tell me
- x 81k 13k 712
- normalirc 5k 20 0

- about 50k remote hosts with one campus botserver in several IRC channels
- a botclient “just changed” into a botserver Friday about 10 am, and acquired many friends fast

botserver conclusions

- from pure IRC POV:
- 1. ping/pong counts
  - entire IRC nets at PSU 40/period, not 2k/period
- 2. number of IPs in channel
  - biggest IRC channel 20 per day, not 10-50k
- 3. total IRC server messages
  - pings/pongs/privmsgs elevate the server
- interesting: total number of high TCP wws
  - external hosts that cannot connect to on-campus bot server (running on windows system)

TCP syn point of view - stats

- 1. L3D/L4D: interesting but statistically weak result
- on the 2 days of the bot server
  - bot server IP had highest count of average L3 destinations per sample period for any campus host
  - 1100 versus next highest which was a web server
  - web server and/or p2p clients typically < 1000
  - all you really say: will score high for that attribute

L4 POV – more stats

- 2. Syn count per period
  - highest on day 1, less so (still bad) on day 2
  - but it was scanning on day 1 as a normal bot client
- 3. pkt count for sent/recv. pkts HIGHEST on day 2
  - RECV pkts/SENT pkts 10/1

botnet client detection

- typical IRC data gives us small meshes on campus of
  - max: 20, min: 2 IRC channels
  - ports used may be 6667, but may vary
  - some automated bots exist (devoted to traditional IRC phenomenon like audio/video dissemination)
  - we have dorms …
- what seems to happen though is that the botnet client meshes SCAN with greater than one host during the day
- we therefore need an hourly/daily summarization

ubuntu channel - benign

ip	tmsg	ping	pong	privmsg	ww	server
net1.1	11598	1912	1910	6494	43	H
net1.2	7265	619	622	5086	0	H
net1.3	17218	4123	4100	7069	37	H
net2.1	28152	3913	3904	17113	0	S

F7 - an evil client mesh

ip	tmsg	ping	pong	privmsg	ww	server
net1.1	1205	377	376	428	42	H
net1.2	113	39	43	25	**96**	H
net1.3	144	60	61	21	**94**	H
net1.4	46	12	14	17	**90**	H
net1.5	701	343	345	11	**90**	H
net2.1	1300	587	593	101	16	S

evil channel sort – rank channels based on simple metric

- f7 ahead of ubuntu –
  - given 4/6 scanners compared to none
- max work weight during day kept is important idea
  - out of set of N, how many were scanners at any time?
- key idea: > 1 scanner in channel
  - plus of course other attributes in logs help
  - including ports
  - length and intensity of scanning

more information

- see http://www.cs.pdx.edu/~jrb
- **"Locality, Network Control, and Anomaly Detection,"** James R. Binkley, Portland State University, John McHugh, Carnegie Mellon University, and Carrie Gates, Dalhousie University, PSU Technical Report 04-04. January 2005. ps
- **"Ourmon and Network Monitoring Performance,"** James R. Binkley and Bart Massey, Computer Science, PSU, Proceedings of USENIX '05: FREENIX Track, April 2005. ps
- **"An Algorithm for Anomaly-based Botnet Detection,"** James R. Binkley and Suresh Singh, Computer Science, PSU, USENIX SRUTI: '06 2nd Workshop on Steps to Reducing Unwanted Traffic on the Internet", July 7 2006. pdf
- **"Anomaly-based Botnet Server Detection,"** James R. Binkley, Computer Science, PSU, FLOCON CERT/SEI, Vancouver WA, October 2006. pdf
- http://ourmon.sourceforge.net

summary

- botnets == scourge
- basic measures apply
  - if you run windows
  - run usoft update
  - run their firewall or get a better one (Zone Alarm is good)
  - run AV software (AVG is free)
  - sane password policy in an enterprise or at home

more information on the Internet

- www.shadowserver.org
- www.dshield.org
- if university affiliation
  - www.ren-isac.net