



# Anomaly-based Bot Server (and more!) Detection

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# outline

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



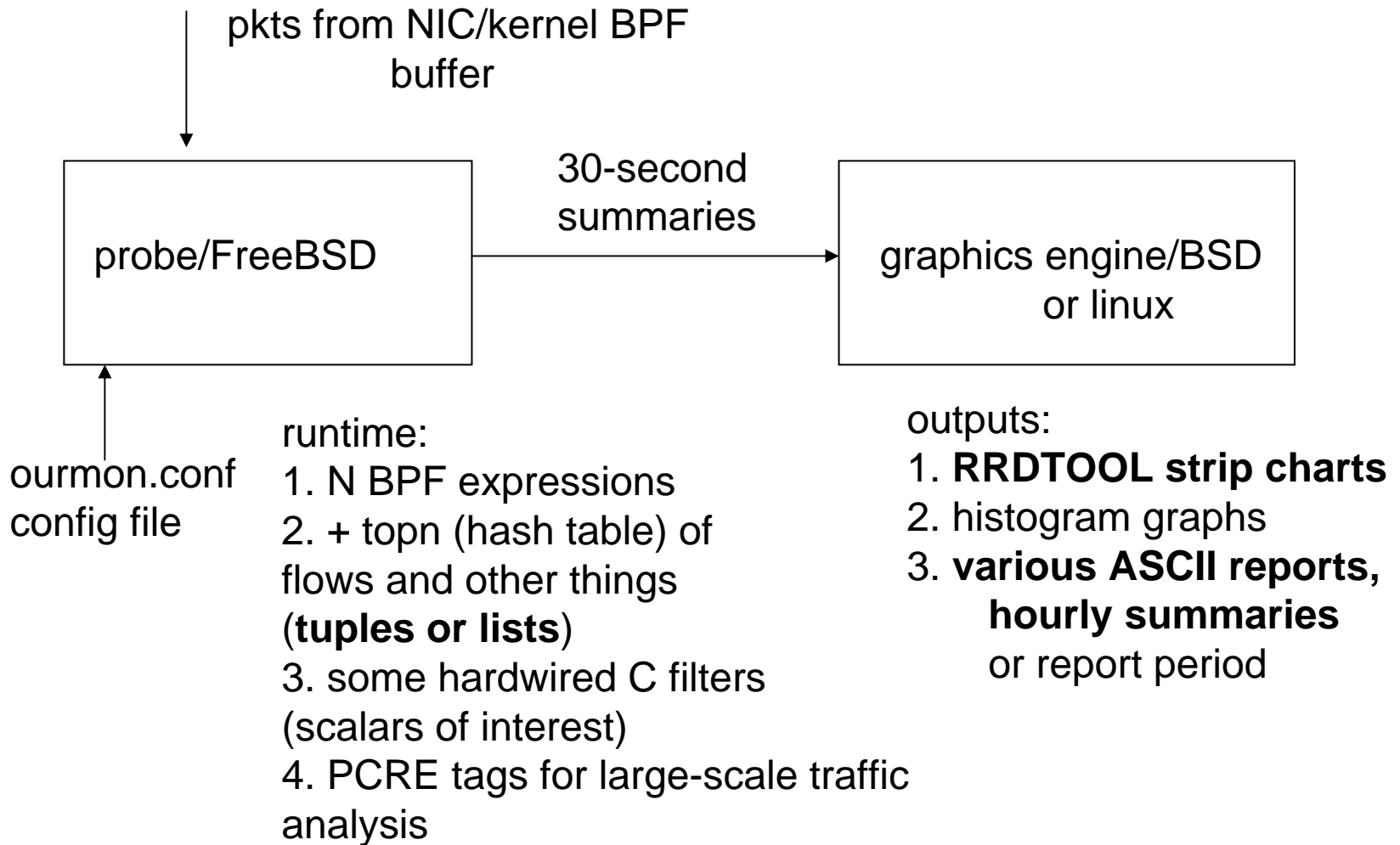
# PSU's network

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- ❑ 26k students/faculty/staff
- ❑ 350 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) – resnet is typically infected
  - massive p2p bittorrent/gnutella traffic

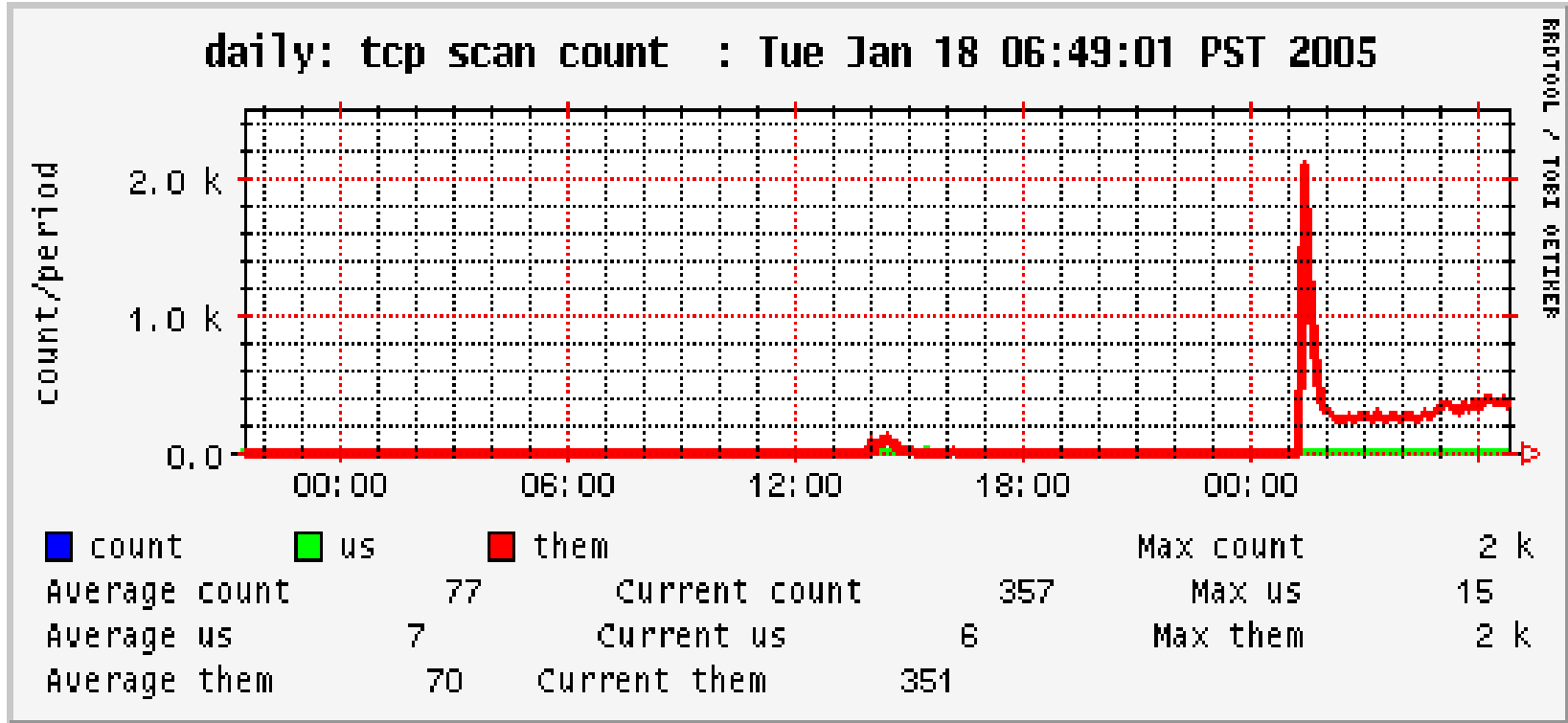


# ourmon architectural breakdown





# scan count graph (worm count) in Jan. 2005

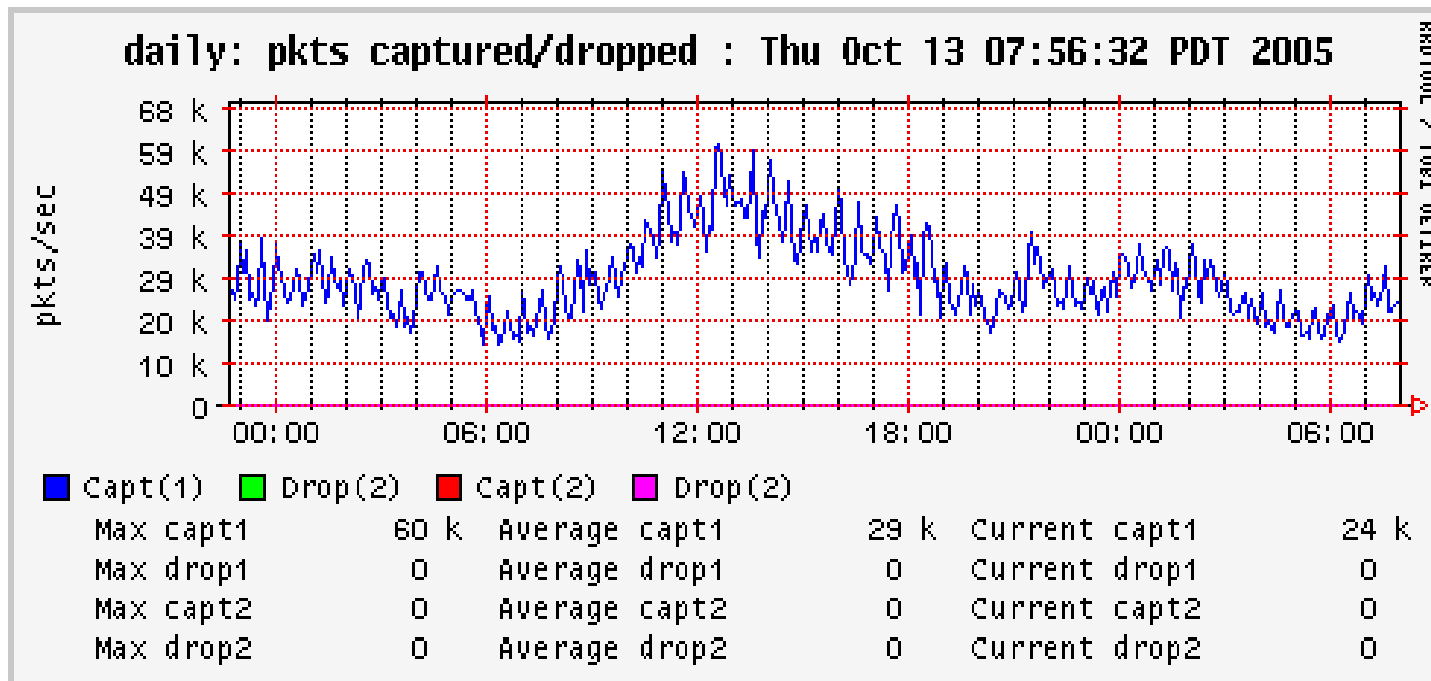


2k external host attack (DDOS) on infected host running IRC



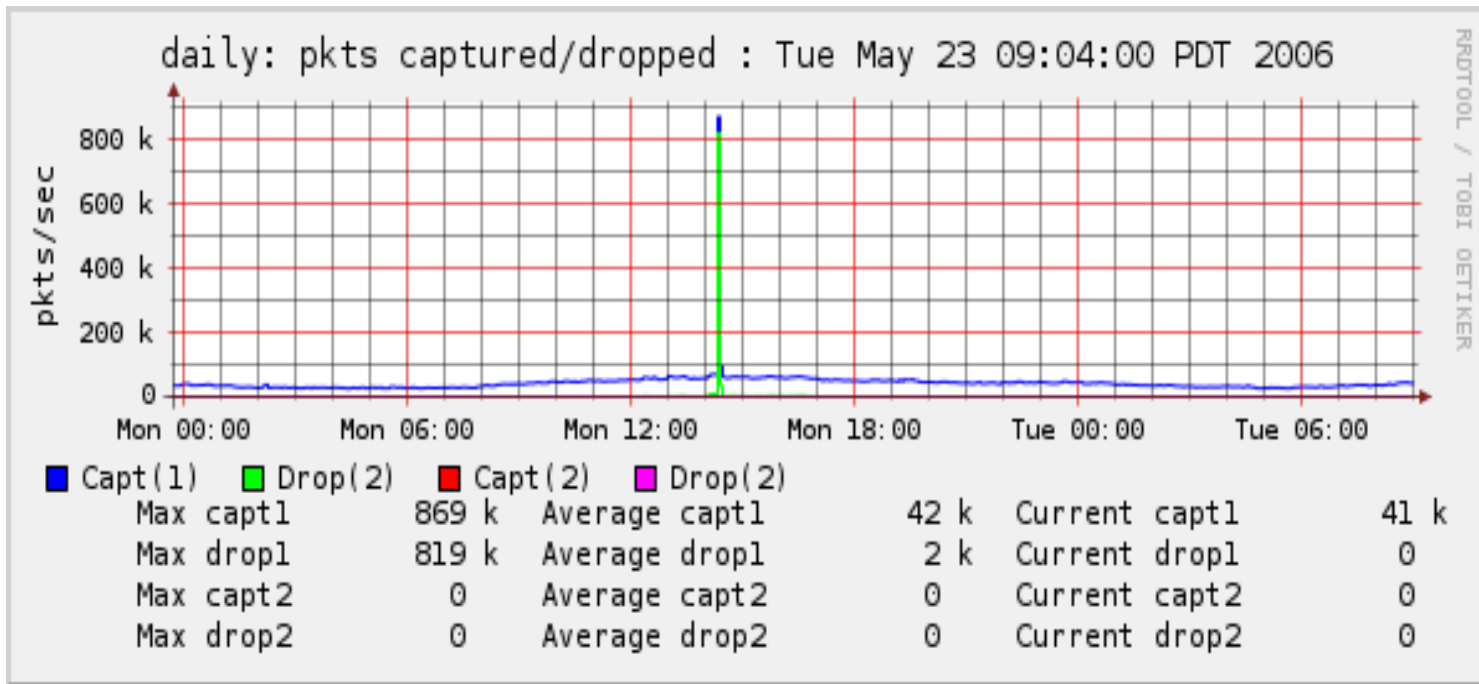
# recent large ddos attack

- fundamental pkts graph looks like this normally:





# ouch ouch ouch



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



# botnet situation

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- ❑ over the last 2 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)

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- ❑ 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

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- 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

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- ❑ 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 =  $(\text{Syns sent} + \text{Fins sent} + \text{Resets returned}) / \text{total pkts}$

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

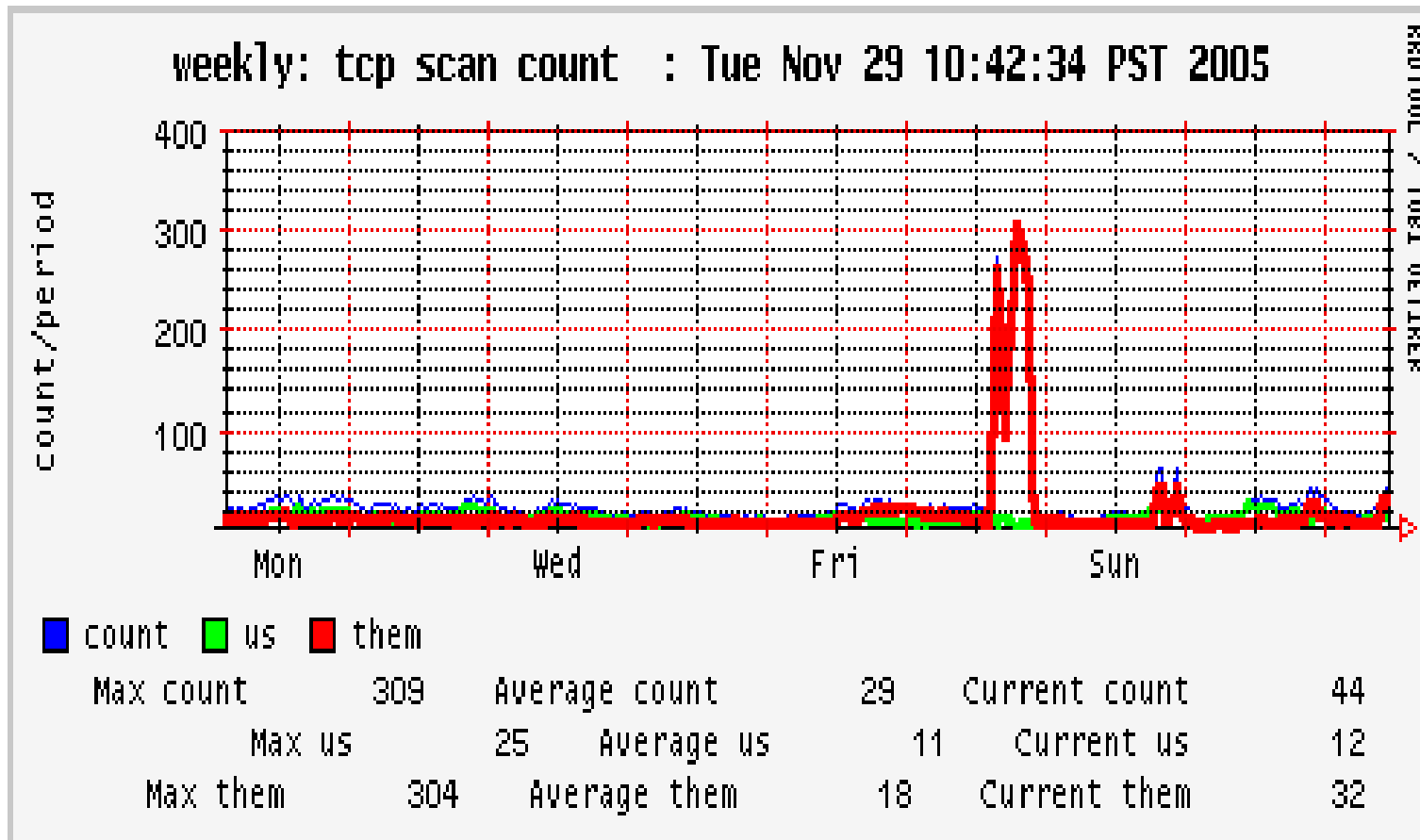


# TCP ww

- ❑ we have 2 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



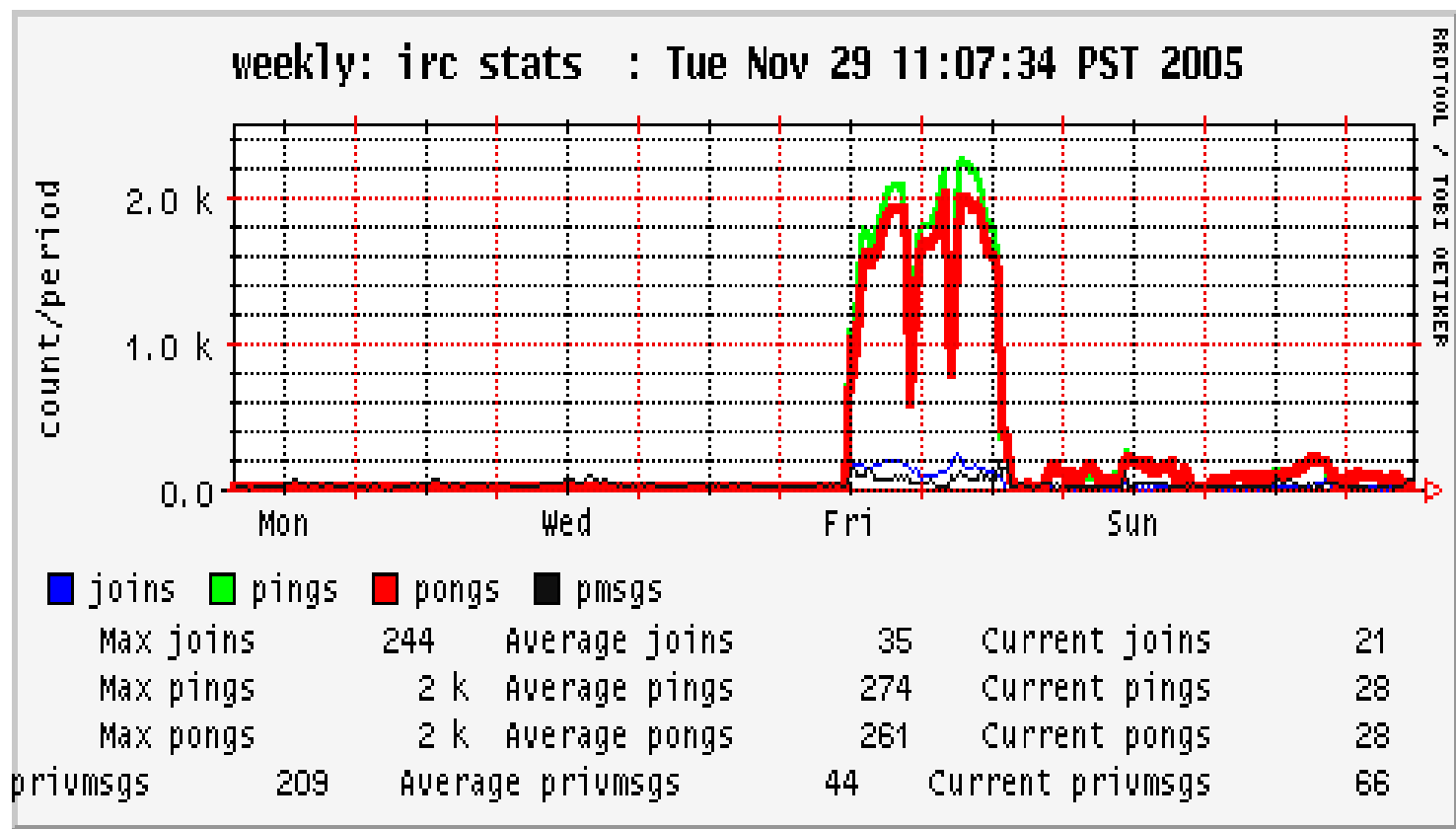
# high abnormal scanner count – ironically was the real alert



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:

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- | 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

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- ❑ 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

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- ❑ 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
- ❑ 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

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- ❑ 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	<b>96</b>	H
net1.3	144	60	61	21	<b>94</b>	H
net1.4	46	12	14	17	<b>90</b>	H
net1.5	701	343	345	11	<b>90</b>	H
net2.1	1300	587	593	101	16	S



# evil channel sort – rank channels based on simple metric

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- ❑ 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



# conclusions/future work

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- p2p vs malware scanners distinction is a problem
  - we have an algorithm for p2p id based on pure attributes
  - it's not perfect but it's not bad
  - we use signatures too (but they aren't perfect)
- given a set of attackers N (scanbots/spambots)
  - **and not using IRC as a mesh organizing principle**  
**how can we determine the mesh?**
  - DNS?
  - p2p meshes are a problem here too
    - except when they are the target



## 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>