Intrusion Log Sharing

University of Wisconsin-Madison

John Bethencourt (bethenco@cs.wisc.edu)
Jason Franklin (jfrankli@cs.wisc.edu)
Mary Vernon (vernon@cs.wisc.edu)

Talk Outline

- Background: Blacklists, DOMINO System
- Open Questions
- DShield logs
- Preliminary Analysis Results
- Ongoing Work

Background: Blacklists

Goal: deny access to hosts considered “bad” relative to the site’s policies

e.g., a host that performs a port scan

Given: a set of firewall and NIDS logs

generate: a blacklist of hosts to block

Blacklist failure: when a connection is not blocked and the source host is later on the blacklist

Background: DOMINO System

- architecture: 20+ “axis nodes” in an overlay network
- each axis node:
  - maintains a NIDS & an active sink
  - obtains NIDS logs from “satellite nodes”
  - exchanges hourly, daily, and monthly blacklists with other axis nodes & distributes to satellite nodes
  - provides query engine with capability to trigger a new summary

Background: DOMINO System

- Analysis of 1600 NIDS logs
  - 40-60 logs together give correct ordering of offenders & target ports
    - /24 site logs or /16 site logs
  - 1024 offenders perform 90% of the scans in a given hour
  - the similarity in 2 sites' blacklist orderings is correlated with the IP distance between the sites
  - 2 years required to scan entire subnet to avoid top 60 hourly or daily blacklist

Background: DOMINO System

- each axis node votes for an alert if:
  - 200% increase in hourly number of scans,
  - 100% increase in number of offenders during hour, and
  - number of offenders is > 5

50 access nodes & 20% consensus:

avg. reaction time for SQL Snake is close to 0

Background: DOMINO System

- summary:
  - 20+ axis nodes, each with satellite nodes
  - sharing blacklists increases site's knowledge of global top offenders & global top target ports
  - consensus alerts for increase in scans & offenders decreases average reaction time for worms

  not known: whether sharing logs decreases blacklist failure

Open Questions

1) benefit of obtaining NIDS logs from other sites for blocking future attacks

- What is the maximum increase in the percentage of future attacks that a site can block?

  i.e., with full blacklist from each other site compared with only the site's own blacklist

- What percentage of future attacks can't be identified from the global blacklist?

Open Questions

1) benefit of obtaining logs from a single active sink (compared to NIDS logs) for blocking future attacks
2) If NIDS logs are beneficial, which minimal set of peers provides the maximum benefit?
3) How frequently should log information be exchanged?

Metric: Blacklist Quality

B_i : blacklist at beginning of time period i

I_i : set of hosts that attempt connections during i

- *quality* of the blacklist at time i:

$$q_i = \frac{|B_i \cap I_i \cap B_{i+1}|}{|I_i \cap B_{i+1}|}$$

- % of attackers that can't be identified:

$$1 - q_i$$

Shared Blacklist Max. Benefit

- maximum possible benefit of shared blacklists:

  compare quality of B_i = local blacklist vs B_i = global blacklist

$$q_i = \frac{|B_i \cap I_i \cap B_{i+1}|}{|I_i \cap B_{i+1}|}$$

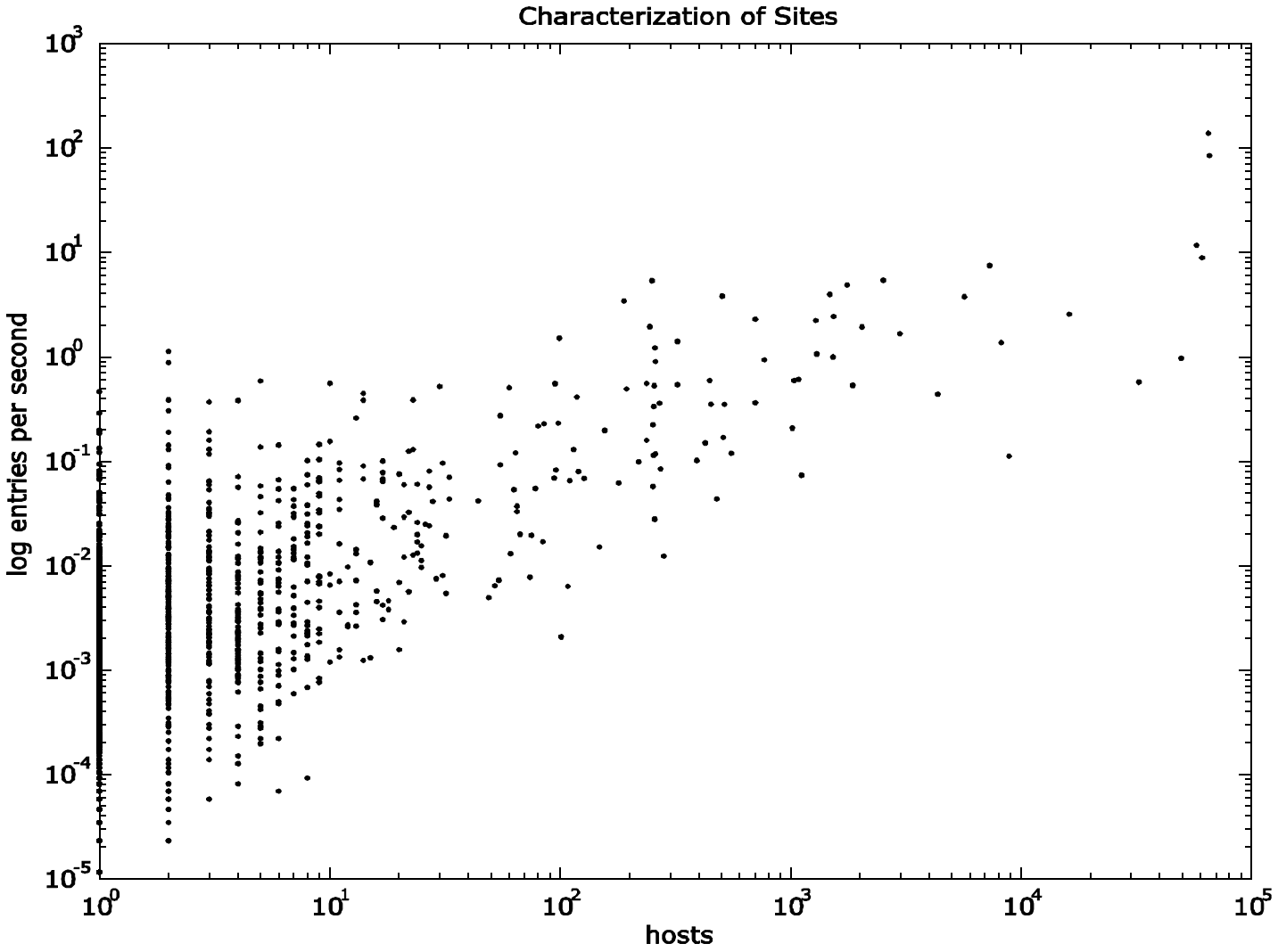
Experimental Data

- DShield project: central repository of NIDS & firewall log data
- collected from 1600 providers across Internet
  - number of hosts: 1 to 65,000
  - number of log entries per second: 10^{-5} to 100
- Initially: 4 consecutive days of data

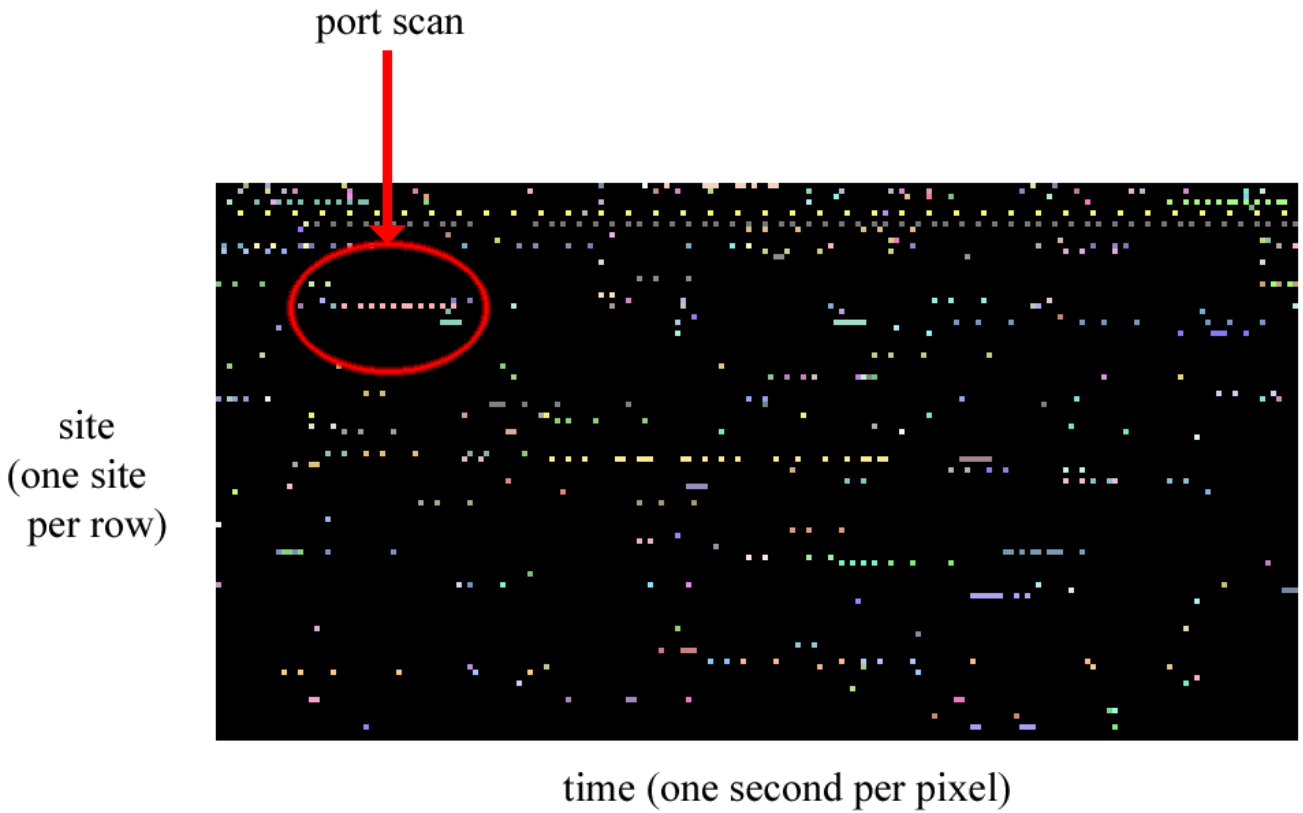
What is DShield?

- ~30 million log entries collected per day
- Log entries are of the form
  - <time, date, submitter, source IP, source port, dest. IP, dest. port>
- Live statistics published at www.dshield.org

DShield Sites: Size & Log Entry Rate



Visualization of Log Data



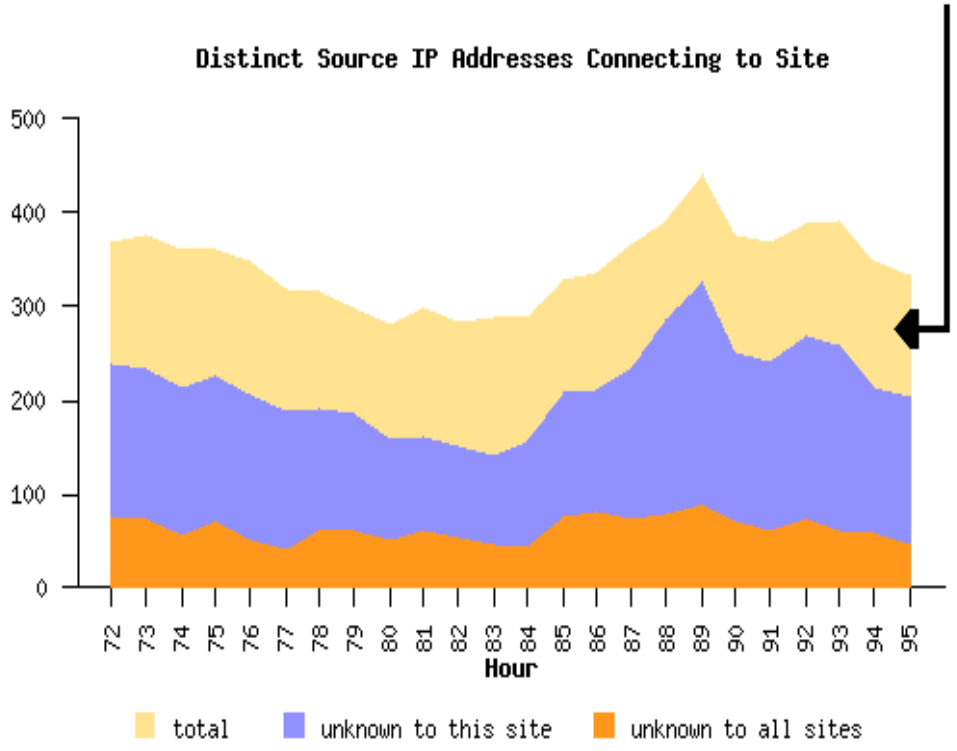
- Each pixel, colored by source IP address, represents a failed connection
- Port scans show up as horizontal sequences of identically colored pixels

Experimental Setup

- Network intrusion logs from 1600 sites obtained from DShield project
  - 4 consecutive days of complete log data
  - Compute for each hour:
    - Number of attack sources not in site's blacklist
    - Number of attack sources not in global blacklist

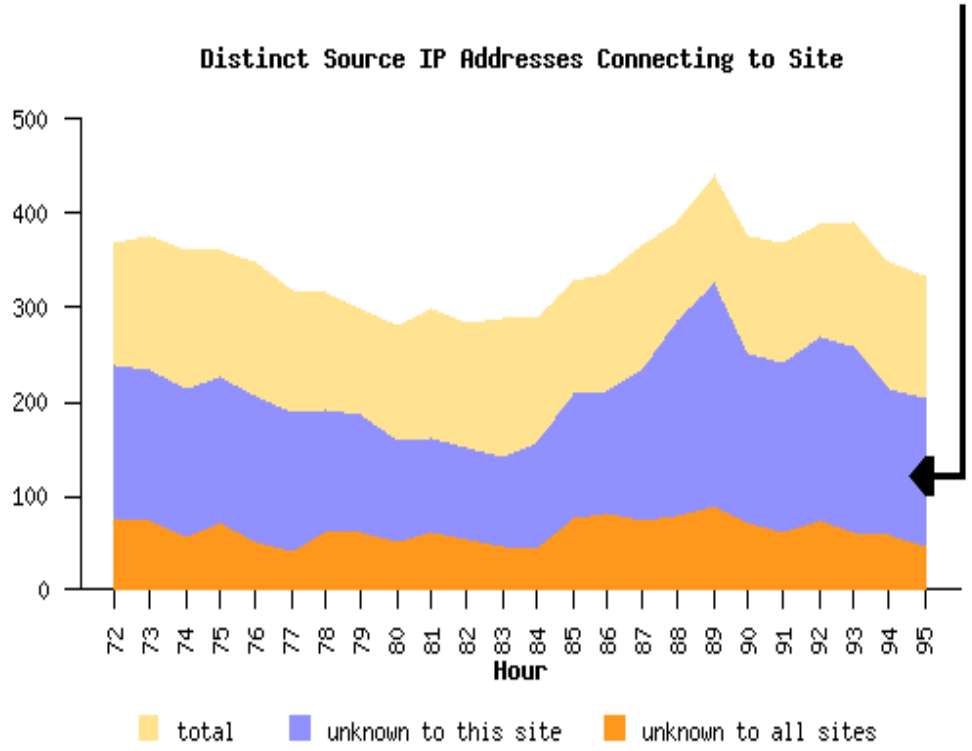
Preliminary Results

- Connections this site can block using only its own experience



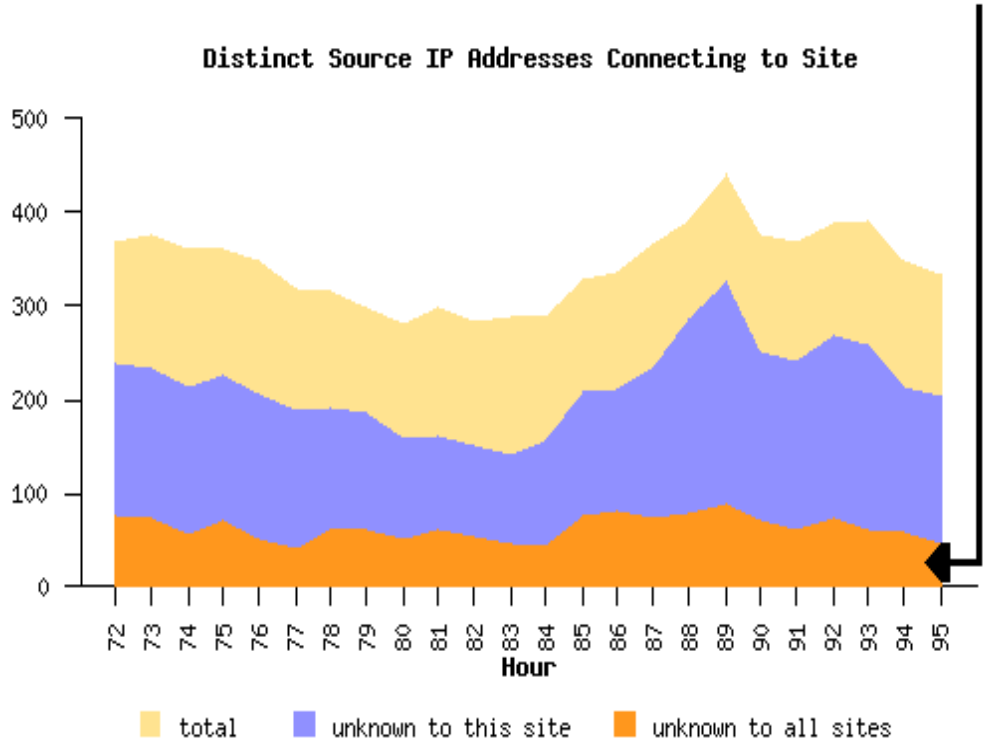
Preliminary Results

- Connections this site can block with the help of other sites



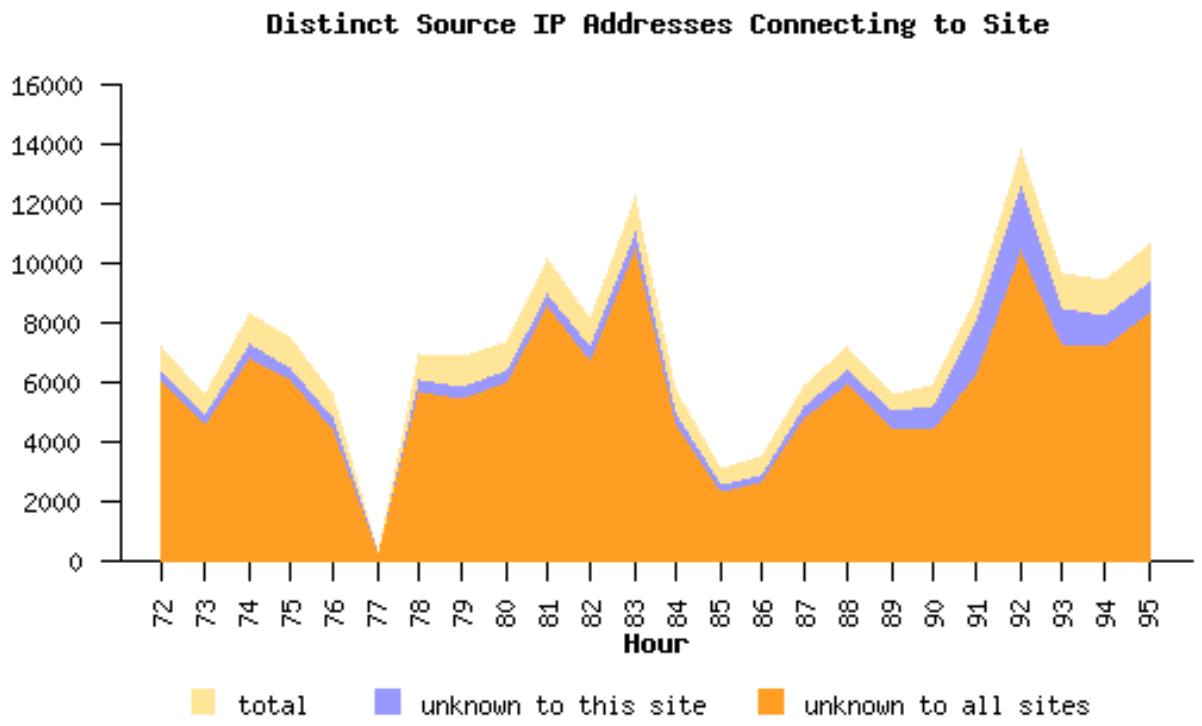
Preliminary Results

- Connections this site cannot block with any data



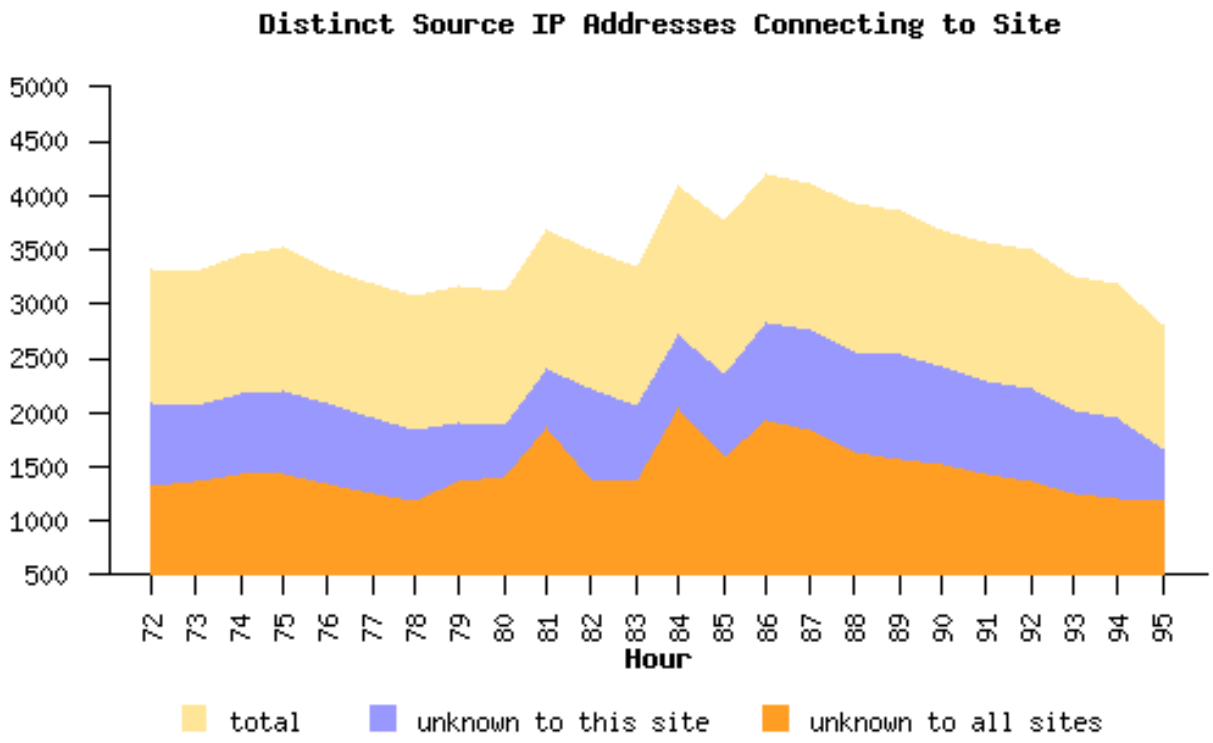
Preliminary Results

- Site with max attack sources, max not in site blacklist & max not in global blacklist



Preliminary Results

- Site with max absolute gain from log sharing



On-going Work

- ## Active Sink Benefit

  maximum increase in percentage of future attacks that can be blocked using blacklist from a single active sink vs size of the sink

Ongoing Work

- Optimal Peering Problem
  - which minimal set of peers provides maximum benefit for blocking future attacks?
  - is the optimal set of peers time-varying?
  - static or adaptive algorithm for determining the set of peers

Ongoing Work

- Essential Data Selection problem
  - What minimum subset of data exchange achieves maximum benefit for blocking future attacks?
  - Log file summary creation
  - Incremental log transmission

Questions

- Questions?
- Comments?

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