Anomaly Sampling

(bringing diversity to network security)

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Basic Idea

- Existing systems focus on accurate counting of packets (or bytes) for large traffic aggregates
  - e.g., Smart Sampling, Traffic Summaries, Adaptive NetFlow, …

- Instead, focus on **interesting,** ***new*** information

Why? – Operational Network Security

- Forensics – “Bad guy did something”
  - When did they do it?
  - How did they do it?
  - What other machines did they get?
- Detection
  - Host ABC unexpectedly responded to a probe
  - Host XYZ used a service it never did previously

Living on the Network Edge

- The problem is **ours**, not our customer's.
- We care about **all** of the hosts.
- But each as an **individual**.
  - Some hosts are naturally more important.
  - Each host has its own services, risks, users, threats to other resources, ….
- We care about **small** events, not affecting performance.
- The problem remains **after** the "event" is over.
- Monitored network bandwidths are still high.

Basic Idea

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- Instead, focus on **interesting,** ***new*** information

What is “interesting” and “new”?

- Imagine you are the poor recipient of collected network data. What do you see?
  - Here’s a record about our web server. Oh, and here’s another record about our web server. And our mail gateway. Oh, here’s another packet about our web server, ….
- Please, tell me something ***I don’t know***
  - Tell me what is “abnormal”, “unusual” or “new”.
  - Tell me “just enough” about **everything**.
  - Do not prioritize telling me redundant information.
- These change over time.

But doesn’t hashing solve this?

- Just put some packet (header) fields together and hash them. Then sample against the hash space.
- Use some memory to avoid redundancy in what has already been reported.
- Voila!
- Unfortunately, packet fields are too variable to use on their own.
  - Imagine the standard “5-tuple” (or 13-tuple, etc). All hits to the web server are sampled the same as a malicious probe to my desktop.

Work in Progress

- Currently trying multiple schemes and examining their operational usefulness.

- Initial results promising, but approaches not polished.

Feature Spaces

- Operator chooses sets of fields/etc. over which they want coverage: (e.g.)
  - Source IP address
  - Destination IP address
  - Source & destination IP address pair
  - Protocol, source port, destination port
  - Src. IP addr., protocol, src. port
  - Src. IP addr., protocol, dst. Port
  - …
- Might chose weights to specify relative importance

Rough Approaches

- Simple novelty of feature combined with weights
- Counting of occurrences of features
- “Bit-vector” distance of features
- Entropy (compressibility) of features
- Hashing, bloom filters, multi-resolution bit maps, sketches, etc are tools
    - Although each has additional advantages for things like garbage-collection, expiry, memory usage, ability to implement in hardware, …

Rough Results

- Using an effective sampling ratio of 1:100 packets
- With “simple novelty” approach, able to get 5-7x coverage of desired feature sets compared to normal 1:100 sampling
- Other approaches do better.
- Current effort is on examining operational usefulness (particularly in forensics).

Conclusions

- The anomaly detection problem appears to be radically different for security at the edge compared with performance inside an ISP.

- Forensic (historical) analysis is a requirement.

- Driven by operational needs, not research goals.

- We are working on a variety of approaches.
  - would love to discuss more about this

What is “interesting” and “new”?

- Imagine you are the poor *person* who has to look at *all* of the collected network data.
  - What do you see? Here’s a record about our web server. Oh, and here’s another record about our web server. And our mail gateway. Oh, here’s another packet about our web server, ….
  - What do you do? Write some code to throw away useless information or aggregate or do anything to make the pain stop.
  - Why is that a problem? The measurement system has not collected what the person wanted. In fact the system is optimized to provide *highly redundant* information.

“Interesting” and “new” changes!

- Imagine a port/host scan. When it starts, that is definitely interesting. But as it keeps going for minutes, hours and days (all from the same source, walking your entire network), the *scanning* isn’t interesting. At that point things are interesting only if a host sends a response or something else *different* from the scanning occurs.