A Modular Multi-Location Anonymized Traffic Monitoring Tool for a WiFi Network

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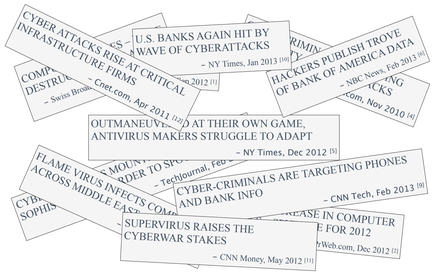
Introduction



- Increasing sophistication of malware makes early detection difficult
- Signature-based detection rates can be as low as 5% [Perlroth 2012]
- Real- time monitoring for anomalous behavior in the traffic data over a network offers a surer approach to protecting networks
- Traffic data collected at a single location is usually insufficient to infer an anomaly
- Volume of collected traffic data can be prohibitively large

N. Perlroth. Outmaneuvered at Their Own Game, Antivirus Makers Struggle to Adapt. *The New York Times*, December 31, 2012.

DataMap

- Modular open-source tool for the collection and real-time analysis of network traffic data
- Configurable sampling, anonymization, filtering, and aggregation of collected data
- Collects data from multiple WiFi locations in a network
- Easily adaptable to new sampling and aggregation techniques
- Can be utilized for real-time monitoring for anomalous behavior using a combination of signature-based and anomaly detection
- Facilitates the study of newer techniques for anomaly detection

Related Work

Snort

- Lightweight sniffer, packet logger and an intrusion detection system
- Generate alerts when it observes specific types of probes or attacks that indicate a potential intrusion attempt
- Detection based on custom or included rule sets that are updated daily
- Runs on a single machine, requiring a complementary set of tools to gather traffic data from multiple locations
- Not able to detect anomalies whose signature is not yet known

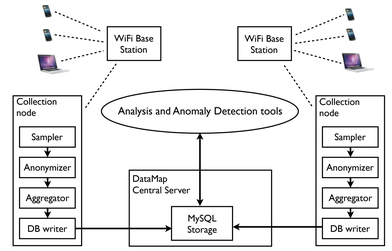
Security Onion

- Linux distro for intrusion detection, network security monitoring, and log management
- Based on Ubuntu 12.04
- Contains Snort, Suricata, Bro, Sguil, Squert, Snorby, ELSA, Xplico, NetworkMiner
- Requires 1GB memory per interface

Suricata

- Open source next generation intrusion detection and prevention engine
- Similar to Snort—signature based detection
- Designed for better performance on multi-core CPUs
- Runs on single machine, without multiple data collection nodes at different locations

Overview of DataMap Components



A DataMap traffic monitoring system showing two collection nodes (also called traffic sensors) and the central server

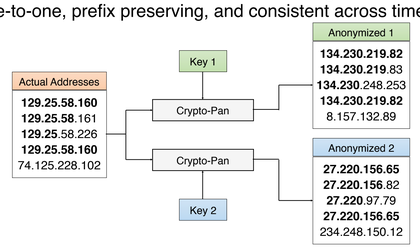
Collection Nodes

Sampler

- Uses Versatile Monitoring Toolkit (***Vermont***) for traffic capture
- Supports configurable ***sampling*** and ***filtering*** schemes
- Places wireless NIC in ***monitor mode*** to capture data from all access points
- Configurable network identification and channel hopping

Anonymizer

- Discards MAC and application layer data
- Anonymizes IP addresses with Crypto-PAn while preserving network topology information
- Crypto-PAn is one-to-one, prefix preserving, and consistent across time and location



J. Fan, J. Xu, M. H. Ammar, and S. B. Moon. Prefix-Preserving IP Address Anonymization: Measurement-based Security Evaluation and a New Cryptography-based Scheme. Computer Networks, 2004.

Aggregator

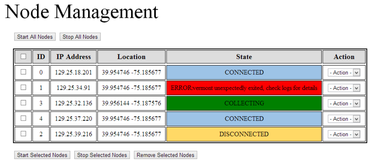
- Aggregates raw network data into configurable width time-slices
- Based on any combination of packet header fields
- Data is passed via shared memory from the ***Sampler*** through the ***Anonymizer*** to the ***Aggregator*** to keep identifying information from ever being written to disk

DB Writer

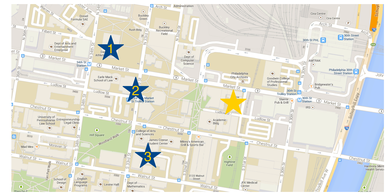
- Sends filtered, anonymized, and aggregated data to central server
- Data is labelled with location of collection node before being stored to allow the investigation of spatial correlations in the collected data

Central Server

- At start-up, a collection node sends a ***Hello*** message containing its ID and location
- Keeps track of collection node state with periodic ***Heartbeat*** messages
- Sends commands to individual nodes to begin/end data collection
- Manages collection node configurations for sampling and aggregation
- Control functionality exposed through included web interface

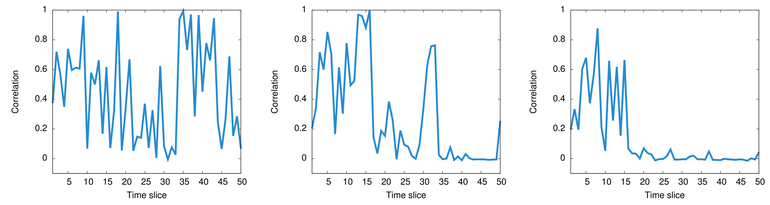


An Example of DataMap Usage

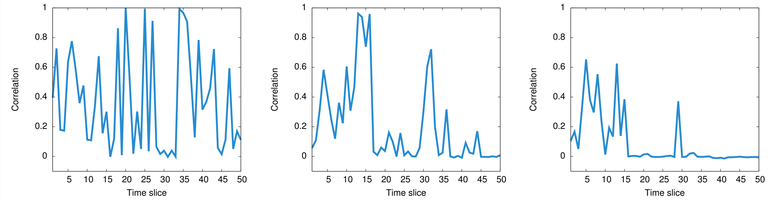


Collection Node Locations
1. **Athletic Center**
2. **University Library**
3. **University Bookstore**

Central Server Location
1. Bossone Research Enterprise Center



Correlation between source address at locations 1 and 2 (left), at locations 1 and 3 (middle), and locations 2 and 3 (right)



Correlation between destination address at locations 1 and 2 (left), at locations 1 and 3 (middle), and locations 2 and 3 (right)

- Data collected over 1800 seconds
- Divided into 50 non-overlapping windows 36 seconds in duration
- Computed the coefficient of correlation between the IP addresses at different locations
- Each data point represents the correlation computed over a 36 second period

- There is a sustained shift in the pattern of correlation between traffic at location 3 and the other two locations beginning somewhere between 540–720 seconds
- May indicate an anomalous event
- May be normal event with legitimate reason for the deviation
- Investigation of the correlations between additional features can be used to determine if the event should be flagged

Typical DataMap Collection Node Hardware

- alix3D3 single board computer from PC Engines
- AMD x86 compatible processor
- 256 MB DDR DRAM
- Atheros AR5414 wireless chipset (supported by ath5k driver)
- Ubuntu 12.04 (requires special kernel for support of non-PAE capable CPU)

`http://pcengines.ch/alix3d3.htm`

Fork on GitHub

https://github.com/DataMap13/DataMap/

Acknowledgment

This work was partially funded by the National Science Foundation Award #1228847.