FAN: FAst Netflow analyser

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I. Introduction and Motivation

Cisco® NetFlow protocol[1] is a valid alternative to Deep Packet Inspection (DPI) for network monitoring, since it provides a lightweight picture of exchanged traffic, avoiding the burden of payload access, like privacy concerns and high resource demand. The NetFlow protocol is able to condensate in a single record (called *netflow*) a unidirectional sequence of packets that share the source-destination addresses and that have the same ports, IP protocol, ingress interface, and IP type of service. Moreover, several other valuable data are included in a flow, like timestamp, duration, number of exchanged packets, and number of transmitted bytes. Actually, NetFlow can be used for many applications, including Intrusion Detection Systems [1], DoS [2] and anomaly detection [3] and more.

DPI and netflow analysers are generally available as closed-source software, since part of commercial network monitoring packages. This has lead academic researchers to perform netflows analysis with ad-hoc, home-made software. In fact, nfdump, that is the most spread open-source project for netflow analysis, has several aspects that limit its adoption. For example, nfdump has a modular structure, but each plugin has to be executed independently on each netflow block (execution time linear with the number of plugins). Moreover, it does not properly manage netflow timeouts and does not allow the addition of a new plugin at run time. Those limitations make it unsuitable for time based plugins and for large scale network analysis (i.e. Autonomous System). This is why we propose *FAN*, an open-source, general-purpose and lightweight framework for fast netflows analysis. *FAN* is written in *C* and can run any kind of plugins for slotted netflow analysis. For example, we already developed some plugins for anomaly detection (Section III). It has a plugin manager able to customize the plugin dependencies, in order to optimise the computations during the analysis. Moreover, it pays a particular attention to netflow timeout management, that is a critical aspect of the Netflow technology.

II. *FAN*: design and principles

The analyser is composed by three elements: the *collector*, the *plugin manager* and the *logging system*. The *collector* receives raw netflows and packs them in blocks according to timeouts. Then, each block of netflows is passed to the *plugin manager*, that is in charge to optimise the operation sequences for netflows analysis. Both collector and plugin manager reports to the *logging system* that will present the analysis results of each plugin. In the following we describe in greater detail the two more interesting elements of our framework, the *timeout* and the *plugin managers*.

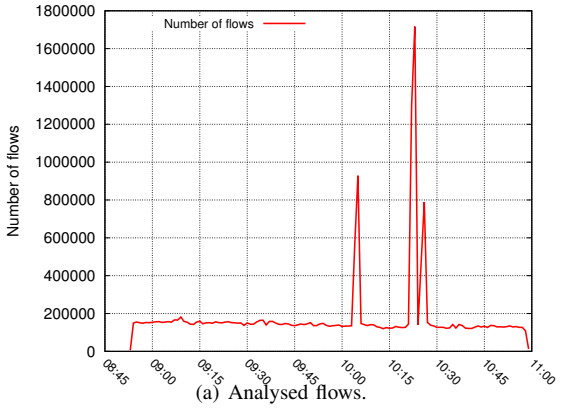
A. Timeout management

A new flow is generated by monitoring probes under two different conditions: when the peers explicitly terminate the connection according to the protocol, and when a *timeout* expires. Netflow probes use two independent timeouts. The *inactive timeout* (θ_i) triggers when the peers do not exchange packets for θ_i seconds and the connection has not been terminated. For each newly exchanged packet, the probe resets θ_i. The *active timeout* is used to break up long-lived flows into several fragments, and triggers each θ_a seconds until two peers exchange packets at a high rate on the same flow. Tuning θ_a parameter can be tricky for network administrators. In fact, long-lived flow fragments can alter the real representation of the data crossing the network. Usually, low active timeout values are used for detection purposes (i.e. high responsiveness), while higher values are typically used for classification tasks (pattern recognition or statistical problems, where there is the need to analyse the flows in the correct order and without segmentation). *FAN* can also be used to perform offline experiments. In facts, with the proper *time slot size* and *block timeout* parameter values, *FAN* can analyse long-lived flows, even when they span over multiple fragments. The *time slot size* τ is used for block grouping: a flow block β_t contains all the flows exchanged during time slot t, of duration τ (e.g. 60 seconds). The *block timeout*, instead, tells *FAN* to cache all the netflows of several blocks and to properly aggregate them to fix the effects of the active timeout. Such feature is needed by behavioural-based traffic detection engines (like [4]) since it enables time-coherent analysis. Further, it makes possible ex-post analysis, quality of service evaluations or the implementation of traffic classification algorithms. Since the active timeout value also affects *FAN*'s cache size, it should be set according with the Netflow probe configuration.

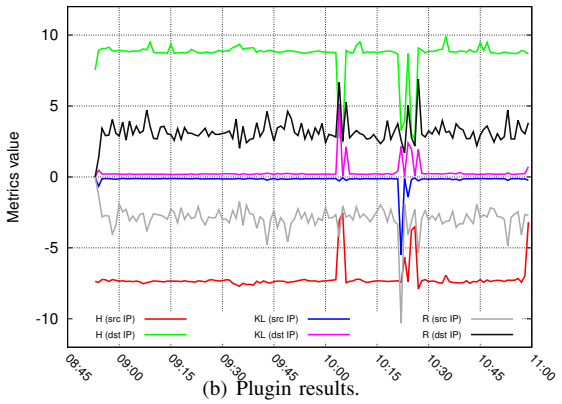
B. Plugins manager

FAN can dynamically load new plugins during its execution, since it exploits the programming interface to the dynamic linking loader, namely *dlopen*, *dlsym*, *dlclose* functions.Each

[1]Also known as IPFIX (RFC3955), Cisco Systems — http://tools.ietf.org/html/rfc3954



(a) Analysed flows.



(b) Plugin results.

Fig. 1. Experiment results. Fig. 1(a): analysed flows (the data set includes a real DoS attack around 10:25). Fig. 1(b): results of the plugins for information theory metrics.

plugin is a *shared object* that can be attached on demand, without restarting the *FAN* process or recompiling its binary.

Each plugin requires the implementation of three functions: *so_init*, *so_process*, *so_close*. The *so_init* function is executed to allocate resources for each flow block. The *so_process* function performs the core operations for the plugin, while the *so_close* function releases the used resources.

FAN also has a *plugin dependency subsystem* to optimise the plugin execution. Using a configuration file, we can define how the active plugins depend between them. For example, we can enable a list of plugins (e.g. p_1, p_2) and require that their executions depend on the results of others plugins (e.g. p_3). The dependency subsystem uses a graph representation to verify consistency constraints and evaluate the order of the plugin executions. In this way, the framework will perform the plugins computation in a rational order (e.g. p_3, p_1, p_2). A *so_getResult* function also is provided for intra-plugins communications. As briefly showed in Section III, this optimisation can strongly reduce the execution overheads imposed by a large number of plugins.

III. Performance Evaluations

In order to evaluate the performance of the *FAN* framework, we implemented a set of plugins for anomaly detection: i) information theory based metrics (Entropy, Kullback Leibler and Rényi), ii) SYN-flood attack detection algorithm, iii) stock market and iv) k-means based anomaly detection. We used *FAN* to evaluate the plugins on a data set of real netflow gathered from a large Tier-II Autonomous System, but for space limitation, we only report the results for type i) metrics.

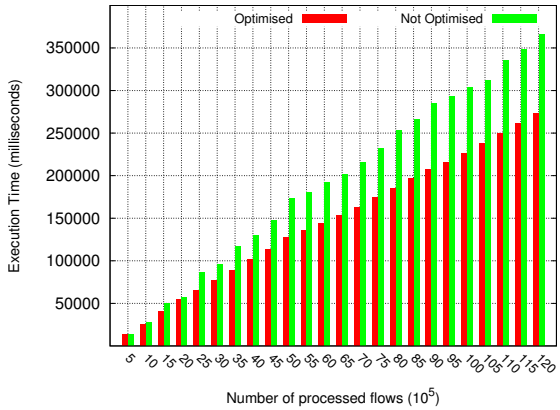


Fig. 2. Effects of the plugins dependency subsystem on the execution time.

Figure 1 reports the experiments on around 2 hours of traffic that includes a publicly-declared DoS attack (Figure 1(a)). *FAN* produced the results shown in Figure 1(b), evaluating 15 millions of flows with 6 plugins in around 17 minutes (i.e. 1011 seconds) of computations.

Figure 2 shows the effects of the plugin dependency subsystem optimisation in terms of execution time. For example, processing 10 millions of netflow the dependency subsystem saves 80 seconds of computations (around 25% of speed improvement), optimising 6 information theory based plugins.

IV. Conclusions and Future Works

In this work we present *FAN*, a framework for fast netflow analysis. It can perform online and offline evaluation for security and network monitoring purposes. *FAN* is modular and suitable for large scale networks, exploiting a rational plugin dependency subsystem for time execution optimisation. Furthermore, the timeout manager assures a time-coherent analysis of the flows, making *FAN* able to process them in the same order they cross the probe. As future work, we plan to implement plugins for netflow manipulation, like obfuscation or anonymization mechanisms.

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