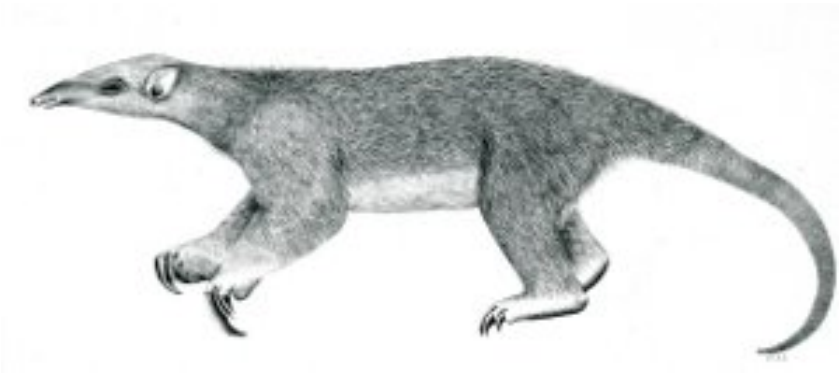
Tranalyzer2

scripts

Various Scripts and Utilities



Tranalyzer Development Team

Contents

1 scripts

This section describes various scripts and utilities for Tranalyzer. For a complete list of options, use the scripts `-h` option.

1.1 b64ex

Extracts all HTTP, EMAIL, FTP, TFTP etc base64 encoded content extracted from T2 und /tmp. To produce a list of files containing base64 use grep as indicated below:

- `grep "base64" /tmp/SMTPFILE/*`
- `./b64ex /tmp/SMTPFILES/file@wurst.ch_0_1223`

1.2 flowstat

Calculates statistical distributions of selected columns/flows from a flow file.

1.3 statGplt

Transforms 2/3D statistics output from `pktSIATHisto` plugin to gnuplot or t2plot format for encrypted traffic mining purposes.

1.4 fpsGplt

Transforms the output of the `nFrstPkts` plugin signal output to gnuplot or t2plot format for encrypted traffic mining purposes. It generates an output file: `flowfile_nps.txt` containing the processed PL signal according to `nFrstPkts` plugin configuration.

```
> fpsGplt -h
Usage:
    fpsGplt [OPTION...] <FILE>

Optional arguments:

    -f findex        Flow index to extract, default: all flows
    -d 0|1           Flow Direction: 0, 1; default both
    -t               No Time: counts on x axis; default time on x axis
    -i               Invert B Flow PL
    -s               Time sorted ascending
    -p s             Sample sorted signal with smplIAT in [s]; f = 1/smplIAT
    -e s             Time for each PL pulse edge in [s]

    -h, --help       Show this help, then exit
```

If `-f` is omitted all flows will be included. If `-d` is omitted both flow directions will be processed. `-t` removes the timestamp and replaces it with an integer count. `-i` inverts the `B` flow signal to produce a symmetrical signal. `-p` samples the sorted signal with the IAT in seconds resp. frequency you deem necessary and `-e` defines the pulse flank in seconds.

1.5 fpsEst

This script takes the output file of `fpsGplt` and calculates the jumps in IAT to allow the user to choose an appropriate `MINIAT(S/U)` in `nFrstPkts` plugin.

```
fpsEst flowfile_nps.txt
```

1.6 gpq3x

Use this script to create 3D waterfall plot. Was originally designed for the `centrality` plugin:

```
cat FILE_centrality | ./gpq3x
```

The script can be configured through the command line. For a full list of options, run `./gpq3x -help`

1.7 new_plugin

Use this script to create a new plugin. For a more comprehensive description of how to write a plugin, refer to Appendix A (Creating a custom plugin) of `$T2HOME/doc/documentation.pdf`.

1.8 osStat

Counts the number of hosts of each operating system (OS) in a PCAP file. In addition, a file with suffix `_IP_OS.txt` mapping every IP to its OS is created. This script uses `p0f` which requires a fingerprints file (`p0f.fp`), the location of which can be specified using the `-f` option. Version 2 looks first in the current directoy, then in `/etc/p0f`. Version 3 looks only in the current directory.

- list all the options: `osStat --help`
- top 10 OS: `osStat file.pcap -n 10`
- bottom 5 OS: `osStat file.pcap -n -5`

1.9 protStat

The `protStat` script can be used to sort the `PREFIX_protocols.txt` file (generated by the `protoStats` plugin) or the `PREFIX_nDPI.txt` file (generated by the `nDPI` plugin) for the most or least occurring protocols (in terms of number of packets or bytes). It can output the top or bottom *N* protocols or only those with at least a given percentage:

- list all the options: `protStat --help`
- sorted list of protocols (by packets): `protStat PREFIX_protocols.txt`
- sorted list of protocols (by bytes): `protStat PREFIX_protocols.txt -b`
- top 10 protocols (by packets): `protStat PREFIX_protocols.txt -n 10`
- bottom 5 protocols (by bytes): `protStat PREFIX_protocols.txt -n -5 -b`
- protocols with packets percentage greater than 20%: `protStat PREFIX_protocols.txt -p 20`
- protocols with bytes percentage smaller than 5%: `protStat PREFIX_protocols.txt -b -p -5`
- TCP and UDP statistics only: `protStat PREFIX_protocols.txt -udp -tcp`

1.10 rrdmonitor

Stores Tranalyzer monitoring output into a RRD database.

1.11 rrdplot

Uses the RRD database generated by `rrdmonitor` to monitor and plot various values, e.g., number of flows.

1.12 segvtrack

If the processing of a pcap file causes a segmentation fault, this script can be used to locate the packets which caused the error. It works by repetitively splitting the file in half until neither half causes a segmentation fault. Its usage is as follows:

```
segvtrack file.pcap
```

Note that you might need to change the path to the Tranalyzer binary by editing the `T2` variable at line 5 of the script.

1.13 t2_aliases

Set of aliases for Tranalyzer.

1.13.1 Description

`t2_aliases` defines the following aliases, functions and variables:

T2HOME
Variable pointing to the root folder of Tranalyzer, e.g., `cd $T2HOME`.

T2PLHOME
Variable pointing to the root folder of Tranalyzer plugins, e.g., `cd $T2PLHOME`. In addition, every plugin can be accessed by typing its name instead of its full path, e.g., `tcpFlags` instead of `cd $T2PLHOME/tcpFlags` or `cd $T2HOME/plugins/tcpFlags`.

tran
Shortcut to access `$T2HOME`, e.g., `tran`

tranpl
Shortcut to access `$T2PLHOME`, e.g., `tranpl`

.tran
Shortcut to access `$HOME/.tranalyzer/plugins`, e.g., `.tran`

awkf
Configures `awk` to use tabs, i.e., '`\t`' as input and output separator (prevents issue with repetitive values), e.g.,
`awkf '{ print $4 }' file_flows.txt`

tawk
Shortcut to access tawk , e.g., `tawk`

tcol
Displays columns with minimum width, e.g., `tcol file_flows.txt`.

lsx
Displays columns with fixed width (default: 40), e.g., `lsx file_flows.txt` or `lsx 45 file_flows.txt`.
Note that ZSH already defines a `lsx` alias, therefore if using ZSH this command will **NOT** be installed. To have it installed, add the following line to your `~/.zshrc` file: `unalias lsx`

sortu
Sort rows and count the number of times a given row appears, then sort by the most occuring rows. (Alias for `sort | uniq -c | sort -rn`). Useful, e.g., to analyse the most occuring user-agents: `tawk '{ print $httpUsrAg }' FILE_flows.txt | sortu`

t2
Shortcut to run Tranalyzer from anywhere, e.g., `t2 -r file.pcap -w out`

gt2
Shortcut to run Tranalyzer in gdb from anywhere, e.g., `gt2 -r file.pcap -w out`

st2
Shortcut to run Tranalyzer with sudo, e.g., `st2 -i eth0 -w out`

tranalyzer
Shortcut to run Tranalyzer from anywhere, e.g., `tranalyzer -r file.pcap -w out`

protStat
Shortcut to access `protStat` from anywhere, e.g., `protStat file_protocols.txt`

rrdmonitor
Shortcut to run rrdmonitor from anywhere, e.g., `t2 -i eth0 | rrdmonitor`

rrdplot
Shortcut to run rrdplot from anywhere, e.g., `rrdplot V4Pkts V6Pkts`

t2build
Function to build Tranalyzer and the plugins from anywhere, e.g., `t2build tcpFlags`. Use `<tab>` to list the available plugins and complete names. Use `t2build -h` for a full list of options.

t2caplist
Shortcut to run t2caplist from anywhere, e.g., `t2caplist`

t2conf
Shortcut to run t2conf from anywhere, e.g., `t2conf -t2`

t2dmon
Shortcut to run t2dmon from anywhere, e.g., `t2dmon dumps/`

t2doc
Shortcut to run t2doc from anywhere, e.g., `t2doc tranalyzer2`

t2plot
Shortcut to run t2plot from anywhere, e.g., `t2plot file.txt`

t2stat
Shortcut to run t2stat from anywhere, e.g., `t2stat -USR2`

t2timeline
Shortcut to run t2timeline from anywhere, e.g., `t2timeline file.txt`

t2viz
Shortcut to run t2viz from anywhere, e.g., `t2viz file.txt`

1.13.2 Usage

Those aliases can be activated using either one of the following methods:

1. Append the content of this file to `~/.bash_aliases` or `~/.bashrc`
2. Append the following line to `~/.bashrc` (make sure to replace `$T2HOME` with the actual path, e.g., `$HOME/tranalyzer2-0.8.3`):

```
if [ -f "$T2HOME/scripts/t2_aliases" ]; then
    . $T2HOME/scripts/t2_aliases             # Note the leading '.'
fi
```

1.13.3 Known Bugs and Limitations

ZSH already defines a `lsx` alias, therefore if using ZSH this command will **NOT** be installed. To have it installed, add the following line to your `~/.zshrc` file: `unalias lsx`

1.14 t2alive

In order to monitor the status of T2, the t2alive script sends syslog messages to server defined by the user whenever the status of T2 changes. It acquires the PID of the T2 process and transmits every `REP` seconds a `kill -SYS $pid`. If T2 answers with a corresponding kill command defined in *tranalyzer.h*, s.b., then status is set to alive, otherwise to dead. Only if a status change is detected a syslog message is transmitted. The following constants residing in *tranalyzer.h* govern the functionality of the script:

T2 on the other hand has also to be configured. To preserve simplicity the unused SIGSYS interrupt was abused to respond to the t2alive request, hence the monitoring mode depending on USR1 and USR2 can be still functional. Configuration is carried out in *tranalyzer.h* according to the table below:

`REPSUP=1` activates the alive mode. If more functionality is requested the `REPCMDAx` constant facilitates the necessary changes. On some linux distributions the pcap read callback function is not thread safe, thus signals of any kind might

Name	Default	Description
SERVER	"127.0.0.1"	syslog server IP
PORT	514	syslog server port
FAC	"<25>"	facility code
STATFILE	"/tmp/t2alive.txt"	alive status file
REP	10	T2 test interval [s]

Table 1: *t2alive script configuration*

Name	Default	Description
REPSUP	0	1: activate alive mode
ALVPROG	"t2alive"	name of control program
REPCMDAW	"a=`pgrep ALVPROG`; if [$a]; then kill -USR1 $a; fi"	alive and stall (no packets, looping?)
REPCMDAS	"a=`pgrep ALVPROG`; if [$a]; then kill -USR2 $a; fi"	alive and well (working)

Table 2: *T2 configuration for t2alive mode*

lead to crashes especially when capturing live traffic. Therefore **MONINTTHRD=1** in *main.h* is set by default.
Note that t2alive should be executed in a shell as a standalone script. If executed as a cron job, the while loop and the sleep command has to be removed, as described in the script itself.

1.15 t2caplist

Generates a list of PCAP files with absolute path to use with Tranalyzer `-R` option. If no argument is provided, then lists all the PCAP files in the current directory. If a folder name is given, lists all capture files in the folder. If a list of files is given, list those files. Try `t2caplist -help` for more information.

- `t2caplist > pcap_list.txt`
- `t2caplist ~/dumps/ > pcap_list.txt`
- `t2caplist ~/dumps/testnet*.pcap > pcap_list.txt`

1.16 t2conf

Use `t2conf` to build, configure, activate and deactivate Tranalyzer plugins or use the `t2plconf` script provided with all the plugins to configure individual plugins as follows:

- `cd $T2HOME/pluginName`
- `./t2plconf`
  - Navigate through the different options with the up and down arrows
  - Use the left and right arrows to select an action:
    * `ok`: apply the changes
    * `configure`: edit the selected entry (use the space bar to select a different value)
    * `cancel`: discard the changes

    * edit: open the file containing the selected option in EDITOR (default: vim)
  - Use the space bar to select a different value

A more detailed description of the script can be found in Tranalyzer2 documentation.

1.16.1 Dependencies

The t2conf and t2plconf scripts require *dialog* (version 1.1-20120703 minimum) and the *vim* editor. The easiest way to install them is to use the `install.sh` script provided (Section 1.16.3). Note that the editor can be changed by exporting the environment variable `EDITOR` as follows: `export EDITOR=/path/to/editor`, e.g., `export EDITOR=/usr/bin/nano` or by setting the `EDITOR` variable at line 7 of the t2conf script and at line 66 of the t2plconf script.

1.16.2 t2confrc

Set of predefined settings for `t2conf`.

1.16.3 Installation

The easiest way to install `t2conf` and its dependencies is to use the provided `install.sh` script: `./install.sh --help` 1Y

Alternatively, use t2_aliases or add the following alias to `~/.bash_aliases`:

```
alias t2conf="$T2HOME/scripts/t2conf/t2conf"
```

Where `$T2HOME` is the root folder containing the source code of Tranalyzer2 and its plugins, i.e., where `README.md` is located. To use the predefined settings, copy *t2confrc* to `~/.tranalyzer/plugins/`.

1.16.4 Usage

For a complete list of options use the `-h` option, i.e., `t2conf -h`, or the man page (`man t2conf`).

1.16.5 Patch

`t2conf` can be used to patch Tranalyzer and the plugins (useful to save settings such as hash table size, IPv6, ...).

The format of the patch file is similar to *t2confrc*:

- Empty lines and lines starting with `'%'` or `'#'` are ignored
- Filenames are relative to `$T2HOME`
- A line is composed of three or four tabs (not spaces) separated columns:
  - `NAME <tab> newvalue <tab> oldvalue <tab> file`
  - `NAME <tab> newvalue <tab> file`
- `--patch` uses newvalue
- `--rpatch` uses oldvalue[1]

[1] This option is not valid if the patch has only three columns.

As an example, let us take the value `T2PSKEL_IP` defined in *t2PSkel/src/t2PSkel.h*:

```
#define T2PSKEL_IP   1 // whether or not to output IP (var2)
```

A patch to set this value to 0 would look as follows (where the spaces between the columns are tabs, i.e., `'\t'`):

- `T2PSKEL_IP 0 1 t2PSkel/src/t2PSkel.h`
- `T2PSKEL_IP 0 t2PSkel/src/t2PSkel.h`

1.17 t2dmon

Monitors a folder for new files and creates symbolic links with incrementing indexes. This can be used with the `-D` option when the filenames have either multiple indexes, e.g., date and count, or when the filenames do not possess an index.

1.17.1 Dependencies

This script requires **inotify-tools**:

Arch: `sudo pacman -S inotify-tools`

Fedora: `sudo yum install inotify-tools`

Gentoo: `sudo emerge inotify-tools`

Ubuntu: `sudo apt-get install inotify-tools`

1.17.2 Usage

t2dmon works as a daemon and as such, should either be run in the background (the ampersand `'&'` in step 1 below) or on a different terminal.

1. `t2dmon dumps/ -o nudel.pcap &`
2. `tranalyzer -D dumps/nudel.pcap0 -w out`
3. Finally, copy/move the pcap files into the `dumps/` folder.

1.18 t2doc

Access Tranalyzer documentation from anywhere, e.g., `t2doc tcpFlags`. Use `<tab>` to list the available plugins and complete names.

1.19 t2fm

Generates a PDF report out of:

- a flow file (`-F` option): `t2fm -F file_flows.txt`
- a live interface (`-i` option): `t2fm -i eth0`
- a PCAP file (`-r` option): `t2fm -r file.pcap`
- a list of PCAP files (`-R` option): `t2fm -R pcap_list.txt`

1.19.1 Required Plugins

- basicFlow
- basicStats
- txtSink

1.19.2 Optional Plugins

- arpDecode
- dnsDecode
- geoip
- httpSniffer
- nDPI
- portClassifier
- pwX
- sshDecode

1.20 t2plot

2D/3D plot for Tranalyzer using gnuplot. First row of the input file must be the column names (may start with a '%'). The input file must contain two or more columns separated by tabs (\t). Columns to plot can be selected with -o option Try t2plot --help for more information.

Dependencies: The t2plot script requires **gnuplot**.

Arch: sudo pacman -S gnuplot

Ubuntu: sudo apt-get install gnuplot-qt

Mac OSX: brew install gnuplot --with-qt

Examples:

- tawk '{ print ip2num(shost()), ip2num(dhost()) }' f_flows.txt | t2plot -pt
- tawk '{ print ip2num($srcIP), $timeFirst, $connSip }' f_flows.txt | t2plot
- t2plot file_with_two_or_three_columns.txt
- t2plot -o "26:28" file_with_many_columns.txt
- t2plot -o "numBytesSnt:numBytesRcvd" file_with_many_columns.txt

1.21 t2stat

Sends USR1 signal to Tranalyzer to produce intermediary report. The signal sent can be changed with the -SIGNAME option, e.g., t2stat -USR2 or t2stat -INT. If Tranalyzer was started as root, the -s option can be used to run the command with sudo. The -p option can be used to print the PID of running Tranalyzer instances and the -l option provides additional information about the running instances (command and running time). The -i option can be used to cycle through all the running instances and will prompt for comfirmation before sending the signal to a specific process. If a numeric argument *N* is provided, sends the signal every *N* seconds, e.g., t2stat 10 to report every 10s. Use t2stat --help for more information.

1.22 t2timeline

Timeline plot of flows: `t2timeline FILE_flows.txt`

- To use relative time, i.e., starting at 0, use the `-r` option.
- The vertical space between A and B flows can be adapted with the `-v` option, e.g., `-v 50`.
- When hovering over a flow, the following information is displayed: `flowInd_flowStat_srcIP:srcPort_dstIP:dstPort_l4Proto_ethVlanID`.
- Additional information can be displayed with the `-e` option, e.g, `-e macS,macD,duration`
- Use `t2timeline --help` for more information.

An example graph is depicted in Figure 1.

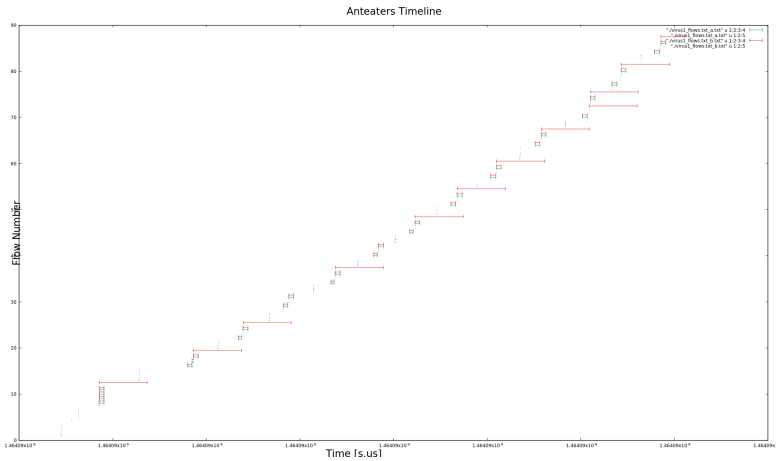


Figure 1: *T2 timeline flow plot*

1.23 t2utils.sh

Collection of bash functions and variables.

1.23.1 Usage

To access the functions and variables provided by this file, source it in your script as follows:

```
source "$(dirname "$0")/t2utils.sh"
```

Note that if your script is not in the `scripts/` folder, you will need to adapt the path above to `t2utils.sh` accordingly.

[ZSH] If writing a script for ZSH, add the following line **BEFORE** sourcing the script:

```
unsetopt function_argzero
```

1.23.2 Colors

Alternatives to `printerr`, `printinf`, `printok` and `printwrn`:

Variable	Description	Example
BLUE	Set the color to blue	`printf "${BLUE}message${NOCOLOR}\n"`
GREEN	Set the color to green	`echo -e "${GREEN}message${NOCOLOR}"`
ORANGE	Set the color to orange	`printf "${ORANGE}${1}${NOCOLOR}\n" "message"`
RED	Set the color to red	`echo -e "${RED}$1${NOCOLOR}" "message"`
BLUE_BOLD	Set the color to blue bold	`printf "${BLUE_BOLD}message${NOCOLOR}\n"`
GREEN_BOLD	Set the color to green bold	`echo -e "${GREEN_BOLD}message${NOCOLOR}"`
ORANGE_BOLD	Set the color to orange bold	`printf "${ORANGE_BOLD}${1}${NOCOLOR}\n" "message"`
RED_BOLD	Set the color to red bold	`echo -e "${RED_BOLD}$1${NOCOLOR}" "message"`
BOLD	Set the font to bold	`echo -e "${BOLD}$1${NOCOLOR}" "message"`
NOCOLOR	Reset the color	`printf "${RED}message$NOCOLOR\n"`

1.23.3 Folders

Variable	Description	Example
SHOME	Points to the folder where the script resides	For `basicFlow/utils/subconv`, `SHOME` is `$T2PLHOME/basicFlow/utils`
T2HOME	Points to the root folder of Tranalyzer	`$T2HOME/scripts/new_plugin`
T2PLHOME	Points to the root folder of Tranalyzer plugins	`cd $T2PLHOME/t2PSkel`

1.23.4 Programs

Variable	Program	Example
AWK	gawk	`$AWK '{ print }' file`
AWKF	gawk -F'\t' -v OFS='\t'	`"${AWKF[@]}" '{ print } file'`
OPEN	xdg-open (Linux), open (MacOS)	`$OPEN file.pdf`
READLINK	readlink (Linux) / greadlink (MacOS)	`$READLINK file`
SED	sed (Linux) / gsed (MacOS)	`$SED 's/ /_/g' «< "$str"`
T2	$T2HOME/tranalyzer2/src/tranalyzer	`$T2 -r file.pcap`
T2BUILD	$T2HOME/autogen.sh	`$T2BUILD tranalyzer2`
T2CONF	$T2HOME/scripts/t2conf/t2conf	`$T2CONF -D SCTP_ACTIVATE=1 tranalyzer2`
TAWK	$T2HOME/scripts/tawk/tawk	`$TAWK '{ print tuple4() } file'`

1.23.5 Functions

Function	Description
`printerr "msg"`	print an error message (red) with a newline
`printinf "msg"`	print an info message (blue) with a newline
`printok "msg"`	print an ok message (green) with a newline

Function	Description
`printwrn "msg"`	print a warning message (orange) with a newline
`check_dependency "bin" "pkg"`	check whether a dependency exists (Linux/MacOS)
`check_dependency_linux "bin" "pkg"`	check whether a dependency exists (Linux)
`check_dependency_osx "bin" "pkg"`	check whether a dependency exists (MacOS)
`has_define "file" "name"`	return 0 if the macro `name` exists in `file`, 1 otherwise
`get_define "name" "file"`	return the value of the macro `name` in `file`
`set_define "name" "value" "file"`	set the value of the macro `name` in `file` to `value`
`replace_suffix "name" "old" "new"`	replace the `old` suffix in `name` by `new`
`get_nproc`	return the number of processing units available
`validate_ip "string"`	return 0 if `string` is a valid IPv4 address, 1 otherwise
`validate_pcap "file"`	return 0 if `file` is a valid PCAP file, 1 otherwise
`validate_next_arg "curr" "next"`	check whether the next argument exists and is not an option
`validate_next_arg_exists "curr" "next"`	check whether the next argument exists
`validate_next_dir "curr" "next"`	check whether the next argument exists and is a directory
`validate_next_file "curr" "next"`	check whether the next argument exists and is a regular file
`validate_next_pcap "curr" "next"`	check whether the next argument exists and is a PCAP file
`validate_next_num "curr" "next"`	check whether the next argument exists and is a positive integer
`validate_next_int "curr" "next"`	check whether the next argument exists and is an integer
`validate_next_float "curr" "next"`	check whether the next argument exists and is a float
`arg_is_option "arg"`	check whether `arg` exists and is an option (starts with `-`)
`abort_missing_arg "option"`	print a message about a missing argument and exit with status 1
`abort_option_unknown "option"`	print a message about an unknown option and exit with status 1
`abort_required_file`	print a message about a missing required file and exit with status 1
`abort_with_help`	print a message explaining how to get help and exit with status 1

1.24 t2viz

Generates a graphviz script which can be loaded into xdot or dotty: `t2viz FILE_flows.txt`.
Accepts T2 flow or packet files with header description.
Try `t2viz --help` for more information.

1.25 t2wizard

Launch several instances of Tranalyzer in the background, each with its own list of plugins (Tranalyzer must be configured to use a plugin loading list (*tranalyzer2/src/loadPlugins.h:24*: `USE_PLLIST > 0`). The script is interactive and will prompt for the required information. To see all the options available, run `t2wizard --help`. To use it, run `t2wizard -r file.pcap` or `t2wizard -R pcap_list.txt`.

1.26 topNStat

Generates sorted lists of all the columns (names or numbers) provided. A list of examples can be displayed using the `-e` option.

1.27 vc.c

Calculates entropy based features for a T2 column in a flow file or the packet file, selected by awk, tawk or cut, moreover it decodes the `'%'` HTTP notation for URLs.
Compile: `gcc vc.c -lm -o vc`
Example: extract url in position 26 and feed it into vc: `cut -f 26 file_flows.txt | ./vc`
Output on commandline:

```
...
5,45,17,4,0,9,0,0    1.000000    0.000000    0.549026    80    16.221350    0.342250
        "/hphotos-ak-snc4/hs693.snc4/63362_476428124179_624129179_6849488_4409532_n.jpg"
...
```

2 PDF Report Generation from PCAP using t2fm

2.1 Introduction

This tutorial presents `t2fm`, a script which generates a PDF report out of a PCAP file. Information provided in the report includes top source and destination addresses and ports, protocols and applications, DNS and HTTP activity and potential warnings, such as executable downloads or SSH connections.

2.2 Prerequisites

For this tutorial, it is assumed the user has a basic knowledge of Tranalyzer and that the file `t2_aliases` has been sourced in `~/.bashrc` or `~/.bash_aliases` as follows[2] (make sure to replace `$T2HOME` with the actual path, e.g., `$HOME/tranalyzer2-0.7.0lm1/trunk`):

```
# $HOME/.bashrc

if [ -f "$T2HOME/scripts/t2_aliases" ]; then
    . "$T2HOME/scripts/t2_aliases"            # Note the leading '.'
fi
```

2.2.1 Required plugins

The following plugins must be loaded for `t2fm` to produce a useful report:

- `basicFlow`
- `basicStats`
- `txtSink`

2.2.2 Optional plugins

The following plugins are optional:

- `arpDecode`
- `dnsDecode`
- `geoip`
- `pwX`
- `sshDecode`
- `sslDecode`
- `httpSniffer`, configured as follows[3]:
  - `HTTP_SAVE_IMAGE=1`
  - `HTTP_SAVE_VIDEO=1`
  - `HTTP_SAVE_AUDIO=1`
  - `HTTP_SAVE_MSG=1`
  - `HTTP_SAVE_TEXT=1`
  - `HTTP_SAVE_APPL=1`
- `nDPI`, configured as follows:
  - `NDPI_OUTPUT_STR=1`
- `portClassifier`, configured as follows:
  - `PBC_NUM=1`
  - `PBC_STR=1`

If one of those plugin is not loaded, messages like `N/A: dnsDecode plugin required` will be displayed in the PDF where the information could not be accessed.

[2] Refer to the file `README.md` or to the documentation for more details

[3] This is only required to report information about EXE downloaded

2.2.3 Packages

The following packages are required to build the PDF:

- texlive-latex-extra
- texlive-fonts-recommended

2.3 Step-by-Step Instructions (PCAP to PDF)

For simplicity, this tutorial assumes the user wants a complete report, i.e., requires all of the optional plugins.

1. Make sure all the plugins are configured as described in Section 2.2
2. Build Tranalyzer and the plugins [4]:
   `t2build tranalyzer2 basicFlow basicStats txtSink arpDecode dnsDecode geoip \`
   `httpSniffer nDPI portClassifier pwX sshDecode sslDecode`
   (Note that those first two steps can be omitted if `t2fm -b` option is used)
3. Run `t2fm` directly on the PCAP file (the report will be named `file.pdf`):
   `t2fm -r file.pcap`
4. Open the generated PDF report `file.pdf`:
   `evince file.pdf`

2.4 Step-by-Step Instructions (flow file to PDF)

Alternatively, if you prefer to run Tranalyzer yourself or already have access to a flow file, replace step 3 with the following steps:

1. Follow point 1 and 2 from Section 2.3
2. Run Tranalyzer on a pcap file as follows:
   `t2 -r file.pcap -w out`
3. The previous command should have created the following files:
   `out_headers.txt`
   `out_flows.txt`
4. Run the `t2fm` script on the flow file generated previously:
   `t2fm -F out_flows.txt`

2.5 Step-by-Step Instructions (MongoDB / PostgreSQL to PDF)

If the `mongoSink` or `psqlSink` plugins were loaded, t2fm can use the created databases to generate the report (faster).

1. Follow point 1 and 2 from Section 2.3[5]
2. Build the `mongoSink` or `psqlSink` plugin:
   - **mongoDB:** `t2build mongoSink`

[4] Hint: use the tab completion to avoid typing the full name of all the plugins: `t2build tr<tab> ... ht<tab> ...`
[5] `HTTP_SAVE_*` do not need to be set as EXE downloads detection is currently not implemented in the DB backends

- **postgreSQL:** `t2build psqlSink`

3. Run Tranalyzer on a pcap file as follows:
   `t2 -r file.pcap -w out`
4. Run the `t2fm` script on the database generated previously:
   - **mongoDB:** `t2fm -m tranalyzer`
   - **postgreSQL:** `t2fm -p tranalyzer`

When generating a report from a database a time range to query can be specified with the `-T` option. The complete format is as follows: `YYYY-MM-DD HH:MM:SS.USEC([+-]OFFSET|Z)`, e.g., `2018-10-01 12:34:56.912345+0100`. Note that only the required fields must be specified, e.g., `2018-09-01` is equivalent to `2018-09-01 00:00:00.000000`. For example, to generate a report from the 1st of September to the 11. of October 2018 at 14:59 from a PostgreSQL database, run the following command: `t2fm -p tranalyzer -T "2018-09-01" "2018-10-11 14:59"`

2.6 Conclusion

This tutorial has presented how `t2fm` can be used to create a PDF report summarising the traffic contained in a PCAP file. Although not discussed in this tutorial, it is also possible to use `t2fm` on a live interface (`-i` option) or on a list of PCAP files (`-R` option). For more details, refer to `t2fm` man page or use `t2fm --help`.

3 tawk

3.1 Description

This document describes tawk and its functionalities. tawk works just like awk, but provides access to the columns via their names. In addition, it provides access to helper functions, such as `host()` or `port()`. Custom functions can be added in the folder named `t2custom` where they will be automatically loaded.

3.2 Dependencies

gawk version 4.1 is required.

Kali/Ubuntu: `sudo apt-get install gawk`

Arch: `sudo pacman -S gawk`

Fedora/Red Hat: `sudo yum install gawk`

Gentoo: `sudo emerge gawk`

OpenSUSE: `sudo zypper install gawk`

Mac OS X: `brew install gawk`[6]

3.3 Installation

The recommended way to install `tawk` is to install `t2_aliases` as documented in `README.md`:

- Append the following line to `~/.bashrc` (make sure to replace `$T2HOME` with the actual path, e.g., `$HOME/tranalyzer2-0.8.3`):

```
if [ -f "$T2HOME/scripts/t2_aliases" ]; then
    . $T2HOME/scripts/t2_aliases            # Note the leading '.'
fi
```

3.3.1 Man Pages

The man pages for `tawk` and `t2nfdump` can be installed by running: `./install.sh man`. Once installed, they can be consulted by running `man tawk` and `man t2nfdump` respectively.

[6] Brew is a packet manager for Mac OS X that can be found here: https://brew.sh

3.4 Usage

- To list the column numbers and names: `tawk -l file_flows.txt`
- To list the column numbers and names as 3 columns: `tawk -l=3 file_flows.txt`
- To list the available functions: `tawk -g file_flows.txt`
- To list the available functions as 3 columns: `tawk -g=3 file_flows.txt`
- To save the original filename and filter used: `tawk -c 'FILTER' file_flows.txt > file.txt`
- To extract all ICMP flows and the header: `tawk 'hdr() || $l4Proto == 1' file_flows.txt > icmp.txt`
- To extract all ICMP flows without the header: `tawk -H 'icmp()' file_flows.txt > icmp.txt`
- To extract the flow with index 1234: `tawk '$flowInd == 1234' file_flows.txt`
- To extract all DNS flows and the header: `tawk 'hdr() || strtonum($dnsStat)' file_flows.txt`
- To consult the documentation for the function 'func': `tawk -d func`
- To consult the documentation for the functions 'min' and 'max': `tawk -d min,max`
- To consult the documentation for all the available functions: `tawk -d all`
- To consult the documentation for the variable 'var': `tawk -V var`
- To consult the documentation for the variable 'var' with value `0x8a`: `tawk -V var=0x8a`
- To convert the output to JSON: `tawk '{ print json($flowStat "\t" tuple5()) }' file_flows.txt`
- To convert the output to JSON: `tawk 'aggr(tuple2())' file_flows.txt | tawk '{ print json($0) }'`
- To create a PCAP with all packets from flow 42: `tawk -x flow42.pcap '$flowInd == 42' file_flows.txt`
- To see all ICMP packets in Wireshark: `tawk -k 'imcp()' file_flows.txt`

For a complete list of options, use the `-h` option.

Note that an option not recognized by tawk is internally passed to awk/gawk. One of the most useful is the `-v` option to set the value of a variable:

- Changing the output field separator:
  `tawk -v OFS=',' '{ print $col1, $col2 }' file.txt`
- Passing a variable to tawk:
  `tawk -v myvar=myvalue '{ print $col1, myvar }' file.txt`

For a complete list of options, run `awk -h`.

3.5 `-s` Option

The `-s` option can be used to specify the starting character(s) of the row containing the column names (default: `'%'`). If several rows start with the specified character(s), then the last one is used as column names. To change this behaviour, the line number can be specified as well. For example if row 1 to 5 start with `'#'` and row 3 contains the column names, specify the separator as follows: `tawk -s '#NR==3'` If the row with column names does not start with a special character, use `-s ''` or `-s 'NR==2'`.

3.6 Related Utilities

3.6.1 awkf

Configures `awk` to use tabs, i.e., '`\t`' as input and output separator (prevents issue with repetitive values), e.g., `awkf '{ print $4 }' file_flows.txt`

3.6.2 lsx

Displays columns with fixed width (default: 40), e.g., `lsx file_flows.txt` or `lsx 45 file_flows.txt`

3.6.3 sortu

Sort rows and count the number of times a given row appears, then sort by the most occuring rows. (Alias for `sort | uniq -c | sort -rn`). Useful, e.g., to analyse the most occuring user-agents: `tawk '{ print $httpUsrAg }' FILE_flows.txt | sortu`

3.6.4 tcol

Displays columns with minimum width, e.g., `tcol file_flows.txt`.

3.7 Functions

Collection of functions for `tawk`:

- Parameters between brackets are optional,
- IPs can be given as string (`"1.2.3.4"`), hexadecimal (`0xffffffff`) or int (`4294967295`),
- Network masks can be given as string (`"255.255.255.0"`), hexadecimal (`0xffffff00`) or CIDR notation (`24`),
- Networks can be given as string, hexadecimal or int, e.g., `"1.2.3.4/24"` or `"0x01020304/255.255.255.0"`,
- String functions can be made case insensitive by adding the suffix `i`, e.g., `streq` → `streqi`,
- Some examples are provided below,
- More details and examples can be found for every function by running `tawk -d funcname`.

Function	Description
`hdr()`	Use this function in your tests to keep the header (column names)
`tuple2()`	Returns the 2 tuple (source IP and destination IP)
`tuple3()`	Returns the 3 tuple (source IP, destination IP and port)
`tuple4()`	Returns the 4 tuple (source IP and port, destination IP and port)
`tuple5()`	Returns the 5 tuple (source IP and port, destination IP and port, protocol)
`tuple6()`	Returns the 6 tuple (source IP and port, dest. IP and port, proto, VLANID)
`host([ip|net])`	Returns true if the source or destination IP is equal to `ip` or belongs to `net` If `ip` is omitted, returns the source and destination IP
`shost([ip|net])`	Returns true if the source IP is equal to `ip` or belongs to `net`

Function	Description
	If `ip` is omitted, returns the source IP
`dhost([ip|net])`	Returns true if the destination IP is equal to `ip` or belongs to `net` If `ip` is omitted, returns the destination IP
`net([ip|net])`	Alias for `host([ip|net])`
`snet([ip|net])`	Alias for `shost([ip|net])`
`dnet([ip|net])`	Alias for `dhost([ip|net])`
`loopback(ip)`	Returns true if `ip` is a loopback address
`mcast(ip)`	Returns true if `ip` is a multicast address
`privip(ip)`	Returns true if `ip` is a private IP
`port([p])`	Returns true if the source or destination port is equal to `p` (multiple ports or port ranges can also be specified) If `p` is omitted, returns the source and destination port
`sport([p])`	Returns true if the source port is equal to `p` If `p` is omitted, returns the source port
`dport([p])`	Returns true if the destination port is equal to `p` If `p` is omitted, returns the destination port
`ip()`	Returns true if the flow contains IPv4 or IPv6 traffic
`ipv4()`	Returns true if the flow contains IPv4 traffic
`ipv6()`	Returns true if the flow contains IPv6 traffic
`proto([p])`	Returns true if the protocol is equal to `p` If `p` is omitted, returns the string representation of the protocol
`proto2str(p)`	Returns the string representation of the protocol number `p` If `p` is omitted, returns the protocol
`icmp([p])`	Returns true if the protocol is equal to 1 (ICMP)
`igmp([p])`	Returns true if the protocol is equal to 2 (IGMP)
`tcp([p])`	Returns true if the protocol is equal to 6 (TCP)
`udp([p])`	Returns true if the protocol is equal to 17 (UDP)
`rsvp([p])`	Returns true if the protocol is equal to 46 (RSVP)
`gre([p])`	Returns true if the protocol is equal to 47 (GRE)
`esp([p])`	Returns true if the protocol is equal to 50 (ESP)
`ah([p])`	Returns true if the protocol is equal to 51 (AH)
`icmp6([p])`	Returns true if the protocol is equal to 58 (ICMPv6)
`sctp([p])`	Returns true if the protocol is equal to 132 (SCTP)
`dhcp()`	Returns true if the flow contains DHCP traffic
`dns()`	Returns true if the flow contains DNS traffic
`http()`	Returns true if the flow contains HTTP traffic
`tcpflags([val])`	If `val` is specified, returns true if the specified flags are set. If `val` is omitted, returns a string representation of the TCP flags

Function	Description
ip2num(ip)	Converts an IP address to a number
ip2hex(ip)	Converts an IPv4 address to hex
ip2str(ip)	Converts an IPv4 address to string
ip62str(ip)	Converts an IPv6 address to string
ip6compress(ip)	Compresses an IPv6 address
ip6expand(ip[,trim])	Expands an IPv6 address. If trim is different from 0, removes leading zeros
ip2mask(ip)	Converts an IP address to a network mask (int)
mask2ip(m)	Converts a network mask (int) to an IPv4 address (int)
mask2ipstr(m)	Converts a network mask (int) to an IPv4 address (string)
mask2ip6(m)	Converts a network mask (int) to an IPv6 address (int)
mask2ip6str(m)	Converts a network mask (int) to an IPv6 address (string)
ipinnet(ip,net[,mask])	Tests whether an IP address belongs to a given network
ipinrange(ip,low,high)	Tests whether an IP address lies between two addresses
localtime(t)	Converts UNIX timestamp to string (localtime)
utc(t)	Converts UNIX timestamp to string (UTC)
timestamp(t)	Converts date to UNIX timestamp
t2split(val,sep [,num[,osep]])	Splits values according to sep. If num is omitted or 0, val is split into osep separated columns. If num > 0, returns the num repetition. If num < 0, returns the num repetition from the end, e.g., -1 for last element. Multiple num can be specified, e.g., "1;-1;2". Output separator osep, defaults to OFS.
splitc(val[,num[,osep]])	Splits compound values. Alias for t2split(val, "_", num, osep)
splitr(val[,num[,osep]])	Splits repetitive values. Alias for t2split(val, ";", num, osep)
valcontains(val,sep,item)	Returns true if one item of val split by sep is equal to item.
cvalcontains(val,item)	Alias for valcontains(val, "_", item)
rvalcontains(val,item)	Alias for valcontains(val, ";", item)
strisempty(val)	Returns true if val is an empty string
streq(val1,val2)	Returns true if val1 is equal to val2
strneq(val1,val2)	Returns true if val1 and val2 are not equal
hasprefix(val,pre)	Returns true if val begins with the prefix pre
hassuffix(val,suf)	Returns true if val finished with the suffix suf
contains(val,txt)	Returns true if val contains the substring txt
not(q)	Returns the logical negation of a query q. This function must be used to keep the header when negating a query.
bfeq(val1,val2)	Returns true if the hexadecimal numbers val1 and val2 are equal
bitsallset(val,mask)	Returns true if all the bits set in mask are also set in val

Function	Description
bitsanyset(val,mask)	Returns true if one of the bits set in mask is also set in val
isip(v)	Returns true if v is an IPv4 address in hexadecimal, numerical or dotted decimal notation
isip6(v)	Returns true if v is an IPv6 address
isiphex(v)	Returns true if v is an IPv4 address in hexadecimal notation
isipnum(v)	Returns true if v is an IPv4 address in numerical (int) notation
isipstr(v)	Returns true if v is an IPv4 address in dotted decimal notation
isnum(v)	Returns true if v is a number
join(a,s)	Converts an array to string, separating each value with s
unquote(s)	Removes leading and trailing quotes from a string
chomp(s)	Removes leading and trailing spaces from a string
strip(s)	Removes leading and trailing spaces from a string
lstrip(s)	Removes leading spaces from a string
rstrip(s)	Removes trailing spaces from a string
mean(c)	Computes the mean value of a column c. The result can be accessed with get_mean(c) or printed with print_mean([c])
min(c)	Keep track of the min value of a column c. The result can be accessed with get_min(c) or printed with print_min([c])
max(c)	Keep track of the max value of a column c. The result can be accessed with get_max(c) or printed with print_max([c])
abs(v)	Returns the absolute value of v
min2(a,b)	Returns the minimum value between a and b
min3(a,b,c)	Returns the minimum value between a, b and c
max2(a,b)	Returns the maximum value between a and b
max3(a,b,c)	Returns the maximum value between a, b and c
aggr(fields[,val[,num]])	Performs aggregation of fields and store the sum of val. fields and val can be tab separated lists of fields, e.g., $srcIP4"\t"$dstIP4 Results are sorted according to the first value of val. If val is omitted or equal to "flows", counts the number of flows. If num is omitted or 0, returns the full list, If num > 0 returns the top num results, If num < 0 returns the bottom num results.
aggrrep(fields[,val[,num[,ign_e[,sep]]]])	Performs aggregation of the repetitive fields and store the sum of val. val can be a tab separated lists of fields, e.g., $numBytesSnt"\t"$numPktsSnt Results are sorted according to the first value of val. If val is omitted or equal to "flows", counts the number of flows. If num is omitted or 0, returns the full list, If num > 0 returns the top num results, If num < 0 returns the bottom num results. If ign_e is omitted or 0, consider all values, otherwise ignore emtpy values.

Function	Description
	sep can be used to change the separator character (default: ";")
t2sort(col[,num[,type]])	Sorts the file according to col. If num is omitted or 0, returns the full list, If num > 0 returns the top num results, If num < 0 returns the bottom num results. type can be used to specify the type of data to sort: "ip", "num" or "str" (default is based on the first matching record)
wildcard(expr)	Print all columns whose name matches the regular expression expr. If expr is preceded by an exclamation mark, returns all columns whose name does **NOT** match expr
hrnum(num[,mode[,suffix]])	Convert the number num to its human readable form.
json(s)	Convert the string s to JSON. The first record is used as column names.
texscape(s)	Escape the string s to make it LaTeX compatible
base64d(s)	Decode a base64 encoded string s
urldecode(url)	Decode the encoded URL url
printerr(s)	Prints the string s in red with an added newline
diff(file[,mode])	Compares file and the input, and prints the name of the columns which differ. The mode parameter can be used to control the format of the output.
ffsplit([s[,k[,h]]])	Split the input file into smaller more manageable files. The files to create can be specified as argument to the function (one comma separated string). If no argument is specified, creates one file per column whose name ends with Stat, e.g., dnsStat, and one for pwxType (pw) and covertChannels (cc). If k > 0, then only print relevant fields and those controlled by h, a comma separated list of fields to keep in each file, e.g., "srcIP,dstIP"
flow(f)	Returns all flows whose index appears in f
packet(p)	Returns all packets whose number appears in f
shark(q)	Query flow files according to Wireshark's syntax

3.8 Examples

Collection of examples using tawk functions:

Function	Description
covertChans([val[,num]])	Returns information about hosts possibly involved in a covert channels. If val is omitted or equal to "flows", counts the number of flows. Otherwise, sums up the values of val. If num is omitted or 0, returns the full list, If num > 0 returns the top num results,

Function	Description
	If num < 0 returns the bottom num results.
dnsZT()	Returns all flows where a DNS zone transfer was performed.
exeDL([n])	Returns the top N EXE downloads.
httpHostsURL([f])	Returns all HTTP hosts and a list of the files hosted (sorted alphabetically). If f > 0, prints the number of times a URL was requested.
nonstdports()	Returns all flows running protocols over non-standard ports.
passwords([val[,num]])	Returns information about hosts sending authentication in cleartext. If val is omitted or equal to "flows", counts the number of flows. Otherwise, sums up the values of val. If num is omitted or 0, returns the full list, If num > 0 returns the top num results, If num < 0 returns the bottom num results.
postQryStr([n])	Returns the top N POST requests with query strings.
ssh()	Returns the SSH connections.
topDnsA([n])	Returns the top N DNS answers.
topDnsIp4([n])	Returns the top N DNS answers IPv4 addresses.
topDnsIp6([n])	Returns the top N DNS answers IPv6 addresses.
topDnsQ([n])	Returns the top N DNS queries.
topHttpMimesST([n])	Returns the top HTTP content-type (type/subtype).
topHttpMimesT([n])	Returns the top HTTP content-type (type only).
topSLD([n])	Returns the top N second-level domains queried (google.com, yahoo.com, ...).
topTLD([n])	Returns the top N top-level domains (TLD) queried (.com, .net, ...).

3.9 t2nfdump

Collection of functions for tawk allowing access to specific fields using a syntax similar as nfdump.

Function	Description
ts()	Start Time — first seen
te()	End Time — last seen
td()	Duration
pr()	Protocol
sa()	Source Address
da()	Destination Address

Function	Description
sap()	Source Address:Port
dap()	Destination Address:Port
sp()	Source Port
dp()	Destination Port
pkt()	Packets — default input
ipkt()	Input Packets
opkt()	Output Packets
byt()	Bytes — default input
ibyt()	Input Bytes
obyt()	Output Bytes
flg()	TCP Flags
mpls1()	MPLS label 1
mpls2()	MPLS label 2
mpls3()	MPLS label 3
mpls4()	MPLS label 4
mpls5()	MPLS label 5
mpls6()	MPLS label 6
mpls7()	MPLS label 7
mpls8()	MPLS label 8
mpls9()	MPLS label 9
mpls10()	MPLS label 10
mpls()	MPLS labels 1–10
bps()	Bits per second
pps()	Packets per second
bpp()	Bytes per package
oline()	nfdump line output format (-o line)
olong()	nfdump long output format (-o long)
oextended()	nfdump extended output format (-o extended)

3.10 t2custom

Copy your own functions in this folder. Refer to Section 3.11 for more details on how to write a tawk function. To have your functions automatically loaded, include them in the file t2custom/t2custom.load.

3.11 Writing a tawk Function

- Ideally one function per file (where the filename is the name of the function)
- Private functions are prefixed with an underscore
- Always declare local variables 8 spaces after the function arguments
- Local variables are prefixed with an underscore
- Use uppercase letters and two leading and two trailing underscores for global variables
- Include all referenced functions

- Files should be structured as follows:

```
#!/usr/bin/env awk
#
# Function description
#
# Parameters:
#   - arg1: description
#   - arg2: description (optional)
#
# Dependencies:
#   - plugin1
#   - plugin2 (optional)
#
# Examples:
#   - tawk 'funcname()' file.txt
#   - tawk '{ print funcname() }' file.txt

@include "hdr"
@include "_validate_col"

function funcname(arg1, arg2, [8 spaces] _locvar1, _locvar2) {
    _locvar1 = _validate_col("colname1;altcolname1", _my_colname1)
    _validate_col("colname2")

    if (hdr()) {
        if (__PRIHDR__) print "header"
    } else {
        print "something", $_locvar1, $colname2
    }
}
```

3.12 Using tawk Within Scripts

To use `tawk` from within a script:

1. Create a `TAWK` variable pointing to the script: `TAWK="$T2HOME/scripts/tawk/tawk"`
2. Call `tawk` as follows: `$TAWK 'dport(80)' file.txt`

3.13 Using tawk With Non-Tranalyzer Files

`tawk` can also be used with files which were not produced by Tranalyzer.

- The input field separator can be specified with the `-F` option, e.g., `tawk -F ',' 'program' file.csv`
- The row listing the column names, can start with any character specified with the `-s` option, e.g., `tawk -s '#' 'program' file.txt`
- All the column names must not be equal to a function name

- Valid column names must start with a letter (`a-z`, `A-Z`) and can be followed by any number of alphanumeric characters or underscores
- If no column names are present, use the `-t` option to prevent tawk from trying to validate the column names.
- If the column names are different from those used by Tranalyzer, refer to Section 3.13.1.

3.13.1 Mapping External Column Names to Tranalyzer Column Names

If the column names are different from those used by Tranalyzer, a mapping between the different names can be made in the file `my_vars`. The format of the file is as follows:

```
BEGIN {
    _my_srcIP = non_t2_name_for_srcIP
    _my_dstIP = non_t2_name_for_dstIP
    ...
}
```

Once edited, run tawk with the `-i $T2HOME/scripts/tawk/my_vars` option and the external column names will be automatically used by tawk functions, such as `tuple2()`. For more details, refer to the `my_vars` file.

3.13.2 Using tawk with Bro Files

To use tawk with Bro log files, use the following command:

```
tawk -s '#fields' -i $T2HOME/scripts/tawk/vars_bro 'hdr() || !/^#/ { program }' file.log
```

3.14 Awk Cheat Sheet

- Tranalyzer flow files default field separator is '`\t`':
  - **Always** use `awk -F'\t'` (or `awkf`/`tawk`) when working with flow files.
- Load libraries, e.g., tawk functions, with `-i`: `awk -i file.awk 'program' file.txt`
- Always use `strtonum` with hex numbers (bitfields)
- Awk indices start at 1
- Using tawk is recommended.

3.14.1 Useful Variables

- `$0`: entire line
- `$1`, `$2`, ..., `$NF`: column 1, 2, ...
- `FS`: field separator
- `OFS`: output field separator
- `ORS`: output record separator
- `NF`: number of fields (columns)

- NR: record (line) number
- FNR: record (line) number relative to the current file
- FILENAME: name of current file
- To use external variables, use the -v option, e.g., `awk -v name="value" '{ print name }' file.txt`.

3.14.2 Awk Program Structure

```
awk -F'\t' -i min -v OFS='\t' -v h="$(hostname)" '
    BEGIN { a = 0; b = 0; }         # Called once at the beginning
    /^A/  { a++ }                   # Called for every row starting with char A
    /^B/  { b++ }                   # Called for every row starting with char B
          { c++ }                   # Called for every row
    END   { print h, min(a, b), c } # Called once at the end
' file.txt
```

3.15 Awk Templates

- Print the whole line:
  - `tawk '{ print }' file.txt`
  - `tawk '{ print $0 }' file.txt`
  - `tawk 'FILTER' file.txt`
  - `tawk 'FILTER { print }' file.txt`
  - `tawk 'FILTER { print $0 }' file.txt`
- Print selected columns only:
  - `tawk '{ print $srcIP4, $dstIP4 }' file.txt`
  - `tawk '{ print $1, $2 }' file.txt`
  - `tawk '{ print $4 "\t" $6 }' file.txt`
  - ```
    tawk '{
        for (i = 6; i < NF; i++) {
            printf "%s\t", $i
        }
        printf "%s\n", $NF
    }' file.txt
    ```
- Keep the column names:
  - `tawk 'hdr() || FILTER' file.txt`
  - `awkf 'NR == 1 || FILTER' file.txt`
  - `awkf '/^%/ || FILTER' file.txt`
  - `awkf '/^%[[:space:]]*[[:alpha:]][[:alnum:]_]*$/ || FILTER' file.txt`
- Skip the column names:
    ```

  - `tawk '!hdr() && FILTER' file.txt`
  - `awkf 'NR > 1 && FILTER' file.txt`
  - `awkf '!/^%/ && FILTER' file.txt`
  - `awkf '!/^%[[:space:]]*[[:alpha:]][[:alnum:]_]*$/ && FILTER' file.txt`

- Bitfields and hexadecimal numbers:

  - `tawk 'bfeq($3,0)' file.txt`
  - `awkf 'strtonum($3) == 0' file.txt`
  - `tawk 'bitsanyset($3,1)' file.txt`
  - `tawk 'bitsallset($3,0x81)' file.txt`
  - `awkf 'and(strtonum($3), 0x1)' file.txt`

- Split compound values:

  - `tawk '{ print splitc($16, 1) }' file.txt # first element`
  - `tawk '{ print splitc($16, -1) }' file.txt # last element`
  - `awkf '{ split($16, A, "_"); print A[1] }' file.txt`
  - `awkf '{ n = split($16, A, "_"); print A[n] }' file.txt # last element`
  - `tawk '{ print splitc($16) }' file.txt`
  - `awkf '{ split($16, A, "_"); for (i=1;i<=length(A);i++) print A[i] }' file.txt`

- Split repetitive values:

  - `tawk '{ print splitr($16, 3) }' file.txt # third repetition`
  - `tawk '{ print splitr($16, -2) }' file.txt # second to last repetition`
  - `awkf '{ split($16, A, ";"); print A[3] }' file.txt`
  - `awkf '{ n = split($16, A, ";"); print A[n] }' file.txt # last repetition`
  - `tawk '{ print splitr($16) }' file.txt`
  - `awkf '{ split($16, A, ";"); for (i=1;i<=length(A);i++) print A[i] }' file.txt`

- Filter out empty strings:

  - `tawk '!strisempty($4)' file.txt`
  - `awkf '!(length($4) == 0 || $4 == "\"\"")' file.txt`

- Compare strings (case sensitive):

  - `tawk 'streq($3,$4)' file.txt`
  - `awkf '$3 == $4' file.txt`
  - `awkf '$3 == \"text\"' file.txt`

- Compare strings (case insensitive):

  - `tawk 'streqi($3,$4)' file.txt`
  - `awkf 'tolower($3) == tolower($4)' file.txt`

- Use regular expressions on specific columns:
  - `awkf '$8 ~ /^192.168.1.[0-9]{1,3}$/' file.txt # print matching rows`
  - `awkf '$8 !~ /^192.168.1.[0-9]{1,3}$/' file.txt # print non-matching rows`
- Use column names in awk:
  - `tawk '{ print $srcIP4, $dstIP4 }' file.txt`
  - ```
    awkf '
        NR == 1 {
            for (i = 1; i <= NF; i++) {
                if ($i == "srcIP4") srcIP4 = i
                else if ($i == "dstIP4") dstIP4 = i
            }
            if (srcIP4 == 0 || dstIP4 == 0) {
                print "No column with name srcIP4 and/or dstIP4"
                exit
            }
        }
        NR > 1 {
            print $srcIP4, $dstIP4
        }
    ' file.txt
    ```
  - ```
    awkf '
        NR == 1 {
            for (i = 1; i <= NF; i++) {
                col[$i] = i
            }
        }
        NR > 1 {
            print $col["srcIP4"], $col["dstIP4"];
        }

    ' file.txt
    ```

3.16 Examples

1. Pivoting (variant 1):
   (a) First extract an attribute of interest, e.g., an unresolved IP address in the `Host:` field of the HTTP header:
   ```
   tawk 'aggr($httpHosts)' FILE_flows.txt | tawk '{ print unquote($1); exit }'
   ```
   (b) Then, put the result of the last command in the `badguy` variable and use it to extract flows involving this IP:
   ```
   tawk -v badguy="$(!!)" 'host(badguy)' FILE_flows.txt
   ```
2. Pivoting (variant 2):
   (a) First extract an attribute of interest, e.g., an unresolved IP address in the `Host:` field of the HTTP header, and store it into a `badip` variable:

```
badip="$(tawk 'aggr($httpHosts)' FILE_flows.txt | tawk '{ print unquote($1);exit }')"
```

(b) Then, use the `badip` variable to extract flows involving this IP:

```
tawk -v badguy="$badip" 'host(badguy)' FILE_flows.txt
```

3. Aggregate the number of bytes sent between source and destination addresses (independent of the protocol and port) and output the top 10 results:

```
tawk 'aggr($srcIP4 "\t" $dstIP4, $numBytesSnt, 10)' FILE_flows.txt
```

```
tawk 'aggr(tuple2(), $numBytesSnt "\t" "Flows", 10)' FILE_flows.txt
```

4. Sort the flow file according to the duration (longest flows first) and output the top 5 results:

```
tawk 't2sort(duration, 5)' FILE_flows.txt
```

5. Extract all TCP flows while keeping the header (column names):

```
tawk 'hdr() || tcp()' FILE_flows.txt
```

6. Extract all flows whose destination port is between 6000 and 6008 (included):

```
tawk 'dport("6000-6008")' FILE_flows.txt
```

7. Extract all flows whose destination port is 53, 80 or 8080:

```
tawk 'dport("53;80;8080")' FILE_flows.txt
```

8. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `host` or `net`):

```
tawk 'shost("192.168.1.0/24")' FILE_flows.txt
```

```
tawk 'snet("192.168.1.0/24")' FILE_flows.txt
```

9. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `ipinrange`):

```
tawk 'ipinrange($srcIP4, "192.168.1.0", "192.168.1.255")' FILE_flows.txt
```

10. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `ipinnet`):

```
tawk 'ipinnet($srcIP4, "192.168.1.0", "255.255.255.0")' FILE_flows.txt
```

11. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `ipinnet` and a hex mask):

```
tawk 'ipinnet($srcIP4, "192.168.1.0", 0xffffff00)' FILE_flows.txt
```

12. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `ipinnet` and the CIDR notation):

```
tawk 'ipinnet($srcIP4, "192.168.1.0/24")' FILE_flows.txt
```

13. Extract all flows whose source IP is in subnet 192.168.1.0/24 (using `ipinnet` and a CIDR mask):

```
tawk 'ipinnet($srcIP4, "192.168.1.0", 24)' FILE_flows.txt
```

For more examples, refer to tawk `-d` option, e.g., `tawk -d aggr`, where every function is documented and comes with a set of examples. The complete documentation can be consulted by running `tawk -d all`.

3.17 FAQ

3.17.1 Can I use tawk with non Tranalyzer files?

Yes, refer to Section 3.13.

3.17.2 Can I use tawk functions with non Tranalyzer column names?

Yes, edit the `my_vars` file and load it using `-i $T2HOME/scripts/tawk/my_vars` option. Refer to Section 3.13.1 for more details.

3.17.3 Can I use tawk with files without column names?

Yes, use the `-t` option to prevent tawk from trying to validate the column names.

3.17.4 The row listing the column names start with a '#' instead of a '%'... Can I still use tawk?

Yes, use the `-s` option to specify the first character, e.g., `tawk -s '#' 'program'`

3.17.5 Can I process a CSV (Comma Separated Value) file with tawk?

The input field separator can be changed with the `-F` option. To process a CSV file, run tawk as follows:
`tawk -F ',' 'program' file.csv`

3.17.6 Can I produce a CSV (Comma Separated Value) file from tawk?

The output field separator (`OFS`) can be changed with the `-v OFS='char'` option. To produce a CSV file, run tawk as follows: `tawk -v OFS=',' 'program' file.txt`

3.17.7 Can I write my tawk programs in a file instead of the command line?

Yes, copy the program (without the single quotes) in a file, e.g., `prog.txt` and run it as follows:
`tawk -f prog.txt file.txt`

3.17.8 Can I still use column names if I pipe data into tawk?

Yes, you can specify a file containing the column names with the `-I` option as follows:
`cat file.txt | tawk -I colnames.txt 'program'`

3.17.9 Can I use tawk if the row with the column names does not start with a special character?

Yes, you can specify the empty character with `-s ""`. Refer to Section 3.5 for more details.

3.17.10 I get a list of syntax errors from gawk... what is the problem?

The name of the columns is used to create variable names. If it contains forbidden characters, then an error similar to the following is reported.

```
gawk: /tmp/fileBndhdf:3: col-name = 3
gawk: /tmp/fileBndhdf:3:          ^ syntax error
```

Although tawk will try to replace forbidden characters with underscore, the best practice is to use only alphanumeric characters (`A-Z`, `a-z`, `0-9`) and underscore as column names. Note that a column name **MUST NOT** start with a number.

3.17.11 Tawk cannot find the column names... what is the problem?

First, make sure the comment char (`-s` option) is correctly set for your file (the default is `'%'`). Second, make sure the column names do not contain forbidden characters, i.e., use only alphanumeric and underscore and do not start with a number. If the row with column names is not the last one to start with the separator character, then specify the line number (`NR`) as follows: `-s '#NR==3'` or `-s '%NR==2'`. Refer to Section 3.5 for more details.

3.17.12 How to make tawk faster?

Tawk tries to validate the column names by ensuring that no column names is equal to a function name and that all column names used in the program exist. This verification process is quite slow and can easily by disabled by using the `-t` option.

3.17.13 Wireshark refuses to open PCAP files generated with tawk `-k` option...

If Wireshark displays the message `Couldn't run /usr/bin/dumpcap in child process: Permission Denied.`, then this means that your user does not belong to the `wireshark` group. To fix this issue, simply run the following command `sudo gpasswd -a YOUR_USERNAME wireshark` (you will then need to log off and on again).