Analyzing 128T Traffic using analyzer.py

The `analyzer.py` tool was designed to help administrators quickly parse through the mountains of data supplied by a 128T Session Smart router, to identify patterns of usage. The information it provides is invaluable for several key workflows:

- Identifying unknown/unexpected network traffic. The `analyzer.py` tool can bring "hidden traffic" to the forefront, for scrutiny by network administrators, security analysts, etc.
- Understanding the composition of the traffic on a network, for the purposes of subsequent service definition, traffic shaping, routing policies, etc.
- Enumerating the various application protocols in use on the network, which can be used to fine-tune `session-type` timer values, to optimize performance

This document walks through applying the `analyzer.py` tool, with several illustrative use cases.

Basic Operation

All good analysis operations begin by simply invoking `analyzer.py` without any command line options to filter the output. As discussed in the README file, this is either done in *online mode* or *offline mode*.

Online mode:

```
[root@labsystem1 ~]# analyzer.py -r newton
```

Offline mode:

```
[root@labsystem1 ~]# analyzer.py -i newton.txt
```

This will produce tabular data that shows "top ten lists" for the most popular services, destinations (forward and reverse), TCP protocols, and UDP protocols.

> Regarding *forward* and *reverse* destinations: sessions processed by a 128T device will consist of forward flows and reverse flows. The forward flow contains the addresses seen by the router upon receipt of the first packet in the forward direction. The reverse flow contains the addresses seen by the router upon receipt of the first packet in the reverse direction. As such, the output can vary significantly depending on whether the router being investigated is receiving "underlay" traffic, or whether it is receiving *Secure Vector Routing* traffic.

> For example: when a client on the LAN of a branch location sends a packet to its local 128T, the forward flow will have the client's IP address as the source, and the destination it's targeting as the destination. Presuming he branch router forwards this using SVR to a head end router at a data center, the first packet received by the data center router will have the branch 128T device's *waypoint* as its source, and its own waypoint as the destination for the forward flow.
>
> After the data center router forwards that packet on to the server, the reverse packet comes back from the server with its address as the source and the client's (LAN) address as the destination. This is what will populate the source and destination IP addresses of the reverse flow, respectively. This is sent over SVR to the branch 128T, *which will see the waypoint addresses as the source and destination address of the reverse flow*.
>
> When accumulating "forward" and "reverse" destinations, the `analyzer.py` script will tabulate the destination addresses for forward flows, and the source addresses for reverse flows. Thus, on branch routers where the majority of traffic is generated toward the data center, the forward destinations are much more relevant; likewise, on data center routers that are the aggregation point for branch traffic, the reverse destinations are typically more relevant.

The tabular data shown by `analyzer.py` will resemble the following:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	98906	192.0.2.222	52489	10.4.50.203	8137	445	9014	137	17726
msft-ad	15802	203.0.113.65	12611	10.4.50.204	7487	8883	5664	389	16119
internet	5834	10.37.226.31	1903	172.16.51.136	3514	10123	4844	902	2739
site01-summary	5158	10.35.34.31	1900	10.3.116.161	2670	443	3841	123	1612
site02-summary	5132	10.34.66.31	1896	10.3.116.85	2606	80	2295	53	1565
site03-summary	4890	10.39.66.31	1879	10.3.119.142	2454	25000	1811	161	751
site04-summary	4674	10.38.66.31	1872	10.3.116.53	2365	9440	826	514	462
site05-summary	4608	192.168.128.129	390	10.3.118.125	2326	389	469	1813	363
dns-traffic	1788	10.40.193.31	201	10.11.222.177	2179	1433	329	500	357
datacenter-lan	1158	10.18.67.62	109	172.16.78.184	1813	48002	299	16409	290

This excerpt is from a busy head end system, with approximately 80,000 active sessions. Each of these sessions is comprised of a forward and reverse flow, and each *Count* in the table will tally a matching flow. (This is why the `Service Name` field is "double counting" the number of sessions for each service.)

This head end is the termination point (hub) for a lot of traffic from the branch sites (spokes). As such, we can see that the overwhelming majority of the "Fwd Dest" flows use `192.0.2.222` and `203.0.113.65`. These are the two waypoint addresses on our head end. The `10.` addresses that make up the rest of the Fwd Dest flows are sessions originating in the data center and heading toward the branches.

> Having some passing familiarity with the topology of the deployment and some of the key addresses (such as the circuit IPs, or "waypoints" on the head end) will benefit you. That said, with a little practice you will be able to identify these fairly quickly even without committing these addresses to memory. Most head end systems see the vast majority of their traffic coming inbound toward resources in the data center, so it is quite common to have the top

> hitters of the Fwd Dest traffic be its waypoints. For the same reason, the top hitters in the Rev Dest column for branch sites will generally be its waypoint(s).

From here, we can explore the active sessions in a number of ways. The use cases in the following sections will take this same basic dataset and analyze it through different lenses, to illustrate some of the properties of the traffic this system is bearing.

Use Case: Session Timer Optimization

Each session's pair of flows created created upon receipt of a "first packet" will have expiry timers assigned to them; this timer for each is set at the time of the session's creation, and each flow decrements every second that it is idle. When an inbound packet hits a flow, its timer is reset to its initial expiry timer again, and the process continues. If neither flow within a session receives packets and both of them tick down to zero, the session is deleted. (TCP flows will also be marked for deletion when the socket is torn down by the session's participants; i.e., upon receipt of a TCP FIN or TCP RST.)

Unless there is configuration to override it, the default expiry timer for TCP-based traffic is 1,900 seconds and the default expiry timer for UDP-based traffic is 180 seconds. (TCP traffic has a nuance, in that there is a short timer set during the TCP handshake that is extended once the first TCP PSH is received.) Overriding configuration comes in the form of the `session-type` object. (For more information on the `session-type` object, refer to the 128T online documentation.)

Because TCP-based sessions have an obvious, signaled end, optimizing `session-type > timeout` values is less fruitful. (Unless you encounter some poorly-written TCP-based applications that abandon open sockets when they're done transacting.) But because UDP has no transport-signaled termination, these sessions will always last at least as long as the `session-type > timeout` value, or 180 seconds when nothing is explicitly configured.

There are many UDP protocols that are extremely short-lived; DNS is a classic example, where a client requests a name resolution and the server responds, completing the transaction with two packets (aside from some possible recursive lookups). For this reason, 128T software ships with *factory default* configuration for DNS, to set the `session-timer > timeout` correspondingly short at five seconds (configured in miliseconds):

```
admin@labsystem1.fiedler# conf auth session-type DNS
admin@labsystem1.fiedler (session-type[name=DNS])# show verbose
name           DNS
service-class  NetworkControl
timeout        5000

transport      udp
    protocol    udp

    port-range  53
        start-port  53
```

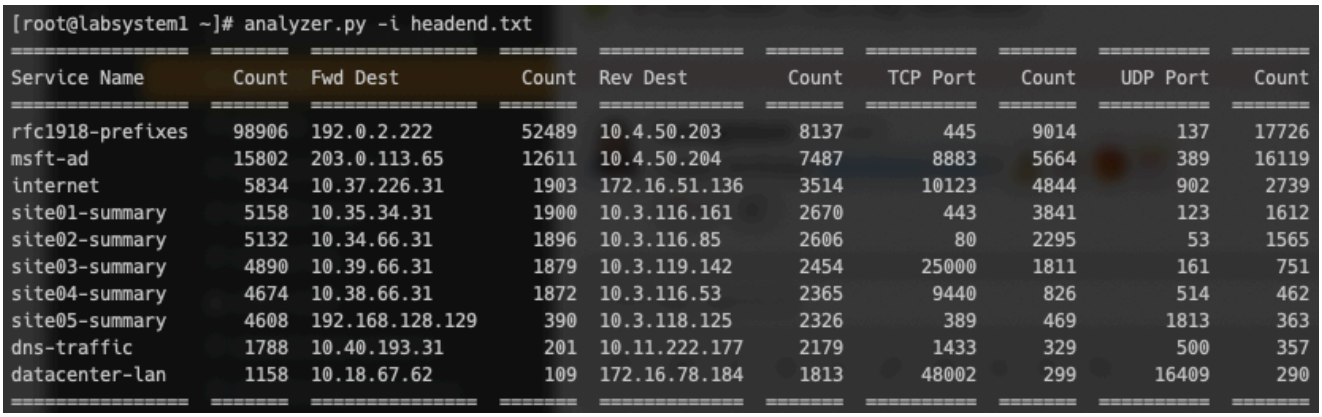
```
    exit
exit

transport      tcp
    protocol    tcp

    port-range  53
        start-port  53
    exit
exit
```

> Note: for factory a default configuration object, unless you have administratively overridden any of its parameters, it will only be displayed when adding the `verbose` flag to your `show` command.

Let's get back to our sample data:



```
[root@labsystem1 ~]# analyzer.py -i headend.txt
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	98906	192.0.2.222	52489	10.4.50.203	8137	445	9014	137	17726
msft-ad	15802	203.0.113.65	12611	10.4.50.204	7487	8883	5664	389	16119
internet	5834	10.37.226.31	1903	172.16.51.136	3514	10123	4844	902	2739
site01-summary	5158	10.35.34.31	1900	10.3.116.161	2670	443	3841	123	1612
site02-summary	5132	10.34.66.31	1896	10.3.116.85	2606	80	2295	53	1565
site03-summary	4890	10.39.66.31	1879	10.3.119.142	2454	25000	1811	161	751
site04-summary	4674	10.38.66.31	1872	10.3.116.53	2365	9440	826	514	462
site05-summary	4608	192.168.128.129	390	10.3.118.125	2326	389	469	1813	363
dns-traffic	1788	10.40.193.31	201	10.11.222.177	2179	1433	329	500	357
datacenter-lan	1158	10.18.67.62	109	172.16.78.184	1813	48002	299	16409	290

Here we can see that there are 17,726 flows using 137/UDP. Given that there are 80,000 sessions, this is a shockingly high percentage of traffic.

Microsoft's NetBIOS uses 137/UDP for a primordial equivalent to DNS. Its transactions, just like DNS transactions, are very quick: a name lookup and a response. By persisting these sessions for 180 seconds, the 128T device is unnecessarily retaining state for these transactions.

To shed more light on the 137/UDP traffic, we'll use the `-p` switch to filter the table to just NetBIOS traffic:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt -p 137
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	17689	10.34.66.33	11	172.17.1.203	7894			137	17726
site02-summary	21	10.34.66.49	9	172.17.1.204	7284				
site12-summary	3	10.37.109.115	2	172.17.1.202	1158				
site01-summary	3	10.37.226.128	2	172.17.1.201	982				
internet	2	10.37.250.115	1	172.16.28.65	274				
site07-summary	2	10.38.249.115	1	10.127.240.8	13				
datacenter-lan	1	10.27.34.49	1	10.127.240.232	12				
site08-summary	1	10.40.198.250	1	10.159.46.23	11				
site13-summary	1	10.35.86.115	1	172.17.1.200	6				
site14-summary	1	10.18.98.115	1	10.95.46.10	6				

This filtered view gives us some very interesting information. The 137/UDP traffic is overwhelmingly using the `rfc1918-prefixes` service, which in our sample deployment is used by the branch offices to contact resources at the head end. This means we should focus on the `Rev Dest` column to see which devices these packets are hitting. Here we can see they're mostly targeting 172.17.1.203 and .204.

Next, we can use the `analyzer.py` built-in histograph function to see how the refreshes are arriving:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt -p 137 -g
Expiry times
################################################################################
                                                                  873  163-180
                                                                  766  145-162
                                                                  794  127-144
                                                                  825  109-126
                                                                  858  91-108
                                                                  820  73-90
                                                                  839  55-72
                                                                  803  37-54
                                                                  721  19-36
                                                                10427  1-18
```

> Note: the histogram will show expired flows (those with a timeout of 0) in the bottommost bin, despite it being labeled as beginning at time = 1. The large number of sessions in the bottom bin of this graph is indicative of a problem with the system's ability to keep up with the purge of expired flows.

In this example we can see that there are approximately the same number of sessions in each of the histogram's bins. If these sessions were active conversations with ongoing traffic traversing in both directions, you would typically see the bars clustered near the top of the graph. If a UDP-based application has implemented some sort of keepalive mechansim (a heartbeat every 60 seconds, for example), you'd see a pronounced cliff after the 60 second bin, with a smattering of data in later stages.

In this example, however, we can conclude that the transactions are arriving at a steady pace, and that they are likely to be "single use" sessions: that is, one forward packet and one reverse packet. We can increase the number of bins to change the perspective, using the `-b` flag:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt -p 137 -g -b 20
Expiry times
################################################################################
██                                                                453  172-180
██                                                                420  163-171
██                                                                429  154-162
██                                                                337  145-153
██                                                                414  136-144
██                                                                380  127-135
██                                                                406  118-126
██                                                                419  109-117
██                                                                440  100-108
██                                                                418  91-99
██                                                                415  82-90
██                                                                405  73-81
██                                                                411  64-72
██                                                                428  55-63
██                                                                403  46-54
██                                                                400  37-45
██                                                                359  28-36
██                                                                362  19-27
██                                                                378  10-18
████████████████████████████████████████████████████████████████  10049  1-9
```

Again we see a smooth distribution. This helps validate the theory that these sessions are single use. To address this, we can create a `session-type` that accounts for this appplication's behavior:

```
admin@labsystem1.fiedler# show config running authority session-type NetBIOS

config

    authority

        session-type  NetBIOS
            name           NetBIOS
            description    "NetBIOS Name Service"
            service-class  LowLatencyData
            timeout        5000

            transport      udp
                protocol    udp
```

```
                port-range  137
                    start-port  137
                exit
            exit
        exit
    exit
exit

admin@labsystem1.fiedler#
```

Use Case: Identifying Undesirable Traffic

Now we will take a look at one of the remote sites. As always, start with a basic run of the `analyzer.py` application to get an overview of the site:

```
[root@labsystem1 ~]# analyzer.py -i site15.txt
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	51076	169.254.252.1	17492	10.11.2.222	17485	7680	12449	53	512
site15-summary	32758	10.3.117.209	10897	169.254.252.2	10905	443	2630	443	240
internet	3592	169.254.252.2	5502	169.254.252.1	8876	8883	468	902	104
dns-traffic	1578	108.177.122.94	157	204.227.140.65	1941	16403	443	5353	72
guest-wifi	1478	172.16.51.136	156	172.18.209.61	114	16445	414	1280	66
cloud-crm	110	10.11.222.177	151	172.18.222.13	101	16461	410	137	37
site15-management	70	172.16.51.137	110	172.18.222.12	99	16585	409	123	35
<BfdService>	66	172.16.78.150	94	172.18.203.228	88	16469	408	16609	31
_conductor_3	34	172.16.78.152	92	172.18.197.70	81	16431	403	16635	27
msfd-ad	34	108.177.122.95	89	172.18.207.120	81	16441	399	16595	27

Here we see that the predominant TCP application in use is port 7680. This is a port used by Microsoft Windows Update Download Optimizer (WUDO), which is a technique used by Microsoft to save WAN bandwidth by having Windows clients download patches and system updates from peers on their LAN. In this case, however, it's hitting the router. Let's filter it to just show the WUDO traffic by using the `-p` switch:

```
[root@labsystem1 ~]# analyzer.py -i site15.txt -p 7680
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	7210	10.111.6.25	13	172.18.222.13	101	7680	12449		
site15-summary	5246	10.111.20.131	13	172.18.222.12	99	52069	1		
		10.111.12.154	13	172.18.203.228	88	54606	1		
		10.111.22.163	13	172.18.197.70	81	50457	1		
		10.111.6.117	13	172.18.207.120	81	53255	1		
		10.111.4.75	12	172.18.198.53	78	52282	1		
		10.110.103.108	12	172.18.205.116	78	51924	1		
		10.157.4.51	12	172.18.208.20	76	55442	1		
		10.108.13.22	12	172.18.197.144	74				
		10.111.13.20	12	172.18.213.205	73				

Indeed this traffic is being sent out to the data center (via the `rfc1918-prefixes` service, which carries the traffic there) as well as coming inbound *from* the data center using the `site15-summary` service. So we can see that the WUDO traffic, which is ostensibly trying to save WAN bandwidth, is actually exacerbating the WAN bandwidth utilization at two locations.

From here we have several options:

- Create a service that is designed to block that traffic
- Work with the Windows team at the site to reconfigure the WUDO settings on the workstations
- Wait it out and let the workstations download their patches from each other

Below is an example service that could block this traffic at all branch sites, using the `router-group` tag `remote-sites`. (You *are* using `router-group` tags, aren't you??)

```
admin@labsystem1.fiedler# show config running authority service WUDO

config

    authority

        service  WUDO
            name                    WUDO

            applies-to              router-group
                type        router-group
                group-name  remote-sites
            exit
            description             "Microsoft Windows Update Download Optimizer"

            transport               tcp
                protocol    tcp

                port-range  7680
                    start-port  7680
                exit
            exit
            address                 0.0.0.0/0

            access-policy           trusted
                source      trusted
                permission  deny
            exit

            access-policy           guest
                source      guest
                permission  deny
```

```
            exit
            share-service-routes  false
        exit
    exit
exit
```

Use Case: Service Creation

Analyzing network traffic can also yield benefits in developing new *service* definitions. More than just merely blocklists, services can allow important traffic to "rise above the fray" and be given specific policies for treatment; this can include packet marking, route preferences, and aggregate bandwidth constraints.

Let's go back to our head end's baseline analysis:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	98906	192.0.2.222	52489	10.4.50.203	8137	445	9014	137	17726
msft-ad	15802	203.0.113.65	12611	10.4.50.204	7487	8883	5664	389	16119
internet	5834	10.37.226.31	1903	172.16.51.136	3514	10123	4844	902	2739
site01-summary	5158	10.35.34.31	1900	10.3.116.161	2670	443	3841	123	1612
site02-summary	5132	10.34.66.31	1896	10.3.116.85	2606	80	2295	53	1565
site03-summary	4890	10.39.66.31	1879	10.3.119.142	2454	25000	1811	161	751
site04-summary	4674	10.38.66.31	1872	10.3.116.53	2365	9440	826	514	462
site05-summary	4608	192.168.128.129	390	10.3.118.125	2326	389	469	1813	363
dns-traffic	1788	10.40.193.31	201	10.11.222.177	2179	1433	329	500	357
datacenter-lan	1158	10.18.67.62	109	172.16.78.184	1813	48002	299	16409	290

For this exercise we're going to pluck out 8883/TCP, the second biggest TCP application behind Microsoft SMB:

```
[root@labsystem1 ~]# analyzer.py -i headend.txt -p 8883
```

Service Name	Count	Fwd Dest	Count	Rev Dest	Count	TCP Port	Count	UDP Port	Count
rfc1918-prefixes	5653	10.26.134.63	1	172.16.78.150	990	8883	5664		
dmz-service	11	10.41.97.57	1	172.16.78.152	979	63846	1		
site06-summary	1	10.38.230.53	1	172.16.78.155	954	54230	1		
site07-summary	1	10.35.93.32	1	172.16.78.151	944	16004	1		
site08-summary	1	10.50.236.142	1	172.16.78.154	923	52955	1		
site09-summary	1	10.35.35.148	1	172.16.78.153	863	52702	1		
site04-summary	1	10.34.168.25	1	204.227.140.147	11	50047	1		
site05-summary	1	10.28.196.64	1			50730	1		
site10-summary	1					55593	1		
site11-summary	1								

With only a handful of exceptions, the McAfee traffic is hitting our control servers in the data center at 172.16.78.150 through .155. Creating a service from this data is a trivial task:

```
admin@labsystem1.fiedler# show config running authority service McAfee

config
```

```
    authority

        service  McAfee
            name                  McAfee
            description           "McAfee endpoint management"
            scope                 private
            address               172.16.78.150/32
            address               172.16.78.151/32
            address               172.16.78.152/32
            address               172.16.78.153/32
            address               172.16.78.154/32
            address               172.16.78.155/32

            access-policy         trusted
                source      trusted
                permission  allow
            exit
            service-policy        management-m2m
            share-service-routes  true
        exit
    exit
exit
```

Here we've defined our service for McAfee traffic, and given it an appropriate `service-policy` to ensure these clients get their security profiles successfully.