網路行為異常偵測

TANET2017論文 –與北區 ASOC共同發表

傳統網路分析之瓶頸與限制
Netflow

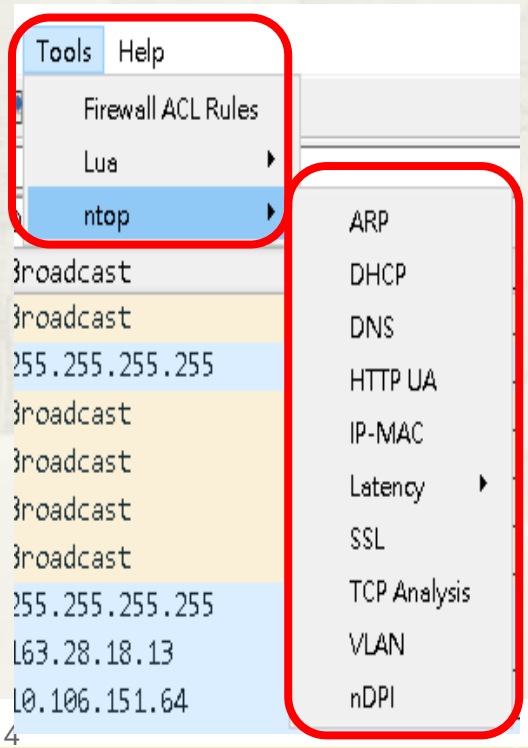
- Layer 2 mac address Level: 無法觀察
  - 無法偵測 broadcast storm, arp spoofing
- Layer 3 IP Level
  - 無法偵測同網段之網路連線行為
  - 無法即時反應網路連線資訊、僅能提供連線 Summary 結果
    - 路由器Netflow Active Time 預設 30分鐘: 一個持續檔案傳輸之連線需30分鐘後才會匯出 Summary傳輸結果資料
  - 無法觀察 TTL(Time to Live) 變化
- Layer 4 TCP Level: 有限分析
  - 無法觀察 TCP Sessions、TCP retrasmistion、Out of order、Duplicate ack ...
- Layer 7 Application Level: 無法分析

傳統網路分析之瓶頸與限制 Wireshark

- 見樹不見林:
  - 可詳細觀察每個封包所有欄位資訊，但缺乏整體統計與分析。
- 針對高速網路 10Gbps,100Gbps 側錄有困難
- 無法針對 Layer7 應用層分析與過濾
  - “filter all Skype” traffic is not possible

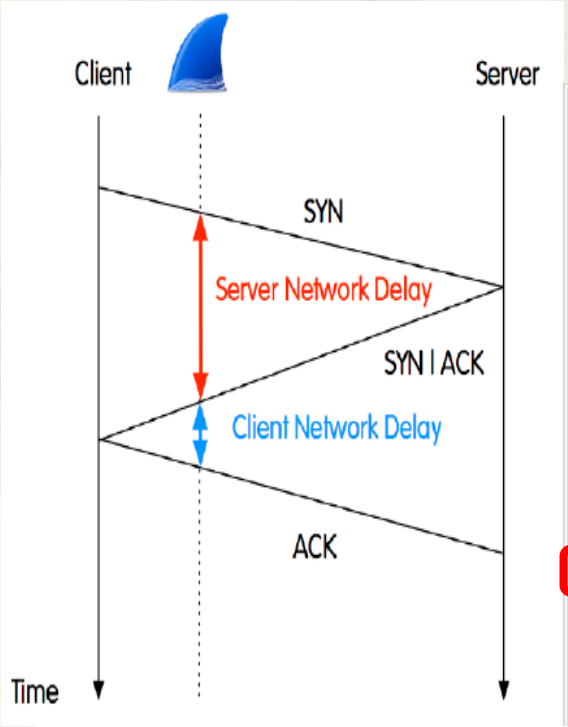
Network Overview based on packet level
Wireshark + ntop plugin

- ntop plugin (sharkfest 2017)
  - Lua script for wireshark (Open Source)
  - https://github.com/ntop/nDPI/tree/dev/wireshark



分析案例一
網路很慢 vs. 網站很慢

* 使用者抱怨反應
  * 網路很慢 vs. 網站很慢
  * Network Delay vs. Application Delay

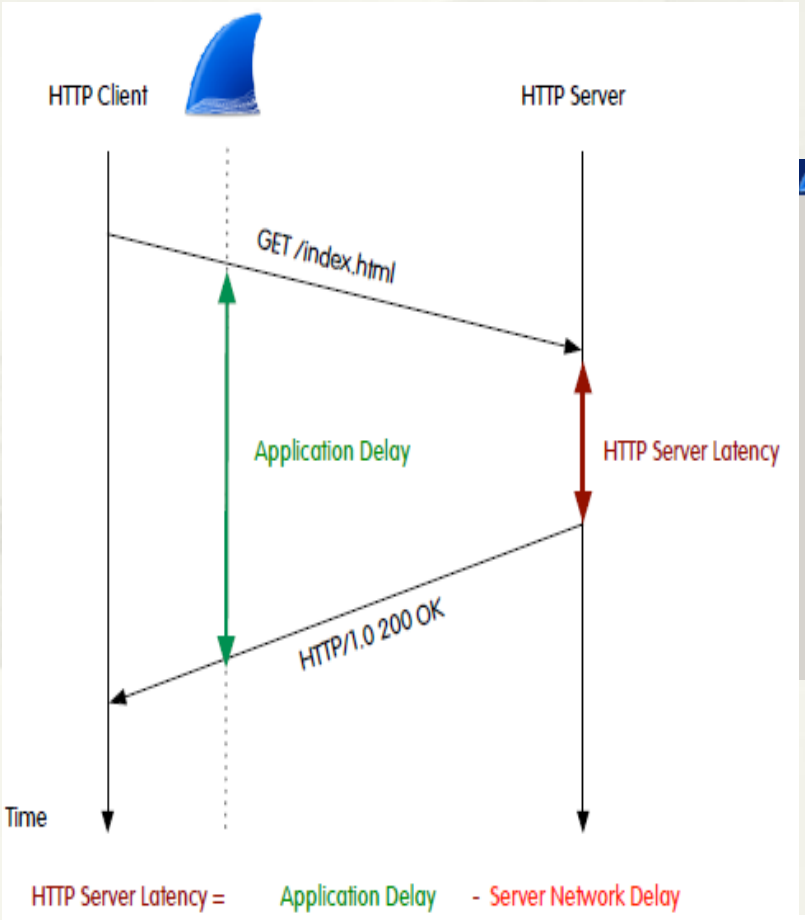


Wireshark · Network Latency

Client	Min/Max RTT
172.16.0.2	0.038 / 0.117 msec
Server	**Min RTT**
54.194.226.6	296.570 / 296.570 msec
72.251.245.181	286.275 / 286.275 msec
37.139.11.123	281.332 / 281.332 msec
34.224.135.40	197.057 / 197.057 msec
34.239.56.165	196.941 / 196.941 msec
205.180.86.172	142.621 / 142.621 msec
64.38.119.27	141.538 / 141.538 msec
103.243.221.109	108.627 / 108.627 msec
106.10.193.33	82.442 / 82.442 msec
103.67.200.188	74.881 / 74.881 msec
50.116.239.135	57.246 / 57.246 msec

分析案例一
網路很慢 vs. 網站很慢

* Application Delay

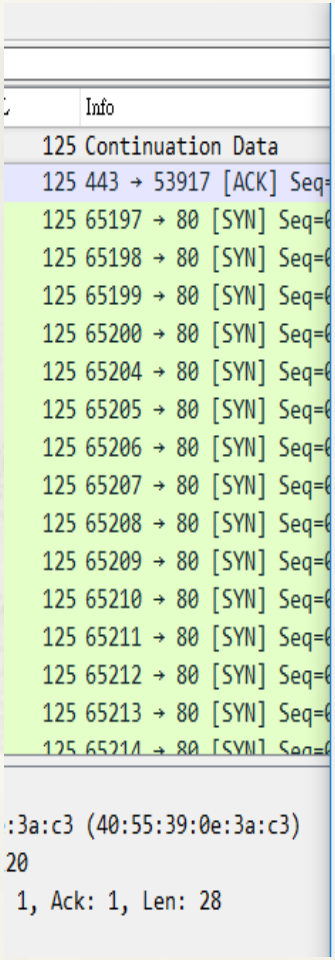


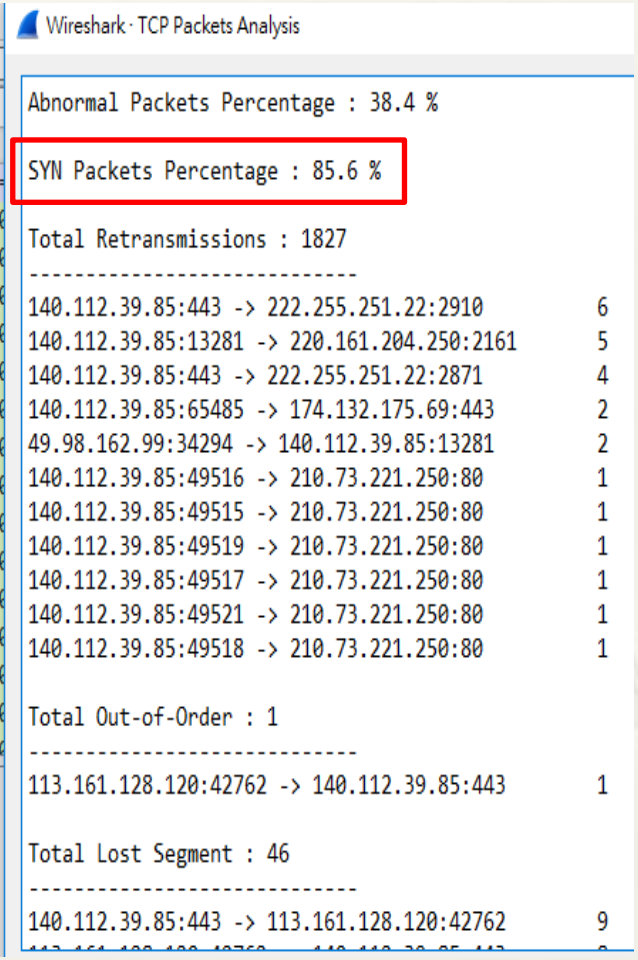
Wireshark · Application Latency

Server	Min Application RTT
103.243.221.109	1429.770 / 1429.770 msec
204.11.109.68	432.199 / 432.199 msec
63.251.252.12	222.961 / 222.961 msec
204.2.197.204	220.601 / 220.601 msec
34.224.135.40	202.335 / 202.335 msec
54.172.137.57	202.254 / 202.254 msec
69.20.20.10	177.324 / 177.324 msec
64.38.119.27	145.299 / 145.299 msec
52.9.175.175	132.866 / 132.866 msec
38.106.10.133	131.861 / 131.861 msec
103.67.200.188	85.984 / 85.984 msec

分析案例二
SYN Flood

- 統計 TCP flag 比例偵測異常行為。
- 自行新增 Lua script 程式碼

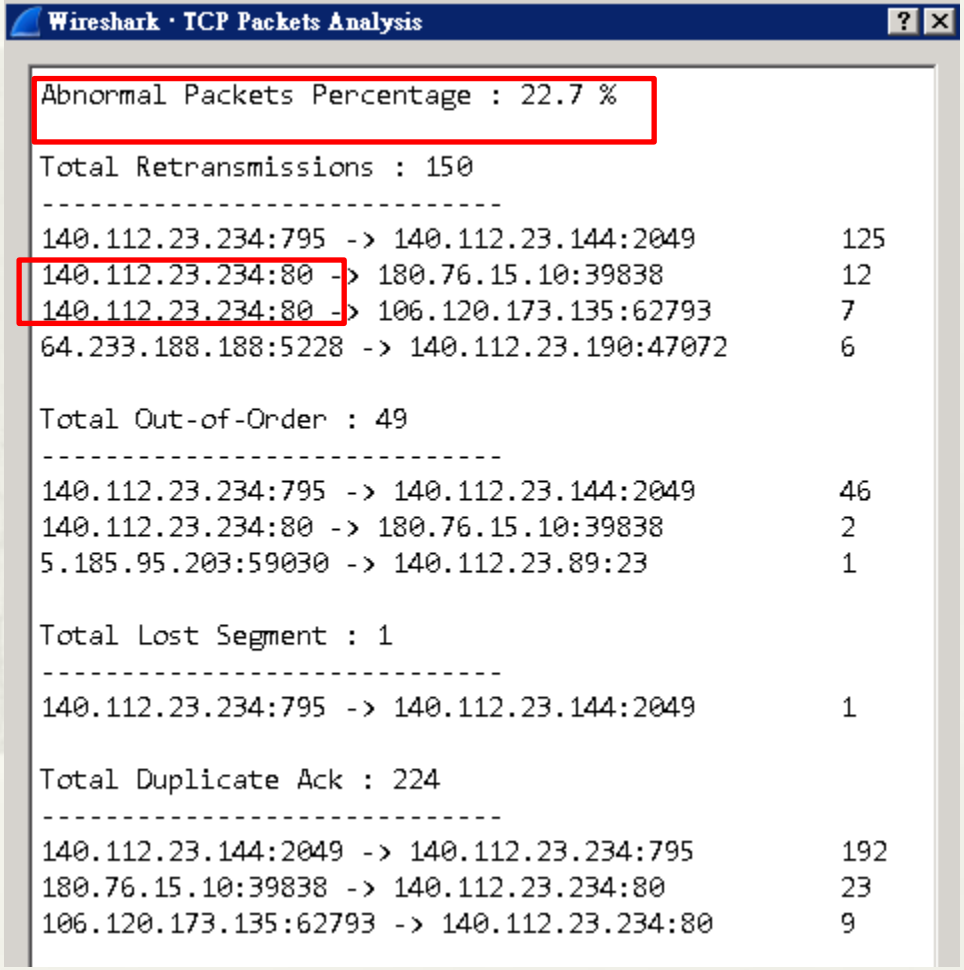




分析案例三
實體網路線異常

* 臺大校內某系所網頁首頁 Web Server
* 新增統計 TCP 封包異常比例，Lua script 程式碼

```
label = label .. "Abnormal Packets Percentage : " .. formatPctg((num_tcp_retrans + num_tcp_ooo + num_tcp_lost_segment + num_tcp_duplicate_ack) / last_processed_packet_number * 100) .. "\n"
```



分析案例四
IPS 誤擋

- 連線臺大首頁 www.ntu.edu.tw 封包遭 IPS 誤擋
- 新增統計 TCP 封包異常比例，Lua script 程式碼(同前頁)

Wireshark · TCP Packets Analysis

```
Abnormal Packets Percentage : 24.1 %

Total Retransmissions : 1395
-----------------------------
140.112.8.116:80 -> 140.112.114.183:56217          358
140.112.8.116:80 -> 140.112.114.183:56214          329
140.112.8.116:80 -> 140.112.114.183:56211          224
140.112.8.116:80 -> 140.112.114.183:56213          184
140.112.8.116:80 -> 140.112.114.183:56215          130
140.112.8.116:80 -> 140.112.114.183:56210          125
140.112.8.116:80 -> 140.112.114.183:56207          23
140.112.8.116:80 -> 140.112.114.183:56218          19
108.177.97.157:443 -> 140.112.114.183:56201        3

Total Out-of-Order : 35
-----------------------------
140.112.8.116:80 -> 140.112.114.183:56213          17
140.112.8.116:80 -> 140.112.114.183:56218          16
140.112.8.116:80 -> 140.112.114.183:56211          1
140.112.8.116:80 -> 140.112.114.183:56215          1

Total Lost Segment : 68
-----------------------------
140.112.8.116:80 -> 140.112.114.183:56218          22
140.112.8.116:80 -> 140.112.114.183:56217          11
140.112.8.116:80 -> 140.112.114.183:56213          10
140.112.8.116:80 -> 140.112.114.183:56214          8
140.112.8.116:80 -> 140.112.114.183:56211          4
140.112.8.116:80 -> 140.112.114.183:56215          4
```

分析案例五
重複嘗試登入

* 不尋常的重複嘗試登入，可能被入侵的徵兆
* 傳統偵測方式：需於應用程式 Access Log 進行分析

SSH login failed

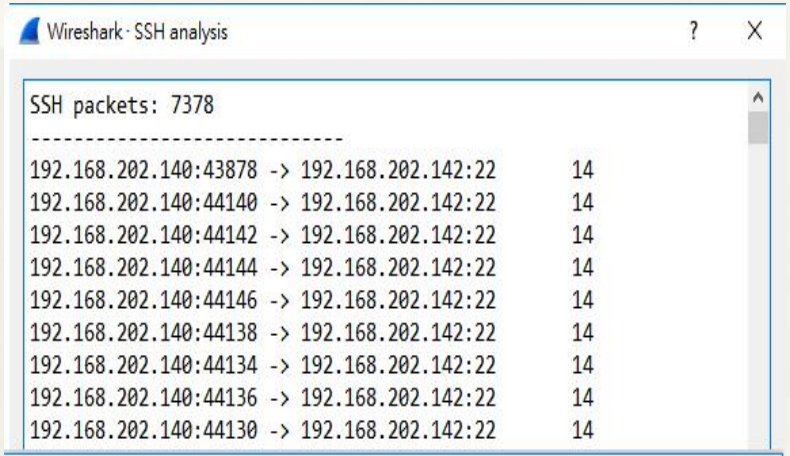
```
Last failed login: Mon Nov 20 08:59:19 CST 2017 from 223.68.134.29 on ssh:notty
There were 4770 failed login attempts since the last successful login.
Last login: Mon Oct 30 20:59:47 2017 from davisyoupc.cc.ntu.edu.tw
```

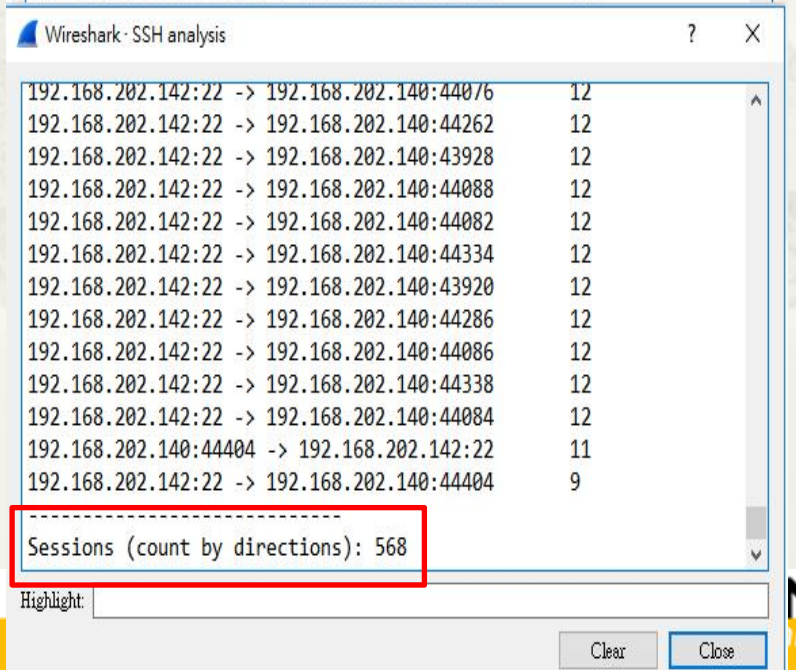
RDP login failed

等級	日期和時間	來源	事件識別碼	工作類別
資訊	2017/10/25 下午 04:06:51	TerminalServices-RemoteConnectionMana...	1149	無
資訊	2017/10/25 下午 04:06:51	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:51	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:45	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:42	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:38	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:34	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:31	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 04:06:25	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 03:53:32	TerminalServices-RemoteConnectionMana...	1149	無
資訊	2017/10/25 下午 03:53:32	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 03:53:32	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 03:05:11	TerminalServices-RemoteConnectionMana...	1149	無
資訊	2017/10/25 下午 03:05:10	TerminalServices-RemoteConnectionMana...	261	無
資訊	2017/10/25 下午 03:05:09	TerminalServices-RemoteConnectionMana...	261	無

分析案例五
重複嘗試登入...

* 分析連入 Server 封包，相同 Clinet IP 在短時間內不斷建立不同 tcp.stream，即可能是嘗試登入行為
* 自行新增 Lua script 程式碼





LAYER 7 網路行為分析

Layer 7 分析-傳統方式

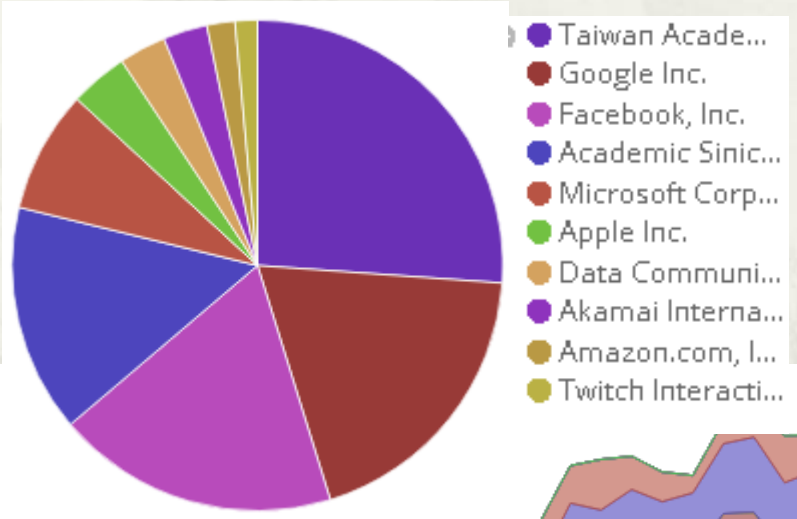
* 傳統分析方式
  * 21 ftp
  * 22 ssh
  * 23 telnet
  * 80 http
  * 443 https
  * …

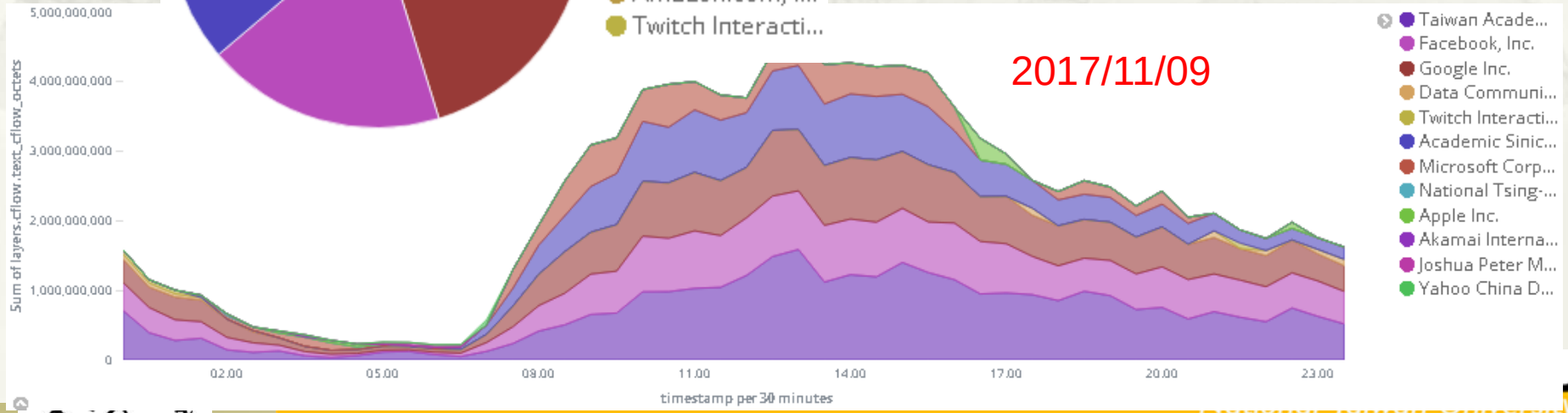
Layer 7 分析-ASN

- 使用 Geoip 查詢 IP 所屬 Autonomous System Number(ASN)
  - 優點: 現有 IP 就可分析，可套用於現成 Netflow 分析工具
  - 缺點: 僅能大略分析網路行為，無法辨識如 P2P 等 Protocol

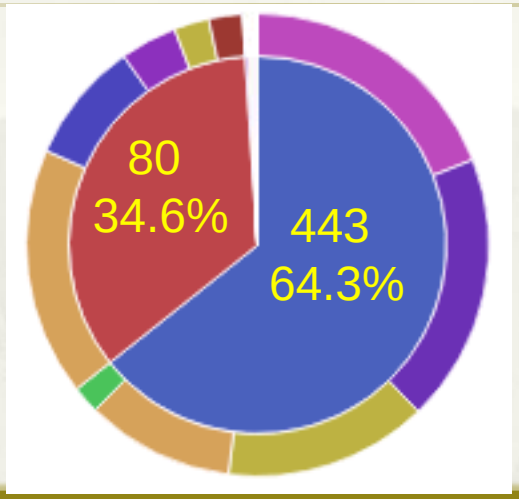
Layer 7 分析-ASN

- 區網 TANet 100G Top 10 ASN 分析結果
- netflow + ELK Stack





Layer 7 分析-ASN



port	Source ASN	%
443	Facebook, Inc.	26%
443	Google Inc.	25%
443	Academic Sinica Network	19%
443	Taiwan Academic Network (TANet) Information Center	14%
443	Data Communication Business Group	3%
80	Taiwan Academic Network (TANet) Information Center	50%
80	Microsoft Corporation	25%
80	Apple Inc.	11%
80	Academic Sinica Network	8%
80	Akamai International B.V.	6%

Layer 7 分析-DPI

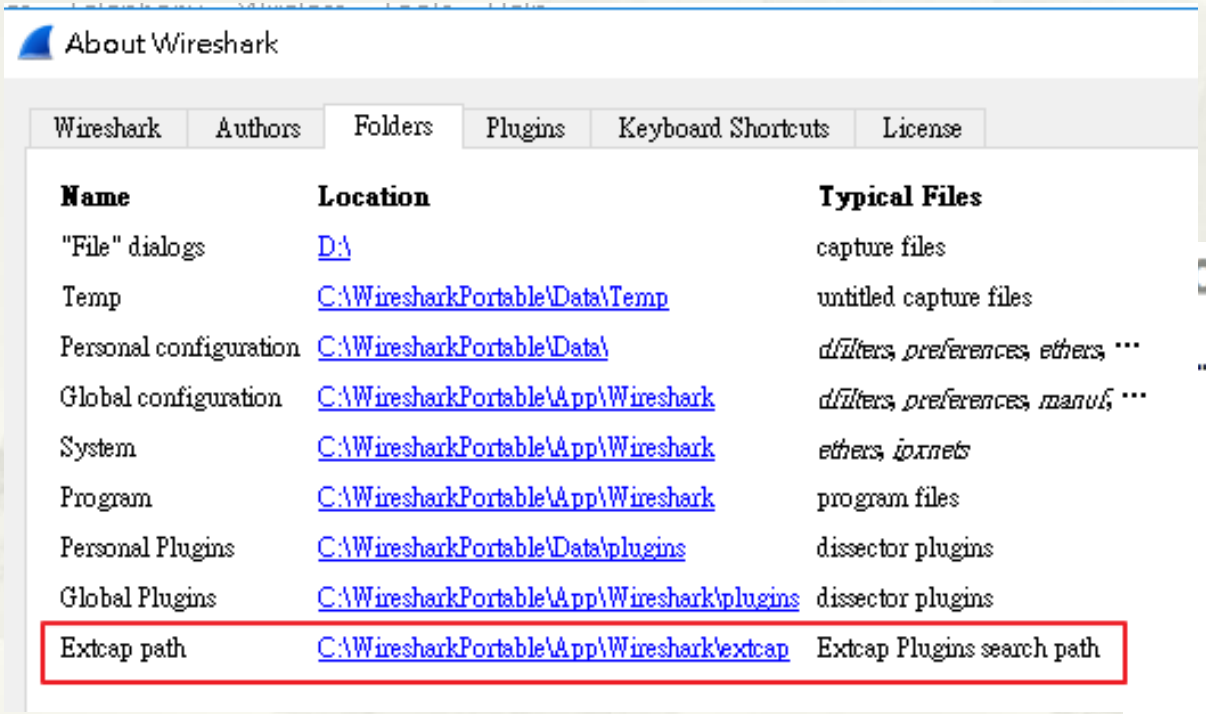
- 使用DPI(Deep Packet Inspection)分析
  - 商業硬體設備
    - Proprietary protocol pattern 非公開
    - 倚賴廠商不斷更新 pattern
  - Open Source DPI Library
    - nDPI，Support 186+ application protocols
    - https://github.com/ntop/nDPI/tree/dev/example
    - 網路社群力量大

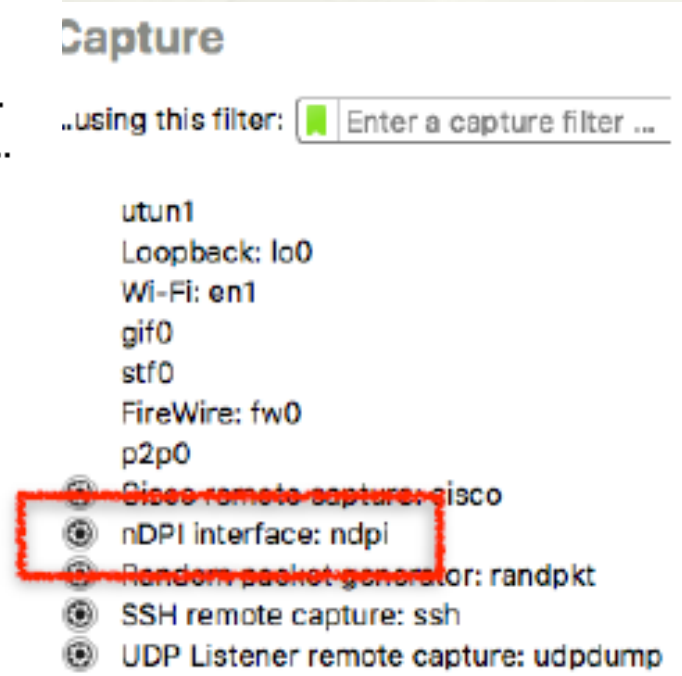
nDPI Support 186+ Protocols

FTP POP SMTP IMAP DNS IPP HTTP MDNS NTP NETBIOS NFS SSDP BGP SNMP XDMCP SMB SYSLOG DHCP PostgreSQL MySQL TDS DirectDownloadLink I23V5 AppleJuice DirectConnect Socrates WinMX VMware PANDO Filetopia iMESH Kontiki OpenFT Kazaa/Fasttrack Gnutella eDonkey Bittorrent OFF AVI Flash OGG MPEG QuickTime RealMedia Windowsmedia MMS XBOX QQ MOVE RTSP Feidian Icecast PPLive PPStream Zattoo SHOUTCast SopCast TVAnts TVUplayer VeohTV QQLive Thunder/Webthunder Soulseek GaduGadu IRC Popo Jabber MSN Oscar Yahoo Battlefield Quake VRRP Steam Halflife2 World of Warcraft Telnet STUN IPSEC GRE ICMP IGMP EGP SCTP OSPF IP in IP RTP RDP VNC PCAnywhere SSL SSH USENET MGCP IAX TFTP AFP StealthNet Aimini SIP Truphone ICMPv6 DHCPv6 Armagetron CrossFire Dofus Fiesta Florensia Guildwars HTTP Application Activesync Kerberos LDAP MapleStory msSQL PPTP WARCRAFT3 World of Kung Fu MEEBO FaceBook Twitter DropBox Gmail Google Maps YouTube Skype Google DCE RPC NetFlow_IPFIX sFlow HTTP Connect (SSL over HTTP) HTTP Proxy Netflix Citrix CitrixOnline/GotoMeeting Apple (iMessage, FaceTime...) Webex WhatsApp Apple iCloud Viber Apple iTunes Radius WindowsUpdate TeamViewer Tuenti LotusNotes SAP GTP UPnP LLMNR RemoteScan Spotify H323 OpenVPN NOE CiscoVPN TeamSpeak Tor CiscoSkinny RTCP RSYNC Oracle Corba UbuntuONE CNN Wikipedia Whois-DAS Collectd Redis ZeroMQ Megaco QUIC WhatsApp Voice Stracraft Teredo Snapchat Simet OpenSignal 99Taxi GloboTV Deezer Instagram Microsoft cloud services Twitch KakaoTalk Voice and Chat HotspotShield VPN

Install nDPI with Wireshark

* Wireshark Extcap plugin





nDPI Layer 7 protocol 分析

Src port	Destination	Dest port	Protocol	Length	info
443	140.112.41.76	2242	SSL.Facebook	1492	[TCP segment of a reassembled PDU]
443	140.112.41.76	2242	SSL.Facebook	1492	[T
443	140.112.41.76	2242	SSL.Facebook	1458	App
443	140.112.41.76	2242	SSL.Facebook	1492	[T
2461	216.58.200.46	443	SSL.Google	135	App
2461	216.58.200.46	443	SSL.Google	138	App
2461	216.58.200.46	443	SSL.Google	124	App
443	140.112.41.76	2461	SSL.Google	151	App
2461	216.58.200.46	443	SSL.Google	120	App
443	140.112.41.76	2461	SSL.Google	88	44
443	140.112.41.76	2461	SSL.Google	120	App
443	140.112.41.76	2461	SSL.Google	88	44
2461	216.58.200.46	443	TCP	82	24
2393	111.221.29.193	443	TCP	82	23
2394	111.221.29.194	443	TCP	82	23
443	140.112.41.76	1808	SSL.Dropbox	339	App
1808	162.125.34.129	443	SSL.Dropbox	1091	App
443	140.112.41.76	1808	SSL.Dropbox	88	44
443	140.112.41.76	1808	SSL.Dropbox	437	App
1808	162.125.34.129	443	SSL.Dropbox	817	App

Wireshark · nDPI Protocol Statistics

nDPI Protocol Breakdown

SSL	2.5 MB	[60.5 %]
QUIC.GMail	725.97 KB	[17.2 %]
SSL.Facebook	438.13 KB	[10.4 %]
QUIC.Google	334.06 KB	[7.9 %]
Unknown	51.76 KB	[1.2 %]
SSL.Google	35.27 KB	[< 1 %]
QUIC	16.23 KB	[< 1 %]
QUIC.YouTube	10.63 KB	[< 1 %]
BitTorrent	10.42 KB	[< 1 %]
SSL.Amazon	7.78 KB	[< 1 %]
DNS	7.44 KB	[< 1 %]

Top nDPI Flows

203.66.159.1 / 140.112.41.128 [SSL]	2.26 MB	[54.7 %]
172.217.24.5 / 140.112.41.128 [QUIC.GMail]	650.83 KB	[15.4 %]
31.13.87.36 / 140.112.41.128 [SSL.Facebook]	238.69 KB	[5.6 %]
31.13.87.5 / 140.112.41.128 [SSL.Facebook]	174.31 KB	[4.1 %]
202.39.235.195 / 140.112.41.128 [SSL]	145.76 KB	[3.4 %]
140.112.41.128 / 172.217.24.5 [QUIC.GMail]	72.36 KB	[1.7 %]
216.58.200.238 / 140.112.41.128 [QUIC.Google]	49.51 KB	[1.2 %]
74.125.204.189 / 140.112.41.128 [QUIC.Google]	49.01 KB	[1.2 %]
74.125.23.189 / 140.112.41.128 [QUIC.Google]	49.01 KB	[1.2 %]
172.217.24.14 / 140.112.41.128 [QUIC.Google]	44.96 KB	[1.1 %]
140.112.41.128 / 172.217.24.14 [QUIC.Google]	38.91 KB	[< 1 %]

簡報完畢
謝謝