

### Article Info

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### Live Monitoring for Forensic Artifacts from IM Messenger Packets Using Freeware

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## ABSTRACT

Numerous smartphone applications such as snapchat pose a major problem for a network administrator, as the chat gets deleted automatically removing every evidence of a conversation. It becomes difficult for an administrator to confirm whereabouts of a captured packet belonging to an IM application. However, if the same is captured in real time using Wireshark-a detailed analysis of the protocols would reveal information regarding the source of packet generation. This paper emulates a closed environment and uses freeware to capture encrypted packets from instant messengers and attempts to produce sufficient artifacts, so as to pin point the sender.

### Keywords: Wireshark; Network Forensics; SnapChat; Controlled Environment; IM Packets; QUIC; STUN.

### **1.0 Introduction**

Network or protocol analyzer is a program that runs on a device that is connected to the network, it passively receives all data link layer frames passing through the device's network adapter. The analyzer captures the data that is addressed to other machines, saving it for later examination [1]. One of the freeware used in the research is ]Wireshark. It is having an interactive GUI which displays all the packets in order, it has many filters available which are in the form of protocols. There are color codes present for various protocols such as green for TCP packets, dark blue for DNS packets, light blue for UDP packets, and black identifies TCP packets with glitches. In this paper, Wireshark observes traffic that passes through mobile hotspot created on laptop and the packets which belong the concerned application are sorted out. Then the relevant information is analyzed with the help of protocols.

Instant Messaging applications are commonly used by wide range of Internet users. These Instant messaging applications are also used in Smartphones these days, they are known as Apps. Any data that travels in a form of packets over a network can be viewed using Network Protocol Analyzer and they can be recorded, monitored also in some cases read. The recorded data is used lawfully by a network administrator to monitor and troubleshoot network traffic. Using the information captured by the freeware an administrator can identify inaccurate packets[1].

Any traffic analysis can be classified into three types: real-time analysis, batched analysis and forensics analysis [2].

- Real-time analysis: It is performed on data that is obtained or using small batches also known as buffers to efficiently analyze data. The response time of this kind of analysis is understood by time elapsed which is either computed or detected. Real time analysis has generally high computational resources requirements. (2)Batched analysis: Batched analysis performs analysis periodically, where the period is enough to collect data in also known as data batches. Depending on the batching policies the response time and related computational resources requirements may be higher or lower, but in general they propose a higher response time and lower computational resources necessities than real -time examination (although they require larger storage size).
- Forensics analysis: Forensics analysis is analysis done when a certain event occurs. An example of forensics analysis is the investigation performed when an intrusion is noticed to a host who is associated to the network. This kind of analysis require that data had been previously stored to be

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analyzed, and may also require of human intervention. Network data examination techniques obtain information of network data by inspecting network header fields of each packet, calculate them and produce outcomes or results. Packet in which packets are decoded and presented in a comprehensible way. Network analyzers like tcpdump, Wireshark are some examples of packet Interpreting applications[2]. In this paper, forensic analysis has been performed and forensics

- 1) Sender information.
- 2) Time stamps of packets.
- 3) Important protocols such as handshake and their timestamps
- 4) artifacts which are considered here are: -

#### 2.0 Network Analysis Experimental Setup

To intercept the network traffic, wireless access point was created to which both mobile devices were connected. This was established using the Windows 10 Virtual Wi-Fi Miniport Adapter feature. This feature enables users to create a virtual network that perform as a wireless access point for numerous devices. To do this, the host computer was linked to the Internet via an Ethernet cable so that the wireless card was not in use. The Ethernet connection was established to part its Internet access with the virtual Wi-Fi Miniport Adapter. Command netsh wlan set hosted network mode = allow ssid test key = 1234567890 was executed to setup the virtual network. The network was then enabled using the command netsh wlan start hosted network. Next, the network traffic was recorded to and from the mobile devices by capturing data sent over the virtual connection. The number of packets dropped and the capture rate were not recorded, as it was not relevant to the goal of this research. Wireshark was used to capture and analyze the network traffic[3].

This set up is shown in Fig 1.

### 3.0 Emulation of the Problem

Initially in the procedure we must analyze the recorded data for the registered mac address. Let us consider 2 devices namely "A" & "B", their Wi-Fi Mac address and the consumed bytes are mentioned in the figure 2.

Now the second step involves the identification of server which can also be recognized with the help of

endpoints feature in Wireshark and we can further confirm it from web as shown in Fig.3 & Fig 5 displays the SYN packet and & Fig 6 displays [SYN, ACK] packet with timestamp.

### Fig 1: Setup for Capture



Fig 2: Endpoints of MAC

Ethernet: 5 Fibre Channel	FDDI <b>IPv4-30</b> IPv6 IPX JXTA	NCP RSVP SCTP TCP	183 Token Ring UD	A 28 US8 WLAN	
			Ethernet Endpoints		
Address	• Packets • Bytes	<ul> <li>Tx Packets</li> </ul>	< TxBytes	<ul> <li>Rx Packets</li> <li>Rx Bytes</li> </ul>	(
5427:58:d3:1cbf	1 729	908 498	920	225 460 809	663 03
d2:7e:35:27:a9:5d	3 694	2 361 210	1969	1993 956 1725	367 25
OneplusT_34:31:7F	1977	1 453 850	817	142 932 1 160	1 310 91

Fig.3: Server Address

17221726.170	6	浙	3	198	3	198	
5220206.137	22	2910	9	1004	13	1906	
21658.19751	108	29916	51	17717	57	12 199	
104.193.187.5		2146		13 859	84	10287	
146.196.34.202	8	122	0	0	1	122	1
🛛 Name resolutio	n 🛛 lin	nit to displa	rfiter				
Help	Çopy	1	/ap				
	- 14	_					

Fig.4: Server Address Confirmed

Address type	IPv4 😧	+ Dener
ISP	Snapchat	Sacrameros forces for Colorado
Organization	Snapchat, Inc	Sanjoor report
Timezone	America/Los_Angeles (UTC-8)	Tetano Las vegas Atsuppriços
Local time	02:57:07	Assa Are More
Country	United States 📕	Tuana Statecal Turson
State / Region	California	Cudad Jairez
District / County	Los Angeles County	O Herrosto Origina
City	Los Angeles (Venice)	Contraction of the second seco
Zip / Postal code	90291	Bioconne Su
Coordinates	33.9882, -118.473	Durango México

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# Fig 5: Packet Sent by "A"

# Fig.7: Client Hello by "A"

💪 3321 2016-10-10:20:15:12 192.168.137.244 104.193.187.5 TCP 74:40697-443 (SNN) Seq=0 Win=65555 Len=0 MSS=1460 SACK_PERM=1 TSinal=10595697 TSecr=0 WS=64	<u>/</u> 3329 2016-10-10 20:
D trama 2371: 74 hutes on wire (502 hits) 74 hutes cantured (502 hits) on interface 0	⊕ Frame 3329: 1
D Themper TT Cres 51:07:50:02:15:66 (51:07:50:02:15:66) Det: d0:70:05:07:00:56 (d0:70:05:07:00:56)	⊕ Ethernet II,
ELITETTET TELEVISION (14.21.10.03.11.01 (14.21.10.03.11.01), USL, U2.70.33.21.03.30 (U2.70.33.21.03.30)	Internet Prot
B INTELLER ALORITOR A. 2011 131 131 131 131 131 131 131 131 131	Transmission
E Transmission Control Protocol, Src Port: 4069/ (4069/), Dst Port: 443 (443), Seq: U, Len: U	Source Port
Source Port: 40697 (40697)	Destination
Destination Port: 443 (443)	
[Stream index: 51]	Sequence nu
[TCP Segment Len: 0]	Next seque
Sequence number: 0 (relative sequence number)	Acknowledam
Acknowledgment number: 0	Header Leng
Header Lenoth: 40 bytes	0000 0
0000 0000 0010 = Flans: 0x002 (SVN)	Window size
Window size value: 65535	[Calculated
[2016] http://www.common.com/	[Window siz
[calculated milloom Size, 05555] □ Charlerum: Avafaa [ua]idatian dirahlad]	H Checksum: 0     Uncept, poin
Unexest existence O	□ Ontions: (1
urgent pointer; u	No-Operat
∃ options: (20 dytes), Maximum segment size, SACK permitted, Timestamps, No-operation (NOP), Window scale	I No-Operat
⊞ Maximum segment size: 1460 bytes	🗄 Timestamp
🗄 TCP SACK Permitted Option: True	Kind: T
⊟ Timestamps: TSval 10595697, TSecr O	Length:
Kind: Time Stamp Option (8)	Timesta
Length: 10	Timesta
Timestamp value: 10595697	E [SEQ/ACK an
Timestamp echo reply: O	[1RTT: 0.
R No-Operation (NOP)	EbyLes In
R Window scale: 6 (multinly by 64)	E TI SV1.2 Rec
a number of the state of the st	Content T

# Fig 6: ACK Packet Sent by Server

🔏 3327 2016-10-10 20:15:13 104.193.187.5 192.168.137.244 TCP 74 443-40697 [SVN, ACK] Seq=0 Ack=1 Win=20960 Len=0 MSS=1440 SACK_PERM=1 Tsval=709119064 TSecr=
B Frame 3327: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
Ethernet II, Src: d2:7e:35:27:a9:5d (d2:7e:35:27:a9:5d), Dst: 54:27:58:d3:1c:bf (54:27:58:d3:1c:bf)
🗄 Internet Protocol Version 4, Src: 104.193.187.5 (104.193.187.5), Dst: 192.168.137.244 (192.168.137.244)
🗄 Transmission Control Protocol, Src Port: 443 (443), Dst Port: 40697 (40697), Seq: O, Ack: 1, Len: O
Source Port: 443 (443)
Destination Port: 40697 (40697)
[Stream index: 51]
[TCP Segment Len: 0]
Sequence number: 0 (relative sequence number)
Acknowledgment number: 1 (relative ack number)
Header Length: 40 bytes
⊞ 0000 0001 0010 = Flags: 0x012 (SYN, ACK)
Window size value: 28960
[Calculated window size: 28960]
🗑 Checksum: 0x7909 [validation disabled]
Urgent pointer: O
🛛 Options: (20 bytes), Maximum segment size, SACK permitted, Timestamps, No-Operation (NOP), Window scale
🛙 Maximum segment size: 1440 bytes
🛛 Timestamps: TSval 789119064, TSecr 10595697
Kind: Time Stamp Option (8)
Length: 10
Timestamp value: 789119064
Timestamp echo reply: 10595697
🛛 No-Operation (NOP)
🖲 Window scale: 7 (multiply by 128)
∃ [SEQ/ACK analysis]
[This is an ACK to the segment in frame: 3321]
[The RTT to ACK the segment was: 0.271019000 seconds]
[iRTT: 0.272794000 seconds]

3329 2016-10-10 20:15:13 192.168.137.244 104.193.187.5 TLSv1.2 195 Client Hello
⊕ Frame 3329: 195 bytes on wire (1560 bits), 195 bytes captured (1560 bits) on interface O
⊕ Ethernet II, Src: 54:27:58:d3:1c:bf (54:27:58:d3:1c:bf), Dst: d2:7e:35:27:a9:5d (d2:7e:35:27:a9:5d)
⊕ Internet Protocol Version 4, Src: 192.168.137.244 (192.168.137.244), Dst: 104.193.187.5 (104.193.187.5)
□ Transmission Control Protocol, Src Port: 40697 (40697), Dst Port: 443 (443), Seq: 1, Ack: 1, Len: 129
Source Port: 40697 (40697)
Destination Port: 443 (443)
[Stream index: 51]
[TCP Segment Len: 129]
Sequence number: 1 (relative sequence number)
[Next sequence number: 130 (relative sequence number)]
Acknowledgment number: 1 (relative ack number)
Header Length: 32 bytes
Window size value: 1369
[Calculated window size: 87616]
[Window size scaling factor: 64]
Urgent pointer: 0
Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
No-Operation (NOP)
H NO-Operation (NOP)     Sectors 1     According to the sector 1     According to the s
⊟ Inmestamps: ISVaI 10595/24, ISECF /89119064
kind: Time Stamp option (8)
Length: 10
Timestamp value: 10593/24
[1017] [1
[Rytes in flight: 129]
R Secure Sockets Laver
■ TLSV1.2 Record Laver: Handshake Protocol: Client Hello
Content Type: Handshake (22)
Version: TLS 1.0 (0x0301)
Length: 124
🗄 Handshake Protocol: Client Hello

# Fig.8: Server Hello

📶 3333 2016-10-10 20:15:13 104.193.187.5 192.168.137.244 TLSv1.2 1394 Server Hello
2332/10/10/2010/10/2010/10/2010/2010/201
[minor size Scaring (micor i ico) @ Checksum: Ox7e33 [Validation disabled] Urgent pointer: O B Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
Mo-Operation (NOP)     Mo-Operation (NOP)     Mo-Operation (NOP)     Mo-Operation (NOP)     Moderation (N
Kind: Time Stamp Ontion (8)
Length: 10
Timestamo value: 789119132
Timestamp echo reply: 10595724
□ [SEQ/ACK analysis]
[iRTT: 0.272794000 seconds]
[Bytes in flight: 1328]
TCP segment data (1262 bytes)
B secure Sockets Layer
□ TLS1.12 Record Layer: HandShake Protocol: Server Hello Content Type: HandShake (22) Version: ITS 1.2 (0x0303) Length: 61
⊞ Handshake Protocol: Server Hello

Fig 9: Certificate Sent by Server

#### R Frame 3334: 1394 bytes on wire (11152 bits), 1394 bytes captured (11152 bits) on interface O Internet Protocol Version 4, Src: 104.193.187.5 (104.193.187.5), Dst: 192.168.137.244 (192.168.137.244) Transmission Control Protocol, Src Port: 443 (443), Dst Port: 40697 (40697), Seq: 1329, Ack: 130, Len: 1328 [2 Reassembled TCP Segments (2415 bytes): #3333(1262), #3334(1153)] H TLSv1.2 Record Laver: Handshake Protocol: Certificate Content Type: Handshake (22) Version: TLS 1.2 (0x0303) Length: 2410 B Handshake Protocol: Certificate Handshake Type: Certificate (11) Length: 2406 Certificates Length: 2403 ∃ Certificates (2403 bytes) Certificate Lenoth: 1270 E Certificate (id-at-commonWane=".addlive.io,id-at-organizationalUnitWane=Domain Control Validated) 🗄 signedCertificate version: v3 (2) serialNumber : 0x1121bb1b72e38350f0b1a87e8994358a2ff9 B signature (sha256withRSAEncryption) B issuer: rdnSequence (0) 🛚 validity ∃ subject: rdnSequence (0) ∃ subjectPublicKeyInfo ■ algorithm (rsaEncryption) Padding: 0 subjectPublicKey: 3082010a0282010100b18026a5949c4a584f27f93be7b3a3... ∈ extensions: 9 itens B algorithmIdentifier (sha256withRSAEncryption) Padding: 0 encrypted: 2ce6f17a5376f19e951436ee5d4f53fcbf6c0bacbf8d9418... Certificate Lenoth: 1127 Certificate (id-at-commonWame=GlobalSign Domain Validation CA - SHA256 - G2,id-at-organizationWame=GlobalSign nv-sa,id-at-countryWame=BE ∃ signedCertificate R algorithmIdentifier (sha256withRSAEncryption) Padding: 0 encrypted: d7459ea0dce0e3615a0b7d7784172d655a829a8da3272a85..

#### Fig.10: Server Key Exchange

1						
	2335 2016-10-10 20:15:13 104.193.107.5 192.168.137.244 TLSv1.2 230 Server Key Exchange		B	ncrypted .	Application	D
		0 0 0 0 0 0	000 d. 010 0 020 bi 030 0 040 0	2 7e 35 2 0 55 e8 a b 05 9e f 5 d6 be 7 0 e4 17 0	7 a9 5d 54 2 7 40 00 40 0 9 01 bb 95 1 a 00 00 01 0 3 03 00 1c 0	7 6 .a
	Secure Sockets Layer ILSV1.2 Record Layer: Handshake Protocol: Server Key Exchange Content Type: Handshake (22) Version: TLS 1.2 (0x0303)	0 0	050 f 060 7	9 99 3a a 4 68 13	9 Ob 11 b1 7	7
	Length: 333 ⊞ Handshake Protocol: Server Key Exchange Handshake Type: Server Key Exchange (12)	_			Fig 13	3
	Eengun: 529 ∃ EC Diffie-Hellman Server Params	Ĺ	3368 20	16-10-10 20:1	5:13 192.168.137.2	4
	Curve Type: named_curve (0x03)	-	Frame	3368 73	10 hvtes on 1	W
	Named Curve: secp25brl (0x0017)		Ethon	not IT (		0
	PUDKEY LENGTH: 05 publicate: 04chE11h5p048018dh20cc0dEcc0683E750h23800dt2cE6E1	t	ELITER	net II, s	NC: 04:27:0	0,
	■ Signature Hash Algorithm: 0x0601 Signature Length: 256 Signature: (hau/1/hU7/c0/0-75/d38122f0/S8f/u730r956e20-35a7e0)	Đ	Trans Secur	net Proto mission ( e Sockets	col Version Control Proti Claver	0
	E Secure Sockets Laver		n Ti c	vi D norr	r cuyer and Louona Ar	
	<ul> <li>□ TLSV1.2 Record Layer: Handshake Protocol: Server Hello Done Content Type: Handshake (22) Version: TLS 1.2 (DX0303) Length: 4</li> <li>□ Handshake Protocol: Server Hello Done Handshake Type: Server Hello Done (14) Length: 0</li> </ul>		HILS C V L	ontent Ty ersion: T ength: 66 ncrypted	ro Layer: A ppe: Applica LS 1.2 (OxO 88 Application	PI t 3
		_ L				

#### Fig 11: Client Key Exchange, Change Cipher Text



#### Fig 12: Application Data Sample 1

#### 3367 2016-10-10 20:15:13 192.168.137.244 104.193.187.5 TLSv1.2 99 Application Data

	me ssor. Se bytes on when (722 bits), se bytes captured (722 bits) on internate o
🗄 Eth	ernet II, Src: 54:27:58:d3:1c:bf (54:27:58:d3:1c:bf), Dst: d2:7e:35:27:a9:5d (d2:7e:35:27:a9:5d)
🗄 Int	ernet Protocol Version 4, Src: 192.168.137.244 (192.168.137.244), Dst: 104.193.187.5 (104.193.187.5)
🗄 Tra	nsmission Control Protocol, Src Port: 40697 (40697), Dst Port: 443 (443), Seq: 256, Ack: 3055, Len: 33
🗄 Sec	ure Sockets Layer
ΒT	LSV1.2 Record Layer: Application Data Protocol: spdy Content Type: Application Data (23) Version: TLS 1.2 (0x0303) Length: 28
	Encrypted Application Data: 00000000000000165f9993aa90b11b177a7d8b964f6bc3f
	Encrypted Application Data: 000000000000000000559993aa90b11b177a7d8b964f6bc3f

#### Fig 13: Application Data Sample 2

3868 2016-10-10 2015:13 192.168.137.244 104.193.187.5 11.5v1.2 759 Application Data	
Frame 3368: 739 bytes on wire (5912 bits), 739 bytes captured (5912 bits) on interface O	
Ethernet II, Src: 54:27:58:d3:1c:bf (54:27:58:d3:1c:bf), Dst: d2:7e:35:27:a9:5d (d2:7e:35:27:a9:5d)	
Internet Protocol Version 4, Src: 192.168.137.244 (192.168.137.244), Dst: 104.193.187.5 (104.193.18	7.5)
Transmission Control Protocol, Src Port: 40697 (40697), Dst Port: 443 (443), Seq: 289, Ack: 3055, Le	en: 673
Secure Sockets Layer	
🛛 TLSv1.2 Record Layer: Application Data Protocol: spdy	
Content Type: Application Data (23)	
Version: TLS 1.2 (0x0303)	
Length: 668	
Encrypted Application Data: 000000000000000023f0f8d0afa66136e7a6ba33db7ead4b0	

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#### Fig 14: ACK for Application Data

After analyzing A's initial activity there were also binding request made by A shown in

#### 4.0 Inference

As discussed about there are two devices namely A and B in a controlled environment where Ip address of A=192.168.137.244 ,Ip address of B is 192.168.137.244.From Fig.3 & Fig.4 it is confirmed that the server address is 104.193.187.5.

The first device to initiate the connection with server is A as seen in Fig.5 and it establishes a 3-way TCP handshake which consist of SYN,SYN-ACK,ACK the time stamp value for ACK are in Fig.6. The TCP handshaking mechanism is designed so that two computers/devices trying to communicate can negotiate the parameters of the network TCP socket connection before transmitting data[4].

The first message is the Client Hello. Since the client machine is requesting the secure communication session, this message involves a set of choices that the client is willing to use to communicate with the server.

The option categories are: Version of SSL to be used, Cipher Suites supported by the client, and Compression Methods used by the client. Other information that is included in this message is a 32byte Random Number that assists the client in establishing encrypted communications, and a SessionID field that is blank (5).

#### Fig 15: Binding Request Made by A



Fig 16: Binding Response by Server

2	3395 2016-10-10 20:15:14 104.193.187.5 192.168.137.244 STUN 74 Binding Success Response XOR-MAPPED-ADDRESS: 146.196.34.202.62602
Ŧ	Frame 3395: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
Ŧ	Ethernet II, Src: d2:7e:35:27:a9:5d (d2:7e:35:27:a9:5d), Dst: 54:27:58:d3:1c:bf (54:27:58:d3:1c:bf)
Ŧ	Internet Protocol Version 4, Src: 104.193.187.5 (104.193.187.5), Dst: 192.168.137.244 (192.168.137.244)
£	User Datagram Protocol, Src Port: 3478 (3478), Dst Port: 55602 (55602)
8	Session Traversal Utilities for NAT
	[Request In: 3390]
	[Time: 0.270999000 seconds]
	Message Type: 0x0101 (Binding Success Response)
	10 = Message Class: 0x0010
	[Success Response (2)]
	00 000. 0001 = Message Method: 0x0001
	[Binding (0x001)]
	0 = Message Method Assignment: 0x0000
	[IETF Review (0)]
	Message Length: 12
	Message Cookie: 2112a442
	Message Transaction ID: 604f52dffa06d9a7494e4bc7
	Attributes
	□ XDR-MAPPED-ADDRESS: 146.196.34.202:62602
	Attribute type: xoR-MAPPED-ADDRESS (0x0020)
	Attribute Length: 8
	Reserved: 00
	Protocol Family: IPV4 (0X01)
	Port (XUK-0): 0398
	[MUTL: 02002] TO (von d), balance
	IF (AUK-U); D3000000
	[1r: 140.190.34.202 (140.190.34.202)]

The second message consist of SSL handshake is the Server Hello. In this message, the server makes choices based on the Client Hello message and makes firm decisions on the Version of SSL to be used, the Compression Method and Cipher Suite [5].

Similarly, A also generates Certificate and agrees with server how data will be encrypted as shown in Fig.9, the screenshot also has the public key and the certificate can also be extracted on the local pc. After this A generates ClientKeyExchange message contains information about the key that the client and server will use to communicate. This is the point where man in the middle can be performed [6]. Fig.12 and Fig.13 shows the sample application data sent by A to SnapChat server and the acknowledgment received from the server Fig.14. Device A also makes binding request to the Snapchat server using STUN protocol. One of the two major fields in STUN is Username and Message Integrity. The USERNAME attribute is used for message integrity. It identifies the username and password combination used in the message-integrity check. The value of USERNAME is a variable-length value. It MUST contain a UTF-8 [RFC3629] encoded sequence of less than 513 bytes, and MUST have been processed using SASL prep (RFC4013)[7]. In our case A's username is

"simh3DqMhacb46Uv:Osni4swdxaUdplkZ".

### The MESSAGE-INTEGRITY

attribute contains an HMAC-SHA1 [RFC2104] of the STUN message. The MESSAGE-INTEGRITY attribute can be present in any STUN message type. Since it uses the SHA1 hash, the HMAC will be 20 bytes. The text used as input to HMAC is the STUN message, including the header, up to and including the attribute preceding the MESSAGE-INTEGRITY attribute. The key for the HMAC depends on whether long-term or short-term credentials are in use. For long-term credentials, the key is 16 bytes [7]:

key = MD 5 (username " : " realm " : " SAS Lprep (password))

So, A makes a binding request with user name and server of SnapChat replies with Binding Success Response XOR-MAPPED-ADDRESS:

146.196.34.202:62601.

The XOR-MAPPED-ADDRESS attribute is reflexive transport address is obfuscated through the XOR function [8-9].The same process is repeated by device B and the exchange through a common server of SnapChat with IP: 104.193.187.5. This gives enough evidence with artifacts that which Server was A in communication with and parallel to that what was the corresponding device.

#### 5.0 Conclusions

Sufficient artifacts have been collected to pin point the sender from Wireshark. The two main protocols Tls1.2v and STUN have also been covered.

To decrypt a 2048-bit RSA TLS cipher text, an attacker must observe 1,000 TLS handshakes, initiate 40,000 SSLv2 connections, and perform 2^50 offline work. The victim client never initiates SSLv2

connections. An implementation of the attack and that can decrypt a TLS 1.2 handshake using 2048-bit RSA in under 8 hours, at a cost of \$440 on Amazon EC2. Using Internet-wide scans it is found that 33% of all HTTPS servers and 22% of those with browsertrusted certificates are vulnerable to this protocollevel attack due to widespread key and certificate reuse.

Given an unpatched SSLv2 server to use as an oracle, TLS cipher text can be decrypted in one minute on a single CPU—fast enough to enable manin-the-middle attacks against modern browsers/applications. Procedures are easily available on web for initiating an attack like this.

A solution to this problem might be Quick UDP Internet Connection (QUIC). As TLS and its security model use one session key, while QUIC uses two, and the data may start being encrypted before the final session key is set. Second, QUIC does not run on top of TCP and implements many of the features provided by TCP itself.

This is done primarily for performance reasons, but QUIC also adds some cryptographic protection, such as protection against IP spoofing and packet re-ordering.

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