



The Effect Of Transport Protocol Performance On Encrypted Traffic Through Ad Hoc Networks

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ABSTRACT

The rapid development of communication technology in wireless communication has led to an increase in technologies related to wireless communication. The WLAN (Wireless Local Area Network) network is one example of a network that continues to experience developments in the wireless communication technology. One of the WLAN network configurations is an ad hoc network. Different protocols, data transmission in an ad hoc WLAN will also experience differences in performance. This final project examines the use of three (2) transport protocols, namely TCP and UDP with their use in WLAN with ad hoc networks and the encryption decryption process to determine the percentage comparison of the success of packet delivery. To analyze the comparison of the three transport protocols on an ad hoc network, the Network Simulator 2 (NS-2) application which is integrated into the Ubuntu operating system and algorithms used such as arcfour, rijndael-192 and tripledes is used. The results showed that the percentage of successful data transmission on TCP was greater with an average of 99.318% on the arcfour algorithm, 99.185% on the rijndael-192 algorithm, 99.132% on the tripledes algorithm. While the percentage of success in sending data on UDP is smaller with an average of 70.711% on the arcfour algorithm, 63.971% on the rijndael-192 algorithm, 64.412% on the tripledes algorithm.

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1. INTRODUCTION

Transport layer protocols in the TCP/IP protocol suite often experience problems in wireless networks. This is due to the high packet loss on the network. On the other hand, the security in a wireless network is lower than in a wired network, because the signal that carries information propagates freely and other people's access to the signal cannot be restricted. Data security solutions that are often done are through encryption.

Both transmission control protocol (TCP) and user datagram protocol (UDP) have advantages and disadvantages for wireless data transmission. Delay and packet loss into consideration both. This thesis examines the effect of achieving transport layer protocols, both TCP and UDP, on encrypted data on an ad hoc wireless network.

2. RESEARCH METHOD

This thesis uses a simulation approach using a network simulator to measure the effect of the performance of the transport layer on the delivery of encrypted data on the adhoc network.

2.1 Network and Traffic Specifications

The study was conducted using the NS-2 simulator with an ad hoc network topology. Each node is connected dynamically and can serve in the routing process. All nodes are evaluated based on the data received.

2.2 Protocols Under Review

The protocols evaluated are TCP and UDP. This is due to the limited research time and implementation capabilities of the protocol.

2.3 Encryption Evaluation Method

The encryption process is carried out before the simulation is run. Encryption is done using tools that are available open source. In this case, this thesis utilizes an online encryption algorithm on the website: <https://codebeautify.org/encrypt-decrypt>.

The results of the encryption are then broken into packets measuring 20 bytes, and the delivery is simulated using a network simulator to determine delay, jitter and packet loss. If the encryption method produces the same cyphertext length, then the network simulation will produce the same pattern because the simulator is deterministic, i.e. repeated simulations give the same results.

The difference is that the description of different encryption methods can produce different data. The results of the delivery, namely the data received are described, including the reduction of lost packets, using the same tools on the website: <https://codebeautify.org/encrypt-decrypt>. With this process, it will be known how far the success rate of encrypted data description, if sent using TCP and UDP.

3. RESULTS AND DISCUSSIONS

3.1 Characteristics of Sending Encrypted Data with TCP

Encrypted data, shredded based on TCP transport protocol capabilities. The received data is aggregated and described. The following are the results of the evaluation of sending encrypted data using TCP.

3.2 Arcfour Encryption Method

a. Delay

Table 1 shows the average data delay experienced by each resulting packet when the packets are sent using TCP.

Table 1. Delay of Arcfour encrypted packets

Number of Nodes	delay
2	0.002022436
4	0.008574443
6	0.03641429
8	0.02601235
10	0.02088144
12	0.05019733
14	0.08386823
16	0.05234833
18	0.08726496
20	0.09936863

Figure 1 shows the plot of the average delay which increases with the increase in the number of nodes. The results of the regression analysis resulted in the trend equation $y = 0.0052x - 0.0103$.

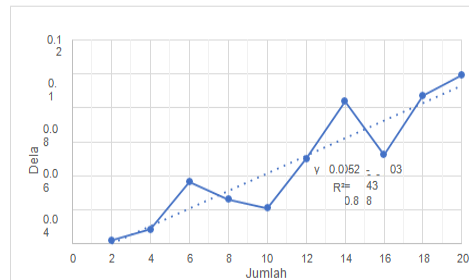


Figure 1. Average delay of Arcfour packets with TCP

b. Jitter

Table 2 shows the average data jitter experienced by each resulting packet when the packets are sent using TCP.

Table 2. Packet Jitter-package encrypted Arcfour

Number of Nodes	Jitter
2	0.00048052
4	0.00389286
6	0.00777959
8	0.01154746
10	0.01254893
12	0.0177959
14	0.01823111
16	0.01811854
18	0.04181797
20	0.02835846

Figure 2 shows the average jitter plot which increases with the increase in the number of nodes. The results of the regression analysis resulted in the trend equation $y = 0.0018x - 0.0037$.

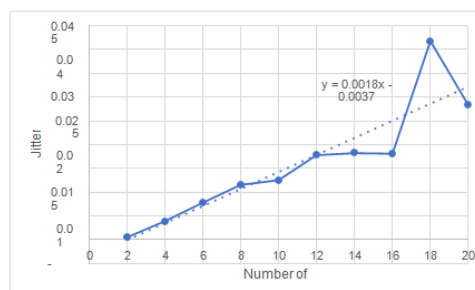


Figure 2. Average Jitter of Arcfour packets with TCP

c. Packet Loss

Table 3 shows the average packet loss data experienced by each resulting packet when the packets are sent using TCP.

Table 3. Packet Loss of Arcfour encrypted packets

Number of Nodes	Packet Loss
2	0%
4	0%
6	0%
8	0.60%
10	0.71%
12	0.86%
14	0.60%
16	0.80%
18	0.46%
20	3.30%

Figure 3 shows a plot of the average packet loss which increases with the increase in the number of nodes. The results of the regression analysis resulted in the trend equation $y = 0.0011x - 0.005$.

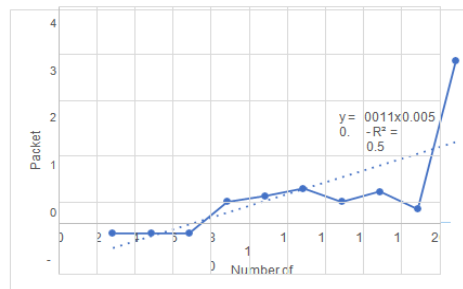


Figure 3. Average Packet Loss of Arcfour packets with TCP

d. Decryption Success Rate

The success rate of the data after being decrypted can be shown in Table 4.

Table 4. Arcfour Decryption Success Rate With TCP Protocol

Number of Nodes	Decryption Result
2	100%
4	100%
6	100%
8	99.45%
10	99.34%
12	99.34%
14	99.49%
16	99.36%
18	99.43%
20	96.77%

The simulation results show that, on average, the decryption results will decrease with the increase in the number of nodes. Figure 4 shows that the results of the regression analysis produce a trend equation $y = -0.0011x + 1.0052$

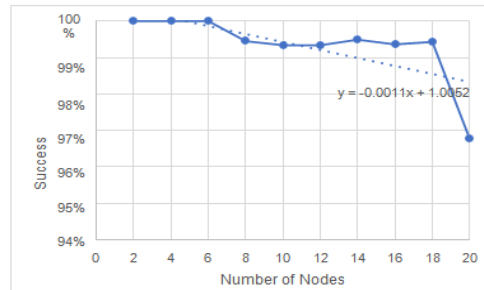


Figure 4. Arcfour Decryption Success Rate With TCP Protocol

3.3 TripleDES Encryption Method

a. Delay

Table 5 shows the average data delay experienced by each resulting packet when the packets are sent using UDP.

Table 5. Delay of TripleDES encrypted packets

Number of Nodes	delay
2	0.00115282
4	0.004272687
6	0.18288052
8	0.0253033
10	0.06602001
12	0.11078979
14	0.12708878
16	0.0709795
18	0.34710979
20	0.13899728

Figure 4 shows the plot of the average delay which increases with the increase in the number of nodes. The results of the regression analysis resulted in the trend equation $y = 0.0162x - 0.0424$

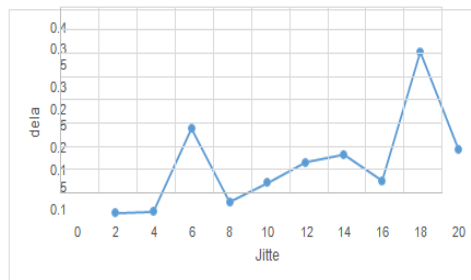


Figure 5. Average Delay of TripleDES packets with UDP

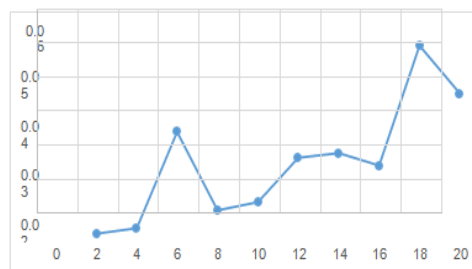
b. Jitter

Table 66 shows the average jitter data experienced by each resulting packet when the packets are sent using UDP.

Table 6. Jitter of TripleDES encrypted packets

Number of Nodes	Jitter
2	0.00031148
4	0.001922479
6	0.030247414
8	0.007150093
10	0.009587053
12	0.022650893

Figure 5 shows the average jitter plot which increases with the increase in the number of nodes. The results of the regression analysis resulted in the trend equation $y = 0.0019x + 0.0006$

**Figure 6.** Average Jitter of Rijndael-192 packets with UDP

c. Packet Loss

Table 7 displays the average packet loss data experienced by each resulting packet when the packets are sent using UDP.

Table 7. Packet Loss of TripleDES encrypted packets

Number of Nodes	Packet Loss
2	1%
4	1.50%
6	1.75%
8	2.20%
10	3.67%
12	4.14%
14	4.67%

3.4 Comparison of Decryption Success between TCP and UDP

The decryption result tends to decrease as the number of nodes increases. The decrease in the percentage of decryption in the TCP protocol tends not to be too large. However, in the UDP protocol, the percentage of successful decryption tends to be higher. In the results of sending data before encryption, the difference in the percentage of success between the TCP and UDP protocols is not too big. This can be seen in table 8 and figure 7 below:

Table 8. Comparison of the Success of Sent Data Packages Before the Encryption Process

Number of Nodes	UDP Sent Data	TCP Sent Data
2	99%	100%
4	98.50%	100%
6	98.25%	100%
8	97.80%	99.40%
10	96.33%	99.29%
12	95.86%	99.14%
14	95.33%	99.40%
16	97.30%	99.20%
18	91.73%	99.52%
20	94.31%	96.70%

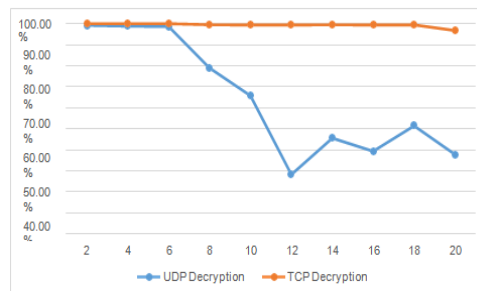


Figure 7. Comparison of Decryption Results with Arcfour Algorithm

Table 9. Comparison of Decryption Results with TripleDES Algorithm

Number of Nodes	UDP Decryption Results	Decryption Result
2	99.36%	100%
4	98.75%	100%
6	98.45%	100%
8	78.76%	99.62%
10	65.63%	99.54%
12	28.22%	99.54%
14	45.46%	99.64%
16	39.27%	99.55%
18	53.30%	99.61%
20	37.72%	96.82%

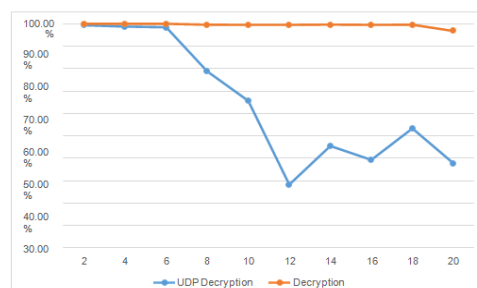


Figure 8. Comparison of Decryption Results with TripleDES Algorithm

4. CONCLUSION

The more nodes, the higher the packet loss. Both on TCP and UDP. Of the 3 algorithms used the difference in the results of the decryption is not much different.

The percentage of successful data transmission on TCP is greater with an average of 99.318% on the arcfour algorithm, 99.185% on the rijndael-192 algorithm, 99.132% on the tripledes algorithm.

The percentage of successful data transmission on UDP is smaller with an average of 70.711% on the arcfour algorithm, 63.971% on the rijndael-192 algorithm, 64.412% on the tripledes algorithm.

The UDP protocol is not effective in sending data because of the low success rate of decryption.

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