International Journal of Computer Theory and Engineering, Vol. 1, No. 3, August, 2009
1793-8201

Evaluating the Effects of Cryptography Algorithms on power consumption for wireless devices

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Abstract—**the increasing of wireless systems provides malicious entities greater incentives to step up their efforts to gain unauthorized access to the information being exchanged over the wireless link. As the world becomes more dependent on wireless networks, it needs to improve the ways that protect them. Security is important for wireless networks, mainly because the communications signals are openly available as they propagate through the air. The security settings can be different in many factors, but the main factors are the choice of ciphers used to provide security functions, the key length, and the number of operational rounds, packet size, and data types. These factors also have a significant impact on the energy consumption for providing security. The design of energy efficient secure protocols for wireless devices needs to understand how encryption affects the consumption of battery power with and without data transmission. The major contributions of this paper are energy-security trades off then, some suggestions for design of secure communications systems. This paper illustrates the key concepts of security, wireless networks, and security over wireless networks. Wireless security is demonstrated by applying the common security standards like (802.11 WEP and 802.11i WPA, WPA2) and provides evaluation of six of the most common encryption algorithms on power consumption for wireless devices namely: AES (Rijndael), DES, 3DES, RC2, Blowfish, and RC6. Experimental results are given to demonstrate the effectiveness of each algorithm.**

Key Word—**Encryption techniques, Computer security, wireless network, ad hoc wireless LANs, Basic Service Set (BBS)**

I. INTRODUCTION

Wireless networks fall into several categories, depending on the size of the physical area that they are capable of covering. The following types of wireless networks satisfy different user requirements: Wireless Personal-Area Network (WPAN) (within reach of a person), Wireless Local-Area Network (WLAN) (within a building or campus), Wireless Metropolitan-Area Network (WMAN) (within a city) and Wireless Wide Area Network (WWAN) (world wide). As the important of wireless network increased, so does the need to protect them. Encryption algorithms provide the solutions for protect data. Many encryption algorithms are widely available and used in information security. They can be categorized into Symmetric (private) and Asymmetric (public) keys encryption. In Symmetric keys encryption or secret key encryption, only one key is used to encrypt and decrypt data. Strength of Symmetric key encryption depends on the size of key used. There are many examples of strong and weak keys of cryptography algorithms like RC2, DES, 3DES, RC6, Blowfish, and AES. RC2 uses one 64-bit key.DES uses one 64-bits key. Triple DES (3DES) uses three 64-bits keys [1-4] while AES uses various (128, 192, 256) bits keys [5-6]. Blowfish uses various (32-448); default 128bits [7] while RC6 is used various (128, 192, 256) bits keys [8].

In Asymmetric keys encryption, two keys are used; private and public keys. Public key is used for encryption and private key is used for decryption (E.g. RSA and Digital Signatures). Public key encryption is based on mathematical functions, computationally intensive and is not very efficient for small mobile devices [1]. Asymmetric encryption techniques are almost 1000 times slower than Symmetric techniques, because they require more computational processing power [2].

This paper examines a method for evaluating performance of selected symmetric encryption of various algorithms on power consumption for wireless devices. A wireless device is limited in resources such as less memory, less processing power and limited power supply (battery). Battery power is subjected to the problem of energy consumption due to encryption algorithms. Battery technology is increasing at a slower rate than other technologies. This causes a "battery gap" [9], [10].We need a way to make decisions about energy consumption and security to reduce the consumption of battery powered devices. This study evaluates six different encryption algorithms used or suggested for wireless local area network (WLANs) namely; AES, DES, 3DES, RC6, Blowfish, and RC2. The performance measure of encryption schemes will be conducted in terms of energy for wireless devices, changing data types -such as text or document, Audio files, Video files and images- on power consumption, changing packet size and changing key size for the selected cryptographic algorithms on wireless devices.

This paper is organized as follows. A wireless network overview is explained in section 2.Related work is described in Section 3. A view of Experimental and experimental design is given in section 4. Experimental results are shown in section 5. Finally the conclusions are drawn section 6.

II. Overview Of Wireless Networks

The primary difference between wireless and wired networks lies in the communications medium. Wired networks utilize cabling to transfer electrical current that represents information. With wireless networks, radio frequency (RF) and light signals have the job of carrying information invisibly through the air[11].

A. Wireless LANs

Wireless LANs supply high performance within and around office buildings, factories, and homes. Wireless LANs consist mainly of two entities: clients or end-user devices and Access Points. Access point represents a gateway between the wireless devices and a wired network [11].The basic structure of a Wireless LAN is called infrastructure WLAN or BSS (Basic Service Set), in which the network consists of an access point and several wireless devices. When these devices try to communicate among themselves they propagate their data through the access point device. In order to form the network, access point keeps broadcasting its SSID (Service Set Identifier) to allow others to join the network.

If the BSS did not have an access point device, and the wireless devices were communicating with each other directly, this BSS is called an Independent BSS and works in mode called "ad hoc mode". The advantage of this configuration is that users can form a wireless LAN quickly. Ad hoc networks are also commonly referred to as peer-to-peer networks. For example, an ad hoc wireless LAN makes it easy for someone to transfer a large file to an associate in a conference room where an infrastructure wireless LAN is not available [12].

a. Security in WLANs (IEEE 802.11 Standards)

The IEEE 802.11 standard specifies a common medium access control (MAC) and several physical layers for wireless LANs. The 802.11 IEEE standards consist of three layers: Physical layer, MAC (Medium Access Control) layer, and LLC (Logical Link Control) layer.

To allow clients to access the network; they must be go through two steps: getting authenticated by the access point, then getting associated. There are two types of authentications used in IEEE 802.11 standard: Shared Key Authentication and Open System Authentication [13].

Open system authentication is mandatory, and it's a two-step process. A radio NIC initiates the process by sending an authentication request frame to the access point. The access point replies with an authentication response frame containing approval or disapproval of authentication indicated in the status code field in the frame body [14].

Shared key authentication is an optional four-step process that bases authentication on whether the authenticating device has the correct WEP key. The radio NIC starts by sending an authentication request frame to the access point. The access point then places challenge text into the frame body of a response frame and sends it to the radio NIC. The radio NIC uses its WEP key to encrypt the challenge text and then sends it back to the access point in another authentication frame. The access point decrypts the challenge text and compares it to the initial text. If the text is equivalent, the access point assumes that the radio NIC has the correct key. The access point finishes the sequence by sending an authentication frame to the radio NIC with the approval or disapproval. Fig.1 shows how Shared Key Authentication works.

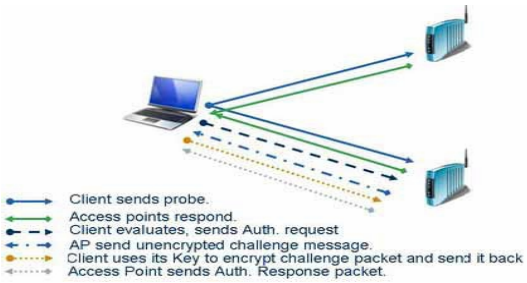

Fig. 1 Shared Key Authentication

b. Data Encryption and Authentication Protocol

The first data encryption and authentication protocol used in WLANs was called Wired Equivalent Privacy (WEP). WEP doesn't provide enough security for most enterprise wireless LAN applications. Because of static key usage, it's fairly easy to crack WEP with off-the-shelf tools [15-16]. Wireless Fidelity (Wi-Fi) alliance, released a new security protocol standard in (2002), and called Wi-Fi Protected Access (WPA), which aims to fix the flaws [17]. A year later, another version of the WPA standard, WPA version 2 (WPA2) [17], was released to provide advanced security services [19]. The 802.11i standard provides two data encryption services called Temporal Key Integrity Protocol (TKIP) and Counter Mode (CTR) Encryption with AES Cipher (CTR-AES), and two data authentication services called Michael and Cipher Block Chaining Message Authentication Code (CBC-MAC). The WPA standard is composed of the use of TKIP and Michael together to provide data encryption and authentication services while WPA2 is composed of CTR-AES and CBC-MAC. Together with CBC-MAC and CTR-AES, it is called CCMP (Counter Mode CBC-MAC Protocol). 802.11i specifies three protocols: TKIP, CCMP and WRAP. TKIP (Temporal Key Integrity Management) was introduced as a "band-aid" solution to WEP problems. One of the major advantages of implementing TKIP is that you do not need to update the hardware of the devices to run it. Unlike WEP, TKIP provides per-packet key mixing, a message integrity check and a re-keying mechanism. TKIP ensures that every data packet is sent with its own unique encryption key. TKIP is included in 802.11i mainly for backward compatibility. WRAP (Wireless Robust Authenticated Protocol) is the LAN implementation of the AES encryption standard introduced earlier. It was ported to wireless to get the benefits of AES encryption. WRAP has academic property issues [20]. CCMP (Counter with Cipher Block Chaining Message Authentication Code Protocol) is considered the optimal solution for secure data transfer under 802.11i. CCMP uses AES for encryption. The use of AES will require a hardware upgrade to support the new encryption algorithm. HiperLAN/2 is a European-based standard that is unlikely to compete heavily with 802.11.

III. RELATED WORK

To give more prospective about the performance of the compared algorithms, this section discusses the results obtained from other resources.

It was shown in [1] that energy consumption of different common symmetric key encryptions on handheld devices. It is found that after only 600 encryptions of a 5 MB file using Triple-DES the remaining battery power is 45% and subsequent encryptions are not possible as the battery dies rapidly.

It was concluded in [20] that AES is faster and more efficient than other encryption algorithms. When the transmission of data is considered there is insignificant difference in performance of different symmetric key schemes. Increasing the key size by 64 bits of AES leads to increase in energy consumption about 8% without any data transfer. The difference is not noticeable.

A study in [22] is conducted for different secret key algorithms such as DES, 3DES, AES, and Blowfish. They were implemented, and their performance was compared by encrypting input files of varying contents and sizes. The algorithms were tested on two different hardware platforms, to compare their performance. They had conducted it on two different machines: P-II 266 MHz and P-4 2.4 GHz. The results showed that Blowfish had a very good performance compared to other algorithms. Also it showed that AES had a better performance than 3DES and DES. It also shows that 3DES has almost 1/3 throughput of DES, or in other words it needs 3 times than DES to process the same amount of data.

In [23] a study of security measure level has been proposed for a web programming language to analyze four Web browsers. This study consider of measuring the performances of encryption process at the programming language's script with the Web browsers. This is followed by conducting tests simulation in order to obtain the best encryption algorithm versus Web browser.

A study in [24] is conducted for different popular secret key algorithms such as RC4, AES, and XOR. They were implemented, and their performance was compared by encrypting for real time video streaming of varying contents. The results showed; encryption delay overhead using AES is less than the overhead using RC4 and XOR algorithm. Therefore, AES is a feasible solution to secure real time video transmissions.

IV. EXPERIMENTAL DESIGN

For our experiment, we use a laptop IV 1.5 GHz CPU, in which performance data is collected. In the experiments, the laptop encrypts a different file size ranges from 321 Kilobytes to 7.139MegaBytes for text data, from 33 Kbytes to 8, 262 Kbytes for audio data, from 28 Kbytes to 131 Kbytes for pictures(Images) and from 4, 006 Kbytes to 5, 073 Kbytes for video files. For our experiment, we studying the effects of cryptographic algorithms on power consumption for wireless devices in case of data transmission and with out data transmission.

In first step

Firstly; studying the effects of changing key size and differentiate between results at different encoding methods (Base 64, hexadecimal base encoding), we calculate encryption time to check the difference in results.

Secondly; studying the effects of changing packet size, (CPU work load, throughput, power consumption in µJoule/Byte and power consumption by calculating difference in battery percentage were calculated)in case of encryption and decryption processes to calculate the performance of each encryption algorithms.

Thirdly; in case of changing data types such as audio, video, and image, (CPU work load, throughput, power consumption in µJoule/Byte and power consumption by calculating difference in battery percentage were calculated)in case of encryption and decryption processes to calculate the performance of each encryption algorithms.

These results lead to second step (calculating with data transmission)

In second step, a comparison is conducted between the results in case of data transmission using BBS and ah hoc wireless network. The main difference between BBS mode and Ad-hoc mode

Firstly, in case of Ad-hoc structure with excellent signals (distance between two laptops less than 4 meters and there are any application running except data transmission) and poor signals (distance between two laptops is greater than 50 meters contains walls in the distance between two laptops).

In case excellent signals, comparison is conducted using two different types of authentication (Open Key Authentication (no encryption), and Shared Key Authentication (WEP)).for each type of authentication, we calculated the transmission time, and power consumption for encryption for different packet size and different data types. So that, we can calculate the performance for each cryptographic algorithms in case of data transmission and with out data transmission for two different type of authentication in Ad-hoc structure using excellent signals between sender and receiver.

In case poor signals, comparison is conducted using (WEP). We calculated the transmission time, and power consumption for encryption for different packet size and different data types. So that, we can calculate the performance for each cryptographic algorithms in case of data transmission and with out data transmission in Ad-hoc structure using poor signals between source and destination.

Secondly, in case of BBS mode, comparison is conducted with excellent signal between sender and receiver the studying the effects of transmitted data using IEEE 802.11i (Open Key Authentication (no encryption), and WPA/TKIP) by calculating transmission time and power consumed for transmission between the two entities for different packet size and different data types.

Several performance metrics are collected:

1- *Encryption time.*
2- *CPU process time.*
3- *CPU clock cycles and battery power.*
4- *Transmission time in many cases.*

The encryption time is considered the time that an encryption algorithm takes to produce a cipher text from a plaintext. Encryption time is used to calculate the throughput of an encryption scheme. It indicates the speed of encryption. The throughput of the encryption scheme is

calculated as the total plaintext in bytes encrypted divided by the encryption time [25].

The CPU process time is the time that a CPU is committed only to the particular process of calculations. It reflects the load of the CPU. The more CPU time is used in the encryption process, the higher is the load of the CPU.
The CPU clock cycles are a metric, reflecting the energy consumption of the CPU while operating on encryption operations. Each cycle of CPU will consume a small amount of energy.

For computation of the energy cost of encryption, we use the same techniques as described in [26]. We present a basic cost of encryption represented by the product of the total number of clock cycles taken by the encryption and the average current drawn by each CPU clock cycle. The basic encryption cost is in unit of ampere-cycle. To calculate the total energy cost, we divide the ampere-cycles by the clock frequency in cycles/second of a processor; we obtain the energy cost of encryption in ampere-seconds. Then, we multiply the ampere-seconds with the processor's operating voltage, and we obtain the energy cost in Joule.
By using the cycles, the operating voltage of the CPU, and the average current drawn for each cycle, we can calculate the energy consumption of cryptographic functions. For example, on average, each cycle consumes approximately 270 mA on an Intel 486DX2 processor [26] or 180 mA on Intel Strong ARM [27]. For a sample calculation, with a 700 MHz CPU operating at 1.35 Volt, an encryption with 20, 000 cycles would consume about 5.71 x 10-3 mA-second or 7.7 µ Joule. We replace total no of clock cycle divided by clock frequency to be duration time for encryption or decryption. Then, the amount of energy consumed by program P to achieve its goal (encryption or decryption) is given by: E=Vcc x I x T joules [26]. Since for a given hardware Vcc are fixed.

V. EXPERIMENTAL RESULTS

A. The effect of changing packet size for cryptography algorithm on power consumption (text files)

a Encryption of different packet size

Encryption time is used to calculate the throughput of an encryption scheme. In this section, we calculated CPU work load, Encryption throughput and power consumption for encryption text files without transmission to show which encryption is more powerful than others. The results are shown in Fig.2

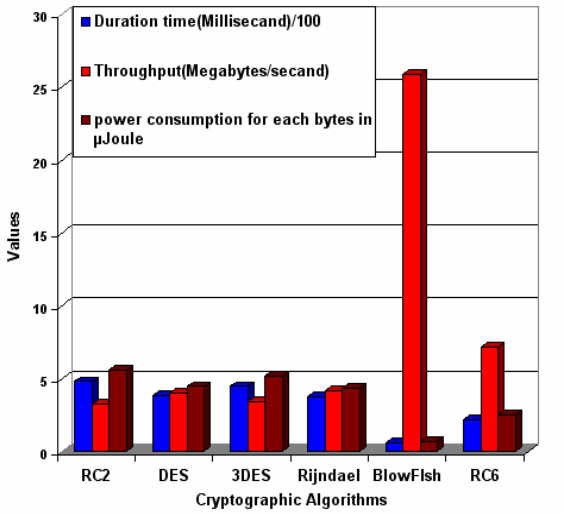

Fig. 2 Time consumption, Throughput, and power consumption for encrypt different Text

b Wireless Environment

we calculated the effect of changes when transmission of data is taken in consideration under different scenario such as transmission of data by using two different architectures (BBS, and ad hoc mode).also we studied the effect of noise ratio on signals (using excellent signals and poor signals).in case of using IEEE 802.11 standard (ad hoc architecture), we calculated the duration time for transmission using the two different types of authentication (open system authentication (no encryption), and shared key authentication(WEP)) .in case of IEEE 802.11i (BBS architecture), we calculated we calculated the duration time for transmission using WPA protocol(TKIP encryption).also in BBS architecture, we calculated the duration time for transmission with out using any encryption techniques.
The results as shown in table.1, and power consumption for transmission (Fig.3)

TABLE. 1
Comparative execution times for transmission of text data using different encryption algorithms

Text Data					
Data to be transmitted	ad hoc mod(802.11standard)			BBS mod	
	Excellent signals		Poor	Excellent signals	
	WLANs Security Protocol				
	No Encryption(Open System Authentication)	WEP(Shared Key Authentication)	Noise(Poor Signals)	IEEE 802.11i (WPA(TKIP))	No Encryption(Open System Authentication)
	Duration Time in Seconds				
No encryption	10.57	10.76	17.35	17.71	16.1
AES	18.5	18.94	45.93	29.28	25.94
DES	12.55	14.38	21.17	20.72	21.07
RC2	18.38	18.82	61.31	29.29	31.92
3DES	17.75	18.05	30.87	27.47	32.45

BF	10.68	10.93	17.49	19.98	13.93
RC6	10.84	11.13	18.26	20	15.09

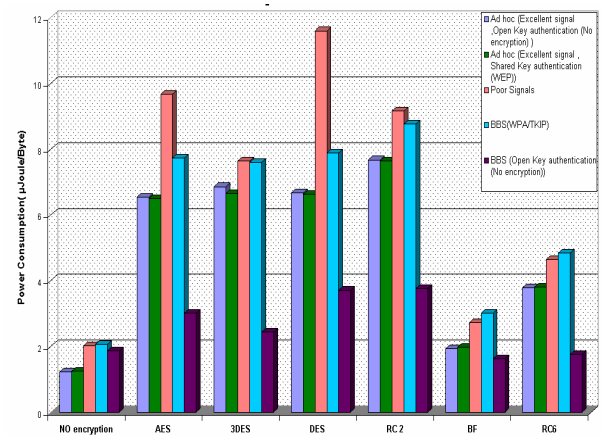

Fig.3 Power consumption for Encrypt different Text document Files in µJoule/Byte with data transmission

In case of encryption time without transmission, the results show the superiority of Blowfish, and RC6 algorithms over other algorithms in terms of the processing time, throughput and power consumption. When we encrypt the same data by using Blowfish and AES, we found that Blowfish requires approximately 16% of the power which is consumed for AES. When we encrypt the same data by using RC6 and AES, we found that RC6 requires approximately 58% of the power which is consumed for AES. Anther point can be noticed here; that AES has an advantage over other 3DES, DES and RC2 in terms of time consumption, throughput, and power consumption. A third point can be noticed here; that 3DES has low performance in terms of power consumption and throughput when compared with DES. It requires always more time than DES because of its triple phase encryption characteristics. A fourth point can be noticed here; that RC2 has low performance and low throughput when compared with other five algorithms in spite of the small key size used. In case of data transmission, we found, there is insignificant difference in performance of different symmetric key schemes (most of the resources are consumed for data transmission rather than computation). Even under the scenario of data transfer by using the two architectures -BBS architectures and ad hoc architectures - it would be advisable to use Blowfish and RC6.in case of ad hoc architecture (8.2.11 standard using open system authentication and shared key authentication with excellent signals), when we transmit the encrypted data by using Blow fish, RC6, and AES, we found that RC6 and Blow fish require approximately 56% of the time consumption which is consumed for AES. In case of BBS architecture (802.11i using WPA/TKIP with excellent signals) when we transmit the encrypted data by using Blow fish, RC6, and AES, we found that RC6 and Blow fish require approximately 68% of the time consumption which is consumed for AES. In case of ad hoc mode (poor signal), we found transmission time increased approximately to double of open shared authentication in ad hoc mod using excellent signals.

B. The effect of changing data type (Images) for cryptography algorithm on power consumption.

a Encryption of different packet size

Now we will make a comparison between other types of data (Images) to check which one can perform better in this case. Experimental results for image data type (JPEG images) are shown Fig. 4, Fig 5, and Fig 6 respectively.

1 CPU work load

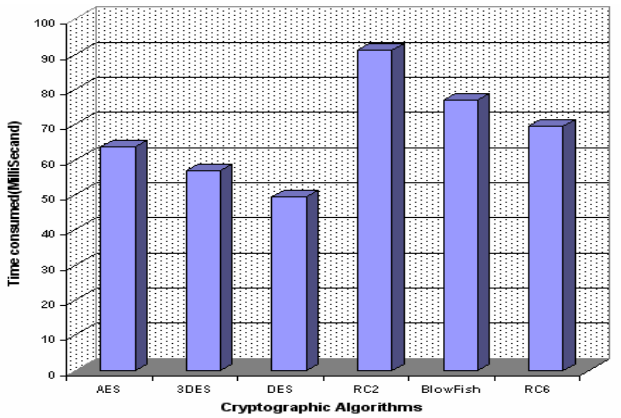

Fig. 4 Time consumption for encrypt different Images with out data transmission

2 Encryption throughput

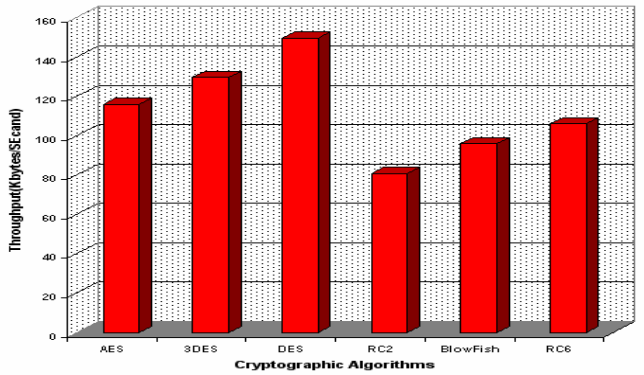

Fig.5 Throughput of each encryption algorithm (Kilobytes/Second)

3 Power consumption

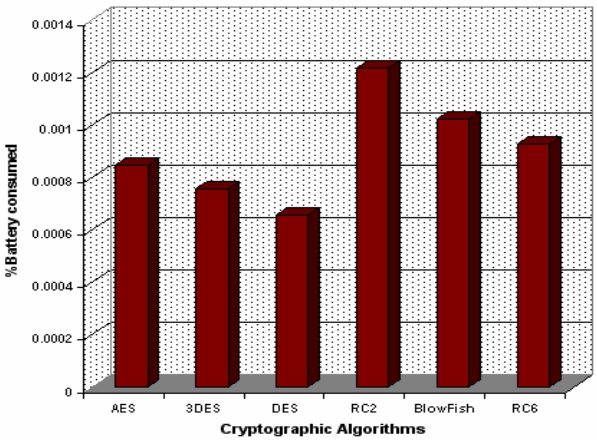

Fig. 6 Power consumption for encrypt different Images Files

bWireless Environment

As we performed in text files we done in Images file. We consider the effect of changes on results when transmission of data is taken in consideration.The results as shown in Fig.7

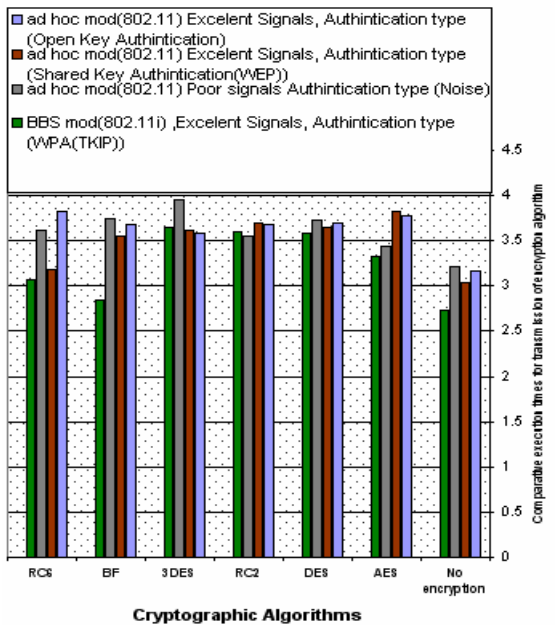

Fig. 7 Comparative execution times for transmission of Image files using different algorithms

From those results, it is easy to observe that RC2 still has disadvantage in encryption process over other algorithms in terms of time consumption and serially in throughput and power consumption. On the other hand, it is easy to observe that RC6 and Blowfish have disadvantage in encryption process over other algorithms in terms of time consumption and serially in throughput and power consumption. It is found that 3DES still has low performance when compared to DES. When the transmission of data is considered, we found there is insignificant difference in performance of different symmetric key schemes. In case of data transmission, we found, there is insignificant difference in performance of different symmetric key schemes (most of the resources are consumed for data transmission rather than computation).

C. The effect of changing data type (Audio files) for cryptography algorithm on power consumption.

a Encryption of different Audio files (different sizes)

Now we will make a comparison between other types of data (Audio file) to check which one can perform better in this case. Experimental results for audio data type to calculate encryption time (Millisecond), Throughput (Megabyte/Second), Power consumption (Micro Joule) are shown Fig.8.

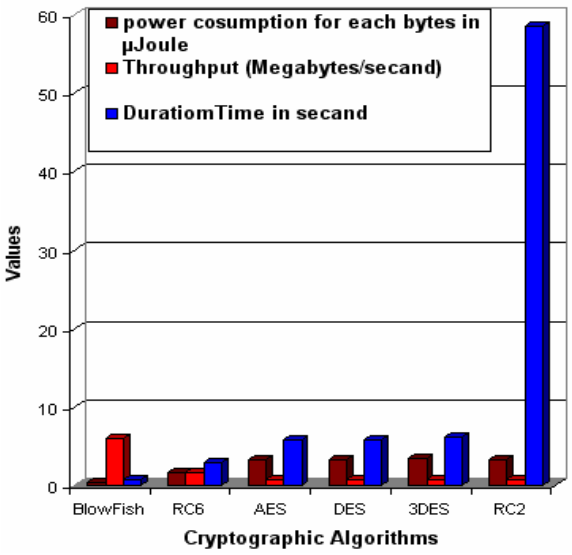

Fig. 8 Time consumption, Throughput, and power consumption for encrypt different Text

b Wireless Environment

As we perform in text files and images data we did in Audio files. We consider the effect of change when transmitted of data is taken in consideration under different scenario the results as shown in table.2, and power consumption for transmission (Fig.9)

TABLE.2
Comparative execution times for transmission of audio data using different encryption algorithms

Audio files					
Data to be transmitted	ad hoc mode(802.11 standard)			BBS mode	
	Excellent signals		Poor	Excellent signals	
	WLANs Security Protocol				
	No Encryption(Open System Authentication)	WEP(Shared Key Authentication)	Noise(Poor Signals)	IEEE 802.11i (WPA(TKIP))	No Encryption(Open System Authentication)
	Duration Time in Second				
No encryption	27.67	28.22	51.14	48.12	43.24
AES	53.82	55.37	93.45	93.59	77.39
DES	54.53	56.48	94.83	99.87	69.97
RC2	55.84	57.2	96.79	92.4	64.52
3DES	53.85	56.93	95.66	95.02	78.25
BF	28.73	29.36	48.11	49.56	34.22
RC6	28.74	28.82	50.26	48.71	36.65

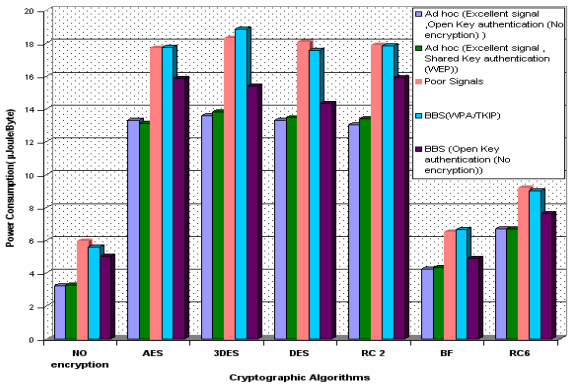

Fig.9 Power consumption for Encrypt different Audio Files (micro Joule/Byte) with data transmission

Results show as the same as in text files. In case of encryption time without transmission, the results show the superiority of Blowfish, and RC6 algorithms over other algorithms in terms of the processing time, throughput and power consumption. When we encrypt the same data by using Blowfish and AES, we found that Blowfish requires approximately 13% of the power which is consumed for AES.and when we encrypt the same data by using RC6 and AES; we found that RC6 requires approximately 48% of the power which is consumed for AES. In case of data transmission, we found, there is insignificant difference in performance of different symmetric key schemes (most of the resources are consumed for data transmission rather than computation). Even under the scenario of data transfer by using the two architectures -BBS architectures and ad hoc architectures - it would be advisable to use Blowfish and RC6.in case of ad hoc architecture (8.2.11 standard using open system authentication and shared key authentication with excellent signals), when we transmit the encrypted data by using Blow fish, RC6, and AES, we found that RC6 and Blow fish require approximately 51% of the time consumption which is consumed for AES. In case of BBS architecture (802.11i using WPA/TKIP with excellent signals) when we transmit the encrypted data by using Blow fish, RC6, and AES, we found that RC6 and Blow fish require approximately 52% of the time consumption which is consumed for AES. In case of ad hoc mode (poor signal), we found transmission time increased approximately by 74% over open shared authentication in ad hoc mod using excellent signals.

D. The effect of changing data type (Video files) for cryptography algorithm on power consumption.

a Encryption of different Video files (different sizes)

Now we will make a comparison between other types of data (Video files) to calculate encryption time (Millisecond), Throughput (Megabyte/Second), Power consumption (Micro Joule) are shown Fig.10

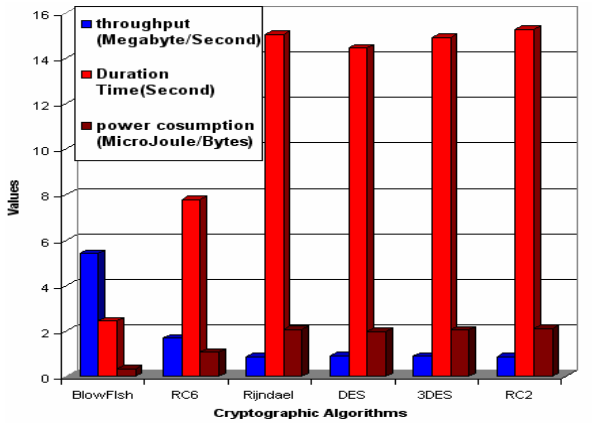

Fig. 10 Time consumption, Throughput, and power consumption for encrypt different Video Files

b Wireless Environment

We consider the effect of change when transmitted of data is taken in consideration under different scenario. The results as shown in table.3, and power consumption for transmission (Fig.11)

TABLE 3
Comparative execution times for transmission of Video data using different encryption algorithms

Video Streaming					
Data to be transmitted	ad hoc mod (802.11 standard)			BSS mode	
	Excellent signals		Poor	Excellent signals	
	WLANs Security Protocol				
	No Encryption(Open System Authentication)	WEP(Shared Key Authentication)	Noise(Poor Signals)	IEEE 802.11i (WPA(TKIP))	No Encryption(Open Systems Authentication)
	Duration time in second				
No encryption	8.27	8.35	19.39	13.7	12.21
AES	14.89	16.24	26.84	27.1	21.47
DES	16	16.66	26.72	26.4	22.7
RC2	15.18	16.3	26.5	26.6	25.5
3DES	16.4	16.85	26.77	26.7	22.5
BF	8.78	9.3	16.17	14.2	12
RC6	8.49	9.36	14.13	13.9	12.68

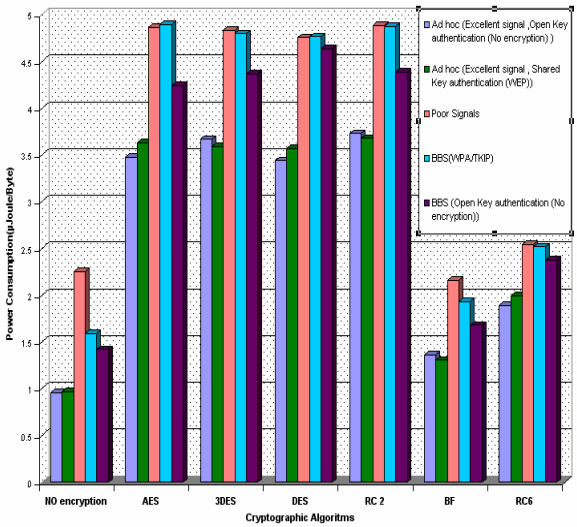

Fig.11 Power consumption for Encrypt different Video Files (micro Joule/Byte) with data transmission

The results as the same as in text and audio file. In case of encryption time without transmission, the results show the superiority of Blowfish, and RC6 algorithms over other algorithms in terms of the processing time, throughput and power consumption. When we encrypt the same data by using Blowfish and AES, we found that Blowfish requires approximately 16% of the power which is consumed for AES. When we encrypt the same data by using RC6 and AES, we found that RC6 requires approximately 51% of the power which is consumed for AES. In case of data transmission, we found, there is there is insignificant difference in performance of different symmetric key schemes (most of the resources are consumed for data transmission rather than computation). Even under the scenario of data transfer by using the two architectures - BBS architectures and ad hoc architectures - it would be advisable to use Blowfish and RC6.in case of ad hoc architecture (8.2.11 standard using open system authentication and shared key authentication with excellent signals), when we transmit the encrypted data by using Blow fish, RC6, and AES, we found that RC6 and Blow fish require approximately 57% of the time consumption which is consumed for AES. In case of BBS architecture (802.11i using WPA/TKIP with excellent signals) when we transmit the encrypted data by using Blow fish |, RC6, and AES, we found that RC6 and Blow fish require approximately 51% of the time consumption which is consumed for AES. In case of ad hoc mode (poor signal), we found transmission time increased approximately by 71% over open shared authentication in ad hoc mod using excellent signals.

VI. CONCLUSIONS

This paper presents a performance evaluation of selected symmetric encryption algorithms on power consumption for wireless devices. The selected algorithms are AES, DES, and 3DES, RC6, Blowfish and RC2. Several points can be concluded from the Experimental results. First; in the case of changing packet size with and with out transmission of data using different architectures and different WLANs protocols, it was concluded that Blowfish has better performance than other common encryption algorithms used, followed by RC6. Second; in case of changing data type such as audio and video files, it is found the result as the same as in text and document. In the case of image instead of text, it was found that RC2, RC6 and Blowfish has disadvantage over other algorithms in terms of time consumption. Also, it is found that 3DES still has low performance compared to algorithm DES. Third point; when the transmission of data is considered there was insignificant difference in performance of different symmetric key schemes (most of the resources are consumed for data transmission rather than computation). There is insignificant difference between open key authentications and shared key authentication in ad hoc Wireless LAN connection with excellent signals. In case of poor signal it is found that, transmission time increased minimum by 70 % over open sheered authentication in ad hoc mod. Finally -in the case of changing key size – it can be seen that higher key size leads to clear change in the battery and time consumption.

For our future work, we will suggest three approaches to reduce the energy consumption of security protocols: replacement of standard security protocol primitives that consume high energy while maintaining the same security level, modification of standard security protocols appropriately, and a totally new design of security protocol where energy efficiency is the main focus.

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