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Study of Symmetric key Cryptography Algorithms

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ABSTRACT:

With the advancement of technology internet and various communication techniques that pass through it has grown in prominence each day. However along with this advancement has also grown the threat of hackers and malicious groups. There has been several passive and active attacks making the role of data security pretty important. Most of the time the data passed via internet might contain confidential or personal information which many people would want to be protected against attacks. Various data encryption algorithms has been developed to make sure that the data transmitted via internet is secure from any sort of hacking or attacks.Several cryptographic algorithms also have been developed for encryption and with each one having some advantages and disadvantages. This paper presents a detailed study of symmetric encryption/decryption algorithms and its advantages and disadvantages.

Keywords:- **Symmetric key Encryption, Symmetric key Decryption, Cipher Text, Plain Text, Cryptography, Crypt analysis, Key DES, AES, TDES, etc...**

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I. INTRODUCTION:

Data exchanging via internet has become an inevitable factor in our day to day life. Even though private networks exist generally people prefer data access and transfer via internet which has become the fastest and the easiest means of data communication. A variety of confidential data/information is exchanged through internet which includes ATM passwords, bank dealings, medical records and information, personal details etc. Confidential and sensitive information should always be protected from hackers. For protection various encryption algorithms are currently used one way or other and it has emerged as the most common method of data protection. Cryptography algorithms play an important role in data protection.

To put in simple terms Cryptography is the art of changing plain text to cipher text or encrypted text. The art of breakingciphers, called cryptanalysis, and the art devising them which is cryptography is collectively knownas cryptology. Cryptography has two stages to it. One is encryption where the plain text is converted to cipher text. The second stage is at the receiver end where the cipher text is decrypted back to the original text.Mainly we can classify cryptography into three encryption models

1) Symmetric key encryption models
2) Asymmetric key encryption models
3) Hash functions (Mathematical) models

In this paper we are concentrating on symmetric key encryption models and tries to compare the performance of the most popular encryption algorithms.

Fig 1– Encryption to decryption flow

SYMMETRIC KEY ENCRYPTION MODELS

Let us see what is a Symmetric Key algorithm? To put in simple terms a Symmetric-key algorithmsallows the usage of the same cryptographic keys for both encryption of plaintext and decryption of cipher text. The keys may be identical or there may be a simple transformation to go between the two keys. In practice however the keys represent a shared secret between two or more parties that can be used to maintain a private

information link. The famous symmetric key encryption algorithms are DES, AES, 3DES, Blowfish etc.

Symmetric-key encryption can use either stream ciphers or block ciphers.Stream ciphers encrypt the digits (typically bytes) of a message one at a time. Block ciphers take a number of bits and encrypt them as a single unit, padding the plaintext so that it is a multiple of the block size. Blocks of 64 bits have been commonly used

II. RELATED WORK:

Milind Mathur.and Ayush Kesarwani et al, [1] presents the comparison in performance of six most useful algorithms: DES, 3DES, AES, RC2, RC6 and BLOWFISH. Performance of different algorithms is different according to data loads. In the case of changing key size – it can be seen that higher key size leads to clear increase in time needed for encryption.

Paper [2] provides a comparison between some symmetric and asymmetric techniques. The factorsare achieving an effectiveness, flexibility and security, which is a face of researchers. As aresult, the better solution to the symmetric key encryption and the asymmetric key encryption is provided.

From [3] evaluation of encryption algorithms like AES, DES, 3DES, RC2, Blowfish, and RC6 are done. That paper tested each of these algorithms and conducted a comparison of these algorithms. The results showed that Blowfish was the best encryption algorithm. Comparison between the different symmetric and asymmetric encryption/decryption algorithms are explained in [4] [5] [6] and [7].

Hardware performance of symmetric algorithms arediscussed in [9]. This allows us to choose the best available one on the basis of their performanceparameter. As technology has grown it canbe all the more important as various functions in our day to day life asreprogrammable devices are highly necessary places where forhardware implementations of encryption algorithms as theyprovide cryptographic algorithm agility, physical security, and potentially much higher performance. This hardware design is appliedto the new secret and variable size key block cipher calledBlowfish designed to meet the requirements of the previousknown standard and to increase security and to improveperformance.

III. SYMMETRIC ALGORITHMS

As part of our performance analysis we have selected the below symmetric algorithms.

DES (Data Encryption Standard)

DES is a block cipher encryption algorithm. This is the first encryption standard that was published by NIST. It is a symmetric algorithm which meansit is operated by the same key for encryption and decryption.It uses one 64-bit key [1] [4] and [13]. Out of 64 bits, 56 bits make up the independent key, which determine the exact cryptography transformation, 8bits are used for error detection. The main operations are bit permutations and substitution in one round of DES.Six different permutation operations are used both in key expansion part and cipher part. Decryption of DESalgorithm is in the reverse order of encryption. The output is a 64-bit block of cipher text. Many attacks and methods recorded the weaknesses of DES, which made it an insecure block cipher key.

3DES

It is an enhancement of DES. As a part of incrementing the security it developed 3 keys for encryption/decryption. In this standard the encryption method is similar to the one in original DES but applied 3 times to increase the encryption level. It uses 64 bit block size with 192 bits of key size [1] [4]. The encryption method is similar to the one used in the original DES but applied 3 times to increase the encryption level and the average safe time.But it takes more time for encryption/decryption.

AES

Advanced Encryption Standard (AES) also known as the Rijndael algorithm. It is a symmetric block cipher. It was recognized that DES was not secure because of advancement in computer processing power. It can encrypt data blocks of 128 bits using symmetric keys 128, 192, or 256. It has variable key length of 128, 192, or 256 bits; default 256. It encrypts the data blocks of 128 bits in 10, 12 and 14 round depending on the key size. AES encryption is fast and flexible [1] [13] and [14]. It can be implemented on various platforms especially in small devices. AES has been tested for many security applications.

BLOWFISH

It is one of the most common public domain encryption algorithms provided by Bruce Schneider - one of the world's leading cryptologists, and the president of Counterpane Systems, a consulting firm specializing in cryptography and computer security [1] [4] and [13].Blowfish is 64-bit block cipher-used to replace DES algorithm. Ranging from 32 bits to 448 bits, variable length key is used. Variants of 14 round or less are available in Blowfish. Blowfish is unpatented and license-free and is available free for all uses. Blowfish is one of the

fastest block ciphers developed to date. Blowfish suffers from weak keys problem, still no attack is known to be success.

IV. COMPARISON OF ALGORITHMS

A comparison of the various algorithms is given below.

	DES	3DES	AES	BLOWFISH
Designers	IBM	IBM	JOAN DAEMEN & VINCENT RIJMEN	BRUCE SCHNEIER
First Published	1977	1998	1998	1993
Derived from	Lucifer	DES	Square	-
Key size	56 bits	112 bits or 168 bits	128 bits, 192 bits, 256 bits	32-448 bit in steps of 8 bits. 128 bits by default
Block size	64 bits	64 bits	128 bits	64 bits
Structure	Balanced Feistel network	Feistel network	Substitution-permutation network	Feistel network
Rounds	16	48	10, 12 or 14 depending on key	16
Attacks	Brute force attack, differential crypanalysis, linear cryptanalysis	Chosen plain text attacks or known plain text attacks	Brute force attack, Biclique attack, Related-key attacks	Second order differential attack
Cipher type	Block cipher	Block cipher	Block cipher	Block cipher
Security	In secure	Secure than DES	Secure	Secure
Keys	Single	Single key divided into three	Single	Public
Speed	Fast	Slow than DES	Fast	Fast
Power Consumption	Higher than AES	Higher than DES	Higher than Blow fish	Very low
Throughput	Lower than AES	Lower than DES	Lower than Blow fish	Very High
Encryption	High	Moderate	High	High

Table .1 Comparison of symmetric key algorithms

V. SIMULATION ENVIRONMENT

This section will describe the simulation environment as well as the software used.
Microsoft's .NET framework has robust support for encryption in the System.Security.Cryptography namespace. The System.Security.Cryptography namespace provides cryptographic services for a develop using which secure encoding and decoding of data, as well as many other operations like hashing or random number generation can also be done. However .net providers support for DES, AES, 3DES and Rijndael but leaves out blowfish. Hence to test blowfish we made use of blowfish library provided by sparkIM project[15]. This implementation has been tested thoroughly and is known to work well.

System used – The experiments were run on a Core I3 PC with Windows 8 64 bit version and 4GB memory. Visual studio 2013 was used to compile and run the tests. The tests were run three times to make sure that the results are consistent.

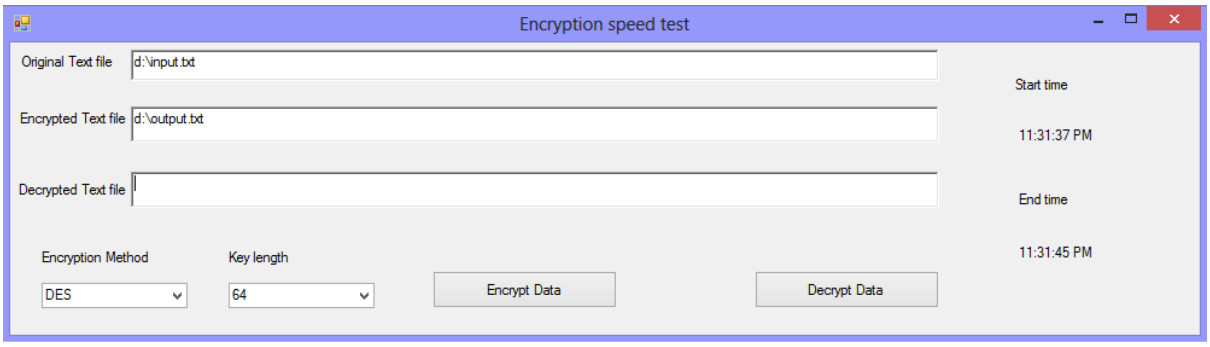
Experiment scenarios – The experiments were done using a standard 200 MB text file as input. The text file was encrypted and decrypted using the algorithms with varying key length. This will confirm the speed variations when using smaller key size and when the key size is increased.

The image of the custom developed .net program is given below. It will accept below parameters.

- Input text file path and file name

- Encryption method
- Key length
- Encrypted text file path and file name
- Decrypted text file path and file name

When the 'Encrypt' button is pressed, the encryption algorithm will run and encrypt the data based on the other parameters selected. The reverse will happen for the decryption. The start time and end time for each operation will be also displayed and from this we can easily find out how much time it took for each operation.



VI. SIMULATION RESULTS

Comparison of algorithms on the basis of speed

Size of input (MB)	DES	3DES	Rijndael	AES	Blowfish
2	1	3	4	2	1
5	2	6	5	4	2
10	3	9	12	6	3
50	10	30	15	12	8
100	18	55	25	25	15

Table 2 – Shows the time taken for encryption for each algorithm in seconds

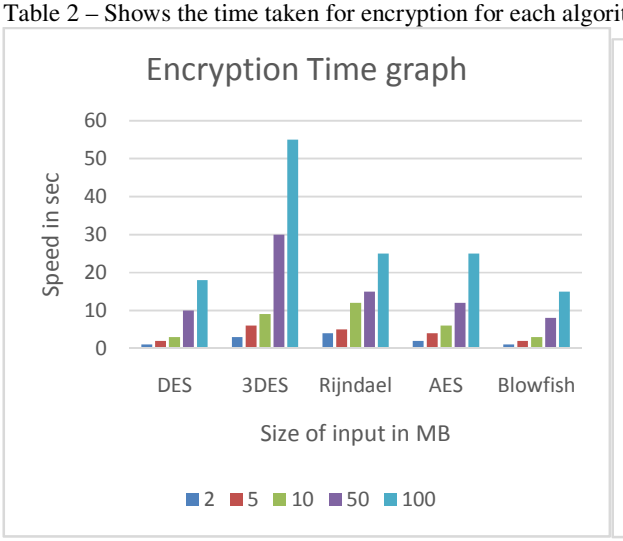


Fig. 2 Comparison of encryption time - bar graph

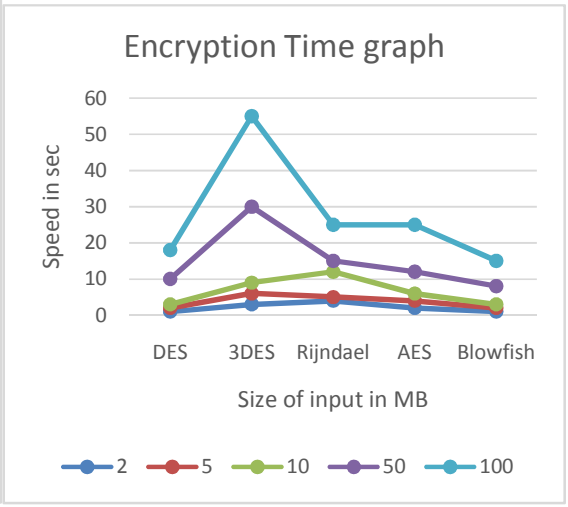


Fig. 3 Comparison of encryption time - line graph

Decryption table

Size of input (MB)	DES	3DES	Rijndael	AES	Blowfish
2	1	2	2	1	1
5	1	3	3	2	2
10	2	6	12	4	3
50	8	24	12	8	7
100	15	45	20	20	12

Table 3 – Time taken for Decryption for each algorithm in seconds

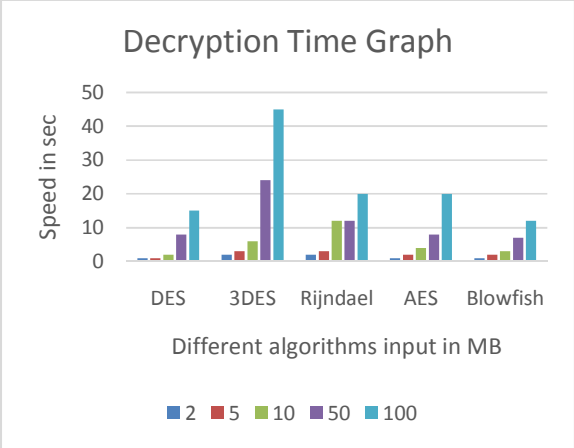


Fig. 4 Comparison of decryption time - bar graph

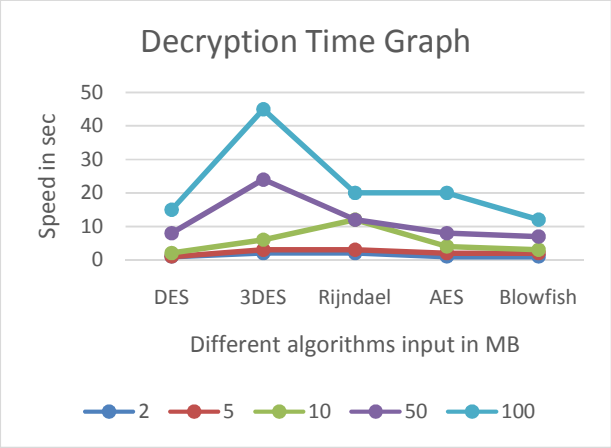


Fig. 5 Comparison of decryption time - line graph

From the above two tables it can be seen that Blowfish have the best performance among the encryption algorithms. AES is slightly slower in performance when compared to Blowfish but it provides better protection against attacks. Another interesting thing is that 3DES takes exactly 3 times to encrypt data when compared to DES because it uses DES 3 times for encryption.

VII. CONCLUSION :

From the studies which we have performed considering security, throughput, speed, encryption/decryption, power consumption and other factors, it is shown that blowfish algorithm having good performance than other symmetric algorithm like DES and 3DES, AES having better performance. The memory requirement of symmetric algorithms is lesser than asymmetric encryption algorithms and symmetrickey algorithms runs faster than asymmetric key algorithms.Further, symmetric key encryption provides more security thanasymmetric key encryption. AES eventhough its widely used today, it uses more processing power when compared with other algorithms.

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