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INTRODUCTION
REVIEW OF LITERATURE
NEED/IMPORTANCE OF THE STUDY
STATEMENT OF THE PROBLEM
OBJECTIVES
HYPOTHESIS (ES)
RESEARCH METHODOLOGY
RESULTS & DISCUSSION
FINDINGS
RECOMMENDATIONS/SUGGESTIONS
CONCLUSIONS
LIMITATIONS
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- Hunker, H.L. and A.J. Wright (1963), "Factors of Industrial Location in Ohio" Ohio State University, Nigeria.

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- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

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- Garg, Bhavet (2011): Towards a New Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

SURVEY OF VARIOUS CRYPTOGRAPHIC TECHNIQUES

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ABSTRACT

Cryptography and encryption have been used for secure communication for thousands of years. Throughout history, military communication has had the greatest influence on encryption and the advancements thereof. The need for secure commercial and private communication has been led by the Information Age, which began in the 1980's. Although the Internet had been invented in the late 1960's, it did not gain a public face until the World Wide Web was invented in 1989. The World Wide Web is an electronic protocol which allows people to communicate mail, information, and commerce through a digital medium. This new method of information exchange has caused a tremendous need for information security. A thorough understanding of cryptography and encryption will help the people to develop better ways to protect valuable information as technology becomes faster and more efficient.

KEYWORDS
Cryptography, Encryption, Security.

1. INTRODUCTION

1.1 OVERVIEW OF CRYPTOGRAPHY

Cryptography a modern encryption technology, comprising of different mathematical processes involving the application of formulas (or algorithms) was conventionally designed to secure discretion of military and diplomatic communications. With the Rapid growth of Information Technology and science of encryption, an innovative area for cryptographic products has stimulated. Cryptography plays a major role in securing data. It is used to ensure that the contents of a message are confidentially transmitted and would not be altered. Network security is most vital component in information security as it refers to all hardware and software function, characteristics, features, operational procedures, accountability, access control, and administrative and management policy. Cryptography is central to IT security challenges, since it underpins privacy, confidentiality and identity, which together provide the fundamentals for trusted e-commerce and secure communication. There is a broad range of cryptographic algorithms that are used for securing networks and presently continuous researches on the new cryptographic algorithms are going on for evolving more advanced techniques for secures communication.

1.1.1 DEFINITION

1. Cryptography: It is defined as the subdivision of cryptology in which encryption/decryption algorithms are designed, to guarantee the security and authentication of data which passes over the interconnected networks.
2. Computer Security: Generic name for the collection of tools designed to protect data and to thwart hackers.
3. Network Security: Measures to protect data during their transmission.
4. Internet Security: Measures to protect data during their transmission over a collection of interconnected networks.

1.2 OBJECTIVES OF CRYPTOGRAPHY

In data and telecommunications, cryptography is necessary when communicating over any un trusted medium, which includes just about any network, particularly the Internet. Within the context of any application-to-application communication, there are some specific security requirements, including:

1. CONFIDENTIALITY

- The principle of confidentiality specifies that only the sender and the intended recipients should be able to access the contents of a message.
- User A sends a message to user B and another user C gets access to this message, without the permission of A and B. This type of attack is called as interception.

2. AUTHENTICATION

- It helps to establish proof of identities; it ensures that the origin of an electronic message or document is correctly identified.
- User C sends an electronic document over the internet to B But C posing as User A, sending a fund transfer request(From A to C's a/c) to bank B. Bank transfer the funds from A to C's a/c ,it would think that user A has requested the fund transfer. This type of attack is known as fabrication.

3. INTEGRITY

- When the contents of a message are changed after the sender sends it, but before it reaches the intended recipient, i.e. integrity of the message is lost.
- Suppose you write a cheque for Rs.1000 to pay the goods. However, when you see your next account statement that the cheque is resulted in a payment of Rs.10000.This is the case for loss of message integrity. This type of attack is known as modification.

4. NON-REPUDIATION

- User sends a message and later on refuses that he had sent the msg.
- User A send a fund transfer request to bank B over the internet. After the bank perform the fund transfer as per A's instruction. A could claim that he never sent the funds transfer instruction to the bank i.e. A denies the fund transfer instruction.
- Thus non-repudiation defeats such possibilities of denying something, having done it.

5. ACCESS CONTROL

- It determines who should be able to access what.
- It means we should be able to specify that user A can view the records in the database but cannot update them.
- It is related to two areas: role management and rule management.
- Role management concentrates on the user side (which user can do what).
- Rule management focus on resources side (which resources is accessible and under what circumstances).

6. AVAILABILITY

- It states that resources should be available to authorized parties at all times.
- For example: Due to the intentional actions of an unauthorized user C, an authorized user A may not be able to contact a server computer B.
- This would defeat the principle of availability. Such an attack is called as interruption.

1.3 NEED OF CRYPTOGRAPHY

- Information Security requirements have changed in recent times.
- Traditionally provided by physical and administrative mechanisms.
- Computer use requires automated tools to protect files and other stored information.
- Use of networks and communications links requires measures to protect data during transmission.

1.4 SECURITY ATTACK

1.4.1 MODERN NATURE OF ATTACKS

1. AUTOMATING ATTACKS

- The speed of computers makes several attacks.
- Someone creates machines that can produce counterfeit coins producing so many coins on a mass scale which will affect the economy.
- This is quite different with computers. Attacker can steal a half a dollar from million bank accounts in few minutes which would give him a half million dollars possibly without any major complaints.

2. PRIVACY CONCERN

- Collecting the information about the people and later misusing it is turning out to be a huge problem.
- Every company (shopkeepers, banks, airlines, insurers) are collecting and processing the huge amount of information about us, without we realizing when and how it is going to be used.

3. DISTANCE DOES NOT MATTER

- Thieves would earlier attack banks because they had money.
- Now Money is in digital form inside computers and moves around by using computer network.
- And it is very easy and cheaper to attack on the computer systems of the bank by sitting at the home.

1.4.2 TYPES OF SECURITY ATTACKS

General Types of Security Attack are:

1. CRIMINAL ATTACK

- The main aim of the attacker is to maximize financial gain by attacking computer systems.

2. PUBLICITY ATTACK

- An attacker wants to see their names appear on television, news channel and newspaper.
- They are not hardcore criminals.
- Such as students in universities or employees in large organizations, who seek publicity by adopting a Nobel approach of attacking computer systems.
- One form of publicity attack is to damage the webpages of a site by attacking it.
- One of such attack was occurred on the US department of Justice's website in 1996.

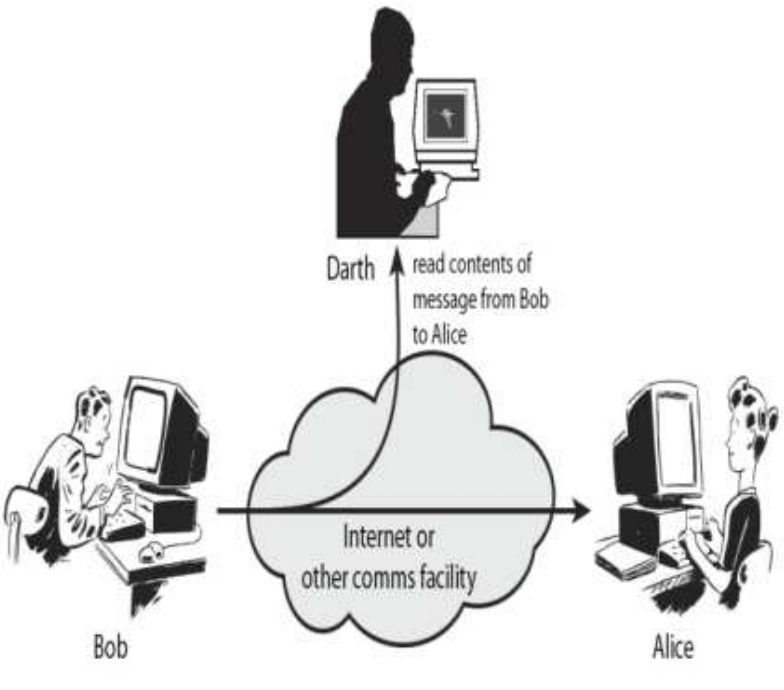
3. LEGAL ATTACK

- The attacker tries to make the judge or the jury doubtful about the security of a computer system.
- The attacker attacks the computer system and the attacked party manages to take the attacker to the court.
- In court attacker tries to convince the judge that there is weakness in the computer system and he has done nothing wrong.
- The aim of the attacker is to exploit the weakness of the judge and the jury in the technological mattes.

Main types of Security Attack are:

1. Passive Attacks

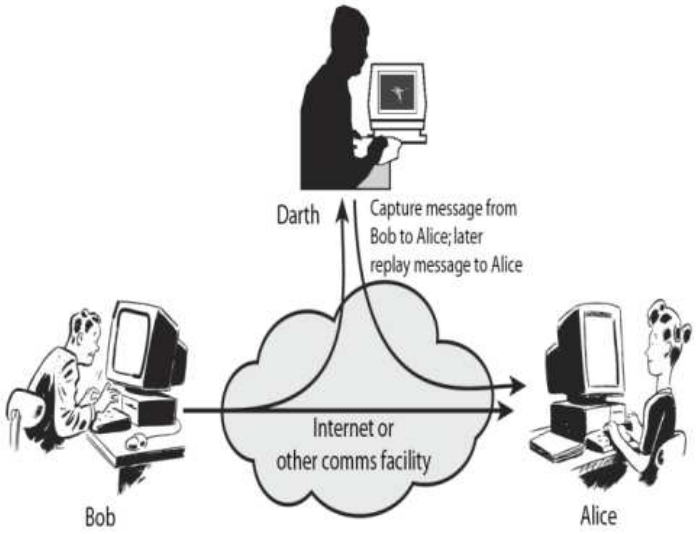
FIGURE 1: PASSIVE ATTACKS



- Eavesdropping or monitoring of data transmissions to obtain message contents.
- Passive attacks do not involve any modification to the contents of an original message.
- Thus the general approach to deal with the passive attack is to think about the prevention rather than detection or corrective actions.
- It is further classified into two sub categories. That is Release of message contents and Traffic analysis.
- Release of message contents: When we send confidential email message to our friend we desire that only he should be able to access it. Otherwise the contents of message are released against our wishes to someone else.
- Traffic analysis: We encode messages using a code language so that the only desired party understands the message. It may happen that a passive attacker could try to figure out similarities between them to come with some sort of pattern that provides him some clues regarding the communication takes place. Such attempts of analysing the encoded messages to come with likely patterns are the work of the traffic analysis attack.

2. ACTIVE ATTACKS

FIGURE 2: ACTIVE ATTACKS



- Active attacks are based on the modification of the original massage in some manner or the creation of false message.
- These attacks can be in the form of interruption, modification and fabrication.
- Trying to pose as another entity involves masquerade attacks.
- Masquerade is a type of attack where the attacker pretends to be an authorized user of a system to gain access to it.
- Modification attack can be classified into replay attacks.
- In this a user captures a sequence of events or some data units and resend them and alteration of messages.
- It involves some changes to the original message.

2. REVIEW OF LITERATURE

2.1 BASIC CONCEPTS OF CRYPTOGRAPHY

1. CRYPTOGRAPHY

- Cryptography is the study of Secret (crypto) writing (graphy).
- Concerned with developing algorithms.
- Conceal the context of some message from all except the sender and recipient (privacy or secrecy).
- Verify the correctness of a message to the recipient (authentication).
- It is the art and science of achieving security by encoding messages to make them non readable.

2. CRYPTANALYSIS

- It is the technique of decoding the messages from a non-readable format back to readable format without knowing how they were initially converted from readable format to non-readable format.

3. CRYPTOLOGY

- It is the combination of cryptography and cryptanalysis.
- That is: Cryptography + Cryptanalysis = Cryptology.

4. CIPHER

- An algorithm for transforming an intelligible message into unintelligible by transposition, substitution, or some other techniques.

5. PLAIN TEXT

- It is a message in clear text which is understood by human.

6. CIPHER TEXT

- When a plain text message is codified using any suitable scheme, the resulting message is called as cipher text.

7. ENCIPHER (ENCODE)

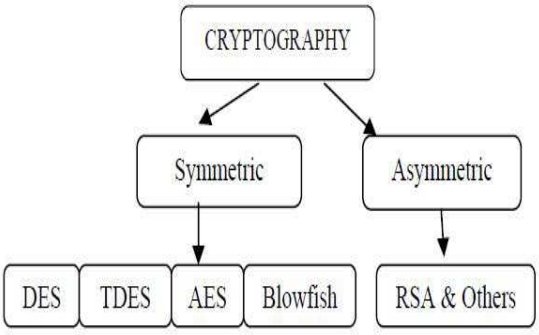
- The process of converting plaintext to cipher text.

8. DECIPHER (DECODE)

- The process of converting cipher text back into plaintext.

2.2 EXISTING TECHNIQUES OF CRYPTOGRAPHY

FIGURE 3: CLASSIFICATION OF CRYPTOGRAPHY



On the basis of number of keys Cryptographic algorithms are divided into two parts.

1. Symmetric Key Cryptography: When the same key is used for both encryption and decryption, then that mechanism is known as Symmetric Key Cryptography. It is also called as Secret Key Cryptography (SKC).
2. Asymmetric Key Cryptography: When two different keys are used, that is one key for encryption and another key for decryption, then that mechanism is called Asymmetric Key Cryptography. It is also called as Public Key Cryptography (PKC).

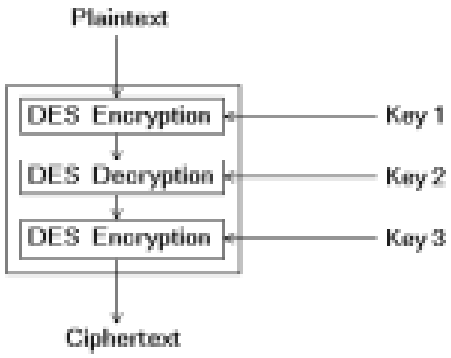
2.2.1 TYPES OF SYMMETRIC KEY CRYPTOGRAPHY

1. DES (DATA ENCRYPTION STANDARD)

It is a symmetric algorithm, means same key is used for encryption and decryption. DES is a block encryption algorithm. It uses one 64 bit key. Out of 64 bits, 56 bits used as independent key, which determine the exact cryptography transformation and 8 bits are used for error detection. The main operations are permutation and substitution. Bits permutation and substitution are performed in one round of DES. Six different permutation operations are performed both in key expansion and cipher part. Decryption process of DES algorithm is similar to encryption, only the round keys are applied in reverse order. The drawback of this algorithm is, it can be easily prone to Brute force Attack. It is easy for the hacker to break the key by applying all possible combinations. In DES, there are only 2^256 possible combinations which are easy to crack. So DES is not secure.

2. 3DES (TRIPLE DATA ENCRYPTION STANDARD)

FIGURE 4: 3DES ENCRYPTION



Triple DES is replacement for DES due to advances in key searching. 3DES uses three rounds of DES encryption and has a key length of 168 bits. It uses either two or three 56 bit keys in the sequence Encrypt-Decrypt-Encrypt(EDE). Initially, three different keys are used for the encryption algorithm to generate cipher text on plain text message..

C(t) = Ek1(Dk2(Ek3(t))) (1)

Where, C(t) is cipher text produced from plain text t, Ek1 is the encryption method using key k1, Dk2 is the decryption method using key k2 and Ek3 is the encryption method using key k3. Another option is to use two different keys for the encryption algorithm which reduces the memory requirement of keys in TDES.

C(t) = Ek1(Dk2(Ek3(t))) (2)

TDES algorithm with three keys requires 2^168 possible combinations and with two keys requires 2^112 combinations. It is practically not possible to try such a huge combinations, so TDES is a strongest encryption algorithm. The disadvantage of this algorithm it is too time consuming.

3. AES (ADVANCED ENCRYPTION STANDARD)

AES is replacement of DES. AES is a variable bit block cipher and uses variable key length of 128,192 and 256 bits. In AES, there are number of processing rounds. These rounds are based on the key size. If the key length is 128 bits, AES will perform nine processing rounds. If key is of 192 bits, AES perform 12 rounds and if the key size is 256 bits then AES perform 14 processing rounds. Each processing round involves four steps:-

- Substitute byte: A non-linear substitution step where each byte is replaced with another according to a lookup table.
- Shift rows: A transposition step where each row of the state is shifted cyclically a certain number of steps.
- Mix column: A mixing operation which operates on the columns of the state, combining the four bytes in each column.
- Add round key: Each byte of the state is combined with the round key using bitwise XOR.

AES encryption is fast and flexible. It can be implemented on various platforms especially in small devices.

4. BLOWFISH

Blowfish is a 64 bit block cipher and have variable length key from 32 bit to 448 bits. This algorithm has two parts – key expansion and data encryption. The key expansion part converts 448bit key into 468bytes A P array of size 18 and four S boxes whose size is 256, each of which are initialized to hexadecimal digits of π. XOR each entry in P array and S boxes with 32 bits of the key. There are 16 rounds of data encryption. In each round a 32 bit sub key is XORed with leftmost 32 bits of plaintext and the result is then passed to the F function of Blowfish. Now, this result becomes rightmost 32 bits for the next round and the output of F function is XORed with the original rightmost 32 bits of plaintext becomes leftmost 32 bits for next round and so on. The f function is distinguishing feature of Blowfish. In Blowfish, key length is 448 bits, s it requires 2^448 combinations to examine all keys. The advantage of this algorithm is, it is simple to implement as all operations are XOR and addition.

2.2.2 TYPES OF ASYMMETRIC KEY CRYPTOGRAPHY

1. RSA

RSA is most widely used public-key cryptosystem. It provides data confidentiality, key exchange and digital signature. The strength of RSA is factoring large numbers. It is a block cipher. In RSA, the plaintext and cipher text are integers between 0 and n-1 for some n. The description of the RSA algorithm is as follows. Plaintext is encrypted in blocks, with each block having a binary value less than some number n.

Public key components:

n = product of two large primes, p and q

e = a random number relatively prime and less than (p-1) (q-1)

Primary key components:

D = e-1 mod ((p-1) (q-1)), the multiplicative inverse of mod ((p-1) (q-1))

Encryption:

C = Me mod n

Decryption:

M = Cd mod n

Digital Signature:

S = Md mod n

M = Se mod n = Med mod n (to verify the signature)

The following requirements must be met for RSA to be satisfactory.

1. p and q , two large primes must remain secretive.
2. It is possible to find value of n, e, d such that,

Med mod n for all M<n.

3. It is infeasible to determine d, given e and n.
4. It is easy to calculate me and C for all values of M<n.

2. OTHER ASYMMETRIC KEY ALGORITHM

Other asymmetric key algorithms are used in conjunction with RSA. These other algorithms have their limitations. These algorithms are Diffie–Hellman, Digital Signature Algorithm, ElGamal and Elliptic Curve Cryptography. The disadvantage of Diffie-Hellman (DH) algorithm is that it is not as versatile as RSA and key generation might be too computationally expensive for the mobile device. Digital Signature Algorithm (DSA) is not as versatile as RSA. Another problem is that the key varies from 512 to 1024 bits, so requiring a strong key size beyond 1024 bits is not possible. DSA is slower than RSA in terms of signature verification. In ElGamal, the cipher text generated is twice the size as the plaintext; therefore it is not suitable in an environment with high latency and low bandwidth. ECC provides equal security for a smaller key size, thereby reducing processing overhead.

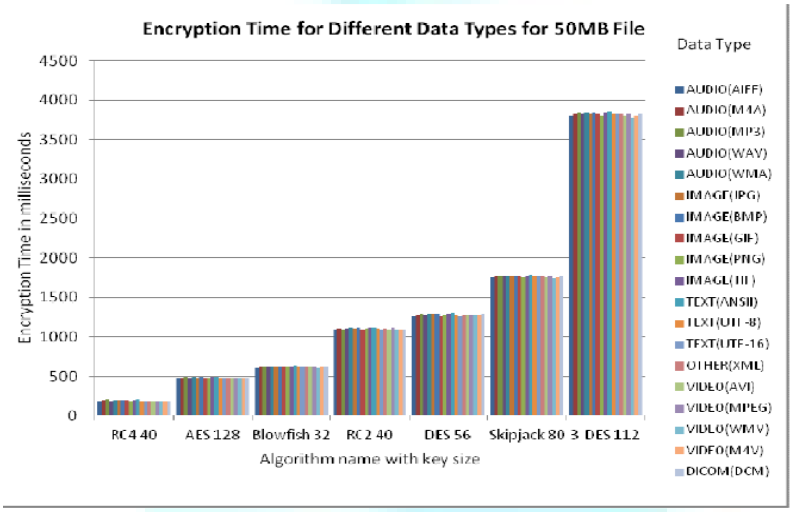
3. ANALYSIS

3.1 ANALYSIS AND COMPARISON OF SYMMETRIC KEY CRYPTOGRAPHIC ALGORITHMS BASED ON VARIOUS FILE FEATURES

3.1.1 FILES WITH DIFFERENT DATA TYPES

This study has taken to check whether the encryption has dependency on type of data. Different data type files like audio, image, textual and video of nearly 50MB in size are chosen and encryption time of different cipher algorithms is calculated for these data types. For all executions of a specific cipher algorithm, varying parameter is data type and constant parameters are key size and block cipher mode. Key size and block mode are at kept at bare minimal parameters. The key size of AES, DES, and 3-DES, RC2, Blowfish, Skipjack, and RC4 are kept at minimum values as 128, 56, 112, 40, 32, 80 and 40 bits respectively. Block cipher mode used is ECB with PKCS#5 padding scheme. Figure shows the execution time of the algorithms for different data type files.

FIGURE 5: ENCRYPTION TIME VS. CIPHER ALGORITHM FOR FILES OF DIFFERENT DATA TYPE



Observation: In Figure it can be clearly seen that encryption time for all the data type is almost same. The result shows that the encryption time does not vary according to the type of the data. Encryption depends only on the number of bytes in the file and not on the type of file. Encryption time of AES is quiet low compared to other block ciphers. RC4 with key size 40 is fastest among the cipher algorithms tested.

3.1.2 DATA FILES OF SAME TYPE WITH DIFFERENT SIZES:

This case study is taken to ensure once again the observations obtained in case study 1. Case study 1 revealed that encryption time depends on number of bytes in the file. To ensure this another study is made in which different files (BMP and FLV) of same types but different sizes are given for encryption and their encryption time is calculated. For all executions key size and block mode are kept at bare minimal parameters. Figure 3.4 show the execution results for BMP and FLV file formats of different sizes respectively.

FIGURE 6: FILE SIZE Vs. ENCRYPTION TIME FOR BMP FILE OF DIFFERENT SIZES

File Type	Varying Parameters (Data Size)	Constant Parameters
BMP	10.7MB, 50MB, 100MB	Data Type, Key size
FLV	50MB, 100MB, 482MB	

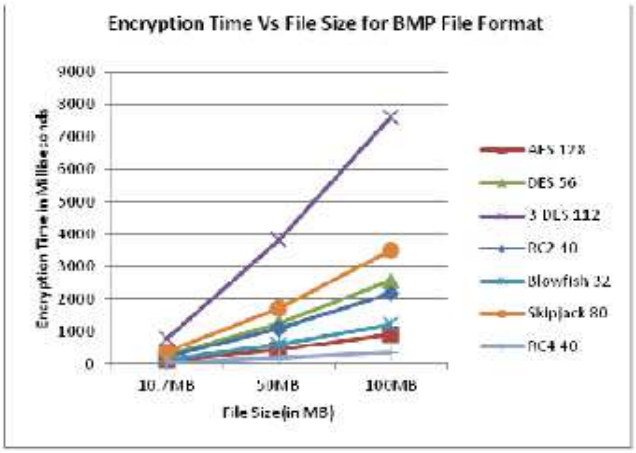
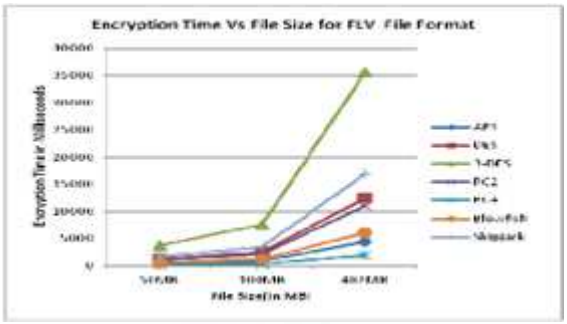


FIGURE 7: EXECUTION PARAMETERS FOR FILES OF DIFFERENT SIZE



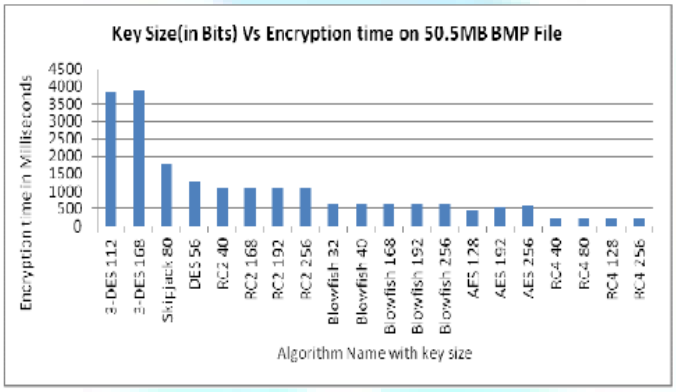
File Type	Size (In MB)	Encryption Time in Millisecond						
		AES 128	DES 56	3-DES 112	RC2 40	Blowfish 32	Skipjack 80	RC4 40
BMP	10.7	101	272	788	238	133	381	40
	50	455	1253	3804	1095	614	1729	198
	100	909	2595	7628	2189	1223	3505	372
FLV	50	456	1268	3810	1112	629	1731	196
	100	918	2586	7631	2224	1267	3515	360
	482	4518	12529	35654	11038	6087	16941	1972

Observation: For each encryption algorithm same parameters are used for files of different sizes. Figure 3.5 shows encryption time of different sizes of files of same type. From the results in figure we can find that the result for different size of data varies proportional to the size of data file. Encryption time increases as file size increases in multiples of data size.

3.1.3 ENCRYPTION ALGORITHMS WITH DIFFERENT KEY SIZES

This case study is to analyze the effect of changing the size of encryption key on encryption time. BMP file of 50.5MB is taken and different cipher algorithms are executed for different size of keys supported by them in ECB mode with PKCS#5 padding scheme. The various key sizes mentioned in Table 1 are used during experimentation. Figure 3.6 shows the result of execution for key size variation.

FIGURE 8: VARIATION OF KEY SIZES FOR DIFFERENT CIPHER ALGORITHMS



Observation: The execution results show that for all ciphers algorithms, the encryption time varies with the change in the size of the of the key. Encryption time increases with increase in key size for block ciphers. The variation in time is very small. AES dominates in the block cipher. RC4 is fastest among all algorithms tested.

From the simulated results it is concluded that encryption time is does not dependent upon data type and date density of the file. The research revealed that; encryption only depends upon the number of bytes present in the file. It also revealed that encryption time and data size is proportional to each other. As the size of data increase the encryption time also increase proportional to data size and vice versa. For all block cipher algorithms that are analyzed, with increase in key size, encryption time also increases, but reduces with increase in key size for stream cipher like RC4. AES is appears to be fastest block cipher with encryption rate of 108MB/sec at bare minimal parameter, but RC4 stream cipher with encryption rate of 270MB/sec comes out to be fastest among all analyzed cipher algorithms.

3.2 CONSTRAINTS FOR SELECTING RIGHT CRYPTOGRAPHIC SCHEME

The selection of right cryptographic technique relies on following constraints:

1. TIME

How much time will be needed for encrypting and decrypting the data and how much time is need to fulfill the prerequisites before starting an encryption how much time is need to fulfill the pre-requisites before starting an encryption.

2. MEMORY

How much memory will be needed especially in case of small devices like PDAs, smart cards, RFID tags.

3. SECURITY

Selected encryption scheme should meet the confidentiality, integrity (authentication, non-repudiation) and availability.

4. NATURE OF DATA

Nature of data means the communicating information is how much confidential or important. If the information is small in size and not too much important; then any encryption scheme is suitable. If information is highly secret or important then joint hybrid combination of symmetric + asymmetric scheme will be suitable.

5. TYPE OF DATA

In case of video data the privacy is more valuable and considerable constraint. If the data is small and in video format the previous described constrains (Time, memory, security) suggest the use of asymmetric scheme but this selection is not sufficient because the third party especially in case of Identity based Public Key Cryptography (ID-PKC) can view the video clip as they have all information (key(s), encrypted data). So in this case the privacy is nothing. That's why the type of data constraint is highly important constraint which should not be neglected in case of right selection of cryptographic scheme. If data type is confidential multimedia (personal video clip) then the symmetric scheme is good but hybrid encryption method (symmetric + asymmetric) can provide all security objectives.

3.3 PERFORMANCE FACTORS OF CRYPTOGRAPHIC ALGORITHMS

Various important factors on which performance of cryptographic algorithms depend are:

1. TUNABILITY

It could be very desirable to be able to dynamically define the encrypted part and the encryption parameters with respect to different applications and requirements. Static definition of encrypted part and encrypted parameters limits the usability of the scheme to a restricted set of applications.

2. COMPUTATIONAL SPEED

In many real-time applications, it is important that the encryption and decryption algorithms are fast enough to meet real time requirements.

3. KEY LENGTH VALUE

In the encryption methodologies the key management is the important aspect that shows how the data is encrypted. The image loss the encryption ratio is based on this key length. The symmetric algorithm uses a variable key length which is of the longer. Hence, the key management is a considerable aspect in encryption processing.

4. ENCRYPTION RATIO

The encryption ratio is the measure of the amount of data that is to be encrypted. Encryption ratio should be minimized to reduce the complexity on computation.

5. SECURITY ISSUES

Cryptographic security defines whether encryption scheme is secure against brute force and different plaintext-cipher text attack? For highly valuable multimedia application, it is really important that the encryption scheme should satisfy cryptographic security. In the analysis cryptographic security is in three levels: low, medium and high.

3.4 COMPARATIVE ANALYSIS OF CRYPTOGRAPHIC TCHNIQUES

TABLE 1: COMPARATIVE ANALYSIS OF VARIOUS CRYPTOGRAPHIC TECHNIQUES

Distinguishing Parameters	DES	3DES	AES	Blowfish	RSA
Designers	IBM	IBM	Vincent RijmenJoan Daemon	Bruce Schneier	Ron Rivest, Adi Shamir, and Leonard Adleman
Published in	1977	1978	1998	1998	1977
Cipher Type	Symmetric	Symmetric	Symmetric	Symmetric	Asymmetric
Key Used	Same key used for Encryption and Decryption	Same key used for Encryption and Decryption	Same key used for Encryption and Decryption	Same key used for Encryption and Decryption	Different key used for Encryption and Decryption
Key Sizes	56 bits (+8 parity bits)	168 bits	128,192,256 bits	32-448 bits	1024-4096 bits
Block sizes	64 bits	64 bits	128 bits	64 bits	Blocks having binary values less than some number n
Structure	Balanced Feistel Network	Feistel Network	Substitution Permutation Network	Feistel Network	Mathematical based
Rounds	16	48	10, 12 or 14 (depending on key size)	16	1
Attacks	Brute Force Attack	Theoretically possible	Side channel attacks	Not yet	A 768bit key has broken
Security	Proven Inadequate	Still Insecure	Secure	More Secure	Secure
Speed	Low	Moderate	High	Very high	High

4. CONCLUSION

Cryptography is an emerging technology which is important for network security. Some well-known cryptographic algorithms have been analyzed in this report. This report gives a detailed study of the popular symmetric key encryption algorithms such as DES, Triple DES, AES, Blowfish and asymmetric key encryption algorithms such as RSA etc. AES is appears to be fastest block cipher with encryption rate of 108MB/sec at bare minimal parameter, but RC4 stream cipher with encryption rate of 270MB/sec comes out to be fastest among all analyzed cipher algorithms. Asymmetric encryption algorithms are more secure than symmetric key algorithms.

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