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   RESULTS & DISCUSSION

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

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# METHODS OF DATA SECURITY USED IN COMPUTER NETWORK

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## ABSTRACT

*The paper is intended to discuss the need of data security in computer network and to explore the different methods available in this connection. The paper basically deals with the different methods and techniques available for securing data to a large extent on a computer network.*

KEYWORDS
Data security, Authentication, Authorization, Cryptography, Symmetric encryption, Asymmetric encryption, Hashing and Digital signature

## 1.0 INTRODUCTION

Nowadays man has been increasingly becoming dependent on internet and web surfing. People are really enjoying this technology because of the fact that it has increased the work efficiency at a tremendous rate. But at the same time, the growing popularity of this technology in public domain led some serious issues like virus infection, tampering of data, spooling and leakage of private information to some unauthorised hands. Therefore, in order to provide data security data encryption is necessary and mandatory. The paper lucidly introduces the major security issues and how these can be dealt that arises while sending data or message from one point to another on a computer network.

### 1.1 DEFINITION

**Data security** refers to the practice of keeping data protected from tampering, corruption and unauthorised access.

### 1.2 IMPORTANCE OF DATA SECURITY

Data security is needed to ensure privacy of personal or corporate/business data. Data security methods/techniques prevent virtual attack, physical attack, flexibility and transparency of data in a firm. The information like client information, payment information, personal files and bank account details need standard security system to a large extent because of the fact that these information can be hard to replace and potentially dangerous if it falls into the wrong hands like hackers or predators.

## 2.0 METHODS OF DATA SECURITY USED IN COMPUTER NETWORK ARE AS ENUMERATED

### 2.1 AUTHENTICATION

It refers to the process of identifying an individual, usually based on a username and password. In general, it verifies “who you are”. The process of authentication is usually required to login into a UNIX server or accessing mail server using POP3 and SMTP client. This method facilitates username/password validation using users own premises Active Directory/LDAP server. Authentication service is installed as a virtual appliance and communicates with user’s local directory using LDAP over SSL. When the user is authenticated, a session token is usually placed into the user’s browser. Usually, PAM (Pluggable Authentication Modules) is used as low authentication schemes into a high level application programming interface (API).

### 2.2 TYPES OF AUTHENTICATION

- **User authentication** -------- refers to the process of determining that a user is who he/she claims to be.
- **Entity authentication** ------- refers to the process of identifying an individual usually based on a username and password.

### 2.3 APPLICATION OF AUTHENTICATION IN DAILY LIFE

- Demanding voter ID or photo ID.
- Entering a country with a passport.
- Logging in to a computer.
- Using a confirmation e-mail to verify ownership of an e-mail address.
- Using internet banking system.
- Withdrawing cash from an ATM.

## 3.0 AUTHORIZATION

It refers to the process of giving individuals access to system objects based on their identity. In general, it verifies “what the user is authorised to do”. Here the user is allowed to login into the (UNIX) system but the user is restricted or not authorised to use or access browser or any other file system. Authorization is usually controlled at file system level.

## 4.0 CRYPTOGRAPHY

It refers to the practice and study of techniques for secure communication in the presence of third parties (called adversaries). The term cryptography comes from Greek words meaning “hidden writing”. It is the science of hiding information so that unauthorised users cannot read it. Cryptography is synonymous with the term data encryption which means the conversion of information from a readable state to apparent nonsense.

### 4.1 DATA ENCRYPTION

It refers to mathematical calculations and algorithmic schemes that transform plaintext into cipher text, a form that is non readable and unusable to unauthorized parties. Modern cryptography is heavily based on mathematical theory and computer science practice. These cryptographic algorithms are to break in practice by any adversary. Cryptographic algorithms and analysing protocols are designed/ constructed to overcome the influence of adversaries. Cryptography or data encryption is directly related to various aspects of information security such as data confidentiality, data integrity, authentication and non repudiation. Historically, encryption systems used symmetric cryptography. As far as computer network is concerned, data encryption is absolutely necessary because it transmits sensitive data over unsecure mediums like the internet.

### 4.2 TYPES OF ALGORITHMS USED FOR DATA ENCRYPTION ARE:

- Symmetric encryption or cryptography and
- Asymmetric encryption or cryptography

Now, each one is discussed as under:

**4.2.1 SYMMETRIC CRYPTOGRAPHY ------** refers to encryption methods in which both the sender and receiver share the same key. It is also known as secret key cryptography. Symmetric cryptography uses the same key for both encryption and decryption.

**KEY ------** In cryptographic systems, the term key refers to a numerical value used by an algorithm to alter information, making that information secure and visible only to individuals who have the corresponding key to recover the information. Therefore, the key has the ability to encrypt or decrypt the data.

**KEY MANAGEMENT** ------ refers to the secure administration of keys to provide them to users where and when they are required.

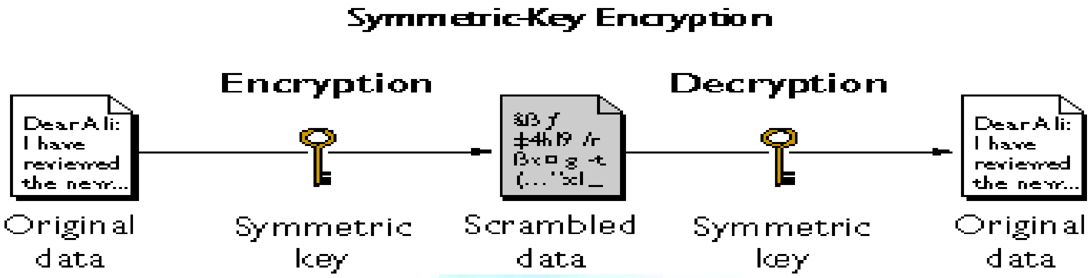
**CIPHER TEXT** ---- Cryptography converts readable data or clear text into encoded data called cipher text.

**4.2.2 Types of symmetric key cryptography (data encryption)**

- Block cipher
- Stream cipher
- Hashing or cryptographic hash functions

**4.2.2.1 Block cipher** ----- refers to the method of encrypting text to produce cipher text. In this method cryptographic key and algorithm are applied to a block of data. Block ciphers generally convert a fixed length block of plaintext into cipher text of the same length, which is under the control of the secret key. Decryption is effected using the reverse transformation and the same key.

**FIG. 1**



Different techniques used to cipher plaintext messages are:

- **ECB** ----- Electronic Code book
- **CBC** ----- Cipher block chaining
- **CFB** ----- Cipher feedback
- **OFB** ----- Output feedback mode

Block ciphers include DES, IDEA, AES, FEAL, SAFER, BLOWFISH, RIVEST CIPHER (RC) and SKIPJACK

**DES (DATA ENCRYPTION STANDARD)** -------- It is the main standard for encrypting data using symmetric algorithm. It is a widely used method of data encryption using a private (secret) key. Earlier it was difficult to break. There are 72 quadrillion or more possible encryption keys that can be used. For each given message, the key is chosen at random from this enormous number of keys. In this case both the sender and the receiver must know and use the same private key. DES applies 56 bit key to each 64 bit block of data. The process can run in several modes and involves 16 rounds or operations.

**APPLICATIONS OF DES** -------- ATM (Automated teller machine) encryption commonly used in banks, e-mail privacy and secure remote access.

**DEMERIT**

DES can be broken. DES is vulnerable or prone to brute force attack or exhaustive key search, a repeated trying of keys until one fits. Example FEAL

**IDEA (INTERNATIONAL DATA ENCRYPTION ALGORITHM)** ------- refers to an iterative block cipher and uses 128 bit keys and eight rounds. This gives much more security.

**ADVANCED ENCRYPTION STANDARD (AES)** ----- This is the newest encryption standard which allows a maximum of 256 bits. AES has not been cracked. Therefore, it is widely used by the US government.

**FEAL** ------ Stands for Fast Data Encipherment algorithm (FEAL). Examples are FEAL-4, FEAL-8 and FEAL-N. They are very insecure.

**SAFER** ----- refers to a symmetric cipher coming with 40, 64 and 128 bit keys.

**BLOWFISH** ----- It is a combination of Fiestal network, key dependent S-boxes and a non invertible F function. It is considered as a strong open source symmetric algorithm.

**RIVEST CIPHER** ------ refers to a group of algorithms that can take on a variable block size, key size and number of rounds. The block size is generally dependent on the word size of the machine. For example, RC5 was designed to run on 32 bit processors. Some of the popular Rivest cipher are RC-2, RC-5 and RC-6.

**SKIPJACK** -------- refers to a symmetric cipher coming with 80 bit keys.

**64- BIT BLOCK CIPHER** ------- refers to the DES (Data Encryption Standard) that encrypts data 64 bits at a time.

**4.2.2.2 STREAM CIPHERS** ------ In a stream cipher, the output stream is created based on a hidden internal state which changes as the cipher operates. For example, RC4. It is a widely used stream cipher.

**4.2.2.3 Hashing or cryptographic hash functions** ------ refers to the function that transforms data of arbitrary length into a smaller fixed length, more commonly known as a message digest. These cryptographic hash functions generally take a message of any length as input and output a short, fixed length hash. It can be used in a digital signature. For good hash functions, an attacker cannot find two messages that produce the same hash. Hash algorithms are often generated by the DES algorithm to encrypt online banking transactions and other communications where messages can't afford to be corrupted. MD4 and MD5 are widely used hash function but now broken.

**WORKING OF HASHING ALGORITHMS** ----- this algorithm generally transforms a text string into an alphanumeric string. Hashes are typically referred to as one way hashes and are difficult to reverse. Usually hash values never need to be decoded, when a user log onto his/her computer. Then the hash value is compared with the hash value stored on the server. When hashing is done, the resulting hash is normally smaller than the original.

Some popular hashing algorithms are: SHA (Secure Hash algorithm) and MD (Message Digest) algorithms.

The following table lists different types of hashing algorithms:

**TABLE 1**

| Hash | No. of bits | Cracked | Developer | Introduced |
|---|---|---|---|---|
| SHA- 1 | 160 | Yes | NSA | 1995 |
| SHA- 2 | | None | NSA | 2000 |
| SHA- 256 | 256 | None | NSA | 2000 |
| SHA- 384 | 384 | None | NSA | 2000 |
| SHA- 512 | 512 | None | NSA | 2000 |
| MD- 2 | 128 | Yes | Ronald Rivest | 1989 |
| MD- 5 | 128 | Yes | Ronald Rivest | 1991 |
| HAVAL | 128 | No | Yuliang Zheng | 1992 |
| RIPEND- 320 | 320 | No | Hans Dobbartin | 1996 |
| Gost | 64 | No | Soviet union | 1970 |
| Whirlpool | 512 | No | Paulo Barreto | 2001 |

**USE OF HASH CODE**

- **Maintaining integrity of messages** ----- a hash code is generally used for comparison purposes to make sure that data has not been changed.
- A hash code is used as a digital signature for the data.

**Digital signature ------** refers to a mathematical scheme for demonstrating the authenticity of a digital message or document. Digital signatures are commonly used for software distribution, financial transactions to detect and prevent forgery or tampering.

**4.2.2.4 Advantages of symmetric cryptography**

- It is safe to send encrypted messages without fear of interception.
- Symmetric cryptography is much faster and is suitable for encrypting large amount of information.

**4.2.2.5 Disadvantage of symmetric cryptography**

- Key management
- As the number of user increases on a network, the number of keys required to provide secure communications among those user increases rapidly. For instance, a network of hundred users would require almost five thousand (500) keys.

**4.3.1 Asymmetric cryptography -----** refers to the encryption algorithms that involve a pair of relative keys to encode and decode messages. Generally, one key is used to encrypt data into cipher text while the other key is used to decrypt cipher text back into plaintext or clear text. This cryptography uses a pair of keys called a private key and a public key. The public key is generally used to encrypt data before sending it to the recipient. When the message is encrypted it becomes viewable only for the owner of the private key, which will allow him to decrypt the information. Also, asymmetric cryptography algorithms are commonly known as public key cryptography.

**4.3.2 Types of asymmetric cryptography**

**RSA (Rivest Shamir- Adleman) algorithm -----** refers to a message that can be securely signed by a specific sender. If the sender encrypts the message using their private key, then the message can be decrypted only using that sender's public key, authenticating the sender.

**PKI (Public Key Infrastructure) -------** refers to the most common public key cryptographic method used on the internet for authenticating a message sender. PKI enables users of an unsecure public network like internet to securely and privately exchange data and money through the use of a public key and a private key pair that is obtained through a trusted authority. This method provide for a digital certificate that can identify an individual or an organisation. A PKI includes the following:

- CA (Certificate authority) ------- is an individual or a person that generally issues and verifies digital certificates. A digital certificate means an electronic "credit card" that establishes users credentials when doing business or other transactions on the web. A digital certificate basically contains username, a serial number, expiration dates and a copy of the certificate holder's public key (used for encrypting messages and digital signatures).
- RA (registration authority) ------- is an individual or a person that generally acts as the verifier for the CA before a digital certificate is issued to a requestor.
- One or more directories where the certificates (with the public keys) are held.
- A certificate management system.

**4.3.3 Application of asymmetric encryption**

- **Making digital certificates -----** Here certificate refers to a package of information that identifies a user or a server, and contains information such as the organisation name, the organisation that issued the certificate, the user's e-mail address and country and the user's public key.

**4.3.4 Advantages of asymmetric key cryptography**

- It is used to solve the problem of delivering the symmetric encryption key to the bank in a secure manner.
- It is considered to be more secure encryption method as its private key is not shared.

**4.3.5 Disadvantages of asymmetric key cryptography**

- Public key cryptography is relatively slow and is only suitable for encrypting small amounts of information such as symmetric keys.
- It did not provide a comprehensive solution to the key management problem.

## 5.0 ADVANTAGES OF CRYPTOGRAPHIC METHOD

- In the past, Julius Caesar was credited with creating one of the earliest cryptographic systems to send military messages to his generals.
- Nowadays, banking, online shopping and even home users uses the method of cryptography to protect data.
- In computer, a web browser automatically encrypts data to prevent intruders from stealing and intercepting private communications.

## 6.0 MODERN CRYPTOGRAPHY APPLICATIONS

- ATM cards
- Computer passwords
- Electronic commerce

## 7.0 CONCLUSION

The paper defines, describes and explains the different cryptographic method and techniques available to encode or decode any text or message to provide reliable privacy and security.

## 8.0 ACKNOWLEDGEMENT

I would like to express my deep gratitude to people around me (especially students and computer users) who most often raise security issues whenever their message passes through public domain using computer. At last I would like to thank the great almighty who has given wisdom, strength and knowledge to visualise and explore things from grass root level and put on papers for the benefit of mankind and promote safe invention and new discoveries.

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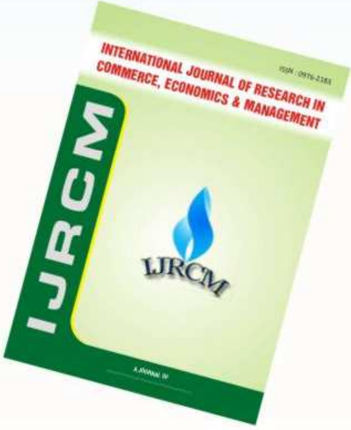
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