Journal of Theoretical and Applied Information Technology

www.jatit.org

Pipeline Data Compression and Encryption Techniques in E-Learning environment.

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ABSTRACT.

One of the recent developments in telecommunication industry is the introduction of communications through Internet. Some of the applications of internet are easy communications, vast library of information at one place, electronic business through internet, e learning modules and so on. E-learning is an important application of communication through Internet. E Learning is an integrated and continues approach to build knowledge skills and competencies through web enabled technologies. Effective e learning is having advantage in delivering the right content to the right person at the right time.

E learning uses the new or existing network connections connected to internet. The wide area network maintains a high speed connection to an internet service provider that local centers can use to connect to the central LAN from a geographical distance away. Though they offer great accessibility, every one using the internet can see the traffic that passes between a local center and central office over these insecure internet LAN connections.

Considering the fact that different encryption approaches target different types of computational complexity, it may be interesting to see if any further improvement can be achieved when different data encryptions are arranged with compression into a pipeline operation. In this work some effort has been put to calculate computational complexities and computational overhead of some encryption algorithms in e- learning environment.

Key words: Compression Algorithm, RSA Encryption, Arithmetic coding algorithm, Comparative study, A new algorithm.

Introduction

When ever a network connection leaves a building, security to data is a must. Virtual protocol network security is most widely used technique for this purpose. This technique uses relatively low cost, widely available access to public networks like the internet to connect remote sites together safely. To obtain security objectives cryptographic techniques are used to block outside traffic from mingling with shared internal network.

Different architectures can be used for virtual networks like 1. Software 2. Look aside (S/W & H/W) 3. Flow through (H/W). All these techniques involve the steps like 1. Encryption algorithms 2. Packet parsing and classification 3. Process packets 4. Compression, encryption & authentication. Crypto processing will require a lot of resources and many hosts will reap significant performance benefits if processing load is reduced. In this context different encryption algorithms will be discussed in terms of their computational overhead, confidentiality &authentication. The study provides some insight into overall improvement in data transmission, better band width utilization, reduction in computational complexity and overall improvement in e learning technologies.

The idea of an encryption system is to disguise confidential information in such a way that its meaning is unintelligible to an unauthorized person. The information to be concealed is called plain text and the operation of disguising it is called enciphering. The enciphered message is called cipher text or cryptogram. The person who enciphers the message is known as encipherer where the person to whom he sends the cryptogram is called the receiver. The set of rules which the encipherer uses to encipher his plain text is called algorithm.

Much of this work concentrates on different security algorithms and their relative advantages and limitations. The different algorithms discussed in this work are substitution cipher, public key algorithm and a new algorithm.

Encryption techniques.

1. **Substitution Techniques**. A Substitution technique is one in which the letters of plain text are replaced by other letters or numbers or symbols. If the sequence is viewed as a

sequence of bits, then substitution involves replacing plain text bit patterns with cipher text bit patterns.

If we assign a numerical equivalent to each letter then the algorithm can be expressed as follows. For the plain text letter P, substitution cipher text C,

C = E(P) = (P+3)mod(26)

A shift may be of any amount, so that general ceaser algorithm is

C = E(P) = (P+K) mod(26)

Where K takes on a value in the range 1-25. The decryption algorithm is simply

P=D(C) =(C-K)mod(26)

If it is known that a given cipher text is a ceaser cipher , then a brute force cryptoanalysis can be easily performed. Simply we have to try all possible 25 keys. If the cryptoanalyst knows the nature of plain text , then the analyst can exploit the regularities of the language.

For example

Plain text: To fill

Key {m,p,g,s,d,t,u,w,b,z,k,n,o,c,q,y,e,u,f,I,k,j,h,j,r,l}

Cipher text iqtbnn.

2. **RSA Encryption**

RSA algorithm is established on the basis of:

$$M^{\alpha(n)} \equiv 1 \pmod{(n)} \quad (1)$$

where n is a product of two large prime numbers P and Q. M is any integer which satisfies $(0 \le M < n)$ and $\alpha(n)$ is the Euler totient function which is set to be: $\alpha(n) = n - 1$, and relatively prime to n. According to the properties of totient functions, we have:

$$\alpha(n) = \alpha(P \times Q) = \alpha(P) \times \alpha(Q)$$
$$= (P-1) \times (Q-1) = n - (P+Q) + 1 \quad (2)$$

To obtain the encryption key, a random integer, d, is selected to be greater than both P and Q. The integer, d, is also relatively prime to $\alpha(n)$, namely gcd(d, $\alpha(n)$)=1 (gcd=greatest common divisor). After that, another integer, e, can be computed by the following equation:

$$e \times d \equiv 1 \pmod{(\alpha(n))} \text{ or}$$
$$e \times d = 1 + k \times \alpha(n) \qquad (k = 0,1,2\ldots) \quad (3)$$

Therefore, if we choose the pair (e, n) as an encryption key, and (d, n) a decryption key, we will obtain the cyphertext for any integer M $(0 \le M < n)$ as:

$$C = E(M) \equiv M^e \pmod{(n)} \quad (4)$$

For decryption, we have:

$$D(C) = D(M^e) = (M^e)^d \pmod{(n)} \equiv M^{e \times d} \pmod{(n)} \quad (5)$$

From equations (1) and (3), it becomes:

$$D(C) = M^{k \times d} = M^{k \times \alpha(n)+1} = M^{k \times \alpha(n)} \times M \pmod{(n)} \equiv M \pmod{(n)} \quad (6)$$

When the input message is represented by a series of integers, which are less than n (message = M), we can get the encrypted message correctly decrypted. Regarding the security of this encrypted message, as long as the prime numbers P and Q are selected large enough, it will be very difficult to find out the two numbers only from n by any existing factoring algorithm.

In the operating procedure, the encryption key (e, n) is normally made public, but the decryption key (d, n) is always kept private. Whenever a message is encrypted by anyone in public, only the person with the decryption key can get the right message.

The encryption algorithm can also be used in the public-key cryptosystem. Assuming person A needs to send a signed cheque to person B, he can use his private key d_A to sign the cheque (message M). The signed file becomes $S=d_A(M)$. For the purpose of privacy, he can use person B's public encryption key e_B to encrypt S, and send the encrypted file $e_B(S)$ to person B. Person B can use his private key d_B to get S. Knowing that the cheque is signed by person A, he then use person A's public encryption key e_A to decrypt S, and finally get the decrypted cheque.

2. A New Encryption Algorithm

The new algorithm has the following features…

1. A set of mono alphabetic substitution rule is used.
2. A matrix is used which is used as a key.
3. The matrix key generates a sequence.
4. This sequence is used to the character in the plain text by a particular chosen rule.

The new algorithm is combination of

- **a.** Substitution cipher
- **b.** Matrix key which generates sequential pattern.
- **c.** Modified Ceaser algorithm.
- **d.** Coding method.

The steps that are involved in the proposed algorithm.

1. The letters of alphabet were given numerical values starting from 0
2. A random matrix used as a key. Let it be A**.**
3. Generate a "**ternary vector**" for 2^3 values i.e from 0 to 8
4. Let this be "**B**".
5. Multiply A *** B**$^{|}$ **;**
6. Consider remainder of the multiple with 3.
7. A sequence is generated.
8. This sequence used as key.
9. Each numerical value of the plain text is added to the key to generate cipher text.
10. The algorithm is reversed to get plain text from cipher text.

It can be seen that to extract the original information from the coded text is highly impossible for the third person who is not aware of encryption keys and the method of coding.

Even if the algorithm is known it is very difficult to break the code and generate key, given the strength of the algorithm .Thus given a short response time through internet communication ,the algorithm is supposed to be safe.

Example:

n=0 to 7
n1=floor(n/2);r1=n-n1*2;
n2=floor(n1/2);r2=n1-n2*2;
n2=r3;
r=[r3 r2 r1];

r=r'= | r3 |
| r2 |
| r1 |
|__ ___|
__ __
A=key= | 4 2 -2 |
| 2 4 -5 |
| -3 2 3 !
|__ _ |
r=remainder(A*r , 3);

r=r(3,1)+r(2,1)*2+r(1,1)*4

End;

OUTPUT

KEY r = 21 8 11 17 10 16 19 7;

Encryption mechanism;

Plain Text

	a	v	n	k	r	i	s	h	n	
	10	31	23	20	27	18	28	17	23	
Key:	21	08	11	17	10	16	19	07	21	
Total :	31	39	34	37	37	34	47	24	44	
%36	31	3	34	01	01	34	11	24	08	
Cipher	v	03	y	01	01	y	b	o	08	I

Decryption mechanism:

Cipher	31	3	34	01	01	34	11	24	08	
+36	0	36	0	36	36	0	36	0	36	
total	31	39	34	37	37	34	47	24	44	
Key	21	08	11	17	10	16	19	07	21	
Difference	10	31	23	20	27	18	28	17	23	
Plain text	a	v	n	k	r	i	s	h	n	.

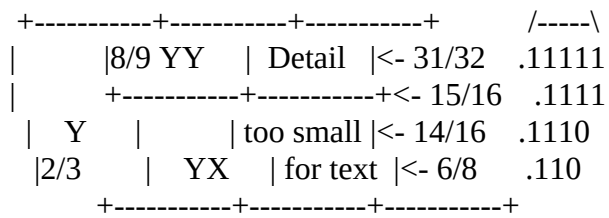
3. Arithmetic Coding

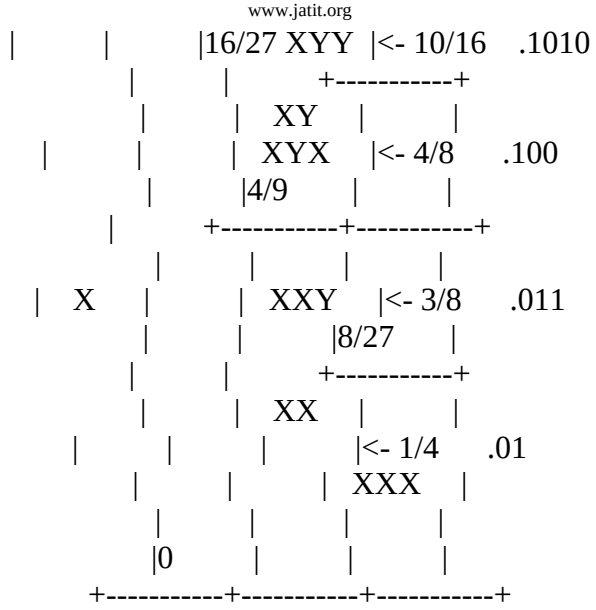
It would appear that Huffman or Shannon-Fano coding is the perfect means of compressing data. However, this is *not* the case. As mentioned above, these coding methods are optimal when and only when the symbol probabilities are integral powers of 1/2, which is usually not the case.

The technique of *arithmetic coding* does not have this restriction: It achieves the same effect as treating the message as one single unit (a technique which would, for Huffman coding, require enumeration of every single possible message), and thus attains the theoretical entropy bound to compression efficiency for any source.

Arithmetic coding works by representing a number by an interval of real numbers between 0 and 1. As the message becomes longer, the interval needed to represent it becomes smaller and smaller, and the number of bits needed to specify that interval increases. Successive symbols in the message reduce this interval in accordance with the probability of that symbol. The more likely symbols reduce the range by less, and thus add fewer bits to the message.

1 Codewords





As an example of arithmetic coding, lets consider the example of two
symbols X and Y, of probabilities 0.66 and 0.33. To encode this message, we
examine the first symbol: If it is a X, we choose the lower partition; if
it is a Y, we choose the upper partition. Continuing in this manner for
three symbols, we get the code words shown to the right of the diagram above
- they can be found by simply taking an appropriate location in the interval for that particular set of symbols and turning it into a binary fraction. In practice, it is also necessary to add a special end-of-data symbol, which is not represented in this simple example.
In this case the arithmetic code is not completely efficient, which is due to the shortness of the message - with longer messages the coding efficiency does indeed approach 100%.

4.Pipeline Data Compression and Encryption

The two pipelines of data transmission can be designed as shown in Figure 1:

The pipeline is designed to analyze the impact of encryption upon the compressed output and to see if the encryption is the favorable transform we are looking for. After compression, the compressed output is a complete random data file (noise) with its redundancy being partly removed. When the encryption algorithm is operated on the random file, the output can be expected to be another random data file. But the encryption process is

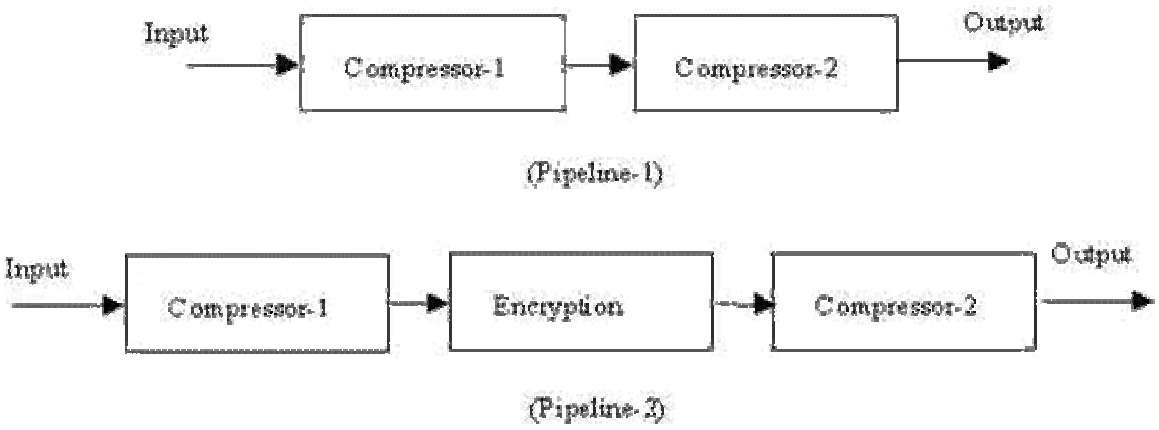


Figure 1: *Pipeline data compression*

completely lossless. Therefore, its insertion will not incur any loss of information, which is exactly what we desired. Hence, the experiment is carried out to see the performance of different encryption algorithms on the transformed random data file. The results are illustrated in Table

Table : Second Pipeline Experimental Results with different encryption techniques.

Parameters for comparative study.	**Encryption: New Algorithm**	**Encryption: RSA algorithm.**
1. Response time	Less than 1 sec.	More than 1 sec.
2. Length of the key: 27 decimal digits.	5 MIPS yrs	5 MIPS yrs
3. Computational overhead. –per character.	6 computations	11 computations (p=11 &q=13 depending on prime numbers.
4. Computational complexity	Exponential	Exponential.

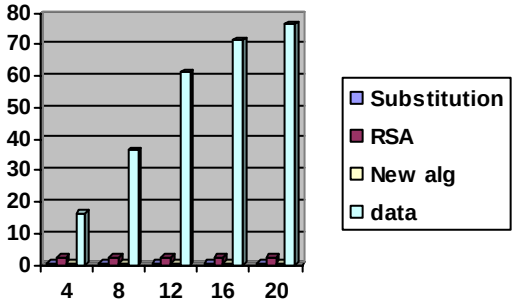
Computer Communications and Networks: A comparative study.

Even though cryptography can resolve the security problem, it also creates some drawbacks. The major part of the disadvantage is computational overhead. There is no perfect encryption algorithm so far. So people who want more secure system are trying to make the encryption algorithm more complex so that no one can break the system. But complex encryption algorithm takes more time to encrypt a message as the complexity of the crypto system increases. In other words, if you want to use more secure system, you have to spend more time on communication. Another problem is data overhead. During the securing procedure, depending on the algorithm that used to make it secure, it may generate some additional data. It is also an overhead in network point of view. Thus by simulating encryption algorithm in various network conditions, we will see how the encryption algorithm affect the network performance.

For fixed band width

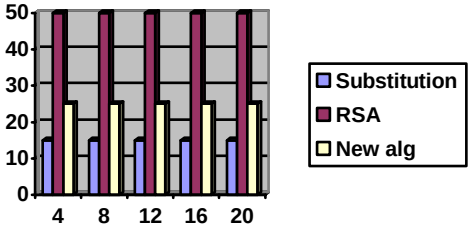
Cryptography overhead with transmission time for data transfer

X axis Data size in KB, Y axis Time in ms (Scale 1: 50)



For a fixed data size, Cryptography over head for different algorithms

X –axis Data size in KB, Y- axis Time in ms (Scale 1:10).



Those two figures show that test results for different data size with the fixed bandwidth. Substitution and New algorithm has least

computational overhead than RSA algorithm. Encrypted data transmission time is also linear to the data size. New algorithm has a slight more computational overhead than substitution algorithm, but for more security. The new algorithm has equal security with RSA algorithm for less computational overhead.

Conclusion

The increasing popularity of internet in e learning makes it highly desirable to use encryption and compression techniques. The study provides some insight into computational complexity, response time and code breaking time of some encryption algorithms. Thus the study provides some insight into overall improvement in data transmission, better bandwidth utilization, reduction in computational complexity and overall improvement in e learning technologies. Thus it can be verified the purpose of encryption and compression algorithms in virtual private networks which forms an integral component of e learning technologies.

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