SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107

An Autonomous Institution

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DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code and Name : 19IT602– CRYPTOGRAPHY AND CYBER SECURITY

III YEAR / VI SEMESTER

Unit 2: SYMMETRIC KEY CRYPTOGRAPHY

Topic : Substitution Techniques

Recap

- Model for Network Security
- Network Access Security Model
- Simplified Model of Symmetric Encryption
- Terms in Cryptography
- Types of Attacks on Encrypted Messages

Substitution Techniques

- A substitution technique is one in which the letters of plaintext are **replaced by other letters or by numbers or symbols.**
  - Caesar Cipher
  - Monoalphabetic Ciphers
  - Playfair Cipher
  - **Hill Cipher**
  - **Polyalphabetic Ciphers**
  - **One-Time Pad**

Hill Cipher

- Multiletter Cipher
- Lester Hill in 1929 – Mathematician
- Encryption
  - m successive plaintext – Substitutes to m cipher text Letters
  - m = linear
  - Each character assigned with numeric values (a=0,b=1…..z=25)

Hill Cipher

- If m = 3 , General form

$$c_1 = (k_{11}p_1 + k_{12}p_2 + k_{13}p_3)\ mod\ 26$$
$$c_2 = (k_{21}p_1 + k_{22}p_2 + k_{23}p_3)mod\ 26$$
$$c_3 = (k_{31}p_1 + k_{32}p_2 + k_{33}p_3)mod\ 26$$

- Expressed in column vectors and matrices

$$\begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix} = \begin{pmatrix} k_{11} & k_{12} & k_{13} \\ k_{21} & k_{22} & k_{23} \\ k_{31} & k_{32} & k_{33} \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix} mod\ 26$$

Or

C= E(K,P) = KP mod 26

P = D(K,P) = K^{-1} C mod 26 = K^{-1} KP = P

Hill Cipher

- Consider m =3 , the plain text " paymoremoney "

$$P = \begin{pmatrix} p & m & e & n \\ a & o & m & e \\ y & r & o & y \end{pmatrix} \qquad P = \begin{pmatrix} 15 & 12 & 4 & 13 \\ 0 & 14 & 12 & 4 \\ 24 & 17 & 14 & 24 \end{pmatrix}$$

- Encryption Key

$$K = \begin{pmatrix} 17 & 17 & 5 \\ 21 & 18 & 21 \\ 2 & 2 & 19 \end{pmatrix}$$

Hill Cipher

$$P.T_1 = \begin{bmatrix} p \\ a \\ y \end{bmatrix} = \begin{bmatrix} 15 \\ 0 \\ 24 \end{bmatrix}$$

$$C.T_1 = Key\ x\ P.T_1\ mod\ 26 = \begin{bmatrix} 17 & 17 & 5 \\ 21 & 18 & 21 \\ 2 & 2 & 19 \end{bmatrix} \begin{bmatrix} 15 \\ 0 \\ 24 \end{bmatrix}\ mod\ 26 = \begin{bmatrix} 11 \\ 13 \\ 18 \end{bmatrix} = \begin{bmatrix} L \\ N \\ S \end{bmatrix}$$

$$C.T_2 = Key\ x\ P.T_2\ mod\ 26 = \begin{bmatrix} 17 & 17 & 5 \\ 21 & 18 & 21 \\ 2 & 2 & 19 \end{bmatrix} \begin{bmatrix} 12 \\ 14 \\ 17 \end{bmatrix}\ mod\ 26 = \begin{bmatrix} 7 \\ 3 \\ 11 \end{bmatrix} = \begin{bmatrix} H \\ D \\ L \end{bmatrix}$$

Hill Cipher

- Decryption – inverse of K^{-1}
- We know that, $K\,K^{-1} = K^{-1}\,K = I$

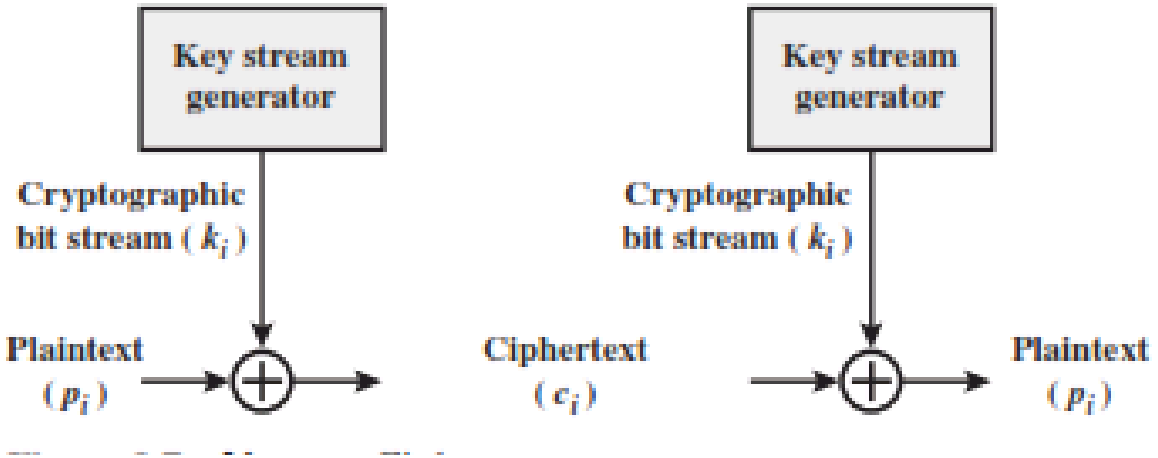
$$K = \begin{pmatrix} 17 & 17 & 5 \\ 21 & 18 & 21 \\ 2 & 2 & 19 \end{pmatrix} \qquad K^{-1} = \begin{pmatrix} 4 & 9 & 15 \\ 15 & 17 & 6 \\ 24 & 0 & 17 \end{pmatrix}$$

$$KK^{-1} = \begin{pmatrix} 17 & 17 & 5 \\ 21 & 18 & 21 \\ 2 & 2 & 19 \end{pmatrix} \begin{pmatrix} 4 & 9 & 15 \\ 15 & 17 & 6 \\ 24 & 0 & 17 \end{pmatrix}$$

$$= \begin{pmatrix} 443 & 442 & 442 \\ 858 & 495 & 780 \\ 494 & 52 & 365 \end{pmatrix} mod\ 26 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Polyalphabetic Cipher

- The first known polyalphabetic cipher was the *Alberti Cipher* invented by Leon Battista Alberti in around 1467.
- Vigenère Cipher $C_i = P_i \text{ XOR } K_i$ $P_i = C_i \text{ XOR } K_i$



Vigenère Cipher Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
X	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

Example

key: *deceptivedeceptivedeceptive*

plaintext: wearediscoveredsaveyourself

ciphertext: ZICVTWQNGRZGVTWAVZHCQYGLMGJ

key	3	4	2	4	15	19	8	21	4	3	4	2	4	15
plaintext	22	4	0	17	4	3	8	18	2	14	21	4	17	4
ciphertext	25	8	2	21	19	22	16	13	6	17	25	6	21	19

key	19	8	21	4	3	4	2	4	15	19	8	21	4
plaintext	3	18	0	21	4	24	14	20	17	18	4	11	5
ciphertext	22	0	21	25	7	2	16	24	6	11	12	6	9

One – time Pad

- Each new message – requires new key of same length
- Unbreakable
- No relationship to plain Text

ciphertext: ANKYODKYUREPFJBYOJDSPLREYIUNOFDOIUERFPLUYTS

key: *pxlmvmsydofuyrvzwc tnlebnecvgdupahfzzlmnyih*

plaintext: mr mustard with the candlestick in the hall

ciphertext: ANKYODKYUREPFJBYOJDSPLREYIUNOFDOIUERFPLUYTS

key: *pftgpmiydgaxgoufhkllmhsqdqogtewbqfgyovuhwt*

plaintext: miss scarlet with the knife in the library

Thank You