Network and Information Security
Lecture 13

B.Tech. Computer Engineering
Sem. VI.

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Transposition cipher Cryptanalysis (continue..)

- Better Approach
- Example
- Suppose that Eve has intercepted the ciphertext “EEMYNTAACTTKONSHITZG”
- The message length L=20 means that the number of columns can be 1,2,4,5,10 or 20.
- Eve ignores the first value because it means only one column and no permutation.

- If the number of column is 2, the only two permutations are (1,2), (2,1).
- (1,2) – no permutation
- (2,1) –
  - EE MY NT AA CT TK ON SH IT ZG
  - ee ym tn aa tc kt no hs ti gz (does not make sense)
  - Therefore (2! -1) trials

- Next, (4! -1) trials (24 -1) [first one is (1 2 3 4)]
- Next, (5! -1) trials (120 -1) [(1 2 3 4 5) does not make permutation]
- This has to be done till we find proper guess
- Worst case

  = (2! -1) + (4! -1) + (5! -1) +(10! -1) + (20! -1)

  Number of trials are required which are better than the bruteforce

- Pattern attack
- The cipher text created from the keyed transposition cipher has some repeated pattern

e	n	e	m	y	**a**	**t**	**t**	**a**	**c**	k	s	t	o	n	**i**	**g**	**h**	**t**	**z**
3	1	4	5	2	**3**	**1**	**4**	**5**	**2**	3	1	4	5	2	**3**	**1**	**4**	**5**	**2**
e	e	m	y	n	**t**	**a**	**a**	**c**	**t**	t	k	o	n	s	**h**	**i**	**t**	**z**	**g**

e n e m y

a t t a c

k s t o n

i g h t z

3 1 4 5 2

e e m y n

t a a c t

t k o n s

h i t z g

e t t h e a k i m a o t y c n z n t s g

3 8 13 18 1 6 11 16 4 9 14 19 5 10 15 20 2 7 12 17

Difference between 2 adjacent is 5 in all the groups

- If Eve knows/ can guess the number of columns (which is 5 in this case) she can organize the ciphertext into groups of 4 characters.
- Permuting the groups can provide clue to find the plaintext.
- In the above example
- L =20 , number of rows = L/number of columns
- Number of rows = 20/5 =4

- Fill the cipher text

Row 1 e e m y n

Row 2 t a a c t

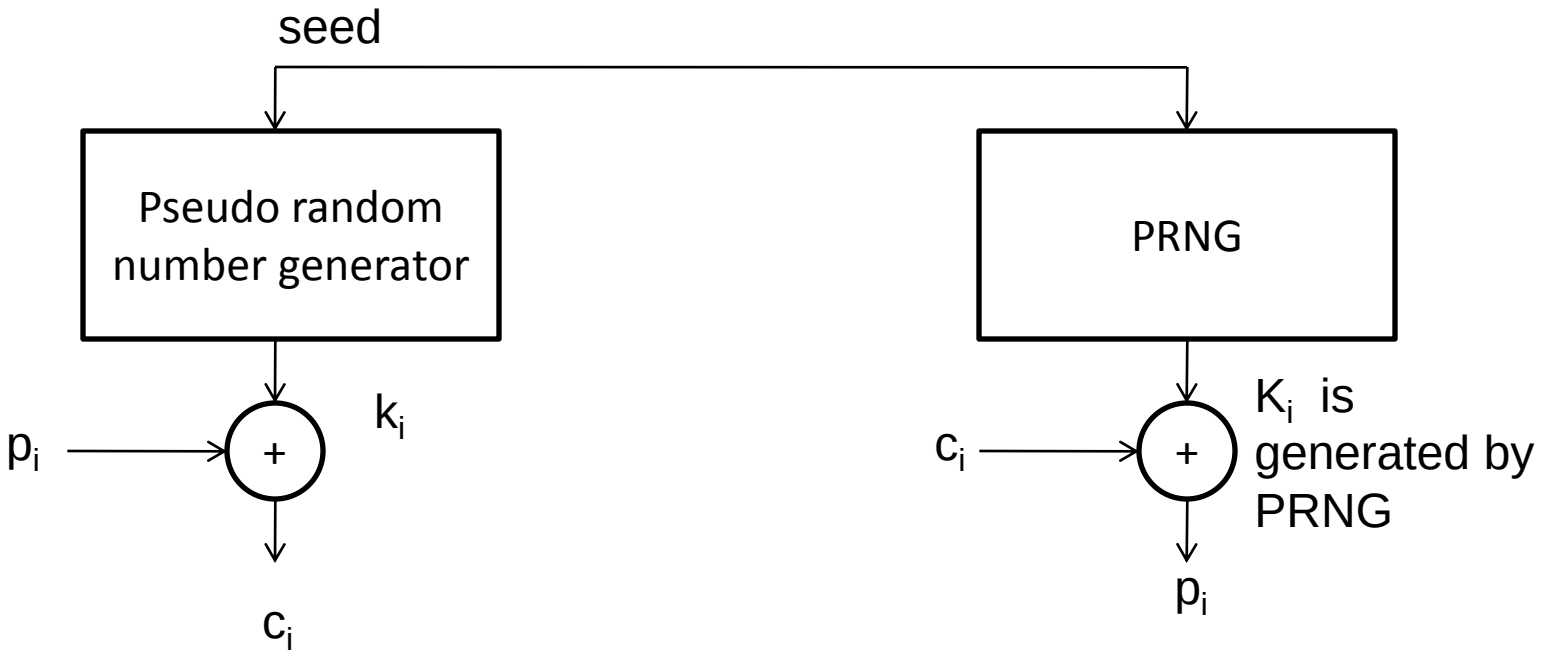
Row 3 t k o n s

Row 4 h i t z g

Find permutation which gives meaningful answer when read row by row

- Traditional ciphers
  - Block cipher (encrypts more than 1 characters at a time)
    - Hill cipher, playfair cipher
  - Stream cipher (encrypts one characters at a time)
    - Shift cipher

- How to approximate one time pad cipher?



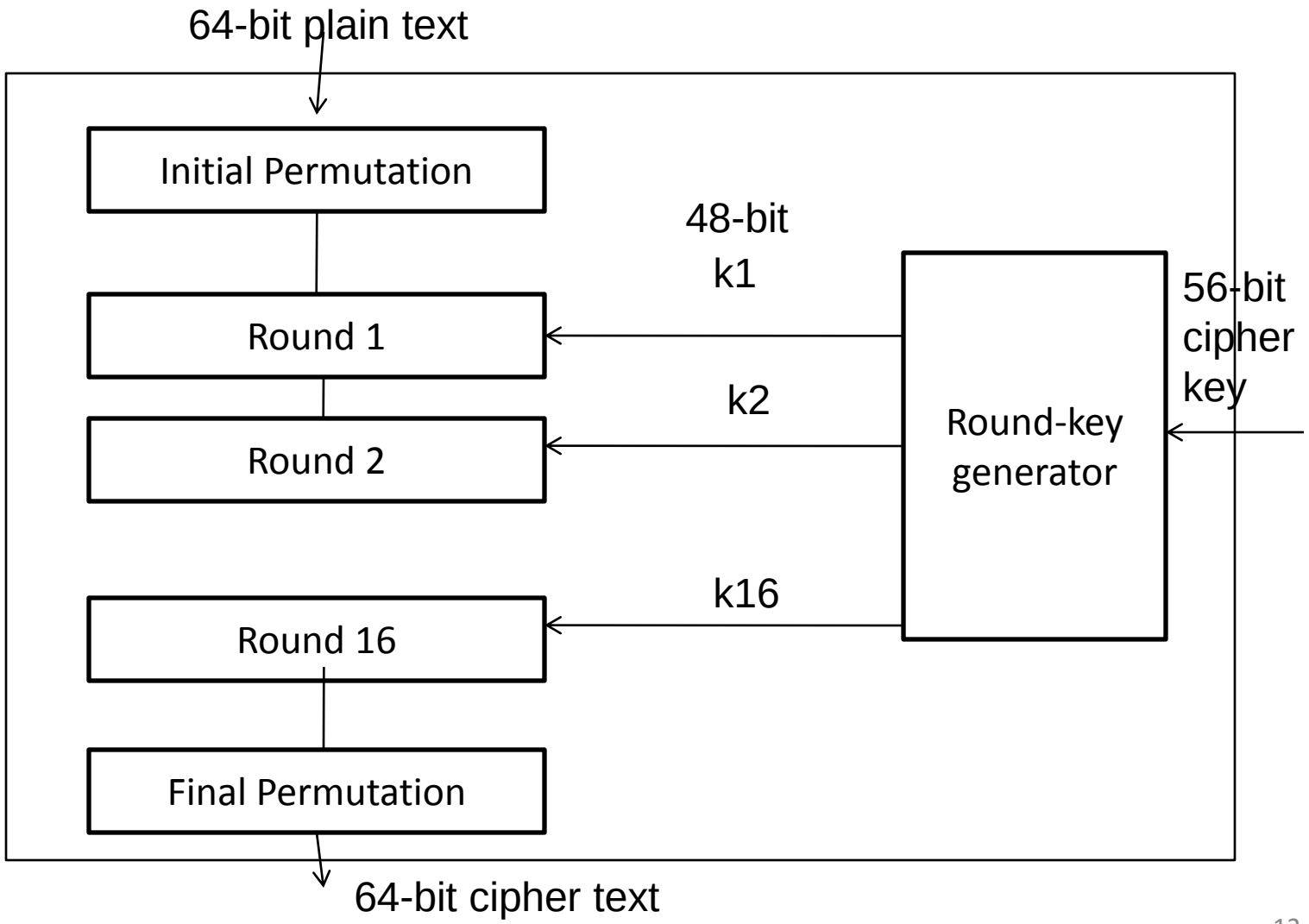
$c_i = p_i \oplus k_i$

$p_i = c_i \oplus k_i$

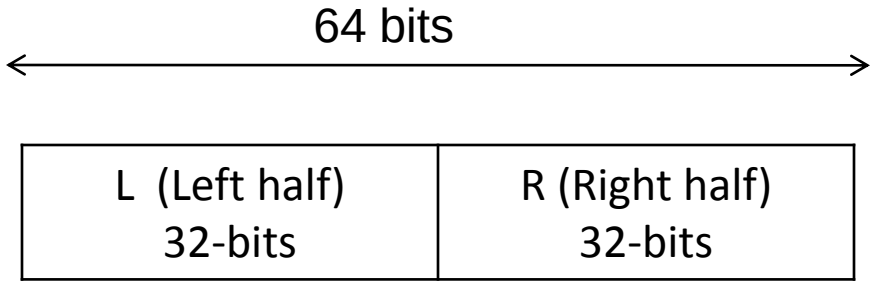
Data Encryption Standard (DES)

- It is symmetric key cipher
- It is block cipher published by NIST (National Institute of Standard and Technology)
- Block size = 64 bits
- i.e. It encrypts 64 bits at a time
- It has 16 rounds
- Structure of each round is same

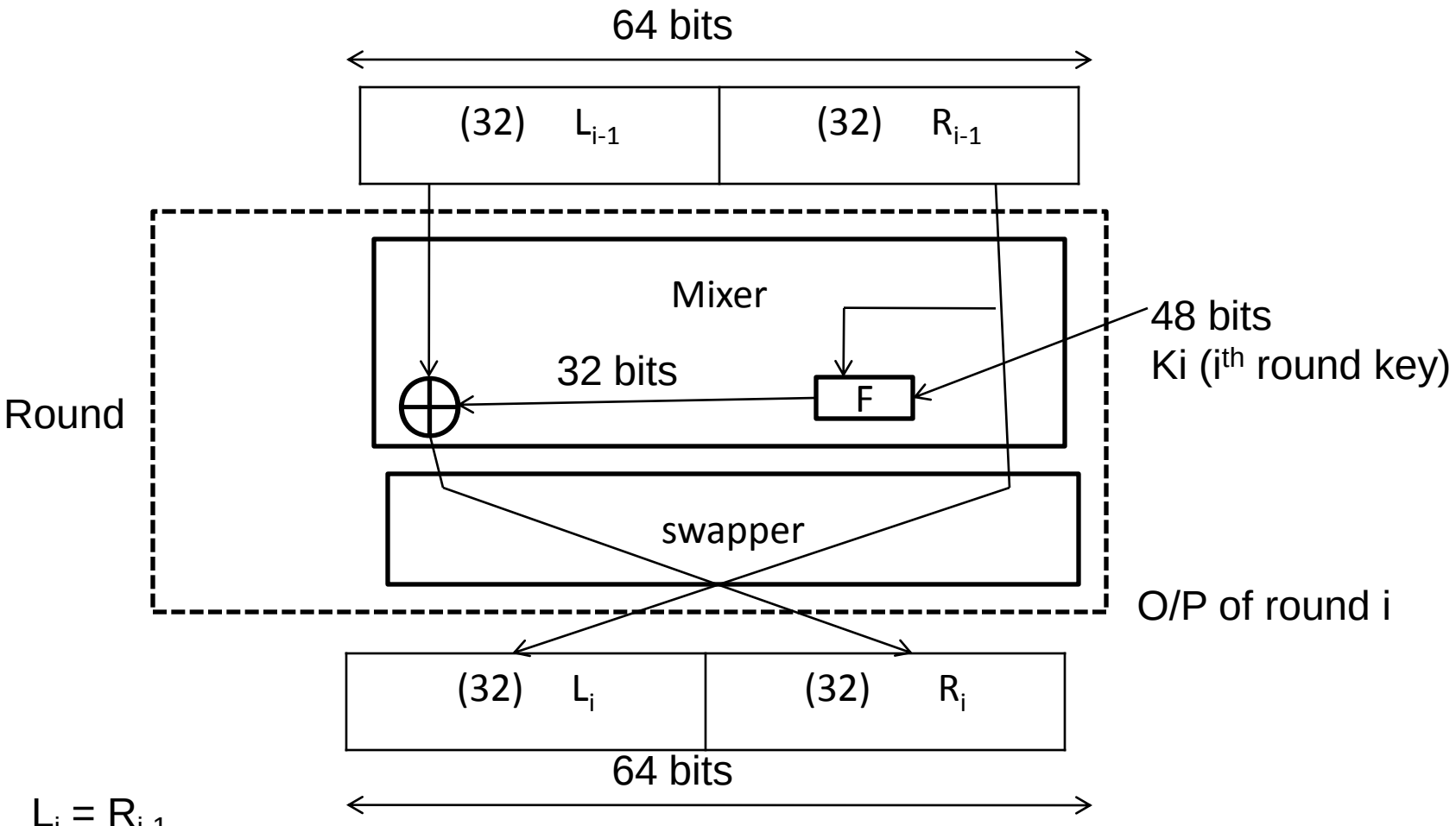
DES Structure



- Round structure
- For round number i
- 64 bits input to round i is divided into two halves each of 32 bits



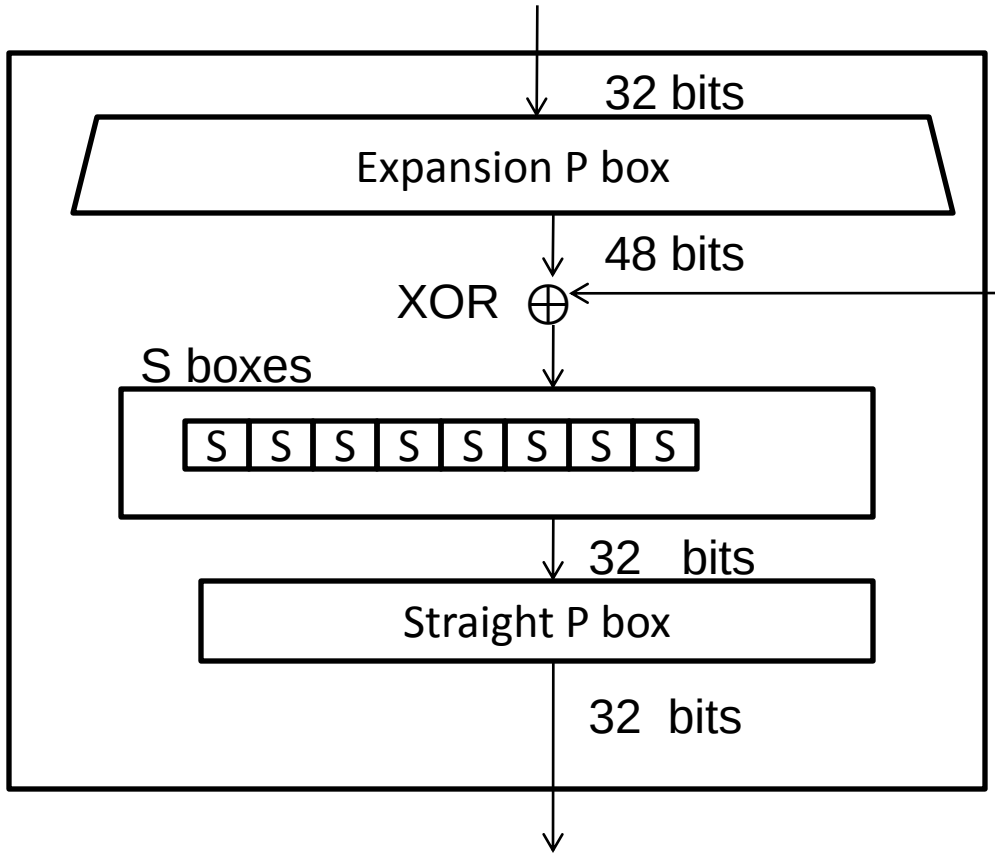
A Round in DES



$L_i = R_{i-1}$

$R_i = L_{i-1} \oplus F(R_{i-1}, k_i)$ F is Round function

DES Function



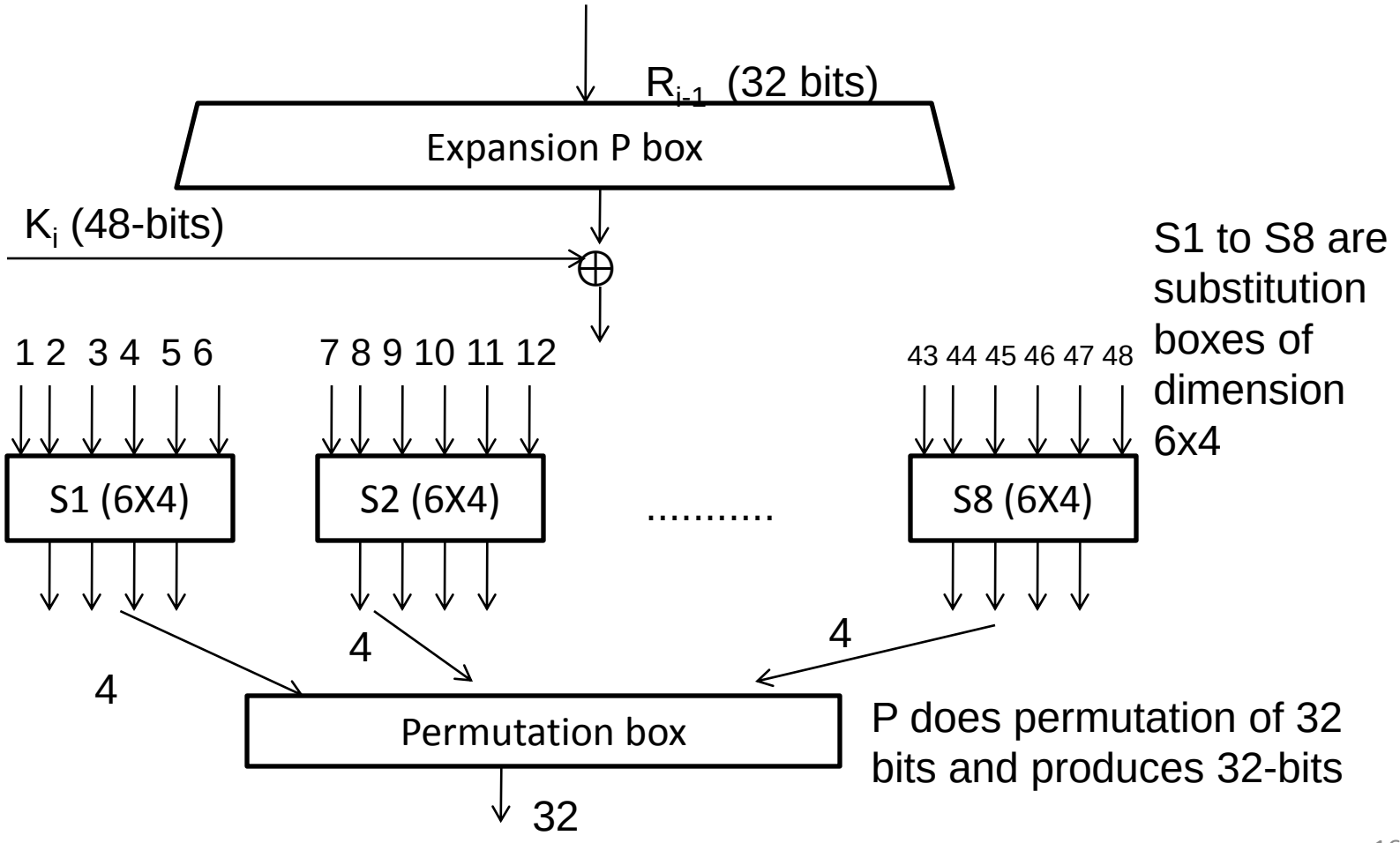
$f(R_{i-1}, K_i)$

K_i (48-bits)

An expansion P box
A whitener (that adds key)
a group of S-boxes
A straight P-box

S-boxes

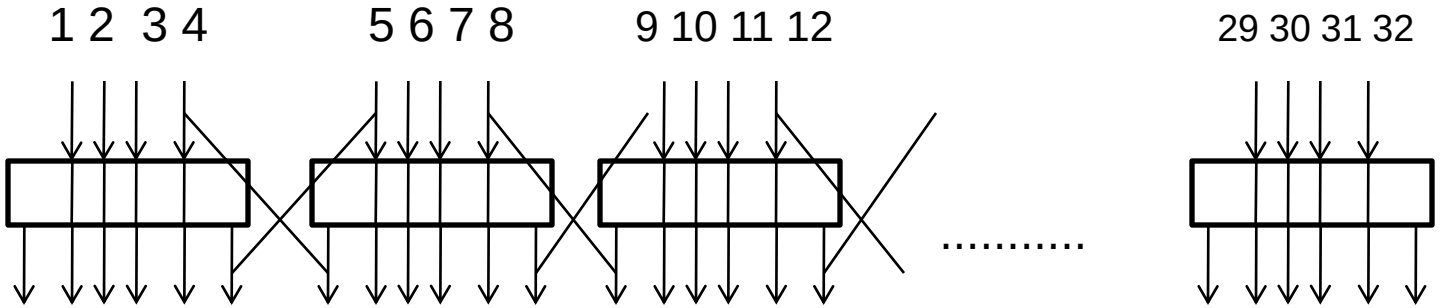
Round function, Input: R_{i-1} (32 bits), K_i (48 bits), Output: 32 bits



- Thus output of rand function F is 32 bits

1. R_{i-1} is expanded to 48- bits
2. 48-bits are ex-ored with K_i (ith round key of 48 bits)
3. Then 8 groups each of 6 bits are given to respective S-boxes to produce 8 groups of 4 bits
4. Output 32 bits are permuted

Expansion permutation



First bit is copied from last 32nd bit of input

last bit is copied from first 1st bit of input

Expansion P-box table

32	1	2	3	4	5
4	5	6	7	8	9
8	9	10	11	12	13
12	13	14	15	16	17
16	17	18	19	20	21
20	21	22	23	24	25
24	25	26	27	28	29
28	29	30	31	32	1

- First entry (1st row , 1st column) is 32 which indicates the index of bit from where we need to copy i.e. 1st bit of output is 32nd bit of input
- Thus by copying bits, we are able to generate 48 bits
- Basically we are adding redundancy i.e. We are creating 16 more bits by copying bits from certain position