Unit 2

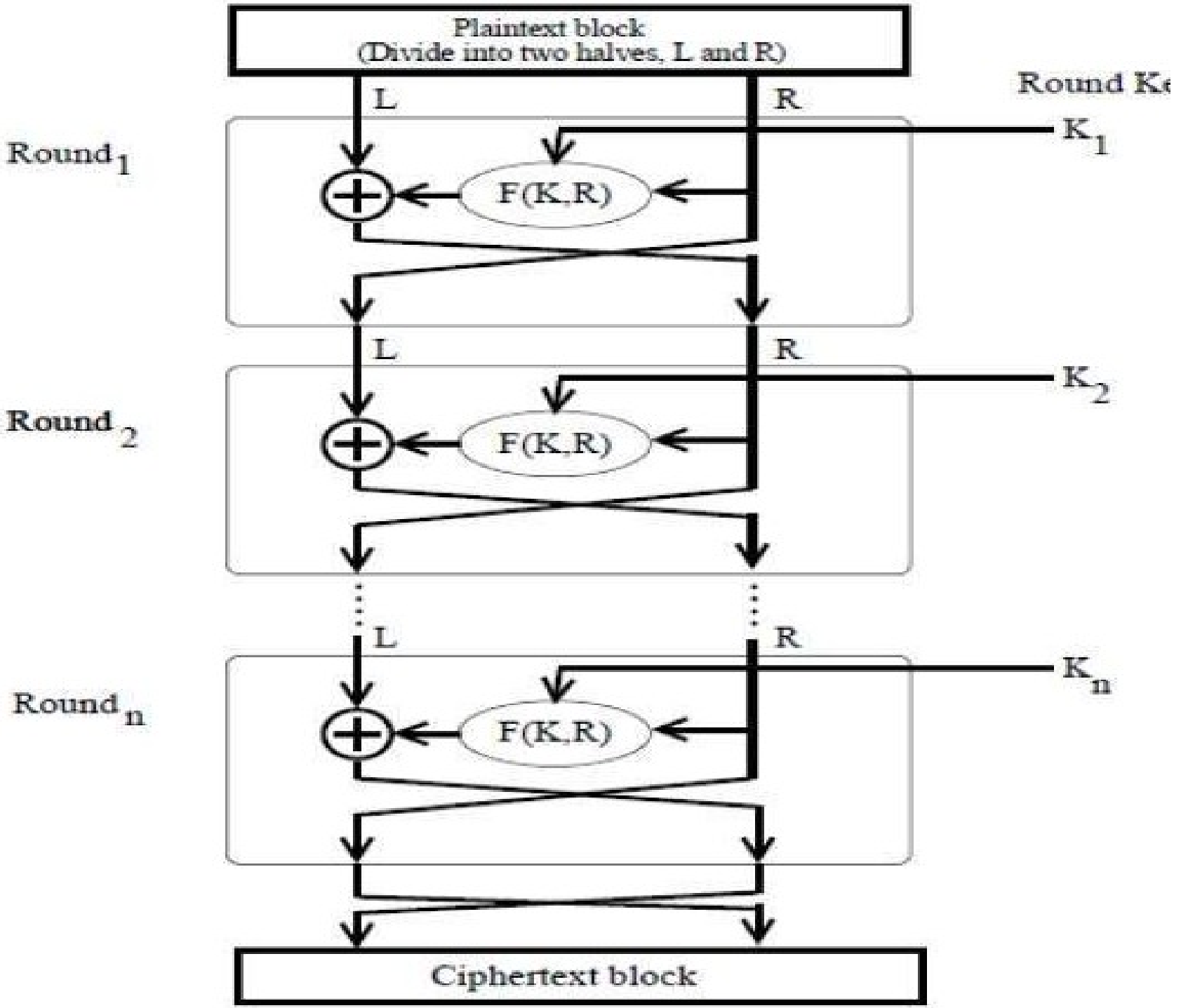
Feistel Cipher

Feistel Cipher

- Feistel Cipher is not a specific scheme of block cipher.
- It is a design model from which many different block ciphers are derived. DES is just one example of a Feistel Cipher.
- A cryptographic system based on Feistel cipher structure uses the same algorithm for both encryption and decryption.

•Encryption Process

- The encryption process uses the Feistel structure consisting multiple rounds of processing of the plaintext.
- Each round consisting of a “substitution” step followed by a permutation step.


Plaintext block
(Divide into two halves, L and R)
Round Ke
L
R
Round 1
K1
F(K,R)
L
R
Round 2
K2
F(K,R)
L
R
Round n
Kn
F(K,R)
Ciphertext block

- The input block to each round is divided into two halves that can be denoted as L and R for the left half and the right half.
- First, we apply an encrypting function ‘f’ that takes two input – the key K and R. The function produces the output f(R,K). Then, we XOR the output of the mathematical function f(R,K) with L.
- In real implementation of the Feistel Cipher, such as DES, instead of using the whole encryption key during each round, a round-dependent key (a subkey) is derived from the encryption key.
- This means that each round uses a different key, although all these subkeys are related to the original key.
- The permutation step at the end of each round swaps the modified L and unmodified R. Therefore, the L for the next round would be R of the current round. And R for the next round be the output L of the current round.
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- Above substitution and permutation steps form a ‘round’. The number of rounds are specified by the algorithm design.
- Once the last round is completed then the two sub blocks, ‘R’ and ‘L’ are concatenated in this order to form the ciphertext block.
- The difficult part of designing a Feistel Cipher is selection of round function ‘f’. In order to be unbreakable scheme, this function needs to have several important properties that are beyond the scope of our discussion.

- **Decryption Process**
- The process of decryption in Feistel cipher is almost similar. Instead of starting with a block of plaintext, the ciphertext block is fed into the start of the Feistel structure and then the process thereafter is exactly the same as described in the given illustration.
- In the case of decryption, the subkeys used in encryption are used in the reverse order.

- **Number of Rounds**
- The number of rounds used in a Feistel Cipher depends on desired security from the system. More number of rounds provide more secure system.
- But at the same time, more rounds mean the inefficient slow encryption and decryption processes.
- Number of rounds in the systems thus depend upon efficiency–security tradeoff.