COMP232 Cybersecurity

Symmetric Encryption. Part 2

Block ciphers modes

- Block ciphers may be used in different modes. Most common modes are

- Electronic Codebook Mode (ECB)
- Cipher Block Chaining (CBC)
- Cipher Feedback Mode (CFB)

Electronic Codebook Mode (ECB)

- **Simple mode**: each block, say of size 64 bits is encrypted with the same key;
- For a given block of the plaintext and a given key the result of encryption is unique;
- If a block of plaintext is repeated several times, the result of encryption contains several copies of the same ciphertext;
- So, the encryption of the lengthy (regular) messages might be insecure.

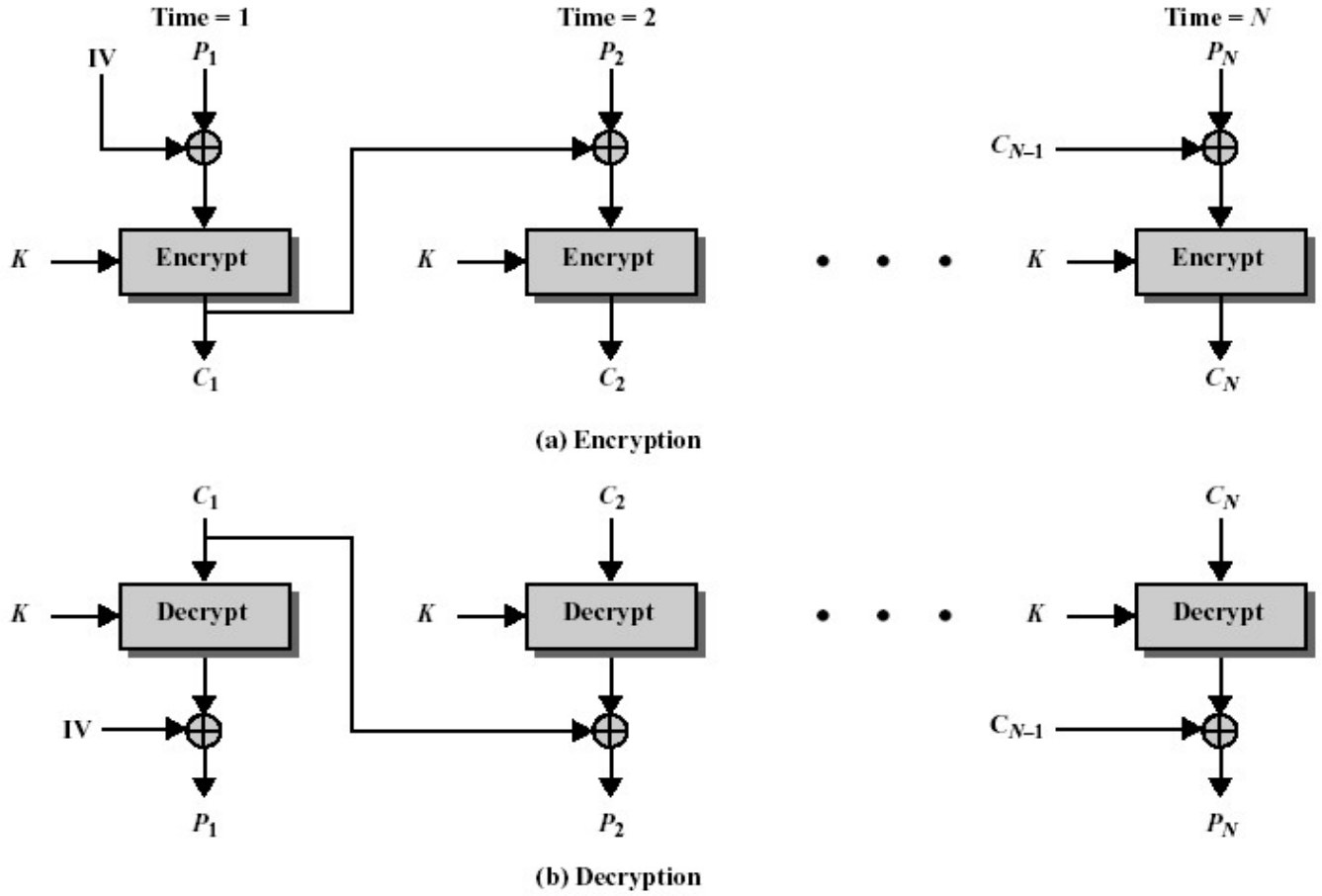
Cipher Block Chaining Mode (CBC)

- CBC mode fixes abovementioned disadvantage of ECB mode: here the **same** blocks of plaintext may produce **different** blocks of ciphertext;
- **Simple idea:** before encryption a block of the plaintext is XOR'ed with the result of encryption of the previous block;

$$C_i = E_K[C_{i-1} \oplus P_i]$$

- For the first block encryption some initialisation vector (IV) is used;
- It is better to keep both a key and IV secret.

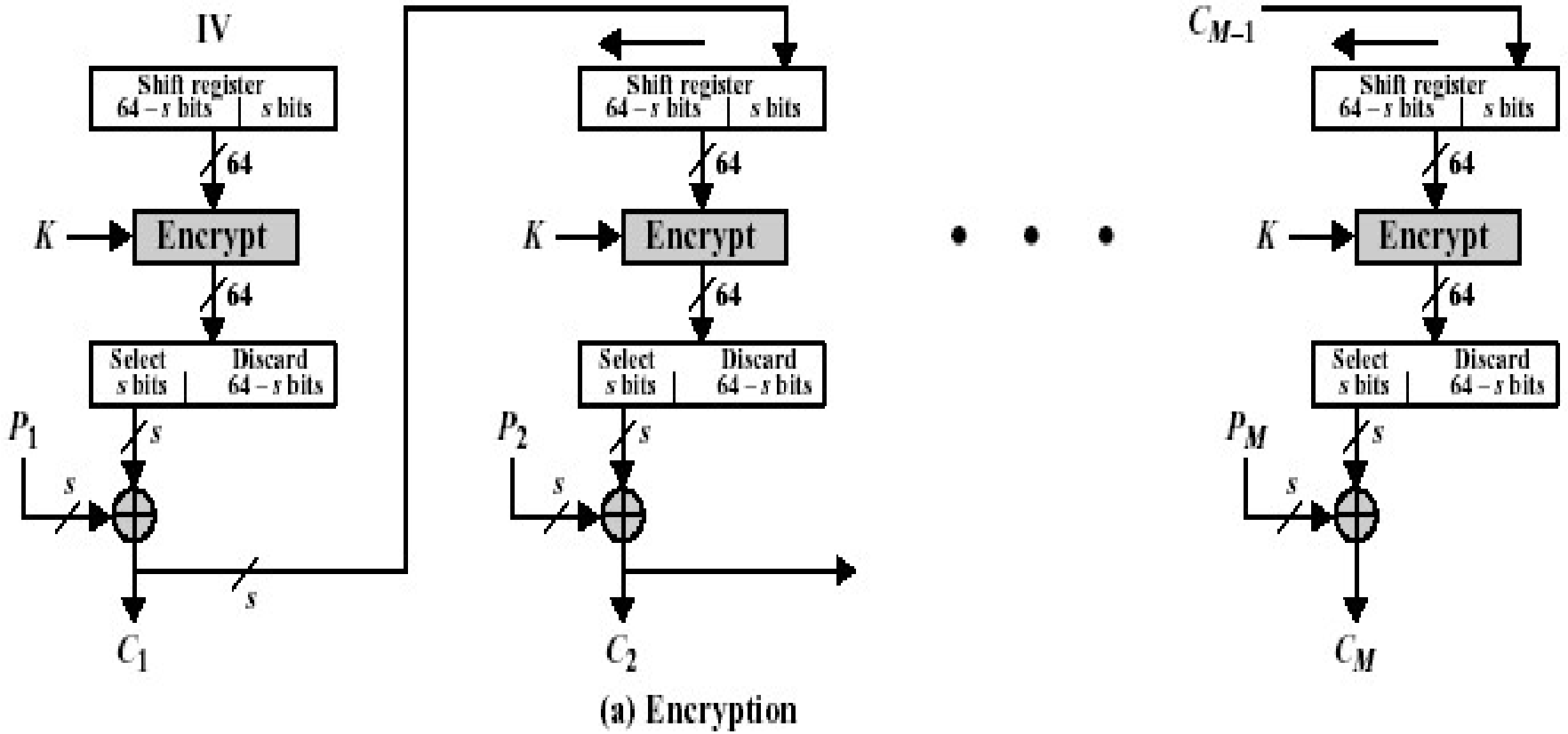
CBC encryption and decryption



Cipher Feedback Mode (CFB)

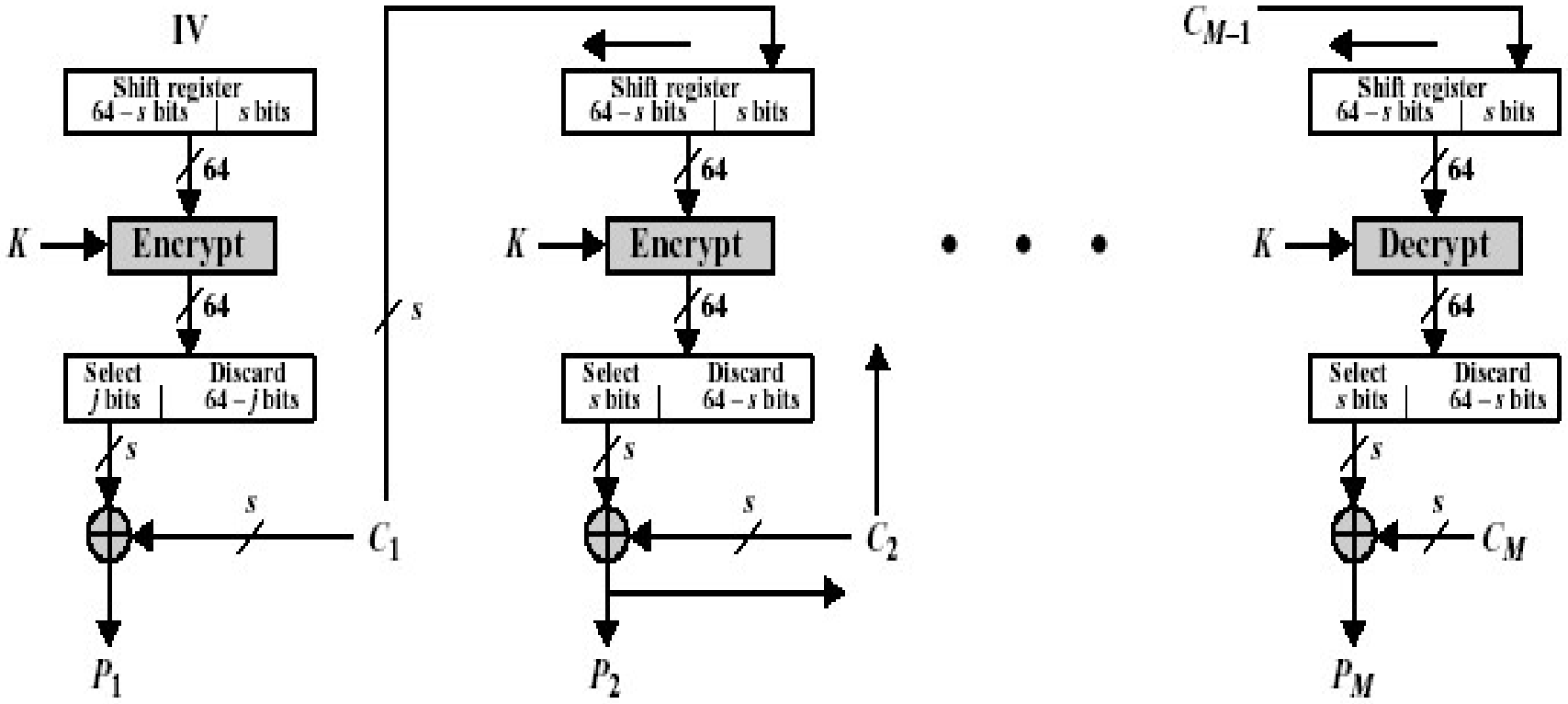
- CFB mode may be used to transform a block cipher to the stream cipher;
- It has a parameter *s* (the size of transmission unit); if 8-bit characters are used as transmission unit, then *s = 8;*
- Shift register of the size equal to the size of the block of the block cipher is used (typically it is 64 bits);
- Again, an initialisation vector is needed.

s-bits CFB encryption



(a) Encryption

s-bits CFB decryption



(b) Decryption

Key distribution

- **From requirements for symmetric encryption:**

- "Sender and receiver must *have obtained copies of the secret key* in a secure way and must keep the key secure"

- **Important issue**: how to distribute secret keys?

Key distribution, manual delivery

- For two parties A and B:
- A key could be created by A and delivered physically to B (or vice versa);
- A key could be created by the third trusted party C and delivered physically to A and B;

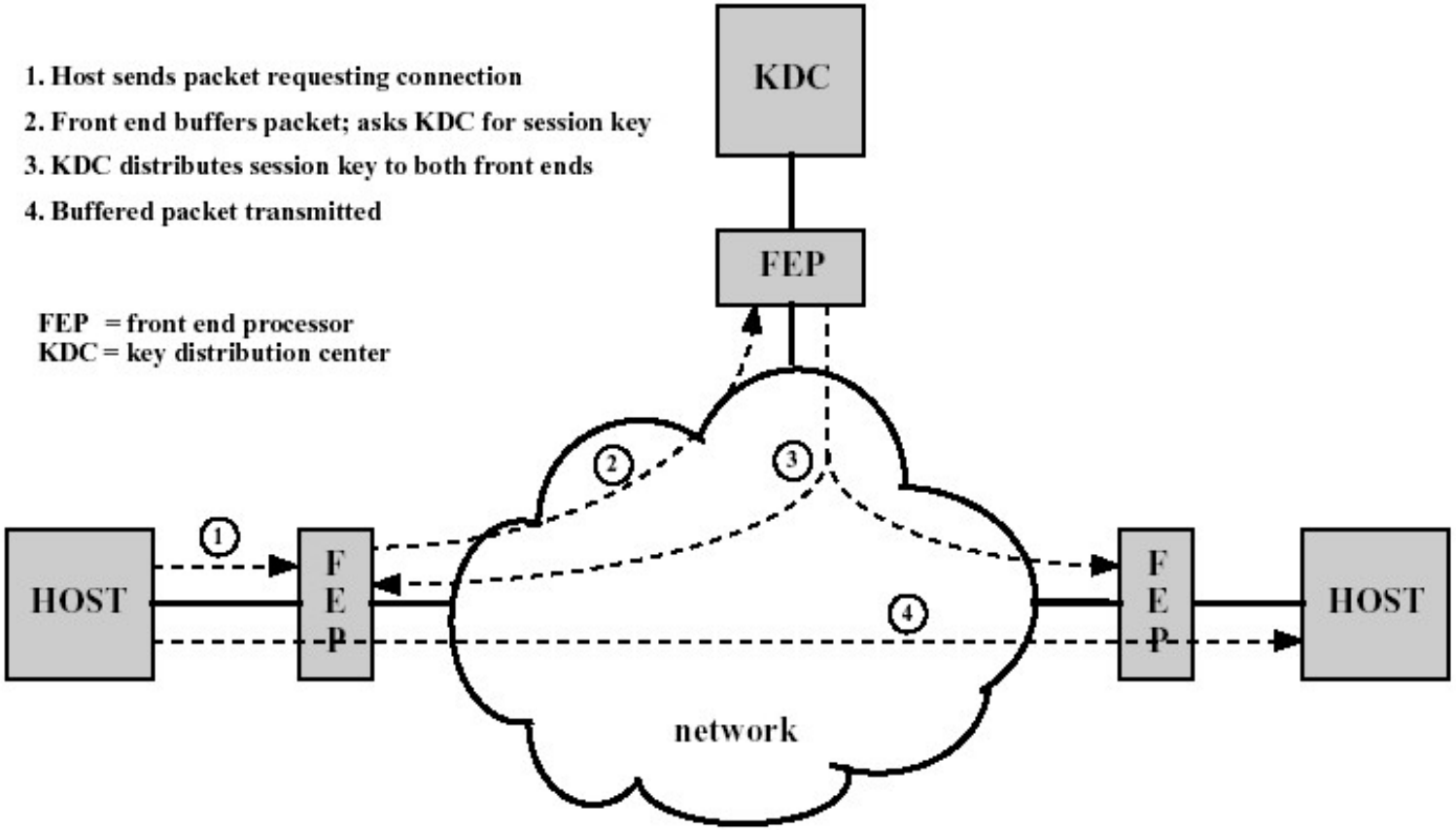
- Difficult to use in wide area distributed systems, when dynamic connections are needed.

Key distribution, further techniques

- If A and B have used recently a secret key, one of them could create a new secret key and send it to the partner using old key;
- *Potential problem: once an attacker learned one key, he can disclose all keys afterwards*

- There is a third trusted party C connected by encrypted channels with both A and B. Then C creates a key and distributes it among A and B using encrypted channels;

Automated key distribution



Finally

- The option we will discuss next time:

- *Both parties use public-key cryptographic techniques*