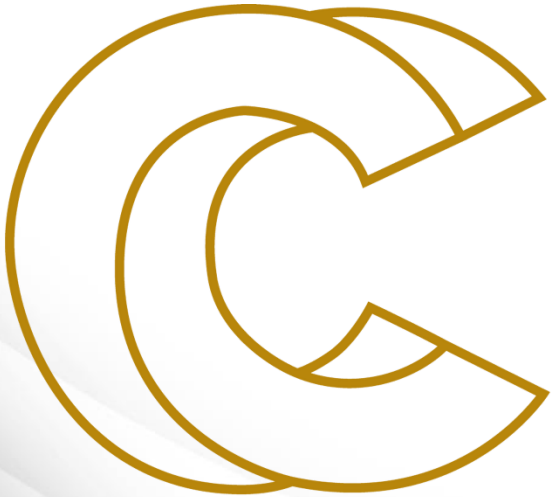

EURO 4SEE

GPU Assisted Brute Force Cryptanalysis of GPRS, GSM, RFID, and TETRA

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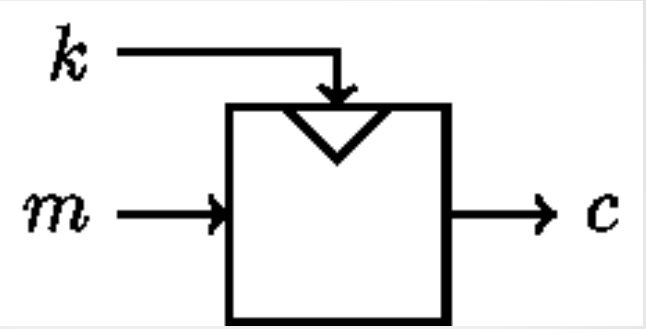
Lesson 1: Introduction to Block Ciphers

Introduction to Block Ciphers

- Cryptography solves many problems and confidentiality is just one of them.
- Encryption algorithms provide confidentiality.
- Data we want to encrypt can be:
  - Data at rest
  - Data in transit
  - Data in process

Lesson 1: Introduction to Block Ciphers

Some Definitions



- Plaintext **m** is what we want to protect.
- Ciphertext **c** is the encrypted version of the plaintext.
- A cryptosystem/cipher is a pair of algorithms that convert plaintext to ciphertext and back.
- Ciphertext should appear like a random sequence of bits.
- Details of a cipher should not be kept secret. The only secret is the secret key **k** that is chosen by the user.

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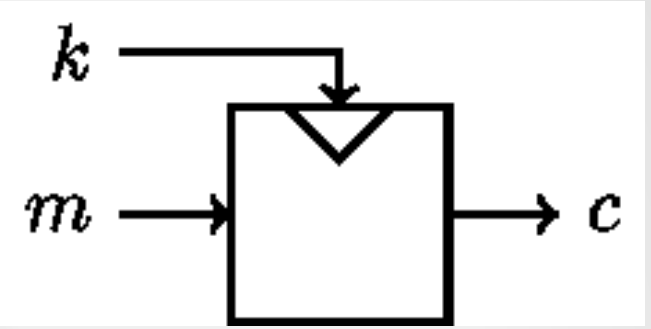
Encryption Algorithms



- We can use public key encryption algorithms like *RSA* or *El-Gamal* but they are not as fast as symmetric key encryption algorithms.
- Symmetric key encryption algorithms can be categorized into two:
  - **Block Ciphers**
  - **Stream Ciphers**
- Block ciphers divide the plaintext into **b**-bit blocks and perform a fixed transformation.
- Stream ciphers can also work on blocks or sometimes on bits but they perform a time varying transformation because they have some sort of a memory that changes during encryption.

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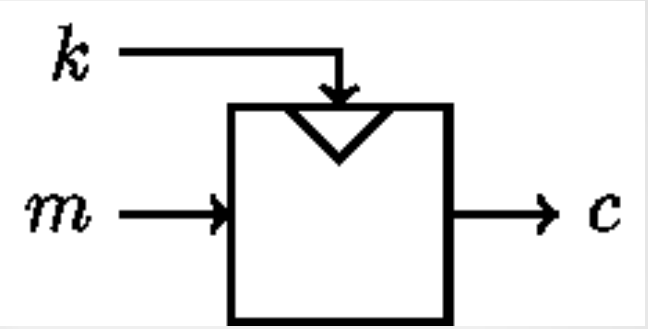
Block Ciphers



- Block ciphers operate on **b**-bit blocks of data.
- Plaintext is divided into **b**-bit blocks.
- Each block is encrypted by a secret key **k** to produce b-bit output.
- Output blocks form the ciphertext (depends on **mode of operation**).
- Thus, a block cipher and the chosen key is actually a permutation from $\mathbf{2^b}$ elements to $\mathbf{2^b}$ elements.
- Generally **b** is 64 or 128-bit and **k** is 128, 192 or 256-bit.

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Block Cipher Design Principles

- Claude Shannon is considered as ”the father of information theory”.
- Contributed to the field of cryptanalysis for USA defense during World War II.
- His landmark paper Communication Theory of Secrecy Systems (1949) introduced the twin ideas of confusion and diffusion for practical cipher design
  - **Confusion**: ”to make the relation between the simple statistics of the ciphertext and the simple description of the key a very complex and involved one”.
  - **Diffusion**: ”the statistical structure of the plaintext which leads to its redundancy is dissipated into long range statistics in the cryptogram”.
- Note that these concepts are not measurable, absolute concepts.
- Thus, security of block ciphers are always measured as security against known cryptanalysis techniques.

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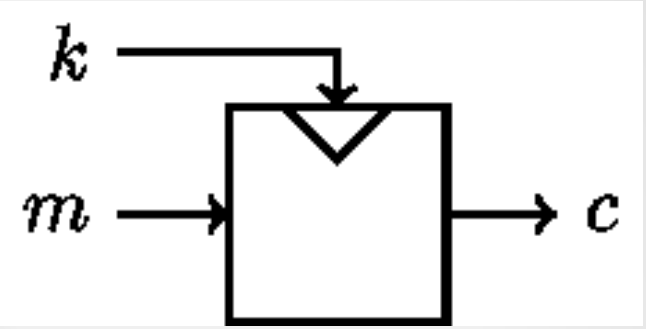
Block Cipher Design



- Instead of designing a very complex cipher, generally a **round** that provides diffusion and confusion is designed and it is repeated **r** times
- Instead of using the key directly in every round, a **key schedule** algorithm is used that generate **round keys** from the secret key
- Common block cipher designs can be categorized as
  - **Substitution Permutation Network (SPN)**
  - **Feistel Network**
  - **Sponge Function / Permutation-based**

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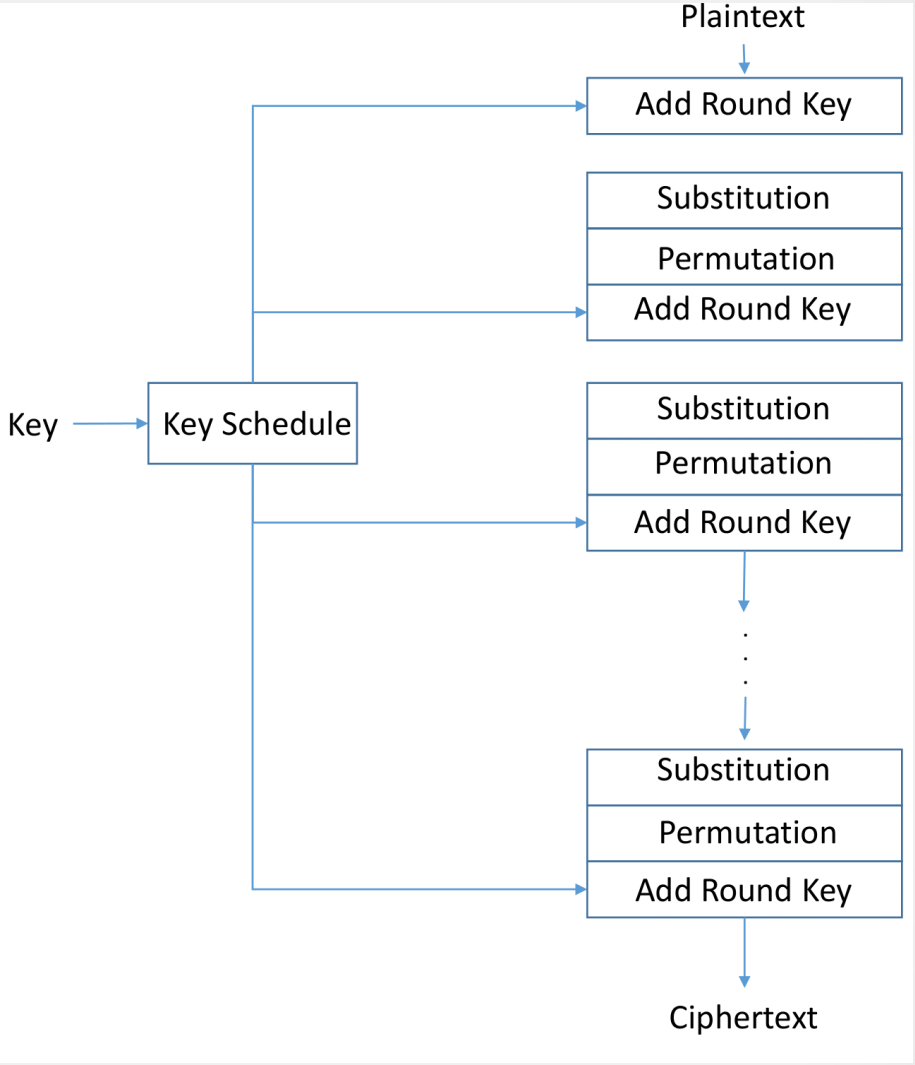
Substitution Permutation Network

- A round of an SPN consists of 3 layers
  - **Key Addition:** Combines the round key with the plaintext
  - **Substitution:** Provides confusion
  - **Permutation:** Provides diffusion
- **AES** and **PRESENT** are examples for SPN



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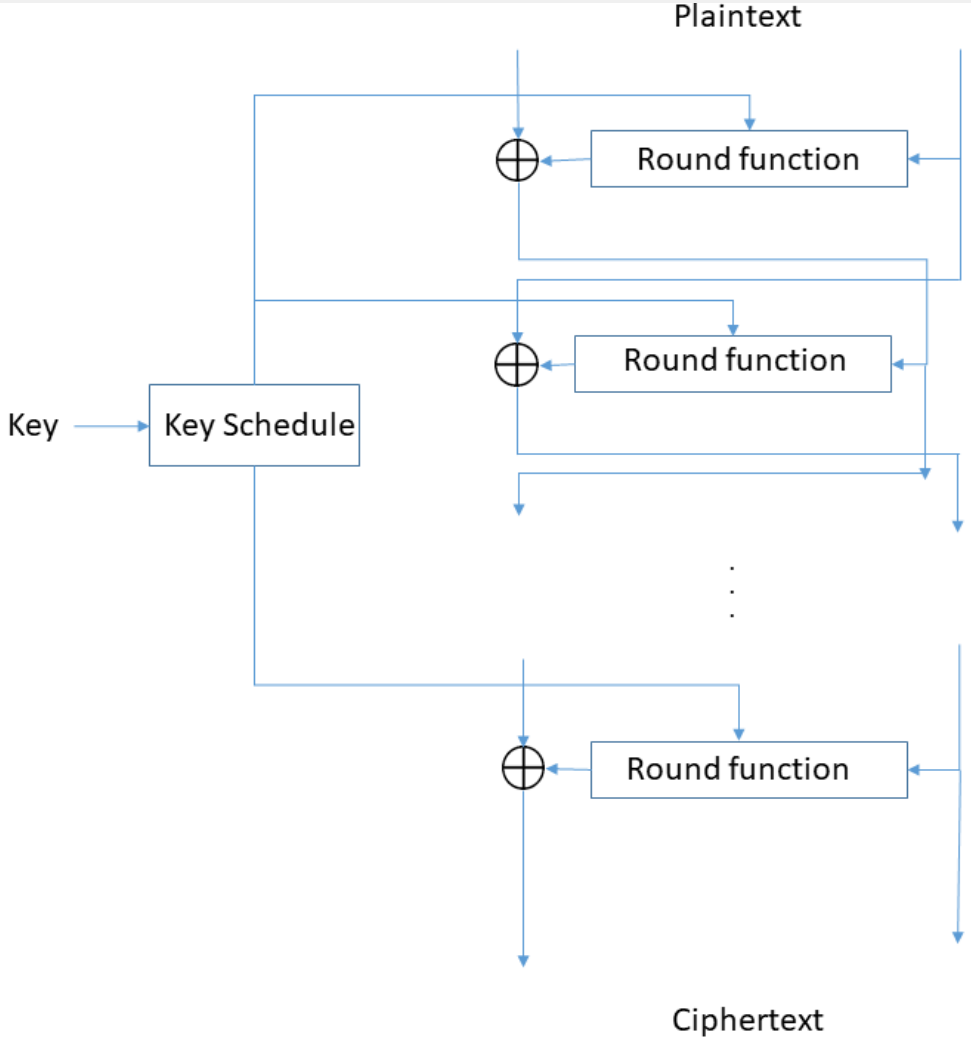
Feistel Network



Next lecture

Introduction to Stream Ciphers

- How stream ciphers work
- Block cipher and stream cipher differences

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Thanks!

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