CECS 378: Intro to Computer Security Principles

Lecture 2

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Week 2

What is Cryptography?

- Is the science of keeping information secure
  - In the sense of confidentiality and integrity (hashing)
- Commonly referred to as encryption
  - It is a subset of cryptography
  - Transformation of unencrypted data, called plaintext or clear text to its encrypted form
- Decryption is the process of recovering the plaintext message
- The science of breaking through encryption is referred to as cryptanalysis

Symmetric Encryption

- Two of the most important symmetric encryption algorithms
  - ➢Data Encryption Standard (DES)
  - ➢ Advance Encryption Standard (AES)
- Often refer to as conventional encryption or single-key encryption
- Was the only type of encryption prior to public key encryption in the late 1970s
- It is still the more widely used between the two types of encryption

5 Ingredients of Symmetric Encryption

- Plaintext
  - Original message or data to be fed
- Encryption algorithm
  - Algorithm use to perform various substitutions and transformations to the plaintext
- Secret key
  - Input to the encryption algorithm, exact substitutions and transformations dependent on the key
- Ciphertext
  - Scrambled message produced as the output.
- Decryption algorithm
  - Essentially the encryption algorithm run in reverse. It takes the ciphertext and secret key and produces the original plaintext.

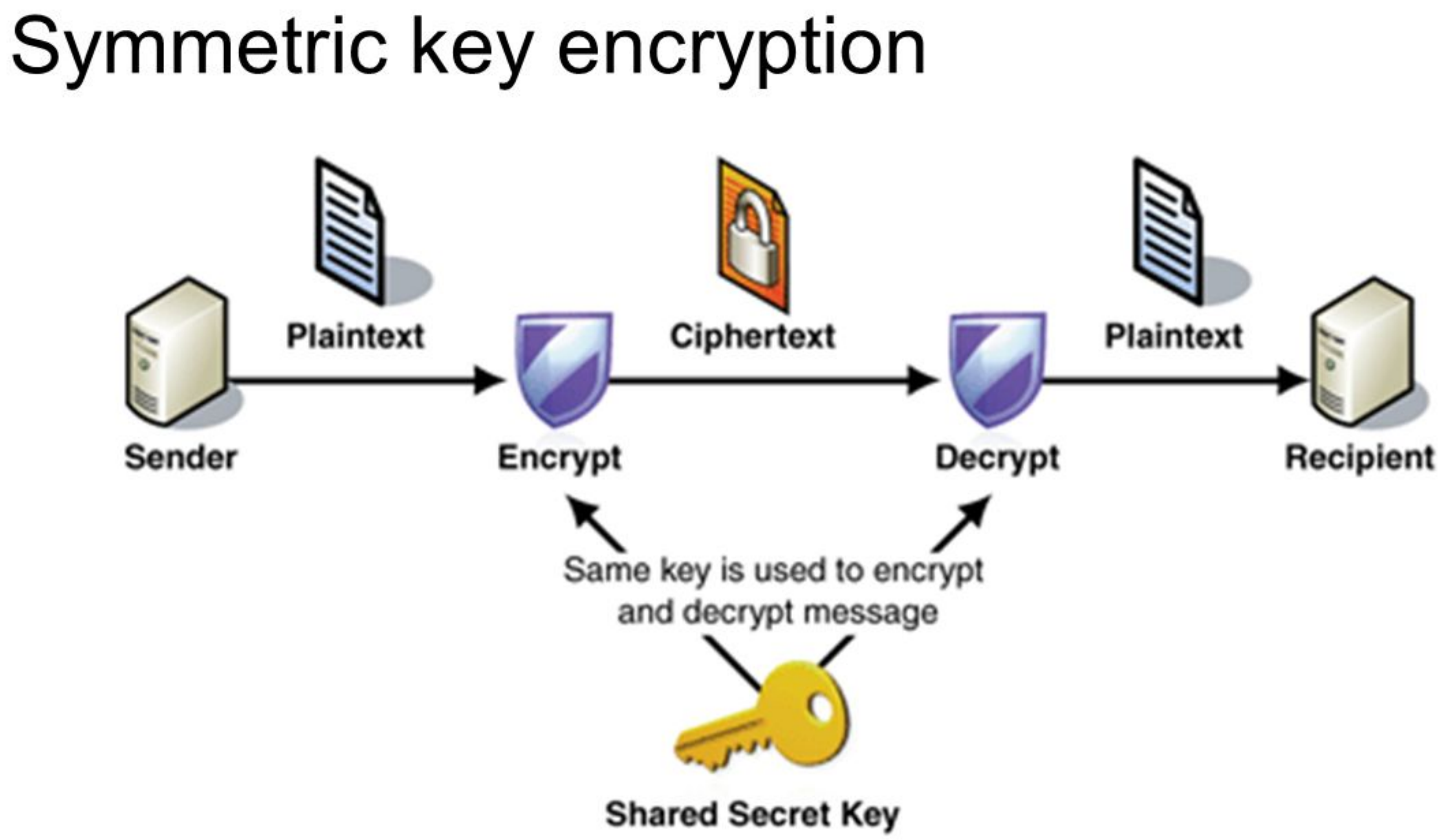
Symmetric Block Encryption Algorithm

- Most commonly used algorithm
- Processed the plaintext input in fixed-size blocks and produces a block of ciphertext of equal size for each plaintext block
- Most important algorithms DES, Triple DES, and AES

Symmetric Cryptography

- Known as Private Key Cryptography
- Single key for both encryption and decryption
- Symmetric key cryptography by itself can only provide confidentiality, and not integrity
- Currently using AES block cipher, supporting:
  - 128 – bit key
  - 192 – bit key
  - 256 – bit key

Symmetric Cryptography



DES Algorithm

- Adopted by National Institute of Standards and Technology (NIST) in 1977
- Refer to as the Data Encryption Algorithm (DEA)
- It takes a plaintext block of 64 bits and a key of 56 bits, to produce a ciphertext block of 64 bits

Triple DES Algorithm

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- Successor to DES
- Same algorithm, but it involves repeating the algorithm 3 times. Using either two or three unique keys
- Key size of 112 or 168 bits
- Two main attractions for 3DES
  - Its 168-bit key length ,which overcomes the brute-force vulnerability of DES
  - The algorithm has been subjected to more scrutiny than any other algorithm and no effective cryptanalytic attack has been found

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Symmetric Encryption Algorithms

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	DES	Triple DES	AES
Plaintext block size (bits)	**64**	**64**	**128**
Ciphertext block size (bits)	64	64	128
Key size (bits)	56	112 or 168	128, 192, or 256

2 General Attacks for Symmetric

- Cryptanalysis
  - Rely on the nature of the algorithm plus having some knowledge of the general characteristics of the plain text
  - Main purpose is to try to deduce a specific plaintext or to deduce the key being used
- Brute-force attack
  - Tries every single possible key on a piece of ciphertext
  - Compression can make this a bit difficult

Feistel Cipher Structure

- Horst Feistel devised the Feistel cipher
  - based on concept of invertible product cipher
- Most Block cipher techniques will follow the Feistel structure
- The first step in the Feistel structure states that the plain text should be broken down into two halves
  - process through multiple rounds which:
  - perform a substitution on left data half
  - based on round function of right half & sub key
  - then have permutation swapping halves

Feistel Cipher Structure

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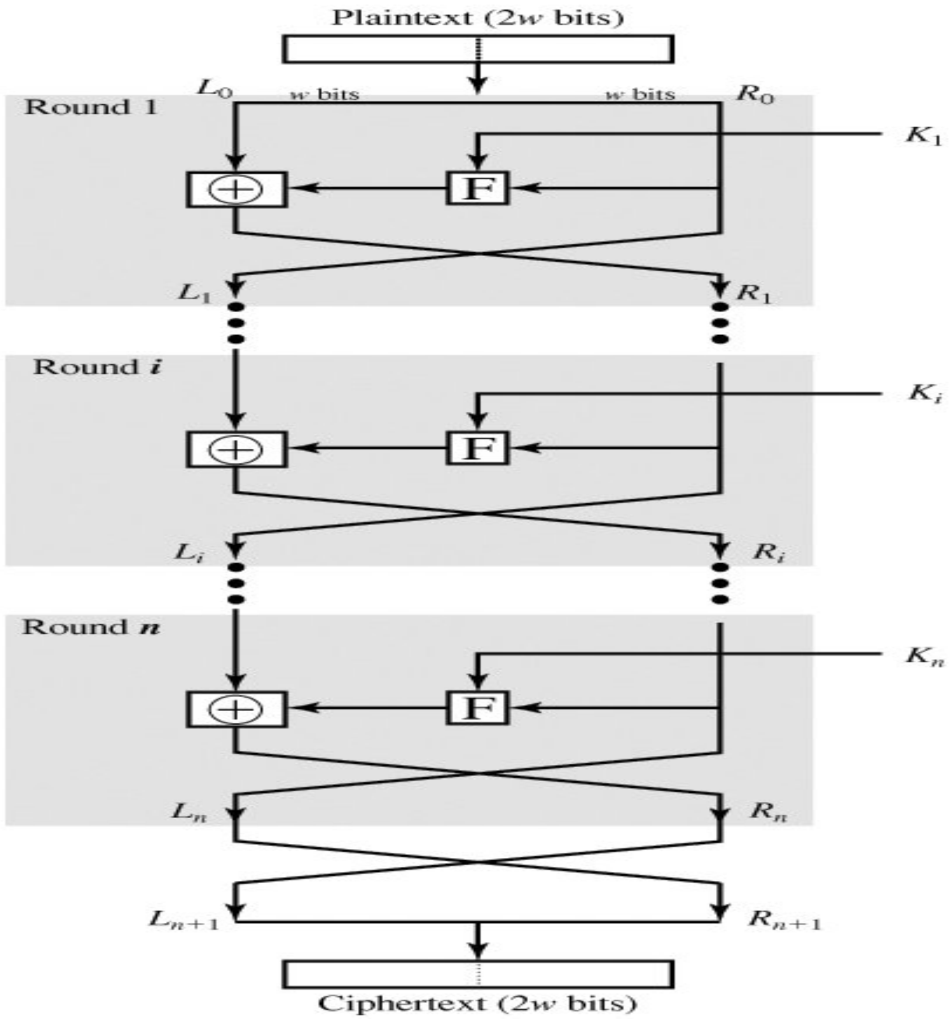
- Virtually all conventional block encryption algorithms including data encryption standard (DES) are based on Feistel Cipher Structure.
- The plaintext is divided into two halves
  - Then the two halves pass through *n* rounds of processing then combine to produce the cipher block.
- Each round i has as input L_{i-1} and R_{i-1} derived from the previous round as well as a sub-key K_i derived from the overall K

Feistel Cipher Structure



Feistel Cipher Design Principles

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- **Block Size:** (larger block means greater security) 64 bits
- **Key Size**:56 bits
- **Number of Rounds**: a single round offers inadequate security, a typical size is 16 rounds
- **Sub-key Generation Algorithms**: greater complexity should lead to a greater difficulty of cryptanalysis
- **Round function:** Again, greater complexity generally means greater resistance to cryptanalysis

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