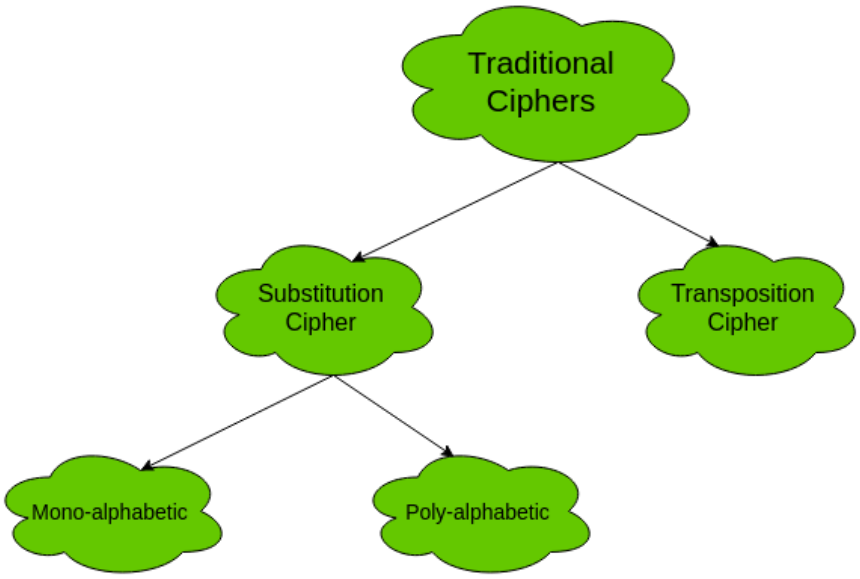
Traditional Symmetric Ciphers

Last Updated : 14 Oct, 2019

The two types of traditional symmetric ciphers are **Substitution Cipher** and **Transposition Cipher**. The following flowchart categories the traditional ciphers:



1. Substitution Cipher:
Substitution Ciphers are further divided into **Mono-alphabetic Cipher** and **Poly-alphabetic Cipher**.

First, let's study about mono-alphabetic cipher.

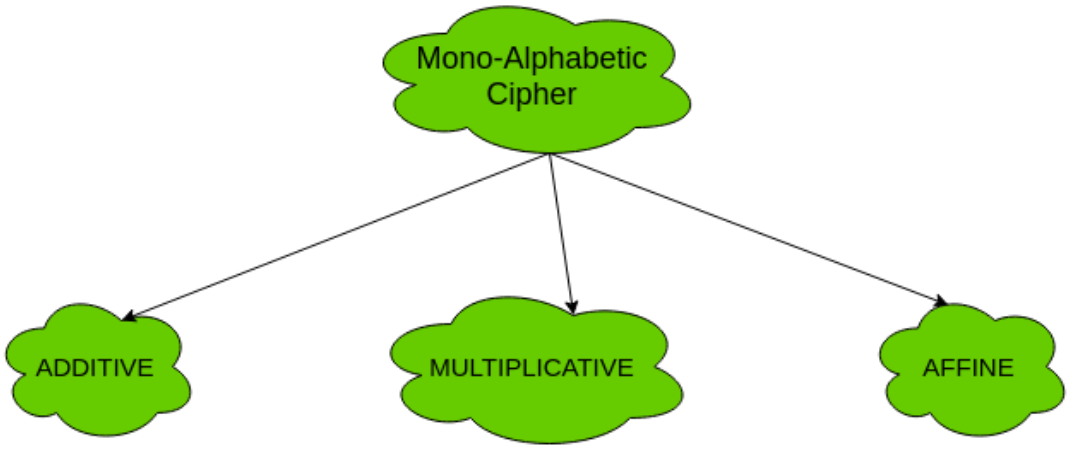
1. **Mono-alphabetic Cipher –**
   In mono-alphabetic ciphers, each symbol in plain-text (eg; 'o' in 'follow') is mapped to one cipher-text symbol. No matter how many times a symbol occurs in the plain-text, it will correspond to the same cipher-

text symbol. For example, if the plain-text is ‘follow’ and the mapping is :

- f -> g
- o -> p
- l -> m
- w -> x

The cipher-text is ‘gpmmpx’.

Types of mono-alphabetic ciphers are:



(a). Additive Cipher (Shift Cipher / Caesar Cipher) –
The simplest mono-alphabetic cipher is additive cipher. It is also referred to as ‘Shift Cipher’ or ‘Caesar Cipher’. As the name suggests, ‘addition modulus 2’ operation is performed on the plain-text to obtain a cipher-text.

C = (M + k) mod n
M = (C – k) mod n

where,
C -> cipher-text
M -> message/plain-text
k -> key

The key space is 26. Thus, it is not very secure. It can be broken by brute-force attack.
For more information and implementation see Caesar Cipher

(b). Multiplicative Cipher –
The multiplicative cipher is similar to additive cipher except the fact that the key bit is multiplied to the plain-text symbol during encryption. Likewise, the cipher-text is multiplied by the multiplicative inverse of key for decryption to obtain back the plain-text.

$C = (M * k) \bmod n$
$M = (C * k^{-1}) \bmod n$

where,
k^{-1} -> multiplicative inverse of k (key)

The key space of multiplicative cipher is 12. Thus, it is also not very secure.

(c). Affine Cipher –
The affine cipher is a combination of additive cipher and multiplicative cipher. The key space is 26 * 12 (key space of additive * key space of multiplicative) i.e. 312. It is relatively secure than the above two as the key space is larger.
Here two keys k_1 and k_2 are used.

$C = [(M * k_1) + k_2] \bmod n$
$M = [(C – k_2) * k_1^{-1}] \bmod n$

For more information and implementation, see Affine Cipher

Now, let's study about poly-alphabetic cipher.

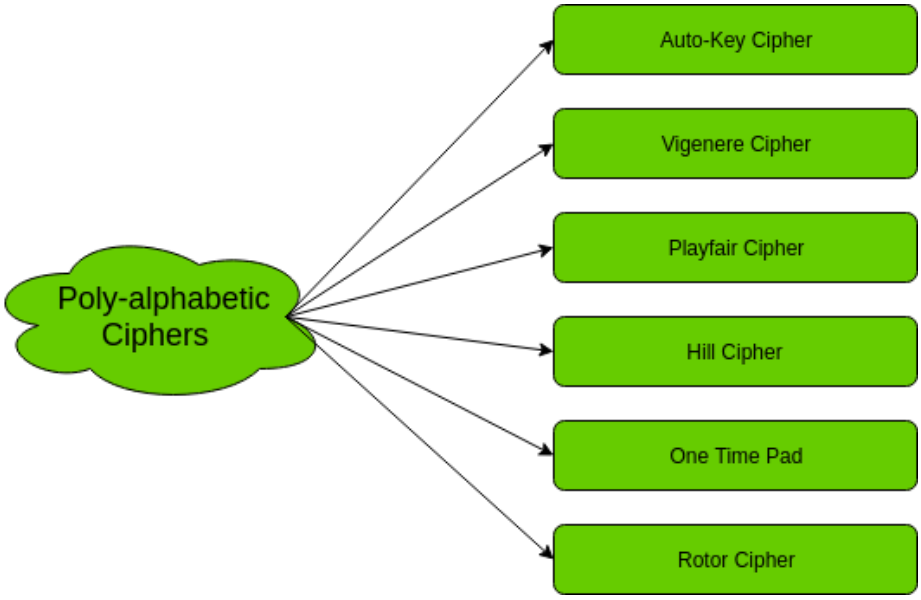
2. **Poly-alphabetic Cipher –**
In poly-alphabetic ciphers, every symbol in plain-text is mapped to a different cipher-text symbol regardless of its occurrence. Every different occurrence of a symbol has different mapping to a cipher-text. For example, in the plain-text 'follow', the mapping is :
f -> q
o -> w
l -> e
l -> r

o -> t

w -> y

Thus, the cipher text is ‘qwerty’.

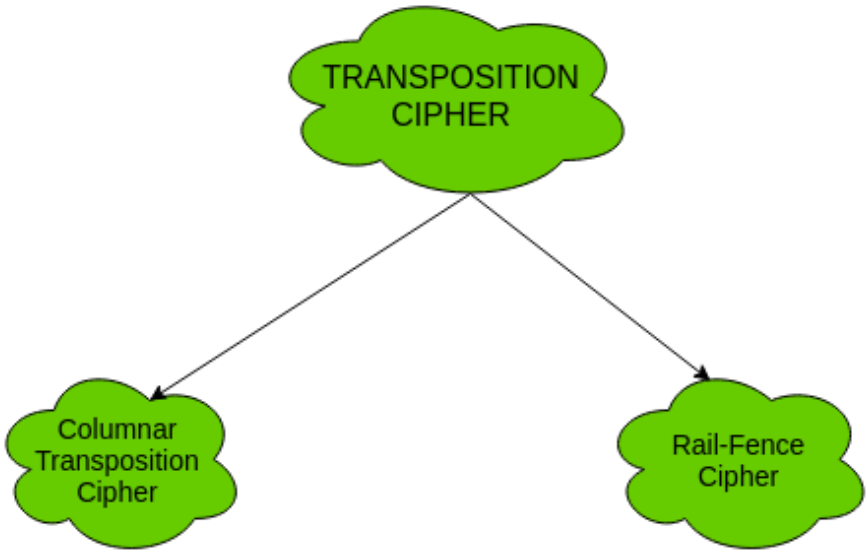
Types of poly-alphabetic ciphers are:



2. Transposition Cipher:

The transposition cipher does not deal with substitution of one symbol with another. It focuses on changing the position of the symbol in the plain-text. A symbol in the first position in plain-text may occur in fifth position in cipher-text.

Two of the transposition ciphers are:



1. **Columnar Transposition Cipher** –
   For information and implementation, see Columnar Transposition Cipher
2. **Rail-Fence Cipher** –
   For information and implementation, see Rail-Fence Cipher

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