4CS401

Cryptography and Network Security

By,
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Prerequisite

- Computer Networks
- Mathematical background

Syllabus

- Module-I: INTRODUCTION
- Module-II: SYMMETRIC KEY CRYPTOGRAPHY
- Module-III: PUBLIC KEY CRYPTOGRAPHY
- Module-IV: MESSAGE AUTHENTICATION AND INTEGRITY
- Module-V: NETWORK SECURITY
- Module-VI: SYSTEM SECURITY

Course Learning Outcomes

CO1: apply different encryption and decryption techniques to solve problems related to confidentiality and authentication.

CO2: Analyze and apply system security concept to recognize malicious code.

CO3: analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP

CO4: Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes.

Agenda

Why Cryptography and Network Security?

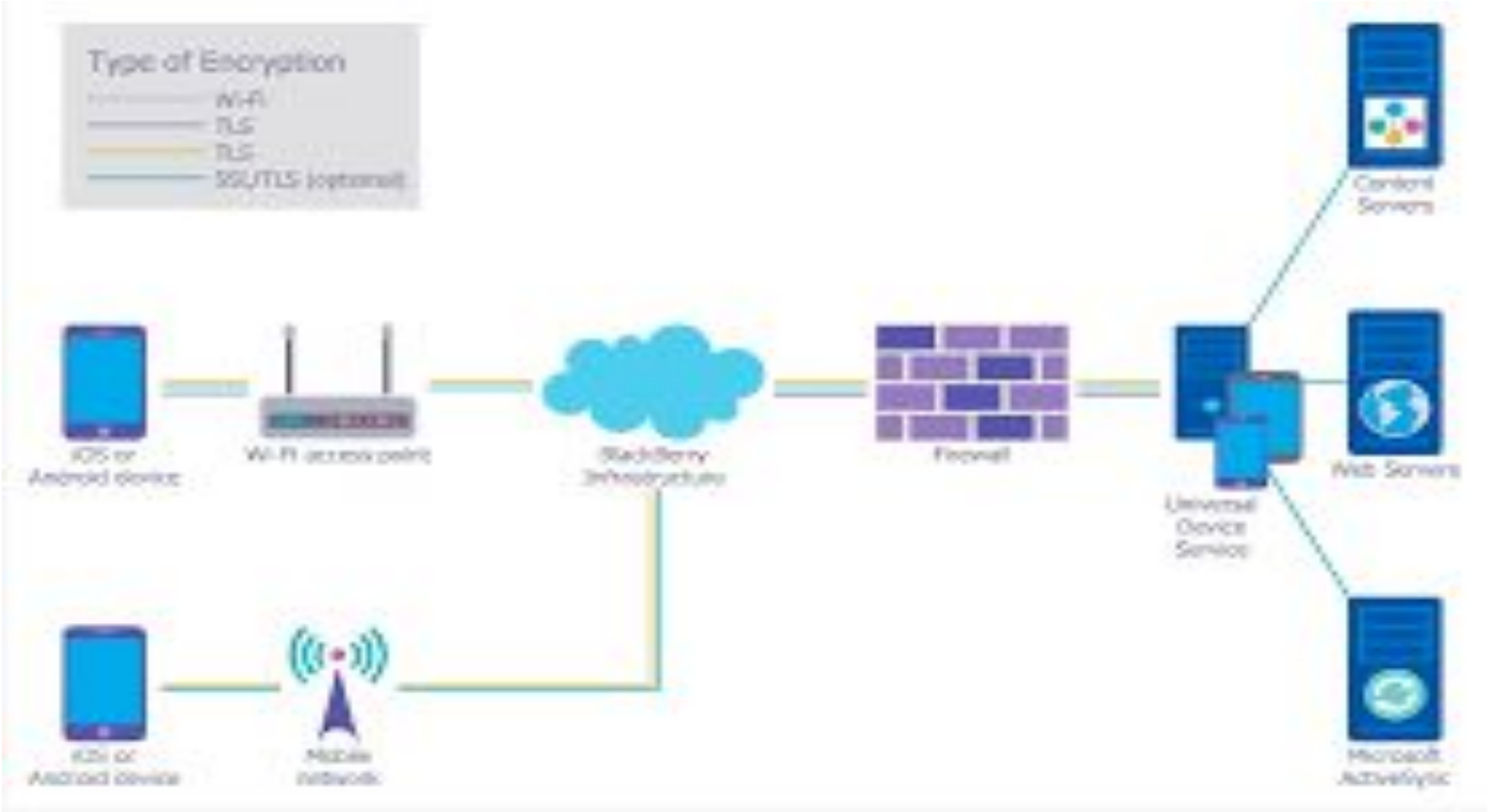
What is Cryptography

Classification of cryptography

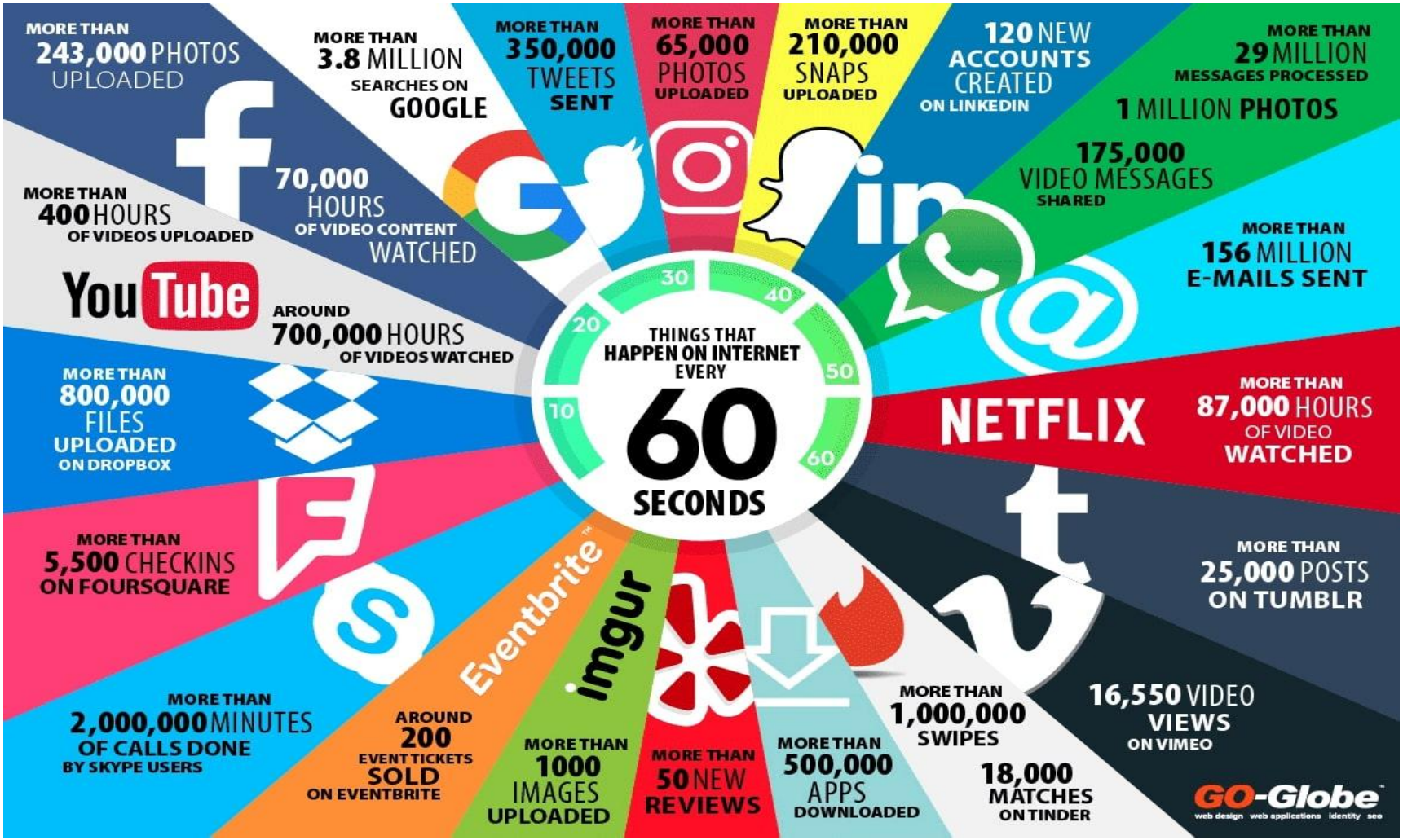
How various cryptographic algorithm works

Connected world

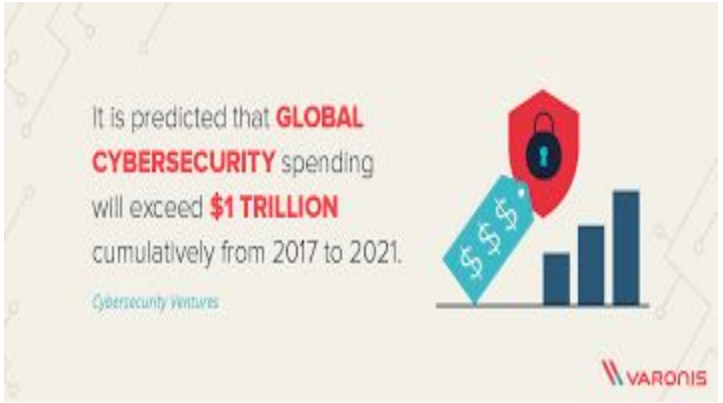
Need for Network Security



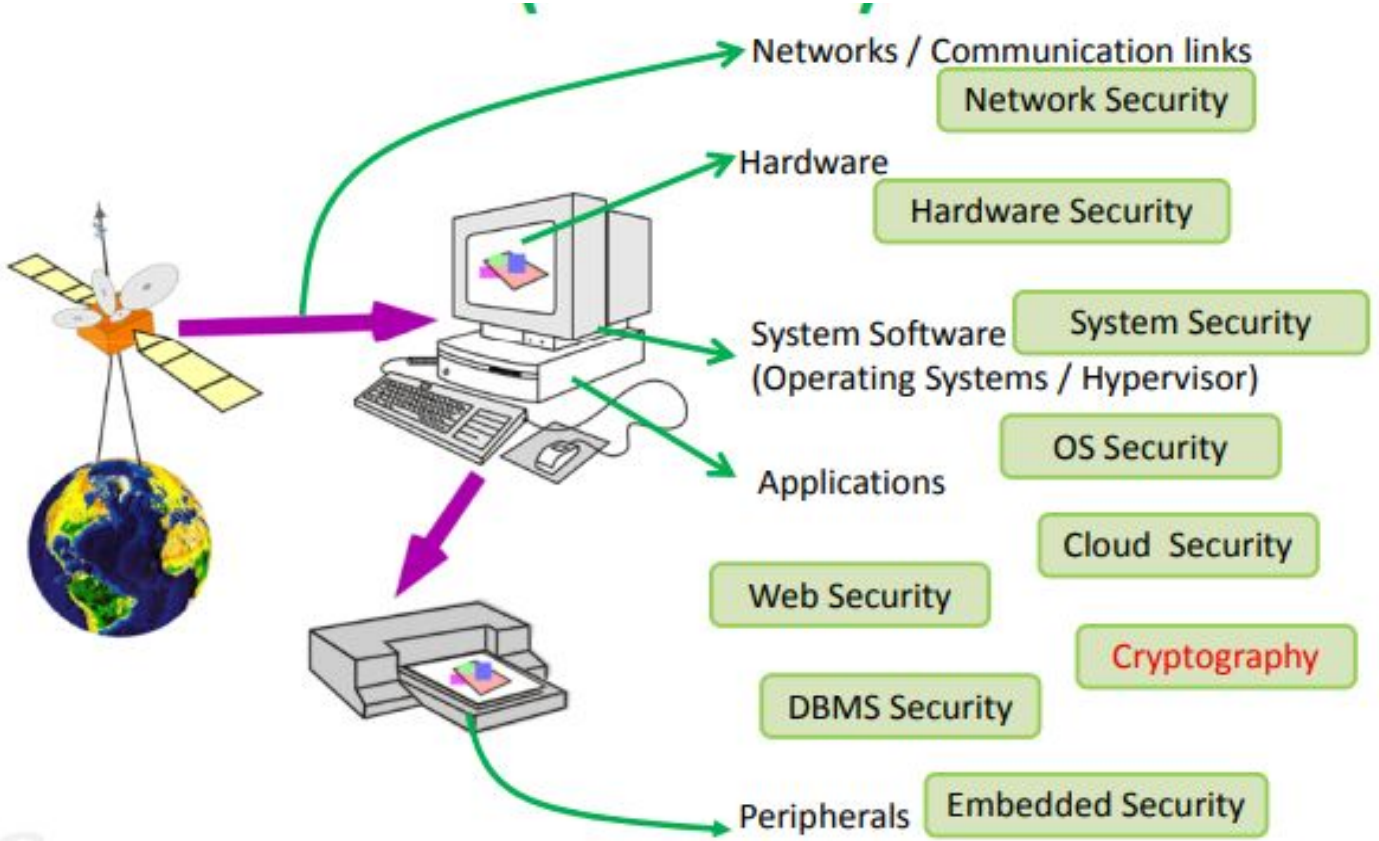
Internet stastistics-2020!



Increased Security Breaches



Security Studies(an ocean)



Information Security vs. Cyber Security vs. Network Security

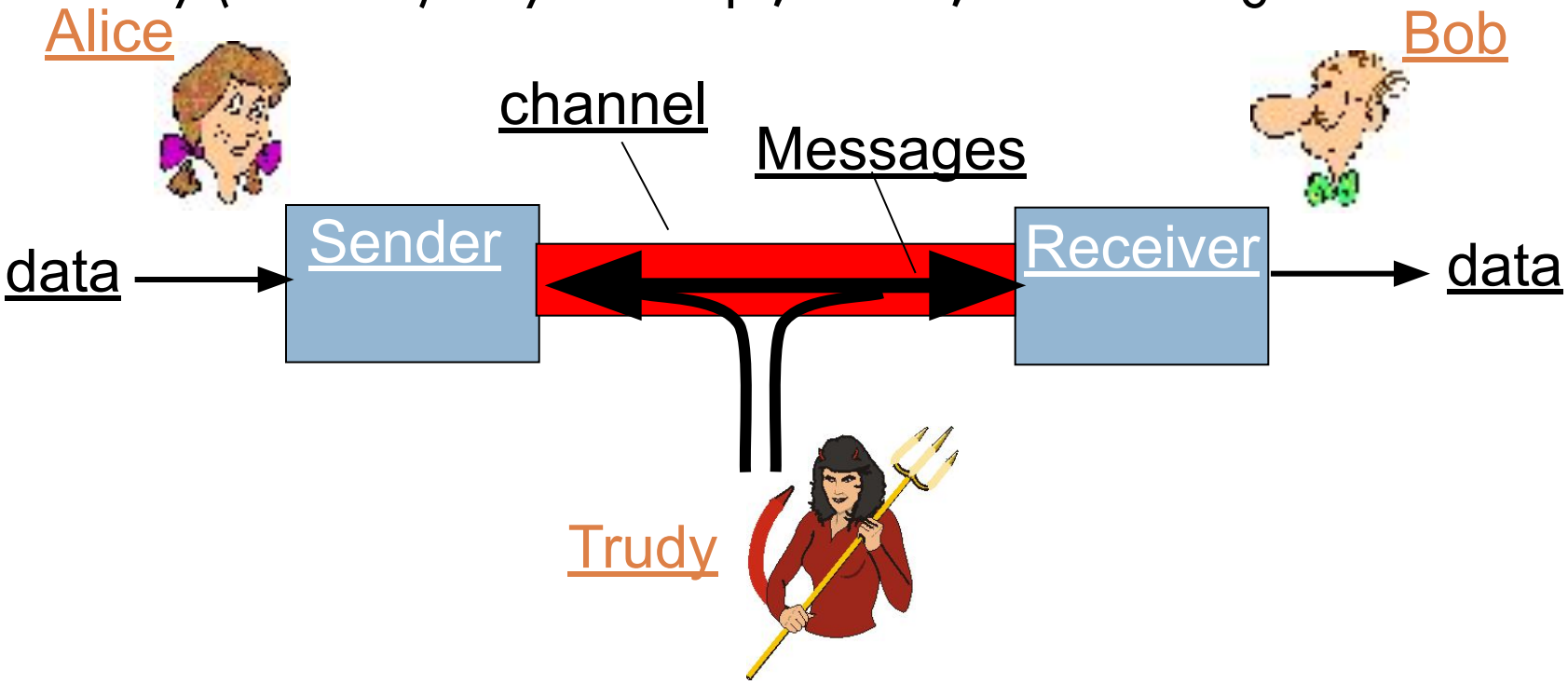
- What is Information Security?
  - Information security (also known as InfoSec) ensures that both physical and digital data is protected from unauthorized access, use, disclosure, disruption, modification, inspection, recording or destruction.
  - Information security differs from cybersecurity in that InfoSec aims to keep data in any form secure, whereas cybersecurity protects only digital data.

Information Security vs. Cyber Security vs. Network Security cont….

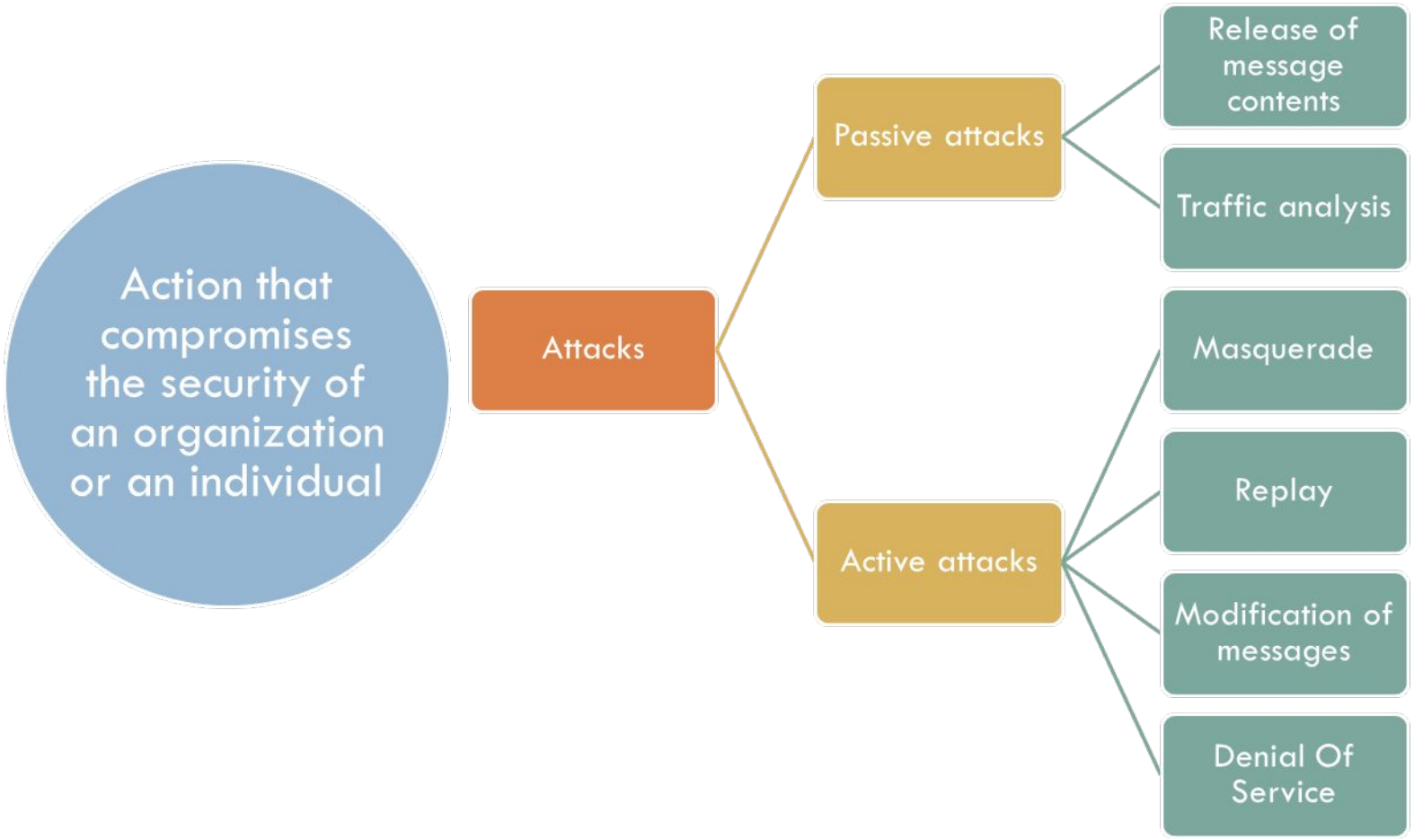
- What is Cybersecurity?
  - Cybersecurity, is a process or measures taken by organizations or experts to protect devices, computer networks, or data from malicious activities.
  - What is Network Security?
  - a subset of cybersecurity, aims to protect any data that is being sent through devices in your network to ensure that the information is not changed or intercepted.
  - role of network security is to protect the organization's IT infrastructure from all types of cyber threats.

Communication over the Internet

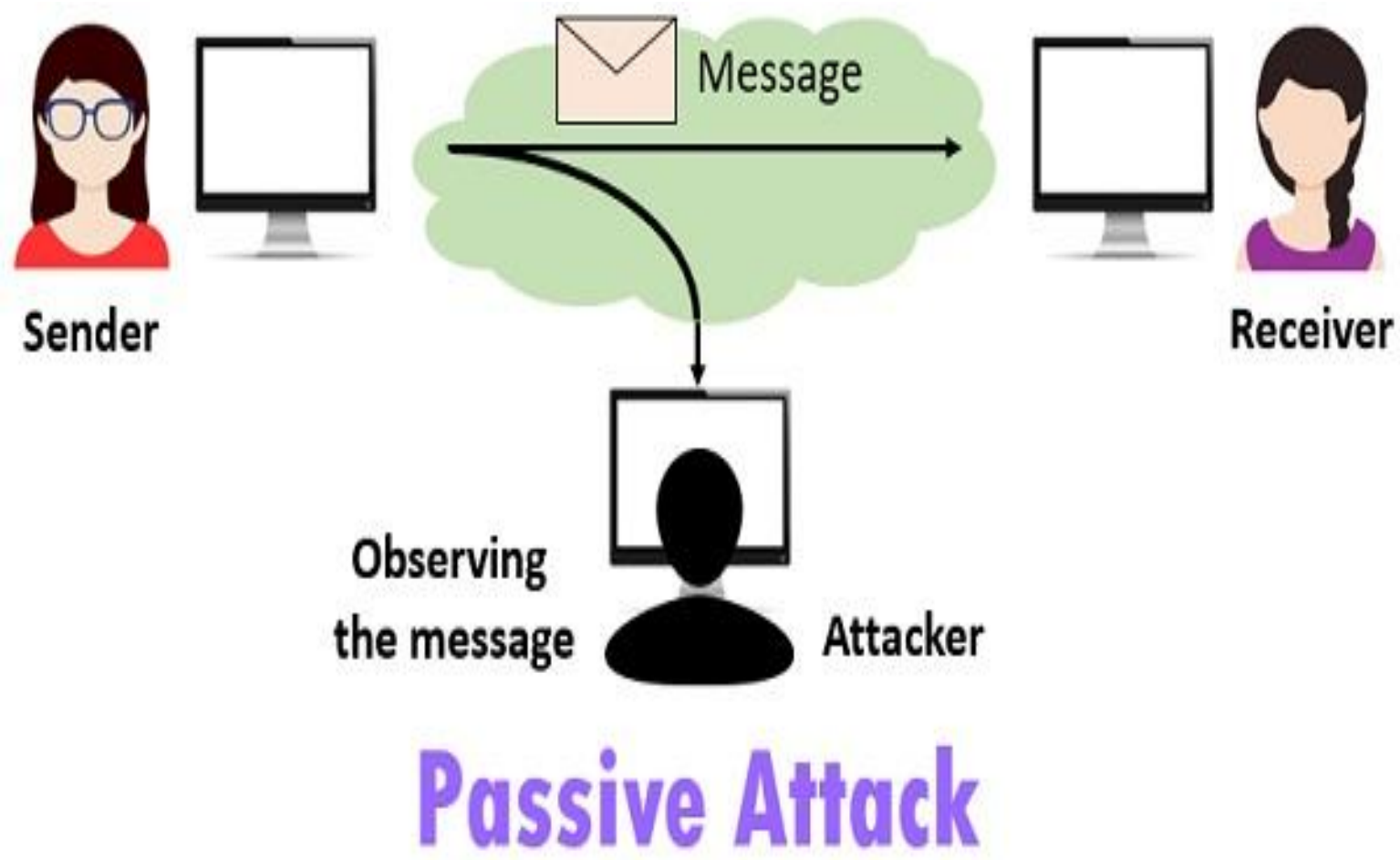
- Friends and enemies: Alice, Bob, Trudy
- well-known in network security world
- Bob, Alice (lovers!) want to communicate "securely"
- Trudy (intruder) may intercept, delete, add messages



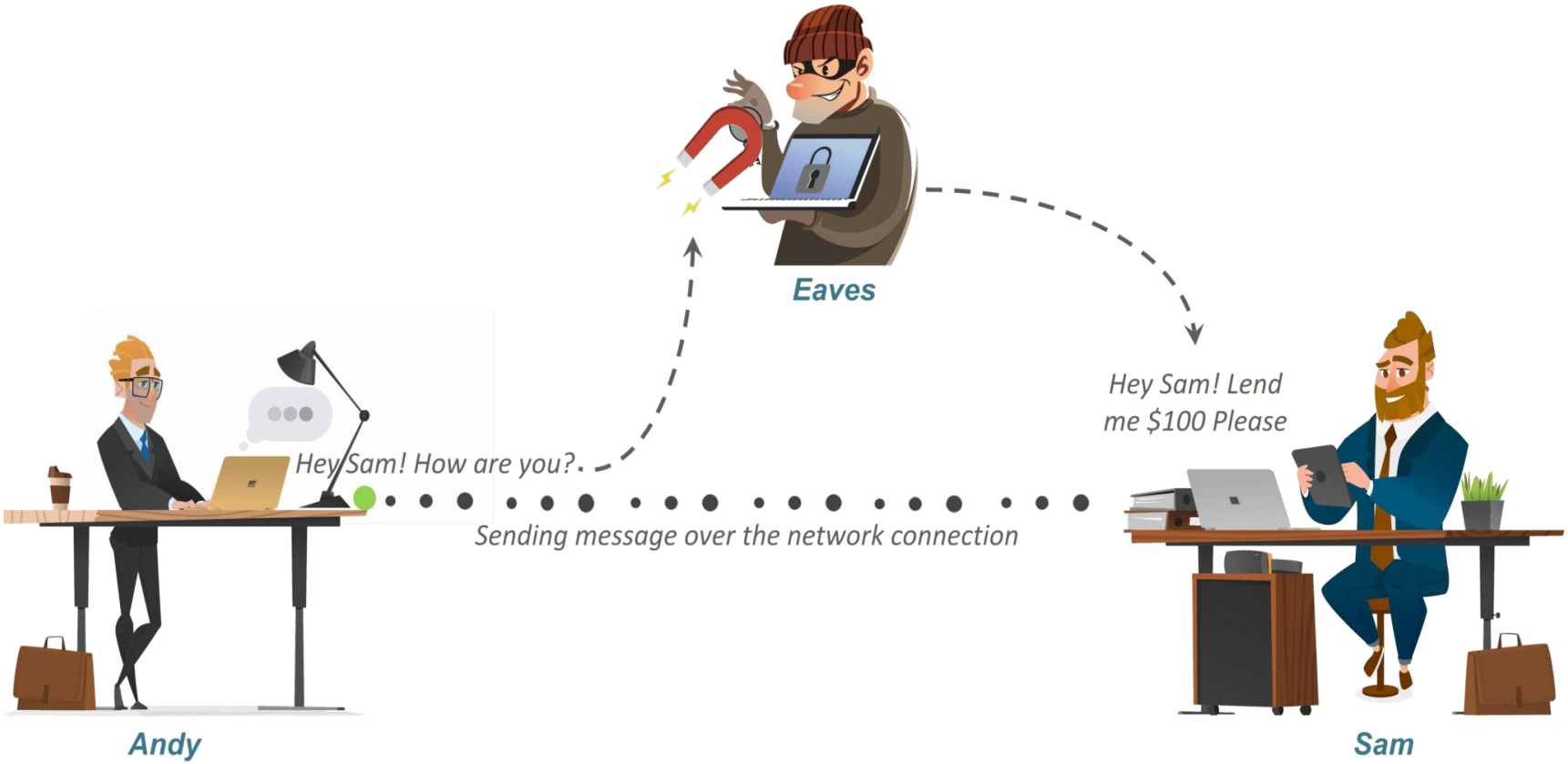
Security attacks



Passive Attacks



Active attack



Security Attacks

A means of classifying security attacks, used both in X.800 and RFC 4949, is in terms of *passive attacks* and *active attacks*

- A *passive attack* attempts to learn or make use of information from the system but does not affect system resources
- An *active attack* attempts to alter system resources or

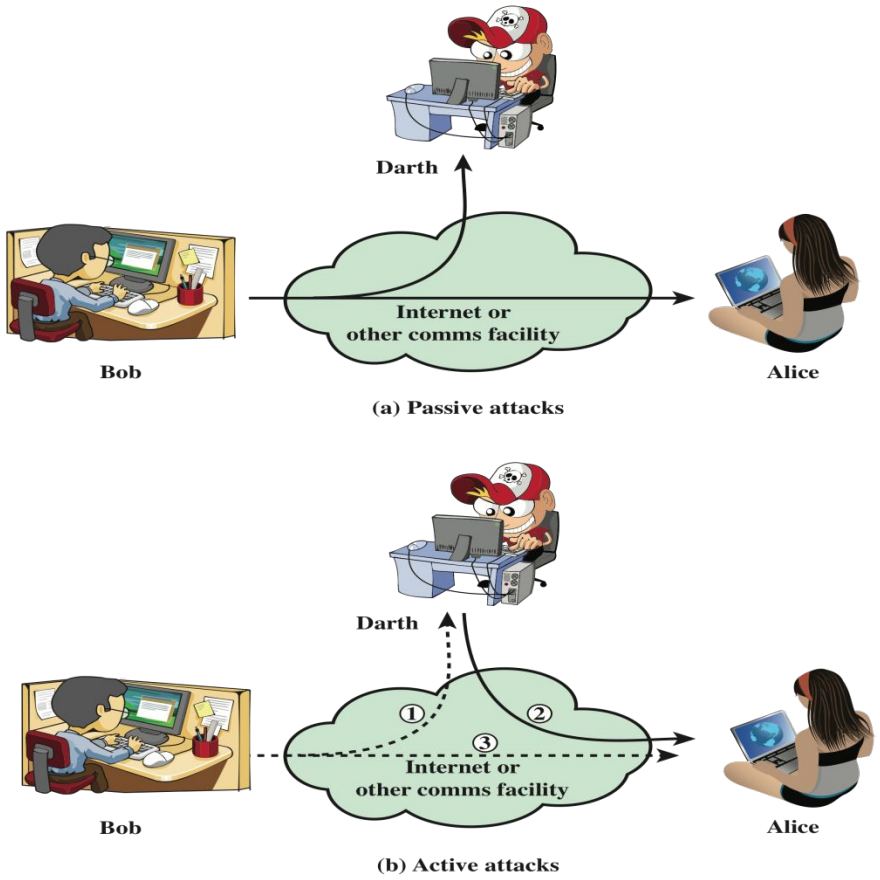


Figure 1.1 Security Attacks

Passive Attacks

- the nature of eavesdropping on, or monitoring of, transmissions
- Goal of the opponent is to obtain information that is being transmitted

- Two types of passive attacks are:
  - The release of message contents
  - Traffic analysis

Active Attacks

- Involve some modification of the data stream or the creation of a false stream
- Difficult to prevent because of the wide variety of potential physical, software, and network vulnerabilities
- Goal is to detect attacks and to recover from any disruption or delays caused by them

Masquerade	• Takes place when one entity pretends to be a different entity • Usually includes one of the other forms of active attack
Replay	• Involves the passive capture of a data unit and its subsequent retransmission to produce an unauthorized effect
Modification of messages	• Some portion of a legitimate message is altered, or messages are delayed or reordered to produce an unauthorized effect
Denial of service	• Prevents or inhibits the normal use or management of communications facilities

Security goals-CIA Triad

- Crucial component in all security system: CIA triad
- Cryptography used to achieve:
  - Confidentiality

    Only authorized users access information
  - Integrity

    Ensure completeness, accuracy and an absence of unauthorized modifications
  - Availability

    Available and operational when requir users

need to define some other security objectives!

- **Authentication -** a mechanism (a protocol) by which a user is identified and uses some token to prove who they are.
- **Non-repudiation-** a way to guarantee that the sender of a message cannot later deny having sent the message and that the recipient cannot deny having received the message.

Cryptography

Cryptography is technique of securing information and communications through use of codes so that only those person for whom the information is intended can understand it and process it.

Thus preventing unauthorized access to information.

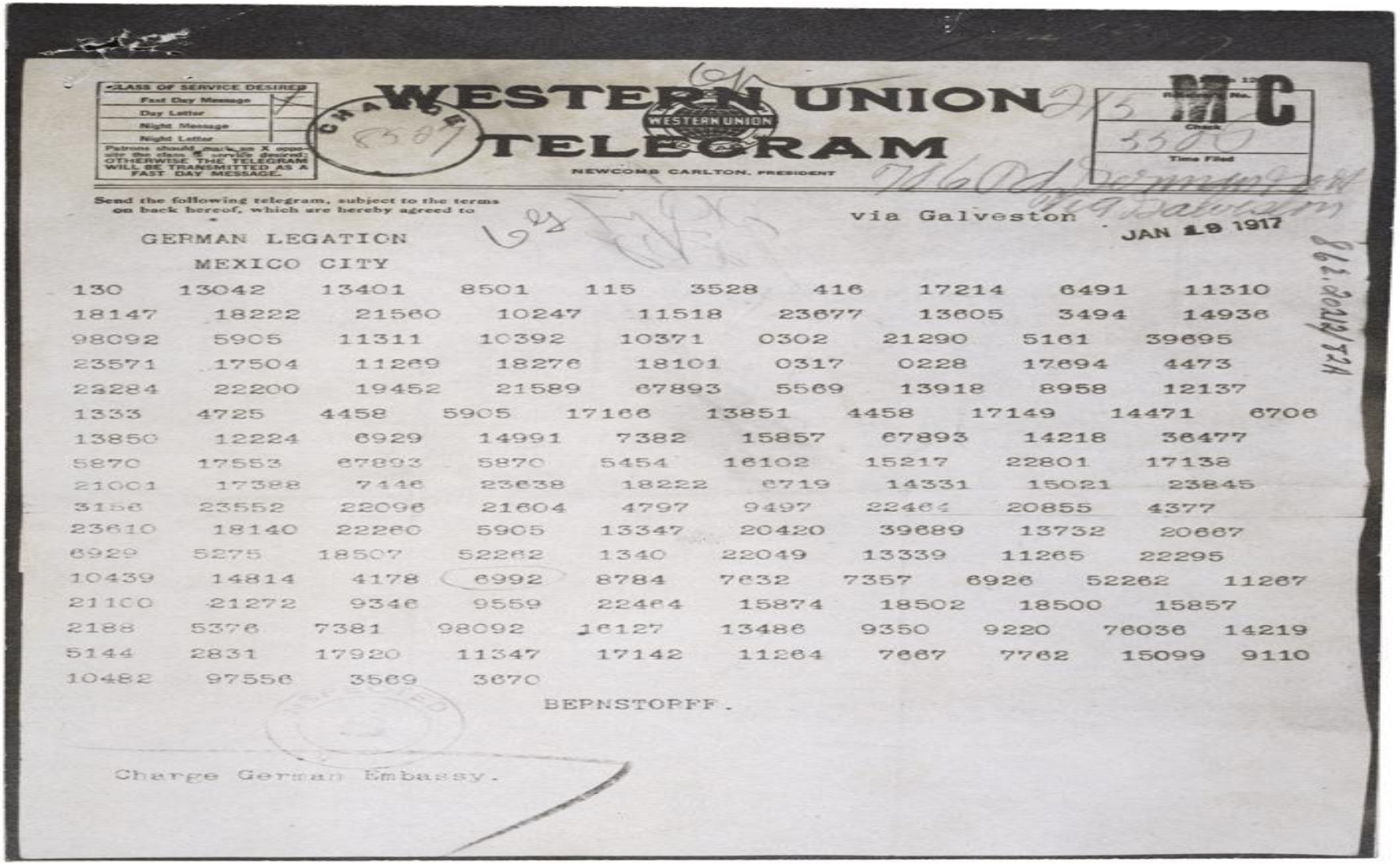
The prefix "crypt" means "hidden" and suffix "graphy" means "writing".

Sample Encrypted Message

```
-----BEGIN PGP MESSAGE-----
Version: GnuPG v2.0.20 (MingW32)

hQEMA5EOTKIA1RLeAQgAk0+I4DzLmyygCxWs/f+R0XjVtJIFp5010gjhcZC5+h58
9vqKZF51ld/+2vi/Jzt6vfSW2ORqPRfkeVcWCzZ4FS6RcHX6d9IkBHENdf6/US+o
IZnqTOx/QIcEvhVqpgEs0iO1yjQ5GyPpUhPwiNchoWcEyjp6p6OjdXSnVXpR8Kw1
6ssbTFIZOx7bO5O0VNH6dExhV9D86OqkGnhE7ap8IH5J8uzUJD1pPdNiRQRTu+Qv
vb30kBQ34egGY5avJKBk88ybtXEbfaWKREbGtZaClkAOXNPjfAEmar/ENx6ceKUF
UzEbJl7j520JFcHGEGdpQufzc8IrPAzfw2XnxzZOMdLpAVzyKMr3+SENCsere+vN
K48dKwosb0gIWFPVtWZh7swEtTRiMnyP7NkHB3PlQ3gtx7N04a5yPQJq0JBUoq0E
SlDv5K2q2gSL+HiCj31lDIltMHkbNGtJDP+/4ETgScId9lAKvr6FK9mzLYrp09gz
+Y8g6Lgz+Ib6YWhQuwyG4ObqkIywZeBvtQ5yWLk9HdrOiqpBFhzLcKfs60NzWUNd
cZIELVn7cqsSlIYBw0CtqAb80vrx6zxIS6MTjNzIwQGwcbH0uaA3ctgGbnF7/E0n
sx8jBCA/8+nACuR3ZEmDqrhCZRvHEUWgo7tBa4Hi8oJ3JaxiO3xMJmulsN2PDyg/
dj+AG6hVJidNBdvBQmFOCdcDTAaBSMPxHeZQeEKoHXG6l7QQr9ZsHuN+1+tRPTZy
1dXWZwcz9Ei55+vO2xwIjVpYfjQT11qofHbVOfTn61LSVuLtTnLDP+pVW6tmalai
zGrqrBK9gm0A7XqIpIF7LqurDVODH0+NvYC75xQwHPOQ7An9P8JUvjmWUbPEZsBJ
1mwb3weQ9WorCYHX2SC16gTLFaKAvyRZyCkivdy2HZQJFnOuCtxN49Kwr37zcam2
Ic9+8IwQcEzwcMO+0W1VumPsTTglNWEXu5JQ1OZC2Oa+6laa5XxbmV0b059P25O+
gKpfQUgVNUF0IicVYCEzH+cZjZ8+JtL+WilO7gsQAyYa4w/eP/nRQXKVgA==
=ZZ4U
-----END PGP MESSAGE-----
```

German Telegram



CLASS OF SERVICE DESIRED
Fast Day Message
Day Letter
Night Message
Night Letter
Patrons should mark an X opposite the class of service desired; OTHERWISE THE TELEGRAM WILL BE TRANSMITTED AS A FAST DAY MESSAGE.

CHARGE

WESTERN UNION TELEGRAM

NEWCOMB CARLTON, PRESIDENT

Check 3300

Time Filed

Send the following telegram, subject to the terms on back hereof, which are hereby agreed to

via Galveston

JAN 19 1917

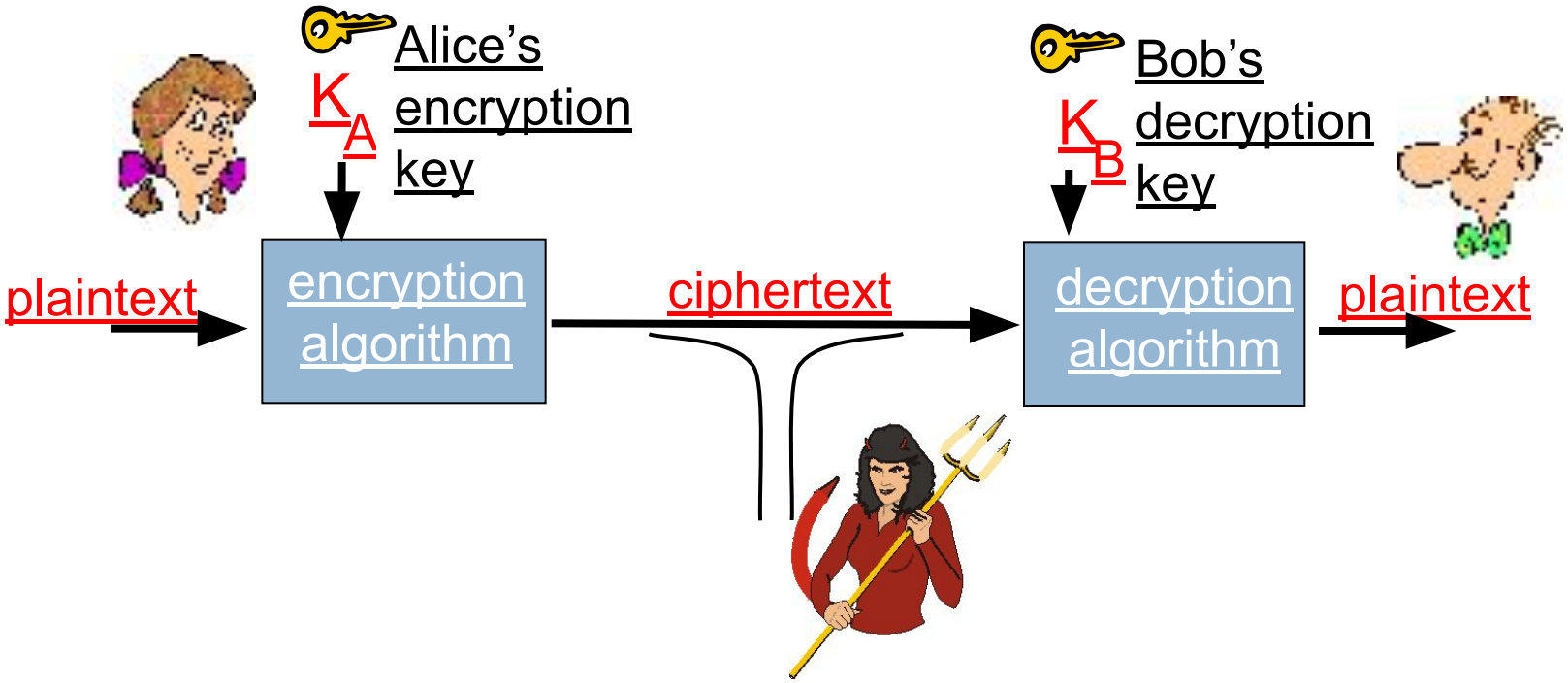
GERMAN LEGATION
MEXICO CITY

130 13042 13401 8501 115 3528 416 17214 6491 11310
18147 18222 21560 10247 11518 23677 13605 3494 14936
98092 5905 11311 10392 10371 0302 21290 5161 39695
23571 17504 11269 18276 18101 0317 0228 17694 4473
23284 22200 19452 21589 67893 5569 13918 8958 12137
1333 4725 4458 5905 17166 13851 4458 17149 14471 6706
13850 12224 6929 14991 7382 15857 67893 14218 36477
5870 17553 67893 5870 5454 16102 15217 22801 17138
21001 17388 7446 23638 18222 6719 14331 15021 23845
3156 23552 22096 21604 4797 9497 22464 20855 4377
23610 18140 22260 5905 13347 20420 39689 13732 20667
6929 5275 18507 52262 1340 22049 13339 11265 22295
10439 14814 4178 6992 8784 7632 7357 6926 52262 11267
21100 21272 9346 9559 22464 15874 18502 18500 15857
2188 5376 7381 98092 16127 13486 9350 9220 76036 14219
5144 2831 17920 11347 17142 11264 7667 7762 15099 9110
10482 97556 3569 3670

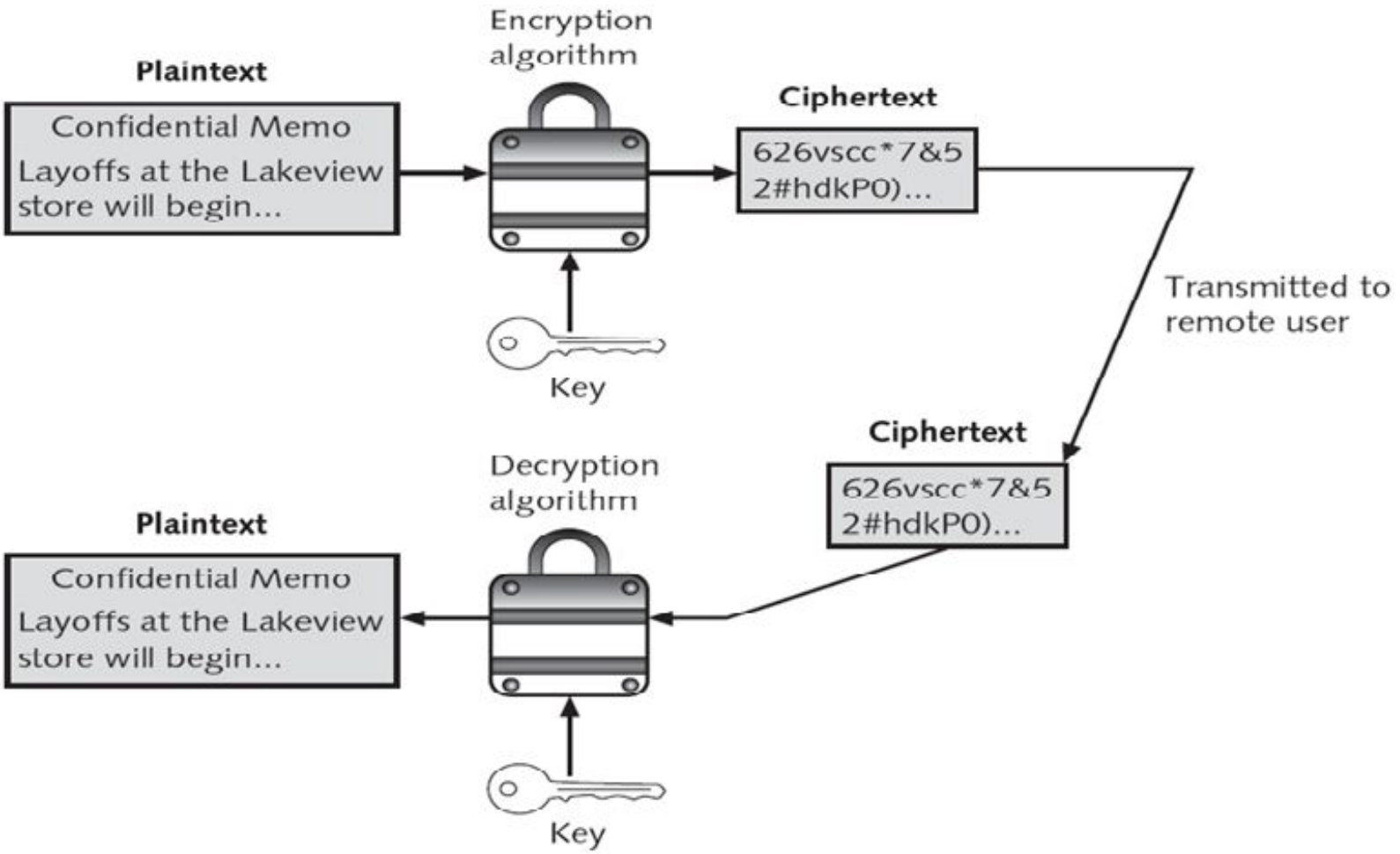
BERNSTORFF.

Charge German Embassy.

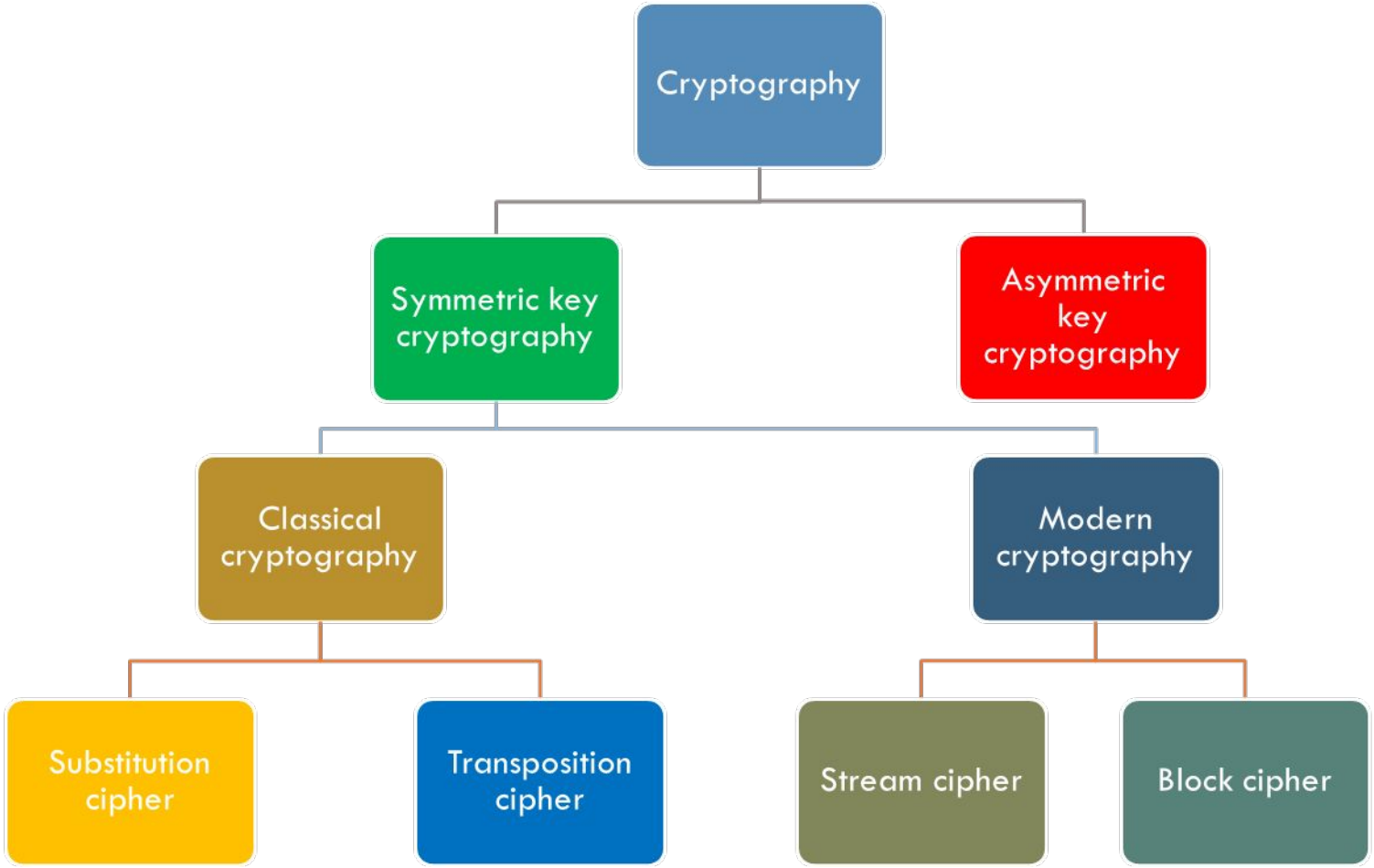
The language of cryptography



Cryptographic process



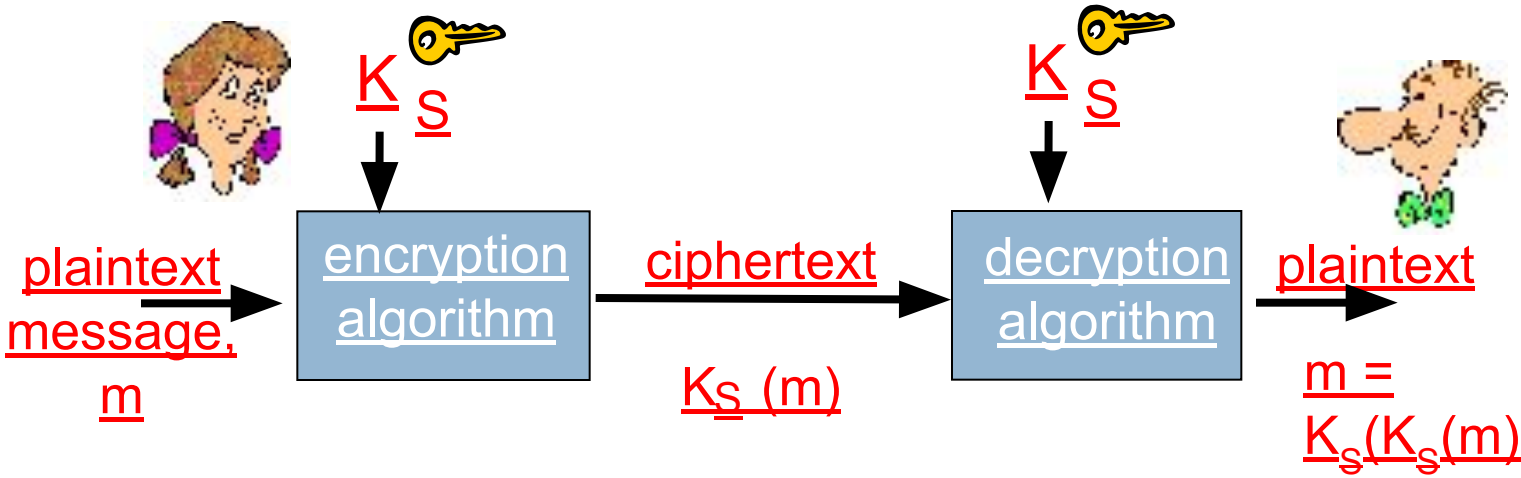
Classification of Cryptography



Types of Cryptography

- Crypto often uses keys:
  - Algorithm is known to everyone
  - Only “keys” are secret
- Symmetric key cryptography
  - Involves the use one key
- Asymmetric key/Public key cryptography
  - Involves the use of two keys

Symmetric key cryptography



symmetric key crypto: Bob and Alice share same (symmetric) key: K

The most common symmetric key system is the Data Encryption Standard (DES)

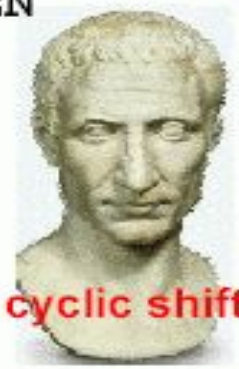
Substitution Cipher: Caesar Cipher

MESSAGE FROM MARY STUART KILL THE QUEEN

Substitution Table - Caesar's Cipher

ABCDEFGHIJKLMNOPQRSTUVWXYZ

DEFGHIJKLMNOPQRSTUVWXYZABC ← key = 3 cyclic shifts



PHVVD JHIUR PPDUB VWXDU WNLOO WKHTX HHQ

General Substitution Table

ABCDEFGHIJKLMNOPQRSTUVWXYZ

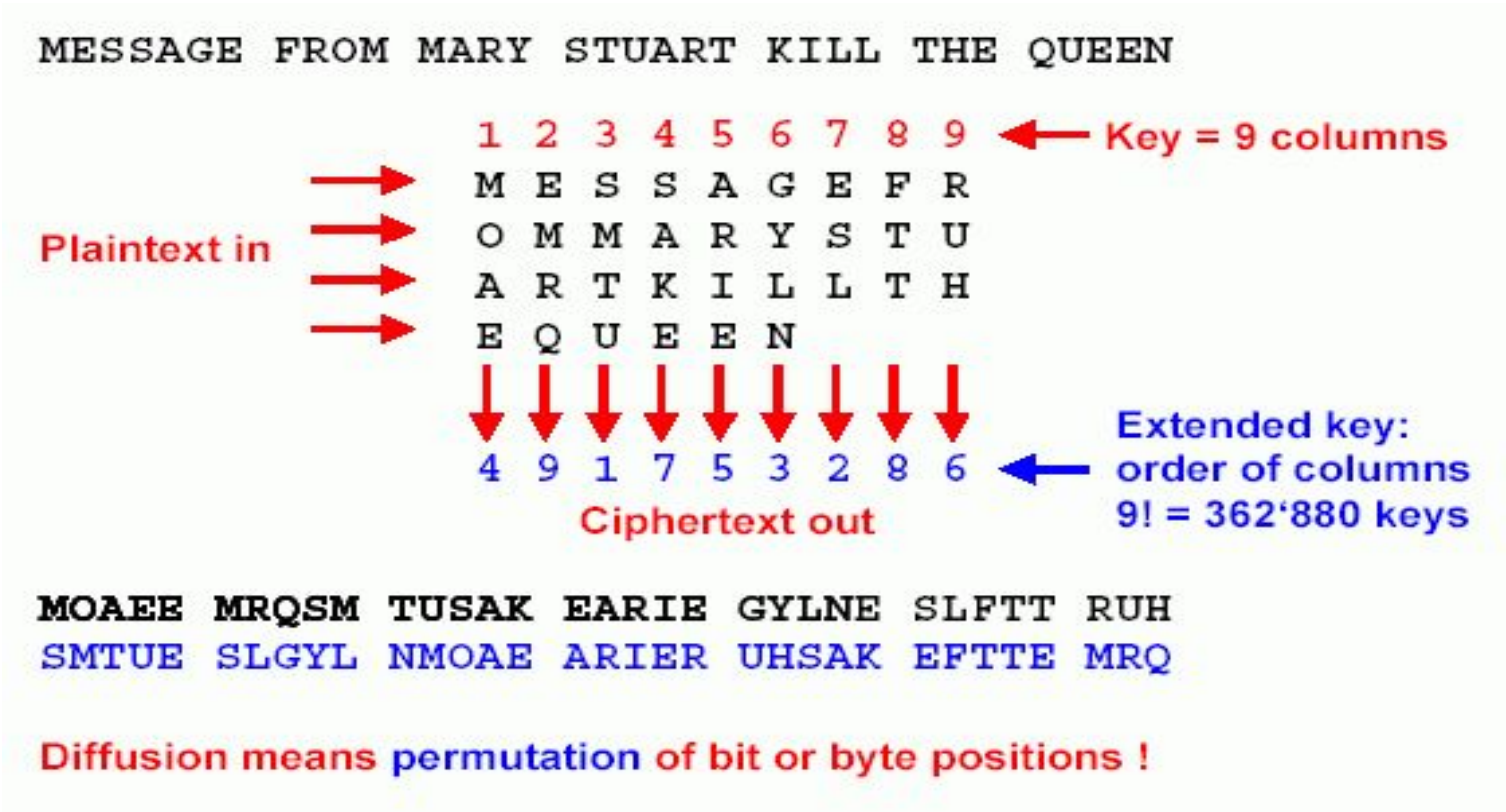
EYUOBMDXVTHIJPRCNAKQLSGZFW ← 26! possible keys

JBKKE DBMAR JJEAF KQLEA QHVII QXBNL BBP

Courtesy: Andreas Steffen

Modern substitution ciphers take in N bits and substitute N bits using lookup table: called S-Box

Transposition cipher

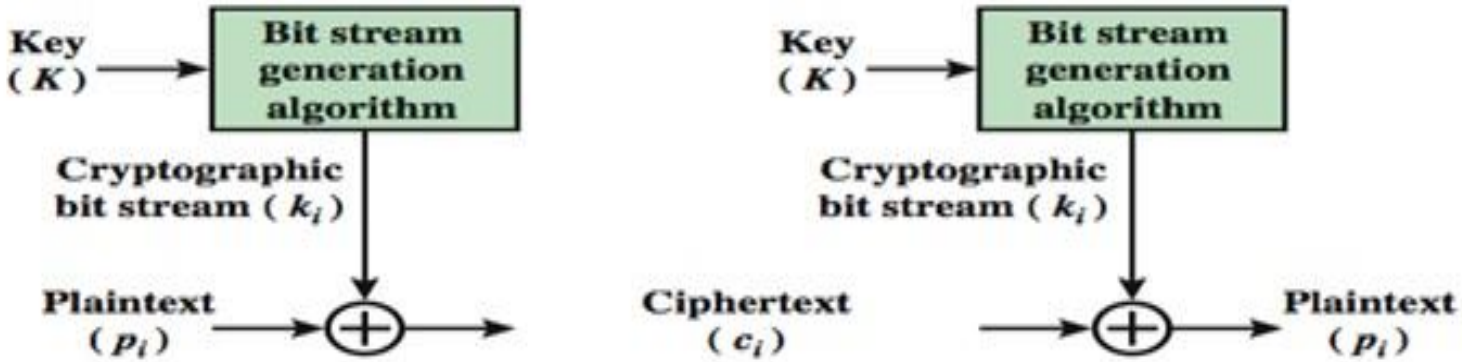


Courtesy: Andreas Steffen

Modern Transposition ciphers take in N bits and permute using lookup table : called P-Boxes

Stream Cipher

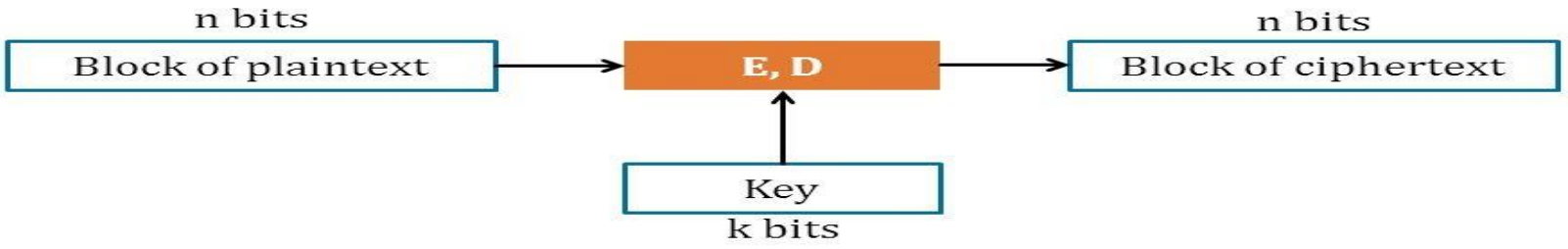
- Combine each bit of keystream with bit of plaintext to get bit of ciphertext
  - c(i) = ks(i) ⊕ m(i)
  - m(i) = ks(i) ⊕ c(i)



(a) Stream Cipher Using Algorithmic Bit Stream Generator

Block ciphers

- Message to be encrypted is processed in blocks of k bits (e.g., 64-bit blocks).



1. 3DES: n = 64 bits, k = 168 bits
2. AES: n = 128 bits, k = 128, 192, 256 bits

Thank You…

Any queries…?

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