Cryptography

Module 18

Unmask the Invisible Hacker.

Market Survey 2014: The Year of Encryption

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60% of those survey said that Edward Snowden revelations have made them more aware of data security

100% of those not interested in security systems admitted to regularly sharing sensitive/ confidential data with external third parties

Among the 60%, approximately **70%** have been directly influenced to look at new data security systems

Over **2/3** of people felt that government certification combined with ease of use would be deciding factors when selecting a data security solution

94% of people looking to invest in new systems are specifically examining secure (encryption) electronic data security systems

One in two people now perceive the Cloud to be less secure as result of Snowden

Only **17%** of those surveyed said their existing secure information sharing system was easy to use

One third of those surveyed were not that upcoming EU DPA reforms would impact the way they or their organization handles and protects data

http://www.egress.com

Case Study: Heartbleed

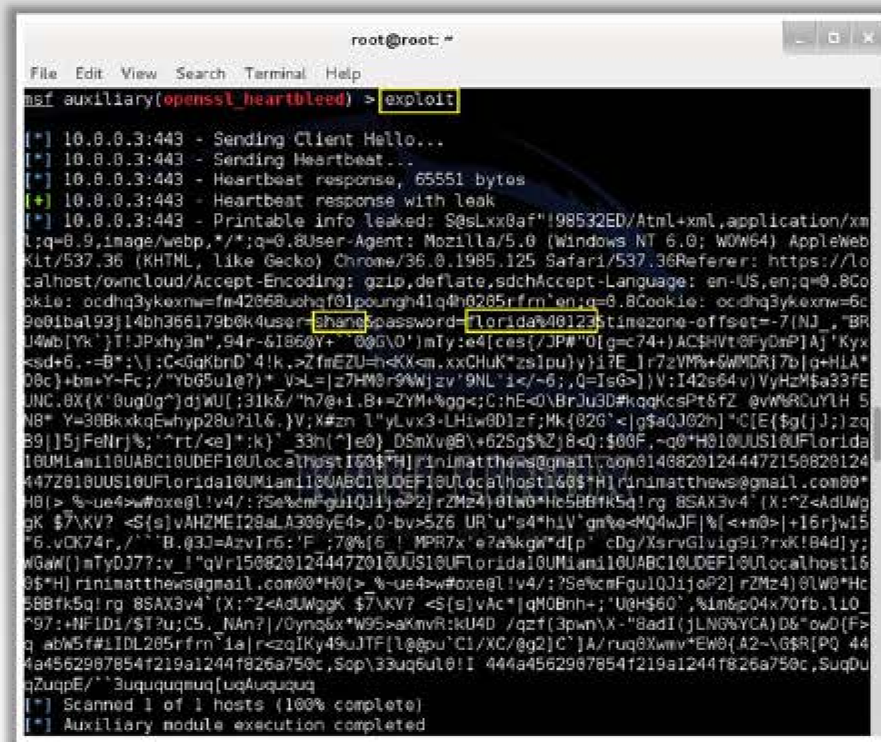
1. Heartbleed is a security flaw in the **OpenSSL** cryptographic software library, which allows data traversal over **SSL/TLS in plain-text**

2. Heartbleed exploits a built-in feature of OpenSSL called **heartbeat**

3. Attackers exploit this vulnerability to get information such as OpenSSL **private** keys, OpenSSL **secondary** keys, up to **64kb of memory** from the affected server, **usernames** and **passwords**, etc.

4. Versions of OpenSSL affected by Heartbleed include **1.0.1** to **1.0.1f**

5. **Updating OpenSSL** to version **1.0.1g** or **higher** resolves the vulnerability



Case Study: Poodlebleed

- Poodlebleed (**Padding Oracle On Downgraded Legacy Encryption**) is a security vulnerability in the design of SSL 3.0
- Attacker exploits this vulnerability to **decrypt ciphertext in transit** between a server and a browser, by means of padding oracle side-channel attack
- **Countermeasures**:
  - Completely **disable SSL 3.0** on the client side and the server side
  - Implement **anti-POODLE record splitting**

https://poodlebleed.com

Module Objectives

- Understanding Cryptography Concepts
- Overview of Encryption Algorithms
- Cryptography Tools
- Understanding Public Key Infrastructure (PKI)
- Understanding Email Encryption
- Understanding Disk Encryption
- Understanding Cryptography Attacks
- Cryptanalysis Tools



Module Flow

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1 Cryptography Concepts

2 Encryption Algorithms

3 Cryptography Tools

4 Public Key Infrastructure (PKI)

5 Email Encryption

6 Disk Encryption

7 Cryptography Attacks

8 Cryptanalysis Tools

Cryptography

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01 Cryptography is the **conversion of data** into a scrambled code that is decrypted and sent across a private or public network

02 Cryptography is used to protect confidential data such as **email messages**, chat sessions, **web transactions**, personal data, **corporate data**, e-commerce applications, etc.

03

Objectives

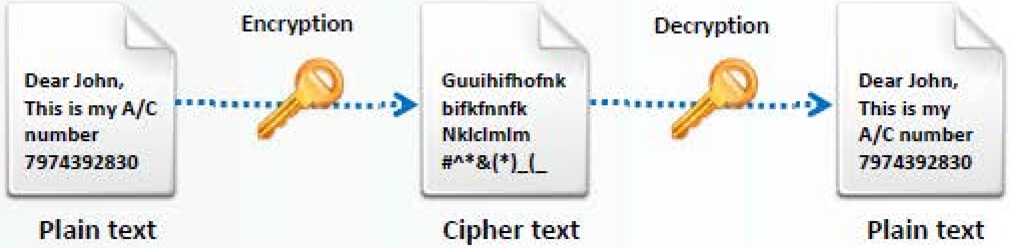
- Confidentiality
- Integrity
- Authentication
- Non-repudiation

04

Types of Cryptography

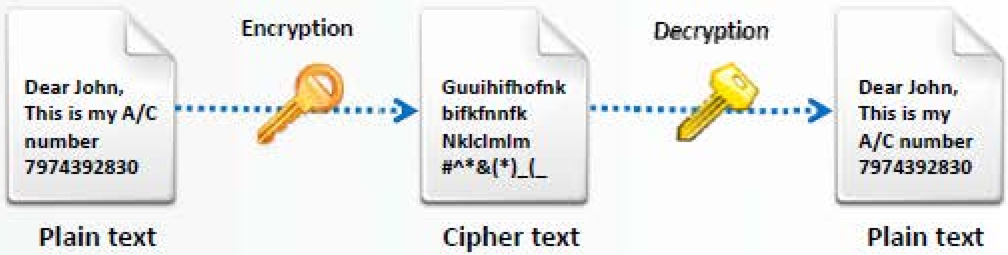
Symmetric Encryption

Symmetric encryption (secret-key, shared-key, and private-key) **uses the same key** for encryption as it does for decryption



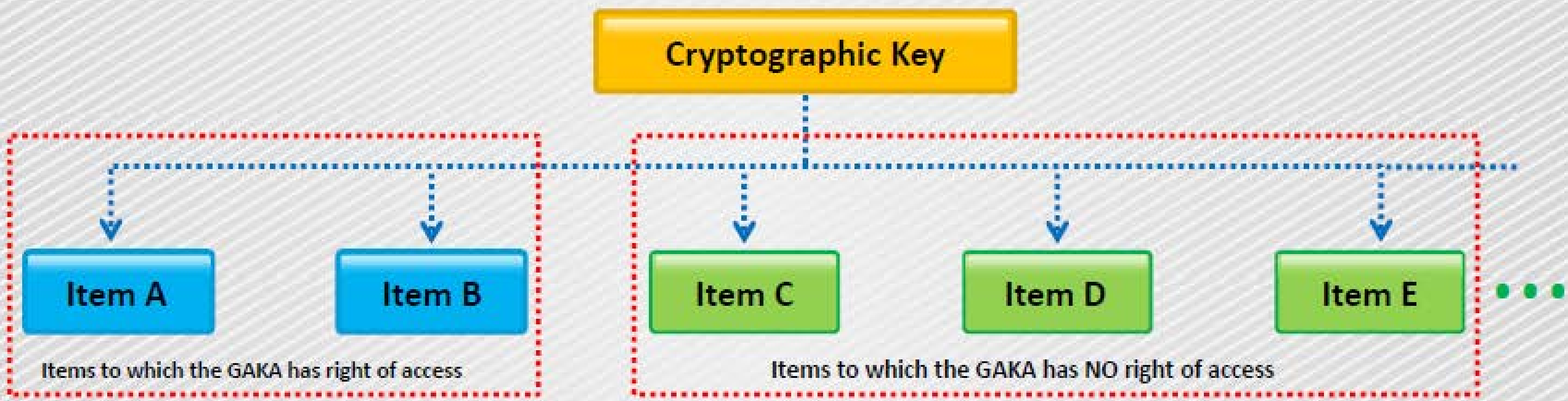
Asymmetric Encryption

Asymmetric encryption (public-key) **uses different encryption keys** for encryption and decryption. These keys are known as public and private keys



Government Access to Keys (GAK)

- Government Access to Keys means that software companies will give **copies of all keys**, (or at least enough of the key that the remainder could be cracked) to the government
- The government promises that they will hold on to the keys in a **secure way**, and will only use them when a **court issues a warrant** to do so
- To the government, this issue is similar to the **ability to wiretap phones**



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Ciphers

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Ciphers are algorithms used to encrypt or decrypt the data

Classical Ciphers

Substitution cipher

A block of plaintext is replaced with ciphertext

Transposition cipher

The letters of the plaintext are shifted about to form the cryptogram

Modern Ciphers

Based on the type of key used

Private Key

Same key is used for encryption and decryption

Public Key

Two different keys are used for encryption and decryption

Based on the type of input data

Block Cipher

Encrypts block of data of fixed size

Stream Cipher

Encrypts continuous streams of data

Data Encryption Standard (DES)

The algorithm is designed to **encipher** and **decipher** blocks of data consisting of **64 bits** under control of a 56-bit key

DES is the **archetypal block cipher** — an algorithm that takes a fixed-length string of plaintext bits and transforms it into a ciphertext bitstring of the same length

Due to the **inherent weakness** of DES with today's technologies, some organizations repeat the process three times (3DES) for added strength, until they can afford to update their equipment to AES capabilities

Advanced Encryption Standard (AES)

AES is a symmetric-key algorithm for securing sensitive but unclassified material by U.S. government agencies

AES is an iterated block cipher, which works by repeating the same operation multiple times

It has a 128-bit block size, with key sizes of 128, 192, and 256 bits, respectively for AES-128, AES-192, and AES-256

AES Pseudocode

```
Cipher (byte in[4*Nb], byte out[4*Nb],
word w[Nb*(Nr+1)])
begin
  byte state[4,Nb]
  state = in
  AddRoundKey(state, w)
   for round = 1 step 1 to Nr-1
     SubBytes(state)
     ShiftRows(state)
     MixColumns(state)
     AddRoundKey(state, w+round*Nb)
   end for
  SubBytes(state)
  ShiftRows(state)
  AddRoundKey(state, w+Nr*Nb)
  out = state
end
```

RC4, RC5, RC6 Algorithms

RC4

A variable **key size stream cipher** with byte-oriented operations, and is based on the use of a random permutation

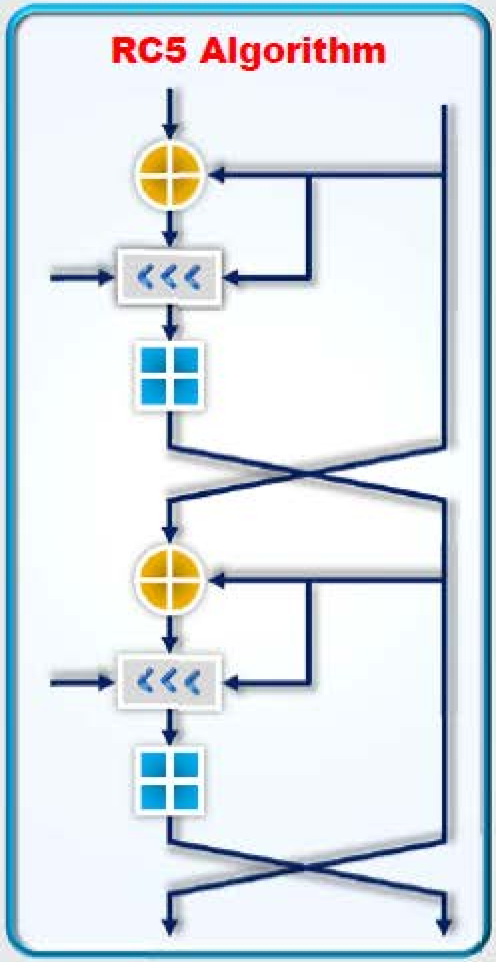
RC5

It is a **parameterized algorithm** with a variable block size, a variable key size, and a variable number of rounds. The key size is **128-bits**

RC6

RC6 is a **symmetric key block cipher** derived from RC5 with two additional features:

- Uses **Integer multiplication**
- Uses **four 4-bit working registers** (RC5 uses two 2-bit registers)



The DSA and Related Signature Schemes

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Digital Signature Algorithm

FIPS 186-2 specifies the Digital Signature Algorithm (DSA) that may be used in the **generation and verification of digital signatures** for sensitive, unclassified applications

Digital Signature

The digital signature is **computed using a set of rules** (i.e., the DSA) **and a set of parameters** such that the identity of the signatory and integrity of the data can be verified

Each entity creates a public key and corresponding private key

1. Select a prime number q such that $2^{159} < q < 2^{160}$
2. Choose t so that $0 \le t \le 8$
3. Select a prime number p such that $2^{511+64t} < p < 2^{512+64t}$ with the additional property that q divides $(p-1)$
4. Select a generator α of the unique cyclic group of order q in Z^*_p
5. To compute α, select an element g in Z^*_p and compute $g^{(p-1)/q} \bmod p$
6. If $\alpha = 1$, perform step five again with a different g
7. Select a random a such that $1 \le a \le q-1$
8. Compute $y = \alpha^a \bmod p$

The public key is (p, q, α, y). The private key is a.

RSA (Rivest Shamir Adleman)

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01 RSA is an **Internet encryption and authentication system** that uses an algorithm developed by Ron Rivest, Adi Shamir, and Leonard Adleman

02 RSA encryption is widely used and is one of the **de-facto encryption standard**

03 It uses **modular arithmetic** and **elementary number theories** to perform computations using two large prime numbers

The RSA Signature Scheme

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Algorithm Key generation for the RSA signature scheme

SUMMARY: each entity creates an RSA public key and a corresponding private key.
Each entity A should do the following:

1. Generate two large distinct random primes p and q, each roughly the same size.
2. Compute $n = pq$ and $\phi = (p-1)(q-1)$.
3. Select a random integer e, $1 < e < \phi$, such that $\gcd(e, \phi) = 1$.
4. Use the extended Euclidean algorithm (Algorithm 2.107) to compute the unique integer d, $1 < d < \phi$, such that $ed \equiv 1 \pmod{\phi}$.
5. A's public key is (n, e); A's private key is d.

Algorithm RSA signature generation and verification

SUMMARY: entity A signs a message $m \in \mathcal{M}$. Any entity B can verify A's signature and recover the message m from the signature.

1. *Signature generation.* Entity A should do the following:
   (a) Compute $\widetilde{m} = R(m)$, an integer in the range $[0, n-1]$.
   (b) Compute $s = \widetilde{m}^d \bmod n$.
   (c) A's signature for m is s.
2. *Verification.* To verify A's signature s and recover the message m, B should:
   (a) Obtain A's authentic public key (n, e).
   (b) Compute $\widetilde{m} = s^e \bmod n$.
   (c) Verify that $\widetilde{m} \in \mathcal{M}_R$; if not, reject the signature.
   (d) Recover $m = R^{-1}(\widetilde{m})$.

Example of RSA Algorithm

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```
P  = 61     <= first prime number (destroy this after computing E and D)
Q  = 53     <= second prime number (destroy this after computing E and D)
PQ = 3233   <= modulus (give this to others)
E  = 17     <= public exponent (give this to others)
D  = 2753   <= private exponent (keep this secret!)

Your public key is (E,PQ).
Your private key is D.

The encryption function is: encrypt(T) = (T^E) mod PQ
                                       = (T^17) mod 3233

The decryption function is: decrypt(C) = (C^D) mod PQ
                                       = (C^2753) mod 3233

To encrypt the plaintext value 123, do this:

encrypt(123) = (123^17) mod 3233
             = 337587917446653715596592958817679803 mod 3233
             = 855

To decrypt the cipher text value 855, do this:

decrypt(855) = (855*2753) mod 3233
             = 123
```

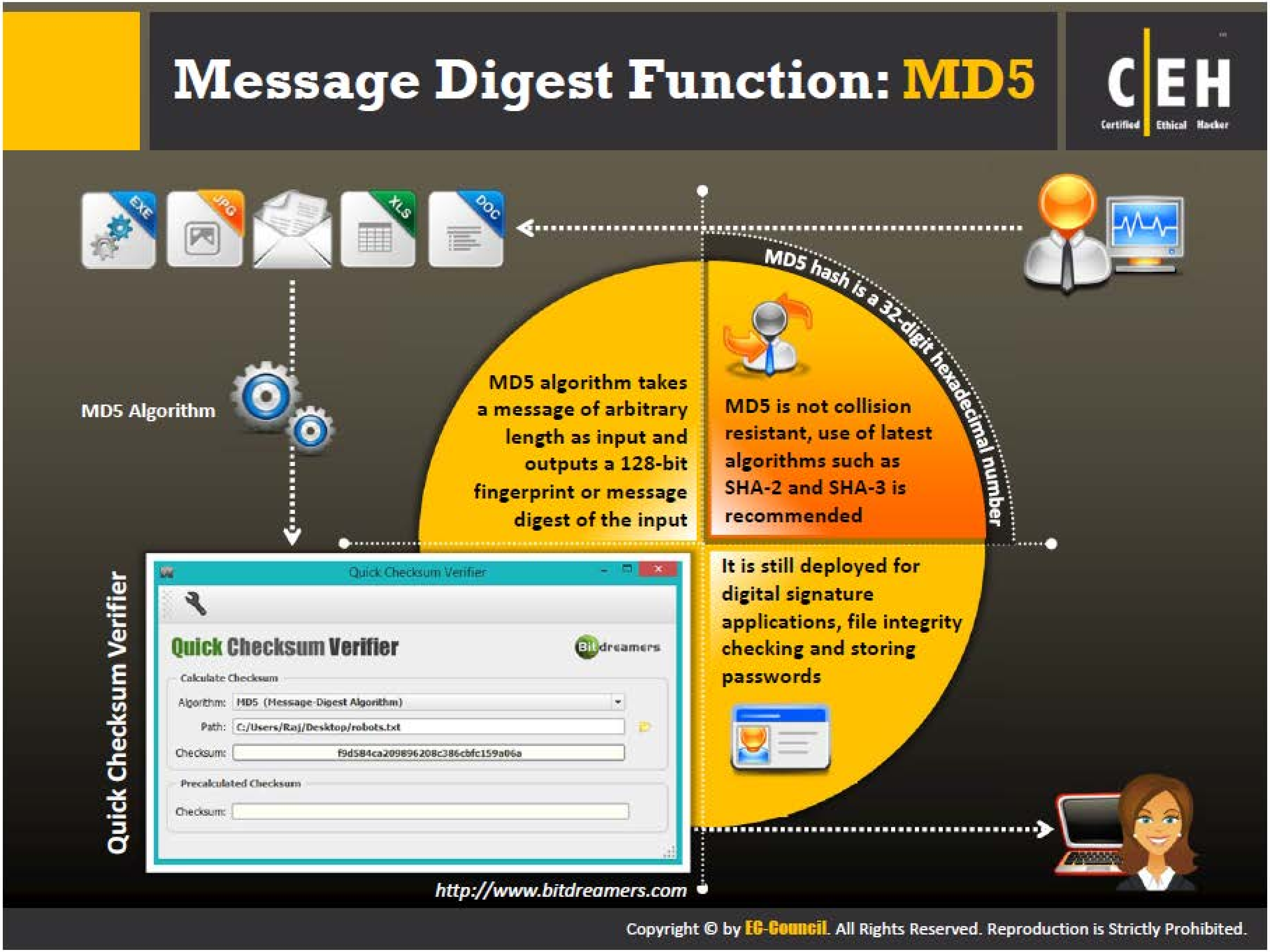
Message Digest (One-way Hash) Functions

Hash functions **calculate a unique fixed-size bit string** representation called a message digest of any arbitrary block of information

If any given bit of the function's input is changed, every output bit has a **50 percent** chance of changing

It is computationally infeasible to have two files with the **same message digest value**

Note: Message digests are also called one-way bash functions because they cannot be reversed


Message Digest Function: MD5
EXE
JPG
XLS
DOC
MD5 Algorithm
MD5 algorithm takes a message of arbitrary length as input and outputs a 128-bit fingerprint or message digest of the input
MD5 hash is a 32-digit hexadecimal number
MD5 is not collision resistant, use of latest algorithms such as SHA-2 and SHA-3 is recommended
It is still deployed for digital signature applications, file integrity checking and storing passwords
Quick Checksum Verifier
Quick Checksum Verifier
Quick Checksum Verifier
Bitdreamers
Calculate Checksum
Algorithm: MD5 (Message-Digest Algorithm)
Path: C:/Users/Raj/Desktop/robots.txt
Checksum: f9d584ca209896208c386cbfc159a06a
Precalculated Checksum
Checksum:
http://www.bitdreamers.com
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Secure Hashing Algorithm (SHA)

It is an algorithm for generating cryptographically secure one-way hash, published by the **National Institute of Standards and Technology** as a **U.S. Federal Information Processing Standard**

SHA1

It produces a **160-bit digest** from a message with a maximum length of **(264 – 1) bits**, and resembles the MD5 algorithm

SHA2

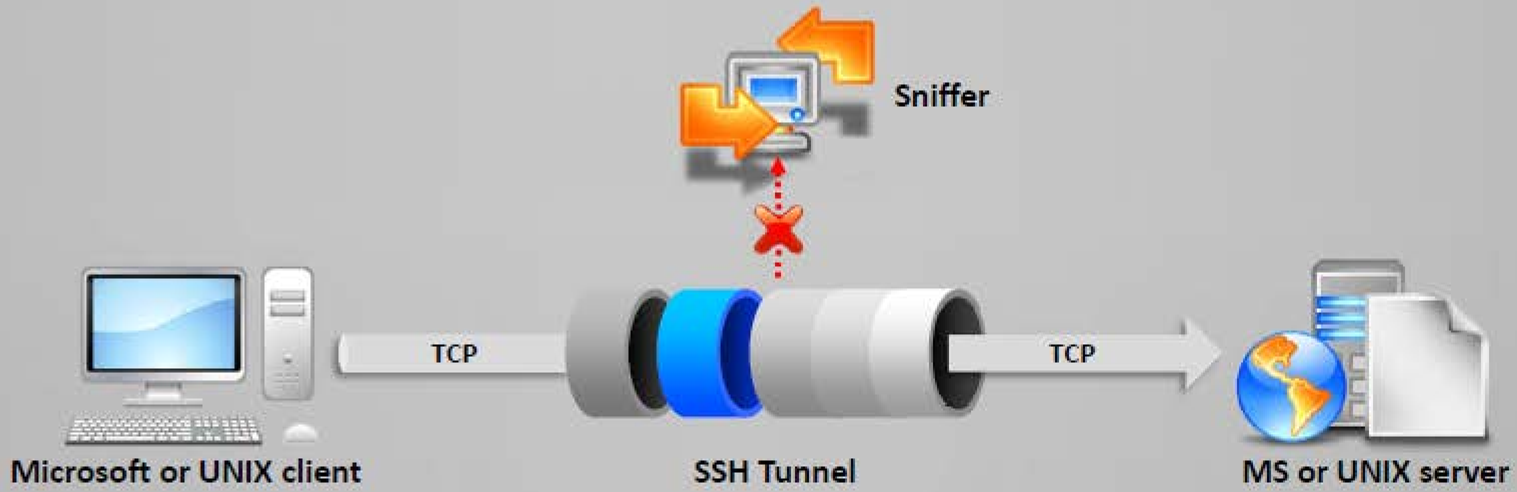
It is a family of two similar hash functions, with different block sizes, namely **SHA-256** that uses **32-bit words** and **SHA-512** that uses **64-bit words**

SHA3

SHA-3 uses the **sponge construction** in which message blocks are **XORed** into the initial bits of the state, which is then invertibly permuted

What is SSH (Secure Shell)?

1. SSH is a secure replacement for **telnet** and the **Berkeley remote-utilities** (rlogin, rsh, rcp, and rdist)
2. It provides an **encrypted channel** for remote logging, command execution and file transfers
3. Provides strong **host-to-host and user authentication**, and secure communication over an insecure Internet



Note: SSH2 is a more secure, efficient, and portable version of SSH that includes SFTP, an SSH2 tunneled FTP

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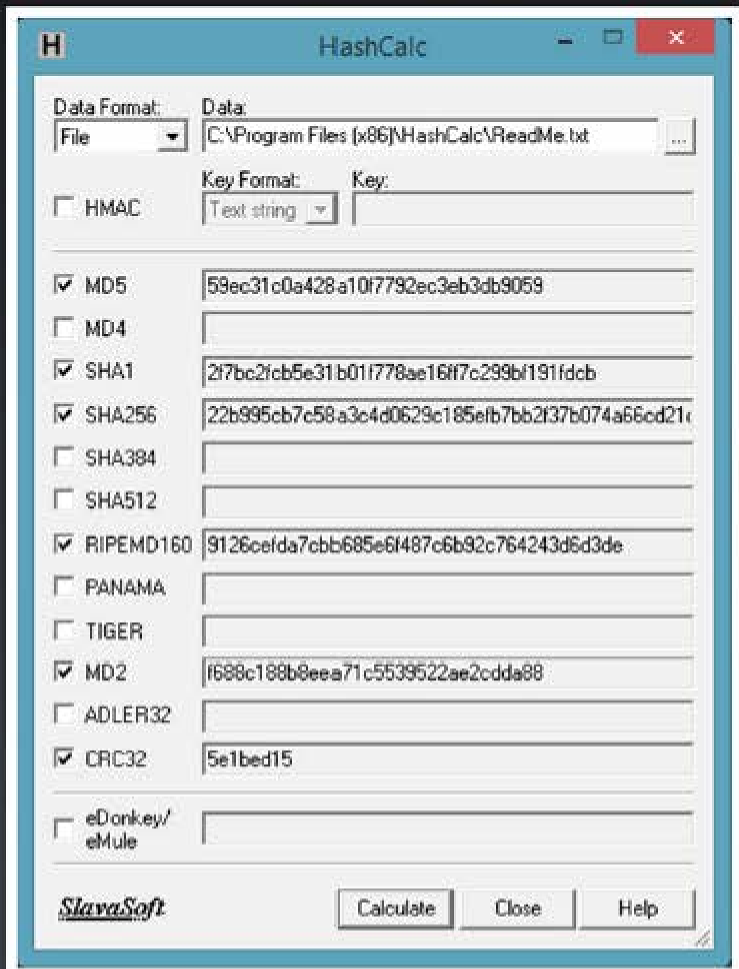
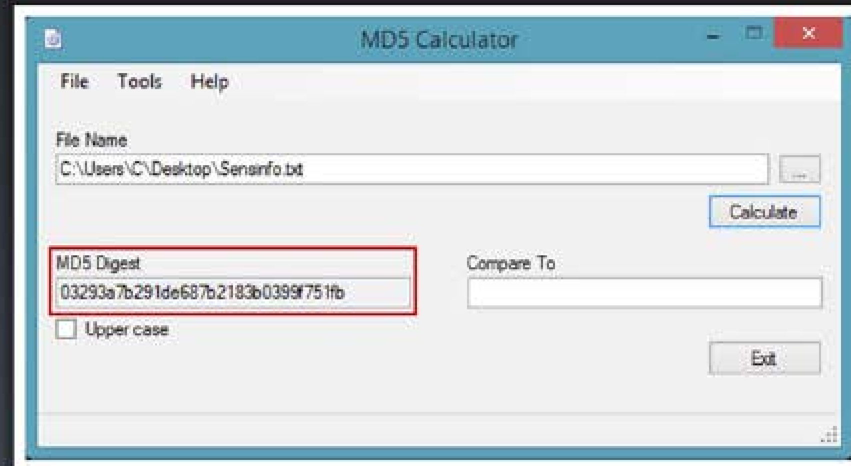
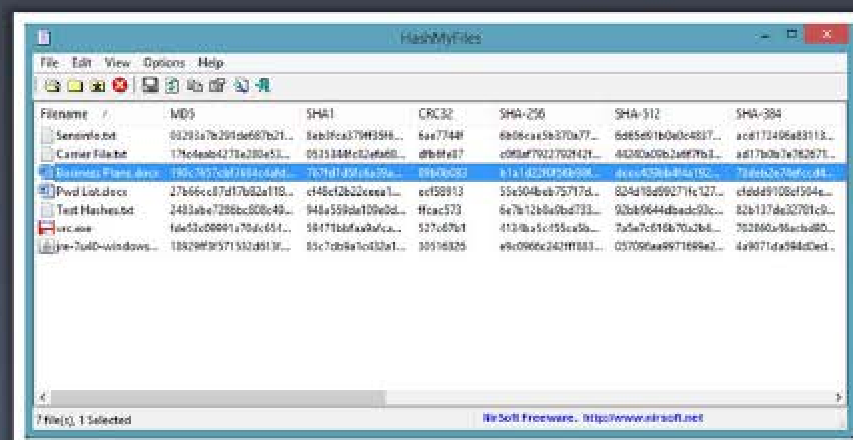
MD5 Hash Calculators: HashCalc, MD5 Calculator and HashMyFiles



http://www.slavasoft.com



http://www.bullzip.com



http://www.nirsoft.net

Hash Calculators for Mobile: MD5 Hash Calculator, Hash Droid, and Hash Calculator

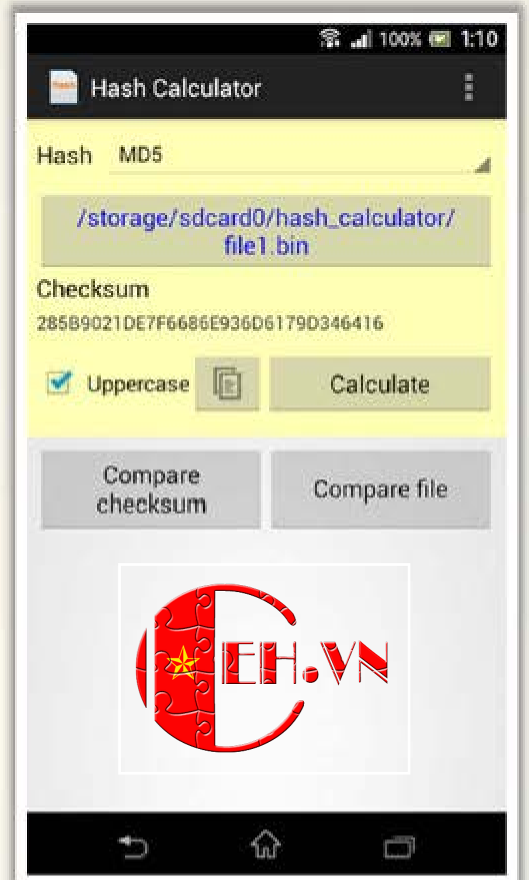
MD5 Hash Calculator

http://md5calculator.chromefans.org

Hash Droid

https://play.google.com

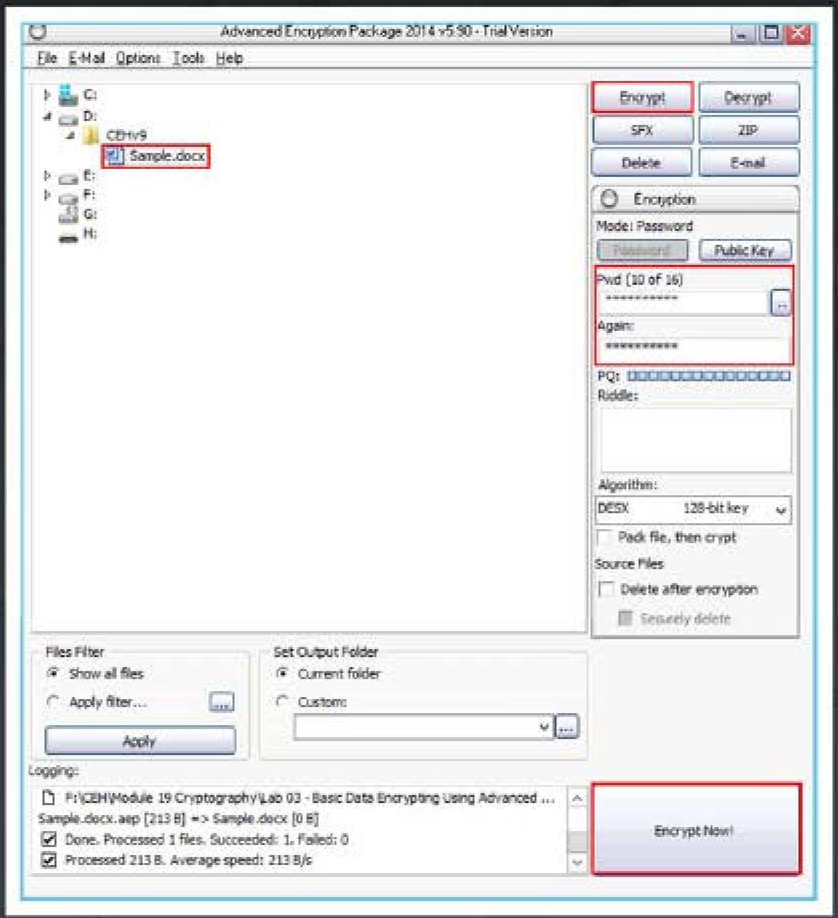
Hash Calculator

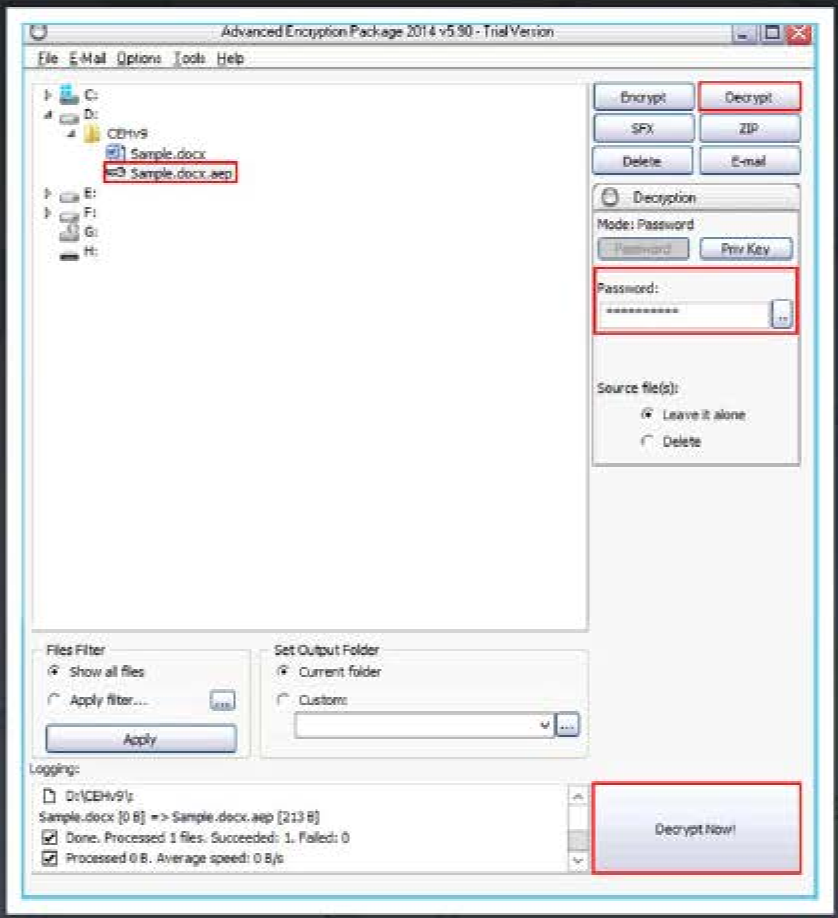


https://play.google.com

Cryptography Tool: Advanced Encryption Package 2014

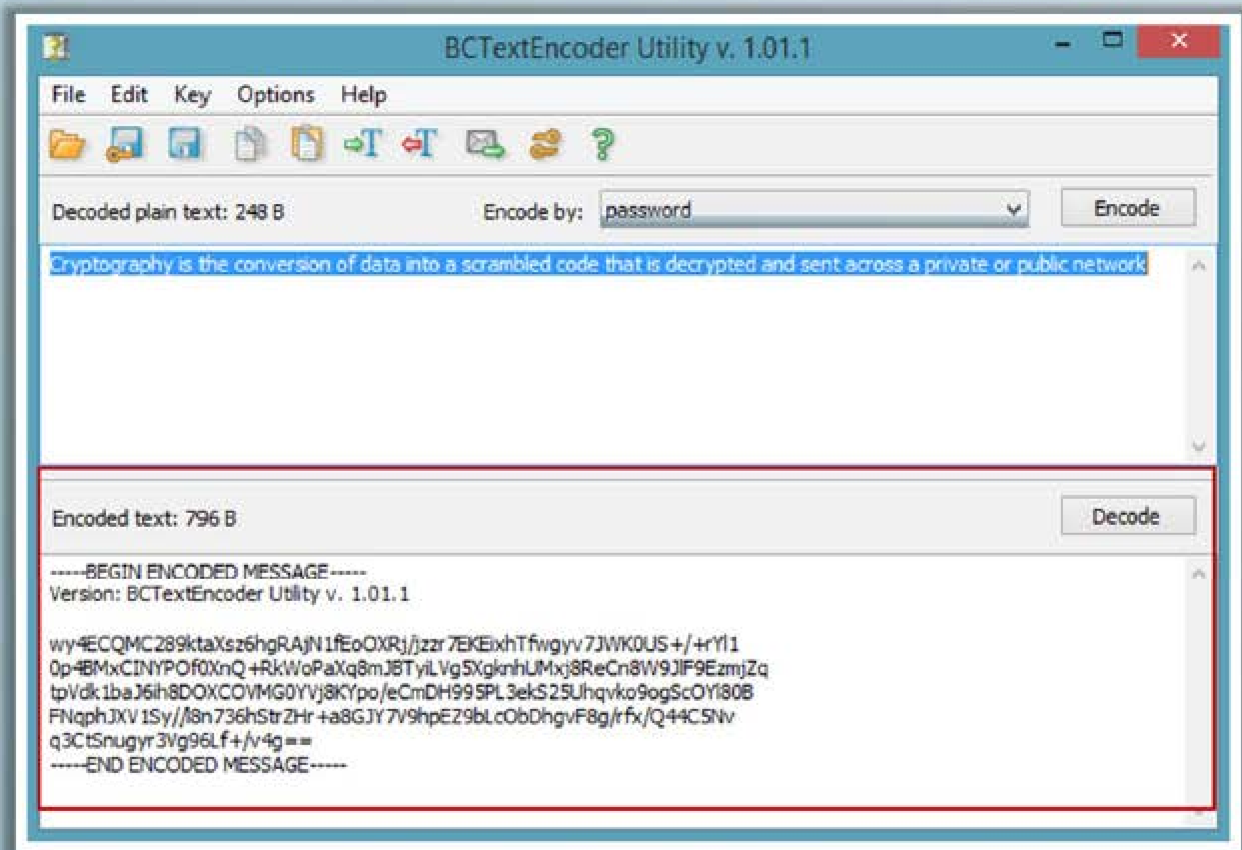
- Advanced Encryption Package 2014 file encryption software supports symmetric and asymmetric encryption





http://www.aeppro.com

Cryptography Tool: BCTextEncoder



http://www.jetico.com

- BCTextEncoder encrypts **confidential text** in your **message**
- It uses strong and approved symmetric and public key algorithms for **data encryption**
- It uses public key encryption methods as well as **password-based encryption**

Cryptography Tools

AutoKrypt
http://www.hiteksoftware.com

Cryptainer LE Free Encryption Software
http://www.cypherix.com

Steganos LockNote
https://www.steganos.com

AxCrypt
http://www.axantum.com

CryptoForge
http://www.cryptoforge.com

NCrypt XL
http://www.littlelite.net

ccrypt
http://ccrypt.sourceforge.net

WinAES
http://fatlyz.com

EncryptOnClick
http://www.2brightsparks.com

GNU Privacy Guard
http://www.gnupg.org

Cryptography Tools for Mobile: Secret Space Encryptor, CryptoSymm, and Cipher Sender

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Secret Space Encryptor

http://www.paranoiaworks.mobi

CryptoSymm

https://play.google.com

Cipher Sender

https://play.google.com

Module Flow

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1. Cryptography Concepts
2. Encryption Algorithms
3. Cryptography Tools
4. **Public Key Infrastructure (PKI)**
5. Email Encryption
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Public Key Infrastructure (PKI)

Public Key Infrastructure (PKI) is a **set of hardware**, **software**, **people**, **policies**, and **procedures** required to create, manage, distribute, use, store, and revoke **digital certificates**

Components of PKI

1. **Certificate Management System**
   Generates, distributes, stores, and verifies certificates

2. **Digital Certificates**
   Establishes credentials of a person when doing online transactions

3. **Validation Authority (VA)**
   Stores certificates (with their public keys)

4. **Certificate Authority (CA)**
   Issues and verifies digital certificates

5. **End User**
   Requests, manages, and uses certificates

6. **Registration Authority (RA)**
   Acts as the verifier for the certificate authority

Public Key Infrastructure (PKI) (Cont'd)

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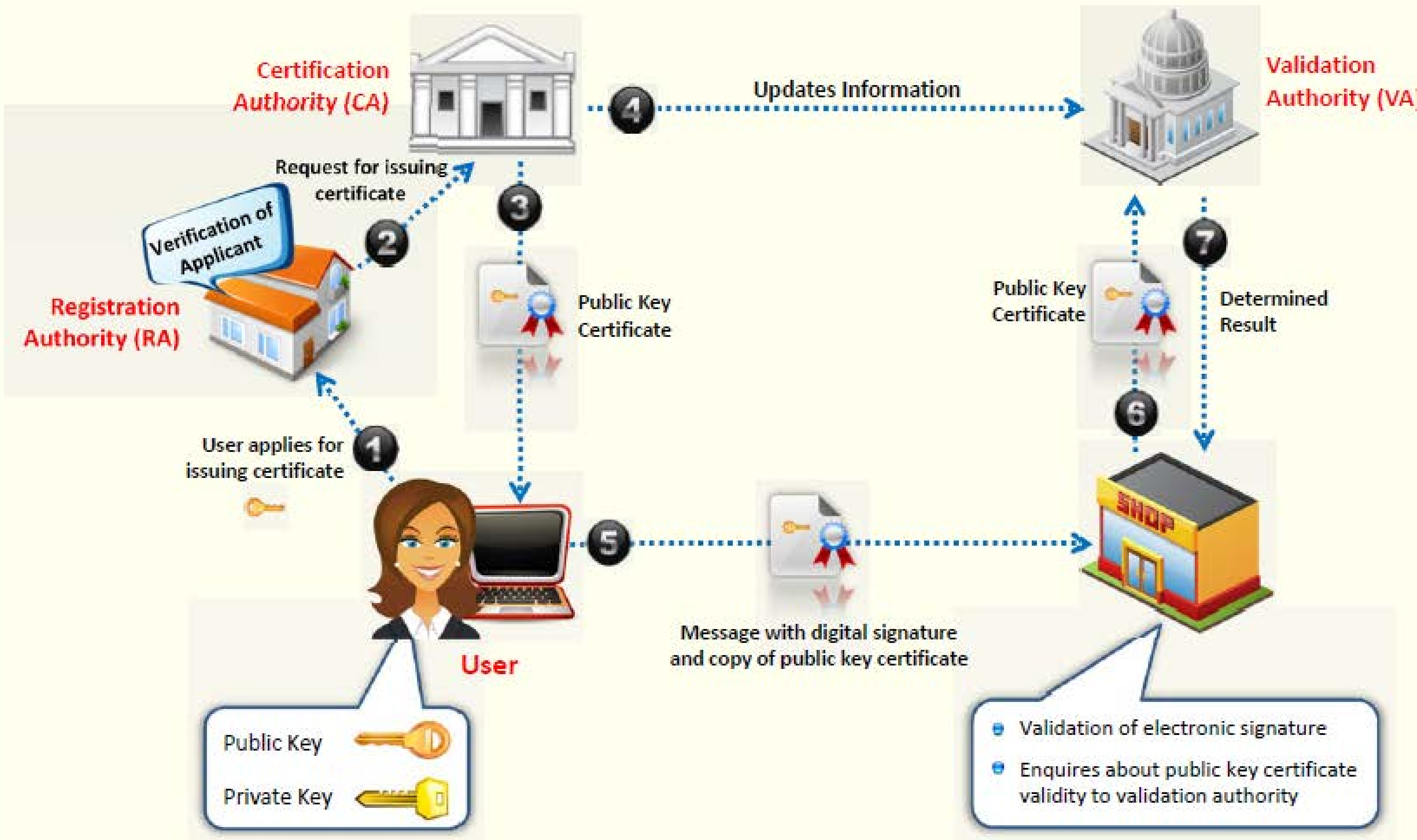
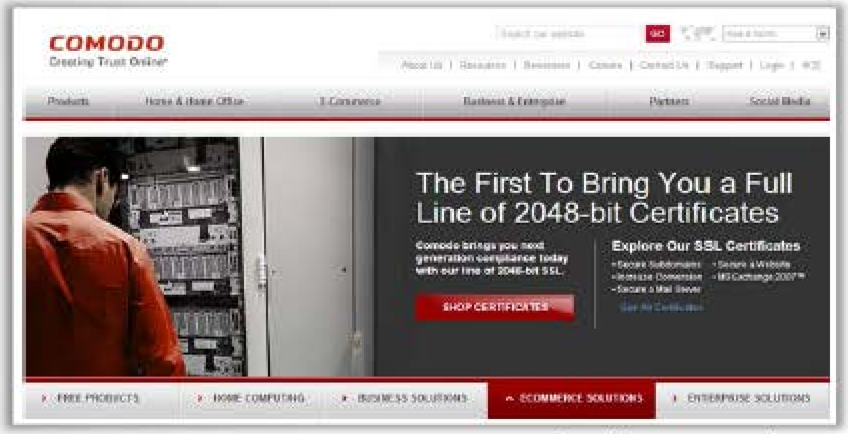
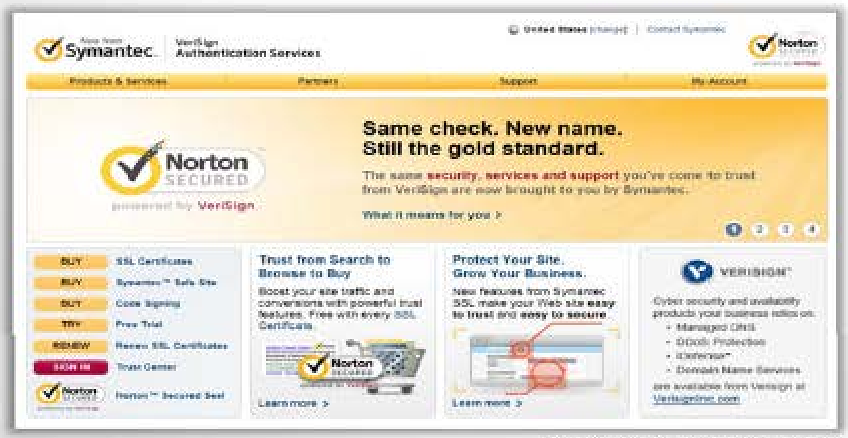


Certification Authorities



http://www.comodo.com

http://www.thawte.com



http://www.symantec.com

http://www.entrust.net

Signed Certificate (CA) Vs. Self Signed Certificate

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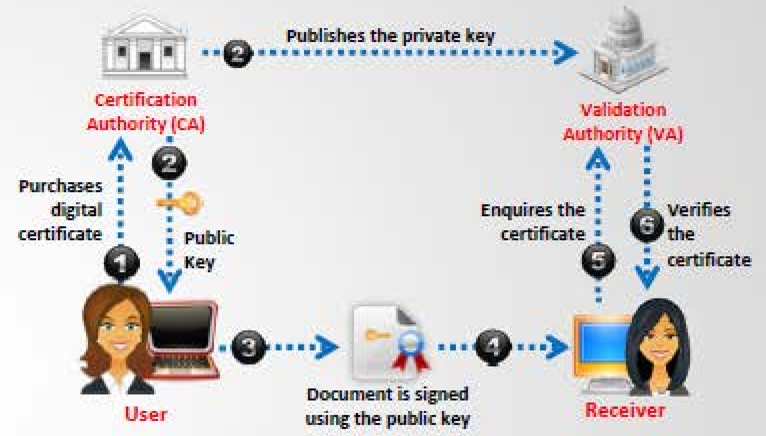
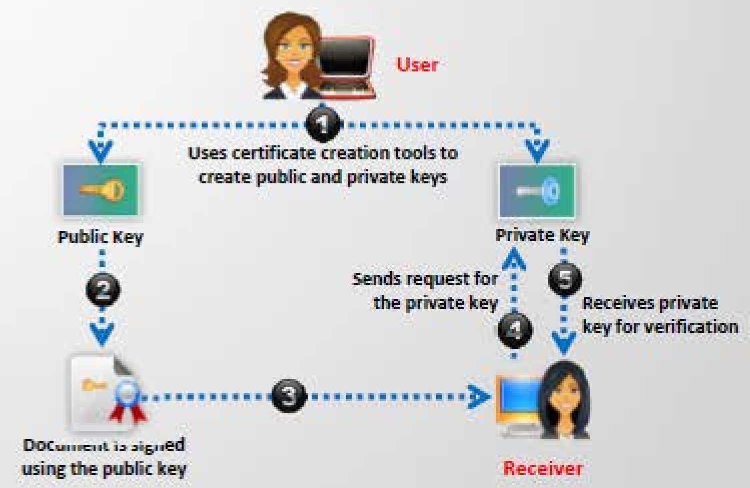
Signed Certificate

- User approaches a trustworthy **Certification Authority** (CA) and purchases digital certificate
- User gets the **public key** from the CA, he signs the document using it
- The signed document is delivered to the receiver
- The receiver can verify the certificate by enquiring in **Validation Authority** (VA)
- VA verifies the certificate to the receiver but it does not **share private key**



Self-signed Certificate

- User creates public and private keys using a tool such as **Adobe Reader**, **Java's keytool**, **Apple's Keychain**, etc.
- User uses public key to **sign the document**
- The **self-signed document** is delivered to the receiver
- The receiver request the user for his **private key**
- User **shares the private key** with the receiver



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Digital Signature

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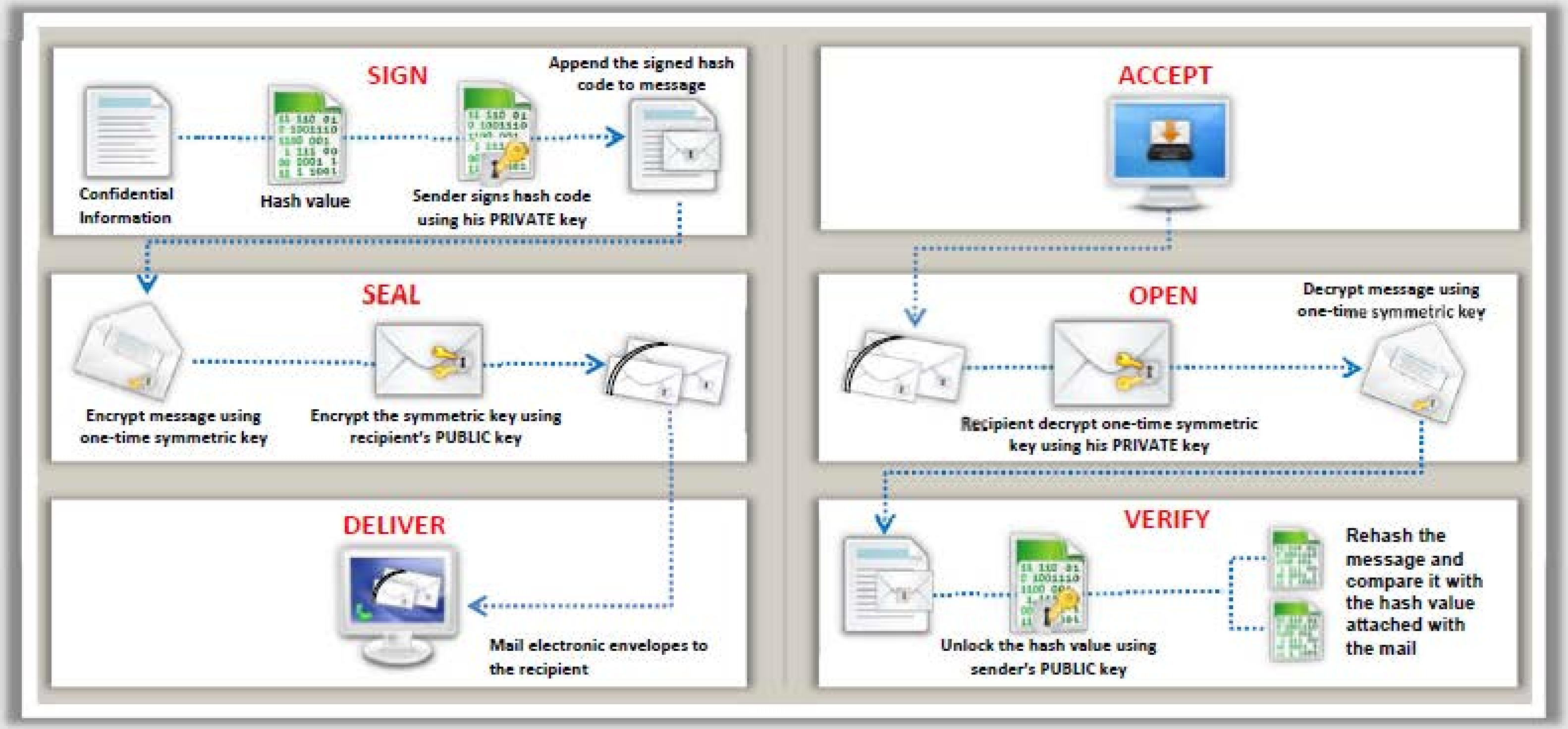
1. Digital signature used asymmetric cryptography to simulate the security properties of a **signature in digital**, **rather than written form**

2. A digital signature may be further protected, by **encrypting the signed email** for confidentiality



SSL (Secure Sockets Layer)

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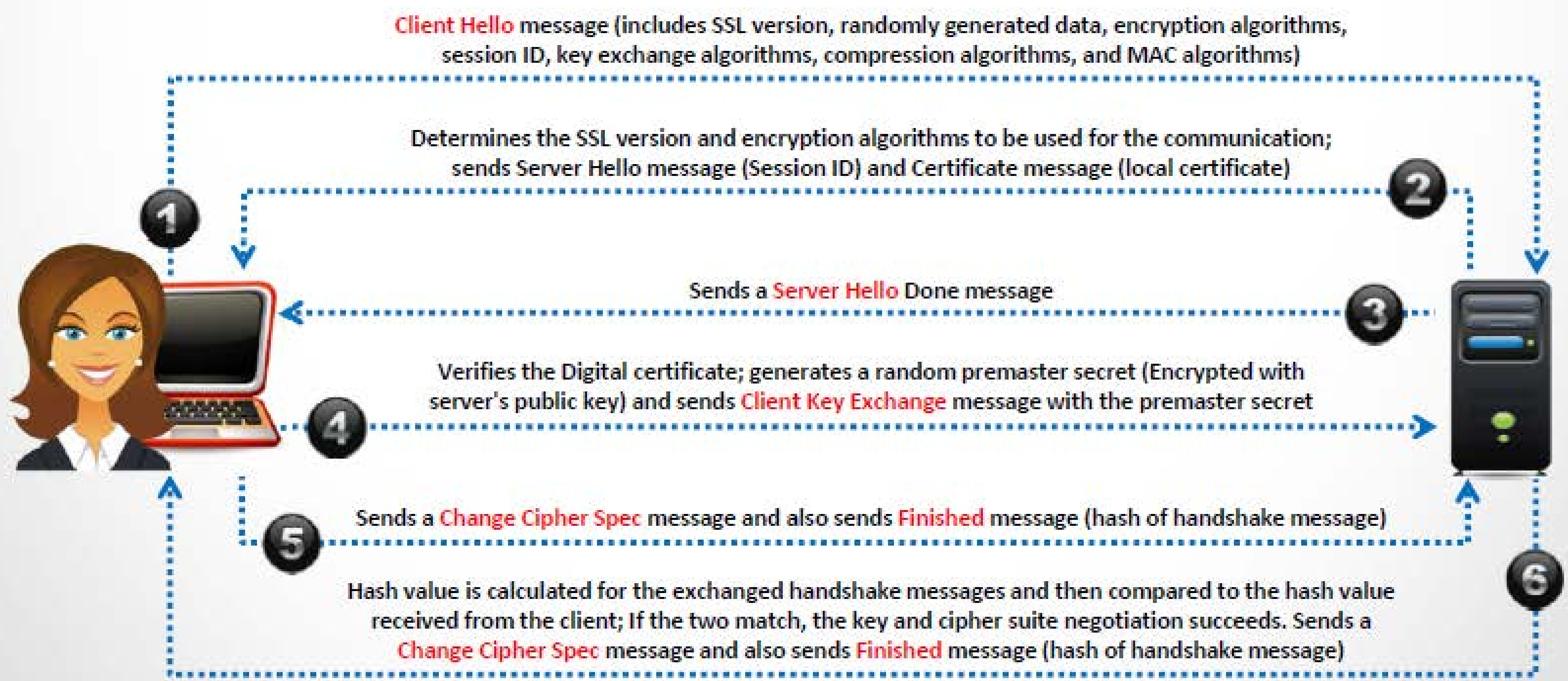
- SSL is an application layer protocol developed by Netscape for **managing the security** of a message transmission on the Internet
- It uses **RSA asymmetric (public key) encryption** to encrypt data transferred over SSL connections



Transport Layer Security (TLS)

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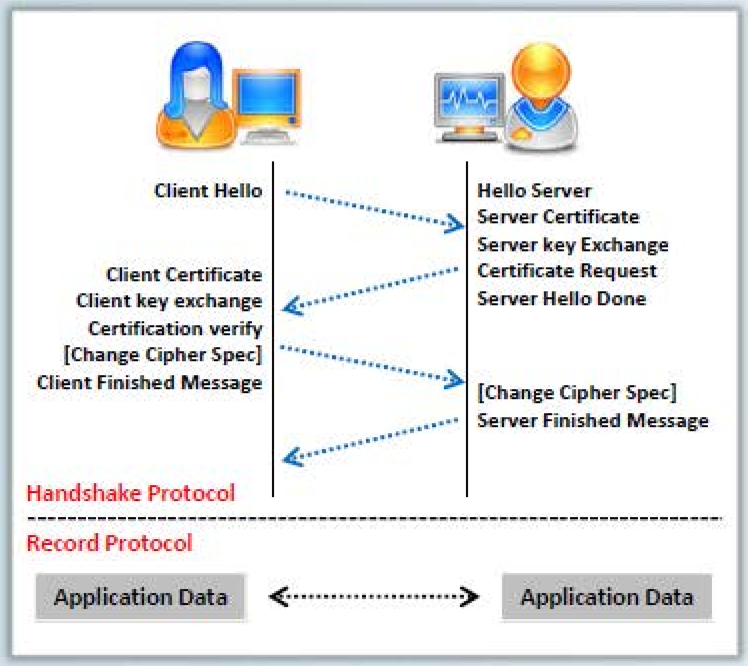
- TLS is a protocol **to establish a secure connection** between a client and a server and ensure privacy and integrity of information during transmission
- It uses the RSA algorithm with 1024 and 2048 bit strengths

TLS Handshake Protocol

It allows the client and server to authenticate each other, select encryption algorithm, and exchange symmetric key prior to data exchange

TLS Record Protocol

It provides secured connections with an encryption method such as Data Encryption Standard (DES)

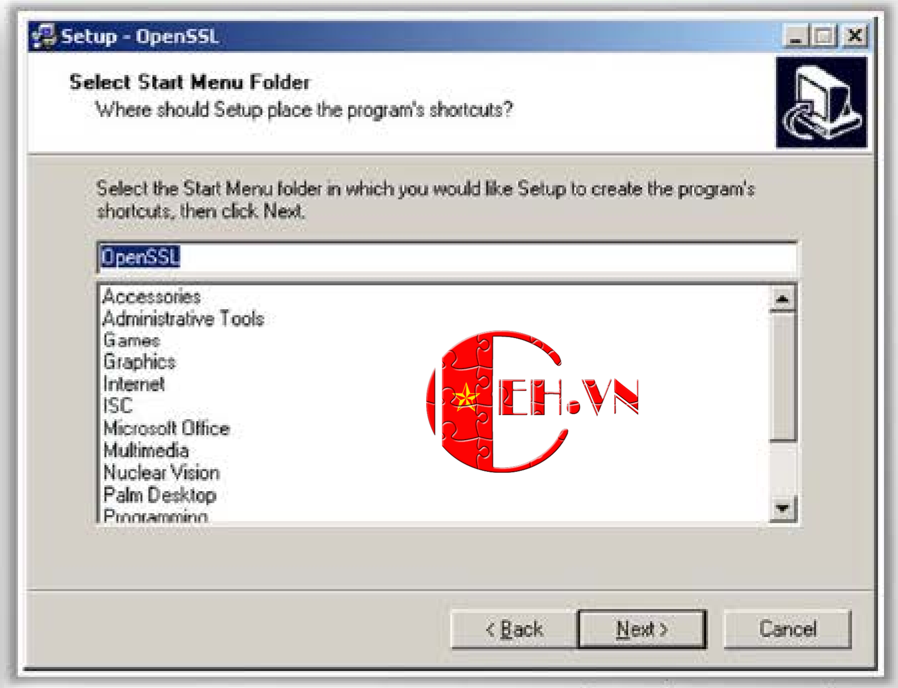


Cryptography Toolkit: OpenSSL

- OpenSSL is an open source cryptography toolkit implementing the **Secure Sockets Layer (SSL v2/v3)** and **Transport Layer Security (TLS v1)** network protocols and related cryptography standards required by them
- The openssl program is a command line tool for using the various **cryptography functions** of OpenSSL's crypto library from the shell

OpenSSL can be used for:

- Creation and management of private keys, public keys and parameters
- Public key cryptographic operations
- Creation of X.509 certificates, CSRs and CRLs
- Calculation of Message Digests
- Encryption and Decryption with Ciphers
- SSL/TLS Client and Server Tests
- Handling of S/MIME signed or encrypted mail
- Time Stamp requests, generation and verification



https://www.openssl.org

Cryptography Toolkit: Keyczar

- Keyczar is an open source cryptographic toolkit designed to make it easier and safer for developers to use **cryptography in their applications**
- It **supports authentication** and **encryption** with both symmetric and asymmetric keys

http://www.keyczar.org

Features

- Key rotation and versioning
- Safe default algorithms, modes, and key lengths
- Automated generation of initialization vectors and ciphertext signatures
- Java, Python, and C++ implementations
- International support in Java

Pretty Good Privacy (PGP)

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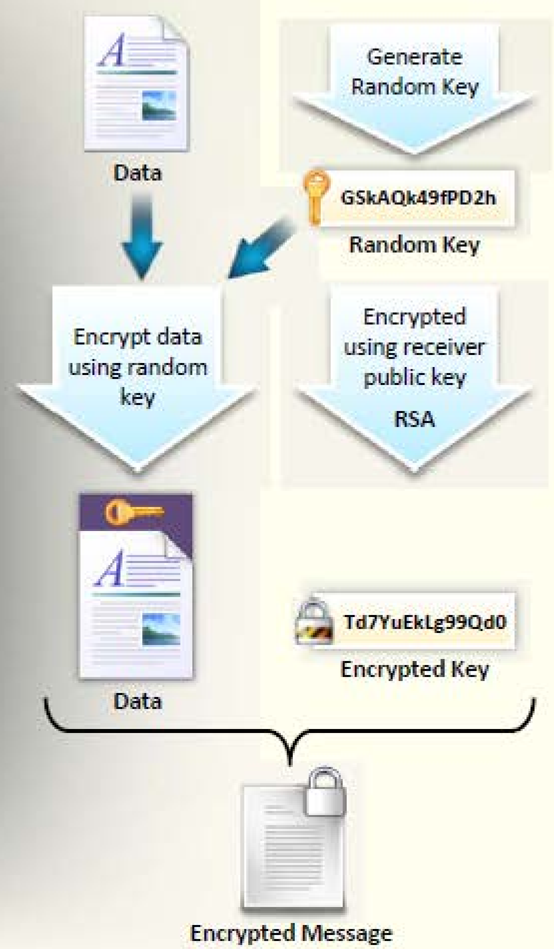
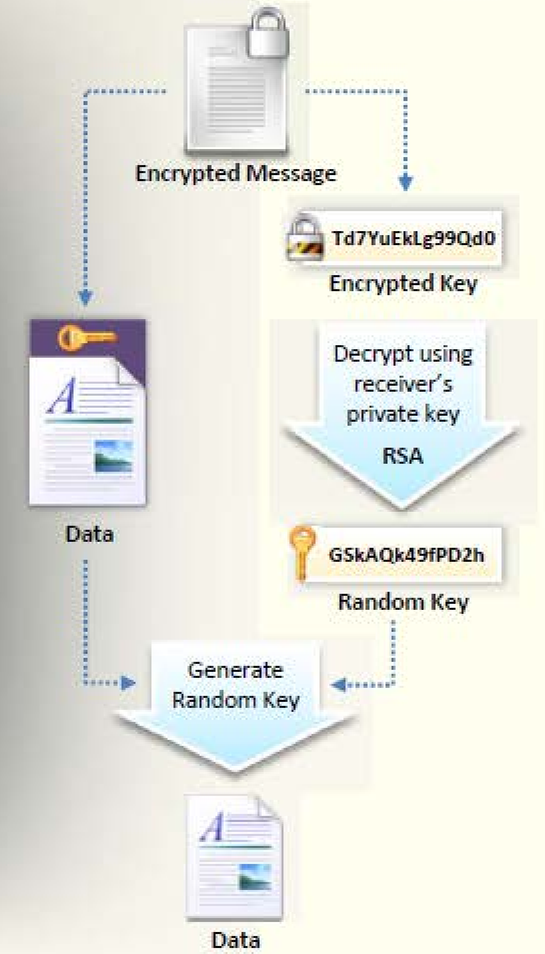
Pretty Good Privacy

- PGP (Pretty Good Privacy) is a protocol used to **encrypt** and **decrypt** data that provides **authentication** and **cryptographic privacy**
- PGP is often used for data **compression**, **digital signing**, encryption and decryption of **messages**, **emails**, **files**, **directories**, and to enhance privacy of email communications
- PGP combines the best features of both **conventional** and **public key cryptography** and is therefore known as **hybrid cryptosystem**

PGP Encryption



PGP Decryption



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Disk Encryption

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01 Confidentiality

Disk encryption protects **confidentiality of the data** stored on disk by converting it into an unreadable code using disk encryption software or hardware

- Privacy
- Passphrase
- Hidden Volumes

02 Encryption

Disk encryption works in a similar way as **text message encryption** and protects data even when the OS not active

- Volume Encryption

03 Protection

With the use of an encryption program for your disk, you can **safeguard any information** to burn onto the disk, and keep it from falling into the wrong hands

- Blue Ray
- DVD
- Backup

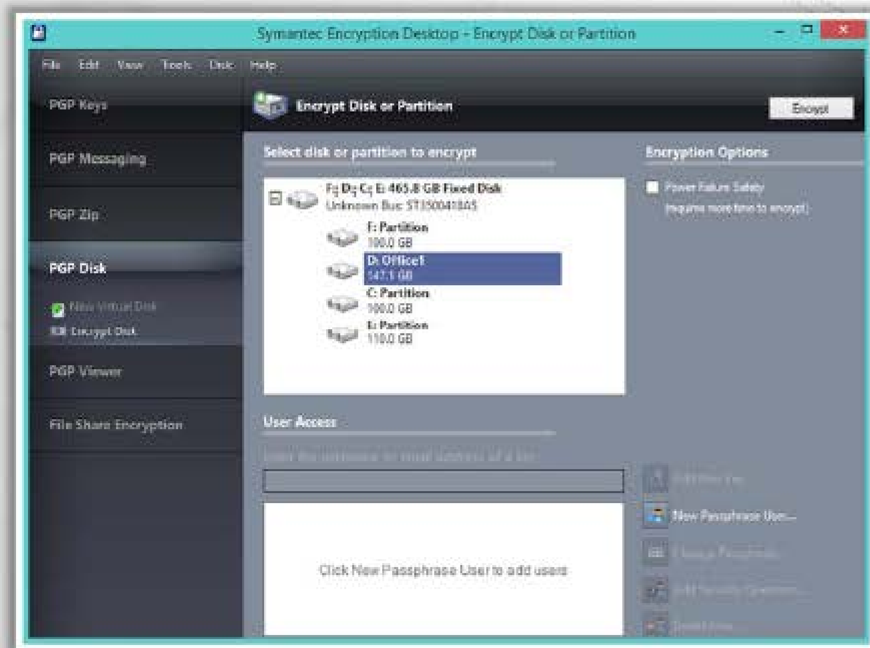
Disk Encryption Tools: Symantec Drive Encryption and GiliSoft Full Disk Encryption

Symantec Drive Encryption

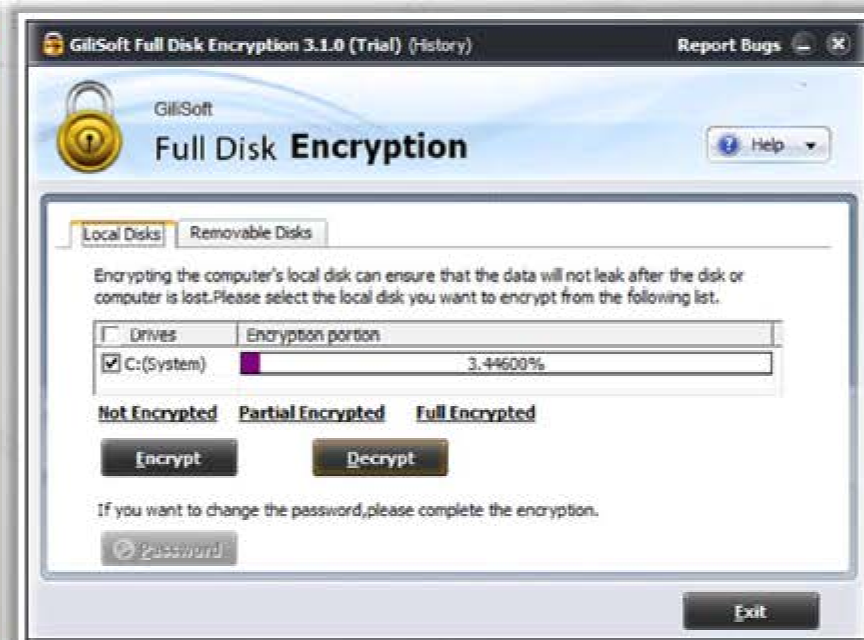
- Symantec Drive Encryption provides **full disk encryption** for all data (user files, swap files, system files, hidden files, etc.) on desktops, laptops, and removable media
- It protects data from **unauthorized access**

GiliSoft Full Disk Encryption

- GiliSoft Full Disk Encryption's offers encryption of all **disk partitions**, including the system partition
- It **provides automatic security** for all information on endpoint hard drives, including user data, operating system files and temporary and erased files



http://www.symantec.com



http://www.gilisoft.com

Disk Encryption Tools

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DriveCrypt
http://www.securstar.com

ShareCrypt
http://www.securstar.com

PocketCrypt
http://www.securstar.com

Rohos Disk Encryption
http://www.rohos.com

R-Crypto
http://www.r-tt.com

east-tec SafeBit
http://www.east-tec.com

DiskCryptor
http://diskcryptor.net

alertsec
http://www.alertsec.com

Cryptainer LE
http://www.cypherix.com

DriveCrypt Plus Pack
http://www.securstar.com

Module Flow

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1. Cryptography Concepts
2. Encryption Algorithms
3. Cryptography Tools
4. Public Key Infrastructure (PKI)
5. Email Encryption
6. Disk Encryption
7. **Cryptography Attacks**
8. Cryptanalysis Tools

Cryptography Attacks

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- Cryptography attacks are based on the assumption that the cryptanalyst has access to the **encrypted information**

- Ciphertext-only attack
- Known-plaintext attack
- Chosen-plaintext
- Chosen - ciphertext attack
- Chosen-key attack
- Adaptive chosen-plaintext attack
- Timing attack
- Rubber hose attack

Cryptography Attacks (Cont'd)

Ciphertext-only Attack

Attacker has access to the cipher text; goal of this attack to **recover encryption key** from the ciphertext

Adaptive Chosen-plaintext Attack

Attacker makes a **series of interactive queries**, choosing subsequent plaintexts based on the information from the previous encryptions

Chosen-plaintext Attack

Attacker **defines his own plaintext**, feeds it into the cipher, and analyzes the resulting ciphertext

Known-plaintext Attack

Attacker has **knowledge of some part of the plain text**; using this information the key used to generate ciphertext is deduced so as to decipher other messages

Cryptography Attacks (Cont'd)

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Chosen-ciphertext Attack

Attacker obtains the plaintexts corresponding to an **arbitrary set** of ciphertexts of his own choosing

Rubber Hose Attack

Extraction of cryptographic secrets (e.g. the password to an encrypted file) from a person by **coercion or torture**

Chosen-key Attack

A **generalization** of the chosen-text attack

Timing Attack

It is based on repeatedly measuring the **exact execution times** of modular exponentiation operations

Code Breaking Methodologies

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Trickery and Deceit

It involves the use of social engineering techniques to extract cryptography keys

Brute-Force

Cryptography keys are discovered by trying every possible combination

One-Time Pad

A one-time pad contains many non-repeating groups of letters or number keys, which are chosen randomly

Frequency Analysis

- It is the study of the frequency of letters or groups of letters in a ciphertext
- It works on the fact that, in any given stretch of written language, certain letters and combinations of letters occur with varying frequencies

Brute-Force Attack

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Attack Scheme

Defeating a cryptographic scheme by **trying a large number of possible keys** until the correct encryption key is discovered

Brute-Force Attack

Brute-force attack is a **high resource and time intensive process**, however, more certain to achieve results

Success Factors

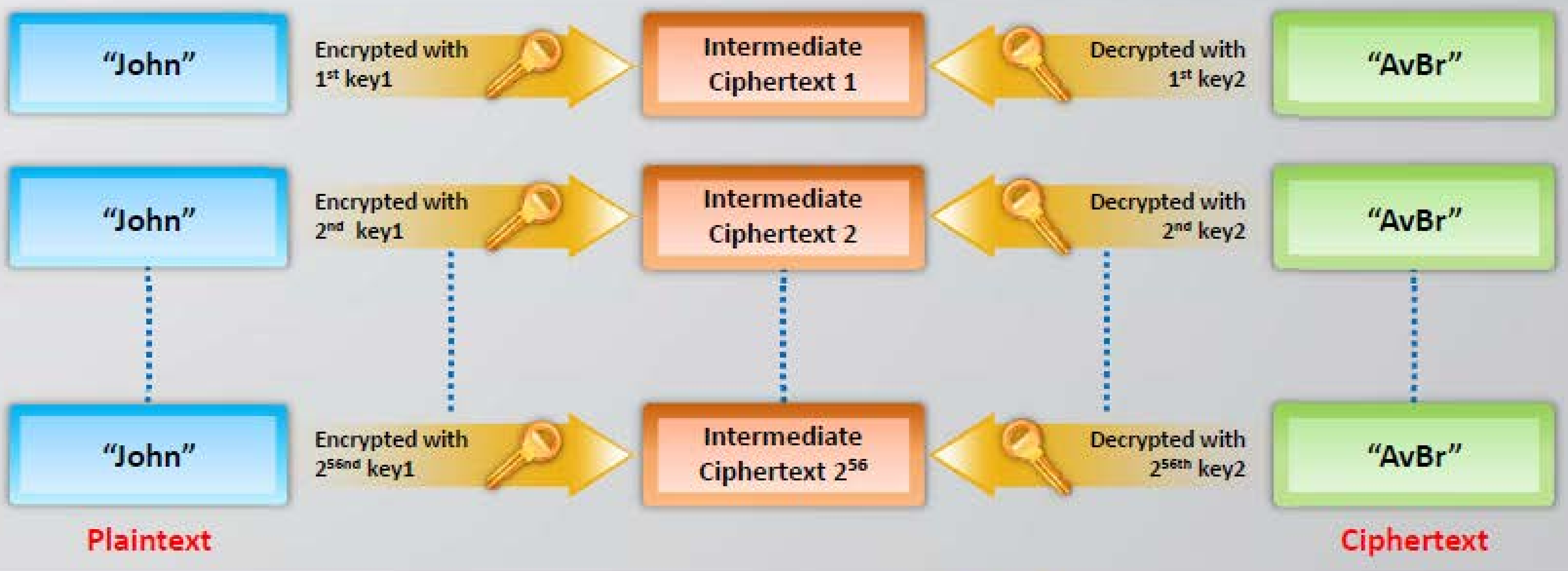
Success of brute force attack depends on **length of the key**, **time constraint**, and **system security mechanisms**

Power/Cost	40 bits (5 char)	56 bit (7 char)	64 bit (8 char)	128 bit (16 char)
$ 2K (1 PC. Can be achieved by an individual)	1.4 min	73 days	50 years	10^20 years
$ 100K (this can be achieved by a company)	2 sec	35 hours	1 year	10^19 years
$ 1M (Achieved by a huge organization or a state)	0.2 sec	3.5 hours	37 days	10^18 years

Estimate Time for Successful Brute-force Attack

Meet-in-the-Middle Attack on Digital Signature Schemes

- The attack works by **encrypting from one** end and **decrypting from the other end**, thus meeting in the middle
- It can be used for **forging signatures** even on digital signatures that use multiple-encryption scheme



Side Channel Attack

01 Side channel attack is a **physical attack** performed on a cryptographic device/ cryptosystem to gain sensitive information

02 Cryptography is generally **implemented in hardware or software** which runs on physical devices such as semi-conductors

03 These semi-conductor devices include **resistor**, **transistor** and so on

04 These physical devices are affected by various **environmental factors** that include: power consumption, electro-magnetic field, light emission, timing and delay, and sound

05 In Side Channel attack, an attacker **monitors these channels (environmental factors)** and try to acquire the information useful for cryptanalysis

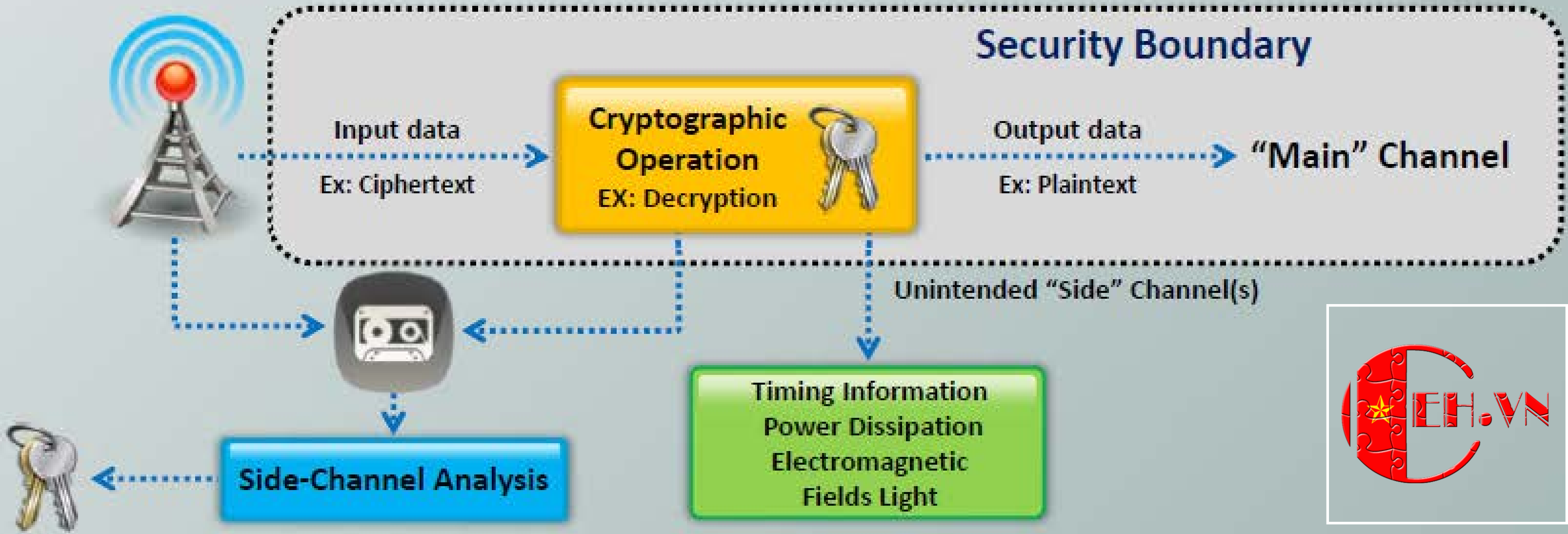
06 The information collected in this process is termed as **side channel information**

07 Side Channel Attacks (SCA) are **no way related to traditional/ theoretical form of attacks** like brute force attack

08 The concept of SCA is **based on the way, the cryptographic algorithms are implemented**, rather than at the algorithm itself

Side Channel Attack - Scenario

- Assume that an encrypted data is to be decrypted and displayed a plain text, inside a **trusted zone**
- At the time of decryption in a cryptosystem, **physical environmental factors** such as timing, power dissipation etc., acting on the components of a computer are recorded by an attacker
- The attacker analyzes this information in an attempt **to gain useful information** for cryptanalysis



Module Flow

C|EH Certified Ethical Hacker

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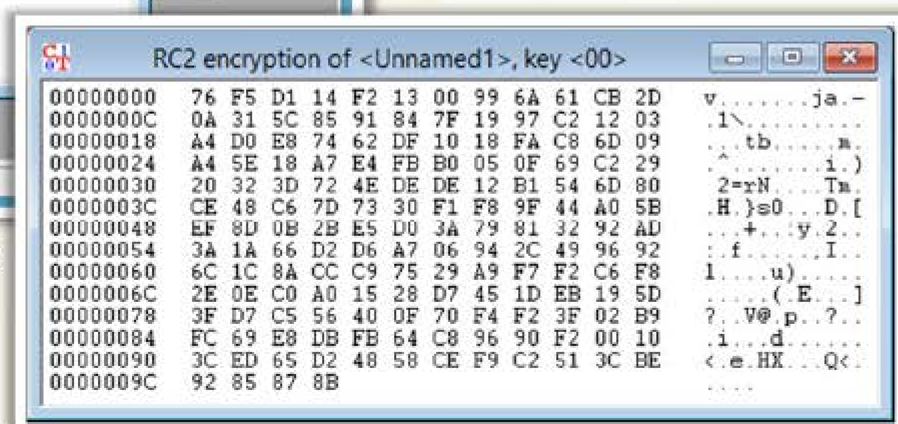
Cryptanalysis Tool: CrypTool

- CrypTool is a free e-learning program in the area of **cryptography** and **cryptoanalysis**
- Subprojects of CrypTool:
  - CrypTool 1 (CT1)
  - CrypTool 2 (CT2)
  - JCrypTool (JCT)
  - CrypTool-Online (CTO)



http://www.cryptool.org

CRYPTOOL Cryptography for everybody

Cryptanalysis Tools

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CryptoBench
http://www.addario.org

AlphaPeeler
http://alphapeeler.sourceforge.net

Jipher
http://cipher.org.uk

Draft Crypto Analyzer
http://www.literatecode.com

Ganzúa
http://ganzua.sourceforge.net

Linear Hull Cryptanalysis of PRESENT
http://www.ecrypt.eu.org

Crank
http://crank.sourceforge.net

mediggo
http://code.google.com

EverCrack
http://evercrack.sourceforge.net

SubCypher
http://www.esclepiusllc.com

Online MD5 Decryption Tools

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MD5 Decrypt *http://www.md5decrypt.org*	**OnlineHashCrack.com** *http://www.onlinehashcrack.com*
MD5Cracker *http://md5crack.com*	**HashKiller.co.uk** *http://www.hashkiller.co.uk*
MD5 Decrypter *http://www.md5online.org*	**Md5.My-Addr.com** *http://md5.my-addr.com*
Hash Cracker *http://www.hash-cracker.com*	**cmd5.org** *http://www.cmd5.org*
MD5Decrypter *http://www.md5decrypter.com*	**CrackStation** *https://crackstation.net*

Module Summary

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- Cryptography is the conversion of data into a scrambled code that is decrypted and sent across a private or public network
- Symmetric encryption uses the same key for encryption as it does for decryption and asymmetric encryption uses different encryption keys for encryption and decryption
- Ciphers are algorithms used to encrypt or decrypt the data
- Hash functions calculate a unique fixed-size bit string representation called a message digest of any arbitrary block of information
- Public Key Infrastructure (PKI) is a set of hardware, software, people, policies, and procedures required to create, manage, distribute, use, store, and revoke digital certificates
- Digital signature used asymmetric cryptography to simulate the security properties of a signature in digital, rather than written form
- Disk encryption protects confidentiality of the data stored on disk by converting it into an unreadable code using disk encryption software or hardware
- Cryptography attacks are based on the assumption that the cryptanalyst has access to the encrypted information