Field	Information
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Desc	This notebook is to solve the third part of lab1

Task3: Partial Known Plain-Text Analysis

Problem Analysis:

- We are solving a partial known plain-text analysis problem
- this means that we know parts of the ciphertext, and its corresponding plaintext
- This should allow us to have a hint about the used key, or to fully compromise the key.
- know lets analyse the given sentences in order to be able to get as much information as we can.

Description analysis:

- we are using 96-Bit-long XOR Key
  - this indicates the length of the used key (96bit = 12 bytes), and the encryption algorithm(XOR)
- The Compression was done with the defaults options using linux zip command-line-tool (version 3.0)
  - now we can have common headers and common algorithm lets search about it and understand how it works then continue
  - I found that it uses constant algorithm called " **Deflate**" for compression, and the output will always start with consistent header which is (50 48 30 04)
  - so this is why our problem is partial known plaintext, because we know this header.
- The file contains no comments:
  - This simplifies the structure of the file, so the analysis should be easier.
- The task may not be solved in one iteration. Assuming a part of the key is known only, you can use zeroes for the missing bytes of the key. So if, for example, you are sure the last two bytes are 0xFF 0xFF, then the key 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0xFF 0xFFmaybeusedinafirst iteration. Think about why this fact is important for your analysis
  - This indicates that we can apply many iterations in order to reach the solution

What I am thinking about

- now we have the header and its corresponding result, so we can try to apply brute force maybe on the remaining parts of the key, to be ablr to get the key

RealTime Trails Screenshots

- Here when printing the header of two different zip files, we got the same begining of the header which is "**504b 0304**"
-

```
root@kali:~/Desktop# xxd file1.zip | head
00000000: 504b 0304 1400 0000 0800 73b2 8e4a a24e  PK........s..J.N
00000010: 8bc5 3b00 0000 4d00 0000 0400 1c00 686f  ..;...M.......ho
00000020: 7374 5554 0900 03a1 fdf0 580d 26f6 5a75  stUT......X.&.Zu
00000030: 780b 0001 0400 0000 0004 0000 0000 e3e2  x...............
00000040: 3234 d003 4143 2305 0503 0b2b 0303 2b23  24..AC#....+..+#
00000050: 732b 3363 2b53 032b 8364 85f0 ccbc 94fc  s+3c+S.+.d......
00000060: f262 4e05 b832 6324 65c6 8e56 4646 4095  .bN..2c$e..VFF@.
00000070: 0ace a979 25f9 c55c 0050 4b01 021e 0314  ...y%..\.PK.....
00000080: 0000 0008 0073 b28e 4aa2 4e8b c53b 0000  .....s..J.N..;..
00000090: 004d 0000 0004 0018 0000 0000 0001 0000  .M..............
```

```
root@kali:~/Desktop# xxd filew.zip | head
xxd: filew.zip: No such file or directory
root@kali:~/Desktop# xxd file2.zip | head
00000000: 504b 0304 0a00 0000 0000 d418 6b59 9306  PK..........kY..
00000010: d732 0100 0000 0100 0000 0f00 1c00 7079  .2............py
00000020: 7468 6f6e 5363 7269 7074 2e70 7955 5409  thonScript.pyUT.
00000030: 0003 6727 3167 4327 3167 7578 0b00 0104  ..g'1gC'1gux....
00000040: 0000 0000 0400 0000 000a 504b 0102 1e03  ..........PK....
00000050: 0a00 0000 0000 d418 6b59 9306 d732 0100  ........kY...2..
00000060: 0000 0100 0000 0f00 1800 0000 0000 0100  ................
00000070: 0000 a481 0000 0000 7079 7468 6f6e 5363  ........pythonSc
00000080: 7269 7074 2e70 7955 5405 0003 6727 3167  ript.pyUT...g'1g
00000090: 7578 0b00 0104 0000 0000 0400 0000 0050  ux.............P
root@kali:~/Desktop# S
```

- **and when I print the version of the used zip, I found it is also version 3, as stated in the problem description:**
-

```
root@kali:~/Desktop# zip -v
Copyright (c) 1990-2008 Info-ZIP - Type 'zip "-L"' for software license.
This is Zip 3.0 (July 5th 2008), by Info-ZIP.
Currently maintained by E. Gordon.  Please send bug reports to
the authors using the web page at www.info-zip.org; see README for detai

Latest sources and executables are at ftp://ftp.info-zip.org/pub/infozip
as of above date; see http://www.info-zip.org/ for other sites.

Compiled with gcc 5.2.1 20150808 for Unix (Linux ELF).

Zip special compilation options:
        USE_EF_UT_TIME       (store Universal Time)
        BZIP2_SUPPORT        (bzip2 library version 1.0.6, 6-Sept-2010)
            bzip2 code and library copyright (c) Julian R Seward
```

- **now when I tried to print the body of different files after zipping them, I got different results:**
-

```
root@kali:~/Desktop# xxd file1.zip | tail
00000040: 3234 d003 4143 2305 0503 0b2b 0303 2b23  24..AC#....+..+#
00000050: 732b 3363 2b53 032b 8364 85f0 ccbc 94fc  s+3c+S.+.d......
00000060: f262 4e05 b832 6324 65c6 8e56 4646 4095  .bN..2c$e..VFF@.
00000070: 0ace a979 25f9 c55c 0050 4b01 021e 0314  ...y%..\.PK.....
00000080: 0000 0008 0073 b28e 4aa2 4e8b c53b 0000  .....s..J.N..;..
00000090: 004d 0000 0004 0018 0000 0000 0001 0000  .M..............
000000a0: 00a4 8100 0000 0068 6f73 7455 5405 0003  .......hostUT...
000000b0: a1fd f058 7578 0b00 0104 0000 0000 0400  ...Xux..........
000000c0: 0000 0050 4b05 0600 0000 0001 0001 004a  ...PK.........J
000000d0: 0000 0079 0000 0000 00                   ...y.....
root@kali:~/Desktop# xxd file2.zip | tail
00000020: 7468 6f6e 5363 7269 7074 2e70 7955 5409  thonScript.pyUT.
00000030: 0003 6727 3167 4327 3167 7578 0b00 0104  ..g'1gC'1gux....
00000040: 0000 0000 0400 0000 000a 504b 0102 1e03  ..........PK....
00000050: 0a00 0000 0000 d418 6b59 9306 d732 0100  ........kY...2..
00000060: 0000 0100 0000 0f00 1800 0000 0000 0100  ................
00000070: 0000 a481 0000 0000 7079 7468 6f6e 5363  ........pythonSc
00000080: 7269 7074 2e70 7955 5405 0003 6727 3167  ript.pyUT...g'1g
00000090: 7578 0b00 0104 0000 0000 0400 0000 0050  ux.............P
000000a0: 4b05 0600 0000 0001 0001 0055 0000 004a  K..........U...J
000000b0: 0000 0000 00                             .....
root@kali:~/Desktop#
```

Lets walk one step by another

1. **Reading the header of the encrypted file**

In [1]:

```
zipFilePath = './XOR.zip.crypt'

# open the file to be read as binary, and read the first 4 bytes as header.
with open (zipFilePath, 'rb') as file:
    headerBytes = file.read(10)

# print the header in hexadecimal
print('Header bytes: ', headerBytes.hex(),  )
```

```
Header bytes:  cc938c162f46d6b8f67d
```

1. **now since we know the common header for any zip file which is 50 4B 03 04**
    - **we can use this information to get first 4 bytes of the key using this method:**
        - **key = cipher xor plain**

In [2]:

```
commonHeaderBytes = bytes.fromhex('504b0304')
encryptedHeader = bytes.fromhex(headerBytes.hex())

# now lets perform the xor
xorByte = bytearray()
for encByte, zipByte in zip(encryptedHeader, commonHeaderBytes):
    xorByte.append(encByte ^ zipByte)

# now lets print the result
print(xorByte.hex())

# now we have
```

```
9cd88f12
```

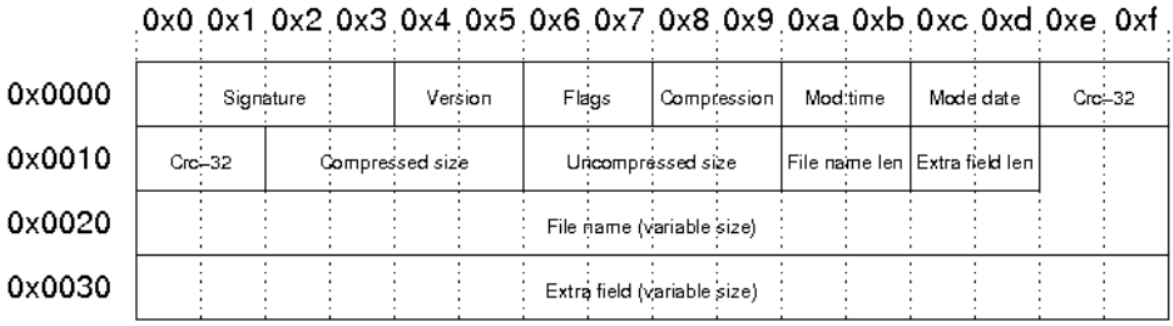
- **now we got 4 bytes out of the 12 key bytes**
- **so by using the last hint in the problem, we can pad our key with zeros, and try it as a first key, and then try to apply further analysis**

In [3]:

```
key = '9cd88f12'+''.join('00' for i in range(8))
print(key)
```

```
9cd88f120000000000000000
```

- **After I try to understand the header more, I found this useful link:**
- **PKZip explaination**
- **and I found that the local file header should be as follow:**
    -



- **so by applying analogy to what we have**
    - **our signature is '504b0304'**
    - **our version can be (v1 -> 0a00) (v2-> 1400) (v3->1e00)**
    - **our flags are 0000 because it is encrypted file**
    - **our compression method is 00 because it is the default method like mentioned in the problem**

- **our compression method is 00 because it is the default method like mentioned in the problem**
- **so we get this:**
  - **504b0304xx0000000000xxxx**
- **now we can apply bruteforce to find the key, we have 2^16 * 3 (the only 3 possible versions) which is a feasible computation.**

trying v1

- **header: 504b03040a0000000000**

In [4]:

```
commonHeaderBytes = bytes.fromhex('504b03040a0000000000')
encryptedHeader = bytes.fromhex(headerBytes.hex())

# now lets perform the xor
partialInitialKey = bytearray()
for encByte, zipByte in zip(encryptedHeader, commonHeaderBytes):
    partialInitialKey.append(encByte ^ zipByte)

# now lets print the result
print(partialInitialKey.hex())

# now we have 10 bytes of the key
```

```
9cd88f122546d6b8f67d
```

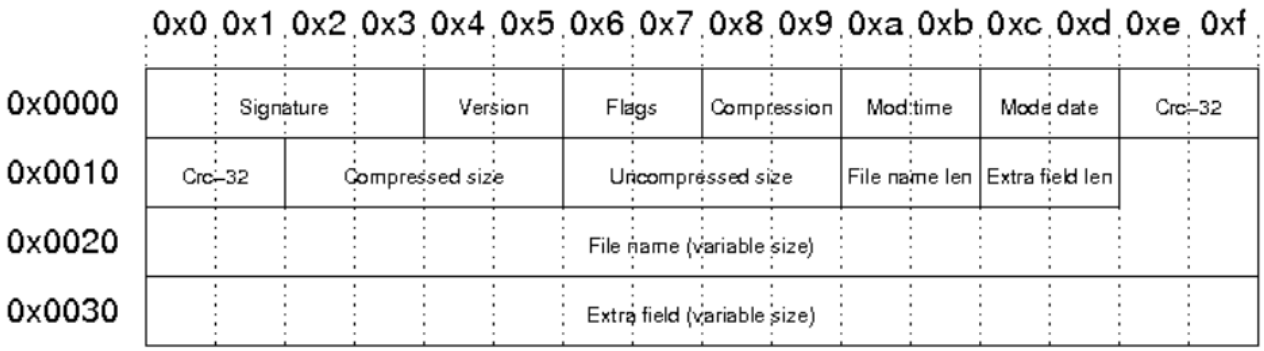
In [5]:

```
import itertools
import zipfile
import io

# Your partial key with the known part: '504b03040a0000000000'
# partialKey = bytearray.fromhex("9cd88f122546d6b8f67d")
partialKey = bytearray(partialInitialKey)

# The encrypted data you want to try to decrypt (read from the file)
with open("XOR.zip.crypt", "rb") as file:
    encrypted_data = file.read()

# Function to perform XOR decryption
def xor_decrypt(data, key):
    key_length = len(key)
    decryptedData = bytearray()
    for i in range(len(data)):
        decryptedData.append(data[i] ^ key[i % key_length])
    return bytes(decryptedData)

# Iterate over all possible values for the 2 unknown bytes (0x0000 to 0xFFFF)
counter = 1
possibleKeys = []
for b1, b2 in itertools.product(range(256), repeat=2):
    # Construct the full 12-byte key with the 2 unknown bytes
    fullKey = partialKey + bytearray([b1, b2])
    # print(fullKey)
    # Decrypt the data with the current key
    decryptedData = xor_decrypt(encrypted_data, fullKey)

    # Check if the decrypted data has a valid ZIP header
    if decryptedData.startswith(b"PK\x03\x04"):

        possibleKeys.append(fullKey)

        # now lets try to unzip the file, and get its content.
        # if this is a valid zip file, we will extract the content, otherwise, we need to
try another key.
        try:
            with zipfile.ZipFile(io.BytesIO(decryptedData)) as zip_file:
```

```
                # List the contents of the ZIP file to ensure it's valid
                fileList = zip_file.namelist()
                print(f"Correct key found: {fullKey.hex()}")
                print("Contents of the ZIP file:", fileList)

                # Save the successfully decrypted data to a file
                with open("decrypted_successful.zip", "wb") as outputFile:
                    outputFile.write(decryptedData)
                with open("XOR.key", "w") as keyFile:
                    keyFile.write(fullKey.hex())
                break
        except (zipfile.BadZipFile, zipfile.LargeZipFile):
            # If decompression fails, continue to the next key
            continue
            # possibleKeys.append(fullKey)
        # break
else:
    print("No valid key found.")

# just want to know how many of generated keys (2^16) can decrypt the header correctly
print(len(possibleKeys))

#! Remark:
# we were lucky that we have found the key in the v1 approach, if we did not, we should t
ry other versions which are v2 and v3
```

```
Correct key found: 9cd88f122546d6b8f67d6951
Contents of the ZIP file: ['README.md']
26962
```

read me content



In [ ]: