when AES(☢) = ☠

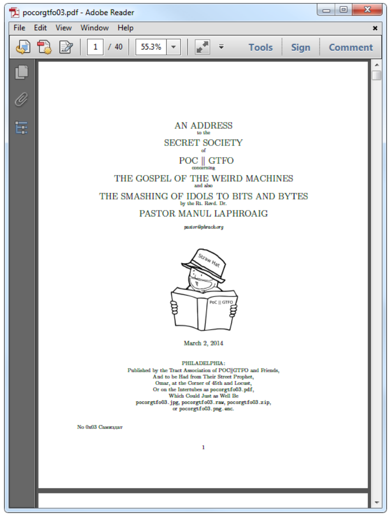
a crypto-binary magic trick

Ange Albertini, April 2014
with the help of Jean-Philippe Aumasson

disclaimer

this was already introduced in PoC||GTFO 0x03 (in 3 pages) and presented at Insomni’hack (in 6 slides :p)

However, I was asked for more details, so here they are...



AN ADDRESS
to the
SECRET SOCIETY
of
POC || GTFO
concerning
THE GOSPEL OF THE WEIRD MACHINES
and also
THE SMASHING OF IDOLS TO BITS AND BYTES
by the Rt. Revd. Dr.
PASTOR MANUL LAPHROAIG

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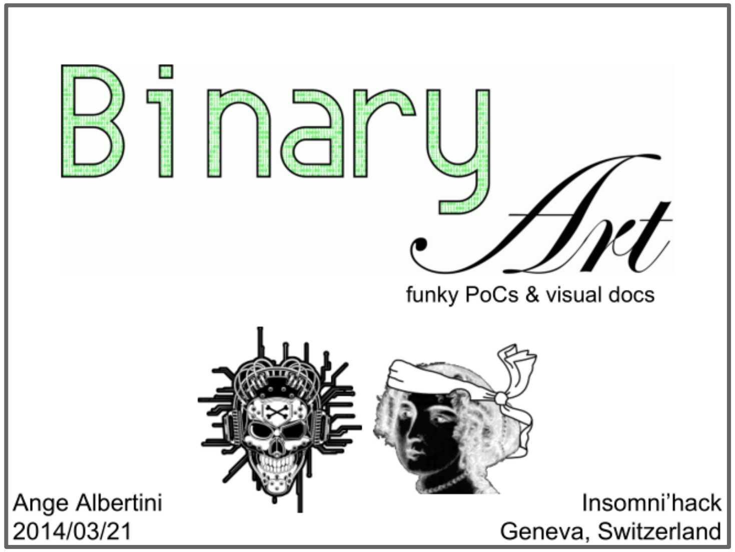
March 2, 2014

PHILADELPHIA:
Published by the Tract Association of POC||GTFO and Friends,
And to be Had from Their Street Prophet,
Omar, at the Corner of 45th and Locust,
Or on the Intertubes as pocorgtfo03.pdf,
Which Could Just as Well Be
pocorgtfo03.jpg, pocorgtfo03.raw, pocorgtfo03.zip,
or pocorgtfo03.png.enc.

No 0x03 Самиздат

1



Binary Art
funky PoCs & visual docs

Ange Albertini
2014/03/21

Insomni’hack
Geneva, Switzerland

Agenda

- basics
    - crypto 101
    - binary formats 101
- the challenge
- Angecryption
- Conclusion
- a walkthrough example

Crypto 101

block cipher, encryption, plaintext...

AES(*) is a block cipher

like Triple-DES, Blowfish...

(*) from now on we’ll say AES for AES-128. it doesn’t really matter, just makes the key smaller ;)

a block cipher

- takes a block of data
    - of fixed size (=“block size”)
        - 16 bytes for AES, 8 for Blowfish/DES^3...
    - padded if smaller than blocksize
- a key
- returns a ‘scrambled’ block of data

- security criteria:
    - invertible (permutation)..
    - but only if the key is known
- behaves as a 'random permutation' (aka 'ideal cipher')

Examples of AES encryption

Parameters	Results
k:'MySecretKey12345' block:'a block of text.'	┐◄n╩i▐☼←∞└╞∙iû╨► (BF 11 6E CA 69 DE 0F 1B EC C0 C6 F9 69 96 D0 10)
k:'MySecretKey12346' block:'a block of text.'	gO┼╗ÑëΩcë ▼LÇk╨î (67 4F C5 BB A5 89 EA 63 89 20 1F 4C 80 6B D0 8C)
k:'MySecretKey12345' block:'a block of text!'	wε╩▬▄y&↕ú@αùαφ♣O (77 EE CA 16 DC 79 26 12 A3 40 E0 97 E0 ED 05 4F)

with a tiny change in the
key or input block,
the output block is
completely different

we can’t control the output

(the differences are unpredictable)

reverse operation

- get the original block with the reverse operation and the same key
- encrypt, then decrypt

In some ciphers (such as NOEKEON), encryption and decryption are almost identical.

Jargon

plaintext = readable, not encrypted (in theory)

a **plaintext** block is **encrypted** into **ciphertext** block

a **ciphertext** block is **decrypted** into a **plaintext** block

example of encryption+decryption

Key = “MySecretKey12345”

Encrypting “a block of text.” with AES gives “┐◄n╩i ▐☼←∞└╞∙iû╨►” (BF 11 6E CA 69 DE 0F 1B EC C0 C6 F9 69 96 D0 10)

Decrypting this with the same key gives back “a block of text.”

Decrypting this with Key = “MySecretKey12346” gives “π╔6I►♣♫Σ♣╝╤→√çφ╡ ” (E3 C9 36 49 10 05 0E E4 05 BC D1 1A FB 87 ED B5)

we can’t decrypt without the key used to encrypt

file formats 101

signatures, chunks, appended data...

file formats 101

- most files on your system use a standard format.
- some for executables (ran by the OS)
  - very complex - depend on the OS
- some for documents (open by Office, your browser…)
  - “less” complex - depend on the specs only

file formats signatures (& headers)

usually start with a magic signature

- a fixed byte sequence

PNG	\x89 PNG\r\n\x1a\n
PDF	%PDF-1.x \r
FLV	FLV
JPG	\xFF \xD8

- enforced at offset 0

why?

- useful for quick identification
- invalid file if missing

data structure

substructures made of chunks

- chunks have different names
    - “chunk”, “segment”, “atom”

structure

- they have an identifier
    - “marker”, “type”, “id”
- (typically) their length
- the chunk data itself
- (sometimes) data’s checksum

why using a chunk-structure ?

- newer chunk types can be ignored for ‘forward compatibility”
- tools can use custom chunks to store extra info while staying standard

chunks example (simplified)

a valid file:

1. magic signature
2. chunks
   a. header
   b. comment
   c. thumbnail
   d. data
   e. end

some chunks are critical, some aren’t (=ancillary).

data structure’s end

- like a magic signature, file formats typically have an end marker.
- the end marker is usually a valid chunk with no data, just an ID

Ex, in PNG (using HexII representation)

```
00 00 00 00  .I .E .N .D ae426082
(length = 0)   IMAGE END   CRC(“IEND”)
```

appended data

most file formats tolerates any data of any length after the end marker

valid file + random data ⇒ still valid

a valid binary file

to be valid, a binary file requires:

1. a valid header
   - including a valid magic
2. a valid chunk structure
   - an end chunk

and is optionally followed by any data

the challenge

(at last)

encrypt a valid JPG into a valid JPG

(or another standard format)

first analysis

since a block cipher’s output is ‘random’, encrypting a valid JPG into a valid JPG seems impossible:

both files can’t even have valid signatures and structures

we would have to control the output of AES (!)

Joke :)

AES( )=
WITH KEY = '\XE3#X\XAD\X05\XA0\X87\X8B\X1A\X83\XE8\XCA\X1D\XB8=N'
ANY RAW IMAGE WILL ENCRYPT AS A RAW IMAGE !

block cipher modes 101

how block ciphers are applied to files

encrypting data bigger than a block

how do one apply encryption on a file?

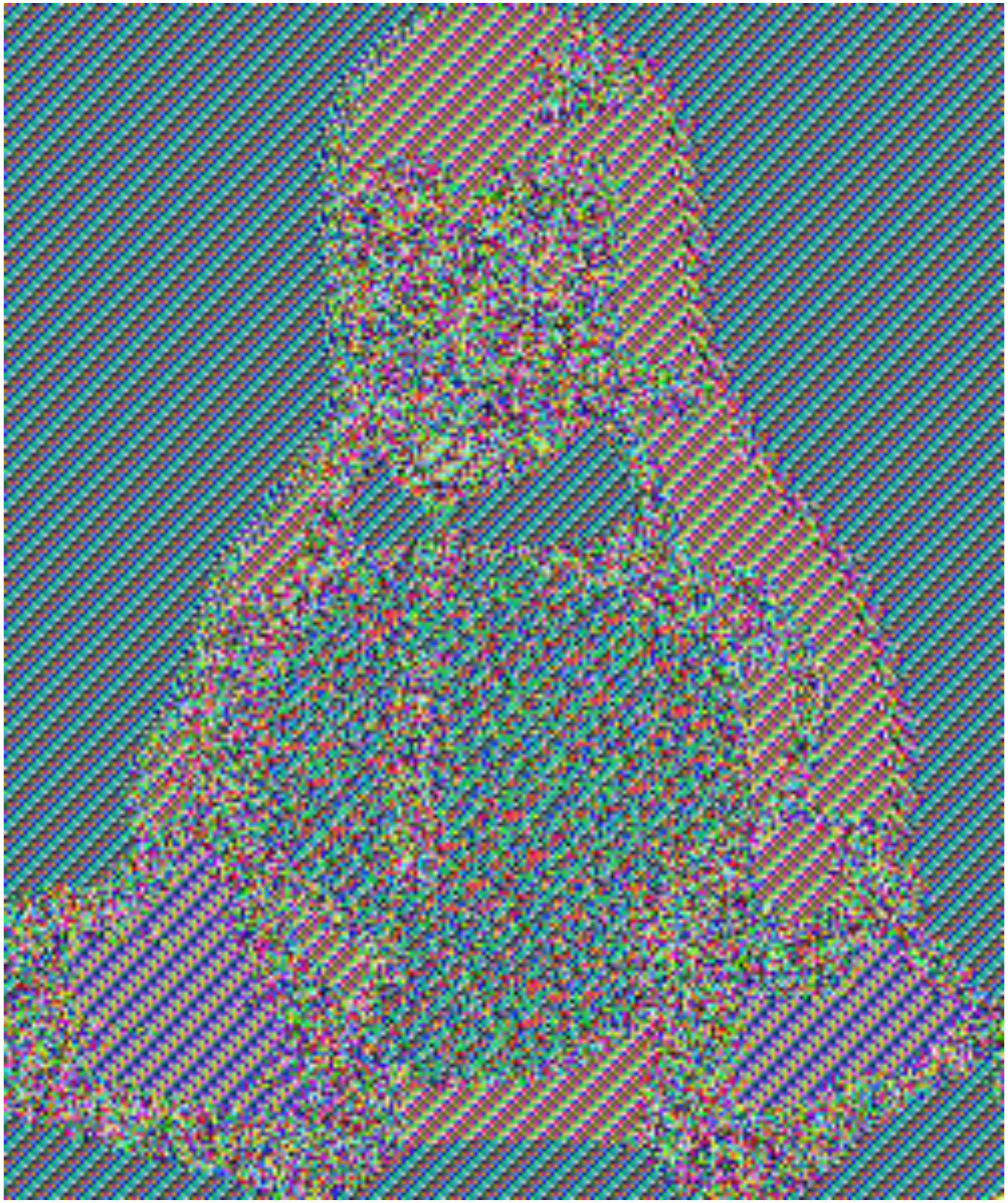
- if the key and plaintext are the same

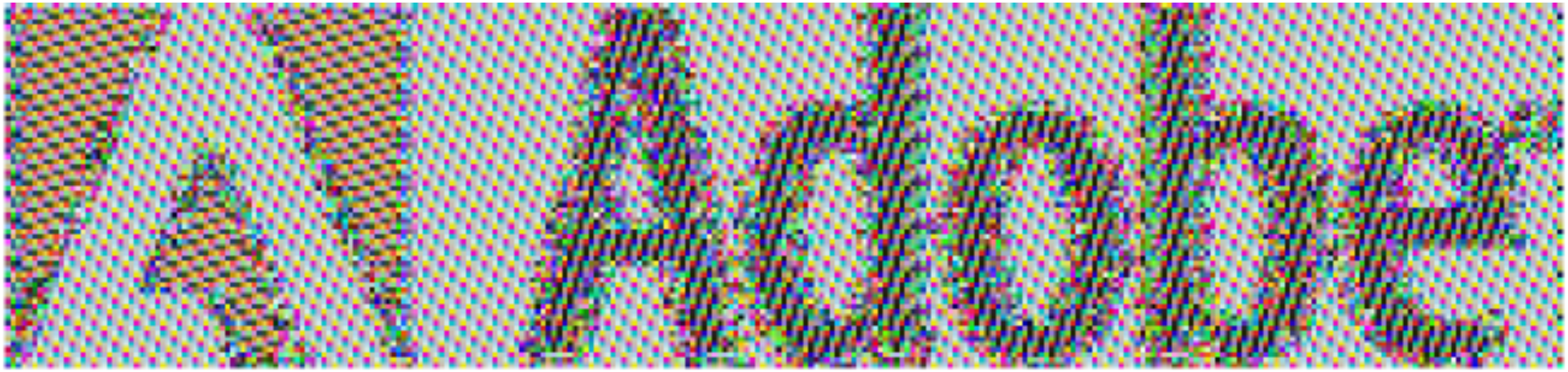
→ the ciphertext is the same

Electronic CodeBook mode

if we just apply the cipher on each block, identical blocks will give identical output

→ big weakness





THE ADOBE LOGO, ENCRYPTED WITH 3DES IN ECB MODE
(THE SAME ALGORITHM THEY USE TO STORE PASSWORDS)

Good job, guys!

Block cipher modes of operation

various modes can be used to operate block ciphers on files:

- chaining each each block’s encryption to propagate differences from the start to the end of the file, killing repetitive patterns

  http://en.wikipedia.org/wiki/Block_cipher_mode_of_operation

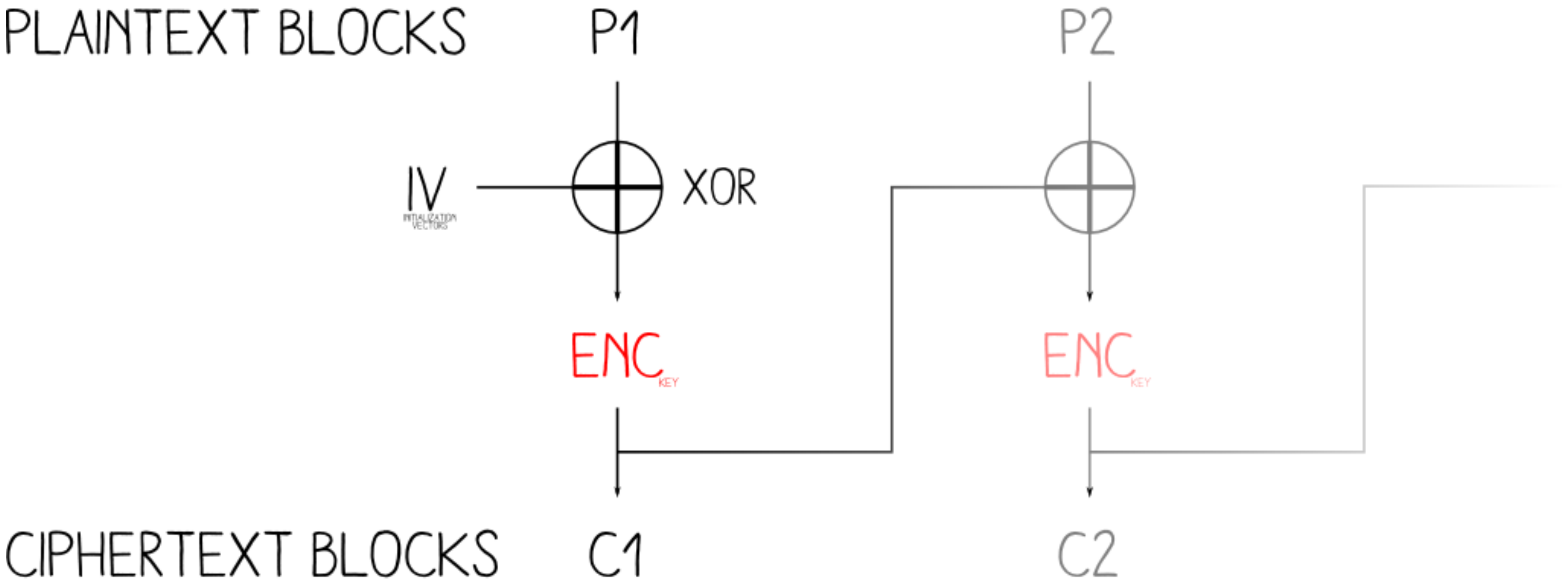
for this, auxiliary input may be needed, such as either:

- unpredictable IV (CBC)
- unique nonce (CTR)

Initialization Vector 101

Several modes (CBC, OFB, CFB,...) introduce an extra parameter *IV* that we can abritrarily choose (and in practice, it should be unpredictable)

Cipher Block Chaining



$$C1 = ENC_{KEY}(P1 \,\hat{}\, IV)$$

$$DEC_{KEY}(C1) = P1 \,\hat{}\, IV$$

$$IV = DEC_{KEY}(C1) \,\hat{}\, P1$$

CBC observations

no matter the key or block cipher,

for a given P1 and C1,

we can determine IV so that

a file starting with P1 will encrypt as a file starting with C1

with IV = Dec(C1) xor P1

status

we control the first block

but

the following blocks will look random :(

decrypting plaintext

(ciphers don’t analyse your input)

encryption & decryption

actually just 2 reverse operations

- they both take any input
- and give the resulting output
- and the reverse operation gives back the original block
  - (if the key is the same)

example (1/2)

key = "MySecretKey12345"

p = "a block of text."

decrypt(AES, key, p) = “ä/ë-╦7 ↓h│ ☻⌂µ[←Ñ”

(84 2F 89 2D CB 37 00 19 68 B3 02 7F E6 5B 1B A5)

it doesn’t really make sense to ‘decrypt’ plaintext…

but it doesn’t matter for the cipher, so...

example (2/2)

indeed, with:

key = "MySecretKey12345"

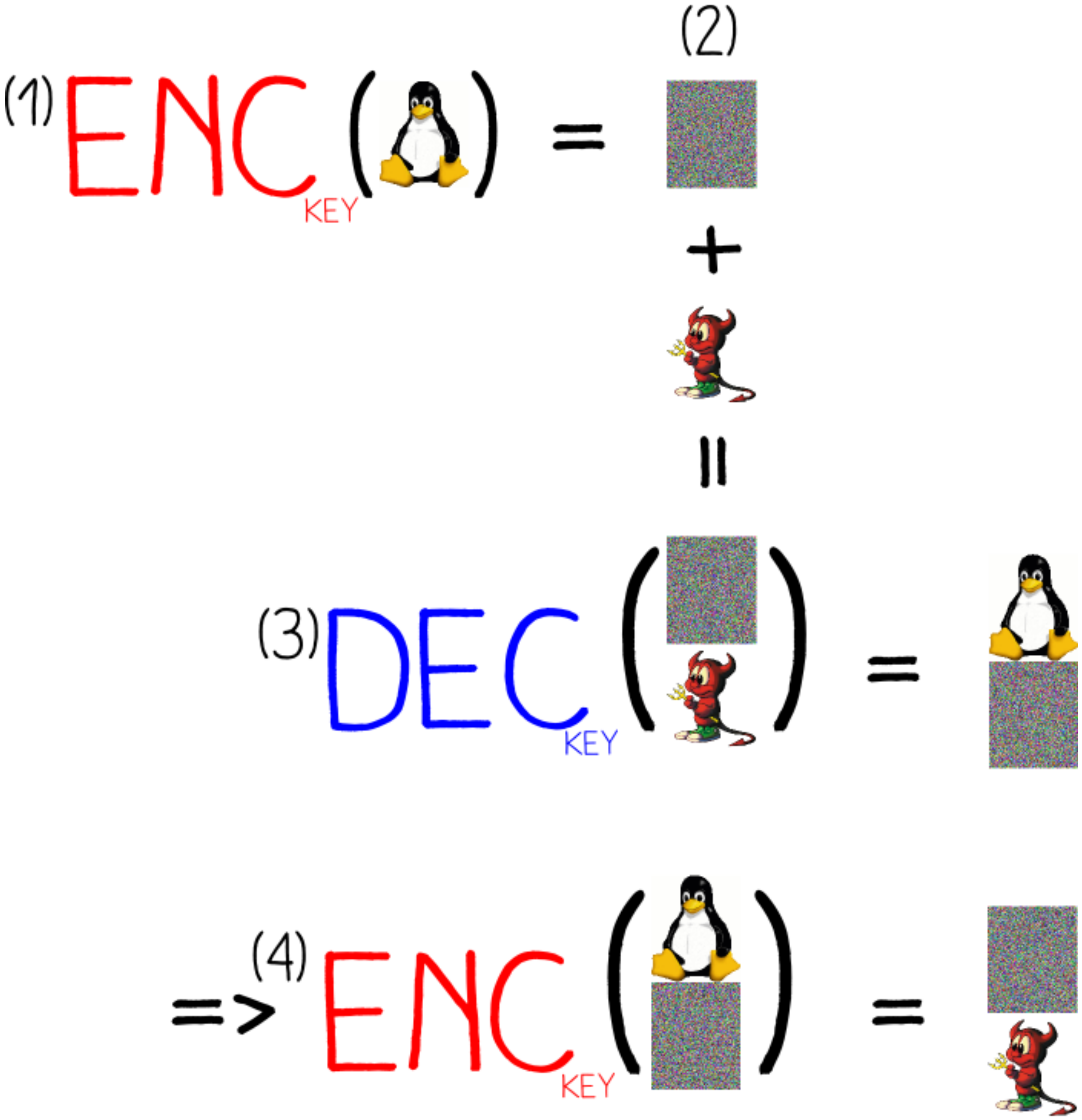
c = “ä/ë-╦7 ↓h│☻⌂µ[←Ñ”

encrypt(AES, key, c) = "a block of text."

you can decrypt plaintext, it gives you back your plaintext after re-encryption

(ie, you can control some AES encryption output)

let’s add plaintext to our encrypted file!


(1) ENC KEY
=
(2)
+
=
(3) DEC KEY
=
=> (4) ENC KEY
=

consequences

1. since adding junk at the end of our valid file still makes it valid
2. we add decrypted plaintext that will encrypt to what we want

status

1. we control the first block
2. we control some appended data

how do we control the encrypted data
from the source file that is in-between?

we don’t

we politely ask the file format to ignore it
(by surrounding this data in an extra chunk)

our current challenge

within a block, get a valid

1. header
2. chunk start

this is specific to each target format

PDF

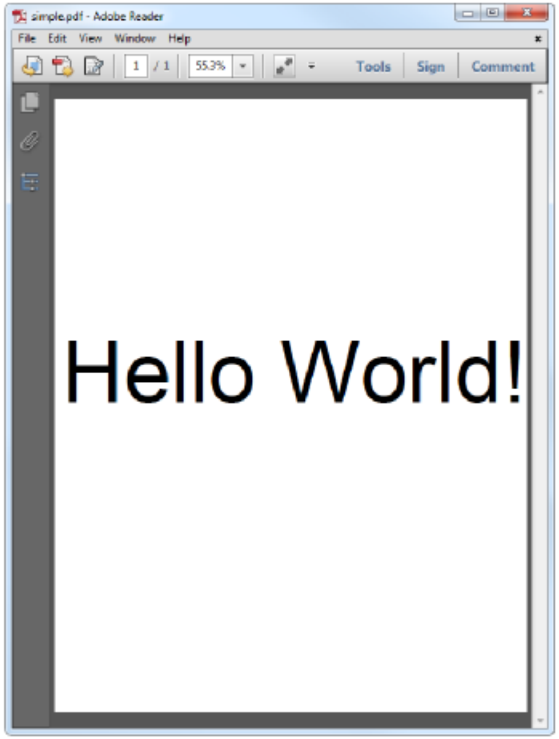
Portable Document Format

PDF in a nutshell

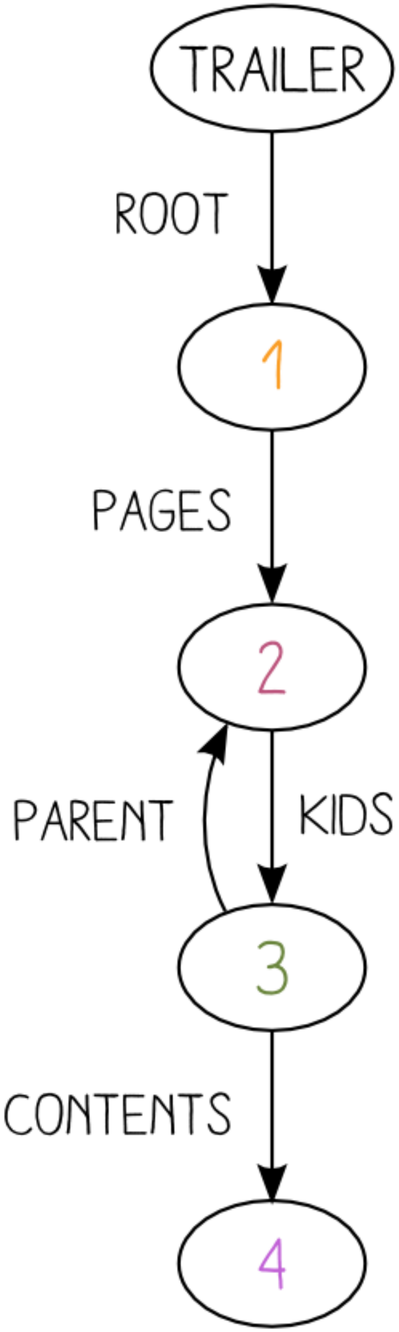
- magic signature: %PDF-1.5\n
- PDF are made of objects
- stream objects can contain any data

```
%PDF-1.1

1 0 obj
<<
  /Pages 2 0 R
>>
endobj

2 0 obj
<<
  /Type /Pages
  /Count 1
  /Kids [3 0 R]
>>
endobj

3 0 obj
<<
  /Type /Page
  /Contents 4 0 R
  /Parent 2 0 R
  /Resources <<
    /Font <<
      /F1 <<
        /Type /Font
        /Subtype /Type1
        /BaseFont /Arial
      >>
    >>
  >>
>>
endobj

4 0 obj
<< /Length 47 >>
stream
BT
  /F1 110
  Tf
  10 400 Td
  (Hello World!)Tj
ET
endstream
endobj

...
```

```
...

xref
0 5
0000000000 65535 f
0000000010 00000 n
0000000047 00000 n
0000000111 00000 n
0000000313 00000 n

trailer
<<
  /Root 1 0 R
>>

startxref
416
%%EOF
```



Hello World!



stream objects

<object number> <generation number> obj

<< ***<parameters>*** >>

stream

<data>

endstream

endobj

PDF encrypted with AES

AES has a block size of 16 bytes

a standard PDF header and object declaration

```
%PDF-1.5

0 0 obj
<<>>
stream
```

takes >30 bytes!

let’s shrink this

1. truncate the signature
   %PDF-\0
2. remove the object number
   ~~0 0~~ obj
3. remove the parameter dictionary
   ~~<<>>~~

et voilà, exactly 16 bytes!

%PDF-\0obj\nstream

PDF laxism FTW

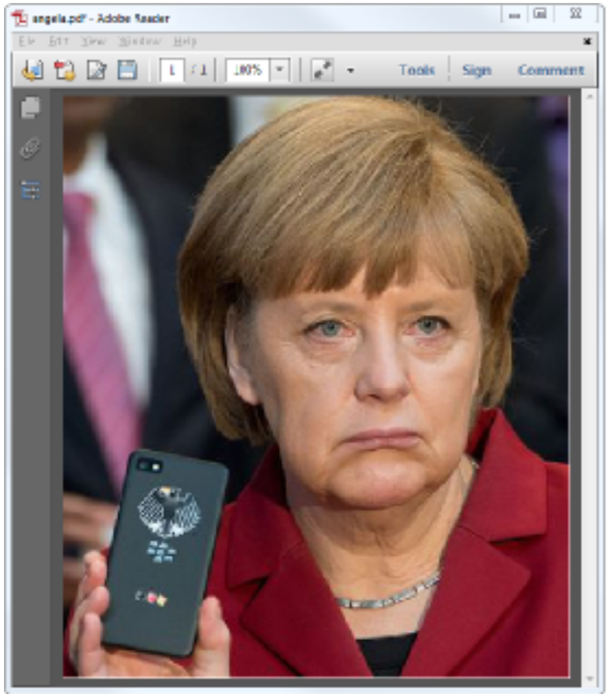
PDF doesn’t care if 2 signatures are present

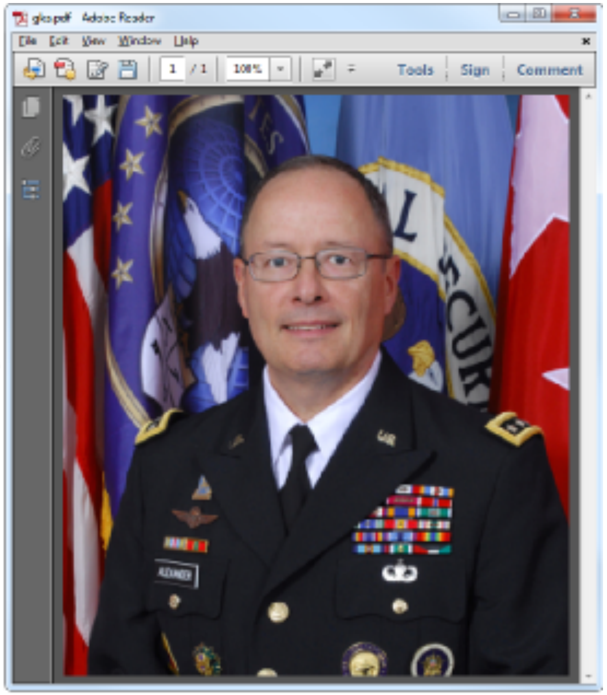
→ we can close the stream at *any* point with:
endstream
endobj
and resume with our original PDF file happily

steps to encrypt as PDF

1. we choose our key, source and target contents
2. our first cipher block: %PDF-\0obj\nstream
3. determine IV from plaintext & cipher blocks
4. AES-CBC encrypt source file
5. append object termination
6. append target file
7. decrypt final file
8. et voilà, the final file will encrypt as expected!

PoC @ corkami.com





JPG

Joint Photographic Experts Group (image)

JPG in a nutshell

magic signature: FF D8 (only 2 bytes)

chunk’s structure: <id:2> <length:2> <data:?>

comment chunk ID: FF FE

→ only 6 bytes are required!

steps to encrypt as JPG

1. get original size, padded to 16
2. 1st cipher block =
   FF D8   FF FE <source size:2> <padding>
3. generate IV from plaintext & cipher blocks
4. AES-CBC encrypt source file
5. append target file minus signature
6. decrypt final file
7. et voilà, the final file will encrypt as expected!
8. ...

PoC

PNG

Portable Network Graphics

PNG

big magic: \x89PNG\r\n\x1a\n (8 bytes!)

chunk’s structure:

```
<length(data):4> <id:4> <data:?> <crc(data+id):4>
```

signature + chunk declaration = 16 bytes (!)

encrypt to PNG

1. get original file size
2. generate cipher block
3. get IV
4. encrypt original data
5. get encrypted(original data) checksum
6. append checksum, target data
   - (target file - signature)
7. decrypt file
8. done

CONTENTS

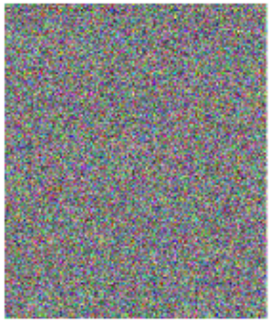
(1)

PNG SIGNATURE `89 .P .N .G 0d 0a 1a 0a`

STARTING A DUMMY CHUNK `.. .. .. .. .. .. .. .. xx xx xx xx tt tt tt tt`

CHUNK LENGTH CHUNK TYPE

RANDOM ENCRYPTED DATA



ENDING DUMMY CHUNK `yy yy yy yy`

CHUNK CRC

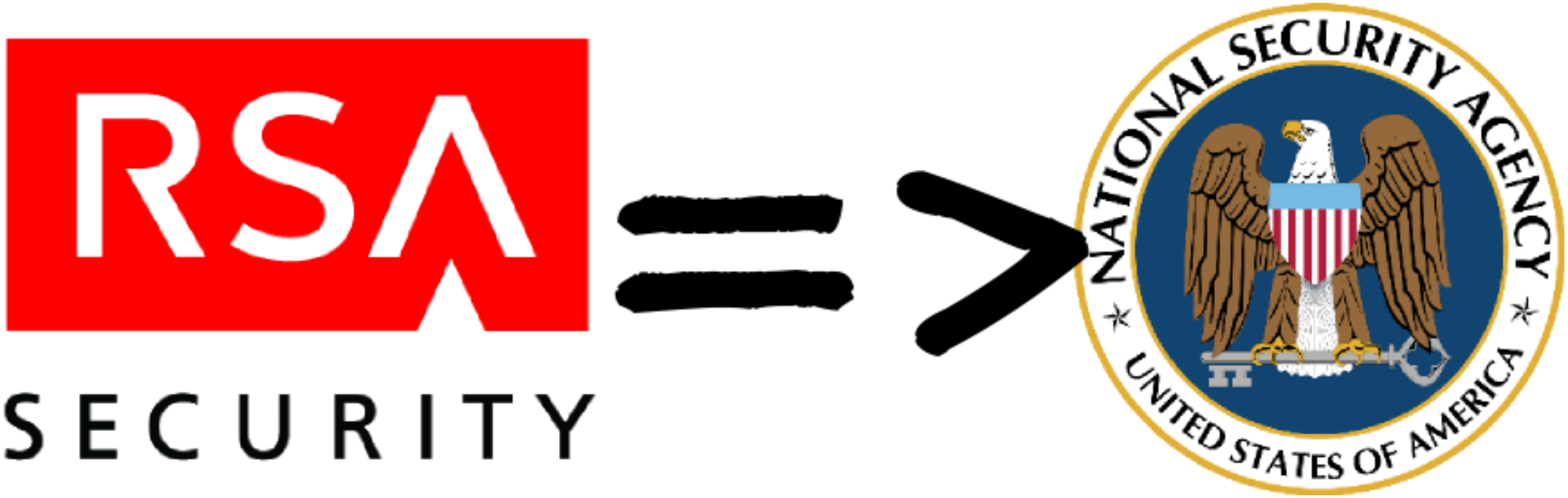
(2)

STARTING CONTROLLED DATA `.. .. .. .. 00 00 00 0d .I .H .D .R`

ORIGINAL IMAGE HEADER

END OF IMAGE `...00 00 00 00 .I .E .N .D AE 42 60 82`

PoC


RSA
SECURITY
NATIONAL SECURITY AGENCY
UNITED STATES OF AMERICA

FLV

Flash Video

Flash Video

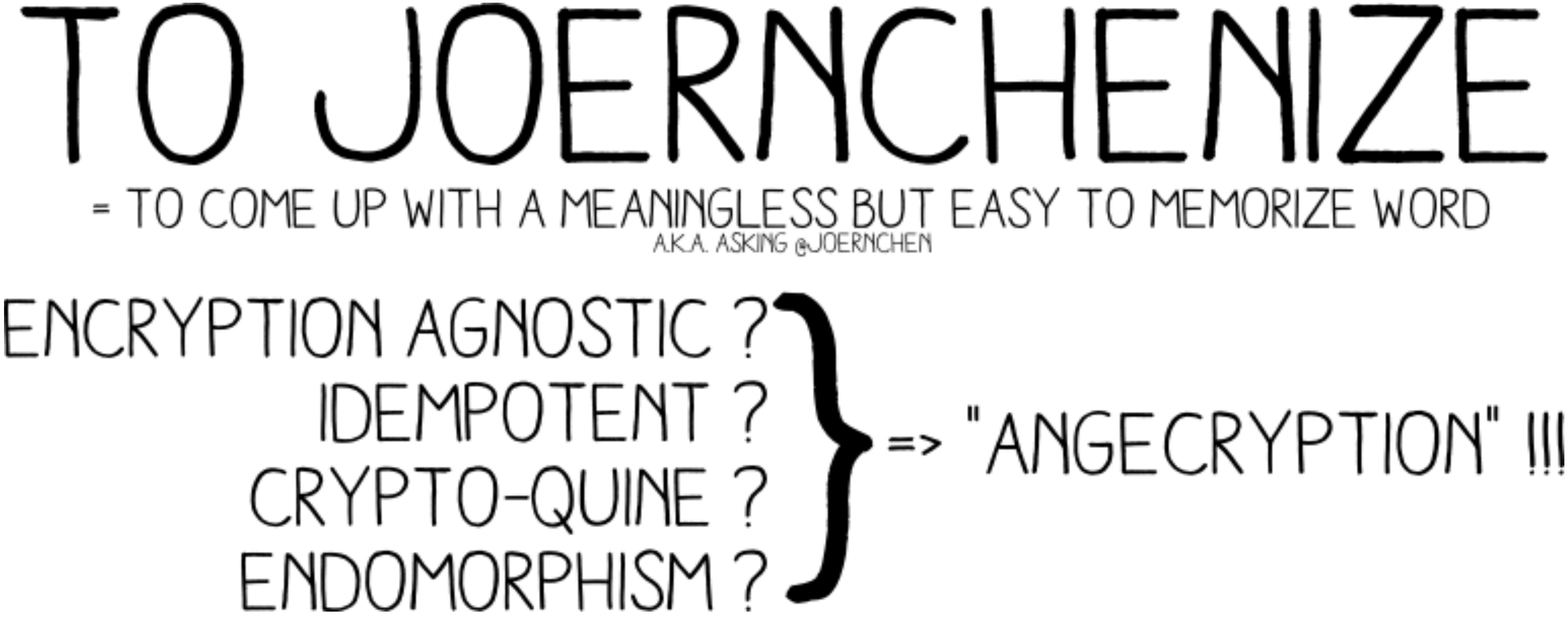
1. magic = “FLV”
2. followed by 2 bytes parameters
3. then **size(chunk)** on 4 bytes

no checksum or trick

→ no challenge

→ no PoC ;)

how can we call that trick?



TO JOERNCHENIZE

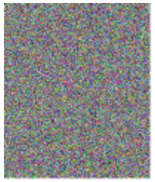
= TO COME UP WITH A MEANINGLESS BUT EASY TO MEMORIZE WORD

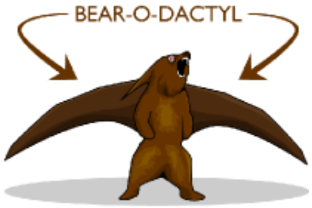
A.K.A. ASKING @JOERNCHEN

ENCRYPTION AGNOSTIC ?
IDEMPOTENT ?
CRYPTO-QUINE ?
ENDOMORPHISM ?

=> "ANGECRYPTION" !!!

bonus: (limited) deniability

 + DECOY KEY =>

+ REAL KEY => 

reminder

- this is not specific to AES
- this is not specific to CBC

required conditions

- control the first cipherblock
- the source format tolerates appended data
- header+chunk declaration fits in “blocksize”
  - the source size fits in the specified size encoding (short, long…)

bonus: chaining

as a consequence

- the same file can decrypt to
  - various files
  - of different formats
  - decrypt or encrypt

Source & PoCs

http://corkami.googlecode.com/svn/trunk/src/angecryption/

Conclusion

- a funny trick
- a bit of crypto magic, a bit of binary magic

possible extensions:

- protocols
- better deniability

@angealbertini

http://www.corkami.com

ACK

@veorq

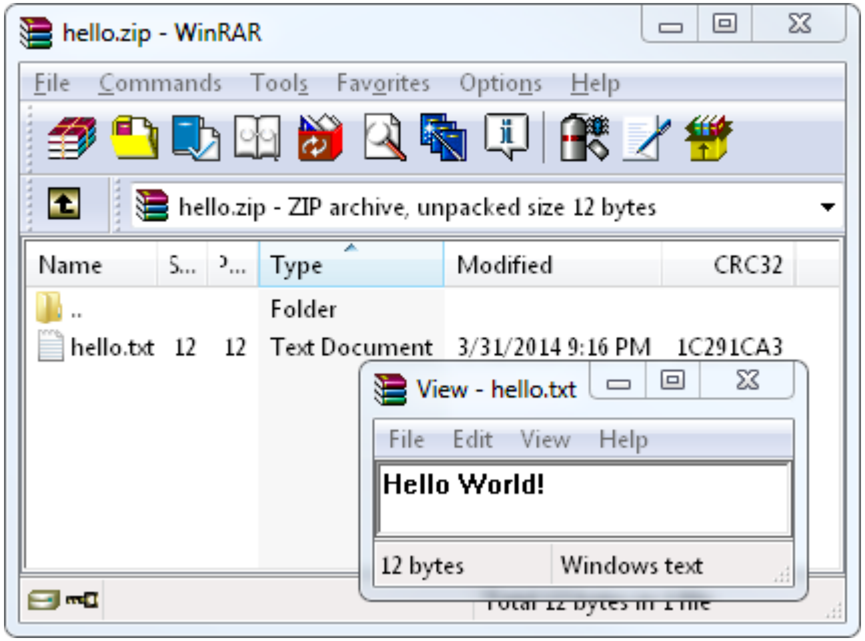
@miaubiz @travisgoodspeed @sergeybratus @cynicalsecurity @rantyben @thegrugq @skier_t @jvanegue @kaepora @munin @joernchen @andreasdotorg @tabascoeye @cryptax @pinkflawd ...

Bonus:
a step by step walkthrough

AES(ZIP) = PNG

let’s encrypt this (ZIP)

```
00:  50 4B 03 04-0A 00 00 00-00 00 11 AA-7F 44 A3 1C  PK♥♦◙      ◄¬⌂Dú∟
10:  29 1C 0C 00-00 00 0C 00-00 00 09 00-00 00 68 65  )∟♀   ♀   ○   he
20:  6C 6C 6F 2E-74 78 74 48-65 6C 6C 6F-20 57 6F 72  llo.txtHello Wor
30:  6C 64 21 50-4B 01 02 14-00 0A 00 00-00 00 00 11  ld!PK☺☻¶ ◙     ◄
40:  AA 7F 44 A3-1C 29 1C 0C-00 00 00 0C-00 00 00 09  ¬⌂Dú∟)∟♀   ♀   ○
50:  00 00 00 00-00 00 00 01-00 20 00 00-00 00 00 00            ☺
60:  00 68 65 6C-6C 6F 2E 74-78 74 50 4B-05 06 00 00   hello.txtPK♣♠
70:  00 00 01 00-01 00 37 00-00 00 33 00-00 00 00 00    ☺ ☺ 7   3
```



hello.zip - ZIP archive, unpacked size 12 bytes

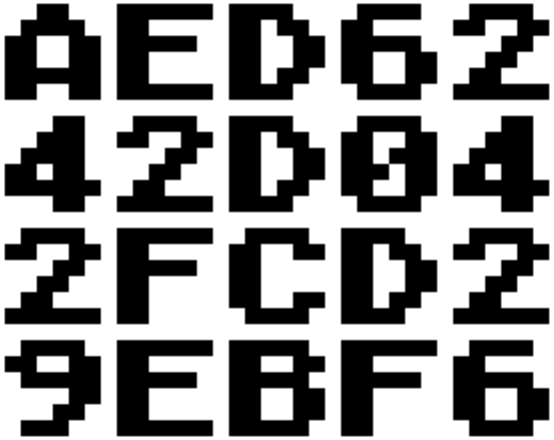
Name	S...	P...	Type	Modified	CRC32
..			Folder		
hello.txt	12	12	Text Document	3/31/2014 9:16 PM	1C291CA3

Hello World!

12 bytes | Windows text

Total 12 bytes in 1 file

into this (PNG)



```
000:  89 50 4E 47-0D 0A 1A 0A-00 00 00 0D-49 48 44 52  ëPNG♪◙→◙   ♪IHDR
010:  00 00 00 22-00 00 00 1B-08 02 00 00-00 96 50 CA     "   ←◘☻   ûP╩
020:  F0 00 00 00-01 73 52 47-42 00 AE CE-1C E9 00 00  ≡   ☺sRGB «╬∟Θ
030:  00 06 62 4B-47 44 00 FF-00 FF 00 FF-A0 BD A7 93   ♠bKGD      á╜ºô
040:  00 00 00 09-70 48 59 73-00 00 0E C4-00 00 0E C4     ○pHYs  ♫─  ♫─
050:  01 95 2B 0E-1B 00 00 00-07 74 49 4D-45 07 DD 01  ☺ò+♫←   •tIME•▌☺
060:  18 0C 39 2E-11 F1 8A 80-00 00 01 05-49 44 41 54  ↑♀9.◄±èÇ  ☺♣IDAT
070:  48 C7 BD 56-CB 12 C3 20-08 04 C7 FF-FF 65 7A B0  H╟╜V╦↕├ ◘♦╟  ez░
080:  43 09 8F 15-EB 4C 38 29-59 40 61 21-B2 88 10 11  C○Å§δL8)Y@a!▓ê►◄
090:  33 13 D1 5A-EB D6 8A 88-58 A5 22 1D-38 F5 20 22  3‼╤Zδ╓èêXÑ"↔8⌡ "
0A0:  9C DA BB A8-D6 52 F1 1D-A4 AE 39 F5-EE 6E 13 3D  £┌╗¿╓R±↔ñ«9⌡εn‼=
0B0:  62 64 8C 37-A9 16 67 B3-45 32 33 33-BB BC AD ED  bdî7⌐▬g│E233╗╝¡φ
0C0:  AC 8A 01 24-4D 54 0B 23-22 AA 4A ED-9D 52 8C 54  ¼è☺$MT♂#"¬Jφ¥RîT
0D0:  7E 1E 51 FB-99 B9 91 59-5D B3 A2 5F-93 D0 CE E7  ~▲Q√Ö╣æY]│ó_ô╨╬τ
0E0:  48 6B A3 9F-AB 00 AA 01-48 BB 1E 55-33 82 B6 88  Hkúƒ½ ¬☺H╗▲U3é╢ê
0F0:  1E B7 DB 01-68 D3 61 94-22 63 1A AD-C6 27 2D 66  ▲╖█☺h╙aö"c→¡╞'-f
100:  A3 13 1E C0-BE FD 94 76-D3 FD 4C F3-F3 E9 3D 42  ú‼▲└╛²öv╙²L≤≤Θ=B
110:  63 EE 62 4E-9F 5D 31 9D-02 F2 14 8C-4C BF FE 2A  cεbNƒ]1¥☻≥¶îL┐■*
120:  D2 A9 CD D1-CC 4F 29 37-01 AF 2E CB-66 7D 8E A3  ╥⌐═╤╠O)7☺».╦f}Äú
130:  FE B0 2E AA-C1 91 6F D3-61 5C 05 6E-52 20 32 E8  ■░.¬┴æo╙a\♣nR 2Φ
140:  25 42 53 F3-87 11 95 00-19 7D A2 B7-40 87 54 5B  %BS≤ç◄ò ↓}ó╖@çT[
150:  24 3A 66 E7-E0 47 CA 09-4A 07 B2 E7-5E 17 5B E4  $:fταG╩○J•▓τ^↨[Σ
160:  F8 63 EC DF-CE B4 34 C5-15 59 C1 81-56 CD 2C F2  °c∞▀╬┤4┼§Y┴üV═,≥
170:  03 4A 02 A6-B8 72 E2 63-1E 00 00 00-00 49 45 4E  ♥J☻ª╕rΓc▲    IEN
180:  44 AE 42 60-82          -           -            D«B`é
```

preliminary

- ZIP tolerates appended data, so does PNG

- our source file is 128 bytes
- AES works with 16 bytes blocks

→ one block of 16 bytes of value 0x10 will be padded (not strictly required here, but that's the standard PKCS7 padding)

P1

the first block of the source file is:

```
.P .K 03 04 0A 00 00 00 00 00 11 AA 7F 44 A3 1C
```

Target format 1/2

the target format is a PNG:

- the encrypted file must start with the PNG signature:

  89 .P .N .G \r \n 1A \n (8 bytes)
- followed by chunk length
  - our source file is 144 bytes (with padding)
  - already 16 bytes are covered by first block
  - so our dummy block will be 128 bytes long
  - encoded 00 00 00 80 in PNG’s little endianness

Target format 2/2

- followed by chunk type
  - 4 letters, non-critical if starting with lowercase
  - we could use the standard ‘tEXt’ comment chunk
  - or just our own, ‘aaaa’

so our target’s first cipherblock will be:

```
89 .P .N .G \r \n 1A \n   00 00 00 80   61 61 61 61
SIG --------------------   LENGTH ----   TYPE ------
```

IV

- the key we'll use is: MySecretKey01234
- with this key, C1 decrypts as:

ee 1b 01 b2 5a a5 bd a8 3a 9e 35 44 2f 5f 23 35

- by xoring with P1, we get the IV:

be 50 02 b6 50 a5 bd a8 3a 9e 24 ee 50 1b 80 29

now, our key and IV are determined.

we just need to combine both file's content.

making the final file

- encrypt our padded source file
- determine the CRC of our dummy chunk once encrypted (even if it will be surrounded by ‘plaintext’):
  - 6487910E, in our case
- append this CRC to finish the chunk
- append all the chunks (whole file minus the SIG) of the target file.

our file is now a valid PNG

our final file

1. PNG Sig
2. dummy chunk start
3. chunk data (encrypted content of source file)
4. chunk crc
5. target file chunks
6. paddings

```
89 50 4E 47-0D 0A 1A 0A-00 00 00 80-61 61 61 61 ëPNG????   Çaaaa
B0 EC 40 7E-FB 1E 5D 0B-5D 87 A9 4A-AF A1 08 A8  ¦8@~v?]?]ç¬J»í?¿
9A D4 46 4A-75 87 6C 72-24 71 23 E6-66 AF 77 B7  Ü+FJuçlr$q#µf»w+
93 AC A7 B3-F5 81 CF C9-31 47 80 AA-73 43 9A C5  ô¼º¦)ü-+1GÇ¬sCÜ+
5A 0F 5F 40-C9 8B 4D AF-A0 D7 CD 3B-86 D0 58 32  Z¤_@+ïM»á+-;å-X2
E1 52 6A 36-E2 3E DD D5-5C 95 BB C5-8C 44 A5 8E  ßRj6G>¦+\ò++îDÑÄ
14 71 89 70-E2 25 F8 95-84 27 DD AD-E3 90 E9 50  ¶qëpG%°òä'¦¡pÉTP
C4 E7 20 FD-0E C6 4A 69-95 B6 0D 73-25 30 D9 9E  -t ²?¦Jiò¦?s%0+P
D1 01 42 A7-5E 32 18 85-A2 BD B8 61-19 9B 52 CF  -?Bº^2?àó++a?¢R-
64 87 91 0E-00 00 00 0D-49 48 44 52-00 00 00 22 dçæ?    ?IHDR   "
00 00 00 1B-08 02 00 00-00 96 50 CA-F0 00 00 00      ???   ûP-=
01 73 52 47-42 00 AE CE-1C E9 00 00-00 06 62 4B  ?sRGB «+?T    ?bK
47 44 00 FF-00 FF 00 FF-A0 BD A7 93-00 00 00 09  GD       á+ºô   ?
70 48 59 73-00 00 0E C4-00 00 0E C4-01 95 2B 0E  pHYs  ?-  ?-?ò+?
1B 00 00 00-07 74 49 4D-45 07 DD 01-18 0C 39 2E  ?   •tIME•¦???9.
11 F1 8A 80-00 00 01 05-49 44 41 54-48 C7 BD 56  ?±èÇ  ??IDATH¦+V
CB 12 C3 20-08 04 C7 FF-FF 65 7A B0-43 09 8F 15  -?+ ??¦  ez¦C?Å§
EB 4C 38 29-59 40 61 21-B2 88 10 11-33 13 D1 5A  dL8)Y@a!¦ê??3?-Z
EB D6 8A 88-58 A5 22 1D-38 F5 20 22-9C DA BB A8  d+èêXÑ"?8) "£++¿
D6 52 F1 1D-A4 AE 39 F5-EE 6E 13 3D-62 64 8C 37  +R±?ñ«9)en?=bdî7
A9 16 67 B3-45 32 33 33-BB BC AD ED-AC 8A 01 24  ¬?g¦E233++¡f¼è?$
4D 54 0B 23-22 AA 4A ED-9D 52 8C 54-7E 1E 51 FB  MT?#"¬Jf¥RîT~?Qv
99 B9 91 59-5D B3 A2 5F-93 D0 CE E7-48 6B A3 9F  Ö¦æY]¦ó_ô-+tHkúƒ
AB 00 AA 01-48 BB 1E 55-33 82 B6 88-1E B7 DB 01  ½ ¬?H+?U3é¦ê?+¦?
68 D3 61 94-22 63 1A AD-C6 27 2D 66-A3 13 1E C0  h+aö"c?¡¦'-fú??+
BE FD 94 76-D3 FD 4C F3-F3 E9 3D 42-63 EE 62 4E  +²öv+²L==T=BcebN
9F 5D 31 9D-02 F2 14 8C-4C BF FE 2A-D2 A9 CD D1  ƒ]1¥?=¶îL+¦*-¬--
CC 4F 29 37-01 AF 2E CB-66 7D 8E A3-FE B0 2E AA  ¦O)7?».-f}Äú¦¦.¬
C1 91 6F D3-61 5C 05 6E-52 20 32 E8-25 42 53 F3  -æo+a\?nR 2F%BS=
87 11 95 00-19 7D A2 B7-40 87 54 5B-24 3A 66 E7  ç?ò ?}ó+@çT[$:ft
E0 47 CA 09-4A 07 B2 E7-5E 17 5B E4-F8 63 EC DF  aG-?J•¦t^?[Sºc8¯
CE B4 34 C5-15 59 C1 81-56 CD 2C F2-03 4A 02 A6  +¦4+§Y-üV-,=?J?ª
B8 72 E2 63-1E 00 00 00-00 49 45 4E-44 AE 42 60  +rGc?    IEND«B`
82 0B 0B 0B-0B 0B 0B 0B-0B 0B 0B 0B-04 04 04 04  é???????????????
```

our file after decryption

1. original source file
2. padding
3. ‘decrypted’ appended data

```
50 4B 03 04-0A 00 00 00-00 00 11 AA-7F 44 A3 1C  PK???      ?¬¦Dú?
29 1C 0C 00-00 00 0C 00-00 00 09 00-00 00 68 65  )??   ?   ?   he
6C 6C 6F 2E-74 78 74 48-65 6C 6C 6F-20 57 6F 72  llo.txtHello Wor
6C 64 21 50-4B 01 02 14-00 0A 00 00-00 00 00 11  ld!PK??¶ ?     ?
AA 7F 44 A3-1C 29 1C 0C-00 00 00 0C-00 00 00 09  ¬¦Dú?)??   ?   ?
00 00 00 00-00 00 01 00-20 00 00 00-00 00 00 00        ?
00 68 65 6C-6C 6F 2E 74-78 74 50 4B-05 06 00 00   hello.txtPK??
00 00 01 00-01 00 37 00-00 00 33 00-00 00 00 00    ? ? 7   3
10 10 10 10-10 10 10 10-10 10 10 10-10 10 10 10  ????????????????
AA 81 13 6A-22 E8 E3 13-E8 BB 56 83-4D 6D 6A E5  ¬ü?j"Fp?F+VâMmjs
96 DE 62 C6-21 11 52 51-60 C4 E4 19-0E 6E 7F FC  û¦b¦!?RQ`-S??n¦n
F0 37 F6 33-AD E0 42 49-21 B5 1C FB-50 EE E1 6D  =7÷3¡aBI!¦?vPeßm
D3 4F 22 43-DB A9 18 2D-0F EC B5 52-F3 A4 8C EE  +O"C¦¬?-¤8¦R=ñîe
69 A8 E4 5A-96 46 4A 3B-5D E2 B6 8F-4E A6 E7 90  i¿SZûFJ;]G¦ÅNªtÉ
CA E9 E1 04-65 24 D3 49-55 DF AC 68-A1 FC 0F 0F  -Tß?e$+IU¯¼hín¤¤
63 7A 2B A4-26 99 13 22-8A 8B 14 08-8D 71 18 83  cz+ñ&Ö?"èï¶?ìq?â
00 A9 85 86-A6 EC 13 9F-9E 16 30 1A-58 56 B5 CC   ¬àåª8?ƒP?0?XV¦¦
73 77 42 99-EC 53 D8 7C-8C 13 3E 74-6F B2 66 1D  swBÖ8S+|î?>to¦f?
7E CA 62 94-6D B2 D7 E4-F0 21 F5 87-AA F3 F7 8C  ~-böm¦+S=!)ç¬=˜î
15 B9 8D F0-DF FA 56 A3-06 A1 07 25-D1 DC 9D 51  §¦ì=¯·Vú?í•%-_¥Q
F4 6C 7B 43-40 32 57 C8-FD 40 A0 98-CA 6E 02 2B  (l{C@2W+²@áÿ-n?+
6D 54 37 7C-0A 1A C5 DD-9D CC C1 8A-72 A7 FD 24  mT7|??+¦¥¦-èr°²$
12 5F 51 84-4B 48 C3 5D-E0 76 8B 05-8F 09 20 17  ?_QäKH+]avï?Å? ?
A5 BD CE DF-E8 B3 E8 5B-CD 76 63 29-C0 77 BF 28  Ñ++¯F¦F[-vc)+w+(
96 FD 32 05-F8 B6 A3 A9-24 2C A6 98-71 6A 83 DC  û²2?°¦ú¬$,ªÿqjâ_
FE 54 EA ED-43 12 12 EF-BB 38 6E 17-59 17 AF 17  ¦TOfC??n+8n?Y?»?
A9 0C 25 F2-19 11 2C 45-5E 40 77 33-10 09 CE BD  ¬?%=??,E^@w3??++
61 CE 65 BB-8E E6 EE 3E-D5 78 29 85-1D F8 3A 39  a+e+Äµe>+x)à?°:9
85 B0 37 79-01 AF 7F 79-D8 60 1B 59-54 8D A6 03  à¦7y?»¦y+`?YTìª?
93 B9 DF 53-83 47 99 E1-1D 0F 5B 00-5A 22 20 1A  ô¦¯SâGÖß?¤[ Z" ?
A7 1D F2 FC-67 28 40 54-3B 12 6C 97-78 4A B5 A2  °?=ng(@T;?lùxJ¦ó
3B 6C B7 29-21 56 B1 A3-1C F1 71 E9-D6 C3 FC FD  ;l+)!V¦ú?±qT++n²
F8 F1 45 E8-7B DD 67 63-FA 62 67 6A-EA 33 0C FB  °±EF{¦gc·bgjO3?v
8F 90 98 2F-11 39 65 64-A3 11 7C C1-38 29 67 0E  ÅÉÿ/?9edú?|-8)g?
```

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