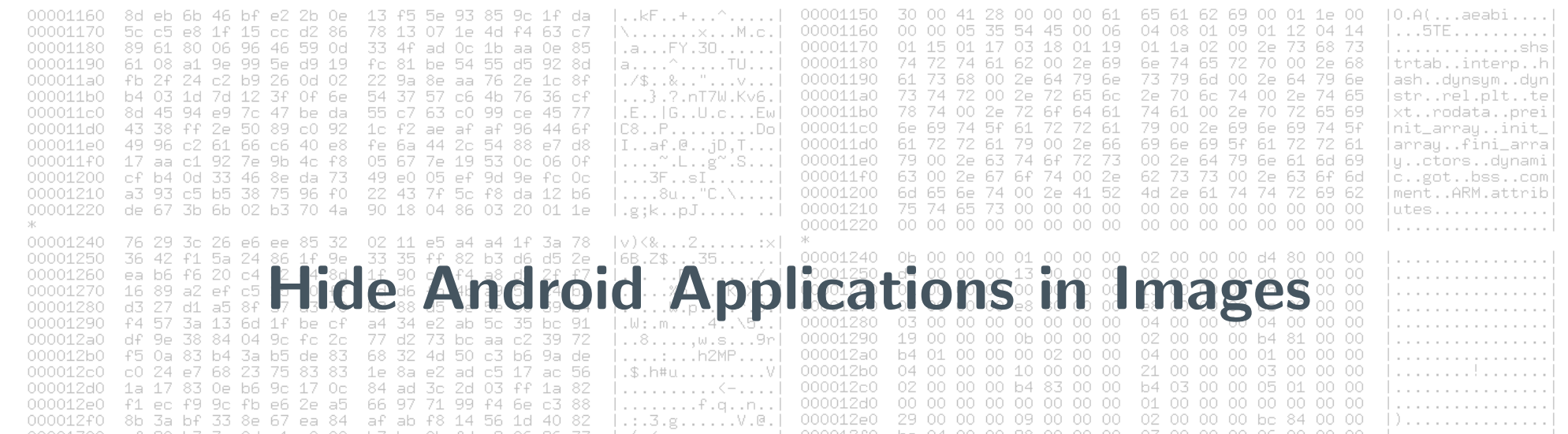


Hide Android Applications in Images

Axelle Apvrille - FortiGuard Labs, Fortinet
Ange Albertini, Corkami

BlackHat Europe, Amsterdam, NH
October 2014

FORTINET®

What is this all about?

Read the title! ;)

What is this all about?

Read the title! ;)

Hiding

What is this all about?

Read the title! ;)

Hiding Android Applications

What is this all about?

Read the title! ;)

Hiding Android Applications

in ...

What is this all about?

Read the title! ;)

Hiding Android Applications

in ... images

Who are we?

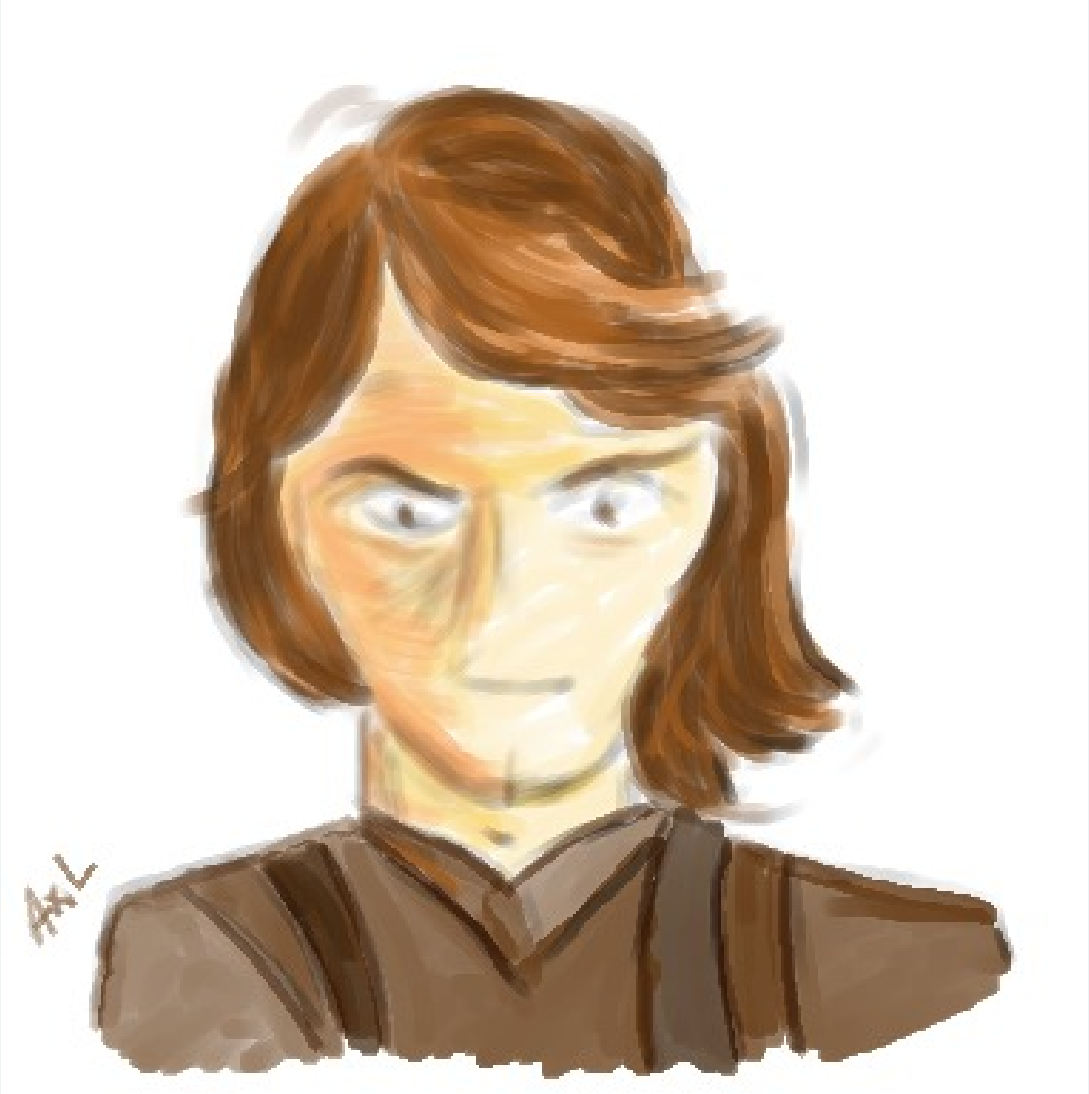
Axelle

```
axelle = {
  ‘‘realname’’ : ‘‘Axelle Apvrille’’,
  ‘‘job’’ : ‘‘Mobile/IoT Malware Analyst and Research’’,
  ‘‘company’’ : ‘‘Fortinet, FortiGuard Labs’’ }
```

Ange

```
ange = {
  ‘‘realname’’ : ‘‘Ange Albertini’’,
  ‘‘hobby’’ : ‘‘Corkami’’ }
```

What is this?



Nice? Thanks that's GIMP art from me ;)

It's an image!

file says...

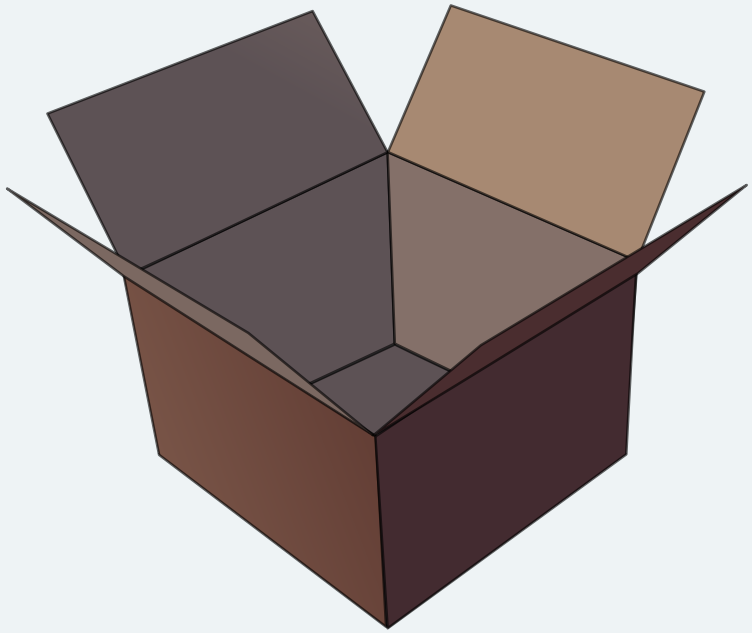
```
anakin.png: PNG image data, 636298042 x 1384184774, 19-bit
```

PNG file format

```
89 50 4e 47 0d 0a 1a 0a  00 01 b4 40 61 61 61 61  |.PNG.....@a
25 ed 23 3a 52 80 fb c6  13 cc 54 4d 74 f5 78 87  |%.#:R.....TMt
ba 7d b5 f6 93 63 43 f0  e0 b9 99 9b 37 06 cc 8f  |.}...cC.....7
32 59 5b 55 da 14 e2 87  68 f7 89 e5 88 14 fe 76  |2Y[U....h....
3e 0b cd 65 ec c4 7a 71  4d 95 c0 4e de 48 30 91  |>..e..zqM..N.
...
```

It is more than that!

AES Decrypt



Valid PNG

Valid Android Package (APK)

Embed this "PNG" in an Android app?

Imagine...

...if that PNG/APK is malicious!

- (Nearly) invisible to reverse engineering!
- The Android app is **encrypted**

Arg! What will I see?

- A **fat** image
- The wrapping application
  - Code that decrypts an asset
  - Code that loads/installs an application

But that depends how well the wrapping app is written

It can be *obfuscated*...

Demo

Party time!
Demo!
Wake up!

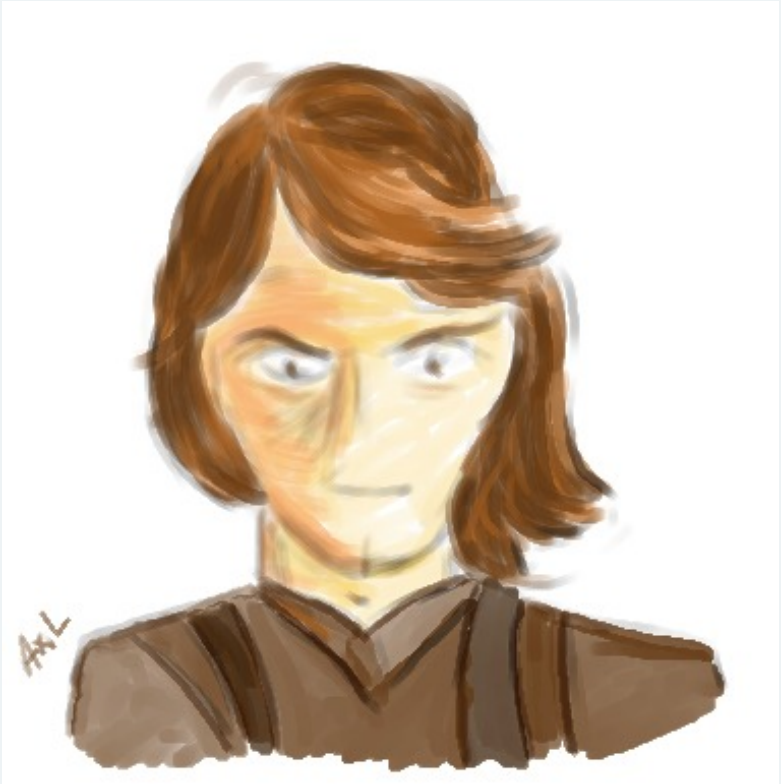
In case the demo crashes - lol

The APK looks genuine

```
Archive:  PocActivity-debug.apk
  Length      Date    Time    Name
---------  ---------- -----   ----
   508720  2014-09-11 13:41   assets/anakin.png
     1272  2014-09-11 14:03   res/layout/main.xml
     1988  2014-09-11 14:03   AndroidManifest.xml
     1444  2014-09-11 14:03   resources.arsc
     7515  2014-09-11 14:03   res/drawable-hdpi/logo.png
     2455  2014-09-11 14:03   res/drawable-ldpi/logo.png
     4471  2014-09-11 14:03   res/drawable-mdpi/logo.png
     8856  2014-09-11 14:03   classes.dex
      634  2014-09-11 14:03   META-INF/MANIFEST.MF
      687  2014-09-11 14:03   META-INF/CERT.SF
      776  2014-09-11 14:03   META-INF/CERT.RSA
---------                     -------
   538818                     11 files
```

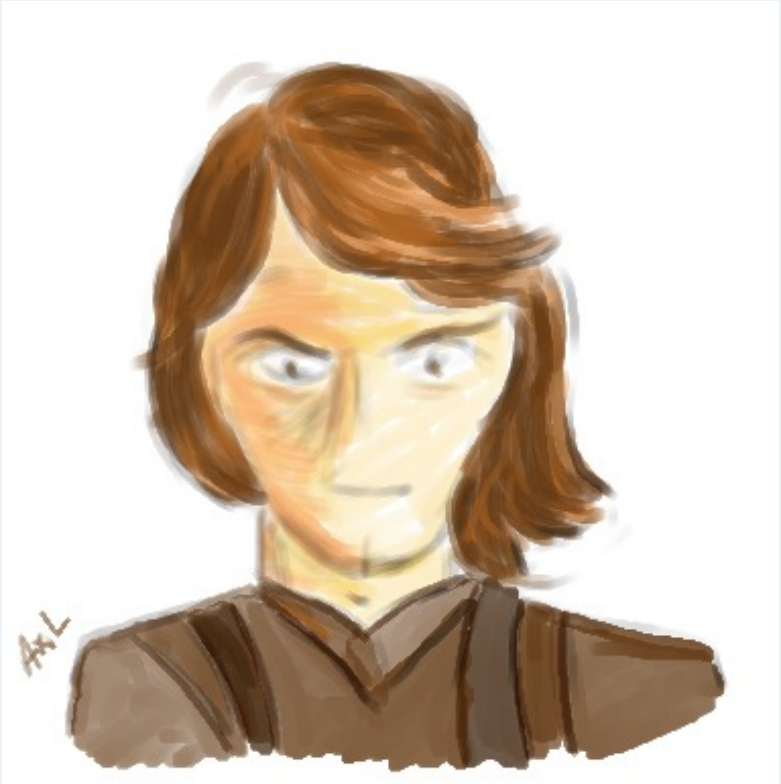
In case the demo crashes - lol

The image looks genuine: assets/anakin.png



In case the demo crashes - lol

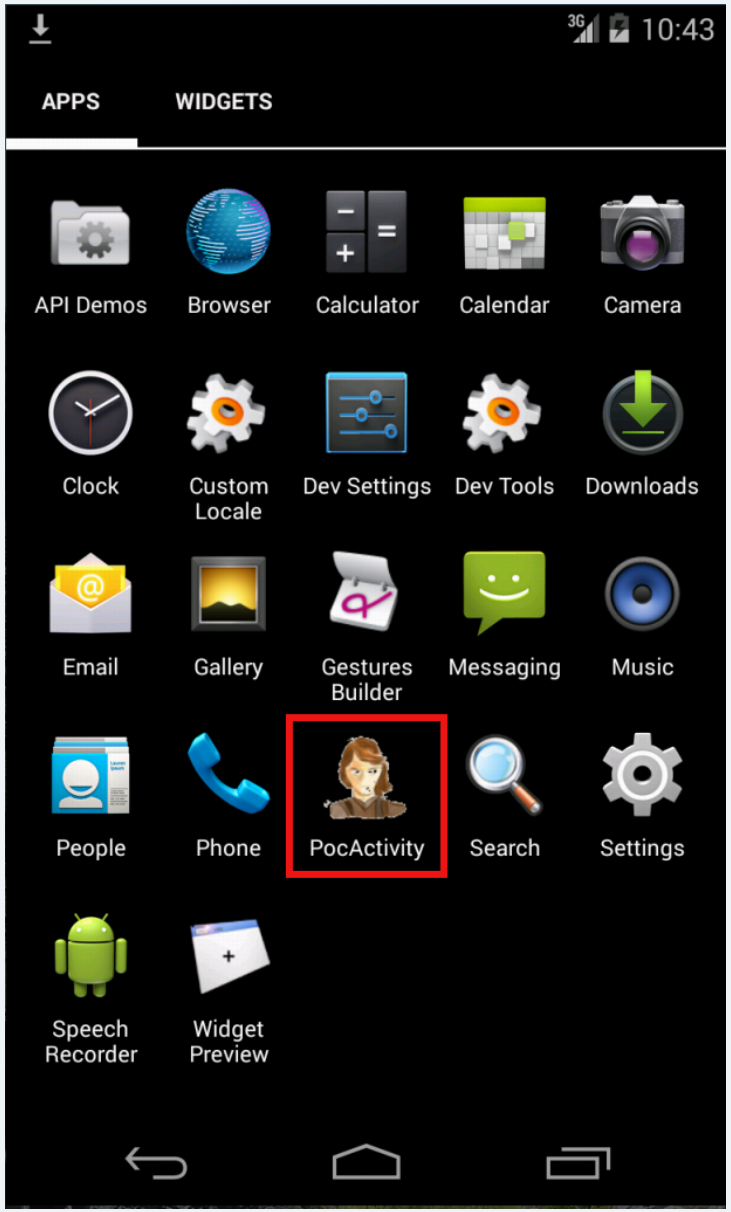
The image looks genuine: assets/anakin.png



Perhaps a bit 'fat'

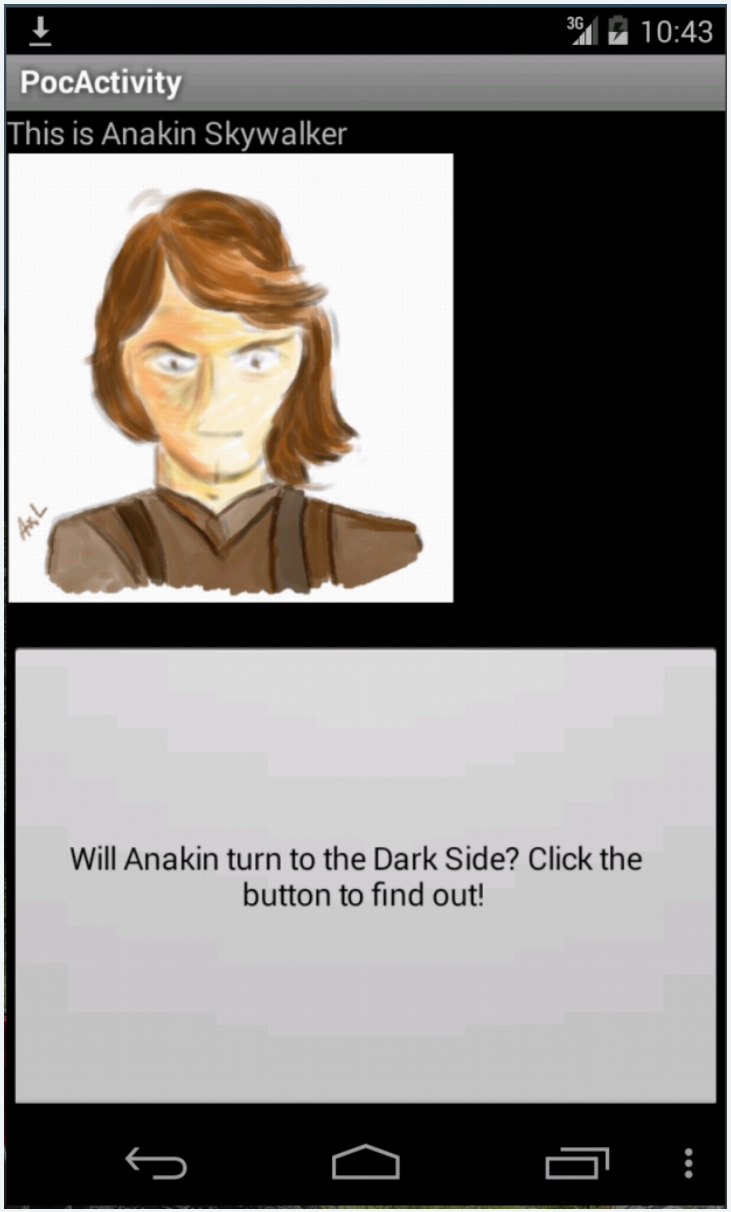
508720 bytes ($\approx$ 500K) for 382x385 pixels

In case the demo crashes - lol

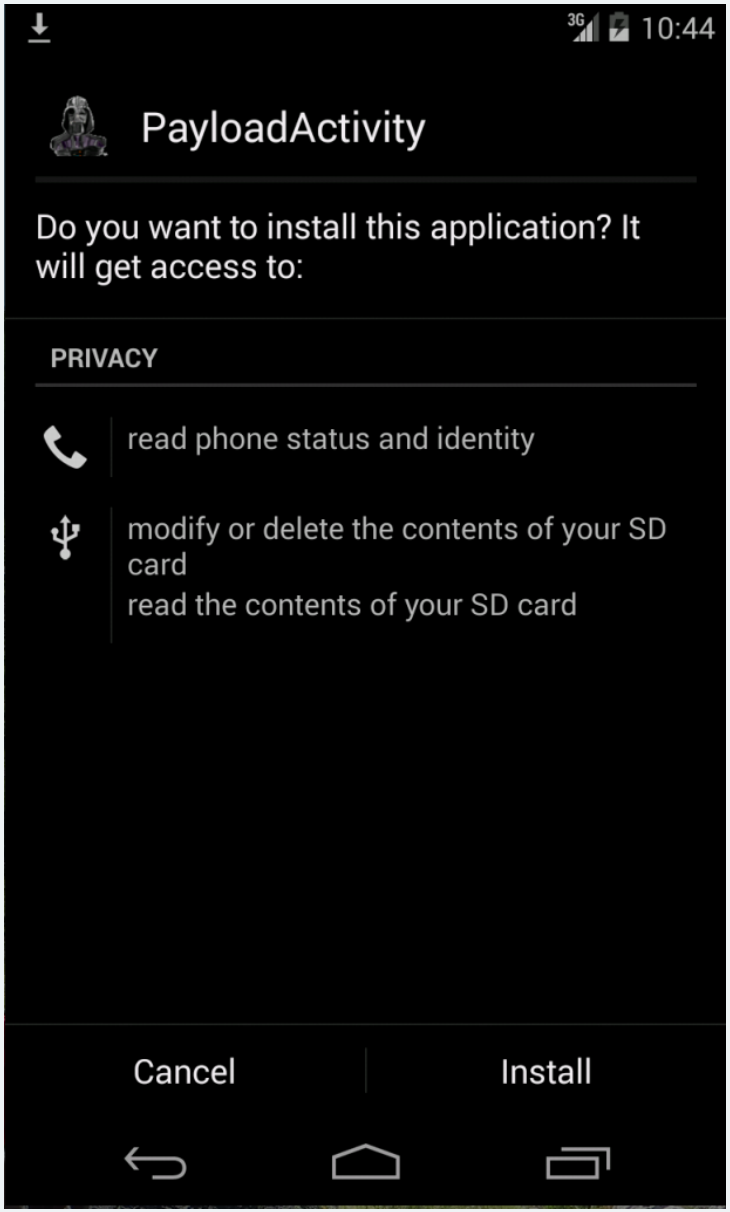



```
adb install
WrappingApk.apk
```

In case the demo crashes - lol

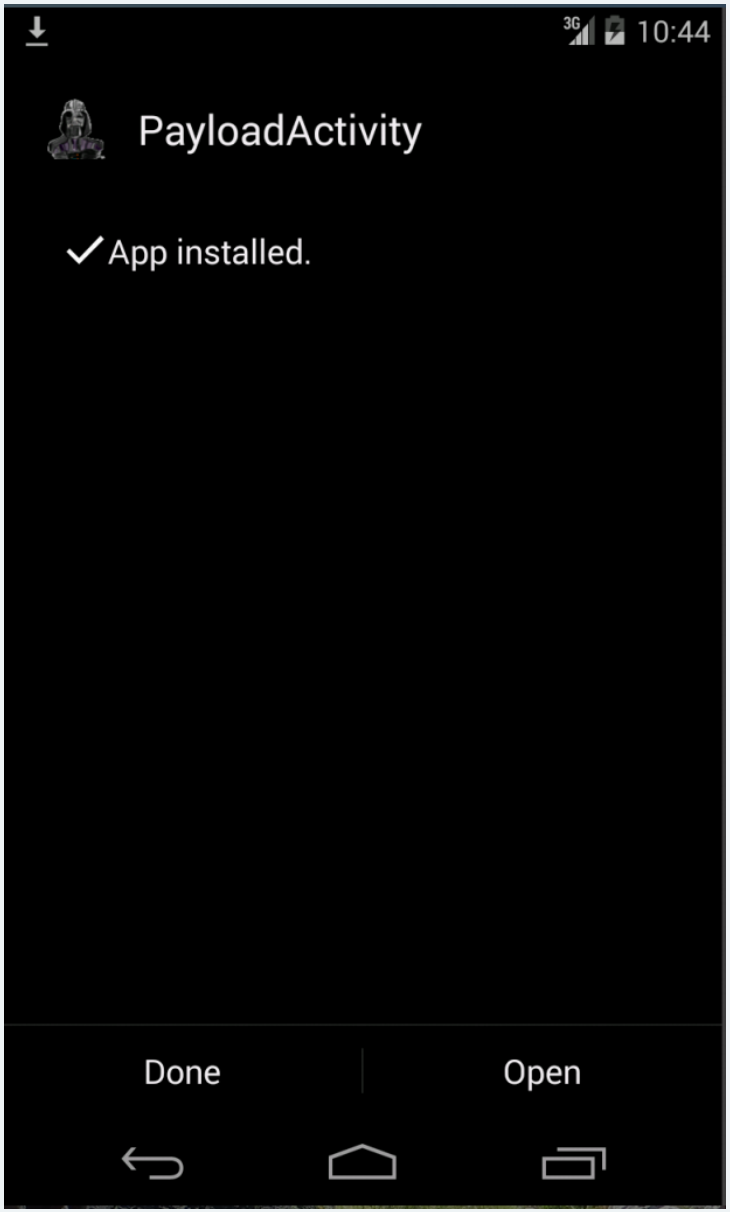


In case the demo crashes - lol



We could use `DexClassLoader` to hide this

In case the demo crashes - lol



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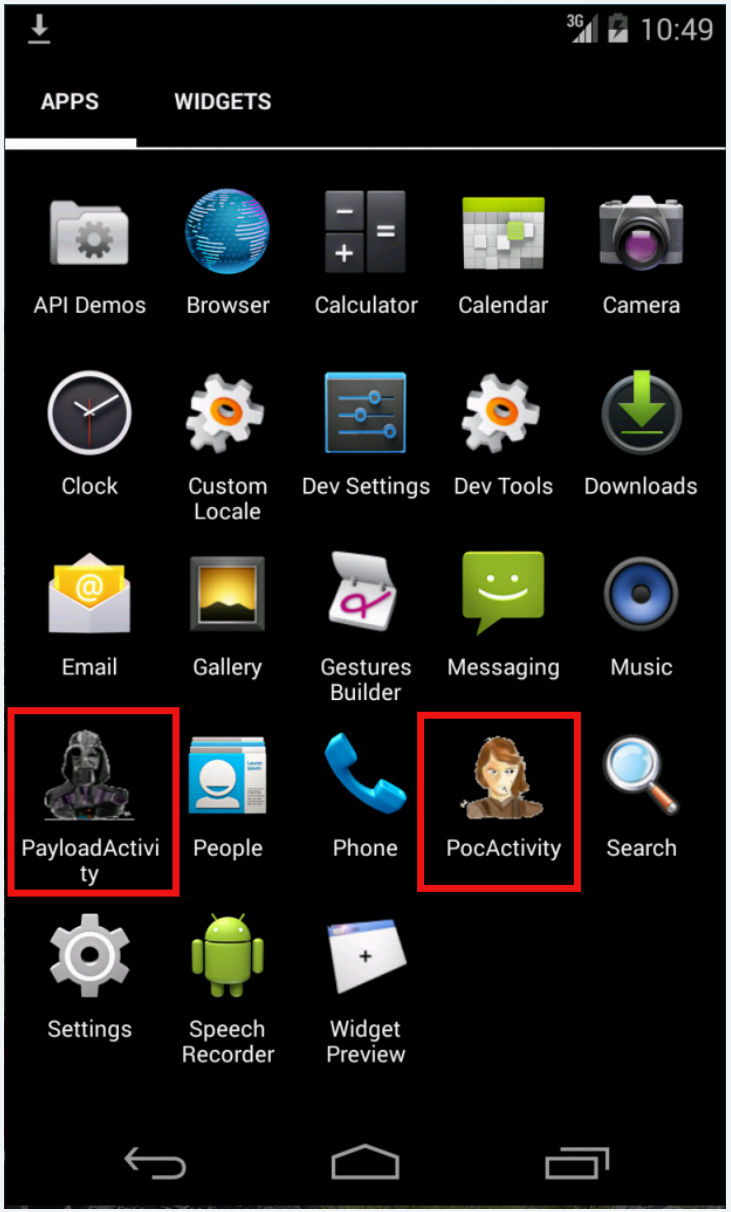
In case the demo crashes - lol



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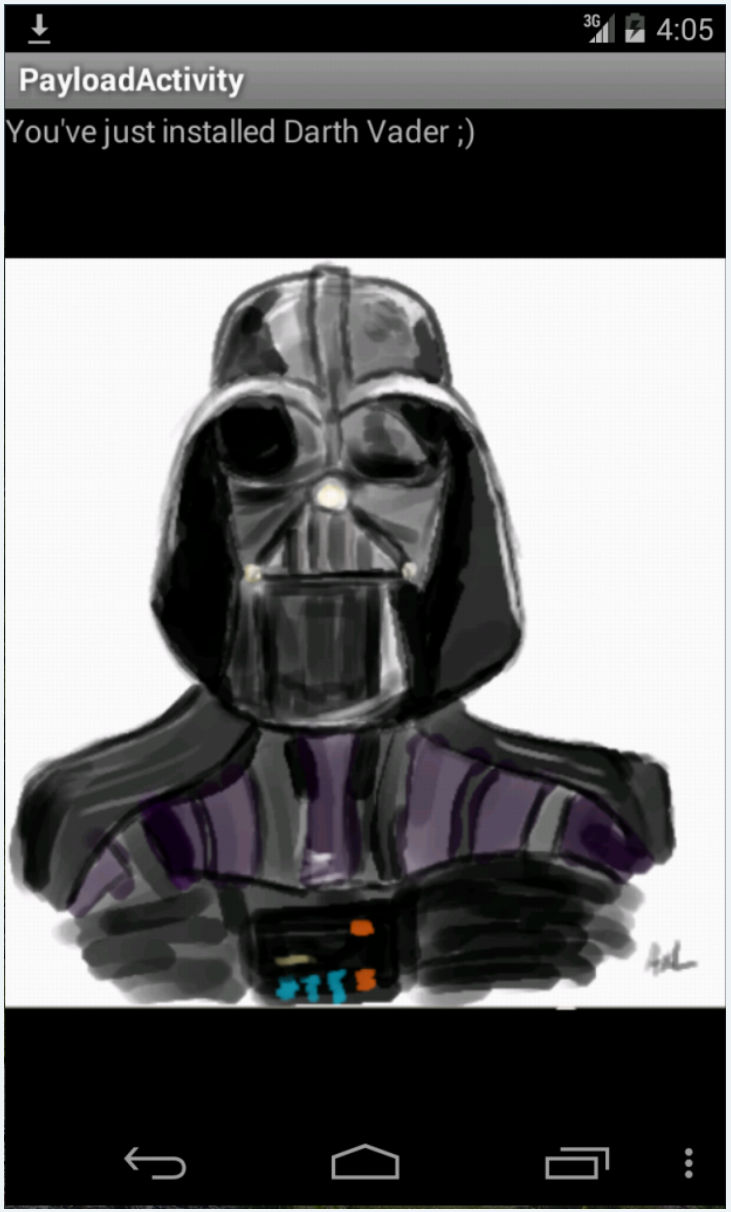

Payload gets executed

How do we do that?

1. We write a payload APK

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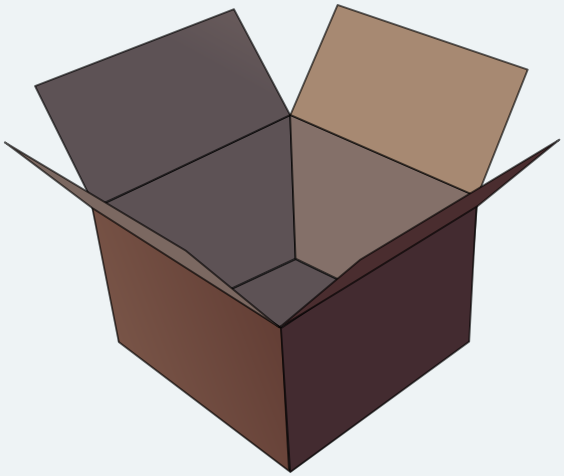
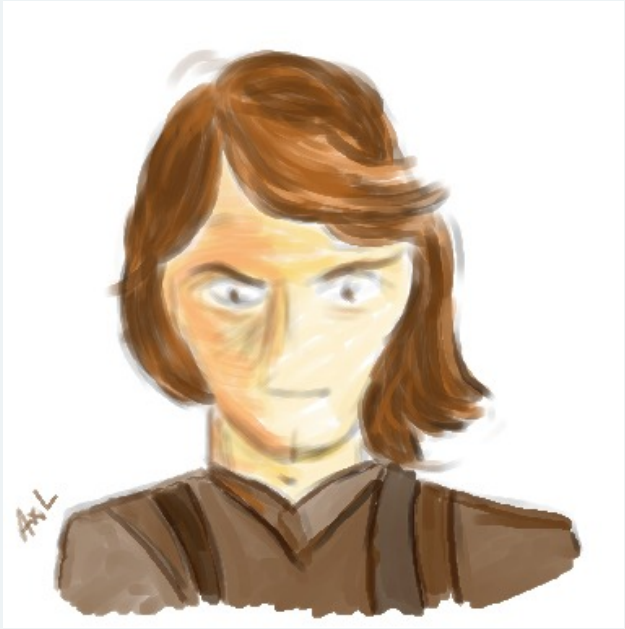
1. We write a payload APK
2. We encrypt it using AngeCryption: it looks like a valid PNG
3. We hack it (a little)
4. We implement another APK containing the PNG

Power: controlling encryption!



encrypt



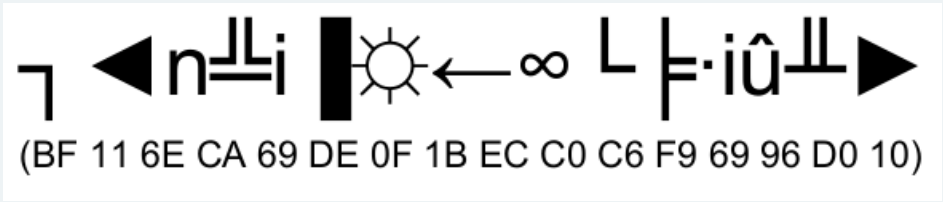
Android Package (APK)
Plaintext

Genuine PNG
Ciphertext

Is this possible?

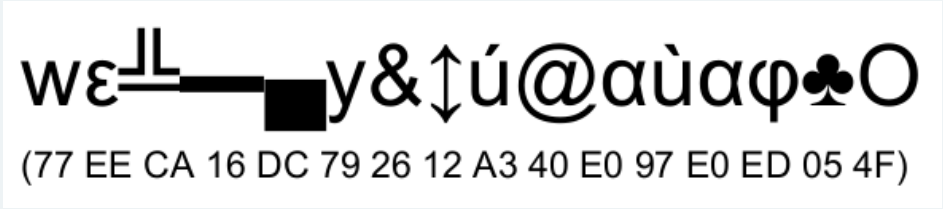
AES encryption in practice

key:'MySecretKey12345'
block:'a block of text.'



key:'MySecretKey12346'
block:'a block of text.'

key:'MySecretKey12345'
block:'a block of text!'



Can we control the output?

With a **tiny change** in the key in the key or the block, the output block is **completely different**

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We can't control the output
The output block is (more or less) 'unpredictable'

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With a **tiny change** in the key in the key or the block, the output block is **completely different**

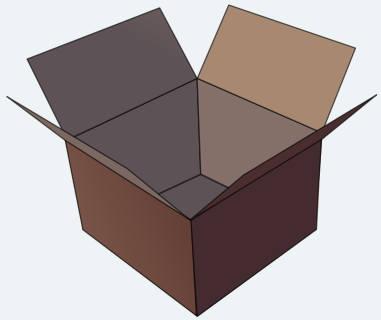
We can't control the output
The output block is (more or less) 'unpredictable'

Yes, we can!
But there's a **trick - AngeCryption**

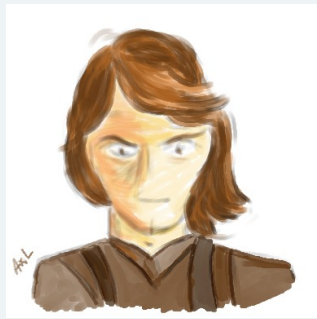
Controlling AES with AngeCryption

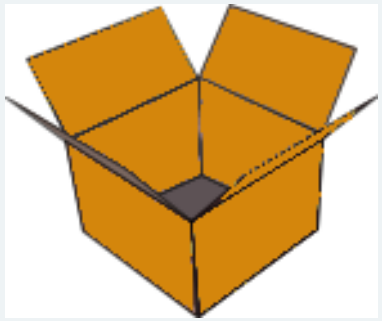
It will look the same ... but be slightly different

The APK **will look the same** to Android
The PNG **will look the same** to our eyes

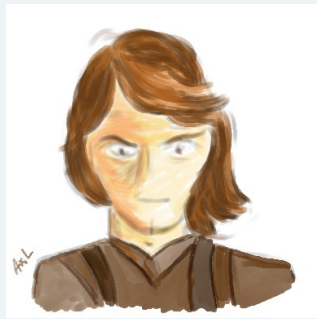


encrypt





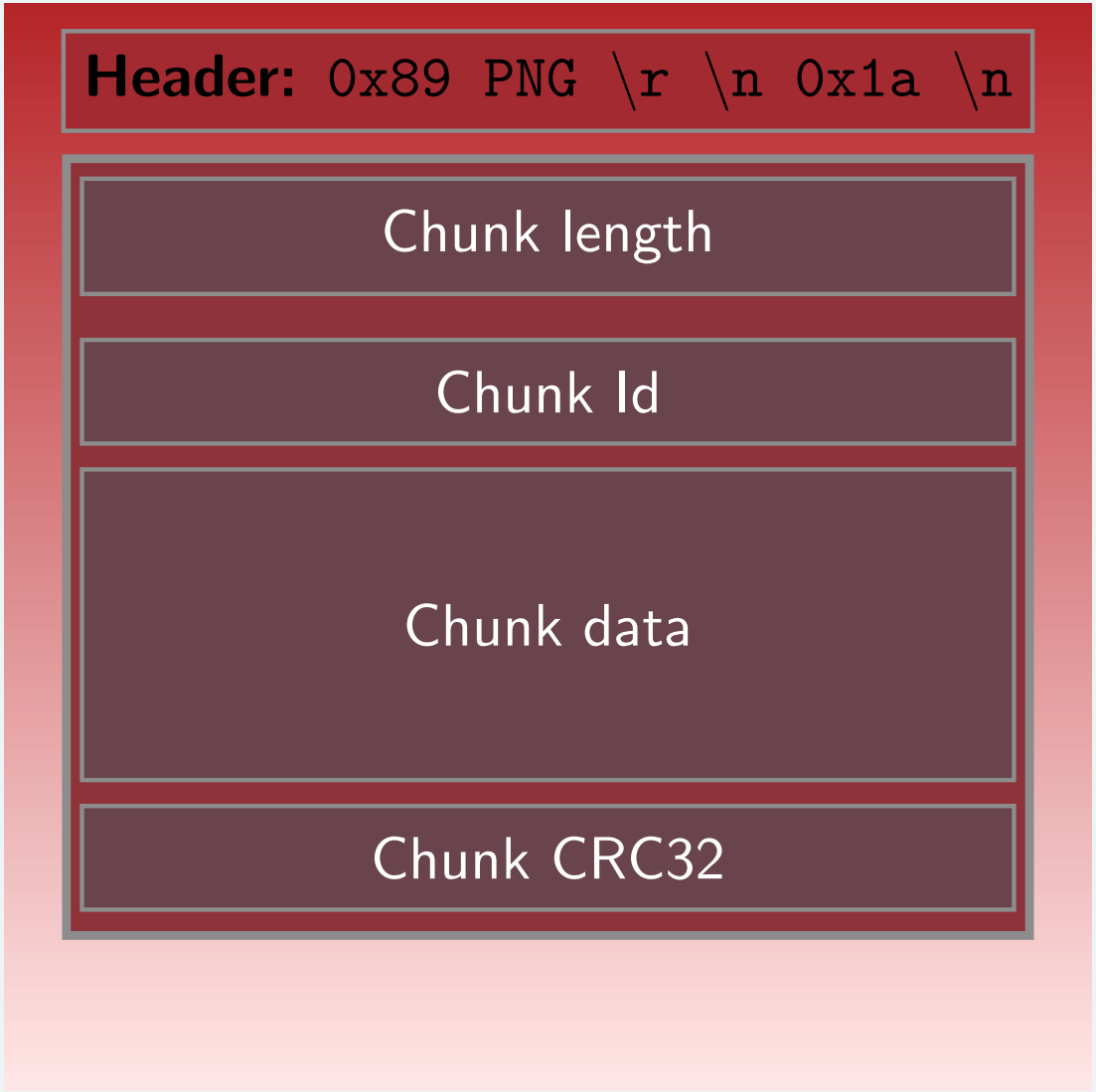
encrypt



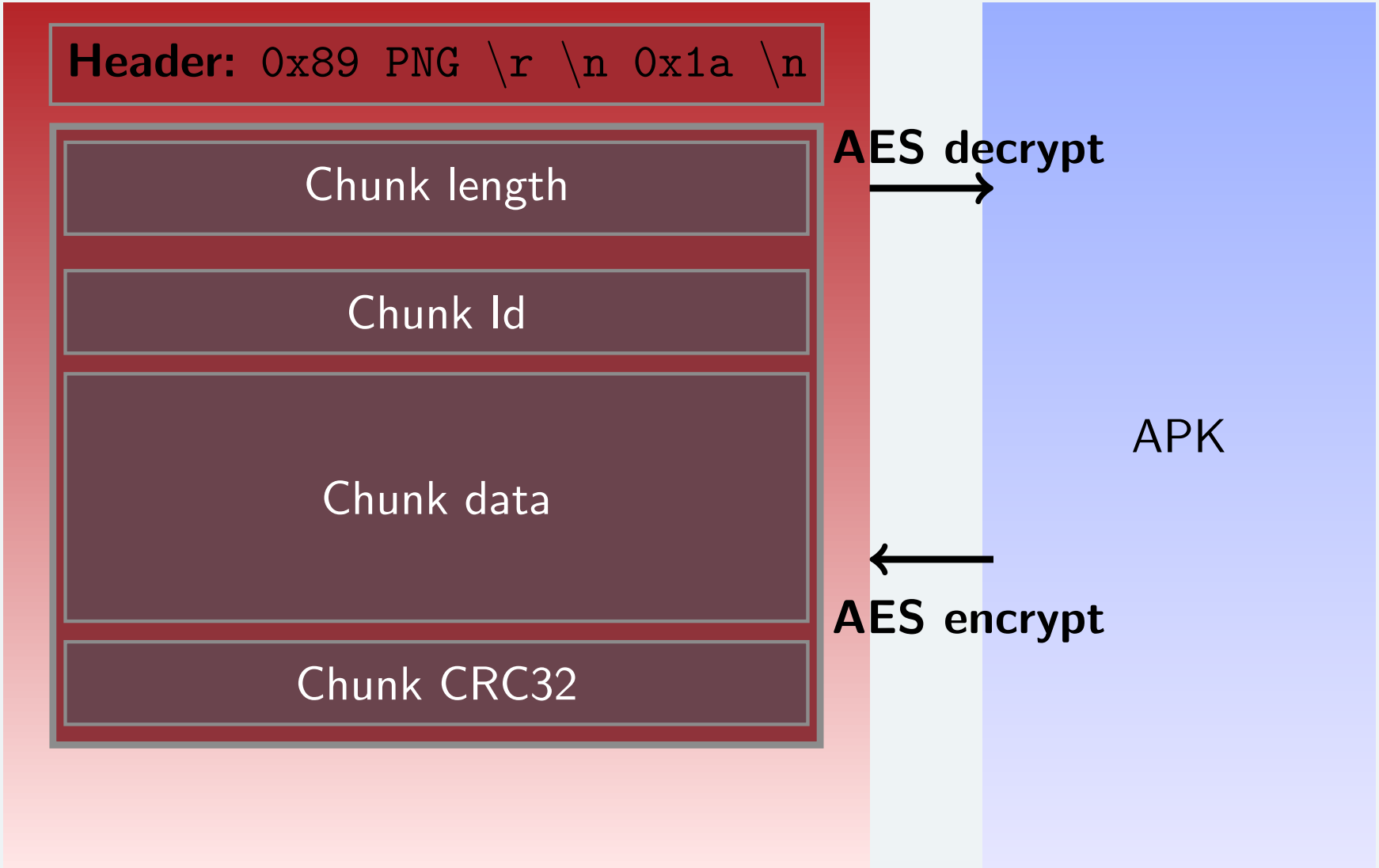
Android does not see the diff Your eye does not see the diff

Manipulate Plaintext so that it encrypts to this PNG

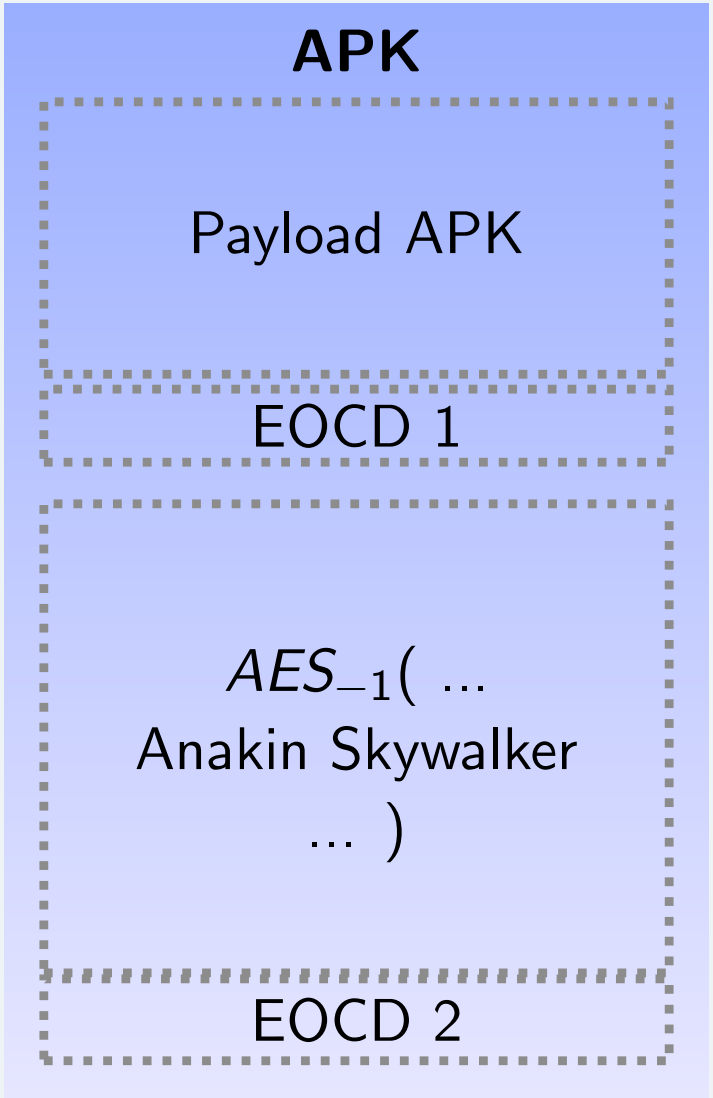
Trick no. 1: dummy PNG chunk



Trick no. 1: dummy PNG chunk



Trick no. 2: appended zip data



Crypto background

- AES is a **block cipher**
- It can only process a **block of 16 bytes**

What if my plaintext is longer?!

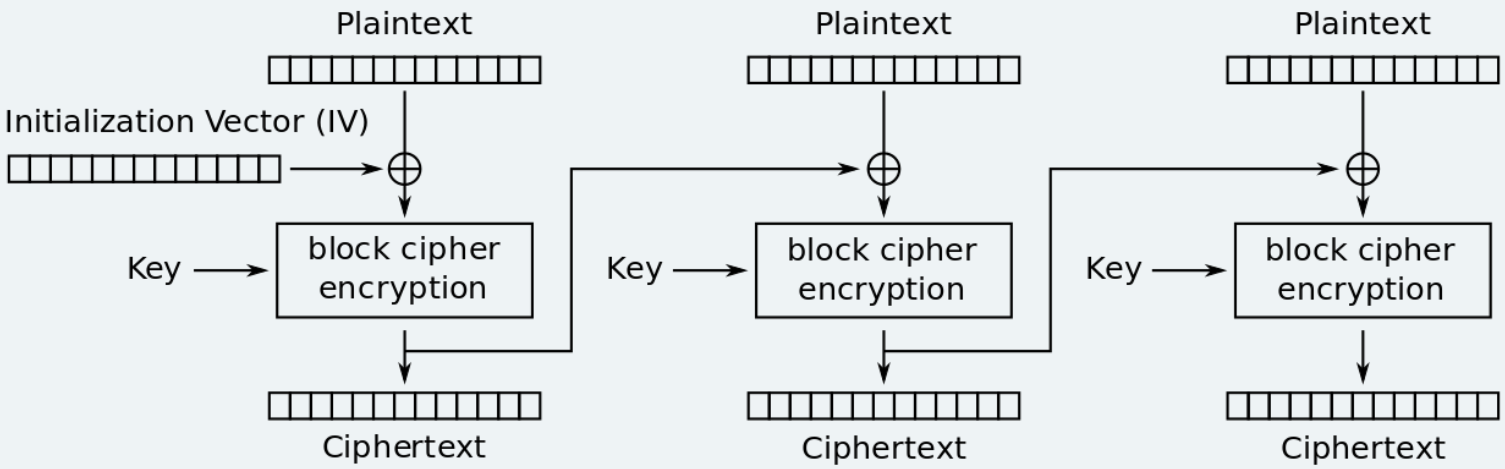
Chaining - 101

- We use **chaining**
- We apply **AES** on **block**
- ... well, that's for ECB (Electronic Code Book). Not very good.

Other chainings

- CBC, CFB, OFB... (see FIPS 81)
- We'll use **CBC** : **C**ipher **B**lock **C**haining

Cipher Block Chaining (CBC) - 101



Cipher Block Chaining (CBC) mode encryption

IV is **Initialization Vector**

Trick no.3: controlling first block

- We have our **plaintext** P_0 and **ciphertext** C_0
- We select a **key K**
- We compute **IV**: $IV = AES_K^{-1}(C_0) \oplus P_0$

Trick no.4: controlling other blocks

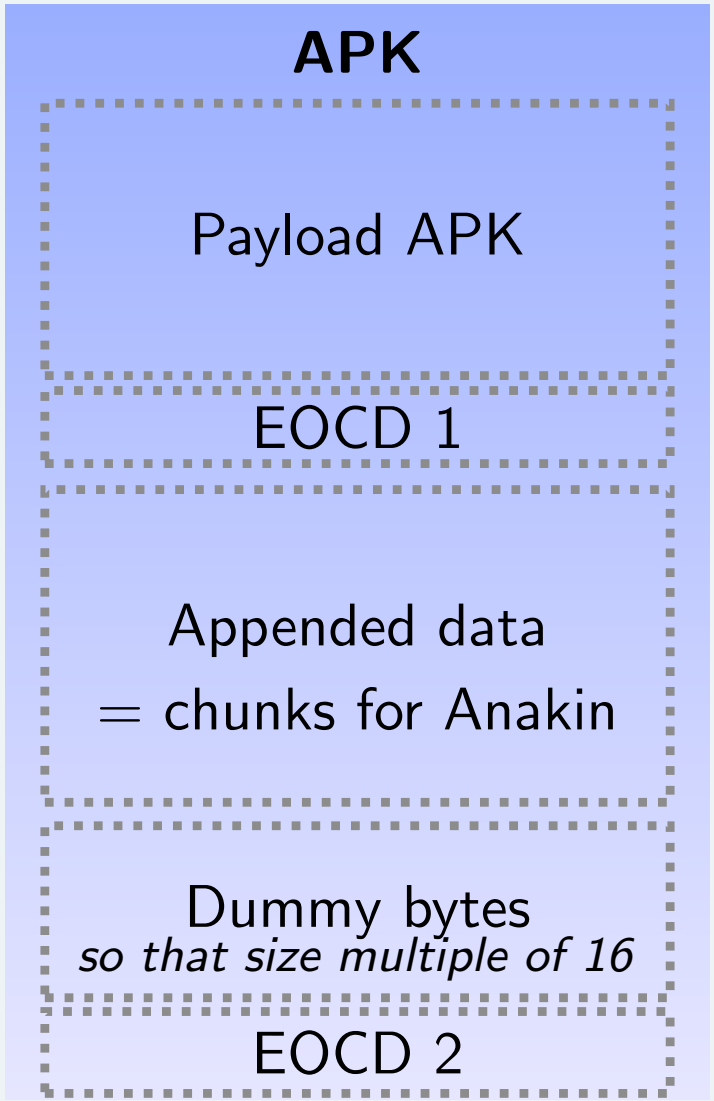
Basically... obvious!

Encrypting then decrypting is like doing nothing
and reciprocally

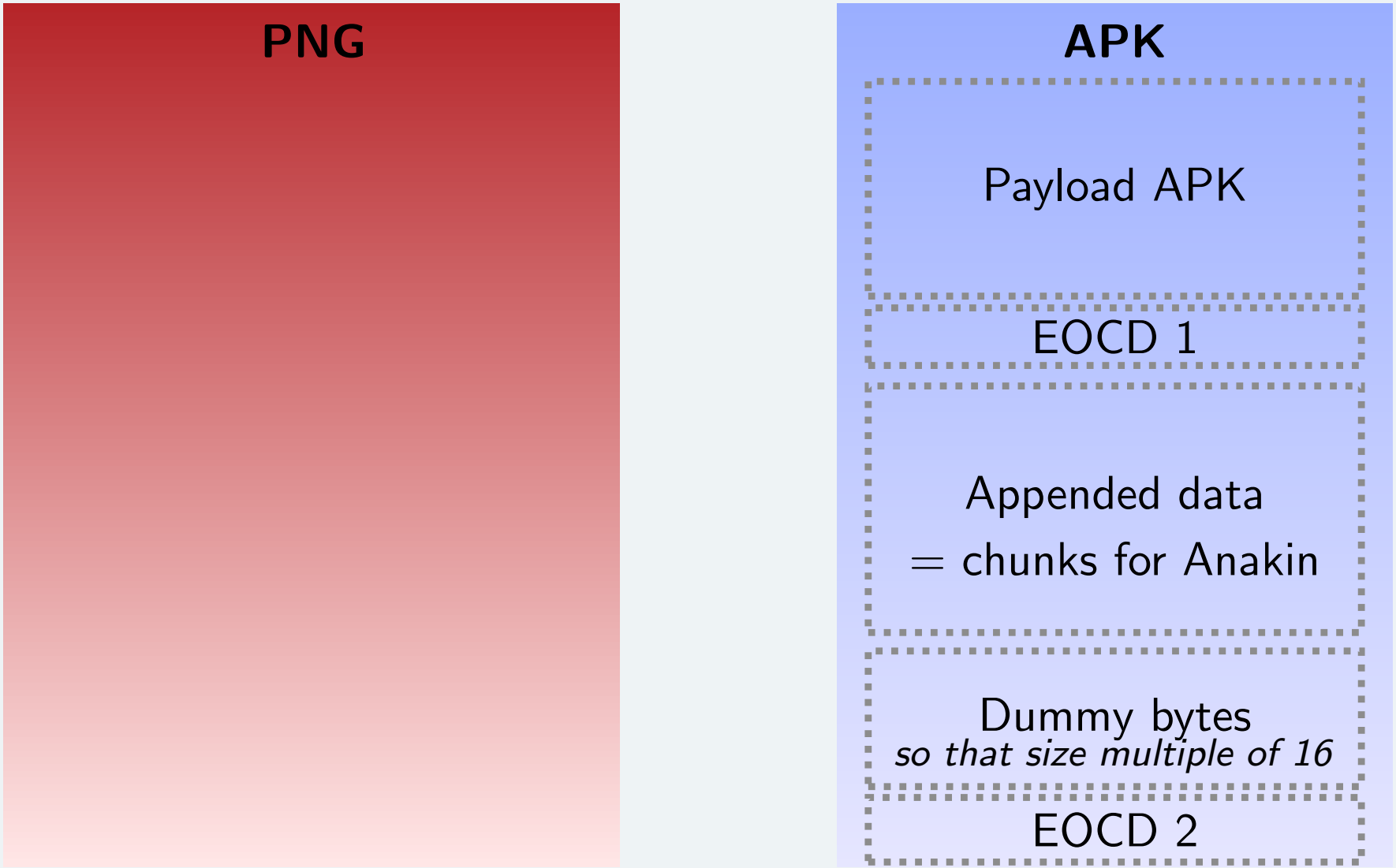
Want ciphertext to be bitmap of Anakin?

Select $plaintext = AES_{-1}(bitmapofAnakin)$
$AES(plaintext) = AES(AES_{-1}(bitmapofAnakin))$ = bitmap of Anakin

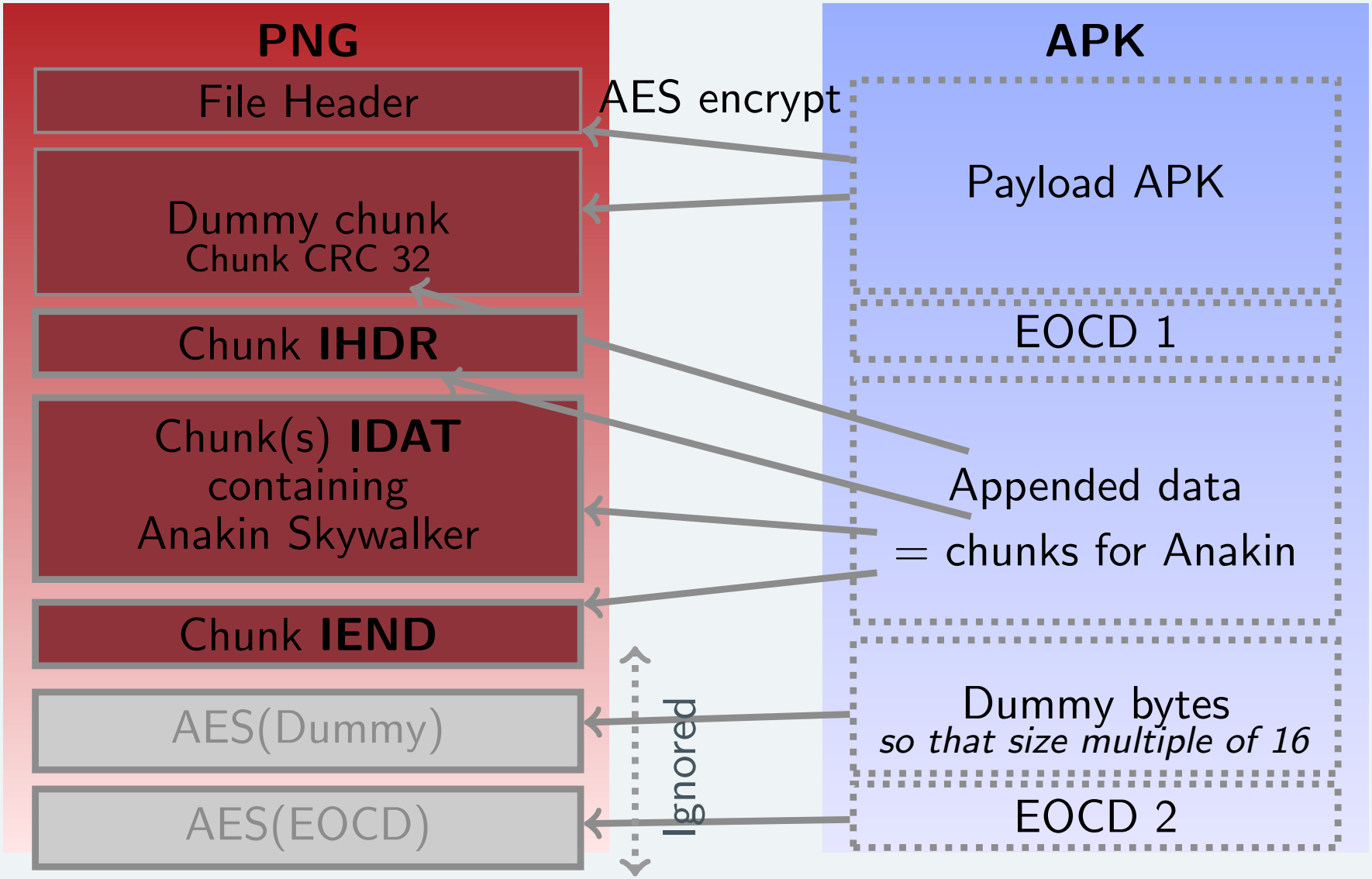
Full picture



Full picture



Full picture



Thank You !

Status

Works on Android 4.4.2

June 2014: Android Security Team notified $\approx$ fixed

Contact info

Me: **@cryptax** or `aapvrille` at `fortinet` dot `com`

Ange: **@angealbertini** or `ange` at `corkami` dot `com`

References

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

Code: https://github.com/cryptax/angeapk - *soon after conf'*

Corkami: https://code.google.com/p/corkami/

Fortinet's blog: http://blog.fortinet.com

Thanks to : @veorq, Android Security Team