WINDOWS PHONE 8 APPLICATION SECURITY

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About us

Dmitriy ‘D1g1’ Evdokimov

- Security researcher at ERPScan
    - Mobile security, RE, fuzzing, exploit dev etc.
- Editor of Russian hacking magazine
- DEFCON Russia (DCG #7812) co-organizer

Andrey Chasovskikh

- Software developer
- Windows Phone addict

Agenda

- Intro
- Security model
- First steps in Windows Phone 8
- Applications
- Application security
- Conclusion

INTRO

(ROOT@DRONE USER)# EOF 2011-01-13 15:01:58 (244 MB/S) - 'FONDO.PNG' SAVED (9045)

Intro

- 29 Oct 2012 – Windows Phone 8 released
- Based on Windows 8 core
  - ARM architecture
- Market share: 3,2% (Q1 2013, IDC)
- 145 000+ applications in Windows Phone Store

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SECURITY MODEL

Chambers

- Trusted Computing Base (TCB)

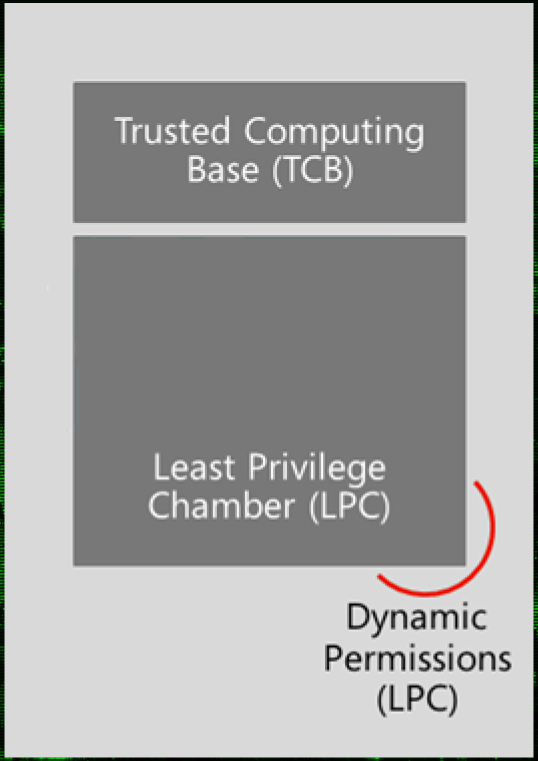
  Kernel, kernel-mode drivers

- Least Privileged Chamber (LPC)

  All other software: services,

  pre-installed apps,

  application from WP store


Trusted Computing Base (TCB)
Least Privilege Chamber (LPC)
Dynamic Permissions (LPC)

Capabilities

WMAppManifest.xml

Developers

- Network
- Camera
- NFC
- SD card access
- Wallet
- Speech recognition
- Front camera

Etc.

Total 27

OEM Developers

- Cell API
- Device management

Etc.

Total 39

System

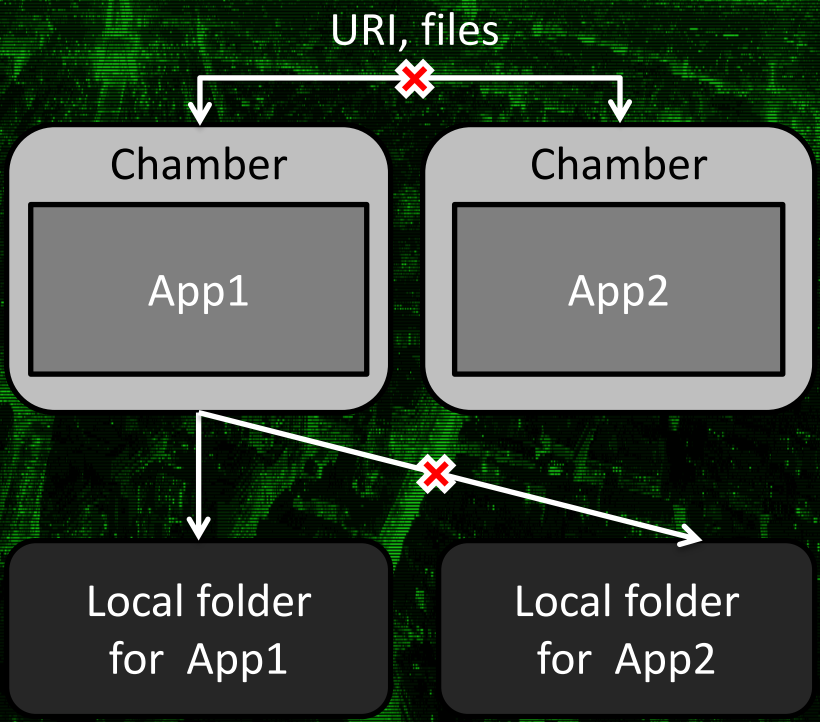
- Debug
- SMS API
- Live ID
- SIM API

Etc.

Total 350+

Sandboxing

- File system structure is hidden
- Local folder
  - Former isolated storage
- Limited app-to-app communication

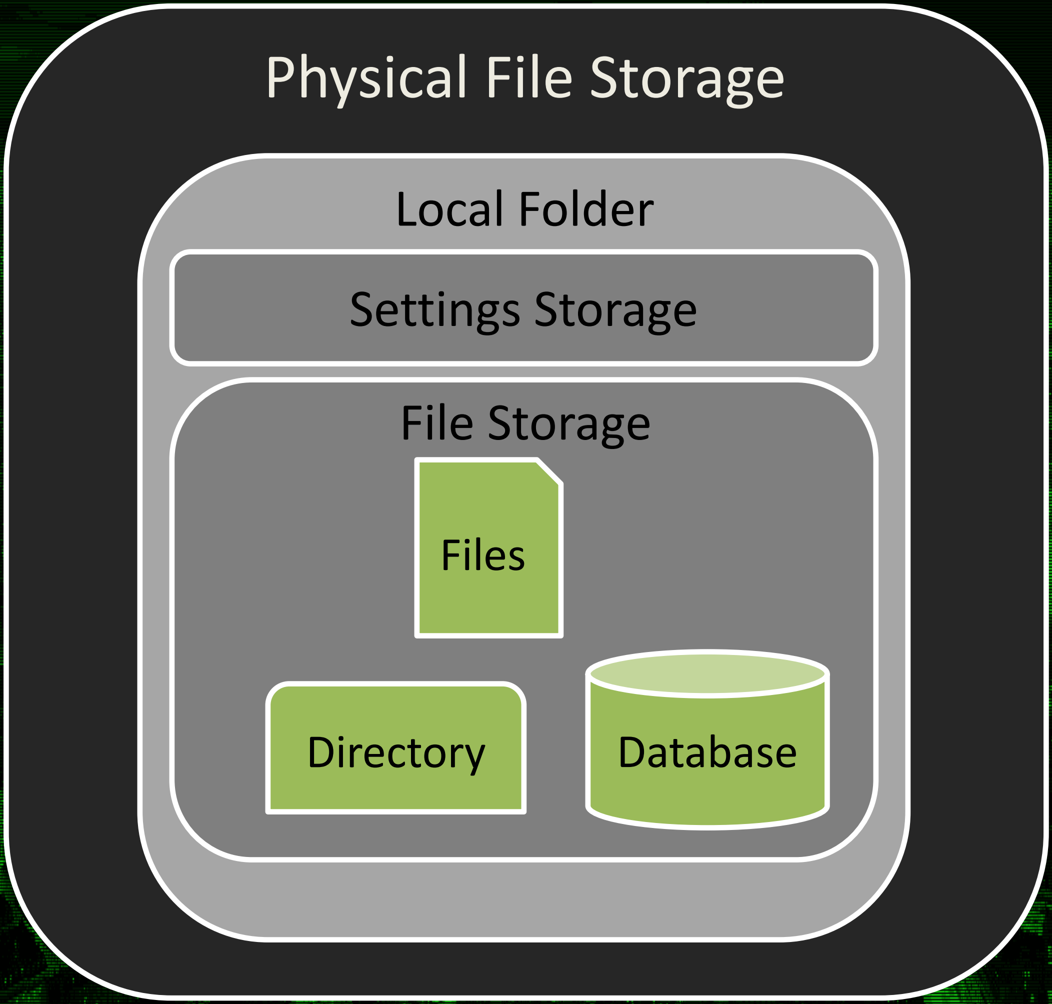


App-to-app communication

- File types associations
  - LaunchFileAsync()
  - Reserved: xap, msi, bat, cmd, py, jar etc.

- URI associations
  - LaunchUriAsync()
  - Reserved: http, tel, wallet, LDAP, rlogin, telnet etc.
  - Proximity communication using NFC

Local folder



Physical File Storage

Local Folder

Settings Storage

File Storage

Files

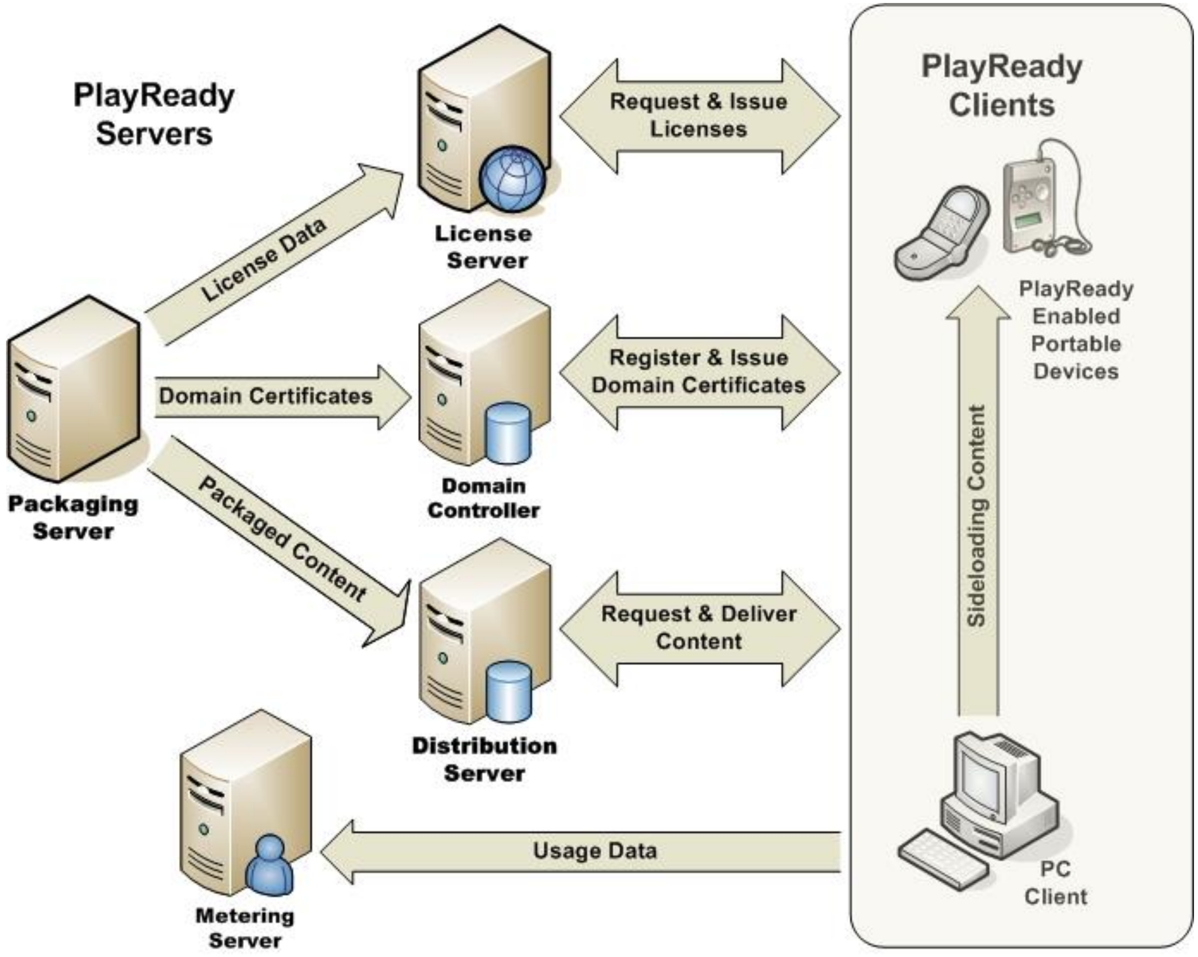
Directory

Database

Application protection

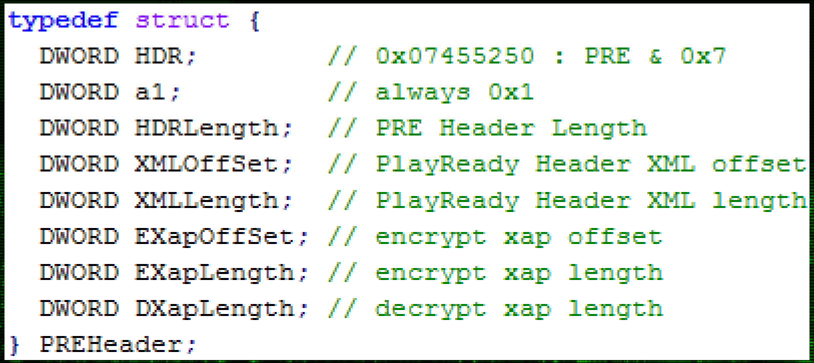
- All binaries are signed
- Application file is signed
  - Kind of checksum file is put into applications
- Certificate pinning for Store
- XAP file has DRM key

The Microsoft PlayReady Ecosystem

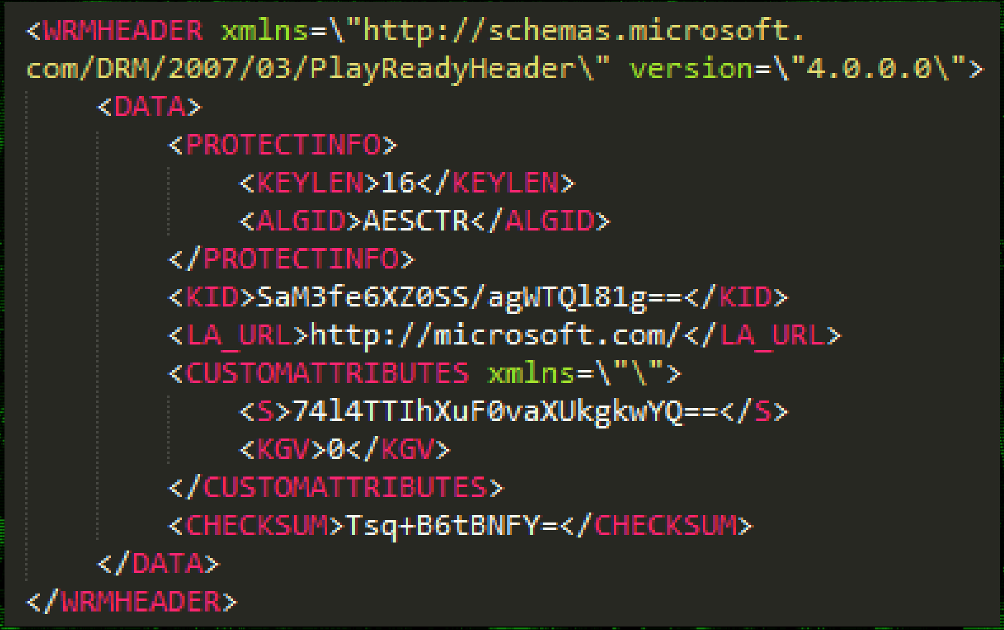


XAP file protection

- Before august 2012
  - ZIP archive
  - Sign
- After august 2012
  - New file format
  - PlayReady Header
  - AESCTR algorithm



```
typedef struct {
  DWORD HDR;          // 0x07455250 : PRE & 0x7
  DWORD a1;           // always 0x1
  DWORD HDRLength;    // PRE Header Length
  DWORD XMLOffSet;    // PlayReady Header XML offset
  DWORD XMLLength;    // PlayReady Header XML length
  DWORD EXapOffSet;   // encrypt xap offset
  DWORD EXapLength;   // encrypt xap length
  DWORD DXapLength;   // decrypt xap length
} PREHeader;
```



```
<WRMHEADER xmlns=\"http://schemas.microsoft.
com/DRM/2007/03/PlayReadyHeader\" version=\"4.0.0.0\">
    <DATA>
        <PROTECTINFO>
            <KEYLEN>16</KEYLEN>
            <ALGID>AESCTR</ALGID>
        </PROTECTINFO>
        <KID>SaM3fe6XZ0SS/agWTQl81g==</KID>
        <LA_URL>http://microsoft.com/</LA_URL>
        <CUSTOMATTRIBUTES xmlns=\"\">
            <S>74l4TTIhXuF0vaXUkgkwYQ==</S>
            <KGV>0</KGV>
        </CUSTOMATTRIBUTES>
        <CHECKSUM>Tsq+B6tBNFY=</CHECKSUM>
    </DATA>
</WRMHEADER>
```

FIRST STEPS IN WINDOWS PHONE 8

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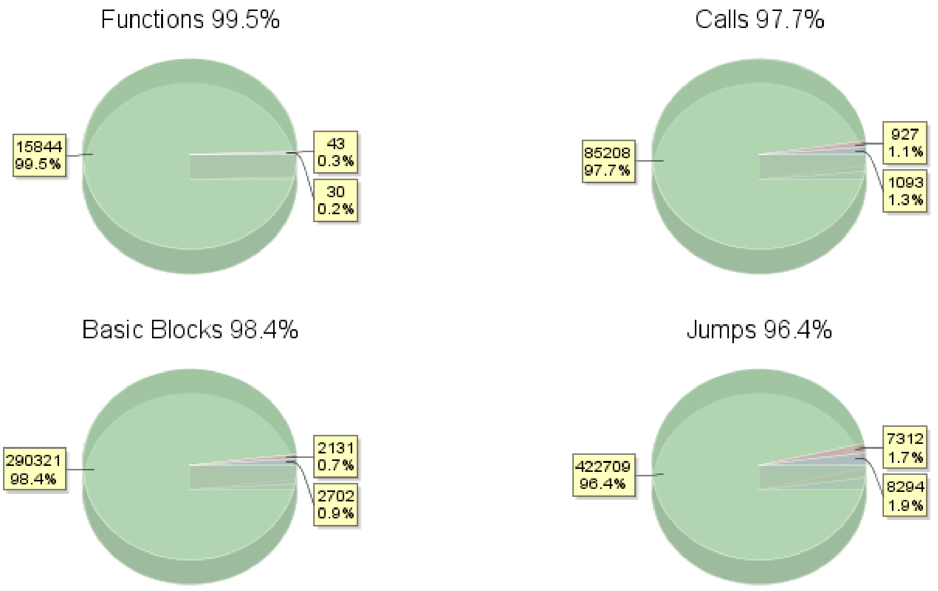
Windows 8 vs Windows Phone 8

- WP8 is migrating from the WinCE core to the WinNT core
- Win8/emulator (x86)
- WinRT/device (ARM)



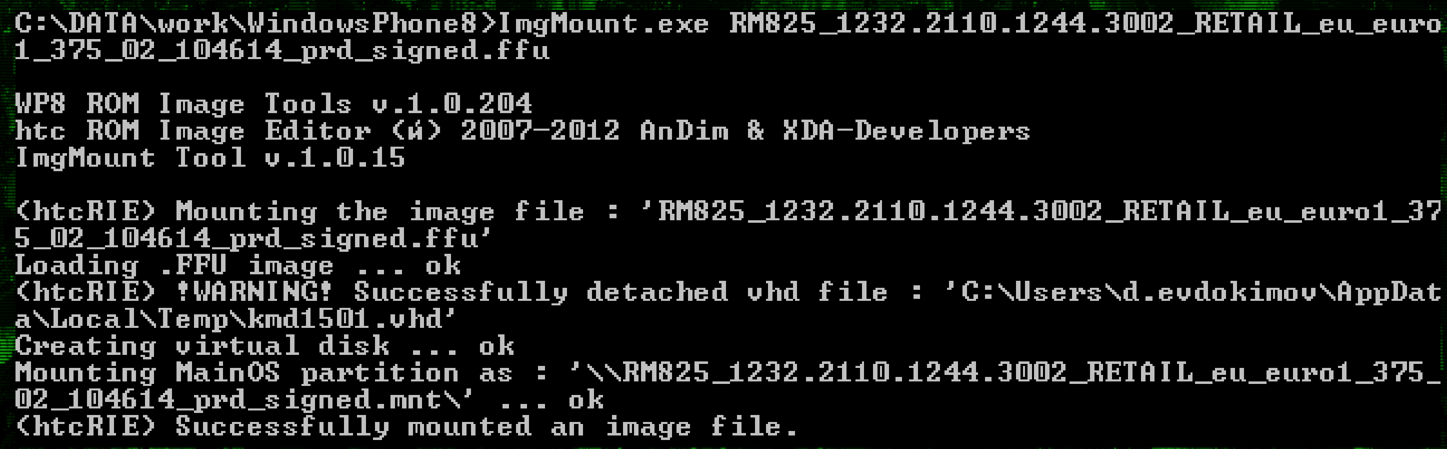
http://intrepidusgroup.com/insight/2012/12/windows-phone-8-and-windows-8-similarity/

WP8 emulator

- **Hyper-V images**
  - %ProgramFiles(x86)%\Microsoft SDKs\Windows Phone\v8.0\Emulation\Images\
- **Emulator vs. Device**
  - x86
  - Fake binaries
    - FakeLed.sys, Fakevibra.sys, FakeModem.dll etc.
  - Different user-agent
  - Prohibited to install apps from the Store

WP8 device

- Windows Phone 8 has standardized bootloader
  – Full flash images are available
- ImgMount tool
  – FFU Image file as a virtual hard drive



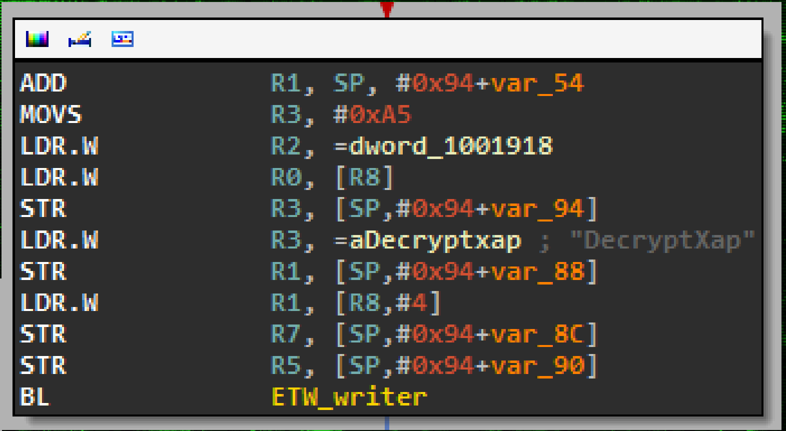
```
C:\DATA\work\WindowsPhone8>ImgMount.exe RM825_1232.2110.1244.3002_RETAIL_eu_euro
1_375_02_104614_prd_signed.ffu

WP8 ROM Image Tools v.1.0.204
htc ROM Image Editor (ώ) 2007-2012 AnDim & XDA-Developers
ImgMount Tool v.1.0.15

(htcRIE) Mounting the image file : 'RM825_1232.2110.1244.3002_RETAIL_eu_euro1_37
5_02_104614_prd_signed.ffu'
Loading .FFU image ... ok
(htcRIE) !WARNING! Successfully detached vhd file : 'C:\Users\d.evdokimov\AppDat
a\Local\Temp\kmd1501.vhd'
Creating virtual disk ... ok
Mounting MainOS partition as : '\\RM825_1232.2110.1244.3002_RETAIL_eu_euro1_375_
02_104614_prd_signed.mnt\' ... ok
(htcRIE) Successfully mounted an image file.
```

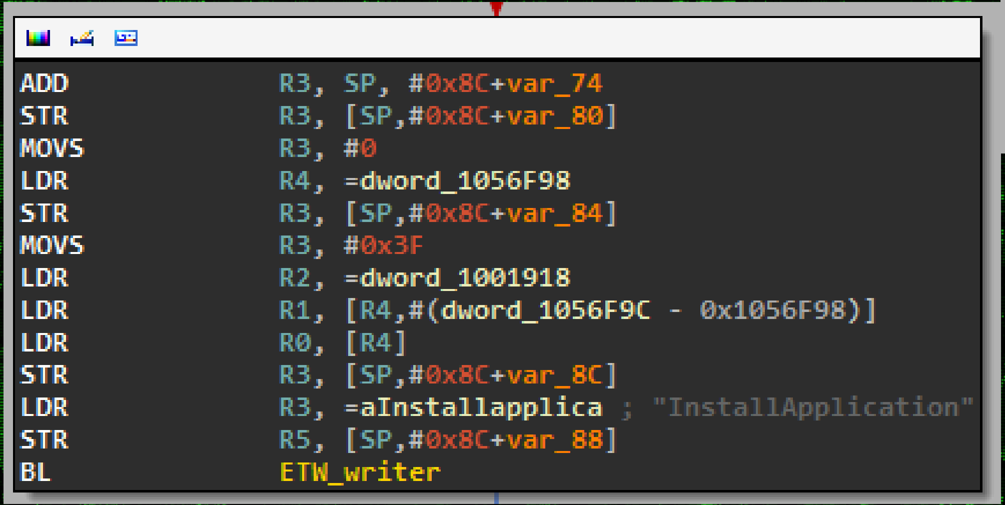
Reversing WP8 internals

- No debug symbols
- Tip: restore information from Event Tracing for Windows (ETW)
- Use IDAPython



```
ADD             R1, SP, #0x94+var_54
MOVS            R3, #0xA5
LDR.W           R2, =dword_1001918
LDR.W           R0, [R8]
STR             R3, [SP,#0x94+var_94]
LDR.W           R3, =aDecryptxap ; "DecryptXap"
STR             R1, [SP,#0x94+var_88]
LDR.W           R1, [R8,#4]
STR             R7, [SP,#0x94+var_8C]
STR             R5, [SP,#0x94+var_90]
BL              ETW_writer
```

*InstallerWorker.exe



```
ADD             R3, SP, #0x8C+var_74
STR             R3, [SP,#0x8C+var_80]
MOVS            R3, #0
LDR             R4, =dword_1056F98
STR             R3, [SP,#0x8C+var_84]
MOVS            R3, #0x3F
LDR             R2, =dword_1001918
LDR             R1, [R4,#(dword_1056F9C - 0x1056F98)]
LDR             R0, [R4]
STR             R3, [SP,#0x8C+var_8C]
LDR             R3, =aInstallapplica ; "InstallApplication"
STR             R5, [SP,#0x8C+var_88]
BL              ETW_writer
```

Windows API calls

- Full Windows API is not available by default
- Originally posted on XDA for WindowsRT apps
  - Find kernerbase.dll address (“MZ”) -> Get “LoadLibraryA” and “GetProcAddress” functions -> call any function you want
  - http://bit.ly/Uw2Gk6
- Works for Windows Phone 8

APPLICATIONS

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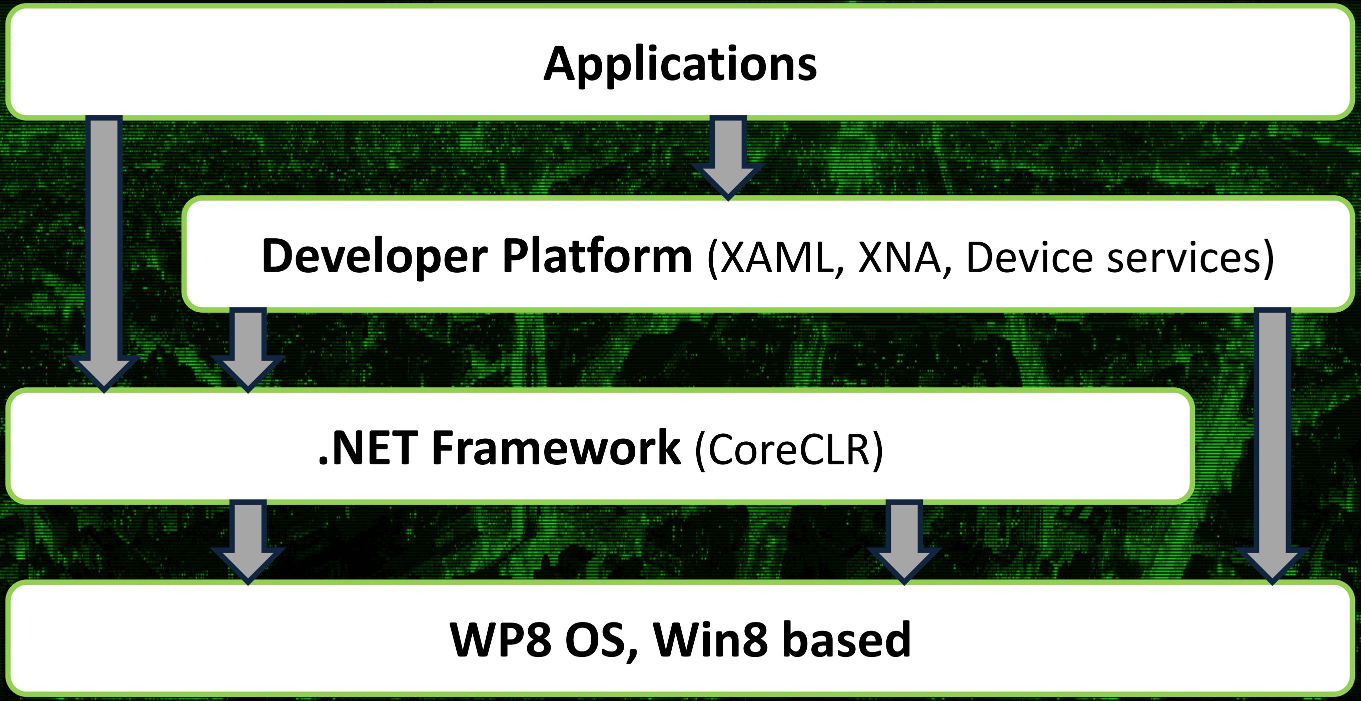
.NET and CLR



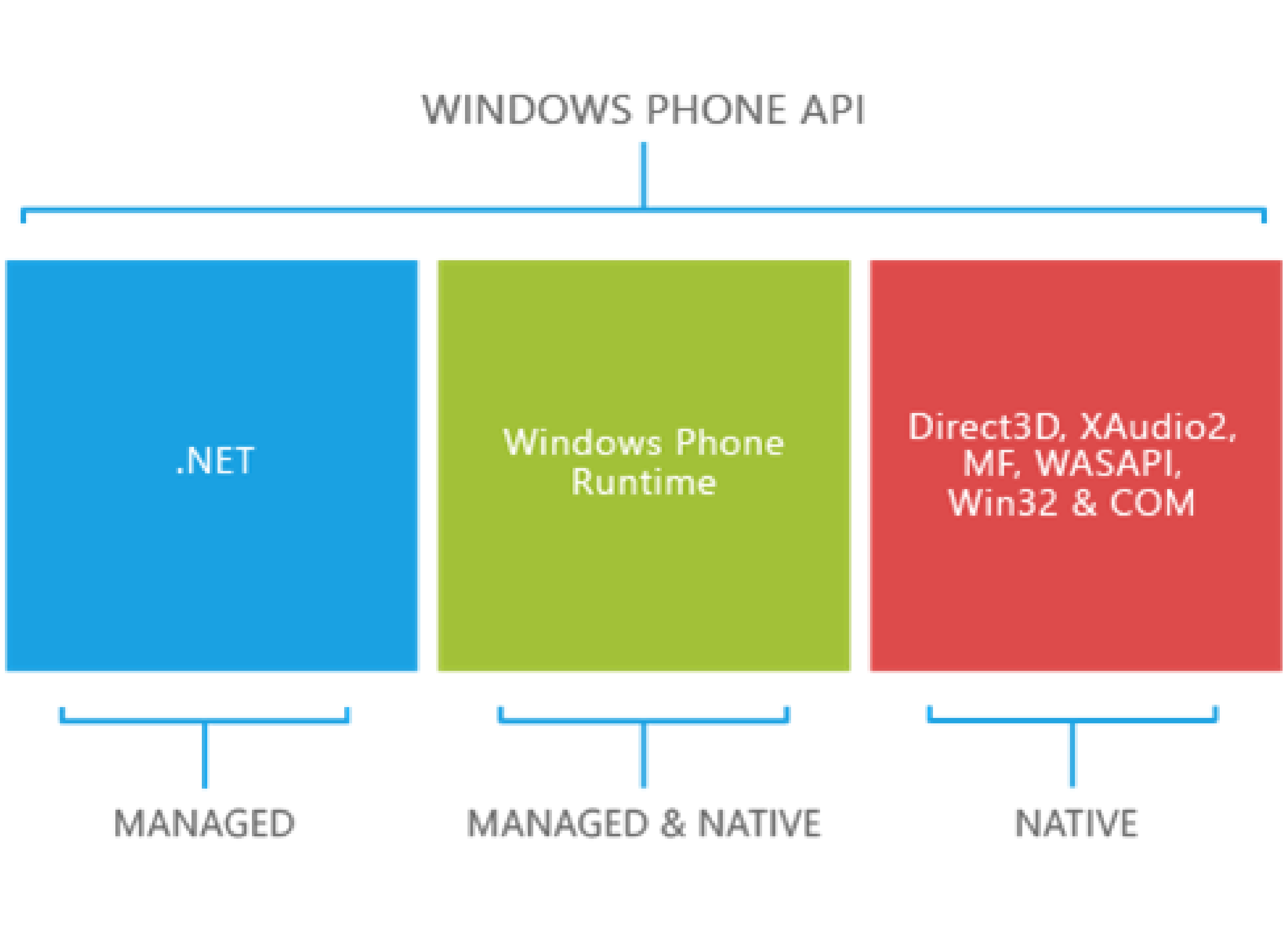
Applications

Developer Platform (XAML, XNA, Device services)

.NET Framework (CoreCLR)

WP8 OS, Win8 based

Frameworks



WINDOWS PHONE API

.NET

Windows Phone Runtime

Direct3D, XAudio2, MF, WASAPI, Win32 & COM

MANAGED

MANAGED & NATIVE

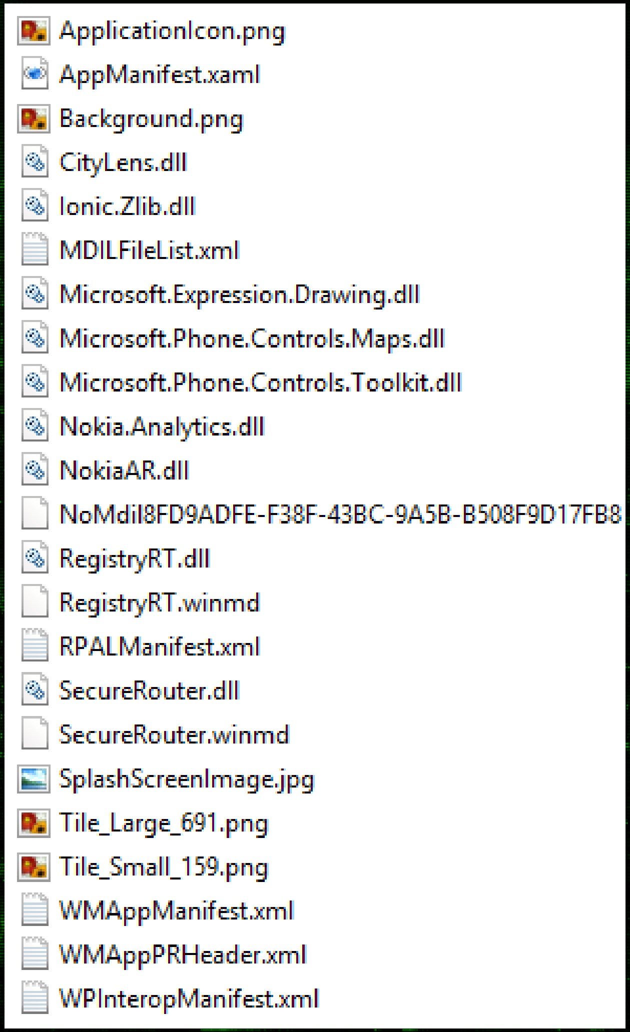
NATIVE

Application kinds

- Microsoft
- OEM
  - XAP files are not encrypted (~ZIP)
  - C:\PROGRAMS\CommonFiles\Xaps\
- Windows Phone Store apps
  - C:\Data\Programs\{ProductID}\Install\
- Company applications
  - XAP files are not encrypted (~ZIP)
  - Company hubs
- Developer applications
  - Need developer unlock

Application file structure

- Application assemblies (in various formats)
- Resources
- AppManifest.xaml
- WMAppManifest.xml



ApplicationIcon.png
AppManifest.xaml
Background.png
CityLens.dll
Ionic.Zlib.dll
MDILFileList.xml
Microsoft.Expression.Drawing.dll
Microsoft.Phone.Controls.Maps.dll
Microsoft.Phone.Controls.Toolkit.dll
Nokia.Analytics.dll
NokiaAR.dll
NoMdil8FD9ADFE-F38F-43BC-9A5B-B508F9D17FB8
RegistryRT.dll
RegistryRT.winmd
RPALManifest.xml
SecureRouter.dll
SecureRouter.winmd
SplashScreenImage.jpg
Tile_Large_691.png
Tile_Small_159.png
WMAppManifest.xml
WMAppPRHeader.xml
WPInteropManifest.xml

APPLICATION SECURITY

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Security?!

“One of the goals of the Windows Phone app platform is to foster the creation of apps that are *secure by design and secure by default*.”

Security for Windows Phone

Application entry points

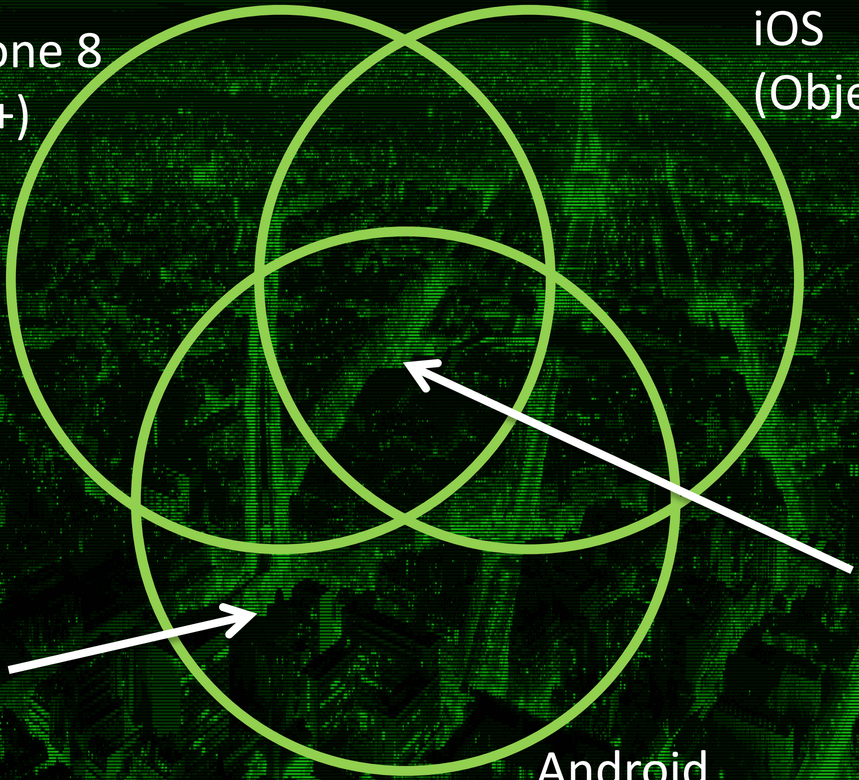
- User input
- SD card
- Sockets
- URI

- Web
- Bluetooth
- NFC
- Speech2Text

Green – Windows Phone 7

White – Windows Phone 8

Vulnerabilities



Windows Phone 8
(C#/VB/C/C++)

iOS
(Objective-C)

Android
(Java)

Platform specific vulnerabilities

Platform independent vulnerabilities

Note: Main programming languages in brackets

Work with SD card

- WP8 allows only read operations
- Only registered file types
- Files on SD cards are not encrypted

OS	Details
iOS	Work with SD card is absent
Android	READ/WRITE

Privacy

- Device Unique ID
  - Requires ID_CAP_IDENTITY_DEVICE
  - DeviceExtendedProperties.GetValue(“DeviceUniqueId”)
- Windows Live Anonymous ID
  - Requires ID_CAP_IDENTITY_USER
  - UserExtendedProperties.GetValue(“ANID2”)
- Both identifiers are per-publisher

OS	Details
iOS	UDID (apps that use UDIDs are no longer accepted, from May 1, 2013)
Android	telephonyManager.getDeviceId()

Privacy, part 2

- Device name, manufacturer, firmware versions
  - – Requires ID_CAP_IDENTITY_DEVICE
  - – DeviceStatus class
- Location tracking
  - – ID_CAP_LOCATION
  - – GeoCoordinateWatcher class

OS	Details
iOS	UDID (apps that use UDIDs are no longer accepted, from May 1, 2013)
Android	telephonyManager.getDeviceId()

Secure storage

- Device can be encrypted (not for all countries)
  - BitLocker 2.0/TPM
  - Available only in business settings
- Data Protection API (DPAPI)
- System.Security.Cryptography
- Algorithms: AES, HMACSHA1, HMACSHA256, Rfc2898DeriveBytes, RSA, SHA1, SHA256

OS	Details
iOS	Keychain, /System/Library/Frameworks/Security.framework
Android	android.security.KeyChain (from 4.0)

Data leak

- Keyboard cache is isolated per-application
- Cache for applications that access internet
  - Controlled by OS

OS	Details
iOS	plist, Custom created documents, Preferences, Logs, Cache data, Keyboard cache, Pasteboard cache, Cookies
Android	shared_preference, logs, external storage, MODE_WORLD_READABLE or MODE_WORLD_WRITETABLE

Work with URI

- Handling function: MapUri()

- Filter user input
- Exclude critical arguments from URI
  - Ex.: prgrm://command?request=data&role=admin

OS	Details
iOS	openURL(), handleOpenURL()
Android	android.net.Uri class

Cross-site scripting (XSS)

- WebBrowser control (based on IE10)
- JavaScript is disabled by default
- To see if enabled:
  - WebBrowser.IsScriptEnabled = true
  - <WebBrowser IsScriptEnabled = “True” />

OS	Details
iOS	UIWebView Class + stringByEvaluatingJavaScriptFromString() shouldStartLoadWithRequest()

Android	WebView.getSettings().setJavaScriptEnabled();
	WebView.getSettings().setPluginsEnabled();

Directory traversal

- Local folder API accepts paths with traversal
  - IsolatedStorageFile class (WP7)
  - StorageFolder class
- Win32 storage API

OS	Details
iOS	contentsAtPath, fileHandleForReadingAtPath, _fopen etc.
Android	ContentProvider + incorrect or missing rights, files functions

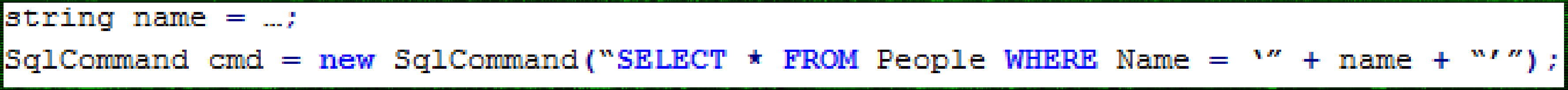
XML External Entity (XXE)

- System.Xml namespace
  - Entity resolving is prohibited by default
- Entities can be resolved by using custom XmlResolver for XmlDocument

OS	Details
iOS	libXML2 + _xmlParseMemory, NSXMLParser + setShouldResolveExternalEntities:YES
Android	setFeature(external-general-entities, True)

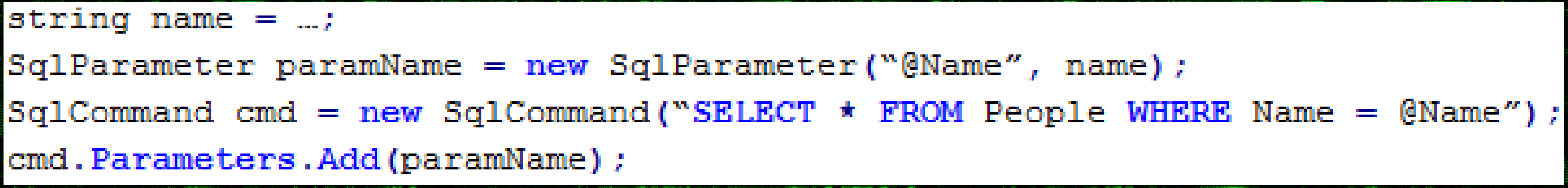
SQL injection

- Bad:



```
string name = …;
SqlCommand cmd = new SqlCommand(“SELECT * FROM People WHERE Name = ‘” + name + “’”);
```

- Good:



```
string name = …;
SqlParameter paramName = new SqlParameter(“@Name”, name);
SqlCommand cmd = new SqlCommand(“SELECT * FROM People WHERE Name = @Name”);
cmd.Parameters.Add(paramName);
```

OS	Details
iOS	sqlite3_exec()
Android	query(), rawQuery()

Memory corruption bugs

- Developers can use native code
- Format string, BoF, use-after-free etc.
  - C/C++ functions
- Compilation flags: /sdl, /GS, /DYNAMICBASE, /NXCOMPAT

OS	Details
iOS	–fPIE, –fstack-protector-all, -fobjc-arc
Android	Only in native libs, -fstack-protector, -Wformat-security, NX, ASLR, PIE

CONCLUSION

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Conclusion

- Windows Phone 8 is pretty secure
- Greater attack surface
- Security-related API
  - More flexible than in iOS
  - More simple than in Android

Q&A

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