Inspection of Windows Phone applications

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About us

Dmitriy ‘D1g1’ Evdokimov

- Security researcher at ERPScan
- Editor of Russian hacking magazine
- DEFCON Russia (DCG #7812) organizer

Andrey Chasovskikh

- Software developer
- Windows Phone addict

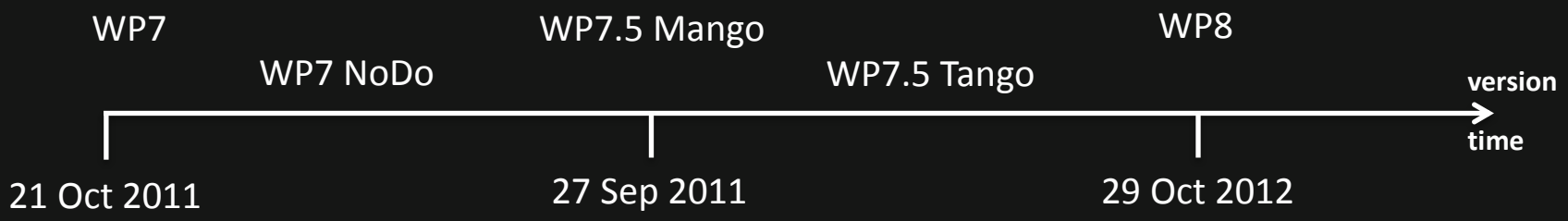
Agenda

- Windows Phone intro
- Security model
- All about applications
- Not all applications are secure
- Tools overview
- Deep dive: finding vulnerabilities
- Conclusion

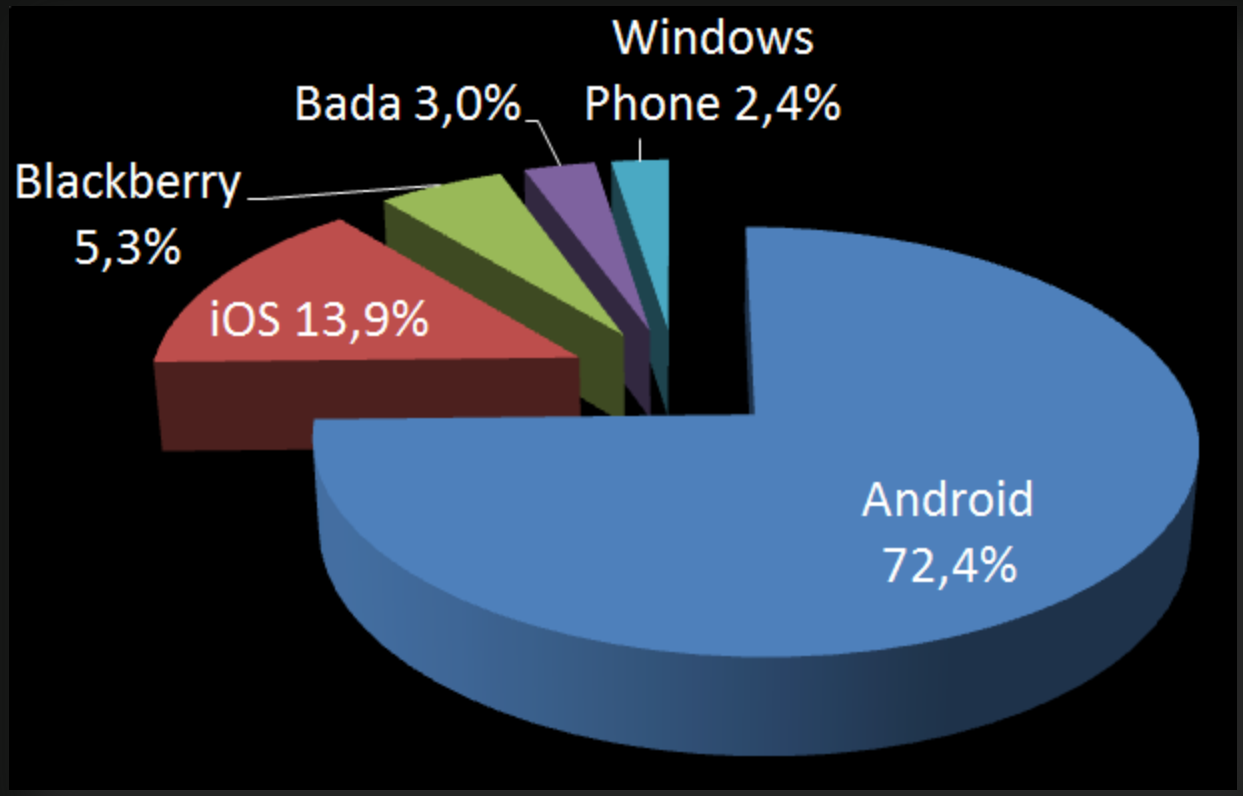
WINDOWS PHONE INTRO

History of Windows Phone

- The successor to the Windows Mobile OS
- 15 Mar 2010 – Windows Phone 7 series announced
- 21 Oct 2010 – Windows Phone 7 released
- 29 Oct 2012 – Windows Phone 8 released



Market share



Source: Gartner, November 2012

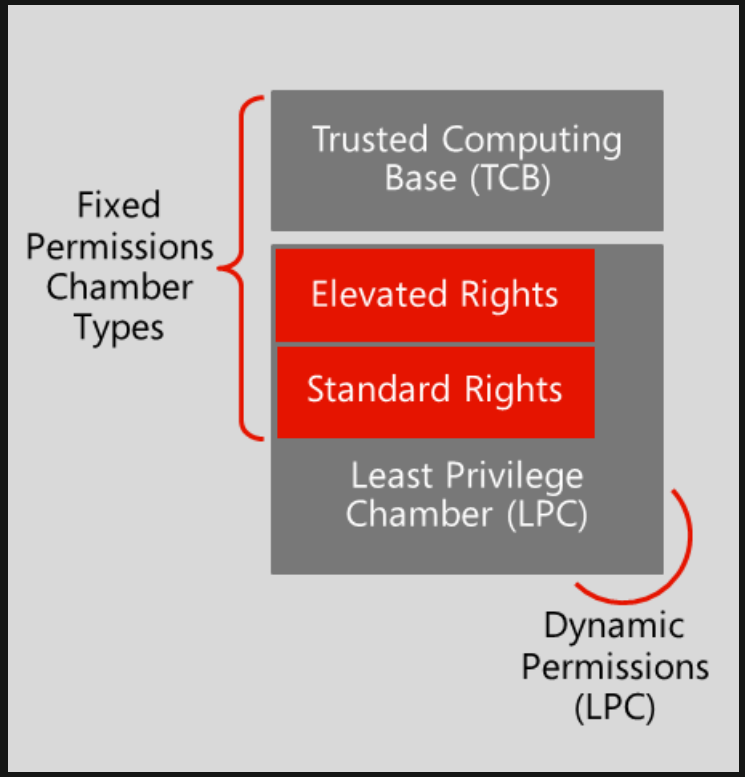
Windows Phone Store

- 125 000+ applications
- Casual apps, social networks, mobile banking, enterprise applications etc.

SECURITY MODEL

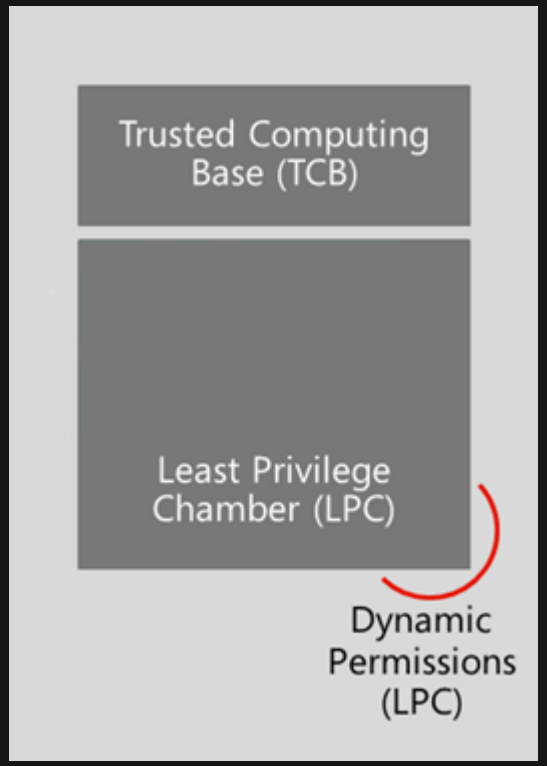
Chamber concept, WP7

- Trusted Computing Base (TCB)
  Kernel, kernel-mode drivers
- Elevated Rights Chamber (ERC)
  Services, user-mode drivers
- Standard Rights Chamber (SRC)
  Pre-installed applications
- Least Privileged Chamber (LPC)
  Applications from WP store



Chamber concept, WP8

- Trusted Computing Base (TCB)
  Kernel, kernel-mode drivers
- Least Privileged Chamber (LPC)
  All other software: services, pre-installed apps, application from WP store



Capabilities

WMAppManifest.xml

Windows Phone 7

- Camera
- Contacts
- Location services
- Owner/phone identity
- Network services

Etc.

Windows Phone 8

- All WP7 capabilities
- NFC
- SD card access
- Wallet
- Speech recognition
- Front camera

Etc.

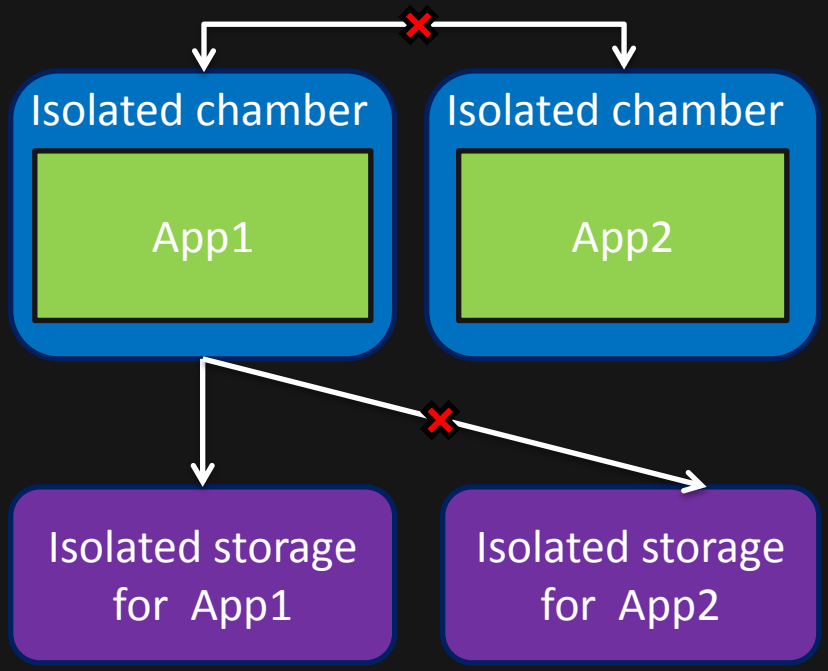
Undocumented

- Native code
- SMS API
- Access to user properties
- SIM API

Etc.

Sandboxing concept

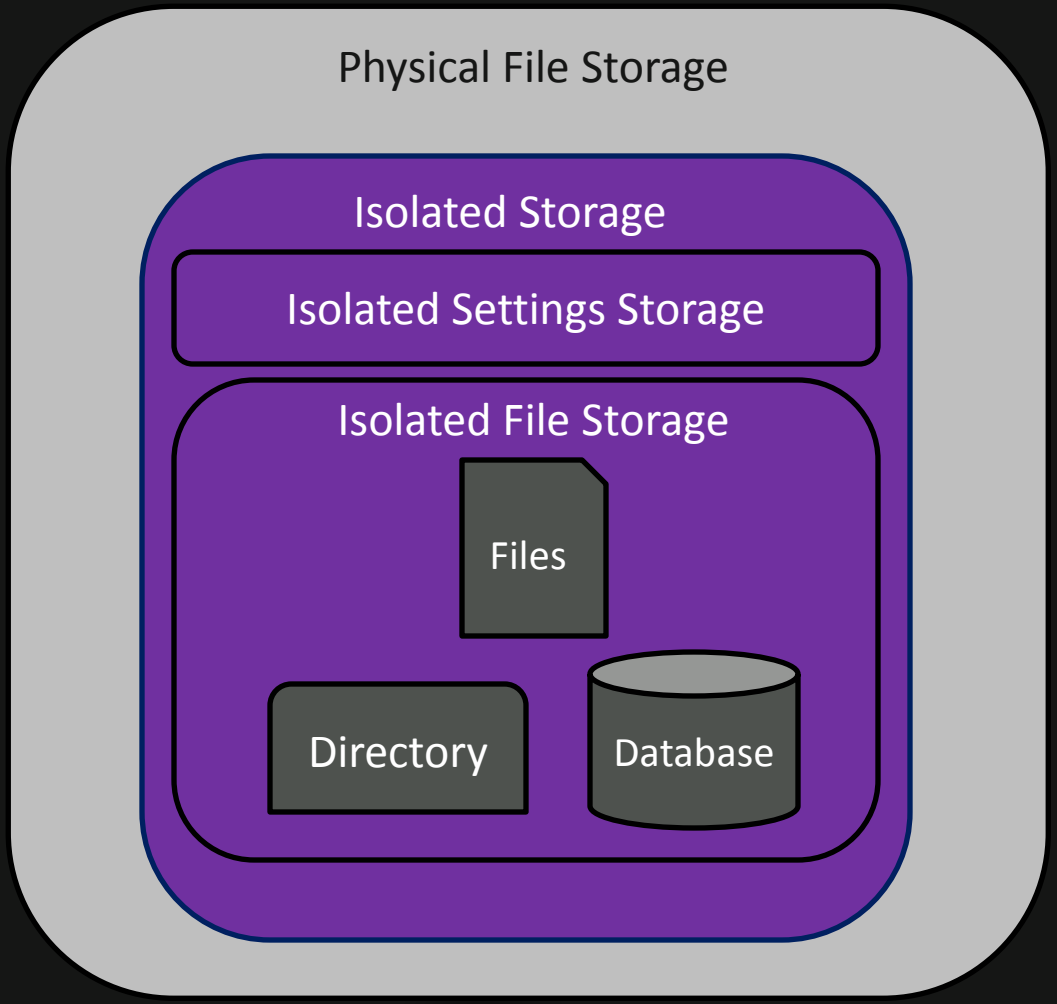
- No app communication in WP7
- Limited app-to-app in WP8
- File system structure is hidden
- Isolated storages



App-to-App, WP8

- File 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

Isolated Storage

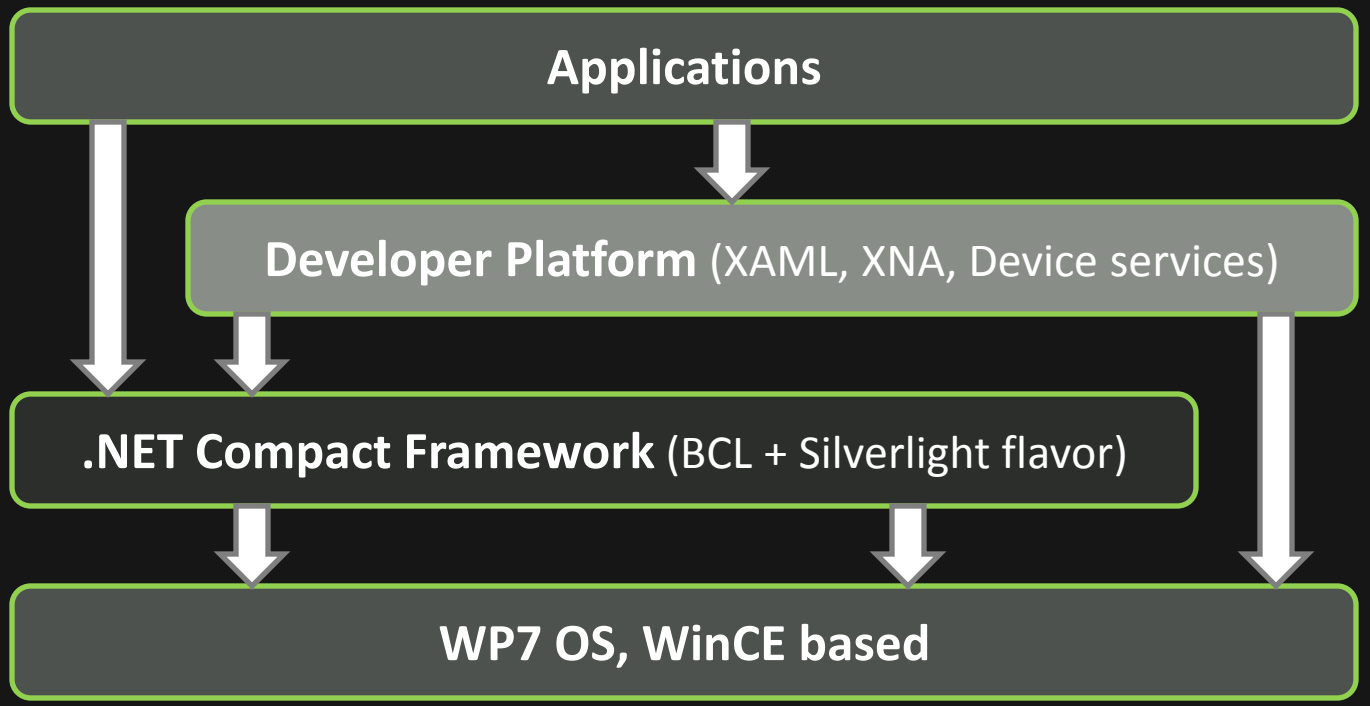


Signing

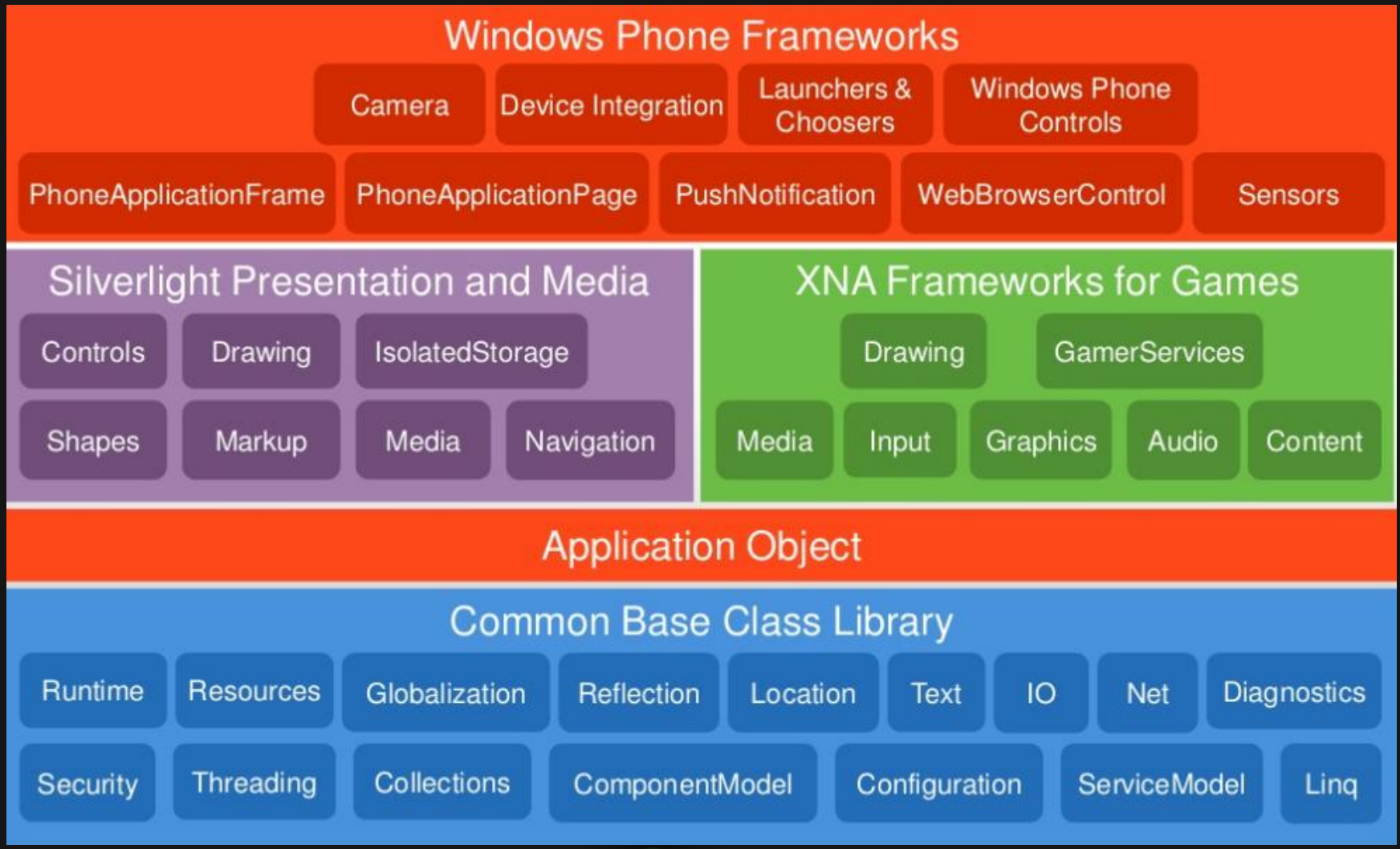
- Store applications are signed in WP7
- All binaries get signed since WP8
- Application file get signed
  - Kind of checksum file is put into applications
- Applications XAP files have undocumented format (since Aug 2012)

ALL ABOUT APPLICATIONS

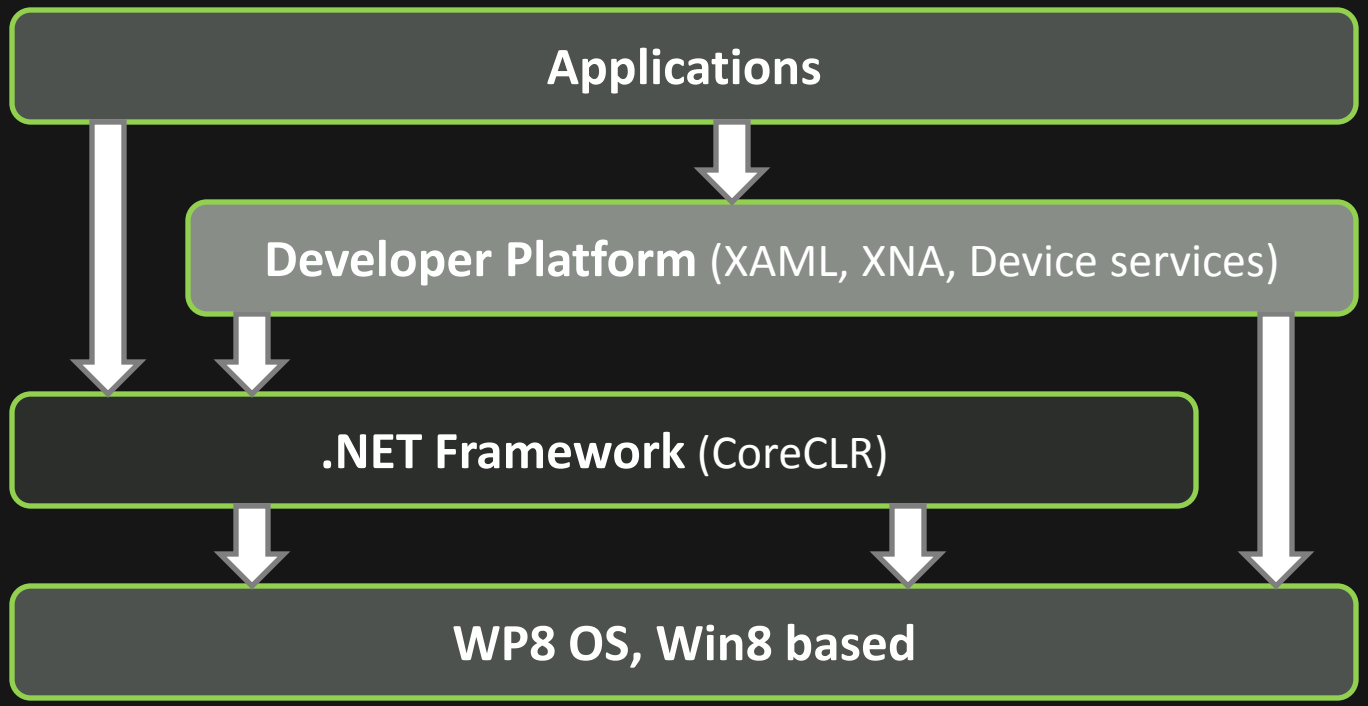
.NET and CLR, WP7



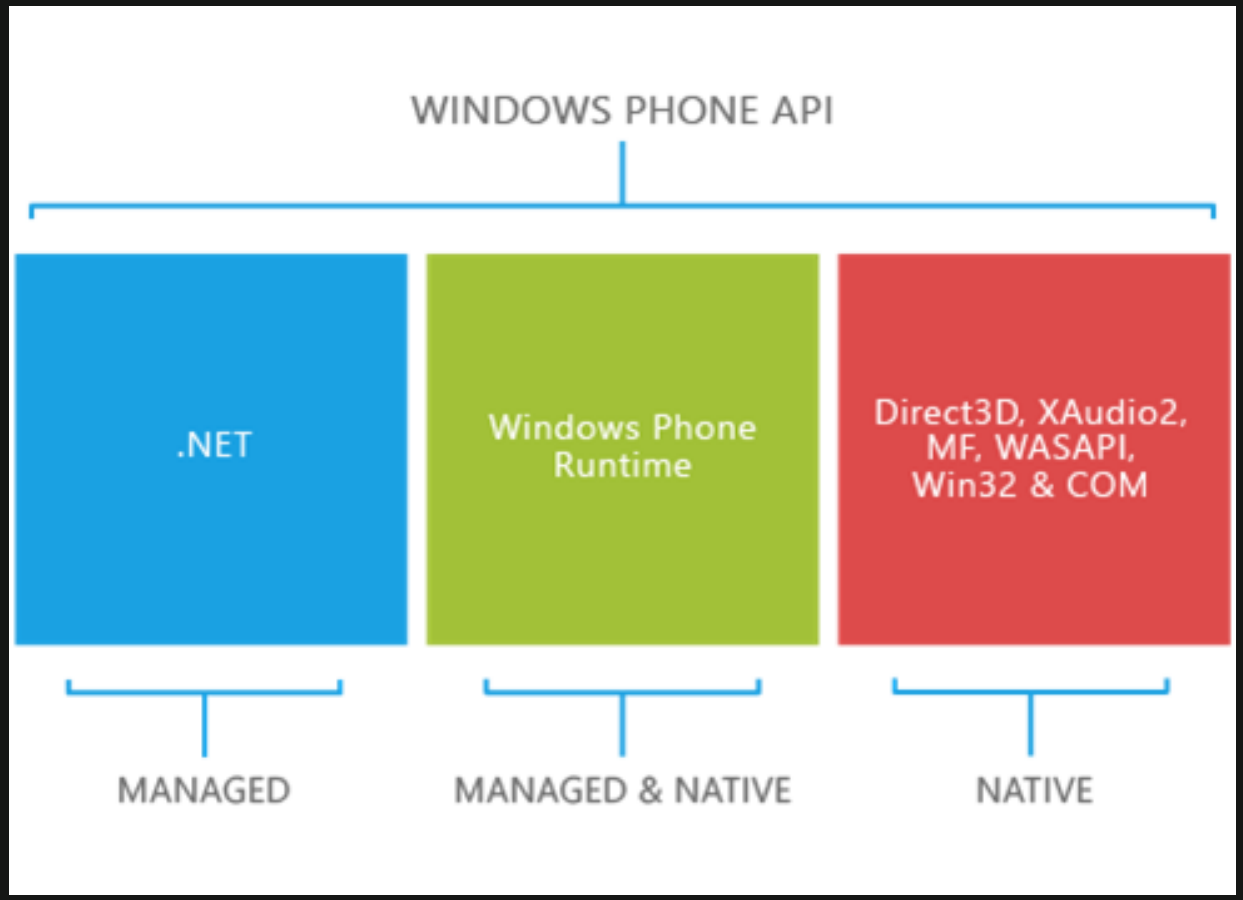
Framework


Windows Phone Frameworks
Camera
Device Integration
Launchers & Choosers
Windows Phone Controls
PhoneApplicationFrame
PhoneApplicationPage
PushNotification
WebBrowserControl
Sensors
Silverlight Presentation and Media
Controls
Drawing
IsolatedStorage
Shapes
Markup
Media
Navigation
XNA Frameworks for Games
Drawing
GamerServices
Media
Input
Graphics
Audio
Content
Application Object
Common Base Class Library
Runtime
Resources
Globalization
Reflection
Location
Text
IO
Net
Diagnostics
Security
Threading
Collections
ComponentModel
Configuration
ServiceModel
Linq

.NET and CLR, WP8



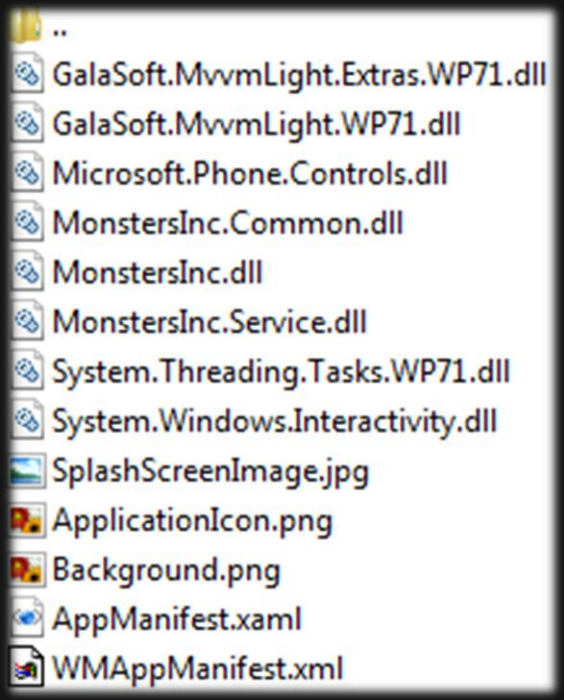
Framework


WINDOWS PHONE API
.NET
Windows Phone Runtime
Direct3D, XAudio2, MF, WASAPI, Win32 & COM
MANAGED
MANAGED & NATIVE
NATIVE

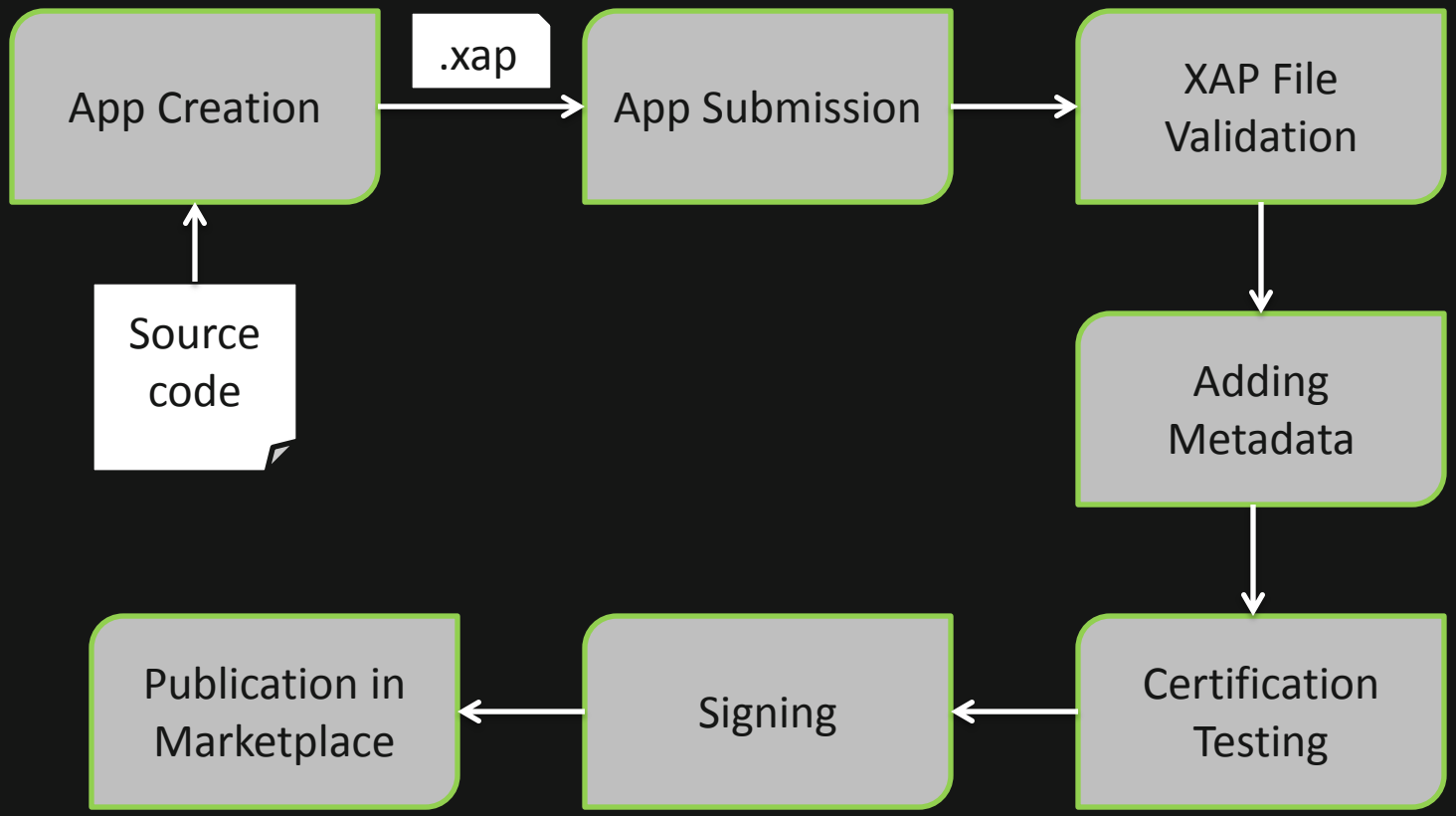
Application file structure

- Application assemblies
- Resources
- AppManifest.xaml
- WMAppManifest.xml
- WMInteropManifest.xml*

* — optional for WP7, absent in WP8



Submission and certification



Applications on a device

WP7:

\Applications

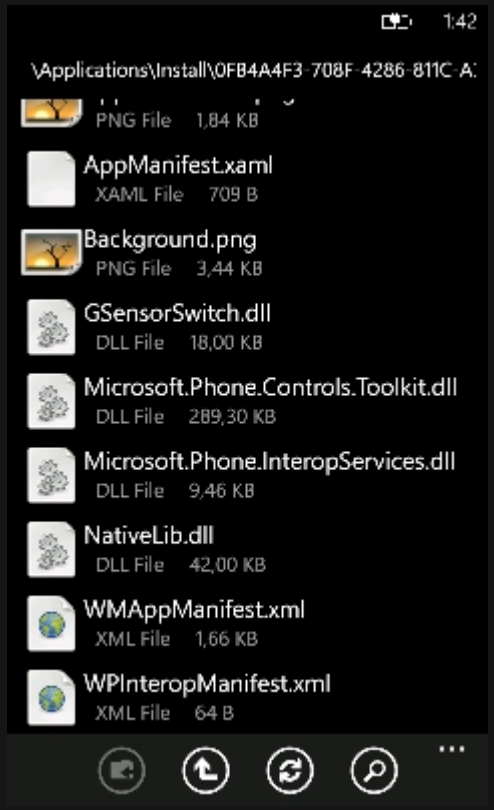
\Install\<ProductID>\Install\

- Content from XAP
- WMAppPRHeader.xml (package signature)

\Data\<ProductID>\Data\IsolatedStorage

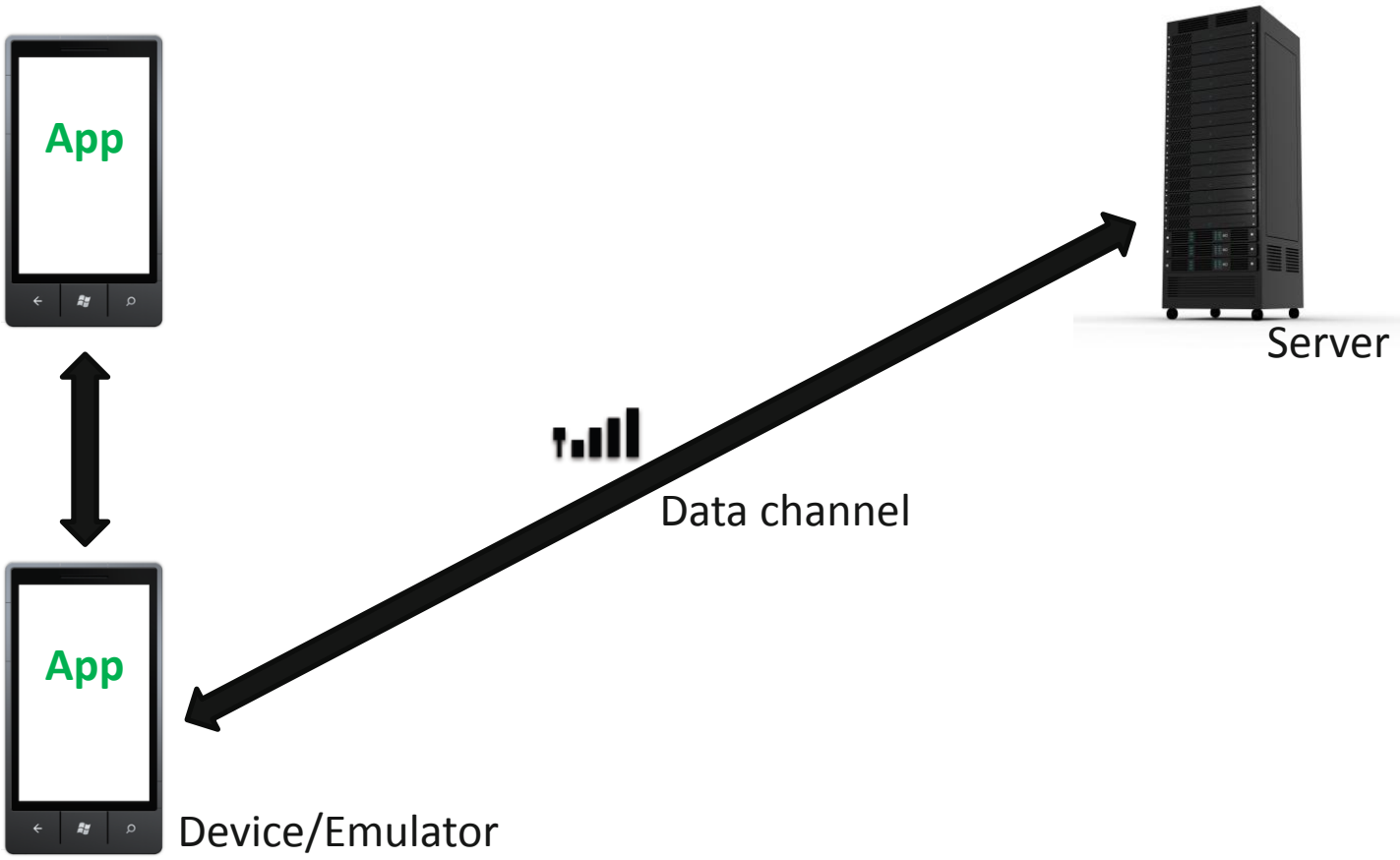
Same idea in WP8, i.e. install path:

C:\Data\Programs\<ProductID>\Install\



NOT ALL APPLICATIONS ARE SECURE

Security assessment



Mobile applications security assessment

Prepare environment

- Get app (unpack/decrypt)
- Configuration device/emulator

Static analysis

- Properties of program compilation
- Metadata analysis
- Code analysis

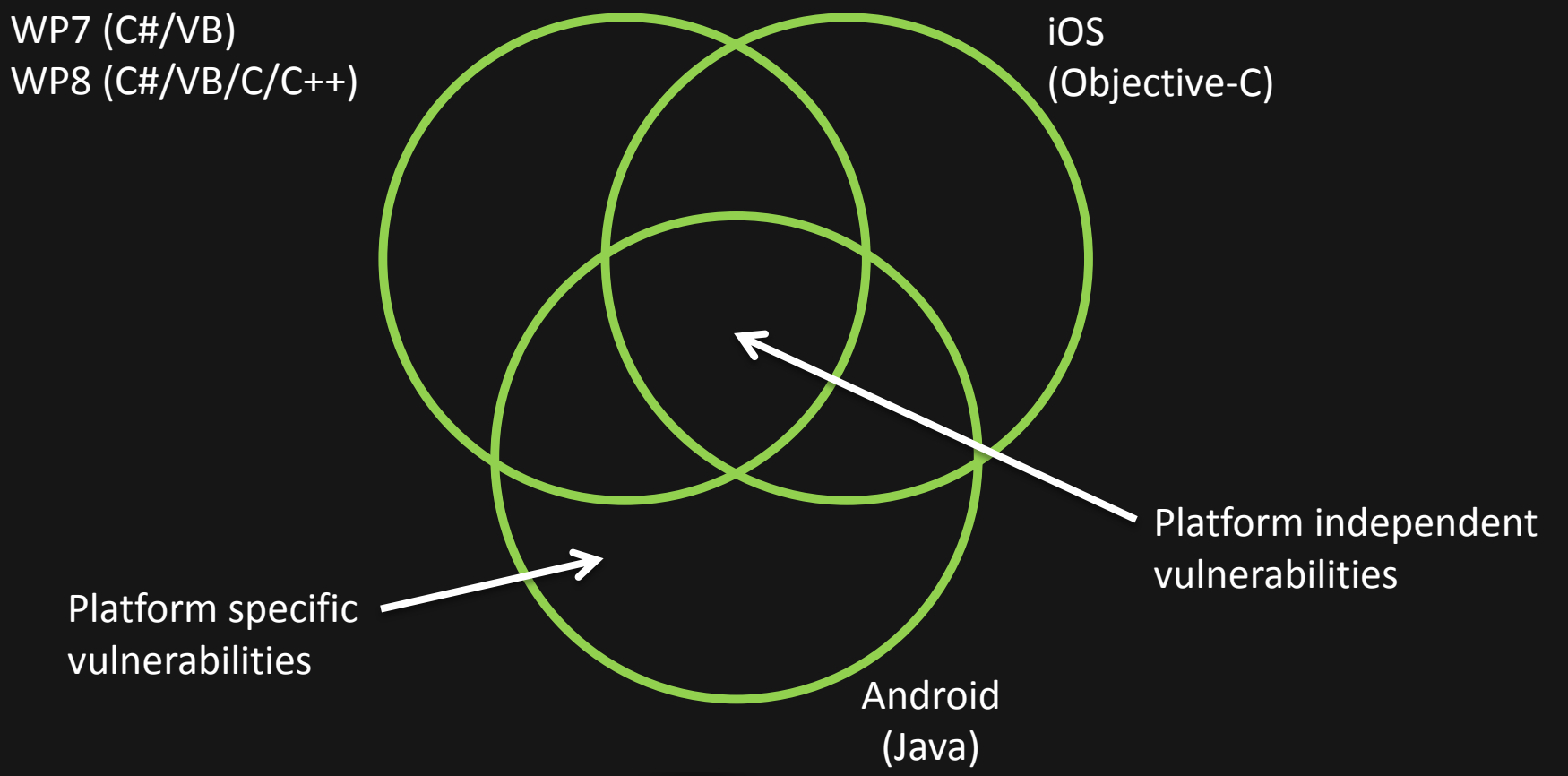
Dynamic analysis

- How application works with file system/network
- Runtime code analysis

OWASP Top 10 Mobile Risks

1. Insecure Data Storage
2. Weak Server Side Controls
3. Insufficient Transport Layer Protection
4. Client Side Injection
5. Poor Authorization and Authentication
6. Improper Session Handling
7. Security Decisions Via Untrusted Inputs
8. Side Channel Data Leakage
9. Broken Cryptography
10. Sensitive Information Disclosure

WP vs. Android vs. iOS vulnerabilities



Note: Main programming languages in brackets

TOOLS OVERVIEW

Arsenal

- Device
  - Full unlock
- Emulator
- Windows Phone Device Manager

- Network proxy: Burp Suite, Charles etc.
- .NET tools: .Net Reflector, ILSpy etc.
- IDA Pro

- RAIN, Boyan Balkanski
- Windows Phone App Analyzer, David Rook
- XAPSpy, Behrang Fouladi
  - XapSpyAnalysis, David Rook

Main issue

Static analysis is insufficient.

Lack of dynamic analysis tools:

- IDE allows debugging with source code only
- No programmable debugging interface
  - Managed code

Solution: static byte code instrumentation.

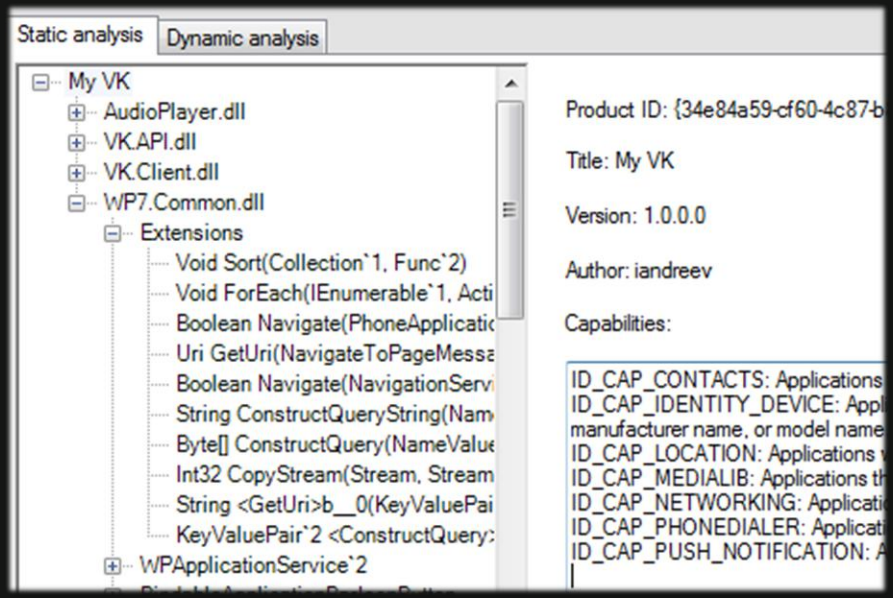
Tangerine

Automates routine with XAP files

- Unpacking
- Removing application signature
- Resigning assemblies
- Packing
- Deploying

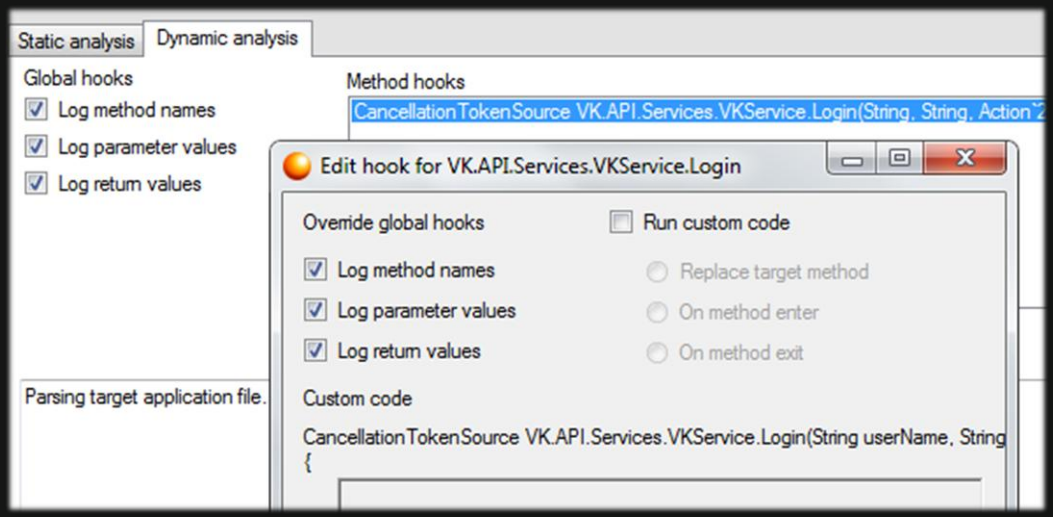
Static analysis

- Application info
- Application capabilities
- Code analysis
  - Code structure analysis
  - API usage analysis
  - View IL code



Dynamic analysis

- Log application stack trace
  - Method names
  - Method parameters
  - Return values
- Run custom code
  - On method enter
  - Replace method
  - On method exit
  - Change parameters values



DEEP DIVE: FINDING VULNERABILITIES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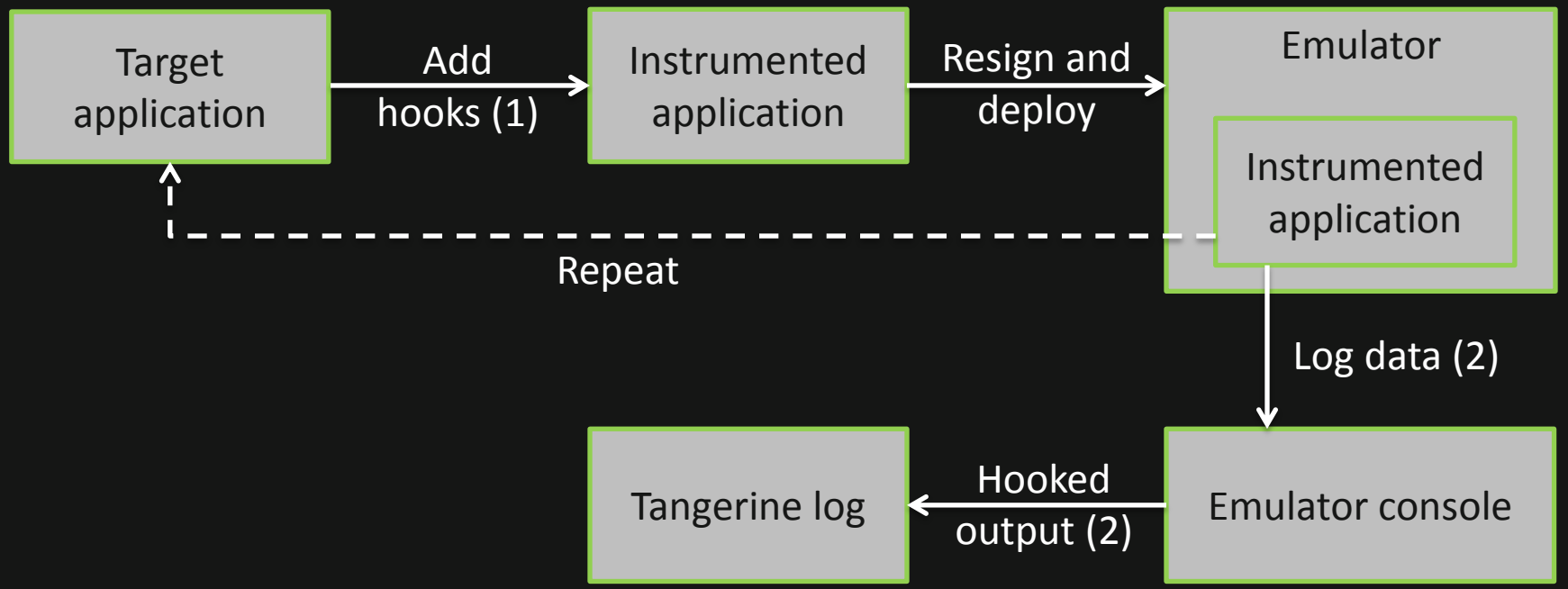
DEMO

How it works

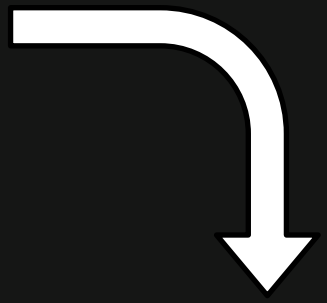
(1) Changing CIL code

(2) Emulator console (writing/reading)



CIL Instrumentation

```
IL_0000:  nop
IL_0001:  ldarg.1
IL_0002:  ldarg.2
IL_0003:  add
IL_0004:  stloc.0
IL_0005:  br.s       IL_0007
IL_0007:  ldloc.0
IL_0008:  ret
```

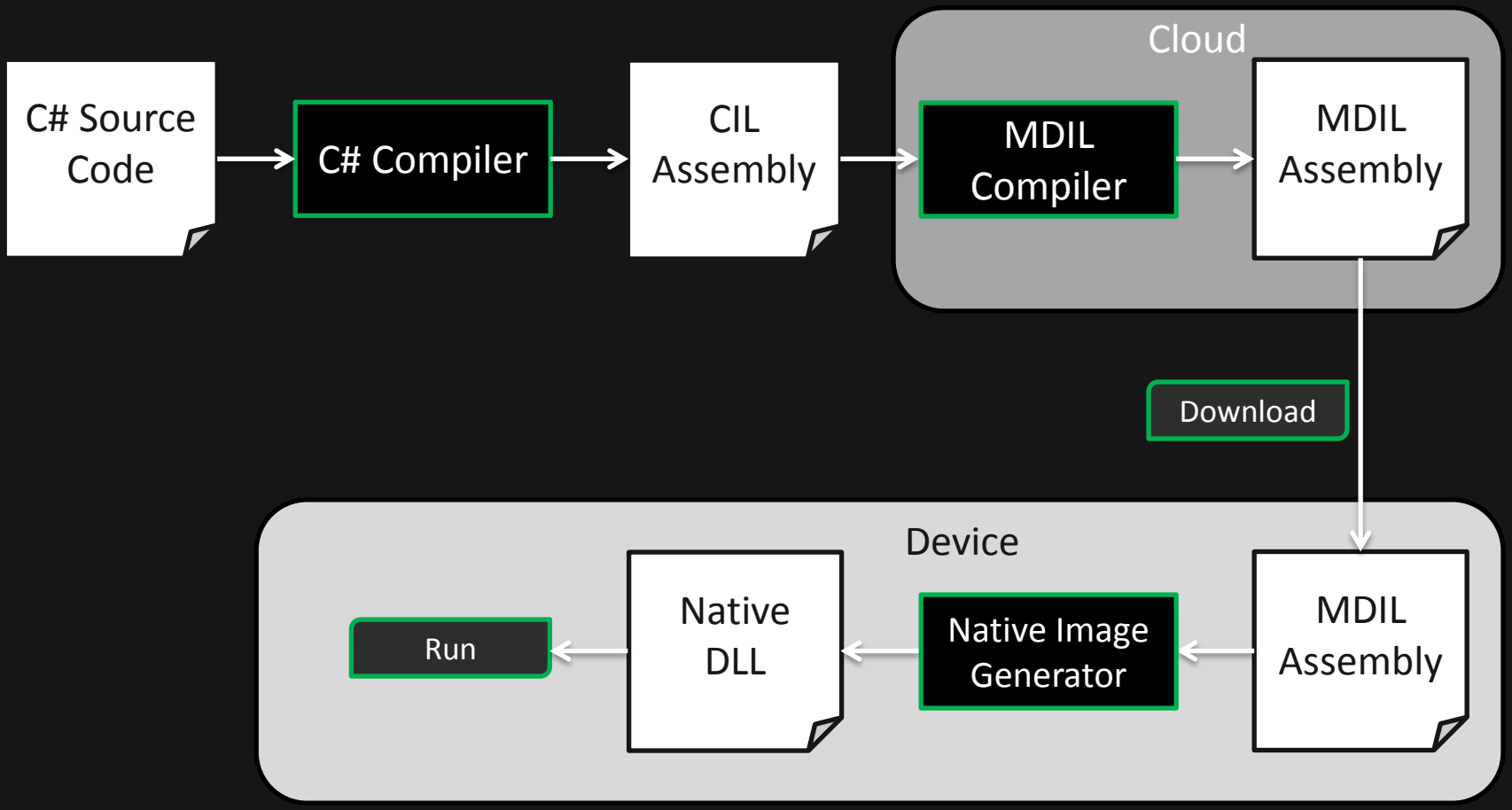


```
IL_0000:  nop
IL_0001:  ldarg.1
IL_0002:  ldarg.2
IL_0003:  add
IL_0004:  stloc.0
IL_0005:  ldloc.0
IL_0006:  call       void [mscorlib]System.Console::WriteLine(int32)
IL_000b:  nop
IL_000c:  ldloc.0
IL_000d:  stloc.1
IL_000e:  br.s       IL_0010
IL_0010:  ldloc.1
IL_0011:  ret
```

Limitations

- Emulator only
- Does not help to overcome obfuscated code
- Does not work with system assemblies
- Applications from store need to be decrypted
- Windows Phone 7 only

Cloud Compilation, WP8



MDIL in work

```
int foo (int a) {return a+j}
```

R0 = this

R1 = a

R0 + 0x10 = j, where **j** is a field from base class

```
LDR R0, [R0 + 0x10]
ADD R0, R0, R1
BX LR
```

```
LDR R0, [R0 + "fieldToken()"]
ADD R0, R0, R1
BX LR
```

MDILDump

```
METHOD_00000008:
000000: b4 bb 01 01 b2 b8 00 b9 9e 00 00 01 4e 03 00 02
000010: 00 20 4e 04 00 bb
MDIL_0000: B4 BB         PUSH_REGS         EBX,ESI,EBP,R12,R13,R15,
MDIL_0002: 01 01         LIT_MACHINE_INST_1       01
MDIL_0004: B2            EBP_FRAME
MDIL_0005: B8 00         FRAME_SIZE        00
MDIL_0007: B9            END_PROLOG
MDIL_0008: 9E 00 00 01   LOAD_STRING       EAX, 70000001
MDIL_000C: 4E 03 00      CALL_REF          0A000003
MDIL_000F: 02 00 20      LIT_MACHINE_INST_2       00 20
MDIL_0012: 4E 04 00      CALL_REF          0A000004
MDIL_0015: BB            EPILOG_RET
Method Size: 23 (0x17) bytes, Routine: 22 (0x16) bytes, Exceptions: 0
```

http://github.com/WalkingCat/mdildump/

Future work

- Support Windows Phone 8 applications
  - MDIL instrumentation
  - Windows Phone RT
- Add new features
  - Code graphical representation
  - Data flow analysis
- Fix bugs ;)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CONCLUSION

Conclusion

- Greater attack surface in WP8
  - App-to-App
  - Applications that use native code
  - New technologies
- Logical bugs never die

Thanks

- Evgeny Bechkalo
- DSecRG team

Q&A

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