

移动DevOps之路：Android 应用质量监控与测试自动化

夏鸣远 博士

加拿大McGill大学 上海交通大学

contact@appetizer.io

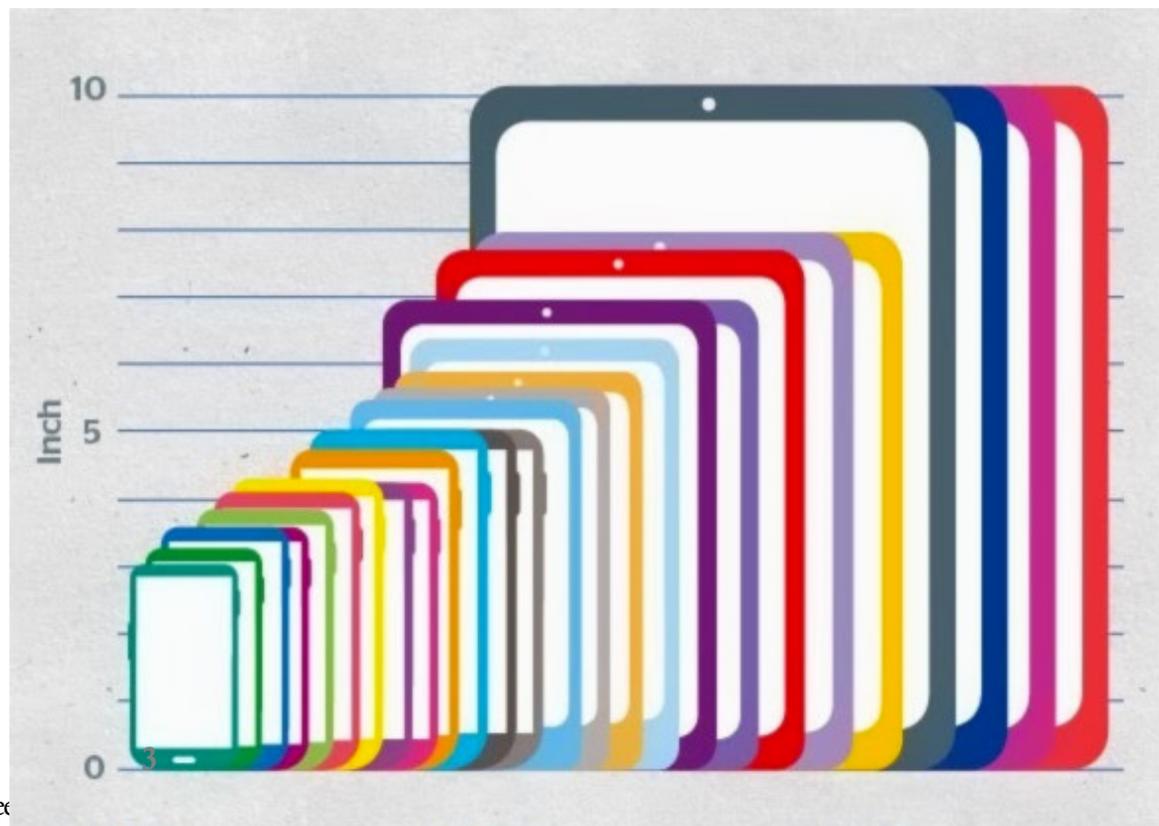


Android平台碎片化

- ❖ 截止2016年8月，总计有**12,518款**不同的Android设备型号

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- ❖ 操作系统定制化
- ❖ 操作系统版本



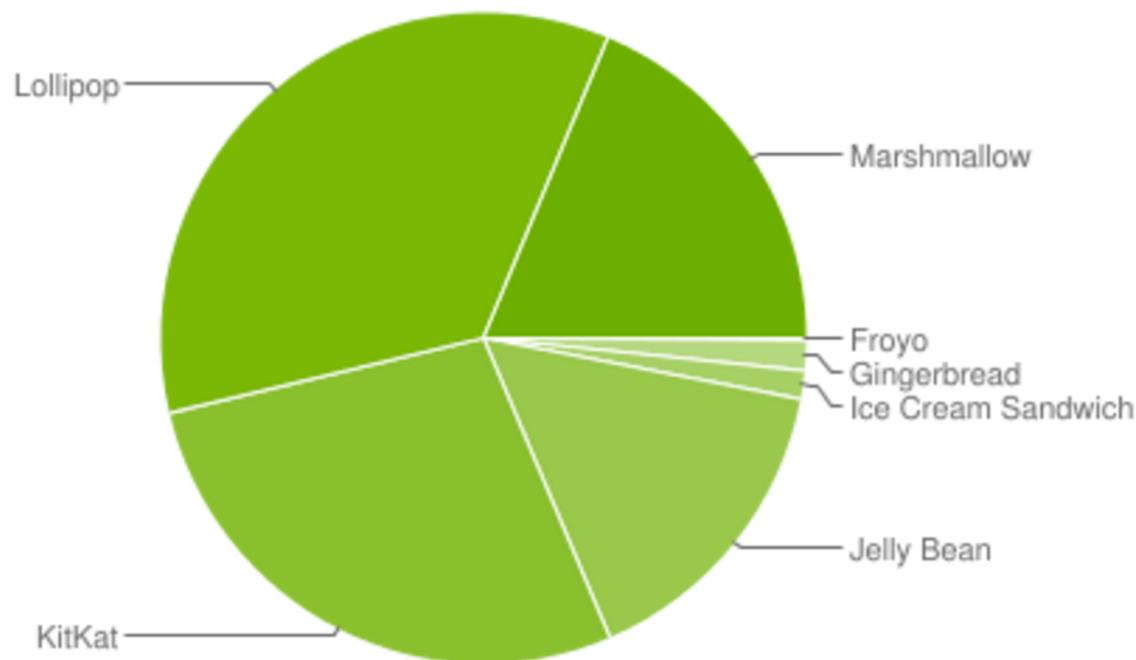
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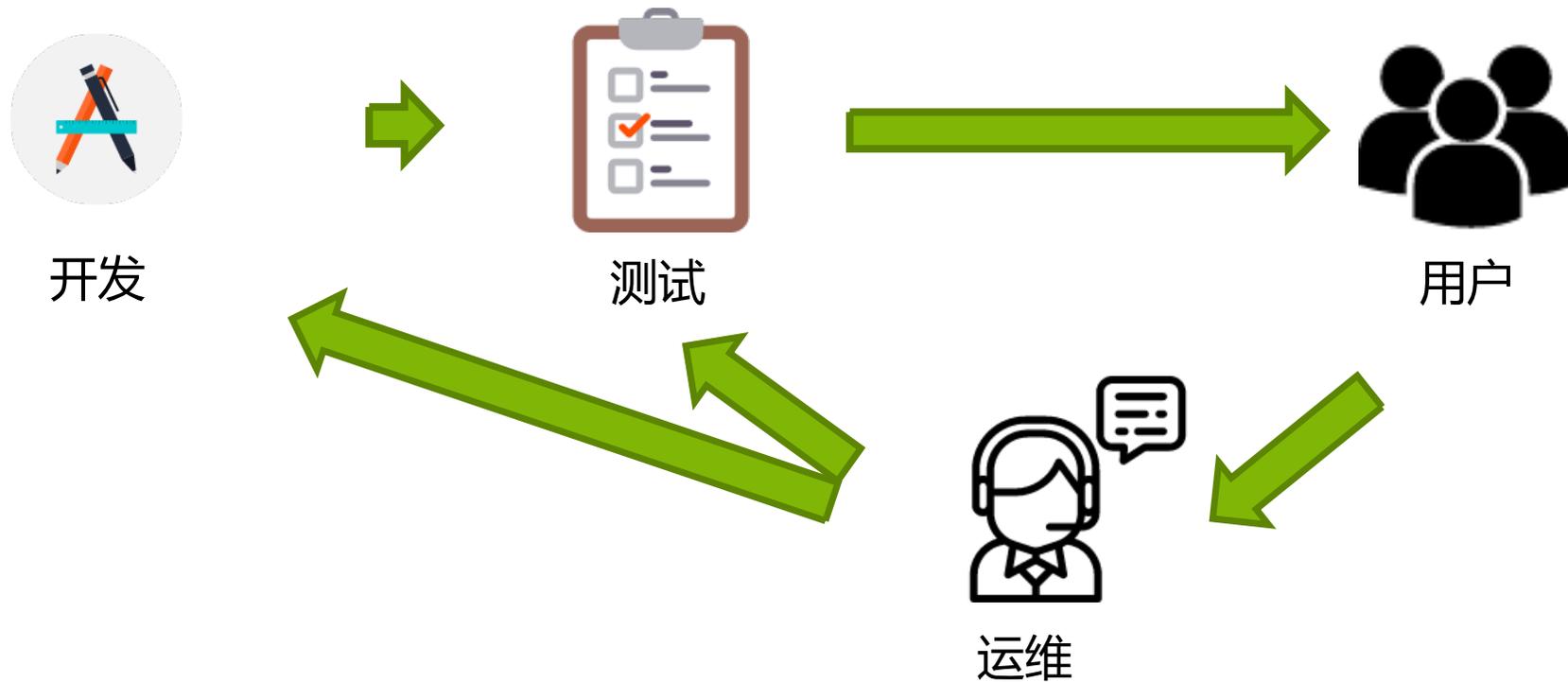


Android平台碎片化

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传统开发模式



传统开发模式

测试返回的结果缺少技术细节，开发人员修正效率低

测试流程低效，多个程序版本多种机型重复劳动



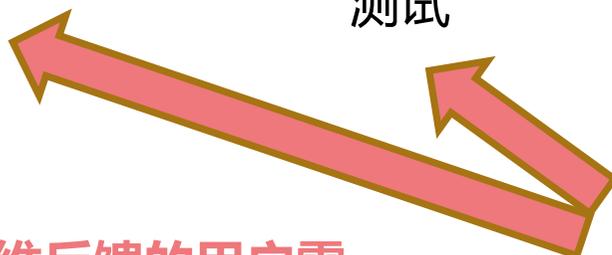
开发



测试



用户



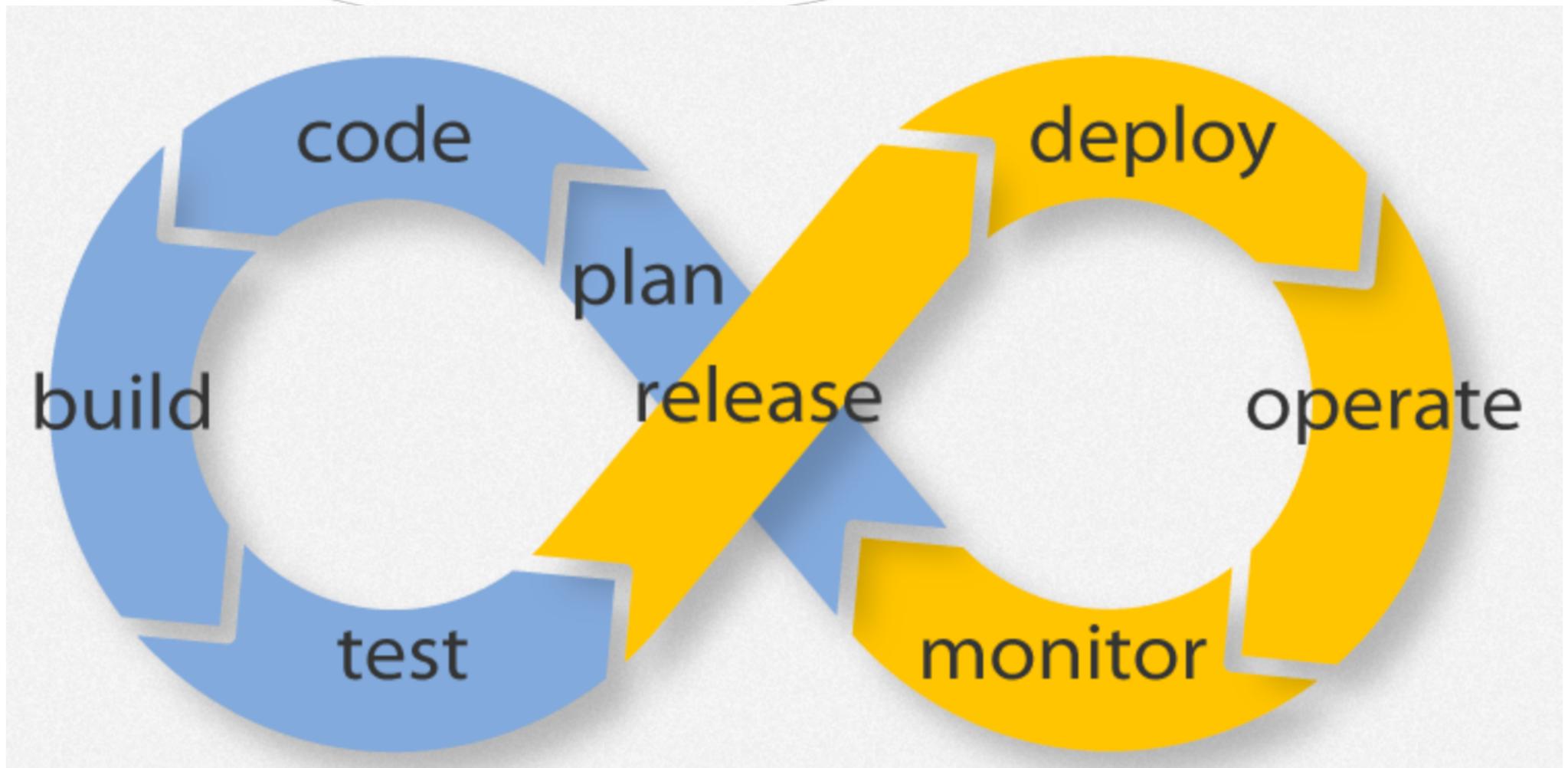
运维反馈的用户需求难量化，交流成本高，理解需求难



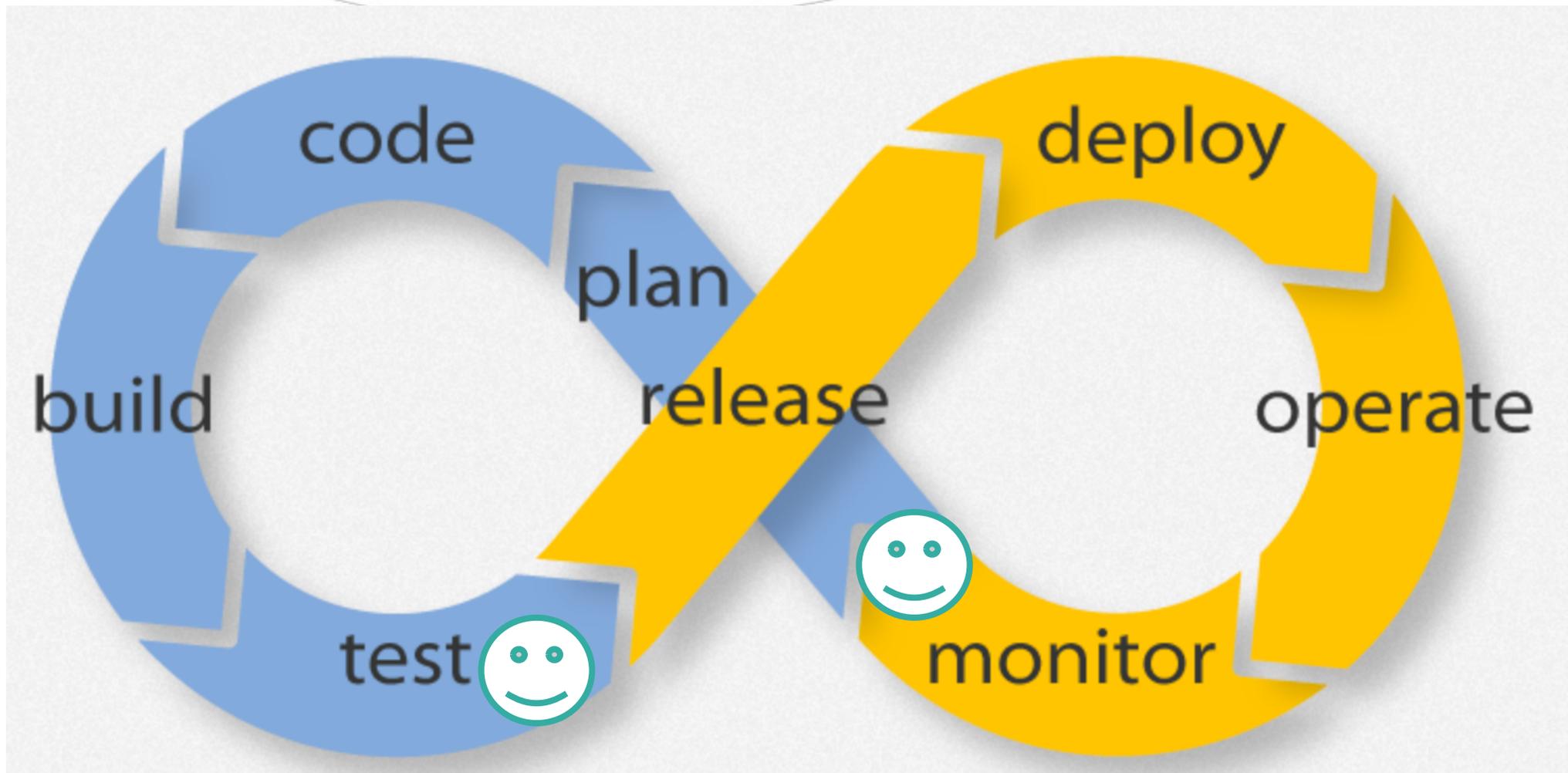
运维



DevOps



DevOps



演讲概要

- ◆ 自动化测试
 - ◆ UI自动化工具、探索类工具
 - ◆ 因人而异，关键是如何选择
 - ◆ 两个案例分析：服务类APP、手游
- ◆ 自动化质量监控
 - ◆ “定量的” “技术的” 质量报告
 - ◆ 基于Dex插桩的自动质量监控

Android App自动化测试工具有哪些？

Android App自动化测试工具有哪些？

知乎

<https://www.zhihu.com/question/19716849>

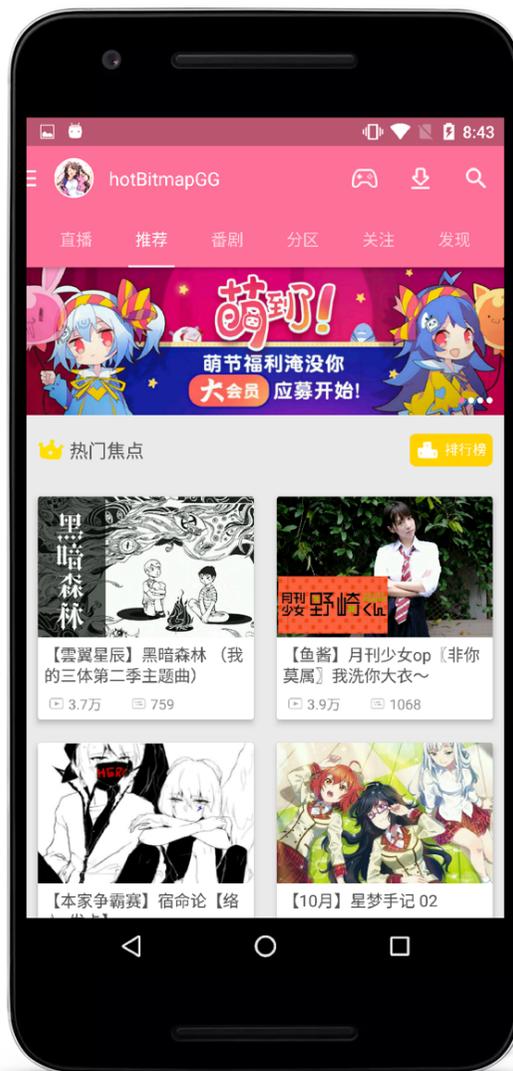
Android App自动化测试工具怎么选？

- ◆ 界面组成：标准组件，WebView，Canvas
- ◆ 交互方式：仅单个应用还是应用+系统
- ◆ API灵活度：有些组件无法操作，有些操作无法模拟
- ◆ 机型差异：软硬键盘/UI布局
- ◆ 交互速度
- ◆ UI自动化工具 vs. 探索类工具

案例一：服务信息类应用

- ◆ 电商类、内容类、社交类
- ◆ 特点：
 - ◆ 服务器端交互复杂
 - ◆ 混合开发（WebView内容）
 - ◆ 前端/业务变化快

服务器端交互复杂



Appium

```
sleep(3)
```

```
textFields = driver.find_elements_by_tag_name('textField')
```

```
assertEqual(textFields[0].get_attribute("value"), "Hello")
```

```
driver.find_elements_by_name('Sign in')[0].click()
```

```
textFields = driver.find_elements_by_tag_name('textField')
```

```
textFields[0].send_keys("twitter_username")
```

```
textFields[1].send_keys("password")
```

```
driver.find_elements_by_tag_name('button')[0].click()
```

Espresso

```
onView(withText("Hello.")).check(matches(isDisplayed()));
```

```
onView(withId(getInstrumentation().getTargetContext().getResources().getIdentifier("com.twitter.android:id/sign_in", null, null))).perform(click());
```

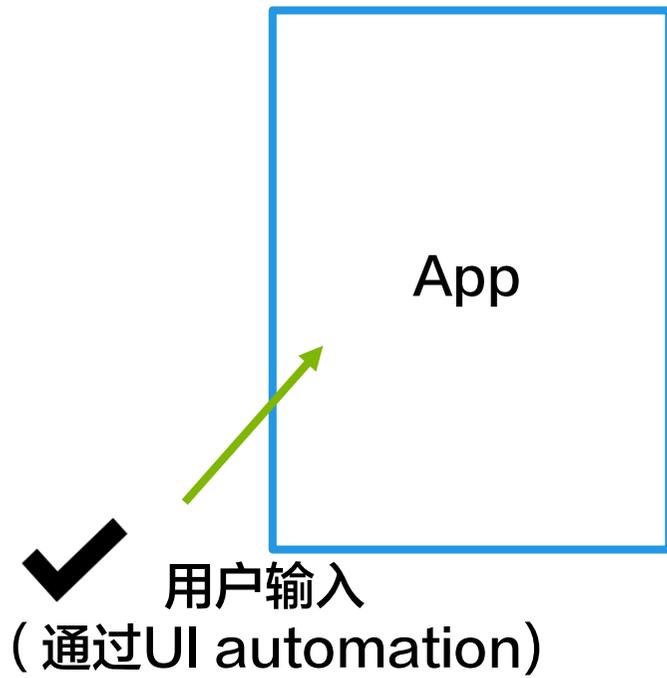
```
onView(withId(getInstrumentation().getTargetContext().getResources().getIdentifier("com.twitter.android:id/login_username", null, null))).perform(typeText("username"));
```

```
onView(withId(getInstrumentation().getTargetContext().getResources().getIdentifier("com.twitter.android:id/login_password", null, null))).perform(typeText("password"));
```

简单比较

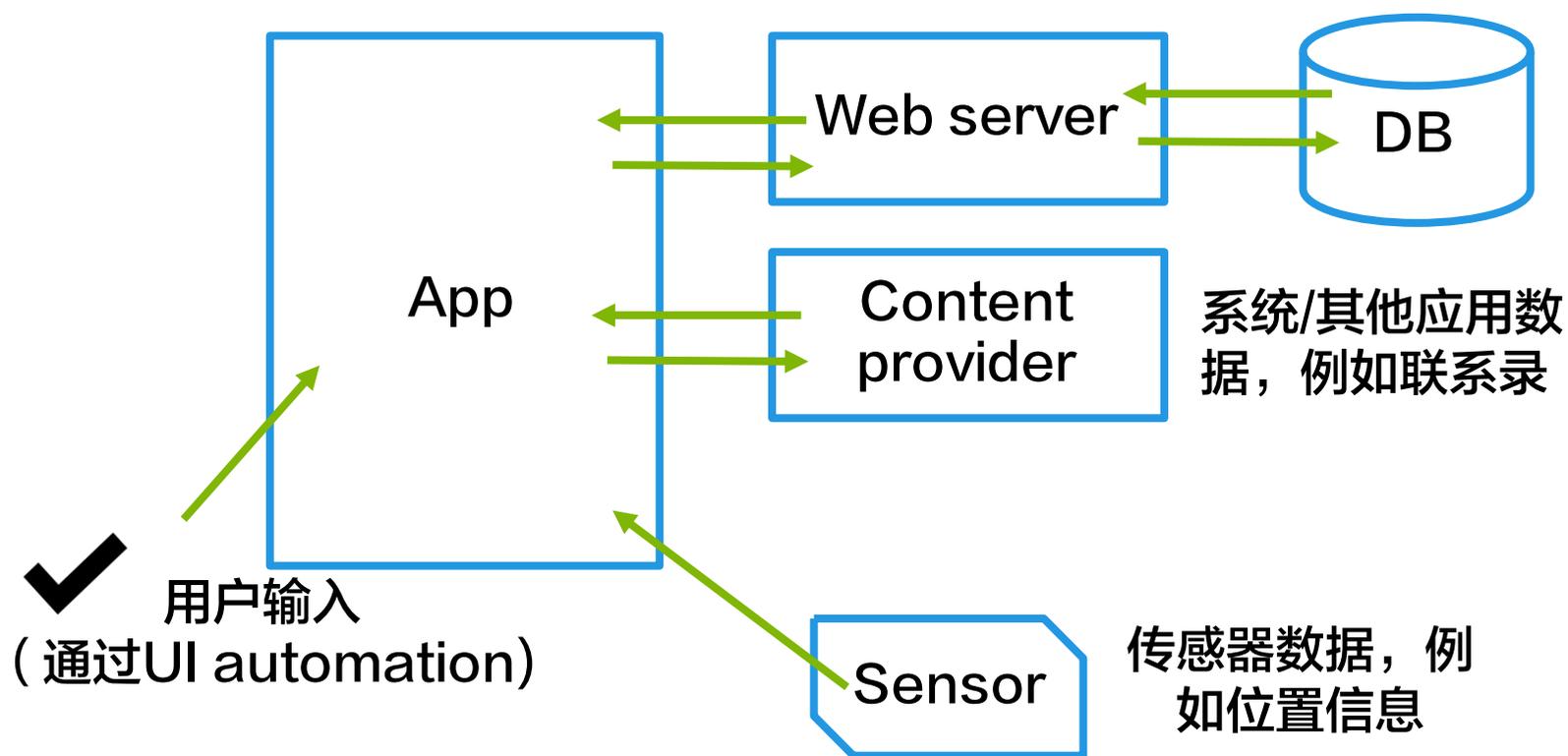
	Robotium	uiautomator	Espresso	Appium	Calabash
Android	Yes	Yes	Yes	Yes	Yes
iOS	No	No	No	Yes	Yes
Mobile web	Yes (Android)	Limited to x.y clicks	No	Yes (Android & iOS)	Yes (Android)
Scripting Language	Java	Java	Java	Almost any	Ruby
Test creation tools	Testdroid Recorder	UI Automator viewer	Hierarchy Viewer	Appium.app	CLI
Supported API levels	All	16 =>	8, 10, 15 =>	All	All
Community	Contributors	Google	Google	Active	Pretty quiet

Mock



Mock

App后端业务

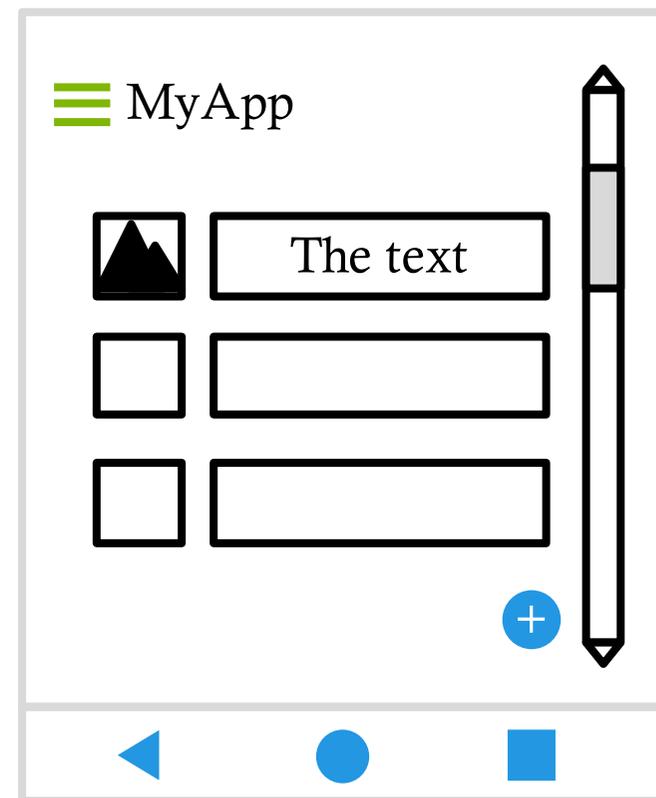


Mock

- ◆ HTTP Mock: Anyproxy
 - ◆ <https://testerhome.com/topics/6300>
- ◆ 微信WebView小程序：
 - ◆ <https://testerhome.com/topics/6954>
- ◆ GPS: Fake GPS app (system admin permission)

前端业务变化快

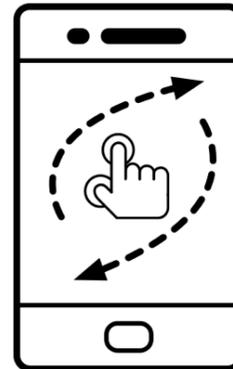
- ◆ 录制UI 事件 + 录制Mock数据库
 - ◆ Robotium Recorder: UI -> Robotium用例
 - ◆ Espresso Recorder (beta) -> Espresso用例
 - ◆ 阿里MQC移动质量中心 -> Appium用例
 - ◆ iTestin->脚本
 - ◆ ...
- ◆ 探索类工具，探索稳定性
 - ◆ Monkey
 - ◆ AppCrawler
 - ◆ AutoClick



案例二：手游

- ◆ 各类游戏，Unity，Cocos-2dx
- ◆ 特点
 - ◆ 用户输入复杂（多点触摸，复杂轨迹）
 - ◆ 没有控件
 - ◆ 实时性强（例如：音乐游戏）
 - ◆ 框架托管环境（C#，native code）

录制测试

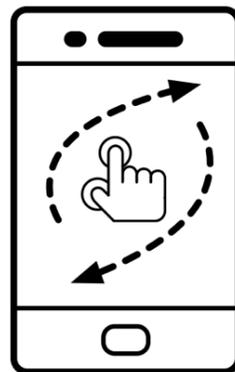


Touch (110, 44)
Sleep 3.024
Touch (119, 48)
...

<https://github.com/appetizerio/appetizer-toolkit>

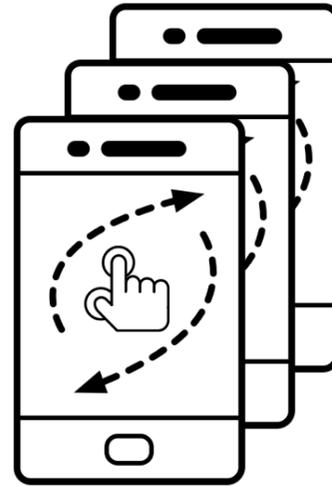
录制测试

- ◆ 多点触摸
- ◆ 复杂轨迹（例如手游的输入）
- ◆ 准确的时序（误差 $<0.1\text{ms}$ ）
- ◆ 广泛支持多种机型，不需要root
- ◆ 例如录制手游的一个关卡，电商App的一次交易



```
Touch (110, 44)  
Sleep 3.024  
Touch (119, 48)  
...
```

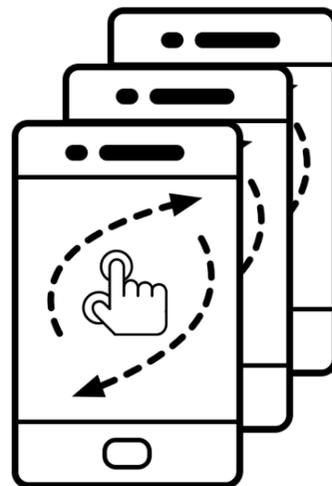
重放测试



Touch (110, 44)
Sleep 3.024
Touch (119, 48)
...

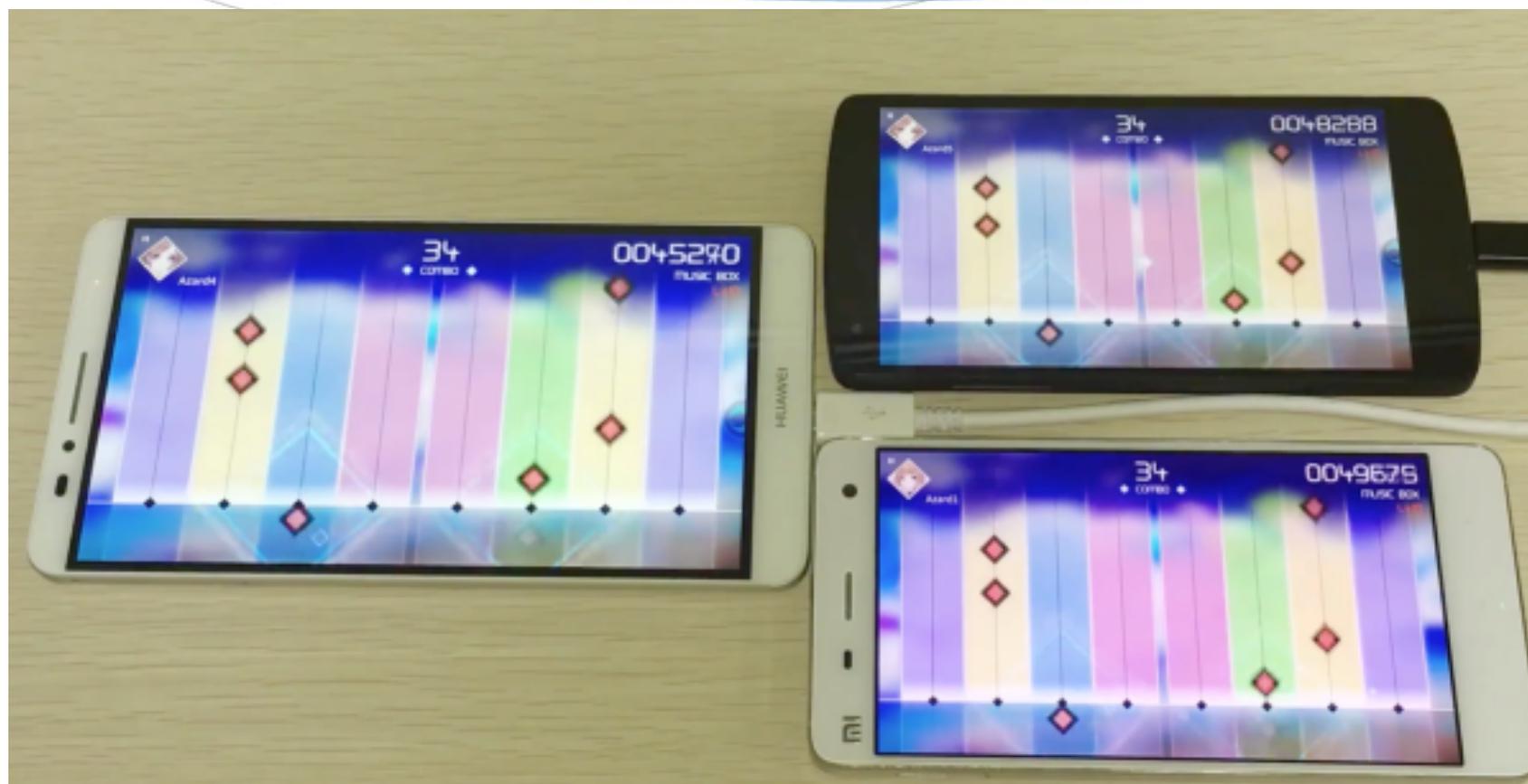
重放测试

- ◆ 多设备、自动化、高精度
- ◆ 同纵宽比自动放缩
- ◆ 适用于手游、应用
- ◆ 触摸屏输入 => 测试可以跨App/系统

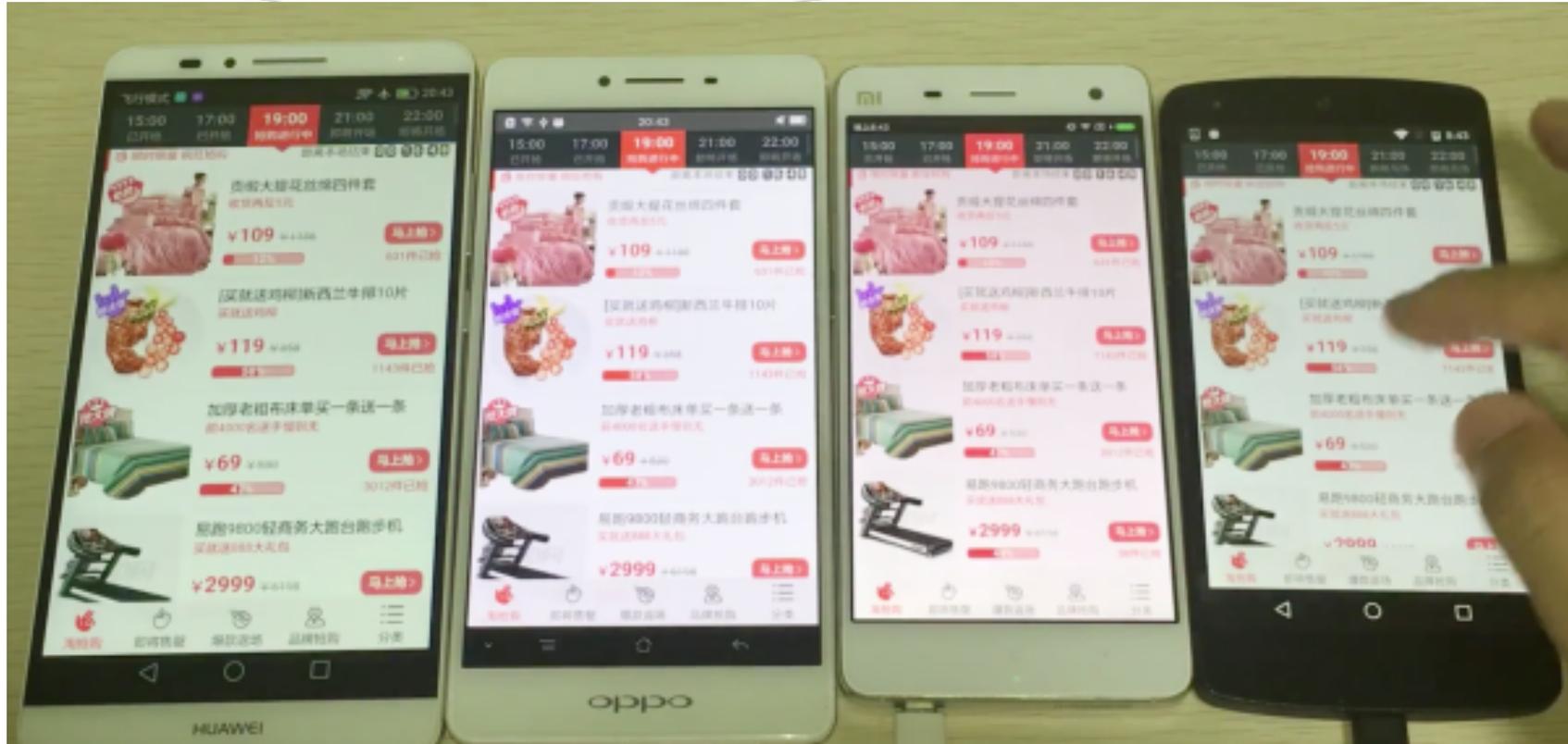


Touch (110, 44)
Sleep 3.024
Touch (119, 48)
...

音乐游戏重放效果



同步操作



测试自动化总结

- ◆ 测试因APP而异，考虑：UI构成，数据流构成，延时要求等
- ◆ 专项测试
 - ◆ 兼容性：设备、系统定制化对一些API的影响
 - ◆ 安全：Intent spoofing，HTTP请求跨站等等
 - ◆ 耗电：Battery Historian
 - ◆ 性能：帧率、交互延时
 - ◆ 弱网络：突发性网络延迟变高
 - ◆ 内存泄露：Leak Canary

质量追踪

- ◆ 测量项目
 - ◆ 指标类：CPU、流量消耗、内存占用、错误报告
 - ◆ 计量类：流畅度、耗电量、HTTP抓包、并发度
 - ◆ 测量工具的局限（root、不全面）
- ◆ 传统人工追踪
 - ◆ log大法（从C语言的printf到Android的Log.d）
 - ◆ 人工埋点低效，不全面（库代码无法修改）
 - ◆ 基于人工的问题诊断

基于Dex注入的自动质量监控



Signed zip

classes.dex

classes2.dex

classes3.dex

Dalvik bytecode:



基于Dex注入的自动质量监控

The image shows a screenshot of a Smali editor interface. The main window displays the source code for `GlobalActions.smali`. The code includes several instructions for setting and getting objects, and for creating a new instance, all related to `GlobalActions$ToggleAction$State`. The right-hand panel, titled `Smali-Fields`, lists various fields from the `GlobalActions$ToggleAction$State` class. The field `mAirplaneState` is currently selected and highlighted in blue.

```
GlobalActions.smali x
148 iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mDev
149
150 .line 123
151 sget-object v5, Lcom/android/internal/policy/impl/GlobalActions$ToggleActio
GlobalActions$ToggleAction$State;
152
153 iput-object v5, p0, Lcom/android/internal/policy/impl/GlobalActions;->mAirpl
GlobalActions$ToggleAction$State;
154
155 .line 125
156 sget-object v5, Lcom/android/internal/policy/impl/GlobalActions$ToggleActio
GlobalActions$ToggleAction$State;
157
158 iput-object v5, p0, Lcom/android/internal/policy/impl/GlobalActions;->mMobil
GlobalActions$ToggleAction$State;
159
160 .line 126
161 iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mSimf
162
163 .line 128
164 iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mIsW
165
166 .line 133
167 iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->imsRe
168
169 .line 1369
170 new-instance v5, Lcom/android/internal/policy/impl/GlobalActions$10;
171
172 invoke-direct {v5, p0}, Lcom/android/internal/policy/impl/GlobalActions$10;-
GlobalActions;)V
173
174 iput-object v5, p0, Lcom/android/internal/policy/impl/GlobalActions;->mReas
```

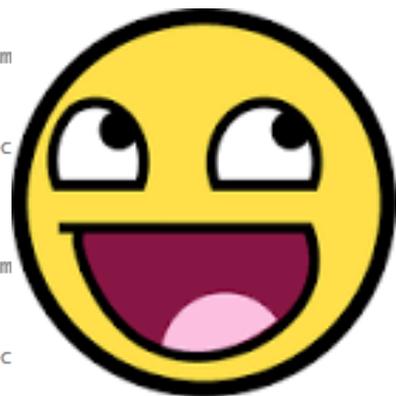
Smali-Fields

Fields

- DIALOG_DISMISS_DELAY
- IMS_REGISTRATION
- IMS_REG_STATUS
- IPUtilesClassName
- MESSAGE_DISMISS
- MESSAGE_NOTIFY
- MESSAGE_REFRESH
- MESSAGE_SHOW
- SENDER
- SHOW_SILENT_TOGGLE
- TAG
- VIBRATE_DURATION
- imsRegistered
- mAdapter
- mAirplaneModeObserver
- mAirplaneModeOn
- mAirplaneState**
- mAudioManager
- mBroadcastReceiver
- mContext
- mDeviceProvisioned
- mDialog
- mHandler
- mHasTelephony
- mHasVibrator
- mWindowManager
- mIsWaitingForEcmExit
- mItems
- mKeyguardShowing

Smali-Fields Smali-Methods

基于Dex注入的自动质量监控



GlobalActions.smali x

```

148   iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mDevj
149
150   .line 123
151   sget-object v5, Lcom/android/internal/policy/im
GlobalActions$ToggleAction$State;
152
153   iput-object v5, p0, Lcom/android/internal/polic
GlobalActions$ToggleAction$State;
154
155   .line 125
156   sget-object v5, Lcom/android/internal/policy/im
GlobalActions$ToggleAction$State;
157
158   iput-object v5, p0, Lcom/android/internal/polic
GlobalActions$ToggleAction$State;
159
160   .line 126
161   iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mSimf
162
163   .line 128
164   iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->mIsWz
165
166   .line 133
167   iput-boolean v7, p0, Lcom/android/internal/policy/impl/GlobalActions;->imsRe
168
169   .line 1369
170   new-instance v5, Lcom/android/internal/policy/impl/GlobalActions$10;
171
172   invoke-direct {v5, p0}, Lcom/android/internal/policy/impl/GlobalActions$10;-
GlobalActions;)V
173
174   iput-object v5, p0, Lcom/android/internal/policy/impl/GlobalActions;->mReas

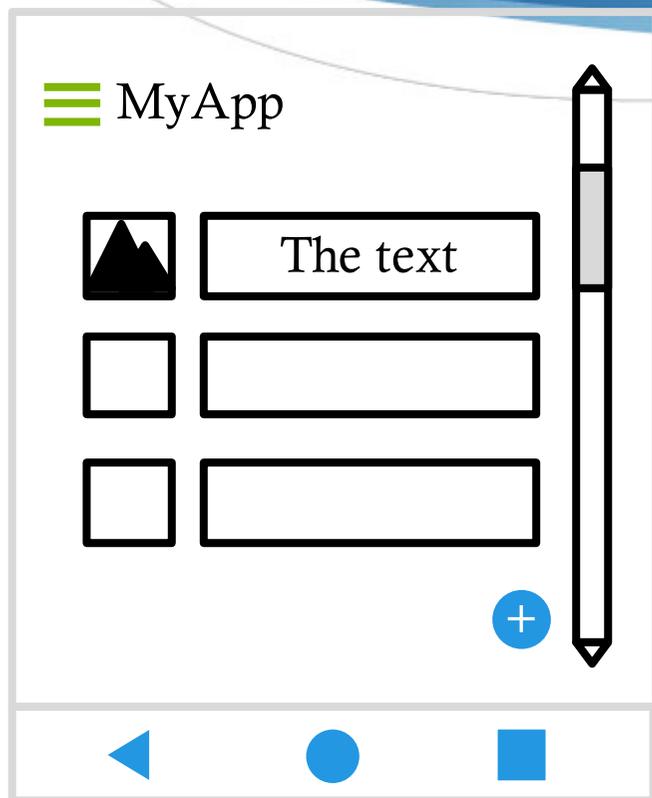
```

Smali-Fields

Fields

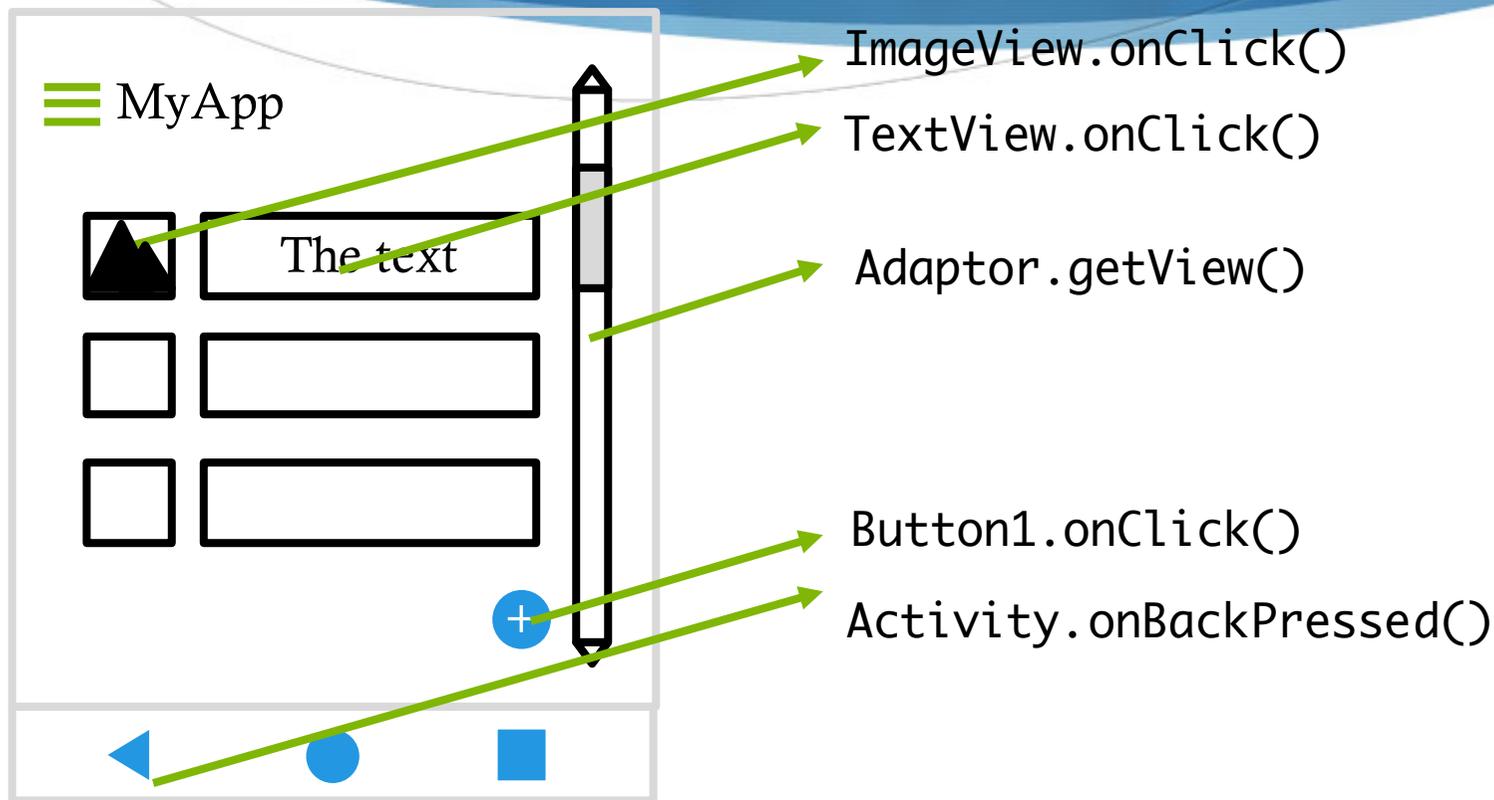
- ▣ DIALOG_DISMISS_DELAY
- ▣ IMS_REGISTRATION
- ▣ IMS_REG_STATUS
- ▣ IPUtilsClassName
- ▣ MESSAGE_DISMISS
- ▣ MESSAGE_NOTIFY
- ▣ MESSAGE_REFRESH
- ▣ MESSAGE_SHOW
- ▣ SENDER
- ▣ SHOW_SILENT_TOGGLE
- ▣ TAG
- ▣ VIBRATE_DURATION
- ▣ imsRegistered
- ▣ mAdapter
- ▣ mAirplaneModeObserver
- ▣ mAirplaneModeOn
- ▣ mAirplaneState
- ▣ mAudioManager
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- ▣ mContext
- ▣ mDeviceProvisioned
- ▣ mDialog
- ▣ mHandler
- ▣ mHasTelephony
- ▣ mHasVibrator
- ▣ mWindowManager
- ▣ mIsWaitingForEcmExit
- ▣ mItems
- ▣ mKeyguardShowing

注入举例



示例应用界面元素

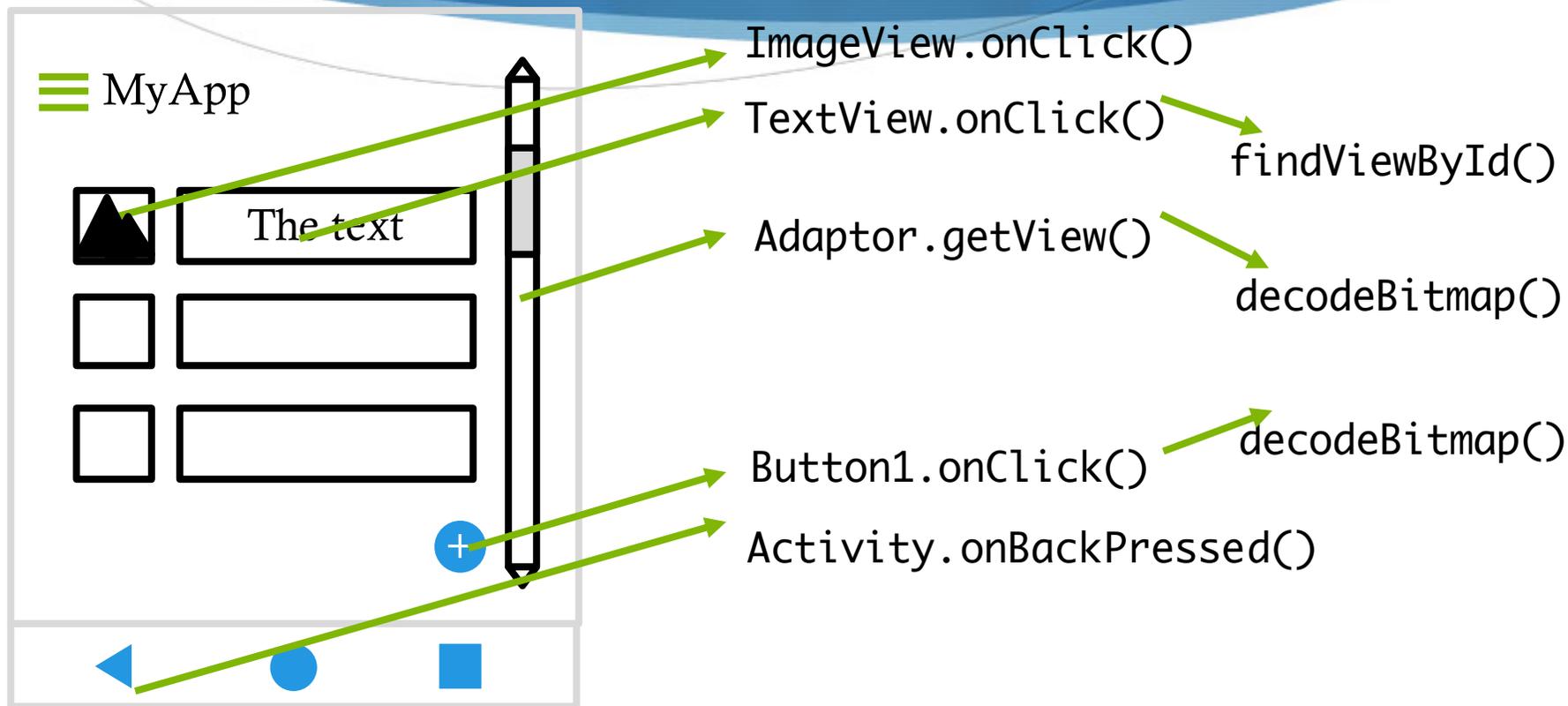
注入举例



示例应用界面元素

事件响应函数
(用户可能感到卡顿)

注入举例



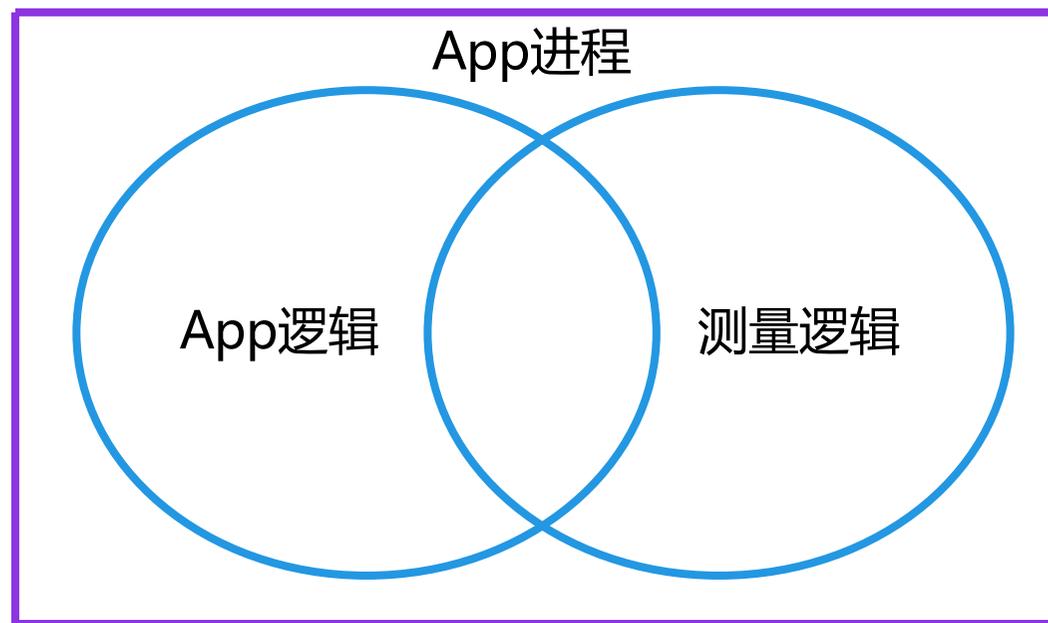
示例应用界面元素

事件响应函数
(用户可能感到卡顿)

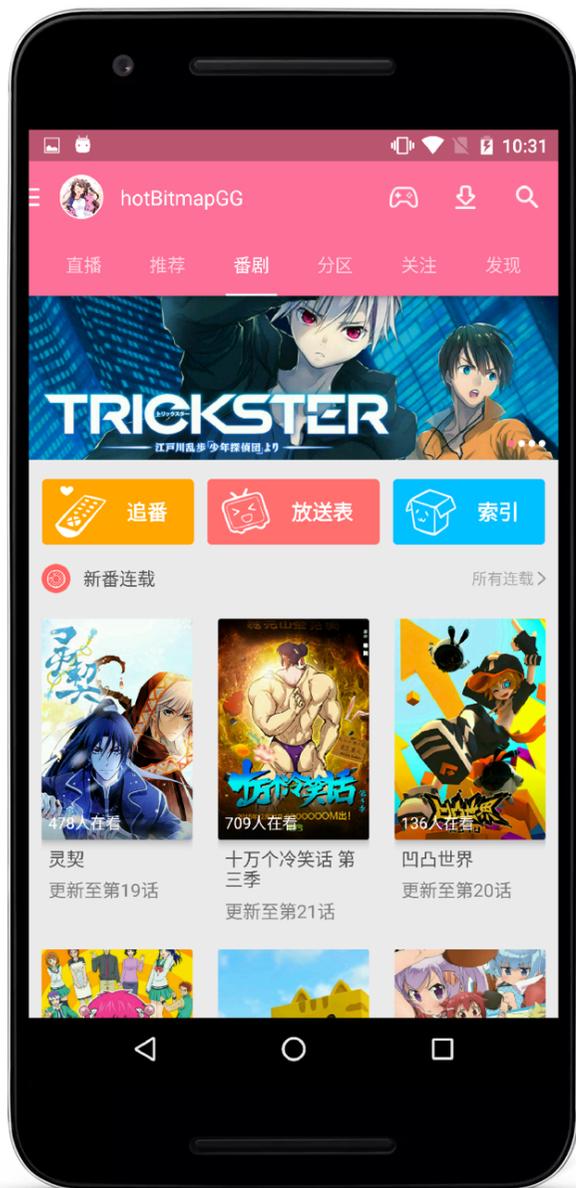
耗时操作

基于Dex注入的自动质量监控

- 人工埋点 -> 自动埋点：全面、自动
- 松耦合的结合
 - 无权限，无Root要求
- 专业的测量方法
- 自动问题诊断



案例分析

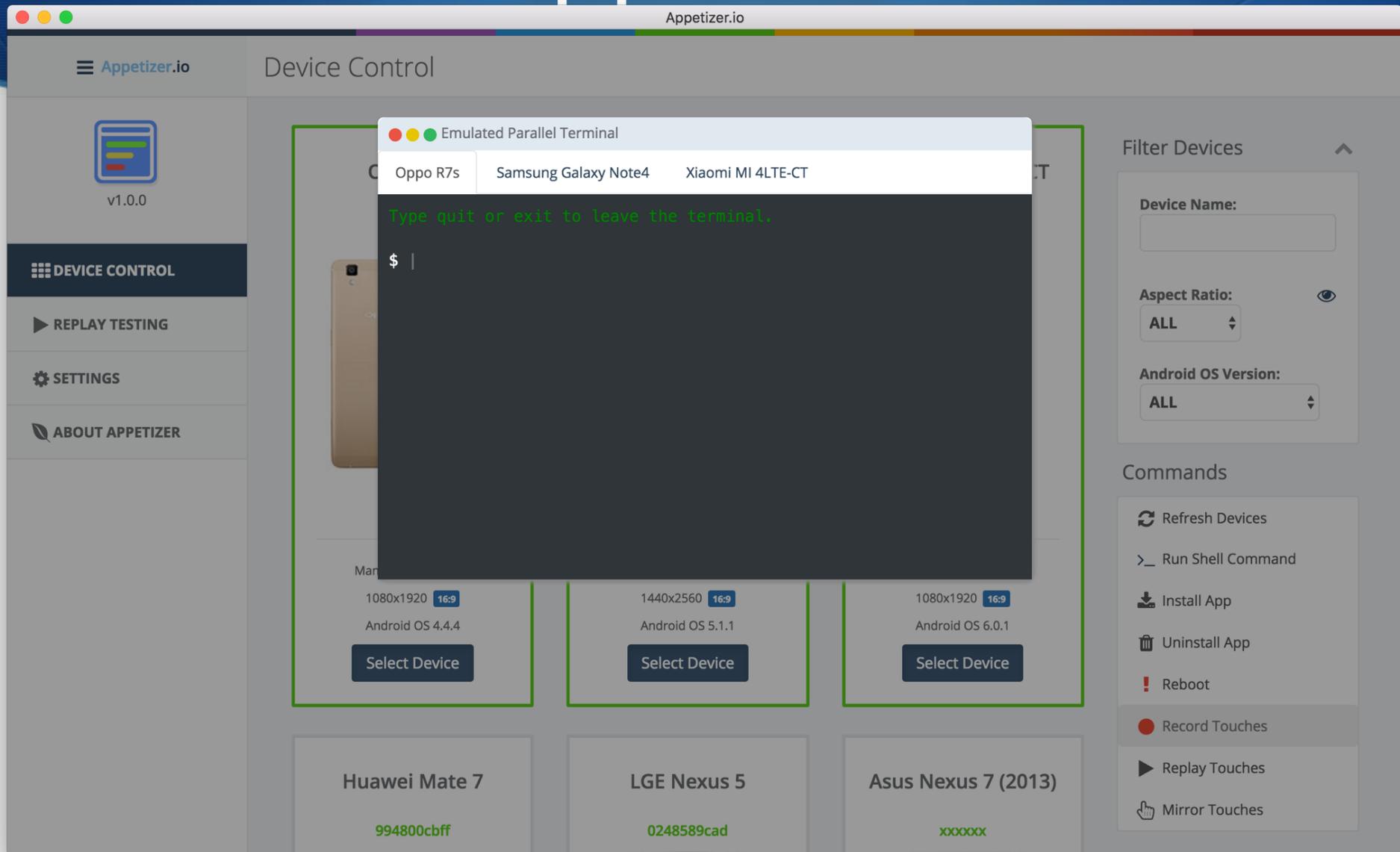


- ◆ 开源bilibili客户端
 - ◆ 34个依赖：UI组件、LeakCanary、ijkplayer、RxAndroid、OkHttp
- ◆ 自动主流程回归测试 + 自动质量监控
- ◆ 开放环境无Mock（实际Http请求）

Appetizer

The screenshot displays the Appetizer.io web interface. At the top, the browser address bar shows 'Appetizer.io'. The page title is 'Device Control'. On the left, there is a sidebar menu with the following items: 'Appetizer.io' (with a hamburger icon), 'v1.0.2', 'DEVICE CONTROL' (highlighted), 'REPLAY TESTING', 'INSIGHTS BETA', 'SETTINGS', and 'ABOUT APPETIZER'. The main content area features a grid of device cards. Each card includes a device name, a model number, a manufacturer, resolution, aspect ratio, and Android OS version, along with a 'Select Device' button. The visible devices are: Oppo R7s (sdsc999c, Manufacturer: OPPO, 1080x1920, 16:9, Android OS 4.4.4), Samsung Galaxy Note4 (13bbacff, Manufacturer: samsung, 1440x2560, 16:9, Android OS 5.1.1), and Xiaomi MI 4LTE-CT (2399c78da, Manufacturer: Xiaomi, 1080x1920, 16:9, Android OS 6.0.1). Below these, the heads of three more device cards are visible: Huawei Mate 7 (994800cbff), LGE Nexus 5 (0248589cad), and Asus Nexus 7 (2013) (xxxxxx). On the right side, there is a 'Filter Devices' panel with input fields for 'Device Name', 'Aspect Ratio' (set to ALL), and 'Android OS Version' (set to ALL). Below the filter panel is a 'Commands' panel with a list of actions: Refresh Devices, Run Shell Command, Install App, Uninstall App, Reboot, Record Touches, Replay Touches, and Mirror Touches.

Appetizer



定制化重放

Replay Testing

Select APK >>

✔ Plan Test Steps >>

Select Test Devices >>

Launch Test



Initialize the test

Uninstall old version, install the app and start.

~8.0 secs



Replay 登录 .txt

None

~32.3 secs



Take screenshot

Take and save screen shot.

~2.0 secs



Replay 主界面探索 !.txt

None

~42.8 secs



Take screenshot

Take and save screen shot.

~2.0 secs

16:9设备测试箱



ColorOS
based on Android



崩溃报告

←
☰ ★
↻

异常全名: java.lang.NullPointerException

Stack trace:

0: com.hotbitmapgg.bilibili.module.entry.HistoryFragment.finishCreateView(HistoryFragment.java:61)
1: com.hotbitmapgg.bilibili.base.RxLazyFragment.onViewCreated(RxLazyFragment.java:55)
2: android.support.v4.app.FragmentManagerImpl.moveToState(FragmentManager.java:1315)
3: android.support.v4.app.FragmentManagerImpl.moveFragmentsToInvisible(FragmentManager.java:2323)
4: android.support.v4.app.FragmentManagerImpl.executeOpsTogether(FragmentManager.java:2136)
5: android.support.v4.app.FragmentManagerImpl.optimizeAndExecuteOps(FragmentManager.java:2092)
6: android.support.v4.app.FragmentManagerImpl.execPendingActions(FragmentManager.java:1998)
7: android.support.v4.app.FragmentManagerImpl.1.run(FragmentManager.java:709)
8: android.os.Handler.handleCallback(Handler.java:739)
9: android.os.Handler.dispatchMessage(Handler.java:95)
10: android.os.Looper.loop(Looper.java:148)
11: android.app.ActivityThread.main(ActivityThread.java:5417)
12: java.lang.reflect.Method.invoke(Native Method:Native Method)
13: com.android.internal.os.ZygoteInit.MethodAndArgsCaller.run(ZygoteInit.java:726)
14: com.android.internal.os.ZygoteInit.main(ZygoteInit.java:616)

■ 已用内存 ■ 可用内存

■ 已用存储空间 ■ 可用存储空间

崩溃报告

←
☰ ★
↻

异常全名: java.lang.NullPointerException

Stack trace:

- 0: com.hotbitmapgg.bilibili.module.entry.HistoryFragment.finishCreateView(HistoryFragment.java:61)
- 1: com.hotbitmapgg.bilibili.base.RxLazyFragment.onViewCreated(RxLazyFragment.java:55)



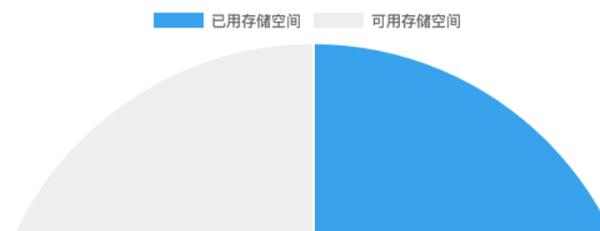
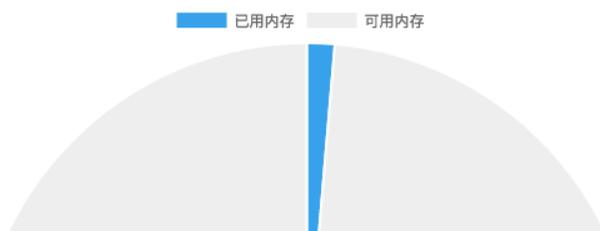
HotBitmapGG commented 28 days ago

Owner



这个问题是番剧界面的广告横幅返回的数据有时候没有，我之前忘记加个判断了，已fix。

- 8: android.os.Handler.nandaicallback(Handler.java:739)
- 9: android.os.Handler.dispatchMessage(Handler.java:95)
- 10: android.os.Looper.loop(Looper.java:148)
- 11: android.app.ActivityThread.main(ActivityThread.java:5417)
- 12: java.lang.reflect.Method.invoke(Native Method:Native Method)
- 13: com.android.internal.os.ZygoteInit.MethodAndArgsCaller.run(ZygoteInit.java:726)
- 14: com.android.internal.os.ZygoteInit.main(ZygoteInit.java:616)



HTTP诊断分析

Appetizer.io
质量监控 beta


v1.1.0

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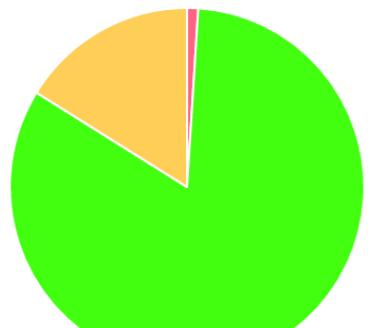
✔ OK 82

⚠ HTTP错误 1

⚡ 已缓存

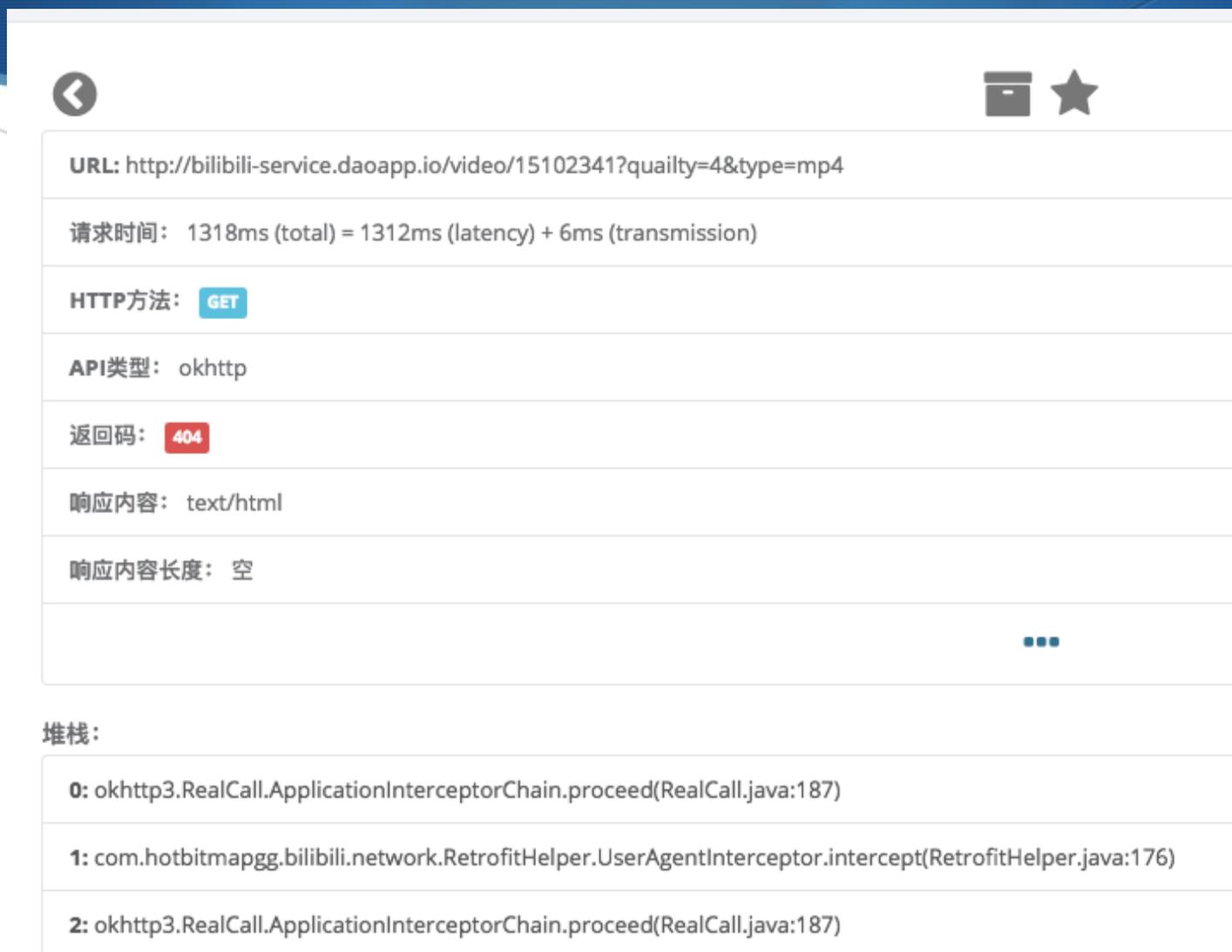
⏱ 高延时 16

⚡ 可缓存 8



Lengthy operation	Invoking a lengthy Android API setImageResource in the UI...
High latency	http://s.search.bilibili.com/main/hotword
Slow	http://i0.hdslb.com/bfs/archive/f4584a984758293e4377fa163345..
High latency	http://i0.hdslb.com/bfs/archive/de0f2a9fb752f63a0d64c71229ed..
High latency	http://app.bilibili.com/x/view
High latency	http://api.bilibili.cn/feedback
High latency	http://i1.hdslb.com/bfs/archive/40f004c5907dbccb242d24a574ee..
High latency	http://live.bilibili.com/AppIndex/home
Slow transmission	http://static.hdslb.com/live-static/images/mobile/android/sm..
High latency	http://i0.hdslb.com/bfs/bangumi/1aa1cee348544dbd677e05cbeaa8..
High latency	http://space.bilibili.com/ajax/Bangumi/getList
Lengthy operation	Invoking a lengthy Android API inflate in the UI thread, ...
Lengthy operation	Invoking a lengthy Android API setContentView in the UI t...
Lengthy operation	Invoking a lengthy Android API setImageResource in the UI...
Lengthy operation	Invoking a lengthy Android API inflate in the UI thread, ...
Lengthy operation	Invoking a lengthy Android API setContentView in the UI t...
High latency	http://i1.hdslb.com/bfs/archive/339c7d6fe7b787cfa12efd4fb3ea..
High latency	http://i1.hdslb.com/bfs/archive/75d267842529b5888cf567a7e1e4..
Slow transmission	http://i2.hdslb.com/bfs/face/4d3bed7e096480ca4b18343e9a6f88d..
Error Status Code	http://bilibili-service.daoapp.io/video/15102341
Slow transmission	http://i2.hdslb.com/bfs/face/7a9a979caad7982d51091a81a82e73f..
Slow transmission	http://i0.hdslb.com/bfs/face/b1286842d8650444355d2bea9863ec..
NullPointerException	Attempt to invoke virtual method 'java.lang.String java.l...
Lengthy operation	Invoking a lengthy Android API setImageResource in the UI...
ANR	Application Not Responding detected
Lengthy operation	Invoking a lengthy Android API setImageResource in the UI...
Lengthy operation	Invoking a lengthy Android API setImageResource in the UI...
High latency	http://live.bilibili.com/api/playurl
Lengthy operation	Invoking a lengthy Android API inflate in the UI thread, ...
Lengthy operation	Invoking a lengthy Android API setContentView in the UI t...

HTTP诊断分析



The screenshot displays an HTTP diagnostic tool interface. At the top, there are navigation icons: a back arrow, a menu icon, and a star icon. The main content area is divided into several sections:

- URL:** http://bilibili-service.daoapp.io/video/15102341?quality=4&type=mp4
- 请求时间:** 1318ms (total) = 1312ms (latency) + 6ms (transmission)
- HTTP方法:** GET
- API类型:** okhttp
- 返回码:** 404
- 响应内容:** text/html
- 响应内容长度:** 空

Below the main content area, there is a section labeled "堆栈:" (Stack). It contains three entries:

- 0: okhttp3.RealCall.ApplicationInterceptorChain.proceed(RealCall.java:187)
- 1: com.hotbitmapgg.bilibili.network.RetrofitHelper.UserAgentInterceptor.intercept(RetrofitHelper.java:176)
- 2: okhttp3.RealCall.ApplicationInterceptorChain.proceed(RealCall.java:187)

自动化质量监控总结

- ◆ 在DEX字节码层面插桩，自动埋点测量APP状态
 - ◆ 测量与业务分开，共享进程（同沙箱）
 - ◆ 崩溃：Java异常、ANR
 - ◆ 交互性能：探索APP中的组件、耗时API
 - ◆ HTTP抓包、延时：URLConnection, Apache, okhttp 2/3
 - ◆ 支持multidex，Hybrid App，混淆
 - ◆ 伴随自动化/人工测试自动产生精确到问题的质量报告

移动DevOps之路：Android 应用质量监控与测试自动化

<https://appetizer.io/>

