Tuning Android app performance for 150 MILLION devices

by Ryan Clements, Owner of Byte Bot 🤖

Home

News by Fire TV

Press ☰ to manage

Enjoy customized news from multiple providers and categories for free. Just say "Alexa, play the news".

YOUR APPS & CHANNELS

news

prime video

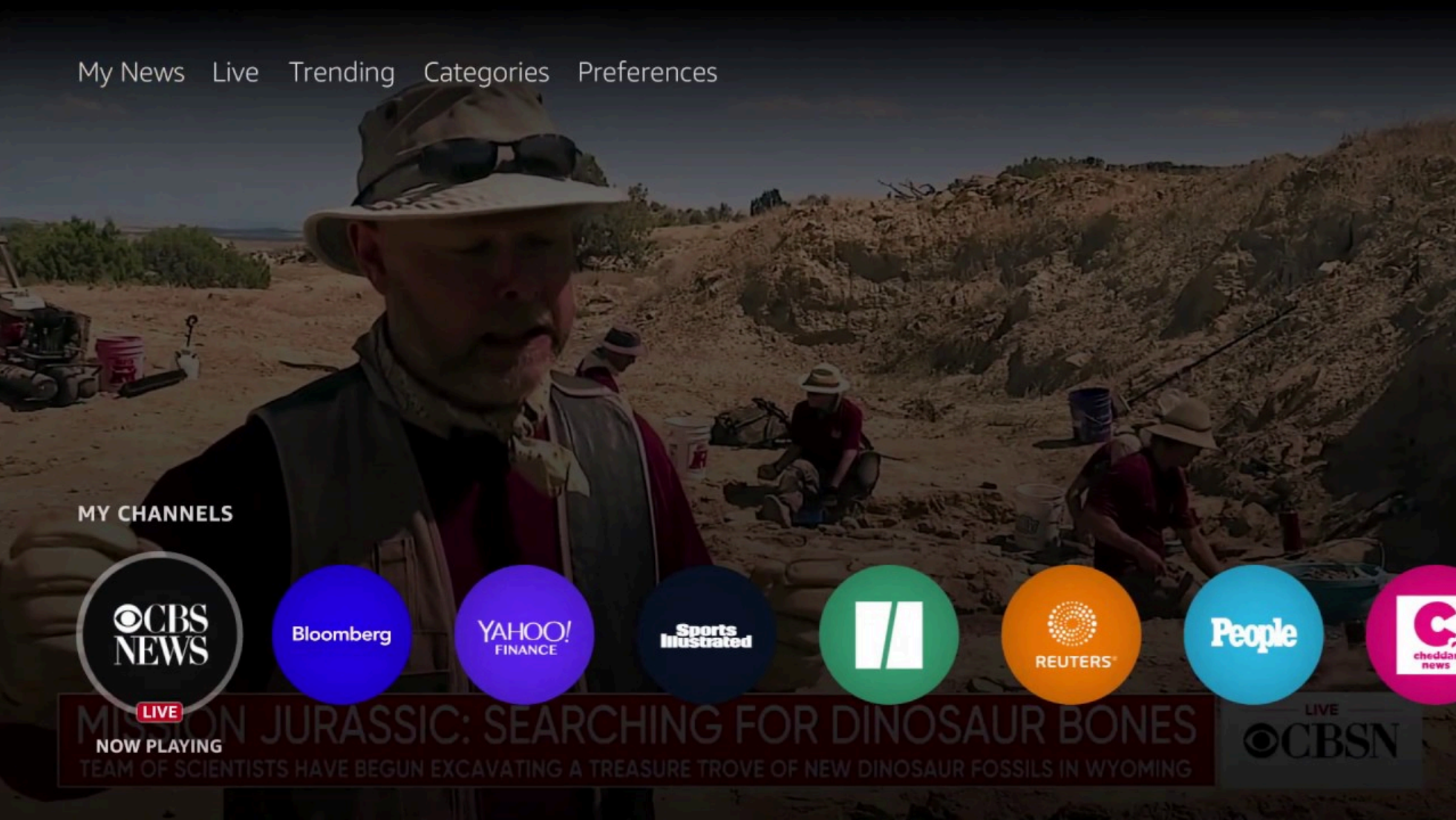
IMDb TV
Always Entertaining. Always Free.

amazon kids
Presented by FreeTime

amazon music

SPONSORED

prime AMAZON ORIGINALS

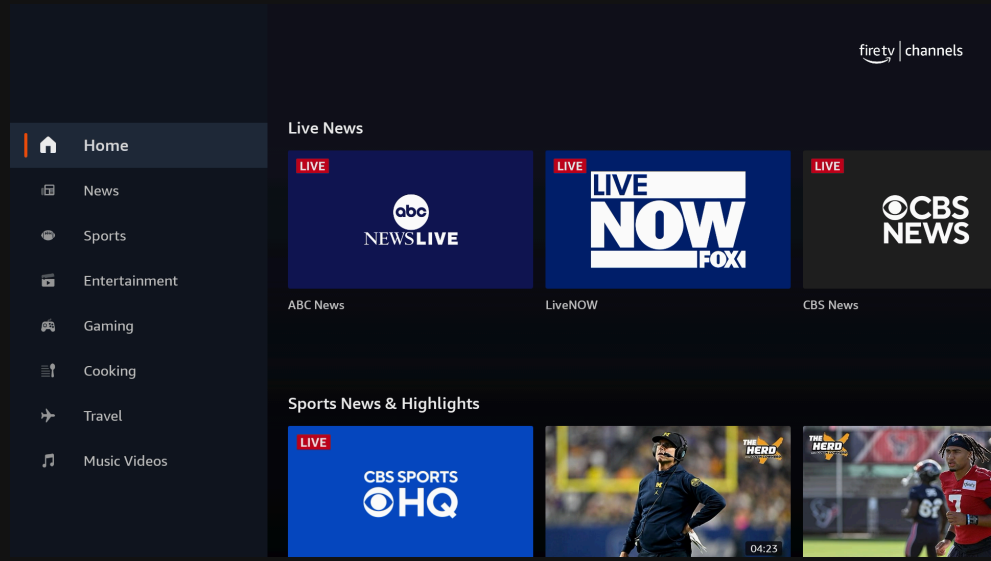

My News
Live
Trending
Categories
Preferences
MY CHANNELS
CBS NEWS
LIVE
NOW PLAYING
Bloomberg
YAHOO! FINANCE
Sports Illustrated
REUTERS
People
MISSION JURASSIC: SEARCHING FOR DINOSAUR BONES
TEAM OF SCIENTISTS HAVE BEGUN EXCAVATING A TREASURE TROVE OF NEW DINOSAUR FOSSILS IN WYOMING
LIVE
CBSN

We wanted...

The same app, but genericized to other types of content like

- 🏀 Sports
- 🎞️ Trailers
- 🍕 Food
- ✈️ Travel

...



Adobe Stock | #146174329


MakeAGIF.com

Who am I?

Ryan Clements, Owner of Byte Bot 🤖

a software agency that helps teams ship full stack solutions to their users through training and consulting 🚀

📲 calendly.com/byte-bot

📧 info@bytebot.io

📩 bytebot.beehiiv.com/subscribe

🔗 linkedin.com/in/ryan-clements-hax

Our first findings were...low tech

Lesson #1: Control your (de)serialization


REFLECTION

50%!

Lesson #2: Keep your dependencies up to date

Our poor app

- 🥲 Kotlin 1.3
- 🤢 Android support libraries
- 🤮 Gradle 3.0

Nice things we can’t have

❌ Flow

❌ androidx.anything (including compose 🤯)

❌ Anything that needs androidx

❌ Android Studio

⚠️ Databinding

⚠️ Documentation

So what serializers can we use?

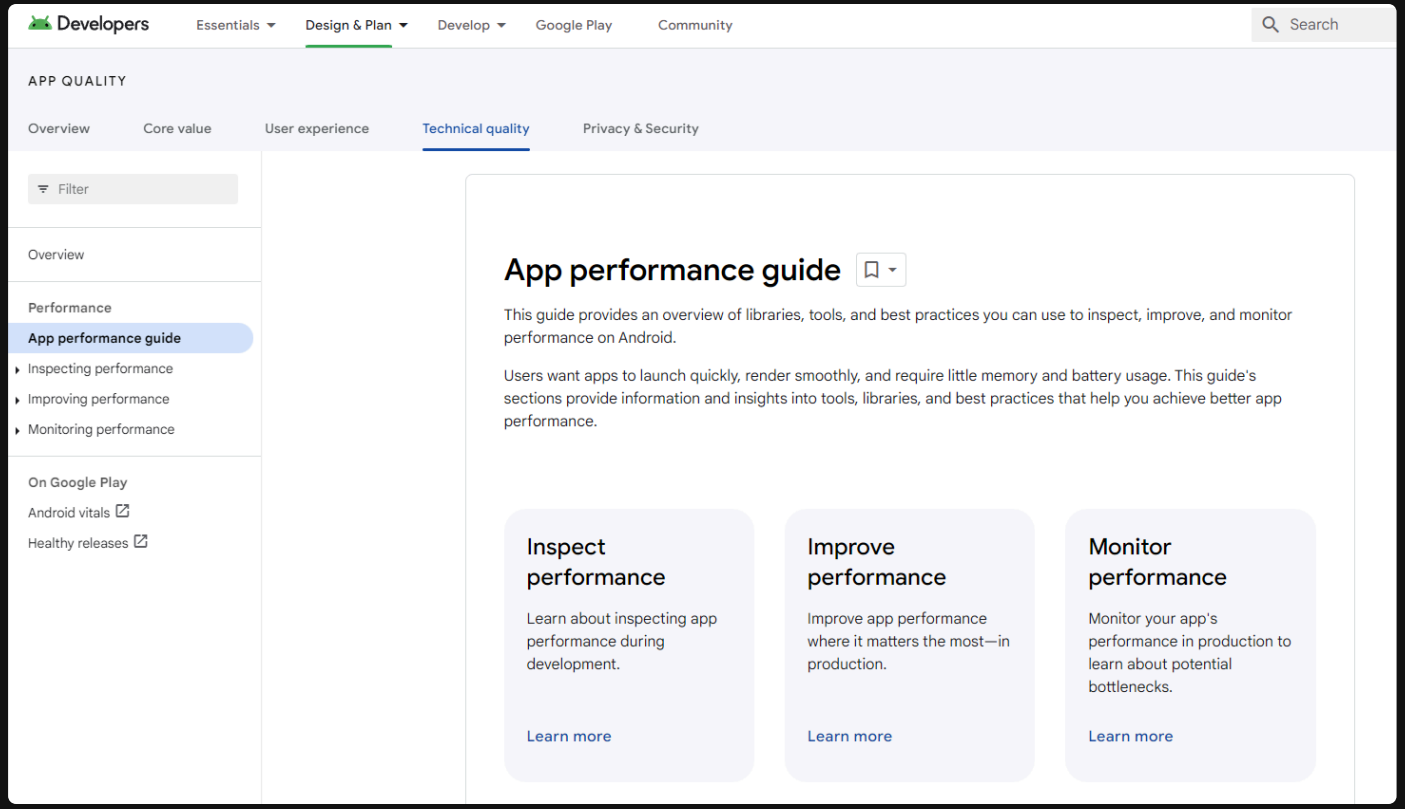
- ❌ kotlinx.serialization
- ❌ Moshi
- ✅ Jackson

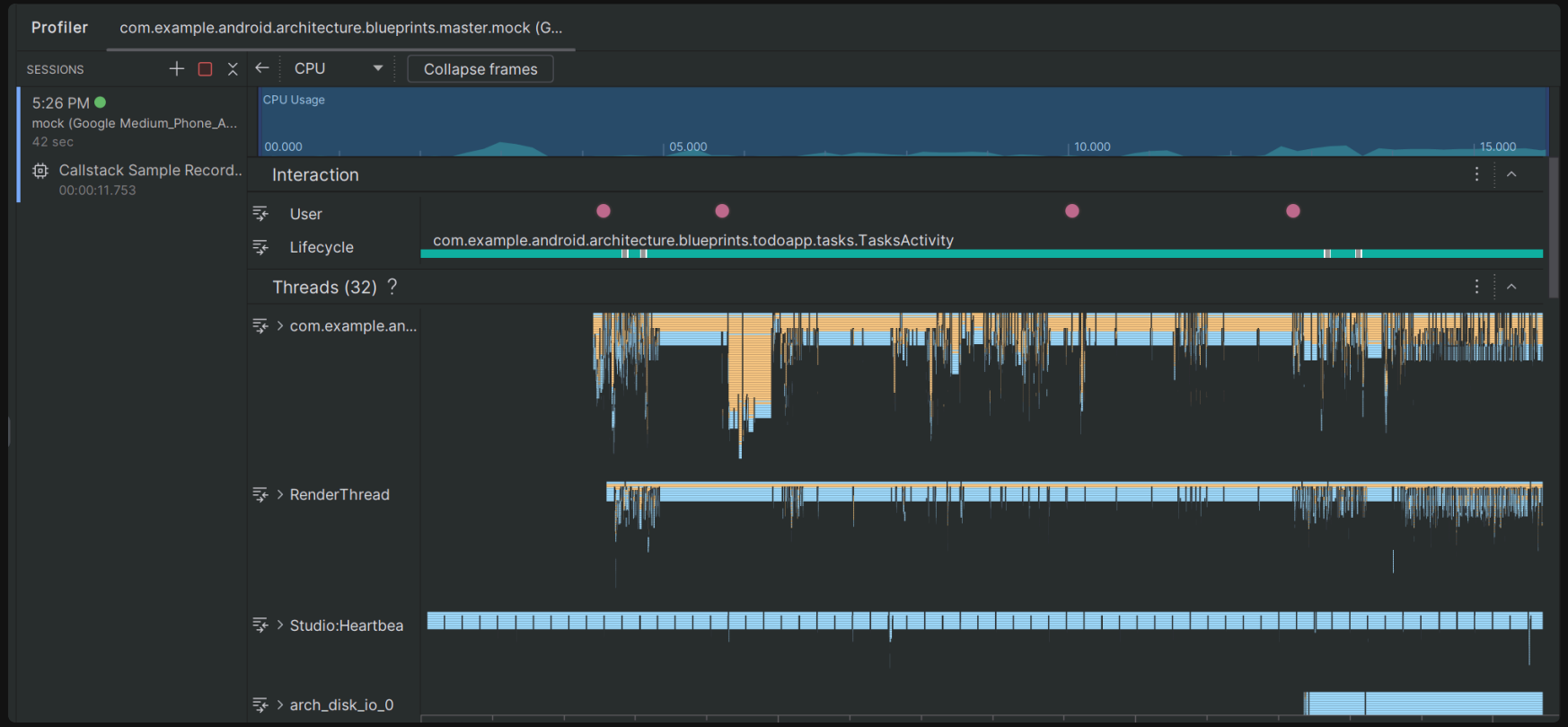

REFLECTION

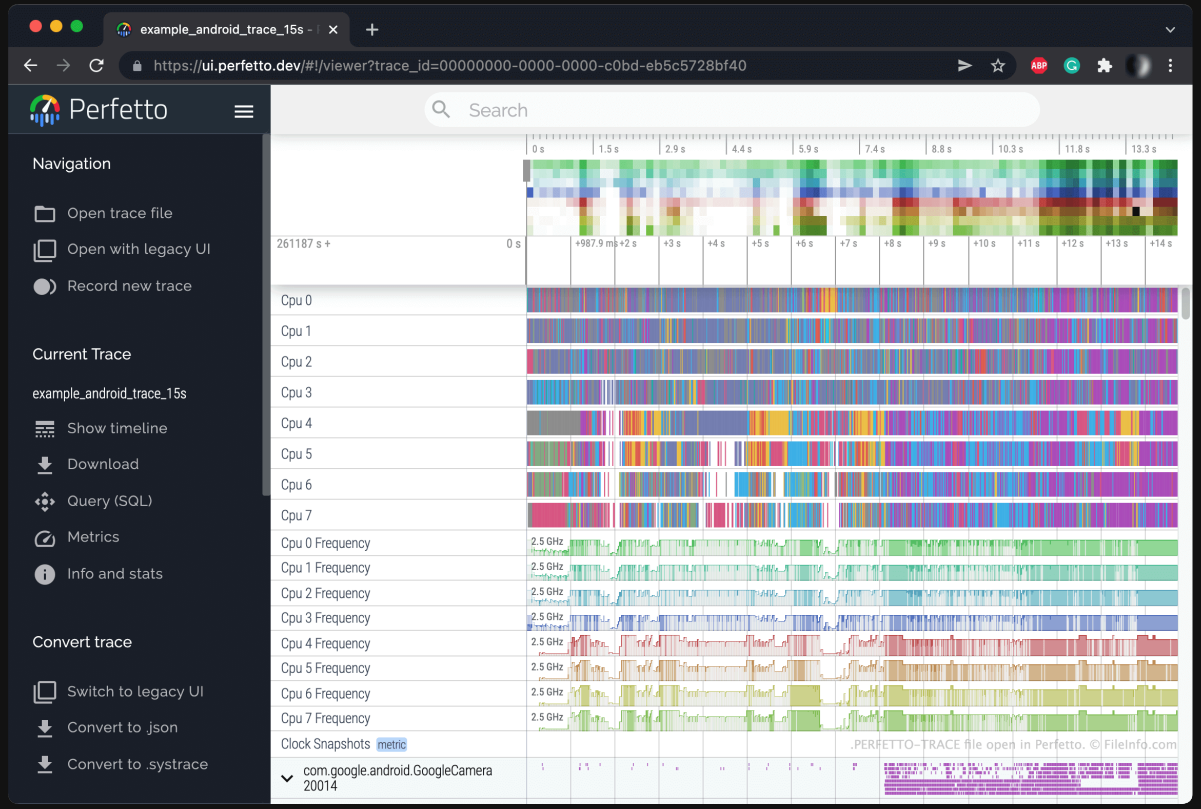
```java
public class ItemSerializer extends StdSerializer<Item> {

    public ItemSerializer() {
        this(null);
    }

    public ItemSerializer(Class<Item> t) {
        super(t);
    }

    @Override
    public void serialize(
      Item value,
      JsonGenerator jgen,
      SerializerProvider provider
    ) throws IOException, JsonProcessingException {
        jgen.writeStartObject();
        jgen.writeNumberField("id", value.id);
        jgen.writeStringField("itemName", value.itemName);
        jgen.writeNumberField("owner", value.owner.id);
        jgen.writeEndObject();
    }
}
```

```
Item myItem = new Item(1, "theItem", new User(2, "theUser"));
ObjectMapper mapper = new ObjectMapper();

SimpleModule module = new SimpleModule();
module.addSerializer(Item.class, new ItemSerializer());
mapper.registerModule(module);

String serialized = mapper.writeValueAsString(myItem);
```

Lesson #3: Use profiling tooling


Developers
Essentials
Design & Plan
Develop
Google Play
Community
Search
APP QUALITY
Overview
Core value
User experience
Technical quality
Privacy & Security
Filter
Overview
Performance
App performance guide
Inspecting performance
Improving performance
Monitoring performance
On Google Play
Android vitals
Healthy releases
App performance guide
This guide provides an overview of libraries, tools, and best practices you can use to inspect, improve, and monitor performance on Android.
Users want apps to launch quickly, render smoothly, and require little memory and battery usage. This guide's sections provide information and insights into tools, libraries, and best practices that help you achieve better app performance.
Inspect performance
Learn about inspecting app performance during development.
Learn more
Improve performance
Improve app performance where it matters the most—in production.
Learn more
Monitor performance
Monitor your app's performance in production to learn about potential bottlenecks.
Learn more


Profiler
com.example.android.architecture.blueprints.master.mock (G...
SESSIONS
CPU
Collapse frames
5:26 PM
mock (Google Medium_Phone_A...
42 sec
Callstack Sample Record..
00:00:11.753
CPU Usage
00.000
05.000
10.000
15.000
Interaction
User
Lifecycle
com.example.android.architecture.blueprints.todoapp.tasks.TasksActivity
Threads (32)
com.example.an...
RenderThread
Studio:Heartbea
arch_disk_io_0


example_android_trace_15s
https://ui.perfetto.dev/#!/viewer?trace_id=00000000-0000-0000-c0bd-eb5c5728bf40
Perfetto
Search
Navigation
Open trace file
Open with legacy UI
Record new trace
Current Trace
example_android_trace_15s
Show timeline
Download
Query (SQL)
Metrics
Info and stats
Convert trace
Switch to legacy UI
Convert to .json
Convert to .systrace
0 s
1.5 s
2.9 s
4.4 s
5.9 s
7.4 s
8.8 s
10.3 s
11.8 s
13.3 s
261187 s +
0 s
+987.9 ms
+2 s
+3 s
+4 s
+5 s
+6 s
+7 s
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+10 s
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Cpu 0
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Cpu 5
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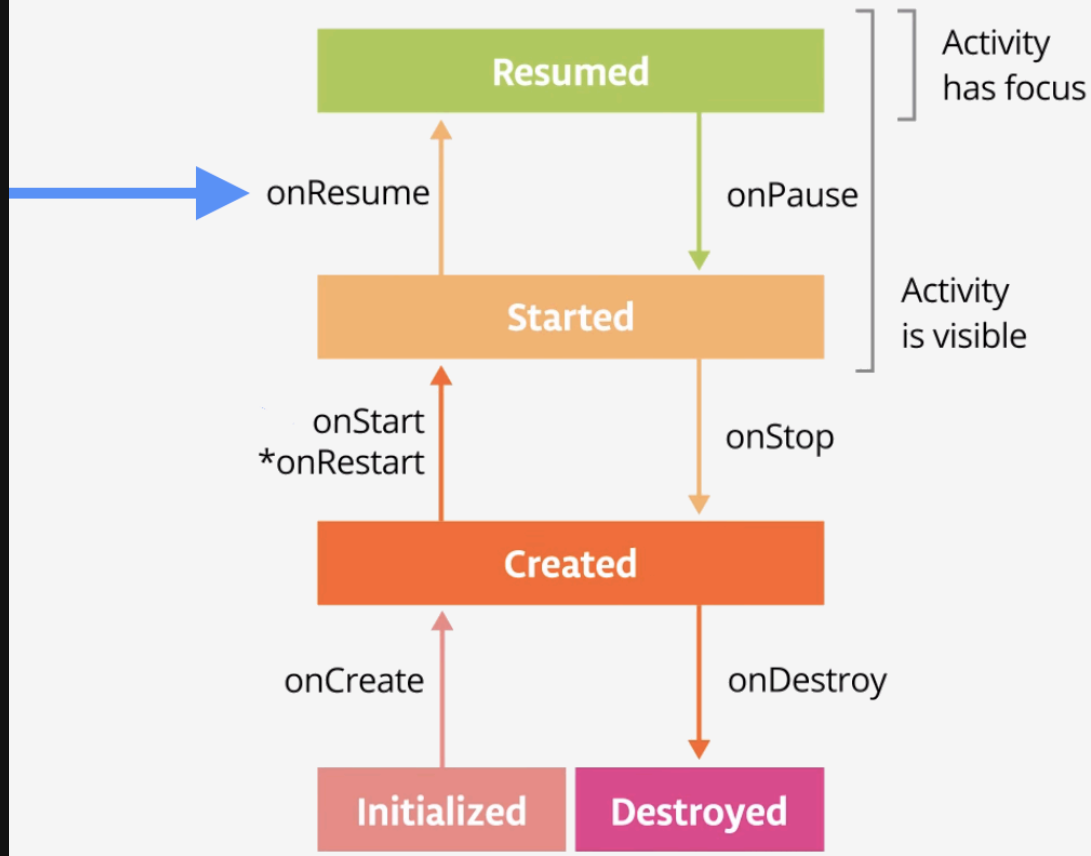
Cpu 7
Cpu 0 Frequency
Cpu 1 Frequency
Cpu 2 Frequency
Cpu 3 Frequency
Cpu 4 Frequency
Cpu 5 Frequency
Cpu 6 Frequency
Cpu 7 Frequency
2.5 GHz
Clock Snapshots
metric
.PERFETTO-TRACE file open in Perfetto. © FileInfo.com
com.google.android.GoogleCamera 20014

Lesson #4: The startup path is sacred

The Activity Lifecycle



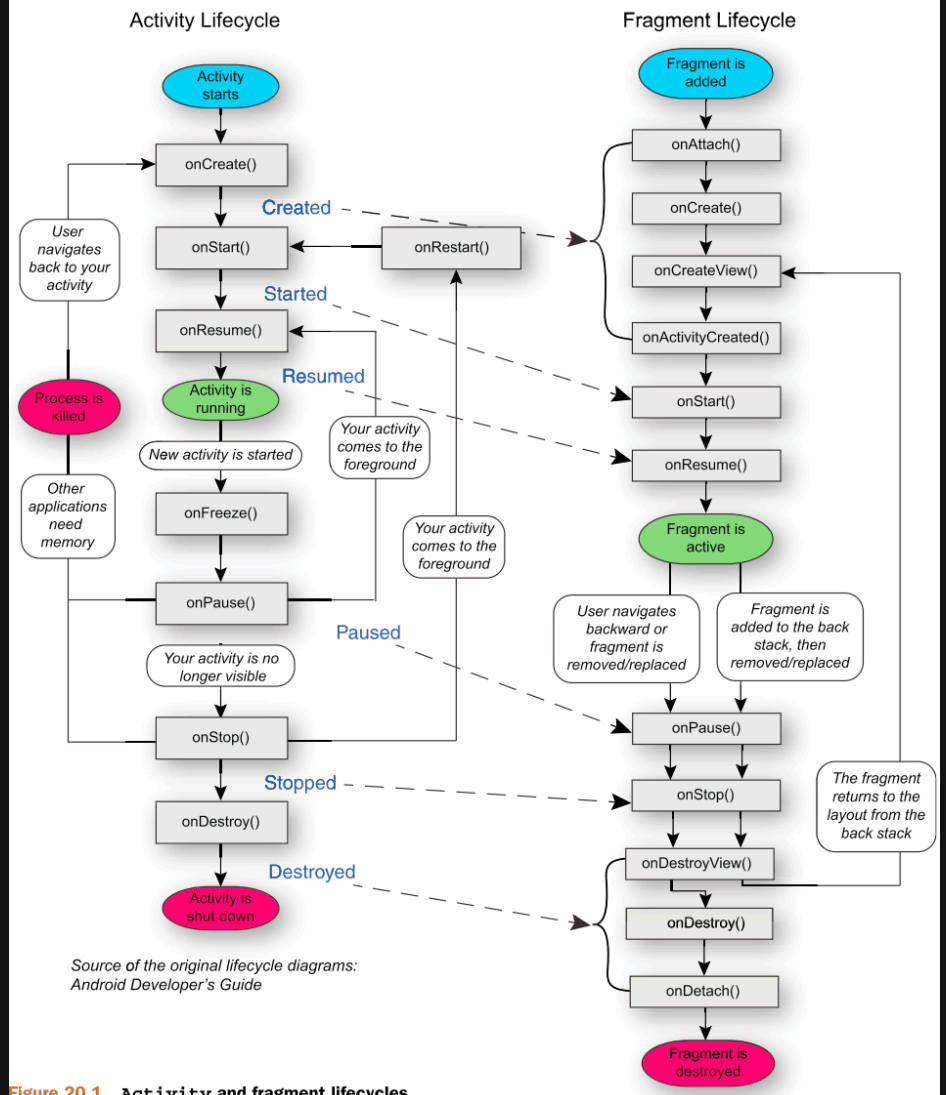


Figure 20.1 **`Activity` and fragment lifecycles**

More on my blog...

Code spelunking: How to dive into unfamiliar code (part 1)

Ever have problems making sense of code you didn't write? I'll help you with proven techniques in this post.

Code spelunking: How to dive into unfamiliar code (part 2)

Reading other people's code is hard. Here is how I do it.

```
class MyActivity : AppCompatActivity() {
    // Initialize DI
    val taskRepository: TasksRepository
        get() = ServiceLocator.provideTasksRepository(this)
    val appComponent: AppComponent by lazy {
        DaggerAppComponent.factory().create(applicationContext)
    }
    override fun onCreate() {
        super.onCreate()
        // Initializing logging
        if (BuildConfig.DEBUG) {
          Timber.plant(DebugTree());
        } else {
          Timber.plant(CrashReportingTree());
        }
        // Inflating views
        setContentView(R.layout.main);
        // Registering broadcast receivers
        val filter = IntentFilter();
        intentFilter.addAction(packageName + "android.net.conn.CONNECTIVITY_CHANGE");
        registerReceiver(MyReceiver(), filter);
        // Kicking off initial tasks
        taskRepository.fetchInitialData();
        appComponent.scheduler.queueBackgroundTasks();
        //  ... and so on  ...
    }
}
```

Beware of ContentProviders

ContentProviders run before other code during startup.

Look through your app's merged `AndroidManifest.xml` for lines like

```
<provider
    android:name="androidx.startup.InitializationProvider"
    android:authorities="${applicationId}.androidx-startup"
    android:exported="false"
    tools:node="merge">
    <!-- This entry makes ExampleLoggerInitializer discoverable. -->
    <meta-data android:name="com.example.ExampleLoggerInitializer"
          android:value="androidx.startup" />
</provider>
```

```java
// http://tinyurl.com/5n78k6cp
public class InitializationProvider extends ContentProvider {
    @Override
    public final boolean onCreate() {
        Context context = getContext();
        if (context ≠ null) {
            // Many Initializer's expect the `applicationContext` to be non-null. This
            // typically happens when `android:sharedUid` is used. In such cases, we postpone
            // initialization altogether, and rely on lazy init.
            // More context: b/196959015
            Context applicationContext = context.getApplicationContext();
            if (applicationContext ≠ null) {
                // Pass the class context so the right metadata can be read.
                // This is especially important in the context of apps that want to use
                // InitializationProvider in multiple processes.
                // b/183136596#comment18
                AppInitializer.getInstance(context).discoverAndInitialize(getClass());
            } else {
                StartupLogger.w("Deferring initialization because `applicationContext` is null.");
            }
        } else {
            throw new StartupException("Context cannot be null");
        }
        return true;
    }

    // ...
}
```

Lesson #5: Define what *"fully loaded"* means

Aggressively defer everything else

1000 foot view of the app

1. Create a separate app per genre ❌
2. Rewrite the existing app ❌
3. Create a new app that had its UI configured from the backend ✅

...but it has to be Trojan horse'd into the News app's apk... 🙃

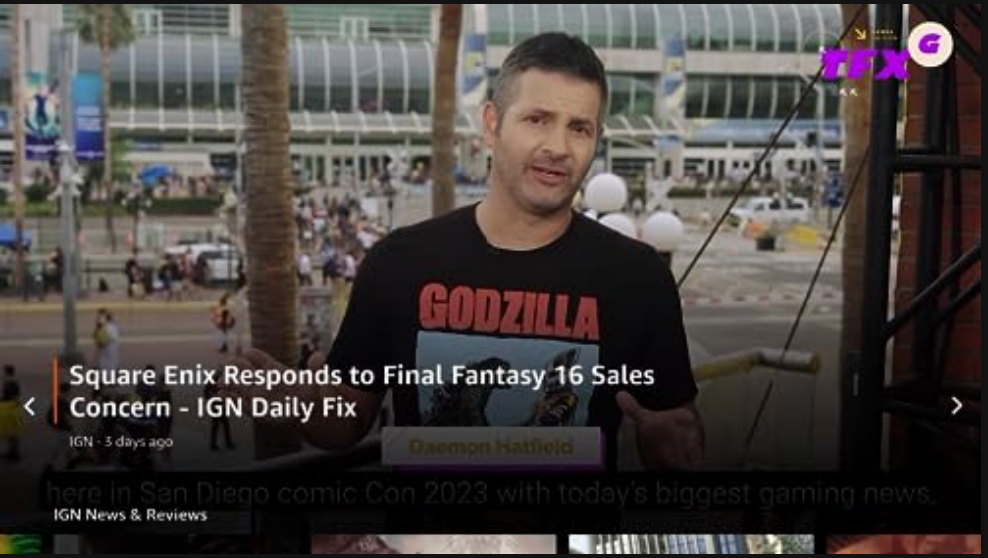
Behold! It’s technically functional

Here is a rough architecture of the app.

Old parts in orange

New parts in green

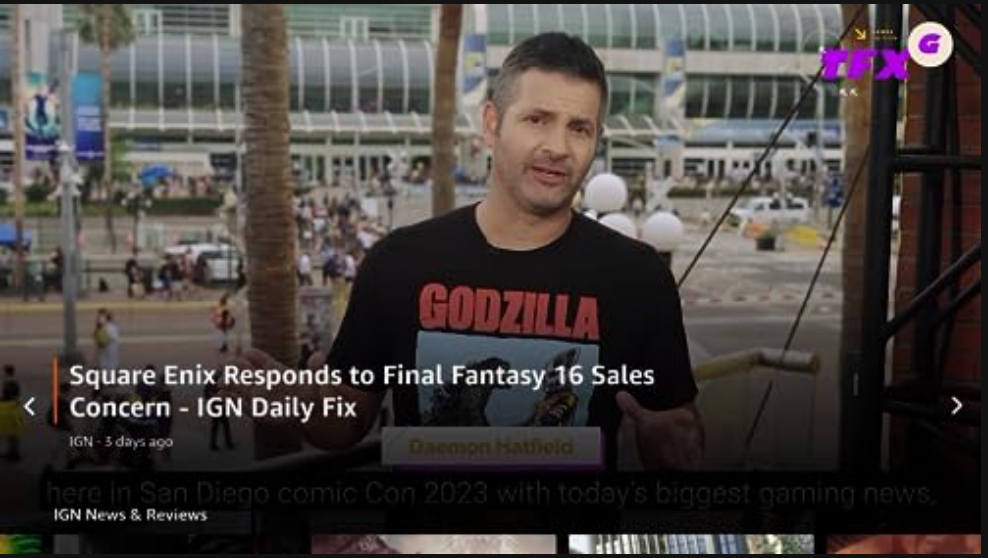
Ugly parts in red 😲



Playback page

Fully loaded = first video frame rendered

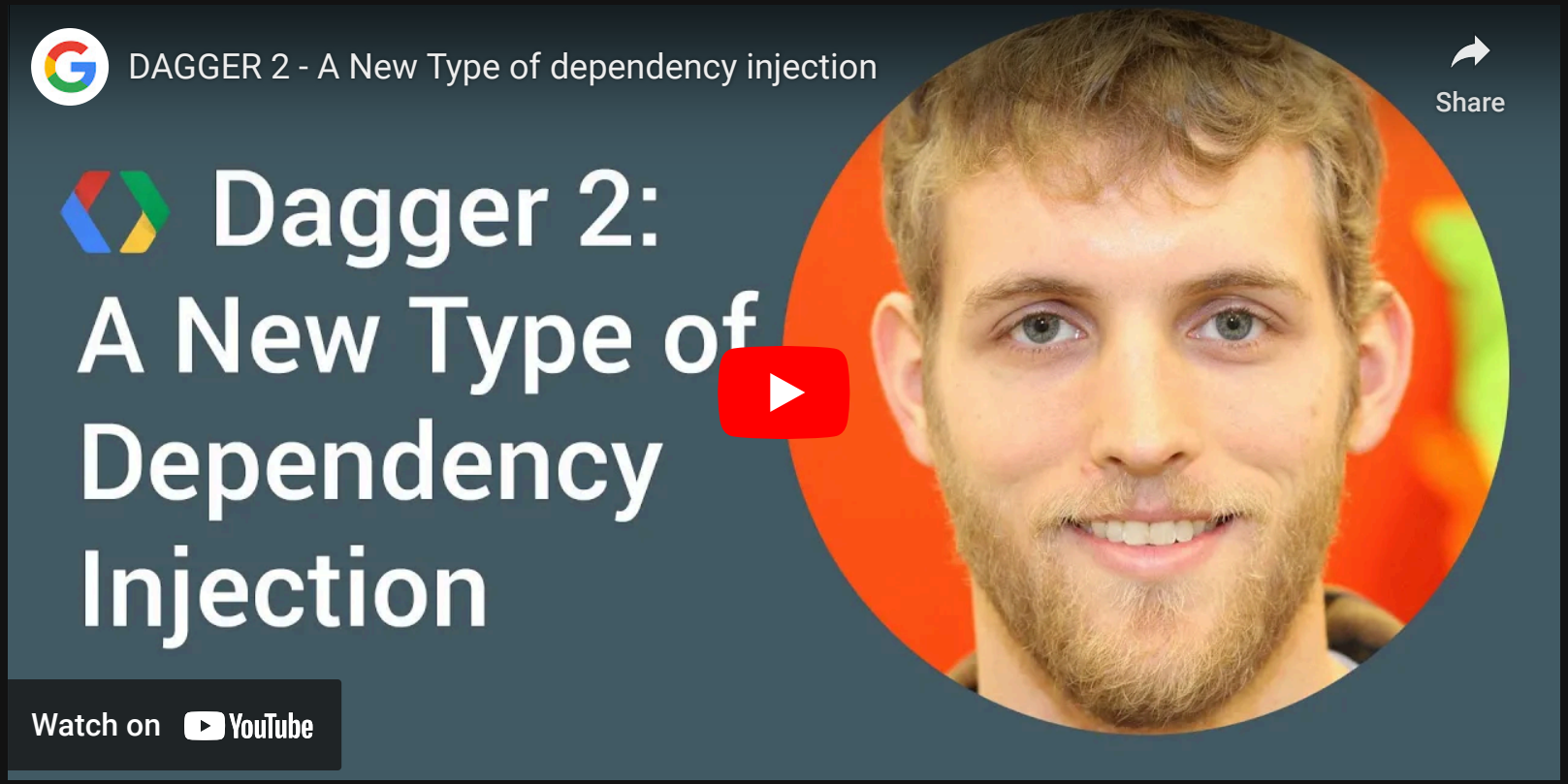
1. Instantiate `NewsApplication`
2. Parse intent, determine experience to start
3. Start `FireChannelsActivity`
4. Instantiate minimal dependency graph
5. Fetch initial data
6. Determine the page to load
7. Inflate view and place the fragment
8. Load video player
9. Play video 👉 // We need to get here



What were we actually doing?

1. Instantiate `NewsApplication`
2. Instantiate dependency graph *for everything*
3. Start background processes *for everything*
4. Parse intent, determine experience to start
5. Start `FireChannelsActivity`
6. Instantiate dependency graph *for everything*
7. Fetch initial data
8. Do cache maintenance
9. Determine the page to load
10. Place the fragment
11. Load video player
12. Play video 👈 // We need to get here

Lesson #6: Dependency injection


DAGGER 2 - A New Type of dependency injection
Share
Dagger 2:
A New Type of
Dependency
Injection
Watch on YouTube

"The downside of tools that make things easy is that they make them easy."

- Me, while debugging this project 😳

What’s the problem?

```
@Singleton
public class SharedPreferencesManager {
  @Inject
  public SharedPreferencesManager(Context context) {
    SharedPreferences sharedPref = context.getSharedPreferences(
            getString(R.string.preference_file_key), Context.MODE_PRIVATE);

    String bigJsonFile = sharedPref.getString("shared_preferences")
    Preferences preferences = new Gson().fromJson(bigJsonFile, Preferences.class);

    // ...
  }
}
```

Another example (a hunch)

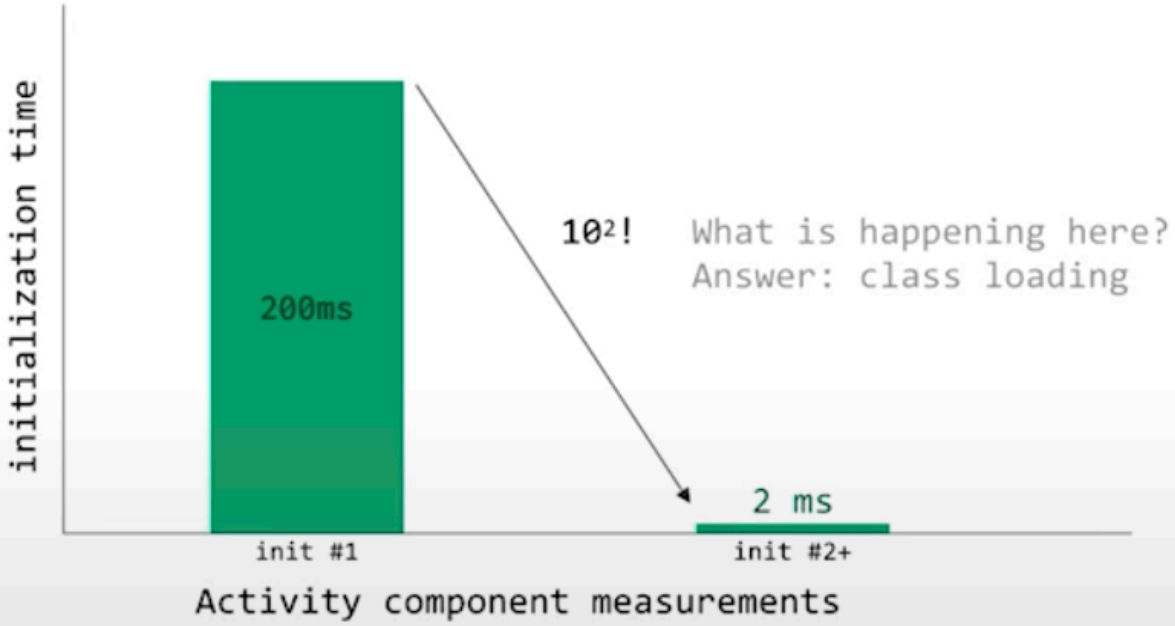
```
@Singleton
public class AuthManager {
  private Executors executors;
  private JobScheduler jobScheduler;

  @Inject
  public AuthManager(Executors executors, JobScheduler jobScheduler) {
    this.executors = executors;
    this.jobScheduler = jobScheduler;
    kickOffBackgroundWork();
  }

  private void kickOffBackgroundWork() {
    this.executors.diskIO().submit(() -> {
      // ...
      this.executors.networkIO().submit(() -> {
        // ...
        jobScheduler.startJobs();
      })
      // ...
      jobScheduler.startOtherJobs();
    })
  }
}
```


droidcon NYC
droidcon NYC 2017 - Optimizing Dagger on Android: Developer Workflow and Ru...
September 25-26 2017
Share
Why does this matter?
Watch on YouTube
touchlab

But just *how slow* is it?

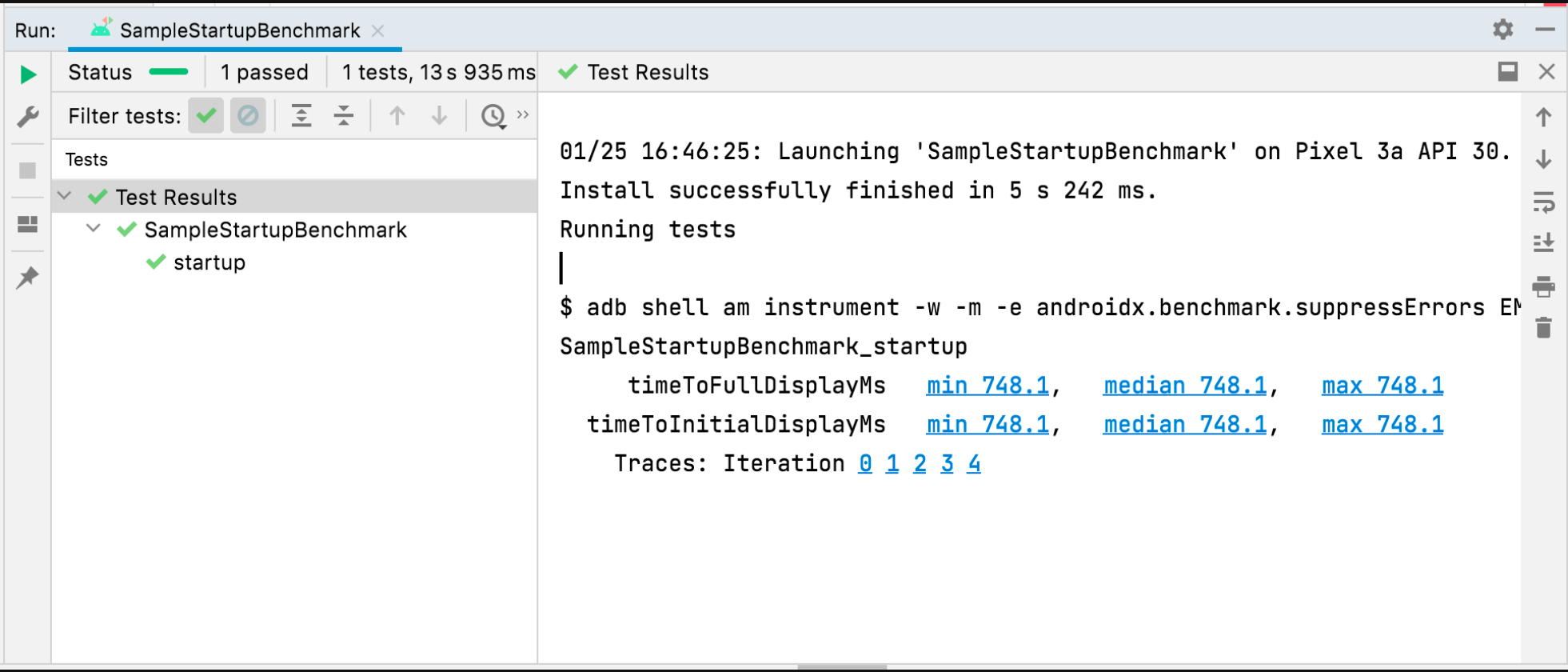


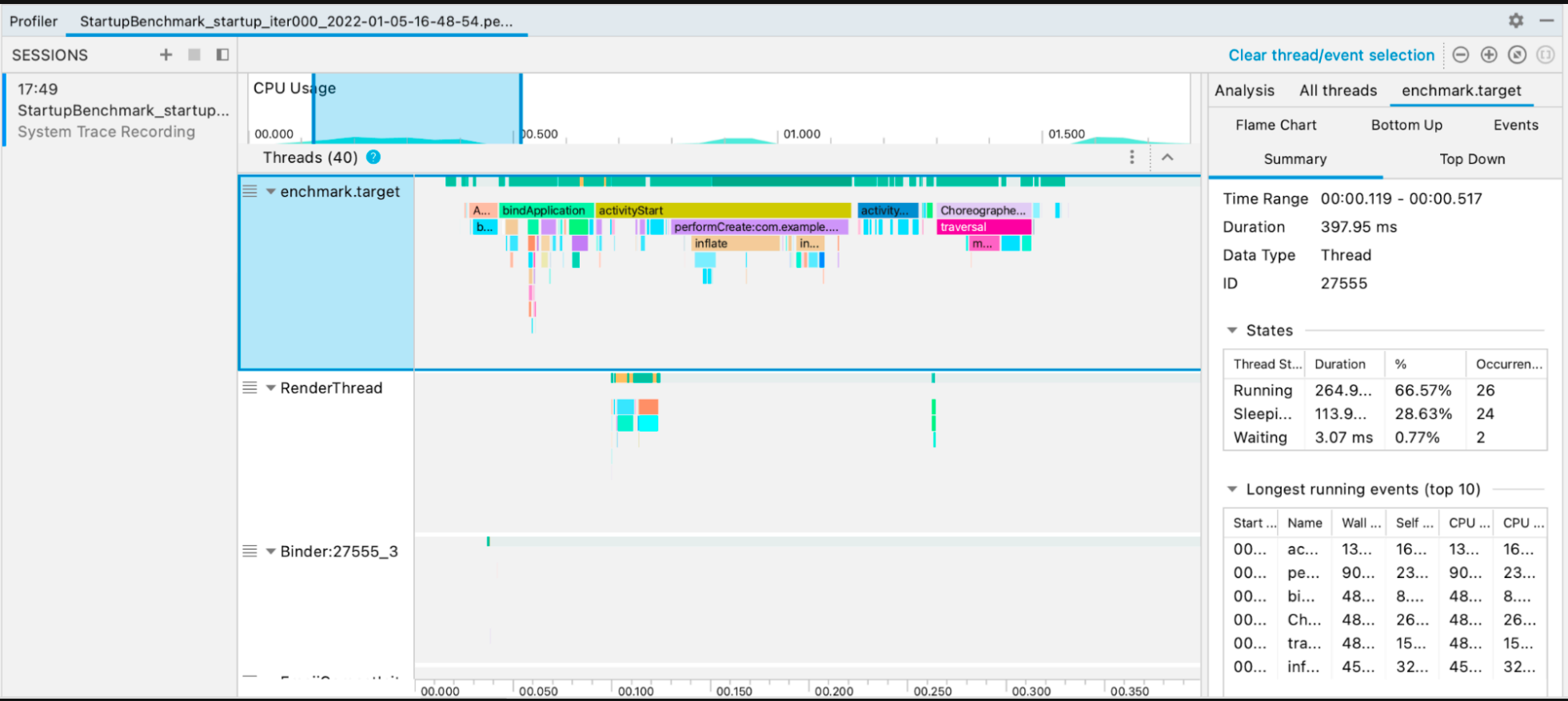
10^2!

What is happening here?
Answer: class loading

50%!

Lesson #7: Continuous testing


Run:
SampleStartupBenchmark
Status
1 passed
1 tests, 13 s 935 ms
Filter tests:
Tests
Test Results
SampleStartupBenchmark
startup
Test Results
01/25 16:46:25: Launching 'SampleStartupBenchmark' on Pixel 3a API 30.
Install successfully finished in 5 s 242 ms.
Running tests
$ adb shell am instrument -w -m -e androidx.benchmark.suppressErrors EM
SampleStartupBenchmark_startup
timeToFullDisplayMs min 748.1, median 748.1, max 748.1
timeToInitialDisplayMs min 748.1, median 748.1, max 748.1
Traces: Iteration 0 1 2 3 4


Profiler
StartupBenchmark_startup_iter000_2022-01-05-16-48-54.pe...
SESSIONS
Clear thread/event selection
17:49
StartupBenchmark_startup...
System Trace Recording
CPU Usage
00.000
00.500
01.000
01.500
Threads (40)
enchmark.target
A...
bindApplication
activityStart
activity...
Choreographe...
b...
performCreate:com.example....
traversal
inflate
in...
m...
RenderThread
Binder:27555_3
00.000
00.050
00.100
00.150
00.200
00.250
00.300
00.350
Analysis
All threads
enchmark.target
Flame Chart
Bottom Up
Events
Summary
Top Down
Time Range 00:00.119 - 00:00.517
Duration 397.95 ms
Data Type Thread
ID 27555
States
Thread St... Duration % Occurren...
Running 264.9... 66.57% 26
Sleepi... 113.9... 28.63% 24
Waiting 3.07 ms 0.77% 2
Longest running events (top 10)
Start ... Name Wall ... Self ... CPU ... CPU ...
00... ac... 13... 16... 13... 16...
00... pe... 90... 23... 90... 23...
00... bi... 48... 8.... 48... 8....
00... Ch... 48... 26... 48... 26...
00... tra... 48... 15... 48... 15...
00... inf... 45... 32... 45... 32...

Macrobenchmark

```
@LargeTest
@RunWith(AndroidJUnit4::class)
class SampleStartupBenchmark {
    @get:Rule
    val benchmarkRule = MacrobenchmarkRule()

    @Test
    fun startup() = benchmarkRule.measureRepeated(
        packageName = TARGET_PACKAGE,
        metrics = listOf(StartupTimingMetric()),
        iterations = DEFAULT_ITERATIONS,
        setupBlock = {
            // Press home button before each run to ensure the starting activity isn't visible.
            pressHome()
        }
    ) {
        // starts default launch activity
        startActivityAndWait()
    }
}
```

Microbenchmark

```
@RunWith(AndroidJUnit4::class)
class SampleBenchmark {
    @get:Rule
    val benchmarkRule = BenchmarkRule()

    @Test
    fun benchmarkSomeWork() {
        benchmarkRule.measureRepeated {
            doSomeWork()
        }
    }
}
```

Lesson #8: Move critical steps earlier

Yup, that was the fix

```
class MyActivity : AppCompatActivity() {
    override fun onCreate() {
        super.onCreate()
        setContentView(R.layout.main);
        backend.fetchInitialData();
    }
}
~~~
class MyActivity : AppCompatActivity() {
    override fun onCreate() {
        super.onCreate()
        backend.fetchInitialData();
        setContentView(R.layout.main);
    }
}
```

Lesson #9: Improve cache hits

```
class MyActivity : AppCompatActivity() {
    override fun onCreate() {
        super.onCreate()
        backend.fetchInitialData();
        setContentView(R.layout.main);
    }
}
```

Lesson #10: Only improve what you need to

```
class MyActivity : AppCompatActivity() {
    override fun onCreate() {
        super.onCreate()
        backend.fetchInitialData();
        setContentView(R.layout.main);
    }
}
```

Lesson #11: Observability

More on my blog...

You Probably Don't Need Mocking

Mocking is overused and can lead to brittle tests. Here I go over alternatives and when you should reach for mocking.

Justifying Mocking

Testing techniques like mocking are often overused, but can be justified. In this post I break down what justifies such techniques.

Fire TV Channels - Free

by Amazon.com

413 customer ratings Guidance Suggested

Price: Free Download

Sold by: Amazon.com Services, Inc

Works with: Game Controllers,Fire TV Voice Remote

Languages Supported: English

Get App

Learn how buying works

By placing your order, you agree to our Terms of Use

Bonus lesson #1: Enabling compression

```
Accept-Encoding: gzip, deflate
```

Bonus lesson #2: Plan for model evolution

```
{
  "type": "com.amazon.fc.NavigationMenu",
  "id": "bf8a4404-2439-41da-ae90-e87d1be142e6",
  "navItems": [
    {
      "type": "com.amazon.fc.NavigationMenuItem",
      "id": "ba5da03a-543d-43e4-887f-dd5cc51f2436",
      "to": "home"
    },
    {
      "type": "com.amazon.fc.NavigationMenuItem",
      "id": "2781c98f-fa28-4e07-9fd8-425347ac2f26",
      "to": "sports.football"
    }
    // ...
  ]
}
```


REFLECTION

```
data class UnknownData(val id: String, val ttl: Int)
```

Bonus lesson #3: Remove network calls entirely

Performance isn’t scary

- 🔨 You don’t need the fanciest tools
- 🚢 You don’t need it perfect to ship
- 🔁 Iterate
- 🧪 Experiment
- ⏱️ Continuously test
- 🎁 Knowledge is transferrable

SCAN ME

Byte Bot helps software teams ship fullstack solutions 🚀

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