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Fixing common causes of ANRs in Android

Jamie Lynch

Software Engineer at Embrace

@fractalwrench

in/fractalwrench

Codelab Overview

- How does Android trigger ANRs in apps?
- How can you identify and fix ANRs in a real-world app?
- How can you fix ANRs in production?

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How does Android trigger ANRs in apps?

Up Next

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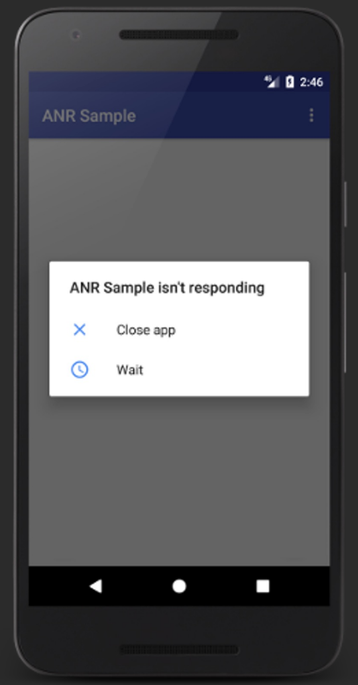
How does Android trigger ANRs in apps?

- ANRs happen when the App is Not Responding (to the system).
- ‘Not Responding’ means the Android OS waited too long for the app to perform a task.
- Usually, ANRs are triggered by main thread blockages.
    - But this is not always the case!



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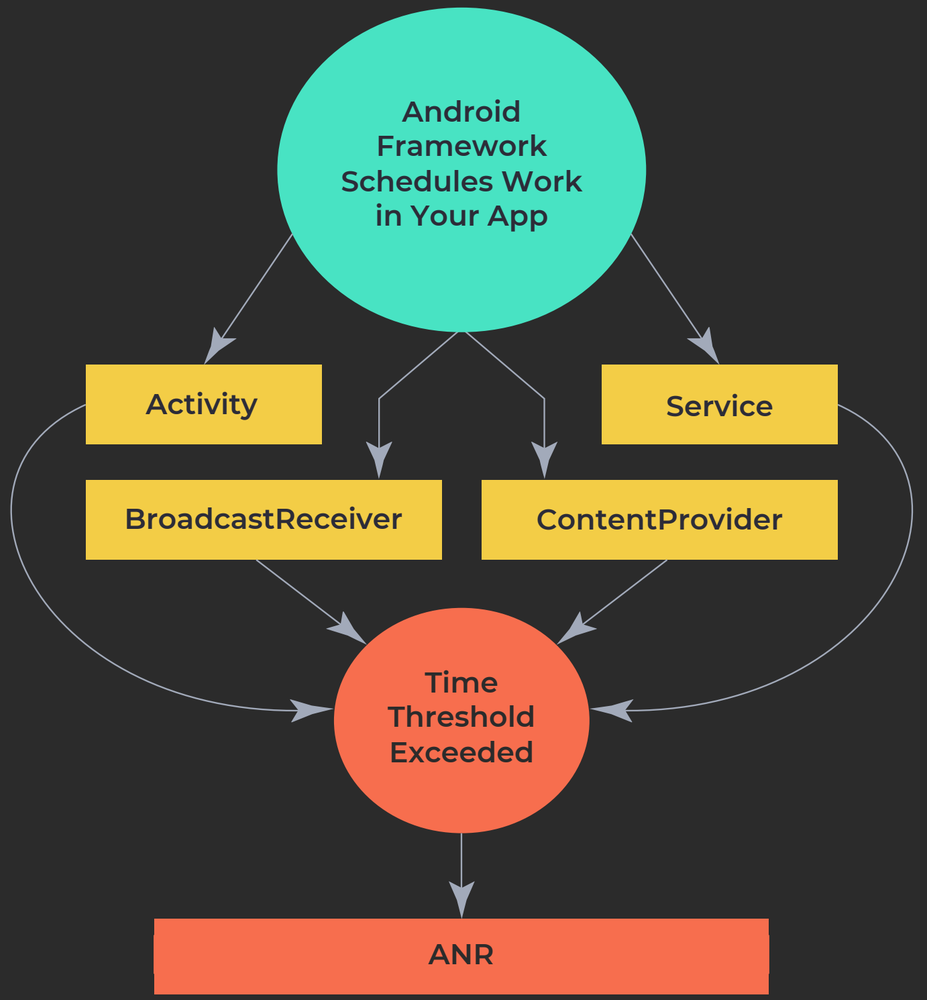
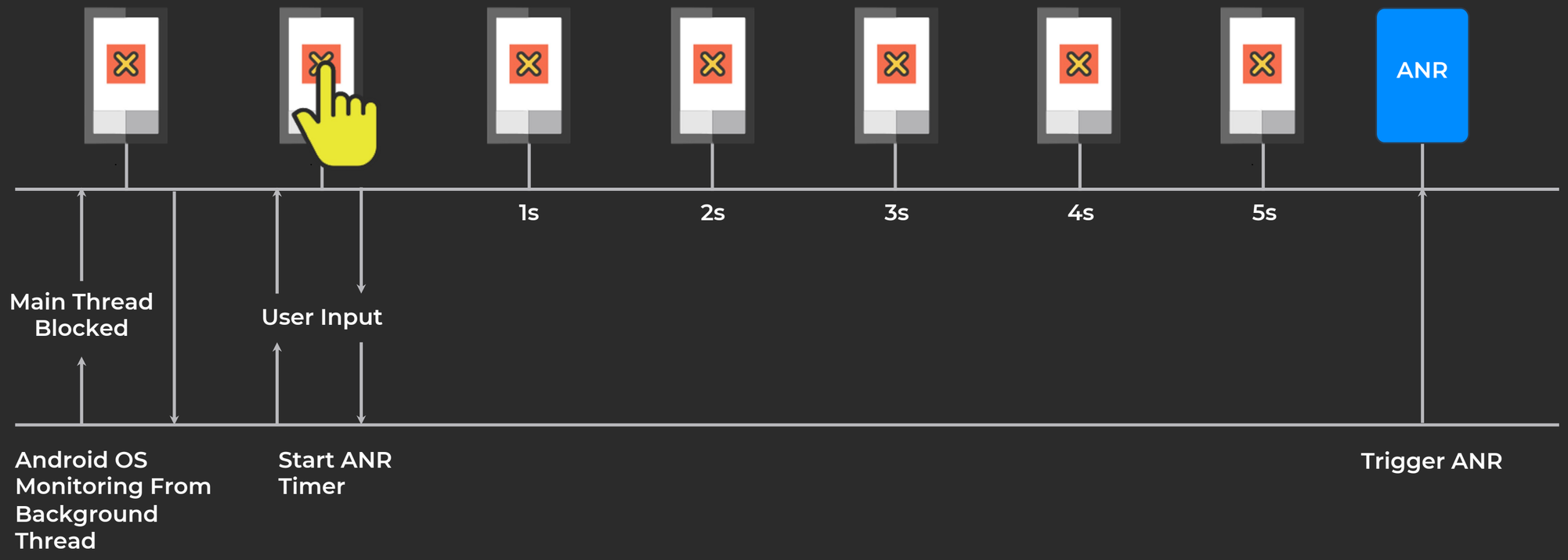
How does Android trigger ANRs in apps?

- The Android OS schedules work in all its components, and ANRs can occur in any component that cannot complete work within a set amount of time.
- Android components:
  - `Activity`
  - `Service`
  - `BroadcastReceiver`
  - `ContentProvider`



How does Android trigger ANRs in apps?

- The most common ANR is when input dispatch takes >5s to process events.
- Android has one UI/main thread, so performing non-UI work can block the UI.
- This is a bad user experience because a user might click a button, wait for 5s, then see nothing change in the app.



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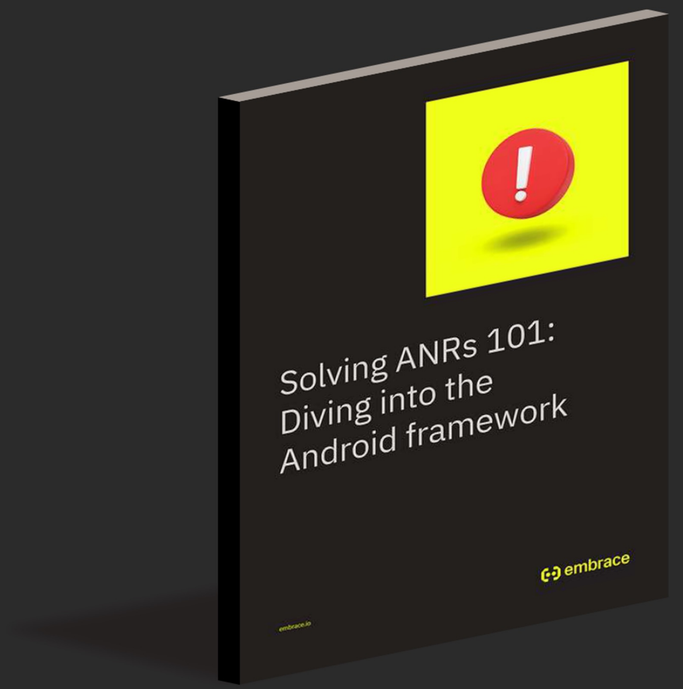
How does Android trigger ANRs in apps?

- The input dispatch queue being blocked is the most common (and user-facing) problem.
- However, there are other ways to trigger ANRs:
  - `BroadcastReceiver` taking >10s in `onReceive()`
  - `Service` taking >20s to start
  - Improper use of system APIs
- **Whenever the Android OS schedules work in an Activity/Service/BroadcastReceiver/ContentProvider in your app and it takes too long, you risk triggering an ANR.**

How does Android trigger ANRs in apps?

- There are dozens of places where an ANR can be triggered.
- We've covered the key ones here.
- If you're interested in the full story, check out Embrace's eBook, "Solving ANRs 101".

https://get.embrace.io/solving-anrs-101/



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How can you identify and fix ANRs in a real-world app?

Up Next

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How can you identify and fix ANRs in a real-world app?

- Let’s identify performance problems that cause ANRs in a real app.
- We’ll open the code repo and solve the following problems:
  - The main thread being blocked for >5s by one operation
  - The main thread being blocked for >5s by many operations
  - Deadlock between the main thread and another thread
  - The main thread waiting synchronously for a Future
  - A `BroadcastReceiver` with a slow `onReceive()` call
  - A foreground service that didn’t call `onForeground()`

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Main thread blocked >5s by one operation

- If the main thread is blocked for >5s while an input event is in the input dispatch queue, an ANR will be triggered.
- This can often be caused by one long operation, such as writing a very large file to disk.

Now let’s go to the code in the repo and fix the problem!

```
fun downloadBinaryResources():
ByteArray {
    Thread.sleep(10000)
    return ByteArray(0)
}
```

Main thread blocked >5s by many operations

- Lots of small tasks add up over time, and these can breach the 5s threshold.
- Here are common examples of operations that cause performance problems:
  - Loading 3rd party SDKs
  - I/O on the main thread
  - JSON deserialization
  - Waiting on other threads

Now let's go to the code in the repo and fix the problem!

```
private fun performWork() {
    val aJson = readFromDisk("a.json")
    val a = deserializeJson(aJson)

    val bJson = readFromDisk("b.json")
    val b = deserializeJson(bJson)

    val cJson = readFromDisk("c.json")
    val c = deserializeJson(cJson)

    val dJson = readFromDisk("d.json")
    val d = deserializeJson(dJson)
}
```

Deadlock between main thread and another thread

- An ANR can be triggered if the main thread and another thread are both waiting to acquire a lock (or similar shared resource).

Now let’s go to the code in the repo and fix the problem!

```
fun triggerDeadlock() {
    backgroundExecutor.submit {
        writeToFileWithLock("Wrote to file from
background thread")

        handler.post {
            writeToFileWithLock("Wrote to file
from main thread")
        }
    }
}

fun writeToFileWithLock(contents: String) {
    lock.lock()

    // forget to release the lock
}
```

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Main thread waiting synchronously for a Future

- Waiting on a background thread to finish can block the main thread.
- A good example of this is calling `Future.get()`.

Now let's go to the code in the repo and fix the problem!

```
private fun performWork() {
    val client = NetworkApiClient()
    val imageFuture = client.downloadImage()
    val image = imageFuture.get()
}

private class NetworkApiClient {

    fun downloadImage(): Future<*> {
        return executor.submit(Callable {
            // simulate network requests
            Thread.sleep(10000)
            ByteArray(0)
        })
    }
}
```

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A BroadcastReceiver with a slow onReceive() call

- If a BroadcastReceiver takes longer than 10s in `onReceive()`, an ANR will be triggered.
- This happens regardless of whether anything is in the input dispatch queue.

Now let's go to the code in the repo and fix the problem!

```
override fun onReceive(
    context: Context?,
    intent: Intent?
) {
    performLongOperation()
}

private fun performLongOperation() {
    Thread.sleep(12000)
}
```

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A foreground service that didn't call onForeground()

- If a foreground service doesn't call `onForeground()` within 10s, an ANR will be triggered.
- A crash will also be triggered.

Now let's go to the code in the repo and fix the problem!

```
class AnrForegroundService :
Service() {

    override fun onCreate() {
        super.onCreate()
    }
}
```

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How can you fix ANRs in production?

Up Next

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How can you fix ANRs in production?

- ANRs are hard to fix.
- The Android OS can trigger ANRs from dozens of different places, with different rules.
- Real apps can have several activities/services/broadcasts all performing work at the same time.
- ANRs are probabilistic - they are less likely to happen on higher-end devices that devs tend to use.
- Most solutions focus on recording a single stack trace at one point in time.

The question becomes: **How can you fix ANRs in production apps?**

Helping engineers
build better
mobile experiences

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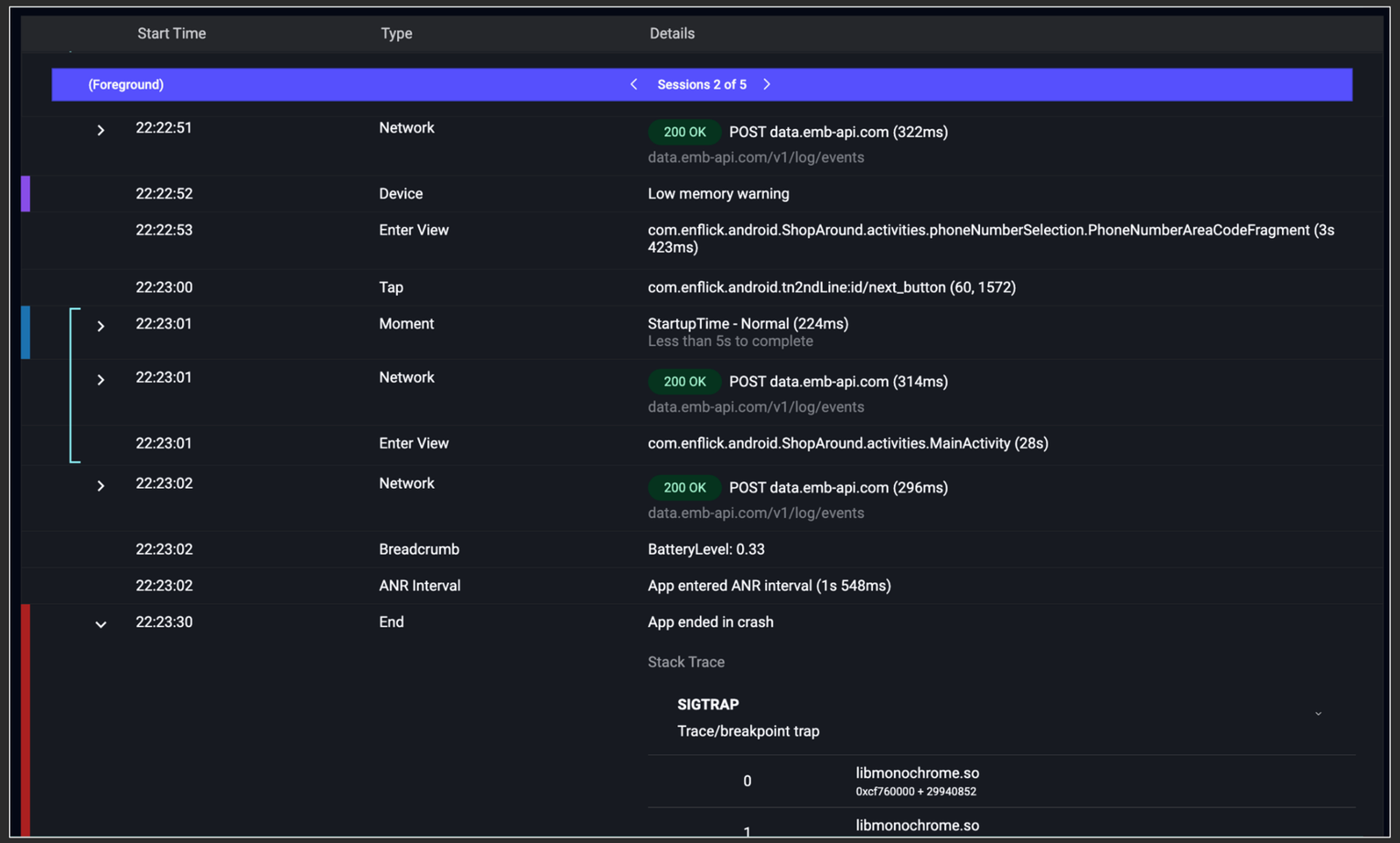
See all the details, clearly

Full user session play-by-play



Auto-collect everything to find true root causes

- User ID look-up (PII compliant)
- OOTB data capture
- Easy integrations
- Seamless pivot to exact line of code and stack trace or see high level user impact

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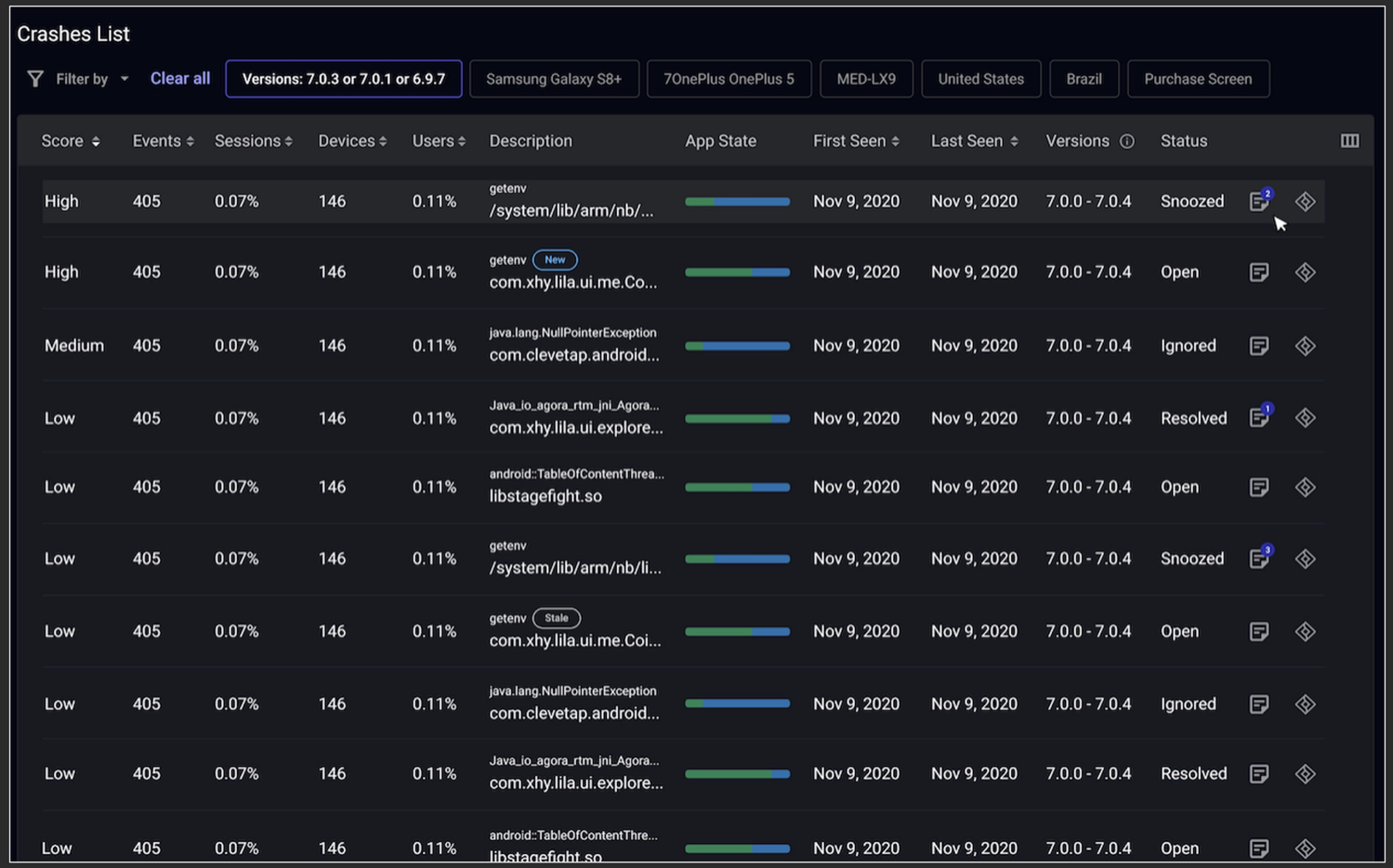
Surface the issues that matter

High-fidelity, structured, and correlated data that helps you focus



Confidently pinpoint where to focus first with a high-fidelity, structured, and correlated view.

- ANR groupings using common problematic methods
- Crash groupings based on most relevant stack frame
- ML-powered crash correlations and scoring
- Alerting and tracing for revenue impacting sessions

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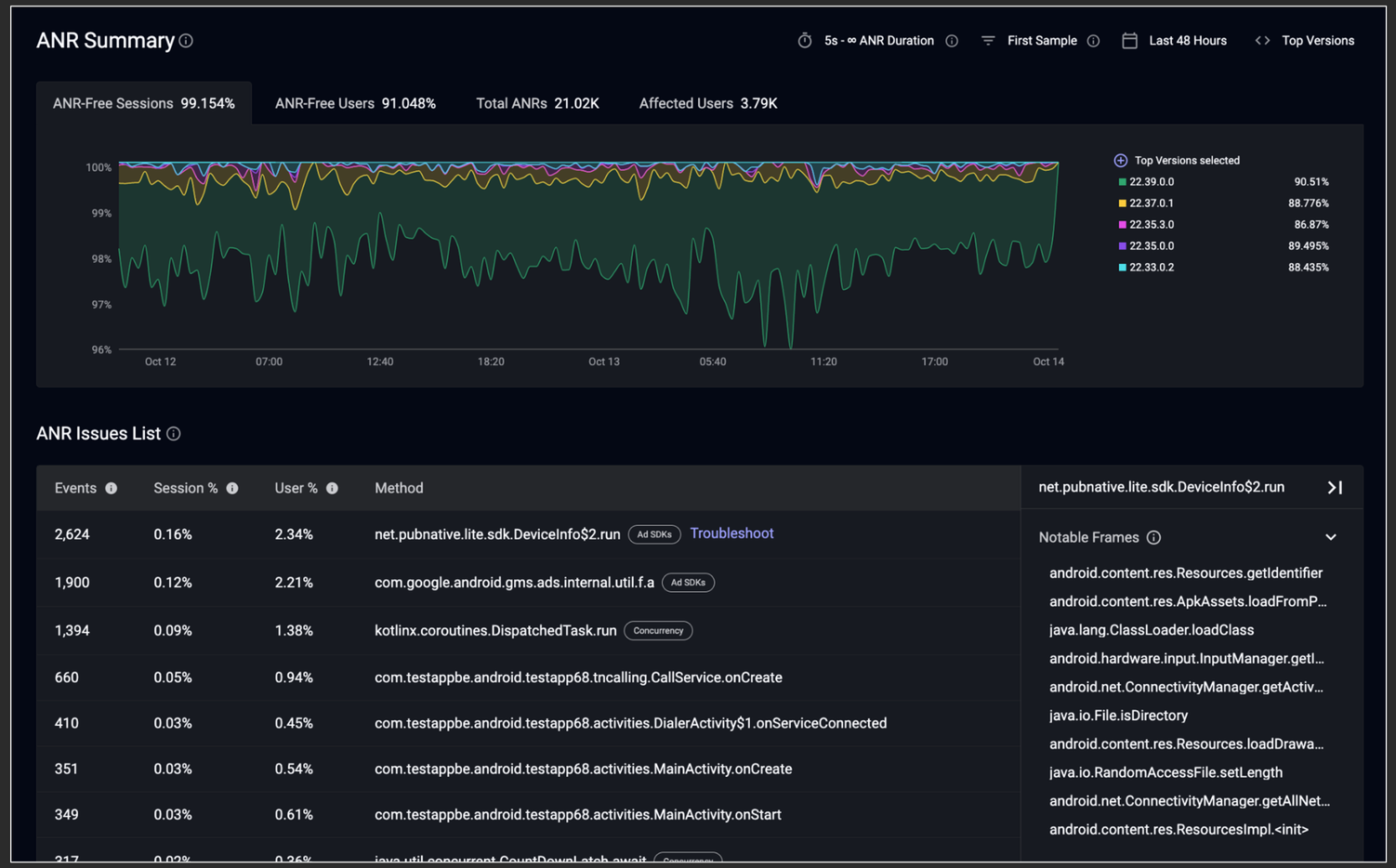
Optimize beyond crashes

See every non-fatal issue to perfect your user's experience



99% crash-free isn't enough. Achieve flawless performance with deep visibility into non-fatal errors.

- ANR stack traces captured at 1s and every 100ms thereafter
- Failing network call insights in every session timeline
- Error tracking for handled exceptions, info logs and warnings
- View app exits and OOM insights that signal poor experiences

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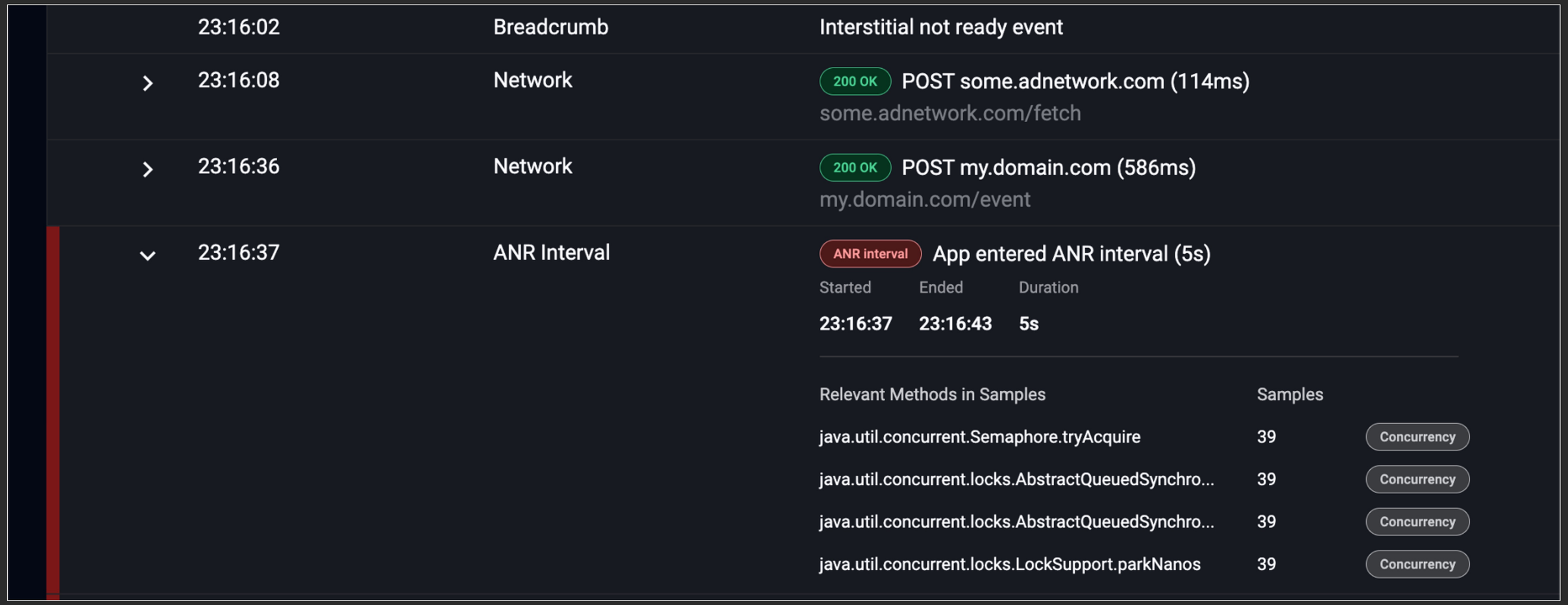
Embrace captures multiple ANR samples



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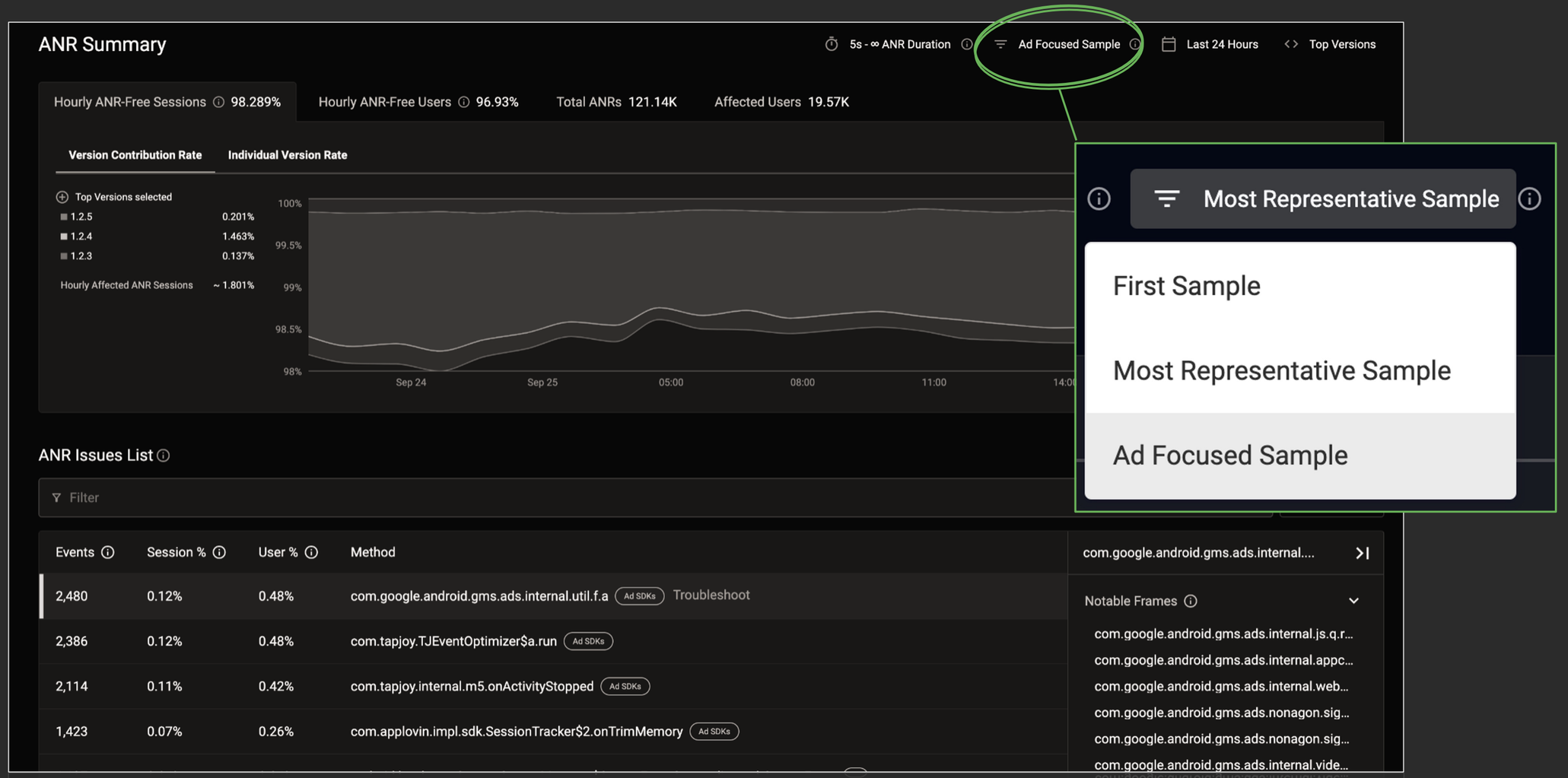
Embrace provides multiple views of the data



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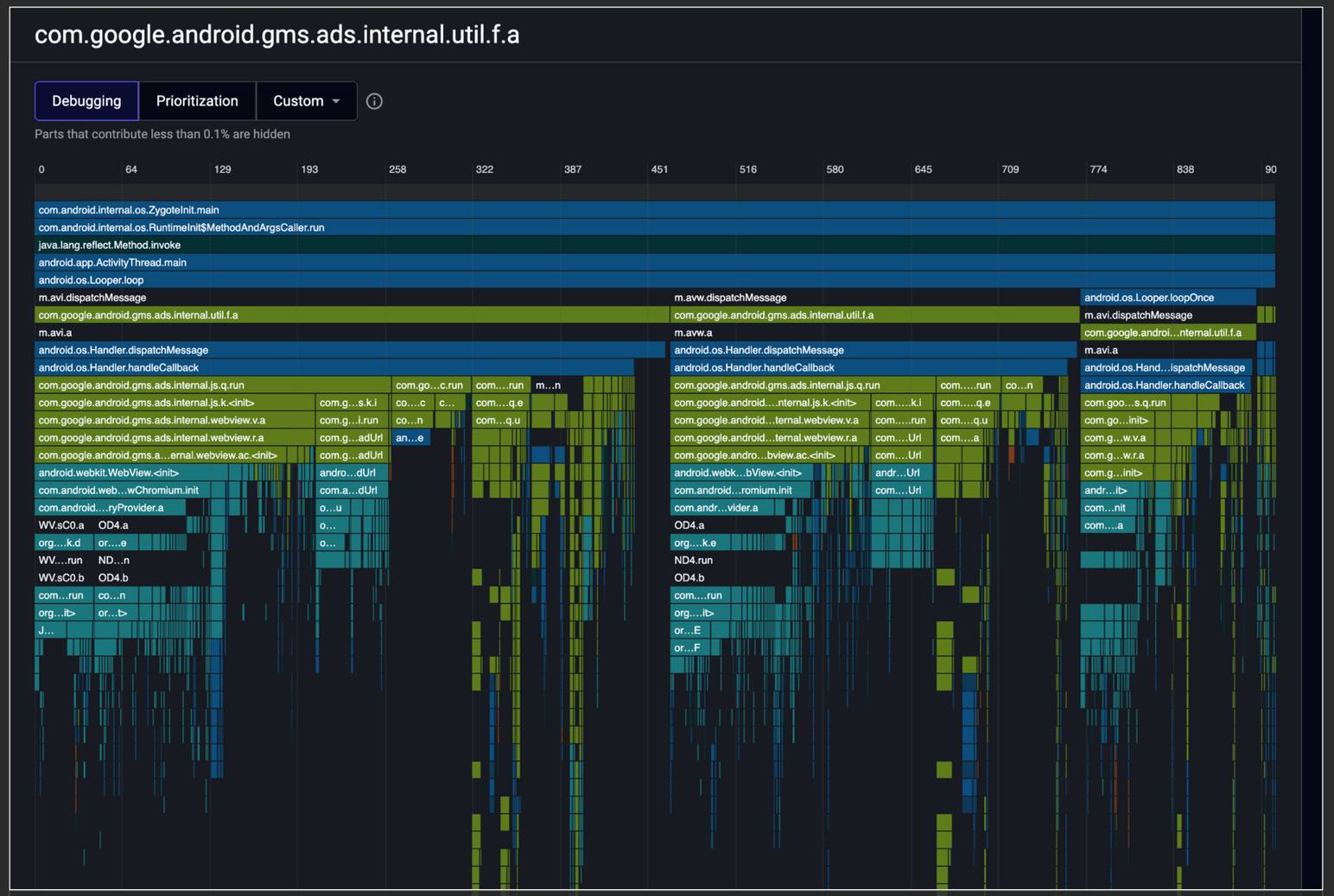
Embrace stitches stack traces into flame graphs



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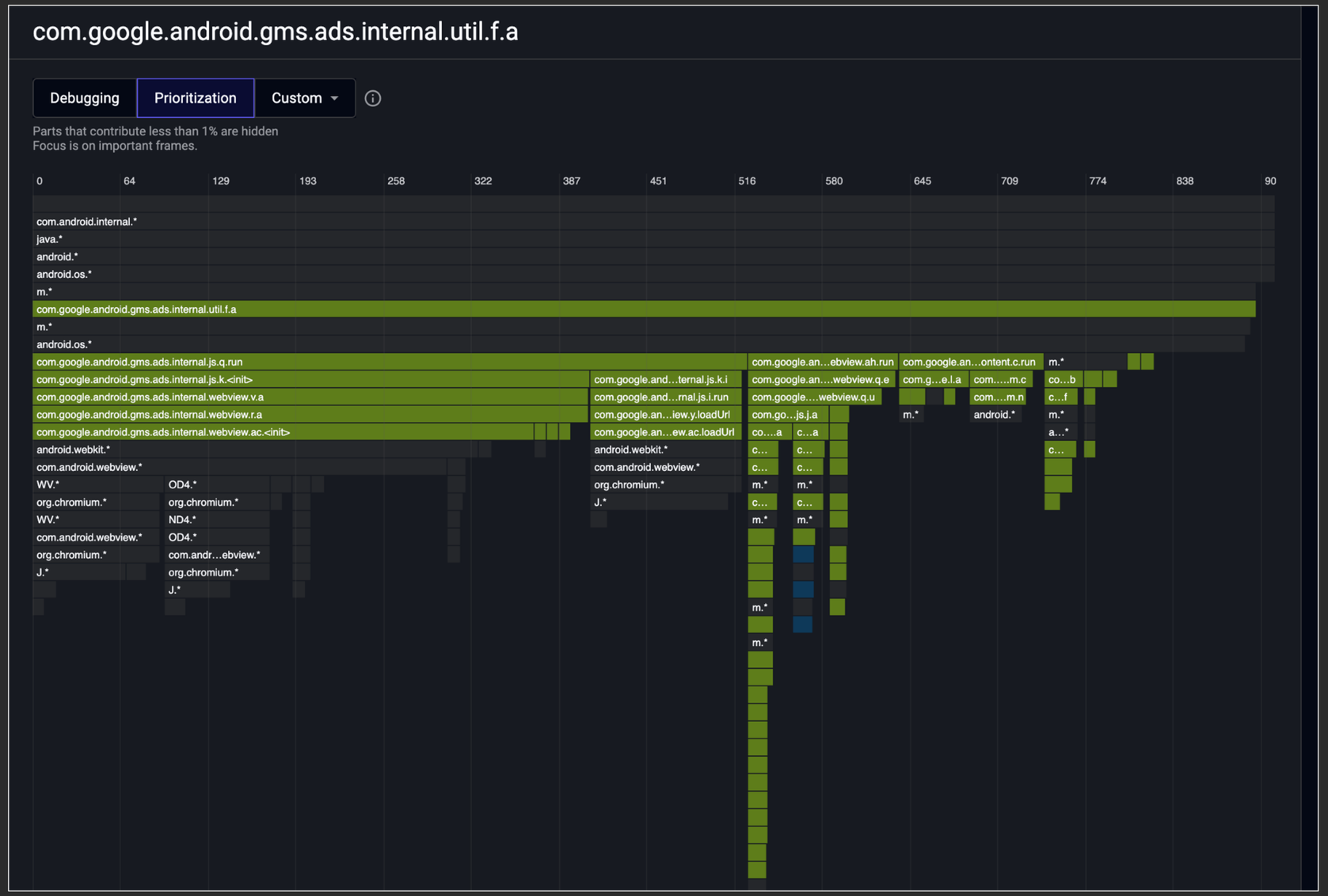
Embrace eliminates noise to help you prioritize



Time for a demo!

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Summary

- There are dozens of places the Android OS triggers ANRs, and usually the main thread is blocked.
- There are various ways that the main thread could be blocked by performance problems in your app.
- Embrace shows the whole story for production ANRs by showing everything that happened in flame graphs.
- We covered several approaches for writing code that prevents ANRs in your app.

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Learn more

Jamie Lynch
Software Engineer at Embrace

jamie.lynch@embrace.io

www.embrace.io