



Memfault

How to Debug Android Devices in Production

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Android Solutions Engineer

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Android Solutions Engineer, Memfault

- ◇ Enjoys: Digging into hard problems
- ◇ Previously: Square (9 years)
 - Android App Development
 - Android Build Systems
 - Android OS Platform
- ◇ Currently: Memfault
 - Android Solutions Engineer
- ◇ Full Time remote out of Colorado, USA



AOSP Diagnostics Overview

The latest in performance monitoring and debugging to understand your AOSP device and fix problems



Overview

Logging



Diagnostic Tools



Observing Your Fleet in the Field



Poll #1

What layer do you see the most bugs with your devices?

A. App layer

B. System Services

C. Android Runtime

D. HAL

E. Native Daemons and Libraries

F. Linux Kernel

Logs for AOSP Developers

Logcat = Circular buffers of AOSP app logs

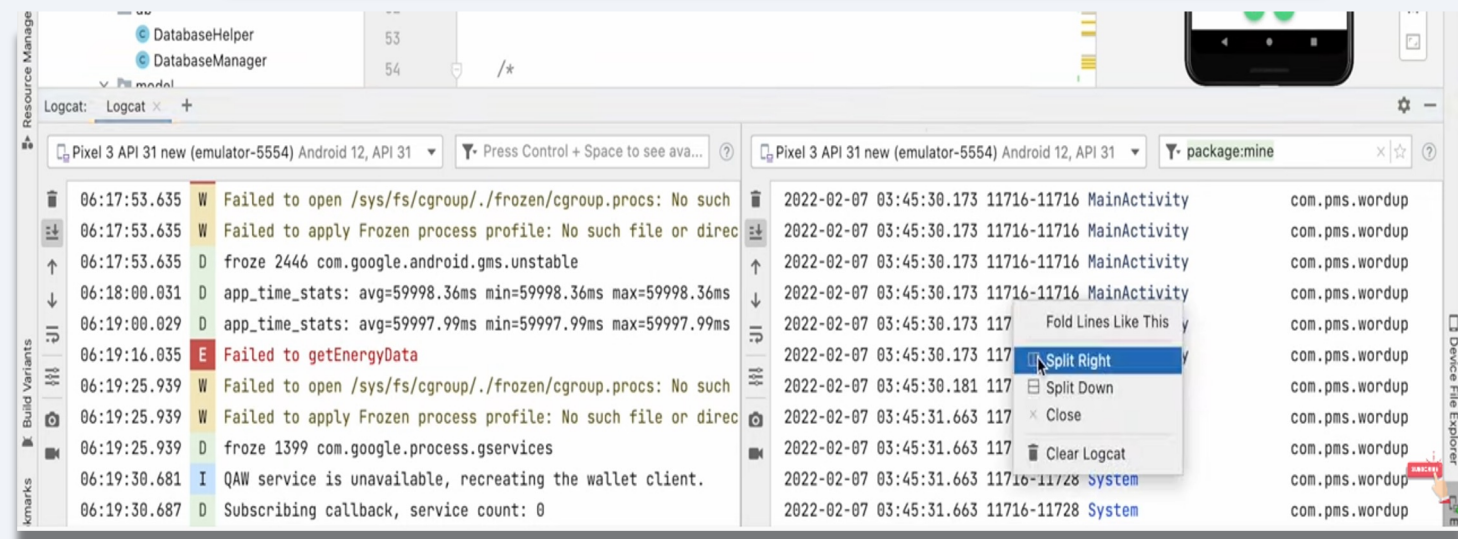
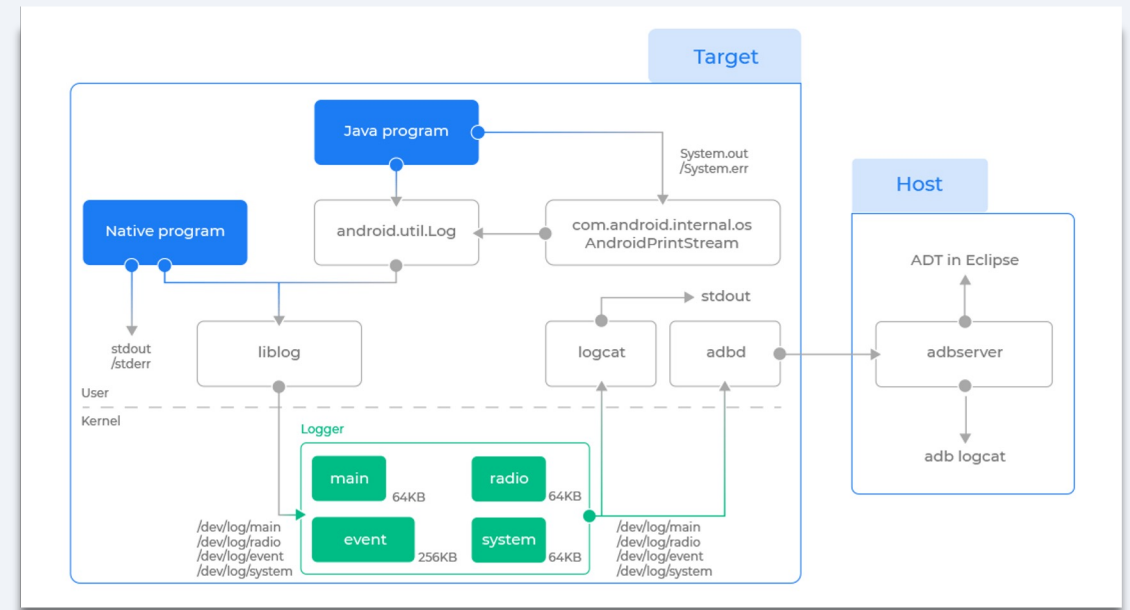
- main, system, crash, radio, event

Kmesg/dmesg = Kernel/driver logs (/proc/kmesg)

- Great for capturing message from reboot

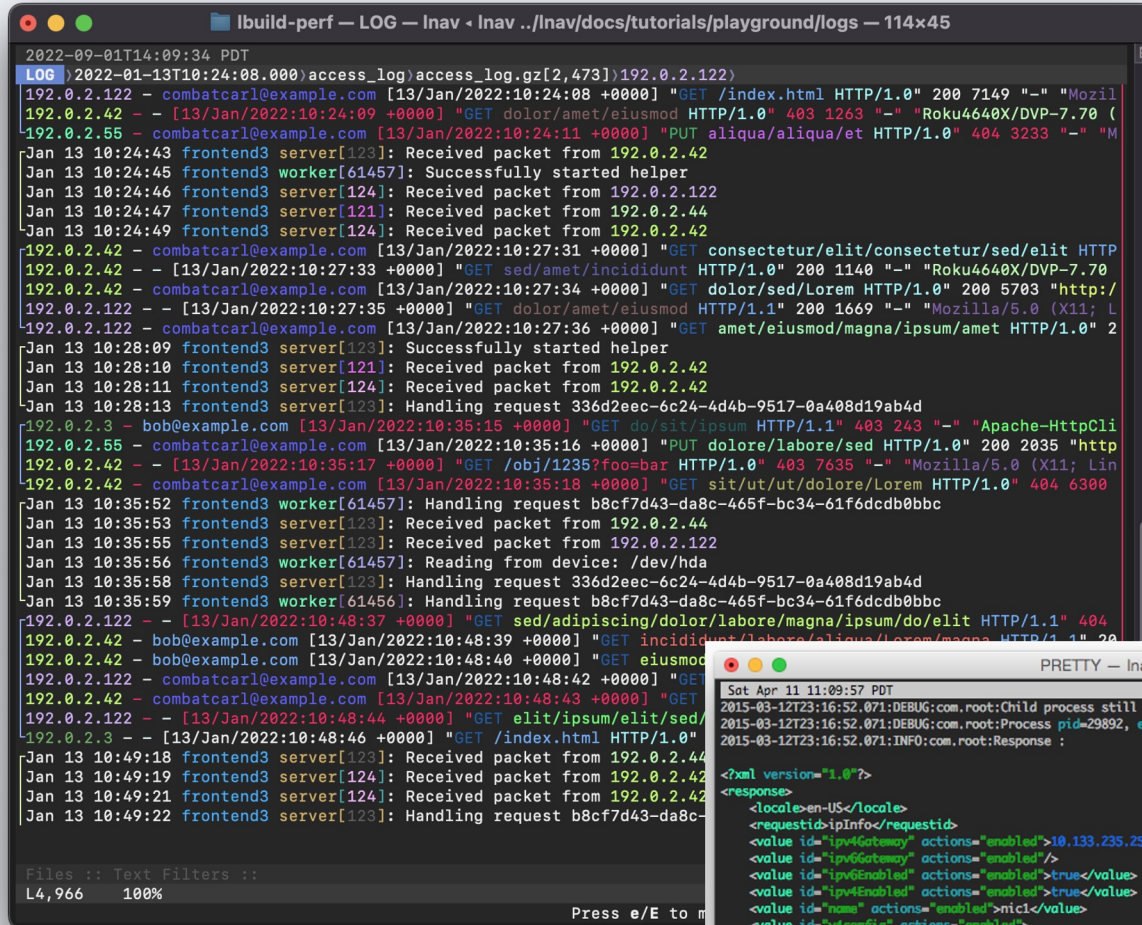
Helpful Resources

- [Android Debugging Core Topics](#)
- [Android Studio Logcat User Guide](#)
- [Android Log Analysis by pCloudy](#)
- [Logcat V2 features from googleblog](#)
- [Logcat V2 detail overview \(YouTube\)](#)



LNAV

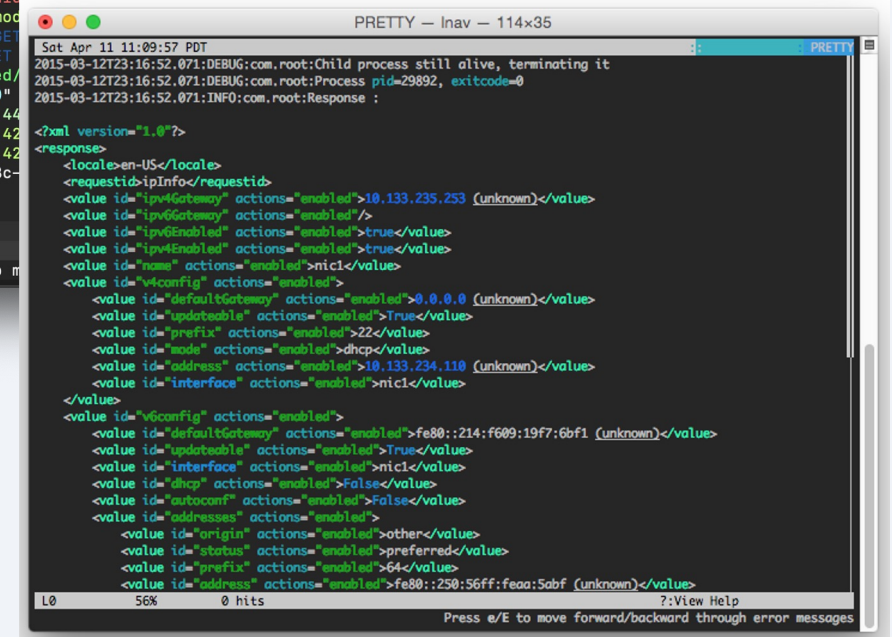
- Feature rich log navigator
- SQL query language built in
- Histogram view
- Multi-log interpolation
 - Merge logcat and kernel logs
- Supports custom log formats
- Syntax highlighting
- Custom regex highlighting
- Pretty-print structured data



```
2022-09-01T14:09:34 PDT
LOG >2022-01-13T10:24:08.000)access_log)access_log.gz[2,473]:192.0.2.122)
192.0.2.122 - combatcarl@example.com [13/Jan/2022:10:24:08 +0000] "GET /index.html HTTP/1.0" 200 7149 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
192.0.2.42 - [13/Jan/2022:10:24:09 +0000] "GET dolor/amet/eiusmod HTTP/1.0" 403 1263 "-" "Roku4640X/DVP-7.70 (Linux; Android 11; Roku4640X Build/RK3083) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/90.0.4430.91 Mobile Safari/537.36"
192.0.2.55 - combatcarl@example.com [13/Jan/2022:10:24:11 +0000] "PUT aliqua/aliqua/et HTTP/1.0" 404 3233 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
Jan 13 10:24:43 frontend3 server[123]: Received packet from 192.0.2.42
Jan 13 10:24:45 frontend3 worker[61457]: Successfully started helper
Jan 13 10:24:46 frontend3 server[124]: Received packet from 192.0.2.122
Jan 13 10:24:47 frontend3 server[121]: Received packet from 192.0.2.44
Jan 13 10:24:49 frontend3 server[124]: Received packet from 192.0.2.42
192.0.2.42 - combatcarl@example.com [13/Jan/2022:10:27:31 +0000] "GET consectetur/elit/consectetur/sed/elit HTTP/1.0" 200 1140 "-" "Roku4640X/DVP-7.70 (Linux; Android 11; Roku4640X Build/RK3083) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/90.0.4430.91 Mobile Safari/537.36"
192.0.2.42 - [13/Jan/2022:10:27:33 +0000] "GET sed/amet/incididunt HTTP/1.0" 200 1140 "-" "Roku4640X/DVP-7.70 (Linux; Android 11; Roku4640X Build/RK3083) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/90.0.4430.91 Mobile Safari/537.36"
192.0.2.42 - combatcarl@example.com [13/Jan/2022:10:27:34 +0000] "GET dolor/sed/Lorem HTTP/1.0" 200 5703 "http://192.0.2.122:8080/"
192.0.2.122 - [13/Jan/2022:10:27:35 +0000] "GET dolor/amet/eiusmod HTTP/1.1" 200 1669 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
192.0.2.122 - combatcarl@example.com [13/Jan/2022:10:27:36 +0000] "GET amet/eiusmod/magna/ipsam/et HTTP/1.0" 200 1140 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
Jan 13 10:28:09 frontend3 server[123]: Successfully started helper
Jan 13 10:28:10 frontend3 server[121]: Received packet from 192.0.2.42
Jan 13 10:28:11 frontend3 server[124]: Received packet from 192.0.2.42
Jan 13 10:28:13 frontend3 server[123]: Handling request 336d2eec-6c24-4d4b-9517-0a408d19ab4d
192.0.2.3 - bob@example.com [13/Jan/2022:10:35:15 +0000] "GET do/sit/ipsam HTTP/1.1" 403 243 "-" "Apache-HttpClient/4.5.13 (Ubuntu)"
192.0.2.55 - combatcarl@example.com [13/Jan/2022:10:35:16 +0000] "PUT dolore/labore/sed HTTP/1.0" 200 2035 "http://192.0.2.122:8080/"
192.0.2.42 - [13/Jan/2022:10:35:17 +0000] "GET /obj/1235?foo=bar HTTP/1.0" 403 7635 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
192.0.2.42 - combatcarl@example.com [13/Jan/2022:10:35:18 +0000] "GET sit/ut/ut/dolore/Lorem HTTP/1.0" 404 6300 "-" "Mozilla/5.0 (X11; Linux x86_64; rv:68.0) Gecko/20100101 Firefox/68.0"
Jan 13 10:35:52 frontend3 worker[61457]: Handling request b8cf7d43-da8c-465f-bc34-61f6dcd0bbbc
Jan 13 10:35:53 frontend3 server[123]: Received packet from 192.0.2.44
Jan 13 10:35:55 frontend3 server[123]: Received packet from 192.0.2.122
Jan 13 10:35:56 frontend3 worker[61457]: Reading from device: /dev/hda
Jan 13 10:35:58 frontend3 server[123]: Handling request 336d2eec-6c24-4d4b-9517-0a408d19ab4d
Jan 13 10:35:59 frontend3 worker[61456]: Handling request b8cf7d43-da8c-465f-bc34-61f6dcd0bbbc
192.0.2.122 - [13/Jan/2022:10:48:37 +0000] "GET sed/adipiscing/dolor/labore/magna/ipsam/do/elit HTTP/1.1" 404
192.0.2.42 - bob@example.com [13/Jan/2022:10:48:39 +0000] "GET incididunt/labore/aliqua/Lorem/magna HTTP/1.1" 200
192.0.2.42 - bob@example.com [13/Jan/2022:10:48:40 +0000] "GET eiusmod/et/velit/et/velit/et/velit HTTP/1.1" 200
192.0.2.122 - [13/Jan/2022:10:48:42 +0000] "GET elit/ipsam/elit/sed/ HTTP/1.1" 200
192.0.2.42 - combatcarl@example.com [13/Jan/2022:10:48:43 +0000] "GET elit/ipsam/elit/sed/ HTTP/1.1" 200
192.0.2.122 - [13/Jan/2022:10:48:44 +0000] "GET elit/ipsam/elit/sed/ HTTP/1.1" 200
192.0.2.3 - [13/Jan/2022:10:48:46 +0000] "GET /index.html HTTP/1.0"
Jan 13 10:49:18 frontend3 server[123]: Received packet from 192.0.2.44
Jan 13 10:49:19 frontend3 server[124]: Received packet from 192.0.2.42
Jan 13 10:49:21 frontend3 server[124]: Received packet from 192.0.2.42
Jan 13 10:49:22 frontend3 server[123]: Handling request b8cf7d43-da8c-465f-bc34-61f6dcd0bbbc

Files :: Text Filters ::
L4,966 100%

Press e/E to m
```



```
Sat Apr 11 11:09:57 PDT
PRETTY -- Inav -- 114x35
2015-03-12T23:16:52.071:DEBUG:com.root:Child process still alive, terminating it
2015-03-12T23:16:52.071:DEBUG:com.root:Process pid=29892, exitcode=0
2015-03-12T23:16:52.071:INFO:com.root:Response :
<?xml version="1.0"?>
<response>
  <locale-en-US</locale>
  <requestid-iprovider</requestid>
  <value id="ipv4Gateway" actions="enabled">10.133.235.253 (unknown)</value>
  <value id="ipv6Gateway" actions="enabled"/>
  <value id="ipv6Enabled" actions="enabled">true</value>
  <value id="ipv4Enabled" actions="enabled">true</value>
  <value id="name" actions="enabled">nic1</value>
  <value id="v4config" actions="enabled">
    <value id="defaultGateway" actions="enabled">0.0.0.0 (unknown)</value>
    <value id="updateable" actions="enabled">True</value>
    <value id="prefix" actions="enabled">22</value>
    <value id="mode" actions="enabled">dhcp</value>
    <value id="address" actions="enabled">10.133.234.110 (unknown)</value>
    <value id="interface" actions="enabled">nic1</value>
  </value>
  <value id="v6config" actions="enabled">
    <value id="defaultGateway" actions="enabled">fe80::214:f609:19f7:6bf1 (unknown)</value>
    <value id="updateable" actions="enabled">True</value>
    <value id="interface" actions="enabled">nic1</value>
    <value id="dhcp" actions="enabled">False</value>
    <value id="autocconf" actions="enabled">False</value>
    <value id="addresses" actions="enabled">
      <value id="origin" actions="enabled">other</value>
      <value id="status" actions="enabled">preferred</value>
      <value id="prefix" actions="enabled">64</value>
      <value id="address" actions="enabled">fe80::250:56ff:feaa:5abf (unknown)</value>
    </value>
  </value>
</response>

L0 56% 0 hits ?View Help
Press e/E to move forward/backward through error messages
```

Helpful Resources

- [Inav features](#)
- [Android Log Format](#)

Android Crash Data from the Logs and Tools

Tombstones - More detail than logcat from a crash.

- /data/tombstones/<file>
- Stack traces of all processes, memory map, open files, etc.

Kernel Panic - Fatal exception in the kernel, often leaves a tombstone.

Kernel/Ram Oops - Serious, possibly fatal kernel errors

- Often times precedes a kernel panic

ANRs - Application Not Responding (5 seconds)

WTFs - an assert message found in logcat

Java exceptions

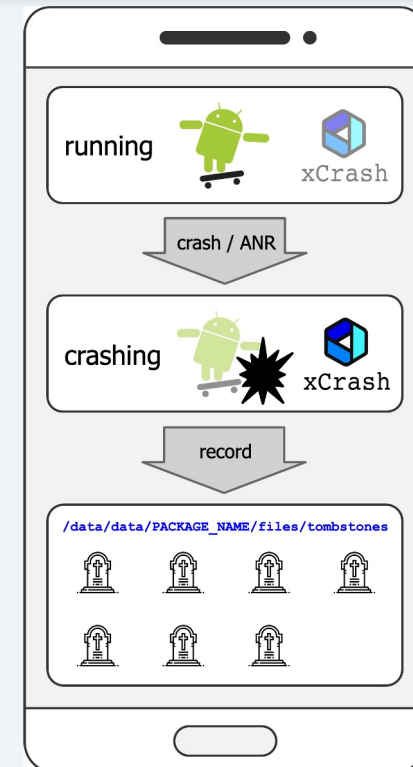
SELinux policy violations

- In audit.d logs

Helpful Resources

- [Debugging Native Crashes in Android Apps](#)

```
< Your System ate a SPARC! Gah! >  
-----  
      ^ ^  
    (xx) \ /  
   ( )  \ /  ) \ / \ /  
    U   |  - - - w  |  
        |  |  |  |  |  
sshhd (pid 19569): Protection id trap (code 27)
```



Debug Tools (log capture and analysis)

ADB – Android Debug Bridge

- Connect your host to device, get logs from logcat

Bug Reports – Snapshot of logs for troubleshooting

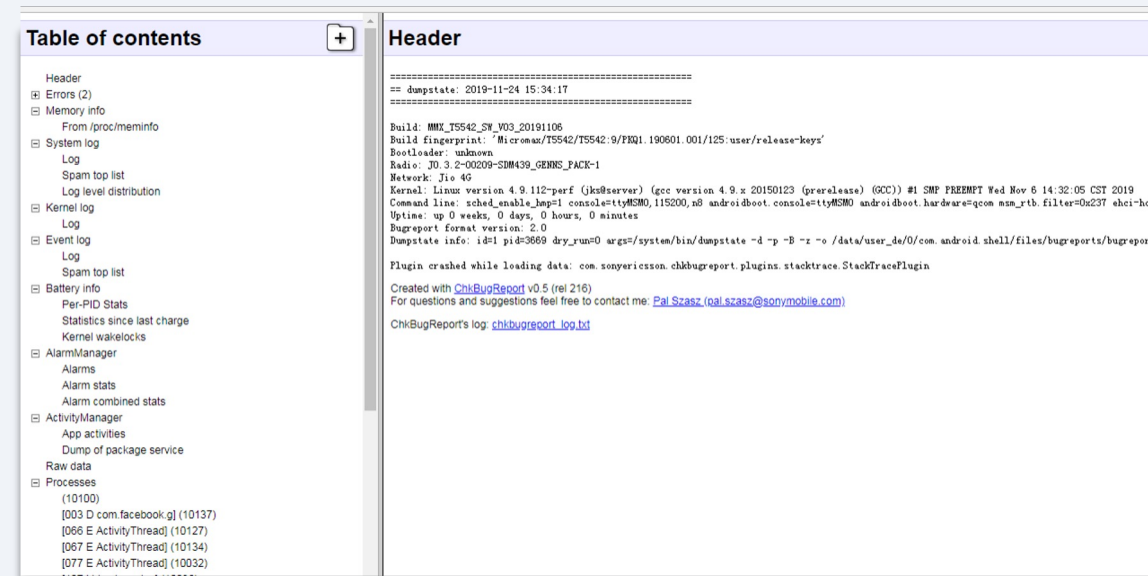
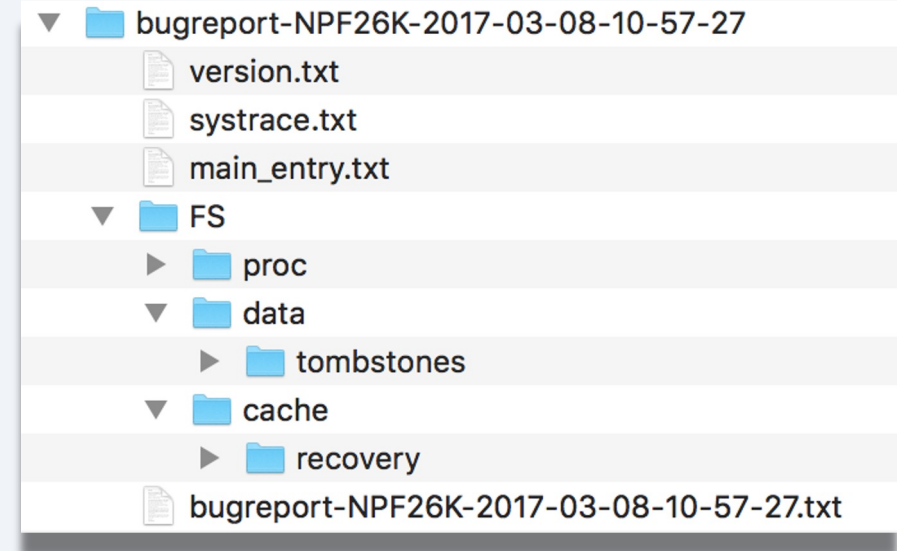
- Dumpsys – System services
- Dumpstate – Error logs
- Logcat – System messages

DropBoxManager – More targeted reports

- Data specifically from apps that crash

Helpful Resources

- [Android Debugging Core Topics](#)
- [Android Studio Bug Report User Guide](#)
- [Android Bug Report Videos \(YouTube\)](#)
- A helpful viewer: [ChkBugReport](#)



Batterystats & Battery Historian

Batterystats – collects battery data on device

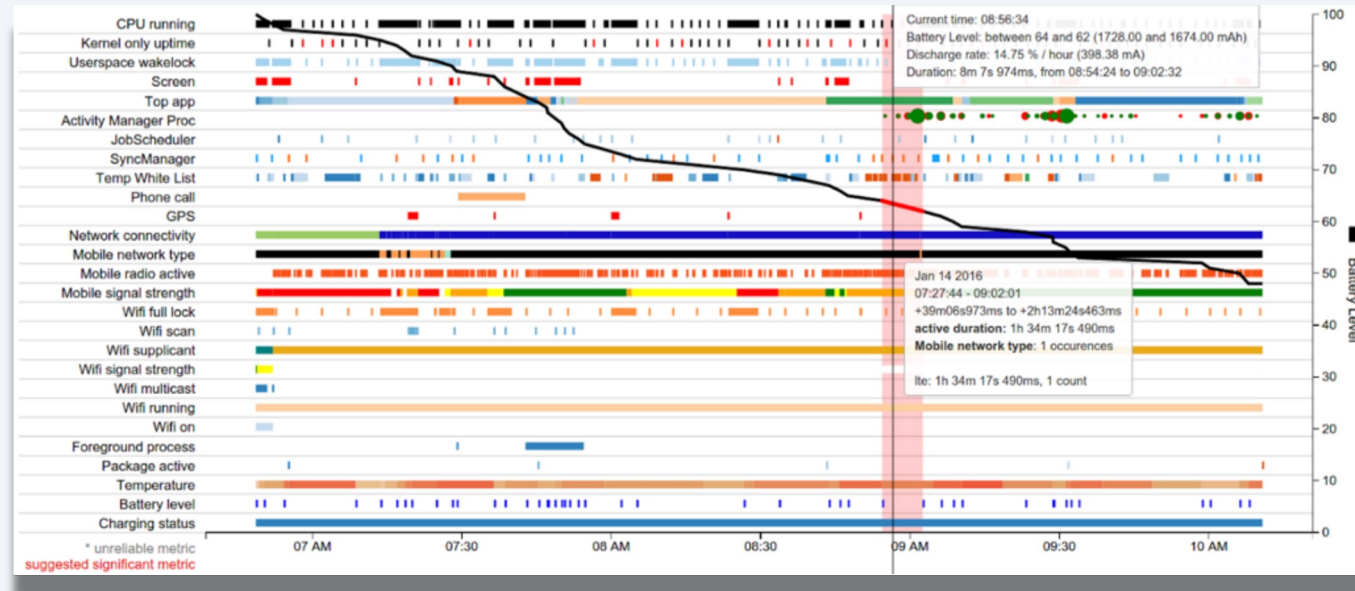
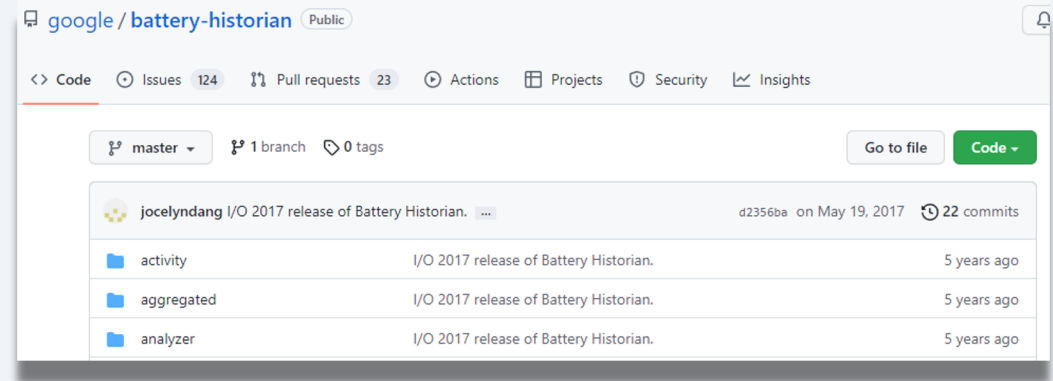
- Which processes are drawing current?
- When are they doing it?
- Adb can get logs

Battery Historian – a viewer for Batterystats

- Can consume a bug report (logs are in it)
- Can show System Stats and App Stats

Helpful Resources

- [Battery Historian GitHub](#)
- [Battery Historian Video \(YouTube\)](#)
- [Deeper Dive on Battery Historian \(YouTube\)](#)



Performance Tracing & Monitoring

Perfetto

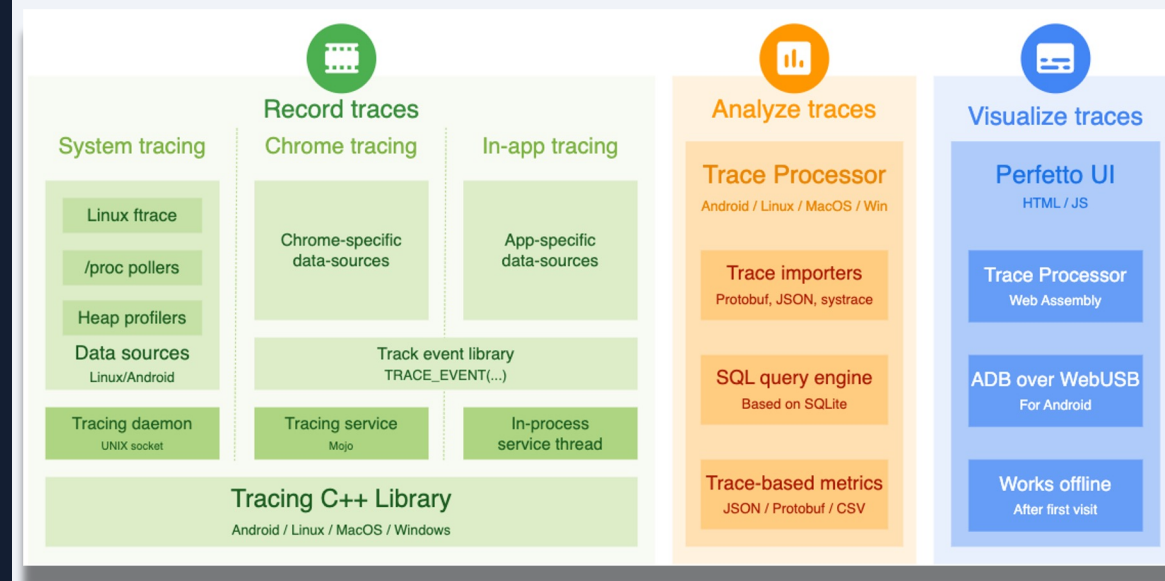
- Full system tracing framework and analysis tools.
- Capture high frequency ftrace data: scheduling activity, task switching latency, CPU frequency and much more

Leak Canary

- A memory leak detection library for Android.
- Built in heap analyzer
- Allows for uploading heap analysis to third party services

Helpful Resources

- [Perfetto GitHub](#)
- [Perfetto Docs](#)
- [Leak Canary Getting Started](#)





What is a common problem with the existing tools and information?

Poll #2

How do you collect debug information from devices in the field?

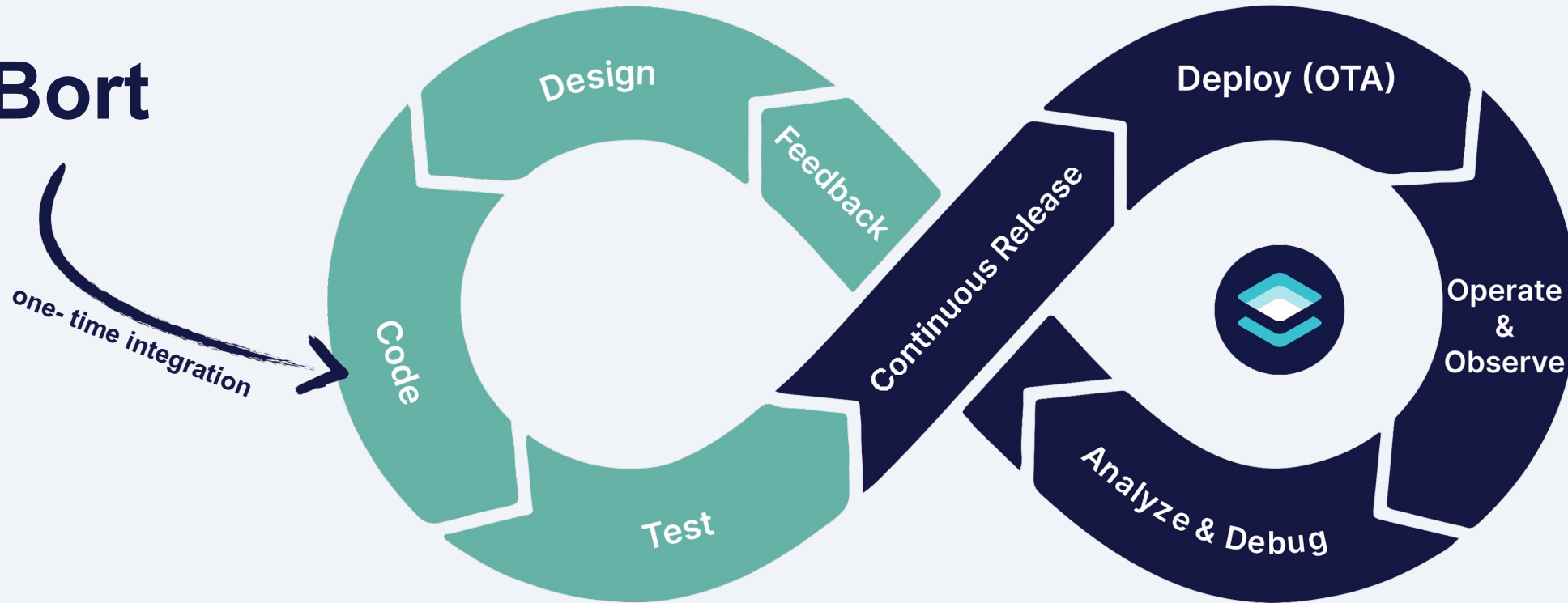
- A. User submitted Bugreports*
- B. In-house built crash detection*
- C. Third-party tools or services*
- D. You don't*



Memfault

Applying DevOps Thinking

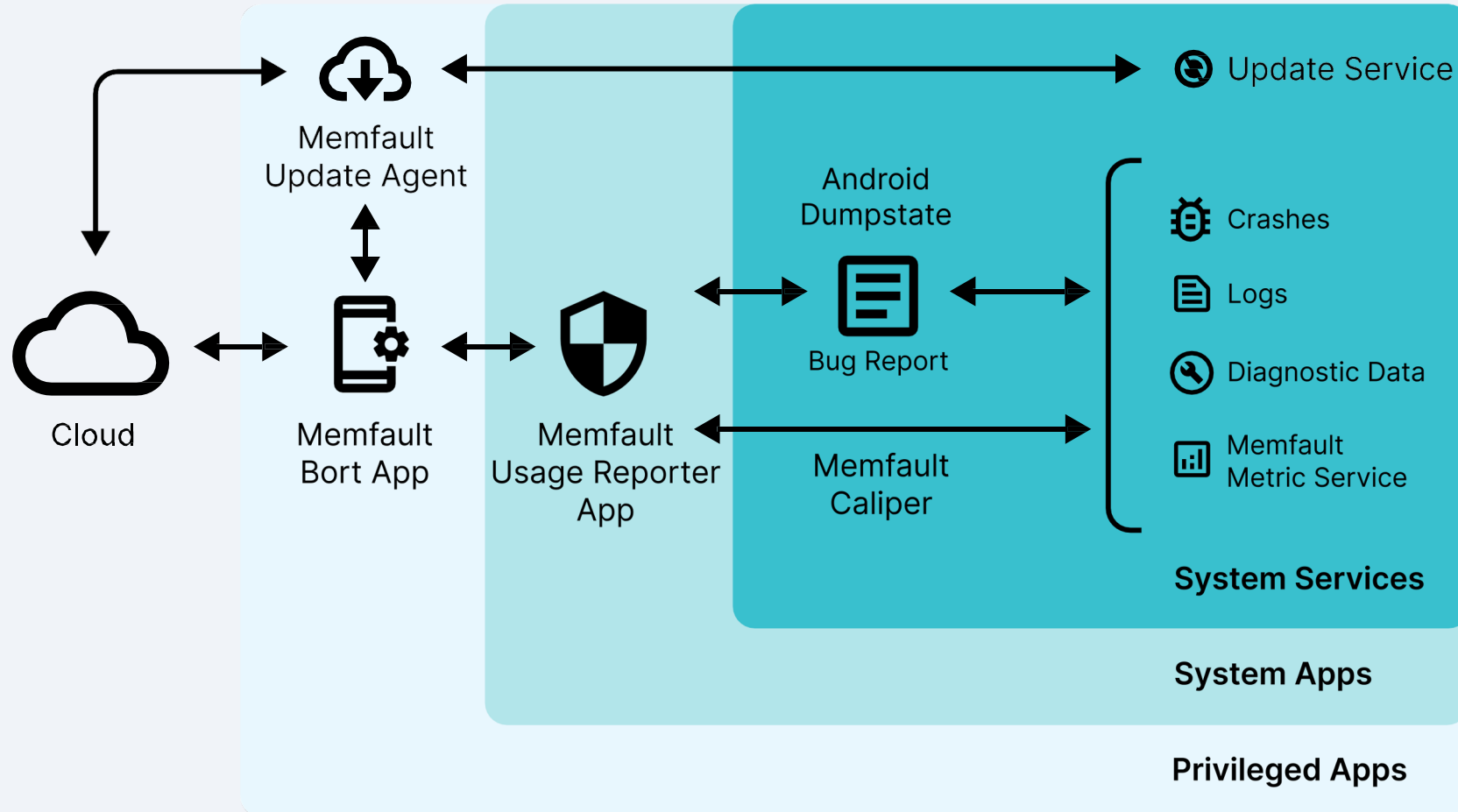
Bort



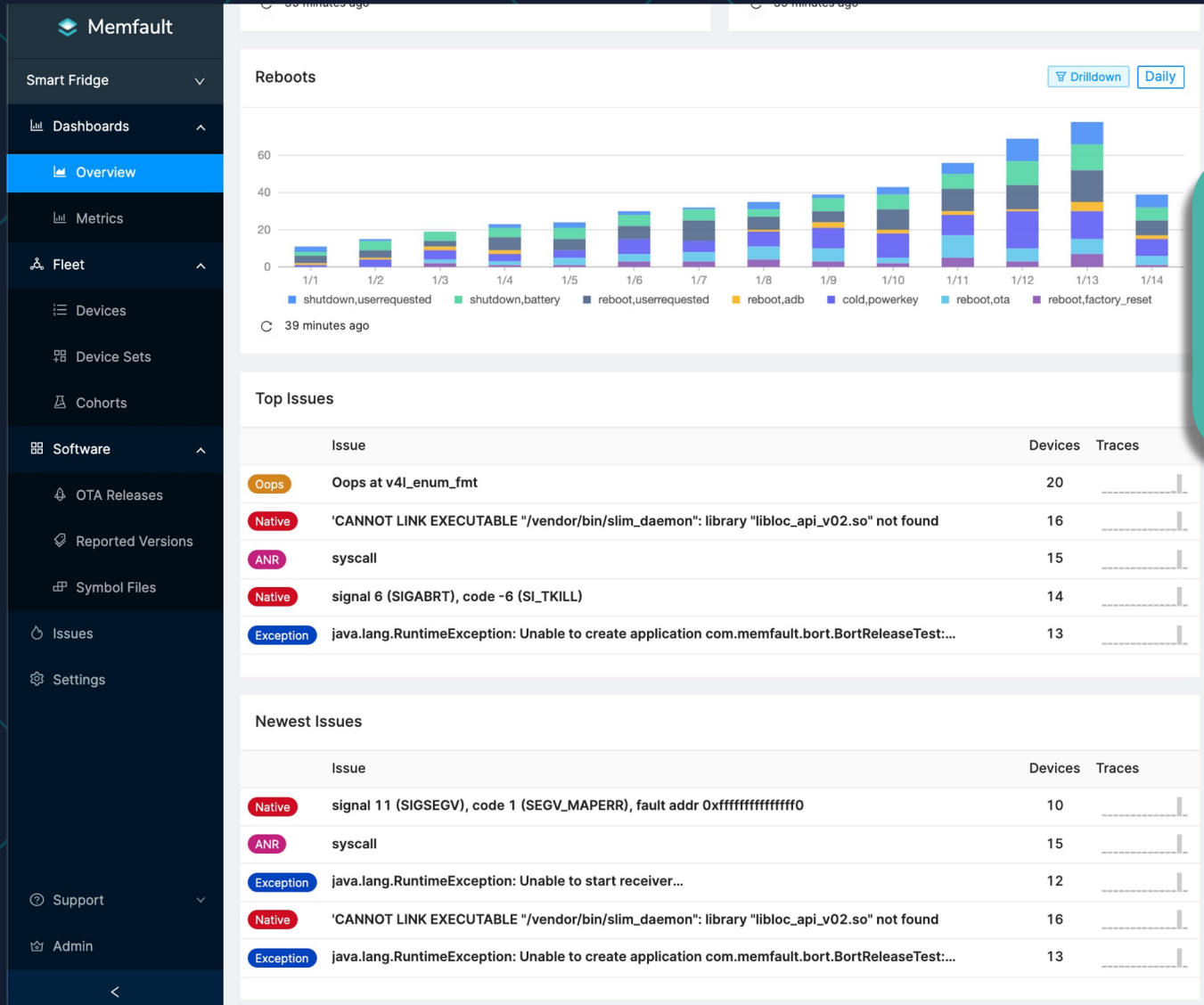
Development Process

Fleet Management & Observability

Inside Bort, the Memfault AOSP SDK

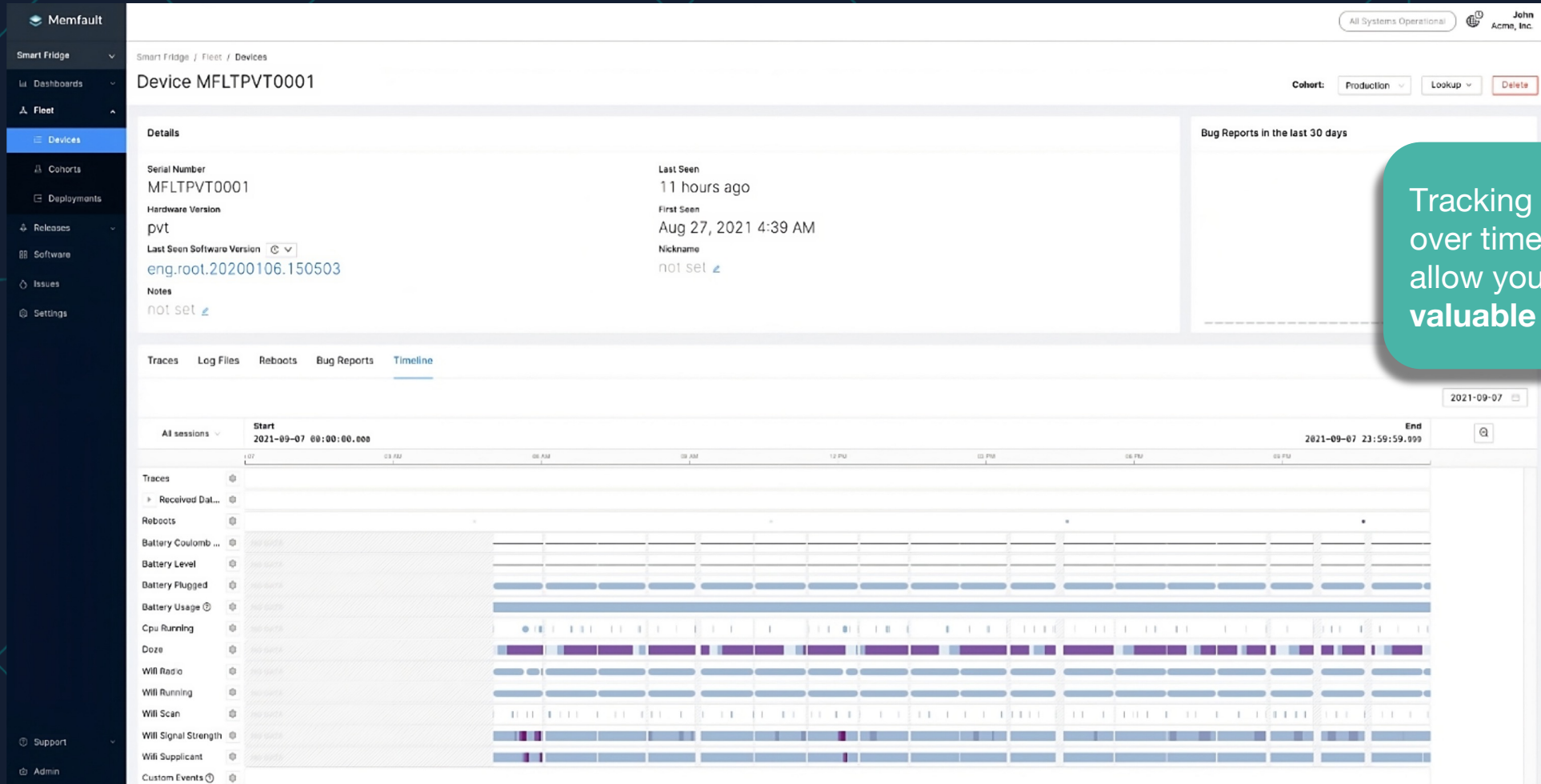


Memfault Platform | Overview



Memfault's **Overview** page gives you oversight of you the overall stability of your fleet and points out **weaknesses**.

Memfault Platform | Device Performance



Tracking critical metrics over time from your devices allow you to gather valuable insights.

Memfault Platform | Debugging

The screenshot shows the Memfault Issues dashboard. On the left is a navigation sidebar with categories like Smart Fridge, Dashboards, Fleet, Software, and Support. The main area is titled 'Issues' and contains a search and filter interface. The filters include Title, Reason (ANR, Exception, Native, Oops), Cohort, Device, Software Type, Software Version, Hardware Version, and date ranges for 'First Seen' and 'Last Seen'. Below the filters is a table of issues.

| Title | Count | Devices |
|---|-------|---------|
| ANR syscall com.memfault.bort_e2e_helper 8.1.0 (27) 19 hours ago - a day ago | 15 | 15 |
| Oops Oops at v4L_enum_fmt android-build eng.root.20200106.150503 19 hours ago - 2 days ago | 92 | 20 |
| Oops Oops: 0 (1 times) android-build eng.root.20200106.150503 20 hours ago - 2 days ago | 12 | 12 |
| Exception java.lang.RuntimeException: Unable to start receiver com.memfault.bort_e2e_helper.receivers.E2ETestReceiver: java.lang.Exception: <TEXT_PLACEHOLDER> com.memfault.bort_e2e_helper 2.7.1+0-DEV-dc4a36119 (2070100) 20 hours ago - a day ago | 12 | 12 |
| Exception java.lang.RuntimeException: Unable to create application com.memfault.bort.BortReleaseTest: java.lang.Exception: Testing 123 com.memfault.smartfridge.bort 2.7.0+0-DEV-975ec4bde (2070000) 21 hours ago - 2 days ago | 13 | 13 |
| Native 'CANNOT LINK EXECUTABLE "/>vendor/bin/slim_daemon": library "libloc_api_v02.so" not found android-build eng.root.20200106.150503 a day ago - 2 days ago | 16 | 16 |
| Native signal 11 (SIGSEGV), code 1 (SEGV_MAPERR), fault addr 0xffffffffffff0 android-build eng.root.20200106.150503 a day ago - 2 days ago | 10 | 10 |

How can we find the issues impacting our devices in the field?
You can filter your devices by pre-defined groups, HW, SW, date ranges, etc.



Live Demo

Learn more about AOSP Tools and Memfault

On-Demand Webinar

How to Debug, Update & Monitor Embedded Android Devices



Recorded: Thursday, October 28, 2021

Speaker



Ryan Case
VP of Engineering, Memfault

[Link to Webinar](#)

On-Demand Webinar

Managing Android Devices at Scale with Memfault AOSP SDK v4.0



Recorded: Thursday, March 24, 2022

Speaker



Heiko Behrens
VP of Product, Memfault

[Link to Webinar](#)

The AOSP and AAOS Meetup

Meetup Group

- Led by Chris Simmonds
- Based out of the UK
- Remote Friendly
- Talks all about AOSP and AAOS!



Thank You!

- memfault.com/android
- twitter.com/memfault
- linkedin.com/company/memfault
we're hiring!



Chris Hayes

Android Solutions Engineer,
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