

Report 4

The phone root

Please note: A beta version of this report was submitted to [AnandTech](#) as part of their *Call for Writers* initiative. It can be safely assumed that I have been rejected from it, and no portion of this report has been previously published anywhere on the internet to the best of my knowledge.

Version 1.0

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Motivation

As a user who never used a smartphone for more than a few months, I was not keen to get a new one just for the sake of university, and hence took a Galaxy S6 (which was nearly 2 ½ years old) from my mother.

While I had no interest in playing the latest games, I still wanted to stay as up to date as possible, and hence decided to flash a custom OS.

Naturally, I could just stay on Android 7 and the official ROM. But,

- It was restrictive – no root – and while I liked TouchWiz, I had an inclination for stock Android.
- Space: the default ROM contained quite a lot of bloatware, something which is common in most Android devices. For example, I had Chrome *and* Samsung Internet Browser, and I couldn't disable either (and on newer Android versions, some apps cannot even be disabled, like the Email app for instance even though Google's Gmail is also there), and the Microsoft apps were hard to get rid off¹.
- I wanted a newer Android version. Samsung won't upgrade the S6 beyond Nougat as it had already received two major software upgrades by then.

The core drawback for taking this root would be the loss of warranty, exacerbated by Samsung's *QFuse* tied to Knox, which trips a hardware switch when unauthorised software (like a custom ROM or a root) is installed directly to the phone, and is hence irreversible.

However, this phone was already past its warranty period (which was for two years), so that didn't make a difference.

The process

The first step was choosing the ROM itself. I initially tried one based on Resurrection Remix, but then switched to NexusOS 8.1 (<https://forum.xda-developers.com/galaxy-s6/orig-development/g92xx-android-o-samsung-galaxy-s6-t3663901>) as the former had horrible battery life (the later one, while a bit better, was still poor as explained in the Battery section). I wanted a simple ROM, but your needs may vary (if you are looking to emulate a particular skin or want something flashier).

As it was a Samsung phone, the first process was to root the phone so that I could install a custom recovery like TWRP to it. Now naturally there were quite a few rooting apps available on the Play Store. The one which I tried was KingoRoot, but that never worked despite trying it with four different phones, so my only option was to flash it through Odin (using adb was not an option due to Samsung's different implementation, which uses a *Download* mode similar to adb push).

Odin seems to be an internal Samsung-made tool for flashing devices², but I saw 'custom' editions with the download website's watermark, which probably meant that they edited the core DLL to do so, as I don't remember an image file which would be easily edited (and Odin is portable).

I won't go into too far on the steps for rooting, as I have written a short guide on https://en.wikibooks.org/wiki/Advanced_phone_customization/Rooting_your_phone.

¹ Office 365 is popular enough that many users *will* install it themselves. Why they must force it onto a user's homescreen is not something that I know. I do remember noticing on a newer phone that the preinstalled apps were just wrappers for the user to install the full version – probably to save space – for which while it's a good idea, the shortcuts are irritating.

² <https://www.howtogeek.com/341321/how-to-manually-update-your-samsung-phone-with-odin/>

The next step is to install the rom itself. Again, I've written the steps at https://en.wikibooks.org/wiki/Advanced_phone_customization/Installing_your_custom_ROM.

I want to point out the step of installing Google Apps using GApps. My choice of nano was simply because the description read "Minimal installation but including the extra functionality that is not available in the Google Play Store". As I'll explain later, that isn't really needed and pico should do you fine. There is no point in installing higher versions as those versions simply installs the Google apps as system apps (which cannot be removed and consume extra space since the base version must always be stored, plus the fact that all of them can be manually installed).

Once the custom rom was installed, then the OOBE (out of box experience) was identical to any other Android phone minus the manufacturer-specific components.

Performance and general experience

I personally felt the general experience to be better, as there aren't any preinstalled apps (other than the necessary ones) to nag me. No Email app, No Chrome, etc. However, since I picked the *nano* version instead of the *pico* one, there were still a few apps like Calculator and Clock (which are useful, but you can always download a similar one from the Play Store). Firefox was also preinstalled in the ROM for some reason, but I simply uninstalled it. If you go for other variants, you'll get apps like Chrome and so on like how ordinary Android phones are shipped with.


One of the most common reasons that I would hear for why a custom ROM should be installed is that it improves the general performance of the phone. While a custom ROM often removes a lot of the bloat, the governor also makes a big difference – that and other kernel features like the scheduler can indeed make a noticeable difference in performance – as shown by *Anandtech* in their Galaxy S9 review.

While there was occasional sluggishness, it wasn't that bad and I simply turned off the animations in the phone. That makes the phone quite snappy but can mean that the waiting time (eg: 4 seconds to open Skype) is noticeable as the animations usually mask it.



In fact, the Android app *CPU throttling test* mentioned an example of an LG G3, wherein the governor was misbehaving on stock causing inconsistent single-threaded performance on an LG G3 which was fixed in a custom ROM. If I remember correctly, that was featured on the app's Play Store description page, through that example is now removed.

Anyway, I tested the phone with various common tools. First up is Geekbench 4:

Samsung Galaxy S6 vs Samsung Galaxy S6

Geekbench Scores			
	Samsung Galaxy S6		Samsung Galaxy S6
Single-Core Score	1326		1457
Multi-Core Score	4014		4020
	Geekbench 4.3.2		Geekbench 4.3.2









System Information		
	Samsung Galaxy S6	Samsung Galaxy S6
Operating System	Android 7.0	Android 8.1.0
Model	Samsung Galaxy S6	Samsung Galaxy S6
Processor	ARM SAMSUNG @ 1.50 GHz 1 processor, 8 cores	ARM SAMSUNG @ 1.50 GHz 1 processor, 8 cores
Processor ID	ARM implementer 65 variant 1 part 3335 revision 0	ARM implementer 65 variant 1 part 3335 revision 0
Motherboard	universal7420	universal7420
BIOS		
Memory	2682 MB	2698 MB

Single-Core Performance			
	Samsung Galaxy S6		Samsung Galaxy S6
Single-Core Score	1326		1457
AES	940 725.3 MB/sec		904 697.5 MB/sec
LZMA	1355		1348

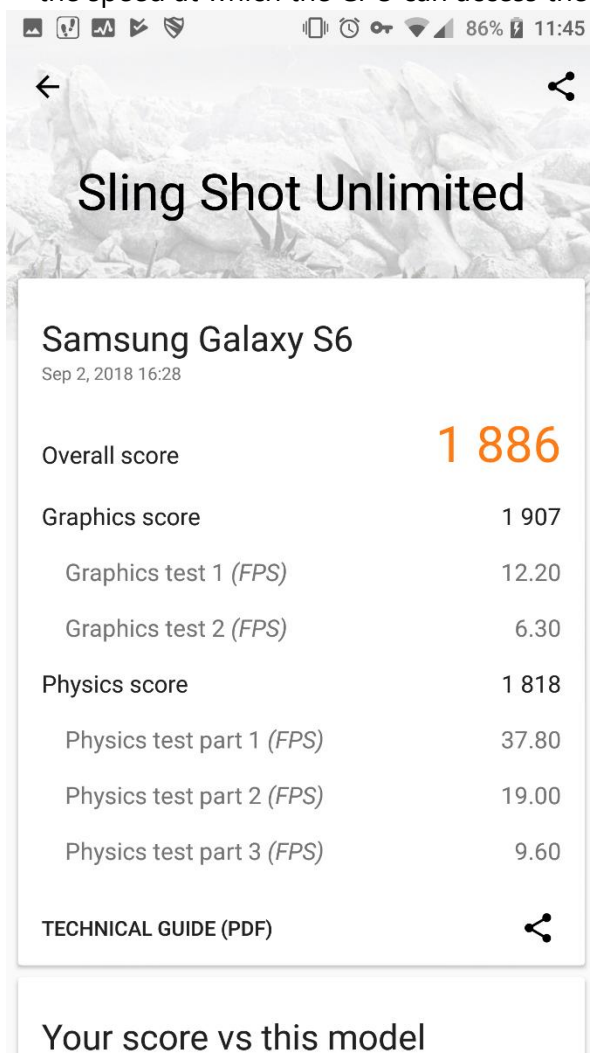
<https://browser.geekbench.com/v4/cpu/compare/12607676?baseline=12613282>

The result on the left was a random S6 testing sample by a random user.

The results were mostly comparable, except in sections of memory:

Rigid Body Physics	4699 13758.0 FPS		5472 16019.5 FPS
HDR	6737 24.4 Mpixels/sec		7042 25.5 Mpixels/sec
Gaussian Blur	2825 49.5 Mpixels/sec		2883 50.5 Mpixels/sec
Speech Recognition	3121 26.7 Words/sec		3074 26.3 Words/sec
Face Detection	4694 1.37 Msubwindows/sec		4504 1.32 Msubwindows/sec
Memory Copy	1419 3.93 GB/sec		1657 4.59 GB/sec
Memory Latency	2593 166.9 ns		2711 159.6 ns
Memory Bandwidth	1211 6.47 GB/sec		1685 9.00 GB/sec

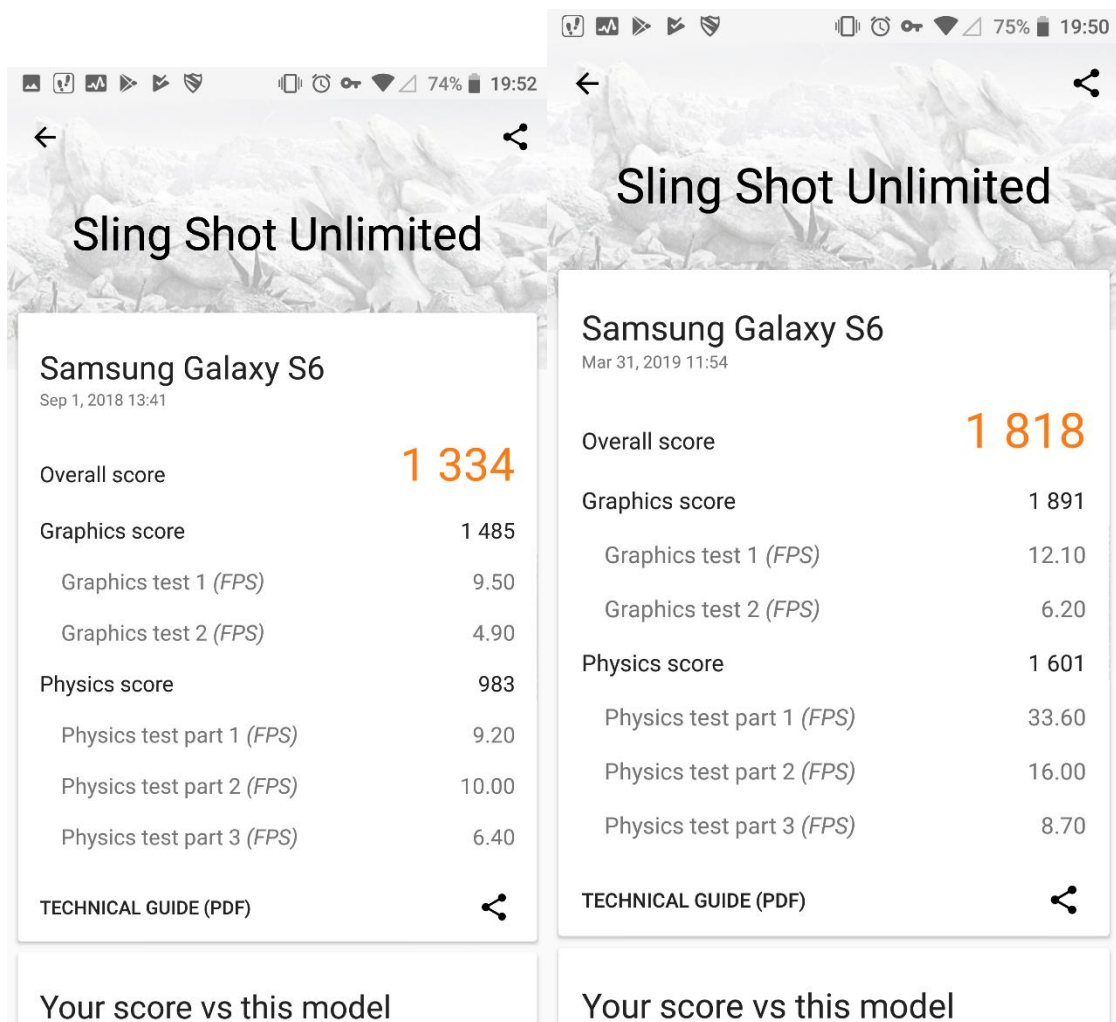
Here the Oreo phone showed a significant improvement in memory bandwidth and copy. This might be because the phone was set in Performance mode, which set the base clock to 1000 and 2100 MHz (i.e maximum clock speed) for the little and big cores respectively, which improves performance by increasing the speed at which the CPU can access the memory.



Testing with other applications like 3DMark also showed interesting results. Indeed, in a best-case scenario, the S6 can do quite well indeed. When I tested it in the *Performance* mode with the phone in a refrigerator (to alleviate thermal issues), the phone was well above the median (see left, this is a 100th percentile score as reported by 3Dmark)

In a more balanced mode, the score decreased by about 30%, despite the phone still being kept in a freezer as the clocks were now free to vary with demand.

In room temperature conditions, thermals come into play, so I re-ran the benchmark in *Performance* mode to see how much it would impact the score.



Balanced (cold): 20th percentile.

Performance mode (room temperature): 83th percentile

The section where we can most observe variances is in the Physics section. This can be correlated to earlier observations I noted above – for the balanced mode, that the CPU is managing clock speed with demand – and for the performance mode, that throttling is taking effect. On the graphics side, though the balanced mode still suffers in performance, there isn't much of a difference between performance mode in room temperature and cold conditions.

Battery

This is a section where the phone as a whole does poorly. I remember that with stock, the battery life of the phone wasn't great, and unfortunately, it's the same with the custom ROM.

On daily use, it can *just* about survive a 9-5 day with light usage, and if I use it a lot, it will die much earlier.

Naturally I tried to investigate as to why that happens. Deep Sleep *does* seem to be activated – it can last a day if not used at all – while not ideal, it's still better than when it's not still (where Deep Sleep does not work).

The CPU simply seems to be inefficient – if heavily loaded, it can die within an hour and half – which is quite short for a phone (a simple use-case is Skype, which can stress the CPU and GPU hard especially if multi-tasking). For example, when I was running the stress test, I had it connected to my laptop's USB socket, yet the battery decreased by nearly 10% in 15 minutes. While most phones indeed would discharge under such conditions (as the USB socket would provide at most 2.5 W), the rate of decrease is astonishing.

While setting it to Power Save helps a bit by reducing the idle clock speed (and does not have a major impact in general usage, though there is a bit of lag), that does not help a lot, though it does not impact peak and long-term loads.

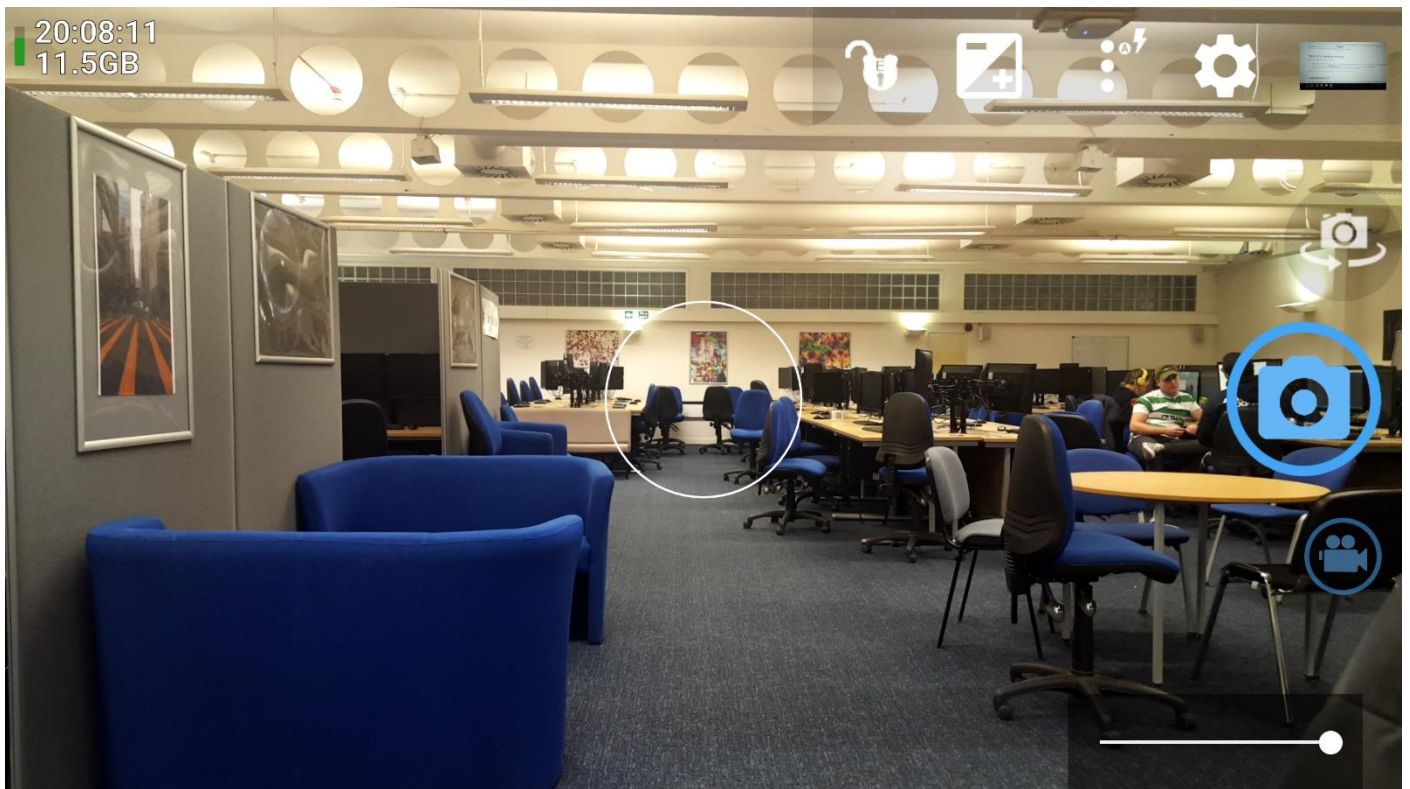
Using an app like *Kernel Toolkit*, it is possible to manipulate the governors of the phone and further reduce clock speed if desired. However, in my testing, it did not stick for long, which was annoying. I would usually set the idle clock speed to 200/200 MHz for little/big, which is less than even the 200/400 offered in the *Power Save* profile.

Camera

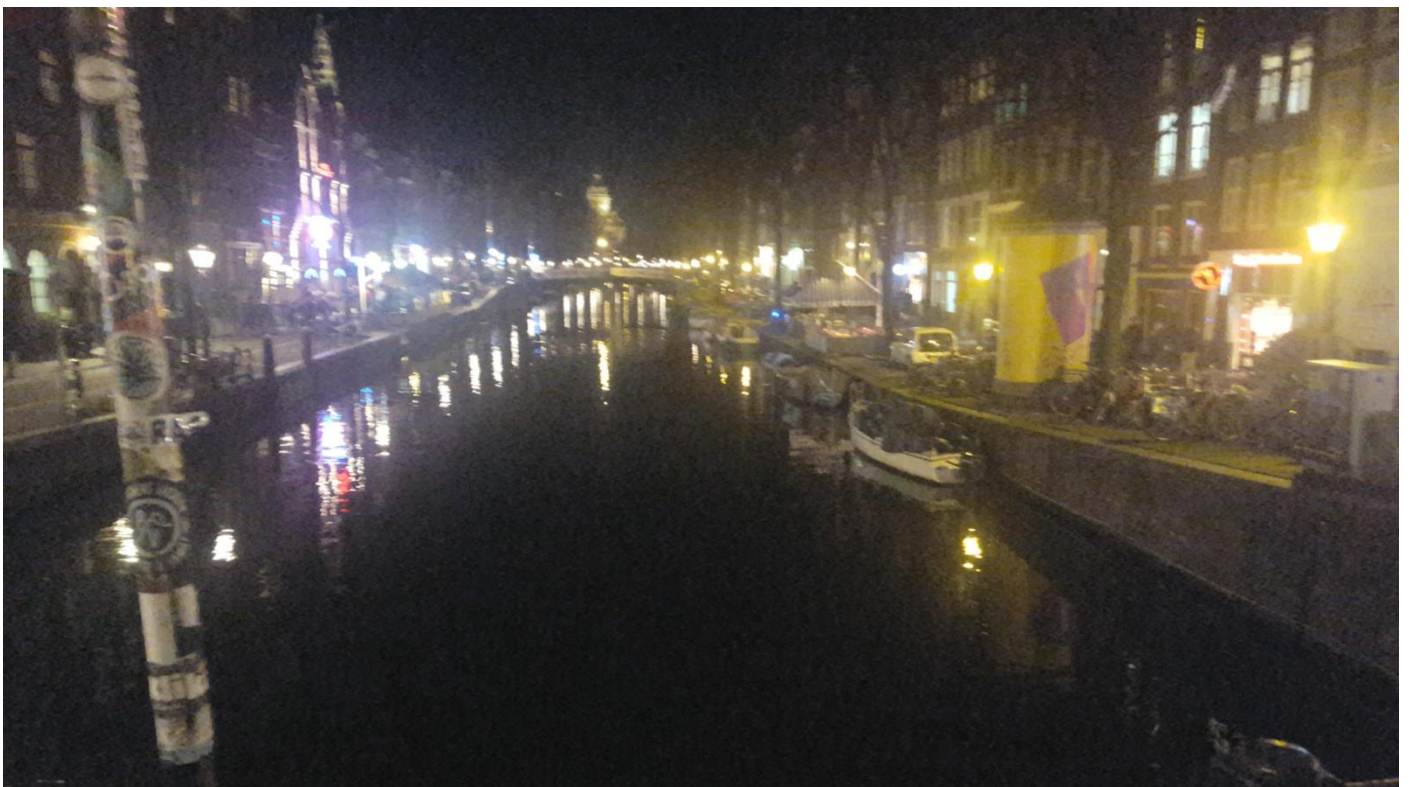


This is a section where the custom ROM falls quite short compared to the stock ROM. The Samsung app contains various useful options and also model-specific optimisations, things which the custom ROM both lacks, even though it ships with two camera apps, the Android camera app (which is quite generic) and the LineageOS camera app (which is better, but not enough) (see top).

I also installed another app in the Play Store: Open Camera.



It's pretty rich in options, and even has options like HDR and various video options. However, selecting HDR and trying to take a photo with it resulted in the app locking up, probably because the ISP can't process one.

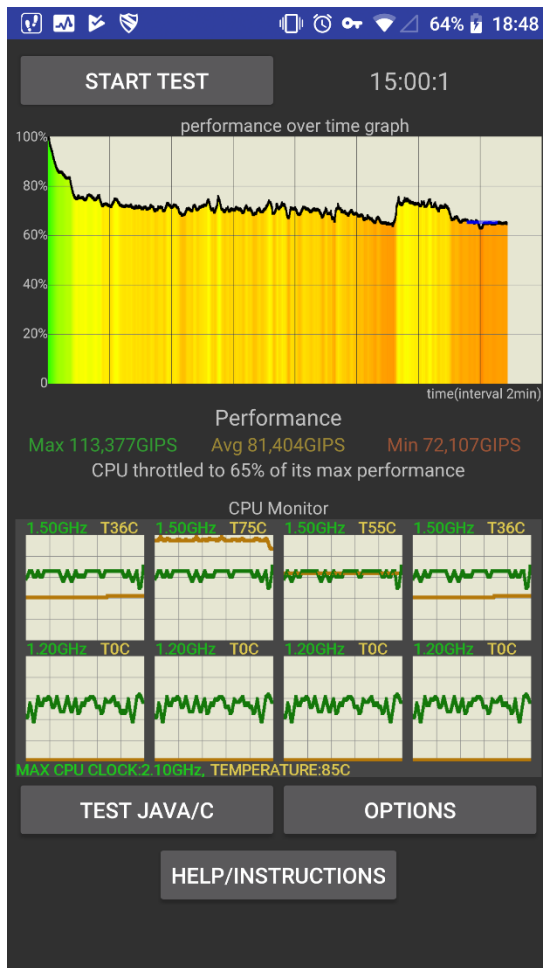


The above is a sample photograph taken with the LineageOS Camera app. The most obvious feature is the level of noise present in the image. Checking the EXIF data shows that this photo was taken with an ISO of 2000, which is well above the 800 that Samsung used to offer for the S6 in the stock app.

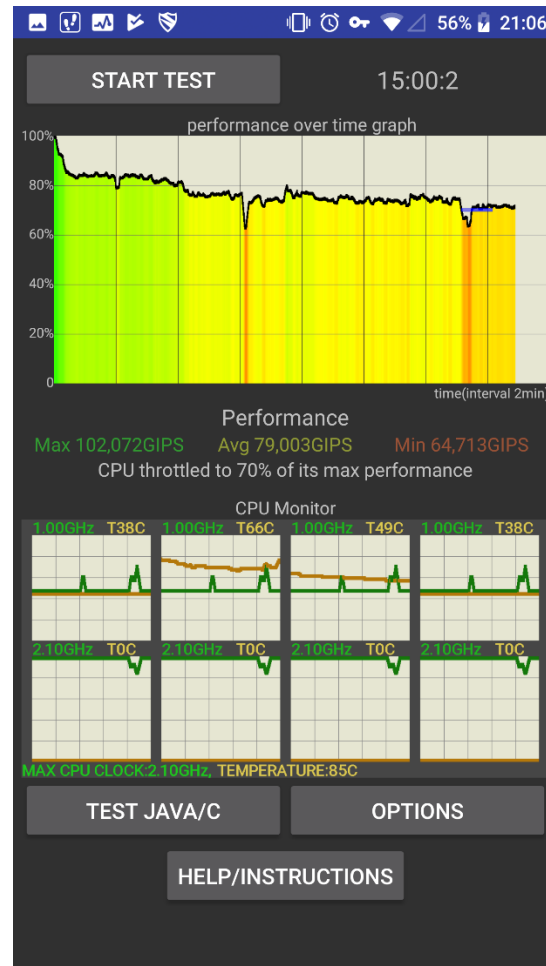
Thermals

The phone performs identically to the stock ROM in that aspect. It does throttle pretty heavily – about 35%

from peak load. The CPU itself goes quite hot at over 80 C (as reported by the temperature sensor), but the battery was quite cool, though in past testing it had peaked at nearly 50 C.



This also shows that the peak and long-term loads do not vary much between the battery modes – the above screenshot was taken in Battery Saver mode. In Performance mode, the phone can sustain the maximum performance for very less time and quickly throttles down to similar levels of performance as Battery Saver.



Top – Battery Saver mode. Right – Performance mode. In fact, there is a 6% decrease in the peak performance in Performance mode, which is interesting. It turns out that the phone cannot sustain the maximum clock speed for more than a second or so, and that time is not enough for the app to measure the theoretical peak performance.

Challenges

The issues in this section are mostly specific to this ROM, as I haven't observed them on stock. Can also be titled as the section on bugs.

1. The camera is sluggish. More importantly, it does not open properly at times - showing a blank image or freezing when trying to take the photograph which is frustrating as a restart of the phone will often be needed. As said on the review, that's one of the worst parts of this ROM.
2. GeekBench reported a single-core score of 200 on the power-save profile, which is inconsistent as the phone performs hardly as bad in reality. As a result, I've not commented on that here.

3. It occasionally disconnects from Wi-Fi networks, and more annoyingly, one can't simply flip the switch. Turning the Wi-Fi from on to off (not vice versa) will freeze the *whole phone* for 15 seconds for some reason.

Conclusion

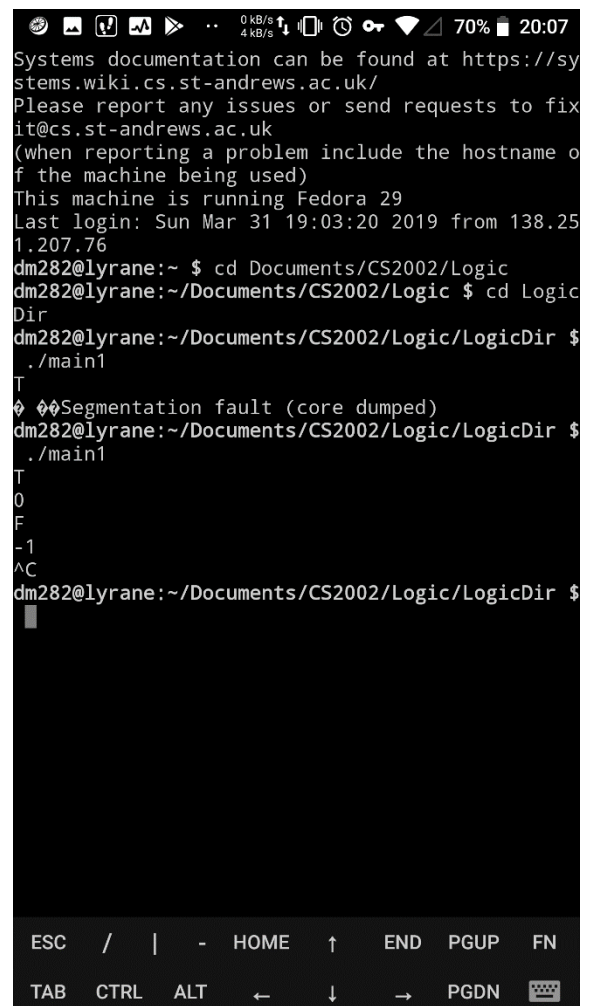
I've mostly been satisfied with the performance and stability of the phone, using it as a daily driver. It's fast enough for what I do, from checking my emails to testing emulation through Wine and working with ssh. Sure, I could simply get a cheaper phone instead of taking this route, but then in many cases an older flagship is still faster than a newer mid-range phone (for example, it's faster than an Galaxy A3 at least, especially in graphics wherein manufacturers have historically been a bit slow with their non-flagship phones), and cheaper phones are less likely to get software updates in the first place, with their support for custom ROMs lacking compared to 'once-flagship phones'. And as I've shown, the average consumer is unlikely to notice the performance to their detriment. 3DMark tells that this phone can outperform around 80% of phones around the world, and I'd tend to agree. Occasionally it was slow – and that was annoying – but it's fine for the most part. The only real drawback is the relatively lacklustre camera performance, for which I think there should be ways to work around this which I've not explored.

As for living with a rooted phone, most apps don't care (including some banking apps like HSBC). And for those who do care (eg: Stagecoach), the ROM offers an easy option to disable the root. The only thing that does *not* work is Google Pay – this is because it uses SafetyNet and the phone fails it. Most guides on the internet ask the user to enable Magisk – which is pointless since the ROM already has a root functionality. It seems that this problem can be fixed by editing build.prop, but I didn't bother as I was fine with just using a contactless card.

Therefore, Android manufacturers' policies of limiting software upgrades to two releases above their base versions at most holds little value, as the performance is usually unaffected for most phones from 2017 onwards. Apple does this quite well for their iPhones – the iPhone 5S still get iOS 12! Would one imagine an S5 getting Android 9? Not by the manufacturer for sure. Yes, an S5 is not an S9, but the average consumer would most likely not care. Unfortunately, most consumers do not explore alternatives to potentially prolong the lifetime of their phone and just get a new one – indeed, options like installing custom ROMs still requires a degree of technical understanding which would deter most from taking such a root. Good for the manufacturer, but bad for the consumer's pockets and the environment.

And do I plan to change my phone anytime soon? No (unless the phone suffers a hardware failure). True, it's not the snappiest – but I can certainly live with it (not true with the Galaxy Grand, for example). But I plan to upgrade to a Pie ROM soon – it's just that it's my daily driver and I don't want to take any risks for now.

Right: Working with SSH and running C code on my phone



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Systems documentation can be found at https://systems.wiki.cs.st-andrews.ac.uk/
Please report any issues or send requests to fix it@cs.st-andrews.ac.uk
(when reporting a problem include the hostname of the machine being used)
This machine is running Fedora 29
Last login: Sun Mar 31 19:03:20 2019 from 138.251.207.76
dm282@lyrane:~ $ cd Documents/CS2002/Logic
dm282@lyrane:~/Documents/CS2002/Logic $ cd LogicDir
dm282@lyrane:~/Documents/CS2002/Logic/LogicDir $ ./main1
T
Segmentation fault (core dumped)
dm282@lyrane:~/Documents/CS2002/Logic/LogicDir $ ./main1
T
0
F
-1
^C
dm282@lyrane:~/Documents/CS2002/Logic/LogicDir $
```

ESC / | - HOME ↑ END PGUP FN
TAB CTRL ALT ← ↓ → PGDN