

COMPARISON OF ANDROID PHONES AND TABLETS FOR MOBILE DATA COLLECTION - 2017

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Smartphones and tablets have become an indispensable part of UNHCR field operations worldwide. Whether it is to respond to emails from the Bureau, to update all team members about events in a camp via WhatsApp, or to collect data quickly and accurately from persons of interest.

One of the most useful applications for Android devices in UNHCR’s operational contexts is mobile data collection (MDC). The advantages of MDC over traditional paper surveys have been well documented,¹ but the question remains which phone or tablet is right for which operation.

This report aims to help UNHCR staff make informed buying decisions for MDC projects based on the experience and tests performed by CartONG staff, while making no pretence of providing a full market overview.² Prospective buyers should also keep in mind that they are likely to use phones for multiple projects and purposes. While a high resolution camera for example might not be a key factor for MDC, it can be important if staff are also supposed to take photos for donor reports.

For this report, CartONG staff tested seven Android phones and three Android tablets. Where applicable, observations from partners and selected external reviews were also taking into consideration. iOS phones and tablets were not considered for this report, because Apple devices are generally more expensive and less compatible with many common open-source MDC tools.

This is the third such report that CartONG has produced for UNHCR, with previous reports having been published in 2014 and 2015.

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¹ CartONG: "Benchmarking of Mobile Data Collection Solutions", June 2017, http://blog.cartong.org/wordpress/wp-content/uploads/2017/08/Benchmarking_MDC_2017_CartONG_2.pdf, Retrieved: 22. November 2017

² In 2015 more than 24,000 distinct Android devices, produced by close to 1,300 brands, were on the market. See: <https://opensignal.com/reports/2015/08/android-fragmentation/>, Retrieved: 22. November 2017

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1. Tablets or phones?

While tablets are more expensive than phones, CartONG’s partners are increasingly considering buying tablets in addition to smartphones for selected use cases. To accommodate the appetite for devices with bigger screens, this report contains comparisons of both smartphones and tablets.

The table below provides an overview of general factors to take into account for field based MDC projects. Additional information can be found on the CartONG website.³

	Phones	Tablets
Size	<p>Lower risk to accidentally skip non-mandatory questions because only one questions is visible on the screen at any time.</p> <p>Can easily be held by hand or worn with a neck strap.</p> <p>Fits into a pocket; less visible when moving.</p>	<p>Very long questions, or questions with many possible answers, can be read without scrolling.</p> <p>Multiple questions visible per screen.</p> <p>More comfortable if surveys contain text fields that need to be filled, rather than defined options.</p> <p>Better for collecting geographical data with a background map (e.g. water networks, agricultural plots etc.).</p> <p>Possible to show multiple pictures with survey questions on a screen (for example pictures of different types of latrines).</p> <p>Bigger size and higher cost of tablets might make them look out of place in very impoverished</p>

³ CartONG: “What criteria should you look into when choosing a Mobile Data Collection device?”, 27. April 2017, <http://blog.cartong.org/2017/04/27/choosing-mobile-device/>; Retrieved: 13. December 2017

		context. Prospective buyers may want to consider how tablets are perceived by beneficiaries.
Weight	--	Will start to feel heavy if used for a long time if enumerators cannot put the tablet down.
Camera	Better for taking photos.	Adequate for MDC.
QR code/ barcode scanning	Better for QR code and barcode scanning.	Not recommended, unless an external barcode reader is connected to the tablet.
Connectivity	Connectivity is generally better.	Connectivity is generally a little worse. In addition, some tablets don't have a slot for SIM cards.
Other	--	If audio is supposed to be recorded as part of the survey, an extra app may need to be installed on tablets.

2. Focus areas for this report

Irrespective of the choice of device, CartONG recommends that large-scale mobile data collection projects should buy identical devices for all enumerators as this will make it easier to train them and to set up the devices.

Prior to any such large-scale project, country teams should also familiarize themselves with the relevant customs regulations, which may influence whether phones should be imported or bought locally.

Whether a device is adequate for a use case depends on the specific needs of that program. Many of these criteria can be compared easily, for example the screen size or the battery life. These criteria are included in the tables in Annex of this document.

In addition, and in order to address the specific needs of humanitarian field staff, CartONG has decided to put a focus on the following areas:

2.1. How well can the device read QR codes and barcodes?

Barcodes and QR codes find many uses in humanitarian operations, most commonly in logistics, but also on ration cards or on the bracelets of patients. Broadly speaking, QR codes are much easier to read for smartphone cameras than barcodes (see box) and only cameras with auto-focus should be used to scan barcodes.

Whether the phone has a built-in flash or flashlight that can illuminate codes in situations without adequate lighting is another factor that should be considered. For this reason, CartONG only tested phones that support auto-focus and have a flash.

Project teams should consider that scanning a large number of codes will require the constant use of the device's camera - and maybe flashlight - which can quickly drain the battery. In this report, the Asus Zenphone Max 4 and the Samsung Galaxy J7 2016 are the two devices with the largest battery capacities.

Smartphones are also significantly slower at scanning QR and barcodes than dedicated, commercial scanners. This makes smartphones a poor choice in situations where many codes need to be scanned quickly.

As UNHCR is mainly using barcodes and not QR codes for MDC, CartONG recommends that phones should undergo additional testing if barcode scanning is their main purpose in the field.

Please note that while many Android devices come with a pre-installed QR and barcode readers, not all devices do and it might be necessary to install a free app to read the codes.

Barcodes versus QR codes

The terms “barcode” and “quick response” (QR) code are often mistakenly used interchangeably. However, their different designs, and where they can be found, poses different challenges for hardware and software in Android devices.

- **Barcodes** represent data through a single row of vertical lines. While many Android devices include software out of the box that can read barcodes, the camera hardware can be a limiting factor since cameras without auto-focus often have problems reading barcodes. In addition, barcodes are often found on the outside of inventory or packaging and may be dirty, smudged, damaged or blurred. The free software package that is pre-installed on a phone may not be able to compensate for these problems and it may be necessary to purchase more advanced software.
- **QR codes** encode data along a horizontal and a vertical axis. Auto-focus is not as important to read these codes correctly. Many Android devices come with a pre-installed QR code reader. QR codes can contain considerably more data than barcodes and can be read from any direction. In addition, the encoding algorithm allows for a larger error margin (7% to 30%) in case the code is dirty or has been damaged.



Barcode (left) and QR code (right). Source: Wikipedia

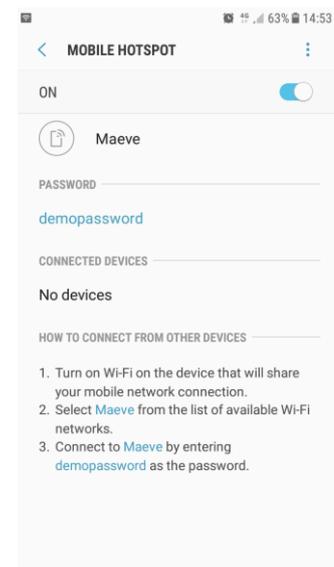
2.2. Can GPS data be collected without a SIM card?

A large number of MDC projects collect GPS data, either as part of the survey data itself, or for reasons linked to quality control. While GPS technology does not require a connection to a mobile phone network, some Android devices require that a device contains a SIM card to activate the GPS module. However, in many MDC projects phones are used only as data entry devices and using them to make phone calls or to establish mobile data connections is neither intended nor desired. In these situations, a requirement to buy SIM cards for all MDC phones would mean additional, unnecessary project costs. CartONG found that particularly locally bought phones often require a SIM card for the GPS to work.

For this report, CartONG chose to only include devices that do not require SIM cards to collect GPS data.

2.3. Can the device be used as a wifi hotspot without a SIM card?

UNHCR’s wireless networks are well protected and the Division of Information Systems and Telecommunications (DIST) has good reasons for locking down many services and protocols on their networks. For MDC projects where data synchronization needs to occur offline, locked down networks can be an issue when trying to synchronize data between the survey computer/server and the enumerators’ Android devices.⁴ A possible workaround is to turn one of the Android devices into a dedicated hotspot that links the enumerators’ devices with the server⁵. This can be done locally without a connection to the internet or a wider network. However, some Android devices require a SIM card to be used as a hotspot.



Screenshot of a mobile hotspot.

CartONG found that none of the Samsung devices tested for this report worked as a hotspot without SIM card, whereas most devices from other manufactures did.

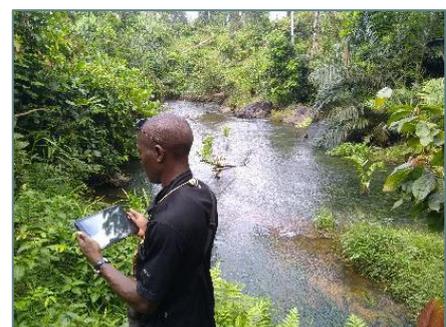
2.4. Resistance to shocks, water and dust

The most powerful and versatile phone or tablet is useless if it breaks on the first day in the field. Particularly low-cost devices are normally built for the living room and not the middle of a refugee camp. But even in a humanitarian crisis, not all use cases require the same amount of ruggedness. An MDC project that involves talking to Colombian refugees in remote locations might need phones that are fairly water-resistant, while a survey tablet that is mainly used inside a UNHCR office-container in Greece might not require any protection from the elements at all. Similarly, a phone that is primarily used to scan barcodes inside a warehouse is more likely to be dropped than drowned, versus phones used for camp mapping will have to deal with multiple environmental hazards.

Given that these devices are supposed to be used in the field, there is a deliberate bias in this report towards rugged or sturdy phones. Prospective buyers should be aware that rugged phones might attract more unwanted attention in conflict settings because they might resemble military hardware.

More than half of the devices tested for this report come with either IP67 or IP68 dust and water protection.⁶ This means they are considered to be “dust tight” and can be submerged in 1 meter (IP67) or 1.5 meters (IP68) of fresh water for 30 minutes.

Of the ten tested devices, the following phones and tablets have no dust or water protection: Asus Zenfone Max4, Samsung Galaxy J7 2016, Samsung Galaxy Tab A 2016 10.1 and Acer Iconia Tab 10 A3-A40.



Mobile data collection in Cote d'Ivoire. Photo: CartONG

Buyers should be aware though, that the IP rating does not say anything about how well a phone is able to withstand a fall: while electric contacts might be well protected from water and dust, the touchscreen can

⁴ In most field operations a dedicated router can be set-up for this purpose. However in some operations it is neither possible to send a router from HQ nor to obtain one locally. In these cases it is very important to be able to use an Android device as an alternative.

⁵ A downside of this approach is that the device that is used as hotspot cannot synchronize its own data (another phone will have to be used for that purpose) and that the IP address of the offline server cannot be fixed.

⁶ For more information on these ratings, see: https://en.wikipedia.org/wiki/IP_Code

still easily shatter or the back fly off, when dropped on concrete in a communal kitchen. The devices with the best protection against shocks are the Crosscall Trekker M1 Core, Hisense Rock C30, Samsung Galaxy Xcover 4 SM-G390F and Samsung Galaxy Tab Active LTE.

3. Android phones

CartONG aims to provide UNHCR with a comparison of phones that are fit for MDC. For this report, CartONG selected phones that cost not (much) more than 300 Euro, had screens no larger than 5.5 inches, were released within the last two years and ideally were sturdy. The desired build-quality was one of the main factors for the comparatively high price of the selected phones. Organisations will be able to find considerably cheaper models if they are not looking for sturdy phones or if they do not expect the phones to be used for multiple surveys per year.

In addition to the criteria mentioned above, positive comments and feedback from CartONG’s partners helped inform the choices.

In other words: none of these phones are terrible. The difference between the phones in respect to MDC are more related to the specific context in which they are used. If it is very dusty, IP67/68 protection can be important, if electricity is a problem, a large battery may be essential, etc.

3.1. Asus Zenfone Max4

The Asus Zenfone Max4 boasts the largest battery in the test by far, making it a good choice for use cases such as camp mapping, where long battery life is important, or for very remote MDC projects where electricity is not always available. The Zenfone’s battery packs an impressive 5,000 mAh, which is 50 per cent more than the Samsung Galaxy J7 which has the second largest battery. The downside is that the Zenfone is also the largest (154 x 17.9 x 8.9 mm) and second-heaviest (181 g) phone tested.

Without doubt, the large battery is the unique selling point for this phone which, according to the manufacturer, gives users up to 40 hours of talk time, 46 days of stand-by-time and 26 hours of wifi use.

During the test, CartONG staff found that they never had to recharge the Zenfone more than once every three days. The Zenfone can even be used to charge other devices, though this might require an adapter depending on the USB connector of the other device. The downside of the big battery, as remarked by other testers, is that the phone takes comparatively long to charge, particularly when charging via a computer. For this reason, charging the phone through wall plugs is recommended.

On the negative side, some reports indicate that the quality of the camera is not as good as one might expect from a phone that has been released in 2017. CartONG found that the Zenphone’s camera sometimes has problems recognizing 2D barcodes when the barcode is small or the contrast is not very high. QR codes were read without any problems.



Asus Zenfone Max4 Photo: Asus

Potential buyers should also be aware that Asus phones ship with a customized version of Android that looks and feels very different from what many users know. This can potentially make on-site troubleshooting and support more challenging, unless all phones for the MDC project come from Asus.

Unfortunately, the Zenphone does not have IP67/68 water and dust protection. This means that while the phone lends itself to be used in remote field locations because of the battery life, these field locations should not be too rough, extremely dusty or wet.

3.2. Crosscall Trekker M1 Core

The ultra-rugged Crosscall Trekker M1 Core is not only the heaviest phone (220 g), but also the phone with the smallest screen (4.5 inch) and with lowest resolution camera (8 MP). Despite this, CartONG’s staff found that the Crosscall Trekker M1 was very pleasant and comfortable to use in the field.

The phone is IP67-rated for dust and water protection and is also clearly built to survive a fall. While, unlike the Samsung Galaxy Xcover 4, the phone makes no promises as to how many drops it can take, the device feels extremely solid and the Gorilla Glass 3 helps it resist scratches. If you are worried about the phone dropping to the ground or rattling around in the back of a truck, then this might be the phone for you.

At the same time, while the phone is perfectly capable of performing as needed for MDC, the unimpressive hardware and software of the Crosscall Trekker M1 may not be ideal if the phone is supposed to be used for purposes other than MDC.

On the positive side, the CartONG reviewer commented that the GPS is able to gather coordinates very quickly and that the battery last long. Even though the phone has only 3,000 mAh of battery capacity, the phone can handle up to 20 hours of phone calls or 10 hours of GPS use according to the manufacturer. This can partly be explained with the small screen which consumes less power.



*Crosscall Trekker M1 Core
Photo: Crosscall*

3.3. Hisense Rock C30

The Hisense C30 Rock is being marketed towards consumers with an active lifestyle who expect to occasionally throw, submerge or drop their phone.

In addition to the IP68 rating and the general robustness of the phone, ([see here for more details](#)) the Hisense Rock C30's camera resolution and screen resolution are among the highest of the tested devices, while battery capacity is among the lowest, enabling less than 8 hours of GPS use or 12 hours of phone calls.

Similarly to Asus, Hisense has customized the Android interface which can be unexpected for people who are used to more common Android installations. As mentioned above, this can be problematic when trying to troubleshoot problems in the field or when looking for support.

CartONG staff was pleased with both the quality of the camera, the quality and brightness of the screen and the speed at which GPS coordinates could be logged. The phone also passed CartONG's tests of barcodes and QR codes without problems.

At 152 x 74.96 x 7.95 mm, the Rock C30 is the second-largest phone that was tested for this report which can make it awkward to use with one hand. CartONG's reviewer described typing text on the Hisense Rock C30 as uncomfortable with a high rate of errors, making this phone possibly not ideal for surveys that include a lot of free text fields.



The Hisense Rock C30. Photo: Hisense

3.4. Samsung A5

The Samsung A5 has received very positive feedback, both from CartONG staff and from external reviewers. It is a phone that almost feels like a top-of-the-line flagship product, but at a mid-range price. At 325 EUR the A5 is the most expensive phone tested for this report, but prospective buyers will find a lot to like: the phone comes with a 16 megapixel camera,⁷ a 5.2 inch screen and IP68 water and dust protection. Unlike many other devices, the A5 has a metal frame and Gorilla Glass 4, which makes it more forgiving when dropped, though it can of course not compete with rugged phones when it comes to falls.

⁷ Camera resolutions always refer to the rear-facing camera unless otherwise noted.

Barcodes and QR codes could be scanned reasonably well, GPS coordinates can be logged quickly, the device is fast and the navigation intuitive. Reviewers also commented positively on the battery life. While using the phone in Bangladesh and Mali, the battery held up for multiple days of light use and would probably last a full day of heavy use. This observations is also backed up by external reviewers. According to the manufacturer, the battery supports between 13 and 18 hours of internet use and 16 hours of talking.

Just like all other Samsung phones tested, the A5 cannot be used as a hotspot without a SIM card.

All things considered, the A5 is the most positively reviewed phone in this report. If ruggedness is not a must and if budget is not a huge factor, MDC projects should seriously consider the device.



Samsung A5. Photo: CartONG

3.5. Samsung Galaxy J7 2016

The oldest phone in this report, the Samsung Galaxy J7 2016 was released in March 2016 but is still readily available via major online retailers. Interestingly, the 2016 model features a slightly larger battery (3,300 mAh) than the J7 2017 model (3,000 mAh, not tested). During field usage in Cameroon and Bangladesh, UNHCR commented extremely positively on the battery life and usability of the phone.

The Galaxy J7 shares two characteristics with the Asus Zenphone: at 5.5 inches, both have the largest screens of all tested devices, however the J7 is slightly smaller and slightly lighter than the Zenphone. Both phones also have in common that they do not have IP67/68 water and dust protection. The phone has only 16 GB of internal memory (11 of which are available to the user), but this can be increased to 256 GB with an extra SD card.

At the time of writing, the J7 2016 was the cheapest phone being reviewed, at just under 200 Euros.

Buyers should be aware that the phone is sold with different screen resolutions, depending on the country of purchase. While CartONG tested a model with 720 x 1080 pixels, models with 1080 x 1920 pixels are available as well. While some external reviewers were critical of the comparatively low-resolution screen, CartONG’s reviewer found it to be a good fit for MDC.



The Samsung Galaxy J7 2016 Photo: Samsung

The J7 2016 passed all of CartONG’s MDC tests, including scanning barcodes and QR codes.

Acquiring a GPS signal took slightly longer compared to other phones when coming from an area with no GPS reception, such as from inside a building.

Just like the all other Samsung phones tested for this report, the J7 2016 cannot be used as a hotspot without a SIM card.

💡 The Samsung Galaxy J7 2017 was not reviewed at the time of writing, but was being tested in the field with promising results (although it is notably more expensive than the J7 2016).

3.6. Samsung Galaxy Xcover 4 SM-G390F

The Samsung Galaxy Xcover 4 is specifically designed for outdoor use, which makes it an interesting candidate for MDC projects. The outside is rugged and helps users keep a solid grip in rain or heat.

In addition to the IP68 standard that protects phones against dust and fresh water, Samsung claims to meet the criteria for the US military standard MIL-STD-810, which specifies that devices also have to work in extreme heat, cold and after multiple drops.

Based on the specs, the Samsung Galaxy Xcover 4 may be the sturdiest of the phones tested for this report, but the manufacturer’s claims should be taken with a grain of salt since no independent authority has to confirm adherence to MIL-STD-810 for civilian devices. In other words: Samsung performed these tests themselves and reviewers found that the sturdiness fell short of their expectations when the phone was repeatedly dropped. CartONG’s own reviewer also stated that the phone felt like it was built with cheap plastic and not very robust. At the same time, based on the specifications, the Galaxy Xcover 4 may be the phone that can best deal with the high temperatures that UNHCR staff frequently have to work in. However, CartONG has not independently tested phones’ temperature tolerances for this report.



The Samsung Galaxy Xcover 4

The battery lasts for around 11 hours, which places the phone in the middle of the tested devices. Unfortunately, charging the phone completely took more than two hours in one test, which is not ideal.

Just like all other tested Samsung phones, the Xcover 4 cannot be used as a hotspot without a SIM card.

In the CartONG test, the phone had no problems reading QR codes or barcodes. The GPS on the other hand showed some slight inaccuracies (~ 10 metres) on an overcast day.

All in all, CartONG’s reviewer found the Galaxy Xcover 4 to be a phone that is responsive, pleasant to use and that surprises neither positively nor negatively.

3.7. Sony Xperia X Dual F5122

The Sony Xperia X Dual F5122 is slightly newer than the Samsung Galaxy J7 2016. Released in May 2016, the Xperia X Dual ships with Android 6.0 and has the smallest battery (2,620 mAh) in the test, which nevertheless translates into roughly 19 hours of talk time and 9.5 hours of internet use. This can be extended significantly with the help of Sony’s “Stamina Mode”.

The Xperia X Dual has one of the smallest screens in the test (5 inches) and is both the lightest (152 g) and smallest (143.7 x 69 x 7.7 mm) phone, which can be a distinct advantage for people with smaller hands. The small screen also helps the battery last longer than one might expect.

The phone ships with 64 GB of internal memory, which is twice as much as in the closest other models. The reason for this generosity is likely the impressive 23 megapixel camera, which needs space to store photos. The camera is the main selling point for this phone and exceeds the needs of MDC teams. On the other hand, a number of users have reported that using the camera to record videos can lead to heat problems that force the camera to shut down. However, since video recording is not a common requirement in MDC, this will likely not be an issue.



Sony Xperia X Dual F5122

CartONG staff remarked positively that the display is very good, making it the best phone to use in bright daylight.

4. Android tablets

4.1. Acer Iconia Tab 10 A3-A40

The biggest difference between the Acer Iconia Tab 10 A3-A40 and the two Samsung Tablets is that the Acer has no SIM card slot and thus has to rely on a wifi network to connect to the internet. The second noteworthy thing about the Acer Iconia is the price: at the time of writing the 10.1 inch tablet could be bought for less than 200 Euros. But is it a good deal?

The Acer Iconia Tab 10 A3-A40 felt solid to CartONG’s reviewer. Barcode and QR code reading worked well after installing an app in good lighting conditions, but without a flash it is questionable whether the tablet would hold up as an acceptable code scanner under field conditions.

CartONG’s test with ODK collect went without any issues.



Acer Iconia Tab 10 A3-A40 Photo: CartONG

One of the weakest points of the Iconia is the screen. Multiple external reviewers commented that it difficult to use in bright daylight. One of the reasons for this is, that Acer did not include a sensor in the tablet to auto-adjust the brightness. Instead, the brightness has to be adjusted manually, and even then the results are not great. Accordingly, the Iconia got the lowest rating of all devices for use in bright daylight.

Acer says that the battery should support about eight hours of use between charges, but at least one external reviewer found this very optimistic and estimated that 4-5 hours is more realistic.

All in all, the Acer Iconia Tab 10 A3-A40 shows its low price. The most appropriate use cases for the tablet would be in office settings with wifi and electricity, for example in an UNHCR office. For mobile teams who are travelling in the field it is probably not a good choice.

4.2. Samsung Galaxy Tab Active LTE

The Samsung Galaxy Tab Active LTE was first released in the US in 2014, which can make it difficult to buy new, but it might still be a good choice for MDC projects due to its sturdiness and small size. Unlike the other two tablets tested for this report, the rugged Tab Active is likely to survive a drop and can withstand dust and water (IP67).

Despite the ruggedness, the Tab Active is comparatively lightweight at only 393 g, which is primarily due to the small screen: the Tab Active has an 8 inch screen, whereas the two other tablets tested in this report have 10.1 inch screens.

The Tab Active comes in a hard rubber case which also helps users maintain a good grip on the device. The case also includes a slot for the Samsung C-Pen stylus. The stylus is particularly useful in cold climates, where users might be uncomfortable without gloves, for example in Afghanistan or the Ukraine in winter.

An external reviewer found that the battery lasted about 14 hours in real-life tests and seven hours when put through an industry benchmarking test. These values are likely to be lower for models that are bought second-hand, unless the battery is being replaced.

When it comes to performance, the Tab Active LTE cannot compete with the newer models. Particularly the camera, with only 3.1 megapixels, falls short of the other models. Nevertheless, CartONG’s test showed that it was capable of reading both QR and barcodes – if slowly.

Just like with the Samsung phones, neither Samsung tablet can be used as a hotspot without a SIM card.

A new version of this model, the Samsung Galaxy Tab Active 2, was released in October 2017 but could not be included in this report before the deadline.



Samsung Galaxy Tab Active LTE Photo: CartONG

4.3. Samsung Galaxy Tab A 2016 10.1

The Samsung Galaxy Tab A 2016 10.1 is in many ways the opposite of the Tab Active that was reviewed above. The Tab A 2016 has a big 10.1 inch screen, a powerful processor, an 8MP camera and a pleasant look and feel. Barcodes and QR codes could be read without problems once a scanner app had been installed. When tested in an urban area, it took about 10 seconds for the GPS to acquire an accurate position.



Samsung Galaxy Tab A 2016 10.1 Photo: CartONG

Unfortunately, the Tab A is also nowhere near as robust as the Tab Active: during the CartONG test, the screen stopped working completely after the reviewer tabbed the screen a little harshly after the tablet had frozen. The Tab A was also the only tablet where a reviewer experienced crashes with ODK Collect.

As mentioned before, neither Samsung tablet can be used as a hotspot without a SIM card.

Both CartONG's own and external reviewers were positively impressed with the battery life of the Tab A. With 7,300 mAh the device has the largest battery in the test and can handle more than 14 hours of continuous internet use. While this is not more than the Tab Active, the Tab A has a much larger screen, which requires more power.

The Tab A 10.1 is being sold in two variants: The original has 2GB of RAM and does not come with a stylus pen. This model was tested by CartONG. However, Samsung is now also selling a slightly more expensive version with 3 GB of RAM that comes with an S-Pen and a pressure-sensitive screen required to use the pen.

5. External sources

CartONG staff personally tested all devices mentioned in this report. In addition, the following online resources were used to complete the picture gained by CartONG:

- Gadgets 360°: <https://gadgets.ndtv.com>
- Gizmodo: <https://www.gizmodo.com.au>
- GSMArena: <https://www.gsmarena.com>
- Mobile Syrup: <https://mobilesyrup.com/>
- NAG Online: <http://www.nag.co.za/>
- Notebook Check: <https://www.notebookcheck.net>
- PhoneArena: <https://www.phonearena.com>
- Techradar: <http://www.techradar.com>

6. Key criteria

The following table lists of the key criteria that CartONG has looked at this year, as well as other aspects that are particularly important for MDC. A complete overview of technical specifications can be found in the Annex.

Phones:	Asus Zenfone Max4	Crosscall Trekker-M1 Core	HiSense Rock C30	Samsung Galaxy A5
Price	249 EUR	279 EUR	269.51 EUR	325 EUR
Pros	<ul style="list-style-type: none"> ● Battery life ● Can charge other devices ● Good screen ● Fairly easy to show phone screen on computer 	<ul style="list-style-type: none"> ● Very robust (rugged) ● Battery life 	<ul style="list-style-type: none"> ● Good screen ● Good camera ● Robust 	<ul style="list-style-type: none"> ● Good screen ● Good camera ● Battery life ● Easy to connect and transfer files to a PC.
Cons	<ul style="list-style-type: none"> ● Occasionally freezes during start-up ● Not very robust ● Interface not very intuitive 	<ul style="list-style-type: none"> ● Screwdriver needed to access SD card and SIM 	<ul style="list-style-type: none"> ● Phone freezes occasionally ● Typing is not very nice ● Interface not very intuitive ● SIM-card difficult to remove without a special tool 	<ul style="list-style-type: none"> ● Very occasionally crashes ● Typing is not very nice
Screen size	5.5 inch	4.5 inch	5.2 inch	5.2 inch
Comments on brightness of screen in daylight ⁸	Fairly good	Fairly good	Fairly good	Fairly good
IP67 or IP68 dust and water protection	No	IP67	IP68	IP68
QR and barcode scanning	Sometimes had problems focusing on barcodes. QR codes worked well.	Yes	Yes	Both barcodes and QR codes worked fine. Occasionally the phone had trouble focusing.
GPS working without network connection?	Yes	Yes	Yes	Yes
Comments on GPS precision/responsiveness	Results at HQ were very good; not tested in the field.	Fast, no problem for Google Maps or OSMand	Fast	Fast, both at the HQ and in the field.
Hotspot without SIM card	Yes	Yes	Yes	No
Connectivity to computer	Installs well through plug and play; all common folder were accessible.	Installs well through plug and play; all common folder were accessible.	Installs well through plug and play; all common folder were accessible. However some photos could not be found.	Installs well through plug and play; all common folder were accessible.

⁸ Good: Screen can be read outdoors in full sun without adjusting the brightness; Fairly good: Screen can be read outdoors in full sun after adjusting the brightness; Limited: Even after adjusting brightness, it is hard to read the screen outdoors in full sun

Phones:	Samsung Galaxy J7 2016	Samsung Galaxy Xcover 4 SM-G390F	Sony Xperia X Dual F5122
Price	198.99 EUR	259 EUR	225 EUR
Pros	<ul style="list-style-type: none"> • Price • Good screen • Easy to connect and transfer files to a PC 	<ul style="list-style-type: none"> • Robust (rugged) • Rated to withstand extreme temperatures 	<ul style="list-style-type: none"> • Good screen • Good camera • 64 GB of memory
Cons	<ul style="list-style-type: none"> • Not very robust 		<ul style="list-style-type: none"> • Felt uncomfortably big to reviewer with small hands. • Taking screenshots is not intuitive
Screen size	5.5 inch	5 inch	5 inch
Comments on brightness of screen in daylight ⁸	Fairly good	Fairly good	Good
IP67 or IP68 dust and water protection	No	IP68	IP68
QR and barcode scanning	Yes	Yes	Yes
GPS working without network connection?	Yes	Yes	Yes
Comments on GPS precision/responsiveness	Can take a bit long to acquire coordinates, for example when leaving a building.	Accurate to approximately 10 meters when overcast.	Achieves 5 meters accuracy fast.
Hotspot without SIM card	No	No	Yes
Connectivity to computer	Installs well through plug and play; all common folder were accessible.	Installs well through plug and play.	Installs well through plug and play; all common folder were accessible.

Tablets:	Acer Iconia Tab 10 A3-A40	Samsung Galaxy Tab Active LTE	Samsung Galaxy Tab A 2016 10.1"
Price	199 EUR	390 EUR	330 EUR
Pros	<ul style="list-style-type: none"> • Price 	<ul style="list-style-type: none"> • Very robust; ruggedized case • Pen is very useful for signatures 	<ul style="list-style-type: none"> • Battery life
Cons	<ul style="list-style-type: none"> • Screen brightness • Battery life 	<ul style="list-style-type: none"> • Can be a bit slow 	<ul style="list-style-type: none"> • Not very robust • Needs an extra app to record sound • Cannot record lines or polygons with Kobo, but works with ODK collect.
Screen size	10.1 inch	8.0 inch	10.1 inch

Tablets:	Acer Iconia Tab 10 A3-A40	Samsung Galaxy Tab Active LTE	Samsung Galaxy Tab A 2016 10.1"
Comments on brightness of screen in daylight ⁸	Limited	Fairly good. Screen brightness is adjusted automatically. However, the glass is very reflective, which can be challenging in direct sunlight.	Fairly good. Screen brightness is adjusted automatically. However, the glass is very reflective, which can be challenging in direct sunlight.
IP67 or IP68 dust and water protection	No	IP67	No
QR and barcode scanning	Yes	Yes. Barcodes took slightly longer to read than QR codes.	Yes
GPS working without network connection?	Yes	Yes	Yes
Comments on GPS precision/responsiveness	No comments.	Good in town.	10 seconds to get good precision in town.
Hotspot without SIM card	No	No	No
Connectivity to computer	Installs well through plug and play.	Installs well through plug and play. Access to all files and folders.	Installs well through plug and play; all common folder were accessible.
ODK Collect test	Worked well.	Worked well in general. Coded form for benchmarking required extra installation of RecForge II app recommended by Kobo Team as else sound recording was not possible.	Worked well in general. Crashed sometimes when trying to skip part of questionnaire from the summary. Needed to install an extra app to record sound.

Annex I: Technical Features

Common Characteristics

To avoid superfluous repetitions, we have excluded some data where devices do not differ. These are:

- All phones and all tablets have capacitive, multi-touch touchscreens
- All displays can show 16 million colours
- All phones support the GSM frequencies 850, 900, 1800 and 1900 MHz, which means that they are compatible with mobile phone networks worldwide.
- All phones and all tablets have a 3.5 mm headphone jack

In addition, rows have been highlighted that show information that has been captured for the first time in 2017 or that is a focus area in 2017.

Android Phones

	Asus Zenfone Max4	Crosscall Trekker-M1 Core	HiSense Rock C30	Samsung Galaxy A5
Overview				
Size	154 x 76.9 x 8.9 mm	147 x 77 x 14.8 mm	153 x 74.86 x 7.95 mm	146.1 X 71.4 X 7.9 mm
Weight	181 g	220 g	153 g	159 g
SIMs (number and type)	2 Nano SIMs	2 Micro SIMs	2 Nano SIMs	1 Nano SIM
Autonomy	Up to 40 h of talk (3G) and 26 h of wifi use.	Up to 20 h of talk (3G) and 19 h of GPS use.	Up to 12 h of talk (3G) and 8 h of GPS use.	Up to 16 h of talk (3G) and 13-18 h of internet use.
Battery capacity (mAh)	5,000	3,000	3,000	3,000
IP67 or IP68 dust and water protection (new in 2017)	No	IP67	IP68	IP68
Operating System (OS)	Android 7.1.1 Nougat	Android 6.0.1	Android 7.0 Nougat	Android 6.0.1
Processor	Octa-core, 1400 MHz, ARM Cortex-A53, 64-bit, 28 nm	Qualcomm Snapdragon 210 Quad-Core 1.1 GHz	ARM Cortex-A53 - 1.4 GHz	Samsung Exynos 7880
Release date	September 2017	December 2016	February 2017	February 2017
Price (at time of purchase)	249 EUR	279 EUR	269.51 EUR	325 EUR
Screen				
Screen (diagonal, inches)	5.5	4.5	5.2	5.2
Resolution (pixels)	1080 x 1920	1280 x 720	1920 x 1080	1920 x 1080
Comments on brightness of screen in daylight (new in 2017) ⁸	Fairly good	Fairly good	Fairly good	Fairly good.
Networks				
GPRS	Class 10: GPRS (4+2)	Class 10: GPRS (4+2)	Class 10: GPRS (4+2)	Class 10: GPRS (4+2)
EDGE, UMTS (3G) and 4G	Yes	Yes	Yes	Yes
Wi-Fi / UMA / UPnP	802.11 b/g/n, Wi-Fi Direct, hotspot	802.11 b/g/n	802.11 a/b/g/n/ac	802.11 a/b/g/n/ac
GPS	GPS, A-GPS, Glonass, BeiDou	A-GPS, Glonass	GPS, A-GPS, Glonass	A-GPS, Glonass
GPS working without network connection?	Yes	Yes	Yes	Yes

	Asus Zenfone Max4	Crosscall Trekker-M1 Core	HiSense Rock C30	Samsung Galaxy A5
(new in 2017)				
Comments on GPS precision/responsiveness (new in 2017)	Results at HQ were very good; not tested in the field.	Fast, no problem for Google Maps or OSMap	Fast	Fast, both at the HQ and in the field.
AV				
Camera	13 MP, autofocus, double LED flash	8 MP, LED flash, autofocus	16 MP, autofocus, flash	16 MP, autofocus, LED Flash
Video	1920 x 1080 px @ 30 fps	1280 x 720 px @ 30fps	1920 x 1080 px @ 30fps	1920 x 1080 px @ 30fps
Memory				
Internal memory	32 GB	16 GB	32 GB	32 GB
RAM	4 GB	2 GB	3 GB	3 GB
Memory card	MicroSD, MicroSDHC, MicroSDXC up to 256 GB	MicroSD up to 128 GB	MicroSD up to 128 GB	MicroSD, MicroSDHC, MicroSDXC up to 256 GB
Office				
Messaging	SMS, EMS, MMS, e-mail (push)	SMS, EMS, MMS, e-mail (push)	SMS, EMS, MMS, e-mail (push)	SMS, EMS, MMS, e-mail (push)
Visualizing docs	Yes (Excel, Word...)	Yes (Excel, Word...)	Yes (Excel, Word...)	Yes (Excel, Word...)
Connectivity				
Bluetooth	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.2	Bluetooth 4.2
Data connectivity	USB 2.0, microUSB, adaptor included	USB 2.0, microUSB	USB 2.0, microUSB	USB 2.0, microUSB

	Samsung Galaxy J7 2016	Samsung Galaxy Xcover 4 SM-G390F	Sony Xperia X Dual F5122
Overview			
Size	151.7 x 76.0 x 7.8 mm	146.2 x 73.3 x 9.7 mm	143.7 x 69 x 7.7 mm
Weight	169 g	172 g	152 g
SIMs (number and type)	2 Micro SIMs	1 Micro SIM	2 Nano SIMs or 1 Nano SIM and 1 SD card
Autonomy	Up to 11 h of talk (3G), up to 15 hours using wifi.	Up to 11 h of talk (3G) or internet use.	Up to 19 h of talk (3G), 9.5 h of internet use.
Battery capacity (mAh)	3,300	2,800	2,620
IP67 or IP68 dust and water protection (new in 2017)	No	IP68	IP68
Operating System (OS)	Android 7.0 Nougat	Android 7.0 Nougat	Android 6.0 Marshmallow
Processor	Octa-Core 1.6GHz	Exynos 7570 Quad-Core 1.4 GHz	Snapdragon 650 Hexa Core
Release date	March 2016	March 2017	May 2016
Price (at time of purchase)	198.99 EUR	259 EUR	225 EUR
Screen			
Screen (diagonal, inches)	5.5	5	5
Resolution (pixels)	1280 x 720	1280 x 720	1920 x 1080
Comments on brightness of screen in daylight (new 2017 attribute)⁸	Fairly good	Fairly good	Good
Networks			
GPRS	Class 10: GPRS (4+2)	Class 10: GPRS (4+2)	Yes (Class not specified)
EDGE, UMTS (3G) and 4G	Yes	Yes	Yes
Wi-Fi / UMA / UPnP	802.11 b/g/n	802.11 a/b/g/n 2.4Ghz + 5Ghz	802.11 a/b/g/n/ac
GPS	A-GPS, GeoTagging, Glonass, BeiDou	A-GPS, Glonass	A-GPS, GeoTagging, Glonass
GPS working without network connection? (new 2017 attribute)	Yes	Yes	Yes

	Samsung Galaxy J7 2016	Samsung Galaxy Xcover 4 SM-G390F	Sony Xperia X Dual F5122
Comments on GPS precision/responsiveness (new 2017 attribute)	Can take a bit long to acquire coordinates, for example when leaving a building.	Accurate to approximately 10 meters when overcast.	Achieves 5 meters accuracy fast.
AV			
Camera	13 MP, autofocus, flash	13 MP, autofocus, flash	23 MP, flash, autofocus
Video	1920 x 1080 pixels 30 fps	1920 x 1080 pixels 30 fps	1920 x 1080 pixels 30 fps
Memory			
Internal memory	16 GB (11 GB available)	16 GB	64 GB
RAM	2 GB	2 GB	3 GB
Memory card	Micro SD up to 256 GB	Micro SD up to 32 GB	MicroSD up to 2TB
Office			
Messaging	SMS, MMS, e-mail (push)	SMS, EMS, MMS, e-mail (push)	SMS, MMS, e-mail (push)
Visualizing docs	Yes (Excel, Word...)	Yes (Excel, Word...)	Not for MS Office; works for Google Drive documents
Connectivity			
Bluetooth	Bluetooth 4.1 with A2DP	Bluetooth 4.2	Bluetooth 4.2
Data connectivity	USB 2.0, microUSB	USB 2.0, microUSB	USB 2.0, microUSB

Android Tablets

	Acer Iconia Tab 10 A3-A40	Samsung Galaxy Tab Active LTE	Samsung Galaxy Tab A 2016 10.1"
Overview			
Size	167.5 x 259 x 8.9 mm	213.1 x 126.2 x 9.7 mm	254.2 x 155.3 x 8.2 mm
Weight	529 g	393 g	525 g
SIMs (number and type)	No SIM	1 MicroSIM	1 Nano SIM
Autonomy	Approx. 6.5 - 8 h	Approx. 10 - 12 h	Approx. 13 h
Battery capacity (mAh)	6,100	4,450	7,300
IP67 or IP68 dust and water protection (new in 2017)	No	IP67	No
Operating System (OS)	Android 6.0	Android 5.1.1	Android 6.0
Processor	Cortex-A53 1.5 GHz	Qualcomm Snapdragon 400	Exynos 7870 Octa
Release date	April 2016	US: Dec 2014	May 2016
Price (at time of purchase)	199 EUR	390 EUR	330 EUR
Screen			
Screen (diagonal, inches)	10.1	8.0	10.1
Resolution (pixels)	1920 x 1200	1280 x 800	1920 x 1200
Comments on brightness of screen in daylight (new 2017 attribute) ⁸	Limited	Fairly good. Screen brightness is adjusted automatically. However, the glass is very reflective, which can be challenging in direct sunlight.	Fairly good. Screen brightness is adjusted automatically. However, the glass is very reflective which can be challenging in direct sunlight.
Networks			
GPRS	No	Yes	Yes
EDGE, UMTS (3G) and 4G	No	Yes	Yes
Wi-Fi / UMA / UPnP	802.11a/b/g/n	Yes: Wi-Fi 802.11 a/b/g/n, dual-band, Wi-Fi Direct, hotspot	Wi-Fi 802.11 a/b/g/n/ac, dual-band, WiFi Direct, hotspot

	Acer Iconia Tab 10 A3-A40	Samsung Galaxy Tab Active LTE	Samsung Galaxy Tab A 2016 10.1"
GPS	Yes	Yes, with A-GPS, GLONASS	Yes, with A-GPS, GLONASS, Beidou
GPS working without network connection? (new 2017 attribute)	Yes	Yes	Yes
Comments on GPS precision/responsiveness (new 2017 attribute)	No comments.	Good in town.	10 seconds to get good precision in town.
AV			
Camera	5 MP, autofocus, flash	3.1 MP, autofocus, flash	8 MP, autofocus, flash
Video	1080p @ 30 fps	720p @ 30fps	1080p @ 30fps
Memory			
Internal memory	32 GB	16 GB	16 GB
RAM	2 GB	1.5 GB	2 GB
Memory card	MicroSD, up to 256 GB	MicroSD, up to 256 GB	MicroSDHC, up to 200 GB
Office			
Messaging	E-mail (push)	SMS, e-mail (push)	SMS, e-mail (push)
Visualizing docs	Yes (Excel, Word...);	Yes, document editor	Yes (Excel, Word...); nothing pre-installed for PDF
Connectivity			
Bluetooth	Bluetooth 4.0	Bluetooth 4.0, A2DP, LE	Bluetooth 4.2, A2DP, LE
Data connectivity	USB 2.0, microUSB	USB 2.0, microUSB	USB 2.0, microUSB

Annex II: Anecdotal feedback

In addition to the tablets and phones that were thoroughly tested for this report, CartONG also collect anecdotal feedback from partner organizations that can be found below. CartONG has not tested these phones and cannot speak to their suitability for MDC.

Model	Type	Screen size	Price	Context	Pros	Cons
Samsung Galaxy V Duos	Smartphone	4 inches	~ 65 EUR (not available in Europe)	MDC in Bangladesh	Price; GPS is fast and works offline. Easy to get local support.	None mentioned.
Samsung Galaxy J2 ACE	Smartphone	5 inches	~ 110 EUR (not available in Europe)	Capture photos and videos in Bangladesh for monitoring and reporting.	Good camera	None mentioned.
Samsung SM-T113	Tablet	7 inches	130 Euro	Erbil / Iraq	Overall satisfied. Performance and battery life are good	Battery takes too long to charge.
TP Link Neffos TP801A	Smartphone	4.5 inch	60 EUR	MDC in Greece	Price	None mentioned.