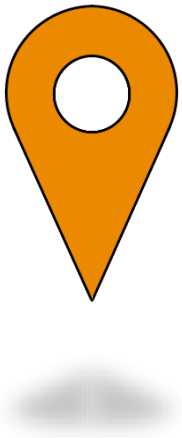


THE101

www.cellebrite.com/the-101

✉ stumpus@cellebrite.com
✉ locations@cellebrite.com

Was it **actually** there?

LOCATIONS CHEAT SHEET

Updated March 2025

This cheat sheet contains a list of common sources for location data found on iOS and Android devices and attempts to grade their reliability based on the purpose the data was saved.

For example, a location record made for the purpose of navigation is generally a more reliable indicator of the device location than a location record made for the purpose of finding out the local weather.

An brief explanation of the data source has been included for informational purposes, although a deeper explanation may be available from the 101 website.

Note that since the grading is based on the purpose of the record, it is still possible that erroneous location data may be recorded.

Scale

Records in this cheat sheet are graded on a scale based on multiple factors. In general, the grading can be understood as explained below:

Most Reliable
Records with good accuracy and a related timestamp.

Reasonable
Records with good accuracy but unrelated timestamps.

OK
Records of a location that was never visited.

Poor
Records of a location that holds some relevance to the device, but is unrelated to locations visited.

Terrible
Records that are unrelated to the specific device.

Categories

Records are also separated into color coded categories as shown below:

Routine	**Media**	**FindMy**	**MapData**
Snapchat	**Weather**	**Geofences**	**WiFi**
Payments	**Other**		

www.cellebrite.com/the-101

iOS

Most Reliable

Routine

/private/var/mobile/Library/Caches/com.apple.routined/**Cache.sqlite**

ZRTCLLOCATIONMO Cached locations whenever the device seeks to find its location.
ZRTVISITMO Aggregates the ZRTCLLOCATIONMO locations every day or two and looks for patterns of locations that were visited for a period of time rather than just passed through.

/private/var/mobile/Library/Caches/com.apple.routined/**Local.sqlite**
/private/var/mobile/Library/Caches/com.apple.routined/**Cloud-V2.sqlite**

Local and Cloud version of the same file but may contain different records.
ZRTLEARNEDLOCATIONOFINTERESTMO locations that have been visited numerous times become "Learned Locations Of Interest".
ZRTLEARNEDLOCATIONOFINTERESTVISITMO Tracks the approximate entry and exit time of the Learned Location.
ZRTLEARNEDLOCATIONOFINTERESTTRANSITIONMO records information about how the device travelled to a Learned Location.
ZRTMAPITEMMO records named locations where the device has been.
ZRTVEHICLEEVENTMO & **ZRTVEHICLEEVENTHISTORYMO** records the location of the device at the time of a vehicle disconnection event. (Note that it's not written to the database until the device has moved away from that location)
Note that for any records related to a "learned location", the CreationDate is not when the device was at the location, but a day or so afterwards when the aggregation function was run. Expiration Date is a future date used for purging which is bumped further every time the device revisits a previously learned location.

/private/var/mobile/Library/Caches/com.apple.routined/**Cloud.sqlite**

ZRTMAPITEMMO records named locations where the device has been. Note that the CreationDate is not when the device was there, but a day or so afterwards.

/private/var/mobile/Library/Caches/com.apple.routined/**CoreRoutine.sqlite**

ZRTCLLOCATIONMO Cached locations whenever the device seeks to find its location.

/private/var/mobile/Library/DuetExpertCenter/streams/predictionContext/local/*****
/private/var/mobile/Library/DuetExpertCenter/streams/location/local/*****

SEGB file which contains multiple plists. Each plist contains location data similar to that found in cache.sqlite [ZRTCLLOCATIONMO]

/private/var/mobile/Library/Caches/com.apple.routined/**cache_encryptedB.db**

Not to be confused with the database of the same name in a different path. This cache_encryptedB.db is from older version of iOS and contains reliable data in the **Location** table comparable to the [ZRTCLLOCATIONMO] from the Cache.sqlite database above.

/private/var/mobile/Library/Caches/com.apple.routined/**StateModel.archive**

Found in iOS versions pre iOS10, this plist stores data about Frequent Locations and has proved to be reliable.

Aggregated Locations

Location Aggregation is a feature of Physical Analyzer designed to improve application performance and make things simpler for the examiner.

With this feature enabled in settings, PA will group together location records which are close in both time and proximity.

As an example, a device may record 1000+ records overnight while at the device owners home address.

Without aggregation, this will result in 1000 records within the table and 1000 markers on the map.

With aggregation, this will result in a single record in the table and a single marker on the map. However, this marker will have a start time equal to the first record in the set and an end time equal to the last record in the set. It will also show a "Aggregated Locations" count of 1000.

While this feature may improve performance and readability, it may also reduce the impact that seeing 1000 individual records may have - especially if the location is important to the investigation.

Harvested Locations

Harvested Locations were mentioned a couple of times within this cheat sheet.

They are WiFi & Cell Tower records downloaded to the device from the service provider such as Apple.

When the user visits a new place, the device may download information about that location, such as the local WiFi networks which it can then use to help identify it's location.

This may result in thousands of records at the same time that cover a fairly large geographic area.

However, the main with this data is that it will be redownloaded again in the future, again resulting in thousands of records. These repeat downloads do not require the device to be anywhere near the location of the data being downloaded.

As such, some of these records may appear relevant, while others are not. This ambiguity about the timestamp and actual location is why harvested locations are ranked low on reliability.

The different accuracy values can be the result of how the location was requested (i.e. Low Accuracy is good enough for a weather application, but High Accuracy is needed for a navigation application), the result of limitations (i.e. a device in a basement is unlikely to get GPS signal) or the result of restrictions the user placed on their location data (disabling 'Precise' Location data).

Sometimes, a request for Low Accuracy data may return a recent High Accuracy value. Conversely, sometimes a request for High Accuracy data may return multiple Low Accuracy results as the device tries to get a higher accuracy result.

While the accuracy data provided is usually reliable, it can be over confident and the device may not always be within the radius it provides.

Carved Locations

Location Carving is a unique feature of Physical Analyzer that allows examiners to easily search files within the extraction for any data that **appears** to be a location.

By selecting a location of interest to start with (either by dropping a pin on the map or allowing PA to search around the most visited locations), PA will process the files within the extraction and try to read the data as though it were a latitude and longitude *regardless of how the data is intended to be read*.

If the carved latitude/longitude combination is within the specified range of the selected location of interest, the carved location will be returned.

It is important to realize that the carver is unaware and uninterested in the actual purpose of the data that it is treating as a location. This means that **false positives are expected**, and it is vitally important to verify the locations important to your analysis.

The Confidence score PA assigns to carved locations denotes the confidence that the data is meant to be read as a timestamp—it has no bearing to the reliability of the location data.

This Cheat Sheet evaluates the reliability of parsed location data based on the source file the location record originates from.

It is common to find completely incorrect location data within files typically considered reliable.

For example, the Location Carver may mistake a Altitude as a Latitude or may report a locations Expiry or Creation date instead of the date visited.

The Location Carver is a powerful research tool to surface location data that may otherwise be missed. But it should not be presumed that the data it returns is accurate.

Media

/private/var/mobile/ Media/PhotoData/**Photos.sqlite**

ZASSET may contain the location data also found within the media item's EXIF data.
ZADDITIONALASSETATTRIBUTES may also contain the HorizontalAccuracy information.
ZMASTER contains a copy of the EXIF data from the media file. ***1** ***2**

/private/var/mobile/Media/DCIM/*

Images may contain location data within the EXIF data.
May also contain the HorizontalAccuracy information. ***1**

/private/var/mobile/ Media/PhotoData/Caches/GraphService/PhotosGraph/**photosgraph.kgdb**

EdgeValue contains location and timestamp information in the **realValue** field grouped by the **elementID**. The data relates to media that exists in the photo gallery. The data is reliable but as with all media data, bear in mind that the device may not have actually taken the image/video. ***1**

FindMy

/private/var/mobile/ Library/Caches/com.apple.findmy.fmipcore/**Devices.data**
/private/var/mobile/Library/Caches/com.apple.findmy.fmipcore/**Items.data**

These files relate to the FindMyDevices information.
The location information contained includes accuracy information and is reliable. However, it is generally **NOT** the location of the device itself, but other devices (Macbook/Airpods/Airtags) or family members.
These files have been encrypted since iOS17.5.

/private/var/mobile/Library/com.apple.icloud.searchpartyd/WildModeAssociationRecord/***.record**

These files relate to the location of the device when an Apple FindMy compatible device (such as Airtag or Pebblebee Clip) is detected. These are devices that are **not** paired to the detecting device's iCloud account.

MapData

/private/var/mobile/Containers/Shared/AppGroup/**GUID**/Maps/**MapsSync_0.0.1**

ZHISTORYTIEM contains Searched Locations and Routes planned.
Generally, the data does not mean that the location was visited, but with one exception. If the user plans a route, the starting point is *USUALLY* the user's actual current location. The **ZROUTEREQUESTSTORAGE** field of **ZHISTORYITEM** is a protobuf blob that contains the start and end information of the route. If there is a value of 1 at node 1/0/3/100 then it is the device's actual location.

Note this source also exists in the Poor section

Snapchat

/private/var/mobile/Containers/Data/Application/**GUID**/Documents/gallery_encrypted_db/3/*GUID*/ **gallery.encrypteddb (.decrypted)**

These locations are the location of the device when a media item was recorded. These media items are "Memories" recorded by the device itself, not received from elsewhere.

Weather

/private/var/mobile/Library/Weather/weather-data.db

The locations found in the various tables of this database relate to both the user's actual location at the time of weather information download, and the locations being tracked in the weather application.

Note that this source also exists in the Poor section

Reasonable

Geofences

/private/var/root/Library/Caches/locationd/**consolidated.db**

GeoFences | **Fences** contains all geofences being monitored on this device.
Reasonable Geofences relate to Geofences monitoring for the device exiting its current location. This may be the device awaiting exit from a Frequent Location or it may be related to a reminder the user has set. i.e., "Do Not Disturb until I leave this location"

Note this source also exists in the Poor section

Media

/private/var/mobile/ Media/PhotoData/Caches/GraphService/**CLSPublicEventCache.sqlite**

This database contains a collection of locations relevant to media analytics. The locations are derived from media items inside the device's gallery (that may or may not have been taken with the device). There are several dates that can be found in this database, one can be ignored as the time that analytics ran. But the Start and End date relate to the time period the media items were recorded. The purpose of this database is to identify an event of interest which can be used to label the moment. i.e., a festival, concert or sporting event.

OK

Media

/private/var/mobile/Media/PhotoData/Caches/GraphService/**CLSBusinessCategoryCache.AOI.sqlite**
/private/var/mobile/Media/PhotoData/Caches/GraphService/**CLSBusinessCategoryCache.Nature.sqlite**
/private/var/mobile/Media/PhotoData/Caches/GraphService/**CLSBusinessCategoryCache.POI.sqlite**
/private/var/mobile/Media/PhotoData/Caches/GraphService/**CLSBusinessCategoryCache.ROI.sqlite**
/private/var/mobile/Media/PhotoData/Caches/GraphService/**CLSLocationCache.sqlite**

Each of these databases contains a collection of locations relevant to media analytics. The locations are derived from media items inside the device's gallery (that may or may not have been taken with the device). The timestamp is related to analytics though and it not relevant to the location. The purpose of these databases is to identify if photos were taken at a place of interest which can be used to label the moment. i.e., "Disneyland".

Other

/private/var/mobile/Library/PersonalizationPortrait/**PPSQLDatabase.db**

loc_records Contains a variety of location records related to various sources including Photos, Apple News and Maps.
Some of the locations may be related to places the device has physically visited but this would need investigating on a per record basis. ***1**

Payments

/private/var/mobile/Library/Passes/**passes23.sqlite**
/private/var/mobile/Library/DeviceRegistry/**GUID***/NanoPasses/**nanopasses.sqlite3**

Passes23.sqlite and **nanopasses.sqlite** both relate to Apple Pay (nanopasses relates to Apple Watch usage).
The locations provided are usually the location of the device at the time of the purchase.
Note that sometimes the location may be the store itself and if the purchase is made remotely (such as online) the location is not reliable.

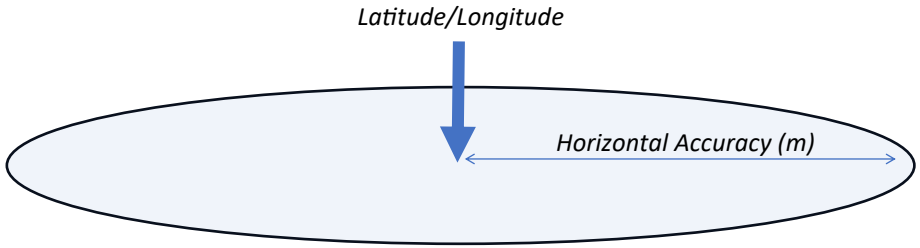
Notes		
***1**	***2**	***3**
Bear in mind that the device may not have actually taken the image/video.	Since iOS15, the user can modify the location and timestamp data.	Since Android 12, the user can modify the timestamp data and/ or add GPS data.

General Information

Horizontal Accuracy

Many location data records found on a device have Horizontal Accuracy and/or Precision information.

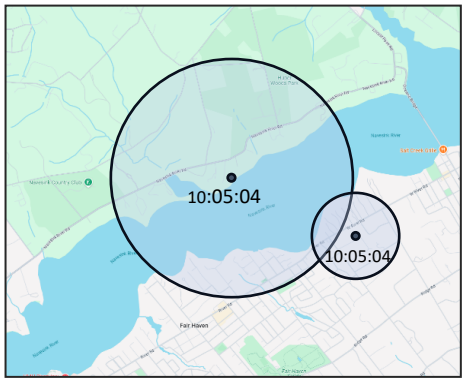
The Horizontal Accuracy is typically a radius measurement in meters that requires drawing around the given latitude/longitude.



This measurement could be as small as 2m (indicating high accuracy) or as large as 20,000m+ (indicating low accuracy).

It is important to realize that the device could be anywhere inside the circle, not necessarily at the center.

This can result in location data that appears contradictory, such as the data below, when in fact it is just the result of different accuracy information.



Poor

MapData

/data/data/com.google.android.apps.maps/databases/**gmm_storage.db**
/data/data/com.google.android.apps.maps/databases/**gmm_sync.db**
/data/data/com.google.android.apps.maps/databases/**gmm_myplaces.db**
/data/data/com.google.android.apps.maps/databases/**portable_geller_*EmailAddress*.db**
/data/data/com.google.android.apps.maps/databases/**new_recent_history_cache_search.cs**

These files typically store Recent Search History, Starred Places and Labelled locations.
None of these types of records mean the device was actually present at the location and these sources are synchronized across the users devices.

WiFi

/data/system/**wifigeofence.db**

geofence_wifi stores a list of the Last/First time that a wifi network was connected to. This source is listed in both Reasonable and Poor since newer versions of Android appear to show the same timestamp for all records and therefore while the location may be accurate, the timestamp may not be.

Poor

Geofences

/private/var/root/Library/Caches/location/**consolidated.db**

GeoFences | **Fences** contains all geofences being monitored on this device.
Poor Geofences relate to monitoring of Geofences around a particular store (as per the installed apps) or predictions about where the device may be headed.
Note this source also exists in the Reasonable section

Harvested

/private/var/root/Library/Caches/locationd/**cache_encryptedB.db**

WifiLocation Contains the BSSID and approximate location of *private* wireless networks.
CellLocation | **LteCellLocation** | **CdmaCellLocation** | **LteCellLocation** | **NrCellLocation** | **ScmdaCellLocation** all contain the Cell ID and approximate location of cells for the specified technology.
Note that the records are downloaded to the device *en masse* based on where the device has been in the past. The timestamp is relevant to the time the record was downloaded NOT necessarily when the device was at that location.

/private/var/root/Library/Caches/com.apple.wifid/**ThreeBars.sqlite**

ZACCESSPOINT | **ZNETWORK** Contains the BSSID and approximate location of *public* wireless networks.
Note that the records are downloaded to the device *en masse* based on where the device has been in the past. The timestamp is relevant to the time the record was downloaded NOT necessarily when the device was at that location.

MapData

/private/var/mobile/Containers/Shared/AppGroup/*GUID*/Maps/**MapsSync_0.0.1**

ZHISTORYTIEM contains Searched Locations and Routes planned.
Generally, the data does not mean that the location was visited, but with one exception as described in the Most Reliable section. If there is no data in the **ZROUTEREQUESTSTORAGE** field of **ZHISTORYITEM** then this record can be assumed to be a search rather than a visit.
Note this source also exists in the Most Reliable section

Weather

/private/var/mobile/Library/Weather/**weather-data.db**

The locations found in the various tables of this database relate to both the users actual location at the time of weather information download, and the locations being tracked in the weather application.
Note that this source also exists in the Most Reliable section

Terrible

MapData

/private/var/root/Library/Caches/locationd/indoor_tiles/**availability.db**

This database relates to the location of stores within malls as shown in the Apple Maps application.
Every iPhone will have the same data and therefore this source can safely be ignored.

Android

Most Reliable

Routine

/data/data/com.google.android.gms/databases/**odlh-storage.db**

The **ODLH (On Device Location History)** database stores data related to the devices visited locations in the **semantic_segment_table** table within the **semantic_segment** protobuf blob.

/data/data/com.samsung.android/rubin.app/databases/**inferenceengine_logging.db**

A log of the locations visited by the device. Includes accuracy in meters and method information (i.e.. Network or GPS etc.)

/data/data/com.google.android.gms/databases/contextDB/**context_*EmailAddress*.db**

This is a database that forms part of the Google Mobile Services. The important data can be found in an encrypted blob within the **proto_blob** column of the **content** table. Data only lasts a few days but is accurate.

/data/data/com.google.android.gms/**app_semanticlocation_rawsignal_db**

This LevelDB database stores the users location data periodically along with accuracy information.

FindMy

/data/data/com.google.android.gms/databases/**personalsafety_db**

This database records the location of the device at the time that it detected a Bluetooth tracker (ie. Airtag).

Media

/data/data/com.samsung.android.providers.media/databases/**media.db**

Files | **location** | **location_datetime_idx** may contain the location data.
*Note that since Android 12, the user can modify the location and timestamp data. ***1** ***2**

/data/data/com.google.android.providers.media.module/databases/**external.db**

Files may contain the location data.
*Note that since Android 12, the user can modify the location and timestamp data. ***1** ***2**

/data/media/0/DCIM/Camera/*

Images may contain the location data within the EXIF data. ***1**

/data/data/com.samsung.storyservice/databases/**dme.db**

Info may contain the location data of the media items. ***1**

/data/data/com.google.android.apps.photos/databases/**gphotos0.db**

Local_media *may* contain latitude and longitude information related to the media files. ***1**

Weather

/data/data/com.sec.android.daemonapp/databases/**WeatherClock**

table_weather_info records the approximate location of the user for the purposes of obtaining the weather forecast. It is reliable location data, although not very accurate.

MapData

/data/data/com.google.android.apps.maps/files/**saved_directions.data.cs**

Stores the last route planned *and started* by the device user. This does not include routes that were only previewed. The start location is the user's actual location which may be referred to as "**Your Location**" within the blob. Rerouting updates result in a new start / "**Your Location**" at the coordinates that the route was recalculated.

Note this source also exists in the OK section

Snapchat

/data/data/com.snapchat.android/databases/**memories.db**

These locations are the location of the device when a media item was recorded. These media items are "Memories" recorded by the device, not received from elsewhere.

Reasonable

WiFi

/data/system/**wifigeofence.db**

geofence_wifi stores a list of the Last/First time that a wifi network was connected to and stores the approximate location of the network. Since the device must be close-by the network in order to connect, it can be assumed that the device was near this location at the time shown.
*Note that newer versions of Android appear to show the same timestamp for *all* records and therefore this source also appears in POOR.

dumpsys_wifi
/data/log/wifi/iwc/**iwc_dump.txt**
/data/misc/apexdata/com.android.wifi/**WifiConfigStore.xml**

These log files track wireless network connections. Location data is not present in these files, but the timestamp can be taken from the log and the SSID/BSSID can be cross referenced against **wifigeofence.db** to get an approximate location at that time.

OK

MapData

/data/data/com.google.android.apps.maps/files/**saved_directions.data.cs**

Stores the last route planned *and started* by the device user. This does not include routes that were only previewed.
This source is listed as both 'Most Reliable' (when referring to the "Your Location" information but also OK as it can also contain coordinates for destinations and waypoints that were not actually visited.
This blob also contains coordinates for local stores that are shown to the user due to their proximity to the route.