TECHNICAL PAPER

Cell connection monitoring

Bars on the phone, and no record of the cell behind them.

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Abstract

Nothing on a phone's status bar names the cell it is camped on, or says whether that camp has been used at this place before. The larger question, a base station someone else put up, needs the baseband or the signaling, which a pocket application does not have. This paper keeps the smaller record. While the phone is still, the camp is saved against the place. A later visit can show a cell this phone has not used there, or a drop to 2G or 3G at a place that had stayed on 4G or 5G. The warning says what this phone did. The first still visit only learns. How long to learn can keep a later visit quiet while the place fills in. A drive does not save the cells it passes.

1. Bars on the phone, and no name for the cell

A phone shows bars. The bars are a camp: one cell, chosen by the phone and the network, and reported after the fact. The camp changes all day for ordinary reasons. A person walks around a building. The carrier hands the phone to a small cell. A drive passes more towers than anyone would write down. Nothing on the status bar names the cell, and nothing says whether this phone has camped on it at this place before.

The question people bring to that screen is whether someone nearby has put up a base station of their own. The work that takes that question seriously uses a different instrument. It reads what the baseband will say about the stations around it, or it sits on the signaling. A pocket application has neither. It has the camp Android has already cached, and it has the places this phone has been still. Treating every new camp as an event would warn on an ordinary handoff. Treating a quiet afternoon as an all-clear would be worse. A phone that never left its usual cell has nothing to compare, and nothing to report.

This paper is the smaller record that camp can support. While the phone is still, the camp can be saved against the place. On a later visit, a camp this phone has not used there can be shown, and a place that had stayed on 4G or 5G can be shown when the phone drops to 2G or 3G. Both are observations about this phone. Neither is a cause. The first still visit only learns, because a warning then would mostly announce that the place is new. How long to learn can keep a later visit quiet too. It starts at 3 days from when the place opened. None leaves the first visit as the only quiet one. A drive does not save the cells the phone passes. What follows is the identity Android actually returns, the way a place is opened and closed, and the order of the checks that either write a warning or return without one.

2. The two questions a camp can support

The camp can support two questions, and only those. At this place, is the phone on a cell it has used here before? And if this place has only ever been 4G or 5G, has the phone just dropped to 2G or 3G?

Both answers are observations about this phone. A new cell at a familiar place can be ordinary: a carrier change, a small cell, a different face of the same site. A drop to 2G or 3G can be ordinary too. In the United States, a drop to 2G is the one to take seriously, which is why the settings page says so, and why it points at the phone's own

“Allow 2G” setting. The dialog still does not name a cause.

Fieldwatch remains a Wi-Fi and Bluetooth receiver for other people's radios. The sentence in the project readme, that the application is not cellular, is still true in that sense. This watch does not hear another phone, a camera, or a tracker on the carrier network. Those stay invisible.

3. What a camp is

A registered cell is the one the phone says it is camped on. Android also returns neighbors. Neighbors are counted on the Diagnostics page and then discarded. They are not learned, and a change in the count does not warn.

The generation comes from the class Android used. GSM is 2G. WCDMA and TD-SCDMA are both 3G, so a drop onto an older 3G radio that some phones still report is still a drop. LTE is 4G. NR is 5G. Identity is the generation, the PLMN (the mobile country and network codes, written as one network field), the area, and the cell identity. On LTE and NR the area is the tracking area. On GSM and WCDMA it is the location area. Zero is a valid identity. An empty network, area, or cell does not learn and does not warn.

The network code also carries a country and, when the shipped list has one name, an operator. The country is the first three digits, taken from the Android Open Source Project country table. The operator is the name that project's carrier list gives for the whole code, and only when that list has a single name for it. A brand that shares the code and is told apart by the SIM is not shown, because this phone's reading does not include those SIM fields. The number stays on the screen. A missing name leaves that line off. The name is who the code is assigned to. It is not a statement that the radio is that company's tower, and it is not a cause. Area, the cell id, and PCI do not carry a country or a company. The names are stored in the app.

PCI and the channel are stored and shown on the place page when the phone filled them. They are not part of the identity. A PCI change, or a channel change, on a cell the phone already uses here does not warn. There is no separate alert for that change. An area-code change on the same generation, the same network, and the same cell id updates the stored area and is not its own warning. A different network is a new cell. A different cell id is a new cell. When the channel number maps to a band, the place page also shows that band and the downlink frequency. A channel that fits more than one band names each of them. Bands that share the frequency show it once. A 2G channel from 512 to 810 lists both frequencies. The channel number stays. The dialog shows PCI, the channel, and the band when the phone filled them. The sit report does not show the band.

4. Prior work, and the line this paper will not cross

The public literature on unexpected cells is mostly about something else. Dabrowski, Pianta, Klepp, Mulazzani, and Weippl, at ACSAC in 2014, built detectors aimed at cell-site simulators by looking at what a baseband will reveal about the stations around it. Shaik, Borgaonkar, Asokan, Niemi, and Seifert, at NDSS in 2016, showed how LTE signaling itself can be turned against the subscriber. Both lines of work assume access to behavior Fieldwatch does not read: paging, identity requests, ciphering, and the modem's own security indications.

Android, separately, can surface a “Mobile network security” notification from the phone's own radio stack. Fieldwatch does not read that notification. If it is showing, it came from the phone's own setting. The watch will not confirm it and will not clear it.

Projects that sit on the modem's signaling, including the Electronic Frontier Foundation's Rayhunter, are a different instrument. Fieldwatch does not import those logs, does not ask for the phone-state permission those tools often need, and does not claim their result. The 3GPP specifications for cell reselection (TS 36.304 for LTE, TS 38.304 for NR) describe why a camp changes in ordinary operation: the phone is supposed to move among

cells. That ordinary movement is the background this watch has to live with, which is why a drive does not record the cells it passes and why the first visit to a place does not warn.

5. The reading

About every two seconds, on the same cadence as the rest of the scan, the watch reads `TelephonyManager.getAllCellInfo()`. That call returns Android's cached picture. The code does not call `requestCellInfoUpdate()`, and it does not request `READ_PHONE_STATE`. The location permission the rest of the application already holds is enough for this call. An empty list, a missing registered cell, or an identity with a hole in it does not learn and does not warn. The absence is not treated as a drop.

Signal strength, in dBm, is kept when the phone filled it. Timing advance is kept when the phone filled it. GSM and LTE expose it directly. On 5G, Android provides `getTimingAdvanceMicros()` from API 34, and that is a different number from a 4G or 2G timing advance. Details on the dialog lists generation, network, country, operator, area, cell, PCI, channel, and band. Country and operator are included when the list has them. PCI, channel, and band are included when the phone filled them. The dialog does not show signal or timing advance. The sit report can show signal and timing advance, and only when the field was filled, and it can show the country and the operator. A 5G timing line should not be read as if it were on the same scale as an LTE one.

A second SIM is noted, not compared. The public method is `SubscriptionManager.getActiveSubscriptionInfoList()`. The older id-list call is not in the public SDK Fieldwatch 1.1.39 compiles against. A security exception, or a null list, is reported as “not returned.” That is not proof of one SIM. Fewer than two subscriptions is off. The watch does not warn because the two SIMs disagree. That comparison is not built.

6. A place is a still phone, not a trail

A place opens when the phone is still, the GPS fix is tighter than 100 m, and the fix is live. Still means the last speed is under 0.7 m/s and the phone has not stepped 4 m from the anchor it set when it stopped. A missing speed is not treated as moving. Only the 4 m step counts in that case. Coming back from a drive is a step, because the anchor moved. The next still reading is the visit.

A fix coarser than 100 m, a missing fix, or a paused receiver does not open a place, does not learn, and does not warn. A moving phone does not open a place and does not save a passing cell. The first still visit only learns. Warning then would mostly announce that the place is new to the phone. How long to learn extends that quiet past the first visit. The choices are none, 1 day, 3 days, 7 days, and 14 days. The start is 3 days, counted from when the place was opened. While it lasts, a later still visit stores a new 4G or 5G cell and does not warn. None stops when the first visit ends. The place row says how long learning has left. The choices do not list the places. None has no clock.

A visit ends when a usable fix is farther than 300 m from the place, or when the watch is turned off. Ending a first visit that learned at least one cell marks the place as having a baseline. An empty visit is deleted. A later still visit can warn once that time has ended, or on the next visit when the choice is none. The 300 m radius is the same radius trusted networks use for “here.”

A place keeps up to 32 cells. The thirty-third replaces the one heard least recently. How long to learn is that clock. While it is open, a 4G or 5G cell the phone uses without a warning is stored on its own. A cell that raised a warning is stored only when the person taps Learn this cell. With the drop warning on, a 2G or 3G camp that would raise that warning is not saved automatically, including during the clock. Saving it would teach the place

that 2G or 3G is normal, and the next drop would go quiet.

The place row shows the generations it has learned, how many cells, and the last visit as a local date and time. When this phone has a fix from the last 30 seconds, the row also says Here if the phone is inside that place, within 300 m, or a distance if it is farther away. The line is left off when there is no current fix. The title is the street and city when Online place names and maps is on and the phone is online. Offline, or with that switch off, the title is the coordinate of where this phone was standing. Privacy mode masks that title and leaves the street off. When Online place names and maps is on, a map sits above the list. Each pin is a place where this phone stood. A tap opens that place. A pinch zooms and a drag moves the picture. A double tap returns to the full view. The place this phone is inside uses a different color. Back from a pin returns to this page with the map at the top. Privacy mode leaves the map off. With the switch off, the list is alone. With no connection, a picture already saved still shows. Where none was saved, the list is alone. Places far from this phone stay on the list. When there is no fix, the map uses the newest place. A swipe to the left asks to forget the place. The row snaps back, and the place stays until that question is confirmed. Each cell is its own section on the place screen. The title is the generation. Network, country, operator, area, and cell are lines in that section. Country and operator are included when the list has them. PCI and channel are included when they were filled, and the band when that channel maps to a band. More than one band is named on that line. Camped is a line in that section, with the label on the left and the number of stays on the right. A stay counts once. First camped and Last camped are lines in that section, with the label on the left and the time on the right. Signal is the strength of that last camp, in dBm, when the phone filled it. A cell saved before First camped uses the last time already stored. A later stay keeps that date and moves Last camped. A hop back during the same stay does not add another. Remove this cell is at the bottom of that section. The back arrow at the top of that screen returns to the place list. Forget this place asks once, then deletes the place and ends an open warning for it. Privacy mode masks the place title. The cell numbers on that screen stay numbers.

7. The three warnings

Warnings need a baseline from an earlier visit, and they need their own switch. Both warning switches start on. The master switch, “Monitor the cell connection,” starts off. With it off, nothing new is learned and nothing new warns. Places already learned stay. A warning that was already open does not beep again when the switch is turned back on. The dialog stays hidden while the watch is off. Recovery and the ten-minute hold still run, so turning the watch back on does not replay an old beep.

Warn on a new cell. The phone is still, at a place an earlier visit already learned, and the identity is not among the cells stored there, after the area-code exception above. One episode per identity. It ends when that identity has been gone for ten minutes, or when it is dismissed or learned. Dismiss holds that identity until it has been absent for ten minutes. Dismiss does not forget the cell.

The title is “This phone camped on a cell it has not used here.” The paragraph is “This phone is camped on a tower it has not used at this place. Fieldwatch cannot tell the cause.”

Warn on a drop to 2G or 3G. The place's learned generations are not empty, and they are only 4G, 5G, or both. The registered cell is GSM, WCDMA, or TD-SCDMA, and the identity is complete. This one can fire while the phone is moving, as long as the fix is still inside that place. It does not fire if the place already learned a 2G or 3G cell, if the phone is outside every baselined place, if the fix is coarse, missing, or paused, or if the drop switch is off. One drop episode at a time. The generation it started with is the generation it keeps. It ends when the phone has been back on 4G or 5G for ten minutes, or when it is dismissed. An empty or unknown generation resets that recovery timer. It does not count as recovery.

A 2G camp says “This phone dropped to 2G.” The paragraph repeats the sentence and adds “Fieldwatch cannot tell the cause.” A 3G camp uses the same shape with 3G.

A still camp that is both new and 2G or 3G can open both episodes in one tick, once How long to learn has ended. The drop is the dialog. The new-cell warning waits behind it. Dismissing the drop can then show the new cell. The new-cell episode is not thrown away to keep the screen simple. While the clock is still open, only the drop is opened. The 2G or 3G camp is not stored, and dismissing the drop does not store it.

8. How the dialog behaves

One dialog at a time. A cell warning waits behind a GNSS dialog and behind a trusted-network dialog. Beep is the same beep as the other warnings, and it sounds when an episode becomes the dialog on screen, not when it is merely queued. Voice speaks the title sentence only, once, at that same moment. It does not read the cell id. Beep and Voice on this page do not change the watchlist, GNSS, or trusted networks. Both start on.

System notification starts off. It is a silent notification. The title is the sentence and the body is the paragraph. The card does not include the cell id. The dialog still shows.

Learn this cell writes the identity onto the place and ends that episode. On a drop, learning the 2G or 3G cell means the place is no longer “only 4G and 5G,” so a later drop there stays quiet. That is the point of the button. Forget this place is not on the dialog. It is on the place page, and a swipe on the place list asks the same question. It asks once.

There is no confidence ladder and no second timer. The warning does not wait for a sit to be running. There is no path-map mark and no TAK pin.

9. The sit, privacy, and Diagnostics

If an episode overlaps a sit, Debrief text, the Debrief PDF, and AI Export gain one block titled “Cell connection monitoring.” It is inserted after the GNSS section and before the privacy section. The lines are the warning sentence, the time in UTC, and generation, network, country, operator, area, and cell for the fields the phone filled and the names the list has. Signal, in dBm, and timing advance are included only when they were filled. There are no coordinates. Compare does not get the block. The log is unchanged. Sit export is unchanged.

Privacy mode masks the area and the cell id in that sit block as the word “masked.” Generation, network, country, and operator stay. The dialog still shows the numbers. The place page still shows the numbers. The mask is the sit report's mask, not a claim that the identifiers were never on the phone.

Diagnostics lists the camp even when the watch is off: registered cell on or off, generation or blank, the names of any empty fields without printing the network code, the neighbor count, and the second SIM as on, off, or not returned. There are no GPS coordinates, no country, and no operator name. Copy includes these lines with the rest of the page.

10. A SIM that is in the phone, and a phone with no SIM

Fieldwatch does not check whether the plan is activated. An inactive SIM is enough when the phone is camped and Android fills the network, the area, and the cell id. A normal call does not have to work. If the phone shows no service and is not camped, the watch stays quiet and does not warn. Diagnostics then shows registered cell off, or on with Network, Area, or Cell empty. This was not tried with an inactive SIM on the phones used while the feature was written.

With no SIM, the phone is usually not camped, so nothing is learned and nothing warns. Towers nearby can still be counted as neighbors on Diagnostics. They are not saved. If the phone camps for emergency calls with no SIM, and it fills the network, the area, and the cell id, that camp is treated like any other. Whether a given phone does that depends on the phone and on the network nearby. This was not tried with the SIM taken out.

11. What is kept, and what a new phone does not bring

Places and episodes live in a file named cell-places.json on the phone, in a small format called fieldwatch-cells. They are not part of AppSettings. Export settings includes the watch, the two warnings, beep, voice, the notification, and How long to learn. It does not include the places. Restore defaults puts those back to the start, which turns the watch off and sets How long to learn to 3 days, and leaves the places file alone. Uninstalling Fieldwatch deletes the file. There is no export of places, and there is no import.

> **What this will not catch**
>
> It does not see another phone, a SIM tracker, a silent text, an identity request, or the cipher. A quiet watch is an empty report. It is not an all-clear. A copy of a cell already used here stays quiet. A PCI change on that same cell stays quiet. The first still visit only learns. How long to learn can keep later visits quiet. None does not. A drive does not save the cells passed along the way. A place that already learned 2G or 3G does not warn on a later drop. Neighbor cells are counted and not saved. A second SIM is noted and not compared. There is no path mark and no TAK pin.

12. From the cached list to an identity

About every two seconds, while Fieldwatch is scanning, the radio reader calls getAllCellInfo on the telephony manager. It does not call requestCellInfoUpdate, and it does not ask for the phone-state permission. The list is whatever Android has cached. The first entry marked registered is the camp. Every other entry is a neighbor, and only the count of those entries is kept. An empty list, or a list with no registered cell, produces a reading with no identity.

The class of that registered entry picks the generation. GSM is 2G. WCDMA and TD-SCDMA are 3G. LTE is 4G. NR is 5G. Anything else is ignored. The network is the MCC and the MNC, joined with a hyphen, and it is kept only when the MCC is three digits and the MNC is two or three, all of them digits. The area is the location area on GSM, WCDMA, and TD-SCDMA, and the tracking area on LTE and NR. The cell id is the GSM or WCDMA cid, the LTE ci, or the NR nci. Android's unavailable sentinel, and the maximum integer, are treated as empty. An identity is built only when network, area, and cell are all present. Zero is a real value and is kept.

PCI and channel ride beside the identity. On GSM the channel is the ARFCN and the code is the BSIC. On WCDMA and TD-SCDMA the channel is the UARFCN. On LTE it is the EARFCN and the PCI. On NR it is the NR-ARFCN and the PCI. None of those enter the key. Signal is the reported dBm, or RSRP when the phone filled that field instead. Timing advance is the GSM or LTE field when it is filled. On NR it is the microsecond field, and only on Android 14 and newer. A missing timing advance is left empty. It is not stored as zero.

A second SIM is a separate read, for the Diagnostics line only. The public subscription list is asked for. A security exception, or a null list, is recorded as not returned. Fewer than two subscriptions is off. Otherwise the subscription that is not the default data subscription is asked for its own cached list, and the flag is whether that list contains a registered cell. The decision below never reads this flag.

13. The book, and the order inside one tick

The book is the file. It holds the places, the episodes, a still-anchor, the dismiss holds, a flag that a drop was dismissed, and the next ids. One tick takes the book, the reading, the current fix, the switches, and the clock, and returns a new book plus any episode that opened on this tick.

Three cleanups run before the watch switch is consulted. A dismiss hold whose identity is the current camp has its last-seen time refreshed, and a hold last seen more than ten minutes ago is dropped. An open new-cell episode whose identity is not the current camp, and whose last update is ten minutes old, is closed. An open drop, or a dismissed drop, recovers only after the registered generation has been 4G or 5G continuously for ten minutes. An empty generation, or a generation that is not 4G or 5G, resets that timer. It is not counted as recovery.

If the watch is off, the tick ends every open visit and returns. Ending a visit marks the place as a baseline when it stored at least one cell, and deletes a visit that stored none. No new place is opened and no new episode is opened. An episode that was already open stays open, which is why turning the watch back on does not beep for it again.

A fix is usable when it is not paused, the latitude and longitude are finite and inside the usual ranges, and the accuracy is tighter than 100 m. Still means usable, and the speed is either missing or under 0.7 m/s, and the step from the stored anchor is under 4 m. A missing speed is not treated as motion. A usable fix that is not still moves the anchor to the new point and leaves it there. The next still reading is measured from that new anchor, which is why a return from a drive is a new stay rather than a continuation of the one before it. A fix that is not usable stops the tick after the cleanups. Nothing is learned and nothing warns.

14. A place, a drop, then a new cell

The nearest place within 300 m is the place for this tick. Distance is measured from the fix to the point saved when the place was opened. An equal distance keeps the later place in the list. If nothing is inside 300 m, every open visit is ended. If the phone is still and the identity is complete, a new place is opened at the fix and this camp is stored on it. That place is not a baseline yet. The same tick returns without a warning.

If a place is inside 300 m, other visits are ended and this one is marked visiting. The last-visit time is refreshed about once a minute, so a long stay does not rewrite the file on every tick. The drop test runs next, and it does not require the phone to be still. It needs a complete identity on GSM, WCDMA, or TD-SCDMA, a place that is already a baseline, a stored set that is non-empty and entirely 4G or 5G, the drop switch on, and the drop not already dismissed. One open drop episode is kept and its signal, timing advance, and identity are updated. A new episode is created only when none is open. GSM is the 2G episode. WCDMA and TD-SCDMA are the 3G episode. The kind stays the kind it opened with.

The new-cell test runs only when the phone is still and the identity is complete. On a place that is not yet a baseline, the camp is stored and the tick returns. Every still camp during that first visit is stored the same way. A moving reading never reaches this store, so cells passed while walking out of the stay are not written down. The place becomes a baseline when the visit ends with at least one cell, which is when the phone is farther than 300 m from it, or when the watch is turned off. While How long to learn is still open, a later still visit does not open a new-cell episode. A known cell is updated. A new 4G or 5G cell is stored. A new 2G or 3G cell on a place that has only learned 4G and 5G is left unstored, and the drop test is what speaks.

On a baseline, the key is generation, network, area, and cell id, joined as one string. An exact match updates the stored PCI, channel, signal, and timing advance where the phone filled them, and closes an open new-cell episode for that same key. A match on generation, network, and cell id with a different area is the same cell. The stored area is replaced. It is not a new warning, and an open new-cell episode for that tower key is closed. A true miss,

with the new-cell switch on and with no dismiss hold for that key, opens one episode per identity, or updates the episode already open for it. With the new-cell switch off, the miss is stored instead, except a 2G or 3G camp that would have raised the drop. That one is left unstored, so a later drop at this place can still speak.

The store holds 32 cells. The 33rd replaces the cell with the oldest heard-at time. Learn this cell uses the same store, then ends the episode and clears any hold for that key. Dismiss ends the episode. For a new cell it writes a hold keyed by the identity. The hold refreshes while that camp is still the registered cell and expires ten minutes after it has gone. Dismissing a drop sets the drop-held flag, which blocks a new drop episode until the ten minutes back on 4G or 5G clear it.

15. Which episode is shown

The dialog is chosen from the open episodes, earliest start first, with a drop ordered ahead of a new-cell episode that started at the same moment. One is shown. The other stays open. Beep and voice run once, when an episode becomes the one on screen. The book is written back to cell-places.json after the tick. Closed episodes are trimmed to the last 40. Export settings does not contain the file.

16. Parameters

Parameter	What the implementation uses
Master switch	Off. With it off, nothing new is learned and nothing new warns. Places stay.
Warn on a new cell	On. Still, at a baselined place, identity not stored. One episode per identity.
Warn on a drop	On. Place learned only 4G and 5G, and the camp is now 2G or 3G. Can fire while moving inside the place.
Poll	Cached getAllCellInfo(), about every 2 seconds. No requestCellInfoUpdate(). No READ_PHONE_STATE.
Identity	Generation, PLMN, area, cell id. Zero is valid. PCI and channel are shown, not matched.
Area-code change	Same generation, network, and cell id: update the stored area. Not its own warning.
Place	300 m. Still: speed under 0.7 m/s and no 4 m step. Fix tighter than 100 m. First visit learns only.
How long to learn	3 days from when the place opened. Also 1, 7, or 14 days. None ends with the first visit. A later 4G or 5G cell is stored and does not warn. A drop to 2G or 3G still warns and is not stored.
Cap	32 cells. The 33rd replaces the least recently heard.
Episode end	New cell: gone 10 minutes, or dismissed, or learned. Drop: back on 4G or 5G for 10 minutes, or dismissed.
Both at once	After the clock, the drop is the dialog and the new-cell warning waits. During the clock, only the drop opens, and that camp is not stored.
Privacy	Sit report only. Area and cell id become the word masked. Dialog and place page keep the numbers.
Not built	No neighbor collapse, no dual-SIM comparison, no tower-location database, no PCI alert, no path mark, no TAK pin, no place export.

References

1. Dabrowski, A., Pianta, N., Klepp, T., Mulazzani, M., and Weippl, E. “IMSI-Catch Me If You Can: IMSI-Catcher-Catchers.” *Proceedings of the 30th Annual Computer Security Applications Conference (ACSAC)*, 2014. doi:10.1145/2664243.2664272. Cited here as the class of detector this watch is not.

2. Shaik, A., Borgaonkar, R., Asokan, N., Niemi, V., and Seifert, J.-P. “Practical Attacks Against Privacy and Availability in 4G/LTE Mobile Communication Systems.” *Network and Distributed System Security Symposium (NDSS)*, 2016. Cited for the same reason: the signaling those attacks use is not what this watch reads.

3. 3GPP TS 36.304. “Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode.” The ordinary rules by which an LTE phone changes cell.

4. 3GPP TS 38.304. “NR; User Equipment (UE) procedures in idle mode and in RRC Inactive state.” The same idea for 5G.

5. Android Open Source Project. `TelephonyManager.getAllCellInfo`, `CellInfo` and its GSM, WCDMA, TD-SCDMA, LTE, and NR subclasses, and `CellSignalStrengthNr.getTimingAdvanceMicros` from API 34. `SubscriptionManager.getActiveSubscriptionInfoList` is the public second-SIM query. The country and operator names are from `MccTable` and TelephonyProvider `latest_carrier_id/carrier_list.textpb`, Apache License 2.0.

6. 3GPP TS 36.101. LTE channel numbers and downlink frequencies. TS 38.104. NR channel numbers and downlink frequencies. A band line names every band the channel fits. Bands that share a frequency show it once.

7. Electronic Frontier Foundation. Rayhunter. A modem-level detector of suspicious cellular signaling. A different instrument. Fieldwatch does not import its logs.

A note on this paper

Cell connection monitoring as described here shipped with Fieldwatch 1.1.38 on 2 November 2026 and remains in 1.1.39. It is the behavior the user guide's section 5.12 describes. It is a description of a method. It is not a test report, and a warning does not name a cause. Later ideas that were written down and not built — a tower-location database, a comparison of two SIMs, an alert on PCI alone, a pin on a map — are not part of this paper's claims.