

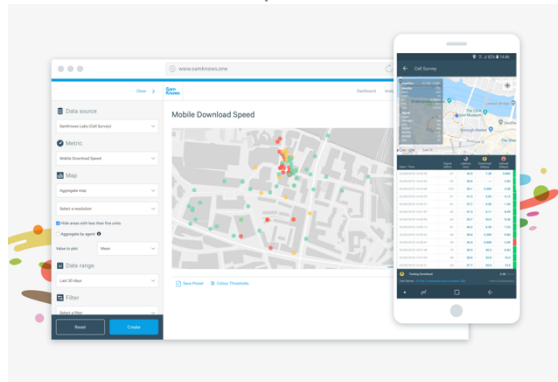
Factsheet

Test Agents – Cell Audit app

Cell Audit app

What's the problem?

Mobile network operators routinely publish network coverage maps. This means those coverage maps may need checking or updating from time to time. Increasingly frequent major climate events caused by global warming are wreaking havoc on communities and their ability to recover is determined by how quickly mobile connectivity can be restored. SamKnows has been working with government agencies and their enforcement officers around the world to build a system which can be deployed quickly to collect data on mobile performance. This data is then used to direct repair efforts, bring people back online quickly and helping save lives. This same solution is being used to audit the coverage maps published by mobile operators to ensure that those maps are correct.



Introducing the Cell Audit application

The SamKnows Cell Audit app is easy to deploy and allows people to travel round targeted areas collecting accurate data. Data is then analysed using SamKnows One, our powerful state-of-the-art platform, that helps provide insights on where connectivity is available.

The Cell Audit app runs continuous active performance tests (download, upload, and

latency) as well as collecting a huge amount of environmental data alongside each test. Key information like signal strength, bearer channel, technology or CQI (amongst others) allow engineers at HQ to identify problem areas and deploy field efforts effectively. That means that help is sent to the right places and money is focused on fixing the problems where it really matters. It also means fixes can be tracked to make sure people can access basic communications. The app is easy to use and can be pushed to lots of people in hard-to-reach areas. All the data collected is shared in real time via SamKnows One and can map out areas that are experiencing issues and those where networks are operating well.

What are the benefits?

Getting up-to-date, accurate, trackable data is useful for everyone.

Consumers – can use this information to fight for better or improve coverage in their area or to help ISPs investigate issues.

Regulators – can use this to ensure people are kept safe and that any money spent is being put to good use, improving areas that really need it.

ISPs – can use this to demonstrate where their network is performing well or to track down issues in hard-to-reach areas.

Cell Audit App overview

Tests

The application runs key tests that can be selected as required by the user. The tests currently available include:

Download speed

Shows the download speed in Mbps when downloading (using TCP) random bytes from a test server.

Upload speed

Shows the upload speed in Mbps when uploading (Using TCP) random bytes to a test server.

Latency

Calculates the average round-trip time of a series of echo packets transmitted over UDP.

Environmental information

As well as the test results, the app collects a large amount of environmental information that gives a detailed picture of how networks are performing. This information is anonymous and does not include any personal data. For more information, please see the table on pages 5-7.

Requirements

Android 8.0+ are the only supported versions. We also recommend a high-performance phone, in our testing we utilise a Samsung Galaxy S8.

When running tests there are also a few environmental requirements:

- Make sure battery is running at more than 50% (keeping it plugged in is recommended)
- Ensure power saving mode is not enabled (high-performance mode is recommended when available)
- Ensure location is set to maximum accuracy
- The app must run in the foreground and the phone must not be put to sleep.

We also recommend that phones are not kept on top of each other as they can become warm after long period of intensive testing and the phones may restart.

Test configuration

The measurements included in the SamKnows Android SDK are Download/Upload throughput, Latency, Jitter, and Packet Loss.

You can specify which tests you wish to run and it will execute them in cycles. Each cycle will be in the order: Latency, Download, Upload omitting any not enabled test.

There are two configurable delays to account for factors such as buffer bloat:

- The inter-test delay, which is the time delay between individual tests in a cycle. The default is 10 seconds.
- The inter-cycle delay which is the time delay between different test cycles (a cycle consists of one run of all the enabled tests). The default is 10 seconds.

The minimum delays are 5 second and maximum delays are 999 seconds.

Download speed

These tests measure the download HTTP throughput in bits per second. The test will run for a fixed duration (in addition to a TCP warmup period). This time is configurable at runtime.

The duration default is 5 seconds, maximum is 30 seconds and minimum is 5 seconds.

Upload speed

These tests measure the upload HTTP throughput in bits per second. The test will run for a fixed duration (in addition to a TCP warm-up period). This time is configurable at runtime.

The duration default is 5 seconds, maximum is 30 seconds and minimum is 5 seconds.

Latency, jitter, and packet loss

This is a single test that provides three separate metrics upon completion: latency, jitter and packet loss. Only latency is shown in-app but all § can configure the packet count, packet interval and test duration at runtime.

The duration default is 5 seconds, maximum is 30 seconds and minimum is 5 seconds. The packet count default is 200, maximum is 500, and minimum is 100.

Test servers

All measurements are carried out to specified SamKnows test servers only. These are available in over 600 locations worldwide.

Tests are carried out to the “nearest” test server by default. This is determined at the start of each test run, and the same server is used for all tests in that run. The nearest test server is determined by establishing a TCP connection on port 6500 and measuring the TCP connection establishment time. The server with the lowest TCP connect time is used for measurements.

The app also lets the user choose from a predetermined list of servers. This means that testing can be done to a static location chosen by the user, in another geographical region for example.

Results submission

All results are submitted to SamKnows One. Results are submitted at the end of every test cycle, if it was unable to submit results (for example due to poor network connectivity) then it will cache the result and submit them next time the app is opened. You can see if a result has been submitted or cached as it will show with a green or red icon on the right-hand side of the test results screen.

If you're experiencing issues with results being submitted (they are showing up as red) due to network issues, simply open the app later on whilst connected to Wi-Fi and all cached results will be submitted.

The results data dictionaries (excluding environmental data) are as follows:

Download speed test

Field	Description
agent_id	Unique identifier for an individual unit
test_id	Unique identifier to the test cycle
dtime	Local device time test finished
dtime_utc	Test finished device time converted to UTC
target	Target hostname or IP address
address	The IP address of the server (resolved by the client's DNS)
duration	Time the test ran for in microseconds
bytes_total	Total bytes downloaded across all connections
bytes_sec	Running total of throughput, which is sum of speeds measured for each stream (in bytes/sec), from the start of the test to the current interval
warmup_time	Time consumed for all the TCP streams to arrive at optimal window size (Units: microseconds)
warmup_bytes	Bytes transferred for all the TCP streams during the warm-up phase.
threads	The number of concurrent TCP connections used in the test
successes	Number of successes (always 1 or 0 for this test)
failures	Number of failures (always 1 or 0 for this test)

Upload speed test

Field	Description
agent_id	Unique identifier for an individual unit
test_id	Unique identifier to the test cycle
dtime	Local device time test finished
dtime_utc	Test finished device time converted to UTC
target	Target hostname or IP address
address	The IP address of the server (resolved by the client's DNS)
duration	Time the test ran for in microseconds
bytes_total	Total bytes uploaded across all connections
bytes_sec	Running total of throughput, which is sum of speeds measured for each stream (in bytes/sec), from the start of the test to the current interval
warmup_time	Time consumed for all the TCP streams to arrive at optimal window size (Units: microseconds)

warmup_bytes	Bytes transferred for all the TCP streams during the warm-up phase.
threads	The number of concurrent TCP connections used in the test
successes	Number of successes (always 1 or 0 for this test)
failures	Number of failures (always 1 or 0 for this test)

Latency/jitter/packet loss UDP test

Field	Description
agent_id	Unique identifier for an individual unit
test_id	Unique identifier to the test cycle
dtime	Local device time test finished
dtime_utc	Test finished device time converted to UTC
target	Target hostname or IP address
status_code	A status code indicating any error states (0 for no failure)
duration	Total duration of test (Units: microseconds)
packet_size	Size of each UDP Datagram (Units: Bytes)
stream_rate	Rate at which the UDP stream is generated (Units: bits/sec)
packets_sent	Number of packets sent in Upstream (measured by client)
packets_received	Number of packets received in Upstream (measured by server)
jitter	Downstream Jitter measured (Units microseconds)
rtt	Average round trip time of all packets
mos	Mean Opinion Score
successes	Number of successes (always 1 or 0 for this test)
failures	Number of failures (always 1 or 0 for this test)

Mapping and test results screen

During a test run environmental data and points are plotted on a map.

It also includes a grid which shows test cycle download, upload and latency results.

Distribution

The cell survey app will be pushed to respective users via Fabric, the deployment platform that allows app version to be pushed to custom distribution groups.

Email addresses of the users requiring the app should be provided to SamKnows ahead of release. Invites will be sent requesting the user install Fabric and once complete the app will be pushed to the device.

Environmental information

Environmental data is collected at the beginning and end of a test. Therefore, all fields are prefixed with beginning or end. When there is no prefix, it is data from the end of the test.

Environmental data

Name	Field name	Type	Example	Description	LTE	GSM	CDMA	WCDMA
Device: Carrier Name	device_environment.carrier_name	String	EE	The name of the carrier on the handset	Y	Y	Y	Y
Device: ISO Country Code	device_environment.iso_country_code	String	gb	ISO2 country code	Y	Y	Y	Y
Device: Operating System Version	device_environment.operating_system_version	String	Android 8.0.0	The version of iOS or Android operating system on the device and Operating System (Android or iOS)	Y	Y	Y	Y
Device: Manufacturer	device_environment.manufacturer	String	Samsung	The device manufacturer	Y	Y	Y	Y
Device: Model	device_environment.model	String	SM-G965F	The device model	Y	Y	Y	Y
Location: Latitude	location.lat	Float	- 0.09613687644	Latitude as determined by GPS	Y	Y	Y	Y
Location: Longitude	location.lon	Float	51.50719166	Longitude as determined by GPS	Y	Y	Y	Y
Memory: Device Free	memory.device_free	Integer	95	The amount of free memory on the device in megabytes	Y	Y	Y	Y
Memory: App Used	memory.app_used	Integer	1796	The amount of memory used on the app in megabytes	Y	Y	Y	Y
Memory: Device Used	memory.device_used	Integer	95	The amount of memory used on the device in megabytes	Y	Y	Y	Y
Cross-traffic: RX Average Bytes per Second	cross_traffic.rx_avg_bps	Integer	5882	The average received device traffic in bytes per second during the course of the test	Y	Y	Y	Y
Cross-traffic: RX Peak Bytes per Second	cross_traffic.rx_peak_bps	Integer	22381	The peak received device traffic in bytes per second during the course of the test	Y	Y	Y	Y
Cross-traffic: TX Average Bytes per Second	cross_traffic.tx_avg_bps	Integer	160	The average transmitted device traffic in bytes per second during the course of the test	Y	Y	Y	Y
Cross-traffic: TX Peak Bytes per Second	cross_traffic.tx_peak_bps	Integer	660	The peak transmitted device traffic in bytes per second during the course of the test	Y	Y	Y	Y
Network: State	network.state	Enum (Associated, Associating, Authenticating, Completed, Disconnected, Dormant, Four Way	Disconnected	Current connection state of the device at the end of the test	Y	Y	Y	Y

Name	Field name	Type	Example	Description	LTE	GSM	CDMA	WCDMA
		Handshake, Group handshake, Inactive, Interface Disabled, Invalid, Scanning, Uninitialized)						
Network: Substate	network.subtype_name	Enum (1xRTT, CDMA, EDGE, GPRS, GSM, IDEN, EHRPD, EVDO-0, EVDO-A, EVDO-B, HSDPA, HSPA, HSPAP, HSUPA, IWLAN, TD-SCDMA, UMTS, LTE, UNKNOWN)	LTE	The specific technology in use	Y	Y	Y	Y
Network: Is roaming	network.is_roaming	Boolean	FALSE	Is the device currently roaming (internationally)?	Y	Y	Y	Y
Network: Is connected	network.is_connected	Boolean	TRUE	Is the device connected to a network at the time of results being sent?	Y	Y	Y	Y
Network: Is failover	network.is_failover	Boolean	FALSE	Indicates whether the current connection resulted from the device failing over from a disconnect from a different network	Y	Y	Y	Y
Telephony: Cellular Technology	telephony.cellular_technology	Enum (simless/2g/3g/4g)	4g	The cellular technology in use when on mobile network	Y	Y	Y	Y
Telephony: Connection Type	telephony.connection_type	Enum (cell/wi-fi)	cell	The current connection type (Wi-Fi or cellular network)	Y	Y	Y	Y
Telephony: Mobile Network Code	telephony.cell_signal.mobile_network_code	Integer	234	The ITU-T E.212 Mobile Network Code (MNC)	Y	Y	Y	Y
Telephony: Mobile Country Code	telephony.cell_signal.mobile_country_code	Integer	12	The ITU-T E.212 Mobile Country Code (MCC)	Y	Y	Y	Y
Telephony: RSSI	telephony.cell_signal.signal_strength	Integer	-89	The (RSSI) signal strength to the nearest cell tower	Y	Y	Y	Y
Telephony: RSSRP	telephony.cell_signal.received_signal_power	Integer	-104	Signal Received Power	Y	Y	Y	Y
Telephony: RSSRQ	telephony.cell_signal.received_signal_quality	Integer	-10	Signal Received Quality	Y	N	N	N
Telephony: RSSNR	telephony.cell_signal.received_signal_noise_ratio	Integer	3	Signal-Noise Ratio	Y	N	N	N
Telephony: TAC	telephony.cell_signal.tracking_area_code	Integer	1034	16-bit Tracking Area Code	Y	N	N	N
Telephony: PCI	telephony.cell_signal.physical_cell_identity	Integer	147	Physical Cell Id	Y	N	N	N
Telephony: CI	telephony.cell_signal.cell_identity	Integer	318494	28-bit Cell Identity	Y	N	N	N

Name	Field name	Type	Example	Description	LTE	GSM	CDMA	WCDMA
Telephony: Bandwidth	telephony.cell_signal.bandwidth	Integer	-2	Cell bandwidth in kHz	Y	N	N	N
Telephony: CQI	telephony.cell_signal.channel_quality_indicator	Integer	6	Channel Quality Indicator	Y	N	N	N
Telephony: ASU	telephony.cell_signal.asu	Integer	26	Arbitrary Strength Unit provided by Android APIs	Y	Y	Y	Y
Telephony: ARFCN	telephony.cell_signal.absolute_rf_channel_number	Integer		16-bit GSM Absolute RF Channel Number	N	Y	N	N
Telephony: Base Station ID	telephony.cell_signal.base_station_identity_code	Integer	7	6-bit Base Station Identity Code	N	Y	Y	N
Telephony: LAC	telephony.cell_signal.location_area_code	Integer	112	16-bit Location Area Code	N	Y	N	N
Telephony: CID	telephony.cell_signal.cell_identity_id	Integer	32233	16-bit GSM Cell Identity	N	Y	N	Y
Telephony: PSC	telephony.cell_signal.primary_scrambling_code	Integer	382	9-bit UMTS Primary Scrambling Code	N	N	N	Y
Telephony: Network ID	telephony.cell_signal.network_id	Integer	655	Cell Tower Network ID	N	N	Y	N
Telephony: System ID	telephony.cell_signal.system_id	Integer	40760	Cell tower System ID	N	N	Y	N
Telephony: Cell Tower Latitude	telephony.cell_signal.longitude	Integer	- 0.09613687644	Base station latitude	N	N	Y	N
Telephony: Cell Tower Longitude	telephony.cell_signal.longitude	Integer	51.50719166	Base station longitude	N	N	Y	N