Directique
Customer Quality Perspectives

هيئة تنظيم الاتصالات
TELECOMMUNICATIONS REGULATORY AUTHORITY
Kingdom of Bahrain - مملكة البحرين

MOBILE NETWORKS COVERAGE AUDIT
KINGDOM OF BAHRAIN – 2018

Version	Date	Author	Changelog
1	01/14/2018	Edouard CLISSON	Creation of document

15, rue Henri Regnault 75014 PARIS
+33 45 45 45 85 directique@directique.fr www.directique.fr siret : 324 007 822 00038 – APE : 70222

TABLE OF CONTENTS

This study is published in accordance with Articles 3(b)(1), 3(c)(2), 3(c)(4) and Article 54 of the Telecommunications Law promulgated by Legislative Decree No. (48) of 2002. The purpose of the study is to evaluate and benchmark Quality Levels offered by Mobile Network Operators, Batelco, Viva and Zain, in the Kingdom of Bahrain. The independent study was conducted with an objective End-user perspective by Cabinet Directique and does not represent any views of the Authority.

This document contains information and statistics that have been obtained from sources believed to be reliable in regard to the subject matter covered.
This document does not however constitute commercial, legal or other advice however so described. TRA and Directique exclude any warranty and, or liability, expressed or implied, as to the quality, completeness, adequacy and accuracy of the information, statements and statistics contained within this document. This document is a study and it is a non-binding document. It has no legal effect. This document does not represent an official position of the TRA, but is intended to stimulate debate in the part of stakeholders and public. It does not prejudice the form or content of any future proposal by the TRA.

TRA and Directique reserve the right to change and update the information, statements and statistics provided in this document at its discretion and without prior notification and assumes no obligation to update the document on the basis of suggestions, comments and/or queries made by third parties.
TRA and Directique assume no responsibility for any consequences that may arise in the absence of such changes and/or updates.

To the fullest extent permitted by law, neither TRA or any of its officers however so described or agents nor Directique will assume responsibility and/or liability for any loss or damage, including losses or damages such as loss of goodwill, income, profit or opportunity, or any other claim of third parties, arising from or related to the use of the content of this document.

1. Executive Summary

Mobile Network Operators are under a coverage obligation as a condition of their Individual Mobile Telecommunications license (IMTL), and it is the responsibility of TRA to verify and validate that each operator is meeting its obligation.

The provisions of the Individual Mobile Telecommunications Licence that was issued on 19 September 2013 require Licensees to provide a mobile telecommunication network that is capable of providing mobile telecommunication services with a nationwide coverage of at least 99% of the population in the Kingdom of Bahrain by no later than nine months from the effective date of such license.

The license obligation defines population coverage for each Mobile Operator's own telecommunication network. The coverage as perceived by the customers is independent of the deployed technology; coverage measurements have been made with handsets in automatic network mode (not locked on any technology):
For voice:

- a set of smartphones LTE enabled

For data:

- a set of smartphones LTE enabled
- a set of smartphones with no LTE enabled

It is important to point out that some areas were not accessible to the audit team, being either private land or reserved for government, which explains why the maps do not show any measurements in those areas of the Kingdom. However those areas are not open to general public.
With this in mind, results are very good and show that there is no significant coverage difference from one operator to the other. Operators meet their coverage obligations.

Directique was also required to audit Mobile Network Operators coverage prediction maps with the actual observed coverage. The maps included in this report contain two layers: a first layer showing the coverage predictions provided by the Operators themselves, on top of which, a superimposed second layer is showing results of the coverage measurements.
Results show that the Operators' maps are reliable.

2. OBJECTIVE

The objective of this audit was to:

- Measure the outdoor coverage of the 3 Mobile Operators; Batelco, Viva and Zain, via an accessibility test
- Establish for each operator a direct correlation between the number of households covered and the percentage of the population, resulting directly from such coverage
- Validate the coverage maps of each Mobile Operator against the outdoor coverage observed during the audit.

3. METHODOLOGY

The audit was conducted from the 3rd to the 19th October 2018 across the Kingdom's 4 Governorates.

Audit results have been weighted with the population percentage living in each Governorate[1]. The result tables present the detailed coverage per Governorate as measured for each operator.

Coverage, from a end-user perspective, cannot be measured based on signal level. A scanner cannot distinguish the difference between the live cells and the other emitting cells and the result would give an over optimistic coverage measurement.
Beside such tools would measure reception levels in dB, and this cannot be interpreted or be easily understood by the end user.

It is for these reasons that the coverage has been audited using tools which are fully representative of how a subscriber would access a mobile service – the audit therefore is fully representive of the subscriber experience, and completed with signal levels.

Measurements have been performed with the following methodology:

- **Voice** :a set of smartphones in 2G/3G/4G auto connect mode, running accessibility voice calls with Directique's proprietary software ***MobiTrace***
  The accessibility test for voice service consist in placing a call and checking if signalling is ok.

- **Data** : data accessibility tests (HTTP DL) with our proprietary software ***MobiSpeed***:
  - 1 set in 2G/3G/4G auto connect, to represent the LTE users
  - 1 set in 2G/3G auto connect, to represent the non LTE users

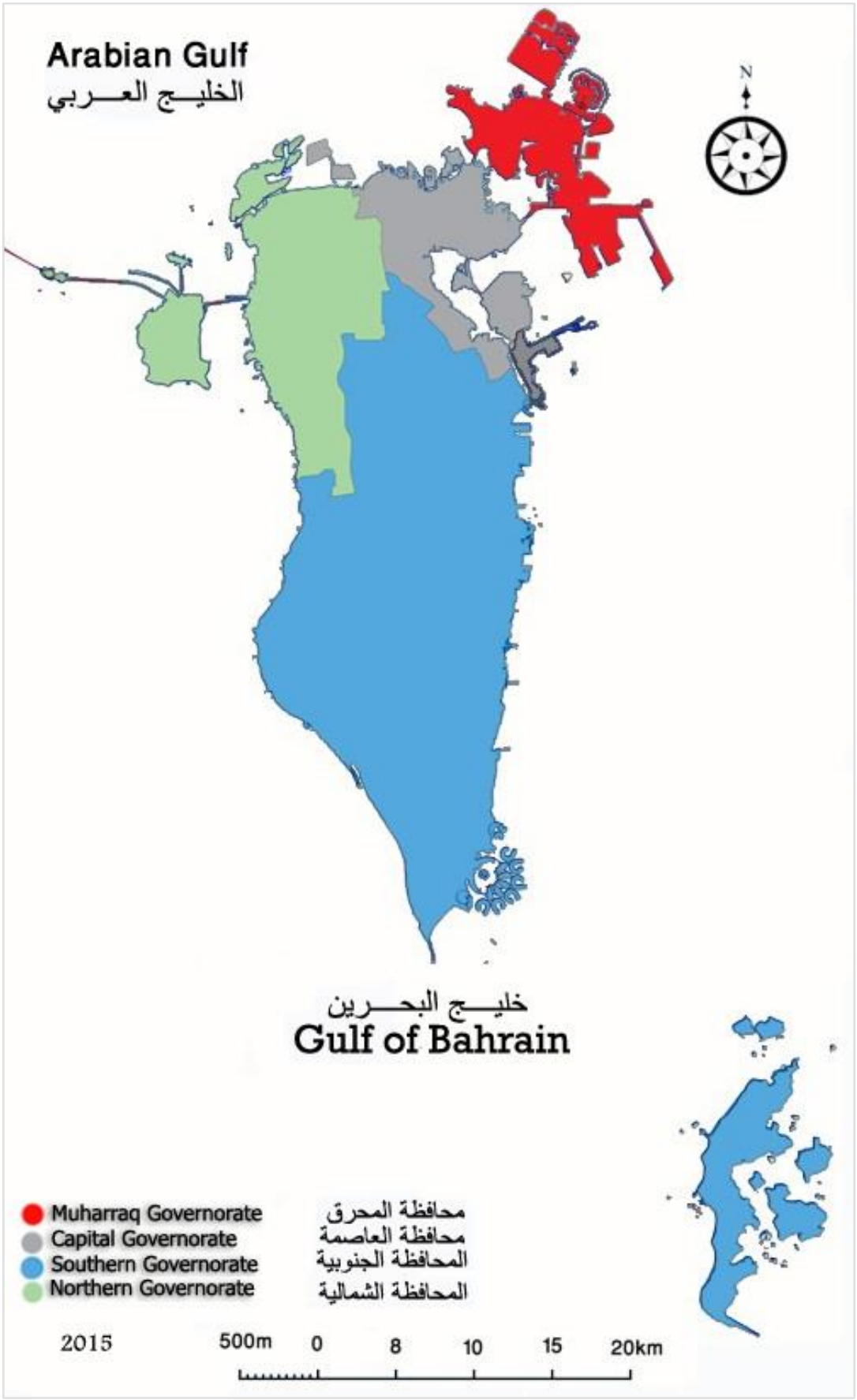
  The accessibility test for data service consist in sending and receiving a 512 byte file with HTTP protocol.

A set is 3 smartphones, one per Operator.

The test vehicle was equipped with the handsets and the software and followed a pre-determined route which was selected to ensure that it covered the 4 Governorates of the Kingdom. Tests were automatically software conducted.

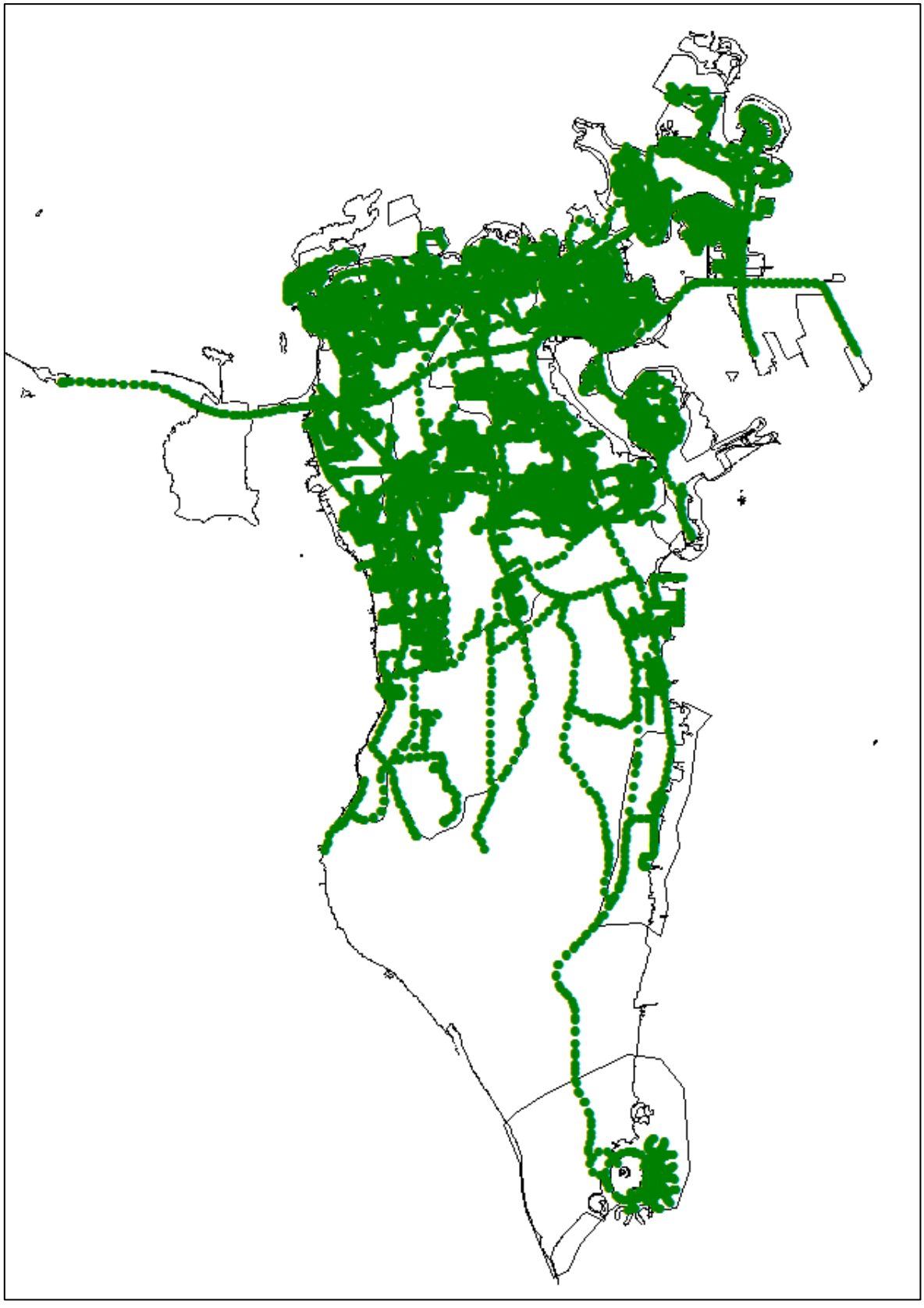
[1] Population data based on CIO latest census (2010)

3.1.1. ADMINISTRATIVE DIVISIONS



3.1.2. DRIVE-TEST ROUTES

Routes followed by the vehicle performing measurements.



3.1.3. EQUIPMENT

Audit measurements were performed using standard mobile phones.

Data coverage
Device: Samsung Note4
Methodology: All devices were set in automatic mode, which means that each data measurement was launched on the best technology offered by the network at the time of the test.
In order to have a representative experience of 2 types of services, those with 4G and those restricted to 3G, devices were set differently:

- One set of smartphones, network mode was: **LTE/WCDMA/GSM (auto connect**).
- On the other set of smartphones, LTE was disabled; network modes were: **WCDMA/GSM (auto connect)**.

Voice coverage:
Device: Samsung Galaxy S5.
Methodology: 1 mobile phone was used for each network, in 2G/3G/4G auto connect, in order to evaluate coverage along the drive, regardless the available technology.
The same setup was repeated to cover all 3 mobile networks, i.e. Batelco, Viva and Zain.

Rooftop box and incar control station

In order to reproduce outdoor test conditions, mobile phones were positioned in a plastic rooftop box. The rooftop box was tested in measuring using a reference signal, attenuation outside and then inside the rooftop box, to validate the absence of significant radio signal attenuation. Similarly the test platform was calibrated using a reference signal to identify and correct any significant difference between mobile phones sensibility.

Inside the rooftop box, mobile phones were positioned vertically on a stable, specifically adapted base, to provide the best possible radio conditions. Electrical supply of each mobile phone was continuously guaranteed to ensure autonomy of the device and optimal radio conditions.

The platform was connected to computer based software recording test results. The set-up was completed with a GPS receiver, which recorded the exact location of each test.

3.1.4. COVERAGE RATE

The geographical coverage rate for each technology is computed using the number of successful measurements on this technology by the total number of measurements.

$$\text{Coverage rate} = \frac{\sum \text{OK}}{\sum \text{OK+NOK}}$$

Data coverage is calculated the same way, using the successful HTTP 512 byte tests among the total sample.

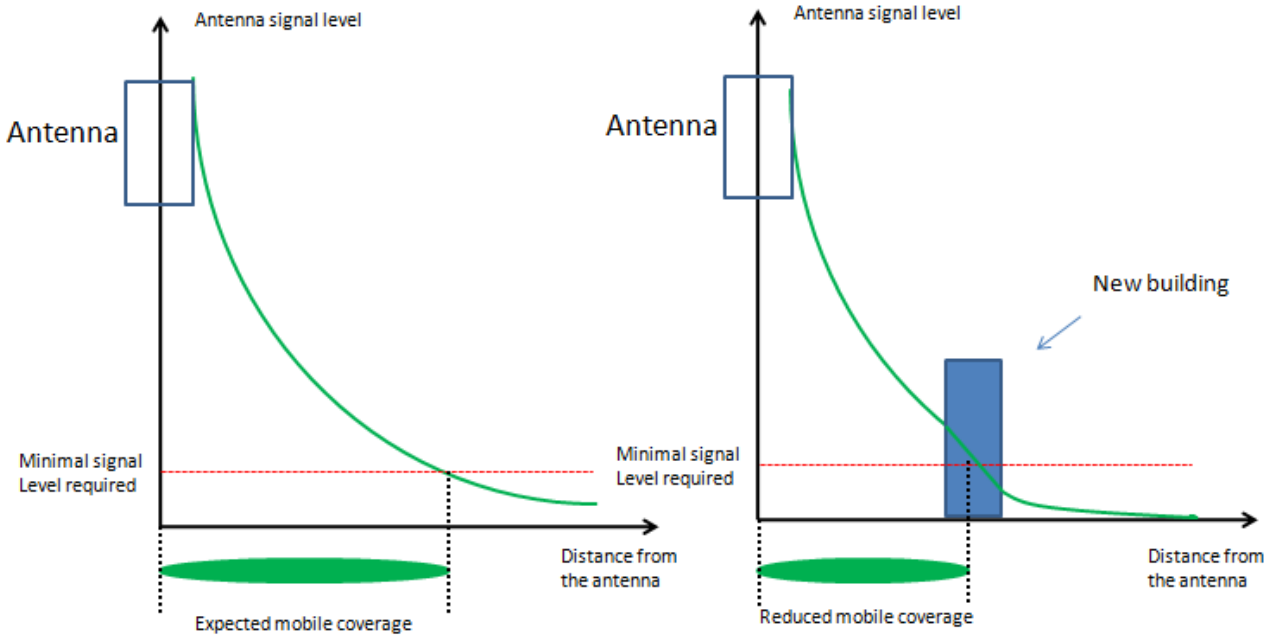
Population coverage is then calculated by weighting these results with the population percentage living in each Governorate, using latest available Central Informatics Organisation (CIO) census statistics for the Kingdom.

3.1.5. ADDITIONAL ELEMENTS

It is important to understand that outdoor coverage is usually better than indoor coverage, because the base station providing the mobile signal is usually located outside, typically on a building roof or a telecommunications mast.

The mobile signal is attenuated when it penetrates a building structure, affected by the thickness of concrete wall and metallic elements used in the construction, thus resulting in lower signal strength inside the building.

In some instances such as malls and large shopping centres, hotels and airports, Mobile Operators implement additional indoor base stations to ensure adequate coverage, however the assessment of indoor coverage was not in the scope of this audit.



Coverage evolution following a new construction

Readers shall understand that mobile coverage can also vary with the evolution of the landscape, the diagram above showing the impact of a new building in a previously fully covered area, and illustrate the need for Mobile Operators to continuously monitor the coverage of their mobile network and take action when necessary to maintain the appropriate coverage level.

4. RESULTS

4.1. POPULATION COVERAGE FOR VOICE AND DATA

4.1.1. POPULATION COVERAGE FOR VOICE SERVICE

		Batelco		Viva		Zain	
Governorate	% Pop	Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	43%	4 333	99.93%	4 479	100%	4 351	99.95%
Northern	26%	3 974	99.95%	4 026	99.98%	3 945	100%
Muharraq	17%	2 024	99.95%	2 094	99.95%	1 982	99.85%
Southern	13%	3 207	100 %	3 290	99.94%	3 265	99.91%
TOTAL		13 538	**99.95%**	13 889	**99.98%**	13 543	**99.94%**

Rate represents the % of successful voice accessibility calls.

4.1.2. POPULATION COVERAGE FOR DATA SERVICE: 4G USER

% of population with a LTE handset with access to data

		Batelco		Viva		Zain	
Governorate	% Pop	Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	43%	7 033	100 %	7 118	100 %	7 138	100 %
Northern	26%	6 666	100 %	6 268	100 %	6 282	100 %
Muharraq	17%	3 135	100 %	3 221	100 %	3 208	100 %
Southern	13%	4 914	100 %	5 169	100 %	5 212	100 %
TOTAL		21 748	**100%**	21 776	**100%**	21 840	**100%**

Rate represents the % of successful http data transfers.

Legend:

Governorate: Governorate name
% Pop: Population percentage in the specific area

Sample: Number of measurements
Coverage: Resulting computed population coverage

4.1.3. Population Coverage for Data service: 3G user

% of population with a non LTE handset with access to data

		Batelco		Viva		Zain	
Governorate	% Pop	Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	43%	6 041	100 %	6 007	100 %	5 985	100 %
Northern	26%	5 657	100 %	5 366	100 %	5 346	100 %
Muharraq	17%	2 285	100 %	2 299	100 %	2 248	100 %
Southern	13%	4 493	100 %	4 569	100 %	4 361	100 %
TOTAL		18 476	**100%**	18 241	**100%**	17 940	**100%**

Rate represents the % of successful http data transfers.

Legend:

Governorate: Governorate name
% Pop: Population percentage in the specific area
Sample: Number of measurements
Coverage: Resulting computed population coverage

4.2. TECHNOLOGY DISTRIBUTION

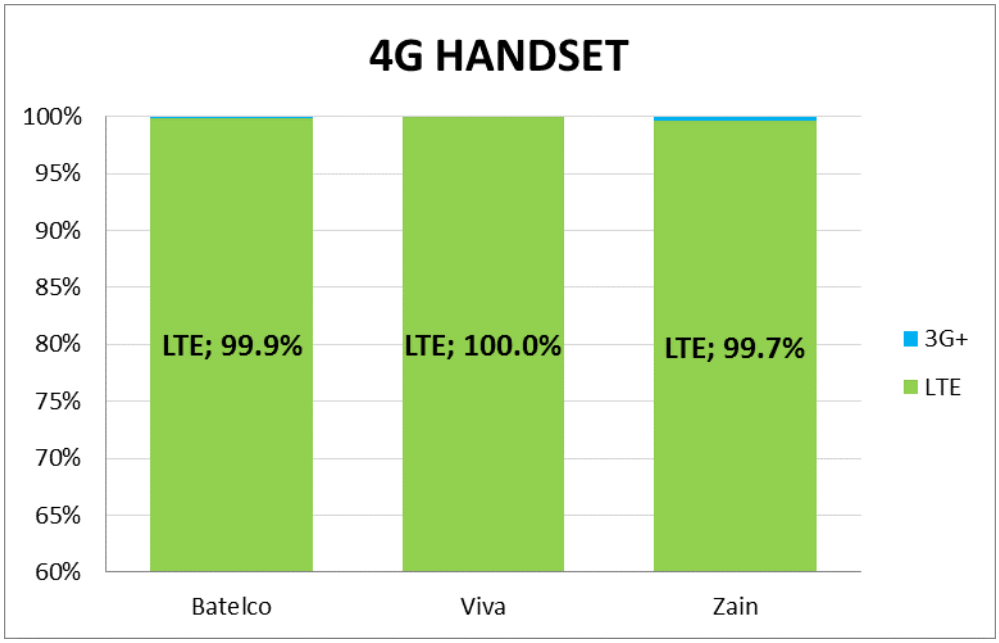
Figures here below show the exact distribution of the data coverage measurements.
First, the rate of successful HTTP test, as a location were the latency was NOK, is considered as not covered.
Then, graphs show the percentages of those successful tests on each technology used by the mobile.

4.2.1. 4G HANDSET

	Batelco	Viva	Zain
Rate of successful HTTP tests	100%	100%	100%

On technology:

LTE	**99.9%**	**100%**	**99.7%**
HSPAP	**0.1%**	**0.0%**	**0.3%**
HSPA	**0.0%**	**0.0%**	**0.0%**

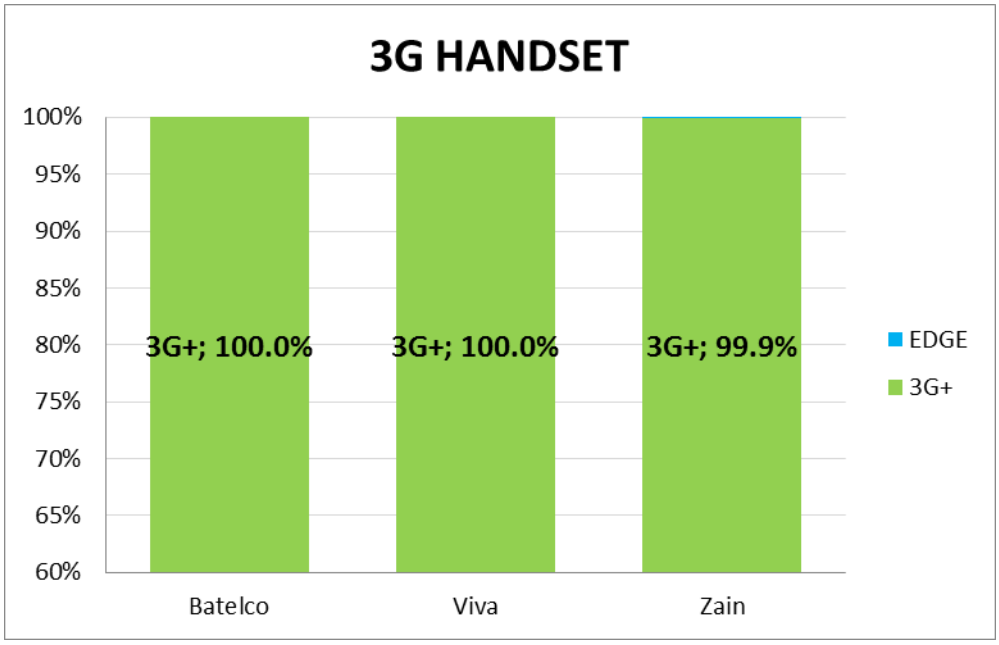


4.2.2. 3G HANDSET

	Batelco	Viva	Zain
Rate of successful HTTP latency	100%	100%	100%

On technology:

HSPAP	**100%**	**100%**	**99.93%**
EDGE			**0.07%**



4.3. AUDIT OF OPERATORS' COVERAGE MAPS

Another objective of this audit was to verify operator's coverage maps reliability. Maps have been provided by each operator at the beginning of this audit. The documents presented hereafter show each operator's coverage maps with a superimposed layer showing results of the coverage measurements performed by Directique, using the following colour code:

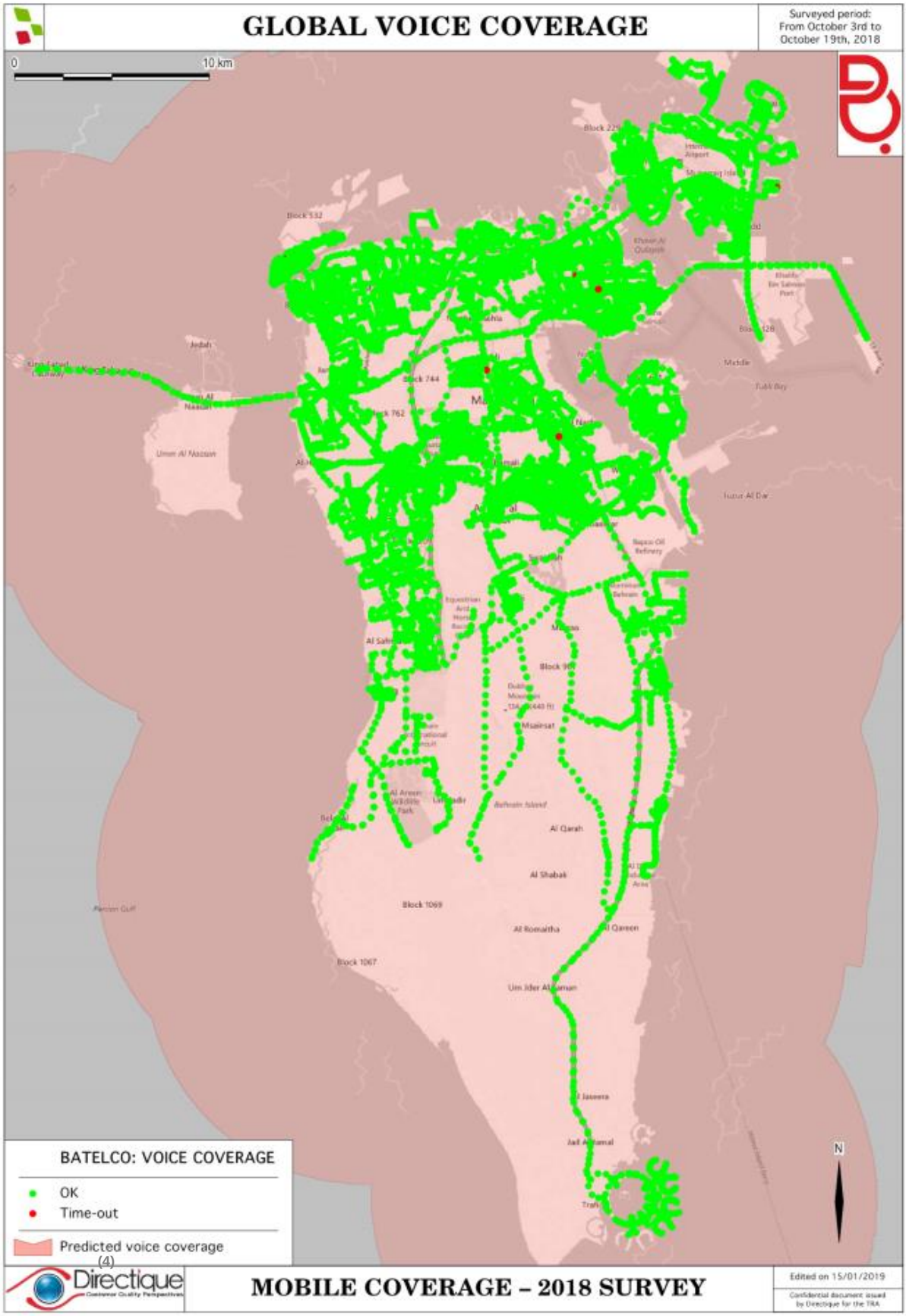
If the spot is **blue**, the test was outside the coverage zone of the operator.

If the spot is **green**, the test was inside the coverage zone of the operator and accessibility to network was effective on the handset

If the spot is **red**, the test was inside the coverage zone of the operator and accessibility to network was not effective on the handset

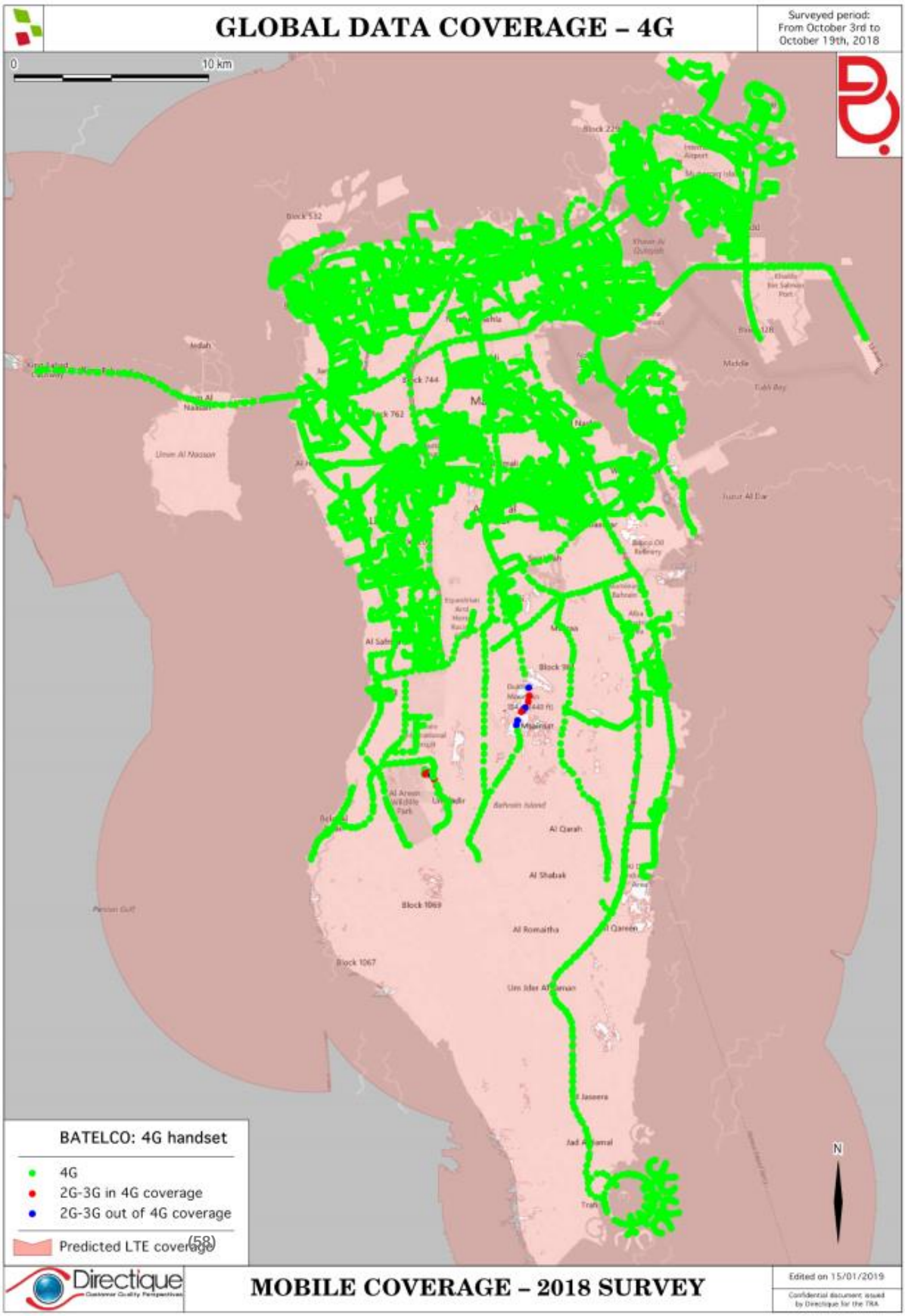
For data measurements, separate maps have been produced for both LTE and non-LTE users.

4.3.1. BATELCO – VOICE COVERAGE

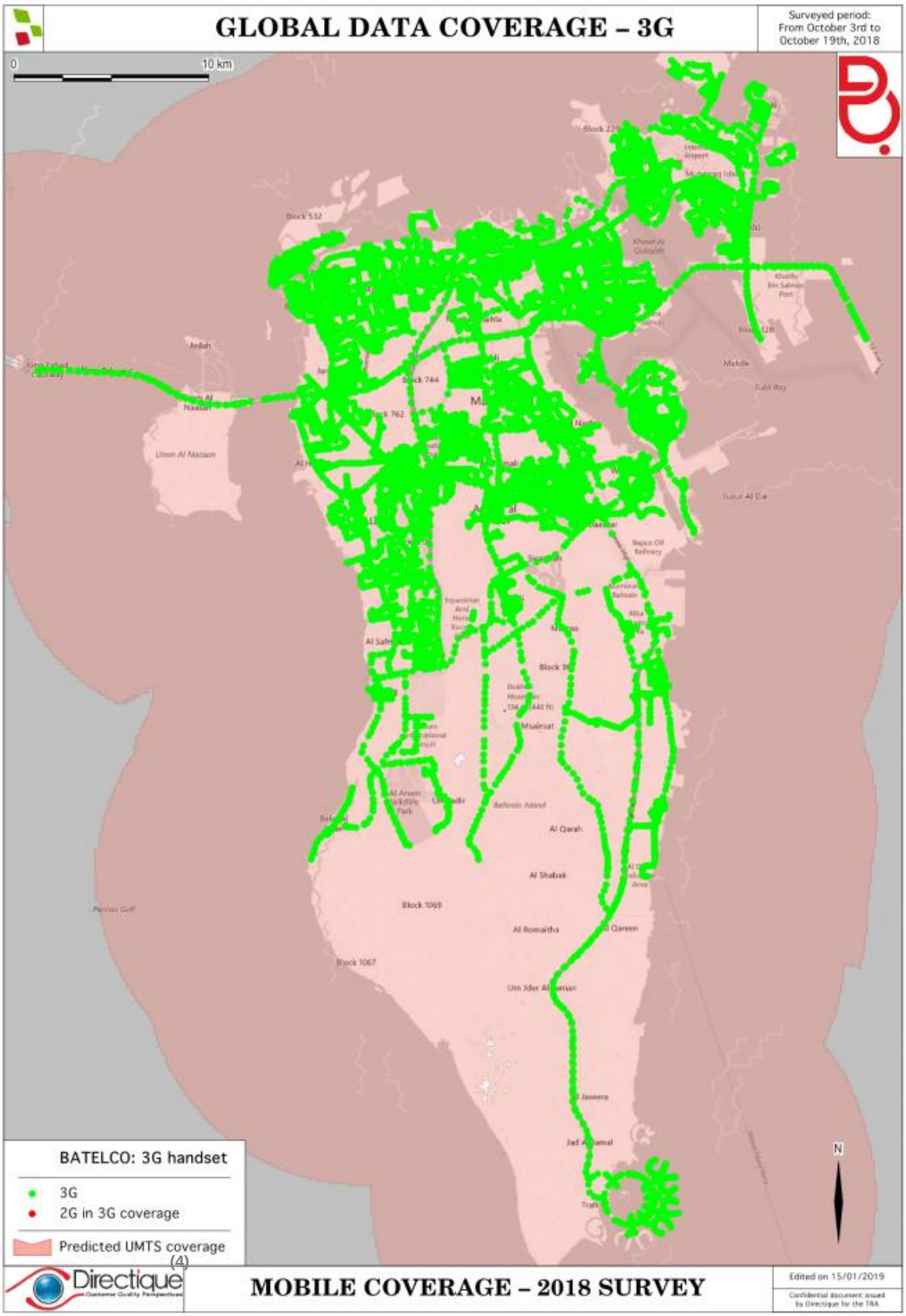


(4)

4.3.2. BATELCO 4G – DATA COVERAGE FOR A LTE USER

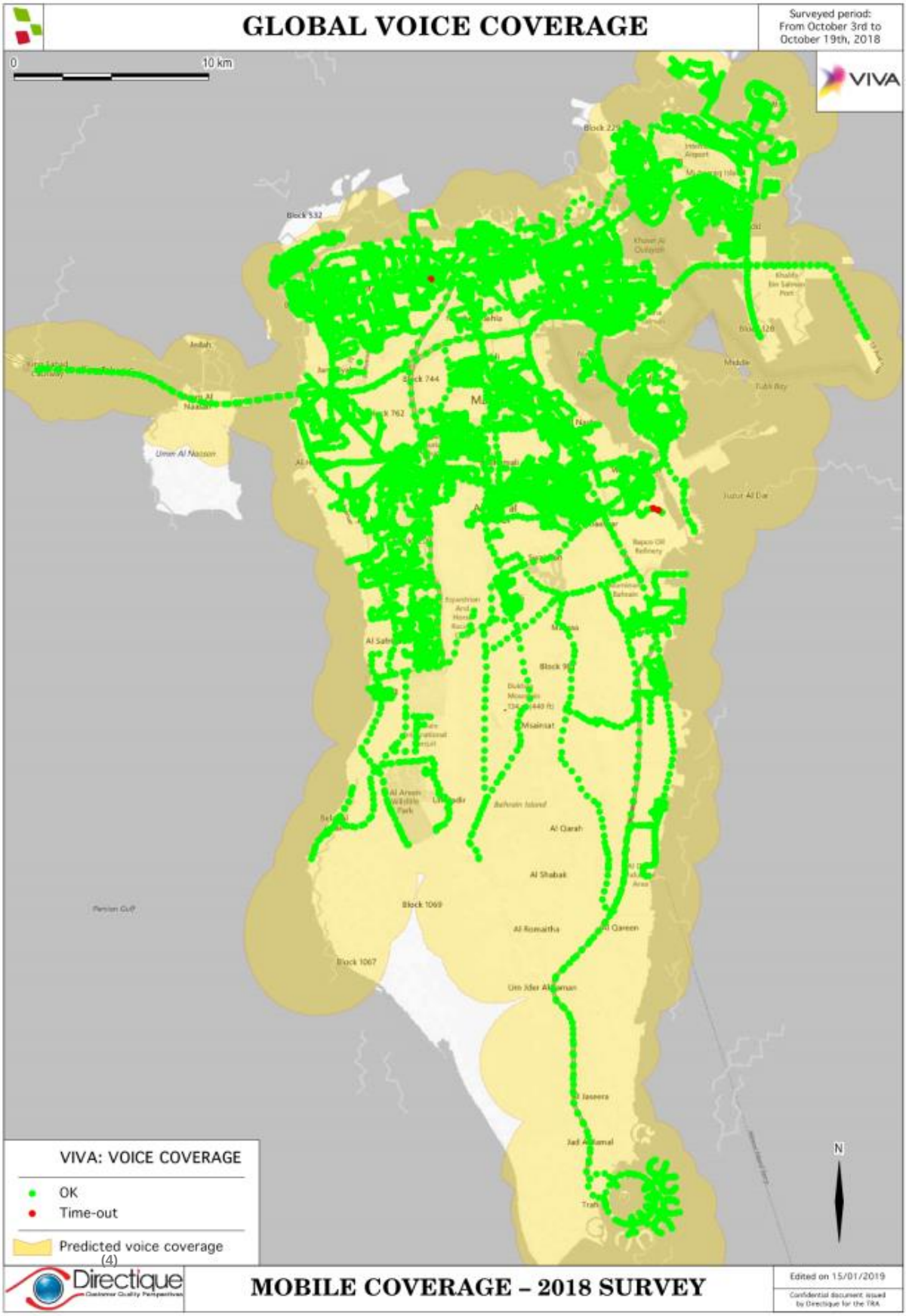


4.3.3. BATELCO 3G – DATA COVERAGE FOR A 3G USER

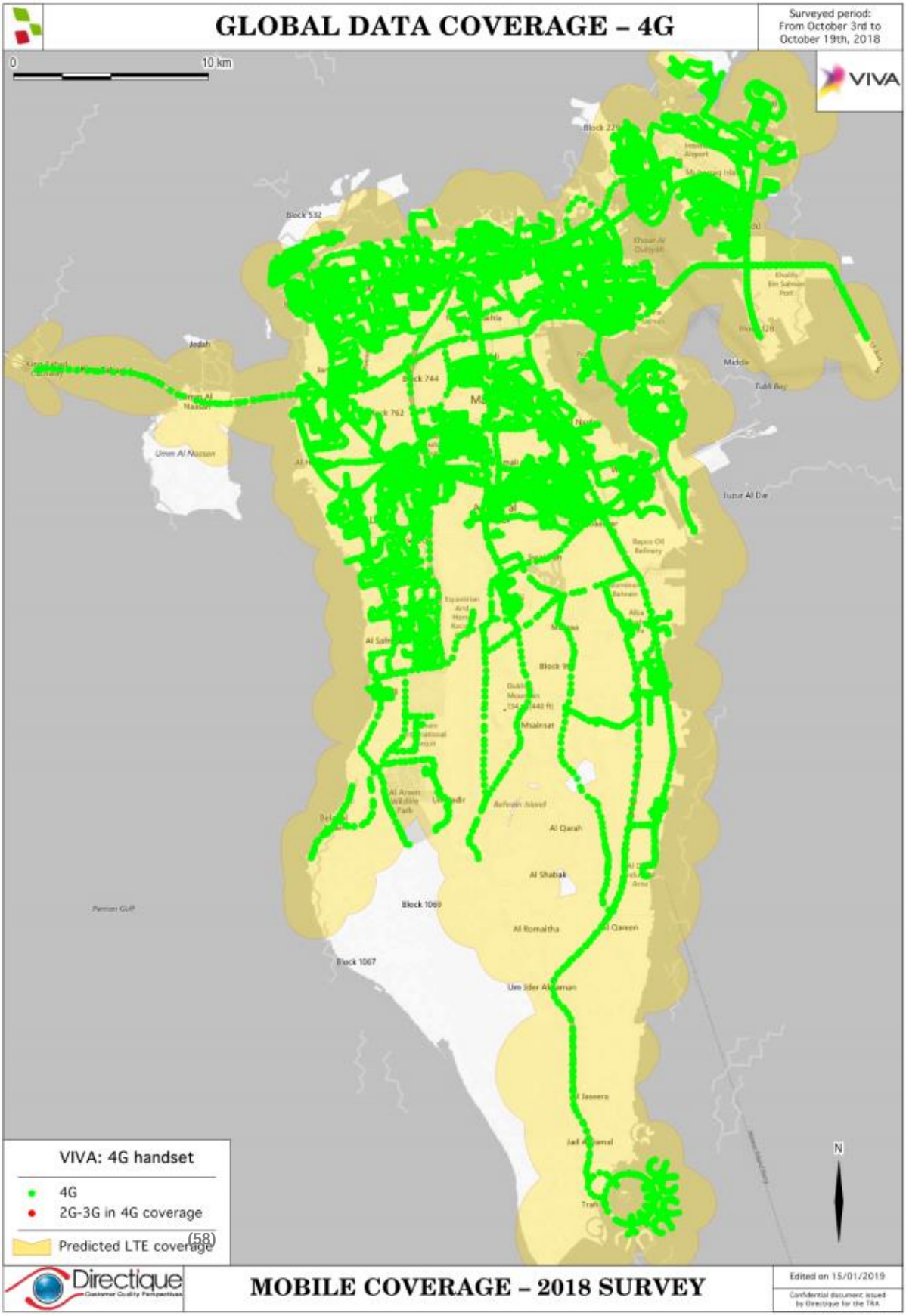


(4)

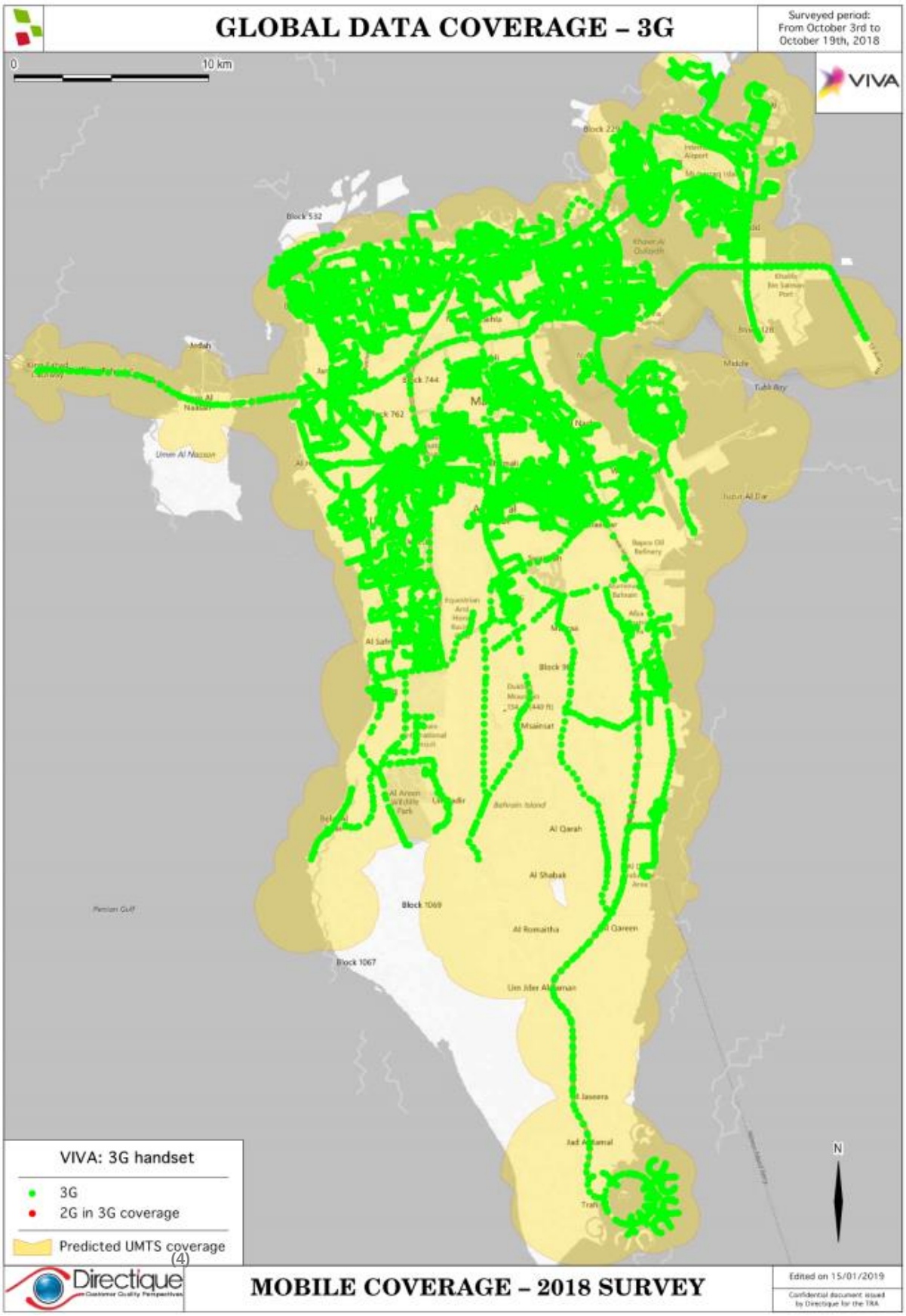
4.3.4. VIVA – VOICE COVERAGE



4.3.5. VIVA 4G – DATA COVERAGE FOR A LTE USER

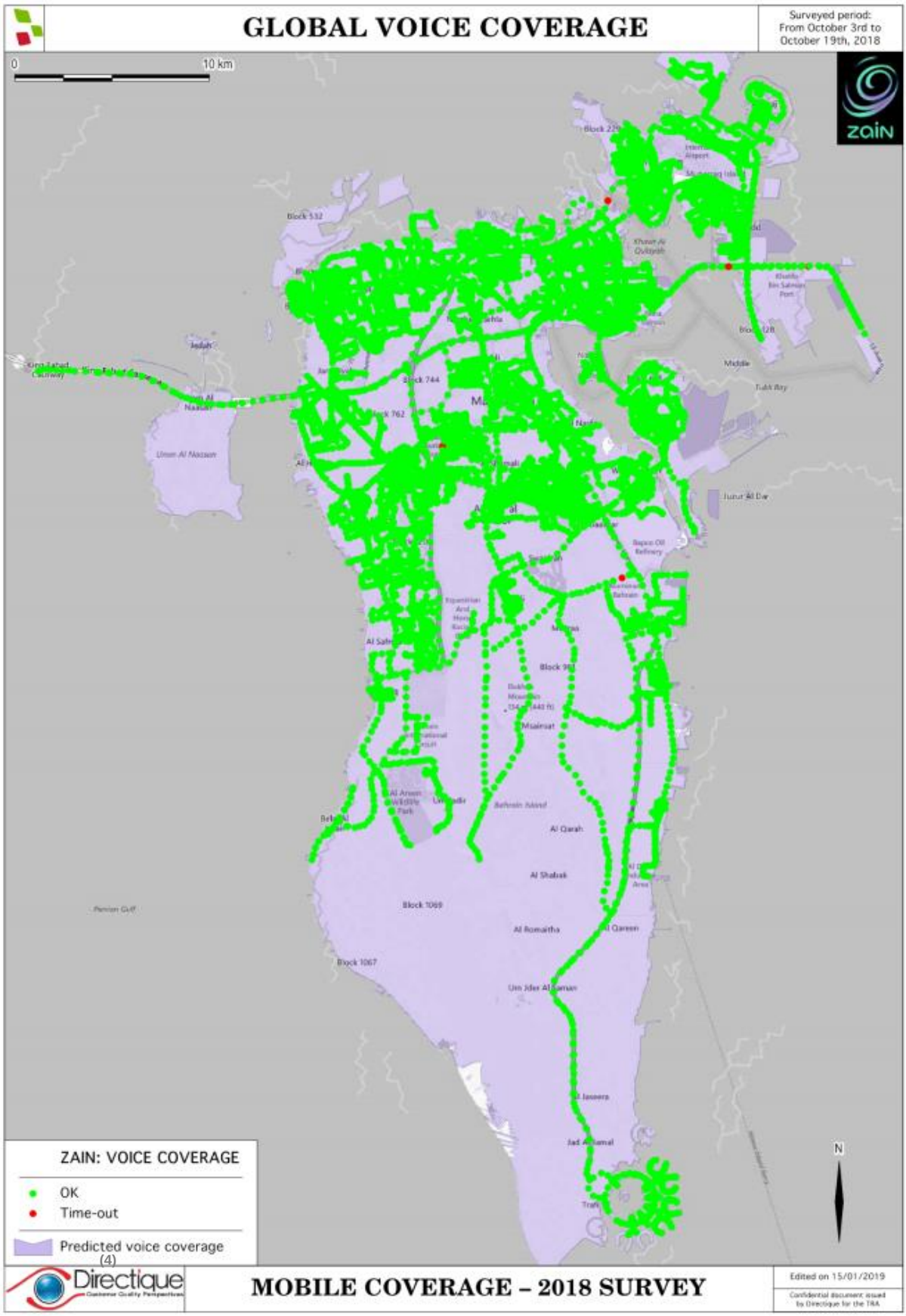


4.3.6. VIVA 3G – DATA COVERAGE FOR A 3G USER

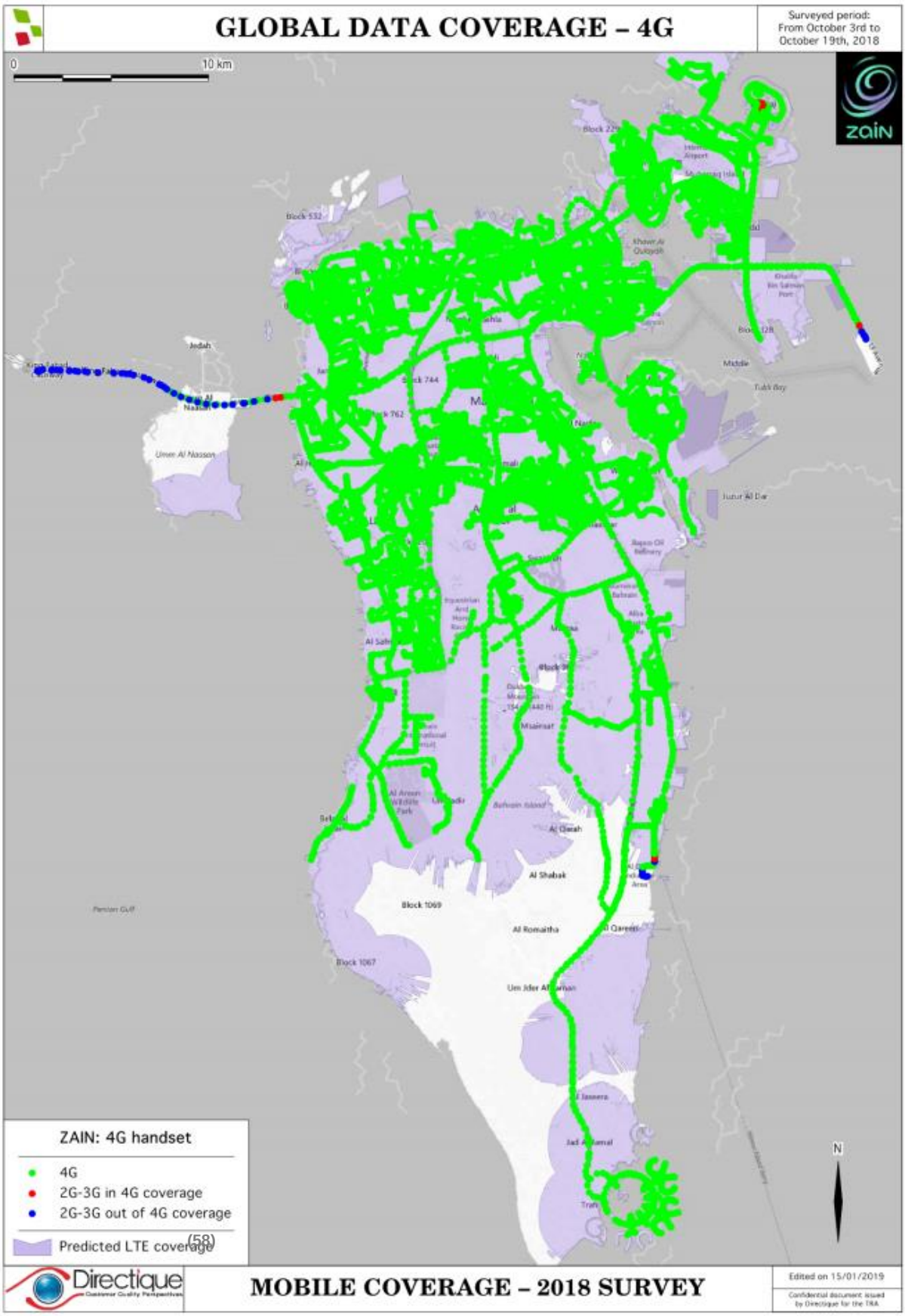


(4)

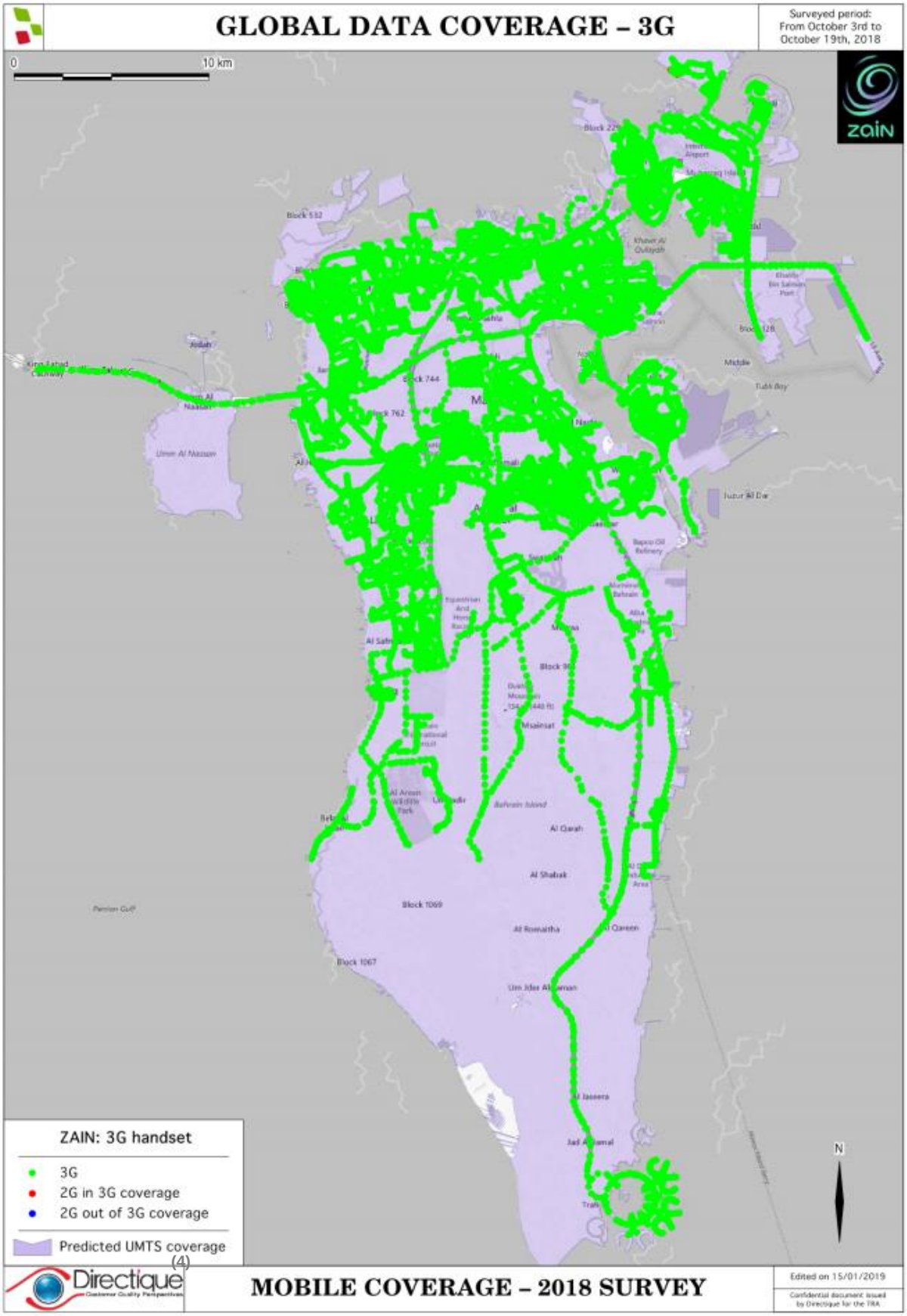
4.3.7. ZAIN – VOICE COVERAGE



4.3.8. ZAIN 4G – DATA COVERAGE FOR A LTE USER



4.3.9. ZAIN 3G – DATA COVERAGE FOR A 3G USER



4.4. IDLE COVERAGE – SIGNAL STRENGTH DISTRIBUTION

All devices were in auto connect mode.

The following results have been calculated using signal strength on the handset while in IDLE, i.e. between accessibility calls.

Batelco - Signal strength distribution (IDLE mode):

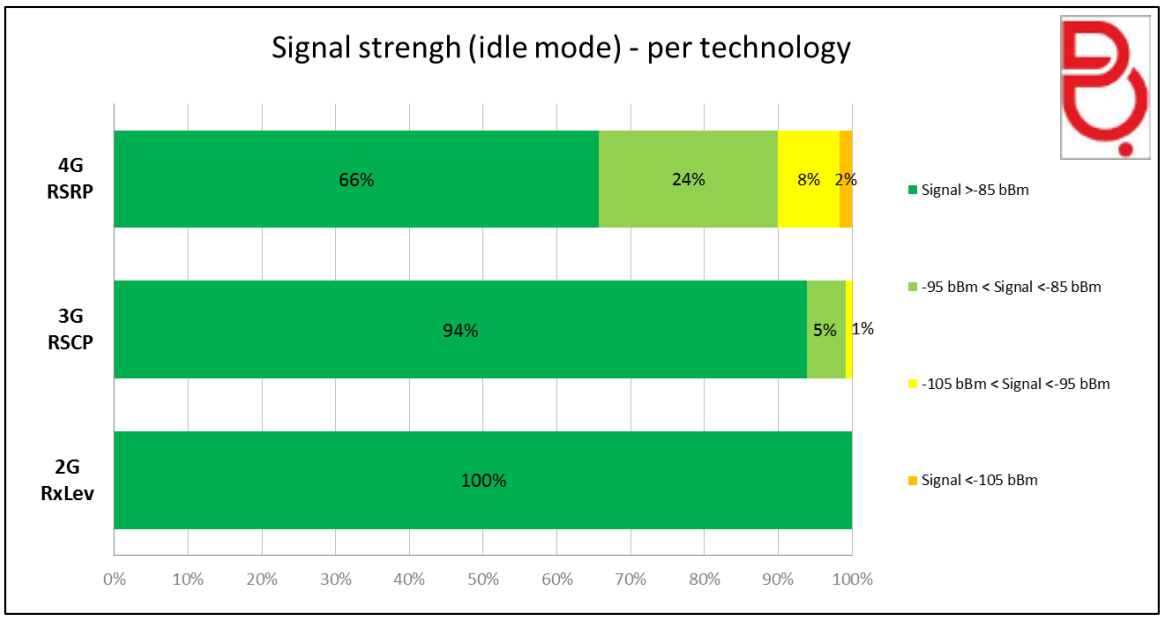
BATELCO	2G RxLev	3G RSCP	4G RSRP
Sample	615	35 413	173 596
Signal >-85 dBm	100%	94%	66%
-95 dBm < Signal <-85 dBm	0%	5%	24%
-105 dBm < Signal <-95 dBm	0%	1%	8%
Signal <-105 dBm	0%	0%	2%

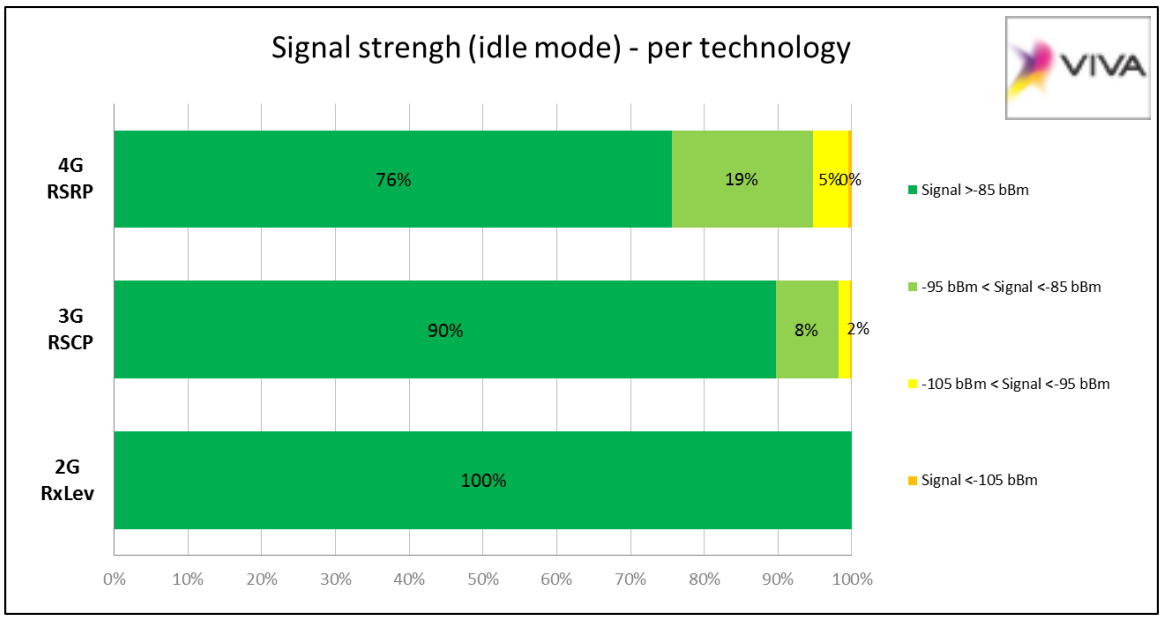
Viva - Signal strength distribution (IDLE mode):

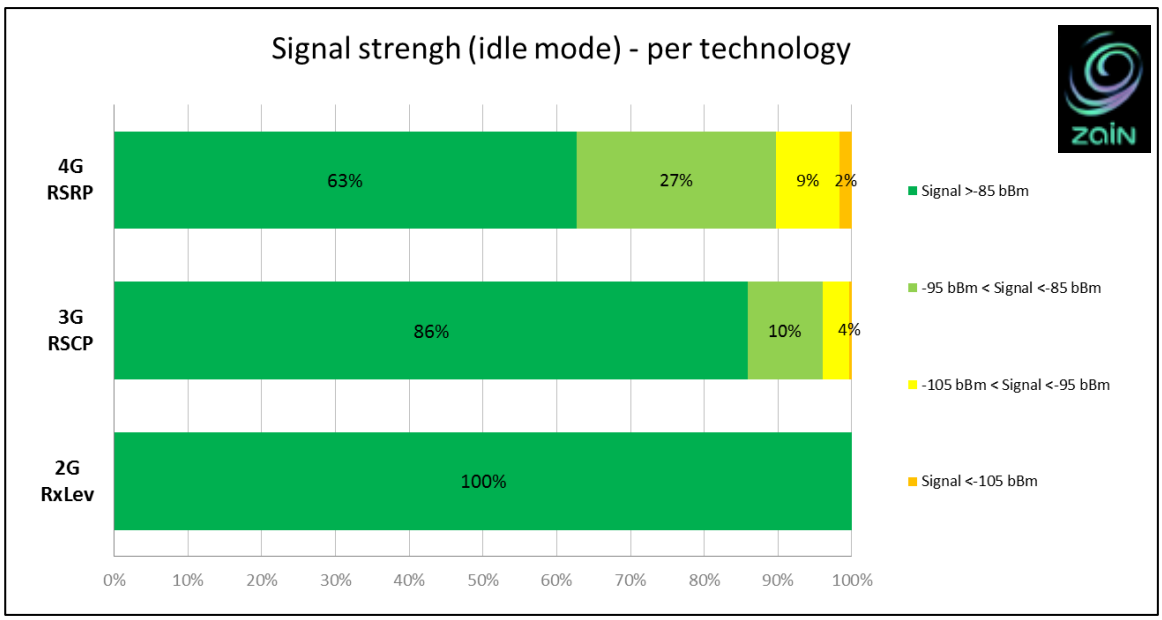
VIVA	2G RxLev	3G RSCP	4G RSRP
Sample	221	15 607	184 782
Signal >-85 dBm	100%	90%	76%
-95 dBm < Signal <-85 dBm	0%	8%	19%
-105 dBm < Signal <-95 dBm	0%	2%	5%
Signal <-105 dBm	0%	0%	0%

Zain - Signal strength distribution (IDLE mode):

ZAIN	2G RxLev	3G RSCP	4G RSRP
Sample	2 108	14 745	198 028
Signal >-85 dBm	100%	86%	63%
-95 dBm < Signal <-85 dBm	0%	10%	27%
-105 dBm < Signal <-95 dBm	0%	4%	9%
Signal <-105 dBm	0%	0%	2%


Signal strengh (idle mode) - per technology
4G RSRP
3G RSCP
2G RxLev
66%
24%
8%
2%
94%
5%
1%
100%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Signal >-85 bBm
-95 bBm < Signal <-85 bBm
-105 bBm < Signal <-95 bBm
Signal <-105 bBm


Signal strengh (idle mode) - per technology
VIVA
4G RSRP
3G RSCP
2G RxLev
76%
19%
5%
0%
90%
8%
2%
100%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Signal >-85 bBm
-95 bBm < Signal <-85 bBm
-105 bBm < Signal <-95 bBm
Signal <-105 bBm


Signal strengh (idle mode) - per technology
zain
4G RSRP
3G RSCP
2G RxLev
63%
27%
9%
2%
86%
10%
4%
100%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Signal >-85 bBm
-95 bBm < Signal <-85 bBm
-105 bBm < Signal <-95 bBm
Signal <-105 bBm

End of document