Directique
Customer Quality Perspectives

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

MOBILE NETWORKS COVERAGE AUDIT
KINGDOM OF BAHRAIN – 2020

Version	Date	Author	Changelog
1	22/02/2021	Olivier GHIBAUDO	Creation of document
2	07/03/2021	Olivier GHIBAUDO	5G added and change according to TRA comments
3	15/03/2021	Olivier GHIBAUDO	Updated from Batelco comments received
4	16/03/2021	Olivier GHIBAUDO	Updated from MNOs and TRA Comments
5	06/04/2021	Olivier GHIBAUDO	Updated from MNOs and TRA Comments
6	21/04/2021	Olivier GHIBAUDO	Updated from TRA Comments

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, STC Bahrain 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.

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 following network mode:
For voice:

- a set of smartphones in Auto connect mode

For data:

- a set of smartphones with 5G enabled
- a set of smartphones with LTE enabled
- a set of smartphones with 3G 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.

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, STC Bahrain 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 20th of November to the 16th December 2020 across the Kingdom's 4 Governorates for Voice, 3G, 4G and 5G coverage.

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.

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.

As 5G newtorks are non stand-alone network but closely linked to 4G network and deployment not finished for all operators, the measurement of the 5G coverage has been based on 5G signal displayed on handset.

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* ***Nemo Drive Test Tool.***

  The accessibility test for voice service consist in placing a call and checking if signalling is ok.

- **3G and 4G Data**: data accessibility tests (HTTP DL) for 3G and 4G with ***Nemo Drive Test Tool***:
  - 1 set in 4G/3G mode, to represent the LTE users
  - 1 set in 3G/2G mode, to represent the non LTE users

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

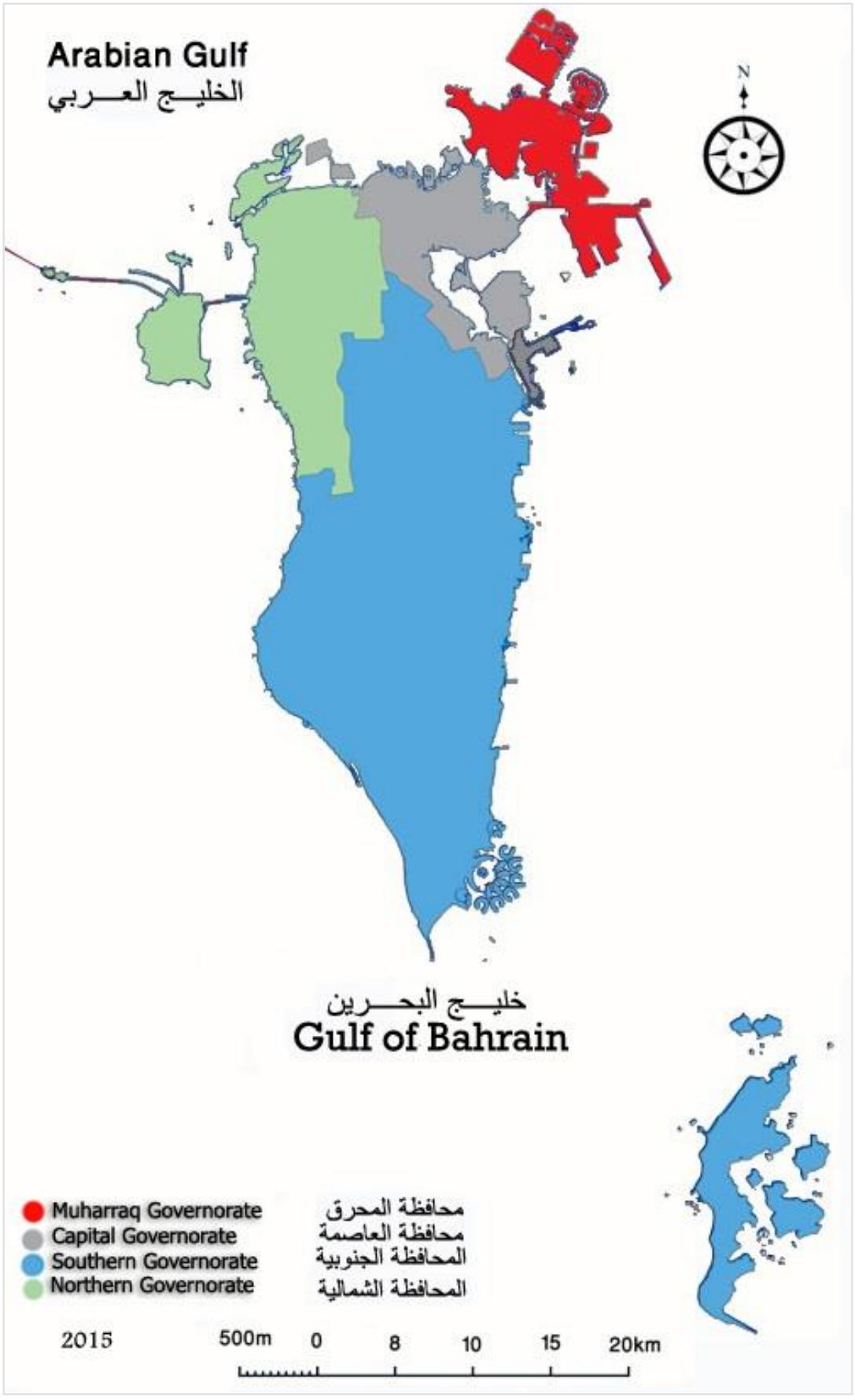
- ***5G Data***: based on 5G signal displayed on handsets with ***Nemo Drive Test Tool***:
  - 1 set in 5G/4G mode, to represent the 5G users

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.

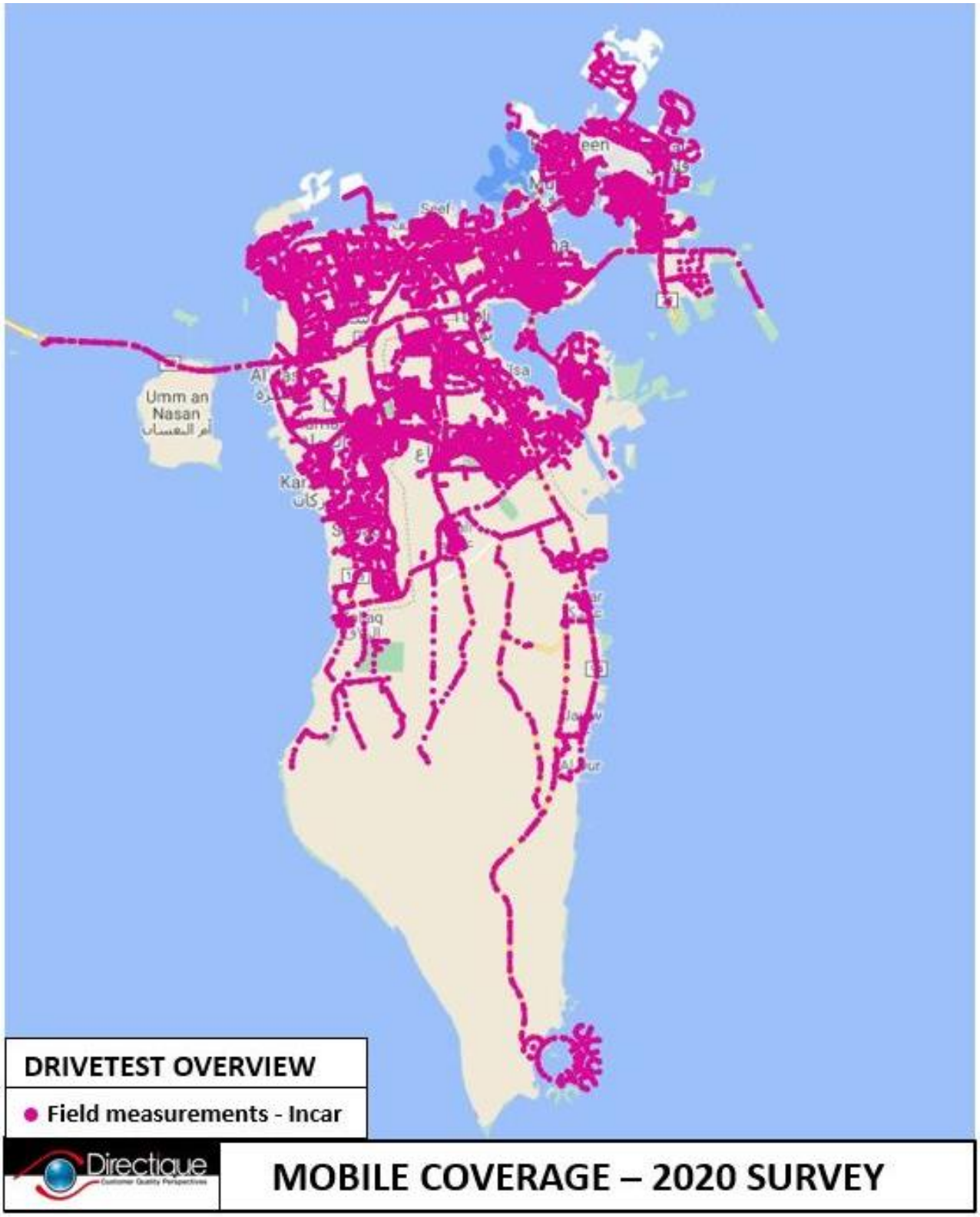
[1] Population data based on CIO latest census (2018)

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 Galaxy S9 for 3G and 4G, Huawei P40 for 5G
Methodology: In order to have a representative experience of 3 types of services, all devices were set in the following technology mode:

- For 5G, one set of smartphones where network mode was **5G/LTE**
- For 4G, one set of smartphones where network mode was: **LTE/WCDMA**.
- For 3G, one set of smartphones where network mode was: **WCDMA/GSM**.

Voice coverage:
Device: Samsung Galaxy S9.
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, STC Bahrain 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.

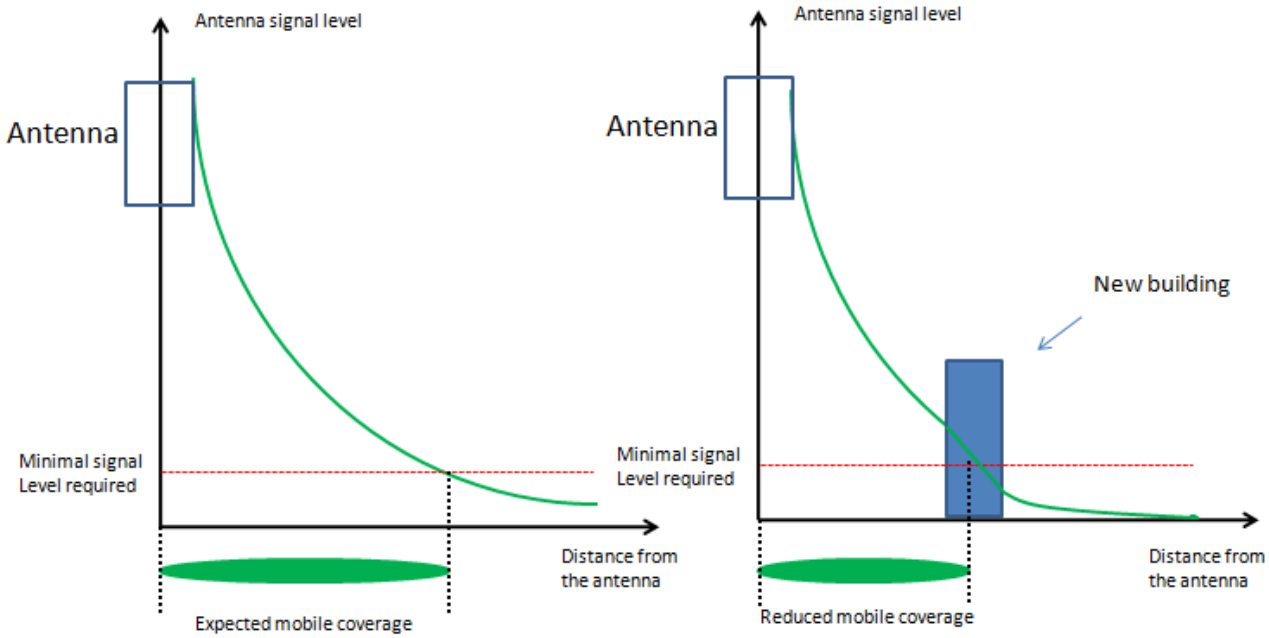
Population coverage is then calculated by weighting these results with the population percentage living in each Governorate, using latest available Central Informatics Organisation (CIO) census statistics for the Kingdom.

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		STC		ZAIN	
Governorate	% Pop	Nb	Coverage	Nb	Coverage	Nb	Coverage
Capital	37%	2 328	100.00%	2 339	99.57%	2335	99.36%
Northern	24%	2 527	100.00%	2 535	99.68%	2568	99.42%
Muharraq	18%	1 216	100.00%	1 219	99.34%	1218	99.59%
Southern	21%	1 673	100.00%	1 681	99.70%	1679	99.70%
Total		7 744	**100.0%**	7 774	**99.6%**	7 800	**99.5%**
Statistical accuracy on Coverage			+/-0.0%		+/-0.1%		+/-0.2%

Rate represents the % of successful voice accessibility calls.

4.1.2. POPULATION COVERAGE FOR DATA SERVICE: 5G USER

% of population with a 5G handset covered with 5G Signal:

		BATELCO		STC		ZAIN	
Governorate	% Pop	Nb	Coverage	Nb	Coverage	Nb	Coverage
Capital	37%	1947	100.0 %	1959	98.9 %	1942	28.3 %
Northern	24%	2613	100.0 %	2631	92.4 %	2620	12.7 %
Muharraq	18%	1227	100.0 %	1237	99.0 %	1224	56.2 %
Southern	21%	1469	99.5%	1437	83.5 %	1460	33.0 %
Total		7 256	**100%**	7 264	**94.1 %**	7 246	**30.6 %**

Rate represents the % of 5G signal displayed on handset.

Legend:

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

4.1.3. Accuracy of the MNOs Coverage Maps for Data 5G

% of accuracy of the MNOs coverage maps provided for Data 5G and the measurement performed:

	BATELCO	STC	ZAIN
% of Accuracy of coverage map provided	100.00%	100.00%	100.00%

4.1.4. Population Coverage for Data service: 4G user

% of population with a LTE handset with access to data

		BATELCO		STC		ZAIN	
Governorate	% Pop	Nb	Coverage	Nb	Coverage	Nb	Coverage
Capital	37%	1900	100 %	1900	100 %	1900	100 %
Northern	24%	2478	100 %	2478	100 %	2478	100 %
Muharraq	18%	1136	100 %	1136	100 %	1136	100 %
Southern	21%	1452	100%	1452	100 %	1452	100 %
Total		6 966	**100%**	6 966	**100%**	6 966	**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

4.1.5. Population Coverage for Data service: 3G user

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

		BATELCO		STC		ZAIN	
Governorate	% Pop	Nb	Coverage	Nb	Coverage	Nb	Coverage
Capital	37%	1914	100 %	1914	100 %	1914	100 %
Northern	24%	2564	100 %	2564	100 %	2564	100 %
Muharraq	18%	1163	100 %	1163	99.9 %	1163	99.8 %
Southern	21%	1425	100 %	1425	100 %	1425	100 %
Total		7 066	**100%**	7 066	**100%**	7 066	**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.

For 5G handset, first the rate of 5G signal displayed on handset is provided, if 5G signal is not displayed on handset then the location is considered as not covered.
Then, graph showing the percentage of those successful 5G signal displayed is provided.

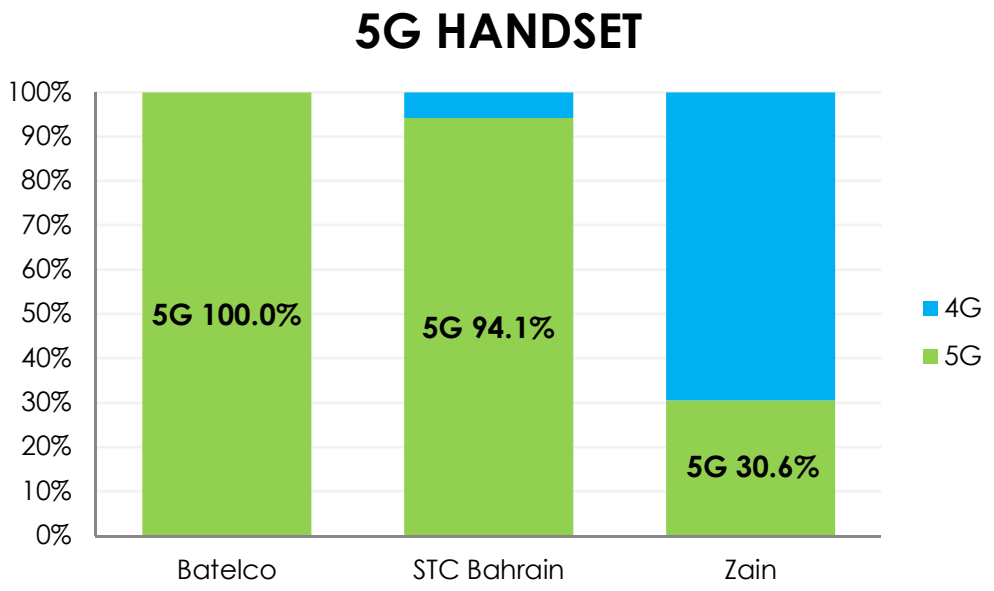
For 3G and 4G handset, first the rate of successful HTTP test is provided, as a location where the latency was NOK, is considered as not covered.
Then, graphs show the percentages of those successful tests on each technology used by the mobile.

4.2.1. 5G HANDSET

	BATELCO	STC	ZAIN
Rate of 5G Signal displayed on handset	100%	94.1%	30.6%

On technology:

5G	**100%**	**94.1%**	**30.6 %**
4G	**0%**	**5.9%**	**69.4 %**

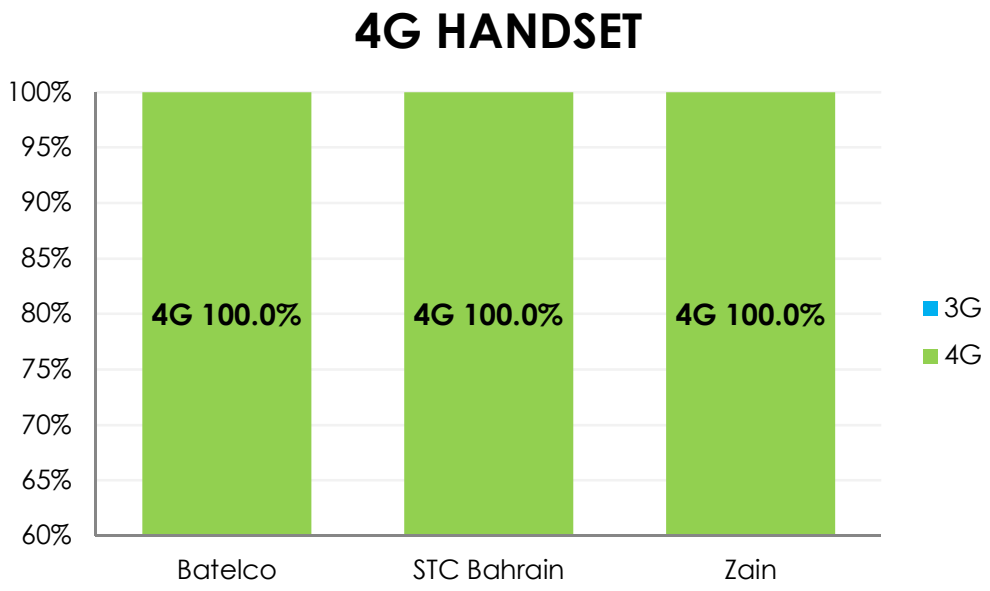


4.2.2. 4G HANDSET

	BATELCO	STC	ZAIN
Rate of successful HTTP tests	100%	100%	100%

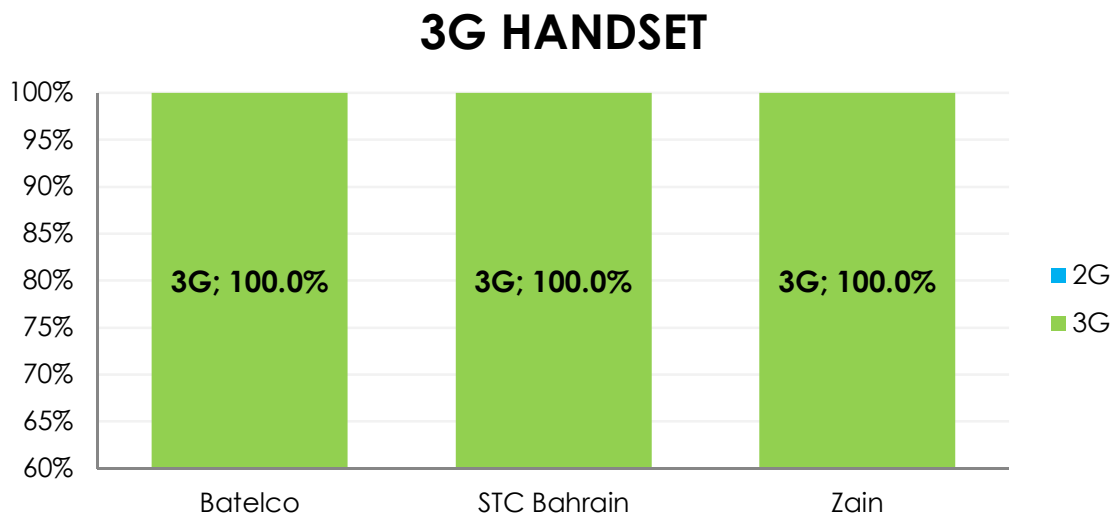
On technology:

4G	**100%**	**100%**	**100%**
3G	**0%**	**0%**	**0%**



4.2.3. 3G HANDSET

	BATELCO	STC	ZAIN
Rate of successful HTTP latency	100%	100%	100%
On technology:			
3G	**100%**	**100%**	**100%**
2G	**0%**	**0%**	**0%**



4.3. AUDIT OF OPERATORS' COVERAGE MAPS

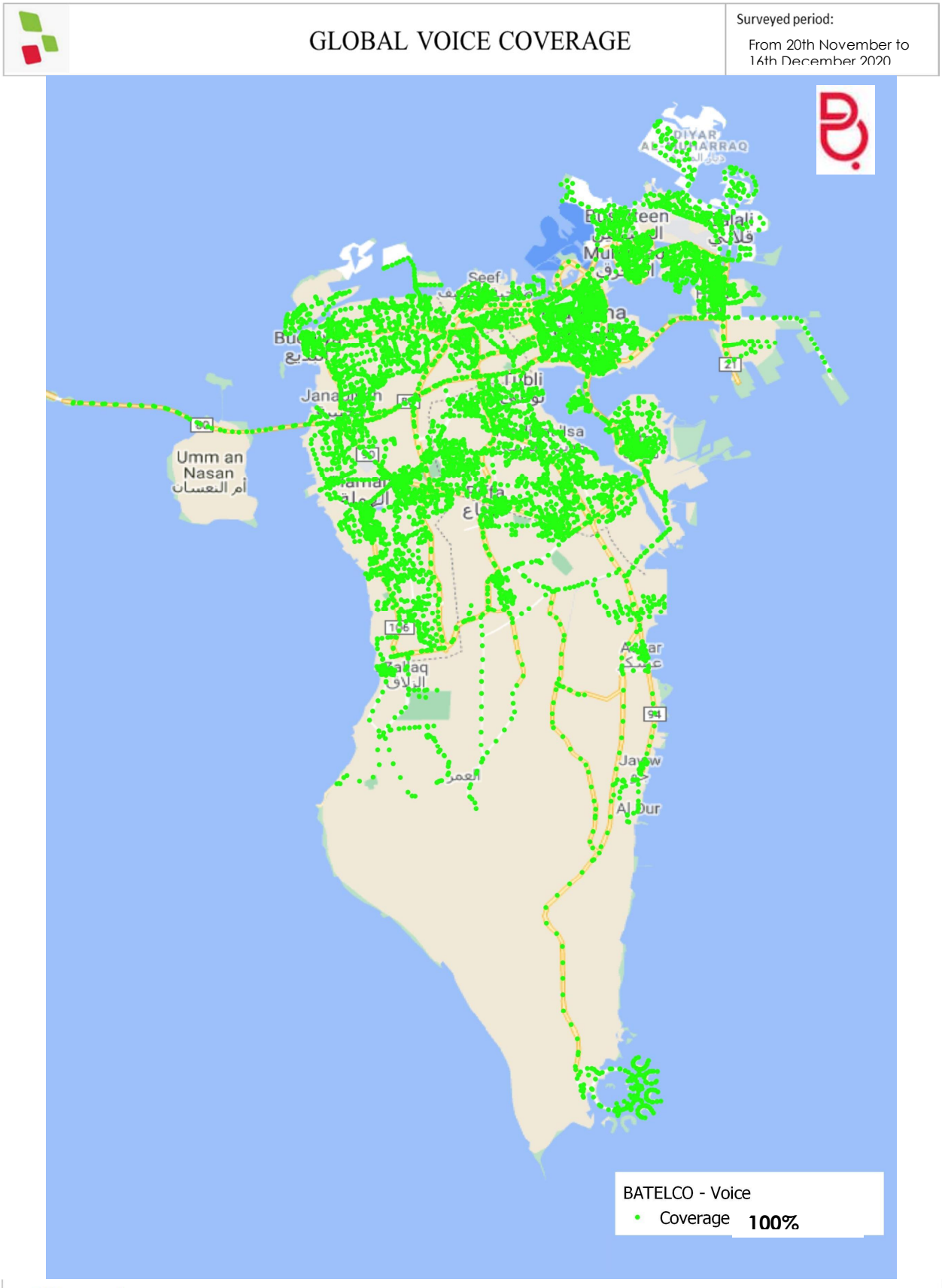
Another objective of this audit was to verify operator's coverage maps reliability.
Maps have been provided by each operator at the beginning of this audit.
The documents presented hereafter show each operator's coverage maps with a superimposed layer showing results of the coverage measurements performed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

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

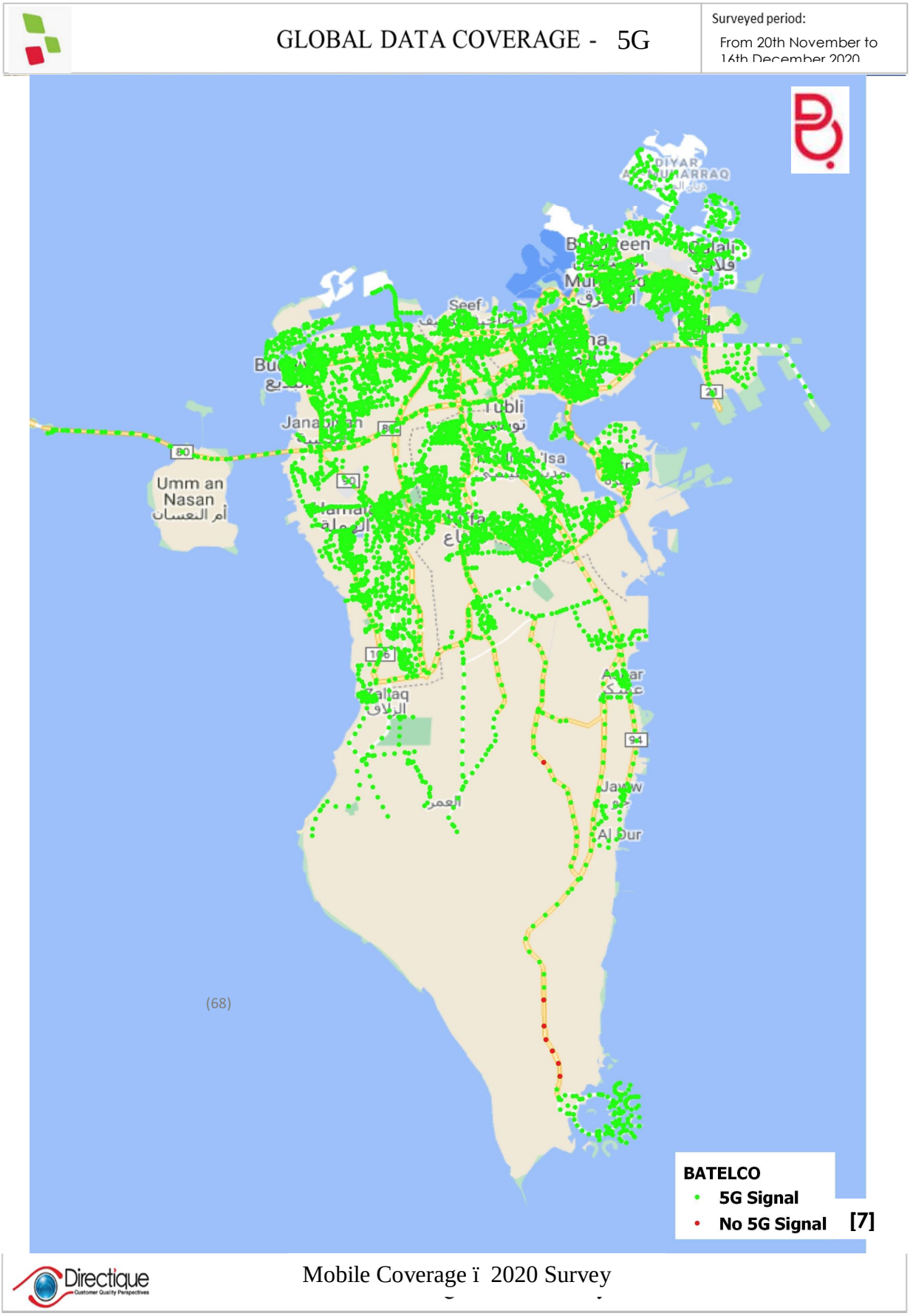
If the spot is **red**, the test was inside the coverage zone of the operator and accessibility to network was not effective on the handset

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

4.3.1. BATELCO – VOICE COVERAGE

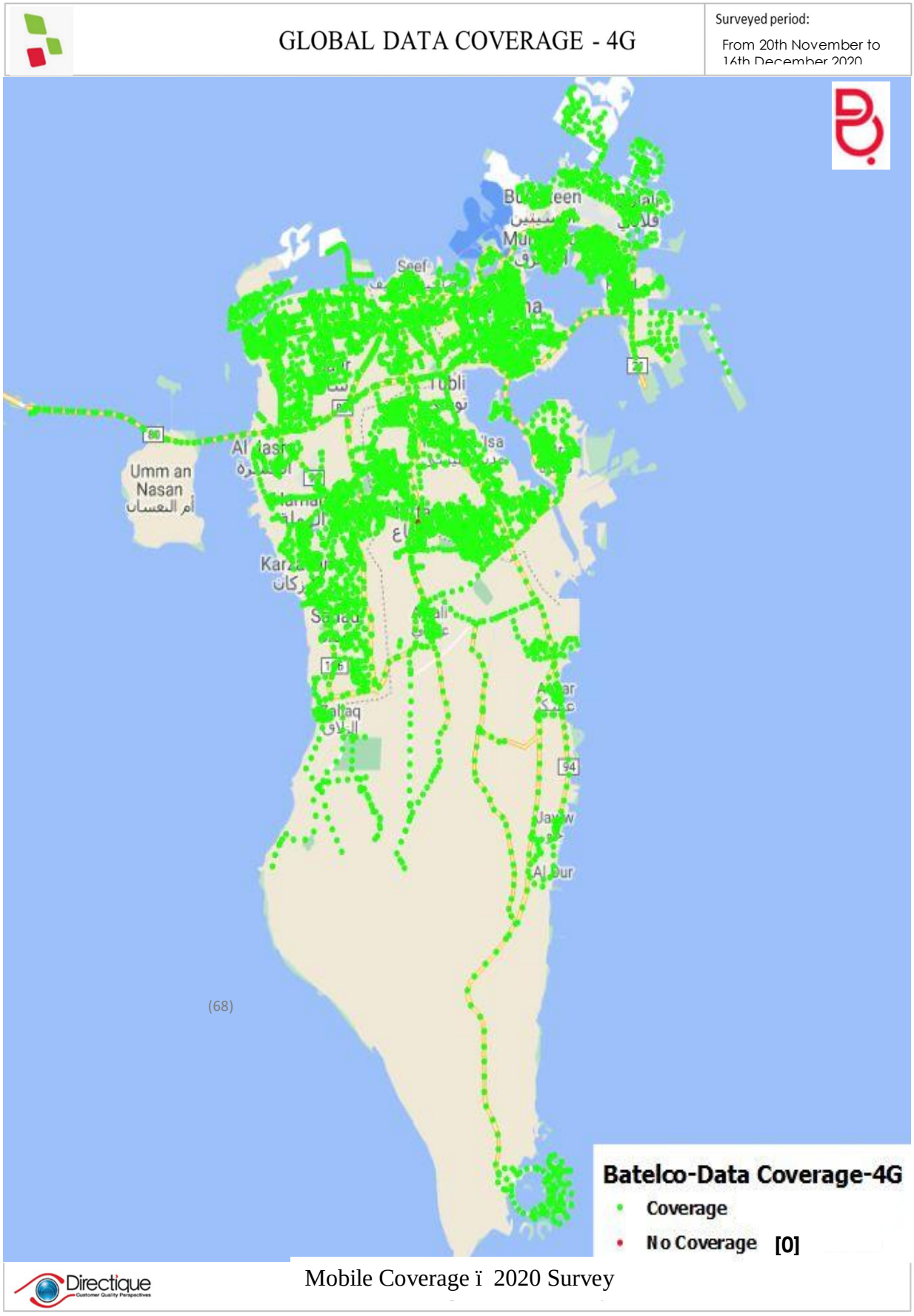


4.3.2. BATELCO 5G – DATA COVERAGE FOR A 5G USER

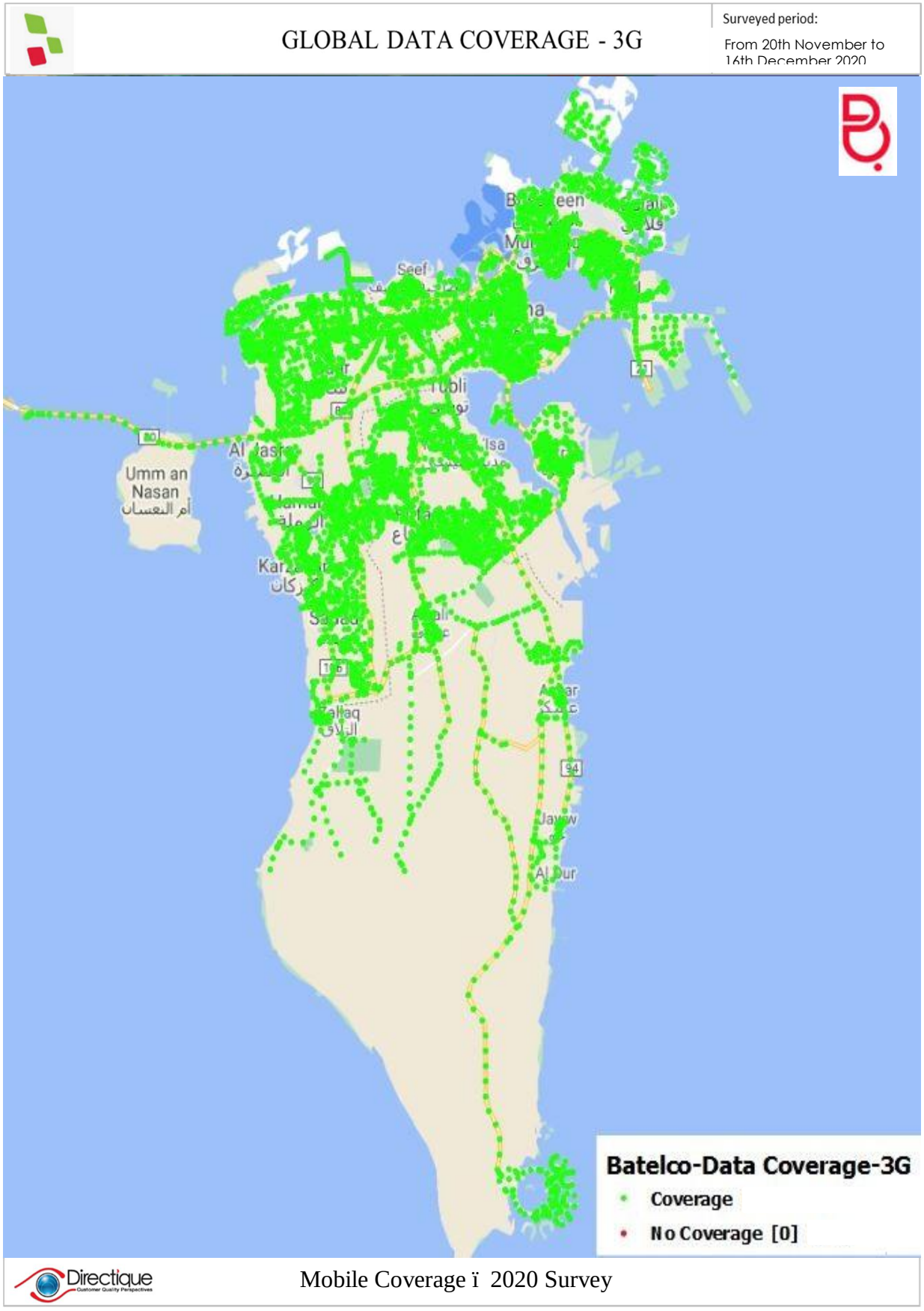


(68)

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



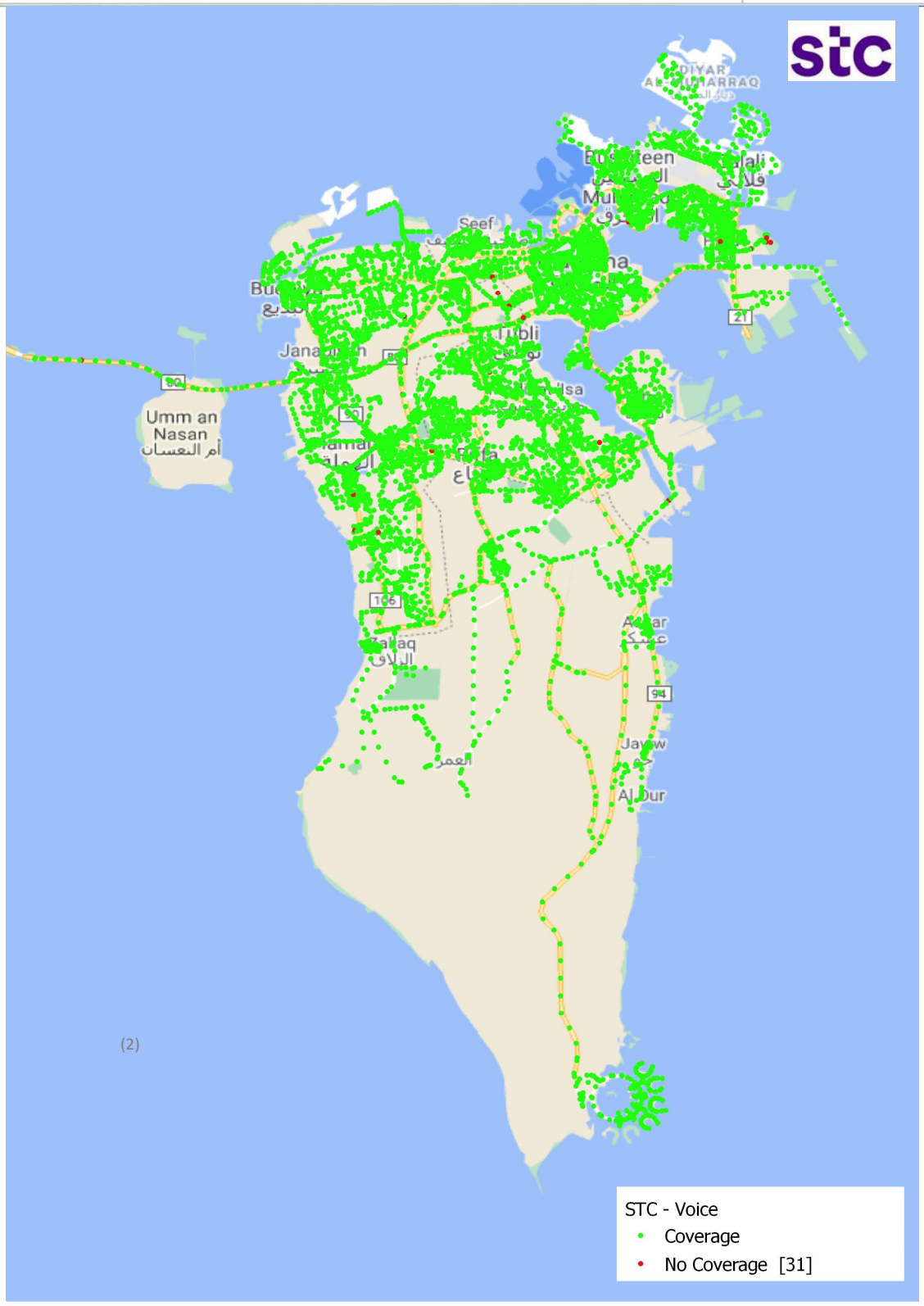
4.3.4. BATELCO 3G – DATA COVERAGE FOR A 3G USER



4.3.5. STC BAHRAIN – VOICE COVERAGE

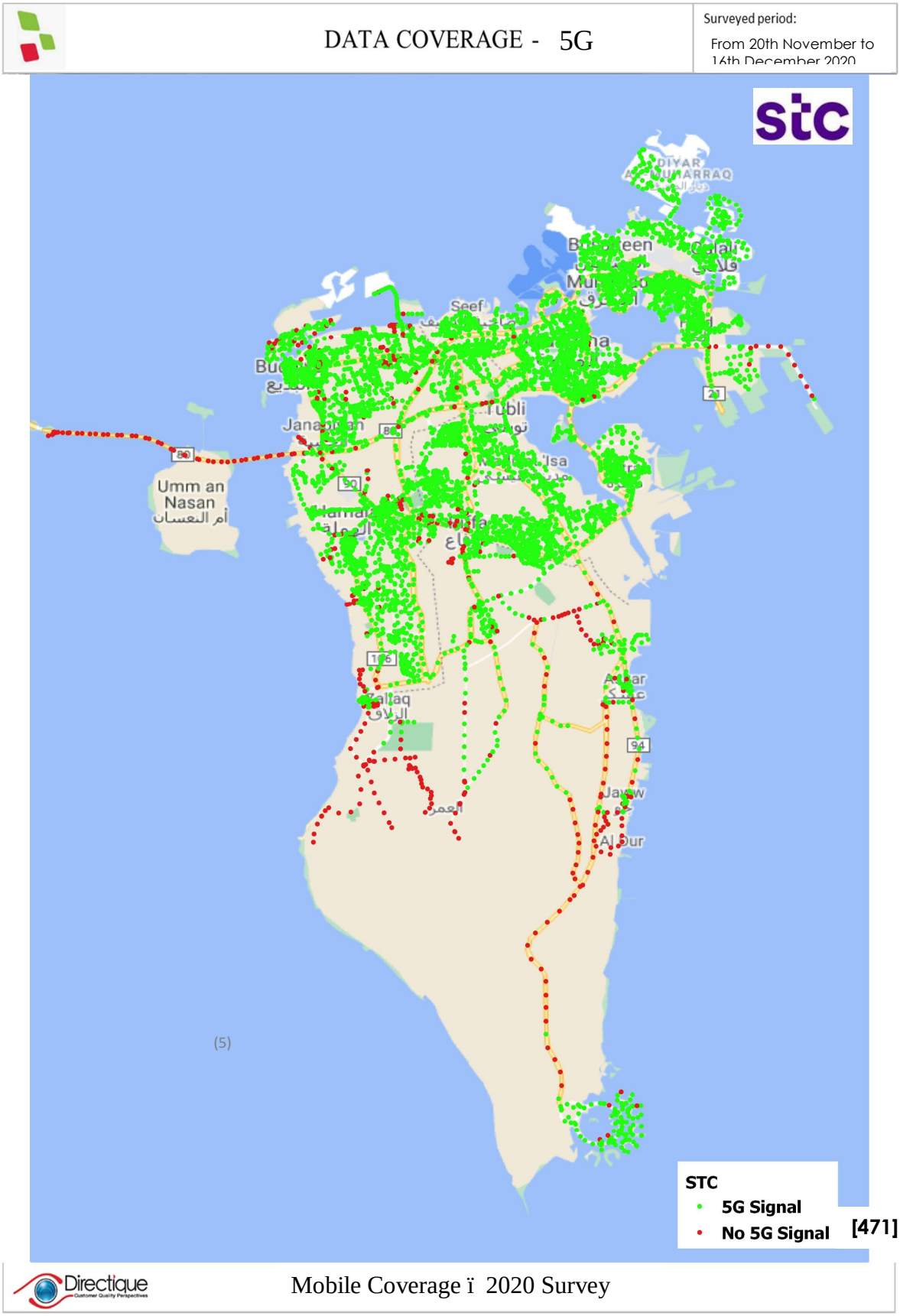
GLOBAL VOICE COVERAGE

Surveyed period:
From 20th November to 16th December 2020

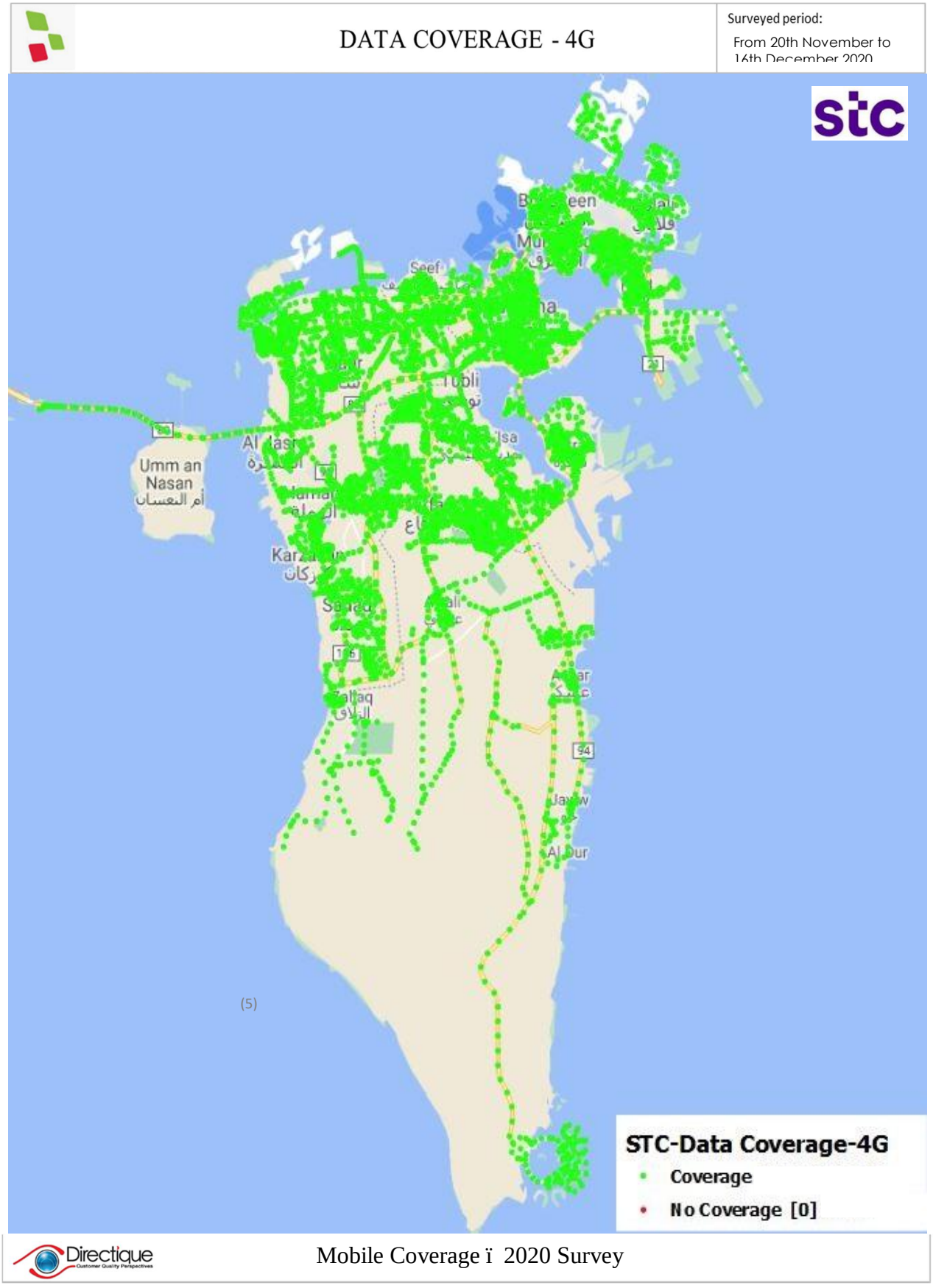


(2)

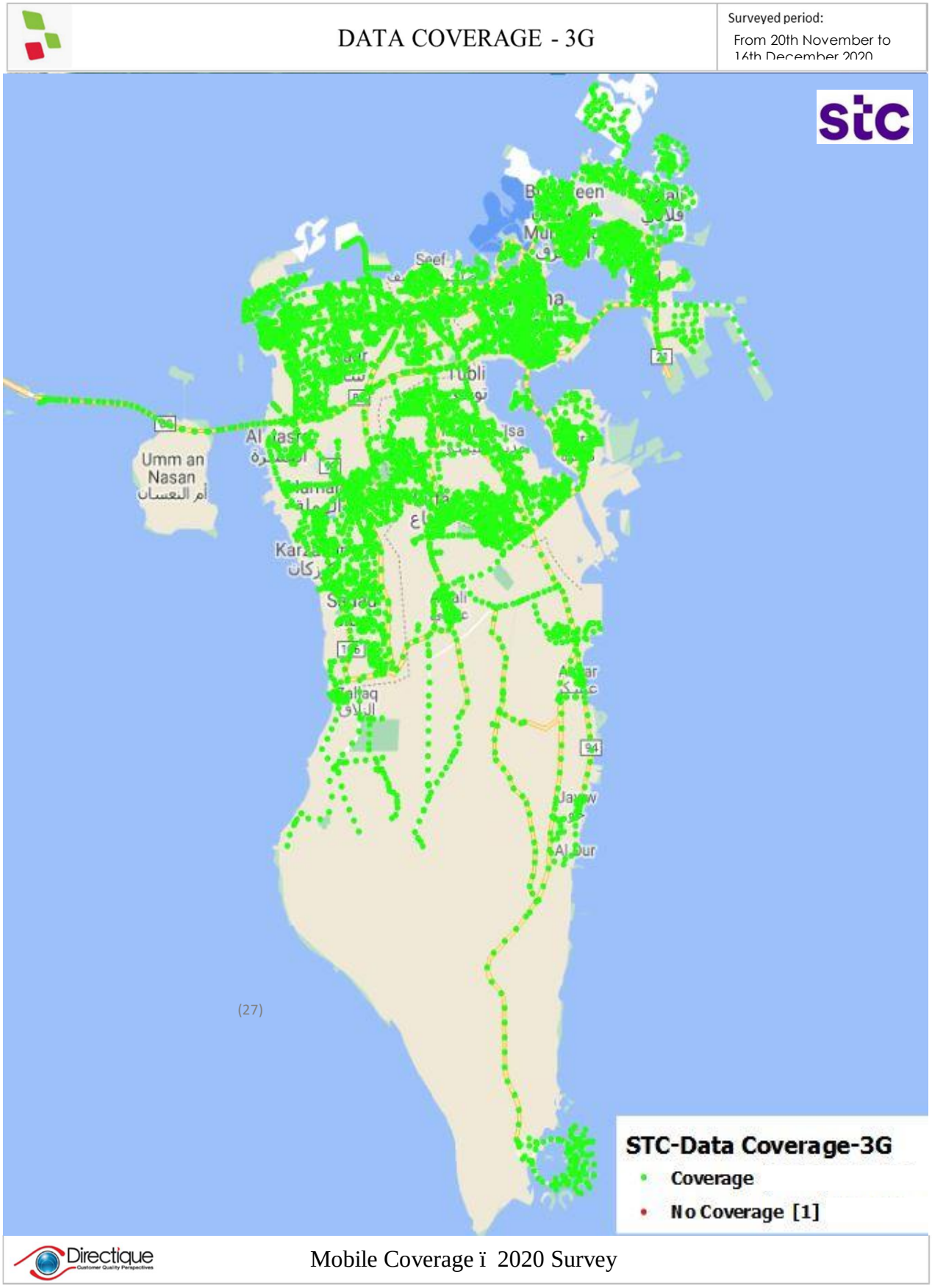
4.3.6. STC BAHRAIN 5G – DATA COVERAGE FOR A 5G USER



4.3.7. STC BAHRAIN 4G – DATA COVERAGE FOR A LTE USER



4.3.8. STC BAHRAIN 3G – DATA COVERAGE FOR A 3G USER

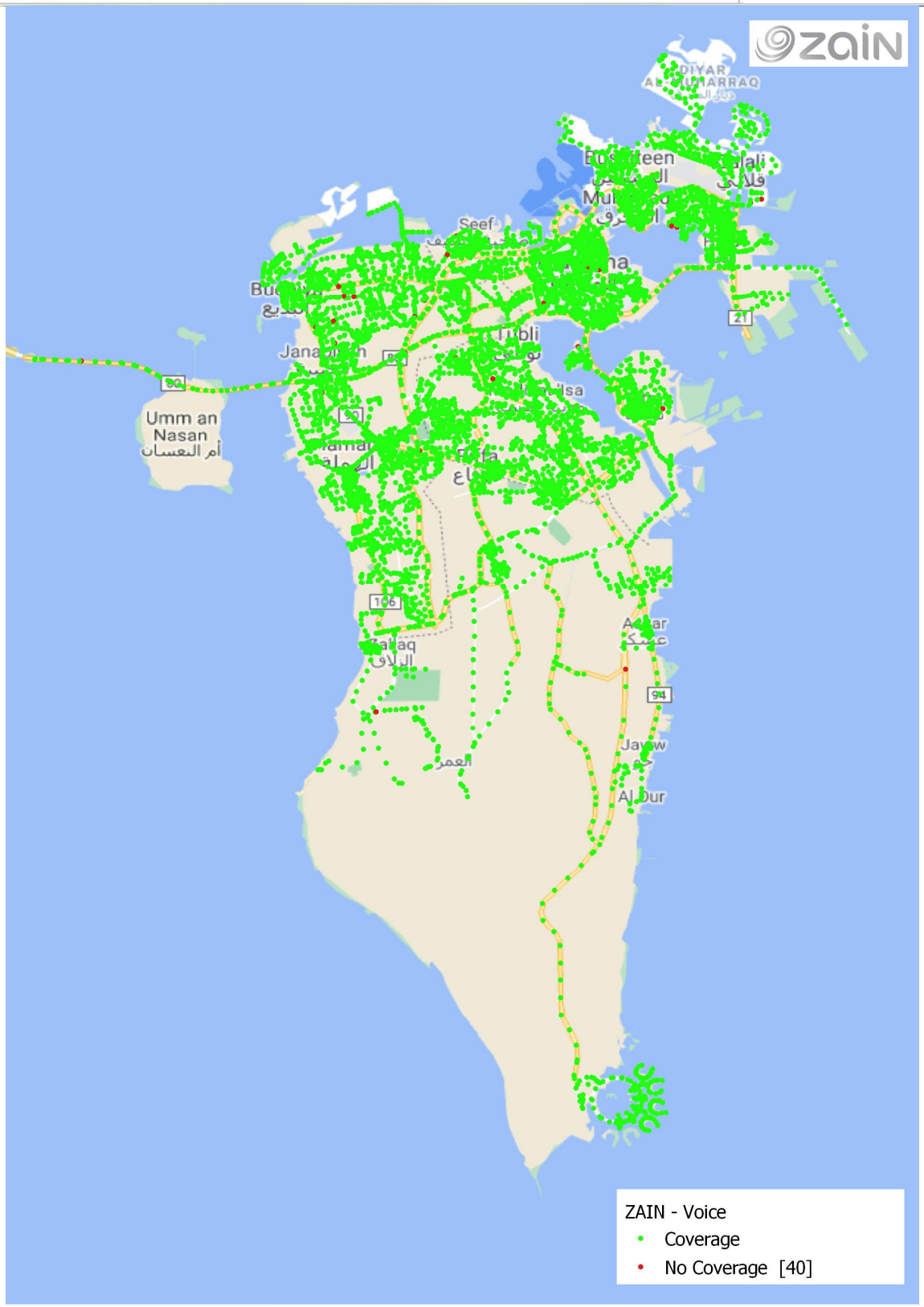


(27)

4.3.9. ZAIN – VOICE COVERAGE

GLOBAL VOICE COVERAGE

Surveyed period:
From 20th November to 16th December 2020



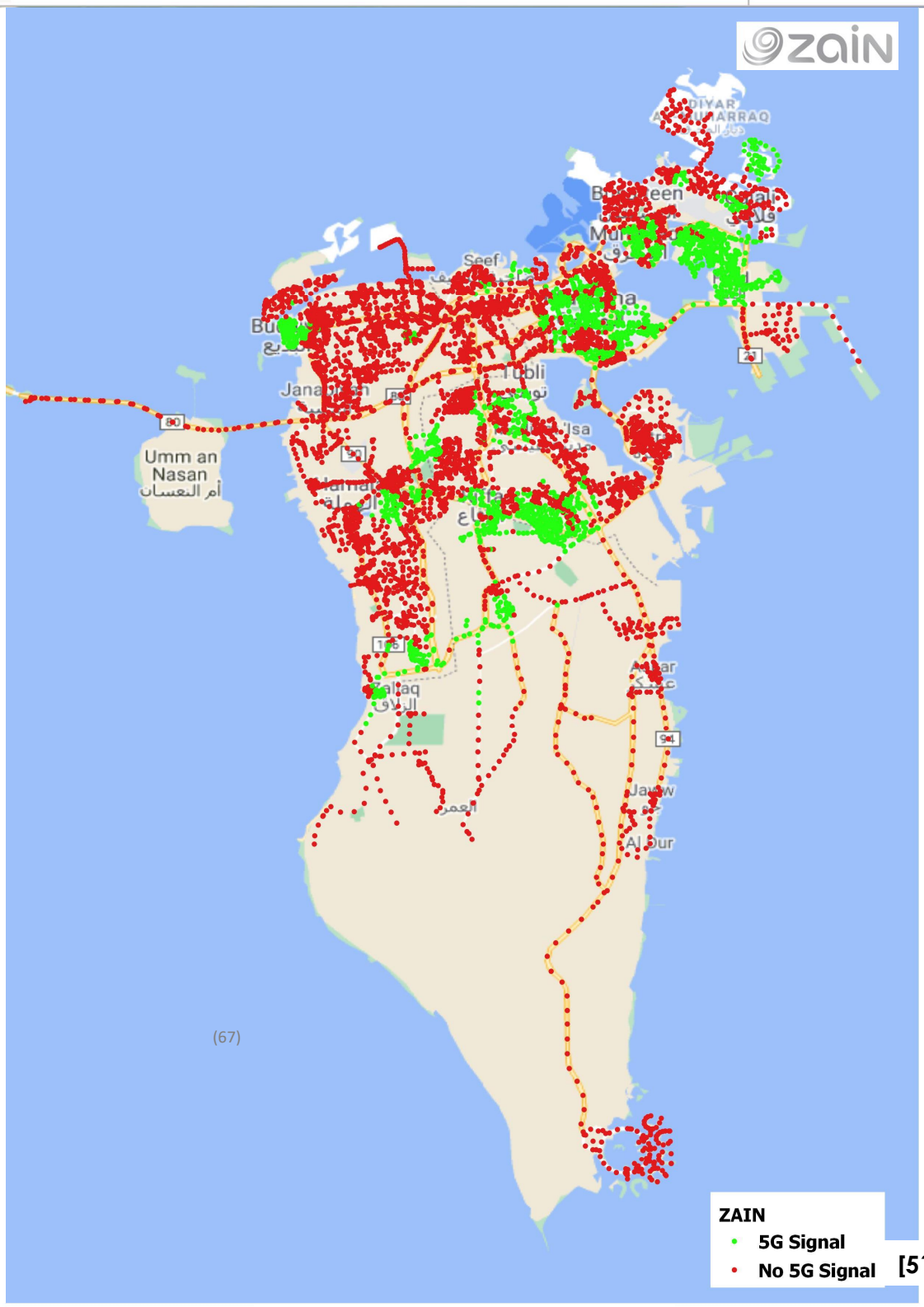
Directique

Mobile Coverage ï 2020 Survey

4.3.10. ZAIN 5G – DATA COVERAGE FOR A 5G USER

DATA COVERAGE - 5G

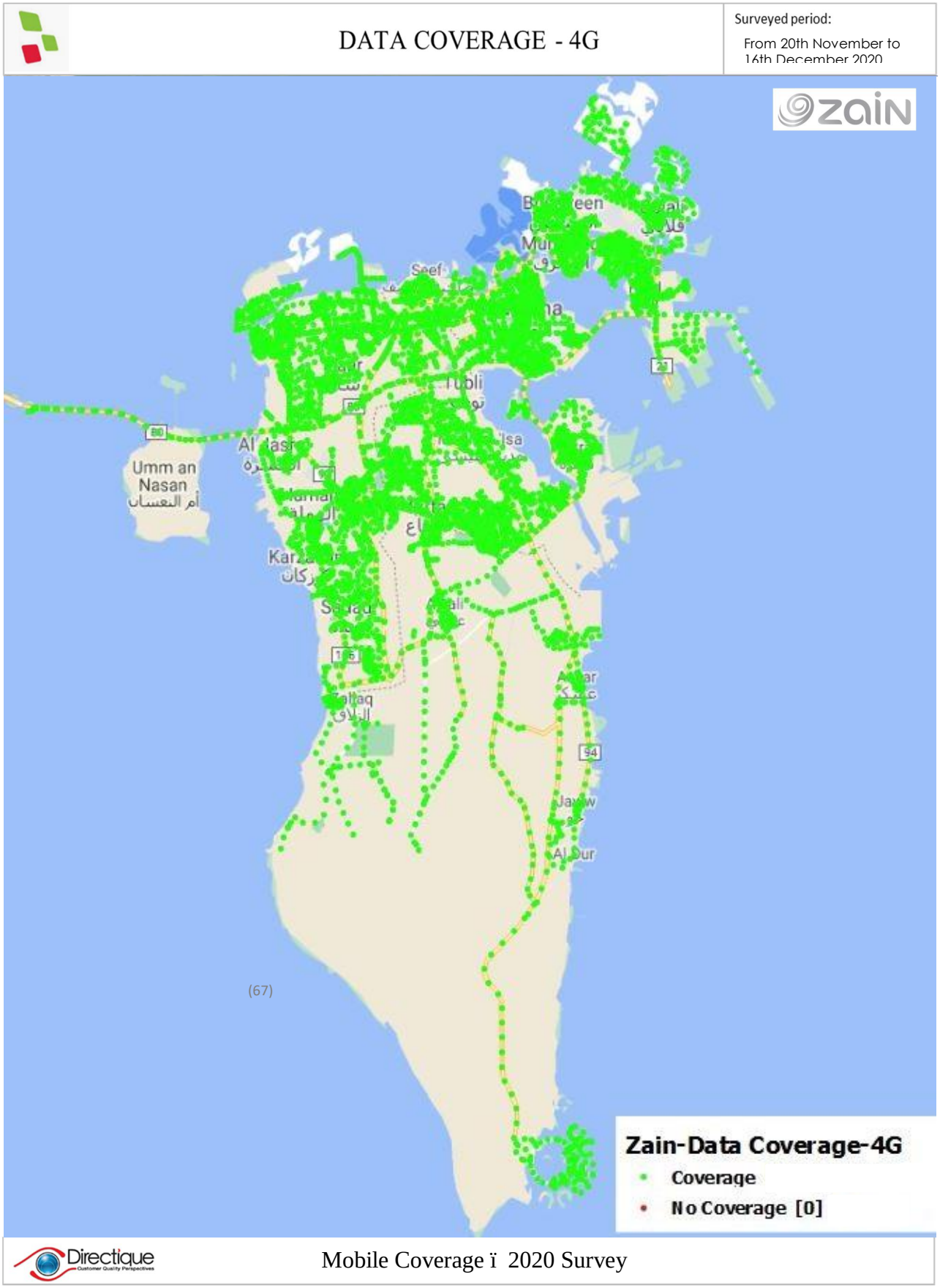
Surveyed period:
From 20th November to 16th December 2020



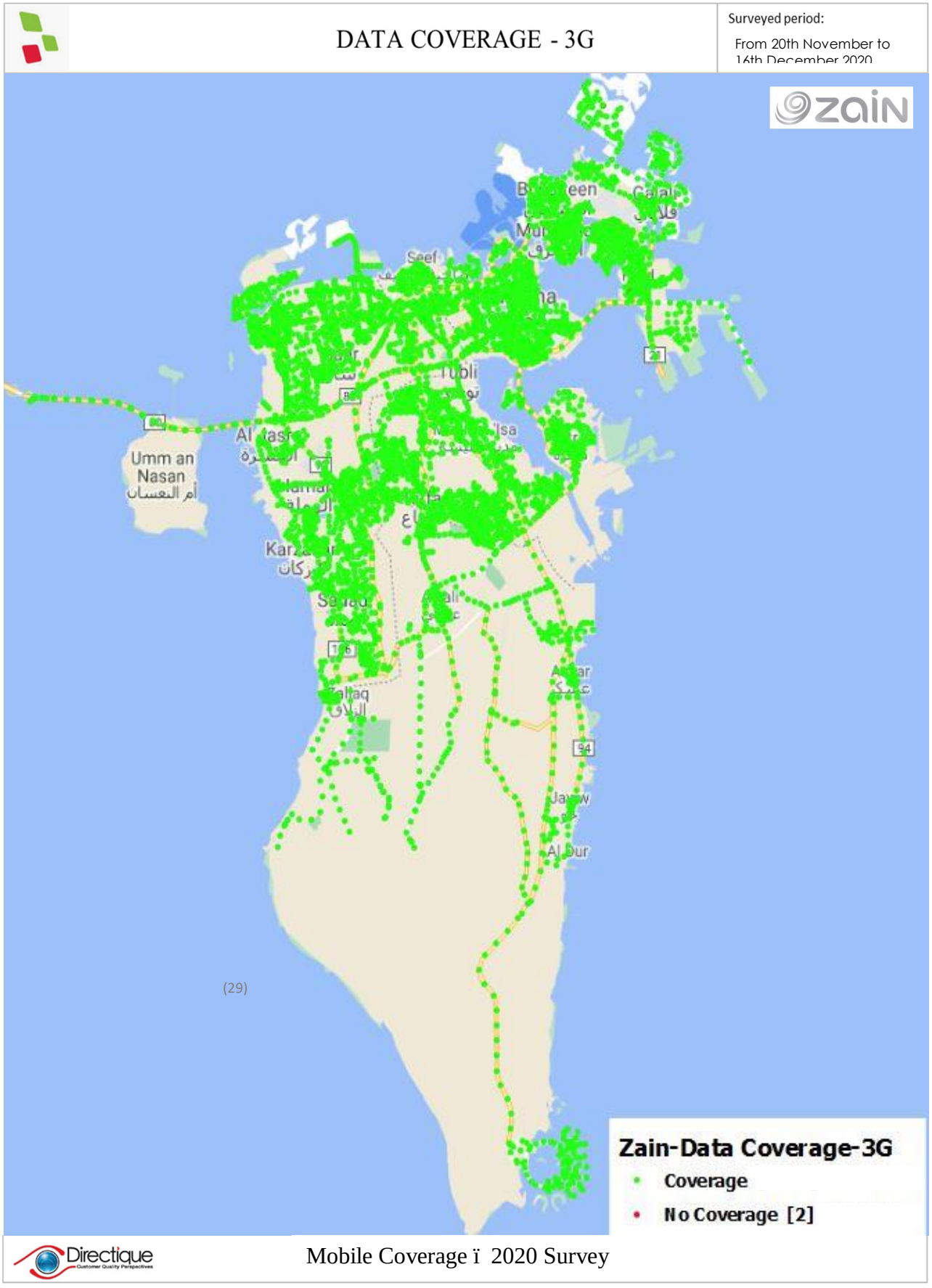
Directique

Mobile Coverage ï 2020 Survey

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



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



(29)

4.4. IDLE COVERAGE – SIGNAL STRENGTH DISTRIBUTION

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):

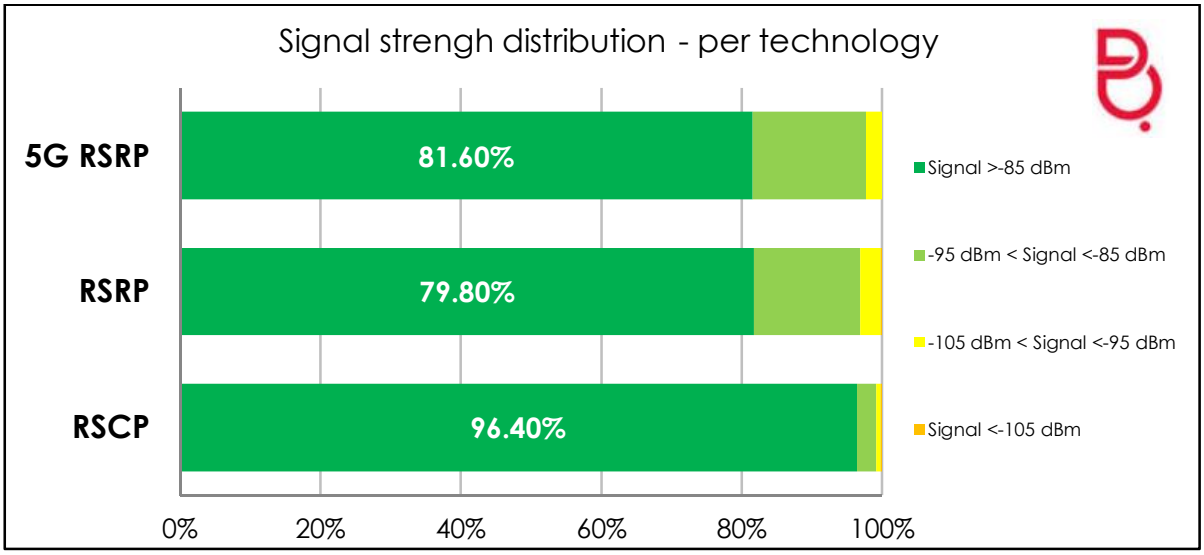
BATELCO	3G RSCP	4G RSRP	5G RSRP
Samples	7 066	6 966	5 505
Signal >-85 dBm	96.4%	79.8%	81.6%
-95 dBm < Signal <-85 dBm	2.7%	14.8%	16.2%
-105 dBm < Signal <-95 dBm	0.7%	2.9%	2.3%
Signal <-105 dBm	0.2%	0.2%	0.0%

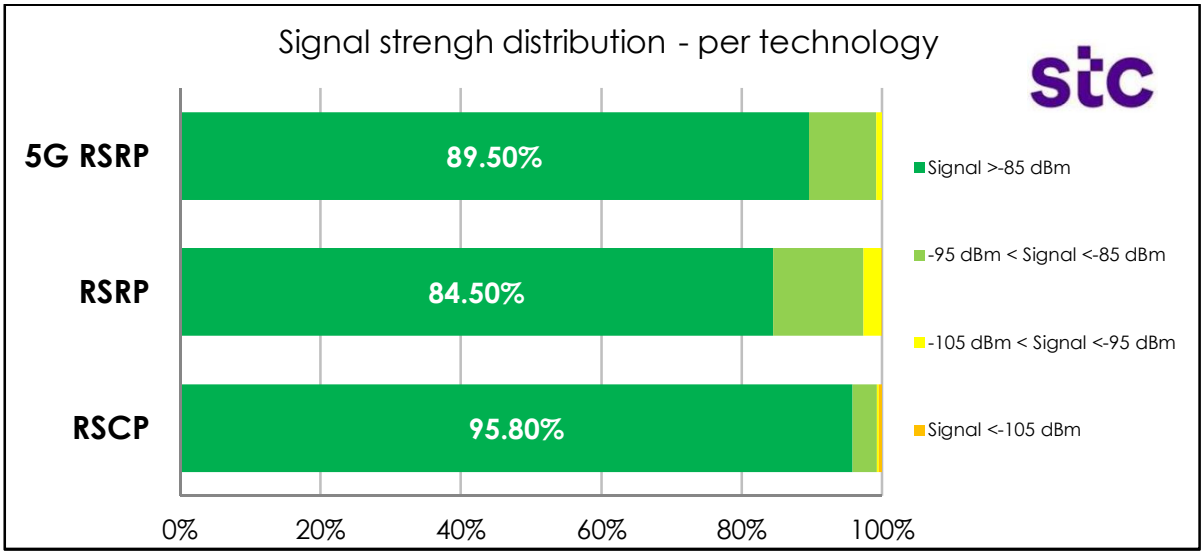
STC Bahrain - Signal strength distribution (IDLE mode):

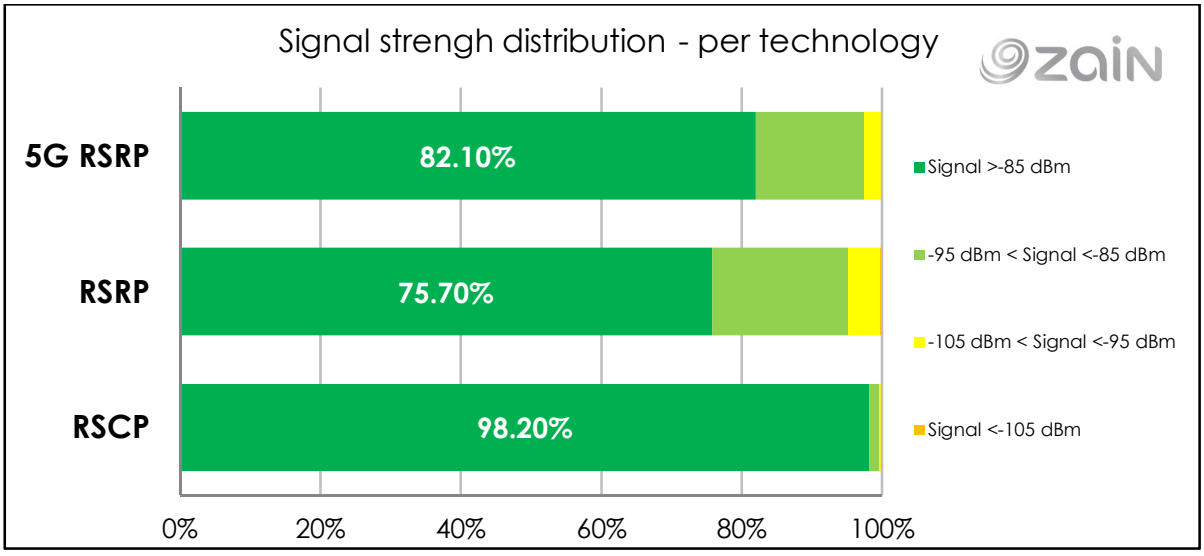
STC	3G RSCP	4G RSRP	5G RSRP
Samples	7 066	6 966	5475
Signal >-85 dBm	95.8%	84.5%	89.5%
-95 dBm < Signal <-85 dBm	3.4%	12.8%	9.5%
-105 dBm < Signal <-95 dBm	0.3%	2.6%	0.9%
Signal <-105 dBm	0.5%	0.1%	0.0%

Zain - Signal strength distribution (IDLE mode):

ZAIN	3G RSCP	4G RSRP	5G RSRP
Samples	7 066	6 966	592
Signal >-85 dBm	98.2%	75.7%	82.1%
-95 dBm < Signal <-85 dBm	1.5%	19.3%	15.4%
-105 dBm < Signal <-95 dBm	0.2%	4.6%	2.4%
Signal <-105 dBm	0.2%	0.3%	0.2%


Signal strengh distribution - per technology
5G RSRP
RSRP
RSCP
81.60%
79.80%
96.40%
Signal >-85 dBm
-95 dBm < Signal <-85 dBm
-105 dBm < Signal <-95 dBm
Signal <-105 dBm
0%
20%
40%
60%
80%
100%


Signal strengh distribution - per technology
stc
5G RSRP
RSRP
RSCP
89.50%
84.50%
95.80%
Signal >-85 dBm
-95 dBm < Signal <-85 dBm
-105 dBm < Signal <-95 dBm
Signal <-105 dBm
0%
20%
40%
60%
80%
100%


Signal strengh distribution - per technology
zain
5G RSRP
RSRP
RSCP
82.10%
75.70%
98.20%
Signal >-85 dBm
-95 dBm < Signal <-85 dBm
-105 dBm < Signal <-95 dBm
Signal <-105 dBm
0%
20%
40%
60%
80%
100%

End of document