

## MOBILE NETWORKS COVERAGE AUDIT KINGDOM OF BAHRAIN – 2019

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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.

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# 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, 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 3rd to the 19th October 2019 across the Kingdom's 4 Governorates for Voice, 3G and 4G coverage.

Audit results have been weighted with the population percentage living in each Governorate<sup>1</sup>. 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 representative 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**:
  - o 1 set in 2G/3G/4G auto connect, to represent the LTE users
  - o 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.

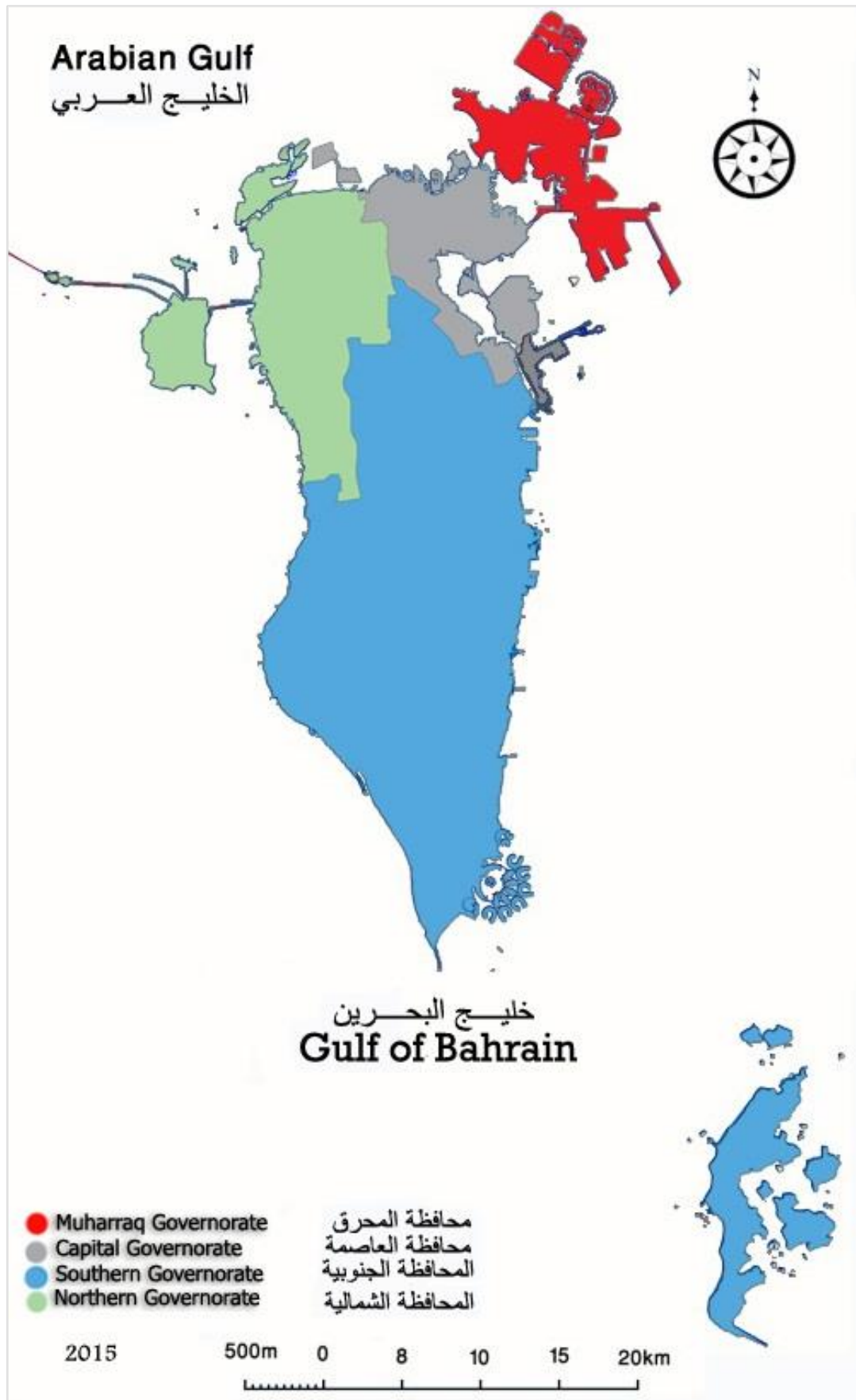
A set is 3 smartphones, one per Operator.

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.

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<sup>1</sup> Population data based on CIO latest census (2010)

### 3.1.1. ADMINISTRATIVE DIVISIONS





### 3.1.2. DRIVE-TEST ROUTES

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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

**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 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.

Accessibility	             
Result	OK OK OK NOK OK ...

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

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

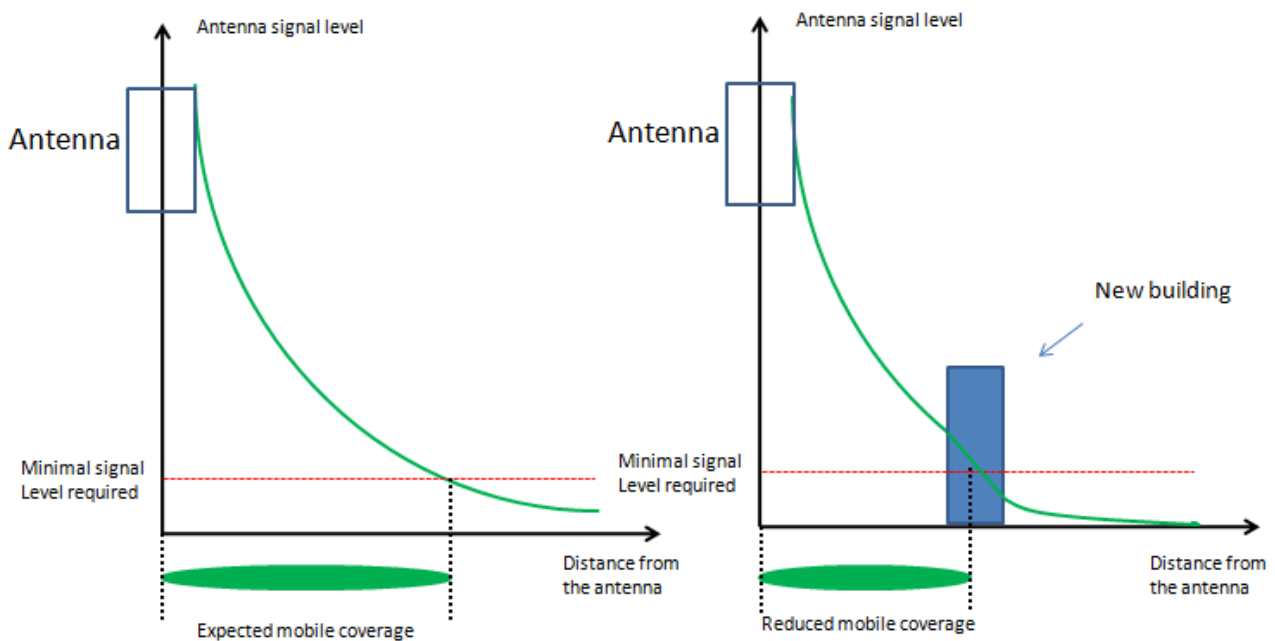
Population coverage is then calculated by weighting these results with the population percentage living in each Governorate, using latest available Central Informatics Organisation (CIO) census statistics for the Kingdom.

### 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

Governorate	% Pop	Batelco		STC Bahrain		Zain	
		Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	37%	3 726	99.95%	3 748	100%	3 685	99.92%
Northern	24%	3 838	99.97%	3 845	99.95%	3 850	99.95%
Muharraq	18%	1 341	99.93%	1 350	100%	1 339	100%
Southern	21%	3 667	100%	3 642	100%	3 654	99.95%
<b>TOTAL</b>		12 572	<b>99.96%</b>	12 585	<b>99.99%</b>	12 528	<b>99.95%</b>

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

Governorate	% Pop	Batelco		STC Bahrain		Zain	
		Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	37%	4 617	100 %	4 675	100 %	4 747	100 %
Northern	24%	4 650	100 %	4 872	100 %	4 792	100 %
Muharraq	18%	1 569	100 %	1 972	100 %	1 915	100 %
Southern	21%	3 421	100 %	3 326	100 %	3 378	100 %
<b>TOTAL</b>		14 257	<b>100%</b>	14 845	<b>100%</b>	14 832	<b>100%</b>

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

Governorate	% Pop	Batelco		STC Bahrain		Zain	
		Sample	Coverage	Sample	Coverage	Sample	Coverage
Capital	37%	3 835	100 %	3 901	100 %	4 004	100 %
Northern	24%	3 869	100 %	3 935	100 %	3 866	100 %
Muharraq	18%	1 403	100 %	1 422	100 %	1 409	100 %
Southern	21%	2 594	100 %	2 666	100 %	2 635	100 %
<b>TOTAL</b>		11 701	<b>100%</b>	11 924	<b>100%</b>	11 914	<b>100%</b>

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 where the latency was NOK, is considered as not covered.

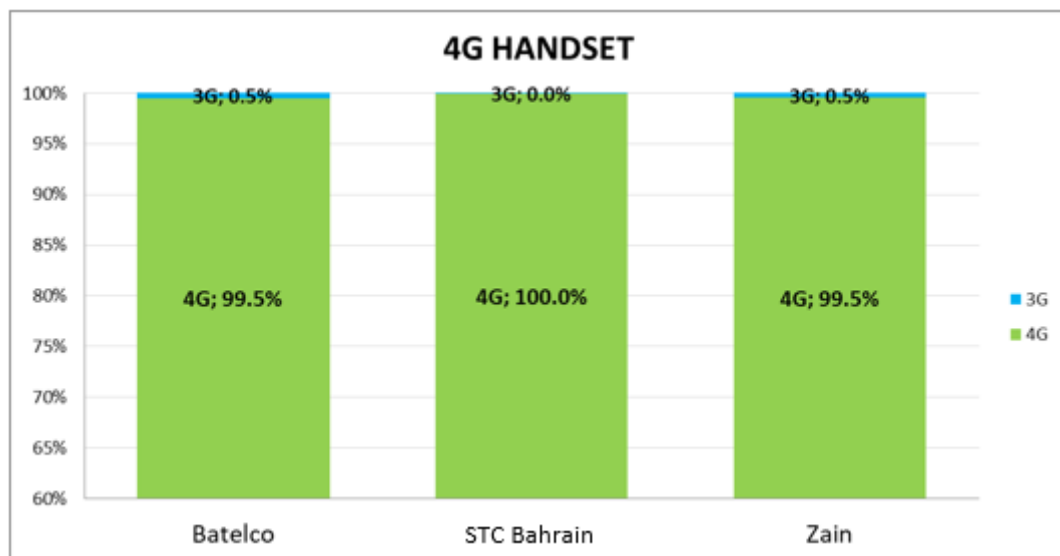
Then, graphs show the percentages of those successful tests on each technology used by the mobile.

### 4.2.1. 4G HANDSET

	Batelco	STC Bahrain	Zain
Rate of successful HTTP tests	100%	100%	100%

On technology:

<b>4G</b>	<b>99.5%</b>	<b>100%</b>	<b>99.5%</b>
<b>3G</b>	<b>0.5%</b>	<b>0%</b>	<b>0.5%</b>



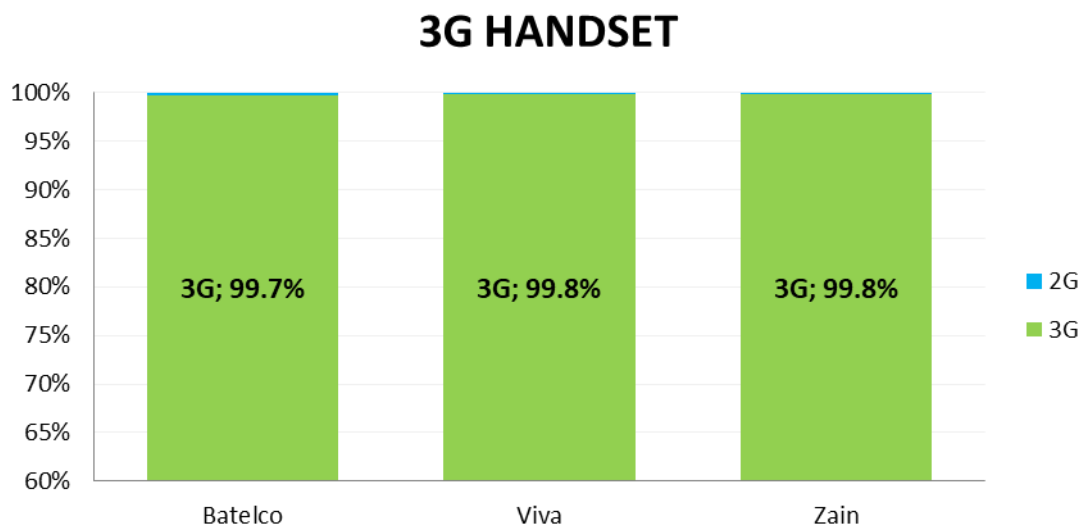


### 4.2.2. 3G HANDSET

	Batelco	STC Bahrain	Zain
Rate of successful HTTP latency	100%	100%	100%

On technology:

<b>3G</b>	<b>99.7%</b>	<b>99.8%</b>	<b>99.8%</b>
<b>2G</b>	<b>0.3%</b>	<b>0.2%</b>	<b>0.2%</b>



### 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:

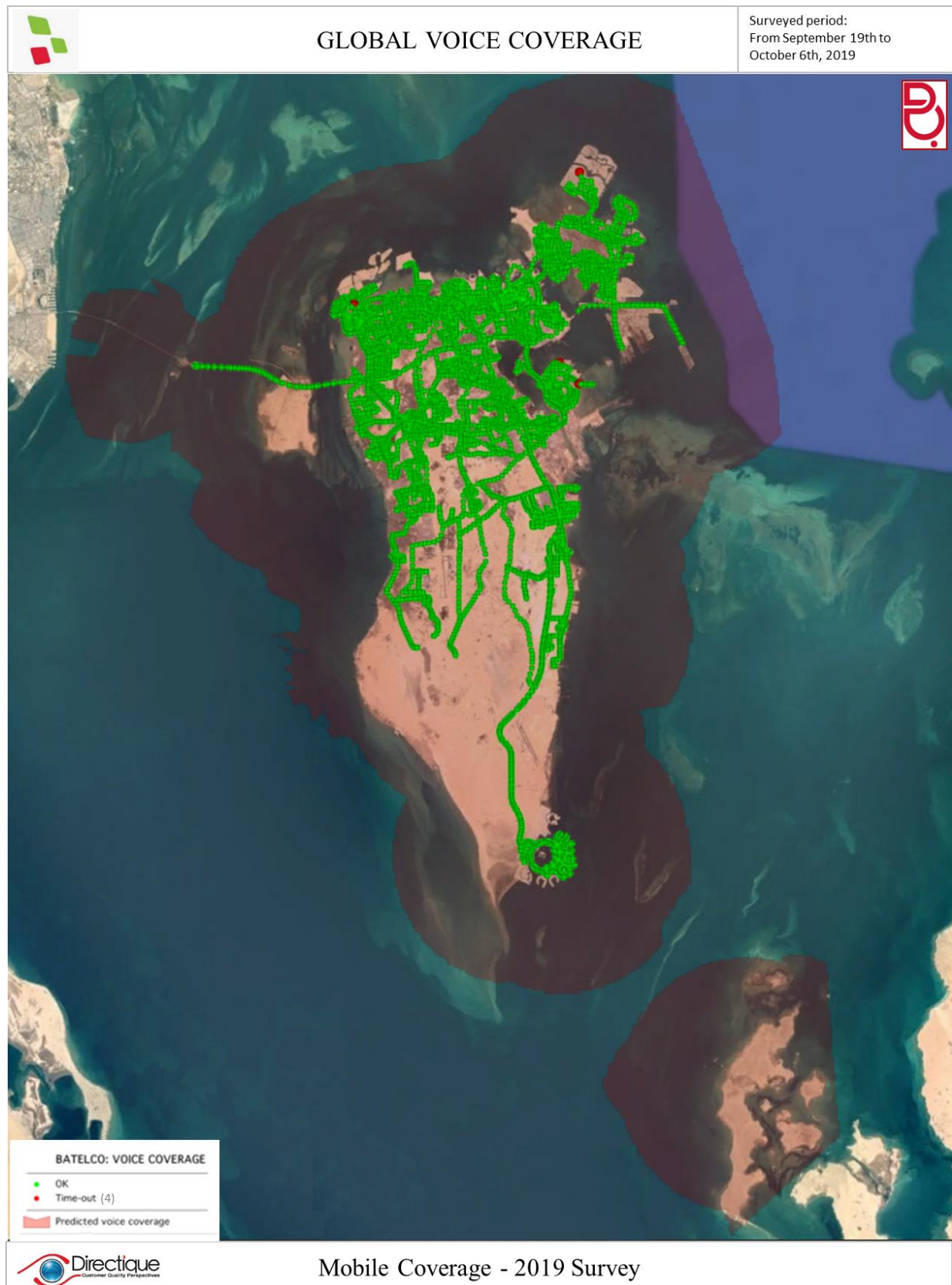
If the spot is **blue**, the test was outside the coverage zone of the operator.

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

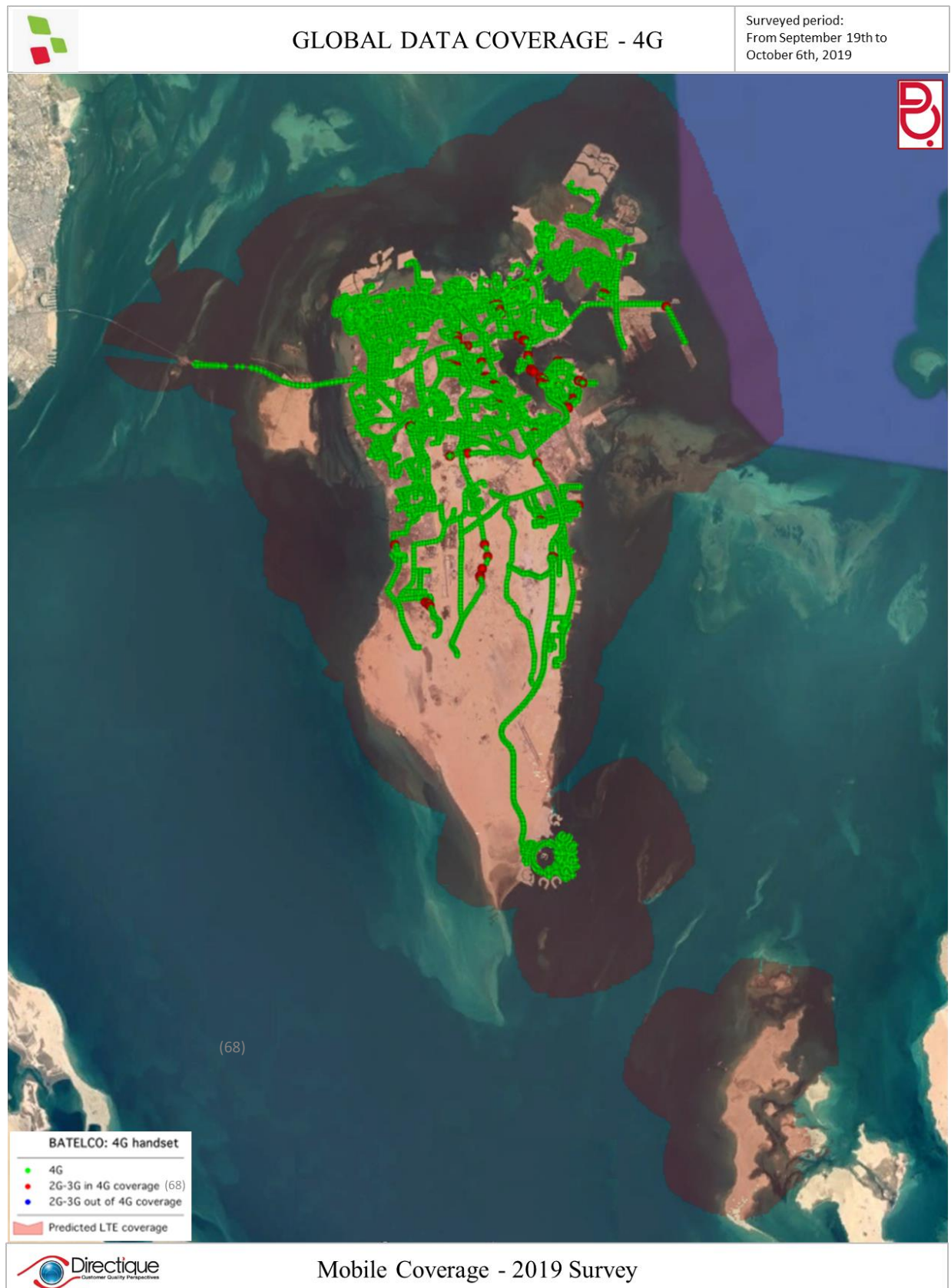
If the spot is **red**, the test was inside the coverage zone of the operator and accessibility to network was not effective on the handset

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

### 4.3.1. BATELCO – VOICE COVERAGE

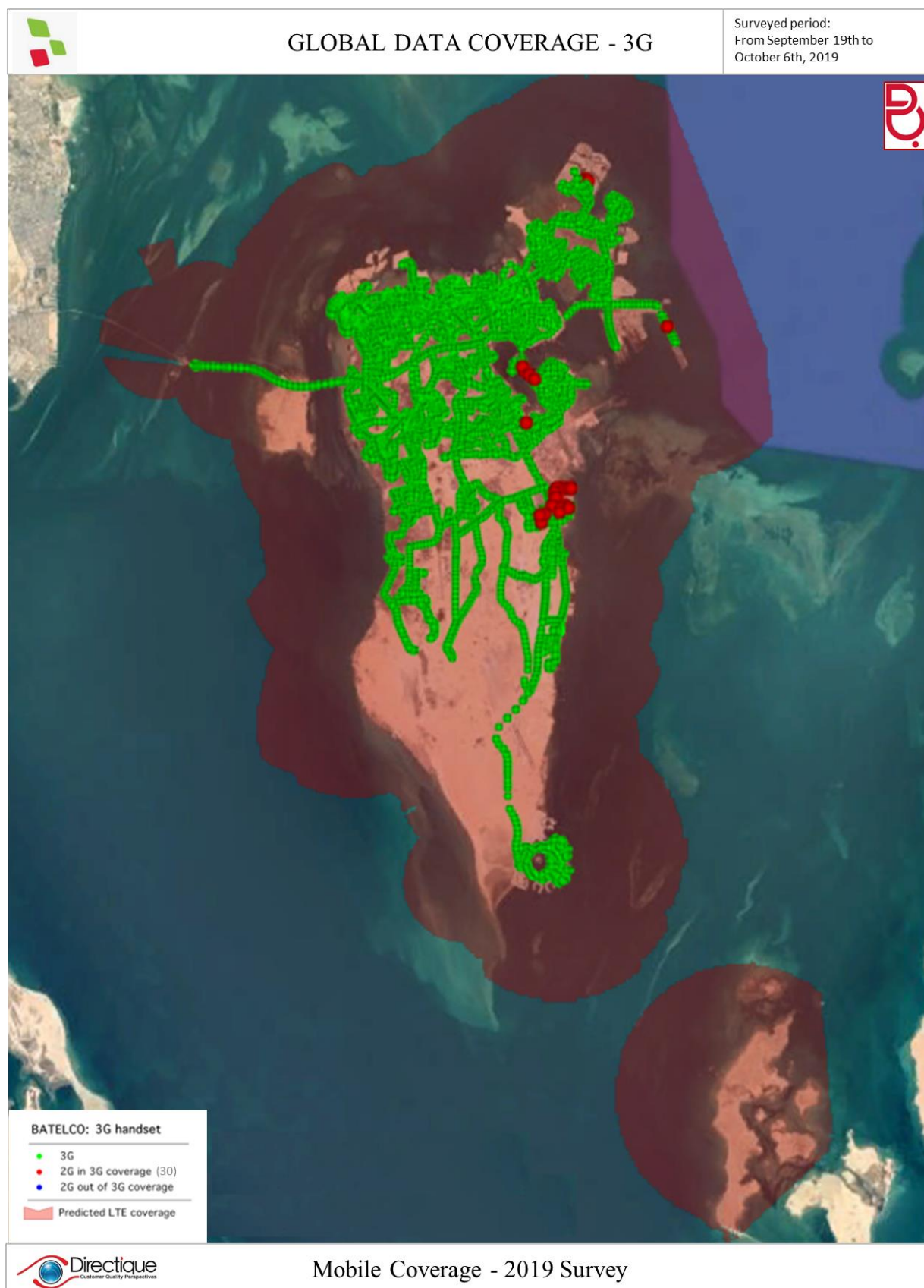


### 4.3.2. BATELCO 4G – DATA COVERAGE FOR A LTE USER

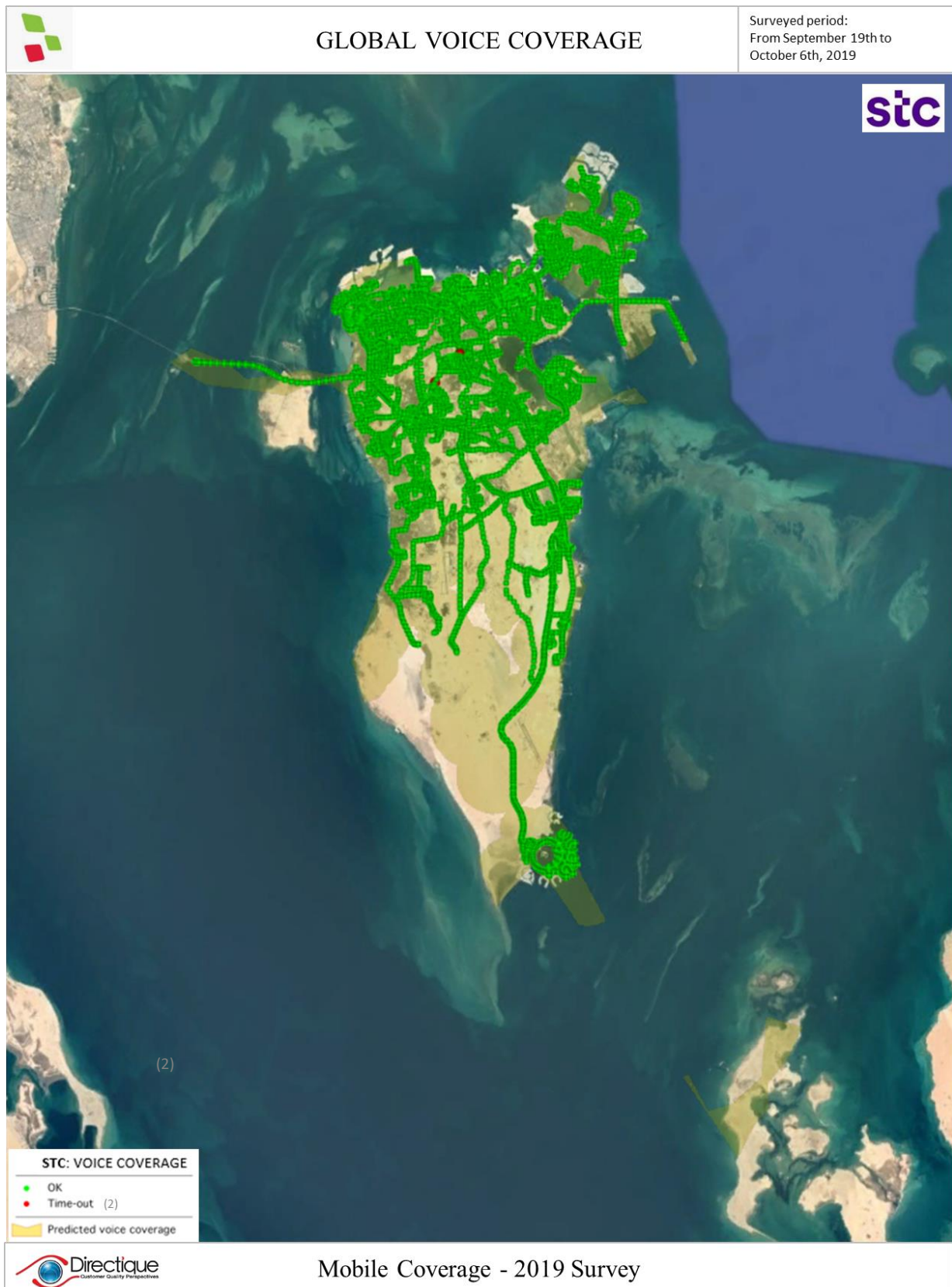




### 4.3.3. BATELCO 3G – DATA COVERAGE FOR A 3G USER



#### 4.3.4. STC BAHRAIN – VOICE COVERAGE

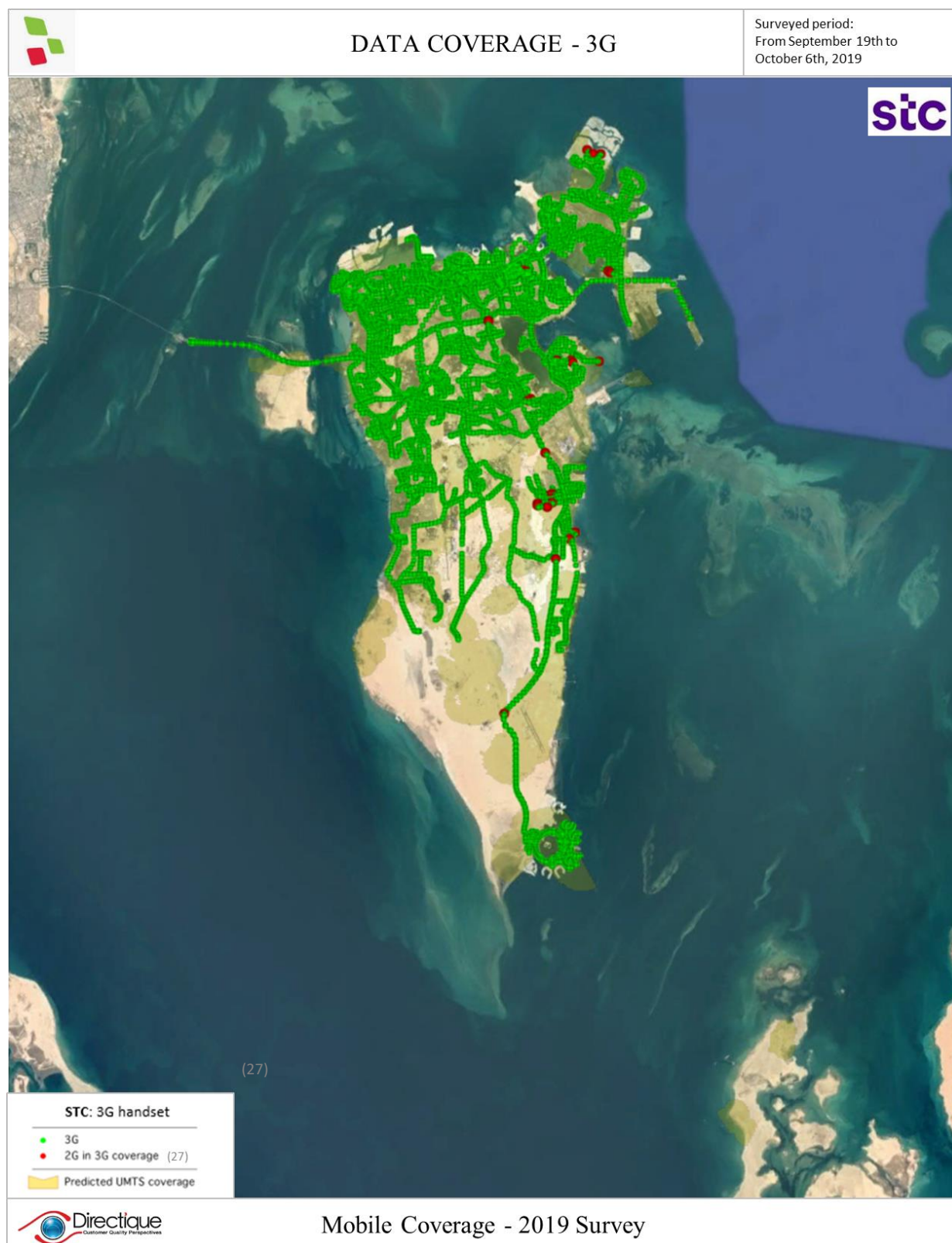


### 4.3.5. STC BAHRAIN 4G – DATA COVERAGE FOR A LTE USER

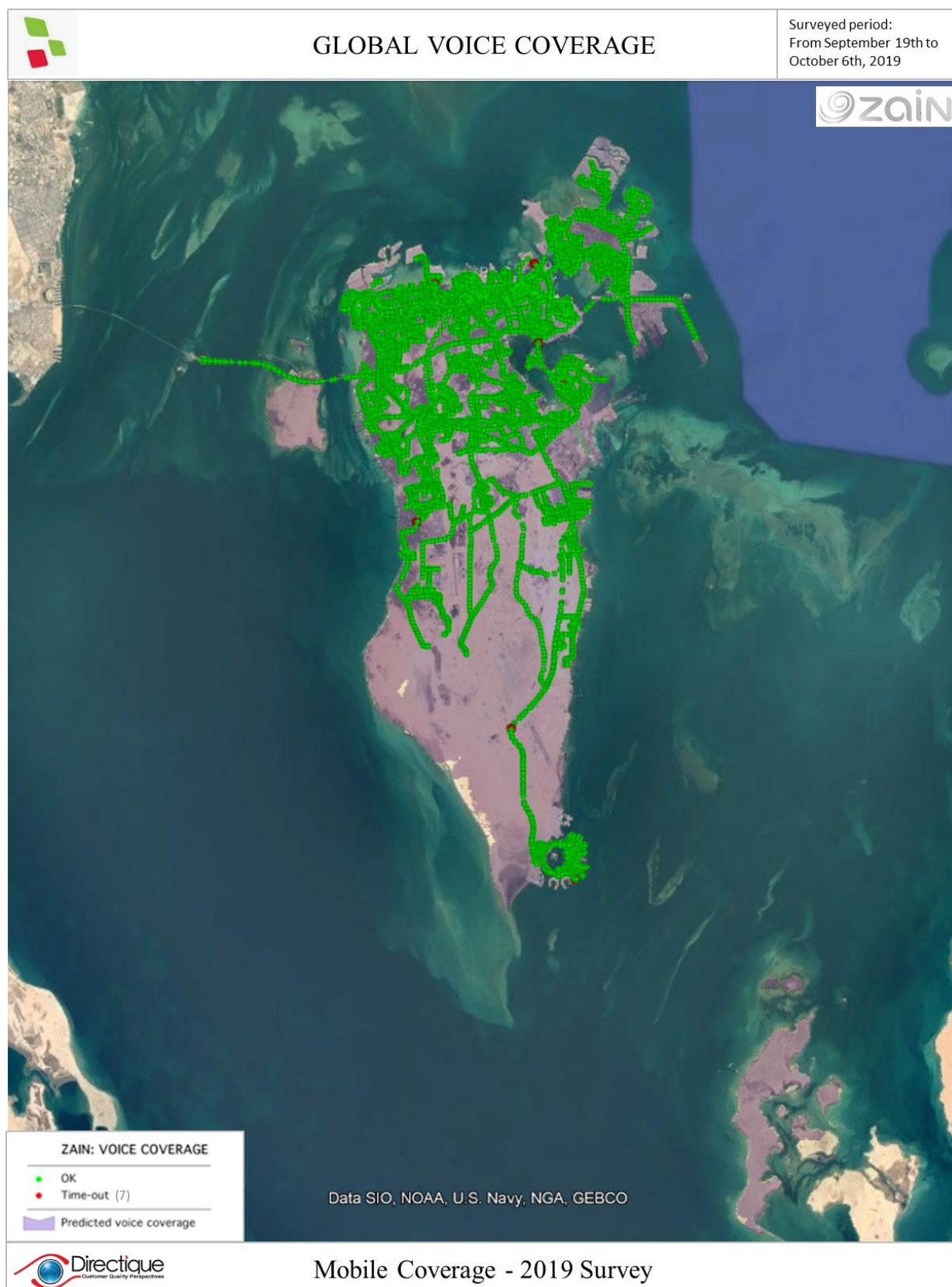




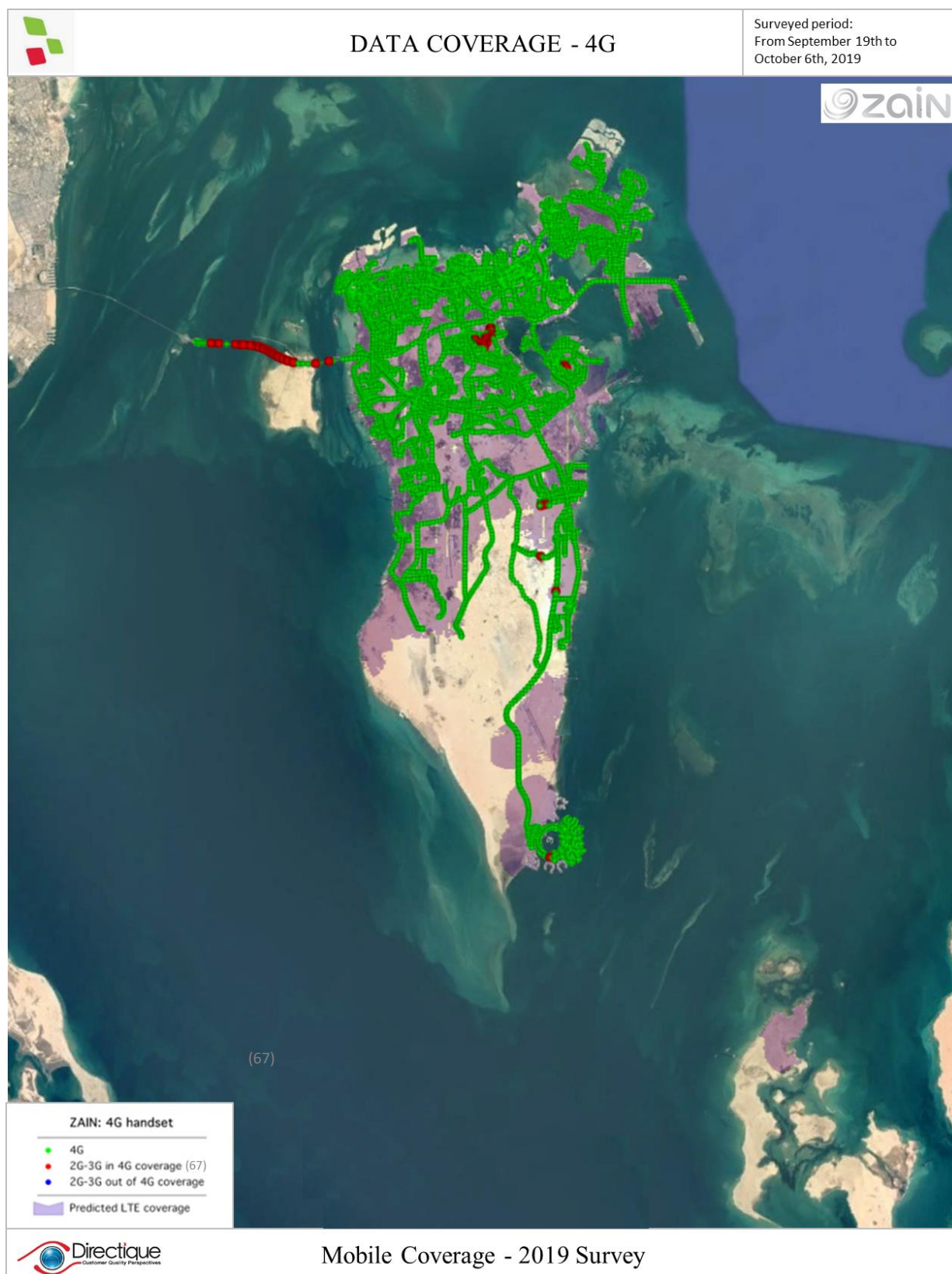
#### 4.3.6. STC BAHRAIN 3G – DATA COVERAGE FOR A 3G USER



### 4.3.7. ZAIN – VOICE COVERAGE

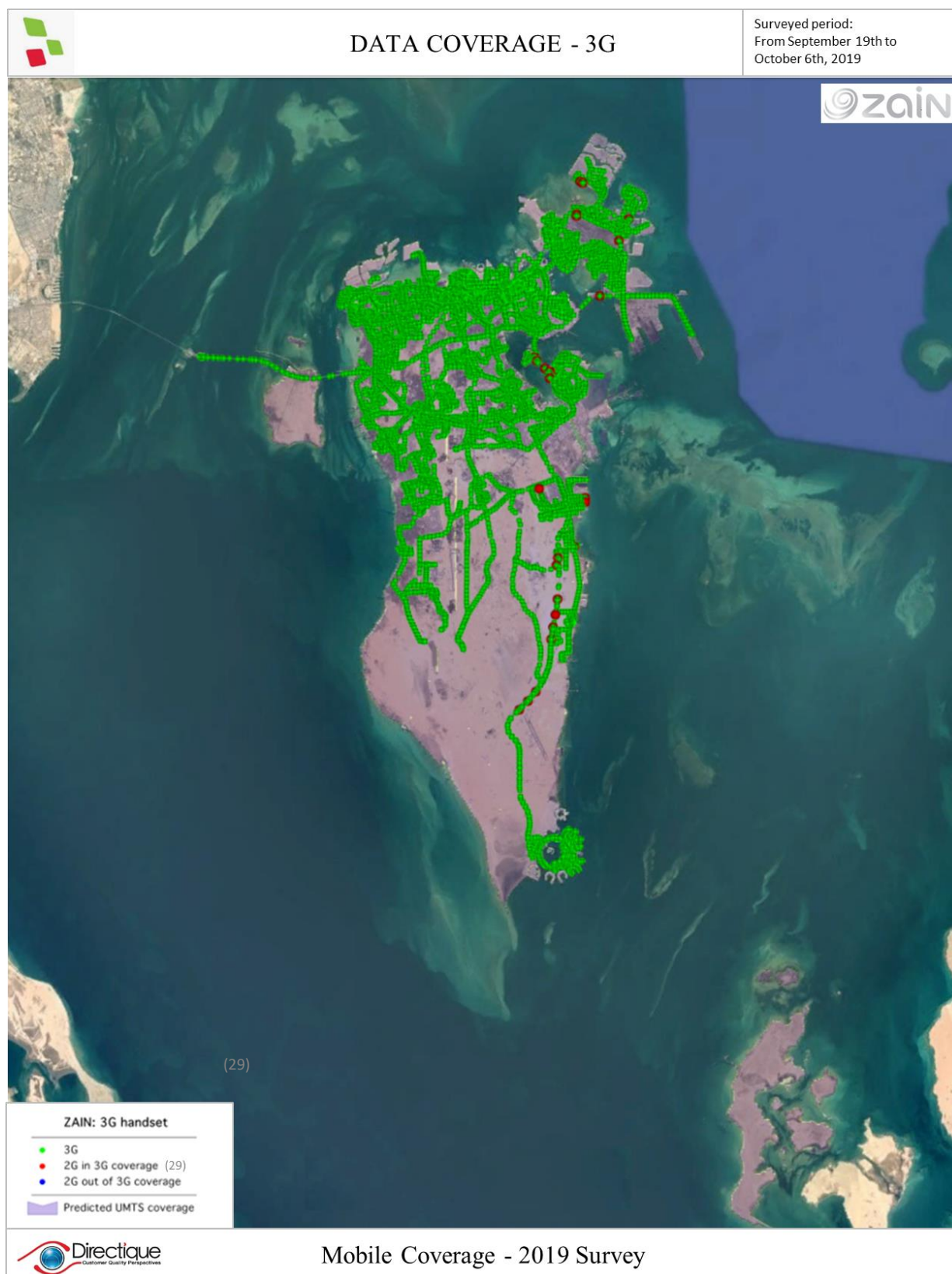


### 4.3.8. ZAIN 4G – DATA COVERAGE FOR A LTE USER





### 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):

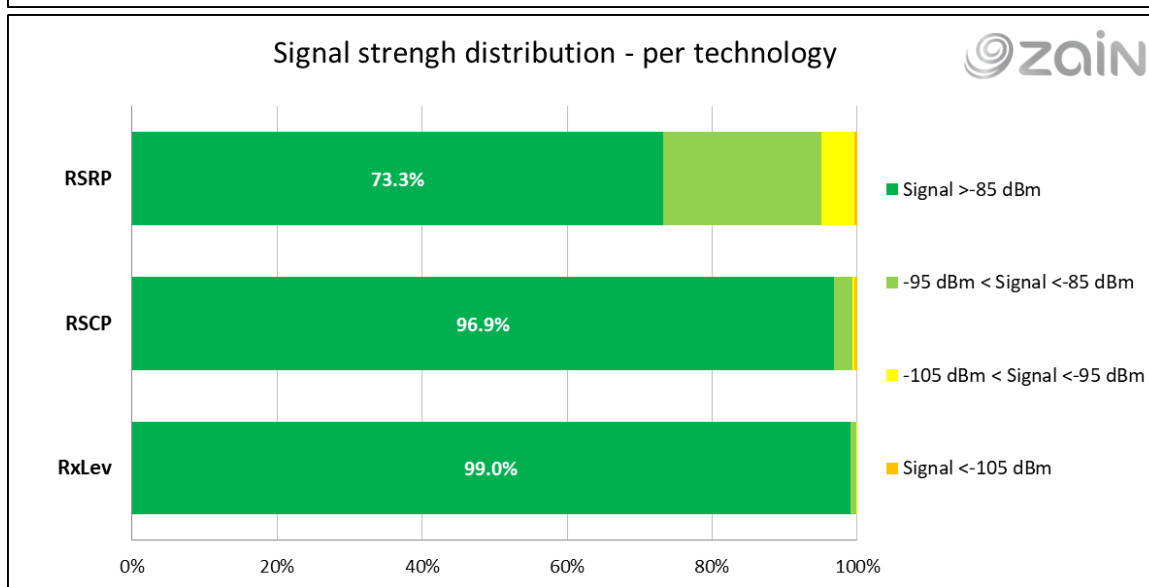
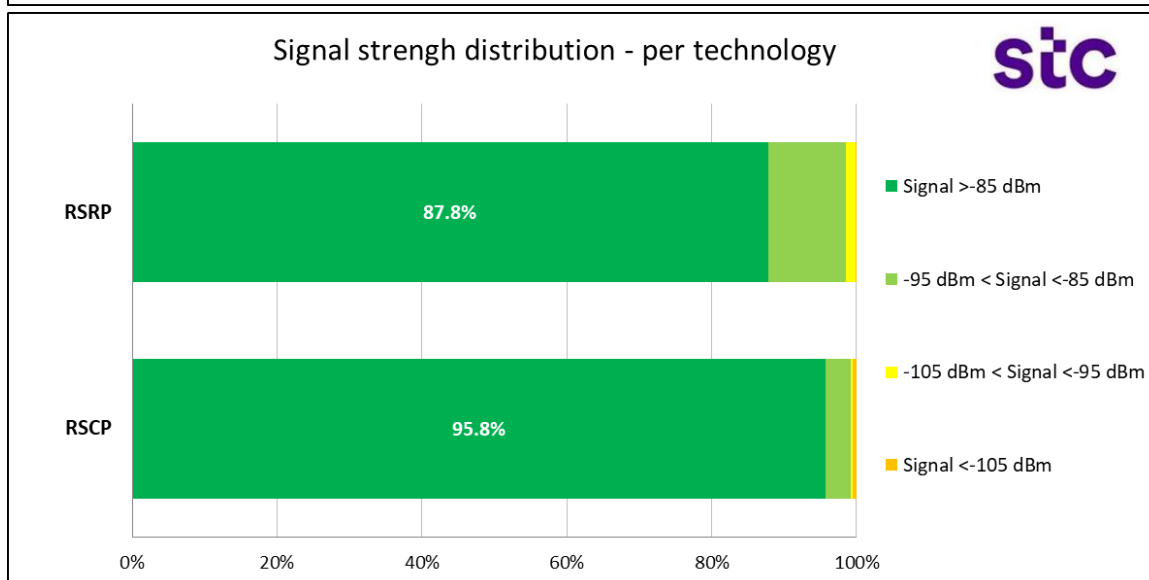
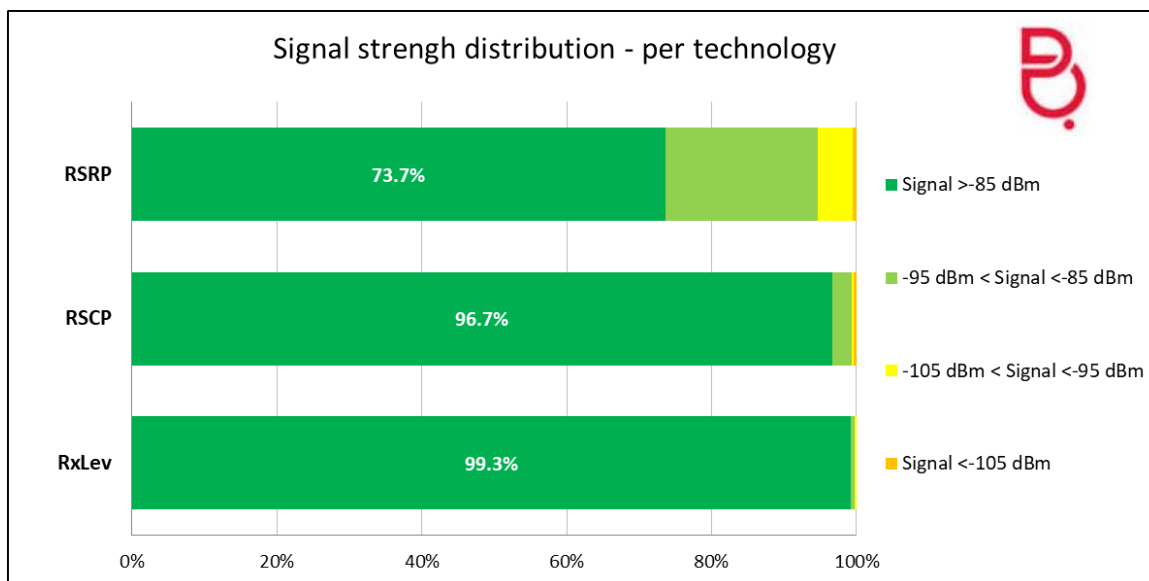
<b>BATELCO</b>	<b>2G</b> RxLev	<b>3G</b> RSCP	<b>4G</b> RSRP
Sample	541	12 030	11 967
Signal >-85 dBm	99.3%	96.7%	73.7%
-95 dBm < Signal <-85 dBm	0.6%	2.7%	21.0%
-105 dBm < Signal <-95 dBm	0.2%	0.3%	4.9%
Signal <-105 dBm		0.4%	0.5%

**STC Bahrain** - Signal strength distribution (IDLE mode):

<b>STC BAHRAIN</b>	<b>2G</b> RxLev	<b>3G</b> RSCP	<b>4G</b> RSRP
Sample	0	12 583	12 572
Signal >-85 dBm		95.8%	87.8%
-95 dBm < Signal <-85 dBm		3.4%	10.7%
-105 dBm < Signal <-95 dBm		0.3%	1.4%
Signal <-105 dBm		0.5%	0.1%

**Zain** - Signal strength distribution (IDLE mode):

<b>ZAIN</b>	<b>2G</b> RxLev	<b>3G</b> RSCP	<b>4G</b> RSRP
Sample	1 585	10 998	12 322
Signal >-85 dBm	99.0%	96.9%	73.3%
-95 dBm < Signal <-85 dBm	0.9%	2.5%	21.8%
-105 dBm < Signal <-95 dBm	0.1%	0.2%	4.5%
Signal <-105 dBm		0.4%	0.4%





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