Directique
Customer Quality Perspectives

هيئة تنظيم الاتصالات
Telecommunications Regulatory Authority

Quality of Mobile Services

Kingdom of Bahrain – 2016

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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. 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.

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1 READER'S ADVICE

For a proper understanding of this report, readers are advised to take into account the following key elements:

Quality of Mobile Services Audit is a snapshot of the observed quality and performance offered by Mobile Operators at the time of the measurements campaign.

Mobile Operators are continuously performing modifications and upgrades (including during the audit). Performance at the time of reading the report may be different.

TRA deliberately chose to assess quality from the end user perspective, which involves for example carrying out measurements with mobile devices which are available in Mobile Operator shops, behaving like the user on the field and cross network testing. Please read section 4 carefully for a full understanding of the test protocol and measurement conditions.

As with any quality audit or survey, the statistical accuracy is systematically presented in the results tables. Accuracy is the error margin to the actual values, so any comparison between results should take this confidence interval into account.

To be consistent with this level of accuracy, results have been rounded up or down to the nearest tenth of a unit. It is reminded that:

- the sum of two rounded results can be different from the rounding of their sum,
- Multiplying one rounded result by another is different than rounding the result of their multiplication.

Other statistical aggregates used in the report are:

- **Standard deviation** shows how much variation there is from the average. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values.
- **Min** and **Max** show the worse and best results (such as delay, throughput) obtained during successful measurements.
- **Average** is always the arithmetic mean of the referred sample.

2 END TO END AUDIT PERFORMANCE APPROACH

This audit is a benchmark focused on qualitative assessment of the end to end service provided from the user point of view.

This means that measurements are performed through an end to end user perspective, in order to gather a faithful record of the customer's quality experience.

The end to end perspective consists in verifying that the service offered by the service providers is accessible for their customers, and measuring probabilities of malfunction, depending on the customer location and types of usage.

To achieve this objective, verifying that a signal is received by the handset is not sufficient, in addition is confirmed that the radio link can be bilaterally established to support the tested service; And that this radio link, with the rest of the network, can be used to initiate calls and establish data communications; And, finally, assess this communication performance, once established (voice and data).

The diagram below show the end to end service path, from end user handsets to services platform located on or outside of the operator network.

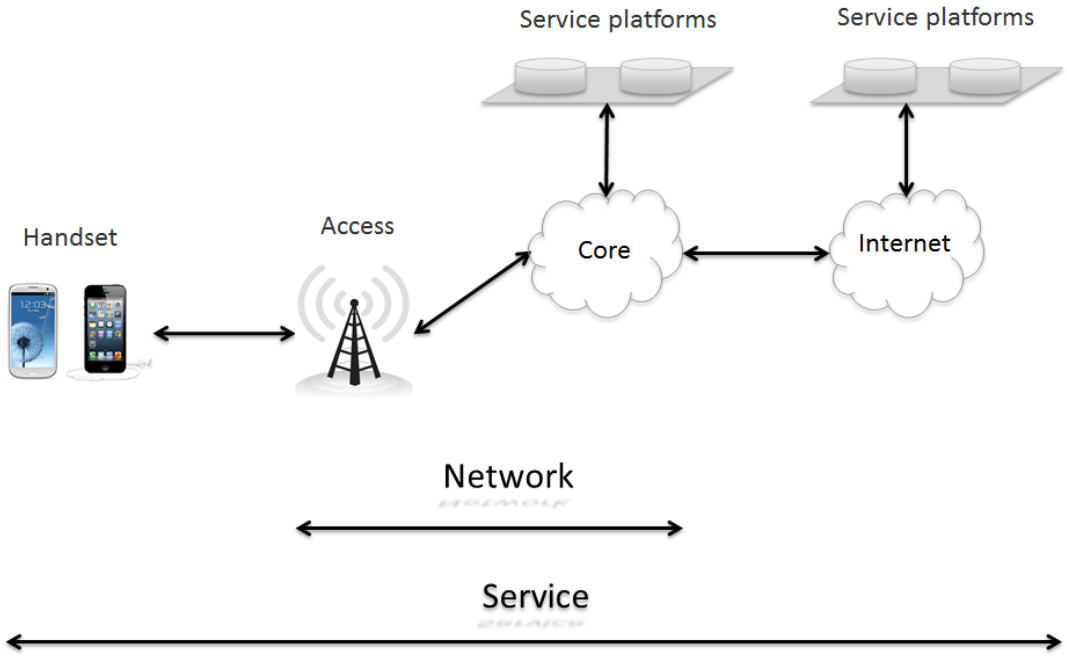

Figure 1 - End to end customer experience

The selected testing methodology reproduces a customer use of the range of mobile services, including:

- Handsets and subscriptions available to a large public. These are then selected from a list of current best sellers provided by the mobile operators. The results observed can therefore be subject to degradations induced by the device provided.
- A representative use of the market: incar, pedestrian inside and outside buildings, or under conditions that simulate correctly these uses.

3 EXECUTIVE SUMMARY

3.1 Introduction

The availability and quality of modern telecommunications services are critical elements for the success of the Kingdom of Bahrain's economy. Mobile telecommunications services are heavily used by consumers and businesses, either located in Bahrain or visiting the Kingdom.

In releasing this study, TRA aimed at evaluating and benchmarking quality levels offered by Mobile Network Operators in the Kingdom of Bahrain, Batelco, Viva and, Zain from an end-user perspective, for the following set of services:

- Voice
- Short Message Services (SMS)
- Smartphones data tests (Web surfing, HTTP file transfers)
- Smartphones data tests on hotspots (HTTP file transfers)
- Video streaming assessment using Smartphones
- Social networks using Smartphones

The Authority selected Directique, an international consulting firm to conduct the assessment using a test method designed to gather a faithful qualitative record from an end users' point of view, avoiding assessing quality through a pure technical angle as this is performed by Mobile Operators themselves on a regular basis.

This QoS audit was conducted from 23rd August to 28th September 2014 inclusive. Measurements were performed between 9:00 am and 11:00 pm every day except Saturdays.

3.2 Industry results

The following tables show the average combined results achieved by the three Mobile Operators for all measurements. Detailed results for each Operator are available in section 5 of this report.

3.2.1 Voice and messaging services

		2016	2014	2012	2011	2010
Global voice service		6 611 tests	6 673 tests	6 828 tests	6 822 tests	7 059 tests
Rate of calls set-up and held for 2 min (SHR)		**98.7%**	95.8%	96.6%	98.2%	96.6%
	statistical accuracy	0.3%	0.5%	0.4%	0.3%	0.4%
and marked	**4-perfect (PQR)**	**96.3%**	93.8%	94.1%	94.5%	94.1%
	statistical accuracy	0.5%	0.6%	0.6%	0.5%	0.5%
	4-perfect or 3-fair (CQR)	**97.6%**	95.0%	96.2%	97.2%	95.7%
	statistical accuracy	0.4%	0.5%	0.5%	0.4%	0.5%

Figure 2 – Voice service – industry results

The three networks offered an excellent level of service with an average setup and held calls rate of 98.6%, which is the best performance since the first audit in 2010.

	2016	2014	2012	2011	2010
SMS service	2 591 tests	4 547 tests	2 637 tests	3 096 tests	1 569 tests
% of received SMS (RS2)	**99.9%**	99.9%	99.6%	99.7%	99.2%
Statistical accuracy	0.1%	0.1%	0.2%	0.2%	0.4%
% of received SMS (RS30)	**97.1%**	98.3%	99.3%	99.3%	96.9%
Statistical accuracy	0.6%	0.4%	0.3%	0.3%	0.9%
% of received SMS (RS15)	**95.1%**	91.5%	96.5%	97.5%	
Statistical accuracy	0.8%	0.8%	0.7%	0.5%	
Average reception delay (s)	**6.6**	6.7	8.1	10.4	13.1

Figure 3 – SMS service – industry results

All networks offered very good SMS service within two minutes with 0.1% defects.

The average observed SMS reception delay was below 7 seconds, like 2014

3.2.2 Smartphone data measurements

⚠ Important:
Size of tests files has been increased since 2014, keeping the same timeout:

- DL : 100MB vs 50MB in 2014 – Time Out = 300 seconds
- UL : 50MB vs 10MB in 2014 – Time Out = 120 seconds

This explains the difference between 2014 and 2016 for "Rate of successful smartphone data transfers" in HTTP DL and UL.

4G HANDSET:

Rate of successful smartphone data transfers	2016	2014
HTTP DL	92.9%	99.3%
statistical accuracy	*1.4%*	*0.4%*
HTTP UL	95.2%	98.5%
statistical accuracy	*1.2%*	*0.9%*
WEB	99.4%	98.1%
statistical accuracy	*0.2%*	*0.4%*

Figure 4 – 4G Handset data service – industry results

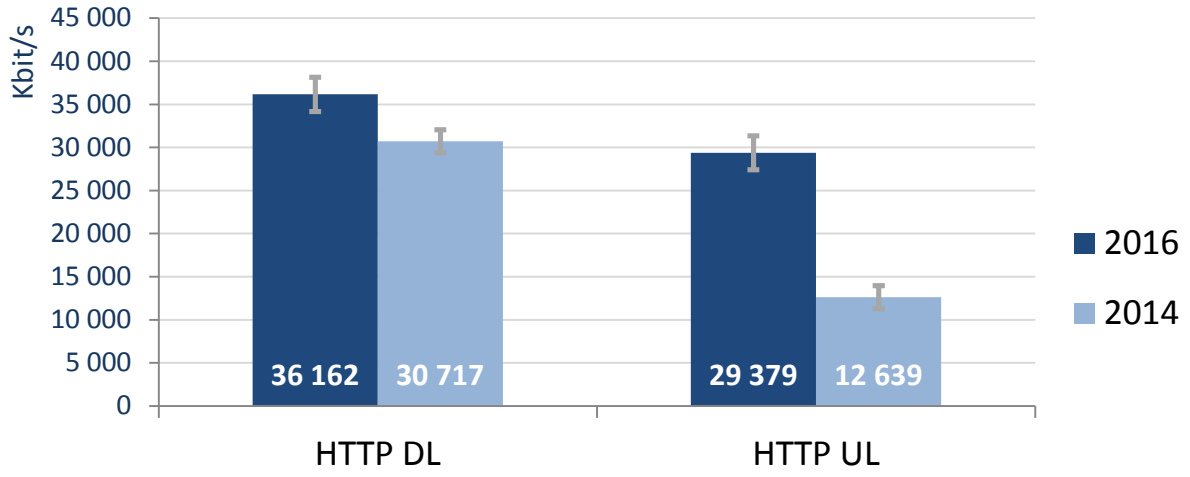

Figure 5 – 4G handset - HTTP transfers - average throughputs

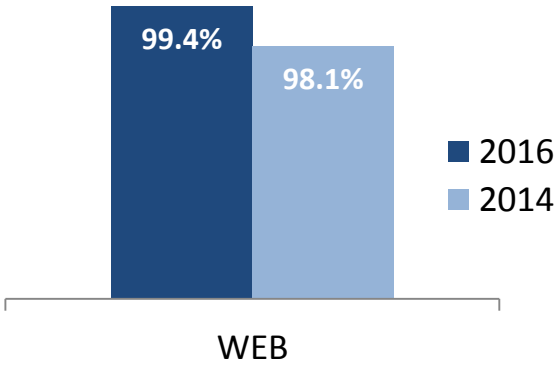

Figure 6 – 4G handset - Web browsing % Successful sessions

3G HANDSET:

Rate of successful smartphone data transfers	2016	2014	2012
HTTP DL	95.4%	93.1%	99.0%
statistical accuracy	1.1%	1.7%	0.5%
HTTP UL	96.8%	94.4%	97.9%
statistical accuracy	1.0%	1.7%	0.7%
WEB	98.2%	93.5%	99.1%
statistical accuracy	0.3%	0.8%	0.1%

Figure 7 – 3G handset - HTTP transfers - average throughputs

Note: the size of tests files has been increased since 2014, keeping the same timeout:

- DL : 100MB vs 50MB in 2014 – Time Out = 300 seconds
- UL : 50MB vs 10MB in 2014 – Time Out = 120 seconds

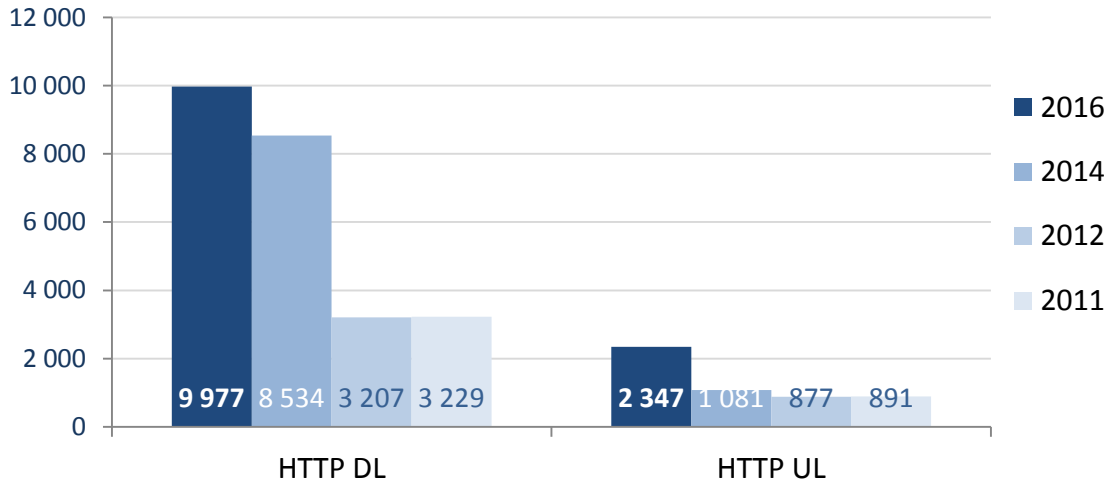

Figure 8 – 3G handset - HTTP transfers - average throughputs

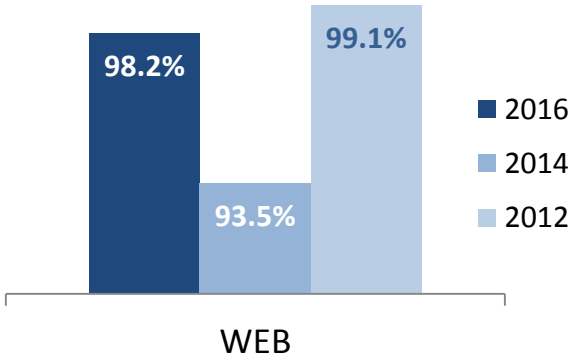

Figure 9 – 3G handset - Web browsing % Successful sessions

3.2.3 Streaming measurements

Streaming - 4G HANDSET

	2016	2014
LHV : % of videos set-up and held for 2 min	100.0%	97.3%
statistical accuracy	0.0%	*1.4%*
VPQR : % of videos set-up, held for 2 min, and marked 4	87.1%	95.9%
statistical accuracy	2.1%	*1.7%*
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	90.4%	93.5%
statistical accuracy	1.8%	*2.1%*
Average delay – access to video (s)	1.0	3.0
sample	1 025	513

Figure 10 – 4G Handset Streaming service – industry results

In comparison with 2014, quality of video is stable on the rate of video with a fair quality, but lower on the perfect quality.

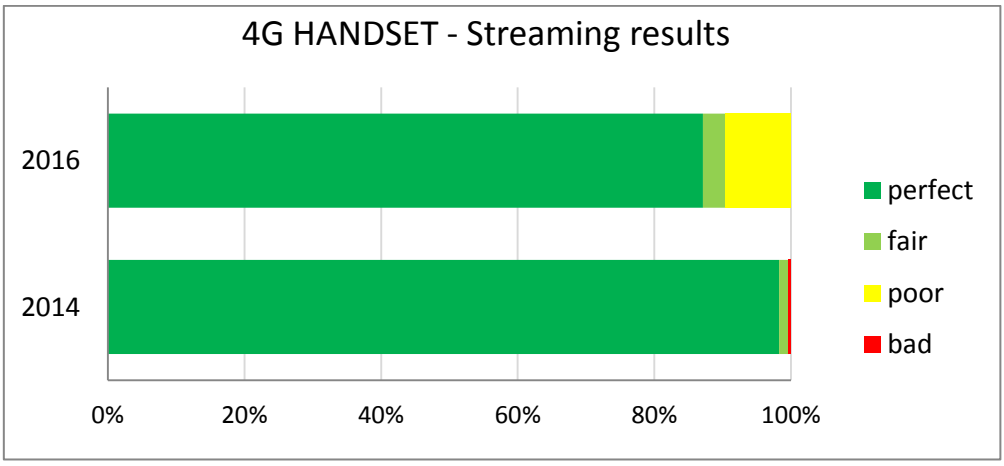

Figure 11 – 4G Handset Streaming service – quality distribution

Streaming - 3G HANDSET

	2016	2014	2012
LHV : % of videos set-up and held for 2 min	99.7%	92.0%	95%
statistical accuracy	0.3%	2.3%	3.1%
VPQR : % of videos set-up, held for 2 min, and marked 4	68.2%	75.0%	20%
statistical accuracy	2.9%	3.7%	5.7%
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	77.5%	77.6%	93.5%
statistical accuracy	2.6%	3.6%	3.5%
Average delay – access to video (s)	2.8	5	9
sample	1 017	513	673

Figure 12 – 3G Handset Streaming service – industry results

In comparison with 2014, quality of the video is stable on the rate of video with a fair quality.

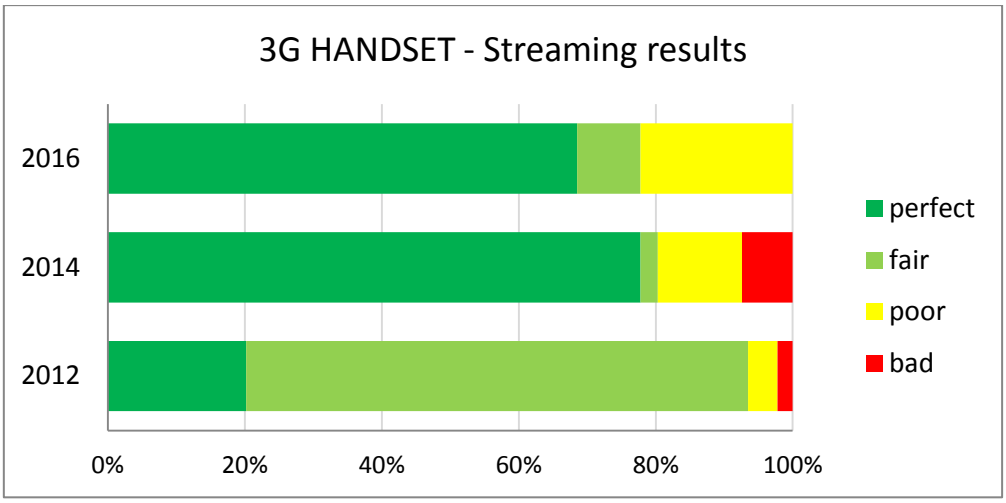

Figure 13 – 3G Handset Streaming service – quality distribution

3.2.1 Broadband performances

Each operator has provided a list of hotspots where network setting should allow higher data performance, in comparison with other locations that have been tested randomly.

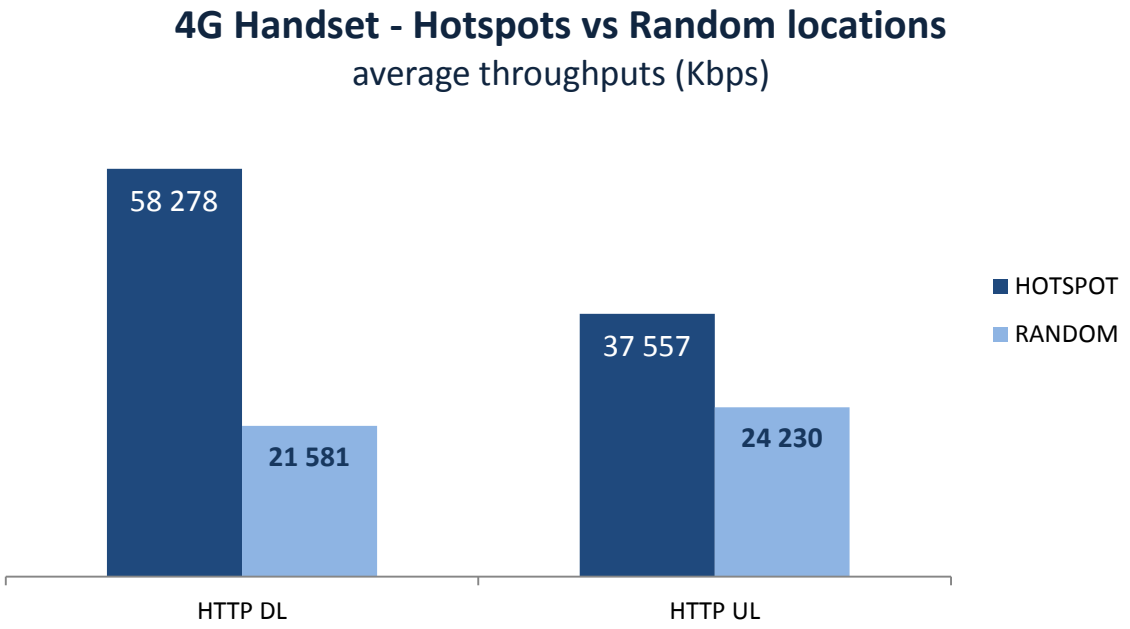

Figure 14 – 4G Handset Hotspots vs Random – average throughtputs

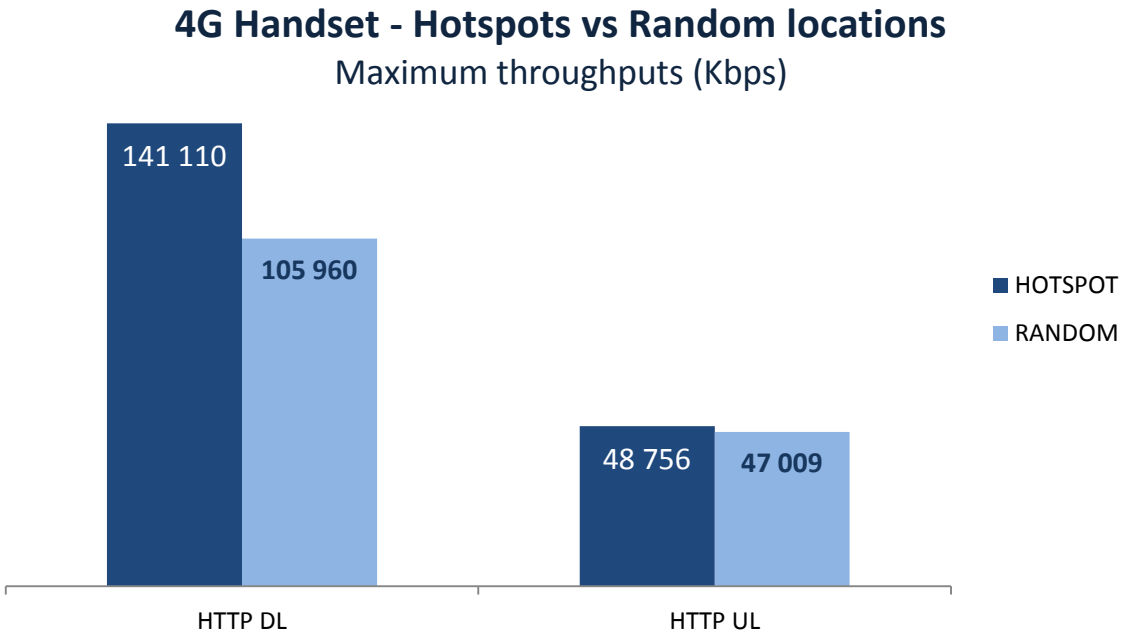

Figure 15 – 4G Handset Hotspots vs Random - maximum throughputs

4 BENCHMARK TO REFERENCE OPERATORS

The following charts are comparing the average results achieved by the three Mobile Operators in the Kingdom of Bahrain, Batelco, Viva and Zain, with the average results obtained by National Mobile Operators in the respective benchmarked markets. Measurements are based on compatible test procedures.

The results shown for Bahrain are the average combined results achieved by the three Mobile Operators.

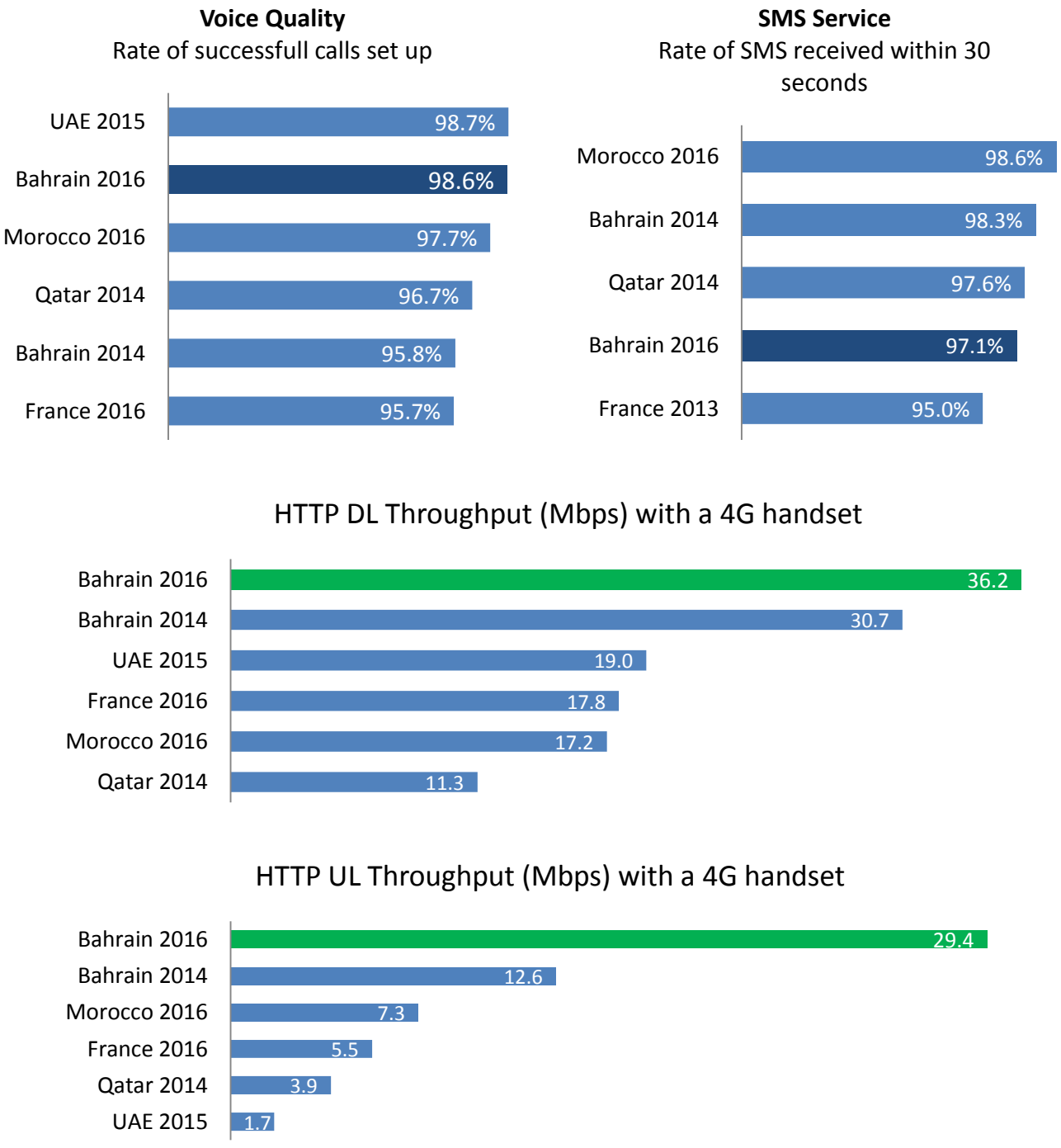

Figure 16 –BENCHMARK TO REFERENCE OPERATORS

5 MEASUREMENTS SPECIFICATIONS

5.1 Team and Equipment

5.1.1 Team

The project was managed by Directique Operations Director with the following project team:

- A dedicated project manager present in Al Manamah during audit launch phase.
- A field supervisor based in Al Manamah for the whole audit duration.
- Test team A performing voice and SMS measurements:
  - 2 engineers and a driver in the field;
  - 2 engineers in an office.
- Test team B performing data measurements:
  - 1 engineer in the field (tests were not carried out while driving)

5.1.2 Equipment

The following mobile devices have been selected, in agreement with Mobile Operators:

Network	Voice / SMS	Fixed Phone	Data/Video
BATELCO	Samsung Galaxy S6 edge	BATELCO	Samsung Galaxy S6+ edge
ZAIN			
VIVA			

All devices were compatible with voice, SMS and data technologies and were recommended or sold by Mobile Operators for 2G, 3G and 4G technologies. Batelco land lines were equipped with a standard fixed phone.

During Incar measurements, mobile phones were used without external antenna. For all voice measurements, a hands-free kit was used with mobile phones.

5.1.3 Sim cards

Directique has sourced the necessary SIM cards locally, from each tested mobile network operator, in a blind test approach.

80% of the tests have been done with prepaid SIMs, and 20% on the following postpaid packages:

- Batelco: Smart Data
- Viva: Postpaid Unlimited LTE Plan
- Zain: Social SIM-only

5.2 Voice service quality testing

5.2.1 Measurement

A voice measurement was a call attempt followed by a 2 minutes conversation. Calls were placed on all networks simultaneously from the same physical location. A measurement was therefore a set of three calls, one per Mobile Operator.

A field engineer was conversing over his mobile phone with an engineer in the fixed office. The engineer in the office was using either a fixed-line phone or a mobile phone.

Each field team had one phone for each mobile network. Either side could initiate the call following pre-defined call sample objectives.

Call distribution was as follow:

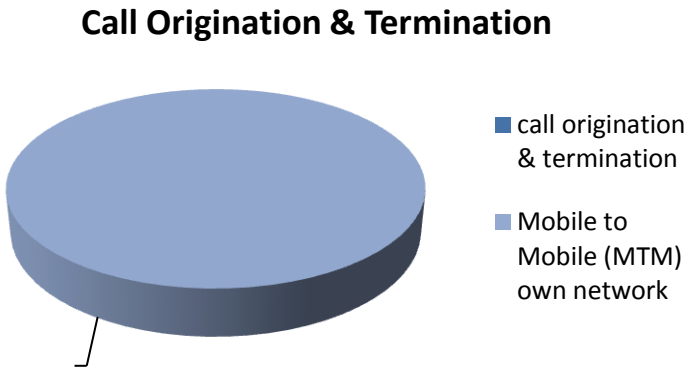

Figure 17 –Voice calls distribution

Voice measurements were performed in three configurations:

- Indoor : Pedestrian Indoor in public and private buildings
- Outdoor: Pedestrian Outdoor in the busiest outdoor places. 50% of the measurements were dynamic, and 50% were static.
- In car: On road links (In car Road) and within Town borders (In car Town)

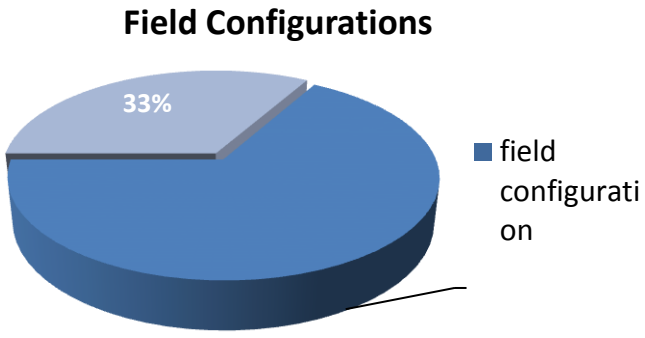

Figure 18 –Voice measurements type

Audio Quality marking:

Failed and dropped calls were registered in the database. Otherwise the audio quality was evaluated for established and 2 minutes maintained calls. Once a call was established, engineers followed a speech guideline, simulating an average conversation, and audio quality was marked on a scale of 1 to 4 as follows:

Level 4 : Perfect	Engineer doesn't notice any defect
Level 3 : Fair	One defect occurs while the conversation goes on uninterrupted
Level 2 : Poor	The natural flow of the conversation is altered and the engineer has to repeat himself
Level 1 : Bad	The defect is so strong that conversation cannot proceed.

Figure 19 – Audio Quality marking

As the call went on, each engineer took note of the identified defects such as metallic noises, voice distortion, echo... At the end of the call the fixed located engineer collected both marks on a scale of 1 to 4, did input results in the database, along with standard description of specific defect(s), if any. In the case field and fixed-end engineers had different evaluation for the call, the worst mark was retained.

5.2.2 Testing Area and sample size

Sampling distribution between towns was based on population data and organized as follow:

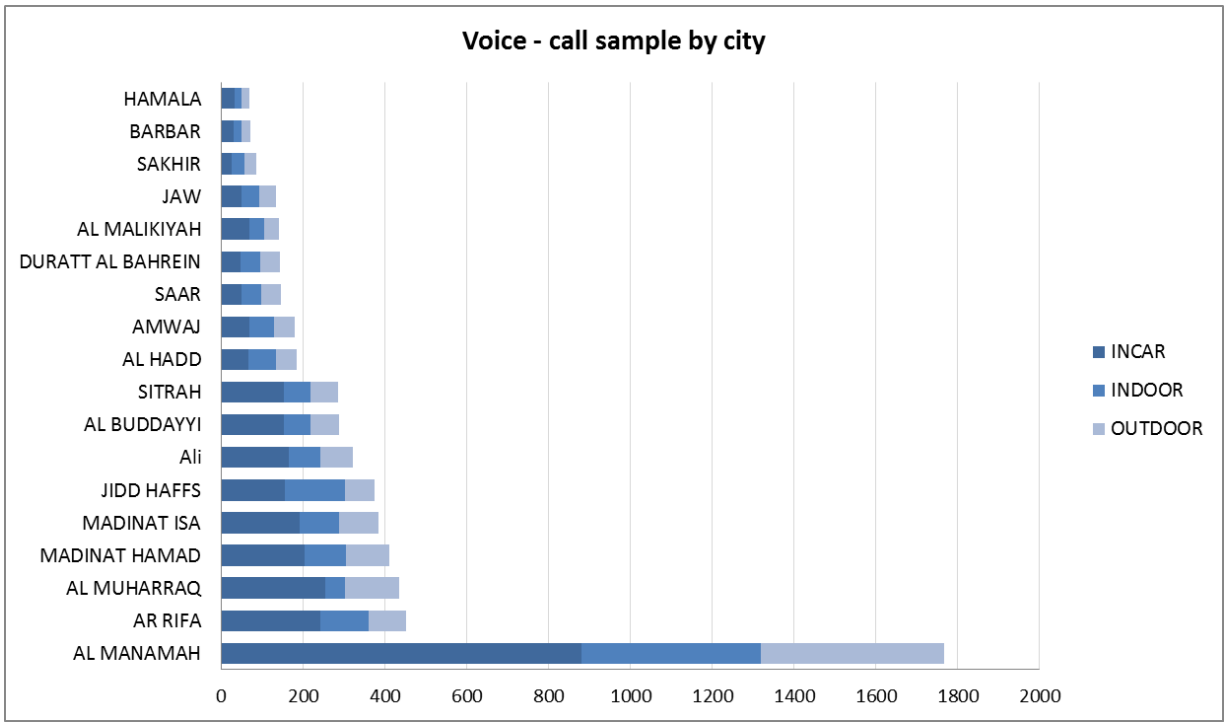

Figure 20 – Voice calls – sample by city

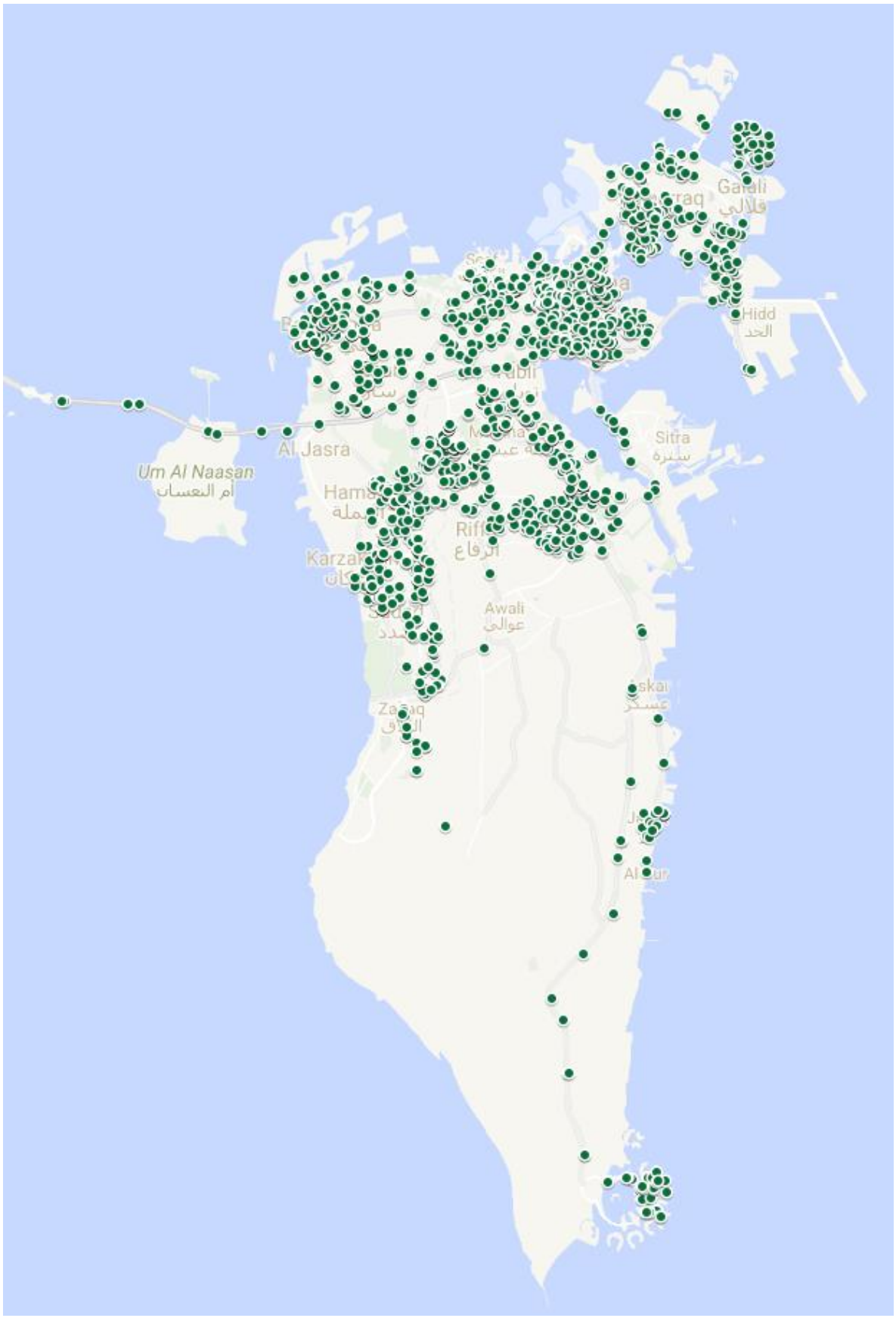

Figure 21 – Test locations: voice service

5.2.3 Measurements specifications - Towns

❖ ***In car measurements***

In Towns of more than 50,000 inhabitants, tested zone were divided into equal areas, and a number of calls were allocated to each of these areas. Field engineers did adapt their journey depending on external events (traffic, one way roads…), with the aim of covering the whole area as per test plan.

In smaller Towns (less than 50,000 inhabitants), measurements were performed on a paths that included major roads and constructed zones (Downtown, malls, stations, touristic places and business centers).

❖ ***Pedestrian measurements***

Pedestrian measurements were equally distributed over an area

- Pedestrian outdoor measurements

1/3 of measurements were dynamic (from a point to another) and 2/3 were static. A single test was performed for each location, to always ensure best repartition over the tested zone. Locations were selected among high-attendance pedestrian places (buildings, parks, malls ...)

- Pedestrian indoor measurements

Calls were placed preferably on daylight indoor (less than 3 meters from a window) or on deep indoor. Any floor in a particular building was tested, except basement and above 12th floor.

Measurements were adapted by building type: 46% in the public places and 54% in offices and residential areas:

- Large places: 3 to 4 measurements were performed
- Small places: 1 to 2 measurements were performed

5.2.4 Measurements specifications - Road links

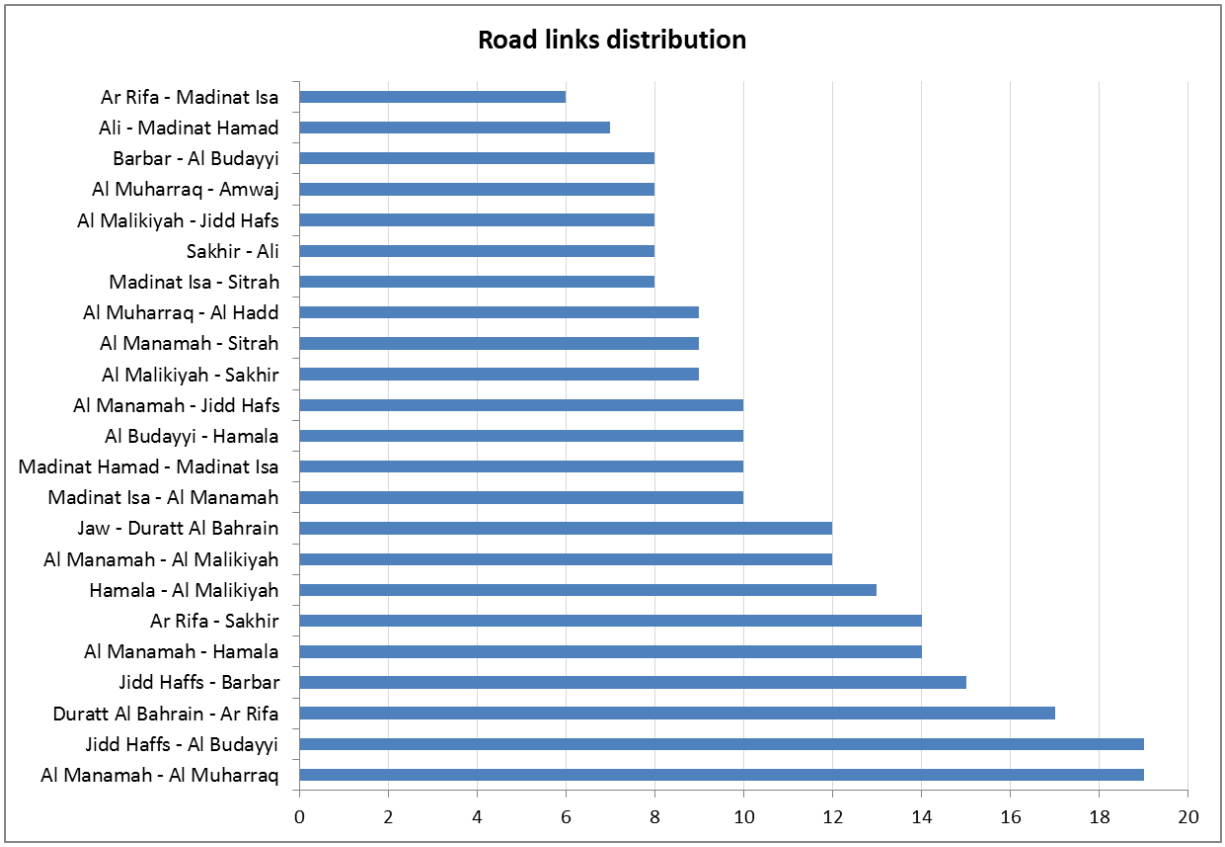

Figure 22 – Road links distribution

This histogram shows the number of incar voice calls made on each road link.

5.2.5 Method

Test methodology followed ITU ref P.800 Mean Opinion Score for voice specification.

The corner stone of Directique test methodology is based on a training method performed on a specifically developed software **FormaTest** ©.This training method allows for a clear and faithful marking system of audio and video quality problems. Directique guarantee consistency across engineers, and a minimum standard deviation of the marks.

All tests were timed stamped and GPS tagged, in order to ensure full traceability of each measurement.

Test phones were verified on a daily basis, and when allocated for field testing, handsets were rotated between teams regularly to avoid bias due potential to small differences between same model phones in radio frequency sensitivity and processor performance.

Measurements software assisted by **ChronoTest** ©, were started simultaneously by the mobile and the fixed operators to synchronize call start. The software provided engineers with all necessary information related to a test call, when a call had to be placed (either mobile originated or mobile terminated) and ended, in order to guarantee a strict adherence to test protocol. **ChronoTest** © was combined with a GPS receiver recording the location of the mobile team every second.

All information concerning test location and call marks were recorded by the engineer at the fixed-end location in a database who ran live coherence checks to guarantee error free recording.

Hands-free kits were used on mobile phones in order to minimize ambient noise and provide a better environment to the field engineer to measure quality of the voice service.

Outdoor, the phone was either held by hand, or placed in a pocket in areas where discretion was required.

5.2.6 No default procedure

In order to guarantee the same level of assessment for all Mobile Operators, engineers were regularly switched from one operator to another.

In order to prevent a faulty phone polluting measurement samples, phones used for the test were new and tested prior the start of measurements campaign.

In case of abnormal behavior of a handset, it was replaced and removed from the test pool.

Every week, test results were computed in a way that singled out any problem that could be related to a test phone.

5.2.7 Statistical Accuracy

For each KPI rate, the statistical accuracy gives the confidence interval of the result, under or above it; and is correlated to the size of the sample.

It is calculated using the following formula:

Statistical Accuracy = 1.96*SQR(R*(1-R)/N), where:

R = Result

N = Sample

SQR = Square Root

5.3 SMS measurements

5.3.1 SMS Measurements

The mobile phones used to receive SMS were at a fixed location in an area served by a strong radio signal from the Mobile Operators. The mobile phones transmitting the SMS were in the field with the testing team. SMS were sent from indoor and outdoor locations used for voice testing to a fixed location.

A measurement, made simultaneously on all Mobile Networks, consisted of:

- Sending a 26 characters message including an index, and recording time
- Observing reception of the message on the other phone and taking note of the time; a message not received after 2 minutes elapse time was marked as failed.
- Opening and checking integrity of the received message and index matching

SMS test areas excluded road links, SMS testing schedule was the same as for voice testing.

5.4 Data service testing

5.4.1 Description

Data measurements are spread between hotspots and random places.

Hotspots are pre-defined locations where operators are supposed to have better performances. A list of 10 hotspots has been given by each operator, among which 9 have been selected for the audit.

Data measurements were done on 2 sets of smartphones for each operator:

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

Tests have been done simultaneously on every location, on test servers provided by each operator for its own set of measurements.

		3G - Smartphone	4G - Smartphone
RANDOM	**HTTP DL / HTTP UL / /WEB**	✓	✓
	Video streaming	✓	✓
	Social Networks (Facebook, Instagram and WhatsApp)	✓	✓
HOTSPOTS	**HTTP DL / HTTP UL / /WEB**	✓	✓
	Video streaming	✓	✓
	Social Networks (Facebook, Instagram and WhatsApp)	✓	✓

Figure 23 – Data tests matrix

5.4.2 HTTP transfer Measurement

On each network, a measurement consists of:

- Downloading a file* through HTTP. Time for downloading the entire file is recorded
- Uploading a file* through HTTP. Time for uploading the entire file is recorded

* File sizes are different depending on the technology:

- 3G : 20MB for DL (TO* = 180s) / 5MB for UL (TO = 120s)
- 4G : 100MB for DL (TO = 300s) / 50MB for UL (TO = 120s)

* TO = Time Out

Test servers, with sufficient bandwidth (100Mb/s) have been provided by the operators.

Data measurements were carried out automatically via ***Mobispeed*** ©, Directique's data test app.

5.4.3 WEB Browsing Measurements

WEB measurements were carried out automatically via ***Mobispeed*** ©, Directique's data test app.

On each network, a measurement consists of downloading one of the 10 most visited public homepages and one page from each Operator, taking note of completion time, errors on the page if any, with a 30 seconds timeout.

The final list of websites retained (which are common among the three operators) for the tests and after analysis of the results are:

http://www.amazon.com
http://www.apple.com
http://www.dailymotion.com
http://www.expatriates.com
http://www.facebook.com
http://www.google.com.bh
http://www.Instagram.com
http://www.msn.com

Figure 24 – List of webpages tested

5.4.4 Streaming Measurements

Streaming Measurements have been carried out by assessing the quality of selected Youtube videos with smartphones in order to represent closely as possible the customer experience. The evaluation started when the video was launched and lasted 2 minutes. Each video and audio defect was categorized and its duration was collected in order to determine if the viewing was perfect, fair, poor or bad. Once the sequence had been completed, a grade was given to describe 3 global appraisal criteria (sharpness, audio/video synchronization and sound quality)

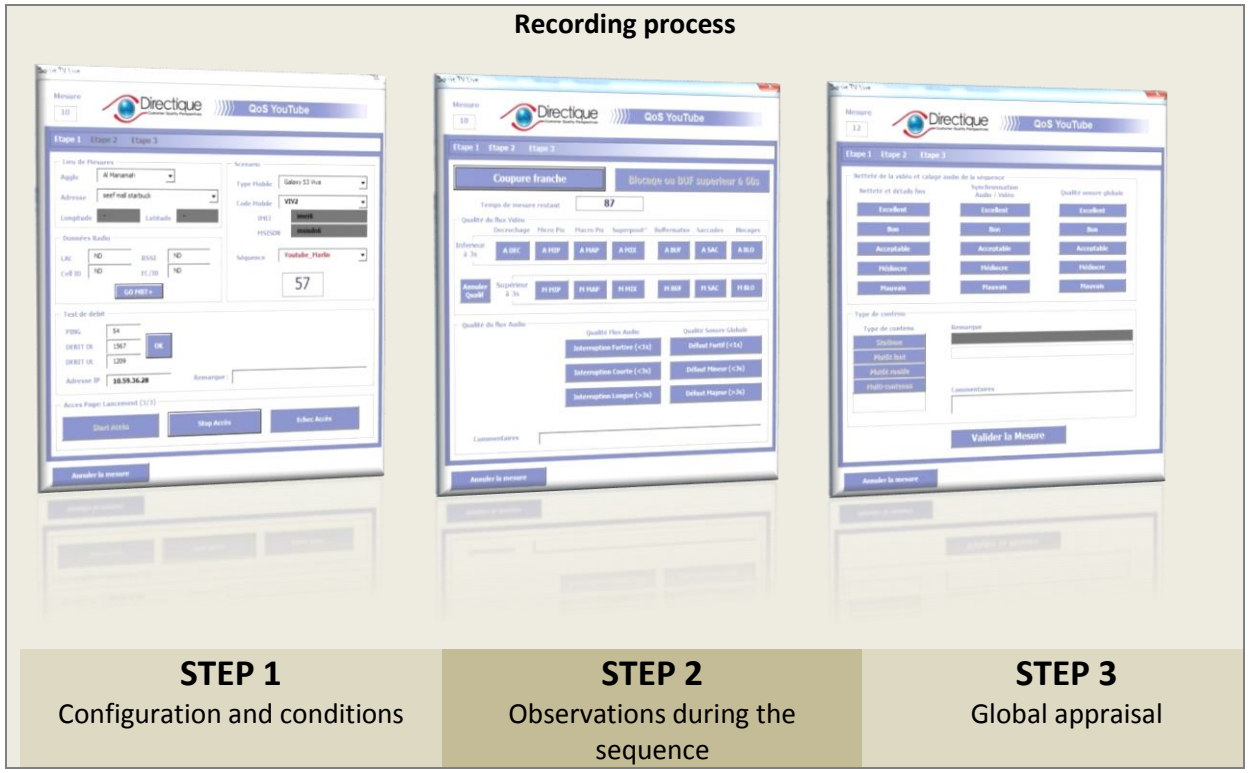

Figure 25 – Streaming tests – recording process

Defects correspond to damages occurring during the assessment and detailed hereafter:

Video appraisal criteria	
SUPERIMPOSITION	Superimposition or interlaced images during transitions between frames
PIXELATION	Single-colored square display elements that comprise the bitmap are visible.
BUFFERING	The sequence stops, a message showing the buffering percentage appears.
JERKINESS	When the frame rate is under 18fps, individual still images may be perceived by the viewer.
FREEZE	A Freeze occurs when the sequence shows a still image during a few seconds

Audio appraisal criteria	
AUDIO INTERRUPTIONS	Silences are categorized as furtive (< 1s), short (< 3s) or long (> 3s)
AUDIO DEFECTS	Punctual audio defects perceived by the user including distortions, crackling, metallic sounds and echoes.

Global appraisal criteria	
AUDIO SEQUENCE QUALITY	Overall audio quality of the sequence
SHARPNESS	Sharpness reflects the level of detail in the images displayed.
AUDIO/VIDEO SYNCHRONIZATION	The level of desynchronization is measured proportionally to the length of the delay between audio and video.

Figure 26 – video streaming - quality appraisal

5.4.5 Social networks

Evaluation of the quality of service on social networks has been measured for the first time in 2016, automatically on Facebook and manually by the data tester on Instagram and WhatsApp, in the exact conditions of a regular consumer.

- **Facebook**

Facebook measurements have been made with our automatic tool QoSuite.

In order to simulate a regular customer experience, the test consisted in sharing content on Facebook.

The uploaded file was a 20MB video, during a maximum delay of 30 seconds.

The tools give the following results:

- Total **downloaded volume (MB)** after 30 seconds.
- Average **Throughput (Mb/s)** during the 30 seconds of the test.

- **Instagram**

Instagram tests have been made manually by the tester, using a semi-automatic input tool to save the results in a data base.

Each operator have been tested separately, one after the other, in order to keep the same testing conditions.

In order to simulate a regular customer experience, the test consisted in sharing content on Instagram.

Description of the tests:

- tester took a photo of the location with the camera of the handset (approx. 4MB)
- tester selected “Share/Instagram”, and measured the delay to access the App
- tester clicked on “Publish”, and measured the delay to publish the photo

- **WhatsApp**

As for Instagram, WhatsApp measurements have made manually by the tester, using a semi-automatic input tool to save the results in a data base.

In order to assess the quality of voice and messaging service through WhatsApp (IP), in comparison with the regular voice and SMS services on mobile networks, we used the exact same protocols:

- Voice: 2 minutes calls
- Messages: sending a 26 characters message

5.4.6 Sample

CITY	HTTP DL	HTTP UL	WEB	STREAMING	FACEBOOK	INSTAGRAM	Total
Al Budayyi	72	72	576	70	34	36	**860**
Al Hadd	61	61	408	52	25	26	**633**
Al Malikiyah	34	34	272	36	18	18	**412**
Al Manamah	775	774	5 332	658	323	331	**8193**
Al Muharraq	126	126	1 008	129	64	66	**1519**
Ali	74	74	592	72	36	36	**884**
Amwaj	52	52	416	36	18	18	**592**
Ar Rifa	171	170	1 272	158	77	80	**1928**
Barbar	38	38	224	28	14	14	**356**
Duratt Al Bahrein	48	48	384	48	22	24	**574**
Hamala	38	38	224	28	14	14	**356**
Jaww	49	48	384	48	24	24	**577**
Jidd Hafs	361	361	2 072	238	119	122	**3273**
Madinat Hamad	98	104	896	108	51	54	**1311**
Madinat Isa	125	125	910	111	56	56	**1383**
Saar	85	85	600	76	35	38	**919**
Sakhir	74	74	512	62	30	32	**784**
Sitrah	70	70	559	84	40	42	**865**
Total	**2 351**	**2 354**	**16 641**	**2 042**	**1 000**	**1 031**	**25 419**

Figure 27 – Smartphone test sample distribution

5.5 Interconnectivity measurements

In order to evaluate the interconnectivity between networks, we have used an automated system that launched crossed network calls following a predefined script.

Those platforms, which consist of a laptop connected to regular phones through our tool Mobitrace, have been installed in several places in Manama and have launched calls continuously during several hours' sessions.

The called mobiles were installed in, our office in Manama, under good radio conditions, and were configured to pick up automatically when called.

On each location, 2 configurations have been tested :

- 1st configuration : Batelco to Viva / Viva to Zain / Zain to Batelco
- 2nd configuration : Batelco to Zain / Viva to Batelco / Zain to Viva

The rate of calls set-up has been compared with Voice audit results (own network).

6 AUDIT RESULTS

6.1 Key Performance Indicators

6.1.1 Voice KPIs

A voice measurement is a successful call attempt followed by a 2 minutes conversation, with an assessment of the audio voice quality for each operator service.

KPIs	Definition
SHC (Set-up and held for 2 min calls)	% of calls set-up and held for 2 min. Call set-up on first attempt and held for 2 min without drop.
PQR (Perfect quality rate)	% of calls set-up held for 2 min and marked 4. Calls excluded = failed on first attempt, dropped before 2 min, or been marked 3 or lower. Rate based on total sample
CQR (Correct quality rate)	% of calls set-up held for 2 min and marked 4. Calls excluded = failed on first attempt, dropped before 2 min, or been marked 2 or lower. Rate based on total sample

6.1.2 SMS KPIs

KPIs	Definition
RS 2 (% of received SMS within 2 minutes)	SMS not refused when sent out and received within 2 minutes. Rate based on total sample
RS 30 (% of SMS received SMS within 30 sec)	SMS not refused when sent out and received within 30 seconds without being altered. Rate based on total sample
RS 15 (% of SMS received SMS within 15 sec)	SMS not refused when sent out and received within 15 seconds without being altered.

6.1.3 Web KPIs

KPIs	Definition
% of successful data transfers	Successful page loading within 60s. Rate based on total sample
Average download time	Average delay once connected, applied only to successful data transfers
Min download time	Best delay to load a webpage
Standard deviation download time	Standard download time deviation applied only to successful data transfers
WEB10 : % of successful data transfers within 10 seconds	Successful page loading within 10s. Rate based on total sample
WEB5 : % of successful data transfers within 5 seconds	Successful page loading within 5s. Rate based on total sample

6.1.4 HTTP

KPIs	Definition
% of successful data transfers	Successful data transfer without radio drop. Indicator is based on the total number of connection attempts
Average Throughput	Average throughput once connected, applied only to successful data transfers
Best Throughput	Best throughput recorded for a data transfer measurement
Average delay (s)	Average delay to successful data transfers within defined Time Out

6.1.5 Streaming KPIs

KPIs	Definition
LHV : % of videos set-up and held for 2 min	Video launched on first attempt, and held for 2 min without drop
VPQR : % of videos set-up, held for 2 min, and marked 4	Video excluded = failed on first attempt, dropped before 2 min, or been marked 3 or lower - (PQR : Perfect Quality Rate)
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	Video excluded = failed on first attempt, dropped before 2 min, or been marked 2 or lower - (CQR : Correct Quality Rate)
Delay (min, average)	delay between the launch click and the beginning of the sequence

6.1.6 Facebook

KPIs	Definition
Average Upload Throughput	Average throughput during the 30 seconds of upload
Best Throughput	Best throughput during the 30 seconds of upload

6.1.7 Instagram

KPIs	Definition
Rate of successful publications (%)	Successful data transfer without radio drop. Indicator is based on the total number of connection attempts
Average delay to publish (access+post) (s)	delay between the selection of “Share/Instagram” and the publication of the picture

6.1.8 WhatsApp

KPIs	Definition
PQR (Perfect quality rate)	% of calls set-up held for 2 min and marked 4. Calls excluded = failed on first attempt, dropped before 2 min, or been marked 3 or lower. Rate based on total sample
RS 30 (% of received messages within 30 sec)	Messages not refused when sent out and received within 30 seconds without being altered.

6.2 Batelco results

6.2.1 Global voice results (Cities & Road links)

		Batelco
Global voice service		2 199 tests
Rate of calls set-up and held for 2 min		**99.0%**
statistical accuracy		0.4%
and marked	**Rate of calls marked 4-perfect (PQR)**	**95.7%**
	statistical accuracy	0.8%
	Rate of calls marked 4-perfect or 3-fair (CQR)	**96.5%**
	statistical accuracy	0.8%

Figure 28 – voice – Global results

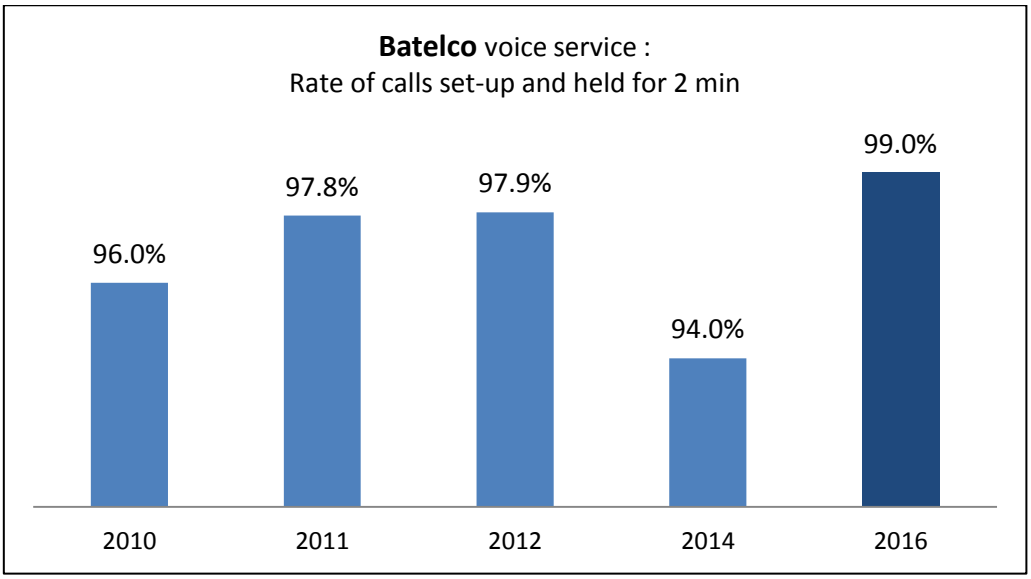

Figure 29 – voice – Global results evolution

		Batelco
Cities voice service (incar, outdoor, indoor)		1 955 tests
Rate of calls set-up and held for 2 min		**99.0%**
statistical accuracy		0.4%
and marked	**4-perfect (PQR)**	**96.3%**
	statistical accuracy	0.8%
	4-perfect or 3-fair (CQR)	**97.1%**
	statistical accuracy	0.7%

Figure 30 – voice – Cities results

		Batelco
Cities voice service (incar only)		944 tests
Rate of calls set-up and held for 2 min		**99.4%**
statistical accuracy		0.5%
and marked	**4-perfect (PQR)**	**96.1%**
	statistical accuracy	1.2%
	4-perfect or 3-fair (CQR)	**97.0%**
	statistical accuracy	1.1%

Figure 31 – voice – Cities incar results

		Batelco
Road links service		247 tests
Rate of calls set-up and held for 2 min		**98.0%**
statistical accuracy		1.8%
and marked	**4-perfect (PQR)**	**89.9%**
	statistical accuracy	3.8%
	4-perfect or 3-fair (CQR)	**91.1%**
	statistical accuracy	3.6%

Figure 32 – voice – Road links results

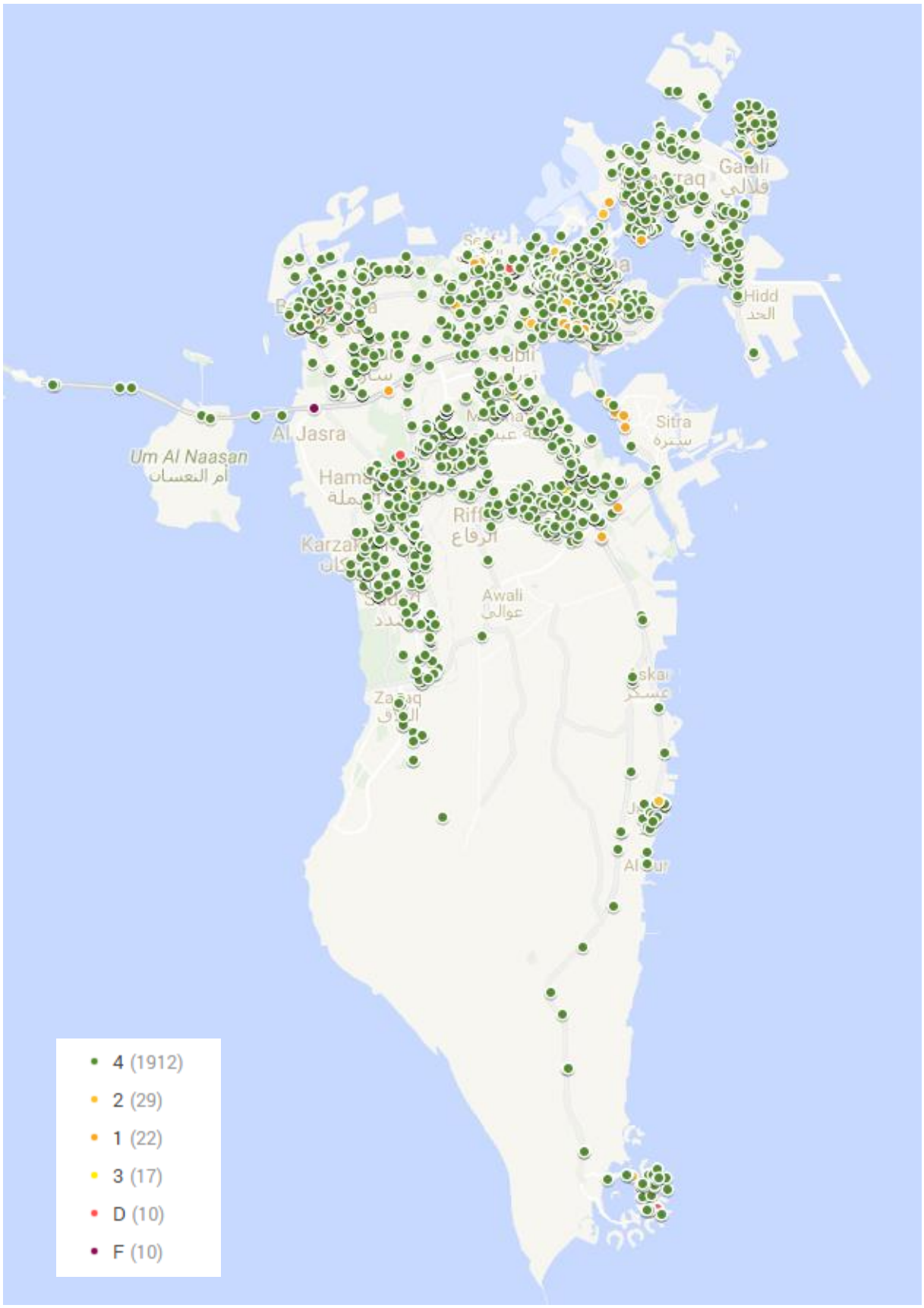

Figure 33 – BATELCO Global voice results

6.2.2 SMS results

	BATELCO
SMS service	995 tests
% of received SMS (RS2)	**100.0%**
Statistical accuracy	0.0%
% of received SMS (RS30)	**96.9%**
Statistical accuracy	1.1%
% of received SMS (RS15)	**95.2%**
Statistical accuracy	1.7%
Average reception delay (s)	**7**

Figure 34 – SMS – Global results

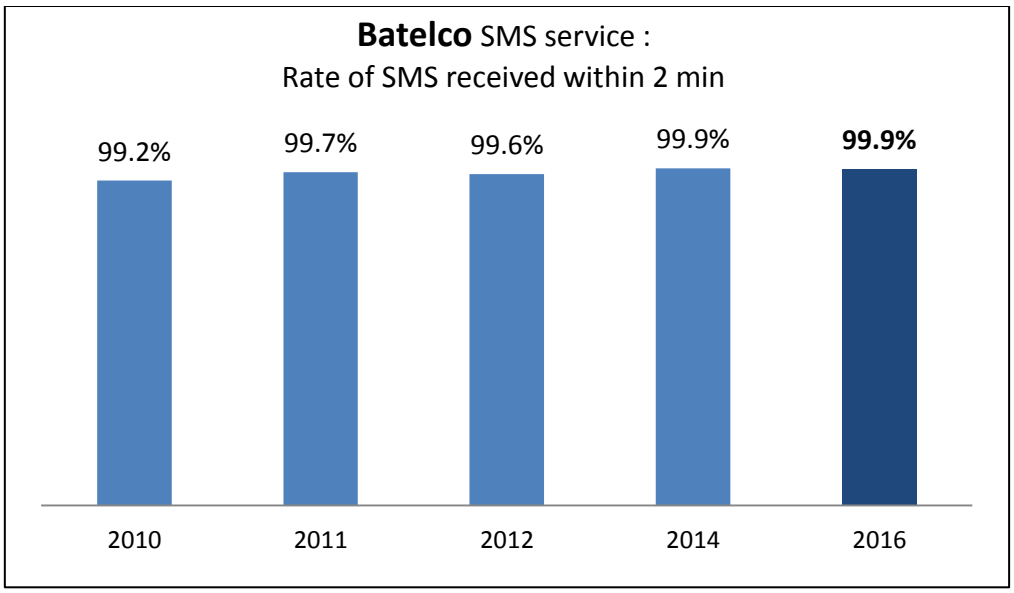

Figure 35 – SMS – Global results evolution

6.2.3 Data smartphone results

6.2.3.1 3G HANDSET

	BATELCO
HTTP DL	352 tests
Rate of successful data transfers (within 180 seconds) Statistical accuracy	**98.3%** 1.4%
Average Throughput (kbps)	**9 193**
Max throughput (kbps)	**28 034**
Standard deviation throughput (kbps)	6 130
% data transfers with a throughput > 2Mbps	91.8%
Average delay to download a 20MB file (s)	31.7

Figure 36 – 3G HANDSET – HTTP DL

	BATELCO
HTTP UL	352 tests
Rate of successful data transfers Statistical accuracy	**96.0%** 2.0%
Average Throughput (kbps)	**2 014**
Max throughput (kbps)	**4 508**
Standard deviation throughput (kbps)	1 099
Average delay to upload a 5MB file (s)	31.5

Figure 37 – 3G HANDSET – HTTP UL

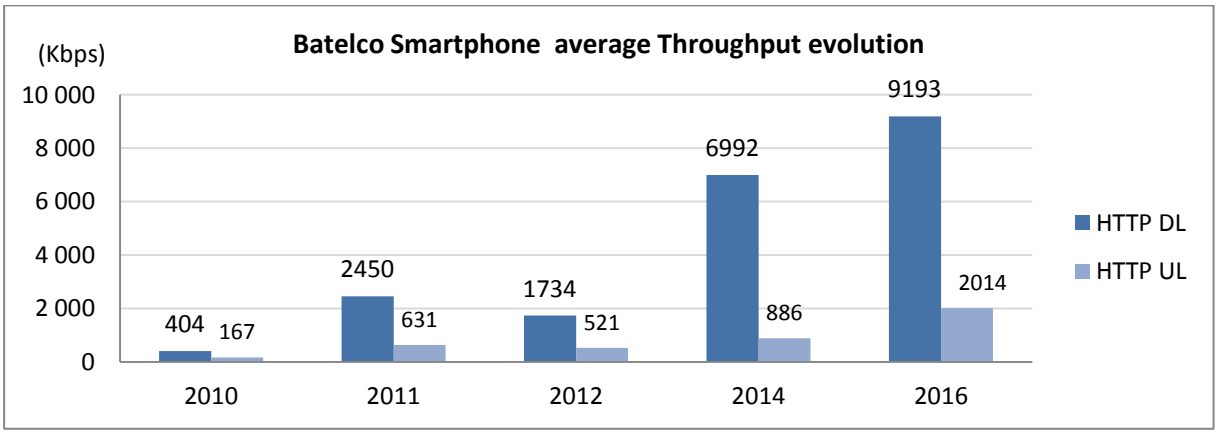

Figure 38 – 3G HANDSET – HTTP DL and UL - throughput evolution

	BATELCO
WEB	2 803 tests
Rate of successful data transfers Statistical accuracy	**99.7%** 0.2%
Average download time (s)	**4.7**
Min download time (s)	**1.4**
Standard deviation download time (s)	3.0
% data transfers within 10 seconds	95.0%

Figure 39 – 3G HANDSET – Web Browsing

6.2.3.2 4G HANDSET

	BATELCO
HTTP DL	447 tests
Rate of successful data transfers Statistical accuracy	**98.0%** 1.3%
Average Throughput (kbps)	**38 870**
Max throughput (kbps)	**141 110**
Standard deviation throughput (kbps)	30 989
% data transfers with a throughput > 2Mbps	98.7%
Average delay to download a 100MB file (s)	43.3

Figure 40 – 4G HANDSET – HTTP DL

	BATELCO
HTTP UL	445 tests
Rate of successful data transfers Statistical accuracy	**96.6%** 1.7%
Average Throughput (kbps)	**29 362**
Max throughput (kbps)	**46 675**
Standard deviation throughput (kbps)	11 627
Average delay to upload a 50MB file (s)	19.0

Figure 41 – 4G HANDSET – HTTP UL

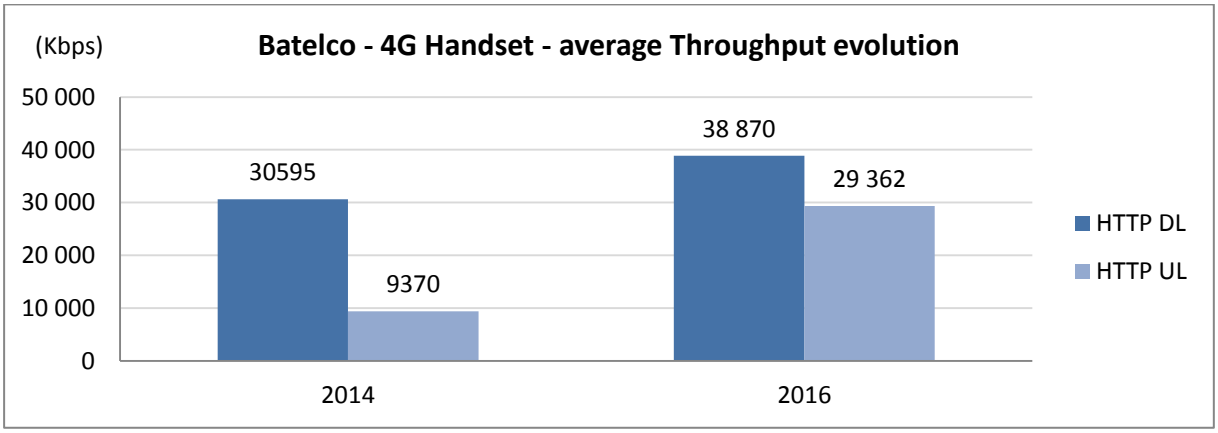

Figure 42 – 4G HANDSET – HTTP DL and UL - throughput evolution

	BATELCO
WEB	2 775 tests
Rate of successful data transfers Statistical accuracy	**99.6%** 0.2%
Average download time (s)	**3.0**
Min download time (s)	**1.2**
Standard deviation download time (s)	1.7
% data transfers within 10 seconds	99.1%

Figure 43 – 4G HANDSET – Web Browsing

6.2.4 Streaming KPIs

6.2.4.1 Streaming - 3G HANDSET vs 4G HANDSET

	3G HANDSET	4G HANDSET
LHV : % of videos set-up and held for 2 min	100%	100%
statistical accuracy	0.0%	0.0%
VPQR : % of videos set-up, held for 2 min, and marked 4	67%	95%
statistical accuracy	5.0%	2.4%
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	76%	96%
statistical accuracy	4.6%	2.1%
Average delay	2.5	0.9
Minimum delay	0.7	0.5

Figure 44 – Video Streaming

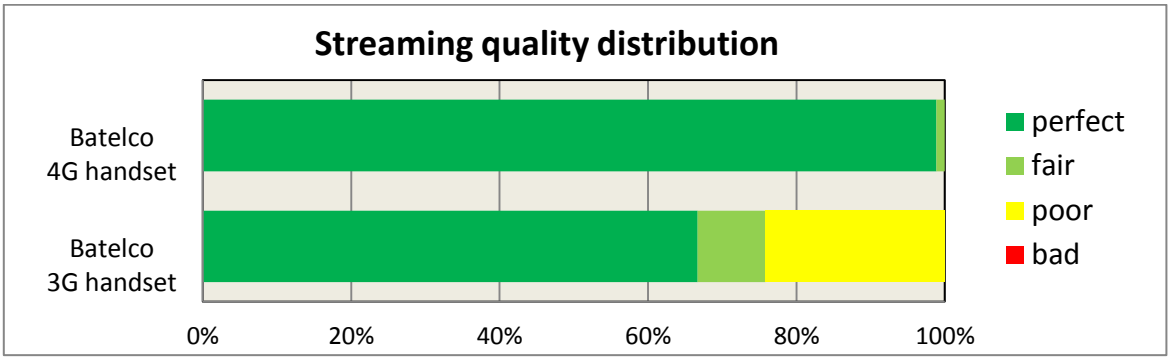

Figure 45 – Streaming - Quality distribution

6.2.4.2 Streaming – High def. (HD) vs Standard def. (SD)

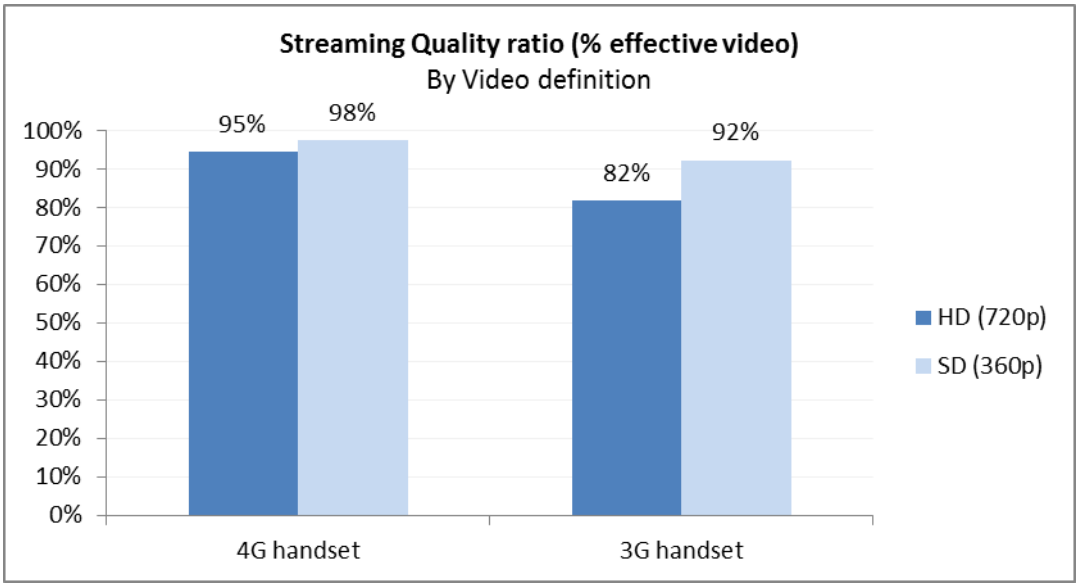

Figure 46 – Quality ratio by video definition

6.2.5 Facebook KPIs

	Batelco	
	4G handset	**3G handset**
Total sample	166 tests	160 tests
Average Throughput	8.0 Mb/s	1.6 Mb/s
Max throughput	18.4 Mb/s	3.8 Mb/s
Standard deviation throughput	3.9 Mb/s	1.0 Mb/s

Figure 47 – Facebook results

6.2.6 Instagram KPIs

	Batelco	
	4G handset	**3G handset**
Total sample	172 tests	172 tests
Rate of successful publications (%)	99.4%	99.4%
Average delay to publish (seconds)	5.4	6.0

Figure 48 – Instagram results

6.2.7 WhatsApp KPIs

	Batelco
Sample	162 tests
Rate of calls set-up and held for 2 min 4-perfect (PQR) statistical accuracy	**100.0%** *+/-0.0%*

Rate of successful received Messages (%)	100.0%
Average delay to send a message (seconds)	1.0

Figure 49 – WhatsApp results

6.2.8 Interconnectivity calls

	Batelco to Viva	Batelco to Zain	Batelco to other networks	Batelco to Batelco*
Sample	1 101 tests	1 086 tests	2 187 tests	2 199 tests
Rate of calls set-up *statistical accuracy*	**99.3%** *+/-0.5%*	**98.1%** *+/-0.8%*	**98.7%** *+/-0.5%*	**99.0%** *+/-0.4%*

* Results of the QoS voice audit

Figure 50 – Interconnectivity calls results

6.3 Viva results

6.3.1 Global voice results (Cities & Road links)

		Viva
Global voice service		2 205 tests
Rate of calls set-up and held for 2 min		**98.6%**
statistical accuracy		0.5%
and marked	**Rate of calls marked 4-perfect (PQR)**	**96.6%**
	statistical accuracy	0.8%
	Rate of calls marked 4-perfect or 3-fair (CQR)	**98.0%**
	statistical accuracy	0.6%

Figure 51 – voice – Global results

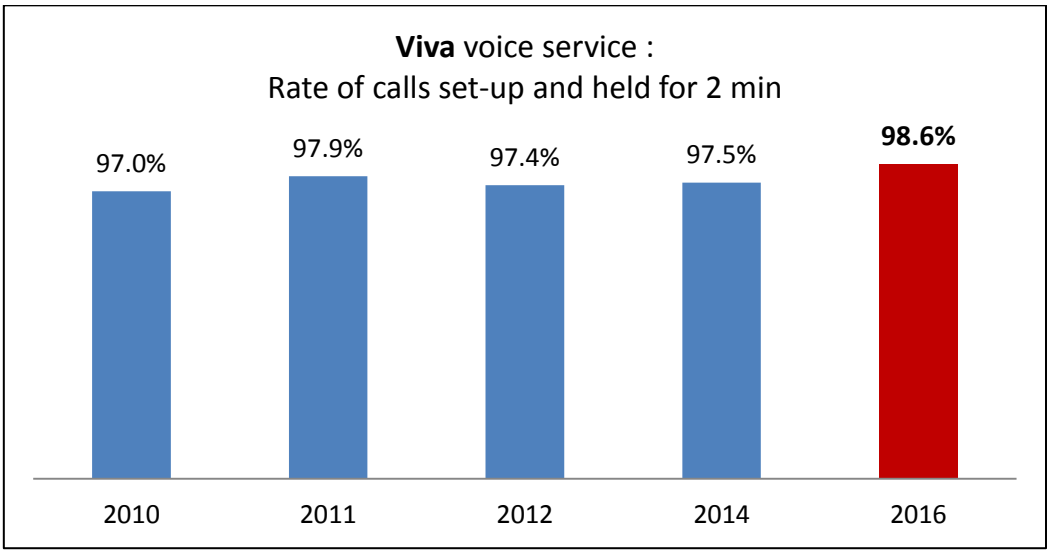

Figure 52 – voice – Global results evolution

		Viva
Cities voice service (incar, outdoor, indoor)		1 959 tests
Rate of calls set-up and held for 2 min		**98.6%**
statistical accuracy		0.5%
and marked	**4-perfect (PQR)**	**96.6%**
	statistical accuracy	0.8%
	4-perfect or 3-fair (CQR)	**97.9%**
	statistical accuracy	0.6%

Figure 53 – voice – Cities results

		Viva
Cities voice service (incar only)		948 tests
Rate of calls set-up and held for 2 min		**98.4%**
statistical accuracy		0.8%
and marked	**4-perfect (PQR)**	**95.7%**
	statistical accuracy	1.3%
	4-perfect or 3-fair (CQR)	**97.2%**
	statistical accuracy	1.1%

Figure 54 – voice – Cities incar results

		Viva
Road links service		246 tests
Rate of calls set-up and held for 2 min		**98.8%**
statistical accuracy		1.4%
and marked	**4-perfect (PQR)**	**96.3%**
	statistical accuracy	2.3%
	4-perfect or 3-fair (CQR)	**98.8%**
	statistical accuracy	1.4%

Figure 55 – voice – Road links results

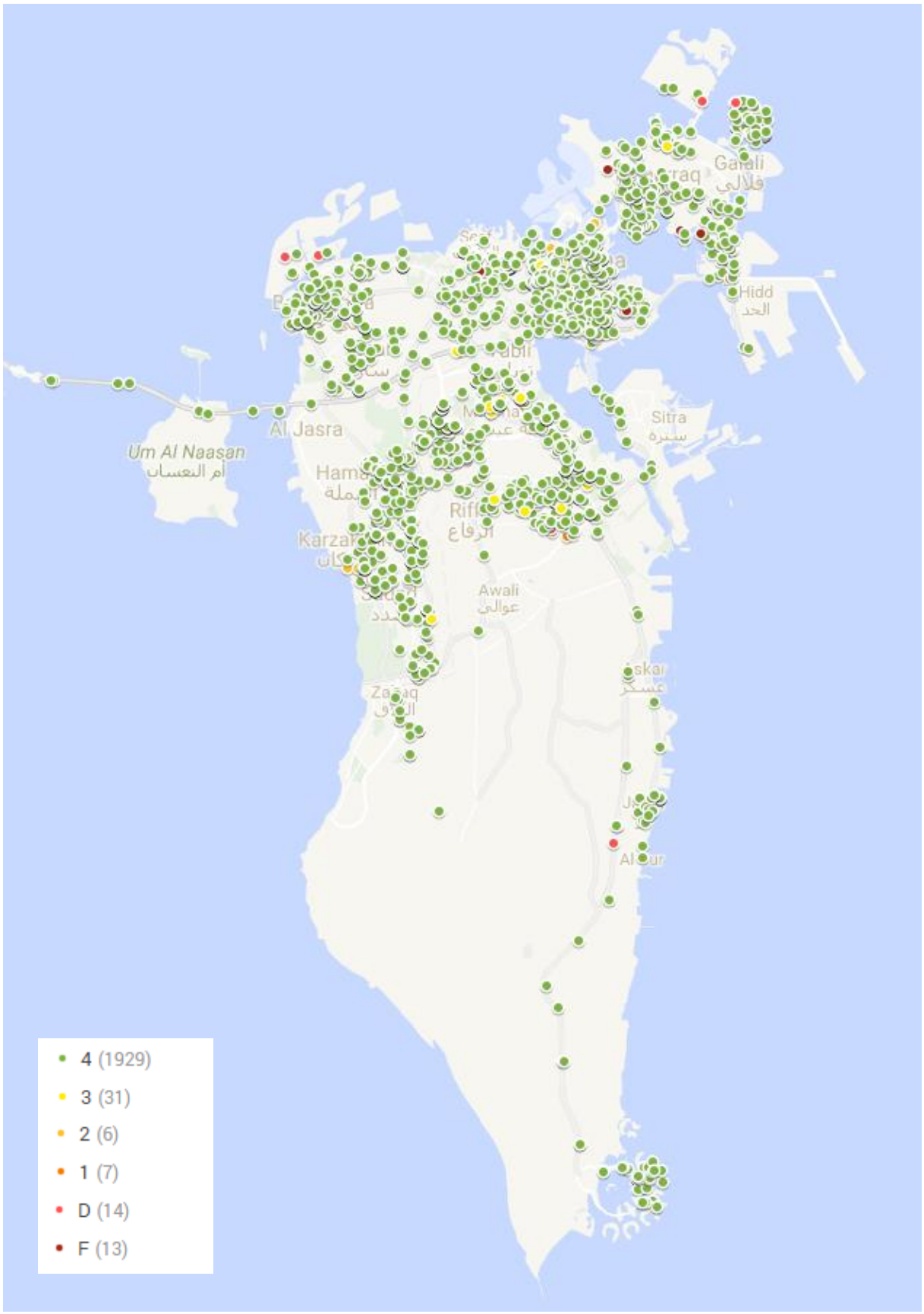

Figure 56 – VIVA Global voice results

6.3.2 SMS results

	VIVA
SMS service	791 tests
% of received SMS (RS2)	**99.6%**
Statistical accuracy	0.4%
% of received SMS (RS30)	**96.3%**
Statistical accuracy	1.3%
% of received SMS (RS15)	**92.3%**
Statistical accuracy	1.8%
Average reception delay (s)	**7**

Figure 57 – SMS – Global results

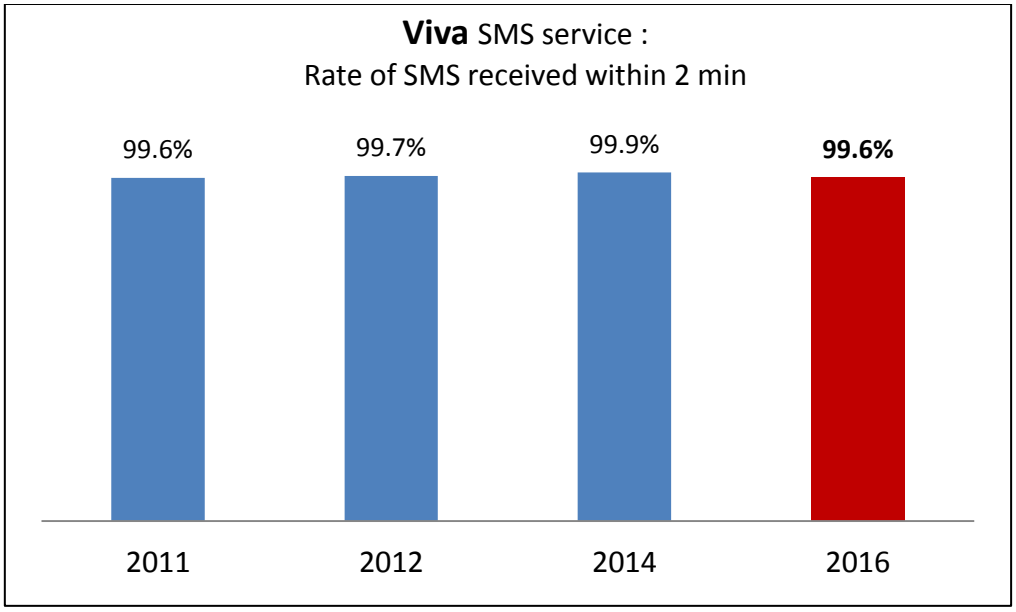

Figure 58 – SMS – Global results evolution

6.3.3 Data smartphone results

6.3.3.1 3G HANDSET

	VIVA
HTTP DL	336 tests
Rate of successful data transfers Statistical accuracy	**99.1%** 1.0%
Average Throughput (kbps)	**12 041**
Max throughput (kbps)	**33 783**
Standard deviation throughput (kbps)	6 258
% data transfers with a throughput > 2Mbps	97.9%
Average delay to download a 20MB file (s)	20.5

Figure 59 – 3G HANDSET – HTTP DL

	VIVA
HTTP UL	344 tests
Rate of successful data transfers Statistical accuracy	**99.4%** 0.8%
Average Throughput (kbps)	**2 924**
Max throughput (kbps)	**4 934**
Standard deviation throughput (kbps)	945
Average delay to upload a 5MB file (s)	16.4

Figure 60 – 3G HANDSET – HTTP UL

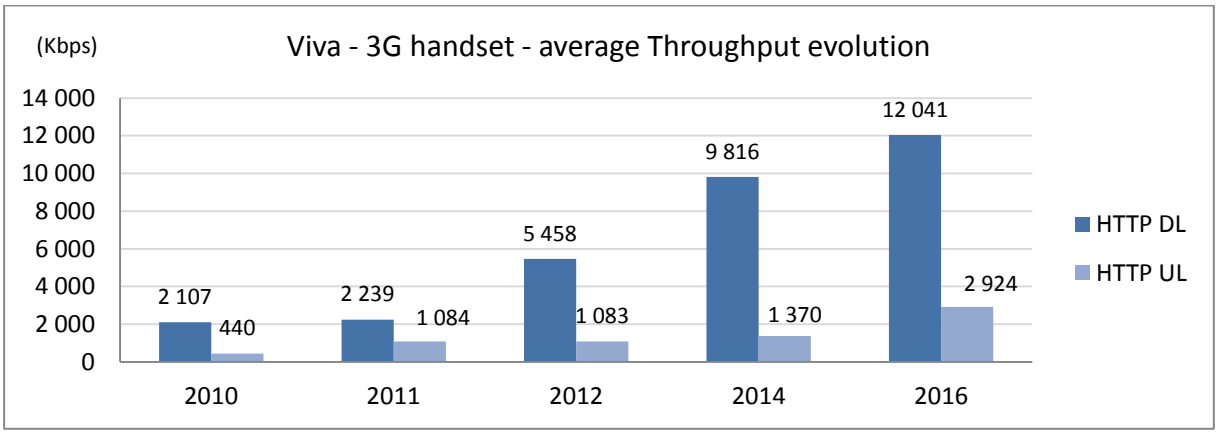

Figure 61 – 3G HANDSET – HTTP DL and UL - throughput evolution

	VIVA
WEB	2 752 tests
Rate of successful data transfers Statistical accuracy	**99.3%** 0.2%
Average download time (s)	**4.2**
Min download time (s)	**1.5**
Standard deviation download time (s)	2.8
% data transfers within 10 seconds	96.0%

Figure 62 – 3G HANDSET – Web Browsing

6.3.3.2 4G HANDSET

	VIVA
HTTP DL	407 tests
Rate of successful data transfers Statistical accuracy	**96.6%** 1.8%
Average Throughput (kbps)	**35 147**
Max throughput (kbps)	**134 813**
Standard deviation throughput (kbps)	31 712
% data transfers with a throughput > 2Mbps	99.0%
Average delay to download a 100MB file (s)	61.5

Figure 63 – 4G HANDSET – HTTP DL

	VIVA
HTTP UL	405 tests
Rate of successful data transfers Statistical accuracy	**95.3%** 2.1%
Average Throughput (kbps)	**31 219**
Max throughput (kbps)	**48 756**
Standard deviation throughput (kbps)	12 888
Average delay to upload a 50MB file (s)	19.8

Figure 64 – 4G HANDSET – HTTP UL

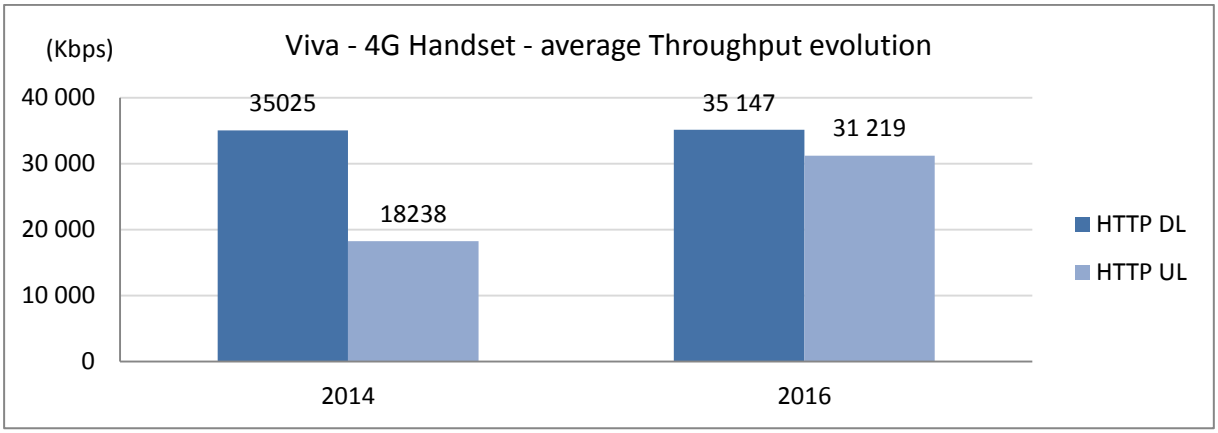

Figure 65 – 4G HANDSET – HTTP DL and UL - throughput evolution

	VIVA
WEB	2 744 tests
Rate of successful data transfers Statistical accuracy	**99.8%** 0.2%
Average download time (s)	**3.1**
Min download time (s)	**1.4**
Standard deviation download time (s)	2.2
% data transfers within 10 seconds	98.6%

Figure 66 – 4G HANDSET – Web Browsing

6.3.4 Streaming KPIs

6.3.4.1 Streaming - 3G HANDSET vs 4G HANDSET

	3G HANDSET	4G HANDSET
LHV : % of videos set-up and held for 2 min	100%	100%
statistical accuracy	0.0%	0.0%
VPQR : % of videos set-up, held for 2 min, and marked 4	80%	89%
statistical accuracy	4.2%	3.4%
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	90%	92%
statistical accuracy	3.2%	2.9%
Average delay	2.5	0.9
Minimum delay	0.6	0.5

Figure 67 – Video Streaming

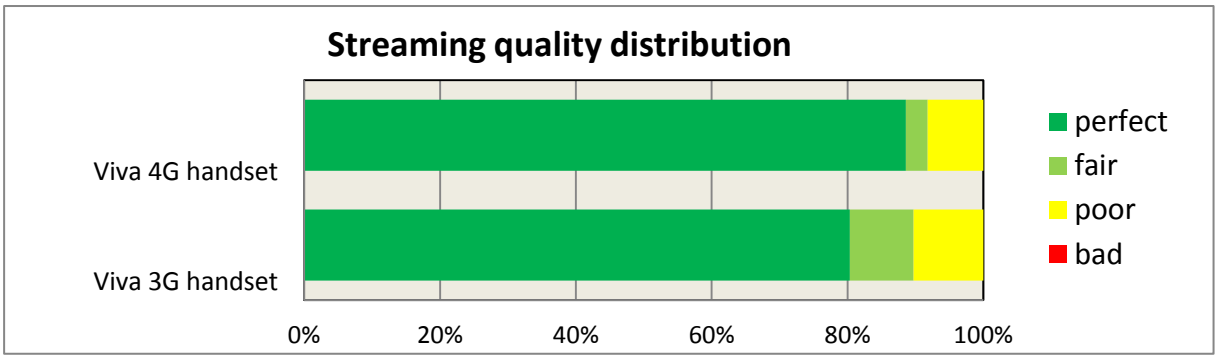

Figure 68 – Streaming - Quality distribution

6.3.4.2 Streaming – High def. (HD) vs Standard def. (SD)

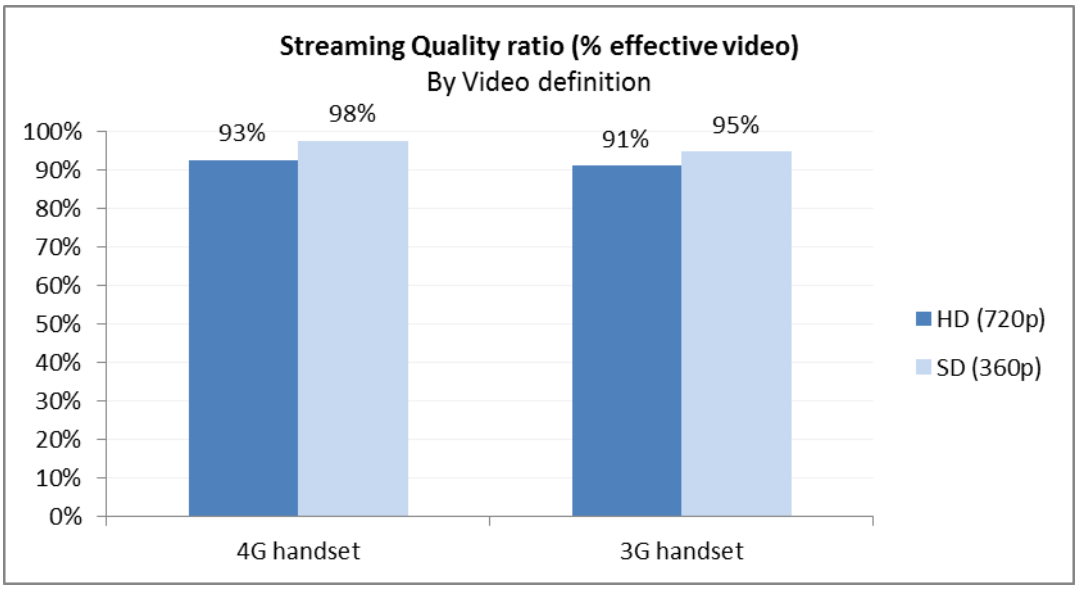

Figure 69 – Quality ratio by video definition

6.3.5 Facebook KPIs

	Viva	
	4G handset	**3G handset**
Total sample	169 tests	171 tests
Average Throughput	10.2 Mb/s	2.7 Mb/s
Max throughput	22.9 Mb/s	4.4 Mb/s
Standard deviation throughput	3.7 Mb/s	0.8 Mb/s

Figure 70 – Facebook results

6.3.6 Instagram KPIs

	Viva	
	4G handset	**3G handset**
Total sample	173 tests	173 tests
Rate of successful publications (%)	100.0%	100.0%
Average delay to publish (seconds)	5.4	5.5

Figure 71 – Instagram results

6.3.7 WhatsApp KPIs

	Viva
Sample	162 tests
Rate of calls set-up and held for 2 min 4-perfect (PQR) statistical accuracy	**100.0%** *+/-0.0%*

Rate of successful received Messages (%)	100.0%
Average delay to send a message (seconds)	1.0

Figure 72 – WhatsApp results

6.3.8 Interconnectivity calls

	Viva to Batelco	Viva to Zain	Viva to other networks	Viva to Viva*
Sample	1 109 tests	679 tests	1 788 tests	2 205 tests

Rate of calls set-up *statistical accuracy*	**99.6%** *+/-0.4%*	**100.0%** *+/-0.0%*	**99.8%** *+/-0.2%*	**99.4%** *+/-0.5%*

* Results of the QoS voice audit

Figure 73 – Interconnectivity calls results

6.4 Zain results

6.4.1 Global voice results (Cities & Road links)

		Zain
Global voice service		2 207 tests
Rate of calls set-up and held for 2 min		**98.5%**
statistical accuracy		0.5%
and marked	**Rate of calls marked 4-perfect (PQR)**	**96.6%**
	statistical accuracy	0.8%
	Rate of calls marked 4-perfect or 3-fair (CQR)	**98.2%**
	statistical accuracy	0.5%

Figure 74 – voice – Global results

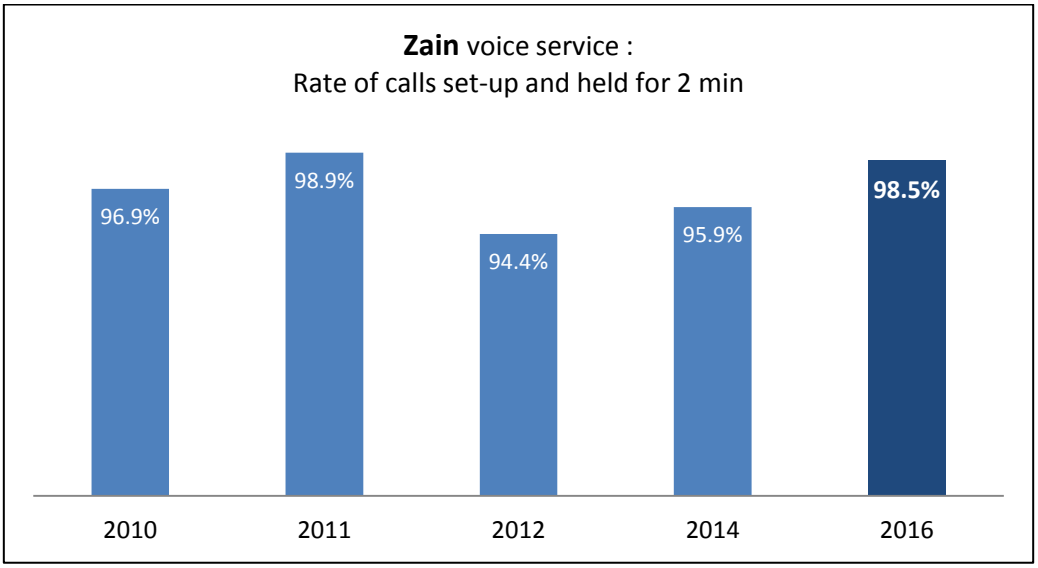

Figure 75 – voice – Global results evolution

		Zain
Cities voice service (incar, outdoor, indoor)		1 9560 tests
Rate of calls set-up and held for 2 min		**98.9%**
statistical accuracy		0.5%
and marked	**4-perfect (PQR)**	**97.1%**
	statistical accuracy	0.7%
	4-perfect or 3-fair (CQR)	**98.6%**
	statistical accuracy	0.5%

Figure 76 – voice – Cities results

		Zain
Cities voice service (incar only)		949tests
Rate of calls set-up and held for 2 min		**99.3%**
statistical accuracy		0.5%
and marked	**4-perfect (PQR)**	**96.5%**
	statistical accuracy	1.2%
	4-perfect or 3-fair (CQR)	**98.7%**
	statistical accuracy	0.7%

Figure 77 – voice – Cities incar results

		Zain
Road links service		247 tests
Rate of calls set-up and held for 2 min		**95.1%**
statistical accuracy		2.7%
and marked	**4-perfect (PQR)**	**92.7%**
	statistical accuracy	3.2%
	4-perfect or 3-fair (CQR)	**95.1%**
	statistical accuracy	2.7%

Figure 78 – voice – Road links results

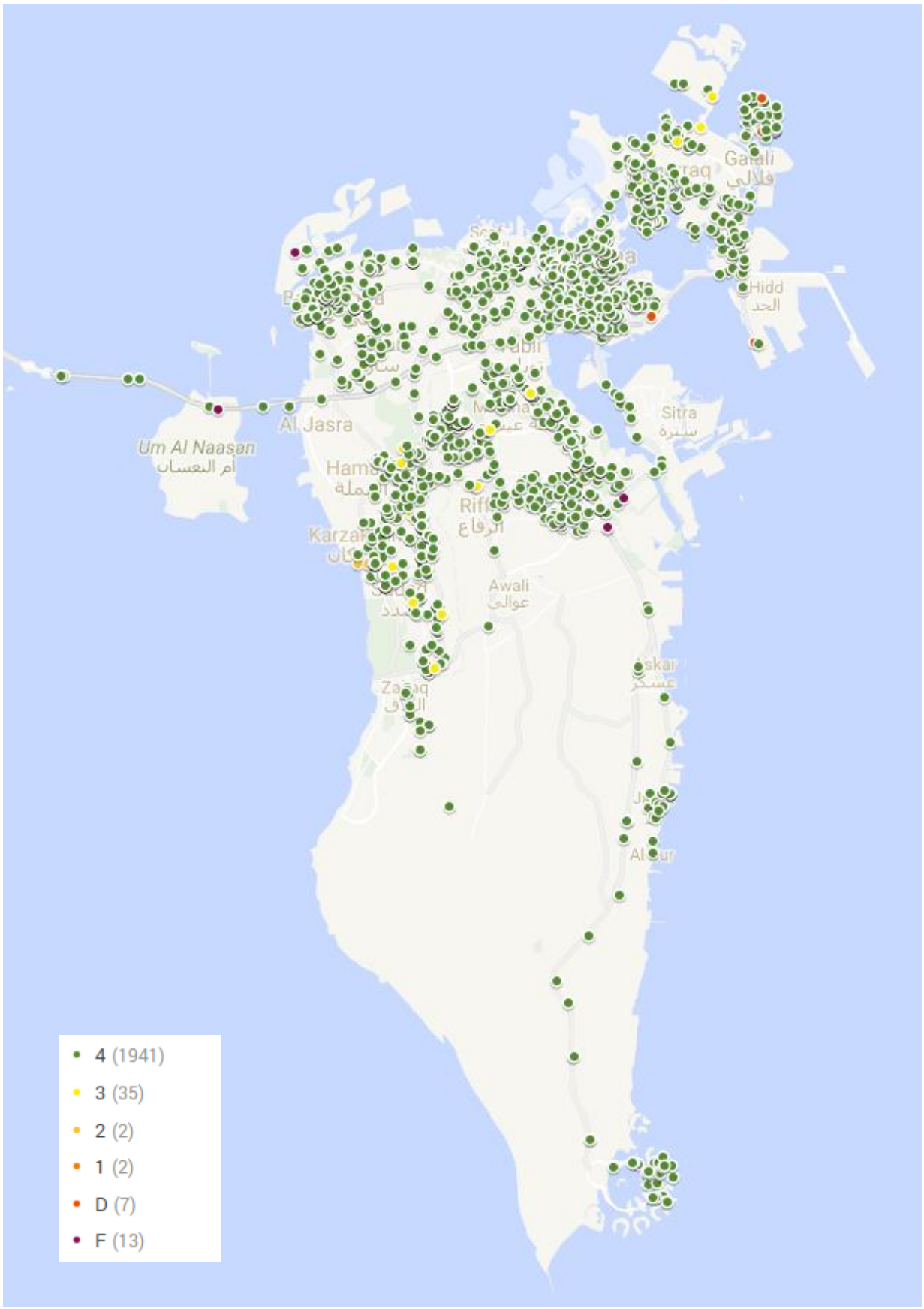

Figure 79 – Zain Global voice results

6.4.2 SMS results

	ZAIN
SMS service	791 tests
% of received SMS (RS2)	**100.0%**
Statistical accuracy	0.0%
% of received SMS (RS30)	**98.4%**
Statistical accuracy	0.9%
% of received SMS (RS15)	**97.9%**
Statistical accuracy	1.0%
Average reception delay (s)	**5**

Figure 80 – SMS – Global results

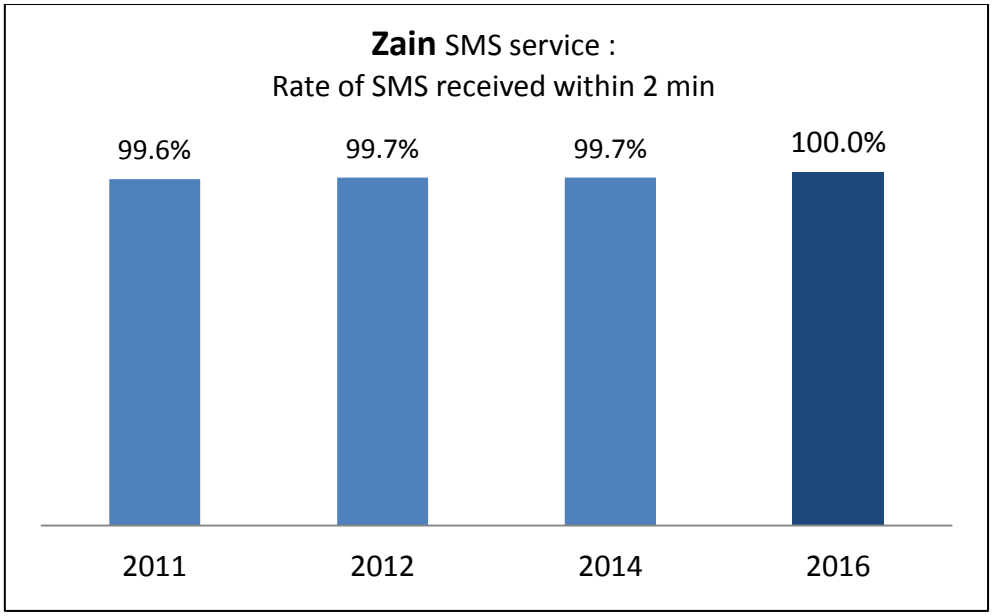

Figure 81 – SMS – Global results evolution

6.4.3 Data smartphone results

6.4.3.1 3G HANDSET

	ZAIN
HTTP DL	353 tests
Rate of successful data transfers	**89.0%**
Statistical accuracy	3.3%
Average Throughput (kbps)	**8 304**
Max throughput (kbps)	**29 420**
Standard deviation throughput (kbps)	6 431
% data transfers with a throughput > 2Mbps	77.6%
Average delay to download a 20MB file (s)	41.8

Figure 82 – 3G HANDSET – HTTP DL

	ZAIN
HTTP UL	353 tests
Rate of successful data transfers	**94.9%**
Statistical accuracy	2.3%
Average Throughput (kbps)	**2 094**
Max throughput (kbps)	**4 137**
Standard deviation throughput (kbps)	1 090
Average delay to upload a 5MB file (s)	27.3

Figure 83 – 3G HANDSET – HTTP UL

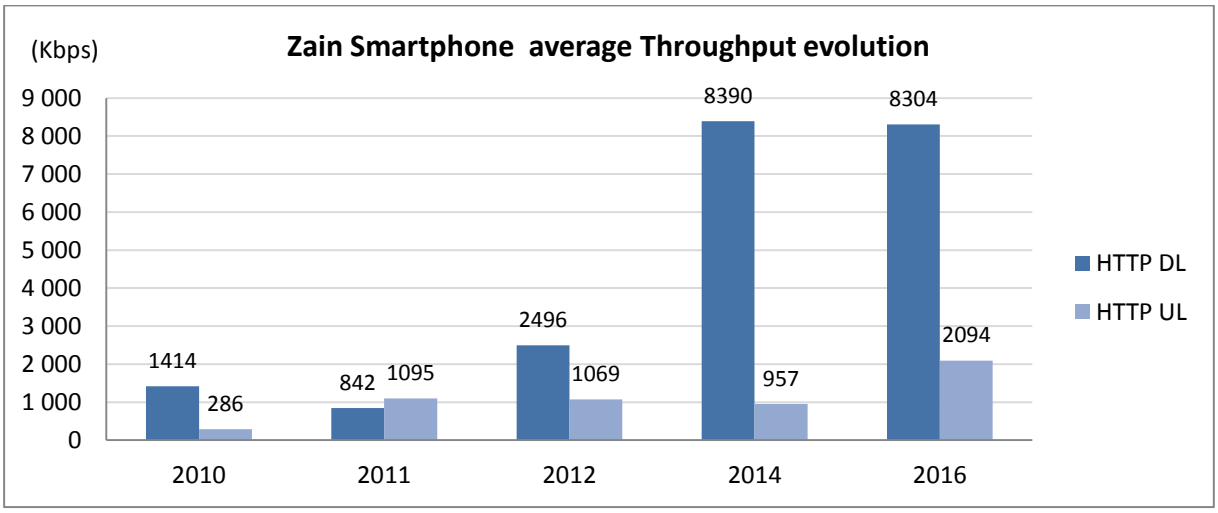

Figure 84 – 3G HANDSET – HTTP DL and UL - throughput evolution

	ZAIN
WEB	2 823 tests
Rate of successful data transfers	**95.6%**
Statistical accuracy	0.8%
Average download time (s)	**4.8**
Min download time (s)	**1.2**
Standard deviation download time (s)	4.0
% data transfers within 10 seconds	88.4%

Figure 85 – 3G HANDSET – Web Browsing

6.4.3.2 4G HANDSET

	ZAIN
HTTP DL	434 tests
Rate of successful data transfers Statistical accuracy	**84.1%** 3.5%
Average Throughput (kbps)	**34 704**
Max throughput (kbps)	**135 579**
Standard deviation throughput (kbps)	32 213
% data transfers with a throughput > 2Mbps	90.6%
Average delay to download a 100MB file (s)	69.9

Figure 86 – 4G HANDSET – HTTP DL

	ZAIN
HTTP UL	434 tests
Rate of successful data transfers Statistical accuracy	**93.5%** 2.4%
Average Throughput (kbps)	**27 757**
Max throughput (kbps)	**48 688**
Standard deviation throughput (kbps)	12 482
Average delay to upload a 50MB file (s)	20.8

Figure 87 – 4G HANDSET – HTTP UL

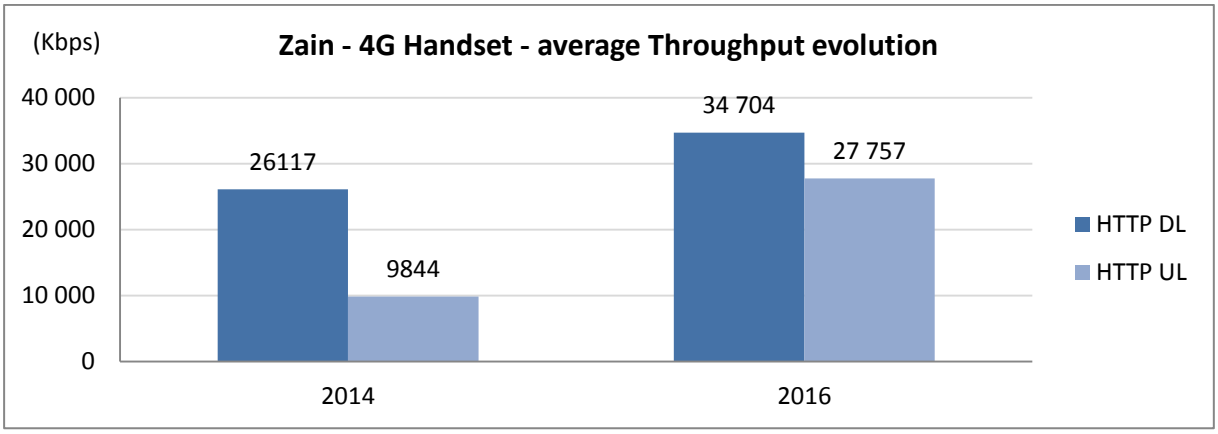

Figure 88 – 4G HANDSET – HTTP DL and UL - throughput evolution

	ZAIN
WEB	2 744 tests
Rate of successful data transfers Statistical accuracy	**98.8%** 0.4%
Average download time (s)	3.6
Min download time (s)	1.1
Standard deviation download time (s)	2.8
% data transfers within 10 seconds	95.8%

Figure 89 – 4G HANDSET – Web Browsing

6.4.4 Streaming KPIs

6.4.4.1 Streaming - 3G HANDSET vs 4G HANDSET

	3G HANDSET	4G HANDSET
LHV : % of videos set-up and held for 2 min	99.1%	100%
statistical accuracy	1.0%	0.0%
VPQR : % of videos set-up, held for 2 min, and marked 4	57.6%	78%
statistical accuracy	5.3%	4.4%
VCQR : % of videos set-up, held for 2 min, and marked 3 or 4	68%	84%
statistical accuracy	5.0%	3.9%
Average delay	3.3	1.1
Minimum delay	0.7	0.5

Figure 90 – Video Streaming

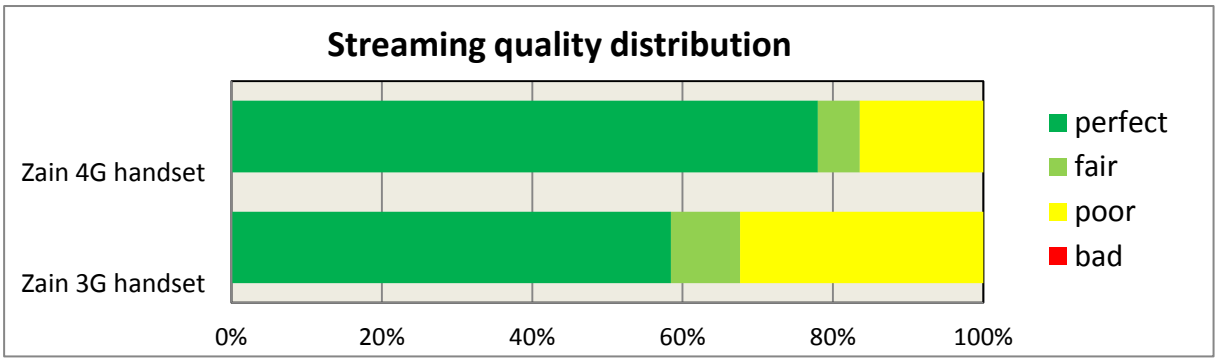

Figure 91 – Streaming - Quality distribution

6.4.4.2 Streaming – High def. (HD) vs Standard def. (SD)

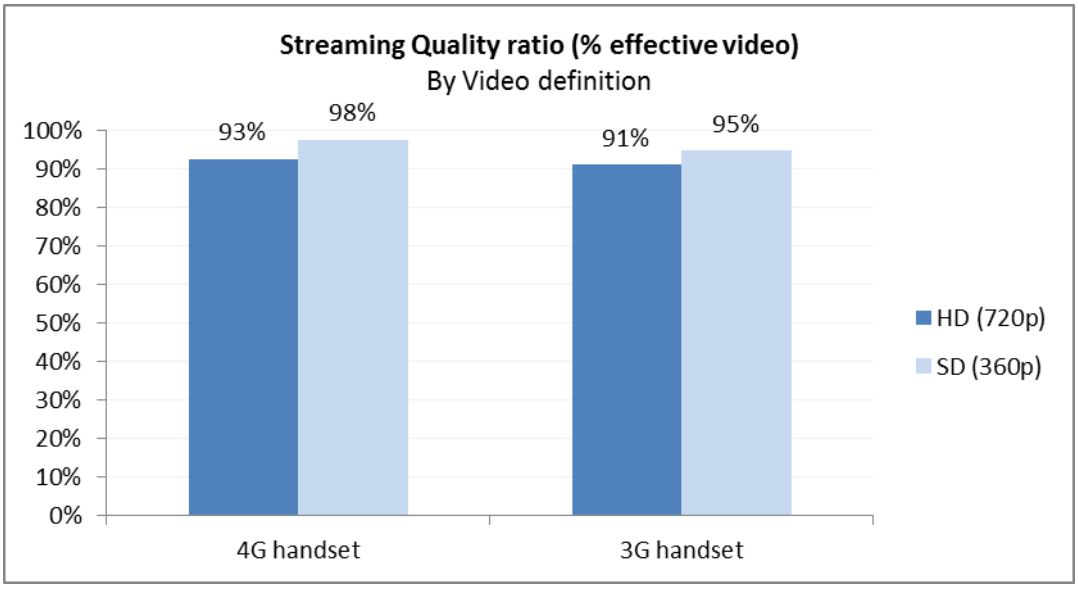

Figure 92 – Quality ratio by video definition

6.4.5 Facebook KPIs

	Zain	
	4G handset	**3G handset**
Total sample	169 tests	165 tests
Average Throughput	11.1 Mb/s	1.8 Mb/s
Max throughput	26.4 Mb/s	3.7 Mb/s
Standard deviation throughput	4.4 Mb/s	1.0 Mb/s

Figure 93 – Facebook results

6.4.6 Instagram KPIs

	Zain	
	4G handset	**3G handset**
Total sample	171 tests	172 tests
Rate of successful publications (%)	98.2%	97.7%
Average delay to publish (seconds)	5.5	6.5

Figure 94 – Instagram results

6.4.7 WhatsApp KPIs

	Zain
Sample	162 tests
Rate of calls set-up and held for 2 min 4-perfect (PQR) statistical accuracy	**98.1%** *+/-2.1%*

Rate of successful received Messages (%)	100.0%
Average delay to send a message (seconds)	1.02

Figure 95 – WhatsApp results

6.4.8 Interconnectivity calls

	Zain to Batelco	Zain to Viva	Zain to other networks	Zain to Zain*
Sample	789 tests	1 132 tests	1 921 tests	2 207 tests

Rate of calls set-up *statistical accuracy*	**100.0%** *+/-0.0%*	**99.8%** *+/-0.2%*	**99.9%** *+/-0.1%*	**99.2%** *+/-0.5%*

* Results of the QoS voice audit

Figure 96 – Interconnectivity calls results

6.4.9 Broadband performances

Each operator has provided a list of hotspots where network setting should allow higher data performance, in comparison with other locations that have been tested randomly.

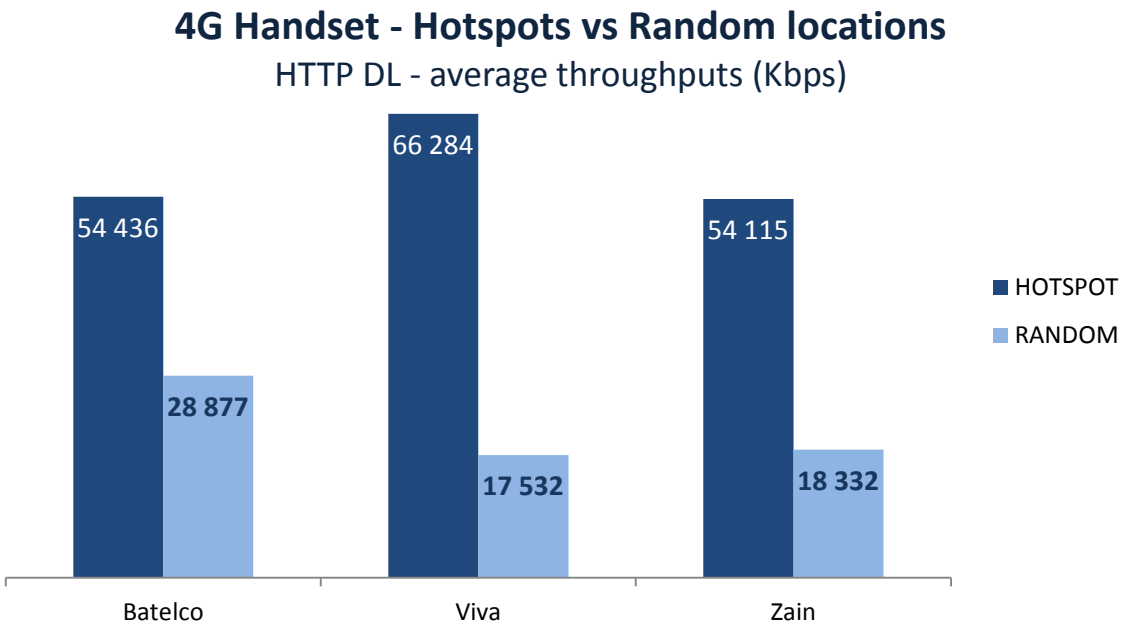

Figure 97 – 4G Handset Hotspots vs Random – average throughtputs

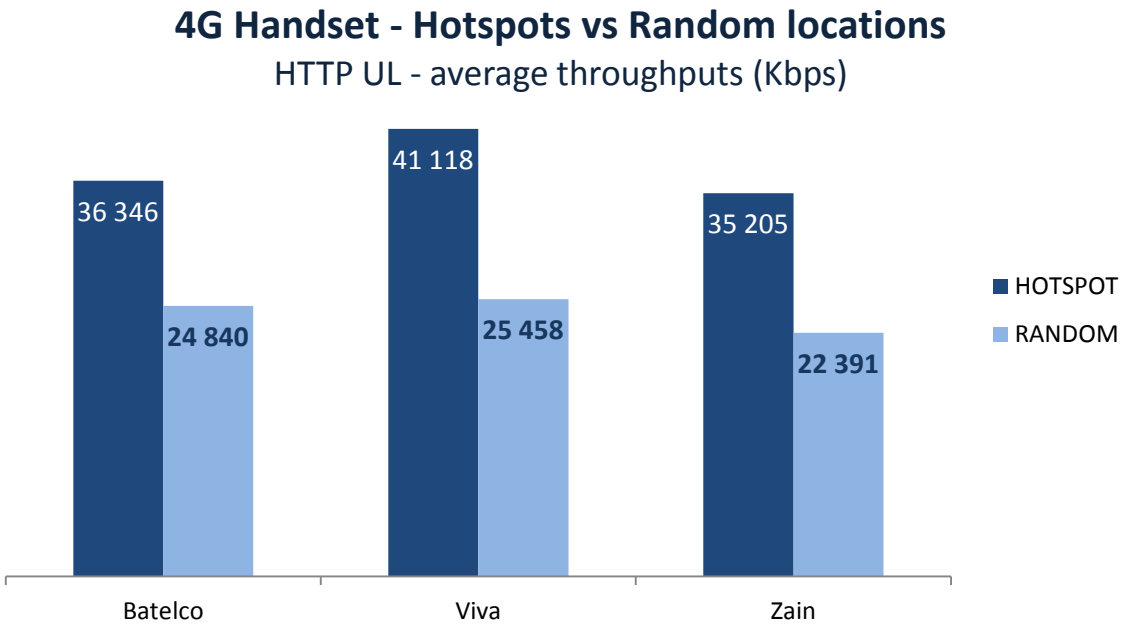

Figure 98 – 4G Handset Hotspots vs Random - maximum throughputs

6.5 Roaming In and OUT

6.5.1 Roaming OUT

Roaming OUT tests have been made using Bahraini SIM abroad.

The purpose was to simulate a customer use when travelling, and evaluate the conditions in which he could use his own SIM in a different country. Here are the different steps of the measurement:

- Switch on the mobile when at destination
- **Customer experience**: Wait for the messages indicating the operator on which the SIM is automatically registered. If no automatic registration, the SIM has been manually forced on the first available Operator
- **Tests** : 60 calls of 1 minute each, and sending SMS, to a receiver Bahrein

Remark: billing of those calls and SMS will be separately analyzed in a specific billing report.

3 destinations have been tested: Doha (Qatar), Dubai, and Paris (France).

6.5.2 Roaming OUT Batelco

1. **Tests in Doha**

Customer experience:

- automatically registered : Yes, on **Ooredoo**
- Tariffs received **:** Yes

Sender	readable_date	body	service_center
BATELCO	2 oct. 2016 11:43:46	Now you can enjoy data while roaming in GCC with selected networks starting from BD5 only! -GCC 1 Day 1GB for BD5 send GCC1 to +97339394554 -GCC 7 Days 2GB for BD20 send GCC7 to +97339394554 -Worldwide 7 Days 1GB for BD40 send WW7 to +97339394554 T&Cs apply.	+97339600683
BATELCO	2 oct. 2016 11:43:54	Dear Customer, Please note that your credit limit and free data are not included while roaming, therefore be aware of your phone configuration and application settings to minimize roaming charges. For more info please visit batelco.com or call +97339611196. To contact the Bahrain Embassy dial 009744839360.	+97339600683
BATELCO	2 oct. 2016 11:44:32	Welcome to Qatar, peak rates per minute BD charges: Ooredoo - Receive call .200, Local call .098, Call to Bahrain .241, SMS .030, GPRS .489 per MB Vodafone - Receive call .200, Local call .098, Call to Bahrain .241, SMS .030, GPRS .489 per MB Rates may be subject to change, For more info visit www.batelco.com	+97339600683

Results:

Voice calls: 60 calls

- 98.3% success (1 drop)
- Call set-up delay : average = 3.4 seconds, max = 8 seconds, min = 2 seconds

SMS: 38 tests

- 100% success
- Delay : average = 4 seconds, max = 8 seconds, min = 3 seconds

2. Tests in Dubai

Customer experience:

- automatically registered : Yes, on **ETISALAT**
- Tariffs received **:** Yes

Sender	readable_date	body	service_center
BATELCO	11 Oct. 2016 23:15:43	Now you can enjoy data while roaming in GCC with selected networks starting from BD5 only! -GCC 1 Day 1GB for BD5 send GCC1 to +97339394554 -GCC 7 Days 2GB for BD20 send GCC7 to +97339394554 -Worldwide 7 Days 1GB for BD40 send WW7 to +97339394554 T&Cs apply.	+97339600683
BATELCO	11 Oct. 2016 23:16:47	Dear Customer, Please note that your credit limit and free data are not included while roaming, therefore be aware of your phone configuration and application settings to minimize roaming charges. For more info please visit batelco.com or call +97339611196. To contact the Bahrain Embassy dial 0097126657500.	+97339600683
BATELCO	11 Oct. 2016 23:17:45	Welcome to United Arab Emirates, peak rates per minute BD charges: du - Receive call .200, Local call .098, Call to Bahrain .241, SMS .030, GPRS .489 per MB ETISALAT - Receive call .200, Local call .098, Call to Bahrain .241, SMS .030, GPRS .489 per MB Rates may be subject to change, For more info visit www.batelco.com	+97339600683

Results:

Voice calls: 60 calls

- 100% success
- Call set-up delay : average = 4.1 seconds, max = 7 seconds, min = 3 seconds

SMS: 35 tests

- 100% success
- Delay : average = 2 seconds, max = 11 seconds, min = 1 seconds

3. Tests in France

Customer experience:

- automatically registered : no, all French operators suggested :

Sender	readable_date	body	service_center
BATELCO	17 Oct. 2016 14:43:53	Welcome to France, peak rates per minute BD charges: Orange - Receive call .350, Local call .450, Call to Bahrain 1.3, SMS .142, GPRS 2.363 per MB SFR - Receive call .320, Local call .450, Call to Bahrain 1.3, SMS .150, GPRS 5.000 per MB BOUYGUES TELECOM - Receive call .320, Local call .483, Call to Bahrain 1.3, SMS .150, GPRS 5.169 per MB Rates may be subject to change, For more info visit www.batelco.com	+97339600683

- manually registered on : **Orange France**
- Tariffs received **:** Yes

Results:

Voice calls: 60 calls

- 100% success
- Call set-up delay : average = 6.4 seconds, max = 12 seconds, min = 4 seconds

SMS: 58 tests

- 100% success
- Delay : average = 2 seconds, max = 11 seconds, min = 1 seconds

6.5.3 Roaming OUT Viva

1. Tests in Doha

Customer experience:

- automatically registered : Yes, on **Ooredoo**
- Tariffs received **:** Yes

Sender	readable_date	body	service_center
OOREDOO	2 Oct. 2016 11:45:21	Ooredoo welcomes you to Qatar! Kindly call 180 for Directory Information, 111 for Ooredoo's customer care service and 999 in case of emergency. Enjoy your stay!	+97333811640
VIVA	2 Oct. 2016 11:45:46	نأمل أن تستمتع بإقامتك في قطر , لطلب المساعدة , يرجى الاتصال بمركز خدمة العملاء على ٩٧٣٣٣١٢٤١٢٤ +. Dear customer, we hope you enjoy your stay in Qatar. For any assistance, call our Centre on +97333124124. ww.viva.com.bh Customer Service	+97333811960
VIVA	2 Oct. 2016 11:46:03	Dear customer, while roaming with Qatar Ooredoo Q.S.C.; following are the VIVA Postpaid charges: calling within Qatar BD 0.098/min, calling Bahrain BD 0.241/min, sending SMS BD 0.030, incoming calls BD 0.132/min, GPRS BD 0.489/MB.	+97333811640
VIVA	2 Oct. 2016 11:50:34	VIVA Unlimited Data add-ons are now available while roaming with Ooredoo Qatar. To subscribe: For 2-Days Data add-on, BHD 5, Send SMS "QTR2" to 81899 For Weekly Data add-on, BHD 12, Send SMS "QTR7" to 81899 Or visit roaming.viva.bh	+97333811960
VIVA	2 Oct. 2016 11:51:07	باقات تجوال البيانات الغير محدودة من فيفا متوفرة من خلال شبكةOoredoo قطر. للإشتراك: لباقة صالحة لمدة يومين أرسل رسالة نصية "QTR2" الى 81899 , التكلفة "BHD5" لباقة صالحة لمدة أسبوع أرسل رسالة نصية "QTR7" الى 81899 , التكلفة "BHD12" او يمكنك زيارة roaming.viva.bh	+97333811960
VIVA	2 Oct. 2016 11:56:31	Dear valued customer, you can contact Bahrain's embassy in Qatar by dialing 0097444839360 or 0097444839361 or 0097444839362 or 0097444839357 فـ ي الـ بحريـ ن ممـ لـكة بـ سـ فارة الاتـ صال يـ مـ كنك الـ عمـ يل، عزيـ زي أو 0097444839361 أو 0097444839360 الـ رقـ م عـ لى قـ طر 0097444839362 أو 0097444839357	+97333811640

Results:

Voice calls: 60 calls

- 100% success
- Call set-up delay : average = 3.3 seconds, max = 6 seconds, min = 2 seconds

SMS: 39 tests

- 100% success
- Delay : average = 3 seconds, max = 5 seconds, min = 2 seconds

2. **Tests in France**

Customer experience:

- automatically registered : no, manually registered on : **Orange France**
- Tariffs received **:** No

Results:

Voice calls: 60 calls

- 100% success
- Call set-up delay : average = 5.5 seconds, max = 9.4 seconds, min = 3.5 seconds

SMS: 60 tests

- 100% success
- Delay : average = 3 seconds, max = 9 seconds, min = 2 seconds

6.5.4 Roaming OUT Zain

1. **Tests in Doha**

Customer experience:

- automatically registered : Yes, on **Vodafone**
- Tariffs received **:** No, only a SMS back in Bahrain :

Sender	readable_date	body	service_center
ZainRoaming	2 Oct. 2016 22:43:43	"We hope you had a comfortable trip. Call your loved ones and tell them you are back. To check your voicemail call 117"!	+97336019011

Results:

Voice calls: 60 calls

- 100% success
- Call set-up delay : average = 3.3 seconds, max = 6 seconds, min = 2 seconds

SMS: 40 tests

- 100% success
- Delay : average = 4 seconds, max = 8 seconds, min = 2 seconds

2. Tests in France

Customer experience:

- automatically registered : no, manually registered on : **SFR**
- Tariffs received **:** Yes

Sender	readable_date	body	service_center
ZainRoaming	17 Oct. 2016 16:25:42	"Enjoy Zain wonderful world of unique roaming services in France for assistance call +97336107107, for voice mail call +97336117117."	+97336019011
ZainRoaming	17 Oct. 2016 16:26:03	For your reference, the peak roaming rates while in (France)in BD/min: (SFR FRANCE CEGTEL) Incoming Calls:0.300 ,Local:0.411 ,Bahrain:1.391 ,SMS:0.167 ,Data:15.294 per MB (BOUYGUES TELECOM) Incoming Calls:0.613 ,Local:0.376 ,Bahrain:1.46 ,SMS:0.174 ,Data:3.338 per MB (ORANGE) Incoming Calls:0.926 ,Local:0.344 ,Bahrain:2.079 ,SMS:0.174 ,Data:5.929 per MB (FREE MOBILE) Incoming Calls:0.480 ,Local:0.500 ,Bahrain:1.500 ,SMS:0.180 ,Data:4.500 per MB Rates may be subject to change. The Bahrain Embassy No +33147234868.For assistance on rates, send H to 8855.For more info call +97336107107 or visit www.bh.zain.com. Ministry of Foreign Affairs Traveller Guide: http://bit.ly/29GpNJS	+97336019012
400499	17 Oct. 2016 16:40:36	YOUR REPLY IS FREE. Dear Zainer, With reference to your call to Contact Center CS 15660647, please rate our services. You may reply with 15660647<space>1-if you are satisfied, or 15660647<space>2-if you are not satisfied. Kindly reply within 12 hours. Have a Wonderful Day.	+97336019012
36107107	17 Oct. 2016 16:40:46	Dear Zain Customer, Thank you for contacting Zain Customer Care Center. In order to enhance your future experience with Zain, a short survey with 5 questions will be sent to you. We would appreciate your input. (participating while in Bahrain will be free of charge)	+97336019012
ZainRoaming	17 Oct. 2016 16:40:48	For your reference, the peak roaming rates while in (France)in BD/min: (SFR FRANCE CEGTEL) Incoming Calls:0.300 ,Local:0.411 ,Bahrain:1.391 ,SMS:0.167 ,Data:15.294 per MB (BOUYGUES TELECOM) Incoming Calls:0.613 ,Local:0.376 ,Bahrain:1.46 ,SMS:0.174 ,Data:3.338 per MB (ORANGE) Incoming Calls:0.926 ,Local:0.344 ,Bahrain:2.079 ,SMS:0.174 ,Data:5.929 per MB (FREE MOBILE) Incoming Calls:0.480 ,Local:0.500 ,Bahrain:1.500 ,SMS:0.180 ,Data:4.500 per MB Rates may be subject to change. The Bahrain Embassy No +33147234868.For assistance on rates, send H to 8855.For more info call +97336107107 or visit www.bh.zain.com. Ministry of Foreign Affairs Traveller Guide: http://bit.ly/29GpNJS	+97336019012

36107107	17 Oct. 2016 16:40:51	How satisfied are you with your recent 107 experience? Reply using a scale from 1 to 5 5 = Very Satisfied 4 = Satisfied 3 = Neutral 2 = Dissatisfied 1 = Very Dissatisfied	+97336019012
Zain Roaming	17 Oct. 2016 16:41:38	"Enjoy Zain wonderful world of unique roaming services in France for assistance call +97336107107, for voice mail call +97336117117."	+97336019012

Results:

Voice calls: 60 calls

- 96.7% success (2 failures)
- Call set-up delay : average = 6.6 seconds, max = 24.8 seconds, min = 3 seconds

SMS: 57 tests

- 100% success
- Delay : average = 3 seconds, max = 20 seconds, min = 1 seconds

6.5.5 Roaming IN

Roaming IN tests purpose was to evaluate the coverage and quality of service offered for foreign customers, with their foreign SIM, when using those in Bahrain.

A set of 3 SIM has been tested:

- 1 SIM **Orange France**
- 1 SIM **Ooredoo** (Qatar)
- 1 SIM **Vodafone** (Qatar)

As for roaming OUT, the mobiles were switched on, and we let them automatically register on a Bahraini network. If needed, network was manually forced.

Accessibility calls to fixed line abroad (in France) were then launched along a drive all over the kingdom, in order to evaluate the access to the service and the continuity of the availability of network.

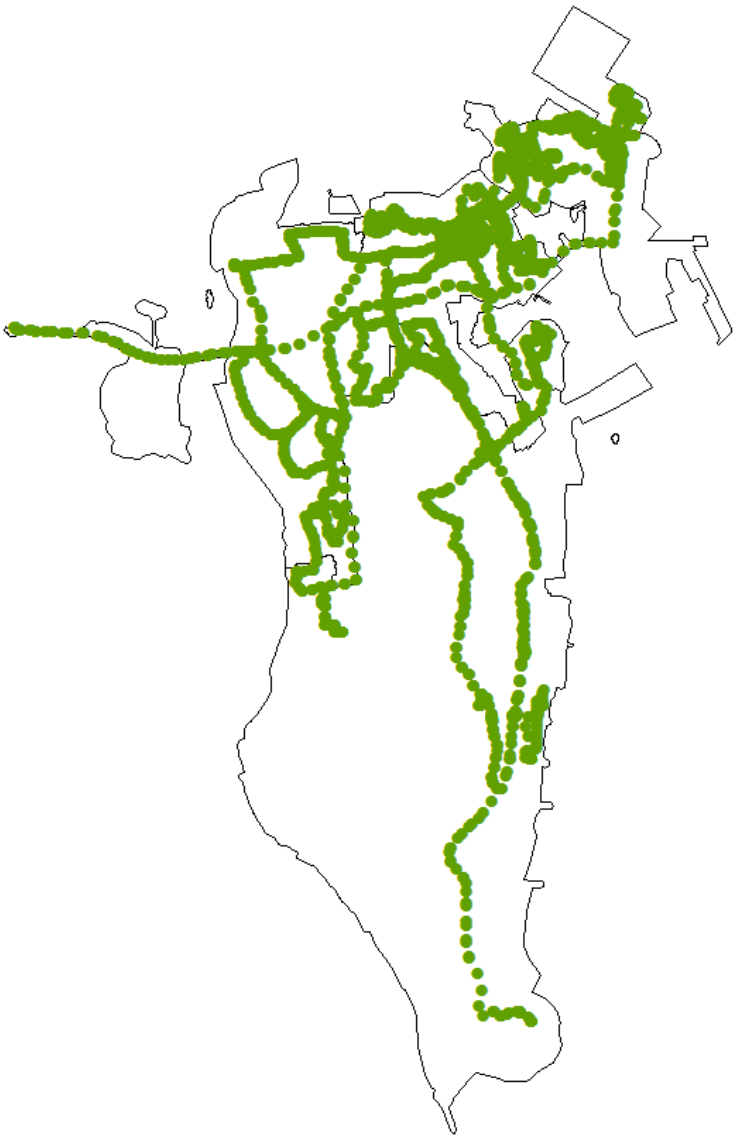

Figure 99 – Roaming IN coverage drive

For each test, MCC MNC on which the SIM was registered, and result of accessibility call have been recorded.

The unique combination of MCC (Mobile Country Code) and MCC (Mobile Network Code) gives the identification of the effective operator registered on the handset.

ORANGE	France			
MCC MNC	**Country**	**Operator**	**Sample**	**% success**
42601	Bahrain	Batelco	903	94%
42604	Bahrain	Viva	2202	96%
42602	Bahrain	Zain	1	0%
42001	Saudi Arabia	Saudi Telecom	3	0%
		Total	**3 109**	**95%**

Ooredoo	Qatar			
MCC MNC	**Country**	**Operator**	**Sample**	**% success**
42601	Bahrain	Batelco	1390	99%
42604	Bahrain	Viva	1289	98%
42602	Bahrain	Zain	51	22%
42004	Saudi Arabia	Zain Saudi Arabia	1	100%
		Total	**2 731**	**97%**

Vodafone	Qatar			
MCC MNC	**Country**	**Operator**	**Sample**	**% success**
42601	Bahrain	Batelco	3434	99%
42001	Saudi Arabia	Saudi Telecom	16	6%
42702	Qatar	Vodafone	3	0%
		Total	**3 453**	**98%**

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