BIPT

DRIVE TEST CAMPAIGN RESULTS 2018

> Next page

TABLE OF CONTENTS

1 Introduction

Publishing reliable and comparable information on network quality increases transparency and helps consumers to know if they receive a high-quality mobile service. It can empower them to make informed decisions before subscribing to a mobile network operator. Such study also helps BIPT in its role as telecom authority to understand mobile network performance in Belgium.

Therefore, since 2015, BIPT publishes maps on mobile coverage, both for consumers and for public authorities (cf. "action plan white areas"). The aim is to provide independent and reliable information on the state of mobile coverage in Belgium. The most recent coverage maps can be found at Coverage-Maps.

The radio signal level illustrated on the maps do not always guarantee that a mobile user can effectively access and use mobile services. Therefore, BIPT has decided to start measuring parameters related to the quality of experience of mobile networks.
Drive testing campaigns offer an opportunity to reflect the customer experience mobile networks offer. To perform its campaign, BIPT selected Commsquare, which has an extensive experience and a deep knowledge of the Belgian and international market.

This additional transparency on the quality of experience provided by the different operators can help to promote competition on quality between operators and possibly stimulate further investments in their network.

Such transparency can help to promote public policy objectives, among other things, the achievement of the 2020 Digital Agenda targets and the achievement of the upcoming 2025 EU Gigabit connectivity objectives.

2 Campaign methodology

2.1. Measurements location

Measurements were conducted by driving 2 cars across Belgium.

The main objectives of the campaign were to measure customer experience, i.e. network performance as experienced by customers using real applications and smartphones. We have measured performance as experienced by users using a 4G/LTE capable smartphone.

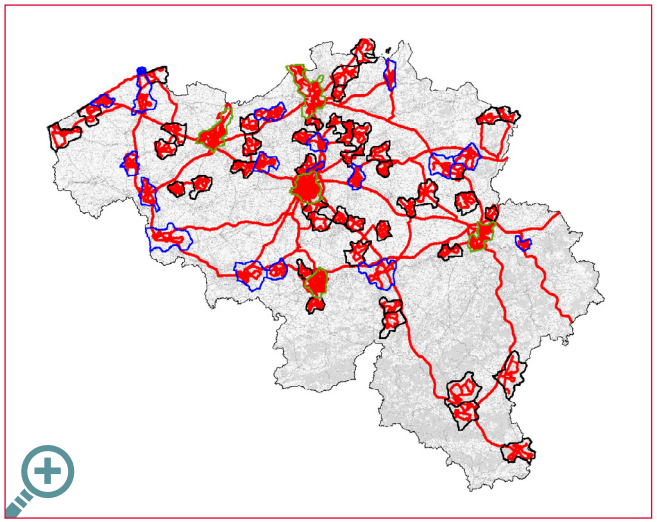
Measurement equipment by Rohde & Schwarz, a reputable test & measurement company, was used. Smartphones were installed in a ski-box. The measurement setup was configured such that the measurements represent in-car and indoor performance (i.e. as experienced by a user in a building or house, close to the window).

The campaign was conducted between 03/Sep and 04/Oct 2018. Drive tests were conducted both during and outside "busy hours" periods; between 7am and 9pm; from Monday to Saturday (excl. public holidays).

A total of 250 hours of drive tests were made (i.e. 125 hours per car).

The selection of the cities and villages was based on their importance and population. The driven areas were chosen by BIPT and Commsquare and were not communicated upfront to the mobile network operators. This ensures a fair approach, i.e. the mobile network operators couldn't optimize or tweak their network in those places we planned to measure.

For details on the measurement locations, please refer to the map and its comments below.



Category	Description	Selection
Capital (1x)	Capital of Belgium	Brussels
Major cities (4x)	Population >150k inhabitants	Antwerpen, Charleroi, Gent, Liege
Medium cities (17x)	Population between 45k and 150k inhabitants	Aalst, Brugge, Genk, Hasselt, Kortrijk, La Louvière, Leuven, Mechelen, Mons, Namur, Oostende, Roeselare, Sint Niklaas, Tournai, Turnhout, Verviers, Vilvoorde
"Rural" areas (44x)	Population <45k inhabitants, reflecting the number of inhabitants per province	8x in the province of Antwerpen, 2x in Hainaut, 2x in Liege, 5x in Limburg, 4x in Luxembourg, 3x in Namur, 5x in Oost-Vlaanderen, 6x in Vlaams-Brabant, 4x in Brabant-Wallon, 5x in West-Vlaanderen
Highways	E-roads (driven in both directions), R-roads (not all) and N-roads	E17, E19, E40, E42, E25, E420, E429, E403, E313, E314, A4; N-roads based on driven "Rural" areas

2.2. Voice telephony

The Sony Z5, an Android smartphone, was used for the voice tests. The phone was operating in 4G-preferred mode.

The latest and best voice technology called VoLTE (which stands for Voice over LTE connection) was not tested, as at the time of the measurements VoLTE usage was not the mainstream voice technology used by mobile phone users in the Belgian market.

Voice calls were made between phones in both cars, i.e. a phone in the first car calling the phone in the second car. A new call was made every 2 minutes: the call holding time was 90s, with 30s pause between test calls.

During the call, the phone was allowed to make unrestricted and non-user-initiated data activity, as is typically the case by a smartphone.

2.3. Data tests

The Sony XZ2 was used for test in 4G-preferred-mode. This means the phone would primarily use the 4G/LTE network, but in its absence, would continue service on the 3G or 2G data network.

The data tests included a series of different tests: throughput tests in downlink and uplink (conducted as a down- or upload during 10s); a file transfer in downlink of a 10MB file and a 5MB file in upload; a selection of 1 test page and 5 popular live pages for web browsing tests (Kepler reference page, Amazon, Google, RTBF, Twitter, Wikipedia), YouTube buffered streaming and Facebook app testing.

Both measurement cars were conducting the same data tests. The data tests (similar to the voice tests) were executed whilst driving.

Both measurement cars were conducting the same data tests. The data tests (similar to the voice tests) were executed whilst driving.

2.4. Known limitations

The approach is a valid approach but has some inherent known limitations.

The results in this report are based on measurements in September 2018. Mobile networks are very dynamic and undergo constant changes and improvements. Therefore, the observations and conclusions are a valid snapshot of mobile network performance in Belgium during the measurement period.

All tests are conducted whilst driving. This approach allows making tests across the entire country. However, it is known most users use their mobile phone in static conditions, i.e. when not moving. It is generally assumed moving users experience a worse experience than non-moving users.

Trains or places that are highly frequented by users, such as shopping malls, pedestrian areas, parks, etc. were not tested. Such tests could be included in future campaigns to obtain a more complete picture of customer experience.

All tests were conducted using Android phone, which is by far the most popular operating system for mobile phones. As mobile phones themselves impact the user experience (sometimes to a large extent), users with older models or different operating systems might experience a different performance.

Tests were configured to simulate performance in indoor conditions. When using a mobile phone in deep-indoor locations (e.g. in basements, far away from a window, in highly-insulated houses, or concrete building), performance will be worse. Coverage is the main driver for obtaining good performance in such deep-indoor conditions.

The latest voice technology VoLTE was not tested. It has faster call setup times and better speech quality than the wide-spread traditional voice technology. VoLTE will be included in future campaigns if its adoption in Belgium has increased.

3 Voice results

3.1. Voice call indicators explained

The performance of voice services is expressed in 3 categories of service indicators. Results are summarized in the table below.

Voice Summary		Orange	Proximus	Telenet
Success Rates				
Call setup success rate	%	99,8	99,7	99,7
Call completion rate	%	99,4	99,2	99,5
Uninterrupted call rate	%	98,2	98,7	99,4
Call Setup Time				
Call Setup Time (s)	Average	4,6	3,7	4,7
Call Setup Time (s) long samples	10% longest	5,8	4,7	5,4
Voice Quality				
Voice Quality	Average	3,7	3,6	3,0
Voice Quality low samples	10% lowest	2,9	2,8	2,5

The diagram below explains the voice service indicators.
A call is initiated by the caller pressing the "Dial" button (1). The call setup time (2) is the time until the caller hears ringing tone (4).

A call setup failure (3) means the user doesn't receive ringing tone and the call is not started.

Successful call setups (3a) indicate the proportion of calls that reach ringing tone. The caller considers this a successful call setup.

Once the call has started, it sometimes drops (5). A dropped call means the conversation is unexpectedly aborted and the conversation can't be completed.

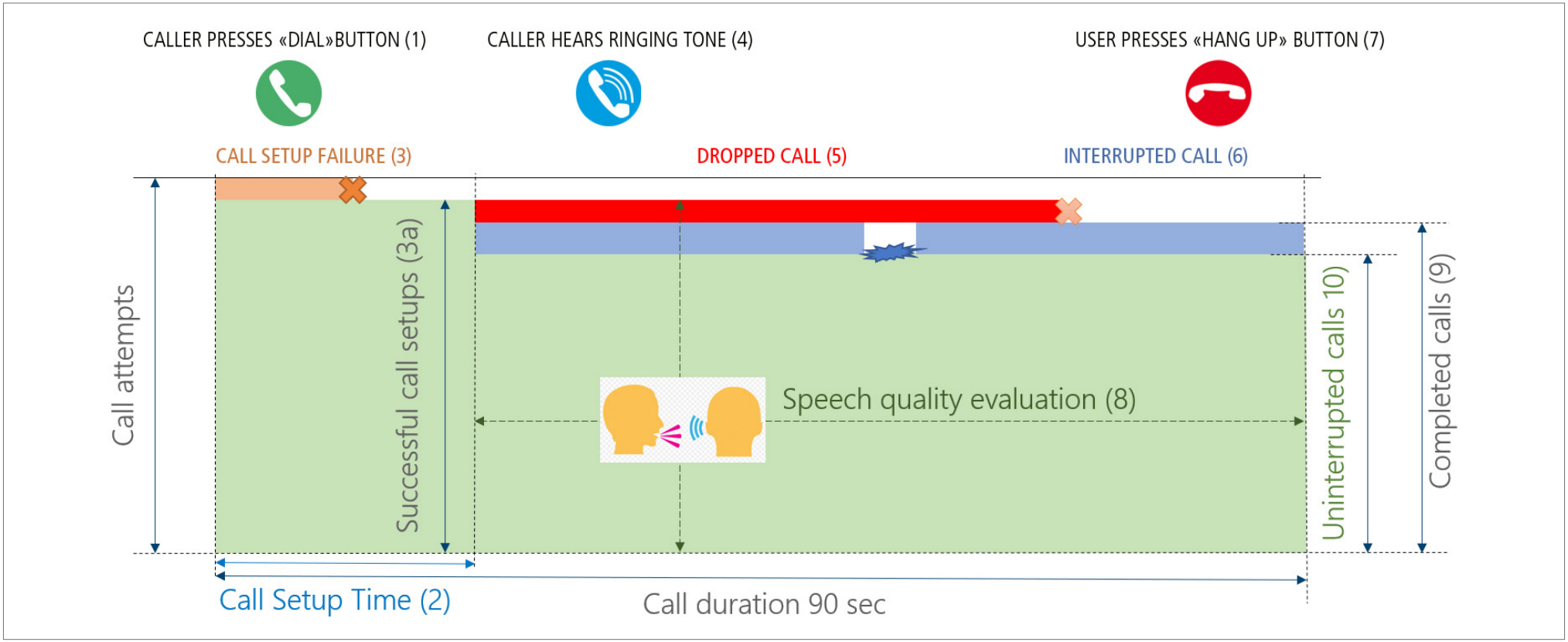
An interrupted call (6) means the call is aborted by the network but it is automatically started again. This results in a gap in the conversation, but the conversation can be completed.

Voice speech quality is evaluated (8) for all calls that were successfully set up, and the analysis includes all dropped and interrupted calls.

Completed calls (9) are the proportion of calls that obtain ringing tone and manage to complete the entire conversation, i.e. the call is not prematurely terminated. Some completed calls experience an interruption in the conversation of several seconds.

Uninterrupted calls (10) are more stringent than completed calls: these calls obtain ringing tone, manage to complete the conversation without any interruption in the conversation.

	Ringing tone	Reach end of conversation	Without interruption
Completed calls	Yes	Yes	No
Uninterrupted calls	Yes	Yes	Yes



3.2. Voice success rate indicators

The voice failure indicators describe 3 scenarios whereby voice call performance is adversely impacted or impaired by quality issues. The negative impact can be major (for calls setup failure & dropped call), whereby the user can't start or complete the call, or moderate (for an interrupted call), where we measured an average gap in the conversation of 3.2s.

A successful call setup means the calling user will hear ringing tone a few seconds after he/she has pressed the dial button. The calling user will consider this a success start of the call. The call setup success rate denotes the proportion of success call setups, i.e. calls that receive ringing tone. There are no significant differences between the networks, with Orange (99.8%), Proximus (99.7%) and Telenet (99.7%) all demonstrating a high call setup success rate.

A dropped call is the event whereby a call that was initially successfully established, is unexpectedly and prematurely aborted before the end of the conversation and beyond the control of the calling parties. The completed call rate measures the proportion of calls that reach the end of the conversation (in our test of 90s). Completed calls are calls that were successfully set up and don't drop. There is no statistically significant difference between the networks for call completion of Telenet (99.5%), Orange (99.4%) and Proximus (99.2%).

Both call setup failures and dropped calls are major failure events, whereby the user doesn't receive the requested service.

An interrupted call is a call that is interrupted by the network due to a temporary quality issue and subsequently automatically re-established by the network. It is an automatic stop/start mechanism to resolve a quality issue, and when successful, the call will still reach the end of the conversation. This technique comes with a price though: an average gap or interruption of the conversation of 3.2 sec. The uninterrupted call rate measures the calls that were successfully set up; don't drop (i.e. reach the end of the conversation); and are not interrupted. Telenet (99.4%) has a higher performance for uninterrupted calls than Proximus (98.7%) and Orange (98.2%).

3.3. Call setup time

Call setup time is the time it takes from pressing the dial button until the caller hears ringing tone.
Both Orange and Proximus use a technique whereby the caller hears ringing tone before the called party hears ringing tone. Telenet doesn't use this technique, and hence the caller in the Telenet network will only hear ringing tone after the called party hears ringing tone.

Proximus has the fastest average call setup time (3.7s), which is roughly 1s faster than the other networks. Proximus also has the fastest call setup when considering the 10% slowest cases (4.7s), which is roughly equal to the average call setup time on the other networks, followed by Telenet (5.4s) and Orange (5.8s).

3.4. Voice speech quality

Voice speech quality measures the quality of the conversation, on a scale from 5 (excellent) to 1 (poor). Good speech quality means clarity of the call, i.e. the speech clearness, fidelity, intelligibility and absence of distortion (such as metallic voice).

Orange has the highest voice quality score (3.7), just ahead of Proximus (3.6). Both operators offer "high-definition" voice, a technique that leads to major improvements in speech quality. The average voice quality in the Telenet network is lower (3.0) than

in the other networks. The 10% worst cases of voice quality score in the Orange (2.9) and Proximus (2.8) networks is higher than for Telenet (2.5).

3.5. Summary on voice performance

All operators have good performance for call setup success and completion rate indicators. There are no statistically significant differences between the networks.

Telenet has the lowest uninterrupted call rate, i.e. no gaps in the conversation. Orange has the highest number of interrupted calls.

Orange and Proximus offer high definition voice and hence have the highest voice speech quality. Orange has a higher voice quality score than Proximus. Telenet has the lowest voice quality score.

Proximus has the lowest call setup time, with Orange and Telenet roughly 1s slower.

4 Data results

The performance of data services is expressed in 5 categories of service indicators. Results are summarized in the table below.

Data Summary			Orange	Proximus	Telenet
Throughput					
HTTP DL fixed duration	DL throughput (Mbps)	**Average**	**58**	**74**	**93**
		Slowest 10%	9,6	10,1	14,9
HTTP UL fixed duration	UL throughput (Mbps)	**Average**	**18,9**	**20,2**	**22,0**
		Slowest 10%	2,4	3,1	2
File Transfer					
HTTPS DL fixed size 10MB	DL time	**Median (s)**	**2,7**	**1,5**	**2,3**
		Success rate (%)	98,3%	98,0%	96,7%
HTTPS UL fixed size 5MB	UL time	**Median (s)**	**2,7**	**2,7**	**2,5**
		Success rate (%)	95,6%	96,7%	93,7%
Web Browsing					
All web pages (blended KPI)	Web browsing time	**Median (s)**	**1,9**	**1,8**	**1,9**
		Success rate (%)	99,4%	99,3%	98,9%
YouTube Video					
YouTube – buffered streaming	Success Rate	**%**	**99,5%**	**99,4%**	**99,1%**
	Time to 1st picture	**Average (s)**	**1,6**	**1,3**	**1,5**
	Video Quality	**Average**	**4,4**	**4,4**	**4,4**
Facebook					
Facebook	Success Rate	**%**	**99,2%**	**99,6%**	**99,4%**
	Total time	**Average (s)**	**2,1**	**2,1**	**2,2**

4.1. Throughput

Throughput (expressed in Mbit/sec) measures the speed the network could offer to a user – it indicates the network capability in terms of speed. High throughput means: high capability to offer fast mobile internet. High throughput also means high available capacity, i.e. the network can support more users simultaneously. Most applications don't exploit or utilise the full throughput available in the network: the maximum throughput achieved by an app depends mostly on the app itself, not on the network. An individual user will benefit from high throughput in case he/she wants to download big amounts of data (several 10's of MBs).

Telenet has the highest average **download throughput** (93Mbps), followed by Proximus (74Mbps) and Orange (58Mbps). Telenet has also the highest download throughput performance (14.9 Mbps) when considering the 10% of slowest test cases, followed by Proximus (10.1 Mbps) and Orange (9.6Mbps).

Telenet has the highest average **upload throughput** (22Mbps), followed by Proximus (20.2Mbps) and Orange (18.9Mbps). The picture changes for the worst 10% of upload throughput tests: Proximus has the highest throughput (3.1Mbps), followed by Orange (2.4Mbps) and Telenet (2.0Mbps).

From the 10% worst samples, we can state that all networks in Belgium offer (1) 9.6Mbps or higher download speeds, and (2) 2Mbps or higher upload speeds in 90% of all tests.

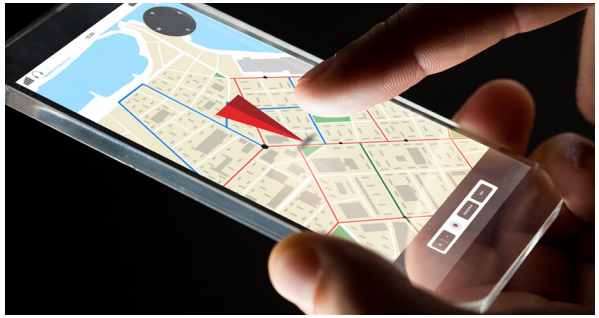
4.2. File transfer

File transfer tests measure the performance of downloading or uploading a file. File transfers are very common, such as in picture uploads or downloads in popular apps, email attachments, etc.
The performance of file transfers is measured by 2 service indicators: (1) the time to complete the transfer and (2) the success rate. The success rate is an indicator of the integrity or reliability of the service; success rate denotes the proportion of download or upload tests that were successfully completed within 40s.

For a **download** of a 10MB file, Proximus has the fastest download time (1.5s), followed by Telenet (2.3s) and Orange (2.7s). Orange has the highest success rate (98.3%), followed by Proximus (98.0%) and Telenet (96.7%).

For an **upload** of a 5MB file, Telenet (2.5s) is faster than Orange and Proximus (2.7s). Proximus has the highest success rate (96.7%), followed by Orange (95.6%) and Telenet (93.7%).

4.3. Web browsing



Web browsing or surfing to web pages is a popular activity of mobile phone users. A selection of 1 static and 5 popular in Belgium web pages was used for the aggregated results. Web browsing results are summarised into 2 service indicators: (1) the time to view the web page and (2) the success rate (i.e. time to complete the web view in 20s).

Web page load time is almost identical in all networks, with values of 1.8s to 1.9s.

Web success rate denotes the percentage of web pages that is completely downloaded within 20s. Orange (99.4%) and Proximus (99.3%) have a higher success rate for web browsing than Telenet (98.9%).

4.4. YouTube video

Video streaming, and YouTube in particular, is amongst the most popular mobile apps. Buffered video streaming was tested, as opposed to live streaming.

YouTube performance is measured as (1) a success rate, i.e. the proportion of tests that had a complete play-out of the video; (2) the time-to-first-picture, i.e. how long it takes for the play-out to start; and (3) the video quality during the entire play-out.

All networks offer similar YouTube service, with small variations in performance.

Orange (99.5%) and Proximus (99.4%) offer the highest **success rate**, followed by Telenet (99.1%).

Proximus has the fastest "**time to 1st picture**" (1.3s), followed by Telenet (1.5s) and Orange (1.6s).

Video quality is the same on all networks (4.4). It captures the effect of low video resolution, freezing of the play-out, etc. When the networks offer sufficient throughput and capacity (5-10Mbps on average), and coverage is present, video quality is expected to be the same in all networks.

4.5. Facebook

Facebook performance is measured as (1) the time to perform several actions and (2) the success rate to complete these actions.

Facebook performance is similar for all operators, with small variations.

Proximus has the highest **success rate** (99.6%) for Facebook performance, followed by Telenet (99.4%) and Orange (99.2%).

All networks require a **similar time to complete** the actions, i.e. 2.1s to 2.2s

4.6. Summary on data performance

All mobile networks offer very good to excellent data performance. There are small variations in performance (possibly the result of design choices made by the operators), with one network offering higher network throughput and the other networks with somewhat higher application success rates.

As to network throughput, Telenet has the highest average download and average upload throughput. The highest throughput is not entirely reflected in the time to download or upload files, where Proximus has the fastest download time and Telenet the fastest upload time. Proximus and Orange have higher success rates for file transfers than Telenet.

For typical applications, such as web browsing, YouTube video and Facebook, the success rate is high and is testament to reliable networks: for Orange and Proximus above 99% for all apps, for Telenet just below or above 99% as well. The various load times for different apps vary between 1.3s to 2.2s, with Proximus better by 0s to 0.3s maximum.

5 Conclusions

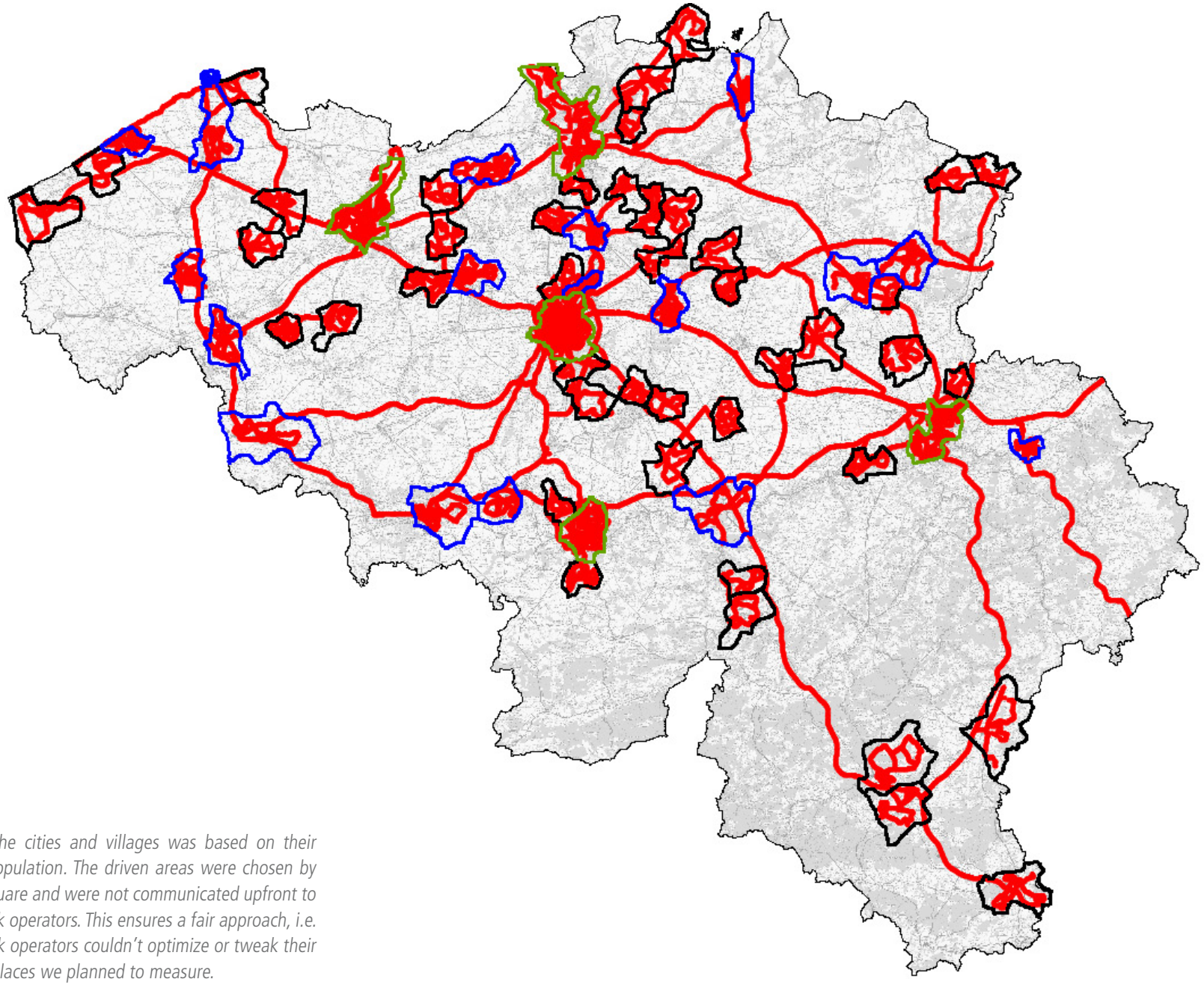
The performance of Belgian mobile networks was assessed, simulating customer experience. The measurements were conducted by driving 2 cars during 250 hours across the entire country in September 2018. Performance was measured in all major cities and highways, as well as in a selection of medium size cities, villages and roads. A total distance of approx. 12,000 km was driven; over 8,000 voice calls were made on each network; and roughly 60,000 data tests were conducted per network. The measurements were configured such that these are representative of customer experience in indoor conditions (i.e. meaning in houses and buildings, close to a window, or in-car).

For voice performance, call setup success and completion rates are close, with Telenet (99.5%) followed by Orange (99.4%) and Proximus (99.2%). As to uninterrupted calls, Telenet users experience very few interruptions, with an uninterrupted call rate for Telenet of 99.4%, followed by Proximus (98.7%) and Orange (98.2%). Proximus is leading in terms of the call setup time by roughly 1s ahead of the competition. For voice quality, on a scale from 5 (excellent) to 1 (poor), Orange (3.7) and Proximus (3.6) are followed by Telenet (3.0).

As to data performance, Telenet has the highest average throughput (93Mbps down, 22Mbps up), followed by Proximus (74Mbps down, 20.2Mbps up) and Orange (58Mpbs down, 18.9Mbps up). For the download of a 10MB file, Proximus (1.5s) is faster than Telenet (2.3s) and Orange (2.8s). For the download and upload of a file, Proximus has the highest success rates (98.0%/96.7%), followed by Orange (98.3%/95.6%) and Telenet (96.7%/93.7%). For other applications, such web browsing, YouTube video and Facebook, Proximus has a faster time than the other networks by 0 to 0.3s. For most data applications, Proximus and Orange present higher success rate, i.e. the probability to complete the intended action, than Telenet.

We observed performance differences between the different networks. However, there is not a single network outperforming the other networks on all service indicators we have measured. These conclusions are valid based on the measurements made in September 2018, simulating indoor coverage conditions. Performance deep into buildings will be different.

Based on our international experience and considering the combination of all service indicators we have measured, all mobile networks in Belgium demonstrate very good performance.



The selection of the cities and villages was based on their importance and population. The driven areas were chosen by BIPT and Commsquare and were not communicated upfront to the mobile network operators. This ensures a fair approach, i.e. the mobile network operators couldn't optimize or tweak their network in those places we planned to measure.

< Back page 4