CUSTOMER EXPERIENCE BENCHMARK IN SWEDEN

Country-wide comparison of subscriber perceived data service quality in Telenor and Telia mobile networks

Omnitele Report | 5 March 2014
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OMNITELE

experience

why we exist

Omnitele is an international telecommunications consulting and engineering company. We provide services for telecom operators and regulators in domains of network strategy, design and quality assurance. Our mission is to maximise mobile subscriber quality of experience and minimise operator network cost.

track record

We have solid track record and over 25 years of experience in telecoms industry. The company was founded in 1988 to set up world's first GSM operator and network. Since then we have completed 1000+ projects in 80+ countries.

presence

Our headquarters is located in Helsinki, Finland. We have local presence in the Netherlands and the Hashemite Kingdom of Jordan. Our company is owned by Finnish telecom investors and we are independent of all international operators and telecom network infrastructure equipment vendors.

omnitele way

Our unique way of working sets us apart from the competition. We call this the Omnitele Way: being Straightforward, Trusted and Intelligent. We deliver tangible results and ensure excellent *Omnitele Experience*.

TABLE OF CONTENTS

executive summary

In January 2014 Telenor assigned Omnitele to conduct an independent customer experience benchmark of mobile data services in Sweden. Project purpose was to assess the competitive quality positioning of mobile operators **Telenor** and **Telia**.

Project objectives:

1. **Measure** mobile data service quality with iPhone 5s smartphones in Telenor and Telia mobile networks across Sweden
2. **Analyse** and compare the customer experience of WWW browsing and YouTube video streaming services for both operators
3. **Report** and publish the survey results for the general public in clear and understandable fashion

To assess the mobile data customer experience, Omnitele conducted a vast field measurement campaign. 680 test locations in urban, rural and typical holiday areas were selected independently by Omnitele. The measurements were executed with end-user centric methodology: testing times, locations, services, SIM cards and terminals were selected based on typical Swedish mobile subscriber behaviour.

Considering the numeric results of mobile data customer experience tests, Telenor scores higher than Telia in 73% of test locations.

From end-user perspective no major differences between the benchmarked operators were observed. In practice both operators have equally good networks for mobile WWW browsing and YouTube video streaming.

Omnitele concludes that both operators provide outstanding customer experience compared to any international references. Good results are mostly explained by the wide 4G network availability.

TABLE OF CONTENTS

Telenor assigned Omnitele to conduct an independent customer experience benchmark of mobile services in Sweden

1. **Measure** mobile data service quality with iPhone 5s smartphones in Telenor and Telia mobile networks across Sweden
2. **Analyse** and compare the customer experience of WWW browsing and YouTube video streaming services for both operators
3. **Report** and publish the survey results for the general public in clear and understandable fashion

telenor

vs

Telia

Three test cases were measured for both WWW browsing and YouTube video streaming. Test sources were selected by Omnitele to represent typical use cases of Swedish mobile subscribers.

iPhone 5s WWW browsing

TESTED WEB PAGES:

Aftonbladet	http://aftonbladet.se
Google search	https://www.google.se/search?q=zlatan
Wikipedia	https://sv.wikipedia.org

iPhone 5s YouTube video streaming

TESTED YOUTUBE VIDEOS:

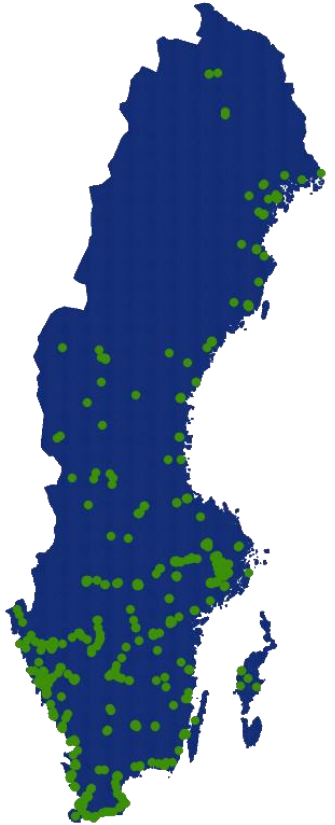
Test video 1 (1:16)	Volvo Trucks – The Epic Split feat. Van Damme
Test video 2 (0:33)	Harlem Shake (original army edition)
Test video 3 (0:51)	What Your Body Does in 30 Seconds

VAST TEST CAMPAIGN

- tests conducted Jan 20 – Feb 14, 2014
- total 101 test days by 5 measurement teams
- 680 test locations across Sweden
- 8 160 individual mobile data use case tests

Test Execution	Totals
Benchmarked Operators	2
Number of cities	79
Number of test locations	680
Test days	101

Sample Counts / operator	Totals
WWW page download attempts	2040
YouTube video stream attempts	2040



680 measurement locations selected by Omnitele in blind test fashion*

Urban (550 test locations)

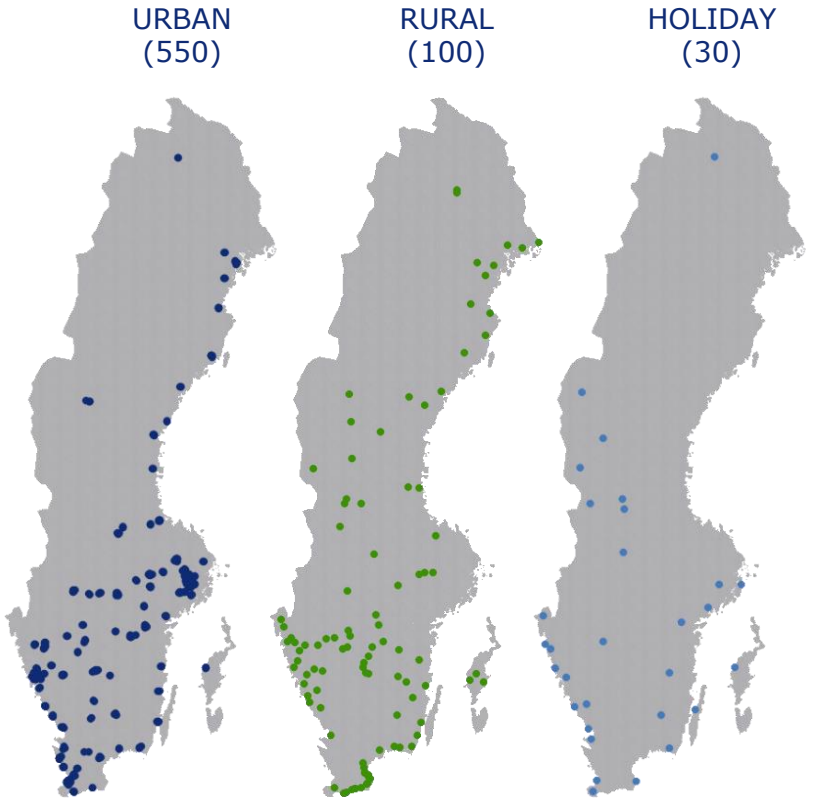
All urban areas with over 15 000 inhabitants covered (79 *tätorter)*. Tests distributed based on population density and selected as per end-user behaviour: shopping malls, restaurants, hotels…

Rural (100 test locations)

Typical mobile data usage locations outside the urban areas, e.g. gas stations.

Holiday (30 test locations)

Popular Swedish holiday areas e.g. ski resort, beach…



*Details in Annex 2.

End-user centric analysis methodology and competitive quality positioning

- For each of the 2 test cases 3 individual measurement samples are collected in every test location
- For each test case, the better operator in a given location is defined primarily based on success rate (1)
- If both operators have equal success rate in a specific test location, the winning operator is defined by test case usability (2)

1. test case success rate

Probability that the user can successfully initiate and complete the use case

2. test case usability

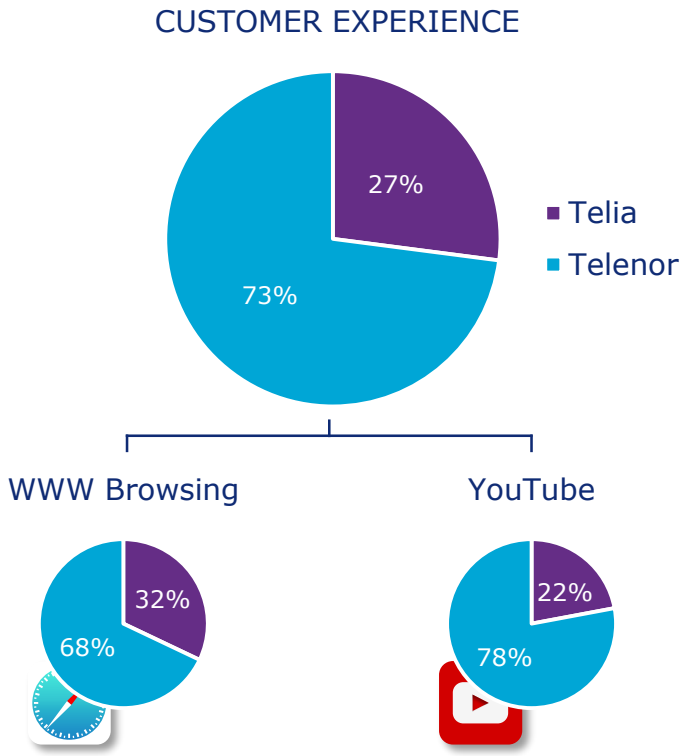
WWW: web page waiting time [s]
YouTube: buffering time [s]

TABLE OF CONTENTS

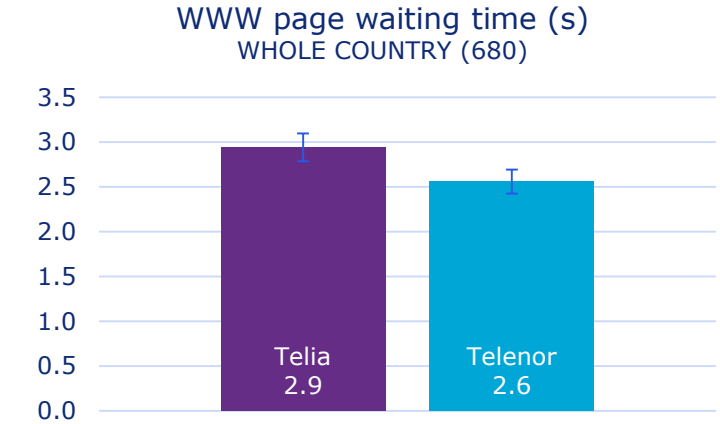
benchmark results | table of contents

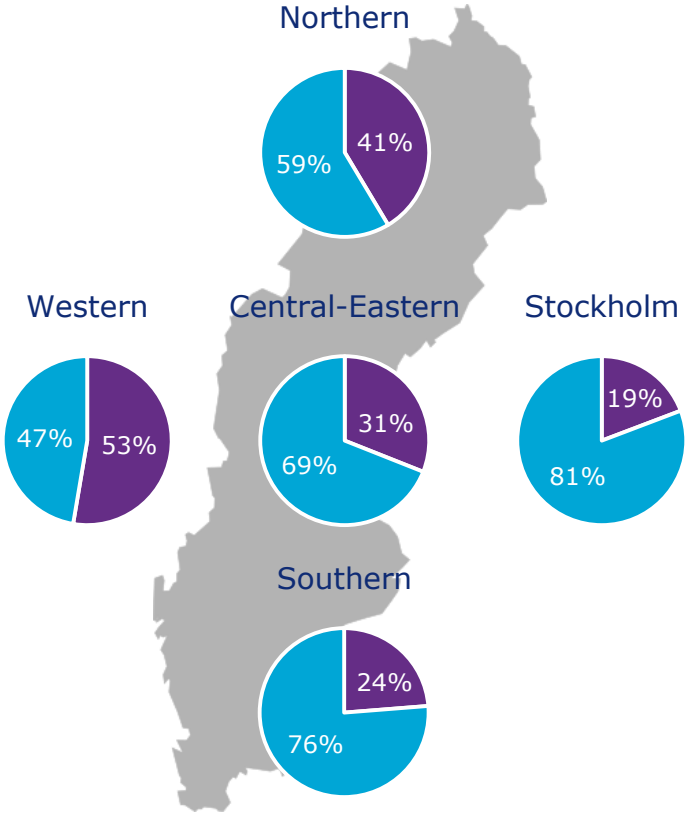
Considering all performed tests, Telenor scores higher than Telia in 73% of the test locations. Numeric results however show that from typical mobile subscriber perspective the differences are rather marginal.

Omnitele concludes that both Operators provide outstanding customer experience compared to any international references and industry standards.

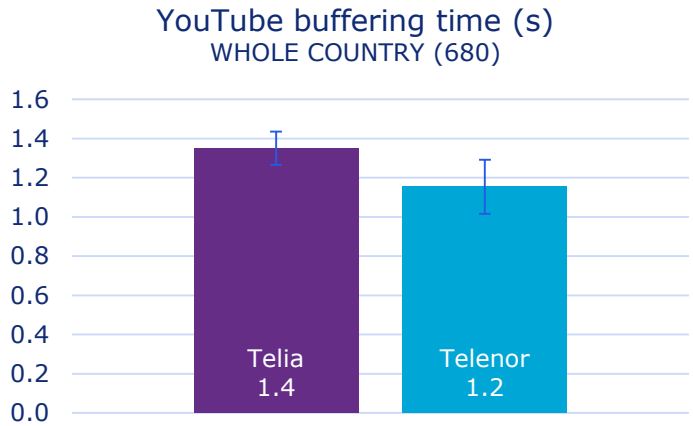


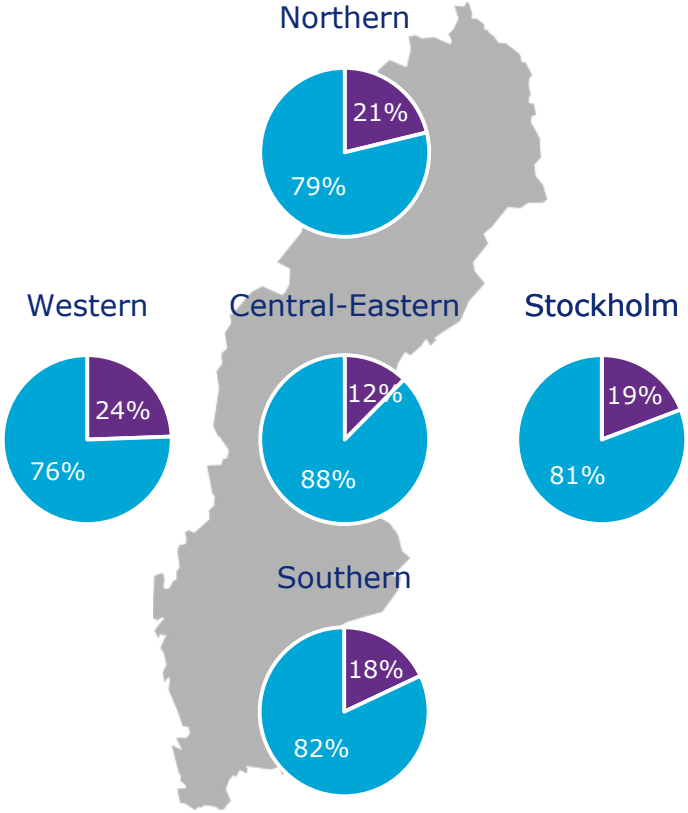
In WWW browsing test Telenor scores slightly better in most parts of Sweden. In Western Sweden Telia results are better. The absolute difference in WWW page waiting time is marginal.



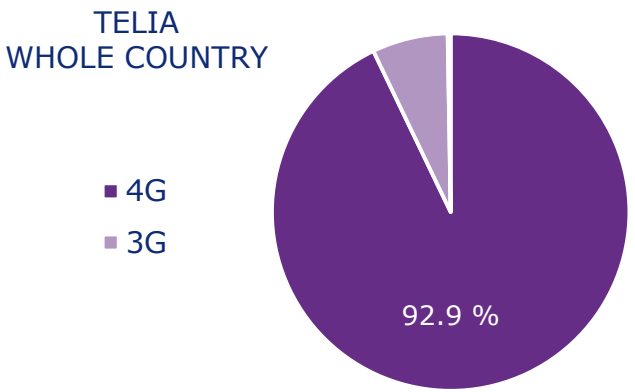


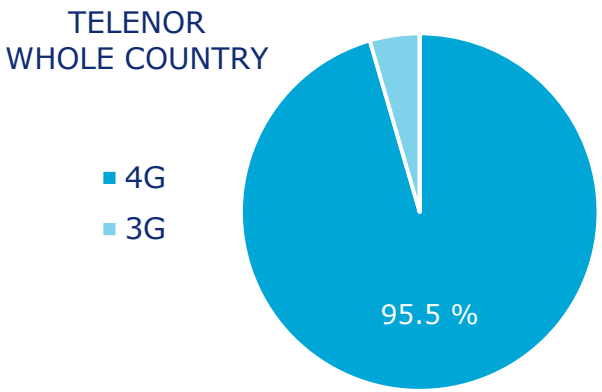
In YouTube video streaming test Telenor scores slightly better than Telia consistently across Sweden. The difference in video buffering time is however hardly noticeable.





4G is no longer a rarity in Sweden but instead widely available across the country with both operators. Considering the tested locations, 4G availability with iPhone 5s terminal is slightly wider for Telenor.



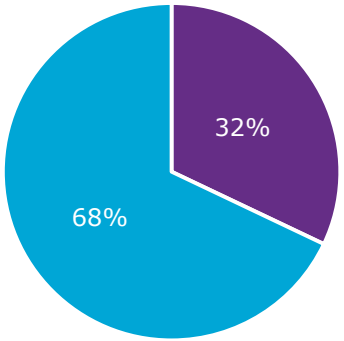


benchmark results | table of contents

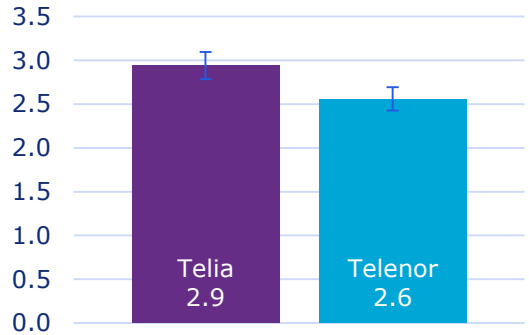
www browsing details | whole country

Considering the whole country, the www browsing tests show that Telenor scores higher in 68% of test locations. Faster web page downloads are measured for Telenor. No statistically significant difference is observed in www page success rate.

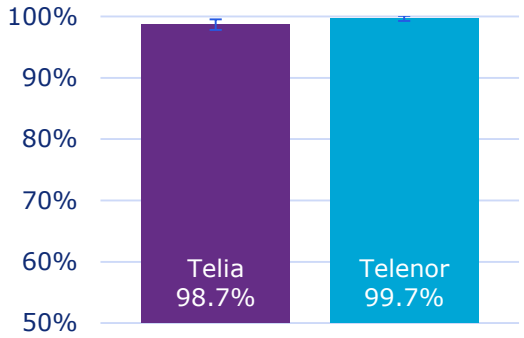
WWW BROWSING, WHOLE COUNTRY (680)



WWW PAGE WAITING TIME (S) WHOLE COUNTRY (680)



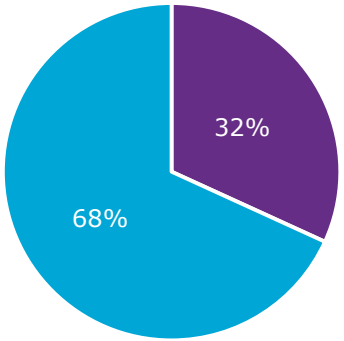
WWW PAGE SUCCESS RATE (%) WHOLE COUNTRY (680)



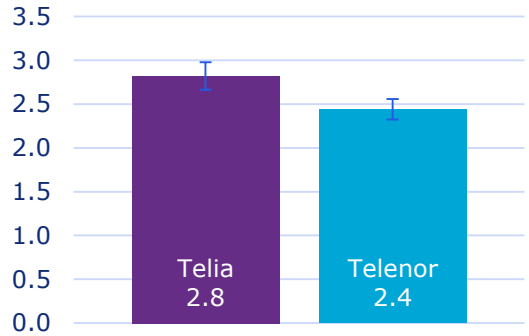
www browsing details | urban areas

In urban areas, Telenor scores better than Telia in 68% of the locations. Faster web page downloads are measured for Telenor. No statistically significant difference is observed in www page success rate.

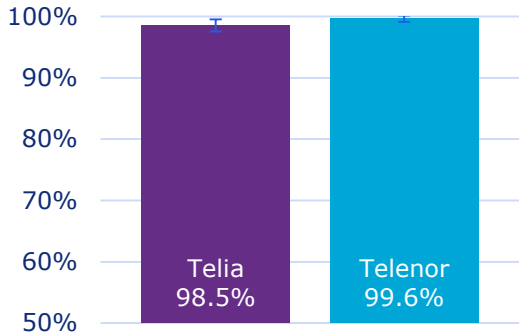
WWW BROWSING, URBAN (550)



WWW PAGE WAITING TIME (S) URBAN (550)



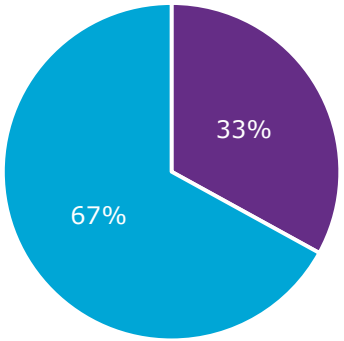
WWW PAGE SUCCESS RATE (%) URBAN (550)



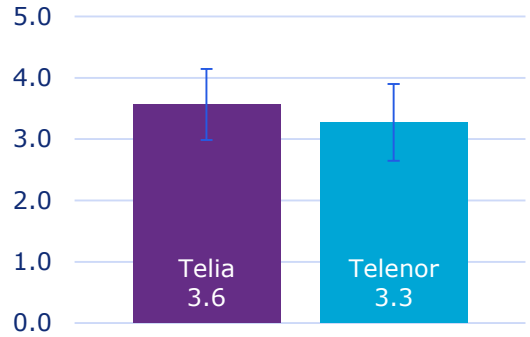
www browsing details | rural areas

In rural areas, the www browsing tests show no statistically significant differences between operators in terms of www page waiting time or success rate.

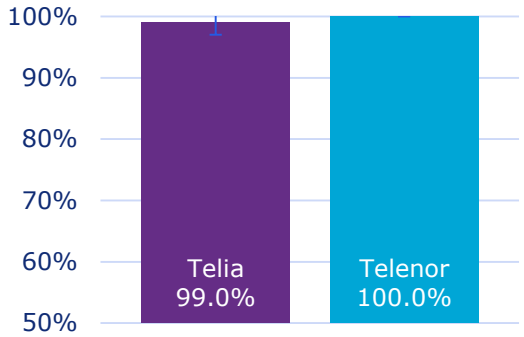
WWW BROWSING, RURAL (100)



WWW PAGE WAITING TIME (S) RURAL (100)



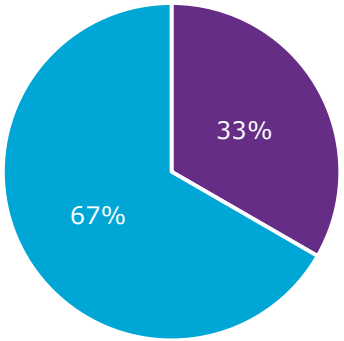
WWW PAGE SUCCESS RATE (%) RURAL (100)



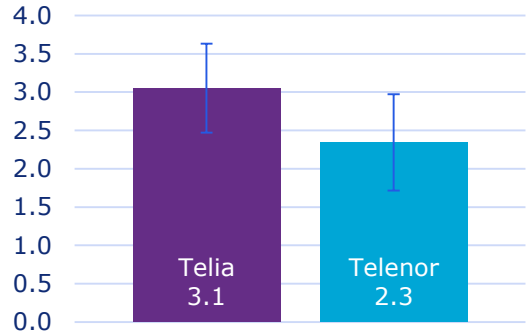
www browsing details | holiday locations

In holiday locations, the www browsing tests show no statistically significant differences between operators in terms of www page waiting time or success rate.

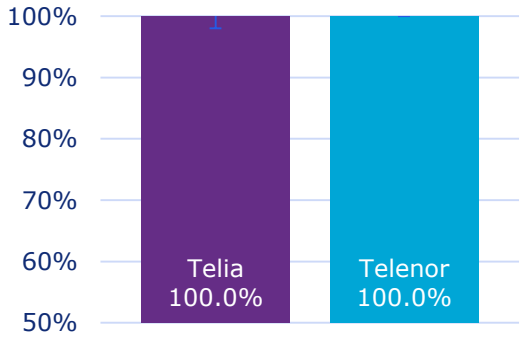
WWW BROWSING, HOLIDAY (30)



WWW PAGE WAITING TIME (S) HOLIDAY (30)



WWW PAGE SUCCESS RATE (%) HOLIDAY (30)

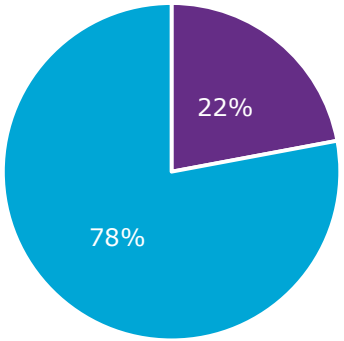


benchmark results | table of contents

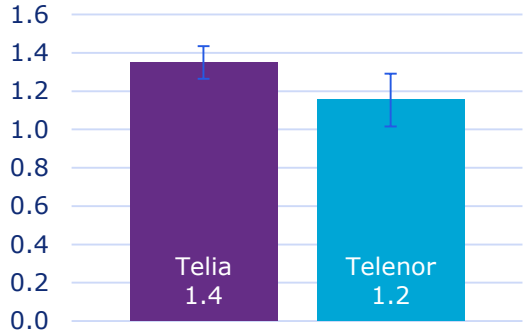
YouTube streaming details | whole country

When results are averaged over whole country, the YouTube streaming tests do not show statistically significant difference in terms of average buffering time or success rate.

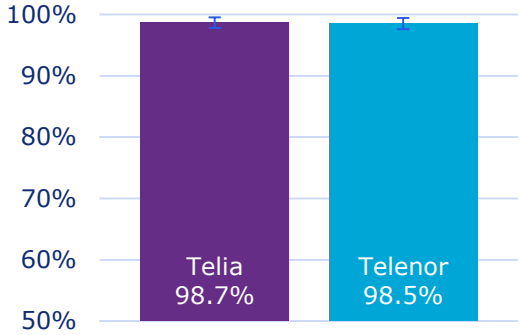
YOUTUBE STREAMING, WHOLE COUNTRY (680)



YOUTUBE BUFFERING TIME (S) WHOLE COUNTRY (680)



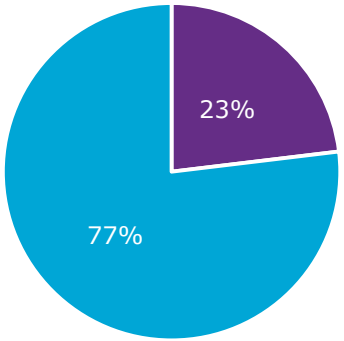
YOUTUBE SUCCESS RATE (%) WHOLE COUNTRY (680)



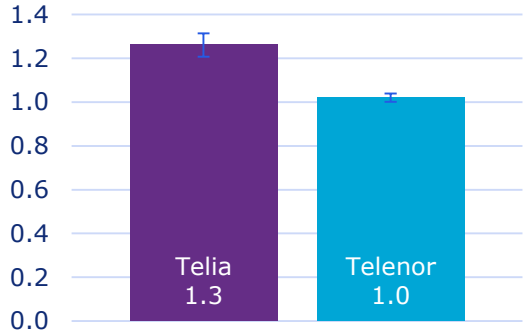
YouTube streaming details | urban areas

In urban areas, the YouTube streaming tests show that Telenor scores better in 77% of the locations. In average, Telenor's buffering time is shorter. No statistically significant difference is observed in video streaming success rate.

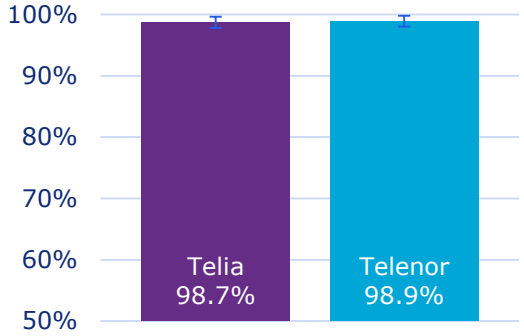
YOUTUBE STREAMING, URBAN (550)



YOUTUBE BUFFERING TIME (S) URBAN (550)



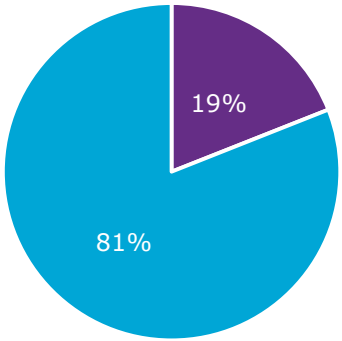
YOUTUBE SUCCESS RATE (%) URBAN (550)



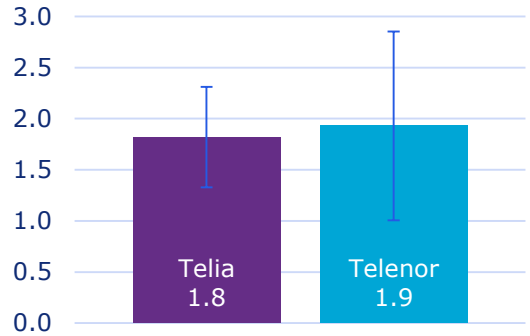
YouTube streaming details | rural areas

In rural areas, the YouTube streaming tests do not show statistically significant difference in terms of average buffering time or success rate.

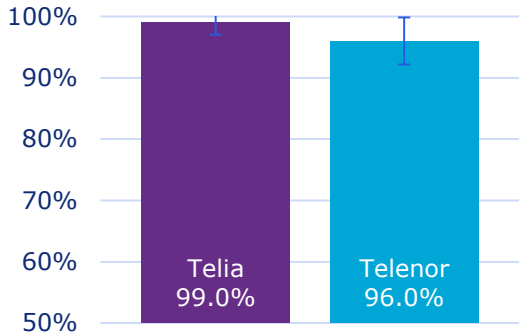
YOUTUBE STREAMING, RURAL (100)



YOUTUBE BUFFERING TIME (S) RURAL (100)



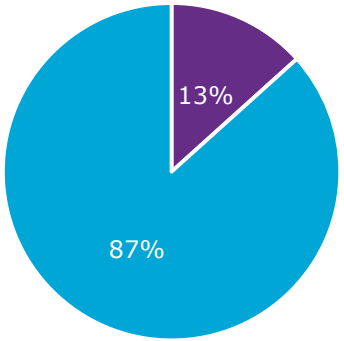
YOUTUBE SUCCESS RATE (%) RURAL (100)



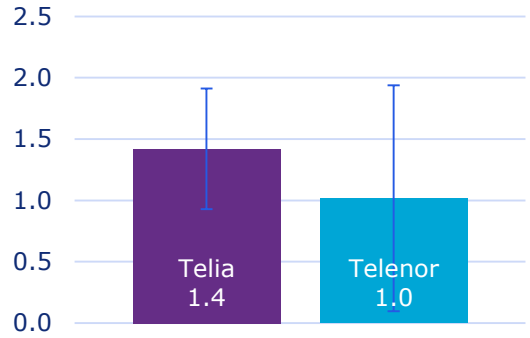
YouTube streaming details | holiday locations

In holiday locations, the YouTube streaming tests do not show statistically significant difference in terms of average buffering time or success rate.

YOUTUBE STREAMING, HOLIDAY (30)



YOUTUBE BUFFERING TIME (S) HOLIDAY (30)



YOUTUBE SUCCESS RATE (%) HOLIDAY (30)

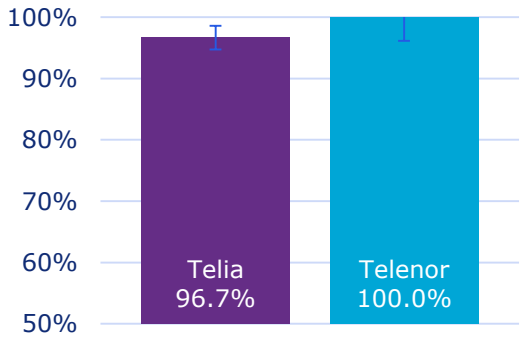


TABLE OF CONTENTS

Measurement methodology designed to capture true end-user experience

TESTING TIMES

- Test days: Monday - Saturday
- Test hours: 06.00 – 00:00, focus on morning and night busy hours
- Saturdays: Measurements between 10:00 – 00:00. No measurements in business or university areas.
- Sundays: No testing.

METHODOLOGY

- Commercial state of the art smartphones used for capturing best available end-user quality
- Devices sourced from retail stores and SIM cards from operator stores
- Test locations chosen independently by Omnitele in blind test fashion
- Frequency band and technology (2G/3G/4G) selection as per network parameterisation
- All tests conducted in stationary state inside car

Mobile data testing was conducted with commercial iPhone 5s terminals and Nemo CEM measurement system. Test cases included WWW browsing and YouTube video streaming.

MEASUREMENT EQUIPMENT

Nemo CEM is a flexible and scalable set of tools for monitoring smartphone data services from the end user perspective.

More information:
http://www.anite.com/businesses/network-testing/products

methodology | test cases and test parameters

Three test cases were measured for both WWW browsing and YouTube video streaming. Test sources were selected by Omnitele to represent typical use cases of Swedish mobile subscribers.

TC1	WWW Browsing
Sequence	3 x WWW page download
Interval	10s interval between WWW requests
Time-out	30s time-out limit for WWW download
Reference point	Public internet
Methodology	Stationary test in a car

TC2	YouTube video streaming
Sequence	3 x YouTube video stream (60s each)
Interval	10s interval between WWW requests
Time-out	30s time-out for setup and re-buffering
Reference point	Public YouTube
Methodology	Stationary test in a car

Test parameters are defined based on ETSI standardisation (TS 102 250-2), success rate includes service accessibility and retainability.

test case	success rate	usability
WWW browsing	$\frac{(\#attempts - \#setup\ failures - \#connection\ drops)}{\#attempts}$	WWW page waiting time [s] = T2 – T1 T2: time WWW page content downloaded [s] T1: time user request WWW page [s]
YouTube video streaming		YouTube Buffering time [s] = T3 + T4 T3: initial buffering time [s] T4: total rebuffering time [s]

ANNEXES

1. result tables
2. measurement location details
3. statistical significance analysis
4. test devices and SIM cards

ANNEX 1 | www browsing, details

WHOLE COUNTRY (680)

WWW browsing, whole country	Telia	Telenor
WWW page waiting time (s)	2.9	2.6
Number of locations with successful samples	680	680
Standard deviation (s)	2.06586936	1.785017
Confidence interval (s)	0.16	0.13
Statistically significant difference?	**YES**	

WWW success, whole country	Telia	Telenor
Number of locations	680	680
Locations with failures	9	2
Locations without failures	671	678
WWW page success rate	**98.7%**	**99.7%**
Confidence interval	0.9%	0.4%
Statistically significant difference?	**NO**	

URBAN (550)

WWW browsing, urban areas	Telia	Telenor
WWW page waiting time (s)	2.8	2.4
Number of locations with successful samples	550	550
Standard deviation (s)	1.88357289	1.399092
Confidence interval (s)	0.16	0.12
Statistically significant difference?	**YES**	

WWW success, urban areas	Telia	Telenor
Number of locations	550	550
Locations with failures	8	2
Locations without failures	542	548
WWW page success rate	**98.5%**	**99.6%**
Confidence interval	1.0%	0.5%
Statistically significant difference?	**NO**	

RURAL (100)

WWW browsing, rural areas	Telia	Telenor
WWW page waiting time (s)	3.6	3.3
Number of locations with successful samples	100	100
Standard deviation (s)	2.9535623	3.205962
Confidence interval (s)	0.58	0.63
Statistically significant difference?	**NO**	

WWW success, rural areas	Telia	Telenor
Number of locations	100	100
Locations with failures	1	0
Locations without failures	99	100
WWW page success rate	**99.0%**	**100.0%**
Confidence interval	2.0%	0.0%
Statistically significant difference?	**NO**	

HOLIDAY (30)

WWW browsing, holiday locations	Telia	Telenor
WWW page waiting time (s)	3.1	2.3
Number of locations with successful samples	30	30
Standard deviation (s)	1.16259226	0.624786
Confidence interval (s)	0.42	0.22
Statistically significant difference?	**YES**	

WWW success, rural areas	Telia	Telenor
Number of locations	30	30
Locations with failures	0	0
Locations without failures	30	30
WWW page success rate	**100.0%**	**100.0%**
Confidence interval	0.0%	0.0%
Statistically significant difference?	**NO**	

ANNEX 1 | YouTube video streaming, details

WHOLE COUNTRY (680)

YouTube video streaming, whole country	Telia	Telenor
YouTube buffering time (s)	1.4	1.2
Number of locations with successful samples	680	680
Standard deviation (s)	1.13489778	1.83703
Confidence interval (s)	0.09	0.14
Statistically significant difference?	**NO**	

YouTube success, whole country	Telia	Telenor
Number of locations	680	680
Locations with access failures	3	5
Locations with connection drops	6	5
Locations without failures	671	670
YouTube success rate	**98.7%**	**98.5%**
Confidence interval	0.9%	0.9%
Statistically significant difference?	**NO**	

URBAN (550)

YouTube video streaming, urban	Telia	Telenor
YouTube buffering time (s)	1.3	1.0
Number of locations with successful samples	550	550
Standard deviation (s)	0.63442774	0.225307
Confidence interval (s)	0.05	0.02
Statistically significant difference?	**YES**	

YouTube success, urban areas	Telia	Telenor
Number of locations	550	550
Locations with access failures	3	3
Locations with connection drops	4	3
Locations without failures	543	544
YouTube success rate	**98.7%**	**98.9%**
Confidence interval	0.9%	0.9%
Statistically significant difference?	**NO**	

RURAL (100)

YouTube video streaming, rural	Telia	Telenor
YouTube buffering time (s)	1.8	1.9
Number of locations with successful samples	100	100
Standard deviation (s)	2.50611147	4.705763
Confidence interval (s)	0.49	0.92
Statistically significant difference?	**NO**	

YouTube success, rural areas	Telia	Telenor
Number of locations	100	100
Locations with access failures	0	2
Locations with connection drops	1	2
Locations without failures	99	96
YouTube success rate	**99.0%**	**96.0%**
Confidence interval	2.0%	3.8%
Statistically significant difference?	**NO**	

HOLIDAY (30)

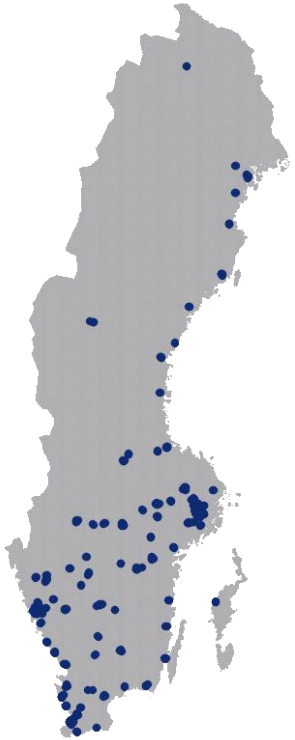
YouTube video streaming, holiday	Telia	Telenor
YouTube buffering time (s)	1.4	1.0
Number of locations with successful samples	30	30
Standard deviation (s)	0.42248054	0.15164
Confidence interval (s)	0.15	0.05
Statistically significant difference?	**YES**	

YouTube success, rural areas	Telia	Telenor
Number of locations	30	30
Locations with access failures	0	0
Locations with connection drops	1	0
Locations without failures	29	30
YouTube success rate	**96.7%**	**100.0%**
Confidence interval	6.4%	0.0%
Statistically significant difference?	**NO**	

ANNEXES

1. result tables
2. measurement location details
3. statistical significance analysis
4. test devices and SIM cards

ANNEX 2 | measurement locations: urban areas



City	Locations	City	Locations	City	Locations
Åkersberga	3	Kiruna	2	Piteå	3
Alingsås	3	Köpings	2	Sandviken	3
Ängelholm	3	Kristianstad	4	Skellefteå	4
Boden	2	Kristinehamns	2	Skövde	4
Boo	3	Kungälvs	3	Södertälje	7
Borås	7	Kungsbacka	2	Stockholm	138
Borlänge	5	Landskrona	4	Sundsvall	6
Enköping	3	Lerum	2	Täby	7
Eskilstuna	7	Lidingo	4	Trelleborg	3
Eslov	2	Lidköping	3	Trollhättan	5
Falkenberg	3	Linköping	11	Tumba	4
Falköping	2	Ljungby	2	Uddevalla	4
Falun	4	Luleå	5	Umeå	8
Gävle	8	Lund	9	Upplands	4
Göteborg	55	Malmo	29	Uppsala	15
Halmstad	6	Mariestad	2	Vallentuna	3
Härnösand	2	Märsta	3	Vänersborgs	3
Hassleholm	2	Mölnlycke	2	Varberg	3
Helsingborg	10	Motala	3	Värnamo	2
Hudiksvall	2	Nässjö	2	Västerås	12
Jönköping	9	Norrköping	9	Västerhaninge	2
Kalmar	4	Norrtälje	2	Vastervik	3
Karlshamn	2	Nyköping	3	Vaxjo	7
Karlskoga	3	Örebro	11	Visby	3
Karlskrona	4	Örnsköldsvik	3	Ystad	2
Karlstad	7	Oskarshamn	2		
Katrineholm	3	Östersund	5		

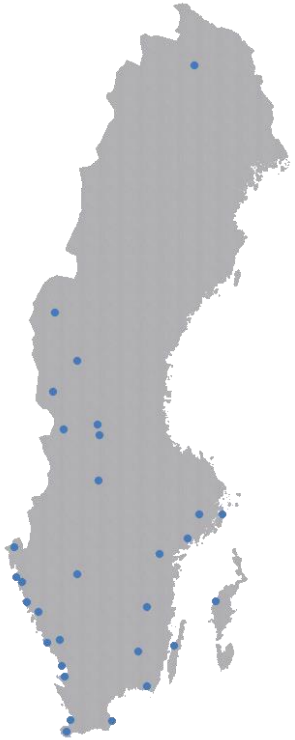
Aggregates	
Total Towns/Cities	79
Total test locations	550

ANNEX 2 | measurement locations: rural areas

Municipality				
Ånge	Falköping (2)	Karlslkrona	Motala	Sveg
Alingsås	Farm	Kivik (2)	Munkedal	Svenstavik
Alvik	Figeholm	Klintehamn	Mölndal	Tanum
Arboga	Forserum	Kosta	Mörrum	Tenhult
Askersund	Gamleby	Krokom	Nybrostrand	Tierp
Älvdalen	Grillby	Kungsbacka	Orsa	Torsås
Älvsbyn	Grängesberg	Kungälv	Ödeshöh	Trelleborg
Beddingestrand	Gränna (2)	Langsele	Partille	Töre
Bjästa	Grästorp	Lidköping	Rengsjö	Uddevalla (2)
Boliden	Haaparand	Listerby	Rimforsa	Varberg
Borås	Hammenhög (2)	Ljugarn	Robertsfors	Vellinge
Brösarp (2)	Hultsfred	Lysekil	Roma	Väja
Bureå	Hummelsta	Malmberget	Ronneby	Vänersborg
Böle	Huskvarna	Malung	Simrishamn	Vännäs
Degeberga	Högsby	Mariannelund	Skivarp	Väse
Dundret	Idre	Mariestad	Skövde	Vinninga
Evertsberg	Irsta	Mark	Smygehamn	Ystad (2)
Everöd	Kalmar	Mellbystrand	Stenungsund	
Falkenberg	Karlsborg	Mjölby	Strömstad	

Aggregates	
Total Municipalities	93
Total test locations	100

ANNEX 2 | measurement locations: holiday locations



City		
Åre	Kosta	Stockholm
Borgholm	Lysekil	Strömstad
Båstad	Malmö	Säfsen
Falsterbo	Marstrand	Sälen
Göteborg	Mora	Trosa
Halmstad	Orsa Grönklitt	Ullared
Idre	Sandhamn	Varberg
Jukkasjärvi	Simrishamn	Vemdalen
Karlskrona	Skara	Vimmerby
Kolmården	Smögen	Visby

Aggregates	
Total Towns/Cities	30
Total test locations	30

ANNEX 2 | measurement locations: geographical distribution

Western Sweden		Southern Sweden		Central-Eastern Sweden		Stockholm Metropolitan Area	Northern Sweden	
Alingsås	Strömstad	Beddingestrand	Mellbystrand	Arboga	Skara	Boo	Alvik	Mora
Borås	Tanum	Borgholm	Mörrum	Askersund	Skövde	Lidingö	Bjästa	Orsa
Forserum	Tenhult	Brösarp	Nybrostrand	Ekilstuna	Tierp	Märsta	Boden	Orsa Grönklitt
Gränna	Trollhättan	Båstad	Oskarshamn	Falköping	Trosa	Norrtälje	Boliden	Piteå
Grästorp	Uddevalla	Degeberga	Ronneby	Gamleby	Uppsala	Sandhamn	Borlänge	Rengsjö
Göteborg	Ullared	Eslöv	Simrishamn	Grängesberg	Vimmerby	Stockholm	Bureå	Robertsfors
Huskvarna	Varberg	Everöd	Skivarp	Hultsfred	Vinninga	Södertälje	Böle	Sandviken
Jönköping	Vänersborg	Falkenberg	Smygehamn	Hummelsta	Visby	Tumba	Dundret	Skellefteå
Kungsbacka	Vänersborgs	Falsterbo	Torsås	Högsby	Väse	Täby	Enköping	Sundsvall
Kungälv	Värnamo	Figeholm	Trelleborg	Irsta	Västerås	Upplands	Evertsberg	Sveg
Kungälvs		Halmstad	Varberg	Karlskoga	Ödeshög	Vallentuna	Falun	Svenstavik
Lerum		Hammenhög	Vellinge	Karlstad	Örebro	Västerhaninge	Farm	Säfsen
Ljungby		Helsingborg	Västervik	Katrineholm		Åkersberga	Gävle	Sälen
Lysekil		Hässleholm	Växjö	Kolmården			Haaparand	Töre
Mariannelund		Kalmar	Ystad	Kristinehamn			Hudiksvall	Umeå
Mark		Karlshamn	Ängelholm	Köpings			Härnösand	Vemdalen
Marstrand		Karlskrona		Lidköping			Idre	Väja
Mjölby		Kivik		Linköping			Jukkasjärvi	Vännäs
Munkedal		Klintehamn		Ljugarn			Karlsborg	Ånge
Mölndal		Kosta		Mariestad			Kiruna	Åre
Mölnlycke		Kristianstad		Motala			Krokom	Älvdalen
Nässjö		Landskrona		Norrköping			Langsele	Älvsbyn
Partille		Listerby		Nyköping			Luleå	Örnsköldsvik
Smögen		Lund		Rimforsa			Malmberget	Östersund
Stenungsund		Malmö		Roma			Malung	

Aggregates		Aggregates		Aggregates		Aggregates	Aggregates	
Total Locations	131	Total Locations	139	Total Locations	129	Total Locations 182	Total Locations	99

ANNEXES

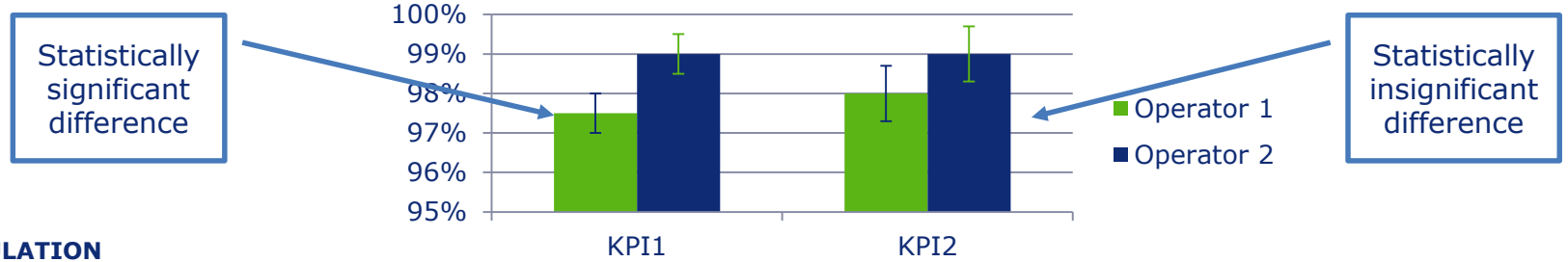
1. result tables
2. measurement location details
3. statistical significance analysis
4. test devices and SIM cards

ANNEX 3 | statistical significance analysis

In order to analyse the **statistical reliability** of the results, Omnitele applies confidence interval analysis on the calculated KPIs. Confidence Interval can be considered as the error margin of the reported results.

The error margins are visible in the error bars of report graphs, see example figure below. In case two operators have differing mean values, but overlapping error bars, the observed difference is not statistically significant. If the error bars don't overlap, the difference is statistically significant.

Omnitele targets to conduct the measurement campaigns so that the confidence intervals allow sufficient accuracy for the conclusions. That is, the error margins are smaller than truly significant QoS differences from end-user point of view. This is achieved by dimensioning the projects with sufficient test sample counts.



CALCULATION

The calculated confidence interval ***CI*** is based on (two-tailed) confidence level of 95%. That is, with 95% probability the true **population mean** is within the **sample mean** +/- ***CI***.

The ***CI*** is calculated as 1.96 x ***SE***, where

- ***SE*** is equal to the standard error for the sample mean, and
- 1.96 is the .975 quantile of the normal distribution (*CL* = 0.95 ⇨ α = 0.05 ⇨ 1- α/2 = 0.975, Norm.Inv[0.975] = 1.96)

Standard Error ***SE*** of the sample mean, is defined as $\boldsymbol{s}/\sqrt{\boldsymbol{n}}$, where

- ***s*** *is the sample standard deviation (i.e., the sample-based estimate of the standard deviation of the population), and*
- ***n*** *is the size (number of observations) of the sample.*

ANNEXES

1. result tables
2. measurement location details
3. statistical significance analysis
4. test devices and SIM cards

ANNEX 4 | test devices and SIM cards

Terminal	Model	Modem Firmware	OS Version	Sourced from
iPhone 5s 32GB Silver/Space Grey	ME435KS/A ME436KS/A	1.03.01	7.0.4 (11B554a)	Apple Store Online

Telenor SIM profile	Telenor Familjeflex 16GB
Telia SIM profile	Telia Mobil Komplett 10GB