Comparing operators

SURVEY OF THE COVERAGE AND DATA SPEEDS PROVIDED BY 3G MOBILE COMMUNICATIONS NETWORKS AVAILABLE IN FINLAND

CONTENTS

SUMMARY

In this survey, the coverage and data speeds of three 3G operators providing services in Finland – DNA, Elisa, and Sonera – were compared. The survey was carried out as a field study in 100 municipalities between the 11th of February and the 13th of April 2010. The municipalities covered account for about 75% of the country's population.

In the present results, it can be seen that Elisa's 3G network has the broadest coverage overall. DNA and Sonera are still pretty even in terms of coverage, although Sonera has improved its results slightly in relative terms. When reception quality was examined on the basis of field strength, it was clear that Elisa's network achieved the highest signal levels. Again in comparison, Sonera and DNA's results are nearly even, although slightly improved performance can be seen with Sonera. Interference levels were also examined, and it was clear that Sonera's network had the lowest interference values. In this comparison, Sonera comes second, followed by DNA in third.

The quality of data services was also compared by downloading files from network terminals and measuring the average data speed achieved on the different networks. DNA's and Elisa's data rates are almost the same, although the DNA data rate is slightly higher than Elisa's. Sonera clearly came in third in the comparison of the data rates.

Voice services were tested by repeatedly making test calls and observing their success in making a connection, and in maintaining it to the end of the call. Elisa's performance was the best in making connections, Sonera was second and DNA was third. The lowest number of dropped calls occurred on Sonera's network. The network with the second lowest number was DNA, and Elisa's network was third.

The number of base station cells was once again compared. A large number of cells generally means a broad coverage and a dense network. Elisa's network has the highest number of base station cells in this comparison, while Sonera comes in second and DNA third.

The survey included Finland's 50 most populous municipalities. Other municipalities were selected from among those municipalities ranked between 51 and 100 (25 municipalities) and those ranked 101 or below (25 municipalities). During the field study, the reception in each municipality was examined by carrying out measurements in town centres and in residential and industrial zones. The limits of the coverage were determined by driving on the main roads leading away from the municipality until no signal was received. Of the 16,160 kilometres covered during the survey, 13,507 kilometres were measuring routes.

The measurements were analysed using eEPOS® software developed by ECE Ltd.

General

This report presents the results of the most recent survey in which the coverage, call success rates, and data speeds of the 3G networks of three Finnish mobile communications operators were examined. The project involved a field study in which measurements were carried out in 100 municipalities across Finland. The project was conducted between the 11th of February and the 13th of April 2011. The three previous surveys were carried out in the spring and autumn of 2008, the spring of 2009, and the spring and autumn of 2010.

Objective

The aim of the survey was to determine the regional coverage and reception quality (signal strength and interference level) of 3G networks operational in Finland. Regional coverage was determined on the basis of measurements taken on transport routes, which does not necessarily give an accurate picture of the coverage area or of indoor reception. However, as a substantial number of municipalities and routes were included, the results can be expected to give a reliable overall picture of the coverage of the 3G networks. The principles of analysis used in the study are described later on in the results section. The objective was to form an assessment of the differences between the operators in the availability of voice and data services.

The aim was also to determine the maximum data speeds currently provided by the operators' 3G networks. This was examined by measuring the amount of data transferred per time unit. The measurement involved 100 municipalities, providing a reliable overall picture of the networks' current data speeds.

The coverage measurements were carried out by setting the measuring device units to idle mode. They were turned on, but were not used for producing voice or data connections during the measurements. The data speed measurements were carried out by continuously downloading a data file of 1GB from the network to the measuring unit (in the downlink direction). SIM cards with unlimited data speeds were used for the measurements. This was to ensure that data transfers could be carried out using the speed available in the network, without the maximum data speed of the SIM card limiting the transfer speed. This method was used in order to simulate the situation in which consumers use the networks. In addition, 90-second test calls were made repeatedly for the duration of the measurement period. This was to verify voice service quality.

The coverage survey was commissioned by Elisa and carried out by European Communications Engineering (ECE Ltd), an independent Finnish expert service company in the field of radio network design, training and development. For more information, please contact:
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Municipalities included

The measurements were carried out in 100 municipalities altogether, and in each of them, the following areas were covered:

- Central area: main streets
- Areas surrounding the central area and other important areas
- Main routes leading to the municipality

The team carrying out the measurements was not familiar with the structure of the operators' networks, and the measuring routes were chosen at random so that they covered large tracts of the areas in question. The survey covered a total of 16,160 kilometres, of which 13,507 km were measuring routes. The picture below shows a typical measuring route (Figure 1).

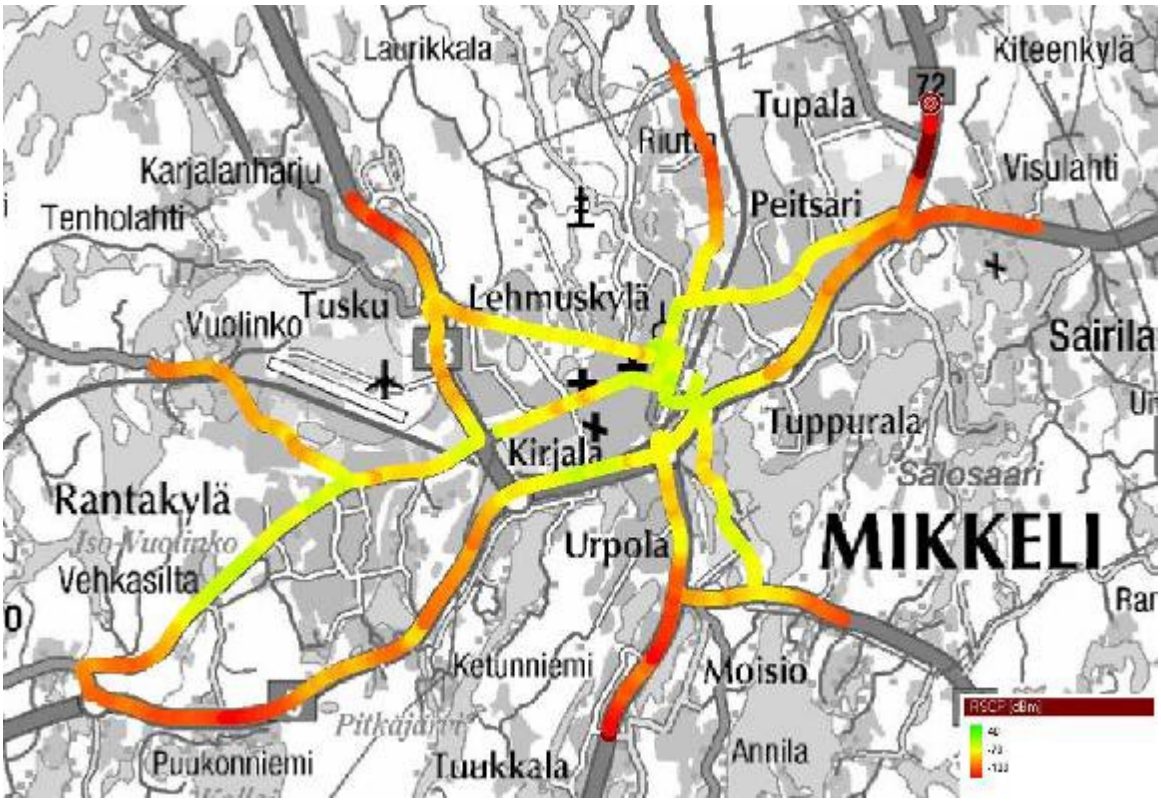

Figure 1. An image illustrating a measurement carried out during the field survey

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ECE selected the municipalities for the survey as follows:
- The 50 most populous municipalities
- 25 municipalities selected at random among those ranked 51-100
- 25 municipalities selected at random among those ranked 101 or below
- Balance of the geographical location was taken into account during the selection

The municipalities selected for the survey which are listed below account for about 75% of Finland's population.

Finland's 50 largest municipalities, in alphabetical order:

Espoo	Kajaani	Nokia	Savonlinna
Hamina	Kangasala	Nurmijärvi	Seinäjoki
Helsinki	Kemi	Oulu	Tampere
Hollola	Kerava	Pori	Tornio
Hyvinkää	Kirkkonummi	Porvoo	Turku
Hämeenlinna	Kokkola	Raahe	Tuusula
Iisalmi	Kotka	Raasepori	Vaasa
Imatra	Kouvola	Raisio	Vantaa
Jämsä	Kuopio	Rauma	Varkaus
Järvenpää	Lahti	Riihimäki	Vihti
Joensuu	Lappeenranta	Rovaniemi	Ylöjärvi
Jyväskylä	Lohja	Salo	
Kaarina	Mikkeli	Sastamala	

The 25 municipalities selected among those ranked 51-100 largest, in alphabetical order:

Akaa	Kontiolahti	Mustasaari	Sipoo
Eura	Kuusamo	Mänttä-Vilppula	Ulvila
Haukipudas	Laukaa	Nastola	Valkeakoski
Huittinen	Leppävirta	Paimio	Ylivieska
Hämeenkyrö	Lieksa	Pedersören	
Ilmajoki	Lieto	Pirkkala	
Kauhava	Länsi-Turunmaa	Saarijärvi	

The 25 municipalities selected among those ranked 101 and below, in alphabetical order:

Alajärvi	Juva	Nurmes	Sodankylä
Enontekiö	Karstula	Padasjoki	Säkylä
Hartola	Kemijärvi	Pello	Töysä
Ikaalinen	Kitee	Pukkila	Utajärvi
Inkoo	Kittilä	Rautavaara	
Jalasjärvi	Kokemäki	Ruovesi	
Jokioinen	Kristiinankaupunki	Savitaipale	

The location of the municipalities is shown in the map below (Figure 2).

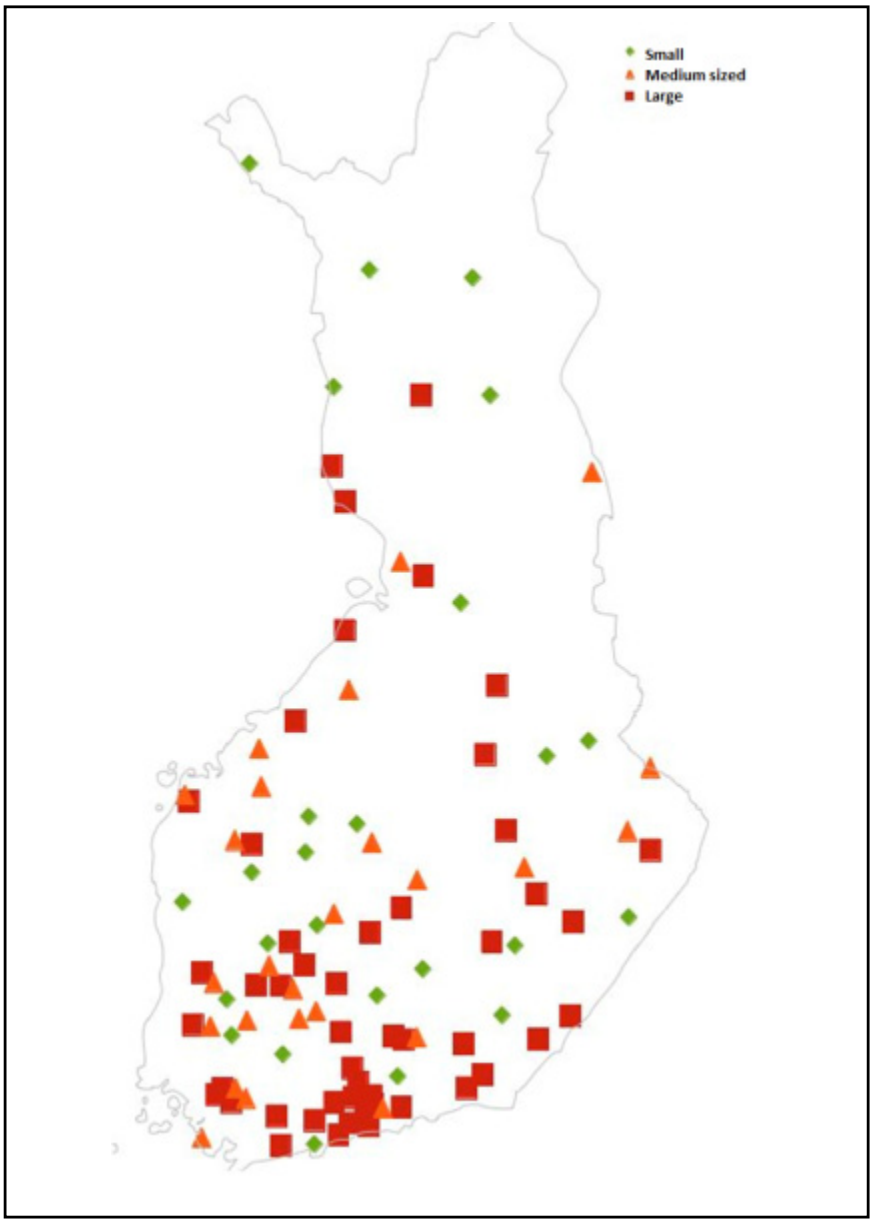


Figure 2. The municipalities included in the survey

Parameters measured and the system used

Parameters measured

The measurements were carried out using nine measuring units installed in the measuring vehicle. Three of the devices measured the network of one operator. One terminal measured reception, one terminal ran file downloads to measure the data rate, and one terminal made repeated test phone calls.

In reception measurements, the units were locked so that they were only able to measure UMTS at frequencies of 900 and 2,100 MHz. The parameters examined in reception were signal strength and interference levels, and were determined relative to the location. Signal strength is commonly described using the unit dBm *, which has a negative value. The higher the value, the stronger the signal. In mobile communications networks, the range is typically between -60 and -100 dBm.

The quality of reception can be determined by measuring the interference level. A situation may arise in which both the signal strength and the interference level are high, which can have a substantial negative impact on the service available to the user. The interference level is measured using the parameter dB *, which has a negative value. The higher the value, the lower the interference. The range is typically between -15 and -2 dB, and levels of -10 dB and higher can be considered good.

The measuring of data speeds helps to verify the quality of services, such as email and the Internet. The higher speed then the faster data, such as e-mail attachments, can be received by the terminal device. Data speeds were measured using Mbps (or Mbit/s = Megabits per second**), which gives the amount of data transferred in bits per second. There can be substantial fluctuations in transfer speeds during the connection. Operators offer consumers connections with different speeds, which means that users can select the maximum speed they want. Also, the data terminal devices measured data speeds at UMTS 900 or 2100 MHz frequencies.

Test phone calls were carried out to determine the quality of the voice service. The terminal equipment was set to make 90-second calls repeatedly throughout the measurement period on either GSM or UMTS networks. This produced results showing how often calls are dropped on each network.

The number of base station cells in each network was also determined. This is indicative of the network structure: a high number of cells usually means a dense or extensive network. Generally speaking, the quality and coverage of the network can be improved by increasing the number of cells.

* = Decibel is a unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale. The unit ‘dBm’ refers to the relationship between the decibel level and milliwatts. Examples:

dBm	W	dBm	W	dBm	W
-10	0.0001	-30	0.000001	-50	0 00000001
-20	0 00001	-40	0 0000001	-60	0 000000001

** = M = Mega = 1024 k = 1048576

Measuring system

The Nemo Outdoor system was used as the measuring system. It consisted of the following components:

- Measuring software: Nemo Outdoor v.5.60.6
- Measuring unit/device: Nokia 6121 (3 pieces)
- Data speed measurement: Sierra Wireless 309/310U (3 pieces)
- Test calls: Nokia N95 (3 pieces)
- GPS receiver: RoyalTek RGM-3600 /LP
- Personal computer: Dell D630 (2 pieces)

Comparison principle

The results were compared on a municipality basis so that each measured area was divided into a grid (120 by 120 metres) using GPS coordinates. Each measured sample was then placed on the grid using the coordinates. Thus it can be determined that, based on the samples, the operator that had the highest number of squares in a particular municipality provides the broadest coverage. The principle is illustrated below (Figure 3).

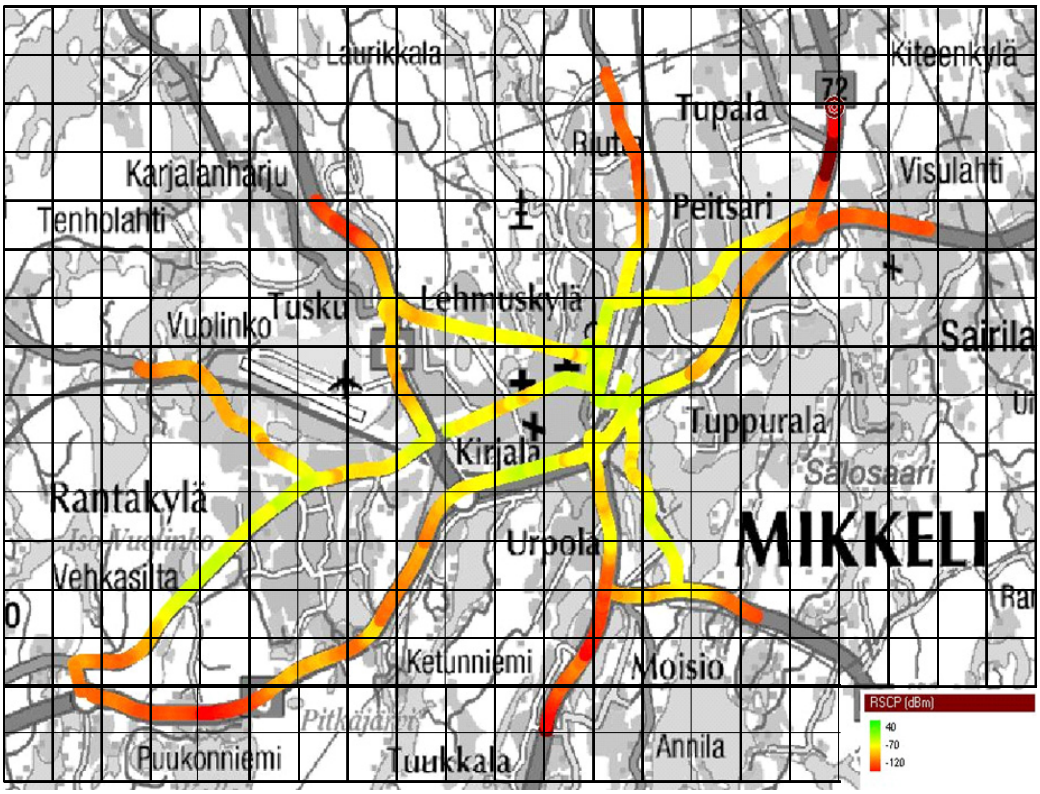


Figure 3. The principle used for analysing the coverage

When the reception quality was compared, the signal strength in each square was analysed. The division of samples into different signal strength categories shows the quality of reception: samples with high values also indicate better reception. The network interference level was also determined using the same method. In this case, high values mean less interference.

In the analysis of the data rates all samples along the measuring route were taken into account, including samples with a data transfer speed of zero.

Call success was determined through success in establishing and maintaining a connection.

Results

The results of the measurements are presented below.

Coverage

The extent of the coverage was examined by calculating the number of geographical locations (squares) in which the operators' 3G signal (pilot signal or RSCP) was above a predetermined threshold value. As the number of squares for each operator was determined on the basis of the threshold value used, the analysis was carried out using a number of different threshold values. In Figure 4 below, pilot signal values between -100 dBm and -60 dBm are used as threshold values. The number of squares in which the operator's signal was higher than the threshold value is shown as a curve. The size of the squares since the previous study has changed to 120 m by 120 m compared previously to 100 m by 100 m. The results sum up the measurements carried out in 100 municipalities.

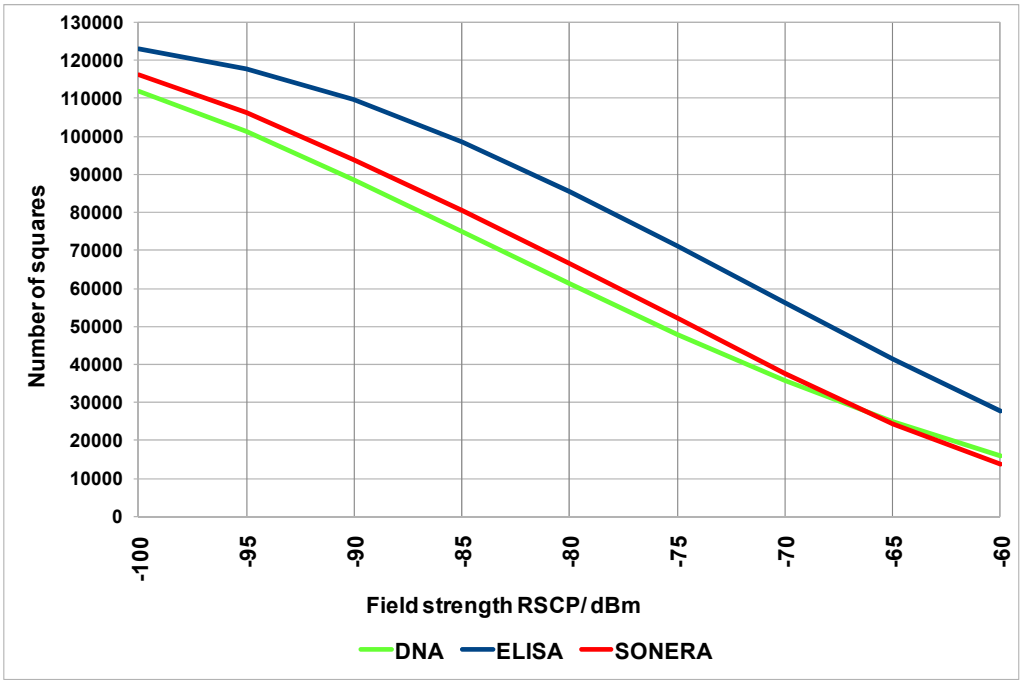


Figure 4. The number of squares at different threshold values.

In Figure 4 above, all the squares in which at least one operator provided coverage have been shown in the graph. In comparison to previous research results, it can be seen that all the operators have increased their coverage territory.

Elisa's 3G coverage is still clearly the largest at all signal levels, though Sonera and DNA seem to have gained a little on Elisa. DNA's and Sonera's coverage seems to be somewhat less extensive, although Sonera has slightly improved compared to DNA since the previous investigation.

Assuming that indoor 3G voice services can be provided at a pilot signal level of -95 dBm and indoor data services (for example, 1 Mbps) at a pilot signal level of -75 dBm, the coverage of these services can be described as shown below (Figure 5).

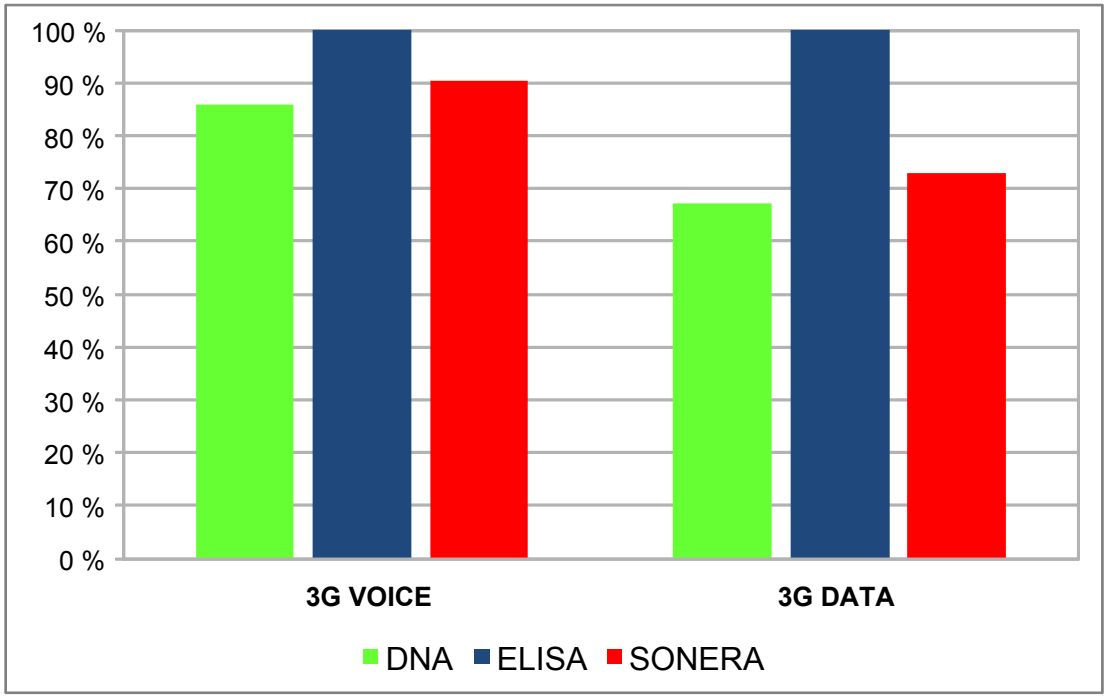


Figure 5. The relative number of squares covered – 3G voice and high-speed 3G data (The number of squares of the operator with the highest value equals 100 per cent).

The number of squares for each operator has been adjusted so that for the operator with the highest value, the total equals 100 per cent. Based on the survey, Elisa has achieved the best results for 3G voice service at the assumed signal rate. This is followed by DNA and Sonera at about equal levels. The results are similar for 3G data coverage, with Elisa ahead of DNA and Sonera, who are fairly even on this basis. Compared with the results of the previous survey, DNA and Sonera have slightly improved their results in relation to Elisa, and Sonera seems to have improved in relation to DNA.

Signal strength

In addition to coverage, the quality of reception was also studied. Operators may have different network-building strategies. For example, one operator may aim to construct an extremely broad but thin coverage, which may mean weak reception indoors. Another operator may have a geographically more limited network that nevertheless provides superior indoor reception and fast data links.

The 3G signal strength was examined in geographical locations in which all three operators have coverage. Geographical areas were again defined as squares.

Figure 6 shows the relative breakdown of signal strength for the shared 3G coverage areas cumulatively.

The probability (horizontal axis) of reaching a different signal level (vertical axis) in the operators' 3G networks can be determined using the graph. Elisa's results clearly stand out, showing that it is more likely to reach a certain signal level than the other operators. Sonera's and DNA's resulting curves are very close to each other and partially overlapping. Differences in signal strength can be detected at –5 to –65 dBm signal strength, where the DNA results are slightly better. To demonstrate Elisa's position in this respect, we can see that Elisa's signal strength is better than –70 dBm in 45% of the shared coverage area. The corresponding figure for DNA and Sonera is 30%.

Compared with the previous survey, the gap between Elisa and the two other operators has remained about the same. The gap between Sonera and DNA is small, but perhaps Sonera has improved its result slightly compared to DNA.

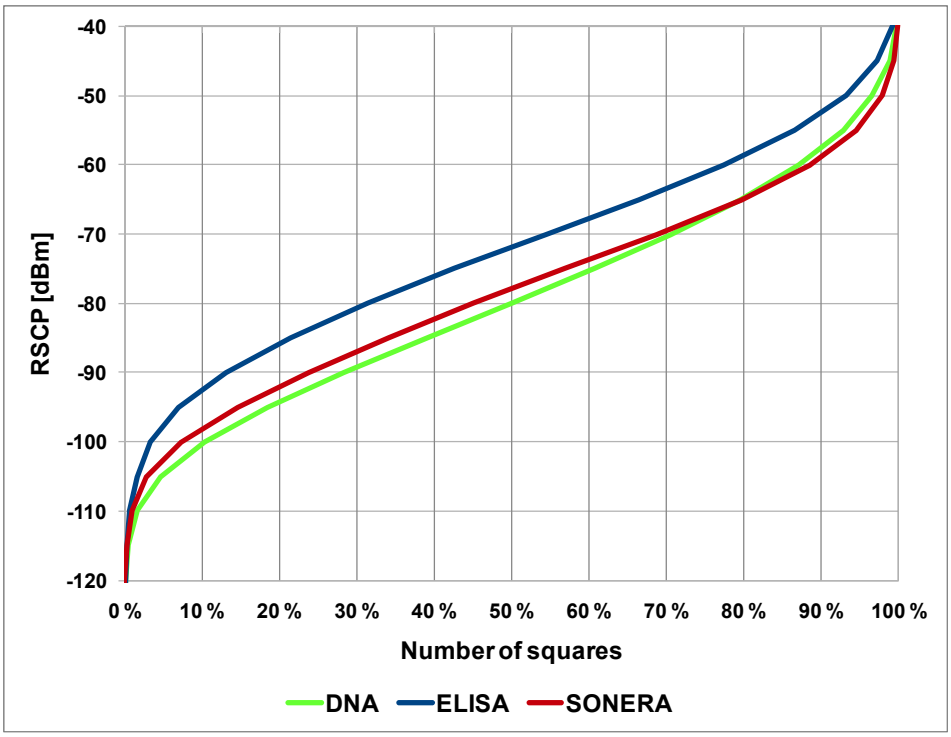


Figure 6. 3G coverage in the shared coverage areas

Signal to noise ratio

Figure 7 shows the distribution of the signal-to-noise ratio of the 3G networks in areas in which at least one operator has 3G coverage (on the basis of reception measurements). The graph shows the proportion of squares in which the measured signal-to-noise ratio exceeds the threshold value.

Examination of a typical range from -10 dB to -2 dB reveals that Sonera's network has the lowest level of interference from -9 dB to -2 dB and Elisa's network has values below -10 dB. In this survey, DNA comes in third.

The impact that interference has on service quality is usually case-specific. A data connection usually becomes significantly slower at EcNo values of about -8 dB and below. Voice connections usually become weaker and interruptions start occurring if the EcNo value drops below -14 dB.

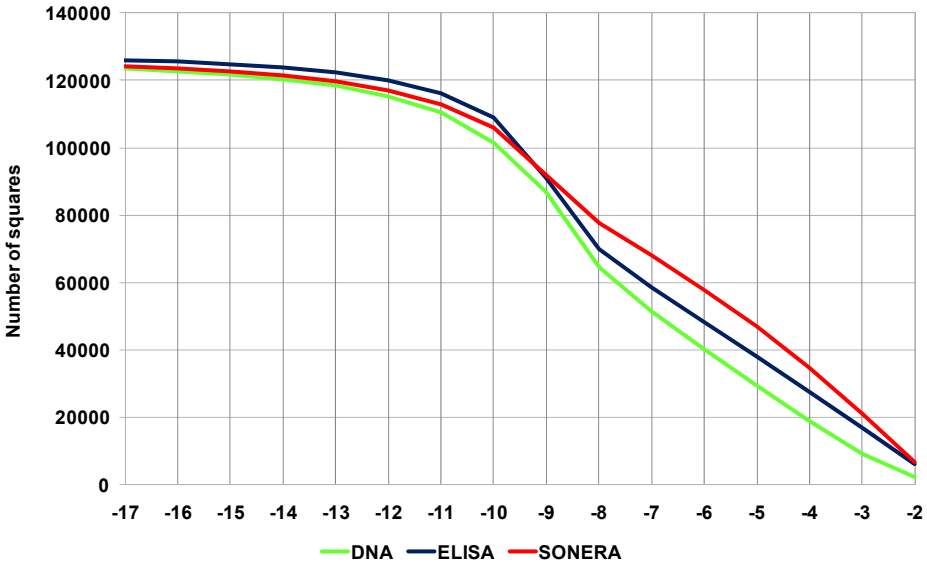


Figure 7. Cumulative EcNo distribution in areas in which at least one operator has 3G coverage.

Data speed

The analysis of the survey also results indicates the average data speed of each of the operators' networks. In this respect DNA's and Elisa's results are almost the same with DNA achieving the highest result, followed by Elisa in second place and thirdly Sonera (Figure 8). Sonera's result is clearly below that of DNA's and Elisa's.

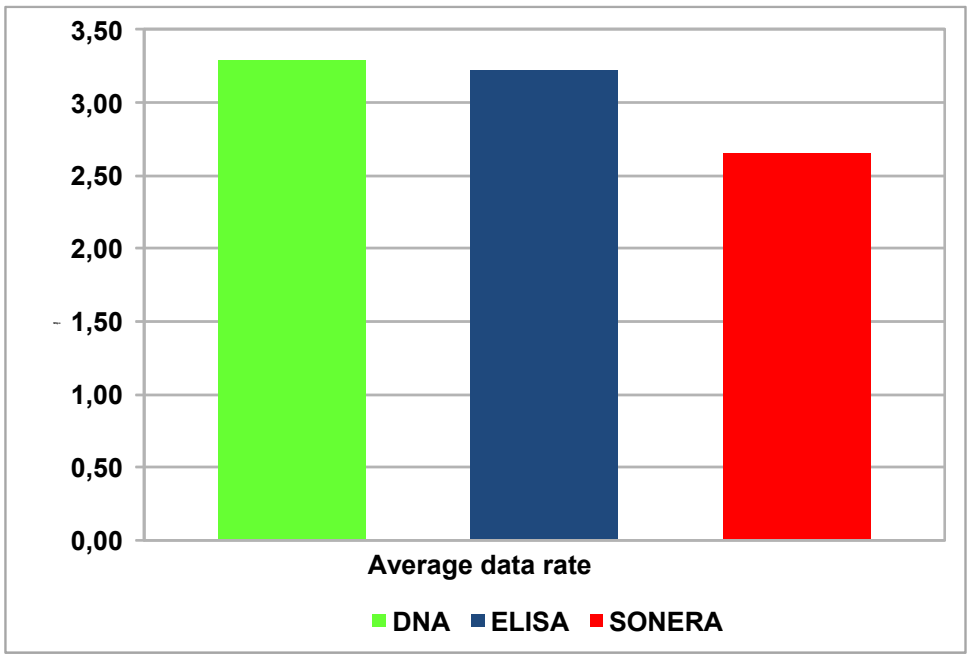


Figure 8. Operators' average data speeds

Figure 9 shows the cumulative geographical extent of the data-speed categories when at least one operator has coverage. The analysis determined how many kilometres each data rate class accumulated measurements for. The graph shows that the results for DNA and Elisa are very equal, with Sonera slightly behind.

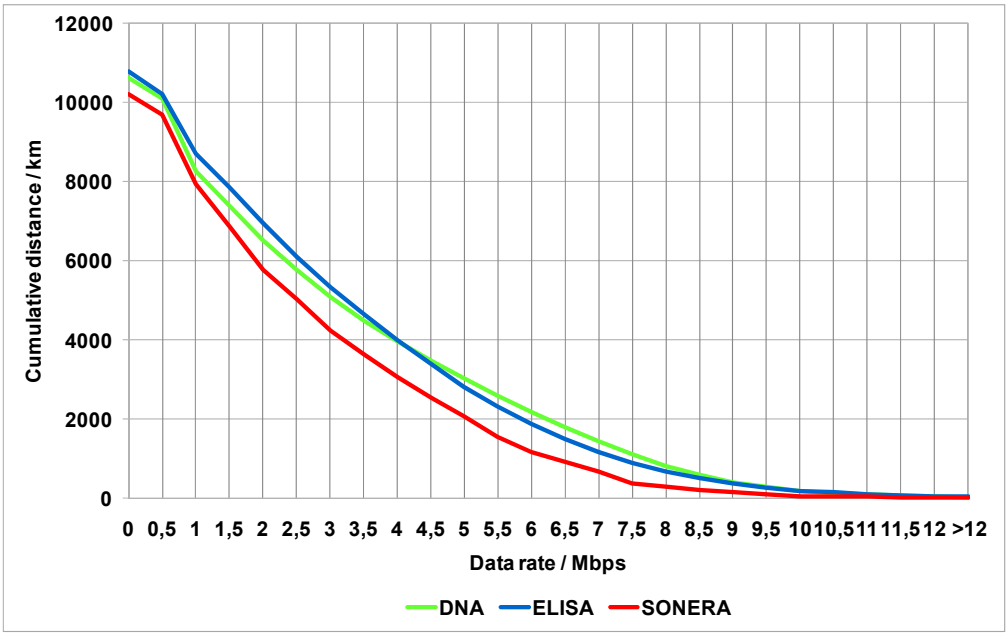


Figure 9. Cumulative data speeds in different operators' networks.

Voice service

The quality of the operators' voice service was verified by repeatedly making calls of 90-seconds duration. Throughout the test time, over 6,000 test calls were made for each of the networks. The tests showed how many call attempts failed, i.e., failed to establish any connection at all. It was also determined how many calls were disconnected after successfully establishing a connection.

Figure 10 indicates the probability of an unsuccessful call attempt. In relative terms, Elisa's network suffered the least number of failed call attempts. The network with the second lowest number of failed calls was Sonera, followed by DNA .

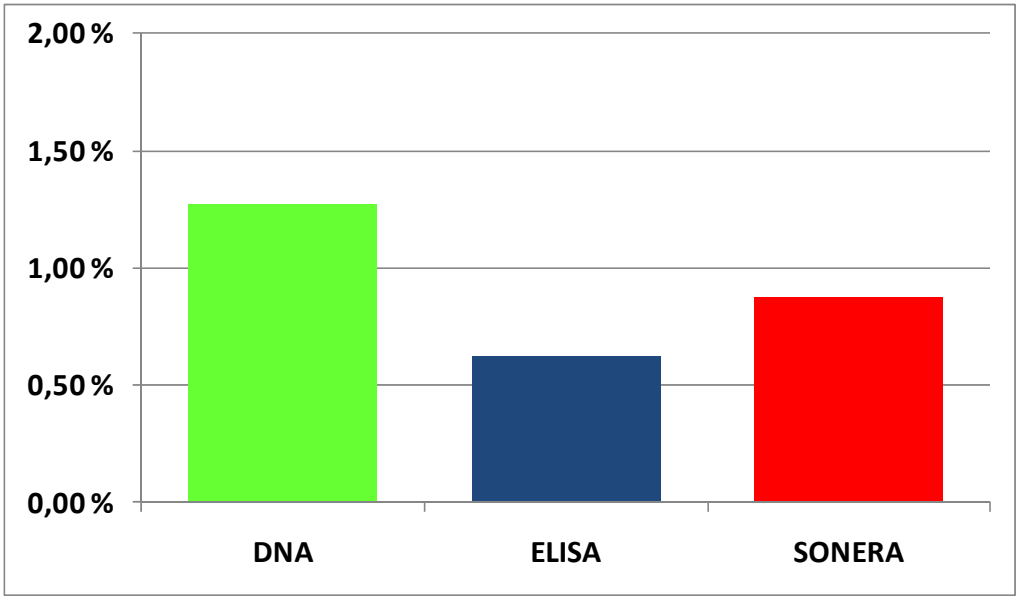


Figure 10. The graph indicates the probability of an unsuccessful call attempt.

From Figure 11, we can see that Sonera's network suffered the least number of dropped calls. The network with the second lowest number of dropped calls was DNA, followed by Elisa.

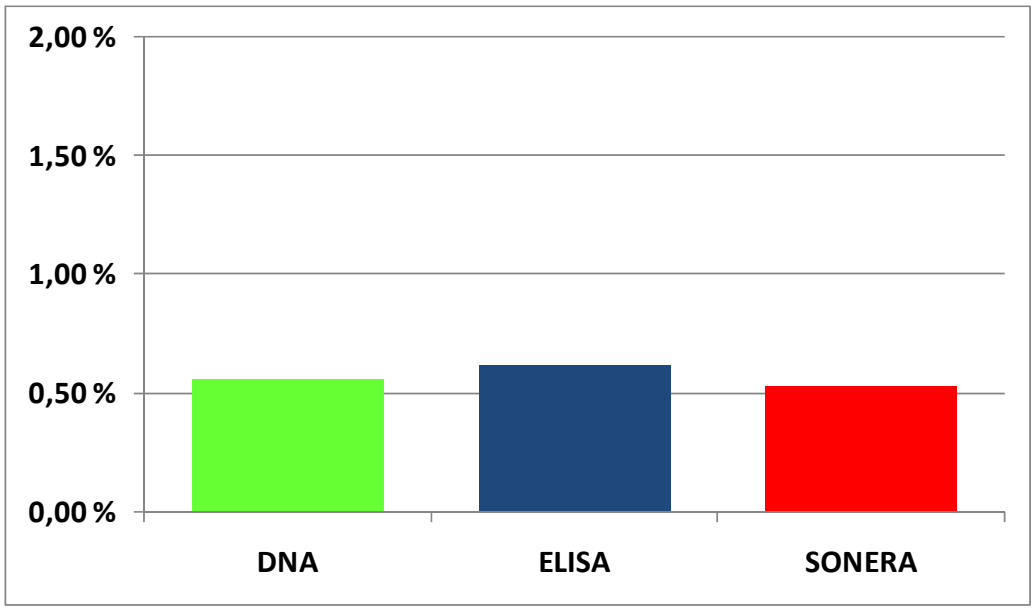
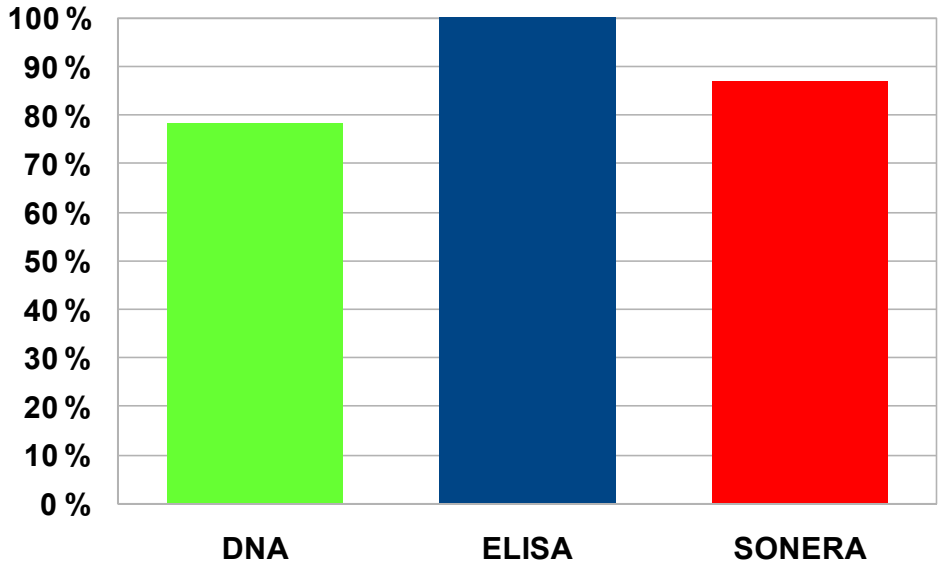


Figure 11. The graph indicates the probability of dropped calls.

All in all, the differences are fairly small, both in the number of unsuccessful call attempts and dropped calls.

Number of cells

In addition to coverage and data speeds, the number of base station cells observed was also examined as part of the survey. The number of cells is usually a good indication of the coverage of mobile phone networks.



(Figure 12). The number of 3G cells observed during the measurements. (The number of cells for the operator with the highest value equals 100%.)

The examination of the numbers of 3G cells shows that Elisa still seems to have the largest number of cells. The difference may have narrowed slightly compared to Sonera in second place, and remained more or less the same in relation to DNA in third position when results are compared with the previous survey.

Conclusions

The survey on network coverage, involving 100 municipalities and carried out from February to April 2011, shows that there are still differences between mobile communications operators providing 3G services in Finland.

Earlier surveys were conducted in 2008, 2009, and 2010, during the spring and/or autumn. The results show that the operators are continually developing their networks. In this survey, Elisa remains clearly ahead of DNA and Sonera in terms of the extent and quality of the coverage (signal strength). Sonera has slightly improved its result compared to DNA's result, clearly improving since the autumn 2010 survey. In the analysis of interference in the network, Sonera achieved the lowest levels of interference. Elisa came in second in this respect and DNA came in third.

In respect to data speed measurements, the results indicate that DNA's and Elisa's networks achieved approximately the same data rates. The difference between DNA and Elisa is very small in this regard, but with Sonera, the difference is clearly visible.

The quality of voice services was studied by determining the number of failed call attempts and the number of dropped calls. Elisa's network achieved the lowest number of unsuccessful call attempts, while Sonera came second and DNA third. Sonera had in turn the lowest number of dropped calls with DNA's result in second and Elisa's in third place.

Elisa also has more base station cells than its competitors, and in this comparison, Sonera comes in second, followed by DNA in third.