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Mobile Matters

Using crowdsourced data to assess people's experience of using mobile networks

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Overview

Smartphones and mobile connectivity are an essential part of daily life for millions of people across the UK. To better understand how people are using mobile services, and the experience they receive, Ofcom has analysed crowdsourced data collected between January and March 2021 from around 280,000 Android devices across the UK.

In this report, we focus on the share of connections across wireless network technologies (2G, 3G, 4G, 5G, wi-fi), the success rate for mobile connections, the response times for different mobile technologies and how people in the panel use voice and data services. We also look at how these vary by network operator and location.

For a more detailed description of the data collection and analysis, please see Annex 1: Technical Methodology and Annex 2: Statistical Methodology.

What we have found

Seventy-three per cent of data connections were made over wi-fi rather than a cellular network, with no significant differences by rurality or nation. This was up 8 percentage points from last year's pre-lockdown levels and in line with the April 2020 figures, probably due to the continued Covid-19 restrictions in the first three months of the year.

As seen in previous reports, people using the Three network had a higher proportion of tests connecting to the mobile network rather than to wi-fi (33% mobile vs 67% wi-fi), while the proportion was lower for people using the O2 network (24% mobile vs 76% wi-fi).

When not connected to wi-fi, 82% of data connections were made on a 4G network, with the remaining 17% of data connections made on 3G networks.

We saw a seven-fold increase in the number of panellists reporting a 5G connection, from around 270 in the first four months of 2020 to just under two thousand people in the first three months of 2021 (0.7% of the total number of panellists). On average, 8% of 5G users' mobile data connections were made over 5G networks and 86% were made over 4G networks; this was higher than the UK average of 82% 4G connections. 5G users also had a much lower proportion of 3G connections than the average (5% vs 17%).

By analysing the success rate for connections while the phone screen was on, we can assess how well the demand for connectivity was met. Our analysis found that people were able to connect successfully to a 4G network on 95.6% of occasions when they were actively using their phone. Connection test success rates were slightly lower for 3G connections (93.2%) and 5G network connections (92.7%).

This year we had access to a new dataset looking at the performance of mobile networks in relation to video streaming. EE had the highest combined proportion of 4G records that were rated as either 'good' or 'excellent' (81%) for video streaming, and the highest proportion classed as 'excellent' (10%). There were no statistically significant differences in the 4G video experience for O2, Three or Vodafone customers, with all three operators having between 70% and 73% of records classed as 'good' or 'excellent'.

Most of the smartphone users in the 2021 panel (57%) were light data users, downloading less than 500MB of mobile data per month, while around a third of panellists (30%) used between 500MB and 2.5GB per month. Voice call durations returned to 2020 pre-lockdown lengths, lasting on average 3 minutes 40 seconds.

Notes on the data included in this report

This research is part of a wider programme of work by Ofcom to research and provide information about mobile quality of service. The data in this report relate to performance when network coverage is available from an operator. For information on coverage of the UK's four mobile networks please see Ofcom's broadband and mobile checker.

The network share and data connection success-rate figures in this report are based on background tests run every 15 minutes. These connection tests are run on the data network technology available to the device at the time and are recorded as either successful or unsuccessful. As we do not know whether the unsuccessful tests would have succeeded on an alternative data network technology, these metrics cannot be viewed as a measure of overall network coverage.

The analysis in this report is conducted at the wholesale mobile network operator (MNO) level, with the exception of the video streaming experience analysis, which is at the retail operator level. For all other metrics, references to the performance of the UK's four MNOs (EE, O2, Three and Vodafone) may include the performance experienced by panellists who are customers of mobile virtual network operators (MVNOs) using these networks such as Tesco Mobile, GiffGaff, iD Mobile and Virgin Mobile.

The analysed metrics are only some of the factors that people may wish to consider when making decisions about their mobile service. Price, handset type, quality of customer service, coverage and contract terms are other relevant aspects that should be taken into account.

For a more detailed description of the data collection and analysis, please see Annex 1: Technical Methodology and Annex 2: Statistical Methodology. The interactive data is also available.

Contents

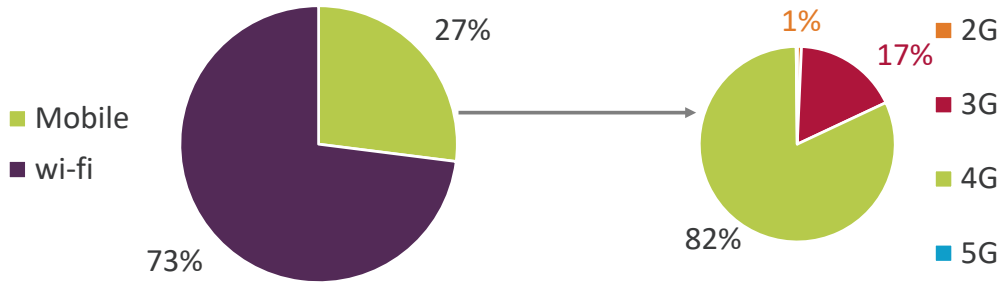
How people are connecting to wireless networks

Network share

Nearly three-quarters of data connections were made over wi-fi rather than a mobile network (2G, 3G, 4G or 5G) during the research period. There was some variation by location, with people in urban areas slightly more likely than those in rural areas to be connected to wi-fi (73% vs 71%). This could be due to several factors, including the greater availability of wi-fi networks in cities and towns areas than in rural areas.

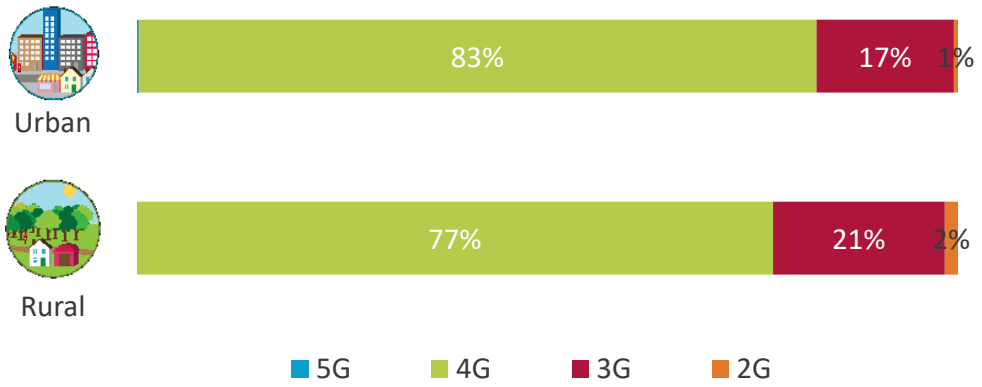
For connections made via mobile networks, on average 82% were to a 4G network, with most of the remaining connections to a 3G network. This varied by location, as seen in figure 2: people in urban areas were more likely than those in rural areas to be connected to 4G, perhaps due to coverage levels and network management choices by the network operators.

Figure 1: Average network share by technology, Jan – March 2021



Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages are rounded to the nearest whole percentage and refer to the percentage of connection tests run every 15 minutes, not data traffic; data refer to period 1 January to 31 March 2021; 5G connections are not shown as the proportions are too low to display.

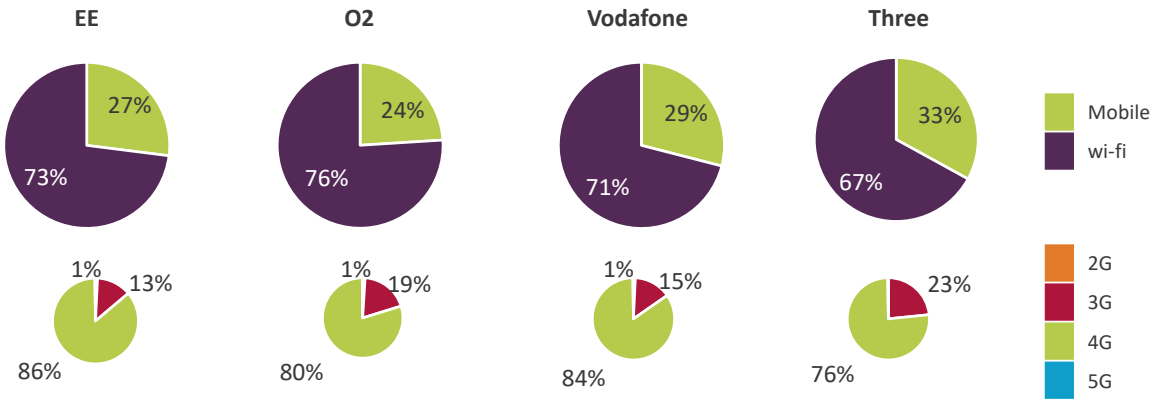
Figure 2: Average mobile network share, by technology and rurality: Jan – March 2021



Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages refer to the percentage of connection tests recorded as being over a mobile network; data refer to 1 January to 31 March 2021; 5G connections are not shown as the proportions are too low to display.

As seen in previous years, people using Three's network continued to spend a larger proportion of time on mobile networks than on w-fi when compared to EE, O2 and Vodafone customers (33% vs 27%, 24% and 29% respectively). Looking at mobile-only connections, people using the EE network spent the highest proportion of time connected to 4G (86%) while people on the Three network spent the highest proportion of time connected to 3G (23%). This is likely to be for two reasons: differing levels of 4G network coverage and varying approaches to network management. It should also be noted that for certain low-demand mobile activities, such as reading an email or browsing the web, a 3G connection can deliver as good an experience as a 4G connection. Operators may choose to revert customers to 3G in areas with a weaker signal or more network congestion, to provide a more reliable connection and to manage capacity.

Figure 3: Average network share, by technology and network operator: Jan – March 2021



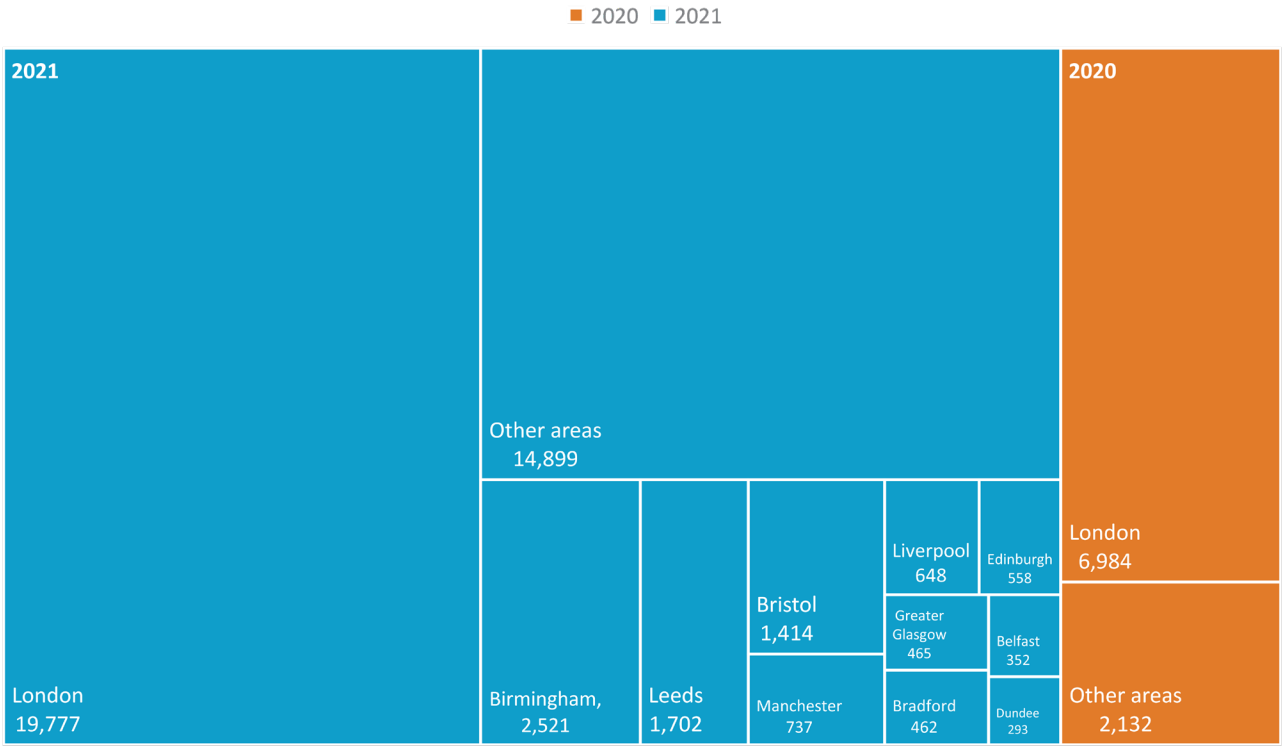
Source: Ofcom analysis of crowdsourced Android data. Notes: The charts show the percentage of connection tests (run every 15 minutes) that connect to different network types, they do not show the share of data traffic; data refer to 1 Jan – 31 March 2021; analysis conducted at the wholesale mobile network provider (MNO) level; 5G connections are not shown as the proportions are too low to display.

Understanding 5G connections

This year we saw an increase in number of panellists reporting 5G data samples, allowing us to look more closely at where these services were being used and how they were performing. From our total panel of c.280,000 Android users, 1,918 (0.7%) reported having at least one 5G mobile connection between January and March 2021[1] - a seven-fold increase compared to our 2020 panel.

In total there were 43.8k 5G connection test records in the 2021 dataset (0.2% of the combined total for 3G, 4G and 5G), 99% of which were in urban areas. Just under half (45%) were recorded in London, compared to two-thirds in 2020, reflecting network operators' strategies of extending their latest technology to more towns and cities across the UK. A full breakdown of these records is available in the interactive report. It is still early days for the development of 5G, but as network operators seek to make use of the new spectrum released earlier this year, and more 5G-capable devices come onto the market, we expect the coverage and take-up of 5G services to grow over the next five to ten years.

Figure 4: Breakdown of 5G records by location

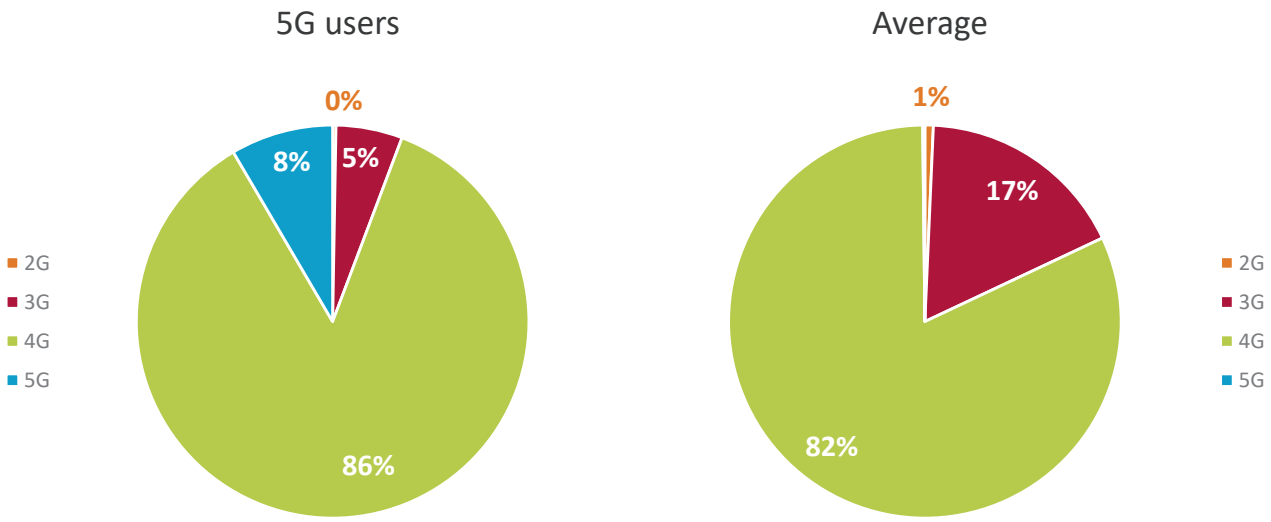


Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021; for the full list of cities and records see our interactive report.

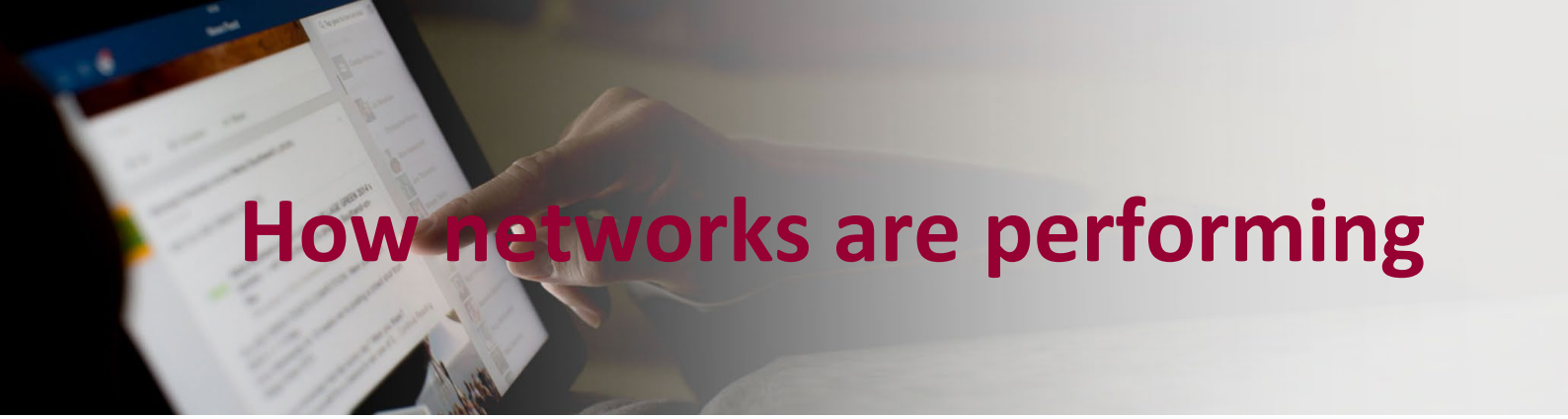
Using the same approach that we use to analyse network share, we looked at the share of mobile data connections for 5G users across mobile technologies. On average, 8% of 5G users' mobile data connections were made over 5G networks and 86% were made over 4G networks, higher than the UK average of 82% of connections. 5G users also had a much lower proportion of 3G connections than the UK average (5% vs 17%).

[1] As recorded by the handset during each fifteen-minute connection test.

Figure 5: Mobile network share for 5G users vs average: Jan – March 2021



Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages refer to the proportion of mobile connection tests run every 15 minutes; data refer to 1 January to 31 March 2021.



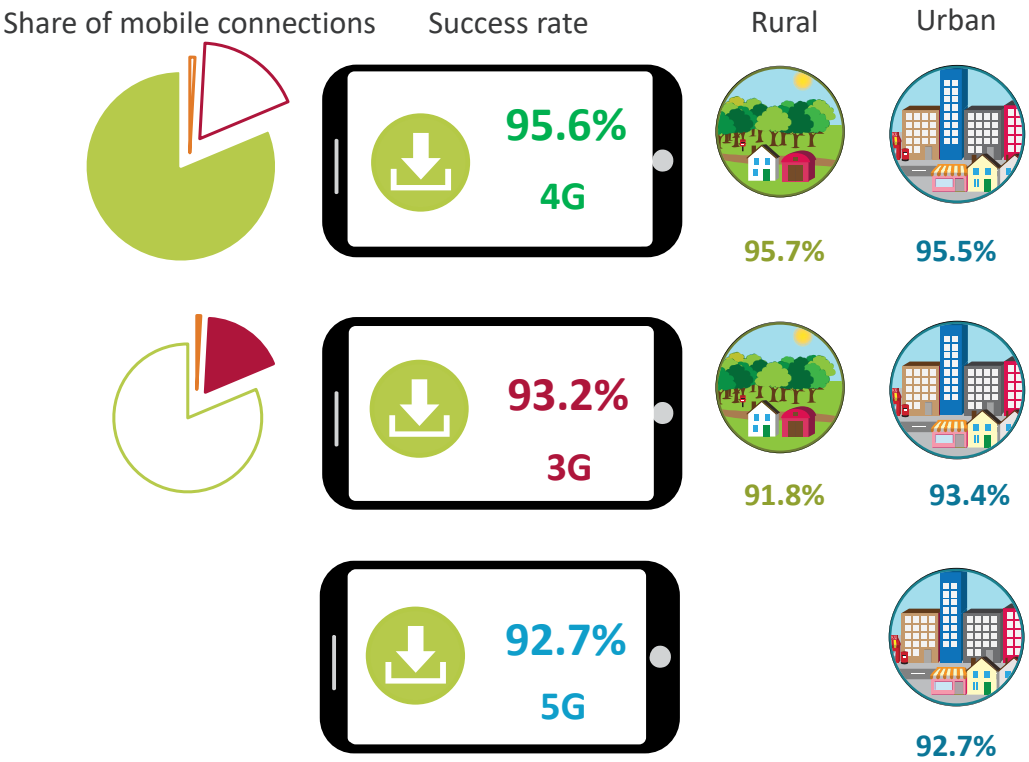
How networks are performing

Reliability of data connections

As mobile phones become increasingly important for everyday tasks like making payments, booking appointments and ordering groceries, people rely on being able to connect to the internet wherever they are. The data revealed how often people could access data services, both when they were actively using their phone and when the screen was off. This is not a measure of mobile coverage, but of how frequently people *could* connect to data services in areas where a network was available.

On average, people could use data services on 4G networks on 95.6% of occasions while the screen was active, with no significant difference by nation or rurality.[2] The success rate was lower on average for 3G connections, which were successful 93.2% of the time, and more successful in urban than rural areas (93.4% vs 91.8%). This may be because 3G connections are more likely to be at the 'edge' of a network, where a 4G network is not available.

Figure 6: Average success rate for 3G, 4G and 5G connections while the screen was active: Jan – March 2021

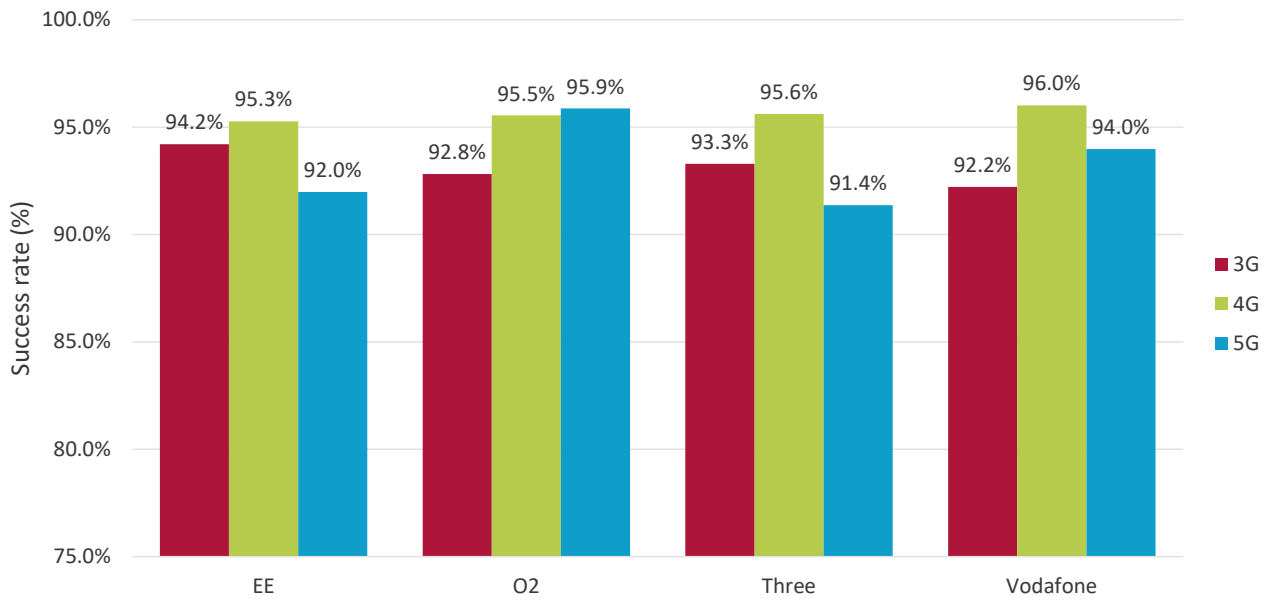


[2] This success rate reflects the reliability of the network in the places that the people in the panel visited or travelled through, not the overall landmass coverage of the network.

Source: Ofcom analysis of crowdsourced Android data. Notes: percentages refer to the percentage of connection tests recorded as successful while the phone's screen was on; data refer to 1 January to 31 March 2021; the sample size for 5G connections is 0.2% of the sample size for 4G (39k vs 25m) so the figure should be taken as indicative only; sample size for 5G rural connections is too low for this analysis.

There were no significant differences in 4G data service availability by mobile network at the UK level. However, 3G connections on the Vodafone network were less likely to succeed than those on EE (92.2% vs 94.2% for Vodafone and EE respectively).

Figure 7: Average success rate for 3G, 4G and 5G connections while the screen was active, by network operator: Jan – March 2021

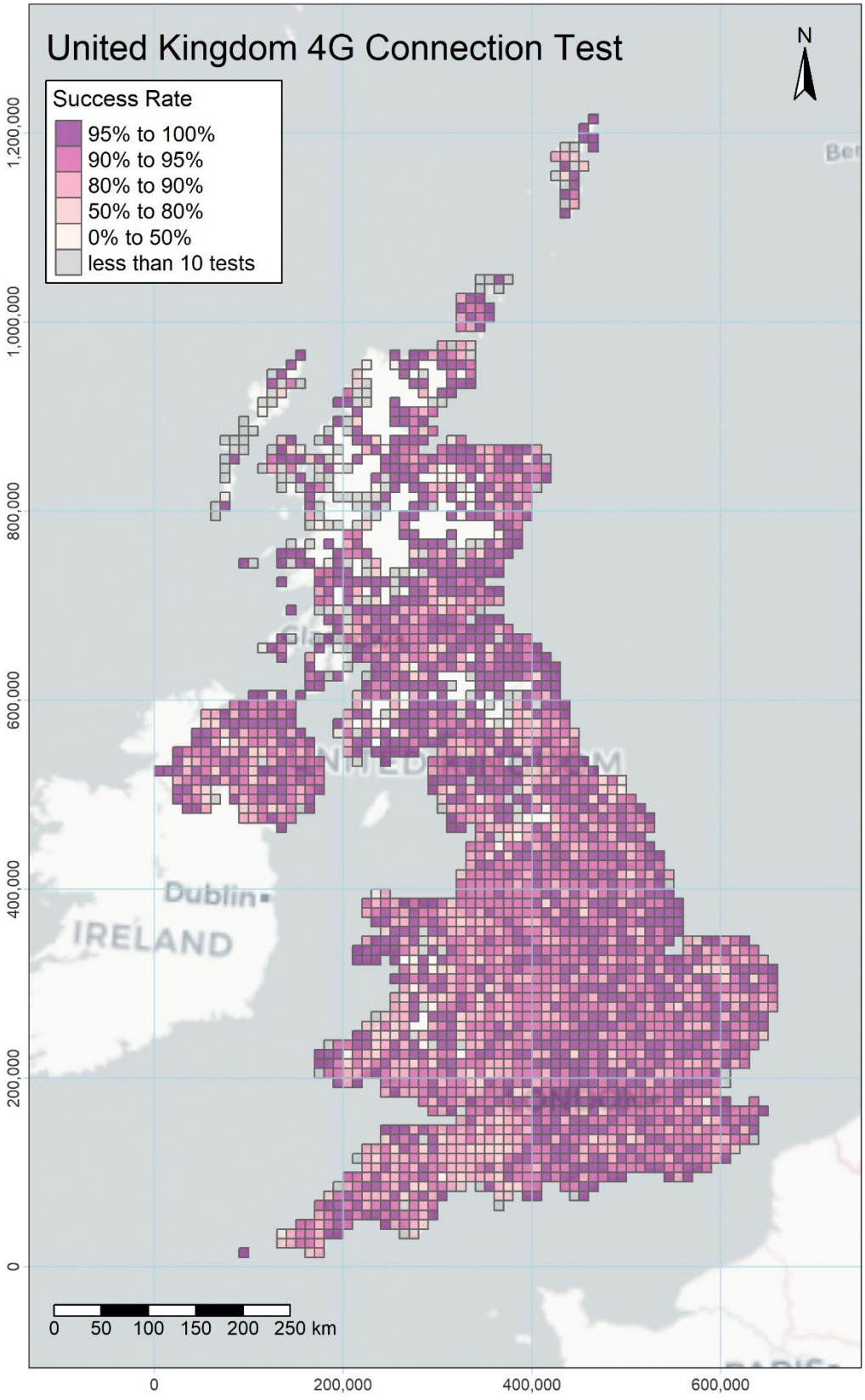


Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages refer to the percentage of connection tests recorded as successful while the phone's screen was on; data refer to 1 January to 31 March 2021; base size for 5G rural tests is too low to show at this level.

To look more closely at variations in 4G performance by location, we divided the UK into 10x10km squares and calculated the average success rate for connections made in each one. The grey squares in the map below had fewer than ten 4G tests and were excluded from the analysis. The blank squares had no recorded 4G connection tests between 1 January and 31 March when the phone screen was on. This might be because there was no coverage, or because nobody on our panel visited that area during the period, which explains why there are more blank and grey squares in sparsely populated and remote locations such as the Cairngorm National Park in Scotland and Snowdon National Park in Wales.

The average success rate for 4G connections was high – over 95% – in several places. But in more densely populated areas, including in and around Manchester, Leeds and London, connections were less reliable and between 10% and 20% of 4G connection tests failed. An interactive version of this map, showing 3G, 4G and 5G connection tests results, is available.

Figure 8: Average success rate for 4G connection tests, UK: Jan – March 2021



Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages refer to the percentage of 4G connection tests recorded as successful while the phone's screen was on; grey areas did not have enough samples to complete the analysis; this map does not depict landmass coverage of 4G networks; data refer to 1 January to 31 March 2021.

We also focused on performance within urban areas at a more granular level, dividing each city into 1x1km squares and repeating the same analysis as above. Interactive versions of these maps are available.

Figure 9: Average success rate for 4G connection tests, Belfast: Jan – March 2021

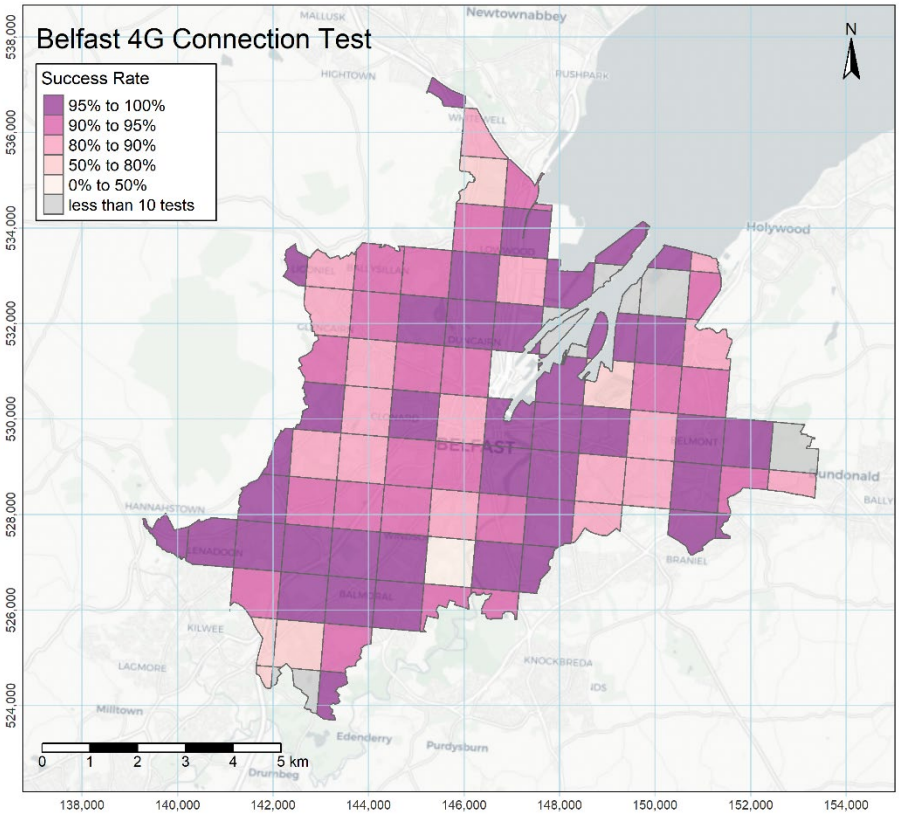


Figure 10: Average success rate for 4G connection tests, Cardiff: Jan – March 2021

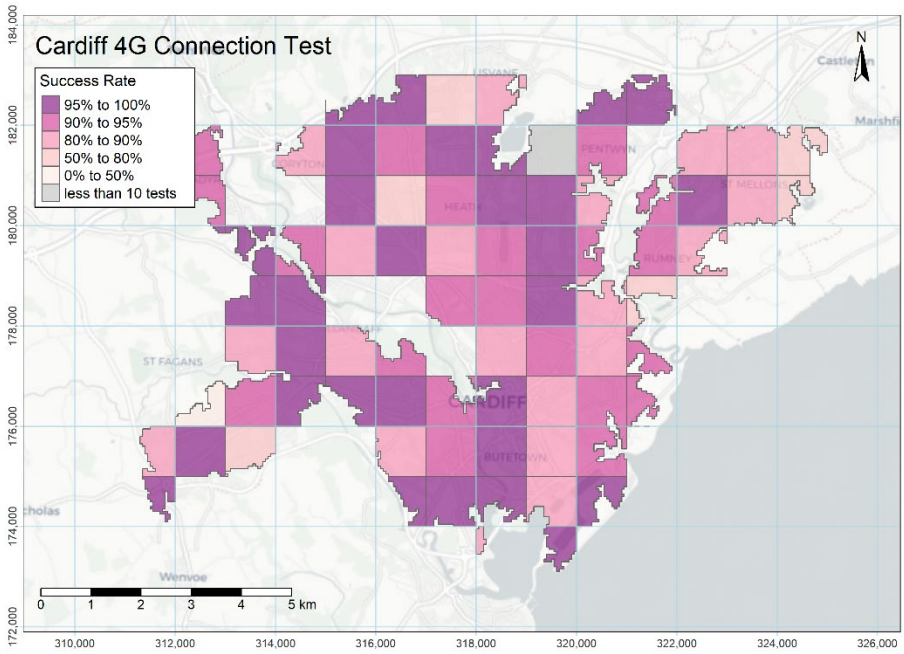


Figure 11: Average success rate for 4G connection tests, Edinburgh: Jan – March 2021

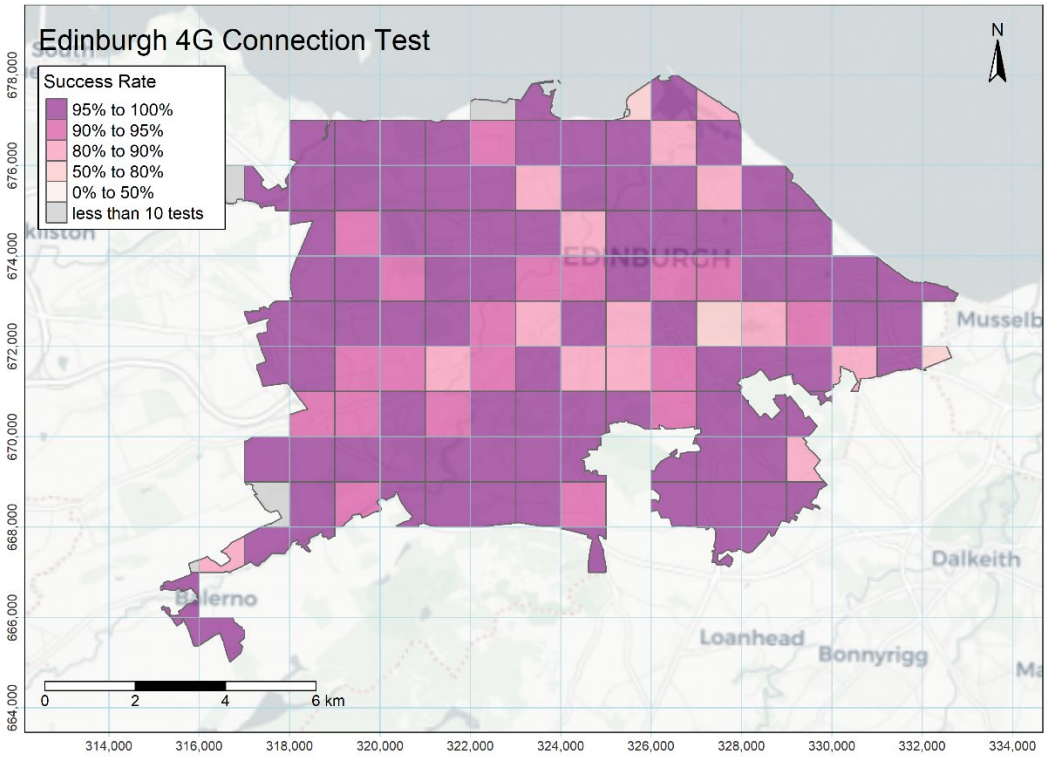
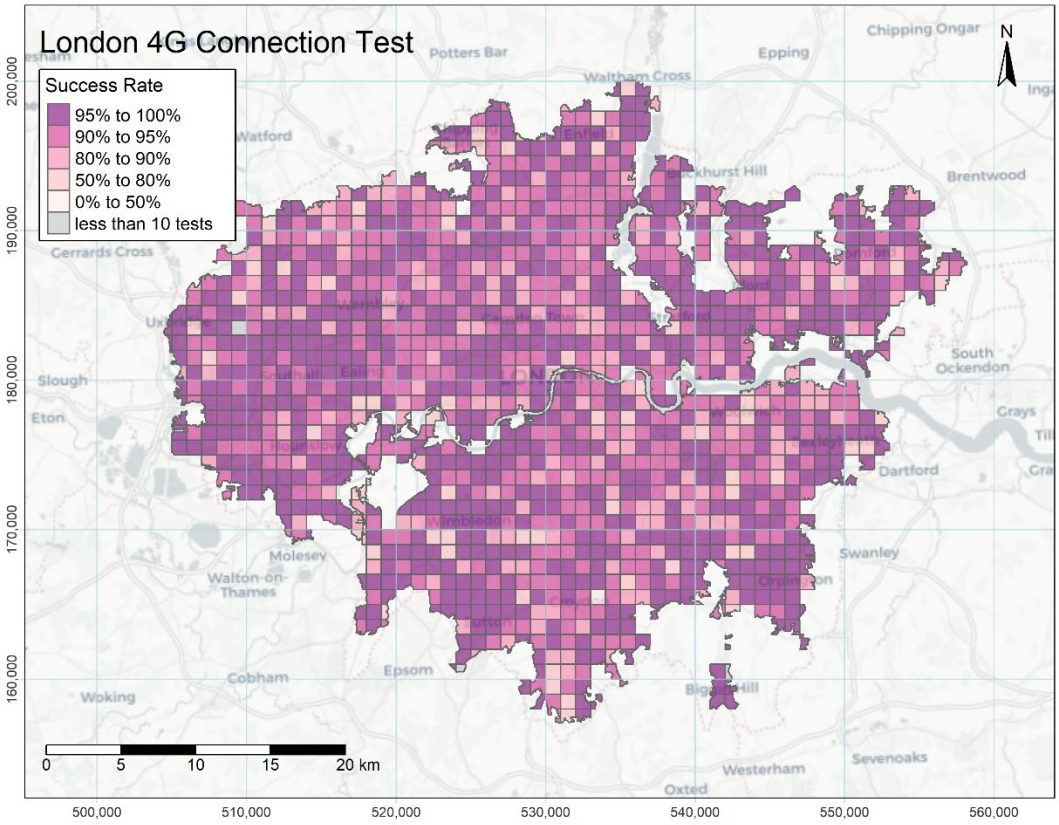


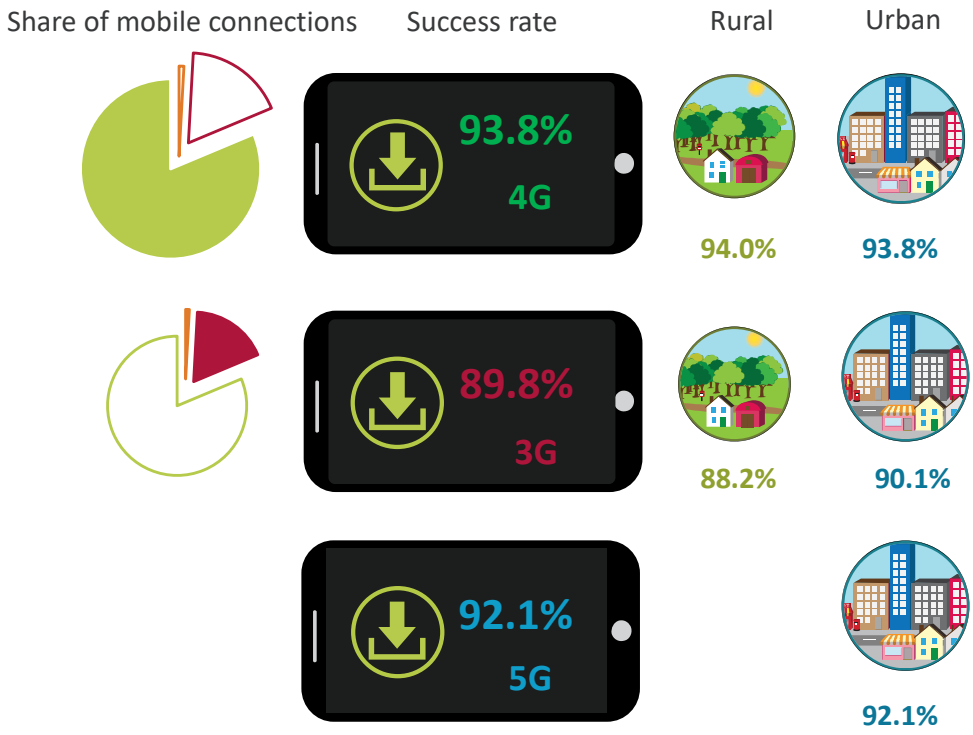
Figure 12: Average success rate for 4G connection tests, London: Jan – March 2021



This year we also looked at the percentage of connection tests that succeeded while the phone screen was off. In this instance people may not be actively using their phone but may still need a reliable data connection, for example to receive emails, notifications or to stream music.

At the UK level, 3G, 4G and 5G connection tests were less likely to succeed while the phone screen was off. This might be because when people were not using their phone, they had it in a place where the reception was poorer, e.g. in a car, back pocket or bag. But it may be that people are adapting their behaviour based on their perceptions of network performance. If someone believes they have a poor data connection, for whatever reason, perhaps because they are in a remote location or on a train, they might not use their phone. To investigate this further we looked again at the difference between urban and rural areas and found that although the average success rates for 3G, 4G and 5G connections were lower when the screen was off than when the screen was on, there was no significant difference between urban and rural areas when the screen was off.

Figure 13: Average success rate for 3G, 4G and 5G connections while the screen was inactive: Jan – March 2021



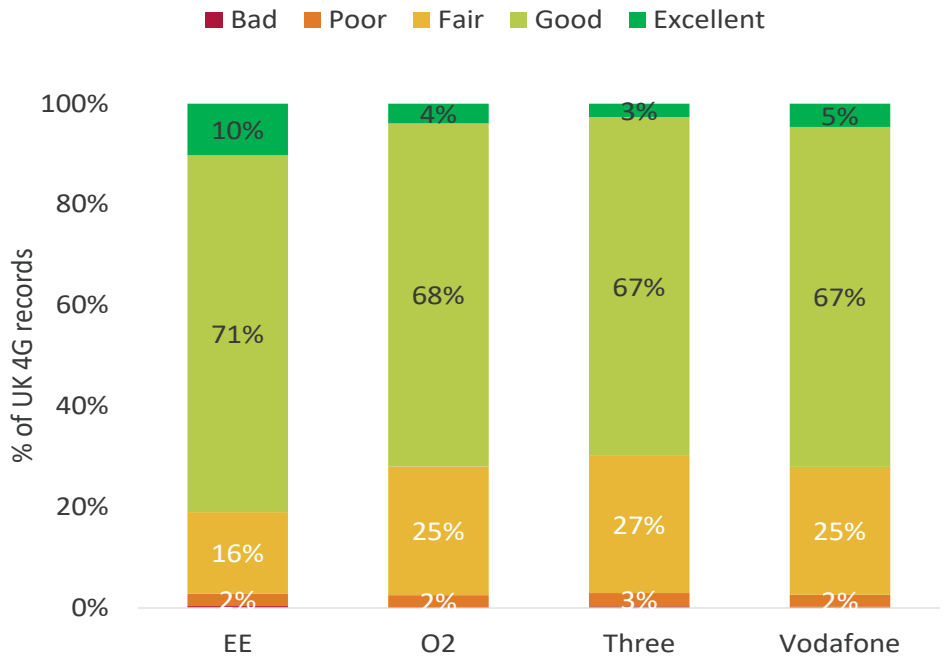
Source: Ofcom analysis of crowdsourced Android data. Notes: Percentages refer to the percentage of connection tests recorded as successful while the phone's screen was off; data refer to 1 January to 31 March 2021; the sample size for 5G connections is less than 1% of the sample size for 4G (9k vs 44m) so the figure should be taken as indicative; sample size for 5G rural records is too low for this analysis.

Video streaming experience

With the increasing popularity of video streaming apps such as YouTube, Twitch and TikTok, mobile networks are under pressure to provide their customers with a good experience while streaming video. This year, Ofcom received new analysis using the crowdsourced dataset: the video experience KPI. Industry benchmarking specialists, umlaut, used various filters to identify sessions when the user was likely to be video streaming. These sessions were then given one of five quality classifications from 'bad' to 'excellent' based on the time taken to start playing the video and its quality when playing. More information on the filters and ratings that were used can be found in Annex 1: Technical Methodology.

At the UK level, EE had the highest proportion of 4G records that were rated as either 'good' or 'excellent' for video streaming experience (81%), as well as the highest proportion of records classed as 'excellent' (10%). There were no statistically significant differences in 4G video experience performance for O2 and Vodafone customers, with both operators having 72% of records classed as 'good' or 'excellent. For Three customers this was lower, at 70% of 4G records.

Figure 14: Modelled 4G network performance for video streaming: Jan – March 2021



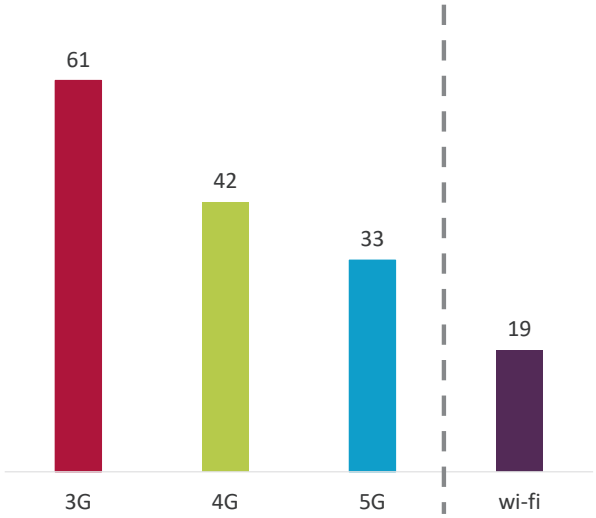
Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021; analysis for this metric is conducted at the retail network operator level, so performance of each of the network operators above does not reflect performance of virtual network operators using the same network e.g. O2's results do not include Tesco customers.

Response times for data requests

The time it takes the network to respond to data requests – for example to load a new web page or stream a podcast – can have a noticeable impact on user experience. In general, most mobile activities need a network response time (often referred to as 'latency') under 100ms to provide a good experience. For more demanding activities such as video calling, this drops to 50ms, while others, such as web browsing, will perform satisfactorily with a slower response time.

Figure 15 shows that on average, wi-fi response times were half those of 4G connections, with no significant differences by rurality. Average response time on 3G networks were a lot slower, with statistically significant differences by rurality (66ms in rural vs 60ms in urban areas). Response times on 5G were statistically significantly faster than those on 3G, 4G and even wi-fi, although most smartphone users would likely not notice this when using their phone for everyday tasks.

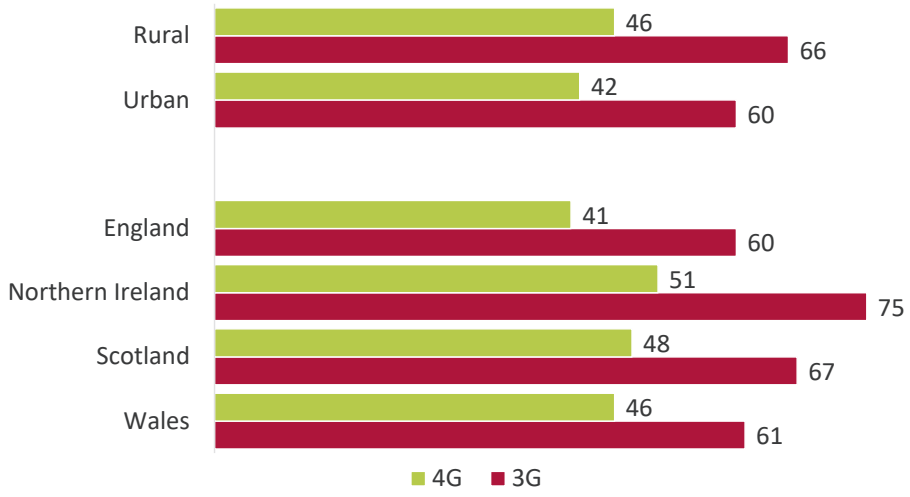
Figure 15: Average response time by network technology in ms: Jan – March 2021 (lower is better)



Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021.

Looking at the data by nation, connections in England were the most responsive, while those in Northern Ireland were the least responsive, on both 4G and 3G networks. This could be because more connections are made further from the mast and towards the 'edge' of cell areas, where the signal strength is weaker, or because content is being cached, and is therefore quicker to retrieve, in areas where more people are using the network.

Figure 16: Average response time by network technology in ms Jan – March 2021 (lower is better)

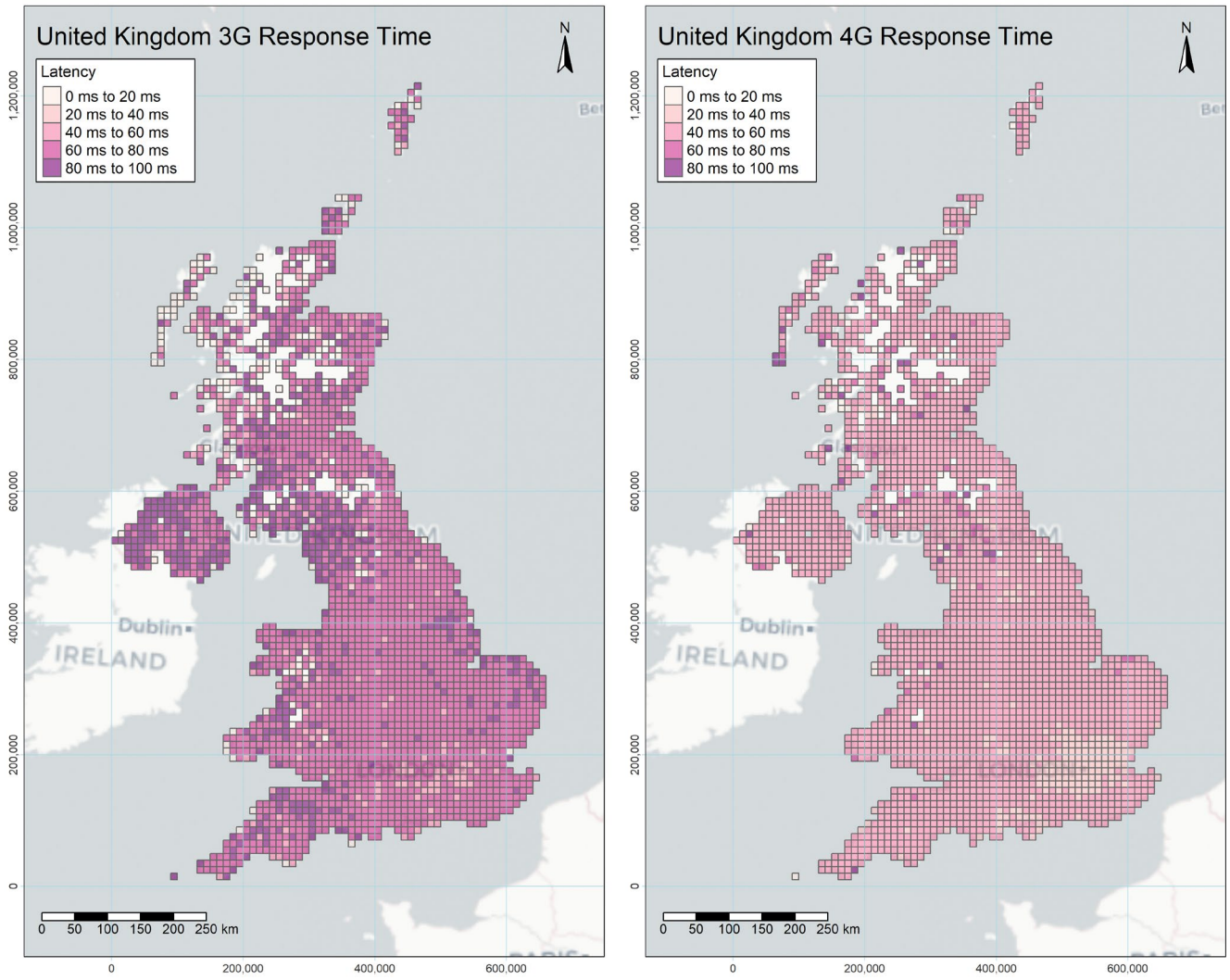


Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021; 5G sample size is too small to display at this level.

To look more closely at variations in response time by technology and location, we divided the UK into 10x10km squares and calculated the median average response time for 3G, 4G and wi-fi connections made in each square. The blank squares had no recorded 3G, 4G or wi-fi latency tests between 1 January and 31 March, which might be because there was no coverage, or because nobody on our panel visited that area during the period. Slower response times appear darker and faster response times appear lighter.

The maps below show that while 4G connections are quicker than 3G connections, there is variation in performance within each technology depending on location, with response times in urban areas typically faster than those in rural areas. Interactive versions of these maps are available.

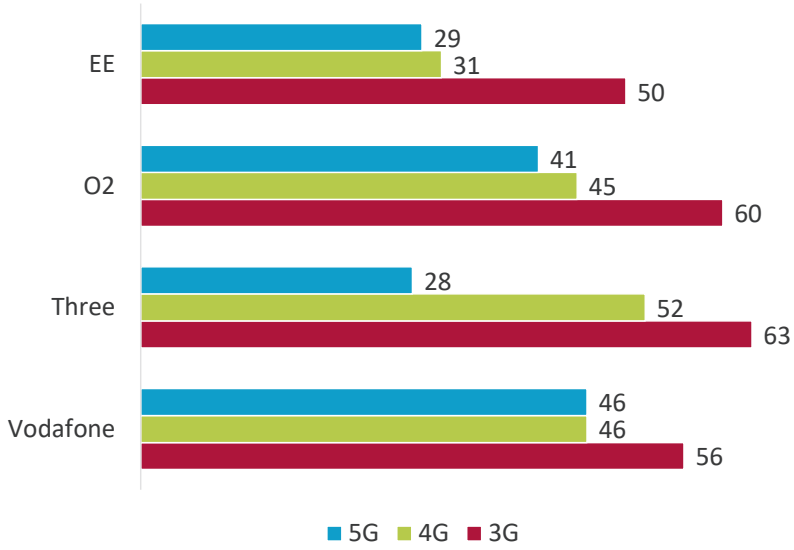
Figure 17: Median response time by network technology: Jan – March 2021 (lighter is better)



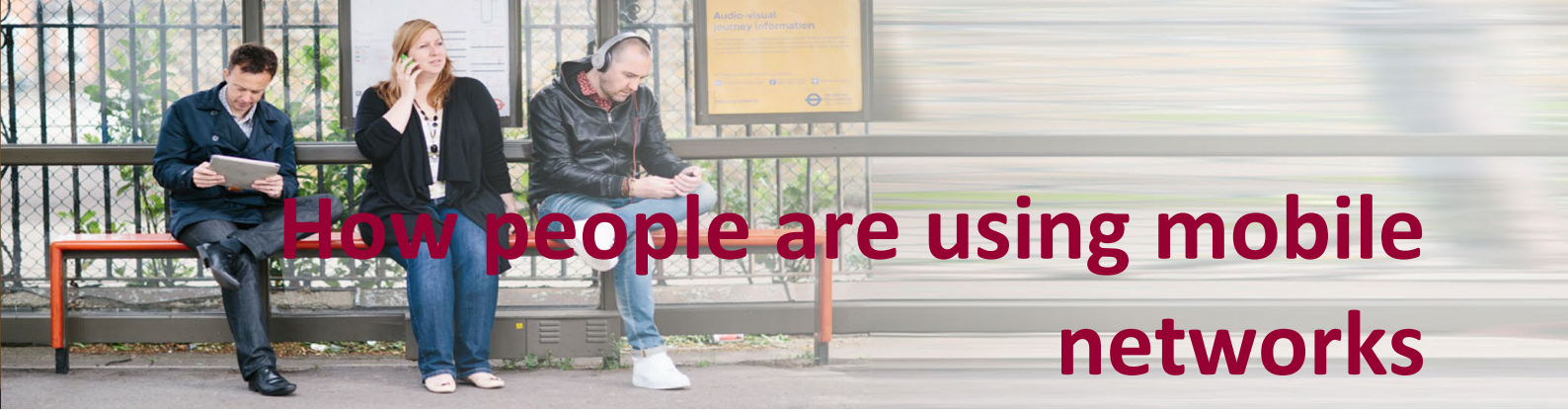
Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021; Interactive versions of these maps are available.

Average response time was significantly faster on the EE network for 4G connections, while 3G connections on the Three network were the least responsive. Three had the biggest difference in response time between 4G and 5G connections out of the four network operators. But all the average response times were below the 100ms threshold, and slight differences are unlikely to be noticeable unless the user is using their phone for services that require very fast response times for optimal performance, such as video calling or gaming.

Figure 18: Average response time by network operator and technology in ms: Jan – March 2021 (lower is better)



Source: Ofcom analysis of crowdsourced Android data. Notes: Data refer to 1 January to 31 March 2021; analysis conducted at the wholesale mobile network provider (MNO) level.



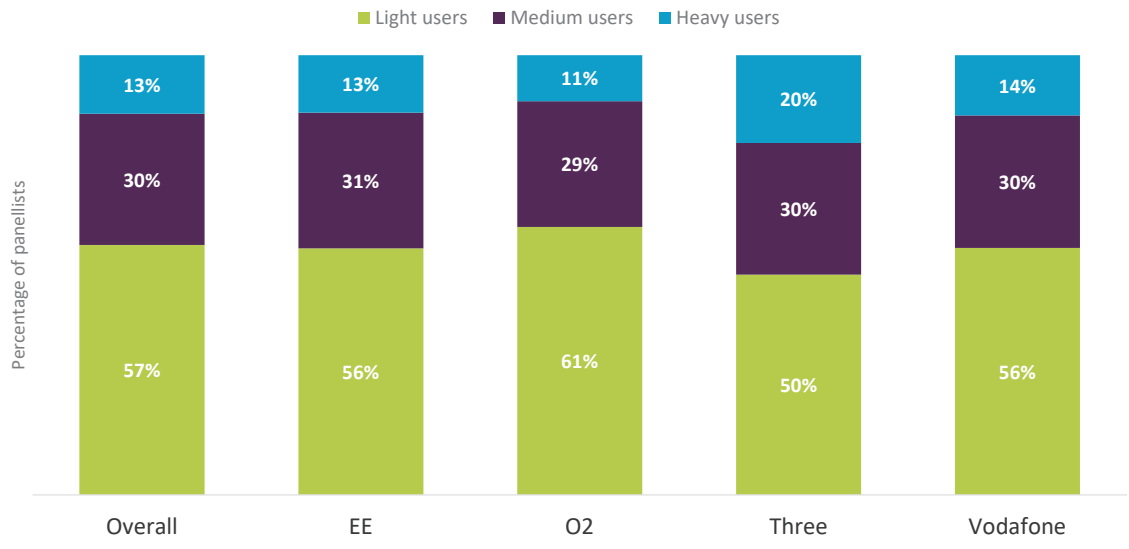
How people are using mobile networks

Data use

Estimated average mobile data use across our entire 2021 Android panel was 2.3GB per user per month[3]; much lower than the 2020 UK average of 4.5GB reported in our latest Communications Market Report. However, this average figure masks significant variations in data use between panellists, and between the four mobile network operators.

The majority of our panellists were light data users, with 57% consuming less than 500MB of mobile data per month. Panellists using the O2 network were more likely to be light data users, with 61% downloading less than 500MB of mobile data a month. Those on the Three network were more likely to be heavy data users, with a fifth downloading more than 2.5GB per month. This fits with the picture from our network share analysis, which shows that O2 network users spend more time connected to wi-fi than those on other networks, while the reverse is true for people on Three. Around a third of users – between 29% and 31% – across all networks downloaded between 500MB and 2.5GB per month. These factors suggest that the majority of data traffic on mobile networks is driven by a minority of users.

Figure 19: Breakdown of panellists by average monthly mobile data use and network operator: Jan – March 2021



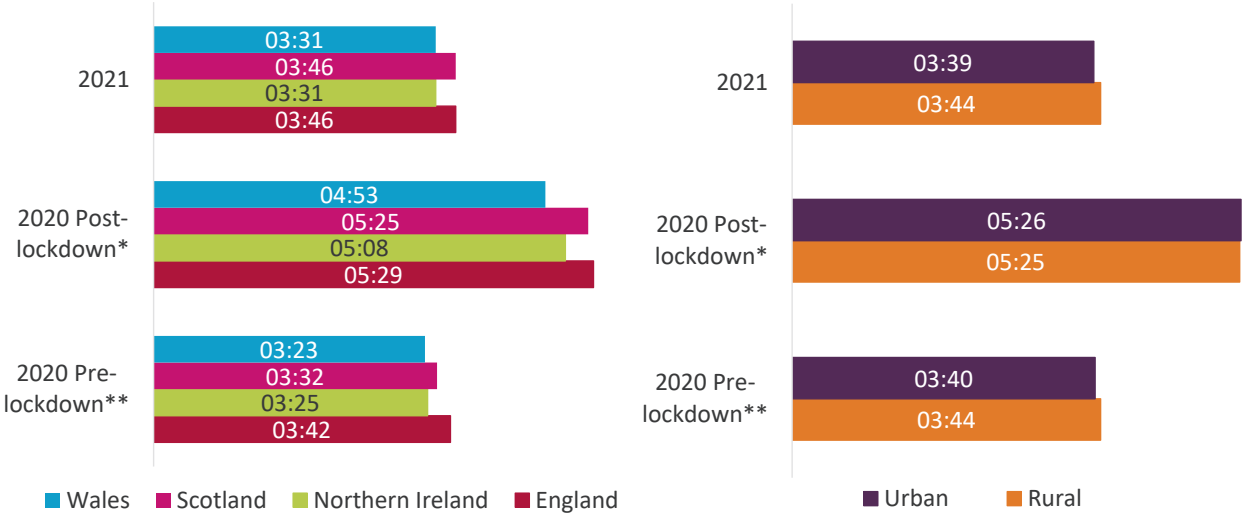
*Source: Ofcom analysis of crowdsourced Android data. Notes: volumes refer to data downloaded over 3G, 4G and 5G networks; data refer to 1 January to 31 March 2021; as panellists contributed data for a variable number of days, an estimated monthly average was calculated by taking the daily average * 30; light users used < 500MB per month, medium users used >= 500MB and 2.5GB per month, heavy users used >=2.5GB per month; analysis conducted at the wholesale mobile network provider (MNO) level.*

[3] Refers to data downloaded over mobile networks; excludes outliers (top and bottom 0.01% of values).

Mobile voice calls

The data in this section relate to standard mobile voice calls, as opposed to calls made via apps such as WhatsApp and Teams. Last year we saw that the average length of a mobile call increased by almost two minutes to 5 minutes 26 seconds in the six weeks following the start of lockdown. However, despite the data collection period spanning the 2021 lockdown, this year that figure had fallen back to 2020 pre-lockdown levels, with voice calls lasting an average of 3 minutes 40 seconds. There were minimal differences when looking at how these figures vary by nation and rurality.

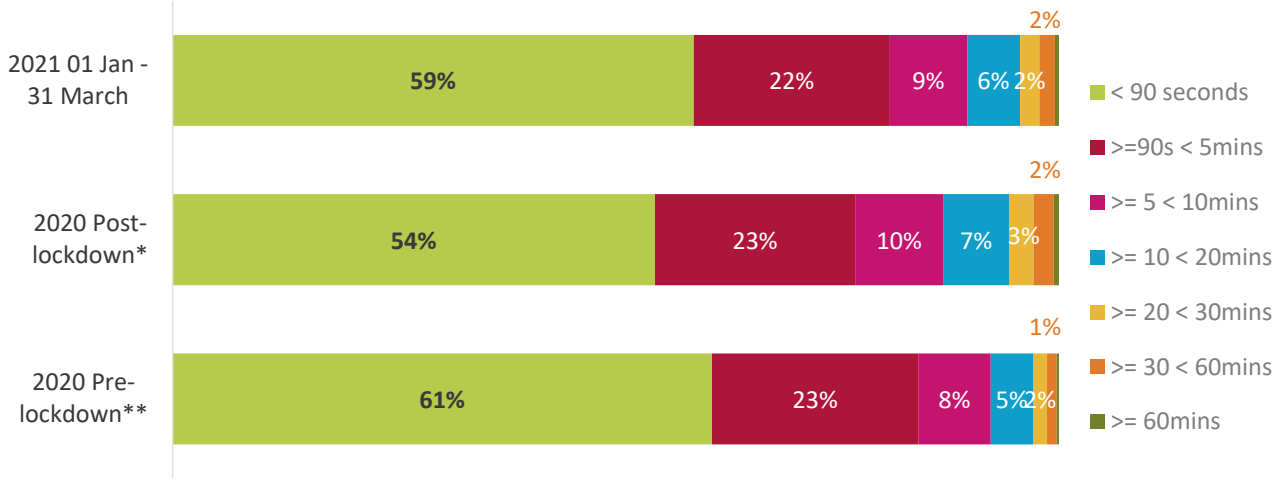
Figure 20: Average call duration (mins:secs)



*Source: Ofcom analysis of crowdsourced Android data. Notes: analysis of outgoing mobile voice calls lasting longer than 10 seconds; 2021 data refer to 1 January to 31 March 2021; * '2020 post-lockdown' refers to 23 March to 30 April 2020; ** '2020 pre-lockdown' refers to 1 January to 22 March 2020.*

Just under three-quarters of voice calls made by our panel in 2021 were under 5 minutes (71%). Last year we saw an increase in longer calls during the first lockdown; the percentage lasting longer than 20 minutes doubled from 3% to 6%, but in 2021 this dropped back to 4%.

Figure 21: Proportion of outgoing calls by average duration



*Source: Ofcom analysis of crowdsourced Android data. Notes: Analysis of outgoing mobile voice calls lasting longer than 10 seconds; 2021 data refer to 1 January to 31 March 2021; * '2020 post-lockdown' refers to 23 March to 30 April 2020; ** '2020 pre-lockdown' refers to 1 January to 22 March 2020.*