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Rialáil Cumarsáide
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Assessment of Mobile Network Operators' Compliance with Licence Obligations (Coverage)

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1 Introduction and background

1. This document presents a summary of the results of the Commission for Communications Regulation's ("ComReg") Drive Testing Programme ("Drive Test") carried out between 26 May 2022 and 13 July 2022, by its contractor Advanced Wireless Technologies Group Limited ("AWTG").
2. The objective of the Drive Test is to assess each Mobile Network Operator's ("MNO") compliance with its coverage licence conditions across the 800 MHz, 900 MHz, 1800 MHz and 2100 MHz frequency bands¹ *as measured on the Drive Test route*.
3. The MNOs are:
 - Three Ireland Hutchison Limited ("3IHL")^{2,3};
 - Eircom Limited ("Eir")⁴; and
 - Vodafone Ireland Limited ("Vodafone").
4. The Drive Test does not assess an end user's quality of experience.

¹ See:

- for "liberalised" rights of use in the 800 MHz, 900 MHz and 1800 MHz bands ("Liberalised Use Licence" or "LUL"): the Wireless Telegraphy (Liberalised Use and Preparatory Licences in the 800 MHz, 900 MHz and 1800 MHz Bands) Regulations 2012 (S.I. 251 of 2012);
- for 3G rights of use in the 2100 MHz band ("TGL"): the Wireless Telegraphy (Third Generation and GSM Licence) Regulations, 2002 and 2003;
- for liberalised rights of use in the 2100 MHz band ("LU 2.1GHz"): the Wireless Telegraphy (Third Generation and GSM Licence (Amendment) and Interim Licensing) Regulations 2021 (S.I. 265 of 2021) and the Wireless Telegraphy (Further Temporary Electronic Communications Services Licences) (No. 4) Regulations 2022 (S.I. 138 of 2022).

² Noting that 3IHL holds two sets of licences. In this report, the original set of 3IHL licences are referred to as "3IHL No. 1" and the former Three Ireland Services (Hutchison) Limited licences are referred to as "3IHL No.2".

³ In an e-mail of 17 September 2019, 3IHL confirmed to ComReg that, since the completion of its network consolidation, all 3IHL Subscriber Identity Modules ("SIMs") can use all of 3IHL's assigned frequencies.

⁴ While Meteor is the licensee, it trades as Eir.

1.1 Drive Tests

5. The Drive Test route covers the full length of Ireland's National Primary and Secondary (N) road network, including all towns thereon and Motorway sections. The route is approximately 5,500 km long.⁵
6. In this document, coverage on the Drive Test route is:
 - assessed in terms of the received field strength measured, as defined in the relevant licence conditions, while the route is driven; and
 - contingent on the ability to place a call or to access services at the specific location and time during the Drive Test using a standard handset.
7. Drive Test measurements are performed from a vehicle containing a computer-controlled measuring system ("Benchmarking System")⁶, which acts as a 'handset', matching a European Telecommunications Standards Institute ("ETSI") standard handset⁷. As such, the Benchmarking System is locked to each individual technology in use by the licensee on the relevant frequency bands. It should be remembered that the radio performance of many handsets differs at a location due to a variety of factors, such as those outlined in section 1.2 below.
8. It is also important to recognise that the Drive Test represents a snapshot of the measurements made on an MNO's network, at the point in time during which the test is conducted while the route is driven.
9. In addition to the Drive Test, ComReg has separately developed a nationwide outdoor mobile coverage map⁸, which is generated using a standard propagation model and data provided by the MNOs. The outdoor mobile coverage map also includes data for the mobile virtual network operators ("MVNOs")⁹.

1.2 Factors Affecting End-User Experience

10. It is not possible to fully account for the wide range of variables that can affect end-user experience. In its licence conditions, ComReg sets minimum requirements for

⁵ See Appendix 2.

⁶ This consists of the Nemo Invex II benchmarking tool, connected to Samsung Galaxy S9 mobile handsets and an FSR1 Multiband Scanner. Measurements are terminated at servers located in Ireland.

⁷ 3GPP TS 36.101

⁸ See here- <https://coveragemap.comreg.ie/map>

⁹ Service providers whose services are hosted by the MNOs. The MVNOs include: 48, GoMo, Lycamobile, An Post mobile, Tesco Mobile, Clear Mobile and Virgin Media.

mobile phone coverage, based on the relevant standards of European and international bodies¹⁰, assuming a certain level of handset performance and on the basis of outdoor use.

11. For a better understanding of the factors that currently affect end-user experience, ComReg has conducted research into the antenna performance of mobile handsets when used for voice¹¹ and data¹² services. The results of the research show a notable difference in performance, depending on the service – either voice or data. Importantly, the research illustrates that mobile handsets perform differently in areas where coverage is weak.
12. ComReg has also conducted research into the radio propagation characteristics of common building materials to determine how such materials affect mobile handset signals in-building (see Document 18/73¹³). Among other things, it was found that building materials containing metals, such as foil-backed thermal insulation or windows with metallic frames, can have a significant detrimental effect on the propagation of radio waves into a building.
13. A further factor affecting the end-user experience is the type of mobile technology being used (2G (GSM), 3G (UMTS), 4G (LTE), 5G etc). Mobile technologies, such as LTE, which provide the user with higher data speeds, require higher signal levels to operate than traditional voice services. All digital modulation schemes rely on a minimum Signal to Noise Ratio (“SNR”)¹⁴ and the higher the data throughput, the greater the SNR required.

¹⁰ For example, the 3GPP and ETSI standards for Users Equipment and Base Stations.

¹¹ ComReg Document 19/110 – Mobile Handset Performance (Voice), December 2019:
<https://www.comreg.ie/publication/mobile-handset-performance-voice-2>

¹² ComReg Document 20/121 – Mobile Handset Performance (Data), December 2020:
<https://www.comreg.ie/publication/mobile-handset-performance-data-3>

¹³ ComReg Document 18/73 – The Effect of Building Materials on Indoor Mobile Performance, August 2018: <https://www.comreg.ie/publication/the-effect-of-building-materials-on-indoor-mobile-performance/>

¹⁴ Signal to Noise Ratio is a generic engineering term and is the ratio of the wanted signal to the unwanted signal.

2 Presentation of Results

14. The following maps provide a graphical representation of the field strengths measured during the Drive Test and are categorised by MNO, then the technology and frequency used.

2.1 Eir: Coverage Maps

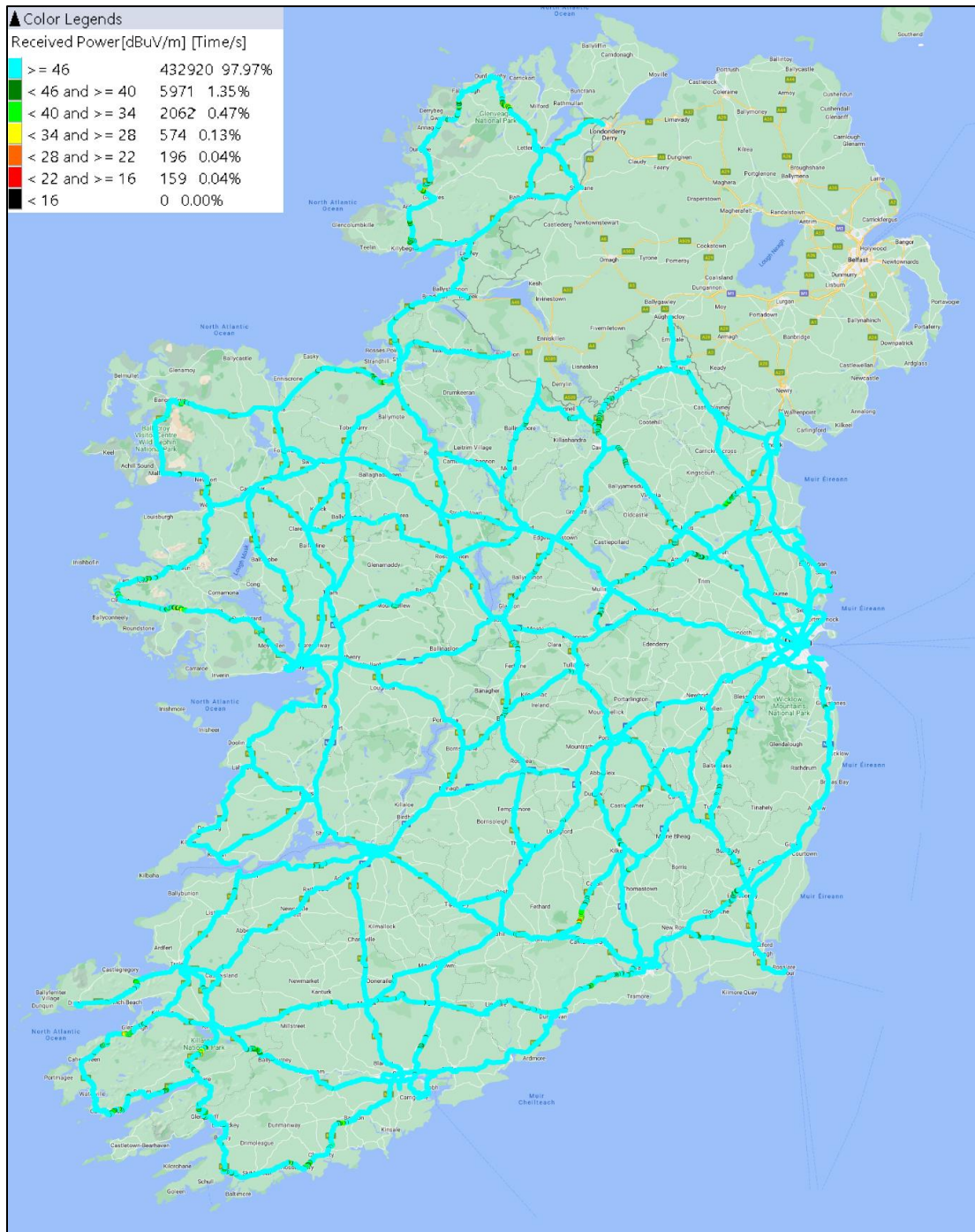


Figure 1: Eir – 900 MHz (2G (GSM))

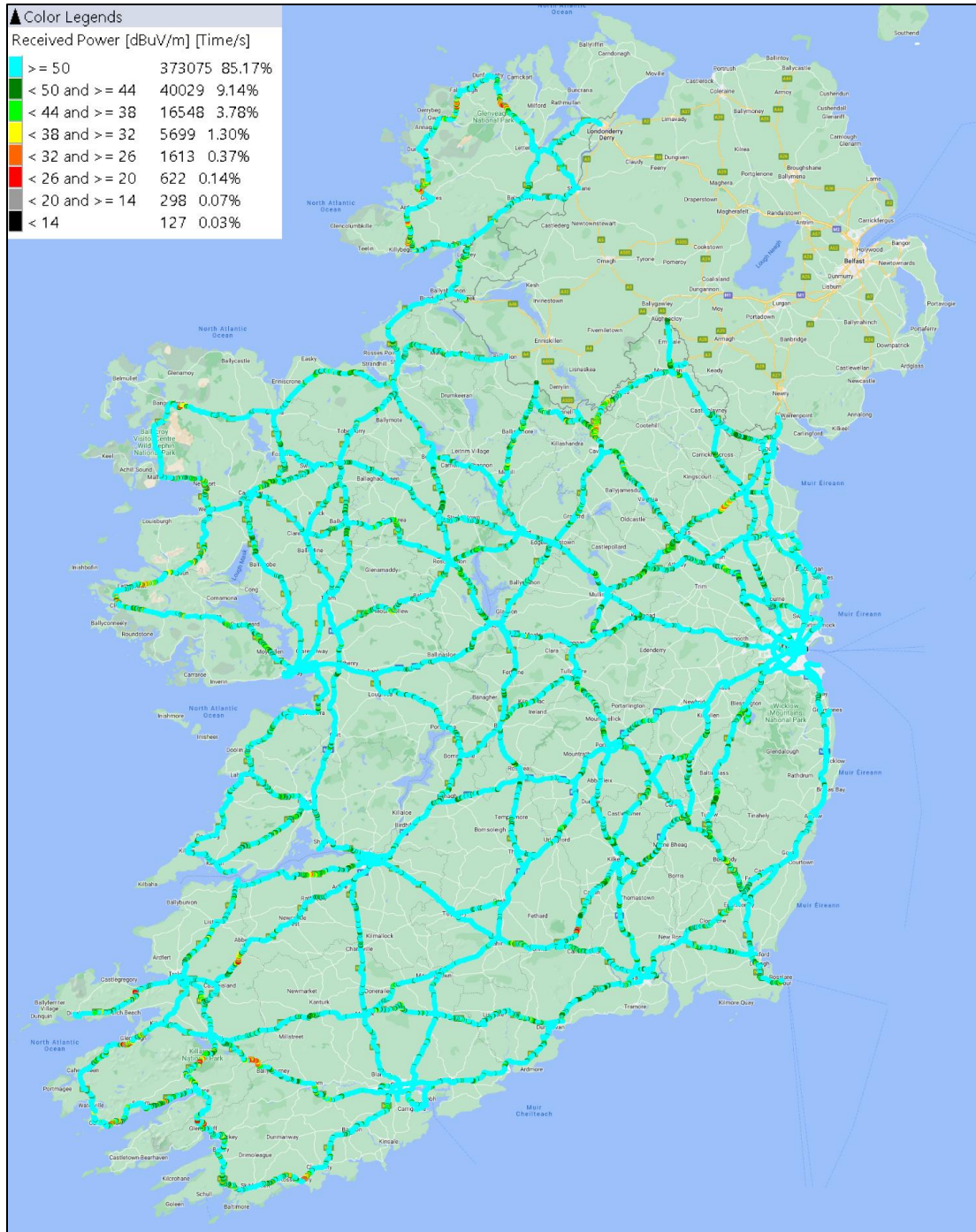


Figure 2 :Eir – 900 MHz (3G (HSDPA/UMTS))

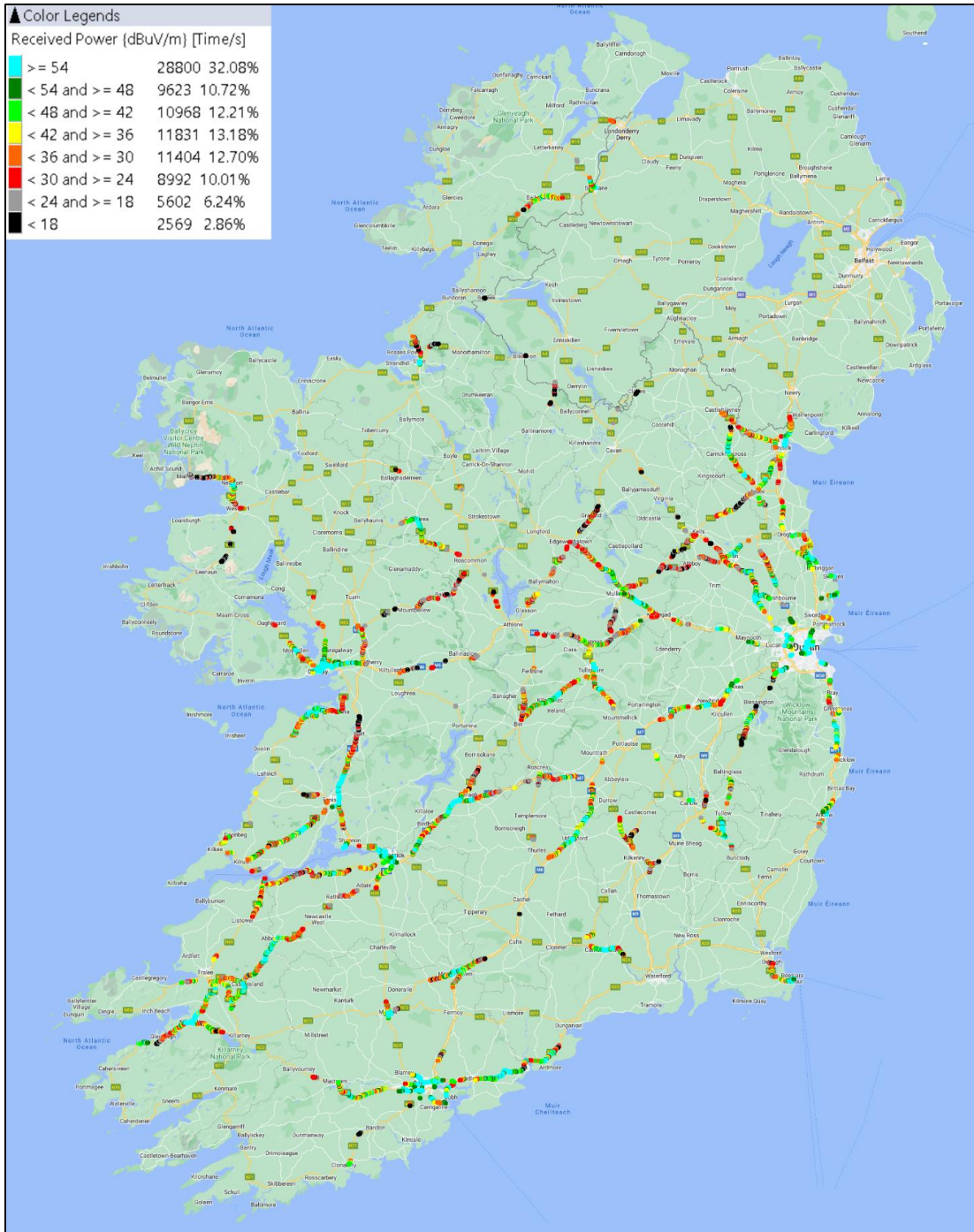


Figure 3: Eir – 2100 MHz (3G (HSDPA/UMTS))

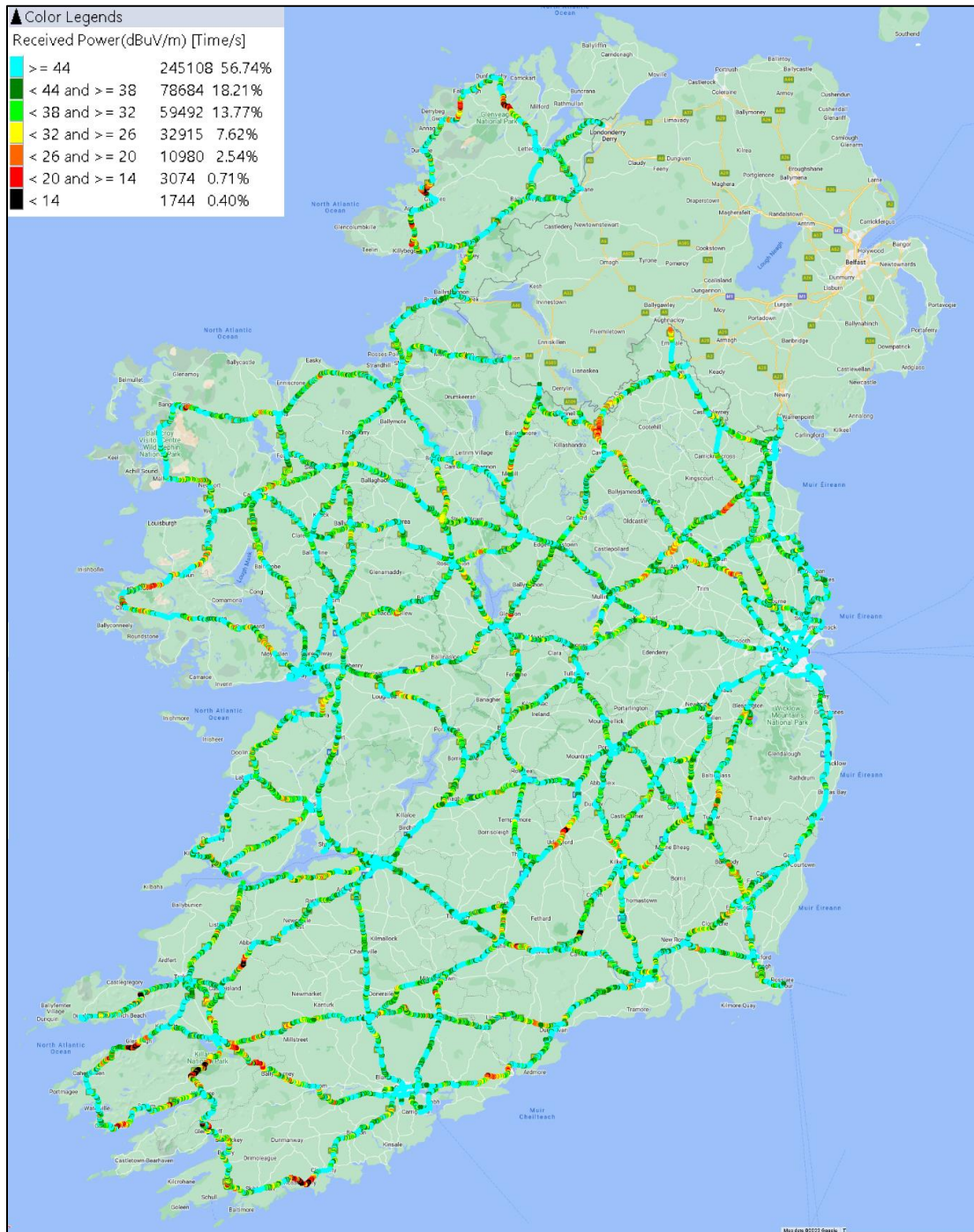


Figure 4: Eir – 800 MHz (4G/LTE)

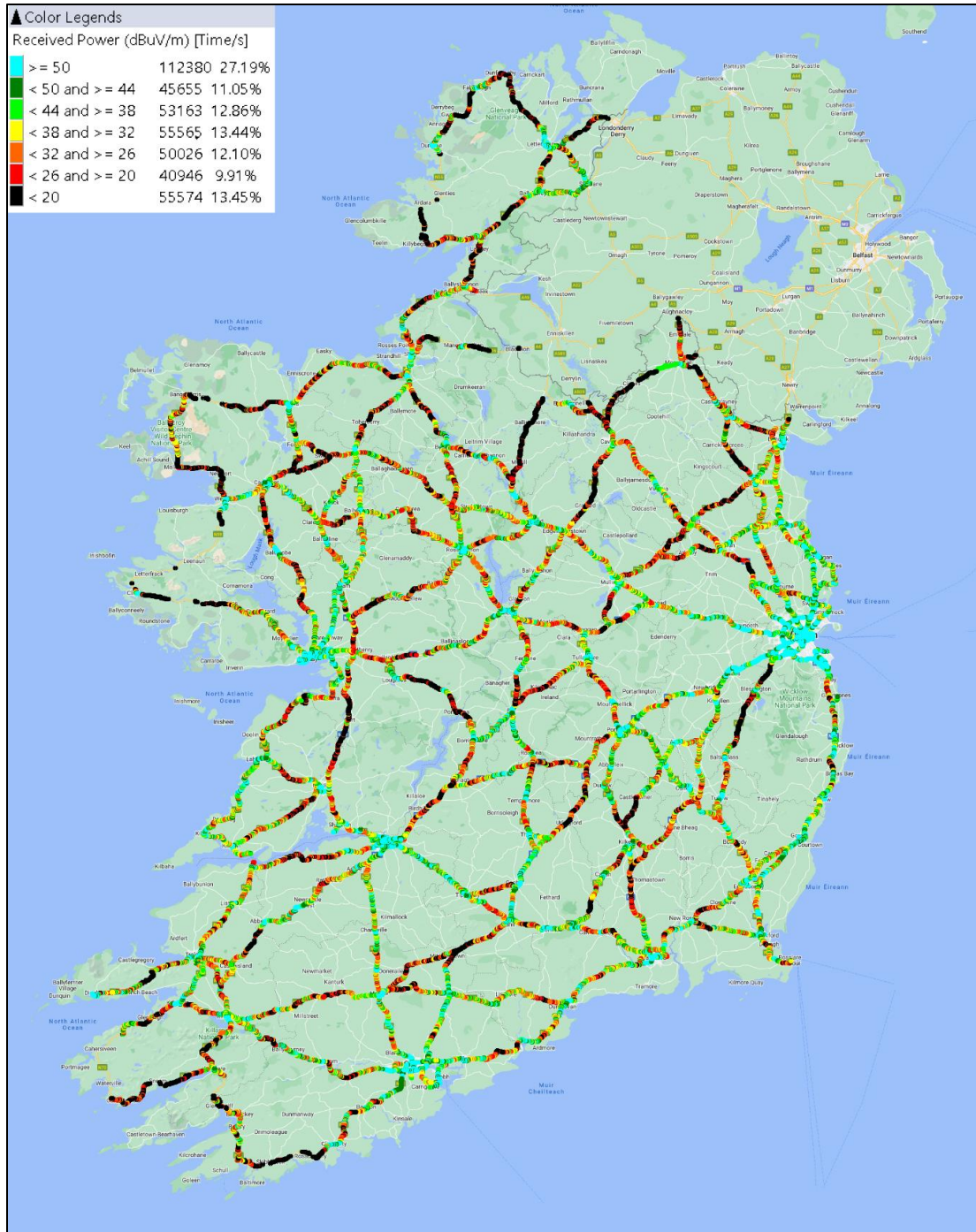


Figure 5: Eir – 1800 MHz (4G(LTE))

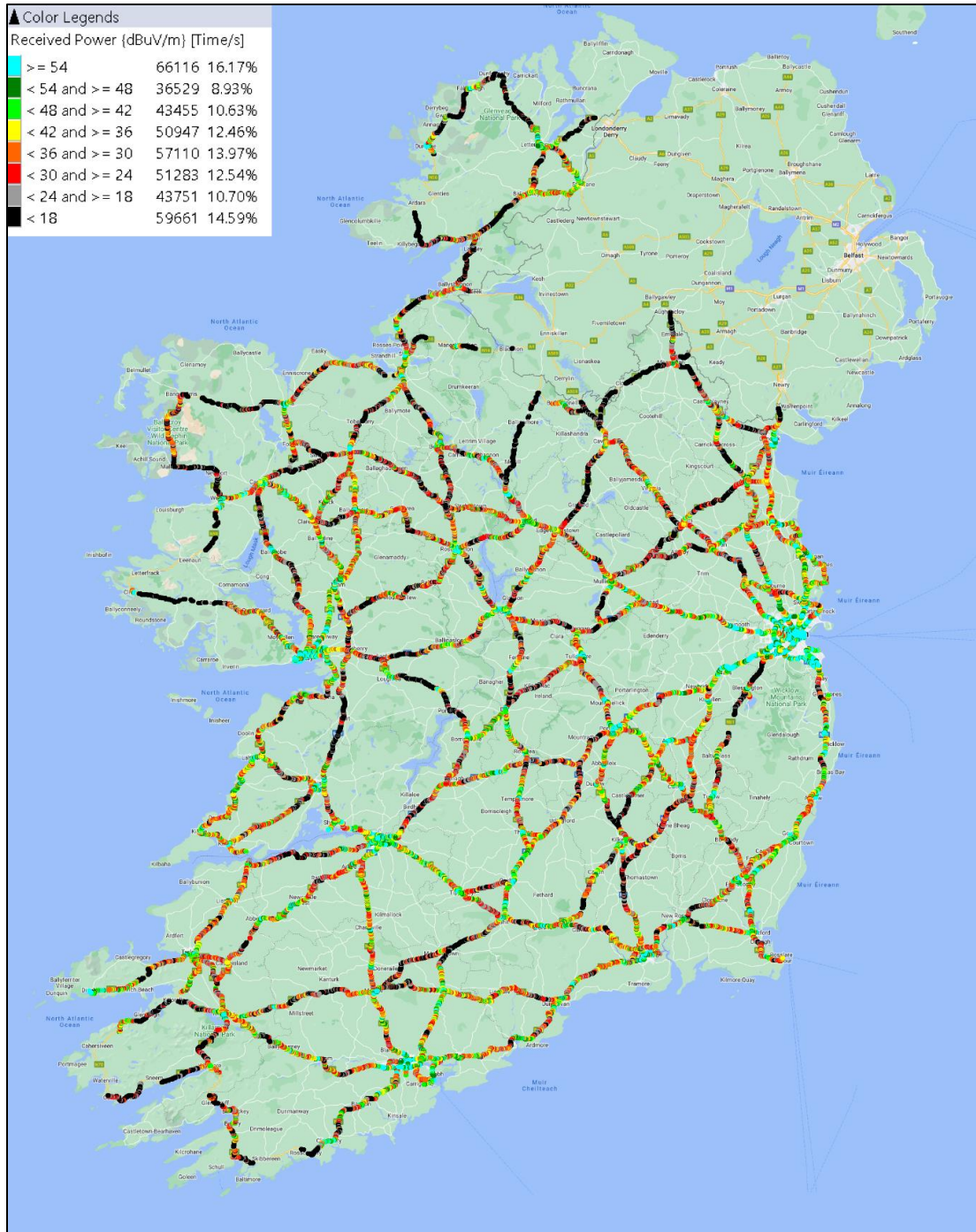


Figure 6: Eir – 2100 MHz (4G(LTE))

2.2 3IHL No.1: Coverage Maps

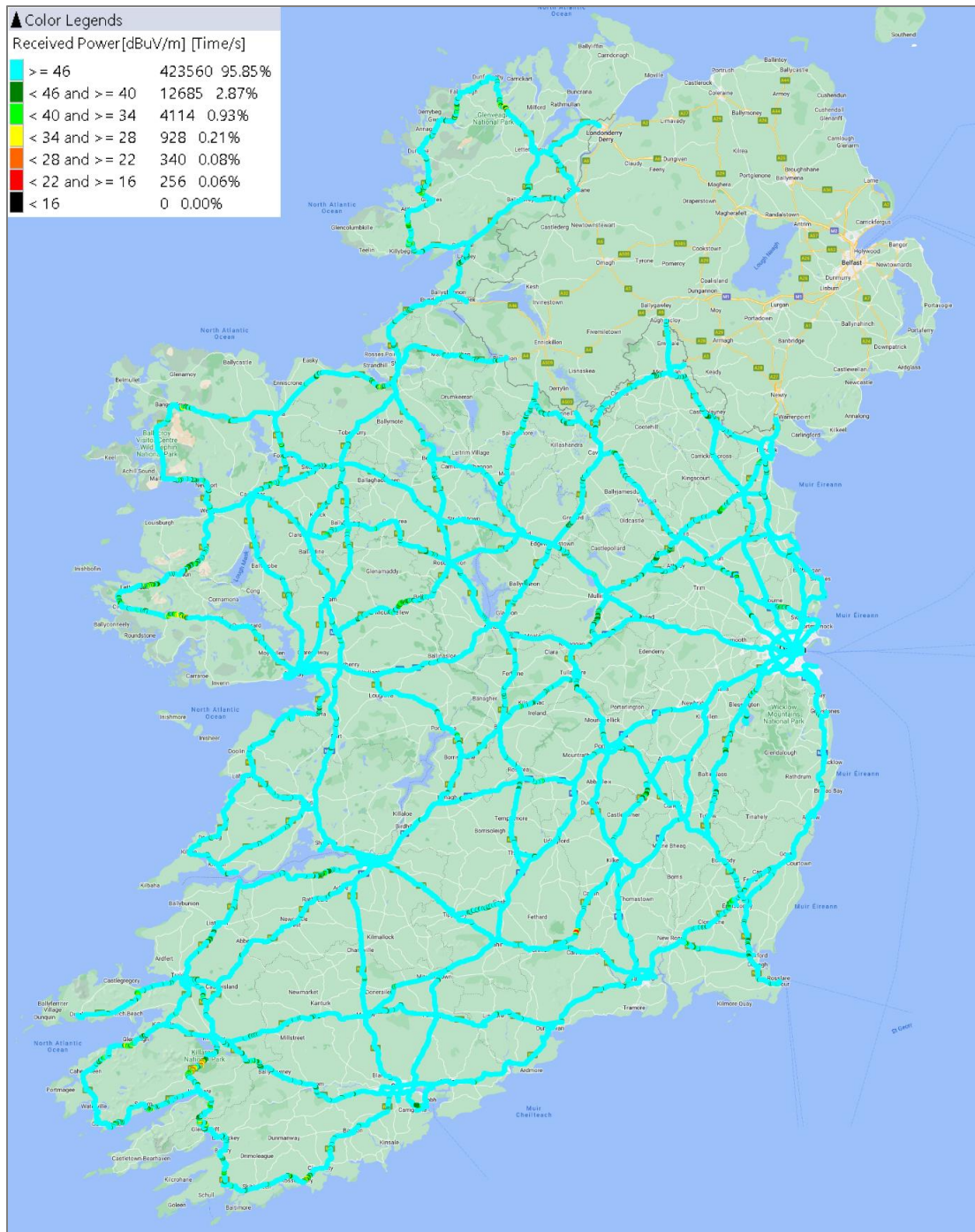


Figure 7: 3IHL No.1 – 900 MHz (2G (GSM))

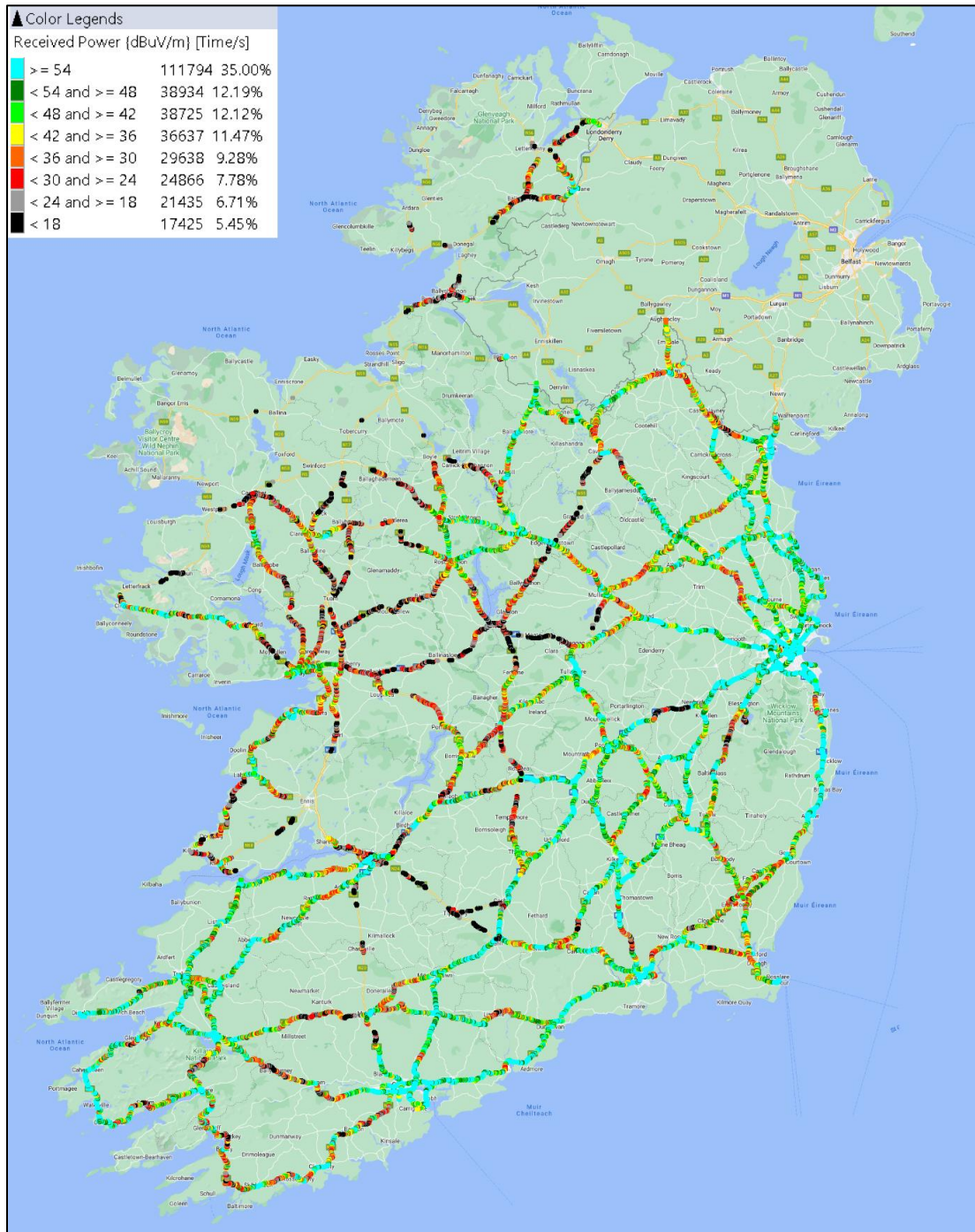


Figure 8: 3IHL No.1 – 2100 MHz (3G (HSDPA/UMTS))

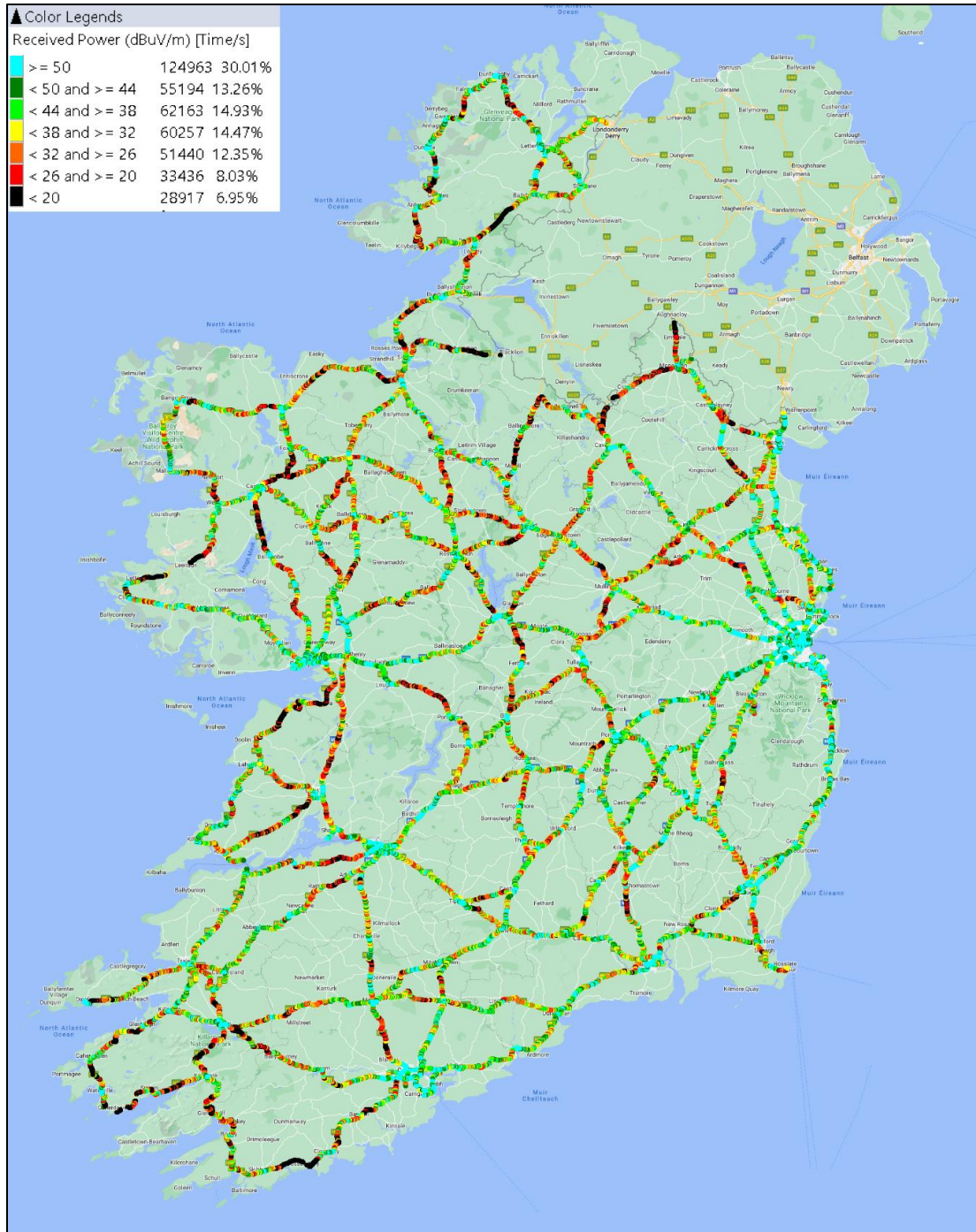


Figure 9: 3IHL No.1 – 1800 MHz (4G(LTE))

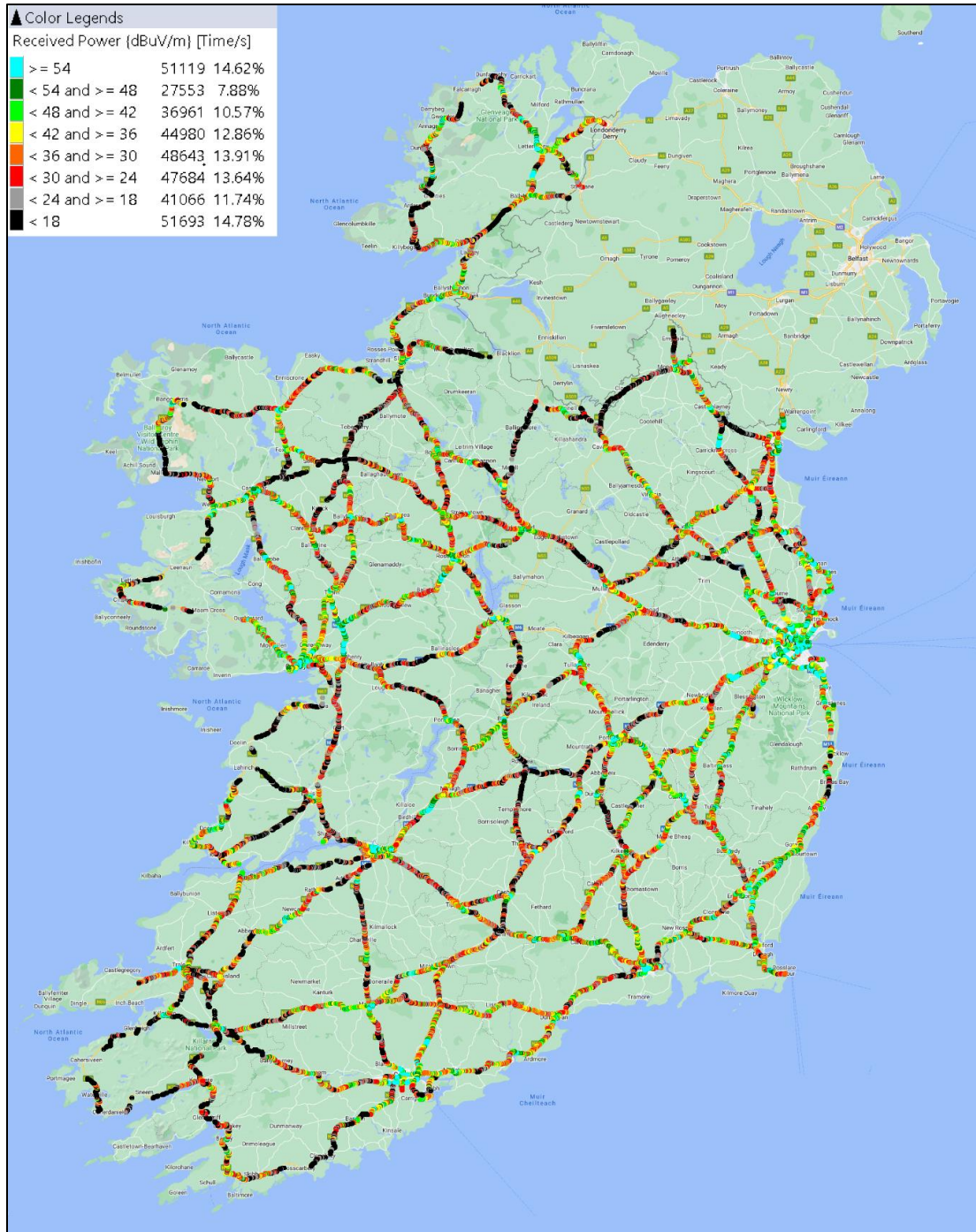


Figure 10: 3IHL No.1 – 2100 MHz (4G (LTE))

2.3 3IHL No.2: Coverage Maps

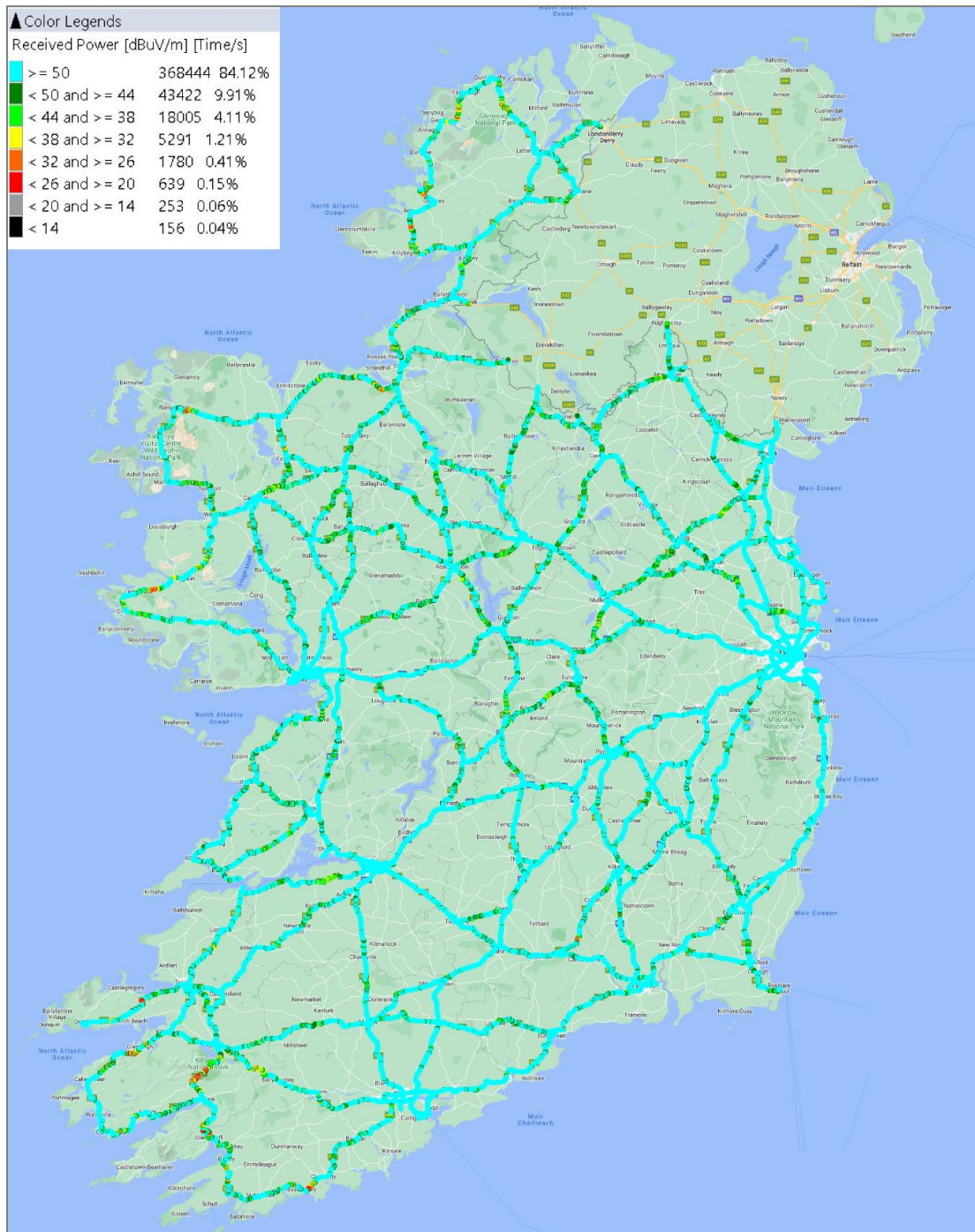


Figure 11: 3IHL No.2 – 900 MHz (3G UMTS/HSDPA)

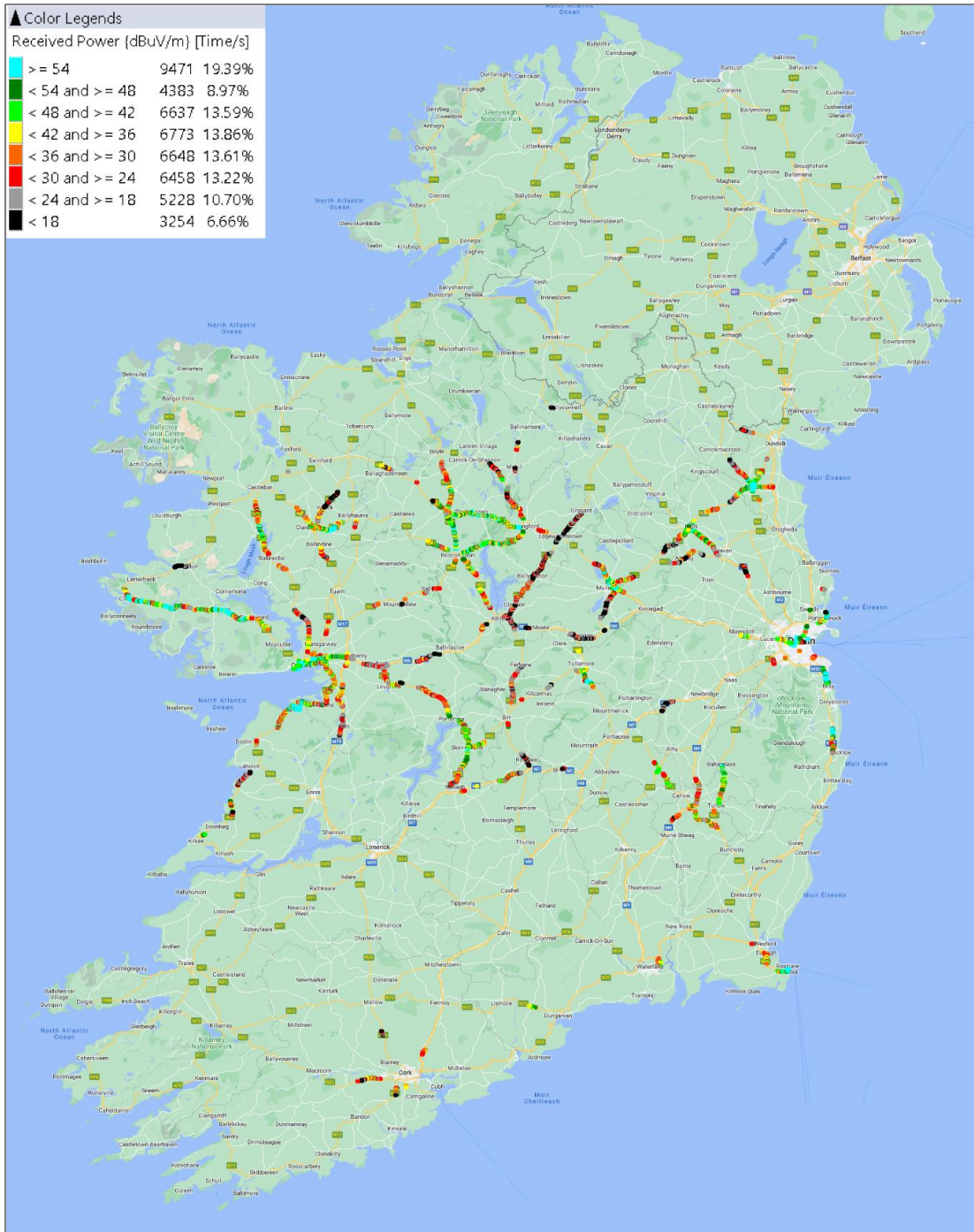


Figure 12: 3HL No.2 – 2100 MHz (3G (UMTS/HSDPA))

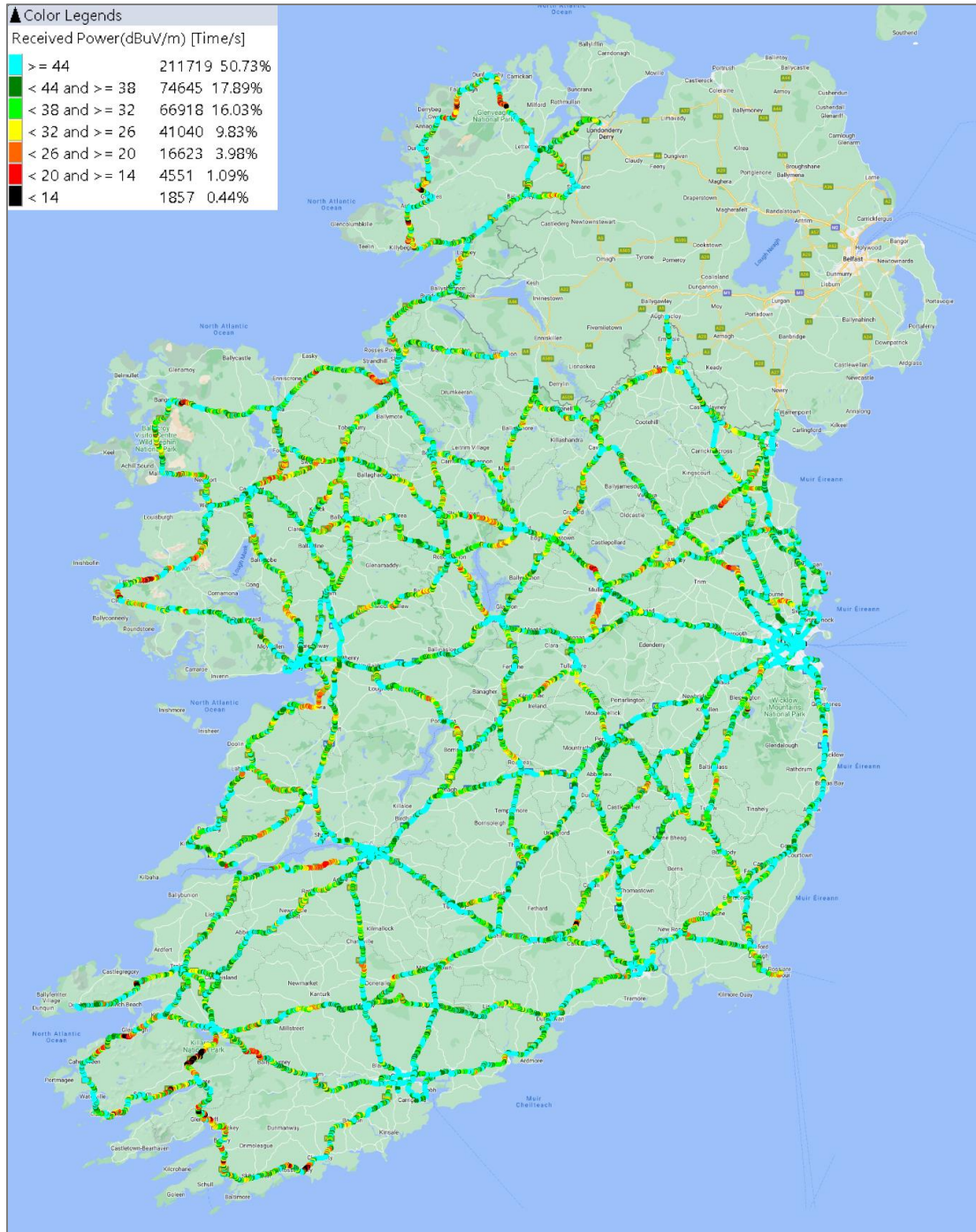


Figure 13: 3IHL No.2 – 800 MHz (4G (LTE))

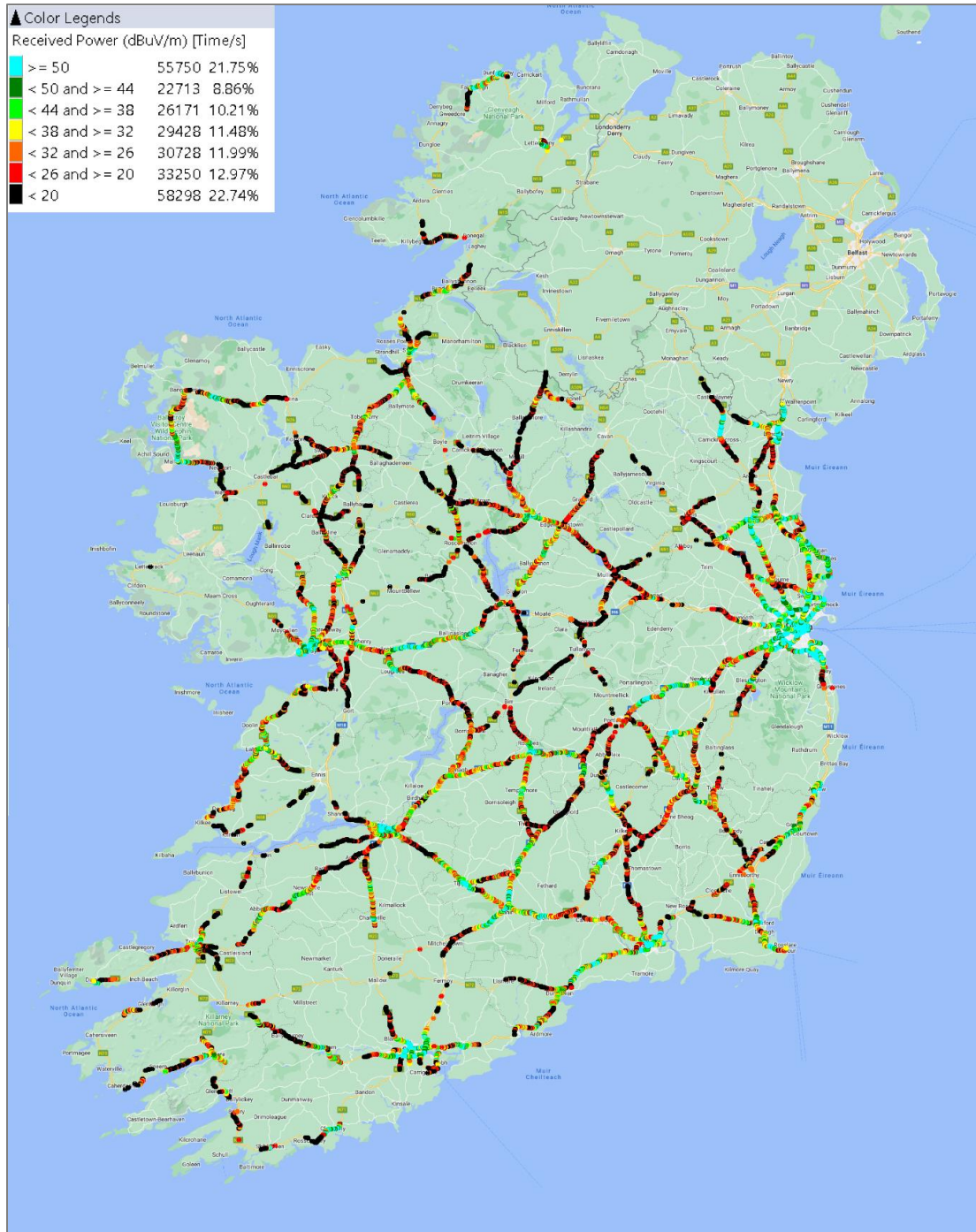


Figure 14: 3IHL No.2 – 1800 MHz (4G (LTE))

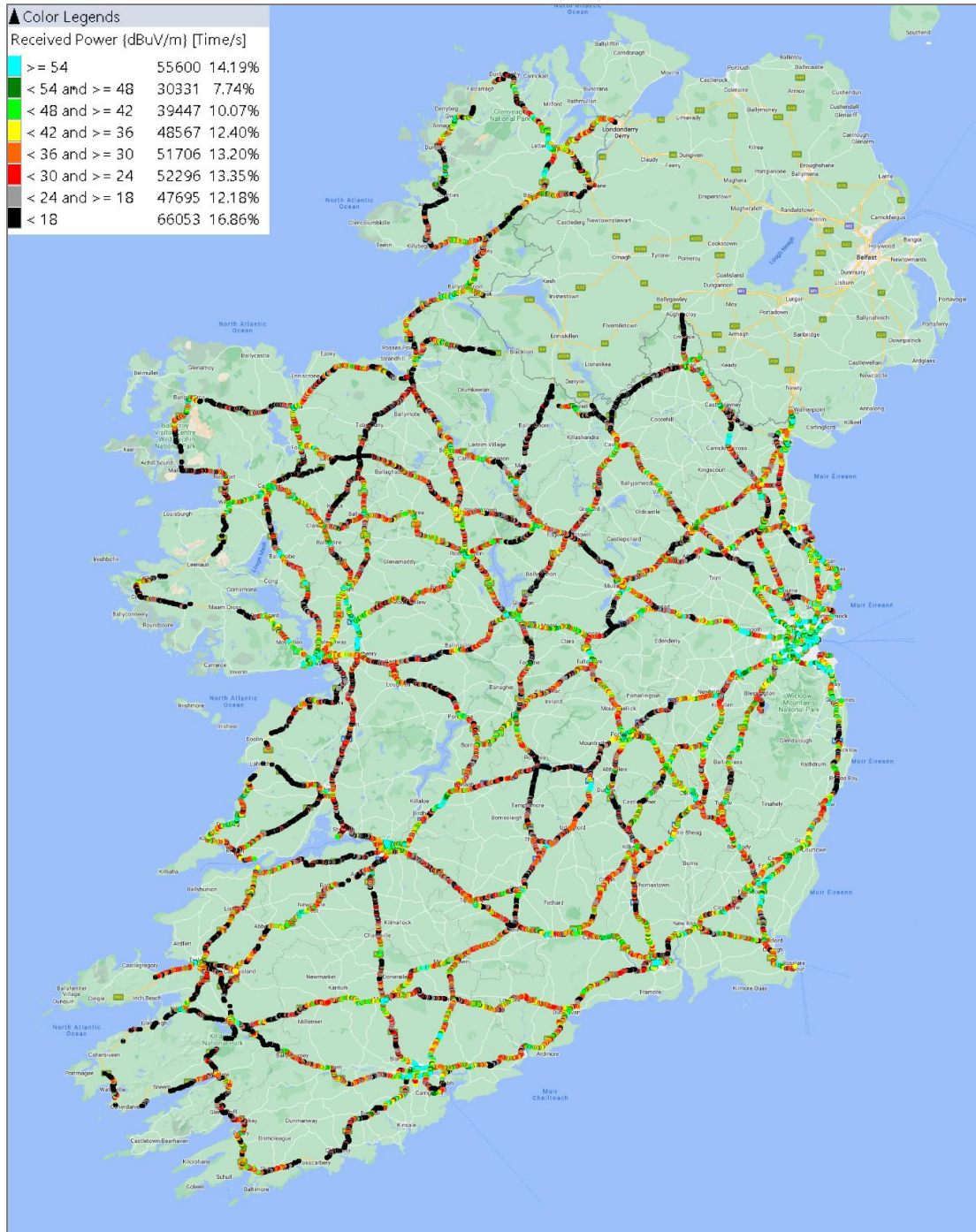


Figure 15: 3IHL No.2 – 2100 MHz (4G LTE)

2.4 Vodafone: Coverage Maps

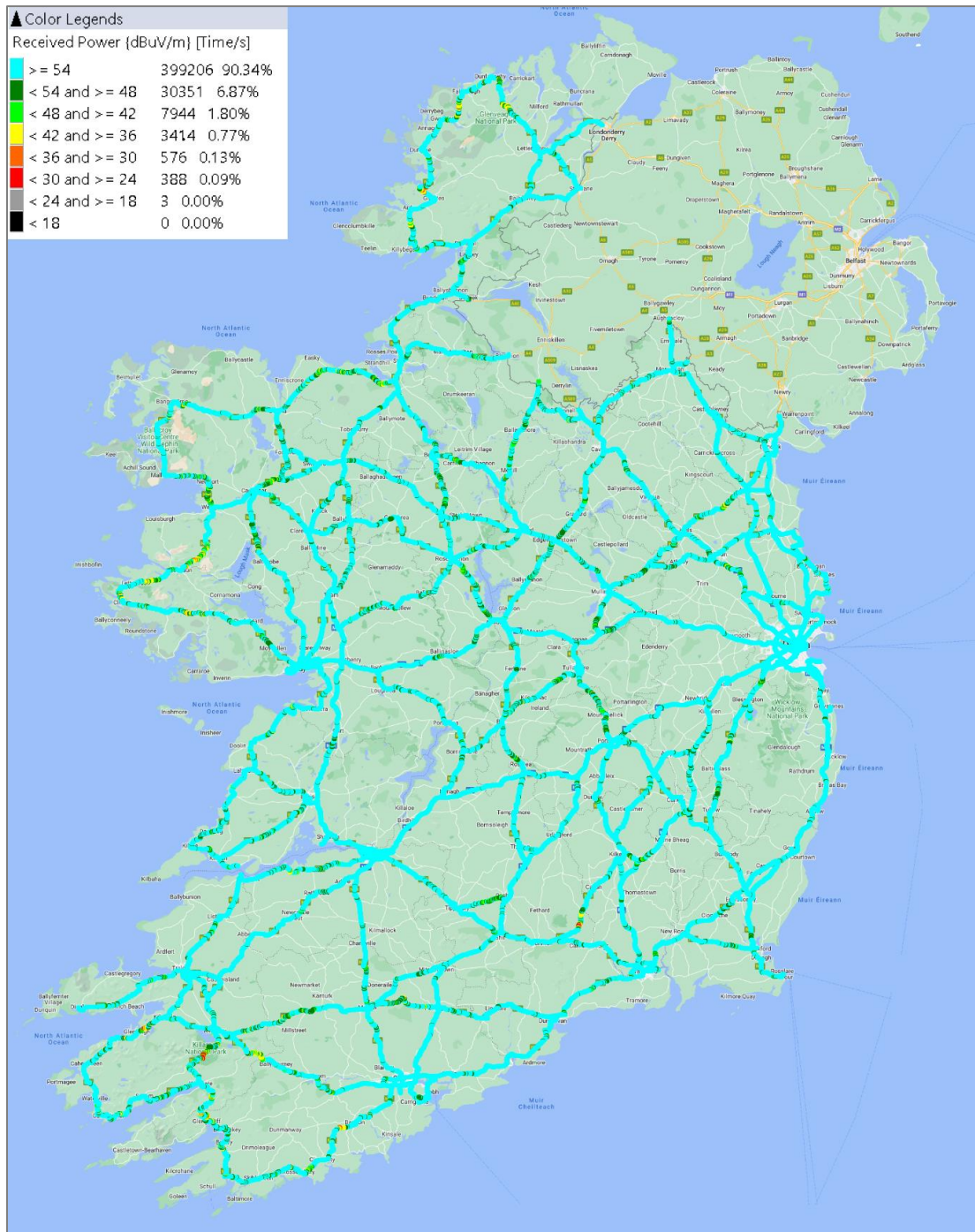


Figure 16: Vodafone – 900 and 1800 MHz (2G (GSM))

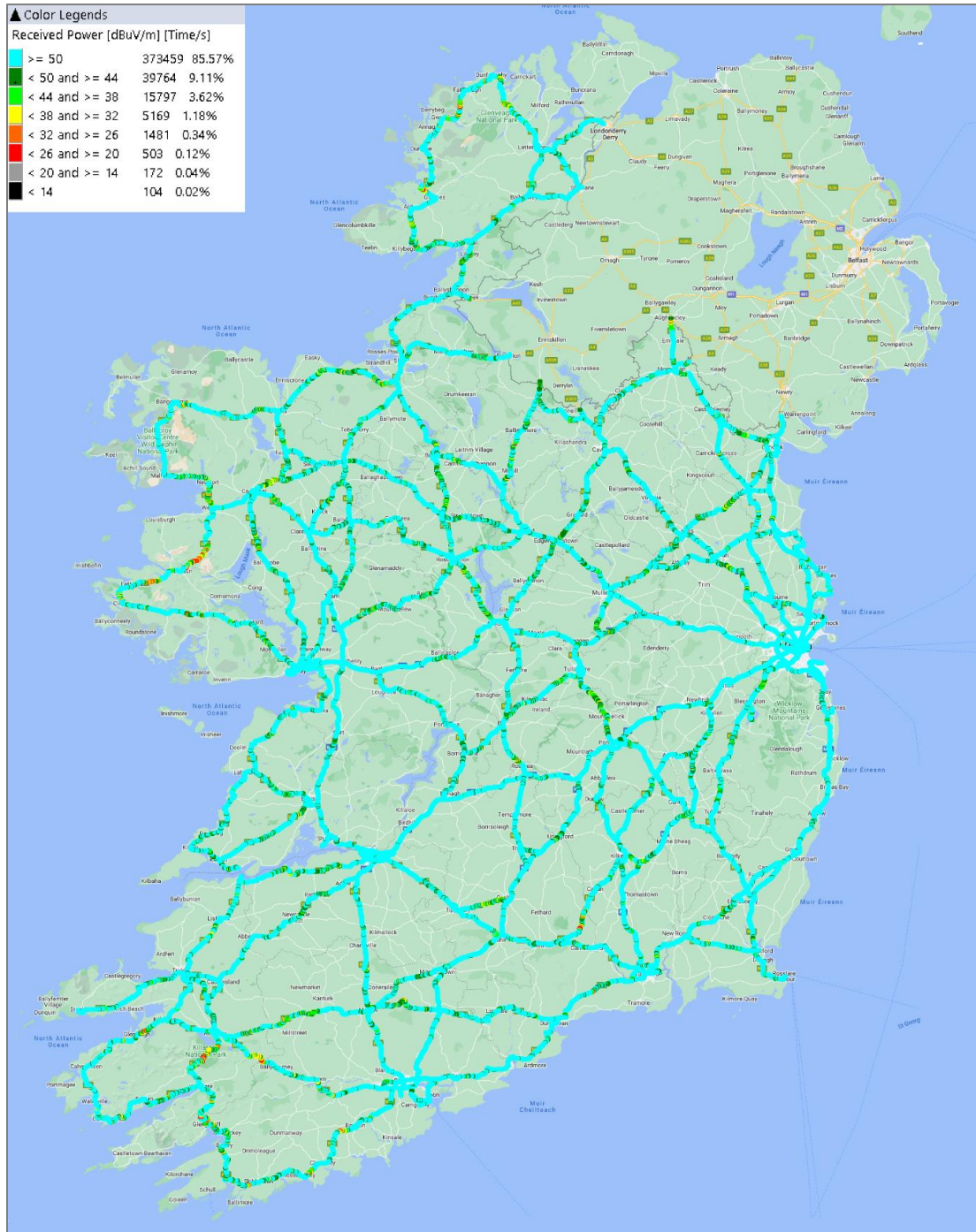


Figure 17: Vodafone – 900 MHz (3G (UMTS/HSDPA))

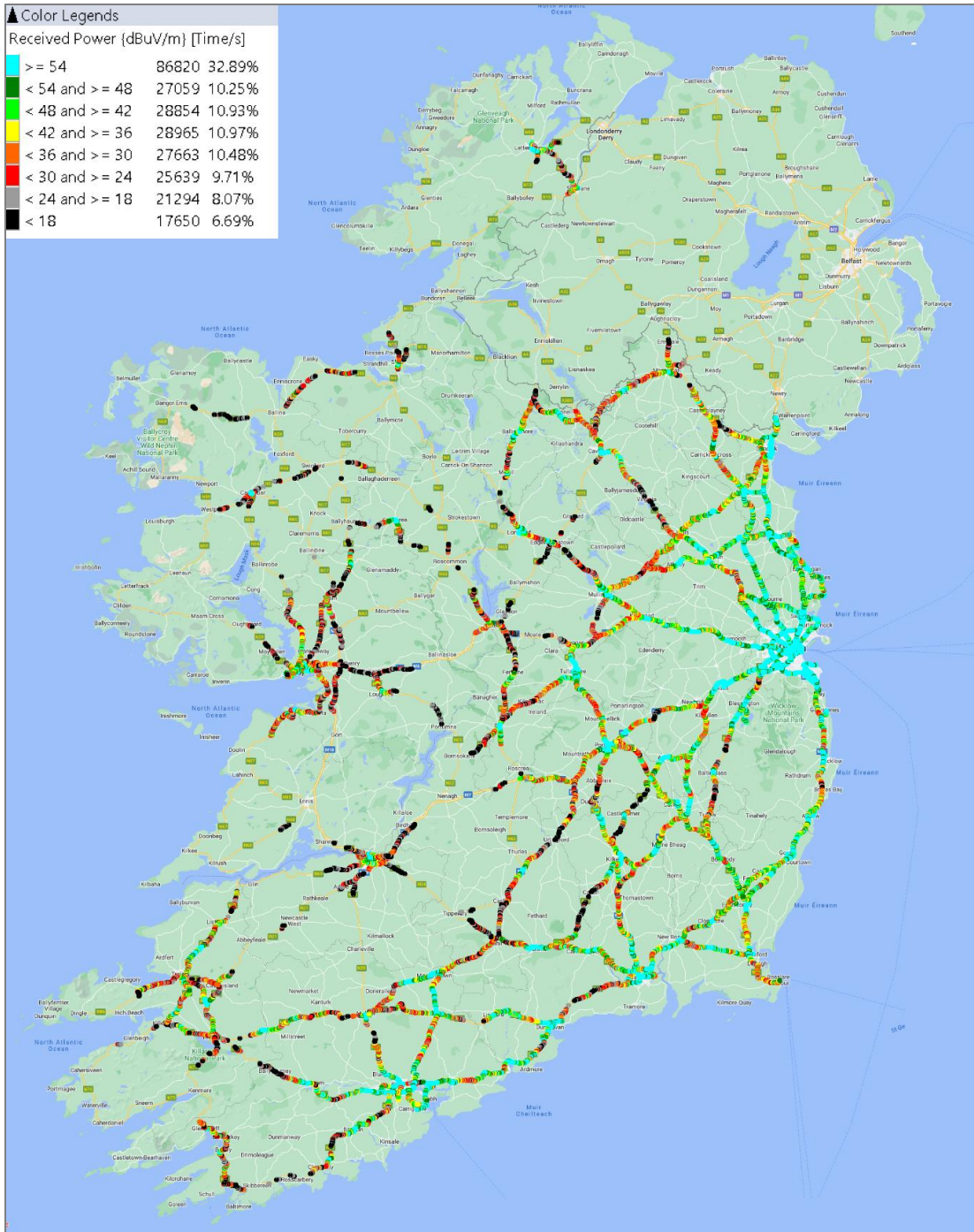


Figure 18: Vodafone – 2100 MHz (3G (UMTS/HSDPA))

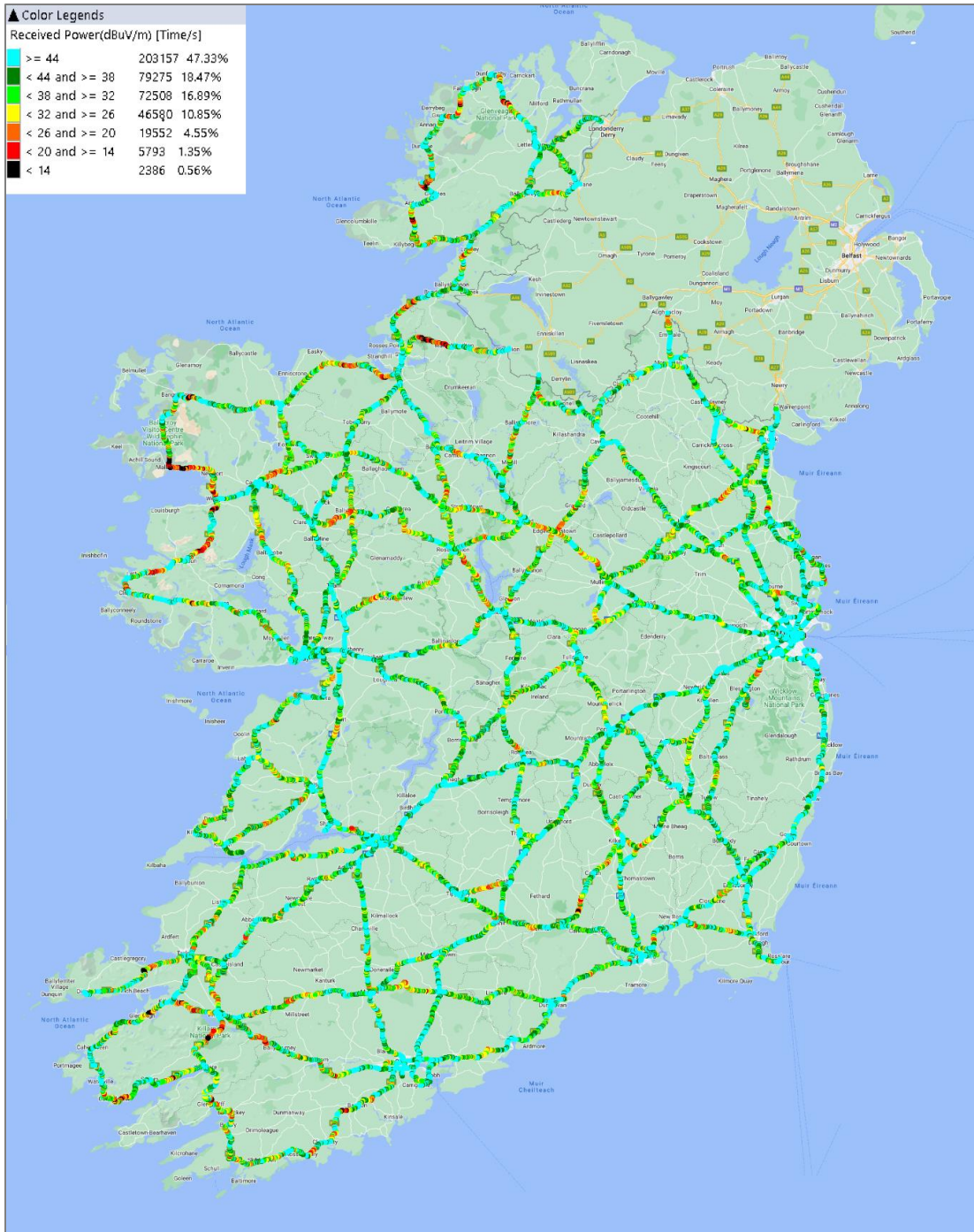


Figure 19: Vodafone – 800 MHz (4G (LTE))

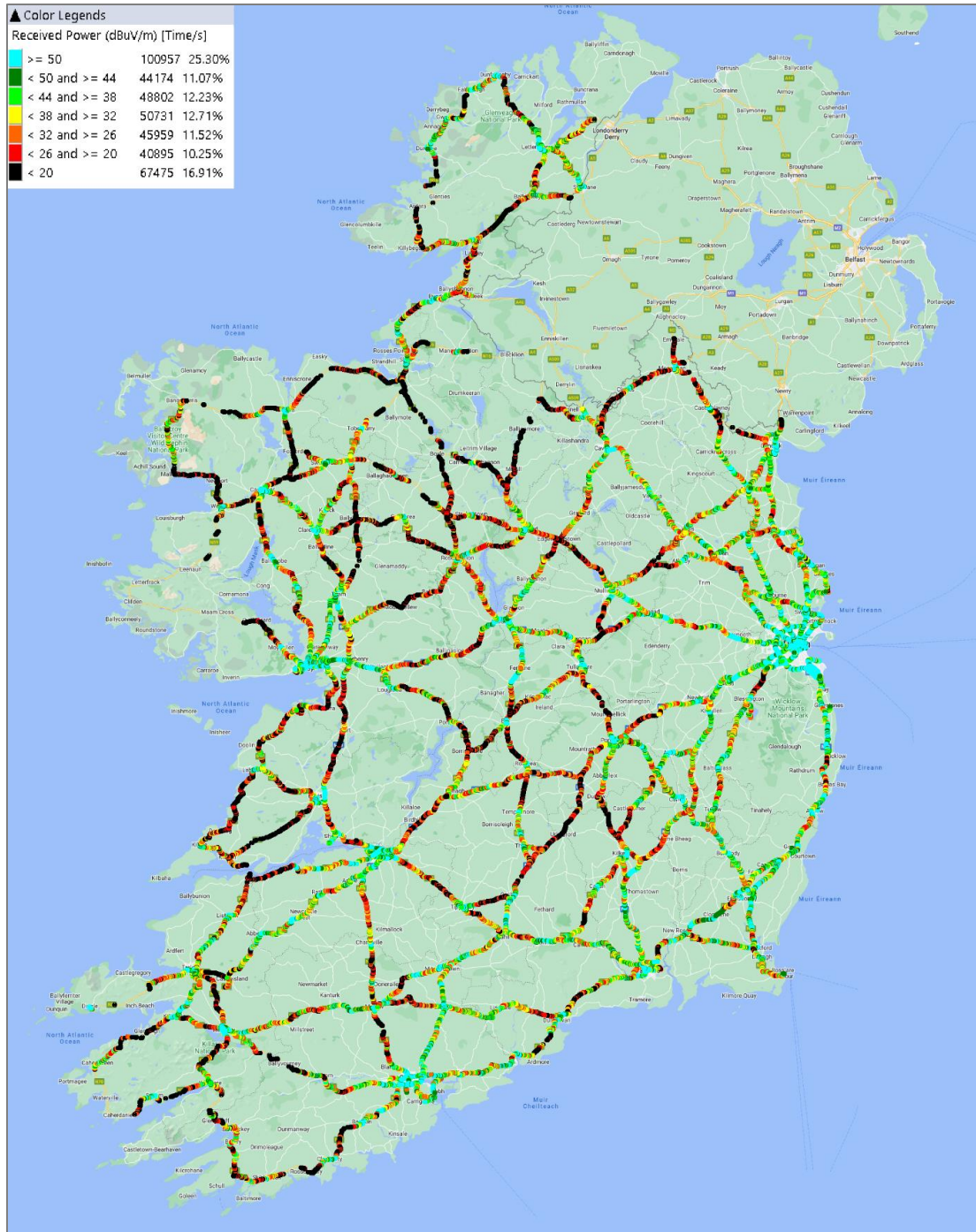


Figure 20: Vodafone – 1800 MHz (4G (LTE))

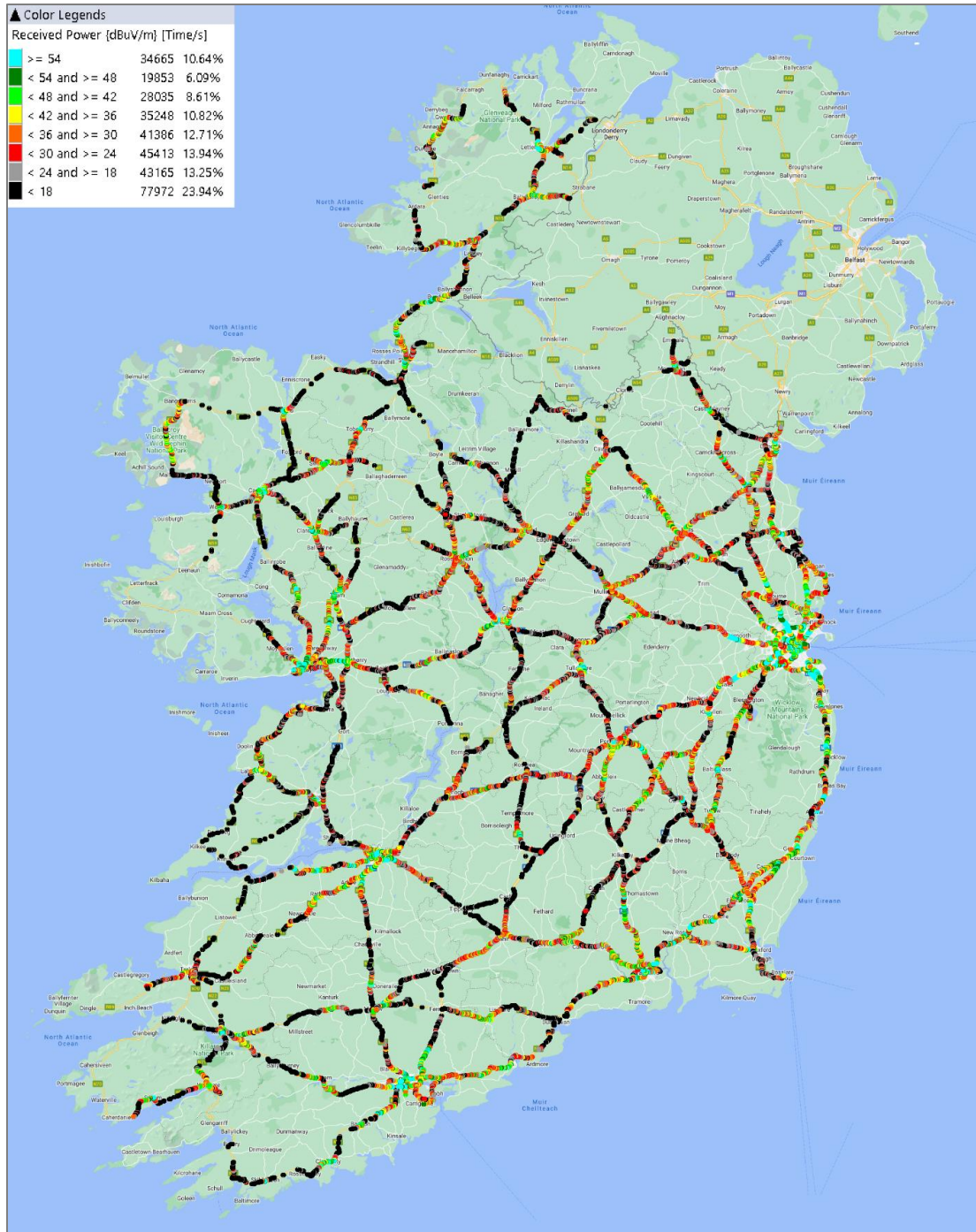


Figure 21: Vodafone – 2100 MHz (4G (LTE))

3 Conclusions

15. Considering the results of the drive test coverage along with information from ComReg's outdoor mobile coverage map, ComReg observes that the MNOs are continuing to develop and improve their networks. For example, compared to the previous drive test report (i.e. for Winter 2021¹⁵), the results of this drive test indicate that:
 - the more spectrally-efficient¹⁶ 4G (LTE) technology now appears to be more widely deployed in each of the 800 MHz, 1800 MHz and 2100 MHz bands;
 - while the legacy 3G (UMTS) technology in the 2100 MHz band would now appear to be less widely deployed.
16. In relation to the coverage obligations for the 800 MHz, 900 MHz and 1800 MHz bands, the results of the Drive Test indicates that each MNO is currently complying with the coverage obligation of >70% demographic coverage as set out in its Liberalised Use Licence.¹⁷
17. In relation to the 2100 MHz band, ComReg observes that each of the MNOs have now deployed two technologies in this band, namely legacy 3G (UMTS) technology and the more spectrally-efficient 4G (LTE) technology, and one MNO has also deployed some 5G services in this band¹⁸.
18. While the coverage obligations in the Third Generation and GSM Licences relate to the deployment of the 3G (UMTS) technology¹⁹, the deployment of 4G (LTE) and 5G technology in this band improves the spectral efficiency of the MNOs' networks and in turn benefits consumers by providing lower latency and higher mobile data speeds.

¹⁵ ComReg Document No. 22/04: <https://www.comreg.ie/publication/assessment-of-mobile-network-operators-compliance-with-licence-obligations-coverage-winter-2021>

¹⁶ See:

https://www.etsi.org/deliver/etsi_tr/136900_136999/136912/11.00.00_60/tr_136912v110000p.pdf
https://www.etsi.org/deliver/etsi_tr/136900_136999/136913/14.00.00_60/tr_136913v140000p.pdf,
https://www.ofcom.org.uk/__data/assets/pdf_file/0015/45501/hspa_vs_lte.pdf

¹⁷ Data available from the Central Statistics Office 2016 is used for estimating the population in the areas covered by the Drive Test. ComReg notes that the populations in many areas now may differ slightly since 2016.

¹⁸ 5G coverage is not measured in this drive test.

¹⁹ When the Third Generation and GSM Licences were issued in 2002 and 2007, the 3G (UMTS) technology was the most advanced technology at that time. It is only recently, in 2020, that the deployment of other technologies, such as the 4G (LTE) and 5G (NR) technology, in the 2100 MHz band became possible in Ireland.

19. Therefore, the **combined coverage** of all technologies deployed in the 2100 MHz band would be the more appropriate basis for assessing coverage in the 2100 MHz band with respect to the coverage obligations in the Third Generation and GSM Licences. In this regard, ComReg observes that the appropriate metrics for this approach should be informed by a consideration of all relevant information available to ComReg²⁰, including the results of drive tests, noting that ComReg intends to carry out a further drive test later this year.

²⁰ For example, considering information from other relevant licensing frameworks, and from ComReg's coverage map.

Appendix 1: Drive Test Route

A 1.1 The Drive Test route covers the full length of Ireland's national primary and secondary (N) road network, including all towns thereon and Motorway sections. The route is approximately 5,500 km long with the coverage levels, of the MNOs' licenced networks in their respective bands, assessed as the route is driven.

A 1.2 In addition to these roads, the Drive Test was conducted on the roads emanating from the 5 main city centres across Ireland, including orbital and interlinking roads in the cities of:

- Dublin, including:
 - 1) *M50 Ring Road;*
 - 2) *North Circular Road;*
 - 3) *South Circular Road;*
 - 4) *R114 from Portobello Bridge to Dame St; and*
 - 5) *O'Connell Street from Eden Quay to Parnell Square East along North Frederick St. to Dorset Street;*
- Waterford City;
- Cork City;
- Limerick City; and
- Galway City

In the cities, detailed above, the Drive Test was primarily conducted during the busy hour, typically between 1700 and 1900 hours and in general, all testing was conducted between 0900 and 2100 Hours.

Appendix 2: Glossary

A 2.1 Terms defined in this Information Notice, unless the context otherwise requires or admits, have the meaning set out below:

2G	Second generation mobile services (e.g. GSM)
3G	Third Generation Mobile System (e.g. UMTS)
3G Licence	A Licence issued under the Wireless Telegraphy (Third Generation and GSM Licence) Regulations, 2002 and 2003 (S.I. 345 of 2002 and S.I. No. 340 of 2003) for 3G services in the 2100 MHz band.
3GPP	Third Generation Partnership Project
3IHL	Three Ireland (Hutchison) Limited
4G	Fourth Generation Mobile System (e.g. LTE)
5G	Fifth Generation Mobile System
800MHz band	The frequency range 791 – 821 MHz paired with 832 – 862 MHz
900MHz band	The frequency range 880 – 915 MHz paired with 925 – 960 MHz
1800MHz band	The frequency range 1710 – 1785 MHz paired with 1805 – 1880 MHz
2100 MHz Band	1920 – 1980 MHz paired with 2110 – 2170 MHz, and 1900 – 1920 MHz
ComReg	The Commission for Communications Regulation
Down Link, D/L	The radio channel from the base station to the user's handset
Drive Test	Measurements conducted from a vehicle containing a computer-controlled measuring system which acts as a 'handset', matching an European Telecommunications Standards Institute ("ETSI") standard handset, which places the calls and transfers the files automatically to a fixed line

	and references the measurements to GPS ("Global Positioning System"), as the route is driven
EC	The European Commission
Eir	Eircom Limited
ETSI	The European Telecommunications Standards Institute
EU	The European Union
General Authorisation	An authorisation for an undertaking to provide an electronic communications network or service under and in accordance with Regulation 4 of the Authorisation Regulations.
GPS	Global Positioning System
GSM	Global System for Mobile Communications from the European Telecommunications Standards Institute ("ETSI")
Hz	Unit of Frequency, one vibration per second
LTE	Long Term Evolution family of standards from European Telecommunications Standards Institute ("ETSI") and Third Generation Partnership Project ("3GPP")
LUL	Liberalised Use Licence
LU	Liberalised Use Licences
Mbps	Mega (One Million) bits per second, a measure of data throughput
Meteor	Meteor Mobile Communications Limited
MHz	Megahertz, One Million Hertz
MNO	Mobile Network Operator
SIM	Subscriber Identity Module
Third Generation	A mobile and wireless communications system based on a standard within the IMT-2000 system capable of supporting innovative multimedia services beyond the capability of second-generation systems such as GSM, and capable of

	supporting the characteristics referred to in Annex 1 of the UMTS Decision
TGL	Third Generation Licence
Up Link, U/L	The radio channel from the user's handset to the base station.
UMTS	Universal Mobile Telecommunications System
Vodafone	Vodafone Ireland Limited

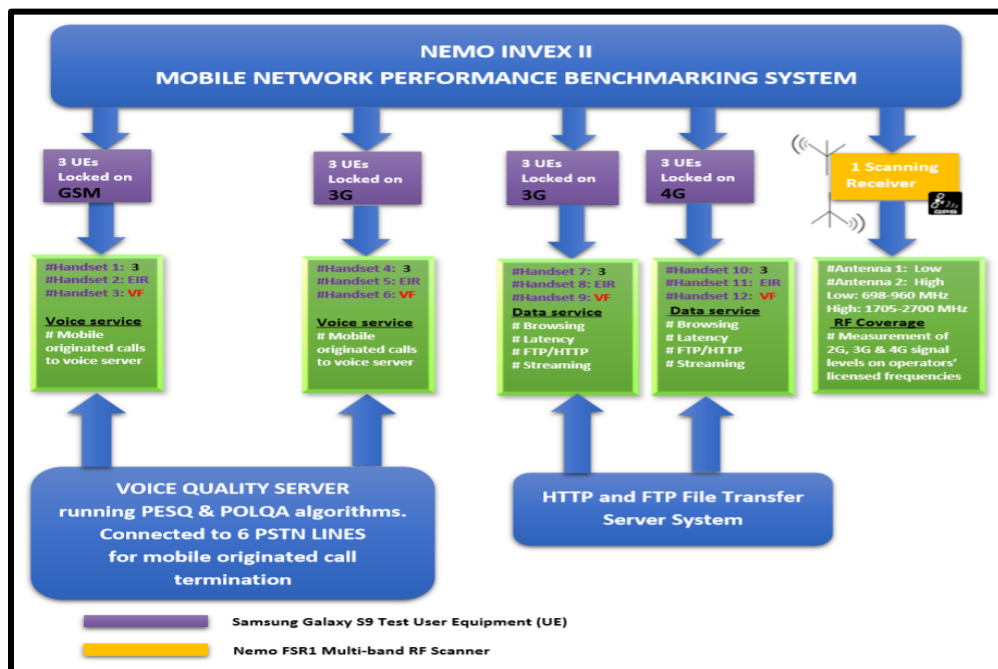
Appendix 3: Drive Test Equipment

A 3.1 The following equipment was used to conduct the measurements during this Drive Test. All equipment was within calibration at the time the measurements were taken:

- Nemo Invox II with associated measurement servers;
- Nemo FSR1 multi-band scanner;
- 2 multi-band antennas;
- Laptop with Nemo Outdoor application;
- Samsung Galaxy S9 test phones with Nemo Media Router application;
- A HTTP and FTP server based in Dublin; and
- Relevant SIM cards.

The equipment configuration is shown in Figure 22 below.

Figure 22: Drive Test Equipment Configuration.



Figures 23 and 24 below show the set up deployed in the measurement vehicle:

Figure 23: Measurement Set Up Showing Handsets.



Figure 24: Nemo Inven II, which connects to the Handsets.

