Mobile Coverage and Deployments in Ports

British Ports Association
MD@telint.biz

Telint

EXECUTIVE SUMMARY

The digitalisation of ports will allow them to operate more autonomously and efficiently. 5G will be the catalyst for such innovation, but the current priorities of mobile operators - for understandable reasons - do not readily lend themselves to providing coverage at ports or developments would be more advanced than they currently are. However, recent market and policy changes have placed ports in a prime position to take advantage of building their own private mobile networks and benefit from increased efficiencies they make possible.

Abroad, many developments are underway, Oulu, Hamburg, Rotterdam, Antwerp, Valetta and Livorno to name a few. Meanwhile, in the UK plans to switch off old copper networks altogether as intend will accelerate the pace of change as indeed could the requirements resulting from Brexit.

There is no such thing as a ”one-size-fits-all” private network that would meet the needs of ports, and neither would this necessarily be very cost effective either given how radio spectrum works. Put simply, the connectivity requirements of a container port, automating through sensors and crane management is quite different to those of a cruise terminal delivering high speed Wi-Fi for video calls and streaming, which is turn is distinct from local fisheries, working with ports and developing new aquaculture businesses. No port is identical, so it follows that there is a wide variation in the types and scale of the network that are emerging. Over the short to medium term we foresee the continued growth of private or other hybrid networks compared with operator alternatives. If an operator is able to meet your specific needs in the timeframes you have and at price points you believe to be reasonable then this remains the obvious option, but now by no means the only one.

One thing, however, is certain 5G is coming to ports, and more quickly than might have been thought. Change is coming, and it is largely being driven by ports themselves. It seems to be that having your own private network is proving more attractive than some had expected, telecoms operators provides solutions remain attractive too if they meet your needs.

The Department of Digital, Culture, Media and Sport (DCMS), is already funding 5G test bed activities in some of the UK’s larger ports. It would be helpful to see what kinds of 5G networks would best serve ports of all sizes and handing different types of traffic with distinct connectivity needs. It is likely that DCMS will have a further call for proposal under the 5G programme later this year. There is absolutely no reason why other ports, if interested, should not consider submitting bids for funding.

BACKGROUND

UK ports are independently owned and commercially managed, operating strategically and financially separate of Government. With very few exceptions, UK port infrastructure investments are privately financed. Port investments are market-led and the UK's industry is currently investing in excess of £1.7bn worth of infrastructure projects. Ports ask for very little from the Government, but they do rely on investment in modern infrastructure, which includes digital networks.

The UK ports industry plays a key role in the country's economy as 95% of the UK's international trade is carried through British ports, which amounts to approximately 475 million tonnes each year. UK ports also handle more than 60 million international and domestic passenger journeys each year and directly employ around 115,000 people.

British Ports Association

The British Ports Association represents a wide variety of ports, including operators that manage over 400 ports and terminals around the UK. These ports collectively facilitate 86% of maritime trade in the UK as well as providing hubs for energy, marine services, fishing, recreation, and tourism. The BPA is currently undertaking a long-term review on three core elements of port connectivity, which includes digital connectivity.

Telint provides help to businesses on both the technical and commercial aspects of 5G deployments. From spectrum management to return on investment they enable the creation of wireless networks to optimise operations. They are currently partners in a 5G Test Bed in Dorset, funded by DCMS, that includes the Port of Portland.

Telint

Contents

1 MOBILE SERVICES IN PORTS

The deployment of wireless services provides numerous advantages over their wired counterparts, in particular ubiquitous and portable connectivity. A comparable wired system would be not feasible due to the sheer volume of cables needed! Therefore, many ports around the world have been new deploying wireless systems. The Port of Livorno is currently constructing a 5G network designed to manage autonomous loading and unloading ground vehicles, to increase port throughput. The Port of Hamburg, has deployed a 5G network, which has; optimised traffic signals, collects real time environmental and movement sensor data, and provides maintenance crews 'heads up' display information through connected glasses. Several ports in China have deployed 5G video monitoring, improving security and providing real time visual feedback for port operators. Singapore also has a range of innovation developments underway.

Another recent tread is for aquaculture operations to be augmented through the use of monitoring sensors for water level, salinity, turbidity, temperature, oxygen and water currents. Underwater video monitoring in particular gives a unique insight into the marine ecosystem. This increased data lets farmers optimise yields while reducing the human required oversight required, and therefore increasing throughput through the port itself. This type of system has already been deployed in the Port of Portland itself, as well as several Scottish Sea Farms locations in Orkney to monitor salmon pens. Plainly, increased connectivity allows for increased efficiency.

Sometimes these changes have been 'telecoms operater driven' often though they have not. We call these non-telecoms operator lead networks ”Private Networks” They are focused on the specific needs a port has, which a more traditional public network was not designed specifically to serve.

2 A PRIMER ON RADIO SPECTRUM

The range of wireless connectivity depends on the type of radio signal used, for example Very high frequency (VHF) marine radio and AIS use frequencies of around 100 MHz to transmit and receive. This gives significant range for communications - as much as 10km between two small vessels at sea level. Yet employing an even lower frequency signal, such as marine High frequency (HF) - operating in 3 and 30 MHz - provides a range as much as 3000km, as this low frequency can reflect off the ionosphere. However, range is not the only relevant factor when designing a radio network - on a standard VHF radio channel, one person can speak at a time. If two users transmit simultaneously, there is interference and the resulting signal is likely to be unusable. The capacity of a VHF channel is therefore very low (1 person's voice). Such a low capacity would not be suitable for modern digital telecommunications networks, such as 2G, 3G, 4G and 5G networks, as these technologies are designed to carry much more information. Therefore, mobile systems use considerably higher frequencies to gain more capacity - 5G networks can use radio carriers in the 3500 MHz band, with widths of as much as 100 MHz. The downside of this much higher frequency is although there is much higher capacity for large quantities of data the range is the signal is reduced. In fact, a high capacity 5G cell will likely only deliver coverage over as little as 1km - ideal for dense urban environments with large numbers of users, but less ideal for sparsely populated areas.

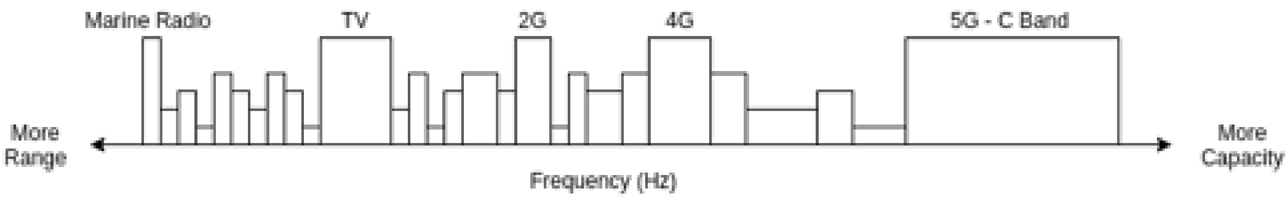


FIGURE 1: RANGE VS. CAPACITY OF SPECTRUM

To mitigate this problem modern mobile communications networks are divided up into areas of land or "cells", each of which has a transmitter and receiver which are reasonable for their area of land. To maximise land coverage the transmitter and receiver - commonly known as a base station - is generally mounted on a high point of land, and it transmits to devices within its area of coverage. However, the coverage of a VHF or HF network will be considerably more than what a mobile network could achieve. This is why a vessel leaving port will most likely lose connectivity on mobile phones long before they lose VHF radio connectivity to the port. The downside to this approach of cells, is as the number of cells required to provide connectivity across a given area, the cost of delivering such connectivity is also increases. Designing a mobile network therefore requires a balance of both low, longer range spectrum and high capacity short range spectrum.

As spectrum - A subset of frequencies - is a finite resource the cost increases with the demand, and just as only one user can speak on a VHF channel at a time, only one mobile network operator can use a given section of radio spectrum at a time. This means that radio spectrum is a highly contested asset, and when access to spectrum is auctioned, prices have tended to be in the order of hundreds of millions of pounds for even small amounts of spectrum. Low frequencies are particularly desirable, as they work across longer distances, meaning less equipment is required to deliver connectivity across a given area, and this means that less of this spectrum is available, due to the demand from other users.

When designing a mobile network, the location of cell sites is important - a cell site positioned high up on a hill will have a better view of the surrounding area, and be able to deliver a stronger signal to users within line of sight of the location. Where there are large numbers of objects or other obstructions to line of sight, it is likely however that coverage will be poorer - these obstructions could include cliffs, other hills, buildings, containers, or vessels themselves! Obstructions like these often reflect the radio signal back, creating a shadow in coverage.

In essence, a 5G mobile network is the equivalent of a super-tanker - huge capacity, but significant complexity - while a traditional marine radio is the equivalent of a personal yacht - simpler but with far less capacity available.

Based on the above, it is immediately clear why, in some ports, coverage may be highyly variable. This issue is compounded by the perceived demand in ports, or rather the lack thereof. Traditional mobile network operator business models are predicted on the target “ARPU” (Average Revenue Per User) of circa £15 per month in the UK to get a return. This is generally made up from a majority of contract users paying over £20 per month for service, and a minority of pay-as-you-go users paying below £10 per month for service. Therefore, understandably operators design their networks around where they can get the highest density of people, rather than on other factors such as presence of ports or similar.

New innovations such as the IoT (Internet of Things) challenge this established business model, since the users of connectivity start to become shipping containers, infrastructure, safety or security equipment, traffic lights, and agricultural machinery. However, as these use-cases will be unlikely to bear costs of £15 per device per month, they typically are seen as an addition to existing coverage rather than the opportunity to expand coverage. This is in part why the uptake of cellular IoT services has been stunted compared to alternatives. Therefore, in order to realise the benefits of IoT, cost effective ubiquitous seamless connectivity is required - in the same way that nobody wants to listen to a radio programme that keeps on being interrupted due to interference and static noise, few will want to use an IoT service that only connects successfully for a few hours overnight.

3 THE STATE OF COVERAGE IN UK PORTS

The huge variation in terrain and land utilisation around the UK's nations makes accurately predicting mobile coverage an immense task, and instead mobile operators have to take a 'best guess' approach using generalisations which is far from perfect, particularly in areas where there is a large amount of metal or large structures, both of which will block radio waves and are abundant in and around ports. These generalised predictions are provided to the telecommunications regulator Ofcom, to establish the state of coverage across the country. However, from a ports perspective, there are two things to note. 1) The coverage predictions do not extend over the water, making it challenging to assess if ships would receive mobile signal. 2) These predictions do not take into consideration the construction materials of buildings. This is important, as different materials have a different effects on the propagation of radio waves, and therefore, where a service could accurately used. This has been particularly problematic with new build structures for example, as although layers of insulation make the building environmentally friendly, they also make them radio frequency unfriendly, blocking much of the required radio signal for a usable service.

A European container Port was chosen to demonstrate this variation between generalised simulation and reality. The port itself is situated next to a large metropolitan centre, giving it the best possible chances of achieving coverage - mobile masts are often positioned in industrial areas which then overlook residential areas. A position of an existing mast was selected and the coverage was re-modelled taking into account the various obstruction within the port environment. This resulted in the coverage being notably worse. The signals struggle to navigate through and past the containers result in various blackspots throughout the port. This is not a surprising result as various academic studies [1] [2] have also found that a Port represents one of the most challenging RF environments, due to the number of large metal objects present there.

This illustrates one of the most significant weaknesses of operator and regulator coverage modelling - it was never not designed to accurately model service performance and availability that will actually be realised. What, for example, would happen if an connected autonomous vehicle or crane lost signal.

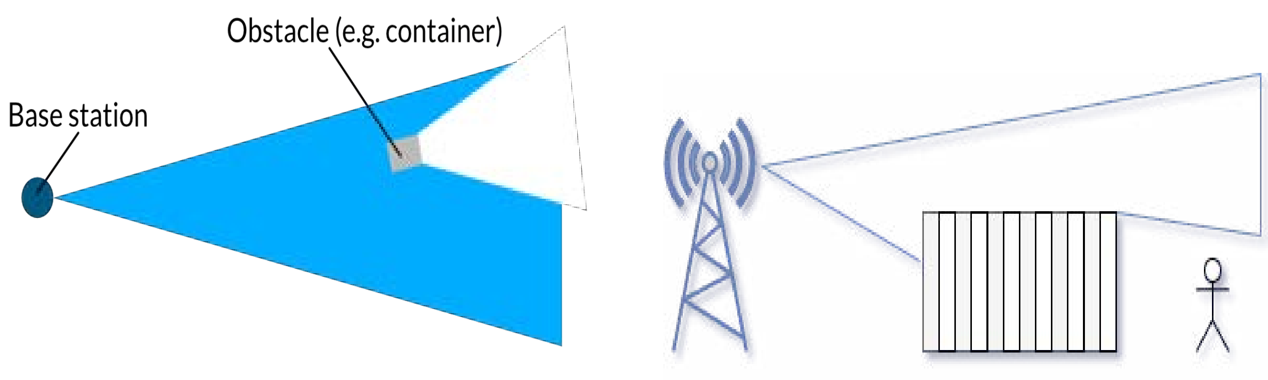
There are significant network planning implications highlighted by this. Firstly, it is clear that coverage in ports will be significantly impacted by ground-based obstacles, including containers and other large metal items. Also as the frequency bands being used increase, they will be increasingly blocked and attenuated (diminished) by such objects, and can only cover much smaller areas. Therefore, the selection of the appropriate band is vital.

[1] Propagation Models for GSM 900 and 1800 MHz for Port Harcourt and Enugu, Nigeria, Ogbuleziel

[2] Characteristics of Propagation Conditions in the Container Terminal Environment, Ambroziak & Katulski

When viewing the coverage plots shown throughout this report, it is therefore important to keep in mind that these are based on reported coverage information from Ofcom. However, from looking at the data maps around the selected European container port it is clear that you should anticipate localised disruption of connectivity due to containers and other solid ground-based infrastructure, which will not appear on these maps, and would be near impossible for telecoms operators to accurately predict their coverage plans.

This underlines the importance of ensuring that if you rely on coverage in your port, it has been designed to meet your specific needs - Moving container stacks and cranes will create dynamically shifting areas of reduced connectivity. This is a scenario that any non-specialist networks would struggle to work around, and an understanding the specific operations of a port is necessary to improve connectivity. It is vital that cell sites are placed at suitable locations based on the working patterns of the port, in order to mitigate such risk.



(a) BIRD'S EYE VIEW

(b) SIDE-VIEW

FIGURE 2: ILLUSTRATION OF RF SHADOWING

It is also important to remember that whilst coverage is generally considered on a 2-dimensional map (i.e. from above), radio waves actually propagate in 3D space. This means that height also plays a significant part in determining what level of coverage will be available. Ports, by their nature, tend to have large, mobile 'RF-opaque' objects in their periphery, ships, in fact, any large obstacles like these will have a significant impact on the whether a signal is received at all, and if one is, its quality.

At ground level, there are likely to be more areas of disruption in a port, as a result of any nearby high objects casting a "shadow" across them. Figure 4a and 4b illustrate this effect. In all, it is immediately clear why ubiquitous coverage in ports is hard to deliver. However, along with 5G has come a relaxation in radio spectrum policy - and with that, greater opportunity and flexibility to address these issues cost-effectively, as more bands are now available, and not just to telecoms operators.

4 IMPROVING CONNECTIVITY AT PORTS

As demonstrated, the quality of connectivity depends on a variety of factors. Simply having a mobile cell site nearby does not guarantee a good quality connection, or indeed adequate bandwidth. In order to deliver a good connection, you require five things:

1. Spectrum - the radio spectrum required to deliver a service
2. Backhaul - the (fibre) connectivity to your port, to connect your network to others
3. Power - the electricity needed to run the base stations and networking infrastructure
4. Infrastructure - suitable locations with robust masts or poles for mounting radios
5. Planning - appropriate permissions from your local authority

4.1 SPECTRUM

Historically, spectrum has been a complete blocker for organisations wishing to improve their own connectivity - their only option until recently, was to use unlicensed spectrum, which is widely used by everyone. For example, Wi-Fi works in the "unlicensed" 2.4 and 5 GHz bands, and is shared amongst other people's Wi-Fi networks, microwave ovens, and similar.

In order to deliver high-capacity data connections, it is necessary to have access to contiguous blocks of uninterrupted spectrum. Additionally, it is necessary to use harmonised spectrum, in order to benefit from international economies of scale - in the same way that marine VHF radios use a standard spectrum band, (and therefore you can buy your marine radio from any supplier), there are international standards for the spectrum bands used for Wi-Fi, 4G, 5G and other wireless communications standards.

The use of harmonised spectrum however, by definition, means that it is necessary to gain access to specific parts of spectrum where there are standardised bands. These have historically only been available to telecoms operators, and were auctioned on a national level. This has changed however in recent years in the UK, and it is now possible to gain access to additional spectrum bands in a number of new ways on a local basis, at dramatically lower prices than previously possible. This means in turn that the cost of that spectrum does not have to be passed onto you, and that some bands might be more suitable for port specific needs.

Not all radio communications systems are standards-based - there are many non-standardised, proprietary radio solutions available on the market. While these can be more flexible in using "off-cuts" of spectrum that would not normally be used for mobile service, these generally lock you into a far smaller ecosystem of equipment, often from one specific vendor, or a smaller subset of vendors (for example, TV Whitespace spectrum, which

FIGURE 3: SPECTRUM USERS ARE 'THINGS' NOT JUST PEOPLE

is used on vessels in the Orkney Islands).

Demand for spectrum is rising as a result of 5G deployments (5G networks use more spectrum than previous generations of networks, since they aim to deliver higher speeds). However Ofcom has now allocated significant dedicated 5G spectrum specifically for 'industrial' use-cases and other local deployments of 5G networks, which can be used by ports as well. This spectrum is available on a "first-come, first-served" basis for applications. An indicative cost for a single-site spectrum license (which can serve many devices within range) under this regime could be as low as £80 per year, as opposed to the millions commanded by nationwide spectrum auctions.

4.2 BACKHAUL

There is little value in a telecommunications network that is unable to communicate with external systems beyond the port gates. A mobile network uses radio signals to communicate with devices that sit in range of the base station cells, but then uses a fixed fibre-based network to "backhaul" the data from the base station to your local data centre, and then on to the wider internet as required.

In order to benefit from 5G connectivity in and around a port, there will therefore be a need for high speed fibre-based connectivity to be available either at or in close proximity to the port - 5G as a technology itself will not replace the need for fibre to be laid to the port area.

In the UK, the telecoms network are still partly based on old copper networks, designed originally for voice telephone calls. With the advent of the internet, various technologies were used to augment these copper telephone lines, and further "sweat" the assets in order to deliver data-based connectivity services. Such service quality was (and is) heavily dependent upon your distance from the telephone exchange or cabinet providing service down the copper line, and the quality of the line itself - this is why when you look for a broadband connection to your home, you are often provided with an estimated speed that may exceed the connection speed you will receive - the actual performance depends, amongst other things on the quality of the copper line.

The 21st Century Network (21CN) telephone network upgrade project, started in 2004, moved the core phone network (i.e. the trunking and switching systems) towards a digital, computer-based fibre network, but the underlying "last-20-miles" phone lines to households still remained copper. In 2019, BT still had 99 exchanges to upgrade.

With the increase in demand for internet connectivity, and growth in multi-device households, bandwidth consumption has significantly increased year on year. Broadband service providers therefore sought to deliver higher speeds of broadband service down copper phone lines - this led to the concept of "Fibre to the Cabinet" (FTTC) connections, where fibre is laid all the way to a local street cabinet, and then the copper phone lines are used to deliver "last-mile" connectivity into premises. Much of the UK now receives broadband on an FTTC connection, with headline speeds typically of 38 or 63 Mbps. However, with the continual push for faster data connections the government is moving to full-fibre connections. Openreach is therefore seeking to decommission it's legacy copper network completely, and migrate the UK towards a fixed-fibre network

Whilst this will help to deliver faster connections to homes and businesses across the UK, some rural areas will likely be waiting a very long time to see this happen - fibre deployments are expensive for large operators to carry out in rural areas, and offering poor returns on investment. In recent years, BT has quoted prices of as much as "£100,000 to £500,000" [3] for installations of fibre to one single rural residential premise.

The economics of delivering fibre to every premise in the country are clearly challenging, and at present, Ofcom, is attempting to work out how the transition from copper to fibre will be regulated. It has recently held consultations that suggest there may be provision for homes and businesses to be "excluded from the definition of a completed ultrafast exchange"[4] when BT's regulated price controls are being lifted on existing copper-based services, but replacement fibre services are not available. While proposals to date are not yet clear, at present there appears to be no safeguards to ensure that there is a guarantee of a full-fibre

[3] https://metro.co.uk/2020/09/20/man-quoted-500000-for-affordable-broadband-at-his-rural-home-13298937
[4] https://www.ofcom.org.uk/consultations-and-statements/category-1/copper-retirement-process

FIGURE 4: SPECTRUM IS VITAL TO SMOOTH PORT OPERATION

connection being in place before price controls are removed.

Some rural ports are in isolated locations and therefore could be some of the last to receive fibre connections. There is therefore a risk that these locations could be "left behind" during the fibre roll-out. While BT has a clearly stated desire to switch off its, expensive to run, legacy copper, it is unclear how or whether they will be able to provide a fibre service to all rural premises. Indeed, if the "USO" (Universal Service Obligation) for broadband Internet is anything to go by, it is likely that there may not be any requirement for a fixed telephone service to be delivered at all - a USO connection can be delivered to a home through a 4G connection capable of more than 10 Mbps.

As a port, and if internet connectivity is a priority, it may therefore be necessary to actively explore options to improve your fixed connectivity yourself, rather than waiting, as your rivals receive upgrades and are able to progress their digitisation and transformation agendas.

In the UK, there exists a rapidly growing sector of independent fibre network providers, delivering high speed fibre connections independently of the main national BT network. These providers typically offer a price-competitive service subscription, using the latest technology, and are able to deploy modern fibre connections themselves at much lower cost. This means that there is a great opportunity to utilise their services to provide the wider backhaul connectivity required to a port. In many cases, they are also intensely locally focused - for example Wildanet, a rapidly expanding Cornish telecoms operator, who provide enhanced Wi-Fi service around the area of Newlyn Port.

4.3 POWER

Mobile base stations require a standard mains power feed to be available. Whilst this will not generally be a problem within a port itself, if you are considering using an off-site location to improve connectivity around a port, it will be necessary to ensure there is access to a power feed. The other consideration for critical operations is network resilience. By default, mobile base stations have very limited power resilience and autonomy. Indeed, Ofcom carried out research with the UK's public mobile operators, and found that the vast majority of cell sites had little or not backup power capability at their base stations - the majority had less than 20 minutes' power autonomy, in order to allow for a 'graceful' shutdown.

> "Both EE and Three have 6 hours or more of back-up power at around 3% of their sites. EE has a further 4% of sites which can continue operating for five days or more during a power cut. The vast majority have no back-up power."
> For Vodafone and O2's shared network, half of Vodafone-operated sites have 4 hours of back-up power, and the remainder have 1 to 2 hours of back-up power. 5% of O2's sites (its hub sites) have 4 hours of back-up power, with the majority of the remainder having no back-up power, and "an unspecified number of larger coverage sites having 10 minutes."
> - Ofcom's 2019 Connected Nations report

This creates a challenge for running critical operations on public networks as there is a little redundancy. Therefore, any deployed solution would have to include battery backups. The Directive on security of network and information systems (NIS Directive) classifies certain port operators as Operators of Essential Services, and therefore, they have a need to provide strong, secure and reliable communications.

4.4 INFRASTRUCTURE & PLANNING

The placement of mobile masts is commonly a trade-off between coverage and convenience. Masts placed on high towers or on top of hills increases the coverage a mast provides, but also increases the costs of deploying the mast. Taller masts must to have a stronger foundation, to better account for wind loading which creates a larger footprint. Also, local residents may dislike the construction of an 'intrusive tower'. Therefore, planning permission must be applied for and accepted, and wayleaves (permission from the landowner, access for a fee) may be required to run additional electrical and fibre cables to the mast itself. This creates long deployment times sometimes taking years to construct a suitable site.

FIGURE 5: POWER IS ESSENTIAL AT ALL PORTS. IF POWER TO LAMP POSTS AND GANTRIES EXISTS, THIS MAY SPEED UP RADIO DEPLOYMENTS

5 BUILD VS. BUY

Each of these considerations for building a reliable wireless network increases the costs of deployment and therefore, reduces the likelihood of additional masts being provided without an economic return on investment. To help with this rural investment, both The UK and Scottish governments have funded projects aimed to cover the capital costs of providing mobile infrastructure, and allowing any operator to use the infrastructure in exchange for providing a service. The UK scheme called 'the mobile infrastructure project (MIP)' originally provided £150m for the creation of 575 masts, however, this was later scaled down to a more manageable 75 masts for £36m to provide mobile coverage to 7,199 premises. The Scotland 4G in-fill program provided £25m for 42 sites of 4G capability.

These projects have increased connectivity in rural areas, by the government providing the capital expenditure required to build more radio masts, this has made it more economically viable for mobile operators to provide additional infrastructure as the number of consumers in rural areas is not sufficient to commercially justify a new mast. Therefore, without intervention it appears unlikely that coverage of ports will improve and deliver the promised benefits of digital ports until the ports are seen as a viable return on investment. Post Covid-19, we may assume that pressures on the public purse will make interventions on the scale needed to deliver ubiquitous connectivity far less likely.

Ports, however, are in a unique position where they can now deploy mobile networks much more cost effectively than the mobile operators. Operators have to bear the costs of providing coverage over a wide geographical area, whilst ports typically cover a comparatively small area providing a high density of specialist network use cases. Ports also often have access to their own infrastructure for the installation of radio equipment, and if they own the land they are able to run any required cables without requiring wayleaves.

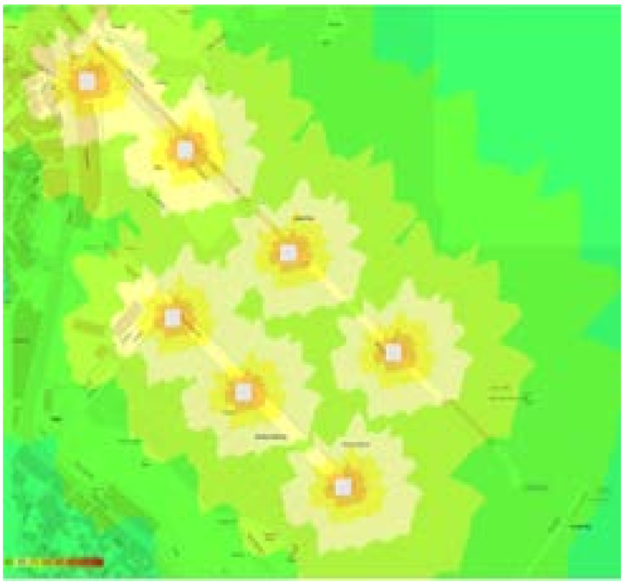
Another large cost for mobile operators is the cost of spectrum but follows recent spectrum legislation changes port are in a position to control and manage their own local networks, as explained earlier. In fact, this already happening in some ports.

6 CURRENT POSITION

UK ports are already beginning the digital transition to try to benefit from the new possibilities afforded by new technology, as detailed in the following examples.

6.1 NEWLYN HARBOUR

Newlyn Harbour is a small, predominantly fishing and leisure port in Cornwall. Wildanet, a local internet service provider, has expanded the port's capabilities through the deployment of a high capacity Wi-Fi network. This has allowed tourists to maintain connectivity to the shore and enables fishermen to report their daily catch to waiting delivery vehicles. The coverage is demonstrated in Figure 6, where each 'cluster' represents a Wi-Fi access point and the colour denotes Wi-Fi coverage strength.



WI-FI COVERAGE

SATELLITE VIEW

FIGURE 6: NEWLYN HARBOUR

6.2 PORTLAND HARBOUR

5G RuralDorset, a £7 million DCMS funded research and development programme aimed at increasing rural connectivity, includes coastal connectivity, agriculture and aquaculture. The aquaculture use case has deployed 5G radio equipment providing coverage for Portland Port. This will be used for aquaculture operations around the port for monitoring aqua life cycles and optimising shellfish and seaweed farming operations. The notably higher transmit powers of mobile services in licensed spectrum allows for a single mobile mast to cover much of the bay. The deployment of a second mast around the industrial area of the port would further expand coverage out into the Channel. In this example, the port is able to lease space for a service to generate income whilst the users can use the technology to improve their profitability. The space is always more desirable as it can generate more income.

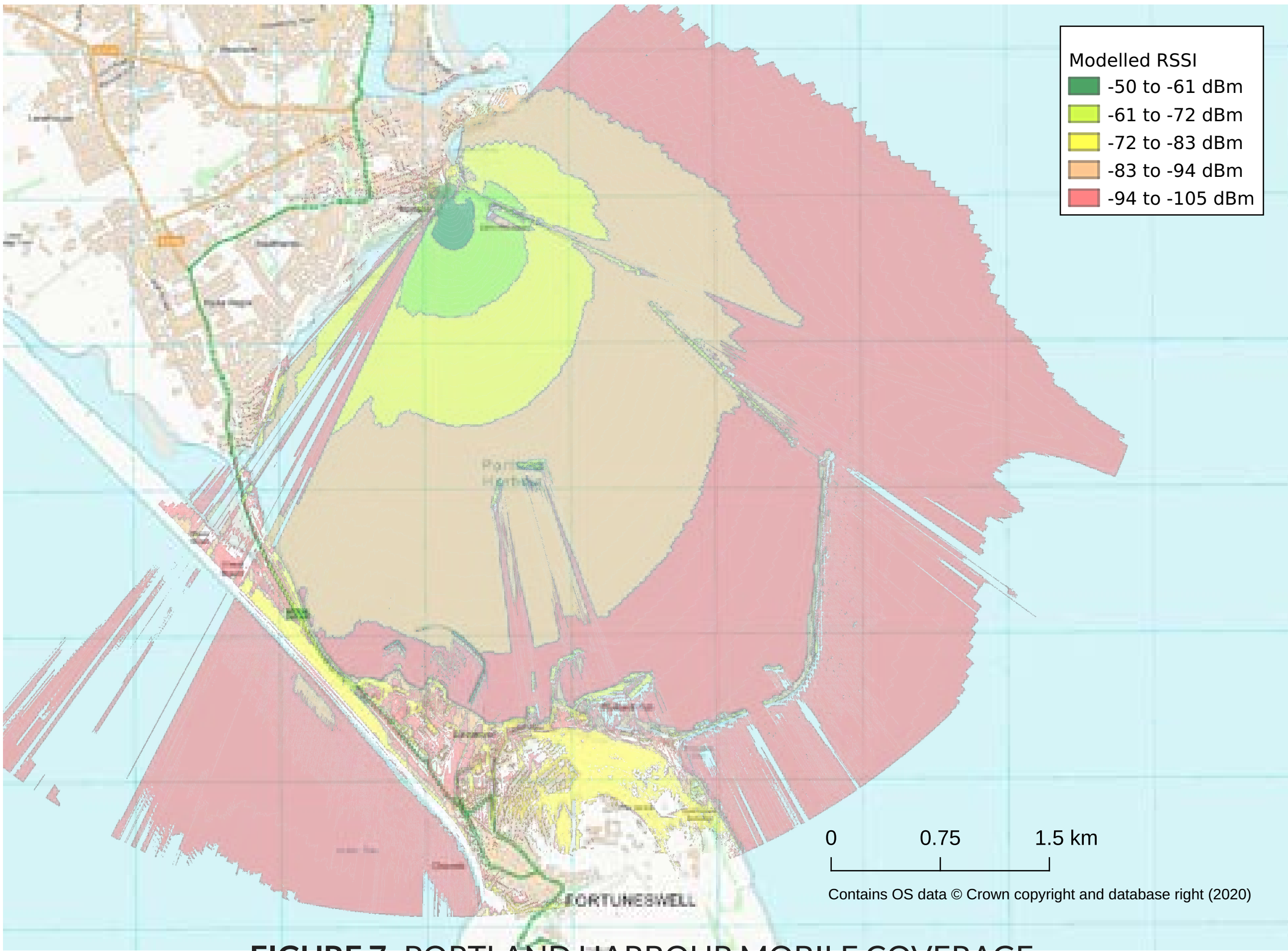


FIGURE 7: PORTLAND HARBOUR MOBILE COVERAGE

6.3 FELIXSTOWE

DCMS has also funded a £3.4 million "5G Create" project, aimed at creating innovative use cases and test beds for 5G. A project just about to start is at Felixstowe, via a strategic partnership between the port authority, Three mobile and Cambridge University, are aiming to deploy Internet of Things sensor devices, increase CCTV coverage and use artificial intelligence to increase efficiencies. However, this is not a “typical” UK port, and further studies at other ports would help to address their 5G needs - which won’t always be ‘container focused’.

6.4 MATCHING THE NEEDS OF EVOLVING DEMAND

At a time where there is concern about a reduction in the amount of goods being shipped through the UK to the Republic of Ireland, some UK ports may risk losing business as a result [5] Ireland increases direct freight shipments to European mainland - Rosslare port has seen a “quadrupling of direct services to mainland Europe”, that is “attributable to the market demand.” Belfast port as also recently partnered with BT to offer a private (also called standalone) 5G Network, specifically designed to achieve the highest levels of ultrafast mobile connectivity, coverage, reliability and security across the Port’s main operational areas.

In such a changing market, there is a clear strategic advantage in ports seeking to use advanced connectivity to gain an “edge”, and evolve their connectivity offerings to match that seen at their European counterparts - in recent months, the Port of Antwerp has announced a 5G network trial [6], and numerous other ports across Europe and Asia are doing likewise [7].

The advantages of advanced connectivity in ports will be best realised when ports at both ends of a voyage are able to make use of interoperable systems based around the connectivity to improve their logistics, speed up the process and reduce costs. Where two ports can offer such a partnership, they may be able to offer a more compelling service to their customers, speeding up the process of loading and unloading cargo, and increasing their throughput capacity. The maximum value for this arises where both ends of the journey are able to do this, and exchange all necessary information through IT networks, allowing for seamless operations throughout the journey. 5G, based on international standards like the well-proven cellular telephone standards that came before it, is therefore well-placed to offer an interoperable solution for ports worldwide.

[5] https://www.ft.com/content/f85c1c2f-9a06-4e5b-9caf-52bdf66a1a28

[6] https://www.portstrategy.com/news101/technology/further-investment-in-5g-in-belgium

[7] https://www.beltandroad.news/business/maritime/5g-innovators-target-port-logistics/

7 CONCLUSION

There are various different types of port around the UK, those handling general non-unitised cargo including grain, steel, and liquids, those of highly containerised units and roll-on/roll-on off, and those feeding local tourism. Each of these ports has a unique set of requirements but each represents a strategic gateway for trade. Growing the local port's eco-system through increased yields, greater optimisation and new markets such as aquaculture, combined with greater connectivity in rural regions which are often built around ports, will help grow local economies and improve employment prospects.

This is achieved through the increase of digital connectivity in ports allows for increasing automation and streamlining processes. Ports around the world are now increasingly taking advantage of the new technology and recent changes within the market and UK spectrum regulations mean that ports are in a strong position to expand their connectivity. Cities have benefited hugely from increased connectivity, so much so this has created a 'digital divide', where those places with high speed reliable connections are better positioned than their poorly connected counterparts. Similarly, better connected ports are more likely to be part of the digital revolution, than those which are not.

Existing Government backed programmes, including the DCMS funded '5G Create' program, have started by looking large container ports, and it would be a very positive step if such initiatives would be rapidly expanded to include a wider range of ports.

A PORT COVERAGE MAPS

O2

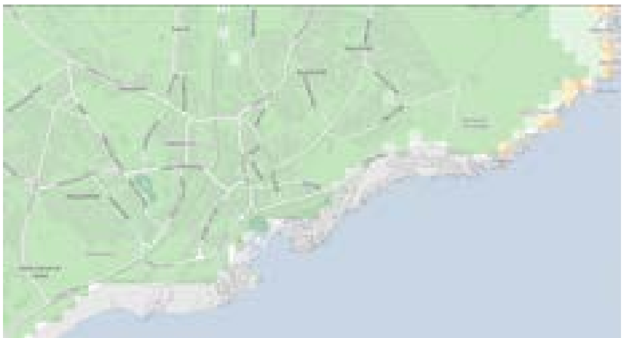
VODAFONE

THREE

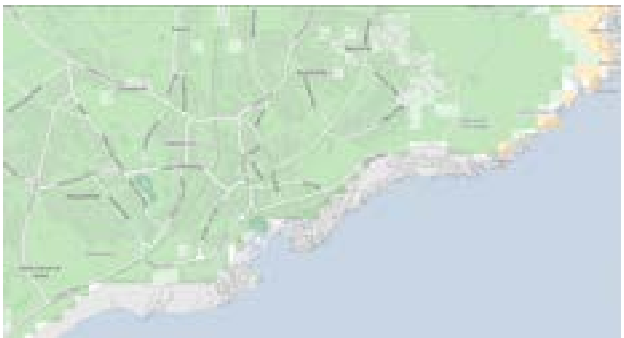
EE

© 2021 Europa Technologies | OS Open Data | OSM

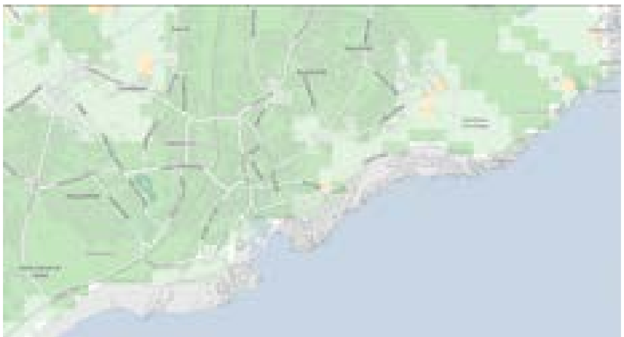
ABERDEEN HARBOUR



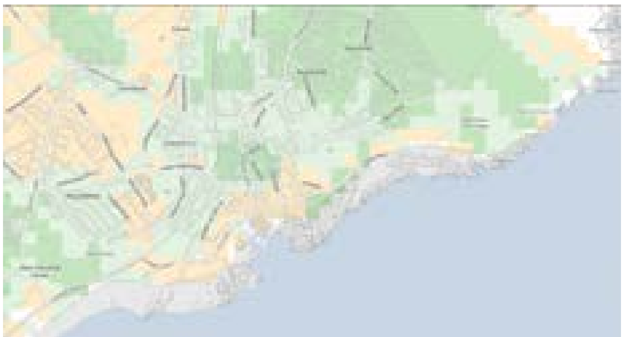
O2



VODAFONE



THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

ARBROATH HARBOUR

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF ARDGLASS

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

BELFAST HARBOUR

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF BERWICK

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF CAIRNRYAN

O2

VODAFONE

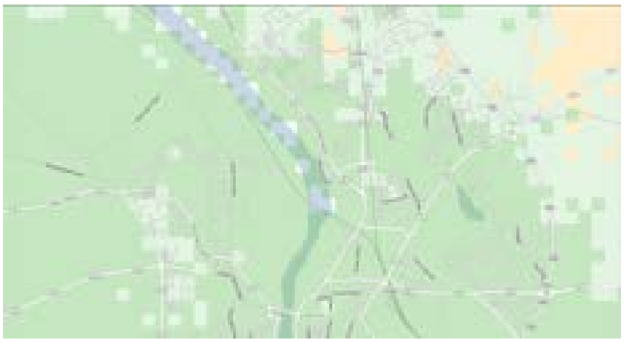
THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

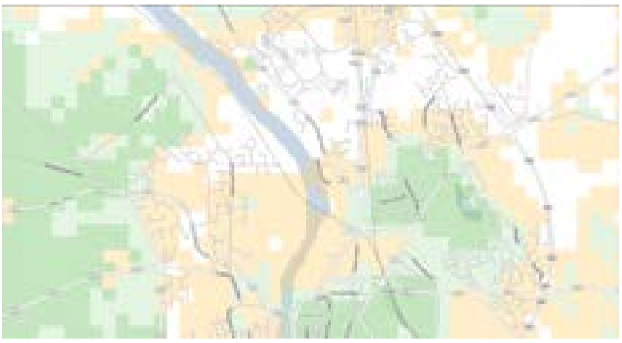
CAMPBELTOWN HARBOUR

O2



VODAFONE

THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF COLERAINE

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF DOVER

O2

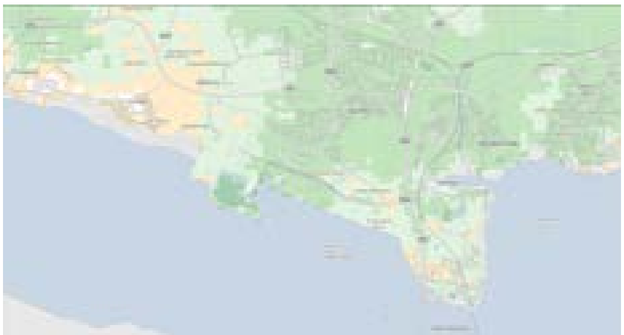
VODAFONE

THREE

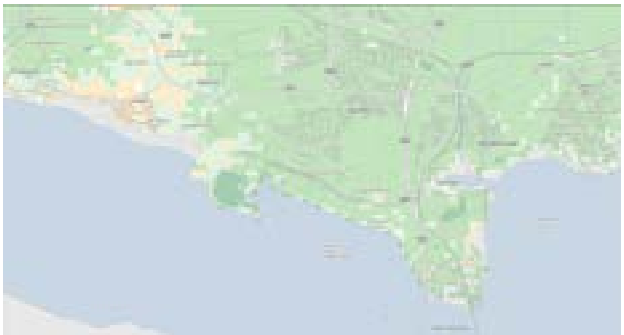
EE

© 2021 Europa Technologies | OS Open Data | OSM

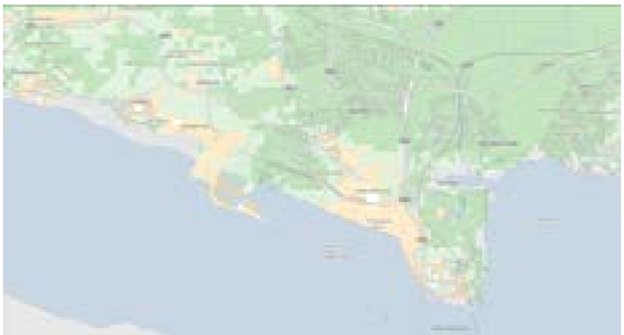
PORT OF FELIXSTOWE



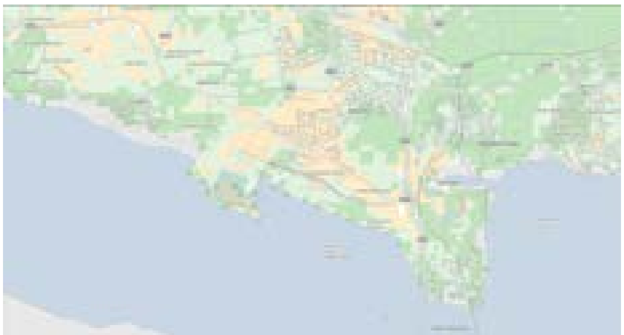
O2



VODAFONE



THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF ROSYTH

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF IMMINGHAM

O2

VODAFONE

THREE

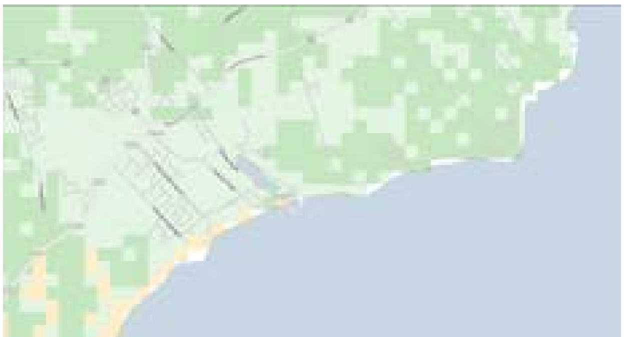
EE

© 2021 Europa Technologies | OS Open Data | OSM

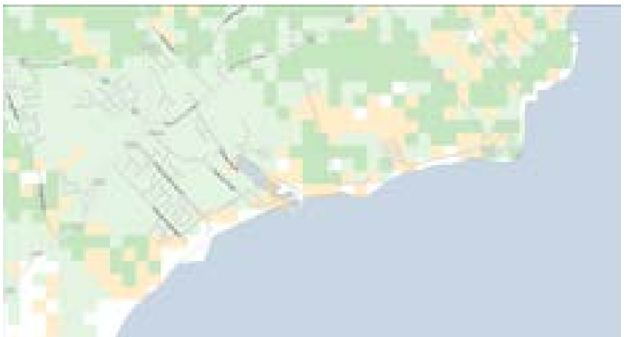
PORT OF INVERNESS

O2

VODAFONE



THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF KILKEEL

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF LARNE

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF LIVERPOOL

O2

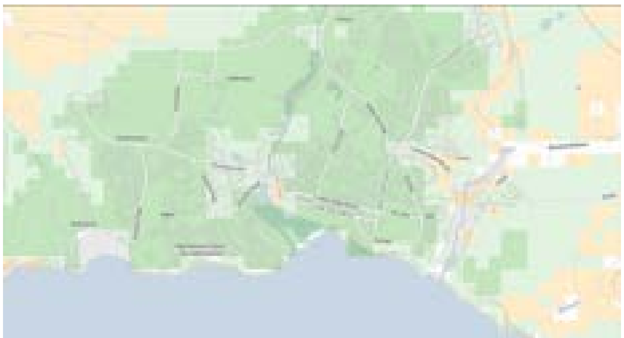
VODAFONE

THREE

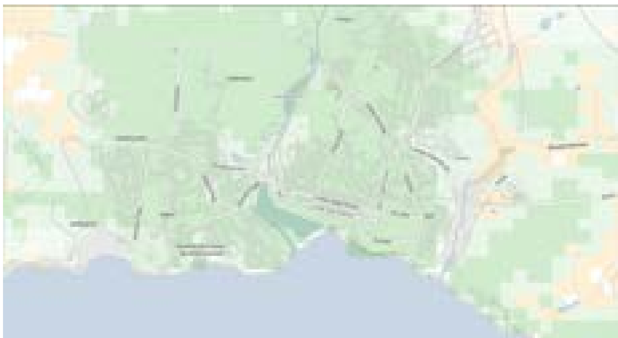
EE

© 2021 Europa Technologies | OS Open Data | OSM

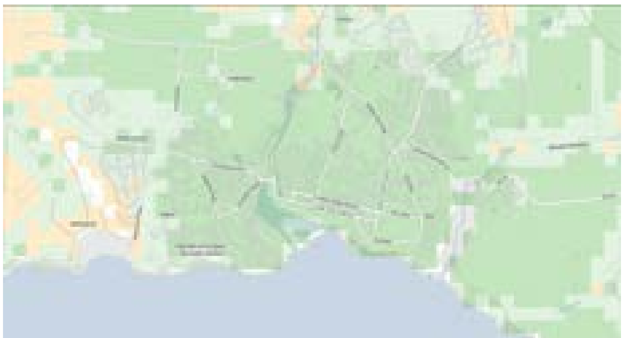
PORT OF LONDON



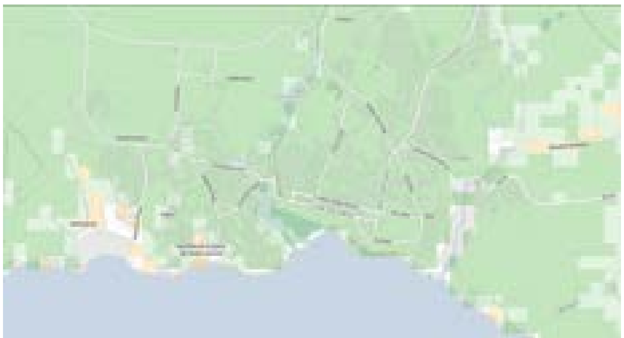
O2



VODAFONE



THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF MILFORD HAVEN

O2

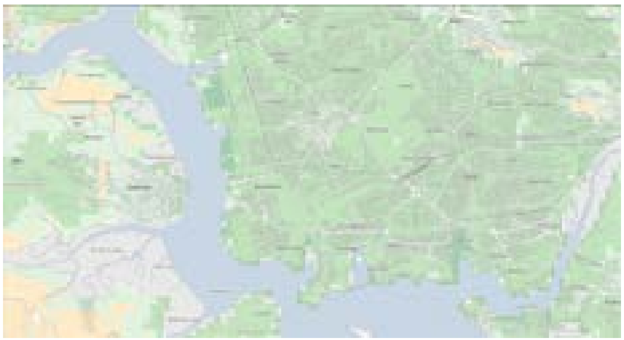
VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF KIRKWALL



O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF PLYMOUTH

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF POOLE

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF GLASGOW

O2

VODAFONE

THREE

EE

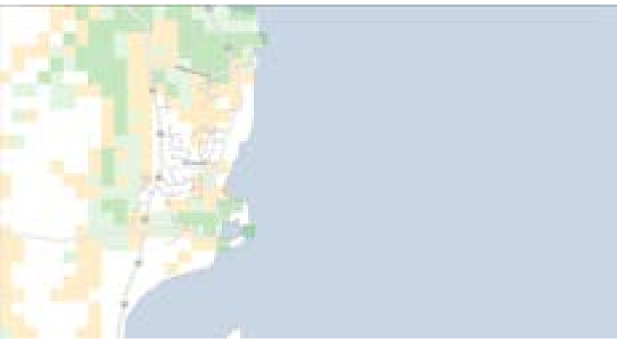
© 2021 Europa Technologies | OS Open Data | OSM

PORT OF LEITH

O2

VODAFONE

THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF PORTAVOGIE

O2

VODAFONE

THREE

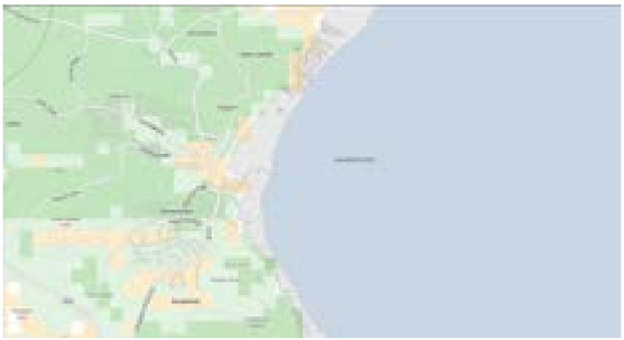
EE

© 2021 Europa Technologies | OS Open Data | OSM

PORTLAND PORT

O2

VODAFONE



THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

SAUNDERSFOOT HARBOUR

O2

VODAFONE

THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

SCRABSTER HARBOUR

O2

VODAFONE

THREE

EE

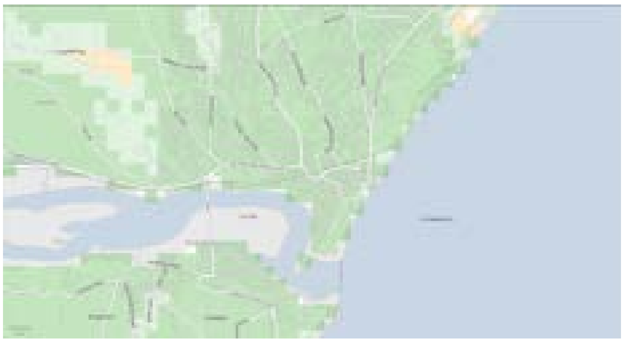
© 2021 Europa Technologies | OS Open Data | OSM

PORT OF SOUTHAMPTON

O2

VODAFONE

THREE



EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF TEIGNMOUTH

O2

VODAFONE

THREE

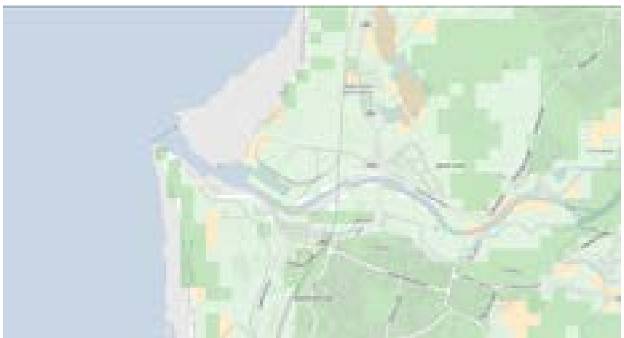
EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF TROON

O2

VODAFONE



THREE

EE

© 2021 Europa Technologies | OS Open Data | OSM

PORT OF WORKINGTON