

The 1800MHz DECT guard-band – some observations applicable to 5G

The proposed use of the 3.6GHz band for 5G includes some spectrum for “lightly licensed use” which implies new entrants offering products into the not-spot and private markets. This in many ways mirrors the existing 1800MHz DECT guard-band segment and some observations from operating in this band may be helpful in defining or refining the licence conditions for the new 3.6GHz 5G entrants.

The 1800MHz DECT guard-band licence

In May 2006, Ofcom made the 1800MHz DECT guard-band (16 GSM paired channels) concurrently available to twelve Operators. Of the twelve, four have been active in the spectrum and the remaining eight simply banked their spectrum access.

A condition of the award was that the twelve Operators created a code of practice that facilitated their concurrent use regarding spectrum access and interference management. So that no one Operator could monopolise the entire spectrum in a locality, an Operator that had taken all the channels is obliged to tighten their frequency plan and free up a channel or two for a second Operator.

Although the licence was technology agnostic, the interference aspects were written around GSM technology. The EIRP level was limited to 23dBm ensuring that the probable use was in restricted range services and not a threat to the MNO's.

In July 2017, a variation to the licence was introduced by Ofcom to allow the use of 3MHz LTE.

Market development

One Operator created a GSM network in parts of London that additionally offered inbound and outbound calls to their mobiles when outside their native coverage areas via a roaming agreement with T-Mobile. T-Mobile customers were not able to roam onto the guard-band network as T-Mobile's view was there was no need.

The other three, including FMS, went into the pbx extension market as an alternative to/replacement for DECT and WiFi and stand alone private networks.

The infrastructure i.e. base stations and core networks have developed over the years, now being offered by small entrepreneurial companies, such that a GSM network is available in open-source on a Raspberry Pi platform.

The market was very slow to develop partly because of the availability of suitable infrastructure and partly because the potential customers couldn't grasp the concept of private mobile networks. It took DECT and WiFi to lift private radiocomms out of walki-talkies and raise the awareness of private mobile telephony and data services.

Lately, a market has emerged in the IoT arena using LTE to control industrial plant where a private network guarantees coverage and capacity and allows full reliance control of their network.

The not-spot market

Aside from private networks there is an opportunity in small areas of no coverage that are below, and will remain below, the economic threshold for the MNO's. These include small villages, country hotels, remote industrial activities and indoor locations.

FMS had some preliminary discussions regarding not-spot coverage with one of the MNO's that ended when the Operator declared it was their intention to cover all not-spots. Clearly this was a naive point of view because it implied non-economic coverage, and history suggested that non-economic coverage, even if deployed using external grants, would ultimately be removed because of negative opex. Infrastructure now exists in the third party world that provides coverage solutions down to villages with 150 dwellings, which is about one tenth of the equivalent MNO costs.

More recently the concept is beginning to emerge where landlords of substantial commercial premises need to extend ownership of the services in their buildings to include mobile, and since the MNO's are not geared up to address this level of coverage granularity, there is the beginnings of a demand for third party solutions.

In FMS's opinion, it is these markets that equates to the proposed use of the 3.6GHz new entrant third party spectrum.

A new entrant third party network can simply carry traffic from the MNO's customers in areas where the Operator is not offering coverage. An extension to the concept is that a community can buy its own coverage from the third party; a DiY community access solution. This approach means there is no complication with the SIMcard, authentication or billing – in fact the third party network is supporting the MNO's endeavours.

However, these solutions can only work if the third party network has inbound roaming agreements with the MNO's. These inbound roaming agreements are crucial to the not-spot coverage solution.

The community access roaming impasse

Inbound roaming agreements allow customers of the MNO's to roam seamlessly onto not-spot coverage and facilitate their automatic billing and account settlement. If a third party operator has no customers of their own, they do not need full bi-directional roaming agreements with the MNO's.

Several of the DECT guard-band licensees attempted to obtain roaming agreements, or at the very least, inbound roaming agreements, with the MNO's, but these approaches have been rebuffed and therefore unsuccessful. This has made the seamless third party coverage solution untenable.

FMS bought a bus from Ofcom to provide transport services to the needy, but finds the bus can only be used on private roads.

The elephant in the room

National roaming has long been resisted by the MNO's, which in my opinion has been the correct attitude given the calls to homogenise their collective coverage. The bitterness that remains after several attempts to introduce national roaming has meant that any mention to the MNO's of anything that resembles national roaming immediately terminates the discussion.

It is against this background that some of the DECT guard-band licensees have sought to provide localised coverage and consequently, supportive roaming agreements with the MNO's. There have been some one-way roaming agreements where New Network customers can, in the absence of their local coverage, attach to the MNO, but not vice-versa. This is very much a third class service and has attracted no business, a situation that will not change until full national roaming is achieved. The market has failed.

Consequently, FMS and others have avoided using the provocative "national roaming" phrase in an attempt to open reasonable conversations with the MNO's – the phrase has become the elephant in the room!

FMS has directly approached all the UK MNO's with partial oblique interest from only one. Some MNO's would not even discuss rural third party roaming, not even returning calls or letters.

FMS attempted to join the GSMA as a route to the MNO's table, but at the time, the GSMA had a policy of excluding the DECT guard-band Operators, so the established roaming path established by the GSMA was denied to FMS.

FMS has approached several non-UK Network Operators who have roaming agreements with all the UK MNO's and who offer roaming hub capabilities - none would support the FMS product concept. Despite being technically possible, there was a fear amongst these roaming hub Operators that such arrangements might be seen in a negative light by the UK MNO's, so they were unwilling to proceed.

Even if an MNO was minded to support third party roaming there are two further obstacles; (a) the call charges – the rural customer should pay the same call charges as city customers, but the third party network earns money from the transiting traffic so the MNO has to pay. And (b), interconnect testing – currently this costs the third

party network several hundred thousand pounds per MNO and there is a queue based on the perceived value to the MNO.

If the initial knee jerk reaction to roaming can be overcome, there is opportunity for a fruitful discussion:-

Firstly, this is not national roaming, it is localised roaming, potentially anywhere there is an absence of the MNO coverage.

Secondly, there are no new SIMcards, so MNO's retain their customers who now benefit from using their phones in places they previously couldn't.

Thirdly, the customer sees the calls on their existing MNO bill – no extra billing is required.

Fourthly, full roaming is not required, only inbound roaming where the MNO re-directs incoming calls and text messages to the mobile when it's on the third party network. All outbound call modes can be near-end handed off directly to the PSTN, all that is needed is a record of each event to support the billing.

This is third party coverage and is a benefit to the MNO, not a threat. Eventually, a really innovative MNO might even consider handing over its service delivery in the truly remote parts of the UK to the third party network.

Dynamic Spectrum Access

The Government has proposed a mechanism called dynamic spectrum allocation where unused spectrum allocated to an MNO could be made available to a third party network for localised use. The expectation being that in rural areas there would be less occupancy from the MNO's and therefore more opportunity for a third party network to provide community access coverage. This follows the Australian model where many outback industrial footprints are served by third party networks using unoccupied National Operator's spectrum.

Whilst this approach works well in Australia, it does so by virtue of the large geographic dimensions where the coverage decision for a MNO is obvious. In the UK however, the coverage decision is less obvious as not-spots are all within the MNO's overall coverage bubble and it becomes more of a "when" decision rather than "if". A simple policy decision from an MNO can block any spectrum allocation to a third party on the basis that it will be needed sometime in the future.

A year ago FMS serviced an industrial private LTE scheme on the Shetland Isles where greater than the 3MHz bandwidth DECT guard-band would have been beneficial. Consequently FMS approached two MNO's requesting the local use of an LTE channel on the Shetland Islands citing the remoteness, the likelihood of traffic demand and the Australian model – there was no reply from either Operator.

It is not obvious how dynamic spectrum allocation model address's the issue of city based in-building not-spots. The probability of a National Operator locally releasing a channel in central London, albeit enclosed by a building, is unlikely as the risk of leakage sterilising the channel in the middle of London is unacceptable. Assuming that only one channel is required by the third party network, there is also the question of which National Network gives up its channel.

As an alternative, FMS favours the Australian model where large rural areas currently bereft of coverage are excluded from the 5G spectrum licensing process and instead become available to anyone who wants to build a base station on a per base station basis. Simple and immediate approval of such requests would inspire innovate coverage solutions and leave the MNO's to what they're good at i.e. carrying mass traffic.

FMS's proposed way forward

In April this year, FMS submitted a paper to Ofcom where in order to service the not-spot markets in a seamless manner, a roaming hub, supporting at least community access inbound roaming, was proposed, see Appendix 2. This is a parallel concept to the national transit initiative managed by BT which is a mandated many-to-one interconnect for all the UK Operators.

FMS advocates that as part of the proposed third party allocation of the 5G 3.6GHz band, a mandatory mobile roaming hub is established, and that this roaming hub is retrospectively accessible to the DECT guard-band Operators. Part of this proposal is the inclusion of the interconnect rates, as they are integral to making it successful.

FMS is of the opinion that making dynamic spectrum allocation work successfully will be particularly challenging and that a proportion of lightly licensed alternative is essential.

FMS Solutions Ltd
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Appendix 1 – An Initial response to Ofcom's 3.6GHz Con Doc

One of the long standing Ofcom requirements is to provide ubiquitous mobile coverage across the UK similar to television coverage, and the ESN project has demonstrated how problematic this is. It has been said that nothing changes if nothing changes, so more of the same approach to spectrum licensing will not change the rural coverage impasse. The explanation lies in the MNO's requirement for a cost positive base station, so their high costs put a lower limit of the traffic that must be carried by a base station and hence a lower limit on the rural hamlet size. No amount of capital injection will overcome the lack of traffic; the answer lies in a much lower cost base station solution. Whilst the equipment costs to the MNO's (from multi-national vendors) is high, the overheads carried by the MNO's force their overall deployment costs up even higher. There has been a market failure.

Contrast this with 2G and 4G equipment suitable for low traffic locations that now exists for ~£3K supported by all the network infrastructure that sits on a server. So today, low cost 2G/4G networks are being deployed in the private sector using the DECT Guardband spectrum. The barrier to rural public coverage is today's need for a second SIMcard and its associated billing. Dual SIM phones or manually swapping SIMcards is very much a second class service and consequently has no traction.

A national mobile interconnect hub has been proposed to Ofcom (see Appendix 2) that would enable third-party coverage suppliers to occupy the low traffic space, carrying traffic from all customers back to their MNO's. The end users experience is preserved because only one SIMcard is required and the calls appear on their MNO's bill, so there is no inequality between rural and urban customers.

Now add the concept of a DiY solution where the end user(s) buy their solution, provide the equipment location, provide power and broadband, so New Telco now provides the design, the equipment, its installation and commissioning, spectrum access, ongoing maintenance and network infrastructure. This really is a low cost solution and could reach all the rural not-spot locations. The bonus's are (a) it doesn't threaten the MNO's because there are no new SIMcards, and (b) the customers help themselves.

New Telco makes money from the cash sale of the equipments, its installation and say 2p/minute from the Home Network for carrying the calls.

So, the MNO's cost base it too high for them ever to provide not-spot rural coverage and they are too slow to innovate an appropriate solution. Third party coverage suppliers can offer the necessary service provided:-

1. The MNO's understand that such provision is a benefit, not a threat.
2. Spectrum is made available to support such provision.
3. A national mobile interconnect hub is established.

CONCEPT & DISCUSSION **DOCUMENT**

NATIONAL ROAMING HUB

FMS Solutions Ltd holds a low power concurrent licence for the DECT Guardband and provides private GSM and LTE networks. This paper was commissioned from Gerard O'Neill, an experienced Consultant in the Mobile Telecomms arena with connections to Regulators and Networks around the World. Infrastructure is now available to make cost effective small GSM/LTE networks in the DECT Guardband spectrum with outbound voice, SMS and data connectivity. The content of the paper emerged from several conversations between Gerard, FMS and others grappling with the seamless call challenge.

Executive Summary

Recent OFCOM statements declare that each of the UK national mobile phone operators cover in excess of 90% of the UK landmass. This is a remarkable figure, especially for a country like the UK with some very challenging topology and terrain. Despite this very high level of achievement, there are still many places in the UK which do not yet have any mobile coverage and examples include small rural villages and towns, holiday parks and centres, temporary construction sites, industrial locations as well as specialised locations such as quarries. This lack of mobile access can severely affect business and everyday life and as a result, many of these locations would, if legally possible, happily implement their own or private solutions. These locations are often left, at great expense to explore the "illegal repeater" market to find coverage solutions. This will change somewhat with the upcoming changes to the licensing of repeaters in the UK but with the planned low output powers, situations suitable for repeater solutions will be limited.

An alternative is to look at bespoke or private coverage solutions using solutions from one of the 12 licensed concurrent spectrum operators. While there has been some success with this approach, solutions are "clunky" as there is no seamless national roaming with the UK operators. Instead, these solution users have to use 2 handsets, dual sim phones, multiple airtime agreements, call forwarding and divert all of which do not give rise to a seamless enjoyment of mobile technology.

The availability of national roaming agreements with the UK operators would make these private solutions into seamless experiences with inbound roamers from the UK operators being validated and authenticated and, supported with TAP record exchange, seamless home billing or one bill and revenue sharing would be possible. However, despite many attempts and approaches, there is no interest from any of the UK operators to provide such national roaming agreements. In fact approaches are ignored. Approaches to overseas roaming hubs to operate in the UK by supporting national roaming have all drawn a blank based on the valid concerns of how the UK operators might react to these roaming hub operators when they find out these international roaming agreements are being used to support national roaming in the UK.

The natural solution and the only way forward to support these community and other private telecommunication projects is to introduce the concept of a national roaming hub, very much along similar lines to the national transit initiative. This "many to one" national roaming operator, operating as a national resource, would facilitate authentication and validation access to all UK mobiles for licensed concurrent access operators and facilitate the exchange of billing information etc. Charges could be on a revenue share basis, again very much in keeping with transit traffic concepts.

This paper explores this concept further.

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Introduction

The UK enjoys very high levels of national Geographic mobile phone coverage with recent OFCOM statements putting this at in excess of 90% geographic coverage for all UK operators.

Despite this exceptional coverage, there are still many “not spots” in the UK and these can take many different forms including:

- Rural hamlets and villages with no coverage due to surrounding topology such as hills and valleys.
- Villages and small population centres with no coverage as network rollout to these locations is uneconomical using typical Operator deployment cost models.
- Small rural industrial units, often in old farm buildings, country houses etc. with no coverage or very poor service.
- Holiday parks and other tourist attractions in rural locations with little or no coverage
- Specialised industries such as quarries and mines where coverage cannot be received due to the sunken/recessed terrain etc.
- Hotels and other commercial buildings with no below ground coverage or even on the ground and lower levels. These coverage issues come about due to building construction and usually affect the bars, restaurants and lounge/reception areas, all very important for mobile use.
- New eco-buildings that exclude radio signals.

To those affected by these “not spot” issues, solutions are vital to ensure access to mobile phone services.

Coverage “Not Spot” Solutions

Obviously there are options around the deployment of “unauthorised” repeaters but they have limited use and can only be used where there is signal to repeat. This unauthorised use will change in April but still, repeater applications are limited. This leaves many locations with coverage issues to find alternative solutions and one very successful solution has been the deployment of concurrent access spectrum or DECT guard band systems. These solutions, operating in spectrum at the top of the 1800 band or band 3, were initially GSM only but can now also support narrow band LTE and provide a standalone network solution to these issues.

These networks, while having some license restrictions such as output power limitations and antenna height restrictions, can provide creditable “not spot” coverage solutions. Examples include:

- Lighting column type deployments and a number of these exist at locations around the country.
- Small cell deployments can be used to provide indoor or outdoor coverage over small areas.

- These small cells have also been used to drive passive DAS equipment inside hospitals.
- New buildings frequently exclude radio signals as a by-product of their construction which makes them less attractive to tenants who inevitably want to use their mobile phones. The current solution is to fit multiple femtoCells, multiple because of the coverage challenge and multiple because there is more than one Operator. DASs can help, but relying on femtoCells, it is not an elegant solution. It is also seen as a landlord problem which increases the complexity in achieving a solution.

While creditable, these solutions are not seamless and do not provide automatic coverage continuity, all of which affect the customer experience.

Issues Using “Not Spot” Solutions

Despite their limited success, these “Guard Band” networks are stand alone networks with their own coverage footprints, network codes, sim cards and billing systems which means that they cannot provide seamless or automatic coverage solutions. Instead, customers wishing to use these private networks must have separate commercial or airtime agreements with the owners/operators. As a separate sim is required, users have to use either 2 phones, one on their home network and the other on one of these 3rd party networks or a dual sim phone or as an alternative switch Sims in their sole phone. (This sim swapping was once known as sim roaming, long before today’s automatic roaming became common place.)

There are also issues around multiple numbering as both networks will have separate numbers issued to subscribers and this requires the use of call forwarding and call diversion and depending on home operator charging policies, often at premium call rates.

Clearly a more seamless and automatic solution is required, one which does not involve the use of multiple airtime contracts, multiple phones or dual sim phones, sim swapping or the use of multiple phone numbers.

Seamless “Not Spot” solutions?

In the preceding section, the topic of sim roaming was mentioned. This is the concept of changing sim cards to access a different network to the home network and was at one time, in the early days of GSM, the only way to support international roaming. Travellers wanting to use mobile networks in overseas countries had to obtain a sim card on one of the visited networks and arrange to pay for this locally. Some companies set up in the UK to supply these roaming sim cards on UK based contracts but people could finally use their phones overseas. They also overlooked the requirement for dual sim phones, sim swapping or the use of two phones as overseas use of your phone was novel. Having multiple sim cards in your wallet was not unusual 25 years ago.

This early sim roaming based international roaming started to take off and the search was soon on to find a more convenient or seamless way to support international roaming without the need to swap sims and use multiple sim cards. This search gave rise to the adoption of bilateral roaming agreements where operators set up point to point roaming agreements. Customers on one home network could now "Automatically" roam to another visited network in another country and the bill "followed" you home. Your call charges appeared on your home bill and all the security checking/authentication/authentication required was handled between home and visited networks. It soon became a race to have the most bilateral roaming agreements with networks announcing tens or hundreds of agreements around the world. One negative aspect was often the limitation to the choice of one network in visited countries; often a network owned by sister companies to the UK based networks such as Vodafone or Orange operators in other countries.

The use of bilateral agreements, while a marketing success, were also not an efficient way to support roaming. Each operator has to test and integrate with any operators they wished to roam with and huge roaming testing departments soon sprung up in operators with long waiting times to get on the test list. Smaller countries could wait 12 months for a test slot and all this replication led to huge amounts of money being spent on testing. Clearly an alternative to these one to one roaming arrangements had to be found and this gave rise to roaming hubs or roaming brokers.

These brokers or hubs are companies that have roaming agreements with multiple operators and offer a one to many roaming arrangement. So instead of an operator in country X having to agree roaming agreements with operators in over 100 countries and possibly multiple operators in each country, it was now possible instead to connect to a roaming hub or broker. This gave the operator in country X access to all the operators on the hub and instantly access to many roaming arrangements. This opening up of hub based international roaming led to a real revolution in the provision of roaming facilities, especially for smaller operators and small countries and subscribers now take it for granted that they can access multiple operators in any country and billing is all automatic.

So what has this opening up of hub or broker based international roaming got to do with "Not spot" solutions in the UK?

Seamless "Not Spot" coverage solutions – The Issues

25 years ago, going to another country and using sim roaming would have been no different to going into a "Not spot" coverage solution today in mid Wales or in the South West or even into the lower floors of a hotel in central London. Like the then overseas visitors, "Not Spot" subscribers swap sim cards or use multiple devices. Clearly it must be possible to learn from all the international roaming improvements to find a solution to providing seamless "Not Spot" coverage solutions.

It is perfectly possible today for these "Not Spot" operators to seek bilateral roaming agreements with each of the UK operators. This would entail testing and commercial discussions with 4 UK operators for each of the interested "Not Spot" operators, most likely two or three in number. Given the relatively small volumes of traffic involved and the revenues involved, this testing would be a significant overhead for

these “Not Spot” operators and even with 3 “Not spot” operators, there would be significant duplication of expenditure. However, this all requires the UK operators to be interested and to accept the requests for UK based roaming testing and to negotiate commercial roaming agreements and to date, there is no interest from any of the UK operators. There is evidence of calls/emails/letters being ignored and not responded to.

As with international roaming, attempts to provide UK based roaming via the use of some of the existing roaming hubs or brokers which is perfectly possible, have also drawn a blank with a very evident apprehension on their part. Using these current roaming brokers is perfectly possible and would be a very quick to market solution but it is evident based on reactions so far that companies are concerned about the reaction/response of the UK operators when they realise that existing agreements are being used to provide national roaming and seamless roaming and automatic billing are in place.

Seamless “Not Spot” coverage solutions – A solution

Clearly an alternative approach has to be found to facilitate seamless or automatic “Not Spot” solutions with automatic home network billing and one approach that needs to be considered is an OFCOM mandated national roaming hub, in a similar way to the existing mandated national transit facility. This facility could also operate on the principle of shared revenues, etc.

Perhaps the provision of this national roaming hub could rest with BT, the national transit provider or a tender process adopted to select an appropriate partner. This is all technically available today and with the right support and oversight could be a relatively quick to market solution.

We would welcome the help and assistance of OFCOM to initiate a consultation process on the topic of the provision of a national roaming hub facility. This really is the next step in empowering local communities to self-provide up to date and modern mobile communications. Community broadband initiatives have been very successful so perhaps now is the time for community based mobile communications initiatives?

“Not Spot” Solutions – The Outcome.....

This national roaming hub facility would offer the opportunity to support community telecommunication opportunities with village funded coverage solutions in association with the Concurrent access operators. Companies could also fund solutions for their buildings as could hotels etc. All with seamless roaming and follow me billing and no wasting of numbering facilities and no need to use call forwarding or call diverts.

FMS Solutions believes that despite assurances from the Operators regarding coverage, there will always be locations below the Operators economic threshold and buildings that exclude mobile phone coverage. Small scale third party solutions are technically possible and the Operators should be encouraged to view these solutions as beneficial rather than threatening – they are after all, solving Operator's coverage problems.

FMS Solutions believes the national roaming hub solution addresses the issues and request that Ofcom give positive consideration to this paper FMS would welcome a public/industry consultation process as the next step and would welcome an opportunity to discuss this further with OFCOM.

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