Improving Consumer Access to Mobile Services at 3.6 to 3.8GHz

ip.access' response to the Ofcom Consultation

December 2016

This response is a based on the ip.access response to the Ofcom Consultation for Innovation in 3.8-4.2GHz (June 2016). We believe the same application model, technical realisation and economic drivers apply in this case, but with fewer obstacles, given the change in band.

Executive Summary

Based on two applications described below, we argue that using this spectrum through tiered shared access, with a neutral host service provider as an essential part of the ecosystem, can unlock at least a billion pounds of value, and directly improve the quality of consumer mobile access in geographical reach and via multi-operator vertical market applications. The shared access model also allows infrastructure sharing between service providers, with consequent capital and operational cost sharing, unlocking the economic value and improving the lot of the mobile consumer at provably minimised cost to the service providers.

Introduction

ip.access is a UK based vendor of GSM, 3G and LTE radio access equipment supplying a global market, and sees opportunities to expand its market by offering products in shared access spectrum generally. We are already engaged in the 3.5GHz CBRS initiative in the US and are excited by this UK based initiative and believe it is best exploited using a shared access model similar to that being defined for CBRS.

The applications described below are inextricably linked with 3GPP based mobile access, and while the band in question is not yet commonly supported by smartphones, the CBRS initiative will bring handsets supporting C-band frequencies onto the market in a 2017-2018 timeframe. We discuss in more detail the associated risks below. The applications and issues described below are not limited to the 3.6-3.8GHz waveband, and are valid for any other band under consideration for shared access, including those that are already supported by current generations of handset.

Problem Statement

The Mobile Broadband market in the UK suffers from two issues that are largely unaddressed by Mobile Network Operators (MNOs) today. While many service providers (not just mobile ones) focus on the headline "speeds and feeds" of their offer, key Quality of Experience (QoE) issues, such as completeness of geographic coverage and multi-operator vertical market applications, go untended. The geographic coverage issue is both a static problem – service is unavailable in key locations – and a dynamic one – calls drop and streaming data stalls as subscribers move into the gaps between cells. The vertical market issue is a structural one, stemming from a misalignment of the commercial objectives of operator and enterprise. Venues of many types serve their customers regardless of their MNO affiliation, and their own customer experience suffers as a result of the inability of MNOs jointly to deliver service in a given location economically. Such venues include hotels, enterprises in shared buildings, residential and commercial property developments intended for shared and mixed use – where the cellular coverage contributes significantly to the value of the venue – and shortcomings are blamed on the venue owner, not on the operator. While the large prime venues such as airports and sports arenas may have custom multi-operator solutions created for them, the vast majority of sites (98% of them, according to Wireless-2020) go without. In short, each MNO wants to own the enterprise, but the enterprise does not want to be owned by one MNO.

The economic conditions in which of the operators find themselves contributes to both the geographic coverage issue as well as the multi-operator enterprise one. Operator revenues are in general falling, yet the traffic demand on them increases at a global average of 60% year-on-year (Cisco VNI 2016). They focus their resources to address the traffic growth, and are unable to provide solutions to these two key customer satisfaction factors with the necessary scale and speed.

On the other hand, the enterprises, individuals and communities affected by these coverage issues have shown themselves willing to pay (Mobile Experts, 2015). In the absence of a cellular solution, however, they resort to Wi-Fi as the lowest-common denominator solution. But this is no solution at all in reality. It provides only short-term relief to spot coverage issues, and suffers well-known quality of experience issues in logon difficulties, data congestion and missed and failed calls and poor voice quality in Wi-Fi calling. It cannot address the outdoor wide-area coverage in-fill application. Such generally poor performance has contributed to a "get what you get" attitude towards Wi-Fi which threatens to make the MNOs irrelevant in their core markets. As more people get used to putting up with best-effort Wi-Fi, the value of quality wide-area coverage reduces – a vicious cycle of reduced value and reduced investment.

A Proposed Solution

One model that would help the operators in their mission, and be responsive to these neglected segments' needs, would be to let customers – enterprises, individuals and communities – take some responsibility and control of their own cellular service through the agency of a Neutral Host Service Provider. Such an entity takes responsibility for the provision of radio access to these customer groups, and operates the radio access network on behalf of all the MNOs. Since the Neutral Host is deploying shared infrastructure, it can share the costs between MNOs and deliver solutions at a fraction of capex and opex that each operator acting alone could achieve. One objection to this model has come from the radio network engineering groups of MNOs who see the free deployment of cellular radio equipment as the end of their ability to deliver consistent high quality service in

their networks. Such an objection is arguable on its own merits, but disappears entirely if the neutral host uses separate spectrum.

Hence the importance and timeliness of this Ofcom consultation in considering such spectrum.

New, easily accessible, dynamically shareable, managed and cheap spectrum availability will go nearly all the way to removing the economic barriers and commercial misalignments, and open opportunities for the Neutral Host to solve these coverage and quality issues on behalf of all the existing MNOs and for the end-user groups.

Such a model has been followed by the tower-sharing industry for many years with great success, where the passive macro network assets – towers, cell sites, power generation and to some extent fibre transmission – are managed by a single company and offer shared access to all the MNOs. MNOs have been understandably reluctant in many cases to share spectrum on a similar model (though counterexamples do exist) but the introduction of shared spectrum takes this barrier away entirely, and allows the introduction of a new generation of service providers who are able to improve the QoE for all MNOs at a fraction of the cost of the MNOs doing it for themselves.

In summary, the applications are two:

Geographic/Dynamic QoE Enhancement – providing cost-effective multi-operator QoE (handover and in-fill) improvements between cells in the macro and indoor network where the static traffic is low.

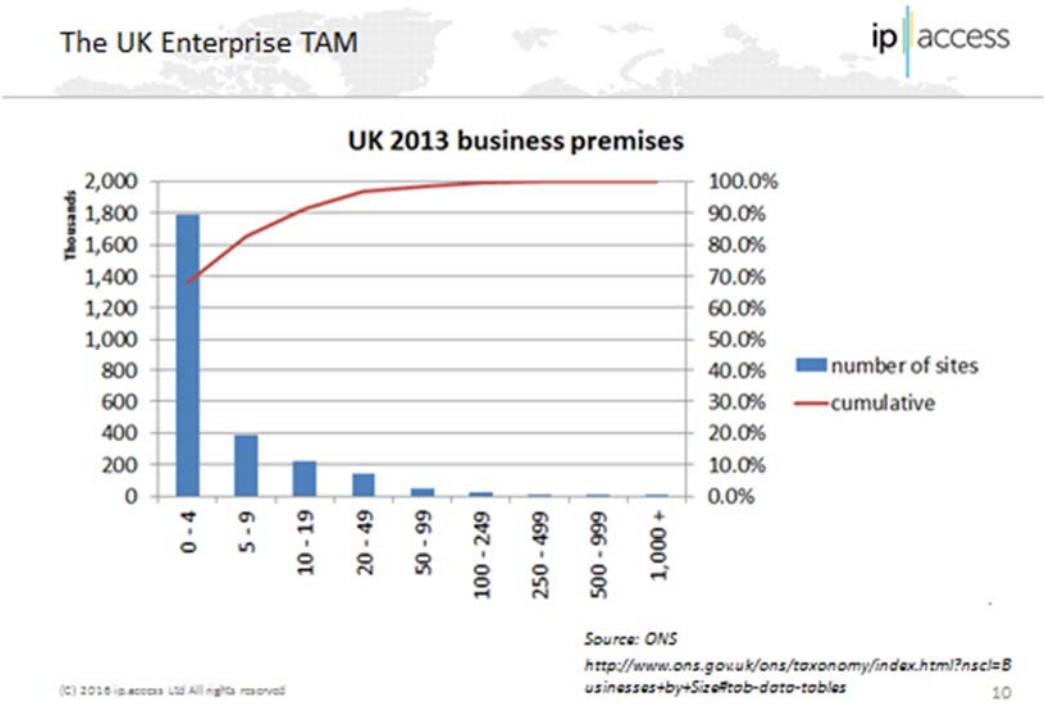
Multi-Operator/Static Vertical Market Access – providing access in locations where multi-operator service is the primary driver.

In terms of the characteristics in the Spectrum Sharing Framework, the two applications described have similar characteristics. In all cases, the basic radio access technology expected to be used by both applications is LTE. While the 3.6-3.8GHz waveband is not widely available in smartphones today, the CBRS initiative in the US is expected to trigger the production of handsets to market in a 2017-2018 timeframe (chipsets in 2017, with phones available in 2018) that cover at least the 3550-3700MHz band. Given the global product specifications of most smartphone vendors, such handsets will become mainstream, and would be able to use at least the 3.6-3.7GHz segment of the proposed band. If this spectrum were made available for MBB use in the UK, it is highly likely that devices to use it will be available in a timely manner. Additionally, if the spectrum sharing and coordination methods were broadly similar to those adopted for CBRS, the technology to exploit it would be available very quickly from UK sources.

Market Size and Economic Value

In the UK, the availability of this new spectrum would allow the deployment of new infrastructure into areas previous uneconomic to provide.

The ONS collects data on the number of enterprise premises and their occupancy, which is graphed here for convenience. The source data is here
http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Businesses+by+Size#tab-data-tables



All of these nearly 2.5m enterprise sites are potential customers for one or more infrastructure elements to improve the cellular access of their consumer customers. With an average deployed value of £1000, it is easy to see a billion pound market emerging from such spectrum, and this is just the enterprise verticals route to the consumer.

In helping the operators with the geographical coverage problem, the same spectrum can be applied for additional value. We have no hard data for the number of potential sites, but it is likely in the many tens of thousands, but with a value per site perhaps five times greater, leading to an economic value in the hundreds of millions.

The CBRS Model in the UK

To address these two applications, among others, we propose a spectrum sharing/spectrum leasing arrangement of a similar nature to that being proposed for the Citizen's Broadband Radio Service (CBRS) in the US. See https://www.fcc.gov/rulemaking/12-354 for a general description of CBRS. Such an arrangement will allow end users and communities to take some charge in extending cellular service into the homes, enterprise and communities, while allowing continuity of service for existing licensees and other priority users of the band. It reduces the administrative and operational load on the mobile operator, avoids any interference issues with existing exclusively licensed spectrum, and allows the mobile operator to scale its service to an extent it has been historically unable to do. It also re-aligns the commercial objectives of all parties. Mobile operators can compete to provide capacity within the framework of the Neutral Host, while the Neutral Host isolates the enterprise from the unwelcome "own-the-customer" instincts of the MNO.

We do not necessarily propose the adoption of the CBRS model wholesale, but adapted to the needs of UK plc. One potential adaption is described below.

The US model has three tiers of authorisation:

Highest Priority: Incumbent Users: In the US these are primarily the US Navy and Coastguard.

Second Priority: Priority Access: These are close to the traditional exclusive use license – but with a shorter term and specific renewal conditions. Even so, such Priority Access must give way to the Incumbent Users on demand.

Third Priority: General Access. This is an innovation, and allows infrastructure devices to request spectrum and be granted it on a time-limited leasehold basis in specific areas. Such spectrum leases may be very short-term and are revocable as usage in higher tiers dictates.

The three tiers are coordinated by a Spectrum Access System, which is essentially a whitespace database administered by third parties. Google and Federated Wireless are often cited as the first two operators of this service. The SAS takes input from the FCC, and from the users of all tiers of authorisation, aggregates it and uses it in the control of the leases, essentially as a coarse grained interference coordination mechanism.

Infrastructure devices are required to have a SAS client in order to interrogate the SAS and respond to authorisations and revocations, and also some method of locating themselves geographically. The method is not defined, so may be GPS, or a configuration setting with some method of confirmation. Such small-cell location technology is well-known, even for in-building deployments – having been pioneered by ip.access, Cisco and AT&T in the residential 3G deployments beginning in 2009.

The CBRS model also allows for an Environmental Sensing Capability – not necessarily co-located with the infrastructure devices – that can provide more fine-grained information as to spectrum usage in particular locations – near naval installations in the US case, for example.

In the UK case, it is to be considered whether the 3-tiers are required, and how they map across. One possibility would be to grant the existing users – the fixed links and satellite earth stations – the status of Incumbent. All other users of the spectrum would be allocated spectrum dynamically around these Incumbent users – thus giving some guarantees to their continued spectrum cleanliness.

In arguments below, ip.access sees a benefit in having long-term stable, narrow-band allocations to simplify the neighbour management of the new spectrum with respect to existing MNO allocations. Such long-term allocations might be managed within the second tier – the Priority Access Layer.

Short-term, non-persistent, traffic-driven allocations would then be part of the General Access Layer.

Time and Duration of Spectrum Authorisations:

Geographic/Dynamic QoE Enhancement:

A baseline of spectrum availability is required 24x7, but diurnal and seasonal variations will exist – for instance rush-hour or holiday traffic – which may require additional spectrum bandwidth in certain cases. In LTE terms, a 1.4MHz carrier will be sufficient for baseline coverage which,

according to the interference studies quoted in the consultation, should be available practically everywhere in the UK.

Multi-Operator Vertical Market Access

When venues are closed a minimum bandwidth requirement to support maintenance and security staff may be available from existing macro networks (especially as the venue staff themselves may all be corporate subscribers to a single network). During operating hours, a full 20MHz carrier or possibly multiple 20MHz carriers may be required.

Geography and Coverage

As described, the applications are intrinsically localised, but they will be nationwide.

The Geographic/Dynamic QoE Enhancement application will be primarily outdoor. The maximum range of the outdoor deployed in-fill application will be less than 1km. The propagation at these frequencies mitigates against long-range operation.

The Multi-Operator Vertical Market Access application will be primarily indoor, but may have some outdoor deployments in enterprise campuses for instance.

Quality of Service

The goal is to offer an improvement in QoE over the existing MNO coverage, taking the MNOs as a whole. Therefore some degree of guaranteed availability is desirable. It's expected that this is achievable with the bounds of the Spectrum Sharing Framework, if the guarantee is expressed in statistical terms.

LTE itself is extremely tolerant of interference and within a single carrier can shift traffic between resource blocks to avoid interference in real-time. It is the ideal radio technology for shared access spectrum.

High Level Technical Characteristics

For the Geographic/Dynamic QoE Enhancement application we expect an ERP to be of a 1-5W level, with an dipole/omni antenna to provide approximately 1km or less of range. As noted earlier, capacity not being the driver for this application – sectored or directional antennas are not specifically required.

For the Multi-Operator Vertical Market Access application we expect a LABS class product with maximum ERP of 250mW or less for indoor deployment will be the norm.

Capacity Requirements

For the Geographic/Dynamic QoE Enhancement application, where reliable handover of mobile traffic is the primary driver, and voice traffic in particular, the bandwidth requirements are not expected to be high – a 1.4MHz carrier will suffice.

For the Multi-Operator Vertical Market Access application, the bandwidth requirements will be higher, but likely deliverable using a single 20MHz carrier, with small cells being the primary capacity enhancer. In some situations potentially multiple carriers may be desirable, but these are not expected to be mainstream.

Density of Use

This is intended for mass market roll-out, using commercially available handsets and infrastructure equipment. We note the limited availability of spectrum in certain areas close to fixed links, and believe the simulations (which are acknowledged to be conservative) show that the small spectrum requirements of the Geographic/Dynamic QoE Enhancement use case make it will be deployable within those availability limits.

Evolution of these Criteria over the Life of an Authorisation

We expect that the spectrum authorisation for these applications will have two lifetimes, one short, one long.

For static/baseline applications and capacity, we expect a long authorisation lifetime of the narrowest bandwidth (e.g. 1.4MHz) will be desirable, to ensure that the neighbour relationships with the incumbent MNOs are stable, and do not require frequent reconfiguration

For busy-hour and enhanced capacity, the applications can tolerate quite short-lived authorisations, since the frequency relationships between the baseline carrier and the capacity carriers can be highly dynamic.

For instance, if carrier aggregation is the method of meeting peak capacity, the primary carrier can be 1.4MHz wide and quasi-statically authorised. The secondary carrier can be 20MHz wide and authorised almost on an instantaneous basis, certainly on an hourly basis.

With these and other methods, these applications can be met with great flexibility and tolerance to the other users of the spectrum.

Economies of Scale and Harmonisation

As has been noted already, the CBRS infrastructure, including the Spectrum Access System to manage the temporary leasing of spectrum as envisaged in this response is planned to be deployed in the US beginning middle of 2017, according to the CBRS Alliance. By adopting a similar spectrum sharing architecture in the UK, we will be able to take advantage of the experience in this US, and re-use technology already developed and proven for the US market.

If this spectrum is allocated for Shared Access, with the applications described above in mind, there will be no shortage of vendors, candidate Neutral Host Service Providers and MNOs ready to exploit it, and with the CBRS deployments as a highly visible model in the US, lack of information will not be a blocker to use of the spectrum, since it will essentially be baked into the mass market devices, and will be used with no user intervention required.

Market Barriers.

As outlined earlier, we believe there is a market of some value behind the applications described - allowing MNOs and others to improve the quality of their networks and the service they offer their subscribers while minimising the capital and operational costs incurred. While it depends on the detail, we don't envisage the transactional costs of sharing to be an inhibitor to this market at all. Additionally, we see these applications as enhancing the value of the incumbents' licensed spectrum holdings, especially for UKBroadband.

Authorisation Barriers

With the tiered authorisation that we envisage, following the SAS/CBRS model described, we don't see particular authorisation barriers. We would expect any frequency specific type-of-service constraints to be burnt into the logic behind the SAS, so that leases can be requested and granted quickly and simply. Obviously if those constraints limit the spectrum that is available for sharing for a given service unduly, that will devalue the proposition, but that almost goes without saying. With a small-cell based, SAS based sharing model, we do not expect these applications to place onerous demands on the spectrum under consultation.

Summary

In summary, we recommend the adoption of a scheme similar to the CBRS/SAS model currently being developed to exploit 3.5GHz shared access spectrum in the US. It carries with it the protection of incumbents, the ability to support priority fixed-term licenses as well as opportunistic, general access licenses. With these three tiers of access, any use or user of the spectrum can be accommodated flexibly and profitably, and the ability of the consumer to control and improve their accessibility to mobile services is transformed.

Annex – the responses as made on the website for reference

Question 1: Do you have any comments on the use of the 3.6 to 3.8 GHz band by existing services?

None, other than to note their geographical concentration.

Question 2: Do you agree with our identification of a trend towards the use of mobile in the 3.6 to 3.8 GHz band?

We do. We note the emergence of a similar band in the US - the CBRS band at 3550-3700MHz - that will create a new generation of mainstream smartphones able to access at least half of the band without change.

Question 3: Do you agree with our high level proposal to make 116 MHz within the 3.6 to 3.8 GHz band available for mobile and 5G services, bearing in mind our statutory duties and the high level trends we have identified?

We would prefer to see the whole band operated under a single tiered shared access scheme, with the UK Broadband and other fixed link and satellite licensees occupying a high tier of the scheme, recognising their incumbency. Ideally we would like to encourage such users to move above 3700MHz, as discussed in the following question.

Question 4: Do you agree with our general approach regarding spectrum currently licensed to UK Broadband?

We would prefer to see UK Broadband's holdings moved above 3700MHz so that the emerging CBRS capable smartphones (which will likely be restricted to operation below 3700MHz) can access the maximum amount of spectrum, under a tiered shared access scheme. We understand the consequential issues of moving one half of the duplex, though we note that the upper half of the duplex can be moved without change of duplex spacing and stay within the 3.8-4.2GHz band. We ask that this option is considered in future discussions and consultations, especially regarding the 3.8-4.2GHz consultation, as you note in the consultation brief.

Question 5: Do you agree with our assumptions, methodology, and conclusions with regards to potential coexistence between mobile and existing fixed links and satellite earth stations? Please refer to annex 5 for further details.

We don't feel qualified to critique the method in detail, but note that sensing technology is moving on apace, and we're not sure the coexistence study took account of the possibility of sensing the actual interference environment dynamically, as opposed to the static simulations on which the conclusions are based. As the study itself notes, the conclusions are likely conservative and therefore the benefits of the change will be underestimated if the optimisations that dynamic sensing and other techniques can bring are neglected.

Question 6: Do you have a view on any of the two options we identified?

We're not qualified to comment on the cost of disruption inherent in Option B, but if the priority is to improve consumer access to mobile services in this band, then this

must be considered seriously. As noted earlier, we see a strong reason for clearing the lower half of the band (3600-3700MHz) as this is the band most likely to be supported by globally available mainstream mobile devices, so consumer demand is most likely to rise most quickly below 3700MHz. Does this constitute a useful middle ground, where licenses are retained above 3700MHz and removed below it?

Question 7: Do you have any quantitative evidence on the costs and benefits associated with the options? This include costs for existing users and/or consumers of existing services associated with potential changes, and benefits to UK consumers in gaining access to mobile services in this band.

In the accompanying paper, we have identified two major applications that would be enabled by the introduction of shared spectrum in this band. We argue that these applications bring an economic benefit to UK plc above a billion pounds, and significant improvements in mobile operator service to consumers, with minimised costs through shared infrastructure.

Question 8: Do you have any other suggestions that would allow widespread 5G availability using the 3.6 to 3.8 GHz band across the UK while allowing certainty for at least some existing users to continue to provide the benefits currently provided by use of the 3.6 to 3.8 GHz band?

In the accompanying paper, we proposed a tiered shared access model, with a neutral host service provider as an essential part of the ecosystem. We believe this is architecturally consistent with the direction of 5G, and accommodates, via the tiering mechanism, the stability that existing users will need.

Question 9: Do you have any comments in relation to these proposals?

Please see the accompanying paper, which is emailed separately.