ALPHA WIRELESS

...Changing the way wireless networks are built.

White Paper: Exploring 3.5 GHz

A band ripe for revolution

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Introduction

In the unrelenting cycle of breakneck change, accelerated by the proliferation of the Internet, mobile operators find themselves in an unprecedented situation - supporting the demand for progressive enhancement of network performance while, in parallel, sustaining an erosion of revenue from traditional sources.

To this conundrum, the telecoms industry has looked to 5G, extolling the virtues of a next-generation mobile network, whose purpose extends beyond connecting the smartphone, and touches every physical object around us, whether that is automating the driving experience or inspiring the next industrial revolution.

But, the process of converting 5G from something that is merely spoken about within the telecoms industry to a transformational wireless technology is complex, and it requires an understanding of the underlying advancements which will propel the technology forward.

This whitepaper will examine the criticality of mid-band spectrum in the 5G roadmap, with a particular focus on the 3.5 GHz frequency band, a pioneering medium for sub-6GHz 5G NR. In parallel, there will be an exploration of Alpha Wireless's market-leading 3.5 GHz antenna solutions.

The Three-Pronged Spectrum Strategy

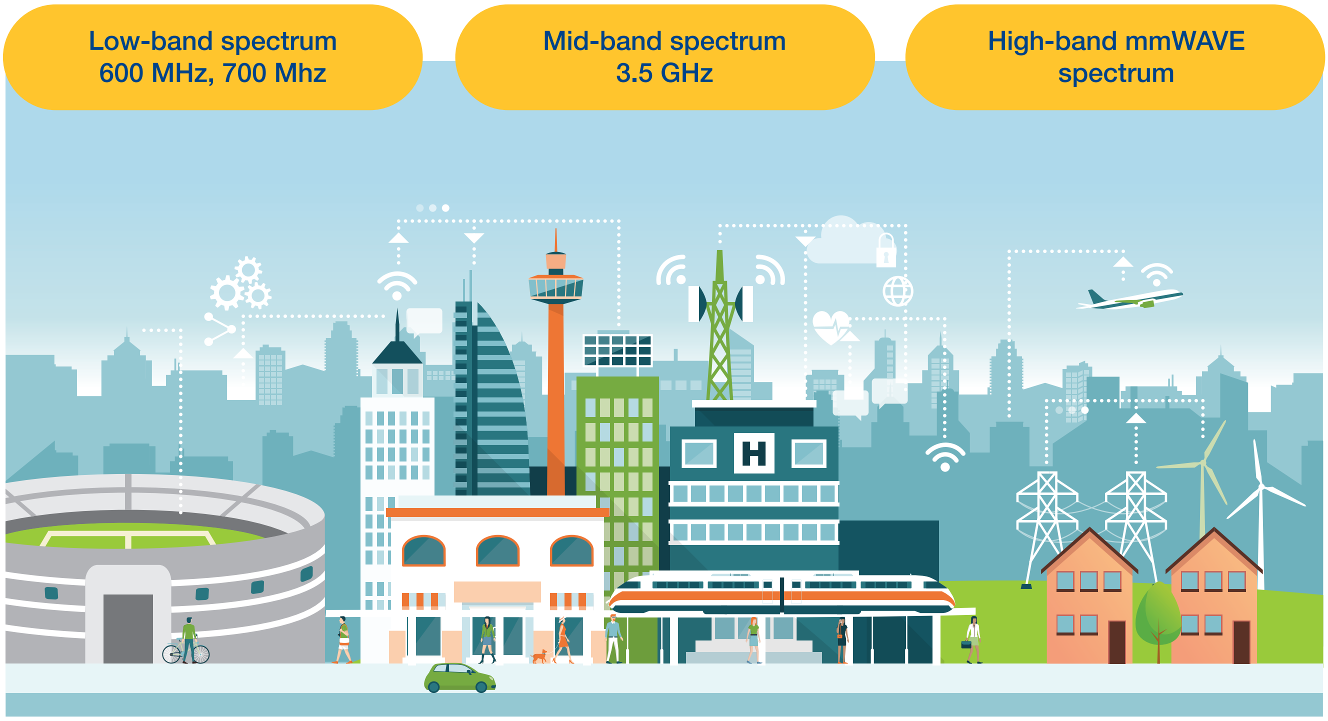
Faced with exceptional demand for network resources, mobile operators have sought new ways to enhance performance across every conceivable metric - availability, latency, throughput, you name it - without prompting a significant incidental uptick in the costs associated with achieving this goal.

With 5G, there are three core strategies, all complementary to one another, that mobile operators are exploiting to set a new performance benchmark. The key is to remember that this is not a one-size-fits-all scenario, but rather, one in which each strategy can be implemented at different stages of network evolution.

Densification of the site grid with additional macrocells and the introduction of a new layer composed of small cells is a key long-term strategy for mobile operators. While this is a CapEx intensive undertaking and one which will require a new level of network planning, it will prompt significant improvement of signal quality at the cell edge and indoors and bolster the network's ability to handle peak traffic loads.

In tandem with densification are efforts to enhance spectral efficiency. On this front, mobile operators are leveraging higher modulation schemes including 256 QAM and higher order MIMO, from 4T4R to 8T8R and increasingly 64T64R (Massive MIMO). However, there are questions as to how much more can be gained by focusing solely on spectral efficiency as we approach the Shannon limit.

This lends itself to the third strategy and the one which this whitepaper is focused on - the deployment of more spectrum, in an increasingly diverse manner, spread across low, mid and high (mmWave) bands.



For mobile operators, the exploitation of mid and high-band spectrum with 5G offers a new path to enhance capacity by leveraging frequency bands where there is wider channel bandwidth available, enabling an extraordinary level of performance, especially on multi-band macrocells where multiple non-contiguous blocks of spectrum can be aggregated to create a “bigger pipe”.

The dramatic expansion in spectrum diversity with 5G is being driven by a strive to achieve performance goals that, under the laws of physics, conflict with one another. It is this precedent which has introduced the concept of a mobile network composed of multiple layers - one for coverage, one for capacity - in which each layer supports the other.

Low-band spectrum including 600 MHz and 700 MHz will form the foundation of 5G availability, providing deep in-building and rural coverage with a low level of network densification. In addition, this spectrum wields the potential to be aggregated with other mid and high-bands, thus enhancing capacity.

By contrast, high-band and mmWave spectrum will be exploited to deliver an extreme level of network capacity in small geographical areas where there is an unusually large number of network users whose resource requirements outstrip those that can be offered by the low-band coverage layers. Think areas where there is high footfall such as sporting venues, shopping centres and transportation hubs.

At the intersection between low and high-bands lies mid-band spectrum, offering a balance between coverage and capacity. The latter is why a large proportion of pioneering 5G deployments, particularly those in Europe and Asia, have leveraged mid-band spectrum in frequency bands including 3.5 GHz.

A 3.5 GHz Deep Dive

The 3.5 GHz frequency band is a key mid-band for 5G, delivering a material increase in capacity compared to existing high-band 4G LTE deployments (1800, 2100, 2600 MHz, etc.) while also providing similar coverage when deployed atop the same high-band 4G LTE site grid.

Exhibiting wide channel bandwidth and the potential to be aggregated with 4G LTE in a non-standalone dual-connectivity architecture, the 3.5 GHz frequency band brings mobile operators closer to an elusive future in which gigabit-class mobile networks are a reality.

To ensure mobile operators can realise the capacity attributes detailed above and deliver on user experience enhancement with mid-band 5G, many within the industry, including GSMA, have called for regulators to make as much contiguous spectrum available as possible in the 3.5 GHz frequency band, with a preference for at least 80 MHz per mobile operator.

Thanks to the continued advancement of techniques such as beamforming, which provides higher antenna gain, mobile operators will be able to compensate for higher path loss at 3.5 GHz compared to the high-bands utilised for 4G LTE. It is precisely this which enables a rapid overlay macrocell deployment and co-location with high-band 4G LTE carriers.

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+
Products Families


Pseudo Omni


CAN


Panel/ Beamforming


Tri-Sector Canister

Given the unparalleled expertise of Alpha Wireless in meeting the needs of operators across the world, our antenna solutions are uniquely positioned to unlock the myriad of network performance benefits introduced by the 3.5 GHz frequency band.

Our 3.5 GHz panel antenna family (3GPP bands 42, 43 & 48) provides the highest performance and quality in sectorized applications, radically enhancing operators' ability to engage in a rapid and cost-effective overlay macrocell deployment of the frequency band.

With the optimisation of beams enabling the provision of coverage directly to the user, Alpha Wireless panel antennas improve data throughput at the cell edge without additional bandwidth. Versatility is a feature that transcends our panel antenna family and fixed, mechanical, and remote electrical tilt options are available.

+
The Unique Applicability of 3.5 GHz for Small Cells

As detailed, densification of the site grid with small cells will be a prime strategy for mobile operators, and the 3.5 GHz frequency band is particularly well-positioned to deliver on the fundamental attributes of small cells - localised low-cost coverage and capacity.

With the ability to exploit aggressive spectrum re-use in low-power operation, 3.5 GHz small cell solutions wield the potential to drastically improve the spectral efficiency of mobile networks, especially at the cell edge. This will be key in the context of utilising small cells to improve in-building and cell edge coverage.

The wide channel bandwidth offered by 3.5 GHz offers optimal future scalability with small cells such that mobile operators can plan for, rather than react to, sudden surges in demand for capacity at high traffic hotspots in densely populated urban areas.

Alpha Wireless has been a pioneer of 3.5 GHz small cell antenna solutions, enabling mobile operators to breathe targeted, localised coverage and capacity into their network. Our Pseudo Omni and CAN (Concealed Antenna Node) solutions exhibit an ultra-compact design, minimising visual pollution and offering a plethora of mounting options.

Boasting variable tilt capability (fixed and electrical) to complement multi-band support, our small cell antenna solutions are ideal for densely populated areas such as amusement parks and sports venues. And thanks to a high port count, multiple operators can exploit a single small cell - paving the way for unprecedented network density and new sharing opportunities.

A 3.5 GHz Ecosystem on the brink of Explosion

Beyond projected performance and cost of deployment, the attractiveness of any particular frequency band for 4G LTE and 5G will hinge on the state of the underlying device and use case ecosystem.

The criticality of this "chicken and egg" relationship cannot be underestimated - healthy adoption of frequency bands will provide commercial incentives for network expansion, driving an incidental acceleration of adoption and the development of new ancillary use cases and applications. It is a revolving cycle.

On this front, relative to other pioneer 5G frequency bands, 3.5 GHz is particularly well-positioned for mass adoption. The first commercially available 5G modems from leading vendors such as Qualcomm (Snapdragon X50), Huawei (Balong 5000) and Samsung (Exynos 5100) already feature support for 3.5 GHz in TDD operation (Band 78).

This level of modem support has transpired in the form of dozens of commercially available 3.5 GHz 5G-capable devices spread across a diverse array of form factors, including smartphones and CPE. Mobile operators across the world are exploiting these devices to make mid-band 5G a commercial reality, acting as an initial gateway into the 5G ecosystem.

As 5G and the utilisation of the 3.5 GHz frequency band proliferates, so too will modem and device support. From 2020, the cost of entry into the 5G ecosystem will begin to fall markedly, a trend that can be attributed to economies of scale and advancements such as multi-mode support.

It is at this point that the democratisation of mid-band 5G will occur, enabling mobile operators to engage in a commercially viable period of aggressive urban deployment, both atop the existing macrocell site grid and across a layer of small cells, to achieve contiguous coverage.

Revolving cycle

3.5 GHz

Smartphones

5G ecosystem

Year 2020 ecosystem fall markedly

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Fixed Wireless Access is a Prime Use Case

The telecoms industry has been awash with the concept of a multitude of new cases and applications enabled by the performance characteristics of 5G networks. This is no surprise - there is, potentially, a renewed path to revenue growth and monetisation spawning in the form of value-added services and differentiated network slices.

However, the acclaimed use cases, which vary in ambition from hyper-futuristic remote medical surgeries to radically enhanced wireless broadband, will require a complete transformation of the underlying mobile network to be viable. This constitutes a fundamental overhaul of not just the Radio Access Network (RAN), but also the core network.

Regardless of how much contiguous spectrum is deployed, the first wave of non-standalone 5G networks will offer little merit for mission-critical applications that are latency-sensitive. In fact, latency performance will continue to closely mirror that exhibited by today's 4G networks until the aforementioned transformation of the core network occurs.

It is for this reason that, with regard to the deployment of the 3.5 GHz frequency band in the short-term, mobile operators should explore bandwidth-driven use cases. These are more than plentiful, and when implemented correctly, they will be emblematic of the blurring performance divide between fixed and wireless networks.

Enhanced Mobile Broadband (eMBB) will be an important pioneer and monetisable use case for non-standalone 5G networks and the 3.5 GHz frequency band. This is exemplified by the plethora of 5G launches that have already taken place across the world, many of which have debuted new mobile broadband offerings in parallel to smartphone ones.

Combined, the availability of significantly wider channel bandwidth in the 3.5 GHz frequency band and aggregation with existing frequency bands paves the way for gigabit-class wireless broadband with massive capacity. The ease of deployment and cost-effectiveness, mentioned earlier in this whitepaper, could help to enhance rural connectivity and thus lessen the digital divide.

For mobile operators lacking fixed broadband infrastructure, or for those seeking to address prospective customers in more places, eMBB and the 3.5 GHz frequency band unlocks new potential.

Alpha Wireless Market Focus

Ireland

In 2017, Ireland became one of the first European countries to hold a successful auction and to assign spectrum within the 3.5 GHz TDD frequency band on a contiguous basis. The Commission for Communications Regulation (ComReg) made 350 MHz of spectrum available across nine geographic regions, implementing a transition plan to vacate incumbent users out of the band (3410 - 3435 MHz).

This auction has increased the amount of harmonised spectrum for mobile networks in Ireland by an impressive 86%, enabling major capacity enhancement across the networks of the five winning bidders. These winning bidders include Ireland's three mobile operators - Eir, Three and Vodafone - all of which managed to secure at least 80 MHz of contiguous spectrum.

One of the mobile operators, Vodafone, has already made 5G a commercial reality in the high traffic hotspots of five cities with the deployment of 3.5 GHz in an overlay macrocell deployment atop its existing 1800 MHz site grid.

Most notably, however, is the fact that the auction has paved the way for the emergence of a new neutral host network provider in Ireland. Dense Air, under Airspan, acquired 60 MHz of the 3.5 GHz frequency band in Irish cities and 25 MHz in rural regions. This development comes as the need for network densification with small cells in the Irish market has become increasingly palpable.

Imagine Communications, Ireland's largest provider of Fixed Wireless Access services, obtained 60 MHz of spectrum across each rural region. Since the auction, Imagine has leveraged the 3.5 GHz frequency band to provide an enhanced wireless broadband service in underserved rural regions where there is lacklustre fixed network availability.

As a key partner of Imagine, Alpha Wireless has and will continue to play an instrumental role in the expansion of its 3.5 GHz network across Ireland. With sites live across more than 155 locations, our AW3376 8T8R pannel antennas are being utilised to provide optimised coverage directly to the user.

In our AW3376 family, the 90 degree with 0.5 lambda spacing offers the best option for soft split and extended coverage at the cell edge. Given the presence of Imagine's network in Ireland's rural landscape, careful consideration has been given to the issue of visual pollution. Alpha Wireless's 3.5 GHz solutions are designed to be as discreet and as compact as possible.

imagine

United Kingdom

The Office of Communications (Ofcom) released 150 MHz of TDD spectrum within the 3.5 GHz frequency band (3400 - 3600 MHz) to the UK's four mobile operators - EE (40 MHz), O2 (40 MHz), Three (20 MHz) and Vodafone (50 MHz) - in 2018. This auction coincided with the allocation of the 2.3 GHz frequency band, in which O2 acquired all 40 MHz of the available spectrum.

Since this assignment of mid-band spectrum, three of the four mobile operators have launched a commercial 5G service in small parts across some of the UK's most densely populated cities, including London and Manchester.

Three, in particular, has managed to groom an impressive 3.5 GHz portfolio (100 MHz contiguous block) thanks to its acquisition of UK Broadband.

Fixed Wireless Access has been trumpeted as a key use case, with 5G broadband offerings being introduced alongside a renewed push for unlimited data allowances.

By the end of 2019, it is expected that the UK will become one of the first mobile markets in the world with all four mobile operators providing a 5G service in the 3.5 GHz frequency band.

United States

In the US, there is profound anticipation building for the availability of spectrum in the 3.5 GHz Citizens Broadband Radio Service (CBRS) frequency band. Here, the sense of captivation within the wireless industry for 3.5 GHz is perhaps more palpable than in any other market, stemming from a brimming ecosystem of equipment and devices, combined with an insatiable appetite for new use cases.

Being a commercialisation pioneer of 4G LTE and more recently 5G networks, what happens in the US market is a microcosm for the wider world. That's why many have scrutinised the apparent lack of mid-band releases there, and poked holes in a 5G strategy that omits a middle ground between low and high-band spectrum.

However, CBRS may prove to be a saving grace for mid-band deprived mobile operators in the US, and its utility is enhanced by the fact that it will, for the most part, be a shared medium of spectrum. This contrasts starkly with the aforementioned nature of 3.5 GHz releases in other markets and means the US is poised to become a hotbed for new applications that do not necessitate the purchase of licensed spectrum.

In spite of lengthy delays, the Federal Communications Commission (FCC) and the CBRS Alliance have been working feverishly to make the 3.5 GHz band (3550 - 3700 MHz) a viable path to enhance wireless network performance in the US, applying to both 4G LTE and 5G. The latter point regarding utilisation of 3.5GHz for 4G LTE is particularly notable, and it points to the often-overlooked projected longevity of 4G LTE networks.

As mentioned, the shared nature of the frequency band means that mobile operators, amongst many others, will be able to tap into its potential in advance of an impending auction for 150 MHz of licensed spectrum in 2020. Leading smartphone vendors such as Apple and Samsung have added support for CBRS (Band 48) across their flagship devices.

Boingo, for example, has outlined its intentions to leverage CBRS to augment capacity at stadiums, airports and transportation hubs where its network is present. This is a product of the FCC's initial commercial deployments (ICDs) programme for CBRS, which seeks to expedite utilisation of the spectrum.

The possibilities are virtually endless with shared spectrum, from enabling fixed operators to outgrow their MVNO status by building out a new, standalone mobile network to inspiring the emergence of new industrial IoT use cases with private LTE and 5G. And that doesn't even include neutral hosts and utilities, and everything in between.

Canada

Unlike some of the other markets mentioned in this whitepaper, Canada has yet to release spectrum in the 3.5 GHz band for 5G. The reasons for this apparent delay are twofold - an initial focus on the assignment of low-band spectrum in the 600 MHz frequency band and the existence of incumbent Fixed Wireless Access users (Bell and Rogers) in the 3.5 GHz frequency band.

This delay, however, will not continue as Innovation, Science and Economic Development Canada (ISED) prepares for an auction of 3.5 GHz (3450 - 3650 MHz) assets in 2020. The incumbent users of the band will reach the end of their ten-year license duration before next year, leading to the liberation of 175 MHz of spectrum.

Each of Canada's three mobile operators - Bell, Rogers and Telus - have expressed interest in acquiring spectrum rights of use in the 3.5 GHz frequency band, sharing the consensus that low-band spectrum alone is incapable of meeting the network performance requirements of tomorrow.

In its consultations with the industry on the proposed 3.5 GHz release, ISED has detailed the importance of Fixed Wireless Access as a pioneer use case for 5G in Canada, particularly in rural areas where the current level of connectivity is subpar.

Australia

In the other side of the world, the Australian Communications and Media Authority (ACMA) has worked to expedite the deployment of mid-band 5G networks there. Following the assignment of 125 MHz of spectrum in the 3.5 GHz frequency band in 2018, two of Australia's three mobile operators, Optus and Telstra, have debuted commercial 5G services.

The 3.5 GHz frequency band is a pioneering medium for 5G in Australia, and it is poised to complement the existing National Broadband Network (NBN) as mobile operators focus on convergence with the bundling of mobile and Fixed Wireless Access services.

Five winning bidders spread across fourteen geographical regions emerged victorious from the 3.5 GHz auction. These include the aforementioned mobile operators and Vodafone, in addition to Dense Air.

Dense Air, a neutral host provider, has similar aspirations in Australia as it does in Ireland, with plans to pimp network capacity using small cell densification in six of the country's largest cities. This will breathe new competition for network quality into the Australian market.

Conclusion

The tenacious focus on enhancing end-to-end network performance with 5G signals the beckoning of a new era for spectrum diversity and densification of the site grid. In simple terms, this means marrying large swathes of low, mid and high-band spectrum with a denser site grid that is, increasingly, bound together on a micro-level by small cells.

As the equilibrium for coverage and capacity, mid-band spectrum is a foundational component of the 5G roadmap, and the 3.5 GHz frequency band is poised to assume this role. In markets across the world, regulators, mobile operators and even new kinds of spectrum users such as neutral hosts are working to deploy the band and to groom an ecosystem of use cases.

With radically new concepts such as shared spectrum coming to fruition, alongside a renaissance in tackling legacy issues including the digital divide, 3.5 GHz is arriving at the beginning of the next sea change in wireless networks.

Alpha Wireless possesses a breadth of market-leading antenna solutions that are acting as a propellant for 3.5 GHz ambitions across the world. Our panel and small cell antenna families aid operators of every kind in their pursuit of uncompromising wireless network performance.

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