An Coimisiún um
Rialáil Cumarsáide
Commission for
Communications Regulation

Redacted version of Dr. Dan Maldoom's report of DotEcon titled "Issues arising from delay of the MBSA2 Award"

Redacted version dealing with the expected economic benefit to Ireland from the widespread deployment of 5G

Information Notice

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1 Introduction

1.1 In the Multi Band Spectrum Award ("MBSA2") High Court proceedings[1], ComReg obtained reports from economic experts Dr. Dan Maldoom and Professor Peter J. Clinch with regard to the economic impact of a delay in the award of MBSA2 rights. Of necessity these reports had to consider the likely economic benefits from the widespread deployment of 5G.

1.2 This document sets out a redacted version of Dr. Dan Maldoom's report dealing with the expected economic benefit to Ireland from the widespread deployment of 5G

[1] High Court Record Number: 2021/9 MCA

dot·econ

Issues arising from delay of the MBSA2 award

20 June 2022

[redacted]

I have been asked by ComReg to consider various issues arising out of potential further delay to the MBSA2 process that might be caused by Three being granted a stay.

This report is split into two self-standing parts, with separate overviews to each part:

- Part I (Sections 1-5) concerns the economic and social costs of delaying the award process and the implications of interim licensing for investment incentives;
- Part II (Sections 6-8) concerns [redacted]

[redacted]

1 Part I: Overview

1. [redacted]

[redacted]

3. Section 3 considers the implications of interim licensing of 700 MHz and 2.1 GHz spectrum currently in use. [redacted]

[redacted]

5. Section 4 reviews existing studies of the benefits of 5G mobile to the economy. These benefits are extremely large because of the profound integration of mobile and wireless services into the economic and social fabric. 5G is expected to have a much more profound transformative effect than previous generational shifts in mobile network technology.

[redacted]

6. 5G is not simply a matter of yet greater mobile broadband speeds, but also a fundamental shift in how services are deployed. It will become possible to prioritise different aspects of service, such as speed, latency, power consumption and so on for different user classers on common network infrastructure and integrate computing resources close to the end-user. This change will enable widespread, high-speed, low-latency and high-reliability connectivity to support the so-called Internet of Things (IoT). Machine-to-machine communication supporting a much higher density of connections per unit of geographical area will become possible for the first time, which is expected to have profound effects in sectors such as transport and agriculture. Therefore, benefits will accrue not just for consumers directly using 5G services themselves, but also for businesses using mobile data connectivity to support new products and services across the economy, for productivity and for the delivery of services by the public sector (such as tele-medicine and emergency services).

7. Given these benefits from 5G, and the necessity of having secure long-term access to spectrum to support the investments required to deliver it, the costs of delay to the process could easily be in the order of €1 bn per annum (and potentially double that). Therefore, even a 3-month delay would cost the Irish economy in the order of €250m. A two-year delay would cost in the order of €2 bn to the Irish economy. Whilst the exact magnitude of these costs is necessarily uncertain, it is highly likely that they will be very substantial.

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3 Uncertainty and investment incentives

25. This section considers the uncertainties for spectrum users created by interim licensing of spectrum and the depressing effect on investment incentives for operators from not having access to long-term spectrum usage rights.

3.1 Temporary access vs. long-term usage rights

26. The MBSA2 award would grant rights to use spectrum until 2042 (IM §3.2). Therefore, operators making associated network investments have certainty of continued access to the associated spectrum far into the future.

27. In contrast, spectrum users face a variety of uncertainties under a temporary or interim licensing regime:

    a) The length of the regime is unknown, potentially lasting a few months or stretching to several years in the worst case;

    b) The regime could end at short notice;

    c) When the regime does end, there is no guarantee that the user would eventually retain the same specific frequencies, or even the same amount of spectrum in each band, once the MBSA2 auction was run and long-term usage rights were allocated; and

    d) There is potential for dispute around the terms of any interim licensing, which could cause those terms to change.

3.2 Irreversible investment and uncertainty

28. Although modern mobile telecommunications networks are increasing agile, allowing reconfiguration through software, many aspects of the associated network investments are sunk. This means that the investment cannot be readily unwound and its costs fully recovered if an operator loses access to spectrum, or wants to modify its spectrum holdings (e.g. swapping spectrum in one band for another). Equipment is required at cell sites, whose geographical layout reflects the propagation characteristics of the specific frequency bands being used. Antennas are typically specific to the spectrum band used. Therefore, a substantial part of the associated network investment will be at risk of becoming stranded unless the operator has long-term access to spectrum.

29. [redacted]

30. Put simply, operators do not have immediate flexibility to respond to changes in their portfolio of spectrum holdings. Network investments and spectrum acquisition need to be planned together over a sufficiently long horizon. Uncertainty around continued access to spectrum under a temporary licensing regime depresses incentives to invest, as operators have an incentive to wait and defer investments until the uncertainties of the temporary licensing regime are resolved by the award of long-term usage rights.

31. Economic theory shows that investment incentives may be acutely sensitive to risk when investment is wholly or partially irreversible.[8] This is because, once made, investment is inflexible and cannot be reserved, redimensioned or reconfigured to respond to changed circumstances, at least without significant additional cost. This creates incentives for investors to wait and allow uncertainties to resolve.

32. This concern with predictable access to spectrum to support investment is reflected in the EECC, which sets a 20-year minimum duration for spectrum licences supporting wireless broadband services.[9] During consultation over the EECC, the GSMA (the industry body for mobile operators) lobbied for even longer 25-year licences:[10]

> *"The mobile industry is ready to step up and deliver 5G and the Gigabit Society. But we can't do it on our own. To ensure the long-term viability of 5G and the Gigabit Society it is essential that EU institutions in their reform of the telecoms regulation, act on the following considerations: … More certainty and predictability for spectrum licenses, including a minimum licence duration of 25 years during which spectrum is actually available, with a strong presumption of renewal"*

[redacted]

[redacted]

[redacted]

[8] See Dixit and Pindyck (1994) "Investment under uncertainty", Princeton University Press.

[9] Article 49 European Electronic Communications Code.

[10] https://www.gsma.com/gsmaeurope/resources/gsma_eecc_recommendations/

[redacted]

4 Benefits of 5G

40. This section sets out key features of 5G and reviews its likely economic benefits that could be lost from delay of the MBSA2 award.

4.1 Features of 5G

41. 5G is the term used to describe the next generation of wireless networks, beyond current 4G LTE networks. 5G networks are expected to build on, and smoothly integrate with, the legacy of previous generations of wireless networks. From 2G to 4G, each radio access technology generation over the last 25 years has focused on improving the speed and efficiency of wireless networks to enhance mobile services. Each transition has been driven by the greater capabilities of each generation over its predecessor. 3G enabled mobile internet and data connectivity at a much more advanced level than 2G. 4G was able to serve the massive increase in mobile data traffic, something 3G was not capable of.

42. With more people using mobile broadband as services and applications expand, more devices of many types connecting to mobile networks and continued growth in data traffic, further enhancements will eventually be required. 5G will support expected mobile data growth, in theory allowing speeds up to 20 Gbps (up from a theoretical limit of 1 Gbps for 4G LTE, although real-world speeds will be lower).

43. The deployment of 5G networks is important in fulfilling expected mobile data traffic growth, but it is not only a matter of enhanced capacity and speed. 5G brings enhanced capabilities, including lower latency, high resource efficiency, decreased energy consumption, and enhanced security. It can support a much higher density of terminal devices within a given geographical area.

44. A key difference with 5G is that operators can configure multiple 'virtual' networks with differing performance characteristics aimed at different types of users, with this being readily reconfigurable through software without needing further physical investment. For example, it is possible to provide a resilient service that cannot be overwhelmed by excessive traffic within another service carried over common physical infrastructure. Such resilient separation is currently impossible with 4G LTE. With 5G, virtual services can be tailored to prioritise different performance characteristics (e.g. speed vs. power consumption). 5G will allow for a shift from networks designed and built from the outset for specific performance characteristics to agile networks that can be programmatically assembled and configured for specific use cases as they arise.

45. As a result, 5G is expected to provide tailored connectivity to meet the particular demands of different user groups, including industries (so-called 'verticals'). Verticals may need data connectivity both to use internally for their own operations and to embed within the products and services they supply to their end customers.

[redacted]

46. Therefore, 5G availability is a precursor to innovation across many industries and sectors and is likely to have wide-ranging impact. 5G will create opportunities for a range of innovative services for enterprises, including IoT (Internet of Things) applications and deep integration of connectivity (e.g telematics with vehicles to support automation and smart roads initiatives). For the first time, mobile networks will be designed to address the varying needs of different industries and user groups, and the rise of ubiquitous connected devices (so-called massive machine-type communications – mMTC). As more devices and objects need to be securely, automatically and remotely connected and monitored – allowing systems, machines and infrastructures to run with end-to-end machine-to-machine communication - a large number of sectors may become increasingly reliant on wireless network services.

47. 5G also provides for computing resources to be deeply integrated into the network (so-called edge computing). This is intended to prove low latency responses in applications such as robotics, where delays in traversing the internet to connect to centralised servers can be avoided. The software and IT industries stand to evolve significantly because the 5G network services will rely on software and virtualisation. This may create options to develop new partnerships and synergies across industries.

48. Therefore, the ultimate effects of 5G are wide ranging. The change is much more fundamental than previous generations of mobile network technology. 5G leads to an increase not just in the capacity of mobile networks, but also in their fundamental capabilities.

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4.4 Rural services and 700 MHz

55. As discussed above, its propagation characteristics make the 700 MHz band particularly important for rural deployment of 5G services. These new services are of particular value as rural areas currently have slower average connection speeds and a more limited choice of Internet connectivity than denser urban areas.[13] Ireland has particularly challenging geo-demographics, with low population density outside urban areas, with little clustering of rural population.

56. Better connectivity is likely to support greater economic activity in rural areas and facilitate home working and small enterprise. Many of the important anticipated applications of 5G presume that there will be largely ubiquitous high-speed, low-latency connectivity to support certain services. In particular, transport applications need sufficient coverage to be viable. Smart agriculture, by definition, requires coverage in rural areas. Safety applications, such as remote medical applications, are of greater usefulness in rural areas where alternatives require significant travel times. Therefore, there are good reasons to be particularly concerned about delay to widespread 5G deployment in the 700 MHz band due to its contribution in the Irish context.

57. In addition, the MBSA2 award may lead to some spectrum being using for high-bandwidth fixed wireless applications by providers other than the three MNOs. Delay in the award directly delays these services, which would very likely be targeted at rural areas where fixed connectivity is relatively poor.

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[13] See, for example, ComReg 18/103 which discusses this issue.

[redacted]

4.5 Quantification of delay costs

58. The general economic benefits of 5G mobile have been estimated in a variety of recent studies, as summarised in the table below. All sources are referenced below. Estimates are given in the original currency used by the study.

Study	Estimated benefit	Benefit per capita[14]	Extrapolated to Ireland[15]
BCG/CTIA (2021)	$1.4-$1.7 trillion contribution to US GDP, **over the next ten years**	$4220-$5130 (€4050-€4920)	€20.2-€24.2 billion GDP contribution over ten years ***€2.2-€2.7 billion contribution in the first year***
McKinsey (2020)	€2.2 trillion contribution to GDP of the EU+UK **from 2017-2030**	€4270	€21.3 billion GDP contribution over 13 years ***€1.8 billion contribution in the first year***
Centre for Policy Studies (2020)	Up to £52.6 billion increase in UK economic output **between 2021 and 2027**	£783 (€916)	€4.56 billion contribution over six years ***€798 million contribution in the first year***
Huawei (2020)	€6 billion *more* cumulative benefit to Irish GDP with high 5G investment, compared to low investment scenario, **by 2025**	€1224	€6.1 billion increase over low investment scenario, over seven years ***€920 million contribution in the first year***
GSMA (2022)	$121 billion contribution to European GDP from 5G mid-band spectrum **in 2030** (N.B. this is a single year)	$221 (€212) (N.B. this is in 2030)	***€1.06 billion contribution*** from mid-band spectrum in 2030

59. The table gives the estimated benefit relative to the affected population of the country considered in the study. Benefits have been accrued over different periods in different studies. For comparability, these have been annuitised to express benefits in a per-annum, per-capita form. For these purposes, I assume a real discount rate of 4% (as typically used for public sector cost-benefit analysis in Ireland) and 2% growth in the benefits over time, reflecting long-run economic growth. These assumptions are not material to the overall

[14] Using ECB exchange rates from 13 May 2022.

[15] Using the estimated benefit/pop and the population of Ireland. First year contribution numbers assume a discount rate of 4% and growth rate of 2%.

conclusions about the order of magnitude of these benefits. Note that the GSMA study reports benefits for one single year in the near future (2030), which is reported unadjusted (other than for conversion from dollars to Euro).

60. These studies suggest that delay costs to the Irish economy could easily be in the order of €1 bn per annum, and potentially double that.

61. These estimates do not consider any of the specific circumstances of the Irish context that might increase these costs, such as low rural population density which makes sub-1 GHz spectrum especially important and so increases the importance of releasing 700 MHz spectrum. Even with transition to 5G, the 700 MHz band can provide significant additional capacity within existing 4G LTE networks.

62. In addition to these direct economic benefits, various studies have also identified further non-market benefits for 5G. For example, Latif et al (2017) identify significant opportunities in healthcare, for remote health monitoring, ingestible or wearable sensors and robot-assisted surgery. West (2016) finds sustainability benefits across water management, air quality, energy efficiency, smart buildings and traffic management.

63. In summary, we have a conservative estimate of €1bn/annum for delay costs of 5G directly read across from the studies listed above, potentially increasing to €2bn/annum on the basis of the more optimistic studies. In addition, there are likely effects in rural areas and non-market benefits that could be added. Delay of the MBSA2 award itself also creates further costs through holding back potential users of 2.3 GHz and 2.6 GHz spectrum entirely, which may include users other than the MNOs. It also potentially freezes in place Three's current spectrum advantage, which may have competitive effects.

4.6 Sources

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6 Part II: Overview

[Part II of the report is redacted in its entirety]

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