**The Economic Significance of License-Exempt Spectrum**

**to the Future of the Internet**

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# Short summary

The economic impact of the internet has already been enormous and the decades to come promise even richer economic possibilities. However, to maximise the benefits a number of challenges will need to be overcome:

* Creating cost-effective delivery methods that can extend broadband internet to the billions currently lacking access;
* Developing the specialised technologies needed to create tens of billions of machine connections to the internet;
* Ensuring that our increasingly critical networks are resilient and adaptable in the face of natural and manmade disturbances.

This new study demonstrates in detail how licence-exempt radio spectrum – which allows businesses and citizens the freedom to deploy their own wireless networks without the need for costly and bureaucratic spectrum licences – is already playing a central role in meeting these challenges. Policy makers and regulators need to act to increase the possibilities for licence-exempt access if they wish to unlock the full economic potential of the internet in the years to come.

## Universal broadband access

Existing models for delivering broadband are expensive and will not accomplish universal broadband access. Fixed broadband access is unaffordable for 3.9 billion people spread across every country in the world. In addition, mobile broadband is unaffordable to 2.6 to 3.5 billion people.

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|  | Europe | N.America | S.America | Africa | Oceania | Asia |
| Fixed broadband unaffordability | 8% | 19% | 57% | 90% | 21% | 71% |

Technologies using licence-exempt spectrum, such as Wi-Fi, are already playing a substantial role in improving the quality and reducing the costs of broadband access:

* Wi-Fi carries more global data traffic than mobile data networks and Ethernet combined.
* Wi-Fi substantially enhances the value of fixed broadband, generating a global economic benefit for consumers of $52 to $99 billion annually. Without these benefits, 50 to 114 million consumers might terminate their fixed broadband subscriptions.
* Wi-Fi carries the large majority of data used by smartphone users. In its absence, mobile operators would immediately require 150,000 to 450,000 new radio base stations at a cost of $30 - $93 billion. By 2016, Wi-Fi will obviate the need for mobile operators to deploy an additional 1.2 million base stations at a cost saving of up to $250 billion – comparable to around one third of the total annual revenue of the telecommunications industry.
* Licence-exempt technologies, including Wi-Fi, are being used by tens of thousands of businesses and organisations worldwide to extend broadband to millions of people not covered by fixed and mobile networks.
* Small-cell licence-exempt architectures use spectrum to deliver broadband much more efficiently than cellular networks. For example, the aggregate spectral efficiency of the 2.4GHz band is at least 30 times greater than the overall efficiency of any cellular band.

Existing licence-exempt spectrum suitable for broadband uses high frequencies that have limited range. However, the Television (TV) white space spectrum will use spectrum at frequencies below 1GHz allowing up to ten times the range of existing Wi-Fi. The white spaces have the potential to create cost-effective large-scale models for delivering broadband that could be used to connect many hundreds of millions of people currently unconnected.

## Machine to machine communications and the internet of things

The internet is also increasingly used for communication between a wide variety of sensors and control mechanisms, including delivery trucks reporting their location, wireless sensor networks used to detect forest fires and pacemakers reporting data to doctors. These new uses are collectively termed ‘the internet of things’.

The number of intelligent connected devices is likely to exceed 100 billion by 2020. This represents a 25-fold increase in the number of terminals, but a 625-fold increase in the number of possible interconnections between these terminals. Under conservative assumptions the economic contribution by 2020 could reach $1.4 to $2.2 trillion per year – around five times that of the economic value of the internet today.

Licence-exempt technologies are cost-effective, power-efficient and provide users a range of technologies and fine control over the networks and infrastructure they deploy. Consequently, at least 95 to 97.5% of the connections to the internet of things will be made using licence-exempt spectrum. Without access to licence-exempt spectrum the internet of things would not reach the scale that is widely expected. Simply assuming that the least-valuable 50% of devices would not be connected, around $560 to $870 billion a year of economic value could be foregone in 2020 – around one-third of the total value of the internet of things.

Spectrum at frequencies below 1GHz, such as the TV white spaces, provides excellent coverage and low power requirements; ideal for a number of machine uses of the internet. At present only some regions have usable licence-exempt spectrum available in these frequencies. The costs of not having such spectrum available can be high; Europe is facing difficulties in the deployment of advanced electricity metering infrastructure that may cost its economy $37 – 56 billion by 2020. Allowing licence-exempt access to the TV white spaces on a global basis will allow every country to take full advantage of the economic benefits of the internet of things.

## Building resilient and flexible networks

By democratising the ability to deploy wireless networks, licence-exempt spectrum is significantly contributing to the overall reliability and adaptability of our communications networks:

* The deployment of many specialised and general purpose wireless networks using licence-exempt spectrum has allowed the architecture of our broadband data networks to become more dense and diversified. A number of the functions of networks such as industrial control systems and home entertainment networks would be immune to the failure of our traditional fixed and mobile networks.
* Low barriers to deploying networks improve the adaptability of our communications systems. For instance, as new opportunities using data connectivity emerge it is likely that hundreds or thousands of companies will attempt to develop solutions using licence-exempt technologies. This dynamism stands in contrast to fixed and licensed cellular industries where only a handful of firms may be in a position to provide a solution.
* Furthermore, in emergency situations, such as the aftermath of a natural disaster or violent attack, traditional fixed and mobile networks often fail. The specialised personnel and equipment needed to restore connectivity may not be available. The deployment of a licence-exempt network, however, typically does not require any specialised equipment. Off-the-shelf or repurposed home and office Wi-Fi access points can be stitched together to create broadband networks. This approach has been used in a number of instances where telecommunications services have been lost, from the aftermath of the Haiti earthquake to areas affected by the Indian Ocean tsunami.

The introduction of technology using the TV white spaces will also extend the possibilities of licence-exempt operation, permitting broadband links that span hundreds of metres and lower speed machine-to-machine links that span many kilometres. TV white spaces will also provide a substantial boost to adaptability by enabling the rapid creation of near ubiquitous networks in the case of disaster. Major TV white space technology trials are investigating these disaster recovery capabilities.

## Policy recommendations

There are two important policy actions that can be taken to unlock the economic potential offered by licence-exempt access to spectrum.

In the short term, nations should work to allow licence-exempt access to the TV white spaces using internationally adopted standards and practices. This band has the unique potential to provide a significant boost to each of the three vital areas explored in this study.

In the longer term, policy makers need to ask broader questions about spectrum management. Conceiving of spectrum as a finite natural resource and treating it as such with the issuing of tradable exclusive-use licences has not resulted in the dynamic markets that were expected. Instead it has led to inefficiently used spectrum. However, licence-exemption has created dynamic markets and industries where spectrum is used intensively. The real-world successes and limitations of existing regulatory approaches should be closely studied before new spectrum management policies are introduced.