

# SPECTRUM AND DEVELOPMENT

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In the field that has come to be known as Information and Communication Technologies for Development or ICT4D, the management and regulation of electromagnetic or wireless spectrum has evaded most donor programmes and debates. Broadly speaking ICT4D is a field that looks at the impact of information and communication technologies (ICTs) on development and explores how equity, rights, and social and economic development can be positively affected by access to ICTs. ICT4D embraces both policy and technology in a quest to create equitable access for all. In this article, I will make the case that the absence of debate or action on the regulation and management of wireless spectrum now stands as a gap in development thinking about ICTs.

### 4.1 WHY WORRY ABOUT SPECTRUM?

Why should wireless spectrum be given special consideration? For much of the developing world, wired technologies, especially in rural areas, are simply not practical. In the industrialised world, wired technologies feature heavily in the last mile for high-speed data whether via an ADSL-enabled copper telephone line or via the coaxial copper cable provided by a cable television operators. However copper-based last mile solutions present particular challenges in poor countries. The roll-out cost of copper infrastructure is comparatively high, and often not practical in lower-income countries, even less so in sparsely populated rural areas. The steadily increasing value of copper as a commodity also makes it a target for thieves. Fibre optic cable infrastructure is another important connectivity technology especially for national and international communication backbones but it is currently only viable as a last-mile solution in wealthy communities. Satellite-based infrastructure is also a powerful technology for delivering access in remote areas but it too is currently not cost-effective as a last mile technology.

This means that when talking about affordable, ubiquitous access to communication in developing countries, wireless technologies offer the most hope for effectively bridging the digital divide. And indeed, the mobile phone has become more or less synonymous with access in the South. Much has changed since mobile networks first began rolling out in the early-to-mid nineties in the South. When the first mobile operators were granted licenses to use wireless spectrum to build their networks, they were simply given the spectrum at no charge. There was plenty of available spectrum to go around. Today popular spectrum bands are auctioned for large amounts of money, often running into the billions of dollars. Because so much money is now at stake concerning spectrum, the process of making new spectrum available has become complex. It is increasingly hard to ensure that spectrum is made available in a timely manner and to the entities that are most likely to serve a country's strategic interest. As ICTs become increasingly valuable to government, industries, and citizens alike, demand for spectrum has steadily increased. Yet the process of making spectrum available and managing it as a resource still fails to feature in ICT4D initiatives and strategies.

## 4.2 SO WHY DON'T WE TALK ABOUT SPECTRUM?

One possible answer to why spectrum doesn't feature significantly in ICT4D lies in its multi-dimensional complexity. It is a daunting issue to address, requiring technical, economic, and legal expertise. Here are just a few of the dimensions in which spectrum is a challenge to understand and manage.

**Technical complexity.** What we understand about wireless spectrum is in flux. Eighty years ago the only way to manage spectrum was to give exclusive rights to a spectrum holder and ensure that significant "guard bands" or gaps between spectrum holders existed in order to prevent interference. Transmitters were obliged to operate at comparatively high power outputs in order to reach the comparatively "deaf" receiver devices. Today wireless communication technology continues to increase in efficiency and in its ability to mitigate interference. There are limits to this, however, and understanding how to maximise the efficient use of spectrum is an ongoing technical challenge which attracts a lot of R&D investment. Understanding the trends and changes in spectrum technology is essential to understanding how to regulate it.

**Money and Corruption.** As the business of telecommunications has become more lucrative, an increasing premium has been put on access to spectrum. As a result, regulators find themselves managing a resource worth millions of dollars to interested parties. Where that much money is on the table, ensuring fair play in the national strategic interest can be

a challenge. Spectrum auctions have emerged as the de facto mechanism for dealing with licensed spectrum yet effective auction design and execution is a challenge even in well-resourced regulatory environments. Success in this area doesn't just involve designing an optimal auction but also creating a sufficiently well-organised and disciplined process that doesn't attract legal challenges from disgruntled parties.

**Market and Manufacturing Complexity.** Spectrum usage is dependent on having technology capable of using a given set of frequencies and this, in turn is entirely dependent on manufacturers producing transmitters and receivers for those frequencies. Many technologies only become practical when manufactured at scale so there is a kind of catch-22 with new technologies that requires commitment from manufacturers to support specific standards and frequencies. In the past, the trend in spectrum allocation has been to tie a particular spectrum band to a particular technology. This has led to chunks of spectrum lying fallow because the markets and manufacturers did not follow the path that regulators expected. Today, there is an increasing emphasis on technological neutrality in spectrum allocation but this can be challenging because some technologies, for example those that require paired spectrum, are dependent on spectrum allocations being organised in a particular manner.

**The Challenge of Coordination.** Prior to the advent of mobile telephony and wireless broadband technologies, the availability of spectrum exceeded demand and incentives to coordinate spectrum allocation existed but were often trumped by local or regional priorities. So while there is broad coordination in general areas of spectrum use, there are critical variances in the details. This has led to the need for mobile phones that operate in three, four, or more spectrum bands in order provide a working service internationally. Regulators today find themselves in a catch-22 situation where they recognise the need to harmonise spectrum but are tempted to act individually because the pace of international coordination is so slow.

**Institutional Capacity.** When it comes to effective regulation of spectrum, there is a clear need for the technical, economic, legal, and administrative capacity within every country to address the above issues effectively. For developing countries, this is often the most significant challenge as communication regulators are typically under-resourced and sometimes insufficiently independent of state and industry alike. Because so much money is on the table, regulators are often outmatched by their wealthy industry counterparts.

### 4.3 WHERE DO THINGS STAND?

In poor countries, regulators and governments are caught between the growing market demand for more spectrum and the need for more human and financial resources to manage the increasingly complex web

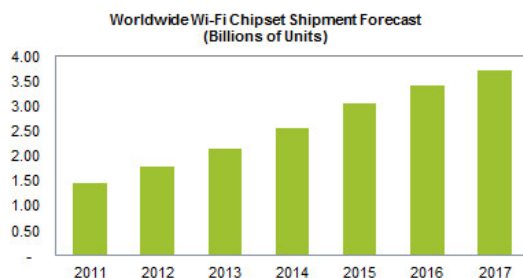
of issues including spectrum auctions, technological advances, regional harmonisation, not to mention vested interests. This is compounded by the fact that decisions about spectrum can have consequences that can last a generation or more. The interplay of investment, evolving technical standards, and administrative complexity tends to make this a very slow moving decision-making environment. This means that not only does it take a long time to introduce new spectrum regulation but also that strategic errors in regulation can take many years to undo. South Africa is a good example of how challenging it can be to carry out a spectrum regulation change. In May of 2010, the South African communication regulator, ICASA, announced an auction of spectrum in the 2.6 GHz and 3.5 GHz bands<sup>1</sup>. The auction was plagued with problems. Insufficient attention was given prior to the auction to the need to migrate incumbents within the 2.6 GHz band in order to preserve technological neutrality. Build-out requirements for the spectrum licenses were claimed to be unrealistic by some major players<sup>2</sup> and other factors were criticized as well. For nearly two years the regulator went through an on-again, off-again process with the auction. Ultimately the auction was withdrawn and three years later the spectrum remains unavailable. Worse, trust in the regulator's capacity to successfully carry out a spectrum auction has been undermined.

1. Icasas broadband spectrum auction: all the details - 28 May 2010 <http://www.techcentral.co.za/icasa-spectrum-auction-all-the-details/14669/>
2. Vodacom may walk away from spectrum auction - 17 June 2010 <http://www.techcentral.co.za/vodacom-may-walk-away-from-spectrum-auction/14998/>

#### 4.4 UNLICENSED VERSUS LICENSED SPECTRUM

Standing in stark contrast to the traditional method of assigning spectrum through exclusive-use licenses is the world of unlicensed spectrum. Unlicensed spectrum is regulated but instead of being managed through a licensing process, it is regulated through the technical specifications imposed on devices operating in spectrum designated as unlicensed. Typically this means that the power output of these devices is required to be much lower than is found in licensed environments. The lower power output limits the ability of any device to interfere with another and any device operating in these bands must be tolerant of interference. Originally conceived for non-communication-related use of radio spectrum, the Industrial, Scientific, and Medical (ISM) bands have come to be dominated by popular communication technologies such as WiFi, Bluetooth, and Near Field Communication. The success of these technologies, WiFi in particular, is something to consider in the context of spectrum management strategies. The ultimate use of the ISM bands was not predetermined. WiFi emerged as a success story more through a process of natural selection than by design. Its success has eclipsed all expectations. According to market research firm IHS<sup>3</sup>, in excess of 2.14 billion WiFi chipsets will ship in 2013 - 20% more than in 2012. WiFi technology is emerging as a critical part of mobile broadband

3. Small Cells with WiFi Set to Reshape Wireless Communications Market - May 15, 2013 <http://ihs.newshq.businesswire.com/press-release/design-supply-chain/small-cells-wi-fi-set-reshape-wireless-communications-market>



Source: IHS Inc., April 2013

Figure 4.1: Worldwide WiFi Chipset Shipment Forecast

infrastructure.

According to a survey of Android devices by mobile analytics vendor Mobidia<sup>4</sup>, WiFi predominates as the access technology for smartphone and tablet data. This research is corroborated by reports from Nielsen<sup>5</sup> that WiFi also dominates smartphone data in the UK with only 22% of data traffic travelling via mobile networks. It is interesting to note that this dominance has evolved without the intervention or design of mobile operators.

The success and importance of WiFi to broadband strategies has begun to receive some attention in the industrialised world but receives almost no attention in debates on bridging the "digital divide". A recent ITU / Unesco report entitled The State of Broadband 2012: Achieving Digital Inclusion for All<sup>6</sup> mentioned WiFi only twice. As a broadband connectivity success story, unlicensed spectrum is under-represented. We rely on WiFi connectivity everywhere we go yet it is seldom mentioned in a strategic context, perhaps because its growth has occurred so organically.

4. <http://www.mobidia.com/products/whitepaper-download/>

5. WiFi delivers over three-quarters of all UK smartphone data - 15 Nov 2012 <http://www.nielsen.com/uk/en/insights/press-room/2012/wifi-delivers-over-three-quarters-of-all-uk-smartphone-data.html>

6. ITU Unesco - Broadband Commission - September 2012 Broadband 2012: Achieving Digital Inclusion for All <http://www.broadbandcommission.org/Documents/bb-annualreport2012.pdf>

## 4.5 TV WHITE SPACES SPECTRUM - A NEW FRONTIER

While the existing unlicensed spectrum technologies have gone from strength to strength, a new opportunity for unlicensed spectrum use has emerged in the form of TV White Spaces spectrum. Originally conceived of as a technology that could take advantage of the guard bands or "white spaces" that were left between television channels to prevent interference, TV White Spaces (TVWS) spectrum is a secondary spectrum technology that can take advantage of unused television spectrum in a dynamic manner. In the US and the UK, communication regulators have endorsed

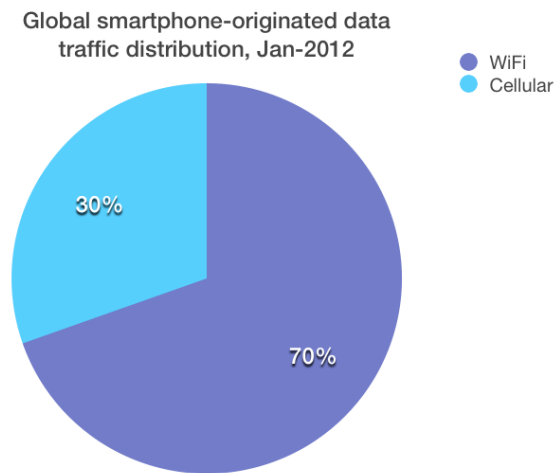


Figure 4.2: Global smartphone originated data traffic distribution (Source: Mobidia)

TVWS regulation and the commercial scale-up of TVWS technology has begun.

#### 4.6 WHAT PROMISE DOES TV WHITE SPACES TECHNOLOGY HOLD FOR THE DEVELOPING WORLD?

There are three key reasons why TVWS technology holds tremendous promise for the developing world:

**Low Risk Regulation.** Because TVWS is a secondary-spectrum-use technology, there is no need to re-allocate spectrum in order to regulate its use. It doesn't commit the regulator to giving away a spectrum band for years to come and doesn't expose the government to the challenges of spectrum auctions which range from stalled processes (as we have seen in South Africa) to widespread corruption (as we have seen in India<sup>7</sup>). Whether TVWS succeeds in its potential to spur the same innovation and market development that has happened in WiFi is a risk for the market not for the regulator.

**Availability of Television Spectrum.** The profusion of terrestrial broadcast channels in use in North America and Europe may limit the impact of TVWS applications in these regions. However, a region like Sub-Saharan Africa (SSA) is very different. Most countries in SSA have few terrestrial broadcast channels in use, leaving large amounts of television spectrum available for use. This is even more true in rural areas where TVWS show their greatest potential. The flexible nature of TVWS technology means that more spectrum can be taken advantage of in the least serviced areas. Of course this doesn't preclude using

7. India's 2G Telecom Scandal Spans the Spectrum of Abuse - 02 Dec 2010 <http://knowledge.wharton.upenn.edu/india/article.cfm?articleid=4549>

television spectrum for other purposes too such as digital terrestrial TV and mobile broadband.

**A Great Rural Technology.** While mobile technology has been an access boon for the developing world, mobile operators still struggle to deploy access in rural areas where low incomes and sparse populations do not make a viable economic proposition for the establishment and maintenance of mobile base stations. TVWS has specific advantages that make it well-suited to being a complementary access technology. First, TVWS use of the UHF spectrum band offers better propagation characteristics than other technologies higher up in the spectrum band. This means that individual base stations can reach further, thereby lowering the total number of base stations required for a given areas. Second, UHF spectrum doesn't require direct line-of-sight between radios. This will also lower the cost of deployment thereby reducing the need for high towers and more complex network design. Finally, the market cost of TVWS devices<sup>8</sup> will be closer to that of WiFi equipment than traditional wireless broadband equipment used by licensed spectrum operators.

**Opportunity for Entrepreneurship.** Perhaps the least acknowledged benefit of TVWS regulation is the opportunity that it will offer to entrepreneurs. Rising demand for licensed spectrum has raised the bar for market entry so high that none but the wealthiest of investors can get involved. The high cost of entry also raises the risks of market entry. By contrast, TVWS technology will open up rural broadband service delivery to an entire generation of entrepreneurs interested in providing local, competitive broadband services. If TVWS technology lives up to its promise, it will not only provide opportunities to small entrepreneurs but perhaps will also provide the foothold they require to nip at the heels of and ultimately challenge the market hold of incumbent operators.

8. TV White Spaces Aims To Bolster Net of Things - 4 March 2013  
<http://www.eetimes.com/design/microwave-rf-design/4410924/TV-white-spaces-spec-aims-to-bolster-Net-of-Things>