TITLE: REGULATING SPECTRUM FOR DIGITAL SERVICES MARKETS:\footnote{This paper is based on a research paper presented to the South Africa electronic communications sector regulator, ICASA in 2011}:
AN E-EDUCATION PERSPECTIVE\footnote{With acknowledgement to Ewan Sutherland for review and comments}

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ABSTRACT

South Africa’s population of 51.5 million includes a school-going population of over 12 million learners in public schools. South Africa’s digital services and media markets have been slow to develop in the past decade. Thus, while two of nine provinces have introduced computers in schools, e-education has not advanced. Education challenges, such as access to knowledge resources, can be addressed by effective delivery of an extensive range of content through e-education channels. However, Internet connectivity is low in public schools and higher education institutions, broadband is inadequate, and there is only limited availability of digital educational media.

Three aspects of historical spectrum regulation have stifled the emergence of e-education: (a) universal service and access obligations in spectrum licenses have proved inadequate in taking Internet to schools; (b) Internet service providers are not assigned spectrum, despite their apparent interest in building wireless infrastructure networks and (c) regulation has tended to focus on market players, rather than on required outcomes.

This investigation into spectrum regulation for digital services markets collects evidence regarding interest in e-education and poses three issues for consideration by regulators: (1) Licensed and unlicensed spectrum: Promoting broadband for public value including educational services, (2) Regulation for innovation in digital services and media markets, and (3) Pricing versus valuing spectrum.
Shift to electronic services in South Africa

This paper, the second in a series of three, seeks to understand the logic of existing and proposed spectrum policy and regulation methodologies, in the context of the emerging digital services and media markets in South Africa. It focuses on questions pertaining to mobile broadband access for the education sector. It proposes alternative approaches to the proposed regulatory measures (ICASA, 2011) that would see new entrants benefit from spectrum assignment in ways that impact on end users in the public services sector, while creating new opportunities for traditional players such as mobile operators.

South Africa, an emerging economy with a population of 51.5 million, has experienced rapid increase in mobile penetration levels, but relatively slow increase in Internet penetration in the past decade. Six million South Africans have Internet access on their phones and 39% of urban users as well as 27% of rural users are browsing the Internet on their phones (Goldstuck, 2011). Mobile devices and Internet applications are attractive to South African consumers, however, only a limited range of digital services, and an even smaller range of public services are available via the Internet. Until 2008, wireless device usage had been oriented towards voice (Goldstuck, 2010), but post-2008 there has been a rapid increase in data access, driven by the convenience of mobile data access and cheaper devices such as smartphones and tablets.

South Africa’s services and industrial economy is concentrated in six metropolitan municipalities: Johannesburg, Tshwane, Ekurhuleni, Cape Town, eThekwini and Nelson Mandela, which have significantly greater levels of Internet penetration than the rest of the country. The services sector contributes approximately 66% to GDP (AfDB, 2011), based on a significant contribution from government services. Yet, while financial, wholesale and retail, travel and tourism services are highly innovative users of Internet-based applications, government is not yet a major user of such applications. Hence, broadband Internet access is low to non-existent for key services segments, such as the education and health services.

Mobile and smartphone access is fuelling Internet access (Goldstuck, 2010), but this form of access does not provide a suitable foundation for e-education in schools.

Spectrum regulation in the context of the digital dividend, offers an opportunity for regulators to consider the strategic application of spectrum to support growth in digital services markets, such as e-education.
Radio-frequency spectrum licensing

Future-oriented regulatory focus for an increasingly mobile and Internet-savvy population requires reform of radio-frequency spectrum management, specifically the assignment of spectrum for mobile and fixed broadband services. Following initial award of GSM spectrum licenses (900MHz) to mobile operators Vodacom and MTN in the 1990’s, spectrum assignment has received limited attention in the last decade, with mobile operators awarded licenses to operate in the 1800MHz band (GSM) and the 2100MHz band (3G). New fixed line entrant, Neotel, was awarded a license to operate CDMA in the 800MHz band and licenses were awarded to iBurst, Sentech and the two fixed-line operators for wireless broadband services (WiMAX) in the 2.6GHz and 3.5GHz bands (Song, 2010). Freeing up of spectrum for novel uses and technology innovation in, for example, cognitive radio is beginning to emerge on the agenda, but the pace of e-development here remains slow.

The freeing up of spectrum will create a digital dividend (DD) which presents the opportunity for service and technological innovations that can utilise the radio-frequency spectrum more efficiently, while also introducing new services and opening up new digital media markets for content provision. As the market in South Africa readies itself to take advantage of DD, the regulator, will need to focus on both economic (market) and development (public value) needs. Existing and proposed policy and regulation does not address the possibility of licensing spectrum or leveraging DD spectrum in ways that enable the electronic communications market to meet the broadband needs for emerging services, such as e-education (ICASA, 2011), though a recent policy draft directs the regulator to prepare a licensing approach that will stimulate “broadband for all” and new market entry (DoC, 2011, p.7).

Historically, spectrum assignment in South Africa has been considered from the perspective of assignment to fixed and mobile operators, and broadcasters. Seldom, if ever, has spectrum regulation been considered from the perspective of the rapidly growing demand for broadband-enabled services and transition to an Internet-enabled services sector. Historically, sectors that have fuelled broadband Internet use include commerce, trade and banking, with social networking pushing through as a strong new sector of demand (Abrahams & Goldstuck, forthcoming).

The state of the discourse on spectrum regulation

In the twelve years 2000–2011, there has been an increasing demand for spectrum,
and for innovation in the theory of spectrum management, driven by technological advances in the mobile and Internet sectors, as well as the freeing up of unused and under-utilized spectrum. The demand for more efficient use and improved regulation of spectrum to avoid artificial scarcity and to enable the use of a variety of ICTs and electronic services requires approaches different from the traditional allocations and assignments. The scarcity of radio spectrum has been touted as the major hurdle to opening the market to more players and to more sophisticated wireless technologies (Ikeda, 2002). However, it has been shown that the economic inefficiency inherent in current spectrum management techniques, such as auctioning, may have created barriers to entry (Klemperer, 2002).

Post-2002, more attention is being paid to spectrum issues, not only by policy makers and the telecommunications industry, but by a broader range of players in the digital services markets\(^3\) and digital media markets\(^4\), driven by the opportunities unleashed by wireless technologies. With the digital dividend\(^5\), the opportunity arises to adopt spectrum management approaches that invite the participation of more players – from traditional spectrum users building very large scale national or regional networks to new entrants who could build smaller, localised networks that address local needs, such as broadband access networks for education and health facilities.

Wellenius and Neto (2005) have critiqued the traditional rule-based spectrum management practices which give insufficient attention to the economics of wireless services and ICT use. What is required therefore is ‘a new system for spectrum management…that permits different models of spectrum licensing (the traditional administrative, unlicensed and new market-based approaches) to coexist so as to promote economic and technical efficiency…’ (Cave, 2008). Such a system should allow new market entrants, operating in the digital services and media markets, to build or access small wireless networks. This view is supported by Cave (2008) who states that spectrum regulation and economic regulation should have the common goal of pursuing the long-term interests of the end users of technologies and services – not market players or government, but the ones at the ‘end of the spectrum’. Thus, in approaching the reform of spectrum regulation, the objective should be

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\(^3\) **Digital services markets**: digital service oriented offerings emerging in sectors such as banking and finance, commerce and trade, travel and tourism, entertainment, health and education, other.

\(^4\) **Digital media markets**: applications and platforms used to deliver electronic content such as mobile broadcasting, triple and quadruple-play.

\(^5\) **Digital dividend**: Spectrum that becomes available in the switchover from analogue to digital television, in the range between the 200 MHz and 1GHz bands.
creating a competitive environment that supports sustained growth of the digital media and services markets, not profitability for only a few firms.

Foster (2010) argues that spectrum regulation should consider both economic and public value. Future sectors where broadband demand is likely to be high include the public education and health services, where public value considerations arise with respect to spectrum assignment for promoting broadband availability. However, the spectrum needs for broadband diffusion in these sectors, through adoption of technologies like WiMax, VOIP and IPTV, as well as e-books and other broadband-enabled access devices, has not been widely researched to inform regulatory decision-making in South Africa.

**Figure 1: Commercial and social value of DD**

An early digital dividend review (Ofcom, 2007) drew attention to the need for regulators to consider both consumer and citizen value, see Figure 1. Broader social value is perceived to include ‘educated citizens’, ‘informed democracy’ and ‘cultural understanding’. These aspects of social value are co-located in educational development in schools, in the home and in communities.

**Source:** Ofcom, 2007, p.28

Other objectives of spectrum reform and the application of digital dividend spectrum will include fostering accessibility of e-health applications in urban and rural communities. Learning from India, a study prepared for the ITU reveals that while many e-health projects have connectivity, very few have wireless broadband connectivity, which would be preferred connectivity for rural health projects.

All of them used bandwidth of 1 Mbps or less at the point of care. … This is in a sharp contrast with expectations that remote sites of most projects would have utilized the country’s base of over 560 Million mobile + DSL landline connections. … (Ramukumar, 2011, p. 10).
These ideas presented in the relevant literature can be tied to the discussion of the role of regulators in regulating for a digital economy (Hernandez, Leza & Ballot-Lena, 2010) in which the authors emphasise the importance of ex-ante regulation in markets where competition is limited, in order to foster digital economies that offer electronic government services, not only digital commercial services.

This brief review of the key concepts pertinent to application of the digital dividend to educational purposes raises questions with respect to the licensing of spectrum in ways that support public value (educational) uses of broadband and broadcast infrastructure. It further raises questions for investigation pertaining to whether a market-led approach will be better than a public value regulatory approach in reserving spectrum for future use.

In choosing how much spectrum to allocate and for whom, regulators not only place emphasis on market valuations and economic efficiencies but also on social, development and cultural goals. Market mechanisms do not necessarily or easily take public policy priorities into account…Measuring (this) value requires the development and assessment of economic, financial, and infrastructure models; a deep understanding of local markets and sectors such as education, banking and manufacturing and an understanding of the interaction of the sectors with new technologies …(Foster, pp. 14–17).

In considering the value of broadband, consideration should be given to, amongst other areas of usage, broadband in the classroom and e-education (Firth & Mellor, 2005; Birmingham & Davies, 2005).

In thinking through spectrum regulatory reform, attention should be paid to the differing outcomes that will arise when considering market-based methods (Cave, 2008) and the ‘relative merits’ of market-based versus spectrum commons approaches (Ikeda, 2002; Wellenius & Neto, 2005).

Spectrum management approaches

There are three primary spectrum management models deployed globally (Marcus, Nett, Scanlan, Stumpf, Cave & Pogorel, 2005):

<table>
<thead>
<tr>
<th>Model</th>
<th>Who decides</th>
<th>When used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command and control</td>
<td>Government</td>
<td>Scientific, military, radio astronomy, emergency, public need</td>
</tr>
<tr>
<td>Market-based</td>
<td>Market</td>
<td>Whoever values spectrum the most</td>
</tr>
</tbody>
</table>
Commons | Technology | To promote innovation
--- | --- | ---
In most of the developed world, the trend is to move away from the central planning to a market-based approach (Wellenius & Neto, 2005).

**Spectrum assignment models**

Various models for assignment have been adopted, with relative strengths and weaknesses:

<table>
<thead>
<tr>
<th>Model</th>
<th>Known for</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-come, first-served</td>
<td>If demand &lt; supply, economically efficient if no scarcity</td>
</tr>
<tr>
<td>Beauty contest</td>
<td>Subjective judgements, not economically efficient</td>
</tr>
<tr>
<td>Lottery</td>
<td>Non-discriminatory, not economically efficient</td>
</tr>
<tr>
<td>Auction</td>
<td>Non-discriminatory, economically efficient</td>
</tr>
<tr>
<td>Combinatorial</td>
<td>Hybrid approach, public interest</td>
</tr>
</tbody>
</table>

**Derived from:** Marcus, et al, 2005

**Market mechanisms**

Furthermore, there are four market-based mechanisms which should be considered:

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auctions</td>
<td>Confronts opportunity cost acquiring</td>
</tr>
<tr>
<td>Secondary trading</td>
<td>Confronts opportunity cost retaining</td>
</tr>
<tr>
<td>Administrative incentive pricing</td>
<td>Confronts opportunity cost retaining</td>
</tr>
<tr>
<td>Liberalised usage of frequencies</td>
<td>No cost</td>
</tr>
</tbody>
</table>

**Derived from:** Marcus, et al, 2005

Thus, spectrum regulation requires a delicate appreciation of the objectives, issues and approaches.

**The state of the problem**

While it may generally be observed that electronic media can bring significant value to the learning experience, existing electronic communications and spectrum licence conditions have generally failed to promote the availability of broadband access networks for schools and online education. Classrooms in the majority of the more than 24,000 public schools are unable to explore the potential of educational uses of broadband or innovation in educational technologies. Innovative applications can include broadcast mobile TV with special educational channels, broadband Internet on a mobile device including e-books and tablets, bespoke educational IPTV channels or IPTV packaged content for educational purposes.
There are no current studies which reveal the extent to which educational technologies are being introduced into basic and higher education and thus what the future spectrum demand may be from educational institutions or educational content providers. A better understanding of the demand side for spectrum can inform future regulatory design for spectrum assignment. Furthermore, the proposed spectrum policy (DoC, 2011) and regulation (ICASA, 2011) does not point to the broader economic and social objective of spectrum allocation and assignment. This study addresses the problem of regulators employing limited perspectives to inform spectrum regulation, resulting in such regulation being informed almost exclusively by market-based views, with little or no reference to public value considerations.

e-Education and the state of Internet access in public schools

In 2009, South Africa had 12,1 million learners attending 24,681 public schools in nine provinces (DoBE, 2011). Many schools have computers, 60% have landline telephones, 43% rely on a mobile phone for communication, 26% have email addresses (DoBE, 2011), however few have Internet access (no statistics reported) and it is doubtful that any have broadband access to the classroom. A significant number of schools are located in very poor, remote areas and operate from an inadequate resource base as regards instructional materials and other resources. The annual survey suggests that the available ICT is for administration, rather than for e-education.

The White Paper on e-Education 2004, entitled Transforming Learning and Teaching through Information and Communication Technologies (ICTs) presented the goals that every learner should be ‘ICT capable’ by 2013. However, the main progress by 2011 has been the availability of electronic learner materials from the national department, though there is limited accessibility. The annual submission on the division of revenue states that:

In South Africa, gross enrolment rates are high at primary levels of education…The challenge facing basic education in South Africa is that completion rates are low at secondary level … the ‘2010 matriculants’ began Grade 1 in 1999 being over 1.3 million pupils but less than half of them made it to grade 12 in 2010⁶…because of high drop-out rates and high grade repetition levels … (FFC, 2011).

However, the utilisation of ICT to improve educational capacity quality and interest has been limited. In South Africa, only a few provinces, mainly Gauteng and the Western Cape, have introduced province-wide “online schools” projects, with varying degrees of success. The application of mobile and broadcast technologies as educational technologies has not thus far received significant attention. The potential utilisation of WiFi or super-WiFi devices, which are portable and may be at lower cost to the educational budget over time has not been reviewed. Nor have the spectrum requirements of such an approach been studied. It is possible that, in the process of reviewing the benefits to be derived from the digital dividend and considering spectrum reallocation, the spectrum needs of existing players may receive priority attention, while opportunities for innovations in public services such as basic education may not receive attention.

Universal service and access obligations (USAO’s) set out in telecoms or spectrum licence conditions for each fixed and mobile telecoms operator included 20 256 PSTS lines to hospitals, libraries, local authorities and schools; 10 Internet access terminals each for 15,000 public schools and high-speed Internet access to 2500 public schools/education institutions (Lewis, 2010). Thus, the industry was required to provide Internet connectivity to 17,500 public schools, or approximately 70% of schools in the Republic in 2009. A compliance report conducted for the industry regulator (BMI-Techknowledge, 2010) reveals low levels of compliance with licence conditions “Generally, there has been very minimal compliance with the USAOs … with regards to roll out of internet connectivity / access and terminal equipment to public schools, the operators had done some roll-out, although not generally fully compliant and not within the prescribed time periods (BMI-Techknowledge, 2010, p. 5).

The report also reveals problems in the design and implementation of the licence conditions, observed in the lack of a holistic operational design to ensure that public schools have effective broadband access to the Internet, as well as end-user computing devices. The licence conditions are focused on listing the number of Internet access terminals and the numbers of terminal devices to be provided, rather than on requiring the licensee to provide effective (fixed or mobile) broadband Internet access and to promote usage in the classroom, as one of the key results of the assignment of spectrum. Thus, the specified conditions become mere additions to the licence, rather than an intrinsic purpose of the licence. Internet access should mean real Internet access and usage in a high proportion of the country’s classrooms. On further consideration, the problem appears to include the fact that Internet access for public schools has been treated as a spectrum license condition and no regulatory
measures have been introduced to progressively encourage heightened competition in the broadband access market.

The question arises: How should future spectrum regulation, including licence conditions, be designed for the allocation of digital dividend spectrum so as to encourage realisation of public value and broadband Internet access in public schools?

The state of broadband Internet access and wireless connectivity

There are an estimated 726 Internet service providers (ISPs) and 250 wireless applications service providers in the South African market, offering opportunities for innovation and competition in the wireless infrastructure and applications markets. These opportunities would include building small, low-cost, localised wireless infrastructure networks in towns and rural villages to be used by households, small businesses and public service organisations.

Undersea cable systems servicing South Africa already offer sufficient international bandwidth which will increase to 8.4Tbps by 2013 (Goldstuck, 2010, p. 47). However, broadband provisioning is a highly concentrated market, with two fixed broadband providers, three fixed wireless broadband providers and four mobile broadband providers. Most ISPs are offering fixed broadband services, however, this is usually reselling Telkom’s ADSL services (Goldstuck, personal communication, 2011).

Municipal broadband infrastructure is being built by four metropolitan municipalities, but service provision has yet to be launched. Given a highly concentrated market and consequently high prices for data access, educational institutions are not likely to realise broadband access in the medium term and the advance towards e-education is being stifled.

A key issue is that spectrum licenses have historically been awarded only to the fixed and mobile operators, while ISPs have been granted electronic communications network service (ECNS) and electronic communications service (ECS) licenses, which do not include spectrum assignment. Thus, ISPs cannot build wireless networks or create competition in the wireless broadband market to service institutions which require bandwidth-hungry services.

Recent policy (MoC, 2011) aims to promote wholesale open access to spectrum in the 800MHz range, while proposed regulation offers three spectrum license packages in a complementary approach for the high demand bands 800MHz and 2.6 GHz (ICASA, 2011). However, only two new market entrants are envisaged, with universal access license obligations to cover a large proportion of rural South Africa in terms of both geographic and
population coverage (licensee 1: 70% geographic coverage in 5 years of which 50% must exclude the three largest metropolitan municipalities; licensees 2 + 3: 50% population coverage in 4 years). This approach would exclude the possibility of many smaller players creating localised (possibly lower cost) wireless broadband networks for towns with small to medium-sized (50,000 – 100,000) populations. The remedy, contained in the draft proposals, is two-fold: (a) a wholesale open access model (‘no locking’, ‘no blocking’, ‘no retail’) and a managed spectrum park. It uses a combination of beauty contest and auction approaches for the award process. A public comment process is currently underway.

**Data on demand for e-education**

The infrastructure challenge for e-education includes the need for minimum 10MHz at speeds above 512Mbps for effective service per educational institution. The first step in building an understanding of the educational demand for broadband is to review trends in the education sector. The next step is to consider selected issues: advancing educational access to broadband infrastructure through spectrum regulation, licensing and broadband access pricing.

A first round of interviews has revealed the following perspectives – educational, regulatory, pricing:

**Educational perspective:**

e-Books are being viewed as the big game changer for education in the next three years to 2013 (Gray, 2011). Gray states that Ingrams and Wiley, among many US and UK publishers, have issued new publishing strategies in this regard. South Korea is also taking the e-books route and intend to have phased out school textbooks by 2013. Textbooks are less flexible formats than e-books. More regular updates are possible in e-books, for example, incorporating case studies from African countries on a particular theme in history, geography or science in the e-text. Also text formats rather than textbooks can be made available for easy download from a large national content repository. South African publishers Naspers and others are taking an interest in these new approaches to making available schooling materials in an Internet era. Small players such as Kawuleza Connect, formerly 24/7 online, are already building educational infrastructure (Butcher, 2011), but further work needs to be done on understanding the participation of small players other than the ISPs.

It is argued (Gray, 2011) that we are only seeing the tip of the iceberg of new uses, which will include in-classroom learning, online textbook publishing, the use of ICT in
schools organisation, introduction of learning management systems, the use of social networking in educational and research settings in higher education, informal self-publishing by academics, and other uses. Without effective regulation of the digital dividend and its uses in infrastructure provisioning, access pricing approaches can create major cost inhibitors to new innovative uses, lack of innovation in educational content and lack of innovation in educational services.

The South African Institute for Distance Education (SAIDE) is engaged in setting up educational systems for higher education institutions. In its discussions with tutors and academics at UNISA and other higher education institutions, it has observed that there are a range of applications that would make an institution like UNISA’s life easier if they knew they could rely on both students and academics accessing these learning management and other educational resources systems. Making the system operate effectively would mean that students should have good quality access at the household level to benefit from an end-to-end delivery mechanism. This will require effective broadband connectivity of at least 10Mbps everywhere, to access the system via an open architecture on an affordable device. Regulatory approaches to support such broadband rollout have been flawed, and require improvement. While the release of radio-frequency spectrum could help drive prices down, South Africa needs more effective competition to drive down prices and get affordable broadband to schools, educational institutions and homes. Pricing has to be affordable both on the education supply side (schools, colleges and universities) and on the demand side (students living at home).

It may be contested that increased demand from higher education institutions will be experienced in the next three to five years. The SAIDE argues that UNISA alone will create a significant demand for broadband by virtue of making available online educational services to 350,000 students in the higher education sector. Furthermore, educational usage can lead to other forms of usage. It can be asked: Why will this time be different? It is argued that the slowness for this educational broadband market to develop was because the institutional systems needed time to develop. Fifteen years later, UNISA is “a whole lot closer”, broadband costs have come down and device costs have come down, though still high for many households.

At the level of the educational system throughput, South Africa is meant to be doubling the number of students coming out of further education and training (FET) system.
“This cannot be done without broadband-enabled ICT applications, resources and services. So, in addition to UNISA and the higher education sector, the FET sector could be the next large sector to see demand for broadband. The latent demand for connectivity is seen to be on a scale that we simply don’t conceptualise. ADSL should be sitting at 100Mbps now, but the reality is that most schools and universities simply cannot conceptualise the demand that is there, because procuring connectivity at a reasonable price is regarded as a pipe dream. The idea that a 4Mbps connection is good enough from a technical perspective has limited our view of the possibilities of broadband for education. If we were contemplating much higher speed connectivity, we would be able to think radically differently about education” (Butcher, 2011).

Looking at broadband as an environment with no limits on the speed of bandwidth can lead to the view that every school and every higher education student should have access to a minimum of 1GB of data per month in 2012.

Municipal and provincial governments, such as the Gauteng provincial government, who wish to provide broadband infrastructure for educational and other uses, face issues of last mile connectivity where access to spectrum is a barrier (personal communication, Hero, 2011). Gauteng Online has operationalized over a 1000 open source thin clients, has live streaming of class lessons in HD quality and is looking to deploy these educational technologies and services to places where there is a lack of teachers. Multicast e-learning platforms are being rolled out. There are continuing challenges of integration and the high cost of technologies. There is the need for local and international content, appropriately adapted to meet the needs expressed by end users. In terms of providing mobile and wireless access, while spectrum sits with licensee Sentech rather than with provincial or municipal governments, bottlenecks to access need to be resolved. Furthermore, granting spectrum licenses to ISPs for specific spectrum bands and for use of interleaved spaces could encourage them to follow the example of municipalities and build small, localised wireless infrastructure networks, where municipalities are building fixed networks.
Current spectrum allocation/assignment arrangements

The matrix in Table 1 maps out the spectrum bands in use and the assignment of spectrum to fixed, mobile and wireless communications:

Table 1: Electronic Communications Spectrum Holdings

<table>
<thead>
<tr>
<th>Major Spectrum Holdings</th>
<th>Spectrum Bands</th>
<th>800 MHz</th>
<th>900 MHz</th>
<th>1800 MHz</th>
<th>2100 MHz</th>
<th>2.6 GHz</th>
<th>3.5 GHz</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neotel (fixed network operator)</td>
<td>~2 x 5 MHz</td>
<td>2 x 12 MHz</td>
<td></td>
<td></td>
<td>2 x 28 MHz</td>
<td></td>
<td>90 MHz</td>
<td></td>
</tr>
<tr>
<td>Telkom (fixed network operator)</td>
<td></td>
<td>2 x 12 MHz</td>
<td>2 x 10 MHz</td>
<td></td>
<td></td>
<td>2 x 28 MHz</td>
<td></td>
<td>100 MHz</td>
</tr>
<tr>
<td>Vodacom (mobile operator)</td>
<td>2 x 11 MHz</td>
<td>2 x 12 MHz</td>
<td>2 x 15 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>81 MHz</td>
</tr>
<tr>
<td>MTN (mobile operator)</td>
<td>2 x 11 MHz</td>
<td>2 x 12 MHz</td>
<td>2 x 15 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>81 MHz</td>
</tr>
<tr>
<td>Cell C (mobile operator)</td>
<td>2 x 11 MHz</td>
<td>2 x 12 MHz</td>
<td>2 x 15 MHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76 MHz</td>
</tr>
<tr>
<td>Sentech (broadcast signal distribution and satellite infrastructure provider)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 x 50 MHz</td>
<td>2 x 15 MHz</td>
<td></td>
<td>80 MHz</td>
</tr>
<tr>
<td>WBS (wireless network service provider)</td>
<td></td>
<td>2 x 12 MHz</td>
<td></td>
<td>1 x 15 MHz</td>
<td></td>
<td></td>
<td></td>
<td>64 MHz</td>
</tr>
<tr>
<td>USALs (universal service licensees)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 x 10 MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 x 14 MHz</td>
</tr>
</tbody>
</table>

Source: Adapted from Zimri (Neotel), 2011 based on ICASA data

The 800 MHz band is largely occupied by broadcasters and will become available following digital migration. This is a good space to release for unlicensed spectrum, encouraging multiple players to share the spectrum for future innovative uses. Will the proposed wholesale open access model encourage ISPs to build wireless networks in areas of historically low Internet access, thus introducing competition, consumer choice and potentially lowering the cost of broadband access? The specifics and considered value of such a spectrum licensing approach is vague and generalised and does not offer insight into the objectives of the proposed regulations beyond the standard universal access and service idea.
**Spectrum economics and broadband pricing perspective**

Spectrum allocation provides the foundation for infrastructure to carry multi-play content on broadband and next generation networks. Vast broadband connectivity will be needed everywhere at significantly lower than current cost if such connectivity is to support educational services. Estimates by the South African Institute of Distance Education (SAIDE) (Butcher, 2011) suggest that broadband should be available at 30% of current cost. To the extent that pricing of spectrum may be a driver of broadband pricing, this should be investigated and understood in order to adopt an approach that is most likely to promote rather than limit the affordability of broadband at to the household and school levels, particularly for middle and low-income households and for public schools. Spectrum auction models may not be the best approach to maximising broadband access for social uses such as education.

The USAO approach where mobile telecoms companies provide connectivity for several thousand schools has been ineffective in taking real broadband connectivity to the classroom in ways that enable the 21st century educational experience. While this could not be ascertained in the first round of study, there are suggestions that it was not cost effective to take Internet connectivity to schools (BMI-Techknowledge, 2010) under the existing spectrum licence conditions. The introduction of the e-rate has been ineffectual, as the 50% discount was still not affordable for schools. Furthermore, to effectively access educational resources, students will need broadband Internet access both at home and at school. Thus, more competitive broadband rates are needed. While the price of broadband has declined, it is still not affordable for the majority of households. The argument that “there is a price for everyone” in the broadband market is not borne out when one considers public education needs. A single student could utilise 600MB–1GB per month, costing above R200 per month (USD27) at current market prices. This is too high for the schooling system and for the vast majority of households.

Creating an affordable broadband market can enable last mile suppliers to come on stream and look for customers. If the regulator were to introduce *ex ante* pricing regulation for broadband (not an e-rate) and a licensing approach which increases competition, this could create a playing field for educational content and services providers to move in and create a new educational services (and publishing) industry, supported by advertising.
Conclusion and Recommendations

This paper adopts the view that the transition of emerging economies from services–based to knowledge–based economies will require major innovations in creating public value. In particular, it will require changes in education, changing the nature of educational access from ‘teacher and textbook’ to facilitated learning and independent learning, while promoting access to the widest possible range of freely available knowledge resources on the public Internet for general schooling and higher education. In the 21st century, the volume of knowledge required to operate effectively in the economy and society has increased to such an extent that teachers and textbooks can no longer offer the wide range of knowledge required by learner to prepare for the world of work or further study. Nor can the existing content medium of the textbook keep pace with the rate of introduction of new knowledge into the global educational environment. At the strategic level, the effective introduction and use of broadband Internet in schools can lead to the creation of learning environments where the variety of media makes learning attractive, rather than just routine. Furthermore, new pedagogies have emerged in the context of ICT innovation, including virtual learning through podcasting and self-learning through the utilisation of the Internet, IPTV and other online technologies for virtual learning. These approaches to the utilisation of educational technologies are no longer new and their use is being explored extensively in schools and universities across the world.

The discussion on the regulation of spectrum to support broadband provisioning for public value must, therefore, be set within the context of the demands for spectrum occasioned by the rapidly increasing demand for broadband infrastructure as the numbers of users, uses and types of access devices increases. The prospective digital dividend can be consumed by a number of key sectors such as commerce, trade and banking; potentially excluding the basic education sector from innovative uses that could apply across urban and rural, high and low-income communities.

What does this mean for the 21st century regulator? Regulating for a digital economy means regulation that will bring ubiquitous, high-speed household and school-based access to electronic media to introduce and advance e-education in schools, in conjunction with the emergence of a digital economy in the broader public and private services sector. This paper argues for an approach to allocation and assignment of the digital dividend spectrum that starts from a services-oriented approach rather than an industry-oriented approach. While it has focused attention on promoting a future online educational services industry, the broad
arguments for spectrum regulation and economics can be applied to other components of the services sector, in particular to social and citizen services. The following recommendations are highlighted:

It is argued that, in the South African case, spectrum should be assigned to many new broadband network providers, encouraging the larger ISPs to enter the market and to encourage efficient and effective use of spectrum for broadband access. The following conclusions are highlighted:

I: Licensed and unlicensed spectrum: Promoting broadband for public value including educational services

(a) The regulator should include public value considerations, not just universal access considerations, in its regulatory design for award of spectrum licenses, in order to encourage innovative ways of getting high-speed broadband to public institutions such as schools and households in rural areas and middle- to low-income communities.

(b) The regulator should design a licensing regime that encourages Internet Service Providers (ISPs) and other small-scale investors to build localised wireless infrastructure networks that have a greater likelihood of providing access for e-education and other public and private sector services at affordable prices. This should be an explicit orientation, rather than an implicit orientation of the regulatory process.

(c) Regulatory approaches should consider unlicensed approaches carefully, in particular whether the managed spectrum park is an implementable approach.

(d) It is important to observe net neutrality in regulating these issues.

II: Regulation for innovation in digital services and media markets

Significantly stronger integration of ICT is needed as a platform technology for the future development of the broad services sector. The ICT, media and services sectors together create the foundations for economic advancement and for future generations of innovators and entrepreneurs, in particular in the education sector. Thus, spectrum assignment should incorporate a services-oriented approach, rather than an exclusively electronic communications industry-oriented approach.
III: Pricing versus valuing spectrum

The regulator should not set out with the sole intent of gaining revenue, thus considering only regulatory tools such as spectrum auctions and other spectrum pricing models. It should adopt a position of valuing spectrum, regulating in such a way to ensure that spectrum is effectively utilised to get high-speed broadband connectivity to public and educational institutions and households, through the design of affordable broadband pricing models.

This research is significant for a few audiences. For the regulator, it presents the opportunity to consider innovative forms of spectrum regulation to promote public value. For education policy-makers, it presents the opportunity to consider the application of a broader range of technologies to education. The study also presents the opportunity to inform the work of institutions engaged in fostering effective expenditure of revenue for educational purposes. This discussion is relevant to other developing countries seeking to achieve the millennium development goal of ‘Education for All’.

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