High-speed data in Africa: An assessment of provision via mobile networks

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Introduction

This paper is effectively the latest in a sequence of papers in this journal (Curwen and Whalley, 2015, 2017a, 2017b, 2017c) that examine a similar theme – that of the introduction and spread of high-speed mobile technologies and its consequences for the structure of the mobile sector in a variety of countries and continents. In this particular case, attention is focussed on the continent of Africa.

The most commonly accepted version has it that there are 54 sovereign states in Africa[1] although for the purposes of what follows the databases below also include the islands of La Réunion and Mayotte that technically qualify as départments d'outre-mer of France as the operators there are independent providers of high-speed connectivity.

Africa has undergone considerable change in recent years. Not only has the population grown such that there are now more than a billion Africans (African Development Bank, OECD and UNDP, 2016), but so has its economy – in 2015, Africa's GDP was $2,259 billion (McKinsey Global Institute, 2016). In response to this, Africa has attracted ever larger amounts of foreign direct investment (FDI) and has witnessed a growth in the number of multi-national enterprises (MNEs) (Barton and Leke, 2016).

Underpinning economic growth has been a transformation in how Africans communicate – mobile replaced fixed-wire as the primary communications technology quite soon after its introduction with the result that there are now more than 500 million mobile subscribers (GSMA, 2016), a figure many times larger than the number of fixed-wire connections. The number of smartphones used in Africa is rapidly growing, and is predicted to reach 50 per cent of handsets by 2020, up from just two per cent a decade earlier (Barton and Leke, 2016). This widespread availability of mobile communications has been transformative, improving existing business opportunities as well as facilitating new ones. Given the inherently dynamic nature of mobile communications, where a new generation of technology appears roughly every decade, this transformation promises to continue. The most recent generation available is the fourth and provides, in particular, faster data transfer speeds than previous generations (Curwen and Whalley, 2013).

As Africa has historically lagged behind other parts of the world with regard to the adoption of mobile communications (ITU, 2015a, 2015b), the advent of a new generation offers the possibility of 'leap-frogging' – that is, missing out a generation altogether and adopting a more recent technology. James (2012) observed that mobile leap-frogging can occur regardless of the income level of the developing country. Given the advantages that accrue from adopting the latest technology, by no means the least of which is the provision of Internet access to Africans considerably faster and cheaper than building costly fixed networks (GSMA, 2016), it is informative to assess the current availability of so-called '4G' across the continent.

With this in mind, the rest of the paper is divided into eight sections. In the next section a brief overview of pertinent issues relating to Africa is provided while section 3 shifts the attention to technological matters, primarily highlighting the licensing of 4G technology across the continent. While a licence gives permission for a mobile operator to use the technology, it does not necessarily mean that 4G-based services are available to be used. In order to shed light on this matter, Section 4 details the 4G launches that have occurred to date. Section 5 sheds light on two key aspects of service provision, namely availability and speed, and is followed in section 6 by a discussion of the role that pan-African operators have played. Section 7 considers the problems posed by a lack of transparency. Conclusions are drawn in the final section of the paper.

Africa

Over the last decade or so, Africa has experienced considerable growth: in 2000, the combined GDP of Sub-Saharan Africa[2] was $367 billion, while in 2015 it was $1,596 billion (World Bank, 2017). The continent's population has also increased, from around 800 million at the turn of the millennium to almost 1.2 billion by 2015 (African Development Bank, OECD and UNDP, 2016). Partly as a result, Africa continues to attract foreign direct investment (FDI) – in 2015, FDI into Africa was $54 billion (UNCTAD, 2016). Although this figure was slightly less than in the previous year, it is worth nothing that it was considerably more than the $12 billion that took place at the turn of the millennium (Diop, Li, Yong and Shide, 2015; UNCTAD, 2016). However, this investment is not evenly spread across the continent. In 2015, six countries – Angola, Egypt, Ghana, Mozambique, Morocco and Nigeria – each received FDI of at least $3 billion (UNCTAD, 2016). In other words, at least one third of the continent's FDI was accounted for by just six countries. Moreover, within these six countries some – for example, Egypt – managed to attract more FDI compared to the previous year while others – such as Mozambique – attracted less. More broadly, although Africa's economy as whole grew between 2010 and 2015 (Barton and Leke, 2016), the growth of some countries accelerated over this period while for others the rate at which they were growing declined – Ethiopia and Ghana are examples of the former, and Nigeria and South Africa of the latter.

The three leading investors in Africa are France, the United Kingdom and the United States (UNCTAD, 2016), with each having FDI across the continent of more than $60 billion. While the growth of the FDI stock held by the United Kingdom and United States increased by roughly 50 per cent between 2009 and 2014, a more dramatic increase is evident for China – in 2009, Chinese FDI in Africa amounted to just $9 billion but by 2014 this had increased to $22 billion (UNCTAD, 2016). Significantly, Chinese investment has occurred across the continent, with the consequence that many countries in Africa now identify this country as their most promising source of future FDI (UNCTAD, 2016; World Bank, 2014)[3].

As Africa's economy has grown, with markets liberalised and opened to foreign investment, this has attracted a diverse array of analysis. Some commentators have explored why and how MNE has entered African markets – see, for example, Demirbag, Apaydin and Tatoglu (2011), Ramasamy, Yeung and Laforet (2012) and Nicholson and Salaber (2013) – while others have examined what factors encourage such entry – see, for example, Wang, Hong, Kafouros and Boateng (2012), Bartels, Napolitano and Tissi (2014) and Hearn, Oxelheim and Randøy (2016) – as well as their impact on the host economy – see, for instance, Rui, Zhang and Shipman (2016).

Information and communication technologies (ICT) have arguably played a significant role in the economic growth that has occurred. There are now more than 500 million mobile subscribers across Africa (GSMA, 2016), with the industry generating revenues of more than $50 billion and giving rise to a series of pan-Africa operators. Not only has the increasingly wide adoption of mobile devices across Africa created opportunities for countries and communities to close the digital divides that they face (Carmody, 2013), but this has led to the emergence of entrepreneurial activity (Jagun, Heeks and Whalley, 2008; Standage, 2009; Wamuyu, 2015). More broadly, ICT in general (Vu, 2011; Sassi and Goaied, 2013) and mobile devices in particular are seen as contributing positively to economic development (Waverman, Meschi and Fuss, 2005; Obijiofor, 2009; Lee, Levendis and Gutierrez, 2011; Chavula, 2013). Furthermore, the extensive use of ICT such as mobile devices has recently been observed (Trestian, Shah, Hguyen, Vien, Gemikonakli and Barn, 2017), with some commentators finding that they provide a means through which those who are marginalised within society can overcome their adverse circumstances (Sam, 2017).

As the impact of ICT is felt across the whole economy, it comes as no surprise that a diverse literature has emerged that explores the diffusion of ICT in developing countries – see, for example, Rouvinen (2006), Garbacz and Thompson (2007) and Kauffmann and Techatassanasoontorn (2009) as well the evolution of the telecommunication sector – see, for example, Frempong and Atubra (2001), Varoudakis and Rossotto (2004), Marcelle (2005) and Jayakar and Martin (2012). Given both the extensive literature that has emerged and the significant role that ICT has played in the growth of the African economy, it is somewhat surprising that relatively little has been written regarding telecommunications-related MNE in Africa or the successive launch of mobile technologies across the continent. Ramamurti and Doh (2004) discussed telecommunications as part of their investigation of infrastructure investment in Africa, though this was undertaken at a relatively aggregate level. Curwen and Whalley (2011) examined the role of Africa in respect of telecommunications FDI, illustrating how many of the most internationalised MNEs have a presence in Africa as demonstrated through the countries in which they operate or the proportionate (equity-adjusted) subscribers that they control. More unusual is Sutherland (2015) who examined how MTN grew to become a pan-African operator or Gomes, Cohen and Mellahi's (2011) exploration of Vodacom's entry into the Democratic Republic of Congo through a joint venture with a local company.

Given that Africa has lagged behind other parts of the world when it comes to the adoption of mobile telecommunications (ITU, 2015a and 2015b) the advantages that accrue from their use, including high-speed access to the Internet, are not being enjoyed by all. Interestingly, while Africa arguably lagged behind other parts of the world when it came to the launch of 2G and 3G mobile telecommunications, there has been a reasonable amount of activity regarding 4G, the most recent technology, across the continent. The remainder of this paper will focus on 4G, outlining which operators have launched their services and identifying a series of issues that have emerged.

High speed mobile telecommunications

Long-term evolution

No industry has ever evolved at the speed shown by the mobile communications industry during the past 15 years (Curwen 2002; Curwen and Whalley 2008, 2010, 2013, 2014). During this period, the main driving force has been technological progress which, in turn, has been concerned primarily with increasing the speed at which data can be transferred between sender and receiver. Through increasing speeds, the technological change that has occurred has broadened the array of services that are accessible via mobile devices – from voice with limited mobility with the first generation to mobile Internet with 3G and 4G (Jho, 2007; Curwen and Whalley, 2013).

3G – otherwise known in Europe and most other parts of the world by the acronyms W-CDMA and UMTS – was first launched in roughly 2000, since when it has reached all bar a couple of countries world-wide (GSMA 2014). Initially it operated very slowly by modern standards, but was steadily enhanced by technologies such as high-speed packet access (HSPA) to the point at which a user might – albeit only in favourable conditions – be able to access a downlink of 10 Mbps (megabits per second).

The arrival of long-term evolution (LTE) was a game changer in several respects. In the first place, it could be used across a wide variety of spectrum bands lying typically between 600 MHz and 2.6 GHz whereas 3G tended to be restricted to bands in the region of 2 GHz with 2G – effectively a technology used for voice communications – separately occupying lower bands. Because the spectrum being used for 2G and 3G was rapidly filling

up, especially in Africa where fixed-wire connectivity is rarely adequate other than in big cities, the fact that LTE is more spectrally efficient than 3G is also very important since it means that much more data can be transmitted via a given slice of spectrum.

LTE is often referred to as 4G. In fact, LTE does not meet the technical specifications for 4G laid down by bodies such as the Third Generation Partnership Project (3GPP) – see Wikipedia (2016a, 2016b) – which are compatible only with LTE-Advanced, a version of LTE that is multi-carrier – that is, it combines spectrum from (at least) two slices of spectrum within a band or, more commonly, in two separate bands in order to speed up data transmission rates. The most recent versions of LTE-A are designated as 4.5G and employ as many as five bands to create a (theoretical) maximum downlink approaching 1 Gbps.

Licensing of LTE

When it comes to the licensing and launch of mobile networks, Africa has tended to lag other regions for understandable reasons by no means the least of which is the high cost of investment relative to the incomes of prospective customers. It is still playing catch-up with respect to 3G but is simultaneously engaged in addressing the need, sooner or later, to roll out 4G in the guise of LTE which is de facto the worldwide standard.

The first aspect for analysis is the state of play in the issuing of licences specifically for LTE. In practice this is a complicated matter because many licences originally issued for 2G or 3G were technologically neutral and hence permitted the introduction of LTE services without the need to amend the licences. In other cases, spectrum has to be re-farmed and a specific regulatory authorisation is required. Finally, new spectrum bands are being opened up and these need to be allocated for the provision of LTE services either via an auction, a beauty contest or government dictat.

[Table I roughly here]

A significant proportion of the 56 listed countries in Africa appear to have taken no concrete action of any kind with respect to LTE provision, and only a minority appear to have awarded spectrum specifically for LTE services. Table I attempts to clarify the position at the end of June 2017 but it has to be admitted that it has not always been possible to verify the information with absolute certainty because regulators and/or operators can be surprisingly coy about releasing this information. It is of interest that whereas most of the licensees are 2G/3G incumbents, LTE licenses have also been awarded on a few occasions to relatively unknown parties. Furthermore, consideration has been given on a few occasions to the establishment of a nationwide wholesale network which then provides capacity to all 2G/3G mobile incumbents.

Rwanda is a case in point. In March 2013, KT Telecom signed a MoU with the government of Rwanda establishing a joint venture – Olleh Rwanda Networks Limited – to provide KT Telecom's LTE technology to the national incumbents via a common network and MVNO arrangements (Cellular-news, 2013). The network was expected to encompass 95 per cent of the population within three years. In May 2014, the government announced that the network would be launched on 1 September but the actual date turned out to be November. MTN was the first incumbent to use the network as a MVNO later in November (TeleGeography 2014) followed immediately by Bharti Airtel. Millicom launched in January 2015.

The companies licensed to re-sell the ORN service include GMAX, Intercom Technologies, Piramie, POPCONN, Simba Supermarket, Suku NSA, TRUCONNECT, Twinning in Corporation and 4Net Africa.

According to the company website, there is provision of paired spectrum in the 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands as well as TD-LTE (unpaired) provision in the 2.6 GHz band. The maximum downlink is claimed to be 150 Mbps and the maximum uplink 50 Mbps.

In February 2015, LTE charges were reduced by 70 per cent after widespread protests about over-charging. In March 2016, MTN became the first operator to provide a LTE service for smartphones and in July 2016, ORN was renamed as Korea Telecom Rwanda Networks.

Another recent case is worthy of note since it involves one of the largest markets, namely Egypt. In June 2016, the regulator offered a concession including spectrum suitable for 4G to fixed-wire incumbent Telecom Egypt although details were held back. For its part, Orange stated that it had been asked to pay $395 million for a 4G licence – of which half was to be paid in dollars – together with a further payment for a fixed-wire licence and another for a licence for international calls. The regulator added that the licences offered to the three mobile incumbents were not at the same price.

In August, the regulator allegedly approved revised terms for 4G licences which increased the available spectrum as the mobile incumbents had all declined to accept the terms initially on offer. On 31 August, Telecom Egypt accepted a 15-year licence – potentially extendable for a further five years – for a fee of $806 million, to be paid in instalments. The spectrum awarded consisted of 5 MHz paired in the 1800 MHz band together with 10 MHz paired in the 700 MHz band. In September, the incumbents were given a deadline to state whether or not they wished to accept similar licences and all three declined. Orange claimed that it had been offered insufficient spectrum to run a LTE network efficiently with the regulator responding that it had not intended initially to provide sufficient for 90 million customers but rather enough to get the networks off the ground. It added that the licences would now be offered to other parties on altered terms (Telecom.paper 2016).

In late October, the regulator stated that Etisalat and Orange had each been awarded a 10 MHz block of spectrum even though Orange had originally been offered 7.5 MHz. In contrast, Vodafone found its allocation cut from 7.5 MHz to 5 MHz. The price to be paid by Orange would be $48.4 million per MHz, representing a reduction of $4.7 million per MHz, while Vodafone would need to pay $67 million per MHz, an increase of $13.9 million per MHz. For its part, Etisalat would need to pay $53.5 million per MHz, a much smaller increase of $2.25 million per MHz. The total for Etisalat ($535 million) accordingly matches that cited above. However, the total for Orange ($484 million) now applied to a 10 MHz block while Vodafone's total of $335 million appeared to relate only to the 4G spectrum although other reports stated clearly that the renewal of 2G/3G licences came as part of a package. Indeed, to add to the confusion, some reports continued to refer to the Orange allocation as 10 MHz paired.

In January 2017, the regulator allegedly requested that all trials of LTE be halted. The problem appeared to be that by running trials using the 2100 MHz band already in use for 3G, interference with the 3G service had become excessive. It was noted that LTE services would not be using this band once they were launched. In April, Telecom Egypt announced that it had signed a MoU with Orange enabling it to provide 2G/3G/4G services over the latter's network. A similar agreement was signed with Etisalat in May after which the regulator stated that it was now ready to hand over the LTE licences.

A final example concerns South Africa which is of interest because of the complex relationships between the mobile incumbents, other telcos and the regulator. The story usefully begins in mid-December 2011 when the regulator published its proposals for the 800 MHz and 2.6 GHz bands, involving a beauty contest due to take place in March 2012. The available spectrum consisted primarily of two blocks of 20 MHz paired, two blocks of 15

MHz paired and two blocks of 20 MHz unpaired in the 2.6 GHz band. The licence conditions included a requirement to host MVNOs and 70 per cent geographic coverage within five years – for 2.6 GHz-only licensees this would be shortened to four years. But the potential stumbling point was a stipulation that applicants must be locally licensed and 30 per cent owned by historically disadvantaged individuals – a stipulation that would, in principle, disqualify mobile incumbent Vodacom. Indeed, the proposal would effectively assign licences to fixed-wireless operator Neotel which had been awarded spectrum in the 800 MHz band in March 2007 that could be used for LTE and to state-owned broadcast and broadband infrastructure company Sentech. In the event, the auction was postponed until an unspecified future date (TeleGeography 2012a) after a wide range of protests was tabled.

The postponement produced a sharp riposte from MTN which claimed that it was ready to launch as soon as it received a licence, but that it was being starved of appropriate spectrum for 4G – it needed at least 10 MHz paired in the 2.6 GHz band. It pointed out that Sentech held 50 MHz of unused spectrum in this band and that it made no sense to allow Sentech or anyone else in a similar situation to be eligible to bid for additional spectrum.

Meanwhile, in October 2012, Telkom (branded as 8ta) announced that it would be conducting a free trial of LTE prior to a launch in April 2013. In this respect it was much slower off the mark than Vodacom, which launched on a modest scale in Johannesburg in October 2012 using re-farmed spectrum (Cellular-news 2012). Mobile incumbent MTN also used re-farmed spectrum in the 1800 MHz band for its December 2012 launch (TeleGeography 2012b).

In April 2013, Sentech decided that the technical difficulties that it faced were insuperable and agreed in April 2013 to return its 2.6 GHz spectrum, acquired in 2007, to the regulator.

Neotel launched in August 2013 but acquired only a very small number of subscribers and hence could not sensibly be regarded as a national incumbent at this stage. However, it came under offer by Vodacom in May 2014 and the regulator had to consider whether to permit the transfer of Neotel's spectrum in the 800 MHz band if the takeover was to be permitted to proceed. Vodacom subsequently stated that it was interested in acquiring Neotel for its fixed-wire assets rather than for its mobile spectrum (5 MHz paired in the 800 MHz band, 12 MHz paired in the 1800 MHz band and 28 MHz paired in the 3.5 GHz band).

In June 2015, Vodacom was authorised to take over Neotel subject to a number of conditions including a prohibition on the use of Neotel's mobile spectrum for wholesale/retail services for two years after final approval or after 31 December 2017 (whichever came first). However, there was an objection lodged by MTN, Telkom and the third mobile incumbent Cell C before the High Court in Pretoria requesting that Vodacom be denied access to the wireless licences held by Neotel and this was upheld. Vodacom responded that it now intended to proceed with a modified deal that excluded the transfer of Neotel's mobile spectrum. However, in the face of ongoing regulatory uncertainty, Vodacom decided to withdraw from the deal at the end of August. In the event, it was Liquid Telecom that, subject to regulatory approval, eventually emerged as the successful majority bidder in June 2016.

Furthermore, the proposed so-called 'merger' between MTN and Telkom was rejected by the Competition Commission in August 2015. In practice, this involved an extension of existing roaming agreements to include bilateral roaming and the outsourcing of the operation of Telkom's radio access network to MTN and the main reason for the rejection was that MTN would gain access to Telkom's spectrum holdings.

In September 2015, Cell C launched its much delayed LTE network using a 10 MHz channel in the 2.1 GHz band providing an average downlink of 30 Mbps. In November, Oger Telecom rejected an offer from Telkom to take over Cell C.

In June 2016, Telkom stated that it intended to re-farm for LTE the 12 MHz paired it held in the 1800 MHz band. In July, the regulator invited applications for spectrum in the 700 MHz, 800 MHz and 2.6 GHz bands with a due date of 17 January 2017. However, although it stated its intention to expand upon the 567 MHz that were classified as suitable for 4G, it did not specify what exactly would be available. A bidder would be permitted to buy spectrum in only one band. The telecoms minister then intervened with a claim that he had not been consulted or informed in advance even though the state was the custodian of spectrum, and that the regulator had decided to proceed despite being told to desist in September 2015.

Legal action was duly initiated in the High Court in Pretoria in August. The government claimed that new entry would be restricted and that the regulator should await the publication of the government's spectrum policy document – expected before the year-end – before proceeding. In September, the regulator duly postponed the date of the proposed auction to March 2017 while at the same time softening the requirement that bidders be 30 per cent black-owned to a requirement that they have 'a level-four broad-based Black Economic Empowerment (BEE) rating'. However, the North Gauteng High Court ruled in October that the auction should not take place at the postponed date.

In October, the government approved the ICT Policy White Paper that had been in progress since 2012. This outlined the establishment of a Wireless Open Access Network (OAN) under the terms of which every operator would be obliged to return their spectrum after which it would be transferred to the OAN. The objective was claimed to be a desire to strip out market dominance and improve competition. The terms and conditions, as well as the timeframe for this transfer would be published subsequent upon the completion of a public consultation exercise. This action effectively removed the need to hold an auction in 2017 and in February 2017 the regulator postponed its planned auction 'until further notice'. In May, six telcos, including MTN and Vodacom, agreed to acquire at least 30 per cent of the OAN and in return were granted the right to retain their broadband spectrum until the licences expired in 2028.

LTE launches

It is of no small interest to compare the data in Table I with the data on LTE network launches which are as listed below in respect of terrestrial networks – as of end-2016 these numbered 69 in total in 35 countries (and as of end-July 2017 the total stands at 75 in 36 countries). It may also be noted that Africa was the last continent to witness an incumbent LTE launch with the first taking place in 2012. This can be compared with the fact that there had been 44 launches in other regions before the end of 2011. Nevertheless, by end-2016, there had been somewhat more than 400 in total world-wide so by that point roughly one in six had taken place in Africa which accounted for 55 of the (depending on source) roughly 225 countries worldwide – that is, roughly one in four.

Clearly, therefore, a major catching up process had taken place and it is significant that 41 of the 69 launches in Africa took place in 2015/16. However, this positive aspect disguises the situation with respect to launches by mobile virtual network operators (MVNOs) – see, for example, Wikipedia (2016c) – which lease capacity on incumbents' networks since (so far as one can tell) fewer than 15 such launches had taken place by end 2016 compared to a worldwide total in excess of 200. This is a to a considerable extent a reflection of the small number of national incumbents going hand-in-hand with a very large number of MVNOs and affiliated networks in the USA, but it does demonstrate that LTE provision in Africa remains for now firmly in the hands of nationwide incumbents.

The list below specifies the number of launches in each country and the relevant year(s). However, it would be counter-productive to name the networks since they are often identified

confusingly in the media by either the name of the holding company – for example, Vodafone – the network name, a historic network name or the brand used to market the services on offer.

- Algeria: 3 [2014, 2016 and 2016]
- Angola: 2 [2012 and 2012]
- Benin: 1 [2015]
- Botswana: 3 [2015, 2015 and 2017]
- Burundi: 2 [2016 and 2017]
- Cameroon: 1 [2015]
- Chad: 1 [2014]
- Comoros (Union of): 1 [2016]
- Congo Brazzaville: 1 [2016]
- Côte d'Ivoire: 1 [2016]
- Ethiopia: 1 [2015]
- Gabon: 2 [2014 and 2015]
- Gambia: 1 [2017]
- Ghana: 2 [2014 and 2016]
- Guinea-Bissau: 1 [2015]
- Kenya: 1 [2014]
- La Réunion: 2 [2016 and 2016]
- Lesotho: 1 [2014]
- Liberia: 1 [2016]
- Libya: 1 [2017]
- Madagascar: 2 [2015 and 2017]
- Malawi: 1 [2016]
- Mauritius: 3 [2012, 2012 and 2015]
- Mayotte: 2 [2016 and 2016]
- Morocco: 3 [2015, 2015 and 2015]
- Namibia: 2 [2012 and 2013]
- Nigeria: 6 [2014, 2016, 2016, 2016, 2016 and 2016]
- Rwanda: 1 [2014]
- Seychelles: 1 [2014]
- South Africa: 5 [2012, 2012, 2013, 2013 and 2015]
- Sudan: 2 [2016 and 2017]
- Tanzania: 5 [2013, 2015, 2015, 2015 and 2016]
- Tunisia: 3 [2016, 2016 and 2016]
- Uganda: 5 [2013, 2013, 2013, 2015 and 2016]
- Zambia: 2 [2014 and 2014]
- Zimbabwe: 2 [2013 and 2014]

As can immediately be seen, only 17 countries had witnessed multiple LTE launches by end-2016 and there is no simple explanation as to why, say, Mauritius was a path-breaker while Egypt has yet to be listed. Logic suggests that once a major incumbent introduces LTE its rivals will rapidly follow suit for fear of losing their best customers – that is, those with the highest levels of income who are willing to pay for a faster downlink and a device capable of handling it. Because so many launches have taken place since the beginning of 2015 it is difficult for the time being to establish whether this claim is accurate in respect of African countries, but the multiple launches in South Africa in 2012/13 and more recently in Nigeria tend to provide some support.

It is also evident that there is a considerable mismatch with Table I which indicates that most launches so far have involved re-farmed spectrum that has been deemed to be technology-neutral. As it happens, regulators and operators in Africa can be rather coy when it comes to specifying the spectrum bands used for launches but it is evident from publicly available data that the 1800 MHz band has been used far more than any other band.

There are signs that Africa will witness significant developments in the spectrum bands higher than those normally used for 2G and 3G – that is, above 2.1 GHz. Incumbent networks almost always utilise paired spectrum bands – one for the uplink and one for the downlink. However, LTE can also be provided using so-called TD-LTE (time division LTE) which incorporates both uplink and downlink within the same band – albeit with the downlink occupying a much larger share of the total bandwidth. TD-LTE typically uses relatively high spectrum bands such as 2.3 GHz, 2.6 GHz or 3.5 GHz. The operators in these bands almost always started out as WiMAX licensees but this technology is now rarely used when 4G is under consideration but rather is overlaid with LTE.

When worldwide interoperability for microwave access (WiMAX) licences were awarded in Africa, usually post-2007, several companies acquired them in a variety of countries. Such companies included iBurst, Smile and, most notably Afrimax which has formed an arrangement with Vodafone to brand itself as Vodafone-Afrimax. However, progress has so far been hampered by a number of factors including poor indoor coverage in urban locations, inadequate bandwidth and lack of scale. The issue, therefore, is whether a small number of operators such as Afrimax will be able to scale up, either via take-overs or by acquiring spectrum returned by rivals that have gone bankrupt, and introduce a service that provides a downlink comparable in speed to that of the incumbents while offering competitive prices.

One obvious advantage of TD-LTE compared to WiMAX is that it much improves the prospects for roaming across incumbents' networks and the fact that state-of-the art handsets are available is another. Hence, Afrimax will present a threat to incumbents once it launches in all countries where it holds licences but progress so far has been modest and there are few operators comparable to Afrimax as things currently stand. Meanwhile, there is clearly no great rush among incumbents to invest on the requisite scale to roll out LTE other than in major cities – a launch can effectively occur on any scale from a single city centre to more or less nationwide – so Africa is clearly destined to remain a LTE backwater for the foreseeable future.

Availability and speed

Due to the relatively recent nature of many of the LTE networks in Africa, there is little comparative data in the public domain that would enable any assessment of their availability or the speeds that they provided. Open Signal (2016) uses crowd sourced data to shed some light on the availability of 3G/4G networks as well as the speed that they provide to users.

The first observation that can be drawn is that only nine African countries are among the 95 countries surveyed by Open Signal (2016). That so few are among the sample is noteworthy, as Africa possesses a quarter of the world's territories yet only 10 per cent of the sample.

[Table II roughly here]

Secondly, only one country – South Africa – is among the top half of the table on either criterion. This suggests that considerable further infrastructure investment is needed to both expand the availability of 3G/4G as well as improve speeds. In all but two cases, the African countries listed are better placed when it comes to availability than speed. The discrepancies that exist between the two may be problematic in the long term, as users are likely to be disappointed by the slow speeds that the networks are offering.

Thirdly, the sample includes Senegal whose LTE licence was only issued in June 2016. Thus, the contribution of 4G to the relative standing of Senegal may not be that great, and should only improve as the technology is rolled out across the country. This highlights another issue, namely, that the data combines 3G and 4G with the consequence that it is not clear what the contribution of 4G alone to the standing of countries actually is. Nevertheless, Open Signal (2016) is useful as it highlights the relatively poor position of African countries regarding the latest mobile technologies. Given the significant socio-economic role that mobile devices play, not least in attracting FDI, this should be of concern to governments across the continent.

While Open Signal (2016) draws attention to the need to improve the availability of fast networks across Africa, it does not address the issue of encouraging use. One possible way to improve the take-up of mobile Internet access is zero-rating, which allows users access to a limited range of websites and online content without being charged. Gillwald et al (2016) explore zero-rating within Africa, albeit with a limited number of countries, and find that it can play a role in encouraging take-up that would otherwise not have occurred. At the same time, however, they also draw attention to its complexity and varied challenges. Not only does zero-rating typically restrict access to a limited range of websites and online content, but it also raises questions regarding how the mobile market should be regulated and whether local content providers need to be protected from their international rivals.

The role of holding companies

It may be argued that, with relatively small numbers able to afford high-speed data-rich contracts, expanding 2G coverage and rolling out faster versions of 3G such as HSPA+ is more of a priority than LTE. Indeed, significant advances have been made in recent years to develop useful applications such as money-transfer schemes so the issue is not an overall lack of progress but rather the perennial desire of those living in developing countries to have access to services increasingly enjoyed in Europe and the USA – only much more cheaply.

However, one significant issue is that a large number of networks are controlled by a relatively small number of holding companies, either majority-owned by Africans or international. As shown in Table III, there were seven such companies with either majority or significant minority holdings in at least six African mobile networks at the end of 2016. These seven included only a single company that can be termed 'African' in origin, namely MTN. It is of interest to note that at the end of 2015, MTN had 179.9 million controlled subscribers – that is, gross subscribers multiplied by the percentage of a network owned – of whom only 38.7 million (21.5%) were based outside Africa. In practice, MTN currently has a

direct interest in 11 networks of which only one lies outside Africa (in Iran). The other 11 networks are held by Investcom, a wholly-owned subsidiary acquired in 2006, with seven of these located in Africa (Sutherland 2016).

[Table III roughly here]

MTN was one of only three companies with stakes in more than 10 African networks in 2006, and another of these companies, Zain, was subsequently to sell out to India's Bharti Airtel in which Singapore Telecom retains a substantial minority stake – Vodafone held a much smaller stake for a good many years but has recently disposed of its residual holding in order to concentrate upon its own network in India. The third, predictably given its former colonial empire in Africa, was France Télécom. However, far from letting this legacy incline it to skulk back to Europe, France Télécom – or Orange as it more commonly known in mobile circles – has recently decided to concentrate upon Africa while at the same time letting go its stake in the UK.

France Télécom was dormant in terms of African acquisitions during 2012/15 but acquired three new networks during 2016 – although, interestingly, it had also recently disposed of networks in (Anglo-centric) Kenya and Uganda. As a result, it currently owns stakes in 21 African networks, comprising roughly one-half of its total mobile holdings. These networks are modest for the most part in terms of controlled subscribers – only Egypt (with over 30 million), the Côte d'Ivoire and Morocco exceed 10 million – but the sale of EE in the UK means that Africa is currently much the most important region overall in terms of this metric.

Given that Singapore Telecom has no direct stakes in Africa that leaves Bharti Airtel and Etisalat as the only other companies with a large number of African networks. Bharti's overall controlled subscribers are dominated by its home market but Nigeria is very important and roughly one quarter of the overall total is to be found in Africa. In contrast, Etisalat has been building up its African empire over a good many years, and the acquisition of a significant stake in Maroc Télécom in 2014 – it was sold by Vivendi Universal rather than one of the other specialist mobile companies – means that it is heavily dependent upon Africa (and particularly Egypt) as a source of controlled subscribers.

It may be noted, finally, that the other well-known 'African' operator, Vodacom, plays no role in the above discussion. This is partly because Vodafone has long held a controlling 65 per cent stake, and neither Vodafone nor Vodacom – more surprisingly given the expansionary behaviour of rival MTN – has shown much interest in developing beyond existing holdings.

It is worth noting, finally, that whereas the operators in the table do compete directly to some extent this is heavily circumscribed by the fact that (unsurprisingly) none of them are present in even half of the continent's countries. Many of these countries have modest numbers of subscribers so it probably makes better sense to concentrate upon those with the largest subscriber numbers. These comprise Algeria, Côte d'Ivoire, DRC, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, South Africa, Sudan and Tanzania. Orange is present in four cases but recently departed from Kenya whereas MTN is present in three, Etisalat in three having very recently departed from Nigeria and Bharti in four including Kenya and Nigeria. In addition, Vodafone is present in three. Hence face-to-face competition is, if anything, on the decline and MTN only faces competition from Vodafone (via Vodacom) in South Africa. Elsewhere, the main competition is between Orange and Etisalat in Morocco as well as in Egypt where Vodafone is also present, between Bharti and Vodafone in Kenya, between Bharti and MTN in Nigeria, between Orange and Bharti in DRC and between Etisalat and MTN in the Sudan.

Transparency is lacking

One point worthy of comment in the light of the above is that in Egypt in 2016, LTE licences were offered to the three long-standing incumbents owned respectively by Etisalat, France Télécom and Vodafone. As previously noted, all refused initially on the grounds that the spectrum offered was insufficient to roll out a profitable network despite the fact that new entrant Telecom Egypt, which is state-owned, had previously bought a licence that encompassed LTE. Although they subsequently changed their minds and applied for licences, this could be taken to suggest that international holding companies are no longer willing to invest solely to build empires but are more concerned with the financial bottom line.

This may seem to be eminently sensible but, unfortunately, as set out in detail with respect to MTN in Sutherland (2016), the provision of mobile services in Africa is not necessarily transparent and above-board. As he notes (p.476), 'Africa was initially ignored because of the perception of high levels of political risk and low returns, but came into play once it was realised risk could be spread over several countries and that a pre-paid service would attract large numbers of customers'. The problem was that licences needed to be acquired and (preferably) regulatory oversight heavily watered down which was only possible in a significant number of African countries via the adoption of corrupt practices. As Sutherland notes (p.496), despite its base in South Africa, a democratic country governed by a strong system of law, MTN was happy to negotiate with 'regimes that range from the mildly democratic to the brutally repressive' and its investors were happy to turn a blind eye.

Although hard evidence of corruption relating to the international holding companies' operations in Africa is less readily available, there is no shortage of evidence that at least some similar companies have been willing to engage in corrupt practices – see, for example, Handford (2016). It is possible to claim that such practices are now less common given the exposure of past misbehaviour and the imposition of massive punitive fines, but it is sensible to assume that they have not been eliminated and that much less attention will be paid to countries where the large holding companies are absent and where transparency is not their hallmark.

Conclusion

This paper focuses on LTE, the latest generation of mobile telecommunication technologies. Based on our analysis in the previous sections, a number of conclusions can be drawn. In the first place, it is evident that most networks in Africa prefer to concentrate on basic provision rather than to invest in high-speed networks based on LTE. In Europe and North America, the penetration rate – the ratio of subscriptions to population – exceeds 80 per cent (GSMA, 2017), primarily because many people carry one device for work purposes and one for leisure use or own a handset as well as a tablet. The penetration ratio in Africa is much lower on average, so it follows that it makes sense to concentrate upon reaching out to the masses rather than investing in LTE which can only be afforded by a small number of city dwellers. That said, the key underpinning role that ICT plays in economic development, especially in relation to FDI and export activity, is likely to encourage some operators to launch LTE networks, albeit in a targeted and geographically limited manner to provide Internet connectivity to MNEs.

3G, which is becoming more or less defunct in advanced economies – where LTE makes much better use of the spectrum allocated for 3G – still has a good deal of potential in Africa as it can be enhanced to provide quite respectable downlink speeds. However, these

are dependent upon the availability of base stations and masts and hence are largely restricted to the larger towns and cities.

As noted above, the number of African countries which have licensed LTE is growing rapidly after a late and slow start, and for the most part the modest fees fixed for these licences have evinced a favourable response although the experience of Egypt demonstrates that if potential buyers are privately-owned they may well reject a package that is not economically viable. Equally, small-scale launches have become more common, particularly where the launch by one major incumbent stimulates its rivals to follow suit. But any expectation that LTE will reach beyond town and city centres is unlikely to be satisfied for some considerable time. As a consequence, there is arguably a role for 3G to play in providing connectivity outside of these areas.

The international holding companies will continue to play an important role in determining where, and to what extent, high-speed data networks are rolled out. They are visible in some of the largest African countries such as Egypt (Etisalat, France Télécom and Vodafone), Kenya (Bharti Airtel, Vodafone), Nigeria (Bharti Airtel and MTN) and South Africa (MTN and Vodafone) where the requisite scale of investment is largely beyond the means of stand-alone operators. Despite this, neither Egypt nor Kenya has shown significant progress so far in relation to LTE and it is potentially significant that France Télécom has recently withdrawn from Kenya and Etisalat from Nigeria.

It is of some import that civil wars or economic crises are recurrent themes in Africa – for example, the current conflict in South Sudan is having severe consequences for investment in infrastructure. Furthermore, political instability is arguably on the increase – currently there are issues in this respect in, for example, Egypt and South Africa. Mobile operators must chart their way through these difficulties within the context of a generally low ARPU (average revenue per user) so it does not take that big a market dislocation to produce losses, especially where investment is remaining high due to the introduction of new technology.

A recurrent complaint has been to the effect that governments impose too much taxation on operators, further reducing their margins, but many countries rely upon such taxes (plus licence fees) as a reliable source of income so are unlikely to make unnecessary concessions. The cost of handsets can also be a contentious issue. By and large, smartphones are expensive, especially in relation to average incomes so progress in terms of penetration partly depends on having access to second-hand (refurbished) handsets. Many of these arrive via unofficial channels and this poses a problem for the authorities as they simultaneously wish to promote the spread of handsets while trying to restrict their availability to official channels.

Ultimately, it is a struggle between two opposing forces. On the one hand, the potential for mobile in Africa is enormous especially when one bears in mind that the rest of the world is approaching saturation with penetration levels comfortably above 100 per cent. On the other hand, the economic, political and regulatory environment can be difficult to navigate and profitability is by no means assured. These two opposing forces will shape the strategies of mobile operators in the next few years, with some limiting their footprint and continuing to invest in their infrastructure to deliver 3G and eventually 4G services. In contrast, other mobile operators will feel able, through drawing on the experiences of those markets in which they already operate, to expand into new countries. Given the relative paucity of research that addresses FDI within the telecommunications sector in Africa, these alternatives are fruitful topics for further research.

Another topic for further research relates to how mobile operators combine their 3G and 4G operations. Are some mobile operators engaged in technological ‘leapfrogging’ and, if so, under what circumstances and are others combining 3G and 4G to reflect the

differences in underlying demand and profitability that they face? Such an analysis would, however, require considerably more extensive and detailed data about the operations of mobile operators across Africa to become available in the public domain. As the opposite appears to be occurring, any analysis of mobile operator strategies is likely to be easier said than done.

Note

1. A full analysis of what comprises the list of sovereign states and dependent territories in Africa can be found at https://en.wikipedia.org/wiki/List_of_sovereign_states_and_dependent_territories_in_Africa.
2. The term 'Sub-Saharan' often appears in the literature. A discussion of how to interpret the term can be found at https://en.wikipedia.org/wiki/Sub-Saharan_Africa.
3. For a fuller analysis of the role of the Chinese as increasingly active investors in African infrastructure see https://deborahbrautigam.com.

References

African Development Bank Group, OECD and UNDP (2016) *African Economic Outlook 2016*. www.afdb.org

Bartels, F, Napolitano, F. and N. Tissi (2014) FDI in Sub-Saharan Africa: A longitudinal perspective on location-specific factors (2003-2010). *International Business Review,* 23 (3), 516-529.

Barton, D. and A. Leke (2016) 3 reasons things are looking up for African economies. *World Economic Forum*, 5 May. www.weforum.org

Carmody, P. (2013) A knowledge economy or an information society in Africa? Thintegration and the mobile revolution. *Information Technology for Development,* 19 (1), 24-39.

Cellular-news (2012) Vodacom launches LTE services in South Africa. http://www.cellular-news.com. Accessed 10 October 2012

Cellular-news (2013) KT to provide LTE technology to Rwanda. http://www.cellular-news.com. Accessed 11 March 2013

Chavula, H. (2013) Telecommunications development and economic growth in Africa. *Information Technology for Development,* 19 (1), 5-23.

Curwen, P. (2002) *The future of mobile communications: awaiting the third generation.* Basingstoke: Palgrave.

Curwen, P. and J. Whalley (2008) *The internationalisation of mobile telecommunications: strategic challenges in a global market. Cheltenham:* Edward Elgar.

Curwen, P. and J. Whalley (2010) *Mobile communications in a high-speed world: industry structure, strategic behaviour and socio-economic impact.* Farnham: Gower Press.

Curwen, P. and J. Whalley (2011) The restructuring of African mobile telecommunications provision and the prospects for economic development, *info*, 13 (2), 53-71.

Curwen, P. and J. Whalley (2013) *Fourth generation mobile communication: the path to superfast connectivity*. London: Springer.

Curwen, P. and J. Whalley (2014) *Mobile telecommunications networks: restructuring as a response to a challenging environment.* Cheltenham: Edward Elgar.

Curwen, P. and J. Whalley (2015) The licensing of mobile operators in Europe and the consequences of new entry for competition. *info*, 17 (3), 16-37.

Curwen, P. and J. Whalley (2017a) The evolution of US mobile operators within a multi-play world. *Digital Policy, Regulation and Governance*, 19 (1), 40-57.

Curwen, P. and J. Whalley (2017b) A tale of many auctions: mobile communications in India struggle to overcome a dysfunctional structure. *Digital Policy, Regulation and Governance*, 19 (3), 225-50.

Curwen, P. and J. Whalley (2017c) High-speed data provision via mobile networks in Latin America and the Caribbean. *Digital Policy, Regulation and Governance*, 19 (4), 287-301

Demirbag, M., Apaydin, M. and E. Tatoglu (2011) Survival of Japanese subsidiaries in the Middle East and North Africa. *Journal of World Business,* 46 (4), 411-425.

Diop, M., Li, Y., Yong, L. and A.A. Shide (2015) *Africa still poised to become next great investment destination*. 30 June. www.worldbank.org

Frempong, G.K. and W.H. Atubra (2001) Liberalisation of telecoms: The Ghanaian experience. *Telecommunications Policy,* 25 (3), 197-210.

Garbacz, C. and H.G. Thompson (2007) Demand for telecommunication services in developing countries. *Telecommunications Policy,* 31 (5), 276-289.

Gillwald, A., Chair, C., Futter, A., Koranteng, K., Odufuwa, F. and J. Walubengo (2016) *Much ado about nothing? Zero-rating in the African context*. Research ICT Africa. 12 September, www.researchictafrica.net (accessed 10 July 2017).

Gomes, E., Cohen, M. and K. Mellahi (2011) When two African cultures collide: A study of interactions between managers in a strategic alliance between two African organisations. *Journal of World Business,* 46 (1), 5-12.

GSMA (2014) *Mobile broadband reach expanding globally*. GSM Association. December. www.gsma.com (accessed 26 October 2016).

GSMA (2016) *The mobile economy: Africa 2016,* GSM Association. www.gsma.com (accessed 26 October 2016).

Handford, R (2016) Telia faces $1.4B Uzbek fine. http://www.mobileworldlive.com (accessed 16 September 2016).

Hearn, B., Oxelheim, L. and T. Randøy (2016) The institutional determinants of private equity involvement in business groups – the case of Africa. *Journal of World Business,* article in press

ITU (2015a) *Trends in telecom reform 2015 – getting ready for the digital economy*, ITU, Geneva, Switzerland.

ITU (2015b) *Measuring the information society report 2015*, ITU, Geneva, Switzerland.

Jagun, A., Heeks, R. and J. Whalley (2008) The impact of mobile telephony on developing country micro-enterprises: A Nigerian case study. *Information Technology & International Development,* 4 (4), 47-65.

James, J. (2012) The distributional effects of leapfrogging in mobile phones. *Telematics & Informatics,* 29 (3), 294-301.

Jayakar, K. and B. Martin (2012) Regulatory governance in African telecommunications: Testing the resource curse hypothesis. *Telecommunications Policy,* 36 (9), 691-703.

Jho, W (2007) Global political economy of technology standardisation: A case of the Korean mobile telecommunications market. *Telecommunications Policy,* 31 (2), 124-138.

Kauffman, R. and A. Techatassanasoontorn (2009) Understanding early diffusion of digital wireless phones. *Telecommunications Policy* 33 (8), 432-450.

Lee, S., Levendis, J. and L. Gutierrez (2012) Telecommunications and economic growth: an empirical analysis of sub-Saharan Africa. *Applied Economics,* 44 (4), 461-469.

Marcellle, G. (2005) How do telecom firms build capabilities? Lessons from Africa. *Telecommunications Policy,* 29 (7), 549-572.

McKinsey Global Institute (2016) *Lions on the move II: Realising the potential of Africa's economies,* September. www.mckinsey.com

Mumuni, A., Luqmani, M. and Z. Quraeshi (2017) Telecom market liberalisation and service performance outcomes of an incumbent monopoly. *International Business Review,* 26 (2), 214-224.

Nicholson, R. and J. Salaber (2013) The motives and performance of cross-border acquirers from emerging economies: Comparison between Chinese and Indian firms. *International Business Review,* 22 (X), 963-980.

Obijiofor, L. (2009) Mapping theoretical and practical issues in the relationship between ICTs and Africa's socioeconomic development. *Telematics & Informatics*, 26 (1), 32-43.

Open Signal (2016) Global state of mobile networks. http://opensignal.com/2016/08 (accessed 25 August 2016).

Ramasamy, B., Yeung, M. and S. Laforet (2012) China's outward foreign direct investment: Location choice and foreign ownership. *Journal of World Business,* 47 (1), 17-25.

Rouvinen, P. (2006) Diffusion of digital mobile telephony: Are developing countries different. *Telecommunications Policy*, 30 (1), 46-63.

Rui, H., Zhang, M. and A. Shipman (2016) Relevant knowledge and recipient ownership: Chinese MNCS knowledge transfer in Africa. *Journal of World Business,* 51 (5), 713-728.

Sam, S. (2017) Towards an empowerment framework for evaluating mobile phone use and impact in developing countries. *Telematics & Informatics*, 34 (1), 359-369.

Sassi, S. and M. Goaied (2013) Financial development, ICT diffusion and economic growth: lessons from MENA region. *Telecommunications Policy,* 37 (4/5), 252-261.

Standage, T. (2009) Mobile marvels – A special report on telecoms in emerging markets. *The Economist* 26 September. www.economist.com

Sutherland, E. (2016) MTN: A South African mobile telecommunications group in Africa and Asia. *Communicatio,* 41 (4): 471-505.

Telecom.paper (2016) Egypt to consider other bids after operators reject 4G terms. http://www.telecompaper.com/news/egypt (accessed 26 September 2016).

TeleGeography (2012a) ICASA bows to operator pressure; postpones 800MHz, 2.6GHz spectrum auction until further notice. http://www.telegeography.com. Accessed 7 March 2012

TeleGeography (2012b) MTN LTE network now up and running in Pretoria, Durban, Jo'burg. http://www.telegeography.com. Accessed 5 December 2012

TeleGeography (2014) MTN Rwanda offers LTE over ORN network. http://www.telegeography.com. Accessed 12 November 2014

Trestian, R., Shah, P., Nguyen, H., Vien, Q-T., Gemikonakli, O. and B. Barn (2017) Towards connecting people, locations and real-world events in a cellular network. *Telematics & Informatics*, 34 (1), 244-271

UNCTAD (2016) *World Investment Report 2016*. www.unctad.org

Varoudakis, A. and C.M. Rossotto (2004) Regulatory reform and performance in telecommunications: Unrealised potential in the MENA countries. *Telecommunications Policy,* 28 (1), 59-78.

Vu, K.M. (2011) ICT as a source of economic growth in the information age: Empirical evidence from the 1996-2005 period. *Telecommunications Policy,* 35 (4), 357-372.

Wang, C., Hong, J., Kafouros, M. and A. Boateng (2012) What drives outward FDI of Chinese firms? Testing the explanatory power of three theoretical frameworks. *International Business Review,* 21 (3), 425-438.

Wamuyu, P. (2015) The impact of information and communication technology adoption and diffusion on technology entrepreneurship in developing countries: the case of Kenya. *Information Technology for Development,* 21 (2), 253-280.

Waverman, L., Meschi, M. and M. Fuss (2005) The impact of telecoms on economic growth in developing countries. *Africa: the impact of mobile phones* Vodafone Policy Paper Series No 2, March (accessed 26 September 2016).

Wikipedia (2016a) 3GPP Long Term Evolution. http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution (accessed 30 September 2016).

Wikipedia (2016b) 4G. http://en.wikipedia.org/wiki/4G (accessed 30 September 2016).

Wikipedia (2016c) Mobile virtual network operator. http://en.wikipedia.org/wiki/Mobile_virtual_network_operator (accessed 30 September 2016).

World Bank (2014) *Foreign direct investment flows into Sub-Saharan Africa*, March. www.worldbank.org

World Bank (2017) *Sub-Saharan Africa*. data.worldbank.org

Table I LTE licensing across Africa, 31 July2017

Country	Spectrum Band MHz	Reserved New Entry	Date	Licence winners
Algeria	n/a[1]	-	May 2016	Algérie Télécom, Djezzy, Ooredoo
Angola	-[2]	-	-	-
Benin	-[3]	-	Mar 2012	MTN
Benin	-[3]	-	Jun 2013	Etisalat
Botswana	-[4]	-	-	-[4]
Burkina Faso	-	-	-	-
Burundi	-[3]	-	Feb 2014	Viettel
Cameroon	-[5]	-	Feb 2015	MTN
Cameroon	-[5]	-	Mar 2015	Orange
Cape Verde Isles	-	-	-	-
Central African Rep.	-	-	-	-
Chad	-[5]	-	Jun 2013	Millicom
Chad	-[6]	-	Apr 2014	Bharti Airtel
Comoros Isles	-[7]	-	Oct 2015	Telma
Congo-Brazzaville	-	-	-	-
Côte d'Ivoire	-	-	-	-
Côte d'Ivoire	-[8]	-[8]	Sep 2016	LPTIC
Djibouti	-	-	-	-
DR Congo	-	-	-	-
Egypt	700	-	Aug 2016	Telecom Egypt
Egypt	1800	-	Aug 2016	Telecom Egypt
Egypt	2100	-	Oct 2016	Etisalat, Orange, Vodafone
Equatorial Guinea	-	-	-	-
Eritrea	-	-	-	-
Ethiopia	-[9]	-	-	-
Gabon	-[10]	-	Mar 2014	Gabon Télécom
Gabon	-[11]	-	Mar 2014	Bharti Airtel
Gambia	-	-	-	-
Ghana	-[12]	-	Mar 2013	All[12]
Ghana	800	-	Dec 2015	MTN
Guinea-Bissau	-[13]	-	Jun 2015	Sonatel
Guinea Conakry	-	-	-	-
Kenya	800[14]	-	Nov 2014	Safaricom
Kenya	800	-	Jun 2016	Bharti Airtel, Safaricom, Telkom Kenya
La Réunion	800	-	Oct 2016	Orange, SFR Réunion, Telco OI
La Réunion	1800	-	Oct 2016	Orange, SFR Réunion, Telco OI, Zeop Mobile
La Réunion	2100	-	Oct 2016	Orange, SFR Réunion, Telco OI, Zeop Mobile
La Réunion	2600	-	Oct 2016	Orange, SFR Réunion, Telco OI, Zeop Mobile
Lesotho	800	-	Oct 2013	Vodacom
Liberia	-[15]	-	Jul 2015	Cellcom[15]
Libya	-	-	-	-
Madagascar	-[16]	-	Oct 2014	All[16]
Malawi	-	-	-	-
Mali	-[17]	-	-	-
Mauritania	-	-	-	-
Mauritius	-[18]	-	-	-
Mayotte	800	-	Oct 2016	Orange, SFR Mayotte, Telco OI
Mayotte	1800	-	Oct 2016	Orange, SFR Mayotte, Telco OI, BJT Partners
Mayotte	2100	-	Oct 2016	Orange, SFR Mayotte, Telco OI, BJT Partners
Mayotte	2600	-	Oct 2016	Orange, SFR Mayotte, Telco OI, BJT Partners
Morocco	800	-[19]	Mar 2015	Maroc Télécom, Médi Télécom, Wana
Morocco	1800	-[19]	Mar 2015	Maroc Télécom, Médi Télécom, Wana
Morocco	2600	-[19]	Mar 2015	Maroc Télécom, Médi Télécom, Wana
Mozambique	-	-	-	-
Namibia	-[20]	-	Mar 2012	AfricaOnline, MTC, Wireless Technologies Namibia[20]
Namibia	1800	-	May 2015	Paratus Telecom
Namibia	2100	-	May 2015	Paratus Telecom
Niger	-	-	-	-
Nigeria	-[21]	-	-	-
Nigeria	-[22]	-	Jan 2014	Bitflux Communications
Nigeria	2600		June 2016	MTN
Rwanda	-[23]	-	Mar 2013	Olleh Rwanda Networks Limited[23]
São Tomé	-	-	-	-
Sénégal	800[24]	-	Jun 2016	Sonatel (Orange)
Sénégal	1800	-	Jun 2016	Sonatel (Orange)
Seychelles	-[25]	-	-	-
Sierra Leone	-	-	-	-

Somalia	Multiple[26]	-	Jun 2014	SomCom Telecom
South Africa	-[27]	-	-	-
South Sudan	-[28]	-	-	-
Sudan	-[29]	-	Feb 2016	Zain
Swaziland	1800	-	Nov 2013	MTN
Swaziland	2G/3G/LTE	Yes	Dec 2016	Swazi Mobile
Tanzania	-[30]	-	-	-
Togo	-	-	-	-
Tunisia	n/a	-	Mar 2016	Ooredoo, Orange, Tunisie Telecom
Tunisia	863-870	-	Mar 2017	
Uganda	-[31]	-	-	-
Yemen	-	-	-	-
Zambia	-[32]	-	-	-
Zimbabwe	-[33]	-	-	-

Notes: 1. Algeria did not licence 3G until 2012; 2. Although Movicel and Unitel launched LTE services as early as 2012 using re-farmed spectrum, it is not possible to establish specific licence arrangements relating to the provision of LTE; 3. The technology-neutral licences were for the provision of 3G and 4G; 4. The original licences awarded to Mascom and Orange dating back to 2007 were technology-neutral; 5. The renewal of existing GSM licences was accompanied by authorisation to provide 3G/4G services; 6. A 3G/4G licence; 7. The second mobile licence encompassed 2G, 3G and 4G; 8 The three incumbents were authorised to provide LTE when their licences came up for renewal in April 2016 and this was in effect the end-product of a selection process involving only minor operators or non-incumbents, although the winner was in practice owned by one of the four very small networks that the regulator had effectively put on notice of licence termination in April. In addition, YouMee Africa has converted its WiMAX network to TD-LTE; 9. State-owned monopolist Ethio Telecom is not subject to normal regulatory constraints such as seeking new licences; 10. A 3G/4G licence; 11. An existing 3G licence was upgraded to include 4G; 12. Re-farming of existing spectrum for LTE was authorised; 13. No details can be established; 14. No details were disclosed but it is evident from later comments that spectrum in the 800 MHz band was awarded. However, Safaricom was also awarded spectrum in this band in June 2016. It paid for the licence in January 2017; 15. In July 2015, licences became technology-neutral; 16. Licences were altered to permit the roll-out of 4G; 17. When its licence came up for renewal on 1 August 2017, Orange Mali was permitted to re-farm its existing spectrum for LTE with a commercial launch in 2018; 18. No new licences appear to be needed for 4G; 19. The regulator invited new entrants to apply but offered no special treatment with predictable results; 20. The licences of these companies – of which only MTC owned a mobile network – were made technology-neutral. Although its own similar licence conversion cannot be traced, Telecom Namibia launched LTE in November 2013; 21. Existing licences can be used for LTE; 22. A national wholesale licence in the 2.3 GHz band; 23. A joint venture between the state and KT Telecom to establish a national wholesale network. It was renamed as Korea Telecom Rwanda Networks in July 2016; 25. Millicom, Orange (Sonatel) and Sudatel had licences to trial LTE. An auction for unspecified spectrum was to take place in 2016Q1 but was ignored by all three incumbents in what was effectively a boycott. However, Orange unilaterally acquired a licence in June 2016 simultaneous with the renewal of its fixed-wire, 2G and 3G licences; 24. Bharti Airtel has launched in the 1800 MHz band but there is no evidence that it needed a new licence to do so; 26. That of Orange was renewed in January 2017 The technology-neutral licence included spectrum in the 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz bands; 27. Although Neotel was awarded spectrum in the 800 MHz band for LTE use in 2007, both itself and other operators have launched using re-farmed spectrum; 28. In July 2017, a new network branded as 'Niletel' was launched with the capacity to roll out a LTE network although the spectrum involved was not specified; 29. The licence appears to have been technology-neutral; 30. It is not possible to identify how licensing for LTE has been conducted, even assuming that it was necessary in the first place; 31. It is not possible to identify how licensing for LTE was conducted; 32. It is not possible to identify how licensing for LTE was conducted; 33. No new licences appear to be needed for 4G but spectrum has allegedly been issued specifically for LTE use.

Source: Compiled by authors from multiple sources

Table II 3G/4G availability and speed in selected African countries

Country	Ranking out of 95 countries	
	3G / 4G availability	Speed
South Africa	34	51
DRC	55	81
Tunisia	57	65
Egypt	74	78
Senegal	75	88
Morocco	77	58
Ethiopia	78	93
Algeria	85	91
Togo	88	86

Source: Open Signal (2016)

Table III Main mobile holding companies. Number of networks at end-2016

	Total	Africa	%
France Télécom	40	21	53
Singapore Telecom[1]	24	14	58
Vodafone	27	8	30
Etisalat	23[3]	15[3]	65
MTN	22	17	77
Bharti Airtel[2]	19	14	76
Millicom	11	5	45

Notes:

1. Because SingTel is a significant minority shareholder in Bharti Airtel, with 32%, the stakes acquired by Bharti in 2010 are credited in this case as indirect holdings.
2. Zain was formerly The Mobile Telecommunications Co. In May 2005, it acquired 85 per cent of Celtel, a pan-African operator with 14 networks. In 2010, it sold 15 networks in Africa (essentially Celtel) to Bharti Airtel.
3. Etisalat withdrew from Nigeria at end-June 2017

Source: Compiled by authors from multiple sources