GTPRN November 2020 Newsletter

**Welcome to the GTPRN November 2020 Newsletter**

We wish that you and your beloved ones are in a good health. We do understand how the past period was difficult for many of us with several countries start to lock-down again. Meanwhile, there have been good news with raged to an effective and affordable vaccine for COVID-19, and we hope by the coming spring, everything will get back to normal.

I am so grateful that we managed to get for this issue two exclusive and excellent contributions for GTPRN on timely topics for the telecom industry.

The first article is by Mr. Roberto Ercole, an international consultant on spectrum and telecom issues, and a well-known expert, at least within the ITU-R, on a must-read topic for telecom regulators. More specifically, it analyses the importance of balancing between regulatory measures to increase competition and the impact on the cost of providing mobile services. Mr. Ercole, is one of the few people, I personally rely on for unbiased objective opinion when it comes to spectrum issues. He usually adopts technical and economic measures when addressing regulatory options. His article can be found here at GTPRN website where you can comment directly on the article, and at the end of this Newsletter.

The second article is by Dr. Shiv K. Bakhshi, VP of Industry Relations at Ericsson, and Dr. Sendil Devar, General Manager Standards & Spectrum at Ericsson on rural connectivity. In particular, they argue that mobile broadband technologies, anchored in global 3GPP cellular standards, may be best suited to meet the policy goals of rural connectivity while highlighting why this may not be the case for license-exempt devices. The article is worth reading indeed, as Dr. Bakhshi is always interested in what the society needs regardless of the technology, especially in the developing countries. I have been advocating him to write down in a book his experience on the different connecting technologies and within the ITU-R and ITU-D for the last decades. Dr. Devar is a main contributor in the mobile standardization process, and he must be very proud with his achievements during the IMT-2020 evaluation process. Their article can be found here at GTPRN website where you can comment directly on the article, and at the end of this Newsletter.

Regarding online events, please check the following list for different telecom policy related topics webinars:

- ITS Webinar on AI International Impact on Economy and Society – November 19, 2020. Event details are here.
- GSA on Fixed Wireless Access global status update (Tuesday, November 24th, 2020 – 4pm GMT). Event details are here.
- Foreign Policy and Nokia webinar on 'Open Networks: How O-RAN Can Drive Collaboration & Security Across the 5G Ecosystem' (17th November). Event details are here.
- The 4th IEEE Internet of Things (IoT) Vertical and Topical Summit will be held as a Virtual Event January 11th - 16th, 2021 in conjunction with IEEE Radio and Wireless Week. If you are interested in suggesting or being a speaker for this event, please provide the following information to the Summit Co-Chairs (CharlieJackson: Charles.M.Jackson@ngc.com, Adam Drobot: Adam.Drobot@gmail.com): 1) The name, title, and affiliation of the speaker; (2) The topic and title of the proposed presentation; (3) A brief description of what the presentation would cover (250-300 words); and (4) please attach any relevant supporting or background material.

With respect to telecom policy journals, please find below these latest releases:

- The November 2020 issue (Volume 44) of Telecommunications Policy is available here.
- The new issue of ITU News Magazine - Regulation for digital transformation is available here.
- The Center for Advanced Research in Global Communication new paper entitled ‘Hectic Slowness: Precarious Temporalities of Care in Vietnam’s Digital Mamasphere’.
- Check Prof. Rob Frieden new blog’s article here.
- Call for Papers (CFP) for a special issue of Telecommunications Policy journal on ‘Innovation in 5G Technology: leadership, competition and policy issues’ is out.

It is worth mentioning that the Center for Advanced Research in Global Communication at the Annenberg School for Communication at the University of Pennsylvania invites applications for a “CARGC Postdoctoral Fellowship.” This is a one-year position renewable for a second year based on successful performance. More details can be found here. Also, the University of Chalmers is looking for two PhD candidates who want to explore the potential of Industry 4.0 with a focus on the future of work and design of future factories

If you are following the progress in smart cities, the IEEE is reaching out to cities worldwide that have important smart city experience in order to create a new global smart cities & technology alliance. Feel free to complete this 5-minute survey by November 29, 2020 which is initiated by the IEEE IoT Initiative Smart Cities Working Group, in collaboration with the IEEE SA Foundational Technologies Practice Community and the IEEE SA AI-driven Innovation for Cities and People.

The International Telecommunications Society (ITS) is currently offering students, new members, existing members and long-time (10+ years) members a promotion on membership and membership renewal until 30th of November.

The PTC'21 conference will be held online from 17 to 20 January 2021 due to the COVID-19 circumstances. PTC has been one of the best forums for telecom professionals and researchers, and I am sure, as the past years, it will accommodate excellent sets of speakers and roundtables. You may register for the event here.

**Finally, please share with us and with the GTPRN community your articles, views, news, announcements. If you have a specific topic that you want to share an update or opinion on in one to three pages, please do not hesitate to share it with us via news@gtprn.org**

Kindly also help us by spreading the word about the GTPRN community and forward this newsletter to your colleagues or students. You are more than welcome to join our Facebook or LinkedIn Groups, or to subscribe directly to our website www.gtprn.org where you have the chance to comment on each article or post.

Take care, stay safe and well.

Mohamed El-Moghazi

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# Fixed Costs in Mobile and the implications for Competition Policy - How to weigh-up the impact of duplicating fixed costs

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## Overview

Ideally, when a regulator introduces a measure such as a spectrum cap or reserving a band for a new entrant or mandating coverage requirements etc, a cost benefit analysis should be done. The CBA should look at the benefits from extra competition compared to any extra fixed costs (i.e. increasing incumbents current or near future costs).

This paper looks at what the cost impacts might be of having extra operators in a market or mandating coverage. This is not intended to argue that there should be a single operator, but that there will be a law of diminishing returns from extra competition that must be balanced against the introduction of productive inefficiency.

## Background

It seems almost a given that regulators should try to encourage competition in mobile markets, by increasing the number of networks. This leads to a fairer share of the economic benefits between mobile operators and consumers. However, the counter argument is that mobile networks require thousands of base stations to offer wide area coverage, and large fibre networks to move data around (as well as billing platforms etc). Each new network needs to duplicate these fixed costs, and that is a large extra burden for an economy to carry.

If a regulator, simply tries to ensure a level playing field and feeds in enough spectrum – allowing market entry and exit - then this is not an issue. The discipline of the market decides on how many operators there are (and who they are). The problem comes if a regulator implements spectrum policies to encourage more opcos, and these polices have a cost impact on the sector. It is the "twisting[1]" of the market by regulatory measures to have more firms than the market would support that is the issue. It is this "twisting" that gives rise to economic inefficiencies that may reduce overall welfare.

This is briefly examined for Saudi Arabia, using a population distribution curve provided by Policy Tracker, and publicly available data for the operators.

[1] As referred to by Motta – se below.

Number of Operators and Economic Welfare

It is tempting to think that a regulator should always seek to encourage more companies into the mobile market. However, there is be a tension between the number of firms and economic efficiency - in a market with high fixed costs and economies of scale – which is what we have in the mobile market. Increasing the number of firms does not necessarily increase economic welfare as was pointed out by Motta in his book[2]. Obviously moving from one to two opcos will have a major impact but moving from five to six will obviously have much less of an impact on competition.

This is easy to see if each mobile network needs 10,000 sites say. Each macro site might cost around $150k to build (civils and 4G radio equipment + microwave backhaul). One might also assume that 10% per annum was needed for running cost (opex). Over 10 years this effectively doubles this cost to $300k. That would put the total for 10k base stations (over 10 years) at $3 billion dollars per operator.

This ultimately needs to be paid for by mobile subscribers (if we assume MNOs are not loss making). This represents an upper bound, as you can argue that in high population areas of a country (where network capacity is the issue) the total number of cells between all opcos ultimately remains similar. This is because each MNO needs fewer capacity cells as traffic moves to the new MNO - assuming subscribers/traffic is equally shared. This would mean incumbent MNOs may be left with extra urban/sub-urban capacity for a time, until the historic trend of data demand growth "catches up" to use this spare capacity.

However, even in capacity constrained areas, there may be "trunking" inefficiencies because spectrum is split between opcos. There may also be problems with shortage of mast sites or having to build the sites away from the centre of the area they wish to cover. In a large cell of several kilometres, placing the mast a couple of hundred metres off centre is not much of an issue. But in an urban area where cells tend to be smaller, two hundred metres on a 500 m cell is a bigger problem. The exact value will vary from opco to opco in various countries, but a realistic number might (at a guess) be around 20% (depending on the situation).

This increase in fixed costs needs to be weighed against the extra benefits of competition. As the number of MNOs increase (all other things being equal) you would expect a more competitive market; So there would be a flow from producer to consumer surplus (MNO profits being competed away to give consumers a

[2] *"Competition Policy"*: by Massimo Motta Cambridge University Press 2004 – Section 2.2.3.

better deal). Increasing competition may also lead to more efficient MNO's through a Darwinian (natural selection) mechanism. This would ultimately lead to the most efficient mobile firms offering the best service to consumers.

It is clear however that there must be some law of diminishing returns, beyond which the extra benefits are outweighed by the extra costs. In a well-functioning market, a regulator does not need to set the number of firms and allows market forces to play out. Players will enter and leave the market and the regulator will try to ensure that there is fair competition, and that enough harmonised spectrum is available to allow for cost effective MNOs.

As Motta notes in his book, a policy of maximising the number of firms can contrast with the objective of economic efficiency. Essentially this fixed cost duplication would need to be balanced by the competition benefit of going from say three to four or five competitors which might be small (few percent)[3].

The Example of Saudi Arabia

A practical example of this could be a country like Saudi Arabia. A recent consultation by the regulator CITC[4] provides a good overview the importance of spectrum to an economy, and the questions that need to be considered in making new spectrum available for commercial use. The release of spectrum by CITC between 2017 and 2019 more than doubled the spectrum available in KSA for mobile services, which had a major impact on the quality of service available to mobile subscribers (as noted in the consultation document).

The pragmatic and speedy approach taken by CITC in awarding much needed harmonised spectrum to the mobile operators has led to the desired outcome of substantially improving mobile internet speeds for consumers. According to an Opensignal report of last month[5], KSA has the fastest average 5G download speed at 144.5 Mbps of any country in the world (with Canada second at 90.4 Mbps).
Data available from Zain for KSA financial information states they have just under around 10,000 sites. This compares with STC at 7,000 sites (of which 3,000 are currently 5G enabled). As noted above, the cost of 10k sites might be around $3 billion. If 50% of sites are capacity limited (and 50% are rural) then the "dead wight" extra cost might be the 50% rural sites and say 20% of the capacity limited (due to trunking and site acquisition problems). That is, then 5k sites (rural) and 1000 sites (capacity limited areas) are unnecessarily duplicated, making 6,000 sites the "dead weight loss", that needs to be compensated for by increased competition. Put another way, each new entrant means the consumers/economy

[3] For example see: http://www.econ.cam.ac.uk/research-files/repec/cam/pdf/cwpe1234.pdf
[4] https://www.citc.gov.sa/en/new/publicConsultation/Pages/14111205.aspx
[5] https://www.opensignal.com/2020/08/26/benchmarking-the-global-5g-user-experience

in KSA needs to pay for another 6,000 sites. As the number of opcos increased the trunking inefficiency and site acquisition problem would grow.

A recent IEEE paper by Frias and others (looking at 4G in Greater London) found that MNOs with double the bandwidth use 42% fewer eNBs on average in dense urban areas (for similar market shares), dropping to around 25% fewer in lower density areas[6]. The paper uses data from Opensignal, so is based on actual handset measurements from consumers. This suggests that 15% maybe on the low side for extra costs in non-rural areas.

The upshot is that the decision to encourage a new entrant via reserving spectrum in an award or placing spectrum caps on incumbents may have a significant impact on fixed costs. This can be exacerbated when one considers MNOs need to have two or three or four different technologies operating at the same time in the valuable sub-1 GHz bands – that is GSM, UMTs, 4G, and now 5G.

The Problem of Mandating Coverage

Regulators will have legitimate concerns about how frequency bands are used across an MNO's network, and the level of rural coverage. Many spectrum licences contain coverage obligations to help address such concerns. However, as with above this can have the effect on the market as it can impose a significant cost burden on an MNO. The exact setting of the coverage target could have a major impact on business cases or costs payed by consumers.

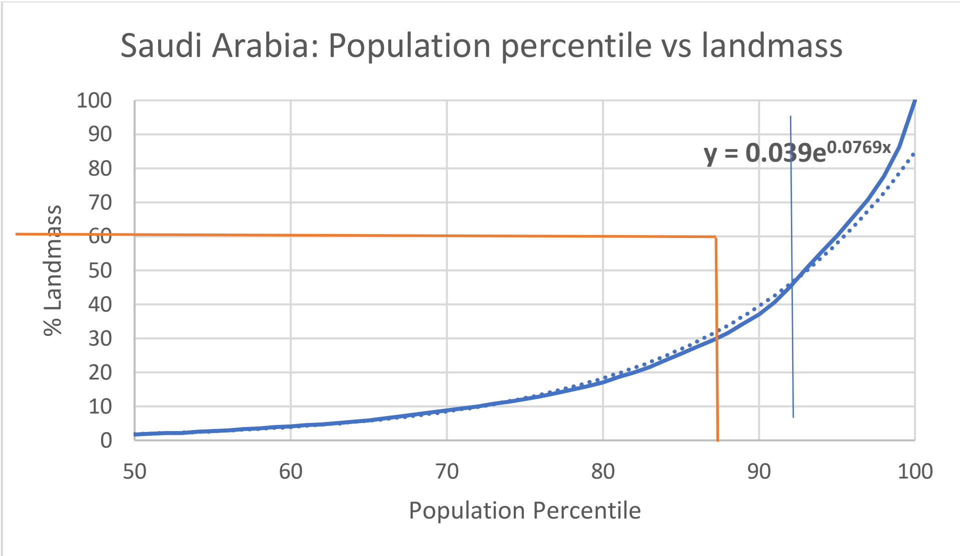
The way an MNO would use various frequency bands across its sites will be complex and will ultimately be designed to provide the required quality of service and capacity for the lowest price. It does not make sense to use all bands at all sites as this may increase the costs without adding any benefits. For example, in a lightly loaded rural cell, perhaps one frequency band is sufficient. As discussed, the Frias paper, this is a complex issue relating to legacy assets as well as consumer traffic profiles etc. Ideally an MNO might use one coverage band and then one capacity band (as needed) in as many places as possible (as the data for London shows) – if they have the spectrum resources to do that. If not, then various additional bands will be used, and this will increase costs because it requires additional radio kit (eNodeBs for 4G).

*An important cost driver will be the population distribution across a country.* Below is a population vs landmass distribution for KSA. It can be seen that 10% of the landmass is where just over 70% of the population live. In terms of a simple business case one can imagine that the sites in this densely populated 10%

[6] https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9229062

of the country generate most of the revenue. However, we know consumers value being able to make a call almost anywhere with mobile, so MNOs cover more than this 10%.

The level of geographic coverage will depend on the extra costs versus how much consumers value it. As we have seen above the costs can depend on the amount and type of spectrum, and CITC has made much more spectrum available in the last few years to help boost mobile broadband coverage and data rates.




*Landmass of KSA 2.1 million Km²* (source : https://www.policytracker.com )

According to the World Bank[7] 4G coverage in KSA is now 91% of the population (compared to 99% for voice). If we assume that consumers are only willing to pay for coverage up to say 95% of population coverage for 4G (for the sake for argument), that is still only around 60% of the landmass of KSA. If coverage is mandated to say 99% of population, then this is around 87% of landmass.

If this 99% coverage is mandated it requires each MNO to potentially add around 50% more sites (5,000 in the case of Zain), which is a significant cost if all three opcos need to do this independently.

An alternative solution would perhaps be to have a common network for the last 4/5% of the population in KSA – perhaps for a period of time. The running of the rural network might be done jointly between the MNOs, with the regulator ensuring that things run smoothly and to time. A variation may be to assign parts of this last 4/5% to each opco and allow national roaming in these areas – or some combination of these.

[7] https://blogs.worldbank.org/digital-development/saudi-arabia-investments-digital-infrastructure-are-paying

Whilst in theory such sharing of infrastructure may be allowed in many countries, the competitive dynamic may make it hard for MNOs to agree such long-term arrangements without the encouragement of the regulator.

**Conclusion**

The way regulatory objectives are set such as coverage or mobile data rates can have a significant impact on the cost of providing mobile services. Similarly, regulatory measures such as spectrum caps or reserving bands for new entrants can also have an impact on MNO costs due to the high fixed costs associated with networks and inefficiencies from reducing the spectrum available to each MNO.

It is suggested that a cost benefit analysis be undertaken for such measures to assess if the potential benefits from extra competition or improved coverage outweigh the costs of such regulatory measures.

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Roberto is a Chartered Engineer in Europe, specialising in mobile radio systems and radio spectrum regulation. He graduated with a degree in Applied Physics in 1988, and a Masters in Electronic Engineering in 1990. He also has a post graduate certificate in EU and UK Competition Policy and Law.

Roberto spent 10 years at GSMA as a senior global policy director for spectrum from 2006 to 2016. He was responsible for the GSMA's WRC campaigns in 2007 and 2012, as well as several regulatory market interventions around the world.

He also worked as a radio spectrum regulator in the UK for 7 years, following that he worked with a UK GSM1800 operator as a spectrum engineer, specialising in regulatory issues (related to the UK spectrum auction for) 3G for 2 years.

Roberto has extensive experience in mobile competition and economic regulation issues. He worked for the UK telecoms competition regulator (Oftel) for 5 years looking at mobile and spectrum competition issues such as spectrum auctions and infrastructure sharing. He has also prepared competition cases for clients.

Prior to joining the GSMA in 2006, He worked as an independent consultant advising on radio spectrum engineering issues, as well as in spectrum valuations. Roberto has also assisted governments developing spectrum liberalisation policies and in helping to promote competition in mobile markets by encouraging new entrants.

Roberto left GSMA in 2016 and now works as a consultant for several clients (including mobile operators and regulators) and has worked extensively in the MENA region.

# Rural Connectivity: Some challenges and opportunities

**Shiv K. Bakhshi, Ph.D. and Sendil Devar, Ph.D.**[8]

Network connectivity – to be precise, broadband network connectivity – has gained tremendous salience during the present global pandemic. It has fast emerged as a critical – and sometimes, the only – means of providing essential services, like education and healthcare, and of keeping commerce going.

The pandemic has thrown existing social fissures into greater relief. In these troubling times, the digital divide risks being widened in the absence of broadband network connectivity for those on the margins of society, both in economic and geographic sense. To mitigate this risk, and to address the inequity this lack of connectivity implies for many at the bottom of the economic pyramid, governments across the world, particularly in developing countries with significant rural populations, are actively exploring technology and policy options that can speedily, and affordably, provide rural network connectivity.

In this paper, we posit that mobile broadband technologies, anchored in global 3GPP[9] cellular standards, may be best suited to meet the policy goals of rural connectivity. We argue that mobile broadband technologies can be deployed fairly speedily for affordable rural connectivity by a) upgrading the existing mobile network, b) methodically extending or densifying the network, and c) deploying fixed wireless access using 3GPP technologies. We conclude with a discussion of some policy initiatives that national administrations may wish to consider.

We see mobile cellular as the technology of choice for providing rural connectivity because, globally, mobile networks already constitute the principal means by which most people access voice and internet services. Third and fourth generation mobile networks (3G and 4G in popular parlance), together cover roughly 90 percent of the world population today. If second generation (2G) GSM networks are thrown into the mix, nearly 95% of the world population is today covered by mobile networks, according to a recent (June 2020) Ericsson Mobility

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[8] Dr Bakhshi is a VP of Industry Relations in Ericsson's Group Function Technology and is based in the US. Dr Devar is a General Manager Standards & Spectrum in Ericsson's Group Function Government and Industry Relations and is based in India. Both are members of Ericsson's global WRC spectrum team. Views expressed here are their own.

[9] The 3rd Generation Partnership Project (3GPP) unites seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC) and provides their members with a stable environment to produce the reports and specifications that define 3GPP technologies. The project covers cellular telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system description for mobile telecommunications. The 3GPP specifications also provide hooks for non-radio access to the core network, and for interworking with non-3GPP networks.

report.  By 2025, more than 90% of the world population is likely to be covered by 4G/LTE networks that are continuously evolving to deliver increased network capacity and faster data speeds. We believe leveraging these ubiquitous mobile networks, and the attendant benefits such global scale offers, should serve rural connectivity well.

However, we recognize that despite the continued expansion of mobile network coverage, roughly 50% of the world population – about 3.4 billion people – is still not connected to the internet, according to the GSMA's latest State of Mobile Internet Connectivity report[10]. Clearly, network coverage notwithstanding, a usage gap persists.

Unless the inter-related socio-technical, socio-economic and socio-cultural root causes of such usage gap – the barriers to internet adoption – are properly understood, and thoughtfully addressed, the benefits of rural connectivity may never be fully realized, and the digital divide may well persist despite the best network coverage.

As a result, we believe, the barriers to internet adoption that lead to a usage gap should be an integral part of the network connectivity discussion  if we wish to bridge the digital divide -- a critical policy objective that is, in important ways, the foundation for realizing many of the stated UN Sustainable Development Goals.

On a separate note,  we have noticed that, in current policy discourse, discussions pertaining to rural connectivity often devolve – and sometimes very quickly -- into a critique of the licensed spectrum management regime, as if  a license-exempt spectrum regime might be the panacea for all the ills that afflict the rural poor. (It isn't, but more about that later.)

Given the above, we think it might be opportune to address these two key strands of the current policy discourse on rural connectivity -- the barriers to internet adoption and the spectrum management regime – at the very outset before we discuss our solution for rural connectivity.

*Barriers to internet adoption*

Network coverage is a *necessary* but not a *sufficient* condition for providing internet connectivity, if the policy goal behind rural connectivity is to bring the unconnected rural populations into the internet fold.

[10] https://data.gsmaintelligence.com/research/research/research-2020/the-state-of-mobile-internet-connectivity-report-2020

The consulting firm McKinsey, in a 2014 report, identified several barriers to internet adoption,[11] beyond network coverage. These range from illiteracy and gender-specific cultural biases to perceived lack of relevance of digital services and the absence of digital services in local vernacular. Poor affordability and lack of infrastructure supporting connectivity (like electricity grids and transmission) are additional reasons.

A 2019 report by GSMA[12] also detailed such barriers to internet adoption but framed the issue in terms of usage gaps and coverage gaps to illustrate the point. According to the GSMA report, the usage gap (those living in areas covered by mobile broadband networks but who do not use mobile internet) often far exceeds the coverage gap (those living outside of areas covered by mobile broadband networks). In other words, even when people live in areas where they could access the internet, many remain unconnected to the internet.

In GSMA's finding, while the coverage gap, globally, decreased from 24% to 10% between 2014 and 2018, the usage gap remained roughly the same, at about 43% over those years. In other words, in 2018, the usage gap globally was more than four times the coverage gap.[13] The usage gaps are more pronounced in developing economies, particularly among the rural population.

## Licensed vs license-exempt spectrum

There is a growing chorus of voices – TV White Space proponents, including their principal industry mouthpiece, the Dynamic Spectrum Alliance, among others – that claim that a license-exempt spectrum regime might be better suited for addressing the coverage gap in rural areas. They see the cost of licensing spectrum through spectrum auctions as a key obstacle to the provisioning of affordable broadband rural connectivity. They argue that UHF spectrum in the 470 MHz - 694 MHz range – currently under active consideration for IMT identification in the next World Radiocommunication Conference, WRC 23 – should be assigned a license-exempt status so that rural connectivity may be provided on the cheap, using, what they maintain, are new and innovative alternatives to 3GPP technologies[14] such as WiFi.

We are hard-pressed to find much merit in the license-exempt spectrum argument, among other reasons, because, as economist Joseph Stiglitz has

[11] *Offline and Falling Behind: Barriers to Internet Adoption*, McKinsey & Company, Sept 2014

[12] *The State of Mobile Internet Connectivity 2019*, GSMA.

[13] *The State of Mobile Internet Connectivity 2019*, GSMA, p. 12

[14] The rhetoric seems designed to leave the impression that the 3GPP based technologies are somewhat passé. This ignores the continuous evolution of technology capabilities even with the same generation, manifest in various specification-related releases that the 3GPP publishes.

noted[15], "Unfettered markets often not only do not lead to social justice, but do not even produce efficient outcomes… Individuals and firms, in the pursuit of their self-interest, are not necessarily, or in general, led as if by an invisible hand, to economic efficiency."

There are several other reasons for our skepticism. For one, we believe unlicensed spectrum may likely fail to attract the necessary capital *and know-how* required to gainfully exploit spectrum for public good. Investors typically seek to be assured of their return on investment, and a free-for-all, license-exempt spectrum regime cannot provide that assurance. It is unclear how, in the absence of licensing rights, renewal expectancies, and guarantees against service pre-emption, an investor might be willing to commit investment dollars for any infrastructure project.

Second, we fear a license-exempt spectrum regime[16] may well result in the Tragedy of the Commons, the economic concept that suggests that individuals, acting independently and rationally according to their respective self-interest, act contrary to the group's long-term best interests by depleting the common or shared resource. The Tragedy of the Commons can, in turn, lead to market failures – a situation where market forces lead to an allocatively inefficient or inequitable outcome – in many ways.

Market failure could result from negative externalities, such as radio frequency interference in the free-for-all, un-regulated usage environment. Market failures could also result if opportunistic market players, absent long-term commitment, choose to quit the market when they fail to meet their internal rate of return on investment within a specified time.

Policymakers should worry about potential market failure and its consequences, including the ensuing chaos and the potential advent of "spectrum squatters." The time and expense needed to clear the spectrum for an alternate socially beneficial use would be a setback for domestic policy agendas. In fact, an Ofcom, UK regulator raised this very point at a recent DSA Global conference.
ITU Radiocommunication Bureau Director Mario Maniewicz, speaking at the same conference, cautioned against "short cuts" that embrace *ad hoc* approaches of one country/technology because of the risk that they may never find global, or even regional, adoption and, lacking scale, may invite early substitution – as was the case with CDMA and WiMAX. The director recommended globally or

[15] Nobel Laureate Joseph Stiglitz, newspaper interview, 2007

[16] License-exempt, or unlicensed, spectrum regime does not always mean an un-regulated spectrum regime. Regulators often still have to work to ensure the neutral and fair usage of the license-exempt spectrum.

regionally harmonized spectrum, citing the benefits of interference free operations[17] and the economies of scale.

Then are the basic public policy questions: *How should society deal with a critical resource like prime spectrum? Should prime spectrum be managed through a deliberative policymaking process, or should it be left to the whims and vagaries of the marketplace?*

This is not to suggest that we are against license-exempt spectrum *per se*. We are not: Society needs a mix of licensed and license-exempt spectrum, like in 2.4 GHz and 5 GHz. We are merely skeptical about the opportunity cost of making prime sub-1 GHz spectrum license-exempt. We believe that sub-1 GHz spectrum – given its excellent propagation characteristics – should be licensed, dedicated and globally harmonized so that it can be meaningfully utilized to serve the policy goals of bridging the digital divide.

Last but not the least, one of the great merits of licensing spectrum, in our view, is that it allows the State to guide the Market in socially desirable directions by attaching policy conditions and obligations – like geographical and population coverage, for instance.

**Rural connectivity and the business case challenge**

Rural connectivity poses two inter-related challenges for network operators. On the one hand, the cost of deploying and maintaining cell sites in rural and remote areas can be significantly high; on the other, the average revenue per user (ARPU) can be significantly low – especially when compared to urban and suburban areas. In other words, the business case is rather weak.

To address low ARPU rural customer segments, network coverage expansion requires cost-efficient solutions. We believe cost-efficiency in providing rural connectivity is best achieved by leveraging existing mobile network infrastructure and assets when and where possible. The economies of scale inherent in globally deployed standards[18] means lower cost of coverage for low-population-density areas, and lower cost of mobile devices,[19] not to mention the social benefits of roaming across the rural/urban divide.

[17] Licensed operation in a globally identified spectrum gives assurance of interference free operation, as this is well studied. This is essential not only for the efficient deployment of the global IMT technologies but also other services operating in the same or adjacent bands.

[18] An additional benefit of 3GPP standards is that these standards support a wide range of frequency bands to meet coverage and capacity requirements of IMT

[19] An overwhelming majority of the world population (between 62% and 77%, depending on the region) currently uses mobile devices to access the internet. Providing rural connectivity through any non-cellular technology would likely introduce an important "disconnect" for rural folks by hampering their seamless access to services while roaming between rural and urban areas. Mobile devices have emerged as the critical tool for accessing digital payments, for engaging in e-commerce. Mobile phone numbers often serve as proof of identity in an unfolding digital world. See https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/asia

The 3GPP technologies are developed to evolve over generations and provide a predictable migration path for network operators to scale up and address growing consumer requirements over time. In short, they are scalable and replicable. By contrast, there is little clarity on the future migration path of most new 3GPP alternatives and little clarity on how they might scale up once users who have been on-boarded to the network start demanding more capacity.

Much is made of the impact of spectrum licensing cost on affordable rural connectivity. The merit of our proposal is that, for network operators seeking to provide rural connectivity, there *is no additional spectrum cost* considering they would have already paid for the spectrum when they acquired a nationwide license. Nor is there any spectrum scarcity in rural areas; in fact, spectrum lies under-utilized in areas where the mobile network is sparsely deployed, and lies fallow in areas where the network may be absent.

**Rural connectivity scenarios**

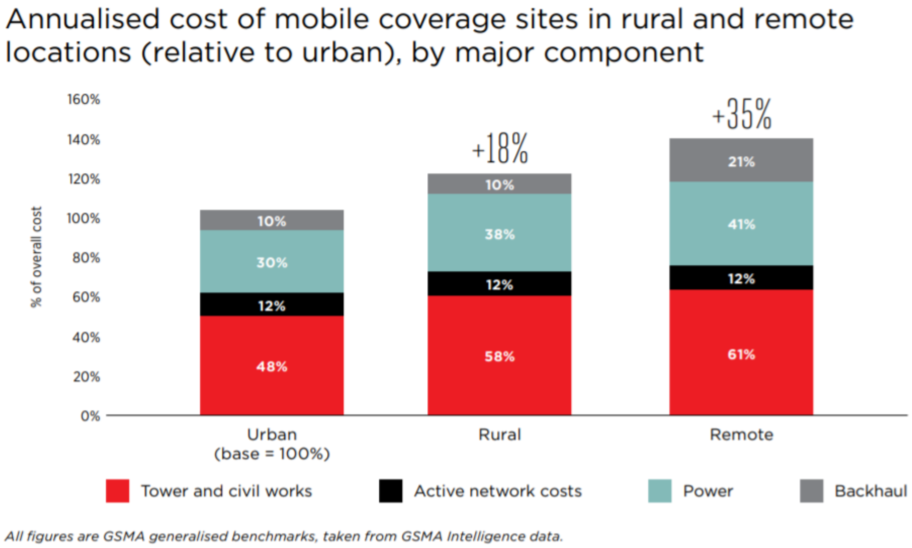
Rural populations may lack broadband network connectivity, broadly speaking, for one of three reasons: They may be geographically located in an area where there may only be 2G coverage (for voice and text), they may be located in remote rural areas where there may be no coverage at all, or they may be living in small clusters dispersed in areas without network coverage.

Mobile broadband connectivity can be provided in each of the above three scenarios through selective investment in mature mobile broadband technologies. Service providers can do so by:

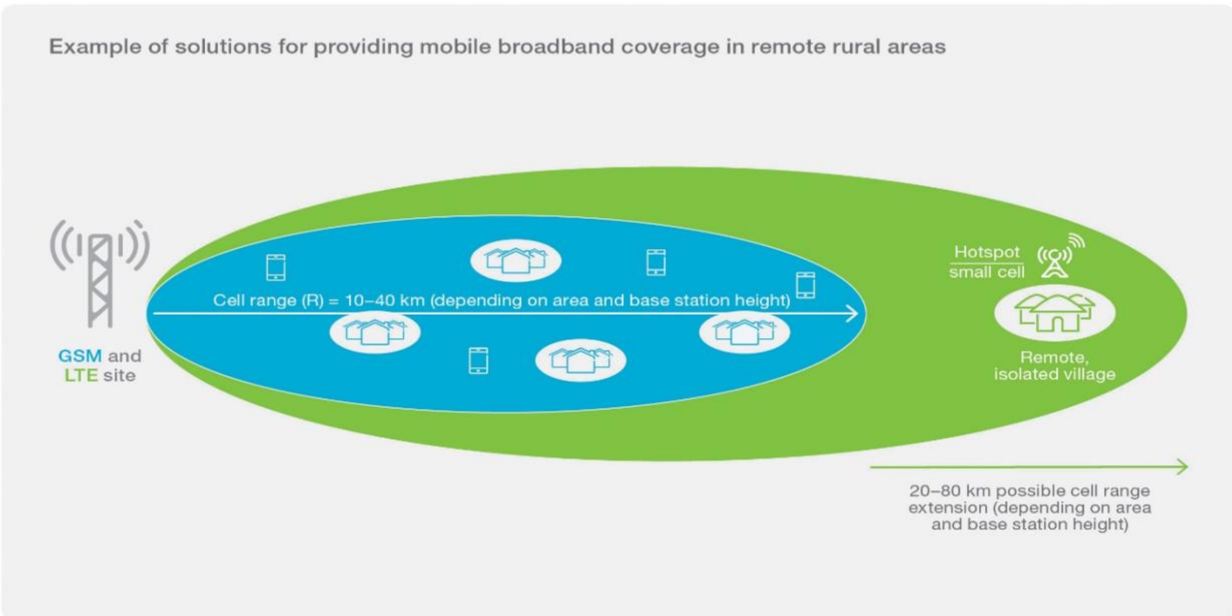
a) Upgrading existing 2G/3G sites to 4G or, where appropriate, 5G NR (New Radio),
b) Extending/densifying network coverage in remote rural areas through low cost 4G solutions, and/or
**c)** Deploying fixed wireless access networks using 5G for those in remote village or isolated clusters.

**Upgrading existing 2G network sites to 4G or 5G NR**

In rural areas that lack broadband connectivity but are within the 2G coverage, the 2G sites can be upgraded to 4G or 5G New Radio (NR) to provide meaningful mobile broadband network coverage. Such an approach requires a low incremental investment as most of the costly items – including towers, power, security and backhaul – may already be available at the existing site.




The argument is anchored in a GSMA benchmarking study (see figure above) that provides important insights into network deployment costs. Active network costs – that is, cost of active elements in the mobile network infrastructure, such as radio related gear – remain largely constant at about 12% between urban, rural and remote network deployments. The most expensive element of network deployment is the establishment of the tower and related civil works, followed by power and backhaul – and cost of each of these factors changes considerably between urban, rural and remote settings, with the remote being most expensive.




Source: Ericsson

Upgrading existing 2G sites to 3G or 4G operating at low bands is possible on the existing network grid, and there is potential to utilize larger antennas and beamforming to increase 4G coverage and capacity even further. As the above figure (courtesy, Ericsson) illustrates, compared to 2G cell coverage, an upgrade to 4G radios on the same frequency band can provide a gain in coverage of up to 7 dB owing to a better link budget – that is, it would double the cell range. Using 4G with beamforming has the potential to double this extended cell range again, i.e. achieving a fourfold extension compared to the base case with 2G. Today, there are hundreds of thousands of legacy 2G sites suitable for a cost-efficient 4G technology upgrade.

Upgrading 2G sites with 5G technology is also be feasible. 5G NR can be configured to perform better than, or at least on a par with, 4G even in rural scenarios. For example, combining 5G NR at 3.5 GHz and LTE at 800 MHz on a 2G grid can provide vastly superior capacity compared to a 4G standalone network. When used together in an effective way, the high band offloads the traffic from lower band, resulting in significantly improved coverage as well as capacity[20].

On an existing 2G grid it is possible to reach downlink data rates exceeding 100 Mbps at cell edge with 5G NR using conventional terminals and normal base station equipment. By enhancing the network and terminal hardware, more than 350 Mbps in the downlink and more than 30 Mbps in the uplink can be achieved.

**Extending or densifying the network in remote rural areas through low cost solutions**

What if it is a remote rural area with no network coverage at all? This can be a bit more challenging, considering many remote rural locations are also, typically, without any reliant power infrastructure. Network operators or service providers could provide mobile broadband coverage in such rural areas by extending their networks, or by densifying their network with the addition of low-cost cell sites. One solution could be to deploy a small cell, with backhaul to a macro site using microwave technology. In the case where the villages are isolated and further away from an aggregation point that a single microwave link can reach, satellite backhaul could be used.

To contain costs, self-supported or guyed-pole towers could be used as part of the solution. For backhaul, microwave might be utilized for a line of sight solution or an LTE Integrated Access and Backhaul (LTE IAB) for a non-line of sight solution. Utilization of a microwave would allow for an easy upgrade of the site to a macro site, if and when needed.

[20] 5G New Radio for Rural Broadband: How to Achieve Long-Range Coverage on the 3.5 GHz Band https://ieeexplore.ieee.org/document/8891556/ and Full Coverage with 3GPP technologies On the feasibility of providing full rural cellular coverage https://ieeexplore.ieee.org/document/9129041

Additionally, a solar power solution could be deployed to save energy and reduce operational expenditure, or op-ex. Also, mix-mode radios may be deployed to reduce power consumption and to upgrade the site easily when required.

By deploying such cost-effective mobile coverage solutions, it is possible to connect low-income subscriber groups with low-cost, energy-efficient solutions in presently unserved areas. The technology can be scaled as the demand for performance grows, all the time providing economies of scale and making it more affordable.

**Deploying Fixed Wireless Access (FWA)**

By Fixed Wireless Access, we mean a broadband network connection that provides last-mile connectivity enabled by customer premises equipment (CPE). of the CPEs may come in various form factors for indoor and outdoor deployment (i.e., may be wall mounted and on rooftops).

Fixed wireless access delivered using a 4G or 5G technology is an increasingly cost-efficient broadband alternative in areas with limited availability of fixed-line services such as DSL, cable or fiber. Increasing capacity – allowed by greater spectrum allocations and technology advancements for 4G and 5G networks – drives higher network efficiency in terms of the cost per delivered megabyte.

To provide mobile broadband connectivity to a village or to distributed populations outside the network coverage area, an outdoor high-gain antenna can be used to provide broadband access to an important hotspot in the area, such as a school or a healthcare clinic using a roof-top antenna on the premises. This solution requires low investment and the 4G site can serve as a “hotspot” that is located 20 km to 50 km outside the 2G coverage range. The site with the rooftop antenna – the school or clinic in our example – would get reliable broadband speeds from the upgraded 4G base station site using 2x10 MHz spectrum. `

By leveraging the existing network assets and infrastructure not only can the school or the clinic be connected, but improved connectivity in the area can be shared with the surrounding homes. For example, network capacity that is used during the day at the school can be re-purposed during the evenings for residential use.

The merit of the idea of using fixed wireless access (FWA) for rural connectivity is that such an approach would be in sync with the operators' revenue growth goals; mobile operators are already deploying FWA as wireless fiber to expand into new markets – to serve enterprises and offer 'smart home' services. And the growing ecosystem may serve the rural underserved well.

## RECOMMENDATIONS

As we have articulated in the discussion above, neither mobile cellular technologies nor spectrum availability pose any particular barrier to rural broadband connectivity, although some spectrum licensing conditions could be tweaked to facilitate and accelerate rural connectivity. The business case may often need help.

Administrations seeking improved coverage for their rural populations could provide direct support for network expansion through their Universal Service Funds,[21] with the USF subsidies helping lessen the CapEx and OpEx burden for network operators – at least during the initial phase of technology adoption.

Administrations could also help network expansion through regulatory support in other ways – facilitating site permits, allowing the use of state-owned assets, like utility poles and reliable power sources, and permitting location of radio and antenna towers as well as microwave links near government buildings on secure campuses, for example.

Policymakers could also permit network operators to enter into co-operation agreements, allowing them to share passive infrastructure elements, especially in sparsely populated and remote areas.

To facilitate easy network upgrades, policymakers could replace technology-specific spectrum licensing framework with a technology-neutral one that permits network upgrade to subsequent 3GPP standards. This would allow network operators the flexibility to retire "antiquated" technologies and re-farm and reuse their existing spectrum for higher-order 4G and 5G networks. The network operators would gain spectral efficiency and the user groups would benefit from superior mobile broadband coverage, higher data speeds and lower prices. Of course, the network operators would make all reasonable efforts – perhaps, under regulatory oversight -- to help migrate long tail customers through handset upgrade initiatives and comparably priced service plans.

[21] In some countries, the Universal Service Fund mandates may need to be rewritten and upgraded. One USF administrator in a developing country recently told one of the authors that while she had substantial amount of monies in her universal service fund kitty, she was unable to spend it mobile broadband because the language of the USF mandate only allowed the funds to be spent on voice services.

Policymakers could also consider permitting voluntary spectrum trading between market actors, so that a market player focused on serving a rural segment could acquire the necessary spectrum that may be lying fallow with the original licensee whose strategic plans may not include rural network deployment.

Policymakers could also permit core network elements to be shared between market players seeking to extend rural connectivity. For instance, an NGO or a community service provider could collaborate with a traditional mobile operator in a revenue share business model in which the NGO builds a radio access network for a rural community, but leverages the network operator's core network to provide services.

Finally, given socio-economic and socio-cultural barriers to internet adoption, policymakers seeking to facilitate rural connectivity to bridge the digital divide must find imaginative ways to stimulate internet usage among the rural poor. Administrations may, in addition to facilitating network connectivity, concomitantly seek to design and provide critical services in local vernacular – say, relating to health, education, agriculture, animal husbandry, weather, bus and train schedules, etc. – that invite rural folks to learn digital skills and induce them to upgrade their mobile devices as they develop an appreciation for the internet.[22] As rural usage improves and proliferates, it may create a greater impetus for network operators to expand and upgrade their networks in rural and remote areas.

In short, administrations would do well to get inter-departmental cooperation in formulating a holistic approach that includes a focus on network connectivity but does not ignore the larger complex of measures that are needed to realize the benefits of that connectivity – that is, bridging the digital divide.

[22] State and non-state actors, including non-governmental organizations and corporations (through their social responsibility programs), can collaborate and play an important role in stimulating the adoption of the internet and an embrace of digital services among the rural poor. This could be done through the introduction of digital literacy in primary education, digital provisioning of government services, including information relating to education, health, weather, agriculture, animal husbandry, etc., and availability of digital content in local vernacular.

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Shiv K. Bakhshi, Ph.D., is Vice President, Industry Relations in Group Function Technology at Ericsson. He is charged with the responsibility of technology and spectrum policy for Africa and the Middle East, and works closely with industry and policy leaders in those regions.

Dr. Bakhshi is a strong believer in the role ICT and mobile broadband can play in economic development and in helping unleash the digital vitalities of the peoples in emerging economies. The use of ICT and mobile broadband for economic development, and for bridging the Digital Divide, remain the defining interests of his work.

Earlier, as an industry analyst, Dr. Bakhshi headed the worldwide mobile network and device programs for a leading research and advisory firm for several years. A frequent speaker at industry, academic and policy conferences, he has presented on a broad range of technology and policy topics pertaining to the structural transformation of the mobile industry and its changing impact on society.

At Ericsson, as member of the company's CTO organization, he is focused on future spectrum issues that are subject of the World Radio Conference and on new and emerging technologies, including those pertaining to 5G and the Internet of Things.

Dr. Bakhshi started his career as a journalist in India. Later, as an academic, he taught international telecom policy and strategy, and directed graduate and doctoral research, at the University of Kentucky.

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He actively contributed in the IMT-2020 Evaluation process and in the development of rural test environment requirements in IMT2020. At Ericsson, he is focused on future spectrum issues that are subject of the World Radio Conference and support for technical studies.

Prior to Ericsson, he worked with research organizations including Samsung R&D, Centre of Excellence of Wireless Technology and Telecom Centre of Excellence. He had contributed to standardization development in both 3GPP2 and 3GPP for HRPD, HSDPA, LTE. He also has a career stint as a mentor in a

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