Connected Society

Unlocking Rural Coverage: Enablers for commercially sustainable mobile network expansion

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Supporting the mobile industry to increase the adoption of the internet for the underserved by tackling key barriers: network coverage, affordability, digital skills and locally relevant content.

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1 Executive Summary

The internet is the most important enabler of social development and economic growth of our time. Already **3.2 billion people are online** thanks to the mobile industry and as a result are directly benefiting from, and contributing to, the digital economy. But that still leaves more than 4 billion people offline, unable to participate in the digital economy and unaware of the opportunities it can offer them.

The pace of growth in mobile internet users is still high at over 300m net additions per annum but it is starting to slow as more developed markets reach saturation point. The biggest opportunities for penetration growth are in developing world markets where adoption faces many supply-side and demand-side challenges. Enabling wider adoption of the mobile internet in these markets will require major collaborative initiatives across network coverage, affordability, digital skills and locally relevant content.

Around 1.6bn out of the 4.2bn people still offline live outside the footprint of a 3G mobile network. So efforts to expand network coverage are an important part of the industry agenda to help deliver wider adoption of internet access via mobile. The mobile coverage gap is most acute in Africa where 3G networks cover only 50% of the population, compared to a global average for population coverage of 78%. On this basis Africa is home to an uncovered population of 0.6bn people. Coverage is also still an issue in certain parts of Asia and, to a lesser extent, Central and Latin America.

Closing the mobile coverage gap is not a technical challenge. It is primarily an economic challenge. Uncovered populations typically live in rural locations with low population densities, low per capita income levels and weak or non-existent enabling infrastructure such as electricity and high-capacity fixed communications networks. These characteristics have a profound adverse impact on all aspects the business case for mobile network expansion. The revenue opportunity for new base stations in rural or remote locations can be a much as ten times lower than in an equivalent site in an urban area. The operating costs can be as much as three times higher and the capital investment costs up to two times higher.

Both the private sector and public sector have important roles to play in improving the business case for mobile network coverage expansion.

Mobile operators are already demonstrating a willingness to balance competition in service provision with co-operation in infrastructure investment by entering into infrastructure sharing agreements. Mobile operators are also exploring new business models with third parties to share the cost and risk of investment in rural and remote locations.

The public sector, and national governments in particular, have an instrumental role to play by aligning key policies around best practice approaches to spectrum allocation and pricing, infrastructure sharing, sector specific taxation, access to public infrastructure, license conditions and market structure. Support for multi-sided business models can also play an important role in creating the right demand characteristics and public funding support for critical enabling infrastructure such as power and national fibre backbones should be prioritized.

Decisions about each of these identified policy areas can have a significant positive or negative impact on the business case for mobile network coverage expansion, especially for the 3G and 4G services needed to deliver effective internet access. By making the right decisions governments can create an enabling environment that leads to more pro-active, commercially sustainable investment by operators. This investment will support economic growth and social development by bringing the power of the internet to new communities.

Key Policy Enablers to Help Unlock Rural Coverage

- **Cost effective access to low frequency spectrum.** Helps improve both the revenue and cost side of the equation for network coverage expansion. The use of low frequency spectrum can reduce (by as much as 50%) the number of base stations required for a rural coverage expansion project. This significantly increases the revenue opportunity per site whilst reducing upfront capital investment and on-going operating costs.
- **Regulatory support for all forms of infrastructure sharing.** Enables operators to share cost of network expansion without compromising competition in service provision. The benefits can be significant, reducing capital investment and on-going operating costs by between 50% and 80% depending on market structure and the sharing model to be implemented.
- **Elimination of sector specific taxation.** In many national markets, governments have chosen to impose sector specific taxes on the mobile industry and consumers of mobile services. These taxes can impact a range of inputs including the cost of imported network equipment, the cost of energy, backhaul capacity and site fees. Sector specific taxes on airtime and devices can also reduce the affordability of mobile access for end-users with low-income groups particularly impacted. It is these customer groups who typically make up the addressable market opportunity for rural coverage expansion.
- **Non-discriminatory access to public infrastructure.** Public infrastructure such as government buildings, roads, railways and ducts for utility services has an important role to play in the cost and speed of network expansion projects. By promoting non-discriminatory access to this infrastructure governments can ensure that all participants in the market have a level playing field when considering the business case for network expansion.
- **Streamlined planning approval processes.** Building mobile networks involves complex and time consuming planning approvals. Putting in place streamlined processes whilst still respecting environmental and community impact considerations can help to facilitate the smooth and cost efficient process of designing and deploying mobile networks to new areas.
- **Flexibility on licence conditions for quality of service in rural and remote locations.** Many spectrum licences contain specific requirements for metrics such as network availability and dropped call rates, with financial penalties for non-compliance. Such conditions can be hard to honour in rural and remote locations where power and backhaul capacity can be unreliable. As such these conditions penalise operators' initiatives to expand coverage.
- **Realistic position on competition policy.** Competition is the foundation of investment and innovation and a principle firmly supported by the mobile industry. It is essential that competition policy for the mobile industry reflects the economic realities of investments in infrastructure-based businesses and is consistent with wider policy goals such as universal access to the internet.

Figure 1

Benchmarked economics differences per site per area

VS URBAN	URBAN	RURAL	REMOTE
Users per site	100%	-60%	-80%
Revenues per site	100%	-80%	-95%
OPEX per site	100%	+25%	+100%
CAPEX per site	100%	+5%	+30%

2 Putting the mobile coverage gap in context

As the integration of digital solutions across all aspects of human interactions reveal their remarkable potential, the mobile industry continues to build and deliver the mobile broadband networks of tomorrow ensuring sustainable growth for both developed and developing economies.

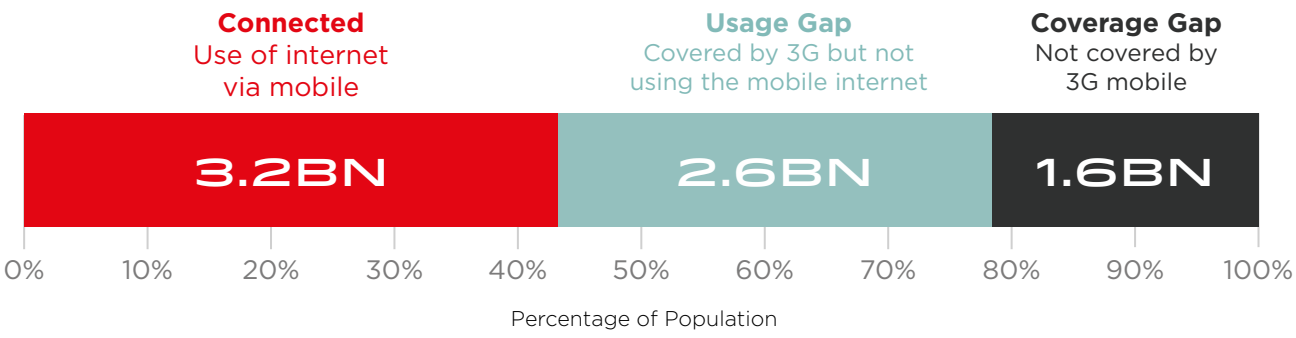
The impact of mobile adoption has wide implications. Recent studies have demonstrated that a 10 percentage point increase in mobile penetration increases total factor productivity over the long run by 4.2 percentage points. A 10% substitution from 2G to 3G penetration increases GDP per capita growth by 0.15 points on average[1]. In turn, the availability of internet services can represent up to 25% of overall GDP growth.

The benefits that can be derived from the digital economy are numerous but connectivity comes first.

This paradigm is as stark as living with or without access to electricity. At the end of 2015 around 4.2 billion people, 56% of the world's population, were still not connected to the internet. Around 2.6bn of this unconnected population face demand-side issues – affordability, digital skills gaps or a lack of locally relevant content. That still leaves around 1.6bn people, nearly 40% of the unconnected population, who live outside the footprint of a 3G mobile network.

Figure 2

Unique mobile internet subscribers, global picture, 2015



Source: GSMA Intelligence Consumer Survey 2015

1. "What is the impact of mobile telephony on economic growth?", A report for the GSM Association, 11/2012

Looking at the coverage gap more closely reveals significant regional variations in 3G mobile network coverage. Compared to a global average of 78% population coverage for 3G, Europe is a notable outperformer with 97% coverage. At the other end of the spectrum the African continent is a notable underperformer with only 50% coverage. We estimate that 0.6bn out of the total 1.6bn people living outside a 3G network footprint are in Africa. Coverage remains an issue in parts of Asia and, to a lesser extent, also Central and Latin America.

Figure 3

Population coverage of mobile networks by technology, 2015

	2G	3G	4G
World	95%	78%	46%
Africa		50%	14%
Americas		94%	68%
Asia		79%	44%
Europe		97%	76%
Oceania		86%	74%

Source: GSMA Intelligence

For mobile operators, the market-led business model has proven effective in expanding coverage to current levels. However, the vast majority of the uncovered population lives in rural locations with low population densities, low income levels and weak or non-existent enabling infrastructure such as electricity and high-capacity fixed communications networks. These characteristics have a profound adverse impact on all aspects of the business case for mobile network expansion – higher capital investment costs per site, higher operating costs and a significantly lower revenue opportunity.

- **Population density.** With 60% of the world population still living in rural areas and about 20% in remote areas, extending mobile broadband coverage to address these population is extremely difficult. Firstly because the populations tend to be spread out from village to village across wide areas, making the business model of building a site in such areas highly unprofitable. Rural areas represent over 90% of the land surface on earth with population density often below 100 people per square kilometre. We estimate that in order to be profitable, a site needs around 3000 active users on a daily basis. Hence only rural areas where concentration is sufficient across a 25 km2 area, the coverage range of a single site using 900MHz spectrum, can be covered on a commercially sustainable basis.
- **Difficult terrain.** Mountains, dense forest and islands, among other geographic features, complicate significantly the network roll out process when it comes to extending coverage to rural and remote populations. Often such projects require building up extensive microwave or fibre backhaul networks crossing seas and inhabited lands. Where the roll out of terrestrial backhaul is not feasible, such as in dense forest, mobile operators often have to rely on expensive satellite bandwidth to connect remote areas to their core network. In addition to the terrain, climate can also have a detrimental impact as satellite signals are often vulnerable to high humidity levels and violent events such as storms that can occur on a regular basis during the rainy season in tropical areas.
- **Lack of basic infrastructure.** Network deployment to rural and remote locations is adversely impacted by a lack of basic infrastructure such as reliable power provision, road access or public buildings. Mobile operators must, as a result, build each site in a self-sufficient manner adding to the up-front deployment costs and ongoing operations and maintenance costs. Africa and, to a lesser extent South-East Asia, are affected by the lack of basic infrastructure.
- **Low per capita income levels.** In addition to being sparsely populated, rural and remote areas across developing world markets are typically inhabited by the poorest segment of the population living significantly below the country's average GDP per capita. In Tanzania, for instance, where average GDP per Capita was estimated at US$3,680 at YE2015, the income per working adult in the countryside was not above US$100 per month - 3 times below national average. As a result, even if rural and remote populations have a strong demand for mobile internet services, their ability to pay is significantly reduced compared with urban populations.

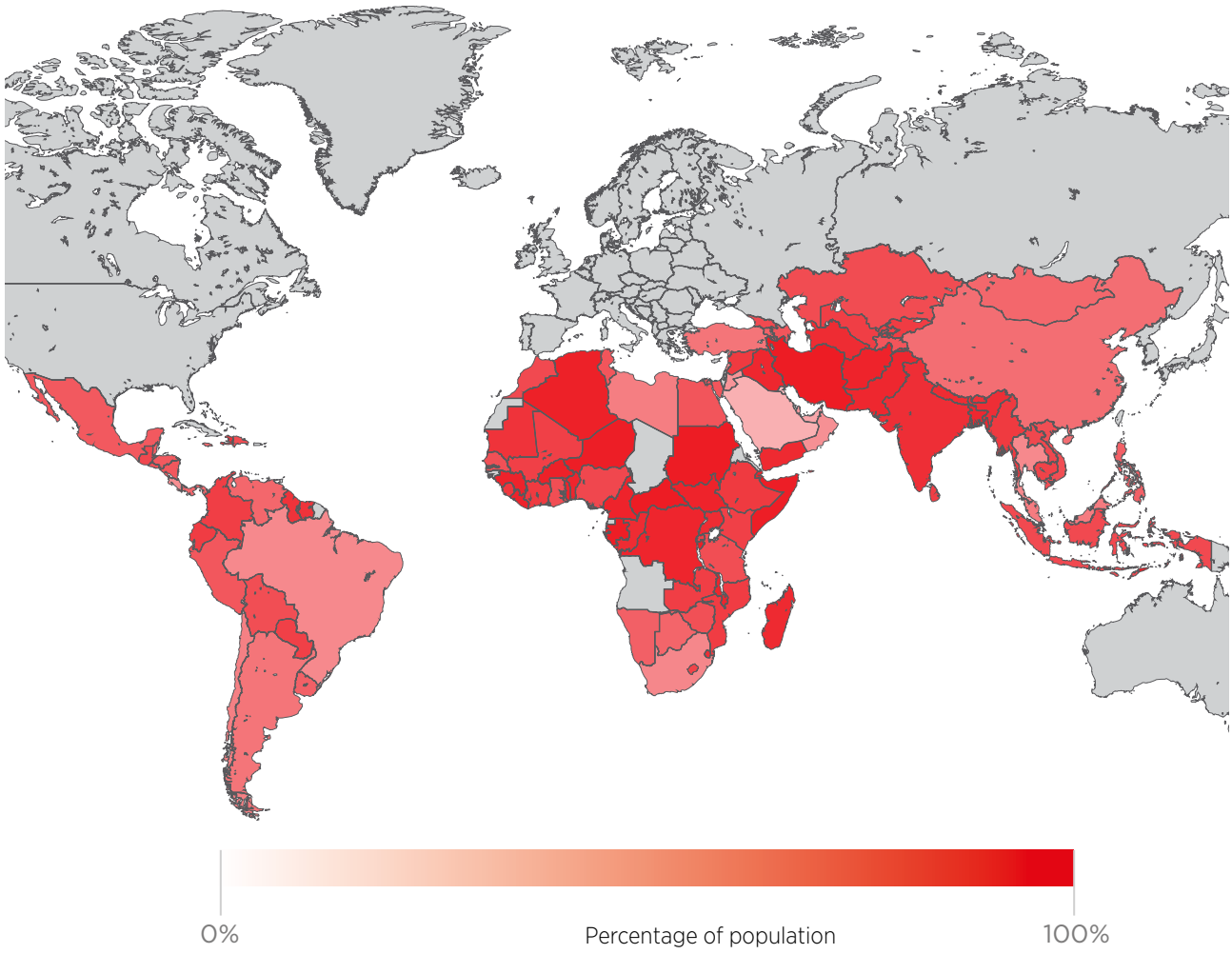
As a result of these factors, mobile operators are increasingly adopting alternative methods to network coverage expansion, notably infrastructure sharing and partnerships with other ecosystem players, to complement traditional network deployments.

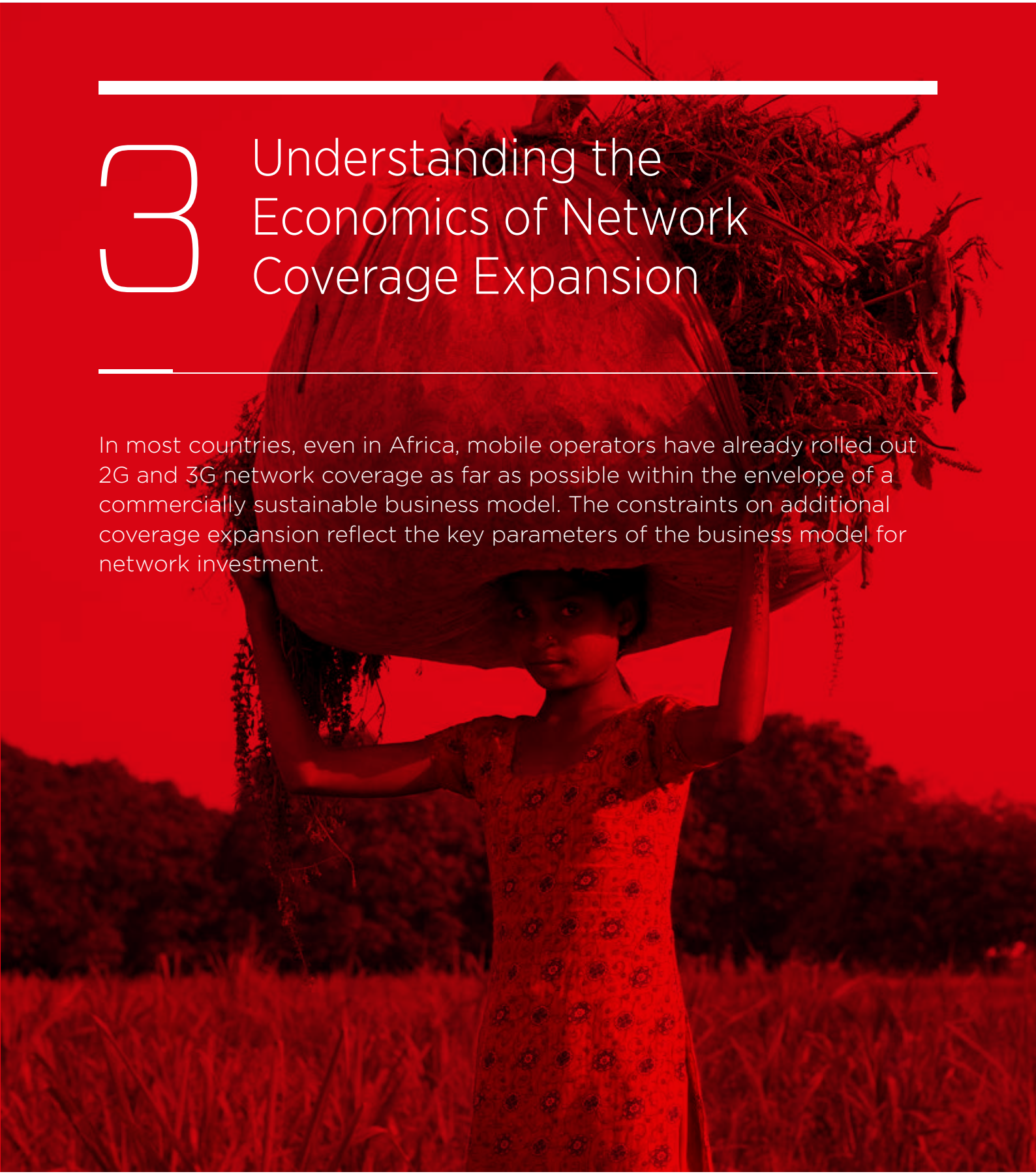
Universal access to the internet is a goal increasingly shared by international institutions, governments and mobile operators alike. To reach such an ambitious target, a multi-dimensional approach and collaboration between governments and the mobile industry is required with the former supporting industry-led initiatives with policies, programs and funding that create the right incentives and an enabling environment for extending connectivity to underserved areas.

In many cases, the efforts of mobile operators to improve coverage are hampered by sub-optimal regulations and policies including strict quality-of-service (QoS) expectations and restrictive planning laws around new infrastructure deployment. Government policies, laws and regulations should be designed to encourage, rather than curb, investment in mobile broadband infrastructure. Underpinned by an enabling policy environment, cross-industry collaboration can help close the coverage gap.

Figure 4

Mobile Broadband Internet Gap as % of population aged 15 and above in Emerging Markets





3 Understanding the Economics of Network Coverage Expansion

In most countries, even in Africa, mobile operators have already rolled out 2G and 3G network coverage as far as possible within the envelope of a commercially sustainable business model. The constraints on additional coverage expansion reflect the key parameters of the business model for network investment.

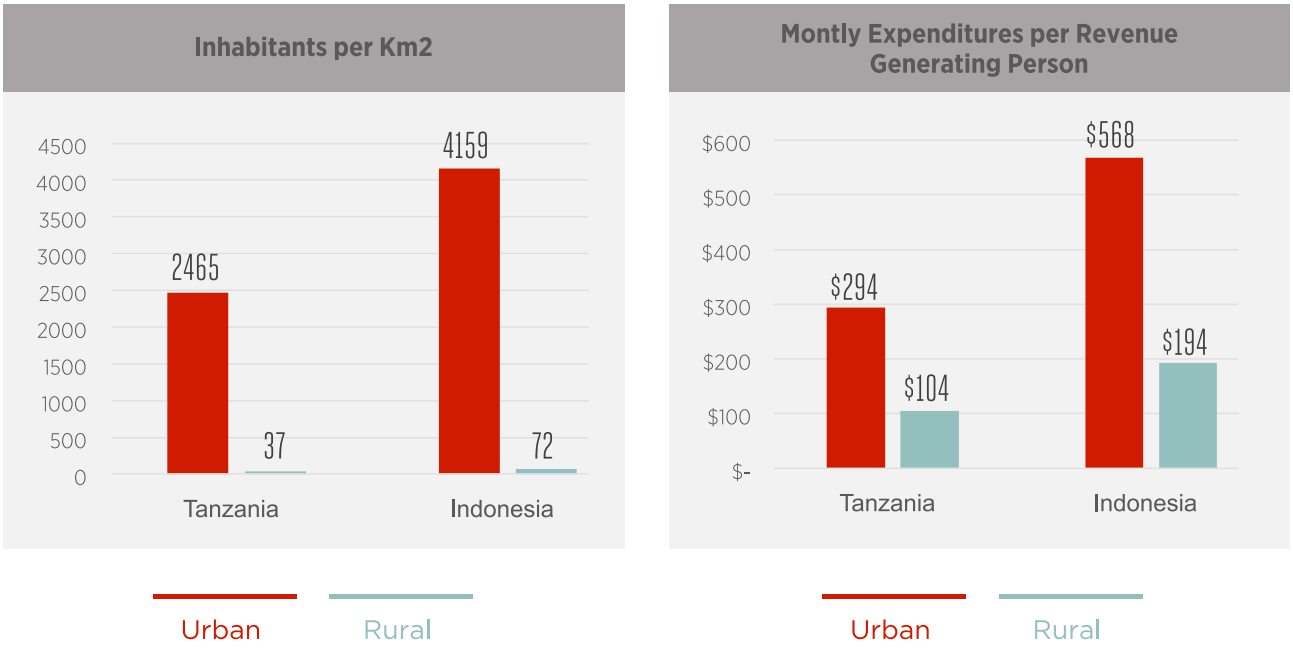
Specific approaches to investments in network coverage expansion vary from mobile operator to mobile operator, reflecting, amongst other things, the market characteristics, business maturity and overall group strategy. But, typically, the decision to invest in coverage expansion will take into account two important factors: 1) how the new sites deployed will contribute to overall business profitability, and 2) whether the investment could be more effectively and profitably used within the existing footprint (e.g. to provide more capacity).

> The business case for investment in new network base stations to deliver additional coverage reflects three key inputs: 1) the incremental revenue opportunity that will be unlocked, 2) the incremental operating costs that will be incurred, and 3) the incremental capital costs required to deploy the site.

Generally speaking the revenue opportunity available from mobile network base stations deployed in rural and remote areas is significantly lower compared to equivalent base stations deployed in urban areas. This reflects the lower population densities (so fewer potential customers) and lower levels of income (so less potential revenue from each customer).

Figure 5

Inhabitants and monthly expenditures per area in Tanzania and Indonesia



Source: GSMA

Conversely the operating and capital costs incurred from a mobile network base station deployed into a rural or remote area can be significantly higher compared to an equivalent base station deployed in an urban area.

Factoring in the need to configure networks to support internet connectivity can add significant challenges to the business model for network coverage expansion relative to 2G (voice and messaging) capable networks. In particular, the higher frequency spectrum typically allocated to 3G (and 4G) based services results in significantly reduced coverage footprints for each base station – potentially halving the revenue opportunity per base station and doubling the number of cell sites required. Internet service provision also requires the installation of high capacity backhaul infrastructure which is much more expensive to procure in rural and remote locations.

Operating costs for rural and remote base stations can also be heavily impacted by licence conditions governing quality of service. These conditions can often stipulate strict requirements for performance metrics such as network availability and dropped call rates. The environment challenges of rural and remote locations (e.g. unreliable sources of power supply and limited backhaul capacity) can make it very difficult to meet these conditions, effectively penalising operators for investing in coverage expansion.

Figure 6

Key drivers of the business case for network coverage expansion

Input	Drivers		Impact of rural and remote locations	
Revenue Opportunity	Population density	↓↓↓	Base stations in rural and remote locations typically have a significantly reduced addressable population with limited spending power	0.1x to 0.5x relative to an urban base station
	Per capita income levels	↓↓↓		
Operating Costs	Site rental	↑	The lack of basic enabling infrastructure such as power and fixed-line infrastructure means operating costs for rural and remote base stations are typically significantly higher	1.5x to 3.0x relative to an urban base station
	Power	↑↑		
	Backhaul capacity	↑↑↑		
	Maintenance	↑↑		
	Sales and marketing	↑↑		
Capital costs	Site preparation	↑	Base stations in rural and remote locations need to be prepared to cope with higher levels of physical security and resilience and more expensive solutions for power (e.g. hybrid/diesel generators) and backhaul (e.g. microwave and satellite)	1.25x to 2.0x relative to an urban base station
	Power supply	↑↑		
	Active network elements	←→		
	Backhaul equipment	↑↑↑		
	Maintenance	↑↑		

Return on Investment per base station is significantly impaired in rural and remote locations due to higher capital costs, weaker revenue opportunity and higher operating costs

Source: GSMA

Upward Pressure on Power Costs

Communities in rural and remote areas of developing countries are often not on the electricity supply grid ("off-grid") or, if they are, they may experience frequent and lengthy power outages. The most common solution for powering cell sites in such areas is a diesel-powered generator set (often in a hybrid combination with cycling rechargeable batteries) but this brings with it further issues such as the diesel oil supply logistics, oil theft prevention, additional frequent maintenance activities, the need to hedge against oil price variability and the environmental impact.

In some countries renewable energy sources are a feasible alternative or addition – particularly solar but possibly wind, "micro-hydropower" or bio-fuel. Typically such power solutions have higher up-front capital costs than diesel-generated power but lower operational costs/risks and less of an environmental impact.

Whatever the power solution, it is worth evaluating whether to outsource it either to an energy service company or to a tower company, the latter also taking on responsibility for tower construction, operation and maintenance.

Given that the actual coverage requirement is typically only the area immediately surrounding a community, a further approach is to use special low-power small-cell RAN equipment. However many MNOs have been reticent to use such equipment because the equipment unit cost is higher than macro cells, although this is offset by the lower passive infrastructure costs, and the vendors are typically smaller companies which present a higher risk than the more established global network equipment suppliers.

Upward Pressure on Backhaul Capacity Costs

Similar to the power problem, rural and remote areas often lack fixed network infrastructure. Backhaul transmission from the site to the core network may involve considerable distances. The most common solution is microwave but this may involve building many hops either due to the distance, the terrain or a combination of the two. As far as possible, the microwave antennas are mounted on the same towers as the 2G/3G/4G antennas but there will be cases where new microwave-only towers will be needed thereby increasing the backhaul costs even further.

Satellite is an alternative backhaul solution to microwave in such areas. Unfortunately many MNOs often refuse to consider it – usually due to an outdated understanding of the costs.

Figure 7

Suitability of Microwave and Satellite Backhaul Solutions

Microwave (MW)	MW or Satellite	Satellite
Low	Population density ➔ sites per aggregation point (hub)	Very low
Flat	Terrain ➔ number of MW hops and distance	Mountainous
<50km*	Distance from sites of PoP	>100 km*
Low	MW spectrum fees	High
Low	KPIs (company or NRA) link redundancy	High

* Distances depend on the other factors shown in the Figure and unit costs
Source: Coleago

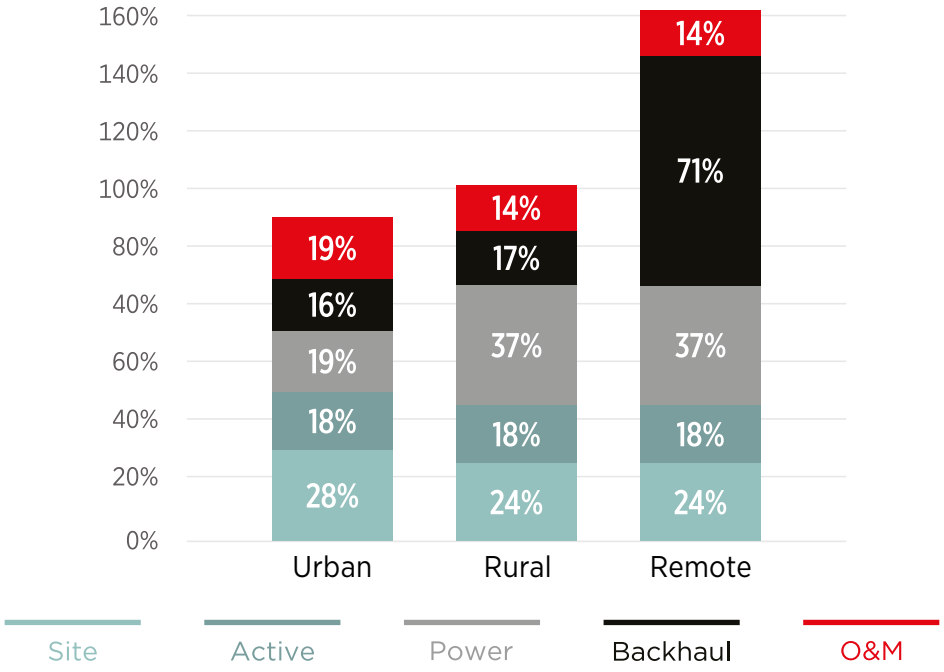
The capital costs consist of the VSAT equipment at each site and the hub/teleport. The latter may be substantial (in the order of $300-500,000) but satellite operators also offer lower-cost virtual and colocation services if they already have a presence in the country. The main operating cost is the satellite bandwidth so selecting the most cost-effective access scheme (fixed or variable) to suit the traffic pattern is important.

Upward Pressure on Maintenance Costs

Site maintenance of the passive and active equipment is typically much higher in rural/remote areas than urban/suburban areas. Distances between sites are greater, road access is often poor or even impassable at certain times of year and more frequent site visits may be required to maintain the diesel-powered generators. Furthermore spares management and logistics also become more difficult and expensive.

Figure 8

Comparison of Rural and Remote to Urban Costs (Annualised CapEx and OpEx)



Source: Coleago

The Relationship between Profitability and Population Coverage

Beyond a certain point of population coverage, adding more base stations to a mobile network will start to have a negative impact on overall business profitability. The point at which this starts to happen will depend on the characteristics of the market.

Generally speaking, in markets where the population is primarily urban, the point of maximum profitability will coincide with high levels of population coverage – the revenue opportunity will be relatively uniform and good availability of enabling infrastructure will keep operating and capital costs in balance. In addition, even when an operator starts to extend coverage into unprofitable areas, the impact on overall profitability of each additional site is likely to be relatively modest.

Conversely, in markets where the population is primarily rural, the point of maximum profitability will coincide with low levels of population coverage and each incremental site added to the footprint will likely have a disproportionately high negative impact on profitability. This is because the contrast of demographics between rural and urban areas is quite pronounced, impacting both the size of the revenue opportunity and adding significantly to the complexity of base station deployment and operation.

4 Industry Solutions to Close the Coverage Gap

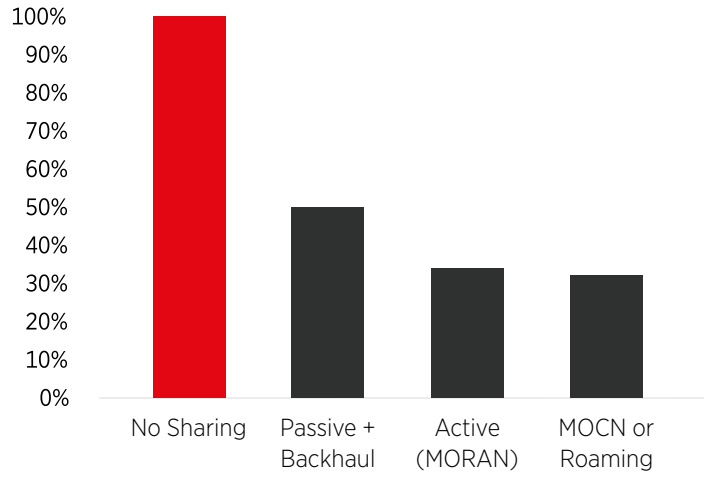
The mobile internet coverage gap exists primarily in markets with high levels of rural and remote populations – especially in Africa and parts of Asia. The economics of network coverage expansion in these markets are especially challenging for mobile operators with maximum profitability levels reached at relatively low levels of population coverage. Because of the significant difference in economics for rural and remote base stations, even small amounts of network expansion beyond the point of maximum profitability can have a significant detrimental impact on overall business performance.

This analysis is based on the traditional approach to network deployment – with each operator building its own discrete infrastructure. Such an approach is not efficient in markets with high levels of rural and remote population and the mobile industry is already actively and successfully finding ways to co-operate on infrastructure investment, expanding network coverage whilst preserving healthy competition in service provision.

Infrastructure sharing models can have a profound, positive impact on the economics of network expansion into rural and remote areas. They allow each operator to reduce their capital and investment costs by as much as 50-70% whilst maintaining the original revenue opportunity.

Figure 9

Impact of different infrastructure sharing models on operating and capital costs over five years for rural/remote network expansion



Source: Coleago

Through infrastructure sharing models, the mobile industry is able to increase the proportion of the population that can be covered on a commercially sustainable basis without the need for public subsidies or development funding. This should be seen by governments and policy makers as the preferred approach to expanding the footprint of mobile connectivity as it preserves competition and commercial sustainability.

There are a number of variations to the infrastructure sharing model that can be considered by mobile operators. The ultimate choice will depend on a range of factors including the prevailing regulatory environment, market characteristics and individual operator strategies.

The key options that are usually considered include:

- **Network roaming** – where operators agree to allow each other's customers to roam onto their respective national networks where they don't have their own coverage
- **Sharing of passive elements** - such as towers, buildings, power supply
- **Sharing of active elements** - such as radio equipment, backhaul capacity or core network functions

Some examples of successful rural infrastructure sharing projects are set out in the following table:

	Partners	Technology Scope	Geographical Scope	NRA Role
Austria	3 and T-Mobile	Roaming	Rural	No
Bangladesh	Banglalink and Grameenphone	Passive	Rural only	No
Finland	TeliaSonera and DNA	MOCN	50% of geo., 15% of pops	No
France	SFR and Bouygues	MORAN	57% of pops	No
Greece	Vodafone and Wind	MORAN	70% of rural, 40% urban	No
Sweden	Telenor and Hutchison	MOCN	70% pops	Yes
Venezuela	Movilnet, Movistar and Digitel	Passive	30 sites in first phase	Yes

Whilst technically it could be possible for operators to share any amount of equipment, implementation can be complex for some forms of sharing. This is particularly true where existing networks are being joined together as opposed to the rolling out of a new, single network. Considerations that must be addressed include the load-bearing capacity of towers, space within sites, tilt and height of the antenna and adverse effects on quality of service (QoS) when antennas are combined and differing standards employed by the equipment vendor. Therefore, site sharing, mast sharing and network roaming are the most common forms of infrastructure sharing due to their relative technical and commercial simplicity.

The strategic rationale for engaging in infrastructure sharing differs between new entrant and incumbent operators, 2G and 3G networks and mature and developing markets. Interviews with MNOs and infrastructure providers supplemented by desk-based research indicates the following:

- MNOs in mature markets: Infrastructure sharing may reduce operating costs and provide additional capacity in congested areas where space for sites and towers is limited. It may also provide an additional source of revenue but may be limited by differing strategic objectives.

- MNOs in developing markets: Infrastructure sharing may expand coverage into previously un-served geographic areas. This is facilitated via national roaming or by reducing subscriber acquisition costs (SACs) by sharing sites and masts or the radio access network (RAN). Infrastructure sharing is also increasingly being used in congested urban centres where new site acquisition is difficult. However, it may be less likely to occur in markets where coverage is used as a service differentiator and, if mandated, could potentially reduce investment incentives for continued network roll-out.

- 3G network operators: Operators are taking the opportunity to reduce capital and operational expenditure by sharing infrastructure from the start of the build-out. This is technically more attractive than joining existing 2G networks since operators, in many markets, are seeking to use 3G to differentiate their products and services, rather than networks. Sharing a new network removes the complexity and cost associated with re-planning existing networks but requires commercial agreement on operations and upgrade costs.

- New entrants: National roaming can be used for a limited fixed period, usually the first few years of network deployment, to quickly expand coverage and in instances where initial cash flows are limited.

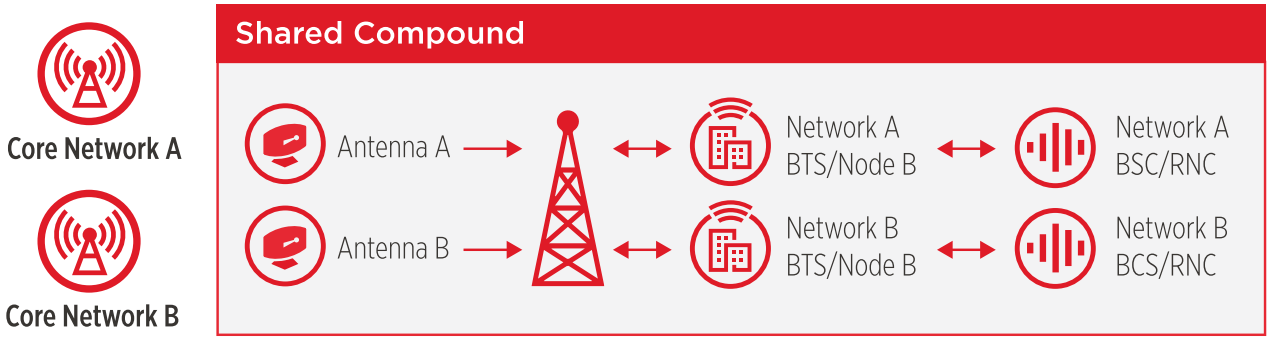
- Third party infrastructure providers: Infrastructure funds are showing more interest in acquiring or establishing third party mast or radio network businesses.

- Network equipment manufacturers: Infrastructure sharing may reduce revenues as less equipment is required by operators. However by assisting in the network planning process and offering managed network services, equipment manufacturers may be able to differentiate their offerings.

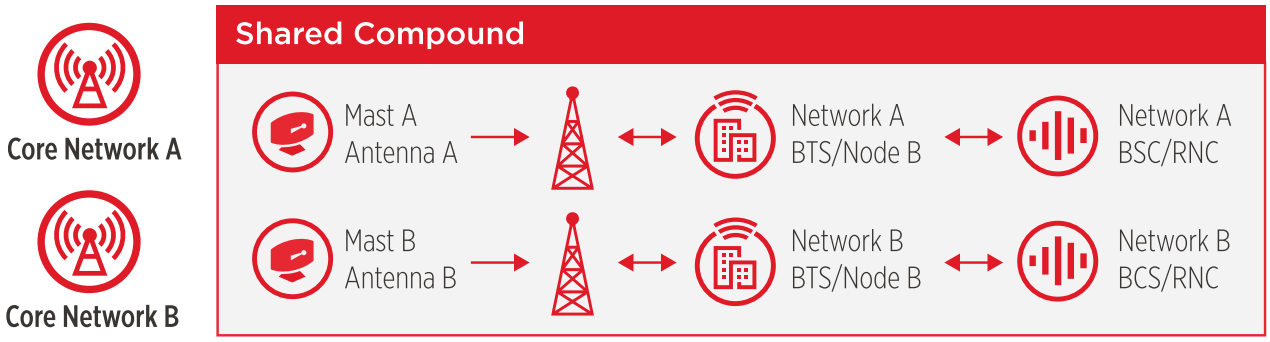
Figure 10

Examples of different types of mobile network sharing

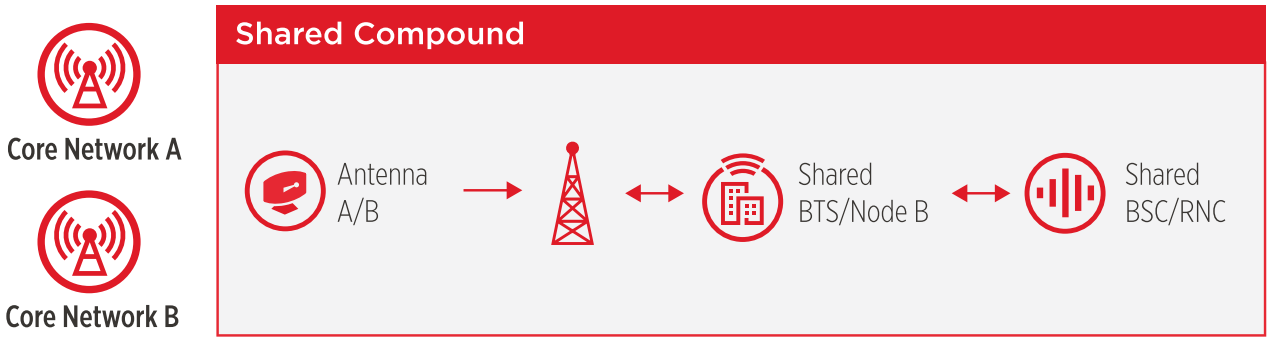
MAST SHARING



SITE SHARING



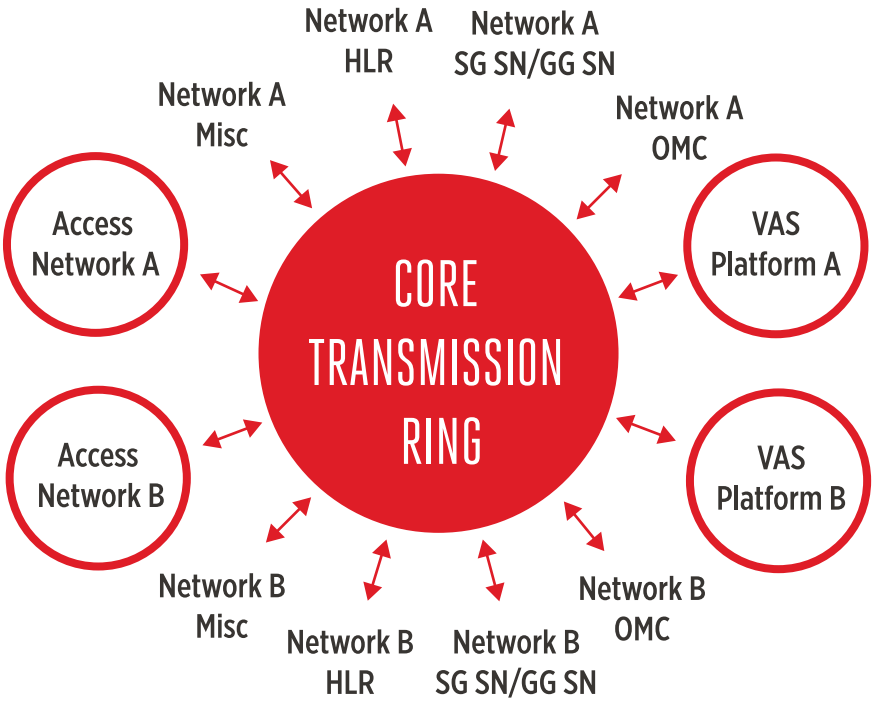
FULL RAN SHARING



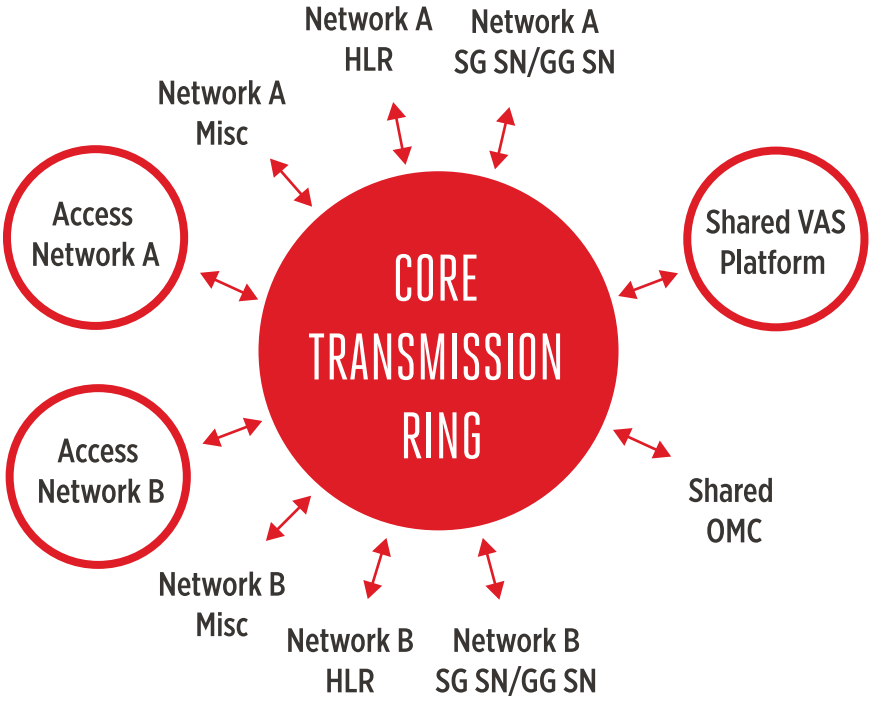
NETWORK ROAMING

Subscriber from Network B has roamed into coverage of operator A and is being serviced by their network

CORE TRANSMISSION RING SHARING



SHARED CORE NETWORK ELEMENTS AND PLATFORMS



Source: Coleago

5 Enabling policies to support private sector investment in mobile network coverage expansion

National governments should have a strong motivation to promote the expansion of internet connectivity to reach all members of the population. Access to the internet can deliver profound improvements in economic growth and social development. In the words of the World Bank's World Development Report 2016 the internet spreads benefits through Inclusion, Efficiency and Innovation.

The spread of internet connectivity is proving to be most challenging in developing world markets, especially in Africa and Asia. National governments in these markets should be acutely aware that private sector investment in internet capable networks beyond urban population centres faces considerable challenges and needs the support of policy makers to maximise the commercially sustainable coverage opportunity.

By taking the time to understand the economic parameters of the business case for mobile network coverage expansion policy makers will be in a better position to adaption legal and regulatory frameworks to improve incentives for private sector investment.

In particular, national governments should look to move policy, legislation and regulation towards best practice in a number of specific areas including:

- **Cost effective access to low frequency spectrum**
- **Support for spectrum re-farming**
- **Support for all forms of voluntary infrastructure sharing**
- **Elimination of sector specific taxation on operators, vendors and consumers**
- **Non-discriminatory access to public infrastructure**
- **Support for streamlined planning and administrative processes**
- **Relaxation of Quality of Service requirements**
- **Context appropriate competition policy, especially concerning market structure**
- **Support for multi-sided business models such as zero rating and sponsored data**

In addition, national governments should look to direct public investment towards the development of critical enabling national infrastructure including the national power grids and even open access high capacity core fibre-based communications networks.

Stable and efficient policies and regulations are critical to ensure that operators benefit from the best conditions to roll out mobile network coverage to underserved areas.

Cost effective access to low frequency spectrum

Efficient spectrum policy can help achieve the goal of expanding mobile network coverage into rural and remote areas through commercially sustainable private sector investment. The amount of spectrum made available, the type of frequencies allocated to mobile operators and the terms and conditions of the licences have a direct impact on the availability, quality and affordability of services delivered to consumers.

Sub-1GHz spectrum is important for cost effective wide area network coverage, especially the 700MHz and 800MHz frequencies due to their combined transmission capacity and wide geographic propagation characteristics.

Deploying a network that uses higher-frequency capacity bands requires more base stations to cover the same area. It is approximately 70% cheaper to provide mobile broadband coverage at frequencies around 700/800 MHz than to use the 3G frequencies at 2100 MHz according to Coleago.

Using low frequency spectrum means networks can be rolled out more quickly and cost-effectively, supporting the business case for wider mobile network coverage and the provision of affordable services to a large share of the population.

These effects are multiplied when countries work together to ensure they allocate spectrum in a harmonised way. Global or at least regional spectrum harmonisation – the identification and release of internationally harmonised bands – must be a vital consideration as regulators assess spectrum policy, creating economies of scale that will drive down the costs of infrastructure deployments and consumer equipment.

Regional spectrum harmonisation also reduces the risk of cross border interference and facilitate mobile roaming. Regulators are encouraged to clear the 700 MHz and 800 MHz spectrum through the migration to digital television which can release the so called 'digital dividend' spectrum for use by mobile services.

The way spectrum is awarded and managed can also have an important impact on the quality and reach of affordable mobile services, in particular when planning investment in less economically viable areas. It is essential that a sufficient quantity of spectrum is made available for mobile services at a reasonable price and under conditions that encourage long-term investment in mobile networks.

Spectrum licences with a long duration (15-20 years) and the assurance of renewal encourage operators to make strategic network investments that are vital for extensive, high quality mobile broadband coverage. Where auctions are the most appropriate mechanism for awarding licences, if they are poorly designed or run they may fail to deliver a positive outcome by making insufficient spectrum available at too high a price to enable effective deployments. This can be due to artificial scarcity, such as by reserving spectrum for new entrants who may not be forthcoming, or by setting high reserve prices that can deter participation or artificially inflate the prices paid thus deterring network investment.

Private sector mobile operators work within the constraints of a limited supply of capital. Every dollar invested in acquiring spectrum is a dollar lost to investment in infrastructure, pushing up the running costs of networks and reducing the size of the footprint that can be served.

Spectrum should be made available to those that value it the most and will generate the greatest socioeconomic value to society. When designing the award process, regulators should balance various factors including licence conditions, enabling a sustainable number of players in the market and package spectrum blocks accordingly. Technical efficiency requires licensing large enough and contiguous block of spectrum. For example, LTE services operate most effectively with at least 2×10 MHz of spectrum per operator. Coverage conditions, such as rural rollout commitments must be viable and determined through consultation with operators and published during the licence bidding phase to ensure they can be factored into the auction bid valuation modeling. Any such obligations should be transparent, consistently applied and remain unchanged through the duration of the licence.

Careful spectrum management is a cornerstone in the delivery of affordable, high quality mobile broadband services that extend to cover rural populations. If regulators can achieve the right balance they can support the development of mobile services that have the maximum positive socioeconomic impact.

Figure 11

Impacts of the policy decisions on the business case for network coverage expansion

Policy Issue	Area of impact			
	Revenue Opportunity	Operating Costs	Capital Costs	Comments
Cost effective allocation of low frequency spectrum	✔	✔	✔	Low frequency (sub 1GHz) spectrum significantly reduces the number of base stations required to cover rural and remote populations. Excessive prices for spectrum divert scarce cash flow away from investments in infrastructure.
Support for spectrum re-farming	✔	✔	✔	Existing low frequency spectrum (e.g. 900MHz) used for 2G services can be more effectively re-used for 3G and 4G service deployment.
Support for all forms of infrastructure sharing		✔	✔	Infrastructure sharing can help to reduce the costs per operator of network expansion by 50-80%
Elimination of sector specific taxation	✔	✔	✔	Sector specific taxes add costs to operators, equipment suppliers and consumers of mobile services impacting all aspects of the business case for network expansion.
Non-discriminatory, cost based access to public infrastructure		✔	✔	Access to public infrastructure is a critical enabler of cost effective deployment of network coverage into rural and remote regions.
Support for streamlined planning and administrative processes		✔	✔	Administrative efficiency supports timely and cost-effective deployment of new infrastructure.
Relaxation of Quality of Service Requirements		✔		Quality of Service requirements such as network availability and dropped call rates are much harder to deliver in rural and remote areas, with fines penalising operators for helping governments deliver their digital strategies.
Context appropriate competition policy	✔	✔	✔	Competition policy needs to balance the encouragement of more infrastructure-based operators with the economics of network investment so there is enough cash flow in the industry to support rural coverage expansion.
Support for multi-sided business models such as zero rating and sponsored data	✔			Multi-sided business models help to provide the revenue needed for infrastructure-based operators to justify investments, especially where the direct spending power of consumers is low.

Source: GSMA

Support for all forms of voluntary infrastructure sharing

Infrastructure sharing can reduce per operator costs of network coverage expansion by 50-80%. It represents one of the most important ways in which national governments can support commercially sustainable investments by mobile operators.

The regulation and practical application of infrastructure sharing has matured considerably over the last decade, particularly in developed countries. But the regulatory framework in many developing countries is still often insufficient and sometimes even a barrier to mobile network coverage expansion. National regulatory authorities (NRAs) should consider revising their policies and regulations to encourage operators to share passive and active network elements on a voluntary basis.

The starting point is to ensure that the regulatory framework with respect to infrastructure sharing is aligned with the relevant government policies. At the request of the Broadband Commission established by the ITU and UNESCO, most countries now have National Broadband Plans with objectives that include universal access. The government and its NRA need to ensure that the infrastructure sharing policy is transparent and will facilitate the National Broadband Plan and any other relevant policies.

From a rural/remote coverage perspective there are a number of key principles that a regulatory framework should embody.

The regulatory framework should address all aspects of infrastructure sharing. Often the existing regulations only cover, for example, passive sharing and are silent on active sharing or national roaming. Considerable time and effort may be wasted attempting to clarify whether a particular solution is permitted. In one extreme case, eighteen months elapsed between two operators agreeing to share and receiving regulatory approval.

Regulation should apply to all third-party infrastructure owners. Suitable passive infrastructure, such as ducts, poles and towers, is often owned by utility companies (electricity, gas, water) or transportation entities (roads, railways). More often than not these companies are publicly owned but do not fall under the mandate of the telecommunications NRA. However the government and the NRA should be instrumental in facilitating such cross-sector infrastructure sharing either by changing the latter's mandate or through joint regulation (as in Brazil) or through some form of co-ordination (as in Costa Rica).

All types of infrastructure sharing should be permitted. Although passive sharing provides the greatest savings, operators need to maximise their savings in order to cover the rural/remote areas which means using active (MORAN or MOCN) sharing or national roaming. NRAs and competition authorities are obviously concerned with potential anti-competitive behaviour so it should be incumbent on the prospective sharing parties to explain how they intend to compete. Suffice to say, from the experience of active sharing in almost 20 countries (for example, Australia, Azerbaijan, Canada, Spain, Sweden, Vietnam, UK, etc.) over the last fifteen years, there is no evidence of any detrimental impact on competition. Far from it, in all cases mobile prices have continued to fall as a percentage of GNI per capita.

Commercial terms for infrastructure sharing should be transparent, fair/economic and non-discriminatory. In particular government-owned passive infrastructure should be offered at cost-oriented prices otherwise it becomes another form of taxation. On the other hand, it is a great opportunity for the government to encourage rural/remote broadband coverage roll-out by offering such facilities at a lower cost or free of charge in consideration of the net positive socio-economic benefits that will accrue.

Elimination of sector specific taxation

Reducing sector-specific tax and fees on the mobile industry, its suppliers and consumers, to align them with those that apply to other standard goods and services has the potential to stimulate investment in extending connectivity, especially in rural areas, increase mobile service adoption, deliver economic growth and increase government tax revenues in the medium-term.

Taxation on the mobile sector supports government revenues and contributes to public services. At the same time, sector-specific taxation that is levied only on mobile or at higher rates for mobile consumers, operators and equipment suppliers has a distortive impact on investment and consumption behaviour, harming long-run socio-economic development.

In addition, regulatory payments and fees such as those levied on spectrum holdings should have the objective of capturing the rent associated with this scarce resource and of covering spectrum management costs. However, they are often not used for their intended purpose and may effectively translate into additional taxation.

It is common practice in developing world countries to apply sector-specific taxation, often in response to the issue of large informal economies where as a result of the visibility of mobile transactions mobile operators have been easy target for tax and fee collection.

A recent survey of 112 countries carried out for the GSMA by Deloitte Economic Consulting found that 45 countries impose sector-specific taxes on mobile consumers, including for example, special excise taxes on voice and data or flat taxes on SIM activation. Of the countries that levy sector-specific taxation on mobile services, 18 are in Africa, 7 are in Latin America, 7 in Asia Pacific, 5 in Middle East and North Africa (MENA), 4 in the European Union (EU) and 4 in Eastern Europe and Central Asia. When accounting for both operator and consumer taxation, in 2014 across 30 developing world countries it is estimated that the industry paid US$ 52 billion in taxes and fees to governments, excluding spectrum auction payments, representing on average 29% of market revenues. Of these, an estimated 35% of tax and fee payments by the mobile sector are sector-specific and not resulting from broad-based taxation: this amounts to US$ 18 billion in sector-specific tax and fee payments.

Taxes and fees on both consumers and mobile operators reduce affordability of services and the incentives for investment in network expansion to less profitable rural areas. Depending on the level of competition in the market, some taxes and fees are absorbed by mobile operators in the form of lower profits, which in turn can reduce investment incentives for mobile operators, whilst others may be passed through in terms of higher prices for consumers, or a combination of the two.

High taxation on consumers can act as a barrier to mobile ownership and has a particularly regressive impact on the poorest and rural households, especially when imposed at a flat rate like in Pakistan where an activation charge of US$ 2.5 (PKR 250) applies on all SIM cards. Other taxes are particularly distortive such as those applied on mobile operator revenues, which discourage investment by reducing the profitability of operators independently of individual investment. For example, Turkey charges a 15% “treasury share” tax on gross revenue, in India 8% is levied as a licence fee including 5% towards USO and in Nigeria 2.5% is applied on net revenues as an “annual operating levy”.

The GSMA has studied the effects of reforms to sector-specific tax and fees in a number of countries and estimated the impact of government revenue of reducing sector-specific taxation. This research suggests, for example, that an abolition of the excise tax on mobile services in the Democratic Republic of the Congo (DRC), one of the poorest countries in the world with a low mobile penetration, could potentially increase market penetration of mobile services in the country by an extra 5% in 2020 relative to a scenario with no tax reform. Most likely these additional subscribers would come from the rural population that currently remains unconnected. Furthermore, additional connections could potentially create a further 3,200 jobs and the tax reduction could potentially yield almost US$ 970 million or nearly 2% of GDP over the same time horizon. The government would be revenue positive within four years. Moreover, as the excise duty only applies to the telecommunication industry, reaching the positive effects only requires the taxation of the sector to be aligned with other sectors in the economy – no preferential treatment of the industry is necessary.

Provide non-discriminatory access to public infrastructure

Policy makers scan support the efforts of mobile operators to expand mobile network coverage by offering open and non-discriminatory access to state-owned public infrastructures such as buildings, roads, railways and ducts for utility services. Such access can be easily implemented and significantly accelerate the network roll out process.

Many national governments have deployed extensive public infrastructure to deliver education, transport, postal and other vital services to their populations. School buildings, hospitals and post offices are often the key reminder of the state existence in the remotest areas. Where feasible, operators should be granted access to publicly-owned facilities to set up base stations. Such a policy can save on the up-front and operating costs of setting up a tower.

The deployment of high capacity backhaul networks is a critical element of mobile network operator investments. National governments should encourage their energy and transport agencies to provide mobile operators with access to their infrastructure. For instance an electricity company can be asked to provide free access to its electricity poles and ducts. Similarly, a rail or road company can be asked to grant access to ditches or ducts.

Access provision to any publicly owned fibre network is also encouraged. Increasingly consortium are being created between the private and public sector to deploy national fibre backhaul networks, made available to all operators on a cost-oriented and non-discriminatory basis. Such initiatives are highly encouraged and should be prioritised.

Support for streamlined planning and administrative processes

Although its impact is difficult to accurately assess, administrative efficiency is key to ensure mobile operators are able to meet coverage expectations. In many markets administrative and process inefficiencies are often responsible for delays penalizing the entire economy.

Planning permission processes are an obvious example of administrative inefficiency in some markets. In Indonesia for instance, operators are requested to ask 2 to 3 administrative bodies for planning permission prior to building out a site: the ministry, the governorate and the district. In this case, a fast track process could lighten the administrative hurdle.

To improve administrative efficiency, government are encouraged to improve the digital administrative channel. Making forms and even processes digital will help save valuable time and support operators in their effort. Governments are also encouraged to centralize all statistical and geographical information suitable to support mobile broadband network roll-out.

Support for the development of efficient information management systems

Information on white zones (areas without network coverage) is still rarely documented or made publicly available by government agencies. Lack of financial resources or personnel often means that regulators rely on individual operators to provide estimates on coverage.

Network coverage assessments should be run yearly by a government agency to ensure that all operators have a reliable and consistent understanding of coverage. Such analysis can also highlight potential areas for network optimisation especially where coverage redundancies are obvious and not required.

Regulators are also encouraged to centralise via a digital platform information that could support operators in their efforts to deploy mobile broadband coverage. For instance, beyond urban areas, regulators could provide the list of available telecom infrastructure that could be shared or rented between operators. Such platform would facilitate collaboration and discussions between operators.

Annex: The GSMA Infrastructure Economics Toolkit

What would be the financial impact on the industry, the government's income from taxes and the country's economy of expanding 2G and 3G coverage to 100% of the population by 2020 from the current position? This is the question that the GSMA's Infrastructure Economics Toolkit (IET) has been developed by Coleago to help answer. It works at an industry level so that operators and government bodies may discuss and examine a range of solutions without disclosing confidential information. Operators will still need to develop their own detailed business case analyses once consensus has been reached.

Overview of the Infrastructure Economics Toolkit

For MNOs, the IET provides a forecast of the:

- **Costs for expanding 2G and 3G coverage to 100% of the population under various infrastructure sharing scenarios**
- **Incremental revenue that results from the expanded coverage taking into account any taxation or regulatory changes that the government may be willing to offer.**

If the costs are forecast to outweigh the revenues over the next few years (typically five), then an operator is unlikely to proceed with any project. As explained in Section 3, this is why most MNOs have stopped rolling out 2G coverage and in many countries will soon reach the same point with 3G.

Using historical and forecast input data and assumptions from the operators, the IET forecasts the costs of expanding 2G and 3G coverage under various infrastructure sharing scenarios (passive, active and roaming). It also forecasts the operators' incremental revenue resulting from the expanded coverage area, taking into account the benefit of any tax changes, which the government may be willing to consider. In most countries, it will require a combination of infrastructure sharing by the operators and tax or regulatory changes by the government to find a solution that is attractive to all parties. In the case of the operators, the cumulative additional revenues should then exceed their costs.

From the government's perspective, the IET provides forecasts of the impact on tax income and GDP as a result of the operators expanding the 2G and 3G coverage. In particular, it will show how reducing some tax rates will actually increase the total tax income received by the government because the new income resulting from the network coverage expansion usually exceeds any loss of income from the existing coverage area.

The IET also includes the ability to evaluate the benefit of infrastructure sharing within the existing coverage areas. The sharing in these areas may (and probably should) be on a different basis from the expansion area.

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