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REPORT FOR THE TELECOM INFRA PROJECT

THE ECONOMIC IMPACT OF OPEN AND DISAGGREGATED TECHNOLOGIES AND THE ROLE OF TIP IN SUB-SAHARAN AFRICA

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NOVEMBER 2021

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Disclaimer and acknowledgements

This report was commissioned and sponsored by the Telecom Infra Project (TIP), and written by Analysys Mason, a global consultancy specialising in telecoms, media and technology.

Analysys Mason is grateful for all inputs during the research and preparation of this report, including from Isabella Kriegler during her time at Analysys Mason, as well as from discussions with individuals from a number of organisations including 9mobile, A4AI, Africa Mobile Networks, Airtel, Atlancis Technologies, Comsol Networks, MTN, Vodacom, and others.

The analysis contained in this document is the sole responsibility of Analysys Mason and does not necessarily reflect the views of TIP or other contributors to the research.

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1 Executive summary

Internet connectivity and digital infrastructure play a vital economic and social role globally, and help to deliver education, health care and other vital services around the world. Despite real progress in recent years, connectivity and the deployment of digital infrastructure in sub-Saharan Africa (SSA) remains challenging, and much remains to be done. Internet connectivity in SSA is and will remain reliant on mobile networks, but connectivity is not consistently available and is not evenly distributed. In landlocked, poorer and more rural areas, many people remain unconnected. According to the International Telecommunication Union (ITU), just 29% of individuals in Africa used the internet in 2019, compared to a global average of 51%.[1] This provides a clear and present opportunity for growth, which is essential to continued economic development in SSA and the rest of the continent.

Expanding the delivery of accessible and affordable broadband internet access requires a constant stream of innovation and efficiency gains in the global supply chain to drive improved performance, diversity and cost-effectiveness of network solutions. For many years, operators in SSA have been dependent on technology provided from outside the continent. Over the past decade, global vendors have supplied end-to-end networks at low prices, which has been positive in terms of making new network deployments more economically viable. However, over the long run, this dynamic can create vendor lock-in, which could constrain innovation, and drive up costs for operators in future.

This report focuses on the emergence of open, disaggregated and interoperable network technologies, a relatively new and promising way to bring network solutions to market. These technologies, which include open radio access technologies (Open RAN),[2] have the potential to reduce vendor lock-in and lead to more diverse supply chains, with lower barriers to entry for new vendors, including innovative providers from Africa.

Operators, network vendors, systems integrators, and the constellation of organisations that support connectivity, including financiers and content providers, have come together in smaller groups and larger organisations, including the Telecom Infra Project (TIP), to explore and develop the potential of these technologies in SSA.

We explore how these technologies could lead to better cost efficiency, greater innovation, and spur the development of local suppliers using local talent in SSA. This could in turn stimulate more diverse supply chains and better connectivity across the region, with more affordable, available and more widely used internet connectivity.

Operators in SSA have announced significant interest in these technologies and are deploying solutions for targeted use cases, while wider adoption of Open RAN could take time to gain traction

African telecoms companies are not short of ambition, and many of them have shown a particular interest in open and disaggregated network technologies. Since 2019, operators serving ~60% of mobile subscribers in Nigeria, Kenya, South Africa, Côte d'Ivoire, Uganda and the Democratic Republic of the Congo (DRC) have announced initiatives related to Open RAN or other open and disaggregated network technologies. When including operators in these six SSA countries that are part of wider international groups that have stated their interest in these technologies in other global regions, the percentage of subcribers served increases from ~60% to ~80%.

As of November 2021, many operators across the region have already begun trials and/or commercial deployments of disaggregated solutions, including TIP-incubated ones,[3] in their transport networks, which, among other things, would help to improve the economics of data transport through fibre optics to mobile sites. In order to help operators to adopt disaggregated solutions, several rural 'network-as-a-service' (NaaS)[4] players have also entered various markets in the SSA region. These players provide viable technical solutions based on open networking principles to meet regional challenges such as limited power supply. They also adopt innovative new business models, both in terms of their commercial agreements

[1] See https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2020.pdf

[2] Refers to the wider industry movement to develop and deploy more open and interoperable hardware and software in radio access networks

[3] For example, the TIP-incubated Disaggregated Cell Site Gateway (DCSG) sits between the access network and backhaul and allows operators to customise their hardware and software choices, reducing operational costs and allowing for quicker upgrades, as well as automated life-cycle management.

[4] Network-as-a-service' business models typically involve operators being offered network capacity on shared active equipment, and can be offered by various types of third parties, ranging from specialised rural providers to larger telecoms infrastructure (e.g. tower and fibre) players.

with operators, as well as the direct support they provide to customers in terms of device availability, internet awareness and digital literacy training. Disaggregated solutions are also emerging in other network areas, with the first commercial deployment of TIP OpenWiFi in the region having been announced in November 2021, involving the deployment of Wi-Fi systems for a university in Kenya.[5] In the short term, more niche opportunities such as indoor small cells and enterprise private networks could start to emerge in the region, either offered by operators, or other types of entities such as neutral host infrastructure providers.

Other use cases, such as the large-scale deployment of Open RAN, might only gain traction in a few years' time. Operators experience challenging deployment economics in the SSA region, as well as difficult operating conditions, including intermittent power supply, high temperatures and humidity. This means that, in the short term at least, they are likely to prefer solutions from more established vendors that have been proven to work in the local context. Vendors driving the development of disaggregated solutions have historically focused on more advanced or emerging mobile technologies such as 4G and 5G, as opposed to legacy technologies such as 2G and 3G. This presents a challenge for operators in SSA countries that are considering disaggregated solutions in the short term, as operators continue to rely on these legacy technologies for service provision. Meanwhile, smaller or newer operators that have fewer legacy network constraints could be more inclined to move more aggressively toward 4G and 5G deployments using open and disaggregated technologies in the short term. Doing so could allow these operators to gain a competitive advantage by deploying networks that can scale more effectively in future.

Eventually, the need for all operators to upgrade networks to future technologies will provide opportunities to implement disaggregated solutions. As demand for data continues to grow, operators would need to be able to upgrade networks in a more flexible and cost-effective manner to support greater capacities. This is a need that disaggregated solutions are well suited to address. Large-scale availability of 5G is not expected in the region for another few years, which provides the emerging 5G Open RAN vendor ecosystem with more time to develop disaggregated solutions that are comparable to proprietary ones,[6] ahead of wider 5G adoption in SSA. This would allow the region to reap the benefits of disaggregated solutions for advanced technologies without necessarily having to invest heavily in these technologies before they reach maturity.

The open and disaggregated ecosystem could also unlock new opportunities for companies based in SSA to play a bigger role in the supply chain. Local companies with roots in managed IT services, distribution, or systems integration for smaller networks, are increasingly looking to capitalise on the emerging open ecosystem to enter other parts of the supply chain. Today, operators in SSA depend on incumbent vendors for systems integration, but could rely more on regional companies to deliver these services in future, which would boost local industry and skills development.

Open and disaggregated solutions could drive significant economic gains: Open RAN alone could drive USD44 billion in cumulative GDP by 2030, with significant upside from faster and wider adoption

In the long term, SSA has the potential to reap significant benefits from the development and adoption of disaggregated solutions. Open RAN is commonly regarded as the best-known family of technologies in this space, and could in itself bring large benefits to connectivity. We estimate that it could contribute to an extra 5.4 million unique subscribers using the internet across SSA and 3.8EB[7] of additional mobile data being consumed per annum by 2030. The increased number of users and larger amount of data consumed across all users in the region would, in turn, have a positive impact on wider GDP growth in the region, reaching an estimated USD15 billion per annum (in real 2020 USD) in 2030 (USD44 billion cumulatively from 2021 to 2030).

These estimates reflect a relatively conservative set of assumptions. Specifically, the estimates reflect the assumption that although these solutions could unlock significant connectivity improvements in the long term, adoption might take some time to gain traction due to other priorities that stakeholders in the region have in the short term.

Stakeholders including operators, vendors, systems integrators, organisations such as TIP, local and regional industry bodies, regulators, as well as financing

[5] See https://www.kenet.or.ke/content/kenet-deploys-first-commercial-openwifi-solution-africa-0

[6] Reaching parity on performance for features that operators would demand for each specific use case, noting that traditional vendors can include more features than strictly necessary in bundles offered to operators.

[7] Exabytes

organisations, all have a role to play in driving the development and adoption of these technologies in SSA. Sensitivity analysis suggests that accelerated adoption and improved efficacy[8] of these solutions could multiply their impact by three compared to the baseline case by 2030. However, our modelling also shows that the impact on GDP could be materially lower if conditions do not allow operators to adopt these technologies successfully over the next decade.

Adoption of disaggregated solutions in SSA would be accelerated by access to more platforms for testing and knowledge sharing, and by more supportive regulatory and funding environments

Today, many of the developments related to the adoption of disaggregated technologies in SSA are operator led, and often involve specific activities that individual operators are undertaking with supply chain partners or other providers, such as rural NaaS players. More collaboration between operators and operator groups of various sizes across the region to test and validate solutions would help to accelerate the development of solutions that can meet region-specific requirements.

TIP is an initiative that seeks to foster collaboration between stakeholders. It serves as a platform for smaller operators, as well as new vendors, to collaborate, and also engages with the larger operator groups in the region. The latter groups already benefit due to their scale and internal knowledge sharing, but would stand to benefit further by collaborating with other operators, small and large, to maximise sharing of knowledge and experience on the use of disaggregated technologies in the region. The TIP community is creating blueprints for testing and adopting solutions. It provides 'badges' that indicate the maturity of specific vendor offerings on the TIP Exchange, which helps to ease the process for operators looking to trial and later adopt these new technologies. Operators that engage with the TIP community would also have the opportunity to test new developments related to software-based network automation, such as continuous integration, continuous delivery (CI/CD) models that will be key in automating the integration and deployment of new network functions and solutions on an ongoing basis.

SSA is home to many local and regional industry bodies with interests that are aligned with the vision of network disaggregation, in terms of the potential to help operators deploy better networks more efficiently, expand coverage and enhance connectivity across the region. Futher sustained effort by proponents of open and disaggregated solutions (such as pioneering operator groups and entities such as TIP) to engage these local and regional industry bodies will help introduce more companies to the growing open ecosystem. Policy makers can also play a role in facilitating collaboration between different stakeholders.

Companies that are leading the exploration of these technologies would also be better able to contribute to accelerated adoption if provided with additional investment for the development of these technologies for the SSA context. In September 2021, it was announced that TIP and the International Finance Corporation (IFC) had entered into a collaboration to accelerate the deployment of cost-effective networks in underserved areas, along with an invitation to other funding organisations to join the effort.[9] Operators and ISPs are already deploying open and disaggregated solutions (such as those for transport networks) that have reached sufficient maturity to deliver tangible benefits to operators. However, other disaggregated solutions, particularly those that need more tailoring to regional requirements, are still maturing and have yet to achieve cost efficiencies and other envisioned benefits for vendors, operators and consumers. Wider availability of funds for pioneering use of open networking solutions would help accelerate adoption further.

Companies could also better leverage disaggregated solutions in more supportive regulatory environments. In particular, operators need clarity on frameworks for active sharing. Meanwhile, rural NaaS players often have to deal with the complexity of obtaining many different types of permits when deploying their solutions across countries. Initiatives such as the Open RAN Policy Coalition, or regional industry bodies, can also serve as platforms for policy makers in the region. This would enable policy makers to share best practice on how to encourage the use of disaggregated solutions, for instance through initiatives such as establishing more laboratory environments for testing and validation of solutions, or facilitating partnerships between industry players and academic or vocational institutions. These types of initiatives could help to further common policy objectives such as coverage expansion or local industry and skills development.

[8] In terms of the ability of these solutions to improve cost efficiency and boost migration to new technologies

[9] See https://pressroom.ifc.org/all/pages/PressDetail.aspx?ID=26646

Sub-Saharan Africa could benefit significantly from open and disaggregated solutions, and stakeholders such as TIP can help unlock this potential

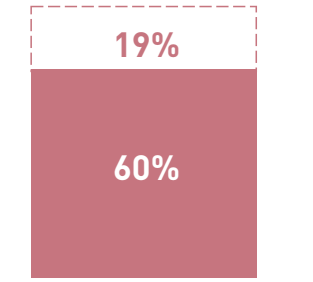
If widely adopted, open and disaggregated technologies will have a positive impact in Sub-Saharan Africa

SSA CONNECTIVITY LANDSCAPE	CURRENT SITUATION	IMPACT OPPORTUNITY
Existing coverage and connectivity levels	Large segments of the population lack access to internet connectivity compared to other regions	Connecting the unconnected / under-served enables economic activity, and can involve greenfield deployments of open and disaggregated solutions
Limitations of traditional solutions	Vendors operate in a challenging physical and commercial environment	Traditional solutions are less flexible and would not be able to easily improve connectivity further, giving open and disaggregated solutions time to develop
Need for the introduction of innovative solutions	Low opportunity cost of experimenting with new models in certain areas	Solutions like network-as-a-service (NaaS) and OpenWiFi are emerging, and could scale with optimised cost efficiency
Potential for home-grown companies to develop	Large operator groups would prefer partners to cover entire footprints	Local / regional systems integrators can expand into new countries, as well as adjacent parts of the value chain

Operators in the region are already deploying open and disaggregated solutions within their networks

Operators have expressed interest in these technologies...

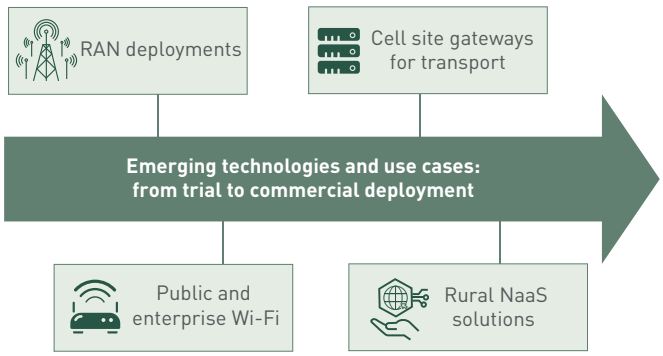
... and are deploying solutions that are ready today, while actively taking part in the design, incubation and trial of other solutions to accelerate their commercial viability



Share of mobile subscribers in Côte d'Ivoire, DRC, Kenya, Nigeria, South-Africa and Uganda

Subscribers served by operators / groups with announced interest in disaggregated solutions

Subscribers served by operators in larger groups with stated interest in other global regions



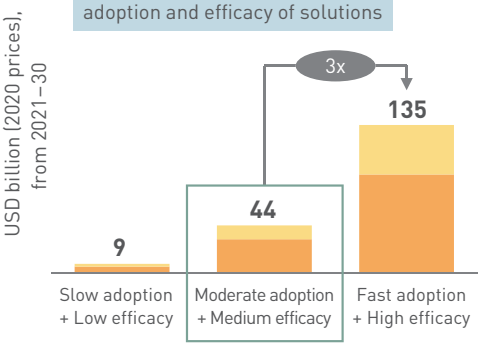
Open RAN adoption in SSA might take time to reach scale,[1] but if accelerated, could generate outsized benefits for the region in terms of GDP gains[2]

Annual impact in 2030 (baseline estimate for SSA)

- **5.4 million** more unique mobile internet users
- **3.8 exabytes** more data traffic consumed
- **USD15 billion** in annual GDP gains, from wider benefits generated across society

Level of success of the Open RAN ecosystem driven by industry, policy makers and initiatives like TIP

With greater effort to improve adoption and efficacy of solutions



Stakeholders with aligned interests have different roles to play to overcome challenges, to unlock the full potential of open and disaggregated solutions for SSA

Barriers

- Challenging site economics and operations
- Ongoing use of legacy technologies by operators
- Need to develop systems integration expertise

Enablers

- Facilitative regulatory environment
- Involvement of local / regional industry groups
- Platforms for collaboration and testing
- Financing to develop region-specific solutions

Effects

- Supply chain diversity, with more regional companies involved
- Improved connectivity and access to services
- Faster growth and better socioeconomic outcomes

[1] Compared to the low-income country group in the global report, as well as India as discussed in the India report, SSA is expected to experience more gradual adoption of Open RAN solutions given initial barriers to take-up, but with more potential in the upside case if barriers are addressed effectively and efficiently. It should be noted that figures across the three reports are not completely comparable as more recent developments that have informed assumptions in the India and SSA reports would not have been taken into account during the global study earlier in 2021.

[2] Measured in USD billion (2020 prices), with estimate range developed based on a similar methodology used in the global and India reports, by adjusting efficacy and adoption parameters relative to the main SSA scenario estimate, with a wider variance shown for SSA than in the global or India reports.

2 Improving connectivity in Africa continues to require investment and innovation, including new supply chains

As telecoms operators today prepare to meet future connectivity requirements, many are actively exploring the use of open and disaggregated network components from multiple vendors, in contrast with the more traditional route of relying on one main vendor for bundled network solutions. These disaggregated solutions are based on open interfaces between components, which allows for a more diverse set of vendors to supply 'best-in-breed' components for each part of the network.

A global report published by Analysys Mason earlier in 2021 described the potential benefits that disaggregated solutions could unlock for the telecoms sector and society.[10] An ecosystem of suppliers providing solutions based on open interfaces and standards would allow operators to reduce vendor lock-in and diversify their supply chains, gaining access to best-in-breed hardware and software solutions for various network elements, and strengthening overall network resilience. Such an ecosystem would introduce improved unit economics,[11] allowing operators to deploy and upgrade their networks more quickly and flexibly, to expand coverage to more areas, support larger data volumes, and introduce new innovative services. This enhanced connectivity can in turn bring about benefits for consumers, businesses, and society. Local industries could also develop further in terms of economic output and skills, through the opportunities enabled by a more open and diverse supply chain. In the global report, it was estimated that Open RAN[12] alone would be able to increase global GDP by USD285 billion from 2021 to 2030. These topics were revisited again in a second report published by Analysys Mason, focused specifically on the potential of these open and disaggregated technologies in India.[13]

This report examines specifically the opportunity for open and disaggregated technology in sub-Saharan Africa (SSA). According to the World Bank, SSA contains over 1 billion people today, with more than half of the population in the region expected to still be under the age of 25 by 2050.[14] Connectivity is expected to be a key enabler to unlock this potential. Economically, the GSMA estimates that over USD155 billion in economic value added will be generated by mobile technologies and services by 2025.[15]

In this section, **Section 2**, we introduce the significant latent potential, economically, socially and in terms of human capital, which SSA presents, and describe how connectivity in general, and open and disaggregated technologies in particular, can help tap this potential. Open and disaggregated technologies, as provided by a wider ecosystem of diverse suppliers, have the potential to allow operators in SSA to deploy more flexible, performant and cost-efficient networks in future, which would contribute to socioeconomic benefits for individuals, businesses and governments.

In **Section 3**, we explore how open and disaggregated solutions are already being developed, tested and trialled by African operators, supported by a global ecosystem of operators, vendors, systems integrators, infrastructure providers, and other organisations such as the Telecom Infra Project (TIP) that are helping to drive the vision of network disaggregation.

In **Section 4**, we illustrate the impact that Open RAN can have on the region specifically. In spite of several challenges to adoption in the short term, Open RAN could still add USD44 billion in GDP across the region from 2021 to 2030, with potential for three times this impact to be realised in more optimistic scenarios.

Finally, **Section 5** highlights how stakeholders across the connectivity ecosystem, including operators, vendors, regulators, policy makers and finance organisations, can come together to help maximise the impact of open and disaggregated technology to improve connectivity faster throughout SSA and unlock the benefits highlighted in the report.

[10] See https://www.analysysmason.com/consulting-redirect/reports/impact-of-open-and-disaggregated-technologies-and-tip/

[11] Unit economics refers to the profitability of producing one unit of a product or service, taking the relevant revenues and costs into account

[12] Refers to the wider industry movement to develop and deploy more open and interoperable hardware and software in radio access networks

[13] See https://www.analysysmason.com/consulting-redirect/reports/impact-of-open-and-disaggregated-technologies-and-TIP/

[14] See https://www.worldbank.org/en/region/afr/overview

[15] See https://www.gsma.com/mobileeconomy/sub-saharan-africa/

2.1 Connectivity throughout SSA has improved in recent years, and there is significant room for further growth

Today, 19% of the SSA population lives outside areas served by mobile broadband networks.[16] To harness the potential of a digital-based economy, access to the internet is necessary. However, it is often not profitable for operators to offer their services in remote areas with low population density, and where people are less able to pay for them.

Operators in SSA still rely on voice retail revenue more heavily than operators in any other region globally. This provides a significant opportunity to grow their data revenue (see Figure 2.1 and Figure 2.2).

FIGURE 2.1: COMPARISON OF VOICE RETAIL REVENUE AS A PERCENTAGE OF TOTAL RETAIL REVENUE IN 2020
[SOURCE: ANALYSYS MASON RESEARCH DATAHUB, 2021]

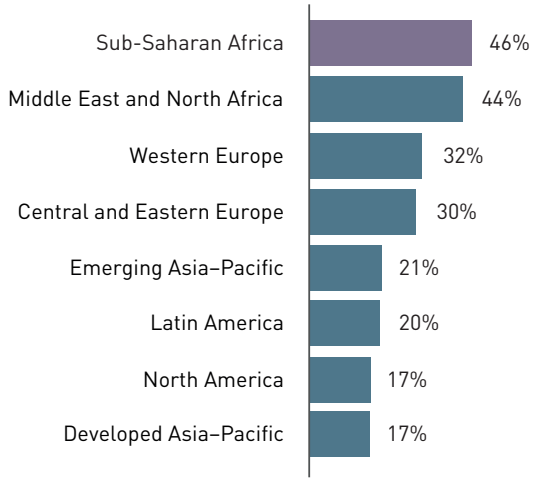
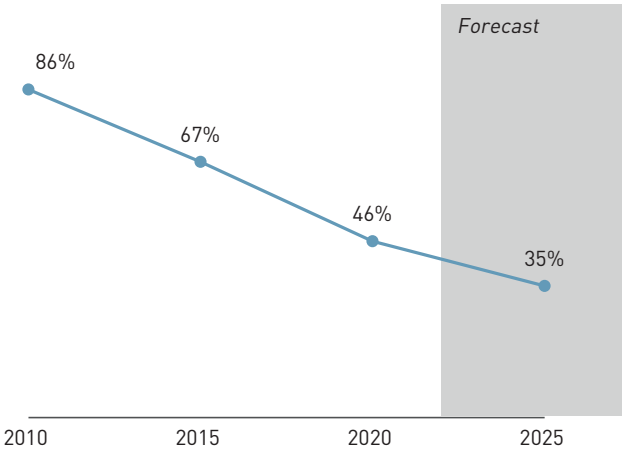


FIGURE 2.2: YEARLY EVOLUTION OF VOICE RETAIL REVENUE AS A SHARE OF TOTAL RETAIL REVENUE IN SSA
[SOURCE: ANALYSYS MASON RESEARCH DATAHUB, 2021]



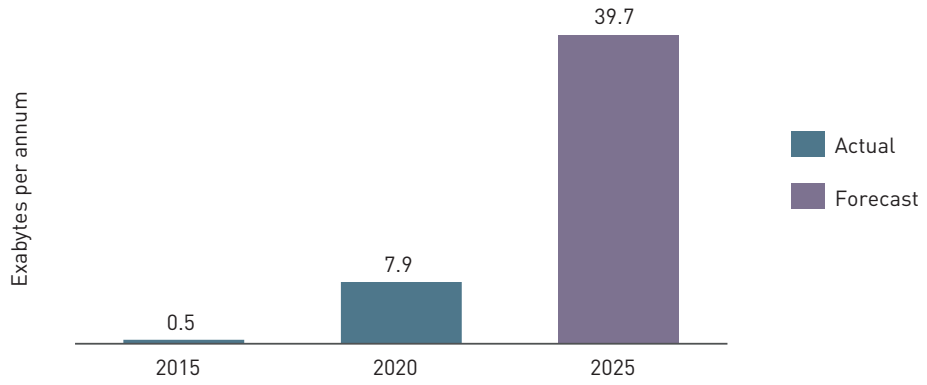
The global surge in mobile internet use has been driven by 4G technology, which allows for the transfer of sufficient data to enable streaming of video and music on mobile devices. The availability of 4G depends on the deployment of upgraded networks, and on the accessibility and adoption of 4G-enabled devices, particularly smartphones. To drive data revenue, operators are addressing constraints to both supply and demand, by rolling out 4G networks and subsidising low-cost smartphones. The roll-out of 5G networks, mainly in high-income markets so far, is expected to support continued increase in mobile data demand, complementing higher-capacity fibre networks.

As a result of investments in mobile data networks, the penetration of mobile internet users in the SSA population is expected to grow from 28% in 2020 to 39% in 2025.[17] As a consequence of these trends, data traffic consumed in SSA is expected to continue growing (see Figure 2.3).

[16] GSMA. (2021). The State of Mobile Internet Connectivity Report 2021. Available at https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf

[17] GSMA. (2021). The Mobile Economy Sub-Saharan Africa 2021. Available at https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/09/GSMA_ME_SSA_2021_English_Web_Singles.pdf

FIGURE 2.3: CELLULAR HANDSET DATA TRAFFIC FORECAST IN SSA
[SOURCE: ANALYSYS MASON RESEARCH WIRELESS NETWORK DATA TRAFFIC FORECASTS, 2020–25]



This growth is significant, but at this rate of growth, SSA will still lag behind the rest of the world. This therefore points to further room for growth, if demand and supply barriers to connectivity can be reduced.

On the demand side, the lack of affordability of 4G-enabled devices remains a key barrier to adoption for yet-unconnected people.[18] There are several ways in which operators and others have looked to tackle this problem, and to drive penetration and their own revenue, as explored in the case study below.

Case study: Availability of low-cost smartphones in SSA

Increasing smartphone adoption in Africa

Lower-cost brands are entering the market

- SSA has seen an influx of smartphones from Chinese brands TECNO and Infinix that cost less than USD100
- However, the upfront costs of these devices still exclude many potential users

African MNOs are launching 3G/4G devices

- 2018: Airtel Uganda launches affordable 'my first 4G smartphone'
- 2019: Vodacom launches the Vodacom Vibe, a 4G smart feature phone, for ~USD20
- 2020: Orange partners with Google to launch Sanza, a 4G smart-phone, for ~USD30

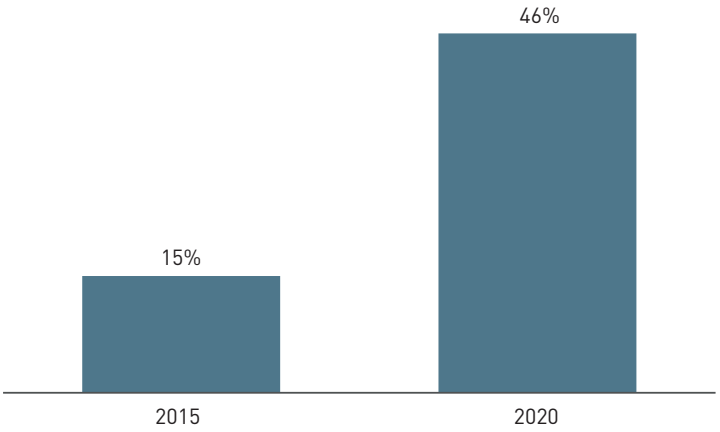
Start-ups are financing smartphones

- Mara Phones is a start-up which has partnered with several African banks to pre-finance devices
- Customers pay USD4–6 per month over several years to fund fully featured devices, which usually cost more than USD100

The joint endeavours of new device manufacturers and operators in launching affordable smartphones, as well as the efforts of micro-financing schemes, have helped to drive smartphone adoption in the region in recent years (see Figure 2.4), albeit within the existing base of mobile users rather than the broader population.

[18] GSMA. (2020). The Mobile Economy Sub-Saharan Africa 2020. Available at https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/09/GSMA_MobileEconomy2020_SSA_Eng.pdf

FIGURE 2.4: SMARTPHONES AS A SHARE OF TOTAL HANDSETS IN SSA [SOURCE: ANALYSYS MASON RESEARCH DATAHUB, 2021]



On the supply side, mobile internet coverage in SSA is less advanced than in other parts of the world. Rural areas within SSA still lack access to basic mobile coverage; as of 2020, 19% of the region's population did not live in the footprint of a mobile network which offered 3G or above.[19] Nevertheless, major operators have announced 4G deployment across the continent and the coverage gap has been reduced from 47% in 2015 to 19% in 2020,[20] indicating that operators' ongoing efforts have been effective and that the underserved portion of sub-Saharan Africans is dwindling.

To extend connectivity to off-grid, remote areas, a variety of alternative business models are emerging. In SSA, 'network-as-as-service' (NaaS)[21] businesses that specialise in low-cost infrastructure for rural and remote areas have partnered with operators to allow them to cover areas that would otherwise have been economically unviable. Companies such as Africa Mobile Networks, Vanu, Inc., NuRAN Wireless and Hotspot Network have partnered with major operators, allowing these operators to reach a wider customer base without the risk of deploying capital in these remote areas themselves. A case study on these rural NaaS players is included in Section 3.3. NaaS business models that are based on active infrastructure sharing would help to reduce costs further. Other traditional infrastructure providers, such as tower companies, have also announced interest in NaaS business models for a wider variety of settings. Within the TIP community, the NaaS solution group counts representatives from tower companies such as edotco and American Tower Corporation as participants.[22] Helios Towers, which has a significant presence in Africa, also appears to be considering the viability of the model.[23]

2.2 Growing demand for mobile internet services continues to drive coverage and capacity needs, which can only be delivered sustainably by efficient mobile networks

Telecoms operators in SSA are facing similar challenges to many others across the world, with commoditisation and competition eating into profit margins (largely to the benefit of consumers), even as new generations of mobile technology require continued investment in networks. Operators will need to achieve lower costs, and in particular much lower cost per unit of data (e.g. GB) in order to deliver on future demand for connectivity in a cost-effective manner.

[19] GSMA. (2021). Mobile Internet Connectivity 2021: Sub-Saharan Africa Key Trends. Available at https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-2021-Sub-Saharan-Africa.pdf

[20] Ibid.

[21] 'Network-as-a-service' business models typically involve operators being charged for network capacity on shared active equipment, and can be offered by various types of third parties, ranging from specialised rural providers to larger telecoms infrastructure (e.g. tower and fibre) players.

[22] See https://telecominfraproject.com/naas/

[23] See https://www.towerxchange.com/how-to-improve-the-performance-of-telecom-towers/

As demand for connectivity continues to grow, operators need to make sustained but cost-efficient investments in future networks, in order to achieve suitable returns over the long run. Wider industry objectives of capitalising on new technologies such as 5G, while also bridging the digital divide,[24] have led operators to consider new avenues and models for enhancing their networks, beyond the traditional vendor ecosystem that is made up of a small number of large providers offering proprietary solutions. Many operators today have expressed interest in a more diverse and vibrant supply chain ecosystem of hardware and software vendors, to fully capture the potential of network technology developments such as virtualisation[25] and automation.

Currently, many operators rely on 'turnkey'[26] networks designed, supplied, installed and maintained by established integrated vendors. These operators have limited flexibility to develop new business opportunities by using networks in new and innovative ways that deviate from conventional vendor roadmaps. Network supply chains have also been relatively concentrated, with a small number of large vendors responsible for the innovation, development, manufacture, integration, and maintenance of turnkey telecoms networks on behalf of mobile operators. While this arrangement has allowed mobile operators to easily outsource the deployment and maintenance of networks, it also limits choice: the same vendor must be relied upon to provide all sections of the network. This 'lock-in' to single vendors keeps equipment prices higher than they might be in a more competitive and innovative market.

Disaggregation of the supply chain promises to improve the economics of mobile networks, and to unlock innovation in new areas for operators, allowing them to meet growing demand in both advanced and emerging markets.

2.3 Open and disaggregated networks could provide greater cost efficiency, and accelerate network deployments and upgrades, to the benefit of end users, operators and society

Open and disaggregated networks provide new opportunities for operators, vendors and systems integrators, to engineer, deploy and operate networks in ways that enable them to improve their coverage and offer better prices to end users. This in turn would lead to increased economic growth, by connecting the unconnected and enhancing connectivity, creating opportunities for local manufacturing, software innovation and workforce development, and contributing to a more rapidly-developing digital economy that leverages better connectivity.

Despite several network interfaces being open and allowing for interoperability (e.g. as standardised by 3GPP)[27] in the main, a typical network relies on proprietary implementations or interfaces specific to the original vendor. Disaggregation is enabled by standardising and making public (or 'open') the interfaces between all network components. This allows 'disaggregated' hardware and software from a variety of vendors to be manufactured according to these open standards, to fit together and 'interoperate'.

In order for more vendors to enter the supply chain, open standards must also be adopted by a critical mass of operator suppliers.[28] Currently, incumbent vendors provide end-to-end, integrated solutions that are upgraded system-wide and periodically. Open interfaces could enable new providers to emerge and slot into targeted sections of the value chain, and ultimately gain competitive advantage in specialised hardware or software. Instead of expanding vertically along individual operator value chains, vendors new and old would be able to develop best-in-breed units of equipment horizontally (i.e. to many different operators) at scale.

[24] Refers to the gap in society between people with access to digital technologies such as the internet, and those without access

[25] Network virtualisation involves replacing physical hardware used for certain components in legacy networks with network functions that can run as software on general purpose hardware. This would embed higher levels of automation and intelligence in networks, to deliver services more flexibly and efficiently.

[26] Refers to a product, solution or service that when delivered, is fully complete and ready for operation

[27] 3rd Generation Partnership Project (3GPP) is a group of standards organisations that develops protocols in mobile telecoms, such as those for the air interface and the S1 interface in the RAN 4G/LTE architecture.

[28] A more detailed overview of open and disaggregated technologies can be found in the global report published by Analysys Mason in May 2021, see https://www.analysysmason.com/impact-of-open-and-disaggregated-technologies-and-tip/

Innovation and competition in an open supply chain can also drive down unit costs for operators. This would involve the commoditisation of hardware, the use of general-purpose processing platforms, and the deployment of software to enable automation. Operators are particularly interested in open radio access networks (Open RAN),[29] with reductions in the total cost of ownership (TCO) as an envisioned benefit. However, continued growth in the demand for data and supporting infrastructure means that total network investment levels for operators are expected to remain relatively stable, despite the increased efficiency of successive generations of mobile technology. As a result, TCO benefits will likely be realised primarily in the form of better value for investments within existing cost budgets.

Nevertheless, in the long term, a disaggregated system will allow operators to deploy network equipment and new functions more quickly and cost efficiently, and to roll out networks that, with existing cost budgets, are more performant and flexible compared to what would be possible using legacy networks. There is still significant potential for operators to expand coverage and capacity within existing cost brackets in an open and disaggregated environment. Open networks allow operators to use new functions and innovative services to generate new revenue streams. Open networks also introduce greater supplier diversity, which can help to improve supply chain resilience,[30] and potentially also improve network security through transparency and testing at scale.

A more accessible ecosystem offers opportunities for infrastructure providers and innovative operators to experiment with new business models and stimulate broader economic growth. For example, to meet capacity requirements in built-up areas, operators have started to sell their passive infrastructure to independent companies, which would reduce costs for operators through the use of infrastructure sharing. Some operators have opted to go further and share their active infrastructure, such as antennas, which can be enhanced by increased virtualisation of networks. Virtualisation enables infrastructure providers to lease active equipment to operators, charging for capacity used instead of for physical space. This enables the NaaS business model, which relies on active sharing of infrastructure. Decoupling of hardware and software is also enabling innovation in the Wi-Fi business model, and new solutions are emerging to improve the potential of the enterprise case.

As a result of the current vertical integration of network supply chains, many operators today lack the in-house capabilities to manage the integration of multi-vendor components, which is essential to ensure that the overall configuration of the network is optimised. This presents an opportunity for third-party systems integrators based in SSA to play a role in installation, configuration, maintenance operations and security. In the event they are able to take on a greater role in the value chain, these regional integrators could, over time, also expand their suite of offerings to the market, which would further contribute to the speed of innovation and advancement of network features in future.

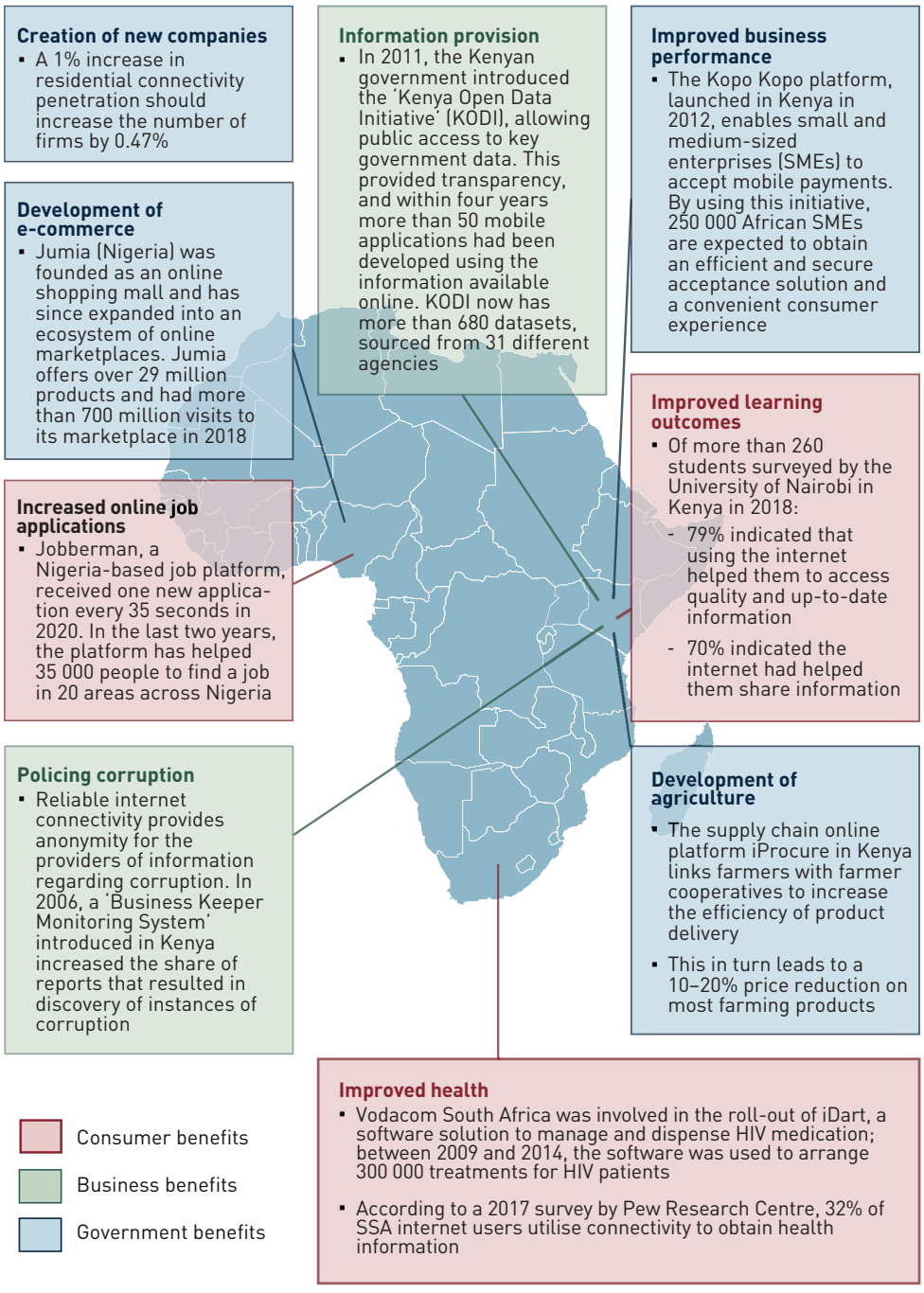
The adoption of disaggregated technologies over the longer term would allow operators to deploy more cost-efficient, flexible and performant networks to increase capacity and support the expansion of coverage to more areas; greater levels of data consumption; and the introduction of new services.

More generally, consumers, businesses and governments would all be in a position to benefit from improved connectivity due to the adoption of digital services, tools and platforms. Examples of how improved connectivity could result in these benefits for SSA are summarised in Figure 2.5.

[29] Refers to the wider industry movement to develop and deploy more open and interoperable hardware and software in radio access networks

[30] Supply chain resilience is an issue that is of increasing concern to operators.

FIGURE 2.5: EXAMPLES OF HOW CONSUMERS, BUSINESSES AND GOVERNMENTS CAN BENEFIT FROM CONNECTIVITY IN SSA
[SOURCE: ANALYSYS MASON, PRESS AND ACADEMIC SOURCES, 2021]



Sources used for this figure include:

Silver L. and Johnson C. (2018), Internet connectivity seen as having positive impact on life in Sub-Saharan Africa; Deloitte (2014), Value of connectivity, economic and social benefits of expanding Internet access; Onyancha O. and Ngulube P. (2018), Internet use among university students in Kenya: a case study of the University of Nairobi; Jobberman website; Lenka S. and Barik R. (2018), Has expansion of mobile phone and Internet use spurred financial inclusion in the SAARC countries?; DIRSI (2014), The Internet and Poverty: Opening up the black box; Internet Society (2017), Promoting the African Internet Economy; American Economic Review (2017), Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers; Malabo Montpellier Panel (2019), Byte by byte, policy innovation for transforming Africa's food system with digital technologies; World Bank; ITU (2012), The impact of broadband on the economy; Kopo Kopo website; GSMA Intelligence (2019), 618 active tech hubs: The backbone of Africa's tech ecosystem; Kenya openData website; Guerriero M. (2015), The impact of internet connectivity on economic development in Sub-Saharan Africa; The World Bank, The Global Findex Database 2017. Measuring Financial Inclusion and the Fintech Revolution; United Nations (2018), E-government Survey.

3 Open and disaggregated solutions are being developed, tested and trialled by African operators, supported by global players

Operators in SSA face a unique combination of market factors that they must navigate to deliver improved connectivity to a continually growing number of people, while managing costs and ensuring their services remain affordable. Many of these operators are already recognising the potential benefits that open and disaggregated technologies could bring in the long run, and are actively exploring the use of these technologies.

TIP, along with a wider ecosystem of organisations that help to drive network disaggregation, is actively engaged with stakeholders in the region that are aiming to use use open and disaggregated solutions for future network requirements.

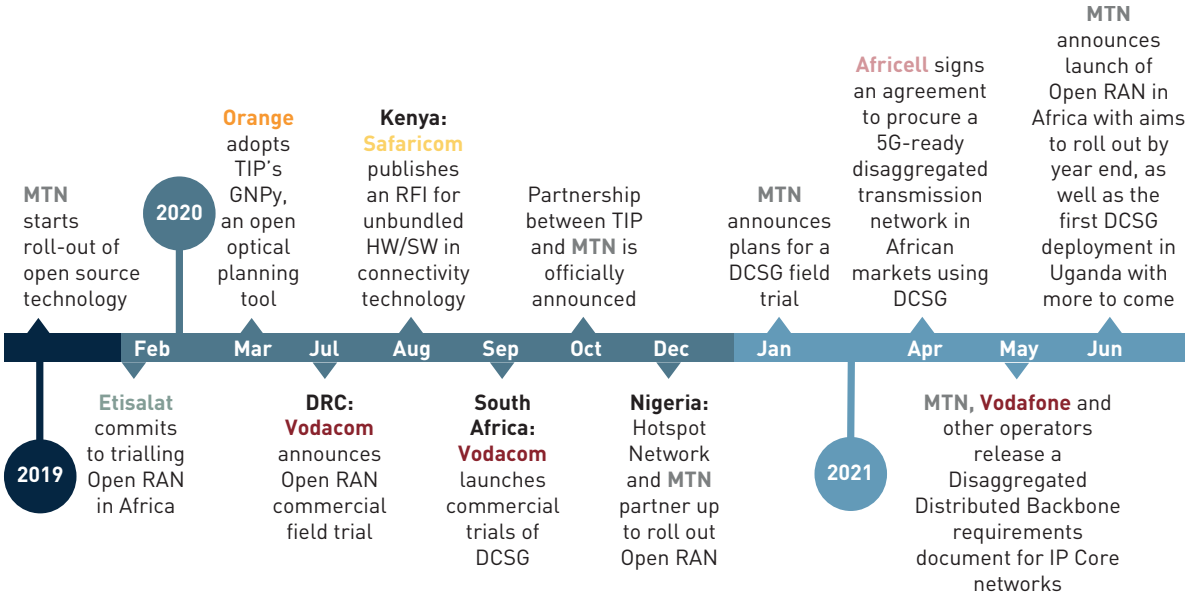
Today, operators are already deploying open and disaggregated technologies for targeted use cases, including the provision of rural networks through NaaS players, fiberisation of sites in dense areas through transport solutions such as the Disaggregated Cell Site Gateway (DCSG), as well as public Wi-Fi connectivity through OpenWiFi.[31]

Operators in many SSA countries belong to larger pan-regional operator groups, and each of these groups has the challenge of working across a set of countries that is relatively heterogeneous in terms of economic growth and telecoms sector development. While operations in some countries are experiencing a boom in demand for data and data-enabled services, operations in other countries are focused on expanding basic mobile coverage to significant portions of the population. Operators have thus had to address a varied set of network priorities in a challenging investment climate.

Most of the large operator groups in SSA have links to TIP and the broader community of stakeholders in the open and disaggregated solution ecosystem, either through direct involvement (e.g. MTN), or through parent companies exploring disaggregated solutions actively in other regions (e.g. Airtel, Vodacom and Etisalat). Operators in SSA have been at the forefront of many TIP collaborations and have also been proactive in the testing and deployment of disaggregated solutions in the market, as shown in Figure 3.1.

3.1 Several major operator groups operating across SSA have been actively exploring the use of open and disaggregated technologies since 2019

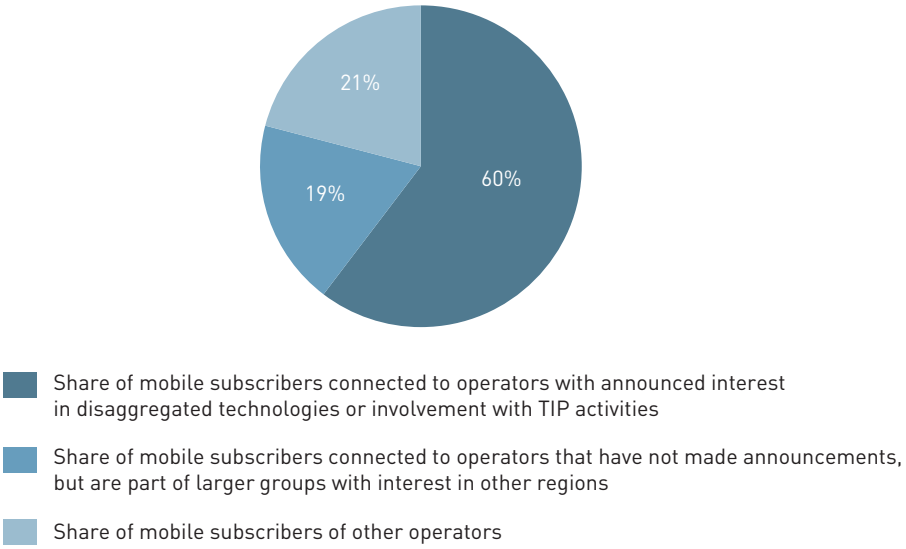
FIGURE 3.1: SNAPSHOT OF ANNOUNCEMENTS BY OPERATORS REGARDING DISAGGREGATED TECHNOLOGIES ACROSS SSA
[SOURCE:OPERATORS' ANNOUNCEMENTS, ANALYSYS MASON, 2021]



[31] These solutions are described in more detail in Section 3.2.

Disaggregation is gaining traction, particularly in larger markets, including Nigeria, Kenya, South Africa, Côte d'Ivoire, Uganda and the DRC. In these six countries combined, operators or wider operator groups serving close to 80% of subscribers have announced an interest in open and disaggregated networks (Figure 3.2).

FIGURE 3.2: MARKET SHARE OF CONNECTIONS OF OPERATORS INTERESTED IN OPEN AND DISAGGREGATED SOLUTIONS IN NIGERIA, KENYA, SOUTH AFRICA, CÔTE D'IVOIRE, UGANDA AND THE DRC [SOURCE: ANALYSYS MASON, 2021]



Across SSA, mobile operators spend over USD7 billion in capex annually.[32] Network investment decisions made by large operator groups with footprints across multiple countries can significantly impact the use of particular technologies in the region.

These announcements made by operators in the region highlight the need for network solutions to become more cost efficient and flexible in future. The proprietary solutions that are embedded in networks today have allowed operators to kick-start demand for data services in recent years, but are unlikely to be able to deliver the same growth in capacity, expansion of coverage, or flexibility in service delivery, that a more open and interoperable ecosystem of diverse suppliers could enable.

3.2 Developments are driven by collaboration between African operators and a global community, including TIP, focusing on building, testing and deploying solutions

Operator groups active in SSA can leverage a wider ecosystem of organisations that help to drive network disaggregation. This wider ecosystem includes standards, specification and requirement-setting organisations, and groups focused on the development of operating systems for use in software-defined networking. Several industry initiatives aim to drive the development of an open ecosystem, including TIP, the O-RAN Alliance, the Open RAN Policy Coalition, and others.

Many of these stakeholders have emphasised the potential that their technologies could have in Africa to enhance connectivity, leading to widespread economic benefits (Figure 3.3 provides a summary of initiatives other than TIP and their involvement in Africa).

[32] See https://www.gsma.com/mobileeconomy/wp-content/uploads/2021/09/GSMA_ME_SSA_2021_English_Web_Singles.pdf

FIGURE 3.3: THE GLOBAL ECOSYSTEM OF INITIATIVES AND THEIR INVOLVEMENT IN AFRICA [SOURCE: ANALYSYS MASON, 2021]

Collaborating group	Activities and involvement in Africa
O-RAN Alliance	Counts major regional operators such as Orange, Airtel and Vodafone among its members[33]
Small Cell Forum	Publishes studies on connecting the unconnected via small cells, with specific reference to the Middle East and North Africa[34]
Open Networking Foundation (ONF)	In February 2021, held an ONF event in Tunisia, with the aim of building the ONF community on the continent[35]
OpenConfig	Has collaborated with TIP and MTN on defining the mandatory use case requirements for software-defined networking transport[36]
Wi-Fi Alliance	In September 2021, published a study forecasting the economic value of Wi-Fi in Africa by 2025, including in the DRC, Kenya, South Africa and Nigeria[37]
Wireless Broadband Alliance	Has published case studies relevant to SSA, including a case study on the future of Wi-Fi in South Africa[38]

Although the above-mentioned groups are crucial players in the aggregation and publication of international standards, they play a limited role in stimulating the development and commercialisation of new products. Within this ecosystem, TIP fosters collaboration to gather technical requirements, facilitates testing and validation of products, and also publishes outcomes of these tests. This provides exposure for new vendor products, and streamlines the process for operators searching for viable solutions.

TIP's particular role is to drive and accelerate commercial deployment of open and disaggregated technologies, by enabling the emergence of fit-for-purpose, validated products and solutions. TIP brings together industry stakeholders to collaborate on open and disaggregated solutions, and has set up a wide range of project groups targeting developments in many network areas based on operator requirements. TIP product project groups focus on specific objectives, across the access, transport and core network sections, targeting distinct parts of the value chain, as seen in Figure 3.4. These groups develop technical requirement documents in consultation with both influential and more niche operators, allowing suppliers to build hardware and software products that can then be tested and trialled in the laboratory and in the field before commercial deployment. Through the TIP 'Test and Validation' framework, products are tested against project group requirements, and the results of these tests are communicated in the form of 'badges' that highlight product conformance and maturity. These badges are highlighted along with vendor product and solution specifications on the TIP Exchange, a portal where operators can access information on specific open and disaggregated solutions for consideration.

TIP has also established several solution project groups. These groups have the wider scope of facilitating end-to-end implementation of specific use cases using products that have been validated by the product project groups. Software project groups, meanwhile, aim to develop open source software to support the use of open and disaggregated network elements.

[33] See https://www.o-ran.org/membership

[34] Small Cell Forum (2015), Business drivers for connecting the unconnected via small cells. Available at https://www.scf.io/en/documents/150_-_Business_drivers_for_connecting_the_unconnected_via_small_cells.php

[35] ONF press release; see https://opennetworking.org/news-and-events/blog/onfs-first-ever-event-in-tunisia-a-step-toward-building-the-onf-community-in-africa/

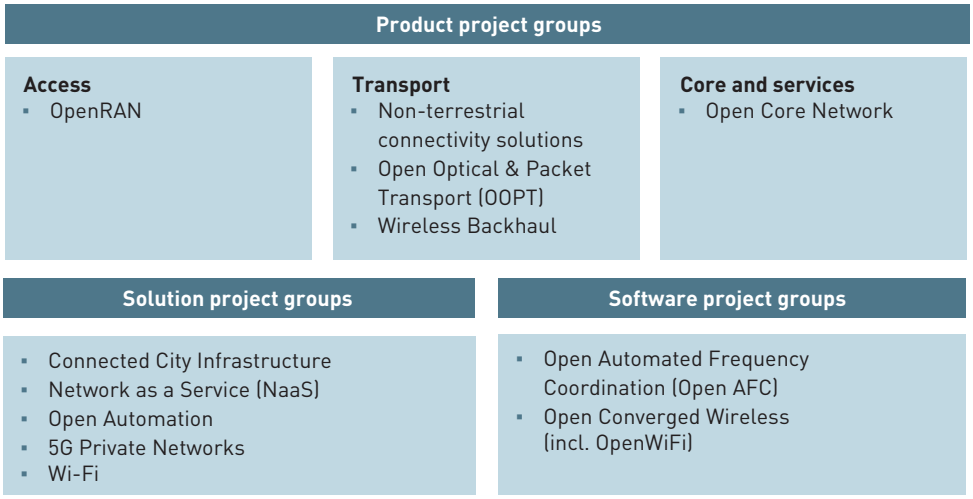
[36] TIP press release; see https://telecominfraproject.com/6-major-operators-to-drive-sdn-for-transport-adoption-and-acceleration-through-telecom-infra-project/

[37] Wi-Fi Alliance press release; see https://www.wi-fi.org/news-events/newsroom/economic-value-of-wi-fi-forecast-in-africa-middle-east-and-india

[38] See https://wballiance.com/case-study-wi-fi-in-south-africa/

By bringing together industry stakeholders to gather technical requirements, test and validate products and solutions, and publish the outcomes of these tests on the TIP Exchange, TIP enables new products and companies to demonstrate their capabilities at scale while reducing the risk for operators. This both encourages innovation and accelerates commercialisation of disaggregated products.

FIGURE 3.4: TIP PROJECT GROUPS [SOURCE: TIP, ANALYSYS MASON, 2021]



Major operator groups in SSA are already testing open solutions and are engaged with the TIP community, either directly, or indirectly through larger parent groups that are already active in other global regions. Further, many African operators have been leaders in commercially deploying TIP products, such as the DCSG, and are also exploring more ambitious endeavours such as Open RAN through the TIP OpenRAN project group. Brief descriptions of key project groups and developments are included in Figure 3.5 below. These project groups are described in more detail in the earlier global report and India report published by Analysys Mason.

FIGURE 3.5: DESCRIPTIONS OF KEY TIP PROJECT GROUPS AND DEVELOPMENTS CONSIDERED [SOURCE: TIP, ANALYSYS MASON, 2021]

Project group / development	Description
OpenRAN	TIP's OpenRAN project group aggregates and publishes technical requirements from operators and gathers a community of vendors and systems integrators to collaborate on trials of new RAN technology.
Open Optical and Packet Transport (OOPT)	The OOPT project group accelerates innovation in optical and IP networks. The different subgroups focus on the development of solutions in the network supply chain in response to operator demand.
OpenWiFi	TIP OpenWiFi is a project managed within the Open Converged Wireless software group. OpenWiFi is a community-developed, disaggregated Wi-Fi software system, offered as free open-source software, that includes both a cloud controller SDK and an Enterprise-grade Access Point (AP) firmware, designed and validated to work with compliant AP hardware.

TIP is actively engaging with stakeholders in multiple countries across the region, as illustrated in Figure 3.6 below.

FIGURE 3.6: SUMMARY OF COUNTRIES ON THE AFRICAN CONTINENT WHERE OPERATORS ARE ACTIVELY INVOLVED WITH TIP
[SOURCE: TIP, ANALYSYS MASON, 2021]

3.3 SSA is positioned to benefit from the promise of open and disaggregated technologies, and operators are already deploying mature open technologies for targeted use cases

Operators in SSA are well placed to benefit from the potential of open and disaggregated technologies in the long term, and are already making use of viable solutions where suitable, including in rural scenarios through NaaS providers, and in transport networks through TIP-incubated solutions such as DCSG and Cassini which would support the fiberisation of sites in dense areas.[39] Open and disaggregated solutions for public and enterprise Wi-Fi could also become more widely used in the short term, with the first such deployment having recently been announced in November 2021.

Disaggregated solutions addressing rural use cases are already available, and new business models and players are leveraging disaggregated solutions to provide connectivity in hard-to-reach areas

In sparsely populated areas, particularly rural areas where economic activity tends to be limited and income levels are low, it is often not cost effective for operators to own and maintain their own networks. Furthermore, the infrastructure designs of large, global vendors do not necessarily emphasise the priorities of SSA operators looking to expand to rural areas. These include the need for equipment adapted to hotter, dustier weather conditions, with a suitable back-up power supply.[40]

[39] This lays a foundation for supporting future growth in data demand, enabling the deployment and use of 5G.

[40] A back-up power supply is important to overcome electricity outtages common in many parts of the region.

An open ecosystem would better enable and incentivise vendors to design solutions that suit specific needs of SSA operators looking to deploy coverage in off-grid areas. These designs might also emphasise the physical security of base stations to guard against battery theft, a problem that operators have encountered in regions where power supply is scarce and particularly valuable.

In SSA, business model innovation based on open and interoperable solutions is already taking place, in the form of wholesale rural network providers that have emerged in recent years to help operators expand coverage in remote regions.

Case study: Rural NaaS providers

The NaaS business model eliminates the need for operators to invest in or maintain their own network infrastructure, and often involves operators being offered network capacity on shared active equipment offered by third-party providers. In this model, the third-party company finances and operates the network, leasing capacity on the network to one or multiple operators. Several variations of this business model have emerged, encouraged by the opportunities of a more dynamic supply chain.

In Africa, several NaaS providers have entered the market by specialising in developing solutions for rural areas. These specifically designed wholesale networks tend to rely on satellite backhaul, and also include solutions to address the intermittent supply of power for mobile sites and other requirements particular to operators in the region. The use of open and disaggregated elements in these solutions not only allows for low-cost deployment with features that directly support the use case, but also allows for updates and upgrades to be made remotely and much more efficiently than more traditional alternatives.

Companies such as Africa Mobile Networks, Vanu, Inc. and NuRAN Wireless are actively playing in this space, and typically run either a revenue share model (in which the operator hands over a split of its customer revenue according to the amount of traffic the network supports), a fixed opex model (in which operators pay the infrastructure provider a monthly fee to utilise its infrastructure) or a hybrid of the two models.

In 2019, Vanu, Inc. was selected by MTN Group to supply up to 5000 sites to extend coverage to off-grid communities,[41] while NuRAN Wireless currently has NaaS contracts with Orange Cameroon and Orange DRC, in which it is solely responsible for the delivery of 2000 turnkey sites.[42]

Africa Mobile Networks operates more than 2000 sites in ten countries as of 2021,[43] and aims to reach almost all countries in SSA.[44] Africa Mobile Networks has also leveraged their local expertise to offer ultra-low-cost-smartphones and has trained local ambassadors to help their communities learn to use them, in order to address affordability and digital literacy challenges.[45]

[41] See https://www.vanu.com/vanu-selected-by-mtn-to-provide-openran-mobile-communications-systems-for-off-grid-communities-across-africa/

[42] NuRAN Wireless press release. See https://nuranwireless.com/investors/nuran-announces-major-network-as-a-service-agreement-with-orange-drc/

[43] See https://www.einnews.com/pr_news/545302571/amn-reaches-milestone-of-one-million-phone-calls-through-new-radio-node

[44] See https://cdn.brandfolder.io/D8DI15S7/at/4fvpmtgwxvj6w2scv3m793/NaaS_Case_Study_AMN.pdf

[45] See https://cdn.brandfolder.io/D8DI15S7/at/fvhtb9fvvjpvjsbbz9s2jbg/NaaS_Case_Study-_Digital_Ambassadors.pdf

Operators have started commercial deployments of open and disaggregated solutions for transport networks, including several TIP-incubated components

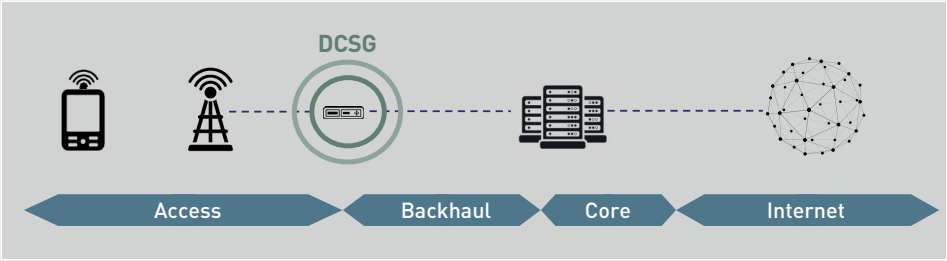
Open and disaggregated technologies have garnered attention throughout SSA, and there are trials investigating the technical and commercial viability of TIP-incubated products in each section of the telecoms network. Transport network products and solutions, in particular, have already been commercially deployed by operators in SSA, as discussed in the case study below.

Case study: Disaggregation of the transport network

There are several methods to connect cell sites in the access network to the core network, including satellite, microwave and fibre-based backhaul. Fiberisation of the mobile network is an increasing priority in major cities, as African operators look to increase the capacity and reduce latency of their transport networks to support 4G and 5G in the future.

Disaggregation enables the flexible deployment of higher-capacity networks, which support faster speeds, at lower costs than proprietary alternatives. Generally, local ISPs and operators rely on the infrastructure of monopolistic incumbents to carry data for their customers. In SSA, many countries are landlocked and there are long distances between major cities, so data transit fees can be very high. Disaggregation allows expansion of local networks using relatively low-cost software and white-box hardware for case-specific solutions. Reduced costs, a wider choice of providers and efficient procurement allows local companies to take ownership of IP transit infrastructure and reduces their reliance on regional incumbents for data transit.

Disaggregation has also enabled further developments in the transport network, including the DCSG, which was developed by TIP's OOPT project group.[46] The device sits between the access network and the backhaul and allows operators to customise their hardware and software choices according to specific requirements. It reduces operational costs, allows quicker upgrades and automates life-cycle management. DCSG technology has already been commercially adopted by various companies in Burkina Faso, Sierra Leone, the Gambia, Cameroon, DRC, Botswana and South Africa.[47]



It is likely that increased competition in the value chain and an ecosystem of invested local companies will stimulate fiberisation, and disaggregated, fit-for-purpose cell-site routers could be installed simultaneously.

[46] See https://telecominfraproject.com/oopt/

[47] TIP, Open and disaggregated technology adoption in Africa

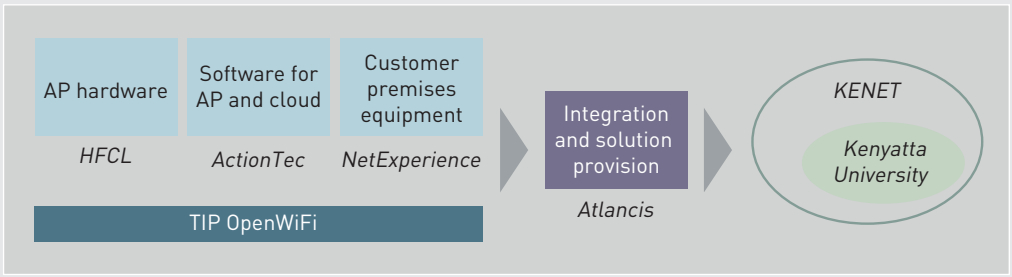
Wi-Fi is expected to contribute to future improvements in connectivity in SSA, and open and disaggregated Wi-Fi solutions are starting to be deployed in the region

The launch of TIP OpenWiFi in May 2021[48] gained traction globally and in India,[49] and has also started to pick up interest in SSA. OpenWiFi is a community-developed disaggregated Wi-Fi software system, which contains a cloud controller software development kit (SDK) and enterprise-grade access point (AP) firmware, that can be used together with compliant 'white-box' AP hardware.[50] A disaggregated ecosystem of hardware and software providers for Wi-Fi would allow operators of enterprise and public Wi-Fi to assemble Wi-Fi networks that are more cost efficient and flexible, and that can be tailored to support a larger variety of features for end users. The case study below highlights recent developments related to open and disaggregated Wi-Fi solutions in SSA.

Case study: Open Wi-Fi solutions for public and enterprise use cases in SSA

Open and disaggregated solutions for Wi-Fi can also help to drive improvements in connectivity across the SSA region. A study published in September 2021 by Telecom Advisory Services for the Wi-Fi Alliance suggests that the economic value of Wi-Fi, including the potential effect of Wi-Fi 6,[51] for Cameroon, DRC, Gabon, Kenya, Nigeria, Senegal, South Africa and Uganda, could reach over USD100 billion in 2025.[52]

The Kenya Education Network Trust (KENET), a not-for-profit membership operator incorporated to support research and education institutions, announced in November 2021 an agreement to deploy the first commercial application of TIP OpenWiFi in SSA to provide connectivity for about 60 000 students and 5000 faculty and staff members at Kenyatta University.[53] The deployment involves multiple TIP ecosystem solution partners, with Wi-Fi integration services provided by Atlancis Technologies (also mentioned in the supply chain case study in Section 4), a regional systems integrator that has taken steps toward becoming Africa's first 'Open OEM'.



Through more deployments such as these, open and disaggregated solutions for Wi-Fi would be able to unlock connectivity expansions and improvements through various public and enterprise use cases across the SSA region in the coming years.

[48] See https://telecominfraproject.com/openwifi-unveiling/

[49] See https://telecom.economictimes.indiatimes.com/news/hfcl-i2e1-team-up-to-provide-pm-wani-wifi-in-karnatakas-baidebettu-village/83805096

[50] See https://telecominfraproject.com/openwifi/

[51] Wi-Fi 6 is the sixth generation of Wi-Fi, which offers higher performance, improved speeds and lower latency compared to previous generations

[52] See https://www.wi-fi.org/download.php?file=/sites/default/files/private/The_Economic_Value_of_Wi-Fi-A_Global_View_2021-2025_202109.pdf

[53] See https://www.kenet.or.ke/content/kenet-deploys-first-commercial-openwifi-solution-africa-0

4 Open RAN may take time to gain traction in SSA, but could ultimately generate USD44 billion in GDP from 2021 to 2030

Compared to operators in other global regions, large-scale deployment of Open RAN solutions would be difficult for operators in SSA to implement in the short term. Challenging unit economics and operating environments, as well as the ongoing relevance of legacy technologies, could prompt operators to opt for more proven vendor solutions, which can be perceived as less risky.

Over the longer term, however, operators in SSA could reap the full benefits of 5G as soon as disaggregated technologies reach a sufficient level of price and performance, and could also rely more heavily on systems integrators based in the region that are currently building up expertise in integrating open and disaggregated solutions. Smaller or newer operators that are less constrained by legacy proprietary networks could start to deploy open and disaggregated technologies more readily in greenfield[54] environments.

Quantitative economic impact modelling suggests that in SSA, Open RAN could add USD15 billion to real GDP per annum by 2030, with cumulative gains over 2021 to 2030 reaching USD44 billion. These estimates are based on more conservative assumptions regarding the pace of Open RAN adoption by operators, compared to the previous global and India reports,[55] to reflect short-term challenges in the SSA region. Effectively addressing these challenges to the adoption of Open RAN could result in up to three times the estimated GDP impact, reaching USD135 billion in cumulative additional real GDP from 2021 to 2030.

4.1 Open RAN is still maturing, and while less likely to be adopted by operators in SSA in the short term, could unlock longer term opportunities for the region

Operators in SSA have started testing Open RAN solutions, focusing on markets that have a lower population density. In 2020, for instance, Orange launched its first commercial deployment of Open RAN in rural parts of the Central African Republic.[56]

However, the large-scale adoption of Open RAN more widely across SSA is constrained by a number of barriers in the short term. These barriers need to be addressed in order to pave the way for large-scale take-up of these solutions in the longer term, and include:

- ongoing support for legacy technologies such as 2G and 3G (thus far, Open RAN vendors have placed less emphasis on these technologies)
- the need for proven reliability and cost benefits in a region where efficiency is critical
- a relatively high reliance on incumbent vendors for systems integration.

In spite of these barriers, operators are actively engaging with new vendors that provide open and disaggregated solutions during their procurement processes. Operators would be well positioned to capitalise on more mature disaggregated 5G solutions over the longer term, once the region is in a position to deploy 5G at scale in several years. Smaller operators with fewer legacy network constraints might also have the opportunity to roll out disaggregated 4G RAN networks more readily, avoiding lock-in to proprietary infrastructure and sidestepping compatibility issues.

Challenging unit economics, operating conditions, and the widespread use of legacy technologies, could lead some operators to opt for more proven solutions over technologies that are still maturing

In SSA, operators typically face greater constraints than operators in other regions in terms of the cost efficiency and reliability of solutions. This is due to the challenging unit economics of deployment and difficult operating conditions across the SSA region. In particular, intermittent power supply, high temperatures and humidity, as well as site security concerns, has meant that even more established incumbent vendors have faced challenges when deploying sites in certain areas. Any newly deployed solution must thus be proven to be reliable, and also compatible with other key requirements such as power-delivery and satellite backhaul solutions for certain regions.

[54] Involves deploying sites in locations that were not previously built on

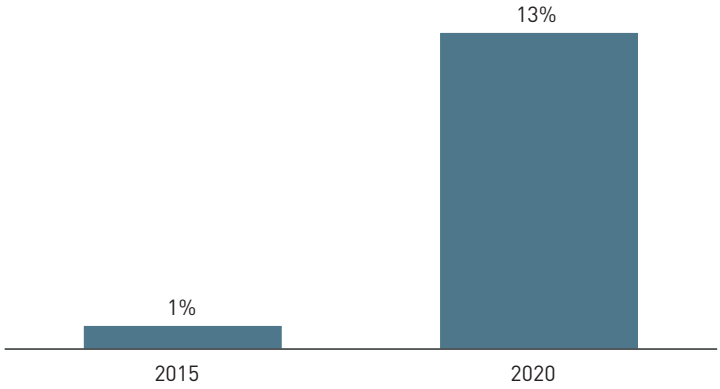
[55] See https://www.analysysmason.com/impact-of-open-and-disaggregated-technologies-and-tip/

[56] Parallel Wireless press release, see https://www.prnewswire.com/news-releases/parallel-wireless-helps-to-deliver-on-oranges-open-ran-vision-in-central-african-republic-301092745.html

Some operators may therefore take a more conservative stance on the adoption of disaggregated solutions in the short term. This is particularly likely if the ecosystem has yet to reach sufficient scale for operators to achieve tangible TCO benefits, or if the solutions have yet to be refined in the context of SSA-specific requirements. Operators may instead be more comfortable adopting solutions from more established incumbents with a proven track record in the region, while continuing to participate in the open ecosystem and trial disaggregated solutions in the short term, before committing to wider-scale deployments of these solutions in the longer term.

Operators in SSA also expect 2G and 3G to continue to be relevant for several more years. Although some operators in the region have been deploying 4G more widely in recent years, 4G connections only account for a small share of total connections in the region (see Figure 4.1).

FIGURE 4.1: 4G CONNECTIONS AS A SHARE OF TOTAL MOBILE CONNECTIONS IN SSA
[SOURCE: ANALYSYS MASON RESEARCH DATAHUB, 2021]



Many new vendors building on open and disaggregated principles have so far focused on hardware and software for 4G, as the technology would be applicable across more global settings than 2G and 3G. The relative immaturity of 4G in SSA provides an opportunity to 'leapfrog' to open and disaggregated solutions, but this is still perceived as risky by many operators.

As mentioned in Section 2, most operators in SSA remain reliant on 2G and 3G revenue, and are keen to ensure that their upgrade path to 4G is compatible with their existing networks. This may make it easier for those operators to buy their 4G solutions from incumbent vendors, rather than invest in new 'all G'[57] disaggregated solutions provided by newer vendors.

Operators with fewer legacy constraints are more likely to adopt open solutions today, while other operators continue to monitor the development of these solutions ahead of wider 5G deployment

Smaller or newer operators that have fewer legacy network constraints might be able to take advantage of open and disaggregated solutions to deploy 4G more readily and widely in the short term. Operators that have not yet started to deploy 4G with proprietary solutions, and that do not have large proprietary 2G and 3G networks to manage, could also find it less costly to deploy open and disaggregated 4G solutions in the near future. This could help these smaller and more nimble operators to differentiate their offerings and gain competitive advantages in new ways, particularly in areas where they are less constrained than larger operators by legacy networks.

While larger operators are less likely to opt for large-scale deployment of open and disaggregated solutions offered by new vendors in the short term, they are actively engaging with these new vendors during procurement. This could incentivise incumbent vendors to reduce the prices of their proprietary solutions or offer open solutions of their own, in

[57] Refers to solutions covering all generations of mobile technology (i.e. 2G/3G/4G/5G)

response to the competitive threat. The bulk of subscribers in SSA are served by large operator groups with operations that span multiple countries, and the scale of these operators are likely to help in negotiations with incumbent vendors, which could push these vendors to open up their portfolios more over time.

In the context of the 5G use case, wide-scale demand for 5G in SSA remains several years away, and operators are likely to wait until solutions, both proprietary and open, mature further before making heavy investments in the technology.[58] Considerable progress is being made in the 5G Open RAN space, and over time disaggregated solutions are expected to narrow the gap with proprietary ones in terms of performance requirements. In April 2021, Vodafone and Qualcomm announced plans to develop technical blueprints to help equipment suppliers cater for 5G Open RAN applications.[59] If more of such developments are successful, disaggregated solutions are more likely to reach performance parity[60] with proprietary solutions for new use cases that require more advanced technologies, by the time these use cases become more relevant for SSA.

At present, operators in the region are dependent on incumbent vendors for systems integration expertise, but may increasingly engage third-party systems integrators based in the region

Typically, large incumbent vendors with headquarters in Europe and Asia fly resources into African countries as and when they are needed to maintain, upgrade and reconfigure their proprietary networks. A multi-vendor ecosystem, on the other hand, will require operators to either build their own in-house capabilities, outsource systems integration to local or regional third-party providers, or more realistically, do some of both. Smaller operators, that are more dependent on incumbent vendors for systems integration and also, in some cases, for vendor financing, would be less likely to develop in-house capabilities.

Many of the larger multinational operators, however, have started to invest in internal capabilities to manage cloud and automation in areas such as IT and core systems: MTN, for instance, has an internal Cloud Centre of Excellence. As technologies become more mature, these larger operators are expected to scale up their internal teams to manage disaggregated solutions in other areas such as transport and access networks.[61] Larger operator groups are likely to also prefer to minimise the number of third-party systems integration partners to whom they outsource activities. These operator groups have the scale to incentivise systems integrators to expand their presence into new markets to cover integration requirements across entire operator group footprints, introducing expertise to new markets and workforces.

African companies in the telecoms supply chain have historically been more engaged in the distribution of equipment to enable the expansion of mobile networks. Some companies have also been involved in providing systems integration or managed services, but few can be considered vendors. Increased demand for systems integration to integrate disaggregated components could provide local or regional companies with a greater foothold in the supply chain. Over time, this might allow them to expand their offerings, building on existing skillsets and acquiring skills required in adjacent segments. The case study below provides several examples of companies in the region that are actively involved in the open and disaggregated supply chain ecosystem.

[58] See https://developingtelecoms.com/telecom-business/q-and-a-interviews/10925-interview-airtel-africa-s-razvan-ungureanu.html

[59] The partnership brings together Vodafone's experience of building high-capacity networks at scale with Qualcomm's expertise in high-performance, lower-power application-specific integrated circuit solutions, aiming to ensure that Open RAN is ready for use in high-density areas; see Qualcomm press release at https://www.qualcomm.com/news/releases/2021/04/29/vodafone-and-qualcomm-blueprint-open-ran-vendor-diversification

[60] Reaching parity on performance for features that operators would demand for each specific use case, noting that traditional vendors can include more features than strictly necessary in bundles offered to operators.

[61] Expertise in managing cloud and automation is relevant to Open RAN, for example. One of the main objectives that operators are trying to achieve by moving toward open and disaggregated network solutions for RAN, is to be able to source software components from a wider variety of providers, in order to assemble end-to-end solutions with embedded intelligence and that make use of automation for better operational efficiency. This is similar to the effects of 'cloudification' seen in core and IT networks over the past few years.

Case study: More African companies can enter the supply chain

In an open and disaggregated supply chain, opportunities will arise for more companies to provide services to operators. The systems integrators that are emerging in SSA are increasingly looking to capitalise on disaggregated technologies to enter different parts of operator value chains.

Atlancis Technologies, headquartered in Kenya, has been a proponent of the Open Compute Project in the data-centre market since discovering the significant cost-saving effects of utilising commodity hardware to build its own cloud platform.[62] It is increasingly involved in offering systems integration services to local operators, and is actively involved in the TIP community, with an eye to offering these services in more network areas.

Infin8Africa, headquartered in South Africa, has also been active in the TIP technology ecosystem. For example, it provided integration services for a trial of DCSG solutions for Comsol Networks, an internet service provider (ISP) in South Africa, which also involved a network operating system (NOS) from IP Infusion, and hardware from Edgecore.[63]

Although local manufacturing of software and hardware is limited in SSA at present, there is an opportunity for local companies to capitalise on existing relationships with operators and expand into these markets. For example, a systems integrator might choose to introduce equipment assembly facilities to guarantee spare parts to its operator customers, to underpin service-level agreements.

4.2 Improvements in connectivity from Open RAN, in terms of mobile internet penetration and data traffic, could drive USD44 billion in cumulative GDP by 2030

The approach used in this report to quantify the potential economic impact of Open RAN for 46 countries in SSA,[64] is the same approach used in the previous global and India reports published by Analysys Mason earlier in 2021.[65] Slightly different input assumptions have been used to reflect differences between SSA and the rest of the world, as discussed further below.

Radio access networks are fundamental to mobile networks, concentrating most of the investment and operational complexity for most operators

The RAN is the section of the mobile network closest to end users, and it accounts for the majority of the cost of upgrading and expanding the footprint to offer wider coverage. The RAN section constitutes over 60% of the TCO, which means that savings on new deployments and upgrades in this area are likely to have a significant impact on overall network economics.

Open RAN solutions promise such cost savings, allowing benefits to be passed on to end users by either reducing unit data prices and driving the adoption of mobile internet or enabling increased usage of data services for equivalent price points. Overall, this would lead to significant societal benefits and increases in country-level gross domestic product (GDP).

Adoption of Open RAN in SSA is likely to be slower than in other regions of the world as a result of the challenges operators face, catching up with the global average as the technology matures

In this report and in the context of SSA, we have assumed a slightly less optimistic end point, and a slower ramp-up in adoption of Open RAN compared to our assumptions regarding low-income countries in the global report, and India in the second report (see Figure 4.2). This is due to ongoing supplier arrangements with incumbent vendors, uncertainty in the short term regarding the suitability of new open and disaggregated solutions for region-specific needs, as well as integration issues with legacy networks. It should be noted that figures across the three reports are not completely comparable; more recent developments that have informed assumptions in the India and SSA reports would not have been taken into account during the global study earlier in 2021.

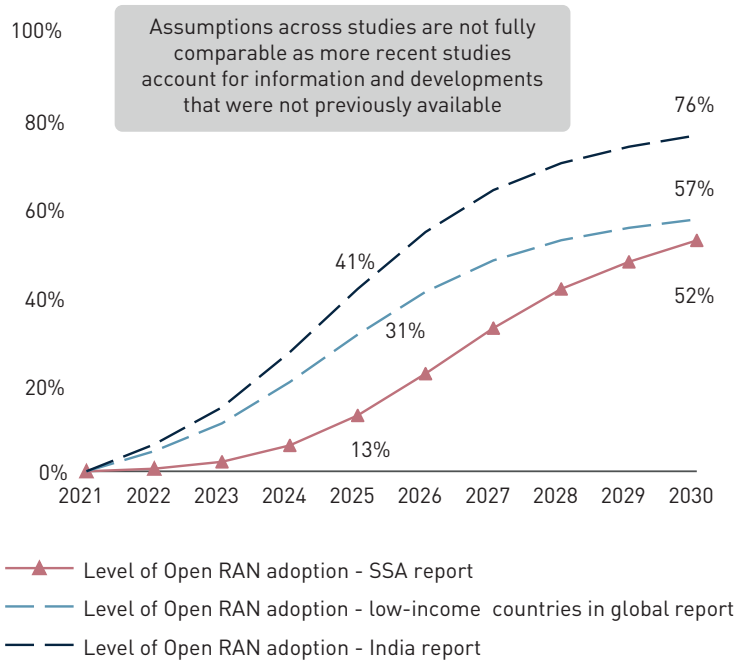
[62] See https://atlancis.com/

[63] See https://www.itweb.co.za/content/VgZeyvJo64p7djX9

[64] See Annex A for the full list of countries

[65] See https://www.analysysmason.com/consulting-redirect/reports/impact-of-open-and-disaggregated-technologies-and-TIP/

FIGURE 4.2: LEVEL OF OPEN RAN ADOPTION IN THE MARKET FOR THE SSA BASELINE CASE [SOURCE: ANALYSYS MASON, 2021]



In the long term, Open RAN networks are expected to be more cost efficient than equally performant proprietary networks. Although the cost of proprietary networks is forecast to decrease over time (through infrastructure sharing and a degree of virtualisation), Open RAN is expected to lead to even greater cost reductions through the added benefits of supply chain competition, increased innovation and the impact of enhanced virtualisation and automation. This comparatively reduced cost would allow operators to either operate a lower-cost network or to upgrade the capabilities of their networks within a similar cost envelope.

As in the global report and the subsequent study on India, we have modelled the benefits of Open RAN as a larger reduction over time in RAN costs (including capex and opex) as a share of recurring revenue. RAN cost reduction using Open RAN is compared to a scenario in which only traditional solutions are available (we call this scenario the 'counterfactual' in the remainder of this section).[66] In the Open RAN case, RAN opex is assumed to be 3% lower by 2025 and 10% lower by 2030. RAN capex is assumed to be 15% lower than that of a comparable traditional network by 2025, and to be 20% lower by 2030. The model cost inputs are summarised in Figure 4.3.

[66] The model covers the costs supporting recurring mobile revenue that is generated at present, and does not consider additional costs needed to support new services and revenue streams that could emerge in coming years, which could be significant (e.g. costs to serve specialised enterprise requirements through 5G).

FIGURE 4.3: MODEL COST INPUTS FOR SSA [SOURCE: ANALYSYS MASON, 2021]

As a share of recurring revenue (as a share of total revenue, assuming constant recurring share)	2020[67]	2030 (counterfactual)	Open RAN by 2030 vs. counterfactual	2030 (baseline)
Opex				
Network (RAN) opex	29% (26%)	27% (24%)	–10%	24% (22%)
Network (non-RAN) opex	18% (16%)	15% (14%)	Not captured in model	15% (14%)
Non-network opex	25% (22%)	23% (21%)		23% (21%)
Total opex	72% (65%)	66% (59%)		63% (57%)
Capex				
Network (RAN) capex	8% (7%)	8% (7%)	–20%	7% (6%)
Network (non-RAN) capex	7% (6%)	7% (6%)	Not captured in model	7% (6%)
Non-network capex	4% (4%)	4% (4%)		4% (4%)
Total capex	19% (17%)	19% (17%)		17% (16%)
Total cost				
Total opex + capex	91% (82%)	84% (76%)		80% (72%)

In the baseline case in which the cost of the network is lower for operators, benefits would be passed on to end customers by reducing the end unit prices compared to the counterfactual. We have tracked the level of price decline to the Herfindahl–Hirschman Index (HHI),[68] and to the long-term level of Open RAN adoption. Higher long-term Open RAN adoption in a more competitive market (i.e. lower HHI) will yield greater benefits to consumers in the form of increased data consumption along with lower average revenue per user (ARPU).

We then quantified the impact that increased mobile penetration and data usage will have on GDP. A similar set of assumptions are used here as was used for the low-income country group in the global report and the India report, but with adjustments to the parameters regarding the percentage point increase in viable mobile internet coverage for a given change in deployment cost, as well as the percentage increase in GDP per capita from an increase in mobile internet penetration (see Figure 4.4). These adjustments reflect the levels of population dispersion and economic output in SSA relative to other regions in the world. The model assumes a progressive adoption of Open RAN, which means that most of the benefits are generated closer to 2030.

[67] The 2020 starting point inputs are based on historical figures from 2012 to 2019, to control for the impact of the Covid-19 pandemic, and as this modelling approach does not explicitly account for year-on-year business cycle effects.

[68] The Herfindahl–Hirschman Index is a common measure of concentration in a market, and is calculated as the sum of the square of each firm's market share, with a higher HHI indicating a more concentrated (and probably less competitive) market.

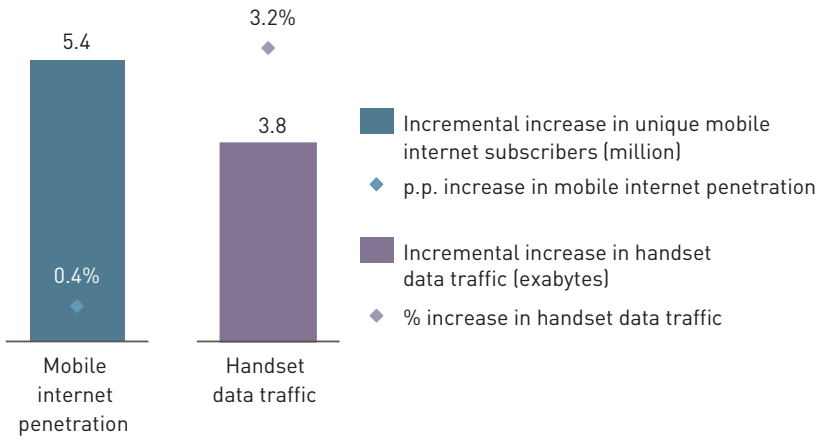
FIGURE 4.4: SSA BASELINE CASE PARAMETERS FOR IMPACT ON GDP FROM GREATER MOBILE INTERNET PENETRATION AND INCREASED MOBILE DATA USAGE [SOURCE: ANALYSYS MASON, WORLD BANK GROUP, ITU, 2021]

Parameter	Value
Impact of greater mobile internet penetration on GDP	
Percentage point (p.p.) increase in viable mobile internet coverage (% of population) for a 10% reduction in cost of rural deployment[69]	2.5 p.p.
Percentage (%) increase in penetration (% of covered population) from a 10% decline in mobile broadband plan prices[70]	3.2%
Percentage (%) increase in GDP per capita from a 10% increase in mobile broadband penetration[71]	2.5%
Impact of increased mobile data usage on GDP	
Assumed acceleration of advanced technology (4G / 5G) take-up by 2030 (in years) due to adoption of Open RAN	1.0
Year-on-year percentage increase in GDP per capita from a doubling of data usage per mobile internet connection[72]	0.8%

The resulting increases in data usage and connected users would drive economic growth, with benefits modelled to reach USD44 billion cumulatively by 2030 in the baseline case

By 2030, modelling suggests that relative to the counterfactual, SSA could see 5.4 million more unique mobile internet subscribers thanks to the adoption of Open RAN, and an additional 3.8EB consumed per annum by handset users, as shown in Figure 4.5 below.

FIGURE 4.5: INCREMENTAL INCREASE IN UNIQUE MOBILE INTERNET SUBSCRIBERS AND HANDSET DATA TRAFFIC CONSUMED PER ANNUM BY 2030 [SOURCE: ANALYSYS MASON, 2021]



[69] Based on recent Analysys Mason project experience related to the viability of rural connectivity solutions, which involved calculating the net present value of rural deployments, accounting for costs and revenue potential.

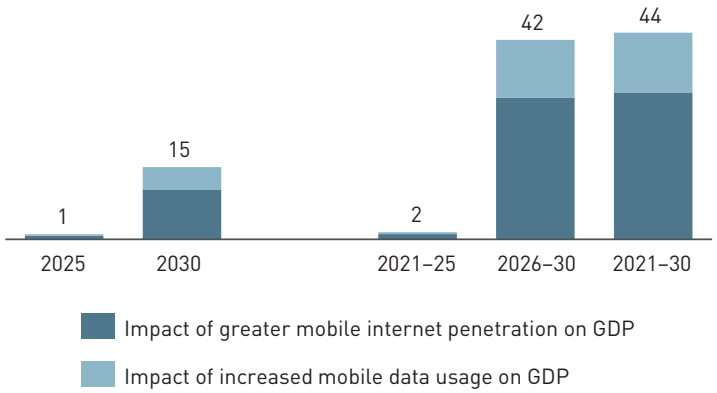
[70] World Bank Group, Broadband Strategies Toolkit. Available at https://ddtoolkits.worldbankgroup.org/broadband-strategies

[71] International Telecommunication Union (2018), The economic contribution of broadband, digitalization and ICT regulation. Available at https://www.itu.int/pub/D-PREF-EF.BDR-2018

[72] Analysys Mason (2020), Economic impact of Google's APAC network infrastructure. Available at https://www.analysysmason.com/consulting-redirect/reports/impact-of-google-network-APAC-2020/

Over the 2021–30 period, modelling suggests that Open RAN could generate USD44 billion in incremental GDP (at 2020 prices) in the SSA region by accelerating growth in mobile internet penetration and data usage. Since the model assumes a progressive adoption of Open RAN, most of the benefits are thus generated in the latter half of the decade, with the modelled economic impact of Open RAN reaching USD15 billion in 2030, as seen in Figure 4.6.

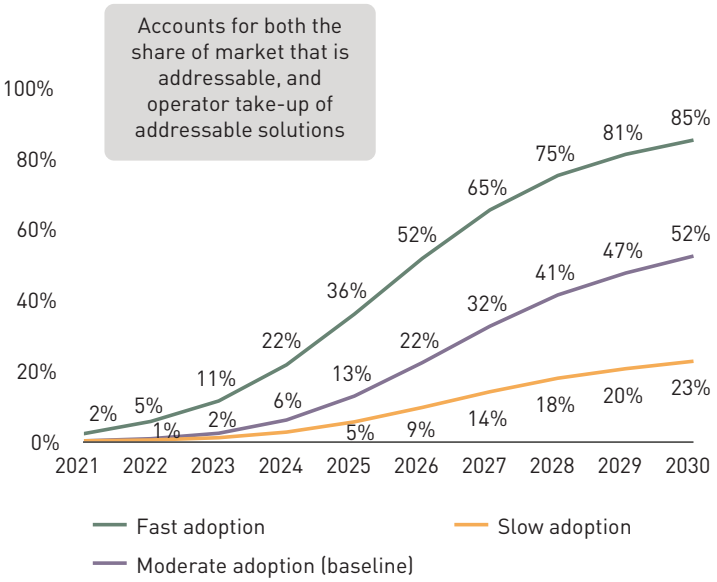
FIGURE 4.6: IMPACT OF OPEN RAN ON REAL GDP DUE TO INCREASED MOBILE INTERNET PENETRATION AND ACCELERATED GROWTH IN DATA USAGE (USD BILLION) [SOURCE: ANALYSYS MASON, 2021]



4.3 Faster adoption and greater efficacy of Open RAN could triple its economic impact to a cumulative USD135 billion by 2030

As in the global report and India report, we considered two sensitivities that might affect the economic impact of Open RAN. The first sensitivity is the pace of operator adoption of Open RAN. For this sensitivity, we modelled 'fast adoption' and 'slow adoption' cases, resulting in a range of possible outcomes around the baseline 'moderate adoption' case for SSA. These adoption curves are shown in Figure 4.7.

FIGURE 4.7: RESULTING LEVEL OF OPEN RAN ADOPTION IN THE MARKET, BY ADOPTION SCENARIO [SOURCE: ANALYSYS MASON, 2021]



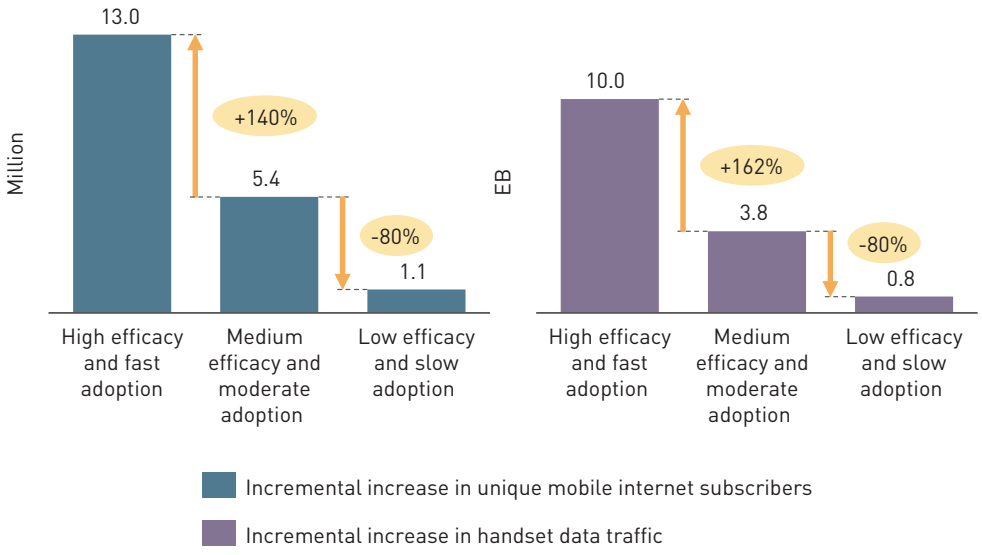
We also modelled different levels of efficacy that might be achieved by Open RAN solutions. Efficacy is measured in terms of both cost efficiency and the potential acceleration in take-up of advanced technologies due to Open RAN. Assumptions to denote different efficacy levels are presented in Figure 4.8.

FIGURE 4.8: ASSUMPTIONS USED FOR HIGH- AND LOW-EFFICACY POTENTIAL CASES RELATIVE TO BASELINE [SOURCE: ANALYSYS MASON, 2021]

	High efficacy	Medium efficacy (baseline)	Low efficacy
RAN cost levels vs. counterfactual (%)			
RAN opex (2025)	–4.5%	–3.0%	–1.5%
RAN opex (2030)	–15.0%	–10.0%	–5.0%
RAN capex (2025)	–22.5%	–15.0%	–7.5%
RAN capex (2030)	–30.0%	–20.0%	–10.0%
Acceleration of 4G/5G take-up vs. counterfactual (years)			
By 2025	0.75	0.50	0.25
By 2030	1.50	1.00	0.50

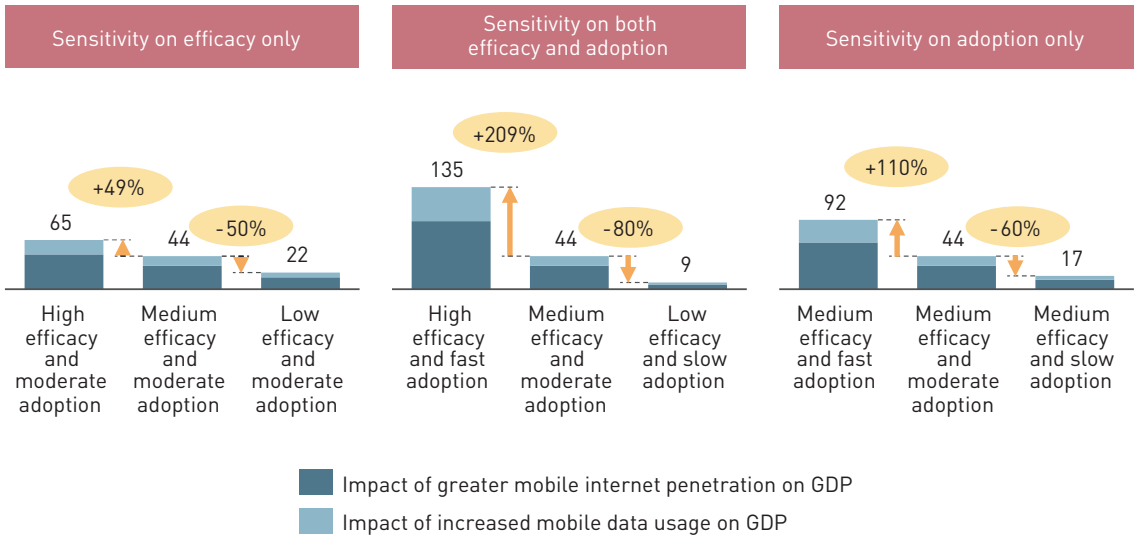
The resulting combinations of both sensitivities, on the pace of adoption of Open RAN, as well as the efficacy of Open RAN, result in a range of outcomes, the extremes of which are the 'high efficacy–fast adoption' case and the 'low efficacy–slow adoption' cases, which would result in either significantly higher or lower increases in unique mobile internet subscribers connected and data traffic consumed by handset users in 2030, as shown in Figure 4.9.

FIGURE 4.9: SENSITIVITY ANALYSIS ON HIGHER- AND LOWER-EFFICACY POTENTIAL AND FASTER AND SLOWER ADOPTION OF OPEN RAN ON CONNECTIVITY METRICS IN 2030 [SOURCE: ANALYSYS MASON, 2021]



As a result of these differences in connectivity outcomes, the impact of Open RAN adoption on GDP would also differ significantly between scenarios, as shown in Figure 4.10. In the most optimistic case, there is potential for the impact on GDP to be tripled compared to the baseline case considered previously.

FIGURE 4.10: SENSITIVITY ANALYSIS ON HIGHER- AND LOWER-EFFICACY POTENTIAL AND FASTER AND SLOWER ADOPTION OF OPEN RAN ON REAL GDP, 2021–30 (USD BILLION) [SOURCE: ANALYSYS MASON, 2021]



The actual pace of adoption of Open RAN and efficacy of Open RAN solutions that will be seen in future will be affected not only by the actions of operators, vendors, systems integrators, TIP or other organisations in the open and disaggregated ecosystem, but also by policy makers and other stakeholders such as local and regional industry bodies, and organisations that provide development finance.

5 More stakeholder support is needed to unlock the full potential of open and disaggregated solutions in SSA

This final section develops some conclusions and recommendations on how to make the most of the opportunities created by the trend towards open and disaggregated technologies in SSA. First and foremost, realising the full benefits of disaggregation will require industry-wide collaboration and initiative, from which all players in the value chain, including operators, vendors, and systems integrators, stand to gain.

TIP is taking an active role, together with operators and vendors already active in SSA. More active involvement and support from local and regional industry bodies and development finance organisations can also help to accelerate the development and adoption of disaggregated solutions that suit specific SSA requirements.

For policy makers in the region, improving connectivity is often seen as a key priority, and relevant policy objectives often also extend to the development of digital skills among the population to support a growing digital economy. Open and disaggregated technologies, if adopted at scale, would be able to contribute significantly to these policy objectives, which suggests that policy makers should consider taking a more active role in facilitating the development and adoption of these solutions.

5.1 Vendors, systems integrators and operators need to remain focused on maintaining openness and interoperability to maximise the economic benefits of these technologies

Many companies in the SSA region are actively exploring open and disaggregated solutions as part of a wider international community, but there is still a need for greater levels of collaboration between operators and supply chain partners within the region, better access to testing facilities, and sharing of best practice across multiple stakeholders, to accelerate the deployment of open and disaggregated solutions in the SSA context.

Vendors, systems integrators and other infrastructure providers will be able to enter the supply chain and offer services applicable to operators in the region

Disaggregation presents new opportunities for all supply chain participants. New or existing vendors can tailor their infrastructure to fulfill the particular requirements of SSA operators on a smaller scale, while remaining profitable. Systems integrators with local expertise and connections might emerge to fill gaps left by incumbent vendors. Meanwhile, infrastructure providers with inventive business models, such as rural NaaS providers, are already stepping up to reduce roll-out risk for operators in rural areas, through specialised equipment designs that suit off-grid rural contexts.

Operators would stand to benefit by collaborating across more platforms to maximise the sharing of expertise

Disaggregation creates flexibility for operators, providing the tools for them to set their own context-dependent roadmap and expand into areas which are more sparsely populated, with the help of rural wholesale networks featuring low-cost network infrastructure. Disaggregation also serves to accelerate virtualisation and network automation, and facilitates infrastructure sharing which would be beneficial for SSA operators in the long term. More collaboration across operators, including both larger operator groups as well as smaller players, would benefit the region as a whole, particularly as the industry considers more innovative models for efficient network deployment, such as active sharing, in future.

5.2 More engagement of region-specific industry bodies, including development finance organisations, would accelerate open solution availability and adoption

More support from local and regional industry bodies, as well as organisations that provide development financing, would help the open and disaggregated ecosystem to develop solutions that are more suited to region-specific requirements.

Local and regional industry bodies can help to foster more collaboration within the region

The ecosystem of open-network advocates drives global standards-setting and commercialisation of disaggregated technologies, and has made strides internationally. However, there are still opportunities for collaboration with local and regional industry groups on a country-by-country basis.

Local or regional representation would be instrumental in developing a bespoke set of requirements particular to the region's connectivity use cases, as well as in driving disaggregation effectively in the region. Groups such as the Southern Africa Network Operators Group (SAFNOG), the Internet Service Providers' Association (ISPA), Wireless Access Providers' Association of South Africa (WAPA), the Alliance for Affordable Internet (A4AI), and others, are actively engaged with local operators, vendors and other industry participants. These groups are already involved in various industry co-ordination activities, including facilitating discussion about regional matters between industry and regulators, facilitating self-regulation and disseminating best practice among companies.

Such local and regional industry groups have established relationships with regional players, an understanding of the local context and are already known to national government, making them potentially important partners in driving network disaggregation in the region.

Greater availability of funding from development finance organisations would also reduce barriers to the adoption of open and disaggregated technologies

In an attempt to accelerate technology adoption and maturation, some operators in SSA are also exploring the use of development finance to subsidise the development and deployment of open and disaggregated technologies, rather than opting for proprietary alternatives. Until the technical and commercial viability of certain open and disaggregated solutions can be demonstrated in specific regional contexts, it would be unlikely that operators would be willing to invest in larger-scale deployments of these technologies.

In September 2021, TIP and the International Finance Corporation (IFC) announced their collaboration to accelerate the deployment of cost-effective networks in underserved areas using NaaS business models.[73] The announcement included an invitation to other funding organisations to participate in the ecosystem. Added funding from new sources would allow operators and other providers to more comfortably deploy new disaggregated networks and business models in the short term, make the investments necessary for supply chain providers to gain experience in meeting region-specific needs, and build scale for wider and more cost-effective deployments across the region in future.

5.3 Open and disaggregated technologies can support government policy, and regulators and policy makers should recognise and emphasise this role

Policy makers in SSA view connectivity as a key enabler of economic growth. Open and disaggregated technologies have the potential to substantially improve connectivity, and policy makers could play an important role in driving the development and adoption of these solutions.

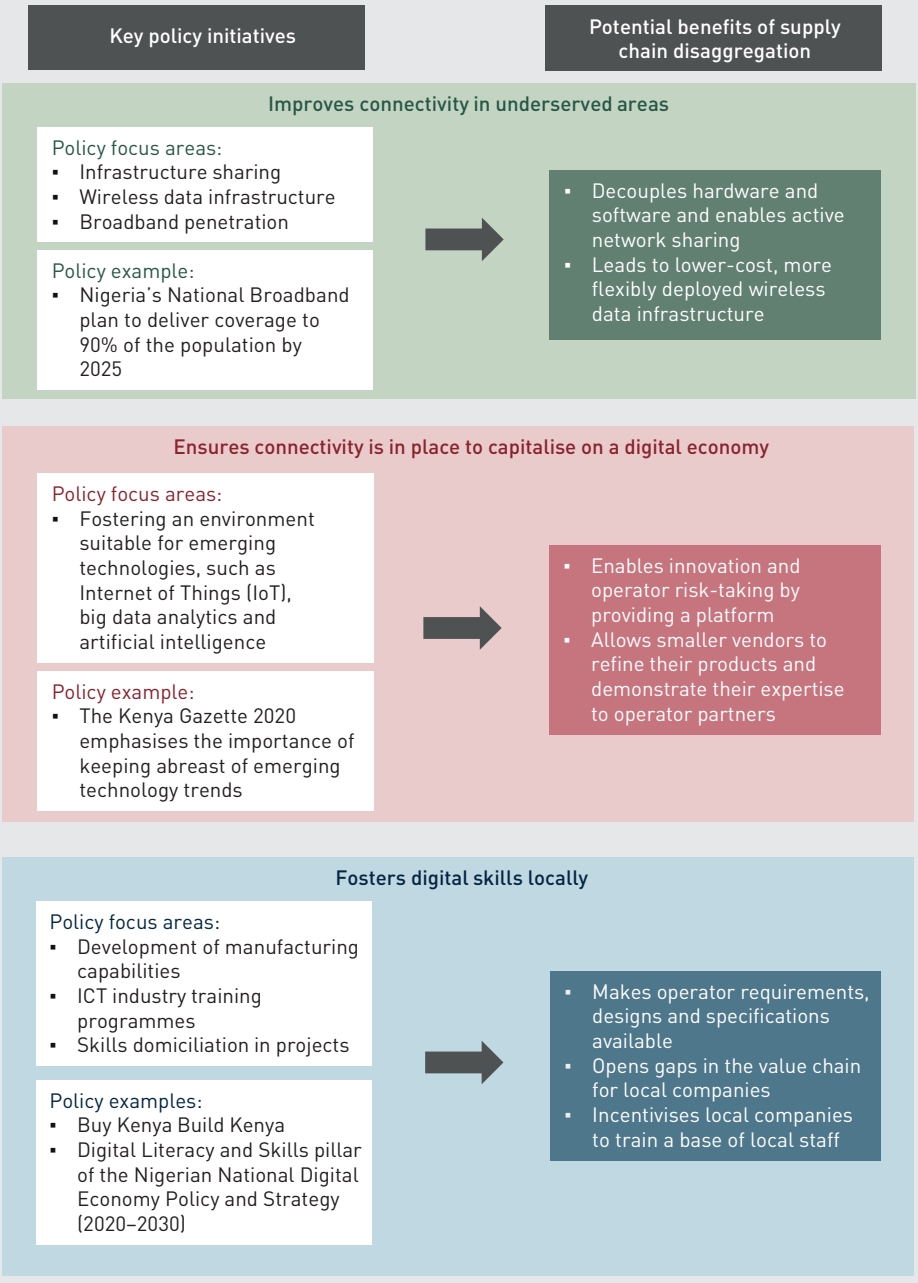
Policy objectives set out by governments in SSA can be advanced using open and disaggregated technologies

An open ecosystem will likely be driven by a combination of industry demand and a conducive policy environment. In turn, many of the benefits of an open and disaggregated network align with the wider societal and economic priorities set out by African governments (see case study on the following page).

[73] See https://pressroom.ifc.org/all/pages/PressDetail.aspx?ID=26646

Case study: Policy objectives and the relevance of open and disaggregated technologies

Governments in SSA are broadly concerned with improving connectivity to underserved areas, ensuring that connectivity is in place to reap the benefits of a digital society, and building local ICT skills. To achieve these objectives, governments have endorsed the deployment of various ICT infrastructure systems in order to enable wider access to connectivity. Governments also note the importance of developing opportunities for innovation and localisation, as well as fostering local ICT skills and education. Disaggregation of the supply chain could help to address these policy objectives in various ways. The diagram below describes several key policy objective areas, drawing on examples from Nigeria[74] and Kenya,[75] and illustrates how open and disaggregated technologies could be relevant in these cases.



[74] See https://www.commtech.gov.ng/Doc/NNBP_16_03_2020.pdf; https://www.ncc.gov.ng/docman-main/industry-statistics/policies-reports/883-national-digital-economy-policy-and-strategy/file

[75] See http://kenyalaw.org/kenya_gazette/gazette/volume/MjE5Nw--/Vol.CXXII-No.150/

Policy makers can help drive the adoption of open and disaggregated solutions by fostering a more supportive regulatory environment, and by facilitating collaborations between more stakeholders

Today, operators and other providers (such as rural NaaS companies) that are attempting to use disaggregated solutions or innovative business models to improve coverage and connectivity have found that regulatory environments could be more supportive of their efforts.[76] Examples of operator concerns include:

- Complexity in obtaining necessary licences and permits – Operators and providers in the region often operate across a number of countries, and need to manage different processes for obtaining licences and permits for deploying networks, which could make the deployment of new types of equipment and business models more challenging.

- Clarity of regulatory frameworks – Operators looking to enter into network- or infrastructure-sharing agreements might not always be supported by the appropriate regulatory frameworks, which could hinder operator-led initiatives to deploy better and more far-reaching networks.

Reducing regulatory barriers and streamlining processes to allow operators to deploy new network technologies and innovative business models more easily, would help enhance connectivity in SSA.

Some policy makers in the region are also well positioned to facilitate collaborations between a wider range of stakeholder groups, in the interest of exploring and realising the potential of open and disaggregated technologies. These collaborations, facilitated by policy makers, could result in several types of initiatives, as illustrated below:

- Coordinated engagement of industry bodies – Policy makers could engage local industry bodies to help better identify opportunities for open and disaggregaated solutions to contribute to local industry, and to use these industry bodies as platforms for the realisation of policy objectives through the open and disaggregated solution ecosystem.

- Establishment of laboratory environments for testing and validation – Regional or international partners (i.e. operators, technology providers, organisations such as TIP) can be tapped to help support the establishment of more environments for testing and validation. Currently, these environments are not as readily accessible to smaller or newer vendors, operators, ISPs and other providers in SSA.

- Partnerships between industry players and educational institutions – Policy makers can help to foster partnerships between industry players (i.e. operators and vendors) and academic or vocational institutions to explore how open and disaggregated technologies could unlock opportunities for talent development in the region.

- Availability of financial support – Collaborations to introduce development financing, such as the one between TIP and IFC (as discussed earlier in this section), can help accelerate the maturity and adoption of open and disaggregated solutions. Policy makers could also play an important role by either engaging organisations that can provide financing, or by providing incentives directly, to companies in the region aiming to adopt or produce these technologies.

[76] Based on interviews

Annex A Impact assessment methodology

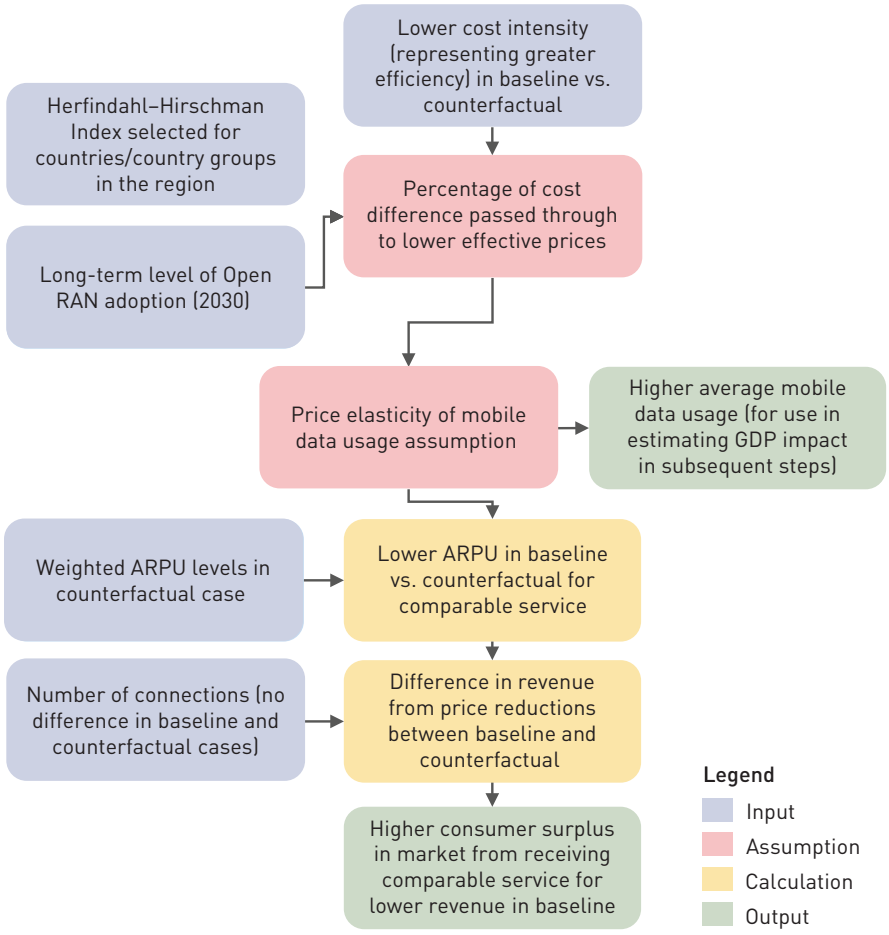
This annex details the methodology used to estimate the impact of Open RAN, and has been adapted from the methodology used in the global report. This approach relies on the establishment of a counterfactual scenario in terms of macroeconomic and telecoms market forecasts, based on third-party data.[77] Changes to telecoms market metrics due to the impact of Open RAN are then estimated for a 'baseline' case. The differences in telecoms market metrics in the baseline and counterfactual cases are then used to estimate the Open RAN impact on macroeconomic metrics such as GDP, based on existing literature linking connectivity and economic indicators.

The 46 SSA countries were selected according to a definition issued by the United Nations.[78,79]

A.1 Estimating the impact of Open RAN on consumer surplus

Consumer surplus is the difference between what consumers would have been willing to pay in the counterfactual case and what they would actually end up paying in the Open RAN case, for a fixed level of service. The methodology used to estimate the impact of Open RAN on consumer surplus for subscribers in the counterfactual case (i.e. excluding any subscribers that might enter the market due to lower prices) is shown below, in Figure A.1.

FIGURE A.1: CALCULATING INCREMENTAL CONSUMER SURPLUS DUE TO TRANSFER OF COST-EFFICIENCY BENEFITS TO LOWER ARPU [SOURCE: ANALYSYS MASON, 2021]



[77] From Euromonitor International, GSMA Intelligence and Analysys Mason Research. It is assumed that third-party data accessed for this analysis accounts for only a limited influence of Open RAN.

[78] The countries included in Sub-Saharan Africa are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, DRC, Republic of Congo, Côte d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

[79] See https://www.africa.undp.org/content/rba/en/home/regioninfo.html

For a fixed improvement in cost efficiency (with lower costs as a share of recurring revenue[80] in the baseline case compared to a counterfactual as a proxy), we estimate a proportion of the total benefit that would be experienced by consumers as lower effective prices for an equivalent service. The price elasticity of mobile data[81] is assumed to be –0.5, reflecting that half of the benefit of lower effective prices would result in lower ARPU, while the remaining half would be in the form of larger data packages available for the same ARPU.[82] The difference between ARPU levels for an equivalent service in the baseline and counterfactual scenarios would result in lower total revenue paid to operators considering all connections and represents the incremental consumer surplus generated by Open RAN.

The parameter which represents the percentage of cost-efficiency benefits that are transferred to customers as lower effective prices accounts for both the HHI or weighted HHI[83] in 2020 for countries in SSA,[84] as well as the assumed level of Open RAN adoption, measured as a percentage of users served with Open RAN networks, achieved in the scenario by 2030.

Both the weighted HHI and the assumed level of Open RAN adoption indicate how competitive dynamics in the market would affect the ability of operators to retain the benefits of cost efficiency. Operators would likely pass less benefit to customers in markets that are concentrated (characterised by a higher HHI) and in markets where a smaller share of operators intend to adopt open solutions over the long term. The percentage pass-through parameter is calculated as:

$$\%\ pass\ through = \left(\frac{10\,000 - HHI\ or\ Weighted\ HHI}{10\,000} \right)^{0.5} x\ Long\ term\ Open\ RAN\ adoption^{0.5}$$

This approach conservatively excludes potential consumer surplus gains from new subscribers that are induced to enter the market due to lower prices. The amount of incremental consumer surplus from these additional subscribers is expected to be minimal, as the marginal subscribers would have a consumer surplus of close to zero, if the market price is barely lower than the amount that they were willing to pay for the service.

Figure A.2 below illustrates the resulting parameter of cost-efficiency benefit passed through to customers as lower effective prices, for different combinations of weighted HHI and level of Open RAN adoption inputs.

[80] Data on recurring revenue, ARPU and mobile SIMs is from GSMA Intelligence, extrapolated over forecast period.

[81] Using a conservative elasticity parameter, based on Dewenter and Haucap (2007), Demand Elasticities for Mobile Telecommunications in Austria.

[82] The part of the benefit that goes to larger data packages is used as an input to calculate the impact on GDP of increased mobile data usage in Section A.3.

[83] The highest possible HHI, of 10 000, represents a monopoly, and would result in -% as the pass through parameter. A weighted HHI is used where countries within SSA are grouped into a category for modelling purposes.

[84] Nigeria, Kenya, South Africa, Côte d'Ivoire, Uganda and the DRC are modelled separately, and have country-specific HHI figures applied, while all other countries in SSA have been grouped into one category, with a weighted HHI used.

FIGURE A.2: POSSIBLE PASS-THROUGH PARAMETERS FOR DIFFERENT HHI / WEIGHTED HHI AND LEVEL OF OPEN RAN ADOPTION COMBINATIONS [SOURCE: ANALYSYS MASON, 2021]

HHI in the country or weighted HHI in the country group	Level of Open RAN adoption in market (accounting for addressable market and operator take-up)										
	-%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
-	-%	32%	45%	55%	63%	71%	77%	84%	89%	95%	100%
1000	-%	30%	42%	52%	60%	67%	73%	79%	85%	90%	95%
2000	-%	28%	40%	49%	57%	63%	69%	75%	80%	85%	89%
3000	-%	26%	37%	46%	53%	59%	65%	70%	75%	79%	84%
4000	-%	24%	35%	42%	49%	55%	60%	65%	69%	73%	77%
5000	-%	22%	32%	39%	45%	50%	55%	59%	63%	67%	71%
6000	-%	20%	28%	35%	40%	45%	49%	53%	57%	60%	63%
7000	-%	17%	24%	30%	35%	39%	42%	46%	49%	52%	55%
8000	-%	14%	20%	24%	28%	32%	35%	37%	40%	42%	45%
9000	-%	10%	14%	17%	20%	22%	24%	26%	28%	30%	32%

A.2 Estimating Open RAN impact on GDP due to greater mobile internet penetration

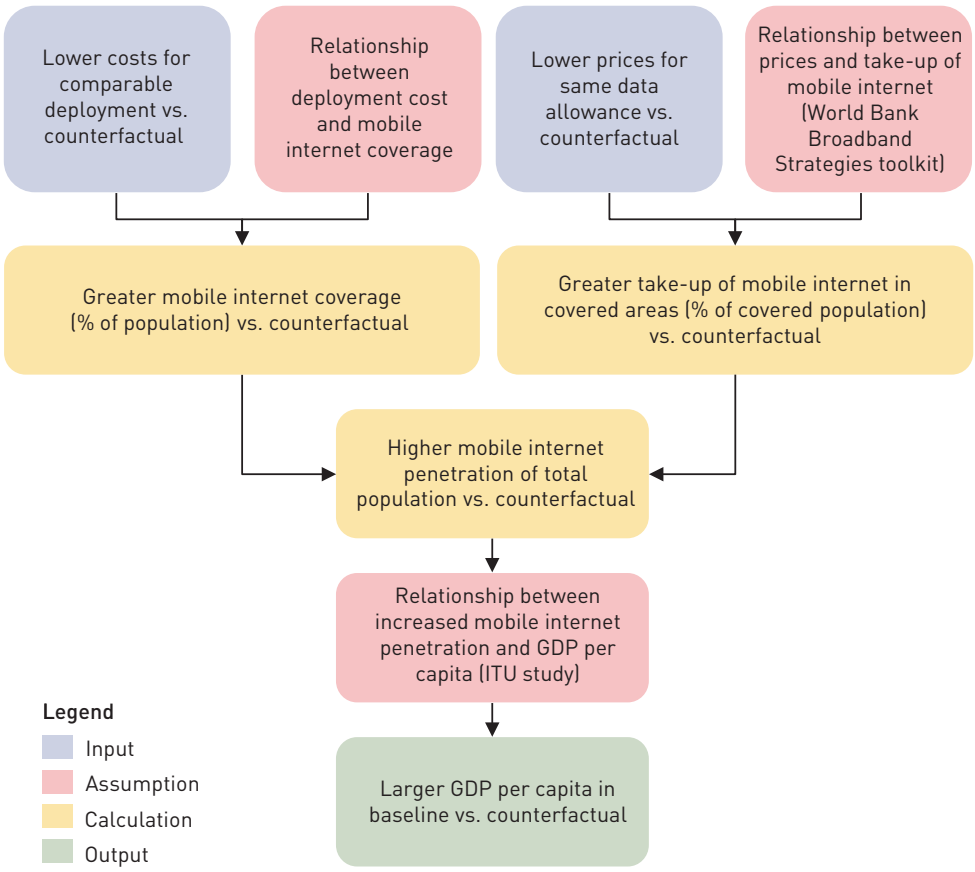
The impact of Open RAN on GDP due to mobile internet penetration (unique mobile internet subscribers as a percentage of population[85]) is modelled by first estimating the effect that Open RAN could have on mobile internet penetration, through expansion of operator network footprints and a higher proportion of take-up within covered areas, which combined provide an indication of the impact of Open RAN on mobile internet penetration.

Next, a study investigating the relationship between mobile internet penetration and GDP per capita based on purchasing power parity (PPP) is cited to translate the greater penetration from Open RAN into consequently higher GDP returns.[86] These steps are illustrated in Figure A.3 below.

[85] Data on population is from Euromonitor International, while data on unique mobile internet subscribers is from GSMA Intelligence, extrapolated over the forecast period.

[86] Conversions from GDP in PPP terms to real terms are applied as required.

FIGURE A.3: CALCULATING INCREMENTAL GDP DUE TO GREATER LEVELS OF MOBILE INTERNET PENETRATION
[SOURCE: ANALYSYS MASON, 2021]



For this model, we assume that a 10% decrease in the cost of rural deployment of mobile broadband sites would lead to a 2.5 percentage point increase in mobile internet coverage (share of population covered).[87] The World Bank Broadband Strategies toolkit[88] indicated that a 10% price decline in mobile broadband plans would result in 3.20% increase in penetration (i.e. take-up in covered areas) for low-income countries.

Finally, a 2018 study by the ITU[89] used econometric analysis of data from countries across the globe to determine that a 10% increase in mobile broadband penetration yields a 2.0% increase in GDP per capita for low-income countries on top of the counterfactual GDP growth projected. For Africa however, this figure increases to 2.5%, which is the figure adopted for this study.

A.3 Estimating the impact of Open RAN on GDP from higher average mobile data usage

In addition to the impact of greater mobile internet penetration, the effect of Open RAN on GDP is also determined by the benefits of achieving increased average data usage per mobile internet (3G+) SIM. This occurs as a result of the lower prices for an equivalent bundle, discussed in Section A.1, and due to the accelerated availability of increasingly advanced technologies (4G/5G).

To determine this added impact, we extrapolate forecasts of the share of total SIMs by technology and data usage per SIM by technology over the entire forecast period considered, to establish a counterfactual level of data usage per mobile internet

[87] Based on recent Analysys Mason project experience related to the viability of rural connectivity solutions, which involved calculating net present value of rural deployments, accounting for costs and revenue potential

[88] World Bank Group, Broadband Strategies Toolkit. Available at https://ddtoolkits.worldbankgroup.org/broadband-strategies

[89] International Telecommunication Union (2018), The economic contribution of broadband, digitalization and ICT regulation. Available at https://www.itu.int/pub/D-PREF-EF.BDR-2018

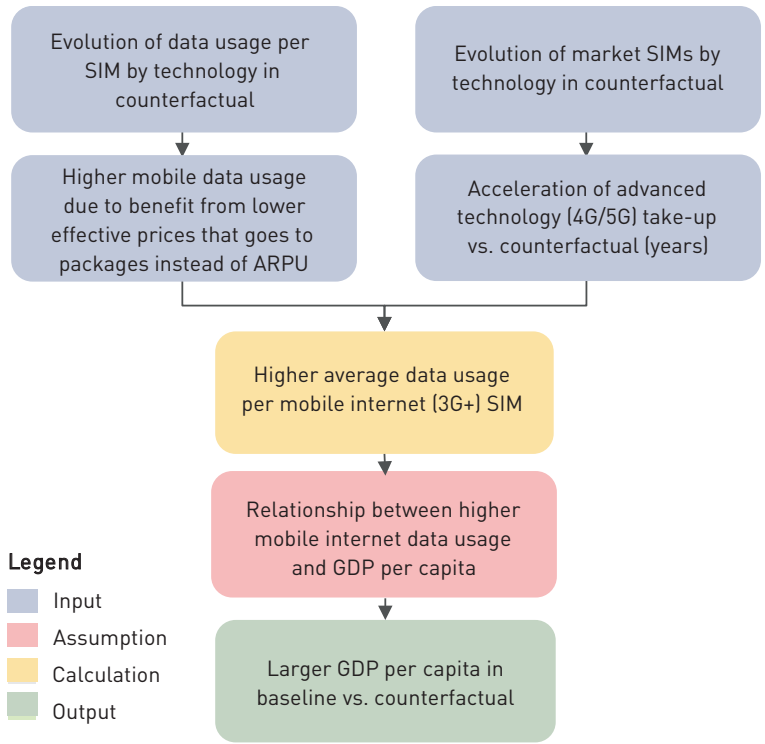
SIM.[90] Next, input assumptions on the benefits of cost efficiency which are translated into larger data allowances for equivalent prices are applied to the counterfactual to arrive at a data usage per mobile internet SIM figure for the baseline case (before accounting for accelerated migration to more advanced technologies).

Thereafter, assumptions on the acceleration of technology take-up for 4G and 5G are introduced. Under the baseline case, a larger share of SIMs can support more advanced technologies in a given year compared to the counterfactual. Because increasingly advanced technologies support higher data usage, the larger share of advanced technologies would result in a blended average data usage per mobile internet SIM figure across technologies that is higher in the baseline case than in the counterfactual. This method accounts for both the effects of lower effective prices and technology acceleration on mobile data usage.

Finally, higher average data usage levels in the baseline case relative to the counterfactual would result in higher GDP levels, according to a study for the GSMA by Deloitte from 2012.[91] For this model, we assume results from a more recently developed endogenous growth model used in another Analysys Mason report, which indicates that a doubling of mobile data results in a 0.8% increase in GDP per capita.[92]

These steps are illustrated in Figure A.4 below.

FIGURE A.4: CALCULATING INCREMENTAL GDP DUE TO HIGHER LEVELS OF MOBILE DATA USAGE [SOURCE: ANALYSYS MASON, 2021]



[90] Data on SIMs by technology from GSMA Intelligence, and on data usage per SIM from Analysys Mason Research, extrapolated over the forecast period.

[91] Deloitte (2012), What is the impact of mobile telephony on economic growth? Available at https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf

[92] Analysys Mason (2020), Economic impact of Google's APAC network infrastructure. Available at https://www.analysysmason.com/consulting-redirect/reports/impact-of-google-network-APAC-2020/

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