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REPORT FOR THE TELECOM INFRA PROJECT

THE ECONOMIC IMPACT OF OPEN AND DISAGGREGATED TECHNOLOGIES AND THE ROLE OF TIP IN INDIA

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1 Countries around the world, including India, can benefit from open and disaggregated solutions given testing, interoperability and policy support

Growing consumer and enterprise demand for mobile internet services in India and around the world will continue to drive coverage and capacity needs, and mobile operators require improved network economics to overcome pressure on margins and to deliver future requirements.

Open and disaggregated technologies, provided by a range of suppliers based on common industry requirements, could provide greater cost efficiency and faster deployment of new network functions, resulting in downstream benefits for service providers and consumers, including:

- connecting the unconnected and enhancing connectivity
- providing opportunities for local manufacturing, software innovation and workforce development
- enabling faster economic growth and a more rapidly developing digital economy.

A more comprehensive overview of the benefits of open and disaggregated technologies can be found in a global report published by Analysys Mason on this issue earlier in 2021.[1]

In India, mobile operators have been actively exploring the use of open and disaggregated technologies in their networks, and have also started to develop in-house solutions that can be exported globally (if and when proven) and scale beyond India to the world. The government of India is also taking steps to strengthen local manufacturing capabilities. This involves incentivising large global players to set up production facilities in India. More importantly in the context of open and disaggregated network technology, the government's efforts also include supporting home-grown companies to develop solutions that could meet local demand for network equipment and software for years to come, while also exploiting opportunities in the global export market. The supply chain ecosystem in India, made up of original design manufacturers (ODMs),[2] vendors and systems integrators, is also responding to growing demand and government-backed initiatives by developing new disaggregated solutions spanning various network parts and by continuing to foster relationships with international customers to capitalise on emerging export opportunities.

Across the globe, the Telecom Infra Project (TIP) helps to aggregate demand for providers of emerging technologies across the network stack, and facilitates the testing and validation of solutions, which helps to accelerate deployment.[3] In India, TIP is currently bringing together operators, vendors and systems integrators to collaborate on open and disaggregated technologies across core, transport and access networks, as well as end-to-end solutions.

India is expected to be at the forefront of open and disaggregated technology adoption and production in years to come due to the amount of activity driven by its operators, the government and supply chain participants in developing open and disaggregated technologies. For Open RAN alone, we estimate that the incremental GDP impact in India could reach USD18 billion per annum in 2030 (USD58 billion cumulatively from 2021–30), driven by enhancements to mobile internet penetration and data usage. Modelling suggests that these impacts could more than double over the period from 2021–30, should industry facilitation initiatives driven by operators, the government, as well as organisations such as TIP be as successful as envisaged by many of the stakeholders driving Open RAN in India today.

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

[2] ODMs design and manufacture products, and either sell products to end users directly, or to other companies for rebranding and downstream sales.

[3] See https://telecominfraproject.com/how-we-work/

In India, multiple stakeholders in the telecoms networking sector are actively driving the development of a diverse supply chain ecosystem

MANY POTENTIAL FACTORS FOR SUCCESS ARE IN PLACE FOR THE OPEN NETWORKING ECOSYSTEM IN INDIA TO ACHIEVE SIGNIFICANT GROWTH

Factors	Present?	Ongoing developments
Operator interest	✓	- Main MNOs are exploring use and development of open solutions - Other connectivity providers are engaged in open industry initiatives
Supply chain investment	✓	- Investments by home-grown vendors, manufacturers, system integrators - Interest from global incumbents in boosting production in India
Industry collaboration	✓	- Local industry bodies such as TAIPA are encouraging enabling policies - Active international initiatives such as TIP
Government support	✓	- Production-linked incentive (PLI) scheme for telecoms network equipment manufacturing - Prime Minister Wi-Fi Access Network Interface (PM-WANI) scheme

CASE STUDY: COMPANIES IN INDIA ARE CAPITALISING ON THE PM-WANI FRAMEWORK AND INDUSTRY INITIATIVES TO LAUNCH OPEN AND DISAGGREGATED SOLUTIONS FOR WI-FI

Policy enablers

TRAI

DoT

PM-WANI framework
- Public data offices
- Public data office aggregators
- App providers
- Central registry

Supply chain activity

- Core solution providers
- App providers
- Management ecosystem (e.g. TIP OpenWiFi)
- AP hardware providers (ODMs & OEMs)[1]

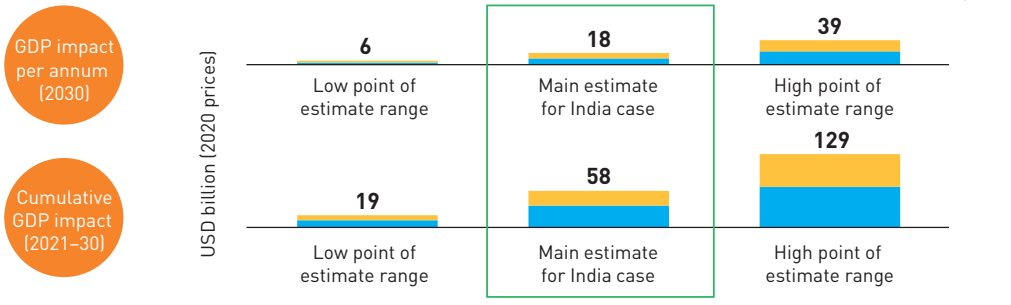
Deployment and provision

March 2021:
1st PM-WANI model village announced in Haryana with TIP OpenWiFi solutions

June 2021:
2nd PM-WANI model village announced in Karnataka with TIP OpenWiFi solutions

CASE STUDY: OPEN RAN IS EXPECTED TO SEE ACCELERATED ADOPTION IN INDIA COMPARED TO OTHER COUNTRIES,[2] AND COULD GENERATE SIGNIFICANT GDP GAINS[3] OVER THE NEXT DECADE

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



[1] 'AP' refers to access point; 'ODM' refers to original design manufacturer; 'OEM' refers to original equipment manufacturer

[2] Compared to the low-income country group in the global report, India is expected to experience more rapid adoption of Open RAN solutions given operator announcements to develop and deploy solutions that are understood to be open and interoperable

[3] Measured in USD billion (2020 prices), with estimate range developed based on a similar methodology used in the global report, by adjusting efficacy and adoption parameters relative to the main India scenario estimate

2 Operators in India are seeking more cost-efficient and flexible network deployment methods to meet rapidly growing demand

2.1 Demand for connectivity in India is expected to continue growing significantly in coming years

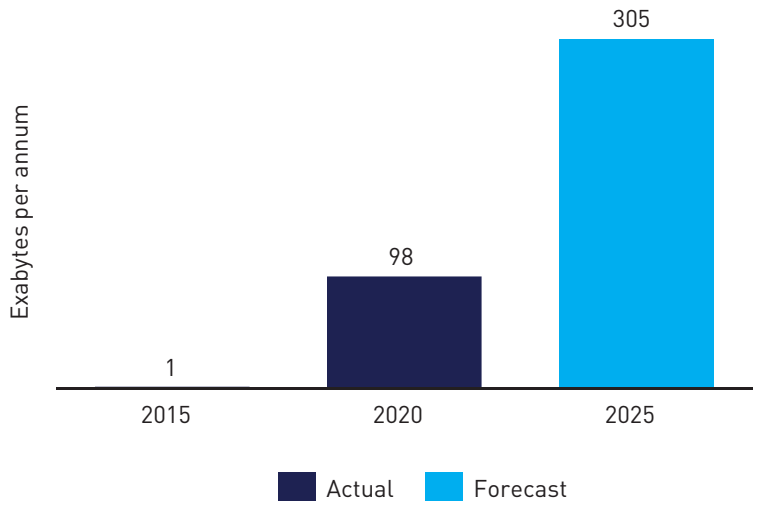
India is the second largest country in the world by population as of 2020[4] and a report by IAMAI and Kantar estimates that active internet user penetration is below 45% as of 2020.[5] This suggests that there is significant room for demand in connectivity to grow in coming years: the same report indicates that the number of active internet users in India would grow from just over 600 million in 2020 to over 900 million by 2025. Today, the vast majority of people in India access the internet through mobile networks, although ongoing developments in other technologies, including fibre roll-out to residential and business premises, and the use of unlicensed technologies such as Wi-Fi at the network edge, will contribute to improved connectivity for years to come.

Despite relatively low mobile internet penetration in India, rapid improvements in 3G/4G coverage, as well as the increased availability of affordable smartphones, has driven significant growth in recent years. According to the GSMA's 'State of Mobile Internet Connectivity 2020',[6] mobile broadband coverage expanded significantly in India in 2019, and 99% of the population now has 4G network coverage. Awareness of mobile internet within rural populations also appeared to have increased rapidly, from 28% in 2017 to 58% in 2019. The GSMA also highlights the emergence of 'smart feature phones' such as the JioPhone, an LTE-enabled handset launched by Jio and KaiOS in 2017 at a cost of less than USD10, which has helped lower the total cost of mobile internet services in India. Despite these developments, however, affordability still appears to be the largest barrier to owning a mobile phone. In 2019, 37% of people surveyed[7] selected affordability as the top barrier, ahead of other barriers such as skills, relevance, accessibility, as well as safety and security.

Meanwhile, mobile data usage in India has grown significantly in recent years, and is expected to continue increasing substantially (see Figure 2.1), driven by intense competition between the three main operators in the market, Jio, Airtel and Vodafone Idea.

Significant efforts have also been made to encourage the use of public Wi-Fi for the provision of connectivity across the country. This is positioned as a complement to cellular mobile coverage, facilitating mobile data offload, extending connectivity to venues and indoor locations, and enabling new Internet of Things (IoT) and enterprise use cases.

FIGURE 2.1: INDIA CELLULAR DATA TRAFFIC FORECAST [SOURCE: ANALYSYS MASON RESEARCH DATAHUB[8],2021]



[4] See https://data.worldbank.org/indicator/SP.POP.TOTL

[5] See https://images.assettype.com/afaqs/2021-06/b9a3220f-ae2f-43db-a0b4-36a372b243c4/KANTAR_ICUBE_2020_Report_C1.pdf

[6] GSMA. (2020). *The state of mobile internet connectivity 2020.* Available at https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-State-of-Mobile-Internet-Connectivity-Report-2020.pdf

[7] GSMA Intelligence Consumers in Focus Surveys 2019

[8] Analysys Mason Research. DataHub. Available at https://datahub.analysysmason.com/

As early as 2015, Airtel and Vodafone Idea launched Firefly Networks,[9] a joint venture providing Wi-Fi services.[10] The government of India has more recently developed the Prime Minister's Wi-Fi Access Network Interface (PM-WANI) framework to enable many more operators, internet service providers (ISPs), software providers and small businesses to be involved in the provision of public Wi-Fi (see Section 3 below for further details). Alternative providers such as RailTel,[11] which was set up in 2000 as a subsidiary of Indian Railways focusing on providing broadband services, have also been active in deploying Wi-Fi infrastructure across India.[12]

This reflects a broader trend among governments across the world, who are looking to expand the role of Wi-Fi.[13] The Department of Telecommunications (DoT) in India has also been called upon to open up 6GHz spectrum in order to further enable the development of new use cases.[14]

2.2 Operators in India are actively exploring open and disaggregated solutions to meet growing demand

In order to meet the growing demand for connectivity, major mobile operators in India are actively exploring the viability of using open and disaggregated technologies to deliver future network requirements, often citing deployment flexibility and cost management as the main reasons for doing so. Recent announcements by operators in India are summarised in Figure 2.2 below.

Connectivity providers are also engaging in industry facilitation initiatives. Airtel, for instance, launched a TIP Community Lab in 2018.[15] Discussing and sharing information related to technical requirements and testing priorities means that operators and ISPs can contribute to accelerating the development of open and disaggregation technologies by driving economies of scale and product harmonisation.

A rather unique feature of the Indian market with regard to open and disaggregated technologies is that operators such as Jio and Airtel have announced intentions to develop in-house 5G solutions that would be used in India and exported to other countries.[16,17] These initiatives coincide with a strong push by the government to deliver its broader 'Make in India' vision,[18] which is aimed at facilitating investment, skills development, local manufacturing and innovation in the country. Within the telecoms space, the government had in 2020 implemented a production-linked incentive (PLI) scheme for the local manufacturing of mobile devices,[19,20] and in 2021, approved plans to extend a similar scheme to the local manufacturing of telecoms network equipment.[21] This scheme is discussed in more detail in Section 3 below.

[9] See https://www.fireflynetworks.co.in/blog/airtel-vodafones-joint-venture-firefly-networks

[10] See https://www.fireflynetworks.co.in/about-us.php

[11] See https://www.railtelindia.com/profile/about-us.html

[12] See https://www.railtelindia.com/our-expertise/railwire-broadband.html

[13] A 2020 study suggests that FCC proposals to open the 5.9GHz and 6GHz bands to Wi-Fi in the USA could add over USD183 billion to the domestic economy by 2025. See http://wififorward.org/news/new-study-by-dr-raul-katz-finds-fccs-wi-fi-proposals-will-add-183-44-billion-to-u-s-economy-by-2025/

[14] See https://telecom.economictimes.indiatimes.com/news/us-tech-majors-intel-cisco-urge-dot-to-delicense-6ghz-for-wifi-6-adoption/80136298

[15] See https://www.thehindubusinessline.com/info-tech/airtel-launches-telecom-infra-project-community-lab/article9952482.ece

[16] See https://telecom.economictimes.indiatimes.com/news/reliance-jio-develops-own-5g-solutions-to-be-ready-for-commercial-deployment-soon-mukesh-ambani/76977082

[17] See https://telecom.economictimes.indiatimes.com/news/airtel-partners-tata-group-to-deploy-indigenous-open-ran-5g-technology-in-india/83714108

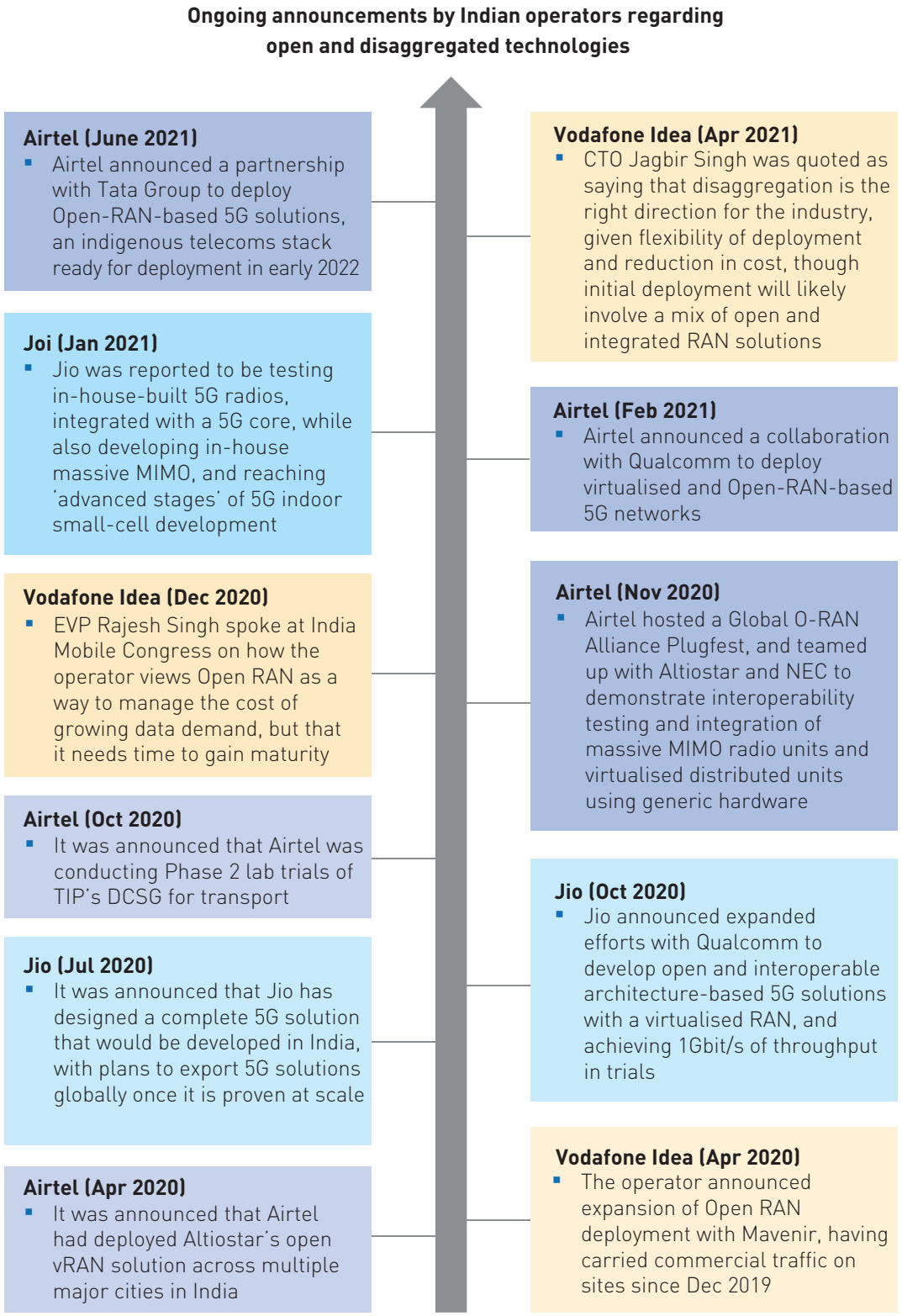
[18] See https://www.makeinindia.com/

[19] See https://www.policycircle.org/economy/industry/make-in-india-indias-mobile-manufacturing-sector-charts-a-success-story/

[20] See https://www.livemint.com/industry/manufacturing/inside-the-plan-to-mobile-make-in-india-11603895399056.html

[21] See https://pib.gov.in/PressReleasePage.aspx?PRID=1698686

FIGURE 2.2: ONGOING ANNOUNCEMENTS BY OPERATORS IN INDIA REGARDING OPEN AND DISAGGREGATED TECHNOLOGIES [SOURCE: ANALYSYS MASON, PRESS ARTICLES,[22-32] 2021]



2.3 A developed open ecosystem could also enable new business models for providers across India

As discussed in Analysys Mason's recent global report on the economic impact of open and disaggregated technologies,[33] those technologies also offer opportunities for infrastructure players and non-traditional operators.

Infrastructure providers and tower companies have been active in helping mobile operators to manage costs by facilitating sharing of passive infrastructure (such as physical space on a mast). Open and disaggregated technologies could enable further sharing of active equipment (e.g. antennas), and also enable new 'neutral-host' or 'network-as-a-service' (NaaS) business models to emerge, where towercos own active equipment and sell capacity to operators, instead of just owning physical space for operators to deploy their active infrastructure.

As new models emerge, all stakeholders involved (connectivity service providers, infrastructure owners, systems integrators, etc.) need to be able to generate viable returns. Best practice sharing is an important step in making this easier for more stakeholders. For example, TIP's NaaS solution group[34] is compiling technical and commercial best practices for new business and operating models that employ open and disaggregated solutions. This addresses a variety of connectivity use cases, including rural and remote coverage deployments, densification in dense urban environments, and 5G private networks for enterprises.

In India, the National Digital Communication Policy of 2018 included provisions to encourage the sharing of active infrastructure in the country. However, this has yet to be implemented in practice, and the Tower and Infrastructure Providers Association (TAIPA) in India is continuing to call on the government to implement this policy.[35] Continued development and maturation of open and disaggregated solutions, and more concrete implementation of active sharing policies, would further enhance operators' ability to deploy cost-efficient, performant and flexible networks, while also generating new opportunities for other companies in the value chain. For instance, disaggregation of hardware and software network elements would further enable the provision of public Wi-Fi (see Section 3 below). This would involve many small businesses that would act as hotspots;[36] open source software from communities such as TIP OpenWiFi would also be used.[37] Larger infrastructure providers also need to play a key role in ensuring that end-to-end network infrastructure, and in particular, fibre backhaul, can be deployed quickly enough to support emerging 5G requirements.[38]

[22] See https://telecom.economictimes.indiatimes.com/news/airtel-partners-tata-group-to-deploy-indigenous-open-ran-5g-technology-in-india/83714108

[23] See https://telecom.economictimes.indiatimes.com/news/vodafone-idea-cto-jagbir-singh-on-5g-network-strategy-openran-use-cases/81912889

[24] See https://www.airtel.in/press-release/02-2021/airtel-and-qualcomm-to-collaborate-for-5g-in-india

[25] See https://telecom.economictimes.indiatimes.com/news/jio-says-indigenously-developed-5g-radio-and-core-readying-indoor-5g-small-cells/80409402

[26] See https://ultra.news/s-e/51861/vodafone-idea-tests-revolutionary-approach-to-network-deployment

[27] See https://www.airtel.in/press-release/11-2020/airtel-hosts-indias-first-o-ran-alliance-plugfest

[28] See https://telecominfraproject.com/tip-community-achieving-significant-momentum-on-the-path-to-open-interoperable-disaggregated-and-standards-based-networks/

[29] See https://www.qualcomm.com/news/releases/2020/10/20/qualcomm-and-reliance-jio-align-efforts-5g

[30] See https://telecom.economictimes.indiatimes.com/news/reliance-jio-develops-own-5g-solutions-to-be-ready-for-commercial-deployment-soon-mukesh-ambani/76977082

[31] See https://www.altiostar.com/bharti-airtel-deploys-open-vran-with-altiostar/

[32] See https://www.mavenir.com/press-releases/vodafone-idea-deploys-mavenir-openran-solution/

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

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

[35] See https://telecom.economictimes.indiatimes.com/news/implement-active-telecom-infrastructure-sharing-taipa-to-dot/82028592

[36] See https://techcrunch.com/2020/12/10/india-cabinet-approves-setting-up-a-massive-network-of-public-wi-fi-hotspots

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

[38] See https://techwireasia.com/2020/10/whats-holding-a-5g-roll-out-back-in-india/

3 The supply chain ecosystem for disaggregated solutions in India is highly active and is driven by government support

As touched upon in Section 2, companies in the Indian telecoms sector are not only focused on adopting open and disaggregated solutions, but also on designing and developing new solutions that could be exported to other operators worldwide. This approach appears aligned with the broader 'Make in India' initiative launched by the government to stimulate growth across a wide variety of sectors.

3.1 Domestic and international companies are contributing to a vibrant network supply chain in India, driven in part by a strong government push to build local production capabilities

'Make in India' and related initiatives have already contributed to growth in mobile handset manufacturing, through the provision of incentives.[39] These incentives have since been extended to semiconductor companies, as well as to telecoms equipment manufacturing (see PLI case study below).

Case study: PLI scheme for telecoms and networking products

In February 2021, the Union Cabinet approved a PLI scheme for telecoms and networking products. The press release by the Ministry of Communications noted that telecoms and networking products represent a USD100 billion export market opportunity globally,[40] which India aims to exploit by attracting investments from global players while helping to develop domestic champions that can become significant players in the global export market.

The scheme would involve a budgetary outlay of INR12 195 crore (over USD1.6 billion) over five years, with the aim to generate significant increases in investment, local production (including for export), and tax revenue,[41] as detailed below:

Budgetary outlay of INR12 195 crore (~USD1.6 billion)

Foreign direct investment of INR3000 crore (~USD400 million)

Total local production of INR244 200 crore (~USD33 billion)

Local production for export of INR195 360 crore (~USD26 billion)

Tax revenue of INR17 000 crore (~USD2.3 billion)

There is also expected to be a minimum investment threshold of INR10 crore (~USD1.3 million) for micro, small and medium enterprises (MSMEs), and INR100 crore (~USD 13 million) for larger companies. MSMEs are to be offered incentives ranging from 4–7% on incremental sales, and other companies are to be offered incentives from 4–6% on such sales.[42] The scheme is also expected to create direct and indirect employment for 40 000 people.[43]

[39] See https://www.policycircle.org/economy/industry/make-in-india-indias-mobile-manufacturing-sector-charts-a-success-story/

[40] See https://pib.gov.in/PressReleasePage.aspx?PRID=1698686

[41] See https://telecom.economictimes.indiatimes.com/news/cabinet-approves-over-rs-12000-crore-production-linked-incentive-scheme-for-telecom-sector-prasad/81052029

[42] See https://economictimes.indiatimes.com/small-biz/sme-sector/how-the-pli-scheme-for-telecom-is-a-key-factor-for-digital-india/articleshow/82652100.cms

[43] See https://www.business-standard.com/article/companies/industry-cheers-pli-for-telcos-says-new-scheme-to-spur-jobs-production-121021701382_1.html

Since the announcement of the PLI scheme, global equipment vendors including Nokia, Ericsson, and others have expressed interest in ramping up existing production activities in India.[44]

Senior executives at Airtel and Jio have also made public statements in support of the scheme.[45] Randeep Sekhon, CTO of Airtel, referred to how this scheme could help Indian suppliers develop local capabilities for export, noting that the company has been encouraging its suppliers to set up production in India, which could serve as a supply hub to other markets. Shyam Mardikar, the CTO of Jio, highlighted that India is well positioned to capitalise on the opportunity in terms of production cost and availability of competencies. Both operators are reportedly developing technology platforms and solutions that could be used domestically and sold to international markets.[46,47]

Other companies are also actively attempting to develop their presence in the telecoms network supply chain and participate in the growth of the Indian market. These includes Indian companies such as ITI Limited, Tech Mahindra and Tata Consultancy Services (TCS), which are reportedly in talks to offer end-to-end infrastructure equipment and services for 4G and 5G networks in India.[48] The state-funded Centre for Development of Telematics (C-DOT), an R&D centre and original equipment manufacturer (OEM), has been given approval for 5G trials alongside incumbents such as Ericsson, Nokia and Samsung. International companies have also taken an interest; for example, NEC has launched an Open RAN lab in India to demonstrate the benefits of Open RAN.[49]

India's strength in IT services and software means that it is well positioned to develop network software solutions in an open ecosystem, but also to play a larger role in the systems integration space. This larger role will be a crucial component that needs to be developed for open and disaggregated solutions to be adopted at scale. Traditional systems integrators are developing capabilities to support multi-vendor product integration, including integration with existing infrastructure deployed by incumbents, as well as managed services, orchestration and automation. Systems integrators that are actively participating in the TIP ecosystem (by offering their facilities to host TIP-facilitated end-to-end integration testing) are also building their own capabilities in performing integrations across network layers, and adding value in orchestration and automation in future.

[44] See https://www.lightreading.com/asia/global-biggies-show-interest-in-indias-pli-scheme/d/d-id/768742

[45] See https://telecom.economictimes.indiatimes.com/news/airtel-jio-ctos-say-pli-scheme-openran-to-grow-local-5g-gear-vendor-ecosystem/81274738

[46] See https://telecom.economictimes.indiatimes.com/news/reliance-jio-develops-own-5g-solutions-to-be-ready-for-commercial-deployment-soon-mukesh-ambani/76977082

[47] See https://economictimes.indiatimes.com/industry/telecom/telecom-news/airtel-looks-to-be-aatmanirbhar-in-5g-via-rd-tie-ups-with-cos/articleshow/78776578.cms?from=mdr

[48] See https://www.indiatimes.com/technology/news/india-4g-5g-tcs-iti-tech-mahindra-527332.html

[49] See https://www.nec.com/en/press/202012/global_20201214_02.html

3.2 TIP is actively involved in facilitating collaboration and accelerating productisation in India

TIP has also been active in facilitating developments in India, with local TIP participants such as VVDN, Sterlite Technologies Limited (STL) and other companies collaborating through TIP to test and validate open and disaggregated solutions for various parts of the network. A few examples of TIP participant companies are provided in Figure 3.1 below – many of these companies support initiatives such as PM-WANI (see case study in this section).

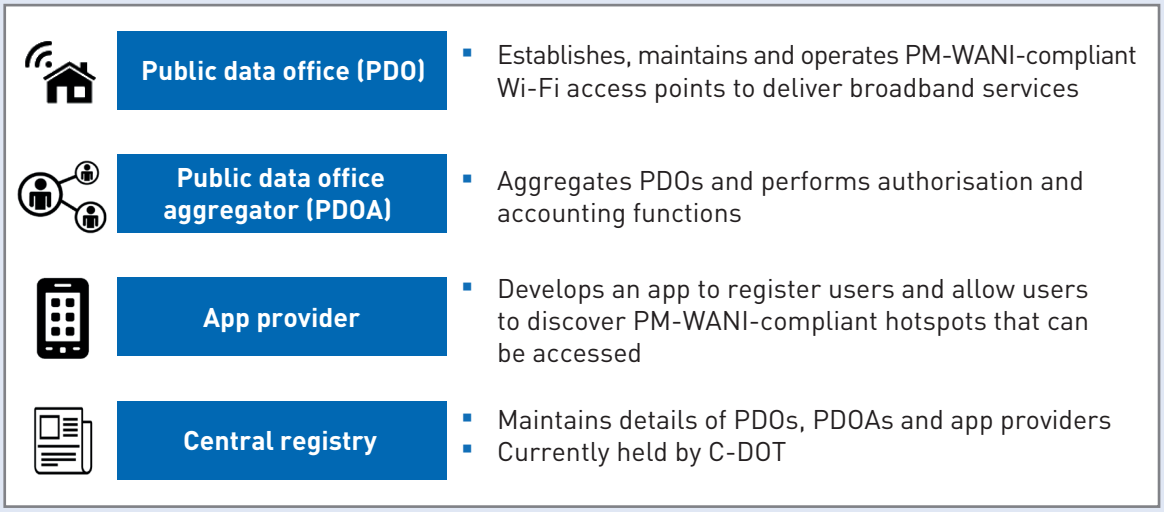
FIGURE 3.1: EXAMPLES OF TIP PARTICIPANTS IN THE INDIA ECOSYSTEM [SOURCE: ANALYSYS MASON, TIP, 2021]

Vendor ecosystem	▪ Locally made hardware and software solutions across the network ▪ Examples of companies involved – HFCL, Indio Networks, Inventum Technologies, Niral Networks, STL, VVDN – some vendors are also active in systems integration
Systems integrators	▪ Entities that facilitate the testing and integration of disaggregated solutions in operator networks, with local origins and global reach ▪ Examples of companies involved – Tech Mahindra, Infosys
Operator and ISP demand	▪ Providers of mobile and fixed internet services across India ▪ Examples of companies involved – Airtel, Vodafone Idea, Spectra

Many of these vendors have been active in the industry for several years, and have new opportunities in an open and disaggregated ecosystem to not only market their existing offerings to a wider audience, but also to branch out into new areas. Vendors could choose to compete across different parts of the network, while offering different types of solutions for each part, depending on market demand, competitive intensity and internal capabilities. For instance, a vendor could focus on hardware solutions for access networks, as well as software solutions for transport. Vendors, as well as systems integrators, are also increasingly looking to expand to reach customers in Asia, Europe, the Middle East, North America and potentially other regions. TIP, with its range of activities in the local and global ecosystems, aims to provide a platform for these companies to establish connections with prospective customers worldwide.

Case study: Public Wi-Fi and developments in the Indian supply chain ecosystem

In December 2020, the DoT obtained approval for the framework of the PM-WANI scheme, which was developed based on suggestions laid out in the DoT's National Communications Policy of 2018 and a related consultation paper from TRAI from 2016.[50] The scheme recognises the important role that Wi-Fi and unlicensed technologies can play in boosting connectivity, and aims to expand the availability of broadband throughout India by enabling local shops and small establishments to become Wi-Fi hotspot providers (public data offices or PDOs), without the need for licences, registration or fees to be paid to DoT.[51] The process would involve the entities shown in the diagram below:



In parallel, companies in the Indian supply chain ecosystem have come together to develop home-grown Wi-Fi products and solutions, to meet demand from PM-WANI initiatives, while also gaining validation and scale for further export opportunities. In 2020, HFCL, a telecoms equipment vendor, and VVDN Technologies, an ODM, had announced the development of Wi-Fi access points that were fully designed and manufactured in India.[52] These two companies subsequently launched a model PM-WANI village in Haryana to help demonstrate the viability of the solutions, as well as of the public Wi-Fi model, with further support from i2e1, a Delhi-based start-up that provides PM-WANI-compliant core solutions.[53] In May 2021, HFCL announced the launch of access points that are compatible with TIP's OpenWiFi platform.[54] In June 2021, the launch of a second model PM-WANI village in Karnataka was announced by HFCL, in collaboration with TIP and i2e1.[55]

The TIP platform was launched in May 2021.[56] It is a community-developed disaggregated Wi-Fi software system, and contains a cloud controller software development kit (SDK) and enterprise-grade access point (AP) firmware, that can be used together with compliant 'whitebox' access point hardware.[57] The platform has been adopted by other vendors in the ecosystem, including Indio Networks.[58]

These developments in public Wi-Fi illustrate how supply chain participants in India are driving improvements in domestic connectivity through investment, collaboration, government support and involvement in the TIP community, while producing solutions that can be used across the globe.

[50] See https://internetfreedom.in/pm-wani-explainer/

[51] See https://dot.gov.in/sites/default/files/202-_12_11%20Brief%20PM%20WANI_0_0.pdf?download=1

[52] See https://telecom.economictimes.indiatimes.com/news/vvdn-to-make-wi-fi-6-based-wireless-solutions-for-hfcl-in-india/76504184

[53] See https://www.business-standard.com/article/news-cm/hfcl-vvdn-tech-to-jointly-set-up-model-pm-wani-village-in-haryana-121030900907_1.html

[54] See https://www.communicationstoday.co.in/hfcl-launches-its-telecom-infra-project-openwifi-compliant-access-points/

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

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

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

[58] See https://www.aninews.in/news/business/business/indio-networks-debuts-tip-openwifi-system20210510145917/

3.3 Maintaining openness and interoperability is crucial for maximising the potential of open solutions

While the push to enhance local production would certainly benefit the Indian economy, there is a balance that mobile operators need to achieve between implementing locally produced hardware and software solutions, and implementing 'best-of-breed' solutions when considering solutions produced by vendors in other parts of the world. In a vibrant global supply chain ecosystem of open and disaggregated technologies, it is unlikely that any one country would produce 'best-of-breed' solutions that satisfies all mobile operator network requirements. There is a risk that placing a disproportionate emphasis on ensuring that all end-to-end implementations are assembled using locally made solutions only could result in a less cost-efficient, performant or flexible network, compared to an implementation that chooses the best interoperable solution for each network component from a diverse group of suppliers within and beyond India.

Other than providing incentives for local production, the government has also extended a local focus to issues of cyber security. In March 2021, it directed that state-owned companies, central ministries and government departments should give preference to locally produced cyber-security products in all public procurements.[59] The government has also amended rules related to the procurement of equipment. Citing national security as a concern, the government stated that from June 2021, telecoms operators would only be allowed to use equipment from "trusted sources". The National Cyber Security Coordinator (NCSC) was given authority to determine which sources are trusted.[60]

As operators, suppliers and the government in India continue to explore emerging opportunities, it is important to ensure that operators retain flexibility to choose implementations that enable them to best compete with other operators and enhance connectivity in the country, while ensuring that networks are secure and resilient. Operators should be able to assemble solutions and networks that are fully interoperable, from vendors across the globe. A more open and disaggregated global ecosystem would provide significant new opportunities for local companies (that were not previously available in a proprietary environment), and India appears well positioned to compete in the global export market.

[59] See https://telecom.economictimes.indiatimes.com/news/dot-directs-all-state-procurements-to-be-of-local-cyber-security-products/81535523

[60] See https://timesofindia.indiatimes.com/business/india-business/telecom-companies-will-be-allowed-to-instal-only-govt-approved-gears-from-june-15/articleshow/81437200.cms

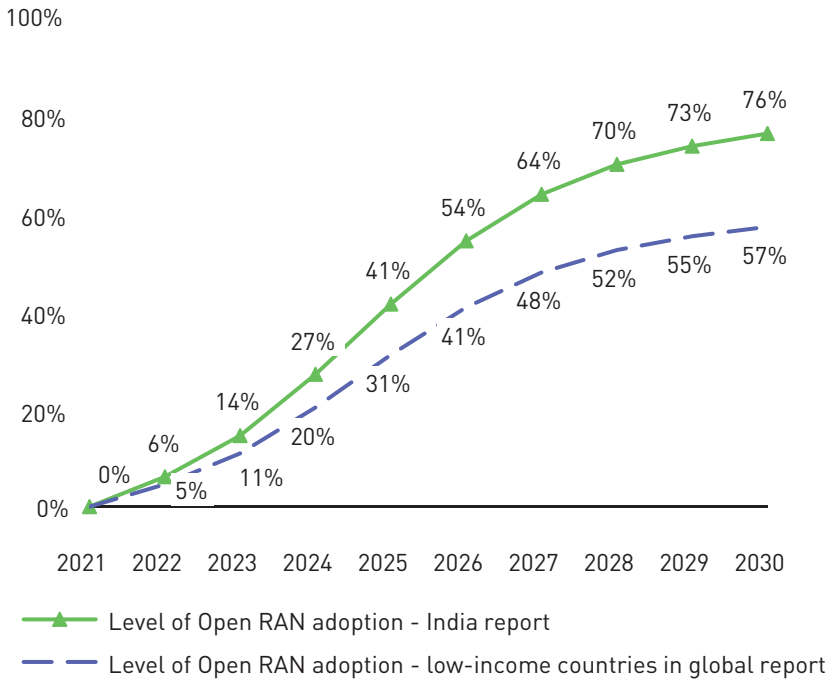
4 Open RAN can generate USD18 billion in added GDP per annum for India in 2030, and USD58 billion from 2021–30

Globally, the radio access part of mobile networks (the radio access network or RAN) represents over 60% of total network costs, as a share of total cost of ownership. It is also the part of mobile networks closer to end users, and therefore concentrates much of the cost of upgrading and expanding mobile networks. Adopting Open RAN solutions can allow mobile operators to improve their network economics. These benefits would also be passed on to consumers in the form of lower unit prices, increased adoption of mobile internet, and greater usage of data services.

4.1 In India, Open RAN can accelerate improvements in connectivity and generate significant GDP impact over the next decade

Given how active operators in India already are in testing and developing Open RAN solutions, the adoption of Open RAN in India could outpace that of other countries. We have modelled a baseline case for India that reflects this current state of play (see Figure 4.1), and includes a more aggressive Open RAN adoption curve than that used for low-income countries in our global report.[61]

FIGURE 4.1: LEVEL OF OPEN RAN ADOPTION IN THE MARKET FOR THE INDIA BASELINE CASE
[SOURCE: ANALYSYS MASON, 2021]



Over time, Open RAN networks are also expected to be more cost efficient than proprietary networks. While proprietary networks are forecast to become more cost efficient even without Open RAN (through increased network sharing and virtualised proprietary solutions), Open RAN is expected to be even more cost efficient, through increased innovation and greater impact from virtualisation and automation. This cost efficiency would allow some operators to operate comparable networks at a lower cost, while other operators could build more performant and flexible networks within similar cost envelopes.

[61] Countries in the 'low-income' bracket are defined as those with GDP per capita (PPP) of below USD12 000, while those in the 'middle-income' bracket have a GDP per capita (PPP) of between USD12 000 and USD22 000, and countries in the 'high-income' bracket have a GDP per capita (PPP) above USD22 000.

As in the global report,[62] we have modelled these benefits through a further reduction over time in the intensity of RAN costs (opex and capex) as a share of recurring revenue due to Open RAN, compared to a scenario where only traditional solutions are available (referred to as 'the counterfactual' in the remainder of this section).[63] RAN capex is assumed to be 15% lower for a comparable network[64] by 2025, and 20% lower by 2030. RAN opex will be very slightly lower (3%) for a comparable network by 2025, with savings increasing to 10% by 2030. The model cost inputs for India are summarised in Figure 4.2.

FIGURE 4.2: MODEL COST INPUTS FOR INDIA [SOURCE: ANALYSYS MASON, 2021]

As a share of recurring revenue (as a share of total revenue, assuming constant recurring share)	2020[65]	2030 (counterfactual)	Open RAN by 2030 vs. counterfactual	2030 (baseline)
Opex				
Network (RAN) opex	32% (30%)	30% (28%)	–10%	27% (25%)
Network (non-RAN) opex	20% (19%)	16% (16%)	Not captured in model	16% (16%)
Non-network opex	27% (26%)	26% (24%)		26% (24%)
Total opex	79% (75%)	72% (68%)		69% (65%)
Capex				
Network (RAN) capex	9% (9%)	9% (9%)	–20%	7% (7%)
Network (non-RAN) capex	8% (7%)	8% (7%)	Not captured in model	8% (7%)
Non-network capex	4% (4%)	4% (4%)		4% (4%)
Total capex	21% (20%)	21% (20%)		19% (18%)
Total cost				
Total opex + capex	100% (95%)	93% (88%)		88% (84%)

These cost-saving benefits would also be passed on to consumers, in the form of lower unit prices. As in the global report, we have linked the level of price decline to the Herfindahl–Hirschman Index (HHI),[66] as well as the long-term level of Open RAN adoption in the market, with a more competitive market (with lower HHI), and a higher long-term level of Open RAN adoption in the market, yielding greater benefits to consumers. These benefits to consumers are realised in the form of lower average revenue per user (ARPU), as well as increases in data consumption. We have modelled these with an elasticity level of –0.5, meaning that consumers will spend half of the cost saving from lower prices to consume more data, which would have an impact on GDP, while the other half would be saved, and translate into slightly lower ARPU, and an increase in consumer surplus.

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

[63] 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).

[64] To a network built using proprietary solutions

[65] Starting point inputs are based on historical figures from 2012–19, in order to control for the impact of Covid-19, and as this modelling approach does not explicitly account for year-on-year business cycle effects.

[66] 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.

We have focused our quantification on the impact that increased mobile penetration and increased data usage will have on GDP. For these calculations, a similar set of assumptions is used for India as was used for the low-income country group in the global report, as detailed in Figure 4.3 below. The only difference relates to the percentage point increase in mobile internet coverage for a reduction in cost of rural deployment, where a more conservative assumption is used for India.[67]

FIGURE 4.3: INDIA BASELINE CASE PARAMETERS FOR GDP IMPACT 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[68]	1.5 p.p.
Percentage (%) increase in penetration (% of covered population) from a 10% decline in mobile broadband plan prices[69]	3.2%
Percentage (%) increase in GDP per capita from a 10% increase in mobile broadband penetration[70]	2.0%
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[71]	0.8%

Over the period 2021–30, we estimate Open RAN could generate USD58 billion in incremental real GDP (at 2020 prices) in India, by accelerating growth in mobile internet penetration and data usage. The model assumes a progressive adoption of Open RAN, resulting in a situation where most of the benefits are generated in the second half of the decade. As such, the economic impact of Open RAN in 2030 will be significant, reaching USD18 billion in 2030 (in real 2020 terms), as shown in Figure 4.4.

[67] A figure of 2 percentage points (p.p.) was used for low-income countries in the global report. This has been adjusted downward to account for a higher initial starting point for India in terms of population coverage of mobile internet.

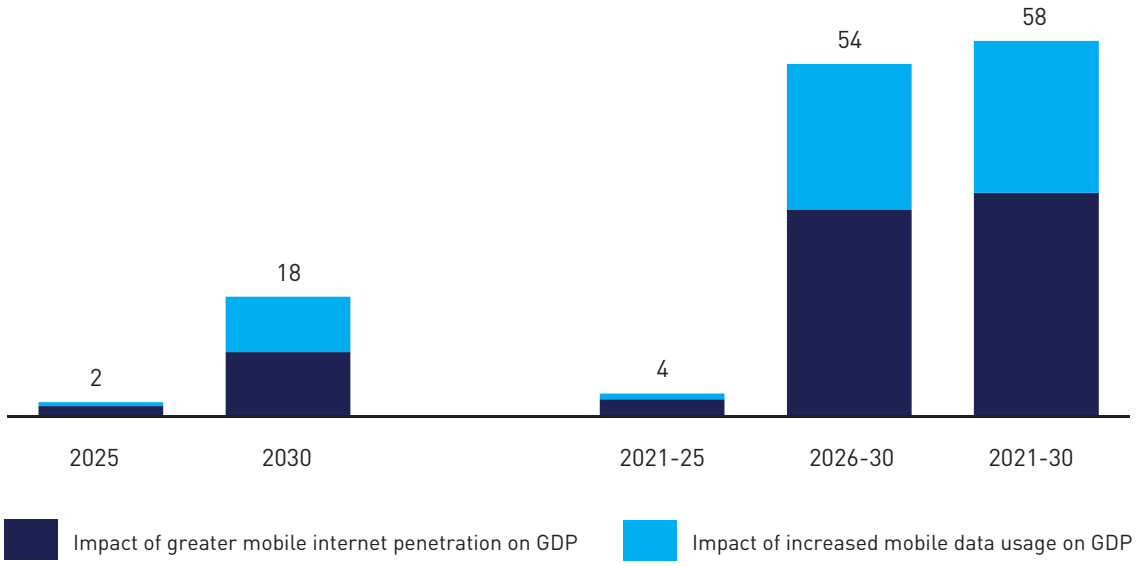
[68] Based on recent Analysys Mason project experience related to the viability of rural connectivity solutions that involved calculating net present value of rural deployments, accounting for costs and revenue potential.

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

[70] 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

[71] 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/

FIGURE 4.4: 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]



4.2 Faster adoption would increase cumulative impacts and greater efficacy would add to higher GDP impact, potentially doubling GDP impact over the next decade to over USD120 billion

As in the global report, we also consider sensitivities that could affect the magnitude of impact that Open RAN could have. In the Indian context, this would depend on the level of success of organisations such as TIP, as well as other industry facilitation initiatives (e.g. by the government, in this context), in enhancing the efficacy of Open RAN solutions (in terms of cost efficiency and acceleration of advanced technology take-up), and driving operator adoption.

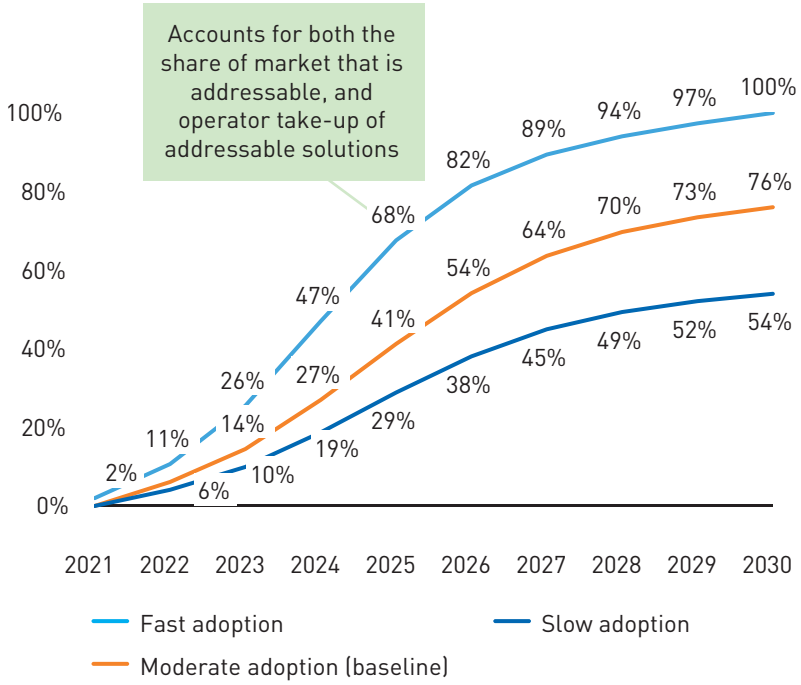
Assumptions used for varying efficacy are unchanged compared to the global report, and are presented in Figure 4.5 below.

FIGURE 4.5: 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

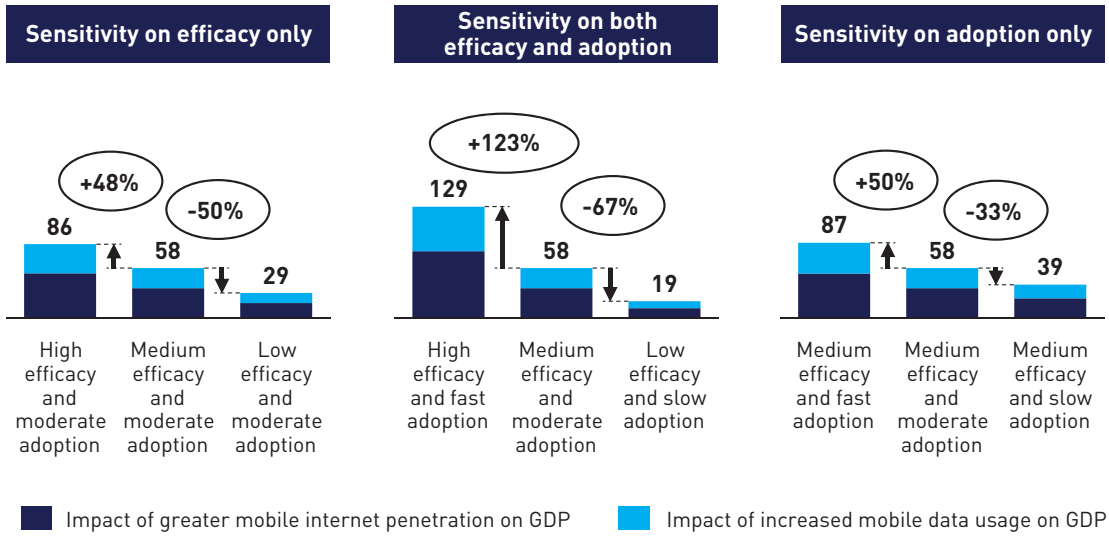
With regard to operator adoption, we have adjusted adoption assumptions in the 'fast adoption' and 'slow adoption' cases for India upward compared to the global report. This is in line with the view that the baseline 'moderate adoption' scenario for India would exhibit a more aggressive adoption curve than that for other low-income countries as modelled in the global report. The resulting Open RAN adoption curves for all three adoption sensitivity scenarios can be seen in Figure 4.6 below.

FIGURE 4.6: RESULTING LEVEL OF OPEN RAN ADOPTION IN THE MARKET, ACCOUNTING FOR BOTH SHARE OF MARKET THAT IS ADDRESSABLE, AND OPERATOR TAKE-UP, BY ADOPTION SCENARIO [SOURCE: ANALYSYS MASON, 2021]



The resulting combinations of efficacy and adoption sensitivity parameters result in a wide range of outcomes, with the most extreme combinations being that of the 'high efficacy–fast adoption' case and the 'low efficacy–slow adoption' case, as shown in Figure 4.7 below, compared to the 'medium efficacy–moderate adoption' baseline case that has been considered for most of this report.

FIGURE 4.7: 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]



4.3 Key stakeholders should be aligned on maintaining openness and interoperability to maximise economic benefits while developing a strong production base over the long term

In our global report, we highlighted that active involvement by policy makers and industry initiatives in facilitating the development of a vibrant open network supply chain ecosystem would help to unlock economic benefits. Also discussed is how a lack of co-ordination on issues such as adoption of open standards, and refragmentation leading to poor interoperability of solutions could reduce the potential for open and disaggregated technologies to deliver economic and supply chain benefits.

Supply chain participants and operators in India have made significant investments in developing new capabilities to meet domestic and global demand for network solutions in recent years, and there are ambitious plans for the future. The government, meanwhile, is also providing support through initiatives such as the PLI and PM-WANI schemes to build production capability and improve connectivity. Organisations such as TIP can also serve an important role in fostering collaboration between stakeholders to ensure that objectives are aligned, and that opportunities such as government incentive schemes are maximised in a way that benefits individual companies and the ecosystem as a whole.

There is a significant amount of activity happening in this space in India, and in this context it is important for network implementations to be based on genuinely open standards and interoperable interfaces, to prevent fragmentation and introduction of proprietary elements that could limit incentives for innovation and diminish the potential for open and disaggregated technologies to deliver economic benefits in the long run. Maintaining openness and interoperability is also crucial for realising the ambition of developing a strong and sustainable export-oriented production base of network equipment and solutions in India.

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