01 **BRIEFING NOTE**

UNITED NATIONS ESCAP Economic and Social Commission for Asia and the Pacific / APCICT

Cross-Sectoral Infrastructure Sharing for Broadband

KEY TOPICS

Infrastructure sharing for expanding broadband

Advantages of infrastructure sharing across sectors.

Approaches for regulation and major business models

Fair competition among sectoral operators.

Broadband network as a 'common utility'.

Various models of cross-sectoral sharing.

Cooperation and collaboration among the sectoral players.

Introduction

The objective of this Academy Module is to introduce the concept of "cross-sectoral infrastructure sharing" and see how suitable strategies for such sharing can be leveraged to expand the reach of broadband connectivity to the underserved rural and the most remote corners of the world. It also explores the policy and regulatory issues around infrastructure sharing and explains prevalent models of cross-sectoral infrastructure sharing with illustrative examples.

The module also discusses the advantages and financial benefits of such a strategy. It highlights the policy and regulatory issues involved in the process and showcases different models of cross-sector infrastructure sharing that are being implemented in different countries.

The module also examines the ramifications of open access policies in broadband deployment which will enable the national regulators to untie an incumbent's bottleneck to make the monopolies more pliable to sharing their infrastructures and services in a competitive business environment. Suitable for policy makers and civil servants at the national and local government levels, the overarching goal of this module is to foster a better appreciation of cross-sectoral infrastructure sharing that supports broadband connectivity to reach the unreached.

02

What is Infrastructure Sharing and Co-Deployment?

The definition of infrastructure has widened in scope over the years. In simple words, **infrastructure** means those basic facilities and systems that are essential for an individual, household, region or nation to function. It includes railways, roads, bridges, highways, other transport facilities, water supply systems, electricity lines, telephone systems and Internet connectivity.

Infrastructure can be categorized into two main types. **Hard or economic infrastructures** are basic facilities and services necessary for the functioning of the economy or the industry such as roads, airports, seaports, railways and electricity. **Soft or social infrastructures** refers to all the facilities, institutions and services required to maintain the economic, health, cultural and social standards such as educational institutions, hospitals, police and the judiciary. These infrastructures contribute to the economy, for example, the education system provides skilled workers to the industry.

Another term **critical infrastructure** is used to indicate a set of infrastructures such as water, wastewater, power, transportation and telecommunication (or telecom) systems without which buildings, emergency response systems and other infrastructure cannot operate as intended. Countries define their critical infrastructure according to their national contexts, needs and priorities, but, in the majority of cases, telecom systems are recognized as critical infrastructure since the operations of many other key infrastructures depend heavily on telecom networks, including the Internet.

History of Infrastructure Sharing

The history of infrastructure sharing goes back to 1843 when the British inventor, William Cooke, collaborated with Great Western Railway to use telegraph services for railway signalling. As time passed, similar sharing of corridors and facilities between the telecom system and other infrastructure systems such as railways, roads and electricity continued. With the need to reduce the clutter, multiple wires were bundled into cables to take less space when installed on poles. This ushered in a new era of infrastructure sharing between electricity and telephone companies – the genesis of a modern-day utility pole that supports a host of public utilities such as electricity, telephone and cable television networks.

Interestingly, the growth of wireless communication and development of microwave technology in the second half of the twentieth century reduced the need to share infrastructure as wireless was cheaper than cable installations over long distances. Mobiles phones were available around as early as 1946, and subsequent developments in digital cellular telephones (second generation or 2G) continued the march of wireless. Meanwhile, the existing traditional telegraph, landline telephone and cable television networks continued the cross-sectoral infrastructure sharing with other networks such as railways, roads and electricity utilities.

The popularity of mobile phones increased demands for faster transmission of voice and data. Instead of microwave links, terrestrial fibre-optic networks were being installed as the national backbone, and undersea fibre-optic cables were replacing the satellite-mediated links. This growing use of fibre-optic cables brought back the need for space to lay the cables. The benefits of cross-sectoral infrastructure sharing came to the forefront, especially from the cost-saving perspective. Deployment of cables once again looked towards rights of way available with other utilities like railways and roads, poles of power transmission grids, water, and gas pipes, and even sewerage lines. The idea of sharing for mutual benefits that started with railways and telegraph has now led to infrastructure sharing that is no longer a choice but a necessity. Opportunities for sharing across sectors have now increased further with varying degrees of challenges and scopes.

Networked World of the Future

Advancement in ICTs, and the increasing capacity to collect, store, process and disseminate data faster with decreasing hardware and software costs have created a networked world. All aspects of modern-day life, transportation, health care, entertainment, work, businesses, social interactions and governance are being bundled together through complex systems that rely on converged and ubiquitous infrastructures. In this networked world, the availability of fast and affordable ICT connectivity is placed at the centre of the 2030 Agenda for Sustainable Development in the Asia-Pacific region. ICTs supported by reliable broadband connectivity are the new drivers of economic growth, increased productivity, and efficiency. Broadband access is seen as a foundation for the digital economy and society across socioeconomic sectors, including health, education, financial services, business, trade, transport, smart agriculture, and energy systems, just to name a few.

In this new networked world, Artificial Intelligence (AI) and Internet of Things (IoT), if devices in IoT are responding to data, AI enables them to analyse the data and make smart decisions themselves. It can be called a replica of human intelligence where machines respond and perform activities like sifting through a set of data and solve a given problem. The prevalent environment of production, employment, productivity, and economic activities will drastically change over the coming years. The broader picture that is gradually emerging is that of a world increasingly dependent on components that include broadband connectivity.

While all these technological developments are becoming a reality faster than we have imagined, the issue of uneven access to broadband connectivity comes to the forefront. The digital disparity between and within countries in the region is becoming more visible with the gaps between developed and developing countries and between urban and rural areas widening. Accelerated efforts to narrow the digital divide between and within countries are urgently needed, and infrastructure sharing to expand broadband connectivity is a proven approach. Cross-sectoral infrastructure sharing has its planning, implementation, financial regulatory and operational challenges. There are issues related to the economic viability and policy contexts of the countries. But there are also success stories and encouraging examples to learn from where these issues have been addressed. Based on this understanding, we can chart our plans for the future.

04

What is Infrastructure Sharing and Co-Deployment?

Infrastructures have been shared by utilities like railways, roads, water, power and telecommunication at different times and levels through different arrangements. However, in the emerging environment of a networked world that is heavily dependent on broadband connectivity, infrastructure sharing among the sectoral players cannot be incidental or one-off experiments. Rather, infrastructure sharing should be well planned and supported by a long-term vision of the emerging nature of the digitalized world. It needs an **integrated approach** and **policy and regulatory support** for collaboration at every stage of infrastructure deployment. It should be seen as an economic advantage to share costs and as a necessity to increase productivity and economic growth.

Traditional partnerships for covering segments of the networks by different infrastructure owners to provide connectivity, particularly in reaching the last mile, is now giving place to new models where a common facility is operated by all partners involved (**mutualization**) or the sectoral operators can join hands to expand new infrastructure (**cooperation**). An integrated approach covers five major dimensions of infrastructure sharing: technology, geography, architecture, partnership, and sourcing.

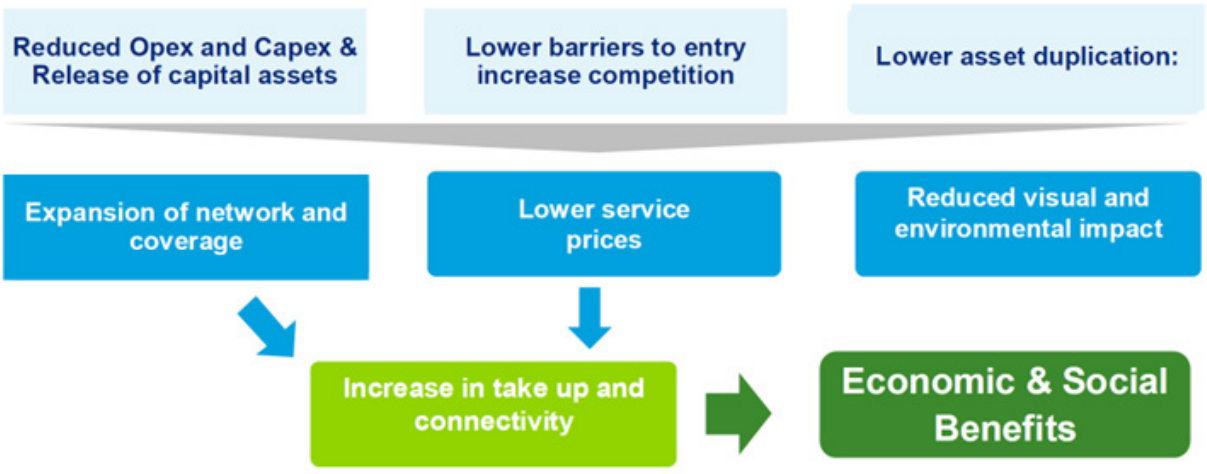
History of Infrastructure Sharing

The most prominent advantage of infrastructure sharing is decreased CapEx and OpEx. Any infrastructure building is expensive, and the need for capital expenses upfront deters many from entering a market, especially if the potential revenue is limited (e.g., in a rural community). The **CapEx** factor becomes more critical as the market becomes more competitive. An operator may find it hard to survive in the competition to recover a huge initial investment. In such a circumstance, it goes without saying that if operators of different sectors join hands and share their infrastructures, they will gain by reducing CapEx. While the infrastructure owner can generate additional revenue and recover its initial investment faster, the partner can also save its CapEx requirement (by not having to build those infrastructures) and enter a market with a more competitive advantage. Partners can pass on these savings to innovate in operations and service delivery.

In terms of savings in **OpEx**, infrastructure sharing can benefit the sectoral operators in reducing maintenance costs, power consumption, rents for sites and buildings, and security expenses. Savings can also be accrued from a combination of other OpEx such as field services, network operation centre costs, spare parts management and ongoing network optimization. Infrastruc-

Optical ground wire in Bhutan: In Bhutan, the Ministry of Information and Communications has invested heavily in executing the National Broadband Master Plan Implementation Project to establish an optical fibre backbone network throughout the country. (Source: Ministry of Information and Communications, Government of Bhutan).

ture sharing offers four major OpEx benefits – site costs, maintenance, power and backhaul. Besides CapEx and OpEx savings, infrastructure sharing brings in many other direct and indirect benefits for all – owners, operators, service providers and the end users (Figure 6). Customers usually benefit from the operators reinvesting the savings in new/enhanced services, further/faster geographic service roll-out, improved service quality or lower prices. In turn, the government benefits from increased tax revenues resulting from increases in value-added (sales) tax (from higher revenue), corporation tax (from higher profits) and personal income tax (from higher employment, investment, etc.). Increased broadband penetration and consumption increases national productivity and investment which in turn is reflected in gross domestic product, employment and further tax revenue. There are also the environmental benefits of infrastructure sharing such as reduced carbon footprint due to energy savings, reduced travel by field engineers, reduced road traffic disruption and less visual pollution in the case of radiocommunication towers. There are, however, a few challenges and risks that may arise in cases of infrastructure sharing. One of the challenges is price regulation. Generally, regulation is a measure to prevent market failures, ensure the quality of services and products, and safeguard consumers' interests and larger social good in access to ICT services. But, when multiple sectors are involved in infrastructure sharing, price regulation can distort the market and lead to cross-subsidization of one sector at the cost of the other, and it may ultimately discourage infrastructure sharing. Closely associated with the issue of regulation is competition. Two types of competition are relevant here: (1) **service-based competition**, where a new operator uses the existing infrastructure of an incumbent at a regulated price; and (2) **infrastructure or facility-based competition**, where the new entrant builds new infrastructures or facilities and then competes with the incumbent in terms of services, quality and coverage.



Advantages of infrastructure sharing
(Source: Deloitte and Association for Progressive Communications)

06

Policy and Regulatory Issues

The phenomenal growth in ICTs, number of consumers and geographical coverage of ICT networks have increased the complexity of regulating the sector at different levels. While the market has become fiercely competitive, with multiple players vying for customers, the cost of infrastructure deployment remains high. Regulators can reduce entry barriers (like the cost of new infrastructure deployment), enabling new players to join the market to provide competition against the incumbents or dominant sectoral players. Regulations are often seen as government interventions justifiable only in special circumstances like a market failure. However, with the emergence of new technologies and the convergence of technologies, utilities and services necessary to run a modern economy, it is increasingly clear that ICT is a universal service for all citizens.

Regulations as having three main aspects: (1) rules, regulations, guidelines, statutes and laws; (2) a general framework for steering the overall economy; and (3) social control mechanisms exerted by the state. All regulatory mechanisms have their strengths and weaknesses in policy directions, economic agendas, enforcement mechanisms and structures. Regulations and regulatory agencies are primarily concerned with public utilities like water and electricity, where incumbents hinder the market's free operations. Regulators are seen to provide confidence and transparency to market operations.

There are two major visions of regulations. One is government intervention as a measure of sheer economic efficiency. Regulators respect the private sector's autonomy, self-regulation and mutual contractual arrangements among the players. The other vision considers regulation as a joint enterprise where economic, social or distributive justice factors are considered. Two aspects of the evolution of telecom regulations across the world may be noted here. First, the boundaries of regulations concerning infrastructure and content are now diminished with technological advancement. Second, to leapfrog ICT development, especially in developing countries, the telecom sector opened for competitive participation before the relevant regulatory frameworks could be put in place.

Voluntary vs Mandatory Regulations

The need to expand infrastructure, improve quality of service, promote innovation, and accelerate technological advancements led to the liberalization of the telecom sector for open market competition. Simultaneously, stakeholders raised non-economic concerns such as universal access to ICT for all, individual privacy, and consumer rights. Regulations are meant to address these issues that are often termed as public interests. Telecom services are both utilities and essential services like water, electricity and gas. As infrastructure sharing is one way to ease the entry of new players in the telecom sector, the regulatory concerns in such sharing attain much importance. The joint utilization of assets and services necessary to provide telecom service means the incumbent, which has built infrastructure over the years, should share its assets with a new entrant to market so that it can offer services in a competitive market.

The **mandatory approach** in telecom regulations considers telecommunication as an essential facility, and its access should therefore not be restricted, syndicated or monopolized in such a way as to obstruct the entry of a new player. However, mandatory infrastructure sharing is not a universal formula for all. The market needs some level of maturity and size to adopt such a policy. The other regulatory approach in telecommunication is **voluntary sharing** when it is left to the infrastructure owner's choice to

adopt a sharing policy based on the costs and benefits. It is recognized that the ideal competitive market in the telecom sector may not be achieved as the initial cost of infrastructure may deter new entrants from joining the competition. is government intervention as a measure of sheer economic efficiency. Regulators respect the private sector's autonomy, self-regulation and mutual contractual arrangements among the players. The other vision considers regulation as a joint enterprise where economic, social or distributive justice factors are considered. Two aspects of the evolution of telecom regulations across the world may be noted here. First, the boundaries of regulations concerning infrastructure and content are now diminished with technological advancement. Second, to leapfrog ICT development, especially in developing countries, the telecom sector opened for competitive participation before the relevant regulatory frameworks could be put in place.

Universal Access and Service

With rapid changes in technology, the idea of universal access to a telephone or the Internet has undergone several changes, and today, broadband connectivity has become the bare minimum for all. With further convergence of technologies and public utility services under NGNs, ICT policymakers face new challenges in providing reliable and resilient universal broadband access and service to all. The regulations and policies around universal access and service are determined by a county's national vision, socioeconomic conditions, and an understanding of public interest as a societal value consideration.

Policy Issues in Cross-Sectoral Infrastructure Sharing

A number of policy issues arise in cross-sectoral infrastructure sharing. Several social aspects beyond market competition scenarios or the usual demand-supply binaries come to the forefront. Many argue in favour of the non-rival social goods that can be obtained at a marginal cost by sharing infrastructure. Sharing infrastructures across sectors like roads, water and gas to provide universal broadband access must be seen from an overall national, regional and global context where socioeconomic activities in any part of the world are inextricably dependent upon stable broadband connectivity. The input (broadband connection) can be treated as a common facility for various operators to offer different services (outputs). Therefore, a good policy environment will take care of this input-output relationship to sustain connectivity in the long run. In cross-sectoral infrastructure sharing, the social goods or benefit considerations must be kept in view while allowing a sector to use the assets.

In order to provide reliable and affordable broadband for all, the cost of broadband connectivity for the end user needs to consider not only the demand-supply scenario but also the price the users may be willing to pay for the value-added services that the broadband connection will generate as social goods. In cross-sectoral infrastructure sharing cases, these social goods or benefit considerations need to be kept in view while allowing a sector to use the assets of another.

In addition to the social value considerations in infrastructure sharing, regulators are concerned with putting monetary value to these services (revenue) and sharing this among the infrastructure owners and service providers. The idea of collaborative regulation, also known as the fifth-generation regulation, is emerging as a new framework to resolve this issue.

Open Access Broadband Network

In open access model of the broadband network, the ownership of the infrastructure and delivery of services are shared by different entities. The section also discussed the open access networks as common infrastructure and explored the different business models of open access broadband. The open access policy promotes sharing of the infrastructure elements at different levels (layers) to increase competition in the broadband sector, expand broadband connectivity to unserved and underserved areas, improve ICT service quality, and reduce the cost of broadband connectivity and ICT services for end users. In cross-sectoral infrastructure sharing, open access can be a policy option where various opportunities to share the backbone, physical infrastructures, and passive and active elements of the broadband networks can be explored. The broader objective behind an open access policy is to convert telecom facilities into a public good available to all. In the open access model, a high-speed, resilient broadband infrastructure is built, and all service providers use the same network by paying a fee and offering their services to the end users or customers.

There are two types of open access arrangements – the two-layer open access model and the three-layer open access model. In a two-layer system, one entity is both the network infrastructure owner and the operator, and multiple service providers use the network to deliver services to the consumers. In the three-layer system, the network infrastructure is owned by one entity – a company, a public sector agency or the government. The operations and maintenance of the network are given to a second party (layer), and the service providers form the third layer.

Models of Open Access Broadband

In the traditional business model for broadband, when used for very limited email and Internet surfing purposes, the subscriber used to get a specific amount of bandwidth "by the bucket" defined by specific upper limit fees per month. When the consumer used this bucket, it was refilled at a cost. Initially, the model worked fine as the bucket was rarely fully utilized by the user. More recently, with the introduction of data-intensive online services and streaming videos, larger buckets were offered and refilled at a cost. Simultaneously, different networks came up at the same locations – with wireless broadband networks and the old copper (digital subscriber line) networks running side by side. These duplications of networks increase the cost for the end user as providers need to recover the network infrastructure costs.

In the **open access model**, a high-speed and resilient network is built, and all service providers use the same network by paying a fee and offering their services to the end users or customers. Customers can pay for the services of their choice from one or multiple providers at a competitive price. Here, many service providers share the network's cost, and hence, lowers the cost for customers. The network owner or its operator is focused on the smooth functioning of the network, while the service providers are concerned with new offerings, quality of service and competitive price.

In **vertically integrated model**, if one actor, like a telecom company, plays all three roles – physical infrastructure provider, network provider and service provider – this type of business model can be termed vertically integrated. Here, incumbent telecom operators usually own the infrastructure, both active and passive, and offer services directly to the end users. Sometimes, they offer wholesale or bulk access to their network or infrastructure to competing service providers. When these players gain significant market power, regulatory bodies often compel them to open their networks

to other competitors to facilitate the entry of new players and generate competition in the market. These three roles are separated in **Open Network Model** where the infrastructure is considered as a common and it is open to all market players on a non-discriminatory basis. Depending on the two-layer or three-layer set-up, the network owner can take up roles of infrastructure provider and/or network provider.

Models of Open Access Broadband

As cross-sectoral infrastructure sharing requires the active support and cooperation of different infrastructure owners, it is important to discuss their roles in such arrangements. Major roles that are played by the sectoral entities are that of: (1) carrier of the telecom infrastructure; (2) facilitator for expansion of national ICT infrastructure plans; (3) generator of additional revenue; and (4) operator and caretaker of a network (backbone).

Different infrastructure sharing models may be adopted to expand broadband connectivity in a country where different sectoral entities may join hands through mutually acceptable arrangements backed by conducive regulatory frameworks. Three prominent models have emerged so far, which are prevalent today: (1) Infrastructure asset sharing, (2) Infrastructure mutualization, and (3) Infrastructure cooperation.

The **first model** of infrastructure asset sharing exists predominantly among the different entities operating in the same market and still share their infrastructure like masts, ducts, antennas, transmitters and rights of use. We have seen the understanding reached in this category between Bangladesh Railways and Grameenphone, and Bhutan Power Corporation and Bhutan Telecom Limited.

The **second model** of mutualization exists where a common infrastructure is built, maintained and managed by a provider. Other telecom service providers rent these facilities in a non-discriminatory manner. Many sectoral entities with their own telecom infrastructure have been licensed to offer their networks to others in India. Public-private partnership arrangements are used to create a common nationwide Internet backbone with commercial telecom service providers covering the last mile.

The **third model** of infrastructure sharing is the cooperation model, the most relevant strategy for different sectoral infrastructure asset owners to provide broadband connectivity. The sectoral entities like roadways, railways, waterways, gas pipelines, or power utilities build or host infrastructural facilities like common ducts, fibre networks, poles and other assets, which are later allowed for use by other sectoral players or telecom service providers in a non-discriminatory manner based on agreed rent. Here, different sectoral owners of telecom networks need to work towards a synergy so that the infrastructures are constructed, operated, maintained and used through cooperation.

Approaches for Partnership in Infrastructure

Examples of **public-private partnership** arrangements include: (1) the cooperative model, where infrastructure and service providers jointly build and operate the infrastructure with government subsidy; (2) the equity model, where the government obtains equity in exchange for its contribution; (3) the concession model, where the government issues a public tender to select a private operator to build and operate the infrastructure; and (4) the management contract where the government issues a public tender to select a private operator to build, operate and commercialize the infrastructure.

Different approaches can be adopted to enter into partnership agreements for infrastructure sharing between sectoral entities. These ap-

proaches are not prescriptive or mutually exclusive; rather, depending on the market and regulatory environment, sectoral infrastructure owners can use them individually, sequentially, or through a judicious, negotiated and pragmatic mix of these approaches. One approach is joint planning and construction where partners negotiate the future ownership, management, revenue sharing and maintenance of the shared infrastructure. Co-deployment of fibre along roadways, railways or any other utility infrastructure can be addressed through this approach.

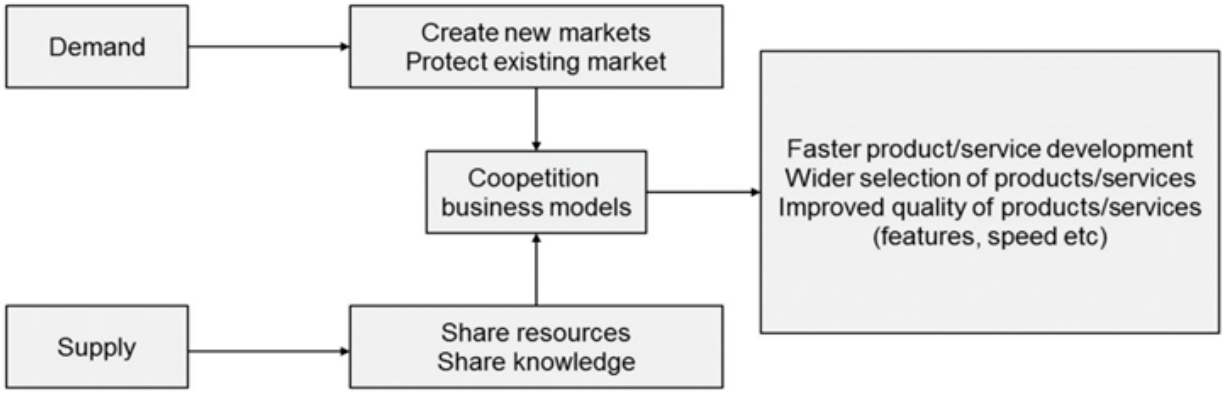
A second approach is the historical railways-telegraph partnership where a sectoral infrastructure owner hosts the telecom infrastructure created by another entity. Here, the host generates additional revenue and may share maintenance costs with the partners, and both benefit from the arrangements besides cost saving and faster deployment of telecom facilities. A third approach is to share unused infrastructure capacity with the incumbent owners. Entities like railway operators (India, Bangladesh), power transmission companies (Bhutan, India) and gas companies (Bombay Gas) can offer the unused bandwidth of their installed fibre network to other sectors as well as telecom companies on short-term or long-term lease for extending broadband services. In India, public utility companies such as Bombay Gas Company Limited, Gas Authority of India Limited, Indian Railways and Power Grid Corporation of India Limited have been leasing their surplus fibre to telecom operators.

Infrastructure Coopetition among the Utilities

Infrastructure sharing between different sectors will primarily depend on cooperation and collaboration among the partners, and a conducive regulatory environment. Despite a nudge from the regulators, the sharing agreements are often not reached by the parties due to operational, financial, industry structure, technological and institutional factors. Researchers have found the need to move from competition to coopetition for fruitful infrastructure sharing, where cooperation and competition work simultaneously among rival parties.

Therefore, any prospective business models for infrastructure sharing should consider internal resources such as technology, capacity and business strategy, and the external environment such as customers, markets and business partners. Business models can be seen as a strategy for developing a value network through an interaction between value proposition for the customer, value creation and value capture.

The way forward for the sectoral utilities, telecom operators and regulators is to create an environment of cooperation and mutual understanding for infrastructure sharing primarily based on negotiated partnership agreements on collaboration and revenue sharing arrangements rather than regulatory compulsions, except perhaps in the cases of market failures.



Coopetition Approach
(Source: Chandler Velu, 2018)