WORLD BANK GROUP

MODULE 2.

FINANCIAL AND OTHER MOTIVATIONS

CROSS-SECTOR INFRASTRUCTURE SHARING TOOLKIT

2 Financial and other motivations

122. All stakeholders have strong financial and other motivations to share infrastructure across sectors. The following submodules describe some of their primary motivations. The disincentives and impediments faced by market participants, and potential ways to address them, are discussed in Modules 3 through 6.

2.1 Motivations of broadband network operators

Worldwide broadband demand is growing exponentially

123. Recent and projected growth in customer Internet demand requires exponential increases in Internet throughput capacity. If voice communications were once the main course of modern telecommunications services, they are now merely a side dish. Over the past several years, telecommunications service traffic has evolved from primarily voice to primarily data, and customer demand for data throughput has grown exponentially.

124. The 80 kbps of throughput required to support a voice line is being dwarfed by the throughput speeds required for retail telecommunications customers to watch videos, download and upload files, access content-rich websites and social media posting, and engage in the full variety of communications supported by the Internet. Business communications today requires a high-bandwidth, always on, data channel to the Internet cloud. In addition, the growing "Internet of Everything," in which inanimate objects increasingly interact with humans and with each other through the Internet, requires virtually every device to be connected to a network and adds significantly to the coverage and throughput requirements of networks.

125. The number of users of broadband is also growing exponentially from the wealthiest to the poorest countries across the world. In 2016, Ericsson estimated there were 3.7 billion mobile broadband subscriptions worldwide, and projected this number to increase to 7.7 billion by the end of 2021.[1] In 2016, the ITU estimated there were 884 million fixed broadband subscriptions, and the Broadband Commission projects this number will increase to one billion by 2019.[2]

126. This phenomena have impacted the planning and investment activities of operators of wired and wireless networks. Both fixed and mobile network operators face pressing and growing needs to upgrade their networks.

Wired networks must become fiber from end to end

127. End-to-end copper telephone access networks using DSL technology and coaxial cable television systems using cable modem technology can no longer support the required throughput to meet consumer and business growth in data demand. The gap between capacity demanded and the capacity supported by this infrastructure will continue to grow over the coming years. The last mile of twisted copper and coaxial cable access networks in virtually every developed country which still has such networks in place must either be replaced with fiber or with wireless broadband links. In 2016, end-to-end fiber-to-the-premises (FTTP) networks) and partially fiber and partially

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[1] *See* Ericsson, *Ericsson Mobility Report* at 2 (June 2016). Available at http://www.ericsson.com/res/docs/2016/ericsson-mobility-report-2016.pdf (last visited 8 Feb 2017).

[2] Broadband Commission, *The State of Broadband 2016: Broadband catalyzing sustainable development* at 22 & 27 (Sep 2016). Available at http://broadbandcommission.org/Documents/reports/bb-annualreport2016.pdf (last visited 8 Feb 2017).

copper or coaxial cable networks, known as fiber-to-the-X (FTTx) networks, together served nearly half of the total market for fixed broadband, a fraction that is growing steadily.[3] In developing countries where the copper network has already been decommissioned, or has limited coverage, fixed broadband must be built from scratch using either fiber or wireless solutions for the last mile. In every country, all upstream metropolitan, intercity and international backhaul links for fixed networks must also be replaced with fiber if they are not fiber already.

128. Cross-sector infrastructure sharing is strategically important to broadband operators building new FTTP networks or adding FTTx links to their legacy networks. Not only do network operators want to use existing lateral corridors, they today also want to share a wider variety of improvements and fixtures in those corridors than in the past. Such sharing can substantially reduce broadband network construction costs and barriers to new market entry. By sharing existing infrastructure, broadband network operators can build or expand networks much more quickly and at much lower cost. For example, passive infrastructure can constitute 70-80% of the cost of an overall investment in a fixed access telecom network.[4] According to the European Commission, civil engineering works constitute the dominant part in overall network deployment costs, with estimates as high as 80% for certain technologies.[5]

Wireless networks require fiber to the tower to support 4G/LTE and 5G

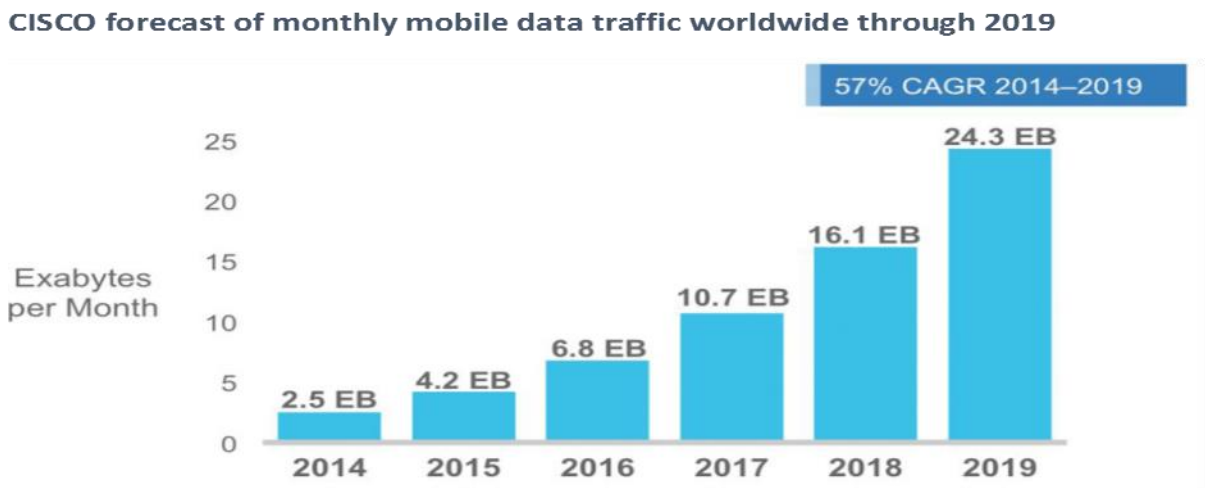
129. Today's investors in broadband wireless access networks can no longer avoid investing in heavy infrastructure as investors in 2G networks once did. Subscribers now expect mobile operators to support devices like smartphones and iPads as well as applications such as Facebook, YouTube and Netflix in both developed and developing countries. Mobile data throughput has steadily increased since 2002, and is forecasted to increase exponentially over the coming years. As indicated in Figure 1 below, Cisco has forecasted 10X growth in global mobile data traffic volumes in the five years from 2014 through 2019.

[3] Broadband Commission, *The State of Broadband 2016, supra*, at 27.

[4] Broadband Commission, *The State of Broadband 2014: broadband for all* at 72-73 (Sep 2014). Available at http://www.broadbandcommission.org/documents/reports/bb-annualreport2014.pdf (last visited 8 Feb 2017).

[5] European Commission, *Proposal for a Regulation of the European Parliament and of the Council on Measures to Reduce the Cost of Deploying High-Speed Electronic Communications Networks* (26 Mar 2013). Available at http://ec.europa.eu/digital-agenda/en/news/proposal-regulation-european-parliament-and-council-measures-reduce-cost-deploying-high-speed (last visited 8 Feb 2017).

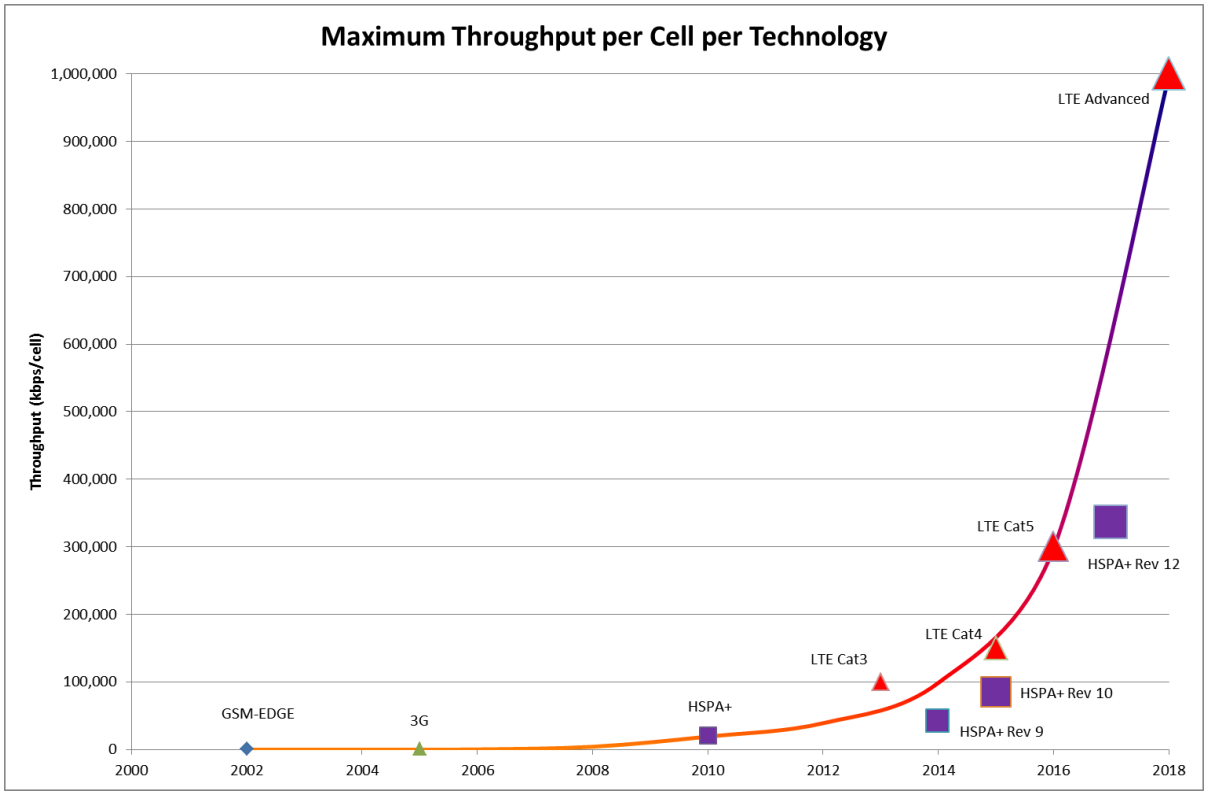
Figure 1 : Growth in monthly mobile data traffic volumes throughput worldwide



Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014-2019[6]

130. Mobile network operators must upgrade and infill their radio base stations to meet increased demand on their radio networks. Figure 2 illustrates the impact of traffic and bandwidth growth on required throughput capacity for each radio base station.

Figure 2: Trend in maximum throughput per cell by technology



Source: Andrew Johnson

[6] Available at https://www.mvnodynamics.com/2015/02/05/cisco-visual-networking-index-vni-mobile-forecast-projects-10-fold-global-mobile-data-traffic-growth-years/ (last visited 13 Feb 2017).

131. In turn, mobile network operators must therefore upgrade their transmission networks from microwave to fiber to realize the potential offered by their upgraded LTE mobile networks, because the growth in cell throughput will eclipse the ability of existing microwave transmission links to handle the maximum traffic loads on individual broadband-equipped cell sites. To support the deployment of 4G/LTE or 5G technology, network operators must build or retrofit their networks with fiber-to-the-tower. Again, mobile network operators benefit greatly in terms of cost and speed to market

Broadband upgrades and deployment thus require infrastructure sharing

132. The broadband revolution thus requires extensive new investments in fiber optic cable networks by both fixed and mobile operators and in 4G/LTE and WiFi wireless networks by mobile and some fixed operators. These infrastructure investments require extensive civil works and must rely heavily, to be viable and practical, on using existing land corridors and infrastructure.

133. In building out their mobile and fixed broadband networks, operators often face a difficult challenge in making the economics work. Such potential investments must achieve minimum viable scale and aspire to achieve minimum efficient scale as quickly as possible. In economic terms, minimum viable scale means the level of output at which total revenue exceeds total cost. Minimum efficient scale means the smallest level of output at which average costs are minimized. These challenges are present in both developed and developing countries.

134. Broadband network operators who share infrastructure within or across sectors may more quickly achieve benefits of scale by reducing their fixed costs. In a developing country, where domestic fiber optic cable investments to support mobile broadband expansion face very challenging market economics, cross-sector infrastructure sharing can often make the difference between viability and non-viability.

135. Wireless broadband network operators face an additional challenge today: growing public concerns about the impact of cell towers on health, safety and aesthetics. These concerns are increasingly restricting the supply of new cell tower sites. At the same time, operator demand for new cell tower sites has reached an all-time high as operators must decrease cell size, and therefore increase the number of cells, in order to upgrade their networks to deliver 4G/LTE services and soon 5G services.

136. All fixed and mobile broadband network operators are anxious to embrace cross-sector infrastructure sharing as a means to reduce the cost of rolling out the fiber needed for their broadband networks and, where applicable, siting new towers for their 4G/LTE networks.

2.2 Motivations of infrastructure owners

137. Cross-sector infrastructure sharing can also provide significant benefits to infrastructure owners. It presents a strategic opportunity for utilities to monetize the latent value of their existing infrastructure to generate alternative revenue streams. In developing countries, where utilities are often state-owned and capital constrained, these additional revenue sources are very important. They can be used to offset expenses of construction or maintenance of their existing infrastructure or construction of new infrastructure.

138. Infrastructure sharing also offers public utilities the opportunity to reduce the external capital required to install or upgrade their internal communications networks. Whereas in the days when the telegraph was developed, the railroads were the only corridor owners with identifiable need for internal communications networks, virtually every infrastructure owner today requires high-

speed and ubiquitous internal networks. Figure 3 below illustrates the potential internal communications needs of host infrastructure owners. While many of these applications do not require the high throughput levels offered by fiber, infrastructure owners have learned that fiber is a cost-efficient and often more reliable alternative to other means of connectivity.

Figure 3 : Common core business telecommunications needs of infrastructure owners

Owner's core business	Communications needs of infrastructure owner
Roads and highways	• intelligent transportation systems • signaling • traffic monitoring • dynamic signage and road user information • connectivity to public safety and work crews
Railways	• signaling • switching • rail track safety management and train control • internal voice and data links • wireless connectivity to rolling stock
Electric power	• network protection • SCADA systems • load management • outage detection • self-healing grids • management of bi-directional electricity flows • video surveillance and security • smart metering • internal voice and data links • connectivity to line crews
Water and sewer	• connectivity to pumping, treatment and control facilities • SCADA systems
Oil and gas pipelines	• SCADA systems • connectivity to well head, control points and delivery points

139. The potential for fiber to improve an infrastructure owner's operating efficiency, reliability and safety provides a strong incentive for all new facilities to include fiber and, where practical, to retrofit existing facilities with fiber. Cross-sector infrastructure sharing can typically improve an infrastructure owner's business case for deploying fiber.

140. For example, electric utilities in most countries now routinely install fiber optic cable on all new or refurbished electricity transmission grids to support network protection, SCADA and many other potential applications. Similarly, railway operators routinely install fiber optic cables along their railways to manage signaling, switching and rail track safety equipment. Although roadways have lagged behind electric grids and railways in deploying fiber, the increasing congestion and demand for intelligent transportation systems is exerting pressure on roads and highway authorities to include ducts and fiber in all construction projects. Likewise, metropolitan pipes projects, such

as water, sewer and natural gas, as well as intercity pipes projects, such as water, sewer, petroleum and natural gas pipelines, all can benefit greatly from the inclusion of ducts and/or fiber being installed whenever there is a new build or refurbishment of a line.

141. Many public utilities and other infrastructure owners have already deployed (or planned to deploy) their own fiber on existing infrastructure for their own internal use. The available capacity on these fiber optic cables usually greatly exceeds the capacity needed by the utility. Excess capacity, often in the form of unused dark fiber, can be sold or leased to telecommunications operators, allowing them to avoid the costs and commercial risks of fiber deployment.

2.3 Motivations of lawmakers, policymakers and regulators

142. Lawmakers, policymakers and regulators are today very focused on stimulating investment and competition in the provision of broadband services. They often seek to intervene in the market for cross-sector infrastructure sharing to support their broadband policy goals. Their objectives are to increase the viability and efficiency of new broadband investments and to ensure effective competition in the provision of broadband services.

143. Like broadband network operators, policymakers have observed that data growth trends quickly eliminate all options other than fiber for all wired networks and every part of every wireless network up to the tower. As noted by the Broadband Commission in 2014, a number of national broadband policies, when planning for the deployment of nationwide infrastructure, have identified fiber as "a more 'future proof' investment" than the alternatives.[7]

144. The emergence of fiber as the primary medium for network design has significant implications for competition policy in the telecommunications sector. Convergence toward fiber is bringing a return of non-replicable *critical facilities* in the sector. Mobile networks, once almost entirely wireless from end to end, must now be upgraded with fiber all the way to the tower – making the cost of redundancy in transmission networks prohibitive in all but the very wealthiest markets. Similarly, twisted copper pair and coaxial cable wired networks must eventually be replaced with fiber from end to end, again placing new importance on the wired network.

145. Though fiber and equipment costs have declined in relative terms, the costs of the works required for physically installing and maintaining fiber optic facilities have increased dramatically. The construction and operation of a fiber optic telecommunications network requires a significant upfront capital investment in fixed assets and ongoing fixed operating expenses. A significant part of these costs reflect investments in infrastructure, such as ducts, fiber optic cable, cell towers and equipment. Most of these infrastructure costs are fixed and do not vary with the volume of services provided (or vary only with large increases in the volume of services). Variable costs of providing telecommunications services typically comprise only a small percentage of overall costs. Sharing infrastructure, across sectors and within the telecommunications sector itself, is the best way to reduce each network operator's costs. The societal impact is to remove barriers to entry, improve financial viability and efficiency, and accelerate the deployment of broadband at a lower cost basis.

146. High fixed costs means new entrants face much higher average costs than incumbents because they initially have fewer customers over which to spread their fixed costs. Because these upfront fixed investments represent sunk costs, established incumbents have an incentive to price aggressively in the face of new entry. This possibility may deter new firms from entering the

[7] Broadband Commission, *The State of Broadband 2014, supra*, at 72.

market to compete based on the concern that market entry will prove unprofitable. Due to the economies of scale for fiber-based networks, overbuilding one fixed wired network with another is still considered economically prohibitive in most geographic areas, with the exception of very dense commercial or business districts.

147. Such *essential facility bottlenecks* lead to market concentration and potential abuse of dominance by the operator which builds its fiber network first. This can lead to a small number of network operators with their own duplicate infrastructure. A vertically integrated network operator with its own infrastructure may be unwilling to provide wholesale access to competing retail suppliers or may only be willing to do so on unfavorable terms. This is an intra-sector infrastructure sharing issue, not a cross-sector infrastructure sharing issue, and it is quite challenging because the infrastructure owner has motive and opportunity to discriminate or deny access to its competitors.

148. Cross-sector infrastructure sharing is particularly attractive to regulators and policymakers as an alternative means of reducing telecommunications infrastructure bottlenecks and intra-sector discrimination by fostering wholesale market entry in competition with telecommunications network operators who are dominant in infrastructure. As a neutral market participant whose only focus is to maximize revenue from infrastructure sharing, an infrastructure owner whose core business is not telecommunications has a strong incentive, even without regulatory mandate, to share its infrastructure with all requesting telecommunications operators on a non-discriminatory basis.

149. For example, multiple wireless and wired network operators can share a single fiber optic cable installed on electricity or railway facilities, with each operator having its own fiber pair in a multi-fiber cable. It is possible for each network operator to have exclusive use of its own dark fiber pair in a single fiber optic cable and install and operate its own equipment at the co-location facilities where there are fiber access points. This limits the concentration of market power.

150. As a relatively new phenomenon, mobile radio towers are now also becoming good candidates for cross-sector infrastructure sharing, as they can be installed on infrastructure or in corridors of other sectors. Demand for a range of macro cells and pico cells, capable of providing 4G/LTE and WiFi coverage, is quickly growing. Radio towers, which were once easily and inexpensively replicated, have increasingly become bottlenecks.

151. This is being driven by two factors. The first is a strong industry-wide drive to reduce capital costs, which is leading to a reduction in the replication of towers and a corresponding development of tower companies. But even the tower companies are having limited impact on the shortage of new tower sites.

152. The second factor is increasing public concern over health, safety and environmental considerations, which has led to increased regulation and enforcement. One trending approach is for regulators and planning authorities to restrict the placement of new towers by imposing a requirement that tower sharing opportunities first be explored and exhausted before new towers will be permitted. Even where mobile network operators enter into voluntary infrastructure sharing arrangements, as they are increasingly doing, they may exclude or discriminate against some competitors, and they still face a shortage of new tower sites to provide infill coverage as they upgrade their networks from 2G/3G to 4G/LTE.

153. Sharing of infrastructure from other sectors, particularly in existing *noxious use corridors*, such as electricity transmission towers and water towers, can mitigate public concerns over radiation or aesthetics and ease the permitting process for new towers. In the United States, local zoning laws frequently require that mobile operators provide evidence, before constructing new towers, that they have made efforts to co-locate on existing nearby radio base station towers and other suitable structures, including in particular electricity transmission towers and water towers.[8]

154. This sharing of infrastructure from other sectors can also reduce the motive to discriminate and ease the shortage of towers – bringing down prices and increasing the options for better coverage.

155. Legislative and regulatory intervention has in some cases gone beyond identification and removal of barriers and disincentives to entry and ensuring fair competition. Some mandatory sharing laws, though well-intentioned, impose obligations and potentially heavy regulation, but leave barriers to entry and disincentives intact. Hence, past legislative or regulatory efforts to mandate telecommunications operator access to utility infrastructure will typically benefit from periodic review and assessment, which can provide the basis for improvements and other reforms where appropriate. Suggestions for improving the effectiveness of government intervention are set out in Module 5.

[8] *See, e.g.,* Brevard County Board of County Commissioners, Notice to applicants for a conditional use permit for wireless telecommunications facilities and broadcast towers (2 Oct 2014). Available at http://www.brevardcounty.us/docs/default-source/planning-and-development/notice-to-applicants-for-towers.pdf?sfvrsn=4 (last visited 11 Feb 2017); Sherburne County Minnesota Zoning Ordinance, Section 16.5, Subdivision 5 (2001). Available at http://www.co.sherburne.mn.us/scip_web_files/zoning_upload/zoning/ordinance/413149c1222d22565.pdf (last visited 11 Feb 2017).