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Chapter 10: Bridging connectivity gaps and expanding network accessibility through strategic technological innovations

10.1. Introduction

The increasing dependence of modern societies on high-speed telecommunication and the high costs needed to provide the necessary infrastructure have made knowledge more concentrated within facilities or a small number of intermediation service providers. These places are becoming more attractive for this reason and, even in the post-industrial society, activities and people prefer to stay here. As a consequence, many problems derive from the high concentration of people and infrastructures in the same places, and the lack of accessibility makes these places less relatively preferred.

In the last ten years, many attempts have been made in the direction of increasing the accessibility of fixed infrastructures. More recently, many trials have also been carried out with satellites. In particular, High Altitude Platforms appear to be very effective in supporting high-density traffic, especially for television and interconnection among gross territory fixed infrastructures in the so-called "backbone" segments. But ambitious satellite systems with near-global coverage continue to suffer many problems: long time to obtain permissions for launching a satellite due to a lot of admittance from many different countries, the high costs needed to build infrastructures, and the time to put them into operation. With the key issue of distributing a huge information traffic among many users in many separate sites quickly and effectively, only satellite systems (and in a restricted way HAP and airships) can represent the enabling technology in the telecommunication arena.

10.1.1. Overview of the Networking Landscape

The worldwide networking infrastructure is rapidly developing: 1. Over the past two decades, we have witnessed a remarkable growth phase in the field of networking that has been seen in the rapid proliferation of networking technologies, used mainly to grow and expand the Internet and other global internetworking services. 2. More recently, and perhaps as a measure of the significance of the Internet to modern society, we are again seeing a significant effort to extend the capabilities of the global infrastructure, particularly to improve upon the performance and stability of the globally interconnected network services that have now become so very important. 3. The ongoing development of internetworking and networked systems, coupled with the improvements in underlying infrastructural technologies, means that we can expect future generations of networked applications and services that are even more powerful and transformative than today's leading-edge network services.

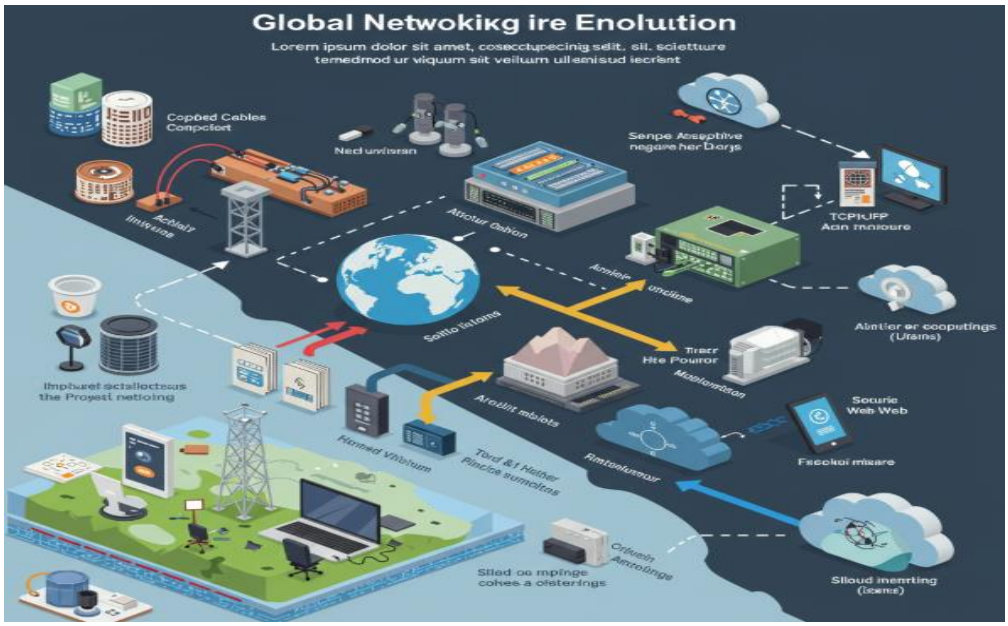

Fig 10 . 1 : Global Networking Infrastructure Evolution

The networking research community, nationally and internationally, plays an important role in driving this continual evolution of function and performance, particularly through the exploration of innovative new capabilities and the identification and resolution of technical problems and limitations. Cutting across all scales of operation, the contributions of the research community play a key role in influencing and shaping the pace of travel in the development of intelligent network designs, improved network service performance, and other key areas of networking research and innovation. This

work is widely recognized for its importance and has many avenues of support, including funding from governmental research programs, as well as support from commercial organizations that see the strategic value in embracing new networking technologies and services.

10.2. Understanding Connectivity Gaps

One of the most important prerequisites to fair development is accessibility to a well-developed transportation network, as it provides the way people and goods come and go from places where they work and recreation. The cities' features and complexity are reflected in the density and diversity of their transportation networks. For such complexity, a "one size fits all" strategy is not going to present the ideal results that are expected, indicating that strategies should be created for each city, addressing the local and tourist-specific demands. There are several problems related to the accessibility of transportation networks, such as connectivity reaching distinct regions of the city and, of course, to all groups of people living in these different areas (Qadir et al., 2019; Alam & Murtaza, 2019; Kato & Watanabe, 2021).

The connectivity of a graph is associated with the ease and speed of going from place to place in a direct way. A well-connected network offers more than a couple of paths between two distinct points, making movement around the system more flexible. For general graphs, the concept of connectivity is related to the number of vertices or edges that must be removed to split the graph into two disconnected subgraphs. If a specific set of vertices is removed, the connectivity of the graph is the size of the smallest partition of a graph that puts the vertices in more than one partition. A graph is "k-connected" if the connectivity is restricted to "k", and "K-edge connected" if the removed vertex set has size "k". For transportation networks, this definition can be extended by replacing vertices and edges with terminals and links, respectively, that are used to represent the starting and ending points in a unique path, and the features that guide the vehicles along the path, respectively. We use the Steiner Tree - Vehicle as a measurement to quantify the connectivity of transportation networks more flexibly.

10.2.1. Definition of Connectivity Gaps

Wireless access networks are made up of several network units that provide wireless coverage to mobile wireless terminals via radio interfaces. Network units are connected to the radio access network (RAN) of a mobile operator and the core network (CN) either through wired or wireless backhaul media. A CN includes network functions such as

gateway and mobility management that provide interconnection among core networks and external networks. Typically, CN functions are located in a few central offices or data centers that are connected through high-speed networks. A RAN can be spatially partitioned into many service areas where each delivers service to users who are located over a relatively small geographic region like city streets or office building floors. Each service area can be served by a network unit that is connected to the CN through a different, possibly diverse, medium. Such a design can be advantageous in several ways. First, aggregating data traffic from a large number of service areas in a small number of central offices can enhance the performance of CN components such as the gateway by enabling statistical multiplexing. Second, the use of diverse media can improve the reliability of the backhaul network, simultaneously increasing wireless coverage and reliability.

Given the time-varying nature of traffic demands and RAN channel conditions, the wireless network infrastructure is provisioned to satisfy user requirements during some periods and is potentially over-provisioned for less busy periods. Consequently, the network's energy consumption, transmission overhead, and installation cost per megabit delivered to users are not uniform across the capacity provisioned in different portions of the network. These observations lead to connectivity gaps, which represent wireless access network capacity that is cost-prohibitive at today's capacity provision methods. An index of deployment cost can compare the costs of different options for providing wireless access. An index can serve this role, as early work showed that wired backhaul connections were the main barrier to the deployment of dense RANs inside buildings and low-cost backhaul can substantially enhance them. The index examines the costs of deployment for an RAN with a broad range of access densities and median data rates.

10.2.2. Causes of Connectivity Gaps

Combating the connectivity divide requires a clear understanding of the issues that cause it. Most of the literature on network disconnections identifies the causes of the vast digital exclusion in developing countries, particularly in rural areas, and the digital illiteracy of middle-aged and senior populations. In general, the most common justifications for the exclusion are low incomes, lack of relevance in the geographical area of services provided by the Internet, low educational levels, as well as the absence of expertise in the appropriate functionalities to access information, education, entertainment, and electronic commercial platforms, as a result of illiteracy in the digital spectrum. In correlation to economic status, income is a major conundrum, particularly in emerging economies. However, in developed countries, the data show that income is much less influential. Regarding inaccessibility, socio-demographic attributes are

significant prejudicial factors; however, age is the most significant aspect, recognized as the prime influential cause of the productivity discrepancy in utilizing the Internet, with several age-related traits surfacing as significant prejudicial factors.

10.2.3. Impact on Communities

The practice of "edge cities" directs development to peripheral areas where transportation and environmental problems are more formidable. Peripheral development also reduces the potential of the inner city for overall corporate vitality. Impeding access and creating a reduction in community vitality may precede negative business performance. Lack of accessibility implies higher operating costs and a less attractive centralized employment pool. As the workforce may not be directly influenced by marketing, sales, and general administration activities, small negative effects may be dispersed throughout the business's operations. However, this dissipation can have large cumulative effects at the end of a business operations chain, where total business performance is tallied. Businesses can react to peripheral edge city development and can influence and capitalize on central city effects. However, when instituting requested services, businesses are reluctant to provide coverage unless the benefits are assured. The establishment of employer-sponsored central employment areas is an innovative strategy for seeking mutually agreeable access solutions (Tafur & Mazumdar, 2018; Zhang et al., 2020).

This study developed traffic demand profiles for company employees who use the parking services of specially contracted parking professionals. The actual high traffic demand period is thought to be reflective of the primary travel time of the company's vital business resources, which need high accessibility to the work site. These findings led to additional study of the unmatched capabilities and assets of the centralized parking professionals, as compared to peripheral edge city facilities. This comparative analysis did generate higher than expected accessibility at a favorable economic cost, despite edge city development. Drawbacks of the centrally located employer-sponsored employment pool are their lack of flexibility and functional interaction in crisis. This strategy is capital-sensitive and the market is local; however, special access features and benefits make this strategy an attractive option to the business community for smaller, particularly well-established core firms.

10.3. Technological Innovations in Networking

Technological solutions enable the capacity, flexibility, and cost-effectiveness required to increase network accessibility. The spread of service provider networks with national or even global scope cannot be driven only by the concentration of user demand. This development ultimately depends on the establishment of competitive network infrastructures. Competition in infrastructures, in turn, results from technological innovations that facilitate the entry of new players. This is a central argument for fostering broadband network investment in historically disadvantaged areas. The national broadband policy gives priority to unserved areas, which require targeted measures to attract enough investment to build sustainable networks, especially since these may not be economically viable in the short term. After outlining the overall structure and main innovations associated with broadband access networks, this chapter describes three general types of strategies for increasing network accessibility: infrastructure sharing, demand aggregation, and regulatory pricing principles.

At the core of these infrastructure innovations are broadband access technologies and equipment. While backhauls, such as metropolitan area networks and core networks, must be scaled to handle traffic exchanged between access networks and with other networks, broadband access equipment must be installed at the end user's premises. Premises include households, businesses, and other anchor institutions that host important Internet servers or contribute to the Internet's growth and technological development. The specific premises depend on the network's service plan and the coverage area, which may encompass part or all of a municipality. For regulatory purposes, network coverage is defined as the designated area within which the network provider has the right and obligation to provide coverage; that is, network service access against reasonable fees and according to service obligations, if any.

10.3.1. Overview of Current Technologies

Recent technological advances in transportation and computer and telecommunication systems have led to a variety of approaches aimed at enhancing the accessibility of transportation networks. Broadly, alternative approaches can be classified into demand management and supply-side strategies. Demand management techniques promote intermediate (or partial) substitution of travel by distributed work, teleconferencing, or remote access to programs or data. Supply-side strategies, on the other hand, concern issues surrounding the location of public facilities and the adoption of new setting techniques, as well as the development and exploitation of new high-technology transportation systems. Supply-side strategies for enhancing transportation network

accessibility include advanced automated or rapid transit systems, street guides and moving walks, and high-speed air cushion vehicles.

In partially implementing any of the supply-side strategies, a fundamental technical issue is: How do we effectively provide the necessary interfaces between the individual transportation system components, and how do we assure production coordination and compatibility? A broad approach to establishing effective automated factory systems, which also addresses this so-called "systems architecture" problem, is known as batch or production flow control. Although the problem for transportation systems has several unique features and practical constraints, traction concepts developed for production flow control have utility for a variety of transportation system design problems, particularly for estimating system capacity and availability.

10.3.2. Emerging Technologies

Many new technology applications are being introduced to improve planning processes, either to identify network deficiencies and set priorities for correction or to evaluate and identify problems after network modifications are implemented. GIS, as a core technology, is used for both activities. For network planning, new capabilities offered by GIS include efficient research and retrieval of existing data, topological and geometric network model development and verification, and visual display and analysis functions that help network users understand the relationship and distribution of network elements. New data images, created using these GIS capabilities, offer network access planners new insight and enhance the accuracy and validity of planning results.

On the margin of GIS activity, the use of remote sensing techniques also offers new data sources that can enrich the planning process without large costs. Satellite data, for instance, can provide missing road positions as well as other infrastructure and environmental details that can enhance the creation of land use databases. Dynamic modeling offers additional data retrieval and manipulation support to GIS tools throughout the evaluation process, enhancing the efficiency, speed, and quality of access planning applications. The combination of static GIS and dynamic modeling software forms the core of a new generation of network access planning and decision recommendation tools, tools that will yield faster, less expensive, and more accurate access planning decisions.

10.3.3. Case Studies of Successful Implementations

Why study case examples of successful implementation? The most favorable conditions for learning are created when a person is doing something he regards as important, engaged in a process of self-examination, led to discoveries by example, and encouraged to transfer capacities of one kind to another. With this report, an attempt has been made to stimulate a learning process about developing and exploiting accessible network infrastructure by allowing the case examples to "speak for themselves" - conveying the specific situations that the infrastructure development and exploitation addressed, the strategies devised by the organizations to meet those needs, and finally, the results achieved.

The case studies describe the travel demand management (TDM) strategies employed by the corporate executive and decision maker to better manage transportation accessibility in their work environment and to secure a leadership role in the regional transportation management solution. Inherent in each of the case examples are factors that broad-based users can translate and integrate into their regional efforts to create demand-responsive, integrated, and convenient regional transportation systems. The case studies included qualitative narrative as well as quantitative performance and evaluation data and required awareness of the role of higher management decision-makers.

10.4. Strategic Approaches to Network Expansion

Network-connected bandwidth in the home is a necessary element in realizing the benefits of online information resources and engagement with e-government and business. As same- and asymmetric-speed access models for homes change, underlying costs to achieving full net accessibility will also shift. Parallel to increasing the percentage of homes with service, corporate attention is now more focused on the costs of connecting to the highest-grade services. This section reviews strategies for service provision to a broader market, emerging opportunities to reduce net service delivery costs, and the importance of home infrastructure in the accessibility equation. Government proactivity continues to play an essential role in public goal success.

The implications of distinct strategies for the provision of network-connected bandwidth are many, from overall costs of bandwidth delivery to speed and service quality perception from the customer, to local network and overall market development. Strategies have proceeded in two dimensions. The first dimension is the distinction between providing a so-called 'last mile' versus a 'local loop' of connectivity. The former strategy focuses on service provision to the end user directly. The latter strategy involves

the identification or use of an existing access portal to users, including fixed and mobile internet service provider networks. Entrusted networks often provide wireless connection options. Current or soon technologies offer distinct IT cost scopes for cable, fiber optics, wire, and wireless technologies in delivering internet service connections.

10.4.1. Public-Private Partnerships

Traditionally, providers or transport authorities are responsible for the formulation and implementation of new transport schemes. With PPP arrangements, however, an innovative delivery arrangement is being sought for such projects. The project is more of a joint team effort with the private partner's inputs being sought from the very inception of the project. The transport authority, or municipality, sets the objectives, specifies the service, and handles the increase of any public subsidy required. The proposal appears for every interested operator to submit a bid for providing the specified service. The results are weighed against the decision-making procedure's objectives, and the offer that best meets those is accepted. Thus, the partnership that develops is shaped in response to the decision maker's objective. In the case of transport services, offering lower average tariffs at specified levels of chance may be a main objective. Offering a higher share of subsidy paid to transport authorities and more certain revenues, in the sense of a minimum income guarantee, might also be included in this scheme. In a concession, the authority specified several outputs for the operator to produce just as with services.

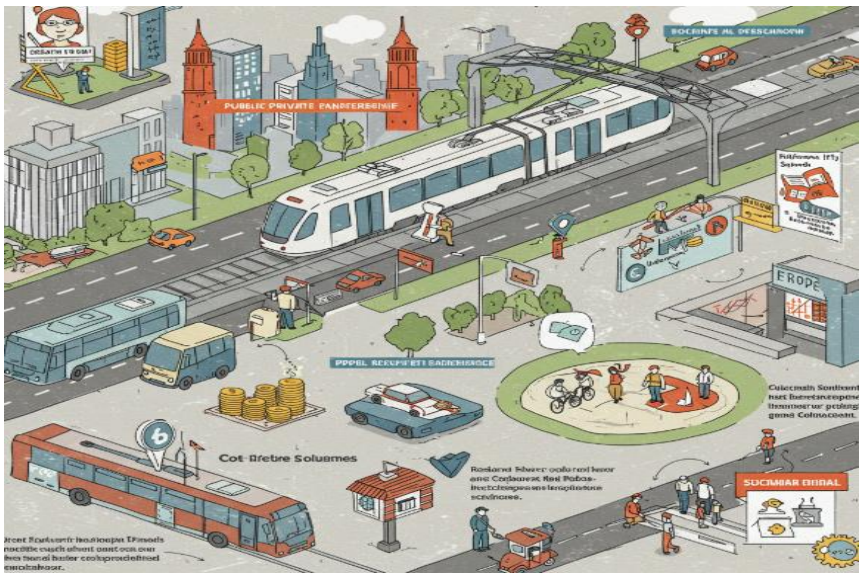

Fig 10 . 2 : Public Private Partnerships in Transport Schemes

The basic characteristic is that the operator has responsibility for both service supplies and demand management. Moreover, payments, including either an assumption of any income loss or a portion of the income that exceeds a specified level, contained a shared risk element. To some extent, this feature of allocation and distribution of risk is similar to the Competitive Franchise System. The latter is classified as a PPP system in the sense of a public subsidy arrangement combined with some kind of shared operating risk. However, the Competitive Franchise process approach differs from the PPP concept. In the PPP, the tender process is initiated without any predetermined service liabilities on the part of the public authority until any legal or economic negotiations have been concluded.

10.4.2. Community Engagement Strategies

Community engagement strategies are critical to a transparent and legitimate planning process. The best-laid plans with the most sophisticated models and the most comprehensive travel surveys will face resistance and be significantly challenged to succeed if community fears and concerns are not addressed. One-on-one meetings and small focus groups can often uncover issues and concerns that stakeholders may not otherwise feel compelled to raise. The views of a potential bus rider or local neighborhood association member, for example, are less likely to be raised at a public hearing or in a public forum. Well-constructed stakeholder groups can help guide the development of specific elements of the transportation planning process and the data inputs and outputs from model interpretation. Including stakeholders in the planning process may lead to decisions that have broader appeal and are easier to sell, ultimately leading to increased political and community support and quicker and less challenging implementation. Special outreach techniques include regular briefings targeted at residents and businesses near large capital projects. Regular community meetings, newsletters, and updates can address recurring issues, concerns, and opportunities and help keep people informed. Public meetings and public hearings are generally obligatory, but simply following standard protocol is often insufficient to achieve meaningful participation. Face-to-face consultations at locations convenient to various stakeholders are often more effective than simply holding a public forum or public hearing, and the input that is generated is often more informed and meaningful. In addition, respondents are more likely to feel a connection to the project and gain a sense of ownership if they are personally solicited for input; this, in turn, increases positive feelings regarding the decision-making process and the team or agency running the process.

10.4.3. Funding and Investment Models

Moving from an initial agreement to the implementation of specific policies or actions often challenges groups of stakeholders, regardless of the funding and investment required. The financing and financial assessment mechanisms used for producing social housing can prove useful here. The term 'social housing' refers to publicly provided or supported housing intended to decrease the cost burden on families and individuals with certain incomes and asset levels. When social housing is part of integrated neighborhood development, social housing projects contribute to the development of neighborhood destinations. Social housing projects whose residents are relatively poor should receive more assistance and complex attention compared to relatively self-supporting housing projects. The provision of performative public services and utilities, such as fast internet and school facilities, not only supports the initial resident population but is attractive to other residential households in the workplace area and the business community requiring available fast internet infrastructure.

In a revitalized business process, public-private partnerships can facilitate the delivery of necessary residential household and work destination services, potentially focusing on the development, management, and marketing of integrated community services and dynamically considering future changes and upgrades. The use of strategic actions in the design, implementation, and monitoring stages can enhance the impact of social housing projects, especially projects designed to deal with integration issues and projects that aim to produce many more social housing projects than currently exist. Such strategic investment decisions could address social housing development without the connotation of renovation or demolishing improved residential buildings. Community land trusts represent an effective vehicle for integrating social housing with privately owned and market-purchased properties and portray a consideration of allowable land uses and building structures. Local development districts experienced the model for sustainable housing, looking at the alternative uses of conservation capital; integrating cleaner transposition, ecology, and economically accessible housing for personnel and preferred businesses.

10.5. Policy Framework for Connectivity

We will now briefly bring together the contents of different chapters to summarize and frame our approach to the policy framework. This will include seven key sub-themes: vision, a statement of quantifiable goals and objectives, structure and process, a multiphase timetable and implementation plan, enabling policies and complementary initiatives, responsive regulatory mechanisms and policies, and ensuring the necessary

cultural change. We have entered a new era in the evolution of communications affected by the convergence of media. It is simply not possible to address the question of the future evolution of communications in a broad sense without being comprehensive. The challenge lies in addressing this area in all its complexity and providing guidance to governments and private sectors that will facilitate the development of effective policies that will realize the vision. In the context of this study, it is necessary to bring dimension to the vision, to agree on a set of goals and objectives, and to agree on the guiding values that underpin the vision. Key issues and strategies arising from the contents of the study are discussed. The objective here is not to provide substantive advocacy or to cover all aspects of policy but to highlight the more important ones and those that represent a genuine balancing of forces. The overarching objective is to contribute to informed and innovative policy-making in the communications area.

10.5.1. Regulatory Considerations

A first set of issues relevant to the shaping of the regulatory structure of transportation services, especially for the provision of paratransit in a more market-oriented manner, includes the expected economic impact of deregulation; the objectives for regulation and implications of changes in the structure of transportation services, with particular attention to providing for the needs of the handicapped; the problems and potential shifts in social costs associated with the deregulation of transportation services; and the deregulation of services serving the mobility needs of the poor and the handicapped, including the provision of demand-responsive services in urban and rural areas for appropriate policy intervention, not only by the public sector but also increasingly by the private sector and large corporations. The interest in the orientation of this research is on the provision of transportation services, particularly demand-accessible specialized public transport, to meet the mobility needs of the handicapped and the poor, who have very limited means of transportation, regardless of the current institutional structure providing services in the transportation sector.

10.5.2. Government Initiatives

Government initiatives have played a critical role in shaping the accessibility outcomes of large cities in different parts of the world. These strong roles are underpinned by the strong investment incentives and regulatory powers of different layers of government at the local, regional, and national levels. Central city governments in mainland China, Hong Kong, and Singapore are often tasked to accommodate largely exogenous population, economic, and tourism growth, and are also often key gateways between

global, national, and regional levels. As such, strong direct plans and interventions in high-capacity public transit systems and land use measures are in the public interest and can be financed, implemented, and managed effectively. In contrast, the organic development of relatively older and smaller cities in places such as Europe, Japan, and the U.S. with inherited legacies and fewer mission-critical roles have rendered interventions more challenging.

Smaller northern European cities are well recognized for their comprehensive and integrated cycle networks and better infrastructure and service frequency, customer service, fare integration, and fare competitiveness of public transit systems. Two European cities and one U.S. city have introduced new zones in the model. In the U.S., the Department of Transportation operates a program that offers a new concept of mileage reimbursements, which uses values to offer graduated scale reimbursements. Among the other Asian cities, Japan has consistently adapted its public transit systems five times in ten years to maintain its publicly owned public transit systems to be viable, promote its local and national policy goals, and fulfill its obligations. Measured outcomes promoted the governance model of Tokyo Metro: it was transferred from the national government to the local governments in 2004 and has since seen its deficit transformed into a surplus.

10.5.3. International Best Practices

While cities in most countries continuously innovate new buses, rail, and other means to enhance public transit, no one place develops the best practices on every issue. For years, domestic research sought out successful strategies in other metro areas, often abroad. More recently, each year the ease of discovering international best practices and staying abreast of overnight changes has vastly improved. Yet turning that foreign finding into local customization often demands organizational openness to embracing fresh ideas. Providing city firms ways efficiently to benefit firstly benefits employees needing transport to work, school, health, and other uses, and thus also sustains general quality of life.

Recent advances in public transit suggest how decision-makers can help bus, rail, subway, and ferry managers better meet present ridership, minimize wait-time costs, and avoid punitive inflexibility when service schedules, especially those directly affecting the public, need updating for seasonal adaptations and atypical performance challenges such as natural and other catastrophes. Yet the best practice on these and other needs for improving accessibility to and from rail and bus is never permanent. A periodic review

of other cities' recent successful solutions can suggest not just short-term service adjustments but also potentially indicate ways to enact more lasting reforms in one's city.

10.6. Challenges in Expanding Network Accessibility

Heightened global demands for electronic commerce, teleeducation, and telemedicine are driving a greater interest in communications infrastructure that can support sophisticated and interactive communication. At the same time, there is an expectation that mobile communications services will rapidly expand, causing a corresponding explosion of the networking demands placed on the terrestrial backbones. The convergence of voice, data, and multimedia communications places strict and sometimes conflicting requirements on the infrastructure. At the information consumer end of the communication network, there is a growing gap between those who have access to more sophisticated and more expensive equipment and those who are relatively communications disadvantaged. However, the capability of accessing the contents of what is potentially the biggest library ever assembled 24 hours per day is highly attractive. Unless the communication issues can be addressed, such services are likely to command prohibitively high prices, which could have the effect of stifling the potential growth and benefits of the information age.

Increasingly, governments and funding bodies are looking for more cost-effective ways of addressing network accessibility issues. In the era of increasing competition, some question the premise that telecommunications operators can be relied on to deliver the services necessary to satisfy the expanding communications requirements. A study of network infrastructure alternatives concludes that the current telecommunication market may not generate an infrastructure that meets the critical needs of the United States. Similarly, a cooperation research initiative formed to address the needs of the healthcare industry concludes that a path to the hospital-facing emergency room of the future involves adding bandwidth to the hospital network, accessing the internet, updating the medical curriculum of students, designing virtual classrooms for the training of hospital staff, developing digital libraries for troubleshooting, emailing, and paging nurses wherever the users are, and making connections from remote sites to the hospital's records system. Of concern is the underwhelming response of both the public and private sectors to these challenges, which require resources that the current marketplace appears unwilling to deliver.

10.6.1. Technical Challenges

1. Introduction

The technical environment for developing decision support systems is often less than perfect because combining and processing available information proves to be quite challenging and demanding. In large cities, telecommunications networks provide limited and expensive bandwidth. The result is congestion in the network, inadequate performance, and the need to customize web services for access from mobile devices. The basic processes that require data transmission, whether by a private vehicle or by mass transit, are quite simple, yet fully modeling the attendant communication and processing requirements is extraordinarily complex. Unfortunately, data communications and processing often dominate system design. At best, network and travel models handle broad categories that represent but fail to capture the temporal and spatial heterogeneity in network demand imposed by large numbers of individual travelers. Even when processing capacity is available, the cost of collecting data from large numbers of trips becomes prohibitive. These challenges, however, can be overcome by utilizing a traveler-centric approach in which connectivity and mobile computing can essentially allow travelers to become sensors, generating data or communicating relevant aspects of their conditions that can be used to inform both themselves and group decisions related to transportation network use. Providing interfaces to travelers in this manner could offer critical data to databases without the cost of installing and maintaining widely distributed static infrastructure.

2. Consistency and Integration

Consistency focuses on ensuring that the time is calculated in a manner that considers available options for actual mode and route combinations. Traditional methods, including using the network assignment models, calculate travel time by considering only the available path choice and then assume that travelers select the minimal time path, given the differentiation in user value of time by mode. Although this works well in congested conditions when auto is a dominant mode, travelers are likely to change modes and willingness to accept or disregard dataset information once it is no longer a data quality issue, but rather a component of travel time information. Elements of travel time estimation should be consistent and integrated and provide an understanding in which the ability to use various data sources to provide reliable information is consistent with the range of current and future travel option enhancement policies, which include connections to destinations, help for travelers to reduce stress in large network spaces, and other features you may not think are relevant to travel time and its value but have been shown to provide benefits to travelers.

10.6.2. Socioeconomic Barriers

Lack of access to private motorized transportation further restricts the travel alternatives of those already in disadvantaged positions. These low-income individuals who have weak labor market positions and face substantial barriers to advancing their economic circumstances should be targets of transit-oriented policies. The focus of policy effort has to be on improving transit for the individual who relies on it, in order to give the person without a choice the same transportation access as the person with an automobile. If transit is available and convenient, the second person may forgo automobile ownership.

Absolute economic constraints are but one option limiting choices about automobile or public transportation use. Additional social values or attitudes, income distribution, or sparsity levels could also determine such a choice. Would the personal or community-oriented costs be too high given the capacity of family and community-based resources and relations? Micro-family socioeconomic structure, land use, urban spatial structure, time budgeting, and spatial constraints may also curtail the use of motoring. The appetite of the working class for car travel has been inherent but thwarted for a long time. Race or ethnicity may enter the picture, though if transit becomes outmoded in the absence of alternatives, minorities who depend on transit may not get the same access to jobs and housing, fair treatment, political representation, and the inherent advantages mobility brings in terms of educational, health care, and economic opportunity.

10.6.3. Cultural Resistance

Several factors may explain this lack of understanding of the potential uses of assistive technologies (ATs). However, beyond the problems of commercializing and making products like these widely available in the marketplace, there is the wider and relatively neglected issue of cultural resistance. This is not necessarily a conscious and deliberate activity led by professionals or any other group within society. It is probably more the case that there exists an inherent lack of knowledge of the range of opportunities and innovations on offer at any one moment in time. Several factors contribute to this kind of resistance, which, if addressed, could undoubtedly enhance the potential use of ATs.

At first, it needs to be recognized how complex accessibility and usability are. There is confusion about the definition of ATs and their purpose. ATs are often viewed as aids for people with disabilities of particular categories or as aids to overcome barriers in specific situations. However, the definition of a disability is complex, and there is a range of interacting factors that may create 'disability'. AT should, therefore, aim to address a range of permutations of factors that may prevent successful task performance. Part of

the confusion arises because of how the requirement for such a plethora of facilities can better be met, for instance, by embedding them in different configurations at key places in a network stimuli/sense-response sequence or matrix.

10.7. Future Trends in Networking Technologies

Abstract: The laws of networking have been continuously developed for centuries; both protocol theories and algorithms have been advanced. In recent years, however, the "gene" of Internet research has been remarkably modified. Hence, we need to reconsider the methodology and the objective of networking research in the coming stage. As for the methodology, mathematical theories have become more important, and regarding the objective, we will need a scalable and reliable network infrastructure. This paper will demonstrate that the new type of networking technology, Peer-to-Peer technology, really works. It will also discuss research topics that would make P2P technologies more scalable, more reliable, and far more pervasive. The current hype associated could indeed diminish; however, some form of P2P technology will survive and possibly overwhelm conventional technologies of today.

The hype of the Internet had faded a few years ago and instead, it is referred to as the Internet Burst. On the other hand, both mobile communications and optical Internet had their time in the mid-1990s, but they still maintain prominent positions in the evolving network infrastructure. As we begin the 21st century, the pursuit of the next generation of network technology will be sustained from the viewpoint of research on networking. I shall refer to it as P2P technology in the context of the intermediate "gene" of the Internet and the next-generation network. The "2" in P2P simply denotes the two-sided connection technique, and both sides operate on a peer-to-peer basis. In a P2P connection, there is no intermediate telephone exchange, no intermediate Internet router, and no proxy server. All kinds of P2P technologies have been proposed and demonstrated to work effectively. P2P has some potential properties for being a next-generation networking technology.

10.7.1. 5G and Beyond

Ongoing research on the new combination of technologies, standards, and ecosystems that support the communication and interconnection of everything, enabling humans as well as machines to reach out to unprecedented horizons, commonly referred to as 'beyond 5G' or '6G', has recently attracted considerable attention from industry, academia, and government sectors of various countries. It is acknowledged that, through

the adoption of advancing communication technologies, network accessibility will receive substantial improvements and high user satisfaction will become a reality. Representative research topics of advanced communication technologies include the propagation characteristics of new communication channels, energy harvesting, beamed communication, LEO, MEO, and GEO technology, 6G-related multiple access, wireless access developed beyond 5G/6G, position estimation, and technology for terahertz frequency bands. Digital twin technology, which allows for the comprehensive and accurate coverage and representation of many objects and phenomena, such as technologies inside smart cities, autonomous vehicles, and human behaviors, helps to develop new services, and this will constitute one of the unique 6G application scenarios.

In this direction, several suggestions related to the development of strategy and policy were given to make 6G services more advanced, intelligent, accessible, flexible, and extensible, thus providing more value to humans and machines. Besides, the extensive application of advanced communication technologies and spatial proximity to agriculture can effectively enhance the user experience of 6G networks. Laying smart grids and sensor networks specifically engineered for smart agriculture not only function to collect user needs such as soil information, water, and nutrition requirements, but also provide additional opportunities for users to vertically engage with 6G services, guaranteeing their on-site accessibility. A holistic consideration of the possible and feasible communication ecosystem developments and network accessibilities together represents the first comprehensive attempt to provide clear support for the sustainable development and service nature of 6G networks. The joint consideration, focused on the internet of tractors and sensors, constitutes a unique point of this research.

10.7.2. Satellite Internet Solutions

Current mainstream satellite internet access requires users to connect with the satellite to exchange information. Latency, as a result, is often dismal - 0.3 seconds at best and often exceeding 1 second. This type of satellite communication is not suitable for internet services. Satellites in GEO are needed for global coverage and serving stationary users. It takes about 0.125 seconds for signals to go to and back from the satellites. Data are also uplinked and downlinked with up to 20-40 GHz K-band and even 80-120 GHz Q band. The applied satellite internet technology uses simple and small VSAT terminals. It is very expensive to launch a satellite dish into space; therefore, the receiver, transmitter, and transceiver chips shall be able to rely on satellites.

Solution: LEO is introduced in this section for broadband satellite internet access. LEO solves the satellite cost problem by letting the user communicate with the terrestrial station and relaying signals.

10.7.3. Mesh Networking Innovations

The key innovation of a mesh network is that it implicitly exploits the wireless medium to decouple network connectivity from physical copper or fiber connections. Mesh nodes can use the airwaves to transmit and receive data to any other nodes within the radio range, making local connectivity within the ad hoc cloud relatively easy. For a typical client device operating in infrastructure mode, such freedom would require scanning for signals transmitted by any number of base stations. Mesh achieves a direct connection by equipping all nodes to forward messages to their final destination via a routing protocol, like packet-switched network traffic carried by wired media. Because coverage can be enhanced without increasing the complexity of the routing logic, mesh has the potential to be remarkably efficient and scalable in large administrative domains.

In this section, we explore techniques that build on top of the basic concept of a mesh network to further improve wireless network functionality. Multi-Radio Mesh Operating card transceivers on non-overlapping channels allow simultaneous transmission and reception of messages. A multi-radio mesh can then easily forward data from a source node to a destination even if these two nodes cannot communicate directly. Such routing is much more difficult to establish for a single-channel mesh. In a single-channel mesh, forwarding would require the message to be transmitted twice on the same channel, which would likely introduce excessive interference at the node performing the forwarding. At best, the forwarding node would need to buffer the entire message, and then serialize the forwarding onto the exact path crossing it. Either alternative is less efficient than direct transmission or reception over non-interfering channels.

10.8. Measuring Impact and Success

It is important to gauge the success of the innovative strategies discussed above not only in their intended purpose of mitigating network-induced inequities but also in general. Doing so requires data collection and clearly defined metrics and goals. This section outlines some ways to measure the success and impact of innovation. First, it is crucial to measure the impact of the solutions outlined in the preceding sections as they apply specifically to network accessibility. This would involve tracking rates of chronic unemployment, educational attainment, individual income, and individual health, among

other metrics. By comparing the network impact metrics of the worst-off individuals with the metrics of the economically better-off, we can assess equity in current network designs. We should also assess how innovative congestion relief policies affect equitable outcomes by comparing the metrics of the worst-off once the proposed policies are implemented. We should focus on the users negatively affected by network congestion to determine how proposals decrease these network inequities. Civil engineering departments are usually adept at generating such data and could be helped in the endeavor by research groups from multidisciplinary projects. An additional challenge is that, especially in low-income countries, chronic unemployment is widespread, and much of the workforce functions informally, so comparisons across countries and regions will be necessary as well. The foregoing task is no less difficult than, and indeed is largely constrained by, the challenge faced by quantitative information-deficit researchers in general: pinpointing those policies, mechanisms, and projects that are most effective.

10.8.1. Key Performance Indicators

Innovative Strategies for Enhancing Network Accessibility

Key Performance Indicators

The incorporation of handicap capabilities into the cost function of a generic regulatory model for time-varying priority pricing is investigated and shown to provide a powerful stimulus for facilitating travel using either supplementary vehicles or improved bus dispatching. Such a discriminative approach serves to assure at least a given minimal performance in serving the handicapped population segment even under time-of-day demand peaks. Furthermore, a modified method is suggested for adjusting the emphasis on various performance indicators used in the cost function according to their social priority levels. In this way, bus systems that have already implemented compromise strategies and that run under inconsistent regulatory frameworks can adapt to a time-varying double social role. They can thus function as inflexible transit carriers for the mass market made up of non-handicapped travelers, punctually transferring this augmented portion of social benefit to mitigate hardships for handicapped persons who are deprived of door-to-door specialty services at costs not unreasonably higher than the available resources.

10.8.2. User Experience Metrics

The utility of innovative strategies for enhancing network connectivity is ultimately determined by the improvements to the level of access they provide the user. Additional research is required to determine how effectively and efficiently these goals are accomplished in urban environments by coupling geographic data with on-the-ground connectivity metrics. An urban planning goal requiring the minimization of average distances or times required to access a fixed percentage of desired activities would necessitate easily calculated accessibility measures that capture trip chaining or multi-purpose trip behavior. Presently, such measures require exhaustive searches through combinations of all possible destinations within specified thresholds and are thus computationally intractable for operational use at a larger scale. It would, however, be useful in future network representation development to consider including measures that capture these types of user decisions about which nodes and paths to include or exclude in the accessibility analysis model.

The terms coverage and spatial search are used interchangeably in a variety of related concepts and are defined based upon the system characteristics other than the particular deterministic characteristics used to define each other. To be consistent, the term coverage is used when referring to the number of cell sites providing a communications network that enables on-demand remote user access from different initial points. Several network-based user experience measures are prevalent in the network design literature. These are derived from the concept of alpha, which consists of interconnected cells, the contents and interconnection of which are assumed to enable connection ability to any user located within or at its periphery.

10.8.3. Long-term Sustainability

As online content continues to grow and networks continue to be accessed by an increasingly large and diverse range of users, the issue of the long-term sustainability of content and network infrastructure is vital for network providers and the research and education community at large. Efforts at higher education institutions through the development of long-term digital content repositories and management strategies must be coordinated with those of network providers so that the overall quality of services and content can be maintained or even increased over time. Fortunately, the development of digital institutional content repositories and information technology services of all forms is inherently valuable to the constituents served and provides universities with an opportunity to become local information and resource management experts. One of the most active and sustainable roles that universities can play in developing long-term

digital content and service repositories that support general as well as research needs is to focus on their primary constituents of faculty, staff, and students. In parallel, libraries have played a substantial leadership role in the activities required to serve and manage their vast and increasing collection of digital and print information. However, recently they have been working more with their local information technologists to develop systems that can be used across all types of repositories. Universities can also share their processes and serve as a model for storing rich data collections collected in the course of research and education. The increased capabilities that universities are developing have heightened the awareness of the need for longer-term access to data collections, and this is reflected in the active interest and investment from both government funding sources and the various industries that are heavily involved in research and education activities. In the future, it can be expected that larger research teams will be formed to collect harder-to-find data, perform complex analyses, and even provide access and services to user communities. As an important aspect, long-term sustainability is a major factor in the interest in passive and other possible types of fiber-optic commercial enterprises in external networks along educational, prime research corridors. However, for many persistent and innovative applications, a developed higher education institution with major networking resources may also be the best or optimal provider of useful data collection.

Fig 10 . 3 : Urban Network Connectivity Analysis

10.9. Conclusion

This chapter has presented and discussed innovative strategies for improving network accessibility through pricing and investments in urban infrastructures. They have stemmed from the objectives held by many cities worldwide:

Maintaining, developing, or regenerating their production capacities; transforming themselves into metropolises of the knowledge economy based on innovation, which leads to growth; and/or enhancing their living conditions, often confronted with radical divergences of living conditions. Therefore, in addition to the traditional consideration of economies of agglomeration and net social benefits, some of the strategies described here are based on the search for suitable alliances between the urban investment necessary for new systems and their operational exercise in the context of the extension of the competitive policies aiming to defend employment.

The institutional design based on a partnership between segregated operators and public authorities contributes to the success of several of these strategies promoted by the cities. Regardless of the type of city, the umbrella strategy, which establishes political targets about the level of service in terms of the overall accessibility of the network and taxes parking located in the city center to finance this overall accessibility, is always the means of consolidating social cohesion around a project and of arousing the interest of the operators guided by an extension of the domain of urban operation.

10.9.1. Summary and Forward-Looking Insights

When we reflect on the various opportunities that have been presented in this book to advance the state of the art in current techniques, models, and measures in transportation network design, all the main contributors put forward a rather optimistic view that network accessibility can reflect the dynamic patterns of all travelers and help in producing long-term plans or strategies that are objective, implementable, and comprehensive. Even from some contributions, a theme develops around the underlying idea that decision-makers, users, and operators have to be treated very differently in the different phases of network accessibility. These foci are of particular significance, as they help in crystallizing the role of network accessibility that is closely aligned with sustainable development and social responsibility in the management and development of transportation in the future. These are the key objectives that have to be achieved, as the value of these contributions can be seen in the various strategies and approaches presented, where there are some key conditions to be satisfied in their policy implementation. On this basis, we are now able to sketch a multi-level approach, which is related to the research, analysis, data collection, and scenario evaluation to be

developed within the multi-modal, environmental, and social context in which the implementation of the measures is foreseen. Furthermore, we can identify the various sources of practical knowledge and the recipient groups for the relevant policies. This is in keeping with the view that strategic policies require comprehensive approaches. The call for integrating network accessibility within a framework based on a clear statement of objectives, applicable policy formulation techniques, and the appraisal and evaluation procedure with spatio-temporal optimization methods is bound to attract more interest and be more practical. After the new line of research has been applied and piloted, it should become part of a living research network, owning a manner by which a brain operates. In the forthcoming wave of studies on the multi-dimensional features of objectives and the control over the way networks are developed, and on their effect in terms of the mobility patterns of more civilized environments, development will be boosted. This can be stimulated by continuous interaction among the engineers, consultants, and practitioners who are responsible for implementing network accessibility principles with a flexible and enlightened regulatory framework. The most promising directions in the effort to enhance network accessibility are to collect further pilot applications, and then to build on synergism with the greater diffusion of advanced models and data representing the dynamic behavior of agents.

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