BANDWIDTH IN ABUNDANCE

Policymakers have reached a stage in broadband development where they should be thinking of deploying bandwidth in abundance as part of next-generation national broadband plans. **BLAIR LEVIN** discusses the policy drivers

At the beginning of this century, the chairman of the US Federal Communications Commission (FCC) declared that broadband was a luxury, comparable to having a Mercedes Benz. Those days are long gone. The international consensus view that broadband is now a necessity has been articulated in over 150 national broadband plans that share the common objective of extending broadband access to all.

But yesterday's definition of broadband can quickly become outdated. When I returned to the FCC in 2009 to manage the writing of the United States National Broadband Plan, the FCC defined the baseline internet speed as 750 kbps down. We recommended more than quadrupling that to 4 Mbps down and 1 Mbps up. Within a few years, the FCC felt the need to increase that to 25 Mbps down and 3 Mbps up. Now some suggest we need to increase it again to 100 Mbps down.

Assuring universal access under old definitions is still a challenge for many nations. Work must continue in closing that access gap. Even wealthy countries face continuing connectivity gaps in pockets of their country. Over the past several years, however, there has been a growing recognition that there is an additional challenge. Countries need to transition from the bandwidth delivered by the networks built in the last century to the abundant bandwidth created by the deployment of next-generation networks, as higher speed connectivity has become the table stakes for thriving in the 21st century information economy. In addition to the strategies and policies for baseline universal access, countries also need strategies to drive such deployments.

This article is a response to that challenge. First, I discuss some of the common challenges and approaches countries used to address the first generation broadband gaps. Then I describe some of the experiences and lessons learned in addressing the challenge of abundance. I conclude by offering six key policy strategies for driving next-generation deployments.

ALL COUNTRIES ARE DIFFERENT

As a starting point, we should acknowledge that all countries have differences that affect their approach to broadband. Demographic differences can affect both the supply and demand for broadband, and the willingness of the private sector to invest new capital into broadband networks. Geographic differences can affect the technology choices. A desert setting might lend itself to fixed wireless networks that may not work in mountainous or forested environment. The economic prospects for a country affect how the government and the private sector analyse the need for and opportunity created by broadband.

Just as significant, countries have a variety of market structures that affect their path forward. Some retain a traditional telephone carrier from the days of government-sanctioned monopoly providers, which, through dominance of wireline asset ownership, still have significant control over the development of the broadband market. Others have cable or alternative wireline carriers that create different options. Some have robust facilities based, wireless competitors, while others rely more on competition from wholesale support for mobile virtual network operators (MVNOs). Some have non-traditional providers, such as those which provide cloud or enterprise services, which have assets that have or might be utilised to address broadband gaps.

> **"There is no one size fits all solution to any of the broadband challenges that all countries face."**

In short, there is no one size fits all solution to any of the broadband challenges that all countries face.

ALL COUNTRIES SHARE SIMILAR DYNAMICS

While all countries have critical differences, there are common factors at play. The similarities can be seen in mutual challenges, analysis and dynamics across the broad spectrum of national broadband plans. All boil down to addressing three challenges:

- How does the country ensure that broadband networks reach everyone (the access gap)
- How does the country ensure that everyone is on the network (the adoption gap)
- How does the country use the platform to improve on the delivery of public goods and services, while also driving innovation and economic growth (the utilisation gap).

In addressing these first generation broadband gaps, countries face similar economic dynamics. Among the economic realities countries face in addressing these gaps, the following are most critical:

- **Impact of scale.** Scale matters. It is difficult to solve connectivity problems with sub-scale enterprises.
- **Impact of density.** Like scale, density matters. The economics of connecting rural areas is significantly harder than that of connecting urban areas, as a critical variable for the economics of deploying networks is how many customers will share the fixed costs of the network facilities. For example, remote mobile access sites cost 2 to 3 times more than urban sites and reach many fewer people.
- **Carriers price to optimise profits, not adoption.** Existing carriers benefit from increases in the addressable market for their services and when the marginal cost of the incremental customer is close to zero. Still, carriers do not have an incentive to eliminate the adoption gap by pricing to the lowest income population. Such a pricing strategy would undercut the opportunity to generate higher revenues and profits from middle and higher income communities.
- **Services depend on a network of networks and a bottleneck anywhere raises prices for all end users.** Delivering internet access is not accomplished by a single network. It is achieved by a network of networks, including a last-mile access network that connects to the end user; a metropolitan connection that aggregates last-mile local traffic; a backhaul network that aggregates the regional traffic; a national backbone that further aggregates traffic; and an international connection that provides a link to the rest of the world. A bottleneck anywhere raises the cost for end users.
- **Where possible, private sector investment and action is preferred.** To a significant extent, the private sector is able and willing to serve the last-mile access market and to varying degrees is also able and willing to deploy the other networks. It is better positioned than the public or non-profit sector to ensure ongoing maintenance, periodic upgrades, and invest in innovations in the networks. As a recent World Bank study of 70 cases of broadband models from around the world concluded,[1] the "cases show a consistent story of the private sector outperforming state ownership and management models".
- **Technology can change the economics.** Technology developments change the economics over time, lowering the capital and operating costs, but also creating the risk of stranded investments.

Common policy strategies. As with the economics, there are a number of common policy strategies. These include:

- **Collecting data.** There is a need for common, reliable, and relevant sources of information for data about variables such as availability, speeds quality, and pricing.
- **Creating the right institutional structure.** Countries have generally recognised the need to have institutional leadership to coordinate different entities to move in the same policy direction.
- **Utilising market forces.** While government subsidies are often necessary, particularly in targeted areas, distribution mechanisms should use market forces to efficiently allocate such funds.
- **Policies for bridging the access gap.** Common policies to close the access gap include eliminating barriers to competition, improving deployment economics (particularly for rural areas, through policies like infrastructure sharing and government subsidies for backbones), allocating spectrum more broadly and transparently, and subsidising anchor institution connectivity.
- **Policies for bridging the adoption gap.** Common policies for closing the adoption gap include lowering prices through enhanced competition, reducing government fees, targeting subsidies for inclusion offers, aggregating demand, and providing digital literacy training.
- **Policies for bridging the utilisation gap.** Common policies for closing the utilisation gap include making more government information available online, migrating communications with the government to online platforms, and programmes related to offering health, education, public safety and employment related services online.
- **Monitoring and course correcting.** Broadband plans have recommended authorising a government entity to monitor progress and course correction policies as markets develop.

The virtuous cycle to closing the gaps. There is a virtuous cycle in which closing any one gap helps close others. More widespread deployment increases adoption and usage; increased adoption improves the economics for more widespread deployment and investment in better applications that drive utilisation; and greater usage improves the value for users, driving up adoption and again, improving the economics of deployment. Thus, plans generally develop strategies for addressing all three.

Similar technology choices and prospects. The market for telecoms devices and network equipment is not local or national. It is international. As countries consider policies to drive the deployment of next-generation networks, they are looking at similar technology choices, both today and into the future. These, in quick summary, are as follows:

- **Wired.** The principal way broadband has been delivered in the past two decades has been over a wire, generally owned by a telephone company. In the beginning, wires were copper but many have been upgraded to fibre. Some countries have wireline competition, often from a cable competitor but sometimes from a fibre over-builder.
- **Spectrum based.** Broadband can be offered through spectrum-based services with spectrum exclusively licensed to an enterprise, unlicensed spectrum and shared spectrum. As to licensed spectrum, the first two generations of wireless services were not capable of providing bandwidth that would be considered broadband. 3G wireless services provided a service similar to first generation wired broadband. 4G services improved the capability, though it still is significantly less robust than the wired offering. Emerging 5G services hold the promise of offering similar speeds and low-latency service that wireline offers. In addition, there are various fixed wireless services, such as those using millimetre wave spectrum, that offer abundant bandwidth. As for unlicensed spectrum, in many places there are Wi-Fi hotspots, though Wi-Fi rarely acts as a competitor to traditional subscription services. As for sharing, there are some nascent but promising examples of carriers sharing spectrum through dynamic sharing databases that prioritise uses and allocate spectrum to prevent interference in ways that may eventually lower costs and spectrum constraints.
- **Satellite.** Satellite has offered limited bandwidth broadband. It is generally only used in rural areas but a new generation of satellites has the promise of a massive increase in bandwidth and lower latency, creating the possibility of improved coverage in rural areas and improved competition in urban areas.

THE NEXT CHALLENGE: TRANSITIONING TO BROADBAND ABUNDANCE

Many of the national broadband plans, written during the early part of this decade, focused on the three broadband gaps noted above. But as broadband networks and applications developed, a new broadband gap emerged: how to deploy broadband networks that meet the demands not just of today, but also far into the future.

The new policy goal: elimination of bandwidth constraints. Paul Romer won the 2018 Nobel Prize in economics for his insight that the key to economic growth lies not in additional physical goods but in ideas, which are non-rivalrous goods and lead to a discovery process that accelerates growth. This can be seen with the internet itself, a tool for discovery that unlike physical goods does not lose value as more people use it. Indeed, the more it is used, the more useful it becomes to the process of discovery and innovation.

> **Abundant bandwidth is a good in itself because it drives new uses in the transition to the digital economy.**

Romer's insight has played out in the evolution of the global economy since the early days of the internet. As the global economy moves from being primarily about the manipulation and transportation of atoms to knowledge exchange, bandwidth becomes our commons of collaboration. Every sector of the economy now depends on bandwidth in producing goods and services. The greater the bandwidth, the greater the opportunities to improve the knowledge exchange. Some sectors, particularly those which rely on imaging or big data, need bandwidth significantly more than others. But as all rely on a common network of networks, bandwidth constraints can present a major obstacle to economic and social progress.

In that light, all countries should have a similar new policy goal: the elimination of bandwidth as a constraint on innovation, economic growth and social progress. Expressed this way, the vision captures a number of different variables, including affordability, ubiquity and performance. It also is, appropriately, a fluid goal, not tied to temporary metrics to measure success. It requires continually evaluating actual and upcoming use cases and accepts the challenge of continual improvement.

The goal of bandwidth abundance might strike some economists as encouraging an overproduction of bandwidth, not justified by actual consumer demand, which could lead to stranded investment. It is true that technological progress can lead to stranded investments but concern about overproduction of bandwidth is misplaced. In the transition to the information economy, abundant bandwidth is a good in and of itself because it drives new uses. Unlike cyclical industries where demand goes up and down, the use of bandwidth has and will likely continue to rise. Although the timing of such investments can lead to financial losses, as occurred in the early years of this century with fibre, assets were not abandoned but were quickly acquired and repurposed by others to improve their own network operations.

In short, all countries should want to move from today's world, where the dominant business model focuses on how to allocate bandwidth scarcity, to the world where there is competition over who can best deploy bandwidth abundance. That does not mean that prior goals – universal access and adoption, and improved utilisation – should be abandoned. Rather, it means that in the process of continually monitoring and updating broadband policies, the new goal of abundance should be included.

Achieving abundance: will market forces be sufficient? What should be the policy framework for achieving such abundance? As national broadband plans and international finance organisations have recognised, market-based competition is the best way to deploy and upgrade networks. In that light, won't market forces alone create bandwidth abundance? It is possible that market forces could do so and that possibility is enhanced by such developments as 5G, discussed in greater detail below. But it is not likely.

This became clear to me while working on the United States National Broadband Plan. We started by commissioning a study of all of the publicly announced plans for upgrading or deploying new networks. The study found that for the first time since the early days of the internet, there were no major carriers that had plans to deploy a network faster than the fastest network at that time, a break from the previous decade, when technical improvements and competing technologies meant periodic upgrades, advancing from dial-up through early cable-based broadband, digital subscriber line (DSL) services offered over the analogue phone network, early fibre-based deployments (notably Verizon FiOS) and cable's last major upgrade as of that time, known as DOCSIS 3.0.

By 2009, however, Verizon had scaled back plans for more fibre, the other telcos also were not investing in fibre and the DSL technology they were relying on was falling behind cable, with cable firms developing but not deploying next-generation capabilities. The broadband market in most areas was migrating to a market structure characterised by two segments – a premium one served by cable and a low-end served by DSL.

Rejected options and the Google Fiber defection. The broadband plan's team held discussions with various parties about how to drive an upgrade. Some suggested nationalising the broadband networks, similar to what Australia did with its telephone network. We thought that impractical as a matter of law, policy and economics. Others suggested an unbundling or open access strategy. We thought both had similar legal, policy and economic challenges and would discourage any private investment in network upgrades. Our view was that where privately funded infrastructure competition was possible, it was a better option. But while we knew what wouldn't work as a matter of policy, we were less clear about what policy would have the necessary impact of stimulating that infrastructure competition.

During those discussions, Google suggested construction of a gigabit fibre test to demonstrate the competitive and economic importance of new applications that would not be possible without next-generation infrastructure. We liked the idea but were sceptical Congress would fund it. But then, in a government-funded experiment, the company announced that it would build that experimental gigabit network and asked cities if they would like to host it. Google announced a competition to host the experiment. To everyone's surprise, Google received 1,100 proposals rather than the 10 to 50 it expected.

Unlike the recent Amazon second headquarters office contest, in which tax breaks were the key criteria, Google decided that what it really wanted were replicable ways of lowering construction costs and minimising build-out delays. The cities then competed on the grounds of administrative efficiency. Incumbents, which initially dismissed the effort as simply a publicity stunt, quickly countered with promises of improved pricing, incrementally faster speeds or some combination of the two, but only where Google Fiber had announced a deployment.

Google then upped the ante with plans to build in 34 cities. Shortly thereafter, the telcos,

THE PRISONER'S DILEMMA AND STALLED BROADBAND UPGRADES

In thinking about why network upgrades had stalled we realised that the "prisoner's dilemma" provided a framework to understand the challenge. In that classic bit of game theory, two people are arrested for working together to commit a major crime. Each is in solitary confinement with no means of communicating with the other. The prosecutors lack evidence sufficient to convict them of the major crime but have evidence to convict them of a minor crime. The prosecutors make each an offer to encourage implicating the other of the major crime. If one prisoner implicates the other, he goes free but the other gets a heavy sentence. If they both implicate each other, they both get moderate sentences. If neither implicates the other, they both get light sentences for the minor crime.

Under that scenario, the prisoners are individually better if they implicate the other but in aggregate are better off if they both do not talk. If they trust each other not to talk they both do well, but if they don't trust each other not to talk, either or both might end up doing badly. Prosecutor want one or both to provide evidence against the other. To do so, they must cause what the game refers to as a "defection". The principal way to cause a defection is to convince one or both that the odds of the other one talking are high.

How does this apply to broadband and investments in next-generation networks?. Substitute the idea of talking with investing. In that scenario, would either cable or the telcos invest in next-generation networks? If they did, they might be able to take greater market share and make more money. There is a risk, however, that the other would respond and both, by virtue of having to invest significant new capital in an upgrade cycle, would reduce the attractive margins they both were enjoying previously by virtue of offering a new product – broadband – on a network they had built for a different purpose: voice for the telcos and video for the cable companies.

On the other hand, if the cable companies and the telcos trusted each other not to invest in next-generation networks, they would both be better off simply harvesting from those past investments. Unlike in the game, both sides had significant visibility into the other's deployment plans and therefore could quickly notice a defection. The lack of new investment plans suggested neither the cable nor the telcos felt a competitive threat from the other which required substantial new investment, trusting in relative peace within their own market segment. That framework illuminated the policy challenge. Removing bandwidth constraints on innovation, economic growth, and social progress required something to spark a defection.

particularly AT&T and CenturyLink, effectively defected, announcing plans to build out fibre in many more cities, taking advantage of the same administrative benefits Google received. Cable then accelerated its plans to upgrade to gigabit services.

By the second half of this decade, a game of "gigs" had commenced. Construction costs fell, and the speed of deployments increased. Only 6 years after Google's initial deployment, 30% of urban residents had access to a fibre-based gigabit internet service with 70% of Americans living in areas served by a gigabit cable offering.

Policy lessons learned about defections, upgrades and next-generation deployments. Google Fiber is, in a way, an idiosyncratic example, unlikely to be duplicated. For one thing, the effort has not done well as a business, discouraging others from trying similar efforts. Further, most countries do not have a company like Google that makes so much money from people using the internet that it has both the means and the motive to invest in bandwidth abundance.

But other countries face a similar challenge of incentivising telcos to upgrade to fibre. As the World Bank study cited earlier noted in discussing the reluctance of telcos to upgrade to fibre, the "presence of existing copper plant was also an enormous disincentive to new infrastructure investment. Hence, many incumbents opted for the short-term fix of upgrading the copper…". So despite the evidence that going directly to fibre would cost between $400-600 per household connection, upgrading in stages using the copper would over time cost $600-$1,000 per household.

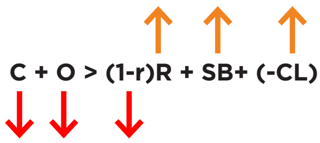
Thus, the experience provides some broadly applicable lessons about ways to stimulate next-generation build-outs. In studying the topic during the writing of the broadband plan, in watching Google Fiber develop, and with a project called Gig.U that I started after the plan involving three dozen university towns seeking to accelerate the deployment of next-generation networks, there were a number of patterns that emerged about the competitive forces that both stall and drive next-generation deployments.

1 **Next-generation deployments always require a new capital allocation decision by an existing or new competitor.** While internet service providers spend a significant amount annually on capital expenditures, mostly capital maintenance and expansion, spending capital on a next-generation deployment is likely to have problematic short-term consequences for the company's free cash flow, creating risks in the market in terms of customer acceptance and a competitive response. The next-generation deployment will not occur unless there are changes that compel a new capital allocation decision.

2 **The new capital allocation decision follows a change in the same formula.** The reason that greater competition has not occurred yet in the broadband industry is because the new or incremental capital (C) and operating expenses (O) of a network capable of offering abundant bandwidth are greater than the total of risk adjusted (1−r) new or incremental revenues (R), the benefits to the enterprise's overall system (SB), and the risk of lost revenues due to competition (CL). These variables represented in an equation are:

$$C + O > (1-r)R + SB + (-CL)$$

Thus, to intensify competition, the maths needs to change to cause capital expenditures (capex), operating expenses (opex), and risk to go down while revenues, system benefits, and competition go up, changes represented in the illustration below.



3 **Historically, the biggest changes in the competitive landscape in communications result from changes in the formula, which themselves often result directly from changes in government policy.** There are many examples in the US of companies reallocating capital to invest in next-generation deployments that demonstrate how policy affects capital allocation and competition. For example:

- In the 1960s and 1970s, cable greatly expanded its network footprint to compete with broadcast television when the government adopted rules lowering the cost of cable accessing utility poles and also for buying broadcast programming, lowering both its capital expenditures and its operating expenses.
- In the 1990s, direct broadcast satellite (DBS), which had superior technology to cable for multi-channel video programming, could finally justify a nationwide build-out when the government adopted rules granting non-discriminatory access to programming, lowering operating costs to enable firms to compete with cable.
- Subsequently, when faced with the loss of revenue from DBS competition, cable upgraded its network to begin competing with the telcos' dial-up internet service.
- In response to that competition, telephone companies upgraded their dial-up offering to DSL and further, successfully lobbied the federal government to prohibit local franchising monopolies and for states to adopt state-wide franchising, and with the lowered capital and operating costs, upgraded their networks to enter the multi-channel video programming distribution (MVPD) market.
- In the 1990s, wireless began competing with wireline voice when the government both enabled more wireless competition with the personal communications service (PCS) spectrum auctions and lowered operating expenses by reducing the terminating access charges wireless had been paying wired providers.

In each case, after a government policy changed the equation, new capital was devoted to a network upgrade that drove others to upgrade and enter new markets as well.

4 Because of the different networks and sub-markets, there can be a virtuous cycle of one upgrade leading to another. In the context of first generation broadband gaps, improvements in any one of access, adoption or utilisation would improve the prospects for improving the others. Unfortunately, that virtuous circle did not necessary lead to improved economics for next-generation deployments. As the examples above illustrate, removing barriers to entry and adjacent entry can create its own virtuous circle of network upgrades (particularly related to DBS competing with cable in MVPD causing cable to compete in internet access causing telcos to upgrade their ISP offerings and compete in MVPD).

5 Next-generation networks are initially deployed by four kinds of competitors, but not all are equally likely to do so. Next-generation deployments are a function of one of the following kinds of competitors making a new capital allocation to an upgraded or new network:

- Existing competitors that are in the same market, but need the new networks to improve their financial position
- Greenfield entrants, consisting of new ventures
- Adjacent market entrants, consisting of existing ventures whose business is close in proximity to broadband services and bring asymmetric assets and interests into the market
- Resale entrants that depend on inputs sold on a wholesale basis.

The first sometimes happens, but it is rare. As noted above, existing competitors prefer to rely on existing infrastructure for as long as possible. Usually, the existing players establish their position as serving a sub-market and it is difficult to justify the capital expense necessary to effectively redefine the market. After some period of time, markets stabilise, and it is difficult to affect the incentives of existing players without introducing a new competitor or a significantly better and/or cheaper technology substitute.

Greenfield entrants also rarely succeed. Network businesses are marked by high capital requirements with small incremental costs for additional customers. Those economics make it very hard to sustain a challenge against incumbents. There are many examples around the world of new entrants not succeeding in an established market, though one counterexample is Jio in India, which in half a decade went from zero market share to becoming India’s third largest wireless provider. The company, however, might offer a unique case, as India’s largest company owns it, and it started by purchasing a licence that gave it a head start in offering 4G to 22 Indian cities.

Most intriguing for causing a defection are adjacent market entrants. The asymmetry assets and motives, if unleashed to enter an adjacent market, lead to far greater disruptions in a mature market than those caused by existing competitors or greenfield new entrants. Google Fiber is an example of an adjacent market entrant, as Google had both existing network assets to lower its cost structure and motive to improve its search business revenues through better broadband performance.

But there are many others. The most prominent around the world are utility companies, which have assets valuable for broadband deployment purposes, including ducts and poles, building and rights of way access, and even their own fibre networks. While the economics vary widely, by way of example, an Italian fibre operator has announced that it reuses 55-67% of an electric company’s ducts, thereby reducing its cost to build by approximately 25%. Similarly, a broadband company set up by a Norwegian utility company enjoys about a 27% price advantage over the cost to build of the incumbent telephone company.[2] More utilities have used these assets to provide others with the ability to offer retail services rather than using them to provide the full spectrum of services themselves, but whether utilised on a wholesale or retail basis, the assets can help drive entry that incentivises multiple upgrades.

Finally, competition can come from resellers of wholesale offerings. Government regulation to require such wholesale offerings (sometimes referred to as unbundling or open access) can work to reduce prices in a mature market, but it discourages broad network upgrades. Such regulation can also be appropriate when the government finances the facility, which usually occurs in rural areas where market forces alone will not justify the investment and the facility is likely to be a monopoly provider of some services. Generally speaking, however, resale and wholesale offerings are not a path to causing new capital to flow to next-generation networks.

> **“Existing competitors prefer to rely on existing infrastructure for as long as possible.”**

An interesting but early counterexample is Mexico’s effort to stimulate competition by creating a wholesale only greenfield enterprise, called Red Compartida. The government awarded the entity 90 MHz of spectrum repurposed as part of the digital television transition, as well as rights to use a government developed backbone, in exchange for agreeing to build out a network to meet certain benchmarks in terms of coverage – with a final benchmark of covering 92% of the country by 2024 – and offering wholesale services on a non-discriminatory basis. The effort was in large part an effort to break up the dominance of América Móvil, which, when Red Compartida was developed, controlled 70% of the Mexican wireless network. It was also an effort to ensure that unserved areas in Mexico received service. So far the entity is meeting its build-out obligations but its economic prospects remain speculative. It helps that it has deployed 4G, the next-generation technology at that time.

In a similar vein, Rwanda has partnered with Korea Telecom to create a national wholesale wireless provider. South Africa also proposed such an entity in 2011 but it has yet to materialise. If the Mexican and Rwandan efforts prove successful, they might provide a model for countries where ➡

market forces will not deliver the optimal coverage of 5G services.

6 New technologies can affect the economics of next-generation deployments. There are a number of emerging technologies that may affect the economics of next-generation deployments.

5G. The biggest market development in broadband is the emergence of 5G mobile services. If one trusts the pronouncements from various vendors, one might conclude that 5G will provide the ubiquitous, low-latency, abundant bandwidth that will make concerns about limited bandwidth a thing of the past. Some 5G deployments will occur and cause others to upgrade and offer more competitive packages. But there is actually a high level of uncertainty about the timing and extent of the build-out and the nature of the offerings.

Bain, for example, is optimistic about 5G's prospects but its survey of mobile executives found that 53% in the 19 largest mobile operators saw no near-term business case for the technology.[3] A recent study from McKinsey found that 60% of operators view the lack of a clear business case as the biggest challenge in their 5G strategy; only 25% expect 5G to deliver a strong business case.[4] Without such a business case, the level of deployment will be limited and most areas will have to rely on other networks for abundant bandwidth. Interestingly, an earlier McKinsey study suggested that in light of the economics of 5G deployments, operators were more willing to contemplate sharing and other business models that reduce capital risk,[5] opening the door to experiments like that of Mexico and Rwanda.

Satellites. The satellite broadband sector is experiencing a significant burst of activity with new developments in high-throughput satellites (HTS), and non-geostationary constellations of low earth orbit (LEO) and medium earth orbit (MEO) satellites. They are generally designed to serve currently unserved areas and provide new alternatives to lower costs in wholesale backhaul, as well as providing certain niche applications. It is possible, but unlikely based on the evidence to date, that these developments will provide a competitive dynamic to drive next-generation deployments in most areas.

Television white spaces (TVWS). Some companies, particularly Microsoft, have advocated the use of unused television channels for broadband related transmission. The spectrum propagation characteristics allow for high capacity, non-line-of-sight, low power transmission, which has advantages over other transmission alternatives in remote areas with difficult terrain. Microsoft has launched the 4Afrika initiative that has 15 pilots in many countries in Africa using TVWS to offer low-cost, high-speed broadband in rural areas. TVWS are also used in some countries, such as Canada, Columbia, and South Africa, for backhaul connections in rural areas. While the technology holds promise, it is not clear it will gain enough traction so that equipment and other costs will provide the necessary economies of scale to become a broader solution.

Non-permanent structures. There are a number of non-permanent structures, such as drones and balloons, that some suggest offer new means to enter the broadband market. Most of these solutions, however, offer short-term means of providing disaster relief where permanent infrastructure has been destroyed, connectivity in emergency migration situations, and capacity assistance where there is a short-term spike in demand. They are unlikely to cause a change in the competitive dynamic. While Google's Project Loon holds the promise of longer-term options, it is still too nascent to consider as a competitive driver of next-generation networks, and Facebook's shelving of its Aquila project suggests such technologies should not be relied upon in considering strategies to drive upgraded broadband.

> **"There are policy principles that fit every situation and would help chart the path to bandwidth."**

POLICY LESSONS FOR GOVERNMENT

As noted, there are no one size fits all solutions for countries seeking to ensure that their residents and enterprises have access to affordable, abundant bandwidth. Further, there are many uncertainties about how current market forces and technologies will deliver such bandwidth. Nonetheless, there are certain policy principles that fit every situation and, if adopted, would help chart a path to such bandwidth. They are as follows.

Improved information. While considering how broadly market forces will drive next-generation deployments, governments should improve their mapping of broadband availability and pricing to more accurately define the geographic and demographic parameters of future gaps and guide actions to fill those gaps. In particular, the information can be useful in identifying bottlenecks and whether market forces are likely to overcome them or whether government action is needed.

Clear goals. Governments should send carriers clear signals about their goals. Carriers generally do not want government interventions but the government should set goals for both coverage and speeds and be clear about how long it will wait, and the network performance it needs, before it will take action, providing private enterprises with incentives to clarify and accelerate next-generation deployment plans.

No build requirements in competitive markets. Generally, government should not impose build-out requirements for next-generation networks. Some argue that just as there were universal build-out obligations for telephone or cable providers, there should be similar obligations on next-generation networks. That argument ignores that enterprises that built the first-generation telephone networks received a government guaranteed monopoly. In today's market, an obligation to build everywhere could result in building nowhere. The exception would be a government created wholesale entity, such as in Mexico.

REFERENCES

1 World Bank Group (2018). Innovative business models for expanding fiber-optic networks and closing the access caps. p79. bit.ly/2u6qIMI

2 Arthur D. Little (2017). Utilities' contribution to national fiber development: How utilities and telecom operators can cooperate to accelerate fiber deployment. p8. bit.ly/2UEucRz

3 Bain & Company (2018). Why the 5G pessimists are wrong. bit.ly/2Hu4eNM

4 McKinsey (2019). Cutting through the 5G hype: Survey shows telcos' nuanced views. mck.co/2SXoJsx

5 McKinsey (2018). Network sharing and 5G: A turning point for lone riders. mck.co/2Pa10UA

Adjust the tools for universal access to target upgrades and new deployments. The tools that countries adopted to encourage universal build-out can be adapted for next-generation deployments.

● **Licensed spectrum.** The spectrum tools generally proposed in national broadband plans, such as making more spectrum available for flexible use, encouraging refarming and secondary markets, and having a long-term plan have value for upgrades as well, both directly for wireless and for the competitive pressure wireless can place on wired offerings. Of particular importance now is freeing up mid-band spectrum for 5G deployments. Countries should also periodically review the actual use so that if the geographic licence size leads to unused spectrum in specific areas, they should consider reassigning the spectrum, as South Africa is doing through its National Integrated ICT Policy, to enable local communities to use spectrum assigned to, but not utilised by, mobile operators.

But there are three problems with increasing available spectrum as the principal strategy. First, it takes a very long time to identify spectrum bands and make them available for use. Second, in some countries, wireless providers also have a significant wireline business, changing the incentives from what they would be if they were separate companies. Third, the next generation of mobility, 5G, will rely on small cells, an architecture that will require greater fibre connectivity, thereby limiting and slowing 5G coverage. Depending on the current market structure and how the Mexican wholesale experiment unfolds, countries wishing to disrupt the current market structure should consider using a wholesale or sharing model for accelerated 5G deployments.

● **Unlicensed and shared spectrum.** Government policy should also enable Wi-Fi based entry, either through MVNOs or through community wide efforts, such as has been done in Barcelona and Singapore. While the service likely will not be as good as a fibre-based or exclusively licensed service, it can be a low-cost, quickly deployed method to raise the bar for all services offered in the area. Guaranteeing that this lever can continually drive competition requires two elements. First, the government should ensure that unlicensed spectrum bands will continue to have sufficient spectrum for expansive use that will not suffer degradation as more customers use it. Second, the cellular market structure should be sufficiently robust to have market forces produce a robust wholesale market.

In addition, countries should monitor the current efforts to utilise shared spectrum, as they have the potential to lower entry costs and make it more attractive for adjacent market enterprises with wired network assets to offer wireless services, stimulating a virtuous circle of upgrades.

● **Lower cost of deployment.** While policies to lower deployment costs for traditional providers remain valid for next-generation deployments, countries should prioritise those that create opportunities for adjacent market entry, particularly policies that encourage the integration of internet infrastructure into traditional infrastructure projects to reduce costs, such as by laying of fibre optic cable simultaneously with road and utility infrastructure construction (known as "dig once" policies); policies that streamline permitting to essential facilities, such as poles and rights of way; and policies that ensure non-discriminatory, low-cost access to public infrastructure.

> **"While policy should not pick the winner, it can – and should – ensure that barriers to adjacent market entry are lowered."**

● **Use government demand to trigger new networks.** Governments have aggregated demand to guarantee a certain level of demand necessary to make the financing of the critical project viable. For example, Malawi awarded a 10 year contract to build and operate a national backbone network, with the deal including a government guarantee of a certain amount of sales to assist the winning entity in obtaining financing. The same can be done for high-speed networks, with the government organising the demand from customers that need next-generation speeds, which includes such public entities as schools, hospitals and universities, to jump-start next-generation deployments.

Prioritise adjacent market entry and virtual circle dynamics. The government should study the market and where it sees deficiencies, it should consider whether potential adjacent market entrants could both deploy and cause a competitive response and whether barriers to such entry can be removed. In many countries power companies are the most likely such entrants, but as noted, there are other players that might start a virtuous circle of upgrades. Generally, governments should be sceptical that a greenfield new entrant will be able to sustain a new effort or that an incumbent in a mature market will have the incentive to shake up the status quo with a relatively risky new round of capital investment.

Encourage geographically targeted solutions and empower local efforts. As 5G emerges, it is likely that some areas of a country will have abundant bandwidth and others will not. It is impossible to know today what the Swiss cheese map of networks will look like. In that light, national governments should adopt policies that empower those most likely to understand and care about the specific nature of any local broadband deficits, especially local communities that know where the holes will be and are accountable to local concerns.

CONCLUSION: CREATING INCENTIVES FOR ABUNDANCE

Every important technological development presents societies with a series of opportunities and challenges. Broadband is no different. Every day we read of concerns about privacy, cybersecurity, algorithm bias, and other issues that only emerged as broadband became the information commons. As governments grapple with these issues, they still need to continue efforts to achieve universal access and adoption, optimal utilisation, and now, bandwidth abundance. Removing bandwidth constraints on innovation, economic growth and social progress requires opportunities and incentives for competitive upgrades. Policy can contribute by causing improvements in the economics of deployment. While policy should not pick the winner, it can – and should – ensure that barriers to adjacent market entry are lowered and that all existing networks have incentives to upgrade their networks for defensive reasons and the opportunity to "play offence" in attacking the offerings and market share of others by accelerating their deployment of networks offering abundant bandwidth.

***BLAIR LEVIN** is a telecoms lawyer, equity policy analyst, and non-resident fellow at the Metropolitan Policy Project of the Brookings Institution. He was formerly chief-of-staff at the FCC, executive director of the 2010 US National Broadband Plan, and executive director of Gig.U.*