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The Role of Communication Infrastructure Investment in Economic Recovery

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THE ROLE OF COMMUNICATION INFRASTRUCTURE INVESTMENT IN ECONOMIC RECOVERY

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FOREWORD

This paper was prepared in the context of the work programme of the Working Party on Communication Infrastructures and Services Policy. It was presented to the Committee for Information, Computer and Communications Policy (ICCP) in March 2009 which declassified the document.

The report was prepared by Mr. Taylor Reynolds of the OECD's Directorate for Science, Technology and Industry. It is published on the responsibility of the Secretary-General of the OECD.

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MAIN POINTS

Public investment in telecommunication infrastructure

Broadband networks are increasingly recognised as fundamental for economic and social development. They serve as a communication and transaction platform for the entire economy and can improve productivity across all sectors. Advanced communication networks are a key component of innovative ecosystems and support economic growth.

Broadband networks also increase the impact and efficiency of public and private investments which depend on high-speed communications. Broadband is needed as a complementary investment to other infrastructure such as buildings, roads, transportation systems, health and electricity grids, allowing them to be "smart" and save energy, assist the aging, improve safety and adapt to new ideas.

Some governments, citing the importance of broadband, have recently invested public funds to address important communication market limitations. These investments fall into two general categories: extending access to un-served/underserved communities and upgrading networks with very-high-speed lines capable of supporting competitive services in regions and municipalities. Announced government stimulus spending on communication infrastructure will largely target these two types of investment.

Economic downturns present serious challenges but can also be viewed as opportunities for structural reform and targeted investment in strategic areas such as broadband. This raises several questions about how governments can best accomplish these goals without displacing or disrupting private investment. What criteria or principles, for example, should be applied in assessing where to allocate resources?

Investment in broadband communication platforms has been largely undertaken and led by the private sector and this should continue. Private operators have been investing heavily to upgrade existing infrastructure, expand capacity and enable a new wave of high-bandwidth services. The scale of this upgrade means that private telecommunication operators are among the largest private investors in their respective economies. This may rapidly change though as economies retract given the highly pro-cyclical nature of telecommunication investment over the previous 20 years and firms' limited access to capital. Telecommunication operators historically have had strong cash flow positions during economic downturns but may face increasing difficulties raising sufficient capital to extend and upgrade their networks.

Despite the significant progress made by operators, there are also still areas in OECD countries without broadband access due to the lack of a reasonable business case. These areas have historically been the target of government plans to extend connectivity.

The recent economic downturn has led policy makers in OECD countries to consider fiscal policies to help return their economies to growth. Most of these plans involve large government expenditures to support demand for goods and services while simultaneously increasing the longer-term productive capacity of the economy. Investments in network infrastructures such as electricity, gas, water, transportation and communications are key elements of most packages due to their immediate impacts on demand and employment as well as their strong potential to expand future supply.

Broadband infrastructure, in particular, can be a good target for economic stimulus spending because many projects can be initiated relatively quickly, are labour-intensive, can minimise economic leakages, and may promise stronger marginal impacts on supply and productivity than investing in established networks such as electricity, gas, water and transportation. The strongly pro-cyclical nature of communication network investment also means that skilled labour and equipment may be left idle and planned projects shelved until the economy improves. This labour and equipment could be quickly shifted to government-sponsored projects. At the same time, governments must ensure that interventions do not interfere with properly functioning markets or displace private investment.

This paper argues that policy makers need to evaluate the costs and benefits of any public investment in telecommunication infrastructure and select projects which can deliver both strong *immediate aggregate demand effects,* such as through the employment created by rolling out the networks, and strong *longer-term aggregate supply-side effects,* which can improve the productive capacity of the entire economy as an improved foundation for commerce and communication.

Governments generally do best when they help facilitate environments that support an innovative and robust participation by the private sector. Over the past three decades, the role of governments in the OECD has been to increasingly support market-led innovation and investment in the communication sector. There has also been a trend against trying to "pick winners" particularly in the development of specific technologies. At the same time, governments recognise that competitive broadband communication networks are increasingly fundamental to economic and social development. They are viewed as a general purpose technology that will not only support critical services but are required for innovation, competitiveness and growth across economies. With that in mind it is understandable that some governments, through their stimulus packages, wish to address areas of potential market failure (*e.g.* reaching underserved areas) or more broadly stimulate investment in the provision of national broadband networks faster than might otherwise be the case. While the financial crisis has spurred a more prominent role for public investment, each country will need to determine the appropriate balance taking into account their policy goals and objectives. It can also be noted that all national plans involving public investment also specify a leading role for the private sector in ownership and operation of the networks receiving public investment.

Roadmap for efficient public investment in telecommunications

If policy makers do decide to use public funds to invest in communication networks then there are a number of important elements to consider. All public investments in telecommunications should balance four key items – connectivity, competition, innovation/growth and social benefit. Projects which focus on one and exclude the others will likely not be optimal for taxpayers.

The results of public expenditure on connectivity will depend on the number of users potentially affected by the investment, their demand for broadband services, their marginal benefit, the capacity of the network put in place, the topology of the infrastructure, the longevity of the installed network and its potential to be upgraded to meet future requirements.

Policy makers may need to evaluate the impact of network rollouts on areas connected to new telecommunication networks and those which may be bypassed or underserved. In some cases the marginal cost of extending a backbone connection to an additional community could be much lower than the benefit it could potentially provide.

Policy makers considering broadband investments need to balance any investment in last-kilometre networks with similar investment in backhaul networks servicing targeted areas. In these situations open-access, fibre backhaul networks can be considered as a part of any broadband stimulus because they provide the needed capacity for all other types of broadband access networks. Governments can also promote wireless development by making spectrum available which could be used for broadband access (*e.g.* the spectrum dividend from the switch to digital television signals). Any investments in last-kilometre DSL, cable or wireless links need to be planned in a way that the connections could be upgraded to fibre if this became economical. Governments must also take great care not to displace private investment.

When the public pays for broadband investment they should expect to benefit from improved service and greater choice in the market place. One means to accomplish this is to ensure that networks built or augmented using any public funding are available via “open access” rules, meaning network providers offer access or capacity to all market participants on cost-based, non-discriminatory terms.

The physical topology of broadband networks has a significant impact on the potential for competitive access in the future. In general, the topologies which offer the most access to competitors are the most expensive to install but may also provide more longer-term economic benefits and improved consumer surplus than other topologies. By way of contrast, some topologies may serve to strengthen existing dominant positions in the market and should be carefully considered before governments commit any public funds. Public investment in passive infrastructure may be another important way for governments to put people to work and build a platform for future economic growth without displacing private-sector investment.

Some experts advocate a model which separates wholesale and retail services for any new networks built using public funding. They argue this provides the strongest competition and largest potential for innovation. It is important to differentiate the treatment of networks built using public investment and debates surrounding the structural or functional separation of networks built by private capital. Creating incentives to promote the maximum choice for consumers should always be at the forefront of such considerations and particularly so when public investment is involved.

Broadband networks are already an important foundation for innovation and growth in the OECD area in an increasingly competitive global marketplace. Communication networks help improve the efficiency of all sectors in the economy and new investments can potentially improve innovation and growth. Policy makers can maximise these impacts by considering the marginal impacts of each investment, its ability to be upgraded to support new services, the benefits to businesses and households and the balance between backhaul and last-kilometre capacity.

Policy makers will need to balance economic and social objectives when evaluating projects. Projects focusing on extending access in rural and remote areas will deliver the intended effects on aggregate demand but may have a relatively low impact on aggregate productivity growth per unit invested because of the limited number of users who would be added to the network. From an equitable viewpoint though, these investments may achieve strong social objectives by bringing significant benefits to these communities. Left without the necessary communication infrastructure these regions will be disadvantaged in participating in the economic and social development that will take place in areas that have superior connectivity.

Investments which bring high-speed backbone networks to a large number of rural communities may be more efficient than projects which pay for last-kilometre connections to homes in a limited number of areas. Policy makers who have committed to investing in markets may decide to invest in high-capacity backbone infrastructure to some rural and remote areas as a way to extend affordable, high-bandwidth connections to the largest number of inhabitants in these areas as possible and leave the last-kilometre connectivity to the private sector. Public investment could be used to target spending on high-speed open-access networks providing connectivity to rural schools, hospitals and other public institutions as anchor points for high-speed connections in the community. Private ISPs could then interconnect at these points and distribute access directly to users using their own facilities and services.

Information regarding government stimulus spending should be made public in a transparent way to ensure that funds are distributed in an efficient and publically acceptable manner. Policy makers should ensure that information about the bidding and selection processes is widely available to the public. In addition, governments should be clear about how communication infrastructure projects will be monitored after the awarding of funds and the results of any monitoring should be publically available.

Policy makers should also consider non-budgetary measures which foster the use of next-generation networks and improve economic efficiency.

INTRODUCTION

The last quarter of 2008 marked the beginning of a severe contraction of economic activity across the OECD area, leaving policy makers examining how to respond to the economic crisis using a variety of stimulus packages. Governments are considering infrastructure investments as a way to counter the cyclical nature of the current economic downturn. Broadband network investment, in particular, is a key component of many national plans.

State-owned entities were responsible for investment in the fixed-line communication infrastructure in many countries for much of the previous century but governments have stepped aside to allow private enterprise to guide service provision and continued investment. Government intervention has mainly been limited to addressing areas where there have been market failures by extending connectivity to un-served or underserved areas and targeting investments to improve capacity. In many cases municipal and regional governments have invested in networks to address competitive market failures.

Government leaders have committed to promoting the extension and upgrade of broadband networks. In the OECD's *Seoul Declaration for the Future of the Internet Economy*, Ministers agreed to ensure broadband networks attain the greatest practical national coverage and to stimulate investment and competition in the development of high capacity information and communication infrastructures. Governments made these two types of support a priority – even before the current crisis came into full perspective.

The recent economic crisis and emphasis on fiscal stimulus spending has opened the possibility of governments directing investment to accomplish these two objectives. These investments could have a significant, positive impact if they can address market failures and promote competition. At the same time, policy makers need to take great care not to disrupt well-functioning markets with unnecessary investments. Targeted investment backed by a sound regulatory structure could help extend and upgrade networks without further entrenching existing firms or creating new players with significant market power.

This paper examines the role of investment in communication infrastructures in economic stimulus packages and argues for several principles which should guide any government investment. The first section of the paper examines the role of investment in communication infrastructures in the overall economy. The second section considers practical issues for policy makers who have chosen to invest in communication networks, concerning the distribution of funds.

General theories for efficient government spending

The credit and housing crises in a number of OECD countries has led to a steep decline in household expenditures and a fall in employment. Both have fed into each other creating a sharp downward cycle. Governments, eager to stop this spiral, have announced a range of stimulus packages designed to increase aggregate demand across their economies. Fiscal policy will play a key role in addressing the economic crisis. The OECD suggests that any fiscal policy be temporary, timely and targeted (OECD, 2009a).

The different impacts of fiscal policy

Governments use fiscal policy as a tool to influence aggregate demand. Fiscal policy works through three key methods – tax cuts, government transfer payments and public expenditure. Money injected via any of the three methods circulates in the economy and provides a potentially stronger impact than the initial injection as a result of the multiplier effect. Such initiatives frequently target segments of the population who have the greatest propensity to consume, in other words those people who will most likely take the money they receive and spend it rather than increasing their savings.

All three methods address aggregate demand in the short term and can be aimed at reversing negative consumption trends during economic downturns. They must be implemented expeditiously to have their desired effect – increasing demand and creating jobs. One of the three elements, public expenditure, has an additional benefit in relation to the other two because it can also expand the output capacity of the economy if targeted at certain investments.

Public expenditures can affect both aggregate demand and aggregate supply and are therefore of keen interest to policy makers. Government investment in a new highway, for example, provides wages for workers and work for enterprises. This shifts out the aggregate demand curve. At the same time, a new road between two areas will likely improve business productivity for firms operating in the connected areas. This efficiency gain represents a shift out of aggregate supply in the economy.

Productive spending

Economic literature focuses on two types of government spending, "productive" and "non-productive". The term "productive" relates to government expenditure that can be included in the private production function and thus is the only kind of spending which has an effect on long-term economic output. In other words, productive spending would increase the productive capacity of individual firms via externalities (Kneller et al., 1999). In terms of the current crisis "unproductive" investment can fulfil the first goal of putting people to work but will not affect the second goal of expanding productive capacity.

The focus on "productive" spending is important because it works as a positive externality to firms in the economy. Angelopoulos et al., (2007), refer to this spending as "the engine of long-term growth" and suggest that governments could improve their growth performance by reallocating public expenditure towards productive activities. This has implications for policy makers considering government stimulus investment. Government spending should target "productive" investments whenever possible because of the dual effects they can provide. They essentially offer much better returns for the same initial investment.

Infrastructure investment can be "productive" because of its effect on long-run aggregate supply. Governments have long been investors in economic infrastructure because targeted investment in core infrastructure has a potentially strong, positive impact on productivity and economic growth. One drawback of such programmes is that they take time to evaluate and put into place. There is a risk for governments that projects under consideration as part of an economic stimulus package could arrive too late to have the desired demand-side effect of reversing consumption and employment declines. However, if an economic downturn is expected to last for more than a year then the timing issue could become less important.

Policy makers need to make careful decisions about the types of investments they choose for the dual role of stimulating current consumption and promoting longer-term productivity gains. In general, government spending should target timely projects which offer the largest demand- and supply-side benefits for the economy.

Network infrastructure investment

Network investments are typically used as examples of "productive" government investment because of the positive externalities they provide. Aschauer (1988) finds that investment in core network infrastructure, including roads, airports, electrical and gas facilities, mass transit, water systems and sewers have a strong and significant impact on economic productivity.

Network industries are important parts of the economy, particularly with respect to investment, where they can account for between one-tenth and one-quarter of economy-wide investment (OECD, 2009a). Over the past two decades, investment in energy, water and transport has been falling as a share of GDP in most OECD countries. More recently, investment in the telecommunication sector has been growing rapidly.

The impact of productive investment goes beyond simply expanding the capital stock of the country. Infrastructure investment can have effects on growth over and above those arising from adding to the capital stock (*e.g.* increasing supply). These effects can occur through a number of different channels such as facilitating trade, improving competition, reducing longer-term costs and expanding access to larger markets. Furthermore, effects on growth can also differ depending on whether existing provision is small or large. For example, a small addition – such as interconnection between two networks – can have marked effects by increasing overall system efficiency, but subsequent investment may have a much smaller effect (OECD, 2009a). Such investment can be transformative, for example, by changing the economic characteristics of a region or sector.

Rietveld (1989) argues that governments have two different options with respect to public network infrastructure. Policy makers can wait for serious bottlenecks and areas of insufficient investment to appear before investing or choose to invest in infrastructure as a way to attract economic activity. The significant time lag between identifying a bottleneck and building a network can have a large economic impact on a region. On the other hand, building infrastructure as an engine for development, at a national or regional level, is also a risk because it may fail to attract additional activity from the private sector.

The demand-side aspects of investment are quite similar across scenarios so policy makers may be more interested in what kind of impact investment in networks will have on the supply side of the economy. In particular, policy makers want to know the impact of investment in network infrastructure on economic growth. Research studying other types of network infrastructure (transportation, energy) can provide insights and lessons for policy makers considering using public investment to fund rollouts or upgrades.

Transportation and electricity

Research from the transportation sector has looked at how installing new roads affected the economic output of different areas. There are important similarities as communication networks are a foundation for transporting information which critically underpins all economic activity.

Chandra and Thompson (2000) find that public investment in transportation networks has different impacts across industries passed by the new roads. Highway investment tends to significantly benefit the areas through which the new roads pass directly. The investment may benefit areas connected by the new roads but it can also pull economic activity away from other areas which are "bypassed" by the investment, possibly leading to an ambiguous result for the region as a whole. Total earnings in adjacent areas (which saw some economic activity shift closer to the new road) fall and retail sectors experience the most precipitous declines.

Recent studies find similar results. Ozbay (2007) finds that capital investment in transportation has a statistically significant positive impact on output in the areas directly served by the new infrastructure. At the same time, areas bypassed by the infrastructure experience some declines. Ozbay finds that the beneficial spillovers of the investment decrease in proportion to the distance from the new roads.

This has implications for investment in communication infrastructure. Policy makers need to evaluate the impact of network rollouts on areas connected to new communication networks and those which may be bypassed. In some cases policy makers may find that the marginal cost of extending a fibre backbone spur to an additional, unserved community is much lower than the benefit it could potentially provide. The transportation findings could have potentially large impacts on telecommunication investments targeting rural and remote areas. Investments which bring high-speed backbone networks to a large number of communities (but not to individual homes) may be more efficient than projects which pay for last-kilometre connections to homes in a limited number of areas.

Another key question addressed in other network literature is causality in the relationship between network investment and gross domestic product (GDP). Does expanding a network influence GDP or does GDP growth lead to network expansion? Understanding this relationship is important because it may be harder to justify public network investment in network industries without a measurable effect on GDP.

On the transportation side, Ozbay examines the causality between highway capital investment and economic growth. Ozbay's causality analysis finds investment influencing GDP with an analysis of investment in highways and county output. Researchers in the energy sectors have addressed similar questions to determine the efficiency of investment in networks. Kraft and Kraft (1978) initially found that causality in the energy sector showed GDP influencing higher energy consumption and not the other way around. A range of studies over time found varied results across sample periods and countries.

It is the electricity component of energy which has the most interesting parallels with telecommunications. Yang (2000) examines the relationship between electricity use (supply) and GDP in Chinese Taipei, in particular the causality of the relationship. Yang finds dual-causality for GDP and electricity. In other words, increased electricity consumption led to higher GDP and higher GDP also led to more electricity consumption. Related research by Morimoto/Hope (2004) finds current and previous increases in electricity supply in Sri Lanka had a significant impact on a change in real GDP.

Indeed the results are similar to studies in the telecommunication sector. Hardy (1980), Cronin (1991) and Norton (1992) examine the relationship between GDP and telecommunications and essentially find that GDP and telephone penetration have causal effects in both directions. As Alleman et al. (1994) state, "telecommunications in thus considered to be both a cause and a consequence of economic growth".

OECD (1994) and Roller and Waverman (2001) examine the effects of telecommunication infrastructure investment and economic performance and find telecommunication investment has significant growth effects, particularly when there is already a substantial network infrastructure in place. The impact is twice as large for those countries which have achieved universal service. More recently, Qiang (2009) and Qiang and Rossotto (2009) find a robust and significant growth dividend from broadband access in developed countries. In high income countries, broadband penetration of 10 subscribers per 100 inhabitants corresponds to a 1.2% increase in per capita GDP growth.

This could have implications for governments looking to invest in new high-speed backhaul infrastructure in some areas but not others. Areas receiving the infrastructure investment may benefit more in the longer-term than those which are bypassed by new infrastructure. The analogy between telecommunications and transportation is particularly pertinent because the communities adjacent to the investment still have access roads but with limited capacity. There will likely be other ways to access the

Internet in communities bypassed by telecommunication investment but policy makers should consider whether targeted investments could shift benefits away from one community to another.

Making a case for telecommunication investment

Telecommunication network infrastructure investments are good targets for economic stimulus action for a number of reasons.

i. Some projects can be initiated quickly and require a significant amount of labour which increases employment (shovel ready).

ii. Wired telecommunication investment, by its nature, is a local endeavour providing localised spending and stronger multiplier effects because of reduced leakages.

iii. Extending telecommunication networks to un-served or underserved areas could have stronger marginal impacts on supply and productivity than simply upgrading previously established networks such as electricity, gas, water and transportation.

Any rapid decline in telecommunication investment leaves workers idle. As telecommunication operators rein in their capital expenditures during the economic difficulties these workers with particular skills will likely be underemployed due to the strong pro-cyclical and "lumpy" nature of telecommunication investment. The term "lumpy" refers to the situation where there could be large investments one year and relatively little additional investment for the remainder of a decade. The large, up-front investments in one year are amortised over a number of years.

Examples of lumpy investments are roads, electricity transmission equipment and fibre-optic telecommunication networks. Each encounters high fixed costs to build out the network but relatively lower variable costs to operate and maintain it. Hirschaman (1958) and Rietveld (1989) highlight that the lumpiness of network industry investment means that there will be relatively long periods of excess supply or demand.[1] This uneven distribution of investment over time means that firms cut capital investment drastically during periods of economic downturn since previous investment is usable for many years and network expansions and upgrades can be postponed until the economic situation of firms improves.

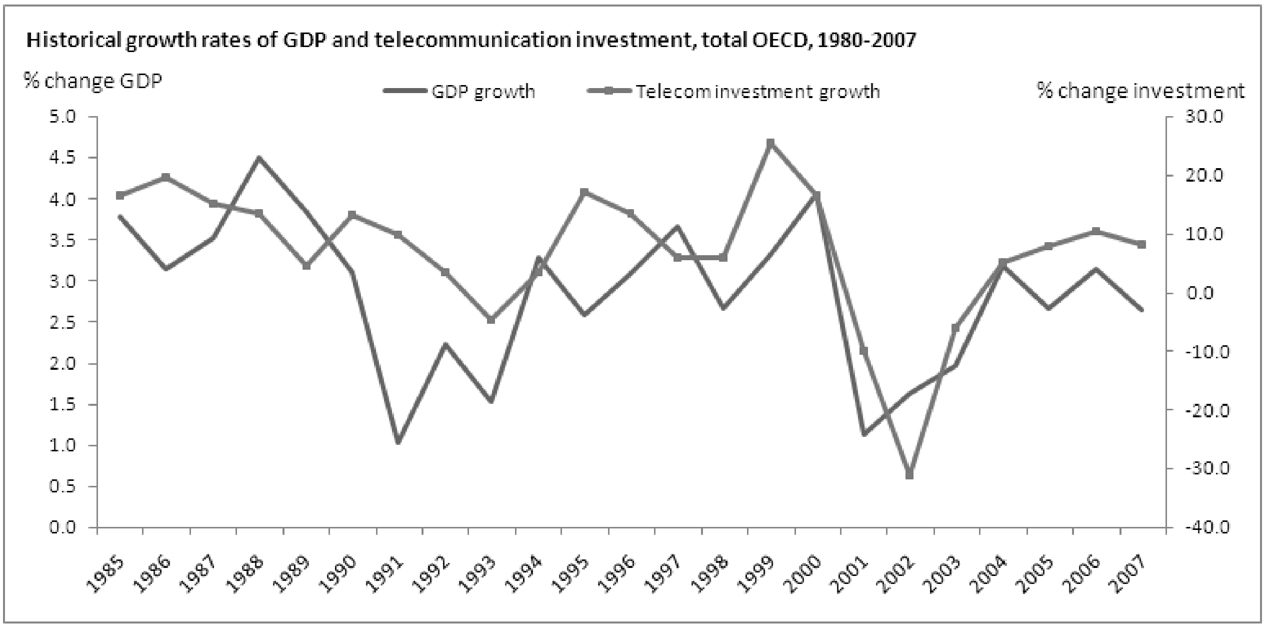
Telecommunication investment has been particularly sensitive to changes in the economic climate over the past 20 years. Figure 1 shows the percentage changes in GDP and telecommunication investment for the OECD between 1985 and 2007. The trends mimic each other with a 60% correlation over the time span but the changes in investment are greatly amplified (as noted by the scale on the right axis) when compared to changes in GDP (the scale on the left axis). A 1% change in GDP corresponds roughly to an 8% change in telecommunication investment.

1 Japan is a good case study in the OECD because it has one of the most advanced and highest-capacity broadband networks in the world. Japan's infrastructure may be ahead of the curve, meaning network can accommodate much higher utilisation than current services demand. This would indicate a situation of excess supply in bandwidth. Policy makers may decide that excess capacity today (with capacity to grow) is preferable to a longer-term situation of excess demand and stunted growth.

Figure 1. The sensitivity of telecommunication investment to economic growth

Telecommunication investment and nominal GDP growth

(1985 – 2007)



The recent economic retraction has already led to significant reductions in actual or planned capital investments by several large operators in the OECD despite continually strong balance sheets, and in many cases, increasing revenues. Verizon reports that capital expenditures fell 11% in 2008 and that planned spending would decline again in 2009.[2] AT&T reports a 40% decline in capital expenditures in the first quarter of 2009 while reporting a 17% gain in operating income during the same time period.[3]

Telefonica reports that 2009 capital expenditure will likely fall by 11%[4] while BT's planned expenditures are slated to fall by 7%.[5] Deutsche Telekom announced a 3% increase in total expenditures for 2009 but a 4% decline in spending on its fixed/broadband network.[6]

The most recent period of severe telecommunication investment declines was during the economic downturn in the year 2000. By 2007 investment levels in the sector had not reached the same level as 1999 at the height of the "Internet bubble". Telecommunication investment fell 30% between 2002 and 2003 alone.

GDP growth also halved between 1990 and 1993 and this led to another pronounced decline in telecommunication investment. Annual telecommunication investment growth fell from 13% in 1990 to

2 Verizon Annual Report 2008 (10-K) at: investor.verizon.com/sec/sec_frame.aspx?FilingID=6435582.

3 AT&T Quarterly Report (Q1 2009) at: www.att.com/Investor/Growth_Profile/download/master_Q1_09.pdf .

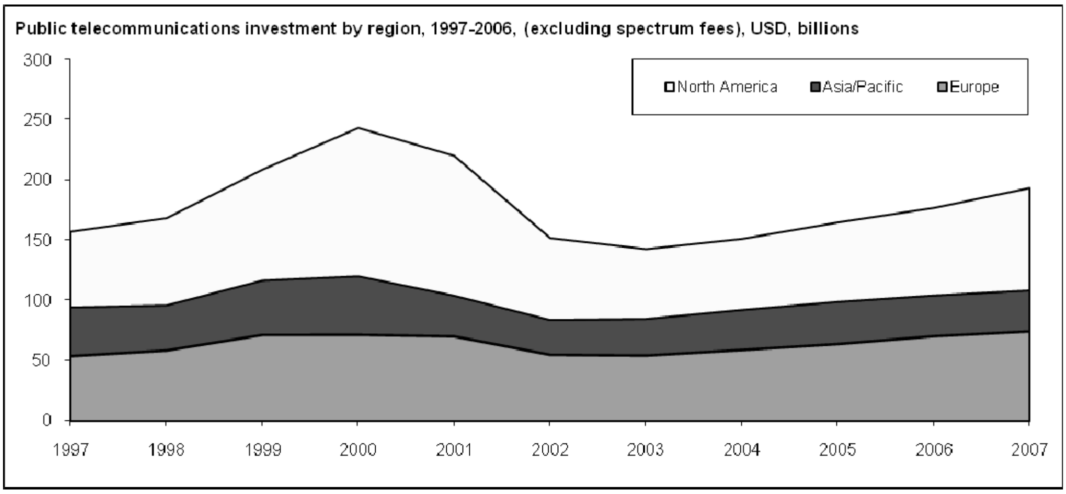
4 Telefonica Annual Report 2008 (20-F) at: info.telefonica.es/accionistaseinversores/ing/pdf/090430_form20-f_2008.pdf.

5 BT Annual Report 2008 at: www.btplc.com/Report/Report08/pdf/AnnualReport2008.pdf.

6 Deutsche Telekom Annual Report 2008 (20-F) at: www.download-telekom.de/dt/StaticPage/63/03/46/Form-20-F_2008.pdf_630346.pdf.

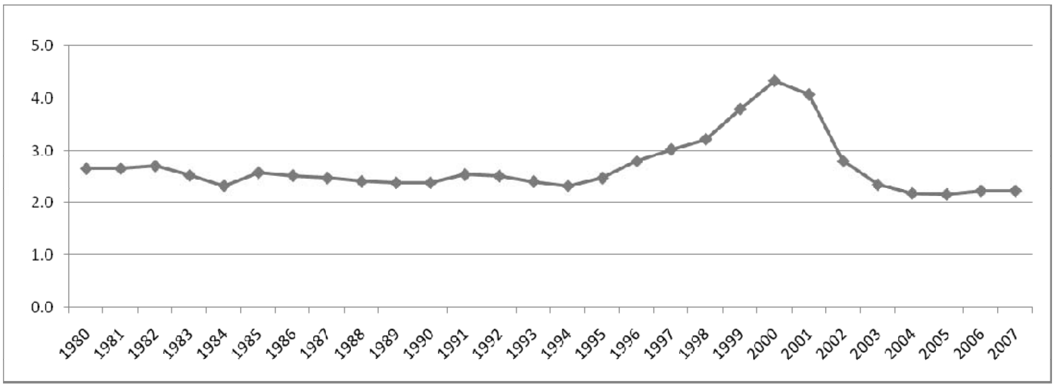
4.5% in 1993. Figures 2 and 3 provide an historical perspective on telecommunication investment by region and as a percentage of gross fixed capital formation.

Figure 2. Trend in telecommunication investment (current USD billions)



Note: Czech Republic, Poland and Slovak Republic are not included.

Figure 3. Ratio of telecommunication investment to Gross Fixed Capital Formation (percentage)



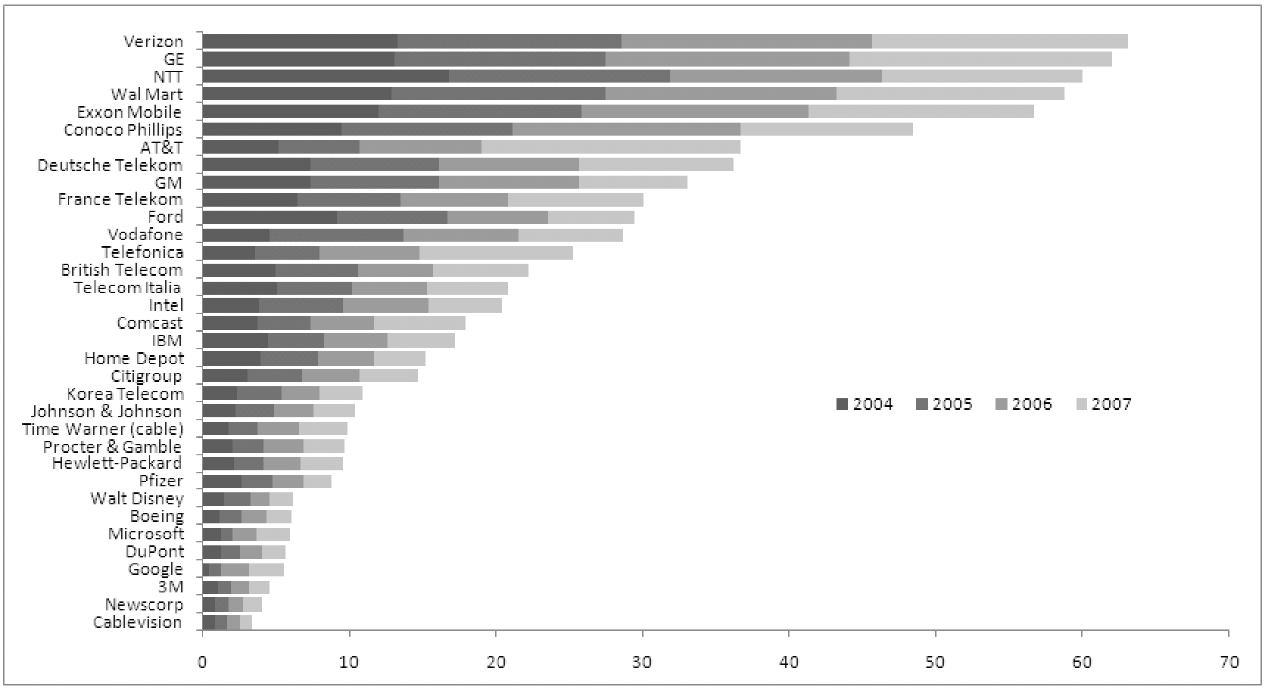
Note: Czech Republic, Poland and Slovak Republic are not included.

Many of the telecommunication investments during the Internet bubble were in fibre backhaul networks and a significant number of operators struggled, unable to recover their initial investments. The silver lining is that now these fibre lines serve as the foundation of the tremendous broadband growth across the OECD between 2000 and 2007. Without the fibre investments of the late 1990s there would be much less capacity now for business and residential broadband subscribers to share, and potentially less innovation in high-bandwidth applications.

The sensitivity of network investment to economic downturns also means these networks are potentially important targets of public investment during downturns as a way to increase demand and employment. Even more importantly, telecommunication investment is one of the largest areas of capital expenditure in OECD countries as highlighted by the number of telecommunication operators in the OECD which had very high levels of investment in relation to other large firms in the economy (see Figure 4).

Figure 4. Capital expenditure by OECD telecommunication operators compared with large US-based companies

Capital expenditure, 2004-2007



Source: Verizon based on data from Yahoo Finance.

Figure 4 shows capital investment between 2004 and 2007 for large telecommunication operators in the OECD compared to other large firms in the United States. Telecommunication investment by some firms was larger than the capital investment of Wal-Mart (the world's largest retailer), leading energy companies such as Exxon Mobile or Conoco Phillips, large automobile manufacturers such as GM and Ford and consumer product companies such as Johnson and Johnson.

The firms with the largest capital expenditure over the previous four years (in Figure 6) were NTT and Verizon, each of which is in the process of deploying fibre-to-the-home connections. AT&T and Deutsche Telekom were also large investors, installing fibre connections into neighbourhoods and then installing VDSL equipment to connect homes over the last hundred metres. Both types of investments are heavily capital intensive and are aimed at providing a foundation for future high-speed services. As a result, a reduction in telecommunication investment will have a significant impact on gross fixed capital formation in the entire economy. This also highlights the potential for targeted government investment to take advantage of the slack in investment to keep people working while building a foundation for competitive high-speed connectivity for the future.

ROADMAP FOR EFFICIENT PUBLIC TELECOMMUNICATION INVESTMENT

Selecting projects

If policy makers decide to use infrastructure investment as part of an economic stimulus then they will face the challenge of selecting which projects should be supported and ranking them in terms of preference. This is difficult for all government spending but the economic crisis means there is a greater imperative for expeditious evaluation. The decisions have to be made quickly but the ramifications of the choices will have an impact over decades because of the nature of infrastructure investment.

While there is pressure to address the crisis issues rapidly, policy makers already have experience in promoting broadband development and there is a substantial amount of research on encouraging investment and fostering competition in communications markets. For example, the *Recommendation of the OECD Council on Broadband Development* identifies key principles and goals for governments which are still applicable in the current setting (OECD, 2004a). The review of the Recommendation and a survey of national broadband plans in 2007 determined that governments have implemented many of the suggested policies but highlighted areas which may need more policy attention (OECD, 2008b). These issues will be important in any discussion of public broadband investment. There are several key considerations to take into account when public funding is used for infrastructure to ensure the projects have the best, long-term prospects for economic and social benefit.

Cost/benefit analysis

Policy makers must evaluate the costs and benefits of any government investment in communication infrastructure. As mentioned earlier, investment in further developing networks is an important element of stimulus packages because it can deliver strong *indirect effects (supply)* in addition to strong *direct effects (demand)* by putting people to work rolling out the networks. Governments are already moving forward with plans focusing on the interaction of demand and supply-side effects. For example, the European Union's recovery plan focuses on what they call "smart investment" – a short-term stimulus focused on long-term goals.[7]

The direct benefits are extremely time sensitive and will not have their desired impact if the projects take too long to come online. As a result, policy makers may decide to assign higher priorities to projects which can be rolled out quickly – even if the secondary benefits of other projects may be higher.

Direct effects

The two most important factors for policy makers looking for aggregate-demand stimulus are:

i. The speed at which investment can come online (*e.g.* are they shovel- or spade-ready)

ii. The composition of spending within the project (probability of money circulating, employment, local equipment, etc).

7 "The Commission proposes € 5 billion new investment in energy and Internet broadband infrastructure in 2009-2010, in support of the EU recovery plan", European Commission Press Release, 28 January 2009, at: europa.eu/rapid/pressReleasesAction.do?reference=IP/09/142.

These two elements will largely determine the primary impact of the demand-side stimulus on the economy. The sooner a project comes online, the faster it could have an impact on reversing declines in employment and spending. Second, the composition of the spending of stimulus money received will determine its impact on aggregate demand in the economy via the multiplier effect.

Government spending on telecommunication projects which create local jobs and use local resources will spread through the economy more effectively than projects which allow for "leakages" out of the economy. Telecommunication, transportation and energy network investment are seen as particularly good for this role because they are "local-labour" intensive. Digging up a street to install new telecommunication cables requires hiring local labour which then typically spends the money again locally. The impact can be significant when the public works component of new fibre installation is up to 80% of the total cost. Wireless projects, by contrast, may require much less labour to install than wired networks and the large percentage of the investment in electronic equipment may represent a leakage out of the targeted area.

Another key concern is leakages out of the stimulus through savings. The goal of any stimulus package is to inject money into the economy and benefit from a high multiplier effect. If the funds made available are immediately saved then the impact of the stimulus is negligible. Projects which pay workers who will turn around and spend most (or all) of the money again are best. While it is difficult to target workers with higher propensities to consume, some projects could be targeted at areas which have been the most severely impacted by the economic contraction as a way to increase aggregate demand in these areas.

Indirect effects

The indirect, aggregate supply-side effects of telecommunication investment will have the longest lasting impact on the economy and will lay the foundations for future growth but may take years to fully develop. Any government spending on telecommunication networks should carefully consider the long-term implications of the investments and look for projects which have the longest lifespan, highest efficiencies and strongest social benefits.

This highlights one of the most important responsibilities of policy makers in charge of allocating and administering funds – setting social and economic objectives for the projects. For example, policy makers must decide whether they are more concerned with objectives for social equity (*e.g.* universal service) or efficiency of the investment (*e.g.* highest return for each unit invested) or consumer surplus. The government's ultimate objectives will influence the ranking of projects.

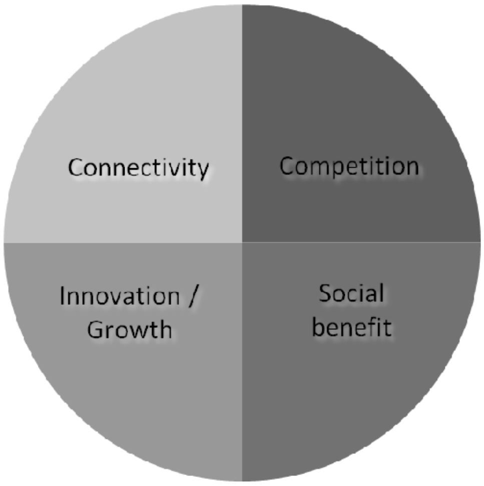
Goals of projects: Connection, competition, innovation/growth and social benefits

Government policy makers should consider four key goals when considering investment in the telecommunication sector*: improving connectivity, increasing competition, stimulating innovation/growth* and *increasing social benefit* (see Figure 4). All four elements are highlighted in the *Recommendation of the OECD Council on Broadband Development.*[8] Successful government investment needs to address and strike a balance of all four elements. Focusing investment on just one element could actually leave telecommunication markets worse off than before the investment. For example, money invested which creates or strengthens a monopoly provider may expand connectivity but will likely stifle competition, innovation and possibly social welfare. On the other hand, simply focusing on projects which ensure economic growth may leave un-served/underserved areas without sufficient connectivity and lead to social

8 *Recommendation of the OECD Council on Broadband Development*, adopted 12 February 2004, at: www.oecd.org/document/36/0,3343,en_2649_34223_34238436_1_1_1_1,00.html.

inequality. Successful public investing needs to consider and address all elements. The next sections will examine each of the four elements in more detail.

Figure 5. Successful government investment: balancing connectivity, competition, innovation/growth and social benefit



Connectivity

In the *Seoul Declaration on the Future of the Internet Economy* Ministers expressed their intention to facilitate the convergence of digital networks, devices, applications and services, through policies that stimulate investment and competition in the development of high capacity information and communication infrastructures. [9] They also committed to ensuring that broadband networks and services are developed to attain the greatest practical national coverage and use. Investments which improve connectivity are a key cornerstone of this vision.

Public telecommunication investments generally fall in two broad categories: *backhaul* and *last-kilometre connectivity*. Investments in these broad categories will target two types of connectivity improvements: *extending* connections to un-served/underserved areas and *upgrading* existing connections with higher capacity (see Table 1).

Table 1. Telecommunication investment matrix

	Last-kilometre	Backhaul networks
Extending networks	Investments in new last-kilometre access for areas which lack wired connectivity. Also investments in wireless technologies to reach users in areas without any connectivity.	Investments which roll out high-speed backbone capacity to areas without existing broadband capacity or high-speed network infrastructure.
Upgrading networks	Investments in next-generation access networks as replacements for wireless or copper-based networks.	Investments in higher-speed network infrastructure than presently available in an area. This may involve installing fibre to replace wireless backhaul to support high-speed consumer or business access. It could also involve upgrading electronics on an existing fibre line.

9 OECD, *The Seoul Declaration for the Future of the Internet Economy*, 2008 www.oecd.org/dataoecd/49/28/40839436.pdf.

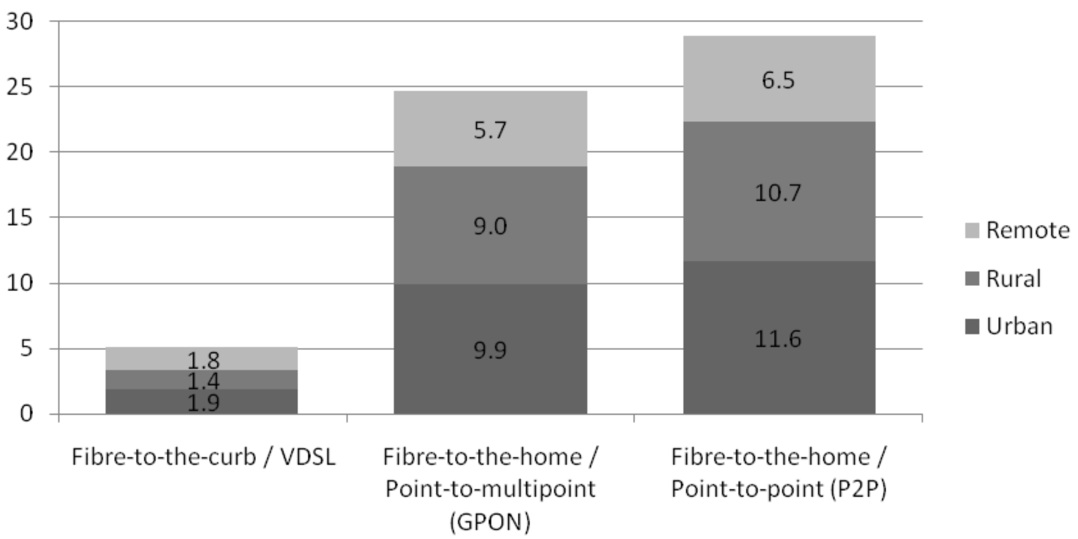
The majority of households and businesses in the OECD already have access to broadband services from at least one provider. In countries such as Belgium, the Netherlands, the United States, Canada and Korea there are two lines reaching most households – telephone and cable. Wireless broadband connections, which are not usually considered as completely substitutable with fixed line connections, are also available in many major markets adding a third potential access path. Investment in areas with existing basic broadband connectivity will likely involve upgrading the last-kilometre connections to support much higher bandwidth and improving competition.

In other countries and regions there are still a significant number of people who cannot subscribe to broadband. Investments targeting these areas will likely focus on extending backhaul connections closer to users and installing new last-kilometre networks. Last-kilometre upgrades in rural and remote areas are typically more expensive than similar upgrades in urban areas. As an example, a Broadband Stakeholder Group report looking at costs of rolling out next-generation network infrastructure in the United Kingdom estimates that the cost of extending VDSL to the 16% of the population in remote areas is roughly the same as connecting the 58% of the population who live in urban areas (see Figure 6).

Figure 6. United Kingdom: urban, rural and remote broadband installation costs

Breakdown of population for FTTC: Remote 16%, Rural 26%, Urban 58%

Breakdown of population for FTTH: Remote 7%, Rural 25%, Urban 68%



Source: Analysys Mason for BSG.

Recent private investment from telecommunication and cable firms has been mainly directed at upgrading existing connections to offer higher speeds and provide new services rather than building out to areas without broadband services. This next-generation telecommunication network investment has been a key investment driver not just in the telecommunication sector but throughout the economy. As mentioned earlier, the firms with the largest investment in the telecommunication sector have been among the largest *total* investors in their respective economies over the previous four years.

Investments in rural and remote areas are highly capital intensive but may be viewed as having a lower return on investment to telecommunication firms given the high costs of reaching a limited number of potential subscribers. Government investment in broadband networks will likely include a mixture of extending access to un-served/underserved areas and upgrading infrastructure in areas which already have connectivity. There are a number of technological choices which each have benefits and drawbacks for government investment.

Policy makers may want to consider investing in partnership with private companies. These public-private sector partnerships have been successful in a number of cases and allow government investment to be coupled with technological and market experience. Often these investments in new networks are based on a division between wholesale and retail service provision.

When policy makers focus on connectivity they will need to consider the number of impacted users, the marginal improvements users will receive, the capacity of the network, topology, longevity and upgradability of the projects under consideration:

i. **Affected users:** Different network investments will affect different numbers of end users. Governments should consider the number of users who will benefit from any network investment in order to perform a valid cost/benefit analysis. The cost of delivering new or improved connectivity to each user needs to be established and considered. It is also important to consider potential demand for services in targeted areas and to couple training or demand-awareness programmes with the investments in order to obtain the largest impact and benefit.

ii. **Marginal improvements**: It is not simply the number of users added to the network but the marginal improvement in connectivity they receive for the investment. Delivering low-speed broadband to an area previously without connectivity will likely have a different impact than upgrading network capacity for existing users at 10 Mbit/s to 100 Mbit/s.

iii. **Capacity:** Certain network technologies offer much more bandwidth than others and should be strongly considered for any government investment looking to maximise demand and supply-side effects. Networks with the most capacity will likely have the strongest indirect effects on the economy in the longer term. Currently, advertised broadband connections for residences in the OECD range from 256 kbit/s to 1 000 Mbit/s. The 1 000 Mbit/s connection has 4 000 times the potential capacity of a 256 kbit/s connection at the bottom of the scale. Policy makers may want to consider very high-speed connections, increasingly available in the 100 Mbit/s range, differently than standard broadband connection speeds, particularly when planning for the future.

iv. **Topology:** The physical topology of a network rollout will affect the characteristics of the lines to end users. Some topologies offer dedicated bandwidth to users while others share the capacity of one line between 32, 64 or even hundreds of users. Policy makers may want to assign a preference to network topologies which offer dedicated bandwidth to end users and those which promote the strongest levels of competition when government funding is involved.

v. **Longevity:** The impacts of network investment on productivity in the economy will be tied to the practical lifespan of the constructed networks. Investments in networks with long predicted life spans will produce higher aggregate impacts on GDP and growth than investment in networks which may need to be upgraded or rebuilt after only a few years.

vi. **Upgradability**: At some point all networks need to be upgraded to allow for higher capacity transmissions. One key question for policy makers is how easily certain networks can be upgraded to accommodate much higher bandwidth and new services. Some physical networks offer a nearly limitless upgrade path while others may not be able to accommodate higher speeds without new, significant investment in the network infrastructure itself. Policy makers may choose to favour networks which offer the lowest-cost upgrades in the future as a way to maximise the impact of the investment in the economy.

The next sections look at technological choices in more detail.

Fibre

Fibre optic networks offer the highest capacity of any current telecommunication network infrastructure. DSL, cable and mobile networks all use fibre optic lines for backhaul within the network because of its high capacity. Fibre is typically used to bring broadband connectivity close to households and businesses where it is then distributed over a range of other technologies (fibre, DSL, cable, wireless, etc).

Fibre has been the backbone of high-capacity networks for over 25 years but current investment has focused on installing fibre deeper into neighbourhoods (and often directly to homes) as a way to offer much higher speeds to end users. Bottlenecks in the last kilometre can limit the speeds and services available on networks even if the backhaul capacity is sufficient.

Operators have responded by installing fibre deeper into neighbourhoods leaving shorter connections over other technologies between the fibre and end users, thus allowing for higher bandwidth. Fibre connections directly into homes and businesses can provide nearly limitless bandwidth. Researchers have been able to transfer 2.5 terabytes a second over a single fibre strand - enough bandwidth capacity to have every person in the world speaking to someone else in a voice call at the same time.

Fibre connections are commonly cited as the most future-proof technology given the ease with which capacity is added to the line by simply adding another wavelength of light. This is a key factor for policy makers to consider. There is a risk that any technology investment could become outdated but fibre offers a much more robust upgrade path than any other known infrastructures. Point-to-point fibre, in particular, offers the most flexible upgrades.

Investing in fibre networks also has drawbacks. Fibre-to-the-home is expensive to install because it requires the installation of a totally new local loop to replace the copper twisted pair and coax lines of operators. Installing fibre often requires digging up roads or installing new aerial lines on poles which is highly labour intensive. This can be a positive aspect in terms of stimulus spending because it does require a large labour component for any installation. Upgrading existing broadband networks to VDSL or higher-speed cable technologies may be less expensive in the short-run given they can make use of existing copper local loop connections going into homes.

The sentiment among most technologists is that all homes will eventually have direct fibre connections but the optimal timing of the upgrade all the way to homes is what remains in question. Some argue that the sooner countries move to invest in fibre-to-the-home the better because future upgrades of a fibre local loop will only involve swapping equipment at either end of the connection. Others believe that the cost of installing fibre will continue falling, so adopting a shorter-term strategy of bringing fibre to a neighbourhood and using existing copper last-metre connections may be more cost-effective given current services available in the market and typical usage patterns.

In either approach fibre investment will be a key part of the strategy because of its role in transporting data and very high capacity deep in the network as well as closer to homes. The question remaining for policy makers is how far out to homes and businesses that fibre will go.

Another key element with fibre investment is that it needs to be done in a balanced way considering the relationship between the backhaul and the last kilometre portions of the network. Many telecommunication exchanges are served by very-high capacity fibre but the bottleneck is in the distribution channel between the exchange and the end users. The copper or wireless connections serving end users cannot support speeds fast enough to take advantage of the fibre's capacity into the exchange. There are, however, other scenarios where very fast connections are advertised to users but the backhaul networks servicing these areas cannot support the combined capacity of all the users in an area. Here investments focusing on upgrading the last kilometre would not improve connectivity because the traffic would still encounter the same bottlenecks on the backhaul portion of the network.

Policy makers considering broadband investments need to balance any investment in last-kilometre networks with similar investment in fibre backhaul networks servicing these areas. Fibre backhaul networks could be considered in any broadband stimulus because they provide the needed capacity for all other types of broadband networks (DSL, cable, mobile, and even satellite).

Wireless

Wireless investment will likely be another key area of focus for government policy makers looking to expand connectivity because wireless networks are often the most cost-effective way of expanding basic Internet connectivity to rural and remote areas. Most cellular wireless networks have close to 100% population coverage though areas with low population densities may have sparse coverage. Wireless networks are often less expensive to install than wire-based networks and now offer speeds comparable to early wired-broadband connections. Wireless broadband will likely be the network of choice in some rural and most remote areas where installing wired infrastructure is too difficult or too expensive. Wireless networks may allow for faster installation than wired infrastructure, assuming the rights for existing towers have been negotiated or new towers has been constructed and spectrum is available.

Wireless connections may be attractive to end-users as well because the connections offer mobility which is not possible with a fixed broadband connection. However, wireless connections are often more expensive and may be subject to download constraints that are much lower than fixed networks. Mobile broadband services are growing quickly in countries such as Australia and Ireland as they can be used with a laptop anywhere within the coverage area.

Satellite connections will continue to play a key role in providing broadband to remote areas out of economic reach of traditional wired networks. Satellite also is among the most efficient methods for delivering high-definition linear television signals. Long-range terrestrial wireless connections will also continue to be an important backhaul technology for certain rural and remote areas. With this in mind, policy makers should examine spectrum allocations to see if there are ways to open up certain frequency bands which have efficient signal propagation characteristics for broadband use. For example, previous OECD research (OECD, 2006) highlights the potential gains from recovered spectrum in the conversion from analogue television to digital.

The key drawback with wireless investment is the limited capacity of wireless technologies. The speed of any wireless network technology is a function of the amount of spectrum available, the number of users sharing the bandwidth and other physical characteristics such as interference. Current and emerging wireless technologies will not be able to provide similar speeds to those on advanced wired networks.

There will be incremental advancements in the amount of data which can be transmitted over a finite amount of spectrum but new high-speed networks will need large amounts of spectrum in which to operate. Wireless connections are also by their nature a shared technology. The capacity in a cell is shared among all users in a given area so the capacity of all users decreases when another user connects to the network in the same area.

This drawback actually is less of an issue in rural and remote areas for two reasons. First, there are relatively few users sharing the capacity of a wireless connection in a rural or remote area so speeds to individual users could be higher than in larger cities. Second, remote areas often have more spectrum available for use than busier metropolitan areas. Broadband investment in wireless networks will also need to be paired with an appropriate spectrum policy. There may be additional challenges with interference because of local geographic conditions which may hinder wireless access.

In many remote areas, wireless technologies are likely to have a lower cost per installed user, making them a key element in extending initial broadband connectivity in un-served areas. Nevertheless, they may not provide equivalent capacity or similar quality to fixed networks. Wireless connections will still need good backhaul connections in order to offer high broadband speeds to users. Public investment in backhaul networks reaching out into rural areas can provide the needed capacity to support new wireless broadband access networks.

Policy makers will still need to consider the state of wired infrastructure when considering wireless proposals. Wireless networks rely on high-speed fixed infrastructure to provide high-speed connectivity to the radio towers.

It is important to note that there is extensive debate in the sector about whether wireless connections should be considered substitutes for wired broadband in the longer term. Clearly, wireless connections can provide basic broadband connectivity capable of supporting most of the current applications available over wired connections. The debate becomes more contentious in any discussion of future high-bandwidth technologies such as the delivery of high-definition television. Current and evolving wireless technologies would not be able to distribute streaming high-definition television to a considerable number of users efficiently. Wireless technologies are much better for broadcast video than video-on-demand. There is also substantial debate as to whether wireless investments provide a robust future upgrade path.

xDSL, Cable

xDSL and cable networks are dominant network infrastructures for delivering broadband services within the OECD area. Both networks have evolved from offering basic broadband services at 256 kbit/s to much higher speeds by making use of fibre connections much closer to homes. Currently VDSL operators in Korea and Japan offer 100 Mbit/s connections while cable network operators in Japan advertise connections up to 160 Mbit/s.

VDSL and cable networks offer very high speeds, primarily because the networks are supported by fibre reaching to the neighbourhoods. Operators achieve these high speeds by installing fibre connections deeper into neighbourhoods and decreasing the distance between the end user and the fibre node which is connected by coax (cable) or twisted pair (telephone) lines. In some ways, VDSL and high-speed cable networks are simply fibre backbone networks with the last portion of the connection delivered over copper.

There are several benefits to investing in cable and DSL networks. VDSL and cable topologies still make use of some portions of the copper network, limiting the cost of new investment. For example, it is less expensive to install fibre optic cables to one central location in a neighbourhood than to each home. This is particularly important because the last hundred metres reaching a household historically have been the most expensive to install for any network technology. The incremental cost difference between rolling out fibre to a neighbourhood and fibre-to-the-home can be significant, particularly in areas with lower population densities. In other circumstances, the cost differential may be insignificant, given a number of cable companies are considering extending fibre connectivity all the way to the end-user's premises.[10]

There are also a number of drawbacks to consider for governments considering investments in VDSL or cable technologies. First, investing in these existing networks often involves strengthening dominant players in a market. DSL operators in most OECD countries are required to unbundle the local loop but cable operators have largely been excluded from any unbundling requirements because of technical difficulties in providing competitive access. When cable unbundling requirements have been put in place they have been largely unsuccessful.

Second, VDSL is commonly viewed as a temporary technology and not a long-term investment path despite the shorter time frame which may be required to perform the upgrade. In other words, investment in VDSL may not be an interim step to putting fibre in the local loop, but would be considered a sunk cost when a decision is made to invest in a fibre local loop. The largest VDSL providers in the world (KT and NTT) are quickly moving away from the technology and replacing the remaining copper in their networks with fibre-to-the-home because of its much higher capacity. The fastest fibre offer available in the OECD in October 2008 was nearly ten times faster than the fastest VDSL or cable offers using the latest technologies. VDSL and DOCSIS 3.0 both require fibre connections near to users anyway for backhaul. The potential lifespan of VDSL and DOCSIS 3.0 should be a key consideration of policy makers who may be supporting these technologies with government funds.

Finally, public investments in VDSL networks may harm competitors by stranding the competitor's existing investments at the telecommunication exchange, particularly if incumbents plan on shutting down and selling the exchanges once the neighbourhood equipment is installed. The new fibre investments into neighbourhoods will be difficult for competitive operators to efficiently replicate. Even if the copper portion of the VDSL network is open for unbundling there will be few, if any, providers who could make an economic case for unbundling at the street cabinet. It is therefore likely that any competitive access made available on VDSL or over cable networks would be via access to wholesale bandwidth over a managed IP connection.

While governments may not choose to invest in cable and VDSL technologies directly, stimulus packages which offer tax incentives to existing firms will likely see significant investments in existing DSL and cable networks rather than new fibre development. In terms of stimulating aggregate demand, these upgrades may be less labour intensive than a fibre-to-the-home rollout.

Competition

The OECD *Policy Guidance on Convergence and Next-Generation Networks* states that, "Policy makers should consider difficulties that may arise in replicating next generation access networks which could lead to the creation of new bottlenecks for competition." In addition, in the Seoul Declaration OECD Ministers agreed that one of their key challenges was promoting Internet-based innovation, competition and consumer choice. They then pledged to work to establish a regulatory environment that assures a level-playing field for competition.

It is vital that policy makers keep these goals in mind when considering investing public funds in the telecommunication sector. Previous OECD work on the regulatory implications of next-generation networks provides significant detail on these issues (OECD, 2008a).

10 "Cable Industry Starts Paving Way for All-Fiber Networks", *Communications Daily*, 4 March 2009.

Government investment in telecommunication networks must be used to foster competition and not to entrench existing operators at the expense of potential new entrants. One risk of governments investing in telecommunications is that they tend to have to choose winners in the market. Once one network is built or strengthened there is a relatively low chance of another infrastructure-based provider entering the market given the financial advantage already awarded to the incumbent via government funding. Governments need to carefully consider their decisions to ensure competition in the market which lowers prices, boosts speeds and encourages innovation.

Government investment in telecommunications has the possibility of hindering or helping competition depending on the way it is distributed and rules attached to the funding. The projects chosen for funding should be examined based on how they will affect competition in the market. Policy makers should also consider attaching elements supporting competition as stipulations to receiving any government funding. Governments could consider open access rules, topology requirements, investment in passive infrastructure and a division between wholesale and retail provision of services for any new publicly-funded networks as ways to ensure competition in markets benefitting from public investment.

Open access

It would not be desirable for public funding to strengthen monopoly or duopoly service providers at the expense of new entrants. All investment should help promote competition for broadband access from the start. When governments do decide to intervene in markets by subsidising communication networks they should consider requiring the resulting network be available via "open access" rules. The term "open access" refers to an arrangement where network providers offer capacity or access to all market participants under the same terms and conditions. Operators of open access networks must allow competitive access to the network on non-discriminatory terms. Open access networks play an important role promoting competition and can help offset market imbalances when certain firms receive government funds but competitors or later entrants may not.

There are six key open-access models used for next-generation networks in the OECD.

i. **Dark fibre provision:** In this model one company provides dark (unlit) fibre connections to homes and businesses and rents the lines at non-discriminatory prices to all operators. The dark fibre provider does not provide any Internet service connectivity, just the raw cables leading to homes. The structure is separated between the company providing the lines and the Internet service provider lighting the fibre and supplying the services.[11] The key benefit of this model is that it promotes competition among providers and new entrants. Governments install the cables but otherwise do not enter the telecommunication business which minimises market distortions. It also saves on total investment since all operators have access to the same cable, rather than building out parallel infrastructures. Finally, operators can manage their own networks since they supply the equipment which lights the fibre. These networks are often built and maintained by municipalities. Perhaps the biggest drawback to this approach is aligning the investment and maintenance objectives of the dark fibre company with those of the Internet Service Providers (ISP). ISPs may need network upgrades in the future to support their services and there needs to

11 The earliest pioneer in this model of open access networks was STOKAB in Sweden. The municipal government in Stockholm helped fund dark fibre throughout the city and surrounding areas without being an ISP itself. STOKAB simply maintains the dark fibre and leases it out to anyone for a set price. The municipal government was already in the infrastructure business maintaining roads so it had the expertise necessary to install and maintain fibre as well. Operators rent a line from STOKAB, attach their own electronics on either end and provide their own services. CityNet in Amsterdam uses this same approach of building a point-to-point fibre network back to a large exchange and renting the dark fibre to ISPs.

be a mechanism in place to prompt for new investment or maintenance. Other drawbacks are that it requires large aggregation points which may be expensive to build and difficult to make space for. It also is not applicable for wireless networks.

ii. **Traditional network unbundling (at the exchange)**: Another approach to providing open access is essentially extending unbundling requirements imposed on incumbents on the PSTN to new next-generation networks. Operators who own the network also provide services over the lines. Regulation requires them to also make these lines available to competitive operators for a set price. Japan has the largest fibre-to-the-home rollout in the OECD and NTT is required to unbundle fibre access. The benefit of this approach is regulators already have a long history with unbundling of copper telephone networks. Experience in unbundling cable networks is limited and the unbundling was not successful. The difficulty of implementing this approach is the topology of next-generation networks will determine what types of unbundling are actually possible. Unbundling a point-to-point fibre network at a large aggregation point is similar to unbundling DSL. However, physically unbundling VDSL at street corners or cable networks at head ends poses significant competitive and economic challenges. Competitive operators are constrained by the topology and the upgrade path of the incumbent operator's physical network if they lack their own last-kilometre infrastructure.

iii. **Unbundling the last 100 metres:** One method for offering competitors access to customers is by mutualising the last several hundred metres of residential connections into one small aggregation point close to residences. In countries such as France, Spain and Korea, the goal of this approach is to allow all operators access to the same internal wiring in apartment buildings. This type of topology requires that operators have networks passing in front of each building and space in the basement to locate their patching equipment. Regulators in countries with VDSL networks have looked at similar approaches which focus on unbundling at the subloop. The benefit of unbundling the last 100 metres is that it requires less space than a larger exchange terminating a large number of connections. Subloops may serve 100 to 200 customers and lines could be unbundled one at a time. The key drawback is that all operators must then build out fibre networks deep into all neighbourhoods in the country in order to connect to the last 100 metres of the connections. There will be relatively few operators which are large enough in scale to compete with the incumbent. Even if they were large enough there would likely be resistance in neighbourhoods against the installation of multiple large street cabinets to house all the competitors' equipment. Again, there are also questions regarding the maintenance and upgrades of the last 100 metres which would need to be addressed.

iv. **Wavelength access:** There are technologies which allow multiple networks to operate on the same fibre using multiple optical carrier signals. The physical characteristics of fibre networks allow different service providers to each operate their own networks over the same physical fibre by using different wavelengths (colours) of lasers. Wavelength division multiplexing technologies code and decode the different wavelengths at each end of the fibre connection. The benefit of this approach is that each competitive operator can manage its own network over its own wavelength on the same physical fibre connection. Adding a second wavelength essentially doubles the capacity on the line. The drawbacks to this approach are the high cost of the electronic equipment which must be installed at each end of the physical fibre and the logistics of supplying service to only certain households connected to a passive optical network with 32 or 64 end users. The wavelength unbundling model may also limit the ability of a single provider to rapidly expand services over multiple wavelengths using multiple lasers if the installed equipment cannot support it. Wavelength unbundling is commonly used to increase capacity on point-to-multipoint topologies but can also be used on point-to-point connections.

v. **Active line access model (Ethernet bitstream):** In the active line access or Ethernet bitstream access model the network provider manages the physical infrastructure and the active electronics of the data link layer for all operators supplying network services over the same infrastructure. As an example, the network owner would supply Ethernet bitstream connectivity to competitive operators who would then operate their own IP networks over the Ethernet-based network. This approach offers more flexibility to competitive operators than a managed IP product and competitors can then manage their own IP networks as they see fit. One key drawback of the approach is that it still relies on the incumbent to upgrade the electronics in order for competitors to make certain speed and service improvements. All operators would be constrained by the electronics attached at the end of the line by the incumbent. Active line access is discussed as an option in areas where physical unbundling may not be viable.

vi. **Managed IP networks:** In this model, the entity building the network moves a step higher in the distribution chain by actually lighting the fibre and running a basic IP-based network. The entity then sells dedicated wholesale capacity directly to Internet service providers who then provide services. The benefit of this type of network is that subscribers can pick and choose services from a large number of different providers. For example, an end-user could subscribe to phone service from one company, television from another and basic data connectivity from a third provider. On some of these networks in Denmark and Sweden consumers can choose between 30 ISPs for data access alone. One important benefit of this structure is providers offering services over the network need not be based near the end users. They can simply supply services over the network to all subscribers from a central location. The drawback of this approach is all the service providers are locked into basic connectivity streams that the network provider offers. ISPs could not install their own equipment and jump from 10 to 1 000 Mbit/s if they wanted to. If the network operator does not upgrade to faster speeds then the service providers are limited as well. Just as in dark-fibre provision, there are concerns about upgrade and maintenance incentives.

Recently, there has been some discussion that open access requirements could potentially keep firms from accepting government funding if they were required to provide competitive access to the network. This assumption has not played out in real-world examples of open-access requirements in the past. Incumbent telecommunication operators have not been unduly harmed under open access/unbundling regulations over the previous five years. The monthly payments for line rentals that competitors have sold are an important source of revenue for many telecommunication firms. While the discussion of open-access requirements in this paper deals specifically with networks built with government funding, regulators in some OECD countries have also suggested that policy makers could consider the possibility of applying the same regulations to firms deemed to have significant market power.

Topologies

The level of competition possible on a network is closely tied to its topology. Any government investment in telecommunication networks must take the implications of different topologies into consideration when evaluating projects.

Table 2. Benefits and drawbacks of various topologies

Topology	Capacity	Cost	Ease of competitive access	Technology flexibility
Point-to-point (large aggregation point)	High	Medium/High	High	High
Point-to-multipoint (aggregated splices)	Medium/High	Medium	Low/Medium	Medium
Point-to-multipoint (no aggregation)	Medium	Low/Medium	Low	Very low
Point-to-multipoint wireless	Low	Low	Very low	Very low

There are benefits and drawbacks to each of these topologies. In general, topologies offering more competition are relatively more expensive to install but will usually have more longer-term economic benefits:

- **Point-to-point (large aggregation point):** The most flexible topology is a point-to-point infrastructure with sufficiently large aggregation points and room for competitive collocation. In a point-to-point architecture there is a dedicated line from each home back to a patch panel in a large exchange. Competitive providers can install their own equipment in the exchange and then use their own choice of technology for sending data down the line to the end user. For example, a point-to-point topology supports both point-to-point and point-to-multipoint transmission standards. This point-to-point architecture is the basis of the PSTN and of many open-access fibre networks. The benefits of this topology are that it helps promote competitive access, offers the highest capacity via a dedicated line to each user and allows operators to choose their own technologies when renting the line. The drawbacks of the topology are it is more expensive to rollout than topologies which split connections closer to users. It also requires more duct space in the ground and requires larger equipment back at the exchange (and thus a larger exchange) than point-to-multipoint technologies.

- **Point-to-multipoint (aggregated splices):** VDSL, cable and some fibre operators use a topology which extends a backhaul connection to a central aggregation point in a neighbourhood and then distributes connectivity from there over dedicated lines to individual users. The aggregation points may be above-ground structures (in the case of VDSL) or in a buried splice box for fibre connections. The key benefits of the topology are in terms of costs. Limiting the length of the individual lines to users allows operators to re-use existing infrastructure for the last several hundred metres or limit the amount of fibre they install leading from the network node to the neighbourhood aggregation point. A point-to-point network requires dedicated lines for each end-user which occupies more conduit space. Point-to-multipoint topologies can run one fibre pair to the neighbourhood aggregation point and break out the connections from there. The topology avoids building one large exchange in exchange for a number of smaller localised exchanges. The key difference between this topology and point-to-point is the location and size of the aggregation point. The drawbacks of this topology are tied to competitive access and capacity. It is difficult to provide competitive access to point-to-multipoint topologies because the aggregation points are often too small and too dispersed. For example, regulators in countries with VDSL rollouts typically require subloop unbundling (at the neighbourhood aggregation point). If competitors want to unbundle they must erect their own cabinets on the street in order to interconnect. They must also have existing fibre reaching into the neighbourhood to supply the neighbourhood boxes. As a result, there have been very few operators able to unbundle at the subloop level. Without subloop unbundling, the remaining two entry points for competitive providers are bitstream access or via an additional light frequency on fibre. In addition, the speed of VDSL services declines rapidly as the distance from the neighbourhood aggregation point increases.

- **Point-to-multipoint (no aggregation):** This topology is similar to the point-to-multipoint topology (with aggregated splices) except there is no centralised point for unbundling individual lines to consumers. This topology is used in many fibre-to-the-home rollouts because of its relatively lower cost. Providers do not need to erect a cabinet for the fibre and typically use small splice boxes buried in the ground in front of a home or on a pole. Unbundling at these splices could still be possible but is typically uneconomical. The capacity of this topology is lower because users spliced from the same feeder fibre will share the capacity of the line. One fibre line typically serves 32 or 64 subscribers. This network topology is among the most difficult for competitive access. Alternative operators could typically offer services only through bitstream access or by paying to run a second laser over the entire branch of network. This has posed problems in countries such as Japan because the operators often have to rent the lines for not the actual number of subscribers but the total number of lines splitting off from an individual fibre.

- **Point-to-multipoint (wireless):** Wireless technologies are the least expensive to install and can service a large area quickly with minimal infrastructure investment. The topology is commonly used for broadband in rural and remote areas with little fixed-line infrastructure and is ideal for reaching areas which may not currently justify the economic rollout of fixed-line infrastructure. The capacity of these connections, while improving, is still much lower than is available on fixed networks. The limited network capacity which is available is also shared among all users in range of the radio signal. The drawbacks of wireless systems are their limited capacity and restricted access to competition over the lines. Competition on wireless systems is typically limited to bitstream or wholesale access. Even bitstream access poses problems because the wireless operator may have difficulty limiting bandwidth to certain providers.

Government stimulus plans will likely support networks using a variety of different topologies and this will lead to different competitive outcomes. Policy makers should keep the competitive effects of each topology in mind when considering the pros and cons of each proposal.

Passive infrastructure

One key way for governments to promote competitive investment in telecommunication networks is by installing passive infrastructure (poles, conduit, etc.) which can then be used by various operators. Rather than becoming a network owner, government funding could be used by municipalities to install conduit throughout an area capable of sustaining multiple fibres to each home.[12]

The passive infrastructure represents the highest-cost portion of new network investment (often cited as close to 80% of total cost) and this is an area where governments could easily invest and boost competition with minimal market distortion. Maintenance of the conduit or aerial infrastructure could be done by municipalities or written into the contracts of any firms using the passive infrastructure to reach homes. Government investment in passive infrastructure, in both urban and rural areas, could help promote the goal of extensive infrastructure-based competition which has so far eluded policy makers.

Investment in passive infrastructure also could have a large impact on the demand-side of the economy because the installation is highly labour-intensive and crews could start digging quickly. In addition, government investment in passive infrastructure may be more efficient than private sector development because municipal governments have access to all necessary rights-of-way.

The passive infrastructure is not just about conduits or poles. Passive infrastructure also includes the telecommunication exchange which serves as a hub for the exiting conduit. Government funds could be used to build “shelters” where different providers would be allowed to install their own equipment as a base for the fibre they would eventually blow through the empty conduit or install over aerial poles. These structures would need to have easy access to fibre backhaul, preferably via open access networks which could provide connectivity to multiple providers. A large scale government investment in passive infrastructure could be paired with a simultaneous investment in open-access fibre backhaul to all exchanges in a given region.

[12] Conduit should be exclusively for optical fibre because of space considerations. Installing new copper into conduits significantly limits entry by other firms because of its physical mass.

The number of operators who would actually install their own lines is difficult to predict but governments should plan for multiple point-to-point fibres to each home as a precaution. Governments must take steps to ensure there is sufficient space in the conduit for multiple operators. Operators, for example, should not be allowed to install more fibre than necessary simply to fill up the pipe and protect against further entry.

Installing conduit could be considered a first step to a larger broadband rollout plan. If governments did, at a later stage, decide to pay to install the fibre themselves then the conduit would be in place and the fibre could be pulled or blown though rapidly and inexpensively.

Network separation of wholesale and retail functions

Network separation is commonly discussed as a way to ensure competition over network infrastructure. There is relatively little practical experience with structural separation in the telecommunication sector, although the United Kingdom, New Zealand, Italy, Sweden and Poland have either already implemented functional separation or are in early stages of moving forward with it. The issue has been dealt with extensively however in the electricity sector. Newberry (1997) explains that up until the mid 1980s natural monopolies were typically operated as vertically integrated monopolies. The industry then shifted to the separation of electricity transmission from production as a way to spur competition. The capital of the network utility is large and sunk so once it is in place the balance of bargaining power shifts from the investor to the consumer. Newman argues that the tensions between the investor and the consumer can be sidestepped by government ownership of the transmission network.

The build-out of next-generation networks has reignited debates over the benefits and drawbacks of separating the provision of wholesale and retail services in the telecommunication sector as a way to promote competition. Much of the discussion focuses on remedies applied to existing telecommunication incumbents where their physical assets would be separated from the elements of the business which sell services. The idea in terms of competition is to ensure that the management of the physical network treats all ISPs, including the incumbent's, on equal terms.

The debates, particularly in Europe, New Zealand and Australia, have centred on the use of functional separation of existing privatised firms only as a last resort when other means of introducing competition have failed. One of the drawbacks of separation cited in the discussions is the high transaction costs involved in separating a private firm into different functional units or two completely separate firms. OECD research (OECD, 2003a) found these high transaction costs could potentially outweigh the benefit in the PSTN environment. Given the costs associated with fibre local loop networks and difficulties (depending on the technology used) of providing open access to fibre local loops, more recent OECD work determined that the benefits of functional or structural separation could be considerable in an NGN environment (OECD, 2008a).

The historical experience with separation in the telecommunication sector has been tied to existing providers but this section examines only the potential role of network separation for new networks built using government funding. This paper does not seek to enter into the debate surrounding the structural separation of existing providers. What makes government stimulus funding possibly different is that the new networks built with government funds could be designed from the start as with separated wholesale and retail components. This would avoid any costs of disentanglement of a combined firm in the future and provide much more competition with lower transaction costs. For example, a new last-kilometre network in a rural area could be run as a separate entity which would rent lines to any private operators who were present at the aggregation point.

Wholesale network access providers (infrastructure companies) may represent good investment targets for government expenditure because all competitive operators could benefit from the investments in infrastructure.

The long-standing debates over separation highlight concerns regarding the investment incentives of separated entities and these apply to newly formed networks. Service providers need network upgrades to support their new products while network owners need enhanced services to match their own investments in network upgrades. Vertically integrated firms, theoretically, have internal communication channels which can internalise these interdependencies better than separated firms although this is the subject of extensive debate.

Joskow (2005) highlights that new investment in electricity generation of any significant size must be accompanied by expansions of the transmission networks. However, the lumpy characteristics of transmission investment and other factors mean that market mechanisms may lead to inefficient investment decisions. A good deal of the electricity literature evaluates how to create market mechanisms to facilitate this co-ordination. Telecommunication investment is also lumpy and requires some sort of co-ordination between those providing services and those investing in the network transmission capabilities.

Governments may choose to invest in new infrastructure but may want to avoid being telecommunication operators given the stronger innovation incentives which come out of the private sector. One way for this to happen is for governments to pay to install physical infrastructure which is then rented out to any firm willing to supply services on equal terms. In certain cases, management of the physical infrastructure could be contracted to a private company or handled by the municipality using low monthly rental fees for line usage. In other situations, open access requirements may be more effective at promoting competition given a mixture of public and private funding.

There are still significant concerns regarding the practical rollout of new networks that separate the provision of wholesale and retail services within the overall telecommunication market in the economy. This is particularly challenging given existing operators have already begun rolling out next-generation networks in many areas. Much will depend on the competitive landscape, particularly on these new networks, and the rollout plans of existing operators.

There may be no immediate answers to some of the key issues but policy makers can essentially hedge their bets on any structurally separated investment by choosing the most "future-proof" technologies available when designing a rollout with separated wholesale and retail divisions. Policy makers should consider transmission media which can support substantially higher speeds with minimal future investment.

Preventing market distortion

The economic crisis poses some significant challenges for policy makers looking at broadband investment as part of stimulus packages because the investment may be expended at areas which already have broadband and have not been shown as clear market failures – just as in areas needing a network upgrade. Investments in competitive areas can distort markets and displace private sector investment which was already planned. Policy makers must take great care to design public investments in a way that they promote competition without disrupting private investment.

The question will arise as to whether governments should invest in areas which may already have broadband access from one or two providers. The answers will likely hinge on whether government investment will significantly increase connectivity options and promote competition. Rolling out connectivity to un-served areas should not pose problems in terms of market distortion but it could easily create a dominant, monopoly provider. Governments need to ensure that there are provisions for competitive access on any networks in these areas.

There are more difficult questions about investments in metropolitan areas which may have one or two broadband providers at slower speeds. A well-placed broadband investment could significantly boost broadband speeds and introduce additional competition into the market. This could be a benefit for users but could also negatively affect existing operators in these areas. In such a case the new infrastructure built with public funds must be open and available to all providers at cost-based prices. Existing operators should be able to switch to the upgraded network if they choose or stay on their own.

Public investment should not limit the ability of other operators to install their own networks in the same roads, conduit, or over the same poles. Any installed conduit or network infrastructure must be open for others to use and other providers must still be granted rights of way and permits to dig in streets to install their own networks. For example, municipalities should continue to allow other companies access to roads and conduit even if the municipality has installed its own open-access network. This concept is very important because the threat of entry will help stimulate investment in any networks built with government money.

Innovation and growth

Identifying areas with the highest benefits

Stimulating innovation and growth via telecommunication networks was a key priority to emerge in the *Seoul Declaration for the Future of the Internet Economy*. Ministers from the OECD and other countries adopted text which emphasises how new networks are an increasingly important platform for research, international science co-operation, creativity and innovation in many different sectors.

The secondary impacts of telecommunication investment on supply in the economy could eventually have the largest impact of any government spending on telecommunications. Policy makers should look for projects which have the highest impact on innovation and growth in the economy and weight them accordingly in the review process. The “productivity” of any government spending on telecommunication is tied to the impact it will have down the line on improving output in the private and public sector.

Governments generally do best when they help facilitate certain fundamental structures which then support an innovative and robust private sector. The role of governments should generally be building a foundation for innovation and fostering its development.

Broadband networks are already an important foundation for innovation and growth in the OECD. Telecommunication networks helped improve the efficiency of virtually every sector in the economy. Their impact can be seen easily during this economic downturn as people turn to the Internet to look for jobs, gather information and shop for discounted goods. Teleconferencing over the Internet has helped firms deal with decreasing travel budgets and environmental concerns. Finally, the Internet has become one of the leading sources for information, news and entertainment in OECD countries.

While there are innovations in network technologies themselves, it is the services which will be available on these networks which will have the strongest effects on productivity, and the economy as a whole. The goal of public investment, therefore, is helping to create a foundation which is capable of supporting new and innovative applications and services. Policy makers thus need to consider certain criteria of projects in terms of their impact on innovation and growth.

i. **Marginal impacts:** Each proposal will have different marginal impacts on the economy and quantifying them may be difficult. For example, installing an overlay fibre network in an area with two existing networks (both offering high speeds) will likely have a lower marginal impact on productivity and growth because many of the services would already be available over existing networks. In such a case, policy makers may choose to target areas with less connectivity or slower speeds. However, policy makers should also consider the impacts on consumer surplus of the introduction of a second or third provider. If the monopoly or duopoly market structure results in high prices and slow services then a targeted open-access network upgrade could still have a significant impact on prices – and therefore penetration. Investments in backhaul infrastructure could also have a larger marginal impact than putting the same investment into connections directly into homes. Areas choked by slower backhaul, particularly those currently served by satellite, could be strongly impacted by a boost in backhaul capacity.

ii. **Upgradability:** Policy makers are not the best placed to predict the future demands that will be placed on network infrastructure. As a result, government investment should focus on infrastructure which can be upgraded easily and inexpensively to offer more capacity when new applications and services needing the connectivity appear. Building more potential for capacity into a project may be marginally more expensive in the short run but could significantly reduce costs and raise productivity in the long term, particularly if it helps avoid laying a second new network only a few years down the road. The overbuilding of capacity during the dot-com boom, while expensive, laid the backbone infrastructure which supports the high-capacity broadband of today.

iii. **Business/residential breakdown:** The productivity gains from improved connectivity in the economy will be spread between households and businesses. Targeted investment expanding capacity to areas with high business concentration may provide a larger impact per unit spent than investments which expand connectivity to a limited number of households in an area. At the same time, businesses may be attracted to locate in areas where employees have access to better connectivity. At a minimum, any backbone investment could be routed through areas where there are business concentrations as a way to boost private-sector productivity.

iv. **Backhaul vs. last kilometre:** As mentioned earlier, there needs to be a balance between investment in backhaul and investment in the last kilometre. The economic impact of any network development depends on users having available capacity all the way back to content and application suppliers. Government spending should take into account backhaul anytime there is investment in connecting users in rural and remote areas. Investment in high-capacity, open-access backhaul between rural communities could spur last-kilometre investment by the private sector as well. Suburban or metropolitan areas may face a different situation where there is fibre running close by but the last kilometre needs to be upgraded for higher speeds to take advantage of it. Again, investments which balance backhaul and last-kilometre capacity are the most appropriate.

Social benefit

Quantifying the economic benefits of a project, while challenging, is easier than judging projects based on their overall benefit to society. Current policies in OECD countries make ensuring voice service to the entire population a key priority and policy makers have devoted significant resources to carrying out this objective. Now, with the prospect of new public expenditure, policy makers are considering upgrading these areas to ensure a minimal level of broadband connectivity.

A number of stimulus packages released through February 2009 have made extending broadband to rural and remote areas a key priority. From a demand-side perspective these projects will have roughly the same impact as spending similar amounts in metropolitan areas unless government investment displaces current investments by private firms. On the supply side, investments connecting rural and remote areas may have less impact on aggregate productivity growth, given the limited number of people and firms which will be added to the network, than an investment in a more densely populated area.[13] From an equity standpoint though, these investments may serve strong social objectives and the priorities of governments. The remote areas with new connectivity will see significant new social benefit and inclusion. There will also be beneficial network externalities if all citizens have access to broadband connectivity.

One of the key benefits that broadband brings to newly-served areas is improved access to government services. Populations without access to the Internet, and broadband in particular, are often segments of the society who could benefit most from improved access to government services. New communication infrastructure to these areas could have a potentially strong, long-term impact on consumer well-being. Data from Eurostat has shown that broadband subscribers are more likely to interact with public authorities over the Internet than narrowband users (OECD, 2008b). Improved access to government information and services could bring significant, tangible benefits to a community.

The Recommendation of the OECD Council on Broadband Development clearly highlights the importance of the social aspects:

> "Member countries should implement policies that promote access on fair terms and at competitive prices to all communities, irrespective of location, in order to realise the full benefits of broadband services.[14]"

More recently, Ministers agreed at the Seoul Ministerial to support policies which use ICTs to provide enhanced services to people with disabilities or special needs. They also agreed to promote the use of ICT networks by all communities.

These mandates mean that policy makers should select projects which can produce social benefits while still addressing the other three items (connectivity, competition and innovation/growth). Policy makers can spend the limited funds available extending high speed networks all the way to a few users or pushing high speed connectivity much closer to considerably more users – creating an environment for rural ISPs to prosper.

Policy makers may find the latter to be the most effective because small ISPs have the means to distribute connectivity locally but may lack the resources or scale to bring high-speed connectivity into the area. One possibility is that government spending pays to build high-speed, backbone connectivity to all the small towns throughout a region. If the network is open-access then any large or small ISP would be able to redistribute the resulting connectivity throughout the area via wireless or other technologies. Leaving the last-kilometre connection to the private sector allows the government to reach a larger total number of communities and improve social welfare of the most people as possible.

Evaluating investment scenarios

Proposals for public funding of broadband projects will all be different and each will need to be evaluated across a wide range of criteria. Table 3 provides a list of the key criteria discussed in this paper which may be used to evaluate different proposals.

13 There is a mitigating element which it is important to consider. Metropolitan areas often already have good broadband connectivity and installing a new physical network may have smaller marginal effects than would be seen when building a network to an area without any connectivity.

14 *Recommendation of the OECD Council on Broadband Development*, adopted 12 February 2004, at: www.oecd.org/document/36/0,3343,en_2649_34223_34238436_1_1_1_1,00.html.

Table 3. Possible criteria for evaluating broadband proposals

Demand side	Speed to come online	Shovel ready
		Rights of way / spectrum availability
	Spending composition	Employment effects (local)
		High marginal propensity to consume
		Avoids leakages
Supply Side	Connectivity	Number of affected users
		Marginal benefit per user
		Capacity of the lines
		Topology effects on bandwidth
		Longevity of the network
		Ease to upgrade network
	Competition	Competitive access to network
		Broadband choices
		Potential for market distortion
	Innovation/growth	Economic impact per unit spent
		Upgradability for new services
		Balanced rollout backhaul/last kilometre
	Social benefit	Universal service
		Cultural benefits
		Inclusion
Long-term viability	Private sector viability	Long-term viability of project after stimulus

The list is not exhaustive and policy makers will need to determine their own weighting mechanisms for each of the criteria. In some cases issues on the demand side will take priority because the aggregate demand side effects will be most important for policy makers. In other cases, decision makers may be able to take a longer view and focus on plans which strike the best balance between connectivity, competition, innovation/growth and social benefit.

Finally, the last category includes the long-term business viability of projects. Policy makers will need to judge whether plans have a viable longer-term business model to sustain the network after completion. They will need to take into account maintenance demands and operational costs of continuing with projects after the initial investment is made. If there were no business case for a private firm to continue operating the network after the initial investment then policy makers will need to determine whether long-term government ownership and continued operation of the asset is economically and socially desirable.

Selection process

When OECD countries allocate resources they have certain common objectives irrespective of the method chosen. These can include efficient allocation of a resource and efficient use of that resource, transparency in the award of a resource, non-discrimination, and the creation of appropriate conditions for market competition (OECD, 2004b). There may also be other broader economic and social objectives.

Once investment targets have been identified, there are a variety of techniques to award government subsidies that enhance the efficient and transparent use of the funds. Governments already use a variety of procedures to allocate and distribute resources for projects. Tender procedures geared to the lowest-priced bid are typically used to award contracts while auctions are common for allocating spectrum. Recently tools such as minimum subsidy auctions coupled with notice-and-comment procedures also have been successfully used to provide universal service in developing countries (OECD, 2004c), (Dymond & Oestmann, 2002).

Transparency

Government transparency is an essential component of appropriate public governance which helps prevent abuses arising from information asymmetry and permits individuals and organisations to respond to information through political, civil, or economic activity (OECD 2003b). Information regarding government stimulus spending should be made public in a transparent way to ensure that funds are distributed in an efficient and publicly acceptable manner. Policy makers should ensure that information about the bidding and selection processes is widely available to the public. In addition, governments should be clear about how projects will be monitored after the awarding of funds and the results of any monitoring should be publicly available.

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