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Rebuilding the Last Mile

Keeping up with world-leading Internet technology

By Roland Renner

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Executive Summary

Canada can no longer be smug about its international ranking in the telecom sector. Once highly touted as a world leader in high-speed Internet and access to emerging online services, Canada has lost its world-leading position over the last several years, particularly with respect to the last mile, which connects households to infrastructure that is capable of supporting the many and varied emerging technologies and services.[1]

The last mile is significant because it is the last opportunity for incumbent telcos (telephone companies) and cablecos (cable companies) to maintain dominant market power in a sector where they have had to face increasing competition over the years. These incumbents, which initially installed the infrastructure when they were monopoly service providers, have until recently been reluctant to replace the old copper wires and coaxial cables with Fibre to the Home (FTTH), claiming there is no money in it.

More recently, facing new demand from customers who are watching video Over-The-Top (OTT)[2] on the Internet, cablecos in a number of major markets have deployed upgraded high-speed cable technology without replacing the last mile coaxial cable. The telcos responded by upgrading their Digital Subscriber Loop (DSL) technology and then installing FTTH to create more capacity than cable can offer.

This recent incumbent activity is welcome progress—but there is room in the market for more players to bring the benefits of competition to this telecom sector. Canada needs to encourage a competitive landscape for the development of this last mile in rural and remote districts as well as in high-density urban neighbourhoods and single-family residential suburbs. The incumbents should lose their sense of entitlement and be prepared to compete with the best to provide the best.

This paper explores the role the Canadian policy and regulatory environment can play in encouraging this kind of competitive environment as well as third-party competitors, the option of customer-owned fibre, co-op ventures and the need for spectrum to support service to Canadians in rural and remote regions.

To further assess the appropriate model for Canada in its quest to rebuild the last mile, this paper will review a number of telecom environments around the world including the United States, the Nordic countries, Asia, Australia, New Zealand, Lithuania and Russia. These countries were selected to explore four key themes.

1. **Nordic Countries, United States—Municipal and Local Electrical Utility Networks**
   - Municipal and electrical utility networks led the way and were followed by competitive private sector suppliers and then the incumbents.
   - In many cases, these networks provided FTTH in the rural areas and small towns that the incumbents usually upgraded last, if at all.
2. **South Korea, Japan, Taiwan—FTTH Leaders**
   - They combined competitive markets, government co-ordination and early incumbent commitment to install fibre.
3. **Australia, New Zealand—Nationalized Last Mile and Structural Separation**
   - They opted for more radical solutions, with Australia nationalizing the last mile, and New Zealand ordering the divestment of the last mile.
4. **Russia and Lithuania—Emerging Telecom Leaders**
   - Private sector competitors are making strong headway in Russia and a strongly committed incumbent is installing FTTH in Lithuania.

By examining the various models in existence, we should be able to develop a hybrid model that will work in our unique Canadian environment. We live in a global, fast paced, accessible world, and if we wish to be regarded as serious contenders, we need to upgrade that last mile now.

> ***Canada needs to encourage a competitive landscape for the development of this last mile in rural and remote districts as well as in high-density urban neighbourhoods and single-family residential suburbs.***

Acronyms

ADSL – Asynchronous Digital Subscriber Loop: Telco technology to increase the capacity of copper telephone wire. It is asynchronous because the download capacity is greater than the upload capacity.

Coax – Coaxial Cable: Used for cable TV service. It has a higher capacity than copper telephone wire does.

DOCSIS – Data Over Cable Service Interface Specifications: Enables Internet access over cable TV systems. DOCSIS 3.0 is new and enables much faster speed.

DSL – Digital Subscriber Loop: A generic term that includes all forms of digital subscriber loops.

VDSL – Very high bit rate DSL: A newer, higher speed version of DSL.

FTTB – Fibre to the Building: Does not include wiring to apartments in a building.

FTTC – Fibre to the Curb

FTTH – Fibre to the Home: Includes the wiring to apartments in a building.

FTTN – Fibre to the Node: A node or pedestal is the neighbourhood collection point for loops.

FTTP – Fibre to the Premises

FTTP – Fibre to the Pedestal: The same as FTTN.

FTTX – Fibre to the Whatever

Ka-band – The name of a frequency band or range of frequencies, in this case used for satellite services. Others include C-band and Ku-band. The names are arbitrary but the distinctions between bands are important because they have different transmission characteristics and require different transmission and reception equipment.

MDU – Multiple Dwelling Unit describes any building with multiple residences. There can be different terms and conditions for access to the individual residents from a demarcation point in the building.

Wi-Fi – Wireless technology for small networks such as homes and coffee shops.

WiMAX – Wireless network for broadband data that covers more distance than Wi-Fi does.

1.0 Introduction

The Canadian policy and regulatory environment has encouraged competition in telecommunications for over 30 years. Competition has been systematically introduced into more and more sectors of the telecommunications market. Today, the last mile of telecom networks that connects to residential households is the last component where the incumbent telephone companies (telcos) and cable companies (cablecos)[3] continue to have significant market power based on their original monopoly status. The justification for policy and regulatory intervention is based on the continuing existence of market power in this component of telecom networks.

Modern telecom networks allow Canadians to participate fully in developing and using the latest Internet services and to participate in the world economy at its most advanced levels. Canada can no longer claim to be a world leader in the telecom sector, particularly in the emerging markets of last mile deployments. Around the world, the last mile is being rebuilt, implementing new technologies, and in many cases, new organizational models. From the perspectives of capacity, competitive environment, service development, pricing and rural development, how the last mile is rebuilt will have an important impact on Canadian telecom for the next generation.

This is not just about teenagers watching movies and playing interactive video games on their computers in their parents' basement; it is about videoconferencing, telecommuting, distance medicine and distance learning. It is about Canadian cultural industries having access to Canadian and world audiences. Ultimately, it is about doing business with the world.

This paper discusses Canada's current telecom environment with regard to the last mile, and it examines the experiences of other countries for policy and regulatory recommendations that could be adapted for use in Canada.

> ***Around the world, the last mile is being rebuilt, implementing new technologies, and in many cases, new organizational models.***

2.0 Canada's last mile

2.1 Canada has lost its leading edge

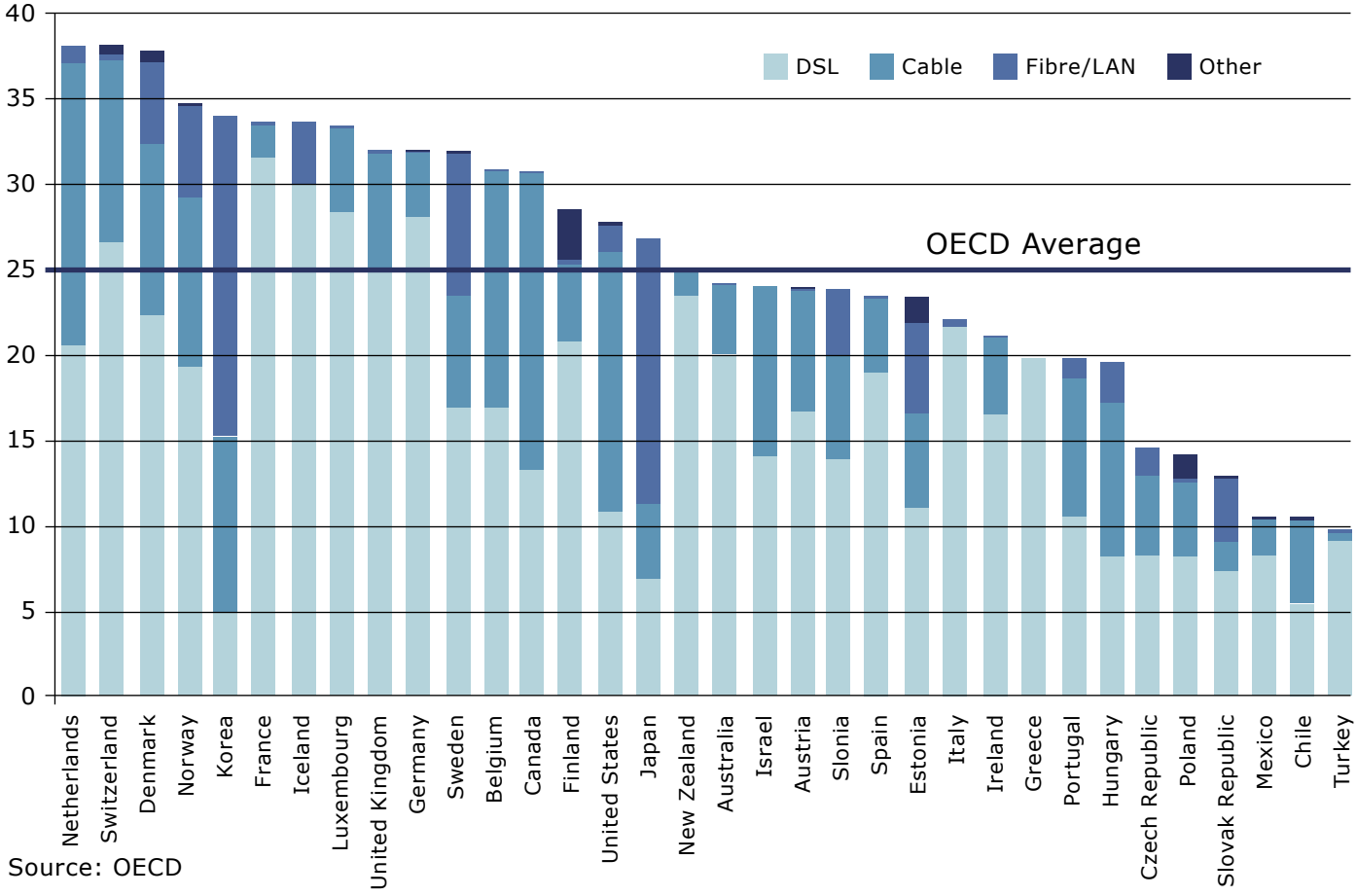
Canada was an Internet world leader—first out of the blocks in enabling access to the latest business, entertainment and education services. This is no longer the case, and we are struggling to maintain a position in the middle of the pack. By late 2002, Canada ranked second in the world in broadband deployment. Broadband is defined here in keeping with the Organisation for Economic Co-operation and Development statistics as anything faster than 256 kbps—slow by today's standards. The following chart shows that we have fallen to thirteenth overall.

More importantly, we are not among the world leaders in FTTH deployment, the technology that offers the fastest speeds and the most potential for future capacity.[4]

Most developed countries, including the EU and the United States, have digital development policies and subsidy programs to provide access to rural areas and to maintain a competitive business edge. Although the current federal government's Digital Strategy is still in development, similar programs have been implemented in Canada.[5]

CHART 1

OECD Fixed (wired) Broadband Subscriptions per Inhabitants by Technology - Dec. 2010



Source: OECD

2.2 The Last Mile: The last vestige of monopoly market power

The rationale for intervention exists because telcos and cablecos have dominant market power in the last mile of the network, which connects to customers. The market for this component of the network is not competitive. Under Canadian law, the terms and conditions of service are regulated by the CRTC.

Market power in the last mile is based on the historical granting of Rights of Way (ROW) to telcos and cablecos that enabled them to construct the original last mile infrastructure.

Both were operating as regulated monopolies with a negotiated set of restrictions and service requirements, which included regulated rates of return, quality of service and, in the case of the telcos, universal service obligations.

Canada has been a world leader in bringing competition to the telecom market. There is a brief window of opportunity to finish the job and extend competition into the last mile, ending the remaining market power of the incumbent cablecos and telcos.

2.3 Last Mile technologies

The last mile connecting residential households to telecom networks is the slowest part and is usually the oldest and the most expensive to replace. In Canada, the last mile to residential homes consists of either copper wires owned by telcos or coaxial cable owned by cablecos. Fixed wireless facilities and satellite provide the balance in areas where cablecos and telcos do not provide service. Independent Internet Service Providers (ISPs) typically use the telco loops for last mile access, although they may have their own facilities for parts of the access network in high-density areas. A small number of competitive ISPs have their own last mile facilities in high-density zones of major urban centres.

Next-generation service depends for the most part on speed and access. Table 1 shows the increase in speed and capacity that wireline Internet access technologies can deliver.

TABLE 1

Terrestrial Internet Access Technology Speeds

Speed	Service Delivery Method
56 kbps	Dial-up internet access using ordinary telephone lines provides up to 56 kbps
4 to 8 Mbps	Telcos DSL technology, Cablecos' DOCSIS
20 Mbps	Telcos using VDSL in selected high-density areas
100 Mbps	Cablecos' DOCSIS 3.0
1 Gbps	FTTH

Telcos have started to deploy fibre more aggressively, because their copper last mile infrastructure has less capacity than the cableco competition. Because their higher capacity coaxial cable outperforms the telcos' DSL technology, cablecos are not under the same pressure to deploy fibre.

The speed and access available to last mile customers in Canada is far behind the 1 Gbps target many countries have set for their households. Attaining 1 Gbps speeds requires replacing the existing infrastructure with FTTH[6], an expensive proposition that necessitates replacing buried cable. Here again, Canada is outpaced by other countries' FTTH deployment.

Mobile technologies, including the massive adoption of smartphones, are creating an overlap with the fixed broadband access sector.

Wi-Fi, WiMAX and LTE[7] all provide new access methods that will capture at least part of this traffic. They will have a major impact in rural areas as well. Broadband is increasingly an important growth component for mobile services, and it is already having an effect on the debate over how to serve rural and remote customers and how to allocate spectrum. It remains to be seen how well mobile broadband performs in a rural environment under actual commercial conditions. New Ka-band satellite broadband access services recently launched in Canada and the United States will improve upon the satellite-based Internet access services currently available. FTTH, however, has the potential for much higher speeds, particularly in urban areas where spectrum limitations will restrict the capacity that mobile services can offer to individual customers.

2.4 Service demand and the revenue model

Incumbents had long argued that the market was not ready for FTTH, as the demand for services was not there. The revenue projections did not justify FTTH investment. In Canada and the United States, Internet Protocol TV (IPTV) has given telcos the motivation to install FTTH so that they will have the ability to use their facilities (instead of satellites) to deliver video services to residential customers as well as phone service and Internet access. This ability to provide three services is often called a triple play (adding mobile telephone service makes it a quadruple play), and it greatly improves their competitive position vis-à-vis the cablecos.

Cablecos and telcos have video distribution services that they want to promote and maintain. Video is both the biggest bandwidth user and a big revenue generator. However, the same IPTV technology that enables the telco video service also enables OTT video that consumers can access with just an Internet connection. The cablecos and the telcos have tried to protect their video offerings by raising the price of Internet access for OTT video users. They have been accused of reserving capacity for their own services by throttling Internet usage and by other traffic management initiatives.

Bell's proposal and the CRTC's approval of a wholesale pricing scheme that required all independent ISPs that lease facilities from Bell to implement the same usage-based subscriber pricing plan that Bell uses launched a nationwide protest. The customer backlash was such that the CRTC had to review its approval of wholesale Internet access pricing, and it arrived at a different solution that gave the independent ISPs more flexibility.

The video and telephone services of the cablecos and the telcos are competing with similar services that are available directly from the Internet. For services such as browsing, online purchasing, audio conference calling, video conference calling and social networking, competing companies have built up multi-billion-dollar businesses. Microsoft, Google, Skype, Facebook, Amazon and a host of others consistently come up with better, more customer-centric ideas than the incumbent telcos or cablecos do. Competition and consumer choice have brought huge changes and benefits to the services available in other telecom sectors. It is time to apply the same policy to the last mile.

2.5 Organizational structure choices in the Last Mile

In suburban residential neighborhoods, the cost of building FTTH[9] is probably between $3K and $6K per household. This is within the range of suburban incomes, and it would increase property values. In downtown business areas, installing fibre to businesses and connecting it to the network is very competitive. These providers are in a good position to expand into the residential market. There have also been cases of companies competing directly with the telcos and cablecos in residential high-rise apartment buildings and condos as well as new suburban neighbourhoods.

The price point for the customer is within reach, and the potential suppliers to suburban residential neighbourhoods exist. Customer frustration with the incumbents was recently demonstrated at the political and regulatory levels. What remains is to establish suitable standards and procedures to enable competitors to access municipal ROW and for processes and procedures to allow interconnection with the incumbents.

This last step should not be a major problem for the incumbents. It removes expensive but mostly low technology items from their cost base. Much of the cost is driven by digging trenches to bury the fibre, hanging it on poles, organizing permission to hang it on poles, and negotiating and paying for ROW. The incumbents long ago dealt with the transfer of responsibility for inside wiring to the homeowner. Similarly, they dealt with the requirement to accommodate competitors that interconnect with their networks.

2.6 Last Mile competition and open access for services

It is often difficult to determine in any given context what exactly the term "open access" means even though it is widely used, and it appears in several instances in the international experience section. At some level, it refers to access to more than one service provider over a given communications facility, but it is important to realize that the term can be used to describe very different situations.

A closed access system, sometimes called a walled garden, restricts the customer to the set of services owned by the company that provides the facility or underlying communications technology. For example, subscribers to Shaw cable services have access to the Shaw video package, Shaw home phone (and long distance) and Shaw Internet access. They cannot choose to use Telus phone service over the Shaw facility.

In a pure open access system, a communications provider sells only the underlying communication service, and the subscriber pays that company for the communications capability. The subscriber is free to choose from any service provider willing to offer service over that facility. Theoretically, the subscriber could choose Shaw Internet, MTS phone service and Rogers video package. In other cases, the service provider deals with the communications facility provider, and the customer deals with only one contact.

In practice, pure open access is rare. Many competitive access providers and municipal networks require a quorum of the population to sign up for a complete bundled service package before its deployment. Nevertheless, in order to make the bundle possible, the competitive or municipal network must be able to access a video package and other services. Sometimes even this is called open access. Another situation that is described as open access occurs when service providers have a one-time opportunity to bid on the right to provide service on a particular communications facility for a given contract period.

Finally, the nature of Internet service provides competitive open access to customers for phone and video services from sources other than the company providing the underlying communications capability. Instead of buying Internet access, phone service and a video package from Telus, for example, the customer can choose Internet access only, use Skype or another Internet-based phone service and watch OTT video from Netflix and other websites.

The incumbents can be expected to work hard to keep their video-service customers. As the largest ISPs in Canada by far, they also have dominant market power in the last mile to the residential households and should not be able to use this advantage to compete in the marketplace.

From a policy perspective, the best way to address this situation is to introduce more competition in the last mile and to establish the rules for interconnection and access to services that are needed to make the market function.

2.7 The Last Mile in rural Canada

Most countries have an overall broadband development policy, although they may call it by another name. The policies range from merely pointing in an overall desired direction to active support and subsidies for service development, facilities deployment or distributing computers to schools. Similarly, most countries offer support for rural and remote deployment in order to provide access in all parts of the country.

Canada also has rural broadband subsidy programs that typically support the installation of satellite or fixed wireless capability and local distribution by a telco, cableco or a community initiative. The service to individual customers is still limited by the shared nature of the satellite and fixed wireless capacity and associated prices and download limits. Subsidy programs may support fibre builds to smaller communities and community access points that are close to major centres, with further distribution usually being the responsibility of the local community. For example, the Eastern Ontario Broadband Network drove fibre closer to the communities, connecting to municipal buildings, schools and libraries but not residences.

In many cases, the market size for these services can be well beyond the 2 per cent

to 3 per cent that Statistics Canada deems rural. Up to 15 per cent of Canadians are beyond the reach of cable and DSL even though they may live on the fringes of a major city.

The challenge is to deliver broadband service to rural and remote areas. Usually, qualifying service providers receive subsidies, so they can supply service to particular communities. A major problem is that the technology is quickly outdated and orphaned, and there is no mechanism to move on to the next technology without another round of funding. Communities that have DSL installed have no way of upgrading until the next subsidy program comes along.

One option is to change the demarcation points so that rural residents can hook into the network further down the road rather than at the house. This would provide an opportunity to run aerial fibre to a connection point closer to a central office (CO) or a tower, reducing the risk and cost to the network provider. Co-op institutions, where they exist, could be mobilized to combine these builds.

New technology is also creating potential opportunities for broadband delivery. Small cable providers in the United States, for example, are upset that the new rural broadband subsidy program will go primarily to the larger telcos. The small providers think that they also have a role.

Ka-band satellite services are now being made available and promise download speeds of 4 Mbps and 8 Mbps at reasonable prices. While preliminary prices and capacity announcements are encouraging, the service, by the nature of the technology, is shared and is more susceptible to signal fading with rain or snow. How well the service performs under the real-world conditions of sharing capacity and the constraints on usage built into the pricing plans remains to be seen.

There is no prospect of increasing the capacity to that offered by FTTH.

The development of new wireless options for rural last miles is particularly important because of the higher cost of installing long fibre runs in sparsely populated areas.

With the proliferation of smartphones, mobile service provides access to the Internet. Carriers are offloading some of this traffic on to Wi-Fi networks. WiMAX is another candidate and claims are being made that LTE can deliver broadband access to rural areas. LTE deployments designed for rural areas are being tested, and a number of U.S. firms have announced their intentions to provide service. LightSquared[10] proposed to build national coverage LTE satellite service and Clearwire is building national WiMAX coverage. Perhaps, rural and remote service is about to become more competitive, and new configurations that combine fibre optic cable and wireless delivery can be devised to serve rural customers better.

For this to happen, access to spectrum will be important. In the past, larger carriers with the best access to spectrum chose, for commercial reasons, to serve remote areas last. Now, carriers that specialize in rural service are requesting that spectrum be set aside for rural service because they will deliver service quickly. More bandwidth can be made available to individual customers in rural areas because spectrum congestion is not an issue. The rural carriers cannot afford to bid against the larger carriers and still provide service. Changes to the design of spectrum auctions to permit rural set-asides, determining the borders between rural areas and the service territories of the mainline carriers, and the ability to trade in spectrum rights have been proposed to help make these innovations happen for rural customers.[11]

3.0 International experience

This section provides examples of last mile FTTH construction, ownership and operation in 11 countries. They are divided into the following four groups:

- Municipal and Local Electrical Utility Networks – Nordic Countries and the United States
- Asian FTTH Leaders – South Korea, Japan, Taiwan
- Nationalized Last Mile and Structural Separation – Australia and New Zealand
- Emerging Leaders – Lithuania and Russia

3.1 Municipal and local electrical utility networks

Since the late 1990s, Norway, Sweden, Finland, Denmark and Holland have led the way in municipal and local electrical utility FTTH builds. As shown in Chart 1, page 8, about 10 per cent of broadband connections are FTTH in these countries. The telco incumbents began to come on board in 2009 and 2010, and they are actively deploying FTTH.

These initiatives, called munis, citynets or stadnets in Scandinavia, are well known and widely promoted by a libertarian brand of Internet activist. These activists view the Internet as a liberating factor for society, enabling mass sharing of information without the intervention of state or corporate intermediaries. Local municipal control of the underlying facilities fits with their vision of what the Internet should be.

One example of mass sharing of information is the music industry, which has been completely reshaped by the Internet. Another is video distribution, which is at the beginning of a similar process. An individual can go on the Internet and get video entertainment without a cable or satellite package that is organized by government regulatory supervision.

Small, remote communities in Scandinavia and the United States saw the potential for these Internet initiatives when they realized it would be a long time before their telco or cableco brought them the technology they wanted. In many cases, these communities got the best technology first, not last. In the United States, the munis are mostly limited to smaller communities, but larger cities in the Nordic countries have them. In Sweden, Stockholm has one, but most stadnets are much smaller. There are over 160 municipal fibre networks in that country.

Municipal and electrical utility FTTH networks in the United States, Sweden, Denmark and Norway are described below. The United States is included to illustrate that this is not just a Nordic phenomenon.

3.1.1 United States

In the United States, telcos are deploying VDSL and FTTH. Several factors have contributed to this development. Cablecos are upgrading their existing technology, so they can deliver speeds up to 100 Mbps, eclipsing the 4 to 8 Mbps provided by the telcos' ADSL technology. With the higher speeds made possible by VDSL and FTTH, the telcos can deliver IPTV in the form of a telco-branded package that rides on reserved capacity. This gives them a triple play, putting them on a level playing field with the cablecos for bundled services. Google is building a model FTTH deployment in Kansas City, Kansas, and Kansas City, Missouri. Dozens of communities vied for the privilege. A final piece of the competitive environment is that some communities in smaller centres that had no imminent hope of getting the latest technology services decided to do it themselves and are building a municipal network.

This movement to build municipal networks in the United States is surprisingly vigorous, given the general ideological opposition to public ownership that is prevalent in that country. Currently, 54 cities and towns own fibre networks and another 79 own cable networks. Together, they have the capability to serve 3 million people. Municipal fibre operations account for about 1 per cent of broadband connections. While this is a small proportion of the total, it nevertheless represents a substantial number of installations.

Major telcos and cablecos have been slow or reluctant to serve these areas because of their small size or long distance from major population centres. In most cases, municipal officials asked the major incumbents to serve their areas, but they were not able to obtain satisfactory responses as to the timing of deployment, service capability or pricing and therefore made the decision to build the networks themselves. The largest municipal network is in Chattanooga, Tennessee, a city of 168,000, and the network serves 30,000 residents.

Communities developed their municipal networks for a number of reasons, often starting with the intention to provide high-speed network access for municipal buildings, schools, libraries or hospitals with, and then they expanded the service to residential households. Because of this process, many of the networks included aspects of open access service provision.

In other cases, the economic development issue was primary. Lacking broadband infrastructure, small, remote communities such as Bristol, Virginia, and Kutztown, Pennsylvania, decided to build their own network in order to attract new business and to encourage residents to stay in the community.

On the supply side, an important factor is the existence of municipally owned electrical utilities that use fibre optic technology for their communications and electrical network maintenance requirements. This provides access to people with the technical skills required to install and operate network facilities. The municipal network movement is large enough that Internet-based self-help groups share information and provide how-to templates for other municipalities.

In spite of the small market share gained by municipal networks, often in places where the major incumbents did not want to provide any service, the cablecos and telcos have formed formidable opposition, leading a number of states to adopt measures to prevent municipalities from building their own networks.

Major cablecos such as Time Warner have lobbied state governments to implement these measures, arguing that competition from municipal networks is unfair because they do not recover the full costs. Eighteen states currently have prohibitions or restrictions on municipally owned networks because of these efforts.

The municipal franchise is often the rationale for these prohibitions and restrictions. In the United State, municipalities have given cable companies exclusive franchises to provide service in their jurisdictions, often in exchange for financial considerations and the provision of free services to schools and municipal facilities. The cable companies then find the municipality competing against them by way of a municipal network, which they see as violating their franchise agreement.

3.1.2 Sweden

The incumbent in Sweden is TeliaSonera, which was formed in 2002 from a merger of the Swedish and Finnish incumbents. The Swedish government maintains an ownership share. Competition began in the 1980s with mobile and expanded to Internet access and cable in the 1990s. TeliaSonera came late in the game to FTTH, but it is fully committed to its FTTH program. As an important international player in Eastern Europe as well as other countries, TeliaSonera participates in major FTTH projects outside of Sweden.

With broadband penetration in Sweden at 31.9 per cent, FTTH (24.4 per cent) has overtaken cable (20 per cent) as the primary alternative to DSL (55 per cent). Overall, 47.6 per cent of broadband access lines have speeds greater than 10 Mbps.

As in other Nordic countries, municipalities and energy utilities in Sweden led the adoption of FTTH. The municipal networks began in the late 1990s, and there are 160 to 200 stadnets or municipal networks in the country. Stockholm has one of the largest city fibre networks (Stokab) in Europe. Stokab works closely with housing corporations, installing fibre to apartment buildings and then throughout the building to apartments. The network is open access and allows for choice among competing service providers of Internet, telephony and TV.

In most cases, the stadnets provide open access to their facilities; however, in some cases, municipalities have been reluctant to allow ROW and trenching permits to competing private sector companies. PTS, the Swedish regulatory agency, has guidelines and rules in place

for municipalities as well as open access regulations for all providers.

The Remote Community Model

Many small, rural and remote communities in Sweden have built networks to address their needs. Consulting groups have formed to assist communities and provide services such as planning, design, training, bulk purchasing, liaising with content service providers and other activities. Typically, a consulting group meets with the local leaders in a community. An association is formed and the rest of the community is invited to join.

> "When enough homeowners have agreed to join the Association a preliminary plan is agreed and a cost model drawn up based on the number of households, their geographical spread and the reasonable assessment of how many of the households that have not joined the association in the community will eventually wish to join.
>
> Each member pays a joining fee that is used to finance the preliminary work on design etc. When the design has been finalised and the numbers are as certain as possible, this initial cost is divided between the numbers of homeowners signed up. The householder then also signs an Irrevocable Letter of Credit equal to the value of their contribution to the build. This householder assigns the Credit Note to the association. The association to obtain a mortgage from a bank then uses these Credit lines.
>
> In addition to the joining fee and the contribution to the construction cost each member pays a monthly subscription to the Association. The monthly subscriptions pay for the mortgage and for their basic connection to the Intranet. All other services procured from other service providers are charged separately.
>
> In the second year the Swedish Government give homes connected to the system a 40% tax rebate on the cost of the connection up to a limit of €3,000. If a householder did not sign up to the initial Association and then want to join at a later date then they have to pay to the Association the full cost of connection, this proviso helps drive a high penetration rate on day one."[12]

This community-dependant model works in Sweden because of its long history of communities owning their utility companies. There is also a high degree of autonomy given to the local communities, which have already established the right to dig in their communities.

A major advantage is that the take-up in the smaller communities is often 70 per cent versus the much lower take-up for typical commercial offerings. Higher take-up means more revenue to cover the cost of providing service to all of the customers of a project.

Rural projects also benefit from the European rural development subsidies. The following is a current example in the community of Säffle, Sweden.

> "A significant feature of the project is that it was initiated by the residents of the community, who joined together to form the necessary financial associations. Through its company, SäKom AB, the community will build, own and invest in the core network. The related area networks (the access networks) will be built and owned by economic associations. In the first part of the project, there will be 7-10 associations, with around 1,500 members in total. Because residents lacked the expertise necessary to create fibre networks, they will work with the company byNet AB to arrange appropriate training.
>
> The cost of the project will be approximately 50 Msek (€5.4M, $CDN 7.1), with the Säffle community and European Union

each contributing 15.8 Msek and private funding accounting for 20 M. Besides investing financially in the project, residents connected to the network will also need to contribute with labour: it is estimated that every individual concerned will put in 3-5 days of work.

There are 2,500 houses in the rural part of the community, and the aim is to connect 1,500 of these. When this is achieved, the next step will be to connect the houses located in the community's urban areas."[13]

3.1.3 Denmark

Even with its small population of 5.5 million, Denmark is a leader in broadband market penetration and FTTH. Broadband take-up, at 38 per cent in 2010, is at the top of the European tables. FTTH connections are 10 per cent and growing rapidly.

As part of the EU, Denmark shares in the EU target of 30 Mbps connectivity that will be available to all Europeans by 2020. The government's position has been to rely primarily on the private sector to handle telecommunications and broadband infrastructure. The regulator, National IT and Telecom Agency (NITA), is moving the industry toward the competitive structure required by EU policy.

Denmark's high standing in the broadband tables was implemented primarily by TDC, the incumbent, aggressively pursuing ADSL deployment. TDC also owns the largest cable television provider, thus limiting the competition coming from this sector. Resellers and regional cable companies are its primary direct competitors. Like other EU countries, Denmark provided for unbundled local loops that allowed resellers competitive access to the incumbent's copper loops. Nevertheless, TDC had over 50 per cent of the retail broadband subscription market as late as 2008.

TDC maintained a policy of FTTN/FTTC until at least 2009. Its contention was that "few customers require 20 Mbit/s+ solutions."[14] Therefore, the policy continued to be FTTN and FTTC, leaving the copper pairs in place from there to the household. The technology change was to upgrade ADSL to VDSL, but the last mile generally stayed copper.

The driving force for FTTH deployment in Denmark from 2002 to 2010 came from consumer co-operative electrical utilities in the rural and outlying regions. In 2010, 15 of these utilities combined their FTTH activities into one organization called Waoo! Of 1.7 million households served, 600,000 were passed[15] by fibre and 155,000 subscribed to the service.

Chart 2[16], previous page, illustrates the competitive environment in broadband for ADSL and FTTH as of 2008. They show both the continuing dominance of the incumbent and the role of the electrical utilities in deploying FTTH during this important period in the growth of FTTH in Denmark.

In most jurisdictions, rural and outlying regions are the last to receive service and often require government assistance to do so. In Denmark, it was the opposite.

The incumbent, TDC, did a good job deploying ADSL, but it was late buying into the vision of FTTH. Consumer co-operative electrical utilities took up the challenge and became major telecom competitors in the process.

The electrical utilities have a consumer-focused history that includes a long time horizon. They thought that FTTH was a major public policy instrument that they could make available to their customers/members.

As electrical utilities, they were already installing fibre networks for internal communications requirements, and they had the existing ROW, both of which are important cost components. They had the expertise; they also had 100 years of experience with infrastructure deployment. In addition, their fibre customers have a lower churn[17] rate than that of other service providers.

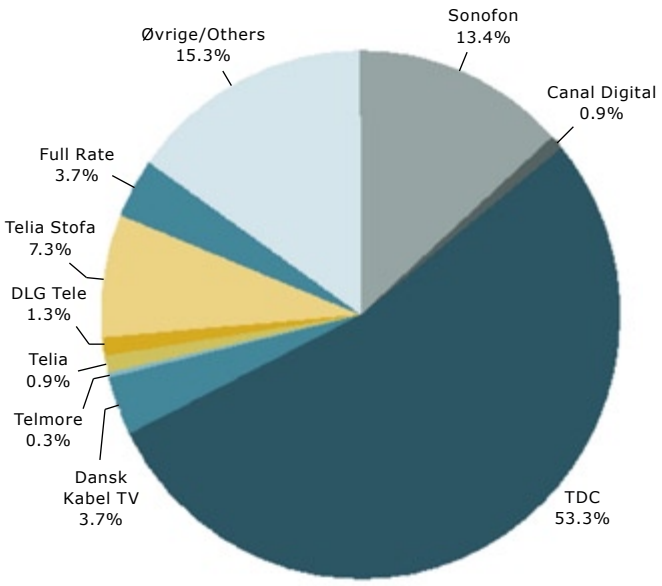
Denmark, like parts of the United States, has restrictions preventing municipally owned electrical utilities from providing FTTH, but this does not apply to the co-ops.

TDC purchased a number of smaller fibre providers and one of the energy companies in 2010. By doing so, it hedged its bets on FTTH. To meet the ambitious new targets set by both the EU and the Danish government through NITA, FTTH will be required.

NITA continues to adjust the competitive environment to provide competitive access to the fibre networks and the copper loops.

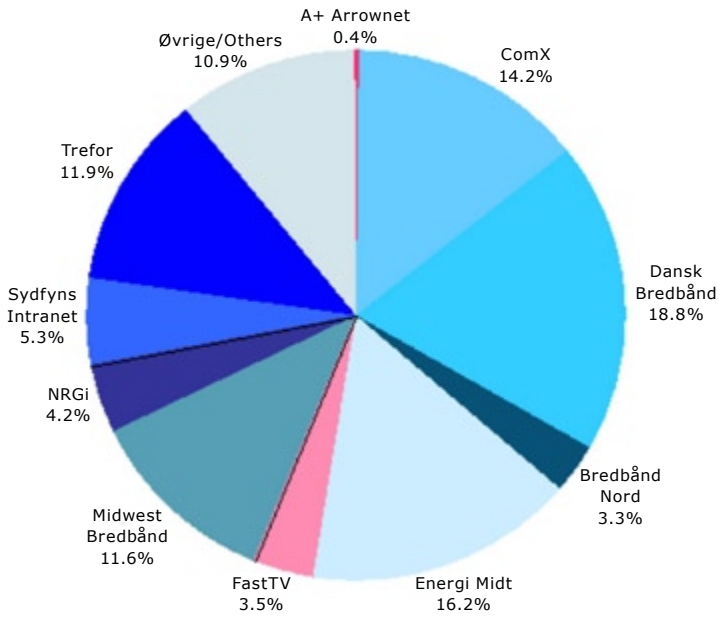
CHART 2

Broadband - Retail Market Situation



- The market share for broadband subscriptions dominated by TDC (incumbent).
- More than half of all subscriptions were sold by TDC.
- The second largest operator on the broadband market is Sonofon with a marketshare of around 13%.
- Wholesale market shares (internal plus external sales included) is larger as service providers use TDCS network

FTTH Subscriptions



- The number of FTTH subscriptions sold in Denmark is increasinf rapidly.
- From the end of 2007 to the end of 2008 the number of subscriptions grew from just under 50,000 to 87,000.
- The FTTH market is dominated by the power utility companies.

Source: National IT and Telecom Agency

3.1.4 Norway

Norway is another example of a sparsely populated Nordic country that leads in FTTH market penetration. During liberalization measures by the government in 1994, the incumbent, Norwegian Telecom, became a public corporation. It was renamed Telenor in 1995. Competition was extended with carrier pre-selection introduced in 1999. Telenor was partially privatized in 2000 and listed on the stock exchange.

As in other Nordic countries, energy companies and municipalities initially adopted FTTH. The incumbent deployed ADSL technology that provided high levels of broadband penetration, but the speed was limited to 4 to 8 Mbps. With competition and local loop unbundling, competitors entered the market, and there were six competing telcos by 2010.

Cable was also a competitor. Municipalities and energy companies started FTTH deployment by the late 1990s, and Lyse Energi started it in 2002. Telenor started upgrading to VDSL and finally launched its FTTH service in 2010 when ADSL market penetration was already in decline.

As of 2009, about 10 per cent of broadband connections in Norway were FTTH, 20 per cent cable and the rest ADSL. The latter, however, peaked at 80 per cent and then began a slow decline to under 70 per cent. Like many incumbents, Telenor did not perceive the need to replace ADSL technology. It had a high market share for broadband connections and did not see a market for faster speeds that would justify upgrading to fibre.

Lyse Energi, a regional utility, launched a point-to-point FTTH service and formed alliances with other regional energy utilities to extend the reach of the service and to provide sufficient size to be able to offer a triple play service. Lyse will provide service if 60 per cent of homes passed commit to taking up the service. It also offers a discounted installation service that takes the fibre to the household's curb and provides the customer with an install kit. The customer has to dig the final trench across the lawn and hook up the fibre. This is surprisingly popular and demonstrates that, from a technical perspective, it is not that hard to do. "Digging is the main cost. … If we can cut that, it makes things much easier."[18]

Lyse said that its motivation for entering this market was the threat of competition in its core energy business. It was looking for additional market opportunities. "Telecommunications was a natural fit because it was an infrastructure play, and Lyse was expert at installing and operating infrastructure."[19]

3.1.5 Conclusions from municipal and local electrical utility networks – Nordic countries and the United States

Most Nordic countries, Sweden excepted, have very small populations. Nevertheless, municipal networks are successful—initially in rural and remote locations, and then in their major cities. The factors below have played a role in their success.

- Strong local institutions with a history and culture of co-operative action.
- Competitive telecom environments provide interconnection procedures and open access to service providers.
- Access to technical expertise.
- The ability to control ROW access is an important factor in both small communities and larger ones.
- A national broadband promotion plan, which includes access to EU rural development subsidies.

The municipal and electrical utility FTTH developments in remote regions were about eight to 10 years ahead of the incumbents' activity. They preferred to change technologies incrementally, having already made major investments in ADSL that extended the lives of their local loops. This technology is not capable of meeting the new national and EU targets and was already in decline by 2008.

The competitive environments mandated by the EU provided an essential basis for the interconnection requirements that are part of the regulatory environment. Service providers stepped up to deliver the content to the FTTH networks. While some networks practised various levels of open access, others, particularly in rural areas, required minimum levels of consumer sign-up including commitments to various service bundles.

When a third party provides the video service, the customer is committed to that provider when signing up for service.

The municipalities had access to technical expertise from their own electrical utilities or from consulting groups that formed to assist them. Particularly in the small, remote communities, access to ROW was already under the utilities direct control, thereby removing a major practical hurdle that can add time, cost and uncertainty to a building program.

The Nordic countries' national government plans promoted broadband access and services in keeping with the overall EU plan. The degree of financial support varies, with Denmark relying most heavily on the private sector. The EU provides funding for broadband development in rural areas.

In these countries, municipal networks are very successful, leading the way in FTTH deployment and in providing the latest technology to rural areas first. Looking at Europe as a whole, however, competitive private sector suppliers had over 70 per cent of the homes passed with FTTH in 2010.

Municipal networks have also flourished in the United States (although to a lesser extent), largely for the same reasons. Because of the munis' success, the telco and cableco incumbents have lobbied for restrictive legislation to prevent the proliferation of these networks.

3.2 Asian FTTH leaders

South Korea, Japan and Taiwan are ahead of the Nordic countries in FTTH deployment and lead the field among the Asian countries.[20] In all three cases, government planning and co-ordination played a major role, particularly in providing service development that would produce a revenue stream to pay for the fibre investments.

The other major feature that distinguishes them from the Nordic countries is the early participation on the part of the incumbents, even in the context of the transition from a monopoly to a competitive telecom industry. The incumbents began the transition early rather than wait for payback on their substantial ADSL investments.

3.2.1 South Korea

South Korea is the world leader in FTTH deployment, although a large proportion is FTTB. By mid 2011, over 35 per cent of the population and 85 per cent of households were broadband subscribers. FTTH accounted for 55 per cent of total subscriptions. Korean households typically pay less than US$30 per month for 20 to 100 Mbps service, which is among the lowest fees in the developed world. The objective is to bring 1 Gbps service to urban households.

Why has South Korea done so well, and how did it do it? Like many countries, South Korea had its own government-owned monopoly service provider, Korea Telecom. In 1993, it was privatized through a series of share sales, which were completed in 2002. Competition was gradually introduced by market segment, starting with international long distance.

Cable service providers began offering Internet access in 1998 and provided an alternative technological path for access. The electrical utility and Korea Telecom provided national backbones for cable distributors.

There are five major competitors in the broadband access market along with additional resellers, satellite and fixed wireless providers.

Besides the creation of a competitive telecommunications sector, the government has played an important role in the development of FTTH broadband access. This has been implemented in several ways:

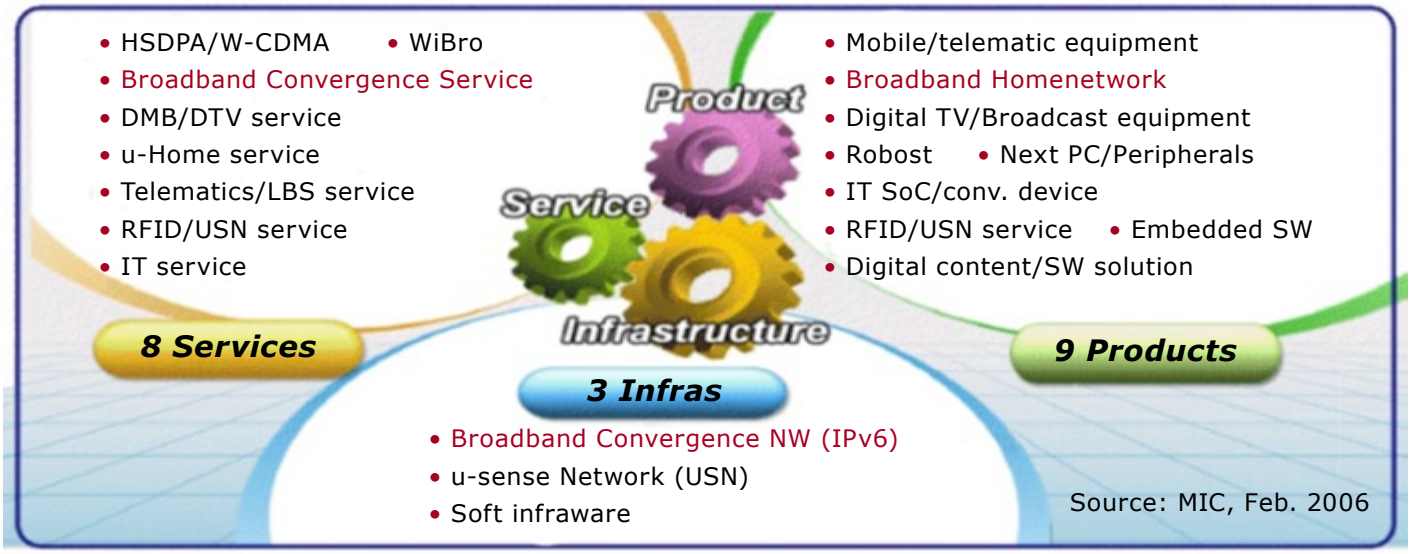
- Development of a series of national plans with specific targets;
- Private sector participation and funding;
- Financial incentive programs;
- Co-ordination with service and manufacturing sectors;
- Organization of model development projects with the participation of multiple competitors.

Chart 3[21] illustrates the concept of multi-sector co-ordination in the Korean planning process, with the simultaneous development of infrastructure, services and products. This was particularly important for creating domestic demand for internet services since Korea has a writing system that is used by no one else in the world.

There is a series of national plans with specific targets that goes back as far as the 1980s when South Korea decided that it would bring teledensity, or individual telephone market penetration, up to the standards of the developed world. This was duly completed.

CHART 3

I-2. u-Korea Strategy



Since then, there have been three plans to increase broadband access capacity, and they were implemented consecutively, as the previous ones were deemed inadequate.

- The Korean Information Infrastructure plan provided for 1 Mbps access.
- A 2010 plan called BcN, or Broadband Convergence Network, and the large-scale implementation of FTTH with speeds of 100 Mbps in urban areas and a minimum of 10 Mbps in other areas.
- A new plan is underway for 2012 with a target of 1 Gbps.

The private sector contributes formally to the national plans with specified investment targets. For example, the current plan calls for US$25-billion, to which the government will contribute only US$1-billion.

The government makes low-interest loans available for specified infrastructure projects. It also has programs of compulsory contributions toward telecom sector investments.

The plans include concurrent developments in related sectors; in this case, it is service or content development and manufacturing. This provides a level of assurance that revenue from new broadband services will be there and that the manufacturing sector is ready to participate in and take advantage of the opportunities in the national market that will help Korea become a world leader in export markets.

The government organizes, with private sector participation, test beds and pilot projects that are large-scale preludes to the major investment programs. Multiple private sector competitors participate, and all have access to what is learned on the bleeding edge. For example, the 100 Mbps plan currently being completed was a pilot project in the city of Gwangju in 2005 in which three major service providers participated. As well as resolving technical issues, mundane but important problems were identified and addressed, such as sharing duct space in apartment buildings.

Part of the plan includes a certification program for apartment buildings that depends on the provision of broadband access speeds of 10 Mbps, 10 to 100 Mbs or 1 Gbps.

In the early 2000s, the government of South Korea planned to replace copper loops with fibre, and it is well on its way to completing the task.

3.2.2 Japan

In Japan in 2011, 68 per cent of households had fixed broadband service. Of these, FTTH reached almost 60 per cent and passed ADSL as early as 2008. Cable is the third competitor, and the incumbent, NTT, has 70 per cent of this market share. Competitors install their own fibre and are most prevalent in the major urban centres. Strong, early participation by the incumbent was also a feature of successful FTTH development. NTT had planned a gradual series of upgrades from dial-up speeds to ADSL and then to FTTH.

The government pitched in early with a Basic Law on the Formation of an Advanced Information and Telecommunications Network Society and set up the e-Japan Priority Program on January 22, 2001, which aimed to provide FTTH to 10 million households by 2005. Facilities-based competitors, local electrical utility companies and the incumbent all began making important FTTH investments. Local governments build fibre in remote and lightly populated areas and provide access to NTT.

NTT cites strong facilities-based competition and market demand for broadband as the major drivers for FTTH deployment. To make this work, NTT invested in additional services such as remote and in-home technical support for applications. It also invested in fibre technology and the development of better construction and installation techniques. For example, to lower installation costs, NTT developed fibre that has improved bending and sheathing properties as well as less friction.

> …[W]e promoted our FTTH service tactically. We started targeting narrow broadband users and introduced a flat rate plan. Our idea was to give them an opportunity to enjoy broadband.
>
> We set up a special site, FLET's Square, an exclusive web site for customers who have subscribed to our broadband service. The site has contents such as cinema, music and community information and a lot of free services. This enhanced our FLET's service and attracted subscribers.
>
> We then sold our FTTH service to existing DSL customers with an appealing bundle of IP telephony service. You may find this interesting. But in Japan, the tariff is increased according to distance. Once our customers switch to the fiber network and subscribe to our IP telephony service, they can make calls at a very attractive price, no matter the distance.[22]

Another important factor in the deployment of FTTH in Japan is the prevalence of aerial cabling, even in residential neighbourhoods. Therefore, it is not necessary to dig to install the fibre, making the cost substantially lower than in Western countries.

3.2.3 Taiwan

Taiwan, with a population of 23 million, also ranks high in FTTH deployment. Seventy-five per cent of homes have Internet access and 80 per cent of those are broadband. Twenty-six and one-half of broadband connections are FTTH, making it the dominant technology.

As in Japan and South Korea, the government in Taiwan has played a major role in planning the deployment of broadband technology and promoting FTTH. The government introduced broadband infrastructure development programs under the Knowledge Economy Project, National Information Infrastructure (NII) Promotion Program and the e-Taiwan Program. "The Broadband Duct Construction Project was established in 2003 to facilitate the creation of a seamless broadband Internet environment, encourage fair competition, and promote the telecommunications and digital content industries."[23]

With more than 180 ISPs in Taiwan, the development of competition has also been a strong feature of the telecom environment. The Broadband Duct Construction Project, for example, was built with public funds and was to be leased to telecom operators on an open access basis. It was intended, among other objectives, to improve the speed of last mile connections. Instead of an open access fibre backbone or FTTH network, the government built duct capacity.

3.2.4 Conclusions – Asian FTTH leaders

The Asian FTTH leaders all had substantial government planning and promotion. While there were various levels of government funding, more importantly, it included the development of a competitive environment, early participation on the part of the incumbent and the co-ordination of service development and product manufacturing capability so that all three sectors were ready to contribute.

This level of co-ordination and private sector investment under government direction or guidance is beyond what could be expected in Western countries. More specifically, it is hard to imagine competitors participating in a major pilot project and sharing the resulting knowledge about everything from duct-sharing problems to technical installation issues.

The incumbents all began participating in FTTH deployment much earlier than did the incumbents in the Nordic countries or North America. This major difference is a result of the government co-ordinated programs. Furthermore, the incumbents made investments in terms of service development and pricing to increase the take-up rate, which is a key risk factor in any FTTH deployment. This contrasts markedly with the more common Western technique of charging early adopters very high prices and then gradually reducing prices as consumer awareness grows and competition expands.

Finally, the predominance of aerial cabling in the last mile significantly reduces the cost of installing FTTH. The developed Western countries cannot replicate this cabling, and it remains a permanent advantage in the major Asian markets. A higher proportion of Multiple Dwelling Unit (MDU) residences also presents an important advantage, making it cheaper to reach more households. Most of the statistics used in this paper include FTTB in FTTH. Since it is uncertain to what extent the fibre continues in the building, the comparisons provided by the overall statistics are somewhat flawed.

3.3 Nationalized Last Mile and structural separation – Australia and New Zealand's

The argument that basic telecom infra-structure is a natural monopoly is making a comeback. This argument, very generally stated, is that an industry can have cost structures such that the bigger a company becomes, the lower its costs. This leads to only one company surviving to serve the market as a "natural" monopoly as opposed to a monopoly that is granted and maintained by the government. The old telco and cableco monopolies were broken up because technical change disrupted the cost structures and enabled competition.

The new argument is that last mile infrastructure has the characteristics of a natural monopoly. The government, or at least a regulated private sector monopoly that is structurally separate from the other service providers, should provide this infrastructure and make it available on an open access basis. Service providers can ride on top, just as private cars, trucks and busses ride on government-owned roads. Australia and New Zealand provide examples of these models.

3.3.1 Australia

Starting in the late 1980s, telecommunications in Australia were gradually liberalized. The incumbent, Telstra, was founded in 1993, and privatization began in 1997, with the sale of one-third of its shares. Optus began as the private sector buyer of Aussat and was licensed as the first long-distance competitor in 1997 when the market was opened to competition. The government later sold most of its remaining shares in Telstra. Telstra and Optus then rolled out competing hybrid fibre-coax networks to carry cable television service.

Broadband connections were 52 per cent of the market in 2008. By 2011, DSL still had over 80 per cent of the fixed line connections with 16 per cent cable and less than 1 per cent fibre. Mobile wireless connections were widespread but used little data.

After years of customer frustration with high prices and slow service, Australia effectively nationalized Telstra's last mile infrastructure and created the National Broadband Network (NBN) Co. Ltd. to build FTTH across the country. At a cost of $37-billion, NBN will bring speeds of 100 Mbps to 93 per cent of the population. NBN will sell capacity to service providers on an open access basis. Delivery to rural and remote areas, largely provided by fixed wireless and satellite service, also played a part in the political motivation to create the NBN.

The incumbent took the position we have seen in many other countries: Consumers are not ready to pay for higher speeds, and there is no market for the additional capacity.

In a country almost as unlikely as the United States to create a government-owned monopoly service provider, the public became so frustrated by the incumbent's position that the political will dveloped to nationalize the last mile.

Some conservatives are having second thoughts. As a government-owned monopoly, NBN has little incentive to be a low-cost service provider, and initial pricing has been causing concerns.

> It is very uncomfortable to sit with telecoms executives in China and be told that the NBN approach would not find favour in their country because, and I quote, "we are seeking to promote competition in telecommunications infrastructure," he said.
>
> "I haven't been to Pyongyang to discuss broadband opportunities … but I imagine our approach would be welcome there," he added.[24]

NBN will be under pressure to recover its costs. As with private sector participants and incumbents, new revenue streams must be found to pay for the infrastructure. Service rollouts have begun in selected areas, but it remains to be seen how well the NBN performs in delivering high-speed broadband to Australians.

3.3.2 New Zealand

New Zealand has taken a different approach. The government imposed structural separation on the incumbent, Telecom Corp of New Zealand. In 2008, Telecom was divided into three divisions: Telecom Retail, Telecom Wholesale and Chorus. Chorus is demerged. Telecom shareholders approved the plans in October 2011.

DSL remained by far the dominant broadband technology in 2011, with fibre connections at less than 1 per cent.

Chorus will have, if it does not already, the infrastructure, the copper last mile network and most exchange buildings along with a contract to build a nationwide fibre network. Telecom is now a retail service provider. As in Australia, how well the policy succeeds remains to be seen.

3.3.3 Conclusions – Nationalized Last Mile and structural separation – Australia and New Zealand

It is too early to form conclusions about the performance of the nationalized approach or the structural separation approach in Australia and New Zealand respectively. Nevertheless, the resultant monopoly structures are unsettling when set against the dramatic improvements that have been made available through competitive telecom markets.

One can understand, however, the frustration of the population with the high prices and the slow adoption of new technology on the part of incumbents, especially when compared with the superior performance of world leaders in Asia. Whether this comparison focuses on the city states of Singapore and Hong Kong or larger countries such as South Korea and Japan, the deployment of FTTH is lagging in Australia and New Zealand and has been for many years.

The lesson for other jurisdictions is that consumers who are aware of global comparisons might be prepared to support dramatic political action to obtain the services that are available elsewhere in the world.

3.4 Emerging leaders – Lithuania and Russia

These emerging leaders have only appeared in country comparisons in the last few years, but their ingenuity and the speed with which they have progressed are worth noting. Lithuania is a tiny country that has managed to deploy broadband at an impressive rate.

Russia, at the other end of the population and geography spectrum, holds the title of fastest-growing FTTH market on the European continent.

3.4.1 Lithuania

In January 2011, fixed broadband penetration was about 20.5 per cent. Of this, the incumbent, LTU, held about 50 per cent of the market share and almost all of the DSL lines. Of the broadband technologies, DSL had 31 per cent, FTTH 13 per cent, FTTB 31 per cent, wireless local loop 13 per cent and cable 7 per cent.

The Lithuanian Information Society Development Strategy for 2010-2015 was under development in January 2011. The strategy set a target of 98 per cent broadband penetration by 2015. Deployment in rural areas is a key part of the plan, as are sign-up subsidies for low-income households.

LTU has been deploying FTTH rapidly, reaching 50 per cent of the population. A WiMAX network reaches 60 per cent of the population.

As an EU member, Lithuania has followed the policy of competitive telecom sectors. The regulator, RRT, has been very active in providing open access procedures and pricing for ducts. This includes the provision of electronic maps of duct infrastructure and co-operation between municipalities and market participants. The RRT has even determined and approved the methodology used to calculate the free space in existing ducts.

In keeping with these initiatives, LTU and the association of cable operators wrote a contract regarding duct use that includes the economic justification for access.

TeliaSonera, the incumbent from Sweden and Finland, is the primary owner of LTU. TeliaSonera took ownership positions in a number of Eastern European countries and brought a strong commitment to FTTH.

Rural deployment has been a strong feature of fibre in Lithuania. There have been two Rural Area Broadband Internet Network (RAIN) projects. This has taken the form of a publicly funded rural fibre backhaul[25] network that provides access to mobile towers, among other technologies. Thirty operators use this network, which illustrates the large number of competitors in a very small market.

Rather than funding last mile infrastructure, the RAIN projects built an open access backhaul network, "…the missing part of the network infrastructure, sufficient bandwidth aggregation part which combines operators' infrastructure segments"[26], as the RRT found that other operators were already building the last mile infrastructure.

EU funding for rural development programs was made available for the RAIN projects.

3.4.2 Russia

Russia is the fastest-growing FTTH market on the European continent, due largely to the increasing competition between the incumbent telephone operators and the cable TV industry in the larger cities. Russia has overtaken the EU in terms of total installations, and it is also ahead of the United States.

ER-Telecom, the fourth-largest cable company in the country, provides an example of this competitive evolution. In 2001, it developed a service called Urban Universal Telecom Networks (UUTN), which combined FTTB with a cable television service and high-speed Internet access. This provided the initial revenue base to compete with the incumbents. ER-Telecom now reaches 5 million homes in 31 cities.

The technology is FTTB only. Further distribution into the apartment buildings is by coaxial cable for the television service and Foiled Screened Twisted Pair (FTP) copper wiring for the Internet connection. ER-Telecom claims that the FTP cable is capable of delivering 1 Gbps service within the building. "To ensure signal quality in each apartment, new metallic and plastic ducts and panels are mounted inside the building, and an individual cable is laid from the converter to each apartment."[27]

ER-Telecom uses municipal electrical aerial infrastructure to deploy the fibre optic cable to the apartment buildings. There is little or no digging involved. It is not clear what terms and conditions are imposed by the municipalities or how this access is negotiated. It takes only four months to deploy the fibre optic cable in a new city and commence service.

3.4.3 Conclusions – Emerging Leaders

Fewer details are available in the emerging leader countries, and the reporting may be somewhat suspect. Nevertheless, these countries demonstrate the development of FTTH in relatively low-income countries.

In Lithuania, a strong commitment from the incumbent, with the backing of ownership experienced in FTTH has been a key factor in the rapid deployment of fibre. EU funding for rural development has a huge impact in small countries such as Lithuania. A little goes a long way. A competitive telecom market, even in a country the size of Lithuania, is a key driver of technological renewal and consumer choice. Finally, the details of access to municipal infrastructure and ROW have also been important.

Russia, on the other hand, is a vast country without any EU subsidies. FTTB, in the ER-Telecom example, has been successful because of a competitive environment. ER-Telecom developed as a start-up with a technical concept for deployment. By combining cable television service with Internet access and VoIP, it effectively created a triple play with the revenue generation capability to pay for the new technology. As in the Asian examples, aerial cabling and access to municipal facilities are major success factors.

TABLE 2

Summary of FTR Development Factors by Country

	Municipal & Local Utility	Incumbent's Commitment	Competition	Government	ROW & Access	Rural
Norway	Early leaders	Recent	Strong	-Promotes digital agenda -Co-ordinates -Rural subsidies	-Municipalities have own access -Dig your own trench	-Early municipal success
Sweden	Early leaders	Recent	Strong (EU)	-Promotes digital agenda -Co-ordinates -Rural subsidies -EU member	-Municipalities have own access -Regulated access	-Early municipal success -EU subsidies
Denmark	Early Leaders	Recent	-Strong (EU) -Some restrictions on municipalities	-Promotes digital agenda -Co-ordinates -Rural subsidies -EU member	-Municipalities have own access -Regulated access	-Early municipal success -EU subsidies
United States	Early Leaders	Recent	Strong, but restrictions on municipalities in 18 states	-Promotes digital agenda -Rural subsidies	-ROW issues are major part of rationale to restrict municipalities	-Early municipal success -Adjusted universal service plan -Wireless possibilities emerging

Cont'd next page

	Municipal & Local Utility	Incumbent's Commitment	Competition	Government	ROW & Access	Rural
South Korea	Minor	Early	Strong	-National plan but private sector dominant	-Field trials to test installation issues, duct -Duct sharing -ROW -Aerial cable	-Part of national plan
Japan	Minor, rural	-Early, -New services & apps for FTTH -Pricing incentives	-Medium, -Incumbent dominant	-National plan but private sector dominant	-Aerial cable -R&D into installation issues	-Municipal participation
Taiwan	Minor	Early	Strong	Major co-ordinating role but private sector dominant	-Aerial cable, -ROW -Duct-sharing major issue	
Australia	Minimal	N/A	-Low/Medium, -Incumbent dominant	-Nationalized last mile -Owns NBN	Frustrations over access a factor in nationalization	-Part of NBN mandate -Wireless
New Zealand	Minimal	N/A	Medium	Demerger	Frustrations over access a factor in demerger	Part of infrastructure mandate
Lithuania	Minor	Recent	Medium, incumbent dominant	-Promotes digital agenda -Co-ordinates -Rural subsidies -EU member		-Private sector last mile with fibre into rural -EU subsidies
Russia	Minor		Medium		Use of utility infrastructure and ROW negotiated	

4.0 Conclusions

4.1 Results from other countries

4.1.1 Demonstrated successes

Countries around the world have demonstrated success with FTTH deployment. The Nordic countries started with municipal and electrical utility networks, often in remote communities. Incumbents are now on board and are deploying FTTH.

In Asia, South Korea, Japan and Taiwan have led the way with competitive markets, co-ordinated planning and early commitment from the incumbents.

In the United States, municipal networks reach approximately 1 per cent of the broadband market, mostly in smaller communities. Major telco incumbents have committed to fibre upgrades in response to the higher speeds that cablecos can offer compared to the telcos' DSL.

Australia has gone so far as to nationalize the last mile infrastructure while New Zealand has forced structural separation on to the incumbent carrier. The last mile infrastructure company remains in the private sector. Neither country is a leader in terms of actual deployment of FTTH, and it remains to be seen if the new state or private sector monopolies can create a better system for consumers in terms of services and pricing.

The following factors are common to differing degrees in the countries that lead in FTTH deployment:

- Competitive telecommunications markets;
- Regulatory structures that define interconnection procedures;
- Access to ROW, infrastructure and services;
- National plans that establish targets and direction for participants.

4.1.2 Rural service

In all cases, the national plans for broadband deployment include provisions for rural and remote development. The EU allocated €1-billion to rural broadband development in 2008. This kind of funding had a huge impact in places like Lithuania. The United States recently updated its universal service fund so that it will apply to broadband access. Other countries have redefined universal service in terms of broadband access rather than access to a telephone.

Nordic countries forming co-operatives to install fibre networks and the United States' municipal network movement meant that rural communities were the first to get FTTH because there was no prospect of obtaining incremental technical upgrades from the incumbents.

In Europe and elsewhere in the late 1990s and early 2000s, delivery of video was an incremental source of revenue that was crucial for the FTTH business model. Direct-to-Home Satellite TV was not able to deliver the vast range of channels in every European language, making it less attractive, particularly in the smaller countries. Rural Europeans live in villages that are more economical to serve with a fibre build than are the widely distributed houses in much of the Canadian Prairies. While this means that European success should be approached with some caution, there are aspects that can be considered for adaptation and adoption in a Canadian context.

4.2 Recommendations for Canada

4.2.1 Leverage competition

The continuing duopoly in the last mile infrastructure is the last element of the telecommunications industry where competition is weak. While the current deployments of FTTH and other technologies to increase bandwidth to the household are to be welcomed, the opportunity to extend competition to the last mile should not be missed. The cost per household is within reach; the potential competitors are in place; and we can bring the benefits of competition to the final segment of our telecommunications networks.

Every successful international example includes competition as a main reason for success. Rural and remote customers who are typically the last to be upgraded by incumbents should, in particular, benefit from this development.

Competition brought benefits in every other sector of telecommunications. Why would we not want to take the opportunity to extend it to the last mile?

4.2.2 Competitors

There are opportunities for third-party commercial companies, for urban business sector fibre installers, and for co-operative initiatives in building FTTH. Local electrical utilities in Canada have not participated much in this market. Yet, we have seen from several examples around the world that these utilities have a natural advantage as infrastructure builders, and they already have ROW. They should be encouraged to participate.

4.2.3 Competitive access to ROW, infrastructure and services

To enhance competition in this sector, there must be processes and procedures to provide companies with access to ROW, infrastructure and services. This was an important factor in all of the leading FTTH countries. The telecom companies have already undergone a similar process to interconnect with each other and to allow resale. Making more adjustments in order to accommodate competition in the last mile should not be a problem.

For example, if the rules and regulations change to allow customer ownership of parts of the last mile out to the nearest pedestal in the neighbourhood, it would remove a large element of risk from the telecom companies, and deployment could proceed more quickly. This is analogous to the change in ownership of inside wiring, which occurred many years ago.

4.2.4 Enabling rural Canada

In rural areas, a connection point can be many kilometres from a household. Co-operative organizations can deliver multiple fibre customers to service providers at planned connection points by using a model that is similar to the Nordic countries'.

Policy-makers and planners need to rethink existing policies and procedures as new wireless technologies emerge so that competitive industry structures will result. In particular, spectrum allocators need to consider the opportunities that are available to drive higher speeds into rural and remote Canada. There will be opportunities to create new configurations of wireless and fibre technologies to deliver services to rural Canada.

Appendix A

The Infrastructure – telecom network fundamentals

This appendix provides a basic understanding of telecom networks and the terminology that is important to the discussion of the last mile. It is not intended to be technically thorough or complete. Tutorials are available on the net for those who are interested in more detail.[28] The incumbent telco network is described first. Cable networks have important differences.

Telco networks used to look this way. The telco owned everything end to end and calls over longer distances were sent to long-haul transmission facilities through a hierarchical switching network. The diagram shows two kinds of local loops: one consisting of twisted copper wire pairs directly from the customer to the CO and another that collects the copper pairs at a remote switch and aggregates them for transmission to the CO using a more efficient carrier system.

Today, there are important differences. Starting at a household, the terminal equipment (phone, computer, router, TV) connects to the inside wiring that connects to a demarcation point, usually on an outside wall. The customer owns everything up to the demarcation point; the telco owns everything after it.

From the demarcation point, a pair of copper wires goes to the CO. COs are sometimes called wire centres or the local switching office. Local loops might also be collected at intermediate steps in pedestals (the boxes or street furniture you see in your neighbourhood) or concentrators that transfer the content into other technologies

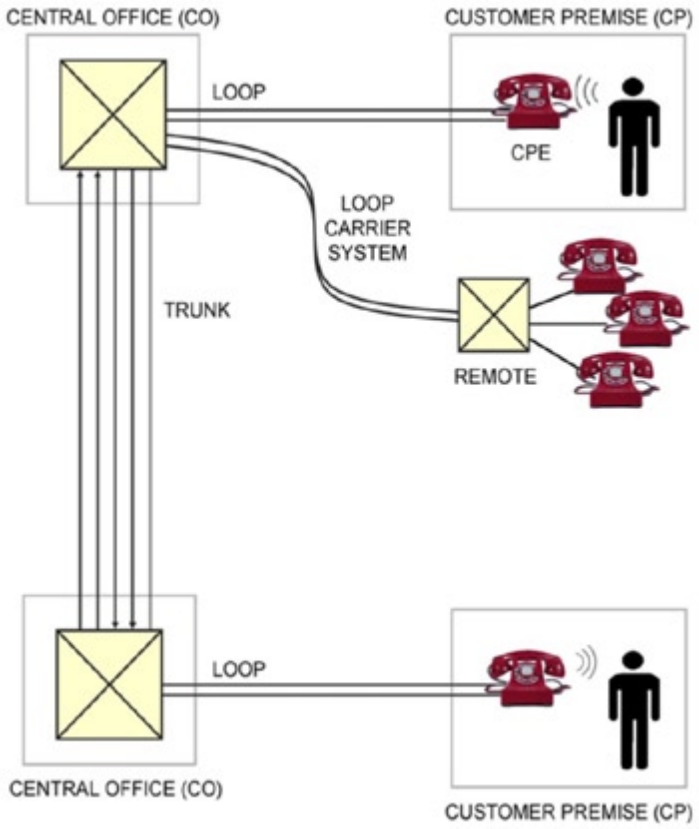


Diagram by TeraCom Training Institute, Copyright 2006

that more efficiently transport it to the CO.

For customers who still have a home phone provided by an incumbent telco), this service might still be provided over old (legacy) technology. High-speed Internet connection is provided using ADSL technology that can use the copper wire in the local loop more efficiently by adding equipment at the customer location and the CO.

From the CO, traffic is sent on very high-capacity fibre optic cables to the next CO in town, across the province or around the world. Fibre optics and the associated transmission capability are behind the huge drop in the cost of telecommunications transmission and the massive increase in capacity over the past 20 years.

Fibre optic cables consist of multiple strands, each of which can be subdivided into wavelengths for data transmission. In many cases, the optical equipment at either end of a fibre optic cable can be replaced with the most recent technology without replacing the cable. When laying fibre, companies will usually install a large amount of spare capacity because the cost of ROW, trenching and installation are high in relation to the cost of the fibre. Dark fibre refers to fibre strands that are underground but do not have the optical equipment attached to transmit data. To light up more fibre means installing the optical equipment so that the fibre is ready to transmit data.

The technical and cost advantages of fibre optic technology are so massive that there is no other wireline technology in use beyond the local loop anywhere that fibre can be installed. Satellite technology competes in point to multipoint applications such as high-capacity video distribution, and it provides services where there is insufficient traffic to warrant installation of fibre. In some cases, fixed wireless technology is used to provide network access and video distribution. Neither satellite nor fixed wireless technology has anywhere near the capacity of fibre.

With earlier telephone technology, calls were switched at the local CO and then aggregated and transmitted to other switches in a hierarchical network system. Telcos handed off traffic at the borders of their territory to the telco in the next jurisdiction. Today, traffic is routed in packets until it reaches its final destination. The language used to transmit Internet traffic is Internet Protocol (IP). Hence, IPTV is the name for television service that is distributed using the same language and technology as the Internet.

Competitive service providers also carry traffic from the CO onward, sometimes using bulk leased facilities from the incumbent and often on facilities they have constructed themselves. From an Internet perspective, the transmission network after the CO is often represented as a cloud.

Competitors can also deliver traffic to COs or intermediate collection points or into the cloud if they have their own access facilities. Resale competitors lease the loop facility or components of it from the incumbent.

Cable networks were originally installed to provide television signals that customers could not receive over the air. The telcos' copper wire did not have the capacity to carry video. The cable companies used coaxial cable that could carry video signals and the associated audio from the head end where they collected the signals and sent them on to their customers. The original systems transmitted in one direction only—from the head end to the customer.

As technology improved, cable investment and capacity grew. Digital compression technology, satellites and fibre optics enabled the cablecos to carry far more channels, and established the capability to include new services when the Internet appeared as the next opportunity. Using a technology called DOCSIS (Data Over Cable Service Interface Specifications), the cablecos became important participants in the ISP market. With this capability, they could provide telephone service using Voice over Internet Protocol (VoIP) and compete in that market as well.

The Last Mile

For telcos, the last mile is still copper. For cablecos, it is coaxial, which has far more capacity than copper but far less than fibre. Telcos have installed fibre beyond the CO to local concentrators or pedestals where the traffic is translated back from optical to electronic signals for final transmission to the homes. They have also begun to install FTTH in larger urban markets. Similarly the cablecos have upgraded technology and installed fibre closer to residents. With higher capacity coaxial cable, in the last mile, they have been slower to bring fibre all the way to the home.

The last mile has not been upgraded to fibre because replacing the local distribution system or building a third one is expensive. It is expensive not only because the technology is more expensive but also because whole neighbourhoods must be converted at the same time, which involves negotiating with municipalities, gas, water and hydro companies that share ROW, and the digging of trenches in established areas. The business case for installing fibre is clear when transmitting massive amounts of data across the country on a few strands. It is less clear in residential suburbs where the traffic density and potential revenue are much lower. Will the existing customers take up new services and make use of the additional capacity in a way that pays for the upgrade? A potential competitor that is contemplating installing a third last mile in addition to the telco and the cableco will have to project how many customers will migrate to its new service and how quickly. Will 30 per cent or 40 per cent change, or only 10 per cent? A great deal of money must be spent before services that generate sufficient revenue to pay for the investment.

The extension of fibre optic technology to residential homes is called Fibre To The Home (FTTH). Intermediate steps also exist. FTTB means to the building, usually an apartment or condominium. The building owner completes the wiring to the individual apartments. FTTC means to the curb. FTTP can mean to the premise without defining how close it comes to the actual building. FTTP usually means to the pedestal, the neighbourhood telco collection point. FTTX is more generic, meaning Fibre To The Whatever.

There are successful examples of competitive FTTX builds. Generally, they are in greenfield subdivisions (The project is built on green fields where new fibre infrastructure can be installed more easily and at lower cost than in areas with existing buildings and roads) or urban apartment buildings and are often connected to local real estate developments and expertise. Incumbent telcos and cablecos have done FTTX builds. In general, however, the last mile still consists of old copper and coaxial cable technology that needs replacing before the next-generation services can really take hold.

There are technical choices that can either enable competitive solutions in the last mile or make it difficult or impossible, thus perpetuating the market power of the incumbents. The cablecos' DOCSIS technology, for example, is difficult to use for resale. While the CRTC requires the cablecos to file interconnection tariffs for purposes of resale, this facility has not been used. Similarly, the telco PON technology described below maintains the single network control model. Other approaches allow for competitive interconnection at the CO, the pedestal or the customer demarcation point.

The following diagram illustrates point-to-point or P2P architecture that connects every customer with fibre. There may also be collection of loops at intermediate points. Competitive interconnection can occur at any of those points. The second diagram illustrates a switched P2P architecture. OLT means Optical Line Terminal and ONT means Optical Network Terminal. OSP means Outside Plant.

The alternative architecture, generally favoured by incumbents, is Passive Optical Networking (PON), where signals are split, either once, or at intermediate steps. Because each customer receives all the signals, competitive interconnection at the intermediate steps is difficult.

Figure 2 – P2P Fibre

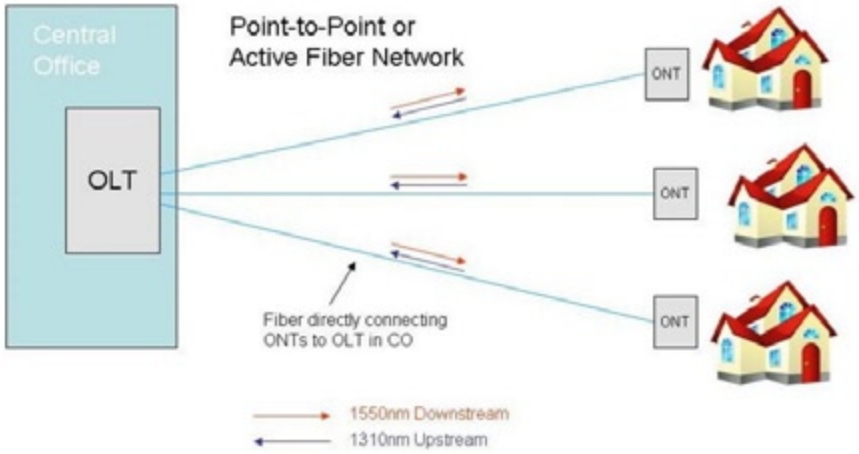
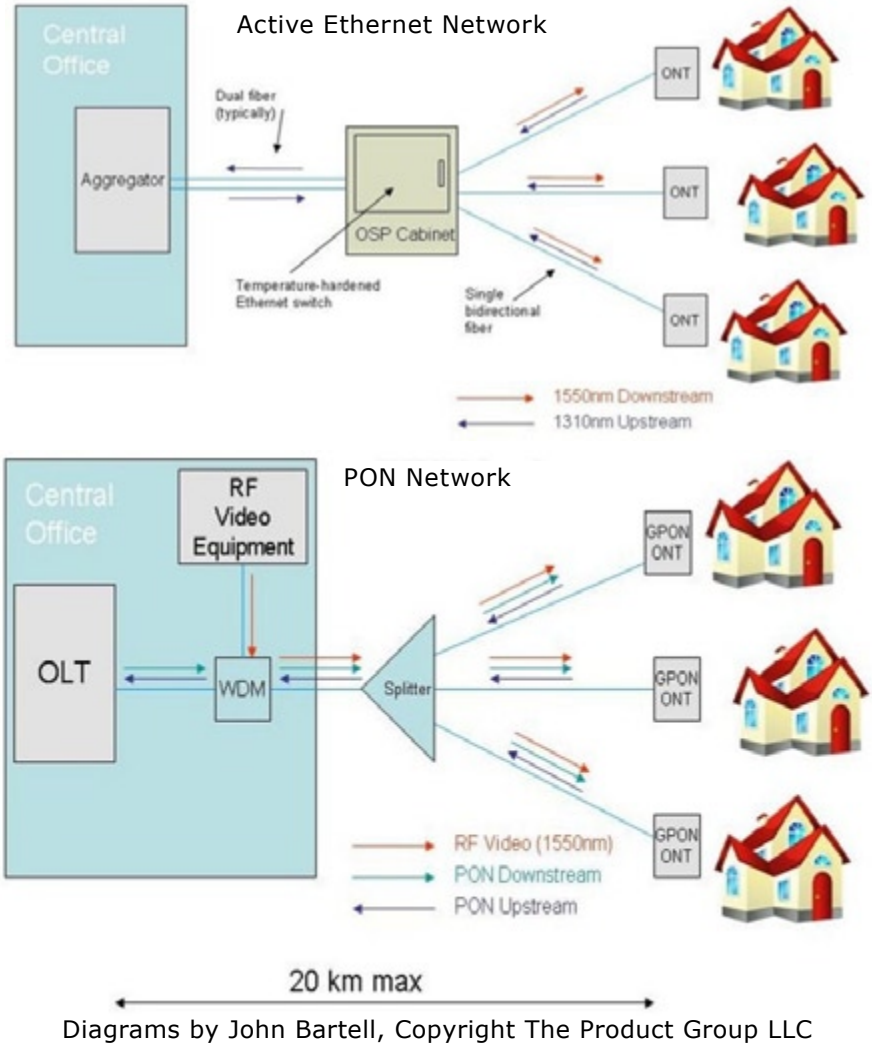


Figure 3 – Switched or Multiplexed P2P Fibre



Diagrams by John Bartell, Copyright The Product Group LLC

Appendix B

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Endnotes

1. Appendix A provides a brief introduction to the technology of the last mile. This appendix was included in an earlier FCPP policy paper "Usage-based Billing and the Future of the Internet."
2. OTT video and the incumbents' pricing responses are discussed in the UBB paper referenced in the previous footnote.
3. Although they provide the same range of services today, the terms "telco" and "cableco" reflect the historical origins of the companies. Thus, Rogers, Shaw and Videotron are cablecos, whereas Bell and Telus are telcos. The distinction is also important because of the different last mile technologies.
4. Broadband and high-speed Internet mean the same thing. Dial-up speed over a regular telephone line provides up to 56 kbps and broadband means anything faster. The government of Canada defines broadband as at least 1 Mbps, and most people think of it as at least 4 Mbps.
5. Other than noting the recognition of the importance of the sector, this paper will not go into further detail on the reasons for considering telecom to be a key agent of economic development.
6. Fixed wireless technology delivers signals from one fixed point to another fixed point like a household or business, as opposed to mobile wireless services that deliver signals to mobile phones.
7. Many of the statistics cited include FTTB (building) or FTTP (premises) as well as FTTH.
8. Wi-Fi and WiMAX are fixed wireless technologies. Home wireless networks are Wi-Fi, as are the wireless access services at most coffee shops and airports. Long Term Evolution (LTE) is the latest mobile high-speed data standard and features higher speeds and capacity. It uses IP, the same protocol as standard Internet transmission.
9. It is difficult to get a precise estimate of this cost. It depends on the type of FTTH deployment, household density, distance to the telco's Central Office (CO) (See appendix) or the cableco's head end from where video signals are distributed to customers, size of the build, take-up rate, time of year and corporate overhead costs and pricing policies. Nevertheless, the main point is that the cost is within reach of the average suburban household.
10. As of the release of this paper, the United States Federal Communications Commission prevented LightSquared from proceeding because of concerns about interference with GPS signals.
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15. Passed means that the fibre is close enough to the household that a customer can subscribe to the service, The proportion that does actually subscribe is called the take-up rate, in this case 25.8 percent.
16. Tomas Skov Lauridsen, National IT and Telecom Agency, Denmark, Broadband Regulation in Denmark, 2009.
17. Churn is the proportion of customers who change to another supplier or drop service entirely over a period of time. A low churn rate means that a supplier incurs lower costs to attract enough new customers to replace the ones that leave.
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24. Malcolm Turnbull, Australia's Liberal Party shadow minister of communications and broadband, quoted by Nick Wood in *Total Telecom,* September 27, 2011.
25. Backhaul is a transmission facility that carries local traffic to the main part of a network. In this case, a local service provider in a remote village can now bring traffic to a location nearby from where it is backhauled on fibre to the main network.
26. Vytautas Tvaronavicius, Public Company Plaèiajuostis Internetas, Head of Technology and Development, Rain Project in Lithuania, 2011, slide 12.
27. FTTH Council Europe, FTTH Case Study, ER-Telecom, 2011, p. 1.
28. See, for example, www.telecomcircle.com, or www.teracomtraining.com, and www.ieee.org has excellent material, as do some of the equipment vendor sites or even Wikipedia.

Further Reading

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