Frequently Asked Questions about Customer Owned Dark Fiber, Condominium Fiber, Community and Municipal Fiber Networks

For more information on this item please visit the CANARIE CA*net 3 Optical Internet program web site at
http://www.canet3.net/news/news.html

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"This FAQ is intended to provoke further thought and debate on the costs and related issues of customer owned, community and municipal fiber systems. The data and information presented here are mine alone and do not necessarily reflect those of the CANARIE board, management or members."

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1. What is customer owned dark fiber?

Dark fiber is optical fiber, dedicated to a single customer and where the customer is responsible for attaching the telecommunications equipment and lasers to "light" the fiber. Traditionally optical fiber networks have been built by carriers where they take on the responsibility of lighting the fiber and provide a managed service to the customer.

With customer owned dark fiber networks the end customer owns and controls the actual fiber and decides to which service provider to whom they wish to connect for services such as telephony, cable TV and Internet. However, most customer owned dark fiber deployments are used for delivery of Internet service.

Professional 3rd parties companies who specialize in dark fiber systems take care of the actual installation of the fiber and also maintain it on behalf of the customer. Technically these companies actually own the fiber, but sell IRUs (Indefeasible Rights of Use) for up to 20 years for unrestricted use of the fiber.

There is no additional management complexity or overhead associated with customer owned dark fiber. In fact in many cases customer owned dark fiber may be more reliable than traditional telecommunication services and easier to manage because it vastly simplifies the network architecture and allows the consolidation of network services to a central hub.

In addition customer owned dark fiber provides for increased competition among service providers and levels the playing field amongst all service providers for the delivery of telecommunication services. With customer owned dark fiber, customers build networks to carriers, rather than the traditional model where carriers build networks to customers.

With customer owned dark fiber, the customer can now interconnect to the carrier(s) of their choice at a convenient meet-me point such as a school board office, municipal building or a carrier neutral collocation facility. This is particularly advantageous for the interconnection to

new smaller innovative communication companies or ISPs who cannot afford to build expensive physical network infrastructure.

In essence customer owned fiber is moving the demarcation point where the carrier interconnects to the customer. In the old days of telephone monopoly the demarcation point was the customer themselves as the carrier owned the telephone and the inside wiring. With competition the demarcation point has moved to the edge of the customer premises. But with low cost fiber and new LAN based Ethernet technologies the demarcation point is moving closer and closer to the carrier.

2. What is condominium fiber?

All across North America businesses, school boards and municipalities are banding together to negotiate deals to purchase customer owned dark fiber. A number of next generation service providers are now installing fiber networks and will sell strands of fiber to any organization who wish to purchase and manage their own dark fiber. Many of these new fiber networks are built along the same model as a condominium apartment building. The contractor advertises the fact that they intend to build a condominium fiber network and offers early participants special pricing before the construction begins. That way the contractor is able to guarantee early financing for the project and demonstrate to bankers and other investors that there are some committed customers to the project.

The condominium fiber is operated like a condominium apartment building. The individual owners of fiber strands can do whatever they want they want with their individual fiber strands. They are free to carry any type of traffic and terminate the fiber any way they so choose. The company that installs the fiber network is responsible for overall maintenance and repairing the fiber in case of breaks, moves, adds or changes. The "condominium manager" charges the owners of the individual strands of fiber a small annual maintenance fee which covers all maintenance and right of way costs.

3. What are community or municipal fiber networks?

Many municipalities are now looking at the advantages of condominium or customer owned fiber. Not only do these networks substantially reduce telecommunication costs, but they have also can significantly increase the number of competitive service offerings because any service provider can also purchase strands of fiber.

It is not necessary that municipality or community own the fiber or build the networks themselves. Municipalities and communities can encourage the deployment of condominium fiber networks in their jurisdiction by tendering their existing telecommunication business only to those companies that will deploy such networks. In some cases provincial, state and federal governments can play a critical leadership role by providing additional funding to make sure that all communities can enjoy the benefits of condominium fiber networks. A couple of excellent examples of this model are:

For Chicago CivicNet see
http://www.cityofchicago.org/CivicNet/civicnetRFI.pdf

For Alberta SuperNet see
http://www.canarie.ca/advnet/workshop_2000/presentations/cheney.ppt

4. What is the advantage of customer owned dark fiber to schools, hospitals and libraries?

The organizations that are usually the earliest beneficiaries for dark fiber are schools and school boards. The initial primary driver for dark fiber by individual customers is the dramatic savings in telecommunication costs. The reduction in telecommunication costs can be in excess of 1000% depending on your current bandwidth requirements.

A typical dark fiber connection may cost one time $25,000. If your organization is currently leasing an OC-3 circuit (155 Mbps) it could be paying anywhere between $3000 - $6000 per month which results in an annual cost greater than purchasing dark fiber. If your organization is leasing local loops with greater capacity then OC-3 the cost savings can be more dramatic.

The typical payback for dark fiber as opposed to purchasing managed bandwidth is 12 to 18 months. And for this short payback the customer gets a "future proof" network for the next 20 years where there is no increase in local loops costs as the customer's bandwidth demands increase except to upgrade the equipment at the ends of the fiber.

Some of these benefits customer owned dark fiber include:

(a) Significantly reduced local loop costs for connecting each school to the central school board office. Typical average cost to connect up a school is $US 25, 000 per school for a 20 year IRU. In some cases the fiber can be leased at price of typically around $400 per month per school.
(b) Reduced network management complexity in that only simple and easy to use Fast Ethernet or Gigabit Ethernet transceivers are needed at each end of the fiber
(c) No additional costs to increase the bandwidth of the network other than to upgrade the transceivers at the end of the fiber.
(d) Dramatic reduction in the number of network, Web and LAN servers. With dark fiber the individual school LANs can be extended to the central school board office. All of the servers can be relocated to the central site and aggregated into single server systems. This significantly reduces network management and complexity.
(e) Significant reduction in network staff and travel, as most of the LAN and network servers are relocated to a central site.
(f) A greater choice of service providers for Internet and other advanced services. For those school boards that use a carrier to connect to the school are then limited to in most cases one or two carriers who can connect up the schools in their district. But if the schools purchase their own fiber they can aggregate their traffic and then connect to a greater choice of service providers at the central school board office. It also makes their network business more attractive for out sourcing.

(g) Development and deployment of new applications and services that would not be possible with a limited bandwidth service. Many schools with dark fiber, for example, are putting Internet telephones on each teacher's desk. With a dark fiber network there is no additional cost to provide such service, except for the purchase of the telephone itself. Other applications include video conferencing and distance education.

CANARIE and Industry Canada have contracted with independent consulting firm to document the benefits and savings of school boards deploying their own dark fiber networks. A presentation ons study is available on our web site at http://www.canarie.ca/advnet/workshop_2000/presentations/waldron.pdf

However, school boards should be careful to compare total solutions package where a carrier owns and manages the fiber to the school versus purchasing their own dark fiber. Many school boards and governments are enticed with the worry free management of wide are network where the carrier owns the fiber to the school or other facility. While this may be attractive at first, it will limit the school in terms of its future options. When a school board goes to renew their contract a few years down the road, the incumbent carrier who installed the initial fiber will have a competitive advantage over any other new entrant in the marketplace who must now also install fiber to the school.

As most schools are located in suburban/rural areas, there is rarely a business case for a second carrier (never mind a third or fourth) to build a fiber network to the school. When the school comes to renew its service contract it will discover that the original provider will have a significant competitive advantage over any other service provider.

Schools, because of their geographic location and because they are usually the first organization to acquire dark fiber in the community have a responsibility, perhaps more so than any other organization in the community, to ensure a level playing field and not to confer competitive advantage to any single carrier.

5. What is the advantage of customer owned dark fiber to a large businesses?

Many large businesses have been acquiring dark fiber for some time now. The advantages for a large business are as follows:

(a) significant reduction in local loop telecom costs;
(b) centralization of servers from remote offices scattered around a city;
(c) ability to capitalize telecom expenses rather than treating them as an ongoing service cost;
(d) ability to deploy redundant paths to multiple carriers. Usually, in the past, this has been done by purchasing to separate SONET services from different carriers at considerable cost;
(e) outsourcing LAN, storage and network servers;
(f) relocation of speed sensitive network servers to a server farm. Normally speed sensitive servers such as LAN based video and audio servers have to be located on the LAN next to the user. However as there are no speed limitations with dark fiber these servers can be easily located at a central server;

A number of integrators and out sourcing companies will arrange the dark fiber connections for a large business as part of the out sourcing package.

6. What is the advantage of customer owned dark fiber to a small business?

Surprisingly, even small businesses with fewer than 30 employees can benefit from customer owned dark fiber. This is particularly true of new high tech e-commerce or other web based businesses. The advantages for a small business are as follows:

(g) Significant reduction in local loop telecom costs;
(h) Ability to capitalize telecom expenses rather than treating them as an ongoing service cost;
(i) "Customer facing" servers such as e-commerce servers, web hosting servers, etc can be located at carrier neutral collocation facility where there is redundant power, 24 hour security, and multi homing services are located. If the telecom link between the collocation facility and the office goes down, no customers are affected.
(j) Outsourcing LAN, storage and network servers;
(k) Relocation of speed sensitive network servers to a server farm. Normally speed sensitive servers such as LAN based video and audio servers have to be located on the LAN next to the user. However as there are no speed limitations with dark fiber these servers can be easily located at a central server;

7. What is the advantage of customer owned dark fiber to high rise office building owners and managers?

Increasingly large building owners are facing congestion in their telecommunication risers from all the new entrant telecom companies who want access to their tenants. A number of large building owners have now declared a moratorium on new entrants. In fact some building owners are proposing that no carriers be allowed into the risers. Instead the building owners themselves are installing fiber in the risers (usually 2 risers for redundancy purpose) from each tenant to equipment room in the basement where they interconnect to the carriers.

But even then that is a partial solution. The access ducts to the building is becoming congested as well as the equipment room in the basement. The next logical step is to extend the tenant's fiber beyond the basement to a nearby open collocation facility. The building owner may acquire 48 or more strands of customer owned fiber to at least 2 separate collocation facilities. As part of the leasehold package the tenant can lease this fiber for the duration of their building lease to access a service provider of their choice at the collocation facility.

In many cities, companies are building collocation facilities to allow the interconnection of networks between competing service providers and for the hosting of web server, storage devices, etc. In fact, many of these facilities are being built by the same companies that have also own large high rise buildings. The collocation facilities are rapidly becoming the obvious location for terminating customer owned dark fiber. With a simple change in the optical patch

panel in the collocation facility the customer can quickly and easily change service providers on very short notice.

The tenants in such buildings can then lease several dark strands fiber within these trunks to one or more of the carrier neutral collocation facilities.

By leasing fiber to separate collocation facilities the tenant is assured of route diversity and redundancy in case of a fiber break. The building tenants can now easily outsource their web and network services to a number of competitive out-sourcing companies located at the carrier neutral collocation facility. With dark fiber there are no worries about congestion or bandwidth bottlenecks for the business to access its own server.

In summary the benefits of customer owned dark fiber to large building owners are:

(a) It eliminates congestion in the risers and thereby saves valuable floor space;
(b) It significantly reduces cost of telecom services for tenants;
(c) It reduces congestion in the building access ducts and machine rooms;
(d) It allows for a new line of business to give the tenants the ability to outsource their server to a collocation facility, particularly if that facility is also owned by the building owner;
(e) It provides for a greater choice of server providers for the tenants in being able to access a greater number of service providers at the collocation facility; and
(f) It allows the tenants to establish redundant and diverse paths to 2 different service providers at 2 different collocation facilities.

8. What is the advantage of customer owned dark fiber to universities and research institutes?

In addition to the many benefits of dark fiber for school and large businesses and universities as listed above customer owned dark fiber has a number of significant advantages for universities and research institutions:

(l) It significantly reduces telecom costs in connecting satellite campuses;
(m) It allows the deployment of new high bandwidth applications without a bandwidth cost penalty; and
(n) It allows the testing and deployment of new optical technologies that would not be possible with a managed carrier service

9. What is the advantage of customer owned dark fiber for the consumer or home owner?

The Fiber To The Home (FTTH) market is still in its infancy. However, customer owned ark fiber is increasingly being seen as a superior alternative to the current proposed approaches for FTTH by the telephone and cable companies.

The telephone companies are focusing on a technology called Passive Optical Networking (PON) and the cable companies are generally deploying Hybrid Fiber Coax systems (HFC). The

problem with both approaches is that network service are closely intertwined with network architecture. This may be of great value for the incumbent telephone and cable company but it does little for the consumer.

Consumers and government want to see more service providers and competition beyond the existing duopoly they have today. Wireless will provide a partial solution but is unlikely to scale to Gigabit speeds.

As an example of the benefits of customer owned dark finer, in Stockholm, where the city has been deploying dark fiber for a number of years, consumers have a choice of 4 cable companies. While in North America competitive service providers are battling for access to a single monopoly service provider.

Several companies are now developing technology for deliver of Ethernet to the Home. The beauty of this technology is that it uses a well know open standard for the delivery of service. The technology can used to support voice, video and extreme high speed data.

Ethernet delivery of services can be best accomplished with optical fiber. The big challenge for governments is whether the deployment of broadband services to the home be a monopoly service like tthe cable and telephone model where the service provider owns the infrastructure, or an open model where the consumer owns (and delegate management to a service provide of their choice) the infrastructure and connects to the service provider of their choice at open collocation facility?

Carriers who have built telecom infrastructures under government regulated monopoly have a significant advantage in the market place. If the consumer owns or controls the infrastructure they can then connect to the service provider of their choice. More importantly it levels the playing field as it allows small service provider who cannot afford to build a costly infrastructure to sell services to the consumer.

10. What is the advantage of customer owned dark fiber to Internet Service Providers?

Many service providers cannot afford to build a large telecommunications infrastructure. Carriers who have built such infrastructures under government regulated monopoly have a significant advantage in the market place. However, if the customer owns the fiber then they can connect to the service provider of their choice at a carrier neutral collocation facility. Customer owned dark fiber levels the playing field and gives all ISPs an equal opportunity to capture the customer's business.

The customer can delegate management of the fiber to the service provider of their choice for the life of the service contract. The service provider is then responsible for fiber maintenance and end to end service. However, when the customer owns the fiber they can change service providers at any time (or at the end of the service contract) to some other service provider and enter into a similar arrangement where the new service provider is responsible for end to end performance.

Carrier neutral collocation facilities are an essential component of providing such an arrangement. Carrier neutral collocation facilities with fiber "meet-me" rooms allow the organizations with customer owned fiber to easily switch from one service provider to another.

11. What is the advantage of customer owned dark fiber to municipalities and governments?

When independent carriers deploy their own fiber networks to the customer premises each provider needs to deploy separate fiber cable to virtually very building and within every riser in each building. This results in a significant number of independent fiber cables and hence road trenching that is required to interconnect all the downtown buildings with the multitude of service providers.

The other result is that many municipalities are declaring moratorium on digging up the roads by carriers who want to install new fiber cables. As well many cities are refusing to grant new construction permits for any road section that has been repaved or rebuilt within the last 5 years. The companies that have already deployed fiber then have a de facto monopoly for the next 5 years. If customer or service providers cannot purchase dark fiber at a reasonable cost it them becomes very difficult for downtown businesses to connect to competitive service providers.

In recognition of this issue some cities are being proactive and are providing incentives or mandating that carriers install additional open access conduit when they dig up the road to install new fiber, or provide open access fiber at an agreed upon price. Municipalities can leverage their existing telecommunication procurements and their private right of ways to negotiate open access fiber builds throughout their jurisdiction.

An excellent example of this approach is the Chicago CivicNet project where the City of Chicago will offer its annual telecommunications budget of $US 25 million and access to city ducts, subway tunnels and other facilities to companies who will install open access condominium fiber to all public sector buildings in the city. For more information please see http://www.cityofchicago.org/CivicNet/civicnetRFI.pdf

The province of Alberta in Canada has launched a similar initiative for all 430 plus municipalities in that province in a project called SuperNet. In this example the province offered its telecommunication business plus $CDN 183 million to a consortium of carriers to deploy open access condominium fiber to all schools, libraries and hopitals in every community in the province. The provinces holds title to the IRUs on all the fiber and then earns back its investment as the fiber strands are sold off to competitive service providers, school boards, etc. See http://www.canarie.ca/advnet/workshop_2000/presentations/cheney.ppt.

There are also some excellent documents on the benefits of community fiber infrastructure at http://www.bev.net/project/digital_library/
that discusses the key structural impediments to an open telecommunications marketplace in communities and neighborhoods, reviews some of the history of community infrastructure

investment, and offers some steps that communities can take to begin to create a level playing field for open, private sector investment in telecommunications.

12. What are carrier neutral collocation facilities?

In many cities, companies are building facilities to allow the interconnection of networks between competing service providers and for the hosting of web server, storage devices, etc. They are rapidly becoming the obvious location for terminating customer owned dark fiber.

These facilities feature diesel power backup systems and the most stringent security systems. The facilities are open to carriers, web hosting firms and application service firms, internet service providers, etc.

Most carrier neutral open collocation facilities feature a "meet-me" room where fiber cables can be cross-connected to any service provider within the building. With a simple change in the optical patch panel in the collocation facility the customer can quickly and easily change service providers on very short notice.

Many of these concepts of carrier neutral collocation facilities were first developed with the next generation Internet programs in the United State and Canada with a concept called a GigaPOP. Leading researchers and universities recognized that there were many benefits to interconnecting to carriers at a common "meet me" point. So rather than having multiple carriers build separate facilities to university campuses, the universities instead built one single telecommunication facility to a GigaPOP and then interconnect to one or more carriers on a new demarcation point that was not on the customer premises.

When selecting a fiber provider, care should be taken to see if their fibers terminate at carrier neutral collocation facilities. Some fiber providers only terminate their fiber in their own central offices which makes it difficult to interconnect to other service providers or attach your own equipment to the fiber.

13. What equipment do I need to light up dark fiber?

With customer owned dark fiber, simple laser devices, called transceivers are all that is required to light up the fiber. These devices will work with SONET, ATM and Ethernet devices at either end of the fiber connection. As such there are only 3 things that can wrong with a customer owned dark fiber - the source transceiver, the destination transceiver or the fiber itself.

Transceivers for Ethernet data can drive fiber up to 120 km. The following are typical distance and prices for Ethernet transceivers:

(a) Fast Ethernet (100 Mbps) transceivers can drive fiber up to 80 km and will run about $US 700 per end
(b) Gigabit Ethernet transceivers will drive up to 60km and will run about $US 2000 per end.

Prices for transceiver are dropping dramatically. Already 10 Gigabit Ethernet transceivers chip sets that will drive 40 km of fiber are being sampled at less than $US 100. These transceivers usually can be controlled and managed by standard LAN management systems.

There are numerous companies that sell fiber transceivers. For more information please see www.light-wave.com.
Most Gigabit Ethernet equipment manufacturers include long haul lasers and can be directly attached to the dark fiber as well.

14. What is the typical costs of customer owned dark fiber?

Customer owned dark fiber is still a very immature industry. As such costs for fiber can be extremely variable from as little as $.50 per meter per strand to $6.00 per meter per strand for a 20 year IRU. Part of the problem is simple economies of scale. The biggest cost component of fiber networks is the installation cost. The installation cost is virtually the same whether you are installing a 12 or 864 strand cable. Fiber networks deployed with 12 to 48 strands have a much higher cost per strand cost than 864 strand systems. Other complicating factors depend whether roads have to be trenched to lay down the fiber, or whether existing support structures such as poles and conduit can be used for the installation of the fiber.

For budgetary purposes $2 - $3 per meter per strand-pair can be used for a 20 year IRU. Additional strands do not significantly increase the cost. So a budgetary price for 4 or 6 strands of fiber may be around $4 per meter. The prices are the same whether it is Canadian or US dollars.

The key thing to note that this is the one time up front cost for the purchase of a 20 year IRU. The IRU can usually can be considered as a physical asset which can be re-sold, traded or used a collateral. As such, the cost of an IRU can be amortized over its 20 year lifetime which results in a monthly cost substantially below traditional telecommunication services.

If your organization is required to go through a RFP process to purchase dark fiber you will probably not get much better pricing than these budgetary numbers. But because the fiber industry still is a very immature and underdeveloped, sophisticated customers who are able to "wheel and deal" can get much better pricing outside of a standard RFP pricing mechanism. By agreeing to pay for certain build outs and swapping fibers with other new entry carriers knowledgeable fiber customers can reduce their per strand cost to less than $.10 per meter per strand. In some jurisdictions independent fiber consultants are available who can also negotiate very attractive pricing.

Ultimately however as the industry matures and large optical cables with 864 strands or greater or routinely deployed the cost of dark fiber is expected to drop down to $.07 to $.10 per meter per strand.

15. What are the some detailed cost components of customer owned dark fiber?

Dark fiber is made up of 3 different cost components:

(a) Trunks;
(b) Laterals; and
(c) Termination panels

Trunks are the main fiber cables that may carry hundreds of fiber strands owned by a variety of carriers and institutions. Laterals are the fiber cables from the customer premises to the nearest splice point on the cable trunk. Generally laterals are used exclusively by the customer and therefore the customer must pay for the full cost of the cable and its installation. Within cities laterals can be short as few meters. They can extend several kilometres in suburban and rural areas.

In some cases the costs of a lateral, particularly in suburban and rural areas can be more costly than the much longer fiber run on a trunk cable.

The minimum size of a lateral is usually 12 strands. But even though a lateral may have 12 strands, only 2 or 4 of those strands may be spliced to dedicated fibers on the trunk. Most fiber provisioning companies provide additional spare strands on the trunk to which the customer can connect to at a later date for an additional cost.

Termination panels are the facilities within the customer's premise for the termination of the fiber. As a rule of thumb a fiber panel termination is about $US 5000, but may very from as little as a few hundred dollars to $15,000 - $20,000. The large variation in cost is due to many factors including whether the installers have to drill through concrete walls to terminate the fiber and/or bring up the fiber several floors in a riser.

For either trunks or laterals the basic cost calculation is the same. Overwhelmingly the single biggest cost is the installation of the fiber itself. On fiber trunks the cost of the installation is shared amongst the owners of the individual fiber strands and so on a large cable trunk of 864 fibers the installation cost per strand can be quite small. On laterals there is generally no other users, so the customer must pick up 100% of the cost.

There are 4 types of fiber installation:

(a) Aerial on existing poles ($3 - $6/meter);
(b) Buried in existing conduit ($7 - $10/meter);
(c) Jet fiber in micro conduit ($3 - $15/meter); and
(d) New trenching and laying of conduit ($35 - $200/meter).

Installation charges are almost entirely made up of labour costs, so the numbers quoted above are pretty well the same whether they are stated in Canadian or US dollars.

Aerial installation on existing poles is by and far the cheapest installation method and the most reliable. Most regulatory bodies have well established rules and procedures for licensed carriers and fiber installers to access existing utility and telephone poles. The variation in the cost of aerial installation is largely dependent on how accessible the poles are from the street. If the poles are in the backyards and only accessible by foot then the installation costs are at the higher end of the range stated above. If the poles run right along the roadside then installation can be done directly from the truck on the roadside.

Installation in existing conduit is the next best option. Many municipalities and regulators require carriers to install extra conduit accessible by any other licensed carrier or fiber installer. As with poles regulators have set prices for the cost of access to this conduit.

Jet fiber is a new approach to fiber deployment. In this case the fiber provider only installs "micro conduit" instead of fiber. When a customer requires a fiber pair it is blown into the micro conduit on demand. The advantage of this approach is that far fewer splices are required and the fiber can be blown all the way into the customer premises. Currently the capital cost of jet fiber is higher than for traditional approaches but it is expected that the on-going systems costs are lower.

If there are no existing conduit or poles, commonly referred to as support structures then a fiber trench must be dug and new conduit installed. This is by and far the most expensive approach. In the downtown core trenching costs can be prohibitive because of the obvious disruption of traffic and the complex existing ductwork that already lies beneath most of our downtown streets.

A new approach which is coming onto the market is installing fiber in sewer lines. This technology appears to be 1/3 to the cost of new trenching.

There are a number of different approaches if you are forced to deploy new fiber where there are no existing support structure such as poles and conduits:

(a) Traditional trenching and conduit deployment with a backhoe;
(b) Direct bury with a "fiber plough" where no conduit is deployed;
(c) "In the groove" technology where a very narrow grove is cut into the existing roadbed;
(d) "Sewer" systems where robotic systems install fiber in storm or sanitary sewers using either specialized cable or stainless steel tubing; and
(e) "Directional boring" where for short distances a tunnel can be bored laterally underneath the ground.

In any event trenching of any kind should be avoided as much as possible. As you will see in later sections fiber on poles in most situations results in the most reliable installation, even over buried fiber.

If you are planning to build a condominium fiber network then you may have to add an additional $1 - $3/meter for engineering, design, supervision and installation. In addition

condominium cables are priced on a section by section basis, with the price varying depending on how many users are in a section and the specific costs of each section.

The cost of fiber cable itself varies depending on the number of strands in the fiber cable and whether it is a standard single mode fiber or a specialized low attenuation type of fiber.

The following costs are typical costs of SMF-28 fiber cable in US dollars:

(a) $.15 per strand per meter for 36 strands or less
(b) $.12 per strand per meter for 96 strands or less
(c) $.10 per strand per meter for 192 strands or less
(d) $.05 per strand per meter for more than 192 strands

The standard minimum cable size is 12 strands. So the lowest cost for a lateral cable is $1.80 per meter for the cable plus $3 - $6 per meter for the installation. As a rule of thumb then laterals are priced at $5 per meter aerial, $10 per meter in existing conduit and $35 per meter if new trenching is required.

On large cable fiber trunks a budgetary number of $.50 per meter per strand (i.e.. $1 per meter per pair) is reasonable. The cost of installation is negligible on a per strand basis.

16. What are the ongoing yearly costs for customer owned dark fiber?

As a rule of thumb the annual maintenance and right of way charges for dark fiber amount to 5% of the capital cost.

In some cases fiber installation companies waive all annual maintenance costs for schools and hospitals if other strands of fiber in the cable bundle are used to carry commercial services.

There are two components to the annual charges:

(a) Right of way charges; and
(b) Annual maintenance charges.

Both charges are assessed against the fiber cable and not the individual strands. So once again the per strand cost of these charges can be very small for large strand cables.

Government regulators such as the FCC in the United States and the CRTC in Canada have established set prices for the costs of right of ways on public land, or for regulated telecommunication facilities. In the United States the situation can become more complex because Public Utility Commissions may have a different set of rules then the FCC.

The regulated telecommunication facilities are called support structures and are devices that are currently used to carry regulated telecommunication services. So generally existing telephone poles, utility poles and telephone company conduit is covered under these regulations. However

utility poles that do not carry any existing telecommunication facilities, railroad bridges and road bridges are generally not covered by these regulations. The owners of these facilities do not have to provide access to other carriers to their facilities, and if they do, they can charge any price the market will bear.

As a rule of thumb the following are the typical right of way costs:

(a) $1 per pole per month
(b) $.50 per strand of support wire between poles per month
(c) $1 per meter of existing conduit

Right of way costs therefore work out to be typically $.50 per meter per year on poles and $1 per meter per year in an existing conduit. Many cities are also assessing right of way charges in the downtown core to reflect increased costs to the city for traffic disruption etc. These costs typically average $20 per meter per year.

It is important to note these costs are assessed against the fiber cable. The more fibers in the cable, the less cost per strand.

Maintenance charges vary between $150 to $250 per kilometre (or mile) per year.

17. How reliable is dark fiber?

Customer owned dark fiber can be more reliable than traditional telecommunication services particularly if the customer deploys a diverse or redundant dark fiber route.

Dark fiber is a very simple technology. It is often referred to as being technologically neutral. Sections of dark fiber can be fused together so that one continuous strand exists between the customer and the ultimate destination. As such the big advantage of customer owned dark fiber is that no active devices are required in the fiber path. Since there are no active devices customer owned dark fiber in many cases can be more reliable than a traditional managed service. Traditional managed services usually have a myriad of devices in the network path such as SONET multiplexers, Add/Drop multiplexers, ATM switches, routers, etc etc. Each one of these devices is susceptible to failure and that is why traditional carriers have to deploy complex networks and systems to insure reliability and redundancy.

Many customers assume that because the carriers deploy SONET rings that they have a reliable network. In fact SONET rings are generally only deployed between carrier central office. Most customers today, except in exceptional circumstances only have one unprotected link to their nearest central office and this is their single weakest link in their network.

For the greatest reliability many customers will install 2 separate dark fiber links to 2 separate service providers. Even with the additional fiber for redundancy, customer owned dark fiber networks are cheaper than managed services from a carrier.

With dark fiber customers have a number of choices in terms of reliability and redundancy:

(a) They can have single unprotected fiber link and have the same reliability as it exists today with their current carrier;
(b) They can use alternative technology, such as a wireless link for backup in case of a fiber break; or
(c) They can install a second geographically diverse dark fiber link whose total cost is still cheaper than a managed service from a carrier.

Because fiber has a greater tensile strength than copper or even steel, it is less susceptible breaks from wind or snow loads.

18. Does dark fiber increase my network management costs and complexity?

Network cost and complexity is significantly reduced with customer owned dark fiber in a number of ways:

(c) Dark fiber has no active devices in the path as in a typical carrier network, therefore are fewer devices to mange and less thing that are likely to go wrong;
(d) Repair and maintenance of the fiber is usually contracted out to 3rd party fiber maintenance companies. These companies are in many cases the same companies that carriers use to maintain their fiber;
(e) Dark fiber allows organization to centralize servers and/or out source many different functions such as web hosting, server management, etc

Many school boards, for example, who have deployed dark fiber have been able to dramatically reduce the number of servers required at each school and the associated management and travel costs.

Dark fiber allows large enterprise customers, universities and schools to essentially extend their in house LANs across the wide area. Because there is no effective cost to bandwidth with dark fiber the long distance LAN can be still run at native speeds with no performance degradation to the end user. It is therefore very simple to relocate a server to a distant location where previously it required close proximity because of LAN performance issues.

19. Won't dark fiber become obsolete like other telecommunication technologies?

Fiber is technology neutral. It is a transparent medium similar to the "air" through which radio signals travel. Similar to wireless networks it is the equipment at the ends that will change but the "transmission medium" remains largely unchanged over time. The equipment at the end of the fiber, as in wireless systems will have to be upgraded from time to time. But the cost of the equipment at the end of the fiber is trivial compared to the cost of the fiber itself.

Fiber that was installed 20 years ago is still good today as when it was installed.

The big change that is occurring with fiber is the cost of installation as calculated on a per strand basis. The single biggest expense of dark fiber networks is the installation of the fiber cable itself. A few years ago most fiber cable systems were only 12 or 48 strand cables. Today many cable systems that are being installed may incorporate up to 864 strands of fiber.

Since the cost of installation is almost the same regardless of whether it is a 12 or 864 strand system, the economies of scale are significantly driving down the per strand cost.

However, to be on the safe side, a general rule of thumb is dark fiber should pay for itself in 5 years or less compared to the purchase of a managed service. If you cannot obtain a 5 year payback then dark fiber may not be the right solution for your organization.

20. Does this mean that governments are becoming telecommunication service providers?

No. But governments are starting to recognize that customer owned dark fiber is a powerful economic enabler of new commercial services and will be as fundamental to the economic and social well being of the community as publicly owned roads and bridges have been in the past.

In recognition of that fact some municipal, state and provincial governments are offering their telecommunication business and offering access to municipal ducts and sewers as an incentive for the construction of open access conduit and customer owned dark fiber networks. The Peel County fiber build
http://www.canarie.ca/advnet/workshop_2000/presentations/wiseman.ppt
and the City of Chicago fiber build
http://www.cityofchicago.org/CivicNet/civicnetRFI.pdf
are examples of this approach.

A number of new next generation fiber companies are now willing to work with municipalities to deploy open access dark networks under terms set by the municipality. These companies do not offer any services. All they do is install and manage dark fiber networks.

21. What role do regulators and government play with respect to condominium fiber?

Regulators and governments at all levels, but particularly municipal governments play a critical role in the deployment of customer owned dark fiber.

It is a generally accepted belief that facilities based competition is the best way of introducing competition and producing a level playing field. Currently most governments and regulators are concerned about access to existing facilities (e.g. unbundled copper, cable modem access) in terms of producing a competitive level playing field.

In addition municipalities increasingly do not want to see their roads torn up by competitive carriers who are private deploying fiber optic systems. If the public roads are being torn up so

that a small number of telecommunications can make profits, municipalities feel that they should be properly compensated, not only for the cost of the repair of the roadway, but also its intrinsic value. However, if the fiber is owned by a much wider representation of the community including businesses, schools, libraries, hospitals, etc then there is a much greater incentive by the municipality to promote its deployment at the lowest possible cost.

One of the great urban myths is that satellite and wireless technologies are equal competitors to fiber. These technologies are complementary but not competitive to fiber. There are many exciting new applications for mobile wireless and short range wireless in the last hundred meters. But it is important to note that one single strand of fiber has more bandwidth capability than all of the satellite and wireless systems combined in Canada.

Once fiber is installed into a neighbourhood or home, there is no business case left for any kind of long haul wireless solution. And therefore given the huge capital costs, the company that first installs fiber to the home will almost certainly have a significant advantage over all other competitors. The "last 100 meter wireless systems" also need fiber deep into neighbourhoods to be any where near competitive with wireline solutions. But there is unlikely to be a business case for 2 or more companies to install separate fiber systems to the home or the neighbourhood. And even if there were a business case for 2 or more fiber providers, municipalities are not going to idly standby and watch their telephone poles be turned into spaghetti trees or their streets turned into war trenches.

The other important thing to understand what cable companies and telephone companies mean when they claim they have 75-95% broadband coverage with their DSL or cable modem services. This is like putting up on mobile telephone tower in a large city and claming that the city is 100% covered for cellular telephone service. Yes that is true for the first 100 subscribers, but as more customers subscribe to the service additional cellular towers have to be constructed. The same is true for DSL and cable modem services. As more subscribed are added the telephone and cable companies have to build out fiber deeper into the neighbourhood. The same is true for wireless companies.

Cable systems on average have fiber serving every 2000-5000 homes. But they know that as the take up increases for cable modems they have to build fiber deeper and deeper into neighbourhood with an ultimate goal of fiber to every 500 homes.

If you look at the business plans for DSL providers, cable companies, and wireless companies you quickly realize they all have the same objective in the next 5 years - to deploy fiber deep into the neighbourhood to approximately every 250-500 homes. If you also look at school boards and municipalities you quickly realize that they also have pressing needs to get broadband to all schools and libraries. Coincidentally schools on average server approximately 200-500 homes.

A similar process occurred with cellular towers - many cellular companies were building towers in close proximity at key locations. Governments got fed up and insisted that cellular companies use one common tower. And now there are companies that specialize in the installation and management of cellular towers that can be used by competitive service providers.

Some municipalities and governments are realizing that the same model should be applied to municipal fiber. Because schools and hospitals already have a pressing need for broadband services forward looking governments can take a bold leap forward and significantly accelerate the next generation of broadband services by contracting with the private sector condominium fiber to every school. Fiber strands can the be purchased by a number of competing service providers to offer services in that neighbourhood. This will dramatically reduce the capital expenditures of all service providers and allow wireless as well as next generation cable and DSL services to be rapidly deployed in the neighbourhood.

Governments at all levels, but particularly municipal governments can play a critical role to insure the rapid role out of customer owned dark fiber and equitable access to all citizens. Management of municipal right of ways is a key part for the rapid deployment of customer owned dark fiber.

With a competitive market it is not practical for a multitude of carriers to build physical networks. Besides only those carriers with huge capital budgets can afford such undertakings. Because condominium dark fiber networks allow access to may competitive services providers it level the playing field and increases competition.

This does not mean that governments should own or build fiber networks. But governments can help facilitate the rapid deployment of facilities based competition through condominium fiber and other techniques. There are a number of approaches of achieving this goal:

(a) Use municipal GIS systems to identify condominium fiber facilities. This allows businesses and other organizations to identify what parts of the city are serviced by condominium fiber;
(b) Build open access conduit through out city; and
(c) Contract with private sector to build condominium fiber networks throughout the city, for which in turn the city directs its telecommunication business and provides access to city owned ducts.

22. Who manages and repairs the dark fiber in case of breaks or other problems?

In most cases management of the fiber is contracted out to a 3rd party who specialize in the repair and maintenance of fiber networks. In many cases these are the same companies who maintain and repair for the major carriers. They offer the same terms and conditions to dark fiber customers as they do for the major carriers.

In many cases the companies that installed the fiber are also the ones who maintain the fiber. These companies will also look after any on-going moves, adds and changes as well as relocating the fiber in case of road construction and so forth.

23. Isn't the big trend toward outsourcing all telecommunication and data services?

Customer owned dark fiber makes it significantly easier to out source all telecommunications and data services. In fact several systems integrator companies now specialize in arranging dark fiber for customers so that they can acquire their out souring business. With dark fiber there is no artificial bandwidth constraints so even those servers that required close proximity to the user to maintain LAN network performance can now be relocated to an out sourcing company.

However if a customer out sources all of their telecommunications and data services, it is important that maintain ownership and title to the dark fiber. The out sourcing company or service provider can manage the fiber on their behalf. But when the contract expires with the out sourcing the customer the user can easily connect to an alternate out sourcing company with a minimum of disruption. If a carrier, or out sourcing company owns the fiber, then customers will have a much more limited choice of out source companies and it may take several months to arrange to connect to a new out source company given the restrictions by many municipalities on new fiber builds.

24. How do I find out where to buy dark fiber in my area?

As the dark fiber industry is still a very immature industry can it be very difficult to find companies who are willing to install, sell or lease customer owned dark fiber. Unfortunately most fiber installation companies still think that the major carriers are the only who would be interested in their services. A lot of market education still has to occur to make these companies understand that there is significantly larger market opportunity with customer owned fiber than the traditional carrier market.

Finding and purchasing dark is usually a process of considerable research and inquiry. One good source of information is the right of way permit office in your municipality. They should have a list of all companies who applied for Municipal Access Agreements (MAAs) to deploy fiber in your area. The state PUC (Public Utility Commission) in the United States and national regulators such as the CRTC in Canada and the FCC in the United States can also be good sources for information on service providers.

Another way to find out about dark fiber is to look for fiber markers on poles in the ground. Usually the markers have telephone numbers for the maintenance company. From there you can out if they are selling dark fiber.

It is useful to find a new carrier that is about to enter your marketplace. As they have no existing infrastructure they are usually the ones most receptive to creative business deals in terms of condominium fiber. Just like condominium apartment buildings, condominium fiber can be usually purchased a lot cheaper before construction than afterwards.

25. How do I go about starting a condominium fiber network?

To build a condominium network you either have to form a consortium or find a contractor who will build a condominium network on spec. The later situation was unheard of a year ago, but is

becoming increasingly common in some jurisdictions. In fact there are now companies will build condominium fiber networks on spec including extra fibers for future growth. These companies will also make arrangements to make payments to the original condominium owners as any additional overbuild fibers are sold to other users outside or inside the consortium. Members inside the consortium usually have preferential pricing for any spare fibers.

If you decide to form a consortium it is critical that you have an anchor tenant for the fiber build. An anchor tenant is a lead organization that has the financial resources and mandate to build the fiber network for its own exclusive purposes. Other members of the consortium may participate in the condominium fiber build which will reduce the cost for all. But the anchor tenant sets the agenda, the network topology and the speed of negotiations. A good anchor tenant is a school board. School boards generally have wide geographic reach and their network topology for the fiber trunk can be used by other institutions. These other institutions would have their own dedicated strands in the fiber trunk and their own lateral. In some cases a lateral can be shared.

Once you have formed a consortium it is sometimes useful to retain the service of an independent engineering firm to complete a preliminary engineering survey. A preliminary survey will cost in the order of $10,000- $20,000. The preliminary engineering survey should give you a project estimate with 15% of the final cost. This will give you a good reference point to evaluate proposals from fiber suppliers.

At that point your consortium may want to issue a Request for Proposal (RFP) to invite potential fiber suppliers to bid on the project. Potential bidders could be companies with existing fiber or new entrants in the market. Again it is better that the anchor tenant issue the RFP rather than the consortium itself.

It is important that all respondents to the RFP have the appropriate carrier license so that they can enter into Municipal Access Agreements (MAAs) with the city and Support Structure Agreements (SSAs) with the owners of the utility poles and conduit. There are a number of fiber sub-contractors who install fiber but are not involved in negotiating MAAs or SSAs. These companies are normally not eligible to respond to a condominium fiber RFP.

Telephone and cable companies are obligated by law to allow any registered carrier to attach to their support structures provided they have entered into a SSA. The incumbent telephone and cable companies can be real sticky about attaching fiber to their support structures and will insist, as is their right in law, that only registered carriers are allowed to attach. The telephone or cable company cannot unreasonably uphold applications for SSAs and regulators have set specific guidelines on the when and how an incumbent carrier must respond to a request for a SSA. The fiber contractor will also have to have liability insurance and may be required to post performance bonds with the owners of the support structures.

When evaluating the responses the key thing to look for in addition to the bottom line is a contractor who will provide the following services:

(a) Undertake to do an overbuild and make the additional strands available in the trunk for some agreed upon amount of time at an agreed upon price;

(b) Undertake to provide individualized prices for installation and maintenance for each member of the organization in accordance with each member's network architecture and fiber count; and
(c) Enter into one on one contracts with each member of the consortium.

The RFP is in fact and umbrella document which sets out the general terms and conditions for all the members, but each member will enter into a one on one contract with the fiber contractor.

Upon award of the umbrella agreement with the fiber contractor, the fiber contractor will then carry out a detailed engineering study. In the detailed engineering study the fiber contractor has to prepare detailed engineering diagrams for every support structure, negotiate SSAs and MAAs, and negotiate with the Support Structure Owner any required upgrades or replacement of the support structures.

The detailed engineering may take 2 to 4 months depending on the size of the condominium network.

At the same time the detailed engineering is underway, the fiber contractor will order the fiber. Currently there is a severe world wide shortage of fiber and it may take several months to have the fiber delivered.

Upon acceptance of the fiber, the customer is provided with the data from an end to end Optical Time Domain Reflectometer (OTDR) test. This test will document the fiber and splice losses as well as the average attenuation of the customer's individual strands of fiber.

The fiber is terminated in a patch panel on the customer's premises. The customer can then connect to the finer with standard fiber connectors.

An example of a condominium fiber contract can be found at
http://www.canet3.net/library/papers/OttawaDarkFiberRFI.html

26. Can customer owned dark fiber be used for long haul?

Customer owned fiber can be purchased for any distance across the state or province or across the country. But after 40 or 60 km access to repeater huts are essential. The customer can then locate repeater equipment in each hut to re-amplify the signal for the next 40 to 60 km hop.

If you are using Gigabit Ethernet as your transport protocol there are a number of companies that provide Gigabit Ethernet repeaters. These repeaters can be remotely managed by anyone who maintains a LAN network. The capital equipment cost for repeaters and related equipment is about $US 200 - $US 500 per kilometre.

Many companies that provide long hail dark fiber systems will also install and maintain repeater huts and equipment on behalf of the customer.

For additional capacity Coarse Wave Division Multiplexing (CWDM) systems can be deployed on the fiber network by the customer. The current systems are usually 4 wavelength systems, but 8 and 16 wavelength systems will be available shortly. The next generation of these systems will also support the new 10Gigabit Ethernet standard which will give the customer owned fiber bandwidth capacity up to 160 Gbps - something unheard of even from the telcos a few short years ago.

The average price for a 4 channel CWDM system is in the range of $US 500 - $US 1000 per kilometre.

27. Is there any business case analysis on the benefits of dark fiber?

Yes. CANARIE and Industry Canada have contracted with an independent consultant to document the business case for a dark fiber network for a school board. This document details the significant cost savings and does a business case comparison of customer owned dark fiber versus other telecommunication technologies. You can see the business case at http://www.canarie.ca/advnet/workshop_2000/presentations/waldron.pdf

28. What about moves, adds, changes and fiber relocation services?

Moves, adds, changes are generally quite trivial and be carried out by the fiber maintenance company on a routine basis. Most moves, adds and changes only require breaking and fusing together existing fiber pairs. The work can be done on an hourly rate, or priced on a per move, add change basis. The cost, terms and conditions for moves, add, changes are usually included in your fiber maintenance agreement.

On very rare occasions fiber has to be relocated because of road construction or repair. Usually the city that had undertaken the road work will pay for the majority of the fiber relocation costs. However, if this not case, minor relocations of several hundred meters are usually included as part of the maintenance contract.

If a major relocation is required most contracts give the customer the option paying their share of the relocation expenses in portion to the number of fibers they own in the cable or cancelling the fiber ownership contract.

Although uncompensated fiber relocations are very rare, it is a factor they should be taken into account when purchasing dark fiber.

29. Is customer owned fiber the same fiber used by the carriers?

Yes. In most cases for metropolitan and long haul fiber the most common of fiber by carriers is Single Mode Fiber (SMF-28). This is usually adequate for most fiber installations. For

particular long spans or long distances speciality Non-Zero Dispersion Shifted Fibers (NZDSF) are used. But given the cost difference single mode fiber is generally the fiber of choice for most customer owned fiber installations.

All splices are performed with an industry-accepted fusion splicing machine and the customer is provided with testing documentation reflecting bi-directional losses by fiber and installed span loss by fiber.

30. What is an IRU?

An IRU is an Indefeasible Right to Use of the fiber. Most companies who offer customer owned dark fiber sell IRUs to the fiber. For regulatory reasons generally only licensed carriers are allowed access to support structures and municipal right of ways. Rather than selling title to the fiber the fiber contractors grant a 20 year IRU. In some cases IRUs of shorter or longer term available. But as opposed to a lease an IRU can be used as collateral, can sold or traded and otherwise treated like a physically owned asset.

Increasingly some fiber operators also lease the fiber for shorter time periods from 3 to 10 years.

31. What is "jet fiber"?

Jet fiber is a new technology that uses micro conduit instead of fiber. The actual fiber is not installed until requested by a customer. Instead the condominium fiber company installs the micro conduit to all required locations. When a customer wants to purchase dark fiber, the fiber is blown through the micro conduit using high pressure air.

The advantage of jet fiber is that it significantly minimizes the number of fiber splices in the fiber run. It also reduces the possibility of cross connecting the wrong fibers at splice points along the cable run.

32. What is the typical span loss for optical fiber?

As a rule of thumb for design purposed .5 db per km is the typical loss budget for SMF-28 fiber. The end-to-end loss value as measured with an industry-accepted laser source and power meter generally will an attenuation rating of less than or equal to the following: @1310nm: (0.40dB/km x km of cable) + (number of connectors x 0.50db per connector) + (0.10 x number of splices); @ 1550nm: (0.30dB/km x km of cable) + (number of connectors x 0.50) + (0.10 x number of splices).

Equipment vendors will provide you with a power budget in order to calculate the distances that you can drive the fiber.

33. What happens in case of fiber break?

Fiber breaks are very rare and typically any given span of 10 km of fiber will suffer an average of less than 5 minutes of outage due to breaks in a year.

If there is a fiber break, the maintenance company will specify an average repair interval. The repair interval for aerial fiber is usually much shorter than buried fiber. A normal fiber break outage for aerial is 4 hours and 6 hours or longer for buried fiber. However these are average repair intervals. With buried fiber, in particular, where there may be water and mud the repair time can be considerably longer.

The fiber maintenance company will splice fibers tube by tube or ribbon by ribbon or fiber bundle by fiber bundle, rotating between tubes or ribbons operated by the separate users of the Cable, including the customer, in accordance with a priority and rotation provided for in the maintenance contract. In general, priority among users of the fiber cable affected by a cut shall be determined on a rotating restoration-by-restoration and segment-by-segment basis, to provide fair and equitable restoration priority to all users of the cable, subject only to such restoration priority to which is contractually obligated by the maintenance company.

34. Won't the new wireless technologies eliminate the need for fiber?

Wireless technologies will undoubtedly play a significant role in the last mile. But the bandwidth of wireless technologies over longer distances is extremely limited compared with fiber. For example the intrinsic capacity of a single fiber strand is greater than all the bandwidth combined on existing satellite or wireless systems.

Once fiber is installed into a neighbourhood or home, wireless or satellite systems cannot compete in terms of bandwidth. On a twenty year amortization the cost of fiber can also be significantly less than most wireless systems.

Last mile wireless systems are a prefect match for municipal condominium fiber systems that extend to schools and other public systems. Municipalities that contract for condominium fiber to all public sector buildings can rapidly enable the delivery of extreme high speed wireless services.

The typical school in North America serves on average between 250 - 500 homes. This is the ideal service delivery area for low power, high bandwidth wireless systems. It is also the ideal geographic size for other last mile technologies proposed by the telephone and cable companies.

There are a number of small innovative companies that are developing LAN based wireless RF and optical solutions. These technologies can deliver up to 50 Mbps per home using very simple low cost components. But in most cases their operating range is only a few hundred meters. Fiber to the neighbourhood is essential for these technologies to be successful.

35. Don't governments have a poor track record in picking technology winners?

There is no question that governments in general have not had a good track record in picking technology winners.

But they do know today that schools, libraries, hospitals and other public sector buildings are in desperate need of bandwidth. Most schools need a minimum of 10 Mbps Internet bandwidth, many need 100 Mbps and a few even require Gigabit Ethernet capacity. This demand for increased bandwidth is only going to increase over time.

The only way to deliver this bandwidth with scalable capacity for future growth is through optical fiber.

Generally the minimum fiber cable size is 6 strands to an individual school. The cost to double the number of strands to a school will typically only increase the overall network cost by 10%. Therefore the incremental cost to build a condominium network with 10 strands available to competitive service providers is very, very small. The attendant risk for governments and municipalities to contract for open access condominium fiber is negligible.
And remember that typical payback for a school to install fiber is typically 12-18 months. So even in the extremely unlikely event that some revolutionary new technology did appear in the marketplace that obviated the need for fiber into the neighbourhood or the school, the risk to governments is extremely small. By the time that revolutionary technology became commercially available, school boards and governments would have already recovered their investment in the municipal condominium fiber project.

36. What are some of the disadvantages of dark fiber?

Customer owned dark fiber is not suitable for every organization. Fiber is not portable. If you lease or rent office space then there is a high probability that your organization will move within the next few years. Customer owned fiber makes the most sense if the organization is a fixed institution like a school, hospital, library or large business.

Fiber networks also take a long time to build. If a condominium fiber network does not already exist in your neighbourhood it can take up to 2 years to have one designed and deployed. The process to deploy fiber is very tedious and time consuming. Detailed engineering studies have to be completed, municipal access agreements negotiated, support structure agreements negotiated and so on before the actual installation of the fiber begins.

Finally customer owned fiber generally does not make sense if your data requirements are less than 1 Mbps and you have no expectation of any significant growth over the coming years.

37. What are some of the future trends with dark fiber?

Here at CANARIE we are working on a number of developments that are natural extension to customer owned fiber under a theme we call "Customer Empowered Networking".

Customer owned dark fiber is the first step in this vision. In addition to customer owned dark fiber we are working on a program that will allow customer to control and route their own wavelengths on a dark fiber network.

We see customer owned wavelengths as a natural extension to customer owned fiber. With a new proposed protocol called Optical Border Gateway Protocol (OBGP) customers can not only own wavelengths they can also route them and control them over a carrier's cloud optical domain. The customer actually owns and controls ports on a carrier's optical switch - so the customer can route the wavelength independent of the carrier.

Finally we see the ultimate step is the creation of application "grids" which are made up of customer owned dark fiber and wavelengths that interconnect with each other autonomously in support of a particular application or service. These grids can be established for specific applications like high performance computing or mundane tasks such as optical virtual private networks.

For more information please see
www.canet3.net

38. Where can I get sample documents for dark fiber RFPs, IRUs, etc?

The City of Chicago has produced a very comprehensive RFP for the deployment open access dark fiber throughout the city:

http://www.cityofchicago.org/CivicNet/civicnetRFI.pdf

A sample IRU is available on the CANARIE web site - www.canet3.net

39. Where can I get additional information on customer owned dark fiber?

A number of related articles and news items can be found under CA*net 3 news archives at:
www.canet3.net

For a good primer on optical networks see:
http://cc.uoregon.edu/cnews/summer2000/

For general technical information on optical networking:
www.light-wave.com
www.lightreading.com

For information on the Stockholm municipal fiber network:
www.stokab.se

For companies that do customer owned and condominium fiber builds in Canada and the US:

Dixon Cable
svsanders@dixoncable.com
rvigier@dixoncable.com
www.dixoncable.com

Expertech Inc
www.expertech.ca

IMS Engineering
r.proulx@muni-ims.qc.ca

Videotron Cable
gbernier@videotron.net

VDN Cable
pgale@vdn.ca

Universe2u
www.universe2u.com

Hollands Consulting
hollands@internet.look.ca

GT Telecom
rwatson@gt.ca

QuebecTel
grouss1@quebectel.qc.ca

Dessau-Sprin
Michael.famery@dessausoprin.com
www.dessausoprin.com

360networks
www.360networks.com

For information on Gigabit Etherent to the Home

World Wide Packets Inc
www.worldwidepackets.com

Vialight Inc
www.vialight.ca

CSTB
http://www4.nationalacademies.org/cpsma/cstb.nsf/44bf87db309563a0852566f2006d63bb/e320a22d8c1191e78525692600776ccb?OpenDocument

For information on carrier neutral collocation facilities

http://www.ovum.com/scripts/campaign.asp?cam=hou&red=sample/hou.htm&spc=tel&id=2264

For information on optical fiber cabling see
www.cablingsystems.com

For companies that make Gigabit Ethernet transceivers and CWDM systems for dark fiber networks:

Canoga-Perkins
http://www.canoga-perkins.com

Tsunami Optics
http://www.tsunamioptics.com

Nbase-Xyplex
http://www.fiberdriver.com/home.cfm

For information on jet fiber and micro conduit:

Nederlandse Kabel Fabrieken
www.nkf.nl

Twentse Kabel Fabrieken
www.tkf.nl

Sumitomo Electric
http://www.sel-rtp.com/

Erricson

www.erricson.se

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