Provision of Optical Fibre, Telecommunications Services Utilising Municipal Infrastructure

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The Civils Bottle-neck

Currently more than a third of the cost associated with an optical communications networks build is entrenched in the civils cost of providing an environment, normally trenching and ducting, for the laying of an optical communications cable infrastructure (Figure 1). Since civils practices for trenching and ducting is a matured technology it's difficult to decrease the cost and increase the provisioning of such projects. Furthermore, civils and construction presents an upfront cost and financing such projects can be difficult. These difficulties are further compounded in an urban environment, where disruption to traffic and basic services are normally the result of such civil works.

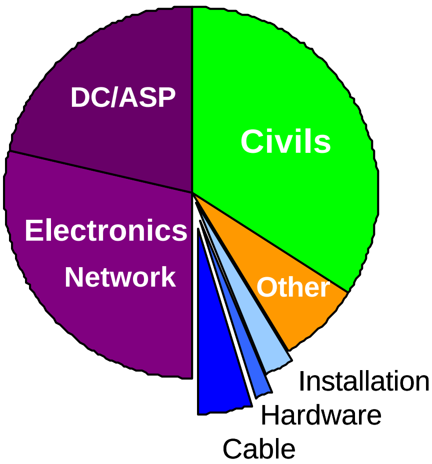

Figure 1. A typical breakdown of the cost involved in deploying an optical fibre cable network in an urban environment.

Clearly, for a network rollout unnecessary civils works, i.e. trenching must be minimised at all cost. One of the more popular ways of reducing the civils scope in an optical fibre network infrastructure rollout is the use of alternative rights of way.

Alternative Rights of Ways

One of the earliest pioneers of the implementation of an alternative right of way was in the power transport markets, where electricity transport utilities used their pylons as an alternative to trenching. By using aerial cables, such as all-dielectric self supporting (ADSS) cables and composite optical groundwire (OPGW) cables, these utilities were able to roll-out optical communication infrastructures at a significantly lower cost compared to the traditional deployment through trenching.

Today, more utilities, such as gas, water and transport, are exploiting their own service infrastructures as an alternative right of way for the provisioning of optical communications networks. By exploiting these shared service infrastructures utilities have the added benefit over providing their communications needs, of having a second source of income through the leasing of communication services or infrastructure to the local incumbent telecommunications provider as well as any competitive telecommunications providers.

Using existing conduits (such as sewer, water or gas pipes) for multiple uses is not a new concept. Early attempts were in Paris more than 100 years ago but poor results led to the abandonment of the concept of installing multiple utilities in the same underground tunnels. The first invention for using existing sewers for installing communications cables was developed by a group of engineers from the Water Research Centre in the UK, in 1984. This invention was further refined by the development of the Nippon Hume robot, in Japan, and led to the installation of more than 990km of optical fibre cables in the Tokyo Metro sewer system.

There are at least 5 robot companies, for the installation of optical fibre in existing fluid conduits for additional functions not originally intended; CableRunner, DTI-CableCat, Ka-te, Nippon Hume and Robotic Cabling GmbH Kabelverlegung. In figure 2 an example of the BerliKomm robot is shown, as well as the attachment of the optical fibre cable to the roof of a sewer.

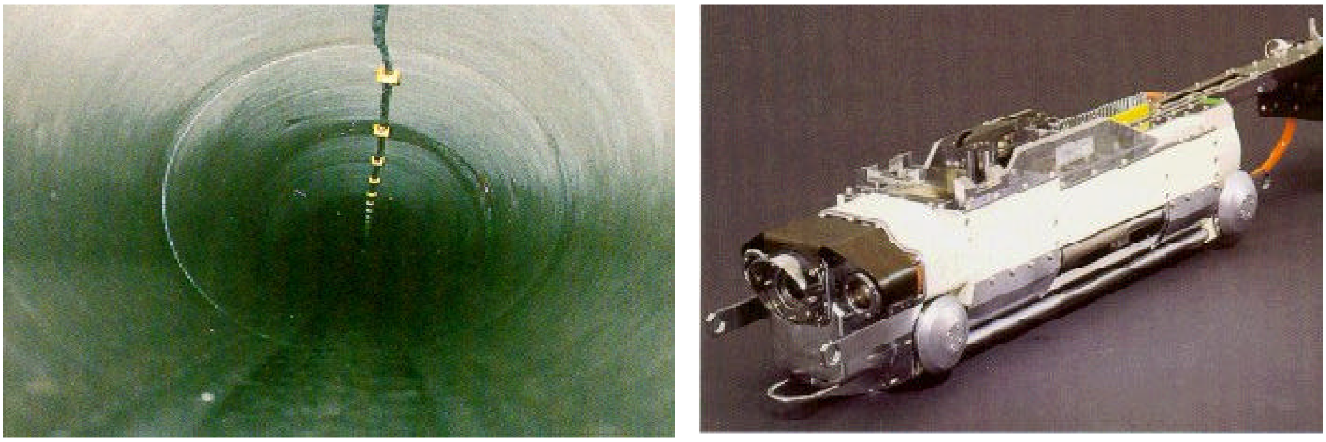

Figure 2. An example of the BerliKomm installation robot and an example of an optical fibre cable installed in Toronto.

Sempra Fiber Links, Alcatel and Gastec are some of the companies that offer new technologies for installing optical fibre cables in natural gas pipes. In Sempra's technology, special fittings are attached after tapping the gas main at two locations to form the entry and exit points for the optical fibre. The gas mains could be even as small as 25 mm in size and the fibre conduit will take up no more than 10% of the gas flow area. In the event a particular gas line can not handle even a 10% reduction in capacity, additional pipe capacity can be added. A small HDPE conduit is threaded through the entrance fitting until it reaches the exit fitting. A special tool is used to grab hold of the threaded conduit by which it can be pulled out through the exit fitting. Once this housing conduit is in place in the gas main, the optical fibre cable is pushed through this conduit from one fitting to the next.

In the Alcatel system, a balloon device is used to pull a specially designed optical fibre cable through the inlet port clear through the outlet using a gas pressure differential. The cable itself has a special metallic barrier, to prevent hydrogen gas migration. Again, the seals and the ports are designed to meet various safety regulations. Gastec offers a solution where a specifically designed shuttle pulls a cord from the inlet attached to the gas main all the way to the exit port using a gas pressure differential. This is done by creating an overpressure of about 150 mbar at the inlet side while a negative pressure is created by flaring off gas through the venting safety valve at the outlet side. If for some reason, the shuttle gets stuck, the exact position will be known to the engineers from the transmitter signal built into the shuttle.

An added benefit of optical fibre in gas deployment is that an extra pair of fibre can be used as a leak detection system by collecting spatial resolution data. When an engineer applies Raman's law and the Joule-

Thompson effect, the exact point along the pipe alignment where a leak appears can be detected within a short response time to take appropriate remedial action.

Corning Cable Systems (CCS) offers two distinct solutions. The first solution is the S.L.I.M. cable technology where a robot attached and optical fibre cable to the roof of a sewer. This installation method is similar to the previously discussed methods, and a schematic of the installation process is shown in figure 3. CCS has further refined this process and up to four optical fibre cables can be installed in a particular sewer run. The second solution offered by CCS is the MCS drain technology, which offers a installation method whereby the integrity of the sewer duct system remains intact as the cable is not attached to the sewer wall. In this case the cable is tensioned between two manholes over guiding pulleys attached to the wall of the manhole, as shown in figure 4.

The other advantage of the MCS installation technique is that no additional equipment is needed. The cable is carried between each manhole by a normal sewer cleaning head provided that the manholes are not spaced to far apart. This technique is ideal for sewer diameters in the 250 to 500 mm ID range and has been deployed in sewers down to 160 mm ID. Using the MCS drain technology it is possible to install more than 1000 m of optical fibre a day.

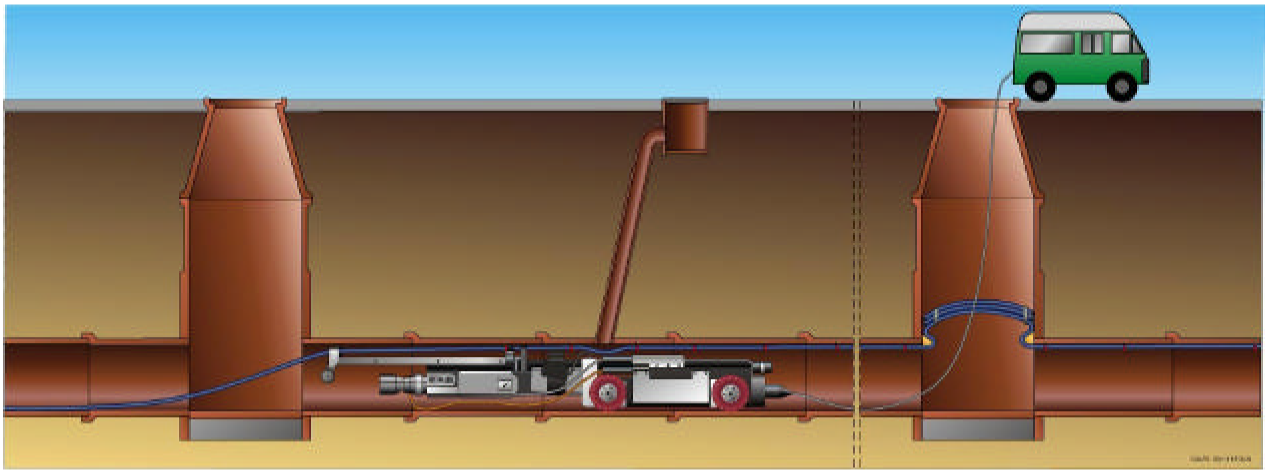

Figure 3. Corning Cable System's S.L.I.M. sewer solution uses a robot to attach the optical fibre cable to the roof of the sewer. With the S.L.I.M. technique the robot is controlled remotely above ground and it is possible to install multiple cables in a particular sewer run.

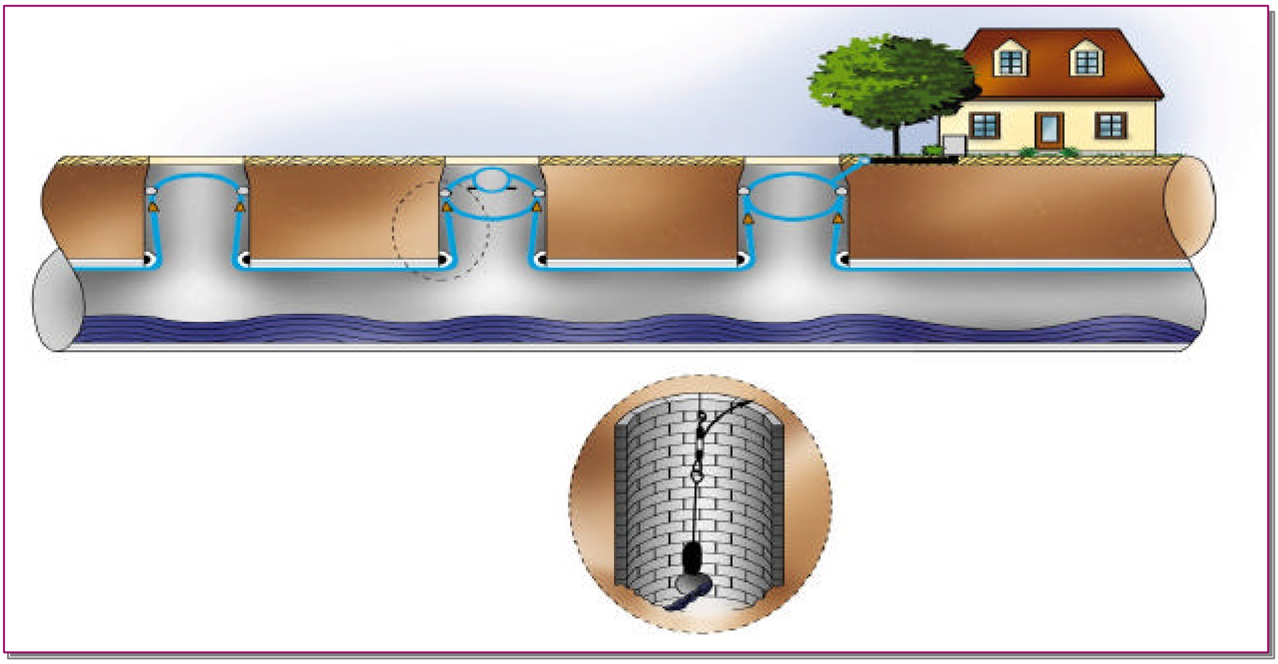

Figure 4. The MCS Drain solution from Corning Cable Systems negates the need for drilling into the sewer wall, as the cable is tensioned between two manholes over guide pulleys which are attached into the manhole wall. Using this installation technique, the possibility of contaminating the groundwater is negated as the integrity of the sewer or drain walling remains intact.

Possible Business Plans for Optical Fibre Cable in Shared Fluid Conduits

- The optical fibre infrastructure builder will either purchase or lease existing retired pipelines that are no longer in used in active service in exchange for either an upfront payment or an annuity type payment to the owner of this strategic asset. Pacific Gas and Electric, Key Span Energy, Con Edison, Atlanta Gas, Peco Energy, are all examples of this business model.
- The optical fibre infrastructure builder will make the pipe owner a business partner. In this case reserve capacity in the existing pipe network could be used by the optical fibre infrastructure builder for installing last mile optical fibre in exchange for a negotiated percentage of the gross revenue. Cities of Albuquerque and Indianapolis are examples.
- The owner of the existing pipe network will take on network providers, content providers and vendors as partners to install optical fibre in their pipe network and operate this network. Other than a few optical fibres needed by the pipe network for self regulatory communications, the rest would be leased to any number of the above mentioned partners for additional revenue. In this instance the majority of the cost for rolling out the optical fibre network is borne by the pipe network owner. The City of Berlin uses this business model.
- The pipe network owner can further build and manage its own optical fibre network through its existing pipe network infrastructure. Cities of Tokyo, Hamburg, Vienna, Boston, New York and Los Angeles are examples of this.

Concluding Remarks

The development of optical fibre cables in existing piplines offers a win-win situation for all parties involved if proper standard of care is afforded. However, working in sewers and natural gas pipelines requires sound pipline engineering input and anything less than that would be shortsighted.

For telecommunications carriers and service providers, these solutions represent a true end-to-end last mile optical fibre network which they could control. For the sewer, water or natural gas pipe infrastructure owners this technology enables an unique and powerful economic development tool, providing added revenue from an existing infrastructure.

We at Aberdare Fibre Optic Cables will be more than willing to assist you in any further information you may require. The information provided only highlights the different ways in which an optical fibre cable network can be alternatively deployed in a fluid conduit system or a pipline network. At Aberdare Fibre Optic Cables, we have looked at developing optical fibre cables to with stand these unique environments as well as improving the economics of such an alternative rollout.